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Terminal Moraine Remnants of the Trail Creek Glacier Northeast of Sun Valley, Idaho

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Geological Field Trips in Southern Idaho, Eastern Oregon, and Northern Nevada

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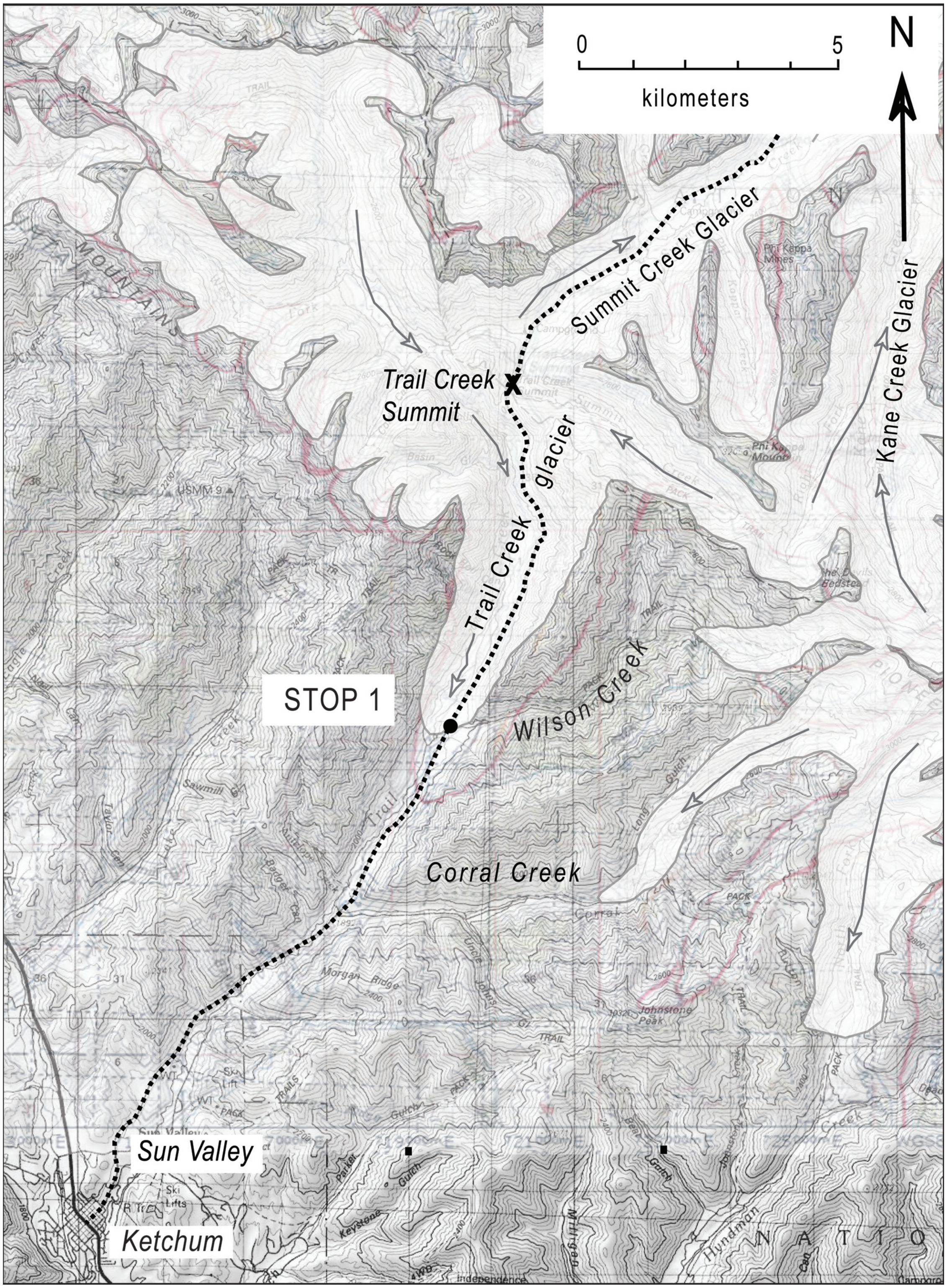

Figure 1. Location of Stop 1, 8 mi northeast of Ketchum. Map shows estimated positions of alpine glaciers in the southern Boulder and western Pioneer Mountains. Reconstruction of glaciers is based upon cirque walls, terminal moraines and canyon topography observed on 1:24,000 maps and not on field mapping.

