Scientists find that Earth and Mars are different to the core

June 28 2007

Research comparing silicon samples from Earth, meteorites and planetary materials, published in *Nature* (28th June 2007), provides new evidence that the Earth's core formed under very different conditions from those that existed on Mars. It also shows that the Earth and the Moon have the same silicon isotopic composition supporting the theory that atoms from the two mixed in the early stages of their development.

This latest research which was carried out by scientists from Oxford University along with colleagues from University of California, Los Angeles (UCLA) and the Swiss Federal Institute of Technology in Zurich (ETH) compared silicon isotopes from rocks on Earth with samples from meteorites and other solar system materials. This is the first time that isotopes have been used in this way and it has opened up a new line of scientific investigation into how the Earth's core formed.

On Earth rocks that make up volcanoes and mountain ranges and underlie the ocean floor are made of silicate – compounds made of silicon and oxygen linked with other kinds of atoms. Silicate dominates down to a depth of 2,900 km – roughly half way to the centre of the Earth. At this point there is an abrupt boundary with the dense metallic iron core. Studies by Birch in the 1950's demonstrated that the outer core had a density too low to be made of pure iron and that it must also be made up of some lighter elements (see notes to editors for further details).

Research team member, Bastian Georg, a post doctoral researcher from

Oxford University's Earth Sciences Department said, "We dissolved meteorites, provided by the Natural History Museum in London, in order to compare their isotopic composition with those of rocks from the Earth. The silicon was separated from other elements and the atomic proportions of isotopes measured using a particularly sophisticated mass spectrometer at the ETH in Zurich".

Professor Alex Halliday, also from Oxford University explains, "We were quite startled at our results which showed that the heavier isotopes from silicate Earth samples contained increased proportions of the heavier isotopes of silicon. This is quite different from meteorites from the silicate portions of Mars and the large Asteroid Vesta – which do not display such an effect even though these bodies also have an iron core."

Silicate samples from Mars and Vesta are identical to a primitive class of meteorites called chondrites that represent average solar system material from small "planetesimals" that never underwent core formation.

Professor Halliday continues, "The most likely explanation is that, unlike Mars and Vesta, the Earth's silicon has been divided into two sorts – a portion that became a light element in the Earth's core dissolved in metal and the greater proportion which formed the silicon-oxygen bonded silicate of the Earth's mantle and crust."

At depths the silicates change structure to denser forms so the isotopic make-up would depend on the pressure at which metal and silicate separate. Quantifying this effect is the subject of ongoing studies. Co-author on the paper Edwin Schauble from UCLA, has produced preliminary calculations that show that the isotopic effects found are of the right direction and magnitude.

This research provides new evidence that the Earth's core formed under different conditions from those that existed on Mars. This could be explained in part by the difference in mass between the two planets. With Earth being eight times larger than Mars the pressure of core formation could be higher and different silicate phases may have been involved. The mass of a planet also affects the energy that is released as it accretes (or grows).

The Earth accreted most of its mass by violent collisions with other planets and planetary embryos. The bigger the planet, the greater the gravitational attraction and the higher the temperatures that are generated as the kinetic energy of impacting objects is converted to heat. Some have proposed that the outer Earth would have periodically become a “magma ocean” of molten rock as a result of such extreme high temperature events.

There is evidence that Mars stopped growing in the first few million years of the solar system and did not experience the protracted history of violent collisions that affected the Earth. There already exists compelling evidence for relatively strong magnetic fields early in martian history but a thorough understanding of the martian core must await geophysical measurements by future landers. It is however thought that the core of Mars is proportionally smaller than that of the Earth and it probably formed under lower pressures and temperatures.

The research also shows that the Moon has the same silicon isotopic composition as the Earth. This cannot be caused by high pressure core formation on the Moon which is only about one percent of the mass of the Earth. However, it is consistent with the recent proposal that the material that made the Moon during the giant impact between the proto-Earth and another planet, usually called “Theia”, was sufficiently energetic that the atoms of the disk from which the Moon formed mixed with those from the silicate Earth. This means the silicon in the silicate Earth must have already had a heavy isotopic composition before the Moon formed about 40 million years after the start of the solar system.

Source: Oxford University

Citation: Scientists find that Earth and Mars are different to the core (2007, June 28) retrieved 25 April 2024 from https://phys.org/news/2007-06-scientists-earth-mars-core.html

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