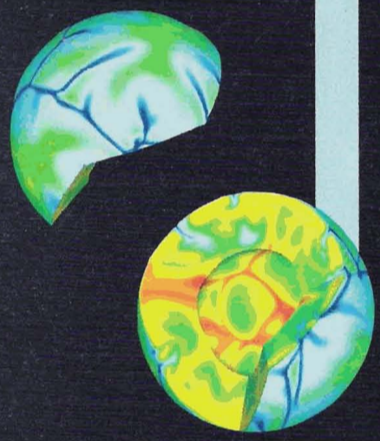
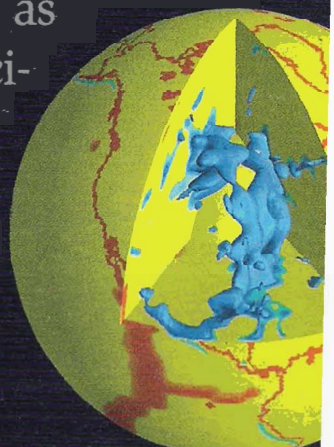
THE CORE



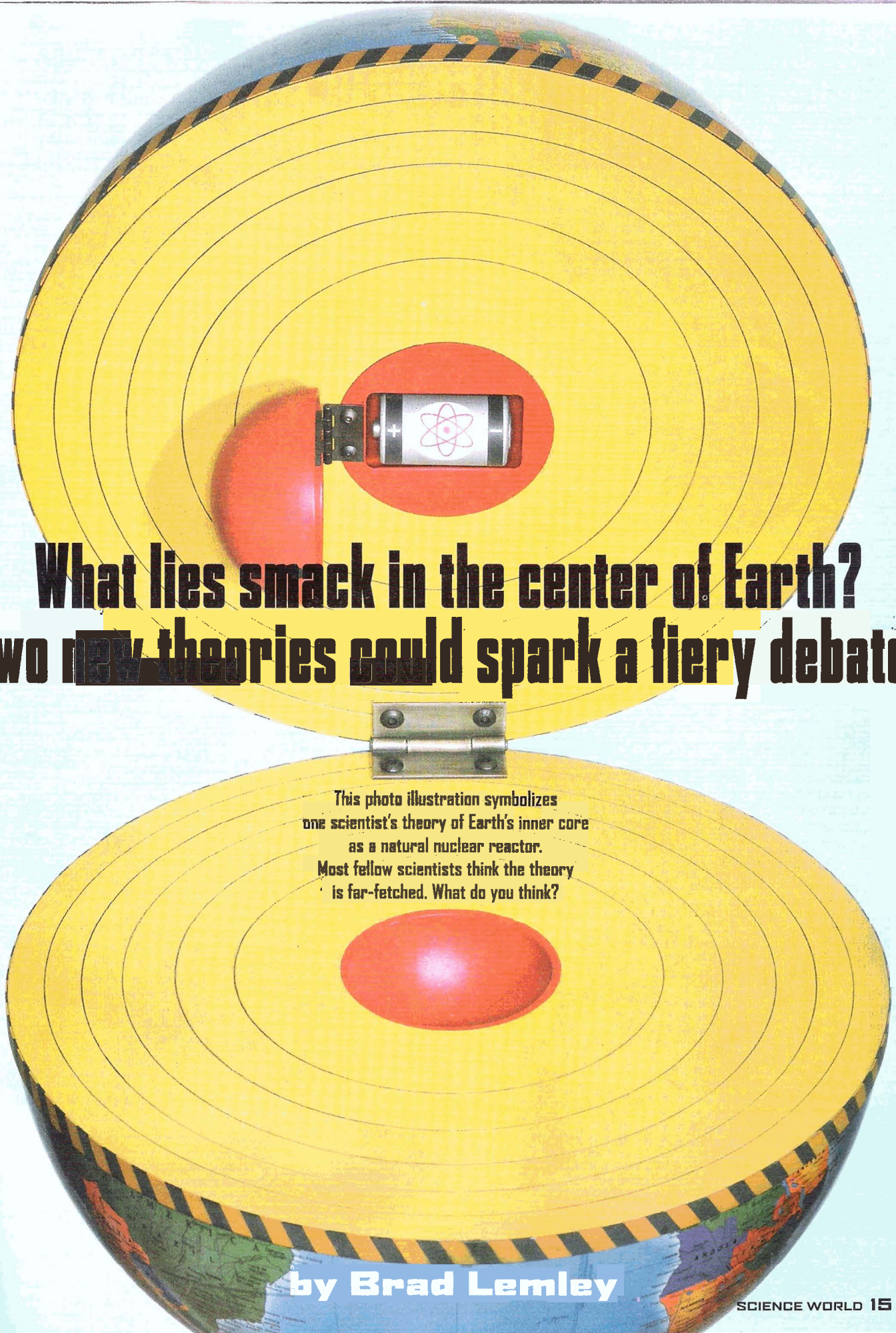
Actress Hillary Swank is a terranaut in Paramount's upcoming *The Core*. (*Above and below*) Scientists use computer models to simulate the constantly flowing heat and rock deep inside Earth.