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Introduction

This optional excursion is 8 miles on paved road from the center of Ketchum (Main Street and Sun Valley Road traffic light), northeast through Sun Valley along the Trail Creek Road (fig. 1). A short walk of 10 minutes takes you to the crests of two moraines of very different ages. Here we view and discuss calcareous soils developed into the deposits, the pretty weathering-rinds developed on the sandstone cobbles, and ages of Pinedale and Bull Lake advances.

During the Quaternary, an extensive system of mountain glaciers accumulated in the Pioneer and Boulder Mountains and flowed down valleys emanating from the ranges (Evenson and others, 1982, Pearce and others, 1988). An ice field several miles across accumulated in the Trail Creek Summit area and contributed ice to both the northeast-flowing Summit Creek glacier and to south-flowing Trail Creek glacier (fig. 2). Despite barroom talk in Sun Valley and Ketchum, we find no evidence that the resort towns or the Mt. Baldy ski hill were glaciated during the last ice ages. Rather, the glacier of closest approach was the Trail Creek glacier that advanced down valley to about elevation 1,950 m (6,400 ft), where Wilson Creek flows into Trail Creek, about 10 km (6 mi) northeast of the Sun Valley Inn.

The remnants of the two terminal moraines are best seen on the spur at the confluence of Wilson Creek and Trail Creek (fig. 3). From the road, facing northeast, the moraines appear as low ridges sloping 12º from the walls of Trail Creek Canyon down to Wilson Creek Canyon. Crest of the upper moraine stands 55 m higher than the lower moraine. The 12º crestal slope down into Wilson Creek, and low position in the valley indicate that this was the terminus of the two glacial advances. Furthermore, only outwash sand and gravel terraces occur below this area; no till or erratics are observed on the canyon walls down valley.

