Nuclear microprobe age mapping of monazite in-situ

D.X. BELTON[1,2], B.I.A. MCINNES[1], C.G.RYAN[1]

[1] CSIRO Exploration and Mining, Melbourne, Australia; David.Belton@csiro.au

[2] ARC Centre of Excellence in Ore Deposits, CODES, University of Tasmania, Hobart, Australia.

U-Th-Pb age mapping of monazite by nuclear microprobe combines the flexibility of chemical dating and the low detection limits for trace elements, with the precision of micron-scale spatial resolution. This approach to in-situ analysis of thin-sections and polished slabs means that analyses retain the geological context of the dated grains and simultaneously provides us with a detailed picture of the temporal and chemical/mineralogical evolution of the sample.

While the age mapping approach has its origins in the EMPA community [1] the nuclear microprobe, by virtue of its much higher energy beam (2-3MeV protons), has several advantages over conventional electron microprobe analysis. The high count rates inherent in PIXE analysis ensure significantly lower detection limits which, in the context of chemical dating, allow us to date younger samples. From an analytical point of view, the higher count rates provide additional benefits. First, they allow faster imaging – a sample that may require 12 hours to acquire sufficient counts under an electron beam can be collected in about 1 hour using protons. Second, higher count rates ensure greater precision of analysis and result in smaller errors in the age determination [2].

The use of 2MeV protons significantly reduces the penetration of protons into this high density mineral, and minimises interference due to variation in composition with depth. Because of the lower background in PIXE data, we used the U*L*, Th*L* and Pb*L* spectra in the age determination. This reduces the amount of overlap and interference encountered at lower energies in the x-ray spectrum. While collecting data on the parent and daughter products needed for calculation of a two dimensional age map, the nuclear microprobe simultaneously collects a suite of trace elements. These include a number of the rare earth elements since these can be readily collected at still higher x-ray energies (eg. La, Ce, Nd, Sm $K\alpha,\beta$ peaks) thus reducing potential peak overlaps.

Our nuclear microprobe age mapping results show considerable promise as a routine application in the combined fields of geochronology, petrology and structural geology where timing is vital to understanding the development and implications of minerals and textures.

[1] Goncalves P., Williams M.L., Jercinovic M.J. *Am. Min* **90**, 578-585 (2005),

[2] Mazzoli C., Hanchar J.M., Della Mea G., Donovan J.J., Stern R.A. (2002) *Nucl. Inst. and Meth.B* **189**, 394-399.