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Changes of the fluid regime behaviour through time in fault zones (Catalan Coastal Ranges, NE Spain)

Irene Cantarero (1), Pierre Lanari (2), Gemma Alías (1), Anna Travé (1), Olivier Vidal (3), and Vinyet Baqués (1)

(1) Departament de Geoquímica, Petrologia i Prospecció Geològica, Facultat de Geologia, Universitat de Barcelona (UB), Martí i Franquès s/n, 08028 Barcelona, Spain (i_cantarero@ub.edu, galias@ub.edu, atrave@ub.edu, vbaques@ub.edu), (2) Institute of Geology, University of Bern, Baltzestrasse 1+3 Bern, CH-3012, Switzerland. (pierre.lanari@geo.unibe.ch), (3) ISTerre, Université de Grenoble I, CNRS, 1381 rue de la Piscine, 38041 Grenoble, France. (olivier.vidal@ujf-grenoble.fr)

Most Neogene normal faults of the central Catalan Coastal Ranges are the reactivation of previous normal Mesozoic faults and Paleogene thrust faults. These faults, such as the Vallès and the Hospital faults, are characterised by developing polyphasic fault-fluid systems. These systems have been inferred from regional to thin section scale observations combined with geochemical analyses. Moreover, the neoformation of chlorite and K-white mica in fault rocks has allowed us to constrain the P-T conditions during fault evolution using thermodynamic modelling. In these two faults, deformation is mainly localized in the basement granodiorite from the footwall.

As a whole, four tectonic events have been distinguished. The first event corresponds to the Hercynian compression, which is characterised by mylonite bands in the Hospital fault. After this first compressional event and during the exhumation of the pluton, crystallization of M1 and M2 muscovite and microcline occurred in the Vallès fault as result of deuteric alteration, at temperatures between 330ºC and 370ºC. The second event, attributed to the Mesozoic rifting, is characterized by precipitation of M3 and M4 phengite together with chlorite and calcite C1 at temperatures between 190 and 310ºC. These minerals precipitated from a fluid resulting from the mixing between marine waters and meteoric waters, which had been warmed at depth, upflowing along the faults. The third event, corresponding to the Paleogene compression, is characterised by low-temperature meteoric fluids, responsible of precipitation of calcite C2, in the Hospital fault. In the Vallès fault, the Paleogene compression generated a shortcut that produced a blue gouge and the uplift of the Mesozoic structures, avoiding the formation of new minerals within them. Finally, the fourth event, related to the Neogene extension, was responsible of syn-rift cements such as chlorite, calcite C4 and laumontite in the Vallès fault and calcite C3 in the Hospital fault. Fluids responsible of their precipitation had temperatures between 125 and 190ºC. Regarding their origin, fluids of the Vallès fault are meteoric fluids which have been warmed at depth and have upflowed through the faults, whereas in the Hospital fault, these fluids have been mixed at the surface with marine waters, due to the situation of this fault in the Miocene shoreline. During the post-rift stage, the Hospital fault was dominated by low-temperature meteoric fluids whereas in the Vallès fault hydrothermalism remains active till nowadays.

The estimated temperatures of crystallisation of chlorites indicate that during the two extensional events (Mesozoic and Neogene), faults acted as conduits for hot fluids producing anomalous high geothermal gradients (50ºC/km minimum).