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Systematization of cadastral data on the Nikolaevskii scheelite mineralization (Right-Bank Region of the Ukrainian Shield)

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SUMMARY

The generalization and cadastral systematization of data on the Nikolaevskii manifestation of scheelite mineralization (Right-Bank Region of the Ukrainian Shield) were made. The cadastral data regarding the Nikolaevskii wolframite mineralization are grouped in four tables. In total, 43 cadastral attributes are determined: 11 cadastral attributes – in relation to spatial characteristics of mineralization; 18 cadastral attributes – in relation to geochemical peculiarities; 9 cadastral attributes – in relation to mineralogical description of scheelites; 5 cadastral attributes – in relation to chemical and X-ray identification of scheelites. The peculiarities of the scheelite mineralization of the Nikolaevskii area: 1) localization in the rocks of the Zelenorichenska suite of the Ingulo-Inguletsk series (Lower Proterozoic); 2) linear-lenticular form of tungsten anomalies and zonal character of anomalies of small metals; 3) direct correlation of tungsten with CaO and Na2O in rocks; 4) presence of transverse zonality of mineralization – W, (Mo, Bi), Ag, (V, Cu, Sn), Zn; 5) stratiform sulfide-scheelite with molybdenite type of mineralization; 6) practically pure composition of scheelite individuals (no impurities); 7) association with pyrite, pyrrhotite, chalcopyrite, molybdenite, magnetite, apatite, leucoxene; 8) removal of barium from tungsten-bearing zones and surrounding areas.

Introduction

Finds of scheelite in the Kryvyi Rig-Kremenchug structural-formational zone are associated mainly with crystalline rocks of the Ingulo-Inguletsk series (Mel'nik and Yaroshchuk, 1962; Lashko, 1995; Kurlov et al., 2002). Scheelite identification confirmed by mineralogical, chemical and X-ray investigations (Mel'nik and Yaroshchuk, 1962; Lashko, 1998; Lashko et al., 1999).

The most perspective in terms of tungsten-bearing here is the Nikolaevskii area of the Right-Bank Region, where tungsten anomalies are exposed by numerous boreholes (Lashko, 1995). Information about scheelite mineralization of the Nikolaevskii area is included in international mineralogical dictionaries (Evseev, 2000; Evseev, 2014).

The purpose of this work is to generalization and cadastral systematization of data on the Nikolaevskii manifestation of scheelite mineralization.

Method

Here we used a cadastral approach similar to our previous work (Lashko, 2020). Data generalization was carried out using general theoretical, abstract-logical and statistical analysis. Data are systematized in tabular form.

Results

Information on scheelite and wolframite mineralizations of the Nikolaevskii area is somewhat different. Therefore, it was necessary to form new cadastral attributes. In particular, Table 1 (Spatial characteristics…) is supplemented by three cadastral attributes: the main rock-forming minerals of the enclosing rocks; structure of scheelite mineralization; the most informative cross-sections of the scheelite-bearing pack. Table 2 (Geochemical peculiarities…) is supplemented by five cadastral attributes: CaO / MgO ratio in rocks (in a scheelite-bearing pack); Na_2O / K_2O ratio in rocks (in a scheelite-bearing pack); a row of transverse zonality (of scheelite mineralization); displacement of geochemical halos relative to granitoids; other distinctive geochemical characteristics. Table 3 (Mineralogical description…) is supplemented by one cadastral attribute – “refraction”. Identification of scheelites of the Nikolaevskii area is unambiguous (Table 4).

It should be noted: 1) the presence of calcium minerals in enclosing rocks of scheelite-bearing pack (sphene, apatite, labrador, bitovnite); 2) grouping of scheelite mineralization into a series of close mineralized zones; 3) distribution of scheelite mineralization in wide limits – in the depth interval 50–400 m from the earth's surface; 4) general accumulation of calcium, magnesium, sodium, potassium in the lower part of the scheelite-bearing pack, which corresponds to the exocontact of the granitization zones (while decrease here the CaO / MgO and Na_2O / K_2O ratios); 5) removal of barium from tungsten-bearing zones and surrounding areas; 6) increased gold content in the upper section of the scheelite-bearing pack (30–100 times higher than the background content for the enclosing rocks); 7) similarity of distribution of at least 7 chemical elements (V, Ag, Bi, La, Mo, Nb, Sn) in a vertical section of a scheelite-bearing pack with distribution of tungsten (Figure 1).

