Mineralized Terranes

Eastern Goldfields Superterrane (EGST)

Targeting Criteria

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Key Parameter → Mineral System → Exploration

is reflected in

scale-dependent translation

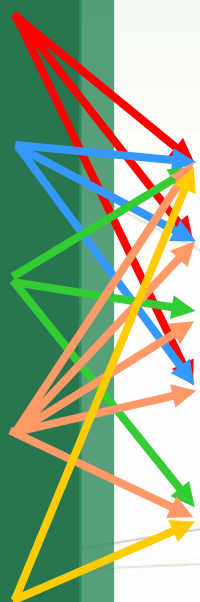
A. Gradient in hydraulic potential

B. Permeability

C. Solubility sensitivity to P, T, C

D. Spatial gradient of P, T, C

E. Time (duration)



5 Questions

1. Geodynamics
2. Architecture
3. Fluid reservoirs
4. Flow drivers & pathways
5. Deposition

Terrain Selection

Area Selection

Drill Targeting

Slide after: A. Barnicoat

Targeting across the scales

- **SCALE 1: REGIONAL ANALYSIS–How to recognise a gold (metal) bearing province (1000 km x1000 km area selection)**
- **SCALE 2: DISTRICT ANALYSIS–How to identify the location of major mineral camps (60 km x 60 km area selection)**
- **SCALE 3: PROSPECT ANALYSIS–How to identify the location of a specific ore deposit (5 km x 5 km area selection)**
- **SCALE 4: ORE SYSTEM DEFINITION (1 km x 1 km area selection)**

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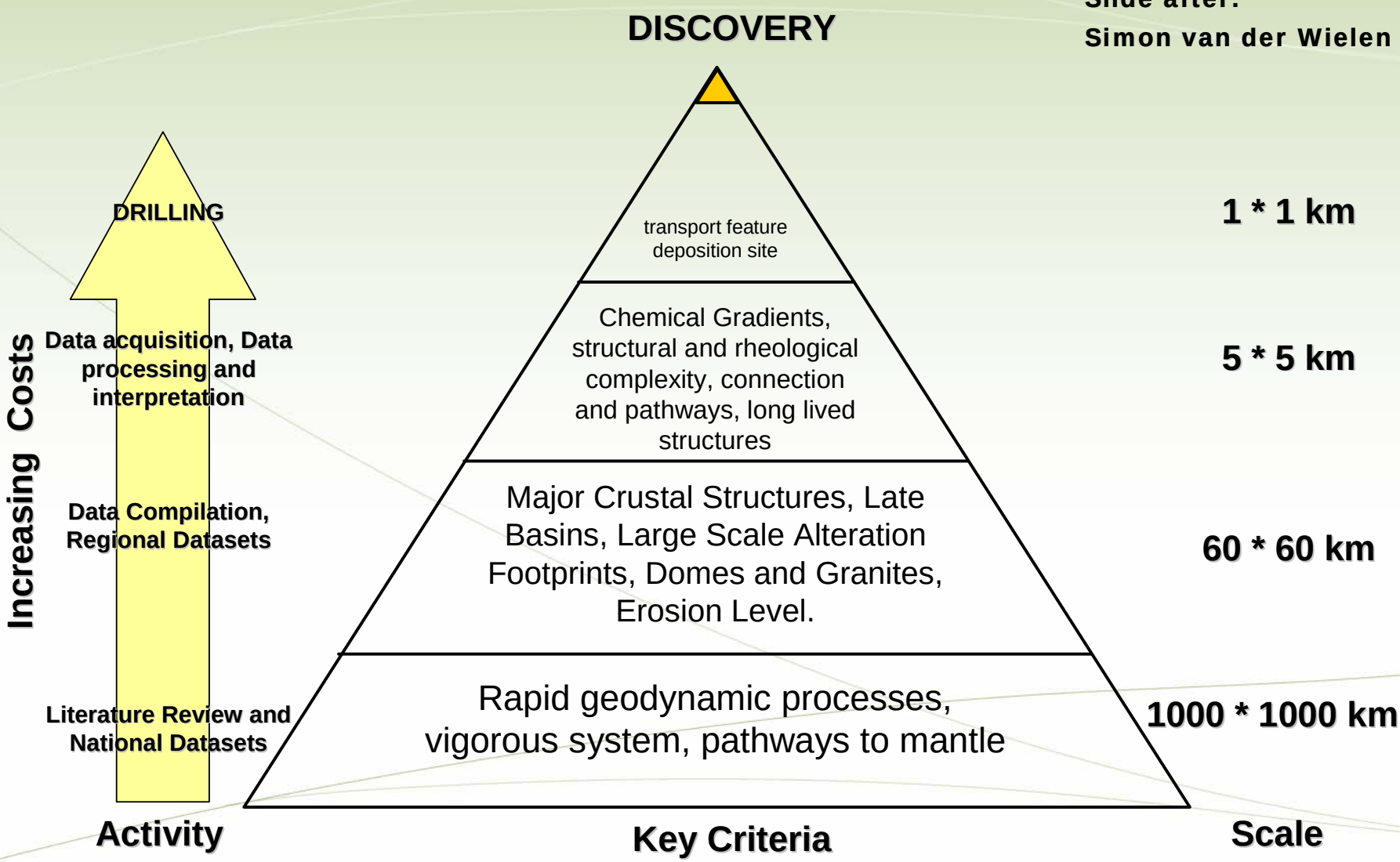
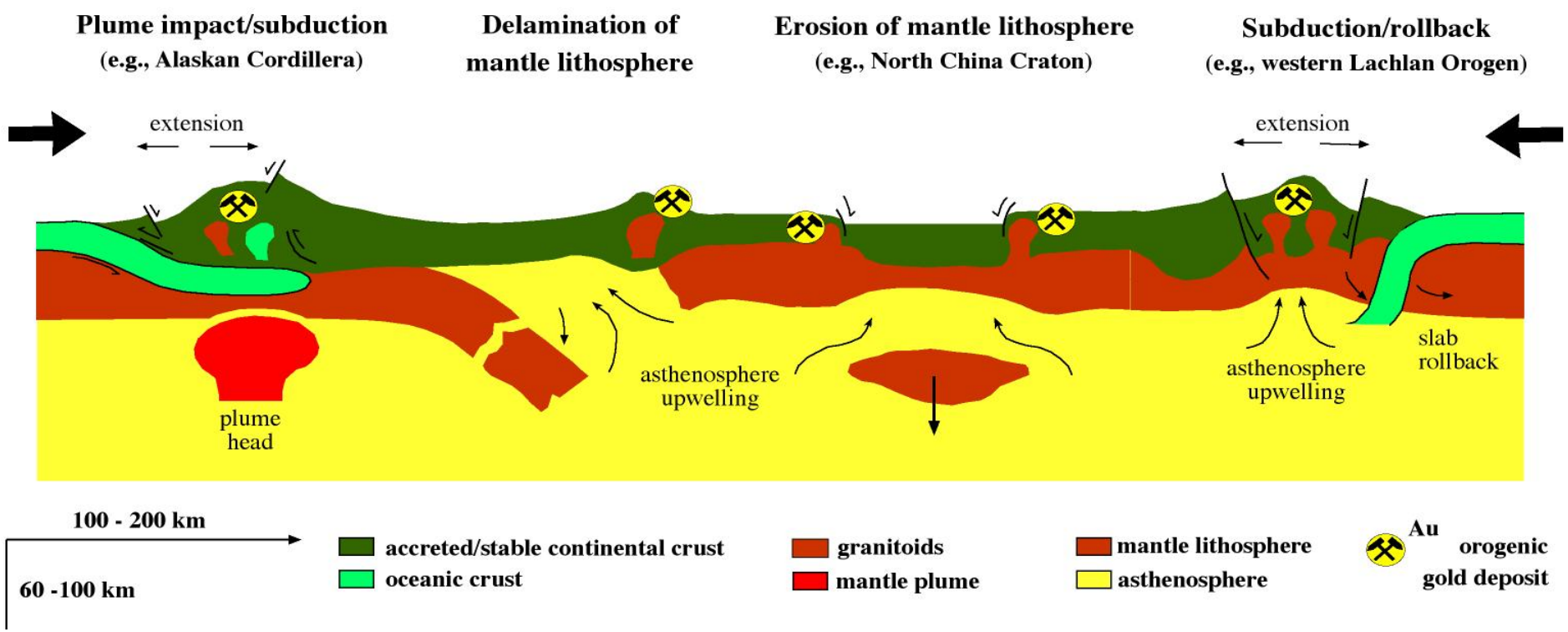
Slide after:
Simon van der Wielen



1000 km x 1000 km

Orogenic Au formation relates to lithosphere-scale processes



Bierlein et al. (2006)

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1000 km x 1000 km

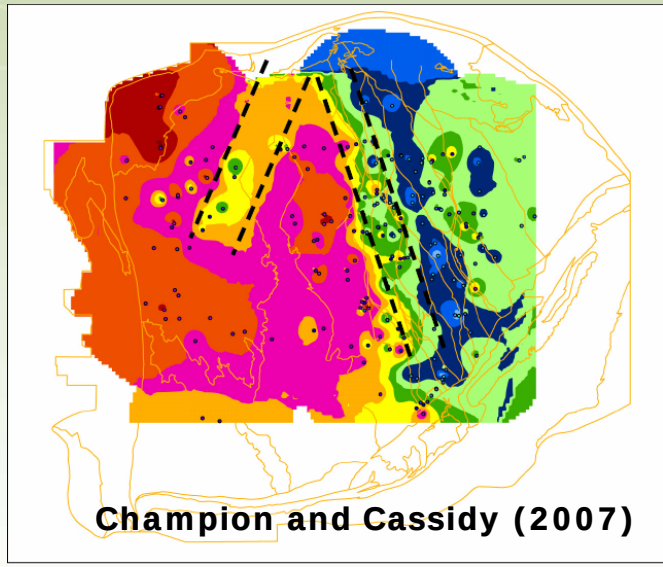
Process: Mantle metasomatism or rejuvenation

Proxies for the Process:

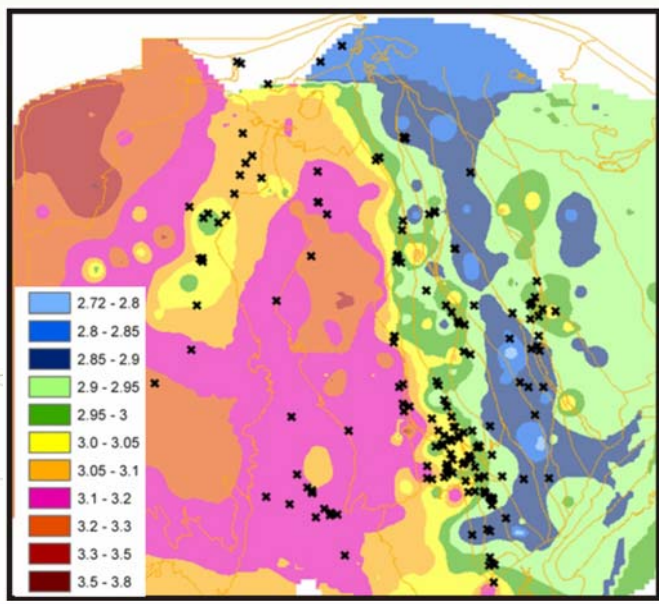
- **thinned lithosphere**
- **relatively juvenile crustal age TDM**
- **Subduction and/or mantle plumes**
- **'greenstone' sequences (komatiites)**
- **mantle magmas incl. sanukitoids**

Intermediate aged crust (2.9-3.0 Ga)hosts most of the major deposits
Two suggested target areas are shown as white boxes.

Blewett et al 2008



Champion and Cassidy (2007)



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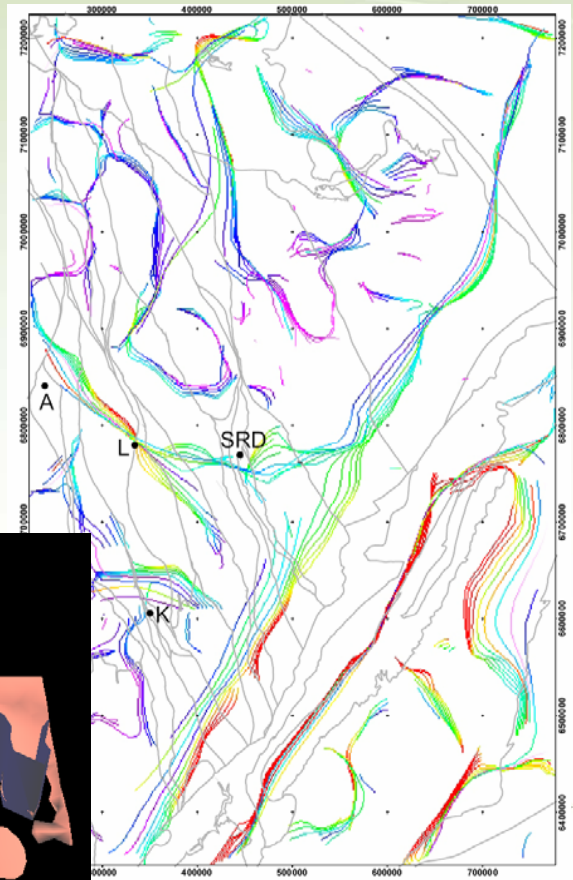
1000 km x 1000 km

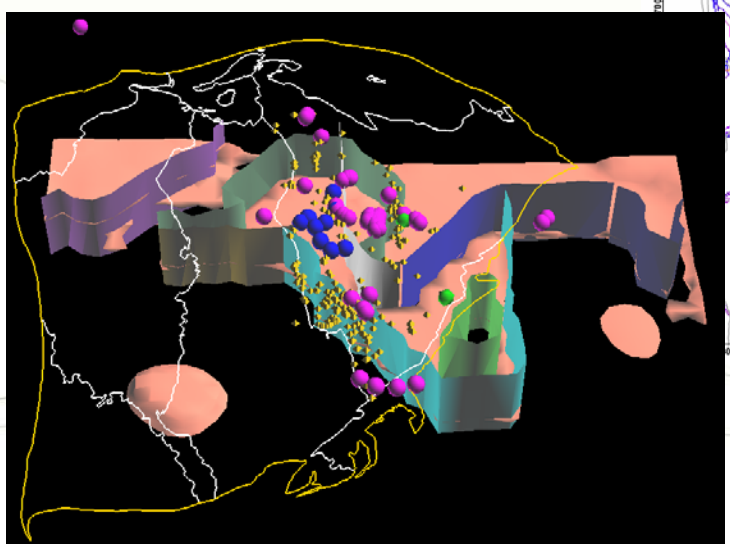
Process: Pathways to mantle

Proxies for the Process:

- **alkalic intrusions incl. syenites, kimberlites, lamprophyres, carbonatites etc.**
- **sutures**
- **mantle edges**
- **crustal cracks**
- **big worms**
- **mafic dykes**

(even young ones)



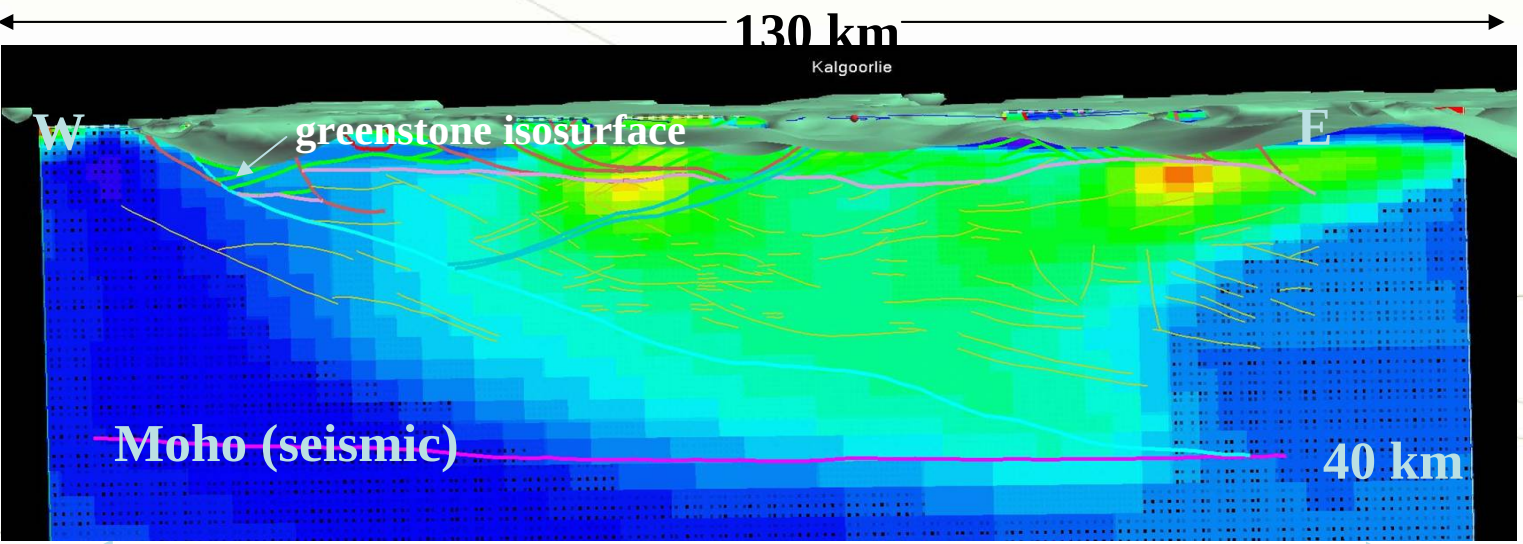


1000 km x 1000 km

Process: Large-scale heating / melting / fluid systems

Proxies for the Process

- large volume crustal melts (Low-Ca or A-type granites)
- metamorphic aureoles
- electrically conductive crustal anomalies

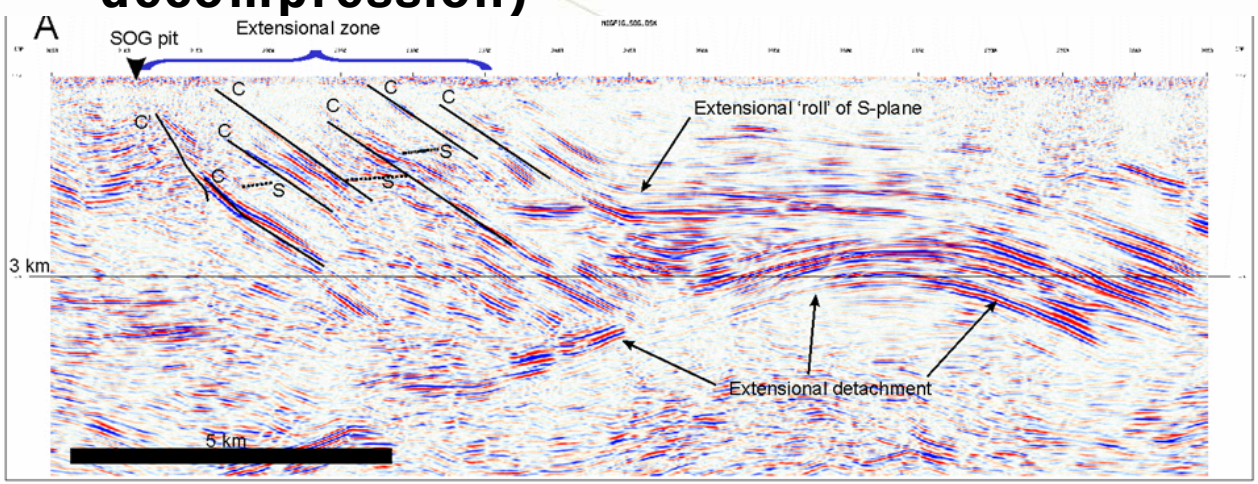


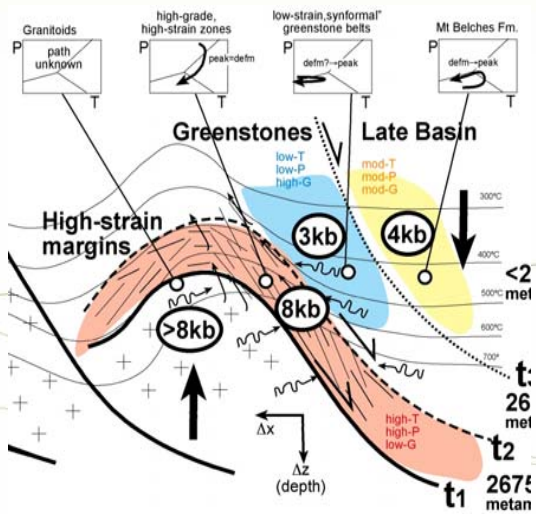
1000 km x 1000 km

Process: Vigorous tectonic system

Proxies for the Process

- **core complexes**
- **late-stage siliciclastic basins with granite (deep rock) detritus**
- **fluviatile systems**
- **compressed event history incl. relevant PT*t* paths (isothermal decompression)**





