Pesquisa, Inovação e Sustentabilidade rumo ao Futuro

SimeXmin
XII SIMPÓSIO BRASILEIRO DE EXPLORAÇÃO MINERAL
XII BRAZILIAN SYMPOSIUM ON MINERAL EXPLORATION

30 ANOS ADIMB
Agência para o Desenvolvimento e Inovação do Setor Mineral Brasileiro

The Maremane Dome and Fe Deposits in South Africa: Perspectives from Structural Evolution and 3D Geological Modelling

Dr Ian Basson

TECT Geological Consulting
Unit 3 Metrohm House Gardner Williams Avenue, Paardevlei, 7130
South Africa

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Sources

Overview of ore-structure relationships and Sishen and Kolomela Mines
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Basson, I.J.[1], Thomas, S.A.J.[1], Stoch, B.[1,4], Anthonissen, C.J.[1,5], McCall, M-J.[1], Britz, J.[2], Mac Gregor, S.[2], Viljoen, S.[2], Nel, D.[2], Vietze, M.[2], Stander, C.[2], Horn, J.[2], Bezuidenhout, J.[2], Sekoere, T.[2], Gous, C.[2], Boucher, H.[2] (Ore Geology Reviews, 95, 306–324, 2018)
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3D implicit modeling of the Sishen Mine: new resolution of the geometry and origin of Fe mineralization
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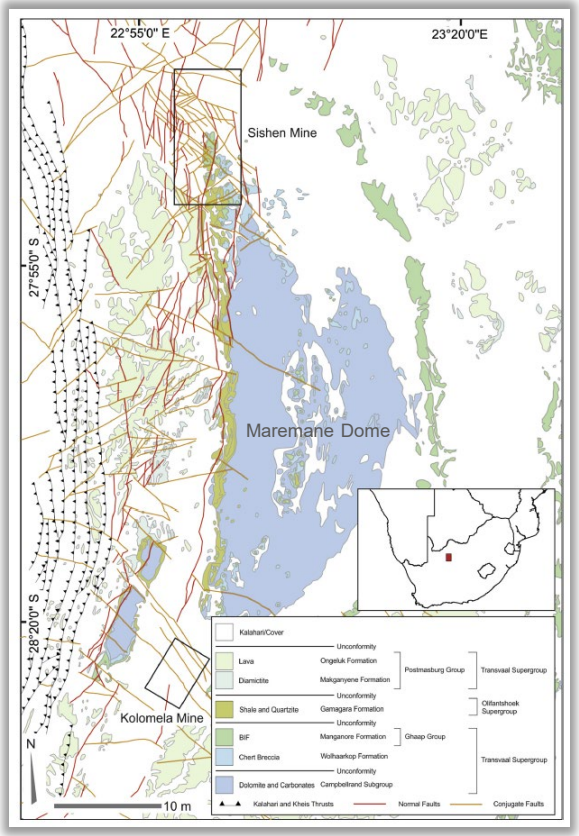
1 Tect Geological Consulting, Unit 3 Metrohm House Gardner Williams Avenue, Paardevlei 7130, South Africa
2 Kumba Iron Ore, 144 Oxford Road, Rosebank, Melrose, 2196, South Africa
3 Xpotential Geoscientific Services (now part of RES), Unit 14, Block B, M5 Park, Eastman Road, Maitland, Cape Town, 7405, South Africa
4 BHP Nickel West Geoscience, Level 43, 125 St Georges Terrace, Perth, WA, 6000, Australia
5 Department of Earth Sciences, University of Southern California, 405 Hilgard Ave, Los Angeles, CA 90095, United States

Maremane Dome



Basson *et al.* (2017)

SOUTHWESTERN KAAPVAAL CRATON

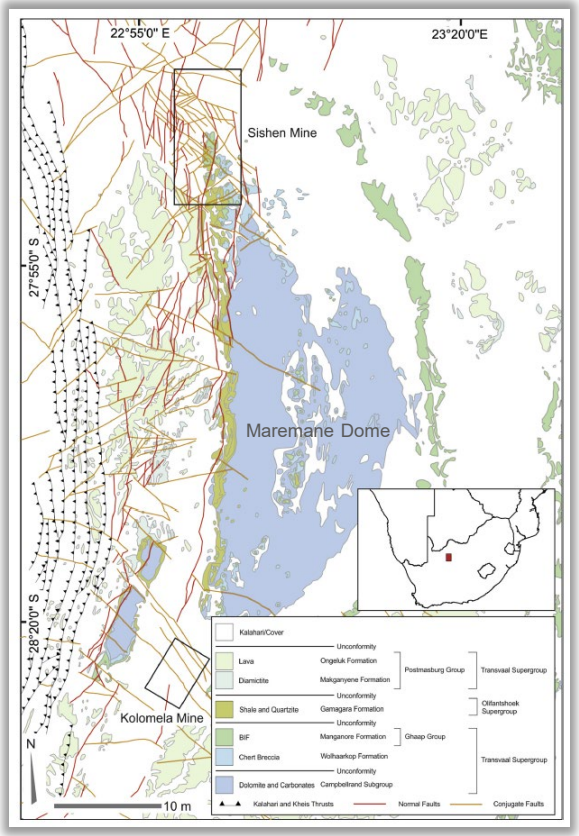
SUPERGROUP	GROUP	SUBGROUP	FORMATION [AGE]	PERIOD
Unconformity	Kalahari			~65-0 Ma
Karoo	Beaufort			~200-120 Ma
	Ecca		Volksrust Vryheid	~280-200 Ma
Unconformity			Dwyka	~310-280 Ma
Olifantshoek	Volop		Groblershoop Brulsand Matsap	~1930-1830 Ma
	Unconformity		Hartley [1928 ± 4 Ma]	
Unconformity			Lucknow Mapedi/Gamagara	~2050-1930 Ma
Transvaal (Griqualand West)	Postmasburg	*Voëlwater*	Beaumont Mooidraai Hotazel	~2220-2100 Ma
Unconformity			Ongeluk [2222 ± 13 Ma] Makganyene	~2350-2220 Ma
	Ghaap	Koegas	Heynskop Naragas	~2430-2400 Ma
		Asbestos Hills	Griquatown [2432 ± 31 Ma] Kuruman [2460 ± 5 Ma] [2465 ± 7 Ma]	~2520-2430 Ma
		Campbellrand	Klein Naute [2521 ± 3 Ma] [2516 ± 4 Ma] Nauga [2552 ± 11 Ma] [2557 ± 49 Ma] Monteville [2555 ± 19 Ma] [2588 ± 6 Ma]	~2590-2520 Ma
		Schmidtsdrif	Lokammona [2583 ± 5 Ma] [2588 ± 7 Ma] Boomplaas Vryburg [2642 ± 2 Ma]	~2640-2590 Ma
Unconformity				
Ventersdorp	Pniel		Allanridge	~2720-2640 Ma

