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Fe-Cr Mixed Binary Spinels as Accessory Magnetic Minerals in the Sudetic Ophiolitic Rocks

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A b s t r a c t

Sudetic ophiolite is formed of three serpentinite massives situated around the Sowie Góry Mts Block: Jordanów-Gogołów Massif (JGSM), Braszowice-Brzeźnica Massif (BBSM) and Szklary Massif (SZM). Chromite Fe-Cr spinels occur in chromium ore (chromitites) in JGSM and BBSM (ore fragments on waste heaps) and as scattered grains in ultramafic rocks. The Fe-Cr chromite series have a general formula of $(Fe^{2+}_{1-x}\,Fe^{3+}_{x})[Fe^{2+}_{1-x}Fe^{3+}_{2-2y-x}Cr^{3+}_{2y}]_2O_4$ is built of mixed spinels with end members: primary chromite $(Fe^{2+})[Cr_3{}^{+2}]O_4$ (y = 0) with normal ordered spinel structure (x = 0) and magnetite $(Fe^{3+})[Fe^{2+}Fe^{3+}O_4]$ (y = 1) with inversed ordered spinel structure (x = 1). Fe-Cr spinels are called ferrichromites for $0.31 < y < 0.63$ and Cr-magnetites for $y > 0.63$. The composition affects substantially Curie temperatures: T_c of primary chromite is -202°C, T_c above r.t. for ferrichromites up to T_c of 585°C for magnetite. The primary chromites crystallize from mafic melt in upper mantle-lower crust environments. They are very stable against metamorphism and retain primary composition of their cores long during later metamorphism. Under cooling below ca 600°C chromite begin to alter: magnetite starts to replace chromite, with subsolidus exsolutions and oxidations processes. The core of the grain retains its primary composition with typical T_c of -180° up -120°C, around it ring 1 composed of Fe-Cr solution grains of ferrichromite and ring 2 of Cr-magnetite formed during metamorphism were observed (Fig. 1). Apart of changes in composition additional alterations, namely order – disorder transformation takes place (e.g., described by Harrison and Putnis (1999)). Such transformation is caused by electron hopping between tetrahedral and octahedral sublattices with help of oxygen ions (x in the above formula presents a fraction of 3+ cations in tetrahedral sublattice). Chromites were studied with magnetic methods as determinations of the magnetic susceptibility upon temperature curves (km-T) at the range -190°C up to 700°C for fresh and previously heated samples as well as with hysteresis properties studies. The Km-T experiments for fresh samples showed a wide spectrum of Km(T) curves depending on the composition (Fig. 2). Changes in composition influence changes in Tc observed on the heating branch of km-T curve, changes in ordering impart changes in Tc observed on the cooling branch. Therefore k-Tc curves are irreversible and Tc of samples observed in Cr-magnetites during heating is higher by 10–20°C than observed during cooling. During next heating – cooling cycles both branches become reversible. The observed thermal hysteresis

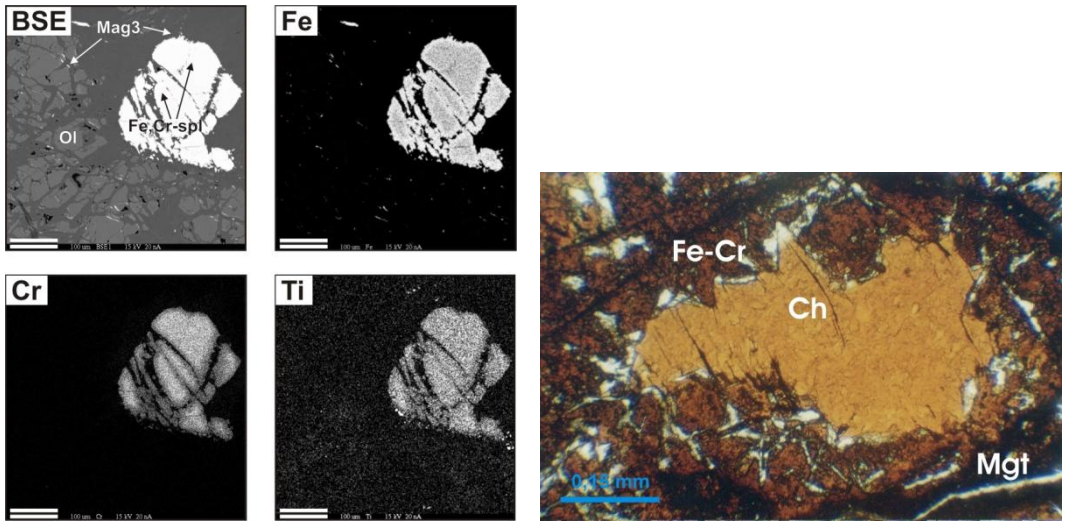

Fig. 1. BSE-SEM maps for chromite grains from chromite ore (JGSM, Tąpadła, ferrichromite).

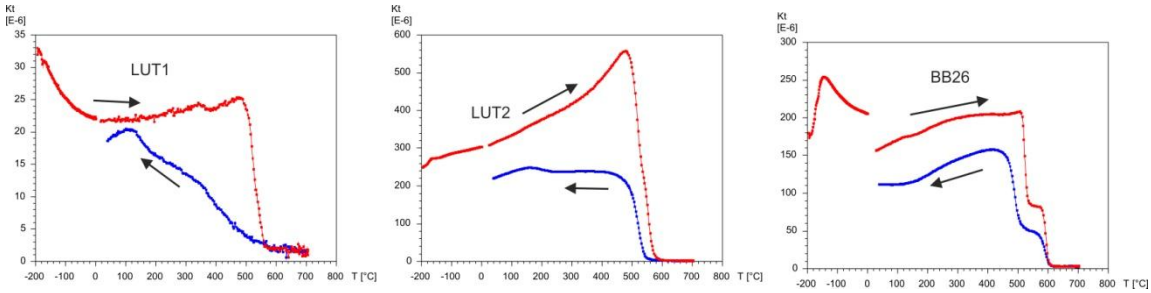

Fig. 2. Magnetic susceptibility Km-T curves -190°C up to 700°C) for chromites of different composition.

during heating-cooling cycle is due to kinetic lag in cation ordering during cooling (Harrison and Putnis 1996). The coercivity usually increases due to heating suggesting subsolidus exsolutions.

Keywords: chromites, magnetic susceptibility, ophiolite.

References

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