Nanolites in the Eastern Rhodopean perlites – preliminary TEM study

Нанолити в източнородопските перлити – предварително TEM изследване

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Transmission electron microscope (JEOL-2000 EX 200 kV) study, performed in IPGP, allowed for the first time to "peep" deeply into the microstructure of acid volcanic rocks. The glass of these rocks is most appropriate for such studies due to the homogeneity of their groundmass. The detected minerals are nanometric in size and named nanolites respectively (width below 0.6 μm – Sharp et al., 1996). Their composition was studied under the same microscope by microprobe analysis (EDS). In case of appropriate sections, they were identified also by local microdiffraction (SAED) in CLMC (Sofia).

Perlites from 3 occurrences were studied: the hyaloclastic flow "Svetoslav" (Studen Kladenets volcano), the domes "Gradishteto" (Bryastovo latite volcano) and "Haskovo mineral springs" (Tatarevo volcanic cluster). They contain phenocrysts and subphenocrysts of sanidine, plagioclase, biotite, magnetite ± quartz, clinopyroxene, and amphibole. In the glassy groundmass the same nanominerals were detected (Fig. 1) + rutile, but the Fe-oxide nanophases are not accurately determined.

Clinopyroxene nanolites were established in the perlites of Svetoslav and Gradishteto. They form strongly elongated, spear-like nanocrystals 100–200 nm wide and ten times longer. Their composition corresponds to almost pure hedenbergite with Mg# 0.05 ($Wo_{40–45.5}Fs_{50.5–56.5}En_{1.7–4.4}$), whereas the subphenocrysts in perlites from the same occurrences are Fe-Mg augite with Mg# 0.4 (Svetoslav) and diopside with Mg# 0.8 (Gradishteto). The nanolites are characterized by their higher Mn content and negative correlation between Mn and Mg#.

Amphibole nanolites were detected in all three occurrences, nevertheless that amphibole phenocrysts are not known in "Haskovo mineral springs" dome. They form in Svetoslav perlites platy nanocrystals with similar dimensions as those of the pyroxene and up to 1000×400 nm in the perlites of Haskovo mineral springs. The amphiboles from Gradishteto perlites are mainly whiskers 1000–2000 nm in length and about 10 nm in width. They are Fe-rich (with very low Mg# – to 0.05) and Ca-lacking varieties, i.e. alkaline amphiboles with high Na content. Their diffraction patterns corresponds to arfvedsonite but due to the considerably higher Al content they are closer to other Fe-alkaline amphiboles as Fe-glaucophane, nyböite (in particular the whiskers in Gradishteto) and Fe-eckermannite (eventually the nanolites in Svetoslav perlites but so far this end member of the Fe-alkaline amphiboles has not been proven in nature). In contrast to nanolites, the amphibole phenocrysts in these perlites are edenite or hornblende (Mg# 0.5–0.76). They are relatively richer in Si with similar Al content and very low alkali content as compared to the amphibole nanohases. However, they are richer in Ti and Mn and show the classic for amphiboles positive correlation between Al and Ti.

Mica nanolites were observed in the perlites of Haskovo mineral springs and Gradishteto. They occur as characteristic platy hexagonal crystals with dimensions 1200×700 mm. In Haskovo mineral

