Early Triassic-Anisian Continental Sediments from SE Iberian Ranges: Sedimentological and Mineralogical Features

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INTRODUCTION.

The present work is part of a multidisciplinary study focused on the reconstruction of the environmental conditions that prevailed during the large biotic crisis at the Permian-Triassic transition and the subsequent Early Triassic recovery, in the SE Iberian Ranges. The causes that promoted such crisis include meteoritic impact, sea level fluctuation, changes in sea water chemistry and volcanic activity related to the Siberian continental flood basalt province (see Erwin et al. (2002) for a critical examination of these extinction mechanisms). The environmental crisis persisted during Early Triassic times, and leaded to a slow recovery of both biological diversity and size of the organisms (Twichett et al., 2004). This period has received growing attention in recent years. The data available are still controversial, especially in continental sediments, where dating and correlation between different areas is hampered by the scarce presence of fossils. The aim of this work is to perform a sedimentological and mineralogical characterization of the Cañizar and Eslida Formations, of Early Triassic-Anisian age (Doubinger et al., 1990), in two stratigraphic cross-sections located in different sub-basins within the SE Iberian Ranges: one section in Talayuelas (Cuenca province), and the other in Gátova (NE of Valencia province). This is an indispensable preliminary step for the multidisciplinary approach.

GEOLOGICAL SETTING.

The Permian-Triassic sediments of this area can be defined in a general way by the classic german trilogy:

Buntsandstein, Muschelkalk and Keuper. The sedimentary record has been subdivided into nine tectono-sedimentary cycles, separated by angular unconformities and hiatuses (Arche and López-Gómez, 2005), but only the third and fourth ones are of interest in this work.

The Cañizar Fm. is part of the third sedimentary cycle and consists of red sandstones which unconformably overlay the Late Permian rocks of the Alcotas Fm. The field study has allowed discriminate six members within the Cañizar Fm., in both the Talayuelas and the Gátova sections. These members show specific sedimentological features and are limited by major boundary surfaces (MBS). Sedimentologically, the Cañizar Formation represents the evolution of sandy braided fluvial sequences with a paleocurrent trend pointing to S and SE (Arche and López-Gómez, 2005). In the Talayuelas section, sandstones of the Cañizar Fm. are directly overlain by dolostones (Muschelkalk facies). Thus, the Eslida Fm. is not represented in this section.

Conversely, in the Gátova section the Eslida Fm., that constitutes the fourth sedimentary cycle, overlays the Cañizar Fm. It is formed by lutites and sandstones. Carbonate nodules are frequently observed in the lutitic layers. These rocks are interpreted as part of a braided fluvial system, with a better development of flood plain deposits, which include paleosol profiles.

MATERIALS AND METHODS

Seventy two samples corresponding to sandstone, siltstone and lutite layers were collected along both sections. Bulk mineralogy was obtained by combining X-ray diffraction (XRD) and petrographic observations. Clay composition was determined by XRD analysis performed on oriented aggregates. Detailed textural features were obtained from back scattered electron microscope (BSEM) images during the microprobe study and from scanning electron microscope (SEM). The composition of the mineral phases was determined by microprobe analysis (EMPA).

RESULTS.

Samples from the Cañizar Fm. contain detrital mica, quartz, K-feldspar and hematite. The clay fraction is composed of illite and minor hematite, together with traces of kaolinite in a few samples. Accessory minerals include zircon, monazite, ilmenite, rutile, tourmaline and apatite.

In addition, small amounts of strontium-rich aluminium phosphate sulphate minerals (APS minerals) are detected on XRD patterns of some samples from both sections (Talayuelas and Gátova). These minerals are members of the alunite-jarosite group. BSEM images reveal that they occur as irregular polycrystalline aggregates (up to 120 µm large), surrounded by detrital mica plates and quartz. Small hematite patches are frequently associated with the APS minerals (Figure 1a). Quartz and illite adapt to the shape of idiomorphic APS minerals in the borders of the polycrystalline aggregates (Figure 1a and 1b), evidencing that the precipitation of the APS minerals predates the quartz and illite cements, The average structural formula for these phases can be expressed as a solid solution between goyazite, svanbergite, crandallite and woodhouseite:

$$Sr_{0.49}Ca_{0.31}(Al_{2.85})(P_{1.61}S_{0.57}O_4)_2(OH)_6$$

Detrital biotite and muscovite are present as elongated and platy crystals (60 to 150 µm large) that may show preferred orientation. Representative structural formulae of detrital biotite and muscovite determined by EMPA can be written as:

palabras clave: Pérmico-Triásico, recuperación, minerales APS, Cordillera Ibérica	key words: Permian-Triassic, recovery, APS minerals, Iberian Range

