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LARGE HISTORICAL EARTHQUAKES IN SWITZERLAND

Multidisciplinary Studies on Damage Fields and Site-Effects

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Presented by

Stefan Fritsche

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Born February 18, 1970

Citizen of Appenzell (AI)

accepted on the recommendation of

Prof. Dr. Domenico Giardini, examiner

Prof. Dr. David Gugerli, co-examiner

Dr. Donat Fäh, co-examiner

Prof. Dr. Massimiliano Stucchi, co-examiner

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Summary

Experience with numerous earthquake disasters has shown that site-effects strongly contribute to local building damage and can raise the number of victims dramatically. Site-effects occur preferably on locations characterized by voluminous but poorly consolidated deposits. For Switzerland, such sites are common in large alpine valleys like the Rhone or the upper Rhein Valley, but exist also in several regions of the Alpine foothills and the Swiss midland. The study at hand demonstrates by means of three historical earthquakes that their damage fields showed the influence of site-effects. Two of these events occurred in the Valais Canton: the 1855 earthquake of Visp as well as the 1946 event of the upper middle Valais region head the list of strongest quakes in Switzerland for the last 300 years. The third examined event took place in Central Switzerland in 1964. Its long lasting series concerned the population of the Obwalden Canton for months. This quake represents the last significantly damaging one for Switzerland.

Although earthquake hazard is only moderate in Switzerland compared with other regions of the world – if the southwestern part is omitted, it is even low – Switzerland faces considerable seismic risk. Primarily, this is due to a high level of industrialization and urbanization. Driven by a constant population growth and a permanent building boom, this risk has increased continuously over the last decades. This applies notably for regions that had not been accessible for settlement and industrial purpose before the regulation of Swiss hydrography. However, precisely these areas achieve the conditions for site-effects. While the events in the Valais Canton took place before this development process began, the earthquake series of Central Switzerland coincides with the beginning of the boom.

All three case studies are based on a similar multidisciplinary approach. A first step addresses the reconstruction and assessment of building damage as well as the mapping of relevant secondary effects. The latter include triggered mass movements like rockfalls, landslides and avalanches as well as effects on springs and terrain changes. This part of the investigation rests mainly upon research into a large variety of historical documents. In a second step, the investigation spotlights the subsoil characteristics of locations for which loss has been verified. In this context, we applied several seismological methods supplemented by geological and geotechnical considerations. Of most importance regarding the seismological research were experiments that allow estimating the fundamental frequency of the ground. This is of relevance since sediments tend to amplify seismic waves in a frequency band near their resonance frequency. Such amplification effects can increase the forces on construction

significantly. This applies especially when the resonance frequency of the ground correlates with that of buildings at the same location, leading to resonance phenomena. Finally, we merge and interpret the results of the previous steps.

From a large number of historical documents, we reconstructed and rated the damage fields adequately. Most notably, this finding held for the events of 1855 and 1964. We discovered for both quakes good contemporary damage assessments. In combination with results from the seismo-geological investigation, we could demonstrate that the damage fields of all three events were influenced by site-effects. This finding is strongest for the 1946 earthquake at two locations in Sierre. Both showed large damage which is strongly correlated to ground conditions. Similarly, we identified locations regarding the 1855 event that were influenced by site-effects, especially for St. Niklaus and Naters. In contrast, we show that the heavy damage observed for Visp is probably not due to the ground. Less distinctly we verified site-effects regarding the 1964 damage field. Its complex geological situation combined with comparatively low intensity made it difficult to quantify the influence of the ground exactly. Despite this constraint, we conclude that site-effects will play an important role in any future earthquake in the investigated regions.

Zusammenfassung

Die Erfahrung aus der wissenschaftlichen Nachbearbeitung zahlreicher Erdbebenkatastrophen hat gelehrt, dass Standorteffekte das lokale Ausmass von Schäden an Gebäuden und damit die Opferzahlen negativ beeinflussen können. Standorteffekte treten vornehmlich dort auf, wo mächtige, locker gelagerte Sedimente anzutreffen sind. Im Kontext der Schweiz finden sich derartige Ablagerungen vor allem in den grossen inneralpinen Tälern wie dem Rhone- und Rheintal, aber auch in verschiedenen Regionen der Voralpen und im Mittelland. Die vorliegende Studie zeigt anhand von drei historischen Erdbeben, dass die dabei entstandenen Sachschäden Einflüsse von Standorteffekten aufwiesen. Zwei der untersuchten Erdbeben ereigneten sich im Kanton Wallis. Sowohl das Ereignis von 1855 in der Region Visp als auch das von 1946 im Mittelwallis gehören zu den stärksten Erdbeben, die das Gebiet der heutigen Schweiz in den letzten 300 Jahren erschüttert haben. Beim dritten untersuchten Ereignis handelt sich um die Erdbebenserie von 1964, welche den Kanton Obwalden über Monate hinweg im Bann hielt. Es ist das letzte grössere Schadensereignis, welches die Schweiz aufgrund seismischer Aktivität erfuhr.

Obwohl die Erdbebengefährdung in der Schweiz verglichen mit anderen Regionen nicht besonders hoch ist, ja sogar als relativ gering eingestuft wird, wenn das südwestliche Gebiet ausser Acht gelassen wird, ist das Erdbebenrisiko beträchtlich. Der Grund dafür liegt im hohen Industrialisierungsgrad und der damit einhergehenden ausgeprägten Siedlungs- und Bevölkerungsdichte. Angetrieben durch anhaltendes Bevölkerungswachstum und andauernde Bautätigkeit stieg dieses Risiko über die letzten Jahrzehnte hinweg kontinuierlich an. In besonderem Masse gilt dies für Regionen, in denen diese Entwicklung in Gebiete vorstiess, die erst im Zuge der grossen Flusskorrektionen solchem Nutzen zugeführt werden konnten. Denn genau diese Gebiete erfüllen die notwendigen Bedingungen für das Auftreten von Standorteffekte meist ausserordentlich gut. Alle drei hier behandelten Erdbeben ereigneten sich in Regionen, die typisch sind, für diese Entwicklung. Während sich die Walliser Beben vor diesem rasanten Entwicklungsprozess ereigneten, erfolgte die Obwaldner Erdbebenserie in dessen Anfangsphase.

Alle drei Fallstudien basieren auf derselben interdisziplinär ausgerichteten Herangehensweise. Ein erster Schritt befasst sich mit der Rekonstruktion und Bewertung der entstandenen Sachschäden an Gebäuden und mit der Kartierung von erschütterungsbedingten Naturphänomenen. Zu den letzteren werden Massenbewegungen wie Steinschlag, Erdrutsche und Lawinen, aber auch Quellphänomene und Terrainveränderungen gezählt. Dieser Teil der

Arbeit ist geschichtswissenschaftlich ausgelegt und präsentiert Resultate, die in erster Linie auf der Analyse von historischen Dokumenten beruhen. Ein zweiter Schritt befasst sich mit der Untersuchung der Bodeneigenschaften für die Gebiete mit nachgewiesenen Gebäudeschäden. Hierbei gelangten verschiedene seismologische Methoden zum Einsatz, flossen aber auch geologische und geotechnische Überlegungen ein. Im Zentrum stehen Experimente, die darauf abzielen, die Eigenfrequenz des lokalen Untergrundes abzuschätzen. Dies ist deshalb von Bedeutung, weil Sedimente dazu neigen, seismische Wellen im Frequenzbereich der Eigenfrequenz zu verstärken und damit die Belastung für Tragwerke und Konstruktionen erhöht wird. Dies gilt insbesondere für den Fall, dass die Eigenfrequenz des Untergrundes mit denjenigen der darauf errichteten Gebäude korreliert, was zu problematischen Resonanzeffekten führen kann. In einem Syntheseschritt werden die Resultate der ersten beiden Schritte zusammengeführt, interpretiert und dargestellt.

Basierend auf einer Vielzahl von historischen Dokumenten ist es gelungen, die Schadensgebiete genau zu rekonstruieren und zu bewerten. Dies gilt im Besonderem für die Ereignisse von 1855 und 1964, für welche die Arbeit in den betreffenden Archiven zeitgenössische Schadenserhebungen zutage förderte. In Kombination mit den seismogeologischen Untersuchungen und Messungen lassen sich Standorteffekte für Lokalitäten in allen der drei untersuchten Schadensgebiete nachweisen. Am deutlichsten treten diese mit dem Ereignis von 1946 zu Tage. In Sierre wiesen zwei Quartiere besonders starke Schäden auf, die klar mit den Eigenschaften des lokalen Untergrundes in Verbindung gebracht werden müssen. Auch für das 1855er Beben lassen sich Örtlichkeiten ausmachen, deren Schäden im Zusammenhang mit Standorteffekten gesehen werden müssen. Während für das schwer in Mitleidenschaft gezogene Visp ein starker Einfluss von Standorteffekten eher ausgeschlossen wird, zeigen die Gemeinden St. Niklaus und Naters Indikatoren, die klar auf solche hindeuten. Etwas weniger prägnant lassen sich Standorteffekte für das 1964er Ereignis nachweisen. Allerdings erschwert die komplexe geologische Situation der Region und die geringe Intensität der Erdbeben eine Quantifizierung des Einflusses. Trotz dieser Einschränkung lässt sich folgern, dass Standorteffekte für alle drei untersuchten Regionen im Falle zukünftiger Erdbebenereignisse, ein nicht zu unterschätzender Faktor darstellen dürften.

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1 Introduction

1.1 Overview

Earthquakes that cause significant damage occur infrequently in today's Switzerland. Compared with other natural disasters such as flooding, storms ore avalanche catastrophes, they are rare. However, every generation of traceable time has experienced at least one earthquake that caused slight to moderate damage and generated considerable costs. In contrast to other natural disasters, earthquakes have remained a threat underestimated and perceived as uncontrollable. Prevention efforts have taken place implicitly or explicitly for many kinds of natural disasters, but not for earthquakes. Buildings and other construction have been subjected to a design process to resist extreme weather conditions. Since the 18th century, enormous projects have been undertaken to regulate the hydrography of Switzerland to prevent infrastructure and agricultural land from flooding. In addition, hundreds of kilometers of barriers have been installed to prevent avalanches from killing people, destroying buildings and intersecting communication lines. A conglomerate of the scientific community, governmental authorities and later on the insurance industries have only hesitantly become aware of the large risk from earthquakes. A first comprehensive step in loss prevention took place in the course of building a nuclear power industry and led to the first nationwide intensity based hazard map, published in 1977 by the Swiss Seismological Service (Schweizerischer Erdbebendienst, 1977). Further maps of this kind were published in 1981 (Schweizerische Geologische Kommission), 1998 (Geoforschungszentrum Potsdam et al.) and 2004 (Swiss Seismological Service, 2004; Giardini et al., 2004). The latter was the first to rest upon expected ground-motion in units of the 5% damped acceleration response spectrum at frequencies of 0.5–10 Hz. Hazard maps rely on models for which historic seismic activity represents the central input data. This is where history enters seismological research. A complete, and if possible long, time series of well localized and assessed events is essential for reliably assessing hazard. Based on such analysis, the Swiss Association of Engineers and Architects (Schweizerischer Ingenieur und Architekten Verein, SIA) created building codes containing recommendations for earthquake resistant designs. A first code (SIA 160) was published in 1970. In retrospect, it proved insufficient. A revised version of this code (1989) later provided appropriate advice for the first time (BWG, 2002). In 2003, it was replaced by the Swisscodes (SIA 260-267), which again increased design standards. However, these codes are not obligatory with some exceptions; they remain at least for the near future

recommendations. The exceptions pertain to buildings and construction in possession of the Swiss Confederation and in Valais and Basel Cantons. While the former group includes retrofitting for construction at risk, the code for the two cantons concerns only new buildings on private and public property as well as the reinforcement of existent lifelines.

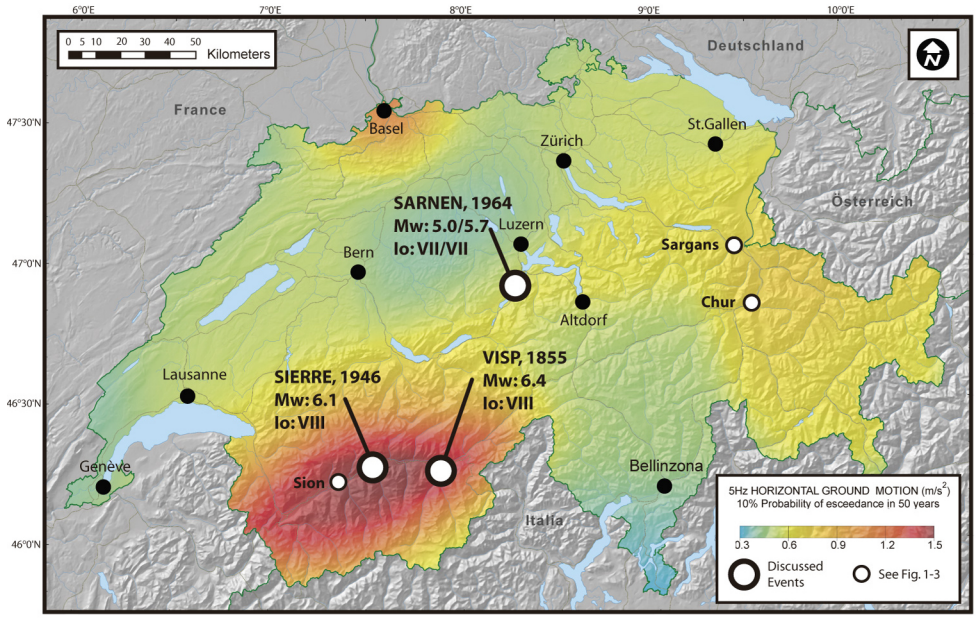


Figure 1.1: Seismic hazard map of Switzerland, depicting the level of horizontal ground-motion in cm/s2 (in units of 5% damped acceleration response spectrum at 5 Hz frequency) expected to be reached or exceeded over 475 years, what corresponds to a 10% exceedance chance in 50 year (Swiss Seismological Service, 2004). The figure includes location and key data with respect to the discussed events within this study.

Of increasing importance during the last fifteen years are attempts to incorporate the possible effects of local ground conditions into preventive measures. Recently, the 1985 Michoacan earthquake in Mexico (MS = 8.1) showed how impressively strong the influence of ground material can be. Although the epicenter was about 350 kilometers away, the earthquake caused the most severe damage in Mexico City. Where the ground consisted of soft lake sediments that behave unfavorably in earthquakes, the ground shaking resulted in disaster. After the work of Anderson et al. (1986) on the Michoacan earthquake, site-effects have become a central issue in seismology. Numerous theoretical and empirical studies have been carried out since then. Where empirical data about earthquake related damage due to ground conditions are absent in the present or the near past, as is the case for Switzerland, a priori estimation of site-effects became an attractive alternative for efficient mitigation of seismic risk. Thus, microzonation studies as well as theoretical investigations to develop reliable methods for assessing potential site-effects have been carried out in Switzerland within several projects (SESAME, SISMOVALP, SHAKE-VAL, INTERREG).

Microzonation work supports loss estimations studies and prevention programs. The most comprehensive research of this kind has focused on the city of Basel (Fäh and Huggenberger, 2006; 2001b; Noack et al., 2000; Fäh et al., 1997). In 1356 the city experienced one of the strongest earthquakes in NW-Europe (Io=9, Mw=6.9; Swiss Seismological Service, 2002) and a considerable number of other strong events. Although seismic activity in the Basel region currently is low, the relatively high hazard (See Fig. 1.1) implies that future strong earthquakes cannot be excluded. Further microzonation studies have been carried out for sites in the Cantons of Obwalden, Nidwalden, Solothurn, St. Gallen (Beer, 1997), parts of the Valais Canton (CREALP, 2006; 2004) and the city of Yverdon (Widmer et al., 2003). The mentioned theoretical projects on the other hand (partly) focus(ed) on improving techniques based on ambient vibration recordings like the simple H/V method introduced in Japan by Nogoshi and Igarashi in 1971 (in the western world known only through Nakamura's publication of 1989) and the more advanced array techniques (eg. Bard et al., 2004). Both these techniques incorporate many advantages of cost and practicability compared with conventional methods. They are inherent to current investigation of site-effects.

This work presents results on damage fields and site-effects for large historical earthquakes in Switzerland. Based on comprehensive historical studies, the reconstruction of damage fields of past earthquakes shaped the data stock for continuing investigations. In the course of this reconstruction, not only damaged buildings and construction were of interest, but also all kinds of macroseismic observations and secondary effects. We then investigated this database with respect to influences of site-effects. Most important, this study is a contribution to earthquake mitigation. An earthquake that occurred once in a particular region with a certain intensity marks the lower limit of what has to be expected to recur at an unknown time in the future. Thus, it is of eminent value to know what consequences historical earthquakes have generated, not only for scientific purposes, but also as well-grounded information to sensitize public and authorities. Particularly in regions with moderate seismicity and relatively long recurring periods for damaging earthquakes, as is the case for Switzerland, it is not easy to keep public discussion going. Accordingly, the risk related to earthquakes has never reached an appropriate importance for the Swiss public. On a subordinate level, our work rests at the intersection between the fields discussed above. It generates enhanced data for prospective hazard analysis, includes elements of microzonation projects, and presents an empirical test field for ambient vibration techniques.

For Switzerland, twelve known earthquakes have caused severe damage with intensities of Io $\geq$ VIII over the last 700 years (Swiss Seismological Service, 2002). Two of them and one intensity VII event are subjects of this study:

- The 1855 earthquake in the upper Valais region, Mw = 6.4, Io = VIII
- The 1946 earthquake in the middle Valais region, Mw = 6.1, Io = VIII
- The 1964 earthquake series in central Switzerland, Mw = 5.7, Io = VII

Each of these events has been investigated within a separate case study. The leading questions for all of them are the following:

- What damage occurred in the course of these earthquakes? What were its characteristics and distribution?
- Is this observed damage related to site-effects?

The study complements detailed historical earthquake investigations at the SED that among others focused the events of 1356 (Fäh et al., 2008b), 1295 (Schwarz-Zanetti, 2004; 2006a), 1601 (Schwarz-Zanetti et al., 2006b, 2003), 1720 (Gisler et al., 2004a) and 1755 (Gisler et al., 2004c).

1.2 Definition of Terms

1.2.1 Seismic Hazard vs. Seismic Risk

The first step in evaluating seismic risk is assessing seismic hazard, defined by the probability of strong ground motion at a given level over a given region. In a wider sense hazard also includes strong motion related phenomena such as fault rupture, triggered landslides and soil liquefaction (Reiter, 1990). The effective seismic hazard remains constant over long periods. However, it is revised from time to time to incorporate new data and improved methods, allowing an ongoing process of approximation to the real hazard.

Seismic risk, on the other hand, is defined by the seismic hazard for a given region multiplied by the values at risk and their vulnerability.

Seismic Risk = Seismic Hazard x Value x Vulnerability

While Switzerland in general shows moderate seismic hazard, the seismic risk is comparably high because Switzerland became a highly developed and densely populated country in the 20th century. Since this development continues beyond protective measures, our seismic risk is increasing. This is a common phenomenon in many countries comparable to Switzerland. In developing or underdeveloped world, the situation is often much worse.

1.2.2 Macroseismic

In contrast to objective instrumental observation, macroseismic observation is done by human beings. Unlike seismic instruments that measure the ground motion itself, macroseismology is sensitive to the effects of earthquakes on *living things* (people and animals), *ordinary objects* (crockery, furniture, etc), b*uildings* (houses, constructions of every type*)* and *the natural environment* such as cracks in the ground or rock falls (Grünthal, 1998). It has been used longer than seismic instruments and incorporates important advantages. On the one hand, its measure or degree of intensity is always directly related to the consequences faced by the population of a certain region. In other words, while a magnitude of 6.4 says nothing about the damage in a given location, an intensity of grade VIII contains information on the degree of loss. A further benefit of the method is that it is independent of technical assets and thus practical for technically undeveloped regions. Finally yet importantly, the interpretive tools provided by the macroseismic method are essential for historical research on earthquakes.

Several macroseismic scales have been in use over the last 130 years. The first of them was the so-called Rossi-Forel scale introduced in 1873. Giuseppe Mercalli (1850-1914) presented in 1883 a new scale based on that (Mercalli-scale). Most of its successors were/are modified forms of this scale: The Mercalli-Cancani-Sieberg Scale (MCS), the Modified Mercalli scale (MM-31 and MM-56), the Mercalli-Wood-Neumann scale ore the Medvedev-Sponheur-Karnik scale (MSK 1964). In most European countries now, the European Macroseismic Scale 98 (Grünthal, 1998) is in use.

1.2.3 Historical Seismology

Historical seismology in its present form has existed in Swiss research for about four decades. It debuted during work on the first hazard maps, where earthquake catalogues provided the basic data. For Switzerland, this entry is strongly related to the work of Mayer-Rosa and Sägesser. They set up the first systematic earthquake catalogue for Switzerland containing macroseismic data for traceable time (Sägesser and Mayer-Rosa, 1978). ECOS, the Swiss Earthquake Catalogue (Swiss Seismological Service, 2002) in use today at the SED is a revised and extended form of that catalogue. Some modifications date back to the work of Rüttener (1995) and major revisions took place in the years from 1999 to 2002. (See http://www.seismo.ethz.ch/ for the catalogue, and for further information Fäh et al., 2003a and Gisler, 2003). Extensions of the historical catalogue involved integrating the Swiss instrumental catalogue (IECOS), containing data since 1974, and incorporating significant information from 12 earthquake catalogues of neighboring countries and international agencies. Figure 1.2 illustrates the earthquakes for Switzerland and its border regions with Mw $\geq$ 2.5 since 1300.

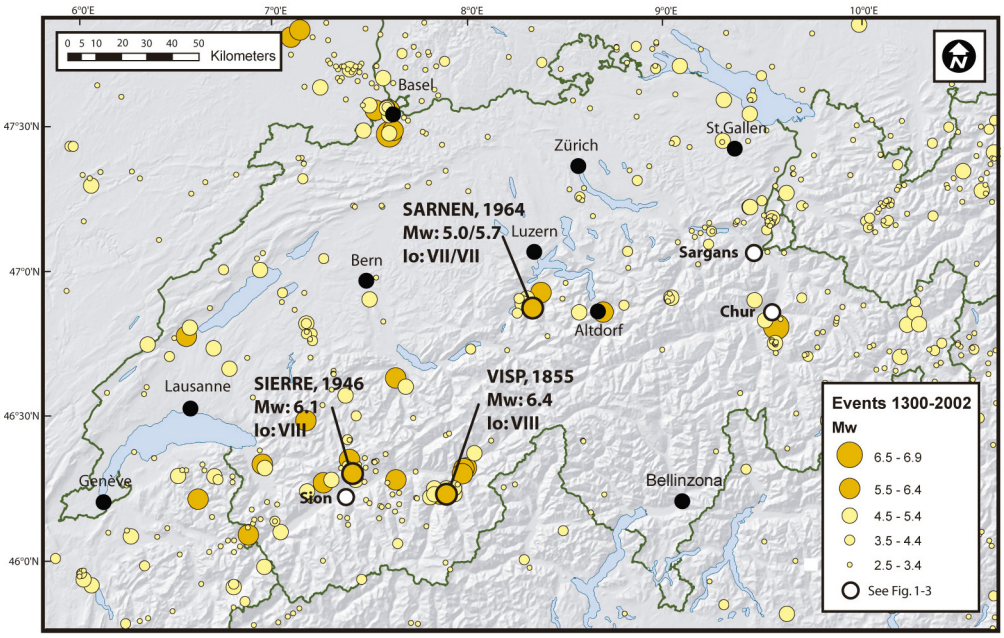


Figure 1.2: Epicenter map of earthquakes in Switzerland since 1300, with Mw $\geq$ 2.5 (Swiss Seismological Service, 2002; Giardini et al., 2004).

The source material used to investigate earthquakes before the modern instrumental period of the SED (before 1974) is manifold. For the years 1911 to 1974, recordings from a limited number of seismic instruments exist. These data are amended by the yearly bulletin of the Swiss Earthquake Commission founded in 1878 and containing macroseismic

information. For earthquakes that occurred earlier, the data rely on an array of sources: earthquake compilations, chronicles, yearbooks, newspaper articles and diaries. Most notably are the works and writings of scientists that became interested in earthquake phenomena at the beginning of modern times. For the region of today's Switzerland, the works of Johann Jakob Scheuchzer (1672-1733) Elie Bertrand (1713-1797) and G.H. Otto Volger (1822-1897) are of specific interest. According to Gisler (2007), the beginning of earthquake research in Switzerland is strongly related to Scheuchzer. Investigating all kinds of natural phenomena, he became interested in seismic events around 1700 with an earthquake series in Glarus Canton. His work is important for assembling earthquake data and in developing earthquake theories (Scheuchzer, 1701; 1706). Bertrand's seismic curiosity began with the famous 1755 event in Lisbon and the Valais event that same year. He is known as the first Swiss scientist to not only collect earthquake data but also categorize and classify events (Bertrand, 1756; 1766). Volger entered our study due to his important work on the 1855 earthquake (Volger, 1856). Furthermore, Volger finished a large earthquake compilation for Switzerland, including a broad database of contemporary sources, reports and observations. He also left elaborate theoretical considerations (Volger, 1857)

During the catalogue revision from 1999 until 2002, particular attention was paid to earthquake parameters, relying directly on historical sources and the compilation of these authors. They were critically reviewed using methods of historical science and compared to other sources referring to the same events. The revision ended in significant modifications to the rating of several earthquakes (see e.g. Gisler et al., 2004a). Furthermore, many events proved to be misunderstandings or duplications. Other earthquakes entered the catalogue due to writing errors of previous authors. They could be deleted from ECOS.

1.2.4 Site-Effects

Site-effects became an important topic within seismology during the nineteen nineties. The phenomenon observed in the 1985 Michoacan earthquake in Mexico was also considered for others like the 1906 San Francisco earthquake and those in Spitak, Armenia (1988), Loma Prieta (1989), Iran (1990), Philippines (1990), Northridge (1994), Kobe (1995), Armenia, Columbia (1999), Turkey (1999), and Bam (2003). All of them contributed additional evidence to the importance of site-effects (Bard et al., 2004). The term 'site-effects' incorporates a multitude of phenomena related to ground shaking. Common to all of them is a

direct relation to the ground conditions of the local site. They can increase damage significantly.

A general distinction can be made between linear and nonlinear effects. Linear effects occur within the theory of elasticity while nonlinear effects do not. In the context of this study, *soil amplification effects* as well as nonlinear effects like *liquefaction* and *masse movements* were frequent phenomena. (Masse movement itself is not defined as a site effect. But the triggering mechanism of a masse movement can be so named.)

Of most importance is the phenomenon of amplification on soft soil sites, since settlements are often built on this ground type. Numerous methods have been developed to evaluate amplification effects during strong earthquakes. In areas of low to moderate seismicity, no strong motion recordings are available and site effect studies must rely on weak motion records and numerical modeling. Numerical modeling requires good knowledge of the geophysical structure, and needs cheap and fast methods to measure important physical parameters. Ambient vibration techniques have therefore become very important: they provide information on the fundamental frequency of the geological structure and estimates of S-wave-velocities as a function of depth. The fundamental frequency of resonance (f_0) can be measured with micro-tremors. These are ambient ground vibrations excited by natural or artificial disturbances such as wind, sea waves, traffic, and industry. They can be recorded using high sensitivity seismometers.

Depending on the complexity of the technique used and on the ground conditions at the investigated site, amplification effect are studied as 1-, 2- or 3-dimensional cases. In the 1-dimensional (1-D) case (horizontally layered structure), amplification results from interference of body waves traveling up and down. In the 2-D or 3-D case where lateral heterogeneities such as thickness variations are present, surface waves emerging on these heterogeneities are affected as well and travel back and forth. In the 1-D case resonance patterns are quite simple, but become increasingly complex for 2-D and 3-D cases. A method to estimate directly potential effects of this kind does not exist. A deeper understanding needs numerical modeling, as has been done for several sites (Oprsal et al., 2004; 2005,). With respect to the Valais region, Roten et al. (2007; 2006) showed that amplification effects in the 2-D and 3-D domain play an important role during an earthquake.

In this study, we used the H/V single station technique assuming horizontal layers of deposits. It was proposed first by Nogoshi and Igarashi (1971) and Nakamura (1989) and has proven convenient for estimating the fundamental frequency of soft deposits (e.g. Field and Jacob, 1993; Lachet and Bard, 1994; Lermo and Chavez-Garcia, 1994). The spectral ratio

between the recordings on the horizontal and vertical components exhibits a large peak at the fundamental frequency of resonance (f_0), as long as the S-wave velocity contrast between the sediments and bedrock is large. The results are clear and simple for horizontally layered structures with large impedance contrasts. This method was validated during the European SESAME project (http://sesame-fp5.obs.ujf-grenoble.fr). However, the seismic noise wave field is complex. When interpreting the H/V ratio, one has to consider possible contributions to it from both surface and body waves, including higher modes of surface waves. The amplitude of the H/V spectral ratio at the fundamental frequency (f_0) indicates the S-wave velocity contrast between bedrock and sediments, and provides information on the severity of possible resonance effects during earthquakes. The higher the amplitudes, the larger the velocity contrast will be. However, the amplitude of the H/V ratio depends not only on the velocity contrast but also on the source-depth and source-distance distributions. Therefore, amplitudes of the H/V ratio indicate only qualitatively the possible resonance effects.

For sites of complex geometrical conditions, we used the advanced array technique in collaboration with other projects. Array measurements of ambient vibrations tend to measure phase velocities of surface waves through analysis of spatial correlation (Aki, 1957) or high-resolution, beam-forming analysis (Capon, 1969). Then P- and S-wave velocity profiles can be derived by inversion. Several studies (e.g. Horike, 1985; Malagnini et al, 1993; among many authors) have illustrated how such array measurements can obtain velocity profiles. During the European project SESAME (e.g. Bard et al., 2004), the team developed a tool for using and comparing different array techniques (Ohrnberger et al., 2004; Wathelet, 2005). They also created strategies for successful measurement.

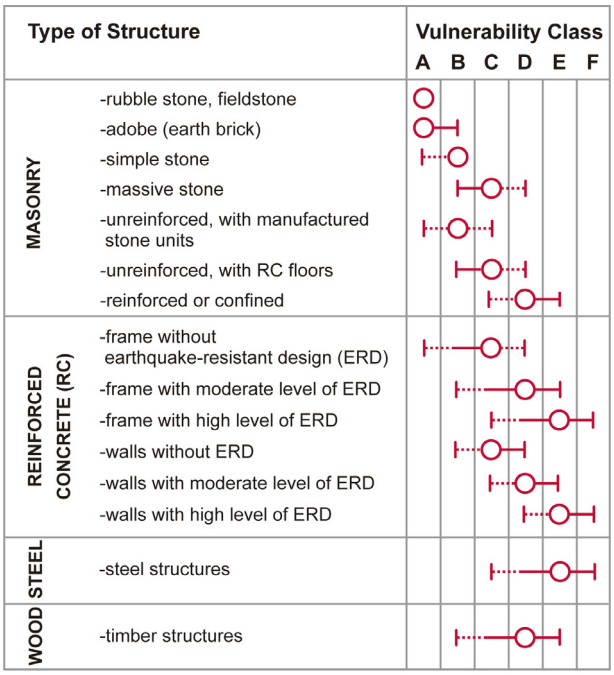
A further class of site-effects resulting in severe consequences is ground failure due to soil liquefaction. The term ‘liquefaction’ describes how ground motion induces liquefying so that soils lose their coherence. The phenomenon occurs because increased pore water pressure suspends cohesion between the particles of the ground. Even well engineered construction can incline heavily without suffering much damage typical of ground motion. Liquefaction strongly depends on particular ground conditions. A high groundwater level is as essential as the composition of the relevant ground layer (grain size and material).

A third class of site-effects is rather frequent in regions showing pronounced topography, as is the case for much of Switzerland. It has been long known that ground motion can trigger rockfalls, landslides and avalanches of all dimensions. One of the most disastrous events of this kind was the 1970 Mount Huascaran landslide killing tens of thousands people in Peru (e.g. Plafker et al., 1971). Although this is an extreme example, triggered

landslides, rock falls and avalanches have a large potential for destruction and casualties. Apart from construction in general, lifelines such as traffic routes, power and communication lines are at special risk from site effect damage since they often cross areas of increased hazard. Masse movements represent potential danger beyond the actual event of an earthquake since their consequences potentially complicate rescue and assistance. Not surprisingly, the investigations regarding the Valais earthquakes resulted in many verified observations of triggered rockfalls, landslides and avalanches.

1.2.5 Vulnerability and Damage

It is one of our main tasks to describe the damage that occurred from the 1855, 1946 and 1964 events. Since buildings and construction in general are complex entities, damage is as well. Depending on construction, quality of workmanship and materials, a huge variety of buildings exists, even in a regionally limited area such as the Valais region or the Canton Obwalden. How can we assess damage to such a variety of buildings, calibrated in a manner that damage data become comparable? What is the measure that allows assessing a large number of damaged objects at a maintainable effort? EMS 98, the European Macroseismic Scale 1998 (Grünthal, 1998), which was developed to assess earthquake effects for recent events, offers a procedure that is practical as well for historical damage assessments. Paragraph 3 of the EMS 98 refers explicitly to the possibility of using it for historical events.



(Grünthal, 1998).

Macroseismic scales in general measure the strength of an earthquake in intensity degrees (see paragraph 1.2.2). A fundamental aspect of this process concerns the evaluation of damaged buildings. EMS 98 thus contains a set of simple tools allowing efficient and adequate assessment of building damage. Since the lack of precise data is a handicap almost always present in damage assessment for past events, these tools get by with limited information about affected buildings and the appending loss. The evaluation rests upon the two terms *vulnerability class* and *damage grade*. While the term *vulnerability class* (VC) expresses the expected resistance of buildings to earthquake generated ground shaking, *damage grade* (DG) classifies the incurred damage. Both measures are essential to assess the strength of an earthquake properly. Table 1.1 illustrates how EMS 98 separates buildings of different construction types into four main classes, including 15 subclasses. The four main classes separate masonry construction from reinforced concrete, steel and wood. Within each of these classes, subclasses regarding different types of construction and materials are related to the vulnerability. The scale ranges from class A (very vulnerable) to class F (high level of earthquake resistant design). Depending on further information such as state of preservation and workmanship - if available – the assigned vulnerability class may be shifted from the most likely (indicated with red circles in Tab. 1.1) to the next higher/lower class. With respect to the events discussed here, regions and time of construction, the classes of masonry and wood are of particular interest. Furthermore, in the Valais region as well as in central Switzerland traditional rural buildings often show a mix of masonry and wood elements. While basement and ground floor usually consist of (simple-) stone masonry, the upper part of the buildings is timbered. This additional structure class has been rated in the range of VC B and C.

For several reasons, it was not possible to assess building vulnerability for all structures that suffered loss. On the one hand, many of the buildings don't exist anymore or are hardly identifiable now. On the other hand, the number of investigated cases of loss (more than 2000) is by far too large for an in situ assessment of vulnerability. We thus concentrated on vulnerability assessments for typical buildings of the respective time and region. Most important were field visits including discussions with local engineers and architects.

Classification of damage to masonry buildings	
	**Grade 1:** Negligible to slight damage (no structural damage, slight non-structural damage) -Hair-line cracks in very few walls· -Fall of small pieces of plaster only -Fall of loose stones from upper parts of buildings in very few cases.
	**Grade 2:** Moderate damage (slight structural damage, moderate non-structural damage) -Cracks in many walls -Fall of fairly large pieces of plaster -Partial collapse of chimneys
	**Grade 3:** Substantial to heavy damage (moderate structural damage, heavy non-structural damage) -Large and extensive cracks in most walls -Roof tiles detach; chimneys fracture at the roof line -Failure of individual non-structural elements (partitions, gable walls)
	**Grade 4:** Very heavy damage (heavy structural damage, very heavy non-structural damage) -Serious failure of walls -Partial structural failure of roofs and floors
	**Grade 5:** Destruction (very heavy structural damage) -Total or near total collapse

Table 1.2: Damage grades 1-5 as defined in EMS 98 (Grünthal, 1998).

In contrast to assessing the VC, we examined cases of damage individually when ever possible. For most of the damaged buildings, we could resort to historical documents that describe the earthquake consequences adequately enough to estimate the severity of damage. An exception are about four hundred cases of loss from the 1964 earthquake for which the available information consists of repair costs only. Cases of this kind had to be extrapolated based on more detailed information concerning the same earthquake. For a few further cases of loss regarding the 1946 earthquake, investigation resulted in identified buildings with damage of unspecified severity.

Like the assessment of the VC, the EMS 98 instruments to estimate damage grades (DG) rest upon a simple table (Table 1.2). This scale divides damage into five grades from DG 1 (negligible to slight damage) to DG 5 (destruction). The main criteria for the distinction are the terms *structural*/*non-structural damage*. While DG 1 excludes structural damage, DG 2 includes slight, DG 3 moderate structural damage. Parallel, non-structural damage increases from slight (DG 1) to moderate (DG 2) and heavy non-structural damage in DG 3. Damage of grades 4 and 5 is characterized by heavy (DG 4) and very heavy (DG 5) structural damage. Additionally the table lists/shows pattern of damage as they occur typically within a DG. These patterns are particular helpful while assessing damage based on short historical descriptions, since these often use similar terms. Whether a chimney collapsed partially or fractured at the roof line (see Table 1.2), for example, is often expressed clearly by a source describing the house. The same applies for most of the other listed damage patterns. An exception, however, is damage of grade 1 (and to a certain degree, grade 2). The investigation of historical documents showed that slight damage was often ignored. On the one hand this has to do with the fact that the earthquakes discussed here had consequences that eclipsed damage of the hair-line crack type. Where vaults collapse, fallen pieces of plaster hardly

matter. On the other hand, sensitivity to minor loss, as described by DG 1, was lower then when compared with today. This applies in particular for the event in the eighteen fifties when houses were of a poorer standard when compared with today. This pattern is less pronounced but still valid for the 1946 and 1964 events.

1.3 Significance

Like Europe in general, Switzerland experienced a tremendous economic growth during the 20th century and particularly in its second half. The prosperous economy and its requirements for production facilities as well as an increasing population and its needs for accommodation all changed the face of Switzerland dramatically. Within a few decades, large parts were urbanized. Of particular interest is this ongoing development in large alpine valleys in Valais Canton (Rhone Valley) or in Grisons/St.Gallen Canton (Rhein Valley). Before the regulation of Switzerland's hydrography, wide parts of these valleys were of no use for residential or industrial purposes. Even for agriculture, much of these areas were inappropriate. The river training and the draining of the plains changed this situation radically. For many years now, these plains have become preferred sites for industrial and residential development and an end is not in sight. Figure 1.3 illustrates this expansion for the regions of Sargans and Chur (in the Rhein Valley) as well as Sion (in the Rhone Valley).

With respect to seismic risk, increased settlement on these plains is highly disadvantageous. The ground conditions as they are given on such sites correspond exactly with the locations where site-effects preferably occur: recent deposits of not consolidated sands and gravels of considerable thickness. In large alpine valleys, they can reach a thickness of up to several hundred metres and thus provoke amplification effects in a frequency band that may generate resonance effects on construction. Additionally such ground conditions are often combined with a high groundwater level, which is, as we have seen above, a condition for soil liquefaction. The percentage of residential and public buildings as well as industrial facilities on these sites showing a higher risk raises the seismic risk in general. (Other regions in Switzerland like the valley of Obwalden or the Linth region north of Lake Zurich suffer from a comparable situation.) Furthermore, many alpine valleys are located in those parts of Switzerland having considerable seismic hazard (See Fig. 1.1). This applies in particular to the Valais region with Switzerland's highest seismic hazard. An exception is the Tessin Canton and to the north of it, the Gotthard region, where seismic hazard is comparatively low.

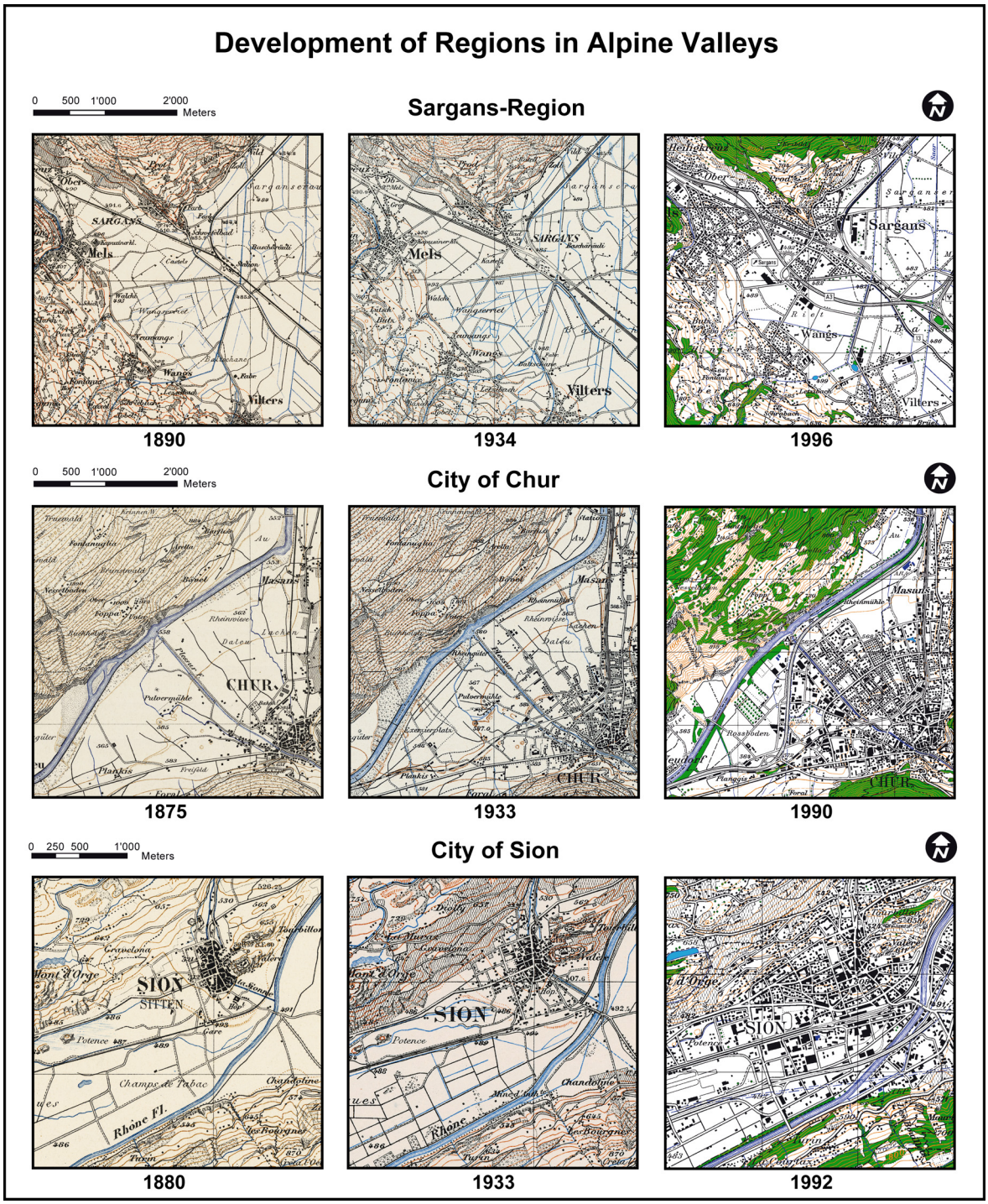


Figure 1.3: Development of the Sargans region (1890-1996), of the cities of Chur (1875-1990) and Sion (1880-1992). The map sequences include the first and last edition of the Siegfried map (no. 267, 406, 486) and a contemporary map of the Federal Office of Topography (Swiss Map 25, no. 1155, 1195, 1306).

From this perspective, the significance of the project at hand becomes evident. Ongoing urbanization in Switzerland raises social vulnerability in general. And booming construction activity on the plains of alpine valleys is relevant since Switzerland will be confronted with events that strike these particular regions. It is not the task of this study to speculate on the consequences of such an occurrence but rather to accumulate and interpret empirical data

from the illuminating events of 1855, 1946, and 1964. Since Switzerland has not been hit by strong earthquakes for a long time (the last event having considerable damage was that of 1964 in Central Switzerland), the events of this study occurred before the enormous construction boom. Our aim is to find whether these locations already showed the impact of site-effects. Our findings will provide arguments for protective measures.

1.4 Methodology

1.4.1 Historical Investigations

Our approach is multidisciplinary, combining historical investigation with seismo-geological research. While the historical investigation focused on questions concerning the consequences of the earthquakes (extent and location of the loss), seismo-geological methods were used to interpret the distribution of damaged objects with respect to the local ground conditions.

Historical investigation into the events presented in this thesis began during revision of the Swiss Earthquake Catalogue (Swiss Seismological Service, 2002). The starting point for these inquiries were archives of the respective regions: the State Archive Valais (StAW) for the 1855 event in the Visp region and the 1946 event in the middle Valais region as well as the State Archive Obwalden (StAOW) for the 1964 event in Central Switzerland. By far the most important documents found in these archives are two contemporary damage assessments of the 1855 and the 1964 events. Finding the assessment of the 1855 event was a surprise. It is almost completely preserved and provides a stable basis for re-evaluating damage (See Paragraph 2). Of similar value is the damage assessment for the 1964 event, but parts of it are lost. While the 1855 assessment consists of lists containing a damage description and corresponding repair costs, parts of the damage descriptions are lost with respect to 1964. Nevertheless, the damaged objects are completely listed and for most of them location is identifiable (See paragraph 4). A damage assessment was also made for the 1946 earthquake. Unfortunately, the documents concerning this assessment are lost or at least not traceable. However, some of its key data are known. Precise reconstruction of consequences for the 1946 quake, as was possible for the first mentioned events, is not feasible for these data (See paragraph 3). In the context of these damage assessments, other sources from the cantonal administration proved of interest. Primarily, these documents report how the cantonal administration managed damage assessment and the distribution of donations (1855 event, Canton du Valais, 1860) or how they prepared for an even more disastrous event (1964 event,

StOW, Von Ah, 1964). A second group of investigated sources are newspaper articles. We searched several dozens of regional and national titles. A list of those investigated is given in the bibliography. With respect to the 1946 event, these articles proved an important data source. To a lesser extent, this applies for the two other events. A third group of valuable sources consists of contemporary scientific articles. Although the question of damage was only marginally addressed, some of these articles were of considerable importance. Particularly an article by Wanner and Grütter (1950) improved our understanding of the 1946 losses. A last group of important sources is exclusively related to the 1855 earthquake. In the weeks and month after the earthquake, the affected region was visited by several interested persons. Most of them had a scientific background and published the experiences and impressions gathered during their visit in journal or newspaper articles. These travelogues offered an important contrast to the data given by the damage assessment and helped to calibrate this information (Nöggerath, 1855; Heusser, 1856; De la Rive, 1855; Colombe, 1855). To the same group of sources belongs the diary of Tscheinen (1857) who was the pastor of Törbel, a village in the Matter-Valley. He lists carefully his observations with respect to the felt main- and aftershocks. This document is unique for the 1855 event and allowed a rather precise reconstruction of the earthquake sequence.

It was our general principle to calibrate the data gathered from the damage assessment with information from other sources. This proved successful in assigning damage grades given by the procedures of EMS 98 (See paragraph 1.2.5), especially when joined with field visits and discussions with engineers and architects concerning the vulnerability of typical buildings. We found in this way a stable basis for reconstructing the damage fields. Since a comparable pool of data does not exist for the 1946 earthquake, our results concerning that event are more fragmentary.

1.4.2 Seismo Geological Investigation

Evaluating the reconstructed damage fields as influenced by ground conditions depended upon seismological methods and available geological information. Most important was the so-called “single station H/V measurement” introduced by Nogoshi and Igarashi(1971). This method allows efficient and reliable assessment of the fundamental frequency of the ground (f_0). Although theoretically not fully understood (SESAME, 2008), the ratio of the horizontal and vertical component of ambient vibration indicates at what frequency amplification should occur. Moreover, the method allows a qualitative estimate of the expected amplification at a

site compared with nearby locations. Although the latter is possible only in a qualitative manner, it is a convenient way to document changes in the expected ground behaviour within a limited area. In total, we performed several hundred of these field experiments on sites within the reconstructed damage fields. This type of experiment was completed with the array measurement method focusing the s-wave velocities (Vs) of the soils.
The two parameters f_0 and Vs are connected via the following empirical equation:

$$f_o = \frac{V_s}{4h}$$

whereas h is the thickness of the soft sediment layer and V_s is the average shear wave velocity. We performed several array experiments on specific sites in collaboration with other projects in the Valais Canton. For detailed descriptions concerning these two methods, see the respective paragraphs 3.3, 3.5.2 and 4.4.2.

To characterize the ground conditions of the relevant sites, we also included several previously published seismological and geological studies. Particularly for the region of the Valley of Obwalden the work of Beer (1997) provided a good data stock. For the Valais region, the microzonation studies carried out by Crealp (2006; 2004) and for Sion the collaboration with Daniel Roten (2007) on the modeling of the 1946 event brought new insights and data. Unfortunately for many locations of interest, the Geological Atlas of Switzerland (Geologischer Atlas der Schweiz, 2006) provides no maps. For Visp, Sion, and Sierre we thus had to be content with older cartographical works. With respect to the Sarnen region a map of good quality was at hand.

1.4.3 Multidisciplinarity of the Project

The project was explicitly set up as multidisciplinary study. While the leading question is clearly seismological, the data aggregation is based on historical science, the interpretation of geological information and on engineering seismology. It is unquestionably interesting and motivating to work on a project covering such variety, its set-up shows certain advantages and drawbacks. A main problem within a multidisciplinary project may occur with respect to the organization of the participating branches. We tried to avoid this by consequently subordinating all of them to the leading question, positioned in seismology. Although this often implied that the potential of other participating sciences was not fully tapped, it proved the best solution. Interesting topics and desirable tasks and questions indeed had to be

dropped, but at the end, only answers with respect to the leading question are relevant. A further problem is that research on a wide range of topics demands a large number of skills and a variety of highly specialized knowledge. It is an ambitious task to satisfy these requirements and I was not always successful in reaching the desired depth. Whenever possible, I tried to discuss emerging problems with experts in the respective field of research. With respect to flexibility, efficiency and creativity, it proved to be a big advantage to deal with all the different topics in the same pair of hands. New ideas and thoughts could be faced quickly and directly, new approaches could be tested without disturbing the interaction between several persons. The most important advantage, however was that the project set-up allowed an overview of the project as a whole. It was possible, for example, to attend historical data from their discovery in archives and literature through all states of aggregation and interpretation as far as their recombination with other kinds of data emerging from modern seismological research. This is where multidisciplinarity has its asset: to know exactly, how data have been collected and what they stand for.

1.5 State of Research

This project is the first time that detailed reconstruction of historic damage fields in Switzerland has occurred. A study of the 1356 Basel event included a similar goal, but since the earthquake dates back many hundreds of years, the expectations were considerably lower (Fäh et al., 2008b). Nevertheless, my studies did not start from scratch. The historical work done at the SED for many years and the revision of ECOS (Fäh et al. 2003a) offered not only good conditions to decide which events might qualify, but also provided a stable basis of documents and knowledge. Furthermore, a diploma thesis addressing the 1946 event with respect to macroseismicity was available at the beginning of this project (Schibler, 2003). An additional diploma thesis regarding the 1964 event (Steiner, 2004) was done in parallel and under my supervision. Both of these diploma theses were of great value and contributed to the success of this study.

Many examples for site characterization studies exist. Ideally, they cover all steps of a microzonation study: soil characterization, numerical modelling and observation of earthquakes. Since this would have gone beyond the scope of this project, we concentrated on those steps of a seismic microzonation study addressing only soil conditions. Thus, we focused on the relevant seismic microzonation of Basel (Fäh et al., 1997; Fäh et al., 2006; Havenith, 2007; Noack et al., 2000). Regarding the Valais region, we fell back on previous

work by Havenith et al. 2007, Roten and Fäh (2007) Roten et al. (2008) and BWG (2000); Crealp, (2006; 2004) and Frischknecht (2000). With respect to the Obwalden Canton, our studies are based on the work of the BUWAL (1996) and Beer, 1997. All this research provided good starting points for more detailed investigation of specific sites.

Regarding traditional buildings in Switzerland, the multi-volume edition of Hunziker (1900-1914) concerning the historical development of typical buildings provides interesting insight into construction details of a wide variety of houses and other construction. The publication was particularly of value with respect to the 1855 and 1946 events in the Valais Canton. Regarding the buildings of Sion and Sarnen we also used architectural inventories (Gesellschaft für Schweizerische Kunstgeschichte, 1996, 2003).

1.6 Objects of Research

1.6.1 Time Frame

Which criteria were crucial for selecting the earthquakes and regions? Since earthquakes of the size investigated within this project occur rather seldom in Switzerland, the selection was more or less given. For earthquakes that occurred earlier than the 1855 event, the available historical data concerning damage is too fragmentary for our goals. This applies to the 1755 event (Valais, Io=VIII; Gisler, 2004b), the 1601 event in the Unterwalden Canton, (Io=VII; Schwarz-Zanetti, 2004, 2006) and the 1295 earthquake (Grison Canton; Io=VIII; Schwarz-Zanetti, 2006a, 2004). With regard to the 1774 Altdorf event in Central Switzerland (Io=VIII), we did a test by setting up a semester thesis (Bühler, 2006). Unfortunately, it turned out that the relevant archive (State Archive of the Uri Canton, StAUR) was destroyed by a fire 25 years after the earthquake. Most of the relevant documents are lost. Regrettably, historical investigation into the strongest event in the second half of the 20th century (Brig 1960, Io=VIII) did not return sufficient data for further research. However in this case there is hope that more information will be found in local archives or personal collections. The 1356 Basel earthquake, by contrast, which is the strongest known event north of the alps (Io=IX), was already subject to a project and resulted in an unexpected amount of information from archeological research in the past century (Fäh et al. 2008b).

1.6.2 Valais and Central Switzerland

Given these facts, the three earthquakes of 1855, 1946 and 1964 remained the most promising events with realistic expectation of success: two of them having an excellent data stock (1855, 1964), and a third with good. And they occurred in areas of Switzerland where similar events have to be expected. Particularly on the wide plains of the Rhone Valley, but also in the investigated region in Central Switzerland, site-effects may play an important role. The events discussed here cover those regions of Switzerland that are of particular interest. Further studies such as the COGEAR project will continue to provide more insights into all phenomena related to quakes in the Valais region.

1.7 Contents of the Work

Paragraphs 2, 3 and 4 present our most important results as they have been presented in (Fritsche, 2006), accepted (Fritsche 2008b) or submitted to (Fritsche, 2008a) scientific journals. The few differences in regard to these publications are of formal nature only.

Paragraph 2 discusses the 1855 event in the Visp region. The complete damage assessment at hand allows us to describe and analyze loss at the village level. In total 32 villages were investigated, covering the whole region of intensity VIII as well as the bigger part of the damage field showing intensity VII. Within a supplementary study focusing on Visp, which suffered the most severe damage, we improved the resolution successfully. We were able to locate about 50 percent of the damaged buildings exactly and performed further investigation into the ground conditions. Our investigation of those villages showing the highest intensities suggests that site-effects shaped the damage field. A special project regarding the St. Niklaus and other sites was presented at a conference in 2005 (Fritsche et al.; see Appendix V). Here it was concluded that 2D and 3D resonances were most probably responsible for the heavy damage. Besides damage assessment and site effect analysis, secondary effects and phenomena are addressed in this chapter.

With paragraph 3, we remain in the Valais region and examine the strongest event in Switzerland in the 20th century: the 1946 earthquake. The available data cover the damage field in a fragmentary way. However, two case studies regarding the cities of Sion and Sierre give good insights into the damage and its distribution on typical sites of the Rhone valley. Thereafter, field investigations concerning site-effects showed that particularly at Sierre, amplification effects were key to the 1946 event. Further consideration addressing the entire

damage field suggests that the plain of the Rhone Valley as a whole showed higher intensities than neighboring villages on the slopes. Beside this, the 1946 event proved an impressive example of how the accentuated topography of the alpine arc is vulnerable to landslides, rockfall and avalanches triggered by earthquakes. A large number of observed phenomena of this kind are summarized and presented within this chapter.

Paragraph 4 finally, is dedicated to the 1964 event in Central Switzerland near Sarnen. As with the 1855 event, there is an excellent data stock on loss. Regarding spatial information and building quality, it is even better. With few exceptions, the losses could be located with high accuracy and assessed exactly. We thus are able to present elaborate results on the spatial distribution of the damaged objects and, in consideration of the building stock composition, the extent of loss and repair costs. On the other hand, the geological and geotechnical situation of a large part of the damage field proved to be complex and difficult to investigate. We will present results that show significant influences of the ground. As a further outcome of this subproject, we will demonstrate a tool developed in the context of the noise data analysis for sites investigated in the Sarnen region. The tool allows us to qualitatively rate the expected amplification of a soft soil site compared with locations nearby. This tool was also used while investigating the 1946 earthquake.

Since the damage assessments are not published, we decided to present them in the appendix of this volume (Appendix I: The 1855 damage assessment; Appendix II: The 1946 damage assessment). Most of the assessment concerning the 1855 earthquake is written in French and the rest in German; the one regarding the 1964 event is fully in German. Both source collections are given literally and in their original form. Finally, we present an appended list of identified secondary phenomena such as landslides and rockfall related to the 1946 event (Appendix III) and to the 1855 event (Appendix IV).

While investigating archives and other data sources, we found much information that goes beyond the scope of this study. Parts of this source material have been used for three contributions to a popular book on historical earthquakes in Switzerland (Fritsche, 2008c, d and e) to be published in 2008 (Gisler and Fäh).

2 Reconstructing the Damage Field of the 1855 Earthquake in Switzerland. Historical Investigations on a Well Documented Event.

By Stefan Fritsche, Donat Fäh, Monika Gisler and Domenico Giardini

2.1 Abstract

The 1855 earthquake at Visp remains the strongest in the last 300 yr in Switzerland. It caused heavy damage in the region of the middle Valais. We reconstructed the damage field of this event studying also site-effects and building vulnerability. The key factors in such a study are the availability and accessibility of sufficient historical data. Given the existence of a complete contemporary damage assessment and the availability of early statistics, our investigation drew upon an excellent pool of data. These sources enabled us to quantitatively analyse the damage field on the village level. Other historical sources described some of the losses with more detail but not across the whole area. These data were qualitatively analysed and then used to calibrate and verify the outcomes of the quantitative analysis.

When it was possible to describe the damage fields of single villages, as with Visp, a high percentage of damaged buildings could be located so exactly as to foster further investigation. In addition we identified several secondary effects such as rock fall, land-slides and changes in the subsurface. The observed damages support the thesis of a normal fault striking along the Valley of Visp (north–south) and dipping to the west.

2.2 Introduction

On July 25, 1855 a strong earthquake struck the region of the middle Valais and caused damage in a wide compass around Visp. In the Earthquake Catalogue of Switzerland (ECOS) (Swiss Seismological Service, 2002; Fäh et al., 2003a), an epicentral-intensity (Io) of 8 and an estimated moment-magnitude (Mw) of 6.4 are assigned to this event. Dozens of aftershocks followed within the next months and years with Io up to 7 (Fig. 2.1 and Tab. 2.1). The epicenters of these events are supposed to be near the villages of Stalden and Visp.

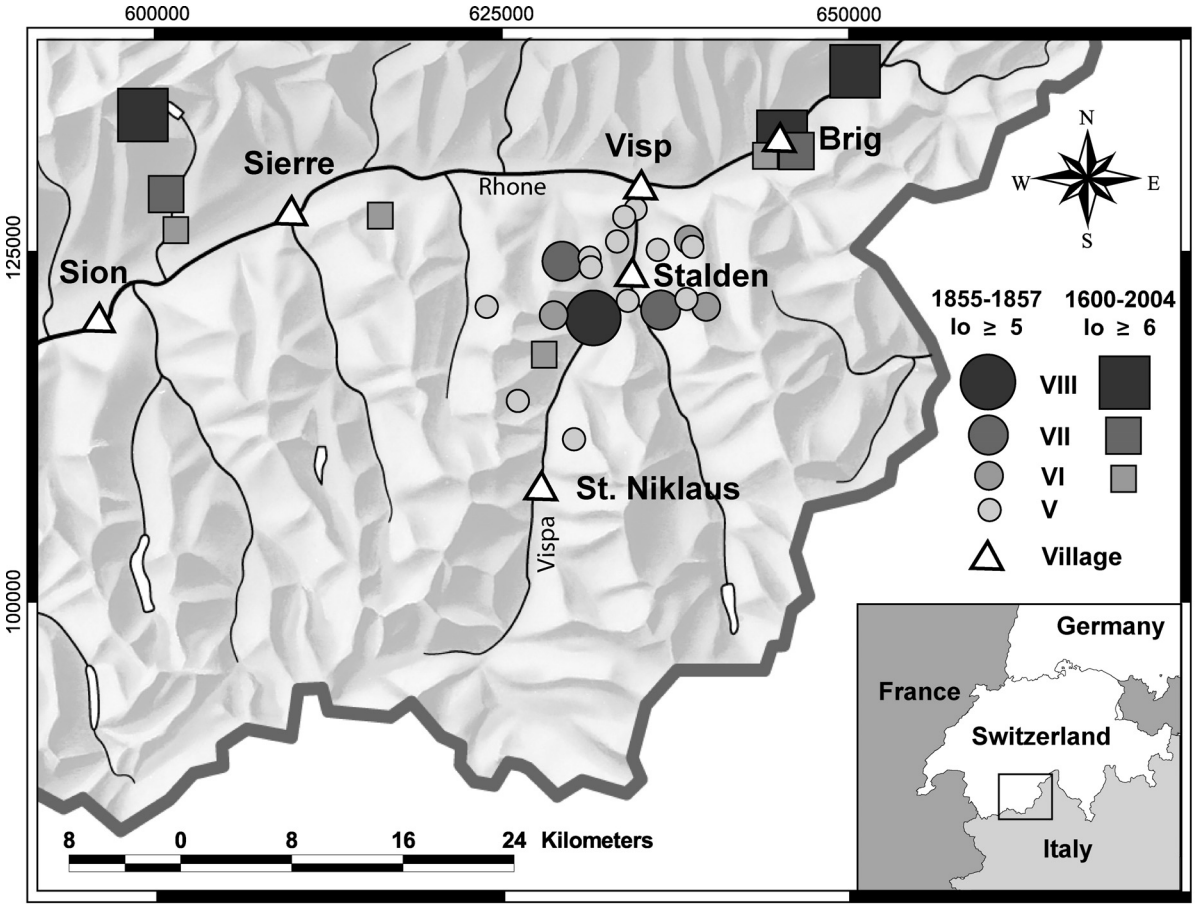


Figure 2.1: Historical seismicity of the investigated region in the middle Valais.

The earthquake at Visp is one of several damaging events in Switzerland investigated within our project to reconstruct damage fields. Our main question is to what extent site-effects and building quality were responsible for these damages. For Switzerland this kind of research has twofold significance. First, Switzerland is situated in a zone of moderate seismic hazard: large, damaging earthquakes are rare but nevertheless possible (Fäh, et al., 2003a). The last event that caused substantial damage occurred in 1964 in the central part of Switzerland (Gisler, et al., 2004b). Historical research is thus an important way of dealing

with damaging earthquakes in Switzerland. Many locations in Switzerland feature an inherent potential for site-effects. Particularly the large Alpine valleys with their wide plains of large fluvial and lacustrine deposits show unfavorable soil conditions. Local amplifications of ground motion and non-linear effects are likely to occur in such areas during an earthquake. However, these naturally marshy plains have become attractive places for expanded settlement in the last two centuries: river regulations allowed many villages and cities to grow extensively on these wide plains, as they do in the Rhine Valley or the Valais (Fig. 2.2). The risk to settlements is therefore increasing. Further research into the relation between damage and possible site-effects is definitively merited.

Methods for answering the above-mentioned questions differ little in principle from approaches used for contemporary events. But all events investigated within this project occurred so long ago that additional and extensive historical investigation must provide useful data. Here we concentrate on the historical part of the proceeding and reconstruct the damage field to accurately assign intensities for the 1855 event.

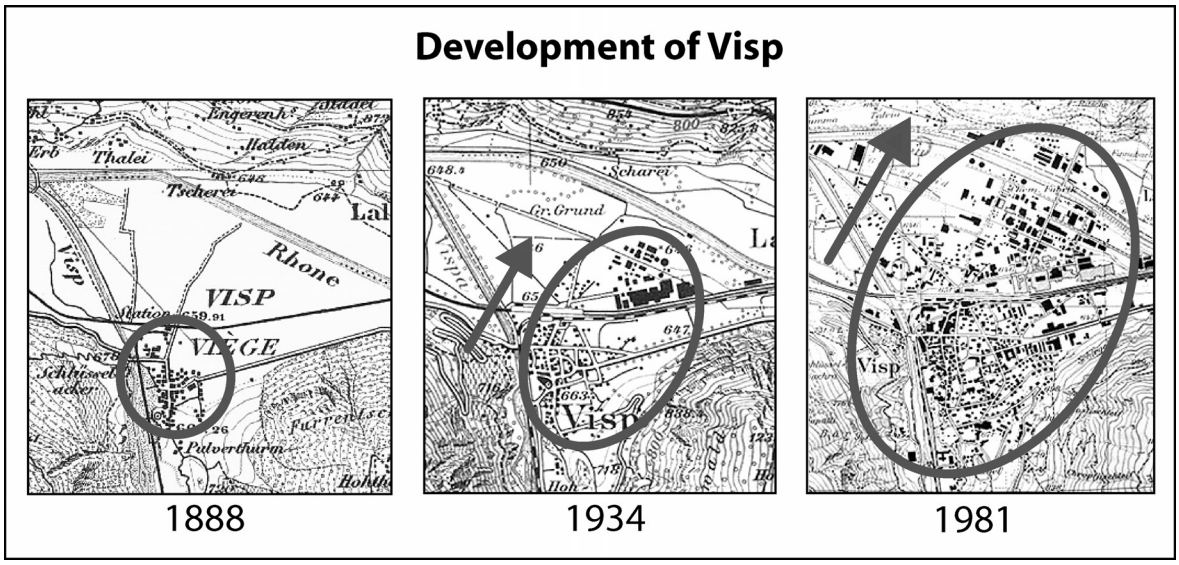


Figure 2.2: Development of Visp from 1888 to 1980. The map sequences include the first and last edition of the Siegfried map (no. 496) and a contemporary map of the Federal Office of Topography (Raron, no. 1288, 1983).

We will start with a short description of method followed by a discussion and contextualization of the investigated historical sources. In subsequent paragraphs we focus on the damage and identify secondary effects such as slope instabilities and rock fall. This will be done in two parts. After an overall description from a broad assemblage of historical sources, we will concentrate on an extraordinary document: a set of contemporary and detailed lists describing the damage to the whole epicentral region. This evaluation was taken in the months after the main shock at the behest of the government of the canton Valais. Given its

unique completeness and consistency, it allows a quantitative analysis of the damage field. Then we discuss the problems of transforming historical information into computable data. The section ends with a discussion of results for the investigated damage. Its last paragraph takes a closer look at the village of Visp because it suffered the most severe loss during the earthquake series and represents special geological conditions. On the border of the Rhone-Valley plain, it has greatly expanded within the last century (Fig.2.2). These factors encouraged an intensified historical investigation which yielded the highest possible resolution of the Visp damage field.

2.3 Approach and Methodology

Our multidisciplinary approach combines methods originating in the science of history as well as seismology/geology. Generally speaking, the first skills were used for data aggregation, while the latter were applied to data analysis.

Given the very informative and consistent written sources, it was possible to complete the historical investigation with high quality and plentiful results in the form of comparable data. While the contemporary damage assessment in combination with statistical data were used for quantitative analysis, other sources were handled qualitatively and used to calibrate the outcomes of the former analysis. This was mainly done by comparing damaged buildings specified in the contemporary damage assessment and other historical sources. Nevertheless, uncertainties and problems of interpretation remained and required care while assessing the damage. This final evaluation followed the guidelines of the European Macroseismic Scale 1998 (EMS 98) (Grünthal, 1998). It provides a set of tools to assess vulnerability classes, damage grades and intensities (see paragraph 2.6). The data were handled in a conservative manner: whenever ambiguous descriptions had to be transformed into damage grades and intensities, the lower limit of this range was used. Assigning vulnerability classes was also done with caution. Then the reconstructed damage field was examined for patterns and distinctive features. After combining this information with geological data (particularly information about the surface geology and topography), we could detect locations that may have exhibited site-effects. These identified locations were then subject to even more detailed investigation. Thus, we improved the resolution of these (local) damage fields by locating and assessing individual buildings that suffered damage. Of course, in many cases it wasn't possible to recover the accurate position of a building that had sustained damage.

Nevertheless, the investigations were successful and provide very useful results for continuing studies, as the example of Visp will show.

2.4 The Source Material

The earthquake of Visp in 1855 is a well-known event for historical seismology in Switzerland. The event was felt not only all over the nation but also in other parts of Europe. The extent of damage was remarkable and is still unsurpassed in the Valais. The large quantity of available contemporary source material such as newspaper and scientific journal articles, travel diaries and entries in chronicles is therefore not surprising. Most known of these sources is the dairy of Pastor Moritz Tscheinen (1857). Tscheinen was an eyewitness living in Törbel, a small village in the epicentral area. With high accuracy, Tscheinen listed the series of main and aftershocks by notifying the date, time, strength and manner of the felt events (Tab. 2.1 and Fig. 2.1). In a few cases he noted information about the damage. Another well-known and important source is the work of the German mineralogist an geologist Otto Volger (Volger, 1856). Volger (1822- 1897) worked several years on historical earthquakes in Switzerland.

Year	Time	M_w	I_o	I_x
1855 - 07 - 25	11.50 am	6.4	8	8
07 - 26	09.15 am	5.6	7	8
07 - 26	01.20 pm	5.2	6	7
07 - 27	10.00 am	4.7	5	6
07 - 28	10.00 am	5.2	7	7
08 - 24	-	5.4	6	6
08 - 26	09.00 am	4.3	5	5
10 - 28	01.30 am	4.8	6	6
11 - 06	03.30 am	4.9	6	6
11 - 13	-	3.9	5	5
1856 - 01 - 05	02.50 am	3.9	5	5
02 - 09	06.13 am	3.9	5	-
08 - 06	01.45 pm	4.8	5	6
1857 - 11 - 04	07.15 am	4.3	5-6	-
11 - 14	03.30 am	3.9	5	-
1858 - 02 - 05	03.45 am	4.7	5	5
02 - 23	09.30 pm	3.9	5	-
04 - 06	02.30 am	3.9	5	-

Table 2.1: Main and aftershocks with I o ≥ 5 (ECOS, Swiss Seismological Service, 2002).

Mw: Moment magnitude.

I o: Epicentral intensity.

I x: Maximum intensity.

A comprehensive publication in 1857 dealt with earthquake phenomena in Switzerland in general (Volger, 1857), another publication with the 1855 earthquake in particular (Volger,

1856). Remarkable for example is his "macro seismic map" of the 1855 event: an early form of an isoseismic map (Fig. 2.3).

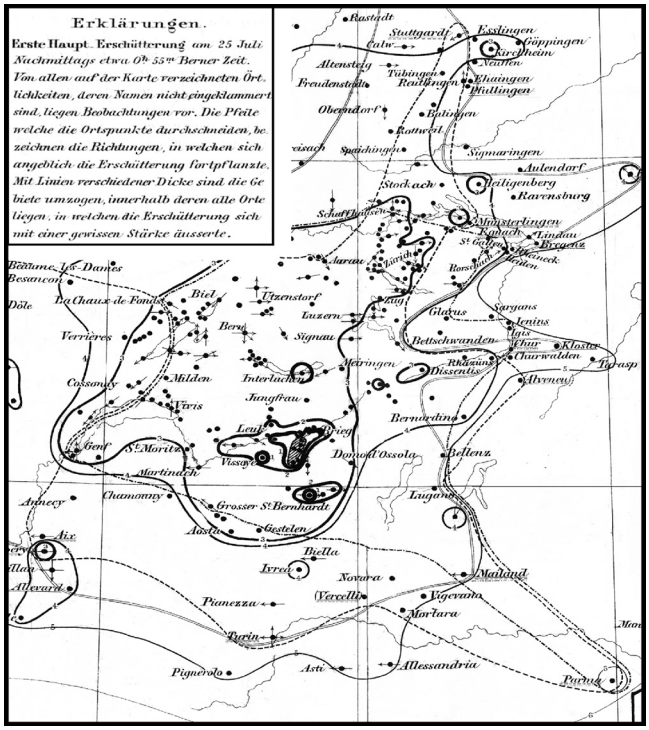


Figure 2.3: Part of the isoseismic map of Volger with a scale from 1 (heavy destruction) to 6 (felt). (Volger, 1856).

Also well known is a travel diary written by Johann Christian Heusser (Heusser, 1856) with information on damage and secondary effects. Heusser visited the epicentral region in the second half of August 1855. His report is very detailed and contains illustrations of an unknown artist (Fig. 2.4 and 2.5).



Figure 2.4: St. Niklaus after the main shock of 1855 July 25 (Heusser, 1856).



Figure 2.5: Visp and the Martinskirche with the damaged tower (Heusser, 1856).

Another travel diary, much less known but of utmost importance, is entitled “Die Erdbeben im Visperthale” (Nöggerath, 1855). Nöggerath was Professor of mineralogy and mining at the University of Bonn. Like Heusser, Nöggerath provides a great deal of useful information about damaged buildings and other effects of the earthquake, sometimes in even more detail. This text was previously unknown to historical seismology and only found thanks to the hint of Bernhard Clemenz, a Person interested in local history of the affected region. Finally a report by Walter de la Rive (De la Rive, 1855) is worth mention. De la Rive accompanied a commission from Geneva founded to help the affected population. This commission visited the region about a month after the main shock. The French article gives an account of this journey and mentions many interesting details. In contrast to the above mentioned authors De la Rive is less interested in scientific insights. His report describes the earthquake more from the perspective of the affected population.

In addition to these published materials, we discovered an important source in the State Archive of the Canton Valais (StAW, Tremblement de terre de juillet 1855: Expertise des dommages; Tremblement de terre de juillet 1855: Révision de la taxe, distribution des secours). It consists of lists assessing all buildings that sustained damage from the 1855 event. This source enables a quantitative analysis and thereby a precise reconstruction of the damage field. Immediately after the main shock of July 25, 1855, the government of the State of Valais, domiciled in Sion, became aware of serious consequences. In its meeting of July 27, the government decided to send a commission of experts into the affected region (StAW, Protocoles des séances du Conseil d'État 1855-57, séance du 27. juillet 1855). This commission had orders to assess damage and consider reparations (Ibid.). During the

following weeks, the commission members travelled from village to village to survey damage. Their descriptive lists usually consist of four columns and, depending on the extent of damage, up to 150 descriptions of cases of loss per township. The first column contains consecutive numbers, the second the name of the owner, the third a short description of the recognized damage and the fourth an estimation of the repair costs in Swiss Francs (Fig. 2.6).

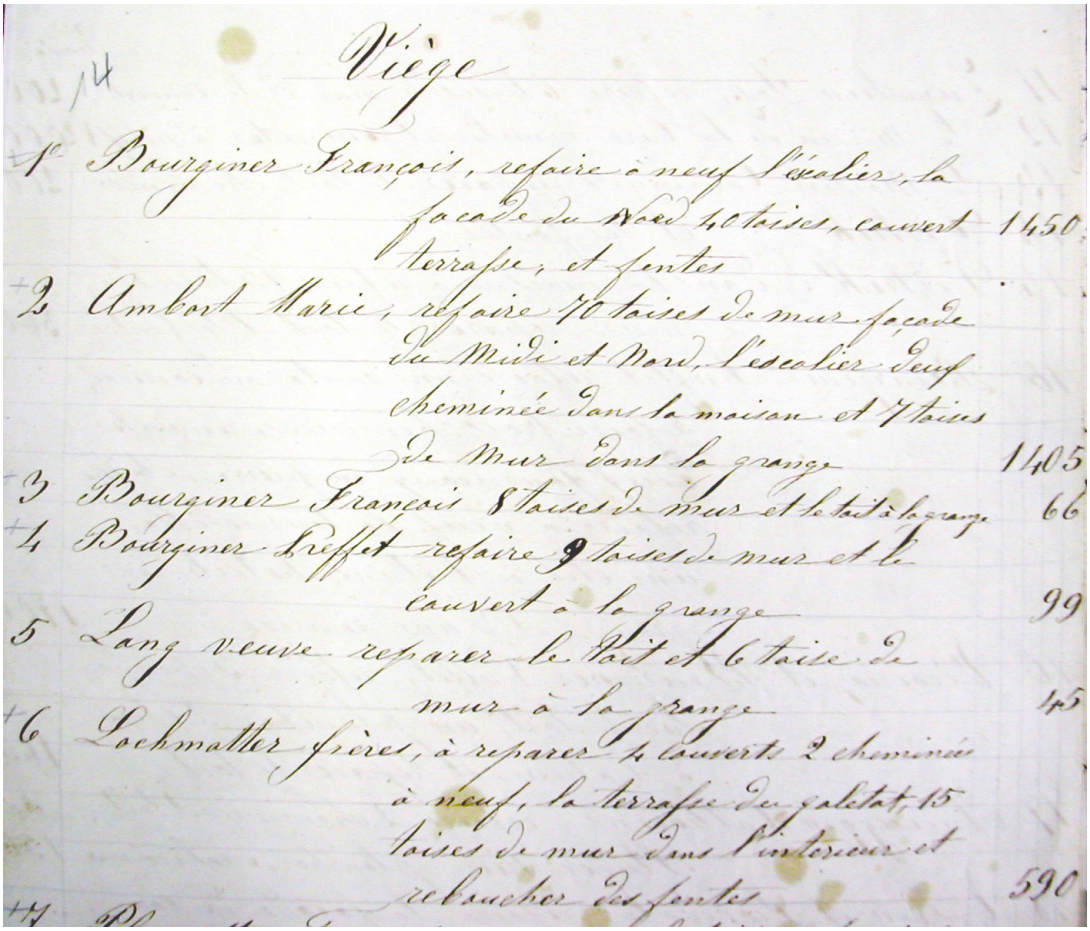


Figure 2.6: First page of the damage list of Visp. The columns contain from the left to the right: consecutive numbers, the name of the owner, a short description of the damage and an amount of money in CHF. (Tremblement de terre de juillet 1855: Révision de la taxe, distribution des secours. StAW, DI, 27.3.3).

In total we could identify 1800 cases of loss. The lists describe the damage to about 30 villages with a total population of approx. 11,000 residents (Statistisches Bureau des eidg. Departement des Innern, 1862, p. 372-389). Today these townships have a total population of approx. 43,000 (Bundesamt für Statistik, 2002).

2.5 An Overall Description of the Damage Field

With the objective of calibrating the outcomes of the quantitative damage assessment, we considered results of a qualitative analysis based on sources other than the damage lists. The following chapter summarizes the most important observations of different eyewitnesses. In contrast to the damage lists, this material offers interesting information about secondary effects.

Johann J. Nöggerath, a German geologist, reached the epicentral region traveling along the Rhone Valley from Lake Geneva via Sion. In Sion (approx. 50 km from the epicenter) he noted the first slight effects of the event: a few partly collapsed chimneys and some cracks in a couple of walls (Nöggerath, 1855, p. 7). But soon after he left Sion, he became aware of more and more serious traces of the quake (see appendix A at the end of paragraph 2). In Sierre Nöggerath noted "large cracks" in walls and for Turtmann he writes of fairly heavily damaged buildings. "The post office has several cracks and the walls of the houses on the opposite side are several times cracked from the top to the bottom, particularly rifts in the edges of the perpendicularly connected walls were widely opened […]." (Nöggerath, 1855, ibid.) On September 9, Nöggerath arrived in Visp, a village of about 130 houses. Several sources point out that the residents of this village left their houses for many days after the main shock to live in tents on a meadow nearby (StAW, Louis Closuit. Lettre adressé par le major Louis Closuit à son épouse, 30. juillet 1855; Nöggerath, 1855, p. 18-19; Heusser, 1856, p. 6). Nöggerath estimated that more than half of the mostly multi-story houses of Visp were built of stone. Like Heusser, who visited Visp earlier, Nöggerath reported that all these stone buildings suffered damage:"[…] some collapsed immediately, others collapsed later or had to be broken away." (Nöggerath, 1855, ibid.). Heusser remarked that not a single stonewall was unharmed in Visp: "[…] several [walls] are completely collapsed […] of other walls sharply bounded pieces fell away […] but all still vertical standing walls, I believe without an exception, are cleft from the bottom up." (Heusser, 1856, p. 6). Nöggerath finally gave account of buildings that suffered heavy damage to the roof: "One finds several houses with thrown off roofs consisting of very heavy and thick slates as well as wholly thrown off trusses […]." (Nöggerath, 1855, p. 13). According to both reports, wooden buildings sustained much less or even no damage, but the two churches of Visp suffered heavy destruction. Both were large stone buildings. Martinskirche lost its famous pinnacle while the rest of the tower remained upright with many large cracks in the walls (Fig. 2.5). In both churches the well-constructed vaults (Nöggerath, 1855, p. 12) collapsed. Nöggerath commented: "If already

these structural collapses [the collapse of the vaults] require strong motion of the lateral walls, an even better proof [for this strong motion] is the fact, that in the Martinskirche the con-rods, tightening the lateral walls below the vault […], partly broke, partly had been pulled out of the walls." (Nöggerath, 1855, ibid.). Heusser was particularly shocked by the heavy devastation inside the churches: "The walls of both churches are disrupted in many cases, and furthermore the interior of both of them form a veritable heap of rubble, as the organ, pieces of masonry and images were all jumbled together." (Heusser, 1856, p. 6). Both visitors also noted cracks in the ground of the village. Heusser gave an account of a particularly large crack with a width "of about one half to one foot" in the eastern part of Visp (Heusser, 1856, p. 6). Nöggerath mentioned several cracks in the alluvial ground in and near Visp (app. B). Nöggerath as well as Heusser reported recent clefts in the rock on which the western part of Visp is built (app. C). Just as remarkable are Nöggerath's observations concerning terrain changes in the ground surface: "For instance, I saw a […] garden, that used to be completely even. Now it has wavelike elevations […] with a level-difference of about one to two feet." (Nöggerath, 1855, p. 14) What kind of ground deformation did he describe here? Does his description indicate that the fault reached the surface near Visp or the presence of liquefaction? We don't have enough information about this phenomenon to decide what happened exactly; unfortunately he gave no details about the location of this observation. But further investigation showed that this phenomenon probably occurred on the northern periphery of Visp. A short note in the protocol of the government's session of September 1, 1859 emphasizes strong secondary effects in these areas. The government discussed whether it should be forbidden to construct buildings on the plain of Visp for the future (StAW, Protocoles des séances du Conseil d'État 1859). Although no such decision was taken, the discussion shows how concerned the authorities must have been about certain effects in this area. Another report by E. Colombe belongs in the same category of observations. Colombe, a French scientist who visited Visp in October, wrote of flat farmland that subsided below the level of the Rhone-river and became swampland (Colombe, 1855, p. 953, see app. D). Some hints in his description indicate that this effect occurred more or less in the same area as the ground deformation reported by Nöggerath. However, a more difficult question to answer is the nature of the ground subsidence. A form of liquefaction must be considered, but other kinds of ground deformation are likely as well.

Nöggerath as well as Heusser mentioned several locations in and near Visp where water leaked from the ground after the earthquake (Nöggerath, 1855, p. 15; Heusser, 1856, p. 14)

(app. E). According to Heusser, most of these sources became weaker shortly after the main shock and ran dry in subsequent weeks (Ibid.).

After their stays in Visp, Heusser as well as Nöggerath traveled along mutual routes through the nearby villages for a couple of days (Fig. 2.1), Heusser in late September, Nöggerath in October, they never met each other. Along the river of the Valley of Visp up to Stalden, St. Niklaus and Grächen, both were constantly confronted by the effects of rock fall, landslides, cracks and rifts in the ground and newly emerged sources (Fig. 2.7). Nöggerath particularly pointed out that "several times boulders of more than a thousand cubic foot" plunged into the river (Nöggerath, 1855, p. 20). Near Stalden he recognized a landslide of "approximately 100 feet in width" (Nöggerath, 1855, p. 21) (see Fig. 2.7). Heusser detected a broad system of rifts and cracks in the surface near Grächen "that took him two hours to walk along". (Heusser, 1856, p. 11) (See Fig. 2.7). According to his report the rift was up to two feet wide and reached the bedrock, although the bedrock itself was not cracked. "… in contrast to the rock, the larches and spruces [growing above the crack, annotation of the author] were cleaved up to a height of 8 feet." (Heusser, 1856, p. 11).

Stalden is situated one-third of the way from Visp to St. Niklaus. Nöggerath estimated the size of the former village to be about 70 buildings; half of them were farm buildings. He explained that the total damage was proportionally smaller than in Visp because Stalden had more wooden buildings (Nöggerath, 1855, p. 20). But the stone houses were "at least as much disrupted as in Visp; collapsed walls are nowhere missing […] and the houses are partly not inhabited anymore." (Ibid.). In addition he remarked that "the church […] and its tower is cleft in many cases, and the wall that separates the vault of the larger room of the church from the [vault of the] choir is collapsed." (Ibid.). Heusser's report on Stalden agrees generally with Nöggerath's assessment.

The next village they visited was St. Niklaus, a small spot of about 30 houses and 70 farm buildings. Like other authors describing the damage to this village, Nöggerath pointed out that the stone buildings suffered heavy destruction: "…all of them are either already collapsed or disrupted in a way, that hardly one of them can be repaired." (Nöggerath, 1855, p. 24). While Heusser's report contains no further information on St. Niklaus – with the exception of a meaningful illustration (Fig. 2.4) - Walter de la Rive's description is remarkable. Similar to Nöggerath and Heusser, De la Rive pointed out that damage is more apparent than in Visp or Stalden. "[…] there is no semi-devastation, the ruins are complete, the houses are not only disrupted but the debris covers the street […] one of the hotels has quasi disappeared, its façades do not exist anymore […]." (De la Rive, 1855, p. 95-96). But if

one believes De la Rive's report, the disaster could have been much worse. According to him, the meadow above the village was littered with boulders of a rock fall stopped only by the soft soil. This circumstance protected the village from a catastrophe: "[…] if the terrain would have been frozen […] nothing of St. Niklaus would have remained […]." (De la Rive, 1855, 95-96, Appendix III) (Fig. 2.7).

For many other villages that suffered impact, the available information is much more fragmentary. This is because, on the one hand, damage to many of these villages was smaller and less spectacular, but on the other hand they also had lower publicity. Visp, Stalden and St. Niklaus are situated on the route to Zermatt, a village that already enjoyed a certain fame from tourism. For instance, several sources emphasize that Zermatt suffered no damage whereas other villages were not even mentioned where the aftermath of the earthquake had been quite serious. The following list includes the most important fragments of information on some of these lesser known villages.

Grächen: D. Lenoir reported that "[…] the vault of the church is disrupted[…]" but the village in general suffered little because "all houses are built of wood […]" (Lenoir, 1949, p. 129).

Törbel: The diary of Reverend Tscheinen described the heavy damaged church: "The vault of the church collapsed and threw down the organ inclusive of the upper gallery […]." (Tscheinen, 1857, p. 29).

Visperterminen: In his letter to the bishop, the Pastor of Visperterminen describes the heavily damaged buildings owned by the church. Among them was the church itself, the charnel house, several chapels, the old rectory and the house of benefice (Brief von P.J. Studer, Archives Episcopales Sion, see app. F).

Brig: Mentioning Brig briefly, Nöggerath was surprised by the slight damage in this township given its comparatively small distance from Visp. "Only many chimneys collapsed, some houses have cracks, and two turrets at the post station collapsed." (Nöggerath, 1855, p. 28).
This list could be continued but we have cited the most significant information. Let us consider instead the damage lists. These are, in contrast to the documents above, much more homogenous and offer completely different possibilities for describing the effects of the 1855

event. The next paragraph specifies the quantitative assessment and analysis we performed using these documents. See also: Appendix I: The 1855 Damage Assessment.

