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Reinterpretation of the Central German Earthquake of March 6, 1872, Using the MSK-Scale, and Conclusions for Its Up-dating

By **W. Sponheuer**, Jena, and **G. Grünthal**, Potsdam*)

(With 2 figures)
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Summary

The reinterpretation of the macroseismic observations of the Central German Earthquake of March 6, 1872, is compared with the previous interpretations by V. SEEBACH and DE LLARENA. The MSK-64 Seismic Intensity Scale has essentially proved to be successful in the evaluation of macroseismic observations of historical earthquakes. An up-dating of the scale is proposed regarding to a new definition of the currently used frequency graduations of observed earthquake effects.

Zusammenfassung

Den früheren Interpretationen des Mitteldeutschen Erdbebens vom 6. März 1872 nach V. SEEBACH und DE LLARENA wird die Neuinterpretation des Beobachtungsmaterials gegenübergestellt. Bei der Bewertung der makroseismischen Beobachtungen bei historischen Beben hat sich die MSK-64-Intensitätsskala im wesentlichen bewährt. Eine Aktualisierung der Skala hinsichtlich einer neuen Definition der Häufigkeitsabstufungen der beobachteten Bebeneffekte wird vorgeschlagen.

1. Introduction

The knowledge of the strongest observed earthquakes of any territory is of greatest importance for the assessment of seismic risk. Frequently, these strongest observed earthquakes date far back into history.

The so-called Central German Earthquake of March 6, 1872, was the strongest earthquake in Central Germany during the last 500 years. The epicentre was near the district capital Gera. The area of macroseismic shaking extends from Berlin in the north to Munich in the south, from Frankfurt (Main) in the west to the then Breslau in the east.

2. Previous interpretations of the Central German Earthquake

We are obliged to Prof. V. SEEBACH, who collected a lot of macroseismic data of the whole area shaken by the Central German Earthquake in 1872, published by him in 1873. V. SEEBACH [4] did not concentrate his interpretation an macroseis-

*) Prof. Dr. rer. nat. habil. WILHELM SPONHEUER, DDR-6900 Jena, Hölderlinweg 10; Dr. rer. nat. GOTTFRIED GRÜNTHAL, Akademie der Wissenschaften der DDR, Zentralinstitut für Physik der Erde, DDR-1500 Potsdam, Telegrafenberg.

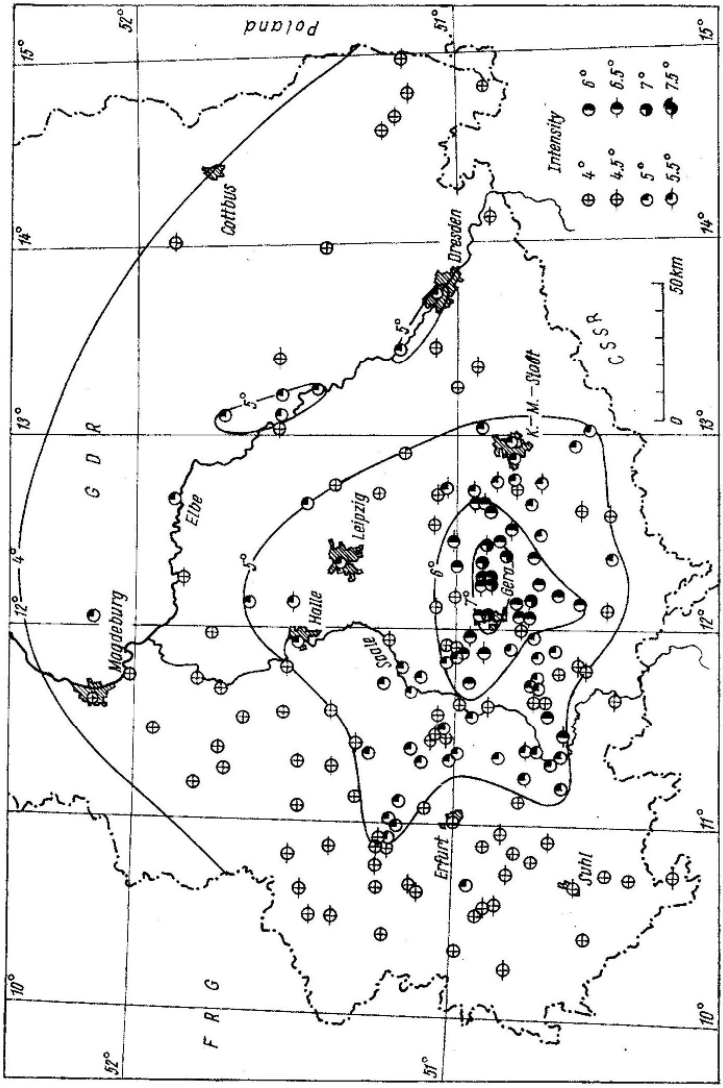

Fig. 1. Revised isoseismal map of the Central German Earthquake of March 6, 1872

mic investigations, but on localizing the epicentre from the observed arrival times of the felt vibrations. This method, based an macroseismic observations only, led to an epicentre which was at a distance of 100 km from the area of maximum shakings. V. SEEBACH classified the observed earthquake effects as follows (see also reprint in [6]):

1st isoseist - the probable boundary of the perceptibly shaken area,
2nd isoseist - the extension of the sound phenomenon,

3rd isoseist - delineates spaciously the area of earthquake effects an structures;

the pleistoseist area - where changes of the water discharge of springs and wells have been observed after the earthquake.

