

Report of TNA no. 077-TNA3

Identifying magmatic sources during continental break-up in New Zealand

Project outline

The Western province of the South Island New Zealand represents a series of metasediments, plutons and accreted terranes formed in a long lived (Paleozoic-Mesozoic) subduction zone setting on the evolving active margin of the Gondwana supercontinent (Mortimer 2004). In the late Cretaceous, regional stresses changed to extension that would eventually lead to the breakup of Antarctica, Australia and New Zealand (e.g. Gaina et al., 1998). Various granitoids, trachyte dikes and tuffs (total of 10 samples) with previously determined ages ranging from 110 to 73 Ma (Tulloch et al., 2009, Waight et al., 1998, Muir et al., 1997, Tulloch & Kimbrough 1989, Tappenden 2003, unpublished data) have been selected for a detailed isotope analysis with a main focus on magmatic zircon. Among these samples is the 82 Ma French Creek Granite (Waight et al., 1998) that intruded at the same age as the first occurrence of oceanic crust between New Zealand and Australia. A comprehensive dataset of the zircon from each of the samples will be built up, consisting of in-situ analyses of U-Pb for age determination and O isotopes, Hf isotopes and trace elements as tools to assess the sources for the parent melt and the conditions of crystallisation. O isotopes have been analysed from Monday the 26th of November to Friday the 30th of November 2012 at CRPG in Nancy, funded by the Europlanet programme TNA no. 077-TNA3. The analyses of additional isotope systems and trace elements of the zircon will be done elsewhere.

Methods

As a part of the study, the $\delta^{18}\text{O}$ ($^{18}\text{O}/^{16}\text{O}$ in the sample minus that of SMOW oceanic sea water multiplied by 1000) in zircon from the selected volcanic samples were measured at CRPG as a proxy to terrestrial oxygen isotope fractionation of the zircon's parent melt. The selected material consists of handpicked zircon grains from the 10 selected samples, mounted in epoxy, polished and carbon coated at the Danish Geological Survey GEUS in Copenhagen. Prior to measurement with the ion microprobe, BSE images of the zircon grains were produced using the electron microprobe at the Department of Geosciences and Natural Resource Management, Copenhagen University. $\delta^{18}\text{O}$ measurements were carried out on the CAMECA IMS 1270 Multi Collector Ion Microprobe at CRPG Nancy by QM with the assistance of Denis Mangin, Claire Rouillon-Bard and Etienne Deloule, using a Cs ion beam. Measurement counting times were 2 minutes per measurement during which 30 blocks of measurements were acquired. Measurements are normalised by bracketing against the G91500 zircon standard included in the same mount.

Results

The acquired data shows variability between the different samples but any assessment of O isotopes alone would be very cryptic and could be misleading. The inclusion of precise age determination by U-Pb and characterisation by Hf isotopes to be done at a later stage will allow for further interpretation of the data.

Quinten H.A. van der Meer

Tod E. Waight

Department of Geosciences and Natural Resource Management, Copenhagen University

10-12-2012

References

Gaina, C., Müller, D.R., Royer, J.Y., Stock, J., Hardebeck, J., Symonds, P. 1998. The tectonic history of the Tasman Sea: A puzzle with 13 pieces. Journal of Geophysical Research 103, 12413-12433.

Mortimer, N. 2004. New Zealand's Geological Foundations. Gondwana Research 7, 261-272

Muir, R.J., Ireland, T.R., Weaver, S.D., Bradshaw, J.D., Waight, T.E., Jongens, R., Eby, G.N. 1997. SHRIMP U-Pb geochronology of Cretaceous magmatism in northwest Nelson-Westland, South Island, New Zealand. New Zealand Journal of Geology and Geophysics 40, 453-463.

Tappenden, V. E. 2003. Magmatic response to the evolving New Zealand Margin of Gondwana during the Mid-Late Cretaceous. Ph.D. Thesis Canterbury University, Christchurch New Zealand.

Tulloch, A.J., Kimbrough, D.L. 1989. The Paparoa Metamorphic Core Complex, New Zealand: Cretaceous Extension Associated with Fragmentation of the Pacific Margin of Gondwana. Tectonics 6, 1217-1234.

Tulloch, A. J., Ramezani, J., Mortimer, N., Mortensen, J., Van Den Bogaard P., Maas R. 2009. Cretaceous felsic volcanism in New Zealand and Lord Howe Rise (Zealandia) as a precursor to final Gondwana break-up. Geological Society of London Special Publications 321, 89–118

Waight, T.E., Weaver, S.D., Maas, R., Eby, G.N. 1998. French Creek Granite and Hohonu Dyke Swarm, South Island, New Zealand: Late Cretaceous alkaline magmatism and the opening of the Tasman Sea, Australian Journal of Earth Sciences 6, 823 - 835