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Timing and nature of magmatic fabrics from structural relations around stoped blocks: Reply

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We thank Dr Hutton for his favorable comments regarding our presentation of the primary data: we certainly agree with Dr Hutton's assertion that there are plenty of discoveries still to be made from good field work. We also appreciate this opportunity to clarify our position on issues that were left implicit or unclear in the original paper. Dr Hutton presents two main concerns with our work, which we address sequentially, below.

Dr Hutton points out that if the stoped blocks have *not* sunk far from the pluton roof contact (i.e. $<$ few tens of meters), then our conclusions about timing of fabric formation, magma strain memory, and implications for pluton emplacement are unsupported. We respond with two points. First, although we freely acknowledge that three-dimensional spatial relationships can never be completely determined using two-dimensional field exposures, we strongly disagree with Dr Hutton's suggestion that an in-situ interpretation for the stoped blocks fits "just as well with the facts". As documented in figs. 2, 3, and 4 of Fowler and Paterson (1997), the stoped blocks lie 600 m horizontal distance from the nearest exposure of the pluton roof contact, they are 360 m vertically below the projected position of the contact, and outcrop control on contact orientation is excellent with consistent dips observed for 1 km along strike on either side of the line of the cross-section (figs. 3 and 4). Additional controls on orientation of the roof contact exist, not shown in fig. 4, which depicts only the southeast side of Tokopaw canyon. Just beyond the northwest end of the section, the canyon walls rise to elevations exceeding 3200 m and are composed entirely of Mitchell Intrusive Suite rocks. In other words, elevation of the pluton roof contact must increase to the north. Thus, an in-situ interpretation for the stoped blocks requires a departure from all orientation trends controlled by data.

Second, we have observed similar relationships between stoped blocks and magmatic fabrics in other plutons. For example Paterson and Miller (1998) document identical relationships around stoped blocks in the Mount Stuart batholith, Washington some located just a few tens of meters below roof contacts and others approximately 1000 m below roof contacts. Structures in these blocks are discordant to those in the host rocks, indicating that they have rotated relative to, and must be detached from the host. In fact, despite numerous occurrences of xenolithic blocks described in the granite literature, we know of no published counter examples.

Dr Hutton asks that we clarify our use of mafic enclave fabrics. The relationship between rock fabric and strain history is a fundamental question in structural geology. Investigation of this relationship is certainly worthy of continued research. In granite tectonic studies, three rock fabrics are commonly utilized, preferred shapes and orientations of mineral grains, of mafic enclaves, and anisotropy of magnetic susceptibility. These fabrics are defined by different elements within the rock, are likely to record different portions of the strain history with variable degrees of fidelity, and must be investigated separately. In Fowler and Paterson (1997), we saw an opportunity to evaluate the strain significance of mafic enclave fabrics independently from mineral alignment fabrics. We measured the enclave fabrics using established techniques and reported the results. We see no inherent

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contradiction in using terms such as 'fabric intensity' or comparisons of axial ratio values when reporting fabric measurements since the degree of preferred orientation of any population of markers with orthorhombic symmetry can be quantitatively defined by an ellipsoid, regardless of the relationship between the fabric and strain ellipsoids. We used these measurements to argue that the enclave fabrics failed to record strong (admittedly inferred) magmatic strains that we believe occurred during a late stage of pluton emplacement. In general terms, we do not, nor have we ever argued against the collection of rock fabric data in granites. We do believe, however, that such fabrics yield an incomplete and unreliable quantitative record of magma strain history (see also Paterson et al., 1998). Nevertheless, they still provide useful information (e.g. information about gradients), at least for some very late part of that history.

In summary we remain convinced that host-rock blocks we see in many plutons truly represent stoped blocks that have rotated during settling to their present positions and that the preserved magmatic fabrics around these blocks largely postdate the trapping of the blocks. It would be surprising to us if this were always the case and encourage others to look for and document counter examples.

References

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