Technology

Geothermal power from the Salton Sea

Hot, saline water from the earth's interior has begun producing electricity for southern California's Imperial Valley district at the 10-megawatt Salton Sea geothermal-electric project. The plant, which was designed, built and operated by Union Oil Co. uses several innovative techniques to extract usable energy from the hot, corrosive brine. This, and Union's older Brawley plant, also at Salton Sea, are the only operating hot-water geothermal plants in the United States.

Hot, dry steam is the most desirable and easily convertible form of energy from the earth, but it is also rare. Hydrothermal fluids—water heated and circulated by the high temperatures of the earth's interior—are more common but are harder to convert to electricity. At Salton Sea, water must be changed to steam to turn the turbines that generate electricity, and the dissolved gases and minerals in the water must be removed or they will corrode and clog the pipes and the generators. The water from the Salton Sea source is the most saline of any known geothermal source in the United States.

Both problems are solved by lowering the water's temperature and pressure. Water is pumped out of the ground from wells 3,000 to 6,000 feet deep. As it moves through vessels on the surface, the pressure is reduced and some of the hot water flashes to steam that is shunted off to the generators. At lower temperature and pressure, minerals come out of solution to form a sludge at the bottom of the vessels. This is separated from the "clarified brine" that is reinjected into the earth. The sludge is hauled away to a dumpsite except for the little bit that is mixed with fresh incoming brine at the start of the process. This little bit acts as seed crystal that helps minerals in the new brine come out of solution more easily.

The Salton Sea plant, which has been operating since July 1982, had its opening ceremonies on Jan. 19. A spokesman for Southern California Edison, the utility buying the power from Union, said they were generally pleased with its operation so far. The U.S. Geological Survey estimates that the Salton Sea resource could produce up to 3,000 megawatts of power. Meanwhile, the Department of Energy announced in late December that it has granted conditional approval for a loan of up to $99.6 million to Republic Geothermal Co. and Parsons Engineering for a 25-megawatt facility on the Salton Sea.

Charged particles upset space hardware

A cosmic ray nucleus passing through the sensitive electronics of a satellite could alter its programing or permanently damage delicate circuits. A nuclear reaction from a colliding proton could do the same. Although this effect has not significantly disrupted the operation of recent satellites, says Peter J. McNulty, a physicist at the Clarkson College of Technology in Potsdam, N.Y., it could happen as satellites with more sophisticated and sensitive electronics are flown. McNulty discusses the physics of this effect in the December PHYSICS TODAY.

The collisions are called single event upsets (SEUs). They can change binary information in a memory from a 1 to a 0 or vice versa (a "soft error"). A collision can also damage a circuit by freezing it into one logical configuration (a "hard error") that might cause voltage surges and more serious damage. SEUs might turn devices on and off for no obvious reason or render them inoperable.

To get space-based data on the problem, NASA and the Air Force are jointly developing the Chemical Release and Radiation Effects Satellite. Its purpose is to study electron and proton belts and heavy nuclei in space that could affect future satellites. It will also measure the energy spectra of collisions using microdosimeters, miniature radiation counters. Although the satellite does not yet have final approval, NASA has budgeted funds for it, according to McNulty.

Earth Sciences

Ears, bats and early moths

Moths in the family Noctuidae are equipped with tympanic organs, essentially devices that act as ears, enabling the insects to detect the ultrasonic signals that bats use to locate prey. These organs help the moths avoid attack, and were believed to have evolved to help them cope with the bat threat. The earliest bats are known from fossils from the early Eocene Period, about 50 million years ago. Now, the discovery of a 75-million-year-old fossil egg from a noctuid moth suggests that the Noctuidae family evolved much earlier than the bats, and that tympanic organs may have developed in response to threats from other flying predators. The finding is puzzling because the fossil record has not revealed similar flying predators that, like bats, use high frequency signals to locate their prey.

Lawrence F. Gall and Bruce H. Tiffney of Yale University report in the Feb. 4 SCIENCE that they found the moth egg in sediments 75 million years old in Martha's Vineyard, Mass. The surface of the ovular egg is marked by strong ridges, more pronounced than those seen in modern eggs. A pattern of low ridges on the surface is similar to that of modern noctuid eggs, leading to its designation as a noctuid. The affirmation that the moths were present 75 million years ago, during the Cretaceous period, supports the proposed timetable for moth evolution. It also suggests, say the researchers, that the noctuids "are important as possible pollinators of angiosperms," the flowering plants that also were evolving near the end of the Cretaceous period, and into the following geological age. The discovery of the egg "indicates that there may be a co-evolutionary relationship [between the moths and the flowering plants] going back at least that far," says Gall. That assumption is more tenuous than the development of tympanic organs. A fossil moth would be helpful; in its absence, the scientists entertain two speculations. Says Gall: "Either the Noctuidae didn't have ears, or if they did, those ears developed before bats were around."

Erosion may alter ice core records

Cores of ice drilled from the world's ice sheets often are considered to encase a relatively unblemished record of the earth's climate history. But the information locked into these frozen archives may need correction after all, reports a team of researchers studying two cores from an ice cap on Ellesmere Island, Canada. They write in the Jan. 20 NATURE that winds, especially in winter, may erode part of the snow that had been assumed frozen in place, and that interpretations based on incomplete cores may be distorted.

The findings are based on comparisons of ratios of isotopic oxygen ($^{18}O/^{16}O$) in cores taken from two sites one kilometer apart. One core is from the top of a hill, the other from downslope. When the researchers studied the isotopic content of the cores, they found that the upper layers of ice from the core at the top of the ridge contained 2.5 parts per thousand more ^{18}O than the core from downslope.

The measurements indicate that the temperatures at the top of the hill were 3°C to 4°C warmer than at the bottom. "This is an impossible difference," says David Fisher of Canada's Department of Energy, Mines and Resources in Ottawa. Fisher, Roy Koerner of the same agency, and colleagues attribute the difference to turbulent winds that erode the soft winter snow. About 30 percent of the total accumulation is removed from the more exposed hilltop, and thus is not frozen into the ice, Fisher says. The core from the more protected slope is not eroded, and thus does not reflect the same distortion. The difference does not persist deeper than ice accumulated in the last 3,000 years, the period during which the ice now on the slope began to flow downhill.

Analyses of ice cores taken from Greenland (SN: 6/19/82, p. 408) and from Antarctica, where ice sheets flow over rolling terrain, may require correction for similar distortions.