Mid-Archaean crustal geodynamics: Solving the Pilbara controversy

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The analysis of the geomorphology and finite strain field characteristics suggests that the Mt Edgar granitic dome in the Pilbara craton extends further west under the Marble Bar belt. This interpretation eliminates the two main arguments put forward against the vertical tectonics model in the East Pilbara. The strong sub-vertical shearing that affects the southern margin the Mt Edgar dome disappears further west because the granite-greenstone contact flattens out under the flat lying Marble Bar belt. The shear zone along the Mt Edgar southern margin is therefore not a detachment fault, but rather a décollement zone that keeps parallel to the granite-greenstone boundary and whose strain characteristics depend on its dip. In addition, when one takes into account the position of the granite-greenstone boundary under the Marble Bar belt, stretching lineations along the Mt Edgar southern margin and in the Marble Bar belt organize themselves into a regular radial pattern as expected along a décollement zone.

We also bring into the debate a new observation. There is in the Warrawoona syncline a family of quartz vein whose pole remains sub-parallel to the stretching lineation that rotates to become vertical where the strain is constrictional. This suggests that the axes of the finite and incremental strain ellipsoids remain parallel despite the rotation of the finite strain ellipsoid. Coaxial yet rotational deformation is highly unusual in deformation driven by far-field plate boundary stresses. However, the rotation of the stress ellipsoid in step with the rotation of the finite strain ellipsoid is compatible from the gravitational pull from the sagducting greenstone.

Finally, we have conducted numerical thermo-mechanical experiments in order to test the gravitational instability model. The results of these experiments show that for realistic density contrasts, greenstone thicknesses and viscosities, the gravitational instability model accounts for the time-scale, and the length-scale of the dome and basin pattern of the EPGGT. Furthermore, the temperature evolution recorded in the upper crustal levels including Ky-bearing assemblages is remarkably compatible with the temperature evolution in our numerical experiments.