New Places to Look for Diamonds

Diamonds are usually found in kimberlite, an igneous rock containing chunks of diamond-bearing rock from the earth's mantle. They also occur in surface placer deposits formed by the weathering of kimberlite. They may be rarely found as tiny crystals in certain meteorites. Now a new geological occurrence has been reported from the Kukchetin block in northern Kazakhstan. Here diamonds are found in gneisses formed by the metamorphism of sedimentary rocks.

The Kokchetev block is about 800 kilometers west of Novosibirsk, Siberia and 1000 km. north of Tashkent. It is a fault-bounded block of high grade metamorphic rock formed approximately 530 million years ago from rocks deposited as sediments about 2 billion years ago. The diamonds are found as perfect cubes and octahedrons about 0.0005 inches in diameter enclosed inside garnet and zircon crystals. Other minerals found here as inclusions in garnet and zircon are titanite, phengite (a type of mica), K feldspar, quartz and kyanite. None of these minerals are traditionally thought to be associated with diamonds. In addition to these minerals, the gneisses contain pyroxene, plagioclase, biotite, chlorite, calcite and graphite.

The diamond-bearing rock was once a sediment deposited on land about 2 billion years ago. It was then buried deeply, metamorphosed and uplifted back to the surface. A major question is whether the diamonds actually grew during metamorphism or whether they had been deposited in the original sediment from an eroded kimberlite somewhere else. This is an important question, because diamonds had never before been seen growing within rocks of the earth's crust.

Sobolev and Shatsky (1990) studied this question with some care and showed that the diamonds did indeed grow in the rock during metamorphism. They cite a number of pieces of evidence for this. First, the diamond crystals' shapes are such that they could not reasonably have survive any degree of transportation as a sediment. Also, the diamonds are intimately intergrown with minerals such as garnet that were known to grow in this rock during metamorphism. Plus, the associated minerals show that the rock was subjected to temperatures of 900 - 1000 degrees C and pressures of over 40,000 atmosphere. This puts them within the stability field of diamond. This also implies that the sediments were buried to depths of over 100 kilometers (60 miles) within the earth. After metamorphism the rocks were uplifted to the surface. The diamonds, which should logically have converted to graphite, survived by being insulated within the garnet and zircon crystals.

There are several interesting implications to this find. First is what I will refer to as the "elevator concept". To make the diamonds, these sediments had to be pushed down into the earth over 60 miles then brought all the way back up to the surface. The forces and causes of such large vertical movements are unknown. Geologists for years have focused on the large horizontal movements of blocks associated with plate tectonics. A small group of geologists, most notably Russian, have argued that large vertical movements were also important. These little diamond crystals are proof that their arguments are justified. I predict that in future years geologists will be thinking more and more about large up and down movement of crustal blocks. The second implication is that if diamonds can be found in a particular rock in one place, they will be found in the same kind of rock elsewhere. These diamonds are very tiny, hence easily overlooked. Most geologists studying high grade gneisses would also not be expecting to find diamonds. A truism in geology is that you usually find only what you are looking for. Now geologists will be on the look-out for diamonds in high grade gneisses in other parts of the world and I think they will find them. Some logical places I would look are in the gneisses of the Adirondacks in New York, of the Beartooth block in Wyoming and, yes, of the Minnesota River Valley around Redwood Falls.

Even though theses diamonds are too small to see without extensive magnification, they are important for what they tell geologists about the complex history of this marvelous planet.

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References:

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