Appendix F: Catalogue for the period 1964 to 1974

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Earthquakes in Switzerland and surroundings during the period 1964-1974

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Summary

A detailed report on the situation of the earthquake service and the seismicity of Switzerland and surroundings in the years 1964-1974 has been done together with a detailed review of all the events of the period. After looking for original data, the catalogue Ecos02 has been checked. Duplicates and fake events have been removed. The fake events are either mislocated strong events abroad but felt in Switzerland or induced events, for example a mine in France or dams in France and in Italy.

A few events might have been attributed to construction of dams in Switzerland, Verzasca (TI), Linth-Limmern (GL) and lac Hongrin (VD) but they were kept in the catalogue as earthquakes.

The general activity is dominated by a swarm activity in the Sarnen region. This high activity in the Sarnen region eclipsed another swarm in the region Trun, in the upper Rhine Valley. Strong events happened in the border area with Germany (Swabian Jura) in the northeast and with France in the Chablais Region, southwest.

Not all the intensity fields are included in the database, however for most events with Io= V a macroseismic distribution of (intensity data points) IDP is available.

The events with a magnitude of 3.5 or higher are considered complete. They have been compiled in the table (Table 3). New information for these events has been added. This information consists of original macroseimic fields, international studies or phase readings. The magnitude and location uncertainties have been reviewed as well. The necessary corrections have been applied to the database and will appear in the catalogue version of Ecos09.

1.Introduction

This report gathers and describes information on the seismicity in Switzerland between 1964 and 1974. It fills a gap in the documentation. Annual reports from the Swiss Earthquake Commission started to be published in 1879. In 1964, the Swiss Seismological Service (SED) ceased the publication of the annual reports.

In 1970-1971, the activity of the SED increased, analog seismic stations for routine location were installed and the network started to grow. Between 1972 and 1974, yearly reports were published again.

The report describes briefly the state in 1963 and in 1973 and gives an overview of the data acquisition and the seismicity. The annexes contain the short chapter in Ecos02 describing this period (annexe1), annual seismic maps for each of these eight years, detailed information on the Glarus event of the 29 September 1971, some suggestions for further studies and references.

2. State of the SED between 1963 and 1972

In 1963, Fritz Gassmann was Professor of geophysics and director of the SED. The people working at SED in 1963 were: Max Weber, Ernst Peter, Nazario Pavoni, Robert Berger and Walter Graber. There were stations at four locations at this time: Neuchâtel, Basel, Chur, Zurich. In Zurich there were three types of seismographs sitting next to each other. Some portable (or better said transportable) stations were also available for aftershock studies. The project to modernise the equipment and install new stations was already launched, but in an initial phase.

From 1969 to 1971, Max Weber served as head of the earthquake service. The institute during these years was busy preparing the move from Clausiusstrasse to the Hönggerberg. Many campaigns of seismic reflection were initiated. Some geophysical equipment was developed at the institute, and there were plans to equip structures such as dams and special buildings with strong motion instruments. There was a small shaking table available at that time.

In 1971, Stephan Mueller was appointed professor of seismology at ETH Zurich and D. Mayer-Rosa became in charge of the earthquake service. From that time, the SED expanded, seismic stations with analog telemetry data transmission started to be installed (see below), and the network continued to develop in Switzerland as well as in the neighbouring countries.

In 1972, the people working at the SED were, beside Prof. St. Mueller and Dr. Mayer-Rosa, Manfred Baer (Computer programming), Zsombor Somogy (Seismogram readings), Robert Berger (Macroseismic; intensity data point determination), Max Dietiker, Heinrich Krämer.

There were 6 stations operating (Neuchâtel, Basel, Zurich, Dixence, Linth-Limmern and Buchberg). The Table summarise the information on the stations.

Analysis of the annual report 1963

We have analysed the report of year 1963 first to see the context in which the data were recorded at that time and to have continuity with the studied period. Some events in 1964 were related to events happening in 1963.

The last annual report was edited in 1963 by Max Weber [Weber 1963]. The report contains, beside very succinct information on stations, two tables and figures. The first table lists the felt earthquakes. It includes macroseimic information: place, time and intensity of the felt event (possible earthquake). The macroseimic data were analysed with the intensity scale Rossi-Forel (I - X) and effects listed with pictograms to describe them. The figures show the location of the felt intensities.

The other table lists the recorded arrival phases, the distance to the station, amplitude, duration of the signal and a location whenever possible. If the same event was identified in one of the two tables, its number was referred to in the other table. The events from the BCIS were indicated (Bureau central international de sismicité).
Comparing the data from1963, which are in the catalogue Ecos02, with the annual report from 1963 we noted the following fake events:

- On the 6th of June there is an error in time.
- On the 20th of June there is a sparsely felt event, which is questionable.
- On the 19th of July 1963 05:47 there is an event located in Ticino in the catalogue. In the annual report, the intensity reported in Bellinzona was III. This event had intensities II reported as far as St Gall, Schleitheim (near Schaffhausen) and Geneva! Looking in a wider area, we found that it was in fact a strong earthquake in Mare Ligure, which reached a magnitude of Ml 5.9.
- On June the 26th the event is very questionable. A single person reported it and there was at the same time a strong earthquake of magnitude on the order of 6 in Yugoslavia, which provoked many fatalities.
- On the 9th of October the event also reported by one person is probably related to the catastrophe of the Vajont dam in northern Italy.

The necessary corrections have been introduced in the catalogue Ecos09.

3. Seismic stations and station coverage

In 1963 there were stations recording earthquakes in Switzerland at four sites only; Zurich, Neuchâtel, Basel and Chur. They were equipped with three-component de-Quervain-Piccard seismometers recording signals on smoked paper. Some had been in operation for more than 30 years (table 1). In Zurich there was as well a Mainka and a Wiechert seismometers (Jahresbericht 1958). These three instruments were sitting next to one another. Some portable stations (transportable) were also available. They have been used in Wallis in 1963 and in the Sarnen Region in 1964-1965. In Degenried the existing Erdbebenwarte (earthquake observatory) was under reconstruction. The renovation in Degenried started in 1964. In 1967 a Broadband vertical seismograph was operating. In 1970 the installation of a small telemetric seismic network started. Zurich was the central station.
In august 1971, in Zurich Degenried, a long period three-component system was installed beside a strong motion vertical component. A network of analog stations replaced progressively the old seismographs. The station in Chur had been dismantled in 1970. The first stations of the new modern seismic network were installed on the Dixence, Linth-Limmert and Contra dam sites. The choice of these sites was commented: "*Despite the high seismic activity in the region of the Valais, this area had shown a gap in the seismic survey and since the station in Chur had been removed in 1970, a replacement was needed also to cover the Graubunden area"*. The station at the contra dam site did not remain.
In the neighbouring countries seismic networks were also being developed. In France, for example, this started around 1960 and by 1971 there were about 40 stations [Rothé 1984]. Some of these stations were in the vicinity of the Swiss border (Figure1) and recorded many events in Switzerland. Much less data come from the German, Italian and Austrian networks at this time.

Table 1. *Stations in use during the period 1964 - 1974*

Code	Station Location	Inst.	Type Components	Lat	Long	Alt (m)	Remarks
BUB	Buchberg, Schaffhousen	Jan. 1972	M V?	47.748	8.602	740	Upper Jurassic limestone
BAS	*Basel (meteo. Obs) Binnigen*	*1934*	*QP V+H*	*47.540*	*7.583*	*309*	*tertiary-sediments*
BLA/BBS	Basel- Blauen	Jun 1974	V+H	47.463	7.508	700	Jurassic limestone
BRI	Brienz	1974	M V+H	46.758	8.120	1330	mesozoic limestone
CHU	*Chur (Kant. Schule)*	*1926 - 1966*	*QP V*	*46.850*	*9.537*	*630*	*Penninic Bündnerschiefer*
DAV	Davos	Aug 1974	M V+H	46.838	9.793	2800	Mesozoic dolomite
DIX	Dixence (dam site)	Nov. 1970	V+H (BB)	46.081	7.411	2400	Schists
EMO	Emosson	Sept 1973	M (+H)	46.060	6.930	1500	Permo-carboniferous rocks
LIN	Linth-Limmern (dam site)	Nov. 1971	V+H (BB)	46.869	8.997	1900	Upper Jurassic limestone
NEU	*Neuchatel (Obs.)*	*1927*	*QP V+H*	*46.997*	*6.957*	*487*	*limestone*
ROM	Romont	Sep 1974	M V+H	46.773	6.961	720	Sandstone, marl, molasse
SIE	Sierre	Aug 1974	M V+H	46.384	7.472	2910	mesozoic limestone
ZUL	Zuerich-Laegern	Jan 1974	M V+H	47.480	8.389	700	Jurassic limestone
ZUR	Zurich	1911	V+H (BB)	47.369	8.580	604	Sandstone, marl, molasse
ZUR	Zurich Degenried	1923	QP V+H	47.369	8.580	604	Sandstone, marl, molasse
ZUR	Zurich	1938	K - W	47.369	8.580	604	
ZUR	Zurich	1967	V (BB)	47.369	8.580	604	Sandstone, marl, molasse
	Portable	De Quervain - Piccard,		T. Wanner-Grütter			
Other	M Mark L4-3D	A Askania		W Weber		K Kreis	

QP de Quervain-Piccard, KW Kreis-Wanner, BM Bosch-Mainka
BB Broad band seismometer. The stations in italic were not operated by SED

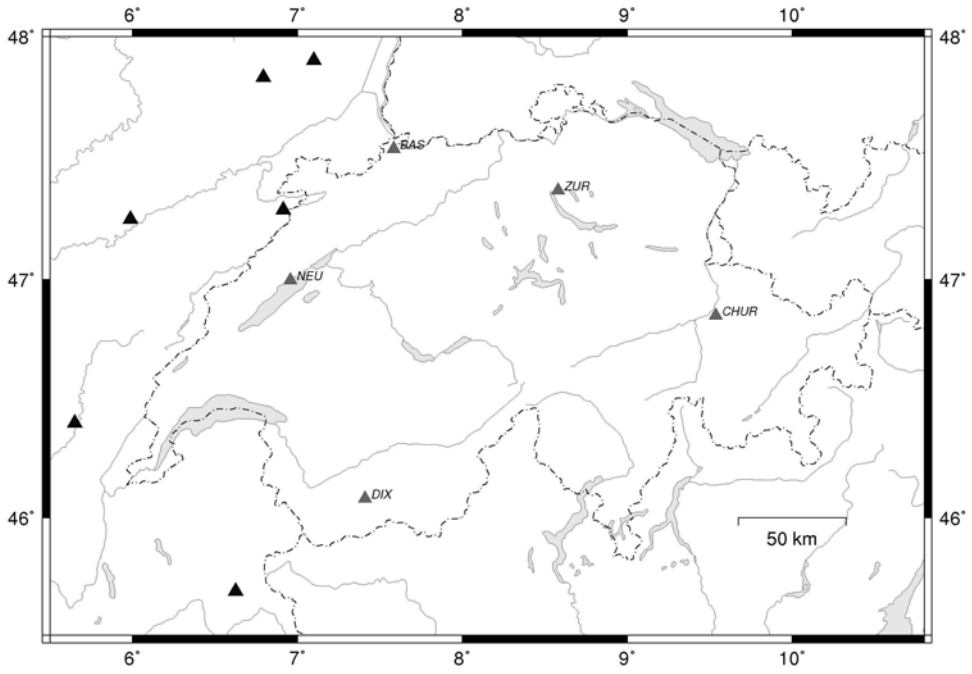


***Figure 1a**. Location of stations in operation within the period 1963-1971. In black station from the French network. Not all the stations were in use during the whole period (see table 1). The installation date of the French station is unknown.*

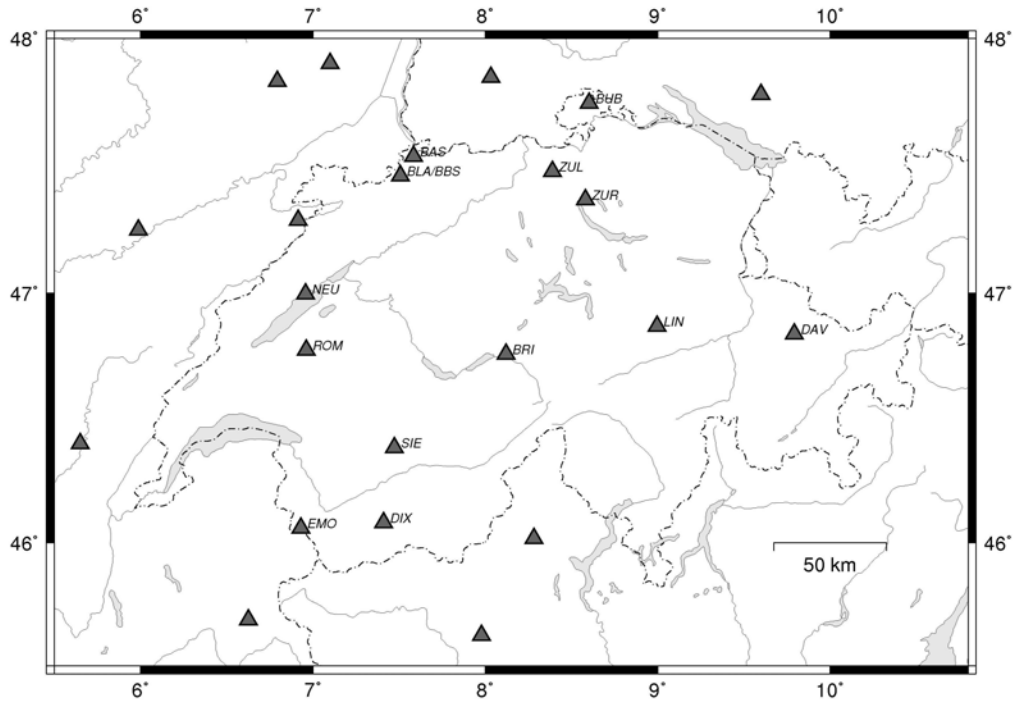


***Figure 1b.** Location of stations in operation end 1974.*

4. Intensity and magnitude threshold

The magnitude threshold depends on the distribution of stations (among others factors). In a Nagra report (Mayer-Rosa 1983), maps of isolines of magnitude threshold from 1928-1966 and 1966-1971 are depicted (Annexe 2). Based on these data, we have come out with an estimation of the magnitude threshold with the distance (Figure 2). This relationship has been used to elaborate maps of the magnitude sensitivity depending on the distribution of the Swiss stations during this time period (see the Figures 3a to 3d). The foreign stations are not taken into account on these plots.

