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Petrogenesis and Significance of the Jebel Dumbier Alkaline-Carbonatite Complex from North Margin of Nuba Mountains, Sudan

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1 Introduction

Scientific study of the geology and mineral resources in Sudan is rather limited. Jebel Dumbier is the first identified carbonatite-bearing alkaline complex in Sudan by El Sharkawi & El Raba'a in 1973. It is located in Northern Kordofan Province on the northeastern margin of the Nuba Mountains. The complex exposed as small elliptical hills with northeast-southwest trending. The outcrops is around 8 km^2. Jebel Dumier complex is composed of dominant orthoclasite and ditroite (**Fig. 1**) and subdominant carbonatite and fluorite dykes in the northeast part of the complex. The dykes are controlled by a NNE strike-slip fault system which has been reactivated in 1966 and 2007 triggering around 5.1 magnitude earthquakes. The fluorite dykes are mined and have similar isotopic features to associated syenitic rocks and carbonatites. Therefore the genetic relationships of the fluorite, carbonatite and distinct syenitic rocks are of great interests and attracted much attention (Harris et al., 1983; Ouf, 2007; Galil, 2008).

2 Petrogenesis and significance of the Jebel Dumbier complex

2.1 Geology and petrography of the complex

The ditroite is in grey color, medium-grained and commonly occurrs as lentoids or inclusions in the orthoclasite. It consists of perthite (50-70%), augite-aegirine (10-30%), nepheline (partially altered to cancrinite, 6-20%), sodalite-group minerals (8-20%), and minor annite-phlogopite (< 5%) and richterite (< 5%). Common accessories are interstitial fluorite, euhedral titanite, apatite and zircon. Orthoclasite is the dominant rock type, with outcrops of more than 80% of the exposed complex. The rocks are pink, coarse-grained, and composed of orthoclase (60-80%), kalsilite (15-35%) and few interstitial biotite (< 5%) and calcium carbonate (< 5%). Fluorite, apatite and zircon are common accessory phases and occasionally occur as large crystals of size 500×200 μm (zircon). On the west margins of complex, ditroites commonly contain abundant country rock (gneiss) xenoliths. Hybridisation textures (e.g., clinopyroxene with reverse zonation; **Fig. 2**), attributable to interaction between ditroite magma and xenolith, present on the contact between the xenoliths and the host. Carbonatites are sovites containing more than 80% calcite. They occur as dykes and elliptical patches of carbonatitic breccia. The NNE trending fluorite dykes are dominated by fluorite but also carry quartz, carbonate and clinopyroxene.

2.2 Dating and geochemical features of the complex

LA-ICPMS zircon dating results reveal that both orthoclasite and ditroite emplaced at around 600 Ma and indistinguishable within error. Geochemical data show that orthoclasites are ultrapotassic rocks with K_2O contents up to 15 wt% and K_2O/Na_2O ratios of 6-48, whereas ditoites are sodic-potassic rocks (K_2O/Na_2O = 0.6-0.9). Relative to orthoclasites, ditroites display higher FeO^{total} and MgO contents and lower Al_2O_3 contents. They are more depleted in LILEs (Rb, Sr, Ba) and enriched in HFSEs (Nb, Ta, Zr, Hf, Th, U) and REEs. Note that ditroites are enriched in volatile elements (F, Cl, Br, S) and have surprisingly high Nb/Ta ratios (mean of 32). Isotopic data imply that the ditoite, orthoclasite, fluorite dyke and carbonatite dykes from Jebel Dumbier originated from a common source of depleted mantle affinities, with identical low initial $^{87}Sr/^{86}Sr$ ratios (0.702-0.704) and high ε Nd (t) values (1.7-2.0).

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2.3 Petrogenesis and tectonic implications

We propose that the ditroites, orthoclasites, carbonatites and fluorites are products of variable degrees of fractional crystallization of mantle-derived magmas. Crustal contamination might be also involved as evidenced by the gneissic xenoliths. The enrichment of CO_2, F, Cl and Br in rocks suggest the source rocks are initially volatile-rich. The Jebel Dumbier alkaline -carbonatite complex correlates with the vast coeval A-type granites in many parts of the Arabian-Nubian Shield, representing the post-orogenic alkaline magmatisms during the end evolution of Pan-African orogen (650-550 Ma).

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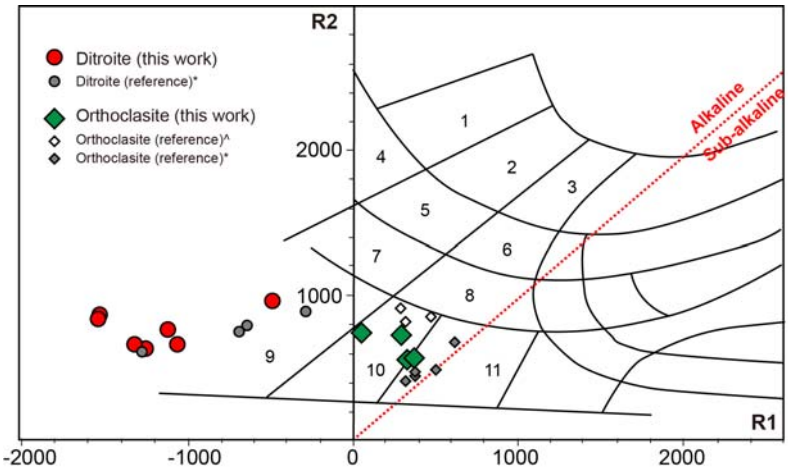

Fig. 1. Chemical classification of the Jebel Dumbier alkaline rocks after de la Roche's (1986). R1=4Si-11(Na+K)-2(Fe+Ti), R2=6Ca+2Mg+Al. 1. melteigite; 2.theralite; 3. alkali gabbro; 4. ijolite; 5. essexitic gabbro; 6. syenogabbro; 7. essexite; 8. nepheline syenodiorite; 9. nepheline syenite; 10. nepheline-bearing syenite; 11. syenite.

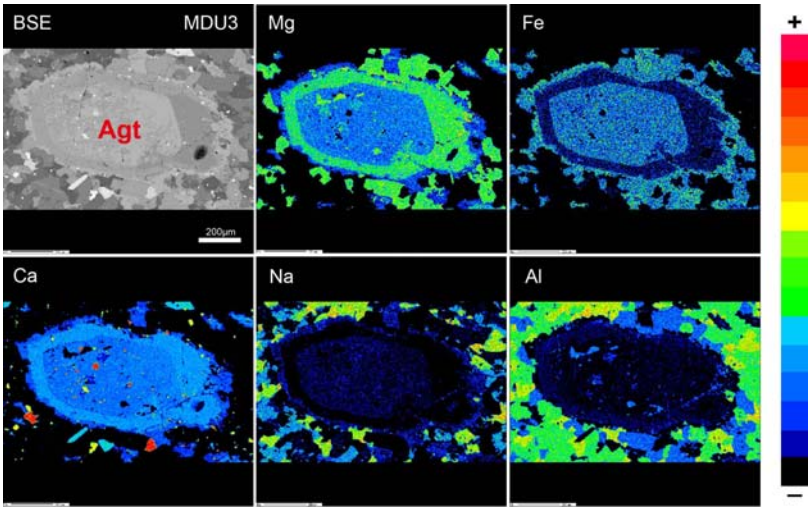

Fig. 2. Backscattered electron image of zoned clinopyroxene grain in the ditroite of Jebel Dumbier complex.