Suitability of using ground magnetics to delineate subsurface dolerite dykes in the Musgrave Province for construction material extraction

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Rian Dutch, Mark Pawley and William Harvey

Geological Survey of South Australia
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Government of South Australia
Department of State Development

Resources and Energy
Department of State Development
Level 7, 101 Grenfell Street, Adelaide
GPO Box 320, Adelaide SA 5001
Phone +61 8 8463 3037
Email dsd.minerals@sa.gov.au
www.minerals.statedevelopment.sa.gov.au

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Suitability of using ground magnetics to delineate subsurface dolerite dykes in the Musgrave Province for construction material extraction

Rian Dutch, Mark Pawley and William Harvey

INTRODUCTION

With the announcement of the construction of a new road through the Anangu Pitjantjatjara Yangkuntjatjara (APY) lands from the Stuart Highway to Pukatja (2014–15 State Budget announcement; Fig. 1), a significant amount of new construction material will need to be located and quarried locally. The doleritic to gabbroic dykes in the Musgrave Province can be an important source of construction materials for the region. Previously, high quality materials sites were proven and quarried for the Stuart Highway and the Tarcoola to Alice Springs Railway Line.

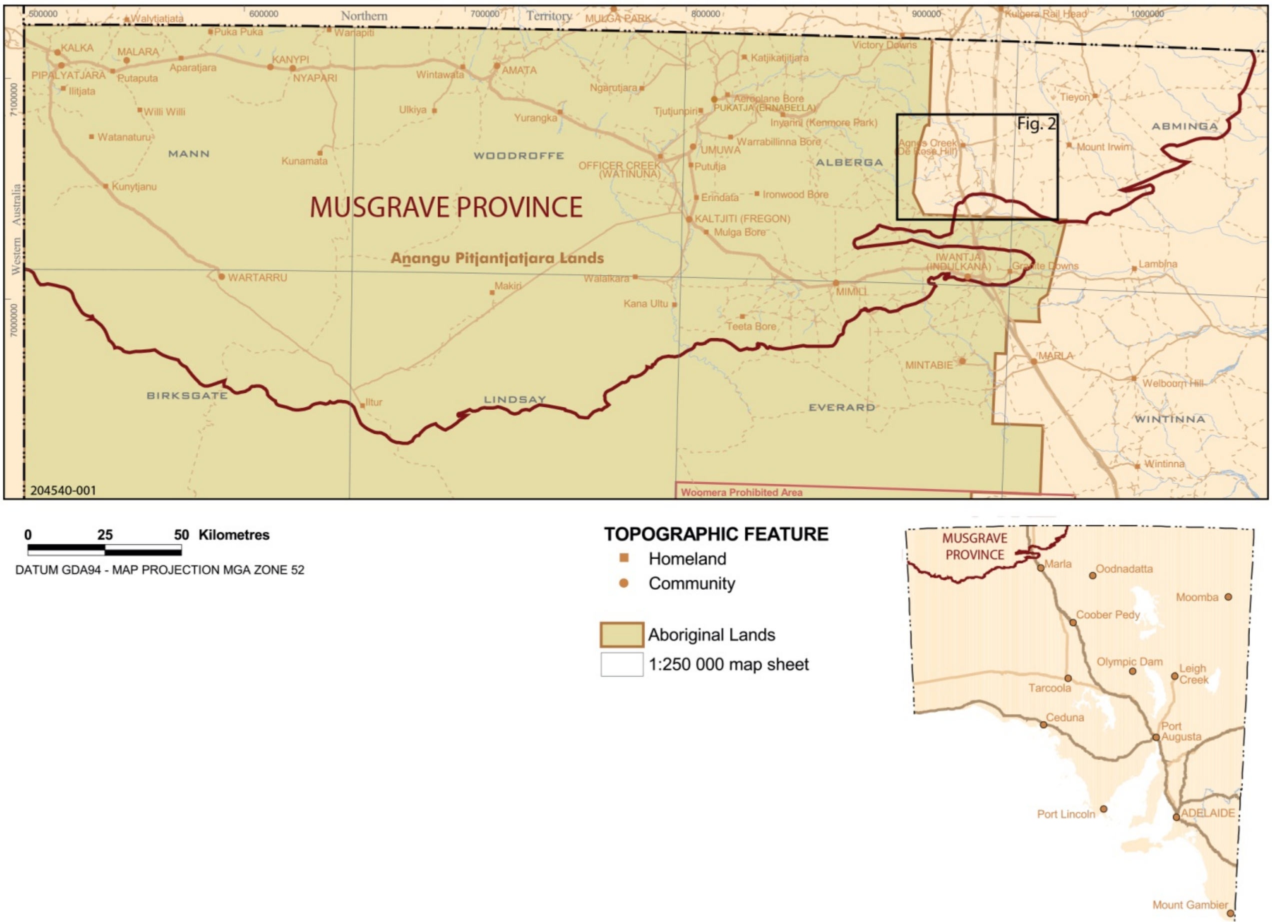

Figure 1. The Musgrave Province in South Australia, including the study area located in the marked box in the eastern Musgrave Province.

The clean, hard stone was identified as suitable for:

- rail ballast (Kulgera NT Quarry and Utah Bore Site), and
- road surfacing aggregates, concrete aggregates and Class 1 crushed rock roadbase (DPTI Granite Downs Crushing Contracts 1 and 2[1], De Rose Hill Quarry Site).

Under surface cover, the dykes displayed a deeper weathering profile with some calcrete development; this material is suitable for open surface road sheeting as well as having also been used for shouldering and base course for the Stuart Highway and for airstrip construction in the APY lands. Fresh rock material from below the weathered zone could be quarried and crushed for the higher quality construction products.

In large areas of the APY lands these dolerite dykes range from subcropping to buried. The use of regional reduced to pole total magnetic intensity (RTP TMI) images can be used as a tool to locate these units under cover (Fig. 2). However, defining the extents of these dykes on the ground can be difficult where there is little or no outcrop.

In this study, we have used a hand held magnetometer to do ground based traverses across known and inferred dolerite dykes in an attempt to determine the suitability of this technique for delineating the extents of the dykes, allowing easier and cheaper exploration of these units for construction material extraction.

