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Provenance and reservoir quality of carbonate-rich turbiditic arenites from the Hecho Group, South Central Pyrenees, Spain

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Turbiditic sediments have been broadly studied from the point of view of their stratigraphy, sedimentology, facies and geometries. In contrast, the petrological composition of turbiditic sediments, in particular of carbonate-rich turbiditic arenites, is poorly documented in the literature. However, the characterization of the composition and provenance evolution is essential in order to understand not only compositional variations, but also reservoir quality of deep marine water sediments deposited in a particular tectonic setting. The aims are the petrological characterization of carbonate-rich turbiditic arenites in order to understand provenance evolution, highlight the links with tectonic setting, as well as to predict trends in reservoir quality of deep water turbiditic sandstones.

The Eocene Hecho Group turbiditic systems, of the Ainsa foreland Basin (South-Central Pyrenees) provide an exceptional opportunity to study the petrological composition and provenance evolution in an active tectonic setting because of the well preservation of the original field relationships between fluvio-deltaic, shelf deposits and turbidites. Hecho Group is made up of four unconformity bounded tectonosedimentary units (TSU-2, TSU-3, TSU-4 and TSU-5) which include arenites (only in TSU-2, NCE_{80} CE_{17} CI_3, n=6), calclithites and hybrid arenites (TSU-3: NCE_{62} CE_{33}

CI_5, n=29; TSU-4: NCE_{58} CE_{35} CI_7, n=25; and TSU-5: NCE_{50} CE_{34} CI_{16}, n=24; NCE are "non carbonate extrabasinal" grains, CE "carbonate extrabasinal", CI "carbonate intrabasinal", and "n" the number of samples quantified by modal analysis). Thus, the turbiditic systems present petrological composition differences. An increase toward the uppermost TSU-5 has been observed in: i) carbonate grains (extra- and intra-basinal), ii) lithic rock fragments (mainly metamorphic and plutonic), iii) low and medium rank metamorphic rock fragments, and iv) feldspars (mainly plagioclase). These compositional trends reflect the progressive unroofing of crystalline basement rocks (plutonic and metamorphic rocks) coupled with carbonate materials. Carbonate extra-basinal sources are the fold and thrust belt associated to the foreland basin (mainly Cretaceous and Paleocene limestones). Carbonate intra-basinal sources are represented by foramol shelf carbonate factories, which are affected by sea level variations.

The Hecho Group carbonate-rich turbiditic arenites show variable degree of mechanical compaction and cementation. Mechanical compaction is evidenced by bending of mica grains, pseudoplastic deformation of ductile carbonate grains, grain breakage, linear grain contact, which resulted in closer grain rearrangement and tighter packing, in some cases, pressure dissolution contacts. Quantification of total intergranular volume versus intergranular carbonate cement indicates that mechanical compaction was far more important than cementation in destroying intergranular porosity in all the studied carbonate-rich arenites. The primary porosity was nearly completely destroyed in all the studied sandstones and only some minor secondary porosity (1-2%) after dissolution of calcite and dolomite cements is present.

In conclusion, tectonism and sea level variations control the type and abundance of carbonate materials of turbitic sediments deposited in active tectonic setting (i.e. Ainsa foreland basin). In addition, weathering can be an important factor in alteration of source materials when tectonic is not active.

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