The Lawlers Anticline and the Mt Margaret Anticline are located at the western and eastern margins of the Kalgoorlie and Kurnalpi Terranes respectively. Both folds are granite-cored and are associated with significant Late Basin preservation, and gold deposits. The initiation of the antiforms may have been during extension, with rising granite magma being emplaced into these incipient domes. The development of extensional shear zones and detachments within the granite and overlying greenstones tilted the country rocks so that when the Late Basins were deposited they 'found' a 'D2' pre-folded sequence. The intensity of this extensional event was sufficient to finally bring the lower-plate to the surface so that granitic detritus could be sourced and deposited both locally and afar. The presence of a layer parallel shear fabric along moderately dipping limbs of antiforms further support to the extension hypothesis since a steep axial-plane foliation which transects the layering would be expected in compression. Figure 61 shows that the partially radial pattern of extension away from granite dome cores during D3 observed at Lawlers is replicated on the regional scale.

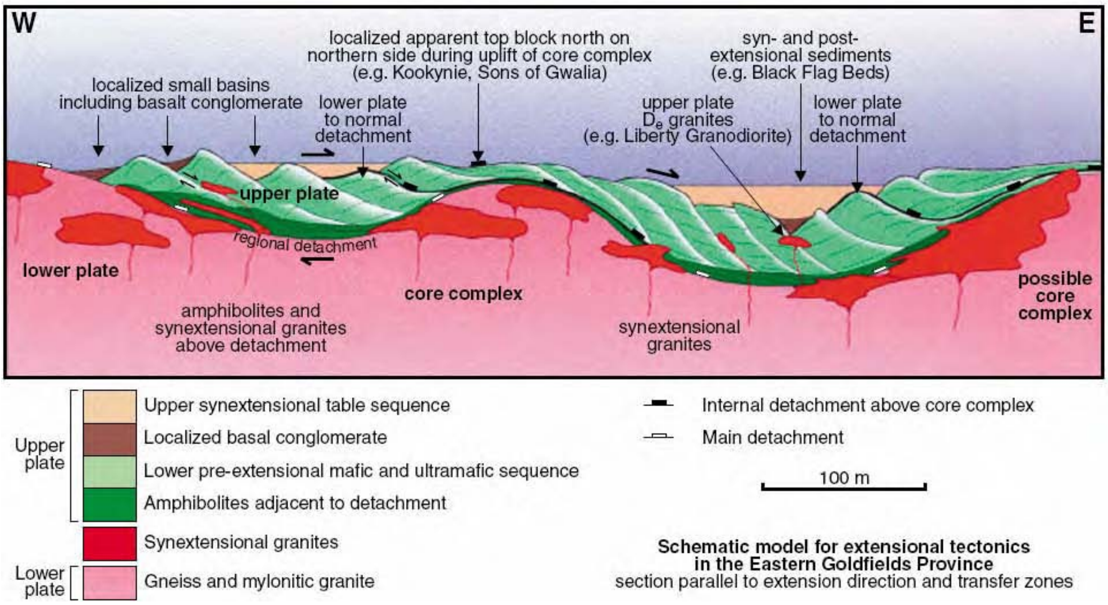



**Figure 68: Schematic diagram from SRK (2000) illustrating the geometry of the extensional architecture of the system. The model has errors of fact such as assuming the Late Basins are the same age as the Kalgoorlie Sequence (Black Flags), but the overall picture is appealing. We have switched the view from on of ENE to one of north as we interpret that the fundamental polarity of extension to be E-W not NNW-SSE.**

*Seismic reflection at Leonora and Pig Well – extensional formation of a Late Basin*

The project was fortunate to have access to publicly funded (GA-GSWA) seismic reflection data (01GASNY1) through the Leonora area (Fig. 59). These data were interpreted as part of the *pmd**CRC Y2 project (Blewett et al., 2004c), and results therefore made available to this project with end its confidentiality. Figure 69 shows the location of the seismic line in relation to the regional solid geology. The main faults, the Ockerburry and Keith-Kilkenny Fault Systems have normal (extensional) map patterns with the younger (Late Basin in brown) on older basement greenstone (green and yellow).

The 01GASNY1 seismic line is a high-quality dataset that was reprocessed by Dr. Leonie Jones at Geoscience Australia. The result was the resolution of macro-scale extensional shear zones (S-C-C' relationships) that can be traced from 5-6 km depth to the surface (Fig. 70).

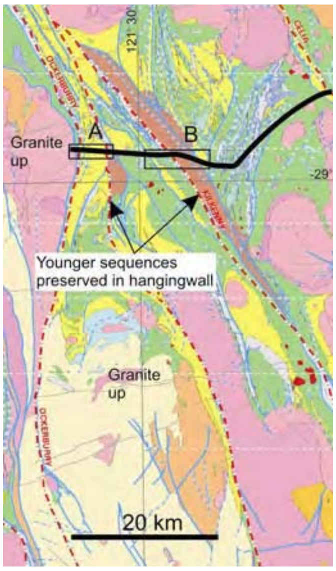



**Figure 69: Location of the 01AGSNY1 seismic reflection line from Leonora across the Pig Well (Late) Basin (brown). The Ockerburry and Keith-Kilkenny Fault Systems have normal (extensional) map patterns with the younger (Late Basin in brown) on older basement greenstone (green and yellow). The relationship is also one of lower granites juxtaposed across E-dipping contacts (shears) against higher greenstones to the east. Location A and B are detailed views of the lines in Figures 69 and 70 respectively.**

The re-processing of seismic line 01AGSNY1 across the SOG pit (Fig. 70) shows excellent S-C-C' relationships; consistent with the mesoscale observation in the pit and surrounding locality. Intense foliation (reflectivity up to 5 km wide) is imaged by the seismic line, and this soles out into a convex up detachment (analogous to core complex development). Geometries such as this are illustrated in the conceptual sketch of a core complex (Fig. 68).

To the east, the Keith Kilkenny Shear Zone displays a similar geometry of S-C' shear bands, consistent with a down to the east sense of shear (Fig. 71). The Pig Well Basin (Graben) appears to partly overprint (with an unconformity?) A foliation (extension?), and is dragged in a normal sense by further extensional movement along this zone. Shear bands within the basin are also extensional in geometry. Examination of map patterns along strike for the Ockerburry, Emu and Keith Kilkenny Shear Zones also show younger rocks preserved on the eastern (downthrown-hangingwall) side of the faults (Fig. 69).

What is most revealing about these seismic lines (Figs. 70, 71) is the spacing of the intensity of reflectivity (foliation development). Intense reflectivity can be correlated at the surface with high-strain zones. These appear to be zones up to 5 km wide both in surface mapping and in the seismic data. These can convincingly be regarded as extensional fabrics, with raises a very serious question about how NNW-trending foliations have been interpreted about the region in the past! This is the so-called 'S2' fabric and it has been used as the correlation foliation by most workers for their site to site correlations, and to construct event stratigraphies. As outlined earlier, the NNW-trending foliation, commonly called 'S2' can be a strike-slip, normal/extensional dip slip, axial planar flattening, and/or a combination of these in any one locality. This variation in its genesis makes it a poor marker fabric.