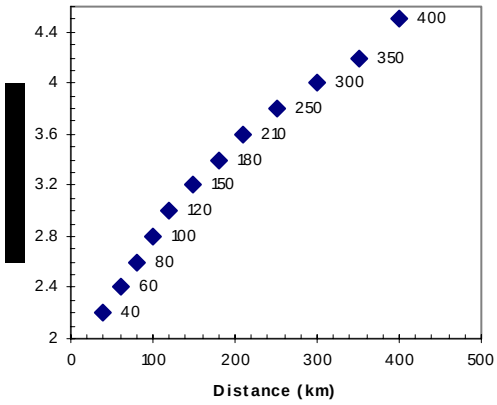
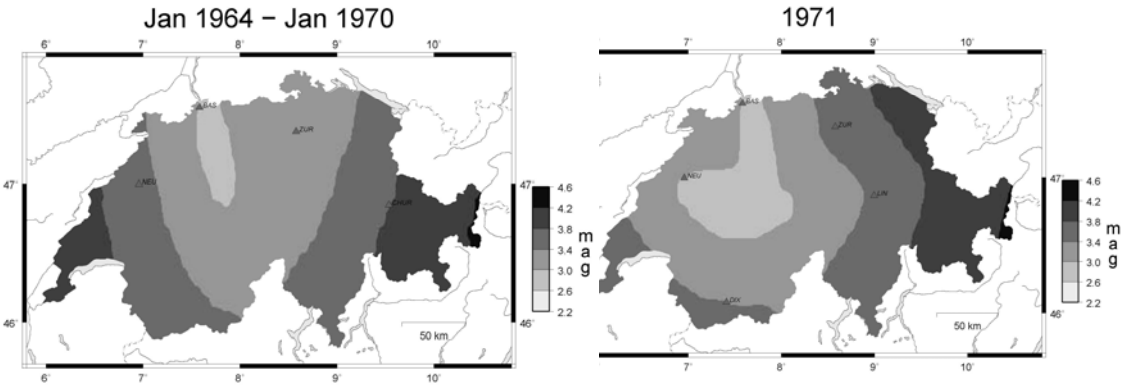
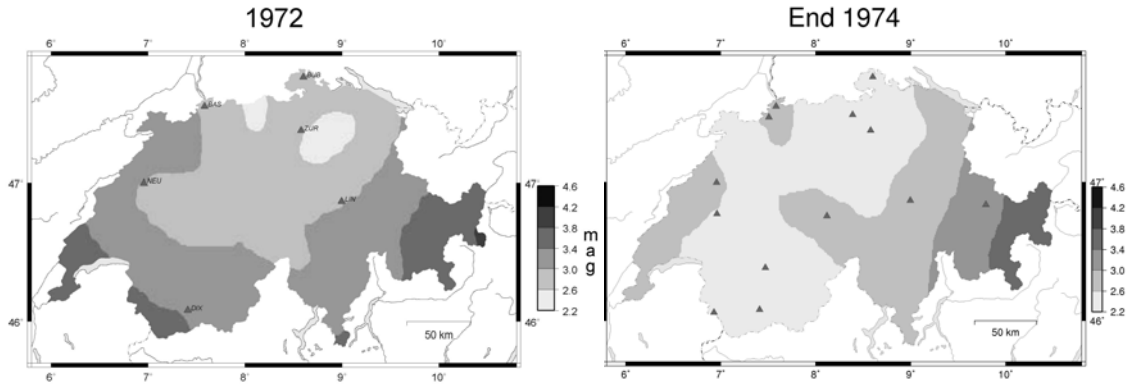


***Figure 2**. Magnitude threshold with the distance based on the information in annexe2*





***Figures 3a-3d**. Seismograph stations operational and evolution of the magnitude threshold with time in Switzerland (this study)*

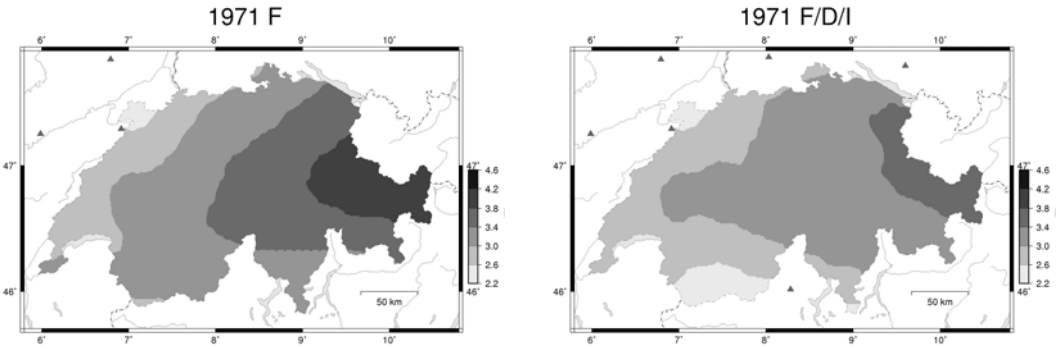


***Figure 3e and 3f** Tentative estimation of the magnitude detection in Switzerland of the foreign station.*

If we compare the two types of magnitude threshold maps, there is a 'discrepancy'. A notable change is happening after 1966. From the information available it does not seem that anything had changed regarding the stations' capabilities in 1966. In Pavoni's file [C3], there is however a change in the recording of felt and registered earthquakes. From 1967 there are readings only from the station in Zurich and no longer from Neuchâtel, Basel and Chur. The Chur station has been dismantled in June 1966, but there is no information on changes at the stations in Basel and Neuchâtel.

On the Figure 3a to 3c we can see that the magnitude threshold is about 2.5 in a limited area in the centre of Switzerland between Neuchâtel and Zurich. However due to the configuration of the Swiss stations, this threshold do not go below 3 to 4 for the whole of Switzerland before 1974 (Figure 3d).

According to the data in the catalogue, the minimum level of magnitude, recorded by the French agency in the west of Switzerland, seems to be in the order of 1.1 to 1.5 in the vicinity of the Alsace region and at the end of the period (in 1971) and up to 2.2 in other part of Switzerland. This corresponds to the magnitude threshold deduced from the configuration of the French station (Figure 3f). A map taking into account all foreign stations is plotted on the Figure 3f. This would correspond to the situation in 1974.

A detailed record of macroseismic information persists for three more years after 1963 but was not published. It is a handwritten document of this detailed listing from 1964 to 1968 (Pavoni's file [C3]). In this period the intensity scale used was the Rossi-Forel scale. Table 2 shows how these values are converted to EMS98 (source Ecos02).

Table 2a Comparison of different intensity scales used by SED							
R-F	I	II	III	IV	V	VI	VII
MSK 64/81	I	III	III	IV	IV- V	V-VI	VI
EMS 92/98	I to II	III	III	IV	IV- V	V-VI	VI

Table 2b. *Magnitude values estimated in the catalogue ECOS02 from the intensity levels considering an earthquake with shallow depth. From intensity level VI the values were reassessed. There is no automatic correspondence*						
EMS 98	II	III	III	IV	V	VI and above
Mw	1.5	2.3	2.3	3.1	3.9	No automatic estimation

5. Overview of the seismic activity from 1964 to 1974

The figure 4 shows the distribution of the epicentres of the events recorded over the period 1964-1974. Among them half had magnitude >=2.5. The activity is concentrated in the Savoy border with Switzerland, Valais, Central Switzerland, Glarus and Grisons. The colour indicates if the earthquake was recorded by the Swiss network (number 1 to 3) or by another network. We can notice that in the western part of Switzerland, many events come from the French catalogue. On figure 5, histograms of the percentage of events recorded per agency are displayed. The first diagram shows all recorded events and the second shows events equal or bigger than a magnitude of 2.5. We can see that beside the SED catalogue, the main contribution comes from the French catalogue (number 11), especially for small events (below 2.5) and in the western part of Switzerland, in particular in the Valais.

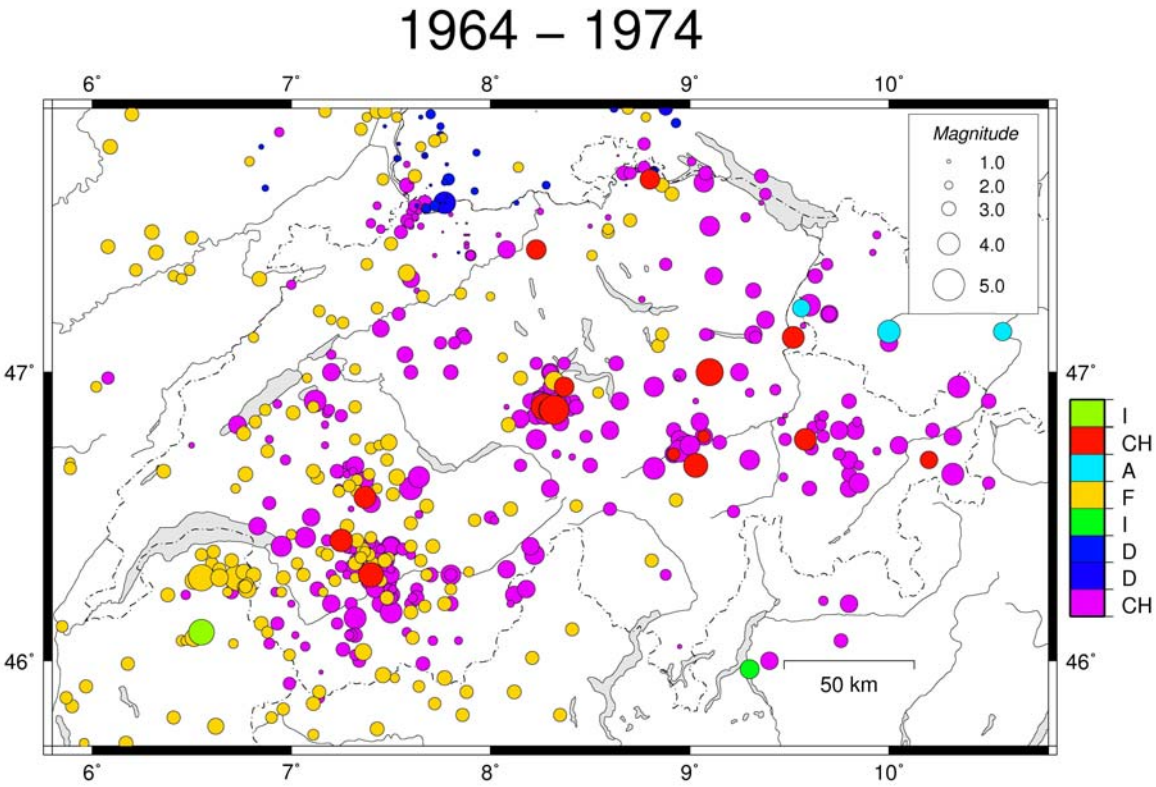


Figure 4. *Seismicity distribution. The colour scale indicates the catalogue origin. Swiss (Ecos 02 and 09), German (BGR and Univ. of Karlsruhe), Italian(CNR Milano and INGV-CPTI04), French (LDP) end Austrian (ZMG)*

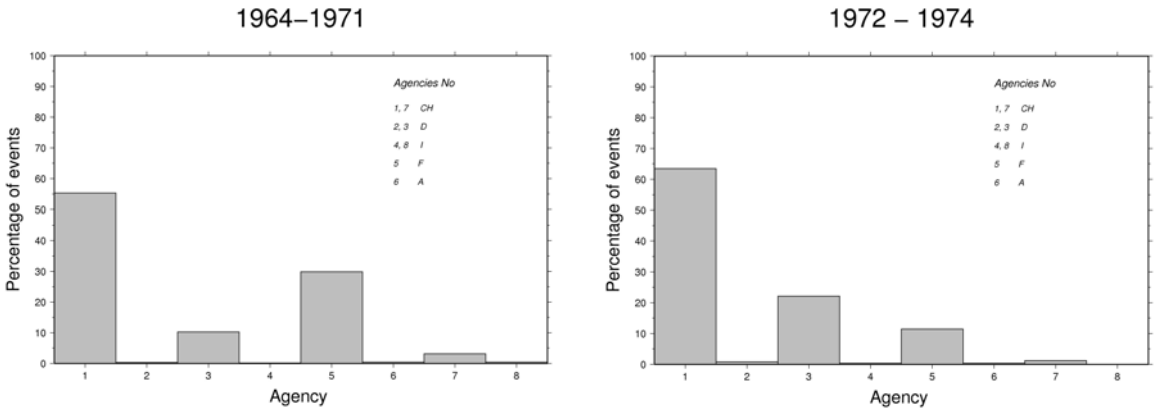


Figure 5. *Percentage of event per agency in the catalogue for the two sub-periods (1964-1971 and 1972-1974)*

The figure 6 shows a distribution of events per magnitude classes for the two periods. In the period 1964-1971, the events in the class of magnitude around Mw=2.5 are numerous. This

distribution is influenced by the swarm episodes, especially in Sarnen region. The distribution of magnitudes in period 1972-1974 is different. This is not only due to the fact that the time is shorter. The detection level is lower. The class of magnitude Mw=4 is higher than the previous class, it is partly due to the conversion of intensities to magnitudes. The four events could be distributed, as well, on three classes of magnitude (2.5, 3 and 4)

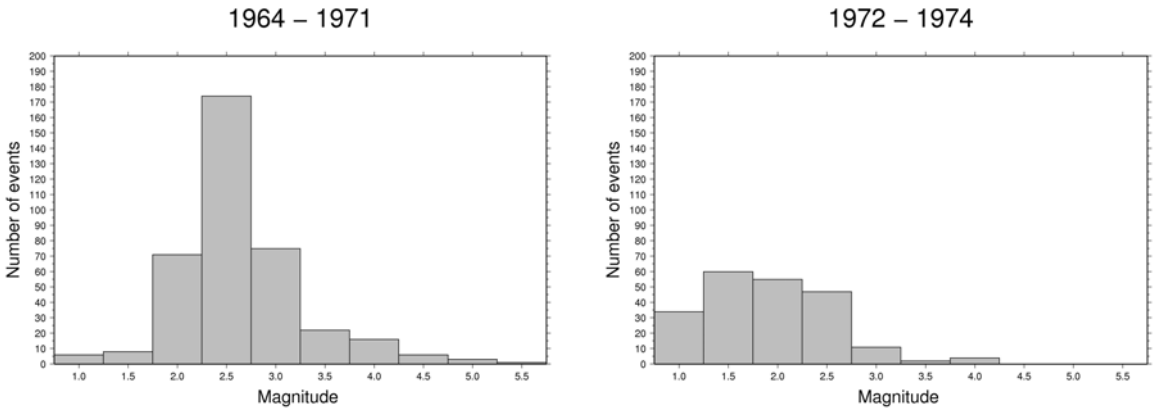


Figure 6. *Histograms of number of events per magnitude for the two sub-periods (1964-1971 and 1972-1974).*

The yearly seismicity (from Ecos02) of the years 1964 to 1971 is plotted in the annexe 2. Dark grey are data from the SED catalogues, light grey data from other agencies (France, Italy, Germany). Annually detailed reports with the seismic activity of the time period 1964-1971 will be published [Sellami in prep]. The years 1964 -1965 are dominated by swarm activity in Grisons (Trun) and central Switzerland (Sarnen). In 1966 - 1967, some activity occurred in the Valais and in the region of the Chablais vaudois. The seismic activity in the years 1968, 1969, and 1970 seems very quiet in Switzerland – *It can be due to the changes of personnel at the seismological service!*

Table 2a *Comparison of different intensity scales used by SED*							
R-F	I	II	III	IV	V	VI	VII
MSK 64/81	I	III	III	IV	IV- V	V-VI	VI
EMS 92/98	I to II	III	III	IV	IV- V	V-VI	VI

Table 2b. *Magnitude values estimated in the catalogue ECOS02 from the intensity levels considering an earthquake with shallow depth. From intensity level VI the values were reassessed. There is no automatic correspondence*						
EMS 98	II	III	III	IV	V	VI and above
Mw	1.5	2.3	2.3	3.1	3.9	No automatic estimation

Significant earthquakes

The table 3 contains the significant earthquakes, in Switzerland during this period. The Figure 7 shows the location of epicentres. These are the events with a magnitude equal or larger than

3.5 and the ones with intensities larger than IV. Events, which have a strong contribution to the energy release, are indicated with a capital letter on the left column.