MAREMANE DOME AREA

SISHEN thickness (m)	SISHEN SOUTH thickness (m)	LITHOLOGY	STRATIGRAPHIC UNIT		AGE
50	50	Sand Calcrete & Clay Boulder beds	Kalahari Grp *Unconformity*		Present-day ~20 Ma ~65 Ma
-	30	Varved shale Tillite	Dwyka Fm *Unconformity*	Karoo Supergroup	~280 Ma ~310 Ma
20	-	Diabase	Intrusive		~2060 Ma
100	30	Andesitic lava	Ongeluk Fm	Postmasburg Group / Transvaal Supergroup	~2220 Ma
20	-	Diamictite	Makganyene Fm *Thrust & Unconformity*		~2350 Ma
30	6	Quartzite (Tech-upper) (Tech-lower)	Gamagara/Mapedi Formation	Olifantshoek Supergroup	>1930 Ma
20	-	Flagstone			
50	50	Shale Conglomerate Shale Grit			
10	5	Gritty ore Conglomeratic ore	*Unconformity*		~2050 Ma
30	30	Brecciated ore Massive ore Laminated ore	Manganore Iron Fm	Ghaap Group / Transvaal Supergroup	~2430 Ma
2	30	Mafic intrusion			
20	-	Banded iron formation	Asbestos Hills Subgroup		
10	-	Thabazimbi-type ore			
40	30	Banded iron formation			~2465 Ma
25	40	Chert breccia	*Unconformity*		~2520 Ma
		Dolomite	Campbellrand Subgroup		~2590 Ma

Fe mineralization occurs at an unconformity at the top of a banded iron formation, which is situated on a dolomite

Maremane Dome



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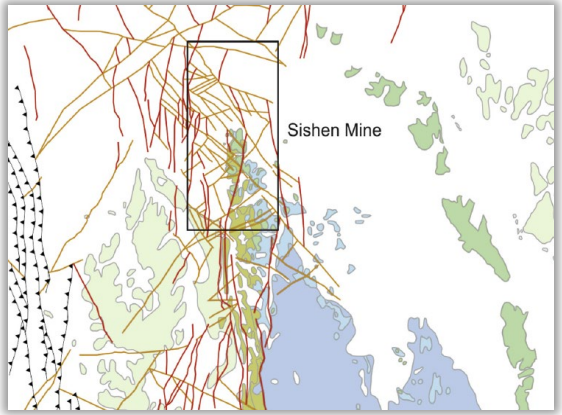
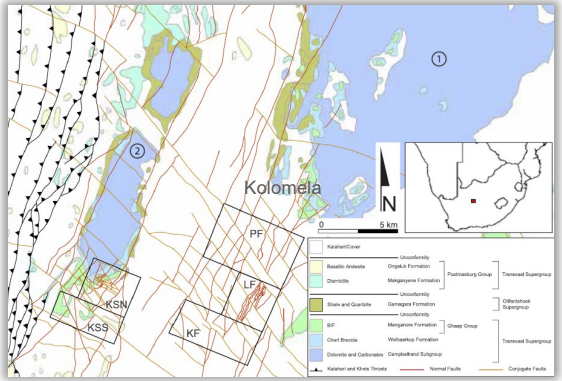




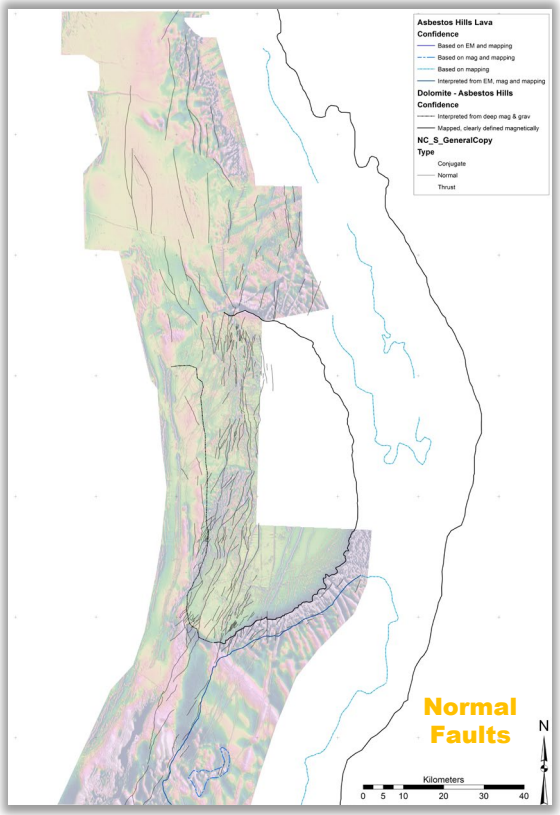
Sishen Mine occurs on the northern end of a very gentle anticline (Maremane Dome), with mineralization locally preserved due to faulting (e.g. wedge-shaped orebodies due to fault drag against inverted normal faults and in small sub-basins) and in palaeosinkholes

Basson *et al.* (2017)

Kolomela Mine occurs on the southern end of the dome, and is closer to the thrust-dominated Kheiss Orogenic Front; mineralization is more structurally-controlled (e.g. tightened synclines in the case of Leeuwfontein - LF), or duplicated by low-angle thrusting and only occasionally occurs in palaeosinkholes

Basson *et al.* (2018)

Geophysical and Structural Interpretation



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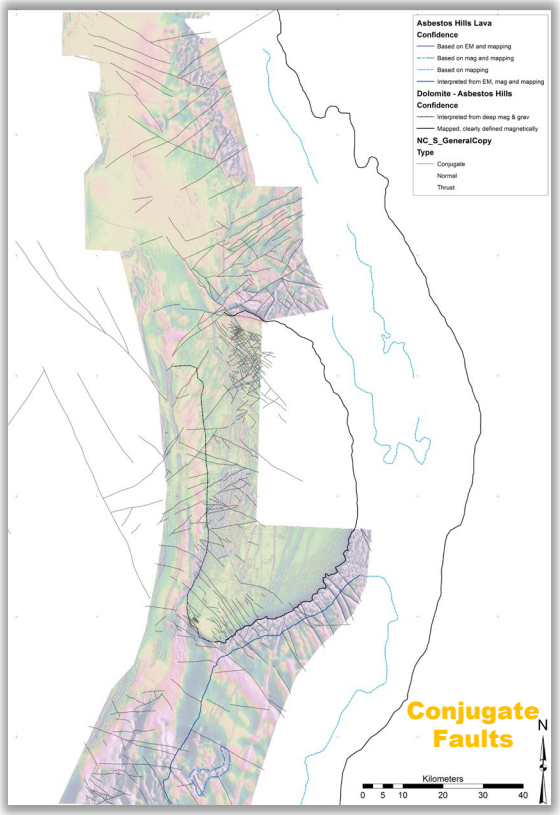
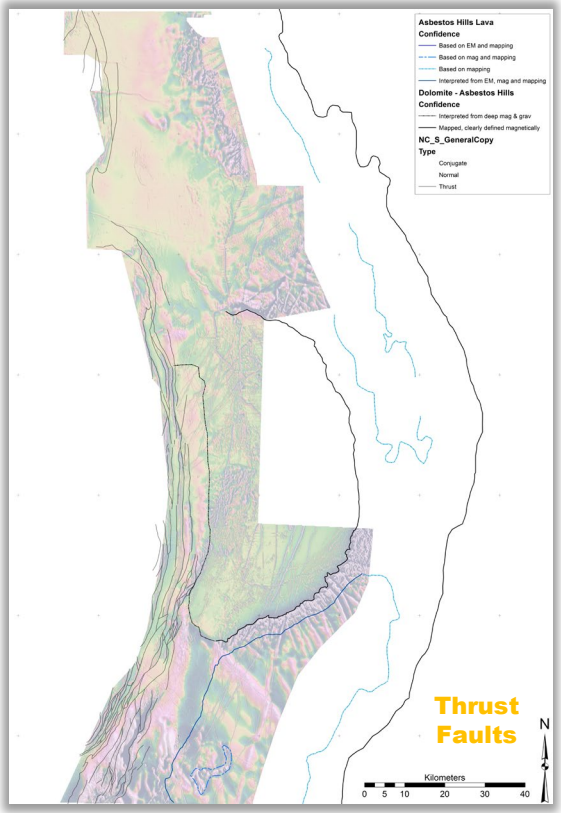


