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Civilab
Civil Engineering Testing Laboratory

Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-1
Field Sample Number:	TP 1	Depth (m):	1.7

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100…			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	353.0	Final back pressure (kPa):	343.0	Final B parameter:	1.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 49.4 t100 (minutes): 9 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100	*50	1963.50	2.0	1591	0.6554	8	2.633 Determined
CONSOLIDATED	99.55	49.77	1945.68	12.5	1612	0.6329	52	
FINAL (After shear)	97.59	50.27	1984.61	12.5	1612	0.6330	52	

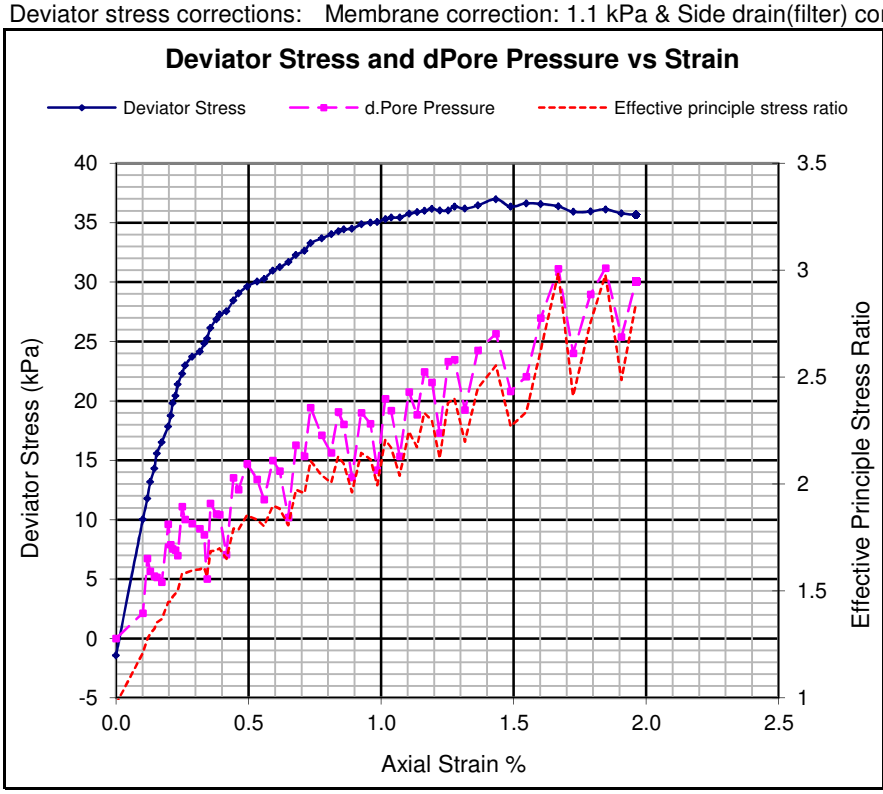
Initial pore pressure (kPa): 383.7 Final pore pressure (kPa): 356.0 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.22				
Initial pore pressure (kPa):	344.6	Initial effective stress (kPa):	49.4		
Parameters at failure:					
Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	1.43				
Deviator stress (kPa):	37.0	Principle Stresses (kPa)			
Excess pore pressure (kPa):	25.6	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.554	86.4	60.8	49.4	23.8

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-1
Field Sample Number:	TP 1	Depth (m):	1.7

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 2

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100…			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	343.0	Final back pressure (kPa):	333.0	Final B parameter:	0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 100.0 t100 (minutes): 100 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100	*50	1963.50	34.4	1220	1.1586	78	2.633 Determined
CONSOLIDATED	98.35	49.17	1898.81	45.6	1283	1.0519	114	
FINAL (After shear)	92.37	50.74	2021.79	45.6	1282	1.0531	114	

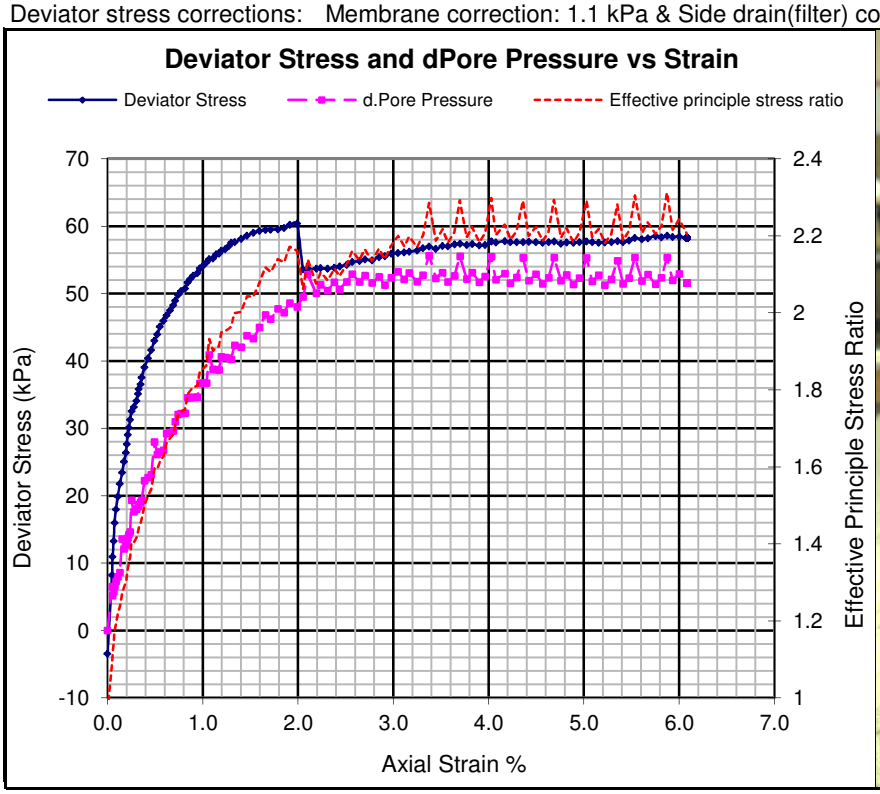
Initial pore pressure (kPa): 420.4 Final pore pressure (kPa): 335.7 PWP dissipation (%): 99

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.24				
Initial pore pressure (kPa):	336.0	Initial effective stress (kPa):	100.0		
Parameters at failure:					
Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	1.99				
Deviator stress (kPa):	60.4	Principle Stresses (kPa)			
Excess pore pressure (kPa):	48.0	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.162	160.4	112.3	100.0	52.0

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-1
Field Sample Number:	TP 1	Depth (m):	1.7

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 3

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100…			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	353.0	Final back pressure (kPa):	343.0	Final B parameter:	0.99

CONSOLIDATION DATA

Effective cons. Stress (kPa): 200.1 t100 (minutes): 400 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100	*50	1963.50	33.0	1243	1.1188	78	2.633 Determined
CONSOLIDATED	97.10	48.53	1849.58	41.1	1361	0.9344	116	
FINAL (After shear)	81.16	53.08	2212.79	41.1	1359	0.9380	116	

