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European and Middle-East ferroan hydrothermal dolomites: lessons learnt with respect to crustal dynamics, fluid circulations and rock-fluid interactions

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Classical case studies of hydrothermal dolostones, which are known worldwide to provide excellent reservoirs for ores and hydrocarbons, often illustrate the presence of iron-rich dolomite phases. The world-class hydrothermal dolostones from the Basque-Cantabrian Basin (Northern Spain) exemplify the initiation of high temperature dolomitization (at about 200°C), with significant amount of ferroan dolomite phases (including up to 2% FeO). These dolomites are believed to be responsible for the pervasive replacement of the original limestone rocks – they are followed by non-ferroan dolomite phases. The associated fluids are supposed to have interacted with basement rocks, and travelled from deep-seated sources along major fault pathways. The geochemical traits of such fluids are also typically similar to, and probably associated with, mineralization fluids (e.g. Pb-Zn, MVT). In the Middle East, several observed dolostones show, on the contrary, a later phase of ferroan dolomite cements which occlude the inter-crystalline porosity of earlier non-ferroan matrix dolomites. Dolomitization occurred under increasingly higher temperatures (from 50 to 100°C) during burial. Here, the origin of iron-rich fluids and conditions of precipitation of associated dolomites do not necessarily involve interactions with basement rocks, but rather a relative Fe-enrichment with further reducing settings.

Based on previous research projects concerning a variety of dolostones from Europe and the Middle-East, this contribution presents observational, analytical and computational results focused on ferroan dolomites. Recent numerical geochemical modelling emphasized the physico-chemical pre-requisites for crystallizing ferroan rather than non-ferroan dolomites (and vice-versa), allowing better understanding of related diagenetic processes. Besides, important larger-scale information on the crustal fluid circulations are demonstrated to be intimately associated to the parent-fluids sources and the conditions of mineral precipitation. By adopting this approach, ferroan dolomites are no longer considered simply as accessory diagenetic phases. They rather provide significant clues for understanding crustal dynamics and the impacts of evolving rock-fluid interactions on carbonate reservoir properties which are essential for ore and hydrocarbon exploitation, and for underground storage and gas sequestration.