Digging at the dolomite dilemma

In geology, the present is often the key to the past. One curious exception to this rule is dolomite, a magnesium-calcium carbonate (limestone). The "dolomite problem," as it has come to be called, arises from data collected earlier this century indicating that considerably more dolomite formed on the ancient earth than is forming today. Why this is so, and how the mineral is created, even in modern settings, are subjects of lengthy debate.

A new paper by David N. Lumsden at Memphis (Tenn.) State University presents the first measurements of dolomite deposited in deep-sea sediments over the last 150 million years. These data verifiy the earlier indication that dolomite production has decreased with time. But what is new is Lumsden's finding that, superimposed on this general decline, there are large fluctuations in the dolomite levels. And these fluctuations appear to be in tune with the rising and falling of the global sea level — a discovery that may help scientists refine their thinking about how dolomite is made.

" . . . there probably is no mineral . . . about which so much has been written and about which we know so little. Lumsden has pulled together the first decent data set, which shows some very interesting relationships," writes Bruce Wilkinson of the University of Michigan in Ann Arbor in the November GEOLOGY, in which Lumsden's paper appears.

Lumsden examined the reported dolomite content of 844 marine sediment samples cored during the Deep Sea Drilling Project from 127 sites in the Atlantic Ocean, Pacific Ocean, Mediterranean Sea, Red Sea, Black Sea and Gulf-Caribbean. In general, he found peaks in dolomite production at about 130 million years ago (Ma), 110 Ma, 90 Ma, 50 Ma and 10 Ma. The similarities of dolomite records at widely spaced sites convinced him that the fluctuations in dolomite concentration were not random, but were due to the same global cause. Lumsden believes that cause is tied to sea level changes; periods of low dolomite formation appear to have corresponded to low sea levels, and dolomite peaked at high sea levels.

Lumsden suspects that the link between sea level and dolomite production lies with shallow-water shelves, which are thought to provide a favorable environment for dolomite formation. According to one theory, the high evaporation rates in these areas selectively enrich the remaining water in magnesium, which can then change calcium carbonates in the underlying sediments into dolomite. At low sea levels these areas dry up, while at high sea levels more shallow water is created. The general trend of decreasing dolomite also indicates that shallow marine environments were more plentiful 150 million years ago than now — an idea also compatible with the existing picture of the Atlantic seafloor being higher at that time.

Changes in sea level may also affect the chemistry of the oceans and atmosphere, which in turn influences the production rates of dolomite. In fact, Wilkinson and others have proposed that chemistry changes over the last 600 million years have been responsible for variations in the relative abundance of two different structural forms of calcium carbonate called calcite and aragonite. Lumsden presents "the first data on dolomite that we can try to relate to that general scenario," says Wilkinson. At this point, Lumsden says, it's still hard to sort out the roles different factors play in dolomite production, but he believes his data indicate that sea level changes, and not geochemistry, are the dominant control.

Whatever the exact forces driving dolomite formation, Lumsden's recent marine data and any future studies of the much older continental record of dolomite are likely to help scientists unravel the dolomite problem. And understanding how dolomite is created may have benefits beyond satisfying scientific curiosities. A significant portion of the world's oil lies in dolomite rocks, and without a conceptual model of how these rocks form, geologists cannot very well predict where oil companies should drill, says Lumsden. "The person who solves the question of the origin of dolomite," he says, "might well . . . improve our ability to exploit those reservoirs."

— S. Weisburd

Radioactive imaging: Snapshots of the heart

Getting a precise idea of what's going on inside a living, beating heart without stopping it or removing a slice has long challenged cardiologists, who have come up with a variety of ways to go about it. At the recent American Heart Association meeting in Washington, D.C., researchers discussed two new methods that they say offer benefits over other techniques. One method shows atherosclerosis in its earliest stages, and the other outlines the exact portion of heart muscle injured in a heart attack.

The atherosclerosis imaging is done with low-density lipoprotein (LDL), one of the proteins that carry cholesterol in the blood. Robert S. Lees of the Massachusetts Institute of Technology and his colleagues from two Boston hospitals have devised a way to purify LDL from a person's blood, tag it with a radioactive substance and inject it back into that person.

Some of this "hot" LDL, like normal LDL, gets taken up by newly forming atherosclerotic plaques. Within a day of injection, the patient is "photographed" with a gamma radiation counter; the resulting picture shows the location of radioactive LDL, and thus where plaque is forming.

Lees and his colleagues have so far looked at 15 patients, who ranged from severely atherosclerotic to disease-free. The researchers have seen no adverse reactions to the regimen, possibly because use of the patient's own LDL keeps the body from mounting an immune response.

Lees hopes the technique will prove useful both as a way to find atherosclerosis before it becomes life-threatening and in monitoring the efficacy of anti-atherosclerotic treatments such as drugs or diet change. The process offers advantages of over other ways of detecting early atherosclerosis: It is safer than X-ray dye studies and more precise than ultrasound, Lees says.

Atherosclerosis can lead to a heart attack, and heart attacks present imaging problems of their own. Determining the extent of injury to the heart muscle is important because it lets doctors know how aggressively to treat a patient.

Dead heart cells release a protein, myosin. Ban-an Khaw, Edgar Haber and their colleagues at the Massachusetts General Hospital in Boston and at the biotechnology firm Centocor in Malvern, Pa., have developed a radioactively labeled antibody to myosin, which can be used to evaluate the extent of a heart attack.

The radioactive antibody is injected into a patient following a heart attack, and concentrates itself wherever there is extracellular myosin. Within about a day the radioactivity is checked on a gamma camera.

While current imaging processes depict blood flow through the heart muscle, they don't necessarily differentiate dead tissue from tissue that is still alive but receiving little blood, notes H. William Strauss of Mass. General, who has been involved in the development of both the radioactive LDL and myosin antibody.

Antimyosin is currently under evaluation at four U.S. institutions, and trials are scheduled to begin soon in Europe. Harvey Berger, who is using it at Emory University in Atlanta, has so far imaged about a dozen patients. He says he has seen no side effects, including no reaction against the antibody. But whether the process can be repeated on a patient, or whether the patient will eventually mount an immune reaction against the antibody, remains to be seen.

— J. Silberner