MINERALOGIA POLONICA
Vol. 35, No 1, 2004
PL ISSN 0032-6267

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PECULIAR NEPHRITE FROM THE EAST SAIAN MTS (SIBERIA)

A b s t r a c t. During field investigations, a rare variety of nephrite was found in one of the nephritic bodies of the ultrabasite Ospino-Kitoj massif (the East Saian). The nephrite is homogeneous, lacking of any spot-like structure typical of nephrite, and shows very good, although dim, grey-greenish translucency. Subtle internal features of the nephrite were observed under the microscope. Its structure is similar to textile weave made of two perpendicular sets of threads, arranged lengthwise (warp) and crosswise (weft). The compactly set and plastically deformed, micrometer-sized tremolite threads form the thicker warp thread (0.02–0.03 mm), while the thinner weft thread is composed of thickly placed, usually singular tremolite threads. Comparing these features with the features of nephrites from the world's deposits it is seen that the differences between them essentially consists in the internal structure. Peculiarity of nephrite from the East Saian Mts lies in its structural, textural and mineral homogeneity, a rare trait of nephrite. It is worth mentioning that such a structure is not characteristic of the tremolite asbestos, which is also present as veins in that deposit.

Key-words: nephrite, tremolite, internal structure, the Saian Mts, Siberia

INTRODUCTION

The occurrences of nephrite in the Saian Mts (Siberia) have been known for a long time. The nephrite was initially spotted by accident among pebbles and boulders left by mountainous rivers and glaciers. The sources of these stones were found in the mid-19th century in the highest, hardly accessible part of the East Saian (especially in the so-called Ospino-Kitoj ultrabasite massif, Fig. 1). It should be noted that Polish investigators, i.e. J. Czerski and J. Morozewicz, made a substantial contribution to the discovery of Siberian nephrite. The Siberian deposits, together with those from Canada and New Zealand, belong to the biggest in the world, and their nephrite is of special attraction (Desautels 1986; Zara 1969).

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LOCATION AND GEOLOGY

The Saian nephrite deposit located in the Ospino-Kitoj utrabasite massif consists of some tens of veins of different thickness and numerous blocks differing in size, distributed over an area of some tens of km^2 (Fig. 1). The rock-types present in the massif (serpentinites, peridotites, pyroxenites) as well as the harsh weathering conditions of high mountains are the reasons that the area looks like Marsian landscape. There are no life symptoms, the unusual rocks display various weathering colours (green, rusty, red, violet, and blue), while gigantesque rubble heaps and huge blocks dot the area against sharp outlines of high mountains (Phot. 1). Most of the nephritic outcrops are located above the forest line (2,100 m a.s.l.). Their size is in the range of 0.6–30 m, and they extend up to 100 m; the weight of the huge nephrite blocks, left behind by rivers and glaciers, reach up to some hundreds of tons (Łapot 2003).

The author spent some days in the Saian Mts. in the summer of 2002. The direct observations of methods of nephrite exploration and exploitation provided a rare occasion to investigate the nephrite varieties on the very spot of their occurrence and enabled to collect unique samples used as the nephrite standards in Poland and elsewhere in Europe.

