Mingled quartz-diorite of the Terra Preta Granite, Água Branca Suite, NE Amazonas: Field and petrographic evidences, and trace elements modeling

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High-K calcic-alkaline granitoids (1898–1890 Ma) from NE Amazonas State, grouped in the Terra Preta batholith (Água Branca Suite), were intruded by A-type hornblende-bearing syenogranite stocks (Canoas Syenogranite, Mapuera Suite). Close to one the contact, a quartz-gabbro dike was emplaced into the still mush Terra Preta hornblende granodiorite, forming a transitional contact zone containing sub-angular to rounded fragments of dike (mafic enclaves) and a mingled rock, the quartz-diorite facies. The main petrographic evidences of mingling process included a mineralogical assemblage formed by poikilitic crystals of quartz and alkali feldspar (string and flames perthites) and xenocrystals of quartz, plagioclase and alkali feldspar from the hornblende granodiorite, which exhibit re-absorption/re-equilibrium features (engulfing, corroded core and patchy zones).

Terra Preta Granite is subalkaline, metaluminous to weakly peraluminous (A/CNK = 0.54 to 1.06), I-type and high-K calcic-alkaline with low CaO/(Na_2O+K_2O) and SiO_2 contents. The Terra Preta Granite is characterized by broad-range in its main composition (quartz-monzodiorite to biotite syenogranite). SiO_2 values vary from 60.2 to 74.4 wt.% and Al_2O_3 contents from 13.2 to 16.7 wt.%. Besides this main rock group, quartz-diorite is also considered an important variation inside the Terra Preta Granite. Its SiO_2 values are 54.7 and 55 wt.% and Al_2O_3 contents are 12.4 and 19.5 wt.%. A synplutonic mafic dike of quartz-gabbro (SiO_2 47.7 wt.%) is not inserted in these compositional variations, and it played a role in the chemical variation of Terra Preta Granite, forming new facies (quartz-diorite) from mingling interaction with hornblende granodiorite. The quartz-diorite displays non-linear, irregular distribution in relation to both major and trace elements, when compared to main composition variation of Terra Preta Granite. This behavior suggests that fractional crystallization cannot be considered in the formation of the quartz-diorite, pointing to magma mingling process, which was also supported by both field and petrography features.

Mingling process modeling was only leaded in trace elements, due to absence of mineral chemistry data from Água Branca granitoids. The modeling tests were driven by the binary mingling/mixing equation $X_M = X_A.f + X_B.(1-f)$ (Albarède 1996), where X_M = element concentration in the mixing, X_A = element concentration in the A-melt (mafic dike), X_B = element concentration in the B-melt (hornblende granodiorite) and $f = X_A/(X_A+X_B)$. The calculated concentrations of Rb vs. Zr, Rb vs. Sm/Nd and Zr vs. Rb/Zr revealed values close to a mingled melt containing from 50% to 40% of the mafic dike composition and from 50% to 60% of hornblende granodiorite. The same calculation was carried out for Zr vs. Rb/Zr and Zr vs. Sm/Nd and the obtained results revealed a mingled melt presenting 40% of mafic dike and 60% of hornblende granodiorite.

Field and petrographic data, binary variation plots and geochemical modeling suggest that mingling process also participates in Terra Preta Granite crystallization with formation of a quartz-diorite facies from mingled melt containing 40% of mafic dike composition and 60% of hornblende granodiorite.

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