Hot nappes and lumpy channels: Mid-crustal flow modes in the western Grenville orogen

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Recent models for the tectonic evolution of large, hot orogens (Beaumont *et al.* 2001, *Nature,* **414**, 738-42; *JGR,* in press) suggest that weak middle orogenic crust may flow outward in response to a topographically-induced pressure gradient. Depending on the properties of the converging crust, a variety of flow modes, including homogeneous channels, heterogeneous ("lumpy") channels, and hot fold-nappes (Beaumont *et al*., this volume), can be recognized in the models. The Mesoproterozoic Grenville Province represents a Himalayan-scale convergent orogen formed on the southeastern margin of Laurentia at ca. 1200-1000 Ma (e.g., Rivers *et al*., 1989, *Tectonics*, **8**, 63-84). Seismic profiles (White *et al*., 2000, *CJES,* **37**, 183-92) and a range of geological, structural, petrological, and geochronological data (e.g., Culshaw *et al*., 1997, *Tectonics*, **16**, 966-82; Carr *et al*., 2000, *CJES*, **37**, 193-216; Slagstad *et al*., *CJES,* in press) suggest that the Central Gneiss Belt (CGB) in Ontario may represent the exhumed remnants of a hot nappe-channel system active during the Ottawan orogeny (ca. 1090-1030 Ma). If so, the CGB provides an unusual opportunity to observe the effects of interaction between an ancient channel flow zone and the underlying lower orogenic crust.

Comparisons between model results and observations suggest that the crustal-scale geometry of the western Grenville orogen can be explained by expulsion of lower crustal nappes during progressive underthrusting of stronger Laurentian crust. Evidence for a low-viscosity channel comes mainly from the Shawanaga and Muskoka domains, which include shallow-dipping, highly migmatitic orthogneisses that form thin, laterally extensive, lobate sheets. The gneisses record very high strains and locally preserve evidence for early (pre-1085 Ma) nappe-like folds. Dates from leucosomes and cross-cutting structures indicate that lateral flow within the Muskoka domain was active at ca. 1065-1050 Ma (Timmermann *et al.*, 1997, *CJES,* **34**, 1023-29; Slagstad *et al*., in press). Granulites of the Parry Sound domain, which preserve steep, pre-Ottawan (ca. 1160 Ma) structures, were transported over younger rocks during the Ottawan orogeny, possibly as a detached lower crustal nappe. Retrogressed eclogite bodies are widespread in parts of the CGB, particularly along domain boundaries where they are also associated with anorthosite (e.g., Ketchum & Davidson, 2000, *CJES*, **37**, 217-34); their petrology requires that they originated at a much deeper crustal level than is currently exposed. These features suggest that hot fold-nappes expelled during Ottawan convergence may have been disrupted by and partly incorporated into a "lumpy" low-viscosity channel flow zone.