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17 November 1967

Mummy Cave: Prehistoric Record from Rocky Mountains of Wyoming

Abstract. *Archeological materials from 8.5 meters of deposits in a stratified rock shelter in the Absaroka Mountains near Yellowstone National Park provide a projectile point sequence and cultural record beginning more than 9000 years ago, and include evidence of human occupation during the Altithermal period.*

Mummy Cave is located on a bend of the North Fork of the Shoshone River in the Absaroka Mountains of northwestern Wyoming. The cave (altitude, 1922 m) is cut into the northeast wall of the valley near the mouth of Blackwater Creek and is immediately adjacent to U.S. Route 20, 54.7 km west of Cody, Wyoming, and 19 km east of Yellowstone Park.

The mountains, which are the eastern extension of the Tertiary volcanic rocks of the Yellowstone Plateau, are deeply dissected in the area of the site, with relief up to 1220 m. The North Fork valley, in which the site lies, is the only passageway in the area leading from the Big Horn Basin around Cody (altitude, 1525 m) to the plateau to the west (altitude, 2440 m).

The cave is a large alcove in a cliff of south-dipping beds of volcanic breccia and tuff. Because of its similarity to an alcove being cut in similar rocks now at river level near Clocktower Creek, the cave is believed to have been formed largely by the erosive action of the North Fork as it cut downward through the volcanic strata. After cutting the alcove, the river shifted its course slightly, and a thick pile of talus and colluvium from the roof and walls of the alcove and from the cliff above gradually accumulated in the cave. In this fill the artifacts and bones were found.

Of special geological interest is the evidence from carbon-14 dating, from the lower part of the fill, that shows that the river must have been at its present level approximately 10,000 years ago and that it has done little downcutting since. According to radiocarbon dates, in general, the rate of accumulation of sediment declines from approximately 2.4 m per thousand years near the base to approximately 0.22 m per thousand years near the top. The rate varies considerably in between.

Significant to the remarkable preservation of bones and perishable cultural materials is the dryness of the cave and its fill. This dryness is due to the low permeability of the overlying rocks, the wide spacing of joints in the immediate vicinity of the cave, and the small catchment area for precipitation provided by the knifelike summit of the ridge containing the cave.

The cave fill, as cross-sectioned by the excavations, consisted of 38 distinct layers with evidence of human occupation contained within 8.5 m of detrital sediment. Radiocarbon dates derived from charcoal (available for about half the layers) start about 7280 B.C. for culture layer 4, and end at A.D. 1580 for culture layer 38 (Fig. 1). The occupied layers consist of gray sandy silt mixed with ashes, charcoal, angular rockfall fragments, animal bones, plant remains, and artifacts. Ash-filled hearths, sometimes containing stones but never lined, are present in several levels. Culturally sterile strata (2 to 30 cm thick) consisting of colluvium and interbedded, thin silt layers separate the occupation layers from one another.

The lower and middle layers of the fill, below about 2.7 m from the surface, generally produced few artifacts, and these were principally chipped stone projectile points. In the upper layers, artifacts occurred in much greater numbers and variety; and layers 30 to 36 (Fig. 1) yielded, in addition to 300 or more points, other objects of stone, bone, wood, animal skin, and plant fiber. Pottery fragments were found only in the uppermost culture layer, within 20 to 30 cm of the surface. The identifiable animal bone shows a surprising range of forms, including at least five bird species, 30 or more mammal species, a very heavy incidence of mountain sheep, but few deer, and almost no bison. The plant remains have not been identified. Pollen was poorly preserved and for the most part could not be identified.

Projectile points were found in 22 levels. They appeared first at a depth of 8 m in layer 4 and continued upward with notable changes in form, size, and other particulars through time (Fig. 1). Medium to large leaf-shaped points with narrow bases occurred exclusively in layers 4 through 15, from about 7280 to 6000 (carbon-14) years B.C. They then give way in layers 16 through 19 (5600 to 5200 B.C.) to side-notched points that suggest eastern plains forms. Stemmed and shouldered types follow; and by about 2500 B.C. points of the well-known McKean type and its variants (*1*) appear in some numbers. Along with these in layer 30 (about 2470 ± 150 B.C.), there were tubular bone pipes, coiled basketry fragments, bits of vegetable fiber cordage and netting, wood trimmings, leather scraps, many flint chips, and animal bones, and other perishable and imperishable materials. Grinding stones that were probably used by inhabitants who relied somewhat on the gathering and crushing of seeds also appear at this level and again in layer 36, dated at about A.D. 720; but these stones are much less common than in Archaic stations on the Great Plains or in the Great Basin. They are associated in the later level with small corner-notched points that have finely serrate edges, and with steatite, basketry, worked wood and leather, abundant bone scrap and flint chips, and various other articles. The dessicated body of an adult male wearing a mountain sheepskin garment, interred from layer 36 about 1230 years ago as judged by radiocarbon dating, gives the site its name.

