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The application of in situ 14C to Holocene terrestrial Antarctic ice-sheet reconstruction

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Determining detailed Holocene ice-sheet behaviour in Antarctica is critical for understanding and predicting likely dynamic responses of ice sheets to future climate change. However, to date terrestrial studies using in situ cosmogenic isotopes have struggled to overcome inheritance issues in this cold-based ice setting. Here we present new terrestrial geological constraints that take advantage of recent technological developments in the extraction and measurement of in situ cosmogenic radiocarbon (14C)– a cosmogenic nuclide with a considerably shorter half-life than that of 10Be (10Be: 1.36x103 kyr; 14C: 5.73 kyr) – to assess the potential influence of prior exposure or recycling of glacial erratics and therefore improve reconstructions of past ice-sheet surface profile changes.

Glacial erratics were sampled from steep exposed bedrock surfaces in the Ellsworth Mountains overlooking the Weddell Sea, serving as 'dipsticks' that allow us to reconstruct past surface elevation changes in the Rutford Ice Stream as it decayed through the Holocene. Our in situ 14C analysis reveals a complex relationship, reflecting inheritance and burial, in samples that record anomalously 'old' apparent 10Be exposure ages from previous exposure. Our results enable us to test and refine previous interpretations and thereby reduce chronological uncertainties in Holocene ice-sheet change in this sector of Antarctica, demonstrating the exiting potential of in situ 14C in ice-sheet reconstruction.