Conclusions

The currently available information on the Nikolaevskii scheelite mineralization of the Right-Bank Region of the Ukrainian Shield can be represented by 43 cadastral attributes: 11 cadastral attributes – in relation to spatial characteristics of mineralization; 18 cadastral attributes – in relation to geochemical peculiarities; 9 cadastral attributes – in relation to mineralogical description of scheelites; 5 cadastral attributes – in relation to chemical and X-ray identification of scheelites.

Table 1 Spatial characteristics of the Nikolaevskii scheelite mineralization

Cadastral attribute	Attribute characteristic
Geographical position	Ukraine, the Pyatykhat district of Dnipropetrovsk region and Oleksandriya district of Kirovograd region
Geological position	Northeastern part of the Right-Bank Region of the Ukrainian Shield within the Kryvyi Rig-Kremenchug zone, Nikolaevskii area
Geological structure	Monoclines
Stratigraphic position	Zelenorichenska suite of the Ingulo-Inguletsk series (Lower Proterozoic)
Enclosing rocks	Biotite-amphibole and amphibole gneisses, magnetite-bearing, with sphene or apatite
The main rock-forming minerals of the enclosing rocks	Quartz, medium plagioclase (oligoclase–andesine No. 23–43, very rarely labrador–bitovnite No. 67–72) and hornblende of medium iron content (n_g = 1.671–1.698; n_p = 1.650–1.676, f = 33–67%; (–)2V = 70–76°; cN_g = 15–23°)
Stratums dip angle	70 – 90° to the west
Width of scheelite-bearing pack	Up to 75 m
Type of mineralization localization	Phenocrysts and streaked
Structure of scheelite mineralization	Series of mineralized zones
The most informative cross-sections of the scheelite-bearing pack	Profile A (northern part of the Nikolaevskii area): the upper section – borehole No. 2425, 50.0 – 94.6 m; middle section – borehole No. 2427, 177.9 – 245.4 m; lower section – borehole No. 2429, 323.8 – 415.8 m

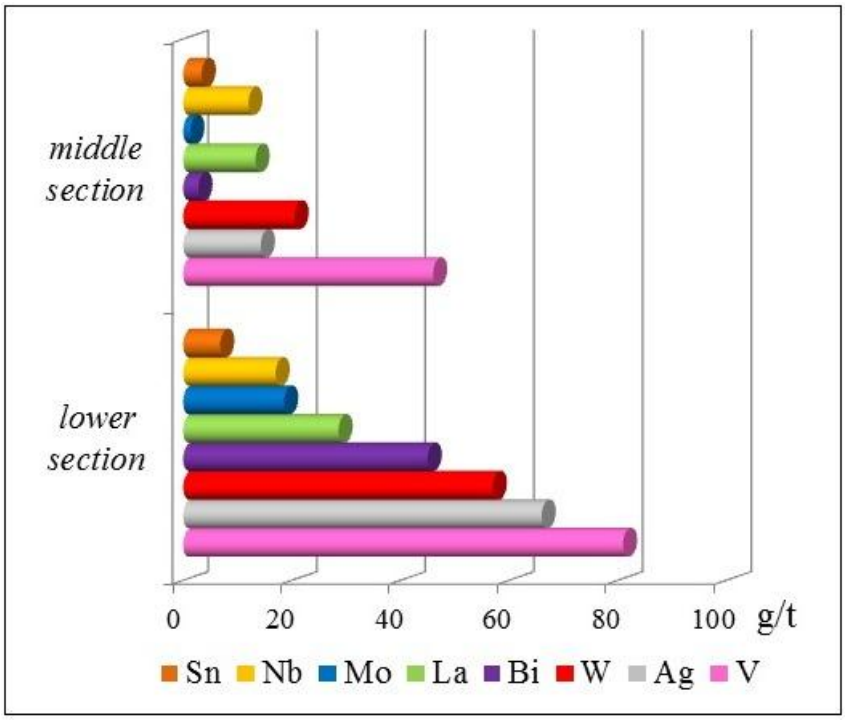

Figure 1 *Changes in the average content of W, V, Ag, Bi, La, Mo, Nb, Sn in sections of the scheelite-bearing pack of the Nikolaevskii area (profile A). The middle section is a borehole No. 2427, tests interval 177.9 – 245.4 m; lower section – borehole No. 2429, tests interval 323.8 – 415.8 m. Units of measurement: W, V, Bi, La, Mo, Nb, Sn – g/t; Ag – cg/t*