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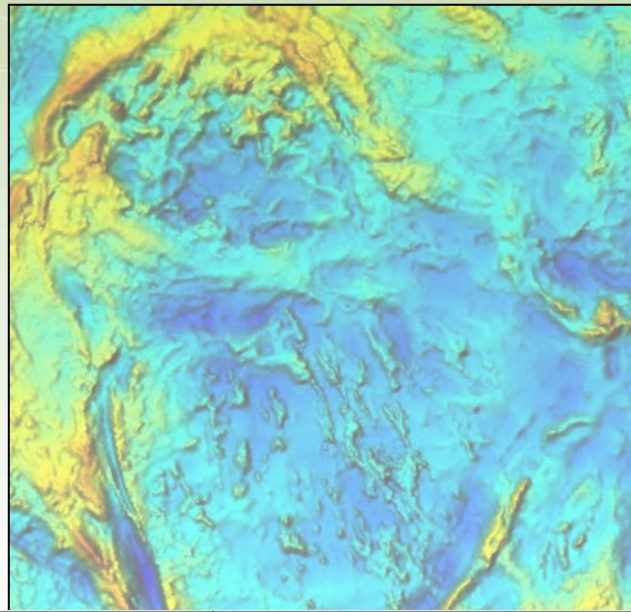
1000 km x 1000 km

Process: Vigorous tectonic system

Proxies for the Process:

- **elongate orogenic belts**
- **subduction-accretion**
- **tectonic mode switching**
- **changing subduction, slab dip or delamination**



Blewett & Czarnota 2007			Swager 1997	Blewett *et al.* 2004b	Miller 2006
Minor contraction		D7			
Minor extension		D6	Collapse	Late De	
Dextral transtension		D5	D4	(D3 D3)	D4
Sinistral transpression		D4b	D3		D3
		D4a	D2	D2b	D2
Extensional doming	Stage 2 Late Basins	D3b	DE	D2e	
	Stage 1 Late Basins	D3a			
Upright folding and reverse faulting		D2	D2	D2a	D1
Extension with intermittent compression		D1	DE	De, D1, D1e	

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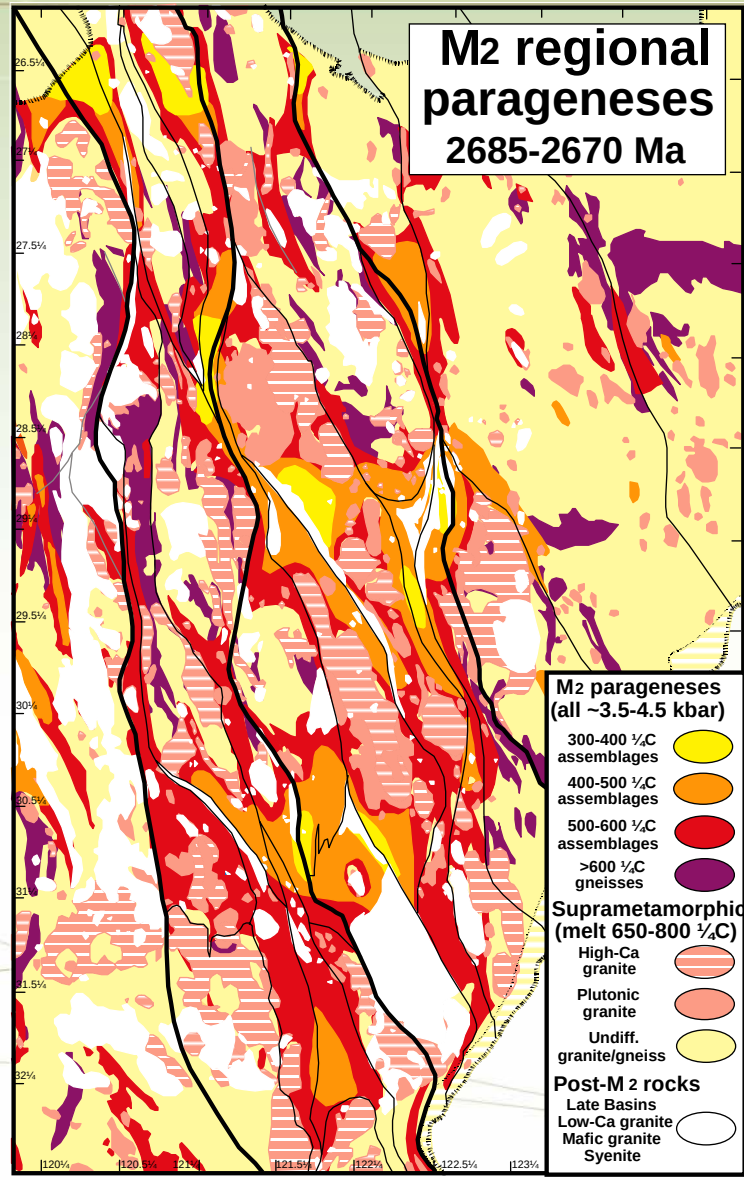
1000 km x 1000 km

Process: Cratonisation and preservation

Proxies for the Process:

- **erosion level with widespread greenschist grade metamorphic rocks preserved**



Goscombe et al 2007

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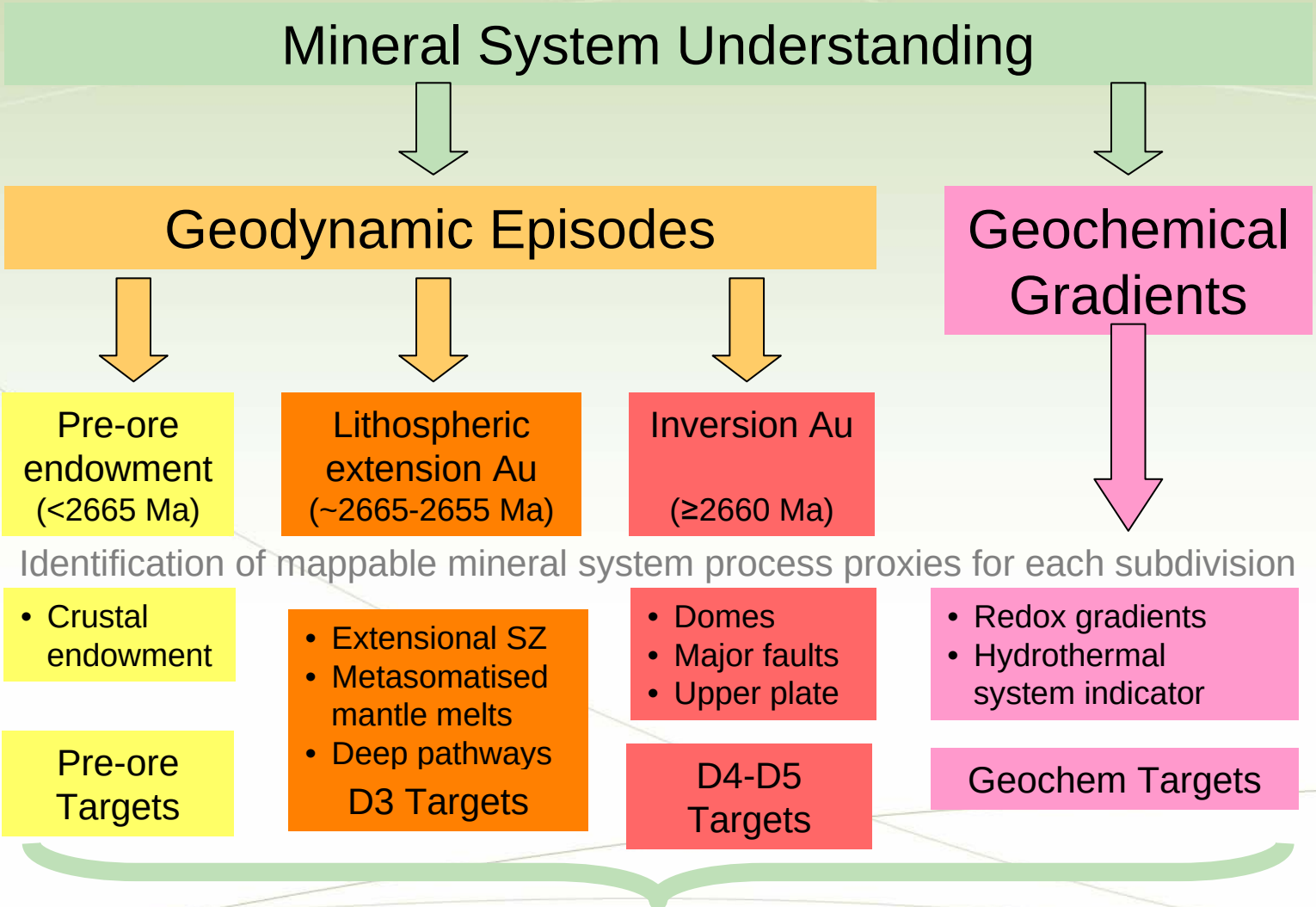