In the upcoming sci-fi flick *The Core*, Earth stops spinning in its tracks. The planet's *magnetic field*—a protective bubble of magnetic and electric currents generated from the planet's core to its poles—shuts down cold. Deadly cosmic rays rip through the atmosphere, and catastrophe rules—from thousands of dea pigeons raining on London to lightning bolts frying Rio de Janeiro. How to save humanity? A team of "terranauts" burrows to Earth's hub to explode nuclear bombs and jumpstart the planet's spin.

Hollywood's guess about what really lies 6,116 kilometers (3,800 miles) beneath our feet may be as good as any scientist's. That's because *geophysicists* (scientists who study Earth's structure) are still clamoring to solve the mysteries of Earth's core. Theories abound, but without a crew of terranauts at their disposal, scientists may never dig up the truth. Or will they?



What lies smack in the center of Earth? Two new theories could spark a fiery debate.



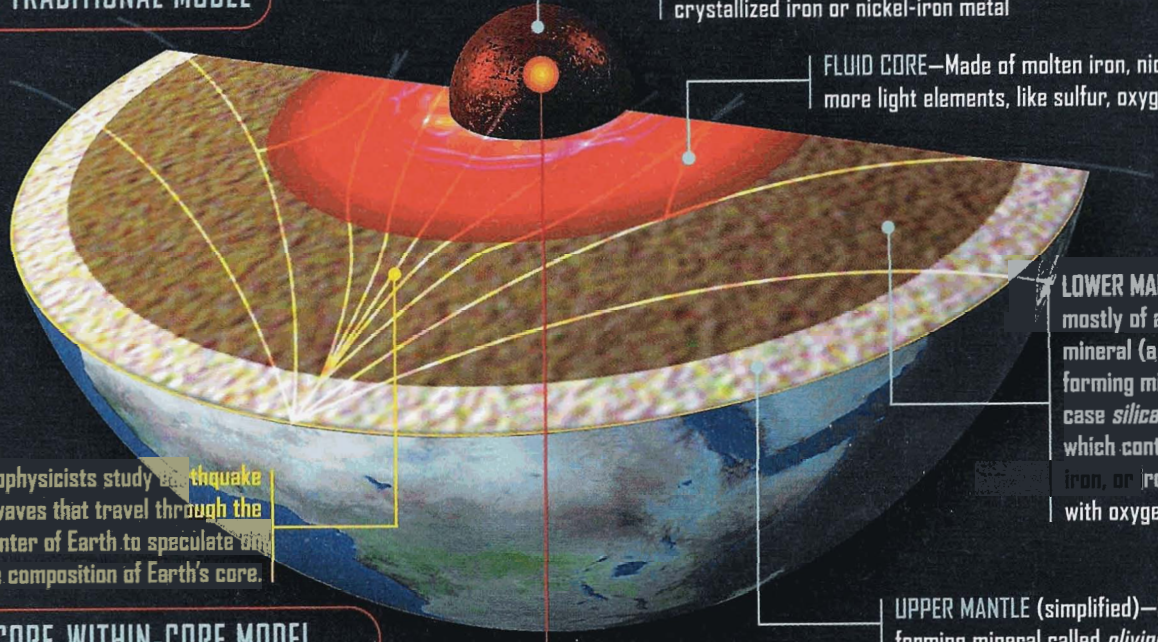
This photo illustration symbolizes one scientist's theory of Earth's inner core as a natural nuclear reactor. Most fellow scientists think the theory is far-fetched. What do you think?

by Brad Lemley

WHAT LIES 3,800 MILES BENEATH YOUR FEET?