Table 3. *List of earthquakes in Switzerland (5.9 - 10.9 / 45.7 - 47.9N) with Mw>= 3.5 during the period 1964-1974.*

	Site	Date	Lat	Lon	Mw	Io (MSK)	IDP	Source	Remarks
A	*Sarnen OW*	*1964.02.17 12:20*	*46.88*	*8.27*	*4.8*[1]	*VII*	*93*	*SED*	
	Trun GR	*1964.02.26 03:22*	*46.75*	*8.98*	*3.9*	*V*	*f*	*SED*	
	Sarnen OW	*1964.03.11 19:19*	*46.87*	*8.30*	*4.2*	*V-VI*	*31*	*SED*	
A	*Sarnen OW*	*1964.03.14 02:39*	*46.87*	*8.32*	*5.3*[1]	*VII*	*428*	*SED*	
	Sarnen OW	*1964.03.14 04:46*	*46.90*	*8.25*	*3.9*	*V*	*a*	*SED*	
	Val Müstair GR	*1964.04.06 02:37*	*46.65*	*10.32*	*3.9*	*V*	*f*	*SED*	
	Kreutzlingen BodenseeTG	*1964.05.04 20:39*	*47.65*	*9.07*	*3.5*	*IV-V*		*SED*	
	Morat FR	*1964.05.27 19:16*	*46.90*	*7.12*	*3.9*	*V*	*f*	*SED*	
	Trun GR	*1964.05.28 20:52*	*46.68*	*9.03*	*4.3*	*V*	*56*	*SED*	
	Trun GR	*1964.06.19 03:42*	*46.70*	*9.30*	*3.5*	*IV-V*		*SED*	
	Sarnen OW	*1964.11.11 02:57*	*46.90*	*8.25*	*3.5*	*IV-V*		*SED*	
	Sarnen OW	*1965.02.10 04:43*	*46.95*	*8.37*	*3.5*	*IV-V*	*23*	*SED*	
	Sion VS	*1965.04.14 04:11*	*46.28*	*7.48*	*3.5*	*IV-V*		*SED*	
	Wald-Arlberg (A)	*1965.06.29 00:43*	*47.14*	*10.00*	*4*	*VI-VII*		*ZMG*	
	Trun GR	*1965.08.01 08:58*	*46.73*	*8.95*	*3.9*	*V*	*f*	*SED*	
	Binntal VS	*1965.08.25 11:33*	*46.37*	*8.22*	*3.5*	*IV-V*		*SED*	
	Sionl VS	*1965.10.13 16:17*	*46.30*	*7.80*	*3.5*	*IV-V*		*SED*	
	Sion VS	*1965.10.24 12:16*	*46.30*	*7.40*	*4.4*	*V-VI*	*135*	*SED*	
	Sion VS	*1965.11.11 11:52*	*46.28*	*7.40*	*3.5*	*IV-V*		*SED*	
	Berner Alps BE	*1966.01.28 17:52*	*46.60*	*7.60*	*4*			*SED*	
	Bisistal GR	*1966.02.12 23:42*	*46.95*	*8.82*	*3.5*	*IV-V*		*SED*	
	Grimentz VS	*1966.02.23 13:47*	*46.17*	*7.50*	*3.9*	*V*	*a*	*SED*	
	Maegenwil AG	*1966.03.16 11:23*	*47.42*	*8.23*	*3.5*	*IV-V*	*100*	*SED*	
	Lac Hongrin VD	*1966.06.09 14:17*	*46.43*	*7.07*	*3.6*			*SED*	
	Trun GR	*1966.09.02 10:15*	*46.75*	*9.00*	*3.5*	*IV-V*		*SED*	
	Wildhorn BE/VS	*1966.12.12 07:36*	*46.32*	*7.32*	*3.9*	*V*	*a*	*SED*	
	Haute-Savoie (F)	*1967.01.05 16:35*	*46.10*	*6.55*	*4.63*	*V-VI*		*INGV*	
	Rawill VS/ VD	*1967.03.24 17:38*	*46.42*	*7.25*	*4.1*	*V*	*92*	*SED*	
	Disentis (Trun) GR	*1967.07.15 02:23*	*46.67*	*8.82*	*3.9*	*V*	*f*	*SED*	
	Lac Hongrin VD	*1967.07.18 00:58*	*46.40*	*6.95*	*3.6*			*SED*	
	Samnaun GR	*1967.08.14 10:16*	*46.95*	*10.35*	*3.9*	*V*		*SED*	

	Wildstrubel BE	*1968.03.07 00:21*	*46.40*	*7.50*	*3.5*	*IV-V*	*f*	*SED*	
B	*Chablais (Abondance) (F)*	*1968.06.27 15:43*	*46.29*	*6.73*	*4.6*[1]	*VI-VII*	*22*	*SED*	
B	*Chablais (Abondance) (F)*	*1968.08.19 00:36*	*46.29*	*6.55*	*4.7*[1]	*VII*	*54*	*LDP*	
	Hochstollen-Lungern OW	*1969.11.05 05:25*	*46.77*	*8.23*	*3.5*	*IV-V*		*SED*	
	Wuppenau TG	*1970.03.11 02:32*	*47.50*	*9.10*	*3.5*	*IV-V*		*SED*	
	Gavardo (I)	*1970.04.19 18:16*	*45.65*	*10.45*	*4.56*	*VI*		*INGV*	
	Feldkirch(A)	*1970.05.10 01:49*	*47.23*	*9.60*	*3.9*	*V*	*20*	*SED*	
	Hochstollen-Lungern OW	*1970.07.16 10:55*	*46.77*	*8.23*	*3.5*	*IV-V*		*SED*	
	Niesen BE	*1970.07.21 11:24*	*46.64*	*7.64*	*3.8*	*III*		*SED*	
	Piz Kesch GR	*1970.08.06 13:54*	*46.62*	*9.85*	*3.5*	*IV-V*		*SED*	
	Stein a. R. SH	*1971.06.17 07:40*	*47.68*	*8.80*	*3.5*	*IV-V*	*88*	*SED*	
C	*Glarus GL*	*1971.09.29 07:18*	*47.0*	*9.0*	*4.9*[1]	*VI*	*297*	*SED*	
	Verbier VD	*1971.11.10 23:59*	*46.15*	*7.32*	*3.9*	*V*		*SED*	
	Churwalden GR	*1973.07.09 00:27*	*46.77*	*9.58*	*3.9*	*V*	*50*	*SED*	Ecos99 Ml=2.9 Z=2km
	Triesen (FL)	*1973.07.24 00:48*	*47.12*	*9.52*	*3.9*	*V*	*44*	*SED*	Ecos99 Ml=2.3 Z=6km
	Zweisimmen BE	*1974.01.19 02:50*	*46.60*	*7.27*	*3.9*	*V*	*12*	*SED*	Ecos99 Ml=3.9 Z=15km
	Saeckingen (D)	*1974.05.21 07:42*	*47.58*	*7.77*	*3.9*	*(V-VI)**	*114*	*BGR*	Ecos99 Ml=3.2 Z=19km
Earthquakes outside the previous the area but widely felt in Switzerland									
	Neustadt schwarzwald (D)	*1965.09.19 08:10*	*47.90*	*8.27*	*4.4*	*(VI)*	*15*	*BGR*	
	Bard (I)	*1968.06. 18 05:27*	*45.68*	*7.72*	*5.2*	*(Vi)*	*190*	*INGV*	
	Sw. Jura (D)	*1969.02.26 01:28*	*48.29*	*9.01*	*4.7*	*(V)*	*937*	*BGR*	
	Sw. Jura (D)	*1970.01.22 15:25*	*48.28*	*9.03*	*4.8*	*(V)*	*1807*	*BGR*	
	Sw. Jura (D)	*1971.04.29 04:35*	*48.32*	*9.00*	*3.5*	*(V)*	*73*	*BGR*	
	Sw. Jura (D)	*1972. 05.18 08:11*	*48.28*	*9.03*	*4.4*	*(IV)*	*82*	*GFZ*	
	Italy Apennine	*1972.10.25 21:57*	*44.08*	*10.41*	*4.95*	*(V)*	*~256(>700)*	*INGV*	
Earthquakes in Switzerland (5.9 - 10.9 / 45.7 - 47.9N) with Mw < 3.5 but widely felt									
	Preda GR	*1968:04.25 18:27*	*46.6*	*9.8*	*3.1*	*IV*	*25*	*SED*	
	Schwaden-Oberhefenschwil SG	*1968.05.07 21:44*	*47.3*	*9.12*	*3.1*	*IV*	*40*	*SED*	
	Biberstein AG	*1971.05.03 05:53*	*47.4*	*8.08*	*3.1*	*IV*	*136*	*SED*	
	Riehen BS	*1971.12.20 04:21*	*47.6*	*7.67*	*2.7*	*III-IV*	*80*	*SED*	

Column Io: (V) max intensity felt in CH
Column IDP: 'a' idp available in consulted documents;
'f' less than 10 idp,
Column Mw: changed according to macroseimic data except
[1] Bernardi et al 2005

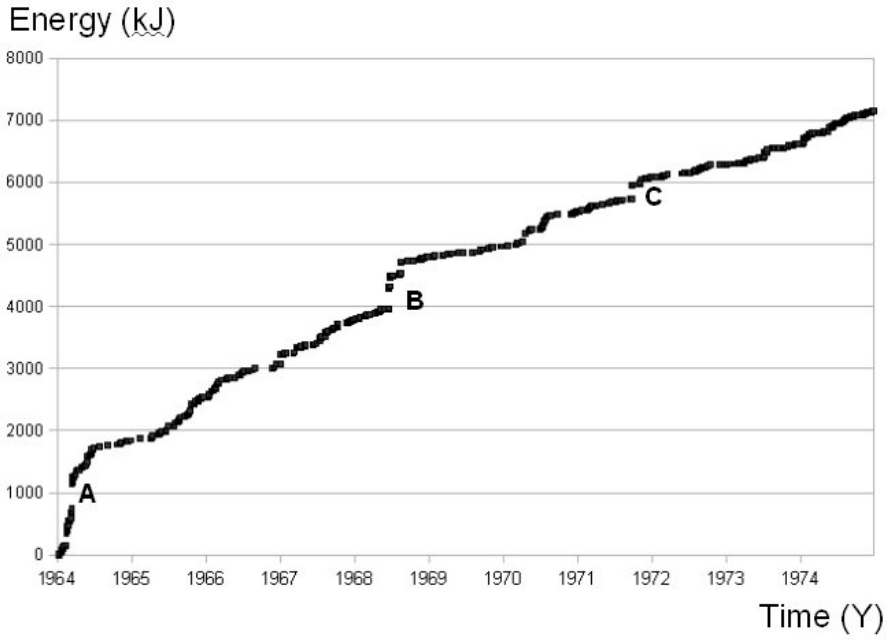


Figure 8. *Energy distribution. The steps (A, B and C) are indicated in the table 3*

The cumulative energy release is shown on Figure 8. The events outside the area but with a large impact in Switzerland are also included. For these ones, the intensity in parenthesis is the maximum intensity felt in Switzerland. The first three larger events from the list happened in February and March 1964, with respective magnitudes of 4.8, 4.2, and 5.3. They belong to the swarm episode in the Sarnen region and contribute to a step (noted A) in the energy release (figure 9). Another sequence of earthquakes, which already started in December 1963 and went on in 1964, produced the event of the 28 April 1964 (M=4.3) near Trun. This sequence of earthquakes occurred in the Surselva Valley in the Grisons. The question arose if this sequence of earthquakes could have been related to the dam of Linth–Limmern, which was under construction between 1957 and 1968.

Not so questionable and documented (Lombardi 1967, Süsstrunk 1968, and Rothé 1971) is seismic activity in the summer of year 1965 in the north of Locarno. The water filling of the Verzasca dam in Tessin, which was under construction between 1961 and 1965, induced earthquakes. The events were distinctly felt in the villages Berzona and Vorgogno east side of the lake, some acoustic emissions were reported but no damages.

The other major event in Switzerland is the Glarus event (noted C) on 29th September 1971, which almost reached a magnitude of Mw = 5. The location of this event is subject to discussion. The original location has been deduced from the location of two after-shocks, which occur respectively, a few minutes and a few hours, after the main shock. Unfortunately the readings are no longer available. The study of 2001 (Ecos 2001) based on macroseismic data came to a different location, and this event was reported at Vorstegstock near Linthhal (Gisler et al. 2005). The other alternatives, together with the last interpretation are detailed in the annex 3.

In the neighbouring countries strong earthquakes, which were widely felt in Switzerland, took place within this period. In 1968 in northern Italy and France close to the Wallis border these couple of events in June and August 1968 reached a magnitude of 4.6 and 4.7 and correspond to the step B of the energy distribution figure 8. The events occurring in 1969 and 1970 in the

Swabian Alps (southern Germany) were largely felt in Switzerland. The event of Jeurre (France) on the 21th of June 1971 it is still an open issue. This event was mentioned in (Rothé, 1974) as induced by the Vouglans reservoir but the conclusion from Pavoni & Peterschmitt, (1984) who studied its the focal mechanism and the relation to the tectonic of the Jura contradicted this assumption.

6. Discussion on data quality and influence on the completeness

Data quality

The data from this time come from diverse sources and are inhomogeneous in quality. The different types of information, which have been consulted, are listings, maps, catalogues, and reports. This information was either contemporary to the earthquakes (1964-1974) or was added at a later time in the frame of different studies (see references). Most of the data between 1967 and 1971 come from secondary sources.

The intensities until 1971 were quantified according to the Rossi-Forel scale. In 1972, the MSK scale started to be used for the evaluation of the new earthquakes. The strong events previous to 1972 were also converted to the MSK scale at the time of the elaboration of the hazard map of 1976 (Saeggesser and Mayer-Rosa). Since the mid-nineties, the intensity scale EMS (92 than 98) is applied to the new events. At the revision of the catalogue (Mecos 99 and Ecos 02) the intensities were noted in EMS scale instead of MSK scale. All events with intensities VI and higher were reassessed but not the one with intensities IV and lower. The conversion between MSK to EMS scales is not noticeable (table) but the switch from the Rossi-Forel scale to the MSK (or EMS) scale leads to a smoothing of the intensity values for the low levels. Level V in Rossi-Forel corresponds to IV to V in MSK (EMS98) scale and example is shown on the Figure 9. This figure allows a comparison of the idp distribution of the earthquake from 28th of May 1964 near Brigels according to two different intensity scales

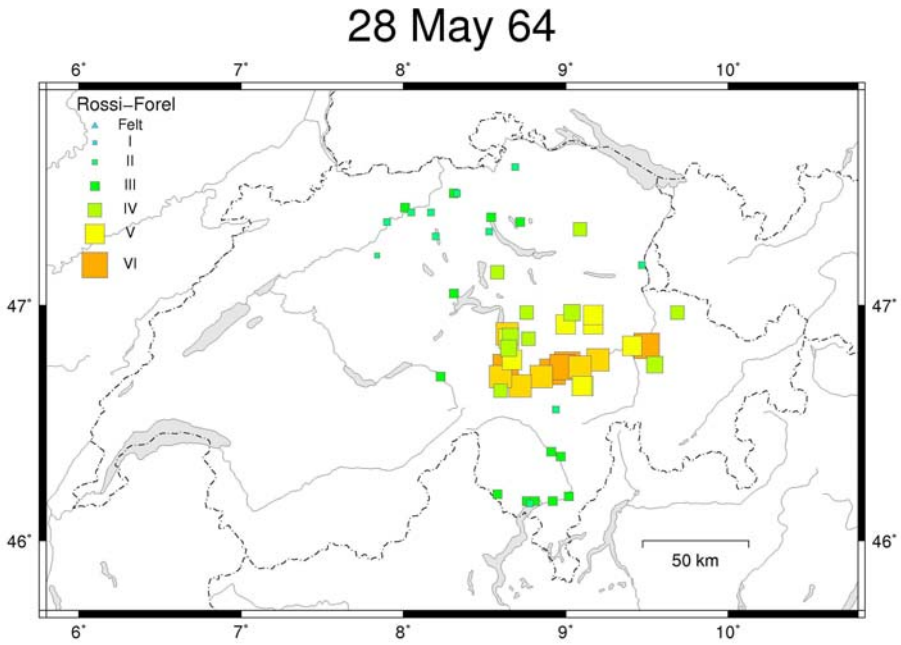


Figure 9a. *Intensity distribution (Rossi-Forel scale) original data from 1964*

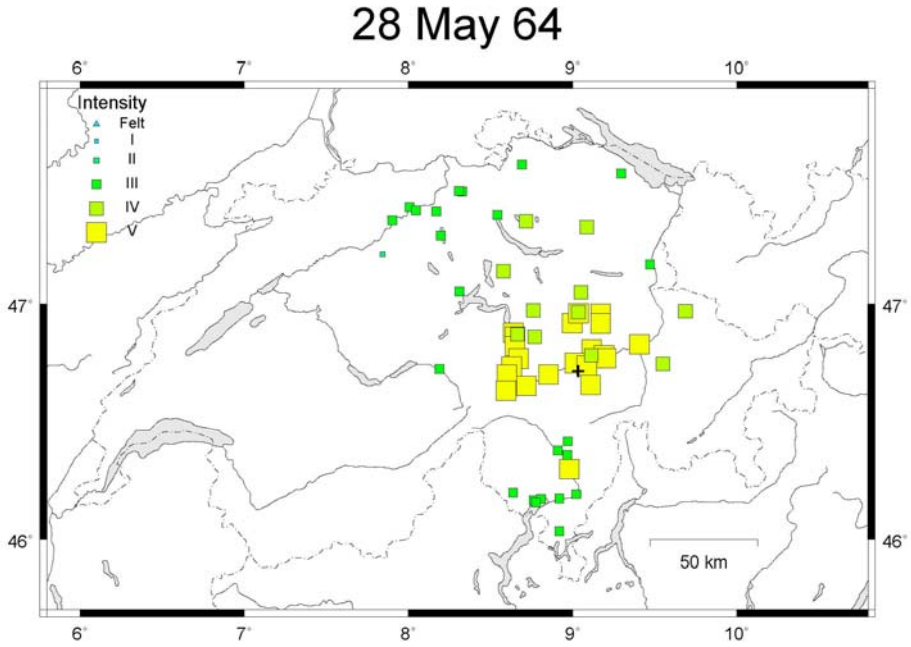


Figure 9b *. Intensity distribution (EMS98 scale) indicated in Ecos02*

In many cases the information on how the intensity data has been derived is not available. The events with a poor quality of the macroseismic data are numerous and give a false image regarding the detection of the small events. In figure 10a, for example, it seems that before 1964, the detection threshold for intensities is low (intensity level II.). One reason is the effort

invested to record intensity data, but these data are not reliable enough and do not cover equally all Switzerland.
In 1972 the network developed and reliable magnitude data were started to being acquired however intensity data are still frequent in the database. A probable reason is that the first hazard map in 1976 (Saeggesser and Mayer-Rosa, 1976), estimated intensities as the ground motion parameter. Therefore intensities should have been attributed to data, which had originally solely a magnitude value. It is sometime difficult to distinguish if the primary source is magnitude or intensity.
The magnitude determination before 1970 (often Md) was poor; it was limited by the station coverage and detection capabilities. In the Mecos99 catalogue the magnitude indicated for this period are often Mw derived from a conversion from intensity value. As a consequence, the magnitudes have discrete values (2.7, 3.1, 3.5, 3.9 etc.) although, in many cases, an instrumental magnitude of unknown origin is present in the previous catalogues (Ecos99). For example the event of 29th Dec. 1963, the intensity is IV, this corresponds to a magnitude of 3.1, an alternative magnitude for this event is 3.4. Having magnitude values converted from intensities improve the consistency of the data, but reduces somehow the accuracy. The magnitude 3.1 corresponds to the intensity IV for a shallow event. This value of intensity may come from a single macroseismic point or from a larger area with several points showing the same intensity grade. This leads to an underestimation (respectively overestimation) of the magnitude value.
Until 1971, the earthquakes were localises using the P-S time and circle method. The model used is not clear and the data found show some inconsistencies (annexe 3). The table 4a to 4c indicate the model and the program used to locate the earthquakes from 1972 to 1974.

