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Thermal damage in Westerly granite investigated by means of Synchrotron radiation based microtomography

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During heating of rocks, material- and orientation induced differences in the thermal expansivity and elastic behavior cause mismatch and heterogeneous stresses between expanding grains. Given sufficient heating, these thermal-elastic stresses cause inelastic deformation, mostly extensive cracking. A special case of thermally induced deformation in natural rocks is the decrepitation of fluid inclusions.

Westerly granite, from Maine (USA) is often used as 'model granite' in rock deformation experiments. A number of these experiments investigate the effects of heating on the granite's bulk properties, in particular its strength, elastic properties, and permeability (e.g., Fredrich & Wong, 1986, Wang et al., 1989, Nasseri et al., 2007). Most thermally induced deformation is ascribed to the formation of grain boundary- and intragranular cracks. The contribution of decrepitating fluid inclusions is rarely considered (Hall & Bodnar, 1989). The relative importance of both deformation processes remains to be quantified.

This contribution reports on a heating experiment conducted inside a microtomograph at sector 2-BM at the Advanced Photon Source (USA). We heated an unconfined 1 mm diameter, 8 mm long cylinder of Westerly granite in 15 K intervals from room temperature to 668 K. During heating, we acquired 26 three-dimensional microtomographic datasets documenting the evolution of the sample over the entire temperature span with sub-micron resolution. These data permit the most detailed temperature-resolved documentation of thermal cracking and fluid inclusion decrepitation to date. We examine (a) how absolute temperature affects the mechanisms by which thermal damage is accommodated in Westerly granite; (b) the evolution of geometrical characteristics of thermal damage; and (c) the effects of a retrograde overprint on deformation localisation.

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