THE LONG-LOST CAVE HAS BEEN FOUND!

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Figure 1. The 1894 photo of the cave site (fig. 3, page 32) shows a surface that is now buried under 30 to 40 feet (9.2 to 12.2 m) of asbestos-containing waste materials. Today the old quarry site surface is covered with grass and trees. Here, Tim Bechtel measures a microgravity and electrical resistivity transect.

After hearing the lore surrounding the Port Kennedy Bone Cave, graduate students from the Masters of Applied Geoscience Program at the University of Pennsylvania (UPenn) teamed up with Enviroscan, Inc., a local geophysics company, and Valley Forge National Historical Park to design and execute a geophysical investigation that could confirm the presence or absence of the cave and its fossils in the quarry indicated by the literature search. Geophysical investigative technology was perfectly suited for this project because the noninvasive nature of the methods avoided the problem of the cave's probable location in one of the park's quarries now filled with hazardous, asbestos-containing materials. Jaime Hojdila, Toni DeMayo, and Sam Baughman of UPenn, and Dr. Tim Bechtel of Enviroscan, developed a three-pronged approach employing the complementary geophysical survey techniques of electrical resistivity, gravity, and magnetics.

We completed surveys during summer and early fall 2004 (fig. 1). The magnetic survey was performed to determine whether rumors of a locomotive that was intentionally crashed into the quarry for the 1915 silent film, "Valley of Lost Hope," were true. The presence of a locomotive at a depth shallower than the Bone Cave could have interfered with attempts to locate the cave using the other two geophysical methods. We measured variations in Earth's naturally occurring magnetic field with the idea that a large, iron-rich object should produce a dramatic magnetic anomaly. The strongest anomalies we found were associated with several pieces of debris visible at the ground surface, and none were of sufficient amplitude or lateral extent to represent the remains of a locomotive at the base of the quarry-waste fill.

The gravity method is based on the phenomenon that lateral changes in subsurface density cause perturbations in Earth's gravity field, with locally higher gravity above denser material, and lower gravity above less dense material. The Port Kennedy Bone Cave is filled with materials of less density (e.g., sand, mud, organic-rich clay) than the surrounding limestone bedrock and was expected to appear as a local low-gravity reading. The resulting gravity map of the survey site illustrated a distinct low-gravity reading (amplitude -0.15 milligals; see anomaly, B in fig. 2, page 36).

The electrical resistivity method uses a pair of electrodes to induce electrical current in the subsurface and another pair of electrodes to measure resulting voltage at various locations. We used the current and voltage readings to calculate the resistivity of the subsurface materials. By adjusting the locations and spacing of the electrodes we calculated resistivity variations for points throughout a three-dimensional block of the subsurface. The scan extends to a depth of 16 meters (52.5 ft) and has a range of resistivity between 1 and 10,000 ohmmeters. The presence of the Port Kennedy Bone

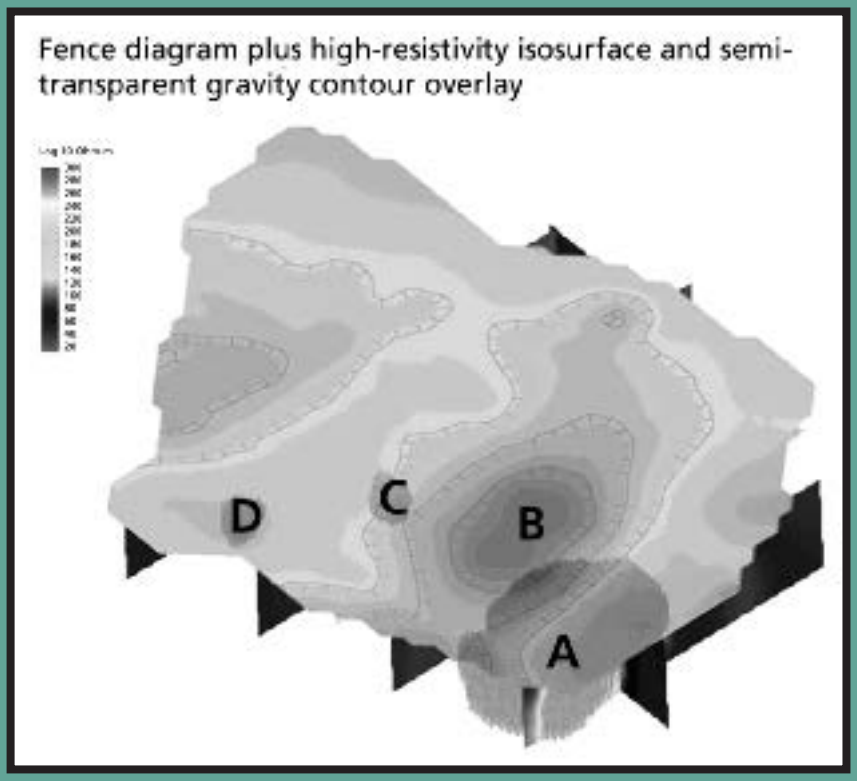

Figure 2. The illustration combines electrical resistivity and gravity measurements to present a three-dimensional view of the Port Kennedy Bone Cave study site. A semi-transparent gravity contour overlays a diagram of the high-resistivity isosurface. The primary feature is the high-resistivity zone (A) roughly beneath (though not perfectly centered on) the main gravity low (B). Two smaller high-resistivity zones (C and D) occur and are possibly consistent with small voids visible in the quarry walls and shown on the 19th century sketches.

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Cave appeared as a zone of anomalous high resistivity (see A in fig. 2).

As a result of this investigation, we are very confident that after being lost for almost 110 years, the Port Kennedy Bone Cave has again been found in 2005.

Dedication

This project is dedicated to the memory of Brian Lambert, Natural Resources Manager at Valley Forge National Historical Park 1987–2003. Throughout his years at Valley Forge he dreamed of one day finding the Port Kennedy Bone Cave, and it seems his dream has come true.

Acknowledgements

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