LATE QUATERNARY GLACIAL HISTORY OF MIDDLE ROARING CREEK VALLEY, SPAR CITY QUADRANGLE, COLORADO.

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Introduction

Middle Roaring Creek Valley, located off the northeast face of Fisher Mountain (elevation 12, 865 ft.) in the eastern San Juan Mountains is a small sub-alpine valley which has been subject to at least one period of glaciation during Quaternary time. Middle Roaring Creek Valley is characterized by a large rectangular cirque which narrows dramatically at the valley midpoint near Middle Lake. The valley then drops down four or five steps, widens out into an area of hummocky ice stagnation features, and finally reaches what is now the valley of the Roaring Fork River in a broad complex of terminal moraines. Atwood and Mather (1932) documented ice limits and flow directions of the latest Pleistocene ice in the San Juan Mountains. The study was extensive, but contained only general boundaries of ice limits in Middle Roaring Creek Valley.

The objectives of this project were to define and map the major geomorphic features in Middle Roaring Creek Valley. Lateral, terminal, and recessional moraines, as well as possible debris flows and rock glaciers were of greatest interest. Through comparisons of soils, slope profiles and weathering rind data, this project will also attempt to determine relative ages of these various features in the valley. In doing so, if significant differences in age exist between the terminal moraines and moraines farther up valley, the possibility of multiple readvances of ice to elevations above the terminal moraines may be considered. Ultimately, a chronology of glaciation of the valley during Pleistocene and possibly Holocene time may be created.

Field Observations

A geomorphic map of major features in Middle Roaring Creek Valley was compiled based on morphology and the presence or absence of diamictons, boulders, and or stratified soils. (See Figure 2) A well-defined terminal limit of ice represented by steeply sloping, nested morainal ridges at 10,500 ft. is present in the northeast end of the valley. These terminal moraines are backed by smaller, kettled and drumlin-shaped moraines.

Kettled moraines then grade into a relatively large area of ice stagnation features at 10, 600 ft.. This area, approximately .75 square km in size, includes belts of ice contact stratified drift (ICSD) as well as at least two eskers.

Distinct lateral moraines border the ice stagnation zone to the northeast and southwest. These lateral moraines begin at the nose of a bedrock ridge farther up valley near Middle Lake at 11,000 ft. and continue down valley merging with the terminal moraines. A small terrace, possibly an older moraine, borders the main lateral moraine in the northwest. To the southeast of the valley, what appeared to be the pair to this "older" moraine is actually bedrock that marks a valley boundary. Smaller, less distinct lateral moraines appear again as a series of parallel ridges near the top of the valley in the cirque between 11,800 and 12,000 ft.

Above the ICSD region a series of "steps" visible in air photos and obvious when walking up valley, extends to the cirque. Two appear to be partially till-covered bedrock; one at 10,700 ft, one at 11,800 ft. The remainder of the steps are a series of compound recessional moraines, many of which show the same kettled appearance of the terminal moraines down valley. Above Middle Lake the steps become less apparent and grade into one another more quickly.

The cirque is covered with talus cones, pro-talus ramparts and occasional indications of recent debris flows and avalanches, including levees, and marred vegetation. A small bog, Top Bog, is located in the southwest corner of the cirque. A core was taken from its center for Carbon-14 dating.

Along the southwest side of the valley from Middle Lake is a series of block-streams or boulder fields, each correlating with a "step" in the valley. The fields often show signs of ice-patterned ground with circles of boulders reducing in grain size towards their centers. Also, a large debris flow exists in the center of the valley reaching down to Beaver Dam Lake. Finally, extending from the cirque in at least three areas, are large lobate structures that resemble small rock glaciers. A more detailed description of this aspect of

the valley, as well as that of the ICSD region mentioned earlier may be obtained from the work of Eric Jensen or Eric Small, respectively in this same publication.

Methods and results

After mapping the above in Middle Roaring Creek Valley, seven of the features (F1-F7) were chosen for analysis by relative dating.

