ΦΥΣΙΚΗ.— **An automated network of electrotelluric stations for the prediction of earthquakes,** *by G. Antonopoulos - G. Augoustis - G. Dimopoulos - P. Economopoulos - G. Giakoumakis - S. Ginis - P. Karapanos - J. Kopanas - M. Lazaridou-Varotsou - D. Papageorgiou - N. Razis - V. Thanos - A. Zisos**. Ἀνεκοινώθη ὑπὸ τοῦ Ἀκαδημαϊκοῦ κ. Καίσαρος Ἀλεξοπούλου.

ABSTRACT

The network of electrotelluric stations in Greece has recently been extended to 18. Many of them are automatically connected to a central station. Examples of the reliability of the prediction of earthquakes are given.

Since June 1982 the network of stations monitoring the electrotelluric field has been extended from eight [**1**] to eighteen. Their sites are shown in Fig. 1; In the initial period of each station the measurements are recorded on site in chart recorders and any signals of interest are telephoned by men of the army to the central station at GLY. The stations REN, SYR and IRA are still in an experimental state. After each station had worked to satisfaction it was automated by sending the measurements telemetrically to GLY. The sequence of the processes is the following: The strength of the electrotelluric field is transformed from analog to digital, transmitted by telephone lines to the central station, there reduced again to analog and registered on multipen recorders. The recordings from the various stations are pursued without interruption for simultaneous signals (M.L - V.). The magnetic field is monitored for magnetic storms at MEG.

A transient variation of the electric fieldstrength is accepted with confidence as a precursor signal (ES) to an earthquake either when it clearly

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exceeds the noise or when it has been collected simultaneously at many stations. It can also pass undetected during strong magnetotelluric disturbances. Another important factor that reduces the reliability of the network is the electronic part. It is especially prone to failure during bad weather because of lightning strokes.

We will now give some information on the experimental uncertainty that can intrude into a prediction of the three parameters.

T i m e. For most of the regions of Greece that have been studied as to their lead-time we initially found the value 6 to 11 hours [**2**]. Lately a region of the west coast showed in a number of cases [**3**] the much longer lead time up to 56 hours.

E p i c e n t e r. The accuracy in the prediction of the epicenter depends on the magnitude of the earthquake because strong earthquakes produce measurable signals even at large distances and therefore can be detetced at large number of stations. As an example the 7 R earthquake of December 18th 1981 at Agios Efstratios gave a clear signal (see Fig. 7 of Ref. 4) at the GLY station (150 km), which was the only one operating at that time. It would presumably have been detected at most of our present stations. By January 1982 three stations were in operation (GLY, MEG, IRA). The 7 R earthquake at Limnos on January 19th 1982 was registered at all three stations (see Figs. 10, 11 and 12 of Ref. 4). Weaker earthquakes (below 6 R) are detected usually at 2 to 3 stations depending on their epicentral distance, the behavior of the station and on a magnetic disturbance eventually happening at the time. We give two examples of predictions with relatively large errors. At 07 : 05 GM of March 8th 1983 signals were collected at two stations, with the strength 0,3 mV at THI and 0.5 at IOA. No signal was visible at GOR, CHAL or VER. The stations VOL and AMF were out of order. No contact could be made with the station at AMF. As a result of the above situation and in view of the paucity of reliable data we predicted a 4 R earthquake between 100 and 150 km to NNW of Athens. On the same day at 15 : 31 GMT a 4,3 R occurred with an epicenter that lied 45 km south-east of IOA. In retrospect we find that the error of 150 km was due to a bad estimation of the available data. Another example of an erroneous prediction concerns the 4.5 R earthquake that occurred 25 km north-west of Skopje (Jugoslavia). A clear signal has been seen at

