Earth Sciences

Is the core pure iron no more?

Our planet has a heart of iron. In the 50 years since the earth's inner core was discovered, scientists have concluded that while the liquid outer core is made of an iron alloy, the solid inner core is pure, crystalline iron.

Now, in the Jan. 22 NATURE, two geophysicists argue that the inner core is not as pristine as once thought. Andrew Jephcoat at the Carnegie Institution of Washington (D.C.) and Peter Olson at the Johns Hopkins University in Baltimore conclude that some element lighter than iron, such as sulfur or oxygen, is also contained in the inner core. They arrived at this conclusion by comparing the inner core density, as calculated by seismologic studies, with the densities estimated from laboratory measurements of pressurized iron and iron sulfide samples.

According to Raymond Jeanloz at the University of California at Berkeley, who comments on the paper in NATURE's News and Views section, if Jephcoat and Olson are correct, then further work may enable researchers to determine the temperature at which the inner and outer core compositions coexist. And since the inner core is small, he adds, this is akin to finding the temperature at the center of the earth.

Jephcoat and Olson's conclusion may also help scientists understand the energy source that drives fluid motions in the outer core (which generate the planet's magnetic field) as well as the convection of the material in the mantle. A major theory holds that outer core motions are driven by compositional differences between the inner and outer cores; dense, iron-rich crystals solidify from the less dense, alloy liquid and sink toward the inner core, stirring up the outer core fluids in the process.

Jephcoat and Olson write that compositional differences may still contribute to outer core fluid motions, although the compositional differences between the inner core and the outer core are not as great as scientists once thought. But because the compositional mechanism is most efficient at low core temperatures, they favor another theory in which the radioactive decay heats the core and the mantle, driving convection in both regions.

Flying high on a basement fossil find

The fossil legacy left by past species usually consists only of bones, because the soft parts of animals normally decay before fossilization. But recently, while cleaning some stored specimens of extinct dolphin-like reptiles called ichthyosaurs in preparation for display, curators at the Leicestershire Museums in England discovered that some of the animals' skin, tendons, muscle and connective tissues were exceptionally well preserved.

Michael Taylor, an assistant keeper at the museums, reports in the Jan. 29 NATURE that the soft parts are preserved as finely detailed mineral casts. This occurred after bacteria and fungi, which had first decomposed the original tissue, were killed and preserved by their own waste products, mainly calcium phosphate or apatite minerals.

According to Taylor, the soft tissues around the forelimbs indicate that they acted as hydrofoils and have been used to support a recently proposed theory that some ichthyosaurs, like present-day penguins, "flew" underwater with their forelimbs and used their tails only for steering. The mainstream thinking is that the animals used their large tailfins primarily for propulsion.

Sadly, more fossils that might resolve the swimming question are probably not forthcoming, he says, because there are few hand-dug quarries from which additional well-preserved fossils might survive excavation. So, he adds, "the paleontologist must excavate in the museum cellar."

Science & Society

Delaying DOE's radwaste program

Where to put high-level radioactive waste now accumulating at nuclear power plants and other nonmilitary nuclear facilities has been a longstanding problem. The latest announcement from the Department of Energy (DOE) puts the answer even farther away. DOE has now concluded that it needs an extra five years before it can begin operating a permanent repository for high-level nuclear waste. That extension would push such a facility's opening date from Jan. 31, 1998, into the year 2003, throwing into disarray the schedule mandated by Congress in the Nuclear Waste Policy Act of 1982 (SN: 1/1/83, p.6).

The department cited delays in the consultation process leading to selection of three candidate sites for the first repository as one of the main reasons for its request for an extension (SN: 1/5/85, p.6). According to DOE's draft amendment to its "mission plan" for the civilian radioactive-waste management program, "additional time is needed . . . to collect needed technical information and to consult with states and affected Indian tribes as well as provide for public participation in the process."

At the same time, DOE's revised plan reaffirms the department's intention to postpone site-specific work on a second repository until the mid-1990s or later (SN: 6/7/86, p.359). Furthermore, DOE plans to submit to Congress a proposal for establishing a facility designed for temporary storage of high-level radioactive waste. That action will occur as soon as legal issues are resolved (SN: 5/4/85, p.277). DOE's preferred site for a "monitored retrievable storage" facility is a cleared area at the Clinch River near Oak Ridge, Tenn., but the state, fearing that the facility may become permanent if it is built, has sued the federal government.

After a 60-day comment period, DOE may, where necessary, revise its draft amendment in response to comments received. Then the department intends to submit the final proposal to Congress. How Congress will react to DOE's change in plans isn't clear yet.

Upgrading basic science education

The National Science Foundation (NSF) last month launched a new, $25 million program to improve science education. According to NSF, the program will be aimed at producing "a consistent and coherent pattern of basic science education throughout elementary and high school." As a first step, the foundation awarded $6.6 million in grants to three private research centers that will work with textbook publishers and selected schools to develop new teaching materials for children in kindergarten through the sixth grade.

"We are failing to provide an adequate background, an adequate introduction and an adequate level of science literacy for the population as a whole," says Bassam Shakhashiri, NSF's assistant director for science and engineering education. "In a technological world, where we compete with equally sophisticated countries, we cannot afford to focus only on the next generation of Nobel Prize winners."

Over the next decade, NSF expects to spend a total of $25 million on the project. Participating publishers are required to match NSF funds. They will be responsible for testing the new materials in classrooms, for training teachers in their use and eventually for marketing the curricula.

Among the announced grants was a $2.2 million award to the Technical Education Research Centers in Cambridge, Mass. Staff at those centers will work with the National Geographic Society in Washington, D.C., which will contribute at least an additional $2.5 million, to develop science units for grades four through six and a telecommunications system that would allow students in about 4,000 schools throughout the country to gather and share data on topics such as acid rain.