# Partitioning of deformation across the metamorphic hinterland in the Swat Region, Pakistan Himalayas

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**Abstract**

A prograde metamorphic mineral assemblage characteristically evolves with porphyroblast growth when a succession of pellitic rocks follow pressure and temperature (P-T) trajectories during Barrovian metamorphism. Since the advent of the concept of metamorphic facies, extensive research has been done on porphyroblasts composition and their key role in thermodynamic modelling of P-T paths. An outstanding result of these studies is the recognition of typical high T vs. high P metamorphic belts across the globe, reflecting a significant role of porphyroblasts in our understanding of mountain building processes. It has been envisaged that the deformation partitioning controls porphyroblast growth in ductile environment and prohibits porphyroblast rotation – a hypothesis that sparked a lively debate in early 1990's and continues undecided today. In this study, it has been demonstrated that how deformation partitioning controls porphyroblast growth during regional metamorphism without significant rotation. The mechanism operates at different scales and provides a window to compare tectonic processes from porphyroblast to the whole orogen. 61 oriented rock samples were collected from the Swat region, which represents the metamorphic hinterland of the NW Himalaya. Advanced 3D micro-structural techniques have been used to unfold deformation partitioning phenomena.

3D geometry of inclusion trails preserved within porphyroblasts was studied in each sample using two independent techniques, namely the 'asymmetry switch' of curved inclusion trails and the 'FitPitch' software analysis. Both methods revealed remarkably consistent orientation of intersection or inflection axes preserved in porphyroblasts. These geographically "fixed" axes, also known as the foliation intersection axes (or FIAs) grouped into three orientation classes, obtained coherently with relative time constraints from many samples: 1) ESE-WNW 2) E-W and 3) NNE-SSW directions corresponding to three different shortening directions during progressive deformation of the Himalayan orogen. Each FIA set is preserved by unique class of porphyroblasts that grew during subsequent deformation event. Different stages of porphyroblasts growth with their respective FIAs, despite having been hosted by samples collected from different locations and even rock formations, revealed remarkably consistent orientations across the region. This is because of the shifting patterns of deformation partitioning operated at porphyroblast scale where the progressive bulk inhomogeneous shortening dominate over other mechanisms at the orogen scale.