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Diagenesis to low metamorphism in the Grès d'Annot basin: a magnetic approach

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The Grès d'Annot foreland basin, SE France, formed in late Eocene - early Oligocene time during the alpine-pyrenean orogeny. The siliciclastic turbidite succession from this basin underwent subsidence and related sedimentary burial (input of sediments from mountain belt relief erosion) followed by tectonic loading (emplacement of alpine nappes with the advance of the thrust front during the Oligocene). Based on thermochronologic (apatite fission track) and petrologic data, Labaume et al. (2008) stated that the maximal burial temperature experienced by the turbidites increased from SW (< 2 km, < 60°C) to NE (8-10 km, >200°C) and that exhumation occurred during the late Miocene (uplift and consecutive erosion related to propagation of underlying basement thrusts).

It is known that the magnetic assemblage may be indicative of burial. For burial temperature <150°C, Aubourg & Pozzi (2010) showed a diagnostic pattern of magnetic assemblage in claystones. For burial temperature >250°C, in the lower greenschist facies, Rochette et al. (1990) observed a diagnostic assemblage which resides in pyrrhotite. In parallel, laboratory heating experiments from 70°C (Kars et al., AGU 2010) to 250°C (Cairanne et al., 2004) reveal formation of magnetic minerals.

As the Grès d'Annot basin covers a wide range of paleo-temperatures and rock maturity (from 0.4 to >4 % in reflectance vitrinite; Labaume et al., 2009), it constitutes a valuable natural 'laboratory' to check the magnetic assemblage evolution.

To characterize the magnetic assemblage, we realized low temperature magnetic measurements (remanence evolution between 10 and 300 K) on claystones samples throughout the whole basin. We observe an evolution of the magnetic assemblage from low to high burial temperature patterns along the studied transect. In the southwest part, low burial temperature claystones (Ro<0.5 %) show a magnetic assemblage similar to that of ∼40°C peak burial temperature claystones from the Paris basin. In the northeast part, the largest burial temperature claystones (Ro>4 %) show a magnetic assemblage similar to that of metamorphosed liassic claystones of occidental Alps. Between these two end-members, we observe consistent patterns of the magnetic assemblage.

We note that warming remanence curves (ZFC) show two distinct behaviors: the first one displays a 2-step pattern (with a break-in-slope at 35 K and 120 K) and the other one shows a decrease of the remanence with an inflexion point at about 200 K. These two signals are distributed with temperature. The 2-step pattern ZFC curve corresponds to low to moderate burial temperature (<150-200°C), whereas ZFC with 200 K inflexion point corresponds to high burial temperature (>200°C). Geographically, the western limit of the latter magnetic signal is roughly situated at the present edge of the alpine nappes and by extrapolation may be an indicator of the advance of the nappes thrust front.

If this is confirmed by further studies, we may assume that the magnetic assemblage can be used as a very low metamorphism marker (< 250°C) and a substitute for conventional paleothermometers.