METHODOLOGY

Four traverses over three dolerites (Fig. 2) were conducted in order to test whether the extents of large, subsurface, dolerite dykes could be delineated. The three dolerites selected are a representative sample of the dolerites in the area being both well exposed and undercover (Alberga Dam dyke), or either a large magnetic high (north Kangaroo Well dyke), or remnantly magnetised low (south Kangaroo Well dyke) on the regional RTP TMI image (Fig. 2).

The survey was undertaken using an Ultramag Geophysics GSM-19 magnetometer with data recorded using a field tablet PC (Fig. 3a,b). Five readings were taken at each location and averaged (Tables 1–4). Readings were taken at ~10 m spacing with lines oriented roughly perpendicular to the inferred strike of the dyke. No correction for diurnal variation was made due to the short time frame over which measurements were acquired and the relative, as opposed to absolute, nature of the survey to differentiate between dolerite and surrounding felsic gneisses and granite. Values for the magnetic susceptibility of the dolerite and surrounding rock units (where outcropping) were collected using a KT-9 magnetic susceptibility meter (Table 5; Fig. 3c).

Traverse 1 across the Alberga Dam dyke was conducted over exposed granite into dolerite then into felsic gneiss. This traverse was run as a potential control line over exposed basement geology (Fig. 4a).

Traverse 2 across the Alberga Dam dyke was conducted ~160 m along strike from traverse 1, where the region was entirely covered by sand, dolerite lag and some gneissic subcrop (Fig. 4b). There was no dolerite outcrop. The regional magnetic signature of this dyke is obscured by the surrounding granitic and gneissic units (Fig. 2).

Traverse 3 was across the large, magnetically high dolerite north of Kangaroo Well. There is a small outcrop of this dyke to the east of the station track and minor subcrop in the track (Fig. 4c). The majority of this dolerite is subsurface and the extents were unknown.

[1] Secondary alteration of dolerite at the Granite Downs site generated some fibrous amphibolite components in the rock; air quality testing during the quarrying and crushing stages did not identify any health hazards.

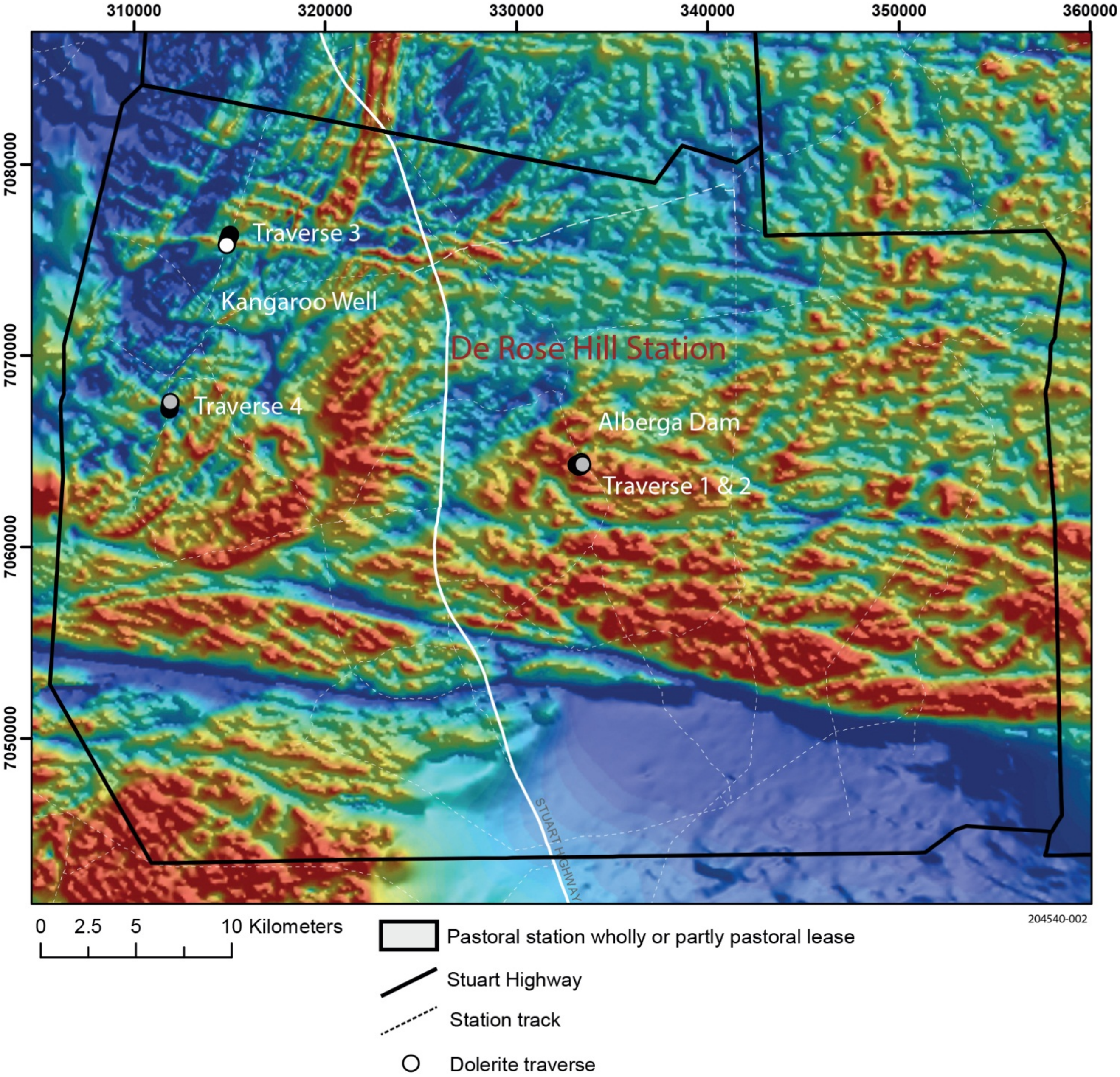

Figure 2. Regional RTP TMI image of the study area. The three dolerites traversed are shown with traverse 1 and 2 being over an outcropping dyke with a hidden magnetic signature in the regional data, traverse 3 over a regional magnetic high and traverse 4 over a remnantly magnetised regional low.