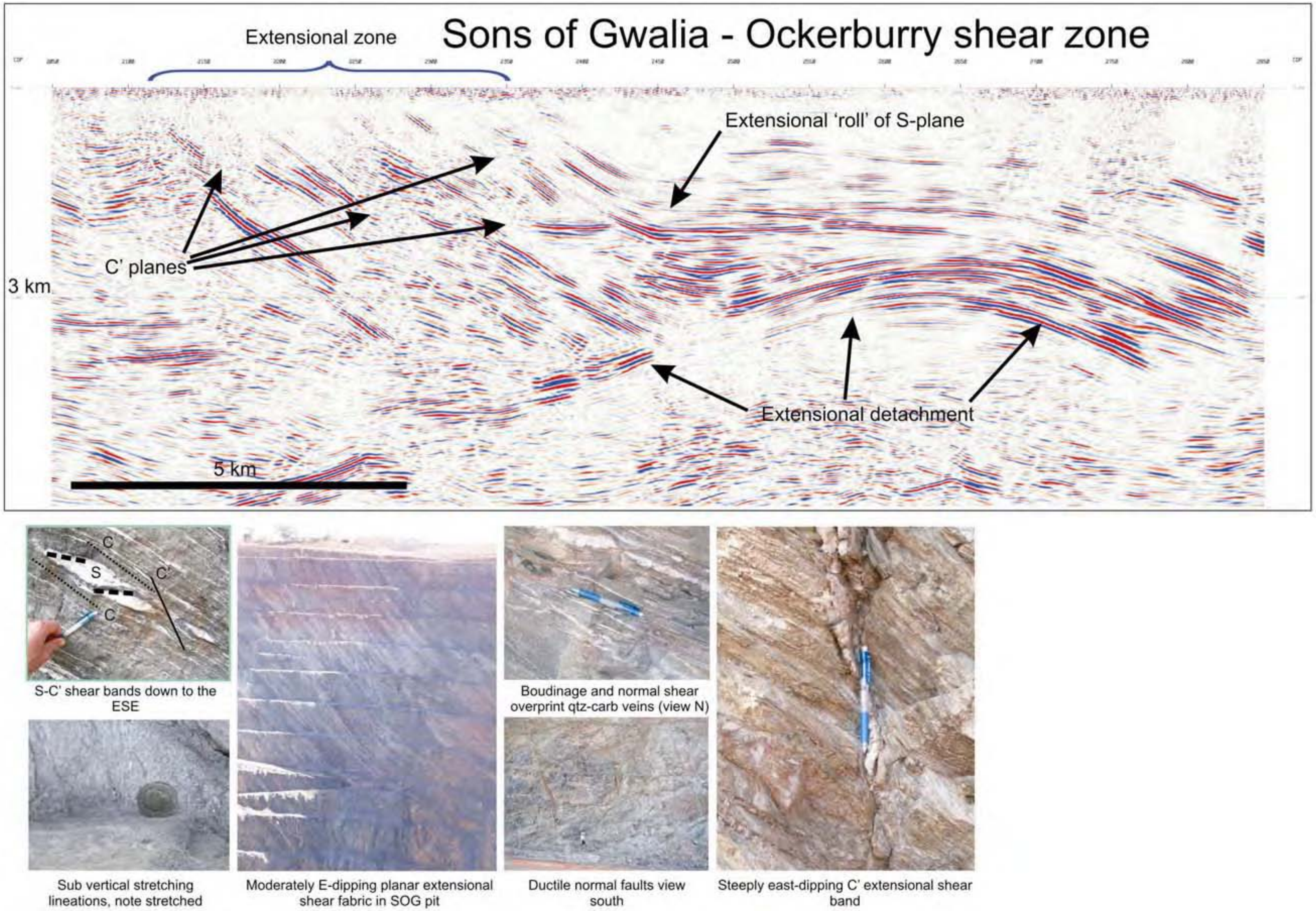



**Figure 70: E-W Seismic line through the Sons of Gwalia pit (SOG) showing a broad zone of extensional shear. Compare this image with the conceptual sketch of a core complex (Fig. 68). These features mapped in the seismic are mirrored on the meso-scale in the pit (see inserts).**

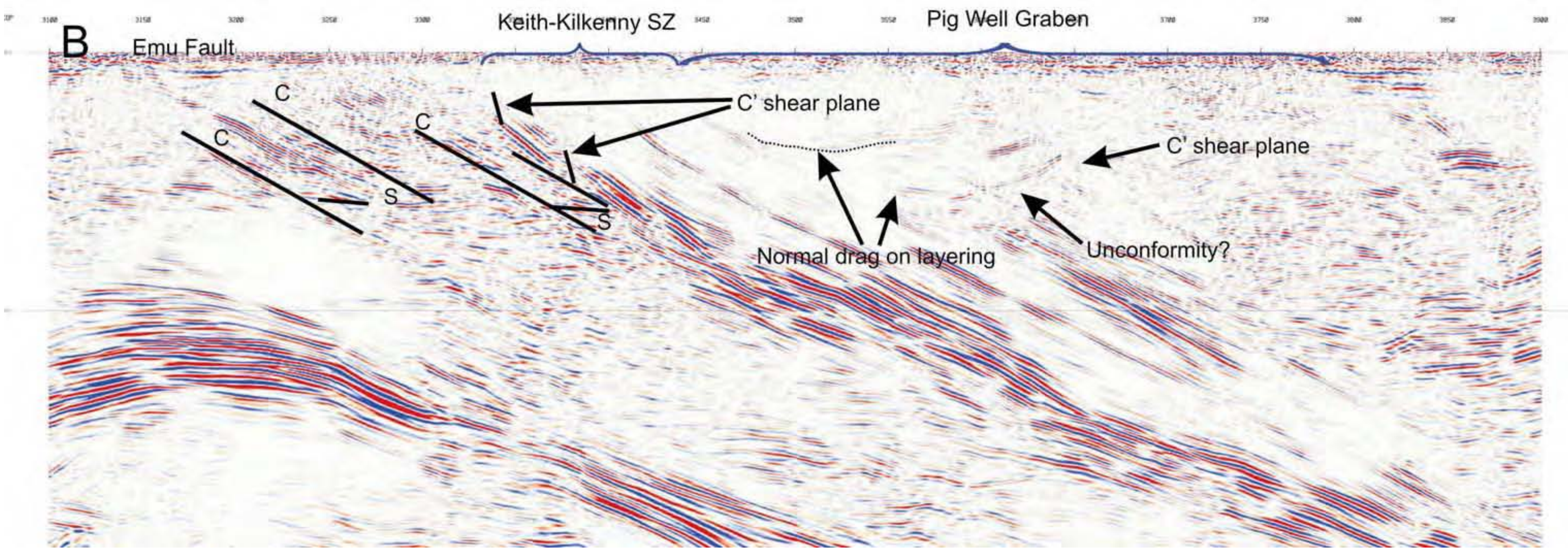



**Figure 71: E-W seismic line showing intense foliation development along a ~3 km wide zone of the Keith-Kilkenny is considered to be a result of extension. The Pig Well Basin (graben) appears to overprint (unconformity) some of the foliation and is also overprinted by a sub-parallel foliation defined by shear bands (C planes). Localised higher angle C' (prime) extensional shear bands overprint the fabrics. The layering of the basin is also dragged into a synformal geometry, consistent with extension down to the east. This suggests that the basin was both formed and deformed by the extensional D3 event.**

*Metamorphism across extensional shear zones*

Figure 68 shows that low-angle extension is an effective mechanism for juxtaposing low-grade upper-plate rocks against high-grade lower-plate rocks. Williams et al. (1989), and later in Williams and Whitaker (1993), related the juxtaposition of high-grade greenstones (immediately adjacent to the Raeside and Mt Margaret Batholiths) against low-grade greenstones across batholith-away dipping shear zones, as a function of extension. Williams and Currie (1992) noted at least 5 km of excision from this extensional event (Fig. 72). In these papers, Williams suggested that the extension was the DE event described by many workers. They may have been right, as these areas have been dominated by extension for much of their history and it is likely that this was a long-lived event.

