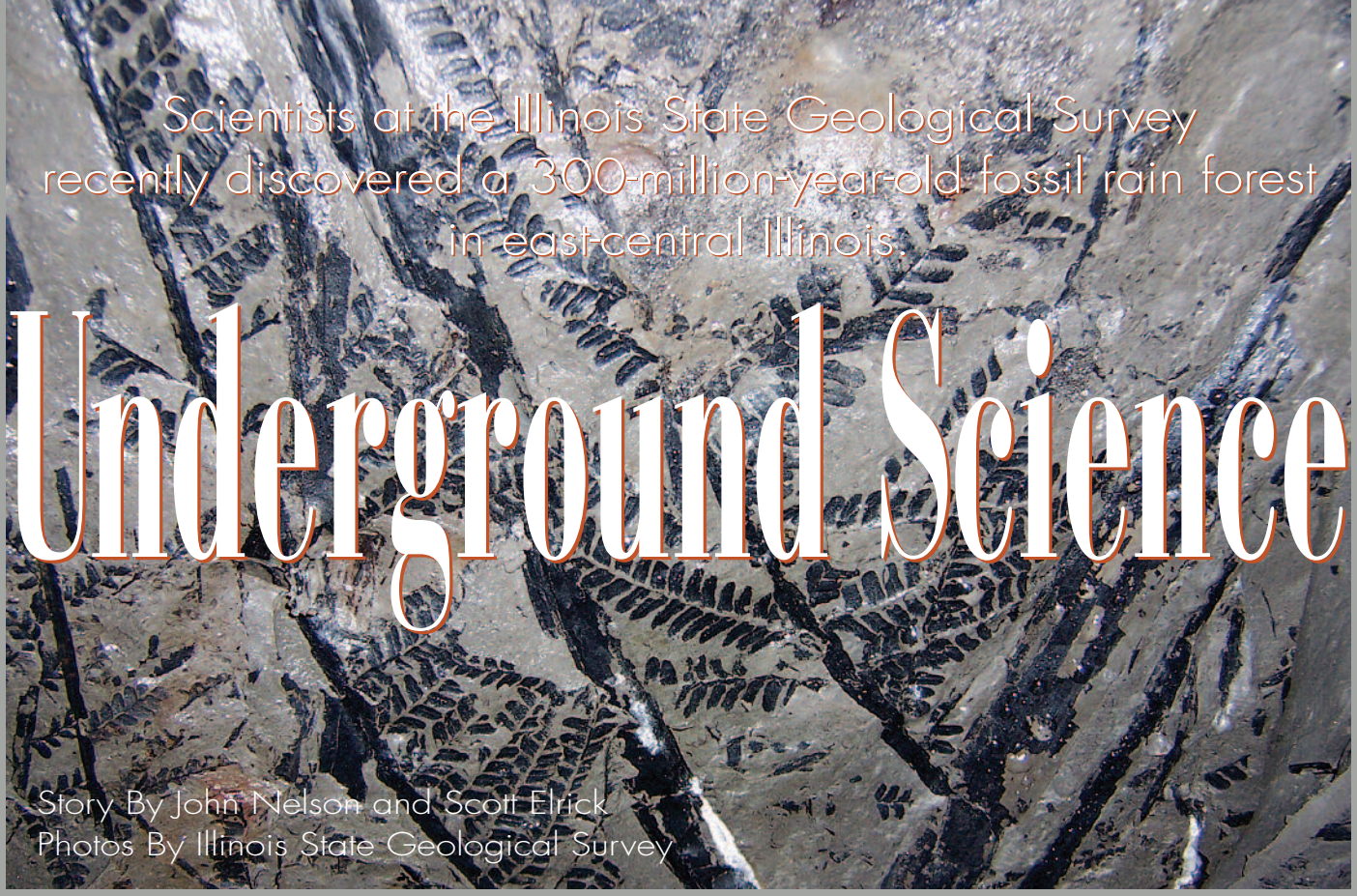

Scientists at the Illinois State Geological Survey recently discovered a 300-million-year-old fossil rain forest in east-central Illinois.

Underground Science

Story By John Nelson and Scott Elrick
Photos By Illinois State Geological Survey

Recently, John Nelson and Scott Elrick, geologists at the Illinois State Geological Survey, reported the discovery of spectacularly preserved plant fossils left by a 300-million-year-old rain forest. The remains of the forest were revealed in the roofs of the Riola and Vermilion Grove underground coal mines, just southwest of Danville. The mines are owned by Black Beauty Coal Company, a subsidiary of Peabody Energy.

