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Cenozoic Plate Tectonics in the Southwest Pacific

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A Cenozoic tectonic reconstruction is presented for the Southwest Pacific region located between Australia in the west, New Zealand in the southeast and Fiji in the northeast. The reconstruction is constrained by a number of geological and geophysical datasets, new rotation poles for the Pacific plate relative to Australia, and new rotation poles for the Lord Howe Rise microplate relative to the Pacific plate.

The reconstruction shows that although the relative motion between the Australian and Pacific plates has been relatively simple over the last 65 Myr, episodes of plate boundary migration have significantly complicated the structure of the region. Plate boundary migration took place at subduction zones, with episodes of subduction hinge-retreat alternated by episodes of hinge-stability or hinge-advance. Hinge-retreat resulted directly from slab rollback processes, which provided space for the overriding plate to collapse into, ultimately leading to back-arc extension in the overriding plate. Phases of rollback of the Pacific slab accommodated opening of north-south to northwest-southeast trending back-arc basins in the Southwest Pacific (e.g. New Caledonia Basin, Loyalty Basin, South Fiji Basin, Lau-Havre Basin). In addition, Lord Howe Rise – Pacific plate rotation poles indicate that from 65 Ma to 52 Ma $\sim$150-300 km of spreading in the Tasman Sea was accommodated by convergence between the Lord Howe Rise and the Pacific plate, implying an additional component of east-directed rollback of the Pacific slab. The model thus predicts that in the Late Cretaceous to Early Eocene, the boundary between the Pacific plate and Australian plate was not a strike-slip boundary or an east dipping subduction boundary, as suggested in numerous other reconstructions, but a west dipping subduction boundary that was retreating eastward to accommodate opening of numerous basins in the overriding Australian plate. In the Early Eocene, the Pacific and Australian plates started

to converge and this convergence, as well as new episodes of east-directed rollback continued to be accommodated by the west-dipping subduction zone.

The reconstruction predicts that since 65 Ma, some 1950 km of Pacific lithosphere has been subducted due to east-directed rollback and some 2650 km due to Australia-Pacific plate convergence. Tomography across the subduction zone shows a slab penetrating to a depth of $\sim$1800 km and the geometry of the high-velocity zone implies a slab length of only $\sim$2600 km. This leaves at least $\sim$2000 km of slab unaccounted for, suggesting that the slab geometry in the lower mantle is not planar but more complicated, with severe folding of the slab. Such slab deformation is indeed predicted by fluid dynamic modelling of subduction at a time when the slab in the upper mantle starts to approach and penetrate into the lower mantle.