U-Th-Ba elemental fractionation during partial melting of crustal xenoliths and its implications for U-series disequilibria in continental arc rocks

RAUL BRENS*[1] AND ROSEMARY HICKEY-VARGAS[2]

[1]Earth & Environment, Florida International University, Miami, FL, USA. (*correspondence: RaulJr00@hotmail.com)
[2]Earth & Environment, Florida International University, Miami, FL, USA. (hickey@fiu.edu)

Understanding U-series isotopic disequilibria of partially melted crust is integral for determining the effect crustal assimilation has on the U-series signature of magmas. The U-series isotopes are too low in abundance to determine by any microbeam technique. Therefore, in this work, U, Th and Ba (as a proxy for Ra) elemental abundances were gathered on the quenched glass in partially melted crustal xenoliths of granitic composition using microbeam techniques. The crustal xenoliths, which are from basaltic volcano Mirador in Chile, are old (Miocene), and can be assumed to be at secular equilibrium, whereas melting occurred during eruption of Mirador in 1979. Any recent fractionation of U from Th or Th from Ra (Ba) by partial melting will result in isotopic disequilibrium. A comparison of the ratios Ba/Th and U/Th in the partial melts with those of the whole rock reveal how much fractionation has occurred during partial melting.

An EPMA was used to locate and analyze glass pockets in the samples, through BSE images. Laser ablation ICP-MS was used to analyze U, Th and Ba in the quenched partial melts and solution ICP-MS was used for the whole rocks.

The SiO_2 content in measured glass samples was between 54% and 75%, Al_2O_3 (13% - 27%), K_2O (0.2% to 7%). Measured Ba/Th (glass/whole rock) are between 0.2 to 51 and Th/U (glass/whole rock) range from 0.3 to 7, with the majority Ba/Th between 1 to 51 and Th/U 0.3 to 1. Different ratios of U, Th and Ba compared to the whole rock substantiate fractionation via partial melting. Thus, assimilation of partial melts of crust can play a role on U-series isotopic disequilibria, which is commonly observed in continental arc magmas. Accessory minerals show variable effects as 'restite', with allanite having a large Th excess and zircon having U excess, these are foremost accessory minerals responsible for the fractionation. Potential U-series disequilibria impacts on magma through melt extraction from country rock or incomplete homogenization during assimilation is discussed.

Mineralizing fluids of the barite-fluorite mineralization at the S edge of the Thuringian Basin, Germany

M. BREY[1], J. MAJZLAN[1], R.J. BAKKER[2] AND W. PROCHASKA[2]

[1]Friedrich-Schiller Universität, Institut für Geowissenschaften, Burgweg 11, D-07749, Jena, Germany (maria.brey@uni-jena.de)
[2] Department Applied Geosciences and Geophysics, Montanuniversity, 8700 Leoben, Austria

Numerous small deposits and occurrences of barite-fluorite mineralization are developed along the southern edge of Thuringian sedimentary basin. It is a series of Upper Permian and Triassic strata (Zechstein, followed by Buntsandstein, Muschelkalk, and Keuper). The Tertiary tectonic activity uplifted the marginal portions of the today's basin where the pre-Permian rock complexes are exposed. The studied mineralization consists mostly of barite, calcite, dolomite, and locally quartz for Kamsdorf and mostly of barite and fluorite in Trusetal and Gehren. The primary fluid inclusions in barite from Kamsdorf show a wide range of salinities between 8-22 wt% $CaCl_2$ eq, the primary inclusions in fluorite from Gehren and Trusetal have about 24 to 27 eq wt% $CaCl_2$ eq. Th measurements range between 85°C to 160°C in barite and between 80°C to 130°C in fluorite. Chemical analysis of fluids extracted from fluid inclusions in fluorite and barite show compositions dominated by Na and Ca. The Cl/Br ratio in the fluorite samples is 260-340 and in barite between 150-240, always lower than in seawater (650). Raman analyses of the vapor phase inside an inclusion suggest traces of N_2 in fluorite and CH_4 in barite. Fluorite samples were analysed for rare-earth elements and two types of REE distribution patterns were found. Type 1 is characterized by high amount of light REE without any Ce anomaly and a steep decrease towards Lu. Type 2 has significantly lesser amount of LREE, a weak Tb/Dy anomaly, and a depletion in HREE. The most fluorite samples belong to the type 2.

The paragenesis of the primary minerals and the physical-chemical properties of the fluids can be explained by large-scale fluid circulation and mixing at the edge of the Thuringian basin and the adjacent Variscan crystalline basement, mostly likely during the late Mesozoic.

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