

Obtaining rates of glacial isostatic adjustment from unequally spaced data

1 Abstract

The ground surface underlying the Laurentian Great Lakes is currently undergoing vertical adjustment after being depressed by the weight of an ice sheet formed in the most recent glacial period. The rate of glacial isostatic adjustment (GIA) varies by location, and exerts a significant control on the flow of water in the Laurentian Great Lakes as the inclination of the ground surface changes. In order to predict the future movement in this area, the rate of GIA must be inferred from measurements of the water level in the geological record. These measurements are made by measuring the elevation of a subsurface sedimentary contact relating to past lake levels, which are then age dated with optically stimulated luminescence (OSL) to provide an age value.

The focus of this paper is to analyze this data by measuring the relative difference in water levels between study sites, comparing differences in relative water levels to create a plot of relative elevation over time. Once this is done, the rate of change per unit time is obtained from a linear regression, representing an estimate of the value of GIA between each pair of sites. This is done for all possible combinations of the four sites used, Grand Traverse Bay (GTB), Au Train Bay (ATB), Batchawana Bay (BATB), and Tahquamenon Bay (TAHB).

The results of this process were a strong agreement of 95% confidence intervals on GIA rates obtained from forward and reverse regressions for the combination of BATB-GTB (difference of 0.0012 m/year) and BATB-ATB (0.0028 m/year). Agreement was also seen for GTB-TAHB (range of 0.0005-0.0007 m/year), ATB-GTB (0.0011-0.0014 m/year), and ATB-TAHB (0.0020-0.0027 m/year), while the rate for BATB-TAHB strongly disagreed between forward and reverse comparisons, making estimation of GIA from that combination of sites unreliable.