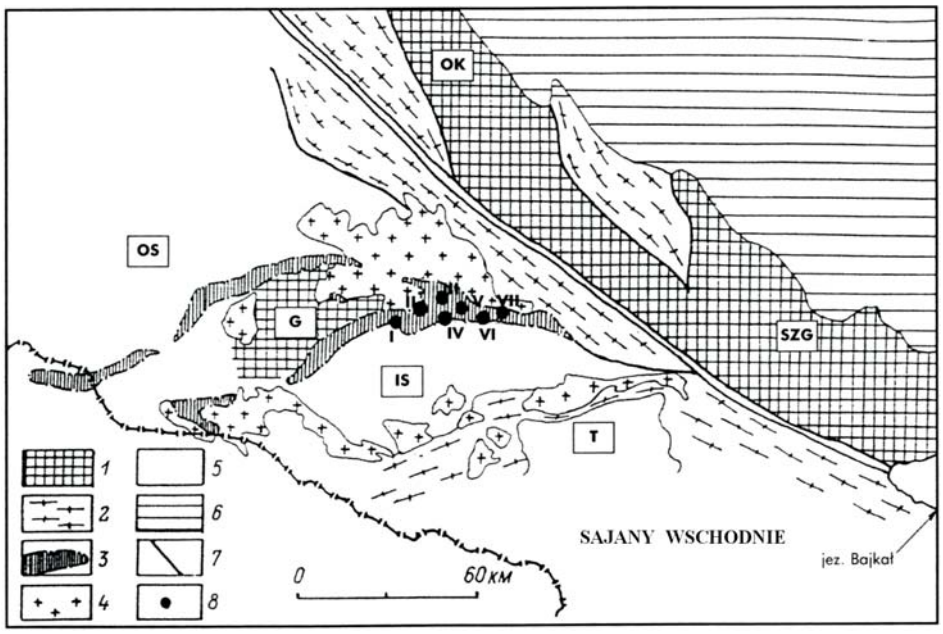

Fig. 1. Nephrite occurrences in the East Saian Mts, according to Prokhor (1990; cf. Łodzińscy A., M. 2002). 1 — Archaic and 2 — Lower Proterozoic crystalline basement of the Siberian Platform, 3 — ophiolite belt, 4 — Palaeozoic granitoids, 5 — Palaeozoic sediments (carbonate rocks, detrital rocks and claystones), 6 — sedimentary cover of the Siberian platform, 7 — faults, 8 — nephrite deposits. Structural elements: OK — Okin elevation, SZG — Saryzaigal elevation, G — Gargan anticline, OS — Okin syncline, IS — Iltshyr syncline, T — Tunkin trough

MATERIALS AND METHODS

During the field trip, an unusual nephrite variety was found in one of the nephrite bodies in the Ospino-Kitoj massif (Fig. 1). It is characterized by homogeneous colour, lack of typical of nephrite, spot-like colour distribution and very good, however dim, grey-greenish translucency; these features give the rock an attractive, unique appearance (Phot. 2). Conchoidal fracture surfaces are also atypical: they are smooth, with no small splinters, characteristic of nephrite. This nephrite variety is a main component of some vast, dichotomically branched veins, from 0.2 m to 1.5 m thick, cutting in different directions a large, typical, lens-like nephrite body about 100 m in length and about 30 m in thickness. The nephrite body mentioned is a component of a vast ultrabasite masif, composed mainly of very hard, massive or schistose dark green serpentinites. Nephrite is accompanied by light, intrusive magmatic rocks showing the features of albitophire, whose outcrops were mapped several metres from the nephrite body.

The internal structure and mineral composition of the nephrite were investigated using a petrographic microscope Olympus BX-60 with magnifications up to 1000x and binocular microscopes: a Gemmaster Superscope with the Eickhorst system and a GemoLite Super 60 Z-Mark X, with maximum magnification 120x, equipped with bright field, dark field and optical wave guide light. Microobservations were also carried out on natural surfaces using an electron microscope ESEM-XL 30 TMP (Philips/Fei) with an EDS (EDAX) detector; they included morphological (BSE) observations and determinations of chemical composition (EDS). X-ray diffraction analyses were made using an X-ray diffractometer Philips PW 3710, with Cu $K\alpha_1$ radiation and graphite monochromator, lamp voltage 35 kV, current 30 mA, counting time 2 s, speed of a counter 0.02°.

RESULTS

Under binocular microscope the nephrite studied is translucent, dim and greenish like it was seen in hand specimens. Its colour is unusually homogeneous, without dark patches, typical of other nephrites. Binocular observations enabled to distinguish a subtle orientation, macroscopically invisible. That orientation can be a result of unusually regular lamination, visible under the petrographical microscope (Phot. 3). A thickness of the distinguishable laminae, similar in the whole portion of a sample, is in the range of 0.02–0.03 mm. These laminae are geometrically conformable. On the fracture surfaces, very evenly distributed burrs, typical of nephrite, could be observed under the binocular. They are, in fact, extremely small and should be thus classified as microburrs.

