

**Field Work 2011**

**ARTHUR RIVER PROJECT**

**Northwest Tasmania**

**October 2011**

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*Unless expressly stated otherwise, all financial amounts quoted in this document are in Australian Dollars. Physical units are in accordance with the international standard SI system of weights and measures.*

*All maps and plans are based on GDA94, Zone 55, unless stated otherwise. The local grid conversion is documented in section 2.4 of this report.*

## Field Work 2011

### ARTHUR RIVER MAGNESITE PROJECT

October 2011

## CONTENTS

<b>1. EXECUTIVE SUMMARY .....</b>	<b>5</b>
<b>2. LOCATION AND ACCESS .....</b>	<b>6</b>
<b>2.1 SCOPE OF REPORT .....</b>	<b>7</b>
<b>2.2 SOURCES OF INFORMATION .....</b>	<b>7</b>
<b>2.3 TENURE .....</b>	<b>7</b>
<b>2.4 CONVERSION TO LOCAL GRID .....</b>	<b>9</b>
<b>3. FLORA AND FAUNA.....</b>	<b>10</b>
<b>4. PREVIOUS WORK .....</b>	<b>10</b>
<b>5. CURRENT WORK .....</b>	<b>12</b>
<b>5.1 GROUND MAGNETICS SURVEY .....</b>	<b>12</b>
<b>5.2 RE-LOGGING OF OLD CORE .....</b>	<b>14</b>
<b>5.3 DRILLING .....</b>	<b>14</b>
5.3.1 <i>Drilling Aims .....</i>	<i>15</i>
5.3.2 <i>Drilling Methods.....</i>	<i>15</i>
5.3.3 <i>Downhole Surveys &amp; Measurements .....</i>	<i>16</i>
5.3.4 <i>Surveying and Capping of Holes .....</i>	<i>17</i>
<b>5.4 HANDLING AND PROCESSING OF CORE.....</b>	<b>17</b>
5.4.1 <i>Recovery and Transport.....</i>	<i>17</i>
5.4.2 <i>Core Photography .....</i>	<i>18</i>
5.4.3 <i>Magnetic Susceptibility.....</i>	<i>18</i>
5.4.4 <i>Specific Gravity .....</i>	<i>19</i>
5.4.5 <i>Alpha/Beta Measurements .....</i>	<i>19</i>
5.4.6 <i>Geotechnical Logging.....</i>	<i>19</i>
5.4.7 <i>Geological Logging .....</i>	<i>19</i>
5.4.8 <i>Core Sampling .....</i>	<i>20</i>
5.4.9 <i>Assays .....</i>	<i>20</i>
5.4.10 <i>Quality Control.....</i>	<i>20</i>
5.4.11 <i>Core Storage.....</i>	<i>22</i>
<b>5.5 METALLURGICAL WORK .....</b>	<b>23</b>
<b>5.6 HONOURS THESIS .....</b>	<b>25</b>
<b>5.7 HYDROGEOLOGY .....</b>	<b>26</b>
<b>6. SUMMARY OF DRILLING RESULTS.....</b>	<b>27</b>
<b>6.1 MB009 .....</b>	<b>27</b>
<b>6.2 PB003 .....</b>	<b>27</b>
<b>6.3 AR027.....</b>	<b>28</b>
<b>6.4 AR028.....</b>	<b>29</b>
<b>6.5 AR029.....</b>	<b>34</b>
<b>6.6 AR030.....</b>	<b>34</b>
<b>6.7 AR031.....</b>	<b>35</b>
<b>6.8 AR032.....</b>	<b>38</b>
<b>6.9 AR033.....</b>	<b>38</b>
<b>6.10 AR034.....</b>	<b>39</b>
<b>6.11 MB007.....</b>	<b>41</b>
<b>6.12 MB008.....</b>	<b>41</b>
<b>7. REGIONAL GEOLOGY.....</b>	<b>43</b>

## CONTENTS - Continued

<b>8. LOCAL GEOLOGY .....</b>	<b>44</b>
<b>8.1 OVERBURDEN .....</b>	<b>45</b>
8.1.1 <i>Alluvial Overburden</i> .....	45
8.1.2 <i>Weathered Overburden</i> .....	45
<b>8.2 MAGNESITE .....</b>	<b>45</b>
8.2.1 <i>Talc Content</i> .....	46
8.2.2 <i>Silica Content</i> .....	48
8.2.3 <i>Solution Features/Weathered Zones</i> .....	52
8.2.4 <i>Other Carbonates</i> .....	52
<b>8.3 DOLERITE .....</b>	<b>52</b>
<b>9. DISSCUSSION .....</b>	<b>56</b>
<b>10. CONCLUSIONS.....</b>	<b>59</b>
<b>11. REFERENCES .....</b>	<b>60</b>

## DIGITAL APPENDIXES

<b>APPENDIX A – DRILLING AND RESOURCE SECTIONS.....</b>	<b>61</b>
<b>APPENDIX B – GEOLOGICAL AND GEOTECHNICAL LOGS.....</b>	<b>61</b>
<b>APPENDIX C – CORE PHOTOS.....</b>	<b>61</b>
<b>APPENDIX D – 2011 ASSAY RESULTS .....</b>	<b>61</b>
<b>APPENDIX E – MAGNETICS SURVEY .....</b>	<b>61</b>
<b>APPENDIX F – MET RESULTS.....</b>	<b>61</b>

## LIST OF FIGURES

<b>Figure 1:</b> Location of Arthur River Magnesite Project. ....	6
<b>Figure 2:</b> Tenure, Arthur River Magnesite Project. ....	8
<b>Figure 3:</b> Surface geology map of the Arthur River Magnesite deposit produced by Mineral Resources Tasmania, showing the boundaries of 24M2009, and retention lease RL18/1987, inferred boundaries of magnesite and the line used for geophysical study by Perry (2011). ....	8
<b>Figure 4:</b> LiDAR DTM of Arthur River ML, oriented to Local Grid showing drillholes and change in relief. Johnny’s Creek runs through the centre of the lease, and from this data it is obvious that it has been a more significant watercourse in the past, with glaciation also likely. ....	9
<b>Figure 5:</b> Plane grid conversion used to convert data from GDA94 Zone 55 to Local Grid. ....	9
<b>Figure 6:</b> Detailed image of the lease area, showing position of holes from the most recent drilling program, with positions of previous holes also displayed. Solid blue outline displays extent of a modelled pit in the area, dashed blue indicates the boundary of magnesite as inferred by Crest, and red hashed area shows the Johnny’s Creek buffer zone. ....	11
<b>Figure 7:</b> Magnetics image for doleritic material cross-cutting the Arthur River Magnesite deposit. A local E-W dyke is clearly seen on the south-western side, apparently broken by multiple faults (black lines), which also appear to translate to the sill. The local magnetic high at the previous pumping bore in the south is caused by a large amount of sub-surface waste steel. ....	13
<b>Figure 8:</b> Retrieving core from AR028. ....	14
<b>Figure 9:</b> An example of presentation of rock core from AR027, showing meter markings on core in addition to bottom-of-hole orientation line. In situations where metres could not be written on the core, meter intervals were written on core trays. ....	18
<b>Figure 10:</b> Grouped results for standards used for assays, showing well grouped results for all analytes. ....	21
<b>Figure 11:</b> Grouped results for standards used for assays, showing well grouped results for all analytes. ....	21
<b>Figure 12:</b> Core logging. ....	22
<b>Figure 13:</b> Section showing MB009 lithologies and inferred geology on 20760N Local Grid. ....	30
<b>Figure 14:</b> Section showing AR006 and PB003 lithologies and inferred geology on 20800N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade. ....	31
<b>Figure 15:</b> Section showing AR024, AR025, AR027, AR028, MB004 and MB007 lithologies and inferred geology on 20420N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade. ....	32
<b>Figure 16:</b> Section showing AR002C, AR027, AR031 and AR032 lithologies and inferred geology on 20480N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade. ....	33
<b>Figure 17:</b> Section showing AR029 lithologies and inferred geology on 20560N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade. ....	36
<b>Figure 18:</b> Section showing AR026 and AR030 lithologies and inferred geology on 20680N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade. ....	37
<b>Figure 19:</b> Section showing AR033 and AR034 lithologies and inferred geology on 20720N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade. ....	40
<b>Figure 20:</b> Section showing MB008 lithologies and inferred geology on 20640N Local Grid. Numbers adjacent to the hole indicates MgO content, with green indicating low grade material, and red high grade. ....	42
<b>Figure 21:</b> HyLogger data for hole AR007, showing mineral contents in relative quantities in the upper section, with the lower section showing the down-hole metre-by-metre scan results. Green represents magnesite, light brown talc, and dark brown/purple at the base is dolomite. Purple at the top of the section represents no material. ....	47
<b>Figure 22:</b> HyLogger data for hole AR007, showing mineral contents in relative quantities in the upper section, with the lower section showing the down-hole metre-by-metre scan results. Green represents magnesite, light brown talc, and dark brown/purple at the base is dolomite. Purple at the top of the section represents no material. ....	47
<b>Figure 23:</b> Comparison of assayed silica content and HyLogger data for hole AR002C, showing a partial relationship between the silica and talc contents. Talc content is represented by light brown, magnesite by light green, and dolomite by dark brown. ....	49

## LIST OF FIGURES - Continued

<b>Figure 24:</b> Comparison of assayed silica content and HyLogger data for hole AR016, showing a strong relationship between the silica and talc contents. Talc content is represented by light brown, magnesite by light green, and dolomite by dark brown. ....	50
<b>Figure 25:</b> Comparison of assayed silica content and HyLogger data for hole MB008, showing a partial relationship between the silica and talc contents. Talc content is represented by light brown, magnesite by light green, and dolomite by dark brown. ....	51
<b>Figure 26:</b> Long section 10080E, oriented on Local Grid S-N displaying modelled position of dolerite dyke and sills. ....	54
<b>Figure 27:</b> Surface geology of the Arthur River Magnesite Deposit. Alluvial materials show as shaded areas, and include weathered doleritic materials that may have been transported, glacial alluvial materials, magnesian clays and landslip materials. Produced using information from drilling and surface mapping. ....	55
<b>Figure 28:</b> Simple section inferring possible geology around MB008 and AR030, with high grade zones of magnesite highlighted. Numbers to left of zones indicate average grades, with numbers to right showing assay results. ....	57

## LIST OF TABLES

<b>Table 1:</b> Surveyed collar locations with hole depth and orientations. Co-ordinates are in GDA94, MGA Zone 55. ....	16
<b>Table 2:</b> Summary table of assay results from drilling program showing significant intersections of high grade magnesite (>40% MgO) and their corresponding FeO and SiO contents. Drill hole AR029 failed to intersect any high grade magnesite of note. ....	17
<b>Table 3:</b> Silicon distributions by %Wt in metallurgical samples analysed by ALS for Koenig Consulting, showing mineralogical distribution of silica for each size fraction. Total silica content of samples vary from about 2.5 to 4.7%Wt. ....	25

# 1. Executive Summary

During the period June 2010 to July 2011 Tasmania Magnesite have completed the following work on the Arthur River Project.

- A Ground Magnetism Survey.
- Geological Mapping.
- Re-logging of all available drill core.
- Metallurgical test work
- Sponsored an Honors Thesis in geophysics / geology at the University of Tasmania.
- A drilling program comprising
  - 8 exploration diamond drill holes for 976.4m of drilling.
  - 2 diamond drilled water monitoring bores for 93.3m of drilling.
  - 1 Open hole hammer water monitoring bore for 48m of drilling
  - 1 Open Hole hammer water bore for 49.5m of drilling.
- A hydro geological investigation.

The recent work has succeeded in mapping much of the distribution of dolerite in the area, finding it to be less extensive than previously thought. Some material which had previously been logged as hanging wall schist was generally found to be extremely decomposed dolerite. This finding has expanded the distribution of dolerite sills in the area. The actual position and nature of both the hanging wall and footwall contacts remain ambiguous, but evidence suggests that the current models are relatively accurate.

A previously unidentified area of very shallow surficial cover has been identified to the north of the dolerite dyke on the western side of the deposit. The magnesite here is comprised of relatively high grade material with low contaminant grades. Whilst this area requires significant resource definition drilling it presents an opportunity for initial open pit development.

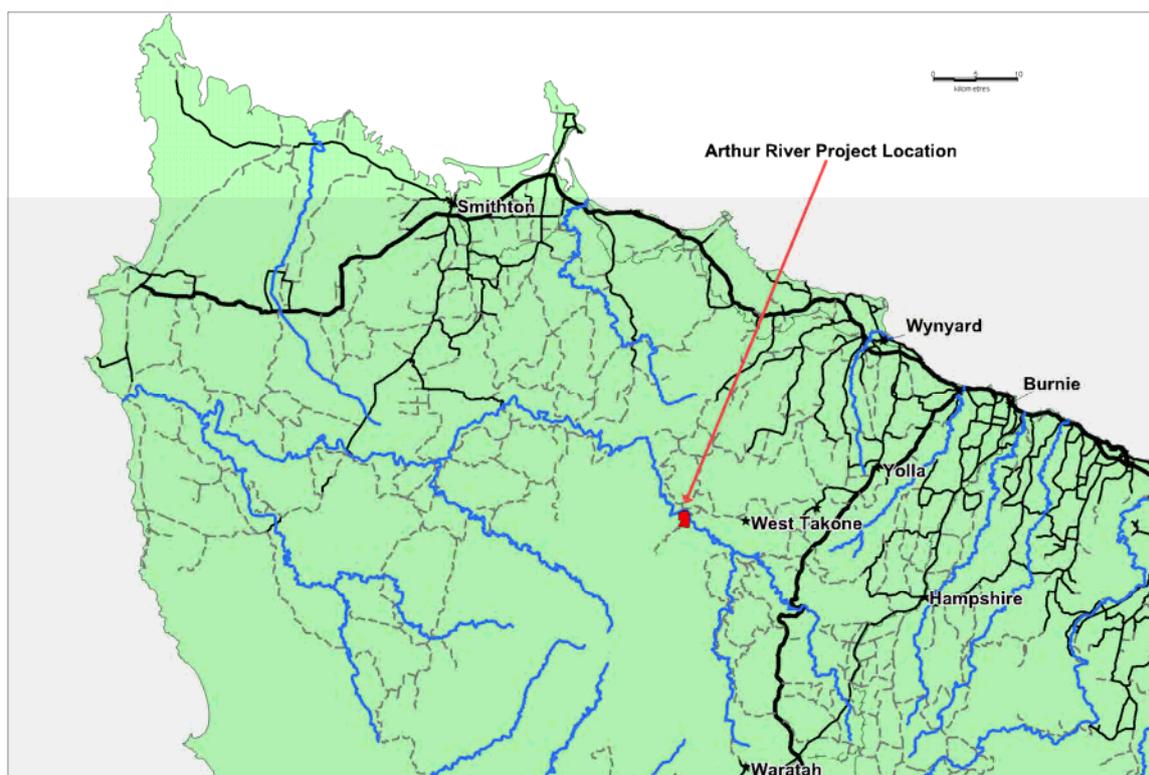
The results of the ongoing University of Tasmania geophysics honors project are better defining the depth of cover, and providing a greater understanding of the geology of the magnesite.

Talc more pervasive than previously thought, with highly variable quantities present in four drillholes which were run through the HyLogger at Mineral Resources Tasmania. It is recommended that in future all drill core is scanned to quantify the talc contents as this may present a significant metallurgical issue.

## 2. Location and Access

The Arthur River Magnesite Project is located approximately 50km to the southwest of Burnie, Tasmania within mining lease 24M2009 (Figure 1), on the site of a currently inactive forestry coup in the area to the immediate south east of the junction of the Arthur and Keith Rivers. Access is via the Murchison Highway, which is followed to the township of Henrietta, where a turn is made towards Takone. This road is then followed through West Takone and Farquhars Road, and crosses the Arthur River by way of a light-duty 4 tonne bridge which is locked to prevent unauthorized use. Access within the lease itself is via a network of 4WD tracks created during prior logging and drilling activity.

The terrain of the region is generally high relief, with the immediate valley showing evidence of glacial action. Hills in the area reach over 500 metres AHD, while the Arthur River adjacent to the lease sits at a height of about 140 metres AHD. The area of interest in the south-western part of the mining lease has relatively low relief, elevations here ranging from approximately 145 to 190 metres AHD. Due to the high relief of the region, river levels are subject to rapid change during rain, with small creeks also rising significantly during periods of rain, the most notable of these being Johnny's Creek, which enters the lease from the south-east and then works its way northwards to flow into the Arthur River.



**Figure 1:** Location of Arthur River Magnesite Project.

## 2.1 Scope of Report

The scope of this report is to;

- Document geological work undertaken on the project in 2011.

## 2.2 Sources of Information

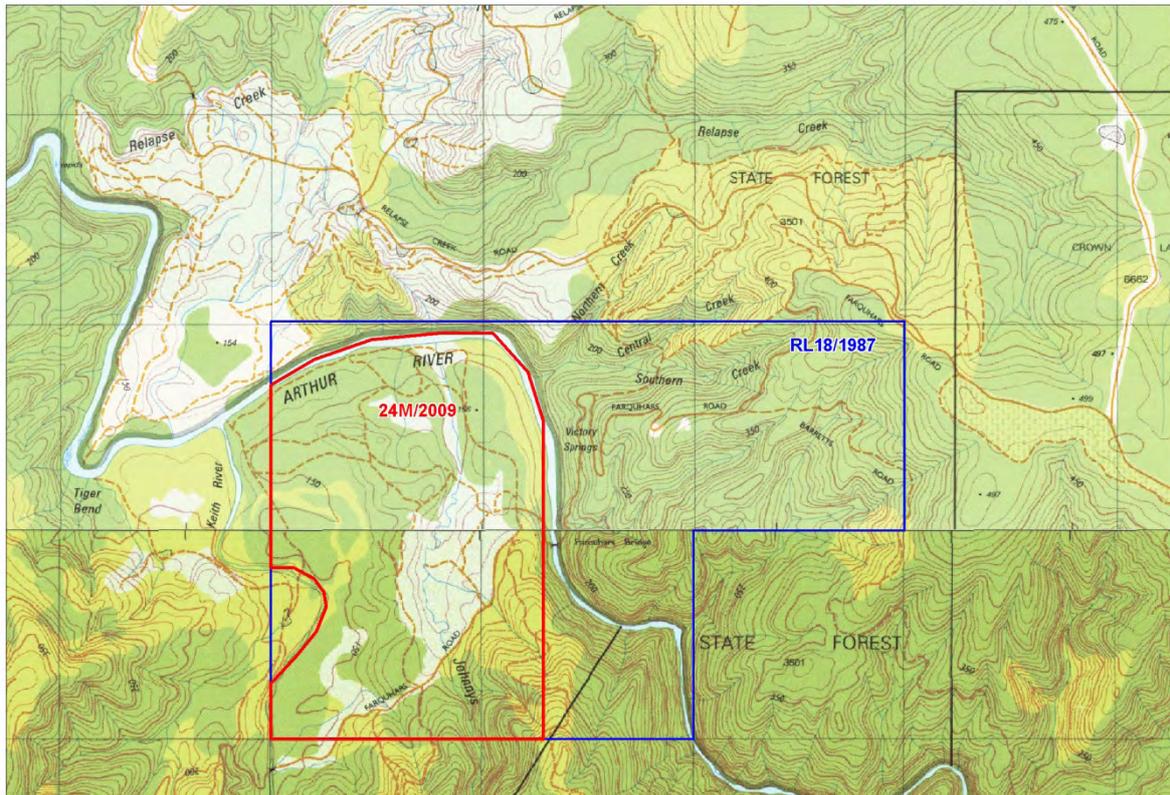
This technical report is based on;

1. Observations made by Chris Allen and Stewart Capp in the course of field work conducted between 2010 and 2011.
2. Information collated from Open File reports by Derwent Geoscience.
3. Information compiled by Derwent Geoscience from Tasmania Magnesite NL Reports and files relating to the period 1997 to 2009.
4. Digital drilling data collected and collated by Derwent Geoscience.