From Czarnota

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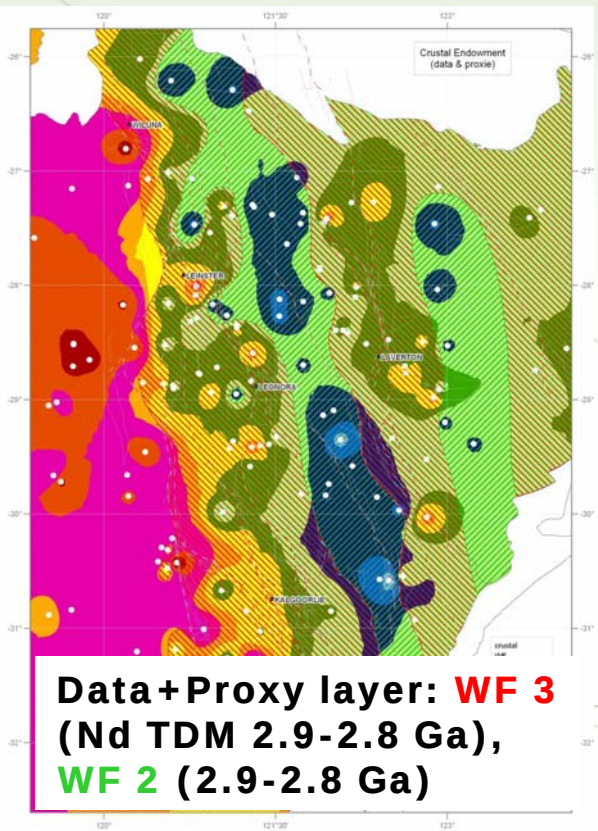
Slide after: K. Czarnota

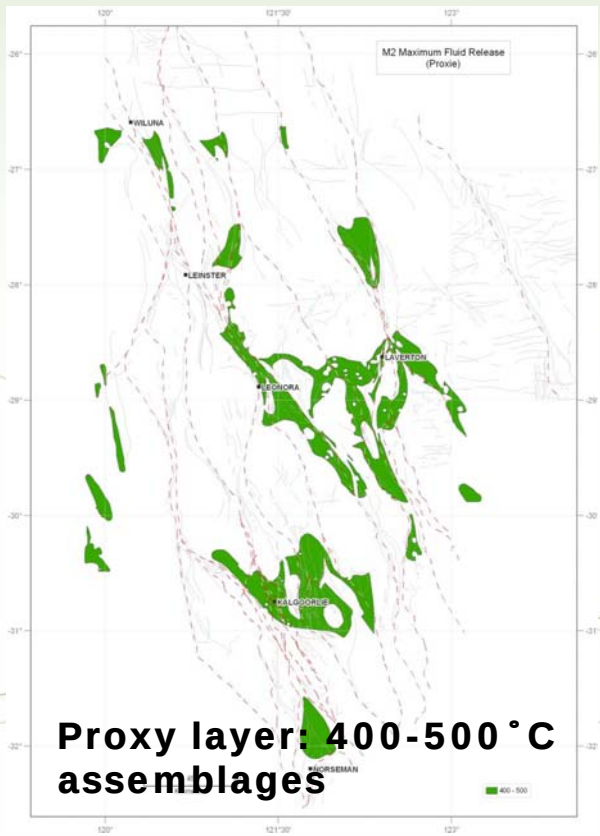
60 km x 60 km

Pre-ore Au prospectivity:

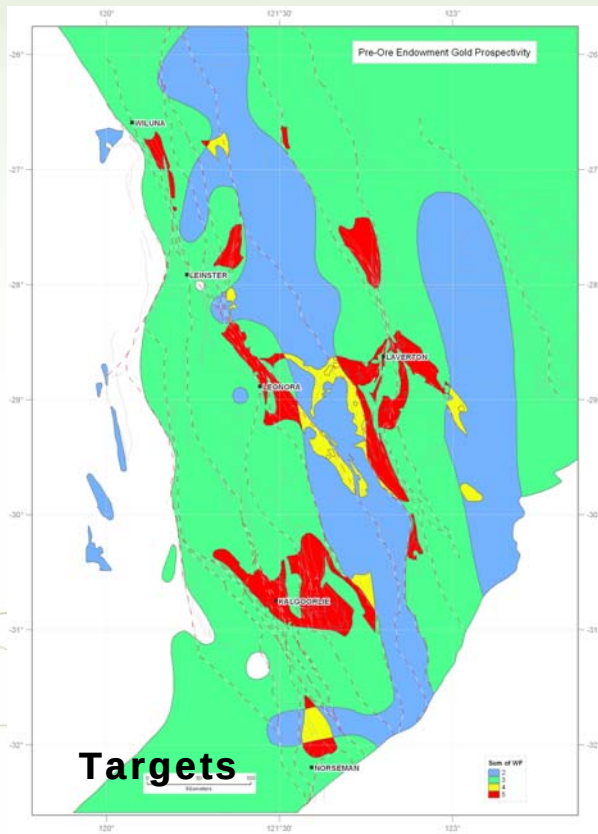
Crustal endowment and M2 maximum fluid release



Data+Proxy layer: WF 3 (Nd TDM 2.9-2.8 Ga), WF 2 (2.9-2.8 Ga)



Proxy layer: 400-500˚C assemblages



Targets

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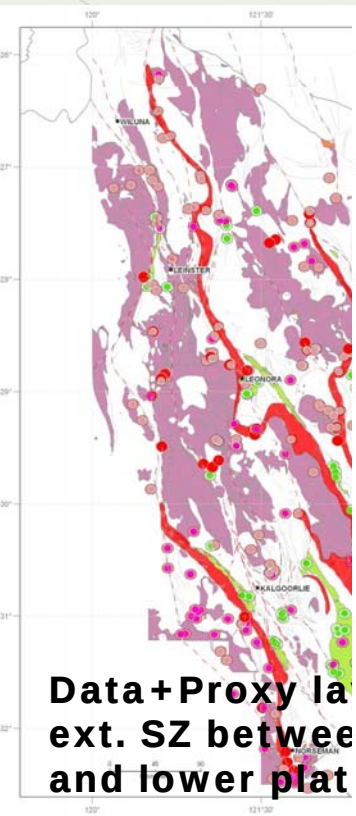
Slide after: K. Czarnota

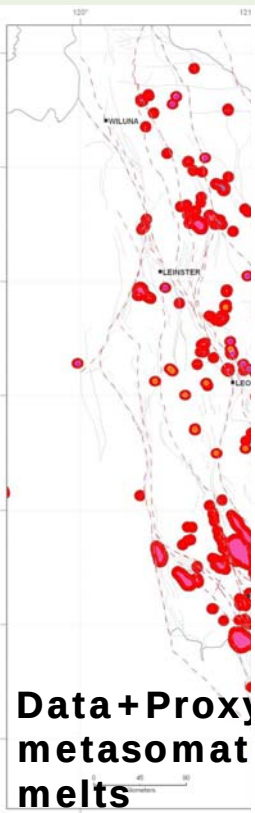
60 km x 60 km

Lithospheric extension:

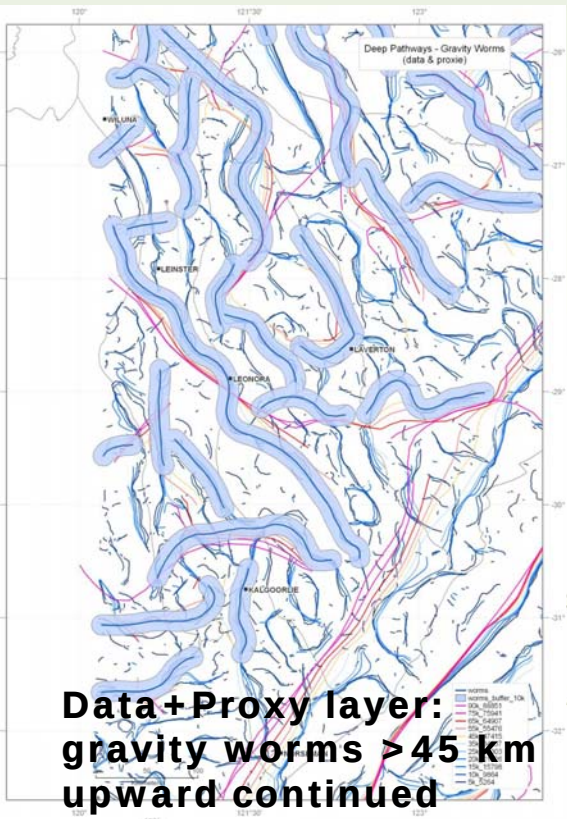
Extensional SZ, Metasomatised mantle melts, Deep pathways



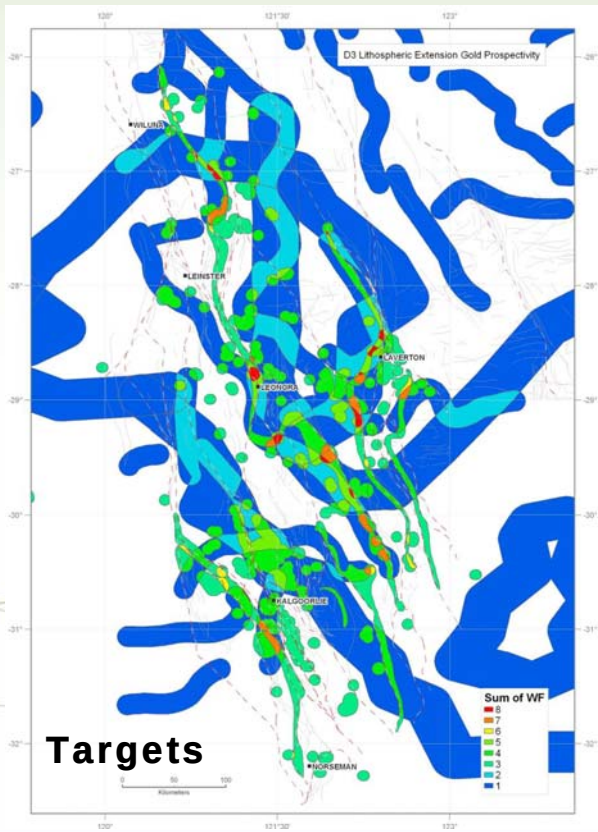
Data+Proxy la
ext. SZ betwee
and lower plat



