NEWMONT
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annual report

Newmont
Tanami Operations
Newmont Tanami Pty Ltd
A.C.N. 007 688 093

ANNUAL REPORT FOR MLS154
(DEAD BULLOCK SOAK)
FOR THE YEAR TO 11 FEBRUARY 2007

Minerals explored for: Au

1:250,000 SHEET REFERENCE:	THE GRANITES	SF52-3
1:100,000 SHEET REFERENCE:	INNINGARRA	4856

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Compiled by: S Dries & G Gonsal Due Date for Submission 11 May 2007 Newmont RN: 33461

SUMMARY

Mining operations undertaken by Newmont Tanami Pty Ltd on MLS154, Dead Bullock Soak, for the calendar year to December 2006, produced 377,020 ounces of gold. Gold was treated at the mill facility in MLS8 The Granites. Ore milled from MLS154 during the year came from mining of the Callie underground resource (Callie UG ROM and Callie UG LG) and the stockpile from the Callie pit.

Exploration drilling targets on MLS154 (Table 1) tested the Wilson, Avalon, Jenna, Auron and North Limb systems for conceptual targets.

Prospect	No. Holes	No. Metres
Wilson	**17 Surface Diamond (including 14 daughter holes)**	**7,705.7**
Avalon	**12 Surface Diamond (including 7 daughter holes)**	**5,375.9**
Jenna	**3 Underground Diamond**	**1040.5**
Auron	**2 Underground Diamond**	**332.4**
North Limb	**1 Underground Diamond**	**454.7**

Table 1: Table of Activities

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1. INTRODUCTION

The Granites Gold Mine is located 550km north-west of Alice Springs (Figure 1).

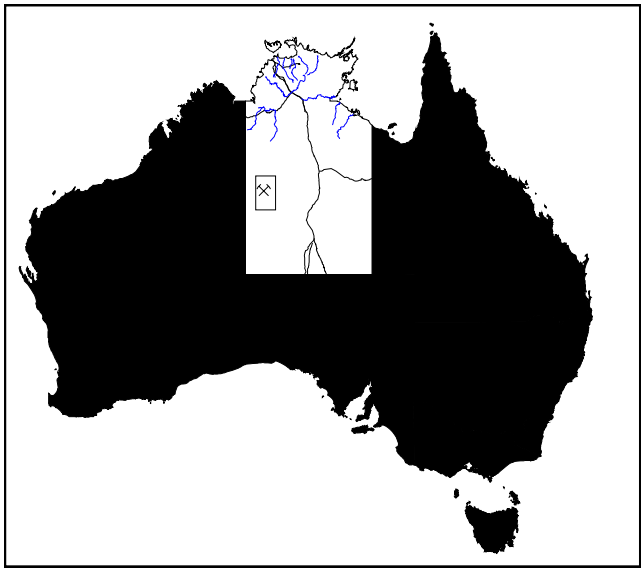

Figure 1: Location map Granites Gold Mine

Gold mineralisation was first reported in the vicinity of Dead Bullock Soak (DBS) by A.A. Davidson in 1900. Newmont Tanami Pty Ltd (formerly Newmont NFM and Normandy NFM Limited) was granted title to the area as EL2367 (Schist Hills) in March 1988 and exploration later that year identified gold mineralisation of economic tenor, hosted predominantly by cherts and banded iron formations. Open cut mining commenced in late 1991, with DBS ore complementing production from The Granites (MLS8) resources.

The quartz vein hosted Callie deposit was discovered in 1991 and rapidly became the focus of gold production for NNFM when open cut mining commenced in 1992. Decline access development to the deposit began in 1995 and the first underground stoping ore was extracted in May 1998. Mining in Callie open cut ceased in 1998 although stockpiled ore continued to be treated throughout 2000. Ore milled from MLS154 during the year to December 2006 came from mining of the Callie underground resource and the mineralised waste stockpile from the Callie pit.

All milling is undertaken on The Granites lease (MLS8). Gold production for the calendar year to December 2006 from MLS154 was 377,020 ounces.

Surface exploration this year focused on Avalon and Wilson projects with 29 diamond holes drilled into the Wilson Shoot. Six underground diamond holes were drilled over three prospects, Auron, Jenna and North Limb.

2. TENEMENT DETAILS

MLS154 is a single mining tenement comprising an area of 1477 hectares (Table 2). It is completely surrounded by EL2367, also held by Newmont Australia Ltd (Figure 2).

The lease was granted to Newmont in February 1991 and gold production started later in that year. Tenure is held until the year 2016.

Title	Area Name	Hectares	Grant Date	Expiry Date
MLS154	Dead Bullock Soak	1477	12/02/91	11/02/16

Table 2: Tenement Summary, MLS154

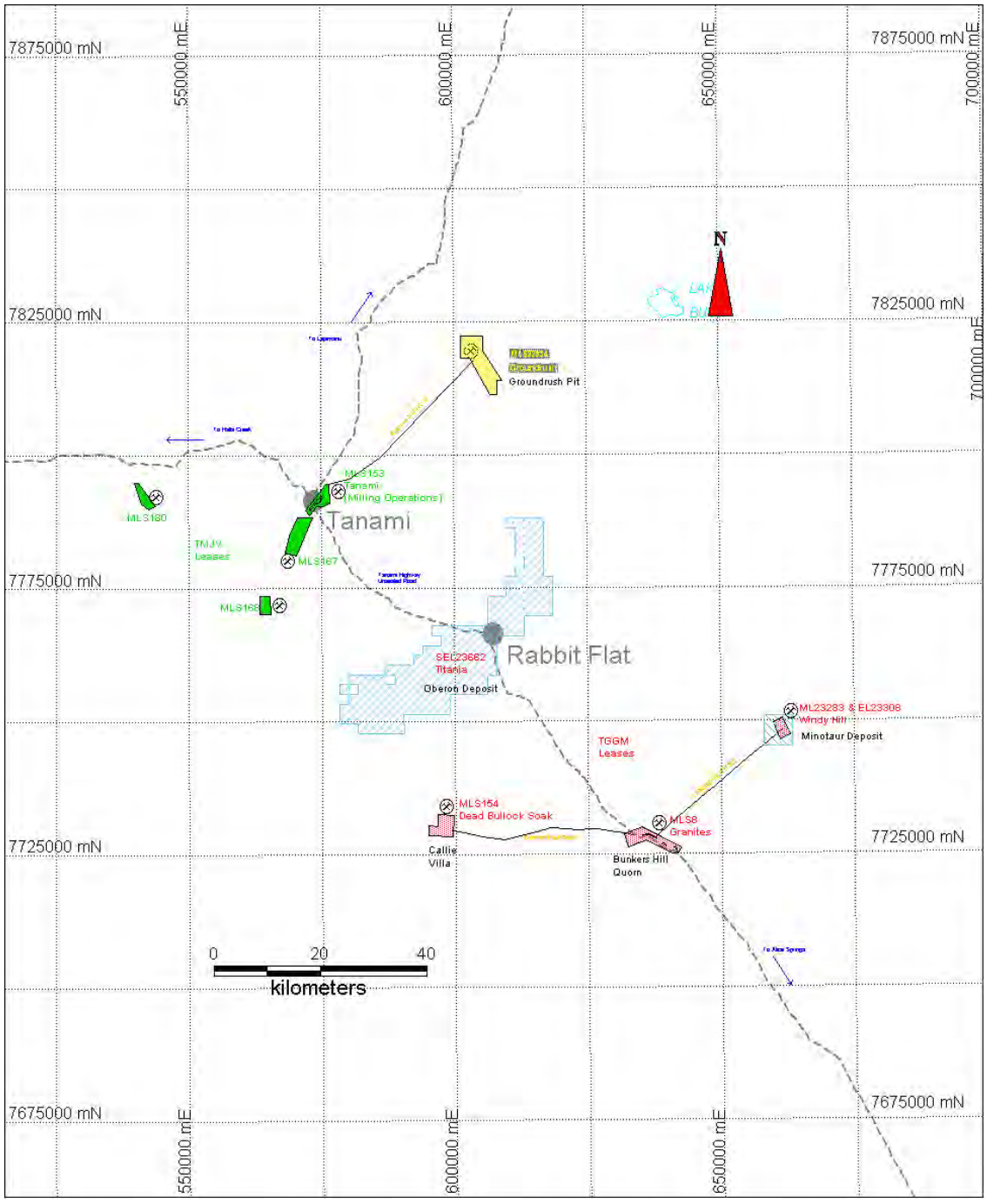

Figure 2: Location: MLS154 (AMG, AGD66-52)

3. LOCATION, ACCESS AND PHYSIOGRAPHY

MLS154 lies approximately 35km west of The Granites Gold Mine (MLS8) and 40km south of Rabbit Flat (Figure 2). The lease is situated on the Inningarra (4856) 1:100,000 map sheet. Access to the tenement is via the Tanami Road to The Granites Gold Mine, and then west by the sealed haul road to Dead Bullock Soak (Figure 2).

The climate is semi-arid with rainfall averaging approximately 450mm per annum. Most rainfall occurs as summer storms associated with the monsoon season between November and March. Daily temperatures range from winter minima of near zero to summer maxima of about 48^{o}C.

The Tanami Desert in which the lease is situated is widely covered in aeolian sand with a vegetation cover dominated by spinifex with low bushes and scattered small trees. However the mining lease is centered about low hills and ridges formed by the more resistant geological units (cherty BIF horizons of the Dead Bullock Formation).

4. LEASE GEOLOGY

The geology of the Dead Bullock Soak area comprises a thick succession of fine to medium grained clastic sediments, with minor chemical meta-sediments and intrusives. These rocks belong to the Dead Bullock Formation of the Paleoproterozoic Tanami Group (Hendrickx *et al*. 2000), previously referred to as the Tanami complex and locally the Mount Charles Beds (Blake *et al.* 1979).

On MLS 154, three sub-units within the Dead Bullock Formation are represented; Blake Beds containing the Callie sequence, Davidson Beds including both the Orac Formation and Schist Hills Iron Member (SHIM), and the Madigan Beds. A semi-conformable dolerite (Coora Dolerite) has been intruded and separates the two mineralised portions of the Davidson Beds, Orac Formation and SHIM (Figures 3 & 4).

Although the deformation history is complex, the most obvious structural features are isoclinal east-west trending folds with moderate easterly plunges. Many crosscutting faults are also evident. Regionally the sediments have been metamorphosed to lower greenschist facies, characterised by predominantly sericite and chlorite. However, locally at DBS the sequence has components of upper greenschist metamorphism, biotite and amphibole (Lovett *et al.* 1997).

The Schist Hills Iron Member, a sequence of banded cherts and siliceous amphibole schists, hosts the Dead Bullock Ridge, Triumph Hill, Colliwobble Ridge and Sleepy Hollow deposits. The Villa, Fumerole and Avon orebodies are hosted by the Orac Cherts which is generally similar to the Schist Hills Iron Member, but lower in the sequence. Gold mineralisation at Callie is described in Section 4.1, Callie Geology & Mineralisation.

4.1 Callie Geology & Mineralisation

The Callie orebody comprises a set of thin sheeted quartz veins (generally <1 to 20mm thick) consistently dipping 70^{o} south and striking approximately 070^{o}. The veins are concentrated within favourable structural positions and in Callie form a weakly defined vein corridor based on the increased density of veins, up to 100m wide and dipping steeply south.

The quartz veins contain gold in potentially economic quantities where they intersect favourable horizons within the folded sequence of sericite, chlorite and biotite altered meta-siltstones of the Mount Charles Beds, now incorporated within the Dead Bullock Formation (Hendrickx *et. al*. 2000). Locally the stratigraphy is subdivided into the Upper Blake Beds, Callie Boudin Chert, Magpie Schist, Callie Laminated Beds and Lower Blake Beds (all local sub-units of the Blake Beds within the Mount Charles Beds) refer to Figures 3 & 4. The Callie Laminated Beds are the most favoured host for Callie type gold mineralisation, although gold bearing veins are known to occur in all units.