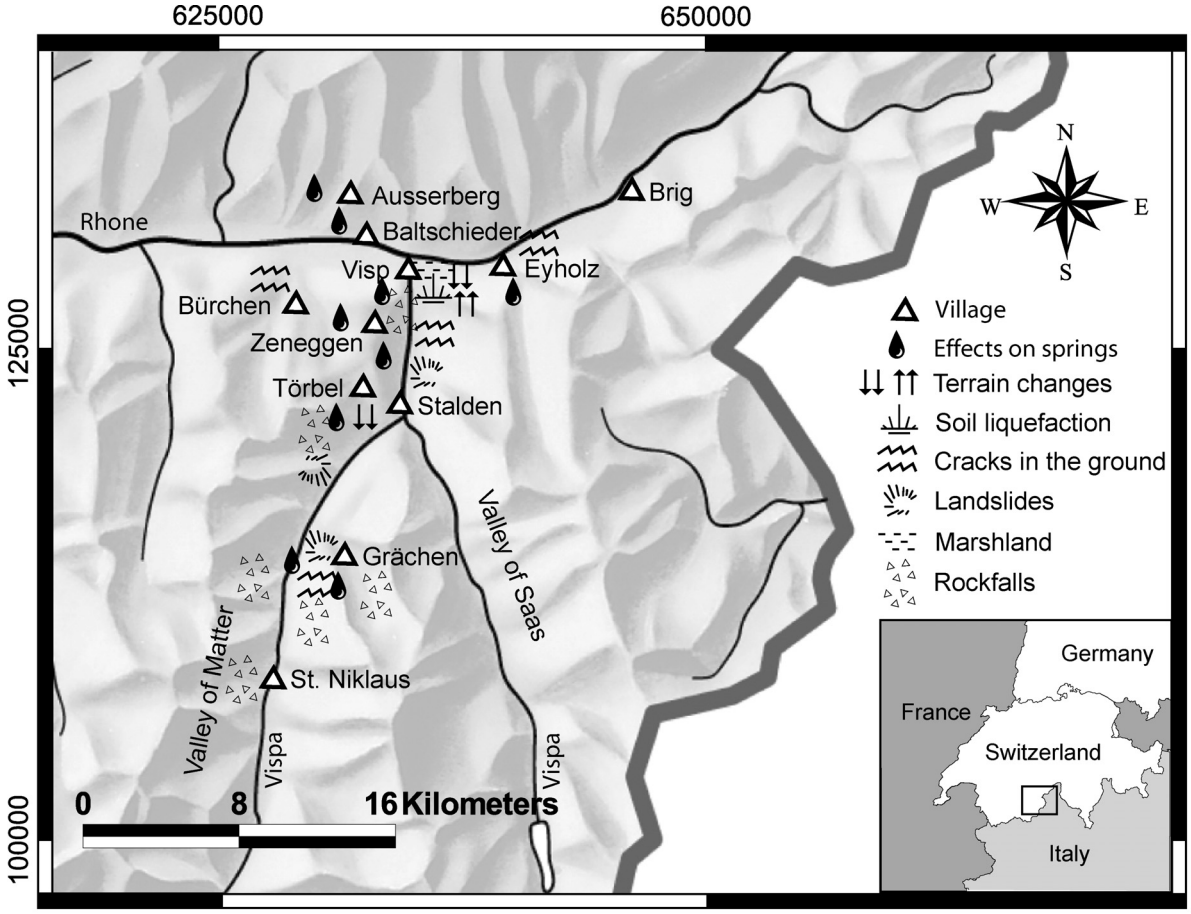


Figure 2.7: Seismo-geological effects in the Valley of Visp.

2.6 The Quantitative Analysis of the Damage-Lists

2.6.1 Assumptions and Conditions

A quantitative analysis of a damage field following EMS 98 consists of three steps. In the *first step,* observed damage to individual buildings has to be divided into classes from grade 1 (negligible to slight damage) to grade 5 (destruction) (Grünthal 1998, 15). The *second step* of a quantitative analysis consists of classifying the buildings by their behavior in an earthquake. Using four general types of structure (masonry, reinforced concrete, steel and wood) and several subdivisions, EMS 98 assigns to each a vulnerability class describing susceptibility to damage. These range from class A (very vulnerable) to class F (very resistant) (Grünthal, 1998, p. 14). Including quantities (*third step)* in terms of "few" (0-20%), "many" (10-60%) and "most" (50-100%) finally supplies the procedure with a statistical element (Grünthal,

1998, p. 17 and p. 25-26). Thus, the proportion of the individual damage grades as well as that of the different vulnerability classes gain quantitative values.

Merging the results from these three steps allows conclusions about a certain location: "many buildings of the vulnerability class b suffered damage of grade 3; a few of grade 4." (Grünthal, 1998, p. 17 and p. 25-26). A set of such conclusions finally allows us to assign intensities ranging from intensity I (not felt) to XII (completely devastating) (Grünthal, 1998, p. 15). Since our investigation relies only on data about damage, the results here will be intensity VI (slightly damaging) or higher (Grünthal, 1998, p. 15).

Our data stock contains information on about 1800 cases of loss which could be assigned to several building types: houses, churches, barns, storehouses and mills. But for two reasons the following analysis was done for houses only. First, the category is more homogenous than the others. Second, although the lists do not mention the number of damaged houses in contrast with the total number of existing stock, this category gap can be bridged through additional sources. Data collections by the Swiss Confederation in 1860 (Statistisches Bureau des eidg. Departement des Innern, 1862) contain useful and accurate information about the numbers of existing apartments and houses. Excluding all buildings other than houses, a dataset of 1074 records remained for further analysis. These records were then classified into groups of clearly identifiable geographical locations: the village mentioned in the header of the lists or parts of this village like a hamlet belonging to a certain township with a different location. With the exception of "Staldenried/Eisten" (two villages located next to each other, for which the reports of loss were mixed up in the same list), the damage could be identified properly and assigned to one of 31 definite locations. Map comparison showed that for all villages inside the affected region a damage list exists and that list is complete for all except the village of "Törbel." However, we learned that a single house was not necessarily characterized by only one entry in the lists of damage. This effect became visible when certain villages suddenly consisted of more damaged objects than houses. A large number houses obviously consisted of more than one apartment. We avoided the problem by shifting the main category from "houses" to "apartments". Although in theory this shift induced a slight bias to the intensities assigned later, the effect is negligible in practise for two reasons. First, the definitions used for quantities following EMS 98 (Grünthal, 1998, p. 17) are given as a wide interval not sensitive enough to perceive this effect. Second, the uncertainties in other factors, such as the assessment of vulnerability classes and damage grades, are far larger than this effect.

Other objections could be made about the time interval between the assessment of the damage cases in 1855/56 and the collection of the statistical data we used. About 75% of the investigated townships could be correlated with data from the 1860 census (Statistisches Bureau, 1862). For the remaining townships and hamlets like Stalden, Neubrück, Gamsen, Raron, Turtig, Rarnerchumma and St. German, adequate statistical data were not available before 1880 (StAW, Originaldokumente der Volkszählung, 1880). However, a look at the demographic development in the second half of the 19th century shows that the population and the number of houses and apartments did not change significantly (Bundesamt für Statistik, 2002). Again, the effect is smaller than the uncertainties occurring during the EMS 98 procedure (Grünthal, 1998) described below.

2.6.2 Assigning Damage Grades

As mentioned in the formal description of the damage-lists, this source describes cases of loss in a twofold way: first, as a short description in a few sentences and second as an amount of money in Swiss Francs. Both forms have their assets and drawbacks. In theory the description contains information about the kind of damage, while the amount of money helps to quantify the loss. However, in practice the descriptions are often difficult to interpret, while the amount of money depends not only on the quantity of loss but also on the workmanship and size of the object under reconstruction. A further problem concerns the value of Swiss currency in the 1850s. What quantum of work could have been done for a certain amount of money? To draw a direct comparison between prices then and now is, of course, not possible. But taking a look at the wages of those days might lead to approximations. A worker in Zurich then earned, depending on his position, between CHF 1.20 and CHF 2.20 per day. (Gruner, 1968, p. 123; Ritzmann-Blickenstorfer, 1996)

If we take into account that the wages must have been lower in Valais because of the economic situation at that time, a fee in the range of CHF 0.80 and CHF 1.80 per day is conceivable for rebuilding. Even more difficult to estimate are the costs of the required materials. A portion of 10 to 40 percent of the total costs is only a rough guess. Even with such estimates, the annotated amount of money helps to quantify the historical losses. Another aid in interpreting the information within the damage lists came from the qualitative analysis. Many types of damage in the lists given in note form only could be identified in other, more detailed sources. In some cases a damaged building from the list could be correlated with a damage description in another source. Including such cross reference helped

to reduce uncertainties substantially. Table 2.2 shows typical losses as given in the damage lists and their assigned damage grades.

Township	Description	CHF	Damage Grade EMS98
Turtmann	032. Oggier, François: For the reparation of a chimney.	5.-	**Grade 2: Moderate damage (slight structural damage, moderate non-structural damage)** Cracks in many walls. Fairly large pieces of plaster fallen. Partial collapse of chimneys.
Turtmann	030. Beyzard, Pierre: For the reparation of small cracks in the house.	5.-	
Glis	020. InAlbon, Eduard: For the reparation of a chimney and some small damage.	14.-	
Eyholz	011. Heinzman, Pierre: For a new chimney and reparations on the roof.	35.-	**Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)** Large and extensive cracks in most walls. Roof tiles detached. Chimneys fractured at the roof-line; failure of individual non-structural elements (partitions, gable walls).
Brig	026. Loretan: For a new chimney, to fix the roof, two ceilings and the latrine etc.	65.-	
Visp	007. Pfammatter, Françoi: For repairs of the roof, for a new chimney, to fix several cracks in the house and for four fathoms of wall at the barn.	191.-	
Baltschieder	003. Nellen, Jean Joseph, baker: Rebuilding 20 fathoms of wall and terrace, repairs on two con-rods, two roofs and several cracks.	400.-	**Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)** Serious failure of walls; partial structural failure of roofs and floors.
Naters	003. Michlig, Therèse: For repairs on the roof, the chimneys and two walls on the façade and several terraces. Uninhabitable.	975.-	
St. Niklaus	001. Tantignoni, Jean, House. Northern part of the house ruined: 56 fathoms of wall, southern part 3 fathoms of wall, repairs on the roof.	2'000.-	
Stalden	001. Kalbermatten, Pierre and Venetz, Anne Marie et Venetz, Joseph Ignaz: The house has collapsed, rebuilding the house.	3'600.-	**Grade 5: Destruction (very heavy structural damage)** Total or near total collapse.
Visp	078. Stauffer, Ant. and Schaller Ant: The house has collapsed, rebuilding the house.	10'000.-	
Visp	083. Stampfer, François: The house has to be razed to the ground. Rebuilding the house.	10'000.-	

Table 2.2: Paraphrased extracts of damage lists. (Ancien fonds du département de l'intérieur. Tremblement de terre de juillet 1855. Revision de la taxe, distribution des secours. StAW, DI, 27.3.3)

Note that damage grade 1 is missing. In fact not a single case of loss could be assigned to this grade, although many had occurred in the investigated region. This distinctive gap occurs because damage of this category did not meet the criteria of loss qualifying for compensation payments. We assume that losses at the lower range of grade 2 had been skipped also. In general losses within damage grade 2 were easy to identify. In contrast, it was sometimes

difficult to decide whether a building had suffered moderate structural damage (grade 3) or heavy (grade 4). Problematic cases were handled in a conservative manner.

2.6.3 Assigning Vulnerability Classes

An individual assessment of the buildings' vulnerability classes was not feasible. Even for Visp, where many buildings of those days still exist, it was not possible to correlate all of them with the entries in the damage-lists (see paragraph 2.7). We therefore assigned universally valid vulnerability classes on the basis of typical building types. In this the regional house specification done by Hunziker (Hunziker, 1900-1914) proved very helpful. A reasonable classification for the region and period under study consists of the following building types:

1. Simple stone structure: This type was dominant in the city-like villages of Visp and Brig, and more often encountered in the villages near or at the bottom of the Rhone Valley than in the Valley of Visp or on the mountainside. They consisted of thick, mortar-strengthened walls and had up to five floors. The roofs were usually covered with heavy slates, or sometimes with large wooden shingles weighted down with stones or heavy wooden planks. According to EMS 98, this type of building fits in vulnerability class B with the possibility of some buildings belonging to class A, depending on their condition and quality.

2. Timber structure: Wooden houses were common in the villages of the upper valley of Visp and on the mountainside in general. They usually rested on a small groundwork of simple stone masonry and were constructed as blockhouses with up to four floors. This type of structure is similar to that of a log-house, with the difference that timber is used. Like the simple stone houses, their roofs were either covered with heavy slates or large, weighted wooden shingles. EMS 98 classifies wooden structures in the range between B and E, with the main focus on D. A blockhouse-structure is basically very resistant. The weak point of these houses is their roof. When covered with slates, they are very heavy and thus vulnerable. When covered with shingles, the insufficient stability becomes a problem. Therefore, we assigned this type of building to vulnerability class C.

3. Combined simple stone/timber structures: Basically this type is a mixture of the two first building types. It was probably the most common structure in those days and existed

throughout the investigated region. Usually the walls were built of simple stone masonry up to the first floor, and rarely up to the second floor (Hunziker, 1900-1914, p. 222). The upper part of these three-to-four storey houses, including the roof construction, shows the same architecture as the pure timber construction. EMS 98 doesn't mention a comparable building type. But vulnerability class B is probably the most appropriate estimate.

Results from qualitative analysis were also included at this level of data interpretation. Many of the respective sources contain important information concerning the building stock (simple stone structures/timber structures). Furthermore, we analyzed old photographs and illustrations from (Hunziker, 1900-1914; Fux, 1996). We conclude that the distribution of vulnerability classes was about as follows. Three-quarters of the existing houses belonged to vulnerability class B, including a few structures of class A for buildings in very bad condition. Another quarter belonged to vulnerability class C, with a few buildings in class D for extraordinarily well built timber constructions. We will discuss the uncertainties of this assumption and its possible impact on the resulting intensity degrees in the next paragraph. With the exception of the houses in the city-like villages of Visp and Brig, the majority of the houses had a regular ground plan and were freestanding.

2.6.4 Assigning Quantities

Our results show that the damage fields of the villages in the main valley were dominated by damaged buildings of vulnerability class B that suffered damage of grade 3 (with the exception of Visp which suffered damage grade 4). Likewise, most villages near the Vispa River (Neubrück, Stalden, St. Niklaus) and those on the western mountainside of Visp (Zeneggen, Bürchen, Unterbäch und Eischoll) showed a similar pattern. To the west the proportion of damage grade 2 for buildings of vulnerability class B increased. In contrast to these locations, most other villages on the mountainside consisted of a higher proportion of timber structures belonging to vulnerability class C. Thus, damage fields of these locations exhibited damage grade 3 to buildings of vulnerability class B and C. The absence of damage grade 4 in the villages Grächen, Embd, Staldenried, Eisten, Ausserberg, Rarnerchumma and Hohtenn has to be seen in part as the effect of better building stock.

2.6.5 Results: Distribution of Damage and Intensity Degrees

Figure 2.8 summarizes the results of the assessed damage field on the background of a reproduced map (1:100 000) first published in 1854 (Bundesamt für Landestopographie, 1988). The investigated regions are plotted as pie charts. Their size is proportional to the total number of existing houses at that time. The colored segments indicate the different damage grades. As mentioned, damage of levels 1 and some of 2 were not assessed and are therefore included in the white colored segment representing the undamaged buildings. The assigned intensity degrees are represented by roman numerals. Before going into detail, we will compare this figure with the descriptions and comments in paragraph 2.5. Two differences are obvious.

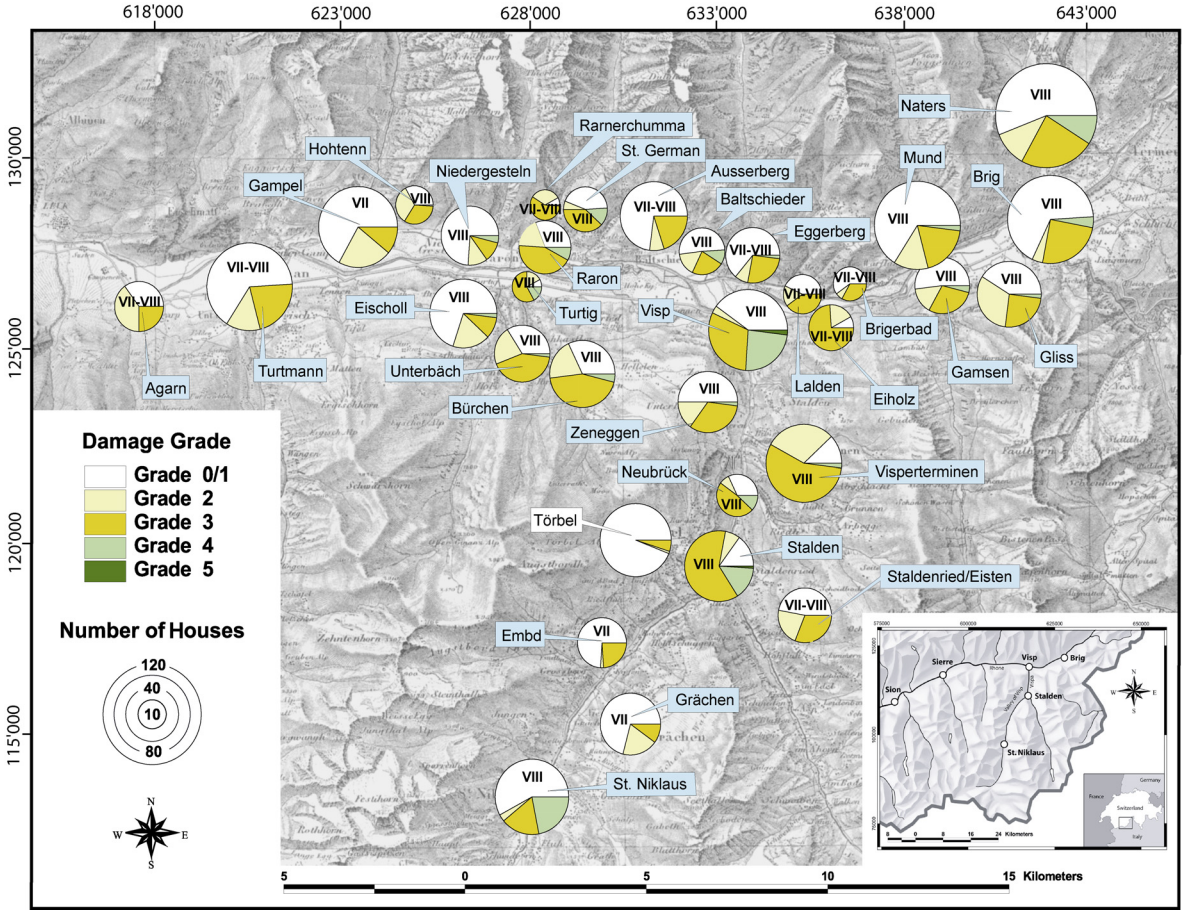


Figure 2.8: Damage grades and intensities assigned on the basis of the damage lists. For locations with intensity degrees in the form of VII-VIII, it was not possible to decide which value is appropriate. They contain elements of intensity degrees VII and VIII. (Grünthal, 1998, p. 57)

While the highest intensities in Figure 2.8 are of grade VIII (heavily damaging), an assignment of intensities on the basis of the quotations in paragraph 4 would instead produce intensities of up to grade IX (destructive). On the other hand, the geographic range containing assured information about losses in this paragraph is much smaller than shown in Figure 2.8.

These are typical phenomena in the context of historical data: historical documents often address a broader public focus in considering the most remarkable or newsworthy effects of an earthquake (Grünthal, 1998, p. 52), particularly if the society believes the consequences of the event as catastrophic. Sources of that type pose the danger of overestimated intensities. In contrast, less spectacular effects tend to be passed over and can lead to underestimating the geographical dispersion of the effects. This phenomenon is often heightened by the relative anonymity of most villages in an epicentral-region compared to a few better known locations, particularly cities. In our case the villages situated in the Valley of Visp were much better known than others. A historical source like the one forming the basis of the quantitative analysis (the damage lists) runs fewer of these risks since its aim was comparable to ours. In general a correlation between the historical information provided in paragraph 2.4 and Fig. 2.8 is clear: The extent of loss increases along the main valley from Agarn via Raron to Visp, where approx. 25% of homes suffered damage grade 4 and a few buildings collapsed totally. The same is true for the Valley of Visp. Stalden and St. Niklaus suffered most with widespread grade 4 damage, while Grächen was much less affected.

After a closer look at Fig. 2.8, the following deserves attention. According to EMS 98 damage occurs in the range of intensity VI and higher (Grünthal, 1998, p. 18-20). But our damage field shows no intensities of degree VI, not even on its borders. This is due to the fact that intensity VI is defined by damage of grades 1 and 2, which did not (or only partly) match the criteria to obtain compensation payments. Thus, we have to assume that outside the figure border localities showing intensities of degree VI were present in 1855. Fig. 2.9 is based on several earthquake catalogues and confirms this assumption, showing the investigated region as part of the entire macroseismic field.

Another distinctive feature is the dispersion of localities with the highest extent of damage grade 4: near or higher than 25%. While the villages of Visp and Stalden are located in the centre, we find Naters and St. Niklaus on the periphery of the damage field. Furthermore all these villages are in the immediate vicinity of others that show a clearly lower intensity with no significantly different building stocks. Both observations suggest that local site-effects could have played a role in the emerging damage pattern. To verify this assumption, we must first produce a higher resolution assessment of the local damage fields of these villages and then perform geologic and seismic investigation. In this paper we will enact the first step in a case study on Visp and present the results of our historical investigations.

The general nature of the damage field suggests that the responsible fault is close to the surface. The geological structure indicates that the mechanism is a normal fault, striking along the Valley of Visp (north south) and dipping to the west (Crealp, 1999). This assumption is supported by C. L. Joris, who observed a neo-tectonic fault approximately 2 kilometres southeast of Visp on the eastern slope of the Valais of Visp. This fault was also visible during construction work on a tunnel (Joris, 2005, personal communication and field visit). Such a fault would explain the macroseismic field shown in Figure 2.9. The intensities in the west of the source (hanging wall) are clearly higher than in the east (foot wall). Finally, the heavy damage in Visp as well as the nonlinear effects to its northeast would support the thesis of this fault's responsibility for the 1855 event. Unfortunately detailed studies concerning this topic were missing until now.

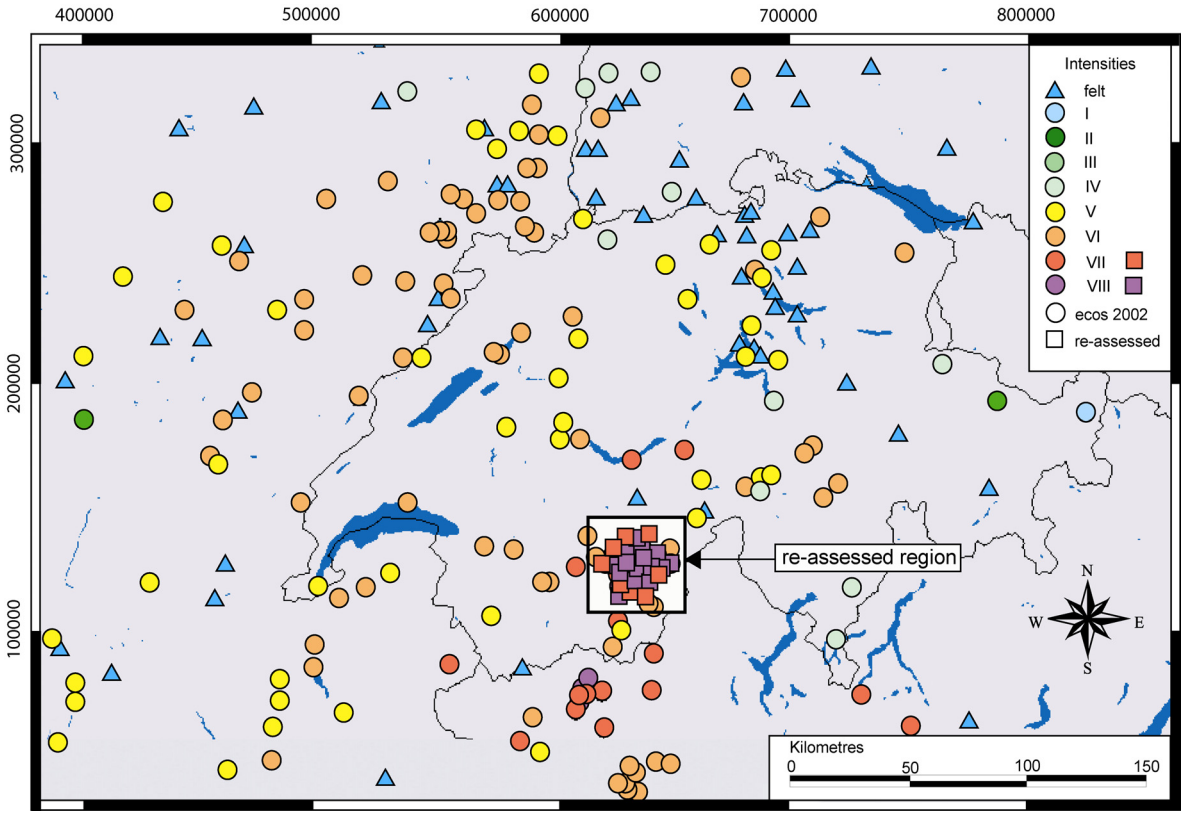


Figure 2.9: Investigated region as part of the entire macroseimic field of 1855. The data for this analysis derive from the revised Earthquake Catalog of Switzerland (ECOS) (Swiss Seismological Service, 2002), from the Italian Catalogo parametrico dei terremoti italiani (Gruppo die lavoro CPTI, 2004)) and from the French catalog SisFrance (BRGM, EDF et al., 2005).

2.7 Visp after the Earthquake in 1855

According to the census of 1860, Visp then consisted of 78 houses and had a total population of 623 inhabitants living in 129 apartments (Statistisches Bureau des eidg. Departement des

Innern 1862, p. 368). A large part of this historical old-town still exists and differs little from the 1850s. This fact allowed us to locate many of the buildings damaged in 1855. For some others no longer existing, it was possible to identify their former position. We were able to locate exactly about 50 % of the houses mentioned in the damage lists.

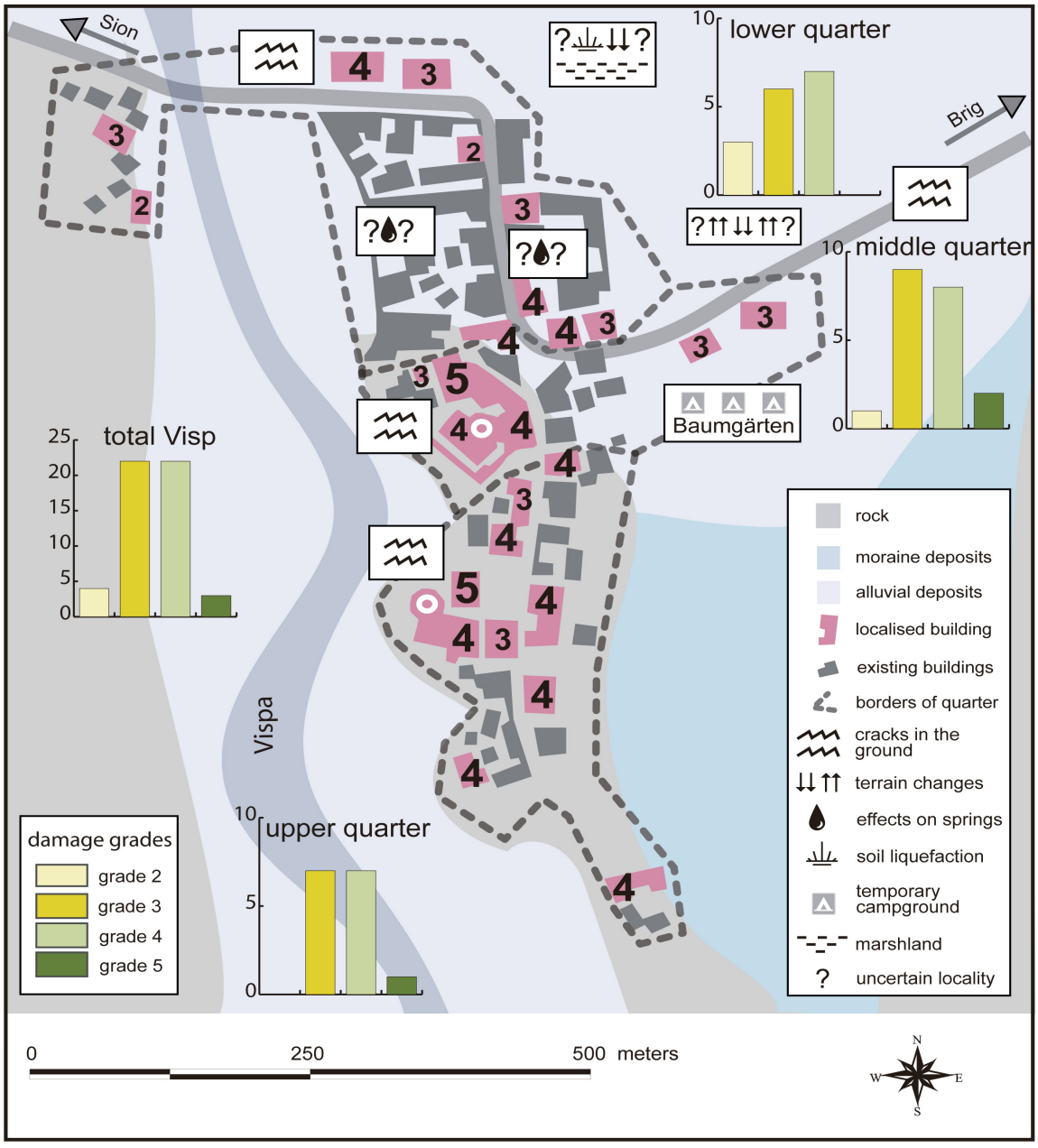


Figure 2.10: Geology, localized buildings, dispersion of damage and approximate position of seismo-geological effects in Visp.

Approximately 20% could be assigned to one of three parts of the township (see Fig. 2.10). This detective work was based upon comparing the damage lists to the original documents of the 1850 population census (StAW, Originaldokumente der Eidgenössischen Volkszählung 1850, Gemeinde Visp) and 1870 (StAW, Originaldokumente der Eidgenössischen Volkszählung 1870, Gemeinde Visp). But even more important than these documents was the

help of the local historian, Christian Fux. His profound knowledge of Visp, its history, and families was indispensable to the completion of this work.

Fig. 2.10 summarizes the results of this historical investigation against the geological background. Exactly located buildings are marked in red. The corresponding number specifies the assigned damage grade. In contrast to this, the black colored houses do not represent the exact situation as it was in the 1850s, but indicate the area of the historical village. The dotted line represents the borders of the historical quarters, as they could be reproduced on the basis of the 1870 census documents. Finally, the bar charts summarize the damage per quarter including that to houses whose location is not exact. All the still existing houses are built in simple stone masonry and belong to vulnerability class B. We assume as well that most buildings no longer existing fit into this category. Indications for this assumption can be found in the photograph of Visp (Fig. 2.11) published by Fux (1996). The bar charts show that the distribution of damage grades is very similar in all three parts of Visp. This is astonishing when we consider that the geological situations of the upper quarter (built on rock) and the lower (built on the large deposits of the main valley) differ significantly. Because of amplification effects, we had expected that more serious damage would have occurred on the deposits than on the rock. The assumption that a site-effect played a major role in the damage distribution in Visp is thus not yet verifiable. A possible explanation for the equal distribution of the damage is a source effect. This thesis would agree with the fault postulated by (Crealp, 1999) and Joris (2005). But to understand better what really happened in the Visp of 1855, we plan to further investigate the local geology and perform extended seismological recordings. For the above-mentioned townships showing analogue potential for site-effects (Stalden, St. Niklaus and Naters), similar considerations should be taken into account.



Figure 2.11: Photograph of Visp in 1856 (Fux 1996, no. 195). Some of the buildings still show damage caused by the earthquake or are under reconstruction.

2.8 Conclusion

To better understand the damage fields of historical earthquakes, we investigated the consequences of the 1855 earthquake in the region of Visp. Since this event is very well documented by contemporary sources, it was possible to reconstruct the damage field with unusual accuracy and an adequate resolution. Published sources on the one hand and a damage evaluation done on the behest of the cantonal government on the other allowed a combination of two different approaches. While the damage-lists were used for a quantitative analysis, the information from the other sources enabled qualitative description of the damage field. Both analyses were done following the guidelines of EMS 98. Comparing the analyses showed in general similar outcomes, but interesting differences in the details. It became obvious that sources addressing a broader public often overestimate particular cases of loss, but underestimate the geographic range of a disaster. This example points out again the importance of treating information based on historical sources with care. In contrast, data

from the damage lists are much more consistent and complete. Given the purpose of these latter documents, their information fits our scientific interest very well. The intensities presented here were assigned after quantitative analysis of these damage lists and with additional information from census documents contemporary with the event. These intensities fall in the range of 7 to 8. The absence of intensity 6 is explainable since damage of grade 1 did not match the government's criteria for financial support. A comparison of all investigated localities shows that the townships of Visp, Stalden, St. Niklaus and Naters suffered most, with remarkable extent of grade 4 damage. Their irregular geographic arrangement and the fact that all these townships are near locations showing much lower intensities suggest that this pattern results from site-effects. The more detailed historical investigation of the damage field of Visp was successful in that we located about 50% of the houses damaged in 1855. Although the ground beneath Visp consists of very different zones of rock and alluvial deposits, the damage was evenly distributed. A site-effect was not identifiable. A possible explanation for this consistent distribution was found in the observation that source effects could have dominated ground motion near Visp. We plan further investigations in Visp and other villages, focusing on their local geological conditions and subsurface fundamental frequencies.

Appendix: Quotations of eyewitnesses

App. A (Nöggerath, 1855, p. 7): "In Sion the traces of the earthquake were small; a few chimneys were collapsed, some walls had cracks and in several rooms the bell rang. […] The first serious cracks in walls occurred in Sierre; I haven't seen them myself.

App. B (Nöggerath, 1855, p. 15): "They run rather parallel to each other through the ground, and continue even through walls of gardens. There are many of this kind of cracks, especially near the bridge crossing the Vispa [River…]."

App. C (Heusser, 1856, p. 15) "Finally I must not forget to mention that the rock, on which the church is built, is cracked. […] The opening [of the crack] had a width of one half to one foot when I saw it […]."

(Nöggerath 1855, p. 15): "[…] in the massive schist occurred numerous vertical cracks. These cracks are a little opened only, but unmistakably new and easy to distinguish from older clefts because of the fresh fracture."

App. D (Colombe 1855, p. 953): "[…] the earthquakes resulted in a clear subsidence of flat terrains in the bottom of the valley, below the level of the Rhone, in a manner that excellent farmland […] is overflowed today and turned into swampland."

App. E (Nöggerath, 1855, p. 15): "During the earthquakes and even much later water poured out of these [cracks] […]; step by step the sources stopped and the cracks disappeared. In Visp itself many of these sources still exist. They even sputter inside a few destroyed houses […]."

3 The 1946 Magnitude 6.1 Earthquake in the Valais: Site-Effects as Contributor to the Damage

By Stefan Fritsche and Donat Fäh

3.1 Abstract

The 1946 earthquake in the Central Valais region in the southwest of Switzerland was the strongest in Switzerland during the last 150 years. It reached an epicentral intensity Io of VIII in the village of Sierre. ECOS, the Swiss Earthquake Catalogue (Swiss Seismological Service, 2002) assigns a moment magnitude of Mw = 6.1 to the event. The earthquake caused moderate to high damage within a circle of about 25-kilometer radius. Slight damage occurred up to a distance of 200 kilometers from the epicenter.

The goal of this study was to reconstruct the damage field on the one side, and to investigate it with respect to possible site-effects on the other side. We used an approach combining historical research with seismo-/geological investigations including a large number of experiments concerning the measurements of the fundamental frequency of resonance and the shear-wave velocities of the sedimentary layers, using the characteristics of ambient vibration. This kind of research is of relevance, since a huge alpine valley characterizes the Valais region, showing ground conditions that make site-effects likely in case of an earthquake. While we searched for damage in an unlimited area, the investigations with respect to site-effects were limited to the Rhone valley in general and to the two locations Sion and Sierre in the Central Valais region in particular.

Since a contemporary damage assessment has survived in fragments only, the results of our historical investigations are incomplete. Nevertheless, it was possible to describe the losses within the epicentral region adequately enough to discuss the possible occurrence of site-effects. Our results show that damage in Valaisan districts with high percentage of settlement area on the lacustrine and fluviatile deposits of the Rhone valley generally show higher losses than other districts. The villages of Sierre and Sion we investigated in more detail. Sion is located on compacted sediments with relatively high shear-wave velocities. The city suffered only moderate damage, rather regularly distributed. In Sierre, on the other hand, we could identify two zones of significantly increased damage, in which site-effects appear to

be a very probable contributor to the observed damage. Local two- or three-dimensional resonance phenomena play an important role in our explanation of this feature.

3.2 Introduction

3.2.1 Overview

It was already dark when the region of the Central Valais was hit by a strong earthquake on January 25 at 5.32 pm. In Sion, the capital city of the Canton Valais and in many other villages nearby the power supply broke down immediately. People rushing out of the houses found themselves on streets covered with rubble of destroyed chimneys, thrown off roof tiles and chipped façade pieces. For many hours, confusion was perfect. Communication lines were overstrained and for some time out of order. It toke several days until the extent of the consequences of this earthquake became clear, with respect to its geographical compass as well as in regard to the severity of the damages. Fortunately, the consequences appeared to be minor than communicated by the newspaper within the first days after the earthquake. Although several villages sustained a lot of damage, severe injury to persons was rare. Three persons died by shock, a forth was crushed by weight of car. A contemporary damage assessment estimates the loss related to buildings to CHF 5.265 Millions. This amount equals about CHF 26 Millions nowadays, and covers only the significant damage to buildings. Beside the losses on buildings, many secondary effects, particularly landslides, rock falls and avalanches are documented.

The 1946 event was the strongest earthquake in Switzerland for more than 150 years. Useful instrumental data concerning this event however do not exist. The few seismometers in use in Switzerland in these days broke all down during the event. ECOS, the Swiss Earthquake Catalogue thus contains exclusively data that rely on macroseismic observations. According to the catalogue, the event reached an epicentral intensity of Io= VIII and a magnitude of Mw=6.1 that was inferred from the macroseismic field (Fäh et al., 2003a). It is supposed that the epicenter of the event is located at 7.40 east /46.35 north (with an uncertainty of 12 km) and that the event occurred in a depth range of about 7-20 km. However, recordings for the same region since 1975 (the start of the analogue short-period network of Swiss Seismological Service) show epicenters at shallower depth in the range of 4-10 km. They all have a significant strike-slip component. Whether the 1946 event in fact occurred at a comparable depth and with a similar fault-mechanism remains an open question.

Another assessment of moment magnitude Mw performed by Bernardi et al. (2005) rests upon amplitude measurements of regional surface waves of seismograms recorded by analog instruments in Europe, outside of Switzerland. With Mw= 5.8, their result for Mw is slightly lower than the ECOS magnitude estimate. According to the yearly reports of the Swiss Earthquake Commission, the series started with two foreshocks in November 1945 (Jahresbericht des Erdbebendienstes der Schweiz, 1945). The stronger of these two shocks occurred on November 10 and reached an intensity of V (Forel-Rossi). Three days later, on November 13 another shock with I= IV (Forel-Rossi) was observed. The assigned epicentral regions for these two events correspond with ECOS data concerning the main shock of January 25 1946. With respect to immediate aftershocks the reports of the Swiss Earthquake Commission (Jahresbericht des Erdbebendienstes der Schweiz, 1946-1950) are not complete, as declared in a personal note at the begin of the report of 1946. Since the seismographs were not operational before 9 pm (on January 25), the report mentions a recording gap of about 3 hours. Moreover, the report of the Swiss Earthquake Commission is also incomplete for the following months and years. Comparison with a later publication of E. Wanner (Wanner and Grütter, 1950), then head of the Swiss Earthquake Commission, shows that the commission considered only few of the aftershocks in the official report. Among them three strong aftershocks. (tab. 3.2)

TABELLE I

Fréquence mensuelle des secousses dans la région épicentrale pour la période 1900-1950

Années	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Année
1900	—	—	—	—	—	—	—	—	—	—	—	—	—
1901	—	—	—	—	—	—	—	—	—	—	—	—	—
1902	—	—	—	—	—	—	—	—	—	—	—	—	—
1903	—	—	—	2	—	—	—	—	1	—	—	—	3
1904	—	—	—	—	—	—	—	—	—	—	—	—	—
1905	—	—	—	—	—	—	—	—	—	—	—	—	—
1906	—	—	—	—	—	—	—	—	—	—	—	—	—
1907	—	—	—	—	—	—	—	—	—	—	—	—	—
1908	—	—	—	—	—	—	—	—	—	—	—	—	—
1909	—	—	1	—	—	—	—	—	1	—	—	1	3
1910	1	—	—	—	—	—	—	—	—	—	—	—	1
1911	1	—	—	—	—	—	—	—	—	—	—	—	1
1912	—	—	—	—	—	—	—	—	—	—	—	—	—
1913	—	—	—	—	—	—	—	—	—	—	—	—	—
1914	—	—	—	4	1	—	—	—	—	—	—	—	5
1915	—	—	—	—	—	1	—	2	—	6	—	—	9
1916	—	—	—	1	—	—	—	1	—	—	—	—	1
1917	—	—	—	—	—	1	—	—	—	—	—	—	1
1918	—	2	—	—	—	—	3	—	—	—	—	—	5
1919	—	1	—	—	—	1	—	—	1	—	1	—	4
1920	—	—	8	9	—	—	—	—	—	1	—	—	18
1921	—	1	—	3	2	—	—	—	—	—	—	—	6
1922	—	—	—	—	—	—	—	—	—	—	8	—	8
1923	—	—	—	—	—	—	—	—	—	—	—	—	—
1924	—	—	—	—	—	—	—	—	—	1	1	—	2
1925	—	—	—	—	—	—	—	—	—	—	1	—	1
1926	—	—	—	—	—	—	—	1	—	—	1	—	2
1927	—	—	—	—	—	—	—	—	—	—	—	—	—
1928	—	—	—	—	—	—	—	—	—	—	—	—	—
1929	—	—	—	—	—	—	—	—	—	—	1	11	12
1930	2	1	—	—	6	—	—	—	—	—	—	—	9
1931	—	—	—	1	—	—	2	1	—	1	—	—	5
1932	—	—	—	—	3	—	—	—	—	—	—	—	3
1933	—	—	—	—	—	—	—	—	—	—	—	—	—
1934	—	—	—	—	—	—	—	—	—	—	1	—	1
1935	—	—	—	—	—	—	—	—	—	—	—	—	—
1936	—	—	—	—	—	—	—	—	—	—	—	—	—
1937	—	—	—	—	—	—	—	—	—	—	1	1	2
1938	—	—	—	—	—	—	—	—	—	1	1	—	2
1939	1	—	—	—	—	—	—	—	—	1	3	2	7
1940	—	—	—	—	—	—	—	—	—	—	—	—	—
1941	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 3.1: Monthly frequency of earthquakes in the epicentral region of the 1946 earthquake from 1900 until 1950, Table 1 in Wanner and Grütter (1950).

The publication by Wanner and Grütter (1950), however lists a total of 517 aftershocks for the year 1946, 44 aftershocks for 1947, 31 for 1948 and 21 for 1949 (Tab. 3.1). Regrettably, the list contains no information concerning the related intensities. However we might expect that all events were felt and have intensities Io smaller than intensity V. Exceptions are the aftershocks listed in table 3.2.

It is interesting to see (table 3.1) that earthquake activity was very low from 1900 until the end of 1945. For several years, the aftershock activity remained high decreasing slowly toward the nineteen fifties. Whether the two mentioned events in November 1945 actually have to be rated as foreshocks or not is not traceable. However, it is apparent that no immediate foreshock occurred that would have warned the population (Jahresbericht des Erdbebendienstes der Schweiz, 1946). Likewise, such a pattern was also characteristic for the 1855 earthquake series in the upper Valais region. It started with a sudden main shock with Io=VIII followed by a long lasting series of aftershocks until the end of the decade (Fritsche, 2006). In contrast the 1755 earthquake series that had its epicenter close to the 1855 event, started with an immediate foreshock so that people left their houses (Gisler, 2004c) It was followed by a main shock of intensity VIII and about 30 aftershocks within the next year (Swiss Seismological Service, 2002).

YEAR	MONTH	DAY	HOUR	MINUTE	CH-X	CH-Y	Mw	Io	Ix
1946	1	25	17	32	597025	133180	6.1	8	8
1946	1	26	3	15	599334	125398	5.2	6	6
1946	2	4	4	11	606037	127624	5.1	5	5
1946	5	30	3	41	598332	127621	6	7	7

Table 3.2: Main- and aftershocks oft the 1946 earthquake series with magnitude Mw larger than 5, verified by the Swiss Seismological Service (2002). ECOS distinguishes two classes of depths for the events: Deep events (about 7-20km depth) and shallow events (about 0-7km depth). The events in the table are all classified as deep events. Of particular interest is the aftershock of May 30 1946, since it triggered a rock fall of about four to five millions m^3 near the Rawylhorn.

3.2.2 Historical Seismicity

The Valais is the area of largest seismic hazard in Switzerland and has experienced a magnitude 6 or larger event every 100 years (1524, 1584, 1685, 1755, 1855, 1946). Damaging earthquakes occur about every 30-40 years (Intensity VI-VIII), with the last event in 1960 close to Brig reaching a macroseismic intensity of VIII. During all such events significant damage occurred from ground motion and different kinds of secondary phenomena such as liquefaction in the Rhone plain, slope instabilities and extended rock fall. (Fig. 3.1) Historical

investigations have shown that the intervals between the earthquakes remained impressively constant for the historically traceable time.

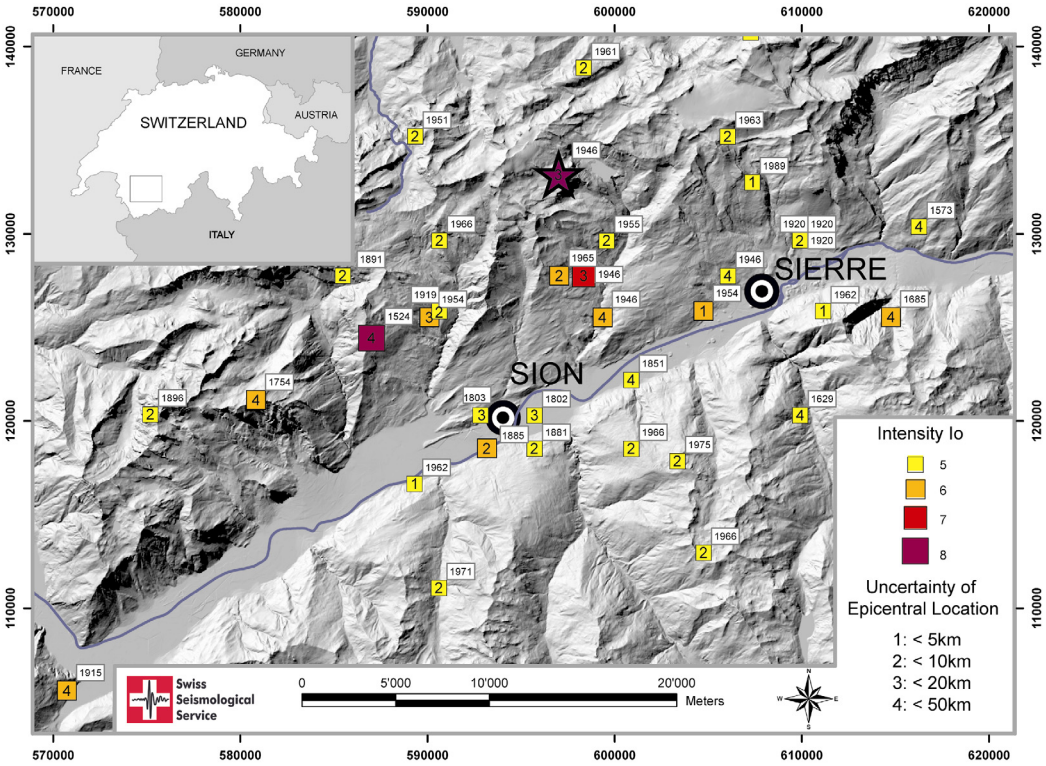


Figure 3.1: Historic seismicity of the middle Valais region based on ECOS data (Swiss Seismological Service, 2002) with Io ≥ 5. :Intensity, epicenter, and uncertainty of the epicentral location.

3.2.3 Significance

What changed significantly during the last century is the use of the land in this region characterized by a large alpine valley of more than 100 km length and a plane with a width of up to 5 km. This plane was not usable for the most part until a comprehensive river correction of the Rhone took place in the 19th and 20th century. Thus, the traditional villages and cities were built either on the valleys slope or on debris cones of tributary rivers, where they were safe from the recurring inundations. With the straightening and canalization of the Rhone River, the plane became interesting for settlement and industrial purpose. Particularly the decades after World War II show a strong and disproportionately high increase of buildings and infrastructure built on the bottom of the valley (see Fig. 3.2) compared to the Valais region in general. Since the valley bottom shows ground conditions that make site-effects likely for wide areas, the seismic risk increases remarkably for this ongoing period. Although empirical observations are absent due to relatively weak seismic activity during the last 40

years, it is assumed, that an event similar to the 1946 earthquake thus would cause significantly higher damage than observed in the past.

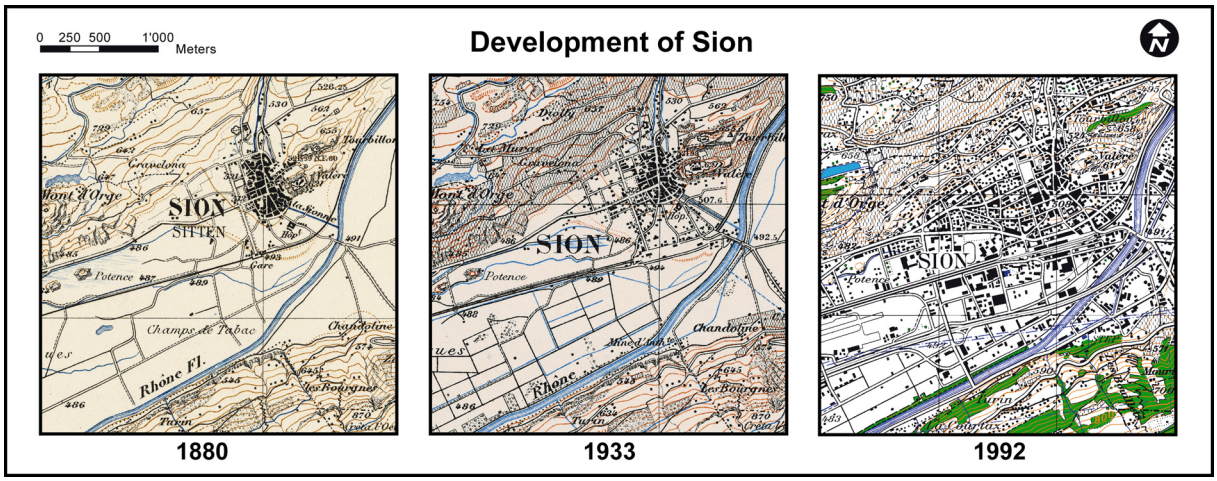


Figure 3.2: Development of Sion from the eighteen-eighties to the nineteen-nineties on historic maps (1:50'000). The figure shows the impressive and still ongoing increase of the city toward the plane of the Valaisan main valley. From the left to the right: first and last edition of the Siegfried map (no. 486) and a contemporary map of the Federal Office of Topography (Swiss Map 25, no. 1306).

In this paper, we will present the findings of our historical investigations concerning the damage field of the 1946 event and the results of field experiments that have been carried out in the cities of Sion and Sierre. We will start with an overview characterizing the entire damage field within the canton Valais. Then we will proceed with the case studies concerning Sion and Sierre. Both of them show interesting ground conditions with respect to potential site-effects as well as a large number of damaged buildings after the 1946 earthquake. The main goal of our investigations was an answer to the question, whether or not site-effects had an impact on the damage field of the 1946 earthquake.

3.3 Methodology

We used an approach combining historical investigations with seismo-geological research, starting with the evaluation of the damage field. Investigation of a large number of historical documents of different types allowed a good qualitative description of the losses within the whole damage field. Most important for this task were newspaper articles. We investigated several dozens newspaper of the affected region and all newspaper with nationwide importance (see paragraph 6, references). Further sources of significance were contemporary scientific journal articles (Wanner and Grütter, 1950; Wanner, 1955; Mercier, 1954; Montadon, 1946; Montadon and Staub, 1946; Marietan, 1946, 1947), the mentioned reports of the Swiss Earthquake Commission (Jahresberichte des Erdbebendienstes der Schweiz, 1939-1956) and documents that give insights into the cantonal council meetings of the respective time (StAW, Protocoles des séances du Conseil d'État, 1946). Unfortunately, a damage assessment accomplished on behalf of the government of the canton Valais is of lower value than expected, since only few summary numbers and amounts of money are known out of it from newspaper articles. The damage assessment itself is lost. A quantitative analysis of the losses thus was possible only in an incomplete way: Newspaper article don't guarantee for completeness, especially concerning the damages of reduced importance. An assessment for individual buildings following the guidelines of EMS 98 (Grünthal, 1998) thus generally was only practicable for buildings showing remarkable damage. Anyhow, for the here focused cities Sion and Sierre our understanding of the occurred cases of damage are relatively good, when compared with other places. While studying historical sources, we focused also on observations related to secondary phenomena. Beside the well-known rockslide at the Rawylhorn, we mapped almost 90 smaller landslides, rock falls, avalanches, and other effects that were triggered by the earthquake of January 25 1946 and its aftershocks.

This first step of historical research was followed by investigations of the ground conditions of the two mentioned sites. For this purpose, we studied the regional geology and carried out field experiments to evaluate the fundamental frequency of resonance at a large number of sites. We investigated ambient vibration H/V spectral ratios. In total, we recorded ambient vibration at 190 sites (75 in Sion, 115 in Sierre) for 20 minutes each and computed the H/V spectral ratios according to algorithms described by Fäh et al. (2001a). Two methods are applied to compute average H/V ratios. The first is the classical polarization analysis in the frequency domain, where *polarization* is defined as 'the ratio between the quadratic mean of the Fourier spectra of the horizontal components and the spectrum of the vertical

component.' We assume that the vertical component in the frequency band of interest, close to the H/V peak, is dominated by the Rayleigh wave. The SH part of the wavefield contributes to the horizontal component of motion in the measurements. If the SH-part could be removed, the H/V ratios would better determine the ellipticity of the fundamental mode Rayleigh wave. This removal requires some assumptions concerning the spectral content of SH-waves. Generally, we assume that the radial component (Rayleigh waves) is equal in amplitude to the transverse (Love waves), and the amplitude of the H/V spectral ratio can then be reduced by log10 (sqrt(2)) when the H/V amplitude is given in a logarithmic scale.

The second method for H/V ratios tries to reduce the SH-wave influence by identifying P-SV-wavelets from the signal and taking the spectral ratio only from them. This is done by means of a frequency-time analysis (FTAN) on each of the three components of the ambient vibrations. In a frequency-time representation of the vertical signal, the most energetic sections are identified in time for each frequency. We assume that this maximum is related to a single P-SV wavelet for which the H/V ratio is computed. The average over all wavelets defines the H/V spectral ratio. For more details we refer to Fäh et al. (2001a).

In addition, we computed the quality of the peak, for all maxima identified in the H/V spectral ratio. This quality of a peak is defined as the average value of 2 quality measures as follows:

$$Q = \frac{(Q_1 + Q_2)}{2}$$

Applied to the H/V curve obtained with the FTAN method. The following definitions are used:

f_0: Frequency of the H/V-peak= Fundamental frequency of resonance

$[f_Q, f_R]$: Uncertainty range of the fundamental frequency of resonance

f_S: Frequency of the first minimum to the left of the H/V-peak

f_T: Frequency of the first minimum to the right of the H/V-peak

The first quality measure of the peak (Q_1) is defined as follows:

$$Q_1 = \frac{\int_{f_Q}^{f_R} \log 10\left(\frac{H}{V}\right) df}{\left(f_R - f_Q\right)} - \frac{\log 10\left(\frac{H}{V}(f_S)\right) + \log 10\left(\frac{H}{V}(f_T)\right)}{2}$$

The second quality measure of the peak (Q_2):

$$Q_2 = 1 + \frac{\int_{f_S}^{f_T} 10^{\left|\log 10\left(\frac{H}{V}\right) - \overline{A}\right|} df}{(f_T - f_S)}$$

$$\overline{A} = \frac{\int_{f_S}^{f_T} \log 10\left(\frac{H}{V}\right) df}{(f_T - f_S)}$$

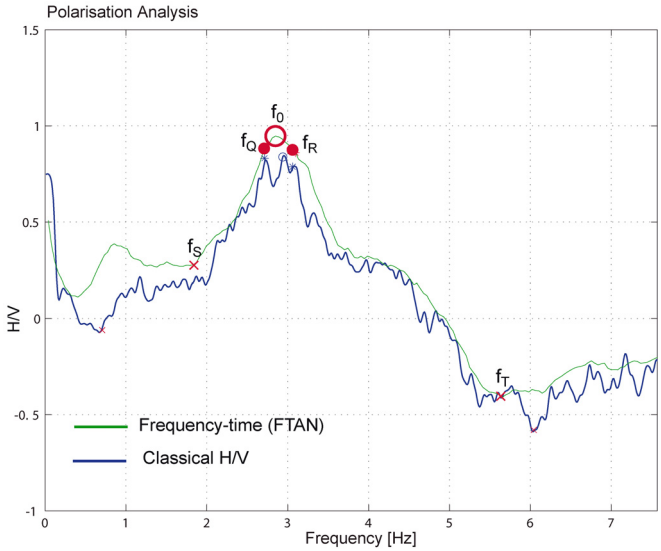


Figure 3.3: Example of a H/V spectrum including the definition of the frequencies f_0, f_S, f_Q, f_R and f_T.

The quality of the peak is not a quantitative measure of the expected amplification, but provides a qualitative description of the impedance contrast between sediments and bedrock. Finally, we included the results from ambient vibration array measurements in our site investigations. These measurements allow a characterization of the sedimentary cover in terms of shear wave velocity as a function of depth. The array method we use is based on the high-resolution frequency wave number estimator or high-resolution beam-forming (HRBF). It was originally proposed by Capon (1969) and further developed by Kind et al. (2005) and Fäh et al. (2008a).

3.4 Results of the Historical Investigations

3.4.1 Overview

The earthquake of January 25, 1946 was felt in an area with a radius of more than 250 kilometers. While the coverage with macroseismic data is dense and substantial for Switzerland (Swiss Seismological Service, 2002) and France (BRGM et al. 2005), data for Italy is sparse, and for Germany and Austria almost absent. Macroseismic data points showing intensity of grade VI and larger (building damage) concentrate in the southwestern part of Switzerland (Fig. 3.4. Serious damage was observed in the Canton Valais and to a much lesser extent in the neighboring cantons Bern (to the north) and Vaud (to the west). In

the Valais, the high intensities (VII-VIII) are observed in the villages and cities in the Rhone valley.

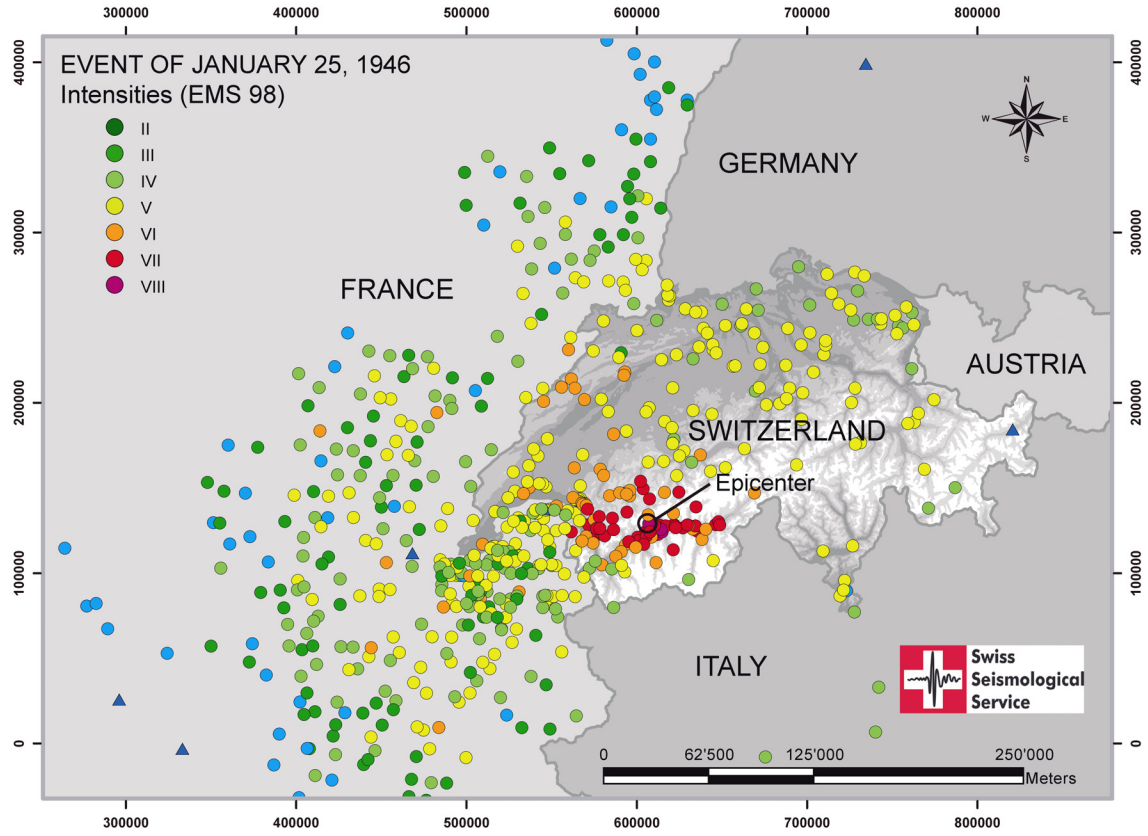


Figure 3.4: Macroseismic map of the January 25, 1946 event based on ECOS data (Swiss Seismological Service 2002) and data from the French catalogue Sis France (BRGM et al. 2005).

A systematic assessment of the losses in the weeks after the earthquake covers only the canton Valais. As mentioned, the relevant documents are lost. All we know rests on a newspaper article that resume a few key data. Furthermore, we know almost nothing about the regulations that ruled this survey. Nevertheless, in combination with statistical data of the census accomplished in 1941 (Bureau Fédéral de Statistique, 1946) a few statements are possible. Tables 3.3 and 3.4 resume the known key data of the assessment. They are not fully consistent, as a summation of the partial amount shows (compare the total damage costs given in table 3.3 and 3.4 as well as the cost assigned to the two building categories in table 3.3). We don't know whether these are errors or rather, a consequence of the approach used for the damage assessment. However, for the calculations shown here the differences are of minor impact.

In total 3485 buildings suffered damage. By far the largest part of the assessed loss relates to damage on residential buildings (about 85%). The remaining 15% concerns public

buildings, churches, and schools. This simple classification reveals that industrial buildings and buildings with agricultural purpose probably were surpassed in the course of the assessment. An interpretation of this data is delicate, since we don't even know how many of the damaged buildings belong to which of the two classes. Assuming that the number of public buildings, churches, and schoolhouses must have been small, when compared to residential buildings (we estimate that this building category makes about 5% of the assessed buildings), we can conclude, that almost every sixth residential building of the canton Valais suffered damage. The average loss per damaged building within the residential building class thus equals to an amount of CHF 1314.-. That corresponds to about CHF 6400.- today, taking into account also the inflation.

Assessed damage in CHF (2006) approx.:	26'000'000.-
Assessed damage in CHF (1946):	5'265'345.-
Damage on public buildings, churches and schoolhouses:	850'130.-
Damage on residential buildings:	4'351'880.-
Total number of residential buildings:	21'744
Number of damaged buildings:	3'485

Table 3.3: Summary of the lost original contemporary damage assessment, done on behalf of the Valaisan government in 1946 (Walliser Nachrichten, May14, 1946). The total number of existing residential houses in 1946 rests upon on a data collection of the Bureau Fédéral de Statistique (1946). The inflation-adjusted amount in CHF bases on data available via http://www.portalstat.admin.ch/lik_rechner/d/lik_rechner.htm.

In addition to the data resumed in table 3.2, the newspaper article discussing the damage assessment includes rudimentary information related to the geographical distribution of the loss. The canton Valais consists of 14 districts for which the article mentions the total loss in CHF (Walliser Nachrichten, May 14, 1946). The total number of then existing residential buildings we extracted from the mentioned statistic (Bureau Fédéral de Statistique, 1946). Assuming that the proportion of residential buildings and the building class consisting of public buildings, churches and schoolhouses is about the same for all districts (95% to 5%), we can calculate an average loss per "assessed building and district". In addition to this value, we estimated the portion of buildings per district built on the plain of the main valley at the time of the earthquake, where we expect higher amplification during ground shaking. This has been done on the basis of contemporary maps, where we decided for each village of a district, whether it is located on the plane of the main valley or not. For most cases, decision-making was easy and we could assign the villages to one of the two categories. In a few cases of villages only partly built on the sediments of the plane, we took only a corresponding number

Brig	62'300.-
Conthey	120'875.-
Entremont	2'450.-
Goms	2'900.-
Hérens	252'930.-
Leuk	557'420.-
Martigny	17'950.-
Monthey	9'000.-
Westlich Raron	19'200.-
Östlich Raron	2'450.-
St. Maurice	33'060.-
Sierre	3'351'880.-
Sion	900'140.-
Visp	32'720.-
Total	**5'365'275.-**

Table 3.4: Loss per district in CHF. (Walliser Nachrichten 14.05. 1946)

of buildings into account. Comparison of the results of this calculation is given in Fig. 3.5. The background shows a zoomed view of the macroseismic map (Fig. 3.4).

Not surprisingly, the highest values are related to the districts in the immediate vicinity of the epicenter. Thereof Sierre shows by far the maximum loss per building with CHF 1071.-. It is followed by the district of Sion (CHF 484.-) and Hérens (CHF 206.-). In general, then the values decrease with distance to the east and to the west. However, we can recognize certain variations. Brig (to the east), for example shows a higher value (CHF 48.-) than Visp (CHF 20.-) or Westlich Raron (CHF 25.-), although the latter are closer to the epicenter.

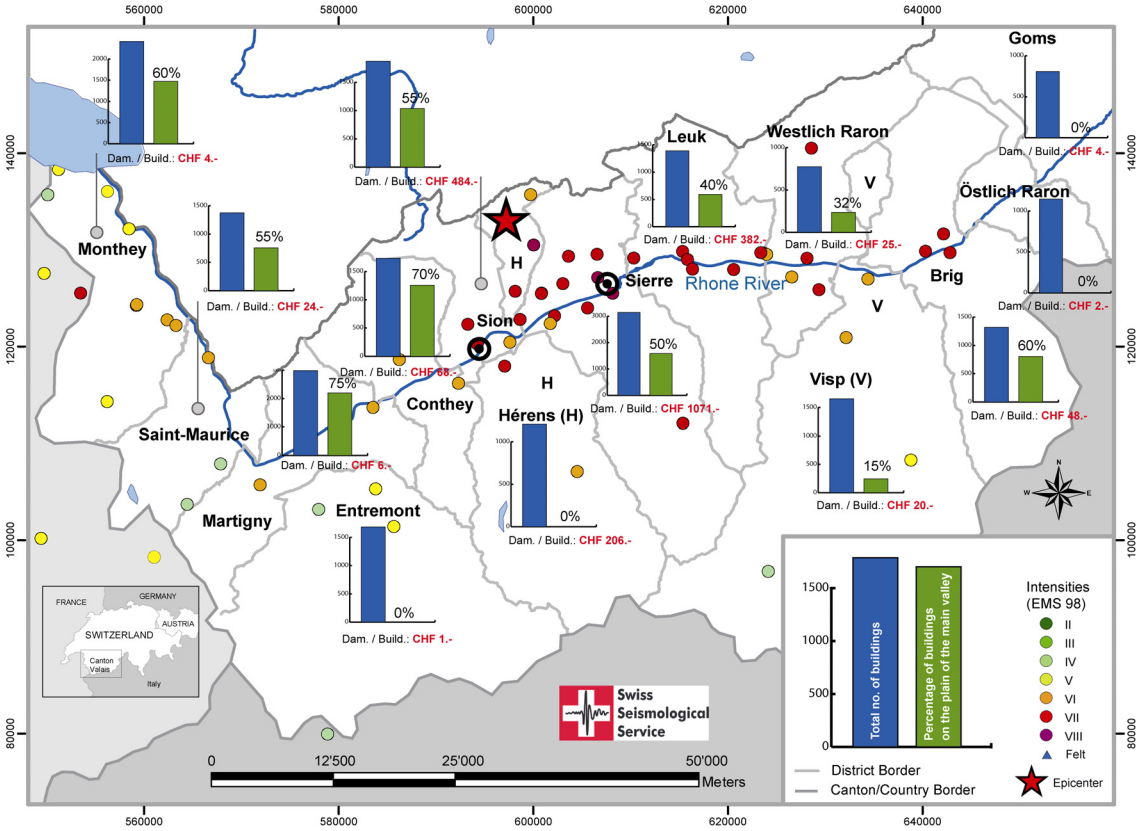


Figure 3.5: Distribution of the loss per district in the Canton Valais, together with the macroseismic intensity data points. The loss per building and district in CHF rests upon data of the lost damage assessment (Walliser Nachrichten, May 14, 1946). The numbers of existing buildings relay on a data collection of the Bureau Fédéral de Statistique (1946). The percentage of buildings located on the plain of the main valley is an estimation based on maps (Siegfriedkarte, Letztausgabe, 2003b. Nr. 476, 477,481, 482, 483, 485, 486, 487, 496, 497, 526, 527) and the just mentioned data collection.

Entremont finally (to the southwest) shows clearly lower losses (CHF 1.-) than its neighboring districts. Martigny (CHF 6.-) with a high portion of buildings located in the Rhone plain on the other hand sticks out through its low value in comparison with Conthey (CHF 68.-) ore Saint-Maurice (CHF 24.-). An explanation for these findings is fragile since they rest upon rudimentary data. However, it is evident, that the average loss is strongly affected by the portion of buildings located on the sediments of the Rhone valley. Brig in this regard shows a high portion of buildings located in the main valley (60%) as well as a high average loss per building (CHF 48.-) compared with Westlich Raron (32%, CHF 26.-) and Visp (15%, CHF 21.-). Entremont that is located completely on the mountainside without settlements in the main valley shows an average loss clearly below its neighboring districts (CHF. 1.-). Two explanations for this phenomenon may be taken into consideration. First, the plain of the main valley shows unfavorable ground conditions for the bigger part. These consist of poorly consolidated sediment deposits of a thickness up to 1000 meters (Rosselli, 2001). Roten (2008) showed with recorded data and numerical simulations for the region of Sion, that these lacustrine and fluviatile sediments have a large potential for amplification effects. Fritsche et al. (2006) pointed out in context with the 1855 earthquake in the Visp region, that several villages in the main valley showed high intensities and remarkable damage compared with settlements on the mountainside. Thus it is probable, that in the case of the 1946 earthquake, districts with large portion of buildings located on the plain of the main valley suffered higher loss. A second explanation refers to building vulnerability. Although systematic data about the building stock does not exist for the respective decades of the 20th century, qualitative investigations have shown (Fritsche, 2006) that in the relevant region buildings on the mountainside tends to constructions in timber for the most part. In contrast, the villages and cities in the main valley show to a much higher degree structures consisting of simple stone, massive stone or brick, that are more vulnerable to ground shaking. Over all, a combination of the influence of ground conditions and building vulnerability is likely and a reasonable explanation for the findings. Not explainable by this assumption is the strong decrease of loss per building from the district of Conthey (CHF 68.-) to the Martigny district (CHF 6.-), particularly because both show comparable portion of buildings located on the plane of the main valley. The decrease from Sion (CHF 484.-) to Conthey however is of similar size, simply on a higher level.

Despite systematic investigation of several dozens of different newspapers and of other potential sources, the gathered information concerning damage on individual buildings is poor (Table 3.5). In total, we could evaluate the damage of 167 buildings. For 105 of these

buildings we identified the exact location. With respect to the Canton Valais, we identified 121 damaged buildings, whereas we know exact location for 65 of them. For another 35 damaged buildings, we know their position, without having information concerning the kind of damage (See the paragraph 3.5.2).

Verified cases of damage:	of grade 1	of grade 2	of grade 3	of grade 4	total	thereof localised
Within the Canton Valais	9	43	55	14	121	65
Outside the Canton Valais	3	32	11	0	46	40
Total	12	75	66	14	167	105

Table 3.5: Damage on individual buildings assessed in the course of this study. To the bigger part, data rely on newspaper article. With respect to also Sierre, the publication of Wanner and Grütter (1950) was a useful source. Not all of them we could localize accurately.

3.4.2 Secondary Effects

Beside damage on buildings, our historical investigations focused likewise on secondary effects. In total 88 observations have been verified (Fig. 3.6) 1946. Sixty-six thereof arose from the main shock of January 25. The remaining 25 observed secondary effects occurred in course of the strong aftershock of May 30 1946. About 90% of these data rely on newspaper articles. The others rest upon a document of the cantonal Administration (Staatsrat des Kantons Wallis, 1947) The most of these effects occurred in a circle of about 20 kilometers diameter around the epicenter. Almost all effects toke place north to the Rhone valley. Table 3.6 resumes the observations in groups of comparable types of effect and assigns them to the main or to the mentioned aftershock. The class of "large rock fall" consists of two events that occurred at the Rawylhorn. Particularly the one that happened on May 30 was of remarkable dimensions. Wanner and Grütter (1950) write of 4-5 millions cubic meters of stone, that overwhelmed a small lake and a mountain pasture. In addition, also the large rock fall of January 25 had severe consequences

Secondary effects	Number of effects		
	January 25	May 30	Total
Large rockfall	1	1	2
Rockfall	20	21	41
Landslip	11	3	14
Cracks in the ground	6	0	6
Terrain changes	6		6
Avalanches	4	0	4
Effects on springs	11	0	11
Visual phenomena	4	0	4
Total	63	25	88

Table 3.6: Secondary effects observed in the course of the 1946 earthquake series.

as it destroyed a couple of mountain huts, pastures, and parts of a forest. The class of "rock fall" in contrast resumes events of smaller dimensions, from a few boulder that fell down to rock falls of several hundred cubic meters rock material. Of similar dimensions were the events resumed in the landslip class. Some of them destroyed or overwhelmed roads (near Leukerbad, Ayent, Gampel, in the Val d'Anniviers). Another has interrupted the railways near Aigle.

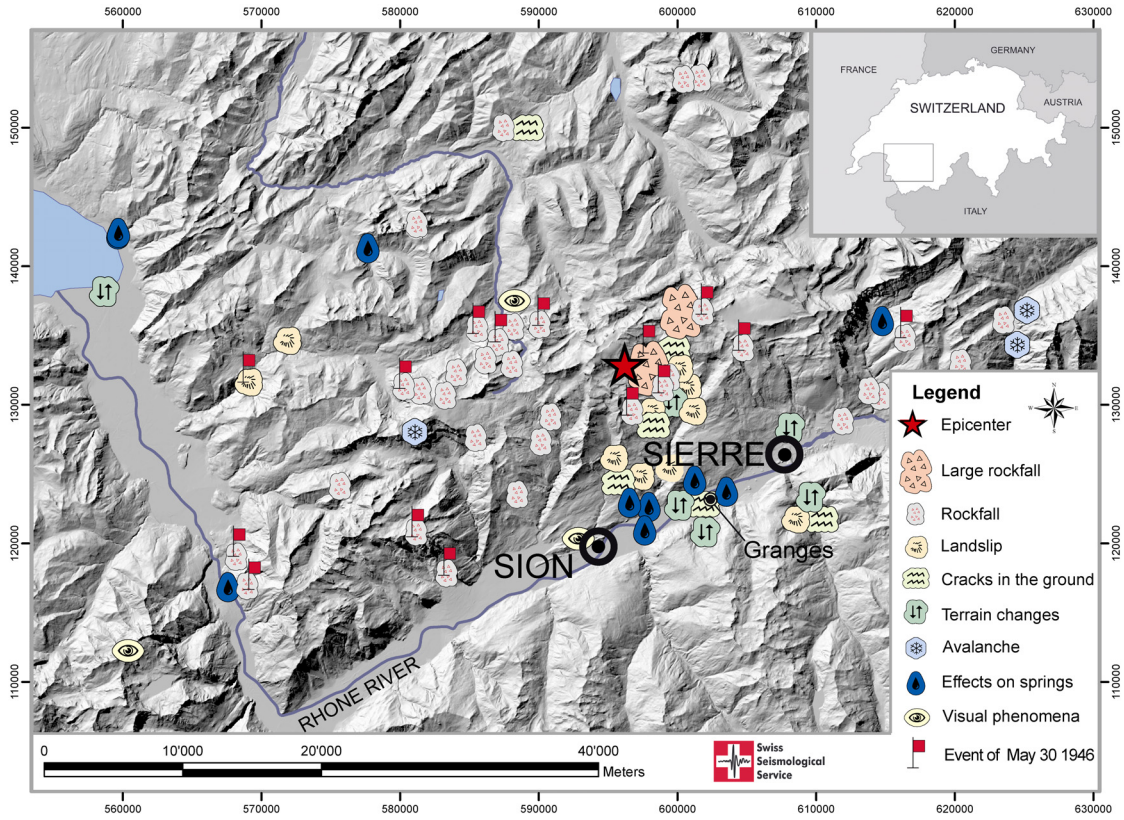


Figure 3.6: Seismo-geological effects observed in the Valais and the neighboring Cantons. The figure includes effect occurred during the main shock as well as consequence of the aftershock of May 30, 1946.

The observed cracks in the ground are probably of minor extent. Some of them occurred on the plain of the main valley (e.g. in Granges near Sierre) others on the mountainside. Not for all observations of this type, we found a locality. Interesting is the class of terrain changes. It includes a collapsed road at the waterside of lake Geneva near Villeneuve, a partly caved in coal mine near Grone (8 kilometers to the southwest of Sierre) and terrain changes on the sides of the Rhone channel at the same location. Avalanches were triggered on January 25 only. Many of them have been observed in the massif of Les Diablerets and in the Valley of Lötschen (20 kilometer to the northeast of Sierre) and between Brig and Domodossola (Italy), where they spilled the railways on several locations. Effects on springs occurred in a radius with more than 40 kilometers from the epicenter. Particularly frequent were observations in

the region between Sierre and Visp where the flow conditions and the water temperature of several sources changed or new sources emerged (Bund, February 2, 1946; VZ, February 1, 1946, ObT, January 28, 1946). Interesting to note is also the fact that the huge subterranean lake (of 6000 m^2 surface) near St. Leonard just in the same region lost a lot of water after the main shock. The lake is situated in the northern slop of the Rhone Valley were it has been formed in a layer of gypsum by the circulation of water over a long period. After the earthquake, water leaked through small fissures into the ground for a certain time (Lac souterrain, 2008). Finally, we found some reports of optical phenomena. They all describe observations of an enlightened sky by "fire" ore thunderbolts in an unspecific way.

In the next paragraphs, we will have look at the damages observed in Sion and Sierre, the two largest cities in the epicentral area. They will be discussed in combination with the findings of our site investigations.

3.5 Site Investigations and Damage Distribution for Sion and Sierre

3.5.1 Sion

In the nineteen forties Sion was a small town with a population of hardly 10'000 persons. It consisted of a medieval centre surrounded by a less dense belt of buildings originating mostly in the 19th and 20th century (Fig. 3.7). Comparison with figures 3.7 and 3.8 points out, how remarkably the city developed during the last six decades. The buildings of the medieval centre consist of a simple stone structure to a large part and have two to four floors. The few public buildings mostly constructed in massive stone have up to four floors. Building vulnerability thus is relatively high in general. Vulnerability class B according to the European Macroseismic Scale (EMS 98) is probably a good assumption for most of the buildings. When the construction or parts of it were in bad conditions, contemporary photographs show that this is particularly true for chimneys and roofs of the medieval centre of the city) vulnerability class A is the correct class. The buildings in massive stone tend to class C. The buildings outside the medieval centre consisted of unreinforced masonry either with manufactured stone units or in massive stone. Vulnerability class B ore C are appropriate estimations for this group of buildings.

Figure 3.7 resumes the assessed damage for which we could identify the location adequately. Reports describing the losses in Sion in a general way, point out that the damages were serious, but not disastrous. "Debris of al sorts cover the ground: Chipped chimneys,

cornices, roof tiles, etc. In certain apartments parts of the ceiling cave in and the floors are covered with rubble." (Michelet, 1990) Other sources write of a large number of broken store windows and cracked walls in the old part of the city (Journal et feuille d'avis du Valais, January 28, 1946; Nouvelliste Valaisan, January 27, 1946). "But one has to enter the buildings to become aware of the danger we just escaped." emphasizes Le Confedere on January 28, 1946. "The walls are cracked, the ceilings are striped [Because the gypsum fell down from the battens. Annotation from the author.] and the dishes are broken."

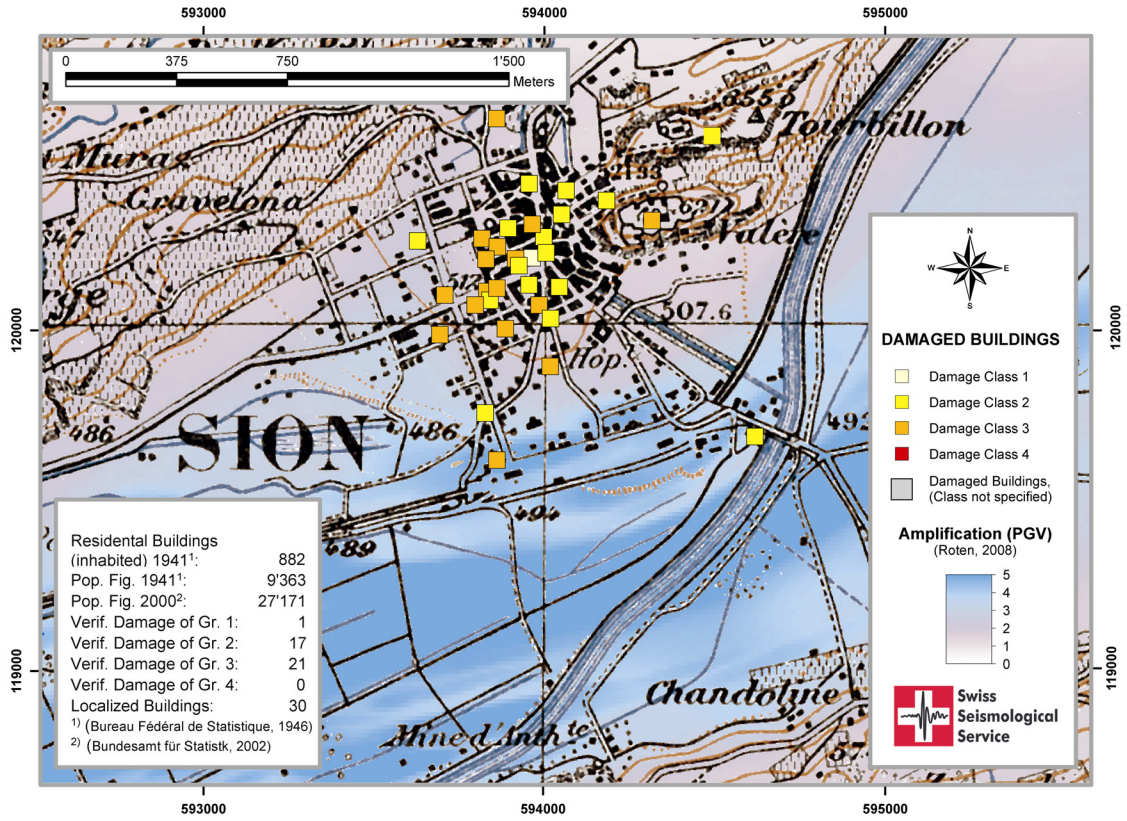


Figure 3.7: Sion on its extent of 1933 (Siegfriedkarte, Letztausgabe, 1933) including localized building damage and the modelled amplification in PGV for the 1946 event (Roten, 2008) . Since the city almost not increased during the following decade, the map represents just as well the situation of 1946.

Our investigations have shown in fact, that the earthquake caused a considerable loss in the city of Sion. Nevertheless, while hundreds of chimneys suffered damage or collapsed, and while pieces of plaster, roof tiles and cullet of broken windows, covered the roads, structural damage was rare. A few buildings showed large and extensive cracks in many or most walls, in a cinema the ceiling collapsed partly, on other houses the chimneys broke at the roofline and penetrated the roof. Since we could not fall back on systematic damage data, our reconstruction of the losses is not complete. It is to assume that damage of grade 1 and as well of grade 2 was omnipresent in the city. Damage of grade 3 was definitely significantly less frequent. Nevertheless, it is difficult to estimate how complete our reconstruction is. In the

case of damage grade 3, the reconstruction is probably good, but not complete. We estimate the grade of completeness in the range of 60-80%. In the case of damage grade 2, most probably we could find only the smaller part of the actual loss. In most of the sources, information comes up in a general mode, without sufficient information concerning locality. Damage of grade 1 anyway was not an issue.

Macroseismic Intensity VII, already suggested by ECOS (Swiss Seismological Service, 2002), is the proper intensity for the city of Sion and the 1946 earthquake. Intensity of grade VIII was clearly not reached. An important observation is that damage of grade 3 occurred to an increased degree to the southwest. Although figure 3.7 does not include all losses of grade 3 it is an indication that amplification was stronger in this part of the city, since we have no evidence that our sources cover this part of the city better than the northern part. This finding is in accordance with the results of Roten et al. (2008) who performed numerical simulations of the 1946 event, using a three-dimensional structural model of the area. The grey and blue colors in the background of figure 3.7 represent the modeled amplification of ground motion indicating the factor of amplification at a frequency of 4hz relative to a reference site on rock. We can see that according to Roten's model the Old Town of Sion was only slightly affected by amplification effects. To the south of the city were damage of grade 3 is more frequent the supposed amplification from the simulation starts to increase. This suggests that site-effects were of minor importance for the damage reported in Sion. Roten et al. (2008) show by numerical simulation that this is however specifically due to the position of the seismic source of the 1947 event relative to the 3D basin in the historical city of Sion. For other source locations thus amplification effects are considerable.

Figure 3.8 resumes the results of our field experiments. We used H/V spectral ratios computed from ambient vibration recordings to estimate the fundamental frequency of resonance. The generally clear peaks of the H/V spectral ratios are qualitatively expressed with the size of the circles. Figure 3.9 shows three typical examples of H/V spectral ratios. A large amplitude of the peak indicates a large impendence contrast between sediments and bedrock.

