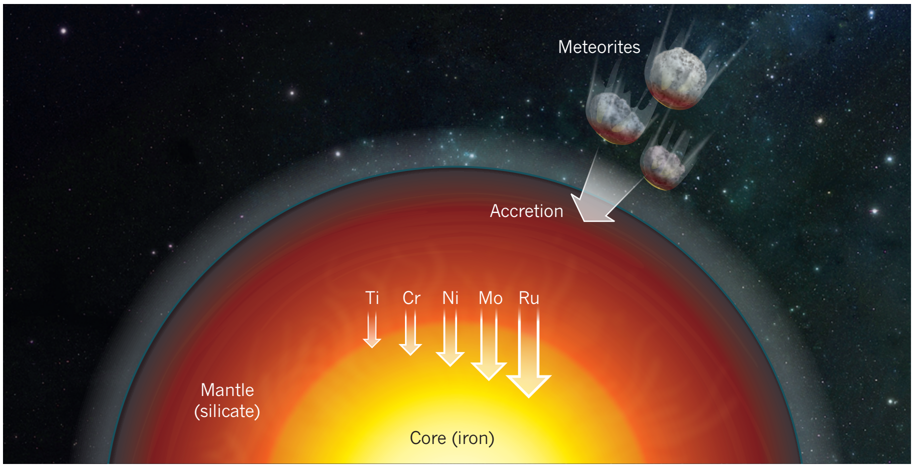

Figure 1 | Probing Earth's formation. When Earth's iron-metal core separated from its silicate mantle, elements more soluble in metal than in silicate were transferred to the core. After core formation was complete, these elements were added back to the mantle by accretion of meteoritic material. Dauphas[1] considers the elements titanium, chromium, nickel, molybdenum and ruthenium (listed in order of their increasing preference for the core). Using the isotopic differences in these elements between Earth and meteorites, the author shows that our planet formed from a mixture of meteorite types during the first 60% of its growth and subsequently almost entirely from oxygen-poor meteorites called enstatite chondrites. Fischer-Gödde and Kleine[2] use high-precision ruthenium isotopic measurements to confirm that the last 0.5% of the accreted material was most like enstatite chondrites.

form of metal or sulfide, rather than oxide). This similarity drove several models that based Earth's composition on enstatite chondrites[4,5]. However, the mismatch in the elemental composition between such meteorites and Earth's rocks led most researchers to continue using models based on more-oxidized and volatile-rich meteorites known as carbonaceous chondrites[6,7].

Improvements in the ability to determine precise isotopic abundances led to the discovery that many elements can be used to distinguish between Earth and meteorites[8]. In 2011, a study of these isotopic differences suggested that Earth was made from a mixture of meteorite types[9], not just the carbonaceous chondrites that had been the main component of most models. Dauphas takes this approach further by developing a methodology in which the isotopic disparity between different groups of meteorites and Earth can be used to track the composition of the materials that accreted to our planet throughout its formation.

The most important chemical differentiation event in Earth's history was the separation of its iron-metal core from its silicate mantle (Fig. 1). When the core formed, elements that are more soluble in metal than in silicate were selectively removed from the mantle. Some elements (such as iridium, platinum, palladium and ruthenium) are so soluble in metal that the mantle should have been effectively stripped of them during core formation. However, the observed abundances of these elements in the mantle are in the same relative proportion as those seen in primitive meteorites. Furthermore, they are depleted by a factor of only about 350 with respect to their abundance in meteorites[10], compared with the million-fold depletion[11] that would be expected were the mantle in chemical equilibrium with the core.

One explanation is that these elements were added back to the mantle by subsequent accretion of meteoritic material (with a mass of about 0.5% that of Earth) after core formation was complete[12]. Dauphas notes that, if this is so, the isotopic composition of ruthenium in the mantle tracks only the last 0.5% of the material from which our planet formed. By contrast, the mantle isotopic composition of elements that are completely insoluble in metal reflects the average composition of all the material from which Earth grew.

Using this approach, for the series of elements titanium, chromium, nickel and molybdenum (listed in order of their increasing preference for the core), Dauphas estimates that their isotopic composition in the mantle reflects the last 95%, 85%, 39% and 12% of material accreted by Earth, respectively. Then, using the isotopic differences in these elements between Earth and meteorites, the author finds that our planet formed from a mixture of meteorite types for about the first 60% of its growth and almost entirely from enstatite chondrites for the remainder. The high-precision ruthenium isotopic measurements presented by Fischer-Gödde and Kleine reinforce the conclusion that the last 0.5% of the accreted material was isotopically most like enstatite chondrites.

The disturbing aspect of this conclusion is that the chemical composition of enstatite chondrites is very different from that of rocks on Earth's surface. Consequently, if Earth is mostly made from enstatite chondrites, its deep interior must have a substantially different composition from its outer layers[5].

NATURE

50 Years Ago

Some of the problems of the links between psychiatry and genetics are discussed in *Research on Genetics in Psychiatry*, the report of a scientific group of WHO. There is clear evidence that genetic factors are involved in the aetiology of a number of mental diseases, although the genetic factors are more obvious in some than in others. Huntington's chorea is the best example of a hereditary mental disease — family trees showing very clearly the inheritance of a single dominant gene have been compiled for a number of families in which the disease is current. In most of the more common mental diseases, schizophrenia, epilepsy and manic-depression, for example, the genetic component is far less clear cut … The WHO group puts forward a number of proposals for topics on which work should be concentrated. It calls for research into the frequency of chromosome abnormalities and the relationship of these abnormalities with mental disorder, particularly from the biochemical point of view. It would like to see more work on twins, preferably on an international scale, including studies of twins separated in early life.

From *Nature* 28 January 1967

100 Years Ago

Stars at a Glance — This simple guide to the stars will admirably meet the requirements of those who are commencing the study of astronomy or who have become interested in the heavens since the lighting restrictions came into operation. It provides an "aspect chart" for each month, which will enable the observer to make a general acquaintance with the stars visible at a specified time and date, and four additional charts showing the constellations in greater detail.

From *Nature* 25 January 1917