sidered the earlier suggestion of Roseman (*Chem. Phys. Lipids*, **5**, 270–297; 1971) that recognition of cell surface sugar sequences may involve surface-located glycosyl transferases. These enzymes normally carry out reactions using oligosaccharide sequences as acceptors. The basic idea is that adhesiveness between cells is achieved by formation of an abortive or non-productive enzyme–substrate complex.

What McLean and Bosmann have done is to assess the ability of intact gametes of either mating type to utilise sugar nucleotide precursors in glycosyl transfer. It is argued that since the nucleotides do not permeate intact and viable cells, any transfer must involve participation by enzymes present at the cell surface. A wide variety of sugar transfer reactions involving galactose, mannose, N-acetylglucosamine, sialic acid, glucose and fucose were detected on *Chlamydomonas* gametes in this way. Transfer takes place on to endogenous glycoproteins presumably also located at the surface of the same or adjacent cells in positions accessible to the enzymes. McLean and Bosmann suggest that the glycosyl transferases and acceptors may be a contributing mechanism in gametic recognition and adhesion in *Chlamydomonas*. Thus, the sugar transfer reactions are enhanced several fold when gametes of opposite mating type are mixed. This interesting result indicates that one or both of the components of the putative recognition system (glycosyl transferase and its glycoprotein acceptor) are present in limited amount at the surface of gametes of either mating type and maximal complex formation involves adjacent cells of opposite mating type. It is assumed of course that such experiments measure surface-located reactions rather than simply reflecting damage to the cells by the conditions of incubation and the revealing of intracellular biosynthetic sites. Though this assumption is still unproven the preliminary results encourage the further use of the *Chlamydomonas* sexual system to define more precisely the recognition mechanisms operating between cells.

Lunar and terrestrial fields

from Peter J. Smith

It is far more difficult to obtain reliable ancient field intensities from rocks than it is to determine valid palaeomagnetic directions. Yet although the study of directions has proved to be the more fruitful on Earth, in the case of the Moon constraints on origin and evolution are far more likely to be derived from field magnitudes. The reason for this is partly one of sampling, for it would be difficult to determine the shape of the ancient lunar field from the few, thinly distributed sites sampled so far even if all the rocks collected had been oriented. Moreover, as continental drift has no relevance to the Moon, one of the most important uses for terrestrial palaeodirectional data has no lunar equivalent. The determination of palaeointensities, on the other hand, requires neither orientation nor dense geographical coverage. It may be true that a complete interpretation of magnitude data requires information on the corresponding field shape, but the lack of such information is not unduly restricting. For a dipole field, for example, field intensities vary by a maximum factor of only two (equator to poles).

The problem with this analysis, however, is that it assumes that the field intensities are actually determinable, whereas in practice this is only so for a relatively small proportion of samples. Moreover, as Hoffman and Banerjee (*Earth planet. Sci. Lett.*, **25**, 331; 1975) have now discovered, there is a whole class of lunar rocks (with no terrestrial analogue) having properties which "could easily render any palaeointensity determination of little value". When subjected to partial alternating frequency demagnetisation, certain crystalline rocks and breccias are found to have intensities of magnetisation which are non-reproducible at given a.f. fields; and in such cases the graph of natural remanent magnetisation against a.f. peak field has an unusual 'zig-zag' pattern. This behaviour has now been observed to varying degrees in many lunar rocks, and raises questions both as to its cause and as to the effects it is likely to have on the picture of the ancient field the rocks potentially provide.

As to cause, Hoffman and Banerjee have used both a.f. and thermal techniques to carry out a thorough study of lunar olivine basalt sample 15535—a rock in which the zig-zag behaviour is particularly marked. Perhaps the most surprising fact to emerge is that a substantial fraction of the total remanence in the basalt (that part responsible for the zig-zag pattern, in fact) is apparently confined to a single plane but is loosely pinned within that plane. When a.f. demagnetisation is carried out to a particular peak field, this 'zig-zag remanence' can take up any direction within the preferred plane; and when repeated demagnetisations are carried out at the same field, the zig-zag remanence will generally end up in a different direction each time. The remanence also varies in magnitude (hence the zig-zag), although neither peak a.f. fields of 1,000 oersted nor moderate temperatures are sufficient to remove it completely.

The conclusion that Hoffman and Banerjee come to is that a high proportion of the basalt's total remanence is carried by a few large disk-shaped multi-domain grains which are aligned by the local magnetic fabric. Whether the same can be said for all other lunar rocks exhibiting zig-zag behaviour is not yet known. But if the loose pinning of remanence to a plane is a common feature, it follows that conventional methods of palaeointensity determinations are likely to be useless. The Thellier method, for example, depends on a comparison of natural and thermoremanent magnetisations which have had a similar history of demagnetisation. If a large component of the natural magnetisation is ultimately undemagnetisable or behaves at all randomly under demagnetisation, the technique collapses.

Fortunately, this phenomenon is unknown in terrestrial rocks, although palaeointensity measurements are often precluded by a multitude of other problems. Nevertheless, using his new anhysteretic remanent magnetisation technique, Shaw has managed to obtain some interesting ancient field intensity data from the R_3–N_3 polarity transition as recorded in the rocks of western Iceland (*Geophys. J.*, **40**, 345; 1975).

The results show that as the transition progressed from the fully reversed state to the fully normal state the field intensity generally decreased to very low values and then increased again. The lowest intensity recorded was equivalent to about 4% of the present value. But not all the intermediate dipole moments were low. When the geomagnetic pole reached the geographic equator it apparently remained there for a time while the dipole moment rose smoothly to a value about 21% higher than even the present fully 'normal' value, and then decreased equally smoothly to the very low values preceding the increase to the N_3 state.

Shaw's interpretation of this remarkable phenomenon is that the Earth's magnetic field could well have a third metastable state (intermediate, in addition to normal and reversed) in which the pole is temporarily fixed and the dipole moment is large. In the short periods (transitions) between metastable states, by contrast, the pole position changes rapidly while the dipole moment is small. Because the intermediate state is likely to be short, examples will be difficult to detect palaeomagnetically; but if confirmed as a general feature of the geomagnetic field, it will clearly place an additional constraint on theories of field origin. It will be a long time before such fine points can be made in connection with the lunar field.