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# FLUVIOGLACIAL FEATURES OF THE ANIMAS RIVER VALLEY, COLORADO AND NEW MEXICO

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## INTRODUCTION

The Animas River heads in the San Juan Mountains, a broad domal uplift approximately 90 miles from east to west and 70 miles from north to south (Thornbury, 1965). The river leaves the San Juan Mountains at their southern boundary, the large hogback ridge immediately south of Durango, Colorado (fig. 1 ). The total distance from the head of the Animas at Animas Forks to the southern boundary of the San Juan Mountains is about 50 miles, although the river flows a considerably greater distance to reach this point. The river continues nearly due south from Durango across the New Mexico-Colorado state line to Aztec, New Mexico where it swings southwest and continues on to Farmington to join the San Juan River.

In the valley of the Animas River, Tertiary volcanic rocks, the most important rocks in the San Juan Mountains, are exposed. Volcanism began in Miocene time and continued at intervals into the Quaternary. Six distinct volcanic episodes have been recognized (Larsen and Cross, 1956). Precambrian, Paleozoic, and Mesozoic rocks are also exposed along the river.

The effects of Pleistocene glaciation can be seen in the Animas Valley of the San Juan Mountains and deposits of at least five glacial advances have been identified. South of the San Juan Mountains, Tertiary sedimentary rocks are exposed along the valley and glacially derived Pleistocene sediments are abundant.

## PHYSIOGRAPHIC AND GEOLOGIC SETTING

The valley of the Animas River heads near Animas Forks about ten miles north-northeast of Silverton. It is the largest valley in the San Juan Mountains and during the Pleistocene was occupied by the largest glacier in the range. The Animas Glacier extended 50 miles down the valley to Animas City and Durango at various times during the Pleistocene. The glacier was fed by over 75 catchment basins and the ice was as much as 2000 feet thick (Atwood and Mather, 1932).

The drainage area of the river extends to the northern margins of the mountain range. The Animas Valley inner gorge is 2000 feet deep at Animas Forks where several tributaries join to form the main channel of the Animas River (Atwood and Mather, 1932). The valley has been eroded by alternating glacial and fluvial action aided by mass-wasting which is very common in some areas. Atwood and Mather state that:

In spite of the amount of glacial erosion, the contour of the canyon still displays at most localities the dual nature of the gorge as represented in the cross-section between Howardsville and Middleton [fig. 2]. There is a pronounced shoulder on the canyon's wall midway between the modern stream channel and the higher summits on each side.

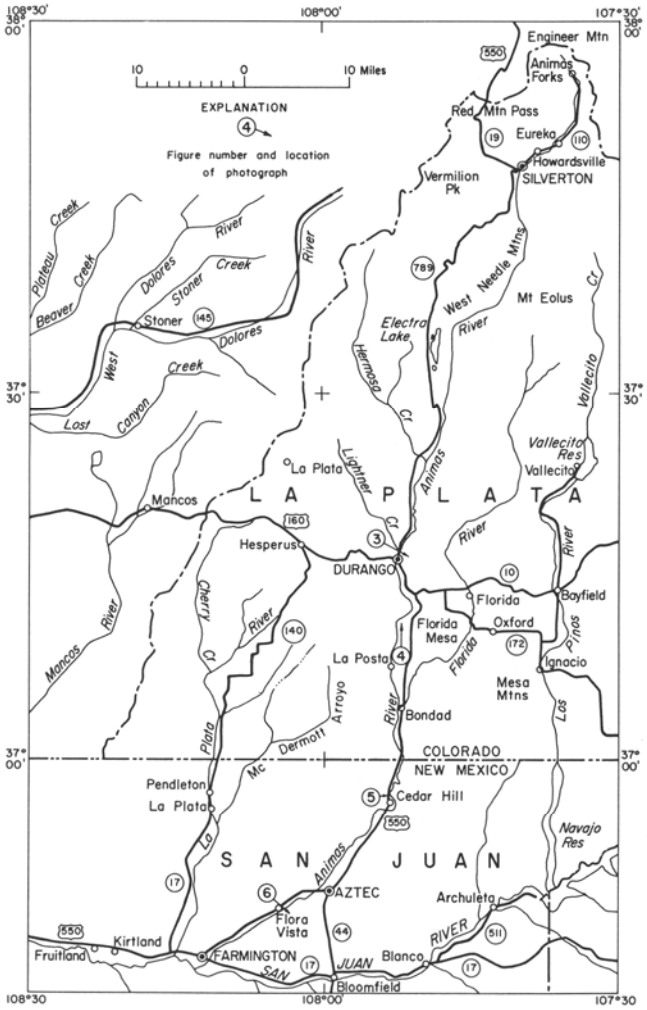


FIGURE 1.
Location map of the Animas River drainage and adjoining areas.

