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Changes in beach deposit characteristics on Joinville and Livingston Islands, Antarctica

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The grain-size and roundness of beach deposits preserve records of past wave climate as well as processes acting on beaches. In this study we examine changes in the grain-size and roundness of two sets of raised beaches on opposite sides of the Antarctic Peninsula (AP): Joinville Island along the Eastern AP (EAP), and Livingston Island along the Western AP (WAP). Overall, the 9 beaches on Livingston Island are stratified with poorly-sorted clasts compared to the better sorted 21 stratified lower beaches and 16 unstratified upper beaches on Joinville Island. The differences likely reflect the difference in foreshore gradient between the two islands. The Joinville profile is steeper, allowing waves to break on the coastline with high energy while the Livingston profile is shallower, enabling wave attenuation before reaching the shoreline. Raised beaches on Joinville Island show an overall increase in roundness through time while grain size remains consistent. However, the roundness trend is interrupted at beaches 5, 13-15.5, and 28. Beach 5 exhibits less and beach 28 exhibits more rounding than the general trend. Less rounding of sediments within beach 5 could be explained by short open water seasons with an increase in sea ice while the opposite could hold true for beach 28. The transition from beach 15.5-13 indicates a decrease in roundness over time, opposite the overall roundness trend. The ages of beaches 15.5-13 tentatively coincide with the onset of the Neoglacial time period ~2.5-1.2 cal kyr BP. The presence of sea-ice could hinder clast rounding during cooler periods associated with the onset of this Neoglacial time period. Livingston Island beach ridges also show an overall increase in roundness through time. However, Livingston Island contains two types of beach deposits: strand plains and storm ridges. Strand plains were deposited by normal swash processes in topographic lows and exhibit sub-angular to sub-rounded sediments. Storm ridges, deposited during periods of high wave energy, exhibit sub-rounded to rounded deposits. Storm deposits should be less rounded than strand plain deposits. However, ground penetrated radar profiles through the storm ridges suggest they bury older strand plain deposits. Therefore, we suggest Livingston storm ridges consist of the recycling of older strand plain deposits by storms. Additionally, no coherent trends in grain sizes were observed at Livingston Island.

Insights into the Sea-Level History of the South Shetland Islands from Ground Penetrating Radar on Livingston Island, Antarctica

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The sea-level curve for the South Shetland Islands (SSI) is atypical from what would be expected in a near-field setting in that it shows a nearly constant slow rate of relative sea-level (RSL) fall through most of the Holocene with a large increase in the rate of RSL fall within the last 600 years. However, most RSL reconstructions from the islands are based solely on the crest elevation of raised beaches. Is more to the RSL history of the SSI hidden within the architecture of the beach ridges? In order to answer this question approximately 10 km of ground-penetrating radar (GPR) profiles and optically stimulated luminescent samples were collected on the South Beaches of Livingston Island within the SSI. In GPR profiles, two broad types of reflections were identified: seaward-dipping reflections and landward-dipping reflections. In addition, scarps of bedrock were identified beneath areas of landward-dipping reflections. The seaward-dipping reflections are interpreted as prograding beach deposits created during normal RSL fall while the landward-dipping reflections are interpreted as overwash deposits preserved from periods of RSL rise. The scarps beneath the beach ridges likely formed as wave cut scarps during sea-level rise. The stratigraphy of the beach ridges suggests higher-order sea-level fluctuations marked by a general sea-level fall interrupted by minor rises in sea level. These higher-order RSL fluctuations support earlier assertions of a weak rheology beneath the SSI; not surprising given their active arc setting. Our results highlight the use of beach stratigraphy in preserving records of past RSL fluctuations.