

## RADIOCARBON DATES FROM THE PLEISTOCENE FOSSIL DEPOSITS OF SAMWEL CAVE, SHASTA COUNTY, CALIFORNIA, USA

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**ABSTRACT.** Dates obtained from the collagen of 5 mammals from the fossil deposits of Samwel Cave, Shasta County, California, USA, show emplacement during the last glacial maximum. These dates support the assignment of the fauna to the late Pleistocene. The Samwel Cave deposits currently do not appear to be stratified.

### INTRODUCTION

Within California, much of what we know about the late Pleistocene derives from understanding the abundant fossil deposits of southern California, such as the famous Rancho La Brea tar pits (Miller 1971; Stock 1992). The late Pleistocene deposits in northern California have been studied to a much lesser extent (Sinclair 1903, 1905; Furlong 1906; Graham 1959; Payen and Taylor 1976). Two notable sites in northern California are Samwel Cave (SC) and Potter Creek Cave (PCC), located in Shasta County. These 2 fossil localities are particularly interesting because of the high diversity represented at each site, presence of both extinct and extant mammal species, and location within 5 km of each other near major climatic and vegetation boundaries. Comparison of the fauna within the 2 localities may provide a unique opportunity to understand the ecology of mammals near the end of the Pleistocene. It is therefore important to determine how these 2 sites relate to one another chronologically. Radiocarbon dates have been published previously from specimens from PCC (Taylor 1975; Payen and Taylor 1976; Meltzer and Mead 1983), but no such analysis has been completed for Samwel Cave. It is the aim of this study to obtain <sup>14</sup>C dates from the fauna of Samwel Cave.

### BACKGROUND

Samwel Cave (Figure 1) is located on the eastern edge of the McCloud River arm of Lake Shasta in the McCloud Limestone at 460 m elevation. Excavation of the cave commenced in the early 1900s by a team from the University of California in an effort to find presence of the first humans in the state (Furlong 1906). Two main excavations were conducted from 1903–1906 in Chambers One and Two by a group including E L Furlong, J C Merriam, and W J Sinclair (Figure 2) (Furlong 1906). Within the chambers, fossils were exhumed in 4-ft<sup>2</sup> pits dug in 10-inch levels. The sediments within Chambers One and Two were similar. At its deepest, the excavation was 2.5 m. The bottommost layer is a mix of earth and breccia (30–140 cm), overlain by a flowstone (2.5–10 cm). Breccia overlies the flowstone (60 cm) and is covered by gravel (10–45 cm), which is capped by a flowstone (3 cm) and a thin layer of reddish clay (Furlong 1906). Many specimens from the excavations are identifiable to the square and depth from which they were obtained. Fossils were found throughout the strata and elsewhere in the cave. Other excavations during the late 1950s were conducted in the Pleistocene Hall (Figure 2). In total, nearly 1000 specimens were collected, representing at least 13 bird and 45 mammal species (Table 1). The collected specimens are housed at the University of California Museum of Paleontology (UCMP).

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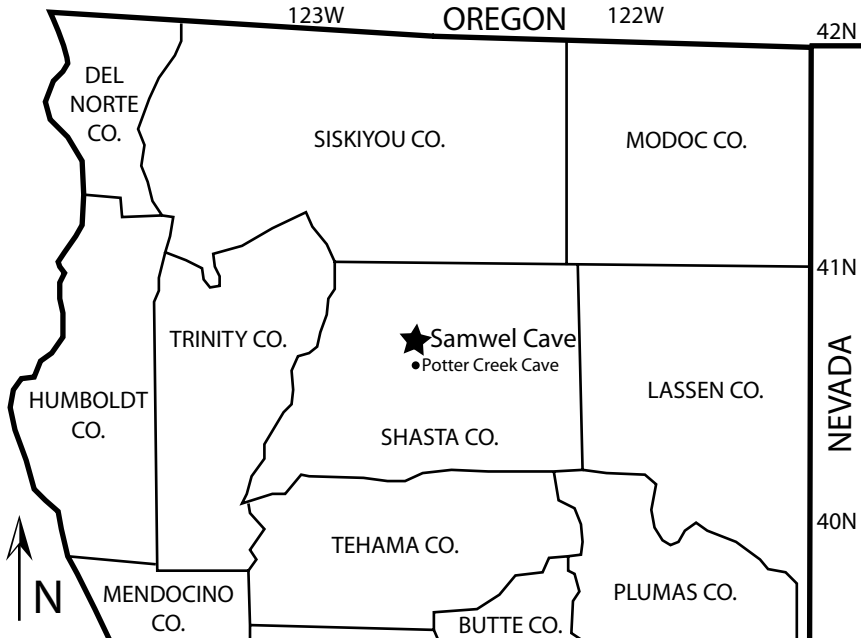


Figure 1 Location of Samwel Cave (★) in Shasta County, California, USA. Also, note the location of Potter Creek Cave to the south.

