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VII.7 Seismic risk analysis for a nuclear power plant at Forsmark, Sweden

NTNF/NORSAR was asked in February this year to participate in a seismic risk analysis for the nuclear power plant under construction at Forsmark, Sweden. Previously, we have participated in similar investigations for the outer Oslofjord area.

In case of the Forsmark investigation (Husebye and Ringdal, 1976) we compiled a detailed seismicity map for Fennoscandia from historic times and up to present. Fig. VII.7.1 shows as an example the epicentral distribution of all reported events between 1891 and 1950, based on the catalogue of Båth (1956), while the largest known historic earthquakes in Fennoscandia are mapped in Fig. VII.7.2. Clearly, the large earthquakes are of particular importance in seismic risk analysis, and in view of the relatively low seismic activity in Fennoscandia, this is our main reason for using a data base covering several hundred years.

The extremal-value theory of Gumbel (1958) is a particularly attractive technique for analyzing recurrence times of large earthquakes. Since only knowledge of the largest events is required, a historic data base, although incomplete, will often be sufficient. In our case, we applied the Gumbel theory to earthquake intensity (rather than magnitude) as the intensity parameter is most directly related to macroseismic observations. Fig. VII.7.3 shows an extremal-probability plot of the largest earthquakes occurring within consecutive 10 year intervals for South Sweden. The straight line indicates the estimated Gumbel distribution, and the fit is seen to be quite good. Clearly, this line should not be extrapolated infinitely; in our case we imposed a maximum intensity of 10 (M.M.Scale) in the model.

Having established the seismicity in terms of intensities, it remains to incorporate intensity decay factors and conversion relations from intensity to ground acceleration. Using Trifunac and Brady's (1975) conversion relations and examining four different models of intensity decay, we found ground accelerations averaging 0,16 g at a probability level of 10^{-5} per year at Forsmark.

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REFERENCES

Båth, M., 1956: An earthquake catalogue for Fennoscandia for the years 1891-1950. Sveriges geol. Unders. Årsbok 50, No. 1, 52 pp.

Gumbel, E.J., 1958: Statistics of extremes. Columbia Univ. Press, New York & London, 375 pp.

Husebye, E.S. and F. Ringdal (1976): Some aspects of seismicity and seismic risk analysis with special reference to the Forsmark, Sweden area, 95 pp, NTNF/NORSAR, Kjeller, Norway.

Trifunac, M.D. and A.G. Brady (1975): On the correlation of seismic intensity scales with the peaks of recorded strong ground motion, Bull. Seism. Soc. Am. 65, 139-162.

