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Autor: Mayer-Rosa, D. / Mueller, St.

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Studies of Seismicity and Selected Focal Mechanisms in Switzerland

Report by *D. Mayer-Rosa**) and *St. Mueller**)

The Swiss Seismic Service ist continuously monitoring the seismic activity in Switzerland by means of a new seismic station network. The main part of this station network consists of 11 three-component short-period telemetrysystems, which are conected by cable or radio transmission with the central recording site in Zurich.

In addition, five short-period stations equipped with one- and three-component seismometers operate with remote recording units.

A long-period station with different filters is in operation in Zurich since 1974 and an ultra-long-period instrument since 1976.

Fig. 1 shows the location of the stations and the central recording site on a schematic geologic-tectonic background. The stations BAS and BBS are run by the Meteorological Observatory in Basel and the station NEU by the Observatoire Cantonal in Neuchatel.

Some of the stations in the Swiss Alps are installed near large reservoirs, such as EMO, DIX, SIE, BRI, LLS and DAV. In the near future it is planned to increase the number of stations to about 20, most of them equipped with telemetry capability.

The existing network of stations allows to localize earthquakes with magnitude 1.5 and up throughout Switzerland. It also allows a rapid determination of the hypocentral parameters by taking advantage of the central recording media and a localization program especially implemented on a modern mini-computer system.

In the last decade the seismic activity in Switzerland was mainly concentrated in the southern part of Switzerland (Kanton Wallis), in the eastern part (Kanton Graubuenden and the Rhine valley bordering Austria) and the northernmost part (border to Germany). Fig. 2 shows the distribution of all located epicenters for the time span between Jan 1972 and Dec 1978 with magnitudes greater than 1.5.

*) Institute of Geophysics, ETH-Hönggerberg, CH-8093 Zurich (Switzerland)

