**Rock Deformation at Plate Boundaries: The Long Path to Steady State**

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Deformation microstructures provide evidence for specific microphysical processes and represent an important link between rock deformation experiments, field-based geological studies, and geophysical observations and theory. However, microstructural evolution is complex, reflecting the numerous feedbacks between deformation and recovery processes. Many geophysical interpretations assume that microstructures in nature are at or near steady-state. However, recent studies have shown that some microstructures evolve progressively over long intervals of geologic history. These observations suggest that there are long transient periods between changes in the deformation conditions, kinematics, or mechanisms, during which microstructure and rheology continue to evolve. Hence, care must be taken when constructing geophysical models or inversions that depend in some way on microstructure. This presentation will include examples from the field and from laboratory experiments that elucidate how polymineralic rocks deform at high pressure and temperature. The slow evolution towards a damaged microstructural state provides a new framework for modeling the initiation and evolution of plate boundary shear zones.