Drumlinoid Landforms in the Upper Rio Grande Area, San Juan Mountains, Colorado

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INTRODUCTION

In the upper Rio Grande area of the San Juan Mountains of Colorado three sites with drumlinoid landforms were investigated (see fig.1). In this report these sites are referred to as Rio Grande (RG), Stage Station Flat (SSF) and Crooked Creek (CC) (see fig. 2).

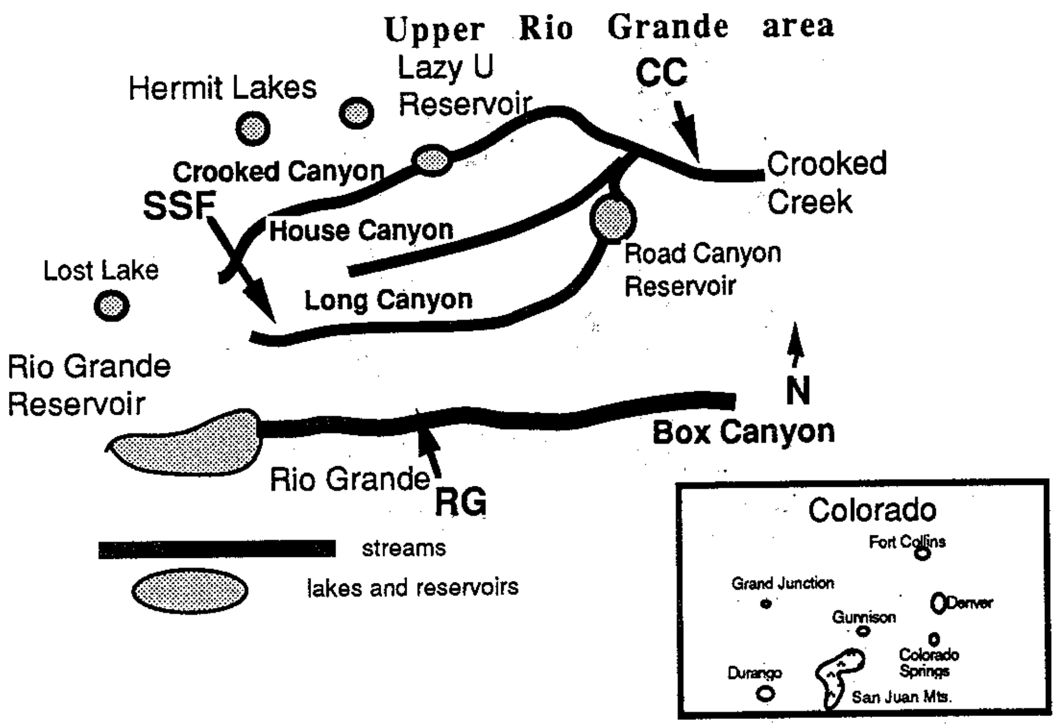


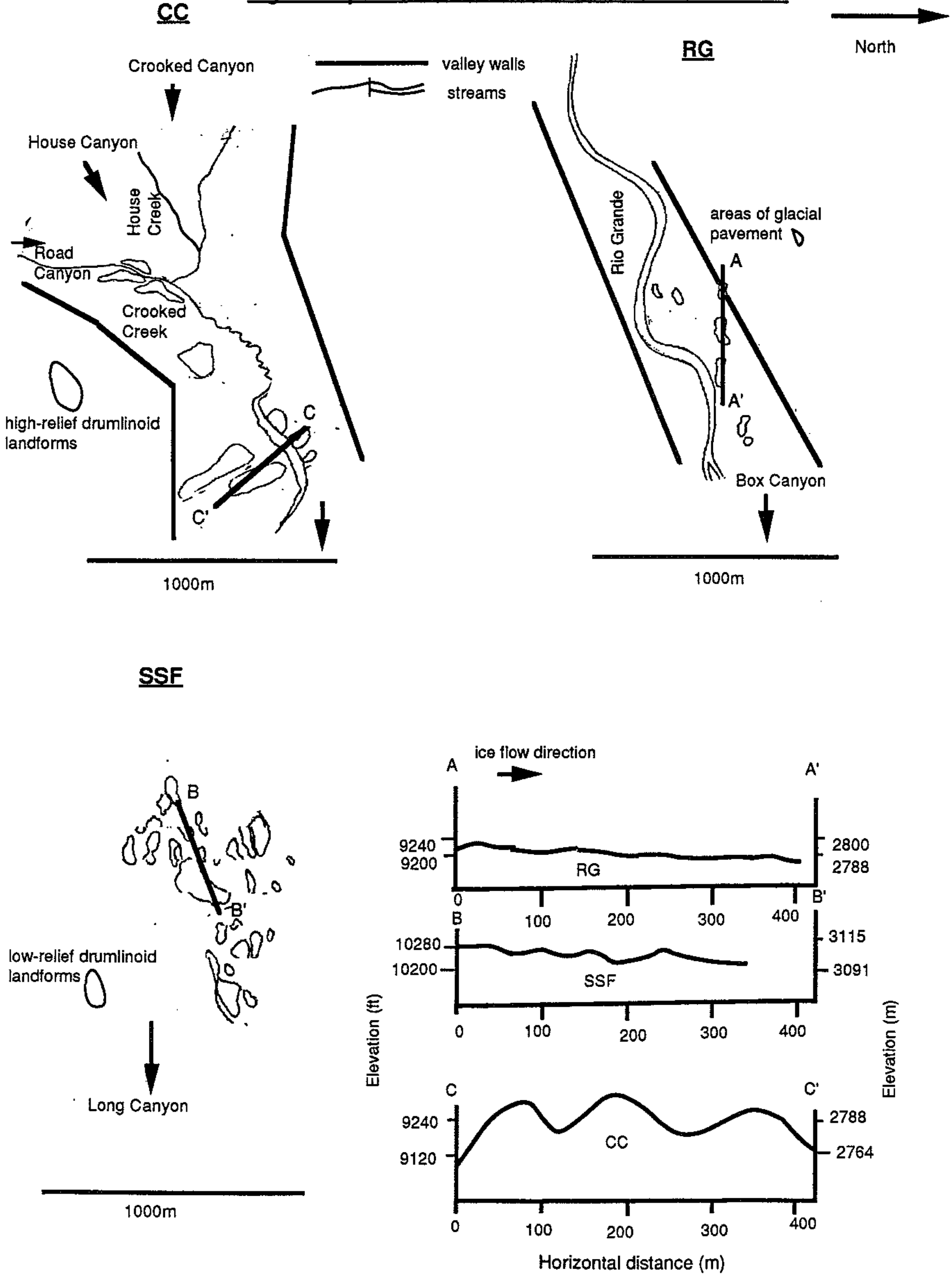
Fig. 1: Map of upper Rio Grande area

The drumlinoid landforms are the result of glacial erosion of welded tuff (the Crystal Lake and Fish Canyon Tuffs). The objective of this study is to isolate the factors controlling the differences in the landforms. There is little difference between the two welded tuffs, so lithology is not considered a significant variable. Variations in ice thickness was originally thought to be a controlling factor. However, one km upvalley of low-relief glacial pavement at RG are high-relief drumlinoid features. Furthermore, one km upvalley of high-relief drumlinoid landforms at CC are areas of glacial pavement. This indicates that ice thickness is not a controlling factor. Joint orientation and spacing and canyon morphology are the primary factors investigated.

METHODS

At the three sites the following data were recorded: orientation and spacing of vertical and horizontal joints, depth of weathering pits, spalling thickness, lichen density, striations, debris cover, and vegetation. There are not significant

Fig. 2: Maps and cross-sections of CC, RG, and SSF.



differences in amount of drift cover, weathering, or vegetation at the three sites. Few striations were found. Field data concerning the degree of quarrying versus abrasion on the stoss and lee sides were also recorded.

SSF and CC were surveyed using a total station. In addition a transit was used at SSF. These two methods provided data regarding size, shape, spacing and orientation of the landforms. The lengths and widths of the landforms at RG were paced out and the reliefs were measured by a hand level and rod.

Field work done was supplemented by study of air photos and topographic maps. Map and photo analysis yielded additional data on joint spacing and orientation, and landform size, shape, and orientation.