The microscope observations revealed also the unusual regularity of nephrite microtexture (Phot. 3). The way of distribution and forms of thread-like aggregates of fibrous amphibole are the cause of this regularity, being a main textural motif of the nephrite investigated. The arrangement of amphibole fibres resembles the textile weave, com-

posed of two sets of threads, a thicker warp, 0.02–0.03 mm in diameter, made of compactly set and plastically deformed, micrometer-sized amphibole threads, and a perpendicularly oriented, much thinner, weft set, composed of densely placed, mostly singular amphibole threads.

Optical observations show the amphibole to be a tremolite. It is characterized by the lack of pleochroism, relatively low light refraction indices (n_α = 1,600, n_β = 1,614, n_γ = 1,625), large optic axes angle ($2V_\alpha$ = 83º) and high birefraction (0.025).

X-ray analyses also revealed the nephrite in question to be almost monomineral, composed of tremolite (Fig. 2). Chemical composition characteristic of tremolite was

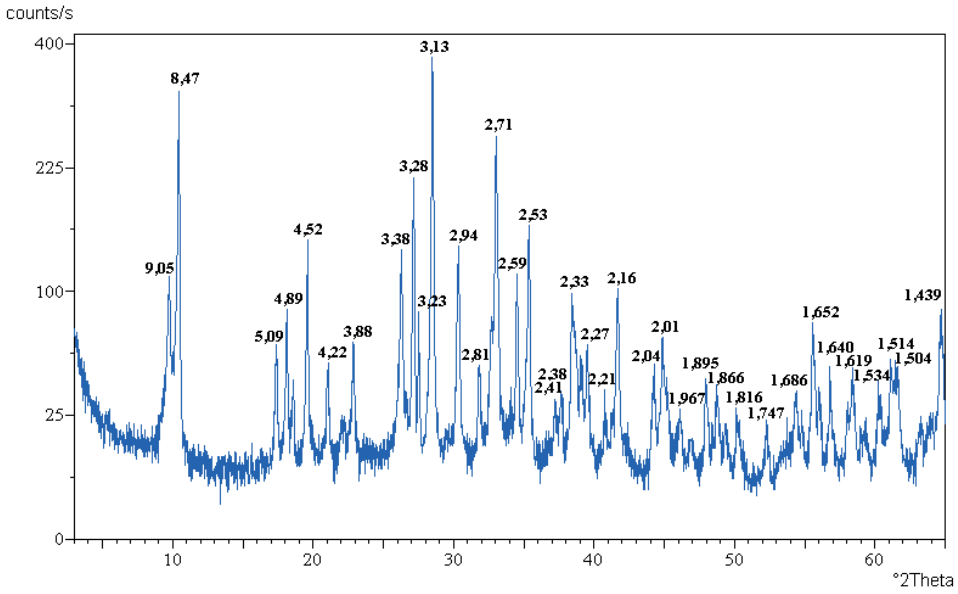

Fig. 2. X-ray diffraction pattern of the peculiar nephrite from the East Saian Mts. Identification of tremolite according to the standard No 13.0437 (JCPDS 1997)

also confirmed by the SEM-EDS analysis (Fig. 3). The size and morphology of singular tremolite crystals were defined under the scanning microscope: it usually forms fibres, about 0.1 μm thick and 5 μm long (Phot. 4). These observations allowed noting a next feature, typical of nephrite: it is the presence of small clots of an opaque mineral, about 0.001 mm in size, distributed evenly among the fibrous amphibole aggregates. EDS analyses revealed them to be chromite (Fig. 4).

GEMOLOGICAL PROPERTIES

The basic properties identifying the peculiar nephrite from the Saian Mts have been listed below.