Traverse 4 was over a large, remnantly magnetised dolerite south of Kangaroo Well. Outcrop of this dyke occurs ~200 m to the northwest on a small rise (Fig. 4d). The traverse was conducted along a station track that traversed sheet wash dominated sand plains with no outcrop or subcrop of basement rocks. The subsurface extents of the dolerite were unknown.

Figure 3. a) Using the Ultramag Geophysics GSM-19 magnetometer along a station track on traverse 4. b) Marking out the traverse and recording data in a field tablet PC. c) Using a KT-9 magnetic susceptibility meter on a sample of gabbro from traverse 3. (Photos 414101–414103)

Figure 4. a) Dolerite at traverse 1. b) Sand and colluvium covering the dolerite at traverse 2. This is along strike from the exposed dolerite dyke at traverse 1. (Photos 414104–414105)

Figure 4. c) The station track used for traverse 3 with subcropping dolerite within the track and minor outcrop to the side of the track. d) Station track used for traverse 4 through sand covered terrain. There is a small outcrop of the traversed dyke on the rise at top right. (Photos 414106–414107)

RESULTS AND INTERPRETATIONS

TRAVERSE 1

Traverse 1 was conducted over exposed bedrock (Fig. 5). The measured magnetic susceptibility of the dolerite was 11.1 x 10^{-3}, which was an order of magnitude greater than that measured for the surrounding felsic gneiss of 1.73 x 10^{-3} (Table 5). The magnetic response for traverse 1 was variable with: high magnetic response in the granite (stops 1–5), a dip within the gneisses near the contact with the dolerite (stops 6–7), a relatively flat response across the dolerite (stops 9–16), a dip at the margin (stops 17–18) and a low response into the felsic gneiss (stops 19–26; Table 1; Fig. 5). Despite the relatively variable and unclear magnetic response and lack of a distinct high or low in the dyke across this exposed region, the dolerite is discernable as a relatively constant magnetic value of ~55 200 nT within the irregular 'noise' from the compositionally variable surrounding basement units.

TRAVERSE 2

Traverse 2 was conducted over the same dyke as traverse 1, but in an area of no outcrop (Fig. 5). This traverse shows an irregular, relatively high magnetic response in the basement units outside of the dolerite and a low response of ~54 800 nT (stops 13–20) which should correlate with the extension of the dolerite dyke under cover (Table 2, Fig. 5). There was some symmetrical variation across the dolerite, particularly a small peak in the centre, which may reflect compositional variation related to fractionation or other magmatic processes.

TRAVERSE 3

Traverse 3 was conducted over a large, magnetically high, linear feature interpreted to be a large dolerite dyke based on exposed and subcropping dolerite. The dyke samples range from a fine-grained dolerite to a coarse-grained, differentiated leucogabbro. The magnetic susceptibility of these two units is significantly different with the fine-grained dolerite being significantly higher (21.54 x 10^{-3}) than the coarse-grained, differentiated leucogabbro (0.74 x 10^{-3}; Table 5). The magnetic response of the traverse over the dolerite correlates well with the measured magnetic susceptibility readings (Fig. 6). The background gneisses are typically below 55 500 nT (stops 1–18 and 45–61), whereas the highly magnetic dolerite is above 55 500 nT indicating that the dyke occurs from stop 19–46 (Fig. 6; Table 3). The two dips below 55 500 nT within the interpreted dyke probably correlate with the coarse-grained, differentiated leucogabbroic core of the dyke, which has a low magnetic susceptibility and does subcrop in the vicinity of stops 34–36 (Fig. 6).

TRAVERSE 4

Traverse 4 was conducted over sand plains with no exposed bedrock, but crosses a large, remnantly magnetised dolerite dyke (Fig. 7). Outcrop of the dolerite occurs ~120 m NW of the traverse on a low rise. This dolerite is similar to the one at traverse 3, displaying both fine-grained doleritic and coarse-grained gabbroic lithologies. The doleritic component has a larger magnetic susceptibility (8.27 x 10^{-3}) than the gabbroic differentiate (0.63 x 10^{-3}; Table 5), similar to the north Kangaroo Well dyke. The traverse (Fig. 7; Table 4) shows a high and fairly variable magnetic response from stop 1–17 above 54 500 nT. Between stops 18–32 the values are generally steady and below 54 500 nT, with a small peak above this value between stops 25–29. This section of lower magnetic response likely correlates with the remnantly magnetic dolerite dyke, with the small peak likely correlating with a low magnetic susceptibility differentiated gabbroic core. Stops 33–38 are above 54 500 nT and likely represent similar background gneisses to stops 1–17. The dip at the end of the line between stops 39–44 may represent a second dolerite dyke with no surface expression, although this cannot be confirmed without further work.

