SELENOLOGY

Solar Wind Interaction

from our Geomagnetism Correspondent

ALTHOUGH there is no evidence to suggest that there is a significant lunar magnetic field at present, the Moon certainly seems to have possessed such a field at some time in the past. A magnetic intensity of 38 ± 3 gammas was recorded at the Apollo 12 landing site, for example; and rock samples brought back by both Apollos 11 and 12 have been found to contain magnetization. Both of these pieces of evidence show that some parts of the Moon are permanently magnetic—a phenomenon which requires the existence of a magnetic field at the time the particular rocks were formed. But there is also another likely consequence of permanent magnetism on the Moon, as Mihalov *et al.* point out (*Science*, **171**, 892; 1971). The magnetic fields set up by the permanently magnetic rocks should, if large enough, deflect the charged particles of the solar wind which impinge on the Moon. The existence of any such deflexion will thus be further evidence for magnetic lunar rocks, assuming that other possible explanations can be ruled out.

Because there is no overall lunar magnetic field the Moon does not, of course, have a magnetosphere like the Earth; but, as the Explorer 35 results showed, there is a diamagnetic solar wind cavity behind the Moon which is bounded by a rarefaction wave. Mihalov *et al.* have found that adjacent to this wave there are sporadic but persistent maxima in the interplanetary magnetic field. If these maxima are produced by sources on the Moon itself (this is, of course, an assumption) then it is likely that the sources lie around the boundary of the Moon's hemisphere struck by the undeflected solar plasma. This is merely the result of the fact that the perturbations along the edges of the cavity formed by the Moon are most likely to be caused by effects at the edge of the lunar disk as "seen" by the solar wind moving outwards from the Sun. And given that the sources lie around the lunar boundary, it is possible to extrapolate the field maxima backwards to determine just where on the lunar surface the interactions with the solar wind take place.

Mihalov and his colleagues thus show that most of the lunar sources lie on the far side of the Moon and therefore by implication in highland regions rather than in the maria. The two largest, for example, each about 10^5 square kilometres in area, lie at about 0°–15° S, 165°–180° E and 15°–30° S, 135°–150° E, respectively. They do not therefore seem to be related directly to the mascons which tend to lie in the centres of ringed maria on the near side of the Moon.

What then is the nature of these supposed lunar sources? Obviously they could be regions of permanent magnetism; but are there any other possible explanations? Mihalov and his co-workers actually consider several but rule them out as being less likely than permanent magnetism. One possibility is transient electromagnetic induction effects in the Moon's surface layer. It is known, for example, that overall electromagnetic induction in the Moon amplifies a part of the solar wind by a factor of up to 4; but the observed magnetic perturbations would have to be produced in regions where the lunar "crust"—as defined by low electrical conductivity—was thin. This is just the opposite of what would be expected from the locations of the sources. The highlands are thicker than the maria and thus on this basis are less likely to be the source of induction effects. Electromagnetic induction in conducting "islands" in the lunar crust can also be ruled out, according to Mihalov *et al.*, as can steady unipolar generators. A further possibility would be the effect of neutral gas outlets producing charge exchange. But there is no evidence of tectonic or volcanic processes which might be accompanied by gas escape, least of all in the lunar highlands.

If the perturbations in the interplanetary magnetic field near the Moon's solar wind cavity really are the result of lunar interactions, the most likely explanation is thus permanent magnetism. This is so not only because other explanations are found wanting but because there is independent evidence for the existence of permanently magnetic rocks on the Moon.

INSECT CUTICLE

Hardening Mechanisms

from our Insect Physiology Correspondent

THIRTY years ago it was suggested by Pryor that the horny substance of the insect cuticle is protein sclerotized by a reaction formed between amino-groups in the cuticular proteins and quinones formed by the oxidation of catechol derivatives secreted into the cuticle. There is now much experimental evidence to support this hypothesis. According to Karlson and Sekeris and

---

Structure of Polyacrylamide Gels

ALTHOUGH polyacrylamide gels have been used extensively by biochemists over the past decade for the separation and characterization of macromolecules, there have been almost no attempts to determine their basic molecular architecture. A step in this direction has been made by Richards and Temple, a report of whose work appears in next Monday's *Nature Physical Science*.

Polyacrylamide gels are prepared by mixing a monomer (acrylamide) with the crosslinking agent (N,N′-methylenebisacrylamide) in the presence of a polymerizing agent. The effect is to produce an insoluble three-dimensional network of monomer chains joined together by bridges. In water this network becomes hydrated—hence the term gel—as a result of the presence of the amide group. By choosing a suitable total concentration, *T*, or monomer plus cross-linking agent in which the proportions, *C*, of cross-linking agent to monomer is defined, it is possible to obtain a gel in which the holes or pores in the three-dimensional network are of similar size to, say, an average protein molecule. This gel can then be used as a molecular sieve to separate protein molecules of a given size range. Variations of the two parameters, *T* and *C*, also affect the physical properties of the gel, in particular its elasticity, turbidity and tendency to swell in excess solvents. Richards and Temple have measured the turbidities and swelling factors of a series of gels of varying *T* and *C* and propose a model of gel structure to account for their observations.

They define an ideal gel as one in which each bridge is connected to its four nearest neighbour monomer chains so that there are no free ends, loops or entanglements. Assuming a random spacial distribution of bridges for any given *C*, a value of *T* (called T_0) corresponding to an ideal gel can be calculated. If $T>T_0$ a crumpled gel is obtained in which there is too much monomer and the chains are less extended. Crumpled gels approach ideal gels if allowed to swell in excess solvent. If $T<T_0$ a clustered gel is obtained in which the monomer concentration is too low and the distribution of bridges is non-random and clustered.

For both clustered and crumpled gels Richards and Temple have calculated the effect of *T* and *C* on the swelling factor and turbidity and the theoretical curves agree qualitatively with their experimental data. In practical terms their results allow a choice of gel composition to optimize the desirable gel properties (such as ease of handling and low turbidity) and still produce a gel which approaches their ideal structure. To this end they recommend gels in which $C=5$ per cent. In clusters this is the value which has been most extensively used and is known to give the best sieving properties.