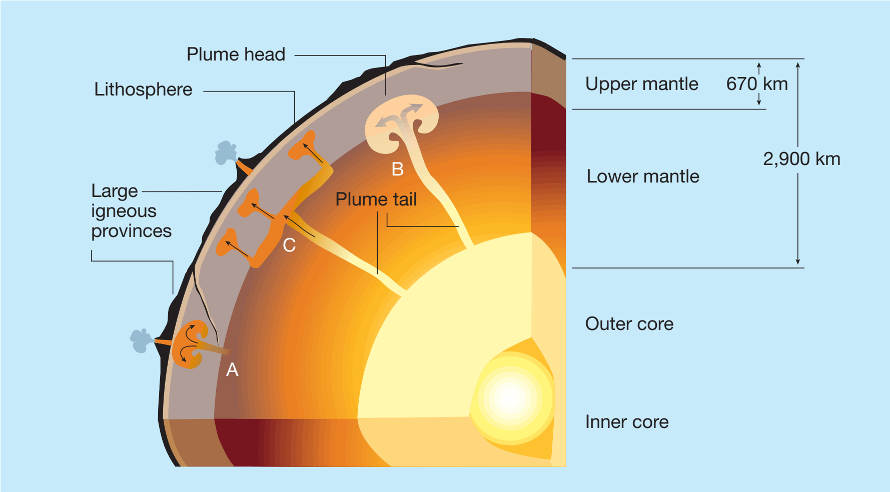

Figure 1 **Different models for mantle plumes. These plumes are responsible for violent volcanic eruptions on the Earth's surface that leave behind thick piles of lava called large igneous provinces. In model A, a plume that rises from the boundary between the lower mantle and the upper mantle forms a head after it reaches the lithosphere[4]. In model B, a plume grows a large, and cooler, head as it ascends from a source at the core–mantle boundary[5]. Thompson and Gibson's discovery of primitive olivines in volcanic rocks would appear to support the first model, which allows for the plume head to be hotter than the tail. But model C, in which a plume stalls at the boundary between the lower mantle and the upper mantle and gives rise to smaller 'plumelets', offers a third explanation.**

magmas — that is, direct melts of the mantle. Most partly crystallize to more 'evolved', less primitive compositions during ascent to the surface. To establish source temperatures, we must either seek out relatively rare magmas that have close-to-primary compositions, such as picrites and komatiites, or we must use relicts from primitive liquids trapped within more evolved lavas.

The latter approach was used by Thompson and Gibson[3], who studied the Etendeka basalts, part of the South Atlantic LIP that was stranded on the African continent in present-day Namibia. They report the presence of unusually primitive olivine, containing up to 93.3% forsterite (Mg_2SiO_4), in basaltic dykes that form part of the Etendeka volcanic province. Most olivine crystals in these dykes have normal, less primitive compositions (84–90% forsterite). The forsterite content is important because it is related to the MgO content of the magma from which the olivine crystallized, which in turn can be used to estimate magma temperature.

Thompson and Gibson argue that the forsterite-rich olivine crystallized from a highly primitive (komatiite) parental magma that was trapped at the base of the crust. Some of these crystals were transported to the surface in magma of more normal, basaltic composition. The authors calculate that the komatiite magma contained about 24% MgO and formed from a plume head that was 300–400 °C hotter than the surrounding mantle, and significantly hotter than that of the sources of modern hotspot islands. They then argue that this conclusion supports models such as that of White and McKenzie, in which the plume head is hotter than the plume tail.

The significance of Thompson and Gibson's study is their discovery of highly primitive olivine and their conclusion that these crystals came from trapped magmas that were far hotter than the basalts that form most of the Etendeka province. The result supports studies showing that the sources of many LIPs are heterogeneous, probably with small regions of hot material and larger regions of cooler material. Komatiites and picrites in the 88 million-year-old Caribbean oceanic plateau provide direct evidence of highly primitive lavas[7,8], and primitive olivine is reported in other provinces[9]. Whether the Etendeka source was quite as hot as claimed is debatable, however, because of uncertainties in our knowledge of the influence of pressure, oxygen fugacity and the presence of water. So Thompson and Gibson's estimate could be up to 100 °C too high or too low.

I would also question whether the result necessarily supports the White and McKenzie model: a Campbell and Griffiths plume head is heterogeneous and contains material hot enough to generate the Etendeka picrites. In fact it may be a mistake to focus attention on only these two models. In more recent models, the form of the plume is quite different from that imagined by the pioneers of plume theory. It has been suggested, for example[10,11], that the plume does not penetrate the boundary between the upper mantle and the lower mantle, but spreads out as a sheet to give rise to a number of 'plumelets' (Fig. 1). To obtain definitive answers about the size, form and temperature distribution of the LIP source, the approach of Thompson and Gibson should be applied to other continental and oceanic plateaux. This, in

NATURE

100 YEARS AGO

It is well known that while country-folk adhere to the old idea that adders when frightened are in the habit of protecting their young by swallowing them, a large number of naturalists regard the feat as an impossibility. In the September number of *The Zoologist* Mr. G. Leighton, a well qualified anatomist, has set himself the task of ascertaining whether there is any foundation for the objection. And he arrives at the conclusion that there is no anatomical reason why the oft-repeated statement of country observers should not be founded on fact. The author concludes by stating that the objections raised on the ground that the swallowing is unnecessary is a mere matter of opinion, adding that all that is now necessary is for a competent authority to dissect an adder which has been observed to swallow its young. 'Until this is done scientific naturalists will continue to regard the question as one capable of proof, if true, but hitherto unproved.'

From *Nature* 27 September 1900.

50 YEARS AGO

One session of the recent meeting at Birmingham of the British Association, held in the Great Hall of the University, was devoted to an account of industrial applications of atomic energy… It will not be possible to decide on the feasibility of nuclear power until pilot power-producers are built. Very rough figures of capital and fuel costs do no more than show that nuclear power costs will be likely to be of the same general order as conventional power costs… Design studies are being carried out on an experimental breeder reactor, one of which is already under construction in the United States. This experimental and development programme is likely to occupy the next decade. If the development work is successful, nuclear power would be likely to start in specialized applications where fuel costs are less important, and then to spread gradually to more conventional power stations. British fuel reserves have been estimated as lasting from 200 to 300 years; power consumption is increasing by 10 per cent a year and there is increasing competition with the chemical engineering industry for fuel. New power sources are therefore of considerable long-term importance, though other potentialities should be pursued in addition to nuclear power.

From *Nature* 30 September 1950.