small coronal discharges from surrounding vegetation but it seems very unlikely that enough free charges could be deposited by the fireball passage to explain the noise. The origin of auroral noise is still a mystery.

Considerable radiation must be produced by the fireball in regions of the electromagnetic spectrum other than the visual and this could provide a possible explanation. Electrophonic sounds for example have been heard by people exposed to beams of low powered radar sets. These have been described as buzzing, clicking, hissing or knocking sounds and seem to depend on the transmitter characteristics. An electromagnetic power density as low as 400 μW cm^{-2} can be heard, but only by people whose audible hearing by air or bone conduction was good above 5,000 Hz. Perhaps radio frequency electromagnetic waves are acting directly on the brain or inner ear. There are distinct similarities between electrophonic noises and anomalous sounds from fireballs but the production mechanisms of both are still unknown.

With luck the bariophonic recorders will pick up examples of anomalous noise as well as the more normal meteor sounds and help solve this problem also. One snag is that anomalous noise seems to be associated with brighter fireballs (average magnitude −13) which are rare objects indeed.

Plate tectonics and general relativity

from Peter J. Smith

THE mechanism responsible for the movement of lithospheric plates over the Earth's surface is a subject of continuing debate. The majority view is that plate tectonic processes are related to convection in the mantle, although there is less agreement about whether convection is the prime mover or a secondary consequence. If the prime mover, convection would be directly responsible for the motion of the overlying plates, and that of ocean floors in particular; but it is also possible to envisage that plates drift for other reasons (for example, by sliding under gravity) and that 'convection' arises from the need to complete the flow patterns at depth. The latter hypothesis bears some resemblance to the minority view of Van Bemmelen (*Tectonophysics*, **1**, 385; 1965) and others, whose 'undation theory' proposes that selective high radioactive heating in the mantle produces warping of the overlying crust followed by lateral spreading under gravity.

But whatever the disagreements over causes, there is general consent that plate tectonic processes are long term phenomena with characteristic time scales of at least hundreds of millions of years. By contrast, the high seismic activity which defines the locations of plate boundaries is sometimes claimed to have much shorter periodicity of about 11 years (see, for example, Simpson, *Earth Planet. Sci. Lett.*, **3**, 417; 1967). Machado (*Geol. Rund.*, **64**, 74; 1975) has now drawn attention to another example of this supposed periodicity—in the seismicity of the Azores—which he finds 'informative'. What makes the Azores particularly interesting is that they lie at the triple junction of the American, African and Eurasian plates and are thus presumably influenced both by the constructive margin forming the mid-Atlantic ridge and by the destructive margin along the Eurasian–African boundary. Machado finds that the 11-year variation in earthquake frequency is apparently present in data both from the islands of Fayal and Pico and from the islands of Terceira and San Miguel. But there is a difference in that the main seismic swarms on the two pairs of islands alternate, the main Fayal–Pico swarms being associated with crustal expansion (constructive) and the main Terceira–San Miguel swarms being associated with contraction (destructive).

Machado generalises from this example by suggesting that expansion and contraction perhaps alternate within an 11-year cycle everywhere. He then goes on to propose that this alternation could be due to 11-year pulsations in the gravitational constant (G). Indeed, he does more than propose; he claims to show mathematically that gravitational pulsations are a necessary consequence of general relativity within an expanding Universe. The physical effect of such pulsations would be alternate expansions and contractions not only of the Earth's lithosphere but of the whole interior. During an expansion phase, rifting would take place at oceanic ridges and mantle material would rise to fill the fractures; during the subsequent contraction phase, excess lithosphere would be forced downward at subduction zones. The net effect would be a drift of the plate; but as envisaged by Machado, the mechanism avoids the paradox implicit in attempting to explain apparently simultaneous expansion and contraction by a variation in G. In fact, there is no simultaneous expansion and contraction; each process takes place over alternate 5.5-year half cycles.

It is difficult to know how far to pursue an idea such as this. Is there really an 11-year periodicity in worldwide seismicity? And if so, do worldwide constructive and destructive processes alternate over half-cycles within each cycle? On the other hand, it would perhaps be unwise to reject the idea of short-period gravitational fluctuations out of hand. The idea of a long term decrease in G has a long and distinguished history; and there is still a lingering suspicion in some quarters that gravitational variations may ultimately be found to account for the Earth's mobility as manifested at the surface by activity at the three types of plate boundary.

Folding proteins along the dotted lines

from Barry Robson

THE relation between the amino acid sequence and conformation of a globular protein is as yet imperfectly understood. But the fact that many proteins can spontaneously fold into their biologically active conformations suggests that computer simulation of the folding process would be likely to throw considerable light on that relation. An interesting technique for carrying out such a simulation has been proposed by Levitt and Warshel in *Nature* (**253**, 694; 1975).

The work of Levitt and Warshel may be considered as an extension of the study by Ptitsyn and Rashin (Preprint, Acad. Sci, USSR., 1973; *Dokl. Acad. Nauk SSSR*, **213**, 473; 1973). Certainly both investigations neglect the polypeptide backbone of the protein, and treat the amino acid side chains essentially as simple single-centred structures with interaction energies calculated from amino acid solubilities in ethanol. In both cases, therefore, emphasis is placed on the hydrophobic interaction between side chains as the principal driving force towards a biologically active conformation. The more recent study, however, is considerably more ambitious. Ptitsyn and Rashin confined their attention solely to the amino acid residues within the extensive α-helical regions of myoglobin, and fixed the conformation of these residues as α-helical from the outset. Levitt and Warshel, on the other hand, propose a technique in which the backbone is free to adopt any conformation.

The problem of manipulating the backbone without having to represent it in detail is overcome by the ingenious use of a device due to the Flory school (P. J. Flory, in *Statistical Mechanics of Chain Molecules*, 248–306, Wiley, New York, 1969). Flory replaced the actual molecular bonds of the backbone by virtual bonds connecting the α-carbon atoms at the base of each side chain. Each virtual bond, represented in the publications of the Flory school as a dotted line, substitutes for one fixed