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40Ar/39Ar constraints on the activity of the Temsamane extensional detachment (eastern Rif, Morocco)

A. Jabaloy Sánchez (1), G. Booth-Rea (2), A. Azdimousa (3), L. Asebriy (4), M. Vázquez-Vílchez (1), J. M. Martínez-Martínez (1), and J. Gabites (5)

(1) Univ. Granada, Geodinámica, Granada, Spain (jabaloy@ugr.es), (2) Instituto Andaluz de Ciencias de la Tierra UGR-CSIC, Campus Fuentnueva s/n 18002, Granada, Spain, (3) Laboratoire LGA, Faculté des Sciences, Université Mohammed I, Oujda (Morocco), (4) Institut Scientifique, B.P. 703, Université Mohammed V, Agdal-Rabat (Morocco), (5) Pacific Centre for Isotope and Geochemical Research, Department of Earth and Ocean Sciences, The University of British Columbia,6339 Stores Road, Vancouver, B.C. V6T 1Z4, Canada

The subducted North Maghrebian passive margin was exhumed by an upper crustal brittle-ductile extensional detachment and brittle low-angle normal faults in a continental subduction transform setting. The Temsamane detachment in the eastern Rif is defined by a ductile shear zone approximately 100 m thick with a low-angle ramp geometry that cuts down into the Temsamane fold-nappe stack. The shear zone shows southwestward kinematics and separates epizone metapelites of the Temsamane units below from the epizone to diagenetic rocks of the Tanger-Ketama-Aknoul units above. To the east, the detachment becomes brittle, branching into a listric-fan that cuts through 10–6 Ma sediments and volcanoclastics in the Tres Forcas cape.
New 40Ar/39Ar radiometric ages on amphiboles and micas from the footwall of the Temsamane detachment indicate that the metamorphic peak was reached in the footwall (Temsamane units) at ca. 21 Ma, producing the amphibolite epidote facies in the Ras Afrou Unit. The cooling of the footwall rocks below the 325 ºC occurred between the 16 and 13 Ma, while apatite fission track ages indicate that the cooling below the 120 ºC occurred at ca. 11 Ma. The 40Ar/39Ar radiometric ages on amphiboles and micas of the metamorphic klippes over the Temsamene units (Ait-Amrâne massif) indicates that the Jurassic marbles of the Tanger-Ketama Unit reached their metamorphic peak at ca. 80 Ma, in agreement with previously published K/Ar ages in micas. The rocks of the Tanger-Ketama Unit cooled below the 120 ºC between 17.0 $\pm$ 2.4 Ma and 13.9 $\pm$ 1.8 Ma. We interpret the increase of cooling rates of the footwall rocks between 15-13 Ma and 11 Ma as due to the activity of the Temsamane detachment fault. Thus, both the North Maghrebian and the South Iberian subducted passive margins were exhumed in the Betic and Rif branches of the Gibraltar arc by SW-directed brittle-ductile detachments during the Late Miocene in an oblique collisional setting.