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Contrasting cooling rates of two Brasiliano terranes in SE Brazil using $^{40}Ar/^{39}Ar$ data – the Gondwana collage propagates through the Silurian-Devonian

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During the collage of West Gondwana tectonic events (Panafrican-Brasiliano) formed mobile belts now exposed along the Brazilian and African margins. The Ribeira Orogen (SE Brazil) is a result of convergent tectonics that started at 580 Ma and continued at least until 500 Ma, due to approximation and final collision between the southern São Francisco Craton, in Brazil, and the Angola Block, in Africa. We present here new Ar-Ar data from the eastern tip of the Ribeira Orogen, mostly covered by the Brazilian marginal basins, which records a tectono-thermal history that has a major mid-Cambrian peak and continues all through the Silurian-Devonian. The thermochonological evolution of the rocks from the Oriental Terrane (Sana Granite and host paragneisses) and the Cabo Frio Tectonic Domain (Buzios paragneisses and Paleoproterozoic reworked basement) are investigated by laser step heating $^{40}Ar/^{39}Ar$ analysis (UQ-AGES Laboratory) on distinct themochronometers (amphibole, biotite, and feldspar) along a NW-SE transect across both domains.

The $^{40}Ar/^{39}Ar$ analyses reveal a protracted cooling history for the Oriental Terrane (OT). Two samples, from the late-tectonic Sana Granite, yield biotite ages varying between 450 ± 2.0 and 444 ± 3.0 Ma and K-feldspar ages ranging from 404.0 ± 2.0 to 397.0 ± 2.0 Ma. Its crystallization age is 491 ± 10 Ma (U-Pb zircon age [1]) therefore, this intrusion cooled from 800^{o}C to 250 ± 50 °C in a period of ~100 m.y, resulting a cooling rate of ~5-6°C·Ma^{-1}. The host rock, two samples of paragneisses, yield biotite ages varying between 451 ± 3.0 and 444.0 ± 3.0 Ma. The plagioclase do not define plateau ages, but reveal younger apparent ages varying between 361 ± 17 and 290 ± 18 Ma (minimum ages). In this unit, U-Pb ages on metamorphic minerals (monazite and zircon) indicate a metamorphic peak of LP-HT at 555 Ma [2]. This similar biotite Ar-Ar ages suggest that the heat of the granitic intrusion reset the argon isotopic system in the host rocks. The feldspar ages indicate that thermal anomalies or hydrothermal fluid circulation may have affected the paragneisses for ~50-100 Ma after the granite cooling. The long-term cooling of the Sana granite (~500 ^{o}C in ~100 my) and the ~150 Ma interval between the metamorphic peak and the Ar-Ar feldspar closure temperature in the paragneiss, indicate that the OT was hot for a long period, with a slow cooling rate in the Ordovician–Silurian.

In the neighbor Cabo Frio Tectonic Domain (CFTD), Neoproterozoic HP-HT metassedimentary rocks present biotite Ar-Ar ages between 469.0 ± 3.0 Ma and 467.0 ± 3.0 Ma. In this unit, U-Pb ages on metamorphic monazites indicate concordant ages at 515-495 Ma [2]. These results suggest that the CFTD units show a much faster cooling rate at ca. ~12-15°C·Ma^{-1}, a contrasting thermal cooling history in comparison with the OT. If we consider only the biotite Ar-Ar-ages, at ca. 470 Ma the former was already at ca. 300°C. The Paleoproterozoic basement reworked in the Brasiliano (515 Ma - U-Pb in metamorphic zircon [2]) yield Ar-Ar ages of 503.0 ± 3.0 Ma, 483.0 ± 2.0 Ma, and 450.0 ± 6.0 Ma for amphibole, biotite, and feldspar, respectively. This data corroborates with the geological data that point out a suture zone between these two terranes. The OT would be the upper plate of a Neoproterozoic-Cambrian subduction zone, a hot plate that remains above 300°C until the Silurian. The CFTD would be the continental crust that went partially under subduction, composed by HP-HT tectonic sheets of supracrustals that were fast exhumed during the Cambrian collision. In addition, this is the youngest record of the thermal events linked to the Gondwana collage indicating that still at. ca. 400 Ma this supercontinent was not stabilized and wielded as a major plate. Part of this inherited heat might affect the formation of the major intracontinental Paleozoic basins.

References:

[1] Valeriano, CM et al. (2011) J South Am Earth Sci 32:416-428.
[2] Schmitt, RS et al. (2004) Precamb Res 133:29-61.