➢ Colour: greenish-grey

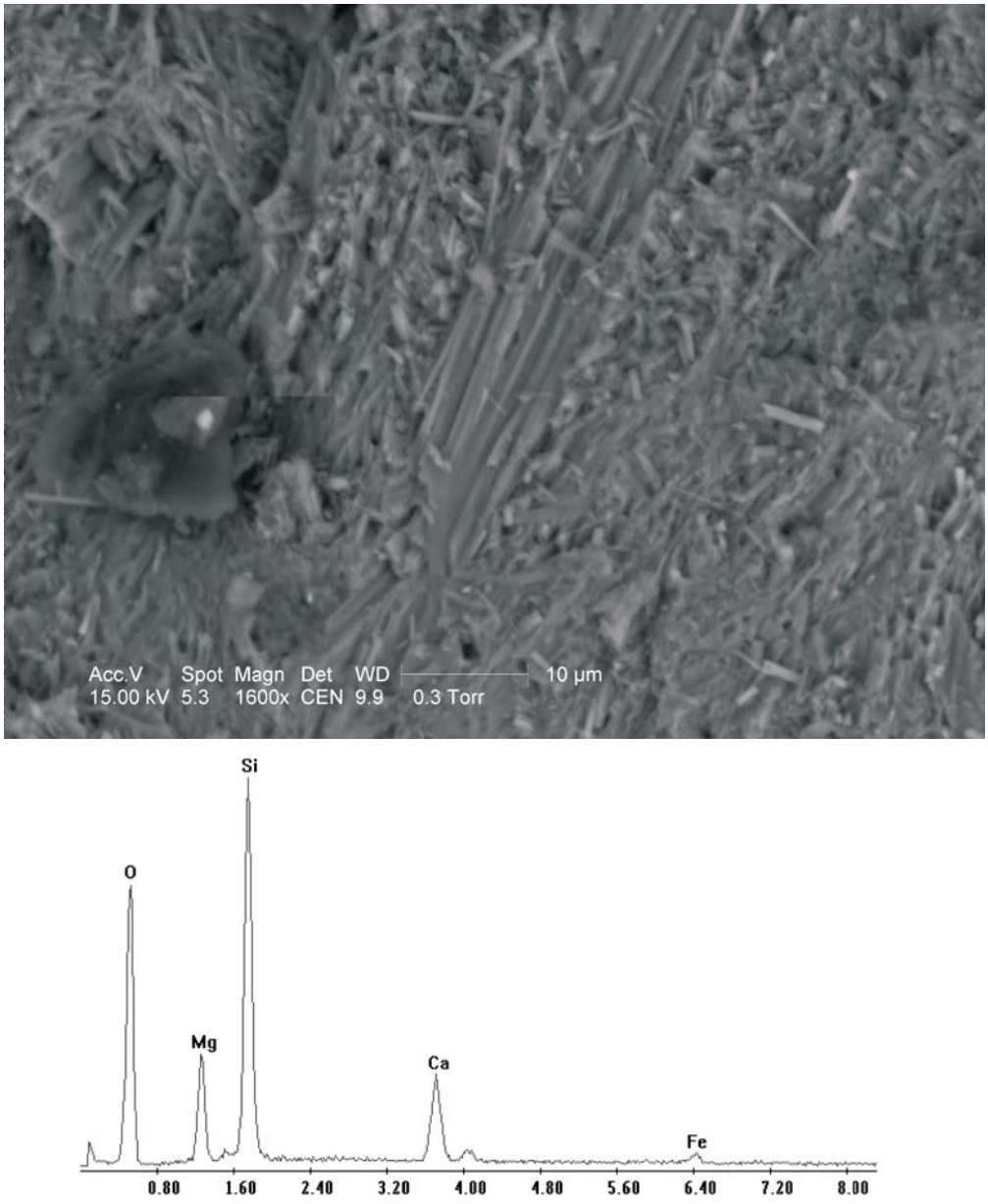

Fig. 3. BSE image of peculiar nephrite from the East Saian Mts (top) and its EDS spectrum (bottom)

- ➢ Optical effects: none
- ➢ Transparency: good translucent
- ➢ Inclusions (gemological binocular, polarizing microscope): rare, fine, evenly dispersed, opaque
- ➢ Hardness (scratch test): 6.0 on Mohs scale
- ➢ Relative density (hydrostatic method): 3.12–3.20

