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Crustal structure of the Chatham Rise and Chatham Terrace – A key of understanding the earliest separation of New Zealand from Gondwana

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The submarine continental Chatham Rise extends up 1500 km east of New Zealand's South Island as part of the continent Zealandia. During the Cretaceous it underwent a twofold tectonic history: 1) At ~100 Ma, the long ongoing subduction of the Proto-Pacific plate at the eastern Gondwana margin abruptly ceased as the Hikurangi Plateau collided with the subduction trench. 2) At least since ~94 Ma after cessation of the subduction, the compressional regime was replaced by continental rifting as evident by the oldest known terrestrial graben sandstones on the Chatham Islands, development of metamorphic core complexes on the South Island and changing geochemical constraints (I-type to A-type granites) in western Marie Byrd Land, Antarctica. Little is known about the geodynamic processes that accompany the rifting as well as the nature, characteristics and extent of continental thinning at the southern margin of the Chatham Rise. We examine two deep crustal seismic refraction/wide-angle reflection lines crossing the southern margin of the Chatham Rise and adjacent Chatham Terrace, and a third deep crustal seismic profile at the southeasternmost part of the Chatham Rise. Modelling of P-wave velocities indicate variable thicknesses for the part of the Chatham Rise close to Chatham Island (~24 km), west of Wishbone Ridge (< 22 km), east of Wishbone Ridge (18 – 12 km), and the easternmost part (only up to ~13 km). While thicker parts of Chatham Rise are probably underlain by the subducted Hikurangi Plateau, the thinner parts of the crust are strongly affected by normal faulting. As part of the southern Chatham Rise margin, the elevated Chatham Terrace shows a crustal thickness between 10 and 7 km. On the Chatham Terrace, P-wave velocities exceeding 7 km/s at the crustal base probably related to magmatic underplating. Our results indicate that the Chatham Terrace has continental affinities as evident from graben structures obvious in the seismic reflection data and from continental-affinity rocks dredged from the Stuttgart Seamount. We suggest that magma-poor continental rifting led to the formation of the Chatham Terrace, Bounty Trough, Canterbury Basin as well as the metamorphic core complex exhumation in the Dunstin Range onshore New Zealand's South Island until ~84 Ma. Highly asymmetric westward propagation of the Pacific-Bellingshausen spreading ridge led to a magmatic overprint and formation of the Chatham Terrace seamounts, separation of the Bollons Seamount from the Bounty Platform and the breakup of the Chatham Rise and Campbell Plateau from Antarctica proceeded.