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Towards a 3-Dimensional common earth model for the Laverton Greenstone Belt, Western Australia.

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The Laverton Greenstone Belt is located in the Archaean Yilgarn Craton, Western Australia. Broadly, the greenstone belt comprises an older mafic-ultramafic stratigraphic association overlain by a younger andesitic volcano-sedimentary stratigraphic association and late-stage sedimentary basins (Hallberg 1985; Standing. *in prep*). The greenstone sequences have suffered a protracted period of igneous intrusive activity throughout their evolution, culminating in widespread granitoid magmatism contemporaneous with basin development (Standing *in prep*). Economic gold mineralisation in the Laverton Greenstone Belt is dominated by several major deposits including Wallaby (7.1 million ounces gold; Nielsen & Currie 1999), Sunrise-Cleo (>9 million ounces gold; Newton et al, 1998), Granny Smith (2.3 million ounces gold; Hall & Holyland, 1990; Ojala 1995), Lancefield (2 million ounces gold, Hronsky 1993) and Mt Morgans (1.2 million ounces gold; Vielreicher 1994). The known gold endowment of the Laverton Greenstone Belt is >20 million ounces making it one of the most economically important greenstone belts in the Yilgarn Block.

In recent years, ongoing work by industry and government agencies has built a substantial database of regionally consistent mapping coupled with detailed regional-scale aeromagnetic, gravity and spectral surveys. In addition, three lines of deep penetrating seismic were shot in 2001 by Geoscience Australia. The combination of these datasets is now being used to build a rigorous 3-Dimensional Common Earth Model (3D-CEM) for the Laverton area using GoCad® technology. The intention is to develop the Placer Granny Smith 3D-CEM into a robust targeting tool to drive ongoing exploration in the Laverton Greenstone Belt.

Coward (2003) provided the initial structural framework behind the Placer Granny Smith 3D-CEM, based on integration of seismic, aeromagnetic and gravity data with in-house regional mapping. A structural sequence was constructed, as summarized in Table 1.

Table 1. Structural history of the Laverton Greenstone Belt (Coward 2003).

Process	Consequences
Vertical tectonics	Thrusting post deposition of early greenstones reflected by thin-skinned shortening in the central part of the Laverton Greenstone Belt. Upper crust flowed NW upon a ductile and less-dense granitic middle crust.
Regional Extension	Extensional structures dip eastwards and sole-out into gently east dipping thrust fabrics at depth (at approximately 5-11km depth). These structures tapped the middle crust enabling deposition of the andesitic volcano-sedimentary sequence at surface. Eastwards these structures step down into the middle crust.
Inversion tectonics	NW-directed over thrusting of the middle crust. Early greenstones folded into a large hangingwall anticline and overthrust onto the younger andesitic volcano-sedimentary sequence, which was itself folded during this inversion episode. Footwall shortcut thrusting created a second overthrust sequence in the western part of the greenstone belt. Strike slip displacement invoked to reactivate steeply dipping, with strike-slip variations inferred to reflect southerly extrusion related to an indenter in the north.
Gravity Sliding	Gravity sliding off the crest of the western thrust and related extensional fgoldlts. Interpreted to correlate with deposition of the late-stage sedimentary basins. Local compression (inversion) deformed these rocks creating a new cleavage.

Coward's (2003) model highlighted several key factors necessary for building this 3D-CEM. Firstly, it highlighted the need to define a stratigraphy based on the various tectono-stratigraphic domains in the greenstone belt and reconcile this against existing geochronology. In addition, this forced us to debate the tectono-stratigraphic model (continental rift/vertical tectonics versus subduction versus terrane amalgamation). Mike Coward was one of the few researchers pushing anything other than subduction related models in the Yilgarn Craton. Finally, it caused us to focus on the cross-linkages between many disciplines of geology-(eg. volcanology, tectonics, sedimentology, geochronology, etc).

The process of creating the initial 3D-CEM involved the following steps:

1. Interpretation of migrated regional seismic sections using techniques demonstrated by Mike Coward, and these were used to constrain the base of the greenstone basin, highlight packages of reflectors, and identify the gross fault architecture disrupting these packages of reflectors.
2. Projection of this architecture onto 10km spaced sections using surface geology as control and the architecture interpreted from the seismic sections as a guide to fault geometry at depth.
3. Forward modelling of the geological sections to provide a best fit with regional detailed gravity data.
4. Import of modelled sections into GoCad® and wire framing of common structural and stratigraphic markers.

The 3D-CEM for the Laverton Greenstone Belt remains a work in progress. Future efforts will focus on integrating results from more recent seismic surveys into the model. More rigorous approaches to model construction will also be implemented by means of techniques such as section balancing, and validation by way of forward modelling of standard and transverse sections through the model using regional aeromagnetic and gravity data. This work will help define regional tectono-stratigraphic features (eg. extensional faults and inversion structures) and allow construction of a realistic tectonic model for the Laverton Greenstone Belt. Finally, the full utility of the 3D-CEM will be realised through incorporation and testing of our evolving exploration models in the 3D-GoCad® environment, and ultimately in the ground.

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