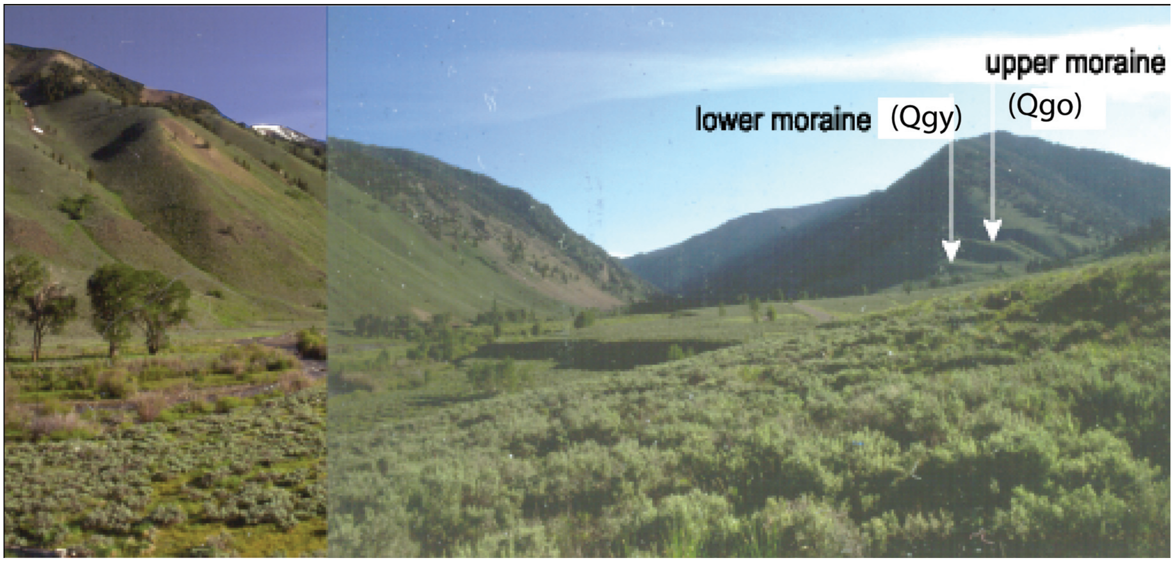

Figure 2. Photo looking northeast up Trail Creek from the Trail Creek Road. Moraine remnants are on the spur where Wilson Creek enters from the right. Shadowed terrace in the center of the picture is one of several Pinedale-aged outwash terraces in Trail Creek Canyon.

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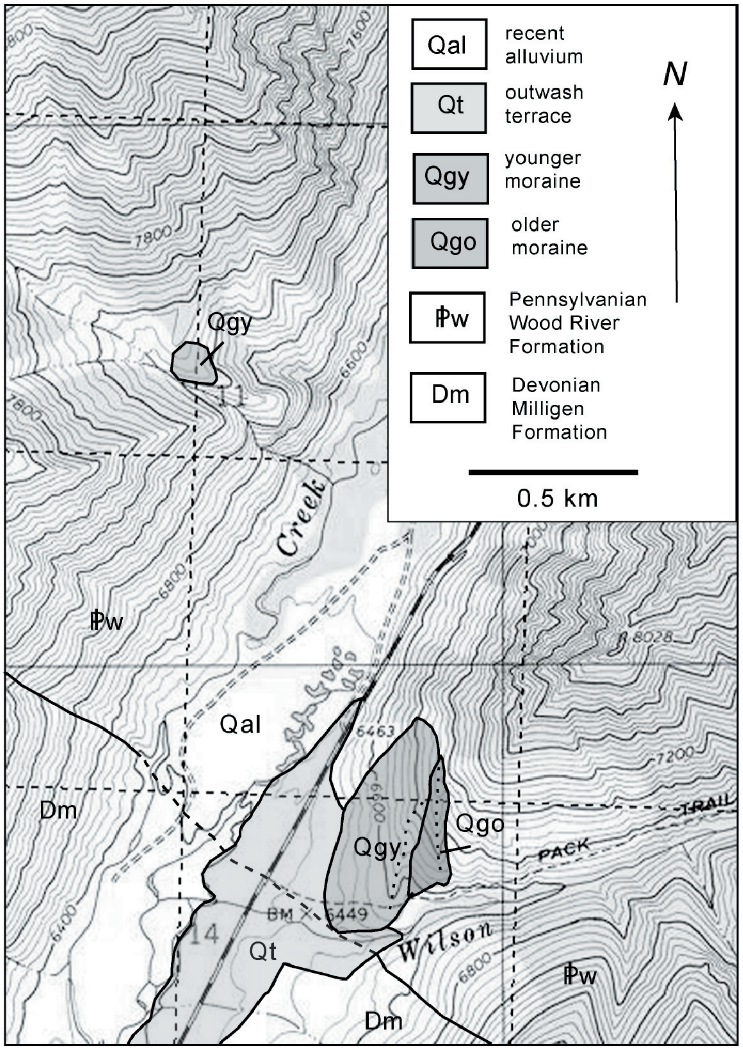

Figure 3. Map showing moraine deposits at the confluence of Wilson Creek and Trail Creek. Mapping based partly on Dover (1983).

