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Seismic imaging of the Quaternary stratigraphic infill history of a terrestrially isolated coastal inlet: Otago Harbour, New Zealand

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Coastal inlets generally are related to estuarine systems that have a substantial terrestrial sediment input. However, isolated inlets with little terrigenous input from rivers (e.g., fjords) contain important records of transgressive and high-stand marine sedimentary units. Inlets such are these are relatively rare at mid-latitudes (40° to 50°). Otago Harbour on the southeast coast of New Zealand's South Island is one such isolated inlet. It resulted from the fluvial erosion of a Miocene volcano that carved out a valley system on the volcanic landmass. During glacial periods in the Earth's history, when global sea levels were lower due to large quantities of available surface water being bound up in polar ice caps, the streams and rivers that flowed from the eroding volcano incised longer and deeper channels that extended across the neighbouring continental shelf. However, during interglacial periods, like we are experiencing now, global sea levels rise above the incised channels, allowing sediment to accumulate on the seafloor.

The types of sediment that can accumulate on the seafloor are primarily controlled by the source of the sediment (i.e. where it comes from and in what quantities) and the ability of the water to carry it (faster water can generally carry more sediment and larger grain sizes). Most of the sediment found in Otago Harbour is sourced from either long-shore drift (primarily quartz sand that flows into the ocean at rivers to the south) or from biogenic processes (e.g., shells of coastal organisms). Very little of the modern sediment in the harbour comes from the nearby volcanic rocks of the Dunedin volcano.

Seismic imaging of sediments and sedimentary rocks relies on contrasts in physical properties between sedimentary strata that can produce reflections at interfaces between contrasting types of rock. Such interfaces can develop as a result of changes in patterns of deposition. In an estuary setting, such horizons can be correlated to interbedded silt (mud) and sand layers, with varying amounts of carbonate. For example, if an overall rising sea level stabilises for a period of time, sedimentation can slow down resulting in a lack of coarse-grained sediments being transported and deposited and an increase in carbonate production from near-shore biological communities.

We present high-resolution seismic data (boomer source, 24-channel micro-eel receiver) collected since 2016 over much of the shallow regions (<2m water depth at high tide) of Otago Harbour that image a >150-m-deep paleovalley infilled during the Quaternary. Distinct horizontal reflections within the paleovalley sediments terminate on the interpreted erosional surface that carved down into the basement rock units underlying the Dunedin Volcano. These reflections can be used to map the distribution of depositional sequences throughout the region, which in turn can be used to evaluate the paleoenvironmental history of the inlet.