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Tomotectonic constraints on the Jura-Cretaceous assembly of the North American Cordillera, and a Southwest Pacific analogue

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We propose a fundamental revision of the Mesozoic paleogeography of western North America and discuss today's Southwest Pacific as a close analogue. Our tomotectonic analysis integrates the 3-D geometries of subducted lithosphere beneath North America, as imaged by seismic tomography down to ∼2000 km depth, with surviving Atlantic and Pacific seafloor isochrons (Sigloch & Mihalynuk 2013). This integration of geophysical observations infers evolving arc, trench, and plate geometries back to the breakup of Pangea. Its results do not support the mainstream tectonic scenario of uninterrupted, eastward, Andean-style subduction beneath the margin of western North American since 200 Ma. Instead, it hindcasts a vast archipelago of long-lived, intra-oceanic arcs in the Jura-Cretaceous seas west of Pangea, and a spatiotemporal sequence of arc overrides and (super-)terrane accretions by westward-drifting North America.

Initially these events involved only intra-oceanic and stationary trenches, including an eastward-dipping Farallon trench that subducted far offshore (contradicting the Andean-type margin commonly asserted). The "Mezcalera-Angayucham Ocean (MezAng)", abutting the temporarily passive margin of western North America, was subducted westward beneath the archipelago.to produce one of the most massive slabs in the mantle. It is a near-vertical wall that fills the mantle column from ∼1000-2000 km depth, and today strikes >10,000-km from Yukon to Nova Scotia and south to the Caribbean, directly mapping out paleo-trench lines. As North America rode into the archipelago, the intra-oceanic trenches were extinguished, flipped, and/or accreted over a time span of ∼100 m.y. (from ∼155 Ma to 55 Ma).

Cordilleran land geology is used as an independent test of these geophysically inferred events and confirms predicted arc and micro-continent collisions correlating with the Nevadan, Sevier, and Laramide orogenies. The starkest model prediction is a previously unrecognized, continent-spanning MezAng Ocean suture, which forms a track of at least 12 collapsed, Jura-Cretaceous basins from Alaska to Mexico (Sigloch & Mihalynuk 2017).

This revision of Cordilleran geology has a striking analogue in today's Southwest Pacific, an equally vast archipelago. Australia [analogue to North America at ∼120 Ma] is pulled into the SW Pacific archipelago by northward subduction of the Indian Ocean [analogue to Mezcalera Ocean] and the Coral Sea [Angayucham Ocean]. The trenches and arc (super-)terranes of Sumatra-Java, Papua-New Guinea, and the Coral Sea correspond to the MezAng trenches and terranes. On the other side of the archipelago, Pacific lithosphere [Farallon Ocean] subducts in the opposite direction. Australia [N. America] rifted from Gondwana [Pangea], opening the Southern Ocean [Atlantic]. Its collision with the Melanesian arc [Insular Superterrane] has created the Papuan fold-and-thrust belt [Nevadan & Sevier orogenies]. Tectonic loading of the continental margin forms the Arafura Sea/Gulf of Carpentaria [Cretaceous Western Interior Seaway]. We develop this analogue by by comparing geologic evidence from the two areas.

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