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Geology of the Pontiac Pit Archeological Site  
Rocky Mountain National Park, Colorado

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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## CONTENTS

	Page
Introduction.....	1
Location and geologic setting of the Pontiac Pit archeological site.....	1
Stratigraphy.....	3
Soil-horizon nomenclature.....	10
Soil description.....	12
References cited.....	15

## ILLUSTRATIONS

Figure 1. Map showing the location of the Pontiac Pit site.....	2
2. Sketch showing the stratigraphy at the Pontiac Pit site and the relationship between stratigraphic units and soil horizons.....	4

## TABLE

Table 1. Laboratory data for the soil profile at the Pontiac Pit site...	5
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GEOLOGY OF THE PONTIAC PIT ARCHEOLOGICAL SITE  
ROCKY MOUNTAIN NATIONAL PARK, COLORADO

By Richard F. Madole

INTRODUCTION

The geology of the Pontiac Pit archeological site, located in the upper valley of the Colorado River in Rocky Mountain National Park, was studied in support of archeological project ROMO 160 supervised by James W. Mueller and Terri L. Liestman of the National Park Service. The purpose of the study was to determine the age and origin of the stratigraphic units present and the nature of the soil developed at the Pontiac Pit site.

LOCATION AND GEOLOGIC SETTING OF THE PONTIAC PIT SITE

The Pontiac Pit site is on a terrace that lies about 5 m above the east edge of the flood plain of the Colorado River, a little more than 8 km north of Grand Lake, Colo. (fig. 1). The site is near the center of sec. 12, T. 4 N., R. 76 W., a few tens of meters east of Trail Ridge Road (U.S. Highway 34) and about 100 m north of a borrow pit, known locally as Pontiac pit. The terrace is composed chiefly of stratified drift of glaciofluvial origin. Two other terrace remnants are present nearby at slightly higher levels. The uppermost of these is the site of Pontiac pit.

The Pontiac Pit site is within the area in this valley that was glaciated during Pinedale time (approximately 30,000-13,500 B.P.). It lies about 8 km upvalley from the terminal moraine of Pinedale age (fig. 1), and about 18 km downvalley from where the Continental Divide crosses La Poudre Pass at the head of the Colorado River. Although concerned primarily with evaluating relative-dating methods, Meierding (1977) shows the distribution of glacial and glaciofluvial deposits in part of the upper Colorado River basin, including the area of the Pontiac Pit site.

STRATIGRAPHY

Four stratigraphic units are present at the Pontiac Pit site (fig. 2). These include from top to bottom (1) dark-grayish-brown to very dark gray silty sand (nearly sandy silt), 3-5 cm thick in most places; (2) brown to dark-brown silty sand, commonly 9-12 cm thick; (3) yellowish-brown to dark-yellowish-brown matrix-supported pebble gravel, 5-10 cm thick; and (4) very pale brown to light-yellowish-brown clast-supported cobble gravel whose thickness is unknown, but probably exceeds 5 m. Unit colors were identified from Munsell Soil Color Charts, and unit textures are according to Shepard's (1954) textural classification of sediments. The range of color listed for each unit represents the range seen in dry to moist sediment.