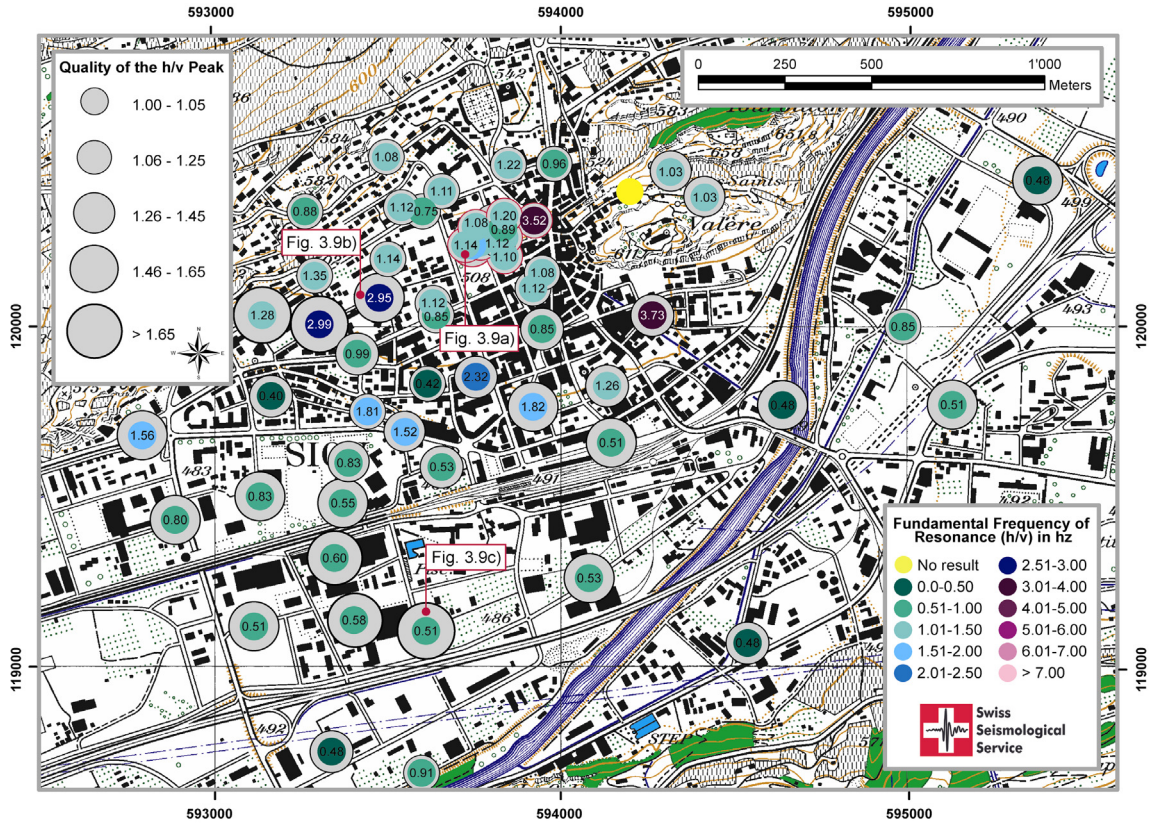


Figure 3.8: Results of the field experiments concerning the fundamental frequency of resonance (colored dots). The grey circles in the background indicate the quality of the peak in the h/v spectra. Large circles are an indicator for strong impedance contrasts. Points with red outer circles are part of arrays that we used to determine the local S-wave velocity profiles. Map in the background: Swiss Map 25. 2000. Nr. 1306, Sion, 1992.

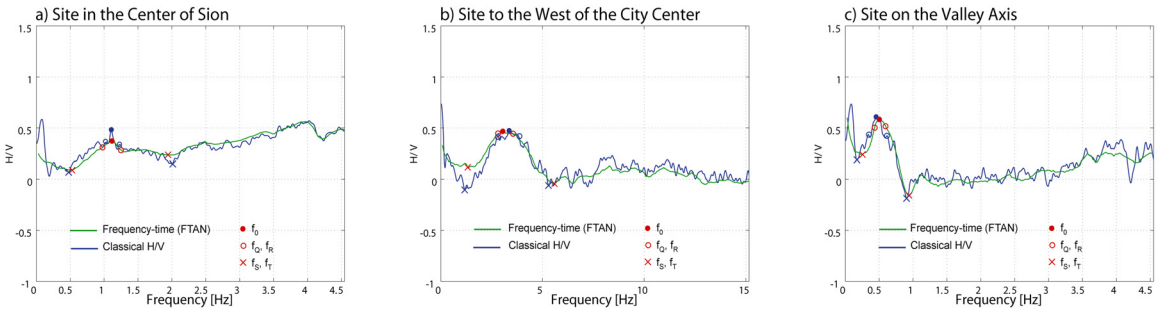


Figure 3.9: Three examples of H/V peaks for sites in Sion. The position of the corresponding sites is indicated in figure 3.8 by letters.

The f_0 values reflect the characteristics of the Rhone valley at Sion. With a few exceptions, the distribution of the f_0 values is homogeneous. Along the valley axis, in the deeper part of the basin, f_0 is in the range of 0.5Hz (Fig. 3.9c). This frequency is related to the global 2D resonance of the Rhone valley, with sedimentary infill of up to 500m (Roten et al., 2008). H/V spectral ratios are due to these 2D resonances. Towards north below the historical part of the city, f_0 increases to values around 1 Hz (Fig. 3.9a). To the west of site 9a, a couple of

locations show pronounced peaks in the H/V ratio (Fig. 3.9b). To the east, the rocky hills of Valère and Tourbillon limit the area with significant deposits of sediments.

Array measurements of ambient noise were conducted at several places in the Rhone valley (see Fig. 3.8 for the sites in Sion) to constrain the shear-wave velocity of the sedimentary fill (Roten and Fäh, 2007; Roten et al., 2008). The surface sediments in the area can roughly be subdivided into two categories (Roten et al., 2008):

(i) Fine lacustrine and deltaic deposits: At such sites a very shallow low-velocity layer (less than 15 meters deep) with shear-wave velocities as low as 100 ms−1 can be resolved. Below this layer, Vs ranges between 320 and 500 ms−1 until about 250 meters depth, where a strong velocity contrast occurs, and Vs increases to 650 to 800 ms−1. Shear-wave velocities in the lowest part of the sediment are in the range between 700 and 1000 ms−1 (see Roten and Fäh, 2007, for detailed results).

(ii) Alluvial fans in the old town of Sion and in Bramois in the southeast of Sion: Apart from a shallow low-velocity layer, shear-wave velocities are much higher at these sites, with values of more than 600 ms−1 measured close to the surface.

Roten et al. (2008) suggested that there is no sharp transition between fine lacustrine and coarse alluvial deposits. The transition however, is indicated by the quality of the H/V peaks at sites in the southern border of the historical city (Figs. 3.8 and 3.9). A small impedance contrast due to the high S-wave velocities in the alluvial fan leads to reduced amplitudes of the H/V ratio. The fine lacustrine and deltaic deposits in the south increase the impedance contrast and therefore the amplitude of the H/V spectral ratio.

3.5.2 Sierre

Historical sources agree fully, that Sierre suffered by far most from all affected villages and cities. Numerous newspaper article point out that Sierre gave a sad picture after the main shock. “In Sierre,” wrote the Nouvelliste Valaisan (January 27, 1946), “everything has been displaced: the stoves, the furniture, the armoires. Ceilings broke down, the walls are cracked and slashed; outside, roof tiles fell down, and chimneys are disrupted.” On January 29, the Journal de Sierre came up with information that is more detailed. “There is damage everywhere. The facades of so many houses show cracks of smaller or larger dimensions; […], about 400 chimneys collapsed“ but ”the quarter that suffered most is the one of Beaulieu […].” This was also the conclusion of Wanner and Grütter (1950) who mapped the most seriously damaged buildings in Sierre. They explicitly pointed out, that the losses

concentrated mainly on two well-defined localities. “The quarter that suffered most is situated to the west of the railway station [Quarter of Beaulieu, Ann. Authors].” (Wanner and Grütter, 1950) Another zone of heavily damaged buildings they identified “in the northeast of the railway station”. Figure 3.7 illustrates the cases of loss shown by Wanner on the background of a map of Sierre of 1933 (Siegfriedkarte, Letztausgabe, Nr. 482). The gray squares indicate the buildings identified by Wanner. The colored squares show further damaged buildings identified in the course of our investigations.

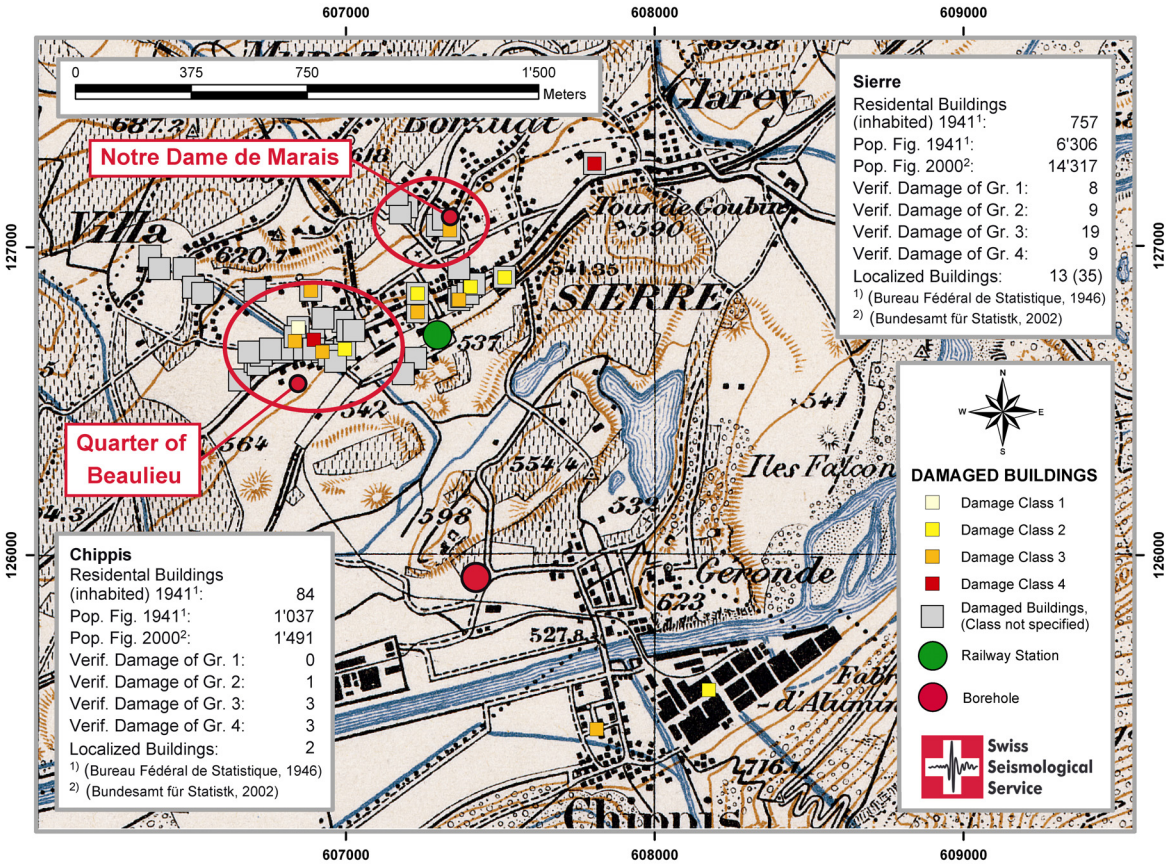


Figure 3.10: Sierre on its extent of 1933 inclusive localized building damage. As in the case of Sion, Sierre developed only marginal in the years before the earthquake. Beside localized and assessed buildings the figure includes buildings, that were mentioned by Wanner and Grütter (1950) as the ones that suffered “most” (gray squares).

Apart from the buildings identified by Wanner, we found independent information about 45 damaged houses, but could only 13 of them localize properly. Almost all of them are identical with buildings mentioned by Wanner. It is as likely as not, that as well many of the not localized buildings correspond with the damaged buildings mapped by Wanner. Comparison of damaged objects identified by us as well as by Wanner, showed, that the latter, by him simply mentioned as “the buildings that have suffered the largest damage” (Wanner and Grütter, 1950), sustained damage of grade 3 to 4. Nevertheless, we passed on to mark the

objects in figure 3.7 by accordant symbols, since this would pretend better accuracy than existing.

Wanner explains the concentration of losses to the two well-defined areas with building vulnerability as well as with the ground conditions. He mentions that the buildings at the Beaulieu quarter have been built at the beginning of the 20th century, at a time where "[…] one has used quicklime for the construction […]", what has weakened the construction with respect to ground shaking. In contrast, neighboring buildings built in reinforced concrete, he remarks, have resisted to the "shocks without any important damages." (Wanner and Grütter, 1950, p. 41). We have not much information concerning the building vulnerability at the Beaulieu quarter since in the last 60 years a lot has changed. Nevertheless, vulnerability class B is probably a reasonable assumption. Most of the damaged buildings we have localized and assessed in Sierre belong to this class. A few others, mainly historic buildings as for example the church of Notre Dame de Marais (damage grade 3) include elements that belong into vulnerability class A. Buildings of vulnerability class C showed only minor damage. The height of the buildings varied from two to four stories in Sierre in the respective time. Over all, building vulnerability is hardly the determining factor for the formation of the damage field as shown, even tough our knowledge is limited concerning this matter. As Wanner, we assume that ground conditions had a crucial impact on the damage distribution. Wanner mentions, that the zone of damage to the west is located on an alluvial cone for the bigger part. The zone with damage to the northeast was according to his comments in earlier days an area of swampland (Wanner and Grütter, 1950). A hint for this is also found in the name of the mentioned damaged church of Notre Dame de Marais, since "marais" ist the French expression for swamp- or marshland.

Nevertheless, the geology of the Sierre region in general is much more complex compared with Sion. Sierre is located at least partly on a debris deposit of a rockslide of about 1000-2000 *10^6 cubic meters (Abele, 1974) that characterizes the infill of the valley as well as the geomorphologic situation of the site. According to Burri (1954) this landslide occurred after the glacier of the ice age retreated. However, later on the glacier passed over again and left his marks on the geomorphology of the region (ibid.). On the northern slope of the valley, where the historic village of Sierre is located, debris of alluvial cones of variable thickness from creeks entering the main valley covers the material of the rockslide partly. In conformance with Wanner, the map of Burri (Fig. 3.11) shows that the Beaulieu quarter's location is on this alluvial cone. The eastern part of Sierre is built partly on the material of the landslide, partly on fluviatile sediments too. The part of Sierre south of the railway station to the village

of Chippis is built on alternating sediment layers deposited by the landslide and the Rhone River. Borehole information available north of the river (about in the centre of the valley, see Fig. 3.10) shows landslide material at a depth of 50 meters (Strassenbauamt des Kantons Wallis, 2007). We assume that this deposit material exists also at larger depth. Rosselli (2001) estimated the maximum thickness of the whole infill to about 330 meters.

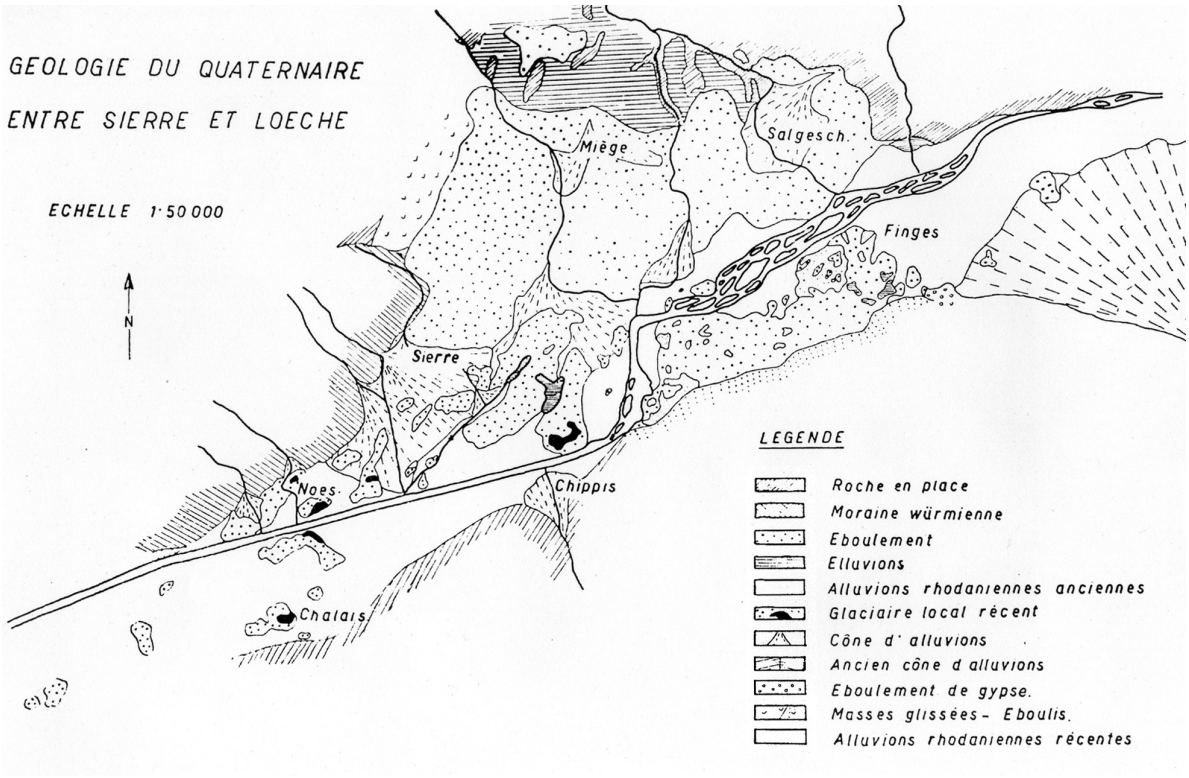


Figure 3.11: Geological situation of the Sierre region. (Burri, 1954)

As in the Sion region, we performed also in Sierre a large number of ambient vibration H/V measurements. In total, we recorded ambient vibration on 115 locations. Figures 3.12 and 3.13 show the results of these experiments. In contrast to the results of Sion, most of the H/V spectral ratios computed for the Sierre site show two peaks, the first in the frequencies range between 0.7 and 1.9 Hz (Fig. 3.9), the second peaks between 1.8 and about 10 Hz (Fig. 3.10). In general the latter are better developed, which is visible in figures 3.12 an 3.13 by the given quality of the peak (grey circle).

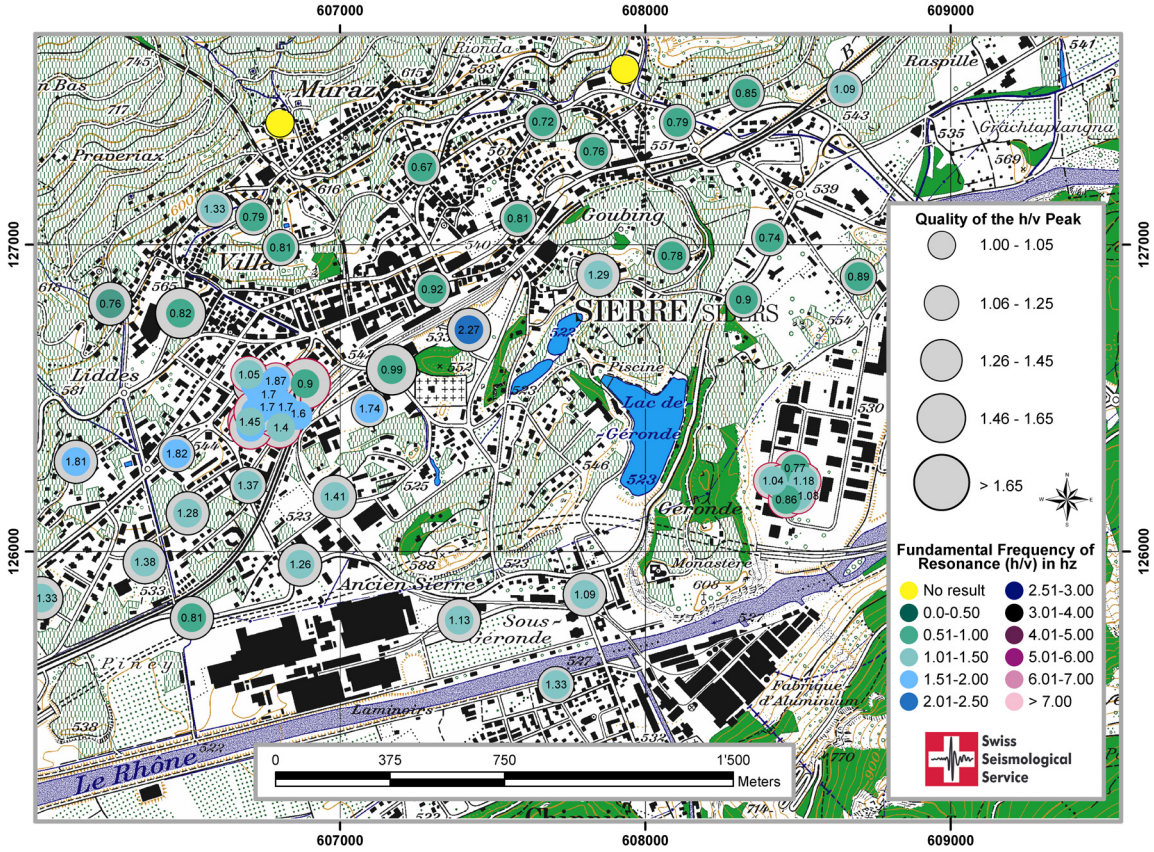


Figure 3.12: Results of the field experiments concerning the fundamental frequency of resonance. Sierre shows almost area-wide two peaks in the H/V spectral ratios. In this figure, we show the peak of lower frequency. Yellow points might indicate a rock site. Points with red and blue outer circles are part of the different arrays that we to determine the local S-wave velocity profile. Points with red outer circles are part of arrays that we used to determine the local S-wave velocity profiles. Map in the background: Swiss Map 25. 2000. Nr. 1287, Sierre, 1992.

We interpret the lower peak as the resonance frequency of the total infill of the valley. Using the simple equation f_0=Vs/4h and a sediment thickness of about 300-330 meters, the resulting average shear wave velocities is about 900-1000m/s (with f_0 = 0.75-0.8Hz). This is a reasonable value for the shear wave velocity in sedimentary deposits, as they exist at the Sierre site.

The peak at higher frequency shown in Fig. 3.13 is due to the impedance contrast between a surface layer with unconsolidated sediments of variable thickness and composition, and the compact debris deposit of the rockslide. Figure 3.14 shows three typical examples of H/V spectral ratios. For the most part of Sierre, the fundamental frequency of resonance of this surface layer (2–6 Hz) is in the range of possible eigenfrequencies of buildings with two to four stories, as they existed in Sierre in the respective time. Furthermore, it is interesting to notice that the better quality of the peak for sites in the two areas with highest damage indicates a stronger impedance contrast compared to other locations. This is an indication for

an increased amplification and can be interpreted in terms of a possible site effect during the 1946 earthquake.

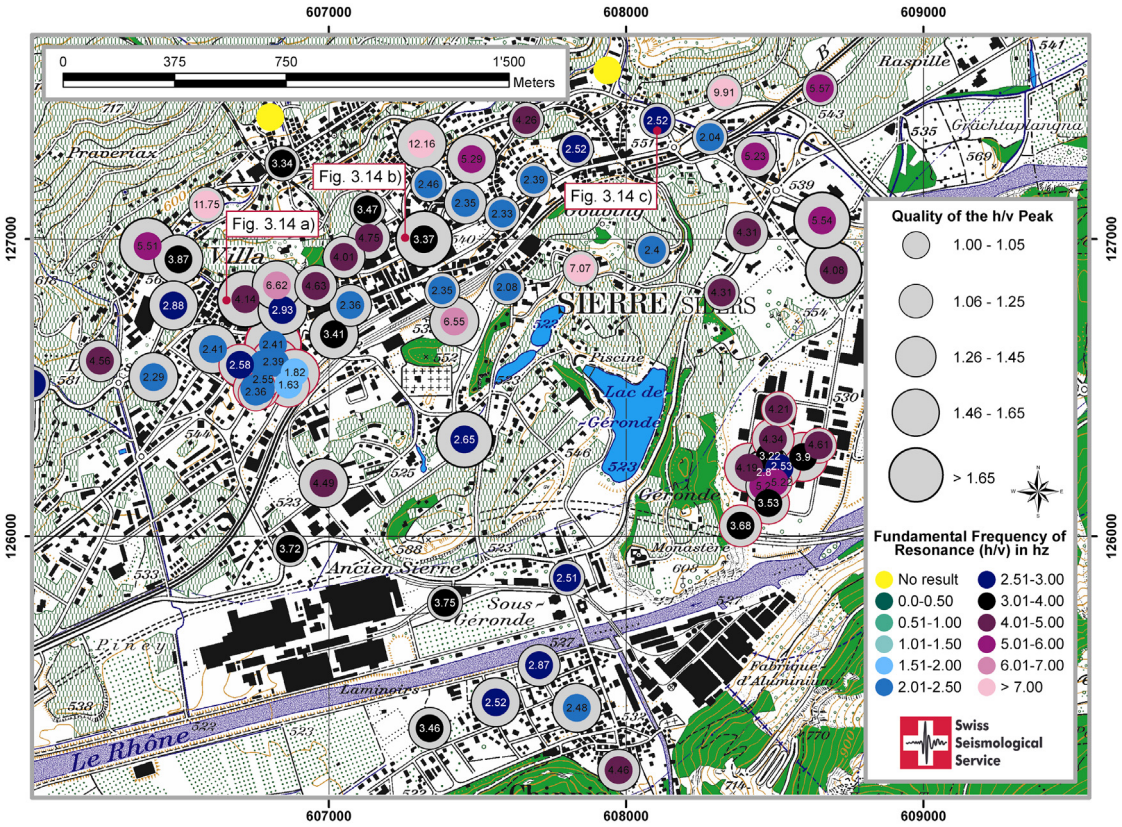


Figure 3.13: Results of the field experiments concerning the fundamental frequency of resonance. Sierre shows almost area-wide two peaks in the H/V spectral ratios. The figure shows the peak at higher frequency. Yellow points might indicate a rock site. Points with red outer circles are part of arrays that we used to determine the local S-wave velocity profiles. Map in the background: Swiss Map 25. 2000. Nr. 1287, Sierre, 1992.

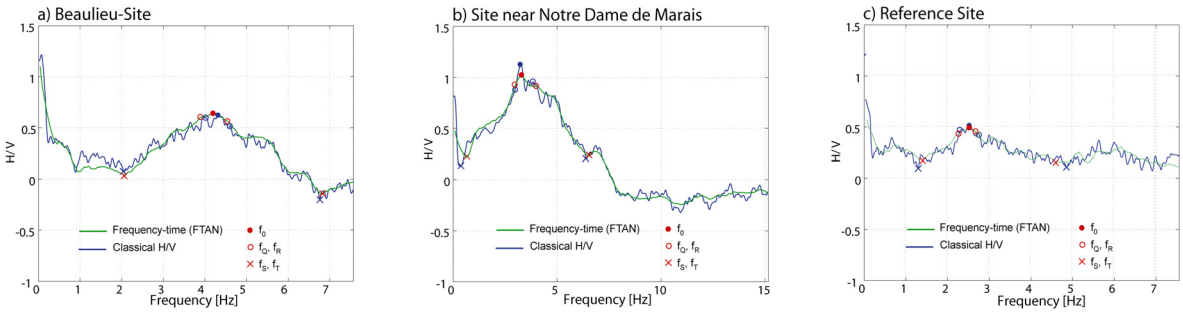


Figure 3.14: Three examples of H/V peaks for sites in Sierre. The position of the corresponding sites is indicated in figure 3.13 by letters. While figure a) and b) are related to sites where heavy damage occurred, figure c) is associated with a location where considerable damage was absent.

In order to better characterize this surface layer at site of the Beaulieu quarter, we performed ambient vibration array measurements. The goal of this experiment was to achieve an S-wave velocity profile of the site, which should help to characterize thickness and

velocity of the subsoil. Due to the large building density, we moved the array slightly to the west of the area of largest damage in 1946 (See Fig. 3.13). We analyse phase velocities of fundamental and higher mode Rayleigh and Love waves with high-resolution beam forming method as outlined in Fäh et al. (2007).

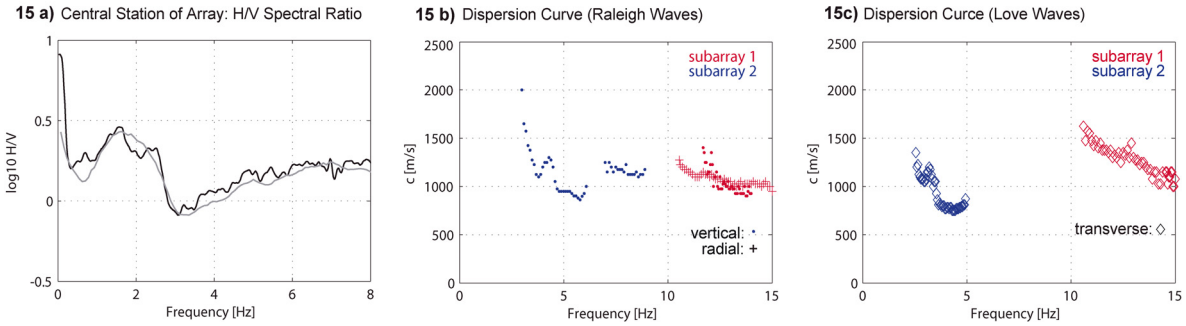


Figure 3.15 a): H/V spectral ratio obtained for the central station of the array. The black line is the result from classical polarization analysis in the frequency domain, and the grey line was obtained with a method based on frequency-time analysis.

Figure 3.15 b,c): Dispersion curve segments for Rayleigh (b) and Love waves (c) obtained from ambient vibration array measurements. The subarrays are shown in different colours. Vertical: analysis of the vertical components; radial: analysis of the radial components; transverse: analysis of the transverse components.

The experiment led to the peculiar results shown in Fig. 3.15. H/V spectral ratios show clear peaks around the frequency of 2 Hz (Fig. 3.15a), indicating the fundamental frequency of resonance of a surface layer with low S-wave velocities. In order to develop such a strong peak in the H/V ratio, we expected S-wave velocity in the range 200-300m/s for the surface layer. It was however not possible to obtain phase velocity curve segments of the fundamental mode Rayleigh and Love waves in the frequency range up to 10Hz with phase velocities smaller than 700m/s (Figs. 3.15b,c). We can however recognize higher modes of surface waves which most probably sample the deeper rockslide debris layers of higher velocities in the range 800-1300m/s. This indicates that standing waves of a 2D or 3D resonance might dominate the wave field at the lower frequency around f_0. The peak in the H/V spectral ratio would then represent the fundamental frequency of resonance of two- or three-dimensional eigenvibrations of the sedimentary layer. Within the city area the variability of the fundamental frequency of resonance of the surface layer over rather short distance might also be an indication for possible 2D or 3D resonance phenomena, in particular in those areas of largest earthquake damage.

Ambient vibration array methods can only be used to map the velocity structure at sites that are not subject to global 2D or 3D resonance phenomena. The method was however successful for the second array shown in Fig. 3.13 (in the eastern part of Sierre). The inverted

structural model obtained form the phase velocity curves consists of a surface layer of 30 m with an average S-wave velocity of about 400 m/s, a second layer of about 50m thickness and 800m/s S-wave velocity, and a layer with S-wave velocities in the range 1300-1700 m/s.

3.6 Conclusion

The aim of this study was to reconstruct the damage field of the 1946 earthquake series in the middle Valais region and to answer the question whether site-effects had an evident impact on its characteristics. The series started on January 25 with a main shock (Mw=6.1) that was followed by several hundred aftershocks until the end of the nineteen forties, among them three in the range of Mw=5.1 - 6. While we considered in the first part of the study the affected region without geographic limits, we focused in a second part the two cities of Sion and Sierre.

Since a contemporary damage assessment was not at hand in its original form, our results concerning the first task rely on unsystematic data for the bigger part. Our findings concerning the damage field thus are fragmentary. It is unlikely that further results can be achieved as long as the original documents of the damage assessment are untraceable, since we investigated all sorts of potential resources including a large number of newspaper article and documents of the cantonal administration. Anyhow, the few known key data with respect to the assessment allowed describing the damage field systematically on the level of the Valaisan districts. Comparison of the average loss in CHF per district and the percentage of buildings located on deposit sites of the extensive Rhone Valley per district, showed some correlation between these two values. Districts with large proportion of settlement on the plane of the Rhone Valley show a higher average loss per building. This is an indication that site-effects influenced the damage field. Due to differences in constructions types, the building stock of the valley plain tends to be more vulnerable than the one of the mountainside. We conclude that the characteristic of the damage field is due to a combination of site-effects and building vulnerability.

Likewise fragmentary as the assessment of individual buildings that suffered damage, are our findings with respect to secondary effect. Nevertheless, we localized a large number of different effects from rock falls, landslides, and avalanches to terrain changes and effects on water springs. Most of them are related with the main shock of January 25, the large rock fall at the Ravylhorn however was triggered by the aftershock of May 30. Due to the location of the fault secondary effects were more frequent on the northern slope of the Rhone valley.

Not surprisingly many observations concentrate on the region of the presumed epicenter. However, many secondary effects of considerable extent occurred at distances up to 40 km.

Proceeding to the second part of the study, we can conclude that the outcomes for the two cities of Sion on Sierre are different in many respects. For Sion we showed that intensity VII was clearly not exceeded. Damage was substantial and omnipresent, but structural failure on buildings was rare. Field experiments with respect to the fundamental frequency of resonance showed that amplification of the ground during an earthquake occurs probably in a frequency range that is lower than the resonance frequencies of the building in the city. Furthermore the average shear-wave velocity of the sediments for the most part of the city, as it existed in the nineteen forties, is rather high and the impedance contrast to the bedrock is low. To the south of the city, fine lacustrine and deltaic deposits dominate and the impedance contrast starts to increase. A tendency to more serious cases of damage is recognizable. According to the numerical simulation performed by Roten et al. (2008), peak ground velocities obtained from the simulation of the 1946 main shock yield no large amplification in the old town of Sion. This is specifically due to the position of the seismic source of the 1947 event relative to the 3D basin in the historical city of Sion. For other source locations amplification effects can be considerably large.

In contrast, the Sierre site reached intensity VIII. Damage of grade 3 was frequent and damage of grade 4 not rare. Our investigations have shown that particularly two areas showed concentration of serious damage. We have strong indications that damage in these areas is related to the local site conditions. One of the sites is former swampland while an alluvial cone characterizes the other. For both of the sites field experiments have shown that the impedance contrast seems to be stronger than for most other sites in Sierre. The fundamental frequency of resonance of the surface layer however varies considerably within the investigation area. It is within a range that is of relevance for the building stock, not only for these two areas of increased damage, but also for almost the whole city. Further investigations based on ambient vibration array measurements showed peculiar results that are likely due to local 2D or 3D resonance phenomena. At the same time, 2D or 3D resonance effect would provide a reasonable explanation for the irregular distribution of damage in Sierre. We can conclude that the ground conditions in Sierre in general show characteristics that favor site amplification effects.

4 Damage Field and Site-Effects: Multidisciplinary Studies of the 1964 Earthquake Series in Central Switzerland

By Stefan Fritsche, Donat Fäh, Brian Steiner and Domenico Giardini

4.1 Abstract

Central Switzerland shows comparatively high seismic activity by Swiss standards. Many historical earthquakes are known and several of them caused damage. The last major event dates back to 1964 and has the characteristics of an earthquake swarm. Among dozens of felt shocks were two main shocks (Mw = 5 and 5.7) that moderately damaged a limited area with hundreds of buildings suffering loss. Our aim here was to reconstruct the damage field and to analyze whether it was influenced by site-effects. Given the existence of a contemporary damage assessment and other historical sources, we could describe the damage field in detail. For about 95% of the affected buildings, we could reconstruct the location and extent of loss, using assessments from the European Macroseismic Scale (EMS 98). Spatial analysis of the resulting data showed that most losses were concentrated in the villages of Sarnen and Kerns. Damage to residential houses and barns was by far most frequent (90%) but expensive losses to the relatively few sacral buildings were responsible for almost 50% of the repair costs. We compared the damage data with deposit thickness and soil composition and carried out field experiments using H/V spectral ratios to measure the fundamental frequency of ground resonance at 75 sites to estimate the frequency band in which amplification occurs. Our results show that locations on both thick fluviatile sediments and large alluvial cones showed higher intensities than did other ground types. Moreover, at some sites intensity was probably increased by a layer of weathered rock below thin deposits.

4.2 Introduction

4.1.1 Overview

People living in the Sarnen region (Fig. 4.1) during the mid-sixties cannot forget a long-lasting earthquake-series that started with a main shock on February 17, 1964. This first shock reached a moment magnitude of 5 and an epicentral intensity of VII (Swiss Seismological Service 2002; Fäh al., 2003a). Several dozens of earthquakes with Mw up to 4.3 followed the next weeks. A second main shock occurred on March 14. This event had a moment magnitude of 5.7 and reached an epicentral intensity of VII. In the subsequent 36 months, earthquake activity remained high and then fell off over the following years and has remained low until today.

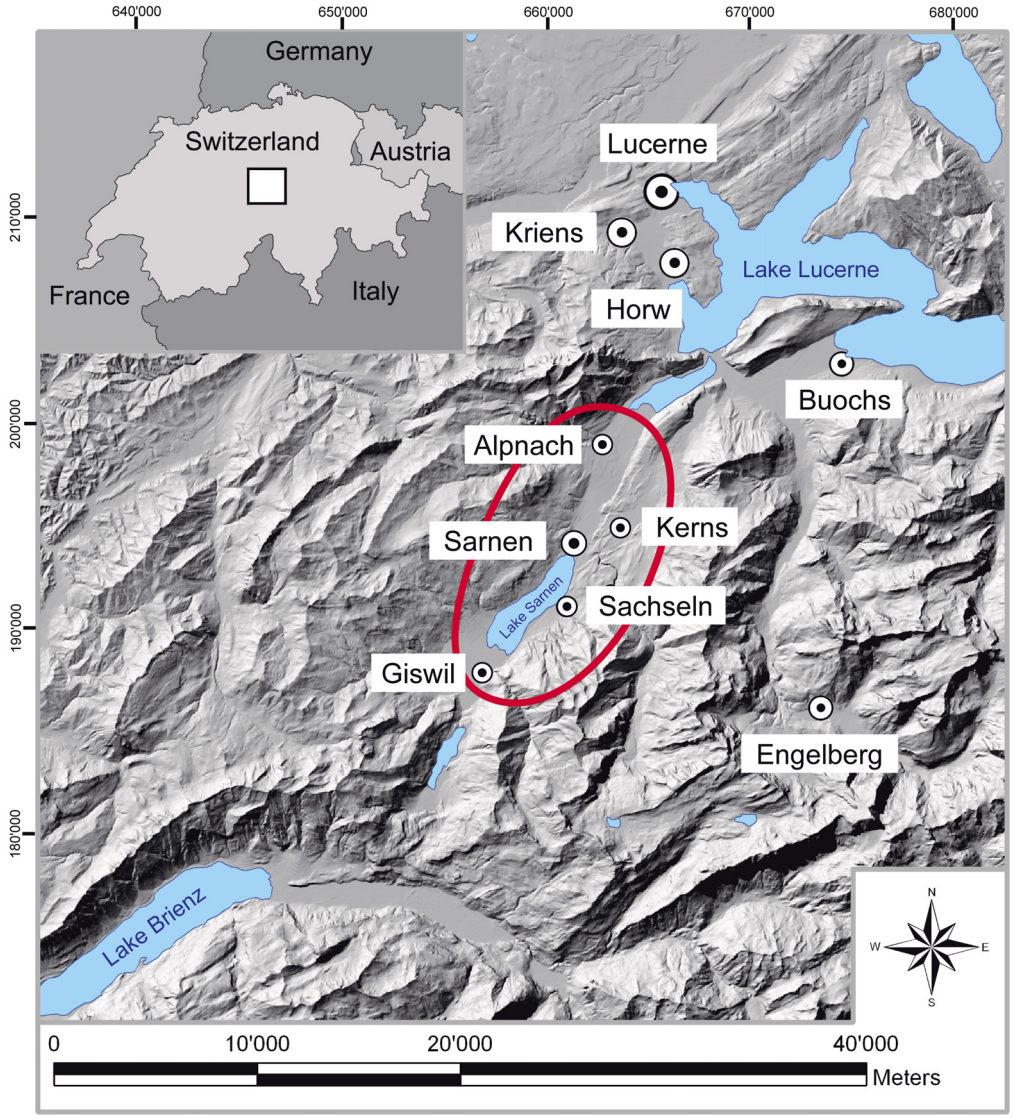


Figure 4.1: Region of interest: Central Switzerland and approximate position of the damage field.

The two main shocks of February and March 1964 caused damage in a limited area (Fig.4.1). But the impact of the February event was clearly weaker, with consequences on the lower bound of intensity VII. Damage caused by the March shock exhibits full intensity VII. Although it would be wrong to describe these events as catastrophic since nobody was seriously injured, their social impact is relevant. Apart from the repair costs, the long duration of the series became burdensome for the population and administration. Particularly in the weeks following March 14, fear and uncertainty were omnipresent and fanned by the continuous shocks as well as memories of the Skopje catastrophe of 1963 (Die Woche, March 18, 1964; Blick, March 16, 1964). Many hundreds of citizens fled to relatives living outside the affected region. Among them were several hundred guest-workers from Italy who returned home for some weeks or months (Vaterland, March 16, 1964). A nunnery was closed temporarily and a high school transferred to another place for a few weeks (ibid.). At the same time, the administration prepared for a potential disaster. Evacuation schedules were set up, civil protection went on alert and military forces were held in readiness (StAOW, Von Ah, 1964).

Beyond such social concerns, the 1964 earthquake swarm is an important object of research. The region shows remarkable, documented historical seismicity and a contemporary damage assessment is also available. Although not complete, it provides a good basis for quantitative investigation (ASED, Feldprotokolle zu den Erdbebenschäden von 1964 in Kerns; StAOW, Erdbeben 1964. Zusammenfassung der Schadensmeldungen.). Furthermore, large parts of the investigated region show ground conditions that make site-effects likely. Flat planes of fluviatile or lacustrine sediments are common and often combined with a high groundwater level. In addition, these areas are experiencing lively housing and industrial development. Thus, seismic risk for the region is increasing.

In this paper we discuss the earthquake series of 1964 in terms of damage fields and site-effects. Ground conditions strongly influence the intensity and duration of local ground motion and consequently affect the characteristics and distribution of damage. Since the area shows a wide variety of ground conditions, we will show that such effects are visible in the damage field of the two intensity VII events.

4.1.2 Methodology

We combined historical investigation with seismo-geological research, starting with the reconstruction of the damage field. Analyzing a large variety of historical documents enabled

with high resolution our quantitative and qualitative description of loss in the Sarnen region. The damage assessment itself was done following the guidelines of EMS 98 (Grünthal, 1998). This first step was followed by an investigation of ground conditions. For this purpose we studied the region's geology and carried out field experiments to measure the fundamental frequency of resonance at many sites. In a third step we spatially analyzed the assessed damage in combination with geological and geophysical findings. The resulting maps of these analyses underlie the presentation and discussion of our findings.

4.1.3 Characteristics of the Earthquake Series and the Historical Seismicity of the Region

The mentioned magnitudes originate from a calibration of macroseismic data (Fäh et al., 2003a). Another assessment of Mw was done by Bernardi et al. (2005) and based on amplitude measurements of regional surface waves of seismograms recorded by analog instruments. For the event in February, they assign Mw = 4.8 (range of uncertainty 4.6-4.9) and Mw = 5.3 (range of uncertainty 5.0 – 5.4) for March. The earthquake-series of 1964/65, a typical earthquake swarm, differs from common main shock/after shock sequences by an increase/decrease in individual magnitudes with no apparent pattern. ECOS (Swiss Seismological Service, 2002), the Swiss Earthquake Catalogue quotes a series of about 70 verified, felt events for that period (Table 4.1).

Date	Mw	Io	Date	Mw	Io	Date	Mw	Io
17.02.64	5	7	28.02.64	1.9	2-3	18.03.64	2.7	3-4
17.02.64	2.3	3	04.03.64	2.3	3	19.03.64	2.3	3
17.02.64	2.3	3	06.03.64	2.3	3	25.03.64	2.3	3
17.02.64	2.3	3	08.03.64	2.3	3	26.03.64	2.7	3-4
17.02.64	3.1	4	08.03.64	2.3	3	12.04.64	2.3	3
17.02.64	1.9	2-3	08.03.64	2.3	3	17.04.64	2.3	3
17.02.64	1.9	2-3	11.03.64	4.3	5-6	14.05.64	1.9	2-3
17.02.64	1.9	2-3	13.03.64	3.1	4	20.05.64	2.5	3
17.02.64	1.9	2-3	14.03.64	2.3	3	18.06.64	3.1	4
18.02.64	1.9	2-3	14.03.64	5.7	7	08.09.64	2.7	3-4
18.02.64	3.1	4	14.03.64	2.3	3	24.10.64	2.6	-
18.02.64	2.3	3	14.03.64	3.9	5	11.11.64	3.5	4.5
18.02.64	1.5	2	14.03.64	2.7	3-4	28.11.64	2.7	3-4
18.02.64	2.7	3-4	14.03.64	2.3	3	20.08.65	3.1	4
18.02.64	2.7	3-4	15.03.64	2.7	3-4	27.08.65	3.1	4
18.02.64	2.3	3	15.03.64	3.4	4	11.10.65	3.1	4
18.02.64	3.1	4	15.03.64	2.3	3	08.11.65	3.1	4
21.02.64	3.1	4	16.03.64	3.1	4	14.12.65	2.7	3-4
22.02.64	2.3	3	16.03.64	2.7	3-4	17.12.65	2.7	3-4
23.02.64	2.3	3	16.03.64	2.1	-	04.03.66	3.1	4
25.02.64	3.1	4	17.03.64	2.7	3-4	13.04.66	2.7	3-4
27.02.64	2.3	3	17.03.64	2.3	3	22.04.66	3.1	4

Table 4.1: Earthquakes of the 1964/66-swarm verified by the Swiss Seismological Service (2002).

Several contemporary newspaper articles point out that "many hundred" earthquakes were felt in the epicentral region during the series. In fact the given list should be much longer. It is practically impossible to reconstruct such a long and intensive series from macroseismic data only. However, we may assume that the events missing in Table 4.1 were of minor intensity. Many

reports describe earthquakes accompanied by a noise like an explosion or the rumbling of a thunderbolt (e.g. Vaterland, February 18, 1964).

Looking further back in time, we see periods with high seismic activity as a general characteristic of this region (Swiss Seismological Service, 2002). Fig. 4.2 reviews the known historic seismicity of the region with Io ≥ 5. Since it is a problem to locate epicenters accurately with only macroseismic data, Fig. 4.2 includes the range of uncertainty. The series in Altdorf (1774, 10 known events) as well as two earlier series near Sarnen (1777, 11 known events but a contemporary observer speaks of 60 felt shocks, and 19 events in 1917) show a pattern similar to that of 1964 (Fig. 4.2 and Gisler et al., 2004c). The strongest known event for the region dates back to 1601 with Imax = VIII and Mw 6.2 (Schwarz-Zanetti et al, 2003; 2006b). With the exception of the 1917 events (no intensities higher than 5), all these series included shocks that caused slight (1777) to moderate (1601, 1774 and 1964) damage. Since the swarm event of 1964, seismic activity has remained low with only a few dozen events smaller than Mw=3 and a couple in the range of Mw = 3 - 3.7.

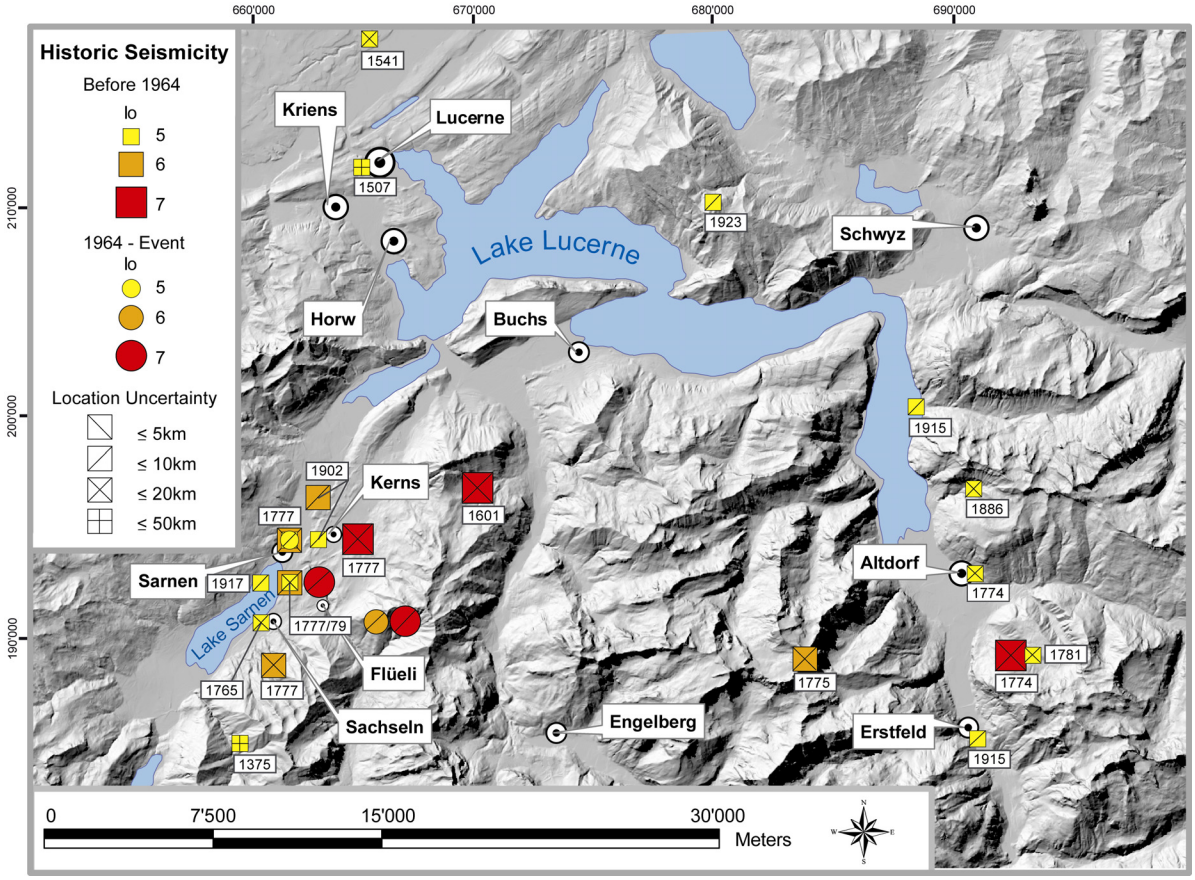


Figure 4.2: Historic seismicity of Central Switzerland based on ECOS data with Io ≥5.(Swiss Seismological Service, 2002).

A characteristic of the earthquakes here is that probably all occurred close to the surface. Figures 4.3 and 4.4 show that for the two main shocks of the 1964 series, the decrease in intensity with distance is remarkably strong, particularly from intensity VII down to intensity V.

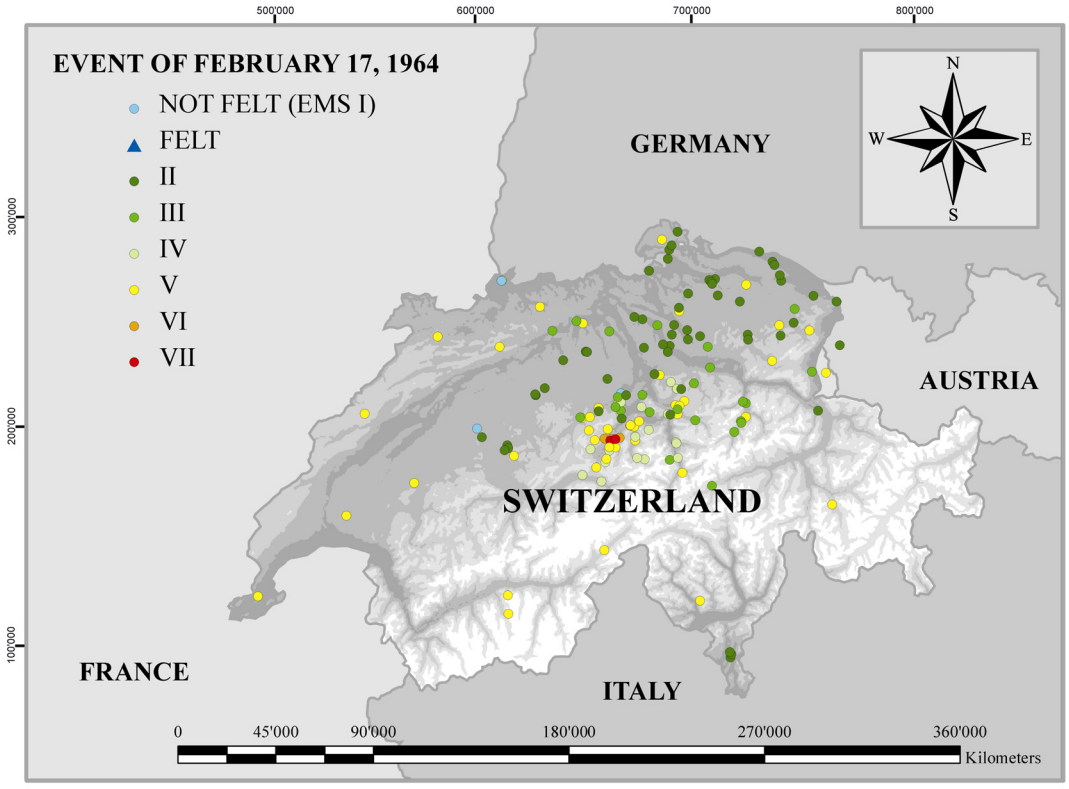


Figure 4.3: Macroseismic map of the February 17, 1964 event based on ECOS data (Swiss Seismological Service 2002).

In general this kind of observation is associated with shallow epicenters. Several indications support the assumption that this pattern holds throughout the region. The few earthquakes that occurred in this area during the last 30 years were at shallow depth. For example, Deichmann et al. (2000) demonstrated that the two small 1985 events at Kerns (Mw= 2.5) and Sachseln (Mw= 2.9) took place in the upper tertiary sediment layer at 1-2 km depth. They argue that the recorded data allow no consistent solution for a focal mechanism which assumes a deeper epicenter. We note that after a period of extremely heavy rainfall from August 19 – August 23 2005, several micro-earthquakes (Mw 1.3 –Mw 1.7) were recorded for August 23 – August 26 (Swiss Seismological Service, 2002). The temporal linking of these events (heavy rainfall and micro-earthquake activity) makes a correlation likely. We suppose that the quick release of energy results from the increased pore water pressure close to the surface (Husen et al., 2007; Hainzl et al., 2006). These observations strongly indicate

but do not prove shallow epicenters in these areas. Therefore, the seismic activity has been too sparse for the time since seismic instrumentation has enabled accurate recording and analysis.

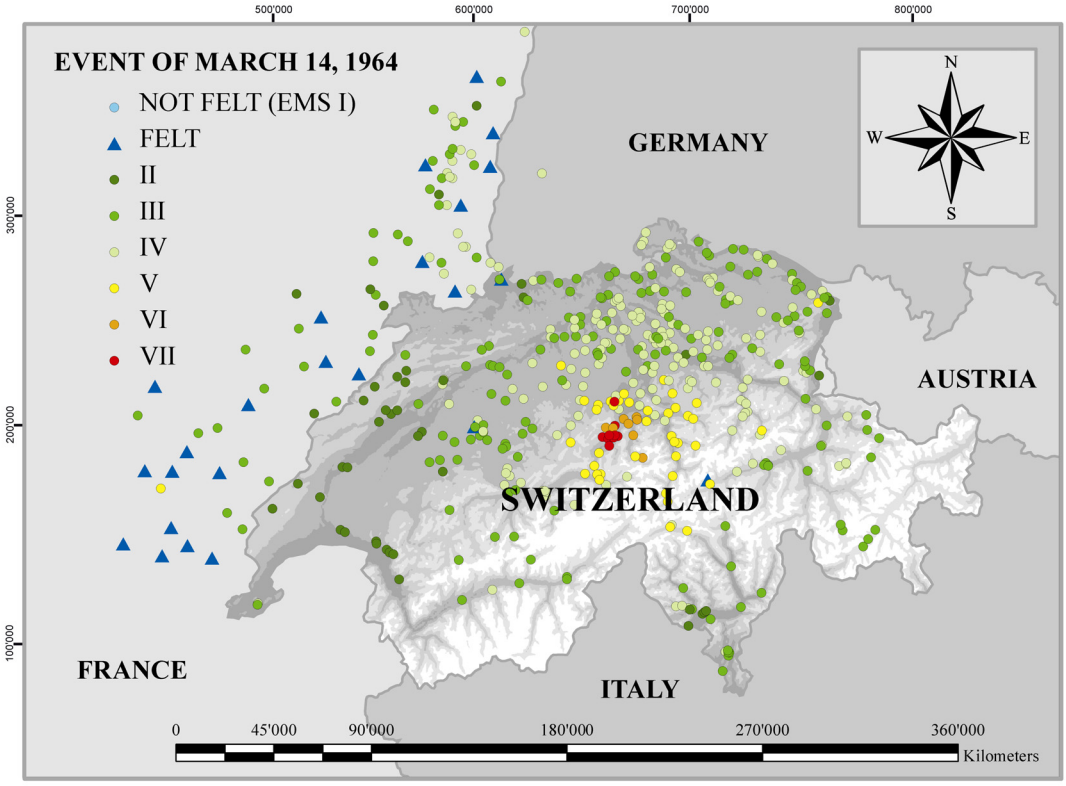


Figure 4.4: Macroseismic map of the March 14, 1964 event based on ECOS data (Swiss Seismological Service 2002; BRGM, EDF and IRSN 2005).

4.2 Reconstruction of the Damage Field

4.2.1 Outline

The most important set of documents, a contemporary damage assessment (ASED, Feldprotokolle zu den Erdbebenschäden von 1964 in Kerns ; StAOW, Erdbeben 1964. Zusammenfassung der Schadensmeldungen.), is not preserved completely. But we have been able to reconstruct the damage field almost entirely.

The contemporary damage assessment formed the basis of our work. It was done by officials of the cantonal administration in the months after the second main shock of March 14, 1964 and covered the stock of damaged buildings in private hands. The motivation for this assessment was that Swiss Building Insurance companies were disposed to cover part of the repairs. Individual losses were assessed on so called “field-protocols” by a short damage

description and an amount in Swiss currency. Later these protocols were compiled in lists that mention only an owner, the sum of money, the type of building and a location. While these lists are preserved completely, almost half the original "field protocols" are lost. In addition the loss to public buildings including churches and chapels is only partly covered by this official assessment. Thus, we explored more administrative documents, newspaper articles, and journals. Of particular interest is an administrative list of all damaged chapels and churches (ASED, Kanton Obwalden, Liste der während der Erdbeben von 1964 beschädigten Kirchen und Kapellen). Although this document describes the loss in monetary terms only, it is the most important source on ecclesiastical buildings. We found more information about many of these ecclesiastical buildings in diverse newspaper articles, and in several cases even a photograph of the damage.

Our attempt to attribute damage to the first or second main shock failed due to a lack of systematic information. While the field protocols partly associate the damage with one of the two main shocks, the recapitulating lists don't separate them. Nevertheless, given this information from newspaper/journal articles, we concluded that the impact of the March 14 shock was considerably stronger. Our finding is confirmed by the macroseismic fields of the two events based on independent data (Figs. 4.3 and 4.4). A time consuming task was locating the several hundred damaged buildings mentioned in the field protocols. House numbers were not in use in 1964 and even street names were frequently omitted. Property names were often the only information concerning the location of the buildings. Such property names or "Flurnamen" in German reduce the type of property to a couple of words and have been used for hundreds of years. Despite these obstacles, we assigned locations for about 95% of the damaged buildings, most exactly and the rest with an error of within 100 meters. The remaining 5% could not be located or were not accurate enough to be used in our analyses.



Figure 4.5: The "Antonius Chapel" in Sarnen was built in 1646. The Earthquakes of 1964 destroyed a precious relief. (Allgemeine Volkszeitung, March 21, 1964).

We also investigated the quantity and quality of the building stock for the mid-sixties. This kind of information is essential for a quantitative damage rating and is integral to the procedures given by EMS 98 (Grünthal, 1998). Thus, we examined pictures showing the region in the mid-sixties, studied traditionally built houses, interviewed engineers and architects and incorporated statistical data as well as maps showing the villages then. Since our data contain excellent information on repair costs, we finally extrapolated the 1964 prices of the building construction sector to a contemporary level. This proved interesting with respect to a monetary assessment, but also useful for classifying damage grades, since it allowed comparison with present prices.

4.2.2 Damage Assessment

The damage assessment was done with procedures of the European Macroseismic Scale 98 (EMS 98) published by Grünthal et al. (1998). The underlying principle is simple and rests upon two input parameters: *vulnerability class* (VC) and *damage grade* (DG). While the vulnerability class describes how well a given building resists ground motion, the damage grade quantifies the real damage. Classification of vulnerability is based on 15 different types of buildings subdivided into 4 general structure classes: masonry, reinforced concrete, steel and wood structures. Each building type is related to one vulnerability class ranging from class A (very vulnerable, equivalent to rubble stone or adobe structures) to class F (having a high level of earthquake-resistant design). Other attributes such as quality and workmanship, state of preservation and regularity of the ground plan may affect the appropriate class or explain an up- or downgrading of the object if information is available. The damage to buildings, on the other hand, is grouped into five classes depending on the grade of failure in structural and non-structural elements. The scale ranges from DG 1 (negligible to slight damage: no structural damage, slight no structural damage) to DG 5 (destruction: very heavy structural damage). Finally EMS 98 contains a simple statistical tool that allows us to quantify the grade of loss in a given damage field (ibid., 25-26). It is based on the terms “few,” “many,” and “most” to represent a narrowly overlapping percentage scale (0-20%, 10-60% and 50-100%). It helps to quantify the mixed damage to buildings of different vulnerability classes with short and clear statements. These summaries allow us to assign one of the twelve intensity degrees provided by EMS 98: from intensity I (earthquake not felt) to intensity XII (devastating).

Since the 1964 earthquake swarm occurred more than 40 years ago and most information on it is in marginal written form, we had to make certain assumptions, particularly about building vulnerability. We specify and explain them below.

4.2.3 Results of the Damage Assessment

Table 4.2 summarizes the damage to buildings in money and damage grades for the affected villages of Sarnen, Kerns, Alpnach, Sachseln, Giswil and Engelberg. We assume that the listing includes all cases of loss for damage grades 2 and higher (with a small exception, see Figs. 4.6 and 4.7). Numerous cases of damage grade 1 were probably overlooked during the 1964 assessment since they fell below the criteria for receiving compensation.

Village	Sarnen	Kerns	Alpnach	Sachseln	Giswil	Engelberg	Total
Population 1960	6'554	3'553	3'211	2'721	2'656	2'646	**21'300**
Damage in CHF 1000 (1964) per village/hamlet	2'447	1'429 (Kerns) 69 (St. Niklausen) 1.5 (Melchtal)	462 (Alpnach Dorf) 9 (Alpnach Stad)	11.5	35.5	6.5	
Total Damage in CHF 1000 (1964) per village	**2'447**	**1'500**	**471**	**11.5**	**35.5**	**6.5**	**4'470**
Damage in CHF 1000 (in 2005)	**8'600**	**5'270**	**1'660**	**40**	**125**	**23**	**15'716**
No of damage grade 1	60	33	10	3	4		110
No of damage grade 2	107	353	22	10	2	1	495
No of damage grade 3	109	114	8		1	1	233
No of damage grade 4	1	3					4
Total	277	503	40	13	7	2	**842**

Table 4.2: Losses in CHF (1964/2005), number of damaged objects and their distribution along EMS damage grades. Summary of the data aggregated during our reassessment of the 1964 earthquake series.

While the loss expenses rely on the assessment documents described above, the listed damage grades reflect the results of the procedure presented previously. The calculation of the price rise was done using the general consumer price index provided by the Swiss Federal Statistical Office (2006). Continuous index series for prices describing price growth in building industries are not available. Extrapolating an existing series from 1940-1991

(Ritzmann-Blickenstorfer, 1996) and from 1998-2005 (Swiss Federal Statistical Office) shows a slightly smaller increase compared to the general consumer price index. Using this index, the damage would reach today about CHF 14 million.

For about 450 of the 842 affected buildings our assessment rests upon primary data sources offering precise information about the kind of damage. Most data come from the field protocols. A few dozen other case descriptions were found in newspapers and magazines including some photographs. These short and rudimentary descriptions usually enabled identification of the building type. We distinguished between residential houses, barns, sheds, shanties and industrial or sacral buildings. A combination of building type, damage description and repair costs finally formed the framework for our damage roster following EMS 98 (Table 4.3).

Damage grade	Typical damage	Examples of the original damage assessment (1964)	Damage in CHF
1	Hair-line cracks and fissures in walls. Fall of small pieces of plaster or gypsum.	Barn: Very slight cracks.	120
		House: Slight cracks in walls and fissures in flagstones of bathroom.	430
2	Partly collapsed chimneys. Slightly damaged roofs. Cracks in walls.	House: Damaged chimneys, damaged roof, harmed gypsum, slight cracks in walls.	2400
		House: Three damaged chimneys, cracks in walls.	1230
3	Heavily damaged chimneys. Large cracks in most walls. Failure of non-structural elements (partitions walls).	House: Damaged chimneys, a collapsed stove, two collapsed walls and cracked walls.	3735
		House: Two collapsed chimneys at the roofline and a damaged roof, damaged stoves and harmed gypsum.	4060
4	Serious failure of walls and/or roofs. (Only a few cases, all of them belong to vulnerability class A.)	Barn: Walls partly collapsed, danger of collapse!	2450
		Garage: Walls heavily cracked, danger of collapse!	6380

Table 4.3: Roster used to assign damage grades. The quoted amounts of money refer to the original data of 1964; the price rise is not included.

The remaining losses (about 400 cases) had to be rated almost exclusively on monetary information. For about 20% of them, building type and/or some other marginal information was at hand. From statistical analyses of those cases including a verbal description, we set up a scale that separates damage grades from 1 to 3.

CHF 0 < DG 1 < CHF 400 < DG 2 < CHF 3500 < DG 3

Damage of grade 4 was not assigned within this part of the data, because there were too few cases of this damage grade to achieve statistically significant values (Table 4.4). But it is not likely that a significant number of damage grades 4 has been passed over.

Our data gathering illuminated the composition of damaged building stock and the cost distribution per building type. While Fig. 4.6a divides the damaged stock into groups of comparable building types including the not definable, Fig. 4.6b illustrates the loss distribution in CHF per building type. Both figures (4.6a and 4.6b) rely on assessed data.

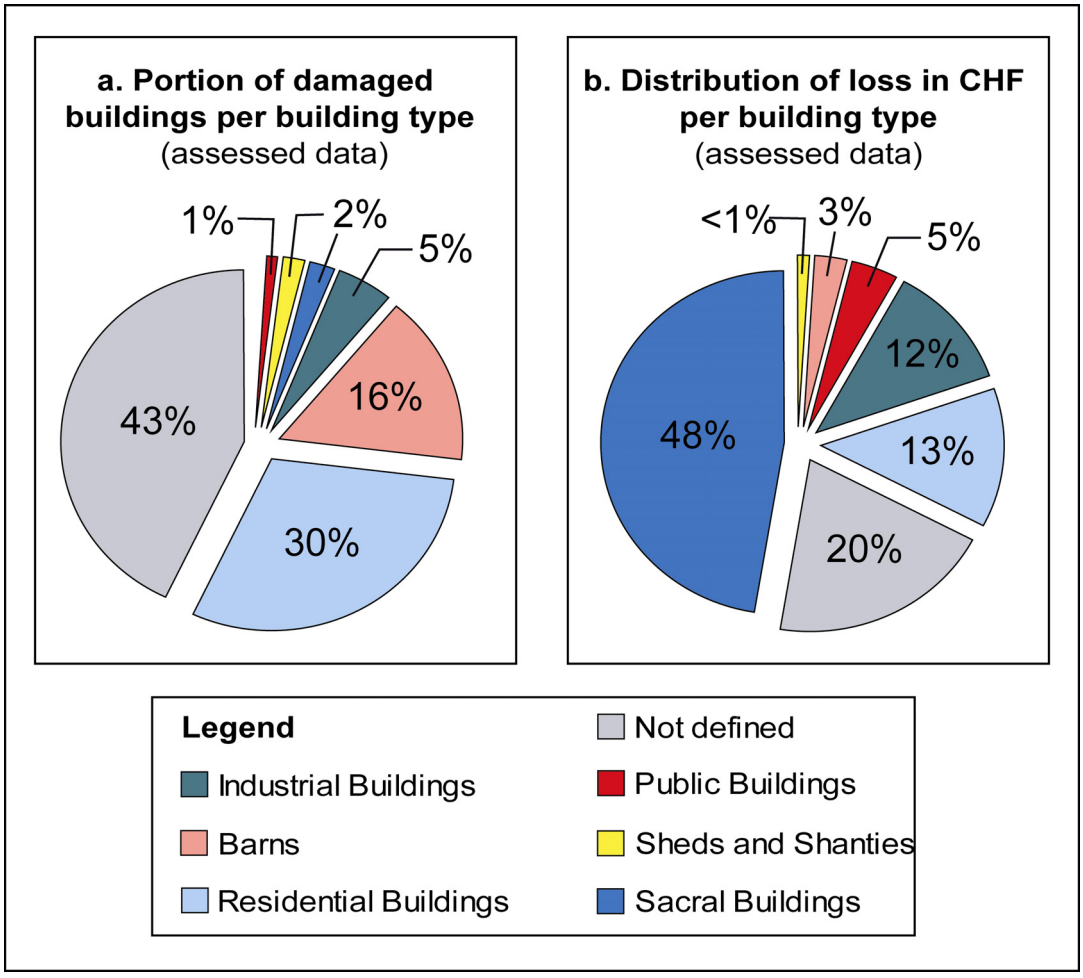


Figure 4.6: Portion of damaged buildings per building type (a) and distribution of loss per building type in CHF (b) based on assessed data including the official contemporary damage assessment as well as the mentioned list describing the losses on ecclesial buildings.

Further investigations have shown that the categories "sacral-, industrial and public buildings" are completely identified in our data. Thus we substitute in Fig. 4.7a the "not defined" building class by larger values for the "residential building class" and the "barn class" proportional to the values as they are given in Fig. 4.6a (two third of residential buildings, one third barns). Figure 4.7a thus shows the composition of damaged building stock in 1964 without the gap of undefined buildings. Figure 4.7b shows the corresponding extrapolation for the distribution of loss in CHF per building type. In contrast to the former extrapolation (7a), the result of this extrapolation shows as well a significant change in the "public building" class. This has to do with the fact that for some damaged buildings of this

class no monetary information is available. We assume that public buildings hold a significantly higher share of the total costs of loss (approximately in a range between 6% and 10%).

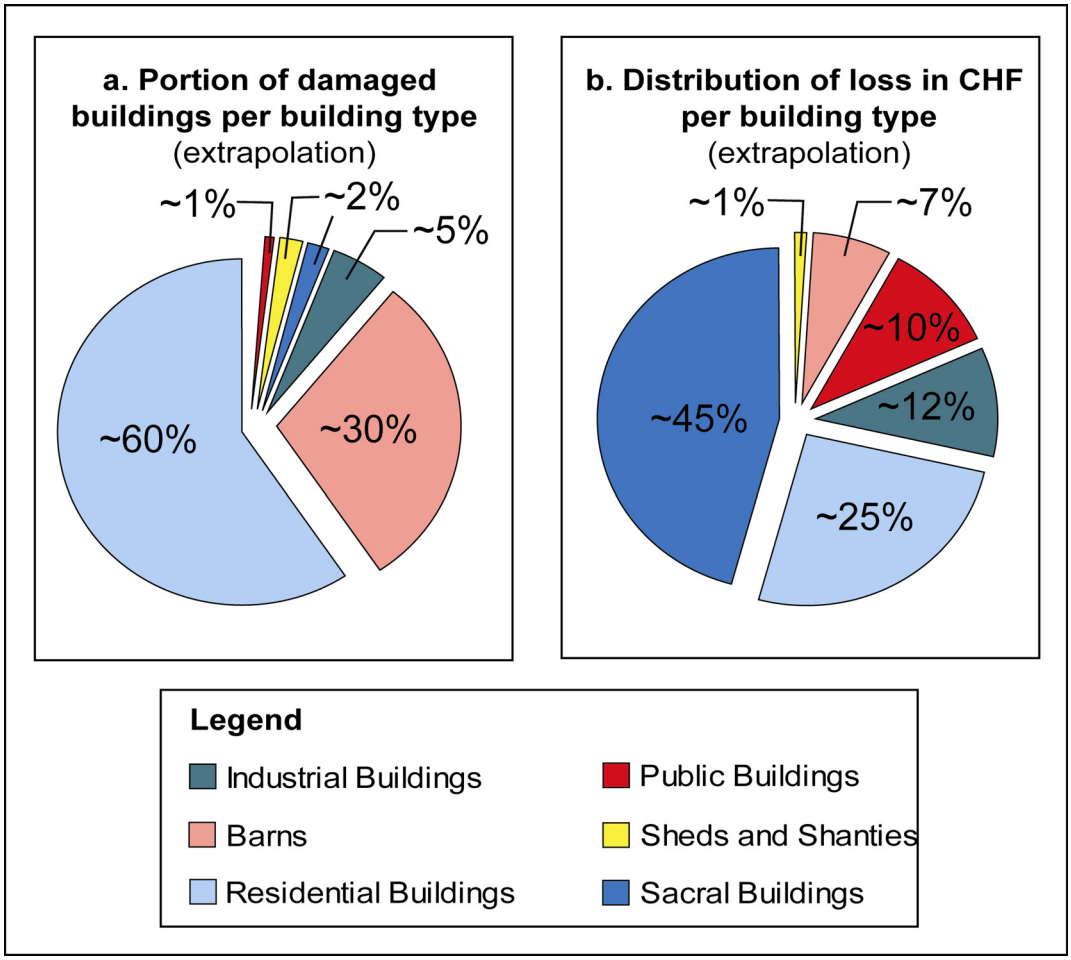


Figure 4.7: Portion of damaged buildings per building type (a) and distribution of loss per building type in CHF (b); extrapolation of Fig. 4.6, including an adjustment of the public building class. Investigation has shown that these categories were monetarily not covered completely by the contemporary assessment.

Comparing Figs. 4.7a and 4.7b gives insights into the loss structure. Damage to the "public building" class, for example, covers only about 1% of the affected building stock but explained about 10% of the total repair costs. Even more remarkably, harm to a few sacral buildings was responsible for almost 50% of the total loss. To a lesser extent such an observation is also valid for industrial buildings. In contrast, residential buildings and barns show inverse ratios: the large number of residential buildings and barns (together representing about 90% of all damaged buildings) sustained only 32% of the total costs. These findings make sense since they are primarily related to vulnerability, size and value of the respective buildings. Public and industrial buildings tend to be larger than residential buildings or barns and sacral buildings not only show a higher vulnerability than most other classes but also

include very valuable components. An individual assessment of these building characteristics was not feasible due to the large number of damaged objects. We thus concentrated on evaluating the 1964 building stock vulnerability within the categories used so far. This task was completed on the basis of photographs, field visits and study of the region's typical construction. Table 4.4 summarizes these results.

Type of building	Characteristics	Vulnerability class (EMS 98)
Residential buildings (traditional)	Two to four stories. Groundwork of masonry in simple stone, massive stone or manufactured stone units up to the first floor. Upper stories: Massive timber construction. Free standing, regular groundwork. Many old buildings among them. Variable state of preservation.	B-**C**-D
Residential buildings (modern)	Two to four stories. Mostly masonry constructions in manufactured stone units. Free standing, regular ground plan. Generally in a good state of preservation.	**B-C**-D
Sacral buildings	Masonry construction in field-, simple or massive stone. Particularly the vaults show high vulnerability. Most of these buildings are several hundred years old. Variable state of preservation. Irregular ground plan.	A-**B**
Public buildings	Up to four stories. Masonry construction in massive stone or manufactured stone units. Generally in a good state of preservation.	B-**C**-D
Barns	Mostly single story buildings with regular groundwork. Masonry and timber constructions. Very often partly in masonry, partly in timber. Clearly weaker construction than residential buildings. Masonry in fieldstone, simple stone or manufactured stone units. Variable state of preservation.	**A-B**-C
Shed and shanties	Small single story buildings in timber, masonry or a mixture of them. Weak constructions. Often in bad conditions.	**A**-B
Industrial buildings	Very different types of building. Construction in manufactured stone units, reinforced concrete, timber or steel. Mixtures of those materials. Partly irregular ground plan. One to four stories.	B-**C**-D

Table 4.4: Building types and vulnerability classes. Letters with underscore indicate the most likely vulnerability class. It is not a contradiction that modern residential buildings tend to be vulnerable than traditional residential buildings since the former consist to a considerable higher degree of masonry than the latter.

Accurate quantitative data concerning the distribution of building vulnerability for the mid- sixties are not available. The following values thus rely on estimations. About 20% of the mid- sixties building stock in the Sarnen region belonged to vulnerability Class A (chapels, barns, shed and shanties). About 30% belonged to Class B (mostly barns, churches and residential buildings). Another 40% of the buildings are part of Class C (residential buildings, public and some industrial buildings. A minority of about 10% belongs to Class D (above average, well built residential, public and industrial buildings).

4.2.4 Discussion of the Intensity and Damage Distribution

Figure 4.8 summarizes the results of the damage assessment on a background indicating the existing building stock around 1969 taken from maps published in 1971 (Alpnach, no. 1170, Melchtal, no.1190); the best available dataset for the respective time. Each colored square represents a damaged object of a certain damage grade. The teal colored areas represent major quaternary deposits (Schindler, 1996).

Since quantitative allocation of the loss to one of the two main events was not obtainable, Fig. 4.8 includes all losses. Many sources giving temporal reference, however, point out explicitly that both main shocks shaped the total damage. Naturally, the first main shock weakened building structures and made them more vulnerable to the second. Despite this lack of information, intensity VII is an appropriate qualitative value for both the two main shocks and the damage related to them both. We concluded that the second event was definitely of stronger intensity. This finding is also clear from the macroseismic fields of the two main shocks (Fig. 4.3 and 4.4) Earlier intensity estimations (Swiss Seismological Service, 2002) are also confirmed by this result. It may appear contradictory that the main shocks individually assessed show the same intensity as both main events together. However, around intensity VII the span from one intensity degree to the next is fairly large. This applies particularly for the intensities describing damage from intensity VI onward.

Due to sparse information, it wasn't possible to quantitatively analyze whether the epicenters of the two main shocks were at the same (or a nearby) location. Nor do qualitative investigations give definitive help. In discussing the damage distribution below, we thus assume that both main shocks occurred at the same or a nearby location.

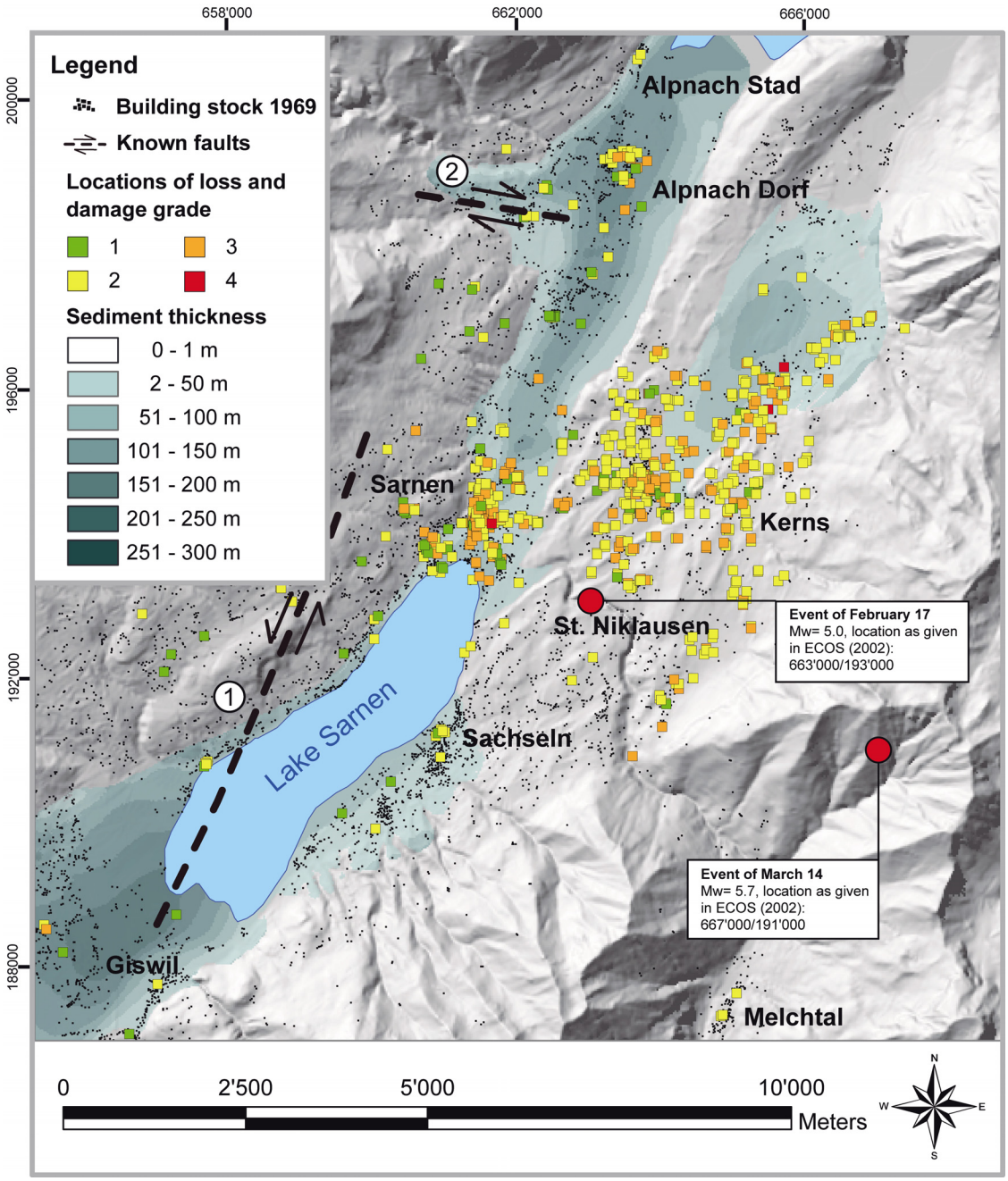


Figure 4.8: Damage field of the 1964 earthquake series including damage grades, building stock (Alpnach, no. 1170, Melchtal, no.1190, 1971) and areas of thick deposits (Beer, 1997). The figure includes all damaged buildings mentioned in the contemporary damage assessment. The epicenters are given according to Swiss Seismological Service, (2002). Since localization relies on macroseismic data, location uncertainty is 10 kilometers in the north-south as well as east-west directions.

A general characteristic of the damage field is its limited area: a few dozen square kilometers. The largest share of damaged buildings occurs in the villages of Sarnen and Kerns. Another location showing comparably high damage is Alpnach Dorf. Further north and south, the number of damaged objects decreases dramatically and remains low. To the south even in Sachseln and Giswil damage occurred sparsely. Only a few additional losses (of

minor extent) can be recognized outside the area shown in Fig. 4.8 (in Lucerne, 20 km north and Engelberg, 20 km southeast of Sarnen). A more detailed insight into the damage distribution is given by Figs 4.9 and 4.10 within which the area is split into squares of 200m on a side. Figure 4.9 illustrates the damage density as a function of damaged buildings and building stock (damaged buildings divided by existing buildings per area); Fig. 4.10 shows the average loss per damaged building and grid unit. While Fig. 4.9 does not consider damage grades at all, Fig. 4.10 incorporates the intensity of damage in monetary terms. The results of the two calculations differ significantly.

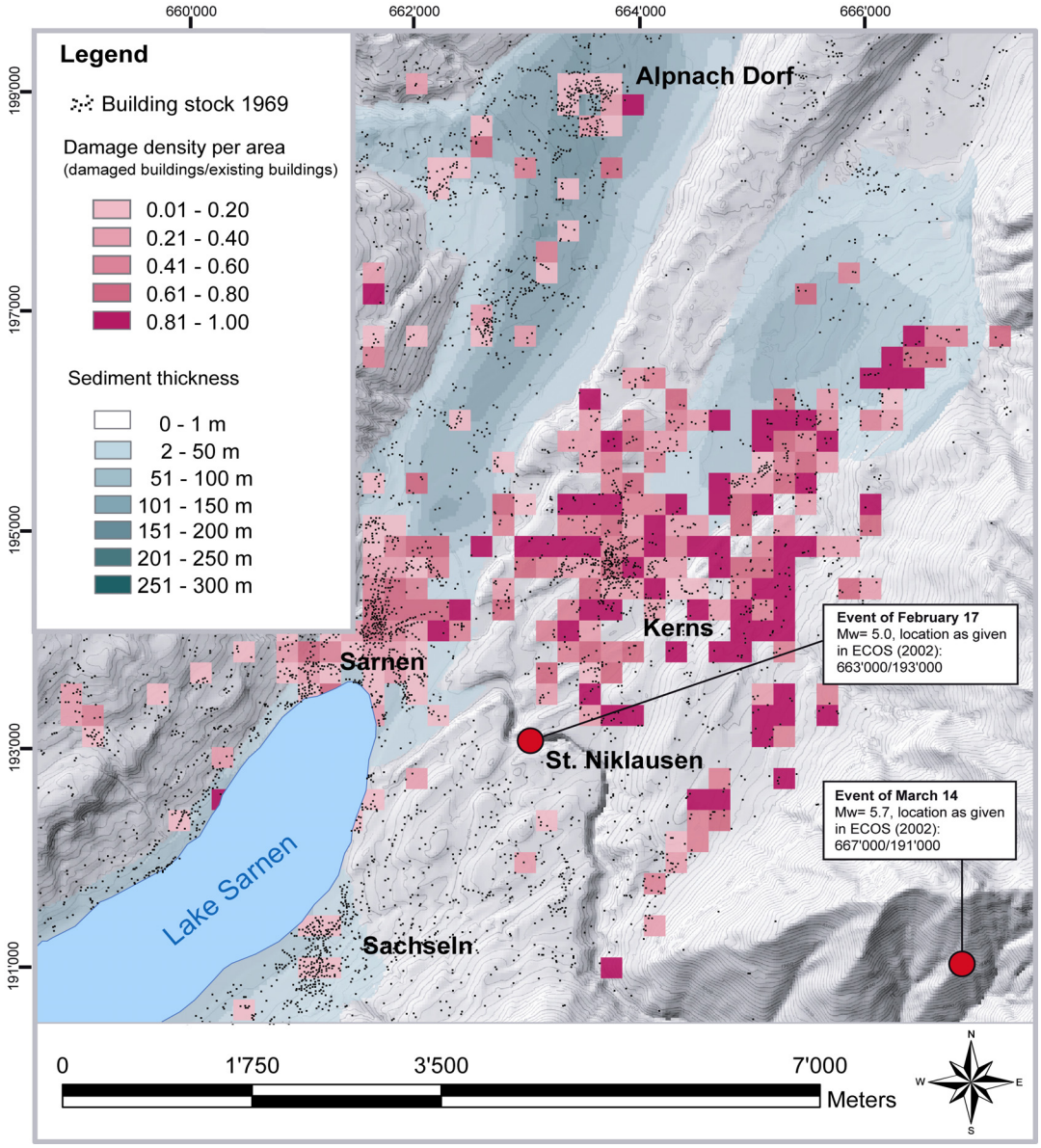


Figure 4.9: Percentage of damaged buildings per grid unit for the villages showing the highest intensity. Dark colored squares indicate areas with high portions of damaged buildings. Damage grades are not incorporated.