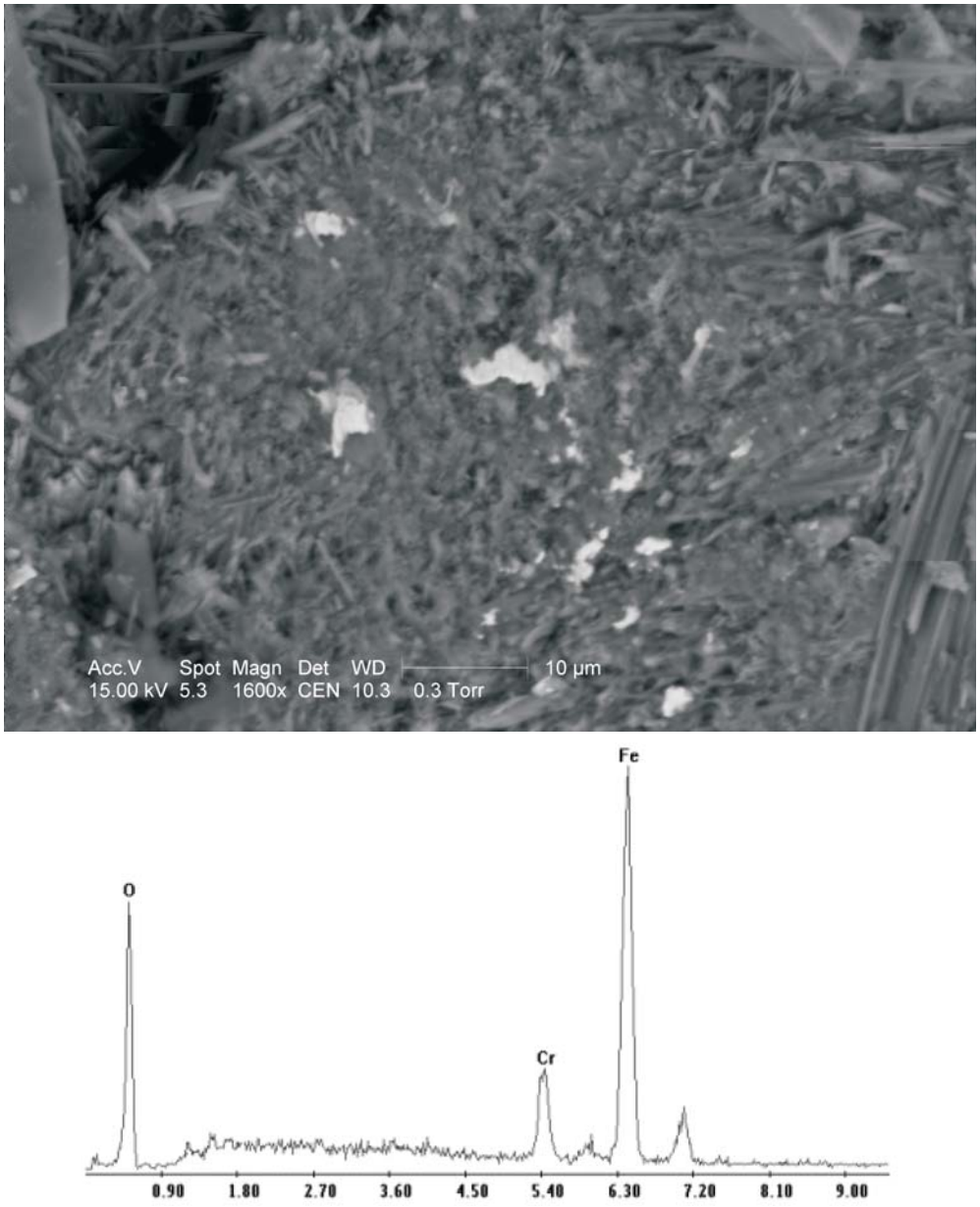

Fig. 4. Chromite clots (light spots) in the peculiar nephrite from the East Saian Mts (top; BSE image) and their chemical composition (bottom; EDS)