Data+Proxy
metasomat
melts



Data+Proxy layer:
gravity worms >45 km
upward continued

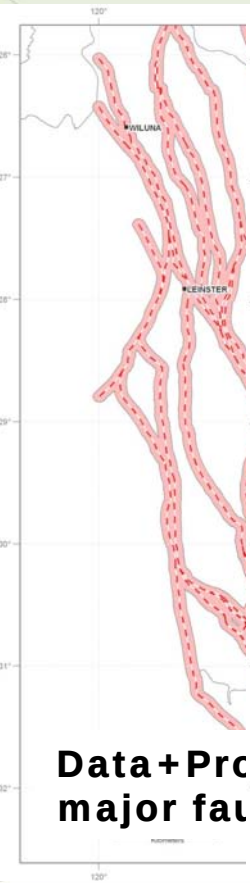


Targets

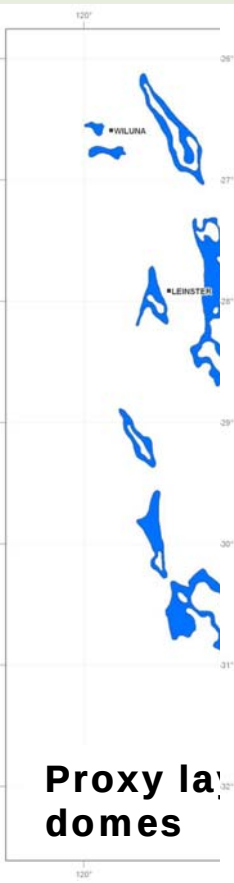
Slide after: K. Czarnota

60 km x 60 km

Inversion Au: Domes, Major faults, Upper plate

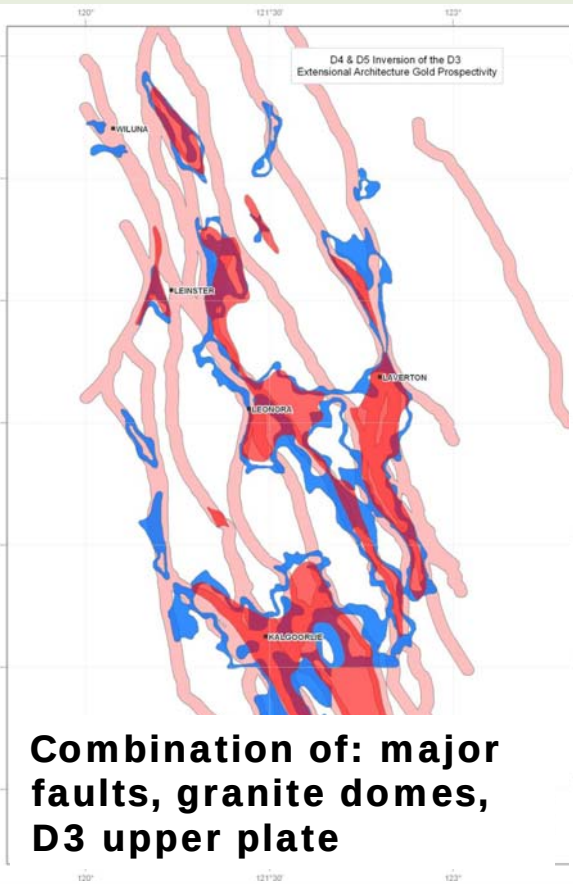


Data+Prc
major fau

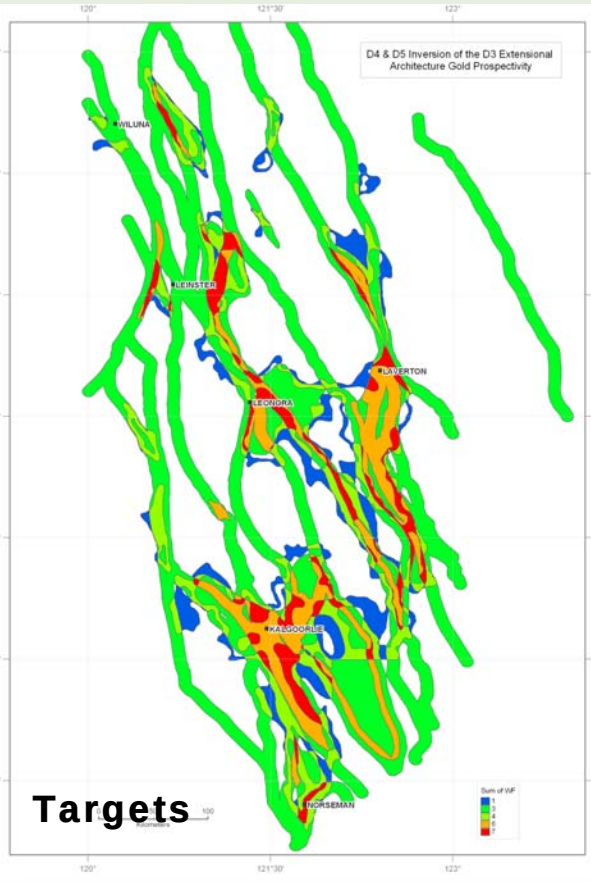


Proxy la
domes

Data+Pr
upper+l



Combination of: major faults, granite domes, D3 upper plate



Targets

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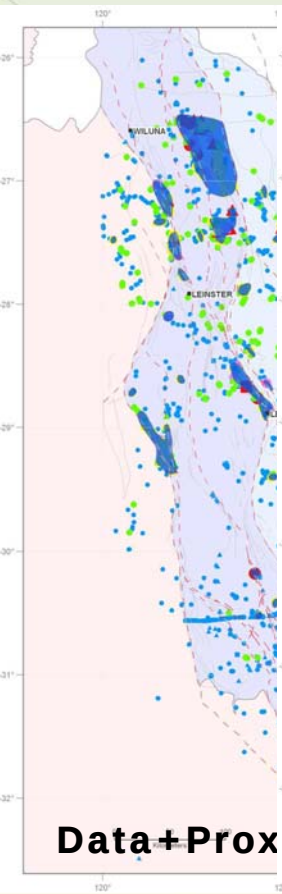
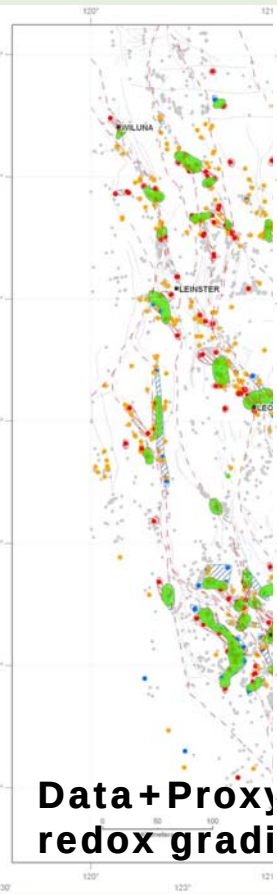
Slide after: K. Czarnota

