



The tectonics and lithostratigraphy of Precambrian to Lower Cambrian metasedimentary rocks of the Douro group (Northeastern Portugal) revisited.

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In northeastern Portugal, between Vila Real and the Spanish border, and along the Douro river, outcrop metasedimentary rocks most of them included in the slate and greywacke complex (“*Complexo xisto-grauváquico*”). These metasediments integrate the designated Douro group of Precambrian to Lower Cambrian age; in the same region are also observed quartzites and slates of Lower Ordovician to Silurian age. The pre-Ordovician rocks are bordered by granitic rocks from the antiforms of Vila Real-Carviçais and Lamego-Escalhão.

The lithostratigraphy of the Douro group, as initially established, includes 6 different formations, which are, from the base to the top: Bateiras, Ervedosa do Douro, Rio Pinhão, Pinhão, Desejosa and S.Domingos; following that author these formations are disposed in a continuous sequence and were mapped in two geological sheets on the 1:50 000 scale (10-D and 14-B). Later, it was suggested the existence of a major synsedimentary thrust inside the Douro group, of sardic age, which could cause the duplication of very similar lithologies: the autochthonous sequence, composed by Bateiras and Ervedosa do Douro formations, and the allochthonous that integrates the other formations.

The geological maps were elaborated almost entirely with the support of field data and doubts remained until nowadays about the tectonics and the lithostratigraphy of the pre-Ordovician metasedimentary rocks in Douro region. Remote sensing data from the

Douro region, collected by the LANDSAT 7 ETM+ and ENVISAT (ASAR) satellites, was used to give new insights relatively to this issue; in the case of the radar systems the data used refers to HH polarization and PRI.

All images were geometrically corrected, georeferenced to U.T.M. projection system and datum WGS-84 and co-registered. To ETM+ optical images it was applied enhance techniques, RGB and IHS transform as well as principal components analyses; from these results the main geological units outcropping in the area were revealed. The comparison with the geological data indicates that the RGB751 composition allowed the best separation between the different lithologies. A lineament analysis was performed using directional filters on the optical data and on the elevation data. The speckle was not removed from the radar image but was applied enhanced techniques. The combination of the filtered optical image and the radar image highlight the major structural pattern of the area, mainly the fault systems; these were recognized automatically and with visual inspection; the Geomatica software (v.10.1), from PCI, was used.

Some lithologies are easily identified in the RGB751 combination and for that reason were used as a guide to reveal the tectonic structure and the lithostratigraphy in the studied area. It is the case of the black shales of the Bateiras formation and the chlorite phyllites of green color from the Ervedosa do Douro and Rio Pinhão formations. The different layers are oriented in the WNW-ESE direction, defining tight anticlines and synclines, and the stratigraphic sequence deduced from the remote sensing data is consistent with that defined in the 10-D and 14-B sheets; no significant changes was detected in this sequence in the all area where the slates and greywackes complex outcrops. The analysis of the lineaments shows the existence of several fault systems, as follows: N20-30°E, N50-60°E, N65-70°E, E-W, N50-60°W, N30-40°W and N10-20°W. In the western part of the region the N50-70°E fault systems dominates while the E-W are more important in the eastern side; all of these systems could be linked to the same shear faulting model (an E-W riedel model). The youngest systems, in particular the N20-30°E system, induced a significant offset in the lithostratigraphic sequence.