- ➢ Optical character (polariscope, polarizing microscope): anisotropic, fibrous aggregates
- ➢ Refraction (refractometer): 1.62 (Benson method)
- ➢ Birefringence (refractometer): not detectable
- ➢ Dispersion (refractometer + monochromator): not detectable
- ➢ Pleochroism: calcite dichroscope — none, polarizing microscope — none

- ➢ Absorption spectrum (prismatic spectroscope): a vague line at 500 nm, vague lines in the red end of the spectrum
- ➢ Fluorescence (a mercury lamp with filters): UVC — inert, UVL — inert
- ➢ Lustre: dull to waxy
- ➢ Lustre of the polished surface: greasy, resinous to vitreous
- ➢ Cleavage: not visible
- ➢ Fracture: uneven to conchoidal
- ➢ Crystal habit: fibrous; massive fibrous aggregates
- ➢ Others: macroscopically homogeneous, microscopically fibrous with directional microtexture.

CONCLUSIONS

Comparing the features of the peculiar nephrite from the East Saian Mts with the features of other nephrites from the world's deposits (Beck 1984; GIA, 1985; Leaming 1995; Lintner 1989) one can state that the essential differences among them is expressed on the internal structure of the Siberian nephrite. Binocular observations allowed revealing the subtle, oriented texture, a result of the distribution and forms of the rock-forming amphibole threads. They form two-directional aggregates, similar to textile weave, composed of two sets of threads: thicker warp tremolite threads, 0.02–0.03 mm across and micrometer-sized, compactly set and plastically deformed, and perpendicular to them, much thinner weft set, composed of the densely placed, mostly singular tremolite threads. The Saian nephrite is peculiar due to its structural, textural and mineral homogeneity, a rare feature of nephrites; there are no changes in the colour, translucency and the character of fracture surfaces. It must be stressed that such a homogeneity and structure are not typical of the tremolite asbestos, forming veins within the same deposit.

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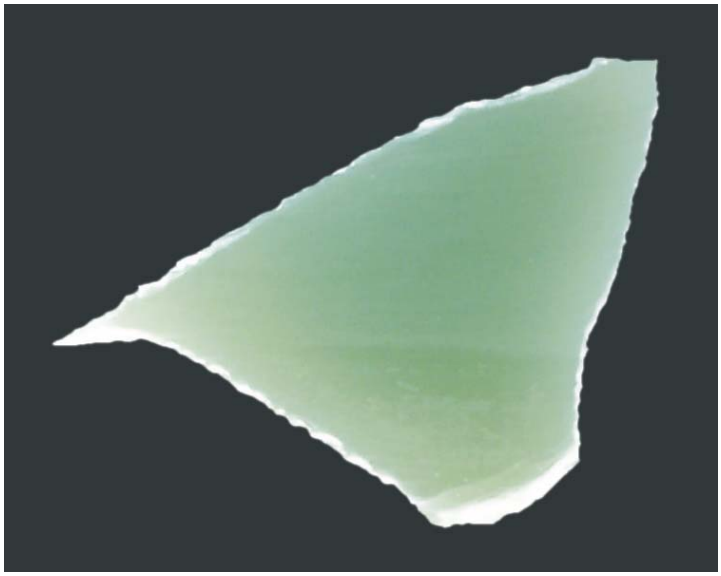
OSOBLIWY NEFRYT W SAJANACH WSCHODNICH (SYBERIA)

