Analysis of surface topography under external stress using vertical scanning interferometry

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A mineral's response to stress is obviously a key material property, but this response also exerts a fundamental control in terms of how the material behaves chemically during growth and dissolution reactions. In this context, it is important to understand the behavior of a surface exposed to an external stress field. Although changes in solubility (i.e., molar volume, isothermal compressibility) are relatively well understood, the key questions we wish to address here involve how *localized* stress affects defect distributions (e.g., screw dislocations) and associated key reactive sites, and how these in turn yield changes in reactivity and reaction rate. This is thus a general problem of wide significance, with a spectrum of applications ranging from water-rock interaction during burial to the affinity of surfaces to microbial attachment [1].

Dislocations resulting from external stress have been shown previously to exert a weak but complex effect on crystal dissolution rate [2], and more recent work has also demonstrated the promise of *in situ* study of dislocations with the AFM [3]. However, a key area of weak understanding is the relationship between the heterogeneity of defect distributions and the effect on dissolution rate and *rate variation*: to answer this problem demands observations over a large field of view. We have developed a novel uniaxial tension and compression device, allowing control of imposed stress in a small sample while performing precise topography measurements by vertical scanning interferometry (VSI). In addition to direct measurement of deformation, we can analyze the changes in corrosion behavior of various materials as a function of deformation by using a fluid-cell modified by the uniaxial device. In this study, we show first results about fluid-solid reactivity as a function of stress of diverse materials including calcite. We discuss the spatial heterogeneity of surface reactivity by using rate maps [4], and link these results to spatial distribution of strain energy. The comparison of new data for spatial rate heterogeneity with those of undeformed samples provides an enhanced quantitative insight into material fluxes in environmental and technical settings.

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