Barium Isotope Fractionation during Subduction Zone Processes

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Terrestrial fractionation of barium (Ba) stable isotopes in nature and their analyis by MC-ICPMS have recently been developed as a new geochemical proxy. The few studies reporting data on natural samples have focused on the use of Ba isotopes as proxy for marine processes such as watermass mixing [1,2]. Published data for continental rocks are mostly limited to USGS refernce materials [3, 4] and few lava/tephra samples [5]. The total range of Ba isotope fractionation oberserved so far is expectedly small (~ -0.5 to +1 permil on the $^{137/134}$Ba ratio) but significant. We present new data on Ba stable isotope fractionation in subduction related rocks. Elemental ratios of Ba and various fluid/melt sensitive elements have been used as an indicator of fluid contribution to the source of volcanic arc rocks. This is due to the incompatibility of Ba in mantle melts, its high enrichment in altered oceanic crust and its fluid mobility that all cause high Ba contents in subduction related fluids [e.g. 6]. In particular high Ba/Th ratios with overall low Th abundances have been, interpreted a an indicator for fluid rock interaction in the mantle wedge beneath arc volcanics [e.g. 6,7,8]. We present data for subduction related volcanic rocks from the Mediterranian that show indications for sediment derived fluids as a source component [7] and data for a suite of rocks from Sunda Arc (Indonesia) showing little evidence of fluid interaction but for sediment-derived melts [8]. These samples show systematic differences in their Ba isotope compositon, with samples dominated by a fluid component being fractionated relative to samples that do not. These results indicate that Ba stable isotopes have strong potential to serve as tracer for fluid/melt interaction in subduction zones and potentially in other high-T settings. In particular, the possible quantification of fluid contributions and thus a better understanding of subduction zone processes are an exciting prospect for the future of this proxy.

[1]Horner et al., 2015, EPSL, 430, 511-522; [2]Cao et al., 2016, EPSL, 434, 1-9; [3]Monyier et al., 2015, Chem. Geol., 413, 1-6; [4]van Zuilen et al., 2016, Geostand. Geoanlaytic. Res., 40, 543-558; [5]Bullen & Chatwick, 2016, Chem. Geol., 422, 25-45; [6]Hawkesworth et al., 1997, Chem. Geol., 139, 207-221; [7]Koenig et al., 2008, EPSL 274, 82-92; [8]Koenig et al., 2011, GCA, 75, 2119-2136