Magmatic signatures encrypted in the dolomites of the Esino and Breno formations in central southern Alps: a comparison with the St. George Group dolomites in western Newfoundland, Canada

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Petrographic examinations identified three generations (dolomicrite D_1, eu- to subhedral crystals D_2 and fracture filling anhedral saddle dolomite D_3) of dolomites that occur as both replacement and fracture-filling cements in the Esino and Breno formations. The near-micritic grain size coupled with low mean Sr concentration (76 ± 37 ppm) of D_1 indicates an early dolomitization of shallow burial environment at near-surface conditions. The larger crystal sizes, homogenization temperatures (108 ± 6°C and 111 ± 14°C, respectively) of primary two-phase fluid inclusions, and estimated salinities (23 ± 2 eq wt% NaCl and 20 ± 4 eq wt% NaCl, respectively) of D_2 and D_3 suggest that they formed at later stages under mid- to deeper burial settings at higher temperatures from basinal fluids of higher salinity. This is consistent with their high Fe (1460 ± 900 ppm and 4462 ± 6888 ppm, respectively), Mn (556 ± 289 ppm and 1091 ± 1183 ppm, respectively) and low Sr contents (53 ± 31 ppm and 57 ± 24 ppm, respectively).

The estimated $\delta^{18}O$ values of the parent dolomitizing fluids of D_1, D_2, and D_3 suggest that D_1 was formed at temperature ~40–50°C in shallow burial setting with possible contributions from volcanic-associated fluids, which is consistent with its abnormal high Fe (4438 ± 4393 ppm) and Mn (1219 ± 1418 ppm) contents, and that D_2 and D_3 developed from fluids of similar isotopic compositions at higher temperatures of deeper burial settings. The similarity in shale-normalized REE patterns, Ce $(Ce/Ce^*)_{SN}$ and La $(Pr/Pr^*)_{SN}$ anomalies of the investigated carbonate generations supports the genetic relationship between the dolomite generations and their calcite precursor. Positive Eu anomaly, coupled with fluid-inclusion gas ratios (N_2/Ar, CO_2/CH_4, Ar/He) and halogen molar ratios (F/Cl and Cl/Br) suggest an origin from diagenetic fluids associated with volcanic activities or circulated through the co-occurring volcanic lenses.

In the St. George Group dolomites in western Newfoundland, earlier studies have also identified three generations with similar crystal sizes and shapes but different cathodoluminescence features in D_2 and D_3 comparing to their counterparts of the Esino and Breno formations. The compositions of major, minor and trace elements, O-isotopes, REEs, fluid-inclusion gases, and halogens in the St. George Group dolomites in western Newfoundland suggest they are typical hydrothermal dolomites developed mainly by basinal fluids without magmatic contributions.

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