Alteration of basaltic glass in residual rate condition: analogy with nuclear glass

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Context

The behaviour of basaltic glasses over geological timescales raises challenging scientific issues when calculating the chemical mass balance of the oceans, or when attempting to assess potential CO_2 sequestration by silicate rocks. Comparaisons between calculations and field observations show discrepancy, therefore the mechanisms ruling the alteration at high reaction progress need to be deeply investigated. Safety of radioactive wastes glass disposal also relies on the understanding of both long term and field issues.

Experiments & Results

Isotopically tagged alteration experiments of model basaltic glass coupons were performed over 600 days in a closed system at 90°C with a solution initially saturated with amorphous $^{29}SiO_2$. Such conditions ensure the first transient stage of glass corrosion to be bypassed and to focus on the long-term rate-limiting mechanisms.

Despite the solution saturation, glass still dissolves. Alteration products were characterized by TOF-SIMS, SEM and TEM. All glass components are released congruently with a very slow constant rate of ~20 nm/y. Evidences on the alteration mechanisms are provided by following the isotopic $^{29}Si/^{28}Si$ ratio with solid caracterisations and solution analysis by MC-ICP-MS and ICP-MS/MS. In agreement with field observations, hydrolysis of the glassy network appears to be the rate limiting mechanism of the basaltic glass alteration at high reaction progress. Hydrolysis is driven by the precipitation of more thermodynamically stable phases, such as phyllosilicates.

Gin et al[1] already performed the same experiments on a six oxide borosilicate glass used as a reference material by the nuclear glass community. Differences linked to the glass structure and composition are evidenced and discussed.

[1] Gin, S. et al. (2015) *Nat. Commun*. **6:**6360