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Constraining post-glacial temperatures of rock avalanche deposits in the Yosemite Valley with cosmogenic noble gas and luminescence paleothermometry

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Yosemite Valley is renowned for its striking topography, with many sheer granite cliffs carved during past glaciations. At the base of these cliffs many large rock avalanche deposits can be found that were deposited since ice retreated from Yosemite Valley. Cosmogenic ^{10}Be measurements indicate that there are at least 10 different rock avalanche deposits that range in age from 13 to ~1 ka.

In this study, we estimate the time-averaged temperatures experienced by rocks from five of these rock avalanche deposits using cosmogenic noble gas and luminescence paleothermometers. These two systems yield independent estimates of valley floor temperatures during the Holocene, information that is useful for reconstructing the local environmental conditions since deglaciation.

Cosmogenic noble gas paleothermometry utilizes the fact that cosmogenic noble gases like ^{3}He experience thermally-activated diffusive loss at Earth surface temperatures in minerals like quartz. The concentration of cosmogenic ^{3}He in quartz relative to a cosmogenic nuclide that does not experience diffusive loss should therefore be a function of a rock's thermal history over the duration of its exposure to cosmic ray particles. Apparent ^{3}He boulder exposure ages from these five rock avalanche deposits are 58 to > 98% younger than the corresponding ^{10}Be exposure ages. Preliminary models that combine these ^{3}He observations and sample-specific diffusion parameters indicate that effective diffusion temperatures (EDTs) recorded by ^{3}He in quartz are similar to or higher than the modern EDT from the instrumental record.

Like with the cosmogenic ^{3}He system, thermoluminescence (TL) paleothermometry of K-feldspars also relies upon the balance between steady signal build-up and thermally-activated loss. The difference is that TL derives from trapped electronic charge at defect sites within the feldspar crystal lattice that accumulates in response to natural background radiation. K-feldspar TL signals comprise a range of stabilities. The least stable sites will experience diffusive loss even at temperatures below 0 °C and the most stable sites will accumulate at upper crustal temperatures.

By monitoring which sites are occupied and how long those sites have been accumulating charge, we estimate both the ambient temperature and the time spent at that temperature.

We compare and discuss the history of rock temperatures estimated from these two systems with implications for the post-glacial climate of Yosemite Valley.