The Peridot Asteroid

One of the most exotic gemstones is from outer space - the rare meteorites called pallisites. These are flashy mixtures of translucent green to yellow olivine (peridot) found as large crystals in a matrix of iron-nickel alloy. When cut and polished the contrast between the olivine and metal is startlingly beautiful. No wonder they are so pricey.

The first pallasite was described in 1772 by Pyotr Pallas. It was a 1,600 pound mass that fell in Siberia. Pallasite is also known in quantity from Kiowa County, Kansas, from the Imilac pallasite that fell in desert of Chile and the Salta pallasite of Argentina.

How do such meteorites form and when do they come from? Such a mixture of silicates such as olivine and metal is presumed to be found in the earth along the core-mantle boundary. How could rocks from the core of a planet get into outer space?

Modern models of asteroid and planet formation suggest asteroids perhaps 50-200 km in diameter may form a layering similar to that of the earth. The accumulation of that much material, including heat producing radioactive substances, would cause the body to melt and the denser iron and other metals to sink to the center of the body. The less dense silicates such as olivine would not sink so deeply, and, with other minerals, form the outer layers of the asteroid. This is also what happens in a blast furnace, when the melted rock separates into the denser iron and lighter materials that will cool to slag. Thus some larger asteroids have the equivalent to the crust, mantle and core of the earth.

In the earth, though, the outer core is still molten, because our planet is so much larger, and still has abundant heat-producing radioactive materials in its interior. The asteroids, on the other hand, would have completely cooled and crystallized. Along their core - mantle boundaries, the separation of the silicates and metals would not be perfect - what natural process ever goes perfectly? Perhaps some late pulse forced cooling iron up into the mush of olivine crystals. Thus the pallasite is born.

The next step is getting the materials out of an asteroid and to earth. Here we use the fact that asteroids, over the length of geologic time, have tended to collide violently with each other. A big enough collision between two asteroids will fracture both, sending pieces flying. These fragmented planetoids are the source of meteorites, including pallasites. Those unfortunate enough to be pulled in by the earth's gravity, after a journey for millennia in space, will fall as meteorites. Since only a tiny part of an asteroid will be a core-mantle boundary, pallasites should be scarce, and they are.

Some asteroid collisions may not be quite so destructive. It is possible that a less violent collision may strip away most of an asteroid's mantle, leaving an olivine studded metallic mass - an asteroid whose surface is covered with peridot gemstones. That would be quite a find.

How could we find such an asteroid, out of the millions stretched through billions of cubic kilometers of space? It's not as impossible as it seems. The mixture of olivine and metal would give off a distinctive spectrum that can be detected with sensitive instruments on earth or in satellites. Some known asteroids do give spectral data showing olivine at the surface. These are termed A-type asteroids, such as 246 Asporia. Some are 30 to 65 km. in diameter. It is astonishing to think that some may be peridot encrusted. Of course other large asteroids may have pallasite layers within if they escaped a collision large enough to blast them to splinters. Then the pallasite "ore" would have to be recovered by interplanetary "hard-rock" mining.

So as prospectors were drawn west by visions of "El Dorado" or the "Mother Lode", perhaps future space explores will blast off in search of the peridot asteroid.

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<u>References:</u>

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