

The Jurassic-Cretaceous Alkaline-Transitional Intra-Plate Magmatism of the High Atlas (Morocco): Evidence of Pre-Existing Lithospheric Thin Spots

Mohamed Khalil Bensalah^{1,2,3}, Nasrddine Youbi^{1,2,3,4}, João Mata^{2,3}, José Madeira^{3,5}, Lúcia Martins^{2,3}, El Hachimi Hind¹, Hervé Bertrand⁶, Andrea Marzoli⁷, Rui Miranda^{2,3}, Abdelkader Mahmoudi⁸, Fida Medina⁹, Chrystèle Verati¹⁰, Giuliano Bellieni⁷, Angelo De Min¹¹, Mohamed Ben Abbou¹², and Rachid Zayane¹

¹Geology Dept., Fac. of Sciences-Semlalia, Cadi Ayyad Univ., Prince Moulay Abdellah Boulevard, P.O. Box 2390, Marrakech, Morocco. E-mail: youbi@ucam.ac.ma

²Centro de Geologia da Universidade de Lisboa (CeGUL), Portugal

³Universidade de Lisboa; Faculdade de Ciências; Departamento de Geologia (GeoFCUL), Portugal

⁴National Centre for Scientific and Technical Research, Angle avenues des FAR et Allal El Fassi, Madinat Al Irfane, P.O. Box 8027, Nations Unies, 10102 Rabat, Morocco

⁵LATTEX, Instituto Dom Luiz - Laboratório Associado (IDL – LA), Lisboa, Portugal

⁶Lab. Sciences de la Terre, ENS de Lyon et UCBL, 46, Allée d'Italie, 69364 Lyon, France

⁷Dipt. di Geoscienze, Univ. Padova, I-35137, Italy.

⁸Geology Dept., Fac. Sciences de Meknès, Moulay Ismail Univ., Meknès, Morocco

⁹Laboratory Geotel (URAC 46), Scientific Institute, University Mohammed V-Agdal, Rabat, Morocco

¹⁰Université de Nice Sophia-Antipolis, UMR Géosciences Azur, Parc Valrose, 06108 Nice, France

¹¹Dipartimento di Scienze della Terra (DST), Università degli studi di Trieste, Via E.Weiss 8 – 34127 Trieste (Italy).

¹²Geology Dept., Fac. Sciences Dhar Al Mahraz, Sidi Mohammed Ben Abdellah Univ., Fès, Morocco.

Basaltic lava flows, dikes and sills, intercalated into reddened clastic continental sedimentary sequences (the so called “Couches Rouges” or “red beds”) are widespread in the Oued El-Abid syncline and represent by far one of the best area to study the Jurassic-Cretaceous magmatism in the Moroccan High Atlas. The volcanic successions was formed during two pulses of volcanic activity, represented by the Middle to Upper Jurassic basaltic sequence B1 (1 to 4 eruptions) and the Lower Cretaceous basaltic sequence B2 (3 eruptions). Whether belonging to the B1 or B2, the lava flows present morphology and internal structures typical of inflated pahoehoe. Owing the geochemical characteristics, the coeval swarm of dykes and inclined sheets and sills can not be considered as representing the lava flows feeder dykes. The Middle to Upper Jurassic pulse is moderately alkaline character, while the Lower Cretaceous one is transitional. Crustal contamination play a minor role in the petrogenesis of these magmas, which were generated by variable partial melting degrees of a garnet-bearing sub-lithospheric mantle source, probably related with a mantle plume. Magmatism may be either controlled by pre-existing hercynian fault system that was reactivated as normal faults during the Triassic and Jurassic-Cretaceous boundary (passive rifting) or by the upwelling of buoyant asthenosphere beneath an abnormally thin mantle lithosphere (active rifting). The asthenospheric mantle has upwelled and migrated from the SW to the NE, into the region underlying the pre-existing Triassic and Jurassic rift (thin spots?).