F1 - Northwest main lateral moraine associated with terminal limits of ice
F2 - Bedrock hill marking the southeast border of the valley
F3 - The "older" moraine bordering the northwest main lateral moraine
F4 - Moraine northeast of Middle Lake, elev. 10,990 ft.
F5 - Moraine below West Bog, elev. 11,980 ft.
F6 - Southwestern most and highest moraine
F7 - Highest lateral moraine near West Bog

For each the following data was collected: 1)boulder frequency, 2) weathering rinds, and 3) slope angles and profile, 4) soil development as seen in soil pits. Boulder frequency, weathering rind, and slope data were also collected from other moraines and block fields within the field area.

1) Boulder frequency data was collected with the expectation of finding fewer boulders on older moraines due to weathering and erosion. Frequency was gauged on a scale of 0 to 5 with "0" being an area of no boulder coverage, and "5" being an area of no surface soil development. Associated with each number is a letter, S, M, L. "S" if the majority of boulders on a feature were less that 30 cm; "L" if the majority were greater than 30 cm; and "M" if the boulders were of mixed sizes. In general boulder frequency and the number of smaller boulders present on top of moraines increased up valley. Large boulders were found throughout the valley. 2) Weathering rinds were measured on rhyolite boulders using a hand ruler. (See Figure 1) As the boulders weathered through time, thicker rinds would be expected. White to pink-red colored rinds which appeared regularly on the boulders were utilized in making the measurements. Twenty rinds on each structure were sampled and the mean rind width and standard deviation were calculated. Three groups of features with similar average rind widths were noted. The first group (mean of 2.7 mm) included solely F-3, the lower "older" moraine. The second group (mean of approximately 1.8 mm) included the terminal moraine, F-1 the main lateral moraine, and the large debris flow located above Beaver Dam Lake. The final group (mean rind between 1.2 and 1.3 mm) was composed of all moraines above Middle Lake including F-4, as well as all block fields sampled including those below Middle Lake.

3) Slope angles were measured on each feature using a hand level and the approximate maximum slope angle for each feature was noted. Given enough time between formation of features, slope angles would decrease with age, and a difference in maximum slope up and down valley might be noticeable. With a partner, slope profiles of lines going both up-valley and across-valley were completed. All moraines which were associated with a significant increase in topography in the valley as well as the main lateral and terminal moraines had a maximum slope angle between 20 and 30 degrees. Those moraines found behind these "main" moraines had maximum slopes of about 15 degrees. Little variation existed from top to bottom in that respect. The only moraine with a significant difference in slope angle was F-3, having a maximum angle of approximately 11 degrees. The "rock glaciers" in the field area often had a snout with a slope angle of just over 40 degrees.

4)Soil pits to a depth of approximately 60 cm were dug on F-1 - F7. Horizons were described and sampled for further analysis in the lab. Though discernable B horizons were reached within each pit, at and around 20 cm of depth, it is doubtful that true C horizons, unaltered parent material, were sampled. Rather, it is likely that secondary B horizons were sampled beginning at a depth generally of around 30 cm. These B and "C" horizons generally showed weak blocky structure with two to three centimeter peds.

Soil samples obtained from F1-F7 were analyzed for grain size in the lab. The A,B, and C horizons for each pit were wet and dry sieved. During wet sieving, a defflocculating agent was used to disengage clay particles from larger particles. The grain size of soil less than .075 mm in diameter, was then determined using a hydrometer, and clay percentages calculated for each horizon in each soil. (See Figure 3)

The differences of clay content in the Band C horizons of the soils were compared expecting that the change in clay content over time between parent material and B horizons would be greater for older features. The features again divided into three groups. F-2 and F-3 showed, however, the *lowest* change in percent from B to C horizons with a 7.6% and 10.0% change respectively. F-1,

F-4, and F-5 showed changes between 15.5% and 16.5%. F-6 and F-7 showed changes in clay percents of 19.1% and 22.6%. This reversal of expected changes in clay content can be explained by the fact that clay content generally increases in amount and thickens in the B-horizon with time. (Birkeland, 1984) Therefore in younger soils, the C horizon might be found at depths as shallow as 60 cm, but in older soils such as F-2 and F-3 that C horizon was never reached. Instead a lower B horizon was sampled, thus causing the differences in clay percentages to be lower on older features. Samples of the soils were also examined microscopically in order to observe any visually noticeable differences in weathering of individual grains. Differences between any two soils were not apparent , as not enough time had passed to accomplish significant weathering effects.

