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The tectonic evolution of the western North American margin since the Devonian

Andres Felipe Rodriguez Corcho[1], Sabin Zahirovic[1], Michele Anthony[2], Dene Tarkyth[2], Christopher Alfonso[1], Maria Seton[1], Dietmar Muller[1], Bruce Eglington[3], and Basil Tikoff[4]

[1]University of Sydney, School of Geosciences, Australia
[2]BHP Billiton
[3]Department of Geological Sciences, University of Saskatchewan, Canada
[4]Department of Geoscience, University of Wisconsin-Madison, United States

The western North American margin records multiple phases of rifting and convergence, resulting from the interaction between western Laurentia, rifted continental fragments, and intra-oceanic terranes originating in the Panthalassa and Pacific oceanic plates. Quantitative plate reconstructions of this margin have prioritised diverging interpretations regarding the subduction polarities of eastern Panthalassa terranes during Jurassic to Cretaceous times. These discrepancies arise from the reliance on either seismic tomography or surface geology as the first-order constraint for determining subduction polarity. We present an updated tectonic reconstruction for western North America from the Devonian to present day. In this new model, we reconcile geological histories based on surface geology, geochronology, paleomagnetism and isotopic data, with interpretations of seismic tomography. The new reconstructions account for the tectonic evolution of the Alaska orocline, western Canada and western United States (US) and south-western (SW) North America, which have not been implemented in detail in previous tectonic models. Our model suggests that most of the terranes of western North America were rifted off Laurentia and Baltica during Devonian to Triassic extension and trench-retreat. Following back-arc rifting and opening, many of the terranes (e.g. Insular, Intermontane, Angayucham) experienced an intra-oceanic phase before accreting to the continental margin of North America at different times, between Early Triassic to Late Cretaceous times. The model illustrates the collision of the Angayucham Terrane, counterclockwise rotation and orocline formation in Alaska during the middle Jurassic. In western US and SW North America, the model showcases Jurassic to Cretaceous extension and rifting. Extension starts first in western US (170-145 Ma) and is then propagated south, causing the opening of the Bisbee Basin (161-105 Ma). The model also captures the Late Cretaceous collision of the Insular Terrane, which triggered transpression, terrane translation for thousands of kilometers and clockwise rotation in western US during Late Cretaceous to Paleogene times. Our updated model highlights the importance of surface geology in constraining the polarity of ancient subduction zones interpreted from seismic tomography.