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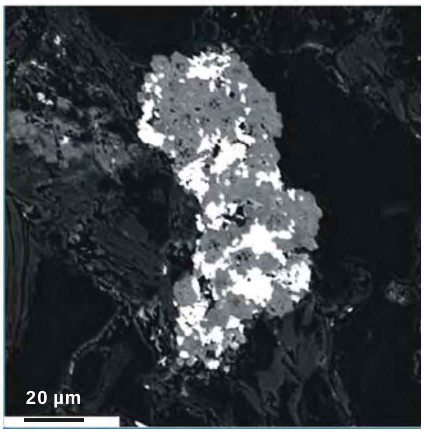
$(K_{1.57}Na_{0.07}Ca_{0.02})$ $(Fe_{2.20}$ $Mg_{1.41}Al^{(VI)}_{1.29}$ $Ti_{0.36})$ $(Al^{(IV)}_{2.21}$ $Si_{5.79})$ O_{20} $(OH)_4$ and $(K_{1.71}$ $Na_{0.11}$ $Ca_{0.01})$ $(Fe_{0.16}$ $Mg_{0.20}$ $Al^{(VI)}_{3.62}$ $Ti_{0.05})$ $(Al^{(IV)}_{1.61}$ $Si_{6.39})$ O_{20} $(OH)_4$, respectively.



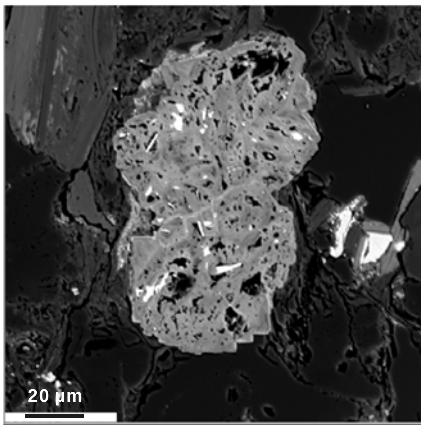


fig 1. *BSEM images of Sr-rich APS minerals from samples of the Cañizar Fm. in the Gátova section, a) intergrown with hematite patches and b) surrounded by quartz and detrital mica.*

BSEM images show that detrital zircon, monazite and apatite grains (up to 50 µm large) are rather frequent in these samples. Rutile occurs as strongly corroded sub-idiomorphic crystals (30 to 40 µm). In addition, analysis of detrital tourmaline allows differentiate both dravite $Na_{0.63}Ca_{0.12}$ $(Mg_{1.39}Fe_{0.94}$ $Al_{0.7}Ti_{0.14})$ Al_6Si_6 O_{18} $(BO_3)_3$ $(OH)_4$ and schorl $Na_{0.65}Ca_{0.04}$ $(Mg_{0.42}Fe_{1.76}$ $Al_{0.76}Ti_{0.03})$ Al_6Si_6 O_{18} $(BO_3)_3$ compositions within the accessory minerals.

Compared with the Cañizar Fm., samples from the Eslida Fm. show a higher proportion of phyllosilicates and feldspar, and a progressive increase in the presence of calcite and dolomite from base to top of the unit.

DISCUSSION.

The comparative study of stratigraphic features points to an enhanced subsidence rate for the eastern sub-basin (Gátova section). Moreover, sediments from the Eslida Fm. are indicative of a significant change in the depositional regime, towards low energy systems in a more open sub-basin.

The presence of the APS minerals can be very important, since they can provide information on the physical-chemical formation conditions (Eh, pH) (Dill, 2001). First of all, there seems to be a stratigraphic control, since these phases had been previously reported in another section of the Cañizar Fm. (Benito et al., 2005). Textural relationships indicate that the precipitation of the APS minerals predates the formation of illitic and quartz cements. Therefore, we can argue that the APS minerals formation occurred shortly after the sedimentation, and most probably were related to the circulation of acidic meteoric groundwater, since low pH environments and oxidising conditions at shallow depths are a common feature to most APS occurrences in different geologic settings (Dill, 2001). This is in good agreement with the origin proposed by Spötl (1990) and Pe-Piper and Dolansky (2005) for APS minerals of similar chemical composition (compound phosphate-sulphate) in terrestrial sandstones in Austrian Alps and Nova Scotia (Canada) respectively. Oxidising and acidic conditions thus, prevailed during the first stages of recovering after the Permian-Triassic crisis in the Iberian Ranges. These conditions were progressively decreasing from the Early to the Middle Triassic, that is, from the Cañizar Fm. to the Eslida Fm.

The increase in the proportion of calcite and dolomite from base to top of the Eslida Fm. in the Gátova section is related to the development of paleosols within the flood plain lutitic deposits, and probably reflect a growing marine influence to the top of this unit.

RESULTS.

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