ATPase. Using cultured 3T3 cells, E. Rozengurt (Imperial Cancer Research Fund, London), could separate the serum-induced stimulation of potassium transport from the increase in phosphate transport and also from the concomitant fall in cyclic AMP levels. The role of cyclic GMP (if any) in the control of growth is still obscure. Data presented by L. Jiminez de Asua (ICRF, London) showed that different stimuli can raise cyclic GMP in 3T3 cells to the same level and yet have very different degrees of mitogenic activity. This suggests that cyclic GMP is unlikely to be the sole trigger for increased growth.

Not all relationships between the cell's interior and the environment need be conducted with chemical messages, physical interaction is also feasible, possibly through proteins which span the cell membrane. Untransformed cells display a protein of about 250,000 daltons on their surfaces, and this protein disappears when the cell is transformed. By making fluorescent antisera to this surface protein A. Vaheri (Helsinki) was able to show that this protein codistributed with actin-containing filaments which lie under the cell membrane. Furthermore, the actin filaments and surface protein disappeared together when the cell was transformed. These results suggest that the surface protein may be linked directly or indirectly to actin-containing structures in the cytoplasm. □

Waxworks for plate tectonics

from Peter J. Smith

An oceanic ridge and the transform faults that divide and offset it are approximately orthogonal, irrespective of the overall trend of the ridge with respect to the plates on either side. The reasons for this particular geometry are still not entirely clear, or at least not beyond dispute. Most of the explanations put forward so far have involved a minimum energy criterion; in other words, it is generally assumed that the final ridge-fault configuration is that offering least resistance to plate separation. But this implies that when plates diverge the resistive forces per unit length of ridge crest are much greater than those per unit length of transform fault, an inference which is apparently inconsistent with the observation that the seismic energy released at ridge crests is no greater than that released along transform faults.

In an attempt to resolve this dilemma, Lachenbruch and Thompson (*Earth planet. Sci. Lett.*, **15**, 116; 1972) suggested that the region in which the seismic energy is released and that chiefly responsible for the resistance to plate motion may not coincide. Specifically, they envisaged that whereas the seismic energy is released at the ridge crest in the crust which is continually breaking, the dominant resistive force is the highly viscous fluid in an intrusion zone below. But as Oldenburg and Brune (*J. geophys. Res.*, **80**, 2575; 1975) now point out, the large resistive forces invoked in this and similar models are a consequence of regarding the lithosphere as a slab of constant thickness and the intrusion zone as a narrow vertical channel beneath the ridge crest—a situation in which the plate thickness is much greater than the width of the intrusive channel. Their own model, by contrast, suggests that this condition may not obtain.

But whereas the Lachenbruch–Thompson model is conceptual, Oldenburg and Brune have constructed a real physical system. They have a tray of melted wax which is cooled until a film of solidified wax has formed between one end of the tray and a moveable paddle. When the paddle is pulled at constant velocity away from the solidified surface in which an initial zone of weakness has been produced, a miniature system of ridge segments and perpendicular transform faults is "easily attainable"—a remarkable imitation of a phenomenon discovered less than 20 years ago, using apparatus which could in principle have been constructed more than 2,000 years ago.

Whether this physical model leads to conclusions that are more or less applicable to the real Earth than those derived from its more theoretical predecessors remains to be seen. In the meantime, however, Oldenburg and Brune believe that it can provide valuable insight into oceanic ridge processes because it can be observed directly on a reasonable time scale, because quantitative measurements may be made and because the properties of the system may be varied and their effects noted. It is a simple matter, for example, to measure the thickness of the solidified surface film of wax at any point in the tray; and 'plate' thickness thus obtained is always found to increase as the square root of distance from the 'ridge'. Clearly this direct result conflicts with the constant thickness assumption built into the Lachenbruch–Thompson and other analyses.

If the wax is to be believed, the idea of high resistive forces at ridge crests may also have to be discarded, for observation shows that the ratio of the thickness of the 'plate' to the width of the intrusion zone can be quite small in the vicinity of the 'ridge crest'. Moreover, order of magnitude calculations by Oldenburg and Brune suggest that the resistive forces per unit length of 'transform fault' are at least two, and possibly as many as four, orders of magnitude greater than those per unit length of 'spreading ridge'. Because so little is known about the physical and dynamic properties of Earth materials at depth, it is difficult to carry out comparable calculations for the real Earth. Nevertheless, assuming that the top few kilometres of the ridge crest act as a vertical channel and that the region below (defined now by a lithosphere increasing in thickness away from the ridge) is a zone of partial melt with Newtonian viscosity, Oldenburg and Brune estimate that the resistive forces along a transform fault are probably about an order of magnitude greater than the viscous forces acting beneath the few kilometres thick crust at a ridge crest of the same length.

Although such calculations must be treated with reserve, they do suggest that previous estimates of the viscous forces at ridge crests may be too high because of an inappropriate geometry assumed for the intrusion zone. Maintenance of the minimum energy criterion for orthogonal spreading would therefore require a large resistive contribution from the upper few kilometres of the ridge crest, thus restoring the seismic energy release contradiction. The only way out would seem to be to abandon the minimum energy assumption for the Earth, just as observation and calculation show it to be inapplicable to the wax model.

Instead, what seems to be crucial in producing the orthogonal pattern is the particular combination of physical properties involved. The wax model does not always lead to perpendicular ridge-fault spreading; it is necessary to use the 'right' kind of wax, and to adjust the temperature of the wax, the rate of surface cooling and the rate of spreading. The wax experiments show, however, that as far as the material is concerned the critical conditions for formation of the orthogonal pattern may be summarised as a single dimensionless parameter G, the ratio of the shear strength of the solid to the resistive stresses along the transform fault. The pattern may only be maintained as long as $G>1$. Once this criterion is satisfied, the development of the pattern is then determined by the symmetry of the applied stress field and the ability of the wax to fracture in a brittle manner under the applied stresses. In the Earth, both symmetry and brittle fracture are assured. G is more difficult to assess, but preliminary estimates suggest that it may be as high as 30. □