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Birth and demise of the Rheic Ocean magmatic arc(s): Combined U–Pb and Hf isotope analyses in detrital zircon from SW Iberia siliciclastic strata

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ABSTRACT

Paleozoic continental reconstructions indicate that subduction of Rheic oceanic lithosphere led to collision between Laurussia and Gondwana which was a major event in the formation of the Ouachita–Appalachian–Variscan orogenic belt and the amalgamation of Pangea. However, arc systems which record Rheic Ocean subduction are poorly preserved. The preservation of Devonian detrital zircon in Late Devonian–Early Carboniferous siliciclastic rocks of SW Iberia, rather than arc-related igneous rocks indicates that direct evidence of the arc system may have been largely destroyed by erosion. Here we report in-situ detrital zircon U–Pb isotopic analyses of Late Devonian–Early Carboniferous siliciclastic rocks from the Pulo do Lobo Zone, which is a reworked Late Paleozoic suture zone located between Laurussia and Gondwana. Detrital zircon age spectra from the Pulo do Lobo Zone Frasnian formations show striking similarities, revealing a wide range of ages dominated by Neoproterozoic and Paleoproterozoic grains sourced from rocks typical of peri-Gondwanan terranes, such as Avalonia, the Meguma terrane and the Ossa-Morena Zone. Pulo do Lobo rocks also include representative populations of Mesoproterozoic and Early Silurian zircons that are typical of Avalonia and the Meguma terrane which are absent in the Ossa-Morena Zone. The Famennian–Tournaisian formations from the Pulo do Lobo Zone, however, contain more abundant Middle–Late Devonian zircon indicating the contribution from a previously unrecognized source probably related to the Rheic Ocean magmatic arc(s). The Middle–Late Devonian to Early Carboniferous zircon ages from the siliciclastic rocks of SW Iberia (South Portuguese, Pulo do Lobo and Ossa-Morena zones) have a wide range in ϵ_{Hf} values (–8.2 to +8.3) indicating the likely crystallization from magmas formed in a convergent setting. The missing Rheic Ocean arc was probably built on a Meguma/Avalonia type basement. We propose for the Pulo do Lobo Zone that the Frasnian sedimentation occurred through the opening of a back-arc basin formed along the Laurussian active margin during Rheic Ocean subduction, as has been recently proposed for the Rhenohercynian Zone in Central Europe. Detrital zircon ages in the Frasnian siliciclastic rocks indicate provenance in the Meguma terrane, Avalonia and Devonian Rheic Ocean arc(s). As a result of back-arc basin inversion, the Frasnian formations underwent deformation, metamorphism and denudation and were unconformably overlain by Famennian to Visean siliciclastic strata (including the Phyllite–Quartzite Formation of the South Portuguese Zone). The Latest Devonian–Early Carboniferous detritus were probably shed to the Pulo do Lobo Zone (Represa and Santa Iria formations) by recycling of Devonian siliciclastic rocks, from the South Portuguese Zone (Meguma terrane) and from a new distinct source with Baltica/Laurentia derivation (preserved in the Horta da Torre Formation and Alajar Mélange).

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