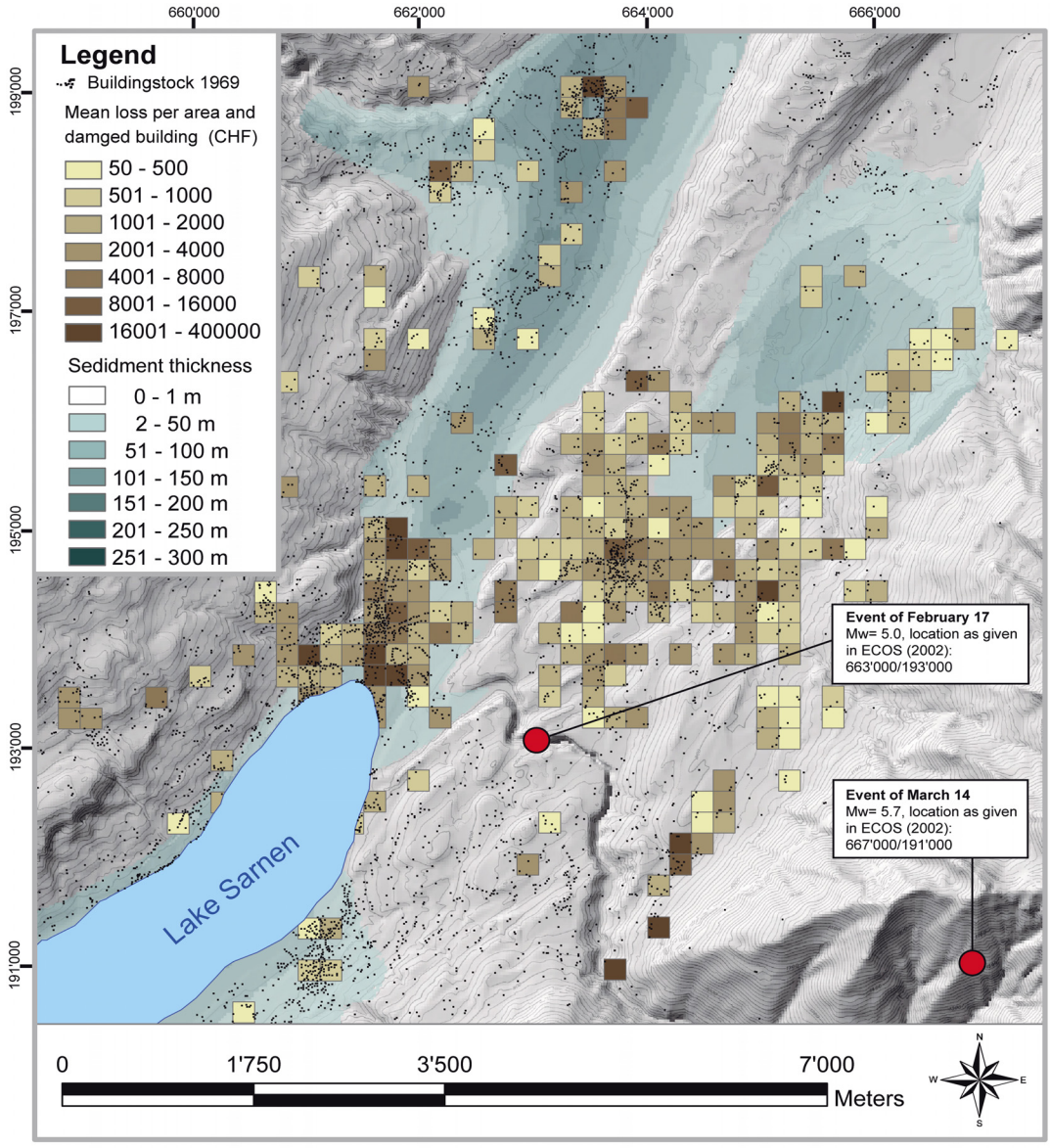


Figure 4.10: Average loss per building and grid unit in CHF (1964) for the villages showing the highest intensity. Squares of dark color indicate areas with high repair costs.

Damage density as shown in Fig. 4.9 tends to be higher in Kerns. In contrast Fig. 4.10 suggests that the average loss per building is larger in Sarnen. The reason for this disparity is explained by the quality and composition of the building stock. Unlike Kerns, Sarnen was already in the mid-sixties a more "town like" village including an industrial area in the north as well as a southern zone with many large public and culturally valuable structures (schoolhouses, churches and a monastery). Damage to these was costly, as we have seen in the last paragraph, raising the average loss significantly (Fig. 4.7). Second, in contrast to Sarnen, Kerns is a widespread village dominated by rural buildings of a simpler standard. Repair costs there were generally lower. Finally, many of Kern's structures are timber and

thus less vulnerable to certain types of damage (Fig. 4.10). The higher damage density (but not cost) in the Kerns region is possibly the result of a larger portion of buildings of low standard and poor condition (particularly barns). Looking more closely at damage in Alpnach we see that it is less serious than it appears from Fig. 4.8. The damage density (Fig. 4.9) is clearly lower than for most parts of Sarnen and Kerns and the relatively high loss per building and grid unit (Fig. 4.10) is due to a few cases of expensive damage to buildings showing high vulnerability (among them a church and an industrial building).

4.2.5 Location of the Faults

A difficult question to answer concerns the location of the responsible fault(s). Seismic instrumentation was sparse in Switzerland at that time (4 analogue seismic stations located in Zurich, Basel, Neuchatel and Chur) so locations could not be assessed adequately. So far attempts to locate the events rely on macroseismic data and thus are imprecise. For more than 30 years now, instrumentation has been improved. But seismic activity was too minimal to detect the active fault that might have triggered the 1964 series. A few small events recorded over the last 30 years support the model of a complex conjugated fault system with quickly changing stress fields in space (Deichmann et al., 2000). Such a model would not contradict geological findings that describe the region as a complex zone of overlaying and partly interlocked nappes disrupted by many tectonic faults. Nor would it contradict our interpretation of the 1964 series as a swarm. The earthquakes occurred at shallow depth and we might expect to find surface expression of the faults. Two faults that are mentioned frequently as part of this system west (1) and north of Sarnen (2) are shown in Fig. 4.8 (Beer, 1997; Schindler et al., 1996). Gisler et al. (2004c) proposed the left lateral strike-slip fault complex west of Sarnen (1) as the trigger for the 1964 event (Schindler 1980; Schindler et al., 1996). Such a fault mechanism would agree with the area's actual stress field derived from instrumental data (Kastrup et al., 2004) The results of our investigation show that the visible faults are probably not responsible for the two big 1964 events, at least not the part close to the surface. An earthquake with the epicenter located on this fault close to the surface would have produced a damage field different from our reconstruction (Fig 4.8). Particularly the region in the immediate vicinity and to the west of this fault shows intensities too low. Our results, in contrast, show that at least the two main shocks occurred closer to the villages of Sarnen and Kerns. However, the location of the source(s) remains an open question and

makes it impossible to consider its influence on the damage field. Directivity effects in particular might have played an important role.

4.3 Site effects: an important factor?

4.3.1 The local ground conditions

With respect to site-effects and damage distribution, the characteristics and thickness of the geotechnically relevant surface layers are important. Below we review the known geological and geotechnical conditions and describe the method we used to clarify them (Fig 4.11). Tectonically, the region of interest is north of the autochthonous basement (Aar Massif) of the Alps in the Helvetic nappes that are succeeded in the north by the Swiss Molasse Basin. The geomorphology is characterized by the main valley of the Kanton Obwalden running north-northeast down to Alpnach where it meets Lake Lucerne. This valley is strongly affected by glacial activity from the last ice age. Due to differences in rock hardness, the glacier formed several deep basins and swells that explain the cascaded pattern of the modern valley (Schindler, 1980). Parts of Sarnen, for example, are built on one of these which explains the varying deposit thickness in the area (Fig. 4.10). The basins are filled with young fluviatile and lacustrine sediments only a little consolidated with a thickness of up to 300 meters (Beer, 1997). The groundwater table is high in these sediments (ibid.). Although on some locations north of Sarnen and Alpnach less than 5m below the surface, ground failure or liquefaction was not observed during the 1964 earthquake series.

Where side valleys enter the main valley, the sediments are topped by extensive alluvial cones. In contrast to the valley bottom, the quaternary deposits on the mountainside are of minor thickness, consisting mostly of rock fall or slope rubble. Exceptions are the debris fans and the alluvial plain near Kerns where the deposits reach a thickness of up to 150 meters. These are unconsolidated like the fill of the main valley. Where the quaternary deposits are almost absent, the massive layers of the tertiary and cretaceous partially outcrop. On the eastern slope of the main valley, the latter consist mainly of lime- and sandstone as well as marl (Kantonales Oberforstamt, 1980). Some minor secondary phenomena (slope instabilities, rock fall) were observed in this part during the two main events. The western slope is dominated by outcrops of flysch and near Sarnen and Alpnach by lime- and sandstone.

The damage field of the 1964 earthquakes cover all these different surface layers. Our experience from comparable sites and earthquakes suggests that these field will express such

alternating ground conditions. Of particular interest are sites on voluminous deposit layers showing low S-wave velocities and strong impedance contrasts, since these sites tend to amplify ground motion on a frequency band that is often similar to the eigenfrequency of buildings. This similarity may lead to resonance effects and more serious damage.

4.3.2 Ground Investigations: Results

Comparing the damage distribution with sediment thickness (Figs. 4.8-4.10) shows that correlation is only partly given. We thus investigated the ground conditions with a statistical analysis of the losses per geological entity and with field experiments concerning the fundamental frequency of resonance.

Our results are given in Fig. 4.11 and 4.12. To check consistency of these findings, our computational results are given in two different scales: a scale representing the bigger part of the damage field and one showing the inner part of the damage field (approximately restricted to the villages of Sarnen and Kerns, represented by the dashed square). Each pie chart describes the damage spectrum on a specific geological unit as the sum of damage grades (0-4). Dashed bordered charts belong to the inner damage field. While the numbers inside the charts summarize the numbers of buildings existing in 1964, the colored segments give information on the proportion of the assessed damage grades. Since grade 1 damage is not completely assessed (see paragraph 4.3.3), we must note that the segments representing undamaged buildings (white color) include a significant number of grade 1 cases. In general the ground conditions in Fig. 4.11 can be divided into two main classes showing similar behaviors during an earthquake: the class of the different types of quaternary deposits on the one side (A-C) and the rocklike layers of tertiary and cretaceous on the other (D and E). The flysch interlayers (F) are minor since few buildings are located there.

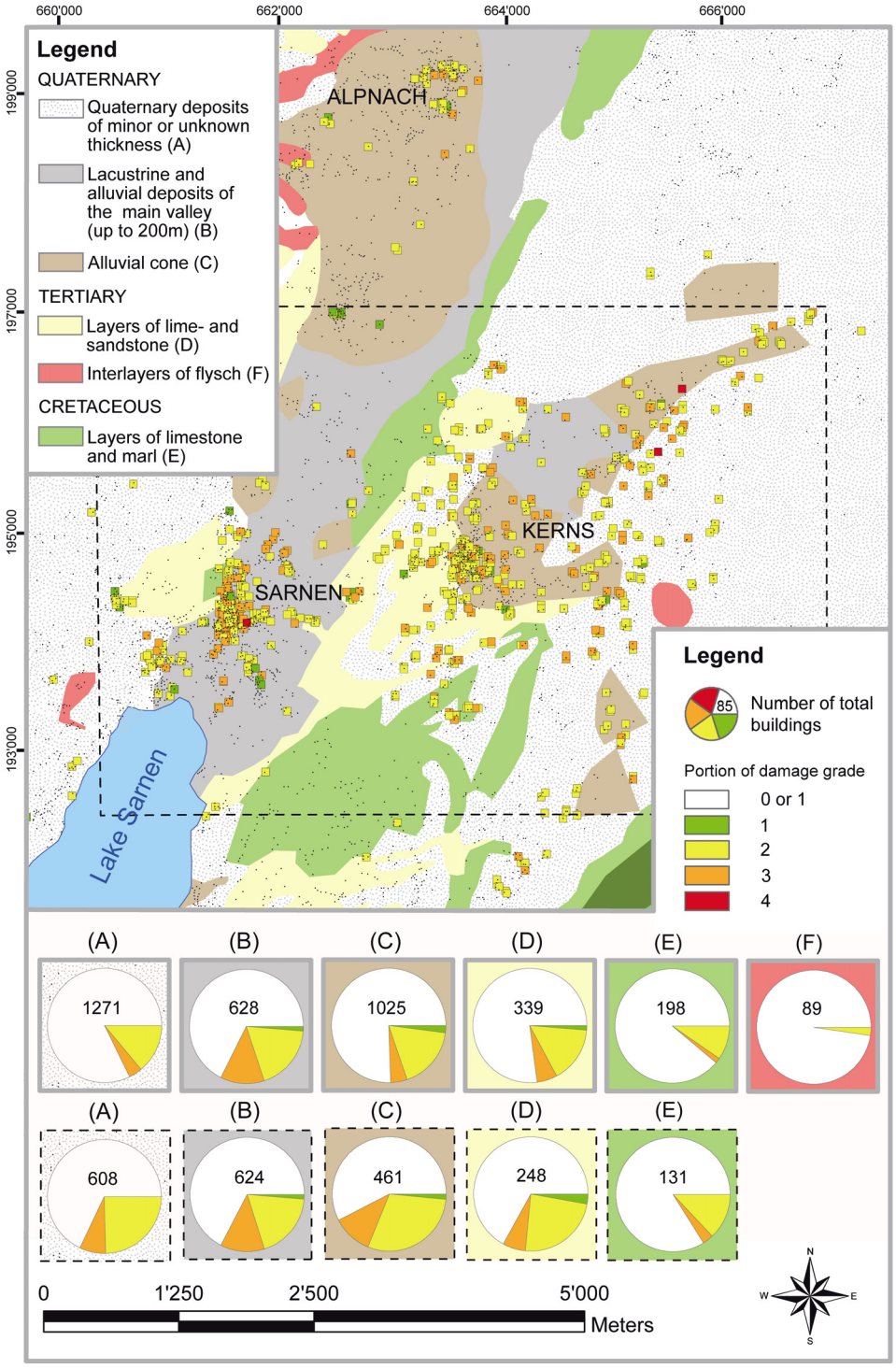


Figure 4.11: Damage grades and geology. The charts show the distribution of damage grades per geological unit on two scales. Dashed charts refer to the area defined by the dashed rectangle. The numbers inside the charts represent the existing building stock. This illustration is based on a geological map published in 1980 (Kantonales Oberforstamt).

Figure 4.13 shows the results of our field experiments concerning the fundamental frequency of resonance. It can be measured with ambient vibration H/V spectral ratios. In total we recorded ambient vibration on 75 sites for 20 minutes each and computed the data

with an algorithm developed by Fäh et al. (2001a). The fundamental frequency of resonance indicates the frequency band at which amplification can be strong. Fundamental frequencies of resonance depend primarily on deposit thickness and composition (S-wave velocity). In addition, for all maxima identified in the H/V spectral ratio we computed the quality of the peak. It is defined as the average value of 2 quality measures in the frequency-time-domain (FTAN):

$$Q = \frac{(Q_1 + Q_2)}{2}$$

Applied to the H/V curve obtained with the FTAN method. The following definitions are used:

f_0: Frequency of the H/V-peak: Fundamental frequency of resonance

$[f_Q, f_R]$: Uncertainty range of the fundamental frequency of resonance

f_S: Frequency of the first minimum to the left of the H/V-peak

f_T: Frequency of the first minimum to the right of the H/V-peak

First quality measure of the peak (Q_1):

$$Q_1 = \frac{\int_{f_Q}^{f_R} \log 10\left(\frac{H}{V}\right) df}{(f_R - f_Q)} - \frac{\log 10\left(\frac{H}{V}(f_S)\right) + \log 10\left(\frac{H}{V}(f_T)\right)}{2}$$

Second quality measure of the peak (Q_2):

$$Q_2 = 1 + \frac{\int_{f_S}^{f_T} 10^{\left|\log 10\left(\frac{H}{V}\right) - \overline{A}\right|} df}{(f_T - f_S)} \qquad \overline{A} = \frac{\int_{f_S}^{f_T} \log 10\left(\frac{H}{V}\right) df}{(f_T - f_S)}$$

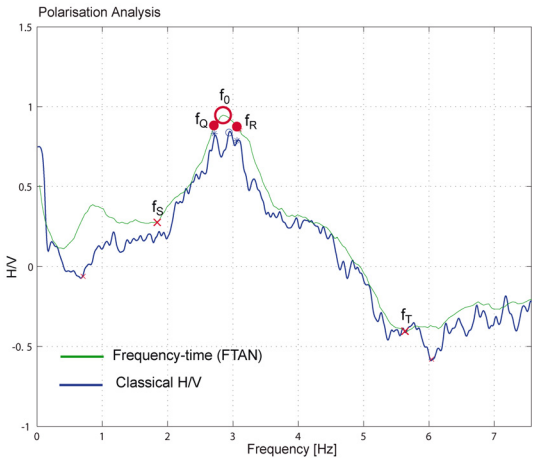


Figure 4.12: Example of a chosen H/V spectrum.

This peak value is not a quantitative measure of the expected amplification, but qualitatively describes the impedance contrast between sediments and bedrock.

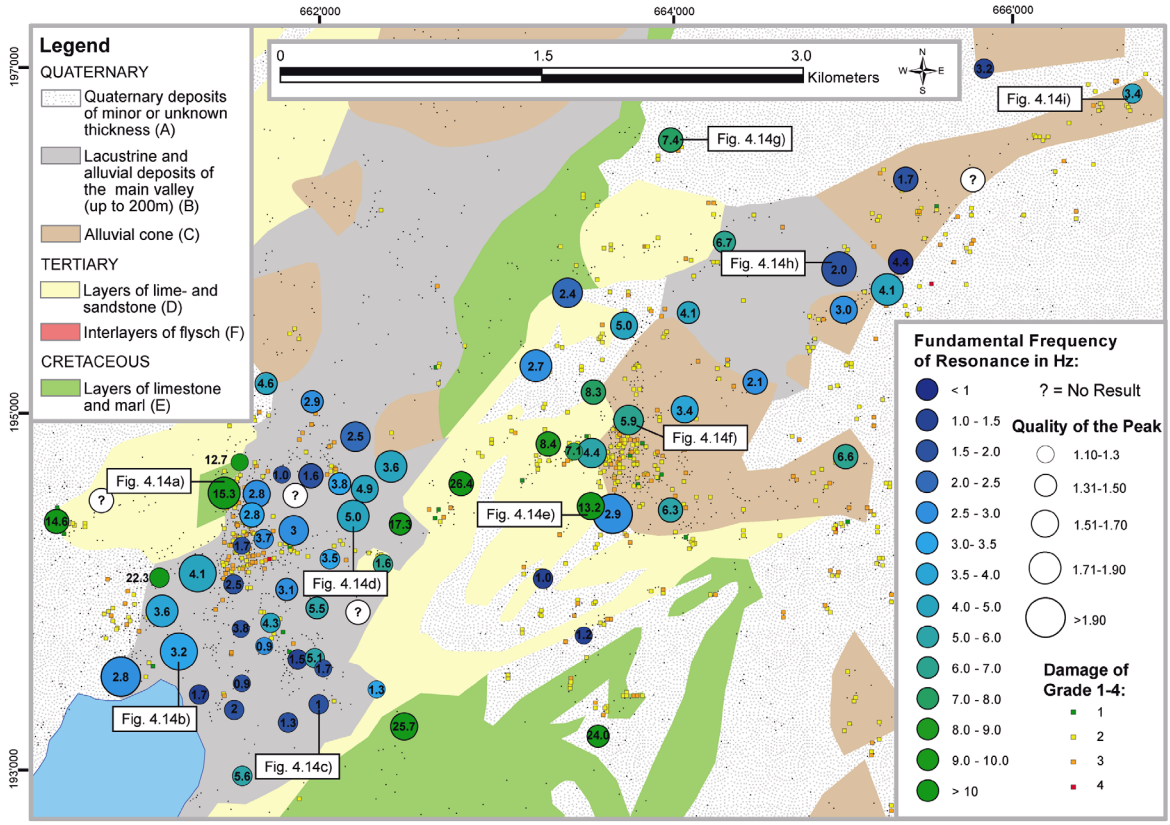


Figure 4.13: Geology and fundamental frequency of resonance. Location and results of 64 field experiments on the background of a geological map.

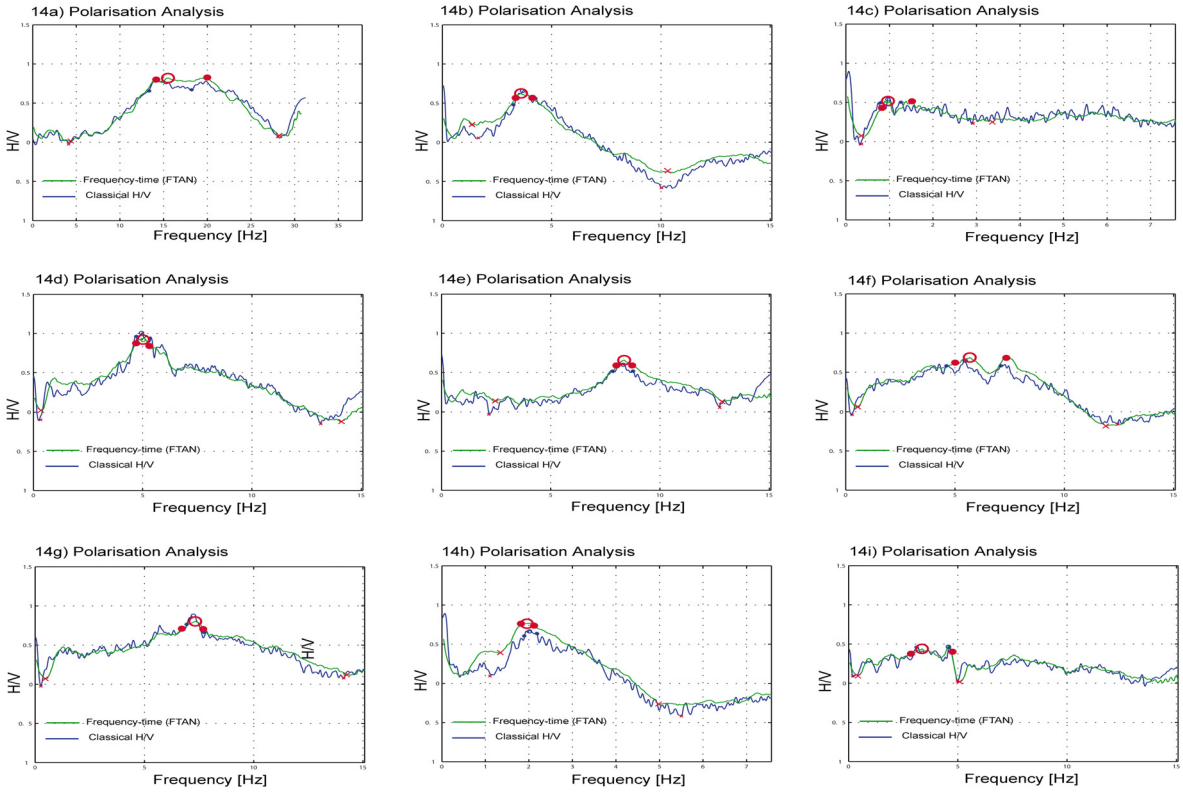


Figure 4.14: H/V spectra of the marked sites in Fig.4.13.

4.3.3 Ground Investigation: Discussion

Starting with the results from the statistical analysis, we note that damage is more frequent and larger on quaternary deposits. This is clear for the whole damage field as well as the inner part of the affected region (Fig. 4.11, dashed square), but more obvious in the latter. Particularly, ground types B and C show significantly higher rates of damaged objects, given their high portion of damage grade 3. Ground types B and C mainly correspond with the basin of the main valley. Thus 2D and 3D effects can not be excluded as long as investigation into this matter has not been done. In contrast, a high value of damage grade 3 is missing for the third ground type of the quaternary class (A). This is due to the thickness characteristics of the sediment layer. Ground types B and C show remarkable thickness for the most part, but type A is probably thin for wide areas. Consequently, these particular areas are not affected by site amplification in a relevant frequency band. Proceeding to the rocklike ground class, we conclude that the results are ambiguous. While ground types E and F fit our expectations by showing lower intensity, damage in type D is significantly higher than anticipated with cumulative damage on a level similar to the quaternary ground classes. However, one difference is visible. Compared to ground types B and C, damage of grade 3 is less pronounced, indicating a lower intensity similar to type A. Nevertheless, the values resulting for ground type D are clearly higher than expected. Why? Figure 4.11 implies that for ground type D (as well as E and F) the rock may reach the surface area-wide. Of course this is not the case for large parts of this region. It is covered with quaternary deposits of unknown thickness in some places. As with ground type A, we don't know exactly how thick they are. Moreover the behavior of rock strongly depends on its state of weathering: a heavily weathered rock behaves more like a sediment layer than a rock in geophysical terms. Our field experiments concerning the fundamental frequency of resonance illustrate that parts of ground type D show clear peaks of moderate quality on the H/V spectrum, unlike rock in a geophysical sense (Fig. 4.13, west of Kerns). Thus, whether or not weathered rock or quaternary deposits explain this phenomenon, we have strong indications for a surface layer that behaves like a deposit. Apart from this the results of the field experiments (Fig. 4.13) clearly correlate deposit thickness and the fundamental frequency of resonance. An empirical formula equates f_0 with $V_s/4h$, where h is the thickness of the relevant surface layer. Although we did not perform a geophysical study of the shear wave velocity for the Sarnen-region, our experience for comparable sites in Switzerland shows that Vs is probably in the range of 400-600 m/s (Havenith et al., 2007; Roten, 2007). Assuming this range for Vs, the formula results in

thickness values similar to the data proposed by Beer (1997) and shown in Fig. 4.10. Most notable are the results for the main valley near Sarnen where the values fit the shape of the bedrock, with low f_0-values along the central valley axis and an increase toward both sides. To the east lies the limestone zone showing results that indicate a more complicated ground situation than our geological data imply. In contrast, the values measured from there on to the northeast are explainable by the thickness and nature of the deposits.

In general the qualities of the peaks show wide variety. Nevertheless, a certain pattern is visible. While the peaks in the Kerns region show moderate quality for most of the measured sites, the main valley can be divided into different zones of poor/intermediate/good quality. Although the measured sites southeast of Sarnen show poor quality, the peak quality is much better on the western border of the plane. To the north of the city center a zone of peaks with intermediate quality is found. When we compare these patterns with the damage distribution, since peak quality is a measure for impedance contrast, we hardly find correlation. An exception is the zone southwest of Sarnen showing rather low damage (Fig. 4.9).

Are these observed f_0-values of relevance for the building stock of the region? The eigenfrequency of a building is controlled by many parameters. Types of construction and materials like the ground plan and many other factors have influence. Hence, an adequate eigenfrequency assessment is individual, complex and impractical for this case. Using general empirical observations, for buildings with 2-4 floors (the majority of the buildings' stock) eigenfrequencies of 3-8 Hz can be expected. Comparing this assumption with the expected soil amplification as a function of frequency band shows correlation for many areas.

4.4 Conclusions

Our aim was to analyze the earthquake swarm of 1964 in the Sarnen region. We explored questions related to the location of the source, the characteristics of the damage field and whether site-effects influenced this damage field.

Given the good documentation of the loss, we assessed the damage with high accuracy. For 95% of the affected buildings, location and grade of damage were reconstructed. One main characteristic of the damage field is its relatively small extension compared to the observed intensity: a few dozen square kilometers. Our finding agrees with observations that suggest shallow epicenters for this part of central Switzerland. The damage concentrates for the bigger part in the two villages of Sarnen and Kerns which experienced for both main events an intensity of grade VII.

Two faults with a surface expression discussed here as a possible source of the 1964 events are probably not responsible for them, at least not the part close to the surface. Their position at the periphery of the damage field makes it unlikely that an earthquake on one of these faults would have caused the observed damage. However, these faults are only the visible part of a complex sub-surface fault system.

In total about 850 buildings were affected, ranging from damage grade 1 up to a few cases of grade 4. About 90 % of the damaged objects were either residential buildings or barns. These buildings were responsible for approximate 35% of the total repair costs. On the other hand, loss to sacral buildings, representing merely 2% of the damaged buildings, amounted to almost 50% of the total repair expense. Analyzing the damage field has shown that varying building vulnerability as well as different ground conditions shaped spatial distribution and degree of damage. However, adequate quantification of these influences is difficult. The building vulnerability could only be assessed generally and the unknown source location made it difficult to separate source from site-effects.

Despite these restrictions, the influence of ground conditions is obvious. Regions of thick sediments in the main valley and the northeast of Kerns show significantly higher damage than places where the rock is covered by thin deposits. An exception is the area dominated by layers of lime- and sandstone between Sarnen and Kerns where the geological conditions are more complex than expected. A thick layer of weathered bedrock or layers of quaternary sediments in some areas could explain this exception. In general these findings are supported by the results of field experiments. In most areas where loss occurred, the measured fundamental frequencies of resonance of the soil are in a similar range to the eigenfrequencies of the buildings. In particular this applies for sites showing a high degree of damage. Furthermore, the gathered f_0-values generally confirm known information concerning deposit thickness. More experiments on locations in the lime- and sandstone layers would probably help clarify the geological situation of this zone. More study would also be desirable for locations further away from the inner damage field. Particularly Engelberg and the lower part of Lucerne would be interesting for further research, since both sustained slight damage at a considerable distance from the epicentral region.

5 Conclusions and Outlook

Site effect studies are important to modern seismological research and provide a wealth of relevant information. Various earthquakes disasters have shown that disadvantageous ground conditions can increase loss and casualties significantly. Where unconsolidated deposits of considerable thickness form the subsoil for construction and facilities, amplification and soil liquefaction effects are common, with drastic consequences when compared with sites showing rocklike characteristics. Another class of potentially dangerous phenomena related to site conditions is mass movements of various types. Earthquake triggered rockfalls, landslides, and avalanches are frequent effects of earthquakes in Alpine areas. In addition to settlements they also endanger lifelines like communication lines, roads and power supply. Generally speaking, site effect studies address two research fields. The first tries to explain how and to what extent ground conditions contribute to the damage after an earthquake. The second applies to a priori estimates of consequences for an earthquake at sites showing accordant ground conditions. The last mentioned type of investigation has a strong preventive or mitigating nature for urban planning.

This study addresses both problems. On the one hand, it is based on empirical damage data related to past earthquakes and investigates whether site-effects shaped the damage fields. But since the investigated regions show a comparatively high seismic hazard for Swiss measures combined with an increasing risk due to settlement, the project also includes a pronounced preventive component: Well-founded information concerning past earthquake events and their consequences will sensitize both a broad public and administrative authorities so that potential harm remains in discussion and acts of prevention may take place.

Our investigation consists of three case studies addressing the historical earthquakes of 1855 and 1946 in the Valais region as well as the 1964 event in central Switzerland. Common to all is that these events occurred in regions where unfavorable ground conditions regarding possible site-effects are frequent and often congruent with areas of increased construction nowadays. Similarly, these events have all provoked a lot of public response. All of them left numerous written testimonials giving valuable insight into the damage and forced the cantonal administration to complete official damage assessments. Unfortunately, the assessment on the 1946 earthquake is not traceable at present.

The events differ with respect to intensity and extent of the damage fields. While both Valaisan quakes reached intensity VIII and produced damage over a considerable area, the event of 1964 in Central Switzerland showed intensity no higher than VII, with damage in a very limited area of a few dozen square kilometres.

Paragraph 2 of the work presents the outcomes of our investigation into the 1855 event in the Visp region. It provoked loss for about 2000 objects and caused repair costs of several hundred thousand Swiss Francs at that time. Based on the completely preserved damage assessment done on behalf of the Cantonal administration, we were able to reconstruct the damage field with a surprisingly good resolution. It was possible to rate loss on more than one thousand houses and to assign them to one of 31 villages that were taken into account for the damage assessment. Since that assessment consists of rather short and rudimentary loss descriptions, we used a wide variety of other historical documents to find an appropriate level in assigning damage grades. This concept of calibrating the data proved a reliable way to gather a consistent and correct reassessment along with the guidelines of EMS 98. In combination with statistical data, we finally could divide the losses into different damage grades. Based on this we were able to assign intensity degrees accurately. Three of the investigated locations faced an intensity degree VII and twelve endured intensity VIII. For another nine locations, it was not possible to decide whether intensity grade VII or VIII would be more appropriate. Taking the villages' locations into account with respect to their general ground conditions, St. Niklaus, Visp and Naters attracted attention. All of them are built at least partly on deposits of considerable thickness and suffered heavy loss, particularly with regard to damage grade 4. Of special interest is that St. Niklaus as well as Naters are located on the periphery of the damage field and in the immediate vicinity of villages showing clearly lower intensities. The impact of amplification effects thus has to be assumed. While investigation into these localities will be expanded within the COGEAR project, we conclude that the damage to Visp was not driven primarily by a site effect. A detailed analysis of the loss distribution has shown that damage on the soft soil part of Visp was not larger than on the rocky part. On the other hand, the investigation showed strong nonlinear effects on the Visp site. In addition to many observations concerning cracks in the ground and the rock, we found reliable information on ground deformation, subsidence and soil liquefaction to the north of the contemporary village. Since a fault that is assumed for the 1855 earthquake passes Visp close by, a source effect has to be considered. Such an effect would explain the equal

damage distribution as well as other observed phenomena. As with St. Niklaus and Naters, investigation into the Visp site are still going on. Besides these results on damaged buildings, we have shown that the 1855 event triggered many secondary effects. In addition to effects on springs observed all over the damage field, we found historical documents describing how the earthquake provoked several landslides and rockfalls of considerable size, particularly in the Matter Valley. According to one author, St. Niklaus only avoided disaster because the meadow above the village was not frozen and slowed down the boulders so they got stuck in the soft soil just before reaching it.

The excellent database on the 1855 earthquake showed impressively how important it is to work thoroughly with historical sources. Critical interpretation of documents may avoid misunderstandings and helps to identify exaggerations and understatements. However, criticism is of similar importance with respect to regions and locations where sources remain silent. Without damage assessment we would have missed much information regarding several villages. Although many of the sources other than the damage assessment reliably describe the loss in detail, they tend to skip locations lacking a certain degree of popularity. At the same time, cases of spectacular loss at a particular location often supersede other cases of less dramatic damage at the same location. However, for the objective pursued in a project like this, lesser losses are of similar value to the more spectacular.

Somewhat similar observation has been done on the 1946 event. The findings concerning this earthquake are summarized in section 3. Since a damage assessment carried out in the weeks after the main shock of January 25 was fragmented, the database regarding the damage is incomplete. The repair costs summed up to almost CHF 5.5 Millions at the time covered loss on about 3500 buildings. For the two locations Sion and Sierre the loss is rather well documented. While Sion is the capital of Canton Valais and thus of special interest for newspaper and journals, Sierre suffered the more severe damage and attracted much public attention. These circumstances permitted reconstruction of damage at these two sites adequate enough to perform further studies. For the Sion site, we showed that damage of grade 3 was not exceeded but frequently achieved. Damage of grades 1 and 2 was omnipresent. Experiments focusing on the fundamental frequency of ground resonance (f_0) were performed all over Sion in its present extension and showed that amplification occurs in a frequency range lower than the resonance frequency of the building stock in the nineteen forties. Numerical simulations done by Roten et al. (2008) finally demonstrate that strong amplification effects start to be significant south of the city

as it existed in 1946 toward the valley axis. An apparent strong site effect is not detectable for Sion in combination with the 1946 earthquake. In contrast to these findings, we identified two locations in Sierre that clearly show a strong site effect. Both of them stick out with a clearly increased intensity compared to surrounding areas. Earlier Wanner and Grütter (1950) assumed that this accumulation of damaged buildings with high damage grades must seen in correlation with ground conditions. While one of these sites is characterized by an alluvial cone, the other is former swampland. For both, field experiments regarding the fundamental frequency of resonance gave evidence that the impedance contrast exceeds that in most other investigated areas of Sierre. Results from ambient vibration array measurements show that 2D or 3D resonance phenomena have to be expected for these sites. However, even if these two stick out, in general Sierre shows ground conditions that favor amplification effects. Most field experiments about the fundamental frequency of resonance resulted in values of relevance to Sierres's building stock. Another part of paragraph 3 examines the few data known from the damage assessment regarding the distribution of loss. Although analysis based on such an incomplete database is delicate, we demonstrate that districts having most building stock on the plain of the Rhone Valley suffered more loss than others. With a few exceptions, these results are consistent along the whole valley. This finding implies that damage in villages and cities on the plain was probably more frequent and stronger than in locations on the mountainside where soft deposits of considerable thickness are not frequent. In this regard, the finding is fully in line with theory. In contrast, more frequent on the mountainside were all kinds of masse movements. We summarized several dozens of rockfalls, landslides and avalanches observed either in the course of the main shock or as consequence of the aftershock of May 30. Most of these occurred north of the Rhone Valley, in the immediate vicinity or just west of the epicenter. The most impressive effect is the large landslide at the Rawylhorn of May 30 with extensions of 4-5 millions cubic metres of stone overwhelming a mountain pasture and lake.

In contrast to the 1946 earthquake, secondary effects were marginal during the 1964 event in central Switzerland. This event is described in section 4 of the work. With Io=VII, the consequences of this earthquake were clearly weaker than for the other two investigated events. Based on an almost completely preserved damage assessment done by the administration of the Obwalden Canton, we reconstructed the entire damage field of this event with high resolution. In total about 850 cases of loss totalizing an amount of CHF 4.5 Millions could be identified. With few exceptions the location of the damaged buildings

and the losses are known exactly. Since the data used included information on the building type that suffered damage, this case study includes detailed specifications. We demonstrate for example that the loss to public and sacral buildings that represent only 2 percent of the damaged buildings was responsible for about 60 percent of the total repair cost. We explained this finding by the fact that old sacral buildings often show poor earthquake resistance and a poor state of preservation. In contrast, traditional residential buildings held up better since important parts of their structure are timbered. Damage to these buildings was very frequent but mostly of minor nature and limited to roofs, chimneys and foundation. The influence of the building stock characteristics is also visible in the damage field. For the Kerns region showing mostly dispersed settlement and traditional buildings, we observed that most buildings suffered minor damage. Serious loss was restricted largely to sacral buildings and other construction of increased vulnerability. In contrast, the village of Sarnen with more recent buildings and industrial facilities showed a lower portion of damaged objects, but higher repair costs per loss.

In a next step we tried to find correlation between the damage distribution and the related ground conditions. This analysis confirmed our hypothesis that damage is more frequent on thick, soft soil layers like those on the plain of the main valley of Obwalden. However, the results were less significant than expected. Further investigation, including a large number of single station ambient vibration experiments, finally showed that the ground conditions of the Kerns are more complex than expected and broadly variable within short distances. Locations of rock alternate with sites showing considerably thick deposits. Some results regarding the fundamental frequency of resonance indicate that heavily weathered rock, that behaves more deposit-like, probably contributed to the observed intensity. More research into the subsoil characteristics of the Kerns region is definitively desirable.

Continuing research on the Valais region is in progress through the COGEAR project. Several sites discussed here will be investigated further regarding the ground conditions. But our work on the historical part of the project showed that the limits of what is possible are close. Long term investigation into these three historical earthquakes makes it unlikely that significant new perceptions well be attainable. This applies to new findings regarding documents describing the consequences of the earthquakes as well as the localization of particular damage. An important exception pertains to the 1946 event, for which we have not given up hope that the related damage assessment can be found some day. Finally, we will not exclude that a new and unknown document will surprise us.

While studying historical sources we found a large amount of information concerning social impact and consequences of the earthquakes. Typically this information was not utilized for this study. In future works, it would be useful to assess and interpret this information systematically. Particularly in the case of the 1855 event many documents exist that give interesting insights into the cantonal administrations management of the disaster.

6 References

6.1 Historical sources

6.1.1 Manuscripts

Archiv der Gemeinde Kerns

Anmeldung von Erdbebenschäden. Kopien von sämtlichen eingereichten Schadensmeldungen im Zusammenhang mit den Erdbeben von 1964. Without signature.

Archives Episcopales Sion

Brief von P.J. Studer, Pfarrer in Visperterminen an den Bischof von Sion, 1. August, 1855. T. 067 No. 030.

Archive of the Swiss Seismological Service (ASED)

Feldprotokolle zu den Erdbebenschäden von 1964 in Kerns. Originaldokumente mit den Nummern 140-219 und 241-326. Without signature.

Kanton Obwalden, Liste der während der Erdbeben von 1964 beschädigten Kirchen und Kapellen. Without signature.

Staatsarchiv Obwalden (StAOW)

Erdbeben 1964. Zusammenfassung der Schadensmeldungen. StAOW, V-D. 03.0735.

Von Ah, H.. 1964. Referat anlässlich des Rapportes der Leiter der Kantonalen Zivischutzstellen, vom 20. -23. April 1964 in Bern. Unpublished manuscript. StAOW, V-D. 03.0735.

Staatsarchiv Wallis (StAW)

Louis Closuit. Lettre adressé par le major Louis Closuit à son épouse, 30. juillet 1855. StAW, Fonds Closuit famille, 2002.

Originaldokumente der Schweizerischen Volkszählung aus dem Jahre 1870 im Kanton Wallis. StAW, 3090, 1870.

Originaldokumente der Schweizerischen Volkszählung aus dem Jahre 1850 im Kanton Wallis. StAW, 3090, 42, 1850.

Protocoles des séances du Conseil d'État 1855-57. StAW, 1101, vol. 49, 1857-1857.

Protocoles des séances du Conseil d'État 1946. StAW, 1101, vol. 97, 1945-1946.

Tremblement de terre de juillet 1855: Expertises des dommages. Ancien fonds du département de l´intérieur. StAW, DI, 27.3.2 (1855-1856).

Tremblement de terre de juillet 1855: Révision de la taxe, distribution des secours. Ancien fonds du département de l´intérieur. StAW, DI, 27.3.3 (1855-1860).

6.1.2 Published sources

BERTRAND, E.. 1756. Mémoire sur les tremblements de terre avec quatre sermons. Vevey.

BERTRAND, E.. 1766 Mémoires historiques et physiques sur les tremblements de terre. Recueil de divers traités sur l'histoire naturelle de la terre et des fossiles. Vevey.

BUREAU FEDERAL DE STATISTIQUE (ED.). 1946. Canton du Valais. Berne: Recensement fédéral de la population 1er décembre 1941. Vol. 16. *Statistiques de la Suisse*. Fasc. 169.

CANTON DU VALAIS. 1860. Rapport du comité central de bienfaisance, chargé de la répartition des secours recueillis pour les victimes du tremblement du terre qui a dévasté, en 1855 les districts de Rarogne, de Brique et de Viège. Sion.: StAW, DI, 27.3.3 (1855-1860)

COLOMBE, E.. 1855. Tremblement de Terre du Valais. *Comptes rendus hebdomadaires des séances de l'académie des sciences, Pari*s, vol. 39. 952-954.

DE LA RIVE, W.. 1855. Une excursion en Valais. *Bibliothèque universelle de Genève*, vol. 30. 78–102.

HEUSSER, J.C.. 1856. Das Erdbeben im Visper-Thal im Jahr 1855. An die zürcherische Jungend auf das Jahr 1856. *Neujahrsblätter der Naturforschenden Gesellschaft*, 58. Stück. Zürich.

JAHRESBERICHTE DES ERDBEBENDIENSTES DER SCHWEIZ. 1939-56. Von E. Wanner. Zürich.

LENOIR, D., 1949. Récit du tremblement de terre du Valais (25 juillet 1855) / écrit par David Lenoir. *Bulletin de la Murithienne,* fasc. 66. 25-28.

NÖGGERATH, J.. 1855. Die Erdbeben im Vispthale. Besonderer Abdruck für Freunde des Verfassers aus Nr. 282 bis 286 der Kölnischen Zeitung von 1855. Köln, Selbstverlag.

SCHEUCHZER, J.J.. 1706–1708. Beschreibung der Natur-Geschichten des Schweizerlands, 3 Vol., Zürich.

SCHEUCHZER, J.J.. 1701. Physica, oder Natur-Wissenschaft, 2 Vol. Zürich.

STAATSRAT DES KANTONS WALLIS. 1947. Verwaltungsbericht des Staatrates des Kantons Wallis, 1946, Sion.

STATISTISCHES BUREAU DES EIDG. DEPARTEMENT DES INNERN (ED.). 1862. *Schweizerische Statistik.* Bevölkerung. Eidgenössische Volkszählung vom 10. December 1860. Bern.

TSCHEINEN, M.. 1857. Tagebuch Über die Erdbeben des Visperthales in den Jahren 1855 und 1856 von Hrn. Pfarrer Tscheinen in Törbel. Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich. 2. Jahrgang. 28-48, 169-198.

VOLGER, G.H.O.. 1857-58. Untersuchungen über das Phänomen der Erdbeben in der Schweiz, seine Geschichte, seine Äusserungsweise, seinen Zusammenhang mit anderen Phänomenen und mit den petrographischen und geotektonischen Verhältnissen des Bodens, und seine Bedeutung für die Physiologie des Erdorganismus. 3 Vol. Gotha.

VOLGER, O.G.H.. 1856. Untersuchungen über das letzt jährige Erdbeben in Central-Europa. *Mittheilungen aus Justus Perthes' geographischer Anstalt über wichtige neue Erforschungen auf dem Gesamtgebiete der Geographie*. Von Dr. A. Petermann. 2. Jahrgang, Heft 2. 12–100.

6.1.2 Newspaper

Investigated Newspapers

Aargauer Tagblatt[1, 2]; Aardorfer Zeitung[2]; Aargauer Volksblatt[2] ;Anzeiger von Saanen[1]; Appenzeller Volksfreund[1]; Appenzeller Zeitung[1,2]; Badener Tagblatt[1,2]; Baselbieter[1]; Basellandschaftliche Zeitung[1]; Basler Nachrichten[1,2]; Basler Volksblatt[1]; Berner Tagblatt[1,2]; Bieler Tagblatt[1]; Blick[2];Bote der Urschweiz[1]; Brugger Tagblatt[1]; Bündner Tagblatt[1]; Burgdorfer Tagblatt[1]; Courier de Genève[1]; Courier du Valais[3]; Der Brienzer[1]; Der Bund[1,2]; Der Freie Rätier[2]; Der Freischütz[1]; Der Fürstenländer[1]; Der Landbote[1]; Der liberale Alpenbote[3]; Der Oberhasler[1]; Der Unterwaldner[1];Die Linth und Rapperswiler Nachrichten[1]; Die Südschweiz[1]; Die Tat[1, 2]; Die Woche[2]; Engadiner Post[1]; Feuille d'Avis de Lausanne[1,2]; Feuille d'Avis de Neuchâtel[1]; Feuille d'Avis de Vevey[1]; Feuille d'Avis des Montagne[1]; Freiämter Zeitung[1]; Freie Innerschweiz[1,2]; Fricktaler-Bote[1]; Gazette de Lausanne[1,2]; Gazette du Valais[3]; Giornale Di Popolo[1]; Glarner Nachrichten[1,2]; Gotthard-Post[1,2]; Hochwacht[1]; Il Doverev; Journal de Genève[1]; Journal de Montreux[1]; Journal de Morges[1]; Journal et Feuille d'Avis du Valais[1]; La Suisse[1,2]; La Tribune de Genève[1]; Le Confedéré[1]; Le Courrier de Leysin[1]; Le Fribourgeois[1]; Le Nouveliste Valaisan[1]; Le Pays[1]; Lenzburgerzeitung[1]; L'Express de Lausanne[1]; L'Express de Neuchâtel[1,2]; Liechtensteiner Volksblatt[1]; L'Impartial[1,2]; Lungern Bote[2]; Luzerner Landzeitung[1]; Luzerner Nachrichten[1]; Luzerner Neueste Nachrichten[1,2]; Luzerner Tagblatt[1, 2]; National-Zeitung[2]; Neue Berner Zeitung[1,2]; Neue Bündner Zeizung[1,3]; Neue Eidgenössische Zeitung[3]; Neue Zürcher Nachrichten[2]; Neue Zürcher Zeitung[1,2,3]; Nidwaldner Volksblatt[2]; Oberland[1]; Oberländer Tagblat[1]t; Oberländisches Volksblatt[1]; Obwaldner Volksfreund[2]; Oltener Tagblatt[1]; Schaffhauser Nachrichten[1]; Schweizer Wochen[1]; Schwyzer Zeitung[1]; Seeländer Volksstimme[1]; St.Galler Tagblatt[1]; Tages-Anzeiger[1,2]; Thurgauer Volkszeitung[1]; Toggenburger Volksblatt[1]; Tribune de Lausanne[1,2]; Vaterland[2];Volkszeitung[1]; Walliser Bote[1]; Walliser Nachrichten[1]; Wiler Zeitung[1]; Wir Brückenbauer[2]; Zofinger Tagblatt[1]; Zuger Nachrichten[1,3]; Züricherische Freitagszeitung[3].

[1]Investigated regarding the 1946 event.

[2] Investigated regarding the 1964 event.

[3] Investigated regarding the 1855 event.

Partial list of newspaper articles

Aardorfer Zeitung. Biologische Anzeichen von Erdbebenkatastrophen. 13.03.1964.

Aargauer Tagblatt. Beeindruckt vom Zucken und Schüttern. 16.03.1964.

Aargauer Volksblatt. Beim Schweizerischen Erdbebendienst in Sarnen. 20.03.1964.

Appenzeller Volksfreund. Ein Bericht aus Siders. 31.01.1946.

Appenzeller Zeitung. Beim Schweiz. Erbebendienst in Sarnen. 19.03.1964.

Badener Tagblatt. Wie wenn 10 Millionen Kilo aus 100 Metern fallen würden. 20.03.1964.

Badener Tagblatt. Erdstösse und Geisterspuck. 21.03.1964.

Baselbieter. Ein heftiges Erdbeben in der Schweiz. 29.01.1946.

Basler Nachrichten. Erdstösse erschüttern die Innerschweiz. 18.02.1964.

Basler Nachrichten. Grosszügige Deckung der Obwaldner Erdebenschäden. 06.06.1964.

Basler Volksblatt. Die Erde bebt wieder . 05.02.1946.

Basler Volksblatt. Ein Bericht aus Siders. 29.01.1946.

Basler Volksblatt. Nachbeben in Basel. 28.01.1946.

Berner Tagblatt. In Bern bebt die Erde. 27.01.1946.

Berner Tagblatt. Folgen des Erdbebens. 28.01.1946.

Berner Tagblatt. Das Walliser Erdbeben: die Schäden. 29.01.1946.

Berner Tagblatt. Erdbeben und Erdbebenversicherung. 31.01.1946.

Berner Tagblatt. Das Erdbeben: Grimentzer Kirche bedroht. 31.01.1946.

Berner Tagblatt. Das neue Erdbeben. 05.02.1946.

Berner Tagblatt. Folgen des Erdbebens. 06.02.1946.

Berner Tagblatt. Einsturz in einem Walliser Bergwerk. 08.02.1946.

Berner Tagblatt. Weitere Erdbebenstösse. 14.02.1946.

Berner Tagblatt. Starkes Erdbeben in der ganzen Schweiz. 30.05.1946.

Berner Tagblatt. Erdbeben in der Schweiz am Auffahrtsmorgen. 01.06.1946.

Berner Tagblatt. Erdbebenschäden im Wallis. 08.06.1946.

Berner Tagblatt. Heftiges Erdbeben in der Innerschweiz. 18.02.1964.

Berner Tagblatt. Es gibt in der Schweiz ausgesprochenen Erdbebenzentren. 17.03.1964.

Blick. "s hät gruuisig tätscht". 18.02.1964.

Blick. Erdbeben: Droht in Obwalden ein zweites Skoplje? - Hunderte flüchteten aus der Heimat. 16.03.1964.

Blick. Beil, Säge, Taschenlampe am Bett bereit. 18.03.1964.

Blick. Obwaldner Erdbeben-Kommission wird Flugblatt verteilen. 19.03.1964.

Blick. Erdbeben-Wallfahrt zu dem hl. Bruder. 20.03.1964.

Blick. Erdbeben-Gefahr: Auszug aus dem Kollegi.... 15.04.1964.

Der Bund. Starkes Erdbeben in der Schweiz. 27.01.1946.

Der Bund. Das Erdbeben vom Freitag und Samstag. 28.01.1946.

Der Bund. Die Erde bebt weiter. 28.01.1946.

Der Bund. Folgen des Erdbebens. 29.01.1946.

Der Bund. Es war ein "Kleinbeben". 01.02.1946.

Der Bund. Wetter, Erdbeben und Sonnenflecken. 04.02.1946.

Der Bund. Historisches über Erdbeben. 04.02.1946.

Der Bund. Die Erde bebt weiter. 05.02.1946.

Der Bund. Über die Ursachen des Walliser Erdbebens. 07.02.1946.

Der Bund. Neues Erdbeben in der Schweiz. 31.05.1946.

Der Bund. Das Erdbeben. 31.05.1946.

Der Bund. Das Erdbeben. 17.07.1946.

Der Bund. Auch am Montag Erdstösse in Obwalden. 17.03.1964.

Der Bund. Sarnen har schlaflose Nächte. 20.03.1964.

Der Freie Rätier. Wenn die Erde bebt. 17.03.1964.

Der Fürstenländer. Heftiges Erdbeben im Wallis: Bedeutende Schäden vor allem in Sitten. 26.01.1946.

Der Fürstenländer. Weitere Erdbebenstösse im Wallis: Erhebliche Schäden in der Rhone Ebene. 28.01.1946.

Der Fürstenländer. Über das Erdbeben in Sitten. 06.02.1946.

Die Tat. Das heftige Nachbeben. 27.01.1946.

Die Tat. Erdbebenschäden im Wallis. 29.01.1946.

Die Tat. Wenn die Erde bebt. 17.03.1964.

Die Tat. Was weiter. 19.03.1964.

Die Tat. Pulsmessung der bebenden Erden. 20.03.1964.

Die Woche. In Obwalden geht das Gespenst von Skolpje um. 18.03.1964.

Feuille d'Avis de Lausanne. Nuit dramatique à Sion. 26.01.1946.

Feuille d'Avis de Lausanne. Le tremblement de terre à Lausanne. 26.01.1946.

Feuille d'Avis de Lausanne. Le tremblement de terre a été fortement ressenti dans le canton de Vaud. 26.01.1946.

Feuille d'Avis de Lausanne. Violent tremblement de terre en Suisse. L'épicentre est en Valais - Des dégâts. Une forte émotion. 26.01.1946.

Feuille d'Avis de Lausanne. Après le tremblement de terre. 28.01.1946.

Feuille d'Avis de Lausanne. En marge du séisme. 29.01.1946.

Feuille d'Avis de Lausanne. Le tremblement de terre du 25 janvier. 21.02.1946.

Feuille d'Avis de Lausanne. En Valais. Une conséquence du tremblement de terre. 28.02.1946.

Feuille d'Avis de Lausanne. En Valais. Les effets du tremblement de terre. 09.05.1946.

Feuille d'Avis de Lausanne. Encore une tremblement de terre. La violence des secousses. 31.05.1946.

Feuille d'avis de Lausanne. Sarnen, vrais et faux visages du séisme.... 23.03.1964.

Freie Innerschweiz. Das Erdbeben wurde auch in der Stadt gespürt. 16.03.1964.

Freie Innerschweiz. Könnte Sarnen ein zweites Skoplje werden? 16.03.1964.

Gazette de Lausanne. La terre tremblait encore dans la soirée. 18.02.1964.

Gazette de Lausanne. Plus de peur que de mal. 19.02.1964.

Gazette de Lausanne. Sarnen: Nouvelles secousses telluriques. 24.02.1964.

Gazette de Lausanne. Les secousses de Sarnen: Un bon suet de composition. 25.02.1964.

Gazette de Lausanne. Les écoliers de Sarnen prendront leurs vacances 10 jours plus tôt. 16.03.1964.

Gazette de Lausanne. Séisme de Sarnen: Le frisson du jeu paiera la secousse. 18.03.1964.

Gazette du Valais. Tremblement de terre dans le Haut-Valais. 02.08.1855.

Gazette du Valais. Nous sommes heureux.... 09.08.1855.

Gazette du Valais. Vendredi matin. 26.08.1855.

Gazette du Valais. Tremblement de terre. 29.07.1855.

Gazette du Valais. Le tremblement de terre. 29.07.1855.

Gazette Lausanne. Une violente secousse sismique fait trembler toute la Suisse. 26.01.1946.

Gazette Lausanne. Echos du tremblement de terre. 28.01.1946.

Gazette Lausanne. Prélude a la fin du monde. 28.01.1946.

Gazette Lausanne. En Valais après le séisme: Plus de dommages a Sierre qu'a Sion. 29.01.1946.

Glarner Nachrichten. Versicherung gegen Erdbeben. 18.03.1964.

Gotthard-Post. Erdbeben - auch in Uri keine Seltenheit! 21.03.1964.

Journal de Genève. Un tremblement de terre a été ressenti dans toute la Suisse. 27.01.1946.

Journal de Genève. Le tremblement de terre a causé un accident mortel à Aix-Les-Bains. 28.01.1946.

Journal de Genève. Les tremblements de terre en Suisse. 30.01.1946.

Journal de Genève. En marge d'un séisme. 06.02.1946.

Journal de Genève. La terre a tremblé dans toute la Suisse. 31.05.1946.

Journal de Montreux. Hier, la terre a tremblé en Suisse. 26.01.1946.

Journal de Sierre. Le terrible tremblement de terre. 29.01.1946.

Journal d'Yverdon. Les tremblements de terre. 29.01.1946.

Journal et Feuille d' Avis du Valais. Un violent tremblement de terre: 1 mort - Plusieurs blessés, gros dégâts. 28.01.1946.

L' express. Les dégâts casés par le séisme en Valais. 29.01.1946.

La Suisse. Un violent tremblement de terre a été perçu dans toute la Suisse. 26.01.1946.

La Suisse. L'observatoire de Neuchâtel a enregistré plus de quarante secousses. 27.01.1946.

La Suisse. Un violente tremblement de terre dont l'épicentre était situé dans la région de Rawyl a secoué toute la Suisse. 31.05.1946.

La Suisse. Hier, la terre à tremblé. 15.03.1964.

La Tribune de Genève. Plus de peur que de mal à Genève. 26.01.1946.

La Tribune de Genève. Violent tremblement de terre en Suisse. L'épicentre dans le Valais. 27.01.1946.

La Tribune de Genève. Les effets du tremblement de terre en Suisse. 28.01.1946.

La Tribune de Genève. Après le tremblement de terre: Choses vues en Valais. 30.01.1946.

Le Confédéré. Après un tremblement de terre. 28.01.1946.

Le Confédéré. Les effets du tremblement de terre. 30.01.1946.

Le Confédéré. Les effets du tremblement de terre. 30.01.1946.

Le Confédéré. De nouvelles secousses sismiques. 31.05.1946.

Le Courrier de Leysin. La terre a tremblé. 29.01.1946.

Le Fribourgeois. Violent tremblement de terre en Suisse. 26.01.1946.

Le Fribourgeois. Le tremblement de terre à Fribourg. 28.01.1946.

Le Fribourgeois. La terre tremble: Les observations sismographiques. 01.06.1946.

L'Express de Neuchâtel. La terre a tremblé hier soir et dans la nuit: D'important dégâts au Valais, foyer du séisme. 26.01.1946.

L'Express de Neuchâtel. De nouvelles secousses sismiques continuent à être enregistrées. 26.01.1946.

L'Express de Neuchâtel. La ville de Sierre a été plus gravement atteinte que Sion. 29.01.1946.

L'Express de Neuchâtel. De secousse en secousse.... 31.01.1946.

L'Express de Neuchâtel. De secousse en secousse.... 31.01.1946.

L'Express de Neuchâtel. Un nouveau tremblement de terre provoque des dégâts en Valais. 31.05.1946.

L'Express de Neuchâtel. Le séisme en Valais. 03.06.1946.

L'Express de Neuchâtel. Tremblement de terre en Suisse. 19.02.1964.

L'Impartial La Chaux-de-Fonds. A Sarnen, l'E.P.F. "mesure" la fièvre de l'écorce terrestre. 20.03.1964.

Lungern-Bote. Wankende Erde. 21.02.1964.

Luzerner Nachrichten. Ein schweres Erdbeben. 02.02.1946.

Luzerner Neueste Nachrichten. Die Erde bebte. Verletzte und Gebäudeschäden im Wallis. 26.01.1946.

Luzerner Neueste Nachrichten. Im eigentlichen Erdbebengebiet. 26.01.1946.

Luzerner Neueste Nachrichten. 41 Erdstösse in 10 Stunden. 28.01.1946.

Luzerner Neueste Nachrichten. Intermezzo auf der "festgegründeten Erde". 26.02.1946.

Luzerner Neueste Nachrichten. Erdbeben in der Innerschweiz, zwei heftige stösse richteten besonders im Obwaldnerland Schaden an - keine Verletzten. 18.02.1964.

Luzerner Neueste Nachrichten. Die Erde in Obwalden hat sich noch nicht beruhigt. 19.02.1964.

Luzerner Neueste Nachrichten. Die Erde bebt! 19.02.1964.

Luzerner Neueste Nachrichten. Neues schweres Erdbeben mit Epizentrum Obwalden. 16.03.1964.

Luzerner Neueste Nachrichten. Es war der stärkste Stoss des Dauerbebens.... 16.03.1964.

Luzerner Neueste Nachrichten. Auch in Luzern wurden Gotteshäuser beschädigt. 16.03.1964.

Luzerner Neueste Nachrichten. Was folgt nach? 17.03.1964.

Luzerner Neueste Nachrichten. Die Erdbebenstation von Sarnen ist eingerichtet. 19.03.1964.

Luzerner Neueste Nachrichten. Die Schäden gehen in die Millionen. 19.03.1964.

Luzerner Neueste Nachrichten. Auf den Machtschutz Gottes Vertrauend. 20.03.1964.

Luzerner Neueste Nachrichten. Die Bevölkerung wurde über die Entstehung von Erdbeben orientiert. 20.03.1964.

Luzerner Neueste Nachrichten. Was im Katastrophenfall vorzukehren wäre. 01.04.1964.

Luzerner Tagblatt. Starke Erdbebenstösse in der ganzen Schweiz. Das Wallis als Erdbebenzentrum. 26.01.1946.

Luzerner Tagblatt. Die Erdbebenschäden im Wallis. Kirchtürme Eingestürzt, ungezählte Gebäude beschädigt, Kamine heruntergeschlagen, ein Todesopfer zufolge Schockwirkung. 28.01.1946.

Luzerner Tagblatt. Der 25. Januar 1946 in Montana. Ein weiterer Erdbeben-Bericht einer Luzernerin. 30.01.1946.

Luzerner Tagblatt. Die Innerschweiz und Luzern von einem Erdbeben heimgesucht. 18.02.1964.

Luzerner Tagblatt. Immer noch bebt die Obwaldner Erde. 28.02.1964.

Luzerner Tagblatt. Nach dem Erdbeben. 16.03.1964.

Luzerner Tagblatt. Und wieder bebte die Erde in Obwalden. 17.03.1964.

Luzerner Tagblatt. Wo liegt der Ursprung der gegenwärtigen Erdbeben? 18.03.1964.

Luzerner Tagblatt. Spüren Tiere Erdbeben voraus? 25.04.1964.

Luzerner Tagblatt. Kampf gegen Krankheiten - Hilfe gegen Erdbeben-Schäden. 06.06.1964.

Luzerner Tagblatt. Können Felsstürze vorausgesagt werden?. 11.09.1964.

Messager des Alpes. Le tremblement de Terre: Les explications d'un savant. 29.01.1946.

National-Zeitung. Erdbeben in der Innerschweiz. 18.02.1964.

National-Zeitung. Wer zahlt die Erdbebenschäden? 16.03.1964.

National-Zeitung. Bebende Erde - verängstigte Menschen. 16.03.1964.

National-Zeitung. Unheimliche Nacht in Obwalden. 16.03.1964.

National-Zeitung. Immer noch keine Ruhe in Obwalden. 17.03.1964.

National-Zeitung. "Von der Geissel des Erdbebens verschone uns, o Herr!". 21.03.1964.

National-Zeitung. Schnellerer Einsatz bei Naturkatastrophen. 26.03.1964.

National-Zeitung. Obwaldner Gemeinden erwarten Bundeshilfe. 13.04.1964.

Neue Berner Zeitung. Unverhüllte Sensationsgier im Obwaldner Erdbebengebiet. 20.03.1964.

Neue Bündner Zeitung. Erdbeben in der Schweiz: Der Herd wieder im Wallis. 31.05.1946.

Neue Zürcher Nachrichten. Stimmungsbild aus dem vom Erdbeben heimgesuchten Obwalden. 20.03.1964.

Neue Zürcher Zeitung. Nr. 137. Erdbeben. Freitag, 25. Januar, 18 Uhr 32' 25". Beobachtungen in Zürich.. 26.01.1946.

Neue Zürcher Zeitung. Nr. 142. Das Erdbeben vom Freitagabend. Der Herd des Bebens im Wallis. 27.01.1946.

Neue Zürcher Zeitung. Nr. 149. Das Erdbeben in der Schweiz. 28.01.1946.

Neue Zürcher Zeitung. Nr. 152. Das Erdbeben. Weitere Nachrichten. 28.01.1946.

Neue Zürcher Zeitung. Nr. 161. Die Erdbebenschäden. Gefährdung der Kirche von Grimentz. 30.01.1946.

Neue Zürcher Zeitung. Nr. 173. Das Erdbeben im Wallis. Eine Erklärung der meteorologischen Zentralanstalt. 01.02.1946.

Neue Zürcher Zeitung. Nr. 155. Die Erdbebenschäden. Einsturzgefahr beim Kirchturm von Bex. 28.02.1946.

Neue Zürcher Zeitung. Nr. 748. Aufruf zugunsten der Erdbebengeschädigten im Wallis. 30.04.1946.

Neue Zürcher Zeitung. Nr. 956. Erdeben. Herd in der Gegend von Sitten. 31.05.1946.

Neue Zürcher Zeitung. Erdbeben in der Innerschweiz. 18.02.1964.

Neue Zürcher Zeitung. Das Erdbeben in der Innerschweiz, Registrierungen in der ganzen Schweiz. 18.02.1964.

Neue Zürcher Zeitung. Das Erdbeben in der Innerschweiz, erneut heftige Stösse. 19.02.1964.

Neue Zürcher Zeitung. Das Erdbeben im Kanton Obwalden. 16.03.1964.

Neue Zürcher Zeitung. Das Erdbeben in Obwalden: Grosse Schäden in Sarnen, Kerns und Alpnach. 16.03.1964.

Neue Zürcher Zeitung. Der Erdbebenherd Sarnen. 17.03.1964.

Neue Zürcher Zeitung. Beobachtungen in Luzern. 17.03.1964.

Neue Zürcher Zeitung. Die Erdstösse im Kanton Obwalden. 17.03.1964.

Neue Zürcher Zeitung. Erdbeben, neue Erdstösse in Sarnen. 26.10.1964.

Neue Zürcher Zeitung. Bern. 26.07.1855.

Neue Zürcher Zeitung. Zürich. 26.07.1855.

Neue Zürcher Zeitung. Schwyz. 28.07.1855.

Neue Zürcher Zeitung. Zürich. 29.07.1855.

Neues Winterthurer Tagblatt. Das Erdbeben im Wallis. 28.01.1946.

Nidwaldner Volksblatt. Was wissen wir von den Erdbeben? 02.05.1964.

Nouvelliste Valaisan. La terre tremble en Suisse. 26.01.1946.

Nouvelliste Valaisan. Le violent tremblement de terre ressenti dans toute la Suisse, en France et en Italie.... 27.01.1946.

Nouvelliste Valaisan. La terre a tremblé. 02.02.1946.

Nouvelliste Valaisan. La terre tremble: Un violent séisme, dont l^épicentre est au Rawyl, secoue toute las Suisse: Importants dégâts. 01.06.1946.

Oberländer Tagblatt. Die Folgen des Erdbebens. 28.02.1946.

Obwaldner Volksfreund. Erdbeben in Sarnen und Umgebung. 18.02.1964.

Obwaldner Volksfreund. Wie lange noch Nachbeben? 21.02.1964.

Obwaldner Volksfreund. Das Verhältnis der Nachbeben zum Hauptstoss. 25.02.1964.

Obwaldner Volksfreund. Sarnen. Um die Stärke der Nachbeben. 28.02.1964.

Obwaldner Volksfreund. Sarnen. Unglückliche Erdbeben-Publizistik. 06.03.1964.

Obwaldner Volksfreund. Das unheilvolle Beben vom 14. März. 17.03.1964.

Obwaldner Volksfreund. Eindrucksmächtige Wallfahrt aufs Flüeli. 20.03.1964.

Obwaldner Volksfreund. Der Schweizerische Erdbebendienst in Sarnen an der Arbeit. 26.03.1964.

Obwaldner Volksfreund. Pflanzengeographie - Geologie - Erdbeben. 31.03.1964.

Oltener Tagblatt. Das Erdbeben in der Schweiz. 26.01.1946.

Oltener Tagblatt. Das Erdbeben. 28.01.1946.

Oltener Tagblatt. Erdeben am Auffahrtsmorgen. 31.05.1946.

Schweizer Allg. Volkszeitung. Es handelt sich um ein Kleinbeben. 01.02.1946.

Schweizer Allg. Volkszeitung. Es bebte die Erde. 21.03.1964.

Schweizer Wochen. Die heftigen Erdbeben in der Schweiz. 02.02.1946.

St.Galler Tagblatt. Das Erdbeben war von der stärke 7. 18.02.1946.

St.Galler Tagblatt. Ein Erdbeben. 18.02.1964.

St.Galler Tagblatt. Die Erde bebt noch immer. 19.02.1964.

St.Galler Tagblatt. Erdbeben nicht selten. 20.02.1964.

St.Galler Tagblatt. Der Erdbebenherd Sarnen. 17.03.1964.

Stuttgarter Zeitung. Mehrere hundert Nachbeben im Gebiet von Sarnen. 07.04.1964.

Tagblatt der Stadt Zürich. Neuer Erdstoss in Sarnen. 17.03.1964.

Tages-Anzeiger. Ein schweres Erdbeben. Der stärkste Erdstoss sei 191, Der Herd: Das Walliser Erdbebengebiet, beträchtliche Sachschäden. 26.01.1946.

Tages-Anzeiger. Das Erdbeben im Walli. Ein Augenzeugenbericht. 29.01.1946.

Tages-Anzeiger. Erdbeben in der Innerschweiz. 18.02.1964.

Tages-Anzeiger. Das Erdbeben in der Innerschweiz. 20.02.1964.

Tages-Anzeiger. Wenn die Erde bebt.... 07.03.1964.

Tages-Anzeiger. Die Erde bebte. 14.03.1964.

Tages-Anzeiger. Bebende Erde - verängstigte Menschen. 16.03.1964.

Tages-Anzeiger. In Obwalden bebt die Erde weiter. 17.03.1964.

Tages-Anzeiger. Obwaldner Behörden beriet über das Erdbeben. 18.03.1964.

Tages-Anzeiger. "Vor der Geissel des Erdbebens verschone uns, o Herr". 20.03.1964.

Tages-Anzeiger. Von mir aus jede Woche. 28.03.1964.

Tages-Anzeiger. Obwalden spart. 02.04.1964.

Tages-Anzeiger. 430'000 Franken für Erdbebenschäden in Obwalden. 13.02.1965.

Tages-Anzeiger. Obwalden fordern Bundesbeiträge. 01.04.1965.

Tribune de Lausanne. Gros dégâts à Sion, Sierre, Loëche. 26.01.1946.

Tribune de Lausanne. Après le tremblement de terre. 27.01.1946.

Tribune de Lausanne. Le clocher de Bex menace ruine. 28.01.1946.

Tribune de Lausanne. Après le séisme. 29.01.1946.

Tribune de Lausanne. La terre tremble encore. 30.01.1946.

Tribune de Lausanne. Tremblement de terre. 03.02.1946.

Tribune de Lausanne. Epicentre: Le Rawyl. 31.05.1946.

Tribune de Lausanne. Après le tremblement de terre. 01.06.1946.

Tribune de Lausanne. Angoisse à Sarnen. 19.02.1964.

Tribune de Lausanne. Les secousses diminuant d'intensité. 20.02.1964.

Tribune de Lausanne. Toujours des secousses à Sarnen. 23.02.1964.

Tribune de Lausanne. Sarnen: La terre ne semble pas vouloir se calmer. 25.02.1964.

Tribune de Lausanne. Secousses telluriques à Sarnen: L’anxiété apparaît à nouveau sur le visage des Obwaldiens. 26.02.1964.

Tribune de Lausanne. Sarnen: Les secousses telluriques ont repris avec un regain d'intensité et de fréquence. 04.03.1964.

Tribune de Lausanne. Nouvelles fortes secousses à sarnen. 14.03.1964.

Tribune de Lausanne. L'angoisse grandit à Sarnen. 15.03.1964.

Tribune de Lausanne. Climat de panique à Sarnen ou le sol tremble toujours. 16.03.1964.

Tribune de Lausanne. Des habitants de Sarnen et de Kerns abandonnent chaque soir leur logis pur passer la nuit hors de ces cités. 17.03.1964.

Tribune de Lausanne. Sarnen: toutes disposition prises pour faire face au pire. 18.03.1964.

Tribune de Lausanne. Une nuit à Sarnen. 19.03.1964.

Tribune de Lausanne. A Sarnen le terre qui s'était calmée se remet à inquiéter la population. 26.03.1964.

Tribune de Lausanne. La région de Sarnen tremble à nouveau. 27.03.1964.

Tribune de Lausanne. Nouvelles secousses telluriques à Sarnen. 12.07.1964.

Tribune de Lausanne. Sarnen, 1500 secousses, 2 millions de dégâts en un an. 18.02.1965.

Vaterland. Ein Erdbeben überraschte die Innerschweiz. 18.02.1964.

Vaterland. Samstag 03.39: die Erde bebt. 16.03.1964.

Vaterland. Ein Bombardement aus der Tiefe der Erde. 17.03.1964.

Vaterland. Das seismographische Amt hat sich in Sarnen Eingerichtet. 19.03.1964.

Vaterland. Erdbeben immer noch wichtigstes Gesprächsthema in Obwalden. 26.03.1964.

Vaterland. Der Schweizerische Erdbebendienst. 31.03.1964.

Vaterland. Obwaldner Erdbebenschäden belaufen sich auf mehr als vier Millionen Franken. 18.06.1964.

Walliser Bote. Das Erdbeben vom 25. Januar 1946. 29.01.1946.

Walliser Bote. Zum Erdbeben. 08.02.1946.

Walliser Bote. Schäden des Erdbebens. 15.03.1946.

Walliser Bote. Für die Erdbebengeschädigten. 02.04.1946.

Walliser Bote. Für die Erdbebengeschädigten. 30.04.1946.

Walliser Bote. Erdstoss bringt das Gewölbe der Kirche von Chippis zum Einsturz. 04.06.1946.

Walliser Bote. Erdbeben ist doch gefährlich. 21.06.1946.

Walliser Nachrichten. Das Erdbeben. 29.01.1946.

Walliser Nachrichten. Erste Bilanz der Erdbebenschäden. 29.01.1946.

Walliser Nachrichten. Wissenschaftliche Feststellungen über das walliser Beben. 01.02.1946.

Walliser Nachrichten. Von den Ursachen des Walliser Erdbebens. 08.02.1946.

Walliser Nachrichten. Erdbebenforschung. 22.02.1946.

Walliser Nachrichten. Neue Erdstösse im Wallis. 03.03.1946.

Walliser Nachrichten. Schäden des Erdbebens. 15.03.1946.

Walliser Nachrichten. Um den Münsterturm zu Bern. 22.03.1946.

Walliser Nachrichten. Erdbeben. 29.03.1946.

Walliser Nachrichten. Folgen des Erdbebens. 14.05.1946.

Walliser Nachrichten. Neue Erdstösse. 24.05.1946.

Walliser Nachrichten. Alp Sérin - nah dem Erdbeben. 13.08.1946.

Weekly Tribune de Genève. Quake shakes villages- Damage, no deaths. 20.03.1964.

Wir Brückenbauer. Obwaldens Erde bebte. 06.03.1964.

Wir Brückenbauer. Am puls der Erde. 27.03.1964.

Wir Brückenbauer. Wenn die Erde bebt. 01.04.1964.

Wir Brückenbauer. Matura in Militärbaracken. 22.05.1964.

Zürcher Woche. Warum die Erde bebt. 20.03.1964.

Zürcherische Freitagszeitung. Wallis. 10.08.1855.

Zürcherische Freitagszeitung. Das Erdbeben. 27.07.1855.

Zürcherische Freitagszeitung. Das Erdbeben von letzter Woche. 31.03.1855.

6.2 Scientific Literature

ABELE, G.. 1974. Bergstürze in den Alpen: Ihre Verbreitung, Morphologie und Folgeerscheinungen. *Wissenschaftliche Alpenvereinshefte.* Heft 25. München.

ANDERSON, J.G., BODIN, P., BRUNE, J.N., PRINCE, J., SINGH, S.K., QUAAS R., AND M. ONATE. 1986. Strong ground motion from the Michoacan, Mexico, earthquake. *Science*, 233. no. 4768. 1043 – 1049.

AKI, K.. 1957. Space and time spectra of stationary stochastic waves with special reference to microtremors, *Bull. Earthq. Res. Inst*., 35. 415-456.

BARD ET AL. 2004. Site-effects assessment using AMbient Excitations (SESMAE). 14.02.2008: http://sesame-fp5.obs.ujf-grenoble.fr/index.htm.

BARD, P. Y., AND M. BOUCHON. 1985. The two-dimensional resonance of sediment-filled valleys. *Bulletin of the Seismological Society of America* 75(2). 519-541.

BEER, CH.. 1997. Erdbebengefährdung in Abhängigkeit vom Geologischen Untergrund. Schweizerische Geotechnische Kommission. *Beiträge zur Geologie der Schweiz. Geotechnische Serie*. Nr. 92. Zürich.

BERNARDI, F., BRAUNMILLER, J. AND GIARDINI, D.. 2005. Seismic Moment from Regional Surface-Wave Amplitudes: Applications to Digital and Analog Seismograms. *BSSA* 95 (2). 408-418.

BRGM, EDF AND IRSN. 2005. SisFrance. 10. Jan. 2008: http://www.sisfrance.net.

BÜHLER, J.. 2006. The earthquake of 1774 in the region of Altdorf. ETH Zurich. Semester thesis. Unpublished.

BUNDESAMT FÜR STATISTIK (ED.). 2002. Bevölkerungsentwicklung der Gemeinden 1850-2000. Eidgenössische Volkszählung 2000. Autoren: Martin Schuler Dominik Ullmann, Werner Haug. Neuchâtel, Bundesamt für Statistik.

BUREAU FEDERAL DE STATISTIQUE. 1946. Canton du Valais. Recensement fédéral de la population 1er décembre 1941. Vol. 16. *Statistiques de la Suisse*, fasc. 169. Berne.

BURRI, M.. 1955. La Géologie du Quartenaire aux environs de Sierre. *Bulletin* soc. *Vaud. Sc. Nat*., vol. 66, no. 289. 141-152.

BUWAL. 1996. Integrierte Auswertung von seismischen und bodenspezifischen Parametern: Gefährdungskarten im Kanton Obwalden. C. Schindler et al.. Landeshydrologie und Geologie. *Geologische Berichte*, Nr. 19. Bern.

BWG, BUNDESAMT FÜR WASSER UND GEOLOGIE (Ed.). 2002. Erdbebengerechter Entwurf von Hochbauten: Grundsätze für Ingenieure, Architekten, Bauherren und Behörden: Richtlinien des BWG/Hugo Bachmann, Bern.

BWG, BUNDESAMT FÜR WASSER UND GEOLOGIE (Ed.). 2000. Beitrag zur seismischen Zonierung des Rhonetals zwischen Sitten und Brig. J.-J. Wagner et al.. Landeshydrologie und –geologie. *Geologische Berichte* Nr. 25. Bern.

CAPON, J.. 1969. High-resolution frequency-wave number spectrum analysis, Proc. *IEEE*, 57(8). 1408–1418.

CREALP. 2006. Carte cantonale au 1:25'000 des classes de sols de fondation. 10. Jan. 2008 http://www.crealp.ch/fr/seismes/construction-parasismique/cartes-telechargeables.html.

CREALP. 2004. Microzonage sismique de la vallée du Rhône entre Brig et le Léman. Cartographie 1: 25'000 des sols de fondation, Selon classification de la norme SIA 261. Rapport Crealp Nr. 04.03, Mars 2004. 12. Febr. 2008: http://www.crealp.ch/images/files/seismes/microzonage_valle_du_rhne_rapport.pdf

CREALP. 1999. Blocs diagrammes présantant les contextes structureaux des séismes de "Viège" 1855 et de "Sierre" 1946. By M. Sartory. 10. Jan. 2008: http://www.crealp.ch/fr/seismes/risque-sismique-en-valais/lalea-sismique-2.html.

DEICHMANN, N., BALLRIN DOLFIN, D. AND U. KASTRUP. 2000. Seismizität der Nord- und Zenralschweiz. NAGRA. Technischer Bericht 00-05. Wettingen.

FÄH, D., STAMM, G. AND H.-B. HAVENITH. 2008a. Analysis of three-component ambient vibration array measurements. *Geophysical J. Int.*, 172. 199-213.

FÄH, D., GISLER, M., JAGGI, B., KÄSTLI, P., LUTZ, T., MASCIADRI, V., MATT, C. MAYER-ROSA, D., RIPPMANN, D., SCHWARZ-ZANETTI, G., TAUBER, J. AND T. WENK. 2008b. An interdisciplinary Revision: the 1356 Basel Earthquake. *GJI,* submitted.

FÄH, D. AND P. HUGGENBERGER. 2006. INTERREG III, Erdbebenmikrozonierung am südlichen Oberrhein. Zusammenfassung für das Projektgebiet Gebiet in der Schweiz. CD and Report (in german; available from the authors).

FÄH, D., STEIMEN, S., OPRSAL, I., RIPPERGER, J., WÖSSNER, J., SCHATZMANN, R., KÄSTLI, P., SPOTTKE, I. AND P. HUGGENBERGER. 2006. The earthquake of 250 A.D. in Augusta Raurica, a real event with a 3D site-effect? *Journal of Seismology*, 10, No. 4. 459-477.

FÄH, D., GIARDINI, D., BAY, F., BERNARDI, F., BRAUNMILLER,J., DEICHMANN, N., FURRER, M., GANTNER, L., GISLER, M., ISENEGGER, D., JIMENEZ, M.J., KÄSTLI, P., KOGLIN, R., MASCIADRI, V., RUTZ, M., SCHEIDEGGER, C., SCHIBLER, R., SCHORLEMMER, D., SCHWARZ- ZANETTI, G., STEIMEN, S., SELLAMI, S., WIEMER, S., AND J. WÖSSNER. 2003a. Earthquake Catalogue Of Switzerland (ECOS) And The Related Macroseismic Database. *Eclogae Geol. Helv. Swiss Journal of Geosciences*, 96. 219-236.

FÄH, D., KIND, F. and D. GIARDINI. 2003b. Inversion of local S-wave velocity structures from average H/V ratios, and their use for the estimation of site-effects. *Journal of Seismology* 7. 449-467.

FÄH D., KIND F., AND D. GIARDINI. 2001a. A theoretical investigation of average H/V ratios. *Geophys. J. Int.*, 145. 535-549.

FÄH, D., KIND, F., LANG, K. AND D. GIARDINI. 2001b. Earthquake scenarios for the city of Basel. *Soil Dynamics and Earthquake Engineering*, 21. 405-413.

FÄH, D., RÜTTENER , E., NOACK, T. AND P. KRUSPAN. 1997. Microzonation of the city of Basel. *Journal of Seismology*. 1. 87-102.

FIELD, E. AND K. JACOB. 1993. The theoretical response of sedimentary layers to ambient seismic noise. *Geophys. Res. Lett.*, 20. 2925-2928.

Frischknecht, Corine. 2000. Seismic soil amplification in Alpine Valleys: a case study: the Rhône Valley, Valais, Switzerland. Genève: Section des Sciences de la Terre, Université de Genève. *Terre & environnement*, Volume 21.

FRITSCHE, S. AND D. FÄH. 2008a. The 1946 Magnitude 6.1 Earthquake in the Valais: Site-Effects as Contributor to the Damage. *Geophys. J. Int.,* submitted.

FRITSCHE, S., FÄH, D., STEINER, B., AND D. GIARDINI. 2008b. Damage Field and Site Effect: Multidisciplinary Studies of the 1964 Earthquake Series in Central Switzerland. *Natural Hazard*, submitted.

FRITSCHE, S., FÄH, D., GISLER, M., UND D. GIARDINI. 2006. Reconstructing the Damage Field of the 1855 Earthquake in Switzerland: historical investigations on a well-documented event. *Geophys. J. Int*., 166. 719-731.

FRITSCHE, S., FÄH, D. UND D. GIARDINI. 2005. Damage Fields and Site-Effects. Investigations on the 1855 Earthquake in Switzerland. *Proceedings of the 250th Anniversary of the 1755 Lisbon Earthquake, Lisbon, Portugal*. 1-4 November, 2005.

FUX, C.. 1996. Erinnern Sie sich. Visp. Visp, Rotten.

GESELLSCHAFT FÜR SCHWEIZERISCHE KUNSTGESCHICHTE (ED.). 2003. Sion, Solothurn, Stans, Thun, Vevey. Inventar der neueren Schweizer Architektur, 1850-1920. Vol. 9. Zürich.

GESELLSCHAFT FÜR SCHWEIZERISCHE KUNSTGESCHICHTE (ED.). 1996. St. Gallen, Sarnen, Schaffhausen, Schwyz. Inventar der neueren Schweizer Architektur, 1850-1920. Vol. 8. Zürich.

GIARDINI, G., WIEMER, S., FÄH, D. AND N. DEICHMANN, 2004. Seismic Hazard Assessment of Switzerland, 2004. Publication Series of the Swiss Seismological Service, ETH Zürich, 91 pages.

GISLER, M AND D. FÄH (ED.). 2008. Nachbeben. Eine Geschichte der Erdbeben in der Schweiz. Mit Beiträgen von Donat Fäh, Stefan Fritsche, Domenico Giardini, Monika

Gisler, Philipp Kästli, Virgilio Masciadri, Ivo Oprsal, Regula Schatzmann und Gabriela Schwarz-Zanetti. Bern. In preparation.

Gisler, M.. 2007. Göttliche Natur? Formationen im Erdbebendiskurs der Schweiz des 18. Jahrhunderts. Zürich, Chronos.

GISLER, M., FÄH, D. AND R. SCHIBLER. 2004a. Revising macroseismic data in Switzerland: the December 20, 1720 earthquake in the region of Lake Constance. *Journal of Seismology*, 8. 179-192.

GISLER, M., FÄH, D. and Ph. KÄSTLI. 2004b. Historical seismicity in Central Switzerland. *Eclogae Geol. Helv. Swiss Journal of Geosciences*. 97. 221-236.

GISLER, M., FÄH, D. AND N. DEICHMANN. 2004c. The Valais Earthquake of December 9, 1755. *Eclogae Geol. Helv. Swiss Journal of Geosciences*, 97. 411-422.

GISLER, M.. 2003. Historical Seismology in Switzerland: Reflections on Issues and Insights. *Environment and History*, 9/2. 215–237.

GRUNER, E.. 1968. Die Arbeiter in der Schweiz im 19.Jahrhundert. Soziale Lage, Organisation, Verhältnis zu Arbeitgeber und Staat. Bern, Franke.

GRÜNTHAL, G (ED.). 1998. European Macroseismic Scale 1998. *Cahiers du Centre Européen de Geodynamics et de Séismologie*. Vol. 15. Conseil de L'Europe. Luxembourg.

HAINZL, S., KRAFT T., WASSERMANN, J., IGEL, H. AND E. SCHMEDES. 2006. Evidence for rainfall-triggered earthquake activity, *Geophys. Res. Lett.*, 33.

HAVENITH, H.-B., FÄH, D., POLOM, U. AND A. ROULLE. 2007. S-wave velocity measurements applied to the seismic microzonation of Basel, Upper Rhine Graben. *Geophys. J. Int.,* 170. 346–358.

HAVENITH, H.B. AND D. FÄH, D. 2006 S-wave velocity measurements applied to the seismic microzonation of Basel, Upper Rhine Graben. *Geophys. J. Int.*, submitted.

HORIKE, M.. 1985. Inversion of phase velocity of long-period microtremors to the S-wave velocity structure down to the basement in urbanized areas. *J. Phys. Earth*., 38. 59-96.

HUNZIKER, J.. 1900-1914. Das Schweizer Haus nach seinen landschaftlichen Formen und seiner geschichtlichen Entwicklung. Erster Abschnitt: Das Wallis (1900). Aarau, Sauerländer.

HUSEN, S., BACHMANN, C., AND D. GIARDINI. 2007. Locally triggered seismicity in the central Swiss Alps following the large rainfall event of August 2005. *Geophys. J. Int.*, accepted.

INSTITUTE OF GEOPHYSICS ETHZ. 2003. Lecture note. Microzonation and Site-Effects. Unpublished.

Gruppo di lavoro CPTI (2004). Catalogo Parametrico dei Terremoti Italiani, versione 2004 (CPTI04), INGV, Bologna. http://emidius.mi.ingv.it/CPTI04/

JORIS, C.-L.. 2005. Neotectonic fault in the south east of Visp. Personal communication.

KASTRUP U., ZOBACK M., DEICHMANN N., EVANS K., GIARDINI D. AND A. MICHAEL. 2004. Stress field variations in the Swiss Alps and the northern Alpine foreland derived from inversion of fault plane solutions. *J. Geophys. Res.,* 109. B01402.

