Preliminary petrological inferences on the high-grade metamorphic rocks exhumed by the South Rif Thrust, Prerif, Northern Morocco

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Abstract

The exhumation of deep crustal rocks along major shear zones is common, yet a highly debated subject, particularly when occurring during recent tectonic events. This is the case of the South Rif Thrust (SRT), a significant shear zone analogous to those described at the Betic Cordillera in Spain. The SRT separates two major geodynamic domains in Northern Morocco: a) the Prerif, to the North, mostly composed of Miocenic sedimentary units on top of a stratigraphic sequence continuously deposited since the Triassic; and b) the Western Meseta, to the South, mostly composed of Paleozoic metasedimentary units, correlated with the Iberian Variscan Belt [1]. Associated to the SRT, and exhumed by its activity, there is a dismembered and exotic high-grade metamorphic belt representative of the middle and lower crust. Also in this region, several thermo-mineral waters occur, whose deep circulation can be traced back to the SRT [2].

Detailed geological mapping, structural, stratigraphic and petrographic analyses on this dismembered and highly deformed exotic sequence reveal the presence of low- to high-grade metasediments (including migmatites and felsic granulites), but mostly high-grade metabasic and basic rocks, including amphibolites, mafic granulites and gabbros.

Preliminary geothermobarometry in the mafic granulites provides an important characterization of the infra-crustal conditions of the pre-Alpine geodynamics and of the activity and exhumation along the SRT since the Miocene: a) the mafic granulites endured M1 metamorphic peak conditions of T = 1030 °C at P = 8.5 kbar, which is consistent with typical conductive continental crust geothermal gradients (~30 °C.km-1); b) M2 retrogression occurred by near isothermal decompression at T = 820 °C and P = 3.5 kbar, implying an initial vertical uplift of >18 km of the granulite-facies rocks to very shallow levels; c) during this period, the geothermal gradient in the region surpassed 60 °C.km-1; d) exhumation and retrogression continued by almost isobaric cooling at T < 750 °C and P = 1.7 – 3.0 kbar with an M3 amphibolitization of the granulites after late water inflow.

The overall metamorphic evolution of these deep crustal rocks is compatible with a clockwise P-T path, involving initial fast tectonic exhumation, followed by thermal readjustment to shallower levels. This is consistent with the currently observed geothermal gradients in the area (≤ 42 °C.km-1) [2] which may still be a reflection of the events during the Miocene.

These petrological constrains on the tectonic processes associated with the exhumation of this lower crust segment and the activity of the SRT during the closure of the Alboran Basin are key to understanding the circulation of deep hot waters, which are an important part of the economy of this region in Northern Morocco. Publication supported by FCT- project UID/GEO/50019/2013 - Instituto Dom Luiz.

references

[1] Michard et al., 2008. Continental Evolution: The Geology of Morocco. Lecture Notes in Earth Sciences, 116, Springer-Verlag, 424; [2] Sabri et al., submitted. Geothermics, 2018.