PALEOMAGNETIC ANALYSIS OF A LONG-TERM SEDIMENT TRAP, KOOKEN CAVE, HUNTINGDON COUNTY, PENNSYLVANIA, USA

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1. ABSTRACT

Kooken Cave is an extensive, deep fissure system developed in Ordovician age limestones of the Valley and Ridge physiographic province, Pennsylvania, USA. The cave floods to significant depth each year, due to influent surface waters. The cave drains slowly, and 45 ft (15 m) of clastic sediments fill portions of the cave. The discharge area for groundwater flowing through the cave is unconfirmed, but appears to be the Little Juniata River, which is steeply incised into the limestone upland containing the cave. The lowest deposits in the cave contain clay, sand, and cobbles, which probably limit draining of the cave. The remainder of the sediments are exclusively fine-grained. Twenty-four paleomagnetic samples were collected and analyzed. They all show normal polarity, indicating deposition within the present chron (< 780 ka). Sample pairs show good correlation, indicating that the sediments maintain a good record of paleosecular variation. Declinations are generally eastward of the present-day field, and most inclinations show shallowing. Sediment accumulation rates extrapolated from recent individual floods suggest that the entire sedimentary package could have been deposited within 1,440 years. Expected river incision rates and other geomorphic constraints lead to an age of <320 ka for the cave. It is likely that Kooken Cave has been accumulating allochthonous sediments for 1,000-10,000 years.

2. INTRODUCTION

Geomorphologists, climatologists, and hydrogeologists frequently try to decipher historical changes in earth systems by interpreting depositional records. In erosional (i.e. most continental) settings this is difficult because the deposits may be discontinuous and short-lived. However, clastic cave sediments have the potential to hold extensive paleoclimatic and paleohydrologic records under certain conditions. A cave can provide a protected environment, at least on timescales from 0 to 5 Ma. To provide the most useful records, the deposits should be continuous and contain material that is capable of being dated.

Kooken Cave is a laterally extensive karst void developed in steeply dipping limestones of the Valley and Ridge physiographic province of central Pennsylvania (Fig. 1). The cave is peculiar for the region, because it floods on at least an annual basis and takes a long time to drain. Therefore, we recognized the potential for the cave to be a long-term sediment trap, and undertook an investigation to evaluate the record that was contained therein.

3. DESCRIPTION OF THE STUDY SITE

The study site is located in Huntingdon County, Pennsylvania (Fig. 1). The area is within the westernmost part of the Valley and Ridge physiographic province, about 4 mi (6 km) east of the Allegheny Front, the boundary with the Appalachian Plateaus province. The entire Valley and Ridge province is characterized by extensive anticlines and synclines, and the structure of this particular area is complicated by the proximity to the Allegheny Front. The study area lies near the nose of Brush Mountain (shown as higher topography in lower left of Fig. 1), which is a southwest plunging syncline. The north-northeast trending Yellow Springs Fault, with numerous splays, is present just to the east of the mountain. The lack of good outcrops leaves the possibility open that other faults may be present. The cave is developed beneath a gently rolling, agricultural upland surface that is at about 1000 ft (300 m) amsl. The rocks are undifferentiated Ordovician limestones of the Coburn through Loysburg Formations (Berg and Dodge, 1981; Shultz, 1999). East of the fault the rocks are mainly dolomites. Further to the northeast the upland has been steeply incised by the Little Juniata River to an elevation of 750 ft (230 m) amsl (Fig. 1). This stream, which serves as local base level for surface and ground waters, is a tributary of the Juniata River, which subsequently joins the Susquehanna River on its journey to the North Atlantic Ocean.

Kooken Cave is primarily a fissure system developed along a steeply inclined (and possibly faulted) bedding plane. In the cave, at the vicinity of the samples, bedrock strikes 068° and dips 64° southeast. In plan view (Fig. 2) the cave follows a gently arcuate pattern. In cross-section (Figure 3) a series of interconnected overlying and underlying passages are seen. The cave has been known since the summer of 1930, when it was dug open (Devitt, 1953). It presented a serious challenge to explorers due to the vertical entrance shaft (requiring ropes), and numerous, large, mud-sided pits (or funnels). The eastern entrance of the cave is at a surface elevation of 988 feet (301 m) amsl, based upon a GPS survey. Most of the cave has a surveyed level of about 860 feet (260 m) amsl, though the high ceilings of the fissures and the depth of the pits make this figure only a generality. The lowest portion of the cave, 809 feet (247 m) amsl, is at the base of a pool in the easternmost portion of the cave.