Glacio-isostatic rebound rates from in-situ cosmogenic chlorine-36 dating of raised marine beaches in Makinson Inlet, eastern Ellesmere Island

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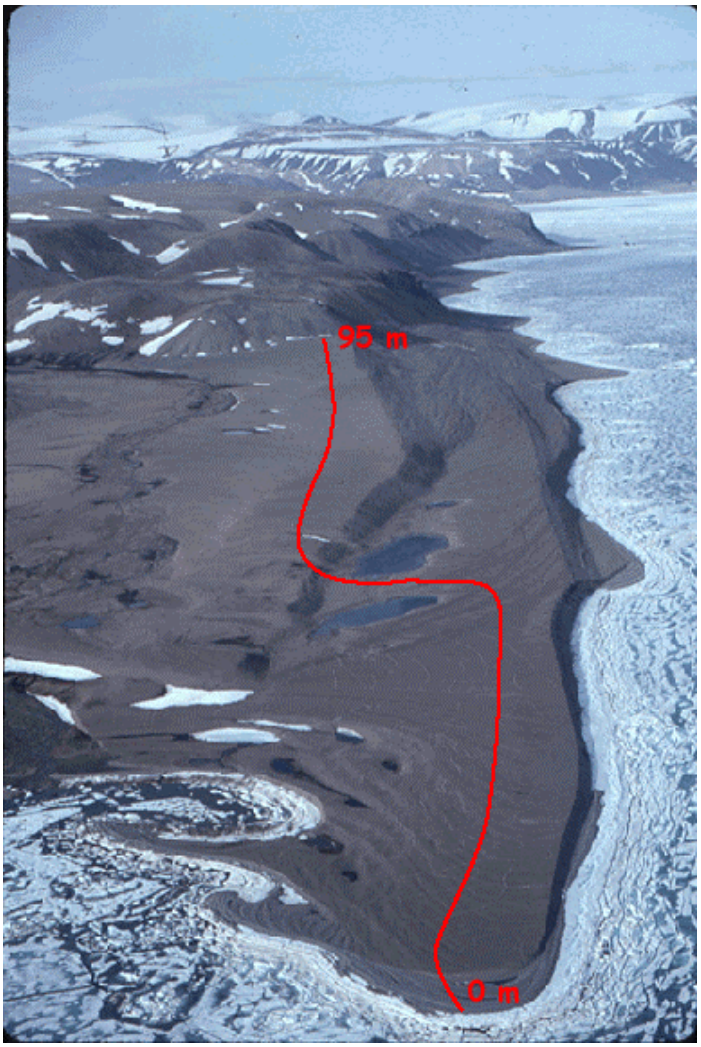
Growth of continental ice sheets causes land subsidence in response to ice loading. The ensuing deglaciation and removal of the ice load result in isostatic rebound. The rate of isostatic rebound depends on the rigidity of underlying rocks and the loading history and, therefore, reflects the regional geology and the paleoclimate. Rebound rates are determined by dating organic materials, such as wood or bones, associated with former sea levels. Because such materials are not ubiquitous, this approach has limited applicability and resolution. We have tried a new approach based on accumulation of cosmogenic chlorine-36 in paleobeaches gradually exposed at the surface due to postglacial emergence.



We collected surface and subsurface gravel samples from fourteen paleobeaches at elevations between the sea level and the Holocene marine limit (ca. 100 m). They gave apparent chlorine-36 ages from ca. 3 to 12 ky, all in an acceptable stratigraphic order. After accounting for changing elevation, possible prior exposure, surface modification and other factors that affect cosmogenic production of chlorine-36, we obtained corrected cosmogenic chlorine-36 exposure ages in the range from 10 ky to recent. The older corrected ages agree well with the carbon-14 ages of shells that date the marine limit, which demonstrates the feasibility of our dating approach. We fitted a function of age vs. total uplift and then differentiated it to calculate instantaneous uplift rates. About half of the total emergence occurred in the first 2 ky, whereas the last 10-15 m of rebound took ca. 5 ky. The rebound rates decreased from about 20-30 m per ky at the beginning of the record, to less than 1 m per ky now. This pattern is the expected response to deglacial unloading at the beginning of the Holocene.

Our preliminary results show that in-situ cosmogenic isotopes can be used in studies of rates of postglacial emergence. The approach has two main advantages over previous methods; both are due to the ubiquitous nature of rocks and sediments that can be dated. (1) It can be used on any material that has been gradually exposed at the surface due to postglacial emergence; one attractive choice is bedrock exposed in fiord walls or in benches at different elevations. (2) An arbitrarily large number of samples can be collected from the same location, thus providing the means of constructing a coherent, high-resolution record of exposure.