Plagioclase lapilli and phenocrysts in the lavas of the 2012-2013 Tolbachik Fissure eruption

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The 2012-2013 Tolbachik Fissure eruption started from lava gushing and effusion in the Menyailov vent on November 27th, 2012; after three days the activity of this vent ceased and the eruption continued from the Naboko vent until its end in September 2013. The eruption produced about 0.7 km^3 of high-Al basaltic trachyandesites (Dvigalo et al., 2014). At Menyailov vent SiO_2 concentrations were as high as 55.35 wt.% and K_2O - 2.67 wt.% - higher than in any previously erupted rocks in Tolbachik monogenetic area. From the beginning of December, SiO_2 concentration in lavas dropped by 2 wt.% and remained at this level until the end of eruption. MgO, TiO_2, Mg# increased, K_2O, Na_2O decreased slightly. Most prominent change we observe in K_2O/MgO ratio, which was about 0.7 in the Menyailov vent rocks and became 0.5 in the Naboko vent rocks. Details of the geochemical composition of the volcanic rocks produced by this eruption are reported elsewhere (Volynets et al., 2013, Volynets et al., 2014 a, b); here we present the results of the geochemical study of the main phenocrysts in the lavas – plagioclase.

For the detailed geochemical study of the plagioclase we selected two samples from the Naboko vent (Pl-phyric lavas, erupted in February and August) and five crystal lapilli (two of them were erupted in December 2012, and three – during 2013, when the new cone has been already built). Plagioclases in these lavas are represented by two generations of labradorite and bytownite. Pl phenocrysts of the 1st generation are large (up to 2 cm on the long axis) strongly resorbed at the edges and sometimes in the cores as well, containing lots of glass inclusions. Pl subphenocrysts of the 2nd generation are smaller (less than 500 µm), usually nonresorbed and clean, having euhedral facets. Normal, reversed and patchy zoning are typical for all studied crystals (fig.1, I and II). Maximum concentrations of An (up to 83% at compositional variation between An50 and 74) has been measured in the patchy zones.

Crystal lapilli are characterized by the oscillatory zoning with An fluctuations around An57-63 (fig. 1, III and IV). This kind of zoning is the result of the diffusion control of Pl growth at low growth rates (Sibley et al., 1976). The edges of lapilli are usually rich of glassy inclusions, tunnel-like dissolution structures, Ol, Px, Mt inclusions (fig. 1, III and IV). There are abundant resorption zones in lapilli, with plenty of glassy inclusions. These zones are characterized by the patchy zoning with An concentration jumps up to An74; usually these high-An areas are observed near the inclusions of glass. At the edges of lapilli there are zones with An gradual decrease towards the rim from An 74 to An61.

