Possible Pb isotopic heterogeniety in chalcopyrite & magnetite- implications for Pb-Pb step-leaching

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Pb-Pb step-leaching (PbSL) is a geochronological tool aimed at unmixing the common and radiogenic Pb components present in low-U minerals, using sequential leaching with a range of acids. Frei & Kamber [1] showed that this approach can produce highly correlated Pb isotope unmixing arrays with age significance for a number of low-U silicate minerals, and thus provide a new single mineral dating tool for assemblages normally unfavourable for U-Pb dating. Studies on titanite suggest that Pb isotopic unmixing involves two main processes: (1) surface/crystallographic site dependent hydrolysis of metal cations; (2) progressive mobilisation of Pb isotope components from the leached gel-like structure. During progressive leaching radiogenic Pb is removed at a different rate to common Pb, resulting in an effective separation of common and radiogenic Pb in sequential leach steps [1]. Initial studies produced reliable dates for silicates and mixed sulphides, however there is some conflict surrounding the validity of the PbSL isochrons, with some authors claiming that isochrons might be the product of initial Pb heterogeneity and/or Pb mixing due to post crystallisation U or Pb introduction. Many potential mechanisms produce linear isotope arrays during PbSL, these include selective Pb removal from high- and low-U domains in strongly zoned minerals, admixture of radiogenic Pb from U-rich impurities trapped during host mineral formation (e.g. monazite, zircon) or post-crystallization contamination along cracks, surfaces and cleavage planes. Clearly, whether or not linear arrays produced via PbSL have age significance will depend upon which of these processes is involved. This is usually difficult to determine.

This study tests the utility of PbSL in directly dating well-constrained hydrothermal chalcopyrite and magnetite and, with the use of LA-ICPMS, examines the possible sources of radiogenic Pb.

References

[1] Frei R., and Kamber B.S. (1995) Single mineral Pb-Pb dating. Earth and Planetary Science Letters, **129**, 261-268.