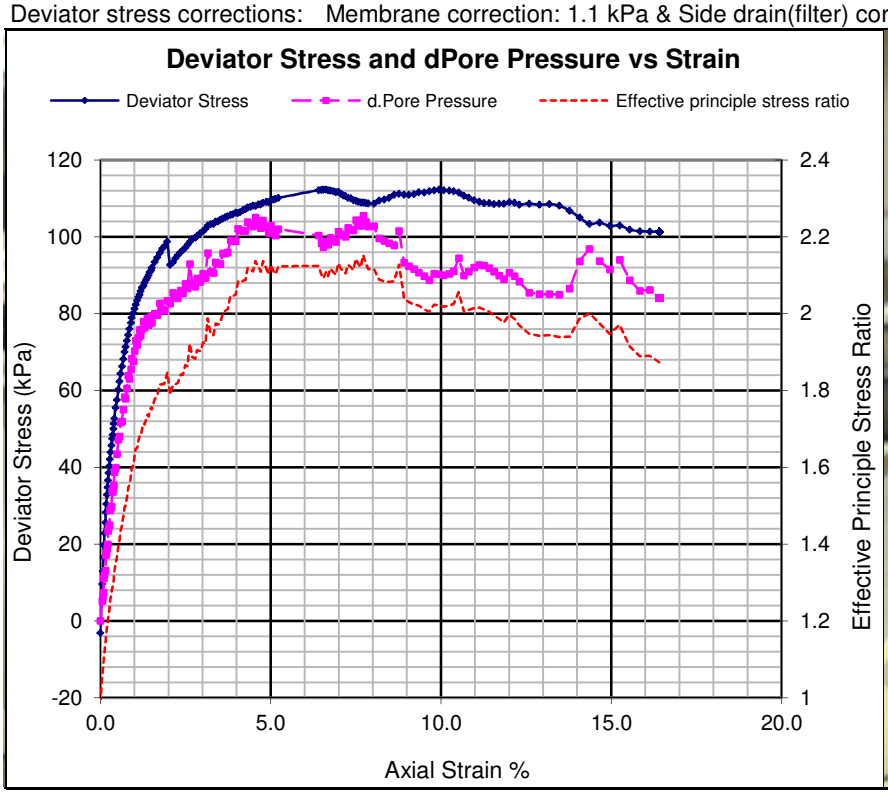
Initial pore pressure (kPa): 506.1 Final pore pressure (kPa): 342.0 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.12				
Initial pore pressure (kPa):	341.9	Initial effective stress (kPa):	200.1		
Parameters at failure:					
Failure Criterion:	Max. Effective Principle Stress Ratio				
Axial strain (%):	7.72				
Deviator stress (kPa):	108.9	Principle Stresses (kPa)			
Excess pore pressure (kPa):	105.5	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.152	309.0	203.5	200.1	94.6

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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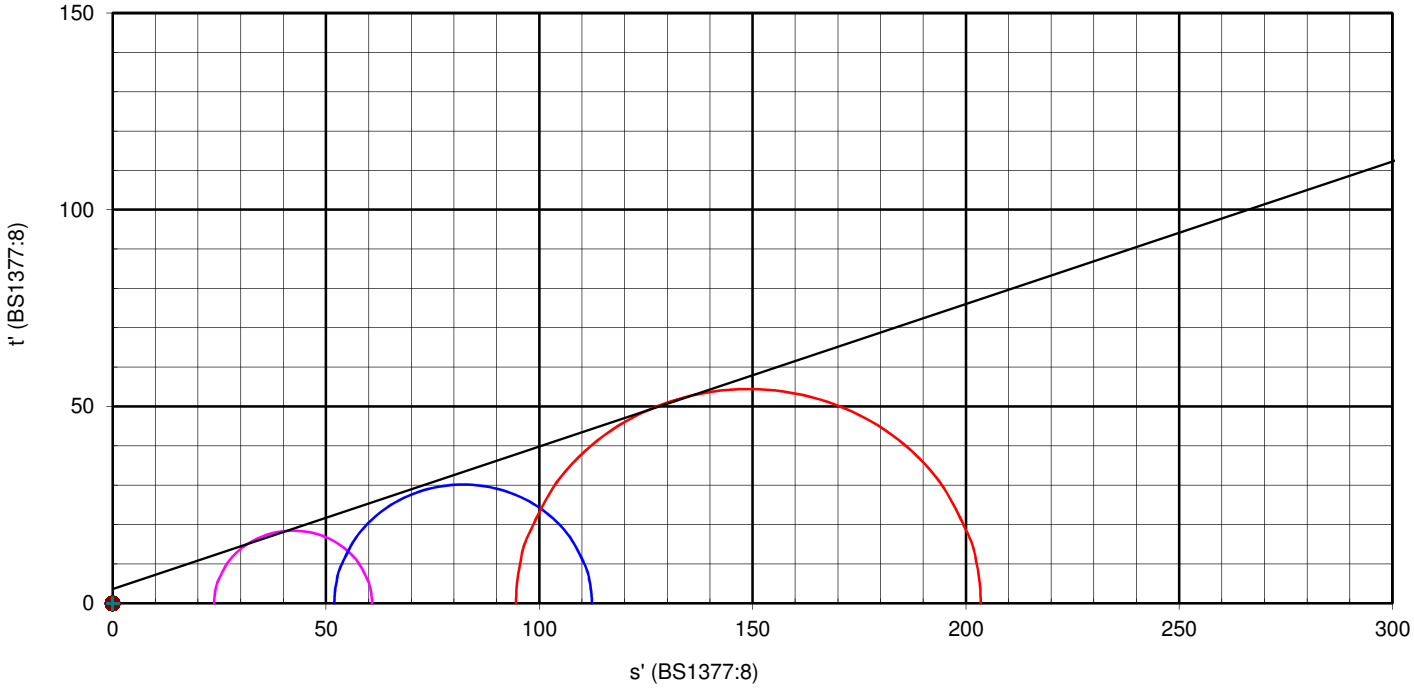
Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-1
Field Sample Reference:	TP 1	Depth (m):	1.7

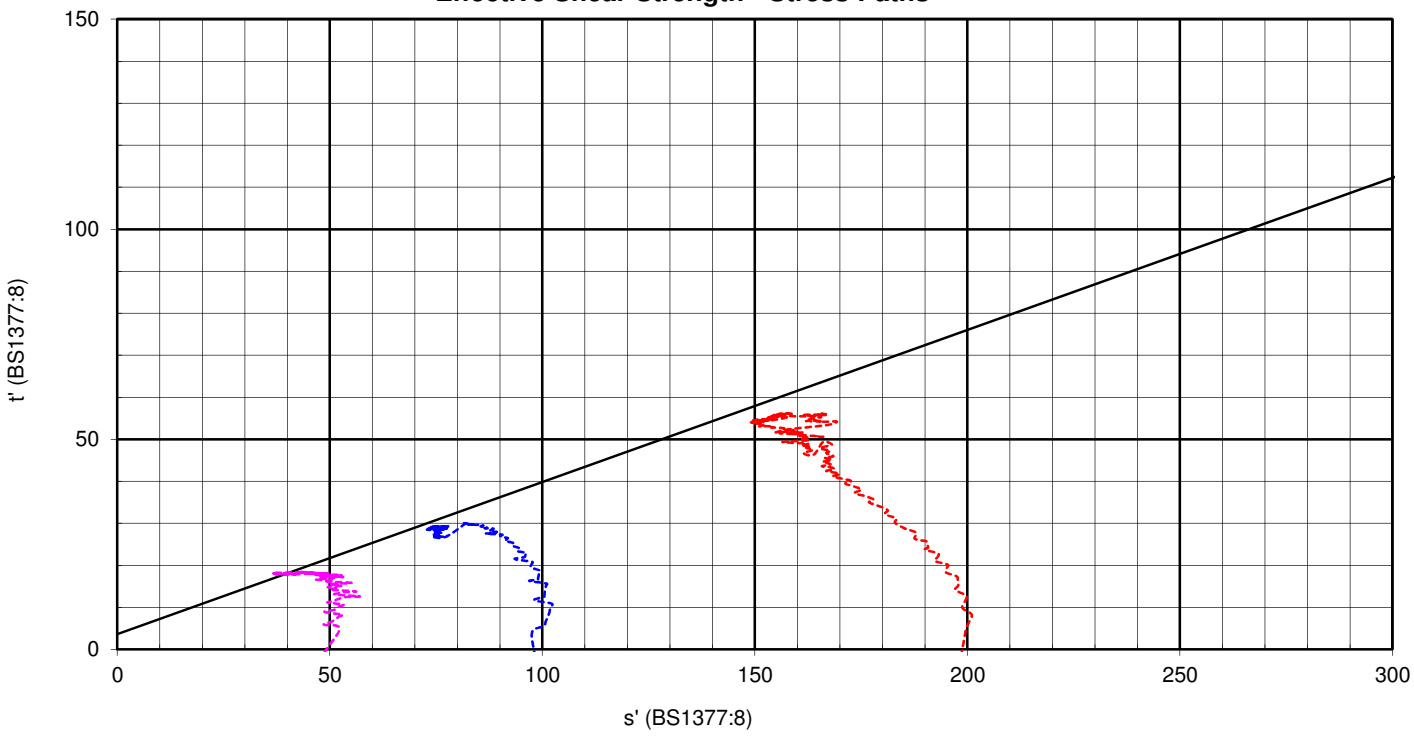
Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	5.3	11.1
Effective	3.6	19.9

