LETTERS TO THE EDITORS

RADIOPHYSICS

Effect of External Conditions on the Phase of Radio Signals

THE emissions at 16 kc./s. from the Post Office *GBR* transmitter at Rugby are in the form of interrupted continuous waves and are used for purposes which include the international co-ordination of standards of frequency and time and studies of propagation[1–3] by comparing the phase of the received signals with that of a local reference source. The relative observed phase of the carrier wave will change, due to changes in the rates of the controlling reference oscillators, to varying radio propagation and to phase changes in the transmitter. Some investigations have been made of the latter by comparing the phases of the aerial current and the carrier source.

We have found that phase aberrations can be caused by the following:

(1) Detuning of the low-decrement aerial by changes of weather conditions and by aerial sway. Throughout November and December 1960, phase shift was recorded during typical weather including gales and icing conditions. Slow changes of phase of 20° or more were observed on several occasions, and once a change of up to 60° in a 2-hr. period would have occurred but for manual re-tuning, which was carried out when the phase had changed some 20°. Aerial sway produced fluctuations of 12° with periods of 1–2 min. Throughout the period of observation the aerial circuit was slightly out of tune (more than 7° shift in phase) for 32 per cent of the time and noticeably out of tune (more than 13° shift) for 2·2 per cent.

(2) Fluctuations in the inductance of the aerial tuning inductors caused by mechanical forces between coupled turns set up by the current. The natural period of the fluctuations is about 3 c./s., but their magnitude is largely determined by the nature of the keyed signals. During the mark signals of normal telegraph traffic, we have observed a random fluctuation of about 7°. The seconds pulses of the time signals cause only a small phase variation from pulse because the off/on ratio has a constant value of 9. A gradually increasing current up to the maximum of 800 amp. under conditions of continuous mark produces a change of 8° corresponding to a change of inductance of 0·07 per cent.

(3) Phase changes in the amplifiers during a mark. The transient electrical and thermal effects in the class *C* amplifiers produced a phase shift of about 30° during the build up of the mark, which takes about 20 msec. to reach 90 per cent amplitude in the aerial. At the end of the mark the aerial, being unloaded by the amplifier, oscillates freely and the phase of the aerial current changes by more than 360° during the decay.

With methods of measurement at present in use, only phase changes under heading (1) would be likely to be observed at a distance. Accurate frequency comparisons are made after integrations of phase during multiples of 24 hr. to remove the diurnal propagation effect[3], but this could include a phase error due to changes of aerial tuning which might amount to 60°, equivalent at 16 kc./s. to 10 μsec. or a little more than 1×10^{-10} in 24 hr. Automatic aerial tuning and other phase-correcting devices now being actively considered, besides keeping power more constant, would reduce this possible error. It would also hold more constant the over-all response of the transmitter to transients and enable more accurate determinations to be made of epoch from time-signal transmissions.

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[1] *Nature*, **174**, 922 (1954).
[2] *Nature*, **177**, 178 (1956).
[3] *Nature*, **187**, 914 (1960).

GEOPHYSICS

Age Measurements on Antarctic Rocks (Queen Maud Land)

WE wish to report here the results of absolute age measurements carried out on rocks from the Sör-Rondane Mountains. These mountains, extending from 23° E. to 28° E. in Queen Maud Land, were explored in 1958 in the course of the Belgian Antarctic Expedition led by Gaston de Gerlache[1]. Preliminary accounts of the geology and of the petrography of this region have been published[2,3] already.

We have measured rubidium–strontium ages on biotites obtained from various types of rocks: 'intrusive' granite and diorite, gneiss and migmatites, granitic and pegmatitic veins. The procedures for the determination of rubidium-87 and strontium-87 were similar to those described by Aldrich *et al.*[4]. The isotopic ratios were measured with a 33-cm. radius of curvature mass-spectrometer equipped with an electron multiplier. The analytical error of the concentrations is between 1 and 3 per cent, resulting in an uncertainty of ± 15 million years in the calculated ages. The analytical data and the resulting age appear in Table 1. The geographical names refer to the map of the Sör-Rondane Mountains, published by the Norsk Polarinstitutt, during 1957.

The results indicate that the biotites are all the same age, ~475 million years, which corresponds in the stratigraphic scale to a Lower or Middle Ordovician age.

Ravitch and Krylov[5] carried out argon–potassium measurements on rocks occurring in the mountains situated west of our region. Their data yield ages ranging from 410 to 500 million years by using the values: $\lambda_\beta = 4{\cdot}72 \times 10^{-10}$ yr.$^{-1}$ and $\lambda_e = 5{\cdot}85 \times 10^{-11}$ yr.$^{-1}$ for the decay constants of potassium-40.

On the other hand, Nicolaysen *et al.*[6] report rubidium–strontium ages of ~515 million years for biotites from pegmatites and charnockitic gneiss occurring near Lützow-Holm Bay, on the eastern limit of Queen Maud Land.

Our data around 475 million years refer clearly to the last major metamorphic episode in Queen Maud