SESSION 211, 08:00 AM

Thursday, November 16, 2000

T51. Reshaping Glacial Geomorphology: New Age Controls on Late Pleistocene Alpine Glaciation I (GSA Quaternary Geology and Geomorphology Division)

Reno/Sparks B1

8:00 AM Clark, Douglas H.

REVISED GLACIAL CHRONOLOGY FOR THE SIERRA NEVADA, CALIFORNIA: LATE-WISCONSIN THROUGH PRESENT.

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Lake sediment cores and age constraints on moraines provide a detailed history of glaciation in the Sierra Nevada during the past ~25,000 yrs. Lake cores indicate that Late Wisconsin (Tioga) glaciers in the Sierra Nevada reached maxima by ~23,500 14C yr B.P. (Benson et al., 1996), maintained those positions for about 5-6000 yrs, and began to retreat by ~17,000 14C yr B.P. (~20,000 cal yr. B.P.). Between 17,000 and ~15,000 14C yr B.P., retreat was gradual and organized, leaving well-defined recessional moraines that record still-stands or minor readvances in most east-side valleys. However, after retreating to 60-80% of their maximum Tioga lengths, most glaciers appear to have stagnated or retreated catastrophically, such that higher recessional moraines are essentially absent, leaving only scattered erratics and till pockets. Lake sediment records indicate that this stagnation probably occurred between 14,000 and 15,000 14C yr B.P. (~16,800-18,000 cal yr B.P.). By ~13,000 14C yr B.P. (~15,500 cal yr. B.P.), Tioga ice had largely or entirely disappeared from even the highest cirques (Clark, 1997).

Cirques remained effectively ice-free between 13,100 and 12,200 14C yr B.P. (15,500-14,200 cal yr. B.P.), after which glaciers reformed and advanced, forming moraines assigned to the Recess Peak event. Recess Peak glaciers lasted only about 1000 yrs, disappearing by 11,200 14C yr B.P. (12,200 cal yr. B.P.). The Sierra Nevada remained largely or entirely free of glacier ice for the next ~9000 cal yr, including during the Younger Dryas chronozone. Cores from lakes downstream of the Conness Glacier indicate that Neoglaciation in the range began by 3200 14C yr B.P. (3400 cal yr B.P.; Konrad and Clark, 1998), but moraine records demonstrate that most glaciers did not reach Holocene maxima until late in the Little Ice Age, probably within the last 200 yrs.

Climatic teleconnections between North Atlantic ocean circulation and Sierra Nevada glaciers during the Wisconsin, suggested by playa lake cores and cosmogenic exposure ages on moraines (Benson et al., 1996; Phillips et al., 1996), appear to break down by the time of the Recess Peak advance, and remained absent through the Holocene. This shift suggests fundamental differences in climatic forcing between the two periods, and complex, non-analogue climates during the transitional period.

8:15 AM James, Allan

EXTENT AND TIMING OF LATE QUATERNARY GLACIATIONS IN THE NORTHWESTERN SIERRA NEVADA, CALIFORNI

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Glacial moraines were mapped in a broad area of the western Sierra Nevada between Sacramento and Reno based on morphostratigraphic principles; e.g., topographic position, ridge morphology, and degree of surface weathering. Lateral moraines in the area include (1) the highest and least-preserved moraines which which rarely have ridge morphology, (2) a high, weathered but well-preserved set of moraines, and (3) two low, weakly weathered sets of bouldery ridges. Cosmogenic radionuclide surface exposure (CRNSE) dates of boulder erratics and striated bedrock reinforce field interpretations of relative ages and constrain absolute surface ages. Two boulders on a high, poorly preserved moraine provided the greatest ages (60.2 and 70.1 ka); the latter is considered a minimum age of that surface. An erratic on a high, well-preserved moraine produced a CRNSE age of 45.3 ± 6.9 ka; in the range of the Younger Tahoe mapped by Phillips et al. (1996) in the eastern Sierra. Two large erratics on a bouldery moraine in Bear Valley, mapped as older Tioga, gave CRNSE ages of 18.6 ± 2.9 and 20.9 ±3.3 ka, similar to the Tioga 3 of Phillips et al. Eight of ten CRNSE dates from a transect up the granitic flank of Old Man Mountain clustered around 14.4 ka providing a fairly precise CRNSE age of dominant younger Tioga moraines in the area.