Dr Ben Goscombe (NTGS and ex-GSWA) has compiled the existing metamorphic database and also analysed all available pelitic assemblages with a probe. His unpublished results show that the general field gradient is one of not only steadily increasing temperature towards the granites from the greenstone synforms (as Binns et al., 1976 showed), but of increasing pressure (Fig. 73). In fact, Goscombe's results show that pressure increases dramatically close the granites, confirming the extensional excision of stratigraphy inferred by Williams and Currie (1992).

In terms of the general field gradients, a question remains regarding the pressure estimates of the granites. Goscombe's work ended at the granite margins and there was uncertainty as to whether pressure dropped in the granites (i.e., the narrow high-grade greenstone margins were channel flow material from the deep crust. However, barometry on granites around the Wilbah Gneiss and Mars Bore (see Fig. 9) showed them to have been exhumed from around 8 kbars or 20-24 kms (Morrie Duggan, unpublished GA data). If these pressure estimates represent the general case for the high-grade granite-gneiss regions, then the channel flow hypothesis is invalid and so a core-complex type model is favoured (*cf.* SRK, 2000).

*Orogenic surge or episodic thrust behaviour during D2*

In general, where D2 contraction is well established, the D3 extension is essentially absent. Similarly, where D3 extension is well established, the D2 contraction appears to be absent.

However, in other sites it was possible to determine that both extension and E-W contraction were switching repeatedly, but invariably one mode would be dominant over the other. Good examples of this switching occur at Tarmoola, Mertondale and Westralia (Fig. 60). Tarmoola appears to have a contractional gold event during dominantly extensional tectonic mode. In contrast, Mertondale and Westralia have extensional switches during a dominantly contractional tectonic mode.

So it is clear that contraction and extension can occur at the same time, and these ideas were explored by Blewett et al. (2004c) in terms of formation of the Late Basins and a tectonic surge. This hypothesis is not considered viable for the formation of large-scale inversions and basin formation (see later in D4 section below). However, the understanding of the mechanics of thrusting and observations of active thrust-convergent systems today indicate that contraction is episodic (surge) and interspersed with periods of relaxation which may led to localised extension. This maybe what is recorded as shock and after-shock sequences in the resolution of structural elements in the pits via the PT-dihedra method, and is likely a key to permeability creation and destruction. The switching between a sequence of coaxial contractional deformation and extensional events may indicate that, at a larger scale, both tectonic modes were active together (*cf.* Lin, 2005).

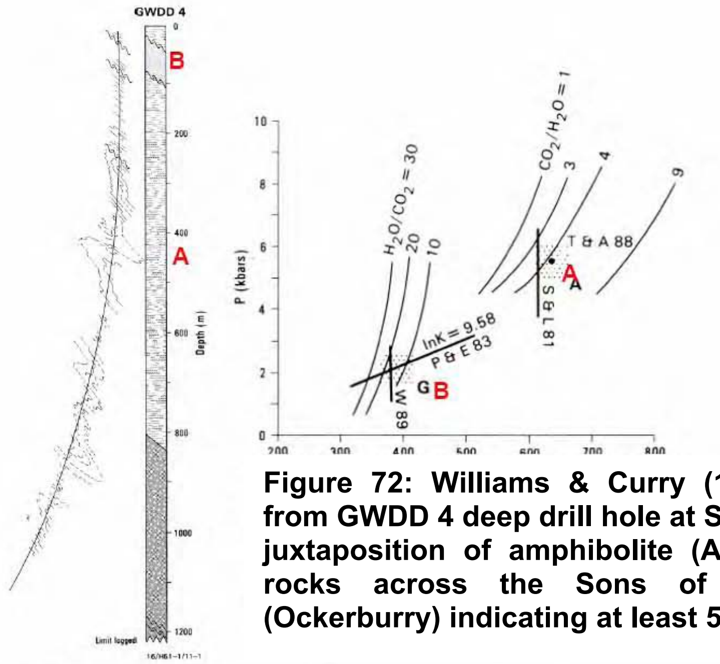



Figure 72: Williams & Curry (1992) P-T calculations from GWDD 4 deep drill hole at Sons of Gwalia showing juxtaposition of amphibolite (A) and greenschist (B) rocks across the Sons of Gwalia shear zone (Ockerburry) indicating at least 5km of excision.

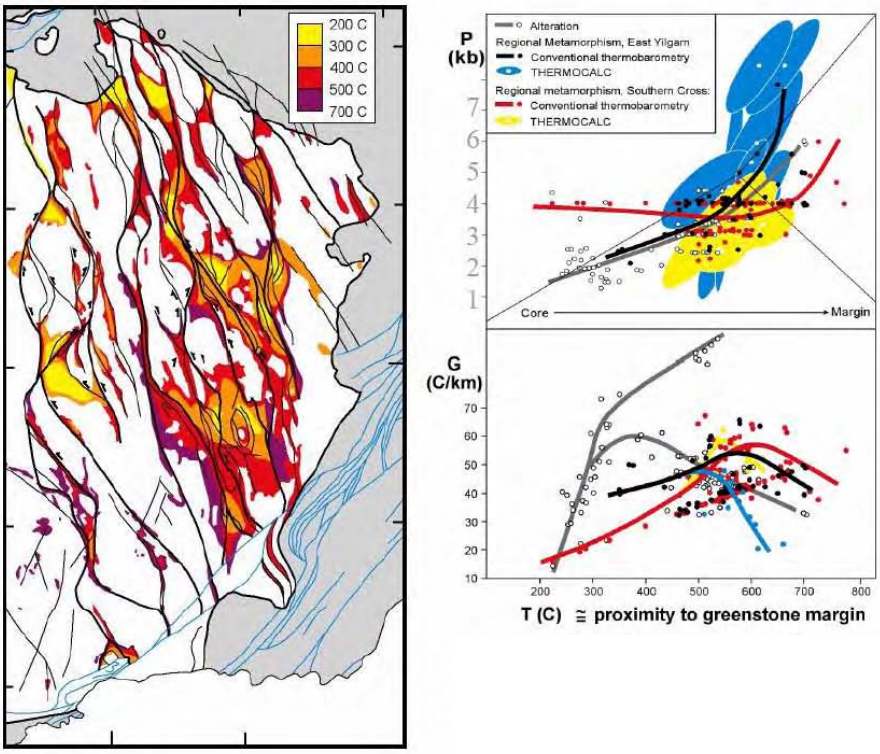



Figure 73: Unpublished metamorphic temperature map (a) and P-T diagrams (b) by Goscombe et al. (2005). NB kinematic indicators in temperature map are sourced from the literature and conflict with the observations in this study.

*Polarity of D2-D3 deformation*

As argued earlier, the long-lived D1 extensional event(s) established the NNW-oriented architecture of the Eastern Yilgarn Craton. Slab roll-back from the east may have favoured the development of an asymmetric system with a down to the ENE sense of shear. The polarity of the D2 contraction can be inferred from the numerous PT-dihedra calculations made in this study. In this study, like many before, D2 contraction was oriented ENE-WSW, and had a likely dextral transpressional couple across it. Much of the movement that was dextral strike-slip occurred along N-S trending structures.

The fundamental grain viewed in the seismic (Figs. 59, 70, 71) is down to the east (ENE), a 'rebirth' of the D1 extension(?). However, in detail the lineations plunge to the eastern hemisphere around the domes (e.g., at Lawlers Fig. 66a). It has been at Lawlers (and by Williams and Whitaker, 1993 at Leonora) that the granites rose upwards in the crust while under extension and the greenstones were shed off these rising bodies. The regional far-field ENE-directed extension from the rolling-back slab to the east was enhanced locally in the domal regions by magmatism. The fact that greenstones slide off to the north, east, and south (and all points in between), and that the granites were locally 'extruded' to the NNW, W, and SSE, imply that the orogen was not fixed at the sides. Davis and Maidens (2003) also described a late D2 extension in the Laverton area (described as D2e), and related this to collapse of the D2 orogen along its axis. In a slightly different model, SRK (2000) suggested that the polarity of extension was NNW-SSE, building on the early work of Hammond and Nesbit (1992; 1993). In these models, the NNW-trending architecture formed the transfer faults (localising Late Basins in narrow troughs in these transfers), while the main detachments were arcuate about the broad granite domes. In both cases, SRK (2000) and Davis and Maidens (2003) mapped the local effects of a larger system.

