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CORRESPONDENCE

The Editor,

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SIR, *Additional data on Arapaho rock glacier in Colorado Front Range, U.S.A.*

The accumulation of data about Arapaho rock glacier in Colorado Front Range is growing (Carrara, 1973; Benedict, 1973[b]; Whalley, 1974), much to everyone's benefit. I have been observing this tongue-shaped rock glacier for more than 14 years (Waldrop and White, 1965; White, 1971[a], [b]), and wish to add information which may help and leave a question to be answered.

In 1961, I descended into the rock glacier to a depth of 4 m and discovered water flowing across a solid ice core, but did not then realize its significance. It was Benedict in late August 1963 who first recognized the ice was that of an old buried glacier, and photographed it (Outcalt and Benedict, 1965, fig. 6). On 22 August 1966, several of us climbed into the central longitudinal furrow and down a narrow channel over 12 m deep in the ice. Sun-warmed water from the saucer-shaped Arapaho South Glacier (Fig. 1) between the cirque headwall and the head of the rock glacier had melted this channel into the old glacier (now an ice core) beneath 2 to 3 m of rocky rubble. Benedict later collected ice there with pollen, plant and insect remains in it dated radiometrically (Benedict, 1973[a], [b]) at ages close to the end of Audubon stade advance of Neoglaciation. Audubon is a new name for Colorado Front Range mid-Neoglacial deposits (Mahaney, 1972).

Following the terminology of Potter (1972), Arapaho rock glacier is an ice-cored rock glacier, with its down-valley half containing interstitial ice. Formerly, it was a short debris-covered glacier, but now is not much different from any of the other eleven tongue-shaped ice-cored rock glaciers east of the Continental Divide or east of the highest ridges in this part of Colorado Front Range (White, in press). Six tongue-shaped rock glaciers west of the Divide contain interstitial ice only, and are termed ice-cemented rock glaciers (Potter, 1972).

No doubt exists as to the rock-fall origin of the huge blocks along the southern up-valley half of Arapaho rock glacier. More than 50% of them are >25 m^3 (White, 1971[b]), and may be matched with scars high on the rock face from which they fell. They did not arrive in one rock fall, inasmuch as they are spread over a down-valley distance of 280 m. It took the farthest blocks perhaps >1 800 years

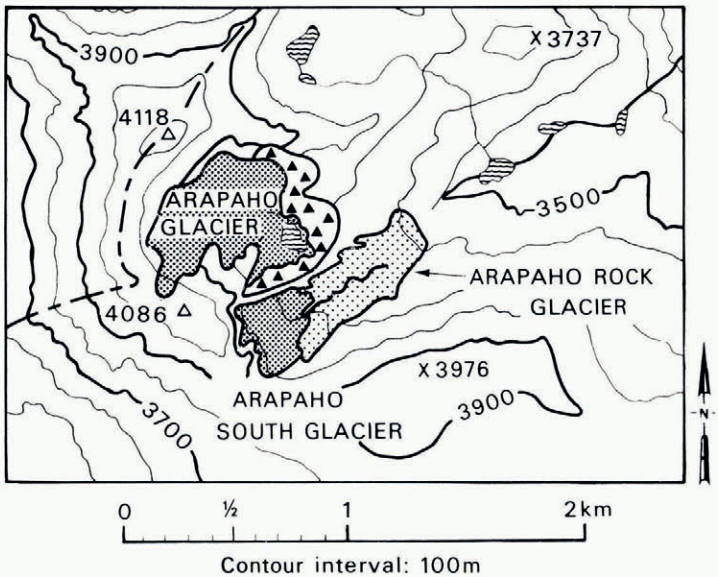

Fig. 1. Arapaho rock glacier, Arapaho South Glacier, and Arapaho Glacier, in cirque at head of Arapaho Valley, Colorado Front Range. Arapaho Peak stade moraines shown by triangles. Central longitudinal furrow on Arapaho rock glacier is sinuous line. Continental Divide is dashed line. Map adapted from U.S. Geological Survey Monarch Lake quadrangle, 7.5 min. series, 1958.

to be progressively dispersed this far. In addition, lichen growing on rocks on the mid-part of the rock glacier head show the rock rubble can not be younger than late Audubon stade. Diameter of the largest thallus of *Rhizocarpon geographicum* growing on the rock glacier surface above the ice dated by Benedict (1973[b]) is 49 mm. Using his lichen-growth curve (Benedict, 1967), those rocks became stable about 1 170 years ago. And near the actual head of the rock glacier, the largest *Rh. geographicum* thalli are 20 mm. These, however, are in a shallow basin where snow remains throughout the year except for 2 months in mid-summer. Per cent of lichen cover on the rocks even so is 20%, an amount falling within the 10–40% range for Audubon stade (Benedict, 1967, 1968). *Lecanora thomsonii* is the dominant lichen, characteristic of a lichen cover from the Audubon stade.

The lack of moraines of Arapaho Peak stade (new name for the most recent Neoglaciation: Benedict, 1973[a]; formerly referred to in this mountain range as Gannett Peak stade) and of rock debris supplied from the cliff is a problem still bothering me (previously discussed, White, 1971[b]). Yet in the same cirque, 100 m north of Arapaho rock glacier, great moraines of Arapaho Peak stade (Fig. 1) are directly in front of the fast-shrinking Arapaho Glacier. And in front of these moraines is a moraine and small rock glacier of Audubon stade (cf. Mahaney, 1974). Blocks pushed from the *south* headwall to test the distance they can travel do not reach the head of Arapaho rock glacier across Arapaho South Glacier, nor, based on my photographs, have any blocks done so since 1939. The Audubon stade glacier formerly existing there was not sufficiently nourished during Audubon–Arapaho Peak interstade time and the deep saucer-shaped depression in the ice may have been produced then as it exists today. Thus, no moraines were built behind Arapaho rock glacier in the Arapaho Peak stade.

But this leaves the question of why Arapaho Peak stade glaciers did not fill *both* cirque heads. Could the configuration of the windward slope which formerly allowed snow to be fed to Arapaho South Glacier have become so changed by erosion during the 600 year interval between the close of Audubon stade and the beginning of Arapaho Peak stade that growth of a glacier comparable to Arapaho Glacier where Arapaho South Glacier now is, no longer was possible in Arapaho Peak stade time?

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