A meteorite mystery: Could this stone be the first meteorite from Mercury ever found?

April 5 2013, by Diana Lutz

One of 35 meteorites of mysterious origin found in the Moroccan desert. This piece weighs 100 grams. The alphabet block to the right is a centimeter on a side. Credit: Stefan Ralew

(Phys.org) —Could this stone be the first meteorite from Mercury ever found? WUSTL's meteorite expert sifts the evidence.

Early in 2012, someone in Southern Morocco picked up 35 greenish stones, including the one shown above. Purchased by a dealer in Erfoud, Morocco, it was then resold to Stefan Ralew, a meteorite collector from Berlin.

The dealer was demanding a high price, and Ralew may have hesitated. But the wrinkled glassy coating on one face of the rock was clearly a fusion crust, a kind of glaze that forms when a meteorite is heated as it passes through the atmosphere.

Looking at other faces he would have recognized it as a type of meteorite called an achondrite, says Randy Korotev, WUSTL's meteorite expert. That meant it was an exceptional stone.

Most meteorites are stony, he explains, and of the stony meteorites, almost all (90 percent) are what are called ordinary chondrites. These are pieces of small, unmelted asteroids that are uniform in composition throughout.

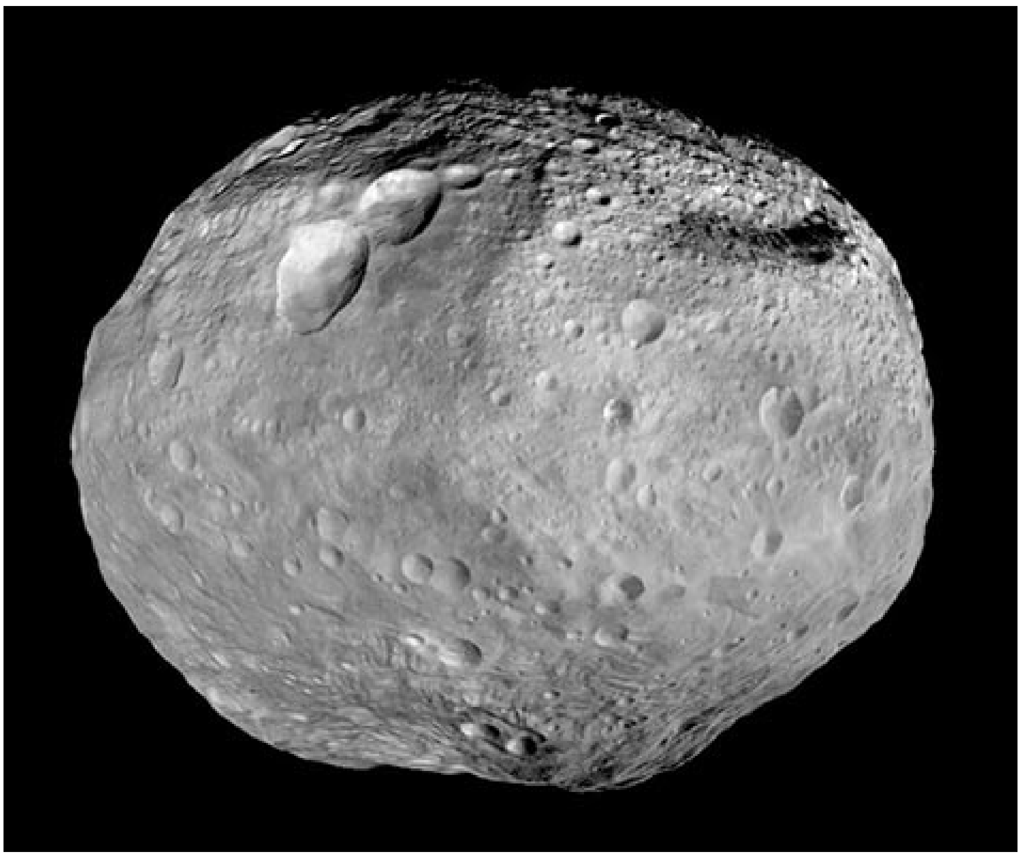
The achondrites, on the other hand are pieces of large asteroids or planets, ones at least 200 kilometers in diameter. These produced enough internal heat early in their history to partially melt and segregate into a metal core surrounded by a rocky exterior. Achondrites, which come from the crust or mantle of these differentiated bodies make up only 5 percent of the stony meteorites that have been found.

So already this find was looking very interesting. Where might it be from? About half of the achondrites come from the large asteroid 4 Vesta. Others come from Mars, the moon, or other asteroids.

To answer the question of origin, the stone's chemistry had to be analyzed. Ralew shipped it to Tony Irving at the University of Washington. "Tony is where all the serious collectors go when they find strange meteorites," says Korotev, to whom Irving sends the "lunars" (possible lunar meteorites), which is what Korotev mainly studies.

Both the iron/manganese ratio of an asteroid and the ratios of its oxygen isotopes (variants of the oxygen atom) are thought to serve as "fingerprints" of its body of origin.

