Constraining OH diffusivity in silicate melts

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The transport of water in silicate melts is mostly dominated by molecular H_2O (H_2O_m) diffusion. Diffusivity of hydroxyl (OH), the other water species, has not been well quantified. It has been previously assumed that OH diffusivity is close to the Eyring diffusivity (i.e., inversely proportional to melt viscosity), or essentially approaches zero. However, in our experimental study of water diffusion in an Fe-free andesitic melt, we found that these assumptions do not hold.

Diffusion experiments were performed at 1 GPa in a piston-cylinder apparatus using a double diffusion couple technique. One couple contained a dry glass (with 0.01 wt% water) and a hydrous glass (with ~3 wt% water), and the other contained the same dry glass and a different hydrous glass (with ~6 wt% water). Both couples experienced the same pressure and thermal history, which is crucial for constraining the dependence of H_2O diffusivity on water content. Diffusion profiles perserved in the quenched products were analyzed with both FTIR and confocal Raman microspectroscopy. Nearly identical profiles were obtained from the two methods for profile length > 1 mm (produced at 1619-1842 K), but for profile length <0.1 mm (produced at 668-768 K) FTIR analysis showed marked convolution effects due to its spatial resolution being inferior to that of Raman.

Previous models neglecting OH diffusivity cannot satisfactorily reproduce the measured profiles. We developed a new fitting procedure that simulataneously fits both diffusion profiles from a single experiment and also accounts for the role of OH diffusion. With the new model, OH diffusivity is constrained to be 10%-20% of H_2O_m diffusivity at 1619-1842 K as total water content approaches zero. The obtained OH diffusivity is much higher than the Eyring diffusivity, indicating that in melt structure OH is not necessarily bonded with network-forming cations, such as Si. On the other hand, OH diffusivity is close to reported F diffusivity (both the size and the valence of OH and F are comparable).

Research on heavy metal environmental geochemistry in urban soils in Haikou, China

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Soil heavy metals constitute serious environmental hazards from the point of view of polluting the soils and adjoining streams and rivers. Therefore, a series of investigations were performed to provide heavy metal signatures of urban soils and to evaluate pollution level. Concentrations of Cd, Zn, Ni, Cr, Cu, Pb, Hg and As were measured on 70 topsoil samples and 16 deep-soil samples collected from green areas in Haikou city, capital of Hainan province. The results indicate that, in comparison with Chinese Environmental Quality Standard IIfor Soils (CEQSSII), urban soils in Haikou have lower metal concentrations as a whole, especially Hg□As□Cu□Pb and Zn (except one maximum) lower than the Chinese Environmental Quality Standard II(CEQSSI). These concentration levels are comparable to those in other studies, such as London, Hong Kong, Shanghai, and so on, we found that these values are lower in Haikou except Cr and Ni. Histograms of distributions of these concentrations show “double peak” or “long tailed”, which may be related to soil parent material types and anthropic contributions. Pollution evaluations of single factor index and comprehensive index indicate that soils in study area are unpolluted by most heavy elements, except that Hg and Cd are medium polluted elements which should be noticed. Speciation analyses show that Zn, Ni, Cr, Cu, Pb and As are mainly in the residual and Fe–Mn oxide phases, while Hg is associated with the organic, humic and residual fractions. The high exchangeable Cd(about 24%) in urban soils need further investigation for ecological and health implications.

Keywords: Heavy metals, Urban soils, Pollution evaluation

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