Table 4a. *Velocity model used in 1970*				
Hypo 71 NCER, Cal.	Layer	P-velocity (km/s)	P-velocity (km/s)	Depth (km)
Model	1	4.0	2.3	0
	2	6.0	3.5	0.5
	3	6.7	3.9	25
	4	8.1	4.7	45
Table 4b. *Velocity model used in 1971-73 Vp/Vs = 1.73*				
Hypoellipse USGS	Layer	P-velocity (km/s)	Depth (km)	Layer thickness (km)
Model 1 Epicentre outside alpine area	1	5.0	0	1.5
	2	6.0	1.5	23.5
	3	6.8	25	20
	4	8.1	45	
Model 2 Epicentre inside alpine area	1	5.0	0	1.5
	2	6.0	1.5	23.5
	3	6.8	25	7
	4	8.3	32	
Table 4c. *Velocity model used in 1974 Vp/Vs = 1.73*				
Hypoellipse USGS	Layer	P-velocity (km/s)	Depth (km)	Layer thickness (km)
Model 1 Epicentre outside alpine area	1	5.0	0	1.5
	2	6.0	1.5	18.5
	3	6.8	25	25
	4	8.1	45	
Model 2 Epicentre inside alpine area	1	5.0	0	1.5
	2	6.0	1.5	18.5
	3	6.7	20	10.0
	4	8.1	30	

The location names present in Ecos02 catalogue have been reviewed and compared to the original data. They were too precise compared to the uncertainty of the location. The name fitted the coordinate, but as the latter are not precise, it gives a wrong impression of accuracy. For example region Yverdon became Yvonand, which is a small village less than 10km away east of Yverdon. When ever possible we corrected this information.
As mentioned above, the seismic network has been developed considerably. In the late sixties, the seismicity is characterised by the large amount of data coming from other network. These data, mainly from French stations, compensate the lack of sensitivity in the western part of Switzerland but the accuracy is unknown.

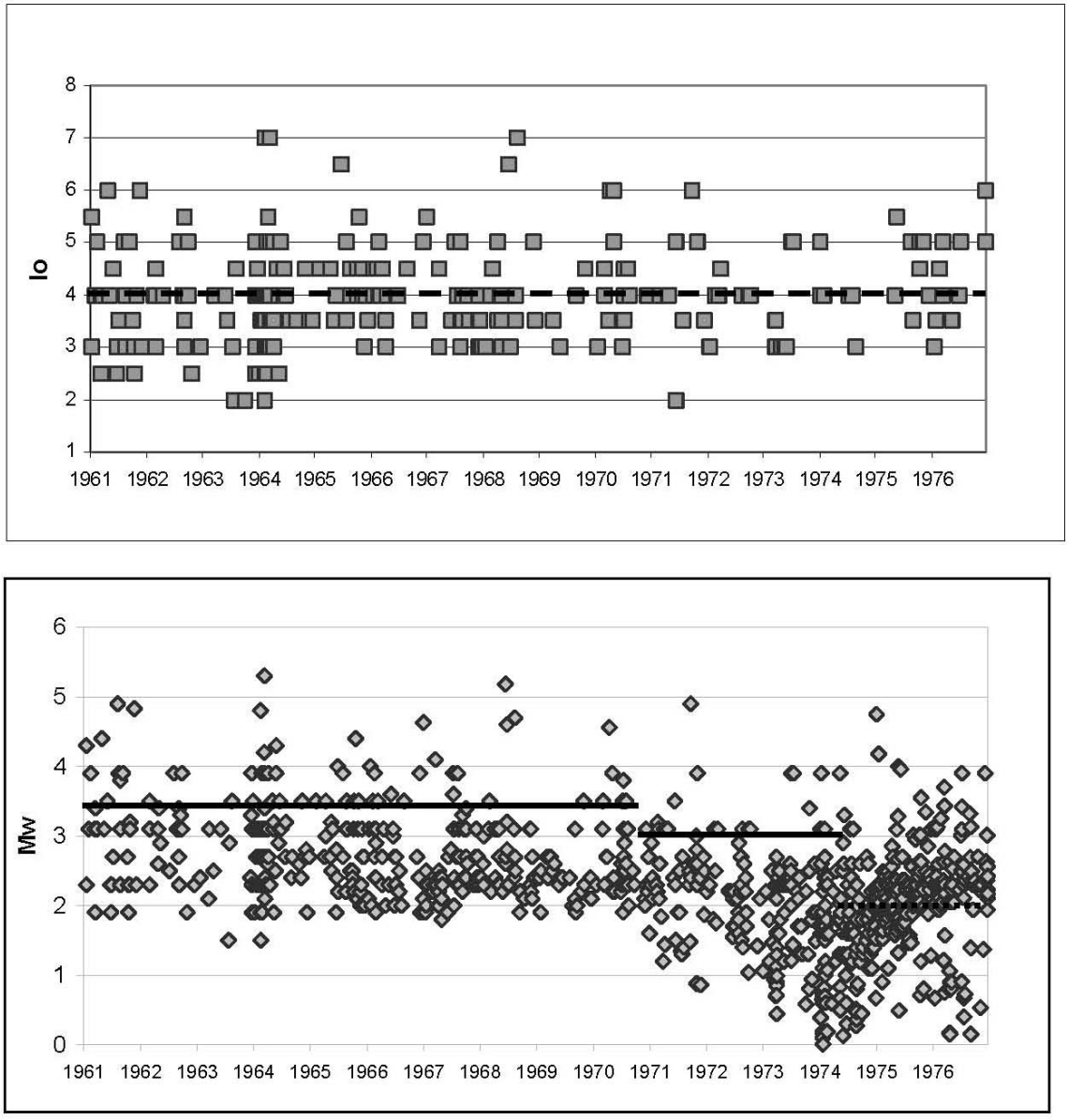


Figure 10. *Comparison of the distributions of EMS98- intensity (above) and Mw-magnitude (below). The dark lines give an estimation of the completeness*

Completeness

The magnitude detection was about 2 from 1960 up to 1964, it decreased from 1972 (see Figure 10b) with the development of the seismic network. The distribution of the magnitude

threshold is not homogeneous in Switzerland because of the limited number of stations (see Figure 3).. The smaller values of magnitude before 1964 are due to the conversion from intensity data and to seismometer installed locally and temporarily. For example, we can observe that due to a temporary network in Sarnen and the awareness resulting from the high seismicity in 1964, they were relatively more small earthquakes registered.
The evolution is also seen in Figure 10a and 10b where the intensity and the magnitude distribution are plotted with time. One can observe the transition from a period where events were systematically registered by their intensities, before 1964, and the period where the magnitude detection threshold improved. The intensities of smaller events became less significant.
The minimum intensity detection is shown on the figure 10b. This threshold is higher from 1965 on, and we observe less intensity data from 1970.
One reason is the cessation of the annual reports in 1963. In 1964 there are still a lot of events due to the Sarnen region activity. The small amount of data until 1966 is due to the missing reports. From 1970 the instrumental data replaced the low and often questionable intensity data.
In Ecos02 the intensity completeness was about III to IV for the entire period. A revision of the catalogue suggests that a value of IV is more plausible.
We can estimate for 1964-1971 the completeness to 3.5, as in the Ecos02 catalogue. For the second period, the magnitude completeness is about 3 for 1971 to 1973 and 2.5 for the year 1974.
The magnitude uncertainty assigned in ECOS02 (see annexe 1) was CMw3 (it means bigger than 1). For a limited number of events this value is too conservative. The location uncertainty is Ce2 (less than 10km) for the majority of the event with magnitude 3.5 and over (listed on table 3). This uncertainty has been re-evaluated and most events have an uncertainty of Ce3 (up to 20km).
Although evens with magnitude of the order of two have been recorded, this magnitude level is far from being complete. For the period until 1971 and if we take into account that the magnitudes are estimated at 1 magnitude degree, the completeness is then on the order of 3.5 at best.

7. Conclusion

The period covered by this report is a transition period between a period dominated by the historical seismicity and the actual covered by instrumental seismicity. We can distinguish two sub-periods, a first period, from 1964 to 1971 referred to as ‘dark-ages’ and the second period 1972 to 1974 ‘the early ages’ of the modern seismology in Switzerland.
The data are rather inhomogeneous. Not only the data come from different networks but also from very different type of stations and data have been modified successively sometime with no record of the changes
This document is a still a draft. We have checked the catalogue Ecos02 according to original printed information. New information for these events has been added. Duplicates and fake events have been removed as far as possible. Completeness, magnitude and location uncertainty have been estimated. The magnitude and location uncertainties have been reviewed as well.
In the appendices complementary information is available and a thorough document containing detailed reports covering each year from 1964-1971 is to be published by SED.

Annexe 1

1.1.1.1 Periode 1963 to 1974.

During the year between1963 to 1974 many changes occur at the seismological service.

The 'Jahresbericht' ceased to be issued in 1963. From 1973 new seismological bulletins were again published. The new network was staring to be developed. It was effective in 1975. Additional information to Mecos catalogue has been collected from 1964 to1975. The MECOS catalogue has being checked, compared and completed from different available information sources.

Printed information:

- Yearly bulletin of the SED 1963 and 1972, 1973, 1974
- Partial information from NAGRA bulletin 83-08. The NAGRA printed catalogue covers only the north east of Switzerland, the region 47-48N and 7.5-9.0E.
- Earthquake cards (found in the archive of SED) for the whole period.

Computer files:

- MECOS and many versions of CHIST files. It is not known if and and to what extend, some of the initial information from the previously mentioned sources might have been contributing to MECOS.
- Swissdata files containing the gfz (potsdam) file, Patrick Smit and Erik Ruettener compilations (not useful because sources information is missing or the magnitude threshold was too high).
- Two data files existed for the whole Switzerland EPIZ6372 and EPIZ7382. They are mentioned in the NAGRA bulletin but are not available!
- A printout of seismological bulletin for the period 1964-1970 which might be EPIZ6372.

This document could not be found in 2008-2009.

In this period, the catalogue has been extensively modified. After the modification of the catalogue, the number of entries increased from 248 to about 478. More over about a half of the existing entries had modified or addition information.

The new events corresponds either to events in the border area of Switzerland or, in the most cases, events with small magnitude or intensity. The threshold magnitude is about 2.

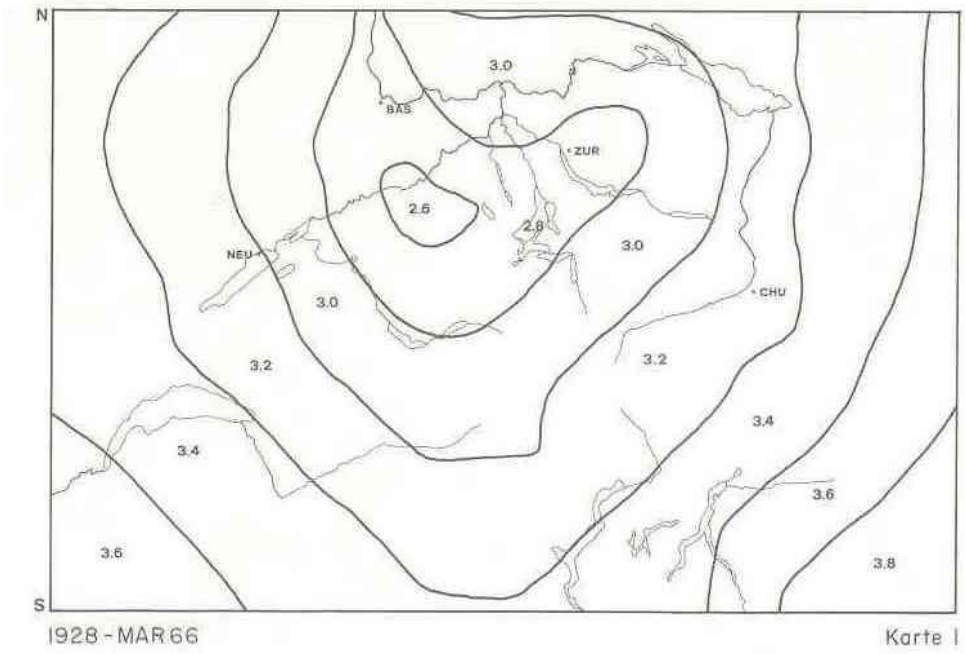
Date	Number of stations available for earthquake location	Jahresbericht	
1963	1-to 3	Interruption of the publication	Ml and Md threshold 2.5 Error on Ml large 1.0
1964	id	Information computer file print out	
1969	Phases readings but no more amplitudes readings		No more magnitude from SED
1972	6 but 4 from SED	New issue of the seismic yearly bulletin	Ml threshold 2, Intensity III Good quality,
1974	Up to 13		

The magnitude added in the period 1963-1969 were duration magnitude (Mayer-Rosa private communication) Md, although the magnitude threshold seems to be low, 2.5, we assigned an uncertainty of Ce3 (bigger than 1). For the later period, from 1972 the data are more reliable.

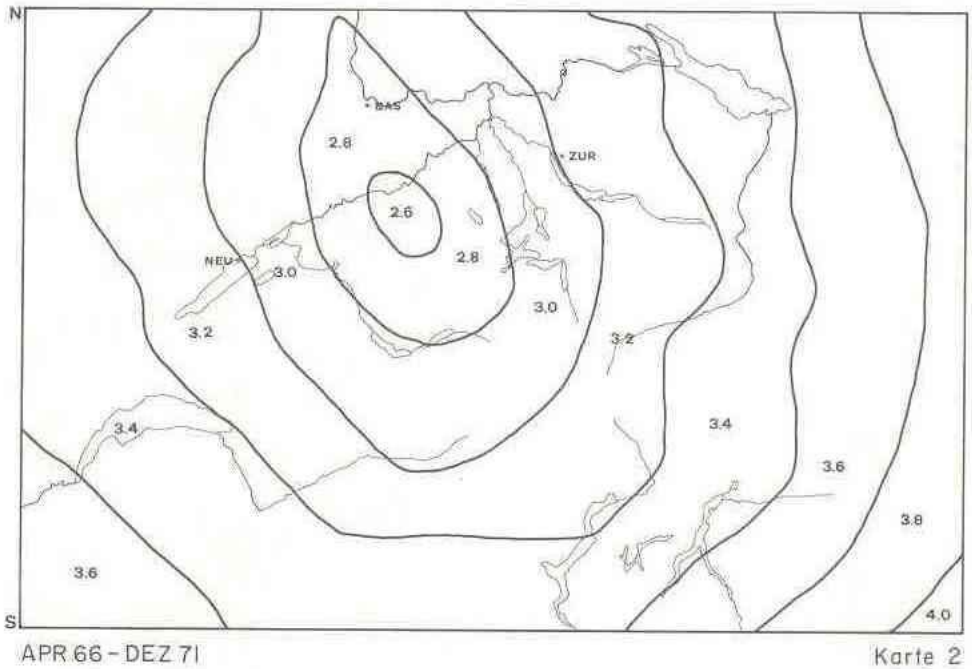
The completeness for the first period should not be better than 3.5 because of the magnitude uncertainty. For the second period the magnitude completeness is about 2.5 to 3. The intensity completeness is about 3 to 4 for the entire period.

