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Zircon morphology vs. whole-rock geochemical characterization in meta-volcanic rocks

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Petrographical and geochemical discrimination in low to high-grade metamorphosed paleovolcanic rocks constitutes one of the most troublesome issues in geological studies. Zircon morphology provides interesting clues to resolve this problem. The Variscan regional Narcea Antiform of the Iberian Massif (N Spain) is formed by Neoproterozoic units outcropping between the mostly unmetamorphosed foreland and the medium to high-grade hinterland. A sequence of acid to basic igneous rocks (plutonic, hypabyssal and volcanic) is exposed within Ediacaran sediments of the Narcea Antiform. Variably deformed and recrystallized granodioritic to gabbroic remnants into the lowermost volcanic-volcanosedimentary series have yielded protolith ages of ca. 600 Ma [1]. Siliciclastic and volcanosedimentary deposits together with a 350-500 m thick pile of rhyolithic to andesitic tuffaceous and lavic rocks dated at ca. 560 Ma [2], and minor diorites form the upper series. Finally, hypabyssal basaltic dykes are found cross cutting both the extrusive and dioritic rocks. Original igneous textures are preserved where deformational processes barely affected the sequence, while secondary mineral assemblages reveal low-moderate hydrothermal alteration. Along the East limb of the Narcea Antiform, siliciclastic Cambrian materials occur in angular unconformity over an Neoproterozoic sedimentary sequence (Narcea Slates). The basal Cambrian occasionally includes (micro)-conglomeratic suggestive of cohesive debris flow and braided channels. Most of the clasts are rhyolithic in composition with scarce andesite and trachyte, mainly of tuffaceous and ignimbritic character with minor lavas, likely representing the last volcanic episode of the Cadomian cycle in this area. The Cambrian rocks above the discordance are no deformed, maintain their original microstructures and clasts show primary severe hydrothermal alteration. The

geochemistry of the Ediacaran upper volcanic series (EUVS) shows features transitional between those of calc-alkaline and alkaline series in the TAS diagram (mainly intermediate to basic rocks), while in the Zr/TiO2-Nb/Y and AFM diagrams depicts a calc-alkaline trend slightly rich in Fe. The rhyolitic volcanic clasts (VC) in the overlying Cambrian units are distinctly richer in silica and poorer in sodium. Content and trend in Y and Nb elements discriminate between rhyolithic EUVS and VC; EUVS shows a variable values in Nb versus Y constant, and opposite trends in VC. In spite of the different bulk rock geochemical features, the morphology of zircons [3] from the clasts and lower volcanics shows strikingly common characteristics. Zircons reveal a common high temperature nature of the crystals, are mostly pale pinkish, show lacks of growth in their general shape and bear a large quantity of glassy and apatite inclusions. The zircons are mainly of the P4 morphological type having overall characteristics typical of alkaline rocks. Such an apparent contradiction is interpreted as a result of a change in the tectonic conditions from a compressive or orogenic to a distensive or anorogenic setting. This would account for the mixed characteristics of rocks having a typical calc-alkaline geochemical signature but with an alkaline mineral assemblage.
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