Below are three models of what lies in the center of Earth. The traditional model has been dominant for six decades, but scientists are churning out new ideas.

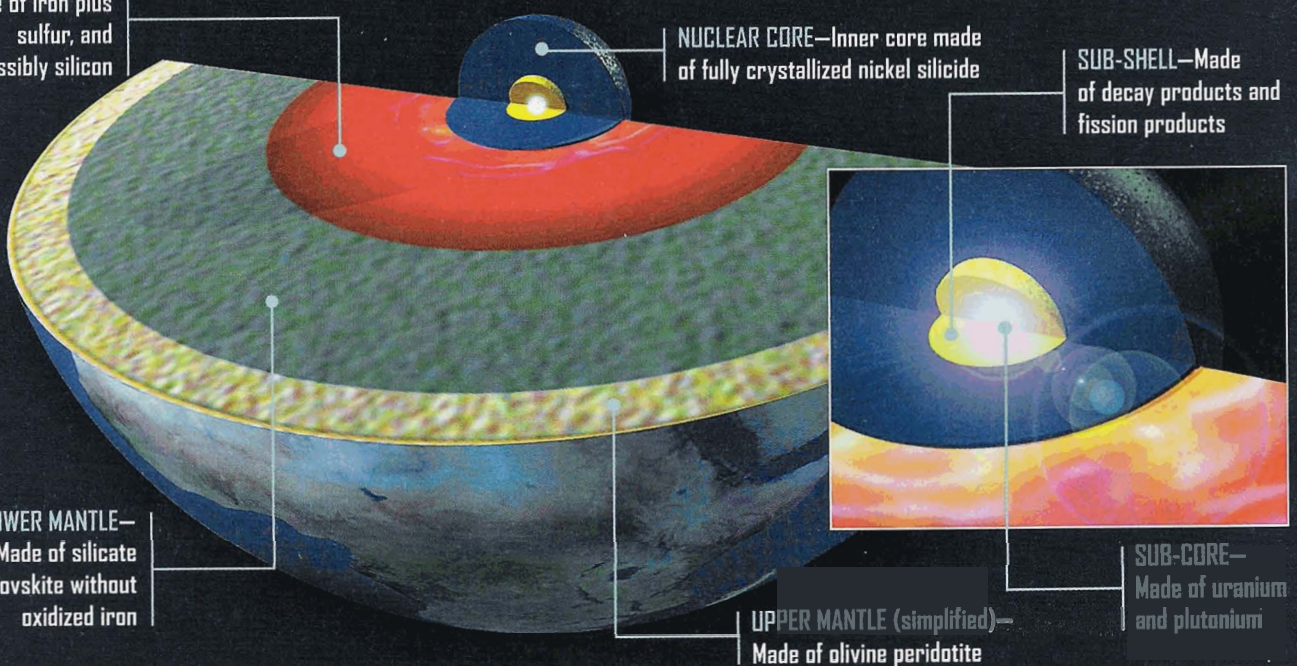
1 TRADITIONAL MODEL



2 CORE-WITHIN-CORE MODEL

Within the 1,440-mile-diameter core lies a 360-mile-wide core of mostly crystallized iron.

3 NUCLEAR EARTH MODEL



IRON BALL

Scientists have long struggled to understand what lies smack at the planet's center. The deepest anyone has ever drilled is about 14 kilometers down. Go much deeper and anything—drill or human—would be crushed by Earth's pressure of 50,000 pounds per square inch (4,000 times that of the atmosphere) and vaporized by a temperature of 1,000°F.

Direct observation is impossible, so researchers must turn to other evidence. In 1889, a German scientist discovered that a severe earthquake in Japan registered on his *seismometer* (earthquake detector) in Potsdam. Geophysicists concluded that shock waves create jolts from one side of Earth through the center to the other side. "The sound of earthquake waves are like music on a CD," says Harvard University geophysicist Miaki Ishii. "And we listen to the music of the Earth on a seismogram to figure out what's in the planet's center."