Basson *et al.* (2016)

Interpretation of regional datasets, generated for hydrological modelling, allow for several types of structures to be resolved

Geophysical and Structural Interpretation



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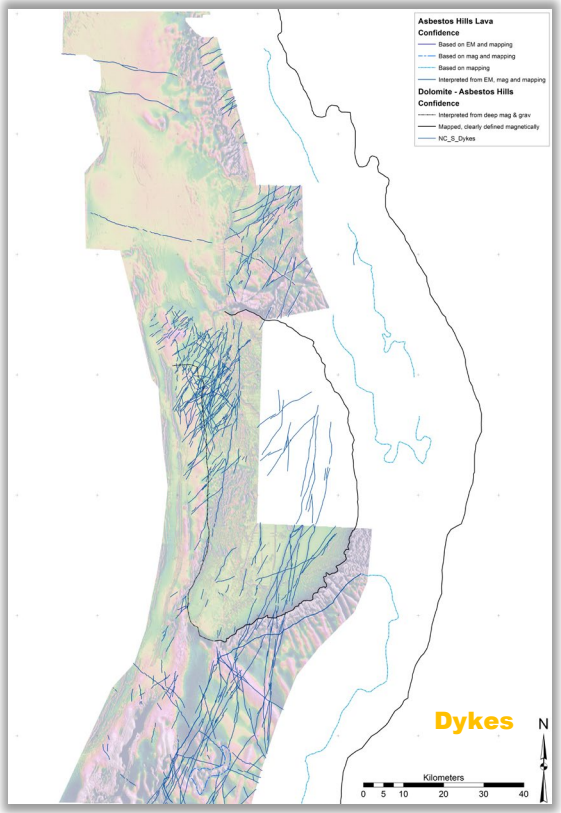

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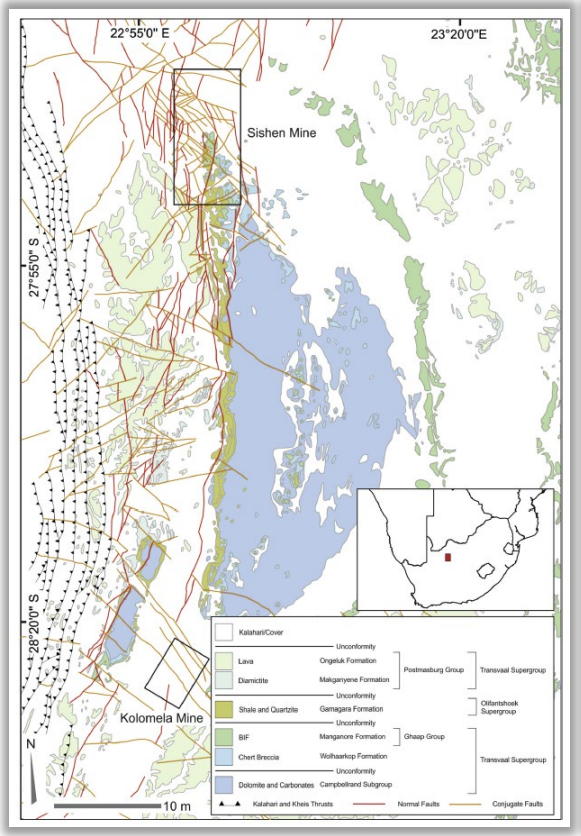

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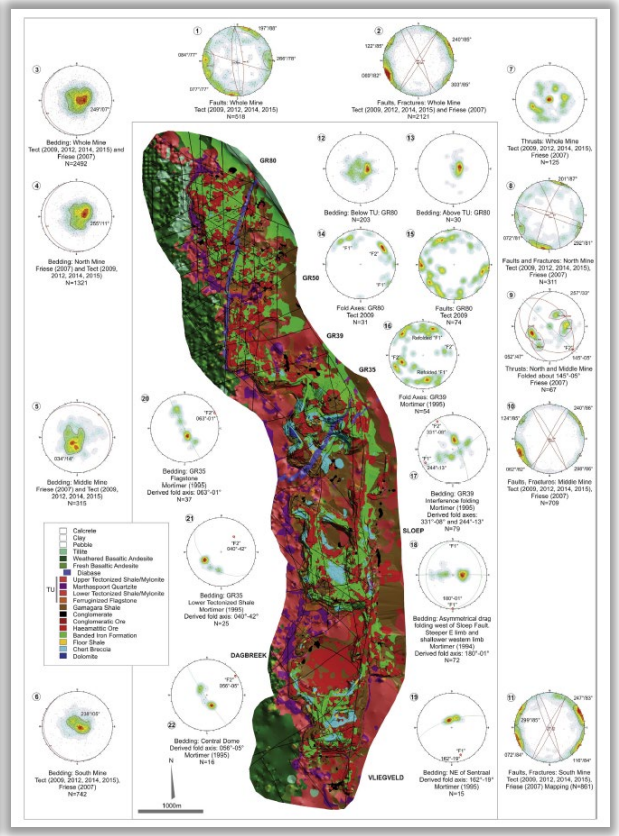
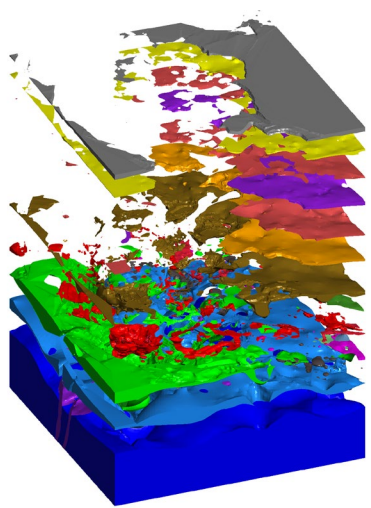


Basson *et al.* (2017)