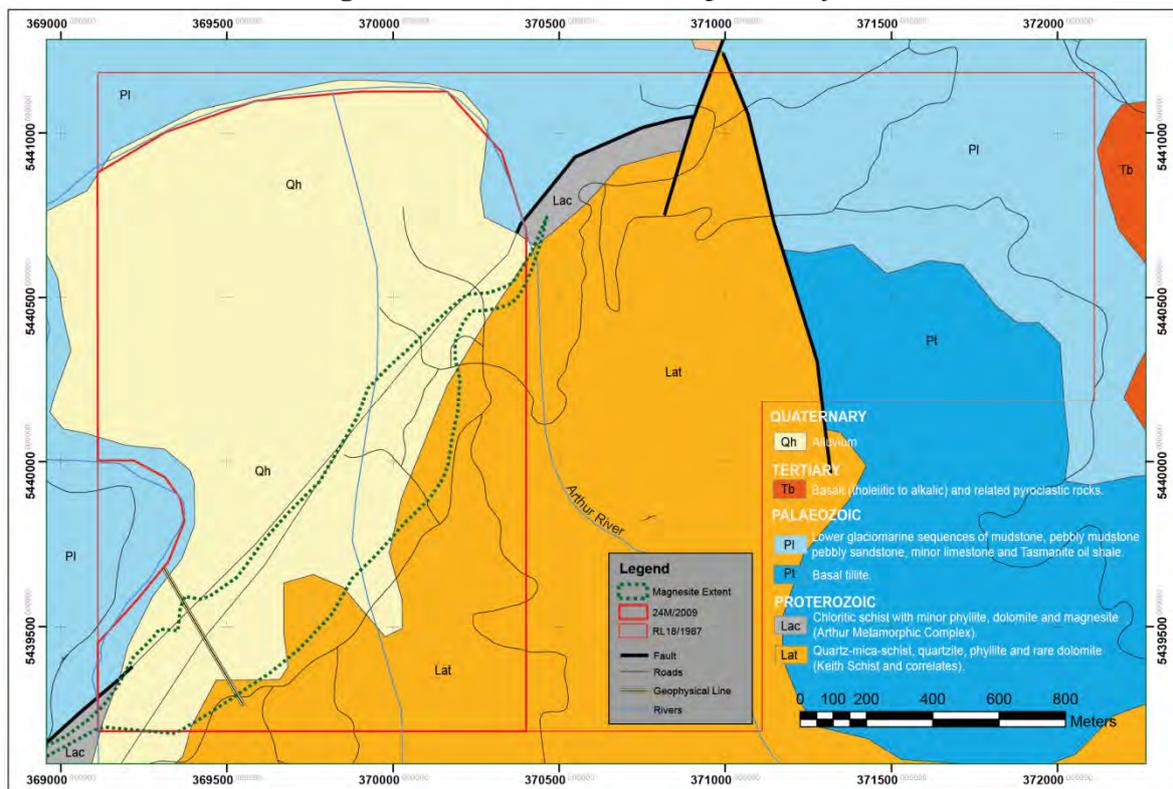
## 2.3 Tenure

Tasmania Magnesite NL, a subsidiary of Beacon Hill Resources Plc., currently holds Mining Lease 24M2009 and retention lease RL18/1987. RL18/1987 was purchased from Mineral Holdings Australia in 1997, with 24M2009, previously known as 1M/99, originally granted in 1999. The lease on 24M2009 expires on 15 August 2020.

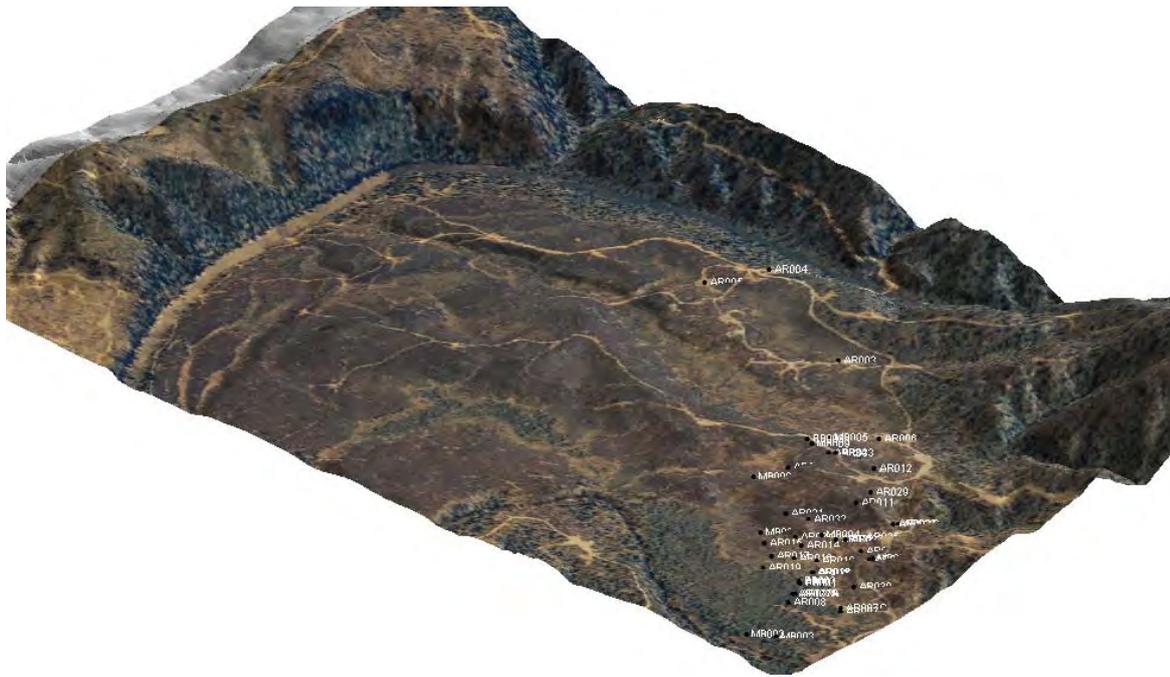
Work in 2011 was mostly conducted within Mining Lease 24M2009, whose bounds are shown in Figure 2, with activities in retention lease areas restricted to reconnaissance of reported magnesite features in an effort to better understand their surface expression. The mining lease is wholly contained within the bounds of Retention Lease RL8718, and is bound by the Keith River to the west, the Arthur River to the north and east, and mountainous terrain to the south. The retention lease over the Arthur River Magnesite Project area extends further to the north and east, covering all known magnesite occurrences in the area, including several large outcrops in the Central and Southern Creek area. An additional retention lease several kilometres to the south-west is also currently held by Tas Magnesite, but this site was only visited once to observe surface features.



**Figure 2:** Tenure, Arthur River Magnesite Project.



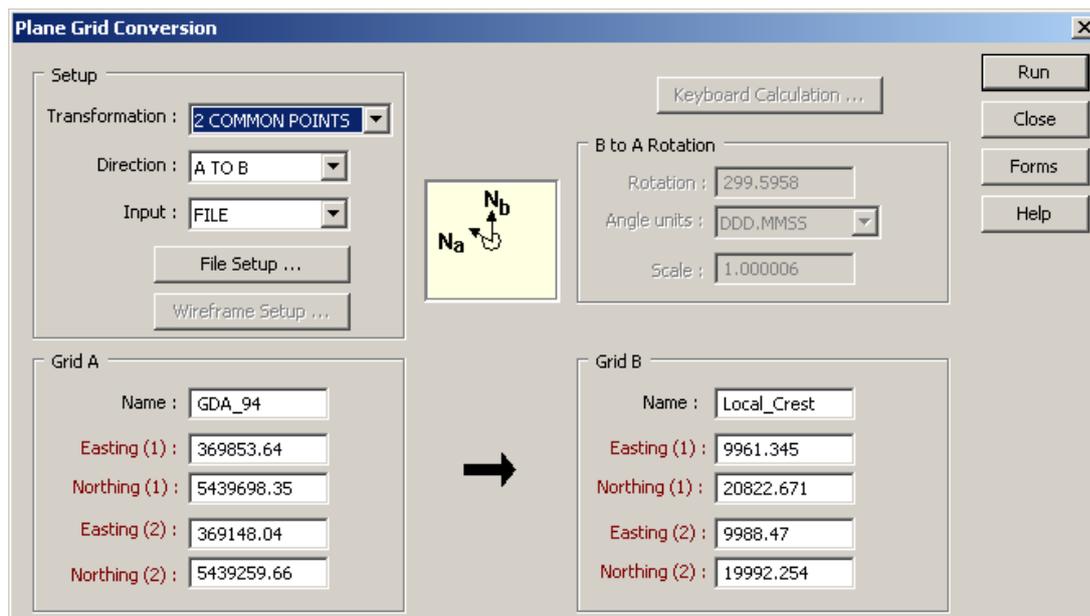
**Figure 3:** Surface geology map of the Arthur River Magnesite deposit produced by Mineral Resources Tasmania, showing the boundaries of 24M2009, and retention lease RL18/1987, inferred boundaries of magnesite and the line used for geophysical study by Perry (2011).



**Figure 4:** LiDAR DTM of Arthur River ML, oriented to Local Grid showing drillholes and change in relief. Johnny's Creek runs through the centre of the lease, and from this data it is obvious that it has been a more significant watercourse in the past, with glaciation also likely.

## 2.4 Conversion to Local Grid

The local grid used during previous works was also adopted for this study. The transformation is based on the collars of drill holes MB002 and MB005, with details of the conversion shown below in Figure 5.



**Figure 5:** Plane grid conversion used to convert data from GDA94 Zone 55 to Local Grid.

### 3. Flora and fauna

Vegetation within the mining lease consists mostly of regrowth forest, with dogwood and eucalypt trees dominating myrtle and horizontal in the southern part of the lease, with ti-tree becoming prominent in the middle and northern part of the lease, generally following the course of Johnny's Creek, which is shown in Figure 2. The western part of the lease is mostly eucalypt, particularly in the more elevated parts which are followed by the road leading to the fjord across the Arthur, which can be used to access the site when the water level is sufficiently low.

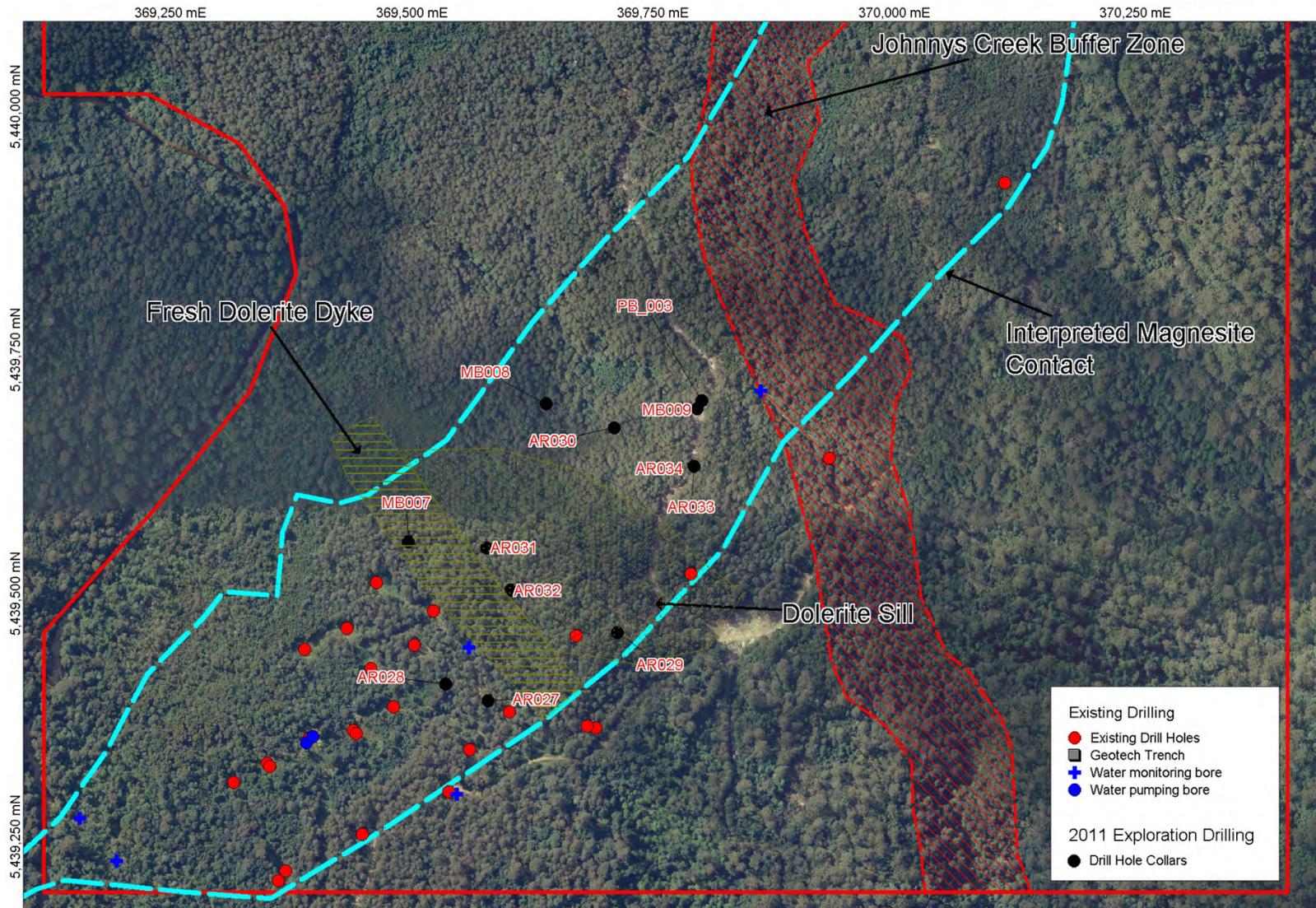
Fauna within the site is generally of a relatively low density, with forestry activities in the area reducing viable habitat for many species. Wallabies, potoroos and pademelons are the most frequently sighted mammals. During the summer months, snake activity is particularly high, with a plentiful supply of frogs and rodents in the area. Creeks and rivers in the area are commonly host to the endangered Tasmanian giant freshwater crayfish.

### 4. Previous Work

The Arthur River magnesite deposit was first discovered in 1925 by the geologist B. P. Nye, who was assessing the suitability of the area for the construction of a dam. Assay results from samples taken returned results of 45 to 47.6% MgO, to give almost pure magnesite.

In 1970, Mineral Holdings Australia were granted EL 43/70, which covers the Arthur River deposit, and over the next several decades explored the area in various joint ventures with sampling of outcrops, percussion drilling and several diamond drillholes.

Prior to the commencement of the most recent program, there had been a total of 28 exploration diamond drillholes, two of which were twinned. There are also 5 vertical monitoring bores, and two production bores as well as multiple airtrack holes which simply penetrated the overburden to the intersection of hard rock. The figures following show the distribution of these holes within the lease, in addition to the most recent holes. Holes prior to this program have largely been concentrated in the southern portion of the lease, with this being identified as the area with the least overburden, and is separated from the remainder of the lease by a doleritic intrusion.



**Figure 6:** Detailed image of the lease area, showing position of holes from the most recent drilling program, with positions of previous holes also displayed. Solid blue outline displays extent of a modeled pit in the area, dashed blue indicates the boundary of magnesite as inferred by Crest, and red hashed area shows the Johnny's Creek buffer zone.

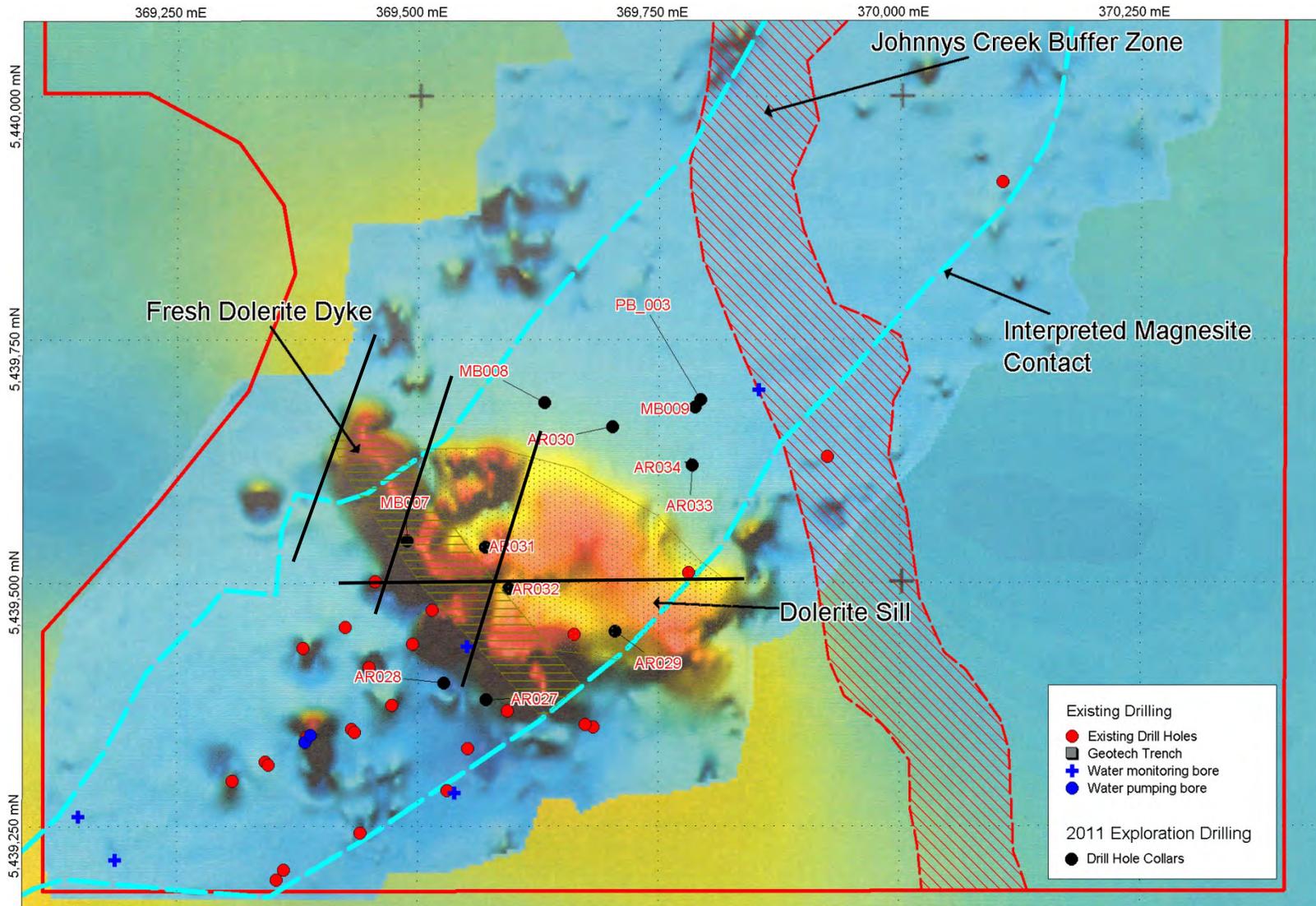
## 5. Current Work

In the past year, several methods have been employed in an attempt to better understand the distribution and character of magnesite and dolerite, and also measure the depth of alluvial cover. These have included a ground magnetics survey conducted in September 2010, which vastly improved the resolution of the magnetic high caused by a dolerite which cross-cuts the magnesite, ground surface mapping, and a drilling program which concentrated on defining the dolerite body and exploring material to the north of the dyke which had not been tested in the past. A pumping test was undertaken by GHD to gain knowledge on the hydrogeology of the area, building on a previous study by Golder Associates. A geophysics Honours project is also currently being undertaken by Owen Perry at the University of Tasmania, primarily investigating the geophysical properties of the overburden to assist with mapping, and extending to mineralogical measurements using the Mineral Resources Tasmania HyLogger, and the University of Tasmania electron microprobe. Results for the ground magnetics survey and drilling program are presented below, with preliminary results from the honours project also briefly discussed.

