The syenite-carbonatite-fluorite association in Jebel Dumbier complex (Sudan): Magma origin and evolution

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Jebel Dumbier is the first-identified carbonatite-bearing alkaline complex in Sudan. It is located on the northeastern margin of the Nuba Mountains in the south part of Sudan. The complex exposed as small elliptical hills with outcrops of around 8 km^2. It is composed of dominant orthoclasite and ditroite and subdominant carbonatite and fluorite dykes. The fluorite dykes are mined and together with the carbonatite dykes are controlled by a NNE strike-slip fault system. Orthoclasite is the dominant rock type, comprising of orthoclase, kalsilite, few interstitial biotite and calcium carbonate and accesserary minerals of fluorite, apatite and zircon. Ditroite consists of perthite, aegirine-augite, nepheline, sodalite, and minor annite-phlogopite and richterite, with common accessories of fluorite, titanite, apatite and zircon.

Zircon U-Pb dating reveals that both orthoclasite and ditroite emplaced at around 600 Ma. Relative to orthoclasites, ditroites display higher FeO^{total} and MgO and lower Al_2O_3 contents, contain higher volatiles (F, Cl, Br, S), and are more depleted in LILEs (Rb, Sr, Ba) and enriched in HFSEs (Nb, Ta, Zr, Hf, Th, U) and REEs. Isotopic data imply that the ditoite, orthoclasite, fluorite and carbonatite dyke originated from a common source of depleted mantle affinities, with identical low initial $^{87}Sr/^{86}Sr$ ratios (0.7033-0.7037) and high ε Nd (t) values (1.6-2.7). The carbonatites display $\delta^{13}C_{(V\text{-}PDB)}$ of -5.8 to -6.7‰ and $\delta^{18}O_{(SMOW)}$ of 9.1 to 11.3‰, typical of primary igneous carbonatite worldwide.

We propose that the orthoclasite, ditroite, carbonatite, and fluorite association in Jebel Dumbier is product of variable degrees of fractional crystallization of mantle-derived volatile-rich magma. Magma immiscibility among silicates, carbonates and fluorates may proceed. The Jebel Dumbier alkaline-carbonatite complex represents the post-orogenic alkaline magmatism during the end evolution of Pan-African orogen (650-550 Ma) at Arabian-Nubian Shield.