Effective Shear Strength - Mohr circles at failure



Effective Shear Strength - Stress Paths



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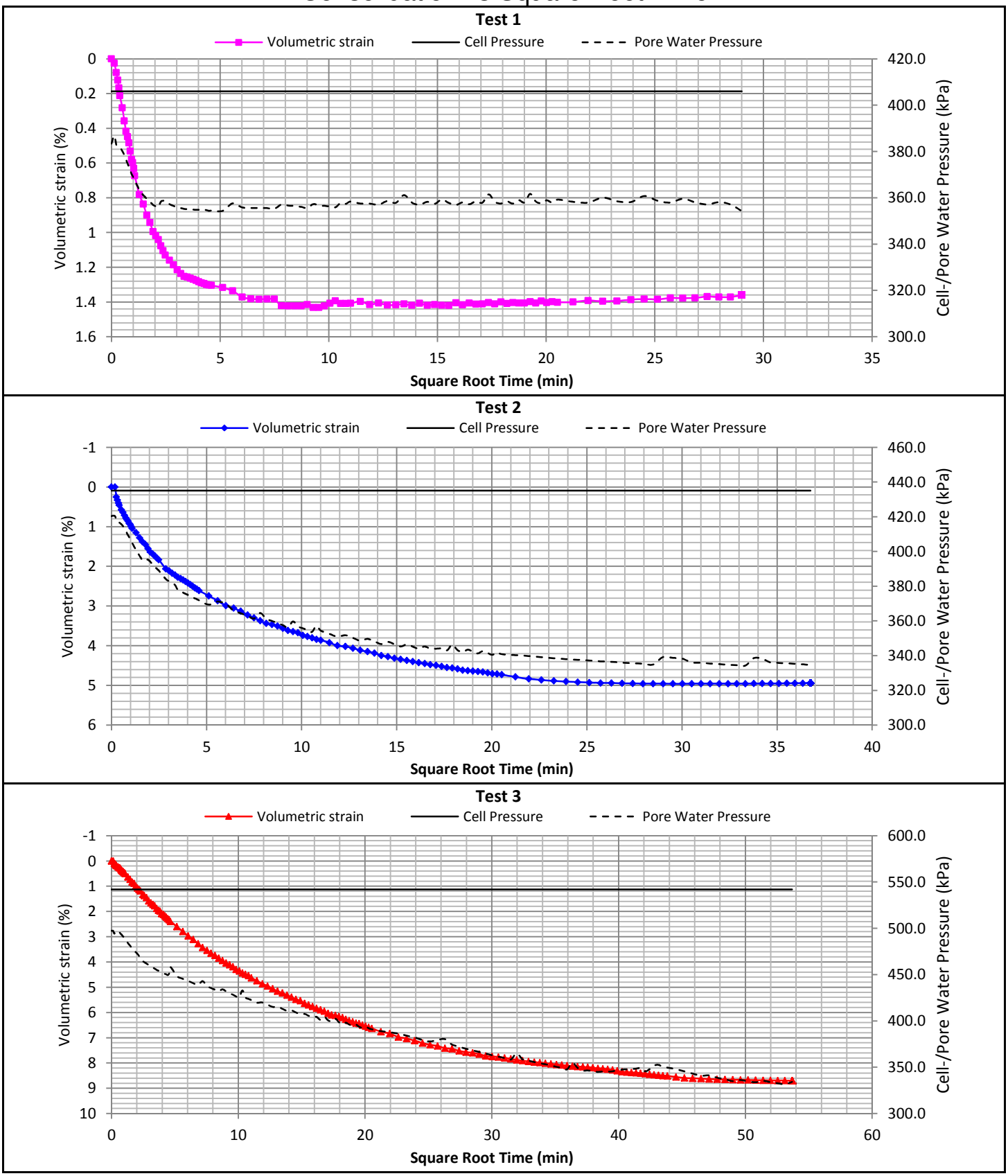
Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-1
Field Sample Reference:	TP 1	Depth (m):	1.7

Consolidation vs Square Root Time



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Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-2
Field Sample Number:	TP 2	Depth (m):	1.8

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on an undisturbed sample tested saturated. The data from this test was not included in the determining the shear strength parameters (c' and phi). PWP pressure sensor suspected of being too unstable prior to being replaced. Insufficient time & sample to repeat specimen.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100…			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	313.0	Final back pressure (kPa):	303.0	Final B parameter:	0.96

CONSOLIDATION DATA

Effective cons. Stress (kPa): 54.7 t100 (minutes): 144 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100.9	*50.45	1999.00	28.9	1317	1.0732	74	2.731 Determined
CONSOLIDATED	100.58	50.29	1986.33	40.0	1330	1.0535	104	
FINAL (After shear)	98.18	50.90	2034.94	40.0	1330	1.0535	104	

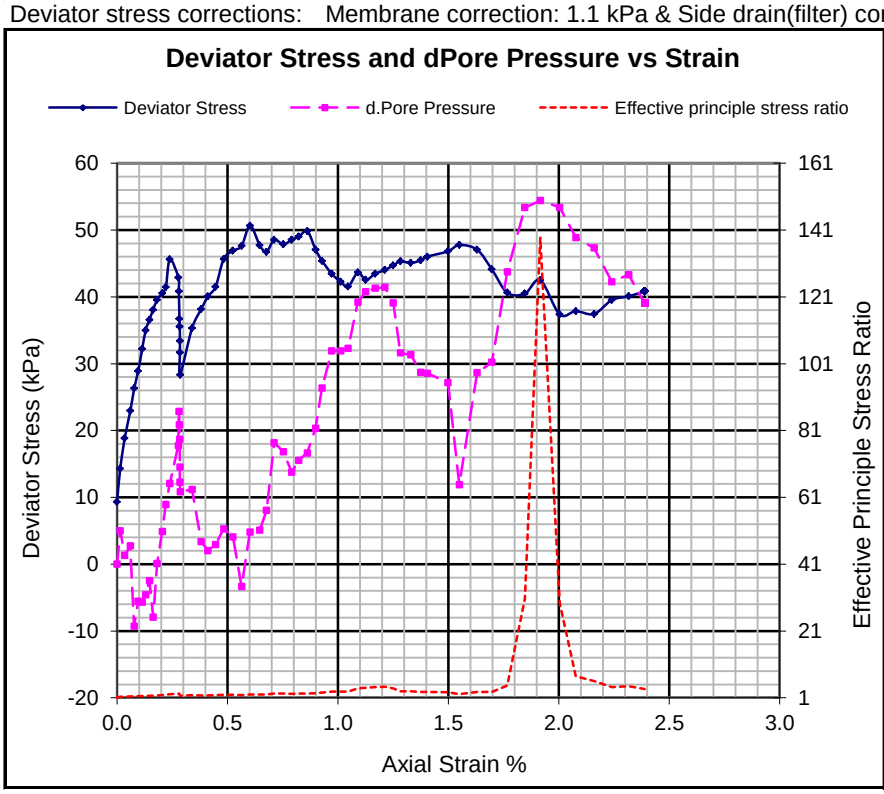
Initial pore pressure (kPa): 339.1 Final pore pressure (kPa): 285.0 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.045				
Initial pore pressure (kPa):	295.3	Initial effective stress (kPa):	54.7		
Parameters at failure:					
Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	0.60				
Deviator stress (kPa):	50.7	Principle Stresses (kPa)			
Excess pore pressure (kPa):	4.8	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.015	105.4	100.6	54.7	49.9

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-2
Field Sample Number:	TP 2	Depth (m):	1.8

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks:	A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 2

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100…			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	353.0	Final back pressure (kPa):	343.0	Final B parameter:	0.96

CONSOLIDATION DATA

Effective cons. Stress (kPa): 96.6 t100 (minutes): 400 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*101	*50.5	2002.96	29.5	1346	1.0297	78	2.731 Determined
CONSOLIDATED	100.41	50.20	1979.55	31.9	1370	0.9941	88	
FINAL (After shear)	93.41	52.05	2127.99	31.9	1369	0.9942	87	