The core taken from Top Bog at 11,940 ft was sent to Crueger Enterprises for Carbon 14 dating. An age of 4705 +/- 155 years before present was calculated.

Discussion

From the data above, it is possible to divide Middle Roaring Creek Valley into three regions of differing ages, Region 1, Region 2, and Region 3. The first and oldest region, Region 1, composed of F-2 and F-3 shows greater alteration through time especially with larger weathering rinds. The maximum slope angle of F-3 is markedly different from that of all other lateral moraines in the valley. These differences suggest that F-3 is associated with an event pre-dating that of the terminal limits of ice in the valley. Given the significance of these differences compared to differences between any other features in the valley, it is likely that this moraine was the result of an event predating the period of glaciation as the entire valley.

The second and next oldest region, Region 2, begins below Middle Lake at approximately 11,000 ft.and continues to Roaring Fork River at 10,200 ft. Region 2 represents the farthest, "second" advance of ice in the valley, wiping out any evidence of previous advances of ice with the exception of that associated with F-3. As the ice retreated from its terminal limits, small blocks of ice, 10-100 m in diameter, were left behind as ice receded and formed pock marks in the landscape seen as kettled moraines. The ice paused and stagnated in the region of Tulula and Tawanda Lakes as is indicated by the presence of ICSD in the area.

Region 3 is that region of the valley located above Middle Lake. The difference in data between Region 2 and Region 3 is enough to suggest that Region 3 represents a smaller readvance of ice into the middle of the valley covering the upper part of the second advance associated with the terminal moraines. Were this region simply part of the retreat of the "second" advance of ice in the valley, a more continual grade of data would be apparent from the bottom to the top of the valley.

The procession of ice during this readvance was ended when the glacier spread out and stopped past the confining bedrock boundaries at Middle Lake. This readvance of ice also accounts for the disordered appearance of moraines above Middle Lake. As ice advanced, older moraines from previous advances were reworked and till deposited over that as ice retreated. From the core obtained from Top Bog, it is known that the valley must have been ice-free before the Carbon-14 date of the development. of the organic materials at the bottom of the bog. The final retreat of this third visible advance of ice into the Middle Roaring Creek Valley, therefore, ended at the very latest approximately 5000 years before present.

References Cited

Atwood, W.W., 1932. Physiography and Quaternary Geology of the San Juan Mountains, Colorado: U.S. Geological Survey Professional Paper 166.

Birkeland, P.W. Soils and Geomorphology Oxford University Press: New York, 1984.