The SRK model (Fig. 68) is appealing in many ways, but does not explain the temporal relationships of the Late Basins, nor the fact that the primary architecture in a multitude of geophysical, geochronological, geochemical and geological datasets show that the fundamental compartments strike NNW (during D1 and D3). These all data point to an ENE-directed extension direction, and may reveal something about the orientation of the orogen's margin (it was likely NNW-trending in today's reference frame).

*Implications for Gold*

In terms of the spatial association of proximity of major gold deposits and Late Basins, it could be that the basins are a consequence of a process that is linked to both. This common process is extension which established deep-connected fluid pathways onto detachments at depth, and their domal focussing architecture. The fact that magmatism (a hot fluid) also favours the domes created by the extension may also point to a common process (or architecture) for magmatism and gold mineralisation. In this study gold localisation has been observed in both extensional and compressional structures. However the majority of gold deposits are localised in compressional structures indicating that compression is an important aspect in focusing fluid. The relationship of inferred and known gold mineralisation to mapped structures is presented in Appendix 3.1.1 & 3.1.10. Gold occurs in D2 through to D5 structures with the majority of the gold localised in: D2, D3 and D5 structures. Gold related to the D4 deformation appears to be confined to the Laverton region. There may be an over estimate of gold mineralisation at D2 and D5 time since at some sites it was not possible to distinguish between these events. When Au was localised in ductile shear zones it was always localised in the central high strain parts of the shear zone thereby indicating that in ductile shear zones permeability and fluid flow is a function of continued deformation.

*Summary of D2/D3*

In summary, the D2 event was contractional with a dominantly ENE-WSW polarity of convergence. The timing of the event marks the first significant contraction at < 2665 Ma. Maps of the 'intensity' and location of the D2 and D3 events (Fig. 60) are shown in more detail in Appendix 3.1.3 and Appendix 3.1.4 respectively. A CorelDraw (v.12) file, layered by event, is also available in Appendix 3.1.10. This file (pseudo-GIS) allows spatial comparison and contrast of the D2-D3 relationship (Fig. 60), and also these with other events, in the context of the geology and regional fault systems.

### *D4: low-strain ~N-S contraction*

The D4 event is a low-strain contraction oriented N-S to NW-SE that overprints the D2/D2 fabric elements. It was first described by Ellis (1939) and remained in the literature up until the early 1970's. It was recognised as broad upright folds and E-W trending foliations overprinting NNW-trending folds and foliation. This event was identified in the granite study of Blewett et al. (2004a), and it was considered significant as it reflected a late palaeostress switch and possibly related to gold mineralisation. The D4 N-S contraction was recognised across all the terranes of the Eastern Yilgarn in the granite study. The style of the deformation event is dominated by N-S to NNW-SSE trending sinistral strike-slip shear zones and both S-over-N and N-over-S thrusts. Previous workers probably identified these sinistral structures as the classical D2 (as described above), rather than a separate event (*cf.* Swager, 1997; Chen et al., 2001).

The localities with well-developed or intense D4 deformation reported here include Jasper Hill, Puzzle, Jupiter, Poison Creek, Turkey Well, Two Lids Soak, Barrett Well and Isolated Hill (Fig. 9; Appendix 3.1.1).

The event is particularly strong in Jupiter and Wallaby (John Miller pers comm., 2005). Interestingly in both these pits syenites are associated with the NW-SE oriented contractional events. At Jupiter the resolved palaeostress changes from NW-SE contraction, to uniaxial (radial) extension associated with the emplacement of the syenite, and returns to NW-SE contraction. The interpretation of Jupiter is that the syenite was emplaced into a regional contractional setting and, at the time of emplacement, the magma pressure was greater than the far-field compression across the orogen.

In the Lawlers area, Beardsmore described a deformation event with WNW-ESE $\sigma1$, post his D2 (E-W $\sigma1$). These structures were dominantly sinistral strike-slip faults. In the granites study (Blewett et al., 2004a), the D4 event is characterised by sinistral strike-slip faults (Fig. 75) and NW-SE dextral faults (Fig. 74). Most structures are low-strain, both brittle and ductile.

**Figure 74: NNW-trending dextral ductile shear zone with granite vein emplaced along the shear.**

**Figure 75: sinistral shear zones in Yarrie Monzogranite implying WNW-ESE contraction associated with gold.**

The D4 event is expressed as the most intense deformation (Fig. 77) in the 'internal' granites of the central Kurnalpi Terrane (e.g., Outcamp Bore, Yarrie and Bernie Bore). Most of the associated structures are steeply dipping sinistral shear zones. At Yarrie, D4 was the gold event (Fig. 75). NW-SE contraction is also the gold event at Jupiter and at Wallaby (John Miller pers comm. 2005). Elsewhere in the granites, dykes of pegmatite and granite (not Low-Ca type) were intruded into the active shear zones (Figs. 74, 76), demonstrating that magmatism was active despite this being a low-strain event (Appendix 3.1.10). Jupiter and Wallaby are the best examples of magmatism during this event.

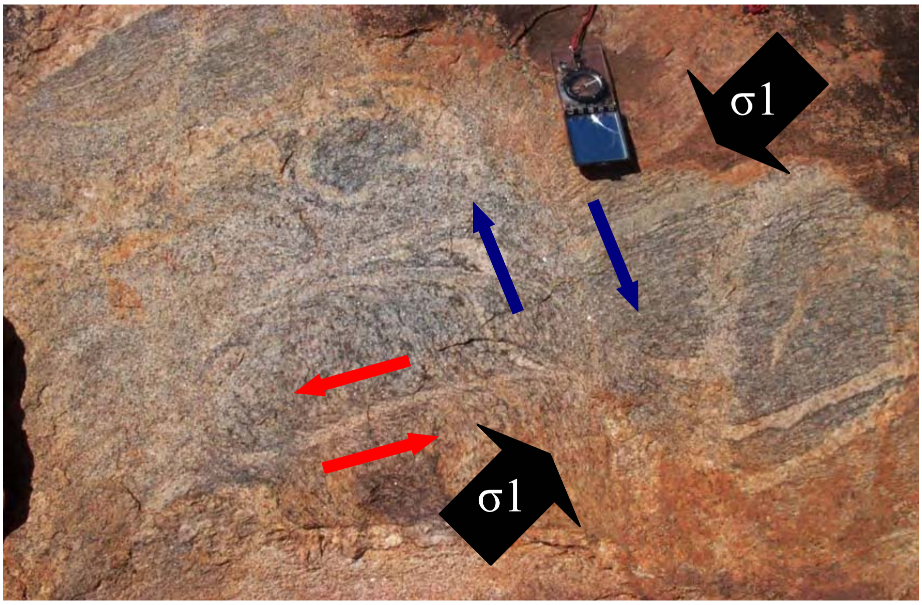



**Figure 76: View east of a Moon Rocks pavement showing ductile (N-trending) sinistral (red) D4a shear zones. These D4a shears and dykes are overprinted by D4b WNW-trending (blue) dextral shears. Maximum compression was likely NW-SE during this event.**

The D4 event is also important in that it 'separates' the D2/D3 deformation from the co-planar and co-kinematic D5 event. In some sites there appears to be only dextral transpression recorded (e.g., King of Creation) and without dating it is not possible to resolve whether the fabric elements are D2 or D5 or both (or a progression *cf.* Weinberg et al., 2003).