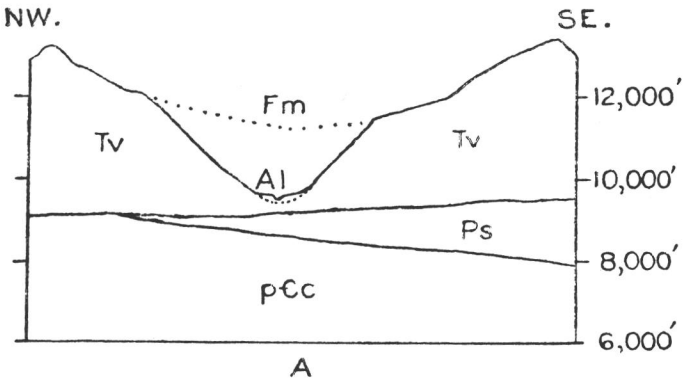


FIGURE 2.
Cross section of the Animas Valley between Howardsville and Middleton. Al, stream alluvium and torrential wash; Fm, graded surface of the Florida cycle; Ps, Paleozoic strata; Tv, Tertiary volcanic rocks; p€c, Precambrian complex. Modified from Atwood and Mather, 1932, Fig. 8.

The Animas Valley is a relatively narrow, steep-walled gorge for about 45 miles from its head at Animas Forks. Fifteen miles north of Durango the valley broadens and the stream begins to meander on a wide floodplain. The valley is filled with glacial debris which was deposited behind the terminal moraines left by the Animas Glacier during its Pleistocene advances. The debris consists of ground moraine, remnants of lateral and recessional moraines, and large quantities of outwash. The gradient of the stream has been lowered here to approximately six feet per mile and the water moves at a very sluggish rate. Oxbow lakes and meander scars are obvious, and tamarisk and other riverside vegetation mark the positions of many former stream channels. In Animas City, immediately north of Durango, the stream has cut through the moraines left by the Animas glaciers and its character changes abruptly to that of a more youthful stream with rapids and a relatively straight course.

Excellent exposures of the Mesozoic and Paleozoic sections can be seen to the north in the valley walls from this point.


FIGURE 3.
Sequence of moraines at Durango, Colo.; pe and pm, early and middle stades of Pinedale Glaciation (Wisconsin stage of Atwood and Mather, 1932); be and bl, early and late stades of Bull Lake Glaciation; s, Sacagawea Ridge Glaciation (type end moraine of the Durango stage of Atwood and Mather, 1932). Photograph by Whitman Cross; figure modified from Richmond, 1965.

## ANIMAS CITY MORAINES

The description below of the moraines in Animas City and outwash terraces south to the Colorado-New Mexico state line is a summary of the work done by Atwood and Mather in 1932 and modified by Richmond in 1965.

There are five terminal moraines of the Animas Glacier in Animas City (fig. 3). The two youngest and most complete moraines extend across the valley floor as nearly unbroken ridges about 50 feet high except where they have been breached by the Animas River near the center of the valley. These deposits were recognized and described by Atwood and Mather (1932) as Wisconsin moraines. Richmond (1965) correlates these moraines with the early and middle stades of the Late Wisconsin Pinedale Glaciation as defined in the Wind River Mountains of Wyoming (Blackwelder, 1915; Moss, 1951; Holmes and Moss, 1955; Richmond, 1948, 1962, 1964). Soil development, weathering of tills and topographic expression were the criteria upon which these correlations were based.

Isolated morainal remnants occur immediately downstream from the Pinedale moraines. These are the remains of two terminal moraines which were not recognized at Durango by Atwood and Mather, but have been identified by Richmond (1965) as early and late stades of the Bull Lake Glaciation as defined in the Wind River Mountains.

