Geophysical Research Abstracts, Vol. 8, 06363, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06363

Apatite, allanite and monazite as petrogenetic indicators in S-, I- and A-type granites of the Cape Granite Suite, Western Cape Province, South Africa

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Accessory mineral chemistry and petrography give insights in the evolution and recycling of continental crust in the Cape Granite Suite. REE's and trace elements partition strongly into accessory minerals and are useful to identify petrogenetic and crystallization processes. Allanite and titanite occur preferentially in the I-type granites, while monazite occurs only in S- and A-type granites. Monazite becomes unstable in Ca-rich magmatic environments such as I-type granites, whereas allanite becomes the stable accessory phase. Apatite occurs in all the plutons as the main P-containing mineral. Rounded crystal habits of apatite and monazite in S-type granites indicate that they are sedimentary relics of the source rocks. Concentric growth- and sectoral zoning, as observed with CL and SEM, are common features in primary apatites. The overprinting of magmatic textures in I- and A-type apatites, such as "patchy" zoning and irregular alteration rims (coronas), reflects evolutionary processes such as magma recycling. CL and SEM observations indicate that the REE's are concentrated into these coronas. Al-Fe substitution in titanite are controlled by P-T conditions, whereas Ca-Mn-Mg substitution are controlled by whole-rock chemistry. LREE and Sr content in allanite discriminate between the plutons and also reflect the whole-rock chemistry. ASI controls the two main substitutions in apatite: Ca+P↔Si+REE and Na+REE↔2Ca. Fe-Mn substitutions in apatite are controlled by oxidation state of the magma and Sr, REE and Mg mimic the whole-rock chemistry. Monazite and allanite's REE patterns show LREE enrichment, while those of apatite and titanite's are mostly birdwing profiles with either LREE or HREE enrichment. Changes in these patterns are influenced by crystallization sequence of coexisting REE-bearing phases, fractionation history of the pluton and by crystallization sequence of the accessory minerals.