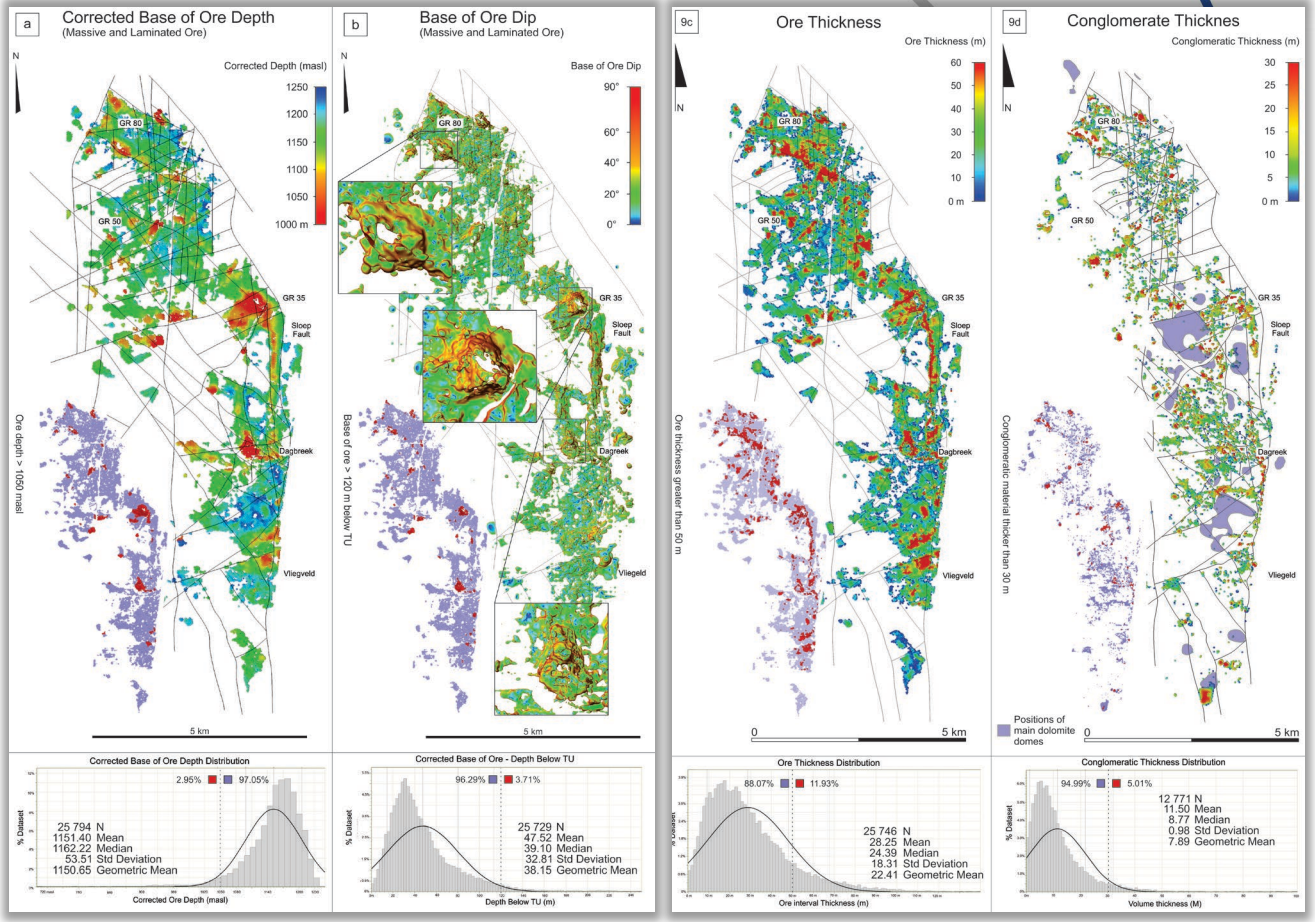
Pit mapping over approximately 15 years and implicit 3D geomodelling allow for several structural domains to be defined

Sishen Mine



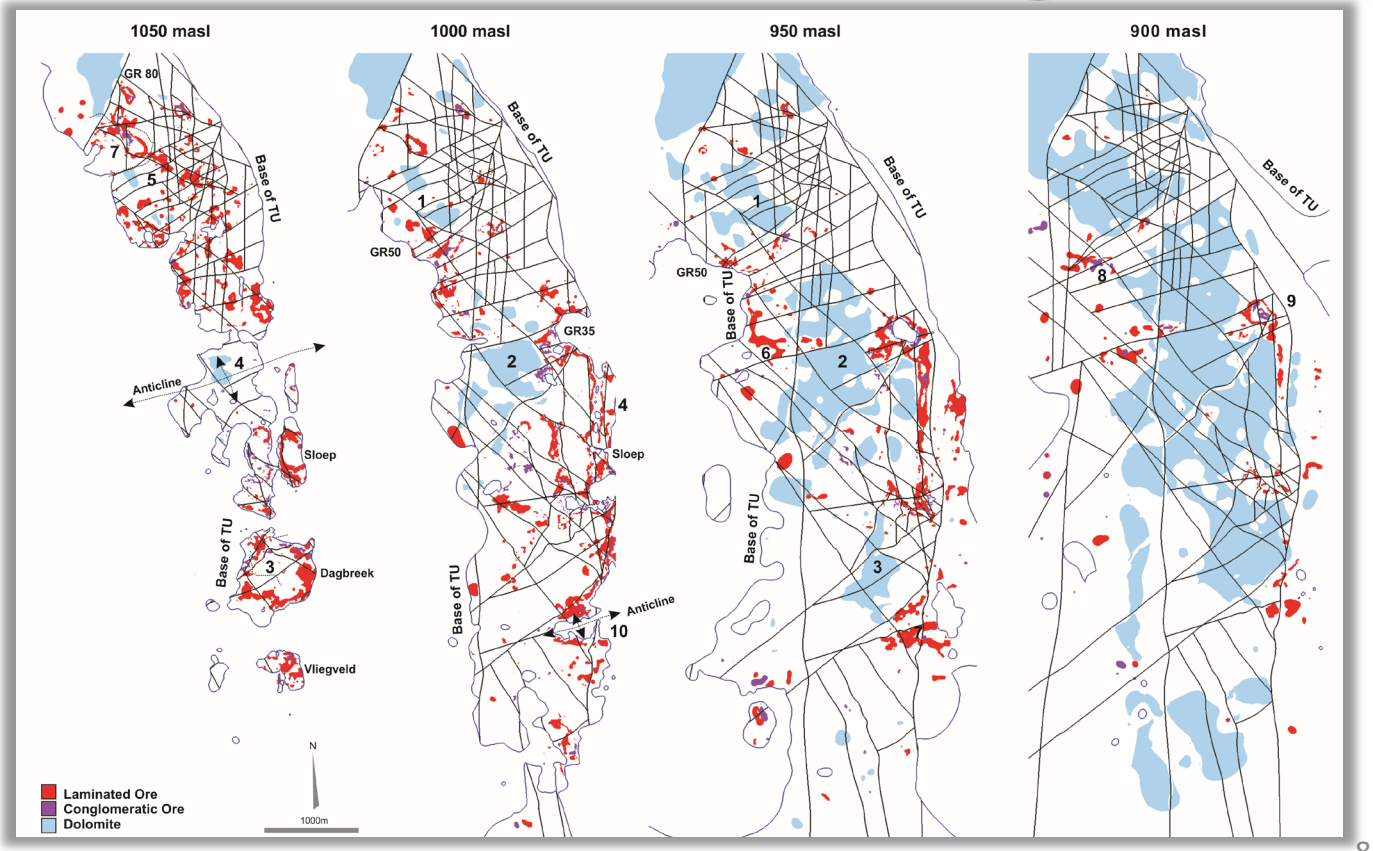
Implicit modelling and the production of smooth, lithologically- and structurally-constrained RBF surfaces provide the basis for interrogation of various aspects of the 3D model, particularly ore characteristics

