SELENOLOGY

Lunar Seismology

from a Correspondent

A CONFERENCE on geophysical and geochemical exploration of the Moon and planets was held at the Lunar Science Institute, Houston, Texas, on January 10 to 12. Although most of the contributions concerned the Earth-based research that had been pursued in recent years, some of the results presented were obtained from the Apollo programme, and there were even some very preliminary data from Apollo 17.

The first contributions, presented by Drs G. Latham and M. N. Toksöz (University of Texas, Galveston) and others, were concerned with the very interesting picture of seismicity that is emerging from the four Apollo seismograph stations now operating on the Moon. It seems that although the Moon is very seismically inactive by comparison with the Earth there is sufficient natural activity (arising from surface impacts and internal sources) for it to be possible to draw a firm outline of the Moon's internal seismic properties within the expected lifetime of this network. Judged as yet only by a very remarkable repetition of the waveforms of discrete events in the seismograms, some forty internal sources that must be very precisely located have now been identified. Only a few of these sources have been given a position within the Moon, but they all seem to be in a zone 600 to 1,000 km deep and there is some evidence that they tend to be immediately below the boundaries of the maria that are associated with mascons. In spite of the primitive state of the data there was talk of this seismicity being the result of mascons dropping back into the Moon—the whole process being triggered by the tidal effects of the Earth. In this connexion it is interesting that the results of laser altimetry from orbiting spacecraft presented by Dr W. R. Wollenhaupt (NASA, Houston) have shown that the sites of mascons are among the lowest places on the Moon's surface. From the study of a few impacts on the far side Dr Y. Nakamura (University of Texas, Galveston) reported that there seems to be a region of relatively high attenuation, with Q no greater than that of the Earth's upper mantle, below a depth of (approximately) 1,000 km.

Problems relating to the character and origin of lunar magnetism continued to attract attention. Information returned from the Apollo 15 and short-lived Apollo 16 sub-satellites travelling in near equatorial orbits, and presented by Dr P. J. Coleman (University of California, Los Angeles), shows that there is a highly structured lunar magnetic field (length scale tens

to hundreds of kilometres) detectable at heights generally less than 100 km. This ties up with the few spot readings taken on the surface. As with the surface topography there seems to be a systematic difference in the character of this field on the near and far side, and there was continuing debate about the way such a field will influence the interaction of the solar wind throughout a synodic month. The cause of this field can be reasonably attributed to the observed remanence of the surface rocks, but the origin of that remains undecided. It only need be added that the discovery of high attenuation in an extensive central region of the Moon, combined with the celebrated lunar reverberation, makes the problem of demonstrating seismically the existence of a small dense core suitable as a site for a lunar dynamo that much more difficult. More results were presented by Dr T. Nagata (University of Tokyo) and Dr G. R. Olhoeft and his colleagues (NASA, Houston) on the electrical conductivity of lunar material under conditions relevant to the inter-

pretation of very shallow and deep electromagnetic sounding of the Moon. Although in the earliest measurements on lunar rocks it seems that enough attention was paid to oxidation of the samples at high temperatures, the latest data do not affect the earlier result that the temperatures deep within the Moon may be no more than 1,000° C.

Interesting contributions were given by Dr C. R. Chapman (Planetary Science Institute, Tucson) and Dr T. B. McCord (MIT) on the analysis of the surface material of various bodies in the Solar System by spectrometric analysis of reflected light. There seems to be enough structure in some of the spectra to indicate differing compositions among the asteroids—some with no meteoritic equivalent. The absence of structure in the spectra of some of the largest asteroids is similar to that of basalt, and suggests that some of these may be chemically differentiated. There were also contributions on the interpretation of photographs of the Martian surface taken on the recent Mariner 9 flight.

Nigerian Thermal Plume Traces

IN next Monday's *Nature Physical Science* (March 5), van Breemen and Bowden report systematic geochronological data in respect of four Nigerian subvolcanic granites. These support the idea that igneous chains are thermal plume traces on moving lithospheric plates.

The non-orogenic granitic ring complexes of the Nigeria-Niger province, which form a narrow intrusive zone about 1,300 km long down longitude 9° E, fall into three geographical groups near Air, Zinder and Jos, respectively (see map). The central Nigerian complexes around Jos have previously been taken to be close to 160 million years old. The new, more detailed rubidium-strontium studies of van Breemen and Bowden, however, give a geographical pattern of ages ranging from 117 m.y. for the Liruei complex (c on the map), through 167.5 m.y. for the Amo complex (f) to 156 m.y. for the Pankshin complex (h). If this age range is taken to be the result of a plume trace, there is a clear implication here that at the relevant time Africa drifted northwards at a rate of about 0.76 cm a year—a conclusion which contradicts the suggestion from Burke and Wilson (*Nature*, 239, 387; 1972) that Africa underwent a Mesozoic standstill.

Van Breemen and Bowden then discuss the consequences of the assumption that the other Nigeria-Niger granite complexes reflect plume traces. For example, the rate of 0.76 cm per year extrapolated to northern Air gives an age of about 300 m.y., which agrees with unpublished potassium-argon age

determinations, although extrapolation to other granites at Hoggar, further north, leads to a discrepancy of about 200 m.y. between predicted and observed ages. Another feature of the Jos area granites which requires explanation is the two different trends represented by *a-d* and *i-k*, on the one hand, and *c-h* on the other. Van Breemen and Bowden tentatively suggest that these changes in trend reflect changes in the direction of Africa's motion relative to the breakup of Pangea.

Some geologists have related the Nigerian granites to a plume now thought to lie beneath Ascension Island, although there is apparently no seamount chain linking the island to Nigeria. Van Breemen and Bowden end by showing that palaeomagnetic data, plate tectonics and the motion of Africa predicted from the postulated Nigeria-Ascension Island plume trace are consistent, suggesting that little polar wandering has occurred since the mid-Jurassic.