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Mineral Dissolution: drawing the balance while looking out to the future

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The interaction between solids and aqueous fluids is - and predictably will be for the foreseeable future - a key issue of strategically important problems in modern industrial society. The International research community recognized this early on and made great efforts to respond to the challenge. The research results are remarkable and an important contribution to the understanding and planning of projects for, e.g., climate stabilization, the operation of underground reservoirs, nuclear waste disposal, and corrosion control or even cement setting.

The fundamental knowledge about solid-fluid interactions has undergone major changes. A detailed understanding of the role of the crystal surfaces was particularly important here. Based on new conceptual insights, we have developed new sophisticated methods and techniques and significantly expanded our theoretical understanding of the interaction kinetics.

Some notable milestones along the way are certainly the use of atomic force microscopy and vertical scanning interferometry, which have generated completely new observations and quantifications of the kinetic processes. The so-called "stepwave model" is a direct result of these measurements (1). As a major change, a much more differentiated picture of the dissolution processes was developed, which finally led to the concept of so-called rate spectra instead of postulated rate constants (2).

The latest discovery in this field is certainly the observation that crystalline matter does not dissolve continuously, but in a pulsating manner (3). Powerful tools that may help to develop theoretical concepts further are mechanistic and mathematical models supported by kinetic Monte Carlo simulations coupled with experimental studies for validation purposes (4). In addition, a key task is to ensure the upscaling of results obtained on very different scales. We have thus also defined the greatest challenge in order to enable the ability to predict and forecast complex fluid-solid systems in the future. The lecture will discuss and highlight these tasks in more detail.

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