WATER IN THE GLASSES OF ALBITE - NEPHELINE BINARY AT P_{H2O}=2 KBAR

Eremyashev V.E. (IM UB RAS, Miass), **Simakin A.G., Salova T.P.** (IEM RAS, Chernogolovka)
sler@ilmeny.ac.ru

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Study of the structural position of the water in the model aluminosilicate glasses can shed light on the mechanism of the water dissolution in the natural magmas. Water bearing silica and albite glasses are studied rather well. We increase scope of the traditional granite model system by including alkaline albite – nepheline binary. Dry glasses are polymerized (NBO/T=0) and have high alumina content (Al/(Al+Si)>0.5). We prepare dry compositions Ab_{100}, Ab_{80}, Ab_{70}, Ab_{50}, Ab_0 (wt.% of albite). Preliminary we synthesize nepheline glass from the silica oxide, alumina and Na_2CO_3. Albite glass was kindly provided by H. Behrens (Institute fur Mineralogy, Hannover). Dry compositions were mixed from minal glasses and melted at 1600°C in platinum crucible. Then dry glasses were saturated with water at T=1200°C, P=2kbar in the internally heated pressure vessel during 2 hours. Quenching rate was 100°/min. Two side polished plates with thickness 100-300 μm were prepared for spectral studies.

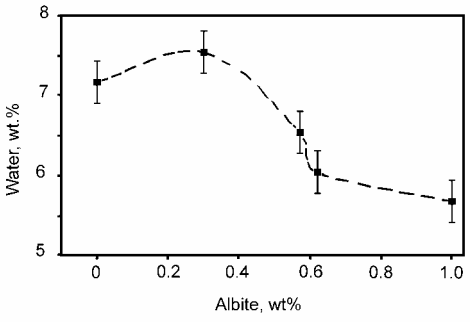

Fig.1. Solubility water in glasses

Water content in the glasses was estimated with several methods. Weight loss and KFT titration (in Hannover) yield consistent results at low nepheline content. At high nepheline content some water is seized in the crystalline nepheline formed at the sample heating during KFT treatment resulting in the error 1-2.5% in the total water content. Weight loss technique was checked by DTA for pure nepheline glass demonstrating a difference less than 0.5%. We find that water solubility at the given PT conditions increases in the melts with higher alkalinity from 5.8 wt.% in albite melt to 7.-7.5% in nepheline one. Solubility dependence has sigma shape with a steep increase in the Ab40-Ab60 range (fig. 1).

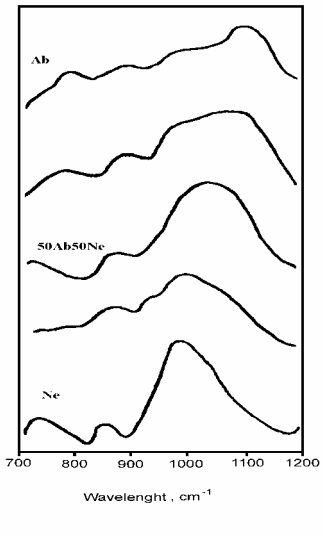

Fig.2. Raman spectra of hydrated glasses

Raman spectra of hydrated glasses at T=20°C (fig. 2) demonstrate following features:

- far infrared parts of the spectra (in 700-1200 cm^{-1} range) are qualitatively similar;
- observed shift of the maximum from 1120 $см^{-1}$ in albite glass to 1000 $см^{-1}$ in the nepheline one presumably reflects variation of the species with different Al/Si ratio in the glass;
- presence of the band with frequency 850-900 $см^{-1}$ in all studied hydrated glasses can be explained with hydroxyl groups terminated Q form (Q_2?) with low connectivity (following Q-classification of the connectivity for the tetrahedral network forming cations).

In the NIR range (4000-8000 $см^{-1}$) bands with maximum around 4500 (OH groups) and 5200 cm^{-1} (molecular water) are well distinguished in all glasses (fig. 3). There is systematic shift of the molecular water maximum towards the lower frequency with increasing of the alkalinity. At the same time molecular water peaks in the nepheline rich glasses have wider lower frequency shoulder. This can be interpreted as increasing interaction with presumably sodium cation (and partially alumino-silicate network) in alkaline glasses. Molecular water in the silica glass has the narrowest peak ($\Delta\approx$70-80 cm^{-1} width on the half height) with maximum value f_m= 5270 cm^{-1}. For comparison in nepheline glass those parameters are $\Delta\approx$300 cm^{-1} and f_m= 5190 cm^{-1}. Similar widening of the molecular water NIR band was

observed in some zeiolites (shabasite) where sodium can be directly hydrated in the large structural cavities. There is also possibility for the hydrogen bonding between water molecules in the glass to contribute to the line widening. Maximum of the hydroxyl groups band also demonstrates systematic shift to the lower frequencies toward the nepheline composition. This shift can be attributed to the growth of alumina content. Moreover in albite glass Al-O-Al avoidance is strictly obeyed while in nepheline glass Al-O-Al content is about 12% of all T-O-T pairs. Therefore, one can anticipate sodium aluminate hydration in the nepheline glass with formation of Al-OH groups. The dependence of hydroxyl band maximum as a function of the nepheline content has sigma-like shape with steep decrease around $ab_{40\text{-}60}$ that stands for the structural transformation of the glass structure at threshold alkalinity.

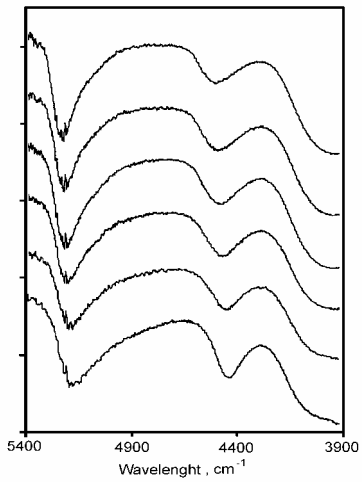

Fig.3. NIR spectra of hydrated glasses

Conclusions

1. Water solubility in the melts in the Ne-Ab binary at $P(H_2O)$=2kbar and T=1200ºC significantly rises with increase of alkalinity. Increase of solubility is accompanied with the rise of relative hydroxyl content in the glasses.

2. With increase of alkalinity water demonstrate more close interaction with glasses with shift of the band maximum to the lower frequencies. Systematic shift of the hydroxyl groups band maximum can be explained with presumably higher role of tetrahedral alumina hydration.

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