Mg Isotopes in High Temperature Saddle Dolomites from the Lower Paleozoic of Eastern Canada: Significance for the Source of Magnesium and Their Origin

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Hydrothermal dolomites are host to major hydrocarbon fields in North America. The process leading to the formation of these high temperature dolomites is controversial with end-members of 1) early, tectonically-controlled, high temperature fluid migration upward along faults and laterally in porous limestones and 2) late, burial-dominated, regional migration of high temperature formation brines. In both cases, large amounts of magnesium are needed for the formation of the dolomite either as limestone replacement or void-filling cement. We present magnesium stable isotope ratios in saddle dolomites as a potential tool for recognition of Mg source and hence new data that could be of use in the ongoing debate.

In the Paleozoic of eastern Canada, saddle dolomites interpreted as hydrothermal are recognized in Ordovician shallow marine platform and slope carbonate, in Lower Silurian carbonate ramp and in Lower Devonian pinnacle reef. The occurrences are distributed from southern Quebec to the Gaspé Peninsula with the host successions occurring on lithologically diverse basement. The saddle dolomite samples were chemically characterized (ICP-ES) and their $\delta^{26/24}Mg_{NBS88a}$, $\delta^{25/24}Mg_{NBS88a}$ and $\delta^{26/25}Mg_{NBS88a}$ ratios measured (MC-ICP-MS).

The saddle dolomites in Lower Silurian carbonates in northern Gaspé were assumed to be sourced, through active foreland faulting, from underlying Ordovician ultramafic slivers; these dolomites and the adjacent fault-controlled dolomite bodies of Lower Ordovician slope carbonates are characterized by negative $\delta^{26/24}Mg_{NBS88a}$, $\delta^{25/24}Mg_{NBS88a}$ and $\delta^{26/25}Mg_{NBS88a}$ ratios (lower than or around 0‰ for the three ratios). On the other hand, Middle Ordovician saddle dolomites in southern Quebec are characterized by positive $\delta^{26/24}Mg_{NBS88a}$, $\delta^{25/24}Mg_{NBS88a}$ and $\delta^{26/25}Mg_{NBS88a}$ ratios (over +1, +0.4 and +0.5‰, respectively). It is noteworthy that saddle dolomite in Lower Devonian pinnacle reef in northern Gaspé are adjacent to the ultramafic slivers but are characterized by positive Mg isotope ratios. This agrees well with the recently published model of magmatic dolomitizing fluids for this case.

There is no significant correlation between the chemical composition of the matrix and the Mg isotope ratios; it is preliminary proposed that the isotopic variations could reflect different sources of Mg for dolomitization but further research is needed to better constraint the applicability of that new tool.