Visco-elastic models of greenstone belt formation by diapiric density inversion and magmatic intrusions.

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The theory of plate tectonics has shaped our current understanding of geodynamics. However, the relative importance of horizontal tectonics in terrestrial environments different from present day Earth (such as in the Archean or on the planet Venus) is not clear. Accordingly, here I present numerical models for the formation of granite-greenstone terranes (whose structure is well documented in the literature) using the numerical code Thermax2D. Thermax2D is a moving mesh visco-elastic code based on the commercially available finite element solver FEMLAB, incorporating temperature-dependent viscosities, erosion, and brittle failure (Bailey, 2005).

In the past, granite-greenstone terrains (e.g. the Superior Province of Canada and the Pilbara Province of Australia) have traditionally been viewed as the result of solid-state diapirism of granite through an insulating layer of volcanically deposited greenstones. Generally, those who prefer vertical to horizontal tectonics in the Archean invoke this model. Numerical work by Mareschal and West (1980) provided some physical constraints; however, they were limited to low activation energies (Ea), and did not include elasticity. Here we present preliminary results of a similar model including elasticity and higher Ea, which show important differences in both geometry and timescale, both of which are well-constrained by field work.

However, a growing body of geophysical and structural work indicates that in some cases GGT granites are quite shallow, and that they intruded as magma. This has led a few workers to suggest that GGT granites may have formed by i) intrusion of a tabular magmatic body, followed by compression due to regional tectonic deformation; or ii) intrusion of magma in batholithic form, with or without regional deformation (e.g. Cruden & Robin, 1998, Blenkinsop & Treloar, 2001). Thermax2D is capable of calculating the visco-elastic response of the crust to magmatic intrusion. Here we present preliminary calculations meant to test the range of usefulness of the Thermax2D for magma intrusion models.

References:

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