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Using geophysical investigations to understand fault reactivation: Evolution of the Waihemo Fault System, North Otago, New Zealand.

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The Waihemo Fault System is a major NW trending structural feature on the South Island of New Zealand. It lies at the base of the Kakanui Ranges, which are the result of an inversion regime, reactivating mid-late Cretaceous normal faulting in the late Cenozoic. The fault system merges with the Hawkdun Fault System at its northern flank, runs offshore at Shag Point, and is aligned with the southern edge of the Bounty Trough. Its relationship with similar parallel-trending faults in the Otago Schist, such as the Hyde-Macraes Shear Zone, the Rise-and-Shine Shear Zone and the Cromwell Gorge Shear Zone, is poorly understood, but it is considered to be associated with the extensional exhumation of the Otago schist ∼110 Ma.

This major crustal structure, as suggested by its lateral continuity, forms the main structural divide between the greenschist facies of the Central Otago Schist, and the prehnite-pumpellyite facies of the Kakanui Ranges. Its lateral continuity belies the fact that it is a complex structure, made up of many segments, with varying degrees of reactivation along the different strands. The greatest movement has occurred along the northern strands, whereas the amount of reverse thrusting diminishes with proximity to the coast.

We have used controlled-source seismic methods to characterise the Waihemo Fault at three locations. A high-resolution seismic survey was carried out offshore in early 2009 to: (1) quantify the reverse movement on the southeastern end of the fault system, and (2) determine whether or not Cretaceous normal movement was still preserved there. A complementary onshore controlled-source seismic survey late in 2009 aimed to image the thickness of Cretaceous conglomerates in the hanging-wall of the fault ∼5 km inland from the coast, and hence give an approximation of the amount of normal movement. Further inland at Pigroot Creek, ∼45 km from the coast, another seismic survey was completed in 2008, which together with OSL dating, river and terrace profiling, and gravity surveying, gives an indication of the evolution of the fault strands in this area up to the Late Cenozoic.

Results to date indicate that the reverse movement offshore has completely compensated for the Cretaceous normal movement, and none appear to be preserved. Inland at Pigroot Creek, Late Cenozoic movement has been dated to between 58-14 ka using OSL dating, with more sampling endeavouring to constrain this further.