60 km x 60 km

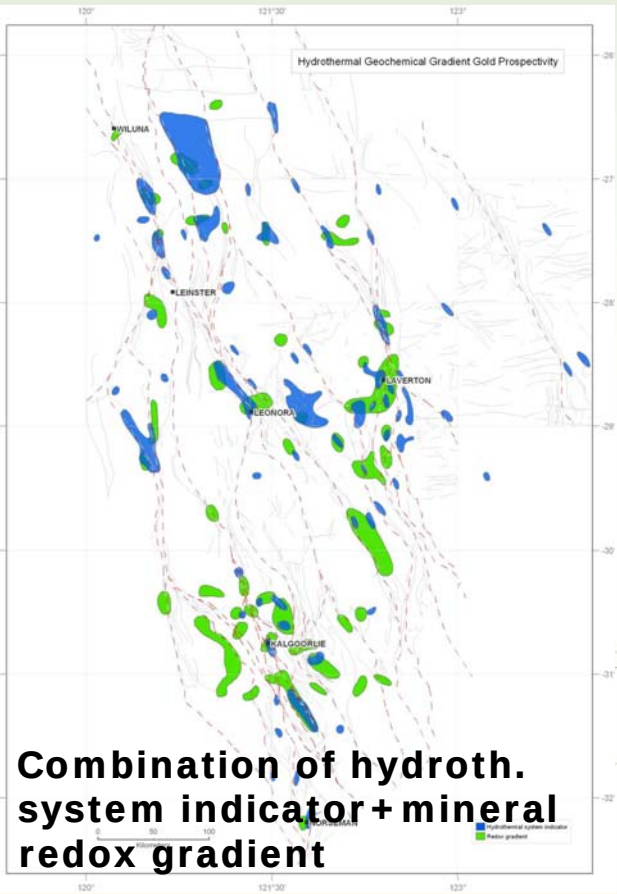
Geochemical gradients



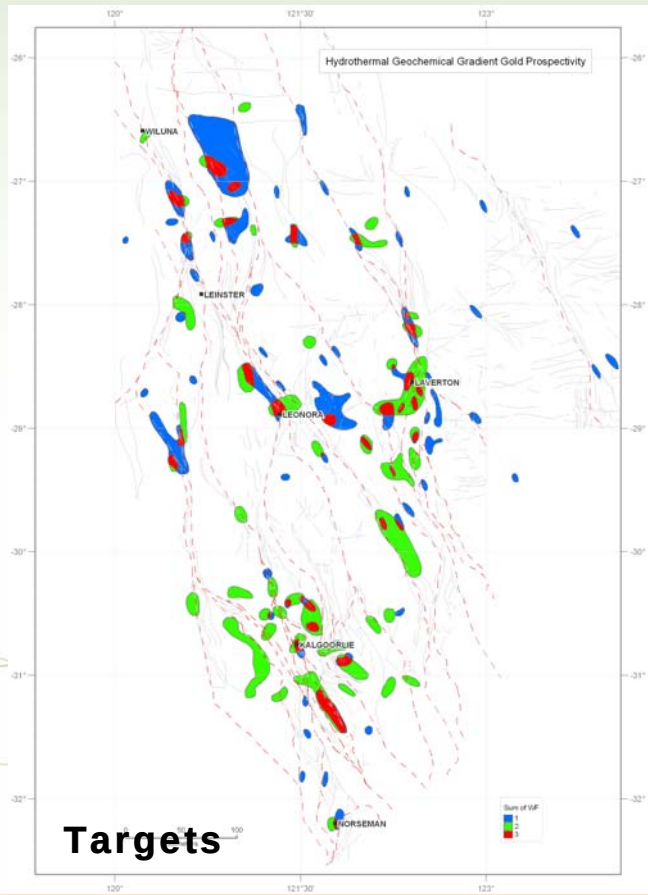
Data+Prox



Data+Proxy redox gradi



Combination of hydroth. system indicator+mineral redox gradient



Targets

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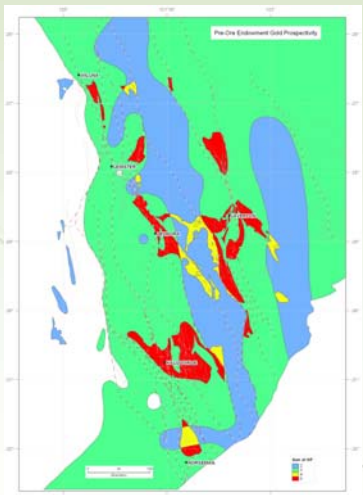
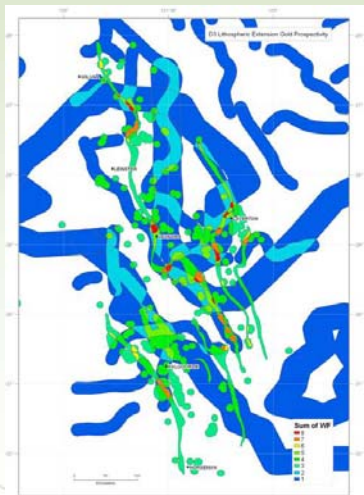
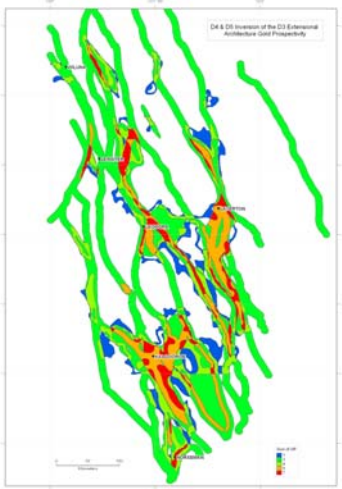
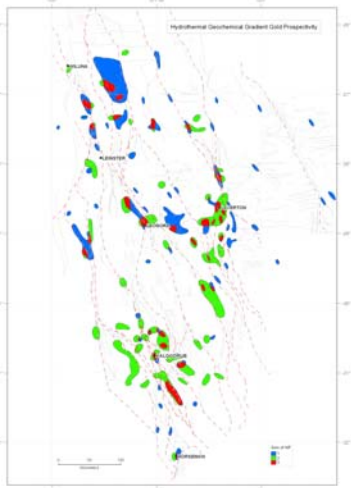
60 km x 60 km

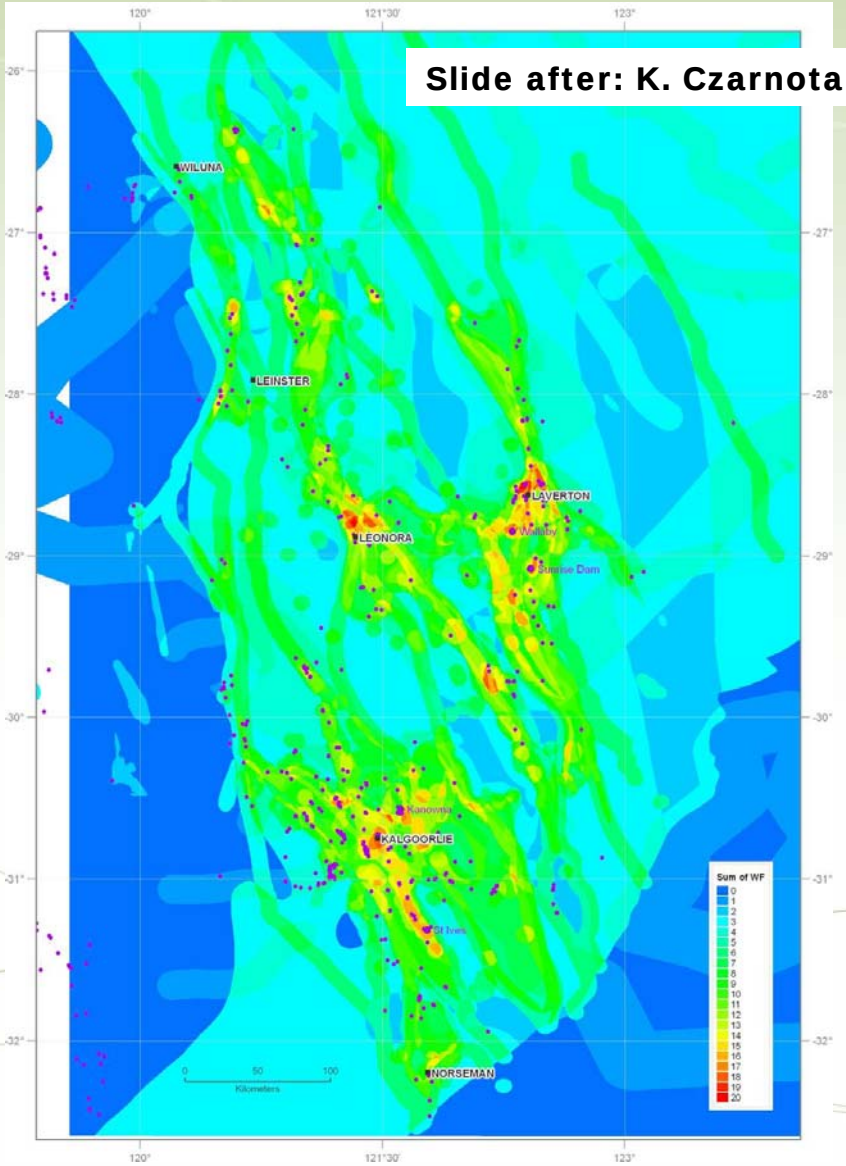








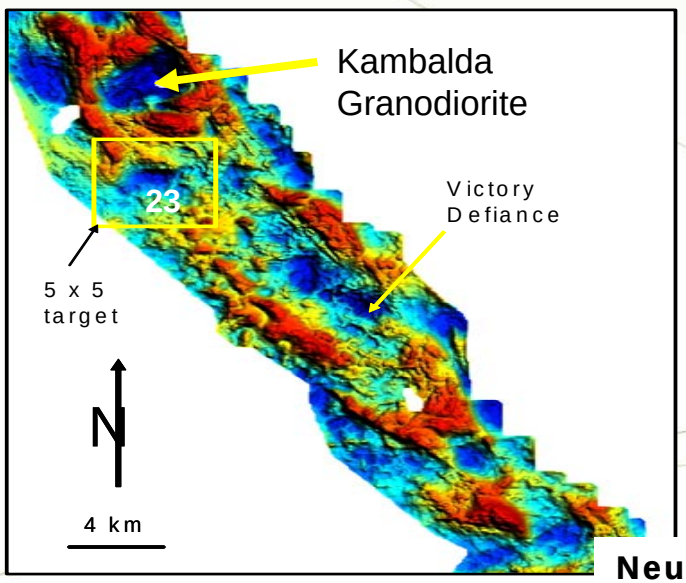
Slide after: K. Czarnota

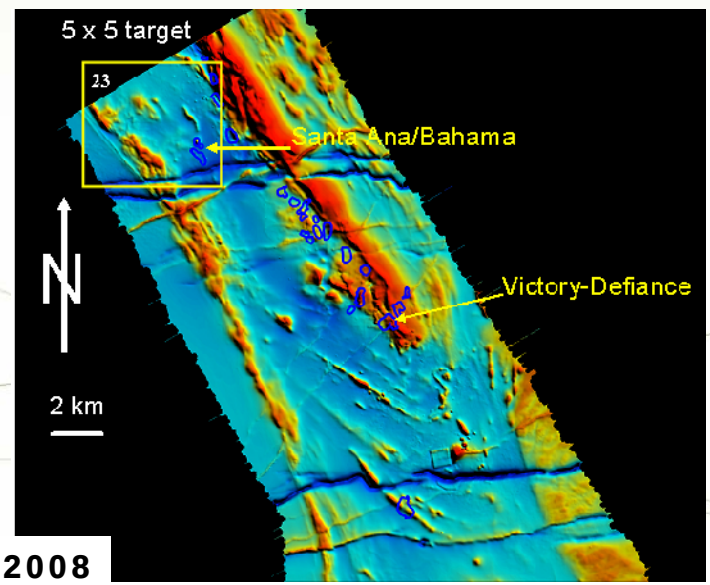


5 km x 5 km

Active hydrothermal systems

- **magnetic anomalies and broad haloes, demagnetised zones**
- **buried granites (in domes)**
- **gradients of oxidised and reduced fluid types in alteration mineralogy**
- **Au and pathfinders (Bi, Mo, W….) above background**

