Chemistry

Building up to be a metal

It sounds like a riddle: How many atoms make a metal? According to present-day theory, the atoms in a chunk of metal sit in an orderly, three-dimensional array, but each atom typically contributes one or two electrons that are free to roam throughout the lattice. Together, these itinerant electrons form a kind of electronic "sea" that gives a material its metallic quality.

The physical question is whether clusters containing only a few dozen atoms still display the magnetic, electrical and optical properties shown by the corresponding bulk metal. At some point, as the number of atoms in a cluster decreases, these tiny chunks of matter must lose their metallic character, and the electrons should no longer be free.

In the March 21 NATURE, Peter P. Edwards and his colleagues at the University of Cambridge in England and Cornell University in Ithaca, N.Y., report that certain magnetic properties characteristic of the bulk metal begin to appear when as few as 10 metal atoms are present. Although this result isn't necessarily true for other properties like electrical conductivity, it is an important step in probing the evolution of metallic characteristics.

The Cornell-Cambridge group investigated a set of molecular cluster compounds that consist of a clump of osmium atoms surrounded by a protective sheath of carbon monoxide molecules. In effect, each cluster has a tiny piece of metal at its center, while the sheath prevents the metal cores from aggregating to form larger particles of bulk metal. By measuring the magnetic susceptibility of these clusters, the researchers discovered that as the number of osmium atoms in a cluster goes from three to 10, the material increasingly takes on the magnetic properties expected of osmium metal.

The researchers now plan to extend their studies to larger clusters containing up to 40 metal atoms. This could reveal the stage at which electrons, initially bound to particular atoms, are actually set free within a material. Studies of large clusters may also help industrial chemists, for example, get a better idea of how big a metal particle must be before it acts effectively and selectively as a catalyst in a chemical reaction.

"There are certainly lots of systems in which metallic particles are used extensively," says Edwards. "At the moment, the physics and chemistry of these particles is not clear." In the future, by specifying the number of metal atoms needed within constituent particles, it may be possible to custom design improved catalysts, photographic emulsions, magnetic recording media, pigments and other products.

Extracting metals the molten way

Two chemists at the Argonne (Ill.) National Laboratory have discovered a simple, two-step method for extracting the metals cobalt and manganese from low-grade ores. The key element in the process is a molten salt that dissolves almost all of the cobalt or manganese found in crushed ore.

The required salt is a mixture of the chlorides of sodium, potassium and magnesium, which melts at a temperature near 750°F. The molten salt extracts cobalt and manganese while leaving unwanted materials behind in the depleted ore. The dissolved metals are then recovered as deposits on carbon electrodes when a low voltage is applied across the liquid mixture. Less than four pounds of the salt mixture are needed for every pound of ore processed.

The Argonne process, developed by Victor Maroni and Samuel von Winbush, provides an economical way of extracting the small amounts of cobalt and manganese found in ores now being mined for copper, nickel or iron. It is also compact enough to be used on ships or platforms fitted for deep-sea mining. Because the United States currently imports more than 90 percent of the cobalt and manganese it needs, the method may also have strategic value if these supplies are ever cut off.

Earth Sciences

Drilling program adrift without UK fee

January — the deadline for countries, money in hand, to sign up for the Ocean Drilling Program (ODP) — has come and gone. Canada, France and West Germany have each kicked in $2.5 million, as promised, for full annual memberships. But with Leg 102 of ODP's drillship *JOIDES Resolution* (SN: 2/2/85, p. 68) well under way, the United Kingdom has yet to marshal its funds; the UK's Natural Environmental Research Council (NERC) had tried unsuccessfully to persuade the country's Department of Energy, suffering from budget cuts, to reinstate its past contribution before the deadline.

Now the executive committee of JOIDES (Joint Oceanographic Institutions Deep Earth Sampling), which oversees ODP, is taking a hard line with the UK. In response to the UK's suggestion that it join as a part member, the committee recently passed a resolution that it would be "neither appropriate nor in the best interests of the program or other full members" for the UK's status to be anything short of its prior full partnership.

The unexpected loss of the UK's dues "has put a considerable pinch on our entire program," says Al Sutherland of the National Science Foundation (NSF). Already, plans for buying some instruments — both land-based and for the ship — have been dropped and the hiring pace has slowed. JOIDES institutions are now scrambling to set priorities and devise cutback strategies that will be presented to NSF in about a week. One possibly big cut, says Sutherland, would be to omit hard rock drilling at the Mid-Atlantic ridge. "But that is so important to the program ... [that] we'll do virtually anything before we have to drop it," he adds. Instead, Sutherland anticipates across-the-board cuts.

In the meantime, the UK has set its hopes on joining in the fall, for the new U.S. fiscal year (which is six months out of phase with Britain's). This may come to pass if NERC is allowed to carry over funds from this UK fiscal year to the next. The NSF has just sent NERC a memorandum of understanding making the UK a candidate observer until October — provided that the UK will promise to join as a full member in the fall. This would enable UK scientists to keep abreast of planning, but denies them active participation in meetings and cruises unless they are specifically invited. JOIDES is firm, however, that observer status will not be extended beyond September.

Great Salt Lake is rising in its feet

After another year of record snow and rainfall, the Great Salt Lake is still swelling. As of April 1, the waters had crept up to 4,209.55 feet — 2.2 feet greater than the value last year at this time and the highest level since 1878—and the spring melt is still to come. The historic high, reached in 1873, was 4,211.5 feet (SN: 3/17/84, p. 172). If the lake exceeds that level this year, it is not known how long it will stay that high or what the environmental impact will be, says geographer Paul A. Kay at the University of Utah in Salt Lake City.

Kay recently organized a conference on the state of predictions for Salt Lake water levels. Scientists at the conference reached a consensus, primarily for the benefit of state planners, that the lake will probably not rise above 4,218 feet in the next 50 to 100 years because the climate probably won't get and stay wet enough to do that, says Kay.

If the lake were to exceed 4,218 feet, it would spill over into deserts to the west and southwest, an event that is thought to have occurred at least three times over the last 6,000 years. Though the lake level has fluctuated in the geologic past, says Kay, a lot more work is needed to understand the frequency and duration of such changes. And because of the limited historical data, researchers also cannot say whether or not the extremely wet weather of the last few years is really unusual. There is some hint that the high rainfall, in both summer and winter, is related to El Niño, but this link has not been firmly established, Kay says.