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Advancing direct pseudotachylyte dating through in situ Rb-Sr: A case study from NE Brazil

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Pseudotachylyte (pst) provides a direct record of high-velocity seismic slip through frictional melting, yet their extreme, localized formation temperatures (>1000 °C) often make traditional geochronology a challenge. Recently, middle- to upper-crustal pst have been tentatively dated by various methods, including whole-rock $^{40}Ar/^{39}Ar$ [1, 2], and monazite and apatite U–Pb [3, 4]. However, results can be ambiguous due to incomplete resetting of the isotopic systems and often hard to distinguish the pst formation age from the host-rock cooling age.

This study demonstrates the utility of *in situ* Rb-Sr dating to overcome these challenges. We analyzed K-bearing pst hosted in a granitic mylonite from the West Pernambuco shear zone (NE Brazil). Using LA-ICP-MS/MS, we directly targeted the pst's dark matrix and the results reveal a Late Ordovician seismic event with a Rb-Sr isochron age of 447 ± 7 Ma. This event took place c. 120 Myr after the ductile shearing (566 ± 7 Ma) of the host rock, captured by the Rb-Sr data from the muscovite and the K-feldspar from the mylonite. The granite protolith originally crystallized at 995 ± 6 Ma, as revealed by zircon U-Pb dating. Trace elements and initial $^{87}Sr/^{86}Sr$ ratios confirm that the pst originated from the *in situ* frictional melting of the mylonite, with no evidence of subsequent alteration by external fluids.

Regionally, the discovery of Late Ordovician seismic slip is particularly striking because it post-dates the Brasiliano orogeny (630–560 Ma) [5], suggesting the region remained tectonically active long after the orogen had supposedly cooled and exhumed. The integration of *in situ* Rb-Sr dating with simultaneous trace-element analysis provides a robust framework for determining the timing of pst formation. This method significantly enhances our ability to date seismic slips, allowing for a more precise assessment of earthquake recurrence and its relationship to global orogenic cycles.

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