Cambrian Rocks of the Takaka Terrane, the Foundation of Zealandia: A Complex Record of Subduction Initiation and Arc Development Exposed in the Nelson Area of the South Island

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The Takaka, Buller and their correlative terranes in Fiordland (Fig. 1) constitute the Western Province of New Zealand and the foundation of the Zealandia microcontinent (Rattenbury et al., 1998 and references therein). Some of the oldest, Middle Cambrian, rocks in the Takaka Terrane are the exhumed products of a marginal arc that can be linked to rocks of similar age and tectonic affinity in Antarctica, SE Australia, and Tasmania (e.g., Cooper and Tulloch, 1992; Munker & Crawford, 2000; Squire & Wilson, 2005; Gutjahr et al., 2006).

The Takaka Terrane (Fig. 2) includes an extensive record of arc-related low-K to high-K calc-alkaline volcanics (Devil River Volcanics Group, DRVG). A record of pre-DRVG arc sedimentary rocks (Junction Formation and the poorly-understood Heath Creek beds) and back-arc volcanic rocks (Mataki Volcanics, range from MORB to low-K arc; similar to modern back-arc tholeiites), are intruded by the boninitic Cobb Igneous Complex (Munker & Cooper, 1999). Boninitic clast-bearing conglomerates of the Heath Creek beds indicate a complex pre-DRVG history involving subduction. The DRVG is overlain by epiclastic volcanic and siliciclastic sedimentary rocks of the Haupiri Group (Pound, 1993). The Takaka Terrane units are now preserved in a series of fault-bounded slices where the bounding faults probably initiated as thrusts, but record a complex history of multi-phase reactivation (Pound, 1993; Munker & Cooper, 1999; Jongens, 2003; Jongens, 2006). The upper Middle Cambrian Lockett Conglomerate (Pound, 1993; Pound et al., 1993) was deposited across an evolving accretionary prism that included broken formation and diapiric intrusion of the Balloon Melange. All of the Cambrian units in the Takaka Terrane are present within the Balloon Mélange, which continued to evolve during the tectonic transition to passive margin sedimentation in the overlying Late Cambrian to Ordovician units.

What Aspects of the Evolution of the Early Paleozoic Part of the Zealandia Microcontinent are relevant to GeoPRISMS?

1. INSIGHTS INTO PROCESS OF SUBDUCTION INCEPTION AND TERMINATION - The oldest successions in the Takaka Terrane may provide a stratigraphic record of subduction inception, as well as arc and back-arc basin development. Sandstones of the Junction Formation and Heath Creek beds may be the detrital hallmark of rapid uplift and erosion associated with induced subduction similar to what has been predicted by geodynamic modeling and/or observed elsewhere in nascent forearc successions (e.g., Marsaglia, 2012; Rains et al., 2012).

There is potential for U-Pb and Lu-Hf work (detrital and tephra zircon dating) that will better define the relations between stratigraphic successions within the fault-bounded packages, as well as potential to constrain arc termination through evaluation of Haupiri Group conglomerates.

2. INSIGHTS INTO THE MAGMATIC/GEOCHEMICAL EVOLUTION OF ARC/BACKARC – New insights into the early history of pre-Devil River Arc evolution could be gained through use of analytical tools including the Lu-Hf system and systematic Pb isotope measurements, which could be used to address the origins and implications of the unusually radiogenic Pb compositions (Munker, 2000; Wombacher & Munker, 2000) of Takaka terrane rocks and arcs in general, and serve as a tool in paleogeographic reconstructions.

