Vestiges of primitive Earth

The depths of the Earth may contain rigid blocks spanning thousands of kilometers

A team of researchers from the Tokyo Institute of Technology and the Swiss Federal Institute of Technology Zurich (ETH Zürich), along with Brazilian physicist Renata Wentzcovitch of Columbia University in the United States, proposed this new hypothesis about the composition and mechanics of the lower mantle in a study published in *Nature Geoscience* on February 27, 2017. Although not considered complete, this hypothesis explains a number of phenomena, such as the upwelling of less dense rocky material from the mantle to the surface and the sinking trajectory of the edges of tectonic plates formed by

The Earth’s interior is believed to contain immense blocks of rock. Because these rocks are denser and more rigid than the material around them, they likely stabilize the movements of the mantle, i.e., the layer between the Earth’s surface and core, which comprises approximately 80% of the planet’s volume. Known as bridgmanite-enriched ancient mantle structures, or BEAMS, these blocks are thought to span thousands of kilometers (km), lie at least 1,000 km deep and float on the lower mantle, near the boundary of the Earth’s core almost 2,900 km below the surface.

Possible distribution of BEAMS (shown in yellow), areas of plume concentrations (in red, regions 2 and 4) and sinking tectonic plates (in blue, regions 1 and 3). The arrows indicate the direction of mantle movement; S denotes plates that have stopped sinking.
Deep discoveries

BEAMS may explain the movements of tectonic plates towards the Earth’s core

In the study, the researchers assumed that the lower mantle has more silicon than the upper mantle, increased the proportion of this element and performed two-dimensional numerical computer simulations of the possible movements of that deep planetary layer. The simulations indicated that much of the mantle formed soon after the birth of the planet might remain to this day in the form of a mineral known as perovskite or bridgmanite (MgSiO₃), without mixing with the adjacent region formed by rocks with a 20 to 30 times lower viscosity. Consequently, the more viscous material, i.e., the BEAMS, could be vestiges of the planet’s earliest existence. “Our simulations indicated that these rigid blocks did not become more liquid as the Earth evolved,” explained Wentzcovitch, who has studied the possible processes involved in the formation and transformations of bridgmanite in the planet’s interior (see Pesquisa FAPESP Issue No. 198). “The silicon that appears to be missing must be hidden in the lower mantle.”

“We don’t know how many BEAMS there are, but there probably aren’t more than three or four,” she noted. “Our next project will be to define them accurately, through a detailed analysis of the changes in velocity of seismic waves.” Proving the existence of BEAMS is a very difficult task.
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