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Inherited vs. detrital zircons: an integrated approach to unravel crustal tectonics

PEDRO CACHAPUZ[1], **PROF. TELMO M BENTO DOS SANTOS**[2,3] AND MARTIM CHICHORRO[4]

[1]IDL - Instituto Dom Luíz, FCUL - Faculdade de Ciências da Universidade de Lisboa
[2]DCTE-FCUL - Departamento de Ciências da Terra e Energia, Faculdade de Ciências da Universidade de Lisboa
[3]Instituto Dom Luiz (IDL), FCUL - Faculdade de Ciências da Universidade de Lisboa
[4]FCT-UNL - Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa

Detrital zircons are key to understanding the paleogeographic evolution of continental blocks. Yet, their age patterns are influenced by external factors, such as nature of the exposed rocks and sediment-transport processes, often amplifying/reducing age signals. Inherited (pre-magmatic) zircons, as survivors of deep crustal melting incorporated into younger magmas, preserve the history of the region's magmatic events, including cryptic episodes that are poorly represented/absent from detrital datasets. Therefore, integrating inherited and detrital zircon age patterns reduces biases, allowing more complete reconstructions of regional geodynamics.

We applied this integrated approach to unravel the evolution of the Iberian crust throughout the Cadomian Orogeny, the Cambrian–Ordovician Rift-to-Drift event, and the Variscan Orogeny.

Cadomian-related detrital spectra display strong Pan-African age signals (49%), whereas equivalent inherited patterns are dominated by Cadomian ages (50%). This suggests that local tectonics during the Cadomian event favoured the exposure and subsequent erosion of older Pan-African crust, being Cadomian magmatism mostly sub-superficial.

Rift-to-Drift-related age patterns highlight how basin location influences detrital spectra, as these show an orogenic bias. These ages are typically underrepresented but can be more prominent when basins are positioned closer to volcanic sources. On the other hand, inherited zircon patterns show more balanced proportions of rift-related and orogenic ages, offering a clearer view of magmatic contributions and revealing cryptic magmatic events.

Variscan-related datasets display the strongest divergence between detrital and inherited patterns. Inherited spectra preserve evidence of all three major geodynamic events recorded in the Iberian Massif, whereas their detrital counterparts show strong orogenic biases. Basins formed during intra-orogenic extension near widespread shallow intrusions show detrital age patterns with predominance of Variscan-related Devonian-Carboniferous ages (40%). In contrast, basins formed in intramountainous settings where pre-Variscan rocks are preferentially exposed have a predominance of Pan-African/Cadomian ages (58%) in their detrital age spectra, reflecting recycling of the exhumed upper crust.

In summary, integration/comparison of detrital and inherited datasets highlight how inherited zircon ages can profoundly influence the interpretations regarding geodynamic evolution within orogenic settings.

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