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Geochemistry of titanomagnetite in rocks and ores of Medvedevskoe deposit, Southern Urals

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Medvedevsky gabbro massif and associated deposit is attributed to northern abyssal group as a part of Middle-Riphean riftogenic Kusinsko-Kopansky gabbro-granite complex in South Urals [1].

Several genetic types of ore mineralization are revealed in Peredovoy quarry of Medvedevskoe deposit: basic magmatic titanomagnetite (Ti-Mt) ores in stratificated gabbroids and skarn connected with xenolites of host carbonate rocks. Magmatic ores are impregnated and can be rich impregnated in ore melanogabbro; Ti-Mt is an accessory mineral in anorthosites and dyke complex. Solid Ti-Mt-chlorite ores are found in tectonic zone. Second outcrop of solid ores is connected with gabbro and calcareous skarn contact zone of Praskovie-Evgenievskaya mine situated in the central part of the massif [2]. Thickness of layer ores on the contact between gabbroids and skarns is 1-40 cm. Ores are composed of chlorite and magnetite, comprising a great amount of thin (5 µm) ilmenite lamells. Gabbroids in the contact with skarn are dramatically depleted with ore minerals. Magnetite accumulations up to 20 cm in diameter are observed in mine's marbles away from the contact, and on the contact between marble and intrusive diabase dyke Mg-ludwigite is developed [2].

Microelement ICP-MS analysis of basic types of rocks and ores and comprising Ti-Mt was carried out in order to study the chemical composition of sorted out genetic types of Ti-Mt ore mineralization. Titanium content in Ti-Mt is quite consistent in different types of magmatic ores and makes from 6.2 wt% TiO_2 in solid ores up to 8.0 wt% in ore gabbroids (rich impregnated ores). In anorthosites magnetite is depleted with TiO_2 (1.5%). Ti-Mt in near-skarn gabbroids is enriched in TiO_2 up to 14.4%, and magnetite in marbles situated away from contact contains significant amounts of Mn and Mg upon almost total absence of Cu, Eu and Ti. Ti/V ratio in Ti-Mt is also unstable: in solid ores 10, ore gabbros 25-69, anorthosites 10, marbles 0,2-11. Trace elements concentrations in Ti-Mt of basic ore types are irregular. Ores with ∑REE content in Ti-Mt can be divided in two groups: ∑REE less than 2 ppm and more than 4 ppm. All samples are characterized by light prevalence of LREE above HREE and small Eu anomalies of different signs. Besides main components (Ti, V, Mg, Al, Mn and Cr), Li, Sc, Co, Cu, Ni, Zn, Co, As, Sr, Ba, Pb, Nb can be regarded as significant trace elements (n-n*10^2 ppm). Ti-Mt of anorthosites is enriched with almost all elements, especially with chalcophylic, up to ten and hundred times as compared to samples from other rocks. In skarn column (gabbro-ore-skarn-marble) to solid ore on the gabbro contact in Ti-Mt concentration of Sc, V, Co, Ni and Ga is increasing, while Li, Be, Na, and Y decreasing, as well as Zn. Concentrations maximum is slightly shifted to Ti-Mt of gabbroids for Ti, Rb, Sr, Zr, Nb, Mn, Ag, Sn, REE, Hf, Ta and W. Gabbroids itself on the anorhtosite contact have higher REE concentrations (23-52 ppm) with increase to 42-78 ppm in anorthosites, and decrease in the central parts of gabbroid layers (0.8-27 ppm). Ti-Mt of their rocks follows this trend. Differences in Ba and Sr behavior can be noted: gabbroids and comprised ore minerals are enriched in Ba (up to 300 ppm) as compared to anorthosites (less than 80 ppm), the opposite situation is for Sr: in anorthosites peak content of Sr is 700 ppm.

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Different meanings for cummingtonite-hornblende association in plutonic rocks (Iberian Massif, Portugal)

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Cummingtonite-grunerite series is frequently related to metamorphism or volcanic environments, but rarely described as belonging to a plutonic assemblage [1]. Recently, in the Iberian Massif (Portugal), there have been several references [2-5] of this Fe-Mg amphibole intimately associated with Ca amphiboles (mainly hornblende) in plutonic rocks. Different textural relationships between two amphibole types have been argued for a primary (igneous) or subsolidus metamorphic origin for Fe-Mg amphibole.

Cummingtonite-grunerite (Cum, hereafter all abbreviation from [6]) from gabbros and diorites of the Carrascal Massif (Central Iberian Zone) occurs as tiny exsolution lamellae within a dominant hornblende (Hbl) crystal [3]. This textural occurrence agrees with the subsolidus growth of the Fe-Mg amphibole, reflecting the equation $Hbl+Qtz=Cum+An+H_2O$ [7].

Nevertheless, in the Hospitais tonalite (Ossa-Morena Zone) Cum occurs as euhedral to subhedral cores usually mantled by Hbl [4]. Although Cum is seldom described in literature as a magmatic mineral in plutonic assemblages, its occurrence in the Hospitais tonalite was interpreted as resulting from an early stage of igneous crystallization [4]. As a consequence of the high water content of calc-alkaline magmas, the Fe-Mg amphibole should reflect the equation $Opx+H_2O=Cum+Mag+SiO_2+H_2$ [8]. The similarity between Mg # on Cum and Hbl from tonalitic rocks suggests an equilibrium crystallizing assemblage, as pointed out by Wones and Gilbert [9] for a hypabyssal igneous suite.

Mineral chemistry data on Cum from the Carrascal gabbro-dorites (Mg#: 0.49-0.64; Al_2O_3: 0.7-2.37%; TiO_2: 0.01-0.37%) and Hospitais tonalite (Mg#: 0.43-0.53; Al_2O_3: 1.22-2.44 %; TiO_2; 0.05-0.27%) exhibit a significant overlap. Therefore, textural relationships should be the main (only?) tool to distinguish between igneous *versus* metamorphic growth. More detailed petrographic studies on plutonic rocks from the Iberian Massif are needed to ascertain the petrogenetic significance of the association Cum-Hbl.

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