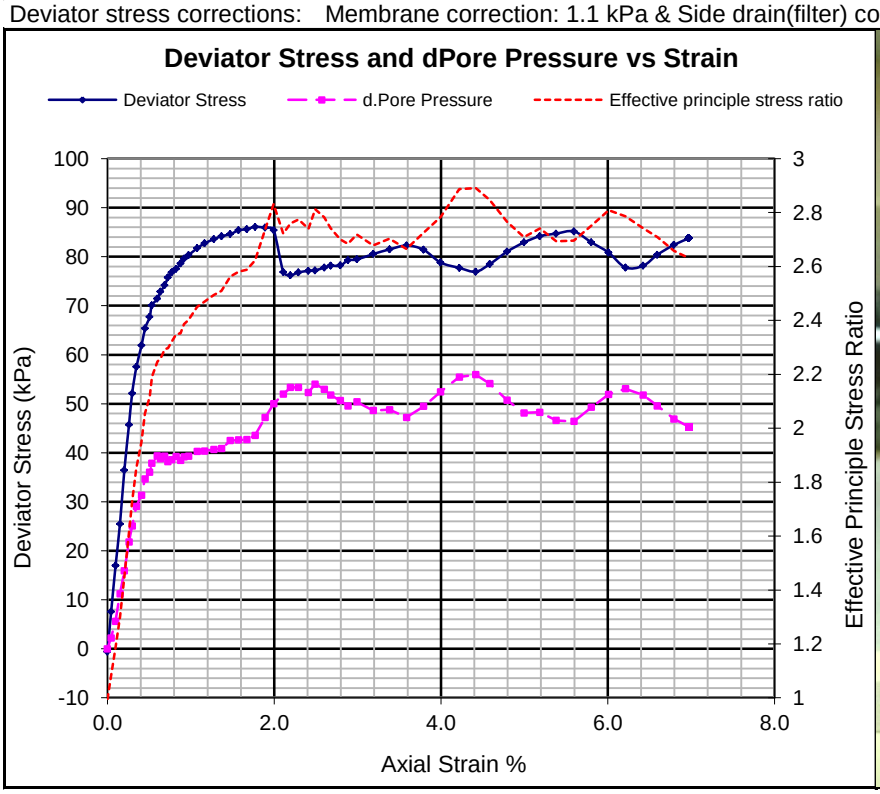
Initial pore pressure (kPa): 433.6 Final pore pressure (kPa): 326.1 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.080				
Initial pore pressure (kPa):	347.4	Initial effective stress (kPa):	96.6		
Parameters at failure:					
Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	1.77				
Deviator stress (kPa):	86.1	Principle Stresses (kPa)			
Excess pore pressure (kPa):	43.5	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.622	182.7	139.2	96.6	53.1

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-2
Field Sample Number:	TP 2	Depth (m):	1.8

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 3

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100…			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	353.0	Final back pressure (kPa):	343.0	Final B parameter:	0.96

CONSOLIDATION DATA

Effective cons. Stress (kPa): 199.5 t100 (minutes): 625 Side drains fitted: Yes

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*101.8	*50.9	2034.82	30.1	1255	1.1758	70	2.731 Determined
CONSOLIDATED	99.90	49.94	1958.89	38.6	1330	1.0540	100	
FINAL (After shear)	93.65	51.58	2089.53	38.6	1329	1.0556	100	

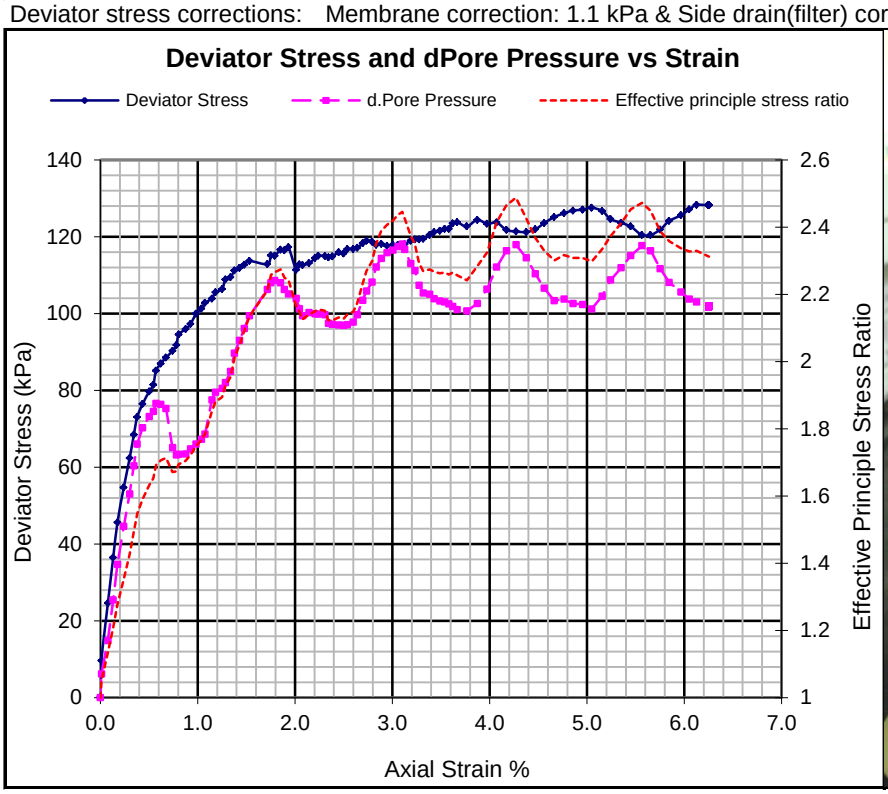
Initial pore pressure (kPa): 339.6 Final pore pressure (kPa): 338.9 PWP dissipation (%): 100

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.805				
Initial pore pressure (kPa):	341.5	Initial effective stress (kPa):	199.5		
Parameters at failure:					
Failure Criterion:	Max. Effective Principle Stress Ratio				
Axial strain (%):	4.27				
Deviator stress (kPa):	121.3	Principle Stresses (kPa)			
Excess pore pressure (kPa):	117.9	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.487	320.8	202.9	199.5	81.6

Deviator stress corrections: Membrane correction: 1.1 kPa & Side drain(filter) correction: 7 kPa for Strains >= 2%



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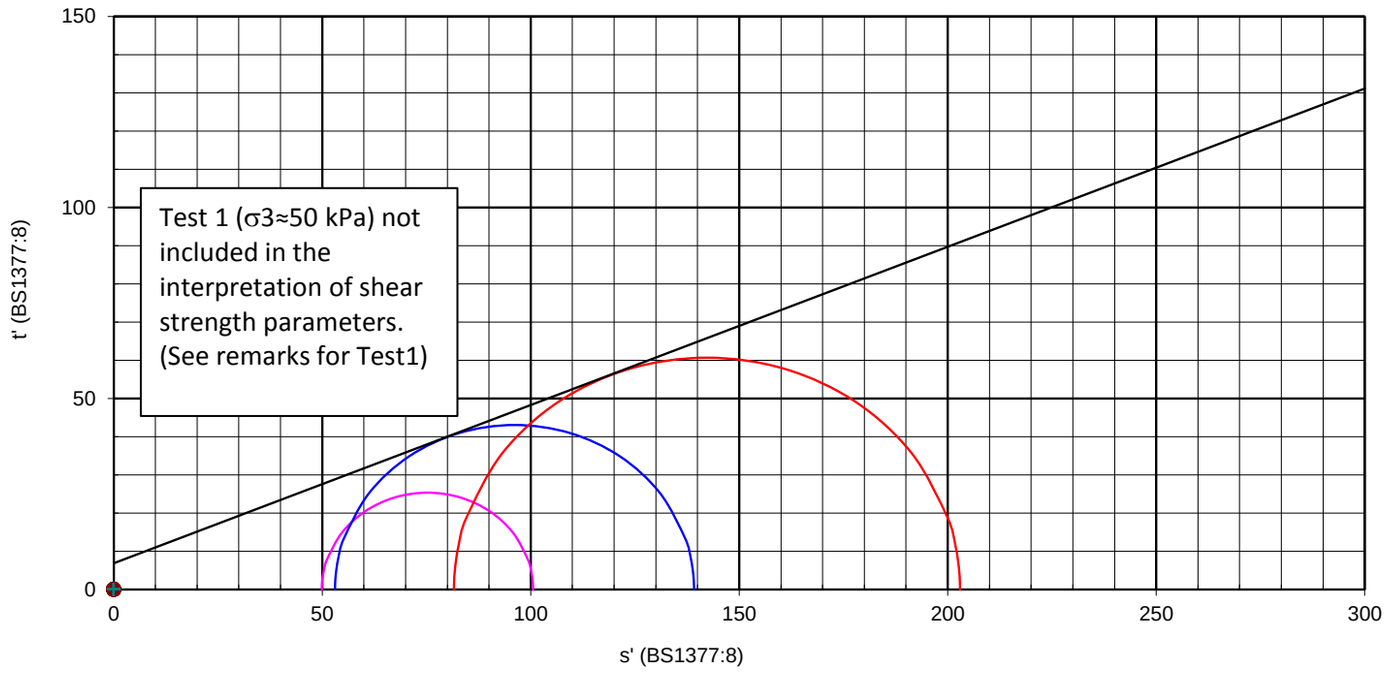
Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-2
Field Sample Reference:	TP 2	Depth (m):	1.8