### 5.1 Ground Magnetism Survey

This survey was conducted in September 2010, using two GSM19 Overhauser magnetometers provided by the University of Tasmania. Previous magnetic modelling of the area had been limited to aerial surveys, and merely indicated the presence of a poorly defined magnetic high cross-cutting the magnesite. The ground magnetics provided a much higher resolution image, clearly mapping a thin dyke, with a sill extending to the north of this for several hundred meters. Figure 7 shows the results of this survey, with several inferred faults also included. The results from this survey also strongly suggest that the dolerite is confined to the body of magnesite, and does not continue into either the hanging wall or footwall.

A more detailed report on this survey is given in Appendix E.



**Figure 7:** Magnetics image for doleritic material cross-cutting the Arthur River Magnesite deposit. A local E-W dyke is clearly seen on the south-western side, apparently broken by multiple faults (black lines), which also appear to translate to the sill. The local magnetic high at the previous pumping bore in the south is caused by a large amount of sub-surface waste steel.

## 5.2 Re-logging of Old Core

Prior to commencing the drilling program, all available drill core from previous programs was geologically re-logged to gain an understanding of the rocks in the area. Diamond drill holes AR001 to AR003 and AR005 to AR007 are currently stored at the Mineral Resources Tasmania core storage facility, with drill holes AR013 to AR026 stored on Calder Road in Wynyard. Drill core from holes AR004 and AR008 to AR012 appear to have been destroyed during whole core analysis, and crushed material from these holes subsequently discarded.

During this process a new logging system was developed, which aimed to distinguish not only between basic units, but also to define any features within the rocks that may assist with grade controls and the general understanding the overall structure.

During re-logging, the magnetic susceptibility of many of these holes was also measured on intervals of approximately 2m, to be later combined with data from the 2011 program.

Results from re-logging are given in Appendix B. As the core had been significantly disturbed, geotechnical logging was not attempted.

## 5.3 Drilling



**Figure 8:** Retrieving core from AR028.

The 2011 drilling program operated from 28 February until 7 June. Edrill, a drilling company based in Wynyard, was contracted to drill all holes in this program. An Atlas Copco CS4000 diamond rig completed 10 diamond drill holes, and a waterbore rig was used to complete 2 open holes for a total of 1,167m and (see Table 1).

### **5.3.1 Drilling Aims**

The aim of the exploration drilling program was primarily to better define the role of intrusive dolerite in order to model its' distribution and determine if there was potential for an open cut operation to extend through this barrier into magnesite existing on the other side.

Another major aim of this program was to gain understanding of materials in the weathered zone, as previous drilling programs have for the most part simply triconed through this zone until a hard-rock interface was found.

In addition to the exploration drilling program, four vertical holes were drilled to a depth of approximately 50m to serve as a pumping bore and three monitoring bores in which water levels could be observed to assist with groundwater modelling of the area. These holes were MB007, MB008, MB009 and PB003, with MB009 and PB003 drilled using the waterbore rig.

This program has shown that the dolerite dyke cross-cutting the area is relatively thin, of the order of 20m. Recoveries within the weathered ore zone often remained quite low, but knowledge of the geology within the area has been greatly expanded.

Table 2 summarises assay results from each of the diamond drillholes from this program, showing high grade magnesite intervals and their corresponding FeO and SiO contents. Three metres of continuous internal dilution within the magnesite has been allowed for in this table. Due to the fact that solution features would easily be separated from ore, these have been ignored.

### **5.3.2 Drilling Methods**

To recover a maximum amount of overburden material the majority of holes were collared with PQ rods, using triple-tubing, and reduced to HQ when fresh magnesite was reached or the PQ rods became bogged. PQ rods were left in the hole to act as temporary casing to prevent the hole from collapsing, with HQ rods run through the PQ, drilling out the landing ring before resuming drilling rock. In the event that HQ rods also became bogged, the same method was used to reduce to NQ. Upon completion of the hole, the smallest rods were pulled first, with the barrel retrieved where possible, otherwise the rods were cut immediately above the barrel.

### 5.3.3 Downhole Surveys & Measurements

Downhole surveys were taken in exploration holes ideally at intervals of 30m where possible. The instrument used, a Reflex EZ-Shot, required to be extended 6m past the end of the barrel to adequately reduce magnetic interference from the steel, but due to the often fractured and weathered nature of the rock, this was often not possible. In most cases the survey tool was only used upon completion of a hole, during extraction of the rods. The EZ-Shot measures the dip, magnetic azimuth, temperature and magnetic field strength. In the event that measurements were taken within the rods, the azimuth was incorrect due to interference by the rods, shown by a variation in the magnetic field strength, which is typically around 6200nT. Temperature can be used to differentiate between ground water and surface water in some cases, but did not appear to be very applicable in this setting.

Core orientation was also employed, using a Reflex ACT II RD tool. Unfortunately, this proved difficult to use, due to the broken nature of the ground. In cases where measurements were obtained a red crayon pencil was used to extend the mark to the outside of the core, with 'ori' written next to this line.

HOLE_ID	NORTHING	EASTING	COLLAR RL	TOTAL DEPTH	DIP	AZIMUTH
PB003	5439707.8	369799.5	188.2	49.5	-90	-
MB007	5439538.6	369485.4	153.0	43.3	-90	-
MB008	5439689.8	369622.6	171.5	50.0	-90	-
MB009	5439687.2	369789.6	188.7	48.0	-90	-
AR027	5439383.3	369565.4	164.8	150.0	-55	60
AR028	5439398.7	369553.0	163.6	71.1	-55	330
AR029	5439449.5	369706.4	198.9	89.1	-60	330
AR030	5439659.9	369691.1	180.6	143.2	-60	330
AR031	5439541.5	369559.3	168.5	150.0	-60	330
AR032	5439493.4	369575.7	167.3	150.0	-60	330
AR033	5439620.5	369786.5	195.2	73.0	-60	330
AR034	5439630.7	369779.8	194.3	150.0	-60	330

**Table 1:** Surveyed collar locations with hole depth and orientations. Co-ordinates are in GDA94, MGA Zone 55.

Hole	Depth (m)	Interval (m)	MgO (%)	FeO (%)	SiO (%)
AR027	102.5	44.2	43.04	0.65	7.35
AR028	39.5	19.6	43.10	0.67	3.53
AR029	-	-	-	-	-
AR030	26.0	47.0	41.40	2.30	5.13
AR031	60.0	90.0	42.34	1.49	5.44
AR032	90.0	36.0	40.87	1.22	3.79
AR032	131.0	15.0	41.09	0.81	8.17
AR033	65.5	5.0	41.12	4.78	6.28
AR034	128.5	9.5	40.56	1.93	10.26
MB007	34.3	9.0	42.84	0.93	0.98
MB008	6.9	43.4	43.79	1.93	2.55

**Table 2:** Summary table of assay results from drilling program showing significant intersections of high grade magnesite (>40% MgO) and their corresponding FeO and SiO contents. Drill hole AR029 failed to intersect any high grade magnesite of note.

#### **5.3.4 Surveying and Capping of Holes**

Upon completion of the holes and removal of the rig, holes were capped using PVC pipe and caps, and their position measured by a licensed surveyor using a Trimble differential GPS (see Table 1).

### **5.4 Handling and Processing of Core**

Once extracted from the tube, core was laid out in trays and moved to the core shed in Wynyard, where it was marked up, photographed, logged both geotechnically and geologically, with magnetic susceptibility, density and bedding and vein feature orientations within the core also measured. Upon completion of measurements of magnetic susceptibility, density, alpha/beta, geological logging and sampling, all data was entered onto Excel spreadsheets and backed up. Detailed procedures are given below.

#### **5.4.1 Recovery and Transport**

Upon extraction of core from the triple-tube, the amount recovered was measured by the driller, and then placed in marked plastic core trays. In cases where bottom-of-core orientations had been obtained, the mark was extended along the core using red crayon pencils. A wooden core block was placed at the end of each run, denoting the run length, drillhole depth and amount recovered. Filled

core trays were removed from site once per day by Derwent Geoscience staff, and transported to the core shed at Wynyard.

### 5.4.2 Core Photography

Upon arriving at the core shed, metre marks were written on core (or core trays where necessary) and orientation lines were extended along core as far as possible using red crayon pencils. These lines indicate the bottom of core, in photography they are facing upwards to show any features present to greater effect.

Trays were photographed one at a time, with the start of the tray located in the top LH corner of the photo, as shown in Figure 4. Digital photos for drillholes were placed in separate folders, with additional photos located within these folders of any interesting features within that hole.



**Figure 9:** An example of presentation of rock core from AR027, showing meter markings on core in addition to bottom-of-hole orientation line. In situations where metres could not be written on the core, meter intervals were written on core trays.

### 5.4.3 Magnetic Susceptibility

The magnetic susceptibility of core was measured using an Exploranium KT9 Kappameter, with measurements taken at intervals of approximately 1 metre where possible, and at closer intervals in zones of more variable rock.

#### **5.4.4 Specific Gravity**

Specific gravity (density) measurements were also taken on the core at approximately 3m spacings, except in zones where the rock type did not change for long intervals, or where the material was likely to decompose in water. A simple buoyancy method was used for this project, with the rock first weighed in dry air, then submerged in water in a cage connected to the base of the scales and weighed again. Upon removing from the water the rock was wiped with a towel and weighed again to check for a change of weight caused by the rock disintegrating or absorbing water. Erroneous readings were repeated. The calculation used for calculating the specific gravity is given below:

$$S.G. = W_{t_{air}} / (W_{t_{air}} - W_{t_{water}})$$

Where:  $W_{t_{air}}$  is the free-air mass  
 $W_{t_{water}}$  is the submerged weight

#### **5.4.5 Alpha/Beta Measurements**

Alpha and Beta measurements using a Kenometer were carried out on core which had been oriented by drillers using the method described in section 5.2.3 in an attempt to delineate any systematic veining, contacts or bedding structures in the hope of gaining structural information. Due to difficulties with orienting core, few measurements were taken.

#### **5.4.6 Geotechnical Logging**

Geotechnical logging was carried out on all new diamond drill holes prior to major disturbance of the core using a system provided by GHD. The main emphasis was on weathered material located at near the top of the profile, with this being a major constraint on any pit designs. Soil and rock logs were completed separately, with rock logs begun at the first sign of in-situ material regardless of how weathered it was.

Factors noted for soils included consistency, grain size and moisture content, while weathering, core strength, recovery and defect spacing were noted for rock geotechnical logging.

#### **5.4.7 Geological Logging**

Geological logging was completed following geotechnical logging. In addition to lithological logging, vein features were noted for their colour, linearity, and if their occurrences were confined to clast or matrix. Other features to note were the presence of talc or sulfides and their nature, the degree

of weathering, and any structures such as faults or foliations. All logging was carried out by an appropriately qualified geologist.

#### **5.4.8 Core Sampling**

Sampling of core focused on zones of fresh magnesite, generally other material (overburden and dolerite) was not sampled. Sampling was generally over 1meter intervals, but in zones of poor recovery or on geological boundaries this was modified.

Material in solution features was not usually sampled, as it was rarely recovered in drilling. The logic behind the sampling is that it is anticipated that the silty/clayey material in the solution features will be easily removed by crushing and wet screening. Including this material in a sample interval containing magnesite would unnecessarily downgrade it and there would be no means of back calculating the grade of the magnesite.

3-part sample ticket books were filled out, noting the meterage and recoveries, with sample numbers written on calico sample bags, one blank ticket placed in bags, one in the core trays at the end of each interval, and one retained within the booklet. Hole numbers, meterage and recoveries were only written onto the ticket retained within the book. These were later entered into the drilling database.

For sampling, HQ and PQ core was quartered, and NQ halved, with one quarter or half respectively placed in the sample bags. In cases where core was continuous over sample intervals, the core to be assayed was broken in the appropriate place and then bagged.

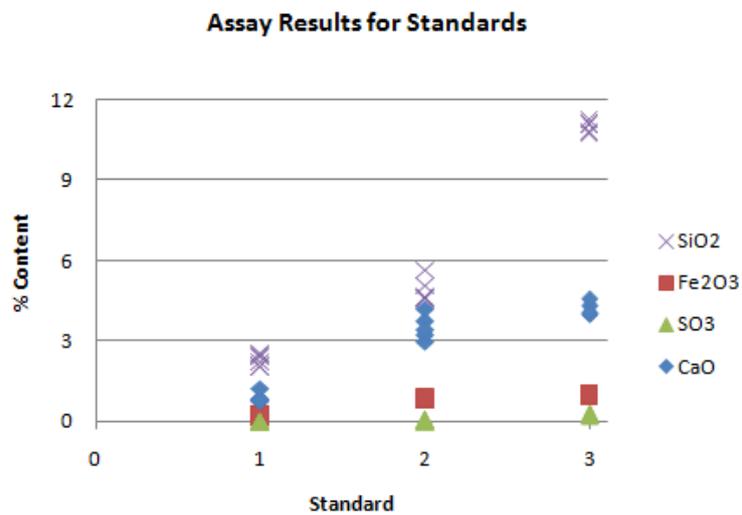
#### **5.4.9 Assays**

Samples were delivered to the Burnie branch of ALS Chemex, and shipped to the central ALS lab in Brisbane from there. The ALS Chemex ME-XRF12s limestone/dolomite suite method was used to analyse samples. This method involves crushing individual samples to a fine powder, of which 15g is selected to be compressed into a disc. ICP-AES is then used to determine quantities of analyte present. Analytes include: CaO, SiO<sub>2</sub>, Fe<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, Mn<sub>2</sub>O<sub>3</sub>, Na<sub>2</sub>O, K<sub>2</sub>O, SO<sub>3</sub>, MgO, TiO<sub>2</sub>, Cr<sub>2</sub>O<sub>3</sub>, P<sub>2</sub>O<sub>5</sub>, SrO and LOI (Loss on Ignition).

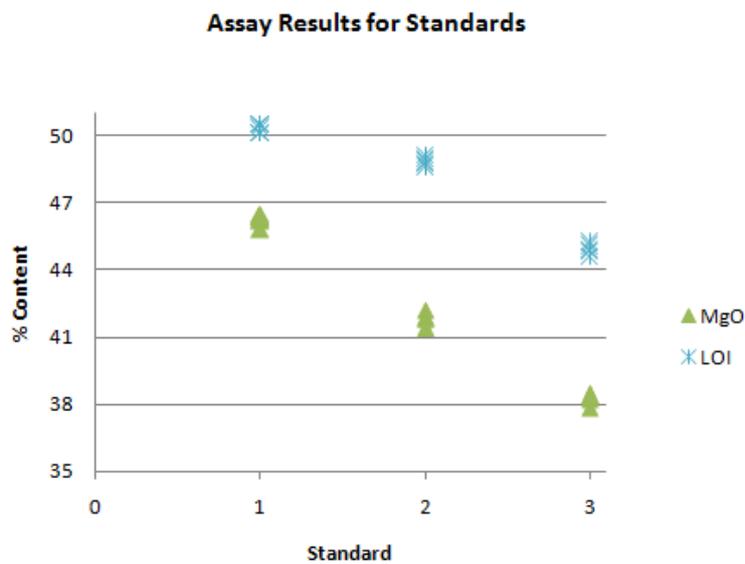
#### **5.4.10 Quality Control**

To provide quality control on sample assays, standards from previous assays were inserted at intervals of approximately 25 samples. Three standards of varying composition were used, each comprised of material used in metallurgical studies. Upon receiving assay results, standards were compared to previous results to confirm the reliability of assays. These are shown graphically in

Figures 10 & 11, which shows all samples well grouped, and each standard has a distinctive composition. Raw assay results for standards are given in Appendix D.



**Figure 10:** Grouped results for standards used for assays, showing well grouped results for all analytes.



**Figure 11:** Grouped results for standards used for assays, showing well grouped results for all analytes.

### 5.4.11 Core Storage

All drill core from the most recent drilling program is currently stored within storage sheds at Wynyard on Calder Road. Available core from previous drilling programs stored here includes AR013 to AR026 and MB002 to MB005. Pulps and crushed rejects from these holes are also stored here.

Several holes are also stored at the MRT core library in Mornington. These holes are diamond drill holes AR001 to AR003 and AR005 to AR007.

Core from drill holes AR004 and AR008 to AR012 was destroyed during whole core analysis.



**Figure 12:** Core logging.

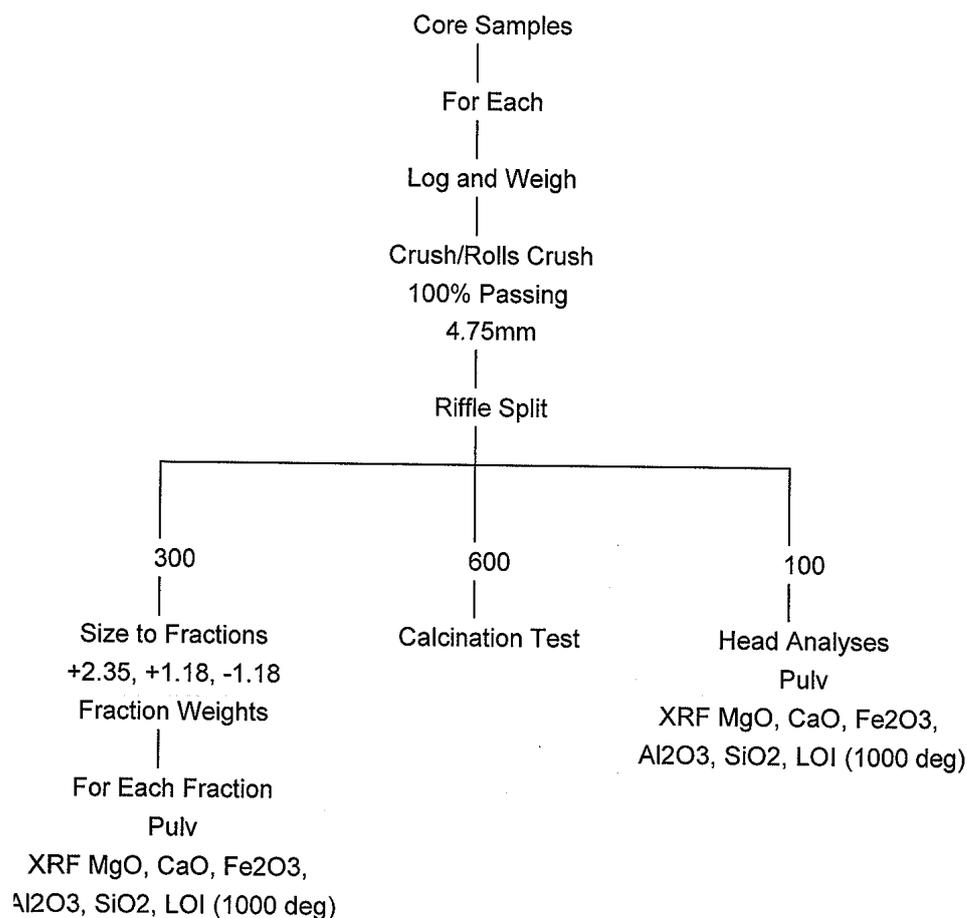
## 5.5 Metallurgical Testwork

Metallurgical work was conducted on four samples from DDH AR013 and AR026. Selection of these samples was based on the following criteria:

1. They were within the conceptual pit put forward by Gemell Mining Engineers in September 2010.
2. There was continuous  $\frac{1}{4}$  core available over an identifiable interval in the existing drill core (AR013 to AR026) in storage in Wynyard.
3. They comprised a minimum downhole interval of 3m, and a minimum weight of 1Kg.
4. They did not contain any obvious contaminants such as cavity fill which might be straight-forward to remove by physical beneficiation.
5. They satisfied the following requirements requested by Process Technologies:
  - a. 2 high grade samples of the order of 44% MGO, 1-2 % CaO and low contaminants.
  - b. 1 sample with higher dolomite/magnesite ratios of up to 15% dolomite.
  - c. 1 sample with higher silica (1-2%).