The vein corridor cuts the axial plane of the major folds at a low angle, producing east-plunging shoots of higher grade mineralisation generally corresponding to the plunge of the folds in the host sequence. The Wilson Shoot is the best of these and has now shown to be developed over a strike of 1.7km. The mineralising trend is essentially east-west and mineralisation is still open at depth to the east. Moving further east mineralisation is intersected both to the south and north of Kerril Fault. This fault is a north-east trending, steep southerly dipping reverse fault. The western limit of known mineralisation is defined by the Soolin fault contact. There is good potential for further extensions in both directions.

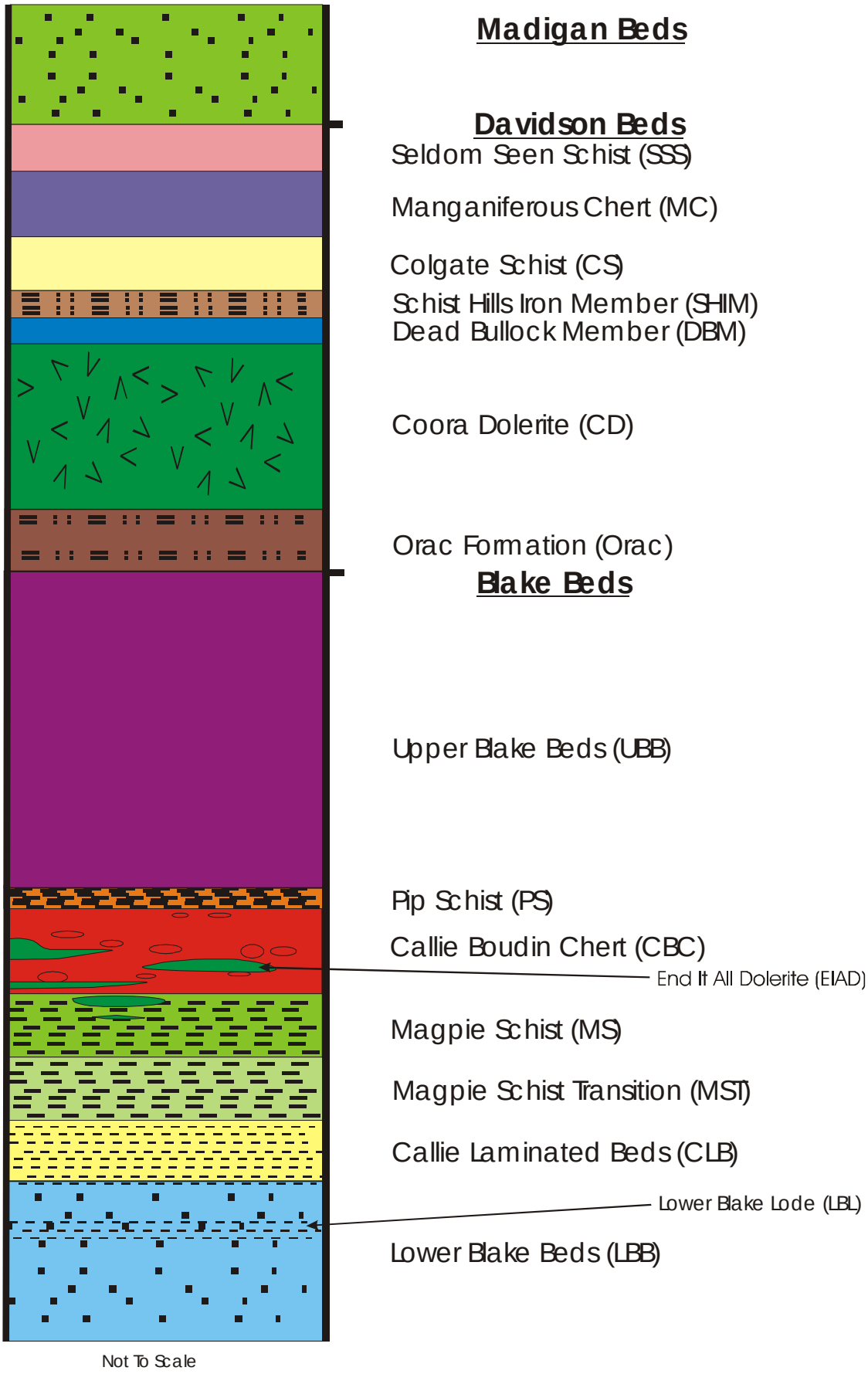

Figure 3: Dead Bullock Soak Simplified Stratigraphic Column

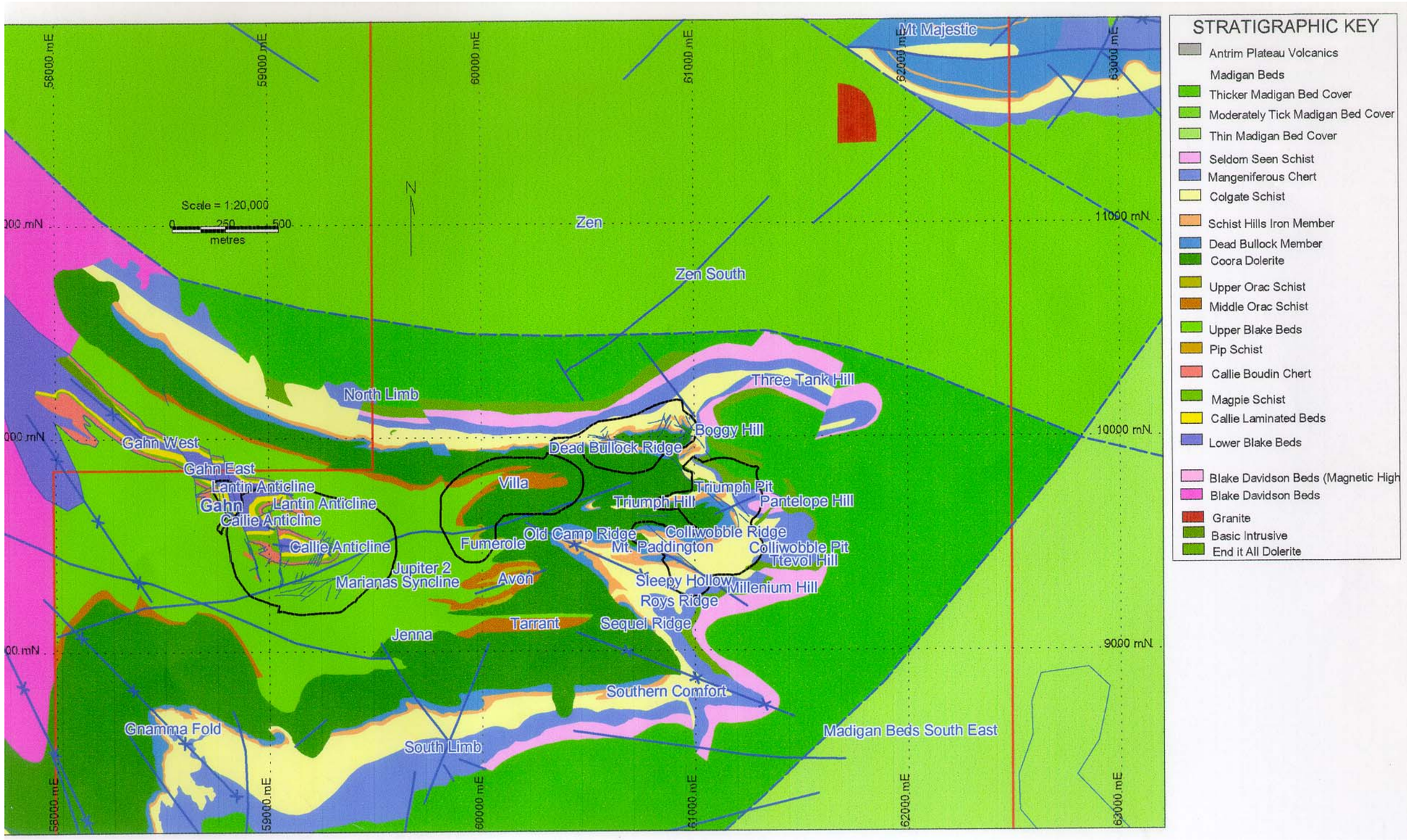

Figure 4: DBS Interpreted Geology Map

5. GEOLOGICAL ACTIVITIES

5.1 Callie Numerical Modelling Project

During 2006 Newmont initiated a numerical modelling project in conjunction with the CSIRO department of Exploration and Mining, Perth, under the auspices of the pmdCRC.

The work consisted of numerical modelling aspects of the Callie ore system to develop a predictive understanding of deformation and fluid flow at Callie and attempt to predict the relative favourability for Callie-like gold mineralisation in one or more partly drilled fold locations in the general vicinity of the defined ore shoots.

The modelling effort investigated several possible scenarios for the formation of foliation and quartz veins at Callie in order to identify the most likely stress and strain history which generated both the overall ore environment and specifically the sheeted vein set which hosts the gold mineralisation. Models were run at two different scales (approximately 5 km^3 and 1 km^3) in order to enable investigations of different scale phenomena, such as rigid elements of the rock package, or the possibility of blind thrust element beneath the deposit. Modelling was entirely structural in nature, and there was no attempt at chemical or fully coupled modelling.

Modelling took place between February and July 2006, using 3D shapes provided by the Mine Geology Team. The CSIRO team produced a 3D model based on these shapes and ran various iterations of the modelling scenarios on the in-house network, using FLAK 3D software. The following conclusion was taken from the CSIRO final report from the project.

“Based on the modelling carried out for this project it seems that vertically oriented veins are most easily formed during sinistral strike-slip deformation. Contractional models with a basement fault in the orientation of the Kerril Fault are able to form steeply oriented veins as a result of horizontal tensile failure and a stress switch. One tectonic scenario for the formation of veins at Callie is as follows:

- N-NNE shortening forming the regional folds
- Rotation of stress field counter-clockwise so that NNW shortening produces kinks in trend of fold axes and forms the ENE oriented foliation
- Continuation of counter-clockwise stress rotation and change to either pure east-west sinistral strike-slip or transpression in this orientation. Veins and mineralisation are more likely to have formed at this stage of the tectonic history. The Kerril Fault may be a late expression of this style of deformation and might have formed as a result of a basement fault in this orientation.” Schaubs, 2006.

The final report for the project is included as appendix D.

6. REMOTE SENSING ACTIVITIES

No work undertaken during this period.

7. GEOPHYSICAL ACTIVITIES

No work undertaken during this period.

8. GEOCHEMICAL ACTIVITIES

The Honours thesis completed by Jeff Bigelow (Bigelow, J., 2005) investigated the relationship between the presence of coarse-grained titanium-rich layers in the Blake Beds at the intersection with the 70/70 quartz veins, and the occurrence of coarse gold in the Callie ore body.

During further investigation in 2006 by Dr Cliff Stanley it was observed that in some instances (particularly in the Lower Blake Beds), coarse gold is present without the associated Ti-rich layers. Thus other controls on the deposition of coarse gold at Callie must exist. Representative samples have been collected and research is currently underway to investigate what these other mechanisms might be.

9. MINERALOGICAL ACTIVITIES

No work undertaken during this period.

10. SURVEY GRID ACTIVITIES

No work undertaken during this period.

11. SUMMARY OF DRILLING PROGRAMMES

Exploration at Dead Bullock Soak during the reporting period involved the completion of 35 diamond holes drilled over 5 prospects for a total of 14,909 metres. The holes are summarised in the Datasheet ann rpt.xls table in Appendix B.

All samples were sent to ALS Chemex in Alice Springs for sample preparation then on to ALS Chemex in Perth for gold ppm analysis using the AU-AA26 method.

Drilling at the Wilson and Federation targets was focused on step out extensions to known resources from the Callie deposit.

At Avalon, drilling followed up on gold mineralised intersections within the SHIM formation, recorded in the upper portions of a deep Wilson shoot hole.