KIND, F., FÄH, D., P., GIARDINI, D., 2005. Array measurements of S-wave velocities from ambient vibrations. *Geophysical J. Int.*, 160. 114-126.

LAC SOUTERRAIN DE ST-LEONARD. Géologie et histoire. 12. Jan. 2008: http://www.lac-souterrain.com/.

LACHET, C. AND P.Y. BARD. 1994. Numerical and theoretical investigations on the possibilities and limitations of Nakamura's technique, *J. Phys. Earth*, 42. 377-397.

LERMO, J. AND F.J. CHAVEZ-GARCIA. 1993. Site-effects evaluation using spectral ratios with only one station, *Bull. seism. Soc. Am.*, 83. 1574-1594.

MALAGNINI, L., ROVELLI, A., HOUGH, S.E. AND L. SEEBER. 1993. Site amplification estimates in the Garigliano valley, central Italy, based on dense array measurements of ambient noise. *Bull. seism. Soc. Am*., 83. 1744-1744.

MARIÉTAN, I.. 1946. Le tremblement de terre du 25 Janvier 1946. *Bulletin de la Murithienne – Société Valaisanne des sciences naturelles*, fasc. 63. 70-87.

MARIETAN, I.. 1947. Le tremblement de terre du 25 Janvier. Almanach du Valais. 53-55.

MASSET, O.. 2005. Modélisation géologique et hydrologique de l'instabilité de falaise de St. Niklaus. Diplôme postgrade. ENAC. Lausanne, EPFL. Unpublished.

MICHELET, H.. 1990. Le Valais. 1475-1634. Récit des événements et aperçu des grands problèmes valaisans de l'époque. Saint-Maurice. Editions Rhodaniques. 1982-1990.

MONTADON, F.. 1946. Les trois récents séismes du Valais central. *Revue pour l'étude des calamités*. Tome IX, fasc. 24. 50-68.

MONTADON, F. AND W. STAUB. 1946. Sur la cause des tremblements de terre du Haut-Valais. *Globe, Organe de la société de Géographie de Genève*. Tome 85. 1-21.

NAKAMURA, Y. 1989. A Method for Dynamic Characteristics Estimation of Subsurface using Microtremor on the Ground Surface. *QR of RTRI*, 30. 25-33.

NOACK, T., FÄH, D. AND P. KRUSPAN. 2000. Mikrozonierung von Basel-Stadt. Landeshydrologie und -geologie, *Geologische Berichte,* Nr. 24. Bern.

NOGOSHI, M. AND T. IGARASHI. 1971.On the Amplitude Characteristics of Microtremor (part 2). *Jour. Seism. Soc. Japan*, 24. 26-40.

OPRSAL, I., FÄH, D., MAI, M., AND D. GIARDINI. 2005. Deterministic earthquake scenario for the Basel area - Simulating strong motion and site-effects for Basel, Switzerland. *J. Geophys. Res.*, 110, No. B04305.

OPRSAL, I., FÄH D., GIARDINI D., AND M. MAI. 2004. Three Dimensional Finite-Difference Modeling of Strong Ground-Motion Site-effects due to the Finite-Extent Source – 1356 Basel Earthquake, Upper Rhine Graben, *Proceedings of the 13th WCEE*, 1 – 6 Aug. 2004. Vancouver, Canada.

OHRNBERGER M.. 2004. User manual for software package CAP - a continuous array processing toolkit for ambient vibration array analysis. SESAME report D18.06, http://sesamefp5.obs.ujf-grenoble.fr.

PLAFKER, G., ERICKSEN, G.E., AND J.F. CONCHA. 1971. Geological Aspects of the May 31, 1970, Peru Earthquake. *Bulletin of the Seismological Society of America,* 61. 543-578.

REITER, L. 1990. Earthquake Hazard Analysis – Issues and Insight, Columbia University Press. New York.

RITZMANN-BLICKENSTORFER, H. (ED.). 1996. Historische Statistik der Schweiz / unter der Leitung von Hansjörg Siegenthaler. Zürich, Chronos.

ROSSELLI, A.. 2001. Modélisation gravimétrique bi- et tridimensionnelle du substratum rocheux des vallées alpines. PhD thesis. Université de Lausanne.

ROTEN, D., FÄH, D., OLSEN, K.B., AND D. GIARDINI.. 2008. A comparison of observed and simulated site response in the Rhone valley. *Geophys. J. Int.,* submitted.

ROTEN, D. AND D. FÄH. 2007. A combined inversion of Rayleigh wave dispersion and 2-D resonance frequencies. *Geophys. J. Int.*, 168(3). 1261-1275.

ROTEN, D.. 2007. Site effects in the Rhone valley analysed by ambient noise, weak motion records and numerical simulations. Ph.D. thesis, ETH Zurich

ROTEN, D., FÄH, D., CORNOU, C., AND D. GIARDINI. 2006. Two-dimensional resonances in Alpine valleys identified from ambient vibration wavefields. *Geophys. J. Int.*, 165. 889-905.

RÜTTENER, R.. 1995. Earthquake hazard evaluation for Switzerland. *Matériaux pour la géologie de la Suisse. Géophysique*, vol. 29. Zurich.

SÄGESSER, R. AND D. MAYER-ROSA. 1978. Erdbebengefährdung in der Schweiz. Basler & Hofmann. Zürich.

SCHIBLER, R.. 2000. Makroseismische Untersuchung der Erdbeben von 1946 im Mittelwallis. Diploma thesis, Institute of Geophysics. ETH Zürich. Unpublished.

SCHINDLER, C., BEER, C., MAYER-ROSA, D., RÜTTENER, E., WAGNER, J.-J., JAQUET, J.-M. AND C. FRISCHKNECHT. 1996. Integrierte Auswertung von seismischen und bodenspezifischen Parametern: Gefährdungskarten im Kanton Obwalden. Bundesamt für Umwelt, Wald und Landschaft. Landeshydrologie und –Geologie. *Geologische Berichte*. Nr. 19. Bern.

SCHINDLER, C.. 1980. Geologisch-geotechnische Voruntersuchungen der N8 zwischen Sarnen und dem Brünig. *Strasse und Verkehr*. Nr. 5.

SCHWARZ-ZANETTI, G., FÄH, D., MASCIADRI, V. AND P. KÄSTLI. 2006a. The Churwalden (CH) Earthquake of September 1295. Fauna and Flora in the Middle Ages. Investigations into the Medieval Environment and its Impact on Human Mind. Sieglinde Hartmann Editor. *Proceedings from the IMC*, Leeds 2001, 2002, 2003. Beiheft der Zeitschrift 'MEDIAEVISTIK'.

SCHWARZ ZANETTI, G., DEICHMANN, N., FÄH, D., MASCIADRI, V., KÄSTLI, P.,SCHNELLMANN, M. AND M. JIMENEZ. 2006b. Das Unterwaldner Erdbeben vom 18. September 1601. Naturkatastrophen in der Zentralschweiz. *Der Geschichtsfreund*, 159. 11-28.

SCHWARZ-ZANETTI G., DEICHMANN N., FÄH D., MASCIADRI V., AND J. GOLL. 2004. The Earthquake in Churwalden (CH) of September 3, 1295. *Eclogae Geol. Helv. - Swiss J. Geosciences*, 97. 255-264.

SCHWARZ-ZANETTI, G., FÄH, D., SCHIBLER R., MASCIADRI, V., KÄSTLI P., AND D. GIARDINI. 2003. The earthquake in Unterwalden and the rockslide from the Bürgenstock into Lake Lucerne on September 18, 1601. *Eclogae geol. Helv. - Swiss J. Geosciences*, 96.

SESAME. 2008. Site EffectS assessment using AMbient Excitations. 12. Jan. 2008: http://sesame-fp5.obs.ujf-grenoble.fr/index.htm

SIA, 1970. Norm SIA 160: Belastungsannahmen, Inbetriebnahme und Überwachung der Bauten, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

SIA, 1989. Norm SIA 160: Einwirkung auf Tragwerke, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

SIA, 2003. Norm SIA260: Grundlagen der Projektierung von Tragwerken, Schweizerischer Ingenieur- und Architekten Verein, Zürich

SIA, 2003. Norm SIA261: Einwirkung auf Tragwerke, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

SIA, 2003. Norm SIA262: Betonbau, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

SIA, 2003. Norm SIA263: Stahlbau, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

SIA, 2003. Norm SIA264: Stahlbau-Beton-Verbundbau, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

SIA, 2003. Norm SIA265: Holzbau, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

SIA, 2003. Norm SIA266: Mauerwerk, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

SIA, 2003. Norm SIA267: Geotechnik, Schweizerischer Ingenieur- und Architekten Verein, Zürich.

STEINER, B.. 2004. Untersuchungen der Schäden verursacht durch die Obwaldner Beben von 1964. Diploma thesis, Institute of Geophysics, ETH Zürich. Unpublished.

STRASSENBAUAMT DES KANTONS WALLIS. 2007. Borehole information. Unpublished Database.

SWISS FEDERAL STATISTICAL OFFICE. 2008. Consumer price index. 9. Jan. 2008: http://www.bfs.admin.ch.

SWISS SEISMOLOGICAL SERVICE. 2002. ECOS - Earthquake Catalogue of Switzerland. 10. Jan. 2008: http://www.seismo.ethz.ch.

WANNER, E. AND M. GRÜTTER. 1950. Edude sur les répliques de tremblement de terre du Valais, de 1946 à 1950. *Bulletin de la Murithienne*, fasc. LXVII. 24-41

Wanner, E.. 1955. Die Lage der Erdbebenherde im Mittelwallis. *Eclogae geol. Helv. - Swiss J. Geosciences*, 48. Nr. 2.

WATHELET, M.. 2005. Array recordings of ambient vibrations: surface-wave inversion. Liège University (Belgium).

WIDMER, F., DUVERNAY, B., FÄH D. AND A. PARRIAUX. 2003. Project pilote de microzonage sismique à Yverdon (VD). *Bull. Angew. Geol.*, 8/1. 5-16.

6.3 Maps

Alpnach. Kartenmaterial. Gesamtnachführung 1969 – Wabern. Eidg. Landestopographie, 1971. Landeskarte der Schweiz 1:25’000; Nr. 1170.

BUNDESAMT FÜR LANDESTOPOGRAPHIE. 1988. Topographische Karte der Schweiz 1:100’000. Vermessen und herausgegeben auf Befehl der eidgenössischen Behörden / aufgenommen und reduziert durch eidgenössische Ingenieure unter Aufsicht des Generals G. H. Dufour, 1833-1863. Nachdruck. Blatt XVIII, Erstausgabe 1854. Wabern.

GEOFORSCHUNGS-ZENTRUM POTSDAM, SCHWEIZERISCHER ERDBEBENDIENST, ZENTRALANSTALT FÜR METEOROLOGIE UND GEODYNAMIK, WIEN (ED.). 1998. Einheitliche Erdbebengefährdungskarte für Deutschland, Österreich und die Schweiz (D-A-CH). Kartenmaterial. G. Grünthal, D. Mayer-Rosa;. Bern: Schweiz. Pool für Erdbebendeckung, 1998.

GEOLOGISCHER ATLAS DER SCHWEIZ. (2006). 1:25 000 (Elektronische Daten). Pixelkarte. Bundesamt für Landestopographie (Ed.) Wabern.

GEOLOGISCHE KARTE DES KANTONS OBWALDEN. 1:25'000. Kartenmaterial. 1980. Kantonales Oberforstamt Obwalden. Sarnen.

MELCHTAL. Kartenmaterial. Gesamtnachführung 1969 – Wabern. Eidg. Landestopographie, 1971. Landeskarte der Schweiz 1:25 000; Nr. 1190.

RARON. Kartenmaterial. Planokarte. Wabern. Eidg. Landestopographie, 1983. Landeskarte der Schweiz 1:25 000; Nr. 1288.

SCHWEIZERISCHER ERDBEBENDIENST (ED.) 1977. Erdbeben-Risikokarten der Schweiz 1:500’000. Kartenmaterial. Karte 1: Wahrscheinlichkeit 0.01 pro Jahr; Karte 2: 0.001 pro Jahr; Karte 3: 0.0001 pro Jahr. Basler & Hofmann, Zürich. Schweizerischer Erdbebendienst, ETH. 1977.

SCHWEIZERISCHE GEOLOGISCHE KOMMISSION (ED.). 1981. Erdbebengefährdung in der Schweiz. Kartenmaterial. D. Mayer-Rosa, S. Müller; Geophysikalische Karten der Schweiz; Karte 7. Wabern: Bundesamt für Landestopographie.

SEISMIC HAZARD ASSESSMENT OF SWITZERLAND, 2004. Kartenmaterial. Domenico Giardini et al. Swiss Seismological Service, Swiss Federal Institute (ETH) Zürich, 2004.

SIEGFRIEDKARTE, ERSTAUSGABE. Elektronisches Kartenmaterial. Topographischer Atlas der Schweiz. Swisstopo (Ed.). Wabern, Bundesamt für Landestopographie, 2003a. Kartenblätter Nr. 406, Chur, 1875; Nr. 486, Sion, 1890; Nr. 496, Visp, 1892. 1:50'000.

SIEGFRIEDKARTE, LETZTAUSGABE. Elektronisches Kartenmaterial. Topographischer Atlas der Schweiz. Swisstopo (Ed.). Wabern, Bundesamt für Landestopographie, 2003b. Kartenblätter Nr. 406, Chur, 1933; Nr. 476, Monthey, 1939; Nr. 477, Diablerets, 1939; Nr. 481, St. Léonard, 1933; Nr. 482, Sierre, 1933; Nr. 483, St. Maurice, 1933; Nr. 485, Saxon, 1932; Nr. 486, Sion, 1933; Nr. 487, Vissoie, 1934; Nr. 496, Visp, 1934; Nr. 497, Brig, 1934; Nr. 526, Martigny, 1933; Nr. 527, Lourtier, 1933. 1:50'000.

SIEGFRIEDKARTE, ERSTAUSGABE. Elektronisches Kartenmaterial. Topographischer Atlas der Schweiz. Swisstopo (Ed.). Wabern, Bundesamt für Landestopographie, 2003a. Kartenblatt Nr. 267, Mels, 1890. 1:25'000.

SIEGFRIEDKARTE, LETZTAUSGABE. Elektronisches Kartenmaterial. Topographischer Atlas der Schweiz. Swisstopo (Ed.). Wabern, Bundesamt für Landestopographie, 2003b. Kartenblatt Nr. 267, Mels, 1934. 1:25'000.

SWISS MAP 25. Elektronische Daten. - Wabern: Bundesamt für Landestopographie, Stand 2000. Kartenblätter Nr. 1155, Sargans, 1996; Nr. 1195, Reichenau, 1996; Nr. 1287, Sierre, 1992; Nr. 1306, Sion, 1992. 1:25'000.

Curriculum Vitae

Stefan Fritsche

Date of birth: February 18, 1970

Citizen of Appenzell, AI, Switzerland

4/1977-4/1983	Primary school, Herisau, AR, Switzerland
4/1983-4/1986	Secondary school, Herisau, AR, Switzerland
4/1986-4/1990	Apprenticeship as cabinetmaker
4/1987-4/1990	„Berufsmittelschule“ (BMS), St.Gallen
1990-2000	Working as cabinet maker
2/1993-6/1996	„Interstaatliche Maturitätsschule für Erwachsene“ (IME) (Type C: Mathematics and Natural Sciences)
10/1996-5/2003	University of Zurich Science of History (main subject) Environmental science (second subject) Political sciences (third subject) Licentiate thesis: “Naturschutzkonzepte – Naturschutz – Natur“
9/2003-2/2008	PhD-thesis at ETH Zurich: “Large Historical Earthquakes in Switzerland: Multidisciplinary Studies on Damage Fields and Site-effects”

List of Publications

FRITSCHE, S.. 2008. Die Erdbeben von 1855 in der Region Visp. In: Monika Gisler und Donat Fäh (Ed.). Nachbeben. Eine Geschichte der Erdbeben in der Schweiz. Mit Beiträgen von Donat Fäh, Stefan Fritsche, Domenico Giardini, Monika Gisler, Philipp Kästli, Virgilio Masciadri, Ivo Oprsal, Regula Schatzmann und Gabriela Schwarz-Zanetti. Bern. In preparation.

FRITSCHE, S.. 2008. Das Erdebeben von 1946 im Mittelwallis. In: Monika Gisler und Donat Fäh (Ed.). Nachbeben. Eine Geschichte der Erdbeben in der Schweiz. Mit Beiträgen von Donat Fäh, Stefan Fritsche, Domenico Giardini, Monika Gisler, Philipp Kästli, Virgilio Masciadri, Ivo Oprsal, Regula Schatzmann und Gabriela Schwarz-Zanetti. Bern. In preparation.

FRITSCHE, S.. 2008. Die Erdbebenserie von 1964 in Obwalden. In: Monika Gisler und Donat Fäh (Ed.). Nachbeben. Eine Geschichte der Erdbeben in der Schweiz. Mit Beiträgen von Donat Fäh, Stefan Fritsche, Domenico Giardini, Monika Gisler, Philipp Kästli, Virgilio Masciadri, Ivo Oprsal, Regula Schatzmann und Gabriela Schwarz-Zanetti. Bern. In preparation.

FRITSCHE, S. AND D. FÄH. 2008. The 1946 Magnitude 6.1 Earthquake in the Valais: Site-Effects as Contributor to the Damage. *Geophys. J. Int.*, submitted.

FRITSCHE, S., FÄH, D., STEINER, B., AND D. GIARDINI. 2008. Damage Field and Site Effect: Multidisciplinary Studies of the 164 Earthquake Series in Central Switzerland. *Natural Hazard*, submitted.

FRITSCHE, S., FÄH, D., GISLER, M., UND D. GIARDINI. 2006. Reconstructing the Damage Field of the 1855 Earthquake in Switzerland: historical investigations on a well-documented event. *Geophys. J. Int.,* 166, 719-731.

FRITSCHE, S., FÄH, D. UND D. GIARDINI. 2005. Damage Fields and Site-Effects. Investigations on the 1855 Earthquake in Switzerland. *Proceedings of the 250th Anniversary of the 1755 Lisbon Earthquake,* Lisbon, Portugal, 1-4 November. 340-246.

FRITSCHE, S. 2004. Natur im Reservat. In: Flüeler, E., Volken M. und M. Diemer (Ed.). Wildnis. Ein Wegbegleiter durchs Gebirge. Zürich. 211-218

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DISS. ETH NO. 17710

LARGE HISTORICAL EARTHQUAKES IN SWITZERLAND

Multidisciplinary Studies on Damage Fields and Site-Effects

Appendices

A dissertation submitted to the

ETH Zurich

For the degree of

Doctor of Sciences

Presented by

Stefan Fritsche

Licentiatus Philosophiae

Born February 18, 1970

Citizen of Appenzell (AI)

accepted on the recommendation of

Prof. Dr. Domenico Giardini, examiner

Prof. Dr. David Gugerli, co-examiner

Dr. Donat Fäh, co-examiner

Prof. Dr. Massimiliano Stucchi, co-examiner

2008

Appendix I: The 1855 Damage Assessment

All documents concerning the revised assessment have been transcribed from the original, handwritten documents and were used for the reassessment. In cases where no revision was made, we used the first assessment. For Visp both assessments have been used.

References:
*Revised assessment***:** Tremblement de terre de juillet 1855: Révision de la taxe, distribution des secours. Ancien fonds du département de l´intérieur. StAW, DI, 27.3.3 (1855-1860).

*First assessment***:** Tremblement de terre de juillet 1855: Expertises des dommages. Ancien fonds du département de l´intérieur. StAW, DI, 27.3.2 (1855-1856).

Population figures are based on: Bundesamt für Statistik (Ed.). Eidgenössische Volkszählung 2000. Bevölkerungsentwicklung der Gemeinden 1850-2000. 2002. Bundesamt für Statistik. Neuchâtel.

[...] corresponds to unintelligible sections.

CH-3950 Agarn
Population figure 1850: 186
Population figure 1850: 2000: 758
Revised damage assessment
Total loss: CHF 1'046.-

001. Nellen, veuve, trois cheminées sur le couvert de la maison, et un couvert de grange. Fr. 60.-
002. Halter, Pierre, maison, reboucher les fentes et réparer deux couverte de grange. Fr. 35.-
003. Schniedrig, Jean Joseph, un cheminée sur le toit de la maison. Fr. 10.-
004. Schillig, Antoine, réparer le toit de la maison. Fr. 10.-
005. Marthé, Jean, refaire le couvert de la maison. Fr. 15.-
006. Furrer, Jean Joseph, maison, refaire la façade du midi, une cheminée et couvert de la maison et grange. Fr. 200.-
007. Erpen, Jean, maison et grange, réparer le toit et boucher les fentes. Fr. 20.-
008. Diroz, Barbe, veuve, maison, refaire une terrasse et une cheminée. Fr. 15.-
009. Lötscher, Jean, refaire le toit de la maison. Fr. 50.-
010. Zenhäusern, Etienne, François, réparer une arc de fenêtre et l'escalier. Fr. 20.-
011. Zenhäusern, Etienne, François, et Borter, reboucher les fentes de la maison. Fr. 10.-
012. Saleller, Marie [...], maison, réparer le couvert. Fr. 10.-
013. Witschard, Anne Marie, maison, réparer le couvert. Fr. 6.-
014. Eggel, Alexandre, refaire une mur. Fr. 30.-
015. Schillig, Jean, et consorts, refaire une cheminée du haut au bas et un mur. Fr. 100.-
016. Schneider, Pierre, maison, réparer le toit et un petit mur. Fr. 10.-
017. [...], Jean Marie, refaire une angle de mur entre la grange et la maison. Fr. 25.-
018. Bovier, Babtiste, refaire un mur dans la maison. Fr. 30.-
019. Genauer, veuve, refaire un petit mur dans la maison. Fr. 6.-
020. Zbrunn, Jean Joseph, horloger, réparer les fentes de la maison. Fr. 18.-
021. Kreutzer, François et consorts, maison, reboucher les fentes, réparer une cheminée et couverts. Fr. 16.-
022. Nanzer, Paul, reboucher les fentes de la maison. Fr. 8.-
023. Bregy, fils, maison et grange, reboucher les fentes et couverts. Fr. 8.-
024. Grand, Stani, réparer le toit de la maison et une cheminée. Fr. 15.-
025. Schwery, Maurice, maison et grange, réparer le couvert. Fr. 140.-

026. Oggier, Jean, Conseiller, maison, refaire une mur et terrasses et l'escalier et couvert. Fr. 140.-
027. Meyer, Jean, reboucher les fentes dans la cheminée et une mur. Fr. 6.-
028. Kalbermatten, huissier, réparer trois couverts de grange. Fr. 25.-
029. Oggier, Allexis, réparer le couvert d'une grange. Fr.8.-

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CH-3938 Ausserberg
Population figure: 1850: 405
Population figure 2000: 628
Revised damage assessment
Total loss: CHF 1'232.-

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001. A Michel Heimen, pour 5 toises de mur, le toit et une grange. Fr. 80.-
002. A Bumann [...], pour 3 cheminées, deux toits et un mur de grange. Fr.53.-
003. A Leiginer, Jean in der Bine, pour un mur et 2 toits. Fr. 35.-
004. Au Président Antoine Geler, pour un toit et une toise de mur. Fr.29.-
005. A Pierre Schmidt, pour un toit et une toise de mure. Fr.15.-
006. A Joseph Schmidt, pour idem (pour un toit et une toise de mure.) Fr.25.-
007. A Biffiger, Chrétien au château, pour 7 toises de mur, le toit, le four à pain et un toit de grange. Fr. 155.-
008. A Stepfer, Antoine et Pierre Schmidt, pour un mur et toit de maison. Fr.34.-
009. A Chrétien Leiginer, pour une cheminée. Fr. 5.-
010. A Biffiger, Pierre, pour 5 toises de mur, le toit et le four à pain. Fr. 65.-
011. A Chrétien Imboden, pour 2 toises de mur, le toit et le fentes. Fr.70.-
012. A Chrétien Biffiger, pour sa grande grange [...] Fr. 25.-
013. A Chrétien Leiginer, pour 6 toises de mut de sa grande grange. Fr.35.-
014. A Pierre Geler, pour 3 toises de mur et un toit. Fr.58.-
015. A Jean Chrétien Geler, pour son toit. Fr20.-
016. Heimen, Jean, pour 5 toises de mur et le toit. Fr.53.-
017. A l'hoirie de Chrétien Heimen fils substitut, pour 3 toits de grange. Fr. 30.-
018. A Threiner, Joseph, pour le toit de la maison. Fr. 12.-
019. A Heimen Pierre, pour une toise de mur et le toit. Fr. 10.-
020. A Sponer, François, pour 3 toises de mur et le toit de maison. Fr.33.-
021. Aux enfants Imhof, pour le toit le fourneau et une pilier de la maison. Fr. 80.-
022. A Biffiger Joseph, pour le fourneau et le toit de la maison. Fr. 47.-
023. A Raempfen, Chrétien, 1 1/2 toise de mur et le toit. Fr. 11.-
024. A Treller, Jean, pour 1 1/2 toise de mur et pour une cheminée. Fr20.-
025. A Biffiger, Jean Joseph, pour une grange à blé. Fr.7.-
026. A Heimen, Jean, pour relever une grange à blé. Fr. 22.-
027. A Theler, Jean, pour 1 1/2 toise de mur et pour le toit. Fr. 12.-
028. A Theler, Chrétien, pour 4 toises de mur, pour 2 toits de la grange. Fr. 77.-
029. Aux enfants Imhof, pour la maison auf der Stege. Fr. 10.-
030. A Leiginer et à Eberhard, Jean, pour une maison [...]. Fr. 45.-
031. A Leiginer, Jean, in der Binn pour une muraille. Fr. 40.-
032. A Theler, Jos Jean im Bach / au torrent, pour une cheminée et le toit. Fr. 16.-

Le haut gouvernement est prié de bien vouloir fixer son attention sur les dégâts fait par les tremblement de terre aux aqueducs, aux tarissement des fontaines dont le dommage ne peut guéret être évalué

CH-3937 Baltschieder
Population figure: 1850: 112
Population figure 2000: 1050
Revised damage assessment
Total loss: CHF 1'535.-

001. Nellen, Maurice fils, dans la maison et grange refaire trois cheminées, deux toit sept toises de mur et des crevasses. Fr. 210.-
002. Nellen, père (de Maurice Nellen), maison et grange refaire trois toises de mur sec et le toit. Fr. 104.-
003. Nellen, Jean Joseph boulanger, refaire vint toises de mur et terrasse, deux clefs, deux toit et plusieurs crevasses. Fr. 400.-
004. Venger, Jean, refaire six toises de mur et réparer deux toit. Fr. 48.-
005. Guntern, Vincent teinturier, une cheminée et galandage. Fr. 40.-
006. Schnidrig, Antoine, un toit et une brèche de mur. Fr. 12.-
007. Maison de Commune, réparer le toit. Fr. 20.-
008. Margelist, Jean Jos., le toit de maison et deux granges écroulé. Fr. 120.-
009. Schuhmacher, Christian, une cheminée. Fr. 10.-
010. Schuhmacher, Pierre, deux couverts une cheminée et un pilier. Fr. 45.-
011. Antensch, Président, à la grange 3 toises de couvert. Fr. 80.-
012. Schepfer, Jos. et consorts, dans la maison et grange. Fr. 27.-
013 La chappel reboucher les fentes et le toit. Fr. 35.-
014. Pitet, Jos. et consorts, maison et grange écroulés. Fr. 80.-
015. Stepfer, François, maison et grange réparer les deux toits. Fr. 8.-
016. Hilpert, Jos. et consorts une toise de mur pourri. Fr. 8.-
017. Stepfer. Martha, un couvert. Fr. 5.-
018. Schuhmacher, Christian, un pilier à la grange. Fr. 18.-
019. Schaller, Jos. dans la grange et maison, réparer deux angles et quatre toises de mur. Fr. 40.-
020. Brigiler, Anne Marie, le raccard écroulé, la maison et grange en ruine. Fr. 260.-

CH-3900 Brig
Population figure: 1850: 721
Population figure 2000: 11590
Revised damage assessment
Total loss: CHF 21'700.-

001. A l'Etat du Valais, pour l'église du collège, pour reboucher les fentes et garnir le toit.
002. Eidem, pour le collège, pour reboucher les fentes, refaire 4 cheminées et réparer les autres, ainsi que le toit et les corridors et faire un plafond neuf. Fr. 2700.-
003. Pour l'église des Ursulines, pour reboucher les fentes, garnir le toit.
004. Eidem, pour le couvert, pour reboucher les fentes, faire 5 cheminées, réparer le toit, le plafond de la chapelle, trois architraves de porte.
005. Pour les [...] du couvert des Ursulines, pour refaire 1.5 toises de mur, mur de clôture, four, regarnir un plafond, refaire à neuf le mur au midi de la boulangerie. Fr. 905.-
006. A Elsig, Jean Jaques, pauvre, pour une maison, pour reboucher des crevasses, cheminée, réparer tout le toit. Fr. 90.-
007. A Kieser, Antoine, pour sa maison, pour remonter l'escalier, la cheminée, le toit, et refaire une règle mur, conjoint Antoine Perrig. Fr. 130.-
008. A Kaempfen, Antoine, moyenné, pour une maison, p. refaire un plafond, une cheminée, un coin de mur de galandage, réparer le toit. Fr. 70.-
009. A Perrig, Bartholemie, pauvre, pour une grange, pour faire 2 toises de mur et réparations du toit. Fr. 50.-
010. A Stockalper, Maurise, aisé, pour refaire 5 toises de mur. Fr. 65.-
011. A Elsig, François, pauvre, démolir et refaire les façades au midi, et couchant, et réparer le toit de la maison. Fr. 120.-
012. A Perrig, Pierre, et autres, moyenné, pour placer une clef, réparer 2 plafonds et la cheminée de la maison. Fr. 50.-
013. A Tscherrig, Antoine, huissier, pauvre, refaire une cheminée et réparer le toit de la maison. Fr. 50.-

014. A Wegener, Gaspard, riche, refaire une cheminée de la maison. Fr. 3.-
015. A Stockalper, Ferdinand, riche, pour placer une clef, boucher quelques lézardes. Fr. 30.-
016. Au même (Stockalper, Ferdinand), pour une autre maison, à refaire 3 cheminées et boucher quelques fissures. Fr. 20.-
017. A Stockalper, Famille, pour la grande maison, à refaire 6 cheminées et réparer 2 tournelettes. Fr. 700.-
018. A Stockalper, Antoine, pour une maison, à refaire 6 cheminées et reboucher des fentes. Fr. 150.-
019 A la bourgeoisie de Brique, riche, pour la maison, à refaire dans deux chambres le règle mur, abattre le plâtre d'un plafond et réparer une latrines. Fr. 85.-
020. A Schmidt Joseph moyenne, pour sa maison, à refaire un plafond et reboucher des fentes. Fr. 35.-
021. A Wegener, riche, pour la grande maison, à réparer la tour, deux cheminées, corniches et lézardes. Fr. 200.-
022. A Eggs, Babtiste, moyenne, pour la maison, pour refaire une cheminée. Fr. 4.-
023. A Seiler, Alexis, pauvre, et à Schmidthalter, pour démolir la partie méridionale de leur maison et l'escalier, les reconstruire à neuf. Fr. 3200.-
024. A Thaler aisé, pour la maison, a refaire la cheminée, réparer le toit, plafond et fissures. Fr. 150.-
025. A Perrig de Sophibus et Guglielminelli, pour la maison, y refaire huit cheminées, réparer le toit, quelques plafonds et un mur dégrue de la grange. Fr. 110.-
026. A Loretan, pour sa maison, y refaire 2 cheminées, réparer le toit, 2 plafonds, latrines. Etc. Fr. 60.-
027. Bornis, pour la maison, y reboucher des fentes, réparer au 2me et 3me étage les fentes, le toit et l'escalier. Fr. 250.-
028. A Perrig, avocat, pour refaire deux cheminées et réparer le toit. Fr. 40.-
029. A Stockalper, Gaspard, pour placer 4 clefs à la tour ou la démolir. Fr. 240.-
030. A Hantzer, moyenne, pour la maison, a refaire la latrines, plafond, refaire l'angle supérieur du mur au sud-est, conjoint avec Schiller. Fr. 650.-
031. A Zur Werra et Dolberg, pour la maison, pour y refaire 4 cheminées, réparer le toit et reboucher les fentes. Fr. 100.-
032. A Heiss, Joseph Antoine et ses cohéritiers paternels pauvres, pour leur maison, a refaire 2 cheminées, un coin de mur, une toise de [...] dans la citerne. Fr. 100.-
033. A Eiholzer Michel, moyenne, pour sa maison, a refaire une cheminée et réparer le toit. Fr. 50.-
034. A Lagger, Martin et Pierre Brindler, pour leur maison, a refaire 2 cheminées et réparer le toit. Fr. 110.-
035. A Falsching et Grünwald, pour une maison, a refaire 2 cheminées, réparer la tournelette, l'escalier et le toit. Fr. 100.-
036. A Sidler, pauvre et consorts, pour la maison, a réparer le toit, refaire une cheminée, refaire le dessus de porte et réparer les crevasses. Fr. 90.-
037. A Nellen, François, moyenne, pour la maison, a reboucher des crevasses et réparer le toit. Fr. 10.-
038. A Fruzzini, veuve, riche, pour la maison, a refaire 3 chemines, réparer le toit, placer 2 clefs à l'angle sud est, reboucher des fissures. Fr. 230.-
039. Escher, veuve, moyenne, pour la maison, a refaire 2 cheminées, repiquer et garnir le mur au midi entre 2 fenêtres, réparer le toit. Fr. 56.-
040. A Inalbon [...] châtelain, aisé, pour la maison, a refaire 4 cheminées et réparer le toit et crevasses, il serait bon de placer un clef au midi. Fr. 100.-
041. A Annexis aisé pour la maison, a refaire 3 cheminées, réparer le toit, reboucher des fentes. Fr. 80.-
042. A Eschinger (Stockalper) et Janaer, pour la maison, a réparer un mur au coin et la façade du mord. Fr. 10.-
043. A Brinden père et fils, moyennées, pour la maison, a refaire 3 cheminées et 2 toises de mur et réparer le toit. Fr. 110.-
044. A Clausen et Gemmeth, pauvre, pour la maison, a refaire une cheminée et 2 toises de mur. Fr. 60.-
045. A Brunle, pauvre, pour la maison, a refaire une cheminée. Fr. 12.-
046. A Diezig, Gaspard, pauvre, pour démolir sa vielle maison. Fr. 2200.-
047. A Hagen, André, pauvre, pour le moulin, a réparer et le plafond. Fr. 15.-
048. A Bschieder, riche, pour la maison, a refaire une cheminée de haut en bas. Fr. 20.-
049. A Ambord, Alexis, pauvre pour la maison, y refaire une cheminée et réparer le toit. Fr. 40.-
050. A Graetz, veuve, pauvre, refaire trois angles au nord de sa maison. Fr. 20.-
051. A Huber et Imhoff, pauvres, pour la maison, a refaire une cheminée, réparer le toit, la latrines et l'angle de la remise. Fr. 50.-
052. A Bomberg, Benoît, moyenne pour la maison, a refaire une cheminée, replaçer deux brichels, faire la terrasse, coucher des crevasses, er réparer le toit. Fr. 80.-
053. A Bornis, Hagen, riche et Scherner moyenne, pour le moulin, a refaire deux cheminées et réparer le toit. Fr. 30.-
054. Au Docteur Loretan, riche, pour un grenier, a réparer le toit.

055. A Müller, Joseph, pauvre, pour la maison, en refaire l'escalier, deux terrasses, une cheminée, réparer le toit et les angles.
056. Au même, pour une grange, en réparer le toit. Fr. 315.-
057. A Amacker, pauvre, pour la maison, en réparer l'escalier et les murs, qui sont tous crevassés. Fr. 100.-
058. A Huser et Thalmann, pour la maison, a réparer le toit, faire deux cheminées et reboucher des crevasses. Fr. 300.-
059. A Arnold et Stockalper, riche, pour réparer un grand toit de grange. Fr. 110.-
060. A Roten, Elia Nicolaus, pour la maison, en refaire quatre cheminée, replacer toutes les ardoises du toit deux plafonds, trois tablettes fendues, reboucher les crevasses. Fr. 400.-
061. A Perrig, Avocat et Ambord, riches, pour la maison, en démolir la tour au levant, réparer l'escalier, refaire quatre cheminées, réparer le toit, changer les dessus de portes et boucher les crevasses. Fr. 1800.-
062. A l'horie Rothen, pour la croix blanche, en démonter et remonter l'angle du sud-est et tout l'escalier, refaire les cheminées, réparer le toit. Fr. 2200.-
063. A l'horie d'Augustin Julier, pour la maison, refaire trois cheminées, placer deux clefs, réparer le toit et les crevasses.
064. Idem pour la grange, a replacer lezardoises du toit. Fr. 250.-
065. A la Confrèrie de St. Sébastian, ou à la bourgeoisie, pour la chapelle, en changer la voûte. Fr. 750.-
066. A Graetz, Pierre Joseph, pauvre, pour la maison, en refaire l'angle au nord, le cheminée et réparer le toit. Fr. 20.-
067. A Inalbon, Eduard, riche, pour la maison, en refaire deux angle-murs, la cheminée et son manteau, la terrasse et boucher des crevasses. Fr. 400.-
068. A [...], pour la maison, a refaire une cheminée, réparer le toit et quelques crevasses. Fr. 40.-
069. A [...] Valentin, pou maison et grange, refaire deux cheminées, et réparer les deux toits. Fr. 80.-
070. A Speckli, pauvre, pour maison et grange, réparer le toit. Fr. 40.-
071. A Cursi, pour la maison, refaire quatre cheminées et réparer le toit. Fr. 80.-
072. A Viller, pour l'hôtel de la poste, démolir la tour de l'escalier jusqu'au toit de la maison, mettre deux clefs à l'angle sud-est, refaire quatre cheminées, reboucher les crevasses, remonter les plafonds et l'autre tour. Fr. 1600.-
073. Inalbon, François, rép. A une grange. Fr. 35.-
074. Madeleine Joller, né Gemt, grange toit. Fr. 20.-
075. Eichers, Jean Joseph, maison, rep. 2 chem. Rep [...]. Fr. 80.-

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CH-3900 Brigerbad
Population figure: 1850: 52
Population figure 2000: see Brig
Revised damage assessment
Total loss: CHF 1'074.-

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001. Chapelle Fr. 80.-
002. Crettaz, Jean [...] et consorts grange. Fr. 65.-
003. Josen, Jean [...] ancien gr. conseiller et Crettaz, Ant., maison. Fr. 195.-
004. Josen Fr. et Ruffiner, Chrétien, grange. Fr. 20.-
005. Josen, Ignace et consorts, raccard. Fr. 70.-
006. Josen, Ignace et Jean [...], maison Fr. 50.-
007. Josen, Antoine, Fr. 6.-
008. Josen, Jean [...] ancien gr. conseiller. Fr. 5.-
009. Imesch, Pierre et Jean [...] Crettaz, maison et raccard. Fr. 95.-
010. Jean Joseph, Crettaz, à [...] grange. Fr. 40.-
011. Zenhussen, Marie et Josen Jos. Ignace grange au Wasserflue(ss) Fr. 20.-
012. Josen, Jean et Christian, grange au Chataignier. Fr. 85.-
013. Crettaz, Jean Joseph, écurie. Fr. 25.-
014. Hagen, Felix, maison. Fr. 27.-
015. Les héritiers Stockalper, maison, Fr. 26.-
016. idem, à l'écurie et grange [...] écroulée. Fr. 315.-
017. idem, la 2ième maison , Fr. 30.-

CH-3935 Bürchen
Population figure: 1850: 332
Population figure 2000: 672
Revised damage assessment
Total loss: CHF 6'156.-

001. A la veuve d'Antoine Dürren, pour un fourneau et une cheminée. Fr. 12.-
002. A Matter, Aloys, pour 20 toises de mur, pour un toit, une cheminée. Fr. 155.-
003. Knubel, Joseph, pour une cheminée. Fr. 15.-
004. A Matter, Ignace, pour une nouvelle cheminée et un mur. Fr. 32.-
005. A Matter, Chrétien, id. (pour une nouvelle cheminée et un mur). Fr. 22.-
006. A Matter et Joseph Werlen, pour relever un raccard. Fr. 30.-
007. A Joseph Beinegger, pour 7 toises de mur et une cheminée. Fr.90.-
008. A Werlen, Joseph huissier, pour un four à pain et un mur dans la cave. Fr.43.-
009. A Bitschin, Joseph porte étendard, pour une cheminée. Fr. 15.-
010. A Zenhäusern, Jost Ignace, pour une cheminée et le boisage. Fr. 32.-
011. A Zenhäusern, Jean Chrétien, pour 1 1/2 toise de mur et un cheminée. Fr. 53.-
012. A Zenhäusern, Chrétien cloutier, pour 1 1/2 toises de mur. Fr. 20.-
013. A Joseph et Chrétien Biner, pour une cheminée. Fr. 15.-
013. A Zenhäusern, Pierre, pur une cheminée. Fr. 12.-
015. A Furrer, Jean Joseph armurier, pour une cheminée. Fr. 12.-
016. A Furrer, Ignace, pour une cheminée et un raccard in Hohlersried. Fr. 32.-
017. A Venetz, André, pour relever un raccard. Fr. 120.-
018. A Matter, Anne Marie, pour une cheminée et un pilier en mur. Fr. 18.-
019. A Furrer, Joseph, pour une cheminée, une toise de mur et le toit. Fr. 20.-
020. A Furrer, étudiant, pour le toit et la cheminée. Fr. 20.-
021. A Catherine veuve de Jean Joseph Furrer pour une cheminée. Fr. 5.-
022. A Gattlen, Jean tanneur (Gerber), pour la tannerie. Fr. 50.-
023. A Furrer, Pierre Joseph, pour un raccard et le mur de la cave. Fr. 90.-
024. A Zumoberhaus, Juge, pour un grenier et une cheminée. Fr. 13
025. A Chrétien Karlen, pour 30 toises de mur, un fourneau et 2 cheminées. Fr. 575.-
026. A Nater, Ignace, pour relever une grange à blé. Fr. 140.-
027. A la société de la cible in der Obermatten pour 9 toises de mur. Fr. 90.-
028. Aux frères Zumoberhaus , pour 20 toises de mur et un toit. Fr. 130.-
029. A Jaques Hartmann, pour 2 cheminées et un four à pain. Fr. 65.-
030. A Werlen, Jean pour une muraille. Fr. 10.-
031. A , Maurice, pour une cheminée. Fr. 36.-
032. A Hildebrand Roten de Rarogne, pour un grenier. Fr. 260.-
033. A Zenhäusern le Napolitain, pour 3 toises de mur et les fentes. Fr. 40.-
034. A Mank, Pierre Joseph, pour une cheminée et un pilier de mur. Fr. 22.-
035. A Gattlen, Ignace, pour 22 toises de mur, une cheminée et un toit. Fr. 255.-
036. A Knubel, Joseph Ignace, pour une maison et grange. Fr. 160.-
037. A Furrer, Joseph, pour une grange. Fr.50.-
038. A Dürrer, Sabine, pour un four, un escalier et une cheminée. Fr. 173.-
039. A Zurbriggen, Jean-Pierre, pour 5 édifices. Fr. 175.-
040. A Furrer, Jean, pour 8 toises de mur, un Four à pain, une cheminée. Fr. 50.-
041. A Furrer, Ignace, pour une cheminée, un toit et un mur. Fr. 60.-
042. A Gattlen, Ignace, pour une cheminée et quelques réparations dans la maison. Fr. 10.-
043. A Gattlen, Jean Joseph, pour un four à pain, cheminée et boisage. Fr. 32.-
044. A Gattlen, Jean, Président, pour 4 cheminées, le toit, 8 toises de mur. Fr. 180.-
045. A Furrer, Antoine, pour une cheminée et fentes de la maison. Fr. 8.-
046. A Imesch, Jean Joseph et consorts, pou un grenier. Fr. 80.-
047. A Zenhäusern, Chrétien Joseph, pour 3 toises de mur, une cheminée. Fr. 54.-
048. A Zenhäusern, Anne Catherine, pour une cheminée, un four à pain, la façade de le maison et 8 toises de mur. Fr. 280.-
049. Aux filles de Zenhäusern Laurent, le mur de la cave et la cheminée. Fr. 155.-
050. A Gattlen, Ignace et consorts, pour un grenier. Fr. 65.-
051. A Nater Tambour, pour une cheminée et un mur. Fr. 30.-

052. A Gattlen, Aloys, pour 7 toises de mur et une cheminée. Fr. 35.-
053. A Catherine Jaggi, veuve, pour 35 toises de mur, pour deux cheminées et deux planchers dans la maison. Fr. 450.-
054. A Zumoberhaus, tonnelier , pour une cheminée et le manteau. Fr. 32.-
055. A Gattlen, Jean Joseph ancien porte drapeau, pour 4 toises de mur et une cheminée, un four à pain et pour un grenier. Fr. 149.-
056. A Gattlen, Jean Joseph et consorts, pour une mur au raccard. Fr. 60.-
057. A Erasme Lehner, pour une cheminée et un mur. Fr. 50.-
058. A Catherine Furrer, pour la maison, 2 toits, 1 toise de mur et la cheminée. Fr. 256.-
059. A la veuve Furrer, maréchal, pur une cheminée et boisage. Fr. 32.-
060. A Furrer, Ignace au bassin pour une grange à Holderwies. Fr. 115.-
061. A Zenhäusern, Ignace (Obscher) pour une grange in der Ubrich. Fr 30.-
062. A Zenhäusern, Jean Joseph (Bodmer) pour une cheminée. Fr. 22.-
063. A Nater, Jean Joseph (le rouge), pour 1.5 toises de mur. Fr. 22.-
064. A Furrer Ignace, meunier, pour sa maison. Fr. 350.-
065. A Furrer Jean pour un vieux four à pain et des murs. Fr. 120.-
066. A Hartmann pour un raccard. Fr. 100.-
067. A Nater, Jean (au champ) am Acker, pour une cheminée. Fr. 15.-
068. A Zenhäusern, Ignace, juge subst. pour une cheminée et un raccard. Fr. 65.-
069. no description
070. A Kalbermatten, Pierre, pour une cheminée. Fr. 13.-
071. A Gattlen, Chrétien, in der Kummen (à la combe) pour réparer les murs de la cave et de la cuisine. Fr. 40.-
072. A Zumoberhaus, Châtelain, pour deux toits remonter ainsi q'un supplément de bâtiment. Fr. 44.-
073. Au même (Zumoberhaus, Châtelain,) pour sa maison d'habitation dont il a un mure, un four à pain et une cheminée à réparer. Fr. 45.-

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CH-3939 Eggerberg

Population figure: 1850: 217
Population figure 2000: 382
Revised damage assessment
Total loss: CHF 4'055.-

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001. Chez Ignace et Jean Zimmermann, une grange [...] et à la maison à Zum Stadel . Fr. 260.-
002 Zimmermann, Jos. Ant. à une Grange menaçant vieux déjà [...]. Fr. 100.-
003. Imhof, Franç. Jos. et Zimmermann [...], un raccard [...]
004. Holzer, Jos. Ant. à la cave et l'écurie. Fr. 100.-
005. Stepher, Maurice et Maria Joséphine, [...] 1 grange. Fr. 150.-
006. Schwery, Eugène, sa maisonnette à Engunhaus. Fr. 300.-
007. Schmied et [...] à l'écurie, [...] au toit. Fr. 40.-
008. Nellen, Maurice, à la grange, exterieure [...] ruine. Fr. 60.-
009. Martig, Jean, à la grange. Fr. 100.-
010. Stocker, Jean au toit. Fr. 40.-
011. Lang, Jean et Schwery, à un Raccard. Fr. 300.-
012. Lang, Jean Jos.: à la grange, au toit. Fr. 60.-
013. Gischig, François, à la maison. Fr. 80.-
014. Lang, Jean Jos.: au toit et à la cheminée. Fr. 90.-
015. Haaguen, Jean, à la maison. Fr. 25.-. Haaguen, Jean et Fourrer, Jean au raccard et à la maison. Fr. 90.-
016 Holzer, Ant.: au toit et au murs de la maison. Fr. 80.-
017. La chapelle im Gorb, extérieure [...] endommagées. Fr. 150.-
018. Gischig, François et Fourrer, Jean, à l'écurie. Fr. 10.-
019. Henzin et Julen, à la maison. Fr. 50.-
020. Durren, à l'écurie et grange. Fr. 80.-
021. et 022. Holzer, Jean Jos.: l' écurie et raccard. Fr. 200.-
023. Stephen, au moulin. Fr. 60.-
024. Gutheil, Presid. et Zimmermann, Maria Josepha, maison. Fr. 60.-
025. Zimmermann, Jos. Ant., à l'écurie. Fr. 60.-
026. Inalbon, Jean. Fr. 50.-

027.et 028. Albrecht, Jean, Inalbon, Jos., à la maison, cheminée, toit et mur. Fr. 50.-
029. Inalbon, Jean, à l'écurie, mur et toit. Fr. 25.-
030. Nellen, Maurice, le toit de la maison. Fr. 15.-
031. Martig, Jean Jos. et Inalbon Jean Jos. Fr. 100.-
032. Bittel, Jean Jos., à la maison, écurie et grange. Fr. 35.-
033. Martig, Jean et Fourrer Jean, leur maison à Finnen. Fr. 230.-
034. Inalbon, Jean et Albrecht, Jos., Grange im Dorn. Fr. 60.-
035. Fourrer, Pierre, maison et écurie, im Gorb. Fr. 90.-
036. Fourrer, Jean Jos., raccard au ober Burg. Fr. 80.-
037. Zimmermann, Jos. et Inalbon, Jean, maison Zumstadel. A la première acclamation n'ont été partis sur le liste des endommagés. Fr. 40.-
038. In der Steinschlucht, Jean, Jos. Inalbon, Jean Zimmermann et les enfants du Président Imstepf. Fr. 10.-
039. Schmidt, Ant., écurie et grange avec celle de Weingarten. Fr. 70.-
040. Zumtor, Weingarten, Lang Jean, et Martig. Fr. 50.-
041. Zumtor , Weingarten, Schmidt, Clemens. Fr. 10.-
042. Nellen, Maurice et Jean Jos. Albener, grange. Fr. 10.-
043. Stephen, maçonier Jean, raccard in der Schluchten. Fr. 25.-
044. Zimmermann, Jean, [...] Truffer, à la maison. Fr. 50.-
045. Gutheil, Presid., auf dem Groben, écurie et grange. Fr. 70.-
046. Jean Truffer, im Ritschig. Fr. 20.-
047. Albener et Zenklusen, [...] grange à Ztennen. Fr. 150.-

CH-3931 Eiholz
Population figure: 1850: 173
Population figure 2000: see Visp
Revised damage assessment
Total loss: CHF 2'614.-

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001. A Pierre Ignaz Gsponer et Pierre Joseph Naepfli, pour réparer la moitié du toit de la grange. Fr. 10.-
002. A Pierre Joseph Gsponer et Antoine Krug, pour refaire neuf toises de mur sec à une vielle grange et en remonter le toit. Fr. 50.-
003. A Catherine Heldner à la fontaine pour faire une nouvelle cheminée deux toises de mur et remonter deux toits. fr. 60.-
004. Au rér. âcre de Viège, pour faire deux toises de mur sec et réparer le toit de la grange. Fr. 25.-
005. A Pierre Joseph Naepfli, pour réparer le toit d'une grange. Fr. 5.-
006. A Heldner, Joseph, pour réparer un angle mur et le toit de la maison. Fr. 12.-
007. A Pierre Joseph Naepfli, pour réparer la cheminée le toit, le fourneau d'une chambre de la maison. Fr. 25.-
008. A Madlaine Albener, pour 2 toises de mur à la maison. Fr.8.-
009. A Pierre Fermer et Heldner, pour deux cheminées le toit et quatre toises de mur à leur maison, pour un manteau de cheminée et la voûte d'un four à pain. Fr. 85.-
010. A Heldner, Franc. Joseph, pour réparer un mur dans la cave et huit toises de mur à écurie. Fr.46.-
011. A Pierre Heinzmann pour faire une nouvelle cheminée et réparer le toit de la maison. Fr. 35.-
012. A Zurkirchen, Claude Joseph, pour réparer une cheminée et le toit de la maison et à l'écurie une toise de mur sec à réparer ainsi que le toit. Fr. 28.-
013. A Truffer, Jean, pour faire une nouvelle cheminée, six toises de mur recrépir, et réparer le toit. Fr.100.-
014. A Joseph Antoine Ruffinner et Chrétien Ruffinner et Alexandre Heldner Pour réparer trois cheminées et le toit , et huit toises de mur sec à refaire. Fr. 130.-
015. A Zeiter Antoine pour six toises de mur, le toit et le fourneau à réparer. Fr. 70.-
016. A Martin Crettaz, pour réparer huit toises de mur et pour remonter le toit de la maison et de la grange. Fr. 50.-
017 A l'ancien Président Pierre Joseph Ruffinner, pour faire neuf toises de mur, réparer le toit et la cheminée, réparer une grange et relever une autre écroulée. Fr. 180.-
018. A Heldner, Ignace et consorts, pour réparer une cheminée et le toit et [...] les lieux et quelques fentes. Fr. 90.-
019. A Heldner, Joseph Antoine, pour réparer une cheminée et le toit de la maison, pour faire quatre toises de mur à la grange et cinq toises de mure dans la cave. Fr. 140.-
020. Inalbon, Anne marie veuve, pour faire une nouvelle cheminée et pour réparer le toit. fr. 40.-
021. A Truffer, Jean fils, pour faire une nouvelle cheminée et réparer le tois de la maison. Fr 50.-

022. A Volken Fr. , au pressoir faire deux toises de mur, à la maison réparer le toit et la cheminée, faire six toises à la grange et réparer la moitié de la maison. Fr. 115.-
023. A Ruffinner, Antoine, pour réparer la cheminée et le toit de la maison. Fr. 40.-
024. A Heldner, Alexandre fils d' Antoine, pour réparer le toit de la maison, faire cinq toises de mur au grenier et trois toises de mur à l'écurie. Fr. 65.-
025. A Pierre Volken, pour réparer une cheminée, un fourneau et le toit de la maison, ainsi que de faire 3 toises de mur à la grange appartenant à Ruffinner Pierre Joseph. Fr. 90.-
025.Pour réparer deux cheminées, le toit et les fentes de la maison d'école. Fr. 95.-
026. A Pierre Volken et consorts, pour trois toises de mur au grenier. Fr. 50.-
028. Pour la chapelle dite auf der Ritti. Fr. 10.- (Zahl durchgestrichen)
029. A Kalbermatten, Jos. J., pour réparations de toit de la grange. Fr.10.-
030. A Kummer, Bartholemie [...], pour réparer le toit, la cheminée, le fourneau et faire une toise de mur à la maison. Fr. 70.-
031. A Nicolas Zurkirchen, pour réparer le toit d'une grange. Fr. 10.-
032. A Heldner, Alexandre et consorts, pour réparer le toit d'un grenier. Fr. 10.-
033. A Krummatter Jean, pour réparer le toit, la cheminée et faire deux toises de mur. Fr. 40.-
034. A Heldner, Philippe et consorts, pour réparations d'une cheminée et du manteau. Fr. 20.-
035. A Naepfli, Pierre, pour réparer le toit et la cheminée de la maison. Fr. 20.-
036. A Gsponer, Pierre Ignace, pour 4 toises de mur et une cheminée à faire ainsi que pour relever un grenier. Fr. 80.-
037. A Pierre Erpen et Pierre Volken, pour réparer le toit et deux cheminées à leur maison. Fr. 40.-
038. A Ruffinner, Antoine et consorts, pour réparations d'un fourneau et [...] toit de la maison. Fr. 10.-
039. A Heldner, Antoine et consorts, pour 5 toises de mur , le toit et la toit cheminée à réparer. Fr. 80.-
040. A Volken, Pierre, pour 2 toises de mur à la grange. Fr. 20.-
041. A Pierre Volken et Antoine Ruffinner, pour 8 toises de mur au grenier et pour relever la grange. Fr. 230.-
042. A la maison communale pour réparations du toit, d' un fourneau et d'une cheminée. Fr. 50.-
043. A Joseph Albrecht et consorts, pour réparations d' un toit de grange. Fr. 20.-
044. A François Albener, pour réparations d'une cheminée et d'un plancher dans la maison. Fr. 30.-
045. A Heldner, Joseph Antoine et Joseph Antoine Ruffinner, pour réparations d'une cheminée et pour six toises de mur à la maison, ainsi que pour réparer une grange. Fr. 70.-
046. A Sattler, François et consorts, pour deux toises de mur, pour réparer la cheminée et le toit de la maison. Fr.50.-
047. A Ruffinner, Chrétien, pour réparer un toit de grange. Fr. 10.-
048. A Heldner, Joseph Nicolas, pour réparer une cheminée le toit et pour reboucher les fentes de sa maison. Fr.50.-

CH-3943 Eischoll

Population figure: 1850: 341
Population figure 2000: 500
First damage assessment and revised assessment
Total loss: CHF 1'264.-

First damage assessment

001.Kapelle auf dem Brunnbiel, für einen Theil des Portals wiederaufzubauen u. verschiedenen Risse im Innern u. Äussern auszubessern. Fr. 450.-
002. Die Pfarrkirche u. Glockenthurm für [...] am Thurm u. [...] Reparation der Risse. Fr. 1000.-
003. Die Kappelle zu Breien, für Reparation der Risse. Fr. 15.-
004. Die Kappelle zu Zubru, für ein Fenster u. ein stück Mauer auf der Abend Seite [...]. Fr. 80.-
007. Das Gemeindehaus in Eischoll, für eine Haustube mittäglich [aufzu...]. Fr. 70.-

Revised damage assessment

001. A Bajard, André, pour une cheminée. Fr. 10.-
002. A Fogel, Ferdinand, pour 4 toises de mur et une cheminée. Fr. 34.-
003. A Guntern, François, pour 2 toises de mur et une cheminée. Fr. 25.-
004. A Bajard, Ignace, pour 2 toises de mur. Fr. 18.-
005. A Pfammatter, Jean Jodoque. Fr. 5.-
006. A Jean Schroeter, zum Oberhaus, pour une cheminée. Fr. 10.-
007. A Pierre Pfammatter, idem, pour une cheminée Fr. 16.-

008. Aux Messieurs Roten de Rarogne, pour une maison, pour 17 toises de mur à la montagne. Fr. 200.-
009. A Pfammatter, Théodule pour 3 toises de mur. Fr. 20.-
010. A Ignace Schroeter, pour une toise de mur. Fr. 6.-
011. A Théodule Amacker, Président, pour une cheminée. Fr. 13.-
012. Au même (Théodule Amacker, Président) pour 10 toises de mur, une cheminée et en escalier. Fr. 60.-
013. A , Jean Chrétien, pour une cheminée. Fr. 10.-
014. A Marthe Amacker pour id. (pour une cheminée) Fr. 10.-
015. A Bajard, Joseph Antoine, pour idem (pour une cheminée). Fr. 10.-
016. A Pfammatter, Joseph, pour idem (pour une cheminée). Fr. 10.-
017. A Amacker, André, pour idem (pour une cheminée). Fr. 10.-
018. A Anne, Brunner, pour idem (pour une cheminée). Fr. 10.-
019. A Bajard, Pierre, pour idem (pour une cheminée). Fr. 10.-
020. A Brunner, Théodule, pour 2 toises de mur. Fr. 18.-
021 A Brunner, Maurice, pour une cheminée. Fr. 10.-
022. A Cheler Anne-Marie et Amacker Théod. Pour 3 toises de mur. Fr. 55.-
023. A Pfammatter, Chrétien, pour 1.5 toises de mur. Fr. 12.-
024. A Jean Amacker, pour 2 toises de mur. Fr. 16.-
025. A Brunner, Jean Joseph, pour une cheminée er 1 toise de mur. Fr. 15.-
026. A Théod. Et André Amacker pour 3 toises de mur. Fr. 24.-
027. A Bajard, Ignace, pour une cheminée. Fr. 10.-
028. A Amacker, Ignace, pour idem (une cheminée). Fr. 10.-
029. A Sterren, Ignace, pour id. (une cheminée). Fr. 10.-
030. A Imacher, François, pour 4 toises de mur. Fr. 37.-
031. A Brunner, Chrétien, pour 2 toises de mur et un angle. Fr. 16.-
032. A Jean Amacher, pour 2 toises de mur et une cheminée. Fr. 18.-
033. A Jaeger, Jean , pour 3 toises de mur et une cheminée. Fr. 27.-
034. A Pfammatter, Joseph, pour 1.5 toises de mur, Pammer, Joseph. Fr. 8.-
035. A Steiner, Thérese, pour 3 toises de mur et pour faire une cheminée. Fr. 33.-
037. A Schroeter, Aloys, Organiste, pour 6 toises de mur. Fr. 30.-
038. A François Amacher, pour 10 toises de mur dans la cave. Fr. 85.-
039. A Ignace Nantzer, vieux, pour réparer quelques fentes de la maison et de la grange. Fr. 15.-
039. A Jaeger, Aloys, p. 9 toises de mur, la cheminée et le toit. Fr. 105.-
040. A Schroeter, Aloys, pour une cheminée. Fr. 10.-
041. A Pfammatter, Aloys, fils de Théodule, pour une cheminée. Fr. 10.-

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CH-3926 Embd
Population figure: 1850: 204
Population figure 2000: 353
First damage assessment
Total loss: CHF 855.-

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001. Sponer, Nic., Fux Franc., maison, rep. Le toit et cheminée. Fr. 30.-
002. Fux, Franc., maison, réparer un mur. Fr. 10.-
003. Sponer, Babtiste, maison, toit, mur etc. Fr. 80.-
004. Schaller, Joseph, maison, toit, chem., mur à faire. Fr.100.-
005. Villener, Eugène, maison, toit et cheminée. Fr. 35.-
006. [...], Clemens comp., grange, toit, mur, cheminée. Fr. 200.-
007. [...], Clemens comp., grange/écur., rep. Toit relever les mur. Fr.130.-
008. Schaller, Joseph, maison, réparer toit et mur. Fr. 60.-
009. Villener, Martin, maison, toit et cheminée. Fr. 20.-
010. Fux, [...]. Jos., John, Ignatz, id. (maison, toit et cheminée.) Fr. 20.-
011. Maison de Commune, réparer le toit. Fr. 20.-
012. église, réparer le clocher, mettre des clefs. Fr. 150.-
013. Lorenz, Jos. Comp. Maison, toit et cheminée. Fr. 30.-
014. Kapelle am [...], réparer toit et crevasses. Fr. 40.-
015. id. (Kapelle) zür Stete, réparer toit et mettre des clefs. Fr.80.-
016. Fux, [...], maison, réparer trois toits. Fr. 50.-
017. Gsponer, Jean Joseph, trois toits à réparer. Fr. 40.-

018. Jarener, Agathe, réparer Grenier et grange et écurie les murs. Fr. 30.-

CH-3945 Gampel

Population figure: 1850: 330
Population figure 2000: 1301
Revised damage assessment
Total loss: CHF 791.-

001. Ilbrant, Christian, grange écroulée, déjà réparée coûte Fr. 35.-
002. Bourfret, Christian, maison 2 cheminée et fente. Fr. 25.-
003. Lescher, Jean Jos., refaire le toit et cheminée de la maison. Fr. 39.-
004. Ilbrant, le petit, 1 cheminée sur le toit. Fr. 10.-
005. Marthe, François, fils, un cheminée sur le toit. Fr. 10.-
006. idem (Marthe, François) et Jean, grange écroulée, refaire 3 toises de mur remonter le couvert. Fr. 160.-
007. Zengafiner, réparer un plancher et fente. Fr. 35.-
008. Fourdere, Barbara, réparer les fentes de la maison et l'escalier. Fr. 70.-
009. Ilbrand, Pierre Joseph, refaire un toit écroulé dans la grange. Fr. 33.-
010. Marthe, Antoine, réparer de petites fentes à la maison. Fr. 5.-
011. Friante, Alexis, 1 cheminée et un mur. Fr. 45.-
012. Marthe, Chrétien, 1 cheminée double sur le toit. Fr. 15.-
013. Schnider, Pierre, refaire un pilier et fente. Fr. 40.-
014. Chérik, Jean, 1 cheminée, un toit. Fr. 10.-
015. Ilbrant, (le boiture) 1 cheminée, un couvert. Fr. 10.-
016. Schnider, Etienne, 1 cheminée sur le toit. Fr. 10.-
017. Brenner, Barbera, 1 mur, fente à refaire. Fr. 15.-
018. Brenner, Martin, 1 brèche de mur. Fr. 4.-
019. Ilbrand, Felix, réparer latrines et fente de la maison. Fr. 35.-
020. Schnider, Jean, réparer le toit de la grange. Fr. 8.-
021. Ilbrand, Jean Joseph, refaire latrine. Fr. 10.-
022. Brenner, Bénédicte, 1 cheminée et fentes. Fr. 15.-
023. Hagen, Joseph, 1 cheminée et fente à réparer. Fr. 15.-
024. Locher, Pierre, refaire 1 cheminée sur le toit. Fr. 10.-
025. Hofer, Jean, réparation faite. Fr. 20.-
026. Sigismond, Dominique, refaire 1 cheminée, 1 brèche de mur. Et François. Fr. 30.-
027. Seiler, Jean, réparer 1 petit mur à la grange. Fr. 10.-
028. Schérik, père, refaire 1 angle à la maison. Fr. 24.-
029. Blatter, Jean, refaire 1 cheminée sur le toit. Fr. 10.-
030. Venetz, Jean, 1 cheminée sur le toit. Fr. 10.-
031. Schnider, David, un toit à réparer. Fr. 15.-
032. Schnider François, réparer les fentes à la maison. Fr. 8.-

CH-3900 Gamsen

Population figure: 1850:unknown
Population figure 2000: see Brig
Revised damage assessment
Total loss: CHF 4'593.-

001. Le toit de la maison de d'Antoine Bürcher à faire neuf Fr. 36.- La moitié du toit de la grange. Fr. 5.-
002. La moitié du toit de la grange d'Anne Marie Amherd. Fr. 5.-
003. De la maison de Louis Amherd, quatre cheminées, le toit et quelques fentes à réparer et un angle de mur à reconstruire dans la grange. Fr. 90.-
004. A Louis Nanzer, Jean Joseph Nanzer et aux enfants de Jean Joseph Amherd, pour reconstruire une grange. Fr. 35.-
005. A Joseph Antoine Nantzer, vétérinaire, pour reconstruire les quatre murs et le toit d'une grange, les matériaux se trouvent sur place. Fr. 60.-
006. A Chrétien Jossen, pour réparer une cheminée, le toit et quelques fentes à réparer. Fr. 35.-

007. La chapelle entière, trois façades, sauf le chœur, à refaire. Fr. 1600.-
008. Dans la maison de Jean Joseph Stoffel et Aloys Stoffel une cheminée et le toit, dans la grange le toit à réparer. Fr. Fr. 43.-
009. Dans la maison de Jean Joseph Tscherrig pour 1.5 toises de mur sec à refaire et le toit à réparer. Fr. 13.-
010. A Fidele Eberli et Bartholomy Ampert, pour réparations d'une cheminée, du toit et de quelques fentes dans la maison. Fr. 96.-
011. A Fidele Eberli, pour réparations de mur et du toit de son moulin. Fr. 25.-
012. A Jean Joseph Ambert, pour réparations de toit, de quelques fentes et minuties dans la maison que pour réparations des toits et murs de deux moulins. Fr. 160.-
013. A François Hug et Xavier Nantzer pour réparations du toit, du manteau de cheminée de la maison et du toit de la grange. Fr. 23.-
014. A la veuve de Jos. Antoine Nantzer née Berchtold, pour réparations du toit et de quelques minuties dans les murs de la maison. Fr. 10.-
015. A Heldner Joseph et Ambert Aloys fils de Felix, pour réparations du toit, d'un cheminée et quelques fentes de la maison. Fr. 30.-
016. A Inalbon, Aloys et François Nantzer, pour reconstruction d'une petite grange écroulé et faite à murs sec. Fr. 45.-
016. Breggi, Chrétien, moitié d'une grand toit tout pourri, 3 petites brèches de mur. Fr. 30.-
017. Aux enfants de Felix Ambort et Aloys Ambort, pour reconstruction d'une grange en plus grande partie faite en murs sec, les matériaux se trouvent sur place. Fr. 100.-
018. A Jean Joseph Ambort l'[...], pour réparations du toit et quelques fentes de la maison. Fr. 20.-
019. A Jean Ambort, Gsponer, Pierre Ignace et consorts, pour [...], un angle de mur ainsi que dix toises du toit d'une petite grange. Fr. 45.-
020. A Pierre Joseph et Aloys Ambort, pour faire une cheminée à neuf, ainsi que le quart du toit et réparer le reste du toit, faire six toises de mur à neuf. Fr. 61.-
021. A Gsponer, Joseph, pour réparations du toit et de la salle. Fr. 8.-
022. A Aloys Ambert et consorts, pour réparations d'une grande partie d'un mur sec et du toit d'une grange. Fr. 75.-
022a. Au même état (Aloys Ambort) et consorts l'hoirie de Jean Joseph Ambort pour réparations du toit d'une grange à mur sec. Fr. 40.-
023. A Antoine Burcher, Joseph Ambort et Aloys Stoffel pour réparations du toit de la grange. Fr. 42.-
024. A Nantzer, François Stupf, un angle de mur à faire à neuf et le reste du mur de la grange à réparer. Fr. 42.-
025. A Gossen et consorts, une petite vielle grange faite à mur sec et dont le bois était en grande partie moise est écroulé. Fr. 5.-
026. Nantzer, Pierre Joseph, la plus grande partie d'une grange dont le bois est en bon état. Fr. 100.-
027. A Nantzer, Ignace tanneur, pour réparations du toit, de deux cheminées, d'une voûte dans le moulin, d'un mur derrière la maison [...], neuf toises, presque tout à faire à neuf et pour reboucher nombreuses fentes dangereux de la maison.
028. A François Boler, pour réparations de quelques fentes dangereuses, tous les quatre murs [d'un mur] d'une petite salle et le tiers du toit à réparer. Fr. 85.-
029. A l'hoirie de Christian Jossen pour réparations ou plutôt reconstructions d'un angle-mur sec et réparations du toit. Fr. 64.-
030. A la veuve Catherine, conjointement avec son [...] frère Joseph Antoine, pour reconstruire une cheminée, réparer le toit et reboucher quelques fentes de la maison. Fr. 64.-
031. A Nantzer, François Stupf, pour reconstructions de deux cheminées et du toit et réparations de la plus grande partie des murs de la maison, pour faire à neuf le toit et le fond ainsi que pour réparer quelques fentes de la grange. Fr. 355.-
032. A François Nantzer le Petit, pour réparations du toit et de quelques fentes de la maison, et pour reconstruire partie en partie réparer tous le murs de l'écurie. Fr. 50.-
033. A Jean Joseph Nantzer, pour faire à neuf le toit de la grange et un angle de mur sec conjointement avec Antoine Nantzer. Fr. 40.-
034. A Nantzer Jean Joseph et Stoffel, Jean Joseph, pour réparer le toit et quelques fentes de la maison. Fr. 60.-
035. A François et Antoine Ambort, pour quelques réparations à leur vielle maison. Fr. 15.-
036. A Tscherrig, Jean Joseph, Alexis Seiler et consorts, pour réparer trois angle-mur et le toit de leur grange. Fr. 90.-
037. A Antoine Ambort, pour réparer le toit et quelques fentes de la grange. Fr. 10.-
038. François fils de Sébastien Ambort pour reboucher deux trous et quelques fentes de mur et réparer le toit. Fr. 53.-

040. A Gaspard Bieler, pour réparer deux vieux murs de la maison et grange à blé, pour une remise bois écroulé pour cause de relusse, et pour un peu réparer eux toits. Fr. 20.-
041. a Aloys Ambort, Gaspard Bieler et Ignace Nantzer, pour faire pieds à une grange-à-blé et pour réparer le toit. Fr. 20.-
042. A Griesser Antoine et consorts, pour faire quelques réparations à la maison, environ trois toises de mur dans l'intérieur de la maison, réparer le toit et deux cheminées endommagées de quelques fentes, et faire quelques réparations à l'escalier. Fr. 85.-
043. A François Nantzer le Petit et Joseph Antoine Nantzer, pour faire de réparations au toit et aux murs de la grange. Fr. 8.-
044. Lauber, et Jean et Antoine Ambort, pour une grange écroulé jusqu'à deux angle-murs secs et dont le bois est presque moisi. Fr. 65.-
045. A Joseph Antoine fils de Jean Joseph Ambort et consorts, pour un trou d'environ trois toises fait dans le mure de la grange et pour réparer quelques minuties au toit. Fr. 35.-

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CH-3902 Gliss
Population figure: 1850:633
Population figure 2000: see Brig
Revised damage assessment
Total loss: CHF 7'218.-

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001. Holzer, Alexandre et veuve Schmidthalter née Ambord, maison, la cheminée et le toit à réparer et 11 toises de mur à faire à neuf. Fr. 170.-
002. A Blatter, Jean, Schaufeli, Jean, Laurent Tscherrig, dans la maison 8 toises de mur à refaire et une cheminée à réparer. Fr. 71.-
003. Dans la maison de la veuve Labor et Maurice Imhoff, une cheminée et le toit à réparer. Fr. 100.-
004. Dans la maison de la veuve Albrecht et de Pierre Kuonen père, une cheminée à faire, quelques petits murs à faire, quelques fentes à boucher. Fr. 40.-
005. Dans la maison de Pierre Kuonen, tailleur, une cheminée à réparer et deux fentes à boucher. Fr. 25.-
006. Dans la maison d'Antoine Imhoff, une cheminée et le toit à réparer. Fr. 30.-
007. Dans la maison d'Antoine Kuonen, une cheminée et une partie de mur à réparer. Fr. 30.-
008. A l'hoirie Nellen, Felix, une cheminée à faire neuf. Fr. 15.-
009. Dans la maison de Bartholemie Blatter, une cheminée à refaire et le toit à réparer. Fr.45.-
010. Dans la maison de Ignace Blatter, une cheminée et le toit à réparer et quelques fentes à reboucher. Fr. 45.-
011. Dans la maison de Pierre Wyden, pas de dommages à " reconnaître "
012. Dans la maison de Blatter, Joseph, de Jean Joseph Hagen, la cheminée à refaire et le toit à réparer. 15.-
013. Dans la maison de Jos. Inalbon et des enfants Blatter, non habité et vielle s'est écroulée. Fr. 80.-
014. Blatter Jean Joseph, procureur d'église, une fente à reboucher dans la maison. Fr. 10.-
015. Wyden, Joseph, dans la maison une cheminée à reconstruire. Fr. 20.-
016. Grange à blé de Jean Joseph Blatter et consorts, deux angles de mur à réparer. Fr. 10.-
017. Dans la maison d'Ignace Lauber un Angle de mur et quelques chose du toit à réparer. Fr. 20.-
018. Dans la maison d'Ignace Krugler, le toit à réparer. Fr. 5.-
019. Sprung Alexis et Krugler Ignace, ont le toit de la grange à réparer. Fr. 5.-
020. Dans la maison d'Eduard In Albon, une cheminée et quelques minutries à réparer. Fr. 14.-
021. Dans la maison de l'imbécile François Nellen, la cheminée à réparer. Fr. 5.-
022. Dans la maison d'Ignace Heimen, une cheminée et un angle de maison à réparer. Fr. 23.-
023. Dans la maison de Gaspard Perrig, une cheminée à réparer. Fr.10.-
024. Dans la maison de François Bieler, une cheminée à réparer. Fr.10.-
025. Dans la maison de Laurent Tscherrig, François Bieler et François Gentinetta, le toit à réparer. Fr. 10.-
026. Dans la maison de Joseph Baurelle, le toit et quelques minuties à réparer. Fr. 20.-
027. Dans la maison de Gaspard Holzer, Gentinetta, Maurice et Holzer Antoine, une cheminée et le toit à réparer. Fr. 25.-
028. Dans la maison de François Nanzer, une petite partie du mur de la maison à réparer. Fr. 10.-
029. Dans la maison de Ferdinand Stockalper, une cheminée et le toit à réparer. Fr. 25.-
030. Sur la scierie d'Antoine Gerig, une partie de mur. Fr. 5.-
031. A la maison de Jean Joseph Wenger, le toit à réparer. Fr. 10.-
032. Dans la maison d'Antoine Guntern, une cheminée et le toit. Fr. 20.-
033. Dans le jardin de César Julier, une partie du mur s'est écroulée. Fr. 10.-

034. Dans la grange de Joseph Sidler, de larges fentes. Fr. 25.-
035. Dans la grange de Gaspard Willa, le toit et quelques fentes à réparer. Fr. 20.-
036. Dans la grange de Joseph Hagen, le toit à refaire à neuf. Fr. 25.-
037. Dans la maison bourgeoisiale, réparations à deux cheminées, le toit faire à neuf, de larges fentes reboucher, travail qu'est déjà fait. Fr. 200.-
038. Dans la maison de Reine Schmidt, quelques fentes à reboucher et réparations à faire au toit. Fr. 16.-
039. A la maison de Jean Joseph Lauber, une cheminée, quelques fentes et le toit à réparer. Fr. 60.-
040. Dans la maison de la veuve François Joseph Perrig, quelques réparations à faire. Fr. 10.-
041. Dans la maison de Jean Joseph et Thérèse Schmidt, deux cheminées, le toit et quelques fentes à réparer. Fr. 35.-
042. A la grange du gr. Châtelain Jean Joseph In-Albon, le toit à réparer. Fr. 15.-
043. A la grange d'Augustin Julier le toit à réparer. Fr. 10.-
044. La maison de Valentin Bielander, a quelques réparations au toit. Fr. 20.-
045. Dans la maison de Grégoire Carlen, une cheminée et le toit et dans la grange le toit à réparer. Fr. 20.-
046. A la grange et grange à-blé de Nicolas Roten et Eduarde Inalbon, le toit à réparer. Fr. 20.-
047. A la maison de Marie Josette Eggs, une cheminée et le toit à réparer et quelques petites fentes à reboucher. Fr. 20.-
048. Joseph Antoine Biffiger et Jean Joseph Zour-Werra, le toit d'un quart de grange à réparer. Fr. 15.-
049. La maison de Jean Joseph Zur Werra a la cheminée, le toit à réparer et de larges fentes à reboucher. Fr. 80.-
050. A la maison de Jean Joseph Imwinkelried, et d'Ignace Lauber, une cheminée, le toit, et de larges fentes à réparer. Fr. 30.-
051. A la maison de Pierre Joseph Lauber, deux cheminées et le toit à réparer, ainsi que faire d'autres réparations. Fr. 55.-
052. La cheminée de la maison de François Wyder et Imwinkelried, a réparer. Fr. 10.-
053. Dans la maison du v. Vicaire, deux cheminées, quelques petites à réparer, ainsi que le toit. Fr. 80.-
054. A la maison du Rectorat, deux cheminées et le toit à réparer. Fr. 20.-
055. Dans la maison de la veuve de François Nanzer, quelques réparations a faire au toit, ainsi que reboucher quelques fentes. Fr. 50.-
056. Dans la maison de Jean Joseph Burcher, de Fr. Blatter et Jos. Ant. Biffiger, à réparer deux cheminées, le toit et quelques fentes. Fr. 45.-
La grange de JJ. Burcher a eu 4 journées à 2 pers. Par jour. Fr. 8.-
La remise, la salle d'entrepôt et une cheminée à réparer et quelques fentes à reboucher. Fr. 15.-
057. Dans la maison de Pierre Nanzer, le toit à réparer et y mettre un cherroni, et quelques fentes à réparer. Fr. 30.-
058. Dans la maison de l'hoirie Augustini, la cheminée et le toit à réparer. Fr. 15.-
059. Dans la maison du rapporteur Ambord, il y a une grande réparation à faire à trois façades, et a reboucher des fentes dans l'extérieur de la maison. Fr. 80.-
060. Dans la maison de l'hoirie François Wyder, la cheminée et le toit à réparer. Fr. 20.-
061. Dans la grange de l'hoirie Alexandre Wyder et de Madeleine Escher, quelques fentes à reboucher. Fr. 10.-
062. La grange de François Wyder et Alexandre Holzer, écroulée par cause de vétusté (alter) et aussi par suite du tremblement de terre. Fr. 15.-
063. Dans la maison de la veuve Laurent Wyder, une cheminée à réparer et quelques vielles fentes à reboucher. Fr. 30.-
064. Dans la grange de Louis Wyder, un angle de mur et quelques fentes à réparer. Fr. 15.-
065. Dans la grange et écurie de l'hoirie François et Alexandre Wyder, un angle de mur à refaire et quelque peu le toit à réparer. Fr. 15.-
066. L'écurie de Mons. Le Préfet Cathrein, le toit et quelques fentes à réparer. Fr. 20.-
067. A Fruzzine, un mur sec recrépi de plâtre d'environ 10 toises. Fr. 50.-
068. Le toit de la Grange de François Spekli, une guérit sont à moitié écroulé dans le jardin, et dans la buanderie la cheminée est à réparer. Fr. 40.-
070. Dans la maison de Borgnis, deux cheminées à réparer, dans la grange le toit à faire à neuf. Fr. 80.-
071. L'église et chapelle antique. Le plafond de l'église d'environ 53 toises est à refaire du coté des orgues, le toit de l'église ainsi que toutes les fentes de l'église et du clocher à reboucher.
072. Dans le presbytère, deux cheminées, le toit et toutes les fentes de la maison, ainsi que de la grange y appartenant le toit à réparer. Fr. 105.-
073. Le toit de la maison et de la grange de François Guntern est à réparer, ainsi que les fentes à reboucher. Fr. 21.-
074. Le toit de la maison de Jean Joseph Volken est à réparer et quelques fentes à reboucher. Fr.12.-

CH-3925 Grächen
Population figure: 1850:338
Population figure 2000: 1254
Revised damage assessment
Total loss: CHF 1'211.-

001. Eglise. Réparations de toutes les fentes dans l'intérieur et à l'extérieur de l' église, et la voûte du chœur, placer une clef de fer derrière l'autel, recrépir et blanchir le vieux chœur, poser le dôme du clocher et placer le clef en fer. Fr. 500.-
002. Charnier. Dans l' [...] du chœur refaire trois et demi toises de mur, y réparer toutes les fentes à l'intérieur et à l'extérieur, dans la voûte du chœur, placer une clef de fer à l' [...] du chœur, ainsi que faire une voûte neuve de cinq toises, et réparer le toit. Fr. 165.-
003. Chapelle dite Auf der Egge. Les réparations dans l'intérieur et extérieur de la chapelle, ainsi que celles faites au clocher ont coûté pour la main d'ouvrier et les matériaux. Fr. 116.-
004. A Ignace Trüffer, pour relever deux greniers de bois, réparer le toit et la cheminée. Fr. 185.-
005. A Aloys Andenmatten et comp., relever une grange à blé haute et caduque. Fr. 90.-
006. A Pierre Abgottspon, pour faire à neuf deux cheminées et trois toises de mur sec de la maison. Fr. 53.-
007. A Anne Marie Summermatter, pour relever une petit grange à blé. Fr. 27.-
008. A Ignace Walter, pour faire deux nouvelles cheminées à la maison et deux toises de mur sec dans la maison. Fr. 46.-
009. A Joseph Antoine Furrer, pour trois toises d'un vieux mur sec. Fr. 46.-
010. A Jean Schnidrig et consort, pour faire une cheminée neuve à la maison quatre toises de mur sec dans l'écurie, et réparer quelques minuties au toit, refaire la voûte d'un four à pain dont les pierres étaient caduQues. Fr. 80.-
011. Chapelle dite in der Bühne, refaire l' arceau de deux fenêtre, réparer tout les fentes dans l'intérieur et extérieure de la chapelle et le toit. Fr.68.-
012. A François Schnidrig, pour faire une nouvelle cheminée dans la maison. Fr. 15.-
013. A Pierre Joseph Sonschaller, pour deux toises de mur sec dans la cave. Fr. 8.-
014. Aux frères Furrer, pour reconstruire la voûte du four à pain et la cheminée. Fr. 40.-
015. A Halter, Jean Joseph, pour relever une grange à blé écroulé et réparer deux cheminées. Fr.70.-
016. A Halter, Jean Joseph, pour réparer le grand toit de la maison et faire une nouvelle cheminée. Fr.64.-
017. A Schallbetter, Jean Joseph, pour réparer une grande cheminée. Fr. 11.-
018. Jean Joseph Abgottspon, pour réparer la cheminée à la maison. Fr. 10.-
019. Brügger, Pierre Josef et consorts , pour réparer une cheminée. Fr. 8.-
020. A Schallbetter, Jean Joseph, pour réparer deux cheminées. Fr.18.-
021. A Walter, Jean Joseph, pour réparer une cheminée et le toit. Fr 30.-
022. A Pierre Williner et comp. Pour réparer le toit d'une grange à blé et pour réparer une petit four à pain. Fr. 20.-
023. Au Président Walter, pour une cheminée et le toit à réparer. Fr. 20.-
024. A Aloys Schnydrig, pour réparer le toit de la grange. Fr. 10.-
025. A Pierre Josef Schnidrig, pour réparer une cheminée, le toit, la voûte d'un petit four à pain, et pour diverses petites réparations dans le moulin. Fr. 55.-
026. A Pierre Josef Halter, pour démolir et refaire un vieux four à pain. Fr.3.-
027. A Pierre Josef Summermatter, pour faire une nouvelle cheminée. Fr.18.-
028. A François Joseph Brügger, pour neuf toises d'un vieux mur sec à refaire. Fr.55.-
029. A Abgottspon, Agathe, pour faire une nouvelle cheminée et à refaire la voûte du four à pain. Fr. 30.-
030. A Schnydrig, Jean, pour faire un mur de trois toises, mur sec et recrepe dans la cave. Fr. 15.-
031. Pour refaire une toise de mur, réparer le toit et quelques fentes de la chapelle dite zur Graechen. Fr. 43.-
032. Schnydrig, Jean Joseph du moulin, à relever un grange à blé. Fr. 38.-
033. A Amstutz, Pierre Joseph, pour une grange à blé et pour en réparer le toit. Fr. 38.-
034. A Halter, Organiste, pour une cheminée et le toit à réparer. Fr. 38.-
035. A Buff, Joseph et consorts, pour quinze toises de mur sec de la maison. Fr. 70.-

CH-3949 Hohtenn
Population figure: 1850:107
Population figure 2000: 200
Revised damage assessment
Total loss: CHF 725.-

001. Bregi, Chrétien, remonter deux mur à la grange et réparer la cheminée. Fr. 34.-
002. Steiner, Jean Jos., deux brichets à la sale, la cheminée, crevasses et mur et terrasse à la grange. Fr. 25.-
003. Langen, Vendolin, remonter deux murs à la grange et maison. Fr. 15.-
004. Achschieder, Jean Jos. Cheminée et fourneau, un mur à la grange. Fr. 55.-
005. Bachofner, Jean Jos., remonter deux murs et plafond. Fr. 55.-
006. Imboden, Jean Hildebrand, une cheminée. Fr. 16.-
007.Imbnoden, Jean Buman, deux murs et la cheminée à réparer. Fr. 20
008. Seiler, Jean, remonter deux murs, réparer une cheminée, fourneau et toit. Fr. 90.-
009. Roth, Joseph, deux murs, fourneau et cheminée et réparer un mur à la grange. Fr. 90.-
010. Ferni, Silvestre, deux crevasses de mur à la grange. Fr. 20.-
011. Imboden, Pierre, crevasse de mur à la maison et grange. Fr. 20.-
012. Kalbermatten, Jean Jos., tambour, deux mur à remonter et réparer le toit. Fr. 125.-
013. Zumoberhaus, Joseph, une crevasse de mur et réparer le fourneau. Fr. 15.-
014. Kalbermatten, le [...], la cheminée, et 2 crevasses de mur à al grange. Fr. 30.-
015. Imboden, Chrétien, tambour, une crevasse de mur à la grange. Fr. 7.-
016. Steiner, Joseph, remonter un mur et réparer le toit de la grange. Fr. 50.-
017. Achschieder, François, réparer un mur et plafond de la grange. Fr. 20.-
018. Stund, Joseph, refaire une cheminée. Fr. 8.-
019. Imboden, Jean Jos. Auf der Verri, refaire une cheminée. Fr. 10.-
020. Imboden, Pierre, refaire une cheminée. Fr. 20.-

