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Eclogite and Peridotite Bodies as Paleoviscometers in the Western Gneiss Region, Norway

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Previous researchers have used structural and isotopic data to hypothesize that dense eclogite and peridotite bodies in the Western Gneiss Region (WGR) of Norway were sinking within their felsic host gneiss during Caledonian tectonism. To provide an independent estimate of the viscosity of the crust, we use these eclogite and peridotite bodies as paleoviscometers of the surrounding gneiss by calculating Stokes settling velocities for bodies on a case-by-case basis. Asymmetrically deflected lineations and foliations, asymmetric block orientations and shapes, and asymmetrically distributed leucosomes were taken as evidence for sinking.
We studied bodies from meter scale to multi-kilometer scale. At the largest bodies—Ulsteinvik, Almklovdalen, Fosnavåg, and Fjørtoft—we collected structural data and oriented samples for electron backscatter diffraction and petrography. Steep lineations of chlorite in the kilometer-scale Almklovdalen peridotite contrast with regional gently inclined lineations, suggesting sinking (Cordellier et al., 1981). No such lineations were found around the Fosnavåg and Ulsteinvik bodies, but these multi-km scale bodies most likely sank. At tens of smaller bodies with 3D exposure sufficient to ensure a complete characterization of each body, we documented meter-scale features and assessed the degree to which they supported or precluded sinking at high P-T conditions. A minimum viscosity from the Ulsteinvik eclogite for the felsic host gneiss—based on the observation that the body failed to sink through the entire crust—and maximum viscosities derived by assuming that certain other bodies sank at least twice their radius, suggest gneiss viscosities of ∼1e19 Pa*s at ∼750-775 ºC, similar to estimates of crustal viscosities from wet feldspar flow laws.