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Evidence for shear band initiation approximately parallel to the acute and obtuse bisectors of the irrotational lines of flow in a general shear zone

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Sets of synthetic and antithetic shear band cleavages (SBC) are developed in strongly anisotropic zones in the low-temperature dextral-general Marbanite shear zone from the Val d'Or area, in the Archean Abitibi greenstone belt of Canada. These cleavage sets have been previously identified as late regional cleavages associated with contractional deformation, but closer inspection reveals that they do not cross-cut the latest structures in the outcrop, they are locally deformed by Z-folds and through-going C' surfaces, and they do not occur in outcrops outside of the shear zone. SBC do not intersect each other, so that they do not represent conjugate pairs of a superimposed regional co-axial cleavage. Photomicrographs of both sets of SBC reveal that the cleavages are indeed discrete surfaces of shear along inclined chlorite-rich surfaces, and not crenulation cleavages commonly associated with contractional deformation. Previous workers have suggested that shear bands may initiate parallel to the inclined eigenvector, the shear zone boundary, the maximum effective moment orientation, or the acute and obtuse bisectors of the eigenvectors (irrotational lines of flow). The shear band cleavages in the Marbanite shear zone have a bimodal distribution throughout the shear zone, and orientation data suggest that the synthetic and antithetic SBC initiated at $\sim 90^\circ$ to each other. This relationship is maintained from lower-strain areas through to higher-strain areas, even though the trends of the SBC change systematically from the former to the latter within the shear zone. This change in orientation of the SBC sets is expected as material lines rotate toward the stable irrotational line with progressive deformation. These observations suggest that synthetic and antithetic shear band cleavages initiate approximately parallel to the acute and obtuse bisectors of the irrotational lines of flow, respectively, during general shear in strongly anisotropic rocks. If this suggestion is correct, then SBC sets could potentially be used as qualitative vorticity gauges in shear zones that lack other significant kinematic indicators.