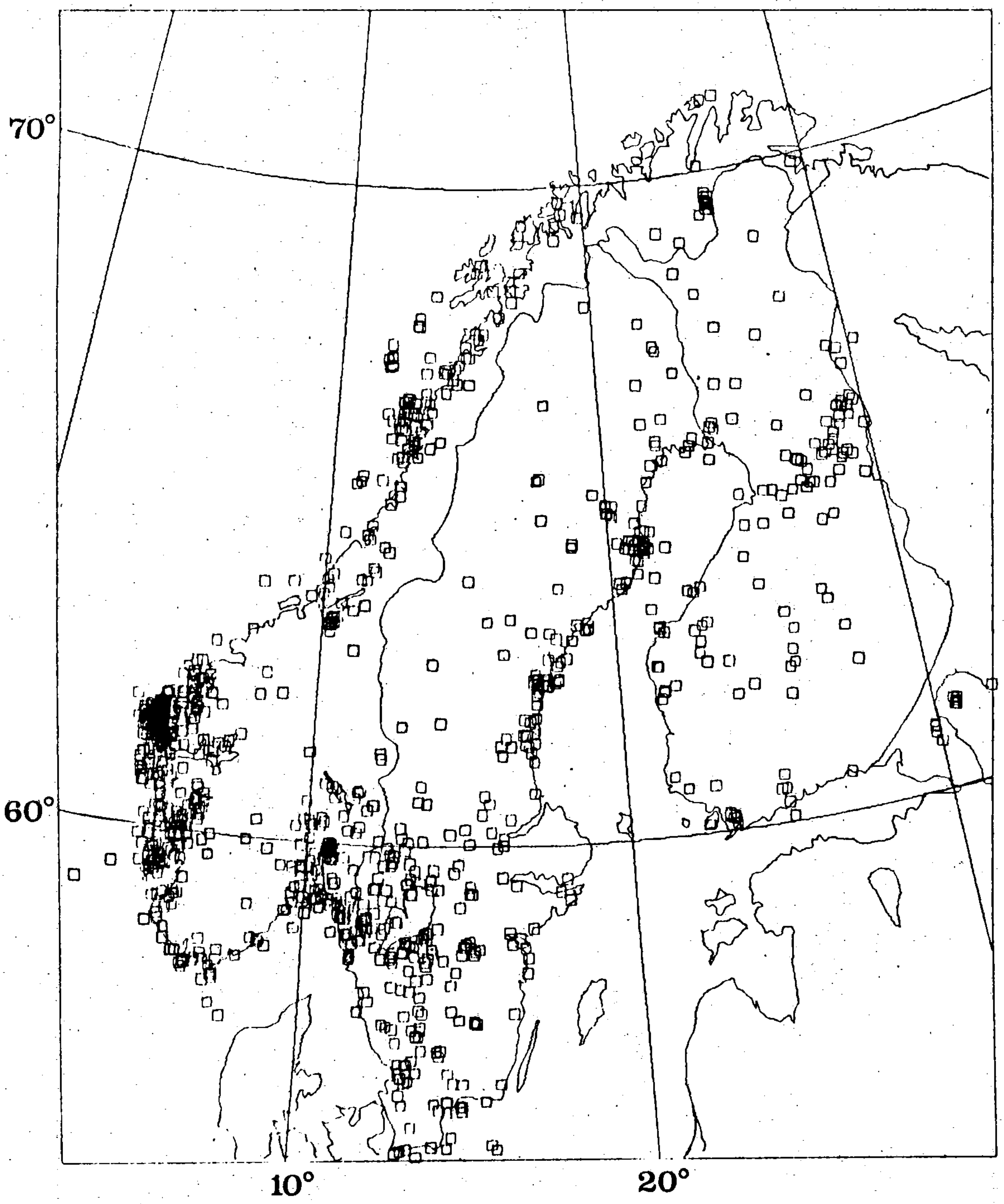

Fig. VII.7.1 Seismicity map for Fennoscandia covering the interval 1891-1950, based on mostly macroseismic data but also a few instrumental observations.