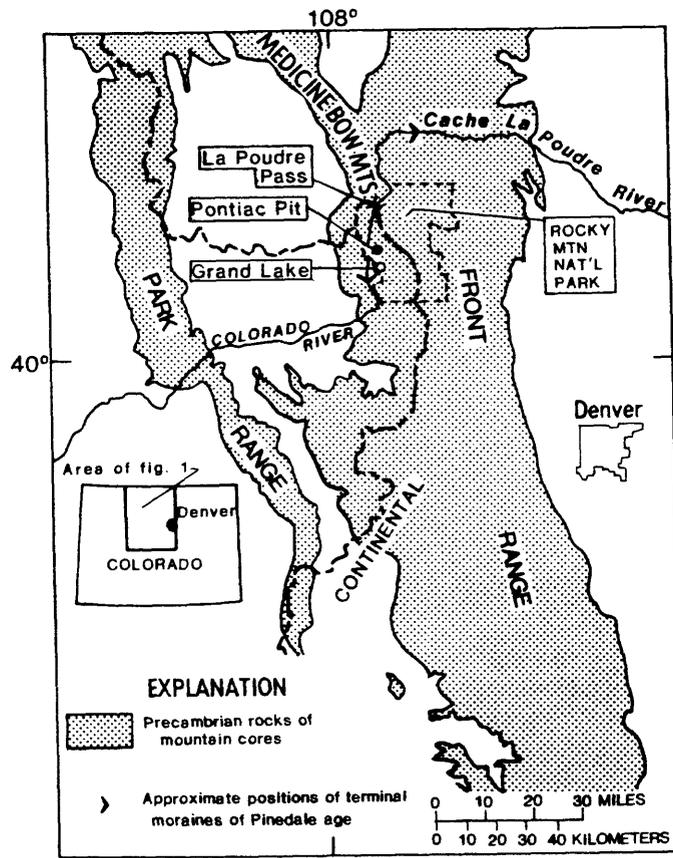


Figure 1.--Map showing the location of the Pontiac Pit site

Unit 1--Dark-grayish-brown to very dark gray silty sand (latest Holocene).--Unit 1 is commonly 3-5 cm thick, but is thicker locally. It mantles the ground surface and overlies an older eolian unit from which it differs texturally in being more silty (table 1). The contact between units 1 and 2 is indistinct because the color of the 2A horizon<sup>1</sup> (fig. 2) developed in unit 2 is only slightly lighter than that of the A horizon developed in unit 1. Initially, the 2A horizon was interpreted to be an incipient E horizon because of this slight difference in color compared with the A horizon.

Unit 1 is believed to be of eolian origin and less than about 800 years old. The interpretation of origin is based mainly on the high percentage of silt in this unit (table 1) and the general absence of particles larger than sand (see soil description). The age assigned to unit 1 is based on the age of the archeological features that underlie it. Unit 1 is younger than about 800 B.P., because it overlies four hearths whose radiocarbon ages range from 780 ± 50 to 980 ± 180 yrs B.P. (T. L. Liestman, written commun., 1984).

<sup>1</sup>The soil-horizon nomenclature used in this report follows that proposed for the new Soil Survey Manual, Chapter 4, which has not been published yet, but has been summarized by Guthrie and Witty (1982). A few symbols and definitions from Birkeland (1974) are used also.

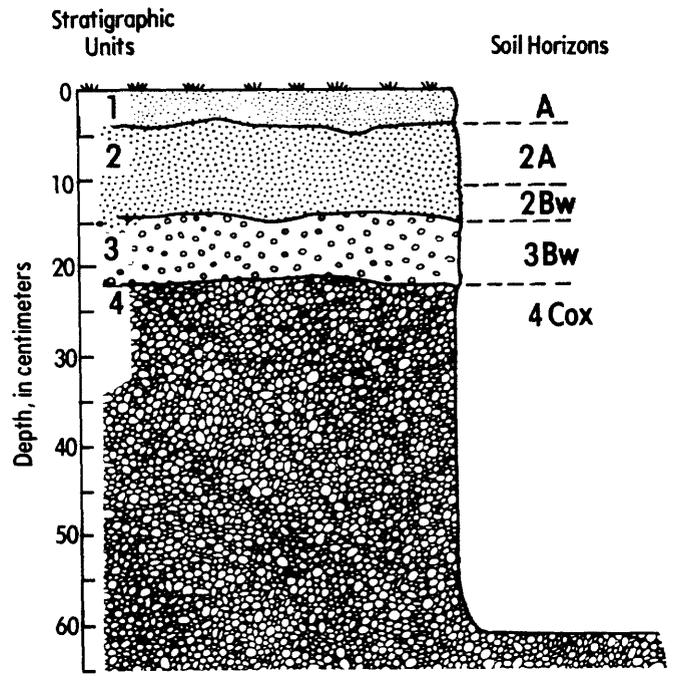


Figure 2.--Sketch showing the stratigraphy at the Pontiac Pit site and the relationship between stratigraphic units and mineral soil horizons. The color B horizon (Bw) is formed partly in eolian sediment and partly in gravel, and is similar in degree of development to B horizons formed in deposits of Pinedale age in other localities in the Front Range. The A horizon is formed in eolian sediment that is much younger than that in which the rest of the soil is developed. Each stratigraphic unit (the four parent materials identified by Arabic numeral prefixes) is texturally distinct (table 1).