It is abundantly clear that during the last 9000 years or more the cave was occupied, abandoned, and reoccupied many times, probably by people coming into the locality from widely different directions, but all of whom tended to adjust their lifeways to a mountain-adapted subsistence economy. The leaf-shaped points from the lower levels are similar to forms that are widely distributed throughout the montane regions of Idaho, Montana, and Wyoming, and are found also on the plains to the east. The side-notched points resemble those found with *Bison occidentalis* at the Simonsen site (*2*) in northwestern Iowa and also at Logan Creek in eastern Nebraska, and they suggest that peoples or cultural influences from east of the Rocky Mountains arrived in the locality. Points from layers 21 through 28 are of types apparently found only in

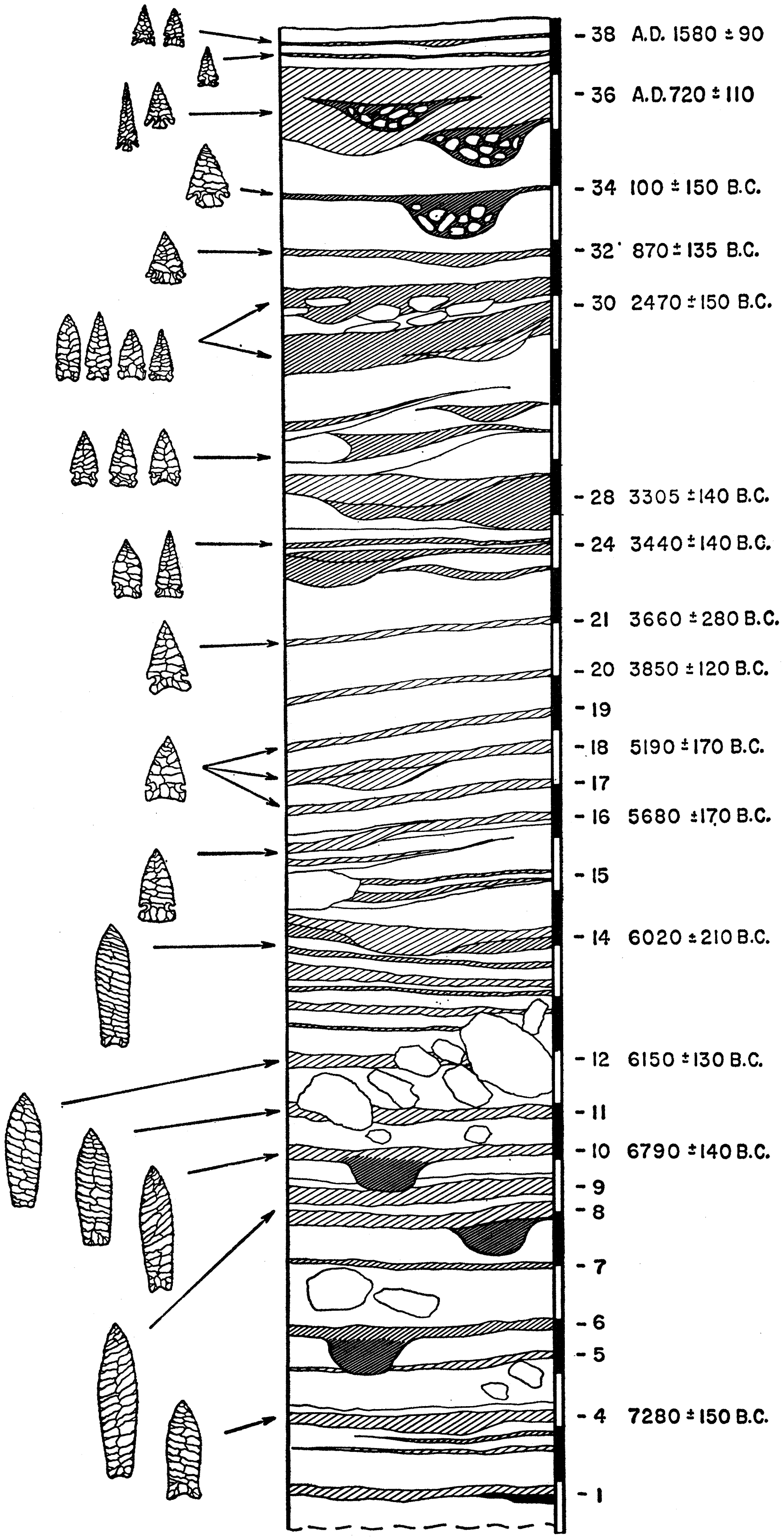

Fig. 1. Stratigraphic section through floor fill at Mummy Cave, Wyoming. Culture layers are numbered 1 to 38, beginning at the bottom. Radiocarbon dates are listed at the right; projectile point types shown at left. Right-hand margin of profile is marked in 30-cm intervals.

