Accessory minerals as indicators of peralkaline and aluminous A-type granites in the coastal area of eastern China

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There exists an extensive Yanshanian (Cretaceous) A-type granite zone in the coastal area of eastern China, which can be distinctly divided into peralkaline and aluminous subgroups according to their geochemistry. The peralkaline plutons include the Taohuadao, Qingtian and Laoshan granites, while the aluminous plutons involve the Suzhou, Putuo and Xincun granites. Detailed electron-microprobe analyses indicate that accessory minerals between two A-type granite subgroups differ distinctly.

The peralkaline A-type granites contain accessory phases zircon, allanite, sparse pyrochlore, and Fe-Ti minerals (titanite, titanomagnetite and Zn-rich pyrophanite). By comparison, the accessory-mineral assemblages in the aluminous A-type granites consist of zircon, monazite-(Ce), and Fe-Ti minerals dominated by magnetite, rutile, ilmenite and rare Nb-bearing pyrophanite. It is also showed that REE carbonates and fluorides are present in the aluminous granites.

The two A-type granites could be further recognized based on the internal structure and chemical composition of accessory minerals. Specifically, zircon grains in peralkaline granite mainly consisted of two distinctly separated parts. One is rich in Th (ThO_2 >1 wt%, and ThO_2/UO_2 >2); the other part is poor in Th (ThO_2<1 wt%), but contains many thorite micro-inclusions with sieved textures. In contrast, zircon in aluminous A-type granites is characterized by low content of ThO_2 (<1 wt %), ThO_2/UO_2 <2, and absence of thorite inclusion.

Accessory-mineral information can be used to infer sources, environments and physicochemical conditions of crystallization of two different types of A-type granites. (1) Th-rich zircon indicates relatively high-temperature and deep-sourced magma for the peralkaline granites. (2) The presence of magnetite and rutile suggests high $f(O_2)$ during the crystallization of aluminous A-type granite. (3) The occurrence of allanite or titanite agrees with stronger Ca/Al ratio of the peralkaline A-type magma relative to monazite-(Ce) which is more stable in aluminous granitic magma.

Investigation of baddeleyite (ZrO_2) solubility in aqueous alkaline solutions

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An experimental study of the pH-dependence of the aqueous solubility of baddeleyite (ZrO_2), the simplest Zr mineral, was performed, with the aim of investigating its geochemical behavior in the presence of a fluid phase and the effects of the coordination chemistry of Zr with inorganic species at high P-T conditions. Baddeleyite is not as common as zircon, but its stability is of great interest because it is used as a geochronometer (Rubatto and Scambelluri, 2003) and is being investigated as a waste form for plutonium disposition. Baddeleyite solubilities were measured in neutral and alkaline fluids (0, 0.01, 0.10, 1.0 molal (m) NaOH), at 600ºC and 2 kbar using the double capsule method in cold-seal pressure vessels. The quenched solution was analyzed using ICP-MS to determine the fluid concentration of Zr at saturation. The results show that the concentration of Zr increases dramatically with increasing OH^- molality (3.1×10^{-6} m in 0.1m NaOH, and $3.8\pm1.8\times10^{-5}$ m in 1m NaOH solution), possibly due to formation of the species $Zr(OH)_5^-$. This suggests that the solubility of others Zr-minerals such as zircon will also be enhanced at high pH due to complexing of hydroxide with Zr. Our results explain why alteration and dissolution-preciptation of Zr minerals seems to associated with alkaline fluids (e.g., Dubinska et al., 2004). Gibbs free energies of aqueous Zr species will be estimated from the measured solubilities and used to calculate Zr mineral solubilities at other conditions.

References

Dubinska E. et al. (2004) *Chem. Geol.* **203**(3-4), 183-203.

Rubatto D. and Scambelluri M. (2003) *Contr. Min. Pet.* **146**(3), 341-355.