Unit 2--Brown to dark-brown silty sand (late Pleistocene (?) and Holocene).--Unit 2 is typically 9-12 cm thick, and it is texturally distinct from the units above and below (table 1). Although minor amounts of windblown sediment may have been added to this unit periodically over a long interval, most of the unit is believed to be older than about 5900 B.P., and possibly is as old or older than 10,000 B.P.

The degree of development of the B horizon, which extends from the lower part of unit 2 into unit 3 (fig. 2), suggests that unit 2 is as old as late Pleistocene or early Holocene. The development of the B horizon is similar to B horizons formed in deposits of Pinedale age in other localities in the Front Range, and the colors of the Bw and Cox horizons are like those of soils in both the Middle and Southern Rocky Mountains that are 10,000 years old (Shroba and Birkeland, 1983, p. 148). Furthermore, a considerable amount of loess was deposited in this region between 14,000 and 10,000 years ago (Madole, 1976, 1980, and unpub. data), and unit 2 might be correlative with this loess.

A variety of artifactual remains and features provide a minimum age for unit 2 (archeological data and related radiocarbon ages are from T. L. Liestman, written commun., 1984). A projectile point of the Middle Plains Archaic period (4500-3000 B.P.) was found at or near the surface of unit 2. Charcoal from several hearths ranging in age from a little more than 2000 B.P. to more than 4,000 B.P. were excavated in this unit. One hearth, dated at  $3920 \pm 160$  yrs B.P. (Beta-7202), clearly postdates deposition of the lower part of unit 2, and a similar feature with an age of  $4710 \pm 110$  yrs B.P. (Beta-6882), but whose stratigraphic relations are less clear, also probably postdates unit 2. Fragments of two projectile points similar to those associated with the Mount Albion complex (about 5300-5900 B.P.) of Benedict and Olsen (1978) were found in two locations at the Pontiac Pit site. Unfortunately, the stratigraphic positions of the two fragments relative to the upper and lower contacts of unit 2 are uncertain. Nonetheless, no reason exists to believe that they predate unit 2. This plus their similarity to projectile points of the Mount Albion complex is the basis for the minimum age of 5900 B.P. listed above.

Unit 3--Yellowish-brown to dark-yellowish-brown matrix-supported pebble gravel (late Pleistocene).--Unit 3 is a matrix-supported pebble gravel, 5-10 cm thick, that overlies the clast-supported cobble gravel that composes most of the deposit underlying the terrace surface (fig. 2). Unit 3 is interpreted to be a mixture of eolian sediment and/or sheetwash containing gravel reworked from unit 4. Matrix supported refers to the fact that matrix (the fraction less than 2 mm in size) is dominant, and clasts (mostly pebbles in this unit) are separated from each other by matrix, as opposed to a clast-supported gravel, wherein clasts are nearly in continuous contact and matrix is subordinate.

The areal extent and significance of the matrix-supported pebble gravel is unknown. It could represent localized disturbance that mixed gravel and eolian sediment, as for example from wind-thrown trees, or it could be due to processes such as frost heave or sheetwash that affected a more extensive area. Without more information, I favor either an origin by frost heave or reworking by sheetwash. This sediment may have been deposited soon after that of unit 4, or it may have accumulated slowly or intermittently throughout the time between deposition of units 4 and 2.