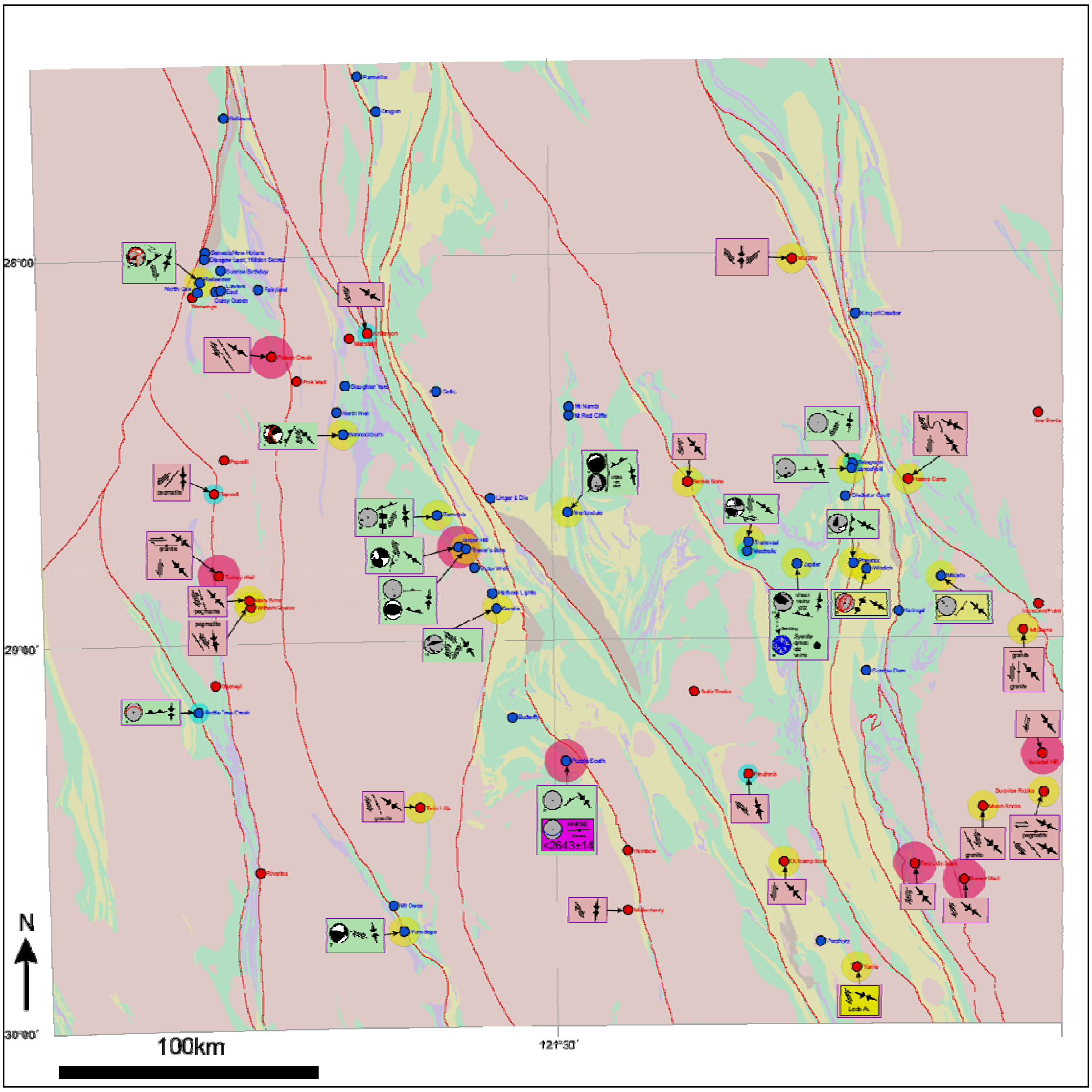



**Figure 77: Map of D4 structures and their intensity across the study area at individual locations. Note the high degree of variability in the inferred maximum compression (σ1) orientation with this event.**

**Pink - granites, Yellow – sediments and felsic volcanics, Green – mafic-ultramafics, and Brown – late basins. Intensity shown as size and colour of circles, with red (high strain), yellow (medium strain), and blue (low strain). See Appendix 3.1.10 for interactive maps.**

### *D5: dextral transpression*

The D5 event is traditionally called D3 in the Swager (1997) nomenclature, and many workers have suggested that it was a progressive event from earlier D2 (e.g., Weinberg et al., 2003 and references therein). However, this study has shown that a significant extensional event and, although low-strain, a significant ~N-S contractional event separates them. Blewett et al. (2004b) defined the D5 event as their 'D2b', with D3 as their 'D2e' events. They, like many others did not account for the intervening D4 event (thinking it was younger than D5 as described here). It is because of this intervening D4 event that the surge hypothesis is rejected (*cf.* Blewett et al., 2004c).

The main feature of the D5 deformation is the re-establishment of the NE-SW contraction, under a dextral strike-slip régime (Fig. 78). In some localities along the eastern margin of the Kurnalpi Terrane the entire history recorded appears to be dextral shear (e.g., King of Creation). It could be that the D5 event was of sufficient intensity to 'obliterate' the pre-D5 history. The fundamental grain of this D5 dextral event was oriented N-S, similar to D2.

*Characteristics of D5*

One of the features of the D5 event was the steepening of layering, reworking of S2 foliations and the tightening of F2 folds. The fact that this was largely co-planar with the previous D2 event, that D3 was related and D4 of low strain; makes it particularly difficult to unravel the structural history through its various increments.

The D5 steepening on the western margin of the Kalgoorlie Terrane resulted in the Scotty Creek Basin being rotated into a vertical attitude. This basin was deposited onto a pre-folded sequence during D2 contraction or more likely D3 extensional doming (see above). With ongoing contraction onto the vertical layering failure was accomplished by thrusting at a high angle (orthogonal) to bedding. This late-stage failure is clearly demonstrated in the New Holland and Genesis pits as brittle-ductile conjugate vein arrays that host the gold. Overall tightening of the regional Lawlers Anticline occurred during this event.

Along the eastern margin of the Kurnalpi Terrane, dextral shear predominates, especially on the Hootanui Fault System (Fig. 78). Further west from the terrane boundary, D5 is partitioned into reverse faulting, with a NE-over-SE sense of movement. This thrust reworking of the earlier D2/D3 architecture gives the impression that this late event was the creator of the architecture. The amount of thrust movement is not known, but many appear to be relatively small scale and unlikely to cause significant crustal thickening. However, some crustal thickening may have been achieved by horizontal flattening and vertical extrusion of the crust.

*D5 and the Low-Ca granite 'bloom'*

A significant feature of the D5 event is that Low-Ca granites are either:

- overprinted by D5 structures (e.g., Mars Bore);
- overprint D5 structures (e.g., Ironstone Point); or,
- are emplaced into active D5 structures (e.g., Mt Denis).

These relationships are significant in that the Low-Ca granite type marks a fundamental change in the thermal régime of crust. These are high-temperature crustal melts and were emplaced over a short period of time (<2655-2630 Ma) relative to the higher-pressure High-Ca granite type (Champion and Sheraton, 1997; Cassidy and Champion, 2003). These granite types therefore provide temporal markers and provide maximum ages for the earlier events.