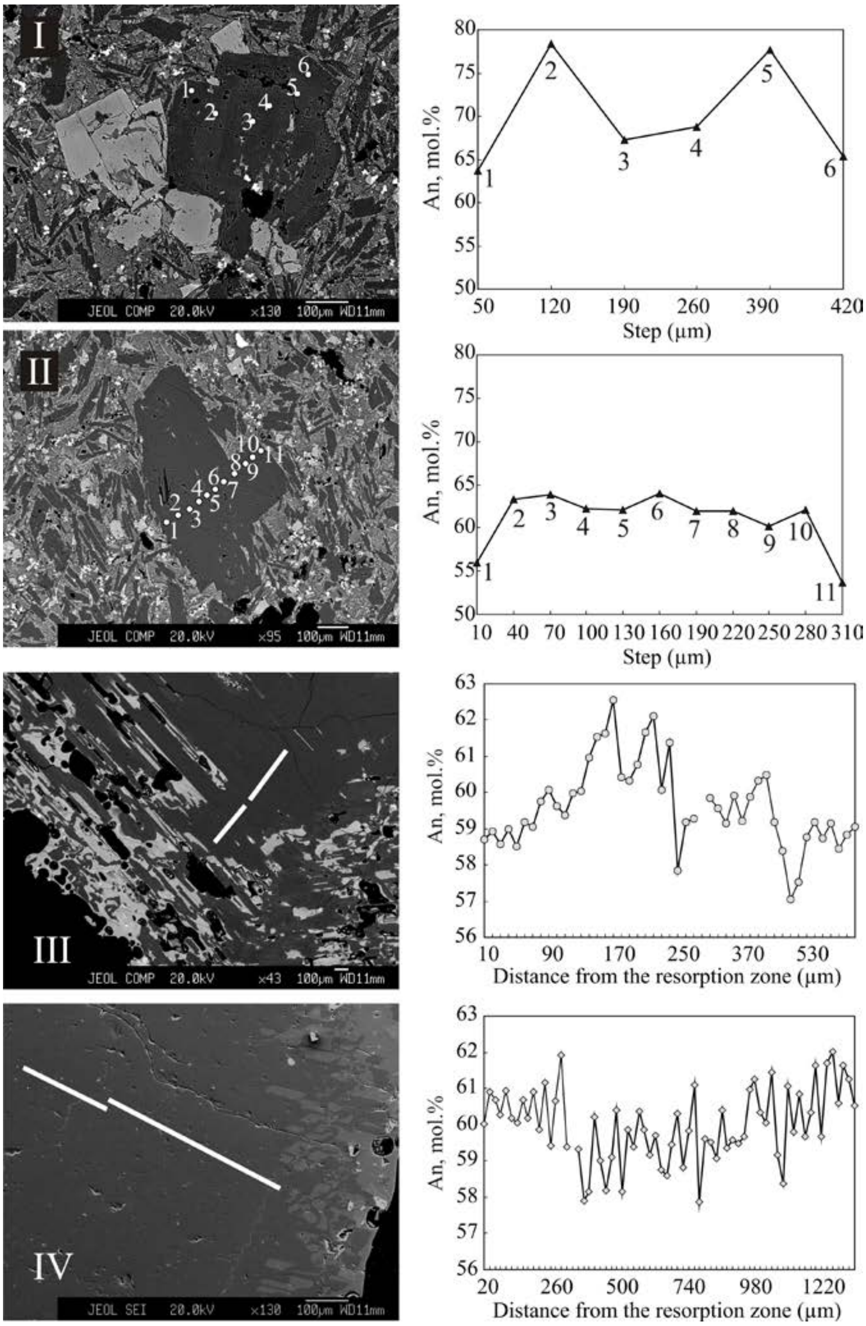
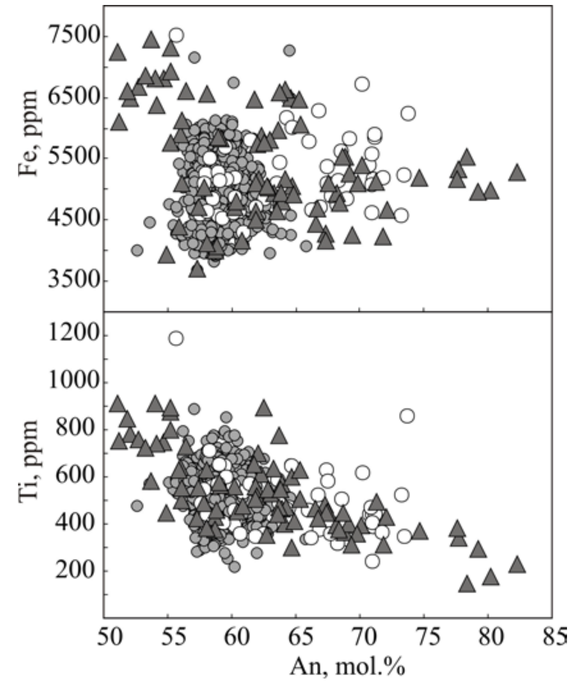


Fig. 1. BSE images (left) and microprobe profiles (right) of the Pl phenocrysts from basaltic trachyandesites of the Naboko vent (I and II, profiles are indicated by the numbered dots) and of Pl crystal lapilli (III and IV, profiles are indicated by the white lines).

Minor and trace elements (Fe, Ti, Mg) are negatively correlated with An in the phenocrysts and do not show any correlations in lapilli (fig. 2). Most prominent correlation is observed for Ti. Sr and Ba are not correlated with An or any other element both in phenocrysts and lapilli. Negative correlations of Fe, Mg and Ti with An may be caused by the differentiation processes and were previously described in (Volynets et al., 1977, Churikova et al., 2007, Bindeman et al., 1998). Absence of correlation of minor and trace elements with An is in accordance with the relatively constant composition of the lapilli parent magma, assumed on the basis of oscillatory zoning occurrence. At the same time, the origin of the high-An zones in phenocrysts and lapilli remains less clear. Possible reasons include mafic magma intrusion, temperature increase at constant chemical composition and water influence on composition of crystallizing Pl. To check the possibility of the mafic injection, we analyzed glass inclusions in Pl and coexisting Ol, glasses from the resorption zones and interstitial glasses for comparison. Studied glass inclusions in Ol (Fo73-74) have compositions similar to the host rocks of the Naboko vent. Glass inclusions in Pl are more silica- and alkali-rich than the host rocks, as well as all interstitial glasses. Therefore, as the current stage of research, we do not see the evidence for the influence of the mafic magma batches to the composition of crystallizing Pl in the Naboko vent lavas and lapilli. Instead, temperature increase (for example, due to the retrograde boiling before the eruption) or addition of water might cause the appearance of the high-An.



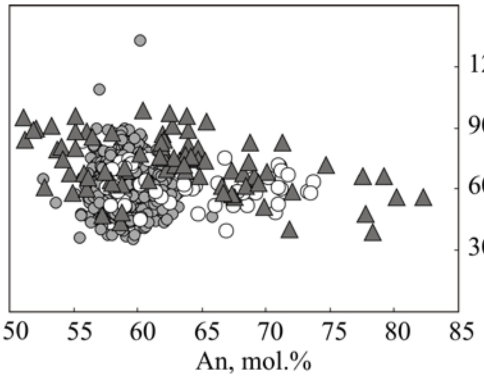


Fig. 2. Fe, Ti, Mg concentrations (ppm) vs. An (mol.%) in plagioclase phenocrysts (dark grey triangles) and Pl crystal lapilli (grey circles – profile measurements, white circles – point measurements).

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