Unit 4--Very pale brown to light-yellowish-brown cobble gravel (late Pleistocene).--Unit 4 was examined in a pit excavated adjacent to the Pontiac Pit site. Although the pit was excavated to a depth of only 60 cm, the sediment observed in it is like that in larger exposures in similar deposits elsewhere in the area; hence, it is presumed to be representative of the terrace deposit as a whole. The deposit is of glaciofluvial origin. Small- to medium-sized cobbles dominate, and only a small percentage of clasts are as large as 15 cm in maximum dimension. Most of the clasts are well-rounded fragments of igneous and metamorphic rocks. The deposit is poorly consolidated and contains so little silt and clay that the walls of the soil pit caved in readily. Medium sand is the dominant size fraction present in the matrix (table 1). The deposit is believed to be at least as thick as the terrace is high, which is about 5 m.

Table 1.--Laboratory data for the soil profile at the Pontiac Pit site

Horizon <sup>2</sup> Average depth (cm)	Particle-size distribution (mm) <sup>1</sup> Percentage of <2 mm fraction													
	Total			Sand			Silt			Clay				
	Sand (2-0.05)	Silt <sup>3</sup> (0.05- 0.002)	Clay <sup>3</sup> (<0.002)	Very coarse (2-1)	Coarse (1-0.5)	Medium (0.5- 0.25)	Fine (0.25- 0.10)	Very fine (0.10- 0.05)	Coarse (0.05- 0.03)	Medium (0.03- 0.02)	Fine (0.02- 0.002)	Coarse (0.002- 0.0005)	Fine (<0.0005)	
A	0-4	44.8	38.7	16.6	8.1	10.5	12.0	7.5	6.7	12.6	7.4	18.7	7.1	9.5
2A	4-11	56.5	27.0	16.4	12.4	14.1	15.7	8.4	5.9	6.2	7.4	13.4	6.2	10.3
2Bw	11-14	61.8	21.3	16.9	13.1	13.6	17.6	10.1	7.5	5.1	5.6	10.6	5.2	11.7
3Bw	14-21	79.4	12.2	8.4	13.8	18.5	27.0	13.1	7.1	3.1	2.6	6.5	4.0	4.5
4Cox	21-60+	96.4	2.5	1.1	17.5	26.5	41.9	7.7	2.9	1.1	0.6	0.8	0.3	0.8

<sup>1</sup>Particle-size distribution determined by the sieve-pipette method.

<sup>2</sup>See the section on soil-horizon nomenclature for an explanation of the soil-horizon designations used here.

<sup>3</sup>Particle-size limits for silt and clay are according to the the U.S. Department of Agriculture particle-size scale (Soil Survey Staff, 1975).

The cobble gravel of unit 4 was deposited sometime between 19,000 B.P. and 13,500 B.P. The Pontiac Pit is about 8 km upvalley from the terminal moraines of Pinedale age; therefore, the cobble gravel at this site is younger than the time of the Pinedale maximum, which in this region is believed to have occurred about 19,000 yrs B.P. (R. F. Madole, unpub. data). Likewise, the site lies far downvalley from the glacier source area, which is believed to have been deglaciated by 13,500 B.P. (Madole, 1980, and unpub. data).

#### SOIL-HORIZON NOMENCLATURE

The soil-horizon nomenclature used in this report follows that proposed for the new Soil Survey Manual, chapter 4, which has not been published yet, but has been summarized by Guthrie and Witty (1982), and also includes a few definitions from Birkeland (1974, Chapter 1). O horizons are surface layers of organic material that overlie the mineral soil. A horizons form in the upper part of the mineral soil, and are as dark or darker than the adjacent underlying horizon. They include humified organic matter that is mixed with the mineral soil. B horizons form below O, A, or E horizons, and are recognized by a variety of dominant features (Soil Survey Staff, 1975, p. 460; Birkeland, 1974, p. 5-6). A chief attribute of B horizons is that the material has been altered to the extent that little or none of the appearance of the parent material is retained. Bw is the new designation used for color or structural B horizons, which have been referred to in the literature as Bs horizons (see for example, Shroba and Birkeland, 1983, p. 145). C horizons underlie B horizons, and are characterized chiefly by a lack of soil formation. Because the C horizon has been affected little by soil formation, it lacks the properties that are diagnostic of A, E, and B horizons. The Cox horizon (Birkeland, 1974) is an oxidized C horizon that does not meet the requirements of a cambic B or color B horizon, but has higher chromas (more color), generally 3 or 4, than the underlying Cn horizon (Birkeland, 1974), which is unoxidized or unweathered.