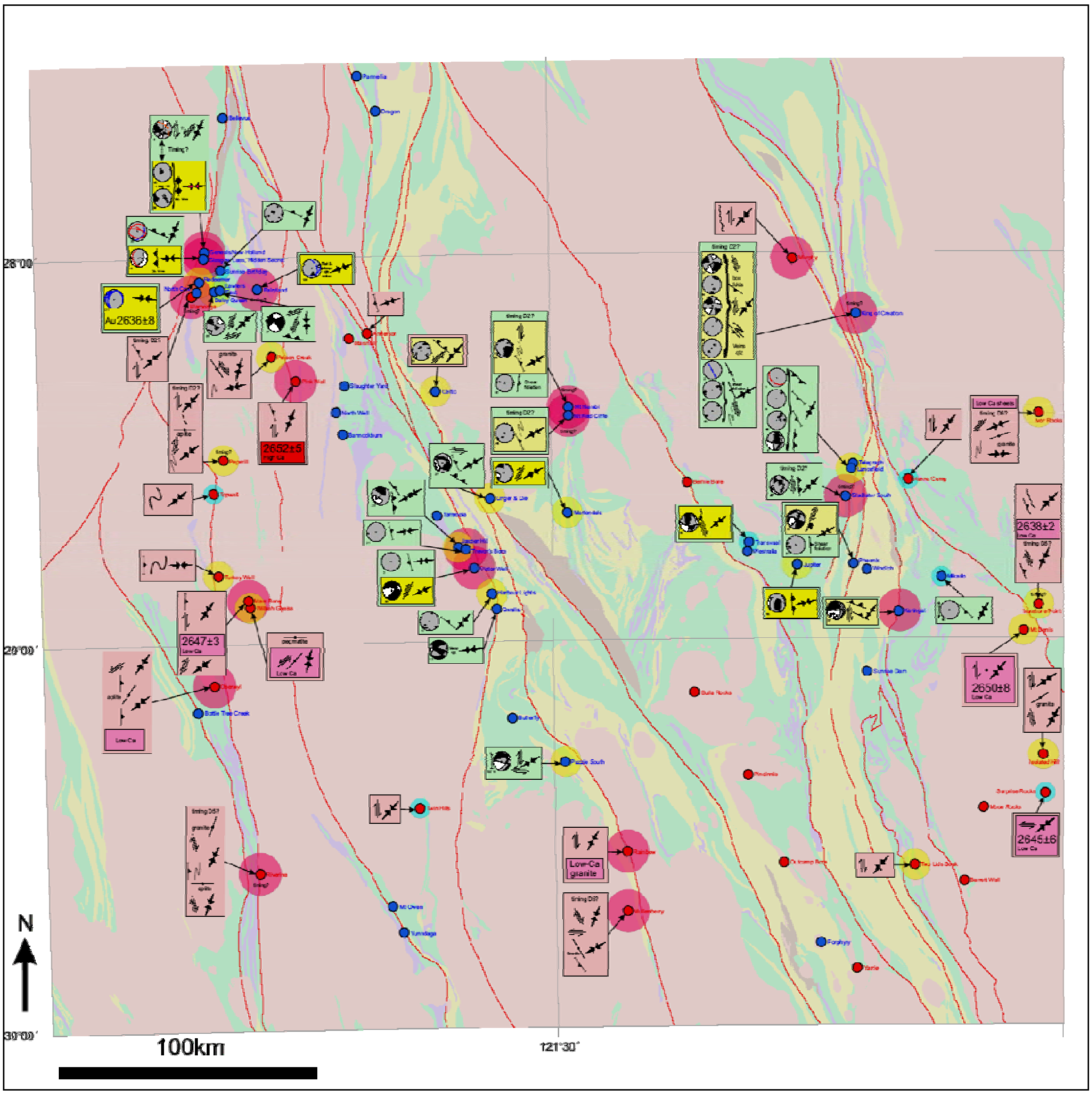



**Figure 78: Map of D5 structures and their intensity across the study area at individual locations. Compare the location, intensity and direction of inferred σ1 for D5 and D2 (*cf.* Fig. 60)**

**Pink - granites, Yellow – sediments and felsic volcanics, Green – mafic-ultramafics, and Brown – late basins. Intensity shown as size and colour of circles, with red (high strain), yellow (medium strain), and blue (low strain). See Appendix 3.1.10 for interactive maps.**

*Significance of D5 to terrane boundaries*

The event is most intensely developed on the western margin of the Kalgoorlie Terrane (Ida-Waroonga Fault System) and the eastern margin of the Kurnalpi Terrane (Hootanui Fault System). The D5 event is mostly weakly developed on the Ockerburry Fault Zone (except at Trevor's Bore and Victor Well), the terrane boundary between Kalgoorlie and Kurnalpi (see Appendix 3.1.10).

It is interesting to note that the boundaries with greatest difference across (Ida-Waroonga and Hootanui Fault Systems) recorded the greatest strain. It may indicate this D5 dextral transpressional event reorganised the Eastern Yilgarn sufficiently for differences in chemistry and age to be recorded across them.

***D6: embrittlement of a dextral system***

The D6 stage is likely a progression from the D5 dextral transpressional stage. It is separated from D5 because the style is brittle (as opposed to ductile) and the intensity and degree of reworking is minor. The D6 event is still present across the Eastern Yilgarn and there does not appear to be any diagnostic spatial significance to its distribution (Appendix 3.1.10). No gold is known from this event, it is traditionally described as D4 in the Swager (1997) framework.

At the largest scale, the consistent E-W sinistral faults offsetting the main NNW-oriented structures with 1-2 km displacements that are visible in aeromagnetic images are interpreted as D6.

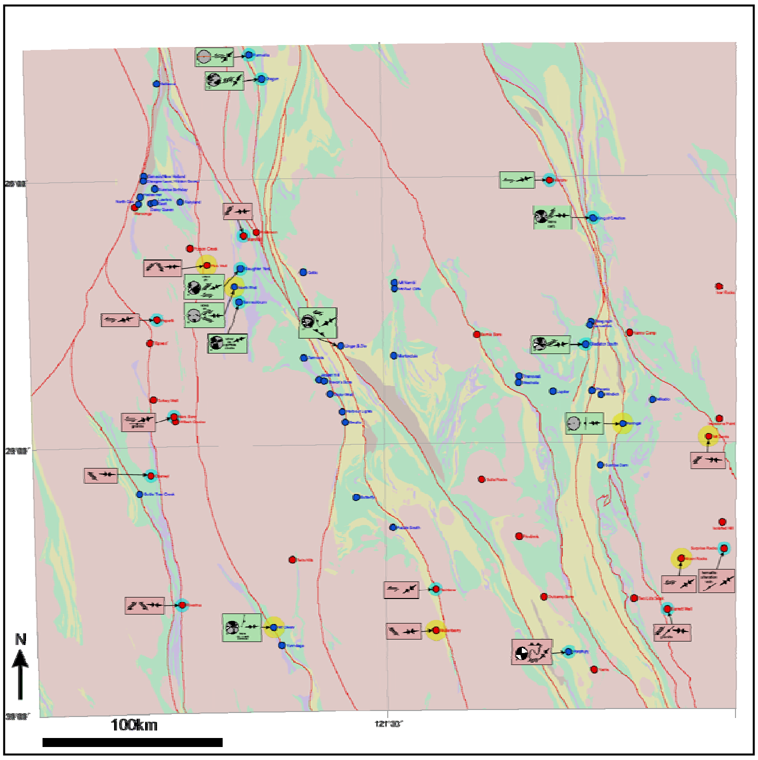
On the scale of the pits and granites sites, the D6 structures include E-over-W thrusts, open folds and strike-slip faults of varying geometry and kinematics. All these structures resolve their PT-dihedra into an ~E-W contractional régime.

