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DIFFERENCES IN MORPHOLOGICAL PROPERTIES BETWEEN THE OLIVINE GROUP MINERALS FORMED IN NATURAL AND INDUSTRIAL PROCESSES

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Abstract

Olivines are a large isomorphic series of minerals, belonging to silicates group. Regardless of their chemical composition, any of these minerals can be formed both in natural and industrial processes. The aim of this work is to describe these minerals and differences of morphological properties between the olivines formed in nature, and those formed as by-products of some industrial processes , as Process Metalurgy-Ironmaking . The olivines whose formation is tied to rock masses (natural process) and the olivines genetically tied to industrial processes of black metallurgy slags (process metallurgy-Ironmaking) are shown in this paper. The morphological properties of these minerals and their differences have been analyzed by optical microscopy in refracted and in reflected light.

Keywords: olivines, slags, natural process, metallurgy proces, microscopy

1. Introduction

Olivine group minerals belong to nesosilicates, a subgroup of silicates, i.e. orthosilicates and diorthosilicates. Basic structural motif of orthosilicates is

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isolated SiO_4 tetrahedron. Basic structural motif of diorthosilicates are two tetrahedrons bonded with one common oxygen ion. This means that radicals of these nesosilicates are $(SiO_4)^{4-}$ and $(Si_2O_7)^{6-}$, respectively. Olivine group of minerals comprises olivine $(Mg,Fe)_2/SiO_4/$ and knebelite $(Fe,Mn)_2$ $/SiO/_4$. Olivine represents an isomorphic mixture of forsterite Mg_2 $/SiO_4/$ and fayalite Fe_2 $/SiO_4/$, while knebelite is an isomorphic mixture of tephroite Mn_2 $/SiO_4/$ to fayalite [1]. Olivine group minerals crystallize in orthorhombic holoedry system. In the nature, these minerals most often form short columnar crystals and grainy aggregates.

2. Materials and methods

In this work, natural material (rocks) containing olivine group minerals and materials formed in technological processes of black metallurgy (slags) also containing olivine group minerals have been used. Thin sections of natural materials - rocks - have been analyzed under microscope in refracted light (Faculty of mining and geology), while thick sections made of materials formed in technological process - slags - have been analyzed under the microscope in reflected light and refracted light (U.S.Steel Serbia).

3. Results and discussion

In nature, olivine group minerals appear in rocks (as petrogene minerals), which are aggregates of various mineral composition, genesis and fabric. Olivine group minerals appear in basic and ultrabsic magmatic rocks and in some metamorphic rocks. The results of analyses in this paper present appearance of olivine and morphology of olivine in komatiites, basaltoids, and in some metamorphic rocks. The characteristic of morphology of olivine group minerals formed in rocks is the presence of phenocrystals and semirounded grains. Olivine from komatiite characterized with dendritic crystals (Figure 6) and are thus very similar in habit to olivine formed in technological processes. Komatiites are ultramafic mantle-derived volcanic rocks. They have low SiO_2, low K_2O, low Al_2O_3 and high to extremely high MgO. It is composed mostly of olivine and monoclinic pyroxene crystals in recrystallized (devitrified) matrix.

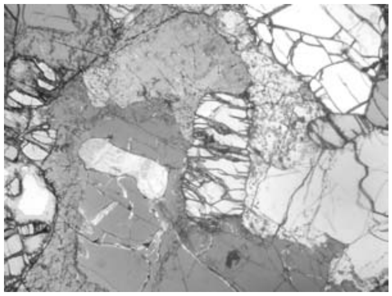

Fig. 1 Microphotograph of the basaltoid with olivine present as emirounded forms, Refracted light, magnification 27x, crossed Nicol prisms , [2]

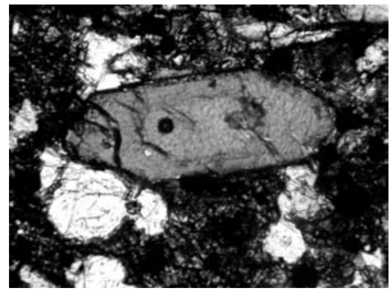

Fig. 2 Microphotograph of the basaltoid with olivine present as visible phenocrystal, Refracted light, magnification 32x, crossed Nicol prisms, [2]

