Three-stage decompression-related halokinesis in the Subalpine Range (SE France): fluid-inclusion evidence in rock salt

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Abstract: Rock salt outcrops from seven Triassic diapirs in the SE basin of France show two mineral parageneses: early generation-0 minerals are either diagenetic or neoformed during diapirism; later generation-1 minerals are neoformed. Three populations of secondary halite-saturated CO₂-bearing fluid inclusions (= type-S FI) are identified in quartz Q0, dolomite D1 or magnesite M1, and sedimentary dolostone D0, based on contrasted ranges of dissolution temperature of halite (= Ts): 400°-250°C (population-0), 250°-180°C (population-1) and 180°-150°C (population-2). All type-S FI contain complex Ca-Mg-Na-K-bearing solutions, either Ca- or Mg-dominant or with intermediate compositions. They also have constant degrees of halite and gas filling, their CO₂-content is either high and variable (populations 0 and 1) or low (<1 mole% CO₂, population-2). At the diapir scale, the temperatures of vapour disappearance (= Tb) are variable and the Ts are near constant.

Reconstructed bulk V-X properties of type-S FI are as follows (in mole % and g cm⁻³, respectively): for populations 0 and 1 FI, near constant compositions of 74 H₂O-6.5 CO₂-19.5 NaCl and 79 H₂O-5 CO₂-16 NaCl, and variable densities in the range 1.29-1.26, 1.26-1.24, respectively; for population-2 FI: 88 H₂O-12 NaCl, CO₂ < 1, d = 1.14. In one diapir (Laragne), population-1 type-S FI are associated with FI showing a variable degree of gas and halite filling (type-VS FI), which yield extreme compositions such as 31.6 H₂O-29.8 CO₂-38.6 NaCl, d = 1.295, and 20.4 H₂O-62.3 CO₂-17.3 NaCl, d = 1 (in mole % and g cm⁻³, respectively).

Each FI population is related to a diapiric stage. The reconstructed P-T trapping conditions of population-0, 1 and 2 FI in that order, are: > 300°C, 270°C, and 150°C, respectively, and minimum fluid pressures always ~ 2 kbar. In detail at the diapir scale, the ~ 50°C Tb-scatter of populations 0 and 1 FI indicates the trapping of fluids with constant composition and variable densities following the decompression related to halokinesis. The fact that the decompressing diapiric fluids are trapped in the two generations of neoformed minerals as primary (Perthuisot & Guilhaumou, 1983) or secondary FI (this study) suggests that mineral neoformation was rapid and synchronous with diapirism. At Laragne, associated population-1 type-S and type-VS FI suggest mixing between a H₂O-NaCl (Ca-Mg-K) liquid and a CO₂-rich end-member, with transient halite saturation. At Propiac, we provide evidence that these two fluid end-members (population-1 type-S and type-Lc FI) were injected separately without mixing. Finally, at Laragne, some population-1 type-S FI are annular and probably represent type-S FI deformed in the anisotropic stress field consequent to enhanced decompression.

The first two halokinetic stages corresponding to populations 0 and 1 FI are related to the Oxfordian extensional episode and to the Late Cretaceous-Eocene tectonic event, respectively. At these two periods, fluid pressures exceeding 1.5 kbar were only reached in the deepest parts of evaporites. In addition, population-0 FI imply a thermal anomaly in the deep basin at the Oxfordian. The discrete population-2 FI at Laragne can be related to the Late Miocene Mediterranean activity.

Key-words: fluid inclusions, salt diapir, thermobarometry, CO₂ hypersaline brines, decompression.

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