Stoch *et al.* (2019)



Sishen Mine

Near-horizontal slices through key modelled volumes highlight the combined control of fault-bounded blocks and palaeosinkholes

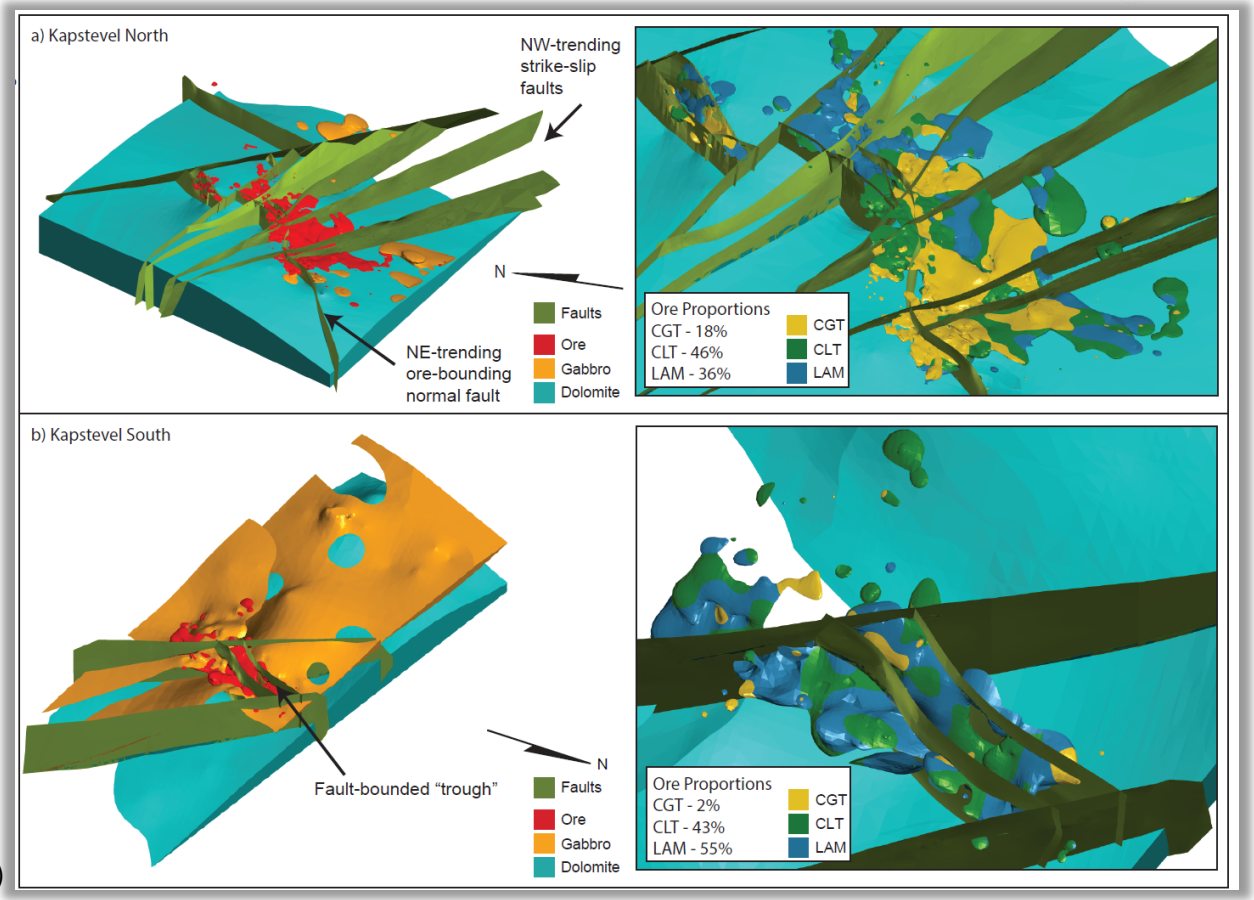


Stoch *et al.* (2019)

Kolomela Mine

Gabbro Sill Ore Types

Thick gabbro sills, which probably exploited low-angle or bedding sub-parallel thrusts, appear to play a key role in ore development: most of the deposits at Kolomela Mine are underlain by a gabbro sill



