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Geochemical features of Palaeoproterozoic organosiliceous deposits (maksovites) of Russian Fennoscandia

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The c. 2000 Ma, 900-m-thick, Zaonega Formation (ZF) in the Onega basin, Russian Fennoscandia, contains one of the greatest accumulations of organic matter (OM) in the early Precambrian during the period known as worldwide Shunga Event (Melezhik et al., 2005). ZF rocks are greenschist-facies volcaniclastic greywackes, dolostone, limestones, organosiliceous rocks (locally termed "maksovite"), mafic tuffs and lavas intruded by numerous mafic sills. Several sedimentary beds are enriched in OM with the overall content of total organic carbon (TOC) ranging from 0.1 to 16 wt.%. The maksovite is most rich in TOC (15 to 45 wt.%) and consists of SiO2 (c. 57 wt.%), Al2O3 (c. 5 wt.%), S (c. 2 wt.%), and minor K, Mg, Fe, Ca and Ti. The maksovite occurs in nine stratigraphic levels in the form of stratified beds and dome-like bodies.
The maksovite represents a challenge because of its unusual geochemical and mineralogical composition, enigmatic origin, unknown source of silica and OM. The current work attempts to reveal some major geochemical features of the maksovites within both dome-like and stratified bodies occurring in different stratigraphic levels. Due to a high content of OM, the maksovites appear to be opaque under transmitted-light, thus traditional optical petrography has a limited use for their detailed study and classification. Hence, a geochemical approach has been employed for classifying the rocks and for revealing their major geochemical features. The maksovite chemical composition has been calculated for TOC-free basis, and a rock-classification of Yudovich and Ketris (2000) has been used to categories TOC-free chemical basis of maksovites. Based on a (TiO2+Al2O3+Fe2O3+FeO+MnO)/SiO2 ratio (GM), the classification reviled five groups, namely, hypersilites (GM$\leq$0.05), supersilites (GM=0.051-0.10), normosilites (GM=0.11-0.20), miosilites (GM=0.21-0.30) and siallites (GM=0.31-0.55).
On TOC-free basis, the hypersilites contain from 92 to 94 wt.% SiO2 (93.4 wt.% on average, n=7), from 1.6 to 3.1 wt.% Al2O3 (2.4 on average); original average TOC content is 25 wt.%. In the supersilites, SiO2 content ranges between 86 and 93 wt.% (89.8 wt.% on average, n=86), whereas Al2O3 content fluctuates between 2.1-7.1 wt.% (4.6 wt.% on average); original average TOC content is c. 30 wt.%. The normosilites contain from 77 to 87 wt.% SiO2 (c. 84 wt.% on average, n=56), from 5.5 to 11.7 wt.% Al2O3 (c 7 wt.% on average); original average TOC content is 36 wt.%. The miosilites have 70-76 wt.% SiO2 (74 wt.% on average, n=4), and 9.5-15.2 wt.% Al2O3; original average TOC content is c. 36 wt.%. Finally, the siallites show the lowers SiO2 abundances (68 wt.% on average, n=3), the highest Al2O3 (c. 14 wt.%), whereas the original TOC content remains rather similar; 37 wt.%.
The five groups of maksovite exhibit the following geochemical features:
1. A positive correlation between (Na2O+K2O) and (Al2O3/SiO2), and between TOC and 2O contents.
2. Base-to-top increase of SiO2 content and decrease of Al, Fe, Mg, Ca and K oxides content in maksovite bodies with no distinct boundaries between zones with different geochemical and mineralogical composition.
3. In all studied maksovite bodies there is a distinct negative correlation between SiO2 and Al2O3 contents, and a positive correlation between TOC content and Al2O3-bearing mineral components.
4. The maksovite bodies located in higher stratigraphic levels are less alkaline and more siliceous with respect to those located in lower levels.
The revealed geochemical features of maksovites with respect to their stratigraphic position are apparently related to their variable genesis. The established geochemical regularities have a potential to assist in correlation of distant exposures, as well as, drilled section within Onega basin.