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# Petrography and geochemistry of dolomite-rich condensed sections: fluid characterisation and evolution (Hecho Group, South Central Pyrenean Basin, Spain)

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The Eocene turbidite systems of the South-Central Pyrenees, known as the Hecho Group, provide exceptional outcrops of overbank deposits related to major channel complexes. These deposits occasionally show distinctive yellowish beds that contrast with the monotonous bluish-grey sandstones and claystones. Such yellow layers have been previously used as marker beds for high-resolution correlations between thin-bedded turbidites from the overbank and major turbidite channels, which are laterally related to overbank deposits. Yellow beds can be considered as condensed horizons based on their very fine grained textures in some instances (micrite) and the preservation of some banding suggesting biogenic (algal) construction on the overbanks. Yellow beds are richer in carbonate (calcite and dolomite) than the host sandstones and claystones. Their detrital content is essentially clayish, and whole-rock geochemical comparisons indicate that a substantial excess of Fe, Mn and P is present: this anomaly is ascribed to condensation and early redox relocations.

Petrographic and SEM observations reveal that most dolomite is authigenic and that it develops much more intensively in the yellow beds than in the host turbidite succession. Three types of dolomite are recognized in the yellow beds:

I) Type I as isolated and disseminated euhedral rhombs (4-10 $\mu$m), restricted dominantly to the micritic and marly micro-facies;

II) Type II euhedral or subeuhedral crystals of 40-60 $\mu$m growing into the intergranular space or replacing micritic intraclasts. These crystals often show perfect terminations except where in contact to clay or when corroded by post-compactional calcite. In some cases they are fractured and filled by this calcite, and they rarely form sucrosic mosaics of dolomite showing c-c and sutured contacts. Under CL Type II dolomite is non-luminescent.

III) Type III dolomites may have a sub-rounded and/or angular detrital core ($> 60$ $\mu$m), surrounded by Fe-rich overgrowths visible under optical microscope owing to the different blue staining. Under CL, they show a dull-luminescing core full of bright inclusions and bright yellow luminescent rims which are partially dissolved. The luminescence colour of this rim is similar to the last intergranular blocky calcite cement. These dolomites have a high microporosity, a variable grain size (from 4 to more than 100 $\mu$m) sometimes even bigger than the siliciclastic grains. Under SEM, in backscatter mode, type III dolomites have two rombohedral overgrowths, the outer being the richest in Fe. They are sometimes corroded, and are also engulfed in post-compactional calcite cement.

Dolomite types I and II are near stoichiometric, with relatively low contents in Fe, Mn and Sr. In contrast, dolomite type III (overgrowths) presents a relatively high Fe-Mn content, an overgrowth texture with Fe zonation and it is post-dated by major mechanical compaction. Dolomite $\delta^{18}$O is variable (-10.4 to -6.2‰ VPDB) being lighter than Eocene marine limestones and $\delta^{13}$C values varies from -0.3 to 2.2‰ VPDB. The most negative $\delta^{18}$O values and $^{87}$Sr/$^{86}$Sr ratios (0.707926-0.707876), representatives of type III Fe-rich dolomite, reflect precipitation during high temperature and deep burial.

Textural relationships chemistries, stable and radiogenic isotopic data suggest an early origin for the dolomite types I and II, $\delta^{18}$O values and the $^{87}$Sr/$^{86}$Sr ratios indicate that the crystals continued to grow during deeper burial, at higher temperatures. The zoned type III dolomite, and the increase progressive of Fe of the later zones, confirms that the precipitation of Fe-dolomite overgrowths and ankerite implicated more evolved ($\delta^{18}$O depleted) pore waters, but still before major compaction. This dolomitisation phase is detectable in all the turbidites, but it affected them much less extensively than the yellow beds.

Thus, dolomitisation generating the yellow beds starts in association with submarine surfaces during sediment starvation periods, combined with a supply of organic matter (P relative enrichment) and likely Mg from red algal oncoids and other Mg-rich bioclasts and/or clay minerals supplying extra Mg for dolomite precipitation. As a result, the yellow beds can be regarded as short-lived condensed sections. The alternance of dolomite-rich bands with micrite suggests that bands levels rich in calcite HMC may have degraded to calcite and early dolomite that acted as a precursor to more extensive dolomitisation.

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