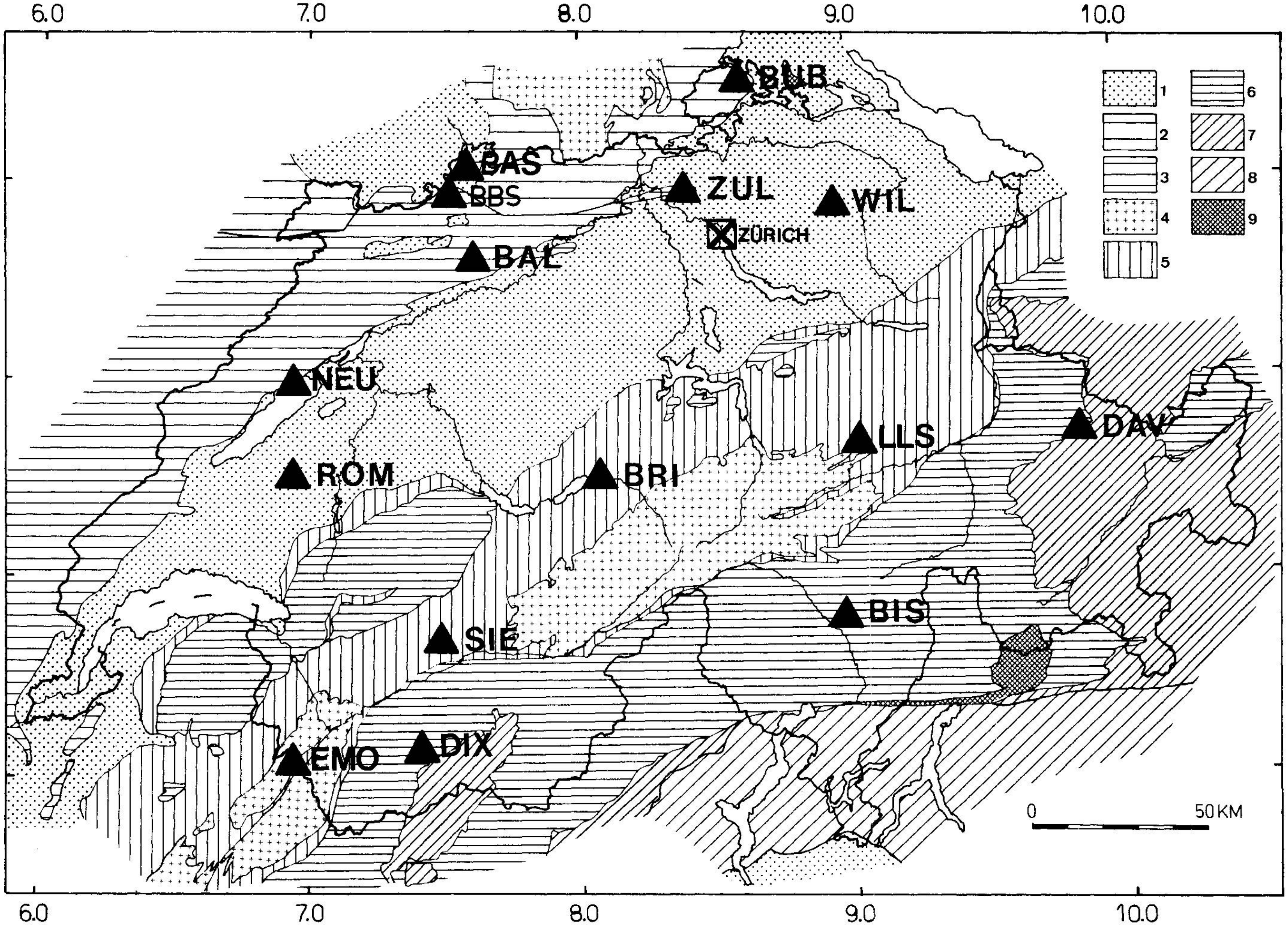

Fig. 1 Seismic station network in Switzerland. Telemetric stations with 3-component short-period seismometers of the SWISS SEISMIC SERVICE: BUB, WIL, BAL, ROM, BRI, LLS, DAV, SIE, BIS. 1-component stations: DIX, EMO, ZUL.
Stations operated by the observatories in Basel and Neuchatel: BAS/BBS and NEU, respectively.

Geologic setting:

1=Tertiary sediments, Molasse
2=Tabular Jura Mountains
3=Folded Jura Mountains
4=Crystalline Massifs and Basement
5=Helvetic autochtonous sediments, Helvetic and Ultrahelvetic Nappes
6=Penninic Nappes
7=Austroalpine Nappes
8=Southern Alps
9=Tertiary Intrusives and Volcanics