Geologic Setting

Bedrocks units in Trail Creek Canyon are equivalents of the Paleozoic Antler orogenic belt sequences extending north from central Nevada (Link and others, 1988). From Sun Valley to Wilson Creek rocks on both sides of the canyon are black argillite or slate and quartzite of the Devonian Milligen Formation. At Wilson Creek, the Wood River thrust fault puts the Pennsylvania-Permian Wood River Formation over the Milligen Formation. Outcrops in the canyon above this point are Wood River Formation, and higher up on the pass are graptolite-bearing black shales of Ordovician and Silurian age (Dover, 1983). The Wood River Formation is chiefly calcareous sandstone, limestone, and dolomite. The area is structurally fascinating with rocks folded and deformed by Mesozoic thrust planes, which in themselves have been folded. Some low-angle thrusts are now interpreted as more recent detachments from the Pioneer Mountains core complex (Wust and Link, 1988).

Background

We originally were drawn to these deposits because the grey calcareous-sandstone clasts of the Wood River Formation within the till develop impressive (cm-scale) brown weathering rinds (fig. 4). Upon digging soil pits on the moraine crests to sample the clasts we also find a significant difference in soil development. All data presented here are field observations; we have no detailed laboratory data.

Soils Developed on Moraine Deposits

The till has abundant carbonate-rock clasts in a sandy silt matrix, which probably also has high initial carbonate-grain content. Soil development in the lower-moraine deposit goes no deeper than 0.8 m, identified by a brown-colored B horizon over unaltered grayish brown till (fig. 5). A 0.15-m-thick calcic horizon (Stage I) of lighter color has begun to form 0.5 m deep within the B horizon, characterized by thin irregular patches of carbonate on the bottoms of stones. Nomenclature for the various stages of calcic horizon development is from Machette (1985) and Birkeland and others (1991). Soil development in the upper-moraine deposit is much deeper. In fact, we have not yet gotten to the bottom

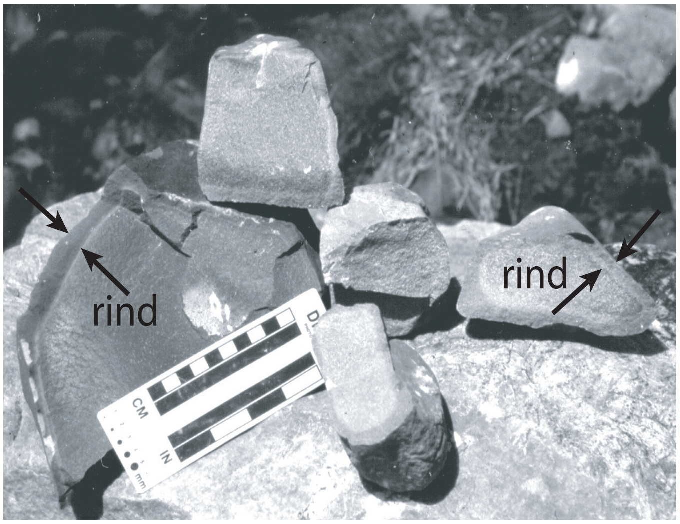

Figure 4. Weathering rinds developed upon calcareous-sandstone cobbles of the Wood River Formation. Thin-section examination shows that calcite has been leached from rind and that iron oxidation has stained the sand grains to give them a yellowish-brown color.

