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Plastic Deformation of Plagioclase in a Gabbro Pluton at a Slow-Spreading Ridge (IODP Hole U1473A, Atlantis Bank, Southwest Indian ridge)

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The crustal architecture of slow-spread ocean crust results from complex interactions between magmatism, hydrothermalism, and tectonics. IODP Hole U1473A (809 m depth) was drilled during IODP Expeditions 360 and 362T at the summit of the Atlantis Bank, a gabbroic massif exhumed at the Southwest Indian Ridge (SWIR). In this study, we identify and quantify plastic deformation processes in oceanic gabbros and active slip-systems in plagioclase from 112 thin sections sampled throughout Hole U1473A.

We describe deformed zones using petrographic observations and modern Electron Backscattered Diffraction (EBSD) analyses made all along the core. Ductile deformation is widespread and is sometimes strongly localized. It initiated during accretion under magmatic conditions and continued until late brittle conditions. Porphyroclastic microstructures testify to post-magmatic, solid-state, high-temperature (HT) deformation. Plagioclase represents ~60% of rock's volume and is the dominant phase accommodating deformation in the gabbro. It shows strong dynamic recrystallization accommodated by dislocation creep, forming a fine-grained matrix. Strain localizes in mylonitic and ultramylonitic zones, and these shear zones are often overprinted by lower temperature deformation.

EBSD analyses reveal weak to moderate crystallographic preferred orientations (CPO) of plagioclase first developed during early magmatic flow, that has produced a primary fabric with a (010) foliation plane and a [100] lineation axis. This CPO is persistent during subsequent plastic deformation and strain localization and is observed in almost all samples. However, a detailed investigation of internal misorientations measured at subgrains reveals the activity of at least 4 to 5 slip systems in plagioclase grains: $[100](010)$, $[001](010)$, $[010](001)$, $\frac{1}{2}[110](001)$, and maybe $\frac{1}{2}[1\bar{1}0](001)$. The strength of CPO is first increasing from slightly foliated gabbros to mylonites before decreasing significantly in ultramylonites, which could be explained by orientation scattering after subgrain rotation recrystallization and grain boundary processes (e.g., nucleation, grain boundary sliding).