Diamond's ugly stepsister has glam pedigree
(Monday January 22, 2007) - Contributed by By JOHN MANGELS

c.2007 Newhouse News ServiceThe stones called carbonado have always been diamonds' strange, dowdy stepsister.

The two share the same mineral DNA _ hard, crystallized carbon _ but otherwise seem as different as night and day.

Diamonds are clear and lustrous, prized for their beauty. Carbonados, sometimes called black diamonds, are dark and plain, gemology's spinsters. They look like lumps of charcoal.

While jet-setting diamonds adorn starlets' fingers and rappers' earlobes, lowly carbonados sacrifice themselves for industry's dirty work. Sold for a fraction of the prices diamonds command, carbonados are crushed into grit that's used in heavy-duty cutting and polishing.

But this gloomy story has a Cinderella ending, thanks to detective work by Steve Haggerty, one of the world's foremost diamond experts; Haggerty's student; and a pair of Case Western Reserve University scientists.

Carbonados, it turns out, have a far more stellar pedigree than their vaunted relatives. While traditional diamonds come from deep within the Earth, the team's research concludes that carbonados originated in space. They apparently are the remnants of a huge carbon-rich meteorite or comet that slammed into the planet roughly 3 billion years ago.

The stones' extraterrestrial source solves a longstanding geological mystery and adds to scientists' knowledge about the ancient Earth and the early solar system.

``I think it's a significant step forward in our understanding of a unique process,'' said Mike Gaffey, a space studies professor at the University of North Dakota, who is familiar with the team's finding. The work was published online Dec. 20 in Astrophysical Journal Letters.

Haggerty, an earth sciences professor at Florida International University, and a few other scientists suspected for more than a decade that carbonados were alien invaders. The circumstantial evidence was strong. But obtaining proof would require a Case-operated machine as big as a stadium and a beam of light powerful enough to illuminate carbonados' individual atoms.

Indications of the rocks' exotic source came from their odd appearance and their sparse distribution on Earth.

Conventional diamonds are forged hundreds of miles deep in the Earth's mantle, below immense continental crusts known as cratons. Here, over several billion years, pressure and heat are high enough to transform carbon-bearing deposits into diamonds' highly ordered, pure carbon crystals.

Explosive volcanic jets then boost diamonds to the near-surface like passengers in a fast-rising elevator. The ride must be quick enough _ less than a million years, rapid by geologic time scales _ to prevent the precious crystals from morphing into graphite or being incinerated.

Those volcanic elevators are situated at points around the globe, belching up major diamond deposits in Russia, Africa, Australia, India, China, Brazil and Canada.

Carbonados, by contrast, have been unearthed in only two places, neither of them traditional diamond-mining areas. One is in the Brazilian state of Bahia, where Portuguese miners first plucked them from the ground in the 1840s and named them after charcoal. The other is the Central African Republic.

Though they're separated by an ocean now, those two sites were essentially one location 3 billion years ago, when carbonados originated. That's because the continents had not yet split apart, so what is now South America was still nestled in the armpit of western Africa.

A mineral confined to a single spot on the planet just didn't fit the way terrestrial processes operate. ``Singularities are not in the parlance of any geology,'' Haggerty said.

A single big meteor impact, however, would account for carbonados' limited dispersal. It also could help explain the stones' funny looks.

Unlike conventional diamonds' uniformly smooth faces, carbonados typically are pockmarked by hundreds of tiny pores on one side, and a charred, glassy surface on the other.

``They look like nothing so much as a lot of fine couscous, colored with some sort of brown broth,'' North Dakota's Gaffey said.

Carbonados' pores formed when gas trapped in the superheated rock bubbled outward and escaped. If carbonados incubated in the same deep-Earth nursery as conventional diamonds, Haggerty said, the unimaginable subterranean pressures likely would keep gases bottled up, or at least would eventually reseal any pores that managed to appear.

So the pores' presence was an argument against a below-ground birth for carbonados. The stones' one-sided charring and partial melting hinted they were survivors of some violent event.

``Carbonado looks quite like the surface of a meteorite that was ablated through its entry into Earth's atmosphere,'' Haggerty said.

But by science's exacting standards, hints aren't proof. For help nailing down his hypothesis, Haggerty turned to Case.

On the outskirts of New York City is a sprawling federal lab called the National Synchrotron Light Source. A synchrotron is kind of a racetrack for atomic particles. Magnets propel streams of electrons around the stadium-size track, accelerating them to near light-speed.

The electrons lose some energy as they hurtle through the turns. Scientists tap that spillover energy, in the form of powerful beams of X-rays and infrared and ultraviolet light, and shine it on various samples to reveal their molecular properties.

Case owns and operates five ``beamlines'' at the New York lab and maintains a staff there. Haggerty's graduate student, Jozsef Garai, knew one of the Case scientists, Sandeep Rekhi. Along with Rekhi's boss, Case biophysical chemist Mark Chance, they arranged to expose samples of carbonado to the formidable infrared beam and see what secrets might spill out.

``It was a dream team,'' said Haggerty, who hails from South Africa, home to the world's most famous diamond mines.

After crushing the ultra-hard stones in a 20-ton press _ ``Man, it's a crack!'' Haggerty chortled _ the researchers placed carbonado shards in the beamline and collected data over several days.

The result ``was pretty shocking,'' Chance said.

What they found was hydrogen, and lots of it. Hydrogen and carbon atoms were linked like lovers throughout the carbonado samples.

Uncaptured, ``available'' hydrogen is the most plentiful element in the universe, but is exceedingly rare on Earth. To hook up with so much hydrogen, carbonado would almost certainly have to have formed in deep space. ``There's no chemical reaction or geologic data to suggest it's possible'' on Earth, Chance said.

The infrared analysis detected additional evidence of carbonado's extraterrestrial birth _ an exotic lineup of mineral ingredients typical of meteorites. One of them was osbornite, which also showed up in samples of comet dust that a NASA spacecraft snagged and returned to Earth last year.

A gaggle of carbon-rich asteroids called the Nysa-Hertha family, orbiting between Jupiter and Mars, may have spawned the meteorite that delivered carbonados to Earth long ago, Gaffey said. Or it might have been the impact of a comet, its core packed with tar-like carbon molecules.

Either way, the carbon vapor spewing from the fiery collision could have condensed into the lumpy black diamonds that now sell for $5 a carat. What a common ending for such an uncommon traveler.

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