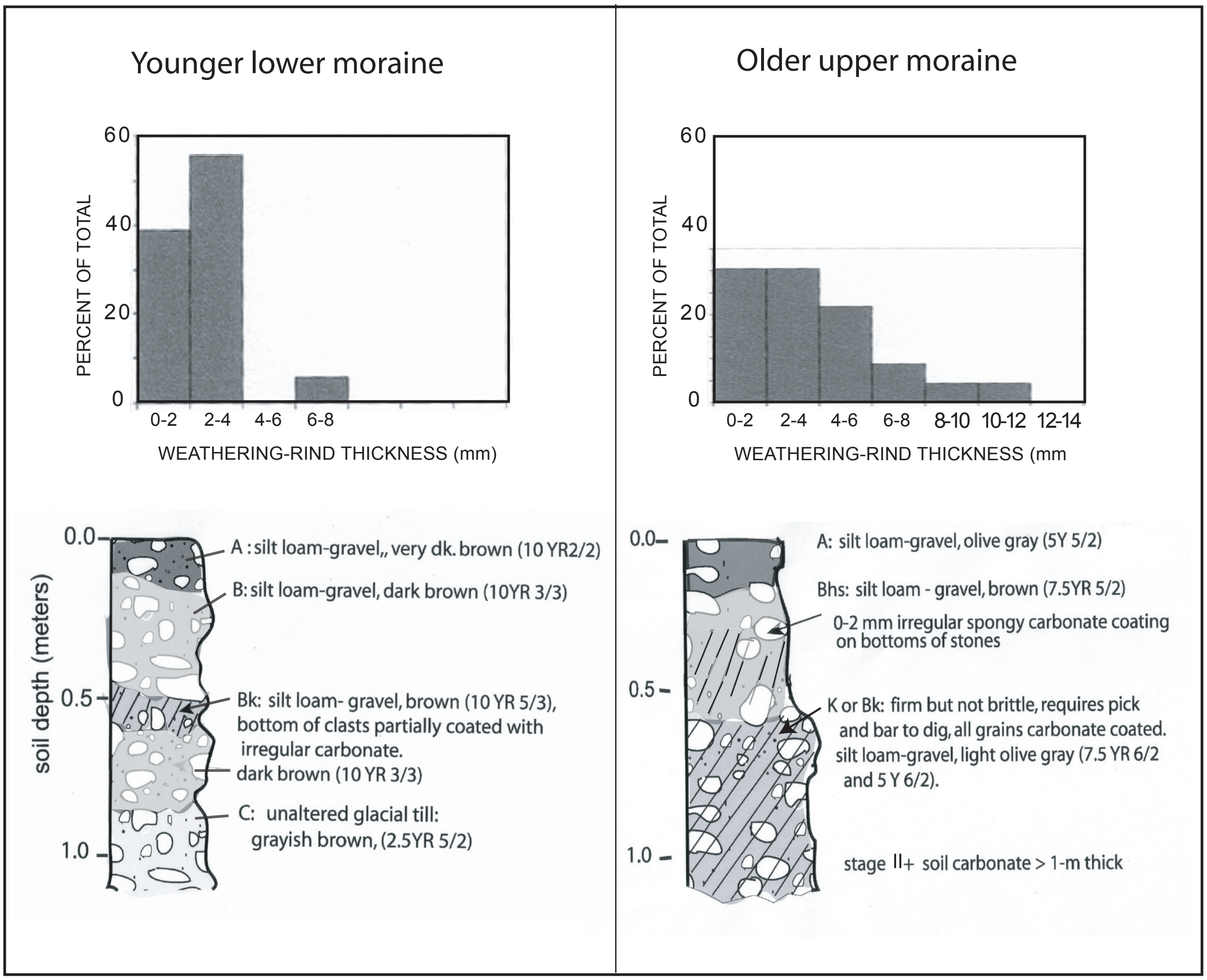

Figure 5. Soil-pit data from crests of moraines: histograms and soil profile descriptions. Weathering rinds are on about 25 stones from 0.15- to 0.3-m deep in the moraine deposits. Thickest rinds on tops of stones are reported. Lower moraine has Stage I calcic soil development. Upper moraine has Stage II+ development.

of the hard calcic horizon in a 1.3-m-deep soil pit. The calcic horizon is more than 1-m thick, and all grains are carbonate coated. Thickness and high carbonate content indicate it is Stage II calcic soil development (fig. 5).

Weathering Rinds on Calcareous Sandstone Clasts

Cobbles of gray, calcareous, fine sandstone of the Wood River Formation have conspicuous pale yellow (2.5Y 7/4-6/2) weathering rinds (fig. 4). Rinds were measured on cobbles from the upper 0.3 m of soil pits at the crests of the two left-lateral moraines. Rinds on the top surface of cobbles are 2–5 times thicker than those on the bottom surface. We report only the thick top rinds of about 25 stones from each of the moraine crests.

