Probing the 'Zircon Zip': Geochronology (FT and SHRIMP)

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SUMMARY

Zircon megacrysts are associated with gem ruby-sapphire deposits along a 12 000 km long zone, from eastern Australia in the south, through South East Asia, to far eastern Russia in the north. Representative zircons were studied from some 6 sites along this zone. This is just a small part of a much broader ongoing study of this zone whose occurrence must be due to some fundamental plate tectonic process.

The time relationship between zircon crystallisation at depth, and transport to the surface via basaltic magmas was studied using zircon FT, U-Pb zircon SHRIMP techniques, and published basalt ages. The results show that for some fields, zircon crystallisation and transport to the surface were almost coeval events, whilst for others, zircons crystallised as much as 200 Ma before later transport.

Key words: Zircon, megacrysts, FT, SHRIMP

INTRODUCTION

Large zircon megacrysts to several cm are associated with gem sapphire-ruby deposits, either within or derived from intraplate alkali basalt fields. They represent corroded 'xenocrysts', transported to the surface by basaltic eruptives from underlying continental or sub-continental regions. Only rarely do zircon ± corundum-bearing xenoliths occur within these fields to provide direct evidence of the possible sources. Thus indirect evidence of possible sources are needed, mainly utilising geochemical and geochronological investigations of zircons and corundums. Within these fields, the zircons occur as both discrete megacrysts and as mineral inclusions within the corundums. These zircons represent mostly magmatic and some metamorphic crystallisations.

The greatest regional expression on earth of the zircon ± corundum/basalt association is within the Cenozoic intraplate basaltic belts that follow the Indo-Pacific continental margins, from eastern Australia in the south, through South East Asia, then north into China and far eastern Russia. This 12 000 km long zone is termed 'Zircon Zip' (ZZ) for convenience. This talk presents preliminary geochronological (zircon FT and SHRIMP) results from an ongoing study of the zircon-corundum deposits located along the Zircon Zip.

METHOD AND RESULTS

To date, zircon megacrysts from 6 sites have been studied in detail (using cathodoluminescence imaging, LA-ICPMS analysis, zircon fission track dating, and U-Pb zircon SHRIMP dating). The sites are: Weldborough, NE Tasmania; Yarrowitch, NE NSW; Mount Mclean, far north Queensland; Dak Nong, southern Vietnam; Ban Huai Sai, Laos; and Podeglbanochny volcano, Primorye, far eastern Russia.

The FT dating (Geotrack International, Melbourne) was conducted to investigate any thermal resetting in relation to the host volcanics. CL imaging combined with U-Pb zircon SHRIMP dating (both done at the Research School of Earth Sciences, Australian National University) were used to determine the zircon crystallisation ages and to detect any earlier inherited cores or later metamorphic overgrowths.

The results (Table 1) show that:

- Most of the zircon megacrysts contain well-developed magmatic oscillatory growth zonation (Fig. 1), though some have more complex sector zonation.
- There is no evidence of any earlier inheritance or later metamorphic overgrowths.
- Most zircon crystallisation ages (except for Weldborough and Mount Mclean fields) are close to the age range of the host basalt sequence.
- The Weldborough field contains two distinct zircon crystallisation events (Early Triassic and Cenozoic), yet only one FT Cenozoic age. This suggests a considerable residence time in the source region (at least 200 Ma) for the oldest zircons, before transport to the surface by basaltic magmas in the Cenozoic.
- Based on known basalt and FT dating, the Yarrowitch field zircons crystallised prior to their host basaltic eruptives, but were transported to the surface over a wide time interval from 62 Ma to as recently as 2.7 Ma ago. This is similar to the Barrington field, some 75 km to the south.
- Zircons from Mount Mclean had a residence time of ~ 20 Ma in their source region before transport to the surface in basalts at ~ 4 Ma ago.
- The Dak Nong and Podgelbanochny zircon crystallisation and transportation to the surface via basaltic magmas were almost coeval events, and associated with the latest basaltic volcanism in these regions.

- Zircons from Ban Huai Sai span a similar range in FT and SHRIMP ages, though both are older than the dated associated basalts. This suggests almost coeval crystallisation and transport to the surface in basaltic magmas which have since eroded away.

CONCLUSIONS

Zircon megacrysts from the intraplate Cenozoic basaltic fields of the West Pacific continental margins have complex time relationships between the age of zircon crystallisation and transport to the surface via basaltic magmas. Combined FT and U-Pb zircon SHRIMP studies are needed to determine these age relationships. The lack of earlier inheritance and oscillatory magmatic growth zoning suggests that many of these zircons crystallised from a melt, and did not involve either crustal melting or assimilation. Combined with geochemical studies (see Sutherland *et al.*, this volume), this work gives us valuable insights into intraplate magmatic processes and the nature of the underlying sub-continental lithospheric mantle of the West Pacific continental margins.

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Field	FT age (Ma)	SHRIMP age (Ma)	Basalt age (K-Ar or Ar-Ar)
Weldborough	47 – 46	249 (most grains) 46 (one grain)	47 – 46
Yarrowitch	62, 55, 40, 2.7	66 – 60	58 – 46
Mount Mclean	4.4	24	3.8 – 3.6
Dak Nong	1.1	0.9 – 0.1	7.1 – 1.1
Ban Huai Sai	4.3 – 2.4	4.09 – 3.3	2 – 1
Podgelbanochny	12.1	11.6 – 11.1	13 – 11

Table 1. Zircon FT and U-Pb SHRIMP ages of zircon megacrysts along with host basalt ages.

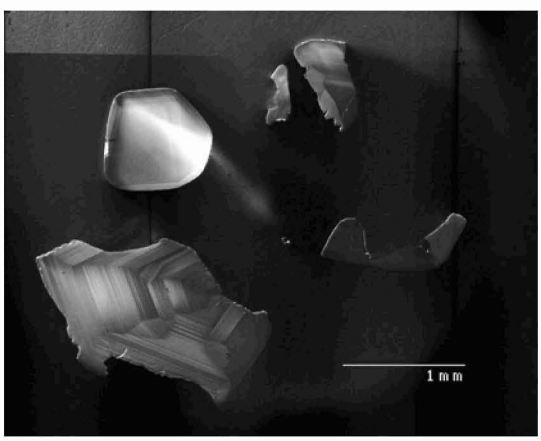

Figure 1. Cathodoluminescence image of zircon megacrysts from the Yarrowitch field, NE NSW.