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VI.7 The Seismicity of the Stiegler's Gorge Area, Tanzania

This project has been described and a few results have also been presented in previous Semiannual Technical Summaries. A substantial amount of new data from the Stiegler's Gorge Network (SGSN) has now been analyzed, and a total of 1450 events are now on file covering the time period September 1978 - January 1980. Hypocentral solutions are computed for about 750 of these, while in Fig. VI.7.1 we have reduced this number to 475 by requiring an RMS time residual value less than 0.75 sec, and standard errors (both horizontally and vertically) of less than 5.0 km. Typically, the RMS value is 0.1-0.4 sec and the standard error 1-3 km. We have moreover required that at least 5 P phases and 2 S phases are used in the hypocentral calculations; this requirement is particularly essential for events outside of the array.

It is seen from Fig. VI.7.1 that there is a high concentration of events near the dam site; this is real enough although somewhat exaggerated because of the decreasing sensitivity of the network to detect events as the distance increases. It is also seen that the activity is confined to two major zones, (i) a NW-SE lineation of events near the dam site and not far from a prominent fault system (Tagalala), and (ii) a SW-NE lineation near stations 5 and 6.

A more detailed seismicity map is presented in Fig. VI.7.2, where also two vertical cross-sections are shown, at directions of N30^{o}E and N120^{o}E. It is seen there that the activity near the dam site is concentrated along a plane dipping about 45^{o} to the NE, striking the surface about 10 km SW of the dam with a direction near N120^{o}E. This is in good agreement with focal mechanisms derived from first motion directions, showing that normal faulting takes place along the plane defined above, with extensional movements in the east-west direction. This is moreover consistent with what we know about the regional tectonics in the area (the east African rift zone).

A problem of great importance for the interpretation of these measurements is the establishment of a reliable magnitude scale for the local earthquakes.

In this case we have developed a scale based on signal duration, and applicable to local as well as regional earthquakes. Only one Stiegler's Gorge earthquake recorded at SGSN has so far been recorded elsewhere, this quake (from 9 June 1979) has been set at a magnitude of 4.2, and the scale has moreover been calibrated against some regional events (distances 11^{o}-19^{o}) recorded at SGSN. The formula reads

$$M = -1.0 + 1.8 \log \tau + 0.1(\log \tau)^2 + 0.002 \cdot \Delta$$

where τ is signal duration in sec (measured from analog recordings) and Δ is epicentral distance in km. This has given a recurrence relationship for Stiegler's Gorge earthquakes as shown in Fig. VI.7.3, where it is seen that the second largest earthquake has a magnitude of 3.1. It is therefore fair to say that the large number of events shown in Fig. VI.7.2 first of all is a result of the high sensitivity of the instruments used, and that the sizes of the earthquakes have so far been quite moderate.