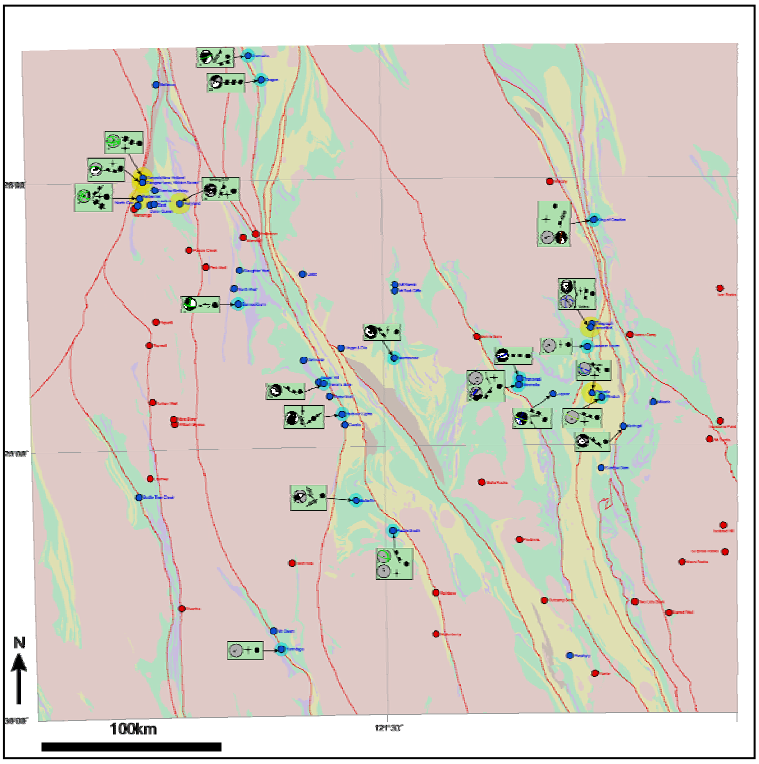
***D7: Low-strain systemic collapse***

The last event of significance is the late orogenic collapse of the system. This event has been described previously by Swager (1997), Davis and Maidens (2003) and Weinberg et al. (2003). Swager (1997) suggested that this event was responsible for the present day juxtaposition of the high-grade Youanmi Terrane against the Kalgoorlie Terrane across the Ida-Waroonga Fault System. If the Ida-Waroonga Fault System collapse is related to the D7 event described here, then a constraint of older than 2640±8 Ma is provided by the stitching pluton of this deformation (i.e., Clarke Well Monzogranite – age from Nelson, 1997).

The D7 event occurs across the Eastern Yilgarn and is represented by the development of crenulations, with sub-horizontal axial planes at a range of amplitudes from millimetres to metres. The fold hinges plunge variably. The structural style is brittle to locally brittle-ductile normal faulting (Fig. 79).

The D7 event is most intensely developed (Appendix 3.1.10) on the western margin of the Kalgoorlie Terrane (Ida-Waroonga Fault System) and the eastern margin of the Kurnalpi Terrane (Hootanui Fault System) (Fig.79). The spatial co-incidence in intensity of D5 flattening and transpression and subsequent collapse in D7 may be significant and reflect re-adjustment of the crust to the previously partitioned D5 event.




**Pink - granites, Yellow – sediments and felsic volcanics, Green – mafic-ultramafics, and Brown – late basins. Intensity shown as size and colour of circles, with red (high strain), yellow (medium strain), and blue (low strain). See Appendix 3.1.10 for interactive maps.**

**Figure 79: Map of D6 (upper) and D7 (lower) structures and their intensity across the study area at individual locations. These are both very low strain events.**

### Timing constraints of deformation

The best dataset available for constraining the ages of the deformation stratigraphy is in the granites (Blewett et al., 2004a). This work was based on the geochronological framework established by many workers, but in particular Nelson (1996, 1997), Fletcher et al., (2001), Cassidy et al. (2002), Dunphy et al. (2004), and Black (unpublished GA data).

The Eastern Yilgarn Craton was deformed by a series of what appears to be long–lived extensional stages associated with granite emplacement, interspersed with short–lived contractional stages. A graphical representation of the timing constraints on deformation is presented in Figures 80 and 81. A comparison to the deformation framework of Swager (1997) is presented in Figure 80 (see also the Forward section in this report). The classical 'D1' N–S contractional event of Swager (1997) appears absent. In this study, D1 is interpreted as a long-lived extensional event with time recorded in the rock record itself. A question remains whether the extension was episodic or continuous.

The Kambalda Komatiite is dated around 2705 Ma (Nelson, 1997), and the Upper Basalt is younger than the Kapai Slate which is dated around 2692±4 Ma (Claoue-Long, et al., 1989). The Kalgoorlie Sequence (Black Flag Formation) has age ranges from 2690 to 2665 Ma (Krapěz et al., 2000). The Kalgoorlie Sequence has a number of unconformities, with one at around 2675 Ma (Fig. 56). At the same time in the 'external' granites, a major melting and exhumation event occurred. The age of the gneissic fabrics are in the range of: 2672±2 (Two Lids Soak); 2675±2 (Barrett Well); 2670±10 (Ivor Rocks); 2681±4 Ma (Isolated Hill), and 2674±3 Ma (Wilbah). Such consistent data, across regionally separate sites (similar ages are reported from Duketon: Dave Champion pers comm. 2005), indicate a maximum age for metamorphism and D1 extension of around 2672 Ma.

The first contractional event is D2, which has a maximum age range constrained by the dates of deformed granites and a minimum age range from cross-cutting granites. In this study the available ages are found in the Burtville and Kurnalpi Terranes. In the Burtville Terrane D2 occurred in the range <2668±4 Ma (Ironstone Point) and inferred to be >2664±2 (Hanns Camp Syenite) based on a relative timing correlation (see appendix 3.1.1). In the Kurnalpi Terrane D2 occurred at <2667±4 Ma (Pindinnis), <2665±4 Ma (Granny Smith Granodiorite), <2667±5 Ma (Porphyry), <2657±8 Ma (Porphyry), and is inferred to be >2660±5 Ma (Bulla Rocks) based on a relative timing correlation (see appendix 3.1.1).

The D3 event is a strong extensional event associated with the development of Late Basins and the emplacement of the Syenite type granites. This D3 extensional event occurred between a major switch in palaeostress from D2 ENE–WSW contraction to D4 NNW–SSE contraction. The Syenite and Mafic granite types are generally regarded as reflecting regional extension, as these rock have 'seen' the mantle (Champion and Sheraton, 1997). A maximum age for D3 can be inferred from the overprint of extensional fabric on granites such as the 2664±2 Ma Hanns Camp Syenite and 2660±5 Ma Bulla Rocks Monzogranite. If the mineralisation at Sunrise Dam is related to the D3 extension then the overlap in Au mineralisation ages at Sunrise can be used to constrain the timing of D3 to 2658±4. This age is consistent with the maximum deposition age of the Scotty Creek late basin of 2662±5 Ma.

The D4 NNW–SSE contractional stage occurred prior to any Low-Ca granite type magmatism which is present across all terranes (and the Yilgarn Craton as a whole).

