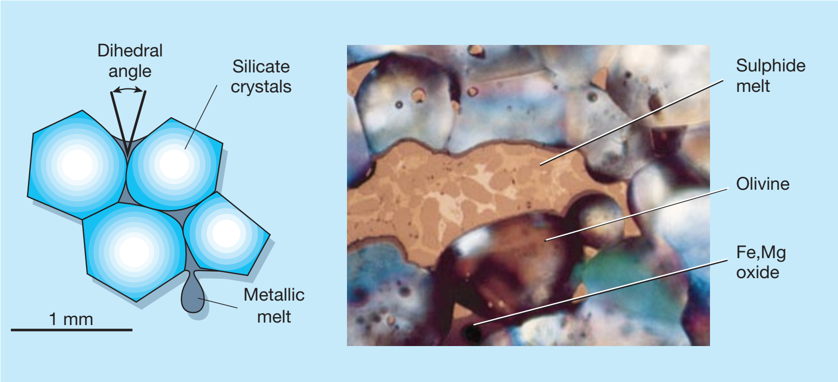

Figure 2 **Degrees of separation. Metal alloys with a lower melting point than silicate minerals form a melt between the grain boundaries of silicate crystals. The dihedral angle (left) is a measure of how likely it is that pockets of melt will connect and separate from the silicate matrix. The photomicrograph (right) shows sulphide melt trapped in a matrix of Fe,Mg oxide and olivine (the silicate that makes up most of the Earth's upper mantle). The dihedral angle is near 90° and, if the melt makes up a sufficiently large fraction of the sample volume, the melt pockets start to interconnect. The field of view of the photomicrograph is about 500 μm.**

record differentiation into mantle and core.

The melting points of alloys of iron, nickel, sulphur and oxygen (900–1,000 °C) are lower than those of silicate minerals (1,100–1,400 °C), so when a cold planetary body is heated a metallic melt forms but the silicate and oxide minerals remain solid. Whether this metallic melt can segregate from the silicate matrix — and eventually form a metallic planetary core — depends on its microstructure, which is in large part determined by the interfacial energies of melt and minerals. These energies can be parametrized in terms of the dihedral angles made by the silicate grain boundaries around the pockets of metallic melt (Fig. 2). Systems with large melt–solid interfacial energies (relative to solid–solid grain-boundary energies) have large dihedral angles, resulting in isolated melt pockets surrounded by melt-free grain boundaries. In such systems, the melt is unlikely to separate from the matrix.

Constraints on this core-forming process mostly come from experiments, as meteorites have lost much of their crucial textural information by the time they reach Earth. Olivine — $(Fe,Mg)_2SiO_4$ — makes up much of the Earth's upper mantle, and presumably made up much of the silicate fraction of accreting planetesimals. Metallic melts within an olivine matrix have large dihedral angles. This implies that, in a matrix that does not deform, core-forming melts would be trapped at grain boundaries. So for the melt to migrate towards the core, higher temperatures are needed to melt a matrix made of olivine and other silicate minerals. This process would produce a different trace-element chemistry in the melt than if the molten metal had percolated through a solid silicate matrix to the core.

Characterizing the permeability of a system using dihedral angles poses several difficulties. First, there are theoretical assumptions. For instance, a single dihedral-angle value for a sample implies that the interfacial energies are isotropic (which is not generally true in a system containing many different, anisotropic minerals); we must assume that the microstructure is dominated by surface reaction kinetics, not by mechanical deformation. In experiments, the system geometry must remain stable during the transition from high temperature and pressure to ambient conditions. Finally, with increasing melt fraction, even a system of isolated melt pockets will start to interconnect, but the 'percolation threshold' — the minimum melt fraction required for interconnection — has been modelled numerically only for simple systems[4].

To overcome these limitations, Yoshino *et al.*[1] have performed the first high-temperature, high-pressure experiments that determine the interconnectivity of metallic melt in an olivine matrix through observed changes in electrical conductivity. Conductivity was measured after the samples were brought to a pressure of 3 gigapascals and a temperature of 1,200 or 1,300 °C, corresponding to a depth of about 100 km in the present Earth or of about 700 km in the Moon. The authors find that about 6% by volume of iron–sulphur melt is sufficient to form highly conductive pathways, representing interconnected (and therefore permeable) melt channels in the olivine matrix. Interestingly, although the formation, in systems with high dihedral angles, of a heterogeneous distribution of larger melt pockets surrounded by many melt-free grain boundaries has been predicted theoretically, and shown experimentally for other systems, Yoshino *et al.* saw no evidence for this in their experiments. This discrepancy is unresolved, and further experiments are needed.

If these high electrical conductivities

NATURE

100 YEARS AGO

In Campbell Island, south of New Zealand, the breeze-fly (*Helophilus campbellicus*), one of the Syrphidae, so closely resembles a blow-fly (*Calliphora eudypti*) that when, in 1901, I captured a specimen of the first, which is rare, I thought it was the blow-fly, which is common… Now in any other locality this resemblance could be put down to mimicry. The blow-fly is common and offensive. The breeze-fly is rare and feeds on flowers. Everything favours this explanation except that in Campbell Island there are no insect-eating birds and no lizards, and consequently mimicry would be useless.

F. W. Hutton

Accidental resemblances between insects are to be expected… With regard to Captain Hutton's special instance, however, there appear to be certain points which require consideration before accepting the conclusion that the resemblance is merely a coincidence:— (1) The possible coexistence of the two species in other localities where the resemblance has a meaning; (2) the possible change of conditions in the struggle for life in the locality itself; (3) our possibly imperfect knowledge of the struggle which is waged there now.

E. B. Poulton

From *Nature* 12 March 1903.

50 YEARS AGO

The Nutrition Society held a symposium on 'The Role of Vitamins in Metabolic Processes' in the Biochemistry Department of the University of Sheffield on December 20, 1952… . In the final paper, Dr. L. J. Harris (Dunn Nutritional Laboratory, Cambridge) examined the literature which, despite its bulk, still leaves us without evidence for a specific metabolic role of vitamin C. Among older hypotheses was one associating ascorbic acid with collagen formation, and also the more general theory that certain formative cells, such as osteoblasts, show reduced activity; in these cells the vitamin has been found to be concentrated in the Golgi apparatus… The great majority of animals can synthesize vitamin C, but, although glucose is known to be its precursor, it is still not known whether synthesis is a property of all cells of the body, or whether certain tissues are specialized for this purpose; similarly, the function of the vitamin in plants is still obscure.

From *Nature* 14 March 1953.