Acta Geodaet., Geophys. et Montanist. Acad. Sci. Hung. Tomus 12 (1—3), pp. 111—115 (1977)

MAGNETOTELLURIC INVESTIGATION OF THE ESKDALEMUIR ANOMALY S. SCOTLAND — PRELIMINARY RESULTS

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During 1974 and 1975 magnetotelluric measurements were made at 13 locations along lines perpendicular and parallel to the strike of the conductivity anomaly in the Southern Uplands of Scotland. At each station data in the 10—1200 second period band were recorded and at 9 of them longer period variations were also obtained. Observations from four stations along a NW—SE traverse have been analysed using auto and cross spectral techniques. The results confirm the existence of an anomaly in this region and appear to suggest that its base is deeper to the NW and SE.

Following earlier studies which have indicated the existence of an electrical conductivity anomaly in the southern uplands of Scotland [2, 3, 4] magnetotelluric and geomagnetic deep sounding studies have been undertaken at thirteen sites in this region. These are indicated by crosses in Fig. 1. At all the sites, 3 components of the magnetic field and 2 horizontal components of the telluric field were recorded in the period range 10 to 1200 seconds. At 8 of them, a long period recording system — 200 seconds to 24 hours — was also operated.

The processing of the data from all these stations is now almost complete and will be published in due course. In this note, some results from the three stations FTH, NEW and TOW which span the suggested strike of the anomaly

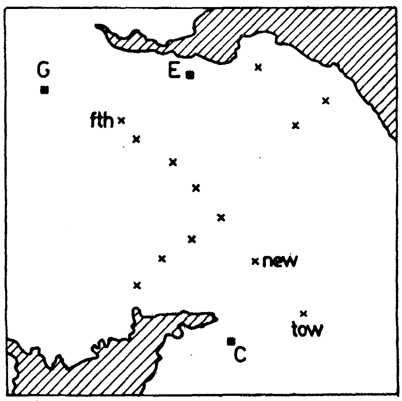

Fig. 1. The location of the MT measuring sites

are presented. For each of these stations, seven data sections have been manually digitised. Following the method of Reddy and Rankin [5] major and minor apparent resistivities and phases have been computed from the Z_{XY} impedance tensor elements rotated to indirections which maximise the partial coherence function $\gamma^2_{\mathrm{ND.H.}}$ ($\gamma^2_{23.1}$ in Reddy and Rankin's notation). Figs 2(a)—(c) show the resulting variation with period of the collated rotated major apparent resistivity data — amplitudes and phases — after rigorous rejection criteria have been applied.

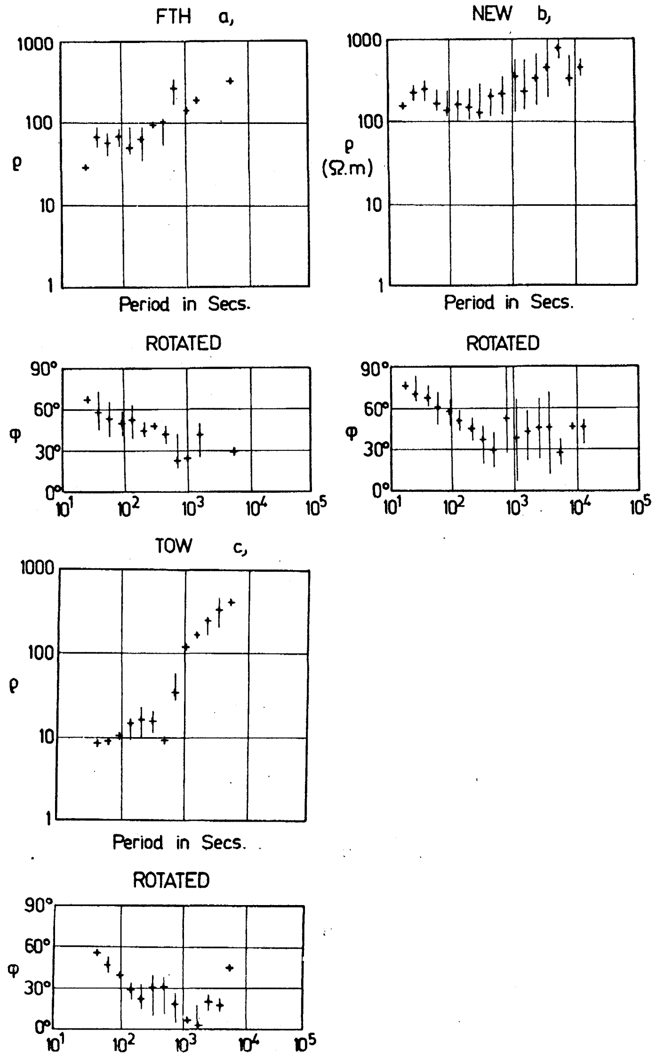

Fig. 2. The variation with period of the average rotated major apparent resistivities and phases at *(a)* FTH *(b)* NEW and *(c)* TOW. The error bars indicate the spread of the individual estimates

