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Multi-episodic Fault Movements and Karstic Fills Along the Vallès-Penedès Fault, Coastal Catalan Ranges, NE Spain

V. Baqués* (University of Barcelona), A. Travé (University of Barcelona), A. Benedicto (AREVA NC) & P. Labaume (University Montpellier 2)

SUMMARY

We describe different fault rocks within a normal fault bordering the Neogene Vallès-Penedès basin in NE Spain. Through this fault, the Lower Cretaceous limestones of the footwall are in contact with the Miocene siliciclastic sediments of the hangingwall.
In the Lower Cretaceous protolith, cataclasites and breccias are a mixture of tectonic and karstic products resulting from multi-stages movement and development of the fault. The localisation of frictional processes generated a cohesive fault breccia and the cataclasite during the progressive opening of the hydrological system. Later, when the fault reached the surface, meteoric diagenetic processes leaded to the formation of calcretes and karstic features and generating the breccia with the pisolithic matrix.

The diagenetic processes taking place in a sedimentary basin during its evolution are closely linked with the processes of deformation and fracturing. In this paper, we describe the karstic processes that occurred along the largest fault of the Vallès-Penedès semi-graben and their relationships with the evolution of the fault propagation.

The NE-SW trending Vallès-Penedès basin resulted from the late Oligocene-middle Miocene extension related with the opening of the NW-Mediterranean basin. The basin is bordered at the NW by the Vallès-Penedès fault.

On the Montjuïc outcrop (Figure 1), the Lower Cretaceous limestones of the footwall are in contact with the Miocene siliciclastic sediments of the hangingwall.

The Lower Cretaceous limestones are constituted by a packstone of charophyta, ostracoda and gastropoda fragments arranged in meter-thick beds. The $\delta^{18}O$ of this protolith is -4 ‰ PDB and the $\delta^{13}C$ is -4,6 ‰ PDB.

Two families of fractures and related breccias and cataclasites are recognized within the Cretaceous protolith along the main fault:

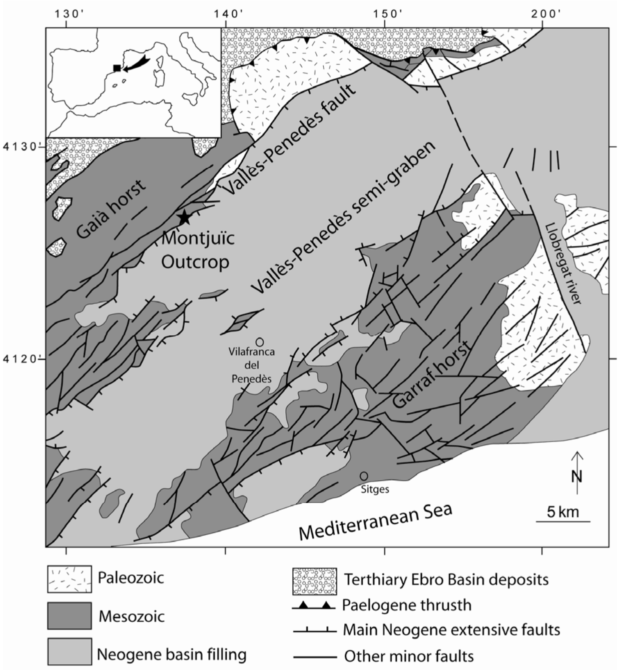

***Figure 1** Simplified geological map of the area.*

Fractures 1, are mode I (opening) trending NNW-SSE. These fractures are filled by the calcite cement **C1** constituted by subhedric-euhedric non-luminescent crystals, 50 to 200 µm in size, showing mechanical twinning planes and with blocky texture. The $\delta^{18}O$ range between -8,4 and -7,0 ‰ PDB and $\delta^{13}C$ range between -6,3 and -4,6 ‰ PDB.

Fractures 2, are mode I and mode II (sliding) trending NE-SW. The fractures mode I are filled by the calcite cement **C2** constituted by euhedric non-luminescent crystals, 25 to 100 µm in size, with a drusy texture. The $\delta^{18}O$ range between -5,3 and -4,9 ‰ PDB and the $\delta^{13}C$ range between -9,5 and -7 ‰ PDB. The fractures mode II are normal faults and strike-slip with a strong normal component faults. Related to these faults, different types of breccias and cements have been recognized (Figures 2 and 3):

Cohesive fault breccia (Figure 2A), formed by angular micro-fragments of protolith limestone rock and cement C1, 100 µm to 1 mm in size. This breccia results from sliding along the normal and strike-slip faults and is cemented by non-luminescent microesparite **C3**. The $\delta^{18}O$ of the microesparite cement range between -5,3 and -4,9 ‰ PDB and the $\delta^{13}C$ is -9,3 ‰ PDB.