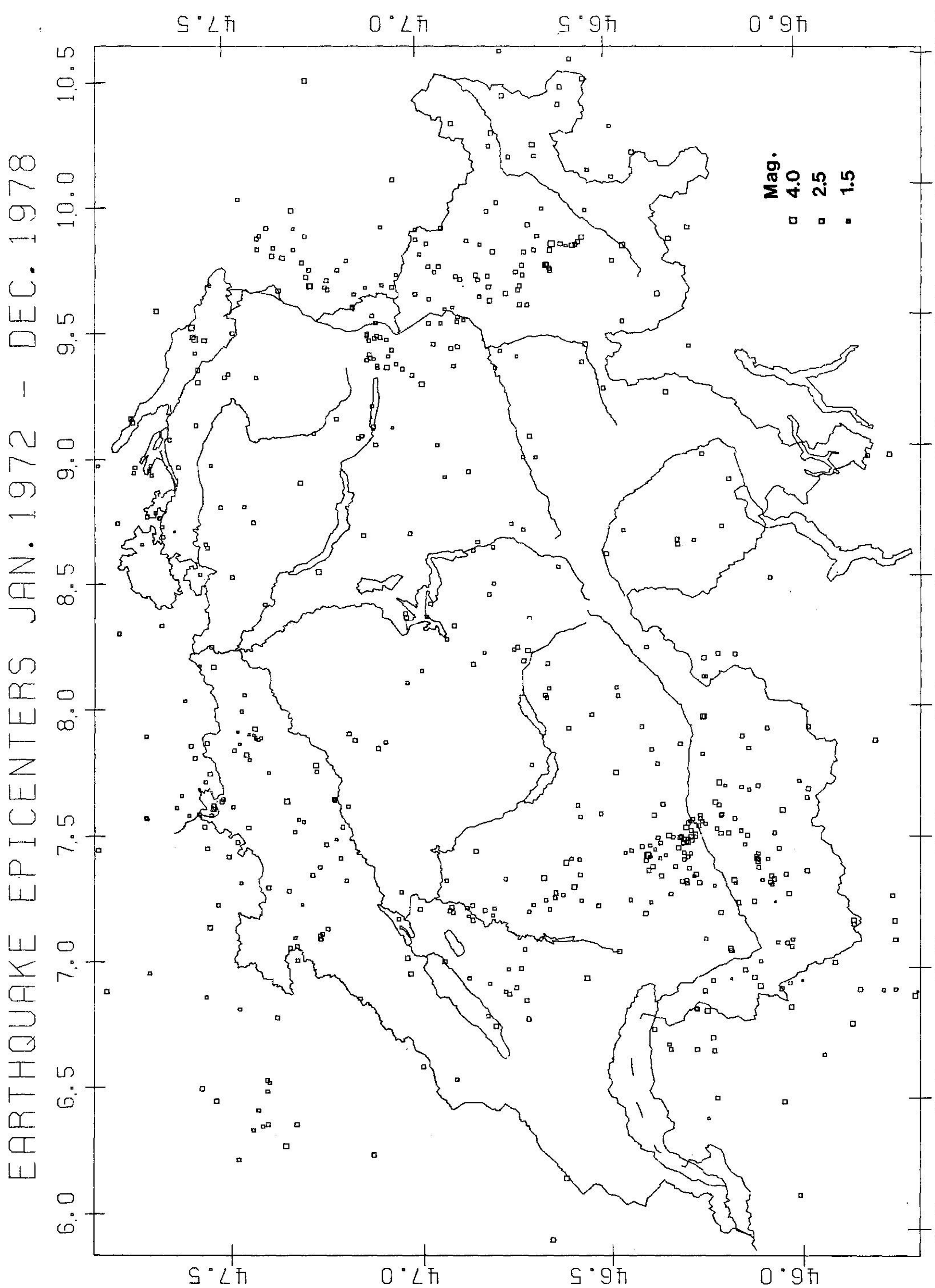

Fig. 2 Epicenter distribution of instrumentally determined earthquakes in Switzerland from 1972 to 1978. The magnitude range is 1.5 to 4.0. The depths of foci lie between 2 and 30 km, the majority around 5–15 km. The calculated epicentral errors are 1–5 km, depending on the date and station distribution used for the localization.

The strongest shocks of about magnitude 4 occurred near Sion in the Wallis, near Arosa in Graubuenden and around the Lake of Constance in the North. A remarkable change in activity compared to the preceding decade has to be noted in the central part of Switzerland. The area near Sarnen, SW of the Lake of Lucerne, suffered in 1964 from a sizable earthquake swarm with several shocks reaching the magnitude 5 range. As can be clearly seen from Fig. 2, no significant seismic activity could be observed there in the 1970s.

During the years 1975 to 1979 several microearthquake surveys were carried out in the central Wallis, in order to find fault zones, especially between the Rawil- and Sanetschpass on the northern side of the Rhone valley. For these campaigns transportable recorders were used, part of which are long-term event recorders developed in the Institute of Geophysics in Zurich.

In connection with a seismic risk mapping project for Switzerland, an elaborate study of historic earthquakes was carried out. Fig. 3 shows the distribution of earthquakes with intensity larger than V(MSK) for Switzerland and the border areas of the neighbouring countries. The time period covered is roughly 1000 years, for which very probably all events with intensity larger than VII(MSK) are included. Events with intensity larger than V(MSK) are nearly complete from about 1750 onwards.

