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Sedimentation, metamorphism and granite generation in a back-arc region: Records from the Ediacaran Nova Venécia Complex (Araçuaí Orogen, Southeastern Brazil)

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ABSTRACT

The Nova Venécia migmatite-granulite-granite Complex (NVC) in the core of the Araçuaí Orogen (AO, 630–480 Ma), southeast Brazil, exposes a mid-crustal section with abundant evidence for high-grade metamorphism linked to production, extraction and emplacement of peraluminous melts. Although the AO represents the textbook example of a confined orogen, there is surprisingly a lack of detailed studies on its metamorphic evolution related to widespread granitogenesis occurring from the Neoproterozoic to early Paleozoic. In this study, we combine U–Pb geochronology and metamorphic petrology to constrain the evolution of the NVC migmatitic metasedimentary granulites, from deposition to high-grade metamorphism, and to correlate the metamorphic history of the terrain with the several episodes of granite magmatism (G1–G5) in the AO. The sedimentation of the NVC can be bracketed within a maximum 13 My period, between its maximum depositional age at ca. 606 Ma and the intrusion of early syn-collisional granitoids at 593 Ma. Compilation of available U–Pb data shows that the bulk of the magmatic rocks in the AO (G1 + G2 rocks) crystallized contemporaneously over a period of 15 My (ca. 595–570 Ma) with a peak at ca. 575 Ma. Although it is inferred a protracted period of crustal heating in the AO (from ca. 640–480), U–Pb ages of metamorphic and magmatic zircons and monazites suggest at least two major heat pulses at ca. 593–560 and 523–495 Ma. The timing of peak regional metamorphism is constrained from 575 to 560 Ma, which temporally overlaps with the crystallization of the youngest granitoids. Phase equilibrium modeling of metasedimentary granulites from three different localities within the NVC, indicates that all areas record similar peak *P–T* conditions of 750–850 °C and 5300–7500 bar. This is followed by high temperature retrograde evolution to 640–800 °C and 4500–6000 bar. A post-collisional thermal event linked to the intrusion of large norite bodies (520–480 Ma) is recorded in our metagreywackes (monazite U–Pb) and in granites (monazite and zircon U–Pb) from 523 to 495 Ma.

1. Introduction

Nearly two decades after the concept of confined orogens was introduced (Pedrosa-Soares et al., 2001; Rogers and Santosh, 2004), its type example, the Araçuaí Orogen (AO, Brazil), still lacks detailed investigation. Studies on classical (or intercratonic) orogens, such as the Fosdick Complex, West Antarctica (e.g., Korhonen et al., 2012), the Ivrea Zone, Italy, (Barboza and Bergantz, 2000), and the Limpopo Belt, South Africa (e.g., Stevens and van Reenen, 1992; Nicoli et al., 2014; Taylor et al., 2014) have provided a valuable wealth of information on a variety of processes that occur during orogenesis, including high-grade metamorphism, partial melting, melt extraction and emplacement. The investigation of these processes ultimately leads to a better understanding of Earth's crustal evolution through time. But how do they operate in confined orogens? In this study, we begin to address this question by investigating one key unit within the high-grade and crystalline core of the AO: the Nova Venécia Complex (NVC).

The Nova Venécia migmatite-granulite-granite Complex is exposed over an extensive area of the AO core, where high-grade metasedimentary rocks occur in close association with voluminous peraluminous and metaluminous granitoids that

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represent pre-, syn- and post-collisonal periods in the Araçuaí orogeny (630–480 Ma, Pedrosa-Soares et al., 2011). Interestingly, the migmatites and granulites preserve a range of high-grade mineral assemblages with little evidence for retrogression.

The novelty of this study consists in the use of combined methods to constrain the nature of these high-grade lithotypes, the ages of metamorphism linked to granite formation and the metamorphic evolution within the NVC, specifically, we use field-based observations, petrography, mineral chemistry, U–Pb LA-ICP-MS geochronology in zircon and monazite and thermodynamic modeling (pseudosections) in order to: (1) constrain the *P–T* evolution of samples; (2) establish why the high-grade rocks record different mineral assemblages; (3) determine a possible source or different sources for high-grade metasedimentary samples based on geochronology; and (4) correlate metamorphic events to intrusion of igneous bodies occurring in close association with the sampled high-grade rocks. This is a contribution to help elucidate crustal processes occurring in the AO, which may also lead to a better understanding of other Gondwana-related orogenic segments today exposed in South America and Africa.