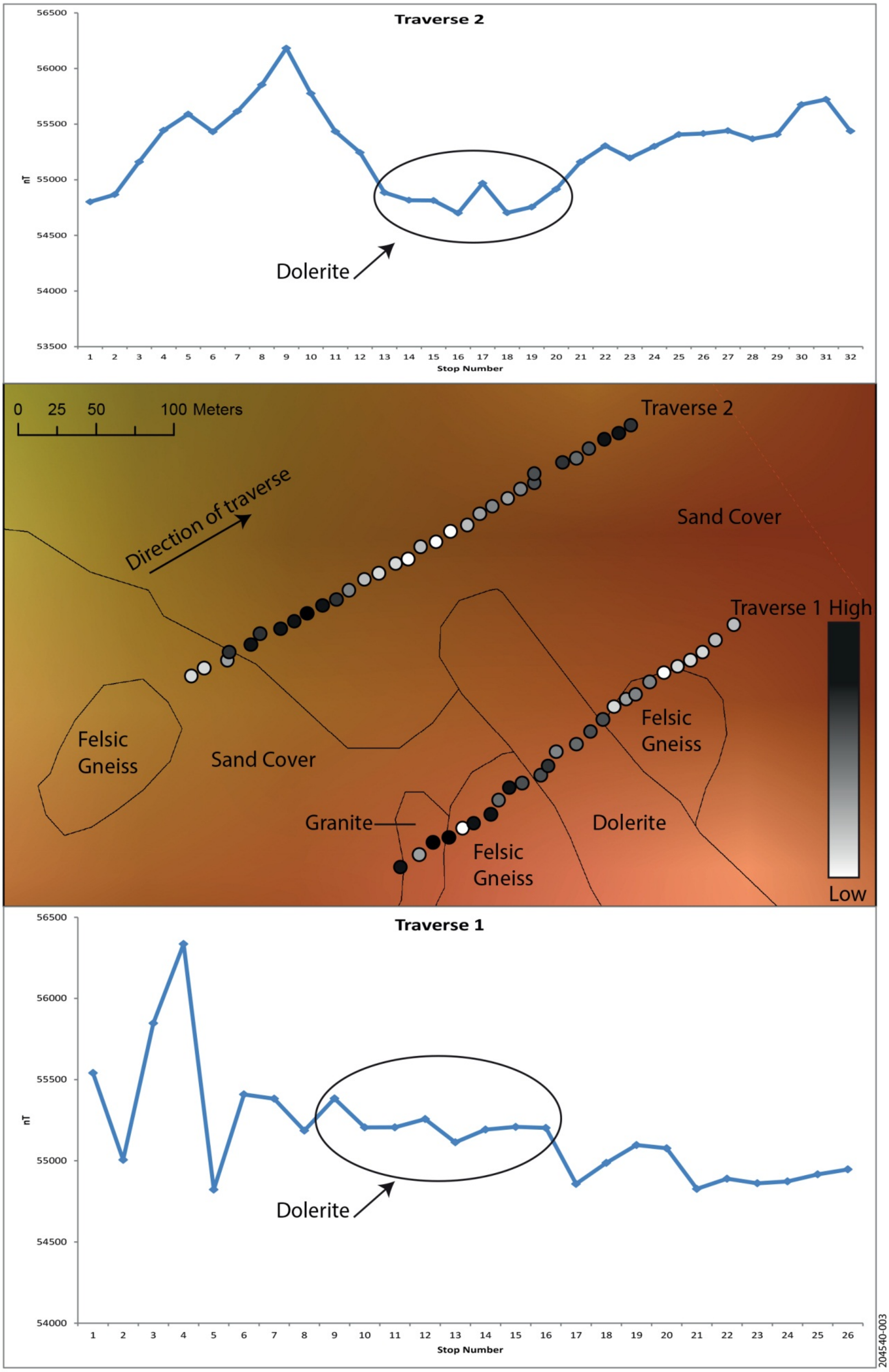

Figure 5. Plan of traverses 1 and 2 shown on an RTP TMI image with the surface geology. The direction of each traverse is shown (SW to NE) and correspond with the graphs of magnetic response starting at the left. The colour coding on the traverse goes from high (black) to low (white) relative magnetic response. The known and inferred location of the dyke from the magnetic traverse is shown by the ellipses on the graphs.

Table 1. Traverse 1 magnetometer readings

Easting	Northing	Stop	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average	SD
333276	7064152	1	55539.46	55537.94	55542.98	55542.56	55544.56	55541.5	2.72
333288	7064160	2	55002.73	55007.87	55006.85	55006.49	55008.05	55006.4	2.15
333297	7064168	3	55845.13	55849.27	55851.26	55845.62	55844.81	55847.22	2.88
333307	7064171	4	56339.33	56334.97	56333.98	56336.4	56336.56	56336.25	2.02
333316	7064177	5	54821.49	54821.25	54827.48	54825.57	54823.49	54823.86	2.67
333323	7064180	6	55407.02	55408.25	55407.73	55408.16	55409.77	55408.19	1.01
333334	7064186	7	55380.45	55380.99	55380.11	55383.84	55384.57	55381.99	2.06
333339	7064195	8	55187.37	55185.89	55187.6	55186.72	55186.17	55186.75	0.74
333346	7064203	9	55385.87	55384.15	55382.48	55384.23	55383.34	55384.01	1.26
333354	7064206	10	55205.77	55206.33	55206.07	55206.09	55205.37	55205.93	0.37
333366	7064211	11	55206.77	55206.65	55205.81	55205.73	55205.61	55206.11	0.55
333371	7064217	12	55257.28	55257.11	55257.26	55257.44	55256.53	55257.12	0.35
333376	7064226	13	55108.78	55108.27	55113.79	55115.06	55117.42	55112.66	4.00
333389	7064231	14	55193.72	55193	55192.22	55192.09	55192	55192.61	0.74
333398	7064239	15	55209.41	55209.38	55209.43	55209.24	55208.66	55209.22	0.32
333406	7064247	16	55203.72	55203.46	55202.21	55201.75	55202.02	55202.63	0.89
333413	7064255	17	54857.72	54857.51	54857.85	54856.99	54856.45	54857.3	0.58
333421	7064260	18	54987.77	54987.61	54987.84	54987.71	54987.23	54987.63	0.24
333427	7064263	19	55097.28	55096.73	55096.73	55096.83	55097.21	55096.96	0.27
333436	7064271	20	55077.88	55077.3	55077.21	55077.18	55076.83	55077.28	0.38
333445	7064277	21	54829.6	54828.4	54827.41	54826.39	54828.55	54828.07	1.22
333454	7064281	22	54889.24	54889.92	54890.84	54889.06	54889.25	54889.66	0.74
333462	7064285	23	54862.43	54864.09	54861.4	54857.29	54862.54	54861.55	2.57
333470	7064290	24	54873.87	54872.96	54873.17	54873.06	54872.87	54873.19	0.40
333478	7064298	25	54917.65	54916.62	54916.62	54916.51	54915.49	54916.58	0.77
333490	7064308	26	54947.6	54947.62	54947.91	54946.9	54946.82	54947.37	0.48