Burnie Research Laboratories (BRL), overseen by Process Technologies staff, conducted the first round of test-work in October 2010. A second round of tests conducted by Koenig Consulting Pty Ltd using ALS Mineralogy in August 2011. Mineral Liberation Analysis was used in this study to determine host minerals for contamination and their size and distribution. A fifth sample containing over 11% silica was also submitted, but was only analysed in the first round of tests.

The flowchart used for sample preparation by BRL is shown below:



The first set of testing was only analyzed for oxides, not mineralogy, with the presence of talc only noted during flotation tests, but not directly analyzed for. The results obtained proved to be very similar to original assay work, with two of the samples considered to be high grade magnesite without any form of beneficiation.

Shortly after this test-work, talc was noted during logging of core, and the necessity of a second round of testing became apparent. ALS used their MLA XBSE technique to measure mineral assemblages, elemental distributions and mineral abundances in different size fractions. Crushed core from the same samples were used in both rounds of testing.

The second round of met work revealed that the bulk of silica was contained within talc in three of the four samples, and mostly quartz if the fourth (see Table 3). Talc ( $Mg_3Si_4O_{10}(OH)_2$ ) also contains Mg, meaning results from previous assays may have been misinterpreted, as it has previously been assumed that MgO measured during assays is sourced purely from magnesite and dolomite. This talc also creates mass balance issues with tonnage estimates.

Detailed sample processing procedures, results and correspondence related to both rounds of metallurgical work are provided in Appendix F.

Mineral	377 +3.35	377 +1.18	377 -1.18	377 Head
Talc	99.7	99.7	98.9	99.4
Quartz	0.3	0.3	0.8	0.5
Other_Silicates	0.0	0.0	0.3	0.1
Total	100.0	100.0	100.0	100.0
Mineral	378 +3.35	378 +1.18	378 -1.18	378 Head
Talc	99.8	93.3	96.8	96.4
Quartz	0.2	6.7	3.1	3.6
Other_Silicates	0.0	0.0	0.1	0.1
Total	100.0	100.0	100.0	100.0
Mineral	379 +3.35	379 +1.18	379 -1.18	379 Head
Talc	99.9	97.7	99.8	98.9
Quartz	0.1	2.3	0.1	1.1
Other_Silicates	0.0	0.0	0.1	0.0
Total	100.0	100.0	100.0	100.0
Mineral	381 +3.35	381 +1.18	381 -1.18	381 Head
Talc	0.5	0.9	0.5	0.7
Quartz	99.5	99.1	99.4	99.3
Other_Silicates	0.0	0.0	0.1	0.0
Total	100.0	100.0	100.0	100.0

**Table 3:** Silicon distributions by %Wt in metallurgical samples analysed by ALS for Koenig Consulting, showing mineralogical distribution of silica for each size fraction. Total silica content of samples varies from about 2.5 to 4.7%Wt.

## 5.6 Honours Thesis

Work for the honours thesis currently being undertaken by Owen Perry at the University of Tasmania centred on the geophysical line depicted in Figure 3, located to the south of the dolerite dyke. The major aims of activity in this area were to define a technique capable of delineating the thickness of cover to magnesite, and the nature of the magnesite rock surface. Methods trialled included gravity, magnetics, DC resistivity and seismic MASW. Of these methods, gravity and magnetics were of little use. However, results from seismic and resistivity surveys correlated very well with drilling results in the area. Images produced from these surveys suggest that the upper surface of the magnesite is relatively flat-lying for the most part.

In addition to geophysics, this project also utilised the Mineral Resources Tasmania HyLogger, running drillcore from four holes (AR002C, AR007C, AR016 & MB008) through the instrument,

primarily to detect different types of carbonates and silicates. This detected significant amounts of talc within core, which had previously only been noted sporadically.

Electron microscopy was applied to several samples, further defining variations in mineralogy and their relations, revealing information on several types of magnesite within the deposit, and possible inter-relationships.

Completion of this project is expected in mid November 2011.

## **5.7 Hydrogeology**

A hydrogeological study of the Arthur River Magnesite Deposit was undertaken to increase knowledge of sub-surface water movement in the area. The study centered around a pumping test conducted from PB003, where water was pumped from the bore at a rate of approximately 5L/sec for 5 days, with water level measurements taken at all monitoring bores, and at the bridges crossing the Keith and Arthur Rivers. A rainfall gauge was also installed on site. In the month leading up to the pumping test, water level measurements were taken of the monitoring bores, rivers and precipitation on a daily basis to form a background for the pumping test. During the pumping test, measurements were also taken at a temporary v-notch weir in Johnny's Creek. Water pumped from the bore was output approximately 200m to the NW, discharging into the bush and down towards the Keith River, with care taken not to contaminate Johnny's Creek. Measurements were also taken for the week following the pumping test to observe rebound of the water table.

A final report from GHD on the results of this test are forthcoming, but interpretation of raw data suggested that there is little connectivity through the dolerite dyke, with little or no response apparent, and a high degree of connectivity with MB005. MB008 did show variations, but mostly oscillating on a diurnal frequency, possibly resulting from biological activity (trees uptaking water during the day), indicating high connectivity to the surface. Interpretation of these results will be complicated by large amounts of rain during the second half of the pumping test.

## 6. Summary of Drilling Results

The following provides brief descriptions of each of the new holes drilled, accompanied by sections oriented to Local Grid to graphically show intercepts within drillholes, along with inferred features such as hanging-wall, foot-wall, extent of dolerite within the section, and the depth of alluvial overburden.

### 6.1 MB009

This was the first hole drilled in the program. It commenced on 28 February, and reached a maximum depth of 48m on 2 March. At this depth the tricone bit hit refusal and was exchanged for a hammer bit. However, the hammer bit failed to reach the bottom of hole due to multiple blockages, and was abandoned with the intent of returning with the diamond drill at a later date to extend the hole. An attempt at this was made, but connectivity to the adjacent pumping bore within the weathered zone was sufficient that the bore pump was damaged by inflow of excessive sediments.

The hole was started in about 5m of predominantly quartzite glacial alluvium before passing into a powdery material, possibly peat, to 7m. From 7 to 16m, quartz-lithic gravel fragments dominated with minor clays, followed by another 8m of iron-rich clays containing quartz-lithic chips. Weathered magnesite was intercepted at 24m, with pink, clear and occasional white chips obtained from here to 48m. Many of these chips appeared to be remnant linear carbonate veins where the surrounding groundmass has been weathered away.

The hole was completed by casing with 300mm diameter steel pipe to a depth of 23m, followed by 250mm PVC pipe pushed to a depth of 37m.

Due to the fact that this was a RC hole, up-hole contamination of samples was unavoidable, and as such, the quartz-lithic fragments obtained between 24 and 48m have been considered as contaminants from up-hole.

### 6.2 PB003

This hole is located 18.5m to the North-East of MB009, and was also completed by the waterbore rig between the dates of 7 March to 9 March to a total depth of 49.5m. It was utilised as the pumping bore to source water for operation of the diamond drill, and also as the pump site for the hydrogeological pump test.

The hole was collared in 8m of brown clays containing angular quartz chips, and then entered a 3m zone of dry, powdery material similar to that in MB009. Clayey gravels with minor charcoal were

present from 11 to 30m, with occasional rounded magnesite chips from 25 to 30m. A weathered magnesite zone was then encountered to the end of hole at 49.5m, with very high water content and many chips of weathered pink magnesite and remnant carbonate veins.

The hole was cased off with 300mm diameter steel to a depth of 33m, followed by 200mm steel to 42m and 150mm steel with slots cut into the lower 6m using an angle grinder to allow for transmission of water, and then 10mm gravel poured between the 200mm and 150mm steel casing to help in the filtration of the water.

### **6.3 AR027**

Diamond drillhole AR027 was drilled for the purpose of delineating the thickness and nature of the dolerite dyke located to the North-East, a potential major factor in the construction of a pit. Drilling commenced on 6 April, and was completed on 20 April at a depth of 150 metres while within magnesite. Average core recovery following intersection of fresh ore was 46.3%. Much of this loss was within the very broken zone of dolerite.

The hole was collared in 4.75m of angular to sub-angular glaciated quartz, followed by intensely weathered and variably sheared dolerite clays which appear to be in-situ to a depth of 20m. From 20 to 45.3m, an assemblage of magnesian sands, gossanous limonite and sheared and undifferentiated Fe-stained clays are present in a very poorly organised manner, raising the possibility that the majority of this is in fact karst fill which has been jumbled together or within a large fault.

The fresh-rock interface occurs suddenly at 45.3m, changing from the above material to fresh, unweathered magnesite in the space of several millimetres. From 45.3 to 75.4m, the rock was generally pink magnesite, with 6 solution features of note, the largest being 1.8m in size at 65.2m. These solution features were most often filled with silts or rubble.

The dolerite dyke was intersected at 75.4m, and continued to a hole depth of 96m, and was generally shattered and highly faulted, very fine to medium-grained and variably magnetic.

Once exiting the dolerite at 96m, the hole once again entered magnesite which varied from white to pink until the end of hole at 150m. Solution features within this magnesite were generally large than those above the dolerite. A total of 7 solution features were intercepted, the largest of which was 13m from 117 to 130m. Minor pyritic siltstone, talc and dolomite were also observed in this interval.

Magnesite above the dolerite was of highly variable quality, but from 102.5m, a 44.2m intersection of high grade material was hit, with an average grade of 43.0% MgO, and 0.7% and 7.4% FeO and SiO respectively.

## **6.4 AR028**

Diamond drillhole AR028 was commenced on 29 April, and completed on 2 May at a depth of 71.1 metres in dolerite. This hole was intended to serve the dual purpose of infill drilling with previous drillholes to the south of the dolerite dyke, and also assist with mapping the surface of the dyke. Average recovery below the weathered zone in this hole, including dolerite, was 87.1%.

The hole was collared in glacial gravels and Fe-rich clays containing occasional dolerite clasts to a depth of 12.4m, followed by extremely weathered and altered dolerite and doleritic clays to 24.1m. Karst fill and peat material were found below this, extending to a depth of 39.6m, where the fresh-rock magnesite interface was encountered. The magnesite in this hole was generally white with grey veining, and was free of solution features. Discing of the core was occurring from a depth of 45m, indicating that rock at even shallow depths in this environment may be under a great deal of stress. Minor amounts of dolomite were also present near the upper surface of the magnesite, and the base, situated between the magnesite and underlying dolerite.

Dolerite commenced at a depth of 60 metres, following a large fault filled with largely dolomite and some dolerite. Below the fault, the dolerite was variably magnetic, typically medium-grained and highly broken. This extended to 71.1 metres, where the hole was abandoned due to the questionable value of drilling through the dyke at a highly oblique angle.

From the intersection of magnesite until the dolomite immediately above the dolerite, the magnesite was generally high grade, returning an average of 43.1% MgO and 0.7% and 3.5% FeO and SiO respectively.

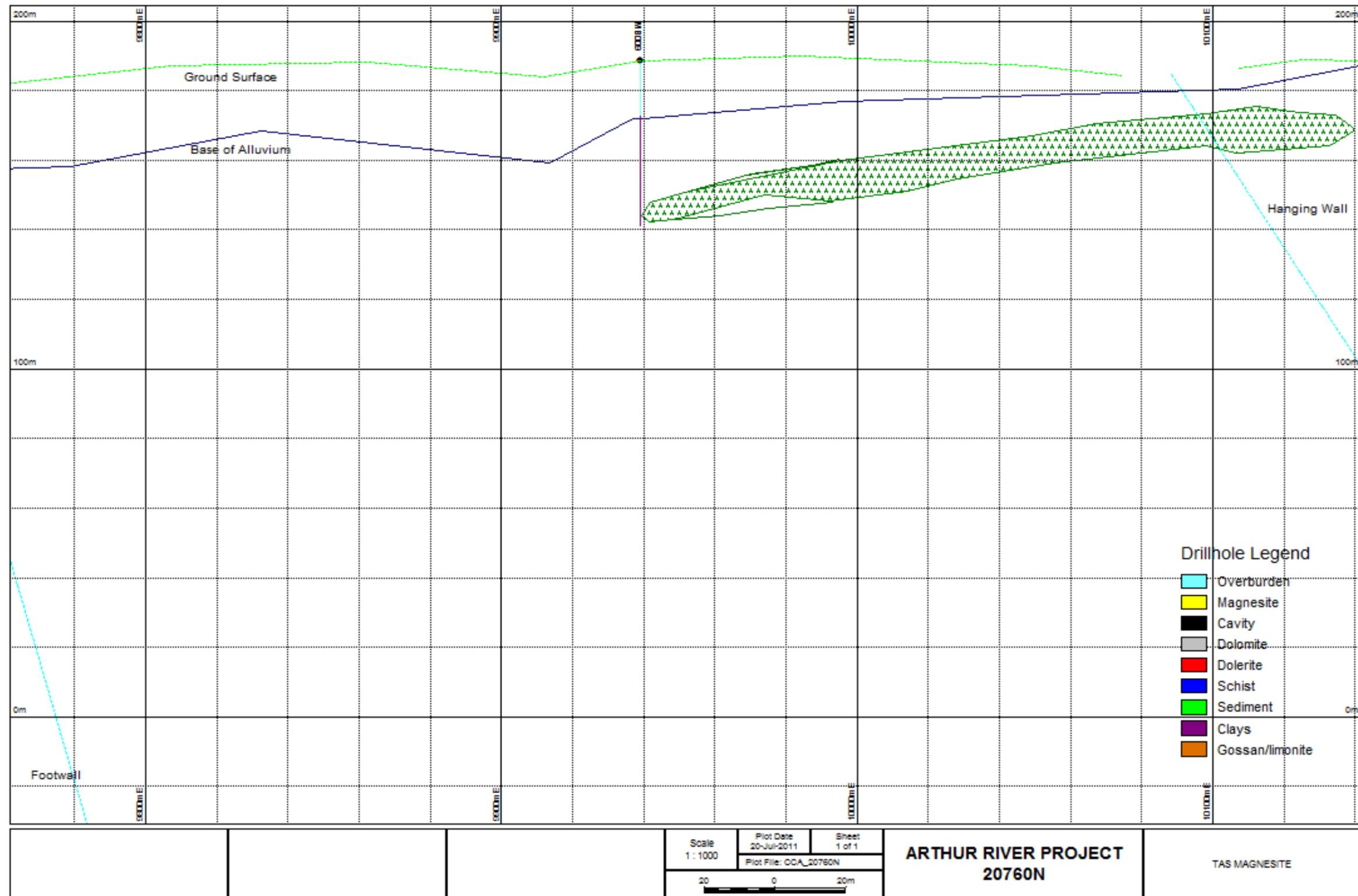
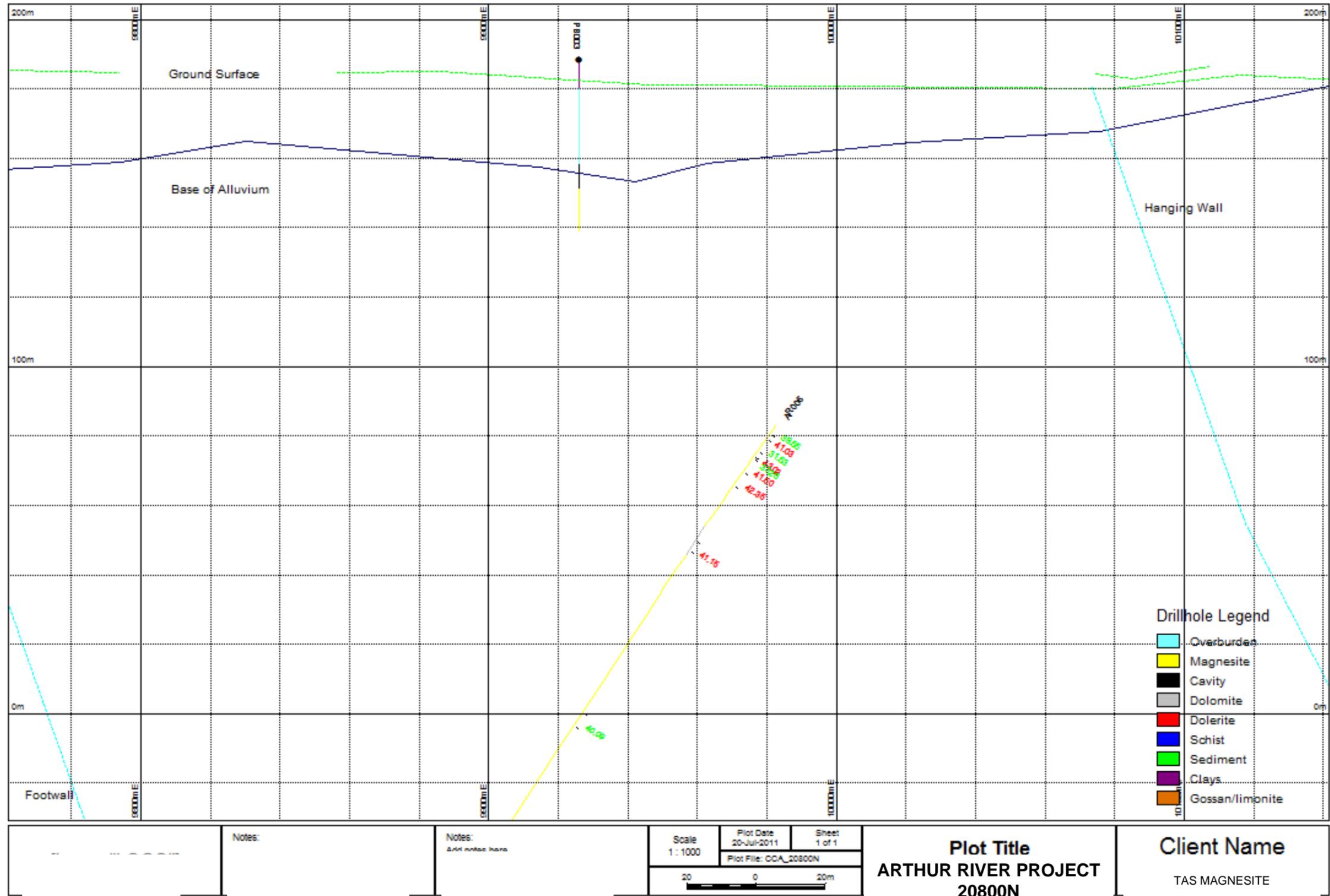
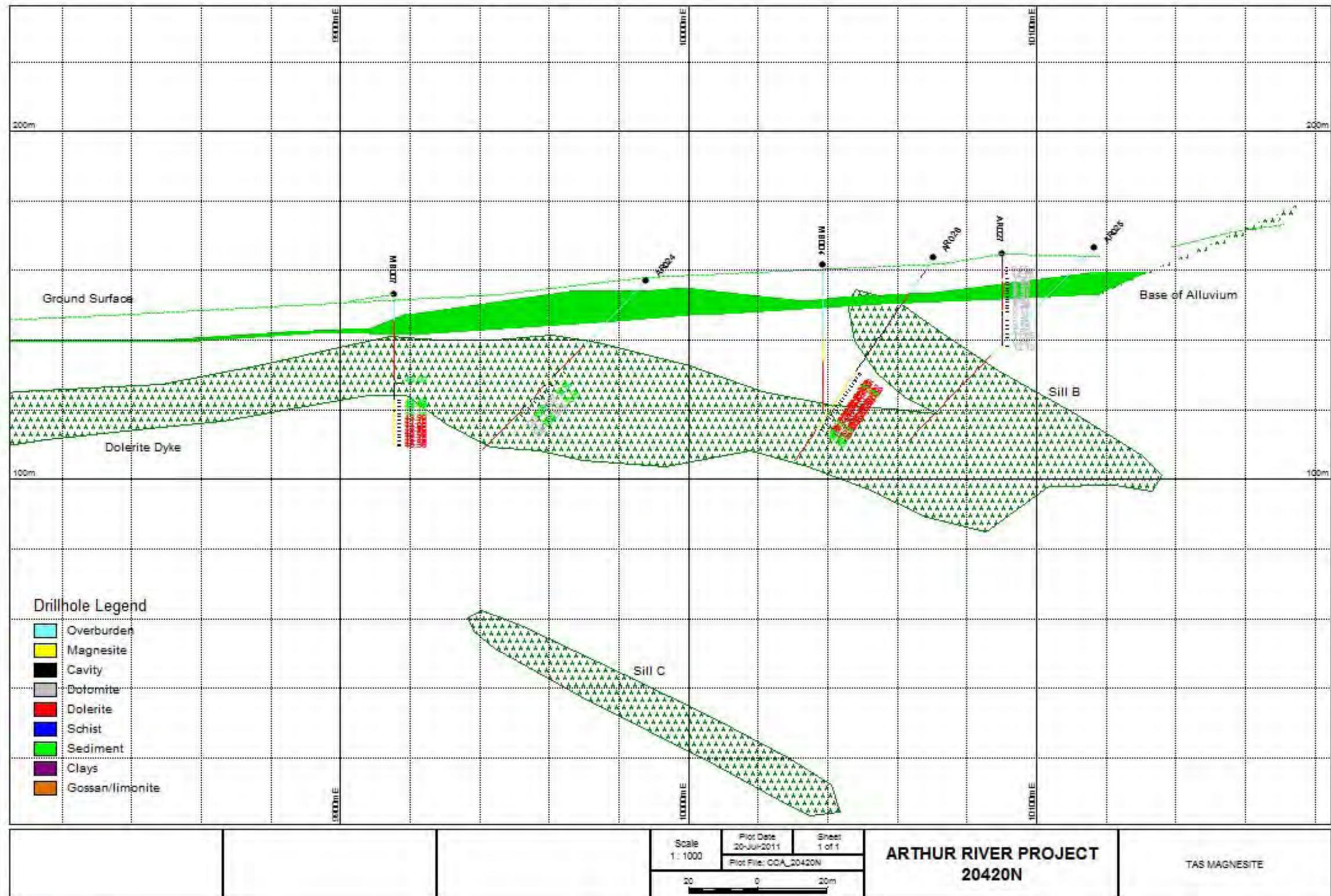


