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Geochemical and Sr-Nd isotopic compositions of Paleoproterozoic metavolcanics from the Ashanti volcanic belt of Ghana

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It is widely believed that the main Paleoproterozoic crustal growth event (or Eburnean orogeny) in the West African Craton (WAC) represents a major juvenile crust-forming process with involvement of only a negligible Archean crustal components. However, there is controversy surrounding the context of crustal accretion (accretionary orogeny versus transcurrent tectonics models) and tectonic setting (arc environments and plume-related magmatism) of the Paleoproterozoic rocks. In this contribution, we present whole-rock geochemical and Sr-Nd isotopic data for Paleoproterozoic metavolcanic rocks in the southern part of the Ashanti volcanic belt of Ghana, and discuss their petrogenesis and the tectonic setting in which they were formed.

The metavolcanic rocks are predominantly basalts/basaltic andesites and andesites with minor dacites. Two types of basalts/basaltic andesites (B/A), Type I and Type II, have been identified. The Type I B/A rocks are characterized by high contents of Cr (670-750 ppm), Ni (220-330 ppm), Co (31-70 ppm) and V (224-260 ppm). They show flat to slight LREE depletion with $(La/Sm)_N$= 0.69-1.03, $(La/Yb)_N$= 0.57-0.71, minor negative and positive Eu anomalies (0.92-1.24), and slightly negative Nb-Ta anomalies and low Th/Nb ratios (0.06-0.11). The Type II basalts/basaltic andesites have high contents of Cr (250-1060 ppm), Ni (100-260 ppm), Co (35-42 ppm) and V (168-275 ppm). They possess fractionated REE with $(La/Sm)_N$= 1.34-2.31, $(La/Yb)_N$= 2.08-4.25 and minor positive Eu anomalies (1.09-1.13), and display strong negative Nb anomalies but relatively smaller Ti anomalies and lower Th/Nb ratios (0.35-0.37) compared to the andesites. The andesites also have fairly high contents of Cr (160-270 ppm), Ni (40-120 ppm), Co (30-48 ppm), V (105-202 ppm) contents, and Mg# (40-54). They show more fractionated REE [$(La/Sm)_N$= 1.97-2.78; $(La/Yb)_N$= 4.11-8.48] with minor positive to non-existent Eu anomalies (0.99-1.15), and display strong negative Nb and Ti anomalies and relatively higher Th/Nb ratios (0.69-0.95). The analyzed dacitic porphyry has fairly high Cr (290 ppm) and Ni (130 ppm) contents, and the least contents of Co (20 ppm) and V (104). It also shows fractionated REE [$(La/Sm)_N$= 2.41; $(La/Yb)_N$= 6.12] with a high positive Eu anomaly (2.12), and displays strong negative Nb-Ta and Ti anomalies and a relatively high Th/Nb ratio of 0.85.

The analyzed volcanic rocks commonly have low initial $^{87}Sr/^{86}Sr$ ratios consistent with previous studies on Paleoproterozoic rocks from WAC. The tholeiitic Type I B/A exhibit back-arc basin geochemical signatures and show high positive epsilon Nd (2.1 Ga) values of +3.89 to +7.21), which suggest a long term depleted source and also indicate that they were produced in an entirely oceanic environment devoid of influence of continental crust. The isotope signatures and trace element data of the Type I basalts/basaltic andesites suggest that their parent magma was generated from a depleted mantle. The Type I B/A have Nd model ages (T_{DM2}) of 1.83-2.09 Ga similar to their formation ages, suggesting that they were juvenile at their time of formation. The andesites and the Type II B/A andesites exhibit characteristics of subduction zone-related magmas, and show initial epsilon Nd (2.1 Ga) values of -1.15 to +1.35 and Nd model ages (T_{DM2}) of 2.32-2.58 Ga. The dacitic porphyry also exhibits characteristics of subduction zone-related

magmas, and have initial epsilon Nd (2.1 Ga) value of -2.24 and Nd model ages (T_{DM2}) of 2.64 Ga. The Nd isotopic data confirms the juvenile character of the Birimian crust, but also suggests some contributions of a pre-Birimian crustal material (or Archean?) in the genesis of some of the metavolcanic rocks. Our geochemical and isotopic data are consistent with the island arc complex model which views Paleoproteozoic terranes of West Africa in the context of subduction-accretion processes.

Keywords: Geochemistry, Sr-Nd isotopes, tectonic setting, Birimian metavolcanics, Ashanti belt