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Can C-isotope fractionation of cryptocrystalline magnesite be controlled by temperature ?

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Cryptocrystalline magnesite (CM) occurs all over the world either as Kraubath-type (KT) which forms veins and networks that are strictly controlled by regional fault tectonics in ultramafic host rocks, or as Bela Stena-type (BST), which forms nodules and layers, that occur at the base of clastic sedimentary cover above ultramafic rocks. These types also plot in different domains on the δ^{13}C/$\delta^{18}O$ diagramm. The KT has lower δ^{13}C-values (-22 to -8‰ VPDB) than the BST (-1 to +4‰ VPDB). $\delta^{18}O$ -values of both types overlap, whereby the KT shows in tendency lower values (+22 to +29‰ VSMOW) than the BST (+26 to +36‰ VSMOW).

This study is based on stable isotope data from Kraubath (Austria) and eleven CM-deposits in Turkey. Kraubath (Austria) contains the lowest δ^{13}C-values (-22.5 to -11.3‰ VPDB) of the whole series of measurement. Turkish KT network deposits (Eskişehir CM-district) range from -11 to -8‰ VPDB. The vein deposit Günaydin has δ^{13}C-values from -9 to -3‰ VPDB. Turkish BST magnesite deposits have either slightly negative C-values (~-6‰ VPDB) or positive C values (+1.5 to +6.9‰ VPDB). $\delta^{18}O$-values of all these mineralizations lie between 25 and 27‰ VSMOW. This indicates that magnesite mineralizations has been formed from different carbon sources (metamorphic, vulkanogenic, biogen and atmospheric) at similar temperatures (~60°C). Exceptions are vein deposits in the Tavşanlı CM-district with negative δ^{13}C (~-12‰) and low $\delta^{18}O_{VSMOW}$ -values (~23‰), and the network and BST deposit Bahtyiar with a very wide isotopic distribution ($\delta^{13}\mathrm{C}_{\mathrm{VPDB}}$:-8.5 to 0‰ $\delta^{18}O_{VSMOW}$: 27 to 35.4‰ caused by the transition from network to BST. This indicates that magnesite veins (Tavşanlı CM-district) formed at ~80°C, network mineralizations close to the surface (~60°C) and zebra mineralizations and BST at the border of the paleosurface at ~30° are plotting along a trendline in the δ^{13}C/$\delta^{18}O$ diagramm .

Well established genetic models show a depth dependency between vein, network and BST mineralizations. We investigate if the temperature can influence C-isotope fractionation and why the δ^{13}C is getting havier while the system is cooling down.

One option is that vein magnesite which has formed at greater depth indicates higher temperatures and pCO_2. Thus the isotope fractionation should be close to the primal composition. When the fluid approaches the surface CO_2degassing happens. Thus $\delta^{13}C$-values of the remaining fluid are getting heavier. At the border to the palaeosurface the isotopic fractionation is additionally enriched by the influx of atmospheric carbon. The δ^{13}C/$\delta^{18}O$ signature of the vein deposit Günaydin (Turkey) and Kraubath are probably caused by mechanisms which are independent of temperature. The highly negative values of Kraubath are possibly related to biogenic carbon. It is not identified yet, if the biogenic carbon is derived by decarboxylation or by microbial activity. Presently lipid biomarker analyses at the Department of Geodynamics and Sedimentology in Vienna investigate whether magnesite formation is microbial or not.