Effect of magnesium on the structure and durability of borosilicate glasses

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Abstract

The structure of glasses is deeply dependent on the intricacy of its composition. Each variation, resulting from the addition of new elements as well as their amounts induces modifications of the glass behaviour. Studying simple glasses is thus mandatory in order to evaluate the impact of a given element on their structure and properties. In this talk, we will focus on the influence of magnesium, a key element in geological science as well as for many applications in various technological fields, on the structure and aqueous durability of borosilicate glasses. It has indeed been seen that its structural role fundamentally differs from that of other alkali-earth cation such as calicum, yet there is still a lack of information on its direct local environment or its impact on the glassy network. A multinuclear solid-state NMR analysis has been performed on 29Si, 11B, 27Al, 23Na, 17O and 25Mg for all compositions. For that matter, several glasses have been isotopically-enriched in order to accurately observe their environment, namely 11B, 17O and 25Mg. MAS, MQMAS and REDOR NMR analyses have been performed as well as neutron diffraction to gain insight into the various interaction between magnesium and its environment, such as charge-compensating abilities regarding aluminum and boron. A comparison has been made between the influence of calcium and magnesium in glasses of equivalent composition, revealing an increased structural disorder generated by magnesium. Moreover, the response of these glasses to aqueous dissolution has been studied in order to try correlating these structural changes with glass durability. To that end, initial dissolution rate measurements have been performed at T=90∘C and pH 9, revealing what appears to be a beneficial role of magnesium compared to calcium in this regime and conditions.

Keywords: magnesium, borosilicate glass, alteration, nuclear magnetic resonance

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