Coordinate system AMG GDA Zone 53: SD = Standard Deviation

Table 2. Traverse 2 magnetometer readings

Easting	Northing	Stop	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average	SD
333142	7064275	1	54802.07	54802.17	54802	54802.09	54802.16	54802.1	0.06
333150	7064280	2	54866.38	54866.3	54866.26	54866.41	54866.47	54866.36	0.08
333165	7064285	3	55162.74	55161.06	55160.57	55160.57	55159.76	55160.94	0.99
333166	7064290	4	55443.31	55443.49	55445.02	55444.99	55445.91	55444.54	0.99
333180	7064295	5	55590.01	55589.93	55589.68	55589.85	55590.08	55589.91	0.14
333186	7064302	6	55430.89	55431.03	55431.31	55431.24	55431.43	55431.18	0.19
333199	7064305	7	55613.53	55613.95	55613.43	55614	55614.87	55613.96	0.51
333208	7064310	8	55853.31	55853.97	55852.96	55853.47	55853.9	55853.52	0.38
333216	7064315	9	56182.65	56183.24	56183.49	56183.08	56183.09	56183.11	0.27
333226	7064320	10	55774.06	55775.19	55775.77	55776.29	55776.8	55775.62	0.95
333235	7064324	11	55433.15	55433.25	55433.59	55433.37	55433.67	55433.41	0.20
333243	7064330	12	55245.02	55245.06	55244.55	55244.75	55244.23	55244.72	0.31
333253	7064337	13	54873.42	54884.41	54877.91	54884.2	54888.85	54881.76	5.43
333262	7064341	14	54816.22	54816.08	54816.27	54815.82	54816.11	54816.1	0.16
333273	7064347	15	54814.49	54813.92	54814.06	54813.38	54813.4	54813.85	0.42
333281	7064350	16	54701.02	54700.86	54700.62	54700	54700.03	54700.51	0.42
333289	7064358	17	54968.74	54968.54	54968.03	54968.31	54968.28	54968.38	0.24
333299	7064361	18	54703.09	54703.2	54702.83	54702.9	54702.72	54702.95	0.17
333308	7064368	19	54754.88	54754.79	54754.9	54754.78	54754.78	54754.83	0.05
333319	7064372	20	54915.43	54915.14	54915.4	54915.58	54915.74	54915.46	0.20
333327	7064379	21	55159.96	55160.39	55163.2	55165.51	55161.49	55162.11	2.04
333335	7064384	22	55306	55305.44	55305.82	55306	55305.21	55305.69	0.32
333345	7064389	23	55195.66	55195.79	55195.69	55195.79	55195.96	55195.78	0.10
333353	7064395	24	55301.13	55299.93	55300.46	55300.22	55299.56	55300.26	0.53
333362	7064399	25	55407.32	55407.31	55407.08	55406.42	55406.39	55406.9	0.42
333362	7064405	26	55415.32	55415.58	55415.63	55415.7	55415.68	55415.58	0.14
333380	7064412	27	55440.44	55440.74	55441.09	55441.28	55441.58	55441.03	0.40
333389	7064415	28	55367.83	55367.43	55367.62	55367.46	55367.17	55367.5	0.22
333397	7064421	29	55406.77	55406.94	55407.06	55406.87	55406.81	55406.89	0.10
333407	7064427	30	55676.1	55676.23	55675.96	55675.78	55675.9	55675.99	0.16
333416	7064431	31	55721.81	55722.63	55722.28	55721.98	55722.64	55722.27	0.34
333424	7064436	32	55437.05	55437.52	55438.29	55437.89	55438.17	55437.78	0.45

