Crustal Evolution and Crust-Mantle Interaction in the Mount Isa Eastern Succession: *TerraneChron* Analysis of Detrital Zircons

E.A. Belousova[1], ebeloous@laurel.ocs.mq.edu.au, W.L. Griffin[1,2], S.G. Walters[1, 3], and S.Y. O'Reilly[1]

1: GEMOC ARC National Key Centre, Department of Earth and Planetary Sciences, Macquarie University, NSW 2109, Australia, www.es.mq.edu.au/GEMOC/; 2: CSIRO Exploration and Mining, P.O. Box 136, North Ryde, NSW 2113, Australia 3: GeoDiscovery Group, Level 1, 14 Primrose Street, Sherwood, Qld 4075, Australia.

The present study is a major 'proof of concept' demonstration of the *TerraneChron* application to a complex Proterozoic metamorphic terrane with proven metallogenic endowment. The Eastern Succession of the Mount Isa Inlier was selected due to its obvious importance as a host to the world-class Cannington Ag-Pb-Zn deposit and several Iron Oxide Cu-Au deposits (e.g. Ernest Henry, Eloise), and a significant existing SHRIMP database (Page and Sun, 1998).

Analysis of large numbers of zircon grains (over 500) obtained from detrital concentrates from the Eastern Succession of the Mount Isa Inlier generates U-Pb age spectra that are used to characterise fundamental terrane-scale events - sedimentary provenance, magmatic episodes, metamorphism and hydrothermal activity. *In situ* analysis of Hf isotopes in zircon using LAM-ICPMS techniques (Griffin et al., 2000) provides additional information on crustal evolution, analogous to that derived from whole-rock Nd-Sm systematics. The trace-element patterns of zircons reflect the rock type from which they crystallised (Belousova, 2000), and a relatively small number of trace elements provide a fingerprint that can be used to characterise original magma types. The combination of U-Pb dating, trace element signatures and Hf isotope systematics for individual zircon grains, enables more sophisticated resolution of 'Event Signatures' compared with that possible from U-Pb dating alone.

Modelling of the composite age spectrum derived from the detrital zircons allows definition of eight major Proterozoic geological events in the Eastern Succession, spanning the period 1400-1950 Ma. These correspond broadly to events recognisable in the existing SHRIMP database (Page and Sun, 1998). Combination of the Hf-isotope and trace element data with the age spectra provides a detailed Event Signature for the Eastern Succession (Fig. 1):

- There were four major stages of crustal evolution in the area: 2550-2330 Ma, 1950-1825 Ma, 1800-1600 Ma and 1590-1420 Ma.
- Each stage has a distinct pattern of crustal recycling and juvenile mantle input.
- Each stage, except the last, ended with a period of crustal homogenisation, which is reflected in the isotopic composition of magmatic rocks generated by crustal reworking in the succeeding stage.

Crust generated in Late Archean time was largely reworked during Early Proterozoic time (2330-2360 Ma). Within each of the next two stages, the importance of juvenile crustal generation, relative to reworking of older crust, increases with time, as does the degree of mixing between older crust and juvenile material (Fig.1). At the start of each succeeding stage, this mixed source provides most of the observed magmatic rocks. This pattern suggests that these two stages reflect increasing degrees of crustal extension through time, followed by orogenesis and physical mixing of crustal reservoirs.

It is not clear from this first study which aspects of this 'event signature' are critical to metallogenesis. More studies are required to create a 'library' of comparative signatures for known endowed versus barren terranes.

References

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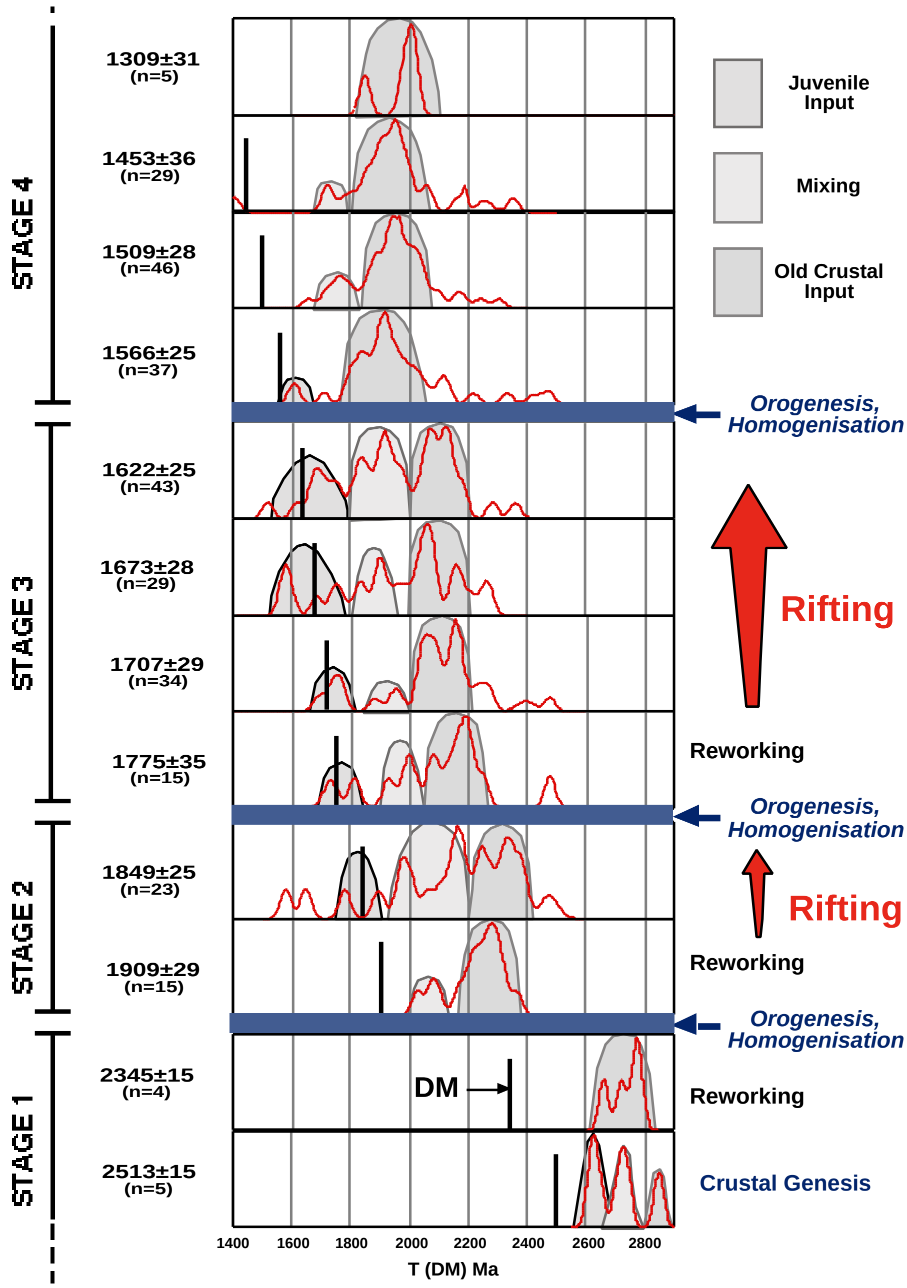

Figure 1. 'Event Signatures' at the Mount Isa Eastern Succession. The time slices determined by the zircon U-Pb dating are plotted against the $T_{(DM)}$ model ages, where DM represents the depleted mantle line. Age peaks are grouped into material derived from juvenile (depleted mantle) sources, reworked old crust and mixtures of both, for each period.