H. Bungum

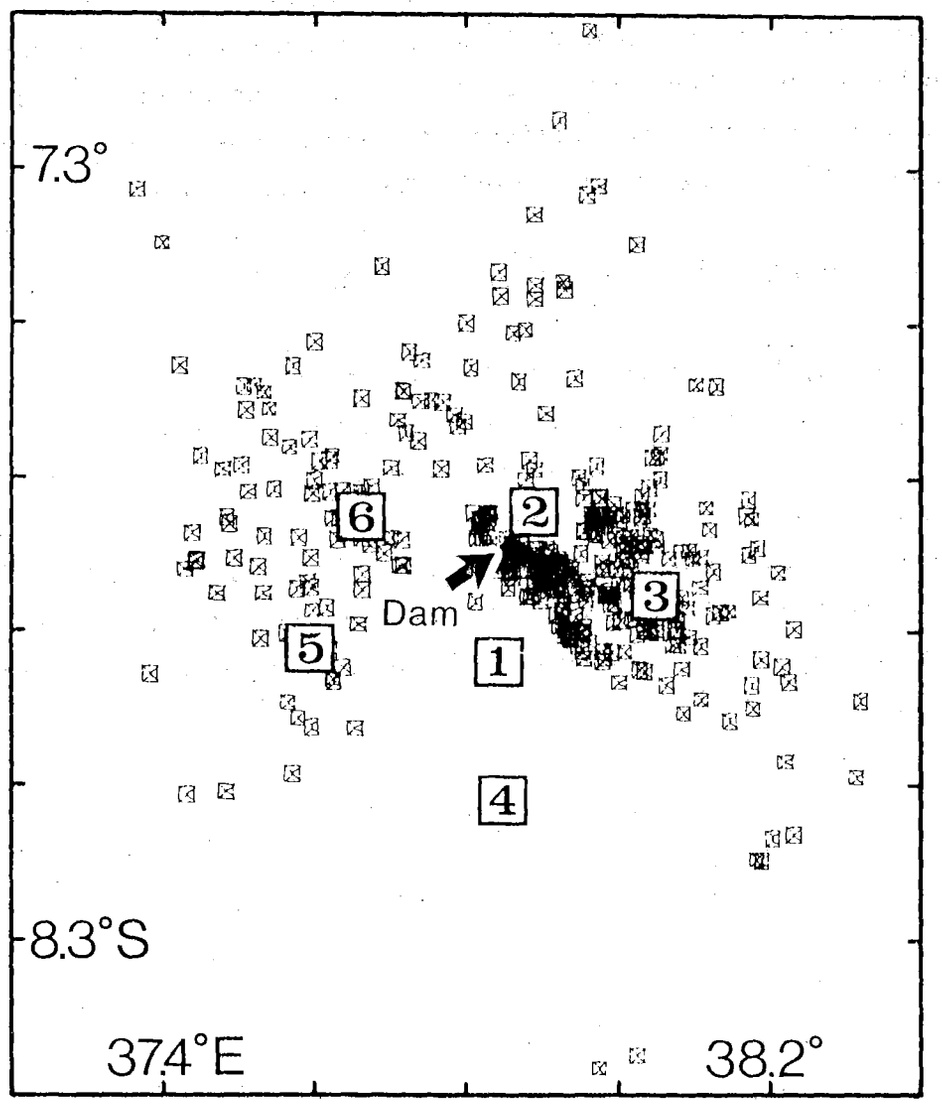

Fig. VI.7.1 Precisely located earthquakes in the Stiegler's Gorge area between 14 Sep 1978 and 16 Jan 1980. The locations of the seismic stations (SGSN) are given as boxed numbers.

