shear stress on the slip zone decreases with depth, whereas Minear and Toksöz (see, for example, *Tectonophysics*, **10**, 367; 1970) incorporated shear stress heating on both boundaries of the descending slab. But as Turcotte and Schubert (*J. geophys. Res.*, **78**, 5876; 1973) now point out, in these calculations little or no attention has been given to the positions of the volcanic chains behind ocean trenches—that is, to the geometry of the very system resulting from the thermal phenomena under investigation.

With the upsurge in geophysical activity during the past decade or so, many such volcanic chains have become quite familiar; and examples include the Kurile Islands, the West Indies, the Volcano and Mariana islands, Sumatra and Java, the Tonga and Kermadec islands and the New Hebrides. Turcotte and Schubert now propose that all these volcanoes lie above the points on the various slip zones where melting of the descending crust takes place. This assumes, of course, that the magma produced at the slip zone rises vertically to the surface, presumably under the buoyancy force arising from low magma density. Because the hydrostatic pressure is at least an order of magnitude greater than the ultimate strength of the rock at the depths of 100–200 km where the magma forms, the magma will probably move through the rock by the rock's plastic deformation rather than through a fracture; and in the absence of any other preferred direction, this movement will be vertically upwards. Accepting this geometry, the positions of the volcanoes may then be related to a specific process (melting) taking place on the slip zone and thus give an additional fixed point in calculating the subsurface temperature distribution.

Turcotte and Schubert develop two different models of heating on the slip zone. In the first, the shear stress along the slip zone is assumed to be constant down to the depth at which the basalt solidus temperature is reached; and thereafter the temperature at the slip zone remains at the basalt solidus (which increases with depth, of course). In the second model, the shear stress on the slip zone is allowed to increase linearly with depth to the point at which the solidus temperature is reached; and again, temperatures at greater depths are assumed fixed at the basalt solidus. Since the linearly increasing shear stress is equivalent to a constant coefficient of friction on the slip zone, the two models may be characterised, respectively, as 'constant shear stress' and 'constant friction'.

To cut a long physico-mathematical story short, what emerges from the Turcotte-Schubert analysis is an equation for each model which may be compared with observation. In the case of the constant shear stress model, the operative equation gives shear stress in terms of the thermal properties of the system, its geometry (including the vertical distance from the volcanoes to the slip zone) and the velocity of the descending plate. Feeding in observational values for eight individual trenches gives shear stresses in the range 1.18–1.60 kbar, with a mean of 1.35 kbar and a standard deviation of 10%. For the constant friction model, the operative equation is for coefficient of friction in similar terms but with the addition of the mean density above the slip zone. Frictional coefficients calculated from observational parameters lie in the range 0.033–0.077, with a mean of 0.054 and a standard deviation of 24%.

In attempting to decide between the two models, these results are perhaps less clear than might have been hoped. Most of the volcano to slip zone distances lie between 100 and 120 km with errors in locating the slip zone estimated to be ±20%. More variable distances would clearly have given a more convincing test for the constancy of either the shear stress or the frictional coefficient. Exceptionally, however, the volcano-slip zone distance for the New Hebrides system is 200 km; and the calculated shear stress at 1.31 kbar is much closer to the mean shear stress than the frictional coefficient of 0.033 is to the mean frictional coefficient. This, together with the smaller scatter of the shear stress values for the eight trench systems, leads Turcotte and Schubert to suggest that the constant shear stress model is probably the better of the two, although they are unwilling to commit themselves to a definite conclusion.

By extending their calculations to depths below the melting zone, Turcotte and Schubert go on to determine the thermal structure of the descending plate consistent with each model, on the assumption that the descending plate is largely olivine and thus that heating due to the olivine-spinel phase transformation, as well as adiabatic heating, is important. Other things being equal, the near-surface heating on the slip zone is somewhat stronger for constant shear stress than for constant friction, although for constant friction melting occurs at a slightly shallower depth. Apart from that, however, the temperature profiles are very similar. Finally, the temperatures on the slip zone are in fairly good agreement with those obtained by Toksöz *et al.* (*J. geophys. Res.*, **76**, 1113; 1971) but the minimum temperatures in the descending plate are about a factor of two lower. Turcotte and Schubert thus agree with others that the plate temperatures obtained by Toksöz *et al.* were probably too high, although the reason for the discrepancy is not clear.

Search for the Superheavies

ONE of the more interesting developments in nuclear physics recently has been the prediction by theorists of the existence of superheavy elements. This island of elements, with atomic numbers in the region of 114, lies significantly beyond the heaviest nuclei (numbers 104 and 105) which have so far been artificially produced and owes its possible existence to the extra binding energy and stability associated with the doubly closed nucleon shells at 114 protons and 184 neutrons.

Prediction of the half lives of these elements is particularly difficult, but some calculations have suggested values as long as 10^9 to 10^{15} years, implying that they might be found in natural materials on Earth. Several searches for superheavy elements in natural ores, minerals and so on have already been carried out and the results from one of the most complete are to be published in next Monday's *Nature Physical Science* (November 12).

The work has been carried out by a large group based on the Oak Ridge National Laboratory in Tennessee. The technique which they use relies on the prediction that superheavy elements are very likely to undergo spontaneous fission and could emit an average of ten neutrons for each fission event, to be compared with values of less than four for presently known spontaneously fissioning nuclides. The neutron multiplicity counter they use records events in which either three, or more than three, neutrons are detected.

The technique has the advantage that bulky samples can be used and no chemical processing is necessary. Materials investigated range from mineral and ore samples, through flue dust and other samples collected during ore processing, to manganese modules and 60 million-year-old sharks' teeth from a depth of 15,000 foot in the Pacific Ocean and meteorites from Mexico.

In spite of this very wide range of samples no evidence was found for spontaneous fission events accompanied by large numbers of neutrons. It seems then unlikely that superheavy elements will be found naturally on Earth and that physicists will have to await attempts to produce them with the heavy ion accelerators now being planned and under construction. The search for the superheavies will no doubt continue.