Diamonds reveal deep source of platinum deposits

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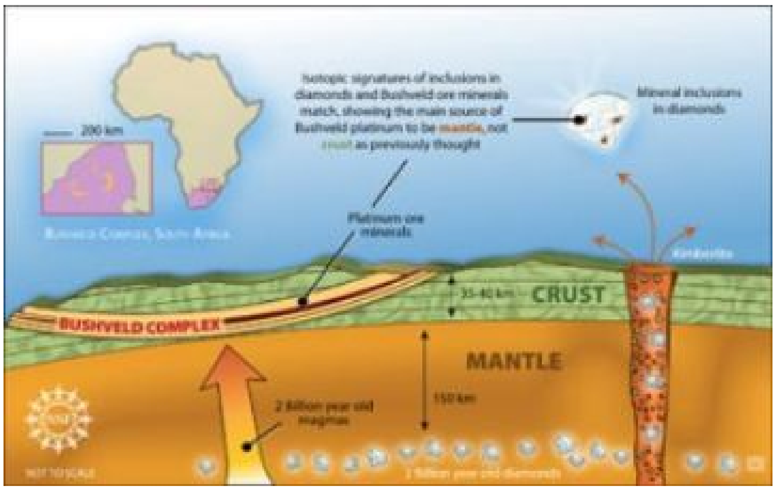

Researchers studied platinum group elements inclusions in about 20 diamonds collected near the Bushveld Complex in South Africa. The complex is vast, measuring hundreds of kilometers in length, and it is one of the few places in the world where PGEs are found in large enough quantities to be mined. The Bushveld Complex is also very old -- geologists put its age at just over 2 billion years -- and formed by crystallization of the Bushveld magmas in a massive crustal magma chamber. The researchers looked at the PGEs in the diamonds, sometimes analyzing grains as small as a few micrograms. They found that the isotopic signatures of the PGEs in the diamonds and Bushveld ore minerals match, showing the main source of Bushveld platinum to be mantle, not crust falling into the magma chamber as previously thought. Credit: Zina Deretsky, National Science Foundation

The world's richest source of platinum and related metals is an enigmatic geological structure in South Africa known as the Bushveld Complex. This complex of ancient magmas is known to have formed some two billion years ago, but the source of its metallic riches has been a matter of scientific dispute. Now researchers from the Carnegie Institution and the University of Cape Town have traced the origin of the unique ore deposits by using another of South Africa's treasures—diamonds.

The study, published in the June 12 issue of *Nature*, suggests that the source of these valuable ores may be ancient parts of the mantle beneath the African continent.

Platinum group elements (PGEs), which include platinum, palladium, rhodium, ruthenium, osmium and iridium, are extremely rare in the Earth's crust. Platinum, the most abundant, is 30 times rarer than gold. Mined only in a few places in the world, these elements are becoming increasingly important in applications ranging from pollution control (they are key components of catalytic converters in automobiles) to microelectronics.

Previous isotopic studies of rocks from the Bushveld Complex had suggested that a significant fraction of the magma that formed the complex and deposited the ores came from shallow parts of the crust, despite the rarity of PGEs there compared to the Earth's mantle. "But the ore layers are extremely homogeneous over hundreds of kilometers," says Steven Shirey of the Carnegie Institution's Department of Terrestrial Magnetism. "The crust is very heterogeneous. That suggests a deeper source for the platinum."

To test this idea, Shirey and Stephen H. Richardson of the University of Cape Town studied minute mineral inclusions in about 20 diamonds mined from areas surrounding the Bushveld Complex. The diamonds formed at depths of 150-200 kilometers within the Earth's mantle. By measuring the ratios of certain isotopes of strontium, osmium, and neodymium in the mineral inclusions, the researchers were able to determine the isotopic "signatures" of the different regions of the mantle where the diamonds grew. They then compared these signatures with those of ore rocks in the Bushveld Complex.

Richardson and Shirey found that the isotopic signatures of the ores could be matched by varying mixtures of source rocks in the mantle beneath the continental crust. That these parts of the mantle were involved in producing the magmas is also suggested by seismic studies, which reveal anomalies beneath the complex. The anomalies were likely the result of magmas rising through these parts of the mantle.

"This helps explain the richness of these deposits," says Richardson. "The old subcontinental mantle has a higher PGE content than the crust and there is more of it for the Bushveld magmas to traverse and pick up the PGEs found in the ores."

Source: Carnegie Institution

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