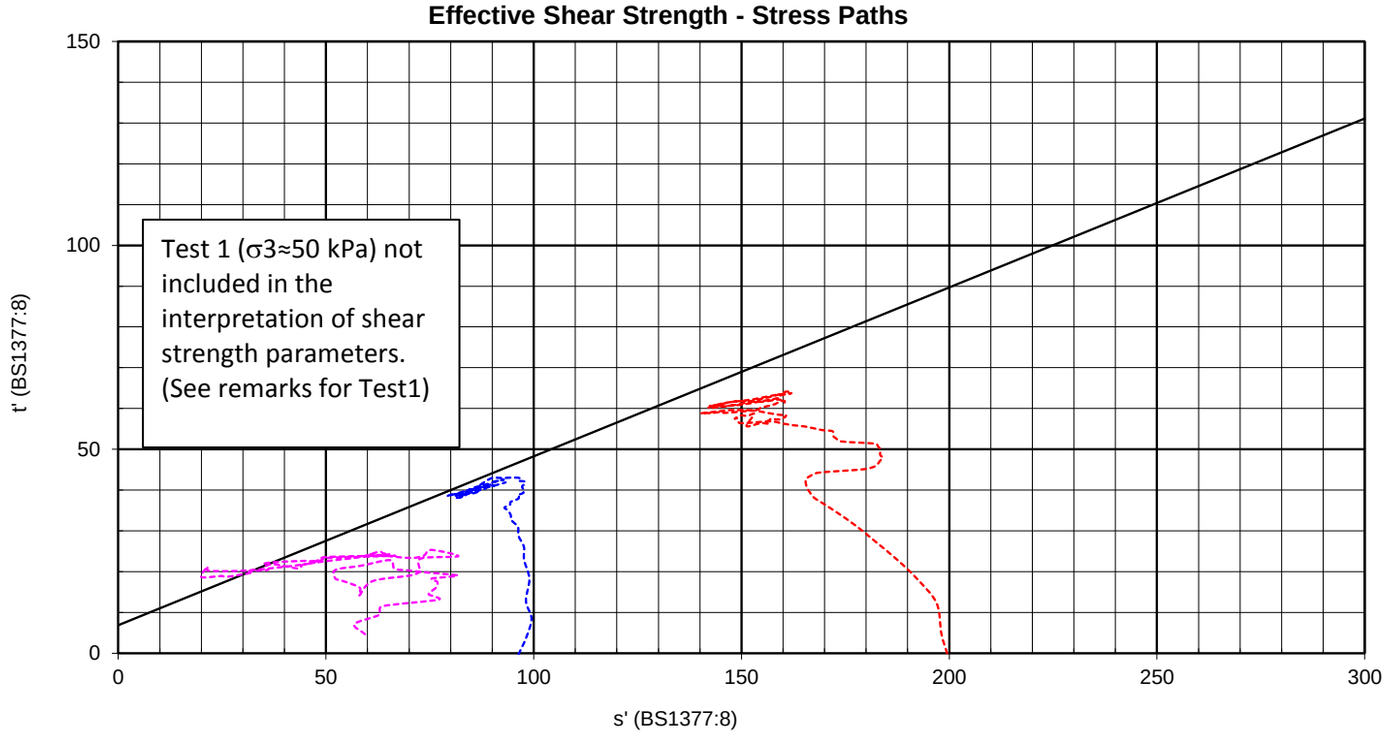
Effective Shear Strength Parameters

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	13.0	10.9
Effective	6.9	22.5