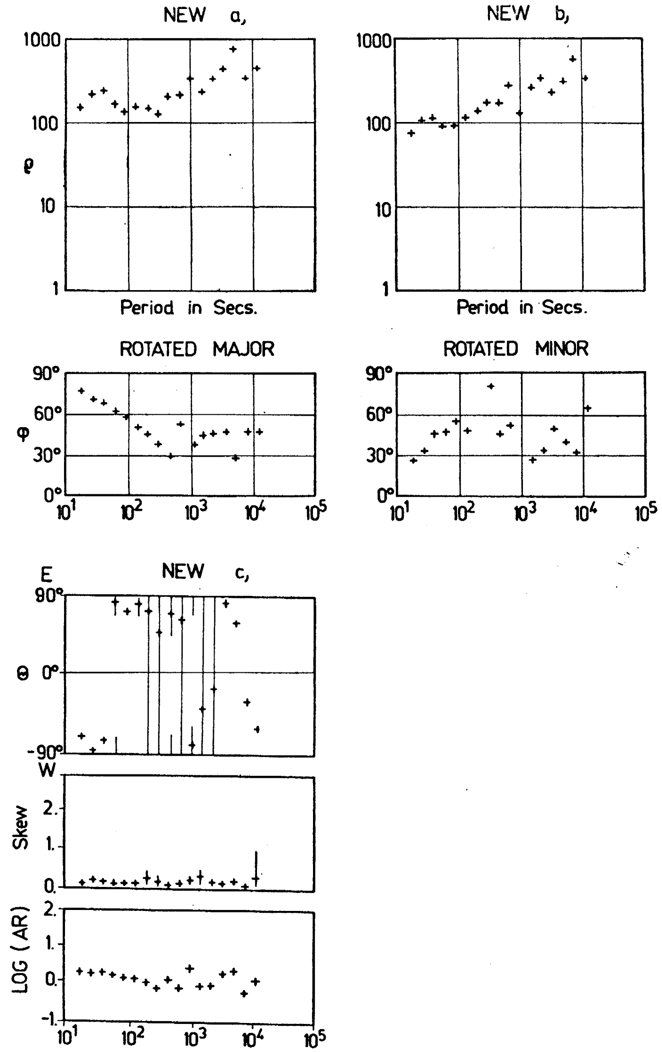

Fig. 3. a) The amplitude and phase of the rotated major apparent resistivity versus period curves for NEW. *b)* The amplitude and phase of the rotated minor apparent resistivity versus period curves for NEW. *c)* The variation with period of: (i) the azimuth of the rotated major apparent resistivity axis at NEW; (ii) the skew factor at NEW; (iii) the logarithm of the anisotropy ratio AR at NEW where $AR = \varrho_{XY}/\varrho_{YX}$

There is a significant difference in the form of the apparent resistivity data at the extreme stations of FTH and TOW and that at the intermediate station of NEW. The apparent resistivity is less than 100 Ω m for periods below 1000 seconds at both FTH and TOW while at NEW the apparent resistivity is greater than 100 Ω m for the whole period range. Comparison of the major and minor apparent resistivities at these stations shows another aspect in which the results at the extreme stations differs from those at intermediate stations such as NEW. The NEW data are relatively isotropic — Figs 3(a) and 3(b) — while those from FTH and TOW (not illustrated here) exhibit anisotropic behaviour. Thus while a 1-dimensional interpretation of the M-T data from the three stations might indicate that the top interface of the resistive substratum is at a greater depth under TOW and FTH than under NEW, 2-dimensional modelling of the results might later show that the data at FTH and TOW are distorted significantly by lateral conductivity inhomogeneities.

The similarity of the major and minor apparent resistivity versus period curves at NEW justifies the assumption of an approximately 1-dimensional conductivity structure under this station, as does the low skew factor for the whole period range and the anisotropy ratio, AR, of almost unity at all periods — Fig. 3(c). For the interpretation of the NEW data JAIN and WILSON's model *A* for Eskdalemuir was used as a first model and by manual iteration several models giving better agreement between observed and theoretical apparent resistivity amplitudes and phases were obtained. All the models which satisfied both the amplitude and the phase data required a good conductor (about 40 Ω m) at lower crustal depths. Inversion of the data from this station [6] has shown more generally that the class of models which fit the NEW observations suggests that there is a region of high conductivity with its top interface at a depth in the range 20—40 km. It is interesting to note that an anomalous seismic layer appears to exist in the region of this proposed lower crustal conductor [1].

Acknowledgement

The support of this project by the Natural Environment Research Council is gratefully acknowledged.

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МАГНИТОТЕЛЛУРИЧЕСКОЕ ИССЛЕДОВАНИЕ ЭСКДАЛЕМУИР АНОМАЛИИ — ПРЕДВАРИТЕЛЬНЫЕ РЕЗУЛЬТАТЫ

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РЕЗЮМЕ

В течении 1974—75 гг. провели магнитотеллуические изменения на 13 станциях параллельно с простиранием аномалии проводимости Южной Возвышенности Шкотландии и вдоль перпендикулярных к ним линии. На каждой станции регистрировали данные, находящиеся в области 10—1200 мин. и на 9 станциях получили данные, относящиеся к длиннопериодным изменениям. Наблюдения, проведенные вдоль профиля СЗ—ЮВ-го направления, анализировали с помощью авто- и поперечноспектральной техники. Результаты укрепляют наличие аномалии на этой территории и указывают, что её основа находится на СЗ-де и ЮВ-ке в глбине.