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Geochemical characteristics of the niobium-rich arfvedsonite granites, Younger Granites province of Nigeria

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Abstract

Arfvedsonite granites are most prevalent in the northern sector of the Nigerian anorogenic ring-complex province wherein they form the main granitic rocks at Kudaru and Fagam and are important components of Kila-Warji, Ririwai and Dutsen-Wai ring-complexes. The albitized variety of these rocks hosts pyrochlore to varying extents depending on the degree of albitization and are, therefore, important targets for niobium investigation. Geochemical data of the granites reveal that niobium has a mean concentration of 111 ppm in the arfvedsonite granite, increasing to 168 ppm in the aegirine arfvedsonite granite and reaching 1568 ppm in the albite arfvedsonite granite. Niobium is thus enriched in the albite arfvedsonite granite by a factor of 8–11 relative to its mean value in the aegirine arfvedsonite and arfvedsonite granites, respectively. Uranium contents show a sympathetic trend with niobium, being also enriched in the albite arfvedsonite granite relative to its abundance in both the aegirine arfvedsonite granite and arfvedsonite granite by a factor of 15. The uranium abundance in the albite arfvedsonite granite is more than 48 times higher than the mean background values in low-calcium granite.

The REE fractionation patterns in all three arfvedsonite granite varieties are characterized by enrichment of both the light (La–Sm) and heavy (Gd–Lu) rare earth elements and a significant negative Eu anomaly. The albite arfvedsonite granite is, however, preferentially more enriched in the heavy REE relative to the aegirine arfvedsonite and the arfvedsonite granites. A plot of the $\sum$REE against Na_2O and niobium reveals positive correlation in the

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arfvedsonite granites. There is also a linear relationship and strongly positive correlation between Nb and Na_2O because the pyrochlore is most abundant in the most extensively albitized variety of the arfvedsonite granites.

Keywords: Anorogenic ring-complexes; Arfvedsonite granites; Albitization; Pyrochlore mineralization; Nigeria; REE patterns

1. Introduction

In northern Nigeria, two groups of granites, which differ considerably in age, structure, mineralogy, chemistry and origin, have been recognized as Older and Younger Granites. The Older Granites generally range in composition from granites to granodiorites with subordinate gabbros, diorites and quartz syenites as defined by IUGS (Streckeisen, 1976). One of the most common types is the coarse porphyritic biotite or biotite hornblende granite, which forms large masses of batholitic dimensions. It is believed that the Older Granites are emplaced at relatively deep levels in the earth's crust under orogenic conditions

In contrast, the Younger Granites are a petrologically distinctive series of alkali feldspar granites, associated with rhyolite, minor gabbros and syenites. They occur in sub-volcanic intrusive complexes as ring-dykes and related annular and cylindrical intrusions within a northerly trending broad belt, about 400 km long and 160 km wide between latitude 8° and 12°N and longitude 8° and 10°E. This belt is often referred to as the Younger Granites province. Often several cycles of intrusion occur within one Complex and the large size of many of the structure is due to overlapping and superposition of separate intrusive cycles (Turner, 1972, 1989; Turner and Bowden, 1979). Age determinations have shown that the Older Granites are probably early Palaeozoic in age, whereas the Younger Granites are entirely Mesozoic (Jacobson et al., 1963; van Breemen et al., 1977; van Breemen and Bowden, 1973). The location of the ring-complexes is shown in Fig. 1.

On the basis of chemistry, two groups of granitic rocks have been identified in the Nigerian anorogenic ring-complexe province. These are peralkaline and subalkaline granites (Bowden and van Breemen, 1972), the former of which is represented by arfvedsonite granites, while the latter are predominantly biotite granites. The subalkaline types of granite are mineralized with rich deposits of cassiterite, columbite, sphalerite, wolframite and galena and are the primary source of alluvial cassiterite and columbite mineralization, which has been the basis for the mining industry that shrived for decades on and around the Jos plateau area. In 1954–1955,

Fig. 1. Map of the Younger Granite ring-complexes of Nigeria (after Kinnaird, 1985). The complexes hosting the arfvedsonite granites studied are (1) Dutsen-Wai, (2) Kudaru, (3) Ririwai, (4) Kila-Warji and (5) Fagam. Inset: Geological sketch map of Nigeria indicating the location of the Younger Granite province.