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Kolomela Mine

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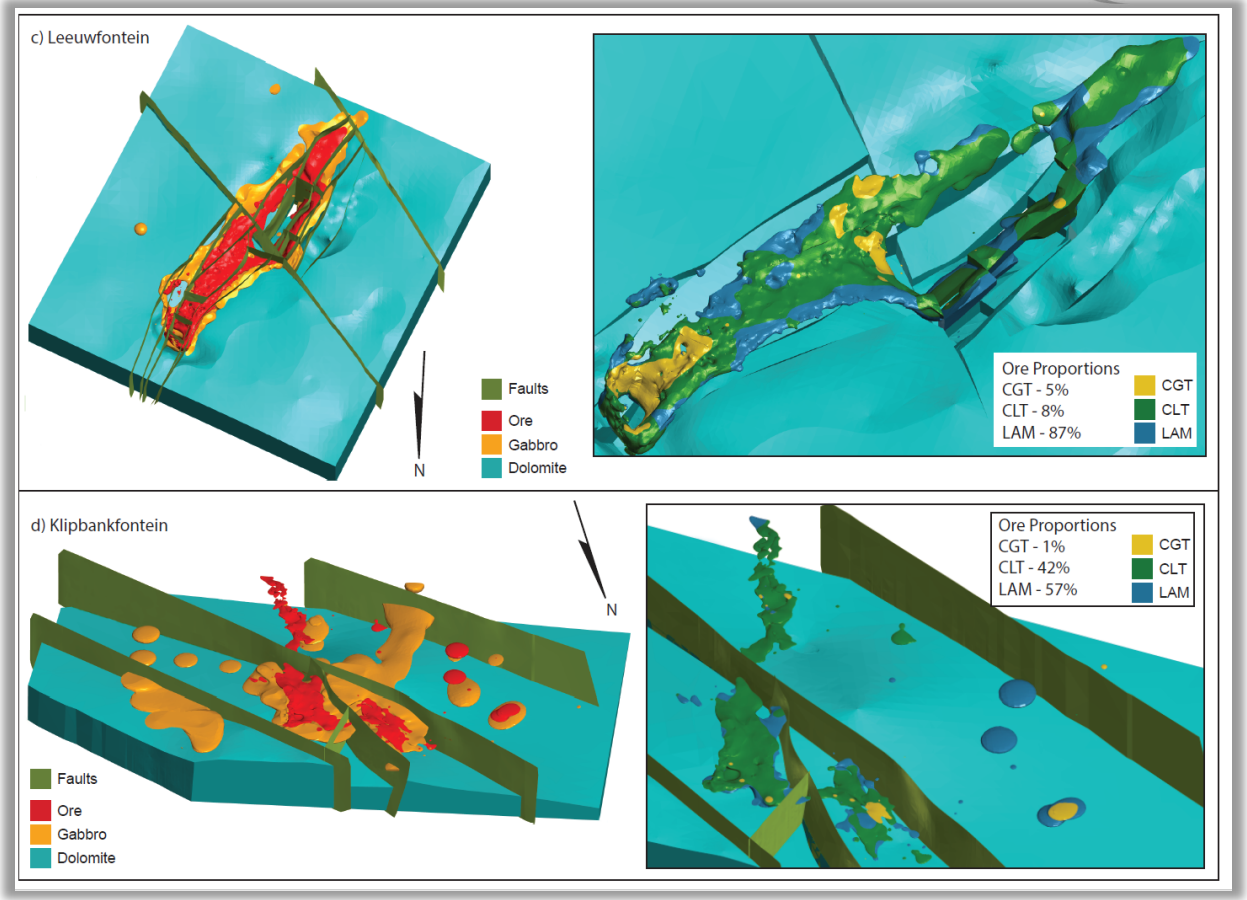
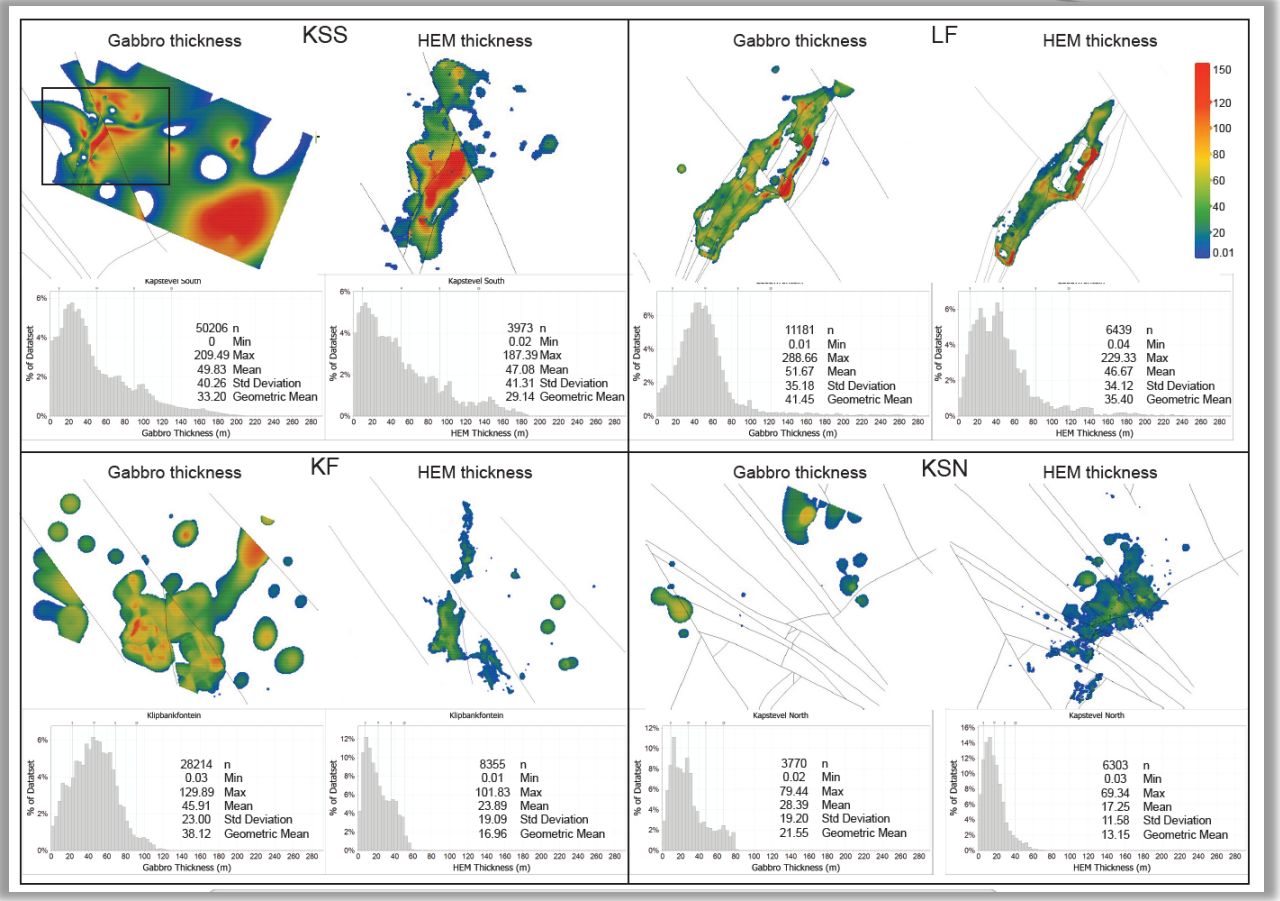


Basson *et al.* (2018)

Kolomela Mine

Gabbro vs Ore Thickness

Gabbro sill thickness correlates well with ore thickness

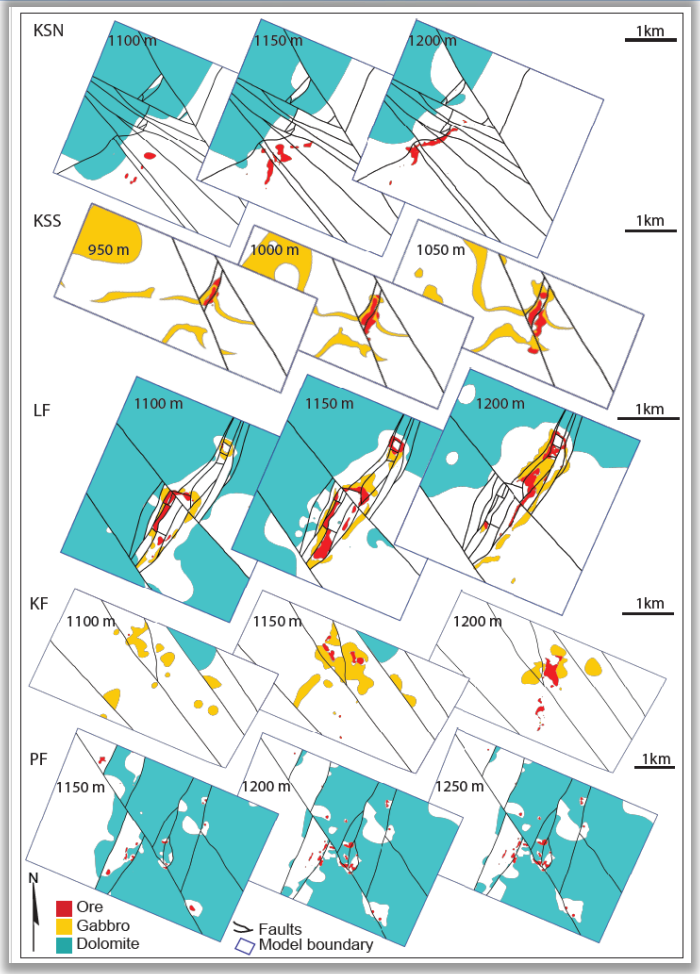


Basson *et al.* (2018)

Kolomela Mine

Depth Slices

Horizontal slices through modelled volumes show that gabbro sills, which probably exploited low-angle or bedding sub-parallel thrusts, appear to play a key role in ore development: most of the deposits at Kolomela Mine are underlain by a gabbro sill



Basson *et al.* (2018)