Annexe 2

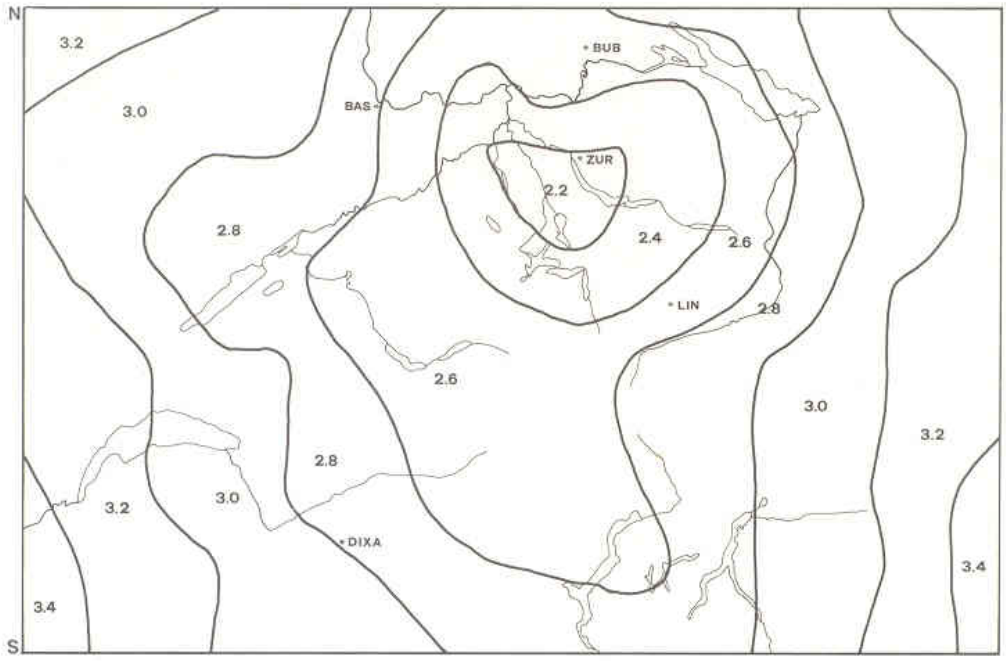
Magnitude threshold



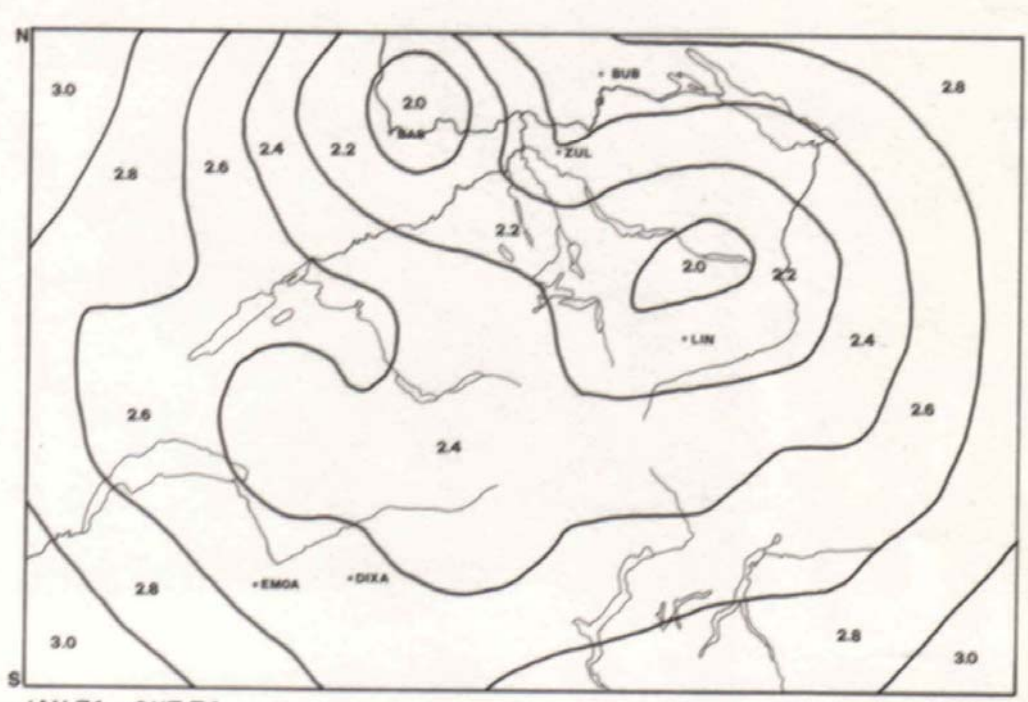
1928 - MAR 66 Karte 1



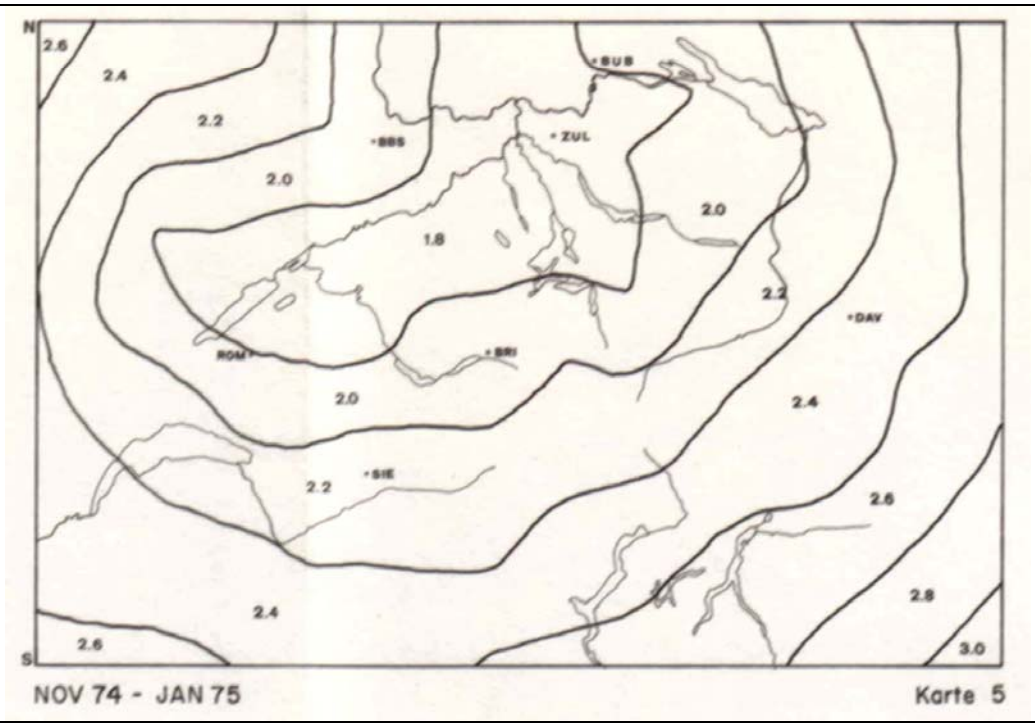
APR 66 - DEZ 71 Karte 2



JAN 72 - DEZ 73 Karte 3

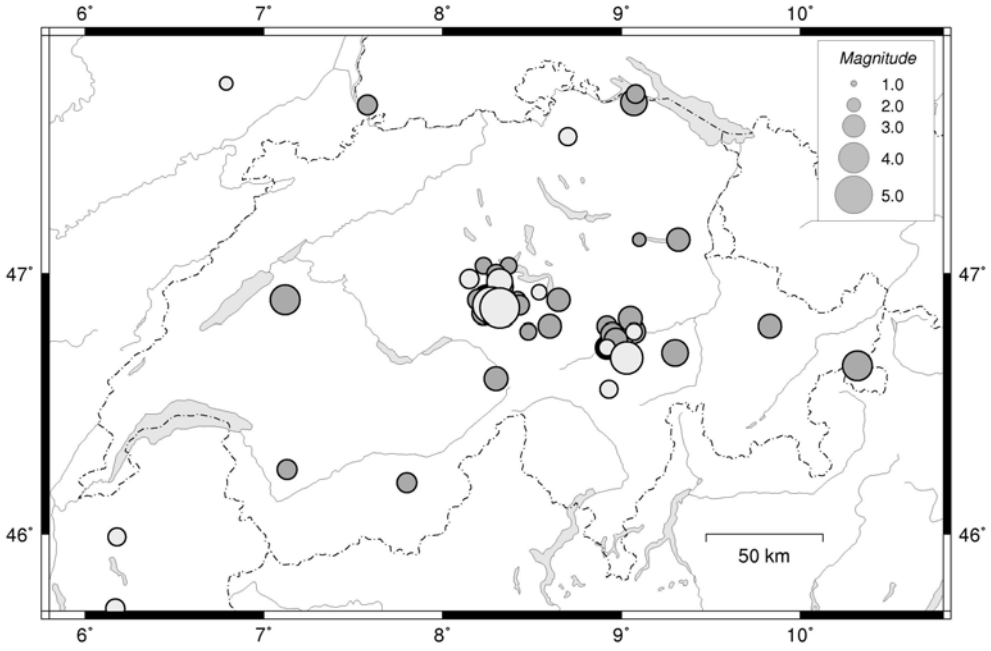


JAN 74 - OKT 74 Karte 4

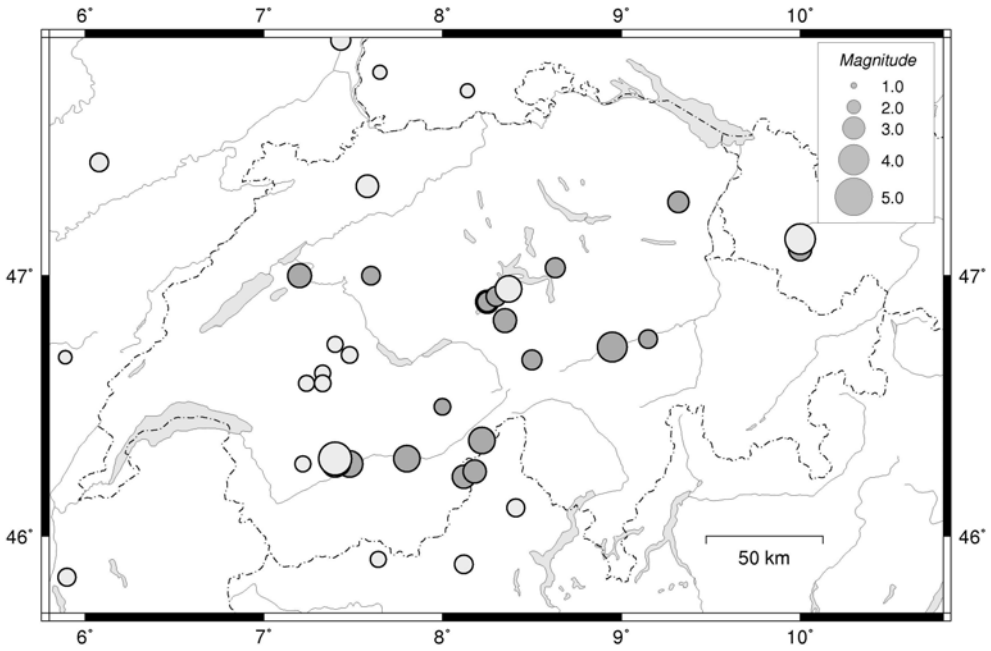


Seismograph stations operational and evolution of the magnitude threshold with time in Switzerland (Mayer-Rosa et al. 1983)