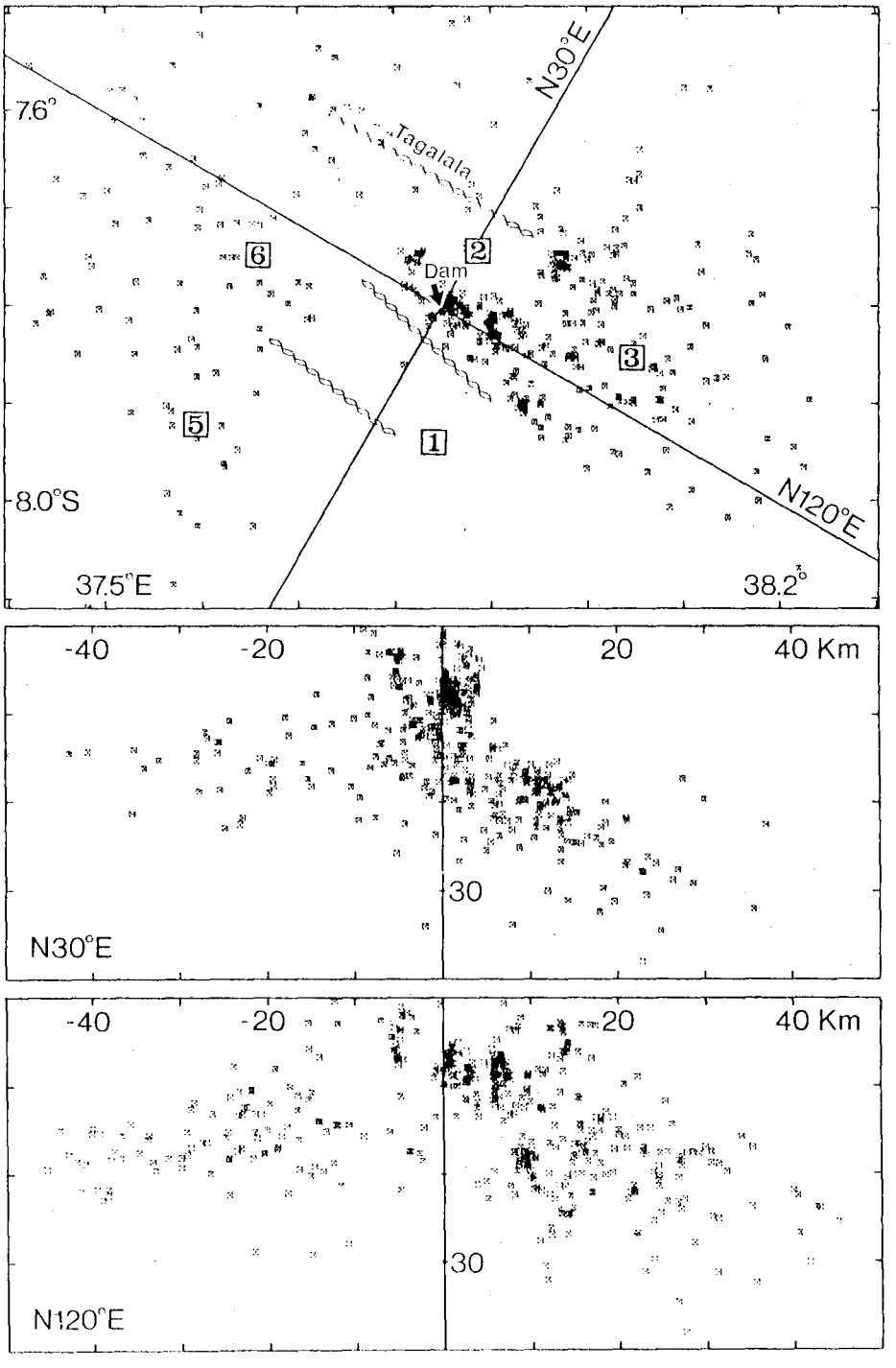

Fig. VI.7.2 Earthquakes in the Stiegler's Gorge area between 14 Sep 1978 and 16 Jan 1980. The epicenter distribution at the top is a blowup of what is shown in Fig. VI.7.1, with additional indication of the three most prominent faults in the area including Tagalala. Below are given two vertical cross-sections, centered at the dam site and along the directions N30°E and N120°E, respectively. The cross-sections extend 100 km across and 40 km in depth, and very few of the more precisely located earthquakes are found outside the volume covered by this figure.

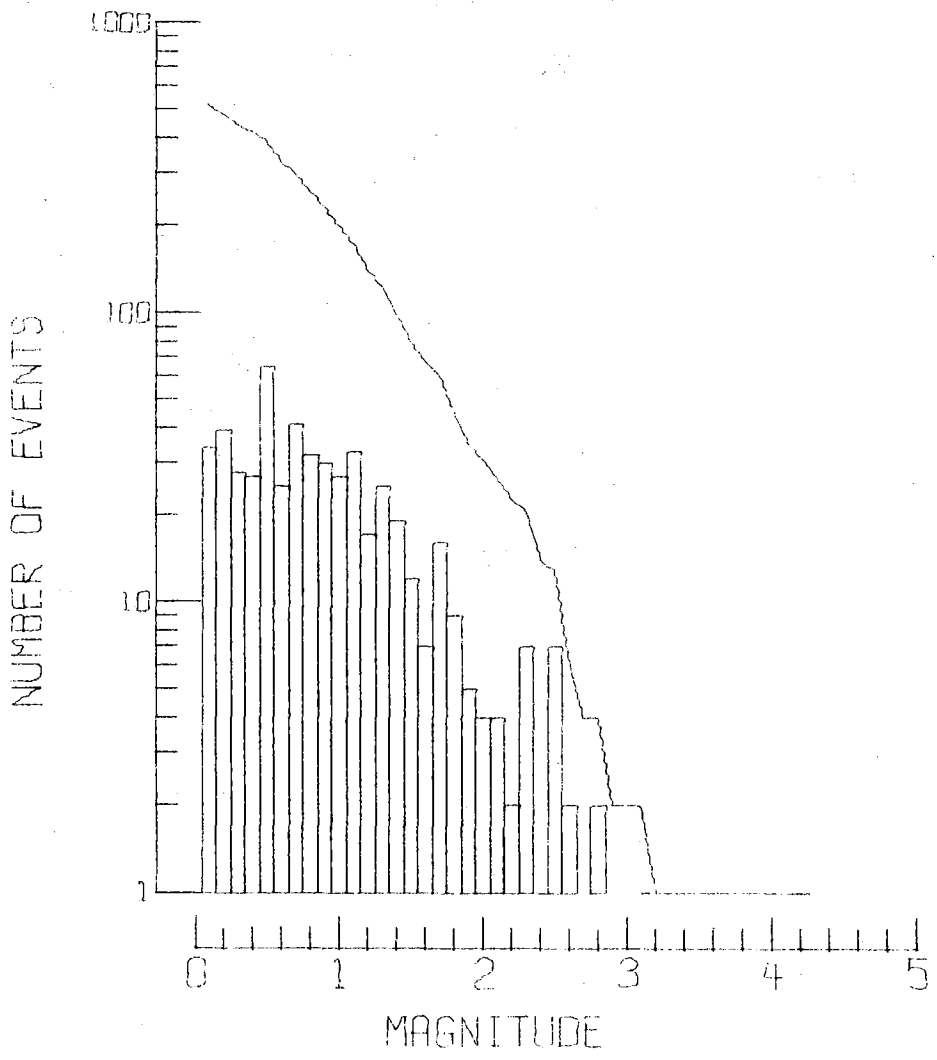

Fig. VI.7.3 Frequency-magnitude distribution for local earthquakes recorded by SGSN. Corresponding epicenter locations are given in Fig. VI.7.1.