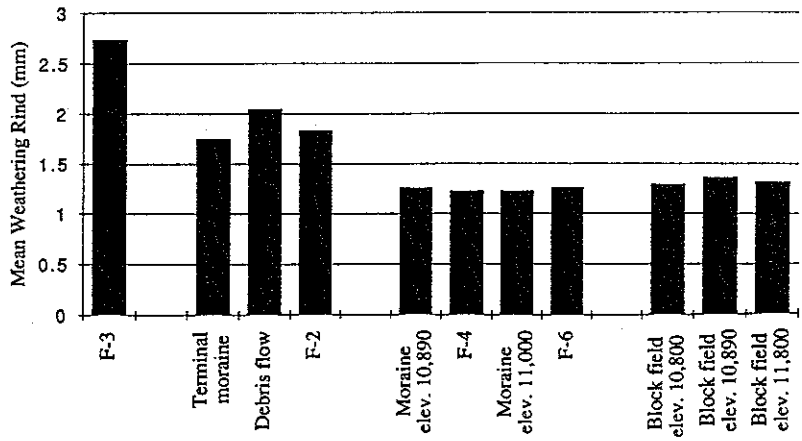

Figure 1: Weathering Rind Data

Figure 2:
Middle Roaring Creek Valley
Topography
and
Geomorphology

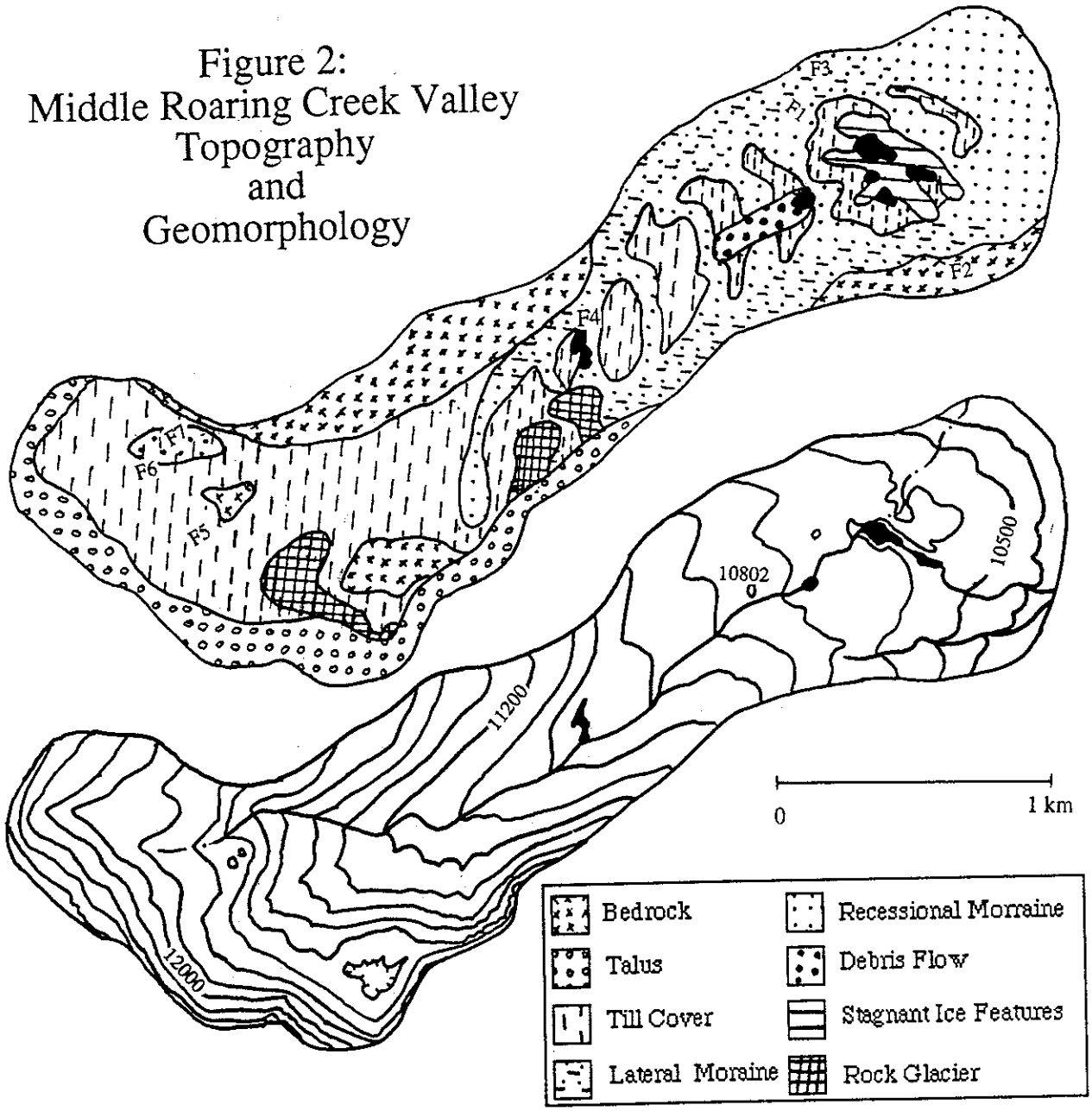

Figure 3: Clay percentages for F-1 - F-7