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Vorticity in Grenville Basement Massifs, Southern Appalachian Mountains

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Massifs of tectonized augen gneiss form large parts of the Middle Proterozoic Blowing Rock Gneiss within the Grandfather Mountain window in the Blue Ridge of North Carolina, Southern Appalachian Mountains. The window, whose contents are allochthonous, and structurally higher thrust sheets are consequences of the Late Paleozoic Alleghanian orogeny, but pervasive structural fabrics internal to the thrust sheets resulted from mid-Paleozoic Taconic or Neoacadian deformation and metamorphism. Those fabrics are manifested in the Blowing Rock gneiss as a strong, composite foliation containing porphyroclastic potassium feldspar grains, shear bands, and intrafolial folds. Kinematic analysis of porphyroclast core-mantle asymmetries , semi-rigid rotated skeletal feldspar porphyroclast stacks, flow path plots of rotated augen, and mesoscopic fold vergence determine kinematic vorticities between 0.6 and 0.8. Shear sense from all kinematic indicators is sinistral, that translates here into top to the northwest movement. There are localized shear gradients within the augen gneiss - ductile shear zones - across which the vorticity number varies, but overall these data are consistent with other kinematic indicators. The wide range of porphyroclast morphologies (sigma, delta clasts; domino stacks; rigid grains) is partly the result of an inherited fabric in the augen gneiss from Grenville deformation. More importantly, however, is the possibility that the present primary composite foliation preserves an evolving fabric in one vorticity regime. Domino porphyroclasts are extremely elongated in the foliation plane up to 150%, where quartz fills voids between rigid potassium feldspar fragments. In some parts of the foliation, presumably where strain is higher, the fragments separated from the domino stack and formed discrete cores mantled with quartz or quartz + mica. These latter porphyroclasts then became sigma or delta clasts. In proximity to ductile shear zones, all clasts are significantly flattened and extended into the mylonitic foliation of the shear zone. Shear bands are the latests discrete planar structures in these tectonites, and they reorient the tail tips of porphyroclasts to be oblique to the main foliation. Shear band geometries are also sinistral as viewed down the vorticity vector direction. Lesser deformed bodies of Blowing Rock gneiss elsewhere in the Grandfather Mountain window contain large augen but these rocks lack the pervasive shear exhibited by regions where core-mantle porphyroclasts are more abundant. The finite strain in highly tectonized Blowing Rock gneiss therefore evolved from rotation, flattening, and disarticulation of feldspar augen followed by or contemporaneous with separation of augen fragments to form discrete mantled porphyroclasts. Late stage sub-simple shearing in the same flow sequence created shear bands.