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Precambrian Dykes in the São Francisco Craton Revisited: Geochemical-isotopic Signatures and Tectonic Significance

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Several generations of mafic dyke swarms (2.7 to 0.8 Ga), highlighted by aeromagnetic data, petrography, geochemistry, isotope geology and mostly U-Pb baddeleyite ages, crosscut the Archean and Paleoproterozoic crystalline basement of the São Francisco -West Congo craton - one of the largest cratons in the Neoproterozoic framework of Western Gondwana. We review the petrogenetic and tectonic significance of the dyke swarms in the São Francisco craton. For this purpose we reassess the emplacement ages and coupled geochemical and isotopic data, in the light of the long-lived polycyclic evolution of the basement rocks and the underneath subcontinental mantle through time. The crustal evolution of the paleo- to mesoarchean core involved multiple juvenile and partial melting episodes building up distinct sialic blocks. These blocks eventually assembled during Neoarchean times (2.80–2.70 Ga) due to subduction of oceanic crust under the proto-continental margin. In contrast, the Paleoproterozoic basement was produced by successive oceanic and continental arcs (2.47–2.00 Ga) that gradually accreted all the ancient blocks, after which the São Francisco paleocontinent was established. Compatible with the more rigid continental lithosphere at the time, the subsequent Proterozoic episodes (e.g., rift basins, bi-modal magmatism, dykes swarms) were chiefly intraplate. The Neoarchean Uauá dyke swarm comprises unmetamorphosed to weakly metamorphosed norites dated (2.73 Ga) and metamorphosed tholeiites (i.e., amphibolites) dated at 2.66 Ga. The latter type exhibits sheared margins, while the dyke centers preserve the primary mineralogy and intergranular texture. This suggests an emplacement through late transpression regime under amphibolite facies metamorphism, in accordance with the field observations. The Lavras-I swarm (norites and subordinate gabbronorites) which is located ca. 1300 km away to the south can be attributed to this oldest episode given they yield ca. 2.66 Ga. The Proterozoic swarms, according to the geographic distribution, are termed: Paraopebas (ca. 2.19 Ga), Lavras-II (ca. 1.97 Ga), Pará de Minas–I (1.80–1.79, 1.71–1.70 Ga), Curaçá and Chapada Diamantina (1.51–1.50 Ga), Diamantina (0.93–0.91 Ga) and Salvador-Olivença (0.92–0.93 Ga), and Pará de Minas – II (0.77 Ga). Most are non-deformed dolerites, basalts, diabases and gabbros (tholeiitic in composition). However three of these swarms also include metamorphic dykes such as metadiabase and amphibolite (Paraopebas, Lavras-II and Chapada Diamantina). Specifically the Diamantina dykes show deformation and metamorphism coeval with the Araçuaí marginal belt. The parental magmas of the Archean and Proterozoic dyke swarms are heterogeneous through time, and involved distinct N-MORB melts due to variable recurrent metasomatic effects in most cases. The main mechanism active in the source, according to the mixing geochemical-isotopic model, is the action of inherited slab fluids from recycled oceanic crust coupled with contamination of sediments overlaying the sub-lithospheric mantle. The hypothesis is consistent with the polycyclic evolution of the continental crust, originated in early continental arc setting (2.80–2.70 Ga) and with the succeeding accretionary regime of magmatic arcs (2.4–2.0 Ga) that built-up the São Francisco paleocontinent. Nevertheless the Lavras tholeiites (ca. 1.97 Ga) as like the Chapada Diamantina (1.50 Ga) dykes do not show effects of slab fluids metasomatism in the parental source. The Neoproterozoic Diamantina and Salvador-Olivença

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swarms show similar heterogeneous mantle sources from an almost depleted N-MORB toward one N-MORB component significantly enriched by OIB-like and slab-derived fluids. From a tectonic point of view the Uauá/ Lavras–I (2.73–2.66 Ga) and Paraopebas - Lavras-II (2.19; 1.97 Ga) amphibolite dykes are linked with alternate extensive and late transpressive episodes during the magma emplacement, accompanying syn-orogenic convergence of the sialic fragments in Neoarchean and Paleoproterozoic times, respectively. Conversely, an intraplate origin is likely for the Pará de Minas-I, Chapada Diamantina-Curaçá and Diamantina-Salvador-Olivença dyke swarms. They are anorogenic and genetically associated with intermittent extensional stress in the São Francisco paleocontinent. In particular the Pará de Minas dykes (I, II) have age match with the basal volcanics of the Espinhaço intraplate basin and A-type granitic plutonism suggesting therefore a common origin that involved melts from the subcontinental mantle. Both, the ca. 1.51–1.50 Ga Chapada Diamantina and the Curaçá (400 km apart) dykes, as well as the ca. 0.93 -0.91 Ga Diamantina and Salvador-Olivença dykes exhibit radiating patterns probably linked with continental rifting, as attempted breakups over old and cool lithosphere. These younger episodes were probably triggered by mantle plumes and/or local thermal anomalies in the subcontinental mantle. Collectively the anorogenic dykes of Pará de Minas–I (1.80–1.79, 1.71–1.70 Ga) as like both radiating swarms (1.51–1.50, 0.93–0.91 Ga) point to intermittent fracturing in the São Francisco-West Congo landmass. From a paleogeographic perspective the Neoarchean and Proterozoic dykes allow potential relationships with igneous activities on nearest sialic neighbours, as follow: a) Neoarchean LIP event (e.g., tholeiitic-komatiite magmatism and continental flood basalts) and/or continental margin magmatism (e.g., Zimbabwe craton); b) Proterozoic mafic dykes and Lips (e.g., Amazonia, Rio de la Plata, West Africa, Angola, Kalahari, North China and Siberia cratons). In other works the dyke records in the São Francisco craton are consistent with the global “barcode” approach of Columbia and Rodinia reconstructions, whilst supported by paleomagnetic data. This work is a contribution to FAPESP thematic project 2012/15824-6.