Cataclasite (Figure 2B), formed by comminute cohesive fault breccia. This breccia is clast-suppported with pressure-dissolution features and contains a micrite orange matrix.

Breccia with pisolithic matrix (Figure 2C), formed by reworked cohesive fault breccia and cataclasite fragments. The pisolitic matrix is formed by orange micrite pisoliths and is cemented by microesparite cement with a blocky texture (**C4**). The $\delta^{18}O$ of the orange micrite pisoliths is -4,5 ‰ PDB and the $\delta^{13}C$ is -10,8 ‰ PDB, whereas the $\delta^{18}O$ of **C4** range between -6,3 and -5,2 ‰ PDB and the $\delta^{13}C$ range between -9,4 and -8,7 PDB.

Cataclasite of pisolitic matrix (Figure 2D), formed by comminute pisolithic matrix. This cataclasite is cemented by the calcite cement (**C4**) with a bladed and drusy texture.

Figure 2 *Distribution of breccias and cataclasites within one of the faults. D.Z.:Damage zone.*

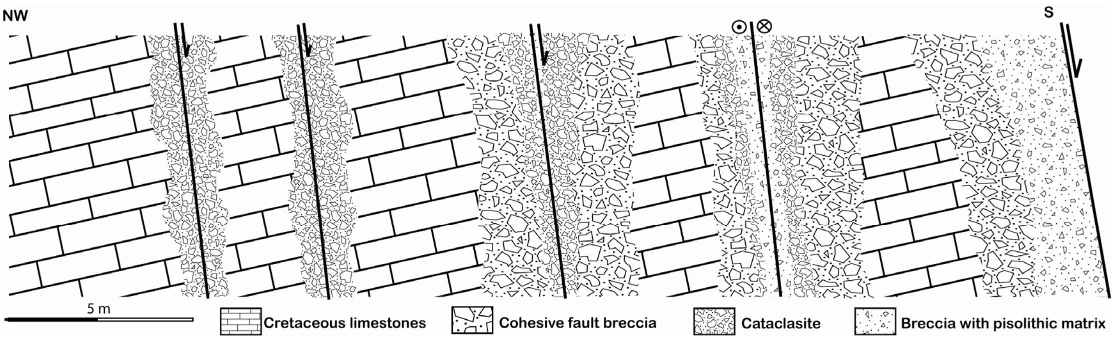

Figure 3 *Synthetic sketch of distribution of breccias and cataclasites within the faults.*

The different cataclasites and breccias are a mixture of tectonic and karstic breccias and resulted from multi-stages movement and development of the fault. The localisation of frictional processes generated the cohesive fault breccia and the cataclasite during the progressive opening of the hydrological system (Figure 4a and 4b), as indicated by the geochemistry of the cements. Later, when the fault reached the surface (Figure 4c), meteoric diagenetic processes leaded to the formation of calcretes and karstic features and generating the breccia with the pisolithic matrix (Figure 4).

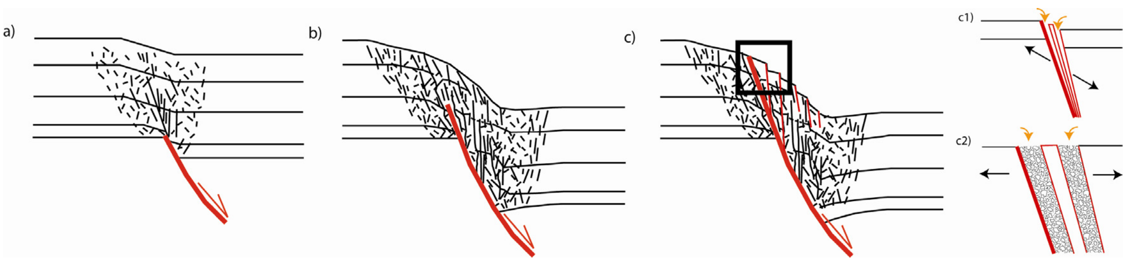

Figure 4 *Propagation fault model.*

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