Improved U-(Th)-Pb dating of monazite by ion microprobe: Correcting for an isobaric interference of PrP0$_4$ on ^{204}Pb

DAVID R. NELSON[1] AND ANDREAS MÖLLER[2]

[1]Department of Applied Physics, Curtin University, Bentley 6102, Australia (d.nelson@info.curtin.edu.au)
[2]Institut f. Geowissenschaften, Univ. Potsdam, D-14776 Potsdam-Golm, Germany (amoeller@geo.uni-potsdam.de)

High U and Th abundances, resistivity to diffusion and resilience to weathering make monazite one of the most important minerals for U-Th-Pb dating. Chemical characteristics (e.g. Y content, REE pattern) can be used as indicators of monazite growth reactions, and allow correlation of age data with metamorphic, magmatic or hydrothermal processes.

It has been noted that ion microprobe analysis of Th-rich monazite can yield discordant Pb-U and Pb-Th dates (e.g. Stern & Berman 2000; Zhu & O'Nions 1998), or may show excess scatter on the ^{207}Pb/^{206}Pb dates. Both effects compromise the analytical accuracy and the geological interpretation. These effects may be attributable to matrix effects, i.e. subtle crystallographic differences may result in different ablation and Pb/U characteristics of unknowns and the monazite inter-element fractionation standard used during SIMS analysis. In comparison to zircon, commonly occurring monazite cover a much wider range of chemical compositions.

To evaluate the effects, we have systematically studied a suite of monazite reference materials with a range of chemical compositions, from the brabantite (CaTh(PO$_4$)$_2$) as well as the huttonite (ThSiO$_4$) solid solution series, and with varying Yttrium content. Independently determined age data exist for all these materials from TIMS measurements.

We propose that the observed excess scatter on the ^{207}Pb/^{206}Pb ratios results from an isobaric interference of PrP0$_4$ on ^{204}Pb that has so far been ignored in ion microprobe data reduction and correction procedures. Using a correction based on the La/Ce counts, routinely measured in monazite analytical session on SHRIMP, and extrapolating to Pr, a correction can be applied before further corrections for Th-related "excess ^{204}Pb are applied. Our correction routine has been built into the recent version of CONCH, a visual Basic program for processing of ion-microprobe analytical data developed by Nelson (2006).

References
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Surface complexation modeling of the adsorption of both arsenate and copper to the surface of goethite

H. NELSON, S. SJÖBERG AND L. LÖVGREN

Department of Chemistry, Umeå University, SE-901 87 Umeå, Sweden (hanna.nelson@chem.umu.se)

To understand the migration and mobility of pollutants in soils, it is important to have knowledge about the sorption processes at the mineral-water interface. Adsorption of metals and ligands to mineral particles in aqueous solution can be described as the formation of surface complexes at specific surface sites. In complex, competitive, multicomponent systems, surface complexation modeling can be a good tool to predict ion adsorption and complex formation. The models are valid over a broad range of pH values and reactant concentrations, provided that they are established using an extensive set of experimental data. Adsorption processes in ternary systems with a mineral phase, a metal ion, and an inorganic anion have seldom been treated using surface complexation modeling.

The focus in this study is the ternary arsenate-copper-goethite system. Goethite (α-FeOOH) is an iron oxyhydroxide that is common in soils and plays a major role in the speciation of metals and (in)organic anions.. Arsenate and copper are components of a wood preserving liquid that has contaminated soils at many sites. Since the two pollutants are emitted simultaneously it is important to study how their coadsorption onto soil minerals impacts their speciation.

Surface complexation models for the ternary arsenate-copper-goethite system and the copper-goethite and arsenate-goethite subsystems will be presented. The surface complexation modeling is based on results from potentiometric titrations, adsorption experiments and spectroscopic data. The Basic Stern Model, together with the concept of charge distribution, is used to adjust for the distribution of charge between different planes at the goethite surface.