CH-3931 Lalden
Population figure: 1850:139
Population figure 2000: 700
Revised damage assessment
Total loss: CHF 1'264.-

001. Les 2 chapelles, mettre une clef, refaire le clocher, rép. Les crev. Fr. 175.-
002. Maison de commune, rép., le toit, boucher les crev. Fr. 25.-
003. Kuter, Franç., Cie, ref. 4 toises de mur, 1 chem., et toit, Fr. 55.-
004. Erpen, Franç. Cie, mais. Et grange. Boucher des crev. Et chem., 3toises de mur, et couvert. Fr.95.-
005. Antoine Vyer, mais rep. Le toit, 1chem, reb. Les fentes Fr. 35.-
006. Jean Vyer
007. Franç. Truffer Cie, mais. Rep. Le toit, 1 chem. , 2 toises de mur, fent. Rep. Fr. 45.-
008. Jean Albiner, id. (maison) rép. Toit, 1 chem. Et 1 toise de mur. Fr. 30.-
009. Truffer et comp. Grang. Ref. 8 toises de mur et couv. A neuf. Fr. 106.-
010. Franç. Erpen Cie, id. (grange) établ. Ref. 6 toises de mur et le toit. Fr. 70.-
011. Franç. Kuter, grange rép. Le toit. Fr. 6.-
012. François, Erpen Cie, ref. 8 toises de mur, rep. Le toit. Fr. 20.-
013. François Ruffinnen, Cie. Grange ref. 3 toises de mur, rep. Le toit. Fr. 40.-
014. [...] Vyer cie., mais. Rep. La façade au couch. Refaire le toi. Fr.145.-
015. Ant. Vyer et Cie. , grange ref. 9 toises de mur, rep. Le couvert Fr.85.-
016. François Huter, mais. Rep., 1 chem. Et toit à rép. Fr.20.-
017. Jph. Ant. Crettaz, mais. Grange rep. Le toit 2 chem. Sur le toit. Fr. 40.-
018. Ruffinnen, Franç. , mais. Rep. Le toit, 2 chem. Rebouch. Les crevasses. Fr. 25.-
019. Pierre Vis, grang. Rép. Le toit et petit mur. Fr. 12.-
020. Pierre Huter, mais., grange rép. 4 toises de mur et ref. la latrine, 1cheminée. Fr. 95.-
021. Ant. Huter Cie. , grange rép. 2 toises de mur et toit. Fr. 25.-
022. Franç. Retz et Cie., mais. 1 toit 1 chem.
023. Pierre Huter et Cie., grang. Rép. Le toit 1 tois. De mur. Fr. 15.-

024. Ant. Huter, maison rép. Le toit 1 chemi. Sur le toit. Fr. 15.-
025. Jean Heiner, grang. Rép.1 chemi., 2 toits, 2 toises de mur. Fr. 50.-
026. Jean Seiter, mais. Rép. 1 chem. Et crevasses. Fr. 25.-
027. Jean [...] Pittet, id. (maison) rép. Le toit et crevasses. Fr. 20.-
028. Ant Bientzli, mais. Rép. Le toit et cheminée. Fr. 20.-
029. Franç. Ruffinnen, grange rép. , remonter 1 grange. Fr. 20.-
030 Ant. Bientzli et comp.
031. Adolphe Burgener, rép. 5 tois. De mur et couvert. Fr. 80.-

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CH-3903 Munt
Population figure: 1850:442
Population figure 2000: 574
Revised damage assessment
Total loss: CHF 2'052.-

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001. L' église pour toutes les réparations à faire et faites. Fr. 2850.-
002. La cure pour réparer les façades, latrine à neuf. Fr. 250.-
003. Antoine Marthe, Antione Faffen, maison refaire l'angle et les fentes, le couvert, 1 cheminée, la dite maison était presque inhabitable avant le tremblement de terre. Fr. 200.-
004. Paul Faffen et consort, maison réparer 1 brèche, fentes et le couvert. Fr. 100.-
005. Albert, Pierre et consort, refaire 10 toises de mur pourri et couvert. Fr. 100.-
006. Panmater, Jean [...] et consort, 2 toises de mur sec, le couvert réparer à neuf. Fr. 80.-
007. Jehner, Christian, un four à pain déjà refait a coulé. Fr. 45.-
008. Veuve, Zen-Klusen, refaire 1 mur à l'écurie et le toit. Fr. 22.-
009. Panmater, Jean [...], et consort, reboucher 3 fentes à la [...]. Fr. 70.-
010. Joden, valentin, réparer le couvert d'un écurie. Fr. 30.-
011. Panmater, les héritiers, réparer 2 murs dans la grange déjà caduc avant. Fr. 50.-
012. Panmater, Christian, maison, faire 6 toises de mur. Fr. 50.-
013. Perrin, Christian, refaire à neuf 5 toises de mur, 2 cheminées et le couvert de grange. Fr. 80.-
014. Maison communal déjà réparée coûte Fr. 100.-
015. Feriker, Joseph et consort, réparer 7 toises de mur 1 cheminée et toit. Fr. 86.-
016. Imstepf, et consort, refaire 1 angle à la cave et couvert déjà réparé coûte en tout Fr. 28.-
017. Valentin, [...], réparer de réelles crevasse. Fr.10.-
019. Faffen, Laurent et consort, réparer 2 brèches de mur, l'une a l'écurie. Fr.30.-
019. idem et consort, maison réparer latrine et cheminée. Fr. 20.-
020. Maison du malguiller, réparations faites coûte F. 35.-
021. Zouvera, Jean [...], maison 1 brèche de mur, 1 plancher et couvert déjà caduc. Fr. 40.-
022. Jean, Joseph Moux, et consort 1 brèche de mur et toit. Fr. 15.-
023. Pierre J. [...] Pfammatter, cave, 2 toises de mur et fente. Fr. 13.-
024. Oublet, Président et Juge, 2 cheminées. Fr. 20.-
025. Bourgener, Veuve, 1 cheminée. Fr. 10.-
026. Imhof, Pierre [...], 1 cheminée sur le toit. Fr. 10.-
027. Imstefe, refaire une cheminée et tout la cuisine écroulée. Fr. 150.-
028. Faffen Jean, maison réparer le fourneau et brèche. Fr. 30.-
029. Faffen, François et Pierre réparer mur et cheminée. Fr. 24.-
030. Jordan, Jos., maison refaire une mur , réparer le toit. Fr. 25.-
031. Schnider, Christian et consorts, 2 cheminées sur le toit. Fr. 20.-
032. Mr. Le juge et consorts, pour relever un raccard à la inférieure. Fr. 100.-
033. La chapelle à Valerfluon, elle est déjà réparée à neuf, d'après les comtes produit par M. le président à coûte Fr. 100.-
035. Ferriker, et consort, maison réparer une cheminée. Fr. 15.-
035. Oublet, frères, réparer un mur su à la cave. Fr. 25.-
036. Hutter, François, réparer 1 angle à la grange. Fr.10.-
037. Forrer, Gaspard, maison refaire 1 cheminée et couvert. Fr. 24.-
038. Les héritiers de Joseph Ferricher, refaire 6 toises de mur su à la grange. Fr. 20.-
039. Pfamater, Christian et consorts, réparer 1 petite brèche. Fr. 10.-
040. Jean [...] Stoupf, réparer dans une cave et salle 2 brèches. Fr. 10.-
041. Oublet, Pierre et consort, pour refaire un vieux mur de grange. Fr. 15.-

042. Jean Komer, maison refaire 3 toises de mur et couvert. Fr. 30.-
043. Pierre [...] Ferriker, réparer le couvert. Fr. 20.-

CH-3904 Naters

Population figure: 1850:763
Population figure 2000: 7515
First damage assessment
Total loss: CHF 11'837.-

001. Eyer, Chrétien et consort, réparer le 3/4 du couvert de la maison. Fr. 20.-
002. Gasser, Catherine, réparer le toit , 2 murs et cheminée, elle est inhabitable. Fr. 162.-
003. Jossen, Maurice, fils du chanteur, réparer le toit, les cheminées et la cuisine entière. Fr. 290.-
004. Michlig, Thérèse, réparer le couvert , les cheminées et remonter 2 murs de façade et plusieurs terrasses, inhabitable. Fr. 975.-
005. Nellen, Clementz, réparer le toit, remonter en partie un mur, de façade et réparer la cheminée. Fr. 50.-
006. Walder, Thomas, réparer le toit et quelques brèches de mur et remonter la cheminée. Fr. 108.-
007. Amhardt, Antoine, réparer le toit et une cheminée. Fr. 16.-
008. Eyer, Michel, réparer un mur de maison et le toit. Fr. 30.-
009. Eyer, Jean dit Roubé, le toit et un mur dégrade. Fr. 10.-
010. Eggel, Joseph, veuve et Wyssen, François veuve, les deux tiers du toit, remonter deux cheminées et deux cuisine en entière. Fr. 400.-
011. Gasser, Antoine, réparer le couvert en partie, 2 toises de murs de façade et une cheminée, inhabitable. Fr. 162.-
012. Salzmann, Jean, une cheminée, réparer une brèche de mur et deux toit. Fr. 100.-
013. Tscheinen, Jean, 2 brèches de mure à la maison. Fr. 5.-
014. Walder, Jean, remonter l'angle de la maison, remonter une cheminée et réparer le toit. Fr. 150.-
015. Eyer, Maurice, refaire un mur de la maison et réparer deux cheminées et le toit. Déclarée dangereuse. Fr. 720.-
016. Stockalper, Maurice, les héritiers, refaire un mur de la maison et réparer une cheminée et le toit et déclaré dangereuse. Fr. 500.-
017. Michlig, Antoine, pour réparer une cheminée. Fr. 10.-
018. Scholpeter, Léopold, réparer le toit de la maison et un mur d'une écurie. Fr. 25.-
019. Walden, Ludwig et Itig, Léopold, pour refaire la voûte des escaliers de la maison, reboucher des crevasses des murs, réparer le couvert et refaire 3 cheminées. Fr. 300.-
020. Maison de la cure, démolir la partie la plus élevée en entier jusqu'au fondement sans retard. Fr. 2600.-
021. Schmidt, Valentin, refaire le toit et une cheminée. Fr. 30.-
022. De Chantonay, Antoine, réparer la crevasse de la maison et dans la grange 2 brèche. Fr. 12.-
023. Albert, Antoine, une crevasse, le escaliers le tout Fr. 80.-
024. Eyer, Jean Joseph, deux toises de mur, l'escalier refaire à neuf. Fr. 60.-
025. Zenklusen, réparer trois façades dans la maison et le couvert. Fr. 80.-
026. Karlen, Maurice, refaire une cheminée et huit toises de mûrs. Fr. 80.-
027. Salzmann, Felix, refaire une toise de mur, une cheminée, dix toises à la grange, réparer le couvert. Fr. 170.-
028. Karlen, Aloys, deux façades dans la maison. Fr. 40.-
029. Josser Antoine, réparer la façade et couvert. Fr. 50.-
030. Wys, Jean, réparer la façade et le couvert de la maison. Fr. 50.-
031. Vylly, Joseph, réparer le couvert , une cheminée et crevasses dans trois maisons. Fr. 90.-
032. Pfamatter, Gaspard, rep. Deux toits une cheminée et crevasses. Fr. 50.-
033. Salzmann, Maurice, rep. 1 mur et 1 cheminée. Fr. 20.-
034. Ruppen, Michel, maison ref. une cheminée, mur et toit de la grange. Fr. 40.-
035. Ruppen, Emmanuelle, rep. Un mur et toit. Fr. 25.-
036. Kempen, Franç. Maison ref. une cheminée, un couvert un petit angle de [...]. Fr. 35.-
037. Salzmann, Maurice, fils de Pierre Jean, maison, inhabitable, doit être démolie. Fr. 800.-
038. Gertschen, vice Juge, rep. Une cheminée un tiers de grange, ref. deux toises de murs. Fr. 71.-
039. Schmit, Jean et Zen-Klusen, Maurice et consort, ref. une cheminée et une brèche de mur. Fr. 50.-
040. Gasser, Jos., maison et grange, rep. Le couvert et crevasses. Fr. 50.-
041. Viss, Jean, rep. Le toit et une brèche de mur. Fr. 40.-
042. Jensch, Antoine, maison, rep. Le fourneau et manteau de la cheminée et couvert. Fr. 60.-
043. Huber, Cécile, maison, repa. Un petit le couvert et mur. Fr. 140.-

044. Burcher, Jos. Rep. Un petit mur et couvert. Fr. 15.-
045. Gaspard, veuve Pfamatter, rep. Le couvert de la maison et mur d'une autre maison. Fr. 40.-
046. Nellen, Jean, rep. La façade du couchant, plusieurs brèches dans l'intérieur, une terrasse, une cheminée et toit. Fr. 530.-
047. Imhoff, Antoine, rep. La [...], 1cheminée et couvert. Fr. 25.-
048. Michlig, Maurice, veuve, rep. Un toit de la maison. Fr. 25.-
049. Bertold, Felix, rep. 2 cheminées, 1 couvert, 5 toises de mur. Fr. 85.-
050. Michlig, Maurice, rep. Un toit et la cheminée sur le toit. Fr. 30.-
051. Michlig, Antoine, rep. Un toit. Fr. 25.-
052. Salzmann, Ignace, ref. une cheminée, rep. Le couvert de la maison, une brèche de mur dans la sale. Fr. 50.-
053. Heutzenberg, Cathérine, maison, ref. un toit écroulé. Fr. 100.-
054. Michlig, Pierre, rep. Un mur à latrine. Fr. 20.-
055. Zumberg, Gaspard, maison, rep. 2 couverts. Fr. 50.-
056. Les enfants de Pierre Valden et veuve Egel, Maurice, remonter un angle de la maison. Fr. 100.-
057. Salzman, fils, Mathieu, Eduarde, Burcher, Ignace, Pfamatter, maison remonter 2 façades et couvert. Fr. 705.-
058. Faller, veuve Bernard, forge, 2 cheminée a la maison et crevasses, remettre trois poutres. Fr. 450.-
059. Jossen, Antoine des Bains, rep. Un mur et toit Fr. 30.-
060. Valder, Michel, veuve, ref. une cheminée. Fr. 25.-
061. Jossen, Maurice, le chanteur, une vielle maison déjà déclarée inhabitable depuis plusieurs années par l'administrat. Fr. 90.-
062. Schmit Antoine, ref. la façade du levant, environ 3 toises de mur et toit. Fr. 40.-
063. Jossen, Andrien, maison, rep. Le couvert et crevasses. Fr. 70.-
064. La veuve de Laurent Volken, maison rep. Le couvert et fentes. Fr. 80.-
065. Karlen, Babtiste, rep. Les fentes à la latrine. Fr. 5.-
066. Valden, Maurice veuve, ref. le toit de la maison. Fr. 50.-
068. Vyss, Antoine, deux brèche de mur. Fr. 9.-
067. Vyss, Pierre Jos., rep. Une brèche au toit. Fr. 12.-
069. Karlen, Crésence, reboucher les fentes. Fr. 10.-
070. Nellen, Maurice, maison, rep. Le couvert, une cheminée et fentes. Fr. 25.-
071. La maison du Vicaire, rep. Le mur du jardin et une cheminée sur le toit. Fr. 45.-
072. L'église, rep. Les fentes. Fr. 450.-
073. Gasser, Jean, fils de Gaspard, rep le toit et 1 cheminée. Fr. 25.-
074. Salzman, Laurent, rep. 1 couvert et 1 cheminée. Fr. 15.-
075. Michlig, Jos. Rep. 1 couvert. Fr. 15.-
076. Ambord, Andres, rep. Un couvert. Fr. 10.-
077. Kummer, Chrétien, une cheminée, un couvert, et 1 chevron cassé. Fr. 40.-
078. Schwery, Maurice, rep. Le couvert de a maison et une angle à la grange. Fr. 35.-
079. Les enfants Holzer, Valentin, ref. une cheminée, rep. Le couvert. Fr. 40.-
080. Veginer, Gaspard, rep. Un angle à la grange. Fr. 15.-
081. Schmid, Ignace Bab., le toit et cheminée. Fr. 35.-
082. Eister enfants de Jean u. [...] , [...] d' écurie. Fr. 8.-
083. Walder, Pierre, enfants, rep. [...] et cheminée. Fr. 12.-
084. Eggel, Maurice, veuve, Fr. 10.-
085. Elsig, veuve, dite Eggen, réparer une brèche dans le mur de la maison. Fr. 20.-
086. Walden, veuve de Gaspard, rep. Une brèche de mur et le toit. Fr. 40.-
087. Marguillue. Fr. 20.-

CH-3942 Niedergesteln
Population figure: 1850: 176
Population figure 2000: 573
Revised damage assessment
Total loss: CHF 1'781.-

001. Seiler, Chrétien et consorts., maison pour refaire50 toises de mur, une cheminée sur le toit et couvert. Fr. 390.-
002. Seiler, Martin et Kalbermatten, refaire 50 toises de mur et un couvert. Fr. 350.-
003. Kalbermatten, Pierre, une petite grange à réparer le mur et toit. Fr. 50.-
005. idem (Kalbermatten, Pierre) et Seiler, Martin, écurie une angle de mur à refaire. Fr. 15.-
006. Seiler, Martin et Imboden refaire un petit mur à la grange. Fr. 15.-
007. Breggi et cons., refaire le petit mur à l'écurie. Fr. 18.-
008. Kalbermatten , Pierre, refaire 8 toises de mur à la grange. Fr. 40.-
009. Seiler, Chrétien, et Pierre, grange écroulé, 20 toises de mur et un couvert. Fr. 280.-
010. Breggi, Jean, maison et grange refaire un mur et couvert. Fr. 45.-
011. Ignace Steiner, maison, refaire une brèche de mur, refaire le toit. Fr. 15.-
012. Chapelle de Lidot, réparer le couvert. Fr. 15.-
013. Breggi, Jean Joseph, réparer une petit grange, un mur. Fr. 25.-
014. , Madeleine, une brèche de mur à la salle. Fr. 15.-
015. Kalbermatten, Pierre, une cheminée sur le toit. Fr. 10.-
017. Seiler, Martin, 2 fentes dans un pilier de grange. Fr. 15.-
018. Kalbermatten, Christian, reboucher une fente à l'écurie. Fr. 3.-
019. Breggi, Jean Joseph, une cheminée sur le toit à réfaire. Fr. 10.-
020. [...]ried, Christian, refaire une partie de la cheminée sur le toit. Fr. 5.-
021 Forny, Christian, réparer un cheminée sur le toit. Fr. 5.-
022. Balgart,Christine, reboucher deux fentes à la maison. Fr. 5.-

CH-3942 Raron
Population figure: 1850:411
Population figure 2000: 1672
Revised damage assessment
Total loss: CHF 7'394.-

001. La chapelle dans le village, réparer les fentes, coûtes Fr. 100.-
002. Weinhardt Marie Josephine, refaire en parti le toit, une cheminée et plancher. Fr. 70.-
003. Theler, Antoine, relever un raquard, 11 pièces neuves. Fr. 150.-
004. Amacker, Jean, refaire 2 toises de mur à n. , latrine, une cheminée et réparer le toit. Fr. 25.-
005. La maison de la commune, cheminée et toit. Fr. 25.-
006. Eberhardt, Jean Joseph, Ebéniste, reboucher les fentes très légères. Fr. 15.-
007. Gatlen, Capitaine, refaire 25 toises de façade du midi, une cheminée, et couvert, 2 clefs. Fr. 355.-
008. Roten Julian de bourten, reboucher les fentes et toit, cheminée. Fr. 250.-
009. Roten, Hildebrand, reboucher les fentes et cheminée, grand couvert et 2 plafonds. Fr. 180.-
010. Imboden, Jean lardonier, deux fentes à réparer. Fr. 12.-
011. Jeiziner, Jean, réparer le couvert. Fr. 15.-
012. Polzgeber, Jos. Boulanger, 2 couverts réparer. Fr. 40.-
013. Wolker, Pierre Jos. Et consorts, réparer 2 couvert, 1 chem., mur. Fr. 50.-
014. Jeiziner, Jos. /Roten, Nicolas, 10 toises de mur et 1 couvert écroulé. Fr. 200.-
015. Breggy, Joseph, un couvert à réparer. Fr. 20.-
016. Schrater, Jean Christian, une cheminée. Fr. 30.-
017. Imboden, Jean. Fr. 70.-
018. La maison du Recteur, réparer le couvert. Fr. 20.-
019. Gatlen, Capitaine, à réparer 2 journées sur le toit, reboucher deux fentes. Fr. 25.-
020. Gatlen, Antoine, remonter à neuf le toit. Fr. 200.-
021. Imboden, Jos. Et consort, réparer un mur, une cheminée, toit. Fr. 45.-
022. Rufiner, Antoine, réparer le couvert, 3 chemi. Fr. 100.-

024. Oberhauser, Jos. Réparer le couvert. Fr. 25.-
025. Roth, Ignace. Fr. 25.-
026. Seiler Martin et Pierre, refaire le toit. Fr.34.-
027. Gatlen, Jean Joseph, réparer le toit et murs. Fr. 40.-
028. Roten, Nicolas/Amaker, Jean/ Oberhauser Jean et consorts, 1 couvert 2 fentes à la grange. Fr. 80.-
029. Zurwerra, Valentin, réparer le couvert à la grange. Fr. 20.-
030. Fontaine, Antoine, réparer le couvert à neuf, fentes à reboucher et 2 cheminées. Fr. 80.-
031. Fontaine, Julie, à réparer le toit, 2 cheminées, fentes et plafond. Fr. 125.-
032. Gatlen, Romain, à réparer le couvert. Fr. 15.-
033. Eckhardt, Christian, refaire un toit et une cheminée. Fr. 25.-
034. Imboden, Joseph Antoine, veuf, un petit mure et toit. Fr. 20.-
035. Theler, Antoine, réparer le toit. Fr. 15.-
036. Theler, Jean, à réparer le toit. Fr. 20.-
037. Imboden, Jos. Veuf, deux. Fr. 20.-
038. Breggy, Marie veuve de Studer à réparer. Fr. 20.-
039. Imboden, Christian. Fr. 20.-
040. le couv. Du Curé. Fr. 10.-
041. L' église, de petites fentes à reboucher. Fr. 40.-
042. La Chapelle de St. Anne. Fr. 20.-
043. Belwald, Alois, refaire un mur, le fourneau et le toit. Fr. 55.-
044. Schmidt, Ignace, refaire 8 toises de couvert une chemi. Et un plancher. Fr. 125.-

Raron Goesch
001. Seiler, Christian, trois toises de mur, le toit et réparer les fentes et toit d'une autre maison. Fr. 70.-

Raron Goler
001. Gatlen Capitaine, fait 4 cheminées, 6 toises de mur, compris le matériaux à reboucher la façade et les fentes. Fr. 490.-

Raron Kummen
001. La chapelle, réparer le toit et la voûte. Fr. 200.-
002. Breggy, Jean Jos., une mauvaise grange le toit écroulée et à la maison réparer le toit. Fr. 60.-
003. Imboden, Antoine, une cheminée, crevasse et le toit. Fr. 20.-
004. Stoffel, Jean Jos., à réparer un vieux mur et le toit. Fr. 25.-
005. Breggy, Jean Christian, réparer le toit et la cheminée. Fr. 25.-
006. Ruffiner Jos., une cheminée et le toit. Fr. 35.-
007. Breggy, Jean Christian, le toit à une grange. Fr. 10.-
008. , Jean Jos., tailleur., le toit à la maison et une crevasse. Fr. 30.-
009. Trogger, Barthélmy, un toit et le fourneau à réparer. Fr. 35.-
010. Eberhardt, Jos., une cheminée sur le toit. Fr. 10.-
012 Stoffel, Jean Jos. Réparer le toit et une cheminée. Fr. 40.-
013. Oberhauser, Jean Jos. Maison à réparer, crevasses et toit. Fr. 20.-

Raron St. Germain
001. L' église, le clocher, la voûte. Fr. 2000.-
002. La maison du Vicaire, refaire deux façades, terrasse, toit et fentes. Fr. 500.-
003. Eberhardt, Pierre, 7 toises de mur , fentes et toit. Fr. 100.-
004. Jergen, François, à réparer un petit toit. Fr. 8.-
005. Jergen, François, une cheminée est à réparer. Fr. 30.-
006. Heinen, Pierre, à réparer le toit, refaire 1 chem. Et 1 petit mur. Fr. 35.-
007. Feller, Cathérine, 2 façades mur, toit et 1 chem. 1 grenier. Fr.120.-
008. Leiggener, Christian veuf, 1 toit et 1 chem. Sur le toit. Fr. 68.-
009. Heinen, Roman, 1 mure, 2 chem., toit, brèche, 1 grenier. Fr. 165.-
010. Vogel, Joseph, déjà réparé coûté Fr. 35.-
011. Belvald, Aloise, réparer un fourneau, le toit et plusieurs brèches de mur. Fr. 80.-
011. Theler, Jean /Todenhandt, réparations faites et ä faire coûté 20.-
012. Leiggener, Christian, réparer un toit et deux brèches Fr. 25.-
013. Pergen, François, à réparer un grand
014. Rey, Nicolas, tout le bâtiment était déjà en ruine. Fr. 70.-
015. Salzgeber, Antoine, une cheminée et un toit et four. Fr. 20.-

016. Mark, Sebastian. Fr.10.-
017. Mark, Sébastien, réparer un toit et une fente. Fr. 12.-
018. La maison de la commune, réparer le toit et un mur. Fr. 30.-
019. Theler, Jos., réparer le toit et couvert. Fr. 20.-
020. Theler, Christian, une brèche de mur et le toit. Fr. 20.-
021. Jeiziner, Jean(Tambour), le toit d'un grenier. Fr. 8.-
022. Eberhardt, Nicolas, une brèche de mur sec et toit. Fr. 14.-
023. Theler, Christian, refaire une mur et le toit. Fr. 20.-
024 Stadler, Jos. Veuf, 1 cheminée, à réparer le toit, et 1 petit mur. Fr. 21.-
025. Nellen, Cathérine, réparer un mur et le toit. Fr. 35.-
026. Jeiziner, Jean, et Stadler , Jos. Couvert. Fr. 10.-
027. Heinen, Jean enseigne, en mauvais état écroulé. Fr. 80.-
028. Nellen, Marie, refaire 1 mur 3/4 toises, et toit. Fr. 10.-
029. Nellen, Christian et Eugène un petit toit. Fr. 15.-
030. Breggy, Jean Jos., à réparer une brèche et toit. Fr. 20.-
031. Jeiziner, Jean Tambour, 1 chem., 1 toit et [...] latrine. Fr. 37.-
032. Breggy, Jean Jos. Tailler, refaire un mur à la grange et toit. Fr. 5.-
033. Brunner, Jean Jos., un toit déjà fait coûté 8 Fr. , réparer une fente Fr. 33.-
034. Heinen, Pierre, déjà réparé coûté Fr. 18.-
035. Zengafinen, Jean Jos. Déjà réparé Fr. 25.-
036. Eberhardt, Jos. Déjà réparé une partie en cave, à réparer une cheminée et une crevasse. Fr. 25.-
037. Grassen, Christian, une cheminée, un mur à latrine et une maison inhabitable depuis 8 ans, un mur écroulé. Fr. 80.-
038. Mark, François Jos. Réparer le toit et crevasses, un mur. Fr. 60.-
039. Heinen, Jean, le toit. Fr. 10.-

Raron Turtig
001. Ellet, Jean, 60 toises de toit et crevasses. Fr. 250.-
002. Breggy, Jean Jos., une cheminée, plusieurs plafonds et 18 toises de mur. Fr. 324.-
003. Roten, Maurice, cloutier, réparer la forge une toise de mur et la cheminée. Fr. 25.-
004. Ellet, Jean, une brèche de mur à l'écurie et fentes. Fr. 40.-
005. Lauber, Jaques, une toise de mur à la grange. Fr. 6.- Pr. Une maison Fr. 40.-
006. Pfammatter, Pierre, une petit brèche de mur. Fr. 10.-
008. Lauber Jaques, à réparer une cheminée, crevasses et un grange Fr. 35.-. Toit et 1 maisonnette de lessive Fr. 15.-
009. Trogger, Barthélemy, à réparer le plancher d'une cuisine. Fr. 40.-
010. Eggel, Joseph, refaire 3 toises de mur et le toit d'une grange. Fr. 50.-
011. La chapelle, démolir jusqu'à terre refaire à neuf. Fr. 1500.-
012. Inderkummen, Gaspard. Fr. 24.-
013. Beuge, Alois, les fentes et toit de la maison Fr. 20.-, une cheminé, 1 mur, 1 petit toit à la grange. Fr. 50.-
015. Inderkummen, Jean Jos. Le toit de la maison déjà réparé. Fr. 20.-
016. Widmer, Joachim, réparé un toit et fentes coûté Fr. 12.-
017. Zurbriggen, Jean Jos. Réparer un mur, 1 cheminé, fentes et tout couvert Fr. 135.-
018. Veber, Anne Marie, refaire 26 toises de mur d'une grange écroulé. 350.-
019. Zurbriggen, Jean Jos., refaire 1 toise de mur sec. Fr. 10.-
020. Zurbriggen, Antoine et frères, maison bâcher forgeron.
021. Zurbriggen, Jean, les édificiérs de ces trois fr. n'ont pas pu être taxé cause d'une éruption qu'est survenu le 13 au soir.
022. Zurbriggen, Jean, le toit d'une grange à réparer. Fr. 10.-
023. Seiler, Christian, tout les murs d'une grange refaire à neuf. Fr. 220.-
024. Allet, Jean et consort, un raquard à recouvrir. Fr. 15.-
025. Furrer, Joseph. Fr. 15.-
026. Maienbacher, laissé l'ancienne taxe.
027. Zurbriggen, [...] Jos, Pierre Joseph Antonie, laissé l'ancienne taxe, ou qu'a cause de l'inondation an n'a pas pu [...].

CH-3924 St. Niklaus
Population figure: 1850:551
Population figure 2000: 2304
First damage assessment
Total loss: CHF 36'130.-

001. Tantignoni, Jean, maison. Partie du nord en ruine 56 toises, au midi 3 toises, le toit à réparer. Fr. 2000.-
002. Vicariat, maison, remonter 8 toises de mur, cheminée, réparer le toit. Fr. 160.-
003. Vicariat, grange (20.-) et grenier (200.-), grange réparer le toit. Grenier tout en ruine, le mur en bas, le bois déchiré. Fr. 220.-
004. Commune, église, Refaire la voûte (6000.-), orgue (2000.-), 7 cires (400.-), 8 toises (240.-), 80 bancs (800.-), 2 clefs (400.-), plancher (400.-), reboucher les crevasses (1760.-). Fr. 12000.-
005. Commune, clocher, 18 arcs, placer 8 clefs, toit et raccard à réparer, à refaire 40 toises de mur du cimetière (400.-). Fr. 2200.-
006. Villa Gustave, maison, refaire 26 toises et cheminée, réparer le toit. Fr. 450.-
007.Imboden Jos, Bodmer, Grange et grenier, en ruine. Fr. 200.-
008. Cure, maison, remonter le toit (50.-), plafond (30.-), 2cheminées et manteau (50.-), galandages (10.-), refaire 10 toises (150.-), 2 clefs (100.-), reboucher la boiserie et lézardes (30.-). Fr. 410.-
008. Cure, 2 grenier/ 2 grange, réparer les 4 toits. Fr. 100.-
009. Perren, Joseph / Jean Joseph Schnidrig, maison, refaire deux cheminées et réparer le toit. Fr. 80.-
010. Kalbermatten, Joseph, grenier, refaire 2 ares de porter et refaire le toit. Fr. 40.-
011. Imboden, François, maison, refaire un coin de mur 8 toises, cheminée, toit Fr. 160.-
012. Summermatter, Jos., grenier, réparer le toit. Fr. 15.-
013. Biner, Ignace, grenier, réparer le toit. Fr. 15.-
014. Imboden, Pierre, maison, refaire un coin de mur et réparer le toit. Fr. 30.-
015. Imboden, Pierre, grenier, réparer le toit. Fr. 10.-
016. Summermatter, Pierre Joseph, grenier, réparer le toit. Fr. 10.-
017. Kalbermatten, Joseph, maison, refaire le façade du nord et couchant 20 toises (300.-), une clef (50.-), 2 plafonds (50.-), 2 planchers (40.-), remonter le toit (60.-). Fr. 600.-
018. Kalbermatten, Joseph, grenier, refaire 6 toises de murs et réparer le toit. Fr. 80.-
019. Truffer, Jos. Et consorts, maison, refaire le [...], latrine, 18 toises, l' escalier, 2 cheminées, 2 plancher, réparer le toit et lézardes. Fr. 500.-
020. Bartoliotti, Jos, maison, refaite un coin de mur, remettre une parti. Fr. 30.-
021. Brantschen, Joseph, grenier, réparer le toit. Fr. 15.-
022. Gruber, Joseph, grenier, refaire 6 toises de mur [...]. Fr. 70.-
023. Kalbermatten, Joseph, cave, refaire 3 toises de mur. Fr. 30.-
024. Kalbermatten, Joseph, grenier, réparer le toit. Fr. 15.-
025. Fuchs, Pierre Joseph, maison, placer une clef, 1 toise de mur, réparer le toit et lézardes. Fr. 80.-
026. Imboden, Pierre François et Joseph Perren, grange, réparer le toit. Fr. 40.-
027. Hoirie Imboden, Lucas jos. Gr. Ecurie, réparer le toit. Fr. 30.-
028. Commune, maison de com., refaire 5 toises de mur, 2 cheminées, et réparer le toit. Fr. 180.-
029. Taugwalder, Pierre / Alois Imboden, maison, refaire 10 toises de mur, 2 cheminées, et réparer le toit. Fr. 200.-
030. Sarbach, Pierre Joseph, Hôtel du Soleil, Fr. 8000.-, Rovina , Devendente rez de chaussée Fr. 4000.-. démolir la maison et refaire à neuf.
031. Imboden, Lucas /Burgener, Pierre Joseph / Knobel frère / Imboden François, maison, refaire 45 toises de mur, 2 cheminées, 4 planchers, remonter tout le toit. Fr. 1000.-
032. Taugwalder, grenier, replacer le grenier et remonter le toit. Fr. 60.-
033. Taugwalder , maison , refaire 20 toises de mur, 2 cheminées, tout le toit, 8 planchers. Fr. 1400.-
034. Bollinger, Jean /Lochmatter, Crésence /Truffer, Augustin, maison, refaire la latrine 3 toises, 2 cheminées, réparer le toit, redresser a parti du fond au nord. Fr. 140.-
035. Lochmatter, Crésence, Gr. Ecurie, réparer le toit. Fr. 15.-
036. Brügger, Joseph, moulin, refaire 14 toises de mur , manteau de cheminée, réparer le toit. Fr. 250.-
037. Brügger, Joseph/ Kalbermatten, Joseph, grenier, refaire 3 toises de mur de soubassement et réparer le toit. Fr. 60.-
038. Burgener, Pierre Joseph, forge, refaire 4 toises de mur et réparer le toit. Fr. 80.-
039. Genton, George, grenier, réparer le toit. Fr. 20.-
040 Genton, George et consort, grenier, refaire 2 toises de mur et réparer le toit Fr. 30.-

041. Genton, George et consort, grenier, refaire le toit Fr. 20.-
042. Genton, George et consort, maison, refaire 15 toises de mur (225.-), cheminée (50.-), réparer le toit (25.-). Fr. 300.-
043. Genton, George et consort, gr. Ecurie, réparer le toit. Fr. 10.-
044. Lochmatter, [...], grenier, réparer le toit. Fr. 20.-
045. Kalbermatten, Pierre, maison, refaire 8 toises soubassement, cheminée, refaire le toit. Fr. 160.-
046. Summermatter, P./Imboden, Créseine/ Pierrig, Joseph, maison, démolir pas [...] de [...] publique et [...]. Fr. 10'000.
046. Pierrig, Joseph, forge, réparer le toit et refaire la cheminée. Fr. 40.-
047. Summermatter, Pierre, grange, réparer le toit et la galerie en bois. Fr. 40.-
048. Imboden, Crésence, maison, refaire 10 toises, une cheminée, 2 planchers, réparer le toit. Fr. 240.-
049. Kalbermatten, Pierre, grenier, réparer le grenier et réparer le toit. Fr. 50.-
050. Imboden, Pierre François/ Schnidrig, Joseph, grenier, réparer le grenier et le toit. Fr. 50.-
051. Summermatter, Joseph, Grange, Grenier, refaire 3 toises de mur à chacun et réparer 2 toits. Fr. 80.-
052. Binner, Marie Jos. Et consort, grange, refaire 2 toises de mur et réparer le toit. Fr. 30.-
053. Binner, Pierre/Graven, Martin/Imboden, Pierre, maison, refaire 5 toises de mur (100.-), remonter le toit (200.-), 4 cheminées (100.-), placer [...] clefs (100.-), 3 plancher (60.-), 2 galandages (40.-), manteau de cheminée(25.-), 2 ares de fenêtres (40.-, reboucher les lézardes. Fr. 680.-
054. Binner, Pierre/Graven, Martin, forge, réparer le four fonder. Fr. 20.-
055. Binner, Pierre, 2 granges, réparer le toit , reboucher les lézardes. Fr. 40.-
056. Summermatter, Joseph, Biffiger, Pierre Joseph, maison, refaire 20 toises de mur (300.-), 3 plancher (60.-), une cheminée (40.-), [...] (100.-) réparer le toit (20.-), reboucher les lézardes,
060. Tantignoni, Antoine, Boutique, refaire 1 toise de mur. Fr. 20.-
059. Veuve Knubel, grenier, réparer le toit. Fr.30.-
058. Brantschen, Pierre Joseph, maison, refaire 6 toises de soubassement [...], chemine, réparer le toit. Fr. 200.-
057. Summermatter, Joseph, Biffiger, Pierre Joseph et Biffiger, Marie, grenier, réparer le toit. Fr. 20.-
059a. Brantschen, Pierre Joseph, grenier, réparer le toit et lézardes. Fr. 20.-
061. Imboden, [...] Lucas, maison, refaire le toit. Fr. 30.-
062. Summermatter, Jos. Greg., maison, réparer le toit. Fr. 20.-
063. Knobel, veuve/ Brügger, Ignace, maison, refaire 12 toises de mur, 1 plancher, 1 escalier, réparer le toit. Fr. 240.-
064. Brügger, Ignace, grenier, réparer le toit, démolir de suite la latrine. Fr. 20.-
065. Brügger, Ignace/Imboden, Joseph/ Knobel, veuve, grange, réparer le toit. Fr. 20.-
066. Biner, Pierre/ Imboden, Crésence, grange, réparer le toit. Fr. 20.-
067. Imboden, Joseph et consorts, grange, réparer le toit. Fr. 20.-
068. Brantschen, Joseph, grenier, réparer le toit, et refaire 3 toises de mur. Fr. 60.-
069. Truffer, Marie Joseph/[...], grenier, réparer le toit. Fr. 20.-
070. Rectorat d. [...], grenier, réparer le toit et refaire 1 toise de mur, Fr. 30.-
071. Brantschen, Pierre Joseph, grenier, réparer le toit. Fr. 20.-
072. Rectorat S. Nicola, maison, refaire 4 toises de mur, cheminée, escalier, toit et lézardes à réparer. Fr. 180.-
073. Brantschen, Joseph/ Imboden, Joseph et consorts, grenier, refaire 6 toises de mur, remonter le toit et replacer le grenier. Fr. 160.-
074. [...], Etienne, forge, la forge en ruine et parte d' outils. Fr. 100.-
075. Imboden, Joseph, maison et forge, refaire 15 toises, l'escalier, cheminée, réparer le toit et remonter à neuf celui de la forge. Fr. 300.-
076. Brantschen, Joseph, maison, refaire 6 toises , cheminées, et manteau, 1/2 plancher, 4 terrasses, escaliers, réparer le toit et lézardes. Fr. 280.-
077. Summermatter, Cathr., maison, refaire 6 toises de mur, 1/2 plancher , réparer toit et lézardes. Fr. 130.-
078. Fuchs, Joseph/ Imboden, [...], maison, refaire cheminée avec manteau, [...] porte, réparer le toit. Fr. 100.-
079. Fuchs, Joseph/Imboden, fr. Bodmer, grenier, réparer le toit. Fr. 25.-
081. Pollinger, François / Zurbriggen, Pierre Joseph, grenier, replacer le grenier et réparer le toit. Fr. 60.-
082. Pollinger, François / Truffer Augustin / Imboden, Jos, / Biner, Ignace, maison, remonter 3 cheminées (60.-), remonter la moitié du toit (80.-), 4 plancher (80.-), galandage (10.-). Fr. 250.-
083. Biffiger, Jean Pierre du [...], maison, refaire 4 toises de mur, cheminée, le toit. Fr. 100.-
084. Binner, Ignace, maison et grenier, refaire la latrine 6 toises, réparer le toit et l'escalier. Fr. 80.-

CH-3922 Stalden
Population figure: 1850:291
Population figure 2000: 1149
Revised damage assessment
Total loss: CHF 12'086.-

001. Kalbermatten, Pierre et Venetz, Anne Marie et Venetz, Joseph Ignace, maison écroulé remonter à neuf. Fr. 3600.-
002. Maison du curé réparations faits et à faire. Fr. 310.-
003. église, pr. Rép. Faites et à faire. Fr. 3250.-
004. Maison du marguillier rép. Faites coûté Fr. 24.-
005. Chapelle, 1 cléf rep. Le couvert rép. Les fentes. Fr. 185.-
006. Berthold, Vendoline, maison. Rep. 1 couv. Et chemin. Fr. 45.-
007. Maison du Vicaire déjà rép. Coûté Fr. 60.-
008. André, Pierre et Gatlen, Franç. Rép. 1 mur de 35 toises, 1 chem. Fr. 500.-
009. Antomaten, Pierre, ref. 1 chem. Mitoyen. Et la latrine. Fr. 100.-
010. Brigler, Pierre Jos. Ref. les crevasses dans 1 salle., 2 chem., 4 toises de galandages, 1 grange le toit à ref. 1 mitoyen, 4 toises de toit. Fr. 108.-
011. Clementz, François Joseph, 1 toit à rép. Fr. 18.-
012. Venetz, Pierre Joseph, 3 toises de mur sec, 1 plancher au grenier. Fr. 35.-
012a. Chon, Chrétien , Haber, Marie, mais. 1 chem., 1 toise mur, et toit. Fr. 25.-
013. Clementz, Franç., rép. Le manteau et chem. Fr. 15.-
014. Eggs, Vice- Chatelain, ref. 1 mur, 3 chem. Et [...], 5 toises de mur. Fr. 140.-
015. Berthold, Jos. Marie, 1 chem., et couvert. Fr. 25.-
016. Villitiche, Franç., ref. 50 toises de mur à neuf, 3 chem. Et galandage, terrasse couvert et fentes. Fr. 500.-
017. Forge Communale. Fr. 40.-
018. Imsent, François, mais. En ruine, les bois sont bons, 40 toises de mur à faire. Fr. 300.-
019. Reitz, Franc. 1 chem., et couvert et fentes. Fr. 23.-
020. Vomsattel, Pierre Jos. , 6 tois. De mur, un manteau de chem., mur sec. Fr. 18.-
021Kalbermatten, fille, mais. Et grange ref. 6 toises de mur , 2 chem. Fr. 68.-
022. Venetz et Eggs, ref. 1 couvert de grenier. Fr. 12.-
023. Berthold, Joseph Marie/ Clementz, François, ref. le soubassement en ruine et le couvert. Fr. 125.-
024. Venetz, Jos. Marie le bâtim. La mais. En ruine, 25 toises de mur, remonter les bois à neuf. Fr. 590.-
024a. Eggs, Franç. Grange, tout les soubassements et toit en ruine, de petit valeur. Fr. 80.-
025. Clementz, Pierre Jos., pressoir 10 toises de mur. Fr. 60.-
026. Berthold, fille, ref. 3 tois. De mur, les escalier, 1 chem. Dans la maison. Fr. 60.-
027. Berthold, Jos. Marie, et Clementz, Jos. Grange.
028. Berthold, Jos. Marie, grange vielle. Fr.10.-
029. Venetz, Jean Jos. Ignace, mais. Et grange très- vieux 5 tois. De mur, 5 toits. Fr. 200.-
030. Abgottsponer, Jos. Marie et Venetz, Ignace, grange. Fr. 20.-
031. Sattler, Jos Ignace, grenier reboucher le mur. Fr. 3.-
031a. id. (Sattler, Jos. Ignace), maison, ref. 1 chem. Et manteau. Fr. 30.-
032. Venetz, Benoit, ref. le chem. Du tout en bas latri., mur de cave. Fr. 99.-
033. Maison de commune plusieurs rép. Fr. 60.-
034. Venetz, Joseph Ignace/ fils de Banderet, ref. deux chem. Escalier un mauvais planch. Pourri et couvert. Fr. 100.-
035. id. (le fils du Banderet) grange toit. Fr. 10.-
036. Venetz, François, mais. Ref. 12 toises de mur, 1 chem., rep. Le toit. Fr. 100.-
037. Venetz, Joseph Ignace / Sattler, Joseph Ignace, grenier. Fr. 10.-
038. Eggs, Franç. , forge, 1 chem. Rep. 1mur. Fr. 15.-
039. Kalbermatten, Jos. Marie, mais. En ruine, les bois sont bons, 35 toises de mur. Fr. 500.-
040. Tantignoni, les frères, rép. Le couv. Et l'escalier, 1 chem., crevas. Fr. 80.-
041. Clementz, Pierre Jos., ref. l'escalier d'un étage, 1 chem., le1/3 du couv. Et crevasses avec les frères Tantignoni. Fr. 70.-
042. Venetz, Pierre Jos., remonter le couv., 9 arcs de fenêtre, 2 chem., 3 fentes à reboucher. Fr. 200.-
043. Providoli, Ant., 1 chem., et 1 mur. Fr. 36.-
044. Pierrig, Franç., 1 chem., 1 couv., petit mur. Fr.
045. Venetz, Alois, mais., partie du midi en ruine. Fr. 170.-

046. Notti, Jean Pierre, mais. Rép. Le couv. Et 1 chem. Fr. 15.-
047. Andenmatten, Jean Pierre, mais. Ref. 1 brèche de mur, 1 chem. Fr. 20.-
048. Venetz, Jos. Marie, grange, rép., 1 mur et toit. Fr. 25.-
049. Clementz, Pierre Jos., et Venetz, Pierre Jos., rep. 1 toit de grange. Fr. 10.-
050. Clementz, Franç. Et Bitet Jean, Jos., grange rep. Le toit. Fr. 10.-
051.Bitet, Jean Jos., mais. Rep. 1 chem. Manteau, et couvert. Fr. 20.-
052. Zumstein, Jean, 4 toises de mur, 2 chem. A rep. Et couv. Fr. 60.-
053. Clementz, Franç., mais, rep. La chem. Sur le toit et 1/2 du couvert. Fr. 20.-
054. Lomater, Pierre Jos., 1 chem. Et 1 couv. Fr. 20.-
055. Lomater, (verm. Pierre Jos.),grenier et cave, 2 toises de mur, 1 couvert de la maison. Fr. 38.-
056. Brigler, Franç., mais., rep. 1 chem., crevas., et couvert. Fr. 25.-
057. Notti, Franç., ref. 4 toises de mur, manteau d'un forge et couv. D'une grange. Fr. 60.-
058. Clementz, Josep., ref. 1 chem. Rép. Le toit de la maison. Fr. 20.-
059. Pour répa. Les 2 parapets du pont de Saas. Fr. 80.-
060. Hausner, Christian, maison, ref. 12 toises de mur , 1 chem., rép. Le toit. Fr. 100.-
061. Laurentz, Maurice, mais. Ref. le sou-bassements, 23 toises de mur, 1 chem. Fr. 180.-

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3933 Staldenried and Eysten
Population figure: 1850:201
Population figure 2000: 554
Revised damage assessment
Total loss: CHF 1'431.-

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001. A Gsponer, Ignace, pour réparer le toit et la cheminée de la maison. Fr. 30.-
002. A Satler, François, pour réparations de 3 cheminées dans la maison, pour démolir et relever une grenier en bois et une grange à blé et pour réparer une cheminée dans la montagne. Fr. 90.-
003. A Pierre Joseph Vomsattel, pour réparer le toit et une cheminée de la maison et le toit de la grange et à la montagne réparations de deux toits de grange et un toit de maison. Fr. 27.-
004. A Fr. Abgottspon, Docteur, pour réparations du toit de la maison à la montagne et d'un toit de grange. Fr. 16.-
005. A Vomsattel, Fr. fils, pour réparations d'un toit de maison et de deux toits de grange et pour deux toises de mur. Fr.25.-
006. Chapelle dite im Spon, pour travaux faits au toit et au mur et pour le clocher qui est encore à rebâtir. Fr. 83.-
007. Chapelle à l'image, zum Bildji, p. réparer le toit la voûte et les fentes de cette chapelle. Fr. 40.-
008. Furrer, Joseph [...] Truffer, pour réparer une cheminée et le toit de la maison, ainsi qu'un toit de grenier. Fr.20.-
009. A Pierre Joseph Abgottsponer, réparer le toit et le fond à la montagne. Fr. 30.-
010. A Furrer, Joseph Ignace, pour faire une cheminée neuve et réparer toit de la maison. Fr. 50.-
011. A François Abgottspon pour relever une vielle grange à blé faite de bois écroulée et pour reconstruire la voûte d'un four-a-pain fait de mauvaises pierres. Fr.35.-
012. A Abgottspon, Pierre Joseph, pour réparer le toit et la cheminée de la maison et à la montagne deux planchers en bois. Fr. 50.-
013. A Abgottspon, Anne-Marie, pour trois toises de mur dans la cave. Fr. 20.-
014. A Andraes, pour quatre toises de mur dans la cave et la cheminée ainsi que le toit de la maison. Fr. 60.-
015. A Abgottspon, Jean Joseph, pour le toit de la maison et la voûte d'un four-a-pain. Fr.30.-
016. A Summermatter, pour deux toises de mur dans la cave et pour réparer le toit. Fr. 30.-
017. A Furrer, François Valentin, pour réparer le toit. Fr. 10.-
018. Au même (Furrer, François Valentin), pour un toit, une cheminée et une toise de mur. Fr.30.-
019. A Andenmatten, Joseph, pour deux toises de mur récrépé. Fr. 15.-
020. A la société de montagne, pour deux toises de mur récrép. et pur le toit. Fr. 30.-
021. A Kalbermatten, Aloys, pour une cheminée et un toit à réparer. Fr. 20.-
022. A Kalbermatten, Pierre Joseph, pour une cheminée et un toit à réparer. Fr. 25.-
023. A Notti, Pierre Joseph père, pour réparer une cheminée, un toit et un four-a-pain. Fr. 60.-
024. A la chapelle Eisten, pour placer une cléf de fer dans le mur, réparer le mur et le clocher. Fr. 80.-
025. A Andenmatten, Joseph, pour le toit et cinq toises de mur récrépi. Fr. 60.-
026. Aux frères Notti, pour une toise de mur sec, pour réparer le toit de la maison, le toit de grange et un mur. Fr. 50.-

027. A Kalbermatten, Jean Joseph, pour un four-a-pain faites de mauvaises pierres et pour cinq toises de mur récrépi. Fr. 55.-
028. A Abgottspon, Jean Joseph, pour réparer une cheminée, une toise de mur et le plancher. Fr. 20.-
029. A Bordnatzen, pour une cheminée, le toit , une toise de mur récrépi. Fr. 70.-
030. A Furrer, Fr. pour un toit de grange. Fr. 20.-
032. A la veuve de Valentin Furrer, pour un four-a-pain, un toit de maison et un toit de grenier. Fr. 80.-
033. A Joseph Summermatter, pour trois toises de mur dans la cave. Fr. 20.-
Staldenried et Eysten (Ilas)
001. A Briggeler, Joseph, pour réparations d'une cheminée et d'un toit. Fr. 25.-
002. Venetz, Joseph Ignace, pour idem (pour réparations d'une cheminée et d'un toit.) Fr. 25.-
003. A Ruppen, Pierre Joseph, pour quatre toises de mur sec et pour réparer le toit. Fr. 35.-
003b. (A Ruppen, Pierre Joseph(003)), pour réparer une cheminée dt le toit de la maison. Fr. 40.-
004 A la veuve Clemens, pour réparer le toit et une cheminée. Fr. 30.-
005. A Ritz, Fr. et ses 5 Consorts, pour reconstruire trente toises de mur et pur remonter le toit. Fr. 310.-

Staldenried et Eysten (Pollern)
001. Aux filles Kalbermatten, pour huit toises de mur récrépi et pour réparer le toit. Fr.60.-
002. A Venetz, Ignatz, pour onze toises de mur sec et pour refaire quatre toits et deux cheminées. Fr.165.-

Staldenried et Eysten (Pont neuf)
001. A Venetz, Ignace, pour une et demie toise de mur sec à la grange et pour réparations de l'écurie et du toit. Fr. 10.-
002. A Willisch, François, pour une toise de mur sec et le toit de grange et écurie. Fr.10.-
003. A Willisch, Catherine et les cinq consorts pour 2 toises de mur sec. Fr.20.-
004. A Pierre Joseph Andraes, pour 2 toises de mur sec et le toit de grange et écurie. Fr. 30.-
005. A Venetz, Ignace, pour le toit d'une grange. Fr. 10.-
006. A Bertoljotti, pour le toit d'un grenier. Fr. 10.-
007. A Venetz, Benoît, pour le toit d'une grange. Fr. 10.-
008. A Jean Abgottspon, pour sept et demie toises de mur à plâtre et pour réparations du toit. Fr. 70.-
009. A François Venetz, pour vingt toises de mur à plâtre et pour réparer le toit. Fr. 150.-
010. A Gattlen, François, pour trois toises de mur à plâtre et pour réparer le toit. Fr. 23.-
011. A Ignace Abgottspon, pour un toit , cheminée, cinq toises de mur et le plancher. Fr. 80.-
012. A Berchtold, Jos. Marie, pour le toit, une cheminée, cinq toises de mur. Fr. 35.-
013. A Berchtold, Jean, pour 2 toises de mur et une cheminée. Fr. 25.-
014. A Andraes, Anne Marie, pour une 2 toises de mur et une cheminée. Fr. 20.-
015. A François Abgottspon, pour une cheminée une toise de mur et le toit à réparer. Fr.40.-
016. A Clementz, François, pour 25 toises de mur à plâtre, pour réparer le toit et l'escalier. Fr. 160.-
017. A la chapelle du pont, pour réparer le toit. Fr. 10.-
018. A Cécile Mangisch, veuve, pour réparations du toit, de la cheminée et pour trois toises de mur. Fr. 60.-
019. A Venetz, Ignace, pour un toit de maison un toit de grange et grenier et pour une cheminée. Fr. 40.-
020. A Anderlini et Chrétien Gsponer, pour faire deux nouvelles cheminées et trois toises de mur sec. Fr. 45.-
Pour le toit de maison, et le toit de grenier appartenant à Anderlini [...] Fr. 380.-
021. A Gsponer, Chrétien, pour le toit de grange. Fr. 10.-
022. Pour les Réparations à la chapelle sous les rochers (Unterflueh). Fr. 40.-
023. A Crésena et Joseph Berchtold, pour réparations du toit, de l'escalier et de toutes le fentes de la maison. Fr. 45.-
024. A Joseph Hossenen, pour réparer le toit de la maison. Fr. 10.-
025. A Kalbermatten, Jean Joseph, p. réparer le toit, reboucher les fentes et réparer quelques toises de mur. Fr. 45.-
026. A l'hoirie de Gattlen, Ignace, pour réparer le toit et deux toises de mur. Fr. 30.-
027. Pour des réparations à la Chapelle Biadji. Fr. 100.-
028. A Gsponer, Abraham, pour une toise de mur sec dans la cave et une partie du fond. Fr. 5.-
029. Travaux à faire à la chapelle de Staldenried: démolir la voûte, démolir dix toises de mure jusqu'au chœur, faire un nouveau clocher, reboucher toutes les fentes à l'intérieur et a l'extérieure de la chapelle, réparer le toit et le fond, et placer deux clefs en fer par le milieu de la Chapelle. Fr. 1555.-

3923 Törbel
Population figure: 1850:508
Population figure 2000: 498
Revised damage assessment (incomplete), the first assessment is lost.
Total loss: CHF 648.-

001. Dommages ou pour refaitures à l' église. Fr. 2550.-
002. Maison de la cible, rep. 4 toises de mur. Fr. 28.-
003. Rouff, Chrétien, rép. 1 toit et 1cheminée. Fr. 20.-
004. Pierre Josef et Jean J[...] Laurentz, rép. 6 tois. de mur et toit. Fr. 58.-
005. Chapelle de Felt, rép. le toit et [...]. Fr. 30.-
006. Visse, rép. le couvert et mur. Fr.40.-
007. Laurentz, Christian, rép. 3 couverts. 2 toises de mur, 1 cheminée. Fr. 58.-
008. Christian, Andrés, 1 raccard au paroi remonter. Fr. 50.-
009. Visse, Felix et consor., rep. 3 toises de mur sec, rem. la grange. Fr. 48.-
010. François [...] Bermat, rep. 1 couvert. Fr.18.-
011. La chapelle à la fontaine pour rép. à faire. Fr. 100.-
012. Pour les autres dommages l'ancienne taxe a été conservée, excepte aux ci-dessus

3946 Turtmann
Population figure: 1850:433
Population figure 2000: 992
Revised damage assessment.
Total loss: CHF 3'323.-

001. Seiler, Antoine, maison et grange reboucher les fentes, et refaire trois cheminées à neuf sur le couvert. Fr. 407.-
002. Inalbon, les frères, réparer trois maisons et plusieurs granges, trois cheminées sur le toit, une lucquerne, quatre plafonds et le toit. Fr. 645.-
003.Inder Koummen, Joseph, maison, réparer des légères fentes et deux couverts de grange. Fr. 30.-
004. Feliser, François, maison, reboucher légères fentes, refaire couvert d'une grange, remonter la grange à bled. Fr. 120.-
005. Zbrunn, Pierre, maison, deux cheminées sur le couvert refaire à neuf, réparer le toit de la grange et les fentes. Fr. 70.-
006.Zummermatter, Pierre, maison, plusieurs fentes et les couvertes à réparer. Fr. 60.-
007. Bregy, Jean Joseph, réparer le couvert, une cheminée sur le toit, et reboucher les fentes. Fr. 60.-
008. Ruffinner, Alexis, maison, reboucher les fentes et remonter la latrine et trois petites cheminées sur le toit. Fr. 100.-
009. Bregy, Joseph Antoine, réparer le toit d'une grange. Fr. 10.-
010. Welsch, veuve, maison, refaire deux terrasses et une cheminée. Fr. 80.-
011. Oggier, François et consort, maison, réparer le couvert d'une grange et les fentes à la maison. Fr. 15.-
012. Morenzi le Juge et son frère, réparation faite à la maison et à faire et dans plusieurs granges le couvert. Fr. 300.-
013. Andrés, Benedict, grange, refaire le couvert à neuf. Fr. 50.-
014. Andrés, Aloys, maison, réparer une cheminée et un plafond. Fr. 30.-
015. Ott, veuve, réparer le couvert de la maison. Fr. 8.-
016. Jäger, Chrétien, maison et grange, reboucher les fentes, réparer le toit. Fr. 33.-
017. Bregy, Joseph Antoine le vieux, reboucher les fentes de la maison. Fr. 20.-
018. Inder Koummen, Gaspard, réparer les fentes de la maison. Fr. 6.-
019. Zbrunn, François, refaire les terrasses et couverts. Fr. 125.-
020. Meyer, François, réparer le couvert de la maison. Fr. 7.-
021. Venetz, Jean Joseph, maison, réparer une angle de terrasse et un cheminée. Fr. 40.-
022. Oggier, Jean Joseph, maison, refaire le toit et crevasses et un cheminée. Fr. 60.-
023. Jäger, Jean Joseph, maison, réparer le toit et quatre cheminées et fentes. Fr.200.-
024. Grand, Jean, refaire un petit mur de la maison. Fr. 25.-

025. Schmid, Joseph, reboucher une fente dans la maison, une sale, refaire un petit mur et un plancher. Fr. 40.-
026. Kalbermatten, Joseph Antoine, à refaire un grange. Fr. 100.-
027. Oggier, veuve, refaire cinq brèchets dans la maison avec escalier et une cheminée. Fr. 120.-
028. Oggier, Jean Joseph, fils d'Antoine, refaire la terrasse et une plancher à la chambre cassée et le foyer et couvert de la maison, et le couvert de deux granges, et une fontaine ayant échoué dans un hameau la fontaine non comprise. Fr. 180.-
029. Meyer, Maurice et Gschieter, Augustin et Franz Summermatter et consorts, refaire trois cheminées et une terrasse, couvert de la grange. Fr. 80.-
030. Beyzard, Pierre, maison au moulin, reboucher de légères fentes. Fr. 5.-
031.Grand, Louis et Ferdinand, grange, refaire le toit. Fr. 5.-
032. Oggier, François, réparer une cheminée. Fr. 5.-
034. Bregy, Pierre, grange, réparer le couvert. Fr. 5.-
035. Zbrunn, Jean Joseph, réparer le couvert de deux granges, et une cheminée dans la maison et deux chevrons. Fr. 38.-
036. Mez, les enfants, réparer le couvert de la maison. Fr. 10.-
037. Witschard, Alexis, maison, refaire un petit mur dans la sale, un pilier a la grange. Fr. 28.-
038. Feliser, François Joseph, reboucher les fentes à la cheminée. Fr. 2.-
039. Herren, Cathérine née Meyer, refaire une cheminée et plafond Fr. 20.-
040. Meschler, Jean Joseph, réparer la cheminée. Fr. 2.-
041. Hartmann, Jeanne, née Bovier, réparer le manteau de la cheminée. Fr. 15.-
042. Ruffinner, Marie Anne, réparer le couvert de la maison. Fr.15.-
043. Bregy, François Joseph, refaire le couvert de la maison. Fr. 30.-
044. Meyer, Jeannette, maison, démolir un mur de séparation et le refaire, plus quatre brichets dans une terrasse. Fr. 45.-
045. Albrecht, Gaspard, refaire un petit mur, toit et terrasse. Fr. 12.-
046. Zbrunn, Jean Joseph, refaire un mur dans la grange et un cheminée sur le toit de la maison. Fr. 60.-
33. Bregy, organiste, à refaire une cheminée. Fr. 5.-

3944 Unterbäch
Population figure: 1850:228
Population figure 2000: 426
Revised damage assessment.
Total loss: CHF 2'328.-

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001. A Furrer Joseph, pour une grange in den Salzinen. Fr. 56.-
002. A Bitschi, porte drapeau, pour 2 toises de mur et le toit. Fr. 30.-
003. A Ignace Wyssen, (au bois) im Holz, 4 toises de mur et un toit. Fr. 30.-
004. A Ignace Venetz, huissier, pour six toises de mur et une grange à blé. Fr. 85.-
005. A Aloys Amacker am Bann pour 5 toises de mur et un fourneau. Fr. 35.-
006. A Furrer, Jean Joseph, pour 7 toises de mur, une cheminée, un fourneau. Fr. 60.-
007. A Fogel, Jean, zur neuen Stube, pour sa maison. Fr. 77.-
008. A Furrer, Jean Joseph, zum obern Steinhaus, pour sa maison. Fr. 60.-
009. A Zenhäusern, Jean Joseph de Loeche, pour une cheminée. Fr. 10.-
010. A Venetz, André, pour une cheminée. Fr. 8.-
011. A Werlen, Ignace, pour une cheminée. Fr. 12.-
012. A Zenhäusern, Jean, pour 2 cheminées. Fr. 19.-
013. A Zumoberhaus, Siméon, pour son moulin. Fr. 110.-
014. A Furrer, Jean Joseph pour id. (pour son moulin) Fr. 80.-
015. A Joseph Oberhauser, pour id. (Pour son moulin) Fr. 70.-
016. A Rouffiner, Antoine pour id. (pour son moulin) Fr. 50.-
017. A Bitschin, Jean, pour un coin de sa maison. Fr. 25.-
018. A Venetz, Jean, id. (pour un coin de sa maison). Fr. 25.-
019. A Pierre Zurbriggen, pour une cheminée et un coin de maison. Fr. 95.-
020. A Zentriegen, Jean Joseph, pour un coin de maison. Fr. 35.-
021. A Schnydrig, Jean Chrétien, pour une nouvelle cheminée. Fr. 32.-
025. A Oberhauser, André, pour un mur et une cheminée. Fr. 20.-
026. A Furrer, Ignace, pour 1 toise de mur et une cheminée. Fr. 33.-

027. A Burgener, Catherine, pour une mur dans sa cuisine. Fr. 38.-
028. A Furrer, Jean Joseph, pour un mur et une cheminée. Fr. 60.-
029. A Chrétien Dürren, pour 2 tois. de mur et une cheminée. Fr. 23.-
030. A Werlen, Chrétien, pour 1 tois de mur . Fr. 5.-
031. A Weissen, Aloys, pour 2 toises de mur et une cheminée. Fr. 20.-
032. A Fogel, Joseph, pour 6 toises de mur, le toit et la cheminée. Fr. 85.-
033. A Bitschin, Jean Chretien, pour une cheminée. Fr. 15.-
034. A Venetz, Ignace, huissier, pour idem (une cheminée). Fr. 20.-
035. A Venetz, Jean, pour idem (une cheminée). Fr. 15.-
036. A Bajard, André, pour 5 toises de mur, une cheminée, et 5.5 toises de mur dans la cave. Fr. 145.-
036. Furrer, Joseph, pour idem (une cheminée). Fr. 16.-
037. A Zimmermann, Maurice, pour idem (une cheminée). Fr. 13.-
038. A Krampf, Jean Joseph, pour idem (une cheminée). Fr. 12.-
039. A Schnydrig, Jean Chretien, pour 7 toises de mur et une grange à blé. Fr. 45.-
040. A Furrer, Jean Joseph et consorts, pour 6 toises de mur et le toit. Fr. 60.-
041. A Schnydrig, Jean Chrétien, pour 3 toises de mur. Fr. 25.-
042. A Attschilier, Jean Jodoque et consorts pour un grange. Fr. 25.-
043. A Bitschin, Jean Chrétien, pour une cheminée. Fr. 10.-
044. A Venetz, Jean Chrétien, pour un grenier et une cheminée. Fr. 80.-
045. A Venetz, François, pour 4 toises de mur et une cheminée. Fr. 24.-
046. A Zenhäusern, Jean Joseph, pour une cheminée. Fr. 11.-
047. A Furrer, Jean, pour 15 toises de mur, la cheminée et le toit. Fr. 300.-
049. Au même (Amacker, Jean Chrétien), pour 5 toises de mur. Fr. 35.-
050. A Weissen, André, médecin, pour sa maison. Fr. 18.-
051. A Amacker, Jean Chrétien, Colonel, pour son vieux manoir. Fr. 43.-
052. Au même, pour sa grange. Fr. 70.-
053. Eidem, pour la maison et la cheminée Fr. 25.-
054. Eidem, pour une grange à blé Fr. 30.-
055. A Furrer, Joseph, pour id. (grange à blé). Fr. 38.-
056. A la veuve de Jean Joseph Speisten, pour la maison. Fr. 38.-

CH-3930 Visp

Population figure: 1850: 529
Population figure 2000: 6550
Revised damage assessment and first assessment
Total loss: CHF 101'838.-

Revised assessment	First assessment
001. Bourginer, François, refaire à neuf l'escalier, la façade du Nord 40 toises, couvert terrasse, et fentes Fr. 1450.-	Faire à neuf l'escalier, tournelette, toit, cheminée et latrine à répare
002. Ambort, Marie, refaire 70 toises de mur façade du mide et nord, l'éscalier deux cheminées das la maison et 7 toises de mur das la grange Fr. 1405.-	Remonter la latrine, escalier, cheminée, rep. le toit et murs (Maison, 1500.-) Rép. un pilier au coin, et une mur de façade (écurie, 150.-).
003. Bourginer, François, 8 toises de mur et le toit à la grange Fr. 66.-	Réparer 4 trumeaux et le toit.
004. Bourginer, Preffet, refaire 9 toises de mur et le couvert à la grange Fr. 99.-	
005. Lang, veuve, réparer le toit et 6 toises de mur à la grange Fr. 45.-	
006. Lochmatter, frères, à réparer 4 couverts 2 cheminée a à neuf, la terrasse du galetas, 15 toises de mur dans l'intérieur et reboucher des fentes Fr. 590.-	Refaire 3 cheminées, terrasse, quelques brèches et murs à réparer.

007. Pfamatter, François, à réparer le toit, 1 cheminée neuve, plusieurs fentes dans la maison, le toit et 4 toises de mur à la grange Fr. 191.-	Rep. l'escalier, toit et des crevasses (Maison Fr. 400.-) Refaire un pars de mur et rep. le toit (Gr. écurie Fr. 100.-).
008. Madame Vierd et consort, déjà fait pour 387, et 10 toises de mur encore à faire pour 520 francs total Fr. 907.-	
009. Eder, Zumstein, Jos. et Imboden, Maurice, dans la maison: la façade du midi, les deux angles du cauchard et une partie de la façade du nord Fr. 9400.-	Démolir et refaire toute la maison.
010. Bourginer, Preffet et Eder Joseph, refaire 8 toises de mur et le toit de la grange Fr. 110.-	
011. Zumstein, Jos., refaire 6 toises de mur et le couvert Fr. 200.-	
012. La maison de la cure, démolir et remonter à neuf Fr. 12'000.-	Démolir et refaire plus petite à cause du fondement.
013. La Maison Commune, réparer le toit, cheminée et les fentes Fr. 200.-	Réparer des crevasses et le toit (Fr. 260.-). Ref. un part de murs, poutraison, cheminée et toit (Fr. 250.-).
014. District, dans la maison à refaire 15 toises de mur, réparer le toit et les fentes Fr. 300.-	
015. Bourginer, Preffet, refaire une voûte au corridor, refaire trois cheminées, remonter deux fourneaux en pierre de taille, refaire à neuf la tournelette, clef à l'latrine, les toits d'une grange et d'une remise Fr. 1700.-	Dem. et refaire la tournelette, corridors au 2e, cuisine, toit, cheminée et latrine à réparer.
016. Vicairiaz et Bourginer Preffet, refaire 3 cheminées sur le toit, un plancher, 2 clefs à l'atrine, et réparer le toit Fr. 165.-	
017. Indereggen, Catherine, refaire 2 cheminées et toit, Studer, Pierre, plancher, [...] mur Fr. 150.-	Ref. 2 cheminée, cap de chem. escalier, plafond, mur (Fr. 300.-). Rep. toit et cheminée(fr. 100.-).
018. Graven et Providoli, refaire la façade du couchant et en partie du nord, réparer le toit, cheminée et latrine. Fr. 1450.-	Refaire la latrine, foyer, cheminée, et reboucher les crevasses.
019. Bourginer, Preffet et Schmitd Jos. Ant., refaire une mur du Nord, 4 toises du midi, 3 cheminées, 2 terrasses et réparer le toit Fr. 1000.-	Refaire le mur au Nord, les cheminées et le manteau du cuisine.
020. Zen-Klusen, père et fils, refaire 2 cheminées et le toit de la maison Fr. 90.-	Rép. 2 cheminées et rep. le toit.
021. Zen-Klusen, père, dans la grange refaire 8 toises de mur, 2 toit, et réparer le toit de la remise Fr. 165.-	Ref. à neuf la face du couchant et rep. les [...].
022. Bourginer, Preffet et consort, refaire écroulée40 toises de mur, et remonter le couvert écroulée de la grange Fr. 915.-	
023. Zurbriggen, Jean Pierre et Zumstein, Alois, à réparer 18 toises de mur du couchant et Nord, 2 cheminées et crevasse Fr. 360.-	
024a. Zurkirchen, Ant., dans la maison et grange réparer 1 cheminée, crevasse et toit Fr. 175.-	Réparer le toit, cheminée crevasses
024b. Zumstein Alois, une sale Fr. 30.-	
025. Providoli, Jaques, dans la maison démolir trois façades et les cheminées et le plancher de la grange Fr. 2800.-	Démolir et refaire la partie du midi et du couchant, réparer le toit, cheminée, rep le plancher de la grange.
026. Hazequer, Jean, la maison à démolir et refaire à neuf Fr. 3000.-	

027. Steren, Marie, Jos., refaire une façade, une partie des escalier et cheminée	Ref. le mure de façade, plancher du galetas, cheminée, terrasse.
028. Kalbermatten, Jean Jos., à refaire trois façades, terrasse, et cheminée et toit, compris la grange de la veuve d'Andenmaten Fr. 4000.-	Démolir et ref. la façade du couchant et du midi, plafond, cheminée, toit, terrasses et autres réparations
029. Andenmatten, Donat, veuve, réparer tout le couvert, 3 cheminées, terrasses, toutes les fentes et réparer la voûte à la porte d'entrée Fr. 2000.-	Refaire le toit, changer la poitrail, refaire le [...] du corridor, cheminée et [...].
030. Clemenz, Conseiller d'Etat et Lochmatter, refaire 8 toises de terrasse, crevasse, cheminée à la maison et mur au grenier et couvert, 6 brèches Fr. 477.- Le même, une grange vers l' église à refaire le couvert à neuf Fr. 50.-	Ref. un [...], terrasses, toit cheminée, crevasses.
031. Rappen, Pierre, refaire la façade du Nord 20 toises de mur, réparer le couvert et deux cheminées Fr. 500.-	
032. Andenmatten, Ignace, remonter 8 toises de mur, deux cheminées et toit, à l'escalier reboucher la crevasse, la tour doit être démolie Fr. 217.-	Refaire la façade , cheminée, boucher les crevasses.
033. Andenmatten,[...], remonter à neuf la maison, l'angle au nord et couchant et réparer le toit Fr. 286.-	
034. Zurkirchen, Barbe, réparer la cheminée, [...] latrine de maison, le toit de la grange Fr. 70.-	Réparer le toit, cheminée et latrine.
035. Kummermatter, Loucas, Gebhard, Georg, dans la maison réparer la cheminée, changer un poutre et tablette, et deux toises de mur à la grange Fr. 90.-	Refaire la cheminée, changer une partie vers la fenêtre, tablette et [...] de fenêtre.
036. Domik, Jean George, réparer un toit Fr. 10.-	
037. Jensch Antoine, la maison déclaré inhabitable écroulée Fr. 200.-	Refaire une façade et le toit.
038. Clemenz, Franc, Providali, et Schmid, dans la grange réparer le toit et 1 angle Fr. 120.-	Réparer le toit, remonter un pilier, réparer les murs
039. Studer, Joseph, refaire 1 cheminée, le toit, les fentes, et les plancher de l'atrine, le couvert de la grange, une parti est réparé, 5 journées fait; 16 à faire Fr. 120.-	(Maison) Refaire cheminé, rep, murs, toit, plancher, [...] 400.-, (Grange) Réparer les murs et le toit 40.-
040. Planzer, Leopold, dans la maison refaire la façade du midi, fentes, couvert, cheminée et une brèche de terrasse Fr. 220.-	Refaire la façade, qu'il doit démolir, placer des clefs, réparer le cheminée, [...].
041. Indenmatten, veuve v, nr. 086	
042. Supersaxo et les sœurs, remonter tout à neuf le couvert, cheminée, 4 toises de mur, toutes les fentes dans la maison, un couvert neuf trois chevrons (Sparren), deux toises de mur Fr. 1320.-	Démolir la maison; il serait opportune de la reconstruire ailleurs.
043. Fourger, François, dans la maison refaire 12 toises de mur, le couver, 2 cheminées et crevasse Fr. 350.-	
044. Albrecht, Valentin et Bilgischer, Antoine, démolir tout l'intérieur de la maison, qui est en maçonnerie doit être reconstruit à neuf et 2 façades [...] Fr. 4500.-	Démolir tout l'intérieur, qui est en maçonnerie et construire à neuf, la partie en bois et sud [...].
045a. Providoli, Laurent, réparer le toit, terrasse et cheminée et latrine Fr. 500.-	Placer une clef à l'étage du milieu, refaire la latrine, faire les terrasses, refaire le toit et cheminée.
045b. Providoli, Jaques, réparer le toit Fr. 20.-	Réparer le toit.
046. Lang, Ignace, reboucher le fentes et toit de la grange Fr. 30.-	Réparer le toit et la porte.

047. Zumstein et consort, un toit à refaire [...] Fr. 25.-	Rep. le toit, changer quelques chevrons.
048. Reinard, Boniface, remonter 9 toises de mur, refaire 2 toit de la grange Fr. 12.-	
049. Bourginer, Preet, dans la grange refaire 2 toits, 3 toises de mur, 1 clef, 1 plancher et crevasses Fr. 18.-	
050. Reinard, Bonivace et François, réparer le toit, crevasse, 2 cheminées sur le toit, tout les plafonds à réparer Fr. 150.-	
051. Tichely, Laurent, 1 raquard écroulé remonter à neuf, et [...] Fr. 200.-	Refaire le mure, rep. le toit.
052. Peren, Maurice, la maison et forge déjà réparé coûté Fr. 24.-	
053. Ticheli, Laurent, une partie déjà réparé et encore à réparer dans la maison Fr. 707.-, réparer le couvert de la grange Fr. 30.-	Refaire le mur de la cour (Hof), toit, cheminée, réparer les murs de la maison.
054. Viotis, Baptiste, réparations faites, faire 38 toises de mur au galetas, façade du Nord, carniche, tout à l'entour, 2 clefs, 2 plancher, Fr. 4134.- à la grange 20 toises de mur, 3 toits Fr. 247.-	
057. Buchmann, Henri, à réparer le toit de la maison Fr. 25.-	
058. Meyer, Oulrich, Moulins, refaire le four, 55 toises de mur, 1 vieux plancher en bois, 2 cheminées et couvert Fr. 850.-	Faire le mur neuf au sud-ouest, four, toit et cheminée.
060. Bourginer, la maison: réparer le couvert Fr. 25.-	
061. Clemenz, Antoine, dans la maison refaire la façade et l'atrine Fr. 75.-	Ref. le mur au levant, latrine et pars de mur au hangar.
062. Kittel sœur, la façade du Levant et Nord refaire à neuf Fr. 250.-	
063. Zimmerman, Alois, refaire 2 cheminées et le toit Fr. 30.-	Ref. 2 chminées et rep. le toit.
064. Stadelmann, à réparer le toit et 1 cheminée Fr. 35.-	Rep. le toit et quelques [...], cheminée.
065. Bourgeoisie, dans la maison réparer le couvert, 3cheminées, 1 façade, terrasse, 8 toises de mur Fr.275.-	
066. Perrig advocat, maison Julier à répare 1 cheminée, le toit 2 clefs et fentes Fr. 275.-	Refaire un [...] mur, cheminée, terrasse, 3 clefs.
067. Sale Bourgeoisiale, réparer une mur Fr. 8.-	
068. Lanz, Ignace, petit maisonnette de [...] réparer un mur et cheminée Fr. 85.-	
069. Viers, père, maison, refaire 2 façades Nord et l'ouest Fr. 150.-	
070. Buanderie Bourgeoisiale, cible réparer le couvert et deux cheminées Fr. 100.-	
071. Paroisse, la grange, le couvert écroulé refaire à neuf, terrasse et 5 toises de mur Fr. 195.-	
072. Zuber, Théodule, Buanderie réparer 1 cheminée et un mur Fr.25.-	Ref. le galandage au levant et la cheminé.
073. Andenmatten, Maurice, dans la grange réparer le couvert, un poutre et 4 toises de mur Fr. 50.-	Réparer le toit (Fr. 50.-). Rep. le mur de soubassement, changer une pièce de bois, replacer le [...] (fr. 40.-)
074. Zurbriggen, Alois, refaire 2 façades, escaliers, cuisine, 1 cheminée et le couvert Fr. 800.-	Ref. une terrasse, replacer des poutres, refaire un mur en midi, cheminée, rep. la façade.
075. Ticheli, Jos., maison refaire un mur dans deux façades, 2 cheminées, et reboucher les fentes Fr. 360.-	

076. Wyss vieux Président, réparer les fentes en dedans et en dehors, et couvert à faire Fr. 215.-, réparation faites compris les matériaux Fr. 1040.-	Rep. le toit, cheminée, plancher, placer des clef.
077. Lang Ignace, maison: refaire l'atrine, des crevasses, le toit, cheminée, escaliers et mur mitoyenne et clef Fr. 1700.-	Ref. la latrine, rép. les murs, trumeaux de fenêtre du 2 iem étage, rep. le toit, cheminée, [...], mur mitoyenne [...].
078. Stauffer, Ant. et Schaller Ant., maison écroulé, rebâtir à neuf Fr. 10'000.-	Démolir le tout, et rebâtir ailleurs sur un point plus élevé.
079. Andenmatten, Gaspard, refaire l'atrine à moitié avec Lang, un éperon à construire 3 terrasses, le mur mitoyen le façade du cauchande et midi Fr. 2400.-, à la grange placer une clef, reboucher les fentes Fr. 100.-	Placer une clef, reboucher les fentes, rep. le toit (Fr. 100.-) Refaire la latrine, un éperon à construire, trois terrasses, et le mur mitoyen (Fr. 2400.-).
080. Ticheli, Jos., refaire le couvert de la maison et du raguard Fr. 85.-	
081. Andenmatten, notoire et Gentinelly, Laurent, démolir tout la maison et rebâtir à neuf Fr. 7800.-	Démolir tout la maison, ils devraient rebâtir dans un autre endroit sur un point plus élevé.
082. Stempler, François, maison; refaire 7 toises de plafond, 2 poutres, 2 cheminées, le toit, un mur du couchant Fr. 620.- Maison démolir jusque aux cave et rebâtir à neuf Fr. 10'000.-	Ref. le fond du mur au levant, ainsi que la mure de [...] du jardin, rep, le toit.
083.Andenmatten [...] et [...], maison démolir jusque aux cave et rebâtir à neuf Fr. 10'000.-	Démolir le tout et refaire.
084. Ruffinnen d'Eyholz, Cathérine, refaire le couvert Fr. 80.-	Rep. le cheminée, platforme et coin de mur au levant.
085. Indenmatten, François, les réparations toutes faites (085/086).	
086. Indenmatten, veuve, la maison et grange déjà réparé Fr. 855.-	Rep. le toit cheminée, latrine, crevasses (Fr. 200.-, maison). Remonter à neuf trois pilaires et le toit (Fr. 500.-, Grange/écurie).
087. Zurbriggen, Maurice, prêtre, réparer 2 cheminées, toit, crevasse, le tout réparé Fr. 33.-	
088. Bresner, Clemenz et consort, couvert Fr. 25.-	
089. Zimmermann, Jos. et frère et sœur, à réparer le toit, cheminée, et petit crevasse Fr. 25.-	
090. Bilgisch, François, la maison et grange déjà fait port Fr. 125.-	
091. Clemenz, François, réparation des fentes, toit et l'hôtel réparé Fr. 881.-	Refaire les cheminées, escalier, (085/086), réparer quelques planchers
092. Ticheli, Jos. dans la maison, à réparer les petites fentes, couvert d'une port, deux fenaîtres, une cheminée et couvert d'un raquard Fr. 80.-	Rep. le toit, cheminée et boucher quelques crevasses.
093. Mengis Docteur, à la grange trois toises de mur Fr. 20.-	
094. Zurbirchen, Ant. à la grange réparer le toit et fentes Fr. 12.-	
095. Lanz, Ignace, réparer les fentes et le toit d'une grange Fr. 15.-	
096. Bourginer, Preffet, à réparer 1,5 toises de mur et couvert à la grange fr. 20.-	
097. Clemenz, Ant. refaire le couvert de la grange Fr. 6.-	Remonter à neuf le toit et autres réparations
098.Furger, François, remonter le subasement d'un raquard et le couvert Fr. 80.-	

The following records of the first assessment were not correlated with records of the revised damage assessment:

Ruppen, Babtiste. Refaire le mur du soubassement et replacer la couvert

Bütmann, Henry. Refaire la latrine. Fr. 20.-

Viotti Babtiste. Déblayer, ref. les cheminées, terrasses, murs mitoyens, croiser des clefs et autres réparations.

Viotti Babtiste. Reconstruire les murs, réparer le toit.

Viotti Babtiste. Reconstruire les murs, réparer le toit.

Maurice Perrod. Réparer les murs, toit et cheminée.

Fuchs, Francois. Placer une clef.

Fuchs, Francois. Réparer les murs. Fr.50.-

Fuchs, Francois. Refaire une partie des murs. Fr. 50.-

Furger, Franc. Refaire le toit neuf

Clemenz François. Réparer le mur, toit et escalier

Ruppen Pierre. Remonter la façade du couchant, rep. toit et cheminée

Madame Wier. Refaire trois cheminées, plusieurs plafonds, corniches et toit à réparer, ainsi que la tournelette et placer une clef.

Clemenz, Franc. Réparer le toit, cheminée, escalier et quelques lézards

Zimmermann, Joseph. Remonter une partie de la latrine, placer une clef

Eglise de S. Martin. Faire un mur de soubassement depuis le glasier, remplir l'hermitage de maçonnerie, pointe du cloche, voûte, dallage

Burgener, Adolphe. Refaire la latrine, cheminée, clouer les plafonds, reboucher les lézardes

Bourgeoisie de Viège. Démolir l' église et le clocher

Fuchs, Joseph. Démolir toute l'adjonction au levant, ainsi que le 3e étage, refaire à neuf le mur au nord, l'escalier; ne pas permettre qu'on reconstruise le 3e étage

Zurbriggen, Vicaire. Ref. 2 cheminées, rep. le toit et petites crevasses

Zurbriggen, Vicaire. Refaire le mur du couchant et au nord

Bilgischer, François. Ref. 3 cheminées, 2 étages de latrine, toit, crevasses

Société de cible. Rep. le porte, fenêtre, et toit. Fr. 15.-

Tichely, Joseph. Rep. le toit. Fr. 20.-

Providoli, Jaques. Refaire le mur au couchant et au nord

Albrecht, Jean. Replacer et rep. le toit. Fr. 50.-

Ticheli, Laurent. Ref. la façade au couchant et au nord, 3 cheminées, replacer le toit et un mur de jardin, crevasses.

Zenklusen, Ignace. Refaire 5 toises de mur. Fr.25.-

Paroisse. Refaire 4 toises de mur. Fr. 20.-

Viotti et consort. Remonter le [...] et refaire le toit

Perren, Maurice. Rep. la cheminée, terrasse, un brèche, rep. le toit. Fr. 60.-

Ticheli, Laurent. Ref. la façade au levant et moitié au nord.

Zimmermann, veuve. Ref. 2 cheminées et rep. le toit. Fr. 30.-

Küttel, Catherine et consorts. Ref. une partie de la façade au levant et au nord, mur de soubassement.

Roderer frères. Réparer cheminée et toit. Fr. 20.-

Bourgeoisie. Réparer le toit. Fr. 25.-

Bourgeoisie. Ref. à neuf une partie de la façade au levant et au midi, refaire les terrasses, placer les bricks

Lang, Ignace. Refaire le mur au levant.

Andenmatten, François. Rep. le dessus de porte et garnir les [...]. Fr. 20.-

Bourginer, Adolphe. Ref. un coin neuf, et réparer un autre, placer une porte, [...]. Fr. 50.-

Andenmatten, Donat. Démolir et remonter la façade, ainsi que le toit.

Zurbriggen: Ref. un mur au couchant, latrine, cheminée (Fr. 400.-) Ref. cheminée, toit, crevasses à réparer (Fr.120.-).