The first reinterpretation of the earthquake of 1872 was initiated by SIEBERG in 1925. He stimulated his disciple DE LLARENA to deal with this work. DE LLARENA [3] used the macroseismic observations from the 324 places published by V. SEEBACH [4].

At that time the notion of strongest earthquake effect of any town was used in the macroseismic practice even if it happened only once. This maximum effect was taken as a basis for intensity valuation by the MERCALLI-CANCANI-SIEBERG scale. DE LLARENA [3] got a rather spotty isoseismal map of the 1872 earthquake (see also reprint in [6]):

- an epicentral zone of intensity 8;
- a relatively large area shaken with intensity 7 (which means in general considerable damage of structures; the recent reinterpretation shows that this statement is exaggerated);
- a largely extended tone of intensity 6;
- furthermore, some isolated localities should have been shaken with intensity 6, e.g. towns along the Elbe river, but also localities very far from the epicentre; e.g., Prague, Stuttgart, Breslau.

This interpretation of the earthquake was the basis of all subsequent seismicity assessments of the territory up to about 1975. The intensity attenuation vs. distance derived from the isoseismal map by DE LLARENA does not agree well with the intensity attenuation curves after SPONHEUER [5], and the focal depth in a very rough approximation results to about 23 km: The magnitude M calculated from the epicentral intensity I_0 and the focal depth h [km] with Kárníks formula (cf. [2])

$$M = 0.5 I_0 + \log h + 0.35$$

is about 5.8.

3. The new interpretation

The increasing demand for precise assessments of seismic risk requires a critical revision of all basic data. So, among others a renewed interpretation of the 1872 earthquake was carried out based an the MSK-64 scale. The new reinterpretation is restricted an the data for the territory of the GDR, because the authors were able to refer not only to the data from V. SEEBACH but also to additional sources.

Comparing the real effects as evaluated by the MSK-64 scale with the intensity data by DE LLARENA an overestimation by the latter up to one intensity degree was found. It proves to be probable that the observed slight damage was partly connected with the structures in disrepair. For the new reinterpretation not the maximum effect at a given place but the relative frequency of the effects was considered. Fig. 1 shows the new isoseismal map of the earthquake. Accord-

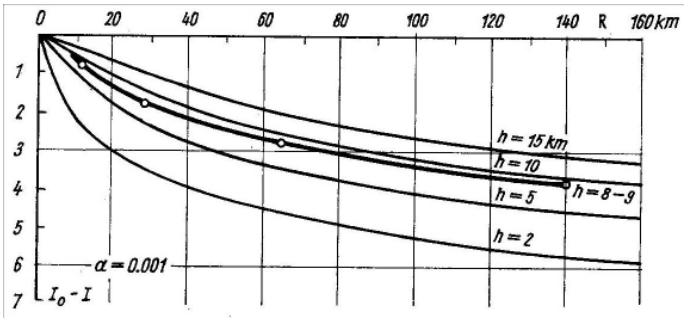

Fig. 2. Focal depth of about 8-9 km estimated from the intensity attenuation versus distance

ing to the new reinterpretation the isoseismal areas are definitely smaller than those after DE LLARENA. There is no longer any area of intensity B. Some isolated regions along the Elbe river have been shaken with intensity 5 instead of 6 as given by DE LLARENA.

Fig. 2 shows the intensity attenuation versus distance graph. The depth h of the focus drawn from the new isoseismal radii is about 8-9 km and the magnitude M calculated with the empirical formula by KÁRNÍK [2] is about 5.0. This example clearly shows that reinterpretations should be based an original observations, whenever possible. The international praxis confirms that previous interpretations are very mach influenced by the specific predominant opinions, conceptions and trends.

4. Conclusions for up-dating of the MSK-64 scale

In the past years in many countries large efforts were undertaken for collecting basic seismic data. In this connection extensive macroseismic evaluations were carried out by using the MSK-64 scale, which has proved to be successful in our revision of historical data of the last 100 up to 200 years. Therefore, drastic changes of the general classification characteristics are not to be recommended. Nevertheless, refinement and more precise definition of the various graduations used should be considered. In our opinion, this applies e.g. to the currently used *frequency graduations of the MSK-64* as

a few - about 5%,
many - about 50%,
most - about 75%.

If we want to stick to a frequency classification in three grades we propose the *new frequency classes*

few - smaller than 10 %,
many - 20-50%,
most - more than 60%.

If we would admit a frequency classification of more than three grades we would concur with the frequency classes proposed by KARAPETYAN ([1], p. 110)

single - about 5%,
some - about 25%,
many - about 50%,
most - about 75%,
all - more than 95%.

But such a classification in five grades would entail a considerable revision of the scale.

References

[1] Karapetyan, B. K., Povre'idenija zdanij s antisejsmiceakimi meroprijatijami. In: Sejsmičeskaja škala i metody izmerenija sejsmičeskoj intensivnosti, Moskva 1975.
[2] KÁRNÍK, V., Seismicity of the European Area, Part 1, Praha 1968.
[3] DE LLARENA, J. G., Die neue Isoseistenkarte des mitteldeutschen Erdbebens vom 6. März 1872. Z. Geophysik 5 (1925), 182-186.
[4] V. SEEBACH, K., Das Mitteldeutsche Erdbeben vom 6. März 1872, Leipzig 1873.
[5] SPONHEUER, W., Methoden zur Herdtiefenbestimmung in der Makroseismik. Freiberger Forsch.-H. C 88 (1960), 15.
[6] u. G. GRÜNTHAL, Das Mitteldeutsche Erdbeben vom 6. März 1872. Veröff. Zentralinst. Physik d. Erde 64 (1980).