Astronomy

Ron Cowen reports from Houston at the annual Lunar and Planetary Science Conference

The case of the misclassified meteorite

For 8 years, researchers had classified a meteorite found in the Allen Hills of Antarctica as a fairly ordinary chunk of rock—a fragment gouged from a familiar resident of the asteroid belt. Tucked away in a nitrogen-filled cabinet at NASA's Johnson Space Center in Houston, the meteorite has borne its commonplace label ever since its discovery in 1984.

That's how things stood until last October, when David W. Mittlefehldt, a geologist with Lockheed Engineering and Sciences Co. in Houston, examined a thin slice of the carefully preserved rock. A detailed analysis of its chemical composition has now stripped the 1.9-kilogram meteorite of its plebeian origin and assigned it celebrity status. The Allen Hills meteorite doesn't come from an asteroid, reports Mittlefehldt, it comes from Mars.

Only the 10th meteorite known to originate from the Red Planet, the Allen Hills rock is the first meteorite identified as having formed beneath the Martian surface. Because of its underground origins, it may provide a wealth of information on the geological processes that helped shape the planet, Mittlefehldt says.

When Mittlefehldt first sampled a section of the meteorite, he wasn't thinking about Mars. He simply wanted to take a close look at a meteorite that researchers had classified as a diogenite. This type of rock is believed to have come from a well-studied asteroid, 4 Vesta.

A devotee of diogenites for several years, Mittlefehldt analyzed the mineral content of the Allen Hills fragment, known as ALH84001. To his surprise, the mineral composition indicated that the meteorite wasn't a diogenite and couldn't have come from 4 Vesta. But the chemical fingerprints did match those of the nine known meteorites believed to be pieces of Mars.

Mittlefehldt says he first suspected that scientists had misclassified ALH84001 when he found an iron oxide with an abundance of triply ionized iron, a characteristic of Martian meteorites. In contrast, the same oxide in diogenites contains iron in the doubly ionized form. The chemical form of sulfide minerals in the meteorite clinched the Martian connection, he says.

One of the most remarkable features of ALH84001 is its concentration of carbon compounds, which may be higher than for any of the other Martian meteorites, notes Mittlefehldt. The meteorite appears to have incorporated carbon dioxide at higher temperatures than the other rocks, indicating that it acquired the gas beneath the Martian surface, perhaps from magma fluids.

The higher pressure below the surface probably prevented more carbon dioxide from bubbling out of the rocky body; a significant fraction remained trapped in the meteorite as carbonates, he suggests. In contrast, other Martian meteorites probably incorporated carbon by soaking up carbon dioxide from the planet's atmosphere.

"This new finding is probably the first convincing case for [a tangible storehouse] of primordial carbon inside Mars," says Mittlefehldt.

NASA/Johnson Space Center

Pieces of the meteorite ALH84001 stored at NASA's Johnson Space Center.

Chemistry

Richard Lipkin reports from San Diego at a meeting of the American Chemical Society

The unbearable lightness of heating

When a person wants to measure temperature, the first thing that comes to mind is a thermometer. But in certain hard-to-reach environments, a thermometer proves too bulky.

Now, scientists report a noninvasive thermometer that can also measure pressure and viscosity of a small number of molecules in a microscopic environment. They do it with light.

Dor Ben-Amotz, a chemist at Purdue University in West Lafayette, Ind., reports a new optical probing system that he calls molecular fluorescence thermometry. "We mix dye molecules into liquids or solids and use them as molecular spies to relay information about their environments by emitting and scattering light. They are reliable for conveying accurate information about temperature, pressure, viscosity, film thickness, and physical composition, even under conditions where all of these parameters are changing simultaneously."

In essence, Ben-Amotz' system pipes a light source through a fiberoptic cable to a tiny probe, which scans a small region of a material. A computer then decodes the light returning from the sample for information on temperature, pressure, and viscosity.

Typically, scientists use spectroscopy to study light from glowing objects, such as stars, to ascertain their elemental and structural makeup. "We're doing the same thing," he adds, "but we're looking for different information in the light."

To determine temperature, Ben-Amotz either measures light scattered by hot and cold molecules or uses a light-emitting dye mixed into the material, leading to measurements accurate to within 1°C. To ascertain pressure, the system measures changes in the molecules' vibrational frequencies as they are squeezed. This information shows up as small shifts in the color of the light that the vibrating molecules scatter. For viscosity, the system watches the rate at which large dye molecules rotate within a fluid, since they spin more slowly as a fluid thickens.

"With this system, we can work with living cells, circuit boards, computer chips, or nanoscale machines while they are under a microscope, without harming or touching them," Ben-Amotz says. Industrial applications will include measuring the properties of lubricating oils between ball bearings, gears, and machine parts while they operate.

Ben-Amotz says that details will appear in an upcoming issue of the JOURNAL OF ANALYTICAL CHEMISTRY.

A better Band-Aid?

Skin loss can be life-threatening for victims of severe burns. For example, people who lose 20 percent or more of their body skin need immediate protection from infection, as well as a bandage that promotes quick healing.

Ideally, the bandage should cover the wound, support healing, prevent infection, and then dissolve away. Jack G. Winterowd, a polymer chemist at Weyerhaeuser Corp. in Tacoma, Wash., working with physicians at the University of Washington in Seattle, has been experimenting with just such a bandage.

Made of naturally occurring chitosan derived from crustacean shells (SN: 7/31/93, p.72) and calcium alginate derived from seaweed, the bandage slowly releases an epidermal growth factor that supports natural skin healing at the wound site. It also fends off infection-causing fungi and bacteria.

"Showering the wound steadily for several days with low doses of growth factor" derived from mouse salivary glands, Winterowd says, causes the skin to begin regenerating. The steady shower comes from growth factor microencapsulated in calcium alginate particles embedded in the chitosan film.

In the presence of alkaline saline and lysozymes at the wound site, Winterowd says, the bandage's "hydrogel film"—similar to soft contact lens material—simply dissolves. Animal tests, he says, will begin soon.