Role of fluids in Fe–Ti–P mineralization of the Proterozoic Damiao anorthosite complex, China

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The orebodies in the Damiao Fe–Ti–P deposit are commonly characterized by chlorite-dominated alteration on both sides of the orebodies in contact with the host anorthosite, suggesting the presence of hydrothermal fluid during mineralization. Baddeleyite blebs and lamellae in the primary ilmenite of anorthosites and Fe–Ti–P orebodies in the Damiao anorthosite complex formed as a result of decreasing solubility of Zr in ilmenite during slow cooling and consequent exsolution of ZrO_2. Two types of zircon formation are identified and both are related to hydrothermal replacement of baddeleyite by Si-rich fluids. The type-I zircon intergrown with magnetite–rutile symplectite indicates a temperature of > 700 °C for fluid segregation from the Fe–Ti–P-rich melt. The type-II zircon occurring as tiny aggregate in the chlorite–quartz–titanite-bearing replacement fronts in the altered anorthosite suggests that the hydrothermal fluid flow was still active at ~350 °C. The Fe–Ti–P mineralization of the Damiao anorthosite complex was associated with magmatic–hydrothermal processes, with the Fe–Ti oxides being formed at the magmatic stage and apatite precipitated throughout the magmatic–hydrothermal stages. The concentration of apatite at the top and marginal domains of the Fe–Ti–P orebodies likely resulted from hydrothermal processes, rather than magmatic crystal accumulation.