The North Limb drilling targeted the mine stratigraphy on the north limb of the DBS anticlinorium. Mine stratigraphy was intersected without encountering significant mineralisation.

Jenna drilling targeted the Lower Blake stratigraphy, testing a quartz corridor behind Callie. This drilling was successful and warrants further investigation.

Auron exploration drilling targeted a quartz corridor that passes below the Callie system and in close proximity to the Callie decline. This too returned some favourable results and is to be followed up in 2007.

Outstanding grades (greater than 50 gram meters) were obtained from the following Drill holes. Table 3 summarises these as **uncut** results.

Prospect	Section	Hole Id	Depth Intersection From (m)	Width and Uncut grade Au g/t
Wilson	60850	DBD0452D6	1510	1m @ 92.90 g/t
Avalon	61550	DBD0465	958	4m @ 12.87 g/t
Wilson	61050	DBD0468	1699	1m @ 162.00 g/t
Wilson	61050	DBD0468	1778	1.5m @ 191.41 g/t
Wilson	61050	DBD0468D2	1793	3m @ 67.70 g/t
Wilson	61050	DBD0468D2	1808	2m @ 82.55 g/t
Wilson	61050	DBD0468D3	1805	1m @ 59.20 g/t
Wilson	61050	DBD0468D6	1724	6m @ 22.23 g/t
Wilson	61050	DBD0468D8	1769	1m @ 82.20 g/t
Jenna		X068_2536	116	1m @ 94.60 g/t
Jenna		X068_2536	120	1m @ 85.40 g/t
Jenna		X068_2536	215	10m @ 7.83 g/t
Jenna		X068_2536	278	1m @ 187.00 g/t
Jenna		X080_2533	244	2m @ 36.40 g/t
Auron		X168_2512	79	17m @ 5.58 g/t
Auron		X168_2513	89	24m @ 3.40 g/t

Table 3: Summary of outstanding grades (>50 gram meter intervals)

A summary of all significant intersections and relevant drilling details is included in Appendix B in the Datasheet annual rpt.xls table. A set of geological cross-sections is included as Appendix C in powerpoint as ***MLS154 DME2007 Appendix C.ppt***. Digital drill log data is included in Appendix B - Digital Data in the files Datasheet annual rpt.xls and Surface&UG Lithology Logs.xls

12. MINERAL RESOURCES AND RESERVES

Tables 4 and 5 show estimated resources and reserves at MLS154 (and other Newmont Tanami tenements) as of December 31 2006.

Open pit resources and reserves were calculated using Indicator Kriging generally within a 1g/t Au mineralised envelope. A range of densities between 2.2g/cm^3 and 2.7g/cm^3 were used to represent rock from oxide to transitional respectively. Resources and reserves are reported at a cut off grade of 1.38g/t Au.

Underground resources and reserves were calculated using Indicator Kriging within geologically defined hard and soft boundaries. A density of 2.84g/cm^3 was used in estimation calculations. Resources and reserves are reported at a cut off grade of 3g/t Au.

RESOURCES As of Dec 31st 2006	**Indicated**		**Inferred**		**Total**
	Tonnes	(g/t)	Tonnes	(g/t)	Ounces
OPEN PITS					
DBS Pits (Villa)			447,000	3.6	51,616
OFF-LEASE					
Oberon	784,000	2.29			57,804
UNDERGROUND					
Callie U/G			5,845,000	7.0	1,320,575
Federation			726,000	5.5	127,350
TOTALS	**784,000**	2.29	**7,018,000**	6.7	**1,499,541**

Table 4: December 31, 2006 Resources – 7.8Mt @ 6.2 g/t (1.56M ounces)

RESERVES As of Dec 31st 2006	**Proven**		**Probable**		**Total**
	Tonnes	(g/t)	Tonnes	(g/t)	Ounces
OPEN PITS					
DBS Pits					
OFF-LEASE					
Oberon			2,264,000	3.1	223,488
UNDERGROUND					
Callie U/G	4,612,000	5.4	4,214,000	6.2	1,634,779
Federation					
Stockpiles	386,000	2.87	2,371,000	1.14	119,905
TOTALS	**4,998,000**		**8,849,000**		**1,978,172**

Table 5: December 31, 2006 Reserves – 13.9Mt @ 4.4 g/t (1.98M ounces)

13. REPORTING OF MINING ACTIVITIES

Mining activities on MLS154 were by underground transverse long hole open stoping of the Callie deposit. Table 6 shows the production for the 2006 calendar year.

Callie	Tonnes	(g/t)
ROM	1,937,698	6.7
Low Grade	38,135	2.7

Table 6: Production summary, MLS154, 2006 calendar year

A geological description of the MLS154 Dead Bullock Soak Mining Lease and the geology of associated mining operations (underground and open cut) is presented in Section 4.

Geological reserves and resources are discussed in Section 12 and detailed in Tables 4 & 5.

14. PROPOSED WORK PROGRAMME

The work programme for the next reporting period (until Feb 11 2008) is entirely focussed on defining additional NRM mineralisation at depth within the Callie Wilson shoot system. An extensive programme of continued step out drilling of the main Callie-Wilson Shoot Lode down plunge is proposed, on sections 60950E, 61150E and 61250E.

The proposed expenditure for calendar year 2007 has been set at $6.4 million.

15. EXPENDITURE INCURRED FOR THE REPORTING PERIOD

Expenditure	Amount
Fuel	$128,095
Inventory	$19,066
Labour	$1,154,077
Materials	$155,428
Other Admin	$41,780
Safety	$20,183
Drilling and Assaying	$4,405,707
Travel & Accom	$719,465
Total	**$6,643,800**

Table 7 : Details of Exploration Expenditure (MLS154) for the calendar year 2006

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17. APPENDICES

Appendix A. Drill Rig Details, Sampling Methods and Analytical Techniques

Appendix B. Digital Data

Appendix C. Sections/plans/maps in Microsoft PPT and Adobe PDF format.

Appendix D. Callie numerical Modelling Project – Final Report.

APPENDIX A – DRILL RIG DETAILS, SAMPLING METHODS AND ANALYTICAL TECHNIQUES

Drilling

Surface Diamond Drill holes were completed either by Drillcorp Western Deephole using a UDR1500, Layne Drilling utilising a Layne1200 and Major Drilling Pty Ltd using a UDR1200 multi purpose rig. All holes are capped on completion with the hole number recorded on the plastic cap. Permanent rehabilitation is undertaken only when all possible re-entry is finalised. This is achieved by the removal of the protruding collar and insertion of a concrete plug 0.3m below ground. The cavity is back filled and mounded. The hole number is inscribed on a wooden peg, positioned adjacent to the plug. All drill hole collars are accurately located by company surveyors utilising theodolite/EDM equipment with reference to the existing DBS grid.

Sampling

Diamond core in all areas where mineralisation is deemed reasonable likely is either half core or whole core sampled at nominal 1.0m intervals. This interval is adjusted where necessary to conform to lithological boundaries. The sampling intervals are clearly documented in the drill hole logs (Appendix B, Digital Data).

Assay

All diamond core is sent to ALS Chemex in Alice Springs for preparation then shipped to ALS Chemex in Perth for gold analysis. Samples are prepared by crushing all the core in a jaw crusher then the entire sample is pulverised by an LM5. The pulps are then assayed by fire assay (method Au-AA26 - 50g charge).

APPENDIX B – DIGITAL DATA (see attached files)

- Digital Data: Drill logs and summary of drill holes (MS Excel Files)

APPENDIX C – SECTIONS (see attached files)

- Sections in Microsoft PPT and Adobe PDF formats.

Figure 1. 2007 Drill Hole Plan.

Figure 2. 60850E sect1

Figure 3. 60850E sect2 (detail)

Figure 4. 61050E sect1

Figure 5. 61050E sect2 (detail)

Figure 6. Avalon 61250 (detail)

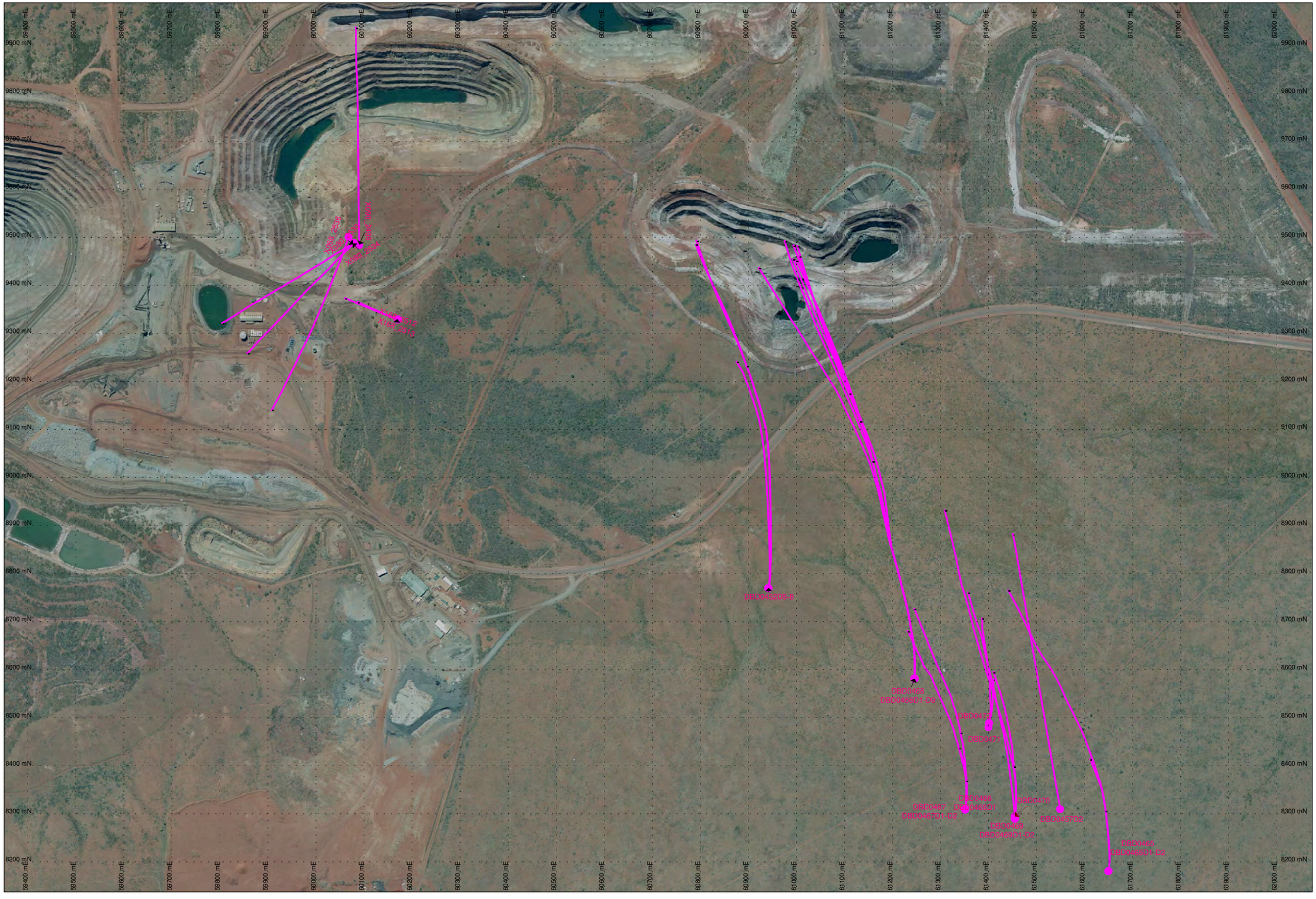
Figure 7. Avalon 61350 (detail)