The thickest 20 percent fraction of the lower-moraine rinds is 2 to 4 mm, whereas the thickest 20 percent of the upper-moraine rinds is 8 to 12 mm. Both have a similar mode of 2 to 4 mm, but are clearly distinguished by considering the thickest 20 percent.

Interpretation of the histograms in figure 5 is problematic. Most lower-moraine rinds do not exceed 4 mm. In the older, upper moraine, many rinds are of similar thickness (4 mm), but there are clearly many thicker rinds up to 12 mm. Arguably, one could make a good case for choosing the more abundant 4 to 8 mm. It is difficult to explain why we do not have a clear mode of thicker rinds in the upper moraine and why similar thin (2–4 mm) rinds predominate on both histograms. Minor lithology differences or the orientations of the upper stone surface upon which the thicker rinds develop may

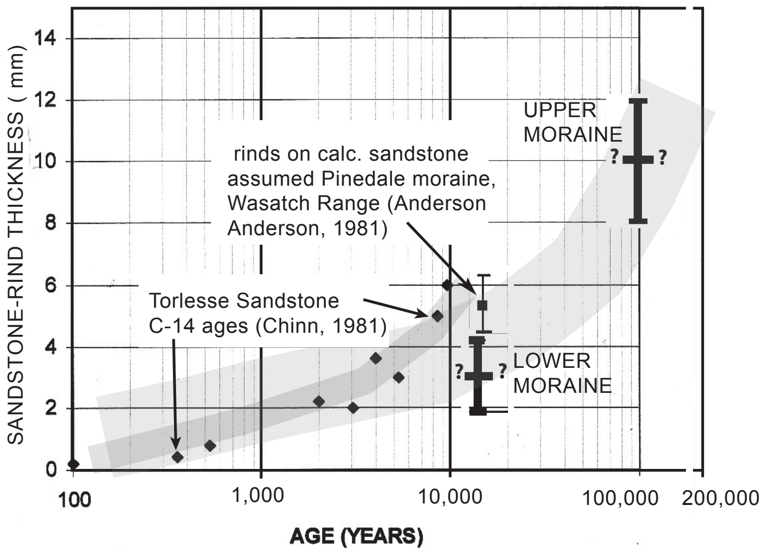

Figure 6. Calcareous-sandstone rind thickness versus estimated age. Symbol showing rinds for lower moraine (Qgy) spans estimated time of the latest Pinedale glaciation and is used as an approximate calibration to extrapolate trend for age of the upper moraine (Qgo). Shown also are the radiocarbon calibrated points for the New Zealand Torlesse sandstone from Chinn (1981) and the estimated age of moraines with clasts of Oquirrh Formation calcareous sandstone with rinds from the Wasatch Range reported by Anderson and Anderson (1981).

contribute to scatter in the data. Some older clasts with preexisting rinds may account for a few anomalous thick rinds. We have chosen the thickest 20 percent (*i.e.*, the tail of the histogram, 8–12 mm) as representative of the oldest and thickest rinds and show those thicknesses on the graph of figure 6.

Discussion

Rind and soil data indicate a significant age difference between these two terminal moraines. If the lower moraine is late Pinedale in age (16–23 ka, according to Chadwick and others, 1997) with 2 to 4 mm rinds, a log-log-plot extrapolation of 8–12-mm rinds suggests an age older than 100 ka. Other workers in the area have identified multiple advances of Pinedale age glaciation and a few separate advances of Bull Lake age (Borgert and others, 1999; Evenson and others, 1982, and Brugger, 1996, and Pearce and others, 1988). We believe most workers would agree that the lower moraine is a Pinedale age advance.

The older upper moraine is interesting because the calcic horizon is thicker than those in the Pioneer Mountains described by Wigley and others (1978) for advances they suggested were Bull Lake age. We have seen similar soils with calcic horizons thicker than 1 m on fan deposits over river terraces mapped by Schmidt (1961) as probable Bull Lake outwash. These terraces are 35 m (120 ft) above the present bed of the Wood River at Ohio Gulch near Hailey.