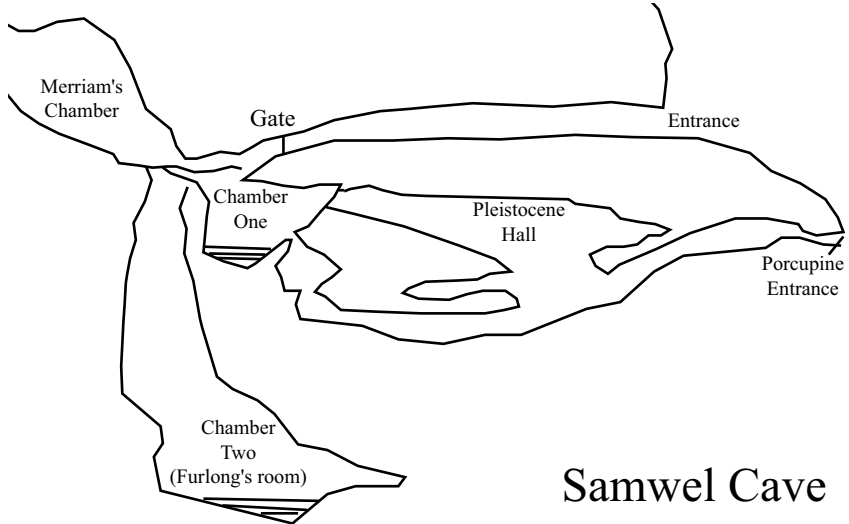


Figure 2 Cross-sectional view of Samwel Cave. The dated specimens come from Chamber Two, "Furlong's Room."

**METHODS**

The ancient bone samples were obtained from the vertebrate paleontology collections at the UCMP. Five different specimens from Chamber Two were analyzed including both large and small species. Preparation procedures generally follow Brown et al. (1988) and Bronk Ramsey et al. (2004). Briefly, samples were first decalcified using 0.5N HCl to obtain collagen. Collagen was then gelati-

Table 1 Mammalian species list for Samwel Cave. Faunal deposits include 45 mammal species. Symbols: †, extinct; ‡, historic extirpation.

<b>Artiodactyla</b>	<b>Perissodactyla</b>
‡ <i>Cervus</i> sp.	† <i>Equus</i> sp.
† <i>Euceratherium collinum</i>	<b>Proboscidea</b>
<i>Odocoileus hemionus</i>	† <i>Mammuthus primigenius</i>
† <i>Oreamnos americanus</i>	<b>Rodentia</b>
<b>Carnivora</b>	<i>Aplodontia rufa</i>
† <i>Arctodus pristinus</i>	<i>Castor canadensis</i>
<i>Bassariscus</i> sp.	<i>Erethizon dorsatum</i>
† <i>Canis dirus</i>	<i>Glaucmys sabrinus</i>
<i>Canis latrans</i>	<i>Marmota</i> sp.
<i>Lutra canadensis</i>	<i>Microtus californicus</i>
<i>Martes americana</i>	<i>Neotoma cinerea</i>
<i>Mephitis mephitis</i>	<i>Neotoma fuscipes</i>
<i>Mustela frenata</i>	<i>Peromyscus maniculatus</i>
<i>Procyon lotor</i>	<i>Sciurus griseus</i>
<i>Puma concolor</i>	<i>Spermophilus beecheyi</i>
<i>Spilogale gracilis</i>	<i>Spermophilus lateralis</i>
<i>Taxidea taxus</i>	<i>Tamias</i> sp.
<i>Urocyon cinereoargenteus</i>	<i>Tamiasciurus douglasii</i>
<i>Ursus americanus</i>	<i>Thomomys bottae</i>
‡ <i>Ursus arctos</i>	† <i>Thomomys microdon</i>
<i>Vulpes vulpes</i>	<i>Thomomys monticola</i>
<b>Insectivora</b>	<b>Xenarthra</b>
<i>Scapanus latimanus</i>	† <i>Megalonyx</i> sp.
<b>Lagomorpha</b>	† <i>Nothrotheriops shastensis</i>
<i>Lepus americanus</i>	
<i>Lepus californicus</i>	
<i>Sylvilagus bachmani</i>	