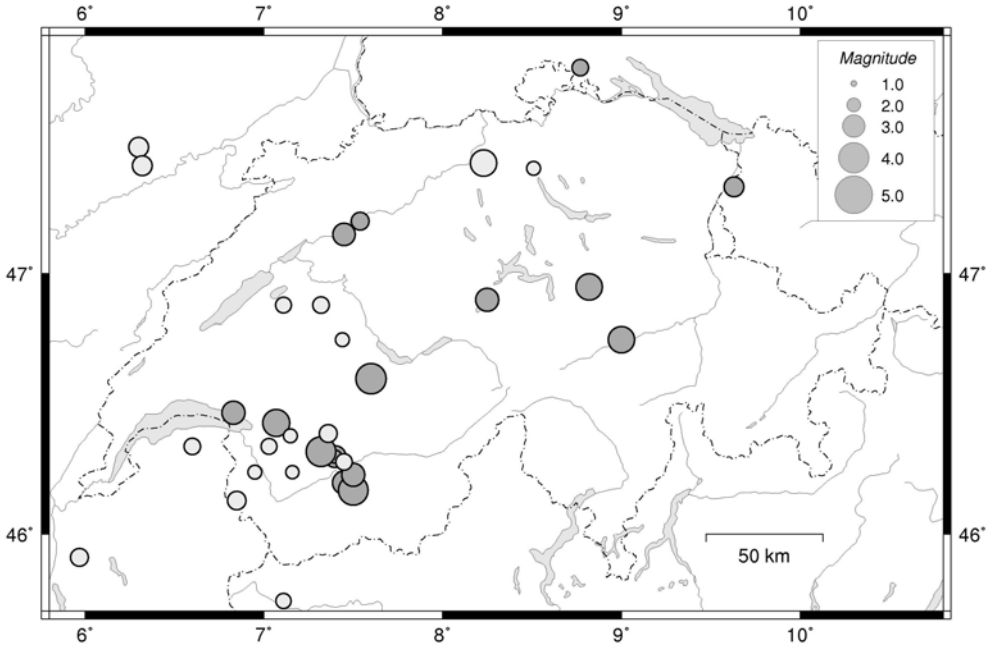
1964


6°
7°
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

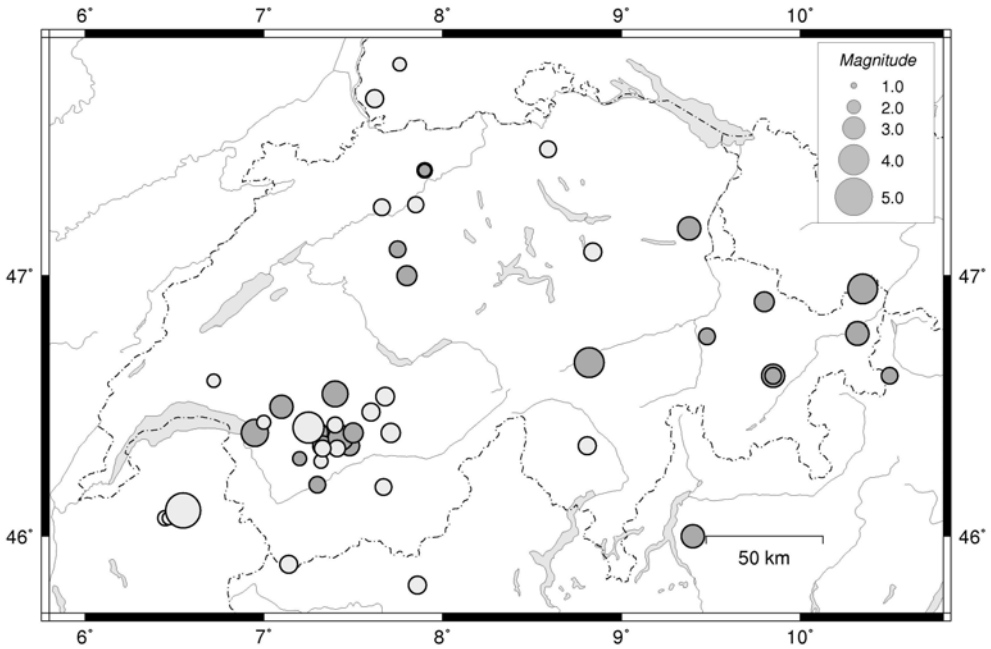
1965


6°
7°
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

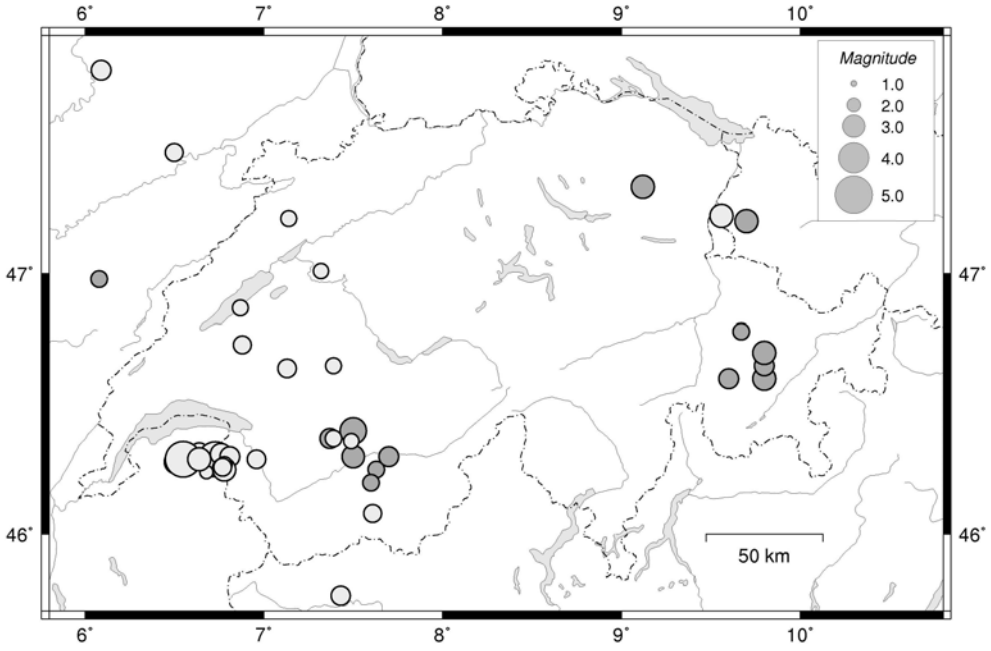
1966


6°
7°
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

1967


6°
7°
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

1968


6°
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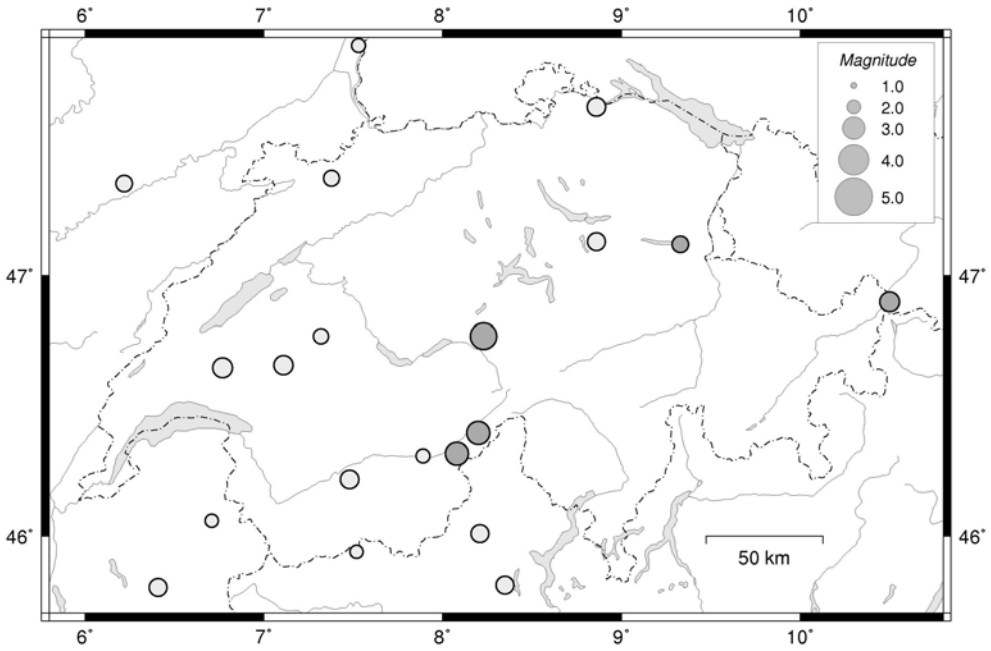
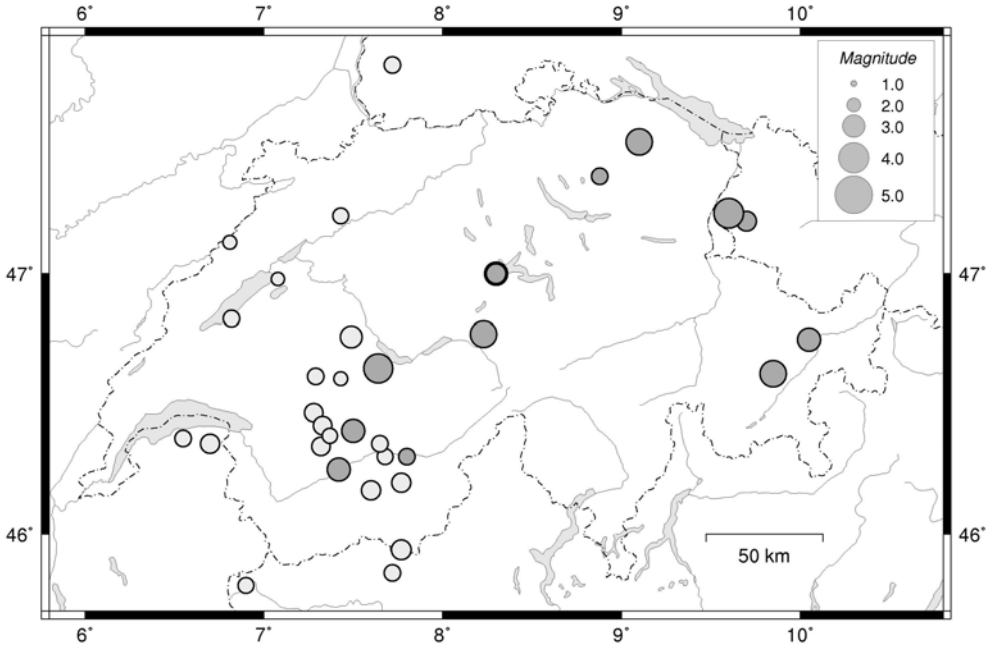
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

1969


6°
7°
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

1970


6°
7°
8°
9°
10°
47°
46°
Magnitude
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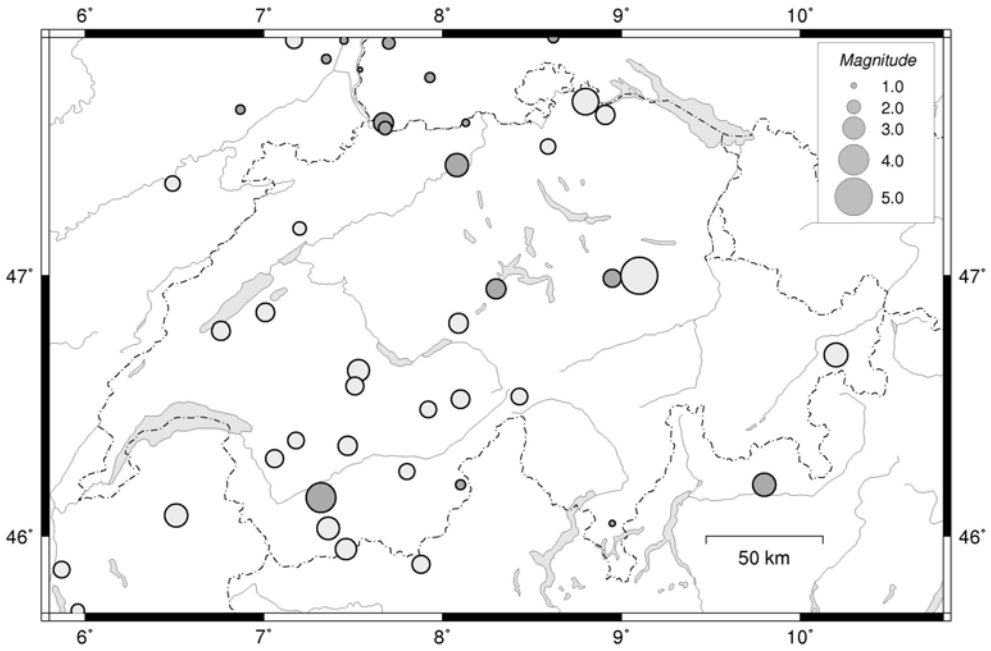
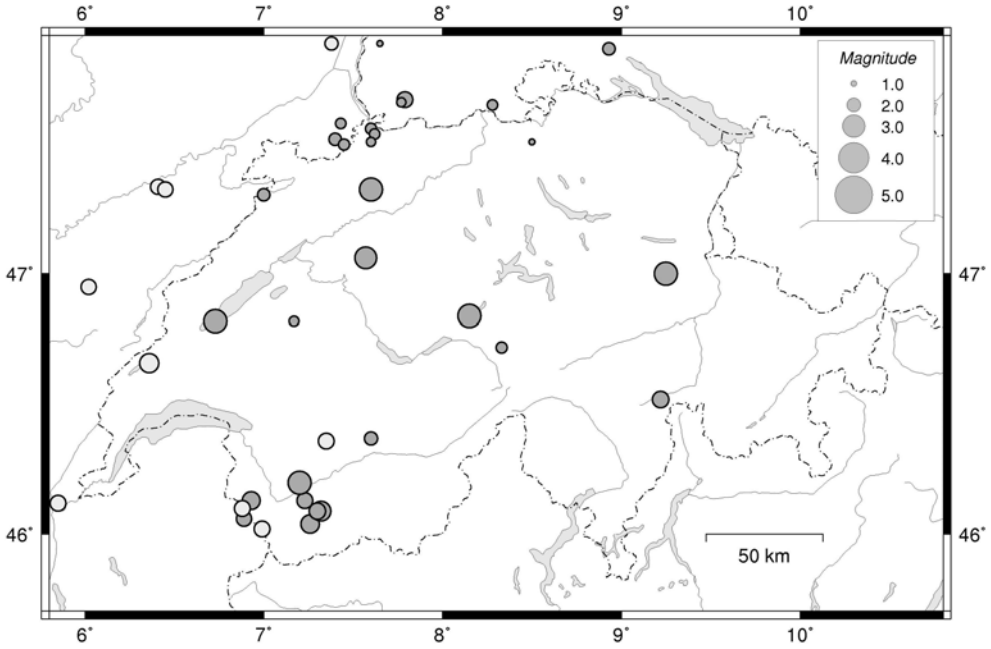
2.0
3.0
4.0
5.0
50 km

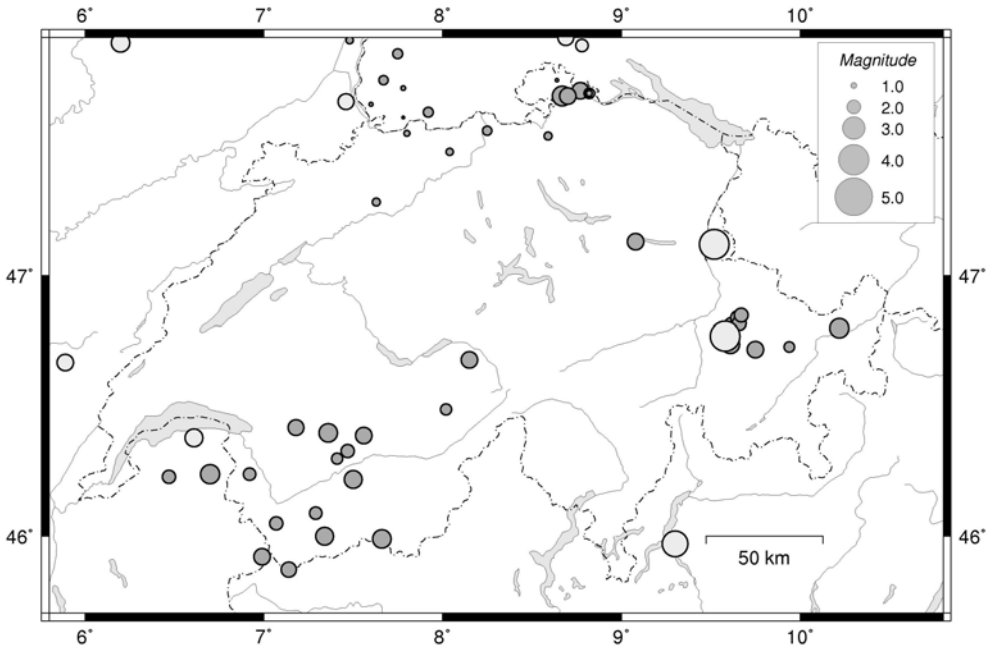
1971


6°
7°
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

1972


6°
7°
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

1973


6°
7°
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46°
Magnitude
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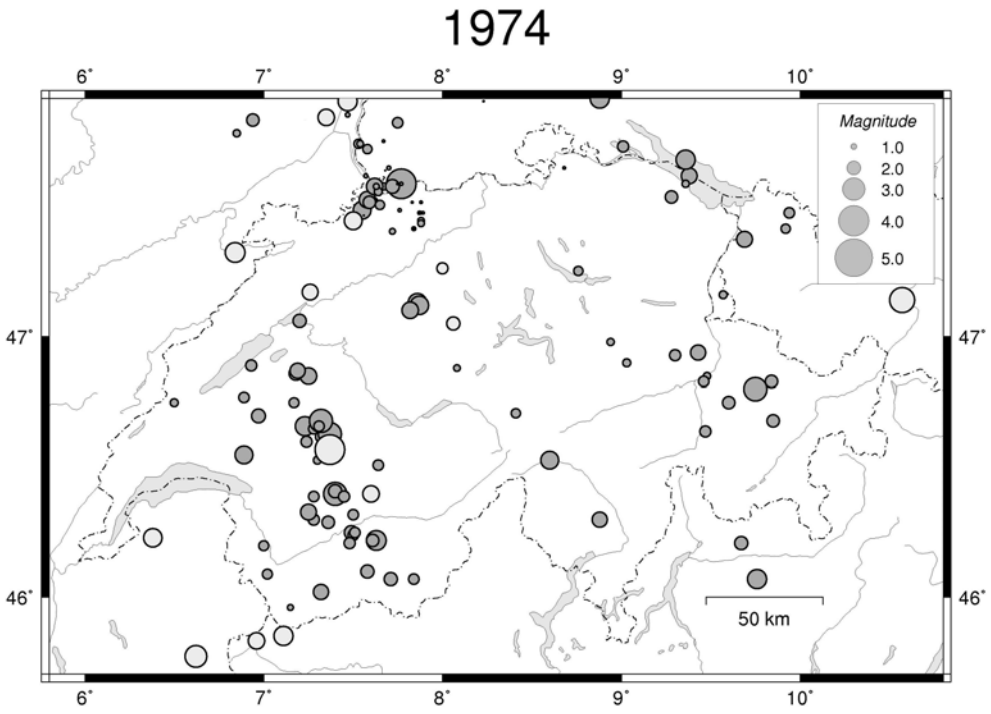
2.0
3.0
4.0
5.0
50 km


1974
6°
7°
8°
9°
10°
47°
46°
Magnitude
1.0
2.0
3.0
4.0
5.0
50 km

Annexe 4

Earthquake of the 29th September 1971 Glarus region.

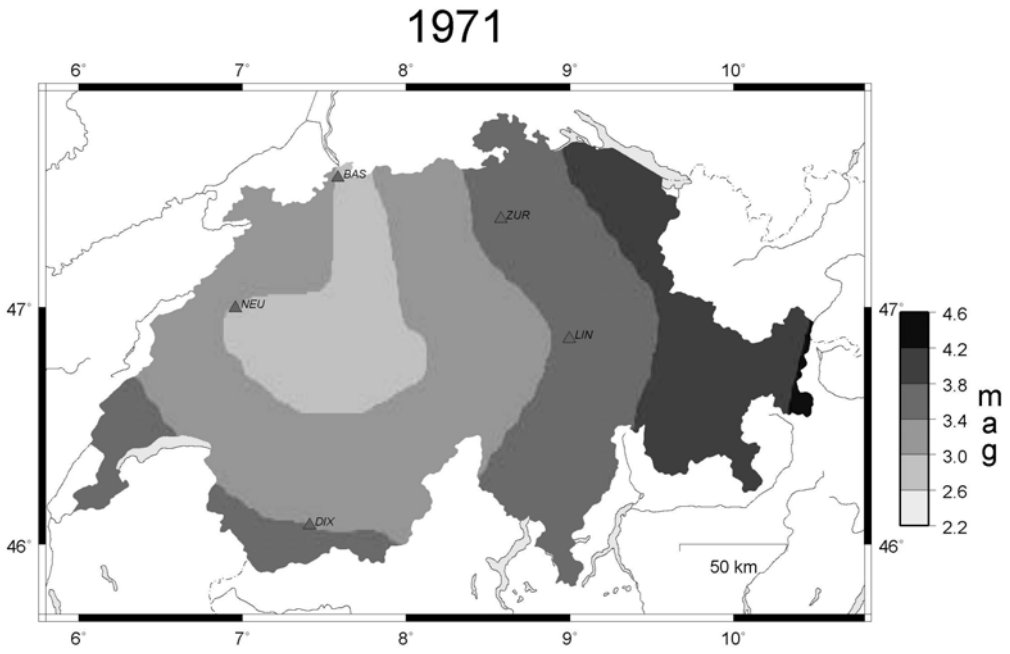
This annex presents the information available on the earthquake on the 29th September 1971. A major earthquake happened on the 29th September at 07:18 in the morning in the Glarus region. The estimated magnitude was Mw=4.9 (Ecos02). The maximum observed intensity is VII (Rossi-Forel scale converted to EMS 98). The earthquake was felt all over Switzerland and in neighbouring countries, the number of intensity observations reached 297. In the epicentral area the intensity was VI over a large area and it reached an intensity of VII in Sool (GL). The previous strong earthquake in the region was in 1573. It had been as well felt in the whole eastern part of Switzerland and had caused damages. [Gisler 2005]

Seismic stations in operating during 1971, station coverage and magnitude threshold.