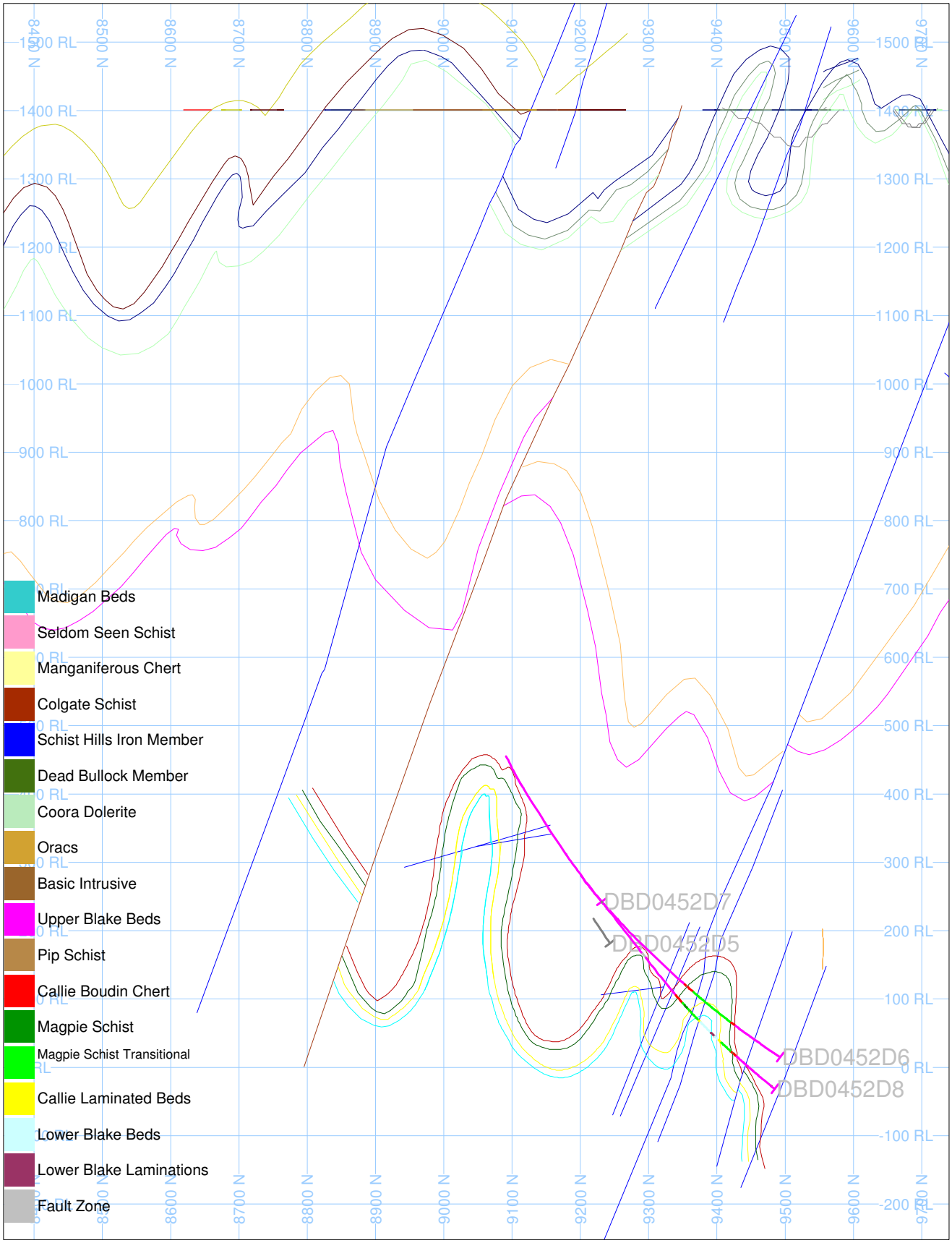
Figure 8. Avalon 61450 (detail)

