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A REVIEW OF THE GENESIS AND TIMING OF ENRICHMENT OF CRITICAL METALS IN A-TYPE GRANITES, NORTH-CENTRAL NIGERIA: INSIGHTS FROM ZIRCON U-PB-HF ISOTOPES, WHOLE-ROCK AND ZIRCON GEOCHEMISTRY.

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Some anorogenic ring complexes among over 50 in north-central Nigeria are rich in key metals such as Mo, Nb, REE, Sn, Y, Zn, and Zr. Recent studies including mineralogy, whole rock geochemistry, electron probe analysis, U-Pb-Hf isotope as well as zircon trace element geochemistry constrained a systematic decrease in age from north to south (214 to 141 Ma) and some of the granites show a multiple-fold increase in the concentration of F, Nb, REE, Y, Zn, and Zr but enrichments could be termed transitional when compared with other world-class deposits. The A-type granites, which formed under varied redox condition (log FMQ = -1.1 to +3.0), are highly differentiated hypersolvus granites with accessory fluorite, topaz, pyrochlore, and a generally homogeneous composition. The alkaline granite magma and associated mineralizing fluids are derived from the lower crust, with upper mantle inputs (zircon Hf(t) values ranging from -10.06 to - 4.38). On the one hand, Sn and Mo are primarily concentrated in peraluminous biotite granites as a result of sodic-potassic alteration or the emplacement of greisen-related mineralization as a result of fluid-rock interactions. On the other hand, critical metals such as Nb and REEs are enriched in peralkaline amphibole-bearing granites whose M-type lanthanide tetrad effect ($TE_{1,3}$ = 1.16–1.43), enriched HFSEs and positive correlation of Na_2O ($r^2 \geq 0.8$) with the enrichments indicate that Na-rich fluid plays an important role in the complexation and Fluorine favoured the retention of these crucial metals in the peralkaline melt until late magmatic-stage. The breakdown of the F-HFSEs and F-REE complexes was accompanied by crystallization of pyrochlore and REE-bearing accessory minerals. The links between whole-rock Rb/Sr and zircon Eu/Eu* highlight that the latter can monitor magma fractionation in these systems. Zircon Ce/Ce* and Eu/Eu* might also define the conditions favourable for the crystallization of rare metal-enriched accessory mineral phases. We propose that the emplacement of these A-type granites was caused by the Mesozoic transtension regime, which reactivated multiple deep-seated Pan-African transcurrent faults and channeled mineralizing fluids. The mineralization was most likely the result of complex magmatic evolutionary processes involving extensive fractional crystallization, crustal assimilation, and late-stage hydrothermal fluid activity.