Effective Shear Strength - Mohr circles at failure



Effective Shear Strength - Stress Paths



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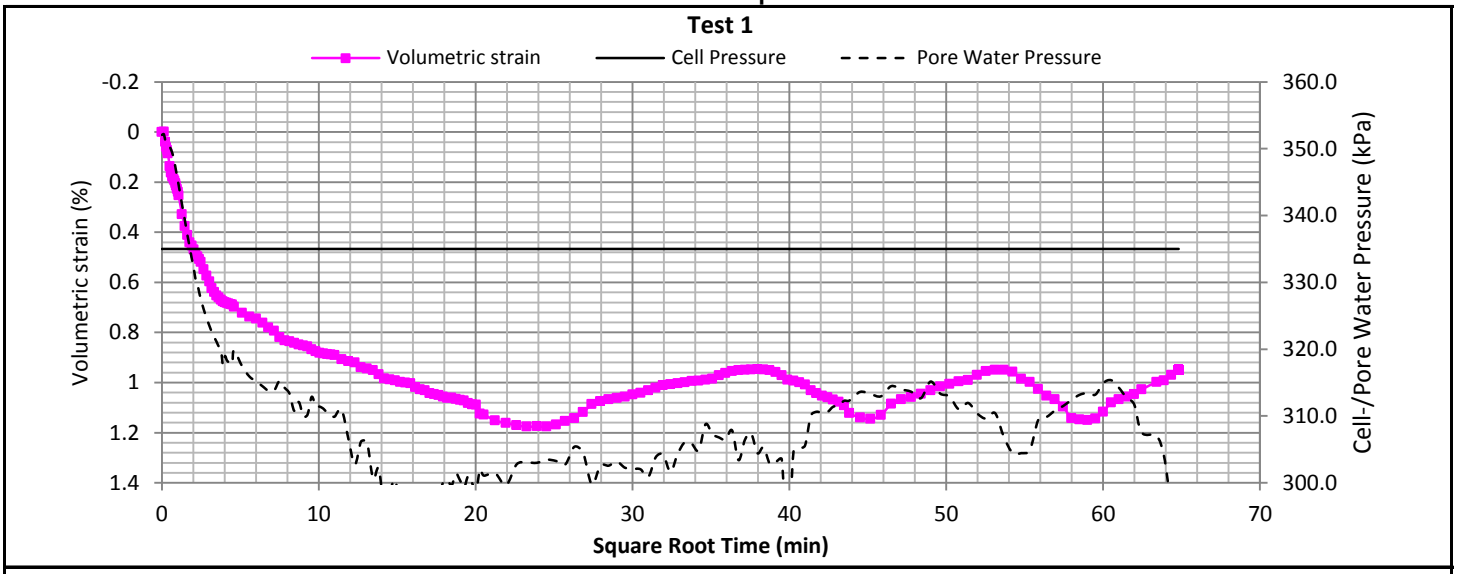
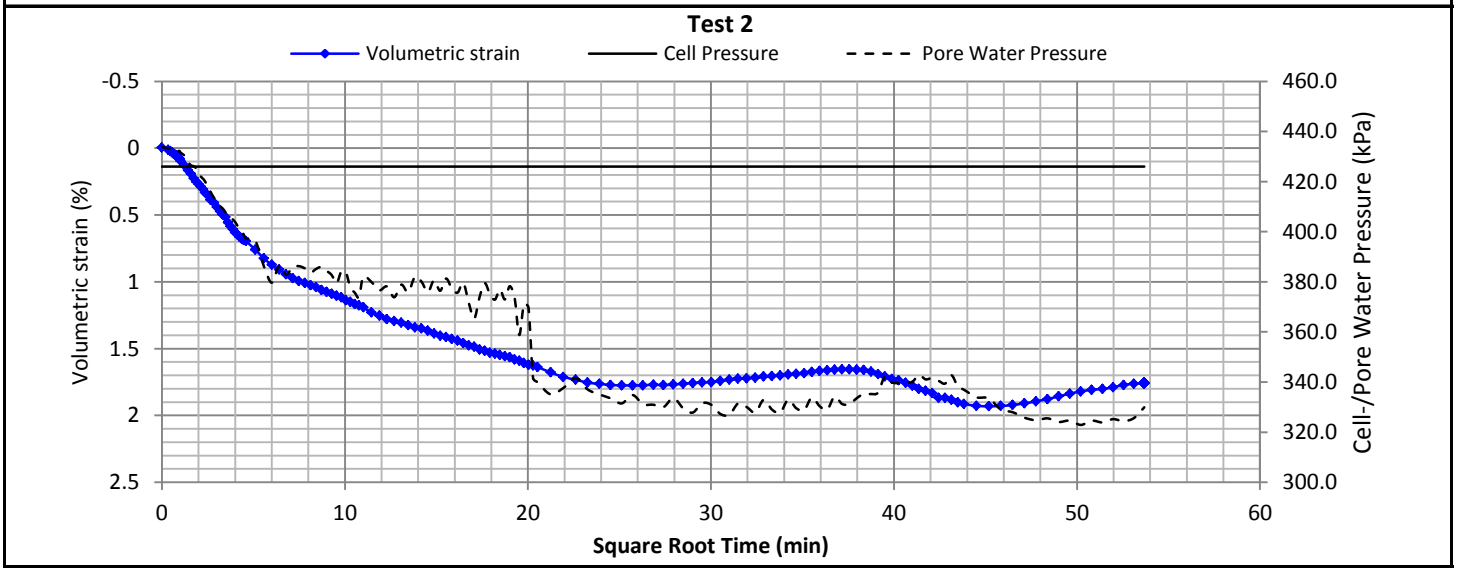
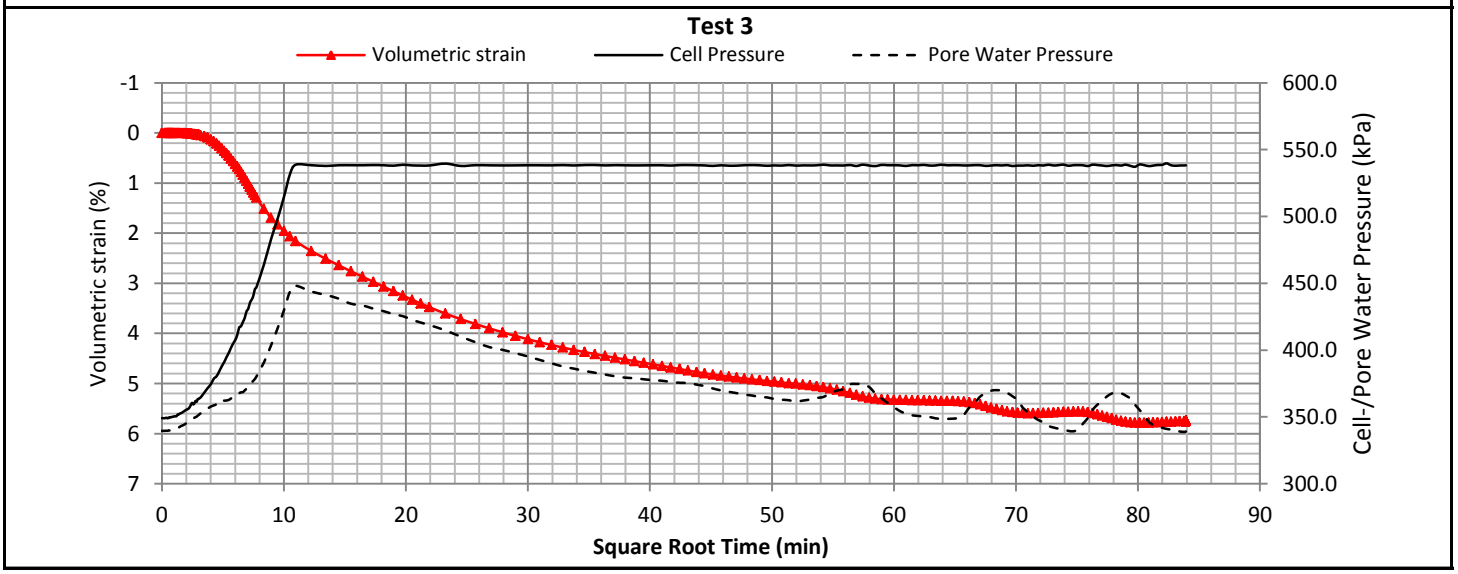
Triaxial Compression Test Results

Project:	Tharisa Minerals	Date Received:	2013/08/02
Job Number:	2013-B-1782	Laboratory Number:	1782-2
Field Sample Reference:	TP 2	Depth (m):	1.8

Consolidation vs Square Root Time







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INROADS CONSULTING
GEOTECHNICAL & CIVIL ENGINEERS

REPORT ON A GEOTECHNICAL INVESTIGATION FOR THE THARISA TAILINGS STORAGE FACILITY IN RUSTENBURG

AUGUST 2011

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REPORT ON A GEOTECHNICAL INVESTIGATION FOR THE THARISA TAILINGS STORAGE FACILITY IN RUSTENBURG

TABLE OF CONTENTS

REPORT ON A GEOTECHNICAL INVESTIGATION FOR THE THARISA TAILINGS STORAGE FACILITY IN RUSTENBURG

1. TERMS OF REFERENCE

This report presents the results of a geotechnical investigation carried out to establish the subsoil and founding conditions within the areas to be occupied by the footprint of two tailings storage facilities (TSF) for the Tharisa mine near Rustenburg. The objectives of the investigation were to:

- establish the thickness and extent of the clay that is known to cover the area;
- determine the shear strength parameters and permeability coefficient of the *in-situ* and remoulded clay;
- provide an estimate of the permeability and shear strength parameters of the highly weathered norite rock or sand underlying the clay horizon.

Inroads Consulting cc was requested by Ms. Georgia Vagis of Epoch Resources (Pty) Ltd to carry out a geotechnical investigation within the two proposed TSF sites.

2. SITE DESCRIPTION

Two sites identified for the tailings storage facilities are located north of the N4 highway near the Buffelspoort Toll Plaza where their ground surfaces fall at fairly shallow gradients in a north and north easterly direction. The ground cover over both sites consists largely of grass and ploughed sunflower fields.

Photographs of the sites terrain are presented in **Appendix A**.

3. INVESTIGATION

The field investigation was carried out between 30th March and 4th April 2011, and again on 13th June 2011. It entailed setting out and excavating 30 test pits employing a Liebherr 974 Excavator.

The position of the holes, referenced TP1 to TP30, are shown on the attached site plan in **Figure1**, and were positioned so as to cover as much of the areas as possible.

The holes were excavated to depths averaging 4,5 m in the range 2,4 to 6,7 m, below which depth the refusal occurred in some of the pits on soft to medium hard rock. They were profiled in accordance with the standard methods and procedures described in the document *Guidelines for Soil and Rock Logging in South Africa*(1).

Soil samples were recovered from certain of the test pit horizons and sent to Civilab, a commercial civil engineering testing laboratory in Johannesburg, for further testing.

The soil profile records for each of the test pits are presented in **Appendix B** of this report.

4. GEOLOGICAL AND SUBSOIL CONDITIONS

According to the 1:50 000 (2527 DA Wolhuterskop) referenced geological map, the area is underlain by norite, quartz norite, quartz gabbro and pyroxenitic norite. Descriptions of the soils encountered are discussed below:

The subsoils encountered are characterised by dark grey or black occasionally dark brown, soft to firm clays which are commonly referred to as “black turf”. They are underlain by grey and olive predominantly very soft to medium hard rock gabbro norite and occasional medium dense to dense sand.

These subsoils are described in detail below:

4.1 Western TSF Site

4.1.1 Soil description

Fourteen test pits referenced TP1 to TP4 and TP21 to TP30 were dug within the site and the subsoils encountered are described below:

Residual clay "black turf": blankets the site to an average depth of 1,8 m in the range 1,4 to 3,2 m. It is shattered and slickensided and exhibits a soft consistency. It covers the whole area and is overlain by topsoil comprising soft clay with sand containing numerous roots to a depth of up to 0,2 m below surface.

