Stable isotopic composition of cryptocrystalline magnesite from deposits in Turkey and Austria

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Introduction

Cryptocrystalline magnesite (CM) is typically associated with ultramafic rocks in ophiolites. The mineralization occurs either as veins and networks, which are strictly controlled by regional fault tectonics (Kraubath-type), or as nodules and layers, which occur in sediments above the ophiolite close to the paleosurface (Bela Stena type). These types are well established and named after their type deposits in Austria and Serbia, respectively (Pohl, 1990; Prochaska, 2000; Wilson & Ebner, 2006).

Overview of the investigated areas

The mining area Bahtyiar, Eskişehir contains two pits (east pit and west pit) which are 500m apart from each other and range over an altitude of 800m. The mineralized zone at the east pit contains Kraubath type magnesite at the bottom covered by several layered magnesite bands, which are overlain by sediments. At the west pit iron-rich magnesite occurs as fine layers in a highly altered serpentinite at the top of the paleosurface.

- The Kraubath-type magnesite shows intermediate δ^13C values (-6.73‰ to -6.73‰) and δ^18O values which are very similar to all other deposits (+27.6‰ to +28.4‰). The layered magnesite mineralization shows higher δ^13C (5.1‰ to -5.1‰) and δ^18O values (+27.6‰ to +30.1‰).

This isotopic composition resembles the Bela Stena type.

Discussion

The currently available CM results show a very different behavior between the C and the O isotopes. δ^13C values range between -20‰ and -13‰ in Kraubath and between -11‰ and -18‰ in Turkey. These values are similar to those explained above (+24.5‰ to +26.2‰).

Isotopic compositions of deposits in Turkey and Austria, respectively (Pohl, 1990; Prochaska, 2000; Wilson & Ebner, 2006).

Our investigations were focussed on the type locality in Kraubath (Austria) as well as on some currently operating deposits in the magnesite districts of Eskişehir and Tavşanlı (western Anatolia/Turkey) and Silvas and Malatya (eastern Anatolia/Turkey) (Fig. 1). Results show that each of the deposits is characterized by a characteristic C isotopic composition. Furthermore, network and vein mineralizations in the magnesite district of Eskişehir can be distinguished by their isotopic pattern: Tutucua/Koçbal and Çünet (network mineralization) - low δ^13C values (-11.0‰ to -8.3‰), Günaydın (vein mineralization) - intermediate δ^13C values (-6.8‰ to -3.1‰), and Çirpit (Bela Stena-type CM in weathered serpentinite at the bottom of lacustrine sediments) - high δ^13C values (+2.9‰ to +3.4‰). The δ^18O values in all deposits are similar (+24.5‰ to +27.3‰).

A different isotopic pattern occurs at the magnesite deposits Silvas and Malatya: Belentarfa, Silvas (network mineralization) - low δ^18O values (-9.5‰ to -7.3‰) and Daban (Magnesite layer at the bottom of lacustrine sediments) - high δ^18O values (+7.4‰ to +9.1‰). The δ^18O values are slightly lower than those explained above (+24.5‰ to +26.2‰).

Fig. 2: The δ^13C and δ^18O values of CM show characteristic patterns for the Kraubath and the Bela Stena type as well as regional exceptions (Horkel et al., 2008). In Bela Stena the isotopic values indicate a slight overlap of both mineralization types within one deposit.

Stable isotopic studies of CM

Previous studies of CM showed that in comparison to sparry magnesite CM has lower δ^13C values (-18‰ to -6‰) and more constant δ^18O values (+22‰ to +29‰) (Krakl et al., 1989). Furthermore, it was observed that the Kraubath-type and Bela Stena-type CM differ in their isotopic composition in that the latter is characterised by higher δ^13C (-1‰ to +4‰) and δ^18O values (+26‰ to +36‰) (Jarkovik & Panic, 2003).

The formation of CM is still a subject of debate. The δ^18O values suggest formation temperatures below 80°C (Krakl et al., 1989; Ece et al., 2005). The C isotope data indicate that the C was either derived from the atmosphere or by decarboxylation of organic-rich sediments (Zedef et al., 2000).

Our research addresses the following major questions:

- What are the reasons for the difference in stable isotopic composition between the Kraubath and the Bela Stena-type?
- Is it possible to distinguish different types of mineralization within a deposit using stable isotopic data and can this information be applied as a tool for CM exploration?
- Do the individual isotopic patterns of the individual deposits reflect different conditions of formation or later (post-mineralization) alteration events?

Fig. 3: Rich magnesite layers on the top of the west pit at Bahtyiar. Red data mark: sampled place.

Results

Fig. 5: Schematic sketch of the mineralized zone of Bahtyiar. MfH pit (Rich magnesite layers with low δ^13C and high δ^18O values is present in the base). The layered magnesite below contains similar δ^13C but lower δ^18O values. The network magnesite mineralization at the bottom contains high δ^13C and lower δ^18O values.

The δ^13C and δ^18O values of CM show characteristic patterns for the Kraubath and the Bela Stena type as well as regional exceptions (Horkel et al., 2008). In Bela Stena the isotopic values indicate a slight overlap of both mineralization types within one deposit.

Fig. 6: Overview of the East pit of Bahtyiar. The northern part contains network magnesite mineralization. At the southern part occurs the paleosurface (Kümürlük). The C isotope values of Kraubath are much lower than in the Turkish deposits: (-20.0‰ to -13.3‰). The δ^18O values (+25.9‰ to +27.3‰). The isotopic composition of Bahtyiar is discussed separately.

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Fig. 4: Rich magnesite layers (+30°C) and altered serpentinite (+25.5°C) at Bahtyiar. The δ^13C values of Kraubath are much lower than in the Turkish deposits: (-20.0‰ to -13.3‰). The δ^18O values (+25.9‰ to +27.3‰). The isotopic composition of Bahtyiar is discussed separately.

Discussion

The currently available CM results show a very different behavior between the C and the O isotopes. δ^13C values range between -20‰ and -13‰ in Kraubath and between -11‰ and -18‰ in Turkey. Two groups of data have been observed, whereby the first contains Kataubath-type values. The second contains values which are closer to the Bela Stena-type CM. Whether this composition is primary or due to the interaction with meteoric water will be addressed in the near future.