



The Upper Triassic alkaline magmatism of the western Neo-Tethys (Bajo Ebro, NE Spain): age and geodynamic implications

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A set of mafic rocks crop out in the north-western margin of the Neo-Tethys (eastern Spain and France). These rocks show three common features: 1) they were emplaced into Upper Triassic sediments (Keuper facies), 2) they are mainly basalts and dolerites and show an alkaline geochemical affinity and 3) these magmas rose to their emplacement level through deep fractures; some of the fractures were newly opened as a result of the Triassic extension (Triassic-Liassic rifting), whereas others had been generated during the Permian extension (Lower Permian rifting) and were reopened. Magmatic activity has also been recognized in these areas during the Jurassic, the Cretaceous and the Quaternary.

The Bajo Ebro sector (NE Spain) comprises two types of Upper Triassic mafic rocks: 1) massive rocks emplaced as dikes, sills and basaltic lavas (10-12 meters in thickness and up to kilometric in extension) and 2) a wide range of pyroclasts (from ash grains to bombs) forming layers more than 100 meters thick, which are usually interbedded with argillites and carbonates.

Protrusions of the sills into the overlying sediments, together with spilitization of the igneous rocks, suggest that the magmas emplaced into unconsolidated sediments. Furthermore, a level of epiclastic-basaltic breccias is recognized overlying the magmatic levels and below the dolostones of the Imón Formation (Rhaetian in age); these breccias are interpreted to represent an erosive episode which affected the magmatic rocks in emerged areas. According to these criteria, these rocks can be considered Upper Triassic (pre-Rhaetian) in age.

The basaltic lavas show alkaline mineral assemblages composed of: olivine (Fo79-65), Ti-rich clinopyroxene (Fs3-15, En52-35, Wo50-42), plagioclase (An80-50), Ti-rich magnetite and apatite. Their major and trace element whole rock compositions show contents in SiO₂ (41,3-49,3 w.%), Nb/Y (1,5-4,1), Zr/TiO₂ (0,0057-0,013), V (157,8-292,1 ppm) and Ti/1000 (11,3-18,53) which indicate that they are rather primitive alkali basalts.

Ultramafic xenoliths are very common in these rocks. They are composed of: olivine (Fo92-81), orthopyroxene (Fs8-9, En90-86, Wo6-1), Ti-rich clinopyroxene (Fs4-8, En58-48, Wo47-35) and spinel. Ultramafic xenoliths are only present in this sector (Bajo Ebro), indicating a geodynamic context which makes possible the ascent of more primitive magmas than in the other sectors of eastern Spain where the Upper-Triassic alkaline magmatism is recognized.