The formation of silica corrosion zones in silicate glasses in silica undersaturated solution

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The mechanism of glass corrosion in aqueous solutions has generally been evaluated in the light of bulk solution data. One idea of corrosion experiments with a flow-through or regular renewal setup is to study the influence of different saturation levels of specific elements in solution on glass corrosion. We carried out a series of flow through experiments with a simple ternary Na borosilicate glass at 90°C using different solution renewal rates of pure water and NaCl solutions. High salt concentration were used to mimic storage conditions in salt mines, which are discussed to be used as nuclear waste repositories in some countries.

Our results show that high salt concentration near the salt saturation point actually decrease the overall corrosion rate in contrast to the accelerating effect of small quantities of dissolved salt. Most importantly, we further observed the occurrence of of amorphous silica as alteration phase even in solutions that are highly undersaturated solution with respect to $SiO_{2(am)}$. The precipitation of silica was observed in NaCl solutions even if high renewal rates (as high as 5 ml/h) were used, This indicates that a silica supersaturated boundary layer at the glass surface must have been developed from which amorphous silica, after congruent glass dissolution, could back precipitate onto the dissolving glass surface. It also shows that non-stoichiometric distribution of elements in solution during silicate glass alteration does not necessarily point to a process that involves diffusion-controlled selective leaching of elements from the glass.

The effect of such an interfacial boundery layers with its ability to establish a different chemical enviroment than the bulk solution need to be considered in glass corrosion not only at (polished) surfaces, but particularely in cracks, which inevitably will form during cooling in the industrial-sized waste glass production or directly during glass-water interaction.