

Constraints on the origins of adakites by using magnesium isotopes

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Adakite is a certain series of andesitic, dacitic and sodic rhyolitic rocks or their intrusive equivalents, with unique geochemical characteristics, e.g., $\text{SiO}_2 \geq 56$ wt%, $\text{Al}_2\text{O}_3 \geq 15$ wt%, $\text{Y} \leq 18$ ppm, $\text{Yb} \leq 1.9$ ppm and $\text{Sr} \geq 400$ ppm. It has attracted intensive attention because of its similar geochemical characteristics to Archaean tonalite-trochilite-granodiorite series (TTG) and its close association with many large porphyry copper-gold deposits. The genesis of adakites has been controversial, particularly on whether formed by partial melting of thickened/delaminated lower continental crust (LCC) or partial melting of subducting oceanic crust. A combination of major elements, trace elements and traditional isotopic systems was used to discriminate adakites formed by partial melting of subducting oceanic crust or LCC. However, traditional Sr-Nd-Pb isotopic composition can be easily altered by upper crust during magma ascent. By contrast, such processes cannot affect Mg isotopes significantly because the mantle has much higher Mg content than the crust. Magnesium isotopes may therefore shed light on the different origins of adakites.

In this study, Mg isotopic composition of a suite of adakites from three districts of central eastern China, the Lower Yangtze River belt (LYRB), the Dabie orogen and the Dexing porphyry deposits, were investigated to constrain their origins, e.g., slab melting or partial melting of thickened/delaminated LCC. The results indicate that adakites from the LYRB have relatively homogeneous mantle-like Mg isotopic composition, with $\delta^{26}\text{Mg}$ ranging from -0.366 ± 0.066 to -0.213 ± 0.078 (2SD). The adakites from the Dexing porphyry deposits have slightly scattered $\delta^{26}\text{Mg}$ from -0.340 ± 0.067 to -0.146 ± 0.068 (2SD), but with mantle-like average. By contrast, those from the Dabie orogen have heterogeneous Mg isotopic composition ($\delta^{26}\text{Mg} = -0.161 \pm 0.065$ to -0.059 ± 0.065 , 2SD), slightly heavier than that of mantle ($\delta^{26}\text{Mg} = -0.25 \pm 0.07$). These distinct Mg isotopic compositions indicate different origins of these adakites, i.e., adakites from the LYRB and Dexing formed from slab melting whereas the adakites from the Dabie orogen presumably have contributions of the LCC components, consistent with previous studies [1,2]. Our studies suggest Mg isotopes may be a powerful tool for constraining the origins of adakites.

[1] Ling, M. X. *et al.* (2009) *Econ. Geol.* **104**#, 303-321.

[2] Ling, M. X. *et al.* (2011) *International Geology Review* **53**#, 727-740.

Radiotracer studies on the kinetics and equilibrium characteristics of adsorption of humic matter

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Introduction

Humic substances are ubiquitous in near-surface natural waters, and they are known to act as carriers for organic and inorganic contaminants [1, 2]. In order to assess the impact of such humic-bound mobilization, transport models are developed (see [3] for a review). As a prerequisite, reaction rates for adsorption and desorption are commonly assumed to be high enough to ensure a steady local equilibrium under flow conditions. For humic matter as a polydisperse system of highly charged colloids, however, it is unclear whether a dynamic adsorption equilibrium (i.e., a permanent run of adsorption and desorption at equal rates) actually exists. Low recoveries in column experiments with geological materials suggest a limited reversibility.

Experimental

Using kaolinite as an adsorbent, the kinetics of adsorption and desorption were studied for a humic acid (Aldrich) and a fulvic acid (isolated from bog water). Their radiolabeling with ¹⁴C (accomplished by azo coupling with [¹⁴C]aniline) allowed sensitive detection and enabled tracer exchange experiments at surface saturation, providing direct insight into the dynamics of the adsorption equilibria for the first time. In these studies, a negligible amount of radiolabeled humic or fulvic acid was contacted with equilibrated systems of kaolinite and non-labeled humic material at different durations ranging from 6 hours to 4 weeks.

Results

The equilibrium state of adsorption was attained within few hours for the fulvic acid, whereas the process took considerably longer for the humic acid (~ 2 days), possibly as a consequence of competition effects within the polydisperse system [4]. In desorption experiments, initiated by diluting the supernatant, not any release was observed within a time frame of 4 weeks, neither for the humic acid nor for the fulvic acid. In view of transport modeling, this finding is rather disturbing since the basic assumptions do not hold if adsorption is irreversible. Our tracer exchange experiments, however, revealed that labeled humic material is adsorbed even though it is confronted with a saturated surface. Consequently, an exchange must take place, indicating a reversible process, albeit an exchange time of ~ 4 weeks was required for both materials until the adsorption equilibrium was quantitatively represented by the tracer. Apparently, the competitive situation in its presence is a stronger driving force for desorption than is a concentration gradient. Models for humic-bound transport are thus applicable under comparable conditions.

[1] MacKay & Gschwend (2001) *ES&T* **35**, 1320-1328. [2] Dearlove *et al.* (1991) *Radiochim. Acta* **52/53**, 83-89. [3] Lippold & Lippmann-Pipke (2009) *J. Contam. Hydrol.* **109**, 40-48. [4] Van de Weerd *et al.* (1999) *ES&T* **33**, 1675-1681.