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Effect of secondary phases on the evolution of glass alteration

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Whatever the environment (soils, water and atmosphere), glass of varying compositions undergo alteration process conditioned by exposure conditions and glass intrinsic chemical and physical properties. Modification varies from a simple loss of transparency to a severe material loss but always involve modifications of the structure and chemical composition at the interface between the glass and the environment (hydration, dealkalinisation, dissolution,…).

In many cases, these alteration of the glass structure are associated to the conjointed precipitation of secondary phases outside of the glass network often in cracks and fractures or directly on the glass outer surface.

On site and laboratory alteration were both carried out for two very different environent : atmospheric and burial conditions. In the case of atmospheric alteration analogues and original stained glasses were compared in order to study the early and long-term evolution of the glass weathering.

The samples observed in the two types of site show comparable alteration patterns. The nature of the precipitates outlines the impact of specific environmental conditions but, in every exposure conditions, similarities can be drawn on the secondary phases retroactive impact on the glass alteration processes.

Nano-scale chemical characterization of the various phases was carried out through SEM-EDX, TEM-EDX; mineralogical characterization through electron diffraction, and STXM (for the structural environment of Si and Fe). From those observation some comparison of the phases influence on the system evolution and glass alteration can be made. Often, the precipitations are located within cracks inside the glass object. In some cases the precipitates have a clogging effect and can even trap glass-borne elements released from further alteration, but more often than not, local dissolution/precipitation of these secondary minerals inside the network favours the widening of the fractures, which facilitate fluid circulation, hence triggering further glass dissolution (congruent and selective) and precipitation of other secondary phases.