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Spatio-temporal reconstruction of the post-glacial sea-level evolution in the Ross Sea, Antarctica

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The complex interactions between the redistribution of water mass in the ocean basins due to continental ice sheet growth and decay, and the attendant Glacio-Isostatic Adjustment (GIA) process play a major role in controlling Relative Sea-Level (RSL) variability since the Last Glacial Maximum (LGM). In near-field regions (e.g., areas covered by the major ice-sheet at the LGM), the rate of GIA uplift during deglaciation often exceeded the rate of RSL rise from an increase in ocean volume due to the melting of land-based ice.

Here, we assembled a database of new and previously published RSL collected along the coasts of the Ross Sea (Antarctica). The set of ^{14}C radiocarbon dates was obtained from samples of Adelie penguin guano remains and shells found on raised beaches and collected during several Antarctic expeditions conducted in the framework of the Italian Programme of Antarctic Researches (PNRA). We further revisited about 300 radiocarbon dates available in literature following the standards of the latest International Geoscience Programme (IGCP) protocols on sea-level studies. All these dates were also recalibrated according to the latest calibration curve

We thus produce a new set of 65 RSL data points which have been classified in i) Sea Level Index Points (SLIP), when the relationship between the sample and the tidal level is clearly known (e.g., raised beaches), ii) marine and iii) terrestrial limiting points which indicate the upper and the lower threshold for the former sea-level position, respectively.

In order to reconstruct the RSL trend in the last thousands of years, a critical interpretation of the dated materials has been carried out. For example, data show that the penguin guano and remains from ornithogenic soil on top of beaches and on abrasion platforms significantly rejuvenated the age actual age of the beach ridges.

We finally applied on the new dataset a spatio-temporal empirical model to reconstruct magnitudes and rates of RSL change (with associated uncertainty) from SLIPs along the Ross Sea area. The model output shows a continuous RSL drop of about 25 m last ~7 ka BP. This drop was generally characterized by average rates comprised between ~2 to ~4 mm/y. An episodic increase of the RSL falling rates, up to ~6 mm/y was found at ~4 ka BP, likely related to a local increase of the GIA contribution

This study, based on a robust number of radiocarbon dated coastal deposits, will allow to better define the recent Antarctic ice-sheet fluctuation and to contribute in the tuning of the GIA models in this key sector of the World's coastlines.