GLACIAL AND QUATERNARY GEOLOGY, UPPER RIO GRANDE DRAINAGE, SAN JUAN MOUNTAINS, COLORADO

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Introduction

The Keck Geology Consortium San Juan Mountains project investigated the glacial and Quaternary geology of the upper Rio Grande drainage on the eastern flank of the San Juan Mountains of Colorado. The aim of the project was to re-examine the Quaternary history of the area, more than 60 years after the last detailed work was done, using modern geomorphic, stratigraphic, and chronologic techniques. Several student projects were aimed at elucidating the history of the late Pleistocene Rio Grande glacier or of smaller glaciers in the drainage. Other projects examined the effects of glaciers on the valley hydrologic system, the sedimentology of glacial, lacustrine, and fluvial deposits, and currently active geomorphic processes, including landsliding and rock glacierization of talus. Field work was undertaken in June and July, 1992. The project was based in cabins approximately 15 km southwest of Creede, Colorado, and nearly all field work was conducted within 20 km of the cabins.

Project Participants

Project faculty were Eric Leonard (Colorado), Dorothy Merritts (Franklin and Marshall), and Bob Carson (Whitman). Visiting faculty included Dave DeSimone (Williams) and Dave Jorgensen (Washington and Lee). Dave Sawyer and Tom Steven of the U.S. Geological Survey also visited the project. Ten geology majors from seven Keck Consortium schools participated in the project. Two Colorado College students, Mike Kerwin and Dave Mueller served as cooks and field assistants. Daves outnumbered Erics on the project four to three.

Geologic Setting

The late Pleistocene ice complex in the San Juan Mountains was one of the largest ice masses in the United States Rocky Mountains, probably second only to the Yellowstone-Absaroka complex in size. Coalescent icefields in the headwaters regions of the Rio Grande, Animas, and Lake Fork of the Gunnison Rivers overrode all by the highest peaks along a 60 km segment of the Continental Divide, and fed large valley outlet glacier systems on both sides of the Divide. The glacier complex in the upper Rio Grande drainage, which covered about 800 square km, was one of the largest in the range -- consisting of high altitude ice fields and a series of anastomosing transection outlet glaciers extending more than 40 km down the Rio Grande Valley, nearly to the site of Creede (figure 1).

Evidence of the former Rio Grande glacier complex is found in extensive areas of glacially sculpted topography, well preserved moraines, and abundant stratified drift deposits. Glacier influence on the valley hydrologic system is shown by ice-dammed lake deposits, valley-wall meltwater channels, and flights of terraces along the Rio Grande down valley from the glacier terminus. Most valleys tributary to the Rio Grande were also glaciated in the late Pleistocene. Some of these smaller valley glaciers were confluent with the main Rio Grande Glacier, others were completely independent glacier systems.

At present there is no glacial ice in the upper Rio Grande drainage. There is, however, abundant evidence of Holocene periglacial activity -- rock glaciers, talus accumulation, gelifluction. Deposits of recent catastrophic mass movement events are also widespread.

Previous Work

Evidence of extensive glaciation in the headwaters of the Rio Grande was first noted by Hills (1884). In the early decades of this century, Atwood and Mather (1932) undertook a monumental project investigating Quaternary deposits and landforms throughout the San Juan Mountains. In the upper Rio Grande drainage they mapped deposits of three glaciations and associated outwash gravels and recognized the former existence of ice-dammed lakes. Atwood (1918; Atwood and Mather, 1932) also devoted some attention to investigating Quaternary landslides in the drainage, especially in relation to potential reservoir sites. Six decades later, Atwood and Mather's remains the only available work on the Quaternary geology of the Upper Rio Grande drainage and much of the rest of the San Juan Mountains.

Quaternary geology was given only very scant attention in more recent investigations in the area (Steven, 1967; Steven and Ratte, 1973; Steven and Lipman, 1973).

Student Projects

Several students worked on main Rio Grande Glacier system and on its effects on drainage patterns and paleohydraulics. Other students worked on glacial/periglacial landforms and history of smaller valleys whose ice was never confluent with the main Rio Grande Glacier. Locations of student study sites are shown in figure 1.

Alex Durst (Colorado) worked on the dynamics of the Rio Grande Glacier system. His field work consisted primarily of mapping and dating of ice limits in several of the anastomosing glacial valleys in an attempt to assess ice thicknesses and surface slopes, and especially the location and depth of ice flow across divides. His lab work has consisted mainly of computer modeling of ice profiles and ice flow.

Two students worked on closely related projects concerning ice dammed "Lake Atwood". **Scott McMillin** (Williams) worked on the ice dam, using detailed mapping and provenance studies to determine the source of the ice which dammed the lake and the timing of ice damming. He also mapped possible lake outflow channels and collected material for C-14 dating of lake drainage. **Kelly MacGregor** (Williams) worked on the lake sediments themselves, with the aim of understanding the history of the lake and the deposition processes which took place in it. Her work involved mapping lake extent, detailed stratigraphic and sedimentological analysis of several sections of laminated lake sediments, and examination of the paleomagnetic record of one of the sections.

