Effect of Elemental Composition of Fe-Ti Oxides on their Thermomagnetic Curves

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Chemical composition of Fe-Ti oxide minerals, an important component of both intrusive and extrusive magmatic rocks, reflects the evolution of magma. The relationship between the composition and geological processes is shown in the ternary diagram of O'Reilly (1984), indicating how various geological processes such as low-temperature oxidation ("maghemitization"), high-temperature or deuteric oxidation, hydration, or kinetically controlled inversion of structure from metastable to stable forms, are associated with magnetic mineralogy. In the present investigations, the effect of elemental composition of Fe-Ti oxides on their thermomagnetic curves was studied on volcanic rocks of the České středohoří Mts.

The elemental composition of the studied Fe-Ti oxide phases was measured in polished thin sections employing Link ISIS 300 energy-dispersive system equipped with CamScan IV electron microscope. The system was operated at an accelerating voltage of 15 kV and a sample current of 2.5 nA. Temperature variation of magnetic susceptibility of the studied volcanic rocks was measured on CS-3 Furnace Apparatus (from 20 °C to 700 °C), CS-L Cryostat Apparatus (from −196 °C to 20 °C), and KLY-3S Kappabridge.

The chemical composition of the most abundant spinel-group minerals is more variable than that of ilmenite-group minerals. The ratio $Mg/(Mg+Fe^{2+})$ of titanomagnetites is highly variable (0.1 to 0.7) in basanites and nephelinites, and usually <0.2 in tephrites and trachybasalts. Separate groups are the titanomagnetites from essexites and camponites, both with $Mg/(Mg+Fe^{2+})$ <0.05, where $Fe^{3+}/(Fe^{3+}+2Ti)$ is between 0.8 and 1.0 for essexite and between 0.4 and 0.5 for camptonite. The Cr/(Cr+Al) ratio is used to identify rock types enriched in Al. Of the rock types measured in this study, the Cr/(Cr+Al) ratio is <0.3 in tephrites, trachybasalts and some basanites and nephelinites, and between 0.4 and 0.7 in other basanites and nephelinites.

Thermomagnetic curves of the rocks under investigation can be divided into several types as follows: simple heating curves with low Curie points (T_c) (between 150 °C and 300 °C), simple heating curves with high T_c (between 450 °C and 580 °C), heating curves with two or more maxima ("humps") and with simple cooling curves, and heating curves with two or more maxima and with complicated cooling curves.

Characteristic T_c of pure titanomagnetite $Fe_{2.4}Ti_{0.6}O_4$ and magnetite Fe_3O_4 are ≈150 °C and 580 °C, respectively (Dunlop and Özdemir, 1997). Different oxidation states and contents of Al and Mg impurities in the titanomagnetites result in various shapes of thermomagnetic curves and various Curie points. Al and Mg impurities lower the T_c, while oxidation raises the T_c.

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References

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P-T Pseudosections, Zoned Garnets and Structural Records from two Structurally Different Mica Schists of the Stronie Formation in the Orlica-Śnieżnik Dome

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Tectono-metamorphic records in mica schists of the volcano-sedimentary Stronie Formation from two localities – Złoty Stok-Trzebieszowice Shear Zone (ZSTSZ) and Krowiarki Mts. – within the Lądek-Śnieżnik Metamorphic Unit (LSMU) were compared using techniques of structural and phase-equilibrium analysis. Both the areas are characterized by the occurrence of very similar rock types, which distinctly contrast in their structural characteristics. ZSTSZ is the NE–SW-trending shear zone with steep foliation, whereas the Krowiarki Mts. region is a strongly folded domain with predominant foliation dipping at relatively low angles. P-T pseudosections for the effective bulk compositions in the KFMASH model system were calculated for a precise determination of the metamorphic paths for rocks of both areas using THERMOCALC program. A combination