Sources of geochemical and modal variability in plutonic rocks of the Sierra Nevada batholith, California

A.F. GLAZNER[1]*, E.B. FOLEY[1], B.R. JOHNSON[1], D.S. COLEMAN[1] AND J.M. BARTLEY[2]

[1]Dept. of Geological Sciences, Univ. of North Carolina, Chapel Hill, NC 27599-3315, USA (*correspondence: afg@unc.edu)

[2]Dept. of Geology and Geophysics, Univ. of Utah, Salt Lake City, UT 84112, USA

Although crystal fractionation has long been used to explain the geochemical diversity of plutonic rocks, several lines of evidence indicate that crystal-liquid separation at the level of emplacement cannot explain the large-scale diversity of plutonic rocks in the Sierra Nevada batholith. Arguments against crystal fractionation include: (1) element-element plots of major and trace elements are typically linear, inconsistent with a changing crystal assemblages or trace-element behavior [1]; (2) high-Ba,Sr crystalline residues of silicic rocks are rare; (3) the inner and outer parts of many zoned plutons crystallized at different times owing to incremental emplacement, precluding a fractionation relationship; and (4) observed crystalline assemblages cannot produce the observed chemical variation.

Spectacular accumulations of minerals in continuous layers, schlieren, 'ladder dikes' (mafic troughs), and K-feldspar mosaics are commonly assumed to be crystalline residues of *in situ* fractionation. However, as Reid *et al.* [2] noted, fractionation of mafic layers from ladder dikes drives the residual magma composition at high angles to observed trends. Our data from layered granodiorites and K-feldspar accumulations are similar; for example, on a plot of MgO-Al_2O_3, the trend of mafic layers and K-feldspar accumulations crosses the observed pattern for the batholith at right angles. Our mapping discloses a common association of mafic layers, K-feldspar accumulations, and small metamorphic xenoliths; we speculate that the mineral segregations and xenolith trains mark fluid pathways rather than magma chamber borders.

These data indicate that the overall geochemical variability of the batholith must arise beneath the level of emplacement, and are consistent with a mixing origin in which overall geochemical variability arises from mixing between basaltic magma from the mantle and silicic partial melts of hydrous mafic rocks in the lower crust [3].

[1] Sisson *et al*. (1996) *Cont Min Pet* **126**, 81-108. [2] Reid *et al.* (1993) *Geology* **21**, 287-590. [3] Ratajeski *et al*. (2005) *Cont Min Pet* **149**, 713-734.

Automated analytical techniques for fission track thermochronology

A.J.W. GLEADOW*, S.J. GLEADOW, S. FREI, F. KOHLMANN AND B.P. KOHN

School of Earth Sciences, The University of Melbourne, Victoria 3010, Australia (*gleadow@unimelb.edu.au)

The microscopic analysis of fission tracks in natural minerals has, since its inception, been a laborious and time consuming process. The central tasks of track identification, counting and length determination have remained entirely manual procedures, dependant on the skill of a trained observer. We have recently detailed an automated image analysis system for identifying and counting fission tracks [1], which although an important advance, addresses only one component of the overall protocol required for fission track analysis. Two other components of any fully-integrated system must be the location of suitable grain areas for analysis, and the location of confined fission tracks for length measurement.

Grain selection in apatite (or zircon) mounts depends on locating grains that have a suitable crystallographic orientation, and have clear areas for counting, free of fractures, inclusions and other defects. Appropriate grains having their c-axes lying horizontally in the mount can be accurately identified using a recently developed c-axis fabric analyser [2]. Further image analysis is required to select grains with large clear areas. An even simpler solution is possible using imaging under circular polarized light. The operator is presented with a sequence of suitable grains in rank order for final confirmation and automated counting.

For track length determination, the most time-consuming and difficult task is locating suitable confined tracks, measurement of their lengths being relatively trivial. Our approach so far has therefore focused on location of candidate horizontal confined tracks by exploiting their bright back-reflections using incident light in c-axis parallel sections. The confined track yield is enhanced by using a separate apatite mount irradiated with normally incident ^{252}Cf tracks. A local image sequence is captured around each feature, and these are presented to the operator off-line for confirmation and then rapid measurement on sceen by clicking at each end.

These developments should provide substantial benefits in overall productivity, precision and consistency in fission track analysis for thermochronology.

[1] Gleadow *et al*. (2009, in press) *Geol. Soc. Lond. Spec. Publ*. [2] Wilson *et al*. (2007) *J. Microsc*. **227**, 30-41.