HETEROGENEOUS FABRIC DEVELOPMENT IN THE ONAPING FORMATION AND THE SUDBURY IGNEOUS COMPLEX AS INDICATIONS FOR A FOLD ORIGIN OF THE NE-LOBE OF THE SUDBURY BASIN, CANADA. C. Klimczak[1], A. Wittek[2], D. Doman[3] and U. Riller[4]
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Introduction: In the NE-lobe of the Sudbury Basin (Fig. 1) the Onaping Formation and the underlying Granophyre were structurally analysed. The Onaping Formation is a heterolithic impact melt breccia [1]. The Granophyre is the lowermost unit of the 1.85 Ga old, layered Sudbury Igneous Complex (SIC) [2,3], the erosional remnant of a solidified impact melt sheet [4]. In contrast to the pervasively deformed Onaping Formation, mesoscopic ductile strain fabrics are lacking in the Granophyre [5, 6], which led to interpretations of a primary origin of the synformal shape of the SIC [7, 8].

We demonstrate that the structures of the Onaping Formation are consistent with deformation in a fold core controlled by the mechanically stronger Granophyre of the NE-lobe (Fig. 1).

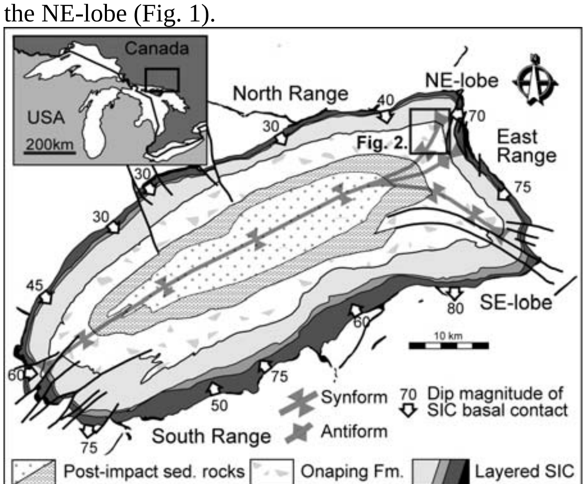

Fig. 1. Overview and simplified structural map of the Sudbury Basin [8, 9].

Discussion: Evidence for a fold origin includes the (1) presence of contact undulations and open structural domes and basins, (2) geometry of metamorphic mineral shape fabrics, (3) variation in shape fabric intensity, and (4) kinematics of prominent faults.

(1) The contacts between the individual members of the Onaping Formation and, to some extent also the contact between the Onaping Formation and the SIC, undulate throughout the Sudbury Basin [10]. In the NE-lobe undulations are well apparent and become more pronounced and form domes and basins towards the higher stratigraphic units of the Onaping Formation and towards the trace of the bisector plane of the NE-lobe at surface, the bisectrix (Fig. 2).

The formation of higher-order, poly-harmonic folds of mechanically less competent materials in the cores of mechanically stronger lithological units forming lower-order buckle folds is a common characteristic for fold-adjustment flow [11]. Accordingly, the structural domes and basins in the mechanically weaker upper stratigraphic units of the Onaping Formation and the thickening of them in the NE-lobe can be interpreted to have formed by fold-adjustment flow controlled by deformation of the mechanically stronger Granophyre and lower unit of the Onaping Formation.

(2) Metamorphic mineral shape fabrics in the NE-lobe, defined mostly by the shape-preferred orientation of chlorite, biotite and epidote, are pervasively planar (S) and in places linear-planar (L-S), notably near prominent faults, whereby the planar fabrics dip uniformly toward the southeast.

The development of the planar mineral shape fabrics is lithology-dependent. The fabrics are generally better developed at higher stratigraphic levels but are less abundant at lower stratigraphic levels of the Onaping Formation. Exept at the bisectrix, the Granophyre is generally devoid of mineral shape fabrics. Here, the planar mineral fabrics strike uniformly parallel to the bisectrix of the NE-lobe (Fig. 2).

