Ribbon tectonics: Ordovician and Silurian evolution of North Queensland.

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Models of the evolution of the eastern margin of Gondwana have largely been developed along the Lachlan Fold Belt and the southern New England Fold Belt. There is a convergence of models towards western Pacific style tectonics (Glen et al., 2010); although in detail there remains considerable debate about the details of the evolution and architecture. North Queensland also preserves an Ordovician to Silurian geological record of the eastern margin of Gondwana. However, despite existing along the same plate margin there have been difficulties in reconciling the geology and tectonics of North Queensland with the Lachlan Fold Belt to the south. This is in part attributed to the architecture of the Thomson Fold Belt, which is very different to that of the Lachlan Fold Belt, and the telescoping of geological terranes into relatively narrow tectonic belts. Andean-style subduction models have been favoured for North Queensland during the Ordovician and Silurian because of the presence of arc rocks and tectonic melanges proximal to stable continental crust (e.g., Henderson et al., 2010). Recent seismic surveys across North Queensland (Korsch et al., 2012) have shown that much of the basement to the east of the arc terranes is continental in origin, suggesting that a simple Andean-type subduction model needs to be readdressed.

We have developed a tectonic model that reconciles geological observation and the architecture of North Queensland during the Ordovician and the Silurian. The key elements of the model are:

1. Following the Delamerian Orogeny continental crust extended (see Fergusson et al., 2007) due to roll-back of a west-dipping subduction zone (ca 490-470 Ma). Two continental ribbons comprise deformed Delamerian basement blocks that were stranded in the back arc region. The ribbons are represented by the basement rocks of the Carboniferous Hodgkinson Province and the Barnard Province. Back arc extension was accompanied by the formation of oceanic crust (separating the continental ribbons) (e.g., Donaldsons Well Volcanic Member (Graveyard Creek Province), and deposition of the extensive turbidites of the Seventy Mile Range (Charters Tower Province) on a passive margin, the Judea Formation (Graveyard Creek Formation) onto an oceanic substrate, and the Pelican Range Formation and Wairuna Formation in the Camels Creek Province.

2. Ordovician subduction roll back also extended the basement rocks of the Thomson Orogen, resulting in a radial plate margin and whole scale re-orientation of Neoproterozoic arc rocks (Boukre arc, Warraweena Volcanics) high angles to the grain of the Lachlan Fold Belt. The Thompson orogeny represents highly extended continental back arc region.

3. Ordovician back arc inversion was accommodated by initiation of an east-dipping subduction zone beneath the Hodgkinson Province basement ribbon and west-dipping subduction between the Barnard and Hodgkinson Province. Development of the Lucky Springs Island Arc at ca 455 Ma (Everetts Creek Volcanics, Carriers Well Formation) occurred at the edge of the Hodgkinson Province.

4. Island arc accretion and collision between the eastern margin of Gondwana and the Hodgkinson Province basement ribbon occurred at ca 450-440 Ma. Collision resulted in the development of tectonic melange (Henderson et al., 2011) and the imbrication of the turbidite (Judea Formation) and oceanic substrate (Donaldsons Well Volcanics), and the Wairuna Formation. This zone of tectonic slicing is preserved in the Graveyard Creek and Camels Creek Provinces and represents the remnants of a suture zone.

5. Collision between the Barnard Province and the Hodgkinson Province was accommodated along the Russell Mulgrave Fault Zone, which we interpret as the suture zone. Oblique sinistral collision is interpreted to have resulted in the development of an oroclinal fault preserved in the Charters Tower Province.

6. Following the re-amalgamation of Delamerian continental ribbons onto the margin of Gondwana, renewed roll back resulted in extensive continental back arc basin development between ca 435 Ma and 370 Ma.

The model presented here is self-consistent with geological and geophysical data. The model suggests, like other regions along the Gondwana Margin, that SW Pacific style tectonics influenced North Queensland. The main difference is that roll-back driven extension resulted in the formation of several continental ribbons outboard of the margin.