

what is left when the strongest dipole reverses is the sum of the other two. But the problem is that suitable lavas which just happened to flow at the time of a reversal are rare—from the evidence so far it looks as if a reversal takes about 1,200 years, and to have good records means finding successions of thick lavas extruded over a few hundred years.

Two contributions on pulsars were summarized at the meeting by Professor F. G. Smith (University of Manchester). The first, by Dr B. J. Rickett (University of Manchester), was an analysis of the irregularities in the interstellar medium from the scintillations which they impress on the pulses. From observations at two radio frequencies and with various bandwidths, Rickett has been able to infer limits to the scale of the irregularities and the magnitude of the perturbations of electron density which they contain. Smith's own contribution was a further analysis of the relativistic beaming mechanism (see *Nature*, **223**, 934; 1969). Both contributions will appear in *Monthly Notices*.

SEA FLOOR SPREADING

Direct Magnetic Evidence

from our Geomagnetism Correspondent

THE magnetic evidence for sea floor spreading is usually indirect. The pattern of magnetic anomalies outward from a mid-oceanic ridge closely resembles the polarity-age scale derived from continental rocks for the past four million years; and the continental pattern is explicable only if reversals of the geomagnetic field have occurred. The implication then is that the oceanic pattern is due to normally and reversely magnetized segments of the sub-oceanic crust, which have spread outwards from the ridge axis.

Direct magnetic evidence, on the other hand, is rare. It can only come from a detailed palaeomagnetic analysis of the rocks which produce the anomalies, and these are usually inaccessible *in situ*. Dredge samples would suffice if they could be oriented, though usually this is not possible. Boer *et al.*, however (*Science*, **166**, 996; 1969), have managed to orient three dredge samples of pillow lava from the Reykjanes Ridge by examining their volcanic features, and thus show that the positive and negative oceanic anomalies are produced by normally and reversely magnetized rocks respectively. Because the Reykjanes Ridge lies in high northern latitudes, the polarity of dredge samples can be determined unambiguously from magnetic inclination measurements if only the top and bottom positions of the samples are known. In the three samples of pillow lava, positions were determined from their shape, the location of their necks and stems and the position of basaltic stalactites joined to them.

One sample was dredged from the region of the axial positive anomaly and gave a palaeomagnetic inclination of $+78^\circ \pm 3^\circ$. This compares with an inclination of $+74^\circ$ for the present field at the recovery site. The second sample, also from the central positive area, had a magnetic inclination of $57^\circ \pm 4^\circ$. This is about 17° too low although explanations are possible. The sample in question contained pahoehoe structures suggesting an original flow of higher than average fluidity which could, for example, have flowed on to

an inclined slope which later rotated because of block faulting.

The third sample, from the first negative anomaly, gave less convincing results. Its magnetic inclination was $-20^\circ \pm 5^\circ$ —certainly reversed, but about 50° lower than would be expected from a fully reversed field at the latitude of the Reykjanes Ridge. Such a large deviation is unlikely to result from block faulting or from non-dipole field components; but because the sample was dredged from close to the edge of the negative anomaly it could have been magnetized during the field transition from normal to reversed (Brunhes-Matuyama boundary). Nevertheless, the evidence from all three pillow lava samples strongly supports the origin of ocean magnetic anomalies in normally and reversely magnetized material beneath the oceanic sedimentary cover.

X-RAY ASTRONOMY

Race to Verify Iron Line

by our Astronomy Correspondent

IT now seems probable that 1970 will see the unequivocal detection of X-ray lines in the emission from a cosmic source, and the race is on to see who is going to be first. Leading the field is the Leicester group, planning an experiment for launch in March, but pressing hard on its heels is the group at Columbia University with an experiment which is believed to be scheduled for April. The group that has come closest to the prize so far is at the Goddard Space Flight Center, and its report is in the current issue of *Astrophysical Journal Letters* (Holt, Boldt and Serlemitsos, **158**, L155; 1969). In 150 seconds of observing time on the X-ray source Scorpius X-1 they found strong indications for line emission at energies of a few keV but add that conclusive evidence is still lacking. With the introduction of a new type of instrumentation in flights planned for the spring this year the gap ought to be filled.

The reason for the excitement, of course, is the anticipation of what a little detective work on a definite line spectrum could do for theories of the X-ray sources. In its brief history, Sco X-1, for example, has been considered to be a binary system, a neutron star, a white dwarf, or some other kind of supernova remnant. Looking at it simply there are two possibilities—either the prodigious X-ray output is the thermal emission of a gas at something like fifty million degrees which would peak in the X-ray part of the spectrum, or it is due to the synchrotron radiation which is the characteristic emission of high energy electrons controlled by a magnetic field. In fact, the observations favour emission by electrons with a thermal velocity distribution, but with the process of emission being the Bremsstrahlung process by which electrons retarded by the powerful magnetic field of another particle emit radiation. This model is again supported by the latest result from Holt *et al.*, although they are doubtful about how isothermal the source is.

The next step is to see whether the upper limits for the presence of line emission can be improved on in the band between 4 and 15 keV covered by the Goddard detectors, which includes the expected positions of several iron lines. Happily when the Goddard data are