Chlorite Composition Controlled by Whole-Rock Geochemistry; A DRX-EMPA-HRTEM-EM Study in Cambrian Basaltic Rocks from the Ossa Morena Zone, SW Spain

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Chlorite is one of the most common very low-grade metamorphic minerals filling vesicles in basaltic rocks. Its composition has been usually used as an indicator of the metamorphic grade, and some empirical geothermometers has been proposed. Also, in these mafic systems, the evolution from smectite to chlorite with increasing temperature is well documented. This transition is normally expressed as the Xc (chlorite content) value, which range from 0.0 (pure smectite) to 1.0 (pure chlorite). In Cambrian formations from the Zafra area (Ossa Morena Zone, SW Spain), a metamorphic evolution from diagenesis to epizone has been previously documented (Lopez-Munguira et al., 1998, Lopez-Munguira & Nieto, 2000). Porphyritic plagioclase basaltic vacuolar lavas, intercalated with shales, are in the upper zone of this sequence. Secondary minerals neoformed in these shales are typical of the diagenesis conditions (IC = 0.50 ±0.07, b0 = 8.997 ±0.005). Good correlation between whole-rock geochemistry and chlorite composition has been found. Meanwhile, chlorites filling vesicles are characterised by relatively high Xc values, as determined from the microprobe data. They range from 0.81 in the top to 0.98 in the bottom (almost 900 m deeper).

The application of the empirical Cathelineau’s geothermometer gives temperatures ranging from 285 to 350°C. Both Xc and temperature calculations are too high for the diageneric conditions established according to the interestratified-shale mineralogy. HRTEM study indicates the complete absence of any smectite layer in the structure of these chlorites; that is, according to lattice images the actual value of Xc is 1. The explanation to the chlorite composition in these basaltic lavas must be in relation with their whole-rock geochemistry. They are characterised by low MgO values (3.08 ±1.53%), high total iron (13.99 ±1.30%) and relatively high FeO/MgO ratios (3.28 ±1.66). In this particular case, these basaltic rocks are not a typical Mg-rich system, and must be considered as an Fe-rich system, with similar behaviour to those of the pelitic rocks. In these Fe-rich systems, direct chlorite formation, without a previous smectite precursor, is a normal case and, consequently, the Xc calculations, as well as some empirical geothermometric calculations, are not adequate.