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# Effect of irradiation and alkali silica reaction on aggregate physicochemical reactivity in nuclear powerplants

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In nuclear power plants, concrete is used in many applications, including as part of the biological shield. Because of this, it is continuously exposed to irradiation, which can modify its physicochemical properties.

Past studies have shown an effect of irradiation on properties of single-crystals but only few data exists on its effect on aggregate, the crystalline component of concrete. In this study, we use a multi-modal approach using SEM/GIXRD/Nano indentation/Raman spectroscopy/VSI to assess the evolution of physicochemical properties of two types of aggregate: a quartzite and a marble. We demonstrate that marble is not affected by irradiation when the latter is simulated using He+ implantation at an energy chosen to reproduce a 70-80 years use of a nuclear power plant. On the contrary, quartzite shows a great variability between the irradiated and the pristine surface. The analysis of the physical properties of the quartzite surface highlights an amorphization of the surface due to the displacement of atoms during the implantation. During the study of the chemical reactivity (i.e., dissolution experiments), this amorphization is leading to a greater dissolution rate of the irradiated surface compare to the pristine surface due to Qn modification from $n = 4$ in quartz grains to $n \leq 3$ in the irradiated grains.

This change of reactivity of the quartzite sample is then correlated with the displacement per atom (dpa) and to the density variation of the sample with depth due to the He+ implantation. This relation between the dissolution rate, the dpa and the density allows linking the dissolution rate of such sample to the number of constraints.