East of Durango on a bedrock bench about 300 feet above the Animas River lies the till identified as the type Durango Till by Atwood and Mather and more recently correlated with the Illinoian Sacagawea Ridge Glaciation of the Wind River Mountains by Richmond (1965).

## AN OLDER TILL?

Atwood and Mather (1932) described a till on Cerro Summit which they called the Cerro Till. It can be found on many upland divides in the San Juan Mountains and was thought to be a till deposited before the canyon-cutting episode began. The type deposit was later examined by R. G. Dickinson (1965) who concluded that the till material was indeed a landslide deposit. Richmond (1965) suggests that although he has abandoned the term Cerro Till, this does not preclude the possibility that some of the other Cerro Till deposits may actually be tills and not landslide debris as is the material in the type area. Further investigation may show the other Cerro Till occurrences to be of early Pleistocene age or even older.

## OUTWASH TERRACES

Outwash terraces extend downstream from the moraines in Animas City and Durango. Richmond (1965) states that the Pinedale moraines:

> are separated by a swale underlain by outwash gravel which extends from the upstream moraine through narrow channels in the downstream moraine. The latter moraine overlies proglacial gravel across which the ice had advanced. An outwash terrace segment, less than 25 feet above the Animas River, extends downstream from each moraine through the town of Durango. Weathering of the two moraines is identical. . . . A gravel outwash plain extends upstream from the moraines for a distance of 12 miles, rising gradually to an ice-contact front and local end moraine segments at 6800 feet. This front probably marks a readvance of the ice during the late stade of Pinedale Glaciation.


FIGURE 4.
View northward along the Animas River from Florida Mesa toward Durango. A. Florida Gravels, Sacagawea Ridge Terrace; B. Bull Lake Terrace; C, D. Pinedale Terraces and Recent alluvium.

Two outwash terraces extend downstream from the Bull Lake moraines in Durango. They are 100 and 170 feet above the river at this point. The lower terrace has been preserved more widely and the gravels can be seen lying on bedrock on both sides of the Animas River north of Bondad. The higher terrace occurs as isolated remnants.

An outwash terrace extends downstream from the Illinoian Sacagawea Ridge moraine. The gravels cap a bedrock bench about 300 feet above the river. This terrace is an imposing topographic feature in the town of Durango and is the site of the Fort Lewis College campus. Farther downstream, two dissected bedrock benches on the east side of the river, capped by the Florida Gravel of Atwood and Mather, form Florida Mesa. The gravels bear a very strongly developed red clayey soil which can be seen from U.S. Highway 550 as it climbs the north end of the mesa. Three to 15 feet of loess overlies the gravels and has been interpreted by Richmond to be of Bull Lake age due to the mature zonal soil in its upper part. However, he interprets an immature zonal soil at the surface of the loess as evidence that the uppermost part of the loess was deposited or locally reworked in Pinedale time. The lower surface of Florida Mesa correlates with the outwash terrace extending downstream from the Sacagawea Ridge moraine in Durango. The upper Florida Mesa surface correlates with isolated gravel remnants found by Richmond 500 feet above the river near the first hogback south of Durango.

Fluvioglacial gravels also have been mapped on Bridgetimber Mountain southwest of Florida Mesa on the west

side of the Animas River. The gravels lie on two bedrock benches approximately 2,000 and 1,600 feet above the river. These deposits were mapped as a single unit by Atwood and Mather and were considered by them to be Pliocene(?) in age. Richmond (1965) considers the lower gravels equivalent to those on the Mesa Mountains to the southeast, and tentatively correlates them with deposits of the Kansan Cedar Ridge Glaciation of the Wind River Mountains. The upper gravels on Bridgetimber Mountain are thought by Richmond to be correlative with the Nebraskan Washakie Point (?) Glaciation of Wyoming.

All of the terraces except the Bridgetimber Mountain and Mesa Mountain gravels have been preserved to a greater or lesser extent along the river in New Mexico as far as the Animas-San Juan River junction in Farmington.