the montane region; their dates correspond to the Altithermal, when the Plains and Great Basin may have been largely abandoned by man. In layer 30 and above, the points are predominantly characteristic of Northwestern Plains and Great Basin cultures of the last 4500 years, that is, of the post-Altithermal period.

Mummy Cave, with its long sequence of discontinuous but undisturbed culture strata dated by radiocarbon, its changing projectile point forms through 9000 years, and its relative abundance of perishable materials from the 2400 B.C. and A.D. 720 levels, is of exceptional importance in the correlation, sequential ordering, and dating of many single-component sites in the Northwestern Plains and in the adjacent mountain valleys toward the Great Basin. Of particular interest are (i) the evidence that the cave was occupied during the presumed Altithermal; (ii) the absence of evidence of the Cody complex as represented at the Horner site less than 64 km down the Shoshone River (*3*); and (iii) the fact the artifact and bone materials from the cave were essentially dissimilar from those of the Plains.

The findings further emphasize the prospective importance of the mountain areas in western prehistory and the great scientific potential of sites—particularly dry cave deposits—situated in and near the front ranges of the Rocky Mountains. Here conditions often favor preservation of material culture items that may have been used by early Plains Indians, as well as by mountain-valley peoples, but of which no traces have survived for the archeologist in the unprotected camp and village sites on the Plains proper (*4*).

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4. See for example G. C. Frison, *Plains Anthropol.* **7**, 246 (1962); ———, *Amer. Antiquity* **31**, 81 (1965).

5. Mummy Cave was first probed in the early 1960's. In 1963, Dr. H. McCracken, of the

Whitney Gallery of Western Art, Cody, initiated excavations supervised by R. Edgar. W. R. Wedel was consultant, and J. H. Moss undertook geological studies. In 1964, the National Geographic Society and private donors supported an expanded operation for which Dr. W. Mulloy provided guidance. In 1966, W. M. Husted studied the artifacts and records, and prepared the archeological report. In 1967, additional information was obtained from a trench dug to bedrock with power equipment financed by National Science Foundation grants to Franklin and Marshall College. No evidence of human occupation was found below layer 1. Pollen from the cave was studied by H. E. Wright; vertebrate remains by A. H. Harris.

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Thymine-Thymine Adduct as a Photoproduct of Thymine

Abstract. *A product isolated from thymine irradiated with ultraviolet light in frozen aqueous solution undergoes dehydration on heating with acids. As judged by elemental analysis, mass, ultraviolet, infrared, and nuclear magnetic resonance spectra, the most probable structures for this compound and its dehydration product, respectively, are 5-hydroxy-6-4′-[5′-methylpyrimidin-2′-one]-dihydrothymine and 6-4′-[5′-methylpyrimidin-2′-one]-thymine. Apparently, this compound is a thymine-thymine adduct and presumably is formed through the rearrangement of an initial photoproduct. Both compounds are closely related to 6-4′-[pyrimidin-2′-one]-thymine which has been isolated from acid hydrolyzates of ultraviolet-irradiated DNA and supposedly is derived from cytosine-thymine adduct. Formation of such adducts between pyrimidine bases is apparently a common photoreaction and may be important to the study of the photochemistry and photobiology of nucleic acids.*

A thymine-derived product having an absorbancy maximum of 316 nm has been separated from acid hydrolyzates of ultraviolet-irradiated DNA (*1*); 6-4′-[pyrimidin-2′-one]-thymine (PO-T) has been suggested as the most probable structure (*2*). We have isolated a closely related product from thymine irradiated, in frozen aqueous solution, with ultraviolet light. Elemental analysis and mass spectroscopy indicate that this compound is an adduct of thymine and thymine which is unstable and undergoes dehydration on heating with acids. This thymine-thymine adduct presumably is formed through the rearrangement of an initial photoproduct. Based on ultraviolet, infrared, nuclear magnetic resonance, and mass spectra, 5-hydroxy-6-4′-[5′-methylpyrimidin-2′-one]-dihydrothymine and 6-4′-[5′methylpyrimidin-2′-one]-thymine can be assigned as the most probable structures for the thymine-thymine adduct (T-T adduct) and dehydration product (MPO-T), respectively.