In contrast to the directions of maximum diameters of the individual domes and basins (Fig. 2) which vary greatly, the uniformity of the planar mineral shape

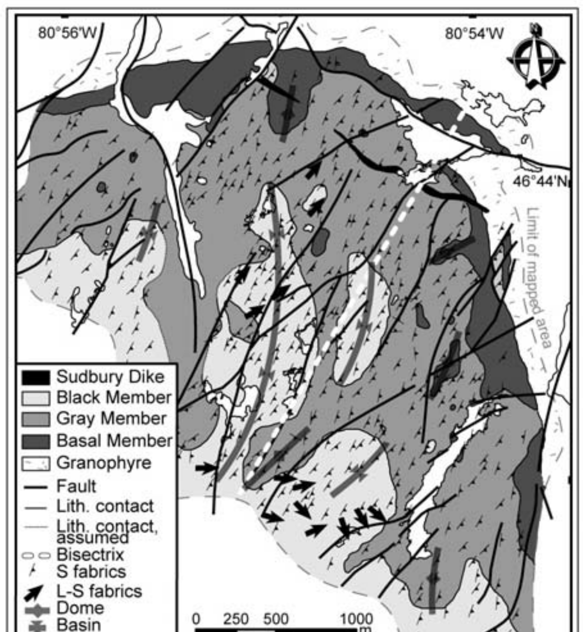

Fig. 2. Structural map of the Onaping Formation in the NE-lobe of the SIC.

fabrics suggests that their formation and the generation of the domes and basins are kinematically unrelated.

(3) Estimates of metamorphic fabric intensity in the Onaping Formation are based on the shape-preferred alignment of matrix minerals and clasts. The estimates vary as a function of mineralogical composition, grain size of the matrix and clast content.

Similar to the variation in planar mineral fabric orientation, fabric intensity increases toward upper stratigraphic levels of the Onaping Formation and, more importantly, toward the bisectrix of the NE-lobe [12, 13]. This suggests that gradients in mineral fabric intensity are controlled by lithology and strain, respectively. Based on the concordance of planar fabrics and the bisector plane, the mineral fabrics can be interpreted as axial-planar fabrics and, consequently, the bisector plane as a fold-axial plane.

(4) A prominent set of NE-striking faults is apparent in the Onaping Formation in the NE-lobe (Fig. 2). Shape fabrics with L-S geometry are only found close to of the faults suggesting that these fabrics developed during fault activity [13]. This relationship and the knowledge of the orientations of the faults (personal communication INCO Ltd. and Falconbridge Ltd.) and mineral shape fabrics can be used to graphically determine the sense of displacement on these faults [14].

Kinematic analysis was conducted at seven stations at the faults. Geometrically, the mineral shape fabric axes, fault orientation and inferred range of shear strain directions indicate overall NW over SE sense-of-shear on the faults. Additionally, a conspicuous pattern in horizontal shear components and respective directions of horizontal shortening is inferred from the kinematic analysis. The pattern of horizontal shear and local shortening directions indicate differential shear on the prominent faults separating elongate zones in the Onaping Formation of the NE-lobe. This pattern may be interpreted in terms of passive folding [15] of the Onaping Formation in the inner arc of the lobe.

Concluding remarks: In terms of scale and structures developed, the deformation of the Onaping Formation and the Granophyre of the SIC in the NE-lobe is highly heterogeneous. Our analysis shows that fabric development in the Onaping Formation was controlled by lithology and proximity to the bisectrix of the NE-lobe of the Basin. The presence of open structural domes and basins, progressive alignment of planar mineral shape fabrics toward axialplanar geometry, increase in shape fabric intensity towards the bisectrix and kinematics of prominent faults are, collectively, compatible with folding of the Onaping Formation on the kilometre scale. Thereby, the bisectrix constitutes the trace of the fold-axial plane. As this plane is inferred from the dips of the lower contacts of the SIC, and the prominent faults affected also the Granophyre, the SIC must have participated in this deformation. Open structural domes and basins in the mechanically weaker upper units of the Onaping Formation are interpreted to have formed as a result of fold-adjustment flow during deformation of the mechanically stronger SIC.

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