

DISTRIBUTION OF TRACE ELEMENTS IN THE CARBON-RICH SHUNGITE ROCKS OF KARELIA

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Shungite rocks are widely spread in the stratigraphic sequence of Lower Proterozoic of Karelia, Russia. The Onega structure is unique in this respect. It is known for a variety of formations differing in nature, composition and carbon content (from 1–3 up to 98 wt. %). Elemental carbon in this region is present in igneous, metamorphic and sedimentary rocks. In places, the sequence includes rocks that are almost pure glassy carbon with most unusual structural characteristics. Although the carbon is X-ray amorphous, electron diffraction indicates that some structure exists in the form of globules (multilayered formations less than 10 nm in size). Diversity of shungite rocks genesis as well as of their mineral and geochemical compositions draw attention because sedimentogenic anomalies of REE and PGE metals were revealed as a source of regenerated complex ore deposits (like Padma). Carbon and carbon-sulphide concretions are found to be the main carrier of REE in different carbonaceous formations. Average concentrations of REE were estimated in shungites. However no data on the distribution of trace elements between carbon matrix and associated minerals have been available up to now. Such data would be helpful in solving shungite metamorphism and genesis problems.

The goal of the study was to determine the distribution pattern of trace elements using X-ray microanalysis. The bonding strength of some elements in shungite and its precipitates after extraction was estimated by mass-spectrometry and spectral analysis.

A Cam Scan scanning electron microscope equipped with Link AN 10000 and Microspec attachments was used. Detection limits were 0.1–0.01 wt. %. Investigations focused on the shungites from four deposits with different metamorphism (Shunga — Sh, Chebolaksha — Ch, Maksovo — M, Nigozero — N) fully characterized before (carbon content 73–95 wt. %)

We compared the frequency of occurrence of trace elements on the surface of the shungites under investigation. Apart from alkalis and alkali earth metals, the most varied set of trace elements was revealed for Ch (La, Ce, Pr, Se, Ga, Ge, Th, Au, Sc, W, Pd, Pb, Sn), Sh contained some of them (La, Pr, Sc, W, Pd, Y, Hg, Zr). None of the elements was found in shungites of M and N. Microcrystals of Sh, Ch were represented in the form of sulphides either enclosed in, or finely intergrown with, a silicate shell. Sulphide mineralization of Ch typically occurred as small (up to 3 µm) particles, but sometimes larger aggregates (up to 20 µm) were found, containing Si, Al, Na, Mg, Ca, Sn, Si, Al, K, Mg, V. Several particles with Th were found as well as complex particles containing Pb, Fe, Pd, La, Ni, Ca and Th, Pr, Pb, La, Au. In Sh the sulphides-silicate intergrowth was observed of the following compositions: (Si, K, S, Cl, As, Mn, Hg), (Si, S, Cl, Ca, W, P, Y), (Si, K, Ca, Sc, Ti, Fe, Cr). Trace element composition was determined on the shungite surface and in its precipitate after treatment with different solvents (acid, alcohol, hexane). The acid treatment resulted in partial dissolution of microcrystals and the precipitate contained Be, As, Mg, Ga, Fe, Al, V, Ti, Y, Cu, Na, Zn, Co, Ni, Zr, Ca, Sr, Cr, Ba. The precipitate composition became poorer after alcohol treatment: Mn, Mg, Fe, Al, V, Ti, Y, Cu, Na, Ni, Zr, Ca and only Mg, Fe, Y, Cu were transferred to hexane. Surface ionization of shungites rich in REE and their extracts showed poorly bound Na, K, Rb, Ba and La.

We found that the highest frequency of REE occurrence was in Ch shungites, which were hydrothermally altered. Carbon in shungite N is known to be re-deposited and the most purified. Poor bonding of some elements, i.e., the possibility of their migration during later metasomatism, was indicated.