Chemical weathering of minerals and corrosion of glasses in aqueous fluids: a unifying view at the nm-scale based on coupled interfacial dissolution-reprecipitation (CIDR)

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The degradation of materials in contact with aqueous fluids touches upon many current and multidisciplinary fields of research, including chemical weathering of minerals, geochemical cycling of elements in the critical zone, corrosion of glasses, and other industrial processes. In order to quantify and model both short and long term controls of degradation, it is necessary to understand the mechanisms that control the chemical alteration reactions that affect the solid-fluid interface. One of the main characteristics of these reactions is the formation of surface altered layers that form in situ and at the expense of the primary solid. They represent a more stable phase and have in general a chemical composition different from the parent material. How these surface layers form is a key to understanding the underlying alteration mechanism.

In this talk I will review some of our recent research on the structural and chemical evolution of fluid-solid interfaces using advanced nm-scale analytical techniques, such as TEM and atom probe tomography. We have applied these techniques to study the alteration of borosilicate glass and some common silicate minerals, such as wollastonite, olivine and feldspar, over a wide range of pH and temperature conditions. Another pertinent question that we have addressed is whether these surface layers form on non-silicate minerals, such as apatite. Our results are surprising and run counter to many accepted concepts.