Darwin's Dinobird Fossil Analyzed at SLAC National Accelerator Laboratory

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The Thermopolis Archaeopteryx Fossil.

(PhysOrg.com) -- A keystone of evolutionary history, the Thermopolis Archaeopteryx fossil, has come to the U.S. Department of Energy's (DOE) SLAC National Accelerator Laboratory to undergo a revolutionary type of analysis. Using intense X-ray beams, scientists will search for characteristics of the "dinobird" that have eluded all previous scientific analyses.

Researchers at SLAC's Stanford Synchrotron Radiation Lightsource (SSRL) are attempting to uncover secrets of the Archaeopteryx hidden from view since the creature sank to the bottom of a shallow lagoon and became entombed in limestone some 150 million years ago. To do this, they are using light source technology developed by DOE and primarily utilized for advanced energy-related research in materials science, biology, and other fields.

Only ten Archaeopteryx fossils have been found and studied. These specimens have undergone extensive visual analyses and even CT scans in the past, but never anything as comprehensive as the X-ray imaging researchers are utilizing at SSRL. Here, researchers are making the first maps of the chemical elements hidden within one of the best preserved specimens, possibly including remnants of soft tissue—not just bone. Approximately 16 by 16 inches (40 by 40 centimeters) in size, the Thermopolis specimen was originally discovered near Solnhofen, Germany, and is now owned by the Wyoming Dinosaur Center, located in Thermopolis, Wyoming.

Archaeopteryx holds a unique place in history. A century and a half ago, just a year after Charles Darwin published On the Origin of Species, the discovery of this fossilized half-dinosaur/half-bird species provided the strongest evidence yet for the theory of evolution.

"If you want to find a single fossil which is a missing link in the evolution of dinosaurs into birds, this is it," said University of Manchester paleontologist Phil Manning. "It's a bird with sharp teeth, claws and a long bony tail. If you were to freeze-frame evolution, you would end up with Archaeopteryx."

However, scientists are still learning about Archaeopteryx. By tuning SSRL's hair-thin X-ray beam to specific energies and sweeping it across the fossil, researchers will reveal detailed maps of the chemical remains. This technique, called X-ray fluorescence imaging, is more commonly applied to very small samples, but has recently been used on historical documents including the Archimedes Palimpsest and a van Gogh painting. Its application to fossils, which may expose trace evidence of soft tissue never before seen, was suggested by Bob Morton of the

Children of the Middle Waters Institute.

"We were intrigued by the possibility of using X-ray fluorescence imaging on fossils 20 years ago," Morton said. "Now with the help of intense X-rays at SSRL, it's become feasible. We're ready to be surprised and amazed."

SSRL scientist Uwe Bergmann added: "What you normally can't see are the chemical elements from the original organism that might still be present in the fossil. Using X-ray fluorescence imaging, we can bring these elements to light, getting a better look at the fossil and learning more about the original animal. We are absolutely thrilled to get this rare chance to look at Archaeopteryx."

In addition to offering an entirely new view on a long-extinct animal, this work may also reveal more about fossilization itself. By understanding how fossilization occurs and what exactly is preserved in the process, researchers will be able to deduce much more about ancient organisms and evolution.

"This is the very infancy of this new scientific method," said paleontologist Peter Larson of the Black Hills Institute in South Dakota. "We don't even know enough about this to know the right questions to ask yet. All of a sudden, we can look at fossils in a very different and new way."

Provided by SLAC