Table 2 Geochemical peculiarities of the Nikolaevskii scheelite mineralization

Cadastral attribute	Attribute characteristic
The tungsten content	100–10000 g/t (spectral analysis)
The form of tungsten anomalies	Linear-lenticular
The form of anomalies of small metals	Zonal character
The length of tungsten anomalies	1000–1600 m
Typomorphic elements	W, Mo, Bi, Ag, Cu, Sn, Be
Companion minerals	Pyrite, pyrrhotite, chalcopyrite, molybdenite, magnetite, apatite, leucoxene
Companion elements with high concentration; degree of their connection	Very strong connection – Ag; strong connection – Mo, Bi; weak connection – Cu, V; very weak connection – Co
The average chemical composition of scheelite-bearing pack	SiO_2 – 56.8–57.1%, Al_2O_3 – 11.03–12.0%, Fe_2O_3 – 2.18–4.72%, FeO – 6.97–8.65%, TiO_2 – 0.78–1.0%, P_2O_5 – 0.12–0.2%, MnO – 0.19–0.22%, CaO – 5.16–8.53%, MgO – 2.27–5.1%, SO_3 sulfide – 0.28–0.29%, K_2O – 0.62–1.13%, Na_2O – 2.22–3.08%, loss on burning – 3.32–5.06%, BaO – 0.057–0.127%, total – 99.267–99.937%, SO_3 general – 2.43–3.93%, H_2O – 0.16–0.25%, CO_2 – 1.036–2.144% (according to 11 tests)
CaO / MgO ratio in rocks	1.67–2.27
Na_2O / K_2O ratio in rocks	2.73–3.58
Correlation of tungsten with petrogenic components	Direct correlation with CaO, Na_2O, TiO_2, P_2O_5
Spatial compatibility of peak tungsten concentrations	The compatibility with the maximum content of CaO and Na_2O in a scheelite-bearing pack
Levels of maximum accumulation of tungsten:	– upper section (borehole No. 2425)
	– lower section (borehole No. 2429)
A row of transverse zonality	W, (Mo, Bi), Ag, (V, Cu, Sn), Zn
Displacement of geochemical halos relative to granitoids	Sn, Mo, Bi → Ag, W → Cu
Type of mineralization	Stratiform sulfide-scheelite with molybdenite
Presumable level of erosion cut	Ore-above-ore
Other distinctive geochemical characteristics:	1) removal of barium from tungsten-bearing zones and surrounding areas; 2) increased gold content in the upper section of the scheelite-bearing pack (30–100 times higher than the background content for the enclosing rocks)

Table 3 Mineralogical description of scheelites of Nikolaevskii area

Cadastral attribute	Attribute characteristic
Mineral form	1) rounded (with smoothed edges) crystals of pseudo-octahedral appearance; 2) rounded grains of a flat or isometric shape; 3) irregular debris
Dimensions	Mainly 0.3 x 0.5 mm, rarely – up to 1.0 mm
Sample color	Yellowish-, brownish- or greenish-gray
Line color	White
Sample transparency	Transparent
Shine	Silky and matte
Refraction	High
Birefringence	Low
Other mineralogical characteristics:	1) frangible; 2) bluish luminescence in cathode rays; 3) when heated in HCl with crystalline tin, it acquires an intense blue color

Table 4 Identification of scheelites of the Nikolaevskii area

Cadastral attribute		Attribute characteristic
Place of samplings		Sample 1: borehole № 2429, interval 361.5 – 363.0 m. Sample 2: borehole № 2401, interval 341.0 – 343.0 m
Analytical devices	Chemical diagnostics	Microanalyzer JXA-5 (Lashko et al., 1999)
	X-ray diagnostics	Camera RCD-57.3, installation of URS-60 with radiation Fe, α, β (Lashko et al., 1999)
Chemical composition		WO_3 – 80.01–80.26%, CaO – 19.60–19.88%, total – 99.86–99.89%. Fe, Mg, Mn, Cu, Mo, Sn, Nb, Ta – not detected
Crystal-chemical formula		$Ca_{1.015–1.028}W_{0.993–0.995}O_4$
X-ray similarity of scheelites of the Nikolaevskii area		Comparable: 1) with the Ural scheelite $CaWO_4$ (sample 522) (Mikheev, 1957, p. 544); 2) with standard 7-210 of the XRDC, 1981 (Lashko et al., 1999); 3) with the sample from Western Krivoy Rog (Mel'nik and Yaroshchuk, 1962); 4) with the sample of the Sorokin zone of the Priazovie (Kravchenko and Rusakov, 1982)

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