Effects of magma hybridization and late-magmatic fluids on zircon in a Variscan post-collisional pluton

M.A. KUSIAK[1], D.J. DUNKLEY[2]* AND E. SŁABY[1]

[1]Institute of Geological Sciences, Polish Academy of Sciences, Warsaw 00-818, Poland (mkusiak@twarda.pan.pl)
[2]National Institute of Polar Research, Tachikawa, Tokyo 190-8518, Japan (*correspondence: danieldd@nipr.ac.jp)

The ca. 315-304Ma [1] Karkonosze pluton of the Bohemian Massif comprises a sequence of intrusive facies that progress from porphyritic and equigranular granites with mafic microgranular enclaves (MMEs), through to hybrid granodiorite, with multistage emplacement of composite dikes. Progressive hybridization of fractionating, crustal-derived, felsic magma with injections of upper mantle/lower crustal-derived mafic (lamprophyric) magma has been recognized from elemental and isotopic geochemistry [2]. Such complexity is reflected in a variation in published isotopic ages (328-300Ma) from both bulk geochemical and accessory mineral analysis; however, there are no clear relationships to the sequence of intrusions observed.

To resolve this issue, zircon in various facies were analyzed by SIMS and electron microprobe, supported by submicron element mapping by field emission electron microprobe [1]. With increasing degrees of hybridization, zircon morphologies diverge from simple, oscillatory-zoned forms typical of growth in a fractionating magma, to grains modified by solid-state dissolution and reprecipitation, and clustered, convolute and skeletal forms characteristic of both quench crystallization and fluid-assisted reequilibration (especially in composite dykes and MMEs. High Th-U contents, metamictization, alteration and recrystallization all play a role in producing variable ages. When accounted for, a sequence of magmatic and fluid events can be revealed: ca. 315Ma for zircon crystallization in fractionating granitic magmas and quench growth in mafic microgranular enclaves; 312-309Ma quench growth and modification by fluid-rich melt in hybrid magmas and composite dikes; and 304 Ma for reequilibration of altered and repreciptitated zircon in MMEs by late-stage magmatically-derived fluids [1].

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[1] Kusiak *et al.* (2009) *Geology* **37**, 1063–1066. [2] Słaby & Martin (2008) *J. Petrology* **89**, 1–29.

Geochemical modeling of slab-derived fluids

C. KUSUDA[1]*, H. IWAMORI[2], K.KAZAHAYA[3], N. MORIKAWA[3], M. TAKAHASHI[3], H.A. TAKAHASHI[3], M. OHWADA[3], T. ISHIKAWA[4], M. TANIMIZU[4] AND K. NAGAISHI[4]

[1]Univ. Tokyo, Tokyo 113-0033, Japan (*correspondence: chiho-kusuda@eps.s.u-tokyo.ac.jp)
[2]TITECH, Tokyo 152-8550
[3]Geol. Surv. Japan, AIST
[4]Kochi Inst. Core Sample Res., JAMSTEC

The main aim of this study is to contribute to better understanding of fluid processes occurring in subduction zones with a comprehensive framework involving slab-derived fluids to near-surface fluids such as seawater, meteoric water and hot spring waters. Several studies estimated the contribution of slab-derived fluids to island-arc magmatism (e.g. [1]). In non-volcanic or forearc regions, their involvements have been hardly found. One exception, however, could be the so-called ‘Arima-type brine’, highly carbonated, non-volcanogenic hot springs with extreme high salinity, welling up in the Kinki district, SW Japan.

Our previous analytical research on these hot springs identified and characterized the concentrated ‘source’ brine in a robust multi-elemental/isotopic space, and so far, supports the idea that NaCl-CO_2-rich aqueous fluids, which are possibly slab-derived fluids originated from subducting oceanic crusts, might have uprisen from a deep part of the forearc region and might supply solutes, gases and water itself to the brine.

Combined with numerically estimated chemical and isotopic characteristics of slab-derived fluids, the $^{87}Sr/^{86}Sr$ ratio of 0.70873 of the observed source brine is close to the predicted value of the Philippine Sea slab-derived fluid, i.e. 0.709492 [1], and distinct from that of the Pacific slab-derived fluid, i.e. 0.704762 [1]. Furthermore, our numerical model to calculate hydrogen and oxygen isotopic ratios of dehydrated fluids also suggests that their isotopic ratios become close to observationally estimated values of the Arima-type brine at about 50 km depth, which coincides with the depth of the Philippine Sea plate beneath the studied area.

Here we present our recent results from further numerical modeling of geochemistry of slab-derived fluids with interpretations of Pb and Li isotope analyses of the brine, and will discuss their possible contributions to near-surface fluids in subduction zone systems.

[1] Nakamura *et al.* (2008) *Nature Geoscience* **6**, 380–384.