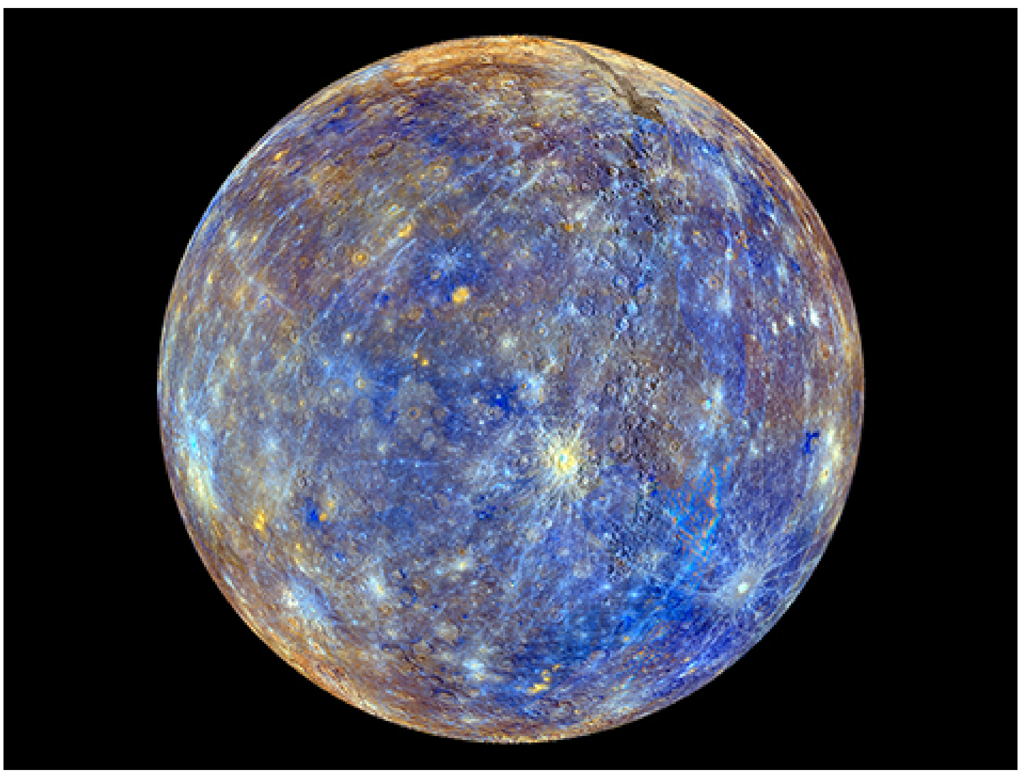
At the 44th Lunar and Planetary Science Conference in March, Irving said that the stone, now officially designated Northwest Africa 7325 (NWA 7325), had highly unusual chemistry. What's more, he said, the chemistry was suspiciously similar to that measured by NASA's Messenger probe, which is currently surveying the surface of Mercury from orbit.



The large asteroid 4 Vesta is the parent body for roughly half the achondrite meteorites, but it doesn't have the right chemistry to be the parent of the mystery meteorite. Credit: NASA/JPL-Caltech/UCal/MPS/DLR/IDA

"It is high in magnesium and very low in iron, which is what they're seeing on the surface of Mercury," Korotev, who attended Irving's talk, says. "But it's got more plagioclase (an aluminum containing mineral) than they're seeing on the surface of Mercury and it plots funny in 'oxygen isotope space.' It's plotting in a region of oxygen isotope space where we've never had meteorite data points before—except for a few ureilites, which also have oddball chemistry."

Some chemical ratios didn't match, but Irving said that might be because the stone had been "excavated from depth," that is blasted into space by a collision that left a deep scar in Mercury.



This colorful view of Mercury was produced from images made by the Messenger space probe. The colors map the chemical, mineralogical, and physical differences between the rocks that make up Mercury's surface. Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

During the question and answer period after the talk, Tim McCoy, the curator of the meteorite collection at the Smithsonian Institution,

said that preliminary data suggested the meteorite had crystallized from the melt 4.5 billion years ago.

That made it implausible it was from Mercury, he said. Lunar highland rocks are 4.2 to 4.3 billion years old and Mercurian rocks should have crystallized at the same time or later than the lunar highland rocks.

That objection was persuasive to Korotev. "The moon began to crystallize 4.5 years ago," he says, "but we don't have any 4.5-billion-year-old meteorites from the moon, because all of those rocks would have been bashed to smithereens during the late heavy bombardment that pockmarked the moon with craters between 4 to 3.8 billion years ago."

Korotev once analyzed a series of glass bottles to see what made them green. The answer is various combinations of chromium and iron. The mystery meteorite includes minerals with much higher chromium content than any of the bottles, which explains its intriguing chartreuse color. Credit: Randy Korotev

"The same thing would have happened on Mercury," he said, "so the question is how did this rock survive for that long? There's no sign of it being brecciated, or busted up. "

"But if it's not from Mercury," he said, "then where is it from? That's really the question."

"It has very odd chemistry for a meteorite," Korotev. "If somebody had walked in with this chemical analysis and nothing else I would have told him that it wasn't a meteorite, just based on the chemistry," he says laughing.

After a moment, he adds, "They haven't talked about cosmogenic radionuclides yet. That would be really interesting."

Cosmogenic radionuclides provide a method for estimating how long a rock has been exposed to solar wind particles streaming off the sun and cosmic rays. "If this stone had exceedingly high cosmogenic nuclides," Korotev said, "that would be an argument for it coming from Mercury, because Mercury is so close to the sun.

In the meantime the Meteoritical Society, which adjudicates all matters having to do with meteorites, has classified NWA 7325 as "achondrite ungrouped," meaning that they believe it is a stone from a differentiated body like a planet or big asteroid but beyond that they are agnostic.

Although Korotev can't say where the meteorite comes from, he can say why it is such a peculiar green. The green comes from a silicate mineral laced with chromium.

"I once analyzed bottles to see what made them blue or green," Korotev says. The greenest bottle had 660 parts per million chromium, but some of the mineral components of NWA 7325 have 7,000 parts per million chromium. That's why it's green."

But the bigger mystery is as yet unsolved.

Provided by Washington University in St. Louis

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