STXM characterization of fossil organic matter from the Montceau-les-Mines Lagerstätte (France)

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The fossil record contains key information regarding the evolution of life and environment on Earth. However, decoding this record can be quite challenging as biogenic organic matter (OM) is inevitably altered during fossilization processes. The combination of transmission electron microscopy (TEM) with synchrotron-based scanning transmission X-ray microscopy (STXM) and X-ray Absorption Near Edge Structure (XANES) spectroscopy now offers valuable capabilities for the *in situ* characterization of heterogeneous and organic-rich samples such as fossilized remains [1]. TEM provides spatially-resolved information on organic constituent texture at the sub-nanometer scale, and allows for crystallographic determination. STXM and XANES enable spatially-resolved characterization of organic constituent speciation at the 15 nanometer scale.

Here we report the multiscale characterization of exceptionnally preserved soft-bodied plants and animals fossilized within carbonate concretions from the Carboniferous Montceau-les-Mines Lagerstätte [2]. SEM and TEM investigations have revealed mineralogical and textural heterogeneities at all scale of observations, likely explaining the exceptional morphological preservation of the investigated fossils. STXM experiments (performed using the 5.3.2.2. ALS STXM Polymer beamline [3]) have allowed to evidence the similar molecular signatures of the OM composing the vegetal and the animal remains. We interpret this surprinsing homogeneity as resulting from the replacement of the initial biogenic OM by newly condensed recalcitrant geopolymer compounds during early diagenesis. Altogether, this study illustrates the capabilities of synchrotron-based STXM and XANES spectroscopy to provide molecular-level information on natural OM.

[1] Bernard S. *et al*. (2009) *Review paleobot palyno* **156**, 248-261 [2] Charbonnier S. *et al*. (2008) *Palaios* **23**, 210-222 [3] Kilcoyne A.L.D. *et al*. (2003), *J. Synchrotron radiat* **10** (2), 125-136.

On some feedback-coupling relations between fluid flow, igneous Intrusion, metamorphic / metasomatic events and deformation during low-P high-T regional thermal metamorphism. An example from the Osor high-grade complex (Catalan Coastal Ranges. NE Iberia)

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Bulk composition (BC) controls assemblages and rheology of metamorphic rocks. BC changes are expected in deep crustal levels due to advective phenomena such as pervasive to channelized fluid or melt flows. Imperatively the following coupled phenomena should be investigated: a) How BC changes influence mineral assemblages b) How resulting rheological changes influence deformation regimes, and c) How subsequent P-T evolution occurs.

In the Osor complex we found evidence for sin-D2 fluid flow during a LP/HT thermal metamorphic event at c. 320 my (age of syn-D2 Susqueda diorite) and also retrograde fluid flow related to leucogranite crystalization at c. 300 my. Prograde flow may have produced modal depletion in q and K-Na phases (mu or pl), and modal increase in fibrolite giving sil-enriched D2 foliation planes, through carrying away SiO_2 and alkalis. Local migmatization and genesis of peraluminous granitoid melts probably contributed also to the silica and alkalis depletion. Retrograde fluids from crystallization of sin-D3 granitoid veins recycled silica and alkalis back to the series and produced growth of blastic mu, bi and Na-rich pl. The recycled silica is found as sets of late q-rich veins. The final result are altered surmicaceous, q-poor rocks with different rheological properties with respect to the original metapelites. The genesis of this rheologicaly week lithology would have enhanced late gravitational instability [1] during the final stages of D2. Subsequent deformation (D3) shows SCC foliation planes, fish-like micas and porhyroclastic albite, which are features related to uplift-exhumation of the Osor high-grade core.

[1] Gerya et. al. (2004). *Geol. Soc. of Am. Spec. pap.*, **380**, 97-115.

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