Margon and Ostriker suggest that because of the small spread in luminosity about this limit, similar groups of X-ray sources in other galaxies could be used as 'standard candles', much in the same way as Cepheids have served till now.

Third, Dilworth, Maraschi and Reina argue that present observations do not rule out the possibility of a third class of low luminosity sources ($\sim 10^{32}$ ergs s^{-1}) which are at present indistinguishable from the isotropically distributed sources which are thought to be mostly extragalactic. This class cannot account for more than about 10% of these but could give rise to the rest of the galactic background emission.

PALAEOMAGNETISM

Past Secular Variation

from our Geomagnetism Correspondent

HISTORICALLY, palaeomagnetic data have been seen largely as indicators of the Earth's ancient dipole, rather than non-dipole, field. This is so whether they refer to the comparatively recent past, in which case the dipole orientation is given directly in terms of the Earth's geographic or geomagnetic coordinates, or to the more distant past, in which case the frame of reference is changed by continental drift and the dipole hypothesis appears as an assumption rather than as something to be determined directly from the data. In either case the scatter in measured palaeomagnetic directions arising from the effects of the much more rapidly varying non-dipole field is usually seen as an embarrassment, and is 'averaged out' mathematically from the results of a large number of rock samples.

But in recent years there has been a growing interest in the scatter itself, or rather in what useful information may be derived from what has traditionally been regarded as a nuisance. If the ancient non-dipole field introduces scatter or 'noise' into the palaeomagnetic dipole 'signal', the argument goes, it should be possible to work back from the scatter to determine the old non-dipole field. Unfortunately, the idea is more easily stated than put into practice because not all of the observed scatter is produced by the non-dipole field. Experimental error, local magnetic anomalies and dipole wobble may increase the scatter and incomplete sampling may either underestimate or overestimate it; and all these and other factors must be controlled or measured in order to assess what part of the scatter is truly due to the phenomenon under investigation.

Some of the difficulties involved are well illustrated in an attempt by Watkins (*J. geophys. Res.*, **78**, 7763; 1973) to determine the secular variation during the Brunhes epoch using lava flows from Réunion Island in the Indian Ocean region. This is not the first time that Réunion rocks have been used for this purpose. A few years ago, Chamalaun (*J. geophys. Res.*, **73**, 4647; 1968) measured the palaeomagnetic directions of forty-nine Réunion lava flows, obtaining what Watkins *et al.* (*Geophys. J.*, **28**, 1; 1972) later calculated to be an angular standard deviation of about 20° in the virtual geomagnetic poles (VGPs) with upper and lower confidence limits of 23.2° and 17.5°, respectively. But Chamalaun used an average of less than two samples per lava flow, and so his data could not be used to calculate, and hence remove the effects of, the within-lava variation. Cox (*Earth planet. Sci. Lett.*, **6**, 257; 1969) thus rejected the final result on the grounds that the sampling was inadequate to allow a true determination of the ancient secular variation; and the field was left open to a much more thorough investigation involving more intensive sampling.

By sampling at a level of at least six samples per lava flow, Watkins clearly hoped to be able to obtain a result which would overcome the objections of Cox and thus be accepted as a true estimate of the ancient secular variation. Accordingly he carefully collected and measured 160 cores which were restricted to the Brunhes epoch by the use of previous potassium-argon ages, field polarity measurements and known stratigraphy, and which were restricted to locations at which accurate orientation could be carried out with respect to known geographic bearings. For flows that did not have anomalous palaeomagnetic directions (three did), the angular standard deviation of the VGPs arising solely from secular variation (that is, after removing other contributions to scatter such as that due to within-flow variation) was 17.7° with upper and lower confidence limits of 22.8° and 14.4°, respectively—which is little lower than the standard deviation obtained by Chamalaun using less than two samples per flow and thus still much higher than that to be expected on the basis of the present field.

Taken at face value the new result seems valid enough. The range of known radiometric ages involved, for example, is about 0.4 million years or over half the length of the Brunhes epoch, suggesting that an adequate range of time has been sampled. On the other hand, if the Watkins result really is valid, its similarity to the Chamalaun result would imply that there is little to be gained by increasing the level of sampling to over six samples per flow. Although this is not impossible, it is intuitively unlikely and conflicts with some previous experience.

But what really throws doubt on the new result is the fact that the angular dispersion supposedly due solely to ancient secular variation is significantly higher than that due to the present field, and is, moreover, out of line with ancient dispersion results from other Indian Ocean islands such as the Comores Islands, the Crozet Islands and Amsterdam Island. This could, of course, be due to a regional secular variation anomaly which affects Réunion but not the other islands. Watkins believes it more likely, however, that an insufficient number of separate lava flows have been sampled, notwithstanding the long time range. Although he took over six samples from each flow, the total number of flows involved was eighteen compared with Chamalaun's forty-nine. Normally, eighteen intensively sampled flows might be expected to yield a valid result where forty-nine poorly sampled flows might not; and indeed Watkins's new value may turn out to be correct. Unfortunately, the level of doubt is sufficient to require yet another investigation involving not only high density sampling but a much larger number of flows.

SOLAR SYSTEM

Vulcan?

from a Correspondent

INSTRUMENTS aboard Skylab may detect an object moving in an orbit closer to the Sun than the planet Mercury, according to Henry Courten of Dowling College at Oakdale, New York. Courten has photographed the regions around the Sun regularly at total eclipses since 1966. During the 1970 eclipse in North America, one object was photographed near the Sun from three widely spaced observing sites. These images could be of a previously unknown member of the Solar System orbiting close to the Sun.

Courten believes a planetesimal "between 80 and 500 miles in diameter" moves in an orbit about 0.1 AU from the Sun. On his photographs, this appears as a star-like object between magnitude +7 and +9. Other images on Courten's plates indicate that a complete asteroid belt may exist between Mercury and the Sun.

Courten is a guest investigator on the Skylab white-light coronagraph experiment. "If intra-Mercurial, solar-orbiting objects exist, they will eventually pass through the coronagraph field of view", he says. The only problem is that the sensitivity of the Skylab instrument borders on the limit of brightness of Courten's photographic images.