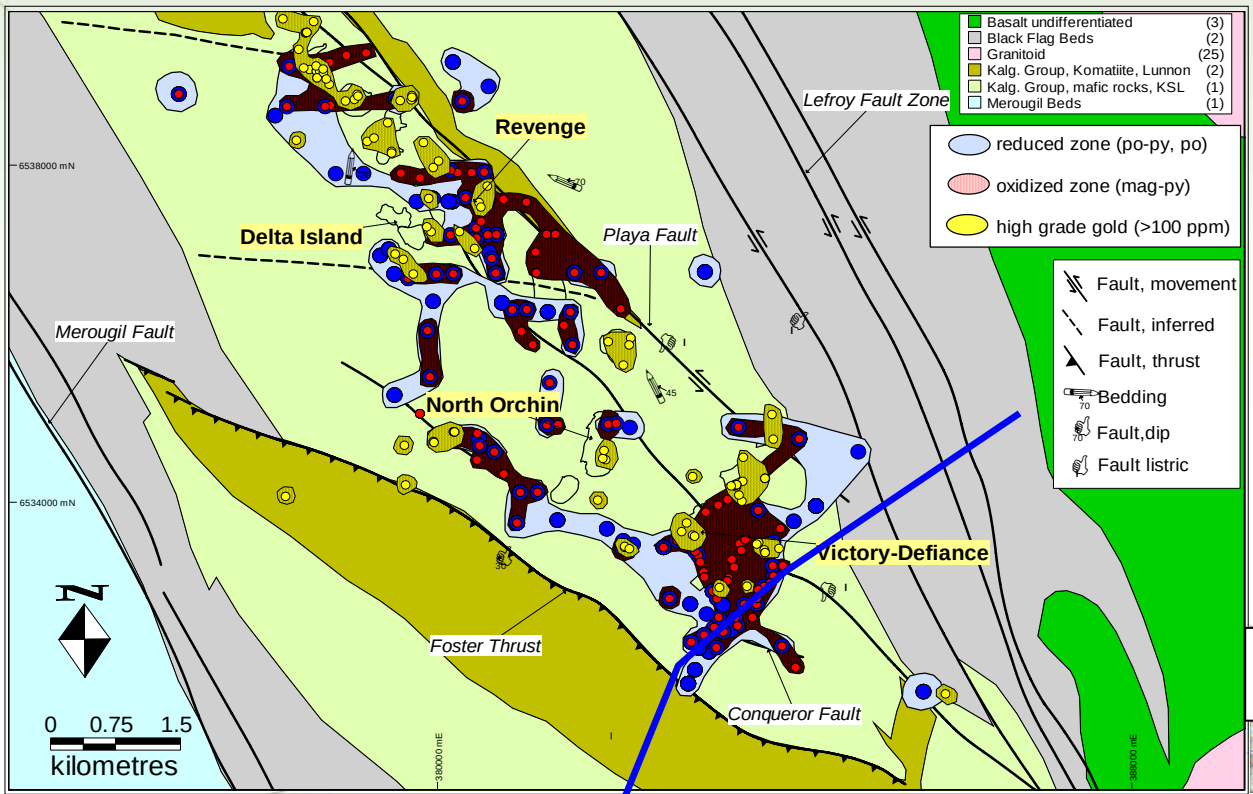




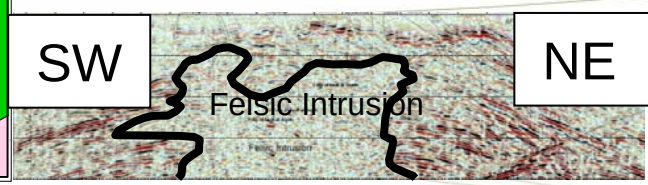
Neumayr and Walshe 2008

5 km x 5 km

Fluid-chemical complexity



- **Detailed gradients of oxidised and reduced fluid types in alteration mineralogy**
- **complex metal associations**



Seismic line

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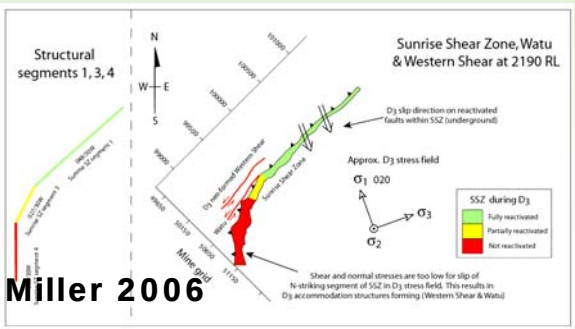
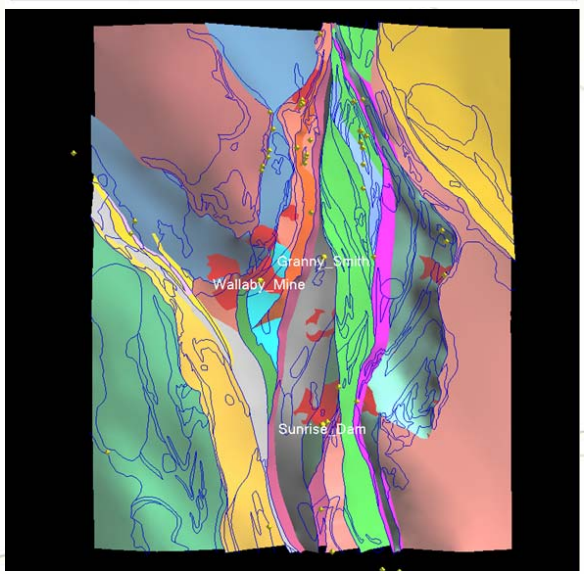
5 km x 5 km