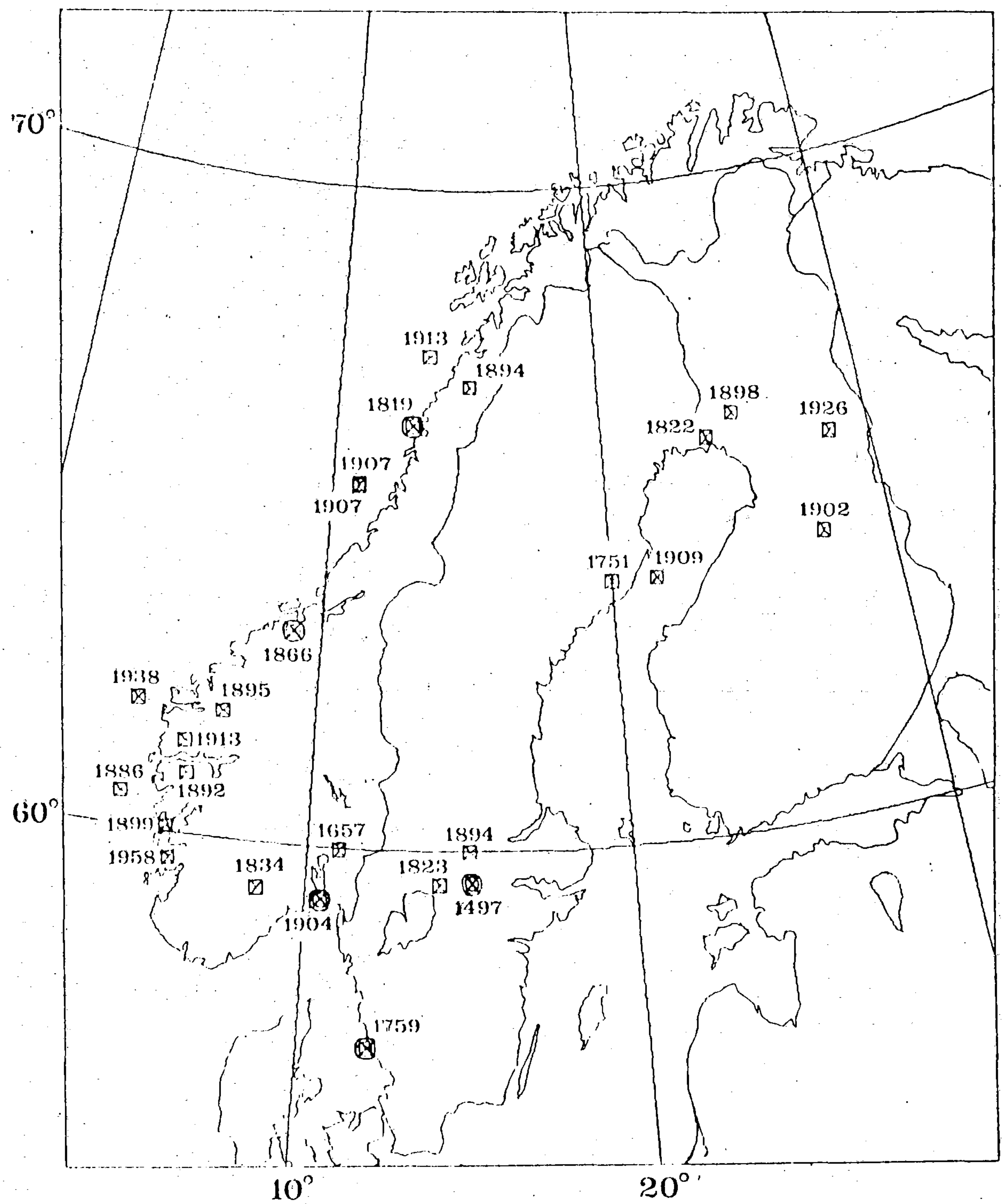

Fig.VII.7.2 Map showing epicenter and year of occurrence of Fennoscandian earthquakes presumed to have a magnitude M of at least 5.0 The double symbols indicate earthquakes presumed to have M of at least 6.0.

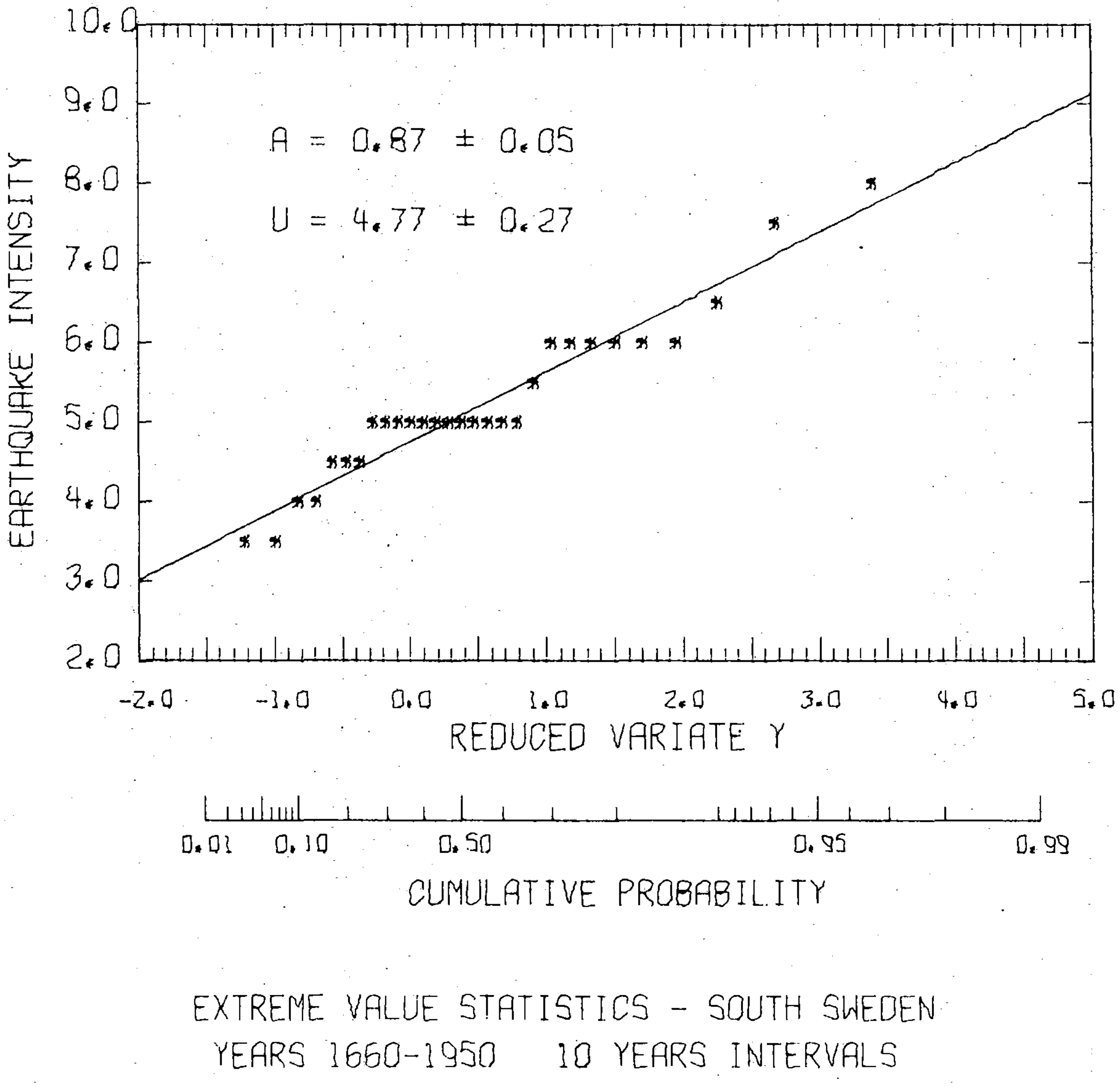

Fig. VII.7.3 Extremal value statistics for observed earthquake intensity in south Sweden and adjacent coastal areas.