the direction of the remnant magnetism of a rock. Paleolongitude is not recorded. Anyone attempting to reconstruct the true APW path is faced with the task of assembling a number of polar positions based only on latitude and age.

The isotopic dating methods for Precambrian rocks, furthermore, commonly have an error of plus or minus 10 percent. Thus, the true age of a 2 billion-year-old rock might fall anywhere within a period of 400 million years, or the time needed for the opening and closing of an ocean the size of the Atlantic. Henry Spall of the U.S. Geological Survey in Reston asserts that, in the light of these uncertainties, the interpretation of limited paleomagnetic data tends to be somewhat subjective rather than objective. For example, essentially the same data used by McElhinny and McWilliams to support a modified form of plate tectonics have been interpreted by Kevin Burke, John Dewey, and W. F. S. Kidd of the State University of New York, Albany, to be consistent with the wandering and collision of a number of different plates.

Keith O'Nions of Lamont-Doherty Geological Observatory and his colleagues have recently applied a new dating technique to early Precambrian rocks which they believe will eventually allow more precise resolution of plate movement. They dated a 3.8 billion-year-old rock with an accuracy of 1 percent using a samarium-neodymium isotopic technique. The absolute accuracy of such an age would thus be comparable to that currently available for the Phanerozoic.

Many Precambrian geologists welcome the new paloeomagnetic data as further support for their long-held contention that the deformation and mountain building of mobile belts did not result from the collision of continents. They have always found it difficult to accommodate the patchwork of cratons and mobile belts of Africa, Australia, and Canada within the framework of plate tectonics. Most geologists recognize that the ramming of the Asian continent by the Indian landmass formed the Himalayas about 45 million years ago.

Speaking of Science

The Oldest Fossil Bird: A Rival for Archaeopteryx?

Although Archaeopteryx is generally considered the earliest bird on record, a recent find suggests that the creature, which lived some 130 million years ago, may not have been the only bird alive then. A new fossil found by James Jensen of Brigham Young University dates back to the same period—the Late Jurassic—and appears to be the femur (thighbone) of a bird. If this proves to be the case, then a reexamination of the postulated role of Archaeopteryx as the evolutionary link between reptiles and birds may be in order.

Jensen unearthed the bone last summer in the Dry Mesa quarry of Eastern Colorado, a dig where he has excavated many other fossils, including those of dinosaurs and flying reptiles. The specimen is now being examined by John Ostrom of Yale University's Peabody Museum of Natural History, who is trying to verify its identity. Ostrom says it looks more like a bird bone than anything else. While he has some reservations about the identification, he asserts, "If it's not a bird bone, I don't know what else it is."

The fossil resembles the thighbone of modern birds more closely than the comparable Archaeopteryx bone does. Archaeopteryx had feathered wings but did not fly well and in many respects was more of a running dinosaur than a bird. In particular, its skeleton was reptilian and characteristic of animals whose survival depends on their ability to maneuver on the ground. For example, the Archaeopteryx femur, which has a large, well-developed knob for a head (the portion that fits into the hip socket), was like that of a ground animal. But birds that are good flyers have femurs with small heads. And the head of the newly found fossil femur also appears small.

Jensen suggests that similar fossils may not have been located previously because a good flyer is not likely to perish in a site where it will be preserved. In contrast, Archaeopteryx, which was at best a glider and not capable of sustained, powered flight, probably had trouble staying in the air. The chances of its plummeting from the sky into a sea where it would be preserved were thus greater.

The hypothesis that Archaeopteryx represents a direct link from reptiles to birds has been generally accepted. The existence of another bird—one that was an adept flyer and thus more advanced on the evolutionary scale—would present a challenge to that hypothesis.

The situation also presents Ostrom with something of a delicate dilemma, for he is one of the principal developers of the evidence regarding the evolutionary role of Archaeopteryx. Although the paleontologist says that the identification of the new fossil is about 90 percent certain, he points out that it is not exactly like any of the numerous bones of modern birds with which he has compared it. This is not especially surprising. More disturbing to him is the fact that the fossil is not perfectly preserved and a portion of the head may be missing. In other words, the femur head may be more reptilian in character than it appears. And Jensen has taken a number of fossilized bones of flying reptiles from Dry Mesa quarry. But Ostrom is not sure that the head is not intact; it might just be different from that of other kinds of femurs.

There is also the question of the exact age of the fossil. It was found in a type of rock that geologists date as having formed some 130 million years ago and therefore comes from the same period as Archaeopteryx. But it could be a few million years older or younger. Since the five Archaeopteryx fossils were found in Europe, direct comparisons of their age with that of the new fossil are impossible. All in all, Ostrom thinks that it would be premature to knock Archaeopteryx off its perch as the oldest form of bird without additional evidence.

Jensen thinks that he may have found such confirmatory evidence in the form of another, more complete fossil femur excavated just a few feet away from the one in question. According to the Brigham Young investigator, this second femur is very similar to that of modern birds. Ostrom has not yet examined this latest find, however. Until he does, the situation will remain very much up in the air.—J.L.M.

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