The Mont-Blanc detachment fault: An example of fluid circulation associated with the necking of the crust in the magma-poor Alpine Tethys margin

Nicolas Dall'asta*[1], Guilhem Hoareau[1], Gianreto Manatschal [2], Charlotte Ribes[3]

[1] Université de Pau et des Pays de l'Adour, E2S UPPA, CNRS, LFCR-France
[2] Université de Strasbourg, CNRS, ITES UMR 7063, Strasbourg F-67084, France
[3] TOTAL SA - Centre Scientifique et Technique Jean Féger (CSTJF) – TOTAL – France

During rifting, important thinning of the crust (from 30 km to less than 10 km) occurs in areas of limited spatial extent called necking zones. Despite numerous seismic observations on modern passive margins, the tectono-sedimentary and fluid evolution recorded in the necking zones remain poorly understood. Recent studies demonstrate that well-preserved fossil necking zones can provide more precise constraints on this evolution (Ribes et al., 2020). Many questions remain concerning the nature of fluids, the thermal evolution and the link to large-scale hydrothermal systems and the impact of element transfer on the diagenesis of syn-rift sediments?

Here we focus on the southern Mont-Blanc massif (Col du Bonhomme , Catogne), which preserves sediments from the rifting phase, (from late Triassic / early Jurassic to late Jurassic), but also detachment faults associated with the necking of the crust (Ribes et al. 2020). The necking occurred during Sinemurian to Pliensbachian. It was associated with deposition of detrital sandstones called" Grès Singuliers", which correspond to the autochthonous cover, and were recently reinterpreted as being closely associated with detachment faults responsible of the exhumation and uplift of the basement during the necking phase (Ribes et al. 2020). These outcrops, which are unique in the Alps, gives the opportunity to study in detail the fluid circulations associated with detachment faults in the necking zone.

Characterization of the detachment faults and overlying rocks requires a multi-scale and multi-disciplinary approach combining field observation, petrography, sedimentology, structural geology, and geochemistry. Preliminary observations indicate that at the outcrop scale, the fractured basement passes to cataclasites and black gouges forming the core zone of the detachment. Injections of gouge material in the surrounding rocks indicate focused fluid flow during deformation. Liassic sandstones lie above the detachment fault with a conformable contact and contain reworked fault rocks (clasts of cataclasite).

At the thin section scale, cataclasites are observed. They are made of quartz, K-feldspars, with secondary pyrites. Feldspars were strongly sericitized during deformation. These cataclasites are reworked in the black gouge, which formed at crustal level below 5Km. Quartz-Hyalophane veins, typical of low-P hydrothermalism, are found in the gouge. They are locally sheared by the gouge, and thus might be contemporaneous to the detachment. Important silicification is also indicative of an important transfer of silica along the faults.

These first observations suggest that the Mont-Blanc detachment was a major structure during rifting and formed an important pathway for crustal fluids, that still need to be characterized in more detail. Understanding the fluid circulations in the necking zone in terms of thermicity and composition and its link to element transfer, early diagenesis and maturation of reservoir and source rocks from the syn-rift sediments and possible enrichment in metals is a key point for future works concerning hydrothermalism during the necking of the crust.

Keywords : Detachment fault, Mont-Blanc massif, Alpine Tethys, Necking zone, Fluid circulation, Grès Singuliers.