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Strain localization in mafic rocks: evidence from the Sudbury Igneous Complex, Canada

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The Sudbury Igneous Complex, the relic of a layered impact melt sheet, was transformed into a synformal fold basin. Shape change leading to folding of the basal Norite and overlying Quartz Gabbro layers is expressed in heterogeneous fabric development within these units. Metamorphic mineral fabrics formed under low- to middle greenschist-facies conditions, whereby brittle deformation caused local hydrolytic weakening of rocks that led to ductile fabric development. Brittle shear fractures represent the nuclei for zones of pervasive ductile strain. Individual shear fault planes and their associated mineral lineations are folded. This indicates that localized brittle deformation was followed by pervasive deformation and that deformation occurred under variable rheological conditions. Overall, deformation is characterized by reverse sense-of-shear on steeply dipping shear faults. Spacing between fault planes varies with position in the Igneous Complex and reflects the variability of deformation intensity in mafic rocks. On the outcrop scale, shear faults, spaced several tens of cm apart, merge and form connected networks of anastomosing fault planes, which in turn coalesce to zones of pervasive metamorphic mineral fabric, often characterized by shear bands. In areas of highest fault density the metamorphic mineral fabric is defined by the shape-preferred orientation of chlorite minerals.
In summary, the formation of zones of metamorphic mineral fabrics from localized brittle shear faults and the presence of folded brittle fault planes indicate that brittle faulting preceded and facilitated pervasive foliation development in mafic units of the Sudbury Igneous Complex.