The isolation of T-T adduct was carried out by irradiation of twice-recrystallized thymine (2 mmole/liter) in frozen aqueous solution for 1 hour (*3*). The thawed solution was concentrated to dryness and dissolved in a minimum amount of $0.1N$ HCl; the solution was applied on Whatman No. 3 paper and developed with an *n*-butanol, acetic acid, and water system (80 : 12 : 30). The dried chromatogram showed by ultraviolet lamp a fluorescent band with an R_F value of 0.29, identical to that of thymine dimer (*4*). The fluorescent bands were cut out; the material was extracted three times with water. The extract was concentrated and applied to a column of Dowex 50W-X12 (H^+, 100 to 200 mesh). The column was eluted with water. The eluent (316-nm absorbancy maximum) was collected and evaporated to dryness. Two recrystallizations from water gave colorless cubes (about 2 percent); melting point, 265° to 270°C, with decomposition.

The T-T adduct was dehydrated by refluxing it (25 mg) for 90 minutes in 50 ml of $0.5N$ HCl. The solution was concentrated and chromatographed on Whatman No. 3 paper with an *n*-butanol, acetic acid, and water system (80 : 12 : 30) as eluent. The major product (R_F=0.5) was rechromatographed with a *t*-butanol, methyl ethyl ketone, ammonia, and water system (40 : 30 : 10 : 20), and it appeared as a single band with the R_F value of 0.45; this material was extracted with absolute methanol. After recrystallization with absolute ethanol, the product (16 mg) melted, with decomposition, above 300°C. The dehydration product can also be obtained by heating the T-T adduct for 1 hour at 170°C with trifluoroacetic acid in a sealed tube, or by heating it above its melting point.

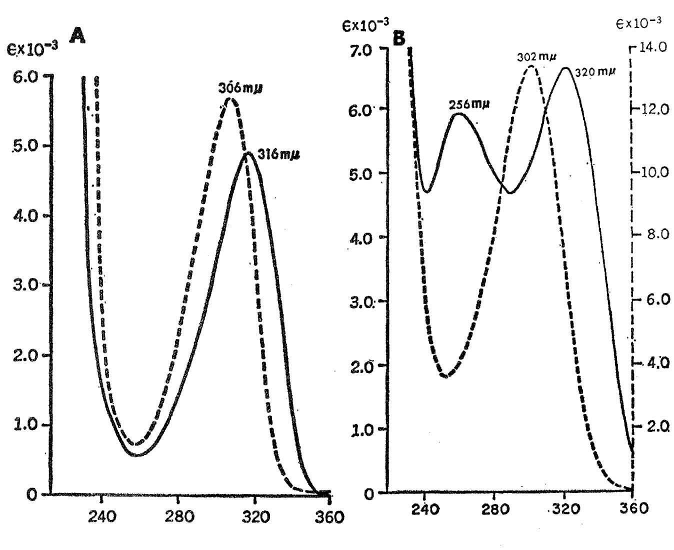

Fig. 1. The ultraviolet spectra (A) of the T-T adduct and (B) of the dehydration product of T-T adduct.

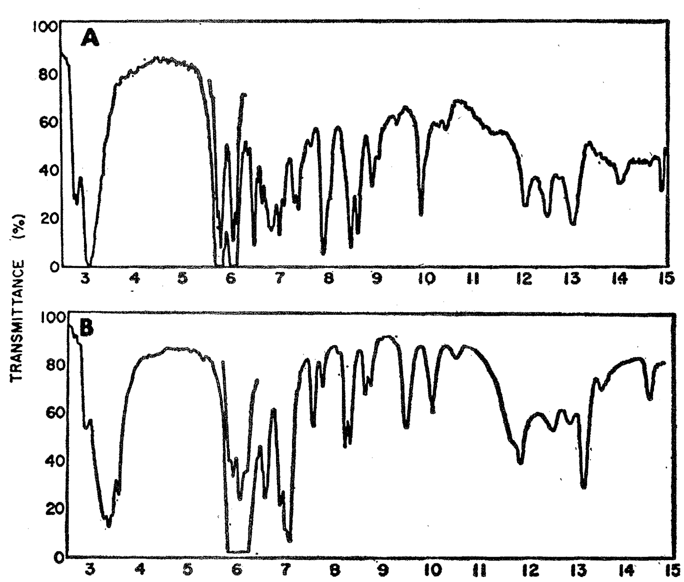

Fig. 2. The infrared spectra (A) of the T-T adduct and (B) of the dehydration product of the T-T adduct.