2. Geological setting

The Nova Venécia Complex comprises migmatitic granulite facies metasediments and granitoids located in the high-grade core of the Araçuaí Orogen, in the states of Minas Gerais and Espírito Santo, southeast of Brazil (Fig. 1). The AO is one of the Neoproterozoic-Lower Paleozoic orogenic segments formed diachronously during the Brasiliano-Pan African amalgamation of West Gondwana to the south of the paleo-São Francisco-Congo Craton (Fig. 2). The terranes once merged into West Gondwana landmass were broken apart by the Cretaceous South Atlantic

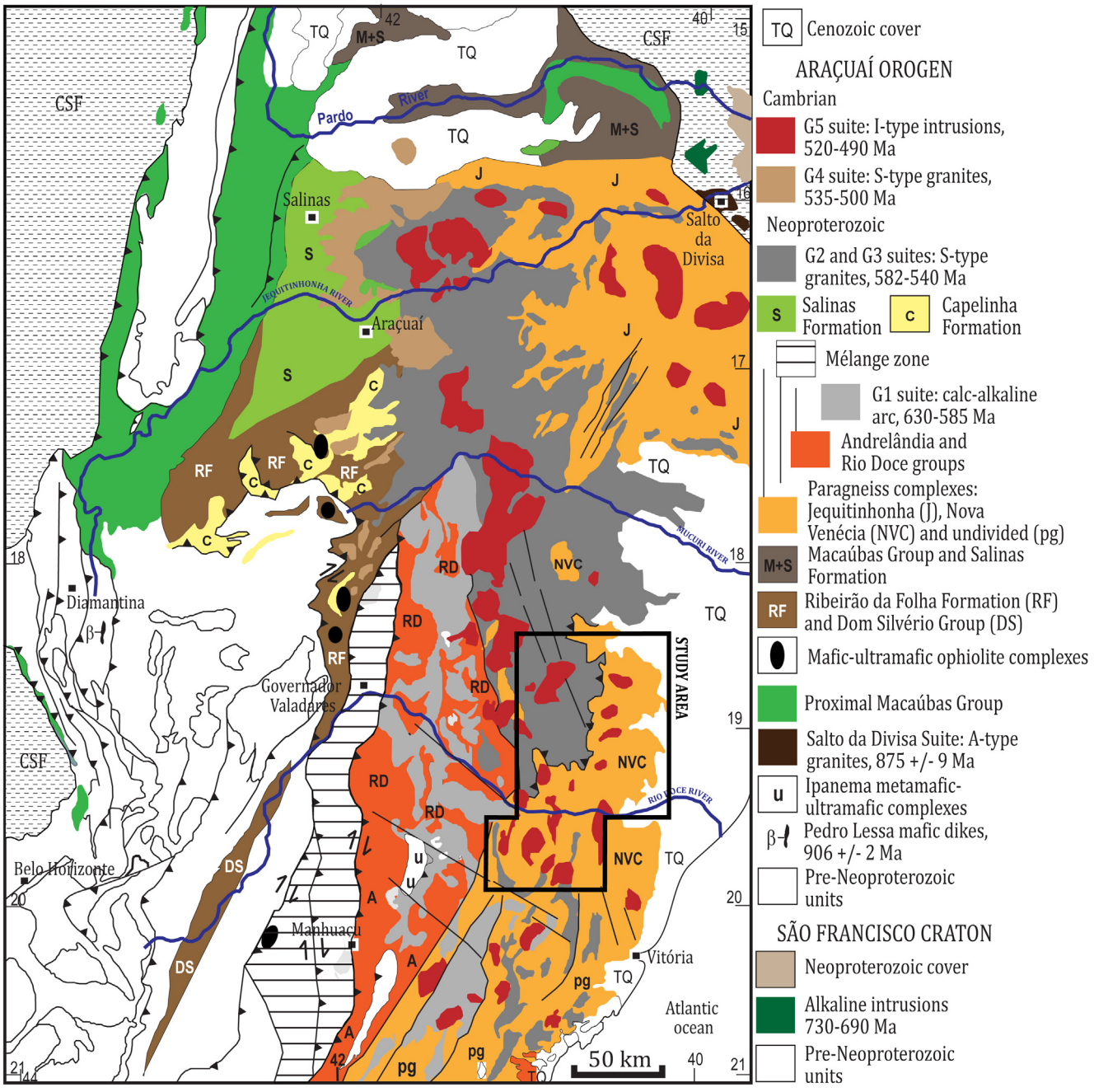

Fig. 1. Geological map of the Araçuaí Orogen and the study area (modified from Pedrosa-Soares et al., 2007).