Geophysical Research Abstracts, Vol. 8, 08528, 2006
SRef-ID:

In-situ U-Pb dating of titanite, allanite and xenotime overgrowths on zircon in polished thick section by quadrupole LA-ICP-MS

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Advances in micro-sampling of accessory phases used for U-Th-Pb geochronology have led to increasing acknowledgement of the complexity of age information within minerals such as zircon. However, this information, if accurate and precise, can be most instructive for interpreting complex geologic processes, if it can be satisfactorily related to the petrogenesis. Zircon is often not the mineral of choice for dating rocks with a complex evolution despite its very high closure temperature for the U-Pb system ($>900^{o}$C), since it is usually a minor phase and extremely difficult to relate to the reaction history of the rock. Minerals that are more instructive in this sense are titanite and allanite, which are relatively more abundant in many geologic environments, often form larger crystals and have a relatively high closure temperature for the U-Pb system (650-700^{o}C). Here we describe a technique for obtaining accurate and precise U-Pb age data from small (as low as 25 X 40 μm^{2}) areas within titanite and allanite crystals by LA-ICP-MS in polished thick sections. The major problem with these minerals is that they can incorporate up to ppm levels of common (non-radiogenic) Pb into their lattice during growth, and so the necessity of an accurate common Pb correction scheme is paramount. This problem is reviewed and we show how we deal with this through combined use of a ^{204}Pb based correction and a ^{207}Pb based (mathematical) correction. We will show specific examples from the economically important metallogenic region (iron oxide – copper – gold) of northern Sweden and highlight how this technique can be applied to extremely complex crystals to delineate processes occurring in the Paleoproterozoic Era (2500-1600 Ma ago), which have not hitherto been recognised by conventional multi-crystal U-Pb dating techniques. A further area

of interest is dating low-temperature processes that are usually difficult using zircon as a geochronometer. Recent work by ion-microprobe on xenotime overgrowths on zircon has been extremely successful in dating authigenic growth in sandstones and hydrothermal flow in hydrothermally altered rocks. Here, we extend the capabilities of LA-ICP-MS further by dating similar sized overgrowths in polished thick section within a Neoproterozoic hydrothermally altered carbonatite dyke from Namibia. We demonstrate that we can achieve meaningful data using laser beams c.9μm in diameter and line rasters c.18μm long, which is competitive with ion-microprobe techniques.