Evidence for Slab Rollback, Back-Arc Rifting and Arc Dismemberment During Assembly of Western Laurentia

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The crystalline crust that underlies the Western Canada Sedimentary Basin in northern Alberta is composed of tectonic domains that accreted to the margin of the Archean Rae province of western Laurentia, ca. 2.1-1.9 Ga. Geophysical data indicate that the basement crust in this region hosts a vast, mid-crustal reflection sequence (Winagami Reflection Sequence) interpreted as an assemblage of mafic sills and an unusually wide domain of Paleoproterozoic magmatic arcs (Taltson Magmatic Zone). The latter are interpreted to have formed during Paleoproterozoic tectonic assembly through near-synchronous closure of small oceanic basins along subduction systems of opposing polarity. Here, we introduce a new tectonic model, which postulates that the Taltson Magmatic Zone represents collated fragments that formed within a single subduction system. Comparison with modern analogs suggest that observed temporal relationships and present-day configuration of Paleoproterozoic arcs can be explained by plate-margin processes of slab rollback and back-arc rifting. Our model is consistent with re-interpreted basement-drillcore petrology, provides a genetic link for the association between magmatic arcs and the Winagami sill complex, explains an extraordinary fit between aeromagnetically defined “conjugate margins” and provides a tectonic framework for the origin of the enigmatic low δ18O magmatic zone (Kimiwan anomaly) along the southern Chinchaga domain.