3. LARGER, GLOBAL IMPLICATIONS - PALEOGEOGRAPHIC RECONSTRUCTIONS OF LARGE/LONG-LIVED ACTIVE MARGINS – Insights into the temporal and and spatial variability in subduction-related segments at convergent margins can be gained at the Cambrian margin of Gondwana. The largely volcanic/sedimentary record of the Takaka Terrane has been linked to sequences in Tasmania and Antarctica, and a variety of plate models have been presented (Gutjahr et al, 2006; Munker & Crawford, 2000; Squire and Wilson, 2005), none of which have accommodated all of the geochemical, sedimentologic, stratigraphic and structural data available. Bradshaw et al. (2009) present a model correlating the Bowers Terrane of Northern Victoria Land with Takaka terrane rocks. Extensive work on Bowers Terrane rocks (references in Bradshaw et al., 2009) provides insights into Cambrian subduction-related processes at the Gondwana margin. There is potential for mapping, stratigraphic, sedimentologic, and geochemical work within poorly-understood units (e.g. Anatoki Formation; Christmas Conglomerate; Heath Creek beds) of the Takaka Terrane in order to better constrain correlations and models, and build understanding of Middle Cambrian subduction-related processes at the Gondwana margin.

4. INSIGHTS INTO THE LONGEVITY AND ROLE THAT FAULTS INITIATED DURING SUBDUCTION MAY HAVE HAD DURING SUBSEQUENT EVENTS – Faults initiated during subduction and arc development record multiple phases and senses of movement. Exhumed Takaka Terrane rocks provide a window into the partitioning of strain, and the evolution of fault geometries over time, including their role during the transition from subduction to extension. There is potential for further examination of these faults.

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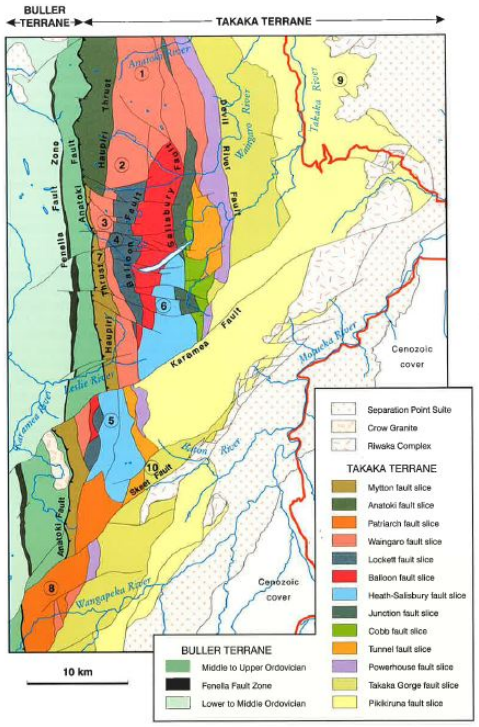

Figure 1

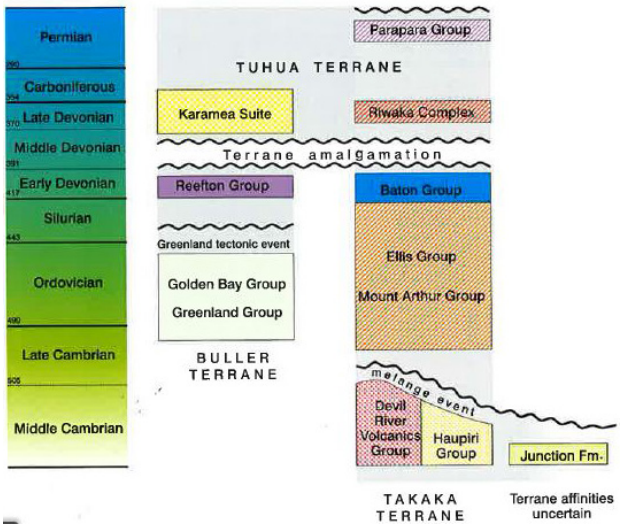

Figure 2

Figure 1. Map of northwest Nelson, showing distribution of Buller and Takaka Terrane rocks within fault-bounded slices (from Rattenbury et al., 1998, Fig. 16)

Figure 2. Major rock units of the Buller and Takaka Terranes of northwest Nelson (from Rattenbury et al., 1998, Fig. 10)