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Sedimentology of Composite Sand-and-Gravel Beach-Shoreface Complexes

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Summary

Process-response relations defined in modern clastic depositional environments aid in predicting relations in sedimentary media. For sand and gravel beaches, relations derived in the modern are broadly applicable to conglomerates preserved in the rock record. On the southwest coast of Vancouver Island, Canada, sedimentological analysis of three composite sand-and-gravel beaches was undertaken to quantify process-response relations. Sediments record two stages of beach deposition and modification. Sand and gravel components of the beaches are deposited during the winter storm season, with a dominant sediment transport direction to the northwest. Sediments are reworked under fair-weather conditions (summer) to produce the beach morphology observed. Sediment caliber is consistent from the lower intertidal zone to 20 m water depth. Strong tidal currents dominating over weak wave processes in the lower shoreface could result in coarser-grained sediments being deposited further offshore. Alongshore, sediments in the intertidal zone show a sinusoidal trend in mean grain size with a wavelength of approximately 400 m. This is close to the wavelength that would be expected for infragravity edge waves set up on these systems. Edge waves could produce the observed trend by enhancing and inhibiting swash run-up, or by producing regularly spaced rip currents that locally inhibit swash run-up.

In addition to grain size trends, sedimentary structures (revealed in sediment cores) exhibit a predictable across-shore distribution. The steeper (reflective) upper intertidal experiences increased wave energy in the form of breaking waves and onshore-directed surf. These processes produce longshore currents, and in turn shore-parallel migrating dunes. These are reflected in the sediment as trough cross-stratification. Trough cross-beds are interbedded with planar lamination and wave ripples produced from swash-backwash and tidal-current processes, respectively. In the lower intertidal zone to at least 2 m water depth, wave energy is weaker, and trough cross-stratification is not produced. Sediments comprise interbeds of plane-bedded and combined flow rippled sand. In 10, 15 and 20 m water depths all primary laminations are destroyed by bioturbation. The sedimentological trends observed reflect hydraulic processes active in the shoreface. These trends aid in predicting the variability inherent in beach-shoreface systems, both in the modern and in the rock record.