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New Ar-Ar age and C-O isotope geochemistry of the Piedade (Aps) carbonatite complex of the Ponta Grossa Arch region, Southern Brazil: petrological implications

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Introduction

The southern side of the Ponta Grossa Arch (PGA), a NW-SE-trending tectonic feature extending over 600 km, was the site of important alkaline and alkaline-carbonatitic magmatic activity in Lower and Upper Cretaceous times (130-70 Ma) in SE Brazil (Figure 1). Alkaline and alkaline-carbonatitic complexes are tectonically controlled by two main N40-60W lineaments: the Guapiara lineament (GL), where Lower Cretaceous mafic-ultramafic and carbonatite complexes are prevailing (e.g., Jacupiranga, Juquiá); and the São Jerônimo-Curiúva lineament (SJCL, central PGA), where Upper Cretaceous syenitic–phonolitic and carbonatite associations (e.g., Banhadão, Itapirapuã) and alkaline dyke swarms intrude the crystalline basement. As a northeast extension of the PGA domain, other alkaline-carbonatite intrusions occur along a NW-SE-trending structure (the Piedade-Itanhaém lineament, PIL) parallel to the GL and intrude the same basement: the potassic alkaline-carbonatitic complex of Ipanema, the poorly-known Tatuí, Salto de Pirapora and Itanhaém occurrences and the new reported here Piedade (Aps) alkaline-carbonatite complex (PACC).

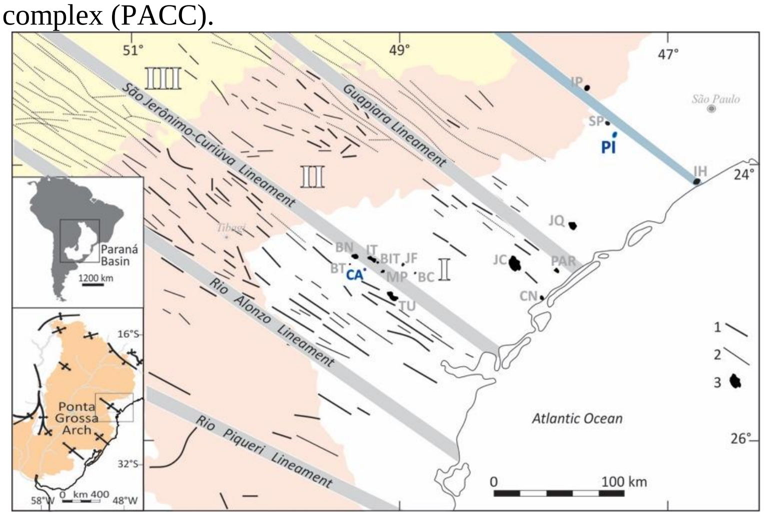

Figure 1. Tectonic setting of Mesozoic alkaline magmatism in the Ponta Grossa Arch (after Almeida, 1986). The NW-SE dyke swarms and the main intrusive complexes are indicated as follows: 1 and 2, dykes inferred by field geology and remote sensing and aeromagnetic survey, respectively; 3) alkaline complexes: BIT-Barra do Itapirapuã, BN-Banhadão, BT-Barra do Teixeira, CN-Cananéia, IP-Ipanema, IT-Itapirapuã, JC-Jacupiranga, JQ-Juquiá, MP-Mato Preto, PAR-Pariquera-Açu, TU-Tunas; I, Basement; II, Paraná Basin; III, Basalt flood. Inset shows the main structural features of southern Brazil.

Results and concluding remarks

The PACC is hidden in the Neoproterozoic granite below its erosional level (30 to 200 m), except for a very restricted outcropping of shonkinite dykes. Geophysical survey indicates a major subcircular alkaline intrusion bearing carbonatite body elongated to the NW in its central southwest portions surrounded by shonkinites and fenites, all enclosed in Precambrian granites. Samples from systematic drilling confirm the structure of the carbonatite body, with prevailing decimeter- to meter-thick veins of both carbonatites and shonkinites, interspersed with each other in varied proportions.

