THE STUDY OF THE ORE BODIES ZONALITY BY COMPOSITION OF OLIVINE IN THE CHROMITE DEPOSIT NO. 219 OF THE VERKH-NEYVINSKY MASSIF (MIDDLE URALS)

A. V. Alekseev

A brief description of the massif and chromites

The Verkh-Neyvinsky massif is one of the least studied chromite-bearing massifs in the Middle Urals. At the same time, the chromite industry of Russia “originated” on it. Here were the very first chromite mines in the Urals (1880s), the remains of which one can still observe today.

The massif has a complex geological structure. It has a drop-shaped form, ranging from 10 km wide in the north to 1–2 in the south, containing the rocks of the Sjuzel, Kirovgrad and Kungurk suites, the contacts of the massif with them are tectonic with a dip to the east at angles of 55–80°. The northern part of the massif is mainly composed of dunites, which contact in the north and east with a gabbroid massif. Along the contact develops a thick zone of clinopyroxenites with subducted verlites and olivine clinopyroxenites. The southern part of the massif is also represented by an extended dunite body, clamped between the clinopyroxenite and the bandings. According to geophysical data, the ultrabasites form a layer-like deposit underlain by gabbroids, the vertical thickness of which reaches 5 km.

A lot of chromite deposits have been identified (and for the most part worked out) on the massif, some of them are single bodies chaotically scattered along the massif, but the bulk of them concentrates in two ore fields. The northern field is the Leshachie ravines (26 chromite displays and deposits), represented by numerous lenticular bodies of solid, less often disseminated ores, and usually worked to a depth of up to 60 m. The distribution of deposits is chaotic, with no apparent reference to any geological structures. The southern field is the Sharomsky Mountains (10–12 objects), represented by lenticular and tabular deposits with a predominance of disseminated mineralization.

Both ore fields have similarities in geological structure. They are confined to the marginal dunite-clinopyroxenite complex (DC), ore bodies occur in dunite blocks, by composition chromites have high chromium content, metallurgical varieties, and are generally susceptible to weakly expressed processes of secondary changes. The Sharomsky field is much smaller (dunite block area is smaller) than Leshachie, so the chromite bodies are smaller, and disseminated ores predominate.

The material for this study

During several years of work, we accumulated a rather large amount of stone material for the chromite deposits of the massif. In the northern group of deposits (Leshachie ravines), we mostly studied abandoned quarries, the remains of ore bodies were rare, most of the material was from dumps or remaining uncovered walls. In the southern group (Zhuzhinsky Mountains), we conducted active prospecting and mining operations for several years, so the accumulated material is highly representative and mainly includes core samples for ores and enclosing rocks.

Overall, a study covers material from 15 wells crossing ore bodies. Of these, a large part (7 wells) is for deposit No. 219.

Objectives. The main objective of this research was to study the structure of chromite bodies with the search for an explicit or hidden zonality in composition. To this end, we studied structures and textures of ores, contacts with host rocks, and selected series of ore samples intersecting ore bodies for successive production of polishes and thin sections with their description.
For the most thoroughly studied (drilled by a dense network of wells) deposit No. 219, we obtained a large volume of microprobe analyzes for coexisting olivine and chromospinelide in order to search for the internal zoning of chromite bodies in terms of the composition of the minerals.

Previous studies on this topic

The first consideration of the search for hidden zonality in chromite bodies appeared in the works of Tsaritsyn [8], who showed a change in chromicity in the ore bodies of the Kempiraysky massif from the center to the edge of the deposit. Later, zonality in chromite bodies by the composition of the ore chromospinelide was covered by various examples in the works of Ukhanov [7], Chashchukhin [9] Alekseev [1], et al. In general, all researchers note a pronounced zonality, consisting in the chromicity increase of the ore chromospinelide from the edge of the ore body to its center. In addition, there is a general increase in the chromium content of the mineral as the density of dissemination of ores increases.

The structure of the studied deposit

Earlier we already considered in detail the structure of the ore-bearing zone of deposit No. 219 [2]. We showed that the ore-bearing zone is a layered body with clearly delineated boundaries. The host rocks are represented by serpentinized dunites with a ferrugi-
The ore zone has a reduced iron content of 7–8 % and a characteristic light color (clarified dunites). Below the ore zone, there is a zone of vein mineralization in the form of thin (up to the few meters) veins of clarified serpentinites with chromite mineralization.

The chromites in the ore zone are characterized by banded textures; the elements of occurrence of banding always correspond to the elements of occurrence of the zone as a whole. The distribution of chromospinelide within the zone is rather chaotic. The results of contouring along the side content distinguish the ore bodies; they have a lenticular shape, the strike as a whole coincides with the strike of the zone.

After the extraction of the ore zone of deposit No. 219, we attempted to find some zonality in the composition of the minerals within it. Since the only primary minerals are olivine and chromo-
Figure 3. Change in the ferruginousness of coexisting olivine and chromospinelide by microsections of samples No. 23/50.5 (a), 25/130.0 (b) and 24/44.5 (c). Note. The arrows show changes in the iron content of olivine from the center of the grain to the edge. The lines show the trend of the olivine compositions changes as it approaches the grain of chromospinelide.
spinelide, they were a focus of the study. In Fig. 2, one can see the most representative section of the ore zone. Of the samples from all the wells, the number of samples and the data obtained from well No. 25 turned out to be the largest and most successful for analysis.

**Description of chromites.** Incipient and banded textures predominate in ores with an ore mineral content ranging from 5–10 to 20–25 %. The shape of the chromospinelide grains is distinctly idiomorphic (octahedral), splices or irregular forms of selections are much less common. The grain size of chromospinelide varies from 0.2–0.3 mm to 1 mm. Hereewith, generally, there is no predominant grain size for each sample. Usually there are large grains surrounded by a scattering of smaller ones. The dependence of the grain size on the density of impregnation exists (in dense and massive ores the grain size is larger than in the poor ones), but it is very weak.

**Conclusions.** The ore-bearing zone of deposit No. 219 has a pronounced zonation by the change in the iron content of olivine from 7–8 % Fa at its boundaries to 3–4 % Fa in the center. The studied samples widely display already known phenomenon of post-crystallization redistribution of iron between coexisting grains of olivine and chromospinelide. We emphasize that it occurs only in a narrow contact zone of both minerals.

The reason for the appearance of such zonality in the composition of olivine is still unclear. Probably, this is a reflection of processes during the formation of the ore zone – crystallization of the residual melt.

**REFERENCES**

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