# WHAT DO GLACIERS TAKE AWAY? WHAT DO THEY LEAVE BEHIND?

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Since Agassiz got us started, people keep asking, "When did the glacier advance, when did it retreat?" For >150 yrs, we have come up with increasingly complex means to answer such simple questions. Cosmogenic isotopes are the latest rage. Each analysis, costing hundreds of dollars and tens of hours of labor, lets us count atoms. A late glacial sample might contain 60,000 atoms/g of 10-Be, seemingly a large number. Consider though, that cosmogenically produced atoms in each gram of rock represent just a couple parts in 1,000,000,000,000,000,000 other atoms.

Most cosmogenic dating is division (age = atoms/production rate) with only a few simple assumptions. Because rates of isotope production are "widely known" to be constant and snow or till "never accumulate" on sampled outcrops, only one lingering doubt remains, inheritance. Did the cosmogenic clock really start at zero the day this boulder was deposited, the day that outcrop was finally clear of ice? Are we guilty of age inflation by counting atoms that really belong to the last interglaciation?

Maybe or maybe not. Seven of eight fjord bottom samples of polished bedrock, morainal boulders, and small cobbles exposed after the Little Ice Age on Baffin Island are free from inheritance. They carry <6,700 to <19,000 atoms/g 10-Be and <18,000 to <33,000 atoms/g 26-Al, the equivalent of < 900 years of exposure. Upland samples, buried by cold-based ice, carry nearly 100 ky of inheritance. Sixteen samples of quartzite and gneiss, bedrock, and boulders, collected from 4 to 12 km behind the terminal zone of the Laurentide Ice Sheet in New Jersey and used to calculate production rates, have too few rather than too many 26-Al and 10-Be atoms, an observation we ascribe to lower-than-currently-accepted production rates. Three boulders from the core of a Sierra Nevada moraine at Bishop Creek, CA probably had < 3 ky of exposure at deposition. But, three analyses of striated quartzite from Baraboo Hills, WI spell trouble; less than 10 km within the Latest Pleistocene (<20 ky) ice-margin, they provide 10-Be and 26-Al average ages of 73, 69, and 35 ky. Ages of quartzite and granite samples (n=8), from outcrops 60 and 100 km up the paleo-flowline, are tightly clustered (14 to 16 ky) and show no such inheritance.

Worried about inheritance? Stay away from cobbles, hard bedrock near ice margins, and cold-based ice.

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