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GEOCHRONOLOGICAL CONSTRAINTS ON THE METAMORPHIC EVOLUTION AT RUNDVÅGSHETTA, EAST ANTARCTICA (ABSTRACT)

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The highest grade rocks in the Lützow-Holm Complex of East Antarctica are exposed at Rundvågshetta, where peak pressures and temperatures are estimated to have reached ~10 kbar, >900°C (Y. MOTOYOSHI *et al*.; The 13th Symposium on Antarctic Geosciences, Programme and Abstracts, Tokyo, Natl Inst. Polar Res., 62, 1993). K. SHIRAISHI *et al*. (J. Geol., **102**, 47, 1994) report U/Pb SHRIMP zircon analyses from a garnet-biotite gneiss. Late Archaean-early Proterozoic ages from zircon cores were interpreted as detrital sedimentary ages, while rim overgrowths with a mean age of 521±9 Ma were regarded as the time of peak metamorphism. Further SHRIMP zircon analyses (this study) lend support to this interpretation, but provide additional information. Zircon separates from two metapelitic rocks (sample numbers R-125 and R-12) have been analysed. Both samples contain a primary metamorphic assemblage of garnet+sillimanite+orthopyroxene with secondary cordierite forming at the expense of garnet. Sample R-12 also shows cordierite+sapphirine+spinel symplectites around sillimanite.

All zircon grains were imaged by cathodoluminescence prior to ion probe analysis, revealing the presence of growth zones with distinct chemistry. Zircons from R-125 fall into two groups based on internal structure. Type I zircons contain cores which are often broken or corroded. These cores yield late Archaean-early Proterozoic ages and are best interpreted as sedimentary detrital zircon. Overgrowing these cores is a euhedral zone, characterised by high U contents (>1000 ppm) and very low Th/U ratios (<0.03). This generation of overgrowth, of probable metamorphic origin, yields a late-Proterozoic age, and has not been distinguished in previous work. A second generation of metamorphic overgrowth forms around the high U band. This second generation zircon has much higher Th/U (typically between 0.5 and 1.0), U contents between 100 and 250 ppm, and is comparable in age to the zircon rims dated by K. SHIRAISHI *et al*. (J. Geol., **102**, 47, 1994). Many grains also show a further narrow rim of zircon

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which is generally too narrow to analyse, and cannot be distinguished in age from the second generation overgrowths. The second type of zircon in R-125 forms equant, homogeneous grains, often with sector zoning. The chemistry (Th/U and U content) and age of these grains is indistinguishable from the second generation overgrowths in type I zircons.

Sample R-12, despite being a similar rock composition to R-125, shows a very different, and much simpler zircon population. All zircons analysed from R-12 are unstructured, unzoned and form a single late Proterozoic-early Cambrian age population, corresponding to the second generation overgrowths in R-125. These grains have a low U content (typically ~50 ppm) and Th/U in the range 0.25–0.5. No detrital cores have been recognized in zircons from R-12.

Several questions are raised by these results;

1) why does R-12 lack detrital zircon, and fail to show evidence of the early stage of metamorphic zircon growth seen in R-125 ?

2) do the two phases of metamorphic zircon growth seen in R-125 represent two distinct thermal/metamorphic events, or

3) are they the result of a single, prolonged *P-T* cycle, during which zircon growth is episodic and controlled by subtle changes in local chemistry (possibly the result of contemporaneous reactions amongst primary metamorphic assemblages).

Answering these questions is central to the interpretation of zircon ages in all high-grade terrains and the subject of ongoing work.

Despite the current uncertainty in interpretation of the results presented above, the conclusion that high-grade metamorphic conditions prevailed at Rundvågshetta at around 550 Ma is inescapable. When considered in combination with K/Ar and $^{40}Ar/^{39}Ar$ ages (see G.F. Fraser and McDougall; Proc. NIPR Symp. Antarct. Geosci., **8**, 137, 1995), this age allows us to constrain the rate of cooling following high-grade metamorphism. Biotite from a biotite gneiss at Rundvågshetta yields a K/Ar age of 516 ± 5 Ma, and a $^{40}Ar/^{39}Ar$ age spectrum suggestive of gradual closure to argon diffusion over the period from 525–500 Ma. These results suggest that the region cooled below ~300°C (closure temperature for argon in biotite) by about 516 Ma. Assuming a temperature of ~900°C (as estimated by Y. Motoyoshi *et al.* (The 13th Symposium on Antarctic Geosciences, Programme and Abstracts, Tokyo, Natl Inst. Polar Res., 62, 1993) for the period of zircon growth at ~550 Ma, the biotite cooling age would suggest an average cooling rate of ~15°C/Ma. For realistic geothermal gradients, cooling of the terrain to <300°C requires considerable uplift from peak metamorphic pressures of ~10 kbars. For example, assuming an upper crustal gradient of 30°C/km implies a maximum pressure constraint of 3–4 kbars at ~516 Ma. However, it is not yet clear whether the ~550 Ma period of zircon growth represents peak pressure conditions, or some stage during the decompression history, therefore it is not possible to confidently constrain the rate of exhumation.

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