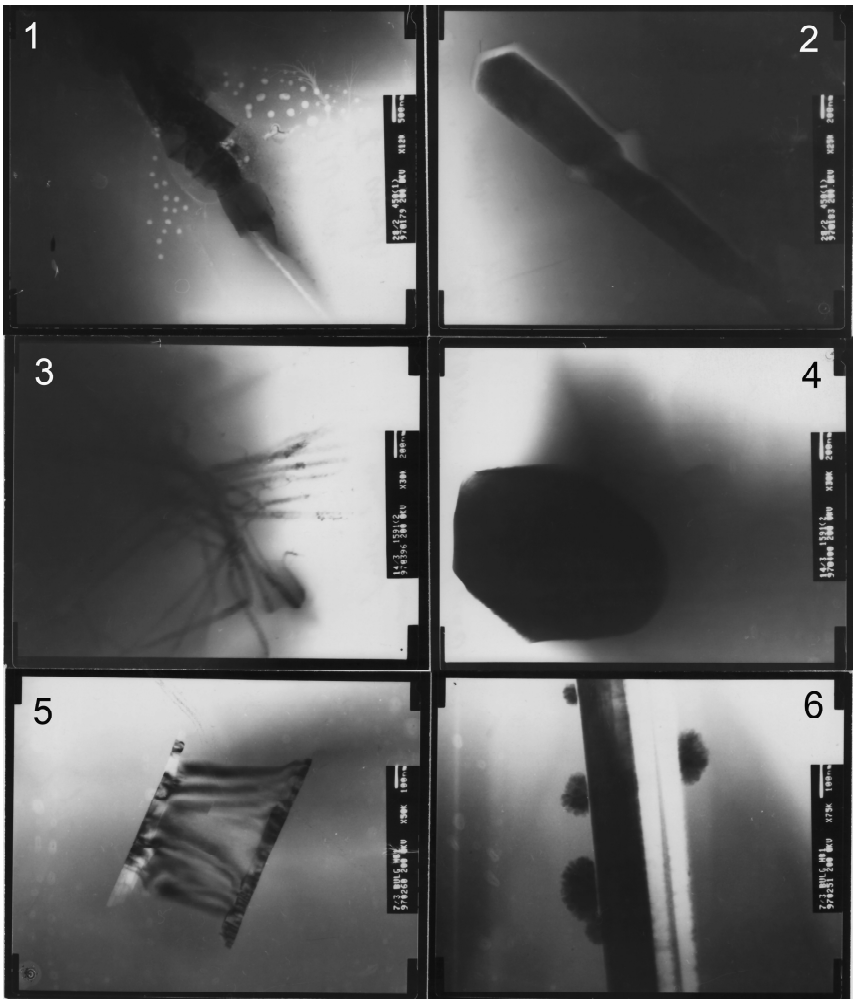

Fig. 1. Nanolites in perlites

Hyaloclastic flow "Svetoslav": *1*, hedenbergite (the white bar on the right is 500 nm), *2*, alkaline Fe-amphibole (200 nm); "*Gradishteto" dome*: *3*, tetra-ferri-containing annite (200 nm), *4*, whiskers of alkaline Fe-amphibole (200 nm); "*Haskovo mineral springs" dome*: *5*, tetra-ferri-containing annite with Fe-oxide nanospherolites (100 nm), *6*, oligoclase with dendritic "tails" (100 nm)

springs perlites they are overgrown by nanospherolites of Fe-oxide phase. The composition of micas corresponds to tetra-ferri-containing annite with Mg# 0.1–0.2 ($^{[4]}$Al<1.3–1.6; the insufficient Al in the Si-Al tetrahedrons being compensated by Fe^{3+} ions). In contrast to nanolites, the biotite phenocrysts from the same perlites correspond in composition to the annite–phlogopite series ($^{[4]}$Al ~2.2; Mg# 0.6) and differ by their lower Mn content.

Plagioclase nanolites were found only in the perlites of Haskovo mineral springs. They form platy skeleton crystals with dendritic "tails" that are characteristic for sanidine microlites. Dimensions – from 500×300 to 1000×300 nm; composition – albite and oligoclase.

In conclusion it can be suggested that the unusual composition of the mafic nanolites, in particular of the amphibole ones, is possibly the result of crystallization of Fe-rich liquid phase, product of immiscibility such as that found in the perlites from Schupenata Planina (Yanev et al., 2000). The Fe-rich drops in this occurrence contain arfvedsonite – Fe-eckermannite nanocrystals.

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