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Variscan metamorphism and fluid-rock interaction in Lower Cambrian carbonates of the Central Iberian Zone (Toledo Mountains, Spain)

Silvia Menéndez (1), Luis González-Menéndez (2), and Francisco J. Rubio Pascual (3)

(1) Museo Geominero (IGME), Ríos Rosas 23, 28003 Madrid, Spain (s.menendez@igme.es), (2) IGME, Unidad de León, Avda Real 1, 24006 León, Spain (l.gonzalez@igme.es), (3) IGME, Área de Cartografía Geocientífica, Ríos Rosas 23, 28003 Madrid, Spain (f.rubio@igme.es)

In the southern Central Iberian Zone of the spanish Variscan massif, at the Urda village and nearby locations, there outcrop carbonate-siliciclastic rocks of the lower Cambrian Navalucillos Formation. These rocks are impure limestones ± dolostones affected by metamorphism and deformation during the Variscan orogeny (Carboniferous: middle to upper Missisipian). Some of the textures observed consist in quartz (± sericite) domains that include calcite nodules where archaeocyathan bioclasts are abundant, with silicate rims of Mg-biotite ± clinochlore ± iron-sulfides ± K-feldspar. Outside the rims, the silicate phases are Mg-biotite, ± muscovite, ± K-feldspar, ± chlorite-clinochlore, ± titanite, ± calcic-plagioclase, and iron sulfides. This mineral assemblage requires metamorphic/ metasomatic conditions to form phases such as Mg-biotite.

Two hypothesis are considered: 1) A chert and clay mineral assemblage that partially encloses calcite/dolomite domains. These set of lithofacies were deformed and affected by the regional metamorphism with a moderate input of external dehydration-decarbonation fluids. 2) Initial impure limestones and dolostones were infiltrated by magmatic H_2O ± CO_2 external fluids carrying variable amounts of Si and other minor components during the variscan orogenic event. This fluid could have been related to granite intrusions located farther east.

P-T-XCO_2 thermodynamic modeling was performed with an effective bulk rock composition of the chert-calcite nodules and its rim of silicate phases. The calculated mineral assemblage matches fairly well with the observed one for low pressure conditions of metamorphism, low to moderate XCO_2 fluid (≈ 0.2-0.5) and a T range of ≈ 300-375ºC. The absence of amphibole or clinopyroxene in the studied rocks indicates temperatures below ≈ 400-450ºC. The presence of chlorite/clinochlore suggests that the fluid CO_2 content was low to moderate and hence this carbonate system could have been infiltrated by H_2O external fluids. The CO_2 was produced by progressive decarbonation during temperature increase and H_2O interaction. The model predicts an iron-carbonate phase at lower temperature (ankerite).The presence of S species (not modeled) probably favored the development of Fe sulfides instead.

Hypothesis 1 of regional metamorphism seems more plausible: the granite outcrops are, apparently, too far away from the studied rocks. Nevertheless, the external H_2O might come from dehydration of metapelitic domains and/or exsolution by granite intrusions. External H_2O input is also favored by the moderate to high variability (up to 6‰ observed in the isotopic δ18O values (Menéndez et al., 2010).

References

Menéndez, S., Rodríguez-Martínez, M., Moreno-Eiris, M., Perejón, A. & Reitner, J. (2010): Palaeo environmental and geochemical approach of archaeocyath-rich facies from Lower Cambrian of western Gondwana margin at Central Iberian Zone (Urda, Toledo Mountains, Spain). EGU General Assembly Conference Abstracts 12: 9359.