ese and Americans in terms of the development of dilatancy in strained rocks, flow of fluids into the dilated region, the hardening of the rocks in dilated form and ultimately the release of strain by the rise of pore pressure along the fault. Both Drs Scholz and Whitcomb drew attention to a very striking correlation between duration of precursory phenomena and size of earthquake. If the correlation holds good in the light of further study it seems that a magnitude 8.0 earthquake would give tens of years of advance warning. In spite of the many questions this work raised during the meeting, particularly about the extent of its applicability, it is clear that earthquake prediction has seen a significant advance in the last year.

The problem of mantle hotspots underwent little resolution during the meeting in spite of many papers on the subject. Based on a suggestion by Professor J. Tuzo Wilson, Dr J. Morgan proposed three years ago that the long linear chains of volcanoes seen in many parts of the world are the consequence of the motion of plates over hotspots in the mantle. The fundamental questions seem to be four in number. (1) Do hotspots exist—that is, are there regions beneath plates where temperature is anomalously high? (2) Do hotspots have a permanence during geological periods of time? (3) Are they connected to any deeper expression of convection such as a rising plume of material? (4) Do they have a global influence on plate motions, that is, is a knowledge of hotspot characteristics necessary to an understanding of the driving forces of plates?

The surface evidence that "something is going on" is indisputable from the long island chains. It was very difficult, however, to perceive any compelling evidence from the many contributions that would cause the last three questions to be answered in the affirmative. There seems as yet to be no clear agreement on the definition of a hotspot (Morgan proposed ten; at this meeting it was suggested there might be hundreds). Evidence from the geological and geochronological record contains too many contradictions to be regarded as supporting wholeheartedly a positive answer to question (2). Very little was presented that bore on questions (3) and (4), but good papers were given by Dr J.-G. Schilling (University of Rhode Island) on the rare-earth geochemistry of ridges and plumes and by Dr B. Minster (Caltech) on the kinematic evidence for plate motions and consequent inferences on hotspot stability. It is, however, difficult to avoid the conclusion that the hotspot hypothesis is indeed no more than that and is in need of some stiff theoretical support as the observational material is so equivocal.

A sparsely attended session was devoted to the Earth Resources Technology Satellite. There can be more than one opinion of whether ERTS is yielding significant results but it was a disappointment that more did not come to learn for themselves whether ERTS has any uses for them. A particularly good technical introduction to ERTS was given by Dr S. Freden (NASA).

Perhaps the clearest impression with which one left the AGU meeting was one of vigorous controversy. There is disagreement about earthquake mechanisms, about plumes in the mantle, about the core-mantle boundary, about dilatancy in earthquake prediction and doubtless about all manner of other things.

METALLURGY

Superplastic Control

from a Correspondent

One topic of particular interest at present to physical metallurgists—grain boundary sliding—was the subject of a conference held at the University of Sheffield under the auspices of the Institute of Metallurgy on April 12. When a polycrystalline metal sample is deformed at relatively high temperatures, not only do the interiors of the individual crystals or grains deform (by well-understood mechanisms) to change shape consistent with the overall deformation but the grains also move bodily with respect to each other. The motion resembles the relative motion of peas channelled to pass through a funnel.

Dr D. McLean (National Physical Laboratory) opened the discussion at the conference by reviewing the evidence from elastic and anelastic damping measurements that grain boundary sliding results from motion of dislocations in the grain boundary in a manner similar to that in which lattice dislocations are responsible for plastic deformation of the grains. The situation is by no means clear cut, and different groups still have different concepts of the nature of dislocations in a grain boundary. This is surprising for, geometrically speaking, the position has been clearly defined by recent work of Dr W. Bollmann (Battelle Institute, Geneva). One indication of this lack of rigour in basic understanding is the proliferation of different nomenclatures for the differing concepts to accord with the various roles that the dislocations are expected to fulfil.

Some beautiful examples of dislocation arrangements in slid bicrystals of aluminium were shown by Dr C. A. P. Horton (Central Electricity Research Laboratories, Leatherhead). The electron microscope was again shown to be a vital metallurgical tool. It will surely lead to the definitive observations on the structural aspects of grain boundaries as it has already done for dislocation structures within the grains.

Grain boundary sliding is of great practical relevance in that the ease or not with which it occurs, relative to other mechanisms of deformation, controls the ductility of materials at high temperature. It is also intimately associated with the phenomenon of superplasticity (the occurrence of extended deformation before fracture). The difference in the behaviour of some commercial and non-commercial materials was illustrated in a presentation of some results on a 316 stainless steel by Dr R. S. Gates (Central Electricity Research Laboratories, Leatherhead) which revealed many unexpected features.

There is still controversy about how the most meaningful measurement of grain boundary sliding is to be made. Some sliding that does not contribute directly to the extension of the material may undoubtedly occur, whereas other sliding gives an independent contribution to the extension. It is only just being realized that the two contributions are evident in extreme forms in superplasticity and low temperature creep behaviour. It was clear from the animated discussion led by Dr G. B. Gibbs (Central Electricity Research Laboratories, Berkeley) that much thought and many more experimental observations on both commercial and non-commercial materials are needed before even certain conceptual problems of the sliding geometries can be finally straightened out.

It was of undoubted interest to metallurgists to learn during the course of the meeting that grain boundary sliding occurs in ceramic materials even though a superplastic ceramic is still in the realms of conjecture. Detailed information was provided by Dr P. E. Evans (University of Manchester Institute of Science and Technology) on alumina, zirconia and scandia and by Dr R. T. Pascoe (Central Electricity Research Laboratories, Leatherhead) on haematite iron oxide. In the field of ceramics the concept of dislocations in boundaries will have to be modified as the common structures are no longer preponderantly cubic as they are in metals. Furthermore, there are difficulties in interpreting both the activation energy and the stress dependence of the observed strain rates in these materials in terms of accepted mechanisms of creep deformation.

Clearly there is much still to strive for in this field. As yet a complete understanding of grain boundary sliding is some time away and much further work is required before the sliding characteristics of grain boundaries can be predicted and the desired improvement made in material properties.