The thick calcic horizon and the thick weathering rinds suggest the age of this upper moraine may be 100,000 yr or more. We would like to know whether this upper moraine was formed during an advance of Stage 6 before the last interglacial (Isotope Stage 5e, 122–128 ka), or if it is an advance since the last interglacial. Mountain glacier advances are dated in the Sierra Nevada between 70 to 100 ka, and at Yellowstone 90 to 102 ka (fig. 7). Although it is tempting to match these mountain glacier deposits to the marine isotope stages, we are cautioned by Gillespie and Molnar (1995) that mountain glaciers may reach their maximum extent before the maximum ice volume of continental ice sheets. It is this continental ice volume

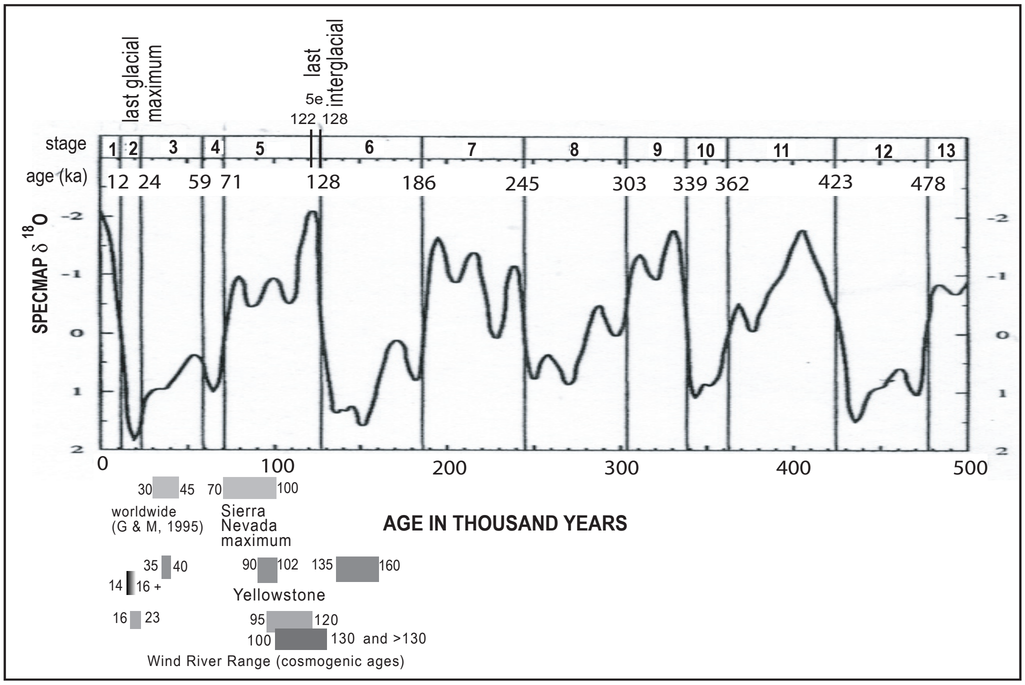

Figure 7. Marine oxygen isotope stages from Wright (2000) after Imbrie and others (1984), ages of mountain glaciation compiled by Gillespie and Molnar (1995), and cosmogenic ages on glacial deposits in the Wind River Range, Wyoming, from Chadwick and others (1997). Cosmogenic age on late-Pinedale northern-Yellowstone ice cap (14 to 16+ ka) from Licciardi and others (2001).

that dominates the marine isotope record. They show that the maximum extent of mountain glaciers may precede the continental ice maximum volume by 15,000 to 20,000 yr.

Ages of Bull Lake advances continue to be a problem in the study of Rocky Mountain glacial deposits. It is our hope that someone will refine the soil and weathering-rind data introduced here to correlate the extensive outwash terrace system in the Wood River Valley mapped by Schmidt (1961). Some of these terrace deposits interfinger with Snake River Plain basalt that can potentially be dated by argon-argon methods.

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