The carbonatites are mostly calcite carbonatites, mainly medium-grained and vary from white to grey in color (Ruberti et al, 2020). The texture is granular xenomorphic to hypidiomorphic with prevailing calcite, sometime subordinate magnetite, dolomite and siderite, accessory oxides, phlogopite and apatite and further scarce REE- fluorcarbonates. Late millimeter to centimeter veins of quartz, apatite and barite are found cutting all rocks. Shonkinites are medium to coarse-grained and typically dark grayish (M' >35%). The texture is hypidiomorphic from serial inequigranular to tightly porphyritic, with pheno- and microphenocrysts of zoned clinopyroxene, biotite, amphibole and apatite set in a fine- to medium groundmass of mainly alkali feldspar (orthoclase), minor nepheline, sodalite and accessories apatite, titanite and oxides. Fenitized granitic wall rocks generally show cataclastic texture with recrystallized alkali feldspar grains and microfractures filled with fibrous amphiboles, aegirinic clinopyroxenes and carbonates.

New phlogopite $^{40}Ar/^{39}Ar$ ages from shonkinites and one carbonatized hybrid sample indicate a weighted average age of 133.0 ± 0.2 Ma for PACC, being genetically related to the Lower Cretaceous alkaline magmatism present in the region.

Carbonatites are chemically classified (Figure 2) as calciocarbonatites and ferrocarbonatites (due to high content of magnetite), with high SrO (0.56 to 2.31 mass %) and BaO (0.07 to 2.98 mass %). PACC samples exhibit carbon-isotope composition (Figure 3) within the mantle range ($\delta^{13}C_{V\text{-}PDB}$: -6.30 to -4.97‰) as expected for primary carbonatites, but with very high $\delta^{18}O$‰ (V-SMOW) (19.74 to 22.51‰) values. Partially, these elevated $\delta^{18}O$‰ (V-SMOW) values could be explained by the overprinting of the carbonate composition by crustal fluids from post-magmatic and deuteric groundwater processes at shallow levels and/or low-temperature metasomatic changes. Otherwise, mixing curves (Figure 4) combining new $^{87}Sr/^{86}Sr$ initial ratios for 133 Ma (carbonatites: 0.706990 to 0.707473; shonkinites 0.706623 to 0.708271) and $\delta^{18}O$‰ (V-SMOW) suggest that all samples tend toward a crustal contamination trend, with an enriched $\delta^{18}O$‰ composition, rather than an enriched metasomatized source.

On the whole, the geochemical and isotopic data, the association of K-alkaline rocks and carbonatites of PAACC are comparable to the neighboring Ipanema body, related to the same lineament, as well as Pariquera-Açu (without carbonatites) in the GL and Banhadão in the SJCL (Figure 1). PAACC is synchronous with the ultramafic-carbonatitic Jacupiranga complex in the GL and coeval to the tholeiitic basalts from the Paraná Magmatic Province.

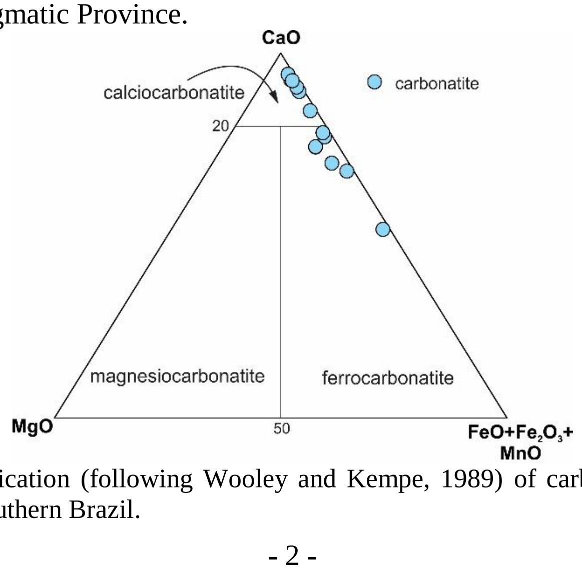

Figure 2. Geochemical classification (following Wooley and Kempe, 1989) of carbonatite samples from Piedade (Aps) carbonatite complex, Southern Brazil.