Coordinate system AMG GDA Zone 53: SD = Standard Deviation

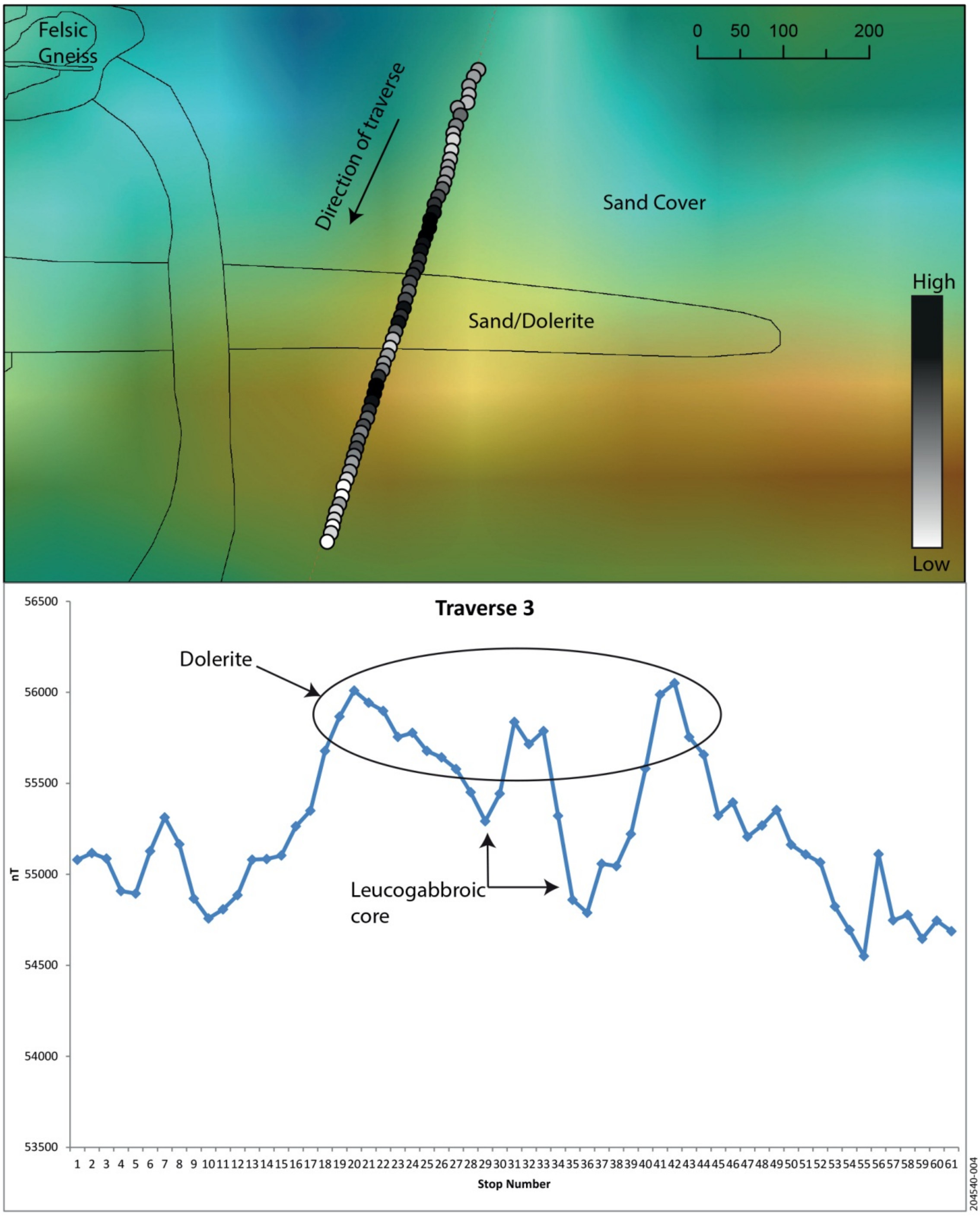

Figure 6. Plan of traverse 3 shown on an RTP TMI image with the surface geology. The direction of the traverse is shown (N to S) and corresponds with the graph of magnetic response starting at the left. The colour coding on the traverse goes from high (black) to low (white) relative magnetic response. The inferred location of the dyke from the magnetic traverse is shown by the ellipse on the graph, with the low magnetic susceptibility gabbroic core indicated.

Table 3. Traverse 3 magnetometer readings

Easting	Northing	Stop	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average	SD
315042	7076322	1	55080.03	55078.95	55079.38	55079.89	55079.9	55079.63	0.45
315037	7076314	2	55120.53	55112.08	55107.82	55120.73	55121.08	55116.45	6.12
315031	7076303	3	55086.26	55085.42	55087.06	55086.25	55085.6	55086.12	0.65
315031	7076293	4	54909.42	54910.81	54907.15	54906.09	54906.32	54907.96	2.07
315029	7076284	5	54895.51	54894	54894.5	54894.36	54892.91	54894.26	0.94
315018	7076278	6	55126.48	55126.85	55126.78	55126.89	55126.68	55126.74	0.16
315021	7076269	7	55312.38	55312.29	55312.32	55312.59	55312.21	55312.36	0.14
315016	7076257	8	55165.03	55164.87	55164.73	55166.23	55164.92	55165.16	0.61
315013	7076248	9	54866.85	54866.88	54866.29	54866.37	54866.25	54866.53	0.31
315013	7076240	10	54758.07	54757.25	54757.42	54757.11	54757.47	54757.46	0.37
315011	7076228	11	54807.18	54807.2	54807.35	54806.95	54806.79	54807.09	0.22
315009	7076218	12	54886.11	54886.31	54885.45	54885.36	54885.5	54885.75	0.43
315007	7076209	13	55080.19	55080.85	55080.46	55080.43	55080.68	55080.52	0.25
315006	7076201	14	55084.08	55084.17	55084.13	55083.88	55083.85	55084.02	0.15
315002	7076191	15	55103.26	55103.68	55103.52	55103.36	55103.81	55103.53	0.23
315000	7076183	16	55263.52	55263.7	55263.43	55263.18	55263.26	55263.42	0.21
314995	7076174	17	55349.45	55350.02	55350.65	55349.49	55348.81	55349.68	0.69
314991	7076165	18	55676.56	55677.69	55678.08	55678.48	55677.66	55677.69	0.72
314990	7076156	19	55868.27	55869.02	55865.57	55865.66	55864.96	55866.7	1.82
314986	7076147	20	56006.11	56010.17	56008.82	56010.73	56010.25	56009.22	1.88
314985	7076138	21	55942.11	55942.81	55943.36	55943.17	55943.17	55942.92	0.50
314981	7076128	22	55897.52	55897.44	55899.32	55896.86	55898.21	55897.87	0.94
314978	7076119	23	55754.95	55752.23	55753.55	55756.01	55755.48	55754.44	1.54
314975	7076111	24	55775.83	55777.34	55777.88	55777.79	55777.61	55777.29	0.84
314973	7076101	25	55678.24	55676.08	55673.85	55680.37	55678.78	55677.46	2.54
314970	7076091	26	55640.4	55640.75	55643.49	55644.58	55642.43	55642.33	1.78
314966	7076083	27	55578.61	55578.21	55578.57	55578.37	55578.42	55578.44	0.16
314962	7076074	28	55450.75	55450.75	55450.73	55450.64	55450.43	55450.66	0.14
314961	7076064	29	55291.73	55291.73	55291.85	55291.41	55291.58	55291.66	0.17
314957	7076054	30	55439.84	55441.6	55439.38	55446.42	55447.3	55442.91	3.71
314955	7076044	31	55838.6	55837.73	55838.67	55836.94	55833.11	55837.01	2.29
314952	7076035	32	55715.14	55714.46	55714.55	55715.88	55714.12	55714.83	0.69
314949	7076027	33	55792.51	55789.64	55780.88	55780.21	55791.93	55787.03	6.02
314946	7076017	34	54918.91	54922.71	54921.84	55923.76	55915.8	55320.6	546.98
314942	7076008	35	54859.22	54859.39	54859.69	54859.73	54859.6	54859.53	0.22
314939	7075998	36	54789.45	54788.23	54788.08	54787.95	54789.26	54788.59	0.70
314936	7075989	37	55058.23	55058.16	55057.87	55057.99	55058.33	55058.12	0.19
314932	7075980	38	55043.68	55043.99	55045.69	55045.85	55045.87	55045.02	1.09
314930	7075972	39	55221.75	55221.34	55221.42	55222.43	55222.22	55221.83	0.48
314926	7075964	40	55578.67	55584.13	55580.94	55579.79	55579.4	55580.59	2.14
314923	7075954	41	55984.45	55987.64	55987.51	55987.31	55987.63	55986.91	1.38
314921	7075945	42	56049.37	56050.05	56049.46	56049.75	56049.71	56049.67	0.27
314918	7075935	43	55753.86	55753.79	55753.86	55753.87	55753.58	55753.79	0.12
314915	7075925	44	55657.44	55656.91	55656.7	55656.89	55656.79	55656.95	0.29
314913	7075916	45	55323.26	55323.48	55322.94	55322.45	55322.88	55323	0.39
314908	7075907	46	55396.7	55393.89	55393.58	55393.87	55393.89	55394.39	1.30
314905	7075899	47	55206.67	55206.49	55207.33	55205.87	55205.58	55206.39	0.69
314902	7075890	48	55268.25	55268.31	55269.34	55268.8	55267.43	55268.43	0.71
314900	7075881	49	55352.8	55352.99	55353.05	55353.23	55353.19	55353.05	0.17
314897	7075872	50	55162.21	55163.15	55162.92	55163.05	55163.23	55162.91	0.41
314895	7075864	51	55108.21	55108.51	55108.42	55108.89	55108.3	55108.47	0.26
314892	7075854	52	55063.6	55065.51	55065.81	55066.21	55066.29	55065.48	1.10
314889	7075845	53	54822.76	54823.27	54823.54	54823.56	54823.68	54823.36	0.37
314885	7075836	54	54693.59	54693.65	54694.24	54693.88	54694.03	54693.88	0.27
314883	7075825	55	54549.86	54548.3	54552.98	54549.54	54550.2	54550.18	1.72
314880	7075816	56	55113.25	55110.21	55109.26	55110.11	55110.27	55110.62	1.53
314876	7075807	57	54746.83	54746.96	54746.51	54746.15	54746.02	54746.49	0.41
314874	7075798	58	54776.21	54775.82	54778.25	54778.13	54778.02	54777.29	1.17
314872	7075790	59	54645.13	54645.37	54646.55	54646.1	54645.72	54645.77	0.57
314870	7075782	60	54745.83	54744.34	54745.23	54745.01	54744.85	54745.05	0.54
314866	7075772	61	54687.56	54687.48	54687.47	54687.38	54687.25	54687.43	0.12

