GEOLOGY OF THE COYOTE CANYON MAMMOTH SITE, BENTON COUNTY, WASHINGTON STATE

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ABSTRACT

The Coyote Canyon Mammoth Site in Benton County, Washington State, provides a unique opportunity to unravel the detailed geologic context for a mammoth skeleton found in Pleistocene outburst flood deposits (i.e., the Missoula Floods). The mammoth site contains the partially articulated skeleton of a mammoth (*Mammuthus* spp.). The purpose of this study was to develop a large (i.e., hectometer to kilometer) scale conceptual model of the site's geologic history to provide the context for small-scale (i.e. centimeter) geologic, paleoecologic, and paleontologic data collected during excavation of the mammoth remains. The primary objectives were to map the nature and configuration of the basalt bedrock surface, evaluate the distribution and possible origins of a basalt ladened conglomerate and possible tephra deposit, and evaluate the history of Ice Age flooding (e.g., the number of ice age floods represented by rhythmites) at the site. This investigation consisted primarily of geologic mapping supplemented by well log data, and visual examination of collected samples.

The uppermost basalt flow beneath the site is believed to be that of the Elephant Mountain Member of the Saddle Mountains Basalt Formation, deposited about 10.5 million years ago. Its surface dips gently to the north along the northern limb of the Horse Heaven Hills anticline. Locally overlying the Elephant Mountain basalt lies a coarse angular basaltic conglomerate interpreted to be of alluvial fan origin (i.e., fanglomerate). This deposit is heavily calcified, suggesting a lengthy period of weathering and subaerial exposure. A thin tephra deposit of unknown origin is locally present at the top of the fanglomerate. There is some evidence that the fanglomerate and tephra deposit have been reworked, possibly by Ice Age flood events that deposited a fairly thick (meters) sequence of rhythmically bedded fine-grained sediment. At least four different graded bed sequences overlie the mammoth bone-bed. These graded beds are believed to represent distinct Ice Age flood events. Where undisturbed, the ground surface is blanketed by a thin (~1 m) veneer of loess. Further investigation of the site is needed to better define the number and frequency of Ice Age floods large enough to inundate this site, and their relationship to the death and burial of the mammoth.

MCBONES Research Center Foundation
Coyote Canyon Mammoth Site

Introduction

The Coyote Canyon Mammoth Site is located south of Kennewick, in Benton County, Washington State. The partially articulated skeleton of a mammoth (Figure 1) was initially discovered there in 2000. The remains are potentially those of a Columbian mammoth (*Mammuthus columbi*, the official fossil of Washington State (Figure 2). The site lies on the northern slope of the Horse Heaven Hills on the edge of the Pasco basin, and presents a unique opportunity to explore the history of geologic events that took place before, during, and after the mammoth was buried. The purpose of this study was to develop a large (i.e., hectometer to kilometer) scale conceptual model of the site's geologic history to provide the context for small (i.e., centimeter) scale geologic, paleoecologic, and paleontologic data collected during excavation of the mammoth remains.

Figure 1. Partially articulated scapula and humerus at the Coyote Canyon Mammoth Site.


Figure 2. A restoration of a Columbian mammoth. Art © 1992 by Mark Hallett.

Methodology

This project was designed to unravel the geologic history of the site, beginning with the basalt bedrock and extending through deposition of loess and erosion of the canyons. Of particular interest were: 1) identification and structure of the uppermost basalt flow(s), 2) origin of a basaltic conglomerate, 3) identification of a possible tephra layer, and 4) the number of Ice Age floods recorded in sediment sequences at the site. Research included literature reviews, field mapping of the uppermost basalt contact, the measurement of selected stratigraphic sections, microscopic analysis of field samples, and analysis of well log data. Global positioning systems (GPS) using barometric altimeters, calibrated daily, were used to locate field observations and samples (Figure 3). A structure contour map of the basalt surface was generated by hand with the aid of a graphical illustration program (Figure 4). Samples of a suspected tephra layer were visually analyzed with a microscope and compared to a tephra sample correlated with the Mount St. Helens set "S" tephra. The basaltic conglomerate was analyzed in the field for clast lithology and sedimentary structures. Detailed field observations and measurements were made at selected sections of accessible outcrops to define the major stratigraphic relationships and identify possible sedimentary sequences within the Ice Age flood deposits (Figure 5).


Figure 3. Exposure of Elephant Mountain Basalt.

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Findings

Literature reviews and mapping of the basalt bedrock surface identified the top most basalt flow as the Elephant Mountain Member of the Saddle Mountains Basalt Formation. The basalt surface dips gently (~2.5°) to the north, with an apparent low running north-south, possibly reflecting an erosional channel (Figure 4). The basaltic conglomerate overlying the basalt surface is composed of a succession of layers comprised of poorly sorted, calcium carbonate-cemented, angular basalt clasts, interpreted to represent an alluvial fan deposit (i.e., fanglomerate). Microscopic analysis confirmed the presence of a tephra deposit overlying the fanglomerate that appears to be intermingled with the top of the fanglomerate/caliche horizon (Figure 6). The top of the fanglomerate/caliche horizon and tephra deposit shows signs of having been reworked by the Ice Age floods, as evidenced by a disconformity at the layers' contact and the presence of fanglomerate clasts within the lowermost Ice Age flood sediments. Approximately six or seven rhythmites (graded bed sequences) were identified in the Ice Age flood deposits (Figure 7).

