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Effect of Temperature on Mechanical Yield of Quartz as Measured by Nanoindentation

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Formation of tectonic plates is influenced by the mechanical behavior of the lithosphere as well as convective processes in the mantle. The rheology of constituent minerals must be well-constrained in order to understand earth's deviance from the stagnant lid regime. The plastic rheology of constituent minerals has proven difficult to isolate from brittle behavior in traditional experiments. Nanoindentation and microcompression are employed here in order to study the plasticity of quartz at low temperatures ($T/T_m < 0.5$). Tests were performed on the (0001) face of a natural quartz single crystal from 23° to 175°C. Nanoindentation experiments return a reduced modulus and hardness values which are used in determining Young's modulus and yield strength. Multiple methods are analyzed here in order to determine the best way to find yield strength for geologic materials, which are both elastic and hard. Preliminary microcompression tests are also conducted as uniaxial yield strengths are readily returned. Data is then fit to flow laws to determine Peierl's stresses for each set of indents. Peierl's stresses close to 19 GPa are reported, higher than previously measured for quartz. We also demonstrate the need for a refinement of methodology for geologic materials.