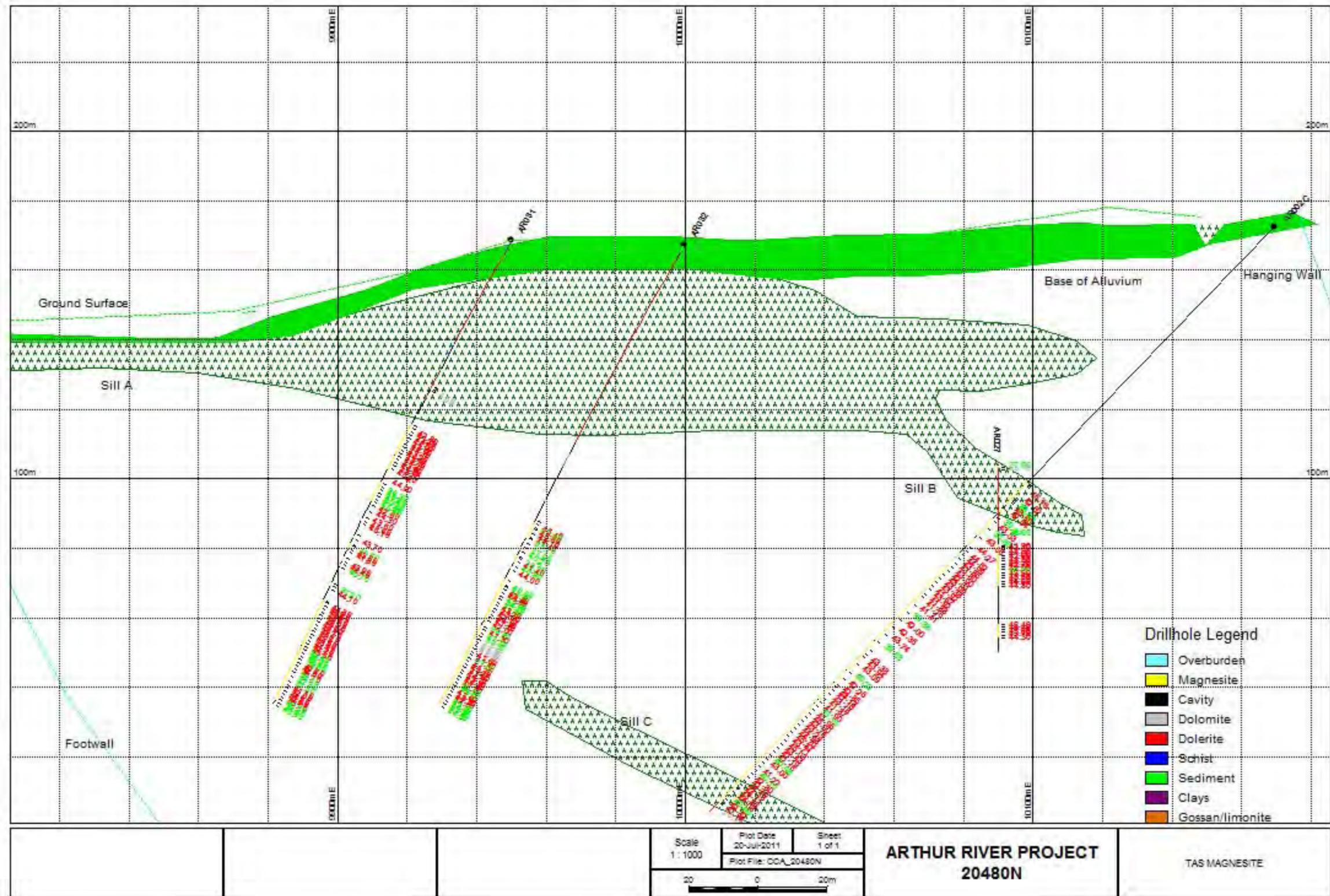
Figure 13: Section showing MB009 lithologies and inferred geology on 20760N Local Grid.



**Figure 14:** Section showing AR006 and PB003 lithologies and inferred geology on 20800N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade.



**Figure 15:** Section showing AR024, AR025, AR027, AR028, MB004 and MB007 lithologies and inferred geology on 20420N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade.



**Figure 16:** Section showing AR002C, AR027, AR031 and AR032 lithologies and inferred geology on 20480N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade.

## **6.5 AR029**

Diamond drillhole AR029 was commenced on 3 May and completed on 9 May at a depth of 89 metres in dolerite. It was situated approximately 40 metres to the east of AR011, for which very little information is available and the location of the core is unknown.

The initial 2.5m through glacial gravels was triconed, with Fe-stained clays following to a depth of 13 metres. From 13 to 45.3 metres, a large shear zone is present, with chloritic shear materials from 13 to 23.5 and 43.6 to 45.3 metres, and reworked limonitic sands and silts between these zones. Talc-rich clays followed the shear zone to a depth of 51.4 metres, with what appears to be limonite-replaced magnesite from 51.4 to 52m. Variably weathered and highly faulted magnesite follows this, but only to 59m, where sheared dolerite exhibiting slicken-lines occurs to a depth of 74m, below which a short, 4m zone of magnesite with carbonated siltstone occurs, followed by another transition into rubbly dolerite.

No solution features were found within the magnesite in this hole, but there was a large amount of core loss in the weathered zone and within the dolerite. As a result of this, core recovery for the entire hole was 53.5%, and from the unweathered zone (below 74.3m) was 57.3%.

No significant intervals of high-grade material were found in this hole, although the average grade from 53 to 56.5m was approximately 43.8% MgO.

## **6.6 AR030**

Diamond drillhole AR030 was commenced on 12 May and completed on 19 May at 143.2 metres depth within magnesite. This hole was placed on the northern side of the dolerite dyke in order to explore the possibility of expanding the mineable resource to the northern side of the dyke.

It was collared in predominantly quartzite sands and glacials, which extended to a depth of 18.8 metres, followed by a short intercept of magnesite with a deep iron-stain which could have been either float or the lip of a karst feature. This was then followed by another 5.7 metres with no recovery, after which fresh magnesite was encountered. This magnesite was most often slightly pink in colour, and hosted 14 solution features which were often filled with silts or rubble between the depths of 25 and 115m, the largest of which was 3.7m, at 28.8m. At 143.2m, another weathered zone was intercepted and the decision was made to finish the hole at this depth in order to avoid difficulties with stuck drill-rods, as had happened in several other solution features in this hole at lesser depths. Also within the magnesite were several small zones with highly sheared clays and carbonated siltstones, most of which occurred between 94 and 96 metres. Core recovery within the magnesite in this hole was 67.5%.

High grade materials were encountered at the fresh-rock interface, and continued for 47 metres at an average grade of 41.4% MgO, with grades of 2.3% and 5.1% FeO and SiO respectively for this interval.

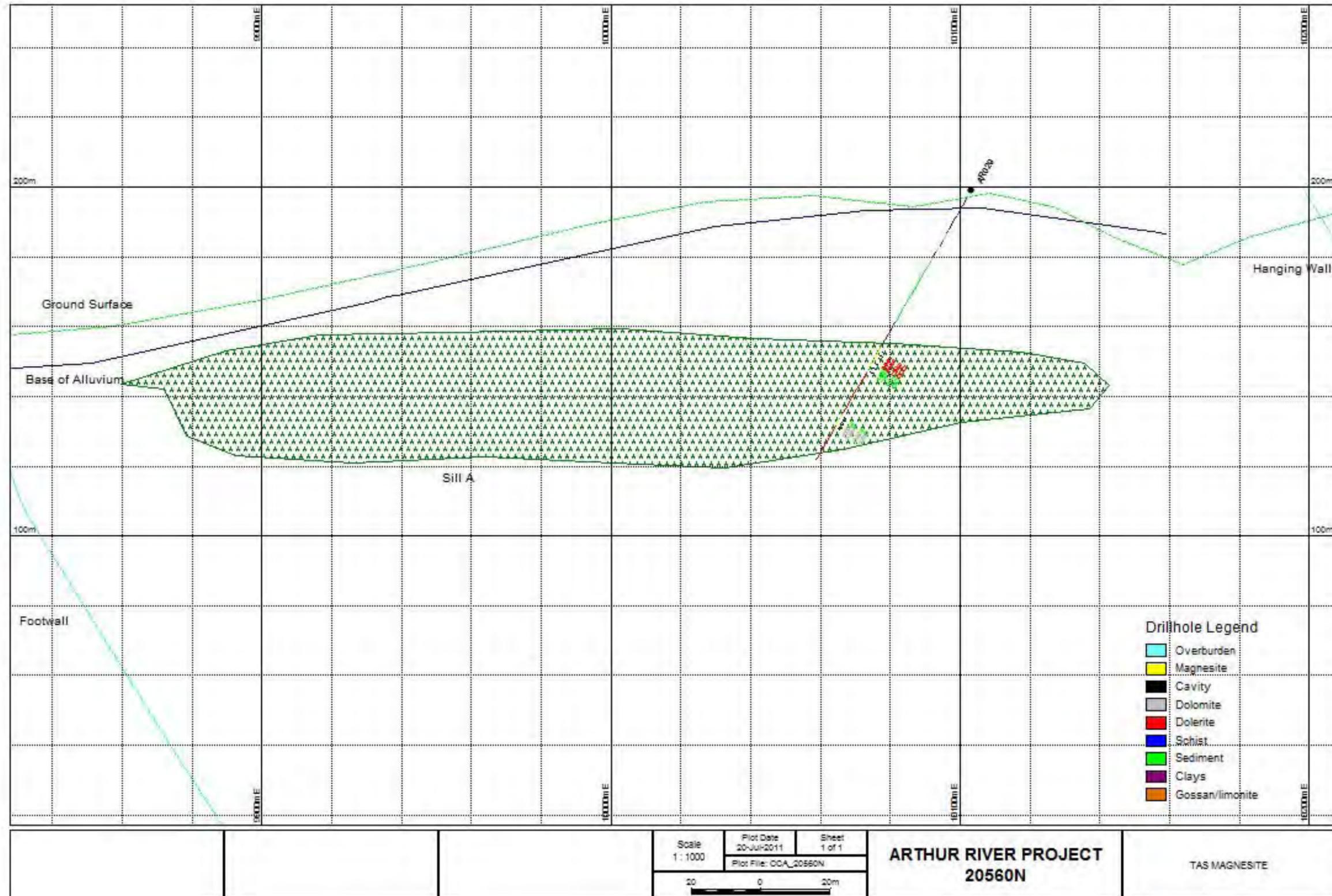
## **6.7 AR031**

Diamond drillhole AR031 was commenced on 20 May and completed on 25 May within magnesite at a depth of 150 metres. The magnesite interval in this hole was 89.9m, with 61.5% recovery within this zone.

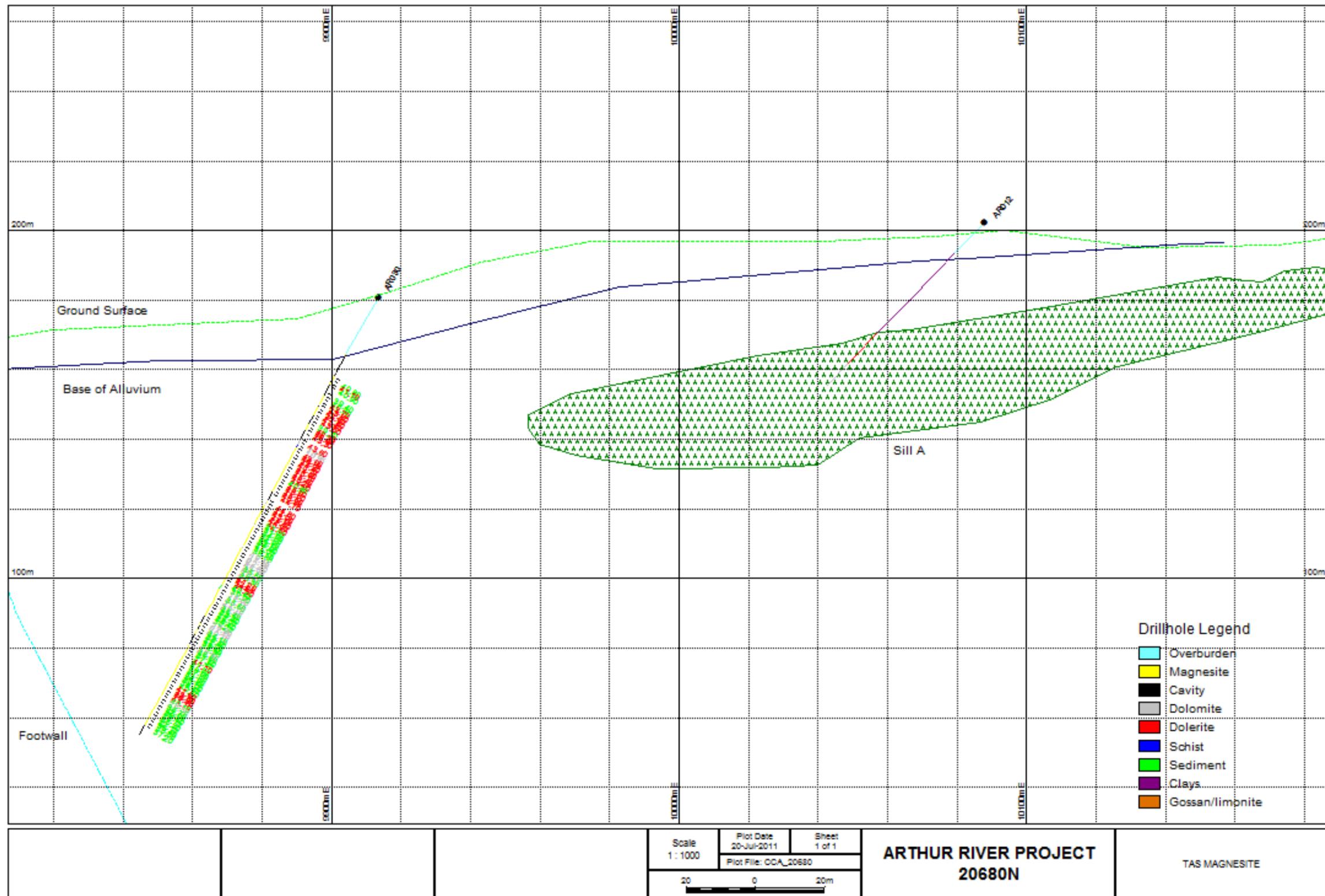
The hole was collared in 8.8m of iron-rich clays containing quartz fragments and rounded dolerite clasts with much limonite. Below this, and extending to a depth of 60.1 metres, extremely weathered and altered dolerite was found, with zones of gossanous and honeycombed limonite. This dolerite has been carbonated and altered by haematitic fluids to the extent that it often appears as simply clay. It has also been extensively sheared in parts so that it resembles a poorly formed and highly weathered schist.

Magnesite was intersected at 60.1 metres, and consisted of generally slightly pink rock which was often slightly weathered, with the rock mass slightly softer than that expected for fresh white magnesite. Solution features in this hole were generally filled with clay or rubble, with a total of 13 solution features in throughout the length of the intersection. The largest of these solution features was 5.7m in length at a depth of 85.3 metres.

Magnesite within this hole was of a generally high grade, with an average of 42.3% MgO for the 90 metre intercept of magnesite to the end of hole. FeO and SiO grades were 1.5% and 5.4% respectively.



**Figure 17:** Section showing AR029 lithologies and inferred geology on 20560N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade.



**Figure 18:** Section showing AR026 and AR030 lithologies and inferred geology on 20680N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade.

## **6.8 AR032**

Diamond drillhole AR032 was located approximately 50 metres to the SSE of AR031, and was commenced on 26 May and completed on 30 May within magnesite at a depth of 150 metres. The magnesite interval in this hole was 59.2m, with 81.4% recovery within this zone.

The hole was collared in 5.5m of iron-rich clays containing gossanous limonite clasts, followed by dolerite weathered and altered in a similar nature to that seen in AR031, being generally carbonated, sheared, limonitic or clayey. This continued to a depth of 69.8 metres, and was underlain by a gossanous limonite zone containing much quartz. From 74.6 to 90.8 metres, limonitic and talc-rich clays dominated, with small zones of gossanous material.

Fresh magnesite was encountered at 90.8 metres, and was often stained a very pale pink. Several zones of magnesite with a sandy texture rather than the usual extremely fine grains almost invariably showed greater signs of weathering. Overall, 7 solution features were found between 93.6 and 124.4m, the largest of which was 3m (106-109m).

There were two zones of high grade material in this hole between 90 and 146m, with a 5 metre zone between 126 and 131m of low grade material with very high iron content. This coincided with the occurrence of limonitic veins which would be easily sorted, hence the high grade ore intercept of this hole includes the material above and below this zone. In all, there is a 51 metre intersection of material grading at 41% MgO, with FeO at 1.1% and SiO at 5.3%.

## **6.9 AR033**

Diamond drillhole AR033 was commenced on 31 May and completed on 3 June at a depth of 73 metres, where the hole was abandoned within magnesite after the drill-rods became irretrievably bogged.