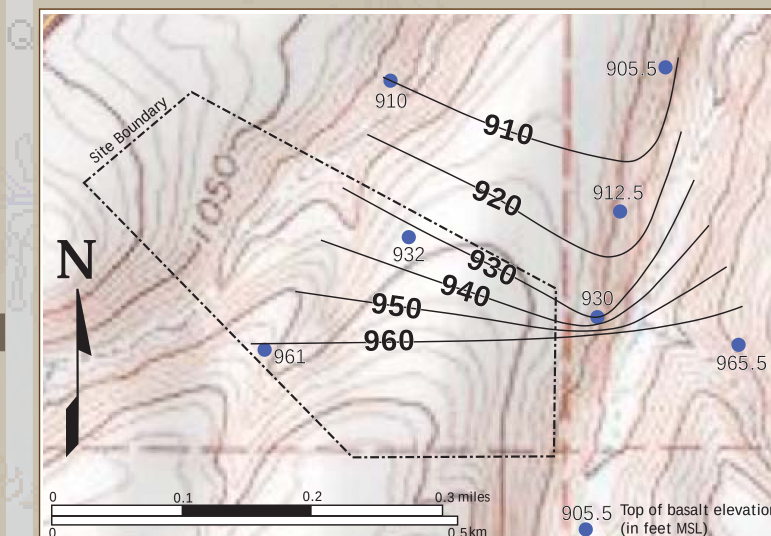

Figure 4. Surface of basalt map.

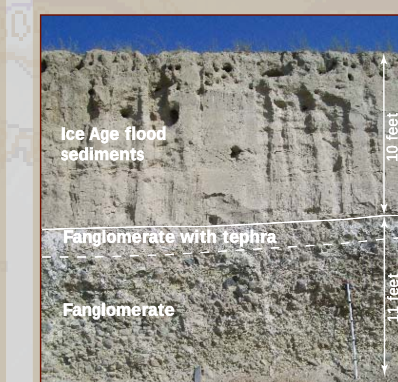

Figure 6. Fanglomerate and Ice Age floods section.

Figure 7. Ice Age floods section.

Discussion

The geologic record preserved at the Coyote Canyon Mammoth Site extends back at least 10.5 million years when the Elephant Mountain basalt flow inundated the area[1]. Structural uplift of the Horse Heaven Hills anticline slowly tilted the basalt surface to the north, and over the next several million years, the basalt surface was exposed to soil development and erosional processes. This gave rise to thick calcic paleosols (caliche horizons) and localized alluvial fan deposits. Coincidentally, with and/or perhaps shortly after deposition of the last alluvial fan sequence(s), a volcanic ash (tephra), presumably from one of the Cascade volcanoes, was deposited on the land surface. This was followed by additional soil development and precipitation of calcium carbonate within the tephra. With the onset of the last Ice Age (some 2.6 million years ago), a series of Ice Age flood events then impacted this area[2], reworking some of the fanglomerate/caliche/tephra sediments and depositing several sequences of flood sediment. The Ice Age floods were primarily the result of glacial lake outbursts that occurred as ice dams from advancing glacial lobes repeatedly failed, resulting in the nearly instantaneous release of immense volumes of water[2]. The most cataclysmic of these floods originated from Glacial Lake Missoula, releasing over 500 cubic miles of water (Figure 8)[2]. These giant surges of water carved the Channeled Scablands and inundated the Pasco Basin, creating such temporary lakes as Lake Lewis[2] (Figure 9). Rhythmically bedded sedimentary sequences deposited in these temporary lakes suggest that at least six or seven of these floods were large enough to have inundated the Coyote Canyon Mammoth Site. One of these floods carried with it the remains of a mammoth (perhaps swept to its death by the floods). Between floods, decades may have passed allowing for decay and scavenging of the mammoth remains. Later floods then buried the remains under a few meters of fine-grained sedimentary sequences, with the last Ice Age flood occurring around 15,000 years ago[2]. Since then, erosion, deposition of eolian loess, and soil forming processes shaped the landscape.


Figure 8. Areas directly affected by floodwaters from Glacial Lake Missoula.


Figure 9. An interpretation of Lake Lewis at its maximum stage[2]. The Coyote Canyon Mammoth Site would be located just to the right of this figure.

Further Investigation

Further investigation of the site's geology is warranted. The fanglomerate, the Ice Age floods' sediment, and the tephra found at the site all deserve further attention. The number of Ice Age floods that were large enough to reach the elevation of the site, before and after deposition of the mammoth, and the timing between these flood events is still very uncertain. The tephra presents a good opportunity for dating some of the earliest floods. Further investigation of the fanglomerate and its spatial relationship could shed light on the growth of the Horse Heaven Hills anticline, and the erosional and alluvial fan processes. The eligibility of the site for scientific investigation makes it an ideal place to further delve into some of the geologic mysteries of southeastern Washington State.

References

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Figure 5. Location of measured sections shown in Figures 6 and 7.