# Trace element analysis and dating of monazite single grains by XRF milliprobe: Quick, cheap, simple

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Single grains (crystals) of monazite (Ce,La..)$PO_4$ are micro objects with size varying from 0.05 mm to 0.5 mm and mass from n·0.1 mkg to n·100 µg. Monazite are known as relatively stable in sedimentary environments and their detrital population could reflect the provenance. Such techniques as LA-ICP-MS, EMPA and SIMPS have good analytical characteristics (low detection limits, high precision and spatial resolution) and usually are applied. But they require expensive hardware and time-consuming sample preparation. This paper presents a new promising technique - XRF milliprobe of single grains (XRF MP/SG) for analysis of monazite trace elements (Sr, Y, Pb, Th, U), and chemical U-Th-Pb dating obtaining in a great number of such grains within a real time. It was designed with two thin X-Ray beams from two independent X-ray tubes, which irradiate the sample by turns. The beam of first tube (Mo anode) is monochromatic by cylindrical crystal-monochromator (LiF, plane 200) for MoKa line, the beam of second tube (Fe anode) is filtered by different changing filters. Both of beams are collimated to diameter 0.5 mm. Characteristic X-ray of a sample is detected by energy-dispersive spectrometer with Si(Li) detector cooled by liquid nitrogen. Detection limits in zircon, monazite for grains with masses 1-10 mg are as follows: Sr,Y – 5-10 ppm, Pb,Th,U – 10-20 ppm. The statistical uncertainty is defined by counting statistics in peak of element analytical line. In the fixed conditions of measurements it depends on weight of grain, concentration of the elements and analyses time.

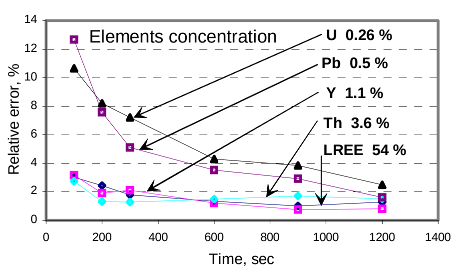


**Figure 1**: Experimental statistic uncertainty of fluorescence intensity for monazite grain (mass 0.46 mkg, ball diameter 0.054 mm).

The systematic dependence between intensity of fluorescence being registered from the grain and mass, form of the grain is calculated.

The method is absolutely non-destructive, small grain can be repeatedly measured for improved statistics (and improved age precision), thus providing a possibility of analysis by other method.

# Trees and weathering: Insights from root-mineral contacts

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Over geologic time scales atmospheric $CO_2$ levels are controlled by the feedbacks and processes of the long-term carbon cycle. One poorly understood aspect of this cycle is the impact of the evolution of large vascular plants (trees) and their role in acclerating silicate weathering. In particular, differences in weathering between gymnosperms (Paleozoic origin) and angiosperms (Mesozoic origin) still need to be unraveled as they may play a critical role in the regulation of atmospheric $CO_2$ in the Mesozoic. Differences in nutritional requirements, seasonal shedding of biomass, extent of association with ectomycorrhizal fungi, and associated microbial and terrestrial burowing organisms are potentially responsible for these differences in weathering impact on soil and bedrock silicate minerals. However, the actual impact of the different trees and associated ecologies remains to be elucidated. Sensitivity analysis of the the GEOCARB model of Phanerozoic atmospheric $CO_2$ (BERNER and KOTHAVALA, 2001) indicates that even small differences in rates of weathering between the two tree types may have a significant impact on the evolution of Mesozoic $CO_2$.

To address this issue, this study focuses on soil cores collected along transects of small groves containing both angiosperms and gymnosperms in the Cascade Mountains of Washington State. These cores were carefully collected and preserved in epoxy with minimal disturbance to the samples. Root-mineral contacts and the spatial geometry of roots and soil particles were successfully captured in the epoxied core sections. Qualitative differences in these cores are observed both along the transect (corresponding to nearest tree type) and with depth in individual cores. Weathering intensity is greatest both near the surface (all cores), with soil particles coarsening with depth, and in proximity to the gymnosperms. Quantitative differences in the root-rock reaction zones will be directly evaluated using the electron microprobe to observe any mineral alteration near roots, as well as overall chemistry and petrology of the soils on a fine scale. This unique snapshot of the complex interactions between tree roots and their host soil mineralogy provides insight into the impacts of different tree types on silicate weathering.

## References

Berner R. A. and Kothavala Z. (2001) *Am. J. Sci.* **301**(2), 182-204.