Figure 9. Underground Exploration Drilling 500 mRL Level Plan

Figure 10. Underground Exploration Drilling Section View

2007 Annual Report - DrillHole Plan




Madigan Beds
Seldom Seen Schist
Manganiferous Chert
Colgate Schist
Schist Hills Iron Member
Dead Bullock Member
Coora Dolerite
Oracs
Basic Intrusive
Upper Blake Beds
Pip Schist
Callie Boudin Chert
Magpie Schist
Magpie Schist Transitional
Callie Laminated Beds
Lower Blake Beds
Lower Blake Laminations
Fault Zone
DBD0452D7
DBD0452D5
DBD0452D6
DBD0452D8
1500 RL
1400 RL
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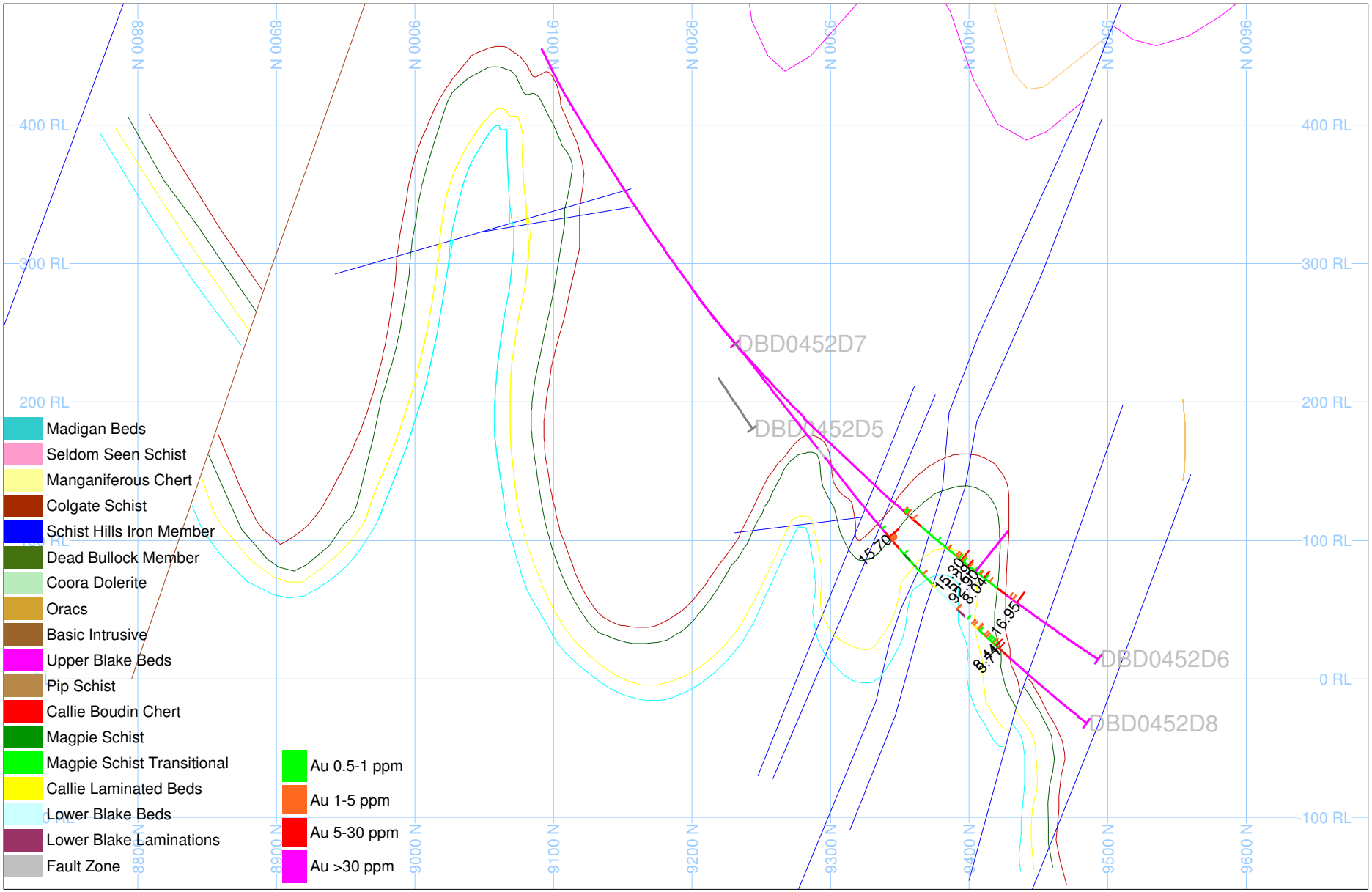
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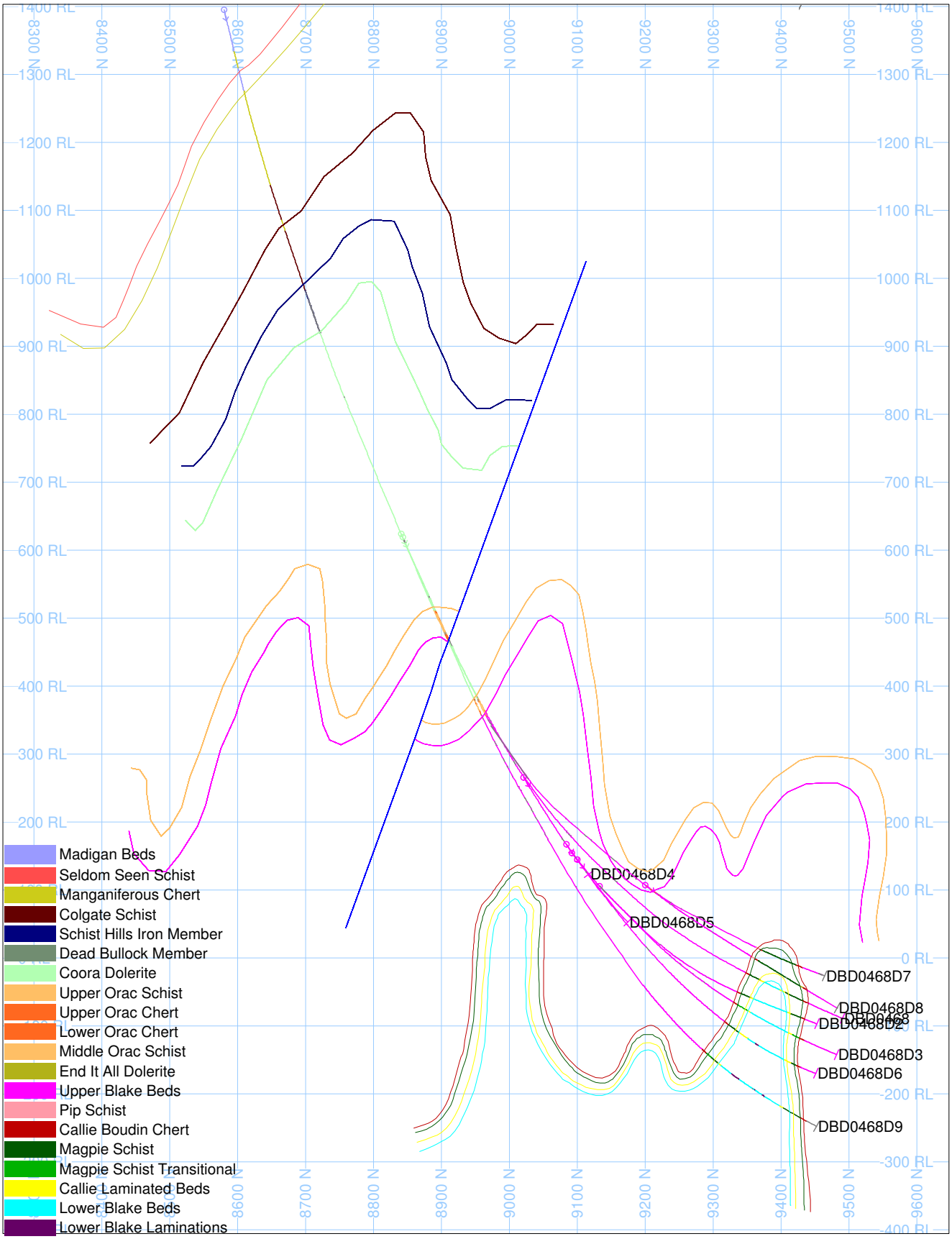
DBD0452D6
DBD0452D8
15.70
15.30
9.68
8.04
16.95
8.44
Madigan Beds
Seldom Seen Schist
Manganiferous Chert
Colgate Schist
Schist Hills Iron Member
Dead Bullock Member
Coora Dolerite
Oracs
Basic Intrusive
Upper Blake Beds
Pip Schist
Callie Boudin Chert
Magpie Schist
Magpie Schist Transitional
Callie Laminated Beds
Lower Blake Beds
Lower Blake Laminations
Fault Zone
Au 0.5-1 ppm
Au 1-5 ppm
Au 5-30 ppm
Au >30 ppm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1000 RL
900 RL
800 RL
700 RL
600 RL
500 RL
400 RL
300 RL
200 RL
100 RL
0 RL
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-300 RL
-400 RL
Madigan Beds
Seldom Seen Schist
Manganiferous Chert
Colgate Schist
Schist Hills Iron Member
Dead Bullock Member
Coora Dolerite
Upper Orac Schist
Upper Orac Chert
Lower Orac Chert
Middle Orac Schist
End It All Dolerite
Upper Blake Beds
Pip Schist
Callie Boudin Chert
Magpie Schist
Magpie Schist Transitional
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Lower Blake Beds
Lower Blake Laminations
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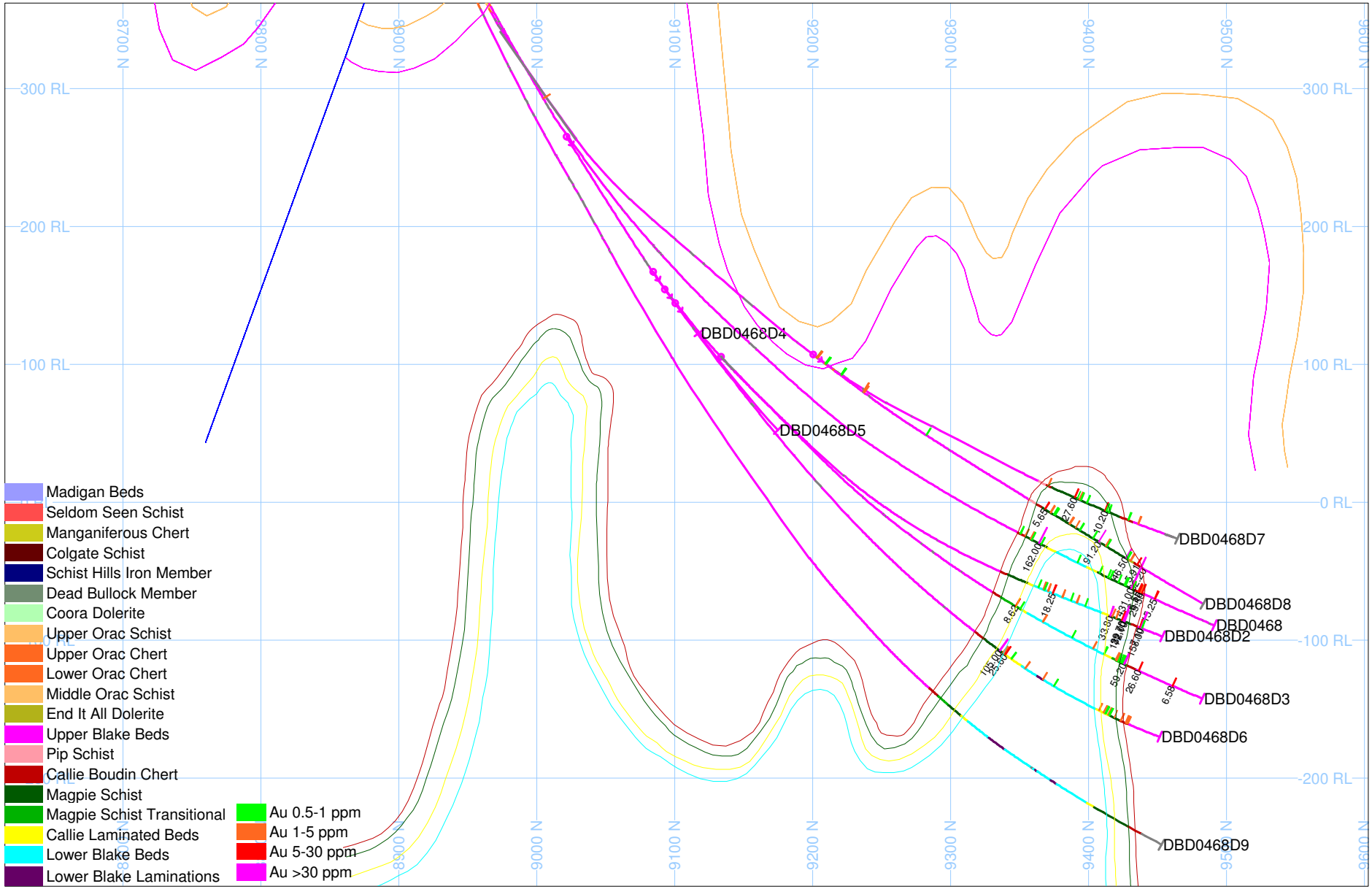
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-100 RL
-200 RL
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DBD0468
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Seldom Seen Schist
Manganiferous Chert
Colgate Schist
Schist Hills Iron Member
Dead Bullock Member
Coora Dolerite
Upper Orac Schist
Upper Orac Chert
Lower Orac Chert
Middle Orac Schist