Regional Geophysical Data Interpretation

Integration of Major Structures, Geophysics and Implicit Modelling

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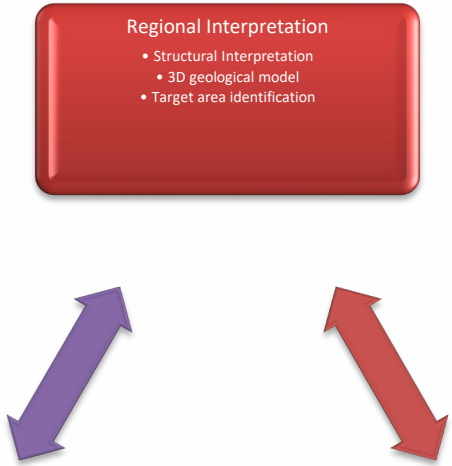
- Regional structural interpretation used to create geological context for mine-scale projects
- Geological setting of known deposits used to refine regional geological model and target generation

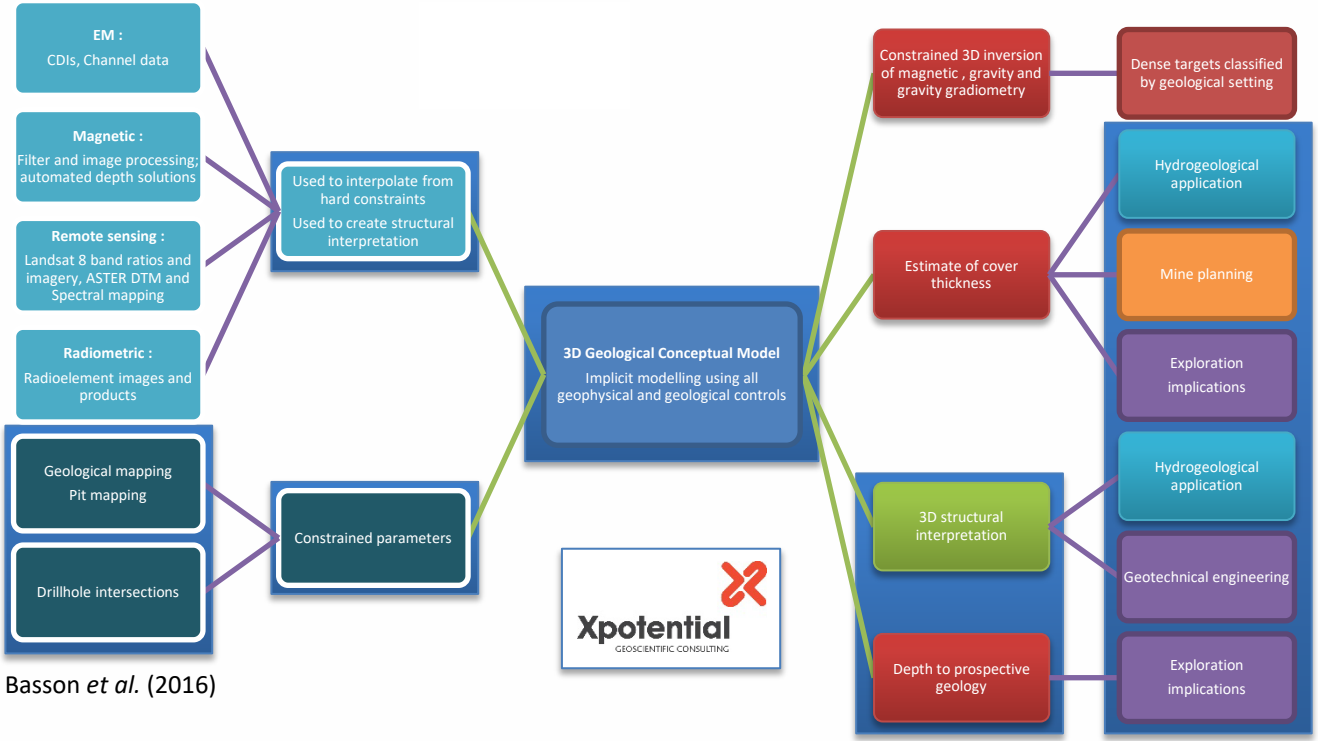


- Regional interpretation used to assist with identification of prospective areas for follow-up / direct target generation
- Drill-testing / ground follow-up on exploration projects used to update regional model

Basson *et al.* (2016)

Regional Geophysical Data Interpretation

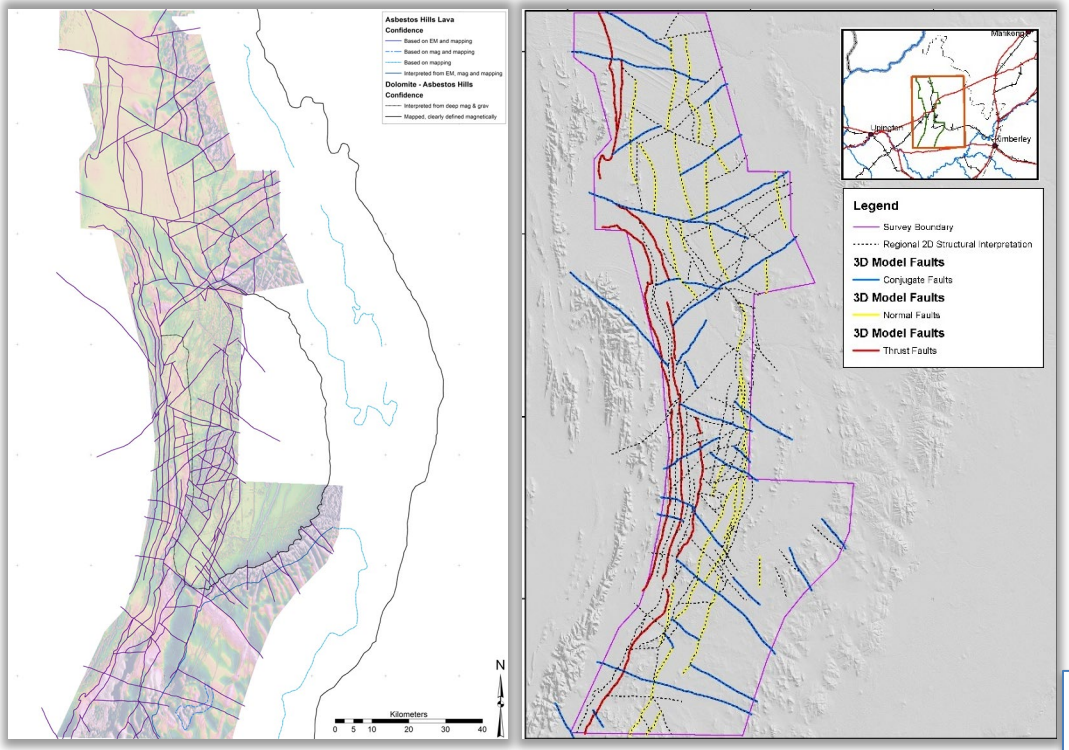
Integration of Major Structures, Geophysics and Implicit Modelling



Basson *et al.* (2016)

