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Can grain size evolution initiate transform faults? - Insights from 3D-numerical modeling

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Transform faults are conservative plate boundaries because they do not produce or consume any crust. Instead, they accommodate deformation via strike-slip movement, whereby their strike is usually perpendicular to the two features they connect. Commonly they are found at the ocean floor but some also occur on land. The processes contributing to the formation and longevity of transform faults are still debated, but it is clear that some form of weakening mechanism has to be active to create and preserve those sharp features.
Several numerical studies have shown that grain size reduction due to dynamic recrystallization is a mechanism for strain weakening which can in turn result in shear and strain localization. In nature, we commonly observe this grain size-reduction in shear zones and find fine-grained mylonites. Studies focusing on microstructural observations of these mylonites also conclude that grain size-reduction can lead to a progressive localization of strain.
We study the effect of grain size-reduction occurring at transform faults using a high- resolution 3D numerical model with a composite rheology (diffusion and dislocation creep) where the diffusion creep regime is grain size-sensitive. Contrary to previous models, we do not employ any strain weakening parameterization, but rather use grain size reduction as a self-consistent physical process to weaken rocks and localize deformation in the ductile regime.
Our results indicate that grain size-reduction can localize strain to such an extent that the initiation of a transform fault is possible. Depending on the efficiency of grain growth, those shear zones vary in width, with some resembling transform faults found on Earth.