First liquid permanent magnet predicted

Magnetic states occur in bulk samples of solid materials when the magnetic moments, or intrinsic magnetic fields, of the atoms line up in orderly patterns. Ferromagnetism is the state in which all the magnetic moments line up in the same direction and cooperate to produce an overall magnetic field.

The fairly rigid arrangement of atoms in a solid is a definite advantage, and, it would seem, virtually a necessary basis for this kind of cooperation. The structure of liquids or gases appears too chaotic for it. Yet there is a liquid that should actually show a ferromagnetic state, according to A. J. Leggett of the University of Sussex in England. It is superfluid liquid helium-3 in the so-called A phase.

Writing in the Dec. 15 NATURE, Leggett points out that it has often been remarked that this phase of superfluid helium-3 possesses "orbital ferromagnetism," but it seems that the term is used metaphorically to refer to the electronic structure of the liquid and not to the existence of any overall magnetism. Leggett proposes that the liquid should be "quite literally ferromagnetic" with a detectable overall magnetism that should have experimental consequences. As such it would be the first natural liquid ferromagnet.

Superfluidity is a property that appears when liquid helium (either 4 or 3) is cooled to within a few degrees of absolute zero. It is a state characterized by a loss of viscosity and rather bizarre behavior. (The liquid flows through orifices that would normally be too small for it; it will climb the walls of its container in seeming defiance of gravity, etc.)

The accepted theory is that superfluidity comes about because the atoms of liquid helium bind themselves into pairs (called Cooper pairs) that travel together. Although the electrons belonging to the two atoms are rotating in opposite directions, they do not quite cancel each other's rotation. The way the electrons arrange themselves leads to a small net orbital angular momentum for the Cooper pair. This orbital angular momentum produces a magnetic moment. In the phase of liquid helium-3 that Leggett is dealing with, all these orbital angular momenta point the same way, so the magnetic moments should add up to an overall magnetism that is tiny but measureable. □

Generating hydrogen in magma deposits

Hydrogen is hardly a household fuel nowadays, but it is clean and efficient and, as fossil fuels are depleted, hydrogen is expected to come into more and more use. Already about 3 trillion cubic feet of hydrogen are used in the United States every year.

A group of physicists and geochemists at the Sandia Laboratories in Albuquerque, C. J. M. Northrup Jr., J. K. Galt, T. M. Gerlach and P. J. Modreski, has developed a method of producing hydrogen that uses water as a source. Because of the earth's huge resources of water, the method has a long-range potential that is virtually endless. Furthermore, it will also produce quantities of carbon monoxide, methane and steam.

The method sounds a bit futuristic but is possible, the Sandia group reports. It consists of reacting water with hot magma in the earth's crust. Ferrous iron contained in the magma would combine with oxygen from the water, and the leftover hydrogen would be freed. Laboratory experiments indicate that the best conditions are obtained by using magma at 1,200° C. This results in the conversion of three mole percent of the injected water to hydrogen. That translates into 500 pounds of hydrogen per hour if 20,000 gallons of water per hour is pumped into the magma body.

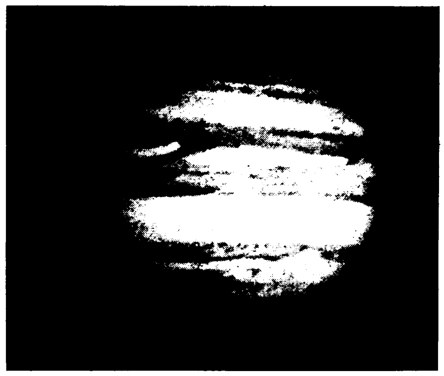
The best magma to use is the basaltic magma under the sea bed, which contains 10 to 12 percent ferrous iron. The magmas usually found under continental landmasses, andesitic and rhyolitic, contain five to seven percent and less than two percent ferrous iron respectively. Ten to 20 holes drilled into a magma with 12 percent ferrous iron could yield 26 billion cubic feet of hydrogen per year.

The hydrogen production can be increased by adding biomass, essentially organic garbage, such as sewage sludge, straw and stalks, bagasse from sugar cane production, or seaweed to the water. Water containing 10 percent biomass injected into a 1,300° magma would yield gases containing 10 percent hydrogen, four percent carbon dioxide, one percent carbon monoxide and a trace of methane. At lower temperatures hydrogen production becomes less efficient. With a 600° magma, methane production would dominate at about three mole percent, with two percent hydrogen and one percent carbon monoxide. Use of cooler magmas would not be practical.

But is it practical at all? The drilling is possible, the Sandia report says, but it is the greatest obstacle. However, there are some magma chambers within two or three kilometers of the ocean bottom. These should be reachable by an extension of present drilling technology.

If the method works out, it will provide a source of hydrogen that will not be tied to the supply of natural gas, from which most hydrogen produced today is made. Hydrogen is an attractive fuel for future use, but the large additional quantities needed for a "hydrogen economy" cannot be made by present methods, Northrup says. □

Rare gas found in Jovian atmosphere



Pioneer 10/NASA

Jupiter: Germane to turbulence.

A rare gas known as "germane," consisting of molecules containing one atom of germanium and four of hydrogen, has been identified in the atmosphere of Jupiter. Besides merely adding to the list of known Jovian components, however, it is said to be another sign of the highly turbulent state of the planet's atmosphere.

The gas was found by Uwe Fink and Harold P. Larson of the University of Arizona's Lunar and Planetary Laboratory and Richard R. Treffers of the Radio Astronomy Laboratory of the University of California at Berkeley. Spectroscopic studies made aboard NASA's Gerard P. Kuiper airborne observatory revealed a concentration of 0.6 parts per billion, an abundance similar to those of minor pollutants in earth's atmosphere. The germane spectra apparently came from a level in the Jovian atmosphere where the temperature was about 300°K (80.6° F), yet, says Fink, it would be expected at temperatures more like 1,000°K (1,340.6° F). The implication is that the substance was formed at greater depths, where such temperatures exist, then transported upward by convection. □

Asbestos: A threat by air or by water

Asbestos in the air is clearly a health problem. It causes both asbestosis, a painful lung disease, and cancer of the lung lining. Last month asbestos workers received more than $5 million in a suit against the government and several private firms. The workers held that negligence resulted in their exposure to asbestos on the job, leading to subsequent health damage.

But what about the effects of asbestos in the water? Those fibrous particles of silica and other elements contaminate many drinking water supplies. Some of the asbestos comes from mining operations, as in Minnesota where Reserve Mining has dumped fibers into Lake Superior. In the San Francisco Bay area, the pollution