No CRNSE date was older than 70 ka. Although more dates are needed, these preliminary results suggest rapid erosion and poor preservation of older moraines on northern Sierra west slopes. Dominant lateral moraine ridges are relatively young, moraine ridges from oxygen isotope stage six and earlier glacial advances are poorly preserved, and there are at least two distinct Tioga moraine sets.

8:30 AM Gillespie, A. R.

FAN-MORAINE SYNCHRONY, SIERRA NEVADA, CALIFORNIA

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Alluviation on fans beneath glaciated drainages is thought to be coarsely episodic, dominantly controlled by the supply of sediment at the range front. Periods of major aggradation may occur at the end of glacial advances, when both abundant till and water for transport are available. In contrast, nearby fans beneath unglaciated drainages should not exhibit the same history of aggradation. If fan aggradation is episodic, then even with a constant rate of soil development alluvial fans of different ages should be separable using spectral remote-sensing techniques (Gillespie et al., 1986). This affords an excellent opportunity to map alluvial fan units over great distances, given similar lithologies and climatic histories. However, the fundamental model remains to be demonstrated. We have mapped the drainages and alluvial fans of Convict Creek, Sierra Nevada, and compared them to existing maps of the Convict Creek moraines to establish clear morphostratigraphic relations over a period of multiple glaciations. Some alluvial fans have been constructed around Convict Creek, an axial stream cutting through the Tioga moraines. Aggradation on these fans could (but need not) have occurred continuously since the Tioga glaciation. Other fans originated from ancestral axial streams that have been abandoned since glacial retreat from Tobacco Flat, such that aggradation ceased at that time. Yet other fans originated from high on the lateral moraines when the glaciers were advanced, and have been inactive since deglaciation. Cosmogenic dating of granitic boulders from the fans and correlative moraines establishes the general synchrony between fan aggradation and glacial retreat. Fans and the correlative moraines have similar ages, and fans associated with pre-Tioga moraines (>25ka) do not have post-LGM ages (e.g., <16ka) as might be expected if climate alone, and not sediment supply, controlled aggradation in this environment. Axial fans and abandoned lateral fans have similar cosmogenic ages, which could only happen if both have been inactive since deglaciation. Therefore, it appears that the 'glacial' model of episodic fan aggradation is valid, at least for the eastern Sierra Nevada.

8:45 AM Hakala, Katharine

LATE QUATERNARY COLD PERIODS AT GRASS LAKE, SOUTHERN CASCADE RANGE, CALIFORNIA

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Grass Lake (40°45'N, 122°10'W, 1540 m) occupies a small volcanic basin in the ponderosa pine forest of the southern Cascade Range in northern California. A lake sediment core records intervals of sparse vegetation suggesting periods of low summer temperatures.

Radiocarbon dates imply these cold periods occurred about 32, 25, and 19 cal ka and correspond to alpine glacial advances in the Sierra Nevada (Phillips et al., 1996) and Washington (Thackray, 1996).

Cold period I (33.2-32 cal ka) coincided with an exceptionally cold stadial in Greenland between Interstadials 5 and 6 (Dansgaard et al., 1993; Grootes et al., 1993; Meese et al., 1994). Precipitation was high at Grass Lake but dense forest disappeared within decades, implying rapid cooling. Summer temperatures decreased as summer insolation reached maximal levels in mid-latitudes and low levels in high latitudes (Berger, 1978). Mid-latitude warming in western North America may have strengthened the Pacific Subtropical High (PSH) so that summer northerly winds associated with the anticyclone advected very cold air from high latitudes, cooling the western North American coast.

Cold period II developed gradually as summer insolation decreased. Decreasing pollen concentrations and lithological changes suggest cooling after 27.5 cal ka, following Interstadial 3. Continued cooling is implied by the disappearance of Symphoricarpos (snowberry) at 26 cal ka; limited pollen accumulation after 25.8 cal ka; and diminished deposition of silt/clay at 25.3 cal ka, suggesting sediment deflation associated with sparse vegetation. The cooling culminated 25-24 cal ka, coincident with drought in the western United States and extreme cold in Greenland. Increases in silt/clay and pollen at 23.4 cal ka mark the termination of the cold period, suggesting warming related to Interstadial 2. A summer insolation minimum at 21.5 cal ka was not associated with extreme cold.