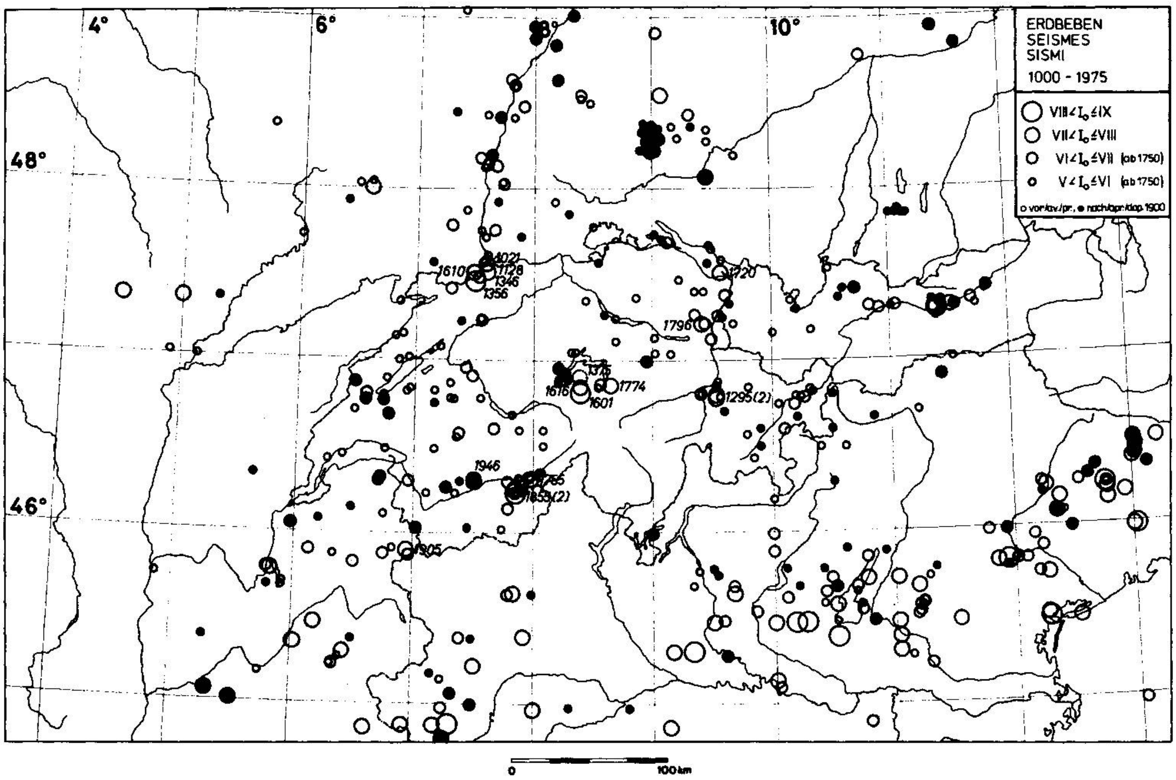

Fig. 3 Distribution of historic earthquakes from 1000 to 1975 with intensity greater than V(MSK). Circles indicate events before, full dots events after 1900.
Also enclosed in the figure are the years of occurrence for the largest earthquakes in Switzerland.