During 1971 the installation of new seismic stations of the new network had begun. The station at the Grande-Dixence dam (DIX) was operating since December 1970 and the station at the dam Linth-Limmen has been installed in November 1971 according to the information in the Annual report (Jahresbericht 1972) [table 1]. This is contradicted by the fact that there were some earlier readings from the station Linth-Limmern on the 1 October 1971. Figure 1 shows the magnitude threshold at the end of 1971.

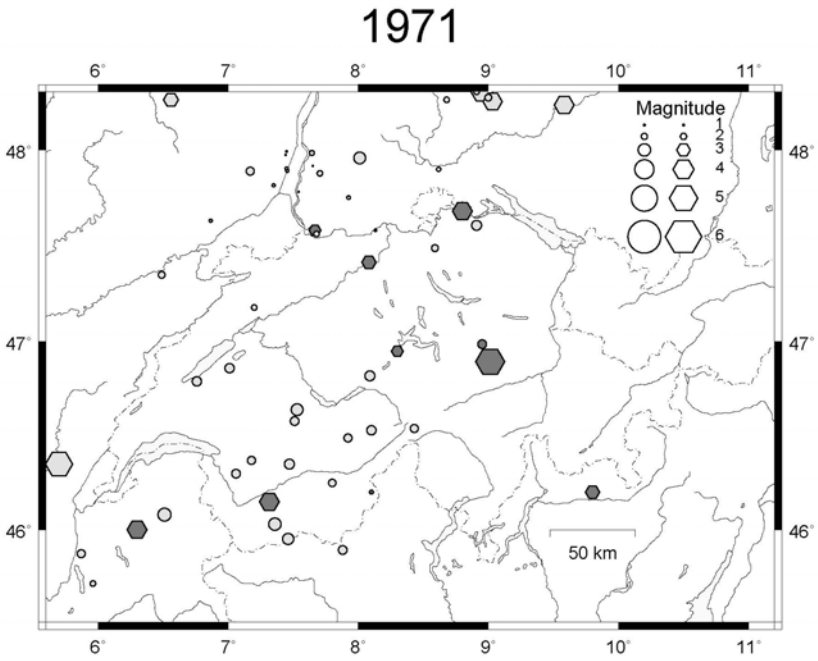
table 1

Code	Station Location	Inst	Components	Remarks
BAS	Basel	1934	V+H	tertiary-sediments
DIX	Dixence	1970	V+H	dam site
LIN	**Linth-Limmern**	**1971**	V+H	**dam site**
NEU	Neuchatel	1916	V+H	limestone
ZUR	Zurich	1911	V+H	sandstone, marl, molasse

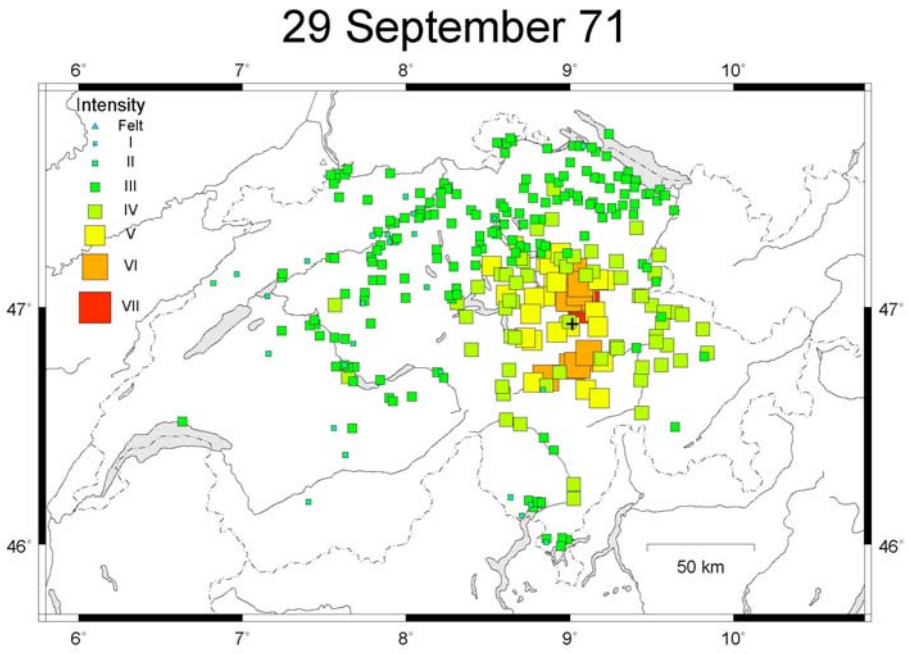


Epicentre distribution in 1971

The year 1971 seems to be a rather seismically quiet period but one should note that it is the period with the least original data available.



Macroseismic distribution (EMS 98)



Discussion about the localisation.

The signals of this earthquake were clipped so no location was possible. A first macroseimic localisation put it at Näfels. Other possible locations are Näfels, Glarus, Sool, Linthal.

Aftershocks:

Pavoni did a localisation from two aftershocks on the 29.91971 at 07.23 and apparently from the 30.9.71 at 8.21 but they are no trace from this event. They were located in Glarus. The original data are not available. What was found in [C2] are the indication of the following aftershocks:

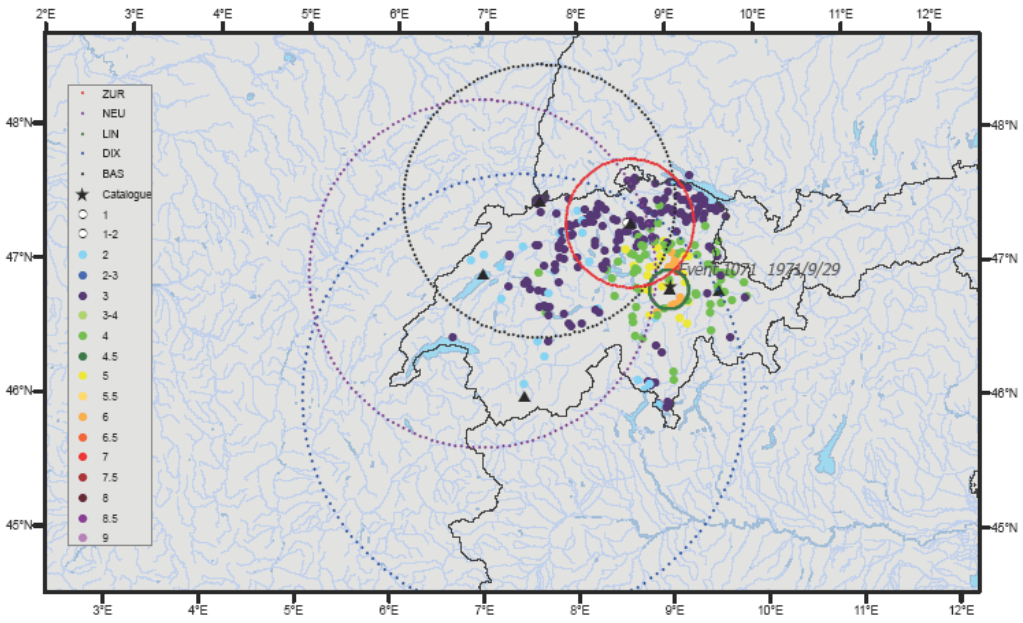
1- 29.9 1971 07:23:35 is missing in the catalogue because it has no magnitude determination.
2- 1.10.1971 03:25:54 the value in the catalog is probably from another agency LDG.

In table 2 the S-P times and distances indicated in document [C2]. The number in parenthesis indicates the aftershock (1 or 2) from above. The distance D indicated does not correspond to a constant proportionality factor. We have calculated the expected distance with a fix factor of 8.

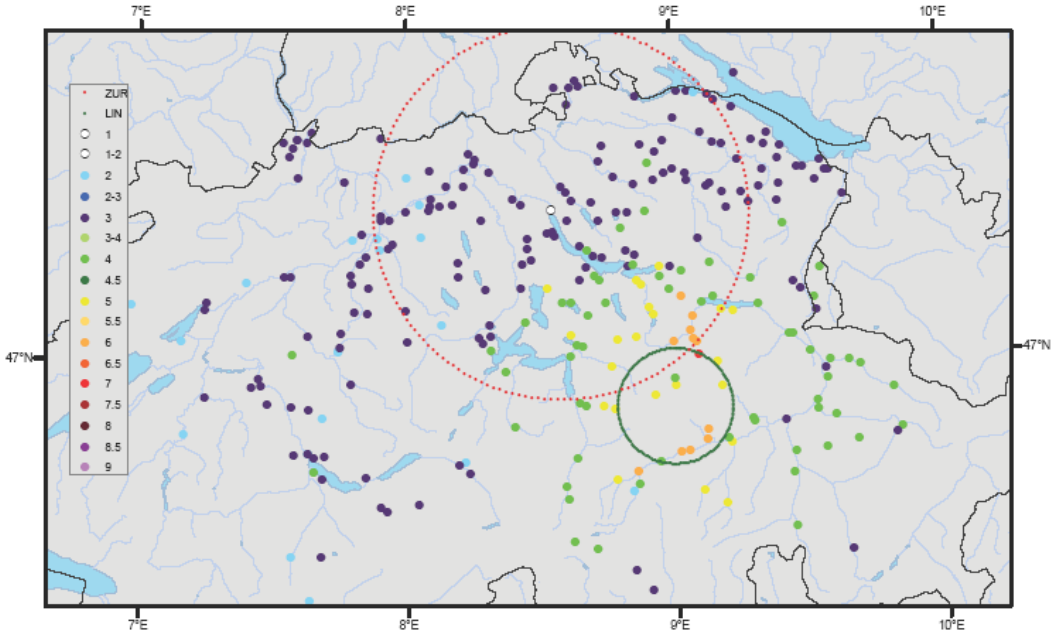
Table 2

Readings found in the original documents (Files C1)

	Dix(1)	**Bas(1)**	**Neu(1)**	**Zur(1)**	**Zur(2)**	**Lin (2 ?)**
S-P (s)	**22.5**	**13.8**	**17.6**	**6.5**	**6.1**	**2**
D km	**185**	**130**	**150**	**55**	**52**	**19**
factor used	8.22	9.42	8.52	8.46	8.52	9.50
Distance with f = 8	***180***	***110***	***141***	***52***	***49***	***16***



The figure shows the results of the rough location using the circle. The data do not allow a good location.



The location from the two nearest stations (ZUR and LIN) is close to the place with the maximum intensity value and to the location of the aftershock (see below)

Different locations for the event

Table 3								
	Location	**Date**	**Lat**	**Lon**	**Mw**	**Ix**	**No Pts**	**Souce**
1	Glarus	1971.09 29 07:18	47.1	9.0	4.8			Pavoni &BCIS
2	Glarus	1971.09 29	47.11	9.03		7 MSK		Ruettener & ISC
3	Niederurnen/GL	1971.09 29 07:18 :52	47.15	9.02	5.1	7		Mecos
4	Vorstegstock Linthal (GL)	1971.09 29 07:18	46.9	9.0	5.1	6 EMS	297	Ecos02 macrosismic
5	Glarus	1971.09 29 07:18	47.15	9.02	4.8			Braunmiller
6	Glarus		46.9	9.0	4.9			Bernardi
			47.0	9.0	4.9			ECOS09
AS	**Aftershock**	**1971 .10.01 3 :25 :54**	**46.99**	**8.95**	**2.4**			

In the french catalogue, Rothe [16] reported the following information:

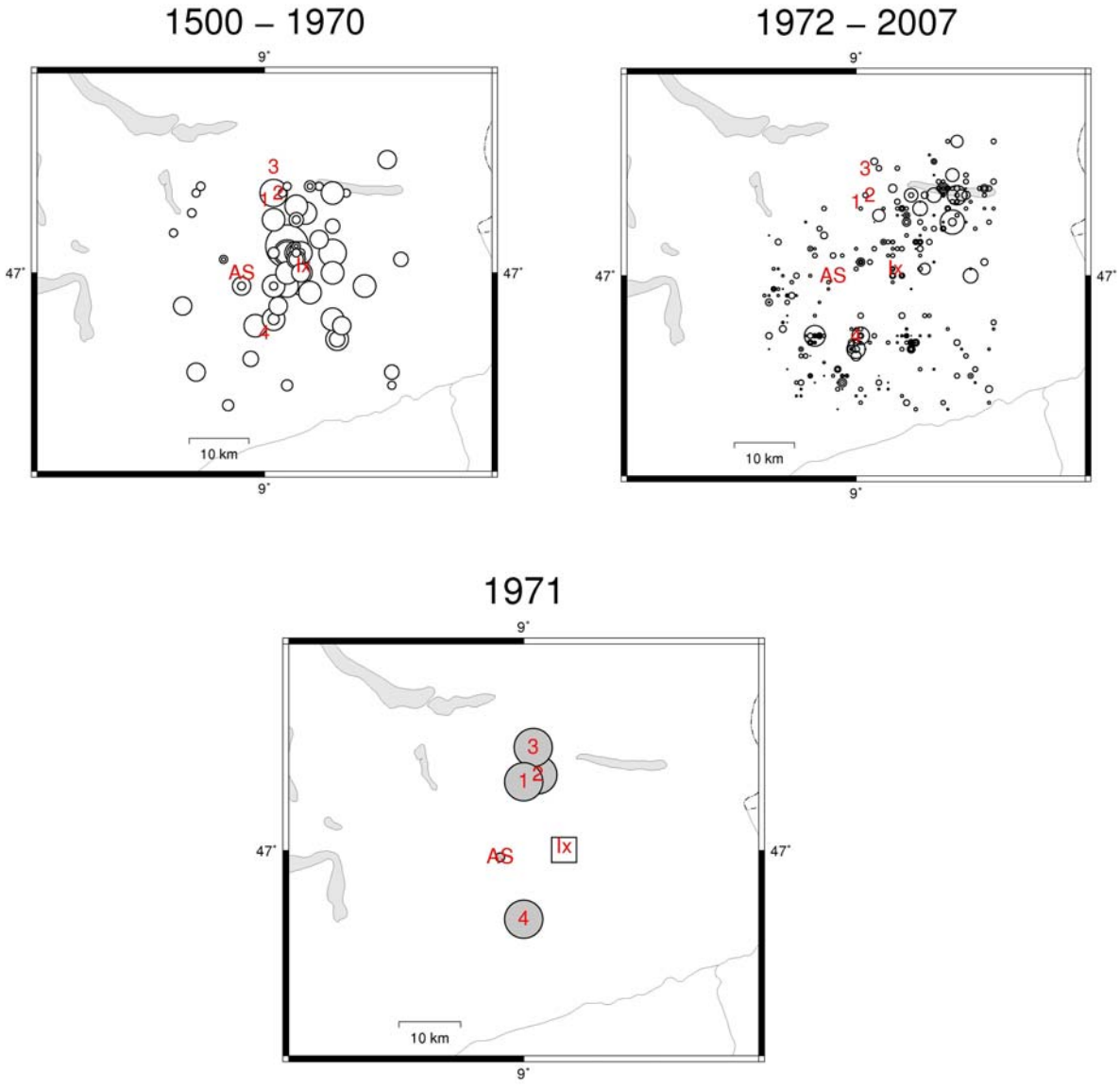
52. - 29 septembre 1971, à 07 h 18 mn - Suisse : 47°1 N, 9°0 E (BCIS)

Important séisme, de magnitude 4,3, qui a causé de légers dégâts en Suisse dans les cantons de Glarus et d'Uri ; il a été largement ressenti en Suisse et localement à Blotzheim (Haut-Rhin), à 120 km de l'épicentre.