Coordinate system AMG GDA Zone 53: SD = Standard Deviation

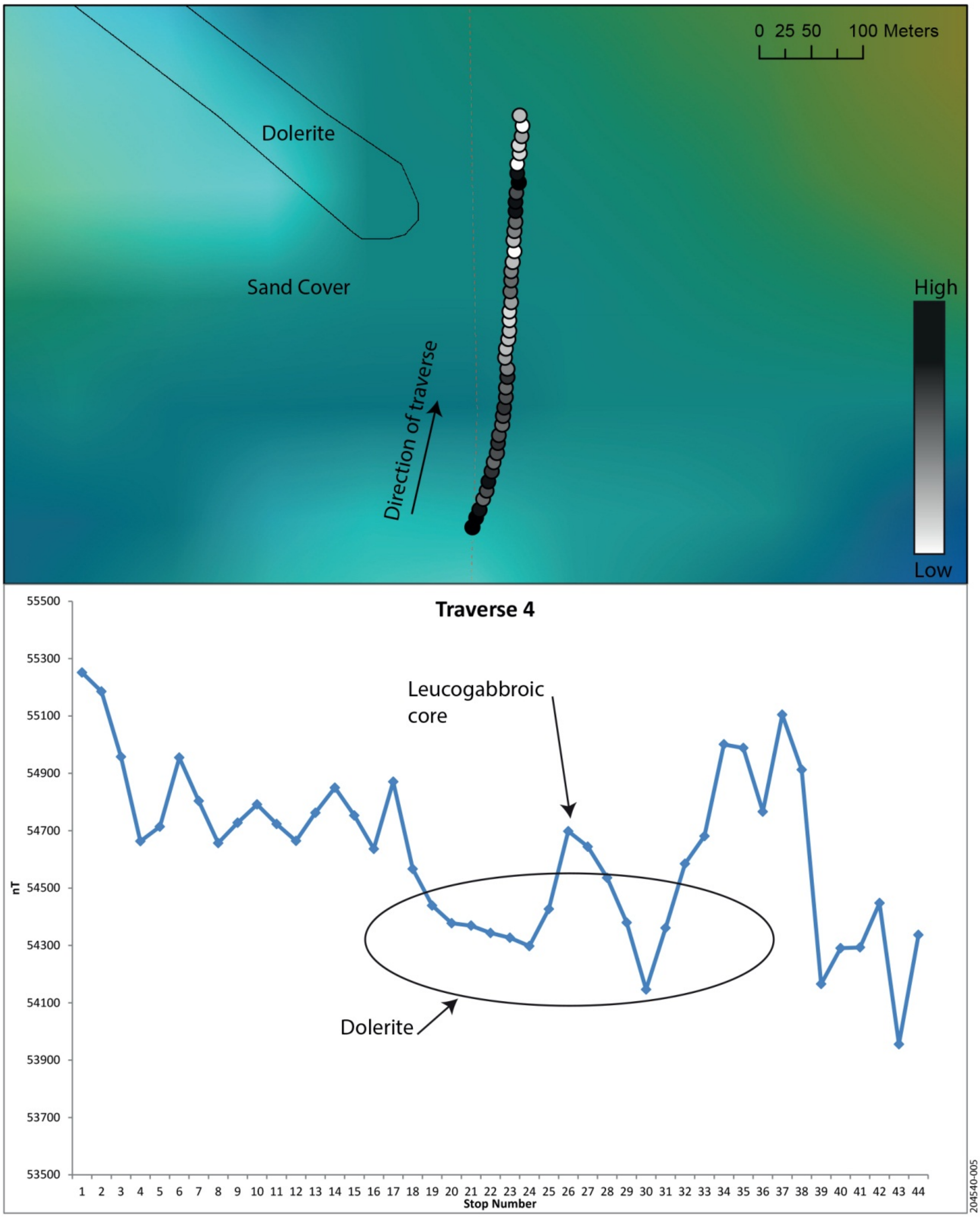

Figure 7. Plan of traverse 4 shown on an RTP TMI image with the surface geology. The direction of the traverse is shown (S to N) and corresponds with the graph of magnetic response starting at the left. The colour coding on the traverse goes from high (black) to low (white) relative magnetic response. The inferred location of the dyke from the magnetic traverse is shown by the ellipse on the graph, with the low magnetic susceptibility gabbroic core indicated.