A 200 mm thick layer of soft to firm, sandy clay occurs sporadically within the site and represents the transition between the "black turf" and the underlying soft rock or residual sand. This frequently comprise minor to abundant fine and medium calcrete and gabbro norite gravels.

The shattered and slickensided structure suggests that the "black turf" is potentially highly active.

Gabbro norite rock: underlies the "black turf" and is predominantly grey and olive, stained black and brown, closely jointed and breaks into angular gravels and sand. In places, however, the rock has weathered to a medium dense to dense sand with minor to abundant angular gravels exhibiting the relict structure of the rock. With depth the strength or consistency of the rock, which is predominantly very soft to soft, improves and the backacter refused within it.

The soil profile records for each of the test pits are presented in **Appendix B**.

4.1.2 Groundwater

Groundwater seepage was encountered in test pits TP21 and TP30 at a depth of 4,2 and 3,6 m respectively, with water standing at these depths after 24 hours.

4.2 Eastern TSF Site

4.2.1 Soil description

Sixteen test pits referenced TP5 to TP20, were excavated within the site and the subsoils encountered include the following:

Residual clay "Black turf": is predominantly shattered and slickensided and covers the site to an average depth of 4,2 m in the range 0,7 m to 6,2 m. This comprises soft to firm dark grey or black

clay which becomes firm and dark brown with depth and contains minor to abundant fine and medium calcrete gravels.

Residual norite sand: occurs sporadically within the site in test pits TP5, TP6, TP10, TP11, TP12 and TP18 and occurs below the "black turf" where it comprises dense to very dense sand which is of a very dense to very soft rock consistency in places.

Norite rock: underlies the "black turf" and the residual sand described above, and is predominantly grey and olive speckled white, stained orange and brown, closely jointed and breaks into angular gravels and sand. With depth the strength or consistency of the rock or residual soils improves and the backacter partially refused within it.

The soil profile records for each of the test pits are presented in **Appendix B** of this report.

4.2.2 Groundwater

No groundwater seepage was encountered within any of the pits.

5. LABORATORY TEST RESULTS

The results of the laboratory tests carried out on selected soil samples recovered from the test pits are summarised below and presented in **Appendix C**.

5.1 Foundation Indicator

For more accurate identification and for classification purposes, particle size distribution analysis and Atterberg limit determinations were carried out on samples of the near surface residual clay and sand and rock fragments and the results of these are summarized in **Table 1**.

The residual gabbro norite clay "black turf" classifies as "CH" soil type according to the Unified Soil Classification (USC) system, this being clay of high plasticity.

According to the AASHTO classification system the residual sand and very soft rock gabbro norite classifies as an A-1-b soil type this being sand with stone fragments.

The plasticity index (PI) for the residual clay averages 52 ranging from 32 to 72, and when weighted averages 50. This suggests that it is of high to very high expansive potential according to the method of Van der Merwe [(2)]. With an average grading modulus of 0,16, the soil is fine grained and comprises largely of the clay fraction.

The residual sand and rock fragments is non plastic (NP) and slightly plastic (SP) with a grading modulus of 1,54 to 2,25 respectively which is coarse.

5.2 Compaction Tests

Standard Proctor compaction tests were carried out on representative samples of the residual sand and gabbro norite rock fragments within the TSF sites, mainly to determine their compaction characteristics in terms of the maximum dry density and optimum moisture content for remoulding in the triaxial apparatus for strength and permeability estimates.

The results of these tests are presented in **Table 2** overleaf.

Samples of the sand and rock fragments tested are all fairly uniform with optimum moisture contents of 12,4% to 14,3% for the sand and 8,2% for the rock fragments respectively, which is typical of a relatively finer grained sand and much coarser rock fragments sampled. The maximum Proctor dry densities for the sand are between 1940 kg/m^3 and 2271 kg/m^3 and for the rock fragments is 2197 kg/m^3.

Table 1: Summary of results of indicator tests

TSF Site	Test pit No.	Description	Depth (m)	LL	PI	PI_{ws}	LS	GM	MIT Size Fraction - %				Classification	
									Gravel	Sand	Silt	Clay	USC	AASHTO
Western TSF Site	TP2	Residual gabbro norite - Sand	1.6 – 4.0	NP	NP	NP	0.0	1.54	7	85	6	2	SP-SM	A-1-b (0)
Western TSF Site	TP4	Residual gabbro norite - Clay	1.0 – 1.2	63	34	33	17.5	0.15	1	15	28	57	CH	A-7-6 (20)
Eastern TSF Site	TP6	Residual gabbro norite - Clay	1.0 – 1.2	60	32	31	15.0	0.06	0	7	25	68	CH	A-7-6 (20)
Eastern TSF Site	TP6	Very soft rock gabbro norite	4.7 – 5.1	SP	SP	SP	1.0	2.25	48	48	3	1	SW-SM	A-1-b (0)
Eastern TSF Site	TP9	Residual gabbro norite - Clay	4.5 – 4.7	105	72	72	22.0	0.04	0	8	28	64	CH	A-7-5 (20)
Eastern TSF Site	TP10	Residual gabbro norite - Clay	4.0 – 4.2	98	64	62	20.0	0.13	1	13	22	64	CH	A-7-5 (20)
Eastern TSF Site	TP14	Residual gabbro norite - Clay	4.0 – 4.2	93	58	50	20.5	0.43	12	9	27	52	CH	A-7-5 (20)
Eastern TSF Site	TP19	Residual gabbro norite - Sand	1.2 – 3.4	NP	NP	NP	0.0	2.25	44	53	2	1	SW	A-1-b (0)

LL = liquid limit; PI = plasticity index; PI_{ws} = plasticity index of whole sample; LS = linear shrinkage; GM = grading modulus, USC = unified soil classification, AASHTO = American Association of State Highway and Transportation Officials; MIT = Massachusetts Institute of Technology

Table 2: Summary of Results of Compaction tests – Proctor

Hole No.	Description	Depth (m)	ρ_d max	omc
			(kg/m^3)	(%)
TP2	Residual gabbro norite - Sand	1.6 – 4.0	1940	14.3
TP6	Very soft rock gabbro norite	4.7 – 5.1	2197	8.2
TP19	Residual gabbro norite - Sand	1.2 – 3.4	2271	12.4

ρ_d max = maximum dry density; omc = optimum moisture content;

5.3 Triaxial test

Undisturbed samples of the residual clay "black turf", and remoulded sand and rock fragments samples were subjected to consolidated undrained and drained triaxial tests respectively, and the results are summarized in **Table 3** below. Both the drained and undrained tests were carried out at cell pressures of approximately 50, 100 and 200 kPa and pore water pressure measurements were taken during shearing for the consolidated undrained tests.

The residual clay tested has in excess of 52 % clay by mass and in terms of effective stresses exhibits cohesion of 20 to 30 kPa and a friction angle of 12 degrees. The remoulded sand and rock fragments exhibit an apparent cohesion of 3 kPa and an angle of friction of between 35 to 43 degrees.

5.4 Permeability Tests

Permeability tests were carried out on samples of the residual clay "black turf" and the remoulded residual sand and rock fragments prepared in the triaxial cell, and the results are summarized in **Table 4** below.

The permeability coefficients for the remoulded sand and rock fragments are in the range 3,0 x 10^{-7} and 2,7 x 10^{-6} m/sec, which classify these soil as being slightly permeable when remoulded to 95% proctor compactive effort. On the other hand the "black turf" is regarded as almost impermeable with the permeability coefficients of between 4.7 x 10^{-10} and 1.0 x 10^{-9}.