nized at 58 °C for 16 hr. The gelatin solution was filtered to remove any remaining solids. The solution was then ultra-filtered to remove the 30-kD fraction, and the 30-kD fraction was then lyophilized. The freeze-dried collagen appeared yellowish-white in color and cotton-ball-like for each sample. The freeze-dried collagen samples were then graphitized for AMS analysis. Percent yields for the samples ranged from 9% to 48% (Table 2). Bone collagen samples were analyzed at the CAMS facility at Lawrence Livermore National Laboratory and calibrated using CALIB 5.0 (Stuiver et al. 2005).

## RESULTS AND DISCUSSION

Five dates were obtained from the Samwel Cave specimens (Table 2). The samples span the last glacial maximum (LGM) (Yokoyama et al. 2000). Three of the samples range from 17,100–17,900 cal BC, while the other 2 range from 21,300–23,600 cal BC. The bone dates do not follow in stratigraphic order, as the date from 50.8 cm (20") down in Section 5 is older than the date obtained from 76.2 cm (30") down in Section 4. So, although the deposits were excavated as if the sediment was stratified, the data currently do not support stratified deposition.

Table 2 Analyzed samples from Samwel Cave. Calibration data from Reimer et al. (2004),  $\delta^{13}\text{C}$  estimated at  $-22\text{‰}$  for all specimens. Abbreviations: CAMS, Center for Accelerator Mass Spectrometry at Lawrence Livermore National Laboratory; UCMP, University of California Museum of Paleontology.

CAMS #	Sample RSF-	UCMP #	Species identification	Element	Section; level	% carbon from collagen	Fraction modern	D <sup>14</sup> C	<sup>14</sup> C age	2- $\sigma$ cal age range (cal BC)
117319	C(14)01	17309	<i>Aplodontia</i> sp.	femur	Sect. 4; 30"	36.29%	0.1325 $\pm$ 0.0023	-867.5 $\pm$ 2.3	16,240 $\pm$ 150	17,100–17,850
117320	C(14)04	none	<i>Rodentia</i>	phalanx	Sect. 4; 12"	43.85%	0.1347 $\pm$ 0.0021	-865.3 $\pm$ 2.1	16,110 $\pm$ 130	17,100–17,500
117321	C(14)05	9773	<i>Lepus washingtonii</i>	jaw	Sect. 5; 20"	48.95%	0.0834 $\pm$ 0.0022	-916.6 $\pm$ 2.2	19,960 $\pm$ 210	21,300–22,500
117322	C(14)06	none	<i>Mammalia</i>	bone	Sect. 3; 36"	39.32%	0.0753 $\pm$ 0.0022	-924.7 $\pm$ 2.2	20,770 $\pm$ 240	22,300–23,600
119156	C(14)21	9128	<i>Euceratherium</i> sp.	jaw fragment	na	9.84%	0.1313 $\pm$ 0.0016	-868.7 $\pm$ 1.6	16,310 $\pm$ 100	17,300–17,900

Based on the mammalian fossil assemblage present and the number of extinct animals at SC and PCC, previous studies suggested that the SC faunal deposits were younger than the PCC deposits (Taylor 1975; Payen and Taylor 1976; Meltzer and Mead 1983). The dates available for the PCC fauna are all Holocene in age. The oldest date provided is  $8250 \pm 330$  BP (cal BC 8178–6457), which is surprising since it comes from the extinct ungulate *Euceratherium*. This taxon is proposed to have gone extinct before the end of the Pleistocene (Barnosky et al. 2004). Either this young date on *Euceratherium* is suspect or northern California acted as a refugium for the species. Because it is unclear what fraction of the *Euceratherium* bone was analyzed to obtain the <sup>14</sup>C date, using the reliability rating system of Meltzer and Mead (1983, 1985) and Mead and Meltzer (1984), the *Euceratherium* specimen would receive a score of 7 and be considered unreliable. Because of recent techniques in what portion of collagen is analyzed and how it is prepared (Meltzer and Mead 1985), the dates presented herein from Samwel Cave would be given a score of 8 or 9 and are considered reliable.

From the current data, it appears that the previous suggestions that the SC fauna are younger than the PCC fauna are incorrect. However, if the *Euceratherium* date is in fact anomalous, the PCC fauna would be expected to occur prior to the LGM. Additional analyses of the PCC fauna are currently underway to reevaluate the chronology of deposition at the site.

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