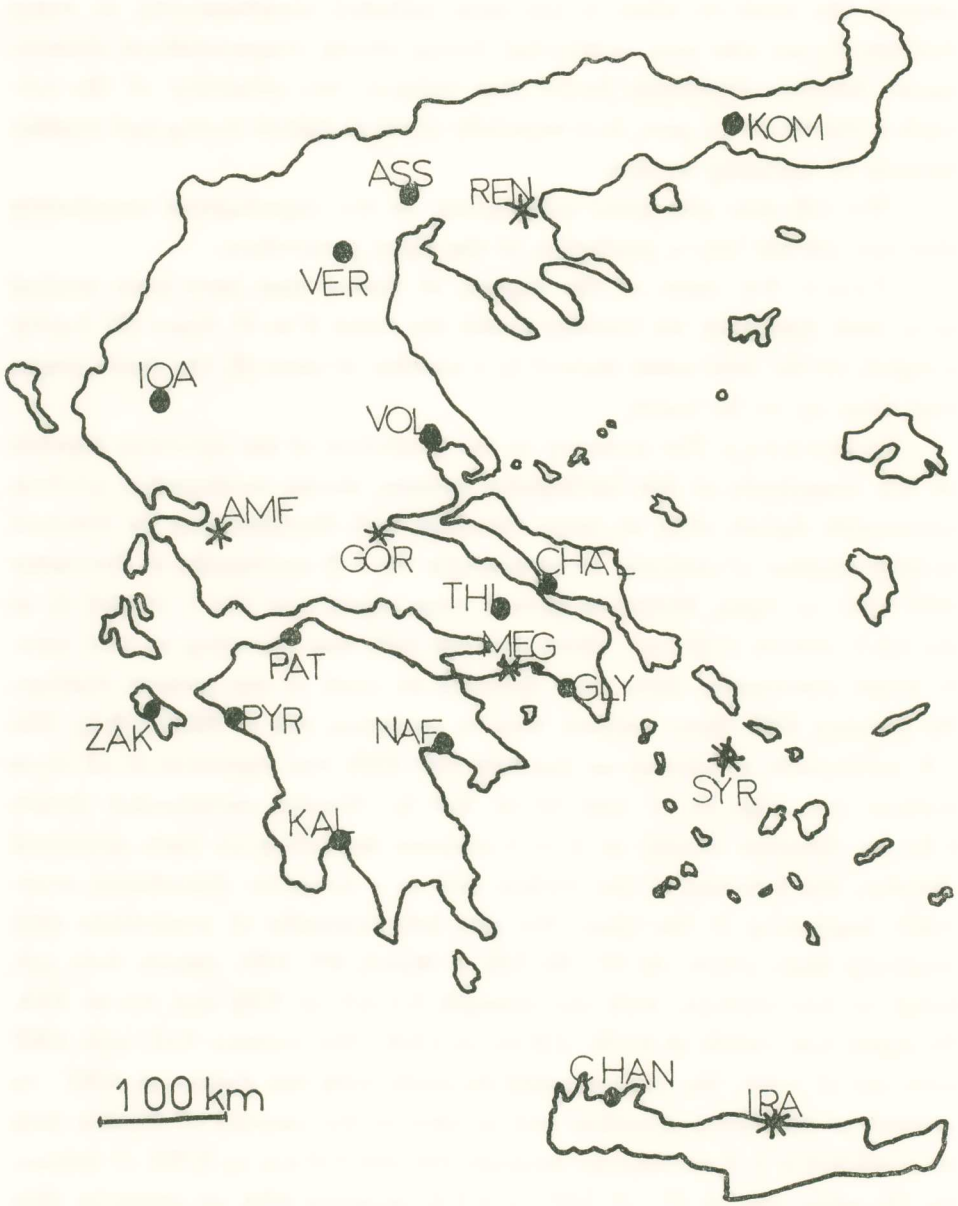


Fig. 1. Network of electrotelluric stations. ● automated ; × not yet automated. The telemetric station of KOM has been tranfered to REN.

Operators.— MEG : (G. Av. ; S. G. ; A. Z.). — IOA : (G. G.). — IRA : (P. E.). KOM : (P. K.).— PYR : (D. P.).— ZAK : (G. An.; I. K.; N. R.).— GLY : (M, L-V). CHAN : (V. T.).— KAL : (G. D.).

ASS and a weaker at VER whereas no signal was visible at KOM, IOA and other stations to the south. The REN station was not in operation. These data led us to a prediction of a 4 R eartquake near Kilkis around 25 km north-west of ASS. The error, larger than 150 km, is due to the epicenter lying far outside the polygon formed by the network.

Of particular interest is the study of cases where the station is very near the epicenter. Two such EQ occured practically under GLY: A 2.2 R earthquake on Sept. 24th 1981 and a 3.1 R earthquake on Nov. 7th 1981 were both registered seismographicaly and localy felt. Their form is given in Figs 1 and 2 of Ref. 2.

In order to evaluate in an unbiased way the possibility of correctly predicting all three parameters of an inpending EQ we applied during the last few months the method followed by Sobolev [**5**]. A prediction of all three parameters was made after each ES and issued in the form to a telegram. The documents were later compared to the actual seismic data. From about 73 such predictions 13 were completely in error. Errors is respect to the time of the EQ were made for some events near Katakolon and Kefallinia before it was realised that their lead-time is around 43 to 56 hours [**3**] instead of the usual 6 to 11 h [**2**]. Errors were also produced by defects in the electronics or the interruption of the communication system due to extremely bad weather. During such periods the number of operating stations was temporarely reduced.

For an estimation of the reliability of the present network we consider 21 earthquakes of magnitude larger or equal to 5 R. For these events 9 predictions of the epicenter were, better than 80 km, respectively 12 better than 150 km.

For the instrumentation we have to thank the Academy of Athens, the Foundation J. Kostopoulos and mainly the Ministries of Public Works and of National Defence. Without the help of the Army the stations could not be operating day and night. We must also thank all echelons of the Organization of Telecommunications, both at the central and the local offices of the stations for helping us set the network in operation. The electronics were designed by Dr. P. Hadjidiakos.

ΠΕΡΙΛΗΨΙΣ

Τὸ δίκτυον σταθμῶν μετρήσεως γεωρευμάτων ἐπεξετάθη εἰς 18 σταθμούς. Πολλοὶ ἐξ αὐτῶν μεταδίδουν τὰς πληροφορίας αὐτομάτως εἰς κεντρικὸν σταθμόν. Δίδονται παραδείγματα ἀξιοπιστίας τῶν προβλέψεων τῶν σεισμῶν.

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