Paleobiology

Earliest evidence of complex life

Most rocks from the first half of Earth's history—the Archean eon—are so aged that they have grown geologically senile. That is, they have lost their molecular memories storing information about what was alive on the ancient planet. Researchers in Australia, however, have now found stones with uncanny recall that fill in critical details about early evolution.

The buried shale deposit from northwest Australia reveals that complex cells called eukaryotes existed at least 2.7 billion years ago, pushing back the earliest record of these organisms by about a billion years, report Jochen J. Brocks of the University of Sydney and his colleagues. They describe their find in the Aug. 13 SCIENCE.

The earliest life on the planet, which appeared at least 3.5 billion years ago, consisted of prokaryotes, such as bacteria. These one-celled organisms lack a nucleus, a cellular skeleton, and many evolved features. Such adaptations all appeared later within eukaryotes—the group including animals, plants, fungi, algae, and such unicellular creatures as amoebas.

The Archean shales that Brocks and his colleagues examined had endured too much heat and pressure to preserve any fossilized cells, but they did contain biochemical remnants of eukaryotes. Researchers call these molecular fossils.

"It was known that these shales were well preserved, but it was completely unexpected to find molecular fossils," says Brocks.

The researchers detected compounds called steranes, derivatives of molecules similar to cholesterol that provide telltale evidence of eukaryotic cells. In the past, searches for such molecules have been hampered by contamination from much younger cells.

In the same issue of SCIENCE, Andrew H. Knoll of Harvard University says, "Brocks and colleagues painstakingly executed laboratory procedures designed to eliminate the possibility that younger biomarkers migrated into their Archean rocks."

The new evidence suggests that eukaryotes appeared by the late Archean, but it doesn't tell what those organisms were or whether they had nuclei, says Brocks. Last week, he started testing 3.2-billion-year-old rocks for signs of steranes.

If eukaryotes appeared so early, they spent more than a billion years biding their time. They didn't start to diversify until between 1.2 billion and 1.0 billion years ago. Some researchers explain the delay by contending that eukaryotic evolution took off only after the advent of sexual reproduction. Others argue that these organisms required a surge in the oxygen content of the oceans.

A wrinkle in the oxygen story comes from other hydrocarbon molecules discovered by Brocks' group in the Archean shales. These biomarkers provide evidence of cyanobacteria, the group of photosynthetic bacteria that produce oxygen. Though these organisms were churning out oxygen during the Archean, the marine abundance of this gas didn't start to rise until 2.2 billion years ago and may have increased in stages over the next 1.5 billion years, says D.E. Canfield of Odense University in Denmark, commenting on a related study in the Aug. 5 NATURE. —*R.M.*

Cancer in the Jurassic ward

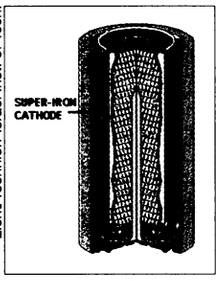
A beautiful dinosaur bone found in western Colorado shows evidence of malignant cancer, the oldest record of this disease, report researchers in the July 31 LANCET.

The bone fragment, filled with colorful agate, has a hole in its internal scaffolding, and in places its outer layer has been eroded almost all the way through. The pathology closely resembles that of metastatic bone tumors in humans, says Bruce M. Rothschild of the Arthritis Center of Northeast Ohio in Youngstown. He previously found benign tumors in dinosaurs and contemporary animals.

"Cancer is an old disease, and knowing how old is useful for looking at when in evolution the propensity toward cancer developed," he says. —*R.M.*

Technology

New battery feeds electron-hungry iron



Licht/Technion-Israel Inst. of Tech.

An unusual iron compound gives this super-iron battery greater energy capacity than an alkaline battery.

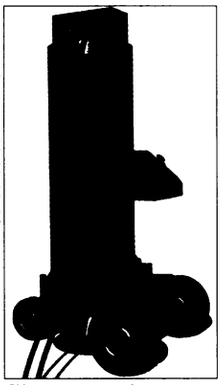
Some salts contain iron atoms that are starved for electrons. In so-called iron (VI) compounds, the iron atoms are missing six electrons rather than the usual two or three. Now, chemists at the Technion-Israel Institute of Technology in Haifa have developed a type of battery whose electron-absorbing positive terminal, or cathode, is made from such salts. These "super-iron" batteries can store in excess of 50 percent more energy than conventional alkaline batteries of the same size, report Stuart Licht and his colleagues in the Aug. 13 SCIENCE.

Moreover, "there is a lot of promise to making the unusual super-iron materials used in the new battery very cost effectively," Licht says. The researchers have patented the technology.

Manganese dioxide molecules in conventional battery cathodes can only accept one electron apiece, whereas each iron (VI) atom in the salts can absorb three electrons.

Although scientists knew for more than a century that iron (VI) compounds have the potential to make good electron sponges, they considered the compounds too unstable to be of practical use. The Israeli researchers say they have solved that problem by eliminating nickel and cobalt impurities that were causing the salts' rapid breakdown. —*P.W.*

Targeting yammering jackhammering



Consolidated Edison Co. of N.Y.

Illustration shows commercial version of quiet pavement breaker standing about 1.5 meters tall.

A muted, concrete-busting gas gun on wheels might one day banish chattering jackhammers from streets and highways. Projectiles fired straight down by the silencer-equipped gun can fracture concrete roadways efficiently and relatively quietly, says Robert E. Hall of Brookhaven National Laboratory in Upton, N.Y.

Hall leads a group that has built a 4.5-meter-long experimental model that can break up 8-inch-thick reinforced concrete. In late September, the group expects to start building a smaller but equally effective version intended for commercialization.

The inventors envision that construction crews would use remote control to roll the pavement-busting machine, which they call RAPTOR, down a street. As it wheels along, the machine would fire at intervals of 30 seconds to a minute. It would shoot steel nails deep into the road, creating cracks running the 8 to 10 inches from nail hole to nail hole.

In about half the time that is required by a jackhammer, "you can cut a line or a circle or a square. It depends what you want," Hall says.

Baffles will keep gun noise below 80 decibels, Hall says. That's about the loudness of a doorbell. Jackhammer blasts are up to 10,000 times as loud and are augmented by air compressor noise. Quiet, bottled gases provide the pressure for the nail shooter.

Hall says that utility companies backing the research hope that eliminating jack hammers will cut the rate of worker injuries and reduce construction noise enough to lift some municipal restrictions on the hours when work can take place. —*P.W.*