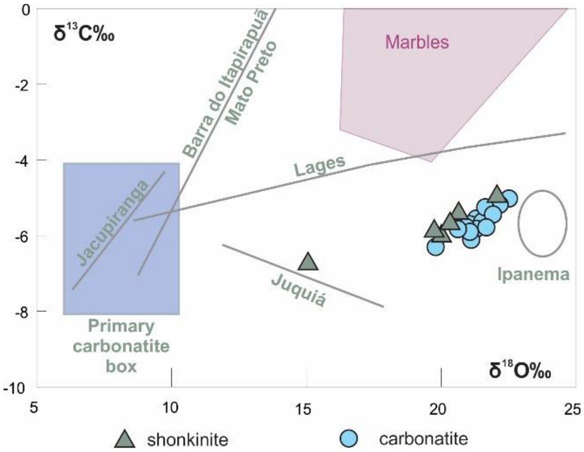

Figure 3. Stable O-C isotope compositions of selected samples from the Piedade (Aps) carbonatite complex, Southern Brazil. The diagram also shows isotopic data for other carbonatite occurrences of Early and Late (Early and Late) Cretaceous age from Southern Brazil associated with the Ponta Grossa Arch province (modified from Guarino et al. 2012).

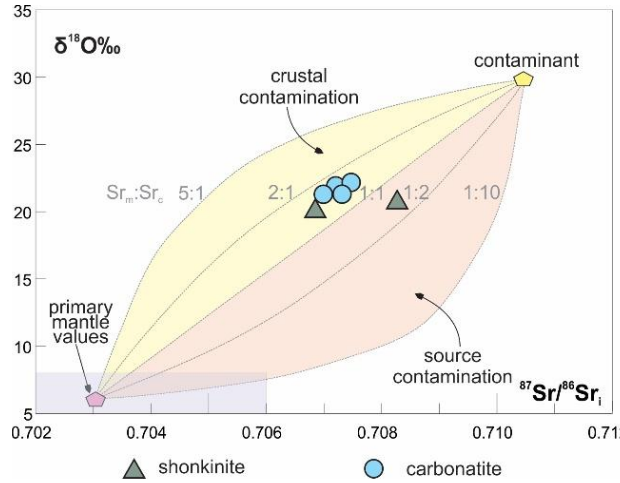

Figure 4. δ^{18}O‰ (V-SMOW) mixing diagram for the rocks from the Piedade (Aps) carbonatite complex. End-members: Brazilian crust and groundwater isotopic compositions. Mixing curves show the different effects of crustal contamination and source contamination on the Sr and O isotopic composition (modified from Guarino et al. 2012).

The association involving carbonatites, potassic to ultrapotassic alkaline rocks and kimberlites is common in the Cretaceous magmatic provinces of Southern Brazil (e.g., Alto Paranaíba Igneous Province). Although diamond alluvial deposits were described in the PGA area (e.g., Tibagi river), kimberlite intrusions are not recognized so far. Uniquely, vulcanoclastic bodies in Cerro Azul in the SJCL and Salto de Pirapora (diatreme?) in the PIL have been preliminarily reported. The possible association of PGA with kimberlites continues to need additional investigation.

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References

Almeida FFM (1986). Distribuição regional e relações tectônicas do magmatismo Pós Paleozóico no Brasil. Revista Brasileira de Geociências 16:325-349.

Guarino V, Azzone RG, Brotzu P, Gomes CB, Melluso L, Morbidelli L, Ruberti E, Tassinari CCG, Brilli M (2012). Magmatism and Fenitization in the Cretaceous Potassium-Alkaline-Carbonatitic Complex of Ipanema São Paulo State, Brazil. Mineralogy and Petrology 104(1–2):43–61. https://doi.org/10.1007/s00710-011-0168-4

Ruberti E, Azzone RG, Gomes CB, Aps V, Bettencourt JS (2020). Aspectos geológicos e petrografia da associação alcalina - carbonatítica de Piedade (APS), São Paulo". In: Gomes CB (Org.), *Os Carbonatitos Cretácicos da Plataforma Brasileira e suas Principais Características*. Edusp and IGc-USP. ISBN: 978-65-86403-00-8, DOI:10.11606/9786586403008.

Woolley, A.R., Kempe D.R.C. (1989). Carbonatites: nomenclature, average chemical compositions and element distribution. In: K. Bell (Editor), *Carbonatite Genesis and Evolution*. Unwin Hyman, London. p.1-14.