Survey coal geologists routinely visit the state's coal mines to record the mine's geology and provide technical assistance to the operators, if requested. When Nelson and Elrick visited the Riola mine shortly after it opened about 10 years ago, they noticed that the gray, nearly flat beds of shale that lay directly over the coal were covered with bright, black impressions of leaves and branches of tree ferns, seed ferns and other strange plants.

Although the geologists noticed the fossils, they didn't think much about them—at first. After all, coal is the compressed remains of peat formed in rain forests, and many other coal mines they visited had fossils in their roofs. As more coal was mined and more of the mine roof was uncovered, however, more fossils were revealed. The roof rocks even held the trunks of trees up to 6 feet in diameter and more than 100 feet long, and there were many upright tree stumps, a very unusual find.

By 2005, Nelson realized that the spectacular fossils had an unusual story to tell.

Two paleobotanists, William DiMichele of the Smithsonian Institution and Howard Falcon-Lang of the University of Bristol, England, were invited to examine the fossils. Their studies, identifying plant species, counting their distribution over the 4 square-mile area of roof selected for study, and some other work, showed that the fossils represented an "intact" forest that had been quickly and exceptionally well preserved. The presence of seed ferns with intact seed bundles, upright stumps, and species from all the ecological niches and forest levels (canopy, ground cover, etc.), suggested that some sort of catastrophic event had quickly killed and buried all the plants at once.

Left: Impression of an extinct seed fern, *Neuropteris ovata*.
Right: Geologists map the mine roof for plant fossil traces.

To figure out what had happened, Nelson and Elrick mapped the variation from place to place in the thickness of the rock layers above and below the coal seam, variations in the thickness of

Left: Scott Elrick examines coal stringers in the exposed roof shale. Top: The blade-shaped, 3-foot-long leaves of a giant *Lycopsid* tree.

the coal, whether the contact between the coal and the overlying shale was abrupt or gradually changed upward from coal to shale, and the characteristics of the area beyond the mine.

Their investigations showed that when the peat that formed the coal was being deposited, and later when the forest was growing with its roots in the peat below, the area was close to the ocean, low-lying and slowly sinking due to the presence of a fault. The previously unsuspected fault was indicated by a rather long (more than 1,000 feet), linear clay dike in the coal (an intrusion of mud into a crack in the peat swamp) that paralleled the fault's expected orientation and location. The previously mapped Royal Center fault in north-central Indiana lined up almost dead-on with their inferred but unknown fault. A regional map showed that the known fault trace ended just northeast of the mines.

Below: Tree-fern stems and cones of *Calamites*, a giant relative of horsetails. Middle: Hands show the edges of a 6-foot-wide, 100-foot-long lycopod tree.

The two geologists also noted that the shale above the coal had a repeated pattern of deposition in the successive layers that indicated they had been deposited by the rhythmic rise and fall of spring and neap ocean tides.

The evidence all fit the following story. One fine day during the Pennsylvanian Period, 300 million years ago, there was an earthquake centered just below the coastal edge of the peat mire. Movement along the southern end of the

Royal Center fault dropped a segment of the coastal swamp about15 feet, enough to catastrophically drown a portion of the forest. The new depression became the locus for rapid deposition of mud and silt layers by the ocean tides, quickly burying the drowned forest. A count of the tidal cycles suggested the forest was covered by 10 feet of mud in as little as four months.

Like many other finds of especially well-preserved fossils, this one was the result of the right people being in the right place at the right time. The catastrophic earthquake event drowned and preserved a large segment of the forest. Mining uncovered the fossils and provided the two Survey scientists and their colleagues ultimately the opportunity to document subtleties of an ancient forest's ecology that could only be guessed at before.

More information about this discovery can be found at www.isgs.uiuc.edu and in a scientific paper in the May 2007 issue of "Geology" by William A. DiMichele, Howard J. Falcon-Lang, W. John Nelson, Scott D. Elrick and Philip R. Ames titled "Ecological Gradients within a Pennsylvanian Mire Forest."

At the Illinois State Geological Survey at Urbana-Champaign, John Nelson is a senior geologist and Scott Elrick is a geologist in the Coal Section.

Below: A hammer shows the scale of a giant *Lycopsid* tree stump that was buried while still upright. This stump was 'rooted' in the top of the coal bed.