Visp Bonelieu: Revised damage assessment

L' église Bourgeoisiale. Refaire la voûte, reboucher toutes les fentes, changer une partie l'allée, le plancher et trente deux bancs et le couvert, quatre clefs en fer et fermer les fentes du clocher, excepté une partie de façade. Fr. 7000.-

L' église communal. Refaire la voûte, quatre clefs en fer, trente deux bancs, plancher et allées, reboucher les fentes, démolir le clocher jusqu'au plancher, faire un grand mur de soutènement le tout. Fr. 20500.-

001 Providoli, Jaues, réparer un angle à la maison et couvert de deux grange
002. Tanner, Jos et consort, réparer un vieux mur dans la maison. Fr. 30.-
016. Wyss, Docteur, le couvert de la maison. Fr. 20.-
017. Clemenz, Conseiller d'Etat, dans la maison, grange à réparer le couvert, des fentes, deux brèches, et trois toises de plafond. Fr. 74.-
003. Andenmatten, veuve et consort, maison à Inalbinen à réparer un mur. Fr. 70.-
004. Steffen, Huftere, le couvert de la maison. Fr. 10.-
005. Wyss, Docteur, dans la maison et la grange 7 toises de mur à réparer. Fr. 40.-
006 La chapelle réparer le toit et les fentes. Fr. 30.-
007. Andenmatten, veuve et Pierre Verd, 2 cheminées, toit et grange à blé. Fr.30.-
008. Verlen, Ignace, réparer un mur et une cheminée. Fr. 25.-
009. Rupen, Babtiste, dans la maison, raquard, et grange réparer un mur, une cheminée et toit. Fr. 64.-
010. Providoli, Jaques et Lochmatter frères, au raquard 4 toises de mur à réparer. Fr. 20.-
011. Pierre, Vierd, refaire une mur à la grange. Fr. 3.-
012. Indenmatten, veuve, boucher les fentes de l édifier dans la grande île. Fr. 3.-
013 Mr. Allet Président de Löeche, une cheminée et le toit de la grange écroulée Fr. 200.-
014. Tichely, Laurent, dans la maison et grange à réparer une cheminée, crevasses et couvert. fr. 50.-
015. Wyss, Docteur et Lochmatter frères, à réparer les crevasses et couvert. Fr. 20.-
018. Lanz, Ignace, dans la grange le couvert, la maison avec consort à réparer deux cheminées, toit , 2 toises de terrasse et plusieurs crevasses. Fr. 150.-
019. Clemenz, François, réparer le couvert de la grange. Fr. 80.-
020. Bourginer, Preffet, 4 toits de grange à réparer et 1 à faire à neuf. Fr. 275.-
021. Albrech, à réparer un mur et le toit de la grange. Fr. 35.-
022. Rupen, Babtiste, refaire un toit et 4 toises de mur. Fr. 45.-

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3932 Visperterminen
Population figure: 1850:511
Population figure 2000: 1357
Revised damage assessment
Total loss: CHF 7'449.-

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001. Zimmermann, Gaspard, refaire le toit abattu de la maison, une cheminée, une brèche de mur à la cave: Fr. 115.-.
002. Société de cible, réparer les fentes et couvert Fr.45.-
003. Zimmermann, Jos. ex-gendarme, à réparer fentes et la cheminée Fr. 18.-
004. Heinzmann, François Boulanger et consort, la cheminée Fr. 27.-
005. Studer Antoine, dans la maison répare une cheminée et couvert Fr. 10.-
006. Margelist Jean Jos., une cheminée et le toit Fr. 20.-
007. Gotsponer Pierre Jos., une cheminée et couvert Fr. 35.-
008. Müllacher, Pierre Jos., refaire 3 toises de mur, le couvert, fentes et une cheminée Fr. 40.-
009. Stoffel, Théodule et consort, une cheminée et toit Fr. 30.-
010. Mangisch, Pierre Jos. et consort, une cheminée Fr. 10.-
011. Blatter, Jean Jos. et consort, une cheminée et toit Fr. 25.-
012. Heinzmann, Joh. Joseph, une cheminée Fr. 12.-
013. Stoffel, François et consort, le grenier écroulé Fr. 45.-
014. Stoffel, Jean Jos., la cheminée et le couvert Fr. 30.-
015. Mangisch, Jean Pierre, la cheminée et toit Fr. 20.-
016. Stoffel, Jean, une cheminée Fr. 9.-
017. Studer, Pierre du Pierre, une cheminée, trois toises de mur [...] Et couvert Fr. 40.-
018. Brügeler, Maurice, une cheminée, refaire un angle de mur Fr. 35.-
019. Karlen, Pierre Jos. et consort, une cheminée et fentes Fr. 15.-
020. Heinzmann, Pierre et consort, trois cheminées Fr. 35.-
021. Stoffel, Jos., deux couvert dans la maison Fr. 19.-
022. Heinzmann, Jos. et consort, le couvert de maison Fr. 22.-
023. Le four de la commune Fr. 10.-
024. Zimmermann, Alois, une cheminée et un coin de mur Fr. 25.-
025. Zimmermann, Antoine, une cheminée, fentes et un angle de mur Fr. 25.-
026. Monsieur le curé, réparer une cheminée Fr. 4.-

027. Mangisch, François veuve, deux cheminée Fr. 30.-
028. Les enfants Pierre Jos. Stoffel, une cheminée Fr. 10.-
029. Mangisch, Etienne, veuve et consort, le couvert Fr. 13.-
030. Heinzmann, Jos., une cheminée Fr. 8.-
031. Stoffel, Maurice, refaire cinq toises de mur une cheminée et couvert Fr. 53.-
032. Zimmerman, François cloutier et consort, le couvert Fr. 4.-
033. Brigiler, Maurice et consort, dans la maison refaire tout le mur de subasement, et remonter la moitié du couvert Fr. 120.-
034. Bourginer, François et consort, quatre toises de mur Fr. 30.-
034. Margelist, Jean Jos. et consort, une cheminée Fr. 18.-
036. La chapelle de Brunnen les réparations faites Fr. 36.-
037. Mangisch, Pierre Jean et consort, réparer le couvert et chminées plus dans la sale douze toises de mur, refaire à neuve Fr. 58.-
038. Zeiter, Jos. une grange à refaire trois toises de mur Fr. 14.-
039. Zimmerman, François, une cheminée et couvert Fr. 18.-
040. La maison communale la cheminée Fr. 10.-
041. Heinzmann, Maurice et consort, 1 cheminée et le toit Fr. 24.-
042. Zimmermann, François capitaine, une cheminée et le toit Fr. 50.-
043. Gotsponer veuve et consort Fr. 18.-
044. Mangisch, Françoise, une cheminée et toit Fr. 18.-
045. Gotsponer, Pierre Jos. une cheminée Fr. 12.-
046. Heinzmann, Maurice et consort, un double cheminée Fr. 12.-
047. Mangisch, Maurice, une cheminée Fr. 18.-
048. Bourginer, Maurice, une cheminée Fr. 15.-
049. Heinzman, François et consort deux cheminée Fr. 25.-
050. Stoffel, François et Ambort, deux cheminée Fr. 25.-
051. Bourginer, Françoise et consort, trois toises de mur et une cheminée Fr. 35.-
052. Stoffel, François Pierre et Heinzman Fr. 30.-
053. Mangisch Pierre Jos. Fr. 12.-
054. Zimmerman François serrurier Fr. 12.-
055. Brigiler, Catherine une cheminée Fr. 12.-
056. Bourginer, Joseph, une cheminée Fr. 18.-
057. Stoffel, Alois et consort, Fr. 12.-
058. Zimmermann, veuve, une cheminée Fr. 10.-
059. Zimmermann Françoise, une cheminée, trois [...] pour une jale, huit toises de mur Fr. 60.-
060. Brigiler, Marie veuve, refaire le toit et la cheminée Fr. 35.-
061. Gotsponer, Jean Pierre, une cheminée Fr. 10.-
062. Walpen, François, une cheminée, un mur et couvert Fr. 55.-. Le même une sale avec [...], plus remonter le toit de la grange. Fr. 30.-
063. Studer, Anne Marie , deux cheminées un mur et toit Fr. 60.-
064. Zimmermann, Antoine, serrurier, refaire deux toises de mur, réparer une cheminée et toit Fr.70.-
065. Brigeler, Antoine, réparer un cheminé, cinq toises de mur, couvert et crevasses Fr. 60.-
066. Ambort, Jean, réparer le couvert, et deux cheminée, [...] du toit, et une brèche de mur Fr. 90.-
067. Gotsponer Pierre Jos. une cheminée et réparer le toit Fr. 20.-
068. Stoffel, Théodule, trois toises de mure réparer une cheminée et le couvert Fr. 40.-
069. Zimmerman, Andres, deux couvert, les fentes dans trois façades et latrine un petit Fr. 115.-
070. Stoffel, Aloise, réparer un cheminée Fr. 10.-
071. Zimmerman, Jos. Gendarme, une cheminée Fr. 20.-
072. Kreuzer, Pierre, réparer une cheminée Fr. 10.-
073. Zimmerman, Marie, tanneuse, quatre brèches de mur et une cheminée Fr. 40.-
074. Heinzman Pierre, une cheminée Fr. 10.-
075. Heinzman, Jos., réparer une cheminée et le couvert Fr. 29.-
076. Zimmerman, Jean et Heinzman Jos., réparer un couvert, une cheminée, réparer plusieurs fentes dans trois façades et latrine Fr. 120.-
077. Zuber, Pierre, réparer deux cheminées et le couvert Fr. 16.-
078. Zimmerman, Antoine, à réparer trois toises de mur à la maison Fr. 15.-
079. Gotsponer, Pierre le petit et Zimmerman François, remonter à neuf la grange Fr. 90.-
080. Zimmerman, François, remonter la moitie du couvert écroulé et trois toises de mur pourri Fr. 80.-
081. Remonter une cheminée et cinq toises de mur Fr. 52.-
082. Kreuzer, Ignace, le toit et trois toises de mur Fr. 18.-

083. Brigiler, Maurice et Bourginen Jos. Refaire huit toises de mur et le couvert Fr. 45.-
084. Brigiler, Maurice et consort deux cheminée et quatre toises de mur sec et le toit Fr. 50.-
085. Ambort, Jean, réparer une cheminée et couvert, brèche de mur, remonter la grange Fr. 65.-
086. Le pressoir (die Presse) de Sattel, sept toises de mur sec et le couvert Fr. 40.-
087. Margelist, Jean Jos. et consort, réparer deux cheminées et le couvert, plusieurs brèches de refaire Fr. 65.-
088. Bourginer, Jos. refaire un couvert d une grange Fr. 20.-
089. Heinzman, Jos. huissier et consort, réparer une cheminée, une brèche et le couvert Fr. 65.-
090. Zerzuber, François, cheminée et couvert Fr. 15.-
091. Heinzmann, François Jos. au [...], trois toises de mur et couvert Fr. 20.-
092. La chapelle de Parmiliere faire tout à neuf.
093. Bourginer, François et consort, réparer deux cheminées, crevasses et couvert Fr. 50.-
094. Stoffel, François, remettre un poutre à la cave, refaire le toit et mur Fr. 39.-
095. Mangisch frères, démolir les deux cuisines et le toit remettre à neufs Fr. 200.-
096. Stoffel, Maurice, réparer une cheminée et le toit de la grange Fr. 40.-
097. Satler, Jean et Gotsponer Jean Pierre, refaire deux cheminées, couvert et crevasse Fr. 55.-
098. Mülacher, Antoine, une crevasse de mur à la cave et terrasse à la sale. Fr. 25.-
099. Heinzman, Jos. huissier, refaire six toises de mur neuf à la grange Fr. 40.-
100. Mangisch, François, le couvert de la grange Fr. 18.-
101. Blatter, Jean Jos. Réparer le fourneau une cheminée et le couvert Fr. 36.-
102. Zimmermann, François (Beschmatter) rep. Le toit et la cheminée Fr. 35.-
103. Le même, le couvert de grange Fr. 10.-
104. Satler, Jean, rep. Le couvert de la grange Fr. 8.-
105. Studer, Anne Marie, maison et grange rep. Le couvert et une cheminée Fr. 25.-
106. Studer, Jean, ref. Le toit d une grange Fr. 35.-
107. Heinzman, Maurice, ref. le couvert d'une raccard, rem. le soubasement d'une maison Fr. 35.-
109. Stoffel, Pierre et consort rep. une cheminée et le couvert Fr. 25.-
110. Les filles Kreuzer, ref. deux toises de mur, deux cheminées Fr. 40.-
111.Zeiter, Maurice, ref. un vieux mur deux cheminées avec consort Fr. 40.-
112. Heinzman, Pierre, et consort rep. un couvert de maison Fr. 15.-
113. Heinzman, Ignace et consort, ref. une ch. Fr. 23.-
114. Bourginer, Franc Jos., et consort, une cheminée à rep. Fr. 15.-
115. Zimmerman, Franc Capitaine, un petit toit Fr. 4.-
116. Zimmerman, Gaspard, deux cheminée et plusieurs fentes reboucher Fr. 60.-
117. Studer, Pierre et consort, une cheminée double sur le toit, et le toit Fr. 30.-
118. Studer, Jos. et consort, un grenier écroulé Fr. 115.-
119. Studer, Andrien, couvert du grange écroulée Fr. 20.-
120. Heinzman, Antoine organiste, trois cheminée Fr. 30.-
121. Heinzman, Pierre, deux cheminées Fr. 20.-
122. Le pressoir (Presse) des consort Heinzman Fr. 10.-
123. Heinzman, Maurice, une cheminée Fr. 12.-
124. Satler, Pierre Jos., rep. le couvert de la maison Fr. 30.-
125. Zimmerman, Marie, Jos., un chem. et couvert Fr. 20.-
126. Heinzman, Franc , [...] une cheminée Fr. 12.-
127. Le pussior de la chapelle, rep. le toit, sept toises de mur Fr. 50.-
128. Zerzuber, Jean Jos. 5 toises de mur à la maison Fr. 25.-
129. Satler, Jos. et consort, une sale rep. un mur Fr. 25.-
130. Satler, Marie Jos. maison réparer le chem. sur le toit Fr. 4.-
131. Studer, Antoine et consort, rep. un toit et une cheminée Fr. 45.-
132. Zeiter, Jos. ref. une cheminée Fr. 10.-
133. Zimmerman, Ant. ref. un couvert de grange Fr. 25.-
134. Zimmerman, Gaspard Presid. et consort, ref. un couvert et un mur dela grange Fr. 25.-
135. Satler, Chretien, rep. le couvert de la maison Fr. 30.-
136. Zimmerman, Président à [...] une cheminée, et crevasse à la cave Fr. 30.-
137. Zerzuben, Jos. à Haren, reguard écroulé refait à neuf Fr. 80.-
138. Une fontaine à Parmille évalué à Fr. 362.-
139. Les deux grands aqueducs servant les eaux de rigation pour les propriétés mille francs chaque Fr. 2000.-
140. Heinzman, François, une grange écroulé le toit Fr. 60.-
141. Satler, Marie veuve, couvert et mur de grange Fr. 37.-
142. Stoffel, Pierre grange 5 toises de mur fr. 20.-

143. Satler, Pierre, 10 toises de mur sec à la grange Fr. 40.-
144. Zerzuber, grange réparer le couvert 7 toises de mur Fr. 55.-
145. D'après les semples produit du Mr. curé Studer daté du deux Novembre 1855 évalué les dommages de l'église et quelques chapelles déjà réparés à Fr. 847.33
146. Satler, Christian, pour rép. à faire au moulin Fr. 85.-
147. Maison du vicaire, Fr. 50.-
148. La vielle cure à Mr. Le curé comme [...] Fr. 150.-
149. La maison de la paroisse Fr. 50.-

3934 Zeneggen
Population figure: 1850:194
Population figure 2000: 235
Revised damage assessment
Total loss: CHF 776.-

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001. Dans la chapelle, deux clefs de fer doivent être placer par le milieu de la chapelle, le clocher, toit, la voûte et les fentes endommagés par le tremblement de terre dans l'intérieur et é l'extérieur de la chapelle doivent être réparer. Fr. 190.-
002. Pour reconstruire une cheminée de la maison communale. Fr. 12.-
003. Pour réparer les fentes de l'intérieur de l' église. Fr. 40.-
004. Pour réparations de quelques fentes de la chapelle attique à l' église. Fr. 20.-
005. A Jean Joseph Müller, pour réparer une cheminée de la maison. Fr. 10.-
006. A Chrétien Zimmermann, pour réparer une cheminée de sa maison. Fr. 12.-
007. A Müller, Jean Pierre, pour réparer deux cheminées et le manteau de cheminée. Fr.24.-
008. Au Président Bitschi, pour faire à neuf une cheminée et réparer une autre ainsi que pour reconstructions d'une pièce de mur écroulé. Fr. 25.-
009. A Jean Joseph Müller, pour faire à neuf une cheminée depuis la cuisine et pour réparer une autre dans la maison. Fr. 36.-
010. A Pierre, Juon, pour une cheminée, dont une moitié doit être faite à neuf et l'autre moitié réparée ainsi que pour réparer le toit. Fr. 25.-
011. A Joseph Imwinkelried, pour sept toises de mur sec à faire, pour reconstructions de deux cheminées et pour réparations du toit. Fr. 100.-
012. A François Pfamatter et Jos. M. Müller, pour façon de cinq toises de mure. Fr. 50.-
013. A Chrétien, Zimmermann et consort, pour relever une grange à blé. Fr. 70.-
014. A Chrétien Andraes, pour façon de trois toises de mur à moitié pourri, et réparations d'une cheminée. Fr. 23.-
015. A Pierre Joseph Andraes, refaire la cheminée de la maison depuis le toit. Fr. 10.-
016. A Pierre Pfamatter, pour trois toises de mur sec dans la cave et pour reboucher quelques fontes dans deux salles. Fr.56.-
017. A François Andraes, pour refaire deux cheminées de la maison faire un angle de mur dans une salle et un bout de mur dans la maison. Fr. 45.-
018. A Antoine Schaller, juge, pour reboucher quelques fentes dans une salle et faire une cheminée. Fr.14.-
019. A Heldner, Felix, pour reconstruire un four à pain dont les pierres étaient vielles et sans grande valeur. Pour diverses petites réparations Fr. 20.-
021. A Saaser, pour réparations d'un vieux mur sec et pour quelques autres réparations dans la maison. Fr.30.-
022. A Babtiste Pfamatter, pour refaire un angle mur dans la cave, mure sec d'environ quatre toises. Fr. 12.-
023. A Juon, François, pour faire à neuf une cheminée et dans la cave un mur sec récrépé d'environ 22 toises qui soutient le reste. Fr.120.-
024. A Joseph Schaller, dans une des maisons à faire quelques réparations, dans l'autre une cheminée à faire à neuf. Fr.20.-
025. A Joseph Marie Andenmatten, pour faire à neuf une cheminée et pour réparer une autre. Fr. 25.-
026. Aux frères Imesch, pour faire une et demi toises de mur sec dans la cave. Fr.2.-
031. A Berchtold, Joseph, pour une cheminée et un toit à réparer. Fr.20.-
20. A Kenzelmann, Jean Chrétien, pour refaire deux cheminées et trois toises de mur sec. Fr. 35.-

Cette commune se recommande au haut gouvernement particulièrement sous le rapport de quelques fontaines dont mention se fait:

1. Dans le village appelé Eggerdörflein, ou il n'y a pas de l'eau ni peu ni beaucoup.
2. La fontaine aux raccards (in den stalden).

3. La prise d'eau de la fontaine servant à l' arrosement de quelques milles toises de pré.
4. La meunière des Hofmatter présente les mêmes difficultés.
5. La fontaine commune a aussi tari.

Appendix II: The 1964 Damage Assessment

The datasets originate from the following documents:

References

For the village Kerns:
Feldprotokolle zu den Erdbebenschäden von 1964 in Kerns. Originaldokumente mit den Nummern 140-219 und 241-326. Archive of the SED. Without signature.

Anmeldung von Erdbebenschäden. Kopien von sämtlichen eingereichten Schadensmeldungen im Zusammenhang mit den Erdbeben von 1964. Archive of Kerns. Without signature.

For all other villages:
Erdbeben 1964. Zusammenfassung der Schadensmeldungen. StAOW, V-A. 03.735.

While the field protocols related to Kerns include a damage description as well as an amount of damage in CHF, the recapitulatory lists regarding the other villages contain only loss in CHF. The coordinates rely on address information given by the documents.

Population figures for 1964 rely on: Bundesamt für Statistik (Ed.). 2002. Eidgenössische Volkszählung 2000. Bevölkerungsentwicklung der Gemeinden 1850-2000. Bundesamt für Statistik. Neuchâtel.

CH-6055 Alpnach
Population figure 1960 : 3'211
Population figure 2007 : 5'198
Total loss: CHF 471’000.-

	Building type	Approx.Position CH/XY		Damage description	Loss in SFr.
1.	-	662460	198830		280.-
2.	-	663560	198930		350.-
3.	-	661440	197390		400.-
4.	-	662480	198770		480.-
5.	-	663770	198540		530.-
6.	-	660980	197470		660.-
7.	-	663430	198950		770.-
8.	-	662150	198390		800.-
9.	-	663080	197630		800.-
10.	-	663690	199060		900.-
11.	-	663310	197840		970.-
12.	-	662830	198560		1000.-
13.	-	663100	197600		1080.-
14.	-	663520	198900		1200.-

15.	-	662420	198790	1200.-
16.	-	663370	199140	1300.-
17.	-	663710	199280	1320.-
18.	-	663510	199310	1340.-
19.	-	663260	199190	1400.-
20.	-	663340	199200	1430.-
21.	-	663570	199270	1470.-
22.	-	661480	197430	1500.-
23.	-	663610	199220	1670.-
24.	-	663370	199270	1770.-
25.	-	662290	198401	1800.-
26.	-	663520	198960	2000.-
27.	-	663630	199310	2020.-
28.	-	661910	199330	2430.-
29.	-	663250	198240	2600.-
30.	-	663510	198970	3040.-
31.	-	663540	198490	3500.-
32.	-	663610	198860	4240.-
33.	-	663525	199230	5700.-
34.	-	663620	199200	7950.-
35.	-	663710	199080	8070.-
36.	Kapelle	662186	198410	12000.-
37.	-	663845	199170	13900.-
38.	Kirche	663440	199220	368000.-

Alpnach-Stad (Alpnach)

1.	-	663710	200570	920.-
2.	Kapelle	663760	200640	8000.-

CH-6390 Engelberg

Population figure 1960 : 2’646
Population figure 2007 : 3'880
Total loss: CHF 6’400.-

	Building type	Approx. Position CH/XY		Damage description	Loss in SFr.
1.	-	675000	185500		450.-
2.	-	673960	186020		5950.-

CH-6074 Giswil
Population figure 1960 : 2'656
Population figure 2006 : 3'407
Total loss: CHF 35’500.-

	Building type	Approx. Position CH/XY		Damage description	Loss in SFr.
1.	-	655100	189450		300.-
2.	-	655810	188230		320.-
3.	-	656720	187100		500.-
4.	-	657370	188750		860.-
5.	-	657110	187790		1060.-
6.	-	655550	188610		2400.-
7.	Kirche	655580	188550		30000.-

CH-6064 Kerns
Population figure 1960 : 3'553
Population figure 2005 : 5'207
Total loss: CHF 1’429’000.-

	Building type	Approx. Position CH/XY		Damage description	Loss in SFr.
1.	Scheune/Stall	666450	196840	Scheune Ruedsperri: Mauerrisse;	50.-
2.	Wohnhaus	665030	195930	Wohnhaus und Scheune: Mauerrisse usw. (div. Kleine Risse)	80.-
3.	Wohnhaus	665430	196150	Wohnhaus: Kamin beschädigt, ebenfalls Ziegel, usw.	92.-
4.	Wohnhaus	666410	196880	Wohnhaus: Kamin beschädigt und Dachziegel zerbrochen, Mauerrisse aussen und innen, besonders in der Küche	100.-
5.	Gewerbegebäude	663780	194750	Lebensmittel (Oel usw.) vernichtet für ca. 150.--	100.-
6.	Wohnhaus	665030	194370	Wohnhaus: Mauerrisse	100.-
7.	Kleingebäude	665740	196130	Dörrofen: Kamin eingestürzt	126.-
8.	Wohnhaus	665360	195610	Wohnhaus: Mauerrisse usw.	149.-
9.	Scheune/Stall	664880	194670	Scheune: Mauerrisse, Jauchegrube gerissen	150.-
10.	Wohnhaus	666020	194580	Wohnhaus: Mauerrisse speziell in der Küche	150.-
11.	Wohnhaus	663740	193370	Wohnhaus: Kachelofen beschädigt, Mauerrisse	150.-
12.	Scheune/Stall	663940	196450	Scheune: Mauerrisse	150.-
13.	-	663250	194090	Sandgrube eingestürzt	150.-
14.	Kleingebäude	666130	196580	Dörrofen: Kamin eingestürzt	155.-
15.	Wohnhaus	665560	195490	Kellermauer nach innen eingestürzt, Kaminverputz	156.-
16.	Scheune/Stall	663620	195140	Scheune Huwel Mauerrisse,	160.-
17.	Kapelle	663680	194750	Kapelle: Beschädigungen innen durch Herausfallen von Verputz bei der Eingangstür; Ausbrechen von Teilen an den Kunststeinen aussen	170.-
18.	Scheune/Stall	664930	195140	Scheune Chlusen: Mauerrisse und Dachschaden	178.-

19.	Scheune/Stall	666040	195070	Scheune: unbedeutend	180.-
20.	Scheune/Stall	663510	196250	Scheune: Mauerrisse,	180.-
21.	Scheune/Stall	665370	194710	Scheune: leichte Risse	183.-
22.	-	663825	194585		200.-
23.	Scheune/Stall	663560	194420	Scheune: Mauerrisse	200.-
24.	Wohnhaus	665340	196270	Mauerrisse, Kamin beschädigt, Bsetzi zerrissen (Kleine Mauerrisse in Aussenwand, Risse im Vorplatzboden, Rissli im Kamin Estrich)	200.-
25.	Scheune/Stall	665300	195900	Scheune 2: Mauerrisse, Balken verschoben	200.-
26.	Scheune/Stall	665170	196140	Scheune 1: Brunnentrog beschädigt, Mauerrisse	200.-
27.	Scheune/Stall	666640	196750	Beide Scheunen: Mauerrisse	200.-
28.	Scheune/Stall	666650	196730	Beide Scheunen: Mauerrisse	200.-
29.	Wohnhaus	666740	196940	Haus Hostettli: Kamin unter dem Dach durchgespalten	200.-
30.	Scheune/Stall	665020	195910	Wohnhaus und Scheune: Mauerrisse usw. (div. Kleine Risse)	200.-
31.	Wohnhaus	666340	196110	Wohnhaus: Kamine beschädigt, Dach beschädigt	200.-
32.	Scheune/Stall	663670	195930	Scheune: Mauerrisse	200.-
33.	Scheune/Stall	664470	192590	Scheune: Mauerrisse, Mauerecke neu aufmauern	200.-
34.	Scheune/Stall	665990	194990	Wohnhaus: Kamine und Ofen beschädigt, Mauerrisse; Scheune: Güllenkasten zerrissen; Ökonomiegebäude: Mauerrisse.	200.-
35.	Scheune/Stall	666070	195300	Wohnhaus: Kamine und Ofen beschädigt, Mauerrisse; Scheune: Güllenkasten zerrissen; Ökonomiegebäude: Mauerrisse.	200.-
36.	Scheune/Stall	665250	194590	Jauchegrube gerissen	200.-
37.	Scheune/Stall	663291	195045	Scheune: grosse Mauerrisse	208.-
38.	Kleingebäude	665050	195260	Holzhütte: verstossen und Mauerrisse	220.-
39.	Wohnhaus	663630	194660	Wohnhaus: Mauerrisse und Kamin beschädigt, Badzimmerschaden	226.-
40.	-	663160	194607		230.-
41.	-				240.-
42.	Wohnhaus	663770	195690	Wohnhaus: Mauerrisse usw.	250.-
43.	Gewerbegebäude	663720	194680	Warenhalle: Kachelofen verschoben, Feuerwand, Decken und Böden gesenkt	260.-
44.	Wohnhaus	665540	196180	Wohnhaus: Stubenkamin und Ofen beschädigt;	270.-
45.	Wohnhaus	664160	194510	Hausmauer gerissen, Zwischenmauer gerissen	270.-
46.	Wohnhaus	665180	194410	Wohnhaus: Mauerrisse, Kamin	275.-
47.	Wohnhaus	663530	193590	Kamin beschädigt, Mauerrisse, Kachelofen in der Stube gerissen	280.-
48.	Wohnhaus	664145	195780	Mauern sehr stark zerrissen, Kamin beschädigt	290.-
49.	Wohnhaus	663080	193470	Wohnhaus: Kamin über Dach beschädigt;	298.-
50.	Scheune/Stall	663500	195240	Scheune: Mauerrisse	300.-
51.	Scheune/Stall	665280	192740	Untere Scheune: kleinere Mauerrisse	300.-
52.	-	664100	194280		300.-
53.	Scheune/Stall	665230	194160	Scheune: Einfahrtstock zerrissen	300.-
54.	Scheune/Stall	665360	194700	Scheune: Mauern zerrissen; Jauchegrube: Mauern zerrissen	300.-
55.	Scheune/Stall	663160	193730	Scheune: Mauerrisse	300.-
56.	Scheune/Stall	663440	193450	Scheune: Mauerrisse	300.-

57.	Scheune/Stall	663580	193330	Scheune Obholz: Mauern teilweise eingestürzt	300.-
58.	Scheune/Stall	663650	194770	Scheune Brunnenmatt: Mauerrisse	300.-
59.	Scheune/Stall	662985	194820	Obere Wolfgruben: Mauerrisse, Kamindeckel	310.-
60.	-	663960	194640		310.-
61.	Wohnhaus	663500	195260	Wohnhaus: 2 Kamine eingestürzt, Dach beschädigt, Mauerrisse;	320.-
62.	Wohnhaus	663320	195230	Mauerrisse, Boden zerrissen (Parterre), Boden im 2. Stock verzogen, 1 Kamin beschädigt	330.-
63.	Wohnhaus	665510	194920	Mauerrisse, Kamin beschädigt	330.-
64.	Wohnhaus	663600	195170	Wohnhaus: kleinere Mauerrisse, Feuerwände in der Küche weggerissen	340.-
65.	Scheune/Stall	666440	196760	Wohnhaus: Kamin beschädigt und Dachziegel zerbrochen, Mauerrisse aussen und innen, besonders in der Küche; Scheune Ruedsperri: Mauerrisse; Scheune Niederwil: Mauerrisse, Einfahrtstock zerrissen, Güllenkasten zerrissen, ganze Scheune verschoben	350.-
66.	-	663940	194620		360.-
67.	-	663850	194820		360.-
68.	Wohnhaus	663820	194815	Kamin beschädigt, Mauerrisse	360.-
69.	Scheune/Stall	665230	195070	Scheune: Mauerrisse ;	370.-
70.	Wohnhaus	665270	194570	Mauerrisse usw.	370.-
71.	Scheune/Stall	666110	196580	Scheune: Mauerrisse	380.-
72.	Kleingebäude	665540	195470	Waschhütten Kamin beschädigt	380.-
73.	Wohnhaus			Aussenmauern: Auf der Süd- und Nordseite des Wohnhauses sind in den Grundmauern senkrechte Risse von ca. 1mm Breite festzustellen. Diese sind auf der Nordseite durchgehend und auch in den Innenräumen sichtbar.; Kamin der Ölfeuerungsanlage: Der Kamindeckel löste sich und fiel auf das mit Eternit gedeckte Hausdach, wo er einige Platten beschädigte.; Einfeuerung und Kamin der alten Heizungsanlage: Es sind einige grössere Risse sichtbar. Der Verputz ist teilweise abgebröckelt. Diese unbenützte Anlage muss vermutlich abgebrochen werden.; Allgemein: In einigen Zimmern (besonders Badzimmer und Küchen) im 1. und 2. Stock sind Schäden am Verputz oder Farbanstrich entstanden.	400.-
74.	Scheune/Stall	663100	194890	Obere Scheune: Mauerrisse, Jauchegrube	400.-
75.	Scheune/Stall	664240	193950	Scheune: Mauerrisse	400.-
76.	Kleingebäude	665030	195280	Dörrofen: neues Kamin defekt	400.-
77.	Scheune/Stall	664260	195860	Scheune: Mauerrisse	400.-
78.	Scheune/Stall	664280	191940	Scheune: Mauerrisse	400.-
79.	Wohnhaus	665370	193490	Wohnhaus: Kamin beschädigt, Mauerrisse, Ziegel ersetzen	400.-
80.	Scheune/Stall	665440	195590	Scheune Rütiflueh: Mauerrisse	400.-
81.	Wohnhaus	666900	196950	Wohnhaus: Kaminschäden	409.-
82.	Wohnhaus	665125	195690	Kamin beschädigt, Mauerrisse, Kellerboden zerrissen	420.-
83.	Wohnhaus	663800	195130	Kamin und Dach beschädigt, Mauerrisse (Kachelofen)	420.-

84.	Wohnhaus	666180	196580	Wohnhaus: Kamin beschädigt, Mauerrisse	429.-
85.	Kleingebäude	663120	194880	Dörrofen: Kamin und Mauerrisse	429.-
86.	Wohnhaus	665280	192740	Wohnhaus: kleinere Risse;	430.-
87.	Wohnhaus	663530	194860	Mauerrisse, Plättli im Bad zersprengt	430.-
88.	Wohnhaus	665740	196170	Wohnhaus: Hauptkamin von oben bis unten gespalten;	430.-
89.	Scheune/Stall	666150	196560	Scheune: Mauerrisse, Dachstuhl verschoben;	432.-
90.	Scheune/Stall	665590	196020	Mauern stark beschädigt	440.-
91.	Wohnhaus	665450	196170	Kamin und Dach beschädigt, Mauerrisse	440.-
92.	Scheune/Stall	665420	195330	Mauern stark beschädigt	440.-
93.	Wohnhaus	665080	194960	Wohnhaus: 2 Kamine beschädigt, Plättli in der Küche zersprungen;	450.-
94.	Wohnhaus	663245	194700	Holzkonstruktion verzogen, Mauerrisse in der Küche, Kamin beschädigt (Westfassade beim Dachstuhl herausgedrückt, Verputzstreifen abgestossen, Kamin über Dach abgedreht)	450.-
95.	Wohnhaus	663260	194720	Mauerrisse, Ofen beschädigt (Risse im Vorplatz und Sockelmauern, Ofendeckel verschoben)	450.-
96.	Kleingebäude	664100	195060	Dörrofen: Kamin eingestürzt, Mauern eingestürzt	450.-
97.	Wohnhaus	666630	196760	Wohnhaus: Mauerrisse;	460.-
98.	Wohnhaus	663270	193860	Wohnhaus: Mauerrisse, Kachelofen	468.-
99.	Wohnhaus	663540	194860	2 Kamine beschädigt, 1 Kachelofen beschädigt, Mauerrisse in den Grundmauern aussen und innen	470.-
100.	Wohnhaus	663850	193371	Grosse Risse in den Mauern (Sockelmauern gerissen, Kamin Kopf + Hut defekt, Kachelofen leicht beschädigt)	470.-
101.	Wohnhaus	666470	196730	Wohnhaus alt, Grundmauern flicken, Kamin über Dach neu erstellen, Dachziegel	480.-
102.	Scheune/Stall	663645	193310	Scheune: Mauerrisse ;	486.-
103.	-	663820	194700		500.-
104.	Scheune/Stall	665530	194900	Scheune: Mauerrisse	500.-
105.	Wohnhaus	665000	194347	Glaswaren (Flaschen, 200.--), Ladenwaage (300.--)	500.-
106.	Scheune/Stall	665270	194590	Mauerrisse, Mauerecke, Jauchegrube gerissen	500.-
107.	Scheune/Stall	664430	194290	Scheune: Mauerrisse	500.-
108.	Wohnhaus	663410	194130	Wohnhaus: Mauerrisse und Kamin beschädigt;	500.-
109.	Scheune/Stall	663270	194090	Scheune: Mauerrisse; Jauchekasten: Mauer zerrissen	500.-
110.	Wohnhaus	664260	196134	Kamine beschädigt, Hausgang Risse, ebenso Hausmauer, Zentralheizung beschädigt, Reparatur des Kühlschranks 140.--	500.-
111.	Scheune/Stall	664810	195350	Scheune: Mauerrisse	500.-
112.	Scheune/Stall	666566	196900	Scheune Hostettli: Mauer herausgestürzt;	500.-
113.	Wohnhaus	666040	196130	Kamin dacheben eingestürzt, Mauerrisse; (Stall: Mauerecke, Jauchegrube)	500.-
114.	-	663880	195950		500.-
115.	Scheune/Stall	665380	193510	Schweinestall: Mauerrisse, Jauchekasten zerrissen	500.-

116.	Wohnhaus	663620	194430	Wohnhaus: Starke Mauerrisse, Ofen losgerissen	506.-
117.	Wohnhaus	663660	194720	Mauerrisse usw.	506.-
118.	Wohnhaus	663600	194596	Kamin beschädigt, Mauerrisse in der Feuerwand	510.-
119.	Wohnhaus	665420	195410	Wohnhaus: Kamin und Ofen beschädigt	510.-
120.	Wohnhaus	664140	194240	Risse in der Mauer, usw. (Küche Riss an Aussenwand, um Kamin und Ofen, Kamin im Estrich, Dachziegel)	540.-
121.	Wohnhaus	663820	195270	Wohnhaus: 2 Kamine beschädigt, Mauerrisse, Plättli in der Küche gespalten, Zentralheizungsofen beschädigt	540.-
122.	-	663850	194470		550.-
123.	Wohnhaus	663250	194670	Mauerrisse	550.-
124.	Wohnhaus	663990	195460	2 Kamine beschädigt	550.-
125.	Wohnhaus	664430	194320	Wohnhaus: Kamine beschädigt, Ofen beschädigt, Mauerrisse	558.-
126.	Kleingebäude	663420	194720	Dörrofen: Kamin eingestürzt, Dach beschädigt	590.-
127.	Scheune/Stall	665420	195430	Rütiflüehli: Mauerrisse	595.-
128.	Wohnhaus	663290	194900	Mauerrisse usw. (Treppe aussen abgesenkt, Vorplatz nachgerissen, Waschküche)	600.-
129.	Scheune/Stall	667390	196855	Jauchekasten beschädigt, Mauerrisse (Kuhstall div. Mauerrisse)	600.-
130.	Wohnhaus	663610	193790	Mauerrisse	600.-
131.	Wohnhaus	663580	193300	Wohnhaus Hostettli: 2 Kamine bis Dach eingestürzt und Mauerrisse	600.-
132.	Scheune/Stall	664910	193870	Scheune Biel: Mauerrisse, 6 Tage Arbeit	600.-
133.	Scheune/Stall	664990	194360	Scheune: Jauchekasten beschädigt und Mauerrisse	600.-
134.	Wohnhaus	663645	193280	Wohnhaus: 2 Kamine beschädigt, Mauerrisse, Zementboden im Keller zerrissen;	606.-
135.	Wohnhaus	664240	191940	Wohnhaus: Mauerrisse, Kamin	610.-
136.	Scheune/Stall	665830	194500	Scheunen: Mauerrisse	626.-
137.	Wohnhaus	663750	195580	Kamin beschädigt, Mauerrisse	630.-
138.	Gewerbegebäude	663630	195940	Mauerrisse (Kachelofen, Kamin)	630.-
139.	Wohnhaus	665440	197370	Ofen und Kamine beschädigt (Risse in Grundmauern)	640.-
140.	Wohnhaus	665440	197400	Wohnhaus Kernwald: Kaminhut, Kaminriss	640.-
141.	Scheune/Stall	665280	193910	Scheune: Mauerrisse	645.-
142.	-	663925	194760		650.-
143.	Scheune/Stall	665315	194970	Scheune: Mauerrisse	650.-
144.	Scheune/Stall	664860	195530	Scheune: Mauerrisse, Jauchegrube beschädigt	650.-
145.	Wohnhaus	663436	193432	Wohnhaus: Mauerrisse	660.-
146.	-	663260	194800		660.-
147.	Wohnhaus	665200	194310	Wohnhaus: Mauerrisse, Kamine	660.-
148.	Scheune/Stall	665200	194340	Scheune Ellenried: Mauerrisse Verputz neu	660.-
149.	Scheune/Stall	663436	193412	Scheune: Mauerrisse	660.-
150.	Wohnhaus	663600	194370	Mittelmauer verschoben, 2 Kachelöfen beschädigt, Kamin beschädigt, Mauerrisse	670.-

151.	Wohnhaus	663720	194700	Mauerrisse in Küche und Stiegenhaus, Kamin beschädigt	670.-
152.	Scheune/Stall	663440	194730	Scheune: Mauerrisse	680.-
153.	Wohnhaus	663680	194740	Mauerrisse usw.	680.-
154.	Wohnhaus	665320	194720	Ofen beschädigt, Mauerrisse und Gips losgerissen	690.-
155.	Scheune/Stall	663610	194650	Scheune: Mauerrisse	692.-
156.	Wohnhaus	664970	194060	Wohnhaus: Kamin beschädigt	700.-
157.	Wohnhaus	664830	194650	Wohnhaus: 3 Kamine beschädigt, Mauerrisse, Dach beschädigt	700.-
158.	Wohnhaus	663940	196470	Wohnhaus: Mauerrisse aussen und in der Küche, Kamine beschädigt, Kamin neben Stubenofen gerissen	700.-
159.	Scheune/Stall	664160	194960	Scheune: Dach beschädigt	710.-
160.	Wohnhaus	665195	194130	Sigristenhaus: Mauerrisse und Kamine beschädigt	720.-
161.	-	664022	194556		730.-
162.	Wohnhaus	665370	195560	Wohnhaus: 2 Kamine beschädigt, kleinere Mauerrisse	730.-
163.	-	663710	194800		730.-
164.	Scheune/Stall	665370	195560	Scheune: Mauerriss	730.-
165.	Scheune/Stall	665280	192710	Obere Scheune: Mauern sehr stark beschädigt	740.-
166.	-	663606	194362		750.-
167.	Wohnhaus	663580	193910	Mauerrisse, Feuerwand gerissen, Decken im Erdgeschoss gerissen, Betonpfeiler zerbrochen, Verputz an der Wand dorfseits lose	750.-
168.	Wohnhaus	663590	195760	Ofen beschädigt, Risse in den Grundmauern (Kachelofen-Sitzbank lose)	770.-
169.	Wohnhaus	664430	192550	Wohnhaus: Mauerrisse, Risse im Kachelofen; Anbau: Mauerrisse;	770.-
170.	Wohnhaus	663430	194820	Wohnhaus: Kamin und Gipsdecken beschädigt, Grundmauerrisse	790.-
171.	Scheune/Stall	662985	194840	Scheune: Mauerrisse, Jauchegrube beschädigt (Mauer verschoben und gerissen, Holzwerk nicht im Senkel)	800.-
172.	-	663939	194670		800.-
173.	-	663240	194750		800.-
174.	Scheune/Stall	663410	193680	Scheune: Jauchegrube Risse	800.-
175.	Wohnhaus	663590	196185	Kamin beschädigt	800.-
176.	-	663940	196000		810.-
177.	-	663313	194720		820.-
178.	Wohnhaus	664830	195370	Wohnhaus: 2 Kamine beschädigt, starke Mauerrisse	820.-
179.	Wohnhaus	663090	194970	Wohnhaus: Mauerrisse, 2 Kamine beschädigt;	829.-
180.	Wohnhaus	664800	195370	Wohnhaus: 2 Kamine beschädigt, ebenfalls Stubenofen, Mauerrisse	835.-
181.	Wohnhaus	663610	194293	Kamin beschädigt, Mauerrisse	840.-
182.	Wohnhaus	665710	195730	Wohnhaus: 2 Kamine beschädigt, Mauerrisse;	849.-
183.	Wohnhaus	666920	197010	Wohnhaus: 2 Kamine eingestürzt, Mauerrisse;	875.-
184.	Scheune/Stall	666940	197030	Scheune: Mauer teilweise eingestürzt	875.-
185.	Wohnhaus	664010	196540	Dachbalken verschoben, Mauerrisse, Güllenkasten hat Risse, Decke im Keller gesenkt	880.-

186.	Wohnhaus	666300	196660	Wohnhaus: 3 Kamine beschädigt, Mauerrisse;	882.-
187.	-	664240	194510		890.-
188.	-	663933	194625		890.-
189.	Wohnhaus	663810	194780	Kamin beschädigt, bis 1. Stock hinunter, Risse in Grundmauern, Glasscheibe in einem Schrank zersplittert	900.-
190.	Wohnhaus	665470	195997	2 Kamine beschädigt	900.-
191.	-	665224	195630		900.-
192.	Wohnhaus	665230	194120	Wohnhaus: 2 Kamine beschädigt, Mauerrisse	900.-
193.	Wohnhaus	664710	194860	Grundmauern und Feuerwand teilw. Neu verputzen, WC-Schüssel gesprungen, Dachziegel ersetzen, Kamine reparieren	900.-
194.	Scheune/Stall	664950	194330	Scheune: starke (sehr viele kleine) Mauerrisse	900.-
195.	Scheune/Stall	663170	194070	Scheune: Neue Mauer, Verputz	900.-
196.	Wohnhaus	665440	196140	Wohnhaus: Kamine beschädigt; Scheune: Starke Mauerrisse	910.-
197.	Wohnhaus	666480	196770	Landgut Schwandi: Kamin umgestürzt und Dach beschädigt	920.-
198.	-	663620	195450		920.-
199.	Wohnhaus	663750	194880	Mauerrisse usw. (Parterremauer, Flachdach nachflicken, Kamine, Dachdecker)	940.-
200.	Wohnhaus	663740	194800	(Neubau) Wohnhaus: Schaufenster und Tragwände beschädigt;	950.-
201.	Kleingebäude	663635	193300	Ökonomiegebäude: Mauerrisse	967.-
202.	-	664040	194310		970.-
203.	Wohnhaus	663980	195450	Wohnhaus: Kamindeckel, Mauerrisse, Ziegel beschädigt	970.-
204.	Scheune/Stall	663970	195430	Scheune: Holzkonstruktion auseinander gerissen, Steinplatte vor Scheune zerrissen	970.-
205.	Wohnhaus	663270	195320	Ofen und Kamin beschädigt, Mauerrisse	980.-
206.	Wohnhaus	665010	194710	1 Kamin beschädigt, Mauerrisse	990.-
207.	Wohnhaus	665440	195720	Starke Mauerrisse	990.-
208.	Wohnhaus	665730	195920	Wohnhaus: Grundmauern gerissen, Kamin beschädigt	1000.-
209.	Wohnhaus	665335	194950	Wohnhaus: 3 Kamine beschädigt, Mauerrisse;	1000.-
210.	Wohnhaus	664280	195860	Wohnhaus: 2 Kamine beschädigt, eines bis auf das Fundament, Mauerrisse	1000.-
211.	Wohnhaus	663670	195960	Wohnhaus: Kamin hinuntergefallen, Mauerrisse	1000.-
212.	Scheune/Stall	663790	194770	Schweinestall Rossfang: Mauerrisse innen, Decken stark beschädigt	1000.-
213.	Scheune/Stall	665710	195940	Güllenkasten leck Mauerrisse	1000.-
214.	Scheune/Stall	666490	196750	Landgut Mettenberg, Scheune: Mauerrisse	1002.-
215.	Wohnhaus	663890	195590	Mauerrisse usw. (Decke in Stube, Kamin, diverse Risse im Wohngeschoss, Fassadenverputz und Aussenmauern)	1010.-
216.	-	663733	194770		1010.-
217.	Scheune/Stall	663270	193830	Scheune Grund: Mauerrisse	1023.-

218.	Wohnhaus	665200	195670	Ofen beschädigt, Kamin beschädigt, Mauerrisse	1030.-
219.	-	663380	195950		1030.-
220.	Wohnhaus	663720	194812	Kamin-Risse, Hausstiege gesenkt, Stütze hat Risse (649.--); Lebensmittel-Schäden (320.--)	1030.-
221.	-	664131	194254		1050.-
222.	-	664153	194967		1050.-
223.	-	663740	194840		1080.-
224.	-	665020	194740		1100.-
225.	Scheune/Stall	663630	193780	Mauerrisse	1100.-
226.	Wohnhaus	663710	194600	2 Kamine beschädigt (TV Reparatur)	1100.-
227.	Gewerbegebäude	663740	194680	Kühlhaus: Fassade bei Decke abgerissen, Risse im Innern und am Kamin	1110.-
228.	Wohnhaus	664845	194490	Wohnhaus: Kamine beschädigt, Mauerrisse, Dach beschädigt, Mauerrisse an Scheune	1150.-
229.	Scheune/Stall	663480	193920	Scheune: Mauerrisse	1150.-
230.	-	663830	194570		1160.-
231.	Wohnhaus	663620	195400	Wohnhaus: Mauerrisse	1160.-
232.	Scheune/Stall	663610	195430	Scheune: Grosse Mauerrisse, eine Seitenmauer wurde schräg	1160.-
233.	Scheune/Stall	663760	193390	Scheune Hostet: Mauerrisse	1200.-
234.	Scheune/Stall	665560	195450	Scheunenmauer auf einer Seite nach aussen gestürzt	1200.-
235.	Wohnhaus	663820	194620	Kamin stark beschädigt	1210.-
236.	Wohnhaus	662910	194765	Wohnhaus: Mauerrisse im Stübli	1220.-
237.	Scheune/Stall	662930	194745	Scheune: Mauerrisse	1220.-
238.	-	664088	194470		1230.-
239.	Gewerbegebäude	663695	194590	Wohnhaus mit Werkstätte: 3 Kamine und Dach beschädigt, Mauerrisse	1230.-
240.	Wohnhaus	665510	194900	Wohnhaus: Mauerrisse, Kaminschäden;	1240.-
241.	Scheune/Stall	665310	195800	Wohnhaus: 2 Kamine beschädigt; Alp Säbel (Hütte und Melkgaden): Mauern sehr stark beschädigt, teilweise eingestürzt	1240.-
242.	Wohnhaus	664260	196200	Grosse Mauerrisse im Keller, aussen und innen, Kamin beschädigt, Kachelofen in Stube beschädigt	1250.-
243.	Scheune/Stall	664230	196200	Mauern stark zerrissen	1250.-
244.	Wohnhaus	664630	192350	Wohnhaus: Kaminschäden, Dach beschädigt, Mauerrisse, Kachelofen in der Stube verschoben und weggerissen;	1252.-
245.	Wohnhaus	633530	194780	Mauerrisse im Stiegenhaus	1260.-
246.	Wohnhaus	663600	195420	2 Kamine und Kamin-Fundament beschädigt, Mauerrisse	1260.-
247.	Scheune/Stall	663760	193370	Scheune Acher: Mauerrisse	1260.-
248.	Scheune/Stall	663620	195300	Mauerrisse	1260.-
249.	Wohnhaus	664640	194290	Kamin und Ofen beschädigt im 1. Stock, Ofen im 2. Stock weitergerutscht	1270.-
250.	Wohnhaus	665820	194520	Wohnhaus: 2 Kamine und Kachelofen beschädigt, Mauerrisse	1286.-
251.	Scheune/Stall	665440	196150	Scheune: Mauerrisse, Mauer eingestürzt	1288.-
252.	-	664140	194270		1300.-
253.	Scheune/Stall	663600	195140	Scheune Rigiblick Mauerrisse, neue Seitenmauer	1300.-
254.	Wohnhaus	663950	194950	2 Kamine beschädigt, Mauerriss (Sockelmauer innen + aussen, Feuerwand	1300.-

				Kamin Küche, Küchenwand innen neu verputzt, Ziegel)	
255.	Gewerbegebäude	665010	195950	Druckleitung: beschädigt; Sägereigebäude: Ziegel- und Kaminschaden, Mauerrisse	1320.-
256.	Scheune/Stall	664660	192410	Scheune: Mauern stark beschädigt	1320.-
257.	Scheune/Stall	664760	192380	Scheune: Mauern stark beschädigt	1320.-
258.	Scheune/Stall	664290	195190	Scheune: Einfahrtsstock zerrissen, Mauerrisse, Strahlenapparat 2x beschädigt	1330.-
259.	Wohnhaus	663360	195380	Wohnhaus: Kamin beschädigt, Ofen beschädigt, Mauerrisse, Vorlaube verschoben;	1338.-
260.	Scheune/Stall	665560	195960	Scheune: Mauerrisse, Holzkonstruktion verschoben	1340.-
261.	Scheune/Stall	666576	196900	Scheune Sitz: Mauer herausgestürzt	1350.-
262.	Wohnhaus	663680	194900	Fensterscheiben zersplittert, Mauerrisse, 2 Kamine beschädigt, Dach beschädigt	1350.-
263.	Wohnhaus			Mauerrisse, Kachelofen, Kamin und Täfer im Haus beschädigt	1358.-
264.	Scheune/Stall	663390	195370	Scheune: Jauchekasten beschädigt, Mauerrisse und Rauchkamin	1360.-
265.	Gewerbegebäude			Mauerrisse, Kamin	1360.-
266.	Gewerbegebäude	633705	194680	beide Kamine defekt (müssen ersetzt werden) Hausmauer und Garage Risse Küchendecken im 1. U. 2. Stock beschädigt, Plättliwand in Küche beschädigt	1400.-
267.	Scheune/Stall	663080	193490	Scheune: Vorderfront der Mauer zerstört	1400.-
268.	Scheune/Stall	665140	194450	Scheune Uechtern: neue Mauer	1418.-
269.	-	664210	194820		1430.-
270.	Wohnhaus	664860	187350	Kamin von der Wand gerissen, Mauerrisse aussen und innen, Gipsdecken beschädigt	1430.-
271.	Wohnhaus	664890	187370	Chalet Erni: Grundmauern zerrissen	1430.-
272.	Wohnhaus	663750	194300	2 Kamine beschädigt, in der Küche Mauer und Plättli zerrissen	1440.-
273.	-	663961	194714		1480.-
274.	-	663610	194352		1480.-
275.	-	663800	194575		1490.-
276.	-	663800	194730		1490.-
277.	-				1500.-
278.	-	664130	194965		1500.-
279.	Wohnhaus	663700	194375	Mauerrisse	1510.-
280.	Wohnhaus	664020	191740	Mauerrisse usw.	1540.-
281.	Scheune/Stall	664040	191720	Mauerrisse usw.	1540.-
282.	Wohnhaus	665970	197560	Kamin stark beschädigt, Mauerrisse	1550.-
283.	Scheune/Stall	666220	196380	Scheune: Starke Mauerrisse	1550.-
284.	Wohnhaus	663815	195100	Wohnhaus: 2 Kamine beschädigt	1560.-
285.	Scheune/Stall	663835	195130	Scheune: Mauerrisse	1560.-
286.	Kleingebäude	664890	195530	Anbau Saustall: Neue Mauer	1564.-
287.	Wohnhaus	664940	194060	Wohnhaus Reih: 3 Kamine beschädigt, Mauerrisse	1600.-
288.	Wohnhaus	666030	195020	Wohnhaus: Kamine und Ofen beschädigt, Mauerrisse; Scheune: Güllenkasten zerrissen; Ökonomiegebäude: Mauerrisse	1600.-
289.	Scheune/Stall	665160	194430	Scheune Wasserwendi: 16 Tage Flickarbeiten	1600.-

290.	Kleingebäude	664930	194090	Dörrofen Reih: Kamin eingestürzt, Dach beschädigt, Risse in der Mauer	1600.-
291.	Wohnhaus	665075	195585	Wohnhaus Ehrli: 2 Kamine beschädigt, Dach beschädigt, kleinerer Mauerrisse	1600.-
292.	Wohnhaus	664430	194440	Kamin abgestürzt. Im Innern des Hauses ist es gerissen, Wasserleitung von Scheune bis Wohnhaus unterbrochen	1650.-
293.	Wohnhaus	663170	194110	Wohnhaus: Sockelmauer neu, Kamin, Küche, Dachausbau, Mauerrisse	1650.-
294.	Wohnhaus	665280	193950	Wohnhaus: 2 Kamine beschädigt, Mauerrisse Grundmauern und Keller	1650.-
295.	Scheune/Stall	665210	194160	Kleine Scheune: grosse Mauerrisse;	1700.-
296.	-	663922	194692		1710.-
297.	Gewerbegebäude	663800	194700	Eisenhandlung: 2 Kamine abgerissen, 1 Kamindeckel heruntergefallen und gebrochen, Schaden im Warenlager im Betrag von ca. 400.--, Risse im Mauerwerk; Schlosserei: 2 Kamine beschädigt, Risse und Verputzschaden im oberen und unteren Gang und in der Küche	1710.-
298.	Scheune/Stall	666440	196420	Scheune: 2 Mauern zerrissen	1715.-
299.	Wohnhaus	663750	194820	Kamin beschädigt, Heizung für Restaurant beschädigt, Mauerrisse, innen (872.--); Schäden an Getränken usw. (749.90)	1740.-
300.	Scheune/Stall	664660	193850	Scheune: Neue Mauer, Mauerriegel Westseite, Mauerrisse	1740.-
301.	-	663690	194630		1750.-
302.	Wohnhaus	663800	193371	Grosse Mauerrisse, Sockelmauer Abbruchreif	1760.-
303.	Wohnhaus	663970	193960	Mauerrisse usw.; (Fabrikgebäude: Mauerecke neu, Mauerrisse kleiner, Ventilatorhaus abgetrennt, Tableauraum); (Kamin auf Spähnsilo); (Wohnhaus: Mauerrisse); (Wohnhaus (Untermieter): Kamine)	1770.-
304.	Fabrikgebäude	663970	193980	Mauerrisse usw.; (Fabrikgebäude: Mauerecke neu, Mauerrisse kleiner, Ventilatorhaus abgetrennt, Tableauraum); (Kamin auf Spähnsilo); (Wohnhaus: Mauerrisse); (Wohnhaus (Untermieter): Kamine)	1770.-
305.	-	663420	195000		1780.-
306.	Wohnhaus	663780	194740	Wohnhaus: 3 Kamine beschädigt; Schweinestall Rossfang: Mauerriss innen, Decken stark beschädigt	1790.-
307.	Wohnhaus	663640	194700	Ofen beschädigt usw.	1800.-
308.	Wohnhaus	663510	196230	Wohnhaus: Mauerrisse, Kachelofen beschädigt (Risse im Erdgeschoss);Jauchekasten beschädigt	1800.-
309.	Wohnhaus	664930	193850	Wohnhaus Biel: Mauer- und Kaminrisse;	1800.-
310.	Wohnhaus	663640	194730	Scheune: Mauerrisse	1800.-
311.	Wohnhaus	663710	194860	Kamine beschädigt, Mauerrisse innen, Ziegel beschädigt	1830.-
312.	Wohnhaus	665370	194740	Wohnhaus: Mauerrisse, Kamine beschädigt, Dörrofen weist starke Risse auf	1831.-

313.	Wohnhaus	663610	194570	Mauern zerrissen, in der Küche Kamin zerrissen	1840.-
314.	-	663740	194390		1920.-
315.	Wohnhaus	663750	194840	Kamin beschädigt, Ofen zerrissen	1920.-
316.	Wohnhaus	663650	194740	Wohnhaus: Kamine beschädigt, ca. 80 Ziegel beschädigt, Mauerrisse innen und aussen;	1945.-
317.	Scheune/Stall	664340	195300	Scheune Ried Wisserlen: starke Mauerrisse, neue Mauer erstellen	1970.-
318.	Scheune/Stall	666340	196150	Scheune: Mauerrisse	1990.-
319.	-	663872	194647		2000.-
320.	Wohnhaus	664340	195270	Wohnhaus: Mauerrisse aussen und im Stiegenhaus, Kamine beschädigt	2017.-
321.	Wohnhaus	663815	195260	Wohnhaus: 2 Kamine beschädigt, Dach beschädigt, Grundmauern zerrissen	2060.-
322.	Kleingebäude	663800	195250	Garage: Dach beschädigt, Mauerrisse	2060.-
323.	Wohnhaus	663600	194770	2 Kamine beschädigt, Zwischenmauer Estrich zusammengefallen, Ziegelschaden	2070.-
324.	Scheune/Stall	663260	193840	Scheune Wyher: Mauerrisse, ein Loch in der Mauer	2102.-
325.	-	663530	194450		2110.-
326.	Wohnhaus	663710	194930	1 Kamin beschädigt, Mauerrisse,	2150.-
327.	Gewerbegebäude	663730	194920	1Kamin und 1 Ofen Beschädigt, Fensterstürze beschädigt	2150.-
328.	Wohnhaus	663740	194740	Postgebäude: Kamin beschädigt, feine Mauerrisse, innen Innenmauern zerrissen, Decken beschädigt	2160.-
329.	-	664151	194244		2210.-
330.	Scheune/Stall	665215	196370	Scheune: Rossstall grosser Mauerriss, Güllenkasten ebenfalls	2234.-
331.	Wohnhaus	663670	194800	Wohnhaus mit Garage: Mauerrisse usw.	2310.-
332.	-	664120	194215		2350.-
333.	Wohnhaus	666040	195030	Mauerrisse; Kachelofen unbrauchbar	2350.-
334.	Wohnhaus			Mauerrisse und Deckenschäden	2360.-
335.	-	663835	194455		2370.-
336.	-	664430	195640		2380.-
337.	Scheune/Stall	666900	196990	Scheune: Mauerrisse	2391.-
338.	Wohnhaus	662810	191990	Kamine beschädigt, Dach beschädigt, Gipsschäden innen, kleinere Mauerrisse	2400.-
339.	Wohnhaus	663794	194810	Wohnhaus: Mauerrisse in der Backstube, Vorräte im Geschäft und Keller Stark beschädigt, Nebengebäude: Kamin beschädigt, Balken auseinander gerissen	2450.-
340.	Scheune/Stall	664960	194330	Scheune: Mauern teilweise eingestürzt (Einsturzgefahr)	2450.-
341.	Wohnhaus	663750	195190	Wohnhaus: Anbau von Hauswand weggerissen und verschoben, Kamin- und Ziegelschäden, Gips- und Mauerschäden	2460.-
342.	-	664089	194600		2480.-
343.	Kleingebäude	664170	195290	Dörrofen: Kamin eingestürzt, Mauerrisse	2500.-
344.	Scheune/Stall	665430	196140	Scheune: Starke Mauerrisse	2500.-
345.	-	664130	195870		2500.-
346.	Wohnhaus	666100	196590	Wohnhaus: 2 Kamine beschädigt, Dach beschädigt, Kachelofen undicht	2505.-
347.	Scheune/Stall	665540	196160	Scheune: Mauer stark beschädigt	2520.-
348.	Wohnhaus	665380	194720	Wohnhaus: Kachelofen in der Stube stark beschädigt, Mauerrisse	2560.-
349.	-	663440	194800		2570.-

350.	Wohnhaus	663160	193750	Wohnhaus mit Ökonomiegebäude: Mauerrisse, aussen und innen, Küche und Gang	2590.-
351.	Wohnhaus	665210	196120	Wohnhaus: Mauerrisse und Bsetzi beschädigt, Kamin und Dach beschädigt, Kachelofen beschädigt	2599.-
352.	-	665180	195950		2600.-
353.	Wohnhaus	664280	195250	Wohnhaus: 2 Kamine beschädigt, teilw. Eingestürzt, Mauerrisse	2600.-
354.	Wohnhaus	663281	195025	Wohnhaus: 2 Kamine beschädigt, Kachelofen in der Stube beschädigt, Mauerrisse, im Bad 2 Fenster zersplittert	2622.-
355.	Scheune/Stall	664900	193890	Scheune Wasserwendi: Mauer teilweise eingestürzt	2630.-
356.	-	664240	194800		2640.-
357.	-	663470	195840		2640.-
358.	Wohnhaus	664490	196130	2 Kamine stark beschädigt, sowie Ofen stark zerrissen, Grundmauer beschädigt (Scheune Jauchegrube)	2650.-
359.	Wohnhaus	665340	195830	Wohnhaus: 2 Kamine beschädigt; Alp Sädel (Hütte und Melkgaden): Mauern sehr stark beschädigt, teilweise eingestürzt	2668.-
360.	Wohnhaus	663900	193970	Mauerrisse, Kamin beschädigt	2680.-
361.	Wohnhaus	666920	197015	Wohnhaus: Kamin beschädigt, Kachelofen zerrissen, Mauerrisse	2680.-
362.	Scheune/Stall	666920	197015	Scheune: Mauerrisse	2680.-
363.	Wohnhaus	663620	195500	Ofenkamin eingestürzt, Hausmauer hat Risse	2700.-
364.	Scheune/Stall	665250	195610	Scheune: Mauerrisse usw.	2740.-
365.	Wohnhaus	664960	194350	Wohnhaus: Kamine und Öfen beschädigt, Mauerrisse;	2850.-
366.	Scheune/Stall	665050	195280	Scheune Chlusen: Kaminschoss verrissen, Kamin einzügen	2850.-
367.	-	663864	195950		2860.-
368.	Wohnhaus	663660	194740	Haus Alpenblick: Deckenrisse in allen Zimmern; Parterre: Gang, Esszimmer, Stube, Arbeitszimmer, Küche, Aufgang zum 1. Stock, dazu auch teilweise Risse in den Aussenmauern; Stock 1: Risse in den Decken von 5 Schlafzimmern Mittelgang, Badezimmer und WC; starke Beschädigung der Untersichten, die von zwei Jahren vollständig neu gemacht worden sind	2883.-
369.	-	663870	194800		2940.-
370.	Wohnhaus	664925	194590	Wohnhaus: 2 Kamine eingestürzt, Risse in den Mauern, Dach beschädigt	2950.-
371.	Scheune/Stall	664905	194570	Scheune: Mauerrisse	2950.-
372.	-	664100	194650		2980.-
373.	Wohnhaus	665350	194580	Wohnhaus: Kamin beschädigt, Stubenofen beschädigt, Mauerrisse	3000.-
374.	Scheune/Stall	666020	194560	Scheune: Güllenkasten beschädigt	3000.-
375.	Scheune/Stall	665350	194560	Scheune: Mauern zerrissen	3000.-
376.	Wohnhaus	664280	191870	Wohnhaus: 1 Kamin beschädigt, Mauerrisse Öfen beschädigt	3010.-
377.	Scheune/Stall	663625	193260	Scheune Riedtli: Mauern stark beschädigt	3030.-
378.	-	664660	192430		3030.-

379.	Wohnhaus	664660	193820	Mauerrisse usw. (Neue Ostmauer, Kamin EG und OG, Mauerrisse Sockelmauer)	3035.-
380.	-	663966	194747		3090.-
381.	Wohnhaus	665235	196390	Wohnhaus: Beide Kamine beschädigt / Ziegelschaden	3110.-
382.	Wohnhaus	664970	195150	Wohnhaus: Stubenofen und Kamin defekt, Mauerrisse	3130.-
383.	-	663820	194770		3140.-
384.	Wohnhaus	664375	195147	Wohnhaus: Kamin beschädigt	3220.-
385.	-	663690	194555		3300.-
386.	Wohnhaus	663880	194640	Wohnhaus und Sennerei: Kamine beschädigt, Mauerrisse	3370.-
387.	Wohnhaus	663950	194970	Mauerrisse usw.	3390.-
388.	Wohnhaus			Kamine und Feuerwerk beschädigt (Mauerwerk, Kachelofen)	3430.-
389.	Wohnhaus	664750	194840	Wohnhaus: 2 Kamine beschädigt, grosser Mauerriss	3440.-
390.	Scheune/Stall	664960	194710	Scheune: grosser Mauerriss	3440.-
391.	-	663820	194710		3540.-
392.	-	664415	194850		3550.-
393.	Wohnhaus				3560.-
394.	-	664490	195160		3590.-
395.	Wohnhaus	663410	195650	Mauerrisse aussen und innen, Mauerrisse an Decken in den Zimmern und im Hausgang, Kamine beschädigt	3670.-
396.	-	663870	195950		3690.-
397.	Wohnhaus	664655	196060	Wohnhaus: Grundmauern und Böden sehr stark zerrissen	3720.-
398.	Wohnhaus	663480	193900	Wohnhaus: Kamine beschädigt, Öfen eingestürzt, 2 Mauern eingestürzt, 1 Mauer defekt, Mauerrisse	3735.-
399.	-	663805	194836		3750.-
400.	Wohnhaus	663440	193470	Wohnhaus: Mauerrisse, Kamine beschädigt	3760.-
401.	Wohnhaus	663720	194650	Steinhaus: Mauerrisse aussen und innen, Mittelwände zerrissen, 3 Kamine beschädigt	3800.-
402.	Wohnhaus	664093	194784	Wohnhaus: 2 Kamine eingestürzt, Kachelofen beschädigt, Dach beschädigt, Mauerrisse	3820.-
403.	Wohnhaus	666270	196440	Wohnhaus: 2 Kamine und Dach beschädigt, Mauerrisse	3832.-
404.	Wohnhaus	663460	193830	Zwei Seitenmauern des Hauses sehr stark beschädigt, Feuermauer von unten bis oben gerissen	4020.-
405.	Wohnhaus	663375	194295	Kamine bis Dachhöhe eingestürzt und Dach beschädigt (2 mal), Öfen beschädigt, Mauerrisse und Gipsschäden	4060.-
406.	Wohnhaus	663900	195578	Wohnhaus: starke Risse im ganzen Haus, besonders im Keller und Stiegenhaus, 2 Kamine eingestürzt und Dach beschädigt	4120.-
407.	Wohnhaus	664270	193950	Wohnhaus: 1 Kamin beschädigt; 1 Kamin total defekt, abbruchreif; Mauerrisse	4220.-
408.	Wohnhaus	663570	193900	Gips im ganzen Haus teilweise heruntergefallen, Haus muss inwendig renoviert werden, Mauerrisse im Keller	4300.-
409.	Wohnhaus	664075	196520	Wohnhaus: Kamin beschädigt	4350.-
410.	Scheune/Stall	664055	196500	Scheune: Mauerrisse, Jauchekasten	4350.-

				zerrissen	
411.	-	665660	196120		4450.-
412.	Wohnhaus	663950	194970	Mauerrisse (Kamin)	4450.-
413.	Wohnhaus	664716	194630	Wohnhaus: Mauerrisse	4460.-
414.	Scheune/Stall	664736	194610	Scheune: Mauerrisse	4460.-
415.	Wohnhaus	663700	194680	Hausmauer stark zerrissen, Kachelofen beschädigt	4480.-
416.	Wohnhaus	663480	194820	Mauerrisse usw.	4500.-
417.	Gewerbegebäude	665750	195985	Schweinestall und Sennerei: Decken an den Ecken ringsherum gerissen, Lager gesenkt	4520.-
418.	Wohnhaus	665740	195965	Wohnhaus und Garage: Mauerrisse	4520.-
419.	Wohnhaus	663820	193371	Seitenmauer eingestürzt, 2 Kachelöfen beschädigt, 1 Kamin beschädigt	4590.-
420.	Wohnhaus	663770	195670	Restaurant: 1 Kamin heruntergestürzt, 1 Kamin zerrissen, Ofen weggerissen, Mauern stark zerrissen und Verputz teilweise weggefallen	4600.-
421.	-				4660.-
422.	Wohnhaus	665790	194940	„Kamine abbruchreif, Öfen stark beschädigt, starke Mauerrisse	4700.-
423.	Wohnhaus	663810	195260	Stiegenhaus und Küche (kürzlich renoviert) stark beschädigt, in den meisten Zimmern Risse. Anbau: Grundmauern zerrissen	4750.-
424.	-	663936	194770		4760.-
425.	-	663708	194900		4780.-
426.	Gewerbegebäude	663670	194700	Garage: Risse horizontal und vertikal	4849.-
427.	Wohnhaus	663410	193680	Wohnhaus: neue Sockelmauer, Kamine, Ziegel; Achergaden: neu mauern	4917.-
428.	Wohnhaus	663400	194700	Wohnhaus: Kamine beschädigt und Mauerrisse, Dach beschädigt	5250.-
429.	Scheune/Stall	664975	194080	Scheune: Mauerrisse	5500.-
430.	Wohnhaus	663670	193810	Wohnhaus: Grundmauern zerrissen, Kamin und Dach beschädigt	5570.-
431.	Scheune/Stall	663650	193810	Scheune: Grundmauern stark beschädigt, teilweise eingestürzt	5570.-
432.	Wohnhaus	665200	196100	Wohnhaus: Mauerrisse, Feuerwerk beschädigt (Kamin, Kachelofen)	5650.-
433.	Wohnhaus			Kamin (nicht im Gebrauch); Mauerrisse in Kindergarten und Schwesternhaus; (Glasbruch Fenster 10 Stk., feine Wandrisse, Heizung, Kindergarten kleine Risse, Klinkerboden zerrissen bei Schwelle)	5860.-
434.	Wohnhaus	664100	195880	2 Kamine stark beschädigt, Mauerrisse, Ofen beschädigt	5970.-
435.	Wohnhaus	663780	194250	Wohnhaus: Kamine beschädigt, Mauerrisse	5980.-
436.	Scheune/Stall	663760	194290	Scheune: Mauerrisse	5980.-
437.	Wohnhaus	663780	194840	Wohnhaus „Consum“:3 Kamine beschädigt, ebenfalls Kachelofen im 3. Stock, Mauern aussen und innen im ganzen Haus stark zerrissen, Ziegel beschädigt	6000.-
438.	Wohnhaus	663730	194840	Wohnhaus (Sattlerei): Mauerrisse, Dachschäden; Coiffeursalon: versch. Berufsmaterialien beschädigt	6120.-

439.	Wohnhaus	665180	194970	Wohnhaus: 3 Kamine von oben bis unten eingestürzt, Rauchkammer im Estrich total auseinandergerissen, Kachelofen in der Stube eingestürzt, Dach beschädigt;	6160.-
440.	-	664120	194975		6370.-
441.	Kleingebäude	665510	195735	Garage: sehr stark zerrissen, Einsturzgefahr	6380.-
442.	Wohnhaus	662625	194440	Kamin beschädigt, Mauern überall innen und aussen zerrissen, ganzes Haus stark beschädigt	6860.-
443.	-	664039	194517		7180.-
444.	Wohnhaus	663935	195010	Kamin Eingestürzt, von Parterre bis Dach starke Risse im Kamin, Dach beschädigt, Mauerrisse in der Hausmauer aussen	7260.-
445.	-	662750	194450		8280.-
446.	-	663900	194605		8480.-
447.	Wohnhaus	663710	194710	2 Kamine total defekt, 1 Kamin Risse, grosser Dachschaden, Blechdach ob Saal beschädigt, Saal Wasserschaden, im ganzen Hause innen Mauerrisse	9110.-
448.	Wohnhaus	665640	195860	Grundmauern zerrissen, 2 Kamine im 2. Stock gerissen, ganzes Haus verschoben	9150.-
449.	Wohnhaus	664960	194310	Wohnhaus: Kachelofen verschoben und beschädigt, 3 Kamine eingestürzt, alle Seitenmauern innen und aussen beschädigt und zerrissen	9440.-
450.	-	663730	194820		10208.-
451.	-	663740	194800		11440.-
452.	-	663720	194730		11870.-
453.	Wohnhaus	663690	194620	Terrassenplatte auf dach verschoben, Kamin verschoben und neu aufgestellt, Gipsrisse im Haus abgebrochen worden, um ein Herunterfallen bei nochmaligem Beben zu verhüten. Ich liess eine Holzdecke erstellen. Die Zimmer weisen durch die Erschütterungen Gipsrisse auf.	11920.-
454.	Kapelle	662710	194395		13000.-
455.	-	665190	195420		14500.-
456.	Kapelle	665340	195850		17000.-
457.	Wohnhaus	664100	194450	1 Kamin heruntergestürzt, Dach beschädigt, verschiedene Risse in der Wohnung	17480.-
458.	Wohnhaus	663860	194640	Sehr grosse Risse von oben bis unten aussen und innen, Gang und Feuerwerk zerrissen, Kamin und Dachschaden	21110.-
459.	Wohnhaus	663820	194840	Starke Mauerrisse aussen und innen, in den Hotelzimmern Gipsschäden, 1 Kamin heruntergefallen, Dach beschädigt	22908.-
460.	Kapelle	663990	196540		30000.-
461.	Kapelle	663644	190940		50000.-
462.	-Gewerbegebäude	664220	192000	Überall starke Risse und grosse Schäden	52560.-
463.	Kapelle	665036	194450	Kapelle: aussen und innen Mauerrisse, ebenso am Gewölbe	90000.-
464.	Kapelle	665730	196320		106000.-
465.	Kirche	663766	194862		192000.-
466.	-Wohnhaus	663630	194730	Ökonomiegebäude: Starke Beschädigung an den Mauern durch Risse; Allgemein: Beschädigung von Bilderrahmen beim Herunterfallen von Bildern im Haus und	

				in der Kapelle	
467.	Scheune/Stall	663780	194760	Schweinestall Rossfang: Mauerriss innen, Decken stark beschädigt	1790.-
468.	Wohnhaus	663590	194240	Wohnhaus: Kamine beschädigt, Dach beschädigt, Mauerrisse	
469.	Kleingebäude	663830	195260	Garage: Mauerrisse	
470.	Scheune/Stall	665095	195030	kleiner Felssturz in produktives Wiesland	
471.	-	665180	194920	Kulturen: Felssturz in Kulturland	
472.	-	667390	196855	Quelle: seit Erdbeben versiegt	
473.	-	665020	195270	Felsblöcke in Kulturland	
474.	Scheune/Stall	663720	194870	Scheune: Mauer stark beschädig	
475.	Scheune/Stall	663580	194220	Scheune: Mauerrisse	
476.	Scheune/Stall	663980	195590	Stall: Grundmauern und Betonböden zerrissen	
477.	-	663960	195550	Kulturland: Kleiner Felssturz	
478.	Wohnhaus			Wohnhaus Heimatland: Mauerrisse aussen und innen, Garage	
479.	Scheune/Stall			Scheune Wyhermatt: Mauerrisse, evtl. Holzkonstruktion teilw. Verschoben	
480.	Gewerbegebäude	665020	194780	Werkstatt: 1 Kamin beschädigt, Mauerrisse	
481.	Scheune/Stall	665040	194740	Mauerrisse, Güllenkasten zerrissen	
482.	Wohnhaus	663665	195690	Wohnhaus Schmelzi: Mauerrisse usw.	
Melchtal (Kerns*)*					
1.	Wohnhaus	665080	187670	Ofen stark beschädigt. Grosser Riss in der Kellermauer, sowie Kamin beschädigt	1600.-
St. Niklausen (Kerns)					
1.	Scheune/Stall	664840	195420	Scheune: Mauerrisse	200.-
2.	Kleingebäude	665165	193050	Holzschopf: neue Wände	200.-
3.	Wohnhaus	665210	193220	2 Kamine beschädigt, Feuerherd weggerissen	200.-
4.	Wohnhaus	664810	195550	Wohnhaus: Mauerecke neu aufbauen, Eingangsmauer sanieren (grosse Risse), Herdverschoben, Feuerwand, Kamin, Dachziegel	286.-
5.	Scheune/Stall	665210	193120	Scheune Quellbrunnen: Mauerrisse	300.-
6.	Scheune/Stall	665030	193510	Scheune div. Risse	300.-
7.	Wohnhaus	664460	192400	Kamin und Ofen stark beschädigt, sowie Küchen- und Kellermauer beschädigt	360.-
8.	Scheune/Stall	665650	193360	Scheune Haldi: Fenster stark beschädigt, Mauerrisse	400.-
9.	Wohnhaus	665040	193210	Wohnhaus: Rissein Boden und Grundmauern, Feuerwand Ofen abgetrennt	450.-
10.	Scheune/Stall	664020	191785	Mauerrisse usw. (Mauerrisse längsseitig durchgehend 1.5cm und Tennboden und Stallboden gerissen)	550.-
11.	Wohnhaus	665730	193440	Wohnhaus: starke Grundmauerrisse, Feuerwerk leichte Risse	591.-
12.	-	664110	191660		640.-
13.	Wohnhaus	664100	191680	Kamin, Feuerwand und Öfen beschädigt, Mauerrisse	880.-
14.	Scheune/Stall	665065	193340	Scheune: Mauerrisse, Güllenkasten zerrissen	1000.-
15.	Wohnhaus	665010	193170	Wohnhaus: Kamin beschädigt und Mauerrisse	1156.-

16.	Scheune/Stall	665170	193100	Scheune z'Matt: Mauerrisse	1310.-
17.	Wohnhaus	665165	193030	Wohnhaus: Kamin dacheben eingestürzt, Mauerrisse Grundmauern und Kellermauern	1920.-
18.	Wohnhaus	664480	192020	Hausmauer stark beschädigt	2080.-
19.	Wohnhaus	665075	193360	Wohnhaus: Kamin beschädigt, Mauerrisse	2660.-
20.	Scheune/Stall	664760	192630	Scheune: Mauerrisse	3035.-
21.	Wohnhaus	664750	192580	Wohnhaus: Kamin beschädigt, Mauerrisse	4134.-
22.	Gewerbegebäude				6300.-
23.	Kapelle	664055	191345		40000.-

CH-6072 Sachseln

Population figure 1960: 2'721
Population figure 2007: 4'542
Total loss: CHF 11'500.-

	Building type	Approx. Position CH/XY		Damage	Loss in SFr.
1.	-	660320	190590		125.-
2.	-	660970	191260		200.-
3.	-	660110	189940		385.-
4.	-	663100	192310		410.-
5.	-	660940	191220		625.-
6.	-	661880	192780		655.-
7.	-	659650	190150		790.-
8.	-	661330	192370		920.-
9.	-	661000	190930		1000.-
10.	-	661420	192460		1015.-
11.	-	661030	191290		1400.-
12.	-	661010	191310		1900.-
13.	-	661070	191270		2025.-

CH-6060 Sarnen
Population figure 1960: 6’554
Population figure 2007: 9’617
Total loss: CHF 2’447’000.-

	Building type	Approx. Position CH/XY		Damage	Loss in SFr.
1.	-	662936	196916		50.-
2.	-	662665	195255		100.-
3.	-	662580	197030		100.-
4.	-	662560	197012		100.-
5.	-	660530	194300		110.-
6.	-	661320	194160		155.-
7.	-	662500	197030		200.-
8.	-	662680	194440		210.-
9.	Wohnhaus	659670	192360		220.-
10.	-	661825	194225		220.-
11.	-	662660	194390		220.-
12.	-	660490	194450		250.-
13.	-	661884	196925		250.-
14.	-	662520	197018		300.-
15.	-	661841	193583		350.-
16.	-	661040	193540		350.-
17.	Gewerbegebäude	661550	195190		360.-
18.	-	569100	193050		360.-
19.	-	657750	190800		400.-
20.	-	661823	193623		400.-
21.	-	661787	193736		400.-
22.	-	657200	192110		430.-
23.	-	657860	193820		440.-
24.	-	662690	194370		450.-
25.	-	660835	193760		500.-
26.	-	660900	193820		500.-
27.	-	661567	194310		500.-
28.	-	661525	194200		500.-
29.	-	660830	193750		500.-
30.	-	660810	193874		510.-
31.	-	661625	194695		520.-
32.	-	661540	194230		540.-
33.	-	661666	194139		560.-
34.	-	661540	194100		585.-
35.	-	657750	192600		590.-
36.	-	661670	194500		590.-
37.	-	660500	194320		600.-
38.	-	661460	194130		600.-
39.	-	662130	194240		620.-
40.	-	661100	193800		630.-
41.	-	661770	193812		640.-
42.	-	657300	192350		660.-
43.	-	660739	196436		660.-

44.	-	662510	197015	660.-
45.	-	661530	194360	700.-
46.	-	662350	194180	710.-
47.	-	659920	193630	760.-
48.	Wohnhaus	660935	193897	790.-
49.	-	660810	193800	790.-
50.	-	662830	195380	800.-
51.	-	661405	196811	800.-
52.	-	660784	193855	820.-
53.	-	661440	194135	830.-
54.	-	661110	194080	840.-
55.	-	661017	193560	850.-
56.	-	660140	192880	870.-
57.	-	662580	197010	870.-
58.	-	660590	194350	900.-
59.	Fabrikgebäude	661920	194770	900.-
60.	-	661675	193850	980.-
61.	-	661511	194196	1000.-
62.	-	661700	194300	1000.-
63.	-	660490	194380	1000.-
64.	-	660910	193800	1040.-
65.	-	661450	194330	1060.-
66.	-	662280	194190	1070.-
67.	-	661618	194969	1080.-
68.	-	658640	193470	1080.-
69.	-	662540	197000	1080.-
70.	-	656900	192910	1100.-
71.	-	661655	194290	1100.-
72.	-	657770	190850	1100.-
73.	Wohnhaus	661540	194270	1140.-
74.	-	662340	194160	1145.-
75.	-	991520	194030	1150.-
76.	-	661550	194700	1150.-
77.	-	660090	192560	1180.-
78.	Wohnhaus	661571	194360	1200.-
79.	-	661870	194190	1200.-
80.	-	662200	194204	1200.-
81.	-	661557	194718	1200.-
82.	-	661500	194300	1230.-
83.	-	660770	193700	1250.-
84.	-	662680	195164	1250.-
85.	-	660650	194340	1260.-
86.	-	661704	194980	1300.-
87.	Wohnhaus	661500	194260	1300.-
88.	-	662065	194690	1300.-
89.	-	660090	192830	1300.-
90.	Gewerbegebäude	661595	194345	1300.-
91.	-	661575	194250	1300.-
92.	-	661430	195565	1300.-
93.	-	659310	194880	1360.-
94.	-	661530	194210	1400.-

95.	-	662060	194805	1430.-
96.	-	661734	193727	1430.-
97.	Gewerbegebäude	661625	194950	1470.-
98.	-	662100	194640	1480.-
99.	-	661500	194060	1500.-
100.	-	662685	195275	1530.-
101.	-	661518	194192	1560.-
102.	-	661670	194630	1560.-
103.	-	661110	193850	1570.-
104.	-	662410	194880	1590.-
105.	-	661830	194205	1600.-
106.	-	662090	194630	1690.-
107.	-	662115	194260	1690.-
108.	-	661854	195478	1700.-
109.	Gewerbegebäude	661693	194489	1700.-
110.	-	661590	194080	1700.-
111.	Wohnhaus	661730	194400	1710.-
112.	-	661525	194618	1720.-
113.	-	661878	195420	1760.-
114.	-	661510	194450	1770.-
115.	-	661930	194170	1800.-
116.	-			1800.-
117.	-	661600	193990	1800.-
118.	-	661007	193820	1830.-
119.	-	662680	195260	1850.-
120.	-	661660	193852	1860.-
121.	-	661290	194160	1870.-
122.	-	657800	190870	1900.-
123.	Gewerbegebäude	661519	194600	1900.-
124.	-			1900.-
125.	-	661870	194250	1900.-
126.	-	661620	194300	1930.-
127.	Gewerbegebäude	661000	193480	2000.-
128.	Gewerbegebäude	661160	193700	2000.-
129.	-	661650	194430	2000.-
130.	-	661825	195450	2000.-
131.	-	661932	193950	2000.-
132.	-	662330	194170	2050.-
133.	-	661445	193380	2050.-
134.	-	660270	195180	2080.-
135.	-	662080	193340	2100.-
136.	-	661800	194245	2100.-
137.	-	661590	196730	2100.-
138.	-	661800	194540	2180.-
139.	-			2250.-
140.	-	662110	194620	2290.-
141.	-	661660	194395	2300.-
142.	-	661541	194637	2300.-
143.	-	661625	194710	2300.-
144.	-	660760	193840	2310.-
145.	-	658800	193280	2320.-

146.	-	661550	195020	2320.-
147.	-	661480	194920	2340.-
148.	-	658810	193260	2340.-
149.	-	660580	194360	2400.-
150.	Gewerbegebäude	661736	194160	2400.-
151.	-	661770	194240	2450.-
152.	-	661450	194660	2480.-
153.	-	660890	193500	2480.-
154.	-	661578	194146	2500.-
155.	-	661656	194575	2550.-
156.	-	661540	194020	2590.-
157.	-	661880	194280	2600.-
158.	-	657780	190830	2600.-
159.	Wohnhaus	661640	194250	2620.-
160.	-	662050	194800	2660.-
161.	-	661635	194690	2660.-
162.	-	660250	193980	2700.-
163.	Gewerbegebäude	661586	194120	2750.-
164.	-	660500	194362	2750.-
165.	-	661850	194200	2800.-
166.	-	662060	194660	2800.-
167.	-	660650	194360	2800.-
168.	-	661730	193825	2800.-
169.	Wohnhaus	661720	193700	2850.-
170.	-	661650	194500	2860.-
171.	-	661445	194043	2900.-
172.	-	661476	194170	2940.-
173.	Gewerbegebäude	661515	194470	3000.-
174.	-	662350	196158	3000.-
175.	-	661540	194240	3000.-
176.	-	661596	194216	3000.-
177.	-	661560	194365	3000.-
178.	Gewerbegebäude	661577	194300	3040.-
179.	-	661580	194190	3060.-
180.	-	662090	194650	3100.-
181.	-	661560	194310	3100.-
182.	-	661583	193990	3100.-
183.	-	661310	194170	3100.-
184.	-	661492	194020	3100.-
185.	-	660960	193740	3130.-
186.	-	661520	194040	3150.-
187.	-	661540	193424	3160.-
188.	-	661780	194195	3170.-
189.	-	661560	194110	3200.-
190.	-	660660	195440	3240.-
191.	Wohnhaus	661490	194083	3250.-
192.	-	685820	193250	3300.-
193.	-	661830	194240	3300.-
194.	-	661480	194235	3330.-
195.	-	661540	194280	3370.-
196.	-	661550	194240	3380.-

197.	-	662080	194825	3400.-
198.	Gewerbegebäude	661573	194357	3400.-
199.	Gewerbegebäude	661610	194310	3430.-
200.	-	661580	194200	3460.-
201.	-	662040	194640	3500.-
202.	-	661700	194660	3500.-
203.	-	661583	194201	3600.-
204.	-	661530	194020	3600.-
205.	-	661575	194295	3600.-
206.	-			3700.-
207.	-	661500	194400	3800.-
208.	-	661450	193370	3800.-
209.	Wohnhaus	661400	193865	3860.-
210.	Gewerbegebäude	661463	194448	3900.-
211.	-	660880	193900	4000.-
212.	Gewerbegebäude	660780	194040	4000.-
213.	-	661490	193620	4240.-
214.	Wohnhaus	661560	194200	4260.-
215.	-	661880	194840	4300.-
216.	-	661680	194100	4320.-
217.	Wohnhaus	660890	193780	4350.-
218.	-	662080	194680	4400.-
219.	-	661470	194150	4400.-
220.	Wohnhaus	661600	194126	4500.-
221.	-	661440	193920	4500.-
222.	-	660800	193830	4530.-
223.	-	662150	194150	4650.-
224.	-			4830.-
225.	-			4860.-
226.	-	662090	194670	4900.-
227.	-	661645	194178	4900.-
228.	-	661488	194233	5000.-
229.	-	661534	194200	5350.-
230.	-	661525	194350	5360.-
231.	-	661950	194928	5420.-
232.	-	661555	194100	5450.-
233.	Wohnhaus	661560	194420	5500.-
234.	-	661610	194138	5500.-
235.	-	685830	193240	5670.-
236.	-	661510	194290	5720.-
237.	-	661533	194478	5750.-
238.	-	661687	194148	5900.-
239.	Wohnhaus	661515	194225	6440.-
240.	-	661520	194540	6580.-
241.	Fabrikgebäude	661620	194570	6600.-
242.	-	658640	193507	6730.-
243.	-	661580	194080	7000.-
244.	-	659420	193410	7000.-
245.	Wohnhaus	661615	194300	7200.-
246.	Gewerbegebäude	661610	194350	7400.-
247.	-	661645	194305	7400.-

248.	-	661675	194190	7500.-
249.	-	661589	194171	7500.-
250.	-	661845	193670	7550.-
251.	-	661500	194100	8000.-
252.	-	661466	194096	8440.-
253.	-	661530	194020	8480.-
254.	Gewerbegebäude	661628	194136	8900.-
255.	-	661530	194560	8900.-
256.	-	661520	194355	9260.-
257.	Gewerbegebäude	661566	194567	9650.-
258.	-	661835	194215	9670.-
259.	Gewerbegebäude	661615	194173	9835.-
260.	-	661547	194017	10580.-
261.	Wohnhaus	661450	194250	12300.-
262.	Fabrikgebäude	662672	195722	13450.-
263.	Fabrikgebäude	661973	194992	15000.-
264.	Gewerbegebäude	661900	194880	15300.-
265.	Kapelle	661708	194156	18000.-
266.	-	661458	194072	18210.-
267.	Kapelle	661499	194119	48000.-
268.	-Gewerbegebäude	661715	193750	60000.-
269.	Gewerbegebäude	661730	194316	80000.-
270.	Schulhaus	661489	193611	190000.-
271.	Gewerbegebäude	661650	195000	323000.-
272.	Gewerbegebäude	661505	193980	440000.-
273.	Kirche	660930	193950	537000.-
274.	Verwaltungsgebäude	661445	194120	
275.	Verwaltungsgebäude	662080	194230	
276.	Verwaltungsgebäude	661550	194160	
277.	Verwaltungsgebäude	661560	194400	
278.	Kapelle	660895	193970	
279.	Kapelle	658960	193080	

Appendix III: Secondary Effects Related to the 1855 Earthquake

Ausserberg

- **Heusser (1856), p. 16: „**So sind in Ausserberg,[...], die beiden einzigen Quellen, die früher reines Trinkwasser lieferten, versiegt, [...].“

Baltschieder

- **Heusser (1856), p. 16:** „Hier unten in Baltschieder ist dafür in Folge des Erdbebens eine starke neue Quelle von reinem Wasser entstanden.“

Bürchen

- **Nöggerath (1855), p. 19:** „Sonst ist noch aus dem stark bewegten Erdbeben- Bezirk zu berichten, dass sich zu Bürchen ein Felsen der Hohe Casteler genannt, in einer halben Stunde Länge gespalten hat. Und als Besonderheit, die mir von glaubwürdigen Männern erzählt worden ist, dass in diesem Dorfe St. Gerbernt [St. German] im Loch durch die Erschütterungen die Rasendecke auf einer bedeutenden Strecke losgetrennt worden sei und sich in grösseren Lappen so aufgerollt gefunden habe, wie die Tabakblätter der Cigarren.“

Eyholz

- **Heusser (1856), p. 15: „**Eine [...] neu entstandene, und zwar sehr starke Quelle liegt an dem bewaldeten steilen Berghang am linken Rhoneufer, oberhalb Eiholz. [...] Eine lange Spalte will ich hier noch erwähnen, die ich etwa 10 Minuten über dem Dörfchen Eiholz fand; sie hatte die Richtung parallel dem Lauf der Rhone, also von West nach Ost.“

Grächen

- **Nöggerath (1855), p. 15:**. „Hier scheint sich eine recht grausige Scene der Erdbeben Folgen, nämliche ein sehr grosser Bergschlüpf, noch in seiner weiteren Ausbildung begriffen. Das Schütt-Terain unter der bewaldeten Oberfläche des von der Vispziemlich jäh und hoch aufsteigenden Terrains ist in der Tiefe gerissen und die Gletscherwasser haben sich von oben darin Wege gebahnt, über dem festen Gestein die mächtige Aufschichtung von verwitterten Felsmassenaufgeweicht und stürzen jetzt unten am Strome aus dem wohl eine Stunde im Umfange messenden, gelösten Gebiete als starker Bach hervor, welcher vor der Juli-Katastrophe gar nicht existierte. In der Oberfläche sind Hunderte lange gebogenen, über den Abhang hinlaufende Spalten gerissen und längs ihnen im Rasenteppich vielfache Abrutschungen vorhanden. Überall erkennt man die Bewegung des Bodens, grosse Steinblöcke wälzen sich aus dem Schlamme hervor, die auf dem Terrain wachsenden Bäume neigen bereits ihre Kronen wie

gesenkte Fahnen in verschiedenen Winkeln. Unter dem Bergschlipf führte früher der einzige Weg vorbei. Kein solcher ist aber mehr vorhanden, Einige Arbeiter bahnten bei meiner zweimaligen Passage eine ephemere Übergansstelle für die Reisenden. Der Übergang bleibt indess genug und man musste in grösster Eile durch die schlammigen Masse durchzukommen suchen; mächtige Überschüttungen, welche Menschen und Pferde einhüllen können, sind jeden Augenblick zu erwarten."

