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A Micromechanics-based Multiscale Approach toward Continental Deformation and Tectonic Processes

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The Earth's lithosphere has abundant structures and fabrics generated by various tectonic processes. These geological features span a wide range of characteristic lengths, from crystal lattice spacing to the dimensions of lithospheric plates. Using field observations of exhumed geological features, we aim to understand the rheological behaviour of Earth's lithosphere. However, our direct field and laboratory observations are limited to the most accessible scales, typically from outcrops to microscopes. There is therefore a significant intrinsic scale gap between direct observations and the tectonic processes operating along plate boundaries. A micromechanics-based Multi-order Power-Law Approach (MOPLA) has been developed to bridge this scale gap. MOPLA treats the heterogeneous rock mass as a continuum of rheologically distinct elements. The rheological properties and the strain rate and stress fields of the constituent elements and the composite material are computed by solving partitioning and homogenization equations self-consistently. The partitioned 'local' fields in individual elements are related to small-scale geological features. The 'bulk' fields and the homogenized rheological properties are associated with tectonic processes and the macroscopic behaviour of the heterogeneous rock mass. The algorithm of MOPLA is implemented in a MATLAB package and has been successfully applied to various studies on multiscale deformation in the lithosphere. In this work, we will introduce this multiscale approach and also briefly introduce our ongoing work on characterising the rheological behaviour of a heterogeneous subduction shear zone using MOPLA.