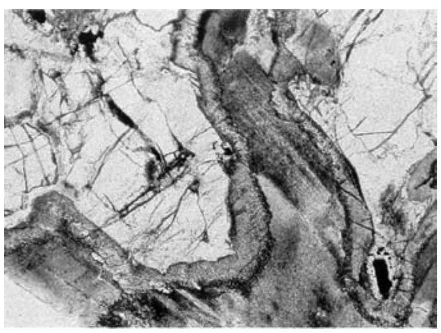

Fig. 3 Microphotograph of metamorphosed olivine-dolerite (diabase),Refracted light, magnification 27x, parallel Nicol prisms , [3]

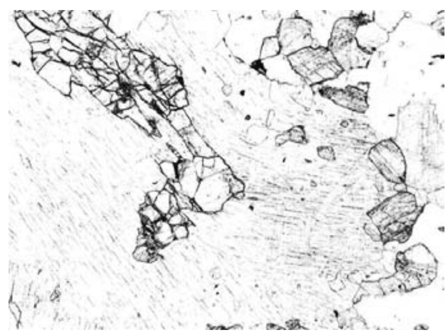

Fig. 4 Microphotograph of metamorphosed serpentinite, Refracted light, magnification 32x, parallel Nicol prisms , [3]

Olivine group minerals have a distinctive morphology when they are formed in materials generated as product of technological processes in Black metallurgy. Those materials are most often slags, i.e. acid slags rich in glass content (Figure12). These glassy slags contain sporadic crystal grains or dendritic olivine crystals in glassy matrix (Figure13).Table 1 presents a results of chemical analysis slag from Blast furnace.

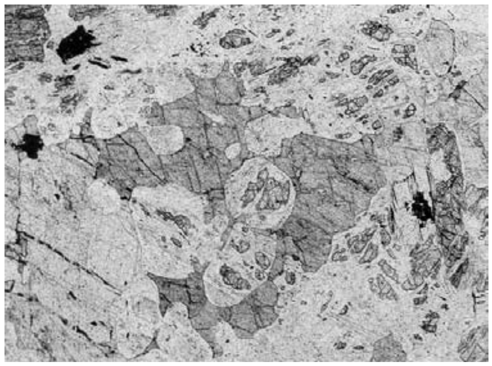

Fig. 5 Microphotograph of serpentinised metaperidotite, Refracted light, magnification 32x, parallel Nicol prisms , [3]

Fig. 6 Microphotograph dendritic olivine crystals from komatiite, [4]

Table 1. Results of chemical analysis slag from Blast furnace (U.S.Steel Serbia)

		CaO	SiO_2	Al_2O_3	MgO	MnO	Fe	S	TiO_2	B
1	24466	37.13	40.00	7.94	8.80	0.56	0.43	0.64	0.34	0.93
2	24516	39.07	39.08	7.90	9.14	0.46	0.34	0.73	0.31	1.00

Olivine grains are sometimes well formed crystals, and sometimes they are just crystal nuclei. Instead of olivine, these slags may sometimes contain melilite group minerals - gelenite and akermanite, as members of melilite isomorphic minerals group.

Beside slags, also acid agglomerates (acidity from 0.9 to 1.3) may contain olivine group minerals.

Figures 7, and 8 present olivines formed in technological processes. Pictures are taken from the relevant literature[5]. Figure 7 shows an interesting skeletoidal form of olivine. Figure 8 shows an interesting morphology of olivine as an elongated crystal phase. Figure 9 shows microphotograph of slag with olivine from Blast furnace[6].

Figures 10 and 11 show slags from archemetallurgical sites. These slags contain magnetite, glass and olivine group minerals - fayalite and tephroite.

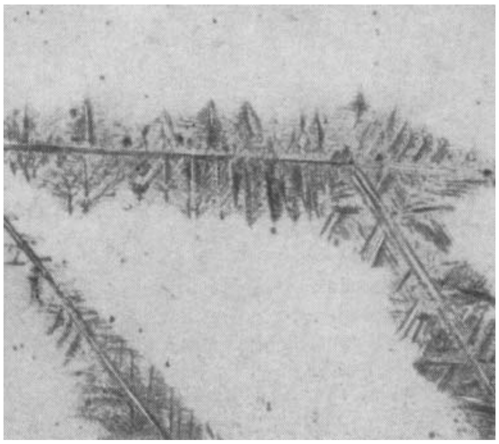

Fig. 7 Microphotograph of olivine with skeletoidal form, originating from technological process, Reflected light, [5]