End It All Dolerite
Upper Blake Beds
Pip Schist
Callie Boudin Chert
Magpie Schist
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Lower Blake Laminations
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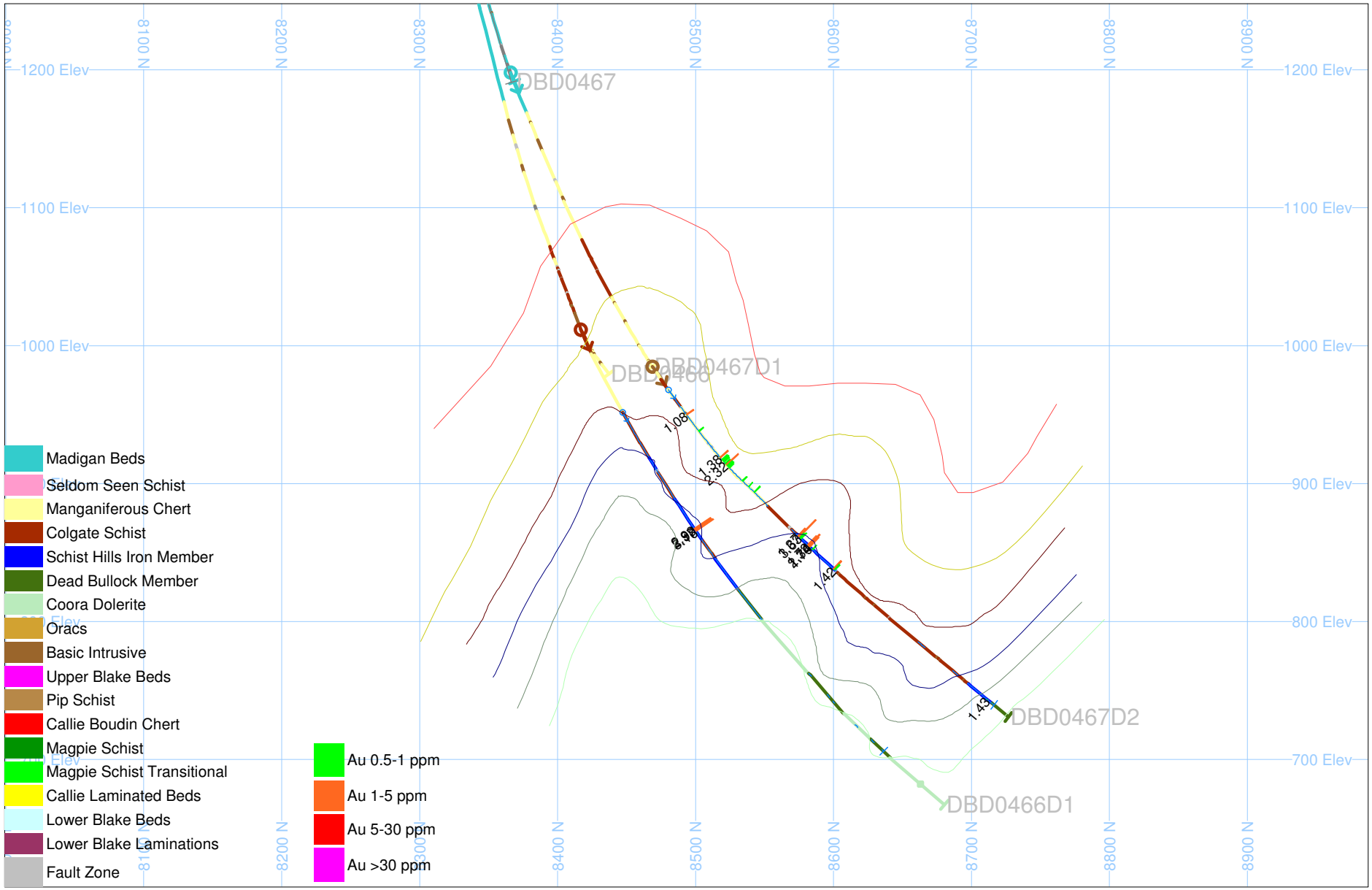
Au 5-30 ppm
Au >30 ppm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700 Elev
DBD0467
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DBD0467D2
DBD0466D1
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1.38
2.32
1.42
1.43
Madigan Beds
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Manganiferous Chert
Colgate Schist
Schist Hills Iron Member
Dead Bullock Member
Coora Dolerite
Oracs
Basic Intrusive
Upper Blake Beds
Pip Schist
Callie Boudin Chert
Magpie Schist
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Lower Blake Laminations
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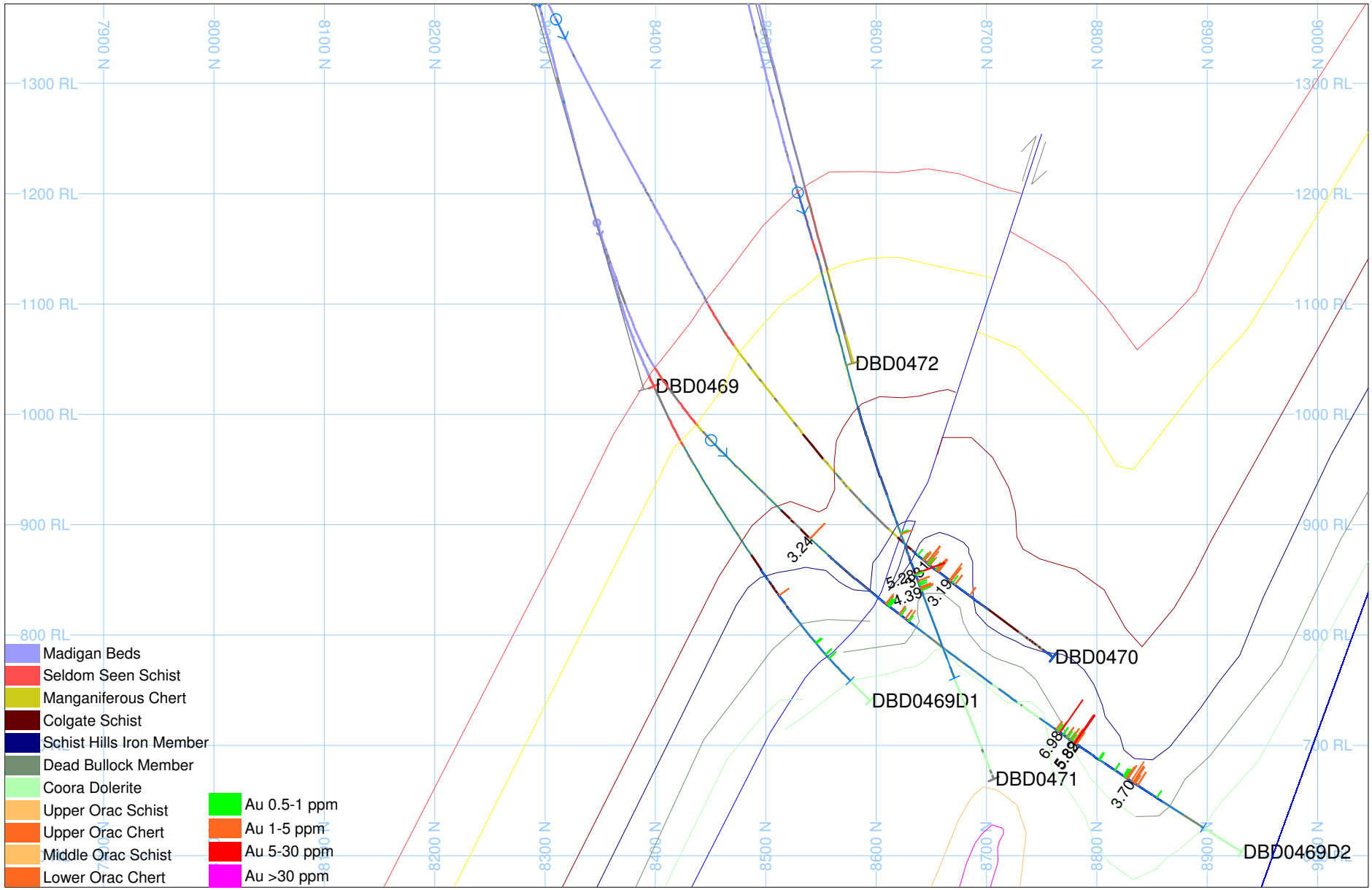
Au 1-5 ppm
Au 5-30 ppm
Au >30 ppm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Madigan Beds
Seldom Seen Schist
Manganiferous Chert
Colgate Schist
Schist Hills Iron Member
Dead Bullock Member
Coora Dolerite
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Upper Orac Chert
Middle Orac Schist
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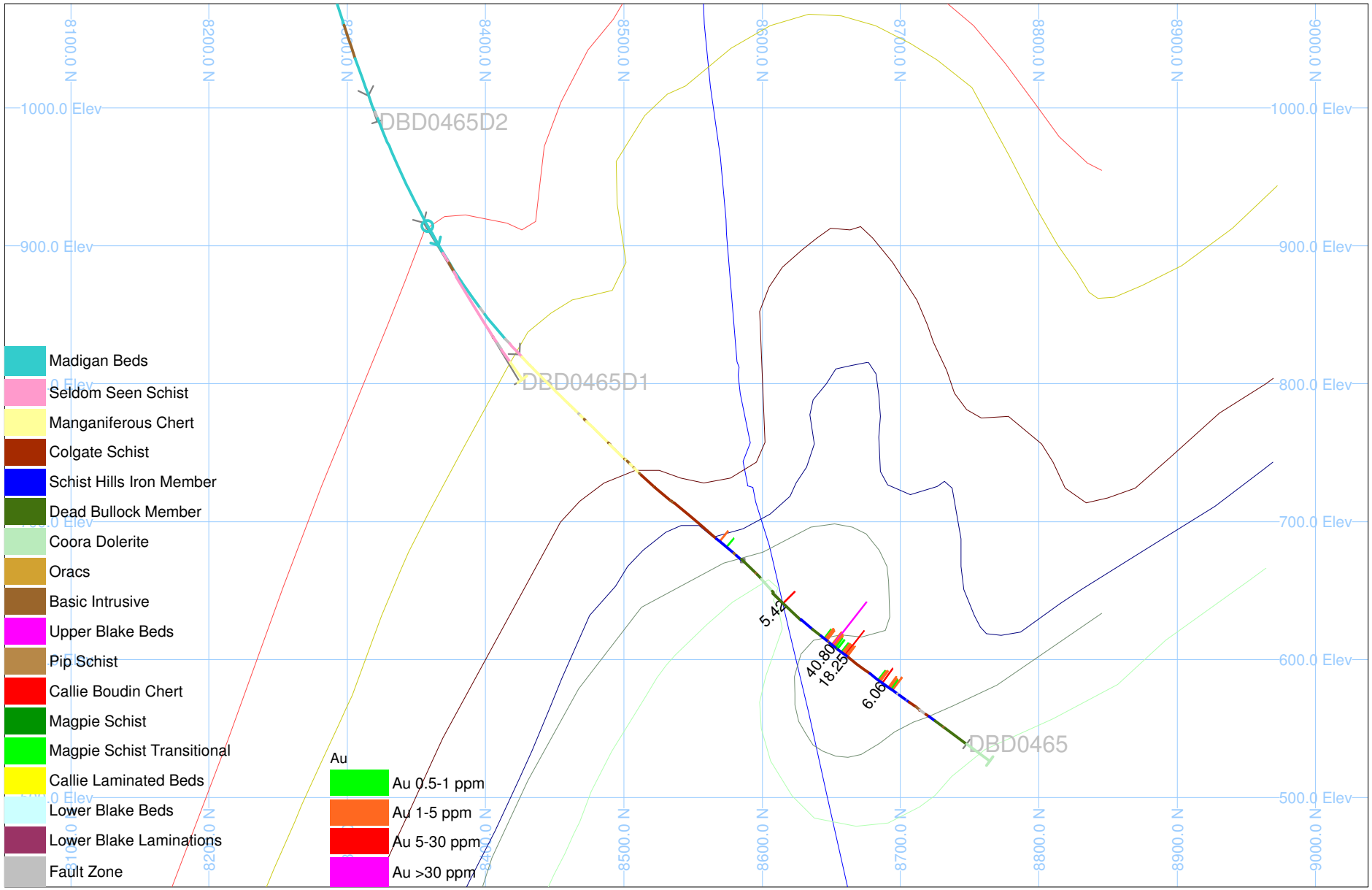
Au >30 ppm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Oracs
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Upper Blake Beds
Pip Schist
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Magpie Schist Transitional
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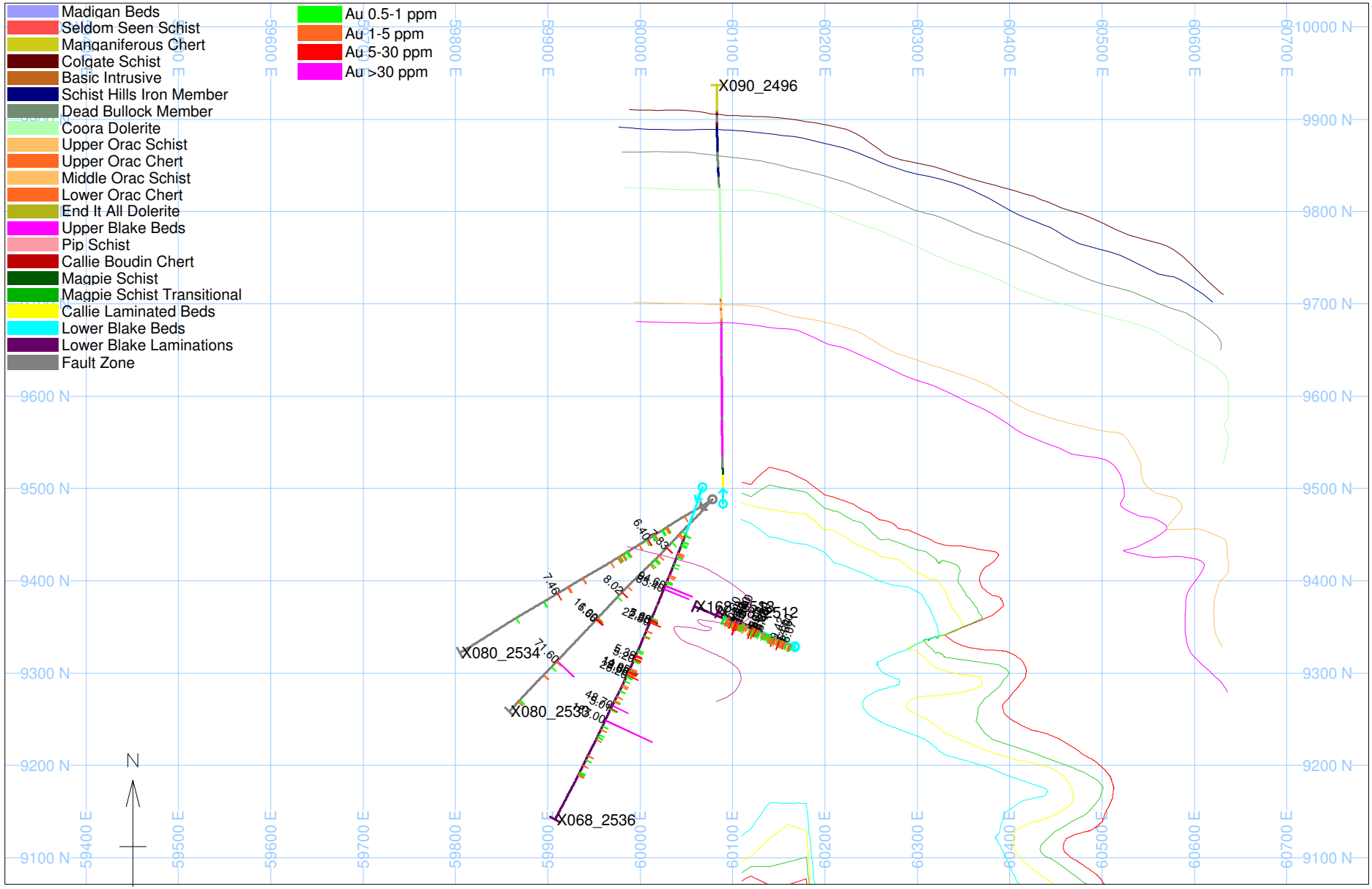
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Middle Orac Schist
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End It All Dolerite
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Magpie Schist
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Callie Laminated Beds
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Au 1-5 ppm
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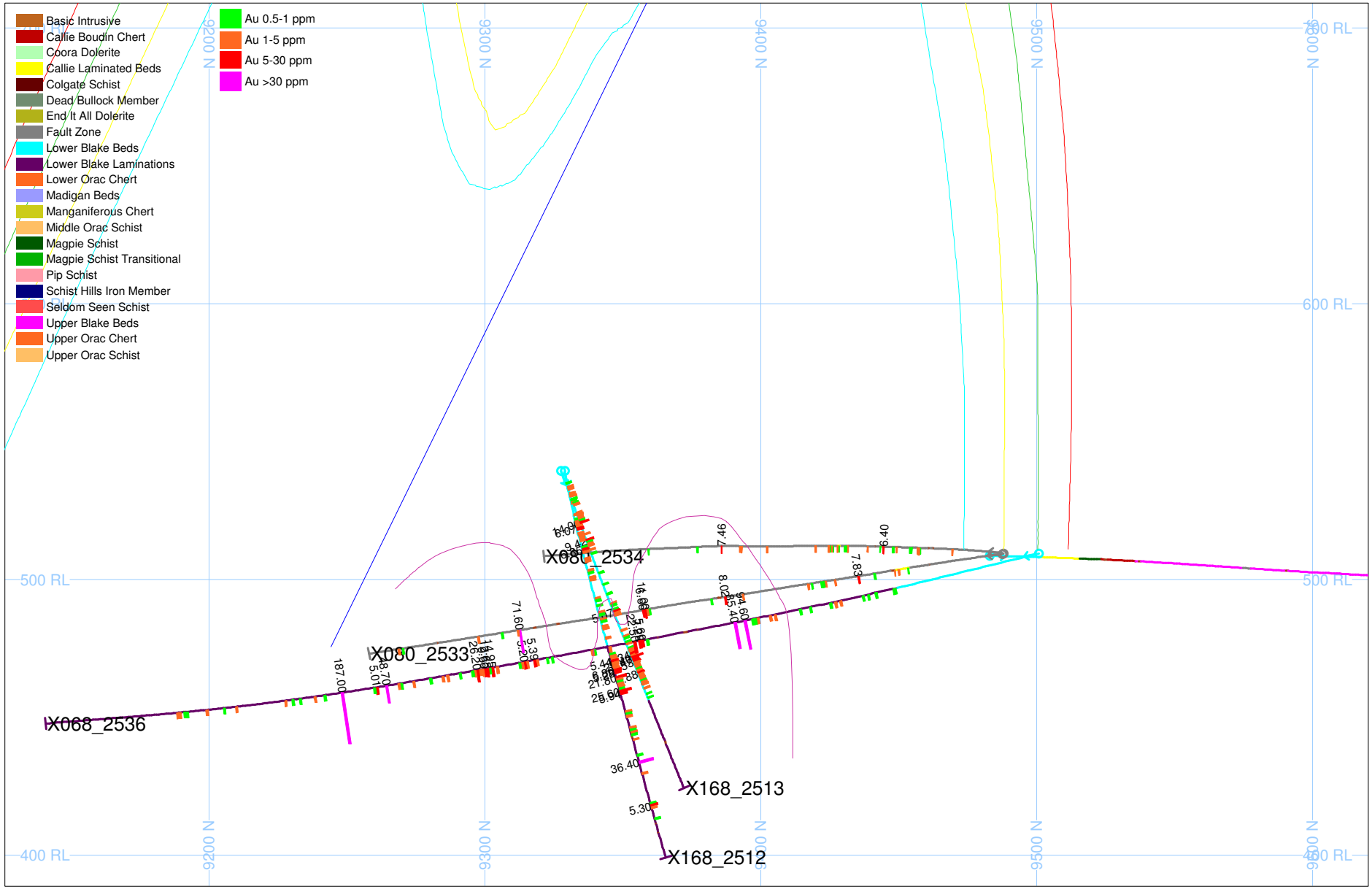
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APPENDIX D – NUMERICAL MODELLING PROJECT (see attached file)