Then in 1936, Danish geophysicist Inge Lehmann studied the waves' patterns to determine that within Earth's core of molten iron lies a solid inner core (*see diagram, left*)—but what that core was made of eluded her. Other geophysicists quickly determined that Lehmann's inner core was composed mostly of iron *crystals*—smooth-faced solids made of atoms arranged in goemetric patterns. Since then, Lehmann's discovery has dominated conventional Earth science.

But now scientists are challenging traditional theory with new findings and radical ideas. For example, Earth's center, much like a peach pit, could actually contain an "inner core within the inner core," claim Ishii and colleague Adam Dziewonski.

Analyzing hundreds of thousands of earthquake wave records, they maintain that the inner core—an estimated 2,317 km (1,440 mi) in diameter and a scalding 5,000°F—has at its heart a tiny, even more solid sphere just 579 km (360 mi) wide. This sphere "may be the oldest fossil left from the formation of Earth," says Dziewonski.

He and Ishii speculate that shortly after Earth formed around 4.8 billion years ago, a giant asteroid smashed into the young planet and nearly melted it. One flying chunk probably formed the moon! But Earth's center didn't quite melt; it gained mass and layers as the planet cooled. The core within a core may be the kernel that endured. "Its presence could change our basic ideas about the origin of the planet," Dziewonski says. However: "The idea of a new region of Earth should generate quite a bit of controversy."

NUCLEAR REACTOR?

Dziewonski's idea is tame compared to the radical theories of independent geophysicist J. Marvin Herndon. Earth's inner core is made not of iron, he claims, but a compound of two elements, nickel and silicon, called *nickel silicide*. Herndon's truly revolutionary notion: Within the nickel silicide inner core is also an "inner" inner core—an 8 km (5 mi)-wide ball of the element *uranium*. Uranium is *radioactive*—the nucleus of each atom spontaneously decays over time. Herndon thinks the uranium cranks out heat energy as its atoms experience *fission*–split and crash into one another in a chain reaction. In other words, we may live on top of a gigantic, "natural" nuclear power plant.

In nature, uranium exists as a mixture of three different forms or *isotopes*. Commercial nuclear reactors use one enriched and highly unstable isotope called uranium-235. Reactions inside each atom create a furious fission chain reaction and release massive amounts of heat energy. Without control rods to slow the process, heat energy could incinerate the reactor. But in Earth's center, claims Herndon, natural uranium in all its forms releases heat energy slowly—"a slow cooker."

How did he stumble on his theory? In 1990, "it suddenly hit me, in the grocery store of all places," Herndon says. He knew French scientists had discovered uranium deposits in the African nation of Gabon. The uranium atoms in the deposits had undergone nuclear-fission chain reactions—in other words, they once functioned as natural nuclear reactors before their burnout 2 billion years ago. He also knew that Jupiter, Saturn, and Neptune radiate about twice the energy into space they receive from the Sun. Scientists discovered this by measuring the *albedo*, or brightness, of these planets, but were mystified by it. Where did all of this energy come from?

"I suddenly realized Jupiter had all the ingredients for a planetary-scale nuclear reactor," Herndon says. Could Earth possess such a reactor as well? And could a natural reactor burn for as long as Earth has existed?

Most geologists are extremely skeptical. One big question for Herndon: How, during the formation of Earth, could so much uranium clump in its center? Uranium tends to bond with lighter elements like oxygen, so it would resist sinking to the core of a young Earth. But very little oxygen existed along with the mix of elements that combined to form Earth's deep interior, says Herndon. That left the uranium free to plunge.

As for the future of his radical theory, says Herndon, "People who challenge established ideas sometimes seem a little nutty, but the theory itself is not nutty at all." And that may be the core truth.

IT'S YOUR CHOICE

CHOOSE THE CORRECT ANSWER TO THESE QUESTIONS:

1 Conventional Earth science theory holds that Earth's inner core consists mostly of
- **A** nickel silicide
- **B** crystallized iron
- **C** uranium
- **D** helium

2 To reach their conclusions about the composition of Earth's inner core, geophysicists study
- **A** topographical maps
- **B** sound waves
- **C** earthquake waves
- **D** soil from other planets

3 Which of the following do two new inner core theories agree on?
- **A** the core's composition
- **B** the core's size
- **C** how the core was formed
- **D** the existence of an "inner" inner core

ANSWERS IN TEACHER'S EDITION