Cretaceous magmatism along the Lower Yangtze River, China controlled by ridge subduction

M.X. LING[1,3]*, F.Y. WANG[1,3], X.Y. YANG[2] AND W.D. SUN[1,2]

[1]Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Wushan, Guangzhou 510640 (*correspondence: mxling@gig.ac.cn)
[2]School of Earth and Space Sciences, University of Science and Technology of China, Hefei 230026
[3]Graduate University of the Chinese Academy of Sciences, Beijing 100049

The Lower Yangtze River Belt (LYRB) of ore deposits is one of the most important metallogenic belts in China, containing more than 200 polymetallic (Cu–Fe–Au, Mo, Zn, Pb, Ag) deposits [1]. The mechanisms for ore genesis and the formation of related Cretaceous igneous rocks in the LYRB are still controversial. The Lower and Middle Cretaceous rocks in the LYRB consist mainly of volcanic volcanoclastic rocks and granitoids, including andesite, rhyolite, shoshonite, trachyte, trachytic basalt, basaltic andesite, welded breccia and tuff. The Upper Cretaceous is characterized by red-bed sedimentary clastic rocks. There are three types of granitoids: a high-K calc-alkaline granodiorite series (gabbro, diorite, quartz diorite, and granodiorite), a calc-alkaline diorite series (pyroxene diorite porphyry and diorite porphyry) and A-type granitoids (quartz syenite, syenite, quartz monzonite, and alkaline granite) [2]. Many of these granitoids are adakitic in composition, and are thought to be formed by partial melting of thickened or delaminated lower crust [3]. Nb-enriched basalts (NEB) are also found together with adakites in the LYRB. In general, NEB are thought to come from mantle metasomatized through interaction with adakitic melts [4]. From Late Jurassic to Cretaceous, it was proposed that eastern China was closely associated with subduction of the Pacific plate in the south and the Izanagi plate in the north. Therefore, the mid-ocean ridge between the two plates was drifting towards and subducting under the LYRB [5]. We infer from the distribution of the different magmatic rocks and the ore-forming temperature grads that during this ridge subduction a slab window opened, which controlled the Cretaceous magmatism along the LYRB.

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Effect of humic matter on metal adsorption onto clay materials

H. LIPPOLD* AND J. LIPPMANN-PIPKE

Institute of Interdisciplinary Isotope Research, Permoserstr. 15, 04318 Leipzig, Germany (*correspondence: lippold@iif-leipzig.de)

In the event of release of radionuclides from subterranean repositories, migration can be considerably facilitated by complexation with humic colloids acting as carriers [1]. The impact of such humic-bound mobilization is, however, not sufficiently described by complexation constants alone since the carrier colloids themselves are subject to a solid-liquid distribution that depends on geochemical parameters. For site-specific risk assessments, the conditions of enhanced or reduced migration must be identified, and transport models must be adapted accordingly.

In this study, the pH-dependent influence of humic acid on metal adsorption onto three clay materials (montmorillonite, illite, opalinus clay) was investigated for Tb(III) as an analogue of trivalent actinides. ^{160}Tb and ^{131}I-labeled humic acid were employed as radiotracers, allowing experiments at very low concentrations to mimic probable conditions in the far-field of a nuclear waste repository.

Humate complexation of Tb depending on pH was examined by anion and cation exchange experiments, also considering competitive effects of metals leached from the clay materials. Adsorption of humic acid was studied as well, showing a moderate pH dependence compared to metal adsorption and complexation.

Our experiments revealed that metal release from clay matrices in consequence of acidification processes is generally counteracted by humic matter. For all clay materials under study, the presence of humic acid caused an increase in Tb adsorption at neutral and acidic pH values.

A commonly applied combined K_d model [2] was tested for suitability in reconstructing the metal distribution in ternary systems (Tb / humic acid / clay) by an additive treatment of data determined for binary subsystems. The model failed to fit our experimental data in all cases. It appears that the elementary processes cannot be considered to be independent of each other. Possible reasons are, e.g., competitive adsorption, confined reversibility, unequal stabilities of dissolved and adsorbed humate complexes, or different adsorption behavior of humic acid and Tb humate at planar and edge surfaces.

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