Cold period III began 19 cal ka as summer insolation and precipitation increased in northern California. Mid-latitude warming may have strengthened the PSH so that summer northerlies advected cold air from the CIS, cooling the Pacific coast states. Cold conditions persisted in the southern Cascade Range for at least 2,000 years.

9:00 AM Swanson, Terry W.

36-CL EVIDENCE FOR MAXIMUM LATE PLEISTOCENE GLACIER EXTENT IN THE CASCADE RANGE DURING MARINE ISOTOPE SUBSTAGE 5D

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Six well-preserved moraines in the Icicle Creek drainage of the southern North Cascade Range were deposited during Late Pleistocene glacier advances. Weathering data and 82 36-Cl ages support subdivision of the glacial record into three drifts. Leavenworth drift includes four successively younger moraines: Leavenworth I and II and Rat Creek I and II.

The 36-Cl ages of the Leavenworth and Rat Creek moraines fall within the span of marine oxygen isotope stage (MIS) 2. Ages for the more-extensive Mountain Home drift imply correlation with MIS 4. Peshastin drift, initially inferred to be equivalent to or older than MIS 6, has mean 36-Cl ages of 106-113 ka (n = 9) if long-term mean erosion rates in the range of 1-4 mm/ka are adopted. Therefore, this drift is provisionally correlated with marine oxygen isotope substage (MISS) 5d. It is unlikely that Peshastin drift was deposited during late MIS 6, as such an interpretation would require erosion rates 2-3 times higher than appears reasonable for the study area.

The 36-Cl chronology implies that the last three Cascade glaciations were in phase with variations in Northern Hemisphere solar insolation at 47°30' N.

The lowest Late Pleistocene July insolation value, which would favor strong summer cooling and positive glacier mass balance, occurred during MISS 5d. Negative values were less extreme during MIS 2 and 4 and late MIS 6. Although the marine oxygen isotope record implies greater global ice volume during MIS 2 and 6 than in MIS 4 and MISS 5d, the integrated ice-volume signal is primarily controlled by the continental ice sheets. Whereas first-order fluctuations of alpine glaciers and ice sheets may have been broadly synchronous, their maximum expansions may not have been. Although an MIS 6 age for the Peshastin drift cannot be ruled out, the evidence and arguments for a MISS 5d age are more compelling.

9:15 AM McCrumb, Daniel H.

USING THE RING CREEK LAVA FLOW TO DETERMINE THE EFFECTS OF SNOW COVER ON CHLORINE-36 PRODUCTION IN HOWE SOUND, BRITISH COLUMBIA

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The Ring Creek lava flow was erupted into the Mamquam Valley following the retreat of the Cordilleran Ice Sheet (CIS) lobe from its late-glacial position in Howe Sound, British Columbia. The dacite flow overlies a delta that prograded into a proglacial lake impounded within the Mamquam Valley during this latest advance. The Ring Creek flow is constrained by maximum and minimum limiting C-14 ages of 12,730 cal. yrs BP on a insitu stump collected from the topset beds of the delta, and 10,570 cal. yrs BP on charcoal collected from an alluvial fan that overlies the lava flow. Surface samples were collected from the Ring Creek flow for Cl-36 dating along an altitudinal transect (300-700 m) to test the effects of snow cover on Cl-36 production.

Calculated Cl-36 ages are progressively younger with increasing elevation when corrections for snow cover are not included in the calculations. Samples collected from 300 meters a.s.l. have minimal winter snow cover and a Cl-36 age of ca. 12,500 Cl-36 yrs BP is consistent with the closest limiting age of the lava flow. Samples collected from 700 meters a.s.l. with longer winter snow cover average ca. 2000 Cl-36 yrs BP younger than true age of the lava flow.

The above data allow us to address three important issues. First, Cl-36 ages from low elevation positions on the dacite flow validate the production rates used for reconstructing the regional deglaciation history of Howe Sound. Second, Cl-36 ages from this low elevation site provide a minimum age for latest deglaciation of the CIS from Howe Sound. Third, uncorrected Cl-36 ages can be used to determine Holocene snow cover. Understanding snow cover and its significance to cosmogenic isotope production is important because even in an area of relatively low modern snow cover, effects over the Holocene may impact surface production rates.