History is rheology: Paleoproterozoic accretionary zoning controls Grenville structural styles in deep crust of Neoproterozoic Grenville Orogen, Central Gneiss Belt (CGB), Ontario, Canada

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A traverse across the CGB from the Laurentian craton to the Composite Arc Belt crosses three stacked tectonic zones of contrasting styles and tectonometamorphic history.

(1) The structurally deepest zone, overlying the Laurentian craton, comprises polycyclic parautochthonous domains that include the Archean basement of the inferred Paleoproterozoic Laurentian (Huronian) inverted passive margin. The Archean orthogneiss is associated with Paleoproterozoic metasediments containing detrital zircons suggesting Huronian protolith. Major overturned folds and amphibolite facies shear zones formed at ca. 1750 Ma (inversion of passive margin). A metamorphic and structural overprint at 1000 Ma resulted in narrow shear zones and fold interference patterns.

(2) Polycyclic allochthonous domains include Labradorian members of the Great Proterozoic Accretionary Orogen (GPAO). Ca. 1650 Ma orthogneiss was migmatized at ca.1450 Ma and ca. 1450 Ma A-type orthogneiss postdated the migmatization. Metasediments contain detrital zircon evidence for proximity to Penokean and Yavapai GPAO members. The complex Kiosk-Algonquin thrust stack contrasts with the fold interference patterns of the Archean parautochthons. The thrust sheets themselves display heterogeneous internal deformation and grain-size refined Ottawan (ca. 1080–1040 Ma) marginal shear zones. Retrogressed eclogites (1090 Ma met) lie within and along boundaries of some thrust sheets.

(3) Monocyclic allochthons, the highest zone, consist of the Pinwarian (ca. 1450 Ma) Shawanaga-Muskoka continental arcs (coeval with the back-arc A-type plutons in the polycyclic allochthons), the Parry Sound domain ca. 1314–1390 Ma arc and ca. 1232–1320 Ma back-arc assemblages that include sediments with Laurentian-GPAO provenance. The Pinwarian orthogneiss, lacking pre-Grenville melting of the polycyclic domains, is highly migmatitic and displays km-scale flow structures enabled by Grenvillian melt weakening. A boundary, decorated by an eclogite-anorthosite assemblage, separates the Pinwarian migmatitic orthogneiss and peripherally retrogressed granulite facies Parry Sound domain from the underlying polycyclic allochthons.

The traverse demonstrates the control exerted on structural style by GPAO accretionary zoning. The foremost control is Pinwarian, or earlier, high grade metamorphism, the presence of which favours formation of Grenvillian shear zones bounding relatively strong nappe cores. The absence of Pinwarian metamorphism in the outboard monocyclic arcs allows pervasive Grenvillian melting, softening and diffuse ductile flow.

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