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Foreword: The Ediacaran-early Palaeozoic Cadomian zircon province fringing Northwest Gondwana

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This special issue grew out of the "The Panafrican and Cadomian orogenies in North Africa and western Europe" meeting, held online in June 2021. It includes a selection of contributions presented at the workshop with the aim of covering a broad range of challenges derived from the application of the Cadomian zircon province concept.

The Cadomian zircon province comprises an Ediacaran-early Palaeozoic realm located along the northwestern margin of Gondwana that comprises a mixture of zircon populations derived from the Cadomian arc mixed with older zircon grains likely sourced from northern African Gondwana, which includes, from west to east, the West African craton, the Trans-Saharan Belt, the Saharan Metacraton and the Arabian-Nubian Shield. The province can be identified by the U-Pb ages and the Lu-Hf isotope composition of zircon populations yielded by Ediacaran-lower Palaeozoic volcaniclastic and epiclastic sandstones and quartzites, and is a powerful tool for palaeogeographic reconstructions. They reflect the stepwise influence of the Pan-African orogenic cycle, Cadomian Orogen, Cambrian rifting processes and Furongian to early Tremadocian opening of the Rheic Ocean in NW Gondwana. Once the denudation of uplifted Cadomian and Cambrian rifting blocks ended and the Gondwana margin evolved to a mature passive margin, zircon populations exclusively derived from Gondwana source areas with no further influence of the Cadomian arc. Then, the province gradually disappeared.

The early stage of the Cadomian (or Pan-African) evolution is characterized by a Cordilleran-type continental magmatic arc established between ~650 and 600Ma. Subsequently, at ~590 to 560Ma, a back-arc basin developed behind the Cadomian magmatic arc, which nearly closed between ~545 and 540Ma, leading to the development of a short-lived Cadomian retro-arc basin. The cause of the demise of the Cadomian arc remains still unknown but a mid-oceanic ridge or a mantle-plume subduction underneath the Cadomian subduction related orogenic edifice have been alleged as possible causes. Subsequent slab break-off of the subducted oceanic plate resulted in increased heat flow leading to voluminous magmatic and anatectic events that culminated at ~540Ma. Oblique incision of the oceanic ridge into the continent may have caused the Terreneuvian onset of rifting conditions, the so-called Atlas – Ossa-Morena – Northarmorican Rift, which ended with a Furongian break-up unconformity, finally evolving into the stepwise opening of the Rheic Ocean in Ordovician times.

The analysis of detrital zircon populations has played a prominent and complex role in interpreting the composition of Cadomian source areas. The tens of published works providing detrital zircon data in the last two decades indicate the increasing success in assessing provenance, palaeogeography and tectonic reconstructions. Selected studies are highlighted in this review to illustrate ways in which detrital zircon can be used for interpreting the stratigraphic record.

Chichorro *et al.*'s contribution shows how the Pan-African and Cadomian orogenic events (790-605 and 590-550Ma, respectively) impacted on the Neoproterozoic units of the Iberian Massif and how the Pan-African/Cadomian signature persisted in the subsequent rift to drift cycle. Detrital zircon age spectra show that the main systematic peak throughout the late Neoproterozoic to Early Ordovician time span (~120m.y. of sedimentary record) occurs at ~610Ma, followed by subsidiary Cadomian peaks (~590-550Ma). The inherited zircon grains incorporated in Cambrian to Lower Ordovician igneous rocks also share typical Cadomian ages (~590-550Ma) but, once again, a remarkably consistent Pan-African ~610-Ma peak is highlighted, despite the almost absence of igneous rocks of this age. Ediacaran (~610Ma) zircon incorporated in Paleozoic magmas provides indirect evidence of a Pan-African magmatism, suggesting that these magmas and their synorogenic sediments likely constitute the cryptic basement of the Iberian Massif. Assuming that the Iberian crust is a fragment of the Pan-African orogen, a relative Ediacaran palaeoposition for the Iberian basement should be placed between the West African craton and the Trans-Saharan Belts.

Padel *et al.*'s work documents an analysis of detrital zircon grains from Cambrian-Lower Ordovician sandstones in the Eastern Pyrenees, which are compared with contemporaneous datasets from neighbouring margins of Gondwana, such as Morocco, the Iberian Peninsula, southern France and Sardinia. During Terreneuvian times, zircon populations allow the distinction of: i) the Atlas–Ossa-Morena Rift axis, at the southwesternmost edge, influenced by Panafrican and Anti-Atlasian sources; and ii) the northeasternmost edge in Sardinia recording the dominant influence of the Saharan Metacraton and the Arabian Nubian Shield; separated by iii) the Gondwana margin preserved in the Iberian massif, the Montagne Noire and the Pyrenees, displaying a progressive influence from Anti-Atlasian/Panafrican to Saharan Metacraton/Arabian Nubian Shield sources. The variation in zircon percentage populations supports similar trends based on climatically sensitive indicators, and Cambrian Epoch 2 biogeographic indicators based on archaeocyathan and microfossil assemblages, all of them pointing to a Cambrian setting of the Pyrenean margin of Gondwana between the Montagne Noire and the Sardinian transects.

The paper of Pujol-Solá *et al.* describes, analyzes geochemically and interpret the emplacement of Cadomian metabasites in the Canigó and Cap de Creus massifs from the Eastern Pyrenees. As discussed in the previous paper, the northeasternmost edge of the Iberian Peninsula does not belong to the Iberian massif, but to its lateral prolongation that links to the Montagne Noire, the Eastern Pyrenees and southern Sardinia. This area lacks any known Cadomian unconformity but the end of the orogeny is represented by the onset of a distinct stepwise magmatic episode whose byproducts recorded successive strong tectonometamorphic events as a result of the forthcoming Variscan and Alpine orogenies. The described Ediacaran basanites (ca. 632Ma in age) reflect the influence of island-arc tholeiites generated in an extensional back-arc basin that formed separating the Cadomian arc and the Gondwana margin.

Finally, Lains Amaral *et al.*'s paper confirms, using previously published U-Pb detrital zircon data, the importance of the Cadomian record in the growth of the South Portuguese crust. The provenance of the oldest strata in the Iberian Pyrite Belt (middle-upper Devonian) that have a remarkable resemblance with the Ossa-Morena Neoproterozoic-Cambrian rocks and the West Meguma's Cambrian-Ordovician rocks, is discussed. The Birimian-Eburnean peak distribution (~1.8-2.2Ga) is an important characteristic to distinguish West Meguma from Ossa-Morena sources. A dominant West Meguma-type provenance (Cambro-Ordovician) is documented for the middle-upper Devonian rocks of the Iberian Pyrite Belt, attending to Birimian-Eburnean pattern similarities and multidimensional scaling dissimilarities. In addition, the similarities between Ossa-Morena Zone and West Meguma's detrital rocks strongly suggest a similar paleogeographic setting (but diachronic?) for both domains during the Ediacaran to early Ordovician times relative to the North African blocks.

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