Table 4. Traverse 4 magnetometer readings

Easting	Northing	Stops	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average	SD
311868	7067177	1	55251.42	55251.49	55251.29	55251.23	55251.14	55251.31	0.14
311872	7067186	2	55185.45	55185.19	55185.51	55185.3	55184.64	55185.22	0.35
311875	7067194	3	54958.19	54958.37	54957.91	54957.29	54957.68	54957.89	0.43
311879	7067204	4	54663.15	54663.09	54663.08	54663.44	54663.54	54663.26	0.21
311882	7067212	5	54713.26	54714.12	54714.48	54714.46	54714.77	54714.22	0.58
311884	7067221	6	54954.97	54954.81	54954.57	54954.84	54954.81	54954.8	0.14
311887	7067231	7	54803.42	54803.98	54803.62	54803.01	54803.65	54803.54	0.36
311889	7067240	8	54656.72	54656.95	54657.13	54657.1	54656.71	54656.92	0.20
311892	7067249	9	54726.22	54727.4	54728.11	54728.65	54728.48	54727.77	0.99
311893	7067258	10	54791.52	54790.98	54791.46	54791.51	54791.92	54791.48	0.33
311894	7067266	11	54724.04	54723.58	54723.59	54723.53	54723.18	54723.58	0.31
311897	7067276	12	54664.22	54664.51	54664.46	54664.38	54664.44	54664.4	0.11
311898	7067285	13	54763.09	54762.42	54762.94	54762.15	54762.35	54762.59	0.40
311899	7067293	14	54849.62	54849.62	54850.42	54849.8	54850.22	54849.94	0.37
311901	7067303	15	54753.18	54752.76	54752.82	54753.61	54752.94	54753.06	0.35
311901	7067312	16	54636.68	54636.72	54636.47	54636.54	54636.52	54636.59	0.11
311902	7067322	17	54870.46	54870.76	54871.23	54871.68	54870.93	54871.01	0.47
311902	7067330	18	54566.21	54566.57	54566.65	54566.68	54566.67	54566.56	0.20
311900	7067341	19	54439.11	54438.69	54438.99	54438.98	54439.04	54438.96	0.16
311901	7067350	20	54377.61	54377.47	54377.54	54377.59	54377.56	54377.55	0.05
311903	7067359	21	54368.99	54369.13	54369.02	54368.79	54368.8	54368.95	0.15
311904	7067367	22	54343.03	54343.29	54343.39	54343.32	54343.35	54343.28	0.14
311904	7067377	23	54326.55	54326.82	54326.74	54326.7	54326.58	54326.68	0.11
311904	7067386	24	54297.98	54297.83	54297.83	54297.79	54297.71	54297.83	0.10
311906	7067395	25	54425.76	54426.86	54426.29	54427.86	54427.55	54426.86	0.87
311905	7067405	26	54698.46	54697.44	54698.1	54698.08	54698.27	54698.07	0.38
311906	7067416	27	54644.92	54644.39	54644.09	54643.25	54644.62	54644.25	0.64
311906	7067425	28	54535.42	54535.56	54536.01	54535.48	54535.31	54535.56	0.27
311907	7067434	29	54380.33	54379.42	54380.3	54379.68	54378.45	54379.64	0.77
311909	7067444	30	54145.9	54146.62	54146.73	54146.51	54146.28	54146.41	0.33
311908	7067455	31	54360.78	54360.82	54361	54361.23	54361.11	54360.99	0.19
311909	7067464	32	54585.92	54584.46	54584.73	54585.38	54584.37	54584.97	0.66
311910	7067473	33	54681.6	54681.13	54681.4	54682.44	54679.6	54681.23	1.04
311910	7067483	34	55002.92	55001.28	55000.33	55001.45	54998.53	55000.9	1.62
311910	7067492	35	54988.12	54988.62	54988.22	54988.77	54988.83	54988.51	0.32
311911	7067501	36	54766.42	54766.55	54766.1	54766.33	54766.36	54766.35	0.16
311913	7067511	37	55105.02	55106.92	55103.4	55103.68	55103.47	55104.5	1.51
311912	7067520	38	54913.54	54912.4	54912.68	54912.47	54912.48	54912.71	0.47
311912	7067529	39	54165	54165.66	54165.51	54165.61	54165.55	54165.47	0.27
311914	7067539	40	54290.6	54290.67	54290.46	54290.22	54290.63	54290.52	0.18
311913	7067547	41	54293.03	54292.82	54293.08	54292.95	54292.88	54292.95	0.11
311916	7067556	42	54447.2	54447.34	54447.68	54447.87	54447.9	54447.6	0.31
311917	7067566	43	53962	53953.57	53953.6	53954.18	53954.35	53955.54	3.63
311914	7067576	44	54345.93	54342.87	54337.29	54329.93	54326.07	54336.42	8.40

Coordinate system AMG GDA Zone 53: SD = Standard Deviation

Table 5. Magnetic susceptibility measurements

Traverse	Lithology	Reading (SI x10^{-3})										Average	SD
		1	2	3	4	5	6	7	8	9	10		
1 & 2	felsic gneiss	0.66	0.82	1.75	0.66	1.6	0.83	3.57	3.5	1.43	2.49	1.73	1.11
2 & 2	dolerite	8.19	10.6	13	12.2	12.8	12.8	9.2	12.2	9.3	10.7	11.10	1.75
3	gabbro	0.54	0.55	0.8	0.59	0.75	0.62	0.6	0.67	1.49	0.75	0.74	0.28
3	dolerite	22.1	22.8	18.7	22.8	23.7	21.1	23.1	20.8	19.7	20.6	21.54	1.62
4	gabbro	0.49	0.54	0.26	1.44	0.8	0.48	0.52	0.36	0.89	0.53	0.63	0.34
4	dolerite	7.64	10.2	10.6	10.8	6.95	6.58	5.31	7.69	10.1	6.78	8.27	1.98

CONCLUSIONS

- The use of the hand held Ultramag Geophysics GSM-19 magnetometer was a simple operation for one or two people, taking less than an hour to complete each of the described traverses.
- The dolerite dykes traversed in this study are representative of the large dolerites within the Musgrave Province, representing both exposed and buried, magnetically high and remnant magnetic lows, and high and low magnetic susceptibility dykes.
- The results of the traverses suggest it is possible to delineate the approximate extents to the dolerites, and to trace them out under cover, using a hand held magnetometer.