- Callie numerical Modelling Project – Final Report by Peter Schaubs, CSIRO Exploration and Mining.

Callie Numerical Modelling Project

Final Report

Carried out for

Newmont Australia Limited

Peter Schaubs

CSIRO Exploration and Mining

June 2005

Introduction

This project aimed to identify one (or more) viable ways in which the Callie vein system formed and to demonstrate how the gold system itself was localised. Specific questions addressed by this project include

- If the entire fold train may have been formed in one event with inhomogeneous strain resulting either from the presence of the thick Coora Dolerite located in the Davidson Group above the Blake Beds or because of a blind structure (possibly a thrust tip) buried at depth below the body.

- If the vein set formed during the later stages of the main fold event or in a separate event afterwards.

- Under which stress orientation and fluid pressure scenarios, tensional opening of the 070/70 vein set could have been generated.

- If the presence of a blind structure was necessary for the formation of the Callie deposit, and if the Kerril Fault represents an expression of this structure which resulted from a post-mineralisation change in stress orientation.

In order to place some constraints on these questions, coupled mechanical (deformation) - fluid flow modelling was carried out at two scales. Mine-scale models (1004 x 1827 x 1085 m) are focussed on the Callie Mine area and incorporate the Lower Blake Beds, Callie Laminated Beds, Magpie Schist, Callie Boudin Chert and the Upper Blake Beds. Camp-scale models (7 x 7 x 11 km) reach higher into the regional stratigraphy and units include the Lower Blake Beds, Blakes Beds (combining the Callie Laminated Beds, Magpie Schist, Callie Boudin Chert) Upper Blake Beds, Orac Fm, Coora Dolerite, Davidson Beds and the Madigan Beds. Model variations on both scales include the incorporation of the Kerril +/- the Meegat Fault (and basement faults in the camp-scale models), a pre-existing foliation and various far-field stress orientations and deformation styles (contraction vs. strike-slip).

The information below is a summary of the modelling results and is meant to be accompanied by the twiki web-pages. For model set up, images, mechanical properties and individual modelling results the reader is referred to the twiki pages which can be found at:

twikipages\WebHome.htm

Summary of modelling results

Mine-scale models

Folding models

In all mine-scale folding models the majority of dilation occurs within the Magpie Schist which has been assigned the weakest mechanical properties overall. The greatest amount of dilation occurs on the south limb of the fold where the dip of the stratigraphy is rather shallow. The highest values occur towards the bottom of this limb where there is a "bulge" in the model. This bulge should probably be removed from the model but does not affect what goes on at the fold hinge. The hinge areas are also areas of significant dilation as one would expect but as the far-field stress is changed from NNW to N to NNE there is a shift of maximum dilation from the Callie Anticline to the Lantin Anticline

Areas of maximum fluid-flux do not correspond directly to areas of maximum dilation because areas of dilation are fluid sinks - regions where the fluid is flowing towards. Fluid flow velocities and fluxes will normally be "upstream" from the areas of dilation.

Areas of maximum fluid flux occur within the Callie Laminated Beds because the largest difference in permeability occurs between the Callie Laminated Beds and the Magpie Schist and therefore there is a large fluid pressure gradient and result high fluid velocities within this unit. The highest values within the Callie Laminated Beds occur where the limbs of the folds are steepest - at the west end of the northern limb of the Callie Anticline and the east end of the southern limb of the Callie Anticline

Changes in far-field stress direction do not change the position of maximum integrated fluid flux within the hinge areas - instead there is a gradual reduction in flux as the stress direction is changed from NNW to N to NNE. Areas of high flux which occur on the east end of the southern limb of the Callie Anticline during NNW shortening do however shift towards the west end when the shortening direction is changed to N and then NNE.

Although there is a switch in the location of regions of both maximum volume strain (dilation) and integrated fluid flux with a change in shortening direction none of the three models on this page shows these regions cutting across from the Lantin to the Callie anticline with one shortening direction.

Principal stress orientations are such that the minimum principal stress (σ_3) is sub-vertical in all three models. This means that any tension veins which form would have a sub-horizontal orientation. Although there are sub-horizontally oriented veins at Callie they are unmineralised and generally overprinted by the later steeply dipping mineralised veins.

Models with pre-existing foliation and multi-stage deformation (NNE to NNW shortening)

With a pre-existing axial planar foliation and NNE shortening the volume strain pattern is similar to the model without the foliation. Maximum values occur on the hinge of the Lantin Anticline within the Magpie Schist. When the shortening direction is switched to NNW the maximum dilation jumps to the top of the Callie Anticline. Integrated fluid flux patterns do not switch so dramatically with the switch in far-field stress direction and high values remain in roughly the same spot. With both NNE and NNW shortening there is a “hole” of low values where the folds have a shallow plunge (in the middle of the model). This is consistent with the models without a plane of weakness.

During both stages of the model the maximum principal stress is horizontal (parallel to the shortening direction) and the minimum principal stress is sub-vertical. When the ENE striking foliation is introduced during NNW shortening there is a moderate dip to the minimum principal stress (towards the SE).

Models with current fold shape

Strike-slip deformation and strike slip faults

Models which include either the Kerril or both the Kerril and Meegat Faults[1] and are subjected to sinistral east-west strike-slip deformation (north side to the west, south side top the east) show that the intersection of (or lack of) the faults with the fold hinge is important for localising areas of dilation, tensile failure and high fluid flux. Areas of highest integrated fluid flux within the host rocks occur where the Kerril Fault intersects the Callie Laminated and Lower Blake beds at the hinge region. Areas where the Kerril Fault intersects these two units elsewhere are elevated but not quite as high. The model with the Meegat Fault shows that this is especially important because dilation and fluid flux are reduced in the host rocks surrounding the Meegat Fault. It appears that because at the scale of this model the Meegat does not intersect the fold hinge or any unit other than the Upper Blake Beds, it does not dilate or act as a significant fluid conduit.

Pre-existing foliations

Despite the presence of the steeply oriented plane of weakness representing a foliation, both the NNW and NNE shortened models produce vertically oriented minimum principal stress (σ_3). With NNW shortening the contraction direction is perpendicular to the foliation and as such allows for vertical (dip slip) movement on these planes. This allows for significant dilation, but no tensile failure on the foliation planes. NNE contraction causes dilation values to be much lower because the shortening direction is at angle which causes the foliation to contract. No tensile failure (on the foliation planes) is exhibited by the NNE shortened model. For tensile failure to occur,

[1] Note that while we refer to the Kerril Fault in this discussion and the TWiki pages, we recognise that the observed fault with this name does show post-ore movement. Therefore this discussion is highlighting the potential for a proto-Kerril Fault, potentially propagated upwards from a deeper fault below that may have played a critical role in ore localisation.

in this manner, the shortening direction would have to be parallel to the strike of the foliation.

In both east-west strike-slip models (with and without the Kerril Fault) the far-field stress orientation allows for tensile failure on the pre-existing plane of weakness. In contrast to the NNE and NNW contraction models the orientation of the minimum principal stress (σ_3) is sub-horizontal which would allow for the formation of steeply oriented veins. As in the model without a pre-existing foliation, integrated fluid fluxes are strongly controlled by the Kerril Fault and in particular where the Kerril Fault intersects the fold hinge.

Gold grades at Callie persist through the synclinal hinge where the mineralisation crosses from the Callie Anticline to the Lantin Anticline. This does not accord precisely with the model results and implies that there is a chemical control at work here as well. Thus, we suggest that while the geomechanical effects were critical in determining the overall structural position of mineralisation, feedback effects with ongoing fluid-rock reaction in the ore-hosting units stimulated development of mineralisation adjacent to the Kerril Fault between the two anticlinal hinges.

Camp-scale models

Folding models

Models with a deep vertical basement fault

The Upper Blakes unit contains the areas of highest dilation because of its weak mechanical properties. In the model shortened from the NNW maximum dilation occurs above the DBS anticlinorium at the western edge (above the area of the Callie Mine). Areas of maximum dilation also occur in the adjacent synclinoria along the entire length of the model. In the North shortened model the overall area of high dilation is increased but occurs in the same positions. When shortened from the NNE, the overall area of high dilation is even larger and there is a greater concentration above the DBS Anticlinorium. The basement fault is an area of contraction in all models.

Areas of maximum integrated fluid flux occur within the Blakes unit because of the large difference in permeability between the Blakes and Upper Blakes units. In all models, the hinge areas of the folds/anticlinoria have the highest values of fluid flux. The area where the trend of the folds changes has elevated values in all models. In all models the DBS Anticlinorium has the largest region of high fluid flux. The NNW and N shortened models have similar patterns but the NNE shortened model has a significantly larger region of high fluid flux. The basement fault also has elevated fluid flux values in all models.

All models exhibit sub-vertically oriented minimum principal stress. In some units the orientation of σ_3 is moderately dipping but there is no evidence of sub-horizontal orientations. This indicates that any tension veins which are likely to form would be sub-horizontally oriented. The change in dip of principal stresses is symmetrical about the fold axis.

The fact that the fault is quite deep within the model, well below the Blakes Beds and the structural level of the Callie Mine, means that the presence of this fault has little effect on the models. Models without this fault are essentially the same.

Models with current fold shape

With basement faults

As with the unfolded models a vertical basement fault which follows the trend of the anticlinoria but is very deep within the model (type 1) does not have much effect on what goes on at the level of the Callie Mine. When the fault is extended to reach the Blake Beds at the eastern end of the model, fluid fluxes are increased within the fault and the Blakes Beds. A fault which dips to the SSW and strikes ESE and reaches above the Blakes Beds at the eastern end of the model (type 2) gives slightly different results, with significant fluid flux values occurring in the fault in both NNW and NNE shortened models. In the model where the fault orientation and position is that of the Kerril Fault, but the fault does not reach the level of the Callie Mine

gives significantly different results with NNW shortening. Dilation is increased relative to the other models, fluid fluxes at the hinge of the DBS Anticlinorium are increased and displacement on the fault is much greater than other models. In all models except the Kerril Fault parallel model the maximum principal stress is sub-horizontal and parallel to the shortening direction and the minimum principal stress has a sub-vertical orientation.

