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Thermotectonic effects of West Gondwana breakup on the southernmost Mantiqueira Province, Brazil, revealed by fission tracks and (U-Th)/He

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Low-temperature thermochronometry has improved the understanding of the evolution of the Mantiqueira Province in the Brazilian passive margin. Most of the published investigations were conducted in the SE of the province, while the region further south, the Sul-Rio-Grandense Shield (SRGS), has had limited attention. Through the joint use of apatite fission tracks (AFT) and (U-Th)/He analysis in apatite (AHe) and zircon (ZHe), this study evaluates the thermotectonic evolution of the SRGS and the effects of the breakup of Gondwana. The SRGS was formed during the Brasiliano/Pan-African Orogeny (Neoproterozoic), after the collision of the Rio de La Plata, Congo and Kalahari cratons. Four main Proterozoic tectonostratigraphic terranes, limited by NE-SW and NW-SE shear zones, compose the SRGS: 1) Taquarembó (SW), 2) São Gabriel (NW), 3) Tijucas (central) and 4) Pelotas (E). These are partially covered by the Camaquã Basin (Late Ediacaran-Cambrian), and limited to the north and west by the intracontinental Paraná Basin (Paleo-Mesozoic), and to the east by the Atlantic Pelotas Basin (Meso-Cenozoic). Analysed samples, collected from the four terranes and the Camaquã Basin, resulted in 18 AFT, 43 AHe and 30 ZHe ages. Thirteen sites in terranes 1, 3 and 4 have similar AFT central ages, ranging from 139.9 $\pm$ 17.2 to 205.1 $\pm$ 19.7 Ma (early Jurassic-early Cretaceous). AFT ages from terrane 2 are late Carboniferous, while the Camaquã Basin has one early Permian and another early Jurassic age. The mean track length of confined tracks from the SRGS range from 10.7 $\pm$ 0.2 μm to 12.8 $\pm$ 0.2 μm, with a normal or negatively skewed distribution. AHe ages, obtained from thirteen locations, present a wide dispersion, although 70% of the mean AHe ages are Mesozoic. Similar dispersion has been reported in other cratonic regions, where apatites remained for long periods in the partial retention zone. The relation between AHe ages, eU and crystal radius is not clear. Mean ZHe ages from three sites in terrane 4 are early Permian, and present a negative correlation with eU. Terrane 2 and Camaquã Basin mean ZHe ages are Devonian. Inverse thermal modelling indicates a Devonian-Carboniferous cooling phase in the west of the SRGS, which is time correlated with two events affecting the surface dynamics of southernmost Brazil: I) end of Gondwana glaciation, which led to a regional uplift due to isostatic rebound and exposed basement rocks to weathering, raising erosion/uplift rates and II) Gondwanides Orogeny, that could have caused regional uplift of the SRGS in response to compressive stresses at the SW margin of Gondwana. A major event affects most of the SRGS between the Permian and Jurassic, slowly cooling rocks from ca. 110°C to 60°C, and is likely related to lithosphere uplift and thinning preceding Gondwana breakup and the onset South Atlantic Ocean opening (early Cretaceous). Samples from terrane 4, closer to the coast, suggest a subtle reheating after this event, probably linked to a geothermal disturbance syn- to post-breakup. A final cooling episode leading to surface temperatures affects the whole SRGS after Paleocene.