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# Comment on ‘‘Relationships between melt-induced rheological transitions and finite strain: observations from host rock pendants of the Tuolumne Intrusive Suite, Sierra Nevada, California’’ by Markus Albertz

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Albertz (2006) presented a study of strain and host rock rheology around the Tuolumne batholith, an area in which my colleagues and I have worked for a number of years. I am concerned about the following points raised by Albertz (2006). There are repeated statements in the paper (e.g., page 1431) that strain ‘‘drastically’’ or ‘‘abruptly’’ increases towards the margin of the Tuolumne batholith and more specifically that on average ‘‘strain intensities increase from ca. 43% to ca. 70–85%’’ (Fig. 7A). I have seen little to no evidence for such a strain increase anywhere around the southern, eastern, and northern margins of this batholith. Furthermore, I do not think the data presented by Albertz support such statements. Albertz (2006) acknowledges that strain is a function of rock type, as is well shown by his data in Figs. 3, 6, and 7. In fact, Fig. 7a and b nicely show that regional strain well outside the aureole of the Tuolumne batholith ranges from almost 0% shortening to 70% shortening along the *z*-axis, with most results falling between 30% and 60% shortening. Albertz (2006) also notes that he sees little increase in strain towards the batholith margin at its northern end and that the shapes of the ellipsoids do not change with distance from the margin. My own mapping and strain studies around the southern, eastern, and northern margin are largely consistent with his statement that very little increase in strain and only local deflection of regional markers is preserved near the batholith margin. Furthermore, my experience of examining strains around other plutons that do cause significant ductile host rock deformation during emplacement suggests that it is unusual for the strain ellipsoids not to change shape as these pluton margins are approached.

A closer examination of the data presented in Fig. 7a and b show that only three data points record high strains near the Tuolumne batholith, two of which were calculated from folded veins, a somewhat problematic approach for determining strain. Furthermore, all the high strain data in Fig. 7b occur in a region, where ductile shear caused by faulting may occur in the aureole of the batholith (Greene and Schweickert, 1995; Tikoff and de Saint Blanquat, 1997). Thus, I would suggest that strain in the host rocks around the Tuolumne batholith is simply heterogeneous regional strain, largely controlled by bulk composition and somewhat by tectonic setting, and shows at best a 5–10% increase in the aureole of the batholith.

Albertz (2006) also acknowledges that ‘‘strain’’ potentially reflects a number of processes, including depositional processes (resulting in primary fabrics), regional tectonism prior to emplacement, and pluton emplacement. He downplays two other processes: strain caused by movement in regional shear zones and tectonic strain during or after pluton emplacement as indicated by magmatic preferred orientations in the batholith. Paterson et al. (2003), Žák et al. (2007) and Žák

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and Paterson (2005) present evidence that four magmatic fabrics occur in the Tuolumne batholith, at least two of which are regional foliations that overprint all internal contacts. One of these regional structures is a NW–SE striking foliation and steep lineation parallel to similar structures in the host rocks. The other is a WNW–ESE striking foliation that is only locally parallel to domainal WNW–ESE striking structures in the host rock. The important point is that both of these foliations indicate that regional strain affected the batholith during and after emplacement and thus presumably also affected the weaker host rocks (see below) in the contact aureole. Thus, any finite strain measurement generally incorporates components of all of the above processes (initial deposition, regional pre-emplacement strain, potentially shearing along faults, potentially emplacement, and additional syn- to post-emplacement regional strain). Additional evidence for all of these processes can be found in the studied area with the one potential exception of emplacement. Thus, I am confused why Albertz (2006) concluded that aureole strain largely reflects emplacement.

I am also puzzled by his interpretation that melt, and more specifically in situ melting of the host rock, played the most important role in weakening the strength of the host rock. I certainly agree with Albertz (2006) that a number of fascinating observations clearly indicate that metavolcanic and metasedimentary host rocks around the Tuolumne batholith are rheologically weaker than the adjacent magma, presumably at a time when the magma was almost fully crystallized. However, the cause or causes of this strength reversal are certainly complex and may include temperature, grain size, anisotropy, fluids, the presence of melt derived from the pluton, and in situ melting. My colleagues and I have found a number of examples where this strength reversal occurs in regions, where no evidence of any melt or melting exists. Furthermore, there is direct evidence that the host rocks are generally finer-grained, have stronger anisotropies, are as rich or richer in quartz and biotite (versus plagioclase and hornblende) than the plutonic rocks, and have been influenced by fluid flow. My examination of melt-veins in the host rock usually indicates that they are derived from the batholith, rather than by in situ melting. Given the above I am puzzled by Albertz' conclusion that melt, and particularly in situ melting, played the dominant role in weakening the strength of these host rocks.

I want to raise one final, minor issue: Albertz (2006) states on pages 1427 and 1429 that "Fry analyses were used in samples with no markers." I am sure this is just a misstatement by the author, since the Fry technique requires knowledge about population centers of some type of markers. What are these markers?

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