a hundred years time Patterson's work will stand much as it does now, a milestone in comparative palaeontology.

Palaeontologists keenly anticipate parts 2 and 3 of this work, which Patterson promises on the palate, lower jaws, gills, shoulder girdles and remaining dermal bones.

Icelandic layer 3 identified?

from Peter J. Smith

THE upwelling of magma to form new lithosphere at oceanic ridges is easy to envisage in general terms, but lack of access prevents any direct investigation of the detailed processes involved. In the study of constructive plate margins, the existence of subaerial conditions such as those of Iceland is therefore invaluable, even though by definition such environments are not entirely typical of oceanic ridge zones. Indeed, insofar as it may also lie above a rising mantle plume, Iceland itself may be even more atypical than it was considered to be in the days when only a single magma source was envisaged. But be that as it may, the few land masses astride ridges offer a unique opportunity of studying an important plate tectonic feature using more traditional geological techniques.

G. P. L. Walker began his extensive field studies in Iceland long before any of these ideas were conceived, let alone widely accepted; and over the years he has been able to throw much valuable light on the island's remarkable characteristics. But that much still remains to be learned is well illustrated by his latest report (*J. Geol. Soc.*, **131**, 143; 1975) in which he draws attention to the significance of a striking geological feature which has until now been largely ignored—the remarkable swarm of inclined basic intrusive sheets which cuts the Tertiary and early Quaternary volcanic pile along the south-east coast.

The swarm is impressive by any standards, being exposed over a zone of about 1,700 km^2. Over a third of that area the sheets comprise more than 10% of the total rock, and over their 100 km^2 of greatest concentration they account for more than 80% of the total. In all, there are tens of thousands of individual sheets with typical thicknesses of 0.2–2.0 m, chilled margins and thickness-related grain size (the thinnest sheets are basaltic, the thickest gabbroic). They increase rapidly in number down the dip, taking the concentration from less than 1% of the total rock at the top to more than 50% within a drop of only a few hundred metres. Moreover, the dip angle is itself closely related to the concentration of sheets, being less than 10° where sheets are scarce or absent but increasing to 35°–50° where they are most abundant. Lastly, and significantly, the direction in which the sheets dip is downwards towards the spreading axis—the same direction as the less steeply dipping country rocks.

How did this remarkable swarm originate? The answer, Walker argues, is by a very simple mechanism involving density contrasts between the Icelandic crust and the uprising magma. As basaltic magma rises, its density changes because of the onset of vesiculation caused by the exsolution of dissolved gases. Generally, this change (decrease) will take place at depths less than 1 km, but different batches of magma with different volatile or phenocryst contents and different chemical compositions will begin to decrease in density at slightly different levels within this range.

The presence of these variations raises the possibility that under certain circumstances different batches of magma may behave in quite different ways as they move up through the crust. For example, the variations could be critical if the density–depth profiles for the magma were close to that for the solid crust, which seems to be the case in the upper 4 km. Below a depth of about 4 km, the density of all the magma is undoubtedly lower than that of the crust, and so the magma will rise in that region. In the upper 4 km, however, where the magmatic and crustal density profiles are comparable, two possibilities arise. If the density of the magma never anywhere rises above that of the crust, the magma will continue its ascent until it reaches the surface and eruption results. On the other hand, if the magma density does rise above the crustal density at some point, the vertical progress of the magma will be there arrested.

Walker's proposal is that some of the magma does one thing and some does the other. In particular, the magma that reaches a level at which its density equals that of the surrounding crust then ceases to rise and, instead, moves away laterally along an equi-density surface as an intrusive sheet. An obvious difficulty with this view is that in practice the solidified intrusive sheets are not actually horizontal but are inclined away from the spreading centre with an inclination that decreases up the dip. However, there are several factors which could account for equi-density surfaces of variable slope, including a non-even distribution of dykes across the width of the active zone, temperature variations in the country rock and an infilling of the voids in the country rock by zeolites in certain areas. All three could contribute to density variations in the crust, although the dyke distribution is thought to be the most important. In addition, however, as the magma sheet rises up-slope its density will decrease, especially if vesicles begin to form, and so it may actually cross equi-density surfaces and move towards crustal rocks of lower density.

According to Walker, therefore, the existence of the swarm of inclined basic intrusive sheets may be explained in terms of processes at the spreading axis, albeit modified by the particular crustal environment through which the axis passes. But if that is the case, why are such sheets limited to this particular

Oceanic polarity test fails

from Peter J. Smith

IN view of the critical roles of magnetic anomalies and the geomagnetic polarity-time scale as evidence for seafloor spreading, it would be desirable to measure the magnetic polarities of as many oceanic rocks as possible. Unfortunately, most of the igneous rocks recovered so far from the ocean floor have been unoriented dredge samples. In some cases the tops of pillow lavas may be recognised; and this limited orientation is sufficient to allow polarity to be determined by conventional palaeomagnetic methods. But for the majority of samples for which this procedure is not possible, Irving (*Can. J. Earth Sci.*, **5**, 1319; 1968) devised a method of determining polarity which involved comparison of the coercive force spectrum of a rock's natural remanent magnetisation with that of an artificially induced anhysteretic moment.

As applied by Irving to five Cainozoic basalt samples of known orientation, the method seemed to work. And in a similar test, Brooke *et al.* (*Can. J. Earth Sci.*, **7**, 1515; 1970) obtained a success rate of 11 out of 12. But in a thorough study by Mohajer-Ashjai (*Can. J. Earth Sci.*, **12**, 62; 1975) on 20 lavas from Oregon and Mull, agreement between known and predicted polarities has been obtained in only 10 cases. Not surprisingly, Mohajer-Ashjai concludes that the Irving technique is not reliable enough. Although it is not completely worthless (since the probability of getting a 50% agreement purely by chance is less than 0.054) it seems that unoriented dredge samples will be of little use as a source of magnetic information about the oceanic crust.