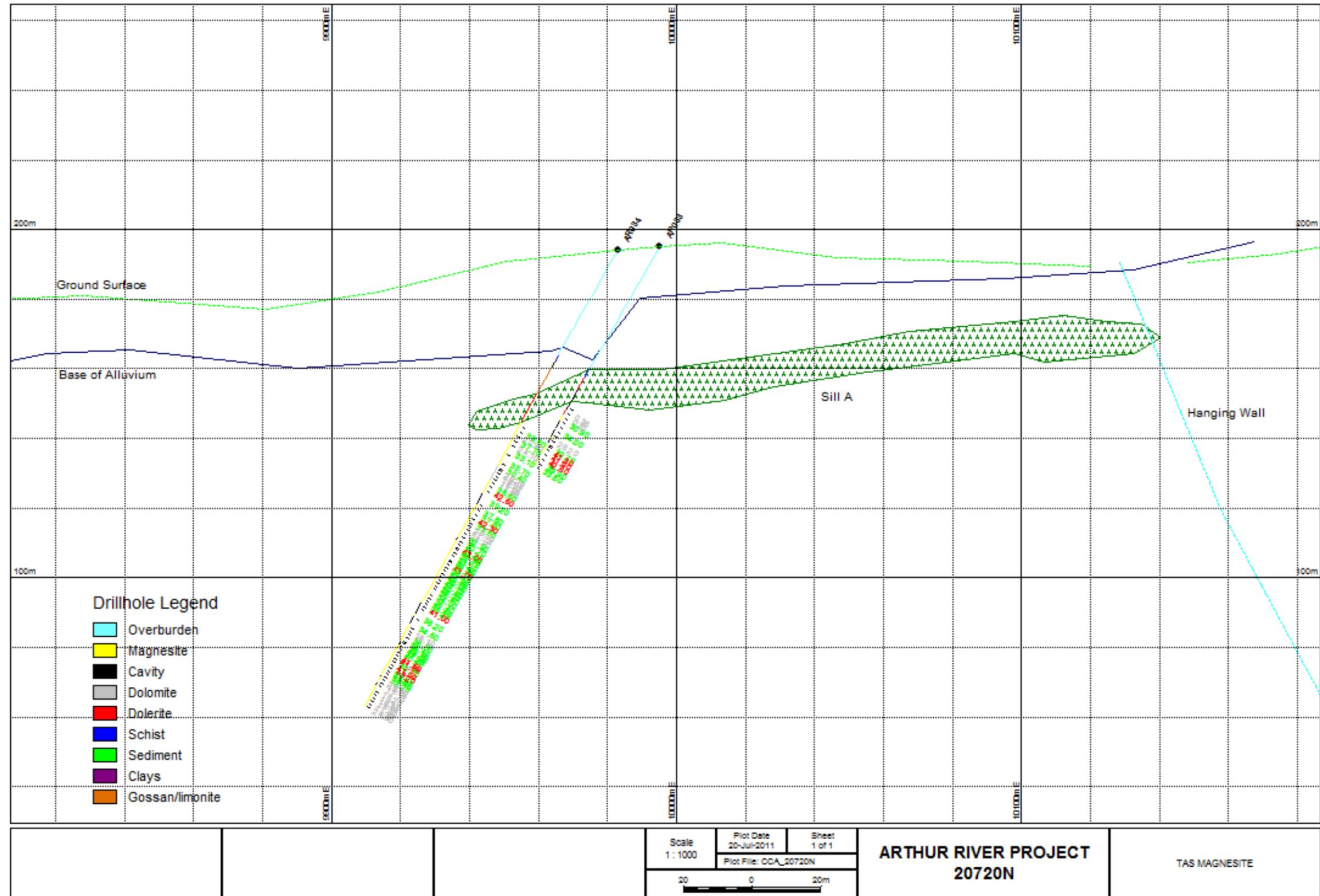
The hole was collared in 10 metres of quartzitic glacial alluvium, and was followed by a partially lithified 2.8m shear zone containing rounded quartzite clasts which otherwise resembled the shear zone observed in AR029. From 12.8 to 41 metres there was very poor recovery, with materials typically being fine to medium sands with occasional talcy clay zones and iron-rich and quartzite clasts. A mixture of extremely weathered schist, dolerite and grey clays followed this to a depth of 56 metres. Magnesite was intercepted at 56m, and was generally very broken or shattered, often appearing as highly weathered rubble. Recovery of magnesite within this 17 metre zone was 27.5%, and was only 24.1% for the entire hole. There was a 5.0m intercept of high grade magnesite at 65.5m with an average grade of 41.12% MgO, with 4.78% FeO and 6.28% SiO.

## **6.10 AR034**

Diamond drillhole AR034 was collared approximately 10m to the NNW of AR033, and was intended to replace AR033, as information on this part of the deposit is very limited. Drilling commenced on 3 June, and concluded while still within magnesite on 7 June at a depth of 150m. In all, 93m of magnesite was intercepted, with a core recovery of 46.5% in this zone.

The hole was collared in glacial alluvium, which continued to a depth of 37 metres with variable amounts of fine, black material which could be peat from a depth of 17 metres. From 37 to 47.5 metres, a silica-rich limonitic rock exhibiting a texture similar to jigsaw-jointed magnesite was present, but any magnesite which may have once been present had been replaced by limonite. Below this rock was 10m of dolerite, mostly decomposed to sands with occasional silicified clasts.

Magnesite was intersected at 57m depth, and was generally pale pink to buff, with many buff sections appearing to have a more sandy texture. 8 solution features were found in this hole between 80 and 144m, the largest of which was 3.7m at a depth of 116.5m. 9.5m of high grade magnesite was encountered at 128.5m, averaging at 40.56% MgO, 1.93% FeO and 10.26% SiO. Dolomite was also found in this hole at a depth of 71.5 to 75.5m, in addition to several wispy pyritic siltstone veins around 101m.



**Figure 19:** Section showing AR033 and AR034 lithologies and inferred geology on 20720N Local Grid. Numbers adjacent to holes indicate MgO content, with green indicating low grade material, and red high grade.

## **6.11 MB007**

Diamond drillhole MB007 was commenced on 21 April and completed on 28 April within magnesite at a depth of 43.3m. This hole was drilled as a ground-water monitoring bore to assist with the mapping of groundwater flows within the magnesite body, but also produced information on a poorly drilled and potentially very important part of the deposit in the event of a pit extending to the north of the dolerite dyke.

The hole was collared in 7.6m of glacial materials, initially glaciated quartzite followed by 0.5m of organic-rich lake sediments. Underlying this was highly weathered and often slightly clayey dolerite, which continued to a depth of 24.8m. Fresh magnesite was intercepted at this depth, and continued to the end of the hole. This magnesite was often very pale pink, and contained 6 solution features, which were all less than 0.2m wide, with the exception of one at 25.4m, just below the intersection with dolerite, this one being 4.9m wide. There was also some minor dolomite at 33.1m.

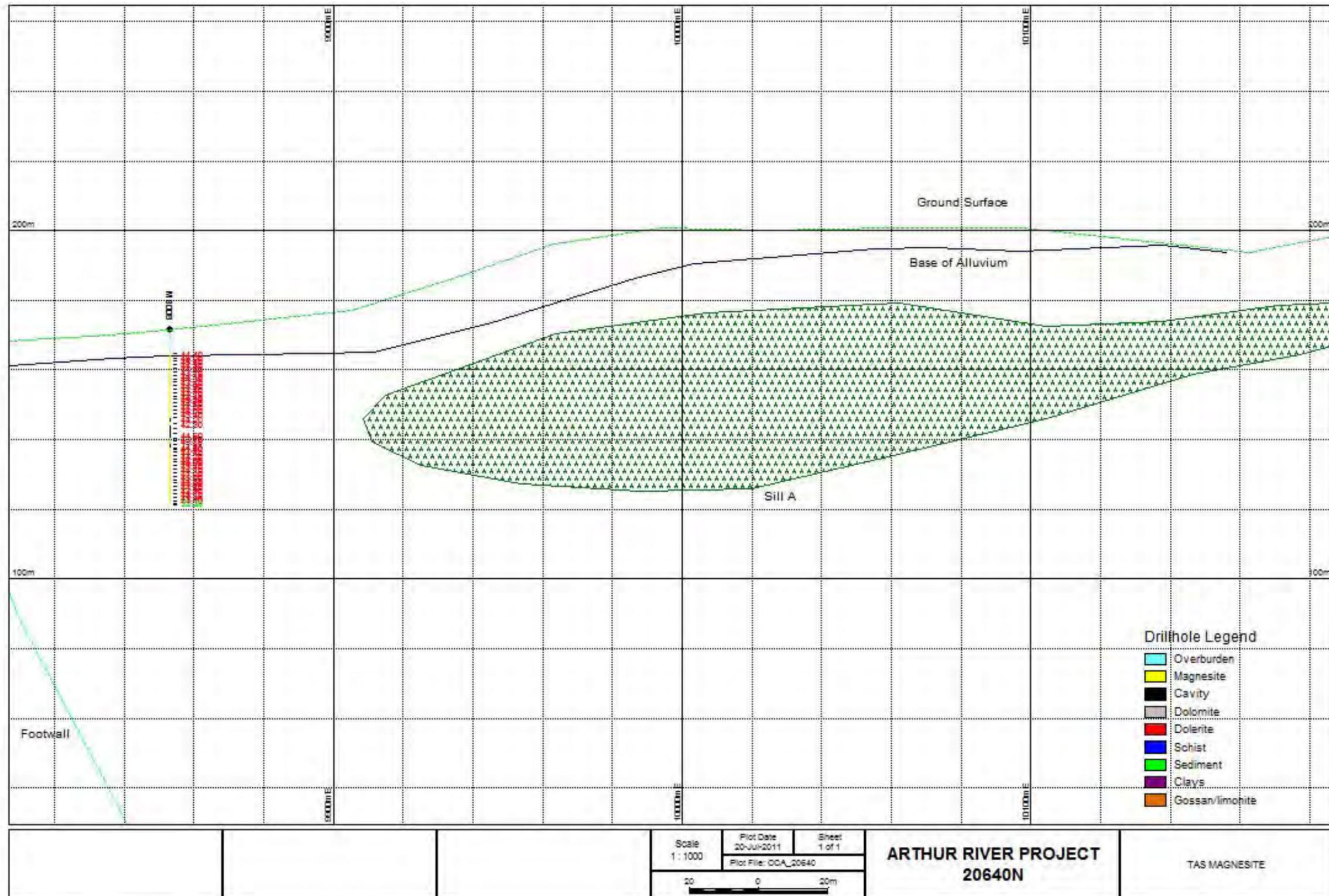
Overall, this hole intercepted 18.5m of magnesite, of which it recovered 67.6%. The upper portion of magnesite was of a low grade, but from 35.0m to the bottom of hole, the magnesite grade was 43.6%, with FeO and SiO at 0.86% and 0.92% respectively.

## **6.12 MB008**

Diamond drillhole MB008 was commenced on 10 May and completed at a depth of 50.3m on 12 May, while still within magnesite. The purpose of this hole was the same as for MB007, with this also being in a part of the deposit which was lacking in information.

The hole was collared in 6.9m of predominantly quartzitic glacial alluvium, with minor dolerite clasts also visible. These glacial materials were directly overlying fresh magnesite which was mostly pale pink in colour. Three solution features were found in this hole between the depths of 25.5 and 33.9m, with the largest being 3.5m at 27.7m. No material was retrieved from these zones, but rocks on the margin of the solution features were found to have a coating of fine, dark material, which would have likely been extremely difficult to capture in the drill-rods. Large quantities of limonite were also found proximal to these solution features.

Overall, the magnesite in this hole was 43.4m, over which 81.9% of material was recovered. From the intersection of fresh rock at 6.9m to the end of hole at 50.3m, the average grade of MgO from assays was 43.8%, with grades of 1.9% and 2.6% FeO and SiO respectively.



**Figure 20:** Section showing MB008 lithologies and inferred geology on 20640N Local Grid. Numbers adjacent to the hole indicates MgO content, with green indicating low grade material, and red high grade.

## 7. Regional Geology

The Arthur River magnesite deposit is located within the Arthur Lineament, which is a NNW-striking belt of highly deformed metamorphic Pre-Cambrian rocks extending from just north of Granville Harbour on the west coast, to Wynyard on the north coast. This belt is approximately 110km long and 8km wide, and is generally steeply dipping to the east. To the west of the lineament are the early to middle Neoproterozoic Rocky Cape Group correlates and the late Neoproterozoic Western Ahrberg Group (Spry 1964). The Rocky Cape Group is composed predominantly of quartzites and siltstones, while the Ahrberg Group is an autochthonous unit composed mostly of shallow marine siliciclastics which were deposited following an extensional phase, and also coincide with the intrusion of tholeiitic dolerite dykes (Crawford & Berry, 1992).

To the east of the lineament are the Burnie and Oonah Formations, which are predominantly Neoproterozoic turbidite sequences, with the Burnie Formation containing greywacke, slaty mudstone and occasional basaltic pillow lavas, and the Oonah Formation also including conglomerate, sandstone, dolomite and chert.

The lineament itself is composed of the Eastern Ahrberg Group and Bowry Formation in the southern part of the lineament, with at least the Bowry Formation appearing to extend past the study area. The distinction between the Eastern and Western Ahrberg group lies in the fact that the Eastern part of the formation shows greater deformation than the western portion, and appears to be a parautochthonous slice of the Ahrberg Group. The Bowry Formation is a fault bounded allochthonous unit within the lineament, and is intruded by granitoids dated to  $777 \pm 7$ Ma, possibly related to the breakup of the Rodinian Supercontinent (Holm, et. al, 2003), however the age of the formation itself remains unknown.

Rocks within the lineament are generally phyllitic to schistose and have been variably metamorphosed to greenschist or blueschist facies, with much material within the Bowry Formation appearing as a chloritic schist. The actual mechanism for the formation of the lineament remains in doubt, but it was formed during the middle Cambrian in the early stages of the Tyennan Orogeny (O.H. Holm & R.F. Berry, 2002). Further deformation occurred during the Middle Devonian due to the Tabberabberan Orogeny, resulting in further faulting and folding.

Several magnesite deposits are known within the lineament, with three deposits in the south, and three in the north of the lineament. The deposits in the southern section are located at: Main Creek, Bowry Creek and the Savage River mine. To the north are the Lyons River, Arthur River and Cann Creek magnesite deposits. Due to a lack of study, little is known about the genesis of these deposits, with Calver (1999)

suggesting Mg metasomatism of dolomite for all of the deposits, although that mechanism is under some doubt (Berry, pers. comm., 2011).

## 8. Local geology

Outcrops of unweathered material in the Arthur River Magnesite deposit area are infrequent, with the bulk of these being siltstones occurring well to the west of the inferred foot-wall contact. The bulk of magnesite outcrops are found to the north of the Arthur River in the Main Creek and Victory Springs area, where sinkholes, blind valleys, pillars, springs and solution tubes were observed. Other outcrops were observed in the Keith River, with some magnesite outcropping, and dolomite and siltstone found down-river (down-stratigraphy).

Prior to the most recent drilling program, the general consensus has been the local geology has been relatively well defined, with a foot-wall consisting of amphibolite and pyritic siltstone underlying a massive magnesite body cross-cut by two doleritic dykes. The position of the hanging-wall was also defined as being in close vicinity to Farquhar's Road, and composed of the Keith River Schists, predominantly composed of quartz and quartz-mica schists. The dip of the general structure appears to range from vertical to approximately 70 degrees.

At the northern end of the deposit, AR001 intersected approximately 50 metres of black chloritic schist reminiscent of Bowry Formation materials before the hole was abandoned. Immediately above this was an intersect of about 20 metres of highly decomposed material which may have once been dolomite, which could represent the pod of mineralisation pinching out. Magnesite does appear further to the north of this in the Aspiring Cave area of Central Creek and Southern Creek, where many magnesite outcrops are visible, but apart from surface mapping of these features, very little is known about their connection to the main body of the Arthur River Magnesite deposit.

The southern-most exposure of the deposit is seen in the Keith River, where white magnesite outcrops in the centre of the river and on the eastern bank. Monitoring bores 2 and 3 are also located in close proximity to this outcrop, and suggest that the magnesite may extend further than previously mapped. The Keith River Gossan is also found a short distance to the south-west of the magnesite outcrop, appearing as an iron-stained, magnesite-rich and partially brecciated material.

## **8.1 Overburden**

There are at least five different types of overburden in the area, with three of these covering significant areas. Glaciated materials are often the most readily observed, but other materials include weathered dolerite, magnesitic clays, schistose land-slip materials and dark brown material which may be peat. The landslip materials are restricted to the eastern extremes of the deposit, and intersections of the peat were infrequent, hence these materials are not discussed any further.

### ***8.1.1 Alluvial Overburden***

Holocene glacial alluvium often forms a 10 to 15 metre cover over the southern part of the deposit where most of the drilling has been concentrated, giving way to Fe-rich clays to the north. This alluvial material consists mainly of unconsolidated glacial quartzite gravels and rubbles, with angular to rounded clasts up to 20cm in diameter. Rare rounded magnesite clasts were also observed in this material.

### ***8.1.2 Weathered Overburden***

The term 'weathered overburden' has been applied to materials which are considered to have been weathered in-situ. The area to grid local south of MB4 generally has yellow/grey clay overburden, shown by Perry (2011) to be mostly of magnesite origin. This area features often swampy, very low topography in comparison to the surrounding environs. To the north of this, appearing to underlie the alluvial overburden in some cases, are Fe-rich clays. These typically have a deep red/orange colour, but range from yellow to purple, and also often have a sheared appearance. These clays appear to be extremely weathered dolerite which has been weathered in-situ, and extend to the north past the most recent round of drilling.

The nature of the overburden to the north of this is largely unknown, with little to no overburden material collected in previous drilling programs, and surface mapping revealing very little information. There is evidence of minor landslips near the base of the hills directly to the east, with clays containing angular to rounded weathered materials overlying some glacial materials.

## **8.2 Magnesite**

The magnesite body forms a large pod approximately 2500m long by up to 400m wide, with drilling proving the magnesite to a vertical depth of 290m with no apparent drop in grade. The dolerite dyke does not have any discernable effect on the grade of magnesite to the south, and there is insufficient information to make such a claim to the north of the dyke. Dolomite is found in the magnesite body, often appearing abruptly along either weathered contacts or delineated by linear carbonate veins. However, in several holes it has been noted that magnesite appears to have been replacing dolomite.

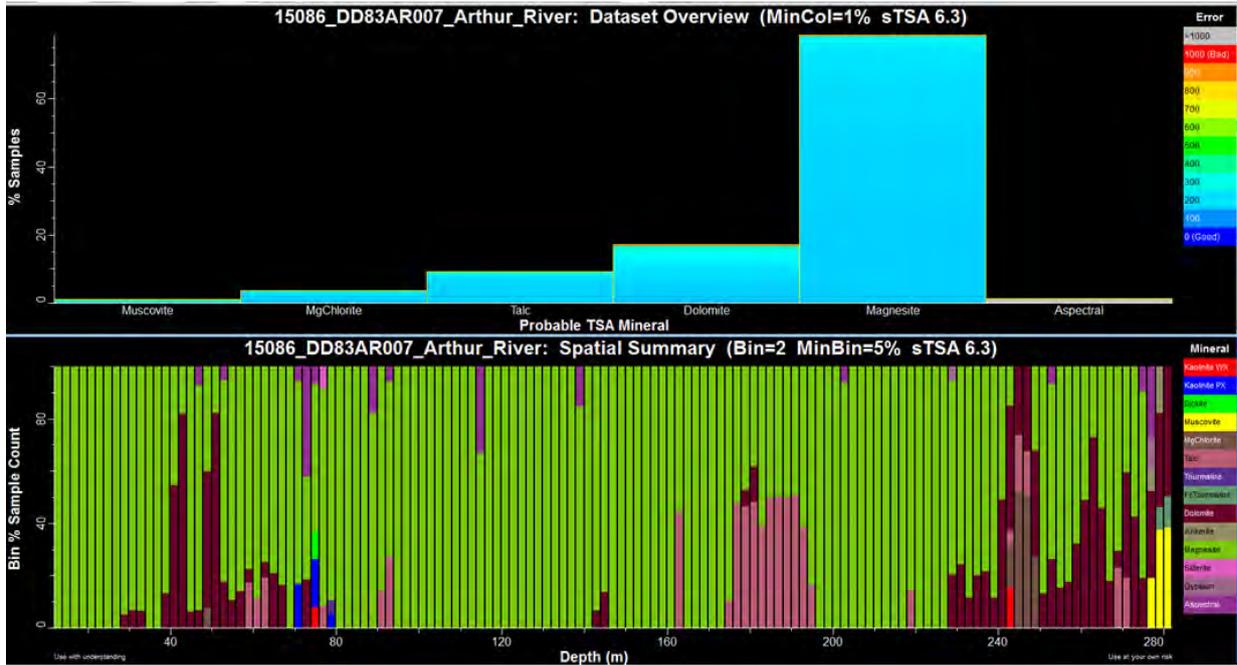
Pyritic siltstone is also found within the magnesite, mostly at depths of over 100m, and in the majority of occurrences as small, wispy veins, giving the appearance of being injected into the magnesite. In several holes this siltstone was intersected for several metres before re-emerging into magnesite.