RESULTS

Landform orientation and orientation of vertical and subvertical joints for the three sites were plotted on rose diagrams (see fig. 3). The strong correlation between joint orientation and landform orientation indicates that joint orientation is a controlling factor in the orientation of the drumlinoid landforms.

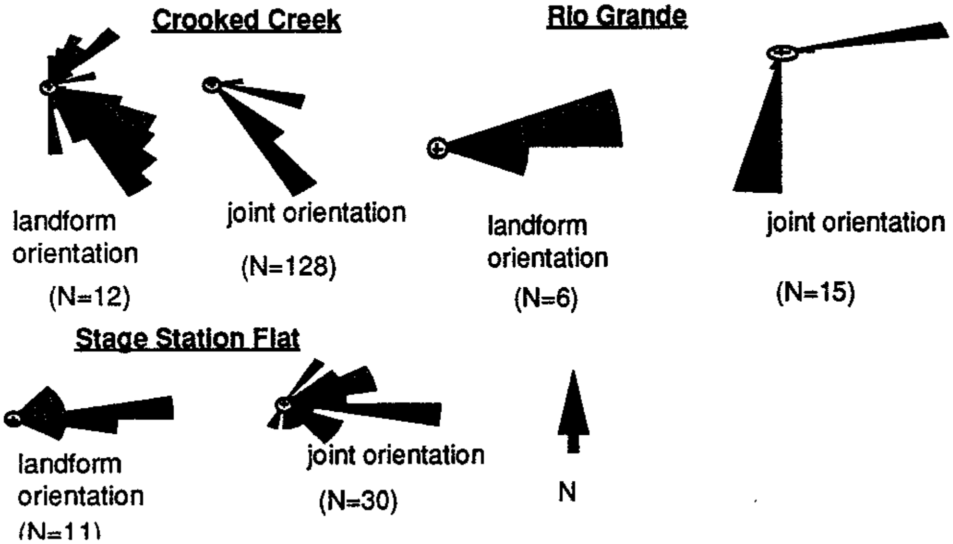


Fig. 3: Rose diagrams of joint and landform orientation. General ice flow direction is easterly.

The data collected from the various methods show trends in mean height, width, and length at RG, SSF, and CC (see table 1). L/H and L/W ratios demonstrate additional relationships. Landforms at RG have low relief whereas those at CC have high relief. The landforms at SSF are somewhere in the middle of this continuum (see fig. 4.). The two dominant processes responsible for creating the landforms at the three sites are quarrying and abrasion. The mean spacing of both vertical/subvertical and horizontal/subhorizontal joints varies at the three sites (see table 1). The large joint spacing at RG suggests that glaciers are less effective at quarrying and create massive landforms, such as glacial pavement. At SSF where the joint spacing is the smallest, plucking is facilitated by closely spaced joints and low-relief landforms are created. It is thought that the intermediate joint spacing at CC facilitates the plucking necessary for high-relief drumlinoid landforms. That is, wider spacing would have resulted in glacial pavement and closer spacing would have led to low-relief drumlinoid features.

Table 1: Dimensions and ratios of landforms at RG, SSF, and CC.

	RG	SSF	CC
mean length (m)	64.25	45.75	157.85
mean width (m)	20.75	24.25	55.40
mean height (m)	1.30	1.65	9.00
L/W	3.10	1.89	2.85
L/H	49.30	27.71	17.55
mean vertical/ subvertical joint spacing (m)	8.0	0.61	1.7
mean horizontal/ subhorizontal joint spacing (m)	2.96	0.48	0.99

The widths, lengths, and gradients of the canyons and other factors of canyon morphology may have also contributed to landform expression. For example, CC is near the site of the confluence of three canyons and has a steep gradient, SSF is a relatively flat site which progresses eastward into a narrow canyon, and RG is on the floor of a glacial trough.

CONCLUSION

The three sites experienced similar processes during late Pleistocene glaciations but different landforms are expressed. The landforms in the upper Rio Grande area represent a continuum from roche mountonnees to glacial pavement. The landforms at RG where relief is minimal represent one end member, glacial pavement. CC represents the other end member, in the form of high relief roche moutonnees with generally gentle stoss sides and relatively steep lee sides. The landforms at SSF are middle member, low-relief roche moutonnees.

References

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