Distinct olivine slip systems in the granular and sheared mantle xenoliths from the Kimberley, South Africa

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The kimberlite xenoliths show well developed deformation microstructures and have two textually distinct types, granular and sheared peridotites. However, what mechanism is responsible for producing the distinct deformation textures seen in the cratonic mantle remains unclear. We analyzed active slip systems in olivine which are sensitive to the physicochemical conditions during deformation. The active olivine slip systems inferred from tilt boundary and lattice-preferred orientation are different between the granular and sheared peridotite xenoliths from the Kimberley. The granular peridotites have a [100](010) slip system, which is commonly found in mantle rocks, whereas the sheared porphyroclastic peridotites show a [001](100) slip system. Although several mechanisms are possible to activate the [001](100) slip system, the deformation conditions of the sheared peridotites, including strain rate, temperature and pressure, suggest that localized high water content is the most plausible mechanism. These observations imply that water has an important role on the deformation of the sheared peridotites. We therefore suggest that such localized water may facilitate deformation locally in the cratonic mantle and causes the textural variations of the peridotite xenoliths derived from the cratonic roots.