Traces of the oldest meteorite impact?

In trying to piece together the origin of the continents and the early history of the earth, scientists turn to the oldest rocks on the planet, dating from the Archean eon 2.5 billion to at least 3.7 billion years ago. But there are only three sites in the world where rocks that were exposed at the surface during the Archean have remained relatively unaltered. Now, at two of these sites, researchers from Louisiana State University in Baton Rouge have identified layers of tiny spherical silicate grains that they suspect are the debris from meteorite impacts – the oldest known impacts on the earth.

If this interpretation is correct, then "we can start to quantitatively assess . . . the rate of meteorite impacts . . . during the Archean and whether [meteorites] played a more significant role in shaping the outer part of the earth's surface then than they do today," says igneous petrologist Gary R. Byerly, who co-authored a paper describing the finds with sedimentologist Donald R. Lowe in the January GEOLOGY.

But before scientists can start thinking about the cosmic consequences of these silicate spherules, Lowe and Byerly will have to convince their colleagues, some of whom have very different ideas about the origin of the grains. In particular, Maarten J. de Wit from the University of Witwatersrand in Johannesburg, South Africa, has concluded that similar spherules were originally formed during volcanic eruptions. De Wit will present his theory this March at the Lunar and Planetary Science Conference in Houston.

Lowe and Byerly discovered the silicate spherules in the course of mapping and sampling rocks from the 3.2-billion- to 3.5-billion-year-old geologic formation in South Africa called the Barberton Greenstone Belt. According to Byerly, other researchers had found similar grains at a few isolated spots in the Barberton greenstone in the past, but none had appreciated just how widespread the spherule layer is. Lowe and Byerly think the layer, which is as thick as 0.5 meter in some places, can be traced over an area of hundreds and possibly thousands of square kilometers.

While the structure of these particles suggests that they were formed by the quenching of liquid silicate – a process involved in both volcanic eruptions and meteorite impacts – the researchers think that the "immense" expanse of the layer is one factor favoring a meteorite impact. "It's almost inconceivable," says Lowe, "that the grains could be carried this far during volcanic processes."

Another of Lowe and Byerly's arguments against a volcanic origin is that the two kinds of spherules mixed in the layer differ so radically in composition that they could not have come from the same magma source. What's more, they say, the compositions match those of the underlying rocks had they been thrown up and melted by the force of a meteorite impact. Lowe notes that there are no glass shards or other volcanic materials in the spherule layer, and he says there are cracks in the rocks that might have been produced by an impact.

The researchers also discovered Archean spherules in western Australia and most recently found two more spherule layers in South Africa. Lowe and Byerly are less certain whether these were formed by meteorite impacts.

De Wit says he holds to the volcanic idea because spherules with the same internal textures as those found by Lowe and Byerly are commonly found embedded in "pillows" of lava in many Archean greenstone belts. Some scientists have suggested that the spherules were created when one chemical compound separated from the rest of the liquid lava. De Wit suggests that the spherules studied by Lowe and others were released from the hardened lava through erosion because the lava matrix was more susceptible to weathering than were the spherules. Because there were so few of these embedded spherules in later times, there must have been some volcanic process operating in the Archean that is no longer common, he says.

If the meteorite interpretation is right, it will have a bearing not only on earth processes but on the history of the solar system as well. The spherules found in South Africa and Australia resemble chondrules, or spherical particles found in chondritic meteorites and in lunar soils. According to Elbert A. King at the University of Houston, scientists have been arguing over the origin of chondrules for two centuries. If Lowe and Byerly are correct, then more chondrules might be formed by impacts – occurring on the parent bodies, which eventually are broken into meteors – than previously imagined, he says. "And if that's true," says King, "then large impacts probably play an even more major role in early solar system history than we now believe." *– S. Weisburd*

Ammonia power for energy efficiency

At a time when a 1 or 2 percent increase in the efficiency of an electricity-generating power plant can mean millions of dollars in fuel savings, the claim of a 10 percent or greater improvement is both hard to believe and tantalizing. Such savings are possible, says Houston inventor Alexander I. Kalina, if the water normally used in boilers is replaced by an ammonia-water mixture.

When water is heated, its temperature rises until it reaches the boiling point. The temperature then stays constant until all the water turns to steam; further heating raises the steam's temperature. An ammonia-water mixture behaves differently. Its boiling point doesn't stay constant but changes. As a result, when heated to make ammonia vapor and steam, the mixture absorbs energy more efficiently than does water alone.

The idea of using an ammonia-water mixture is an old one. However, Kalina solved a problem that previous engineers had failed to master. He invented a way of condensing the ammonia-water mixture at standard temperatures and pressures so that it can be recycled.

"Instead of a simple condenser," says Myron Tribus, director of the Center for Advanced Engineering Study at the Massachusetts Institute of Technology, "you have this combination distillation, condensing and mixing unit. However, the overall gain in efficiency is quite impressive."

Last week, Tribus, who has been studying the theoretical thermal properties of ammonia-water mixtures, organized a seminar to explain how the Kalina cycle works. "The conclusion was that this was a promising cycle that ought to be developed further," says Tribus.

Later this summer, the Fayette Manufacturing Corp. in Tracy, Calif., will begin building a 6.5-megawatt power plant, which it hopes will demonstrate that the Kalina cycle works in practice. The company holds a worldwide, exclusive license covering Kalina's patented technology.

So far, the utility industry has shown some interest but has been reluctant to jump into a still unproven technology. The Electric Power Research Institute, based in Palo Alto, Calif., is just starting to study ways in which current power plants can be modified to take advantage of the Kalina cycle. The cycle works with any kind of heat source, from nuclear to geothermal, says Fayette's H.M. Leibowitz.

Typical power plants now run at perhaps 35 or 37 percent efficiency, says Tribus. Schemes have been proposed that raise the efficiency to 45 percent. The Kalina cycle could take that as high as 55 percent, he says.

"There's an intense competition in this field," says Tribus, "but at the moment, [the Kalina cycle] looks as though it has a very distinct advantage over other systems." *– I. Peterson*