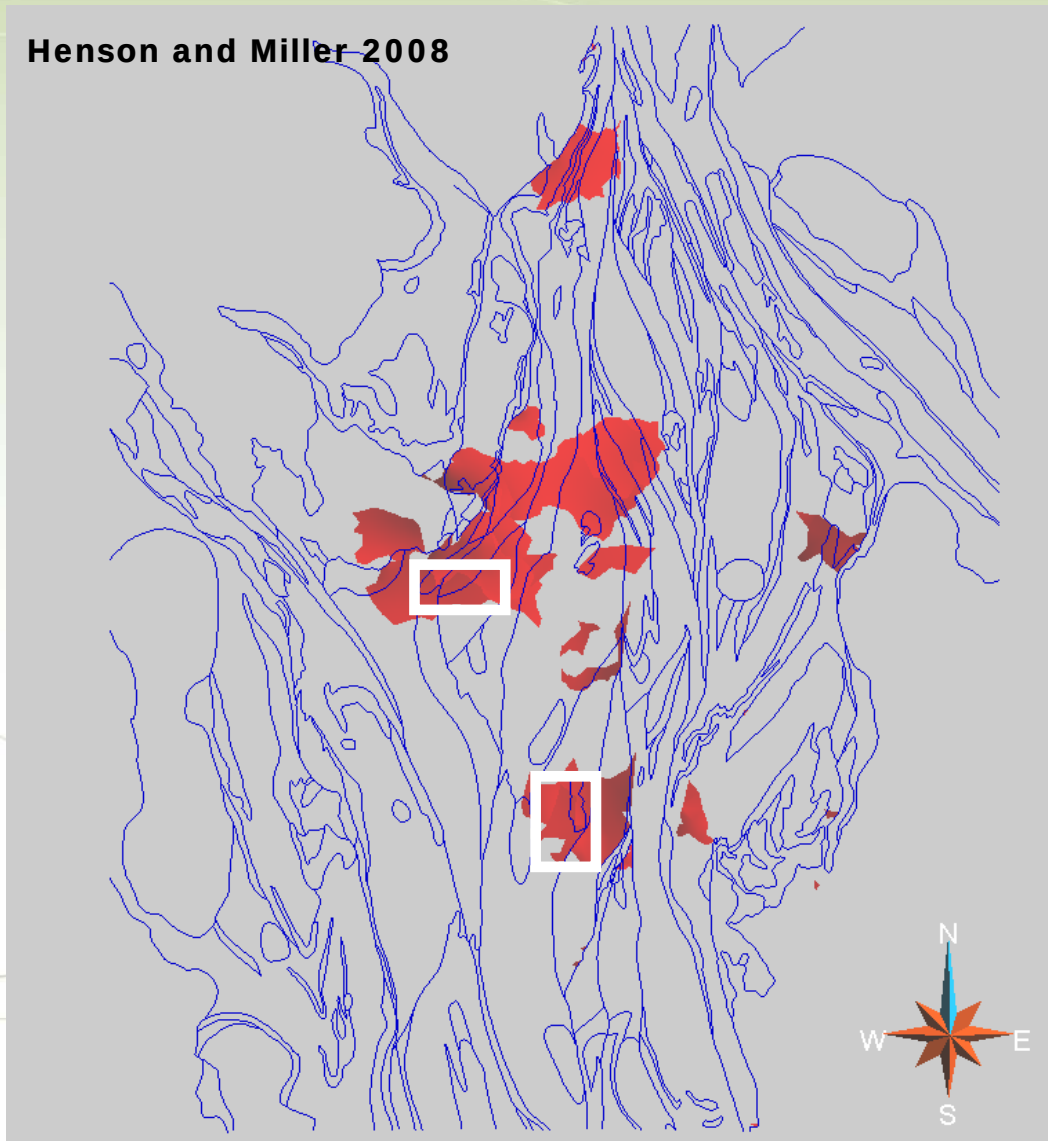
Faults / architecture



Miller 2006



Henson and Miller 2008



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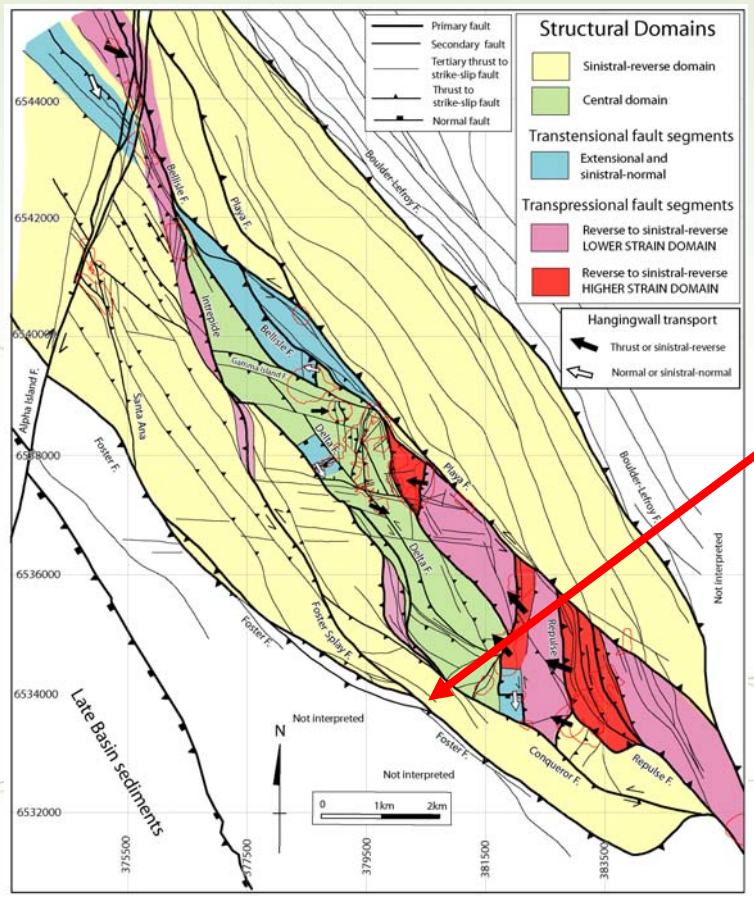
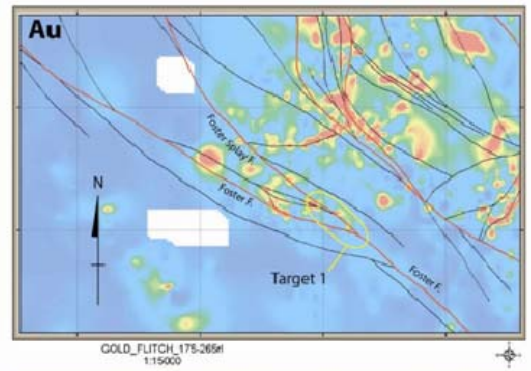
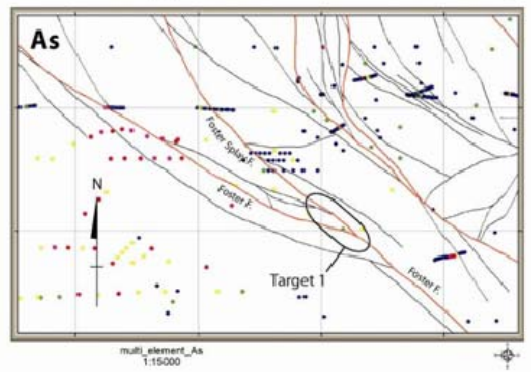
5 km x 5 km

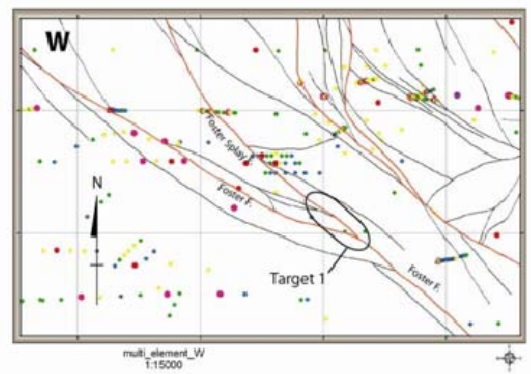
Faults / architecture

- Utilised kinematics to define analogues
- Compressional versus transtensional jogs
- Assessed geochemical signals on each structure









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Scale: Ore

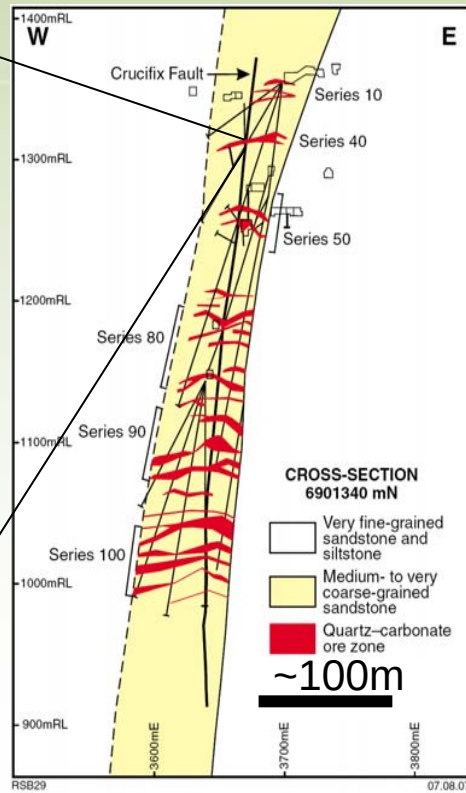
Structural complexity

Favourable fault orientations

Faults that operate as pathways or seals

Proximal to porphyries

Boundary between units with competency contrasts



Rheology contrasts are important controls on dilation / mineralisation at a range of scales within a mine (e.g., New Holland)

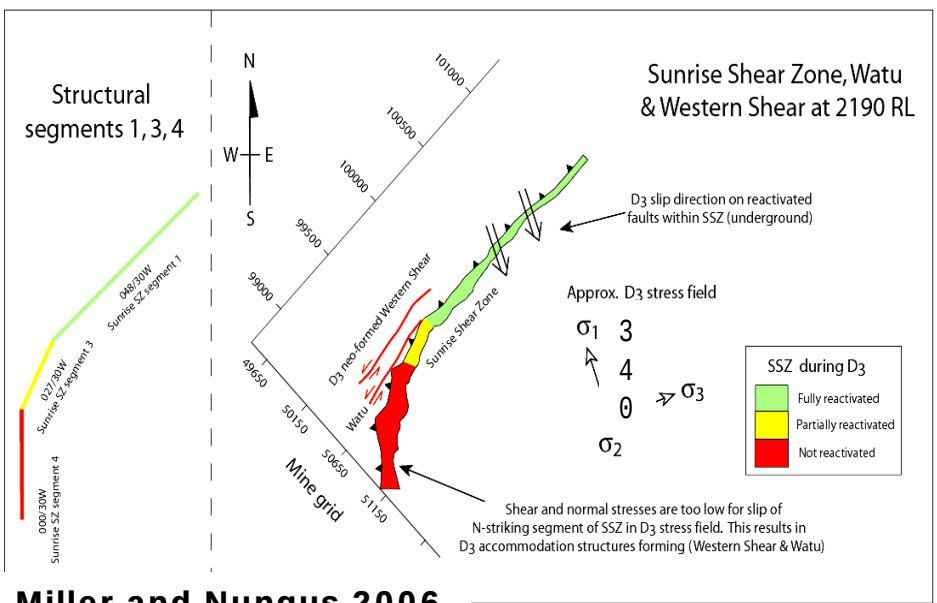
Slide from P. Henson

Scale: Ore

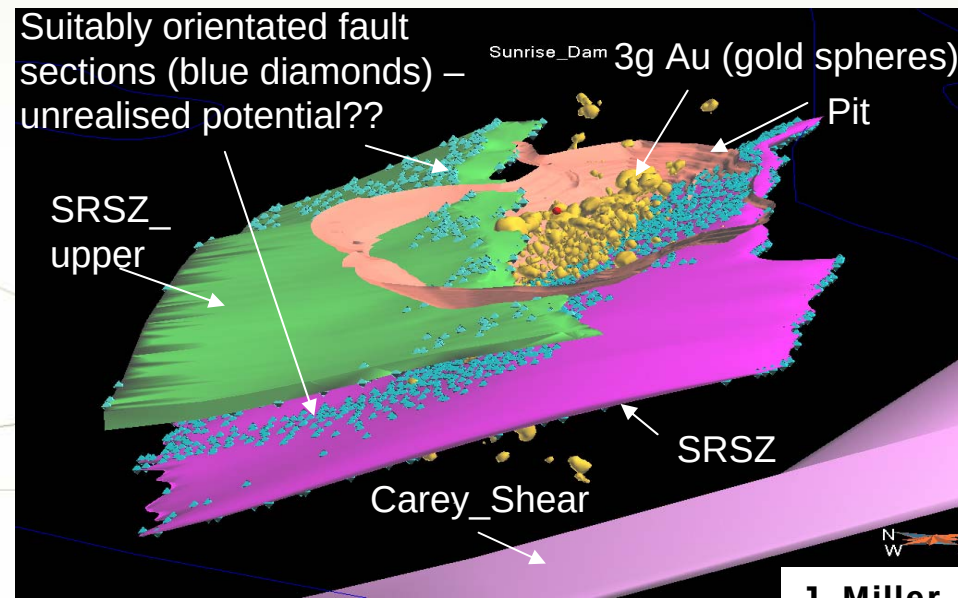
Sunrise Dam

Detailed structural analysis of the Sunrise Dam deposit

Statistical analysis of 3D fault orientations delineates spatial regions that will preferentially reactivate/ dilate



Miller and Nungus 2006



J. Miller

*predictive mineral discovery*Cooperative Research Centre*

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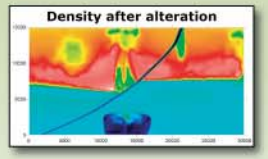

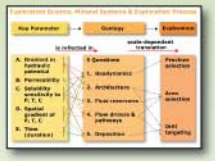

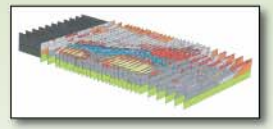

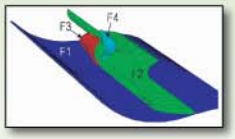

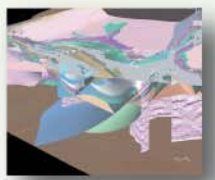

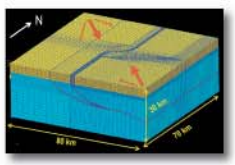

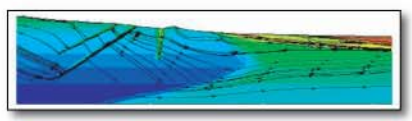

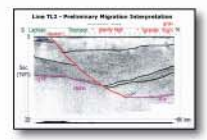

*pmd*CRC* working with industry

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*pmd*CRC* research nodes

*pmd*CRC* working with State/Territory Surveys

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