

# Application of Long-term Tectonic Simulations to Predictive Mineral Exploration: The Victorian Goldfields Architecture

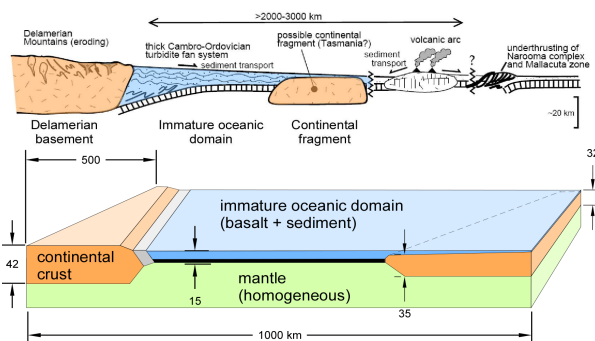
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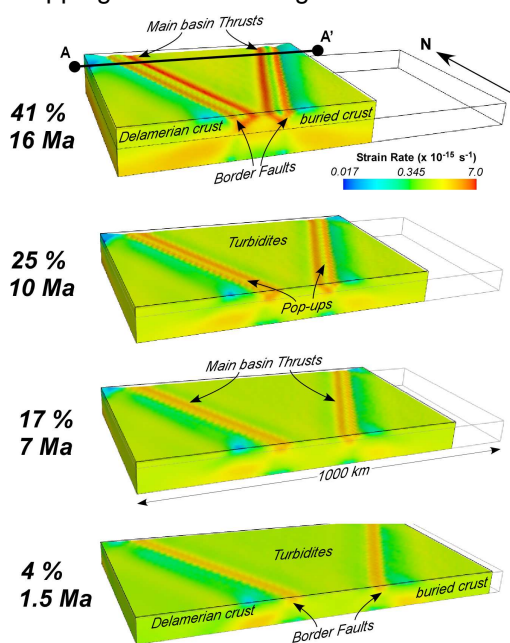
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A series of high strain simulations were run to examine the conditions favourable for the formation of terrane-scale high strain zones that provide the host architecture for most orogenic gold deposits in the western Lachlan Orogen of Victoria (SE Australia). Gale, a visco-plastic finite-element code based on Underworld, has been used to simulate the tectonic evolution of the area. It allows the simulation of large scale deformation under realistic convergence rates. A simplified geometry representing an immature oceanic turbidite basin and its margins was shortened up to 60%. These simulations successfully reproduce some of the geological features of the western Lachlan Orogen, such as the development of major faults, their spatial distribution and their relative chronology.

**Figure 1:** Model design. Comparison of the Lachlan tectonic model at 455 Ma (after Foster and Gray, 2000), incorporating a microplate in the eastern part of the western Lachlan with the model initial geometry used for the simulations. Crustal materials are visco-plastic, combining a Mohr-Coulomb yielding rheology and Frank-Kamenetskii viscous rheology. Mantle is defined as purely viscous. A constant velocity condition (convergence at 2.2 to 4.4 cm.yr<sup>-1</sup>) is applied on the right wall of the model. Top surface is free to move.



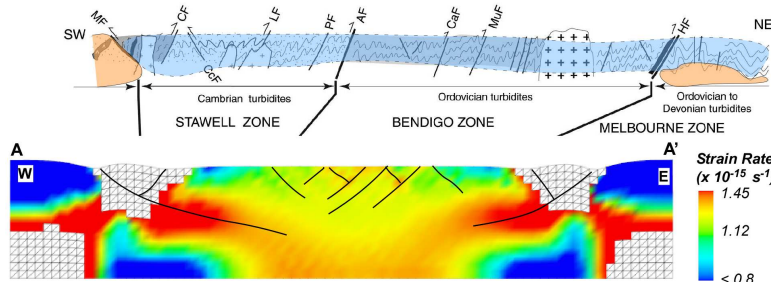
Gale simulation results (Fig. 2) shown that the first structures to be activated as thrusts are the basin's passive margins (Border Faults). After about 3 Myr, these high strain zones start to widen. After about 7 Myr, backthrusts, dipping toward the edge of the basin develop within the basin and accumulate most of the strain (Main basin Thrusts).



At that time 2 pop-ups are formed between the marginal border Faults and the Main basin thrusts.

The general timing and fault sequence observed in our model is compatible with the tectonic evolution of the western Lachlan orogen as reported by Gray and Foster (2004) and Miller et al. (2006) (Fig. 3). Simulations also illustrate that the shortening is preferentially accommodated within the turbidite basin.

Gale simulations successfully reproduce the general deformation pattern proposed by previous authors resulting from field observations and recent geophysical interpretations.



Long-term tectonic simulations are helpful tools to test simplified regional deformation scenarios and to understand crustal architecture. They also have the potential to inform exploration at increasing depth and undercover, and promote the discovery of new deposits in greenfield terranes where only coarse geological features are known.

**Figure 2:** (Left) From bottom to top: Evolution of the Strain Rate second invariant between 1.5 (4% shortening) and 16 Myr (41% shortening). As the convergence starts, thrusts develop at the basin's passive margins (Border Faults). After about 3 Myr, these high strain zones start to widen. After about 7 Myr, backthrusts, dipping toward the edge of the basin develop within the basin and accumulate most of the strain (Main basin Thrusts). Simultaneously, 2 pop-ups are formed between the Border Faults and the Main basin thrusts. (model resolution: 80 x 15 x 40).

**Figure 3:** (Right) Comparison of a geological cross-section of the western Lachlan Orogen where major faults are highlighted (after Miller et al., 2006) with strain rate image along vertical section A-A' for Gale simulation (Fig. 2). The spacing and general distribution of the faults in the simulation (approximated by higher strain rate, highlighted by continuous black lines) is compatible with geological observations.

## References

Foster, D., Gray, D., 2000. Annual Reviews of Earth and Planetary Science, 28, 47-80; Gray, D., Foster, D., 2004. Australian Journal of Earth Sciences, 51, 773-817; Miller, J., Wilson, C., Dugdale, L., 2006. Australian Journal of Earth Sciences, 53, 677-695.

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