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Polar gravel beach-ridge systems as archive of climate variations (South Shetland Islands / Western Antarctic Peninsula)

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The architecture of polar gravel beach-ridge systems is presented and their potential as archive of past wave-climate conditions is evaluated. Raised beaches are common on paraglacial coasts which experienced a net uplift during the Holocene as the result of postglacial isostatic rebound. Ground-penetrating radar data obtained along the coasts of Potter Peninsula (King George Island) show that beach ridges unconformably overlie seaward-dipping strata of the strand plain. Whereas strand-plain progradation is the result of swash sedimentation at the beach face under enduring calm conditions, ridge construction reflects enhanced wave action at the beach as the result of increased storminess or reduced nearshore sea ice. The number of individual ridges which are preserved from a given time interval varies along the coast depending on the morphodynamic setting: Sheltered coasts are characterized by numerous small ridges, whereas fewer but larger ridges develop on exposed beaches. The sedimentary architecture of individual beach ridges is interpreted to reflect maximum wave-runup height during the time of ridge construction. Ridges at sheltered parts of the coast exhibit either seaward-dipping beds, interpreted to result from swash deposition, or an aggradational stacking pattern being the result of wave overtopping. At exposed beaches, larger ridges develop composed of seaward- as well as landward-dipping beds. Radiocarbon data indicate that the frequency of ridge building ranges from decades in low-energy settings to more than 1500 years under high-energy conditions. In the study area, beach ridges group into four distinct levels: up to 4 m, 5.5 m, 7.5 m, and 10 m above the present day storm beach. Hence, these levels are interpreted to reflect periods of increased wave activity in the area of the South Shetland Islands at about 4.3, 3.1, 1.9, and 0.35 ka cal BP.