Bykov V.N., Nasedkin V.V., Eremyashev V.E., Anfilogov V.N. Water in volcanic glasses: studying by X-ray spectroscopy in the nearest zone.

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A structural position of water in obsidians and glasses was studied by X-ray spectroscopy in the nearest zone. The water content in the studied volcanic glasses ranged from 0.3 to 8.4 wt.%.

The two absorption lines with the 5200 and 4500 cm^{-1} maxima are observed in the X-ray spectra. The 5200 cm^{-1} maximum is due to combinations of valence and deformation variations of molecular water, and the 4500 cm^{-1} is due to combination of valence variations of Si(Al)-OH groups.

The concentrations of hydroxyl groups and molecular water were determined by the intensity ratio A^{4500}/A^{5200} according to the following equation system:

$C_{OH}/C_{H2Omol.} = \varepsilon^{5200}/\varepsilon^{4500.} A^{4500}/A^{5200}$

$C_{OH}+C_{H2Omol.} = C_{H2Otot.}$

The $\varepsilon^{5200}/\varepsilon^{4500}$ ratio for obsidians and perlites is considered to be the same as that in the experimentally hydrated rhyolite glasses.

The concentrations of water and hydroxyl groups calculated from the X-ray spectra are presented in Table 1 and Figure 1 (experimental points). The correlations of various forms of water (OH and H_2O) concentration with the total water content for the experimentally hydrated rhyolite glasses obtained by slow air quench [Silver et al., 1990] are also presented in the Figure. This correlation indicates the contents of hydroxyl groups and molecular water fixed during formation of the natural glasses, i.e. it characterizes primary glasses resulted from cooling of magmatic melts.

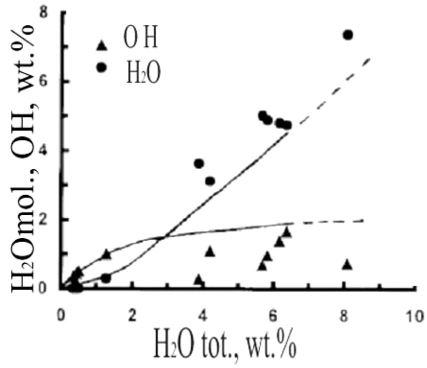

Fig. 1. Distribution of water among structural positions in obsidians and perlites depending on the total content of water. (The curves characterize the glasses resulted from quenching of water saturated rhyolitic melts)

In all the perlites the content of hydroxyl groups is lower, and the content of molecular water is higher than those in the quenched glasses of the melts. That means some part of water was involved in these glasses during the low-temperature post-magmatic hydration of glasses taking place without transformation of molecular water into the hydroxyl form.

The total content of primary water (hydroxyl + molecular) contained in perlites during their formation was determined. During further evolution of glasses their hydration at low temperatures resulted in increasing content of water in molecular form.

The calculated concentrations of primary high-temperature and secondary low-temperature water, and also a degree of secondary hydration of perlites (n) defined as the ratio of the secondary water content and its total content normalized to 100 % are presented in Table 1. The corresponding histograms demonstrating the primary and secondary waters in volcanic glasses are presented in Fig.2.

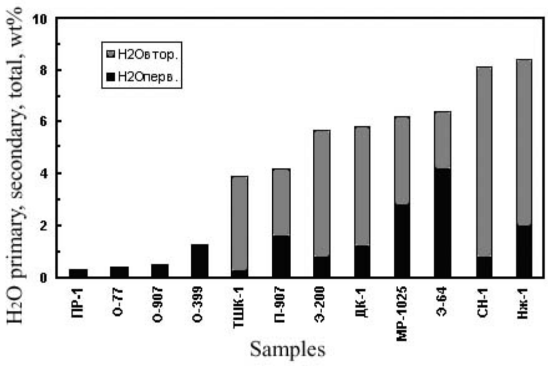

Fig. 2. A histogram of distribution of primary and secondary water in volcanic glasses

Table 1. Concentration of water in molecular and hydroxyl forms, contents of primary and secondary water, degree of secondary hydration of volcanic glasses.

Sample No.	H_2O_{tot}, wt.%	OH, wt.%	H_2Omol., wt.%	H_2Oprimary, wt.%	H_2Osecondary, wt.%	n, %
PR-1	0.34	0.3	0	0.3	0	0
O-77	0.42	0.4	0	0.4	0	0
O-907	0.50	0.5	0	0.5	0	0
O-399	1.27	1.0	0.3	1.3	0	0
TSHK-1	3.88	0.3	3.6	0.3	3.6	92
P-907	4.20	1.1	3.1	1.6	2.6	62
E-200	5.68	0.7	5.0	0.8	4.9	86
DK-1	5.83	1.0	4.9	1.2	4.6	79
MP-1025	6.17	1.4	4.8	2.8	3.4	55
E-64	6.37	1.6	4.7	4.2	2.2	34
SN-1	8.08	0.7	7.4	0.8	7.3	90
NZh-1	8.37	1.2	7.2	2.0	6.4	76

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Reference:

1. Silver L.A. Ihinger P.D., Stolper E. The influence of bulk composition on specification of water in silicate glasses // Contrib. Mineral. Petrol., 1990, N 2, p. 142-162.