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Correlating deformation and metamorphism around orogenic arcs

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ABSTRACT

The timing of metamorphism and the *P-T-t* path the rocks have undergone commonly varies around orogenic arcs, hindering correlation along orogens. Isotopic dating enables broad correlations to be made, but detailed correlations can be difficult using this approach where several phases of metamorphism are present. This is compounded by the large size of oroclines, which hinders correlation of deformation and metamorphism using a succession of structures and associated metamorphism. However, foliation inflexion-intersection axes (FIAs) preserved in porphyroblasts provide a tool for correlation around oroclinal arcs. Consistent successions of FIAs that remain constantly oriented around folds and across large tracts of multiply ductilely deformed country rock allow correlation of periods of metamorphism taking place during the one direction of horizontal bulk shortening, rather than correlation of inferred growth events. Consequently, rocks that have undergone different *P-T-t* paths can be correlated.

Measurement of FIAs around the spectacular Kimberley Arc in northwest Australia reveals that the first-formed set maintain a consistent average trend of 127° and a subhorizontal plunge. This FIA trend is parallel to the western arm of the arc, but lies at a very high angle to the eastern arm. Foliations preserved as inclusion trails in porphyroblasts are continuous with foliations in the matrix on the western arm, where the FIAs and structural grain are sub-parallel. However, inclusion trails in porphyroblasts defining FIAs with these same trends on the eastern arm are truncated by the matrix foliation. This indicates that foliations in the matrix on the eastern arm postdate all foliations in the matrix on the western arm. Two late sets of locally developed, small kinks of the matrix foliation on the western arm, which have axial planes parallel to foliations on the eastern arm, are weak expressions of the overprinting events that controlled the geometry of the latter arm.

A second group of FIAs has been found in some samples on the eastern arm that lie sub-parallel to the northeast trend of this arm. They are defined by inclusion trails that are continuous with the matrix foliation and that occur in the rims of porphyroblasts. Such porphyroblasts generally contain a core with inclusion trails defining the first-formed FIA that lies sub-parallel to the western arm. The inclusion trails in porphyroblast cores are truncated completely by those in the rims, in the same manner that those without this rim-set of inclusion trails are truncated by the matrix foliation. This second set of FIAs has not been found in any samples from the western arm.

FIAs thus provide a simple tool for correlating metamorphism around orogenic arcs. The porphyroblasts with consistently oriented FIAs around the arc can be readily correlated and grew during the same period of metamorphism that affected both arms. Those with northeast-trending FIA record a younger period of metamorphism that affected only the eastern arm. Indeed, until techniques and standards for dating porphyroblasts and their inclusions by both the microprobe and ion-microprobe improve, FIAs may provide the only quantitative tool that integrates metamorphic and structural phenomena and thus allows detailed correlation of these events along an orogen.