

# **Hydrothermal processes facilitate rare metal fractionation and mineralization**

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The behavior of hydrothermal fluids at the magmatic-hydrothermal transition during the formation of intrusion-related ore deposits is poorly understood, and the role of hydrothermal process in facilitating concentrations and fractionations of rare-metal remains contentious. Here we present a coupled macro- and micro-observations on a 600-meter-long drilling hole from the Daping mineralized granite to decipher the behaviors of rare-metal and hydrothermal fluids. From the depth of 600 m to ~350 m, both Nb and Ta concentrations doubly increase whereas Nb/Ta ratios overall decline. At the site about 350 m deep, Nb, Zr, REE, and Si show a cliff drop in concentrations whereas Ta and Rb display a reverse trend, which results in Nb/Ta ratios decrease to less than 1. Till to the surface, their values display no significant fluctuation. Correspondingly, columbite-group minerals at 285 m have more complicated texture, represented by a wide Ta-rich overgrowth, than those at 540 m, while the zircons at 285 m are mostly hydrothermal and richer in Hf than those at 540 m. These results reveal that during the magmatic-hydrothermal transition hydrothermal fluids exsolved from the deep granitic melts are enriched in F, Na, Rb, and rare metal elements, and can migrate upward to accumulate a hydrothermal “pond” in the granite cupola. Stable hydrothermal “pond” caused by fluid focusing should facilitate a prolonged interaction among hydrothermal fluids, granitic melts and early-formed crystals, producing a local re-equilibrium distribution of rare metal elements and strong albitization within the space of hundreds of meters.

This study was supported by National Key R&D Program of China (2016YFC0600408).