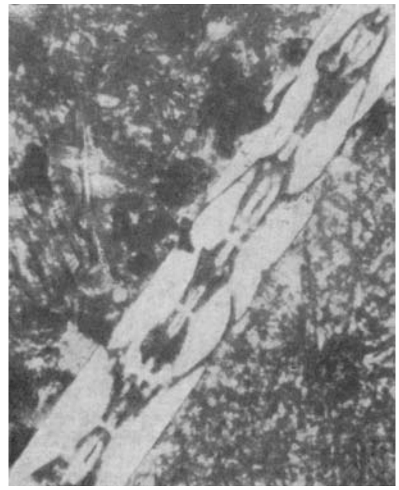

Fig. 8 Microphotograph of olivine with coarse, elongated crystal form, originating from technological process, Reflected light, [5]

Fig. 9 Microphotograph of slag with olivine from Blast furnace, Reflected light [6]

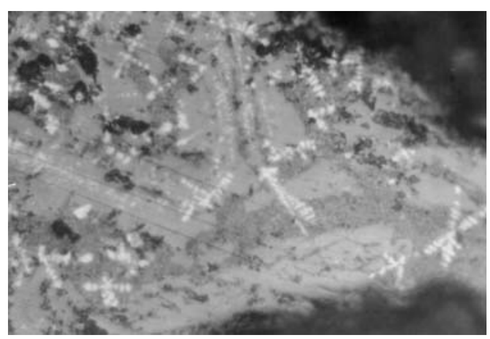

Fig. 10 Microphotograph of olivine with elongated form (light grey colour) in slag, Reflected light, magnification 250x, parallel Nicol prisms, [7]

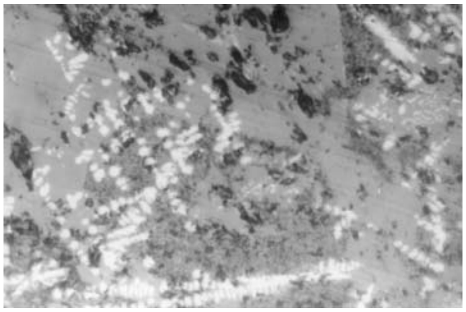

Fig. 11 Microphotograph of olivine with elongated form (light grey colour) in slag, Reflected light, magnification 250x, parallel Nicol prisms, [8]

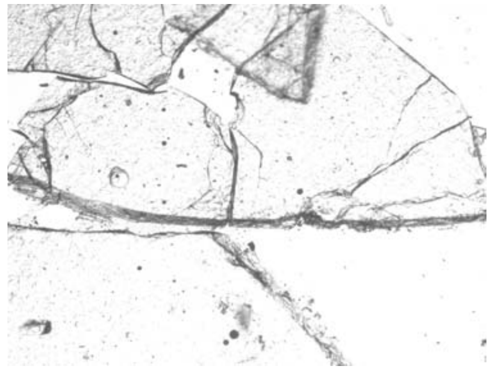

Fig. 12 Microphotograph of slag, Refracted light, magnification x, parallel Nicol prisms(U.S.Steel Serbia).

Fig. 13 Microphotograph of olivine in slag, Refracted light, magnification x, parallel Nicol prisms, (U.S.Steel Serbia).

4. Conclusion

Based on the results of the research and of analyses presented in this paper, the following can be concluded:

- Olivine group minerals can be formed in natural and in technological processes - in certain mineral aggregates (rocks), in slags of the Blast furnace and agglomerates.
- Olivine group minerals crystallize in the same system, both in rocks and in slags, but their morphologies are different.

- The most frequently occurring forms of olivine in rocks have been analyzed by optical microscopy in refracted light. These forms are crystal and rounded.
- Olivine group minerals from slags show skeletoidal or crystal form under microscope.
- Morphology of olivine crystal forms in slags differs from those in natural aggregates (rocks).

Reference

1. P. Ristić, R. Kovačević, Special mineralogy, RGF- Tuzla,1983 (in Serbian)
2. M. Jovanović, Bazalti Srbije, Ph.D. Thesis, Faculty of mining and geology Beolgrade, 2004
3. B. Yardley, W. MacKennzie, C. Guilford, Atlas of metamorphic rocks and their textures, Longman Group Limited, UK,1990
4. Wikipedia encyclopedia
5. K. Frye, The encyclpedia of mineralogy, Hutchinson Ross Publishing Company, Stroudsburg, USA,1981
6. S. Blomgren, E. Tholander, *Scandinavian Journal of Metall.*15 (1986)151 -160
7. S. Dević, M. Tomović, M. Cocić, Prceedin. International Conference Archeometallurgy in Europe Milan , Italy, 2003 pp. 27-32
8. A. Vasić S. Dević V. Milovanović, Proceedin. International Conference Varna, Bulgaria, 2001 pp.137 -142