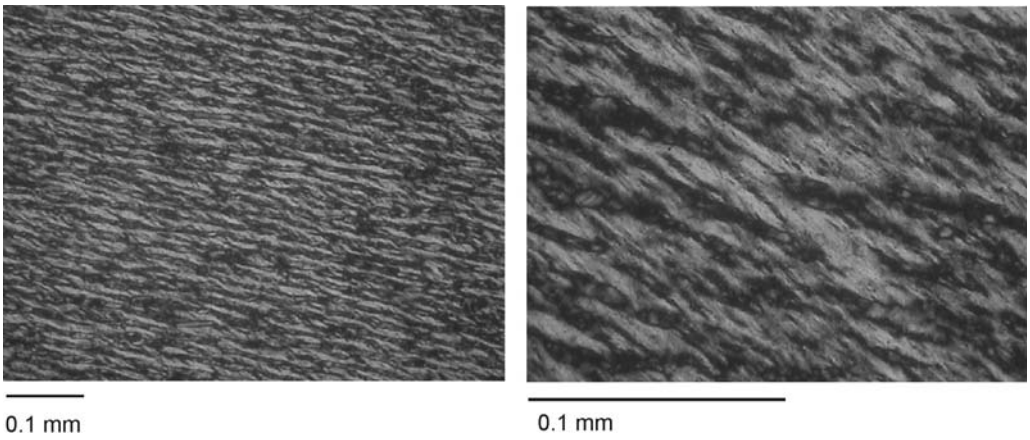
Streszczenie

W trakcie zwiadu terenowego, w jednym z nefrytowych ciał ultrazasadowego masywu ospińsko-kitojskiego (Sajany Wschodnie) natrafiono na odmianę nefrytu o rzadko spotykanym wyglądzie. Wyróżnia go jednorodność barwy i brak tak pospolitej w nefrycie plamistości oraz bardzo dobre, choć mętne, zielonawoszare przeświecanie. Subtelne cechy budowy owego nefrytu ujawniono za pomocą obserwacji mikroskopowych. Do złudzenia przypomina ona tkacki splot, powstały z przenikania się dwu wzajemnie prostopadłych układów nitek: podłużnego (osnowy) i poprzecznego (wątku). Grubszą nić osnowy (0,02–0,03 mm) tworzą ciasno splecione, plastycznie powyginane, mikronowe włókna tremolitu, natomiast cieńszą nić wątku stanowią gęsto rozmieszczone, przeważnie pojedyncze włókna tremolitu. Porównując cechy owego nefrytu z cechami nefrytu z innych światowych złóż można stwierdzić, że różnice dotyczą głównie jego budowy. Osobliwość polega na rzadko spotykanej w nefrycie, niezwykłej wprost homogeniczności strukturalno-teksturalnej i mineralnej. Warto podkreślić, że nie jest to budowa charakterystyczna dla azbestu tremolitowego, którego żyły są także obecne w tym złożu.

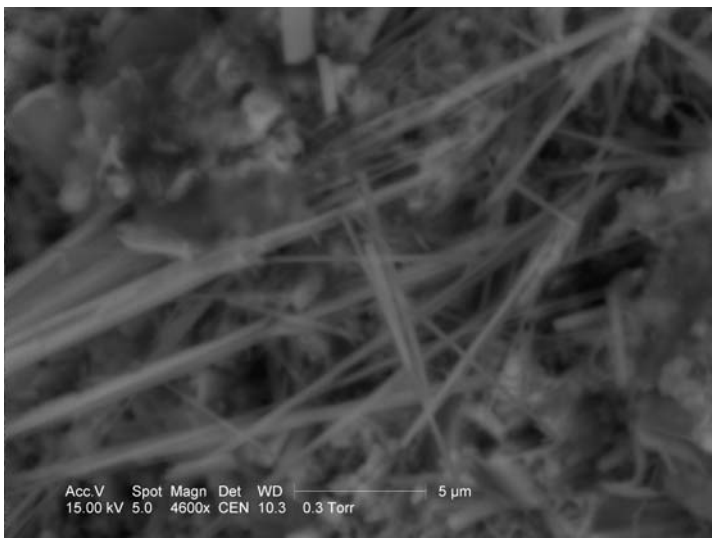
Phot. 1. A panorama of the Ospin-Kitoj massif in the East Saian Mts



Phot. 2. Peculiar nephrite from East Saian Mts with homogenous structure and colour, and dim, greyish translucency



Phot. 3. Microphotograph of the peculiar nephrite from East Saian Mts (crossed polars)



Phot. 4. BSE image of fibrous tremolite crystals in the peculiar nephrite from the East Saian Mts