Changes adopted from the new Soil Survey Manual include (1) a change from Arabic numerals to lower-case letter suffixes for subdivisions of the O horizon, (2) elimination of the Arabic numeral suffix 1 for A horizons and (3) a change from Roman numerals to Arabic numerals for prefixes that denote lithologic discontinuities in the parent material. The suffixes used for subdivisions of the O horizon are defined as: a--highly decomposed organic matter, e--intermediately decomposed organic matter, and i--slightly decomposed organic matter. With the elimination of Arabic numeral suffixes from A horizon designations, A1 horizons are now simply A horizons, whereas what were formerly referred to as A2 horizons are now referred to as E horizons.

## SOIL DESCRIPTION

Location: A few tens of meters east of U. S. Highway 34; Grand Lake 7 1/2' quadrangle; SE 1/4, SE 1/4, NW 1/4, sec. 12, T. 4 N., R. 76 W.

Altitude: 2,675 m (8,780 ft)

Vegetation: Chiefly lodgepole pine, willows in topographic lows along nearby stream, and a sparse cover of grass and forbes on forest floor; little or no understory.

Parent Material: Eolian sediment of two ages, a thin layer of mixed eolian sediment and gravel, and glaciofluvial gravel derived mainly from granitic and gneissic rocks.

Topography: Gently sloping surface graded to a small side-valley stream that has cut through the terrace to the level of the flood plain of the Colorado River.

Climate: An estimated 45-50 cm of mean annual precipitation; an estimated -11°C mean January temperature and 13°C mean July temperature<sup>1</sup>.

### Horizon

Oi  
2-1 cm<sup>2</sup>  
(1 cm) Scattered patches of pine needles; very abrupt smooth boundary.

Oe and Oa  
1-0 cm  
(1 cm) Very dark grayish brown (10YR 3/2, dry) to black (10YR 2/1, moist) humified organic matter; very abrupt smooth boundary.

A  
0-4 cm  
(4 cm) Dark-grayish-brown (10YR 4/2, dry) to very dark gray (10YR 3/1, moist) loam; weak, medium granular; nonsticky, slightly plastic; negligible material greater than 2 mm in size; abrupt smooth boundary.

2A  
4-11 cm  
(7 cm) Brown (10YR 4/3, dry) to dark brown (10YR 3/3, moist) sandy loam; weak, fine to medium subangular blocky; nonsticky, slightly plastic; less than 5 percent material greater than 2 mm in size; abrupt smooth boundary.

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<sup>1</sup>Estimates of mean annual precipitation and mean temperature for January and July are based on data from the Grand Lake weather station for the period 1939-1952.

<sup>2</sup>Because O horizons at the surface may be rapidly altered in thickness or be destroyed by fire or by the activities of man or other animals, the depth limits of O horizons that are at the surface are always measured upward from the top of the underlying mineral soil (Soil Survey Staff, 1975, p. 460). Horizon thicknesses are shown in parentheses.

2Bw 11-14 cm (3 cm)	Yellowish-brown (10YR 5/4, dry) to dark-yellowish-brown (10YR 3/4, moist) coarse sandy loam; weak, fine subangular blocky; nonsticky, slightly plastic; grains larger than 2 mm, mostly granules, compose an estimated 5 percent of the material; abrupt smooth boundary.
3Bw 14-21 cm (7 cm)	Yellowish-brown (10YR 5/6, dry) to dark-yellowish-brown (10YR 4/6, moist) gravelly coarse sandy loam; very weak, fine subangular blocky; nonsticky, nonplastic; granules and small pebbles 5-10 mm long are abundant, and compose an estimated 10-15 percent of the material; abrupt smooth boundary.
4Cox 21-60+ cm (39+ cm)	Very pale brown (10YR 7/4, dry) to light-yellowish-brown (10YR 6/4, moist) cobbly coarse sand; single grain; nonsticky, nonplastic; pebbles and small- to medium-size cobbles compose 30 percent or more of the material; lower boundary not exposed.

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