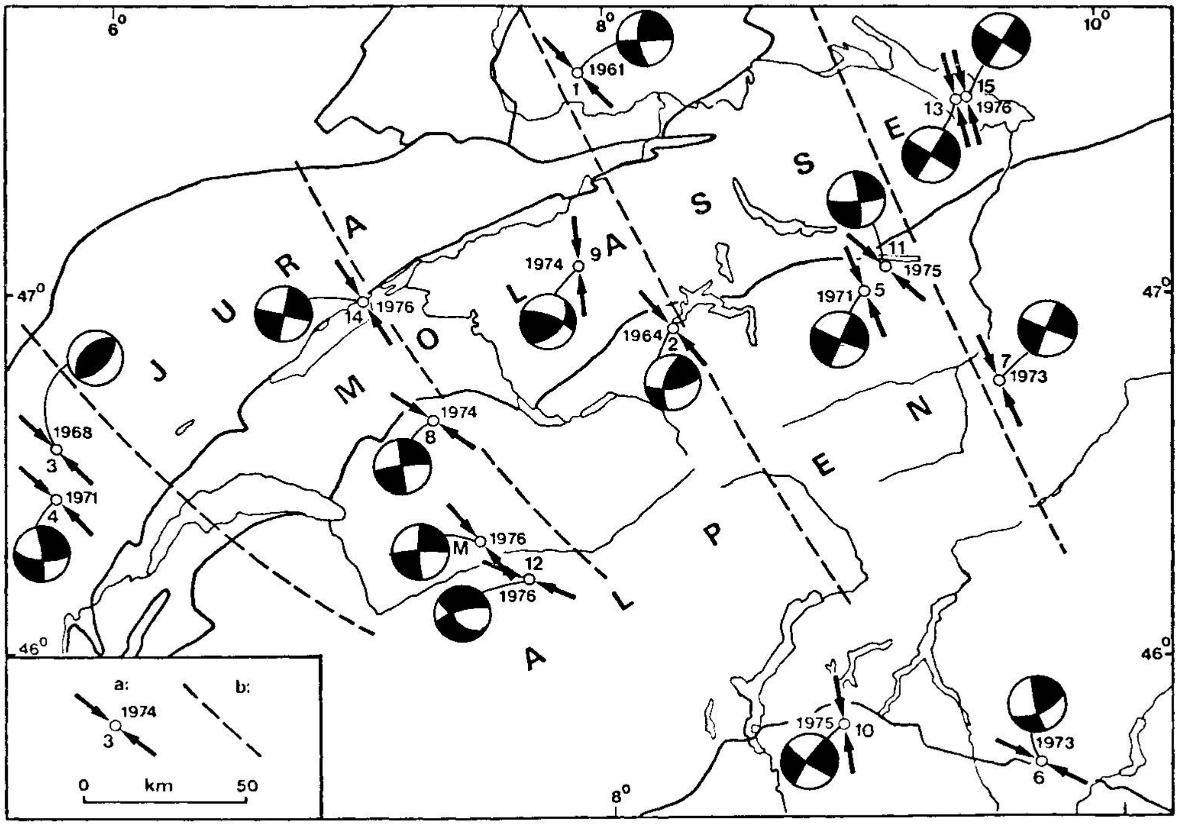

Fig. 4 Fault-plane solutions of earthquakes and derived direction of the maximum horizontal stress components (a) with the year of occurrence. Generalized field of the direction of maximum compression (b), after N. PAVONI.

The seismic activity of the past millennium shows preferred regions, such as Basel (e.g. the large earthquake of 1356), Valais (e.g. 1855 Brig, 1946 Sion), Lake of Lucerne (e.g. 1601 Engelberg, 1774 Altdorf), Graubuenden (e.g. 1295 Chur), Lake of Neuchatel and the Rhine valley bordering Austria. The strongest shock was certainly the Basel 1356 earthquake with a magnitude of 6.5 and intensity IX to X(MSK), and in this century the Sion 1946 earthquake with magnitude 5.5 and intensity VIII(MSK).

The seismic hazard maps of Switzerland were worked out using probabilistic methods, the historic and instrumentally determined earthquakes and a new seismotectonic map of Switzerland.

A number of earthquakes were analyzed with respect to the distribution of the first P-wave motion. Most of these events within and outside the Alps show a dominant left-lateral strike-slip mechanism. Only one event in the Jura mountains (No. 3 in Fig. 4) has a thrust-type mechanism.

From the fault-plane solutions the directions of the compression axes were derived. It can be seen from Fig. 4 that within a small scatter of the data all mechanisms fit into a general stress regime, which is characterized by a NNW-SSE to NW-SE direction of the maximum horizontal stress component, perpendicular to the strike of the Alps in this region.

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