LETTERS TO THE EDITOR

GEOPHYSICS

Nuclear Explosions and Normal Mode Oscillations of the Earth

THE article in *Nature*[1] under the title "Recent Nuclear Explosions and Earth Tides" suggesting that nuclear explosions can excite the normal mode oscillations of the Earth needs careful reconsideration.

The free oscillations of the Earth, though theoretically predicted even in the nineteenth century, have been experimentally observed only on two occasions. The first observation was by Benioff *et al.*[2] when they reported fifty-seven minute waves on strain seismograph records after the Kamchatka earthquake of November 4, 1952. The great Chilean earthquake of May 22, 1960, also caused very noticeable oscillations and several of the spheroidal and toroidal modes of the Earth were detected and identified from gravity meter and strain seismograph data. Ness, Harrison and Slichter[3] used a very high resolution La Coste–Romberg gravity meter with the smallest measurable signal of the order of 0·023 microgal (r.m.s. noise figure) to record the Chilean earthquake and detected several of the spheroidal modes (only these are observable on gravity meters) in the period range of 3–55 min. Many other observational and theoretical discussions on the subject have appeared and a comprehensive bibliography is given at the end of the masterly discussion on toroidal oscillations of the Earth by MacDonald and Ness[4].

The energy demand to excite normal mode oscillations of the Earth is enormous and hence only very large earthquakes cause noticeable effects and even then very sensitive instruments are required to detect them. The Kamchatka earthquake had a magnitude of 8·25 and the Chilean earthquake was even bigger with a magnitude of 8·75. These magnitudes correspond to an energy release of the order of 10^{27} ergs. The largest nuclear bomb exploded so far communicated energy of the order of 10^{20} ergs (magnitude of equivalent earthquake, 5·5–5·75) to the ground. It will indeed be an 'earth-shaking' effect if this small amount of energy (relatively speaking) can excite free oscillations of the Earth.

One should not lose sight of the fact that gravity meters and vertical seismographs are very sensitive to barometric fluctuations, and whether the Askania gravity meter referred to in the note in *Nature*[1] could be the exception is a point worth investigating.

H. M. IYER*

Meteorological Office,
Bracknell, Berks.

* Gassiot Fellow in Seismology.

[1] *Nature*, **194**, 342 (1962).
[2] Benioff, H., *et al.*, *Trans. Amer. Geophys. Union*, **35**, 979 (1954).
[3] Ness, N. F., *et al.*, *J. Geophys. Res.*, **66**, 621 (1961).
[4] MacDonald, G. J. F., *et al.*, *J. Geophys. Res.*, **66**, 1865 (1961).

WHILE reporting the effects of nuclear explosions on the gravimeter installed in our laboratory, it was mentioned that possibly sometimes the free oscillations of the Earth could also be observed. It is obviously necessary that an adequate amount of energy will have to be communicated to the Earth for this to occur and in order to identify these oscillations the records have to be harmonically analysed. This is now being done.

The instrument is pressure-tight and shows a change of less than 0·05 mgal. for pressure variations corresponding to a difference in height of 500 metres. The observed changes in g are much greater than this and hence may not be attributed to the pressure fluctuations.

S. BALAKRISHNA

Department of Geology,
Osmania University,
Hyderabad, 7.

Annual Change in the Declination ('Variation') in Western Scandinavia and the North Sea

THE annual change (secular variation) for about 10 years (1941–52) in the declination was remarkably constant, namely + 8′ (E.), for Norway, Denmark, Sweden and also for the North Sea (Lerwick, Shetland). However, starting in 1952, there has been a gradual decrease in the annual change, and for the period 1952–60 it was about + 5′ (dropping from 8′ to 4′). Fig. 1 gives the secular change for three magnetic observatories, Lerwick (Shetland), Rude Skov (Denmark) and Tromsø (Norway). For Rude Skov it may be seen that there is a gradual decrease, disregarding scatter, from 11′ to 4′ during the period 1927–60, apart from the temporary stagnation mentioned here. The same tendency may be shown for

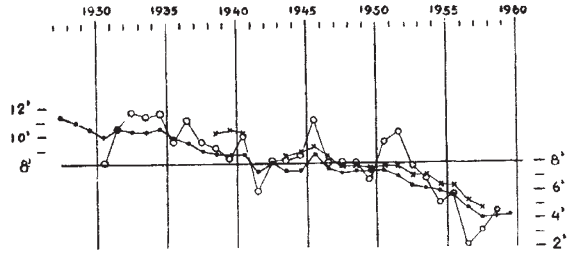

Fig. 1. Annual secular variation in declination for the observatories in Lerwick (Shetland) (×), Rude Skov (Denmark) (●) and Tromsø (Norway) (○)

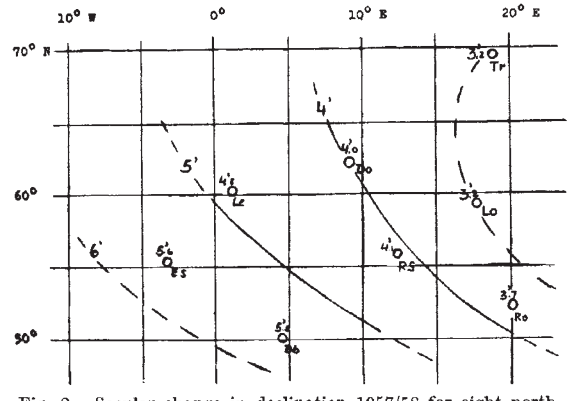

Fig. 2. Secular change in declination 1957/58 for eight north European observatories