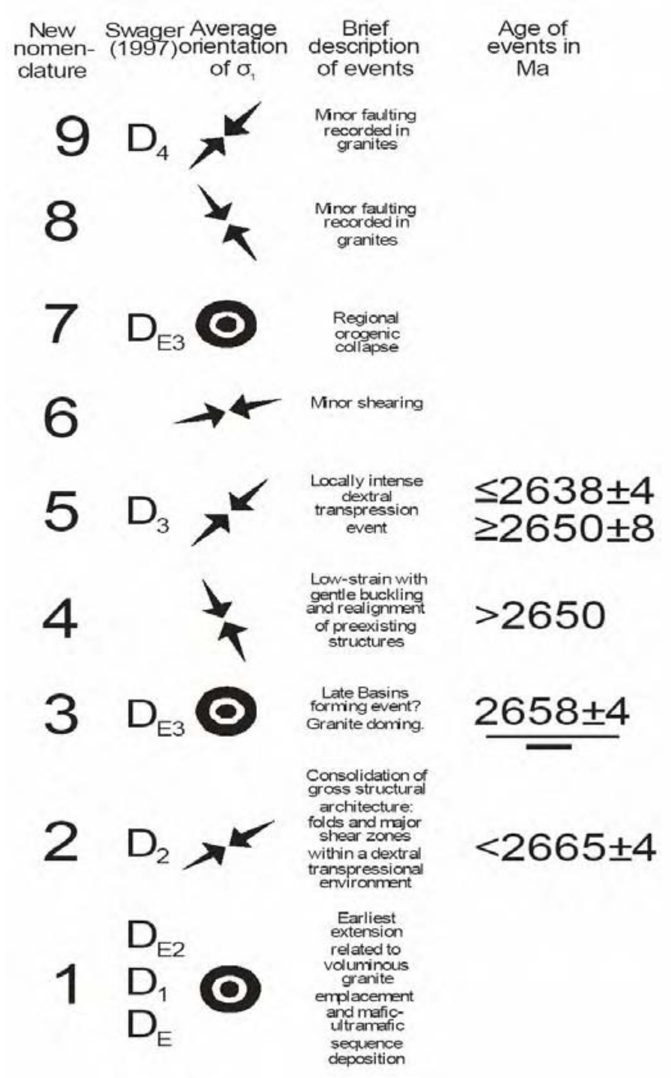



**Figure 80. A synthesis of the timing and deformation history presented here in as compared to Swager (1997).**

The Low-Ca granite type granites were emplaced following a switch in palaeostress back to NE–SW contraction (D5). These granites provide a maximum age for D5 as <2652±5 Ma (Pink Well), <2650±8 Ma (Mount Denis), and <2645±6 Ma (Surprise Rocks). At Mars Bore a dyke of Low-Ca type granite with an age of 2647±3 Ma overprints D5 dextral shear zones and is overprinted by D5 dextral shear zones. A minimum age for D5 is obtained from Low–Ca granite type dykes that overprint D5 fabric elements of 2638±2 (Ironstone Point).

SHRIMP dates of the youngest phases of the Low–Ca granite types of the Burtville Terrane provide temporal constraints on the D7 extensional collapse, which occurred between contractional D6 and D8. At Ironstone Point, 2638±2 Ma Low–Ca granite dykes are overprinted by D6 ENE–WSW contraction. At Moon Rocks, 2637±7 Ma Low–Ca granite dykes are syndeformational and were emplaced into dextral faults during the D8 NW–SE contraction. Despite both the Moon Rocks and Ironstone Point ages being within error, and considering the larger errors bars at Moon Rocks, it is suggested that the D7 extensional collapse occurred at about 2635 Ma. The regional orogenic collapse event on the Ida Fault System described by Swager (1997) has a minimum age of 2640 ±8 Ma (Clarke Well Monzogranite: not in this study area), and is consistent with this estimate.

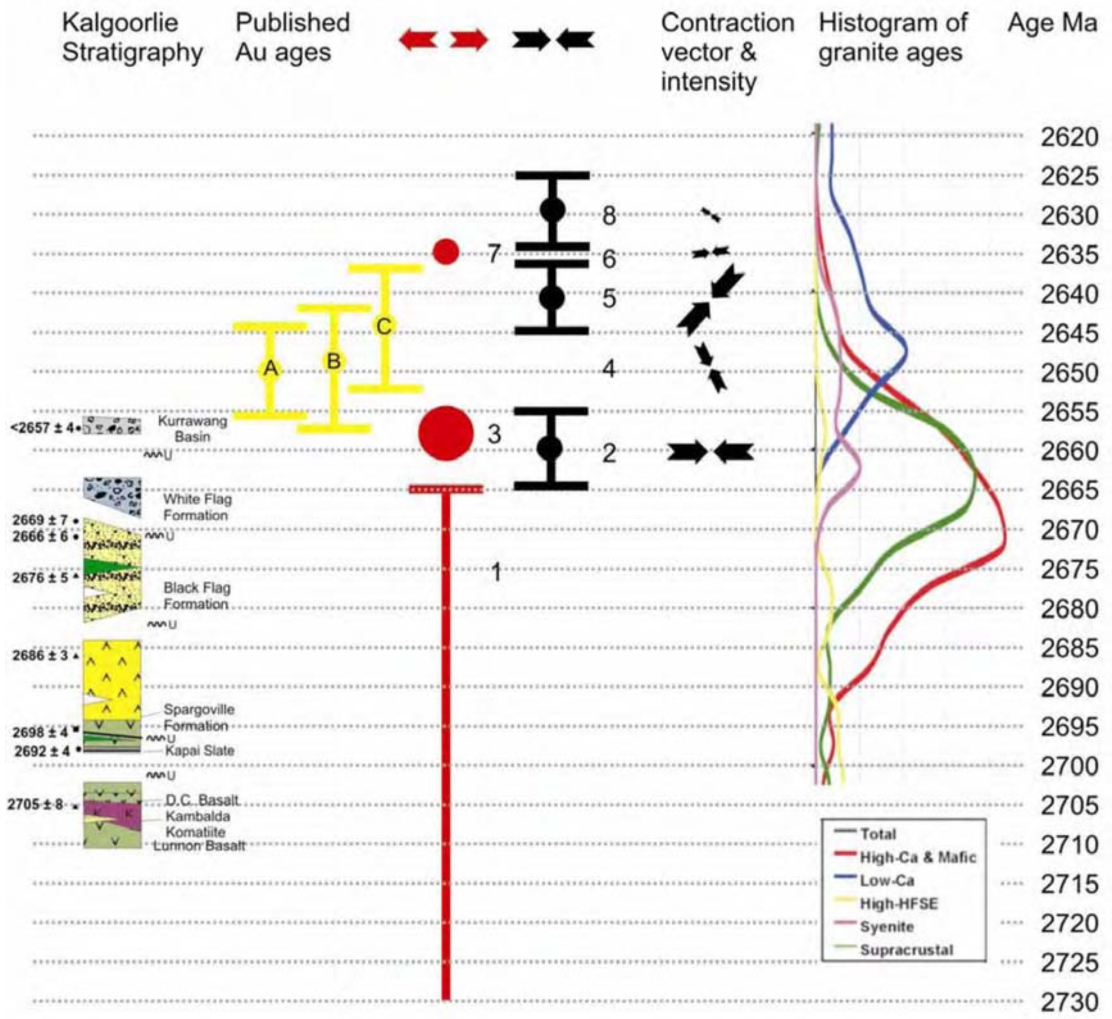



**Figure 81: Time event intensity history chart for the Eastern Yilgarn Craton. The chart compares granite ages (from Cassidy and Champion, 2002) and the Kalgoorlie stratigraphy (from Krapěz et al., 2000). Note the peak High-Ca type granite age of ~2673 Ma and the unconformity at the top of the Black Flag Formation followed by the onset of coarse clastic sedimentation (White Flag Formation). Vectors of contraction and stylised intensity are shown in black arrows. Error bars for the ages of the contractional events are shown (see text for details). Extensional events are dominantly ENE-directed, with local perturbations around individual domes. Published direct-dating of gold deposits (A-Wallaby: Salier et al., 2004; B-Sunrise Dam: Brown et al., 2002; C- Chalice: Bucci et al., 2004) are around 2650 Ma. All occur within error at the switch from High-Ca type to Low-Ca type granites and during a switch in contractional palaeostress from dominantly E-W (NE-SW) to NNW-SSE vectors (during D4).**

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