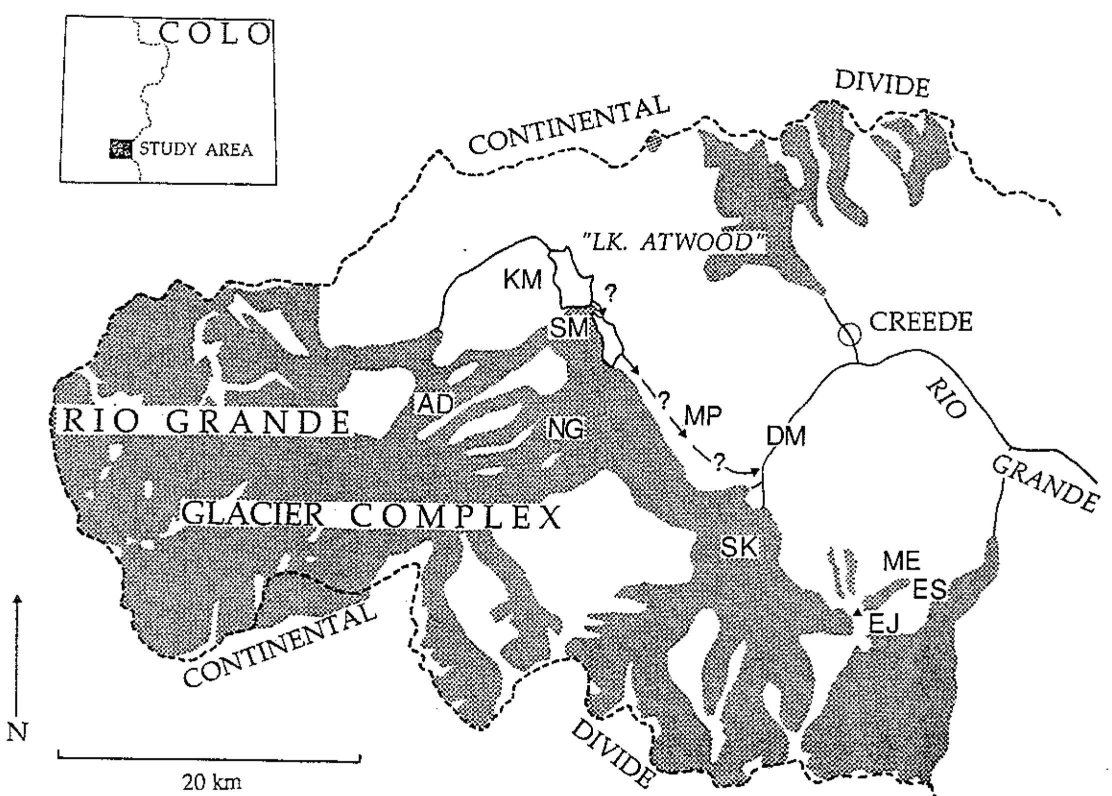

Figure 1 - Late Pleistocene ice extent and drainage, upper Rio Grande valley, San Juan Mountains, Colorado. Ice extent (stippled) and glacial lakes are shown according to mapping of Atwood and Mather (1932). Student project field localities are indicated by initial: AD - Alex Durst; KM - Kelly MacGregor; SM - Scott McMillin; NG - Nancy Grumet, MP - Maria Panfil; DM - Denise Muriceak; SK - Susannah Kitchens; ME - Martha Eppes; ES - Eric Small; EJ = Eric Jensen. Dashed line on insert state map is Continental Divide.

Susannah Kitchens (Smith) worked on the relationship between the Rio Grande Glacier and the glacier in the valley of Red Mountain Creek, a large right-bank tributary. Although Atwood and Mather (1932) mapped the glaciers as confluent in the late Pleistocene, a moraine complex at the mouth of Red Mountain Creek suggests that they were not confluent and that their advances may have been out of phase. Susannah mapped the moraine complex and examined till provenance, weathering, and soil characteristics, in an attempt to shed light on these questions.

Denise Muriceak (Franklin and Marshall) examined the outwash terrace sequence down stream from the terminal moraines of the main Rio Grande Glacier. She undertook a detailed survey of terrace and paleochannel geometry, and examined clast size and morphology with the aim of assessing changes in stream hydraulics which occurred in response to upstream glaciation. She also hoped that work with large flood (?) boulders might shed some light on the question of the drainage of glacial "Lake Atwood".

Maria Panfil (Carleton) examined the geomorphic history of the Santa Maria Valley, a small fault-bounded valley which parallels part of the main Rio Grande valley. The valley shows some evidence of glaciation of uncertain timing and likely served as a drainage channel for glacial "Lake Atwood" and other meltwater during the late Pleistocene. The valley has also been the site of repeated large rock fall and landslide (?) events. Maria's work involved mapping and dating the deposits and examining the paleohydraulics of fluvial deposits in the valley.

Nancy Grumet (Whitman) worked on the distribution and morphometry of rock drumlins and low relief polished surfaces at several sites in the western portion of the study area. Her work involved detailed mapping of the features and examination of possible lithological, structural (jointing), and ice dynamics (ice thickness, flow velocity) controls on the formation of these landforms.

Three students worked in the Middle Roaring Fork valley, which held a small late Pleistocene glacier which was never confluent with the Rio Grande Glacier. The valley contains abundant glacial and periglacial deposits. **Martha Eppes** (Washington and Lee) worked on the Pleistocene and Holocene (?) glacial history of the valley. Her work involved mapping deposits which appear to date from several phases of glaciation, examining soils and weathering characteristics, and sampling bog material for radiocarbon dating. **Eric Jensen** (Carleton) worked on late Holocene periglacial deposits in the valley -- talus cones, protalus lobes, and rock glaciers. The work involved mapping and morphometry, development of a regional lichenometric dating curve, and approximate lichenometric dating of the features. He also cored trees at timberline sites to allow development of a tree growth chronology to compare to the periglacial chronology. **Eric Small** (Williams) did a detailed morphologic and sedimentological study of ice wastage deposits in the valley and did similar work of a more reconnaissance nature in two other valleys. His field work was aimed at identifying different types of ice contact stratified drift and determining their extent and their location within the valleys. Much of his follow-up work has been devoted to developing a model explaining why ice stagnation occurs in some valleys while active ice retreat happens in others nearby.

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