The appearance of the magnesite is quite variable, with the bulk of it being white to slightly pink, with clear veining of several varieties giving the rock a general brecciated appearance. The colour of the rock often related to the proximity of zones which have been chemically weathered, and frequently fails to extend past linear magnesite veins, even in cases where clasts are cross-cut by said veins. The degree to which the magnesite has this brecciated appearance is also highly variable, sometimes with only occasional very fine white magnesite clasts within what could be large holocrystalline veins extending for several metres, and at other times almost devoid of veining. There also exists a fabric to many of the fine-grained clasts, with hairline fractures or weaknesses filled with clear carbonate veins and often roughly aligned.

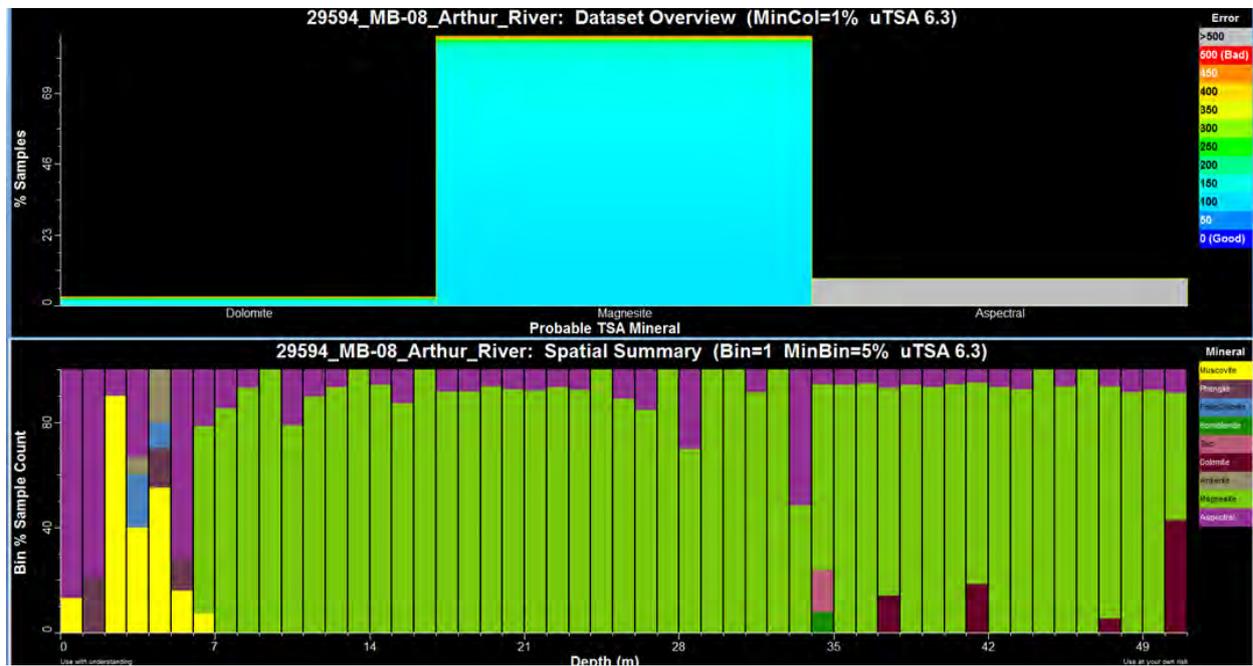
In several holes, alteration haloes were noted to surround magnesite clasts, raising the possibility of several generations of hydrothermal fluids moving through the rock. Using electron microprobe analysis, Perry (2011) found that the alteration haloes and associated veining were also magnesite, but of a more ferric variety, which could possibly be associated with the intrusion of the local dolerite body.

### **8.2.1 Talc Content**

During the course of logging, talc was observed to form occasional veins. Talc is a Mg silicate mineral, and hence has the potential to produce mass-balance issues if not accounted for. DDH AR002, AR007, AR016 and MB008 were analysed using the Mineral Resources Tasmania HyLogger, in which highly variable talc contents were detected within the groundmass of the magnesite (see Figures 18 & 19).



**Figure 21:** HyLogger data for hole AR007, showing mineral contents in relative quantities in the upper section, with the lower section showing the down-hole metre-by-metre scan results. Green represents magnesite, light brown talc, and dark brown/purple at the base is dolomite. Purple at the top of the section represents no material.



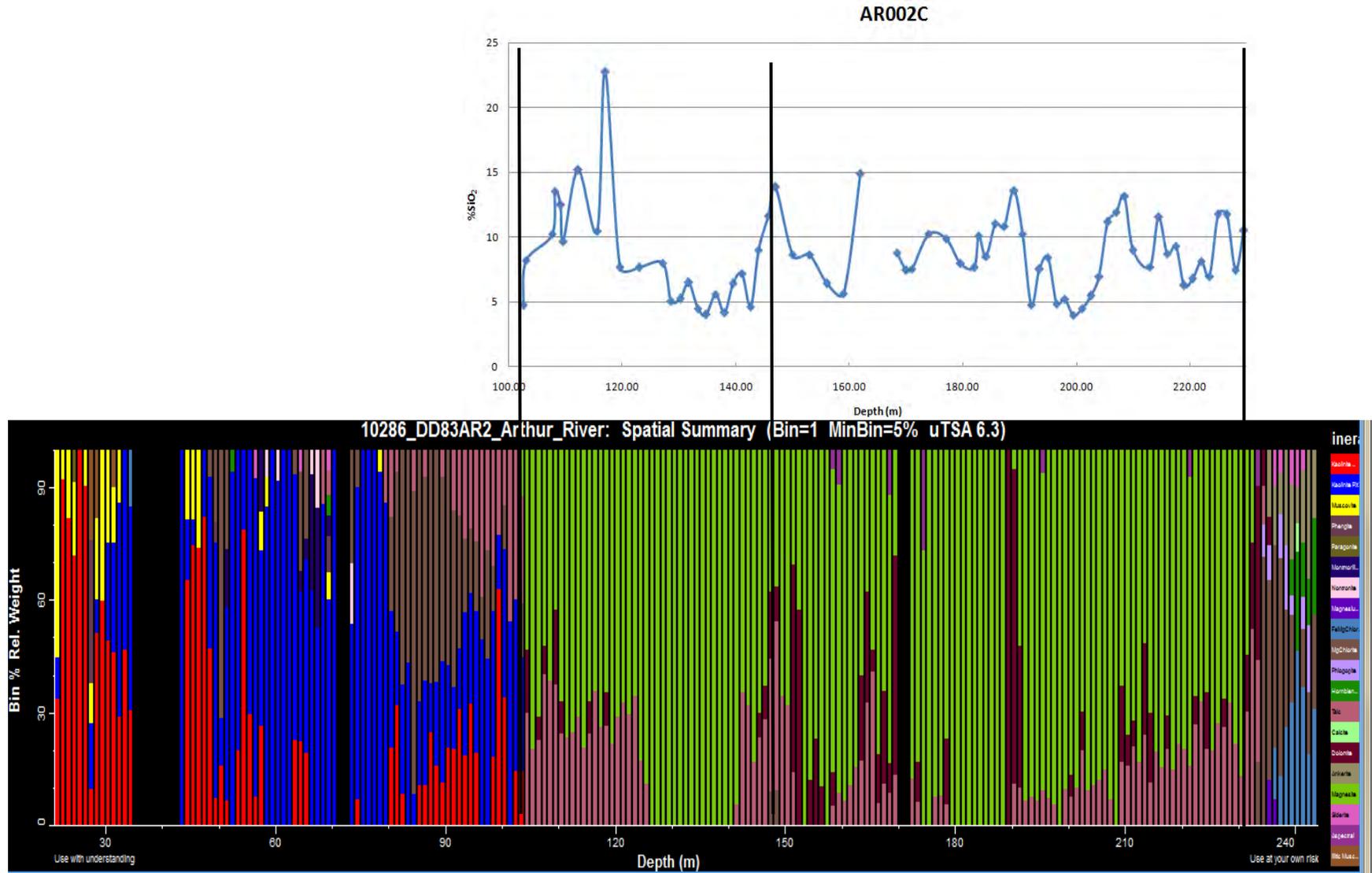
**Figure 22:** HyLogger data for hole AR007, showing mineral contents in relative quantities in the upper section, with the lower section showing the down-hole metre-by-metre scan results. Green represents magnesite, light brown talc, and dark brown/purple at the base is dolomite. Purple at the top of the section represents no material.

MB008 was the only hole to the north of the dolerite dyke which was analysed, and was shown to have extremely little talc. The other holes had variable amounts of talc, and showed some zones which had been logged as dolomite to be magnesite with a high talc content. With the exception of these areas with a dolomitic appearance, these contents often do not affect the appearance of the rock to any visible degree, with pure magnesite and talc-rich magnesite looking almost identical to the eye. This talc has the potential to create issues with the processing of magnesite.

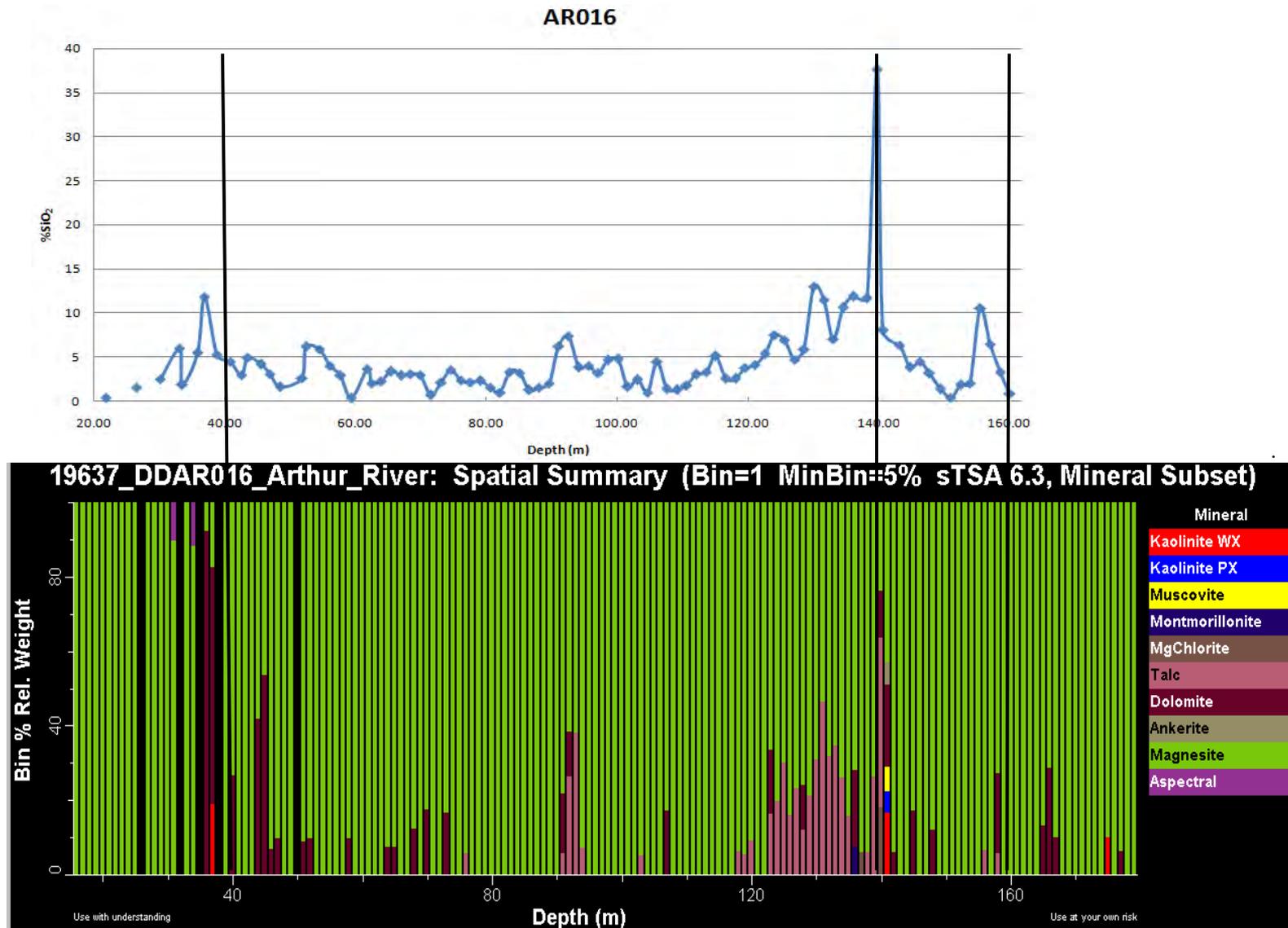
### **8.2.2 Silica Content**

As with talc content, silica concentrations vary unpredictably within the magnesite, with some intersects which appear to the eye as pure magnesite having contents of up to 10%. However, for the most part, the content varies between 0 and 5% in magnesite, with greater values for the hanging-wall and foot-wall sequences.

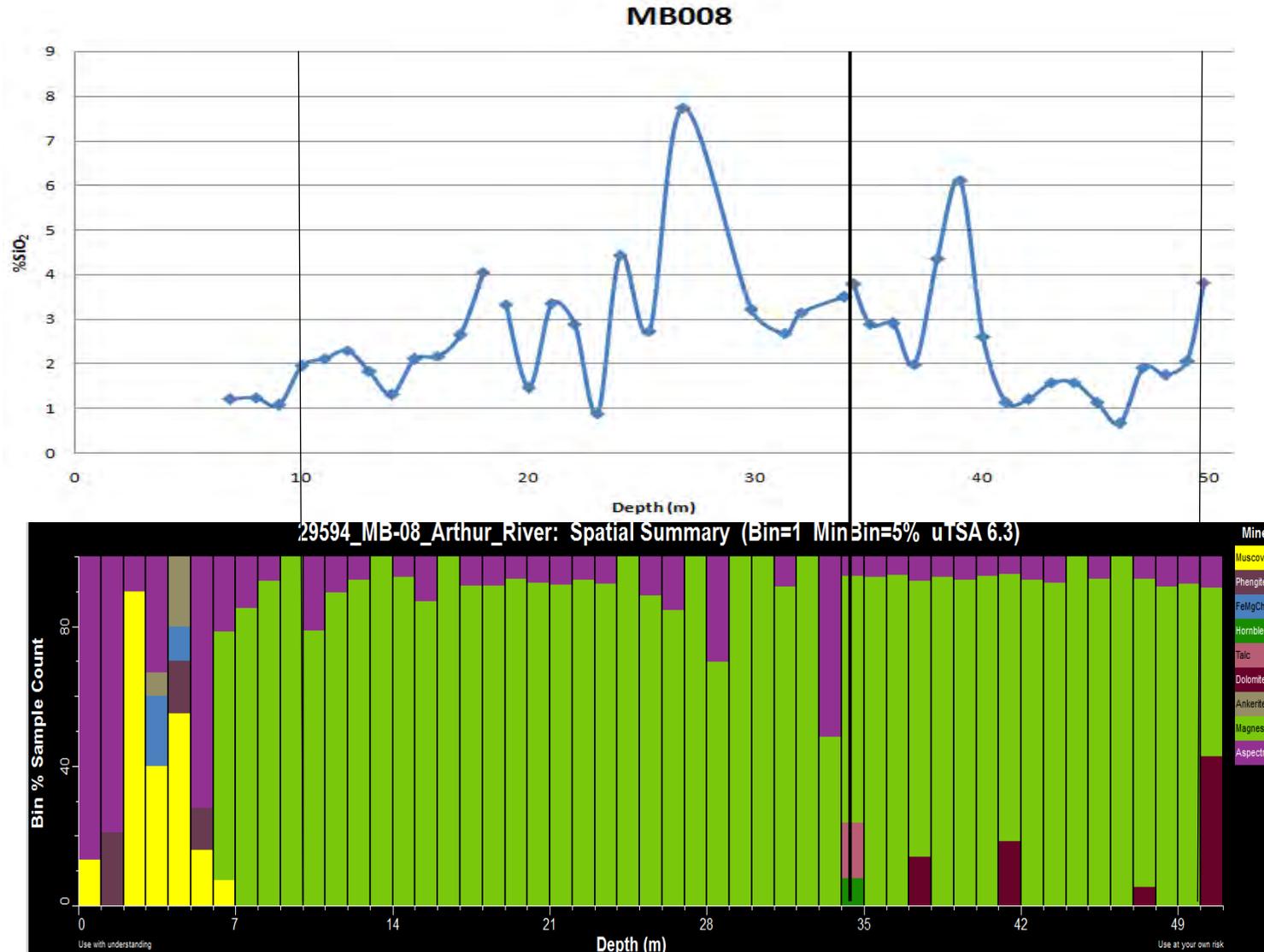
There appears to be an absence of quartz veining within the magnesite, but it is occasionally visible within the magnesite in the form of individual sub-angular crystals up to 3mm in diameter, but due to the fact that clear magnesite is visibly almost identical to quartz, it is often difficult to find. The presence of micro-crystalline quartz within the matrix of the magnesite is possible, but in the light of new information regarding talc within the magnesite, it is considered more likely that a large fraction of the silica is contained within this, not quartz. Calculations have not been performed on these data to determine any relationship, but a cursory comparison of the assayed silica content vs the talc recorded in HyLogger measurements reveals a partial relationship, but this does not account for all silica, as displayed in Figures 21, 22 & 23.



**Figure 23:** Comparison of assayed silica content and HyLogger data for hole AR002C, showing a partial relationship between the silica and talc contents. Talc content is represented by light brown, magnesite by light green, and dolomite by dark brown.



**Figure 24:** Comparison of assayed silica content and HyLogger data for hole AR016, showing a strong relationship between the silica and talc contents. Talc content is represented by light brown, magnesite by light green, and dolomite by dark brown.



**Figure 25:** Comparison of assayed silica content and HyLogger data for hole MB008, showing a partial relationship between the silica and talc contents. Talc content is represented by light brown, magnesite by light green, and dolomite by dark brown.

### **8.2.3 Solution Features/Weathered Zones**

Many solution features were encountered during the drilling process, but the vast majority of these appeared to be filled with sediment, most often derived from the weathering of the surrounding magnesite. As such, the term 'cavity' has not been applied, as this implies a void. In the past these zones were logged as cavities. This appears to be an erroneous assumption due to the lack of core recovery in these zones. In many cases these solution features exhibit relict clear carbonate veins cross-cutting areas where the groundmass magnesite has decomposed to clay. It would appear that rock adjacent to natural pathways for the movement of ground water, such as faults and joints, are being altered to clay over time, but the strength of water flow is insufficient to displace the resultant clay.

### **8.2.4 Other Carbonates**

Dolomite was the only other carbonate noted during lithological logging, and its' occurrences were found most often proximal to doleritic intrusive. However, this was not always the case, and as shown by HyLogger data, it is distributed throughout the magnesite to varying degrees, and does not always appear significantly different from magnesite. The HyLogger also detected ankerite, which was not noted during logging. This is a carbonate mineral similar to dolomite, but in which magnesium has been partially or wholly replaced by iron and manganese. The compositions of these carbonate minerals are variable, and there are transitions from one mineral to another depending on the amount of metallic ions present.

