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Using in-situ cosmogenic C-14 and Be-10 depth-profiles to quantify site-specific Holocene soil erosional events: a sensitivity analysis

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We assess the sensitivity of *in situ* cosmogenic C-14 and Be-10 depth-profiles for quantifying site-specific Holocene erosional events on a soil formed on a Younger Dryas moraine in Scotland. Our C-14 and Be-10 depth-profile-based approach for determining amounts and timing of Holocene soil erosion is as follows. The cosmogenic exposure age of a boulder on a moraine is an estimate of the moraine's age and an uneroded soil/till on the moraine must have the same cosmogenic nuclide inventory as the boulder. Any shortfall in the soil/till material cosmogenic nuclide inventory is therefore a measure of erosional loss. Cosmogenic nuclide determinations have been carried out on samples from two localities near Glasgow, Scotland: the first at Wester Cameron, where the soil shows no apparent signs of soil loss, and the second at Lake Menteith, where the soil has visible signs of erosion. The results obtained at Wester Cameron agree with those obtained in two glacial erratics from the same locality, with a mean exposure age of 10,500 $\pm$ 900 years, confirming the initial observation of no soil loss at this site. To constrain the magnitude and timing of soil/till erosion at the Lake Menteith site, we employed a Monte-Carlo type approach whereby we calculated cosmogenic C-14 and Be-10 depth profiles for a wide range of soil/till erosion events. Each erosional event consists of the instantaneous removal of a certain thickness of soil/till (between 0 - 100 cm) at a certain moment in time (between 0 - 10,500 years BP). A reduced-χ^2 goodness of fit test suggests that our cosmogenic C-14 and Be-10 depth profiles for the Lake Menteith site are best explained by an erosional event that occurred between 200 - 500 years BP and resulted in the removal of $\sim$40 cm of soil/till. Sensitivity analyses suggest that the predicted timing and magnitude of the soil erosional event is highly sensitive to the assumed moraine age and to the soil/till density value used – in our case both of these being constrained by measurements. Further, the sensitivity analyses also suggest that properly accounting for muogenic production is important even for such relatively shallow and young depth profiles.