BCIS :	47°1 N,	9°0 E ;	H = 07 h 18 mn 52 s
USCGS :	47°1 N,	9°0 E ;	H = 07 h 18 mn 51,6 s
LDG :	47°05 N,	8°79 E ;	H = 07 h 18 mn 52,1 s ; h = 0 ; M 4,3 ± 0,2
CLDG :	47°04 N,	9°00 E ;	H = 07 h 18 mn 52,3 s ; h = 0 ; MD 4,4 ; (A) ; NB 81
ISC :	47°11 ± 0,02 N,	9°03 ± 0°29 E ;	H = 07 h 18 mn 51,7 s ± 0,24 s

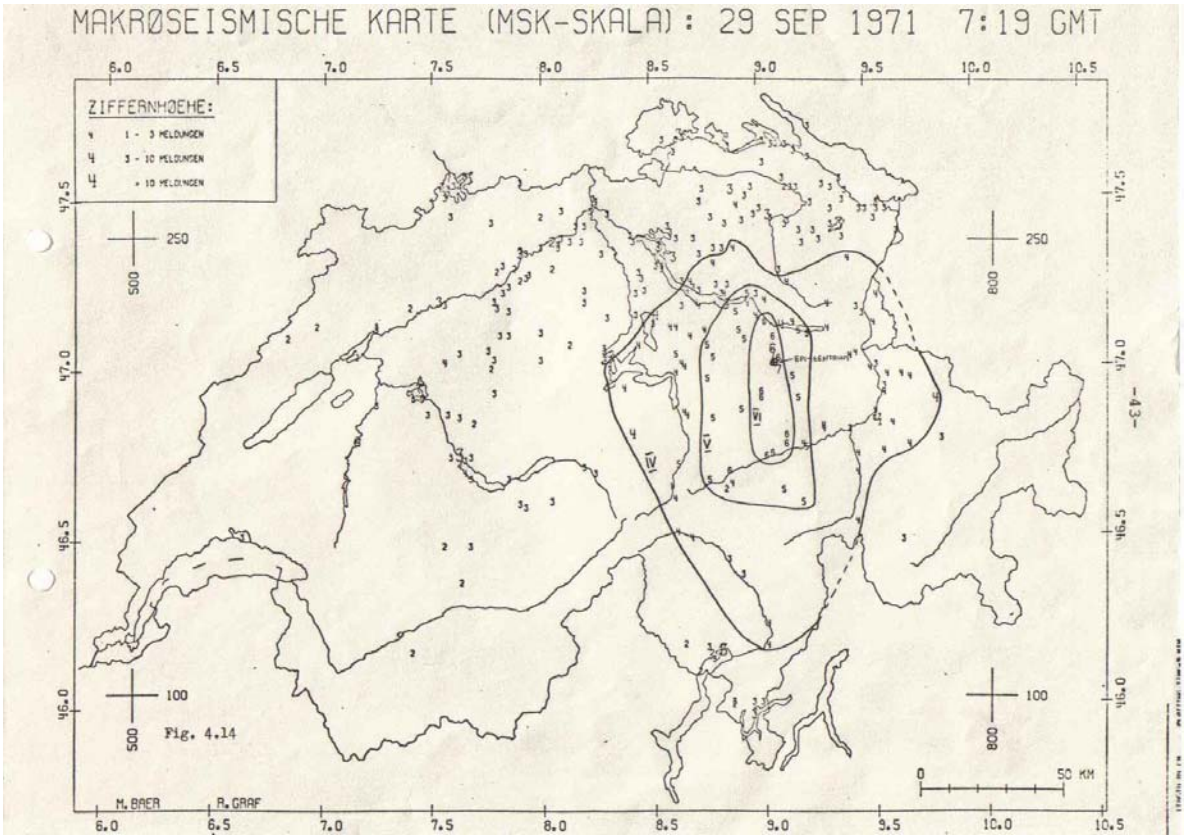
We have plotted maps of the seismicity of the area before and after 1971. The numbers indicate the location in table 3. They are three main regions

- 1/2/3 are the first locations indicated in the early catalogues (Iecos, Ruettener…).
- Ix is the location of the highest intensity points, AS is the location of the aftershock. The LDG and CLDG locations, indicated in Rothe, are situated between these two sites.
- 4 is the location in Ecos02. This is the result of a macroseismic determination of the earthquake parameters. This location is influenced by the high intensity values reported in the Vorderrheintal (see figure 3).



The different locations of the earthquake (table 2) match the intensity level VI showed on the macroseismic map (in MSK-scale).
The debated point on the location arouse from the high intensities in the Vorderrheintal. Are these values truthful or are they overestimated either to because of a geological site effect or

to a special awareness of the population due the high seismic activity in the Vorderrheintal the previous years (19643-1965).



Magnitude

As mentioned above the signal recorded at the Swiss stations was clipped. A duration magnitude has been estimated. Pavoni gives a value of Ml=4.8. The values given by French station are rather low. LDG estimated a 4.3 and duration magnitude of 4.4.
The magnitude determined in Ecos02 from macroseismic studies gave a value of 5.1.
This earthquake has also been studied by Braunmiller et al. and a moment magnitude value of 4.8 has been determined from the recordings available from European stations http://storing.ingv.it/es_web/Data/events/60541map.html
The new evaluation of magnitude(Mw=4.9) is describe in appendix D.

Focal mechanism

In the publication "fault plane solutions of earthquake in Switzerland from 1971 to 1976", Mayer-Rosa and Pavoni 1977 located the earthquake using the program Hypo71. They attributed a depth of 10km and found the following parameters:

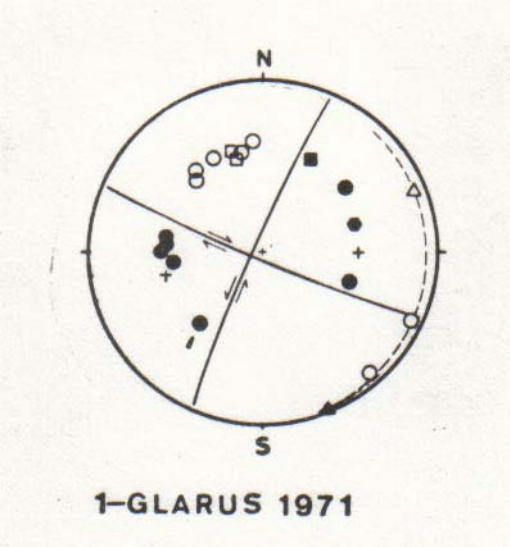
P-axis Az=158 Dip=0 T-axis AZ=68 Dip=6

The depth from macroseismic data was estimated to be 6km
Crustal model used to locate the earthquake

Depth	P velocity
0-1 km	4 km/s

1-20 km	6 km/s
20-36 km	6.7 km/s
Below 36 km	8.1 km/s

The focal mechanism corresponds to a strike slip with a NNE-SSW orientation of the nodal plane and with sinistral sense of displacement (see figure 5 below). This displacement corresponds to the system of NS to NNE-SSW of striking young faults with tendency of sinistral lateral displacement observed in the Glarus area.



Date	**29 Sept. 1971**
Time	**7:18:52**
Lat / Long	**47.1N/ 9.0E**
Mag	**4.8**
Region	**Glarus**
P	**158/0**
T	**68/6**

Uncertainty

This event will be reassessed in the version Ecos09 of the catalogue. One could try a location using the program nonlinloc to constrain the area with the higher probability. Until further investigation, we suggest to give for this event the coordinate 47.N and 9E with ±10km of East-West uncertainty and ±20km North-South.

Annexe 5

Source of information and bibliography

Special document

- A folder from at **Pavoni**'s containing copies of original information of the years 1964-1971. This was the main source of new information.

This catalogue for the years 1965-1966 is very useful because it was the base of the non-published annual reports. It contains readings (arrivals) of earthquakes and some macroseismic information. This document has been scanned and is found in annex. The catalogues for the years 1968-197 are less exhaustive. Below a description of the entries for1964-1966

1	2	3	4	5	6	7	8	9	10
Nr	Datum Zeit (MET)	Anzahl	Ort [Koord.] Schüttergebiet	Max Int RF	Regiestrierung Zeit h mn sec		Dauer mn	Δ km	Bemerkungen

1. Number of the event (not used)
2. Date Middle European Time
3. *Number of recordings*
4. *Location or felt sites*
5. *Intensity maximum in Rossi Forel scale, or intensity for the different location if available*
6. Recording Stations P and S arrivals
7. Signal amplitude in mm
8. Signal duration
9. Epicentral distance from each station
10. Remarks: Phase description (iP, eS…); P-S time; BCIS coordinate (Lat, long) and BCIS number of the earthquake

In the archive of the SED

- Annual reports of the SED

We consulted the yearly SED report in the years just before and after the 'dark period' 1958 to1963 and 1973.1974.

- Annual reports of the institute of geophysics

From 1964 we looked at the annual reports of the institute of geophysics. They had very little information concerning the seismicity; but we got list of publications and information on the changes regarding the seismic stations.

- Folders with macroseismic data (1964-1970) and (1971-1974)

„Macroseismische Auswertung der Erdbeben 1964-1969 and 1970-1974"
These two big folders contain some primary and secondary information on the earthquake. The primary information is the record of macroseimic data (Rossi-Forel

scale as they were to be published in the annual reports) and some 'hand-made' maps with a tentative localisation of the earthquake (P-S method) and macroseimic field.
The secondary information is the listing of macroseismic data and computer generated maps in MSK scale produces after 1972. They were probably done when studying the seismicity activity for the hazard map of 1976.
The folder contains also

- the **annual bulletins of natural damages in Switzerland**. "Schweizerischer Fonds für Hilfe bei nicht versicherbaren Elementarschäden"
- Some statistics on the earthquakes registered in Zurich (number, amplitude, but rather useless)

For the year 1964

- Additionnal information on the temporary network in Sarnen
- List of earthquake sequences for Sarnen earthquakes and Trun earthquakes

- A folder containing some information on the station availability (mainly in Zurich) during the time.

- *On the internet one can find the original seismograms from international stations and macroseismic data for the strongest events, two Sarnen, Chablais and Glarus. http://storing.ingv.it/es-web/Data (see table)*

- French macroseimic catalogue and historical catalogue (Rothé) on internet

- Nagra report 83-08 for station information.

Documents consulted during the previous study (2001):

- A catalogue as **cards** describing macroseismic data which have been established for the 1976 hazard map.

- Instrumental catalogue Iecos, as well as other catalogues (Ruettener, Potsdam)

- Catalogs listed in Nagra reports

- *A printout of a computer file containing an instrumental catalogue*

There was no indication of its origin and it contained readings (many were new) from the years 1964 to 1968. This document, which had been in the hazard group could not be found again (it might has been lost during the move to "Technopark" and back to Hönggerberg?)

Note: *The work on "darkage" started shortly before the move of the archive from Hönggerberg to Centre and some documents were already packed.*

Annexe 6

No	Reference	Description and Situation
1	Ahorner et al., 1972 L. Ahorner, H. Murawski and G. Schneider, *Seismotektonische Traverse von der Nordsee bis zum Apennin*, Geol. Rundsch. 61 (1972), pp. 915–942.	
2	Deichmann N., Baer M & al. (1997) *Earthquakes in Switzerland and surrounding regions during 1996* Eclogae Geol. Helv. Vol 90, 557-567	
3	Florin R. (1984) *60 Jahre geophysikalische Arbeiten in Chur. Eine Wissenschafts-geschichtliche Studie* Jahres Bericht NaturForschung Geselschaft. Graubünden 101, 31-52	
4	Frankle A.und Gutdeutsch R. *Makroseismische Abschätzungen von Herdparametern österreichischer Erdbeben aus den Jahren 1905-1973* J. Geophys. 40, 173-188, 1974	
5	Fritsche S. , Faeh D., Steiner B. and Giardini D. (2009) *Damage Field and Site-Effects: Multidisciplinary Studies of teh 1964 Earthquake Series in Central Switzerland* Natural hazards, vol. 48, n°2, pp. 203-227	
6	Gassmann F. and Weber M. (1964) *Jahresbericht 1963 des Schweizerischen Erdbebendienstes* ETH-Z Institut für Geophysik	SED Archives
7	Gisler M., Weidmann M., and Fäh D. (2005): *Erdbeben in Graubünden. Vergangenheit, Gegenwart, Zukunft*., Desertina Chur, 144 p	
8	Lomax, A., Michelini A. and Curtis A.. *Earthquake Location, Direct Global search Methods*	http://alomax.free.fr/nlloc/
9	Lombardi J.(1967) *Quelques problèmes de mécanique des roches étudiés lors de la construction du barrage de Contra (verzasca) Q.32, R15* Commission Internationale des grands barrages. Neuvième Congrès des Grands barrages Istamboul 1967	http://www.lombardi.ch
10	Mayer-Rosa D. *Jahresbericht 1972-1974 des Schweizerischen Erdbebendienstes Seismological Bulletin* ETH-Z Institut füe Geophysik	SED Archives
11	Mayer-Rosa D.& Pavoni N. ,(1977) *Fault palne solutions of earthquakes in Switzerland from 1971 to 1976* Publ. Inst. Geophys. Pol. Acad. Sc., A-5 (116)	
12	Mayer-Rosa D., H. Benz, U. Kradolfer, K. Renggli *Nagra Technischer Bericht 83-08. Inventar der Erdbeben 1910-1982 und Karten der Magnitudenschwellenwerte 1928-1982 SED,Juli 1982*	
13	Pavoni N. (1977) *Erdbeben in der Schweiz* Eclogae Geol. Helv., Vol 70, pp 351-370,	
14	Pavoni, N., and E. Peterschmitt (1974), *Das Erdbeben von Jeurre von 21. Juni 1971 und seine Beziehungen zur Tektonik des Faltenjura*, in Approaches to Taphrogenesis, edited by J. H. Illies and K. Fuchs, pp. 322– 329, Schweizerbart, Stuttgart, Germany. Peterschmitt	
15	Rothe J.-P. (1972) *La sismicité de la France de 1961 à 1970 Les Annales de l'Institut de Physique du Globe de 1936 à 1970 - partie géophysique. Tome 9.* Annales de l'institut de physique du Globe de Strasbourg	http://www.seisme.prd.fr/donnees/pubIPG/annales_geop_TOME9.pdf
16	Rothe J.-P (1983) *La sismicité de la France de 1971 à 197. Observations sismologiques - Sismicité de la France entre 1971 et 1977* Bureau Central Sismologique Français	http://www.seisme.prd.fr/donnees/publi/1971-1977/obs_sismo_1971-77.pdf
17	Sägesser, R. and D. Mayer-Rosa (1978). *Erdbebengefährdung in der Schweiz*. Schweizerische Bauzeitung, Zürich, 78/7, 3-18.	
18	Süsstrunk A. (1968)*Erdstösse im Verzascatal beim Aufstau des Speicherbeckens Vogorno 1968* Verhandlungen der Schweizerischen Narurforschenden Geselschaft 1968	

19	Swiss commitee for the International Geodynamic Project (1975) *International Geodynamics Project First report of Switzerland July 1975* Scnat	
20	Weber M. (1963) *Jahresebericht des Scwhweizerischen Erdbebendienstes 1963*	
21	Wössner J. *(*2002) *Revision of the Macroseismic catalogue snd database for Switzerland in the time period 1879 to 1963* SED internal report	
22	*Schweizerischer Fonds für Hilfe bei nicht versicherbaren Elementarschäden* 1965-1969	
	Catalogues	
C1	SED *Macroseismische Auswertung der Erdbeben 1964-1969*	SEDArchive, File (see description in annexe 4)
C2	SED *Macroseismische Auswertung der Erdbeben 1970-1974*	SED Archives, File (see description in annexe 4)
C3	Pavoni N. *In der Schweiz verspürte Erdbeben 1964-1971*	Pavoni and scanned, File (see description in annexe 4)
C4	SED *The pegasos earthquake catalogue Ecos version 02* Nagra/ Pegasos TP1-CAT-0003	
C5	SED (1999). Instrumental earthquake catalogue of Switzerland and Iecos.	[http://www.seismo.ethz.ch/products/catalogs/]
C6	SED (1999). Macroseismic earthquake catalogue of Switzerland and Mecos	[http://www.seismo.ethz.ch/products/catalogs/]
C7	*Sisfrance*	http://www.sisfrance.net/
C8	*Catalogo parametrico dei terremoti italiani*	http://emidius.mi.ingv.it/CPTI/
C9	*Euroseismo*	http://storing.ingv.it/es_web/
C10	SED *Karten*	SED Archives