The model with a basement fault in the orientation of the Kerril Fault has a significant change in stress orientation somewhere between 3 and 4% shortening. At 3% shortening minimum principal stresses have a sub-vertical orientation and tensile failure is minimal. As shortening continues, a large portion of the model fails in tension as a result of movement on the fault. Following the tensile failure the principal stress orientations switch where the maximum principal stress becomes sub-vertical and the minimum principal stress becomes sub-horizontal although it is oriented in a NE-SW orientation. Any veins formed would be steeply dipping but have a NW-SE strike. Tensile failure with the stress axes in this orientation is minimal, but his model shows that a basement fault can produce sub-horizontal minimal stress orientations during contraction.

With a switch from NNW shortening to E-W sinistral strike-slip the same model produces maximum principal stresses with a NE-SW orientation and minimum principal stresses with a sub-horizontal SE-NW orientation. Veins formed under these stress conditions would be similar to those observed at Callie.

Strike-slip deformation and strike slip faults

Camp-scale model which include the Kerril +/- the Meegat Fault are consistent with the mine-scale models. Dilation is greatest where the faults intersect the Upper Blakes Beds, while integrated fluid flux is highest where the faults intersect the Blakes Beds. The intersection of the faults with the top of the DBS Anticlinorium does seem to be as important as the intersection with the Blakes Beds; however the footwall sides of the fault do have the highest fluid flux values, consistent with gold grade distribution. The Meegat

Fault intersects the Blakes Beds in these models and has high fluid fluxes in these areas. Stress orientations are similar to other strike-slip models on both the camp- and mine-scale.

Pre-existing foliations

Under both NNE and NNW shortening conditions, models with a pre-existing foliation with a 070/70 orientation result in maximum dilation within the Upper Blake beds at the DBS anticlinorium. Under E-W sinistral strike slip conditions both the model with and without the fault result in a stronger concentration of maximum dilation values at the top of the DBS anticlinorium. The model with the fault results in elevated values within the weak fault itself.

Contractional models (both NNE and NNW) result in high fluid fluxes within the Blakes beds at the top of DBS anticlinorium. With strike-slip deformation the Blake Beds also have the highest fluid fluxes but the presence of the fault localises the highest values at the intersection of the Kerril Fault with the Blakes Beds. This is consistent with the same models on the mine-scale.

As in the mine-scale models, both the NNW and NNE shortened models result in maximum principal stress parallel to the shortening direction and sub-vertically oriented minimum principal stresses. Strike-slip models produce minimum principal stresses with a sub-horizontal orientation.

Tensile failure on the foliation planes is minimal in the contractional models but strike-slip models exhibit significant tensile failure on these planes above the top of the DBS anticlinorium.

Key outcomes of the modelling

- Sub-horizontally oriented minimum stress σ_3 orientations occur in all the strike-slip models. Steeply dipping tension veins are more likely to form with the minimum principal stress in this orientation.

- Folding models with contractional deformation (horizontal shortening) generally produce sub-horizontally oriented σ_3. Steeply dipping tension veins will not form under such conditions and if veins are formed they are more likely to have a sub-horizontal orientation
- Where there is a dip to the minimum principal stress it varies across the fold hinge and is symmetrical about the fold axis – the dips are opposite on either side of the fold hinge. This suggests that if σ_3 was sub-horizontally oriented during folding that any veins formed as a result of tensile failure would also have this symmetrical pattern. In strike-slip models the principal stress orientations show little variation across the fold hinge which is consistent with the overall cross-cutting nature of the 070/70 vein set.
- Interaction of a fault such as the Kerril Fault with the Callie Laminated and Lower Blake beds at the fold hinge is important.
- The regional scale model shows that fluid flux is located mainly in the footwall of the Kerril Fault consistent with observed grade distribution in the mine.
- Presence of a pre-existing foliation during strike-slip deformation strongly controls the stress-orientation and enhances fluid flux. In some case a pre-existing foliation in the folding models causes the dip of principal stress axes to be more asymmetric across the fold hinge (i.e. dipping same way on either side of the fold axes?). The minimum principal stress is still oriented sub-vertically in these models.
- The presence of basement faults which are vertical or have a strike parallel to the trend of the DBS anticlinorium all produce vertically oriented σ_3. A basement fault in the orientation of the Kerril Fault (but does not reach the stratigraphic level of the Callie Mine), does produce sub-horizontally oriented σ_3. This occurs with NNW contraction after a large portion of the model has failed in tension under conditions where σ_3 was originally vertically oriented. The minimum principal stress is oriented in a NE-SW direction; however, and would produce NW-SE striking veins.

Addressing the questions

1. **If the entire fold train may have been formed in one event with inhomogeneous strain resulting either from the presence of the thick Coora Dolerite located in the Davidson Group above the Blake Beds or because of a blind structure (possibly a thrust tip) buried at depth below the body.**

Models presented here were unfolded at most 10% do not address this question sufficiently. To properly unfold the stratigraphy and test this hypothesis would require more work than was anticipated prior to starting the project.

2. **If the vein set formed during the later stages of the main fold event or in a separate event afterwards.**

It is more likely that veins formed during a separate event rather than during the main folding event. As outlined above steeply dipping tension veins are more easily formed when the minimum principal stress has a sub-horizontal orientation. All folding models produced sub-vertically oriented σ_3, except for the model with basement fault oriented in a Kerril Fault orientation.

3. **Under which stress orientation and fluid pressure scenarios, tensional opening of the 070/70 vein set could have been generated.**

East-west directed sinistral strike slip models produce stress orientations where the maximum principal stress has a NE-SW strike and the minimum principal stress has a sub-horizontal orientation. These models are most consistent with the 070/70 vein orientation. The strike-slip orientation may be slightly different and there may have been a slight contractional component to produce the SSE dip to the veins.

4. **If the presence of a blind structure was necessary for the formation of the Callie deposit, and if the Kerril Fault represents an expression**

of this structure which resulted from a post-mineralisation change in stress orientation.

The presence of a basement fault in the orientation of the Kerril Fault does seem like a viable option. Although in the model presented in this study the likely vein orientation is NE-SW, it shows at least that a stress switch can be triggered by a movement on faults of a certain orientation.

Exploration implications

The models show that the presence of a fault in the orientation of the Kerril Fault either during strike-slip or contractional deformation strongly controls the location of increased dilation, fluid flux and failure in tension. This indicates that this may be a key ingredient for producing high-grade gold mineralisation at the Callie Mine. The presence of a fault alone is not enough however. The models show that the interaction of the Kerril Fault with the Callie Laminated and Lower Blake Beds is important and that where the Kerril Fault intersects these units at the fold hinge may be vital. The regional model also shows that integrated fluid flux is elevated on the footwall side of the fault on the southern flank of the Callie anticline.

In mine-scale models the Meegat Fault does not intersect either of these units or the fold hinge and therefore it shows little elevated fluid flux or dilation. In the camp-scale models the Meegat Fault does intersect both the fold hinge and the Blake and Lower Beds and there the fluid flux is elevated. Models without the Kerril Fault show that the fold hinge is a site for increased fluid flux during strike-slip deformation in its own right; however, this is enhanced with the presence of the Kerril Fault. The fact that the Federation mineralisation on the eastern down-plunge portion of the Callie Anticline lies in the hanging wall and is further may from the Kerril Fault may explain in part why it has somewhat lower grades relative to the “Callie mineralisation” on the Lantin Anticline. The implication would be that we would expect the Federation mineralisation on the Callie Anticline to generally decrease in intensity down-plunge as it moves away from the Kerril Fault unless it comes into contact at greater depth with the Meegat Fault.

Based on this information, other potential mineralisation might occur on the flanks of the Callie Anticline to the west of the Callie Mine in the footwall of the Kerril Fault. In all of the models, we see some increase in fluid flow associated with flatter dips on the southern flank of the Callie Anticline. So it is possible that the combination of Kerril Fault in proximity with the favourable stratigraphy and flat dips on the southern flanks of the Callie Anticline might

see a re-development of ore grades somewhat separated from the main zone of mineralisation.

The Federation mineralisation on the Callie Anticline has the potential to increase in grade downplunge if the Meegat Fault comes in close proximity.

Further work and outstanding issues

Anisotropic permeability

In some models mechanical anisotropy was simulated by incorporating pre-existing planes of weakness representing the foliation. The code used for these models also allows for anisotropic permeability and might simulate stronger flow along any foliation incorporated into the models

Flexural slip

Davies and Campbell (2005) note that flexural slip may have played a role in the formation of the mineralised veins at the Callie Mine. Although there is a discussion regarding the relative merits of this hypothesis, no models presented here have simulated flexural slip. The modelling code we use does allow for the incorporation of discrete slip planes and might be something to test in the future.

Starting geometry for folding models

The starting geometry for the folding models could be improved by flattening the models more and starting with only slight perturbations so that the fold still form in the right position. This would allow us to determine the fold evolution over a longer period.

Mechanical properties in camp-scale models

In the camp scale models some of the results show patterns which indicate that the mechanical properties might need adjusting. For example, some of the models show tensile failure along the foliation planes at the hinge of the DBS anticlinorium but within the Orac Fm. One might have expected tensile failure in this orientation to have occurred lower down in the stratigraphy. Mechanical properties for the mine scale models were based on geotechnical information provided by Newmont. Some of this data were used in the camp-scale models but there was a certain amount of simplification in these models (CLB, MS & CBC lumped together) as well as some uncertainty

as to the properties of the units above the Upper Blakes. A parameter test on the mechanical properties used in these models was not carried out due to lack of time but is something that should be done if further work is carried out. Petrophysical testing on representative sample from the higher stratigraphy would also be useful (if it hasn't already been carried out).

Transpressional deformation

The effects of transpression have not been tested. Strike-slip models presented here indicate that steeply dipping tension veins can form under these conditions. Models with both a contractional and strike-slip component may give similar results.

Extension of mine-scale model down plunge

The mine-scale models could be extended to the east and down plunge to test the effects of the change in fold trend to a more E-W orientation.

Chemical effects

As noted previously, there is clearly a chemical control on mineralisation in this system as well. Clearly (and not surprisingly) all of the purely geomechanical models show a reduction in fluid flow and volume strain in the synclinal position between the Callie and Lantin Anticlines. The grade shells tell a different story, however. The suggestion is that feedbacks between chemical reaction and mechanically controlled dilation could well have ensured that the system propagated through the syncline between the two anticlines. Some coupled modelling of deformation and chemical reaction is required to test this idea, however.

Summary

Based on the modelling carried out for this project it seems that vertically oriented veins are most easily formed during sinistral strike-slip deformation. Contractional models with a basement fault in the orientation of the Kerril

Fault are able to form steeply oriented veins as a result of horizontal tensile failure and a stress switch. One tectonic scenario for the formation of veins at Callie is as follows:

- N-NNE shortening forming the regional folds
- Rotation of stress field counter-clockwise so that NNW shortening produces kinks in trend of fold axes and forms the ENE oriented foliation
- Continuation of counter-clockwise stress rotation and change to either pure east-west sinistral strike-slip or transpression in this orientation. Veins and mineralisation are more likely to have formed at this stage of the tectonic history. The Kerril Fault may be a late expression of this style of deformation and might have formed as a result of a basement fault in this orientation.

18. BIBLIOGRAPHIC DATA SHEET

REPORT NUMBER	
REPORT TITLE	ANNUAL REPORT FOR MLS154 (DEAD BULLOCK SOAK) COVERING WORK UNDERTAKEN FROM 12 FEBRUARY 2006 TO 11 FEBRUARY 2007.
PROSPECT NAME	Dead Bullock Soak
TENEMENT NUMBERS	MLS154
OWNER/JV PARTNERS	Newmont Tanami Pty Ltd 100%
COMMODITIES	Gold
TECTONIC UNITS	Granites Tanami Block (Inlier)
STRATIGRAPHIC UNITS	Arunta Complex
1:250,000 MAPSHEET	The Granites SF52-3
1:100,000 MAPSHEET	Inningarra 4856
KEYWORDS	Dead Bullock Soak, Callie, Wilson Shoot, Federation Shoot, Underground Exploration, North Limb, Jenna, Avalon.