Regional Geophysical Data Interpretation

3D Surfaces and Structures



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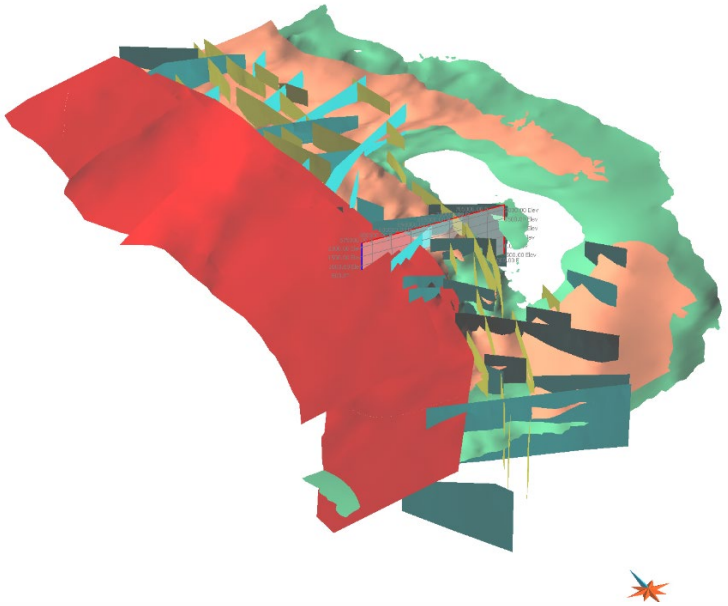

3D implicit model illustrating surfaces with 3D fault interpretation of selected major structures. Red – thrust faults, Blue – conjugate faults, Yellow – normal faults

3x vertical exaggeration

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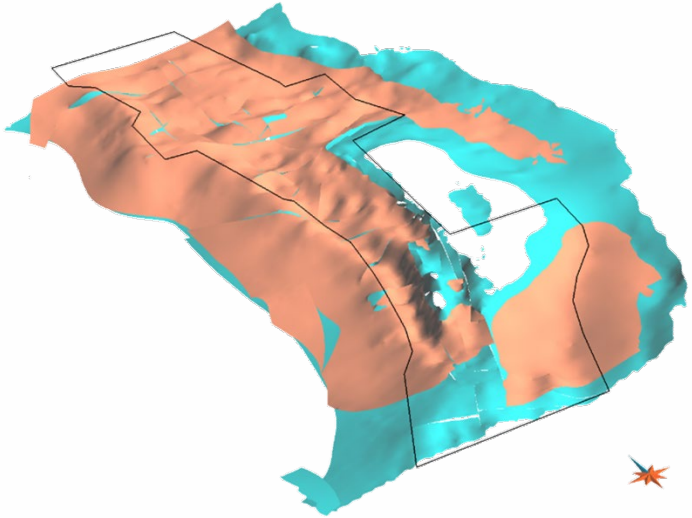
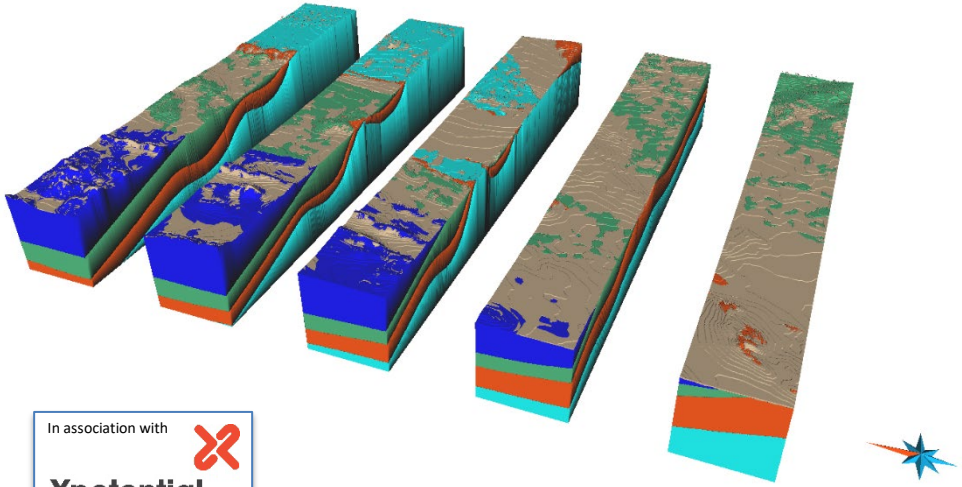
Regional Geophysical Data Interpretation

3D Major Contacts



3D implicit model illustrating top of prospective BIF unit (orange) and top of dolomite (blue)

3x vertical exaggeration



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Exploration

Model Slices with Dense Target Sources

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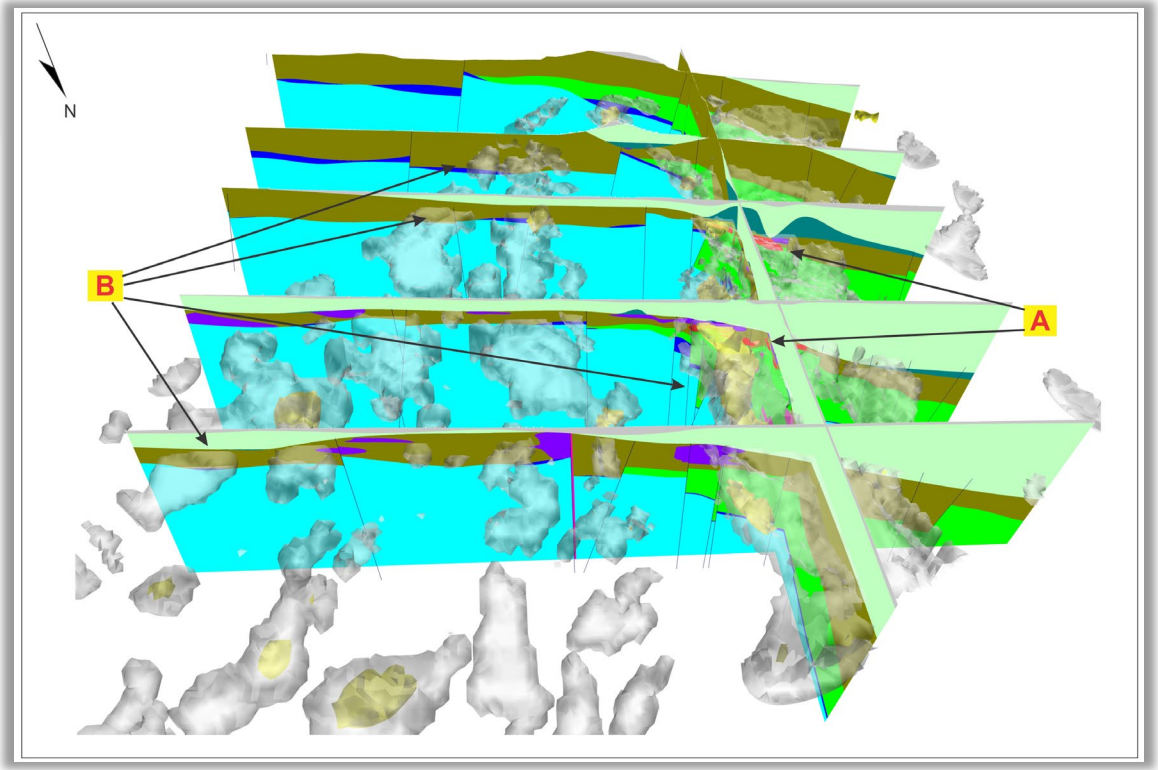

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