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ORIGINAL PAPER

The enigmatic ascent of Ca-sulphate rocks from a deep dense source layer: evidences of hydration diapirism in the Lesina Marina area (Apulia, southern Italy)

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Abstract
In the Lesina Marina village area, the cropping out gypsum rocks, that rose up from the deep and thick Upper Trias Burano Fm anhydrite layer, have been analyzed to investigate the trigger mechanism for their ascent. In this regard, we focus on the anhydrite-to-gypsum transformation starting from the deep source layer. Indeed, petrographic observations of the widespread corroded anhydrite crystals embedded in these gypsum rocks revealed unequivocal evidences of the anhydrite-to-gypsum transformation. In addition, and referring to gypsum, microstructural features indicate that ductile deformation mechanisms initially operated under higher temperature conditions. This temperature should be close to 107 °C, namely the value of the upper temperature limit of stability of gypsum from Lesina Marina, above which it starts to transform and dehydrate, as revealed by microthermometry heating/dehydration experiments combined with micro-Raman analyses. All these evidences are in favor of the dramatic density decrease and volume increase due to anhydrite-to-gypsum transformation by hydration in the deep source layer; these variations of physical conditions, triggered by hydration, promoted diapirism of the gypsum mass, in other words "hydration diapirism". As revealed by seismic lines interpretation, the diapirism, which gave rise to the Lesina diapir, occurred during Plio-Pleistocene and was genetically related to the Lesina graben-type structure. Hydration at depth was favored by the downward circulation of water-rich fluids channeled in faults, and the gypsum mass used the weakened zone of the southern fault to pierce the overlying Mesozoic and Tertiary sediments.

Keywords Lesina diapir · Anhydrite–gypsum transformation · Deformation microstructures · Microthermometry · Micro-Raman spectroscopy · Seismic profiles

Introduction

In the northern Bradano trough–Apulian Foreland transition (Fig. 1a, b), namely in the Lesina Marina village area, exotic gypsum rocks crop out along the Acquarotta canal (Cotecchia and Canitano 1954; Carella 1963; Amendolagine et al. 1964; Martinis and Pieri 1964; Bigazzi et al. 1996), which was excavated during the 1920s to connect the Lesina Lake to the Adriatic Sea (Figs. 2 and 3). Cotecchia and Canitano (1954) and Bigazzi et al. (1996) argued that these Ca-sulphate rocks rose up from the deep and thick Upper Trias Burano Fm anhydrite layer. But the suggested diapirism (Cotecchia and Canitano 1954), possibly promoted by tectonic squeezing (Bigazzi et al. 1996), is not yet constrained at all.

The Ca-sulphate rocks in several diapirs around the world have been considered passively transported upwards during ascent of halite, since it is well known that the Ca-sulphate rocks, including especially anhydrite, have a density considerably higher than halite. For those diapirs, the absence of halite in the exposed gypsum and/or anhydrite bearing rocks was remedied proposing dissolution processes. Moreover, the presence of halite have been hypothesized in their cores, since sometimes found in the source salt layer (e.g., Seni and Jackson 1983; Underhill

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