- **Heusser (1856), p. 10-13:** „Von Stalden nach St. Nikolas führt der Weg zunächst noch eine halbe Stunde auf der linken Seite der Matter-Visp, dann geht er auf die rechte Seite über und führt auf derselben durch Waldungen nicht hoch über dem Flussbett bis etwa ¼ Stunde vor St. Nikolas. Dieser Waldweg nun ist es, der durch Erdschlipfe vielfach zerstört ist, wie die Zeitungen berichtet haben. Will man sich aber von dem ganzen Umfang des Schadens und der noch drohenden Gefahr eine richtige Vorstellung machen, so muss man vom Weg bis nach Grächen aufsteigen; [...] So habe ich von Grächen in gerader Richtung gegen den Fluss heruntersteigend oben im Wald eine solche Spalte gefunden, die ich in nordöstlicher Richtung also nach Stalden hin, eine halbe Stunde weit verfolgte; im Maximum war diese Spalte gegen 2 Fuss, meist aber bloss einige Zoll breit [...] und so vielleicht gegen zwei Stunden lang ist. [...]; den Fels selbst fand ich, wie gesagt, nicht gespalten, [...]. Im Gegensatz zum Felsen sind aber die Lerchen und Tannen, welche die Spalte in ihrer Längsrichtung getroffen, vielfach gespalten, und zwar bis zu einer Höhe von etwa 8 Fuss. In die Tiefe reicht die Spalte ohne Zweifel bis auf den Felsen, [...]. Etwas weiter gegen den Talgrund absteigend traf ich eine Spalte, die mehrere Klafter breit ist, und in dieser Breite vielleicht 100 Schritte fortzieht, dann wird sie zu beiden Seiten schmäler, [...]. Hier in der Gegend dieser grossen Spalte ist auch der Boden am stärksten zerrissen; kleinere Spalten derselben Längsrichtung ziehen sich noch in Menge durch, eine von der anderen um wenige Fuss entfernt; und da finden sich denn allerdings auch viele Querspalten, senkrecht auf den Thalgrund zulaufend; [...].Vielleicht in der Mitte zwischen dem Thalweg und dem obern Ende des Waldes liegen einige Hütten von grünen Wiesen und einem Gärtchen umgeben; der Anhang ist aber doch so steil, dass das Gärtchen auf der unteren Seite durch eine Mauer gestützt wurde; diese Mauer ist eingestürzt, und hat ein vierjähriges Kind unter sich begraben, merkwürdigerweise das einzige Menschenleben, welches dem Erdbeben zum Opfer gefallen ist, so viel ich wenigstens habe in Erfahrung bringen können. [...] Die erwähnten, in diesem Walde [Kipfer-Wald] entstandenen Quellen, waren ganz klar, zeigten gar keinen auffallenden Geschmack, und eine Temperatur von etwa 6 ½ o Celsius bei 19 o Lufttemperatur. [...] In den grünen Matten etwa ¼ Stunde oberhalb Grächen, wo das Terrain weniger Steil, und auch nicht von so zahlreichen Sprüngen durchsetzt ist, ist ebenfalls eine sehr starke neue Quelle entstanden [...]."

Stalden

- **Nöggerath (1855), p.14:** „Furchtbar zeigen sich aber die Boden-Zerreissungen in und bei Stalden. Der Hügel ist nach den mannigfaltigen Richtungen von Erspalten durchzogen, besonders auf seinem Gipfel, an welchem auch nach der Richtung des Abhanges viele Senkungen längs den Zerspaltungen von einigen Zollen Höhe vorkommen. [...] Stalden gegenüber in etwa viertelstündiger Entfernung am rechten Gehänge des Thales, ist ein grosser Bergschlipf erfolgt. Er hat eine mehrere 100 Fuss lange Scharte von vielleicht 100 Fuss Breite am Berg gebildet, und unten aus dem entstandenen Schuttkegel

ist eine Quelle ausgebrochen, welche als kleiner Bach hervorrieselt, wovon aber vor dem Erdbeben keine Spur vorhanden war."

- **Heusser (1856), p. 12:** [From Stalden to St. Niklaus] „Steine sind aber hier in Menge heruntergefallen, und haben die in der Nähe von Stalden gelegenen Weinberge zerstört. Herr Tscheinen schreibt mir übrigens am 20. Nov., dass wischen Törbel und Stalden ähnliche Erdrutsche und Spalten sich zu bilden angefangen haben, wie im Küpfen-Wald, und dass die Bewohner von Z'brunnen, einem kleinen Dörfchen eine Stunde unterhalb Törbel, behaupten, ihre ganze Gegend habe sich mehr als 2 Schuh gesenkt."

St. Niklaus

- **De la Rive (1855), p. 95-96:** „Le village de Saint-Nicolas est enfoui dans le repli d'une prairie qui se relève en pente douce jusqu'au pied des montagnes. Cette prairie est semée de rochers qui se sont incrustés dans le sol un peu tendre; cette circonstance a sauvé le village: si le terrain eût été durci par le gelée ou par toute autre circonstance, il ne resterait plus aujourd'hui aucun vestige de Saint-Nicolas; on peut suivre sur la pelouse verte les traces du passage des blocs comme on suit le lit d'un torrent; on voit qu'ils ont procédé par bonds immenses; les pas du géant sont profondément creusés dans le sol; le premiers sauts sont prodigieux, mais chaque contact avec le terrain, chaque dépression use sa force, et l'intervalle entre les empreintes diminue jusqu'à ce qu'on arrive à une dernière et plus langue ouverture, dans laquelle le roc semble s'être planté avec une sorte de rage désespérée. Des rochers forment une barrière au-dessus de Saint-Nicolas; quelques-uns sont parvenus jusqu'à une trentaine de mètres du village; on le voit, il ne s'en est fallu que de bien peu qu'il ne fût enveloppé et étouffé dans un de ces durs et sinistres linceuls de pierre, semblables à celui sous lequel Goldau dort, à jamais enseveli."
- **Heusser (1856), p. 8:** „Bei der grossen Anzahl von grösseren und kleineren Steinen, die an der steilen Bergabhängen lose herumliegen, konnte es nicht fehlen, dass in Folge des Erdbebens eine Menge derselben ins Thal stürzte, und so auch ihrerseits Schaden anrichteten. So habe ich z.B. kurz vor St. Nikolas einen Stadel gefunden, auf dessen Trümmern das Felsenstück, welches in seinem Falle den Stadel getroffen und niedergeschmettert hatte, noch zu sehen war. Auch wurden mehrere Menschen durch solche herunterrollende Steine verletzt."

Törbel

- **Heusser (1856), p. 16:** „Auch von der Gemeinde Törbel schreibt mir Hr. Pfarrer Tscheinen am 4. Oktober, dass bereits 21 Quellen versiegt, 1 neue entstanden und mehrerer wasserreicher geworden seien, und ferner am 4. November, dass immer noch mehr Quellen versiegen, während andere reicher werden."

Visp and surrounding region

- **Colombe (1855), p. 953:** „La destruction des maisons n'est pas le seule désastre qui ait frappé ce malheureux pays; les tremblements du sol ont eu aussi pour résultat d'abaisser sensiblement au-dessous du niveau de Rhone le terrains plats situés dans le fond de la vallée, de sorte que d'excellentes terres cultivées en blé, mais, pommes de terre, sont aujourd'hui immergées et se transforment en marais. Cette immersion des terres provient –elle réellement, comme on dit dans le pays, de l'affaissement du sol, ou plutôt de l'abondance des eaux et de sources qui ont surgi de tous les côtes à la suite du phénomène et qui n'ont pas trouvé d'écoulement suffisant? L'apparition de ces sources fait supposer qu'il y a eu déplacement dans le s conduits souterrains, mais il ne semble pas s'être étendu à de grandes profondeurs, puisque toutes celles que j'ai eu l'occasion de visiter n'ont pas une température plus élevée que les autres, elles ne sont pas thermales."
- **Nöggerath (1855), p.7:** „Das Terrain im Orte und in seiner Umgebung hat ebenfalls mancherlei Veränderung erlitten. Man braucht [...] kaum zu erwähnen, dass von den hohen Bergen, welche das Dorf rundum einschliessen, bei der Katastrophe von allen Seitengrosse, theils gelöst gewesene, theils durch die Erschütterungen erst losgetrennt wordenen Steinbrocken und Felsstücke herabgefallen sind. [...] Im Alluvial-Boden sind manche früher nicht vorhanden gewesenen Unebenheiten zurückgeblieben. So sah ich z.B. einen in Mauern eingefassten Garten, der früher ganz horizontal geebnet war. Jetzt hat er wellenförmige Erhebungen und Vertiefungen, welche eine Niveau-Differenz von 1-2 Fuss darstellen.

  Zu den Beweisen besonderer Kraft des Erdbebens gehört nicht allein, dass der nach der Visp hin mauerartige anstehende feste Fels, auf welchem die Fundamente des Porticus der Martinskirche stehen, vielfach zerspalten und zum Theil herunter gestürzt ist, sondern auch, was in jener Beziehung noch schlagender erscheint, dass an dem Hügel, welcher zu dieser Kirche führt, inmitten des festen Schieferfelsens zahlreiche senkrechte und in die tiefe niedersetzende Spalten sich gebildet haben. Die Spalten sind wenig geöffnet, aber unverkennbar neu und durch ihren frischen Bruch gut von den älteren Spalten zu unterscheiden. [...]

  Ausser diesen Felsrissen kommen im Dorfe und in seiner Umgebung noch viele grössere Bodenzerspaltungen vor, welche sichtbar nur den Alluvial-Boden der Visp und der Rhone betroffen haben. Sie laufen parallel untereinander im Terrain, setzen auch wohl durch Gartenmauern hindurch. Solche Risse sind viele, besonders in er Nähe der Vispbrücke, aber auch anderwärts entstanden. [...]

  Indess gibt es auch noch viele bei dem Erdbeben entstandene Quellen in Visp. Sie Sprudeln sogar im innern von ein paar zerstörten Häusern hervor, welche jetzt ganz im Wasser stehen; andere sind noch im freien Felde. Man hat diese Erscheinungen besonders auffallend finden wollen, um so mehr als Vispbach früher gar keine Quellen oder Brunnen besass [...].
- **Heusser (1856), p. 14-15:** „Im Dorf Vispach selbst sollen unmittelbar nach den Stössen vom 25. Juli eine Menge Risse in den Strassen selbst entstanden, und aus denselben kalte Quellen hervorgesprudelt sein. Bald nachher nahm die Wassermenge bedeutend ab, und viele dieser Spalten schlossen sich wieder, so dass ich am 14. August nur noch ganz unbedeutende Quellen im Dorf selbst sah. [...] die Strasse soll in der Nähe des Gasthofs zur Post senkrecht zu ihrer Längsrichtung gespalten gewesen sein, also von Nord nach Süd, und zwar so stark, dass man eine Hand der Breite nach

hineinlegen konnte; [...], hingegen sah ich noch eine Spalte, die der Richtung der Strasse annähernd parallel, also unter etwa 60-70^{o} zu jener erst erwähnten Spalte geneigt war.

Visp toward Stalden

- **Nöggerath (1855), p.13:** An den Felsen sind dagegen auf dem ganzen Wege überall kräftige Spuren der Erdbeben zu bemerken. An vielen Stellen haben sich Felstücke losgelöst, mehrmals Blöcke von über 1000 Kubikfuss Inhalt und sind in die Visp gestürzt [...].
- **Heusser (1856), p. 14:** „Eine grosse Spalte hat sich nun ferner gebildet zwischen Vispach und Stalden auf dem rechten Ufer des Flusses, kurz bevor man aufwärtsgehend zur neuen Brücke gelangt. Diese Spalte ging parallel dem Flusslauf, also von Norden nach Süden, ist aber nicht Spalte geblieben, sonder der untere, dem Fluss zu gelegenen Theil des Erdreichs ist heruntergefallen, und hat hier einen schönen grossen Weinberg mit in den Fluss herunter gerissen. Auf diese Weise ist senkrecht zur Visp ein kleineres Seitenthal, oder wenigstens eine Seitenschlucht gegen Visperterminen hinauf entstanden, aus welcher nun ein klarer Bach herunter läuft, von dem früher keine Spur vorhanden gewesen war. Etwa 100 Schritte über dem Thalweg entsteht der Bach aus 10-20 verschiedenen Quellen.“

Zeneggen

- **Heusser (1856), p. 16:** „Ebenso sind in der Gemeinde Zeneggen laut Nachrichten, die ich der gütigen Mittheilung des Pfarrers dieses Dörfchens, Hrn. Kämpfen, verdanke, bis zum 8, Oktober 11 Quellen versiegt, 3 neue entstanden, und mehrere früher schon vorhandene sind wasserreicher geworden; zwei der neu entstandenen sollen unten im Thale liegen, und zwar in gerader Linie von einzelnen versiegten aus gegen den Fluss.“

Appendix IV: Secondary Effects Related to 1946 Earthquake

VBS[1]: STAATSRAT DES KANTONS WALLIS, 1947, Verwaltungsbericht des Staatrates des Kantons Wallis, 1946, Sion: 216f.

Region	CH-X	CH-Y	Typ	Beschreibung (paraphrasiert)	Referenz	Event vom:
Rawilpass	600300	136900	Bergsturz	Fruchtbare Erde wegradiert, dafür türmen sich riesige Blöcke auf. Alles ist bedeckt. Sennhütten uns Ställe wie vom Erdboden verschwunden oder nur noch Trümmer zu sehen. Ganze Waldstücke in die Schlucht der Lienne heruntergestürzt, Stauung.	WB 26.4	25.01.1946
Schönried	588400	150200	Blocksturz/ Steinschlag	Auf der Piste bildeten sich zentimeterbreite Risse im Schnee, die im Zickzack Nord-Süd verlaufen. Riesige Felsblöcke lösten sich in den umliegenden Bergen.	LUTb 29.1.	25.01.1946
Gummfluh	581250	143150	Blocksturz/ Steinschlag	Riesige Felsstücke löste das Beben und unter grausamen Tösen donnerten die Kolosse zu Tale.	LUTb 29.1.	25.01.1946
Oldenhorn/ Becca d'Audon	583300	130850	Blocksturz/ Steinschlag	Riesige Felsstücke löste das Beben und unter grausamen Tösen donnerten die Kolosse zu Tale.	LUTb 29.1.	25.01.1946
L'Argentine	575700	124300	Blocksturz/ Steinschlag	Links vom Lion d'Argentine gegen Perris Blancs Steinschlag und Blocksturz ausgelöst.	FAL 28.1.	25.01.1946
Strasse nach Leukerbad bei km 5	614700	130800	Blocksturz/ Steinschlag	Strasse durch grosse Felsblöcke, Bäume usw. verschüttet.	VBS[1] 1946	25.01.1946
Strasse nach Leukerbad Rumeling	613900	131200	Blocksturz/ Steinschlag	Strasse durch grosse Felsblöcke, Bäume usw. verschüttet.	VBS[1] 1946	25.01.1946
Ayent	597500	125000	Erdrutsch	Zahlreiche kleinere Risse im Boden der Region Ayent. Erdrutsch riss 6 Hütten mit und beschädigte weitere stark.	WB 19.2. NZZ Nr.149 ObT 28.1. I.M. BM 63	25.01.1946
NE von Botyre	598300	125600	Erdrutsch	Erdrutsch ausgelöst.	SdCP 7.6.	25.01.1946
Liène, oberhalb Mündung Ertentense	600900	131400	Erdrutsch	Das mit Nadelhölzer bewaldete Terrain rutschte auf einer Breite von 500 m und Höhe von 200 m und einer Mächtigkeit von circa 5 bis 10 m und verschüttete das Bachbett der Lienne, ohne dass sich jedoch deren Wasser staute.	SdCP 7.6. I.M BM 63	25.01.1946

Lötschental-strasse zwischen Gampel und Mittal.	624000	131700	Erdrutsch	Strasse durch einen grossen Erdrutsch verschüttet. Mehr als Fr. 1000.- Schaden.	VBS[1] 1946	25.01.1946
Pra Combère/ Praz Combeira	599800	130300	Erdrutsch	Gewaltige Erdmassen sind hier von der Höhe (1850 m.ü.M.) im Walde 500 m wie eine Lawine zu Tale gestürzt und haben kurz vor dem Dörfchen Halt gemacht. Tannen ragen kreuz und quer aus dem Schutt, Grasschollen sind schuppenartig aufeinandergeschoben.	WN 14.5. SdCP 7.6.	25.01.1946
Ravouené / Ravionet	598300	129700	Erdrutsch	Mehrere Erdrutsche ausgelöst. Die Erd- und Gesteinsmasse hat am linken oberen Ende des Talkessels gelöst und ist heruntergerutscht bis zum Torrent de Croix (Bach) und hat fünf Chalets mitgerissen.	SdCP 7.6.	25.01.1946
Strasse Siders-Vissoie-Ayer	610500	121900	Erdrutsch	Mehrere Erdrutsche und erhebliche Risse durch das Erdbeben verursacht.	VBS[1] 1946	25.01.1946
Vatseret/ Vatzeret	600300	132800	Erdrutsch	Mehrere kleinere, weniger wichtigere Erdrutsche produziert.	I.M. BM 63	25.01.1946
Montana	601300	129700	Erdrutsch	Erdrutsch vernichtet 10 ha Wald auf der linken Seite der Lienne	VBS[1] 1946	25.01.1946
Ayent	595600	126300	Erdrutsch	Erdrutsch vernichtet 4 ha Wald auf der rechten Seite der Lienne	VBS[1] 1946	25.01.1946
Lötschental-strasse oberhalb Goppenstein	624300	135600	Felssturz	Bedeutender Felssturz ausgelöst.	VBS[1] 1946	25.01.1946
Lötschental-strasse oberhalb Goppenstein	625300	137000	Lawine	Lawine ausgelöst. Strasse auf einer Länge von 80 m verschüttet die Schneemassen erreichten eine Höhe von 12 m.	VBS[1] 1946	25.01.1946
Lötschental-strasse bei Rotloiwi	624600	134500	Lawine	Lawine ausgelöst. Riss Rotloiwibrücke weg.	VBS[1] 1946	25.01.1946
Les Diablerets Massiv	581100	128200	Lawine	Zahlreiche Lawinen ausgelöst.	NZB 28.1 BT 27.1 Bund 27.1. NZZ Nr.142 LB 26.1. BüT 26.1.	25.01.1946
Simplon-linie	661200	116700	Mehrere Lawinen	Zwischen Brig und Domodossola wurde die Eisenbahnlinie an mehreren Stellen durch vom Erdbeben ausgelösten Lawinen verschüttet.	BSN 28.1.A	25.01.1946

Spitzhorn, oberhalb Sanetschfall	588300	135500	Optische Phänomene	Breites Feuer strahlte auf, das aber bald darauf wieder erlosch.	WB 5.2.	25.01.1946
Dents du Midi	560400	112400	Optische Phänomene	Die Bewohner der Region Montreux sahen ein immenses Licht hinter dem Dents du Midi	ExN 26.1.	25.01.1946
Sion / Sitten	592900	120500	Optische Phänomene	Der Himmel färbte sich mit einem gräulichen, schmutzigen Farbton. Grüne Blitze verstreiften den Himmel.	GaL 26.1. TL 26.1.	25.01.1946
Annecy	498500	84500	Optische Phänomene	Kurz nach dem Beben erleuchteten weissliche Schimmer den Himmel.	NZB 28.1. Bund 27.1. NZZ Nr.142 LB 26.1. WN 29.1. LibFR 26.1.	25.01.1946
Crin (bei Montreux)	559650	142500	Quellen-Phänomen	Lange noch nach dem ersten Beben war das Wasser aus einem Wasserhahn trübe und leicht schmutzig.	JMon 26.1.	25.01.1946
L'Etivaz	577700	141500	Quellen-Phänomen	Wasser nahm sogleich weissliche Färbung an, weisser Niederschlag in den Behältern (Kalksulfate).	BT 6.2.	25.01.1946
Lavey	567600	117000	Quellen-Phänomen	Leistung nahm bis Anfangs Februar von 70 bis 75 l/min auf 150 bis 200 l/min zu. Die Wassertemperatur blieb zwischen 45 und 50°C.	I.M. BM 63	25.01.1946
Montreux	559700	142600	Quellen-Phänomen	Das Wasser von vielen Brunnen war schmutzig noch lange nach dem ersten Stoss.	JMon 26.1.	25.01.1946
Granges	602500	123900	Quellen-Phänomen	Abnormaler Anstieg der Temperatur der Quellen.	TL 26.1.	25.01.1946
Leukerbad	614850	136230	Quellen-Phänomen	Erdbeben vertrübte das Thermalwasser. Seither hat es sich nach und nach wieder aufgeklärt. Der Ertrag hat zugenommen und drei neue Quellen sind entstanden.	FAL 14.2.	25.01.1946
Liène/ Lienne	598000	122800	Quellen-Phänomen	Wasserführung verdoppelt.	Bund 2.2. NZZ Nr.149 I.M. BM 63	25.01.1946
St-Léonhard	597700	122200	Quellen-Phänomen	1. Mehrere neue Quellen entstanden, westlich des Dorfes und im oberen Teil einer Schlucht in den Reben. Eine ist sehr eisenhaltig und tritt einige Meter neben einer alten Quelle hervor. Dieses Quellen entstanden wo es bereits Quellen gab oder in deren Nähe.	Bund 2.2. FAV 28.1. FRB 26.1. JFAVS 28.1.	25.01.1946

St-Léonhard	597800	123100	Quellen-Phänomen	2. Mehrere neue Quellen entstanden, westlich des Dorfes und im oberen Teil einer Schlucht in den Reben. Eine ist sehr eisenhaltig und tritt einige Meter neben einer alten Quelle hervor. Dieses Quellen entstanden wo es bereits Quellen gab oder in deren Nähe.	Bund 2.2. FAV 28.1. FRB 26.1. JFAVS 28.1.	25.01.1946
Gegend von St.Léonhard	601600	123900	Quellen-Phänomen	Kleines Wässerlein wurde zum Wildbach, schnitt die Strasse von Lens ab und riss elektrische Leitungsmasten um. Das Anschwellen ist wahrscheinlich auf Veränderungen in den unterirdischen Wasserläufen (durch das Erdbeben) zurückzuführen.	VZ 1.2. ObT 28.1. I.M. BM 63	25.01.1946
Schönried	588400	150200	Risse	Auf der Piste bildeten sich zentimeterbreite Risse im Schnee, die im Zickzack Nord-Süd verlaufen. Riesige Felsblöcke lösten sich in den umliegenden Bergen.	LUTb 29.1.	25.01.1946
Ayent	597700	125200	Risse	Zahlreiche kleinere Risse im Boden der Region Ayent. Erdrutsch riss 6 Hütten mit und beschädigte weitere stark.	WB 19.2. NZZ Nr.149 ObT 28.1. I.M. BM 63	25.01.1946
Granges	601950	123000	Risse	Risse im oberflächlich gefrorenen Talboden sichtbar.	Bund 7.2. NZZ Nr.149 WN 29.1. Conf 28.1. JFAVS 28.1 JFAS 28.1.	25.01.1946
Ravouené / Ravionet	598300	129700	Risse	Ein bisschen weiter östlich hat sich ein Spalt mit einer Tiefe von 2.5 bis 3 m gebildet. Die Gleitmasse übersäht mit Rissen ist Mangels Plastizität stehen geblieben.	SdCP 7.6.	25.01.1946
Strasse Siders-Vissoie-Ayer*	610500	121900	Risse	Mehrere Erdrutsche und erhebliche Risse durch das Erdbeben verursacht.	VBS[1] 1946	25.01.1946
Zw. Alp Sérin und Alp Rawil	599000	133500	Risse	Zahlreiche kleinere Risse im Boden.	I.M. BM 63	25.01.1946
Vallée des Ormonts*	572000	134800	Rutschung	Bergrutsch ausgelöst.	F.M. 47	25.01.1946

Villeneuve	560500	138700	Sackung	Seequai/ -ufer auf einer Länge von 100m eingestürzt.	NZB 28.1. BT 27.1. Bund 28.1. NZZ Nr.149 ObT 28.1. Jmon 26.1. MesA 29.1.	25.01.1946
Grône	601500	122150	Sackung	In der Kohlenmine entstanden Risse und Spalten, wenige Tage darauf stürzte dieselbe ein.	JFAVS 28.1. AV 31.1. TL 29.1.	25.01.1946
Spitzhorn; Sgaggen Gebiet unmittelbar unter Hohmahd bei Gsteig	588200	135800	Stein-Lawine	Steinlawine: Felsmatte von mehreren Tausend Kubikmetern losgelöst. Fegte alle Lärchen und Tannen weg. Kam im geschlossenen Burgwald am Fusse des Felsenhanges zu stehen.	WB 5.2. AS 31.1. VZ 30.1, 4.2. LUTb 29.1.	25.01.1946
Raspelli-bach Salgesch	608200	128500	Steinpyramide	Bei der alten Mühle stürzte eine Pyramide um und verschüttete ca 900m² Rebberg. Sein Zwillingsbruder weist einen grossen Riss von oben bis unten auf.	WB 29.1.	25.01.1946
Oberwil	589200	168200	Steinschlag	Von den Bergen rollten Steine in Mengen herunter, auch Holz wurde niedergerissen.	VZ 28.1.	25.01.1946
Mensfluh	0	0	Steinschlag	Felsstücke aus den Flühen herausgebrochen ohne jedoch Schaden anzurichten.	WB 5.2. AS 31.1. VZ 4.2.	25.01.1946
Mittaghorn	587100	134700	Steinschlag	Felsstücke aus den Flühen herausgebrochen ohne jedoch Schaden anzurichten.	WB 5.2. AS 31.1. VZ 4.2.	25.01.1946
Nägelihorn	584100	132500	Steinschlag	Felsstücke aus den Flühen herausgebrochen ohne jedoch Schaden anzurichten.	WB 5.2. AS 31.1. VZ 4.2.	25.01.1946
Schluchhorn	586400	134100	Steinschlag	Felsstücke aus den Flühen herausgebrochen ohne jedoch Schaden anzurichten.	WB 5.2. AS 31.1. VZ 4.2.	25.01.1946
Strasse Siders-Vissoie-Ayer, unterhalb der Wirtschaft des "Pontis"	609700	123500	Steinschlag	Bedeutende Schäden verursacht. Strasse durch Felsstürze überschüttet. Böschungen auf einer Länge von etwa 300 m eingesackt.	VBS[1] 1946	25.01.1946
Turtmann	620500	133200	Steinschlag	Von den Bergen der Nordseite lösten sich viele Felsstücke, die mit gewaltigem Lärm in die Tiefe sausten.	TGZ 28.1.	25.01.1946
Zw. Salgesch und Leuk/ Susten	612000	129000	Steinschlag	Steinsturz versperrt Bahnlinie.	NZB 28.1. NZZ Nr.142 LB 26.1 ObT 26.1.	25.01.1946

Sex Rouge in 2900 m.ü.M.	581500	131200	Steinschlag	Felsmasse von mehreren hundert Kubikmetern ging zu Tale an der Nordflanke oberhalb vom Col de Pillon.	NZB 28.1.; BT 27.1.; Bund 27.1.; NZZ Nr.142; LB 26.1.; BüT 26.1.	25.01.1946
Region Sion-Sierre-Montana	605000	128000	Steinschlag	Zahlreiche Steinschläge zerstören Wald	VBS[1] 1946	25.01.1946
Rhône bei Granges	600800	122900	Terrainver änderung	Kanalbett gehoben, Geschiebe auf beiden Uferseiten abgelagert.	SGE 27.1.	25.01.1946
Pra Combère/ Praz Combeira	599720	130370	Terrainver änderung	Ein wenig oberhalb der Chalets entstand ein Riss im Rasen, welcher schief den Abhang schneidet; die Bodensenkung beträgt circa ein Meter. Unterhalb des Weilers sieht man kleine Risse im Rasen und an einen Ort eine Wölbung mit Rissen.		25.01.1946
Strasse Siders-Vissoie-Ayer, unterhalb der Wirtschaft des “Pontis”	609700	123500	Terrainver änderung	Bedeutende Schäden verursacht. Strasse durch Felsstürze überschüttet. Böschungen auf einer Länge von etwa 300 m eingesackt.	VBS[1] 1946	25.01.1946
Arth	681300	215000	Wellen	Obwohl kein Wind herrschte, gab es Wellen auf dem Zugersee.	SZZ 28.1.	25.01.1946
Auf dem See, Vierwald-stättersee, Alpnacher-see	667000	204000	Wellen	Eindruck als ob Schiff von unten einen heftigen schlag erhielte, um dann senkrecht in die Tiefe zu fahren. Nacheinander noch weniger starke Stösse verspürt. Das Wasser hat sich dabei ziemlich stark bewegt.	UW 30.1.	25.01.1946
Wallis / Valais	0	0		Veränderung im Ertrag der Quellen und Bäche.	Bund 7.2. Conf. 28.1.	25.01.1946
Gsteig	586500	135100	Steinschlag	Herunterstürzen von Felsgeröllen an einigen exponierten Stellen.	ObT 1.6. VZ 2.6. BLZ 1.6.	30.05.1946
Männlichen kette	638100	163400	Steinschlag	Etliche lose Steine herabgekollert.	OBV 3.6.	30.05.1946
Mittaghorn bei Gsteig	587100	134700	Steinschlag	Zahlreiche Steine und Felsblöcke lösten sich und stürzten mit grossem Gepolter in die Tiefe.	VZ 2.6. BLZ 1.6.	30.05.1946
Roten Fluh, Färmel, Rothorn*	601700	153800	Steinschlag	Grosser Stein löste sich, stürzte zu Tale und beschädigte ein Haus im Fermeltal schwer.	VZ 2.6.	30.05.1946
Spillgerten Zwei-	600500	153700	Steinschlag	Grosse Steinschläge.	VZ 5.6.	30.05.1946

simmen						
Spitzhorn bei Lauenen	590120	135980	Steinschlag	Auf der Lauener Seite stürzte durch die Couloirs viel Schutt in die Tiefe und eine Staubwolke deutete auf umfangreichen Steinschlag auf der Gegenseite.	VZ 2.6. BLZ 1.6.	30.05.1946
Exergillod	569200	131800	Erdrutsch	Bahngeleise Aigle-Sépey-Diablerets durch kleinen Erdrutsch verschüttet.	FAL 31.5.	30.05.1946
Lavey	568600	118500	Bergsturz	Weitere Gesteinsmassen die durch die Explosion gelockert wurden gerieten in Bewegung und stürzten nieder.	AV 1.6.	30.05.1946
Sex Rouge, Region Rochers de la Marchande	580300	131500	Steinschlag	Steine und Blöcke stürzten an der Nordseite herunter.	FAL 4.6.	30.05.1946
Oberwallis	0	0	Erdrutsch	Kleinere Rutschpartien.	BT 1.6. WB 31.5.	30.05.1946
Leuk	616500	135000	Steinschlag	Steinstürze	NVS 1.6. PVS 1.6.	30.05.1946
Montana	604800	134300	Steinschlag	Grössere Abstürze beobachtet.	WN 31.5. NVS 1.6. PVS 1.6.	30.05.1946
Ravionet (N. von Sitten)	598300	129700	Bergsturz	Zahlreiche Alphütten verschüttet.	Bund 31.5.	30.05.1946
Haut de Cry	581200	121000	Blocksturz/ Steinschlag	Grosse Felsblöcke fielen vom Haut de Cry herunter.	NZB 31.5. BT 1.6. Bund 31.5. NZZ Nr.956 LB 31.5. ObT 31.5. BüT 31.5. 1.6. NVS 1.6. PVS 1.6.	30.05.1946
Rawylhorn, Six des Eaux Froides	598000	132800	Erdrutsch	Grosser Erdrutsch von circa 4,5 Millionen m³ etwas oberhalb vom Gendarme du Trot und Couloir du Trot ausgelöst. Ein Teil ging Richtung NE, Hauptchalet der Alp Rawil, ohne diese jedoch zu erreichen und kam ein bisschen oberhalb von Tseuzier zu stoppen. Der grössere Teil jedoch stürzte in die Senke des Lac Luchet, füllte diesen auf, rutschte weiter, der Geländeorientation folgend, Richtung Osten nach Alp Sérin und kam erst nach 2 km im Wald bei ca. 1750 m.ü.M. zu stoppen. Breite der Gleitmasse bis 2 km.	W & G 50 I.M. Nr. 63	30.05.1946

Dorbagnon	590700	128900	Bergsturz	Der Weiler Dorbargnon wurde mit Materialmassen von ausgelösten Steinschlägen verschüttet. Ein Chalet ist dabei eingestürzt.		30.05.1946
Roua	590600	128200	Bergsturz	Der Weiler Roua wurden mit Materialmassen von ausgelösten Steinschlägen verschüttet. Ein Chalet ist dabei eingestürzt.		30.05.1946
St. Maurice	568600	118200	Bergsturz	Weitere Gesteinsmasse die durch die Explosion gelockert wurden gerieten in Bewegung und stürzten nieder.	AV 1.6. NVS 1.6. PVS 1.6.	30.05.1946
Val d'Anniviers	616500	116000	Erdrutsch	Erdrutsche und Steinschläge. Schafe verschüttet.	NVS 1.6. PVS 1.6.	30.05.1946
Ayent	599450	132150	Steinschlag	Strasse Ayent-Rawyl durch Steinschlag verschüttet	VBS[1] 1946	30.05.1946
Alp Serin (Ayent)	599000	131400	Blocksturz/ Steinschlag	Von grossen Steinblöcken verschüttet. Gewaltige Schuttmassen, Chalets niedergewalzt.	NZB 31.5. BT 1.6. Bund 31.5. NZZ Nr.958 LB 31.5. Conf 31.5. NVS 1.6.	30.05.1946
Diablerettes massiv	585500	127800	Steinschlag	Mehrere Steinlawinen	NZB 31.5. BT 1.6. LB 31.5. Büt 31.5.	30.05.1946
Neimia	583400	118000	Felssturz	Felsstürze vom Haut de Cry. Grosse Blöcke fielen auf den Weiler Nemia	BT 1.6. Conf 31.5.	30.05.1946
Hinteres Liène-Tal	588500	123700	Felssturz	Felsstürze	BT 1.6.	30.05.1946
Rawilpass	600300	136900	Felssturz	Felsstürze	BüT 1.6. SüS 5.6.	30.05.1946

Appendix V: Damage Fields and Site-Effects

250TH ANNIVERSARY OF THE 1755 LISBON EARTHQUAKE

Damage Fields and Site-Effects

Investigations on the 1855 Earthquake in Switzerland

By Stefan Fritsche[1], Donat Faeh[1] and Domenico Giardini[1]

[1]*Swiss Seismological Service, Institute of Geophysics, Swiss Federal Institute of Technology Zurich.*

ABSTRACT

During the last few hundred years, several earthquakes occurred in Switzerland that caused damage (e.g. Luzern, 1601; Brig, 1755; Visp, 1855; Sierre, 1946; Sarnen, 1964). In order to understand to what extent site-effects influenced the resulting damage pattern, we try to reconstruct the damage fields of these earthquakes. We then combine the results of these historical investigations with data of recently measured data concerning the fundamental frequency of resonance. For this purpose, we use the well-known H/V method. In this paper, we discuss the results of our investigations regarding the 1855 earthquake in the region of Visp. It will be shown that it was possible to decide whether certain locations were affected by a site-effect although the earthquake dates back many decades. In the case of the Village of Visp, the hypothesis of an occurred site-effect could be negated. In contrast to this example, our investigation ended in findings that make a site-effect in the village of St. Niklaus very plausible.

INTRODUCTION

The epicentre of the 1855 earthquake is in the Canton of Valais that is situated in the south-western part of Switzerland (fig. 1). This region is characterised by the mountains of the central Alps and the valley of the upper Rhone-river. The region shows the highest seismicity of Switzerland. Among a large number of small events, the Earthquake Catalogue of Switzerland (ECOS) (Swiss Seismological Service, 2002 1870/1880) contains data of several earthquakes that caused damage in the mentioned region during the last few hundred years. The most important of these Earthquakes occurred in 1755 ($I_0 = 8$), 1855 ($I_0 = 8$), 1946 ($I_0 = 8$) and 1960 ($I_0 = 8$). The 1855 event was with an estimated moment-magnitude (Mw) of 6.4 the

strongest of them and caused damage in a wide compass. Its dimensions were never exceeded in Switzerland since then.

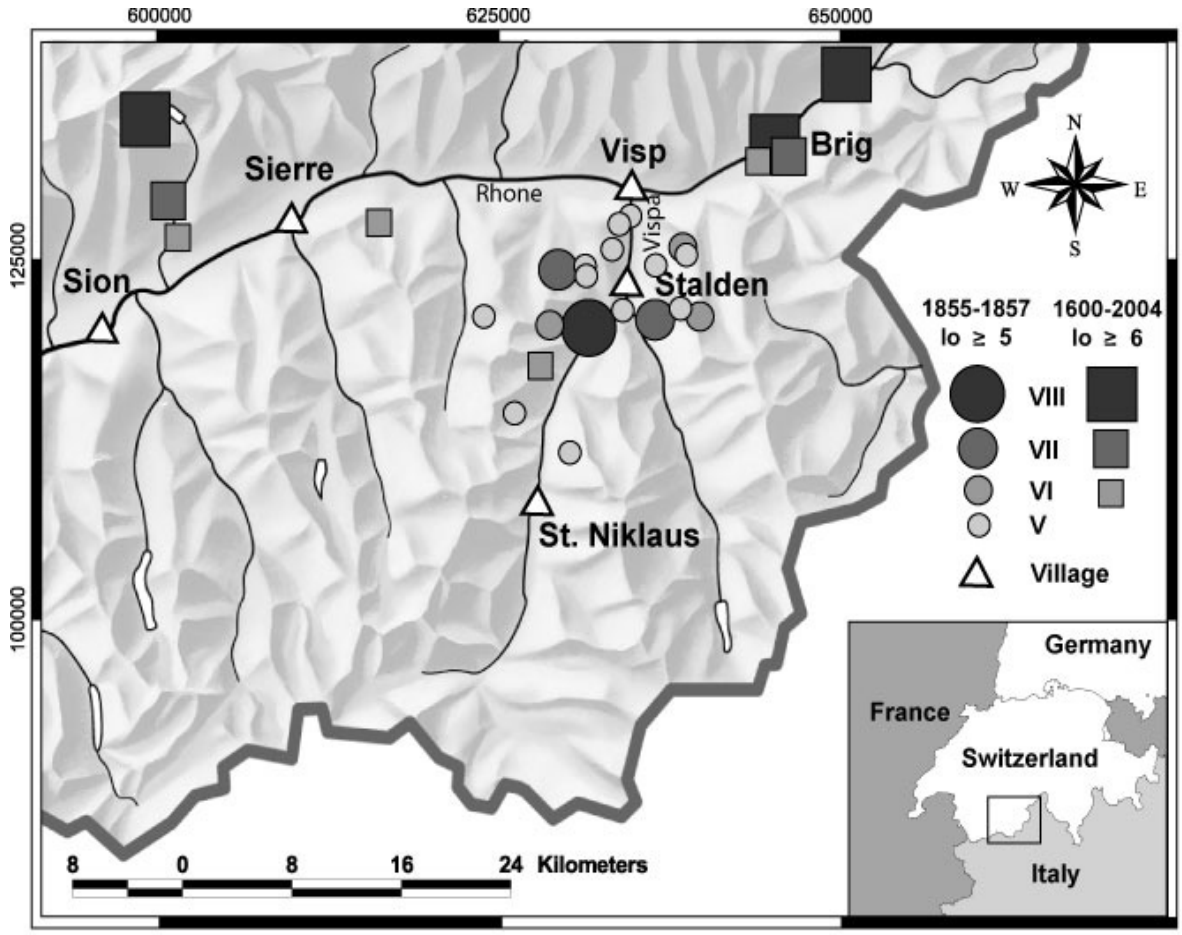


***Figure 1**: Large historical earthquakes in the Valais region and the event of 1855.*

In accordance with the work of several authors, the geological conditions of the region allow the assumption that site-effects could have been an important factor for the reported losses (Lecture note Institute of Geophysics ETHZ, 2003). The main valley on the whole and the side valleys in parts show substantial fluviatile and lacustrine sediments with a thickness up to several hundred meters. Our investigation thus concentrated on the question whether site-effects are verifiable for certain locations in the case of the 1855 earthquake.

The presented investigations and results of this paper are based on a study concerning the reconstruction of the damage field (Fritsche et al., 2005). We will show that parts of this damage field in fact are related to site-effects by using geological information and measurements of the fundamental frequency of resonance. The article starts with an explanation of the used methods. In doing so, a resume of the methods applied for the

reconstruction of the damage field will be included. This section is followed by the presentation of the results and a subsequent discussion and interpretation of the outcomes.

METHODS I: THE DAMAGE ASSESSMENT

It is difficult to reconstruct the damage field of an earthquake that dates back many decades in an adequate and useful manner. In the case of the 1855 earthquake this was possible due to a document discovered in the state archive of the Canton Valais (Staatsarchiv Wallis, 27.3.3). The document is the result of a damage assessment done on behalf of the government of the canton Valais in the months after the earthquake in 1855/56. The government used this assessment as a basis for the distribution of incoming donations. The document is well preserved, complete and its authenticity of no question. It consists of about 30 handwritten lists (one per affected village) describing the damaged objects such as houses, barns, and storehouses. The description of a single object consists of one to a few phrases and of an amount in Swiss Francs. In total, we identified about 1700 cases of loss.

This information was analyzed using the guidelines of the European Macroseismic Scale 98 (Grünthal, 1998). As recommended by EMS 98 we combined the results of the analysis with statistical data concerning the total number of existing buildings. This data originate from documents of the population census of 1870 and 1880 (Staatsarchiv Wallis, 1870/1880). Admittedly, these documents contain only data concerning the houses. Thus, the final analysis incorporates only this type of building. Nevertheless, the results describe the damage field of the affected region precisely (see fig. 2). A qualitative verification of the outcomes with other documents (such as newspaper articles, dairies, letters etc.) showed very similar results concerning the dimensions of the losses. For a detailed description of the methodology regarding the reconstruction of the damage field, see Fritsche et al., 2005.

METHODS II: MEASUREMENT OF FUNDAMENTAL FREQUENCIES

Assuming that parts of the damage field show influences of site-effects, we applied seismological and geological methods to explore the local ground conditions. Primarily the so called single station H/V-method, first introduced by Nakamura (Nakamura, Y, 1989) was used. The principle of this method is to compute the spectral ratio between the horizontal and vertical component of the measured ground motion. Many studies have shown that the method is able to detect directly the fundamental frequency of the ground. If the measured frequency is in the range of the eigenfrequency of buildings, (up to 10 Hz) a site-effect can

have a serious impact. The H/V method is easy to handle, everywhere applicable (including urban areas), not time consuming and needs only a minimum of equipment. On each explored site, we recorded the ambient vibration for 20 minutes with a sampling rate of 200 samples/second. In total 78 sites were measured. 46 sites distributed over the whole damage field (two per village) and another 32 sites on locations that showed a very high degree of damage (Visp: 20 measurements, St. Niklaus 12 measurements).

The algorithm used to compute the recorded noise is based on a frequency–time analysis (ftan-analysis) and on the classical H/V analysis in the frequency domain (Fäh et al., 2003). The information concerning fundamental frequencies of resonance, we combined and interpreted with data concerning the local geology and the reconstructed damage field. This algorithm is only valid in 1-D cases, in other words in the case of horizontal layers over a half space. Therefore, we used for locations where we assumed that the wave field is dominated by a 2-D resonance additionally another algorithm. This algorithm rests upon on an analysis in the frequency domain by making H a function of the azimuth. This way the algorithm includes the direction of the wave field for the horizontal components. The algorithm allows thus to detect the fundamental modes of the dominating SH and SV –waves in the 2-D case.

RESULTS AND DISCUSSION I: THE DAMAGE FIELD

Figure 2 summarizes the results of the entire damage field. The circles describe the assessed damage of the single villages. Whereas the size of the circles indicates the quantity of existing houses in 1855, the inlaying segments represent the proportion of the different damage grades.

It is apparent that damage grade 1 is missing even for villages showing lesser damage. This is an effect of the damage assessment of 1855/56. Damage of grade 1 includes according to EMS 98 hairline cracks in very few walls, fall of small pieces of plaster etc. Moreover, this kind of damage did obviously not fit the criteria of the government to receive compensation payments.

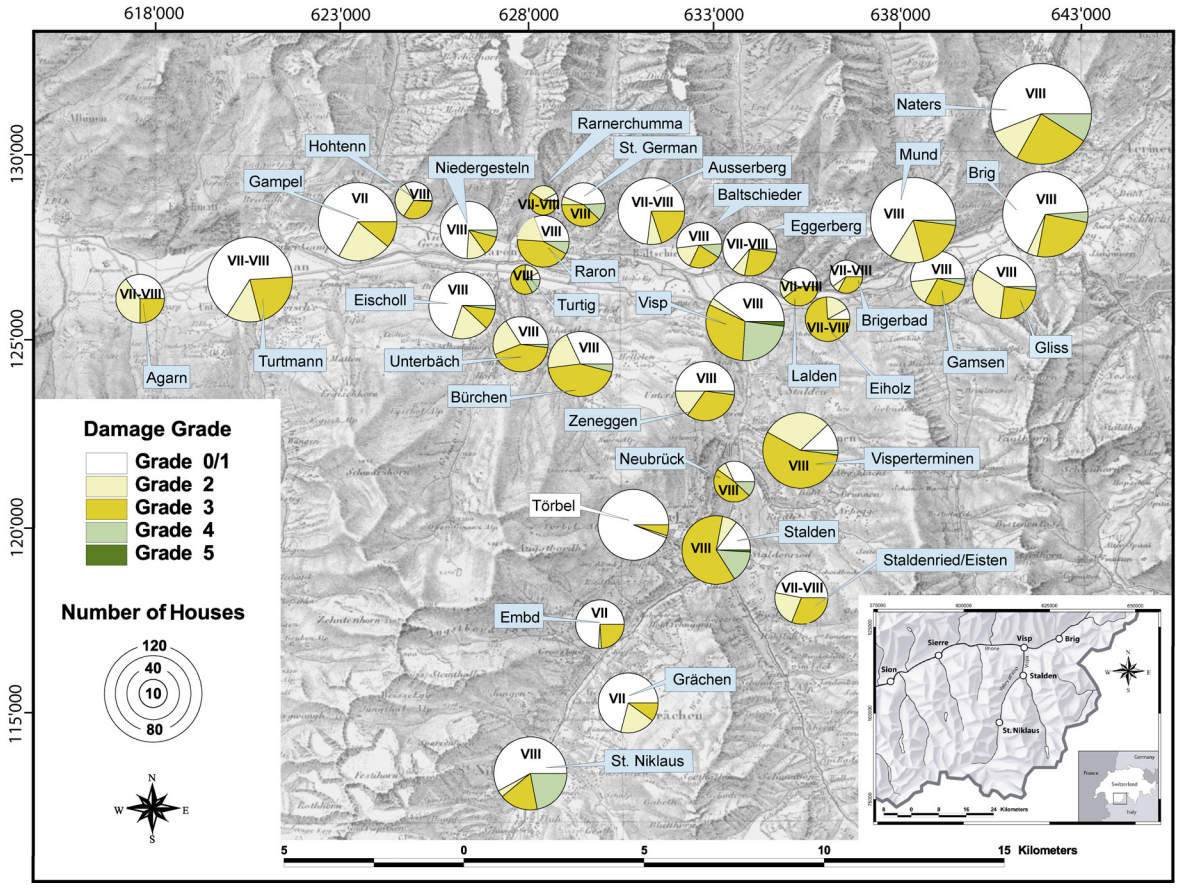


Figure 2: *Complete damage field of the 1855 earthquake in the region of Visp on the background of a map produced in the middle of the 19th century.*

The assigned intensities vary between VII and VIII. Generally, an increase of the losses on the east west-axis toward the village of Visp (along the main valley) is clearly visible. An exception is Naters in the northeast showing substantially higher losses than the neighboring villages. More inhomogeneous is the distribution of losses in the north south direction. The intensities of St. Niklaus and Stalden are comparable with the intensity of Visp, while Grächen Embd and Staldenried show clearly lower losses (Törbel is an exception because the document of the assessment is not preserved in its full length). Based on fig. 2 the villages of Visp, St. Niklaus, and Naters appear to be affected by a site-effect. All of them rest, at least partly on voluminous sediments and suffered heavy losses. Another indication for the possible existence of a site-effect is the fact that St. Niklaus as well as Naters are on the periphery of the damage field. Additionally our investigations showed clearly that other villages in the immediate vicinity of Naters or St. Niklaus were almost unharmed. Zermatt for example, situated only a few kilometers south of St. Niklaus suffered almost no damage. For Stalden the situation is slightly different. Although this village suffered also heavy damage, an impact of a site-effect is not likely because the village rests almost directly on rock.

Thus, we decided to intensify the investigations on the remaining villages Visp, St. Niklaus, and maybe Naters (the investigations concerning this village did not start until now). The best pre-condition for interesting results offers the village of Visp. The village rests partly on rock and partly on the unconsolidated sediments of the main valley. Furthermore, the history of Visp is well documented including information concerning the size in 1855. A large part of the historic village is well preserved and differs not much from the days in the 1850s. This allowed a closer look into the damage field including the localization of about 50 percent of the damaged houses. Finally, yet importantly, the village of Visp is a very good example for the increasing seismic risk due to the extensive growth of settlements into areas with unfavorable ground behavior in case of an earthquake. Like Visp in the last 150 years (see fig. 3), many other Swiss villages and cities grew and still grow into the planes of large alpine valleys that were not populated due to flooding before intensive land improvement took place in the past two centuries.

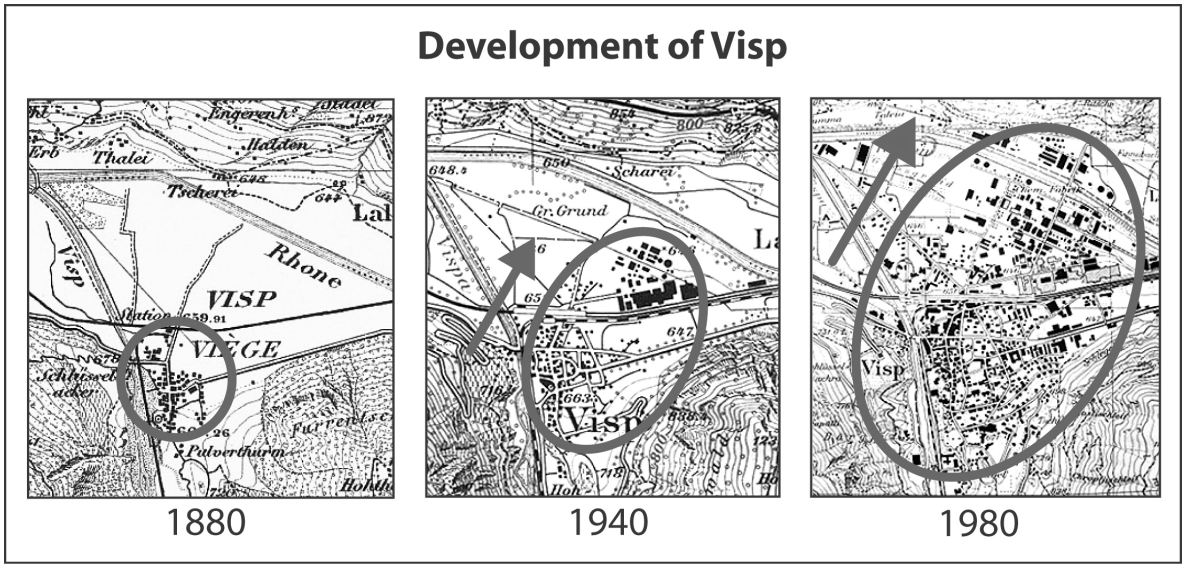


Figure 3: *Development of Visp between 1880 and 1980. The population increased between 1860 and 2000 by a factor of ten from about 620 to 6500 residents. Therefore, and due to a growing complex of chemical industries, the small Village of the mid-nineteenth century turned into a remarkable small town.*

The investigations concerning the localization of the damaged houses in Visp was done in collaboration with the local historian Christian Fux. Original documents of the population censes of the years 1850, 1860 and 1870 provided a good basis for this task, but many other documents were necessary to improve the result. Figure 4 summarizes the outcomes of this work. As for the reconstruction of the entire damage field, building types other than houses and churches could not be incorporated because the necessary information does not exist. About 50% of the mentioned houses in the historic damage list of Visp could be located.

Many of them still exist. Another 20% we could assign to one of the three historical quarters. The later are not marked as located in figure 4, but are included in the histograms.

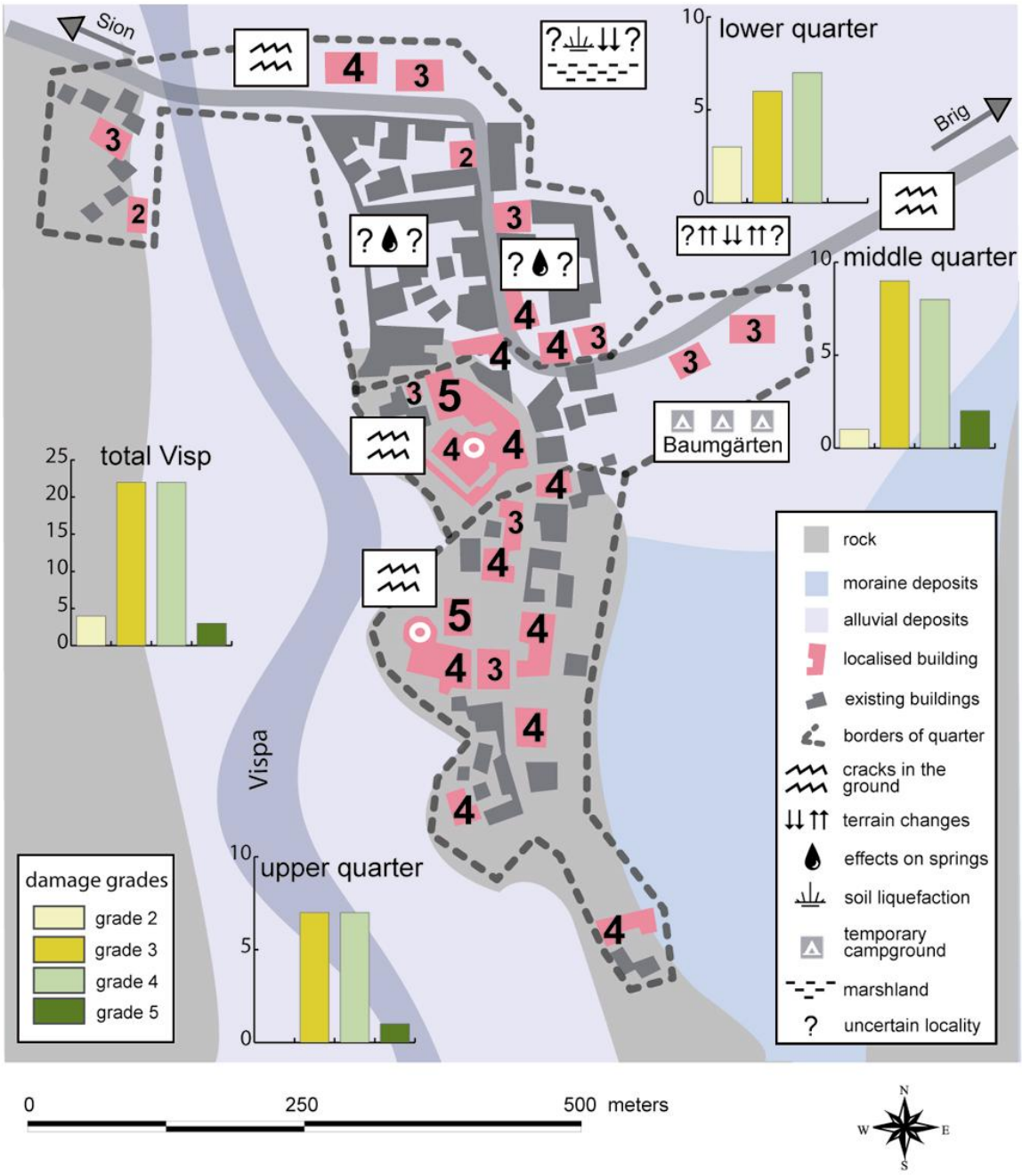


Figure 4: *The damage field of Visp on the background of the geological conditions and the historical quarters. Identified buildings are marked with red color. The respective numbers indicate the damage grades assigned following EMS 98. Furthermore, the figure contains contemporary observations of secondary effects.*

We started this investigation with the hypothesis that the losses on houses built on rock have to be smaller than on houses constructed on the sediments. This assumption was disproved by the results of our analysis. The histograms show that the damage seems not to be related to the existent ground conditions. It even seems that the lower quarter – mainly built on sediments – suffered slightly lesser damage because there are no damages of grade 4. One could argue that

the mentioned sediments are much better consolidated than expected or much less voluminous. However, the available geological information as well as the results of our analysis of the fundamental frequencies oppose to such explanations. What else could produce this kind of a damage field?

During the historical investigations, a number of documents containing unusual information attracted our attention. In one of them, a German geologist reported that a garden sustained a substantial terrain change: "For instance, I saw a […] garden, that used to be completely even. Now it has wavelike elevations […] with a level-difference of about one to two feet" (Nöggerath, Jakob, 1855, 14). What kind of ground deformation did he describe here? Is his description an indication that the fault reached the surface near Visp? Other documents describe the existence of clefts in the part of Visp built on rock originating from the earthquake with a width of one half to one foot, or of phenomena that probably describe liquefaction (Heusser, Johann Cristian, 1856) (Colombe, Ed., 1855). Finally a protocol of a governmental session indicates that a discussion took place about the question whether parts of Visp should be closed for future constructions of buildings (Staatsarchiv Wallis). Although not easy to interpret, all these information about secondary effects together (see fig. 4) allows the assumption that the fault passed the Village of Visp in a very short distance. The homogeneous damage field thus probably has to be interpreted as the result of a source effect. There are several faults that could be related to the 1855 event (Bundesamt für Wasser und Geologie BWG, 2000). A further fault recently found very close to Visp during tunnel construction works (Joris, Charles-Louis, 2005) finally could explain the theory of source effects responsible for the damage field in Visp.

RESULTS AND DISCUSSION II: FUNDAMENTAL FREQUENCIES

In total on 78 locations, ambient vibrations were recorded. Most of these locations are situated in the old centres of the villages. In Visp and St. Niklaus, additional locations were taken into account. Before having a closer look on the results of these more intensively investigated villages, a summary of the general outcomes will be given. Our investigations showed that the H/V method produces very consistent and reliable results as pointed out already by several other authors. The comparison of the measured fundamental frequencies with available data concerning the local geological conditions (and S-wave velocities) shows a very good correlation. An example for this are the results of the villages located on the side of the main valley. They are partly built on the sediments of the valley plain and partly on the rock of the

slope. The measured fundamental frequencies reflect this situation properly (See Gampel, Niedergesteln and Raron on fig. 5; Baltschieder on fig. 6 and Brigerbad, Lalden on fig. 7).

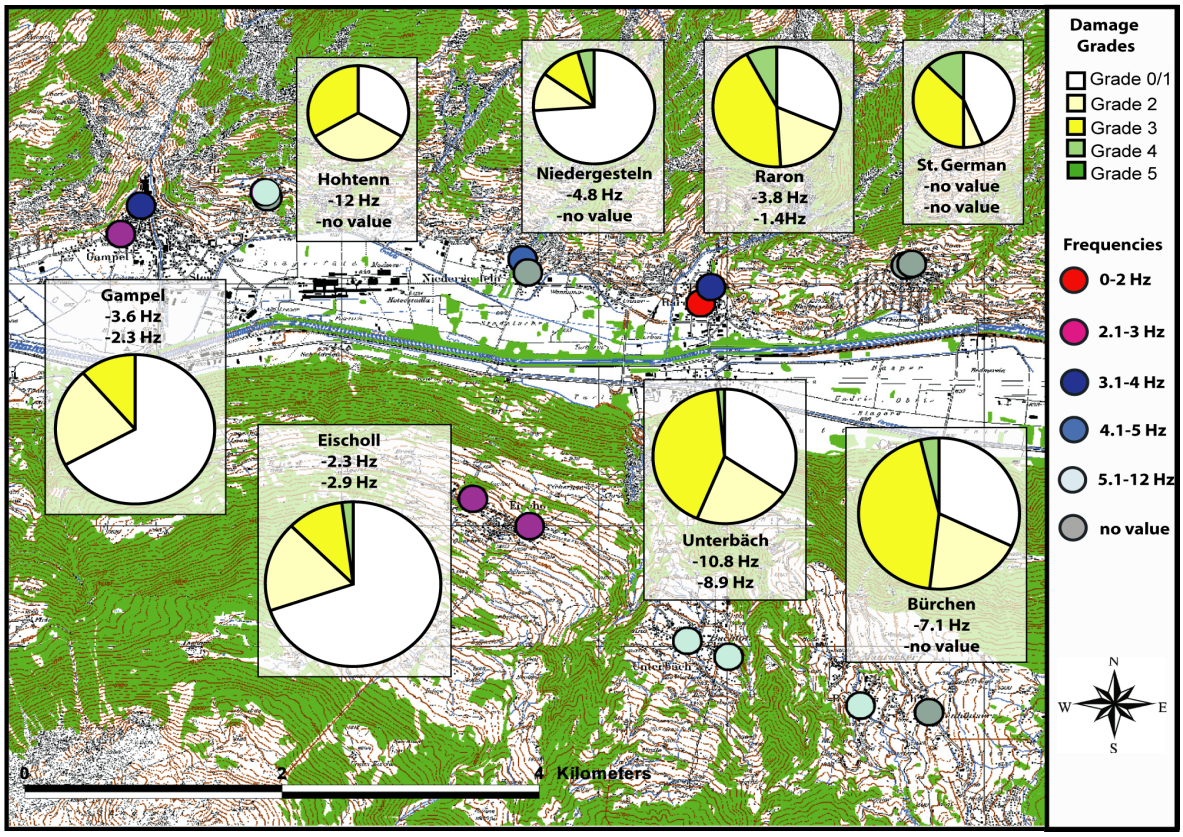


Figure 5: *Western part of the damage field*

On the other hand, the villages built on homogenous ground show values that differ not much (Eischoll, Unterbäch, Bürchen and St. German on fig 5; Zeneggen and Eggerberg on fig. 6; Brig, Gliss and Gamsen on fig. 7.) Locations in villages built directly on rock or on very thin sediments show either no interpretable picks in the H/V spectra or very high values of f_0 (Hohtenn and St. German on fig 5; Eggerberg, Ausserberg and Zeneggen on fig 6.). These locations tended to be less affected by the earthquake in 1855. The lacking of values for Gliss has probably another reason not identified yet.

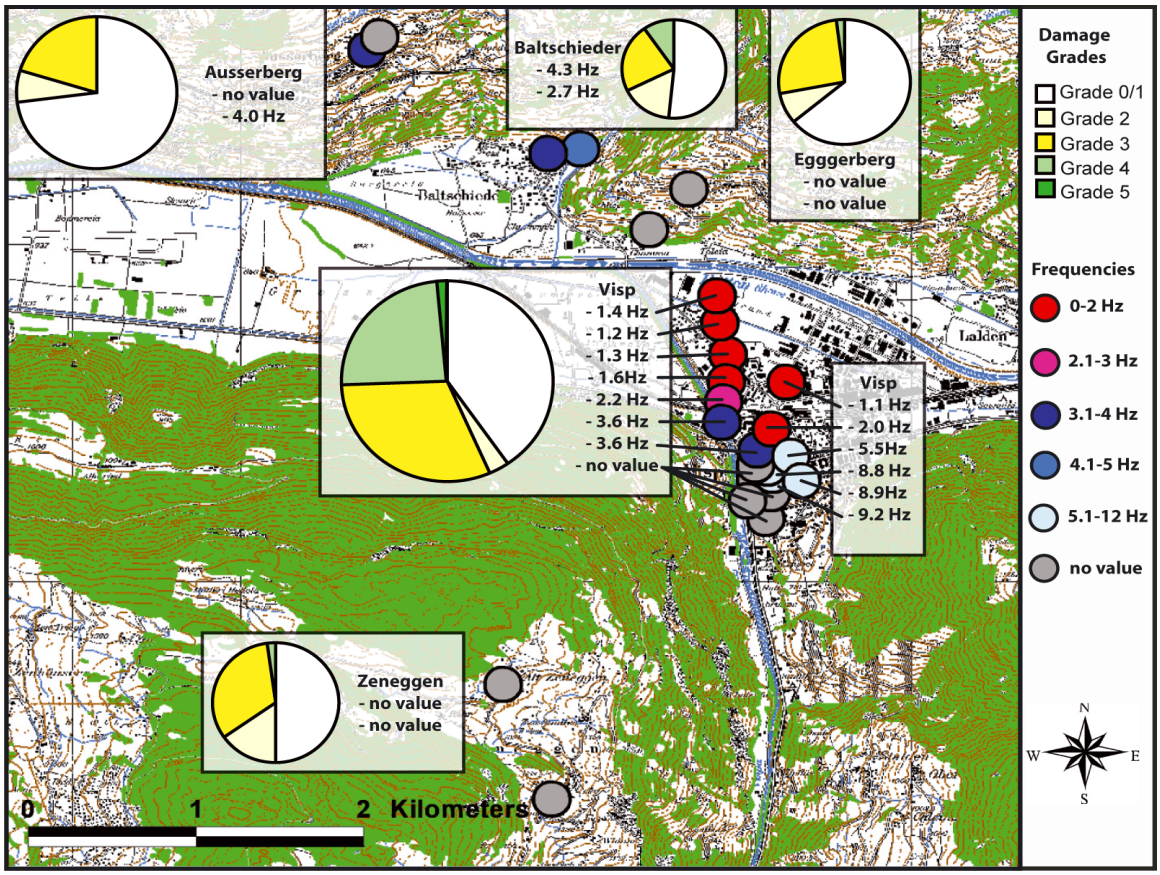


Figure 6: *Damage field of Visp and of the surrounding villages*

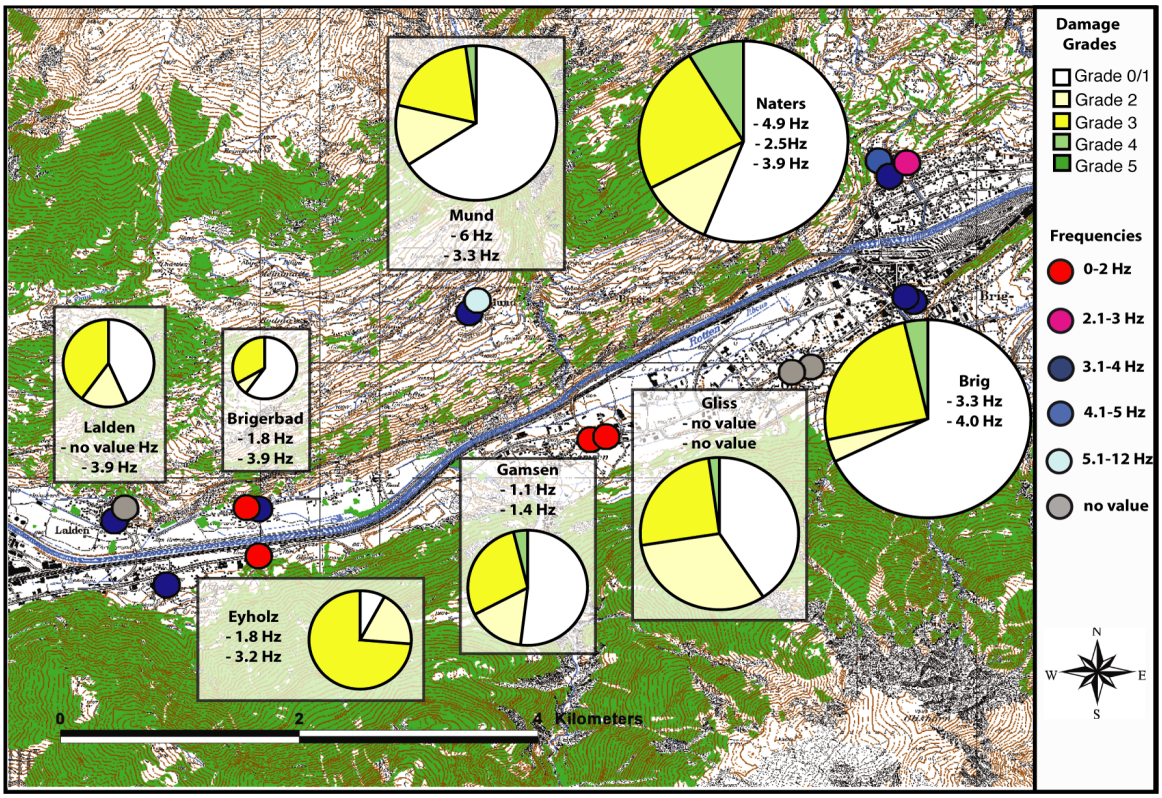


Figure 7: *Eastern part of the damage field*

As well, the data concerning Visp are consistent with the local geology. The southern part of the village, where we could not identify fundamental frequencies, corresponds exactly to sites with rock. To the northeast of this rock sites a relatively shallow basin connects the Valley of Visp with the main valley. This basin becomes deeper to the north. It consists of moraine deposits (to the south) and of alluvial sediments of the Rhone River (toward north). The increasing depth of these soft sediments corresponds with the decreasing values of the measured fundamental frequencies down to the location were a value of 5.5 Hz is observed. From there on to the north, the basin of the main valley is dominating the geology. The thickness of the deposits increases quickly up to several hundred meters. According to this, the fundamental frequencies drop down to values around 1.5 Hz with a minimum of 1.2 Hz approximately in the middle of the valley plain. As we pointed out in the previous chapter, the damage field of Visp corresponds not well to the local geology and thus we assumed that the damage of Visp is rather an outcome of a source effect than of a site-effect. The findings of the measured data affirm this conclusion. At the same time the example shows how important it can be, to know as much as possible about the exact distribution of the occurred damages.

Likewise, in the previous chapter we assumed that - in contrast to Visp – the damage fields of Naters and St. Niklaus in fact show influences of a site-effect. Their positions on the border of the general damage field, the geological conditions, and the heavy losses in these villages are a strong indication for it. In the case of Naters, the measured fundamental frequencies don't conflict with this hypothesis. The values vary in the range of 2.5 Hz and 4.9 Hz. A site-effect thus is possible. Nevertheless, more measuring data and further investigation concerning the distribution of the damages are necessary for a final evaluation.

On the other hand, we are able to show that St. Niklaus in fact shows the impact of a site-effect. The village is situated on the lateral slope of the comparatively narrow Valley of Visp. A cross section trough the valley on the position of St. Niklaus results in a width of approximately 1 kilometer. The valley is U-shaped and has an infill consisting of alternating layers of gravel, moraine, and fluviatile deposits. During construction, near the centre of the village lacustrine deposits were identified as well (personal communication Herrmann Rovina). Assured information concerning the depth down to the bedrock is unfortunately not available.

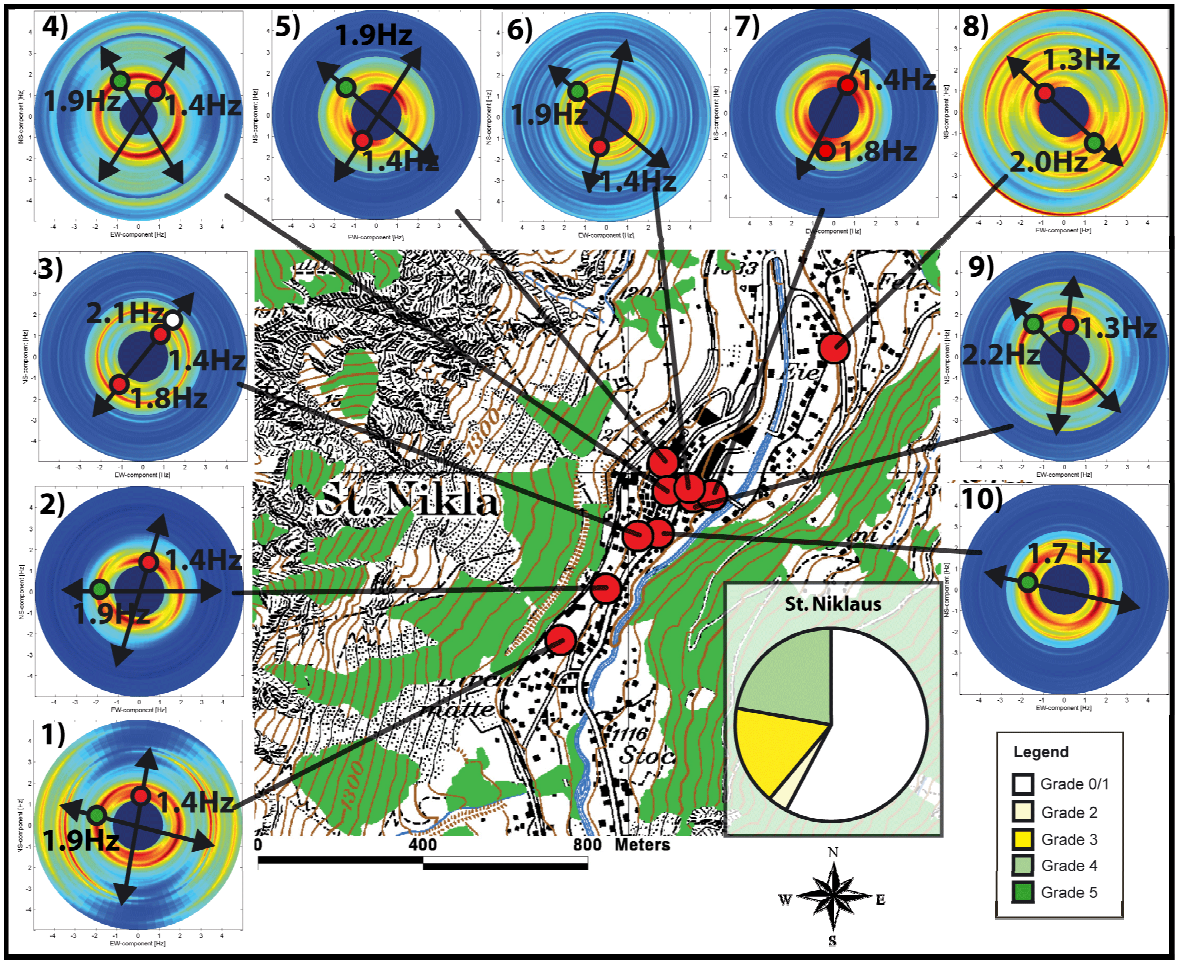


Figure 8: *2-D resonance and damage field of St. Niklaus*

The only existing deep borehole is located 5 kilometers to the south of St. Niklaus on the eastern side of the valley. It reaches a depth of 80 meters without meeting the bedrock. After all, this information allows the assumption, that the valley must be deeper in the middle of the cross section – probably much deeper. This assumption is affirmed by the work of Masset. He interpolated the cross section of the valley by means of geological and topographical information (Masset, 2005). The results of this interpolation show that the valley has a depth of up to 200 meters in the middle of the cross section. With such dimensions (a cross section of 2000 meters length and up to 200 meters depth) the valley is in the range were 2-D resonance effects may dominate the wave field (Bard and Bouchon, 1985). The measured noise data thus were used to compute H/V making the horizontal component a function of the azimuth. This allows to test whether a 2-D effect is visible or not. Figure 8 summarizes the results of this analysis. The circles show the dominating frequencies in the range of 1 to 5 Hz. The colors indicate the relative values of the amplitude from blue (low) to yellow to red (high).

The results are quite consistent. Most of the locations show a clear polarization in the direction approximately rectangular to the valley axis (from east to southeast). The concerning frequencies are around 1.9 Hz. This part of the wave field can be interpreted as the fundamental mode of SV (SV_0). On the other hand, almost all locations show a polarization along the valley axis (north-northeast). The frequencies vary in the range of 1.3 to 1.4 Hz. Accordingly to the direction of the polarization this part of the wave field has to be identified as the fundamental mode of SH (SH_0). These values of (SV_0) ≈ 1.9 Hz and of (SH_0) ≈ 1.4 Hz can be explained by theory. Thus, the assumption that the Valley of Visp is dominated by a 2-D resonance in the region of St. Niklaus is probably correct. With this finding all indicators suggest, that the damage field of St. Niklaus was in fact the consequence of a site-effect.

CONCLUSIONS

The main task of our investigation was to decide whether site-effects affected certain locations during the 1855 earthquake in the region of Visp. In a first step, we reconstructed the damage field. Due to the existence of a contemporary damage assessment done shortly after the earthquake, we were able to complete this task adequately. In a second step, we carried out measurements of the fundamental frequency of resonance on a large number of locations. The H/V method proved to be a very convenient tool producing very reliable data. The findings of these first steps we then combined and interpreted with available geological data. Thereby it was possible to show that from the list of locations possibly affected by a site-effect (Naters, Visp and St. Niklaus) the village of Visp had to be removed because the village did not show variable damage between rock and soft-sediment sites. The damage field of Visp and certain contemporary observations let us assume that source effects were responsible for the losses. This assumption was affirmed by findings of the geological and seismological investigations. The example of Visp points out how important adequate information concerning the damage field is. For the village of Naters further investigations would be necessary to confirm the existence of a site-effect. The so fare-collected data don't contradict with our assumption. In the case of St. Niklaus all indicators suggest, that a site-effect occurred in 1855. The damage was remarkably high although the neighboring villages to the south suffered almost no damage. In addition, the geological conditions imply the existence of a 2-D resonance effect. This 2-D resonance finally could be verified by ambient vibration measurements.

A general outcome of the investigation was that for clear and plausible results all three types of data used are of the same high importance. Adequate historical data is needed just as well as information concerning the geological conditions. The measured fundamental frequencies of resonance finally allow deciding whether the occurrence of a site-effect on a certain location is plausible or not.

REFERENCES

BARD, P. Y., AND M. BOUCHON. 1985. The two-dimensional resonance of sediment-filled valleys. *Bulletin of the Seismological Society of America* 75(2). 519-541.

BWG, BUNDESAMT FÜR WASSER UND GEOLOGIE Ed.. (2000). Beitrag zur seismischen Zonierung des Rhonetals zwischen Sitten und Brig. *Geologische Berichte* Nr. 25. Bern.

COLOMBE, E.. 1855. Tremblement de Terre du Valais. *Comptes rendus hebdomadaires des séances de l'académie des sciences, Paris,* vol. 39: 952-954.

FÄH, D., KIND, F. and D. GIARDINI. 2003.. Inversion of local S-wave velocity structures from average H/V ratios, and their use for the estimation of site-effects. *Journal of Seismology* 7. 449-467.

FRITSCHE, S., FÄH, D., GISLER, M., UND D. GIARDINI. 2006. Reconstructing the Damage Field of the 1855 Earthquake in Switzerland: historical investigations on a well-documented event. *Geophys. J. Int*., 166, 719-731.

GRÜNTHAL, G (ED.). 1998. European Macroseismic Scale 1998. *Cahiers du Centre Européen de Geodynamics et de Séismologie.* Vol. 15, Conseil de L'Europe. Luxembourg.

Heusser, J.C., 1856. Das Erdbeben im Visper-Thal im Jahr 1855. An die zürcherische Jungend auf das Jahr 1856. *Neujahrsblätter der Naturforschenden Gesellschaft*, Vol. 58.

JORIS, C.-L.. 2005. Neotectonic fault in the south east of Visp. Personal communication.

INSTITUTE OF GEOPHYSICS ETHZ. 2003. Lecture note. Microzonation and Site-Effects.

MASSET, O.. 2005. Modélisation géologique et hydrologique de l'instabilité de falaise de St. Niklaus. Diplôme postgrade. ENAC. Lausanne, EPFL. Unpublished.

NAKAMURA, Y. 1989. A Method for Dynamic Characteristics Estimation of Subsurface using Microtremor on the Ground Surface. *QR of RTRI*, 30, p. 25 – 33.

NÖGGERATH, J.. 1855. Die Erdbeben im Vispthale. Besonderer Abdruck für Freunde des Verfassers aus Nr. 282 bis 286 der Kölnischen Zeitung von 1855. Köln, Selbstverlag.

Tremblement de terre de juillet 1855. Révision de la taxe, distribution des secours. Ancien fonds du département de l´intérieur. 27.3.3.

Originaldokumente der Schweizerischen Volkszählung aus dem Jahre 1870 im Kanton Wallis. StAW, 3090, 1870.

Originaldokumente der Schweizerischen Volkszählung aus dem Jahre 1850 im Kanton Wallis. StAW, 3090, 42, 1850.

Protocoles des séances du Conseil d'État 1946. Conseil d'état. 1101: protocoles des séances du Conseil d'Etat. StAW, 1101, vol. 49, 1857-1857.

Protocoles des séances du Conseil d'État 1855-57. Conseil d'état. 1101: protocoles des séances du Conseil d'Etat. StAW, 1101, vol. 97, 1945-1946.

Tremblement de terre de juillet 1855: Expertises des dommages. Ancien fonds du département de l´intérieur. StAW, DI, 27.3.2 (1855-1856).

Tremblement de terre de juillet 1855: Révision de la taxe, distribution des secours. Ancien fonds du département de l´intérieur. StAW, DI, 27.3.3 (1855-1860).

SWISS SEISMOLOGICAL SERVICE. 2002. ECOS - Earthquake Catalogue of Switzerland. 10. Jan. 2008. http://www.seismo.ethz.ch.