The Bull Lake terraces are covered at some localities with loess capped by a red soil similar to that found on Florida Mesa. Exposures of the loess can be seen in road cuts and along tributary streambeds east of the Animas River. In Hart Canyon the loess can be seen overlying gravels and thinning to the east where it lies upon Tertiary bedrock. The loess varies in thickness from 3 to about 8 feet. The most spectacular terraces in this area can be seen extending along the valley to the southeast. They may best be viewed from Cedar Hill where U.S. Highway 550 emerges from the steep-walled canyon just south of the Colorado-New Mexico state line.

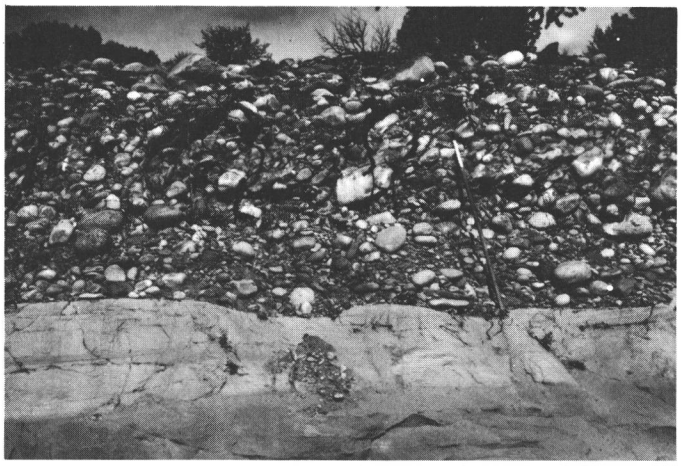

FIGURE 5.
Outwash of Bull Lake Glaciation lying on sandstone of the Tertiary Nacimiento Formation, as exposed in a roadcut on the east side of U.S. Highway 550 at Cedar Hill, New Mexico. Rod is six feet long.

In the town of Aztec the terraces are absent and do not reappear on the east side of the river for about 1½ miles. Four terrace levels are well-developed from this point downstream to Farmington. On the northwest side of the river the terraces are very well-developed about a mile south of Aztec and become smaller and more spotty as the river approaches Farmington. It appears that in most places the terraces are well-developed on one side of the river and are either small remnants or non-existent on the opposite. This can be explained as the result of shift in the stream channel since the cutting of the last Pleistocene terrace. Lateral erosion by the present Animas River may have destroyed terraces which had developed, or some parts of the stream may now occupy an area never reached by the Pleistocene Animas River.

The San Juan River has similar terraces along its course, in spite of the fact that its headwater area was much less extensively glaciated. This suggests that climate was probably not the most important factor in the formation of these river terraces, but that changes in base levels of the streams in the area and tectonic activity were most likely the principal controlling factors. The existence of similar terraces in a valley less affected by glaciation such as that of the San Juan also raises the question as to whether the Animas terraces can rightfully be called outwash terraces as far south as Farmington. It seems indisputable that the gravels capping the terrace levels in Durango are glacial outwash, but it is questionable whether the gravels should be called outwash 25 miles downstream. However, no boundary seems to exist along the river at which point outwash gravels can be separated from normal stream gravels.

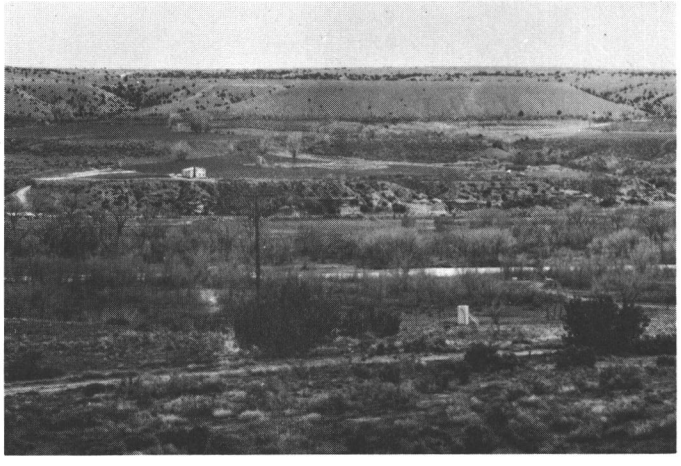

FIGURE 6.
View east across the Animas from a point near Flora Vista, New Mexico. Gravels related to Pinedale glaciation and Recent alluvium in foreground. Two older terraces are discernible in background.

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