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On the effect of strain rates on the deformation creep mechanisms in deep Earth mantle

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The transport of heat from the interior of the Earth drives convection in the mantle, which involves the deformation of solid rocks over billions of years. Significant advancements have been made over recent years to study lower mantle assemblages under relevant pressure and temperature conditions, which have confirmed the usual view that ferropericlase is weaker than bridgmanite. However, natural strain rates are 8 to 10 orders of magnitude lower than those observed in the laboratory, and remain inaccessible to us. Once the physical mechanisms of the deformation of rocks and their constituent minerals have been identified, it is possible to overcome this limitation thanks to multiscale numerical modeling, which allows for the determination of rheological properties for inaccessible strain rates. This presentation will demonstrate how this theoretical approach can be used to describe the elementary deformation mechanisms of bridgmanite and periclase. These descriptions are compared with available experimental results in order to validate the theoretical approach. In a subsequent phase, the impact of very slow strain rates on the activation of the aforementioned mechanisms is evaluated. Our findings indicate that significant alterations in deformation mechanisms can occur in response to changes in strain rate.