

Age, geochemistry, and origin of Proterozoic rapakivi granites in the North Qaidam Orogen, NW China

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Proterozoic rapakivi granites are mainly distributed within craton in the Northern Hemisphere. However, Proterozoic (ca.1770Ma) rapakivi granites have been recognized from the North Qaidam Orogen, the west segment of the Central Orogenic Systems of China. These granites exhibit typical rapakivi texture. They are A-type granite characterized by high FeOt/(FeOt + MgO) and Ga/Al ratios, and SiO₂, Na₂O + K₂O and rare earth element (except Eu) contents. Their whole-rock $\epsilon_{Nd}(t)$ (-6.09 to -5.74) and zircon $\epsilon_{Hf}(t)$ (-9.4 to -2.8) values, similar to those of the Proterozoic rapakivi granites in North China Craton (NCC), indicate they were derived from old continental crust. These granites contain magmatic microgranular enclaves and are intruded by diabases. The enclaves (more felsic) and granites show a uniform decrease in TiO₂, CaO, Na₂O, K₂O, FeO, and MgO with increasing SiO₂, and similar trace element patterns but different whole-rock $\epsilon_{Nd}(t)$ values. The diabases and other enclaves (more basic) deviate from the trend and have high whole-rock $\epsilon_{Nd}(t)$ values (ca. +4), suggesting their derivation from mantle. All these features indicate that the granites are almost the same as the Proterozoic (ca. 1700 Ma) rapakivi granites in NCC and belong to the Proterozoic rapakivi granite suit in the Northern Hemisphere. They were involved in the Paleozoic North Qaidam orogen. It is first time to recognize Proterozoic rapakivi granites in Phanerozoic orogens. This also reveals that Precambrian craton in North China were strongly destructed and reworked during Phanerozoic.

Rare earth elements in hydrothermal fluids from Kueishantao, off northeastern Taiwan

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The Σ REE concentrations of Kueishantao hydrothermal fluids are 813-1212 ng/L, 1-2 orders of magnitude higher than those of seawater (Σ REE of shallow seawater is 92 ng/L; Σ REE of deep seawater is 14 ng/L), but are lower than they are in most deep-sea hydrothermal fluids [1] and acidic hot waters in continental geothermal fields [2-4]. The difference may be caused by the low leaching efficiency under the seafloor due to the short duration of fluid-andesite interaction in the Kueishantao hydrothermal field [5].

The REE_N distribution patterns of the yellowish fluids (108°C, pH≈2.6, the flux is 35 m³/h) show a slight enrichment of LREE and a slight convex-downward curvature at Eu. The whitish fluids (51°C, pH≈4.9, the flux is 19 m³/h) have REE_N distribution patterns that exhibit a higher enrichment of LREE than those of the yellowish fluids and without Eu anomalies. The REE_N distribution patterns of Kueishantao fluids are different from those of shallow seawater (generally flat with a negative Ce anomaly), deep-sea acid-sulfate fluids, the acid-sulfate fluids in Taiwan Tatun volcanic area and other acid-sulfate hot waters in continental geothermal fields. The Eu anomalies of Kueishantao hydrothermal fluids are controlled mainly by the lower temperature and relative oxidizing conditions. The fractionation between LREE and HREE of the yellowish fluids is influenced mainly by the very low pH and the precipitation of native sulfur. In contrast, the LREE/HREE ratios of the whitish fluids may be related to the adsorption by small sulfur particles.

[1] Zeng (2011) *Beijing: Science Press*, 289-300. [2] Bau *et al.* (1998) *Chem Geol*, 293-307. [3] Sanada *et al.* (2006) *Geothermics*, 141-155.[4] Wood(2006) *J Geochem Explor*, 424-427.[5] Chen *et al.* (2005) *Acta Oceanol Sin*, 125-133.