## **8.3 Dolerite**

The mafic material forming dykes and sills in the area has previously been logged and mapped as amphibolites, dolerite, gabbro and foot-wall. In this report it is all referred to as dolerite. It is only observed within or overlying the magnesite in varying states of decomposition, and not within either the hanging wall or footwall. Doleritic dykes and sills materials appear exhibit chilled margins with magnesite and dolomite, but not in all case. Beyond these chill margins the dolerite is typically medium to coarse-grained.

From the results of the recent ground magnetics survey and drilling in the area, it would appear that the dolerite producing the magnetic high in the area may not be as extensive as first thought, with only one dyke which was shown by diamond drill hole AR027 to be relatively thin. The remaining dolerite in the area appears to be in the form of several small sills, all sourced from the dyke, not the wide dyke as suggested by others from the interpretation of aerial magnetic data of relatively low resolution. Much of this dolerite is extremely weathered, such as the sill to the south of the dyke. This area returned highly un-magnetic readings for the magnetics survey, but upon close inspection of material in the weathered zone which appeared initially as partially schistose, partially carbonated Fe-rich clays. From these holes,

it was concluded that the material was in fact in-situ weathered dolerite which had been subjected to moderate shearing and carbonation, with several minor faulted zones. This interpretation extends to several other holes to the north of the dyke, most notably diamond drillholes AR031 and AR032, which intersected materials very similar to that found in AR027 and AR028, but are located on the western side of the mapped magnesite body.

With the greatly improved amount of information on the distribution of dolerite, it has been concluded by this study that the dolerite in the immediate vicinity is constrained to the magnesite body, generally in areas which now have a slightly elevated position. This dyke has acted as a feeder to the sills found near the surface to the north and south of the dyke with another sill of unknown thickness at a depth of approximately 20m RL on the northern side. This deeper sill has only been intercepted by DDH AR002C, and more drilling will be required to map it out more accurately. An attempt at dating the dolerite proved unsuccessful (Perry, pers comm., 2011), but it is suspected that it was emplaced during the Tyennan Orogeny, and subsequent deformation during the Tabberabberan Orogeny produced the faulting and partial shear fabric which may have caused the weathered upper sills to be mistaken for weathered Keith River schists in the past. Minor faulting may also explain the occasional lack of chilled margins within the dolerite proximal to the magnesite when it was present at other contacts.

Figure 20 shows a long section, oriented along Local Grid S-N at an easting of 10080. This displays AR027, directed to Grid North to intersect the dolerite, along with sections of many other holes in the area. The dyke is clearly shown as a steeply dipping feature, with near-surface sills to the north and south. This section is based on drill intercepts, with the remainder inferred from magnetics data and wireframe models built from the full drillhole database.

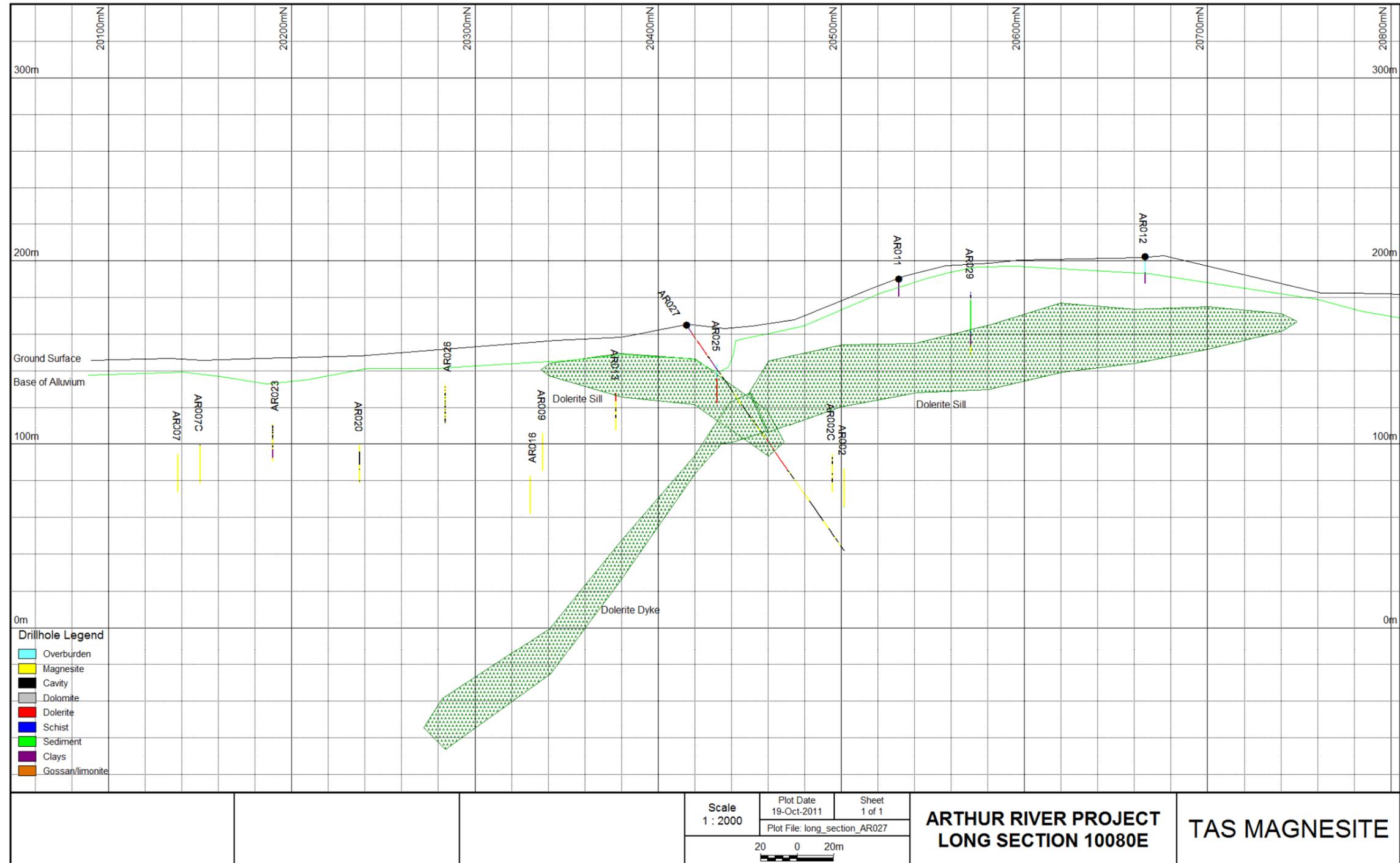
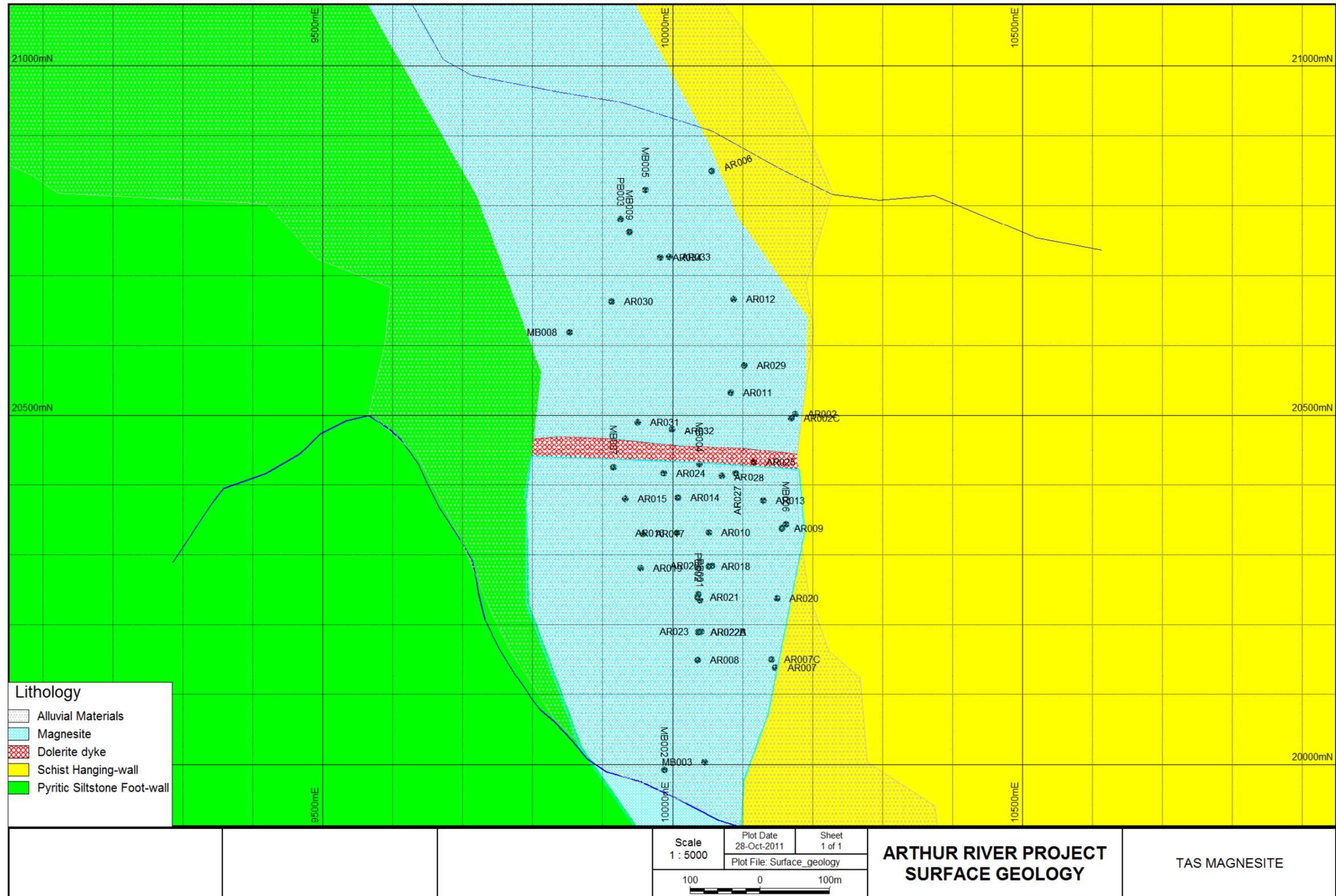


Figure 26: Long section 10080E, oriented on Local Grid S-N displaying modelled position of dolerite dyke and sills.



**Figure 27:** Surface geology of the Arthur River Magnesite Deposit. Alluvial materials show as shaded areas, and include weathered doleritic materials that may have been transported, glacial alluvial materials, magnesitic clays and landslide materials. Produced using information from drilling and surface mapping.

## 9. Discussion

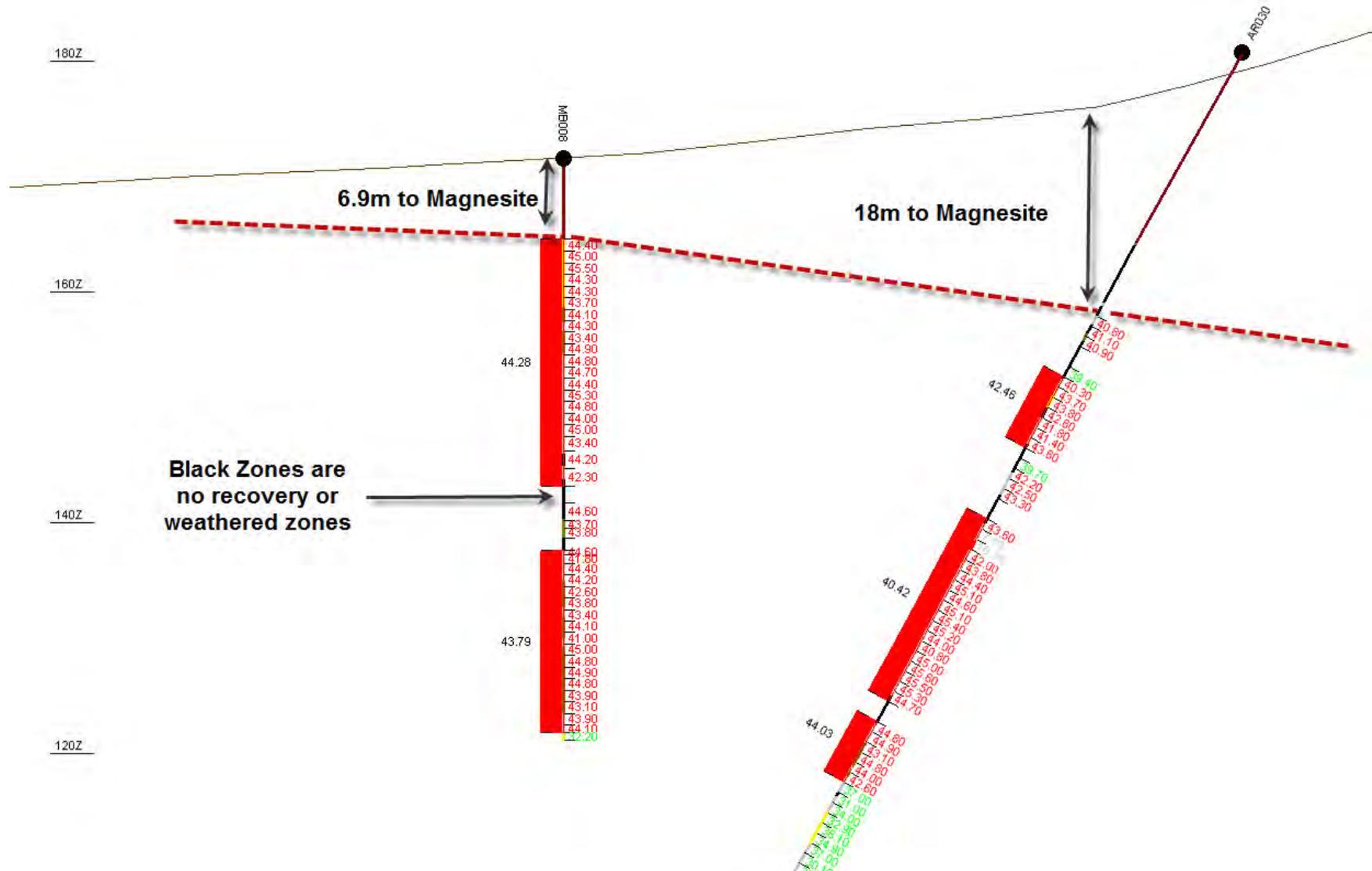
With data from the most recent drilling program, it has become apparent that the boundaries of the magnesite body are in fact ill-defined. The mapping of the footwall contact is also in doubt, due largely to the fact that in holes such as AR005 and AR007, intersections of pyritic siltstone were encountered at depths of 120 and 245 metres respectively, before once again emerging into magnesite. These intersections were as long as 5 metres, yet other holes were discontinued effectively immediately after hitting siltstone with no indicator as to whether it was the true footwall. In addition to this, from the modelling it has been found that there is little evidence that amphibolite forms part of the footwall, as the dolerite intersects used to justify this theory have been found to fit well with the dyke and lower sill. Occasional small zones of mylonitic material have also been noted near the base of several holes, suggesting a degree of movement in the vicinity of the foot-wall.

As a result of the conclusions above, it is possible that the true hanging- and foot-walls have not yet been intercepted. However, if the assumption that the dolerite is constrained to the magnesite, then the bounds of the magnesite would not be extended greatly, with the hilly terrain to the east impeding development of the area, and the definite presence of siltstone mapped in the Keith River.

The chloritic shear zone material which was found in diamond drillholes AR029 and AR033 shows that the magnesite has undergone very high pressures and shear forces, supported by the occasional presence of talc within the magnesite, the brecciated nature of the rock, and the discing of drill core at relatively shallow depths. These factors, combined with the mapped distribution of the magnesite suggest that the magnesite pod may in fact be a mega-boudin, formed at depth during the Tyennan Orogeny. In this scenario, the siltstone to the west would have formed the foot-wall, with the Bowry Formation being the hanging-wall. During the development of the lineament in the Middle Cambrian and subsequent movement, dolomite was boudinaged to form the large pods observed today. On the cessation of movement of the lineament, pressure was released on the dolomite body, allowing Mg-metasomatism to occur. The position of the dolerite dyke delineates a major failure of the rock where the dolerite intruded at a later date, with heat and fluids from this possibly providing a mechanism for upgrading the resource.

Without detailed chemical analysis it is difficult to confirm the genesis of the present materials, but it is likely that given the similarity of their geological settings, the magnesite deposits in the north and south of the lineament have a very similar history, and proper analysis of any one of the deposits would help greatly with confirming the genesis of the other deposits also.

Diamond drillholes MB008 and AR030 were drilled in an area almost 200 metres from any previous drillholes, within an area previously thought to be underlain by a large dolerite body. There is in fact no



**Figure 28:** Simple section inferring possible geology around MB008 and AR030, with high grade zones of magnesite highlighted. Numbers to left of zones indicate average grades, with numbers to right showing assay results.

dolerite here, with glacial alluvium covering fresh magnesite. Both of these holes enter high grade material on first contact with fresh rock and are located in an area with a low topographic expression which extends past the bounds of the holes. Footwall material was not intersected in either of the holes, and the possibility of a significant resource residing here is a matter for future exploration. Figure 23 shows a simple interpretation of drilling results from these holes.  $\alpha$  and  $\beta$  measurements of linear veins within AR030 roughly aligned the high grade materials from both holes, raising the possibility that at least some of these veins may represent bedding planes. If this alignment is in fact bedding which defines a high grade zone, it could possibly extend to AR031. Again, future exploration in this area is required to confirm this.  $\alpha$  and  $\beta$  measurements from the south of the dyke lacked the consistency of measurements observed to the north of the dyke, with no consistent structures apart from several faults, all of which were measured in AR028 in an interval spanning less than 10 metres.

The presence of significant amounts of talc may present down-stream processing issues caused by material clogging up machinery, and the distribution of talc within the magnesite is not yet understood. It is often extremely difficult to detect in hand specimens, but the MRT HyLogger has proven highly successful at detecting it. When combined with assay results, there appears to be a partial relationship between talc and silica, but it also becomes apparent that not all silica can be bound within the talc. However, the HyLogger is not a whole-rock technique, and only spectrally analysis a surface, unlike assays, which are whole-rock. Whole-rock analyses such as those completed by Koenig Consulting Pt Ltd in August 2011 show that the bulk of silica is often contained within talc, but this is not a rule, with one of the samples showing extremely little talc, but high amounts of silica.

## 10. Conclusions

The most recent program of works has succeeded in mapping much of the distribution of dolerite in the area, finding it to be less extensive than previously thought. However, material in the east which had previously been logged as hanging wall schist was found to be extremely decomposed dolerite. This finding has expanded the distribution of dolerite sills in the area greatly, but only in areas which are unlikely to be developed due to the previously known depth of cover. The actual position and nature of the footwall contact remains ambiguous, with material which had previously been logged as footwall found to be doleritic, and on several occasions material which had been previously referred to as footwall was drilled through to re-emerge into magnesite.

A previously unknown potential resource has been drilled to the north of the dolerite dyke on the western side, revealing a high grade resource of appreciable quantity with little cover which requires further definition. The results of the geophysics honours project may go further to defining the depth of cover, and provide a greater understanding of the surface weathering features of the magnesite, while the pumping test should give details of weathering within the magnesite itself.

Information produced using the Mineral Resources of Tasmania HyLogger provides extremely useful information on rock composition, and it is recommended that drill core in the future be analysed using this instrument to assist with grade control.

More work is required to define the position and nature of the footwall contact, with this not intercepted in the most recent program. This may not only extend the available resource, but also provide insight into the genesis of the deposit.

## 11. References

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## **DIGITAL APPENDIXES**

**APPENDIX A – Drilling and Resource Sections**

**APPENDIX B – Geological and geotechnical logs**

**APPENDIX C – Core photos**

**APPENDIX D – 2011 Assay results**

**APPENDIX E – Magnetics survey**

**APPENDIX F – Met Results**