Radiation damage, internal textures and post-growth history of the Plešovice zircon standard

N. NORBERG[1], L. NASDALA[1], J. KOSLER[2], J. SLAMA[2,3], J. GÖTZE[4] AND N. GROSCHOPF[5]

[1]Institut für Mineralogie und Kristallographie, Universität Wien, Austria (nicholas.norberg@gmx.at; lutz.nasdala@univie.ac.at)
[2]Dept. of Earth Science, University of Bergen, Norway (jan.kosler@geo.unib.no)
[3]Dept. of Geochemistry, Charles University, Prague, Czech Republic (slama@natur.cuni.cz)
[4]Institut für Mineralogie, TU Bergakademie Freiberg, Germany (goetze@mailserver.tu-freiberg.de)
[5]Institut für Geowissenschaften, Johannes Gutenberg-Universität Mainz, Germany (groschop@uni-mainz.de)

We have studied internal textures and the post-growth history of accessory zircon crystals from a granulite near Plešovice, southern Czech Republic. This zircon has recently been proposed as a new reference material for determination of U-Pb ages using the laser-ablation inductively coupled plasma mass-spectrometry (LA-ICP-MS) technique (Slama *et al.*, 2006). Extraordinary properties of the Plešovice zircon include its uniform, concordant U-Pb age, relatively high U concentrations (>600 ppm), homogeneous Hf isotopic composition, and its availability in a large quantity.

In spite of its isotopic homogeneity, the Plešovice zircon shows heterogeneous incorporation of trace elements. Typically there is strong primary zonation, including both oscillatory growth zoning and sector zoning. About 10% of the grains show sectors (corresponding to the growth of pyramid faces) that are particularly rich in actinides; here U content may be as high as 3000 ppm. Those sectors are easily recognized, e.g., from particularly high BSE intensities. The Plešovice zircon is in general moderately radiation-damaged whereas the high-U sectors are strongly metamict. All areas are roughly as radiation-damaged as it would correspond to U and Th concentrations and an assumed accumulation of radiation damage since the time of Variscan zircon growth (cf. Nasdala *et al.*, 2001), which excludes any major thermal annealing event. Heterogeneous metamictization has resulted in zoned fracturing; fractures have been filled with secondary phases such as Fe hydroxides. First LA-ICP-MS U-Pb analyses of high-actinoide micro-areas turned out to be most difficult and unreliable. Consequently, these areas need to be avoided in using the Plešovice zircon as a U-Pb standard material.

References

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Geochemical meddling, microbing, Marsing, and mitigating mine drainage

D. KIRK NORDSTROM

U.S. Geological Survey, 3215 Marine St., Boulder, CO 80303 USA

Acid mine drainage (AMD) and acid pit lakes, for all their ugliness and environmental damage, provide opportunities for scientists and engineers to test their skills, push the frontiers of their research, and make a contribution to the remediation. Extreme environments such as the Rio Tinto mining district, Spain, have become favorite sites for both researchers and tourists because of the presumed analogy to the Martian surface. Rio Tinto and Iron Mountain, California, USA have also been a major focus of microbial research. The production of AMD is a complex hydrobiogeochemical process that is much better understood today because of sustained research in the fields of geology, hydrology, geochemistry, and microbiology. Mine-site remediation cannot proceed effectively without the combined expertise from these fields. Further, the most cost-effective remediation benefits from an independent technical oversight committee with such expertise.

We now know that pyrite oxidation can create waters of negative pH, that mine plugging is often an ineffective remediation method, that microbial catalysis of pyrite oxidation involves a community structure including, but not limited to, *Acidithiobacillus*, *Leptospirillum*, *Ferroplasma*, and heterotrophs, that surface-water contaminants are attenuated and can be modeled, that dynamic rainstorm events can cause increases in concentration destroying aquatic life, that remediation scenarios can be evaluated before executing, and that the collaboration of scientists and engineers working together on remediation is far better than just engineers working alone. Research papers on sulfide mineral oxidation and mine-site characterization have proliferated over the last two decades. We also know much more about the processes (dissolution rate, solubility, sorption) controlling concentrations of Ca, Mg, Fe, Al, Mn, Cu, Zn, Pb, and Cd in surface and ground waters.

A technical issue that still needs attention is the hydrogeological characterization of mined sites. However, our scientific understanding of acid mine drainage systems has advanced to the point where incorporation of applicable research into mine-site remediation as standard practice, communication of useful research to policy makers and project site managers, and communication of information that bears on risk assessment to project managers and the affected public, can make a substantial contribution to mine-waste management.