Table 3: Summary of triaxial tests

Hole No.	Depth (m)	Soil Description	Remoulded/ Undisturbed	Type of Test	Dry density (kg/m^3)	Moisture content (%)	Cohesion (kPa) c'	Angle of friction (degrees) ϕ'
TP2	1.6 – 4.0	Residual gabbro norite - Sand	Remoulded	CD	1820	14.6	22	35
TP4	1.0 – 1.2	Residual gabbro norite - Clay	Undisturbed	CU	1259	33.7	20	12
TP6	4.7 – 5.1	Very soft rock gabbro norite	Remoulded	CD	2051	9.5	15	38
TP10	4.0 – 4.2	Residual gabbro norite - Clay	Undisturbed	CU	1299	38.4	30	11
TP19	1.2 – 3.4	Residual gabbro norite - Sand	Remoulded	CU	1994	14.0	3	43

CD = Consolidated Drained; CU = Consolidated Undrained with measurements of pore water pressures

Table 4: Summary of permeability tests

Hole No.	Depth (m)	Soil Description	Dry density (kg/m^3)	Moisture Content (%)	Coefficient of permeability (m/sec)
TP2	1.6 – 4.0	Residual gabbro norite - Sand	1830	14.1	4.5×10^{-6}
TP4	1.0 – 1.2	Residual gabbro norite - Clay	1259	33.7	9.1×10^{-10}
TP6	1.0 – 1.2	Residual gabbro norite - Clay	1298	36.4	4.7×10^{-10}
TP6	4.7 – 5.1	Very soft rock gabbro norite	1933	10.6	3.0×10^{-7}
TP9	4.5 – 4.7	Residual gabbro norite - Clay	1222	38.2	1.0×10^{-9}
TP14	4.0 – 4.2	Residual gabbro norite - Clay	1121	45.2	5.4×10^{-10}
TP19	1.2 – 3.4	Residual gabbro norite - Sand	2209	16.9	2.7×10^{-6}

6. GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

Based on the detailed profiles of 30 tests pits excavated within the area identified for the design and construction of the TSF's, together with the results of laboratory tests, the following findings and recommendation are provided.

6.1.1 Subsoil Conditions

Both the Western and Eastern TSF sites are covered by the residual clay "black turf" to depths in the range 1,4 to 3,2 m and 0,7 to 6,2 m respectively. Laboratory tests indicate that the clayey horizons are of very low permeability, typically in the order 10^{-9} metres per second and, depending on their thickness, should contribute significantly to reducing seepage into the underlying sand and rock strata. The underlying rock sand rock strata appear to be relatively permeable from the soil profiles, however, the remoulded samples tested indicates that, based on the coefficient of permeability in the range 3,0 x 10^{-7} and 2,7 x 10^{-6} m/sec, they are "slightly permeable"

6.1.2 Impoundment Wall

Rock Fill

It is understood that the TSF's will be constructed of rock fill to form a perimeter impoundment wall. This configuriguration will require substantial fill with which to construct the impoundment. It is estimated that about 1.0 Mm^3 and 3.5 Mm^3 of residual clay can be sourced from within the basin of the Western and Eastern TSF's respectively, with which a clay lining can be formed.

Filter

By virtue of its coarse grained composition and concomitant relatively large voids, the rock fill must be considered pervious, in which case the upstream face should be provided with a suitable filter blanket to prevent tailings piping into and through the rock fill wall. Consideration should be given to placing a protective layer of earth over the filter to protect it from damage through scour erosion during tailings deposition. If possible, during operations coarse tailings should be carefully deposited against the filter under controlled conditions.

Stability

Stability of the wall by shear failure through the underlying clay and sliding along the dense residual gabbro norite underlying foundation and the tailings should follow conventional methods, including rotational and sliding failure.

For analysis purposes the clayey layer should be assumed to extend to a maximum depth of 6,0 m below surface and shear strength parameters of c' = 10 kPa and φ' = 12° should be used for analysis. Design shear strength parameters for the sand and rock fragments of c' = 0 kPa and φ' = 33° are considered reasonable.

7. REFERENCES

1) Geoterminology Workshop (1990), *Guidelines for Soil and Rock Logging in South Africa.* Association of Engineering Geologists, Geotechnical Division of the South African Institute of Civil Engineering and South African Institute of Engineering Geologists.

2) Van der Merwe, D.H. *The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction.* Trans. S.A. Ins. Civ. Eng. No. 6, 1964.

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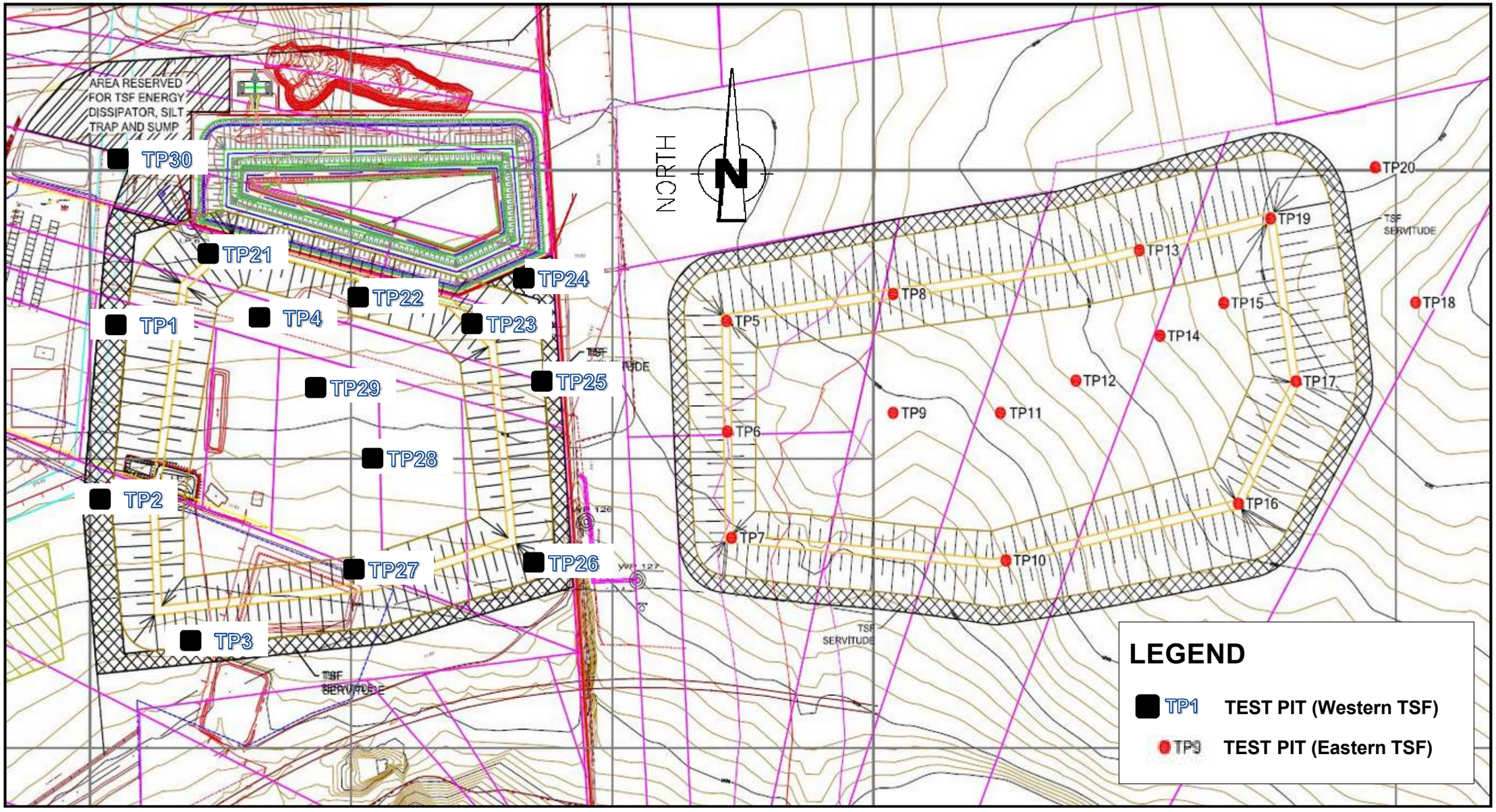

Ref: 0996/g	**EPOCH RESOURCES (PTY) LTD.** **THARISA MINERALS TAILINGS STORAGE FACILITIES**	**Figure No 1**
	SITE PLAN SHOWING POSITIONS OF TEST PITS	

APPENDIX A

PHOTOGRAPHS OF SITE

View of the Western TSF site from near TP4 looking south west.

View of the Eastern TSF site from the southern border looking north.

APPENDIX B

SOIL PROFILES

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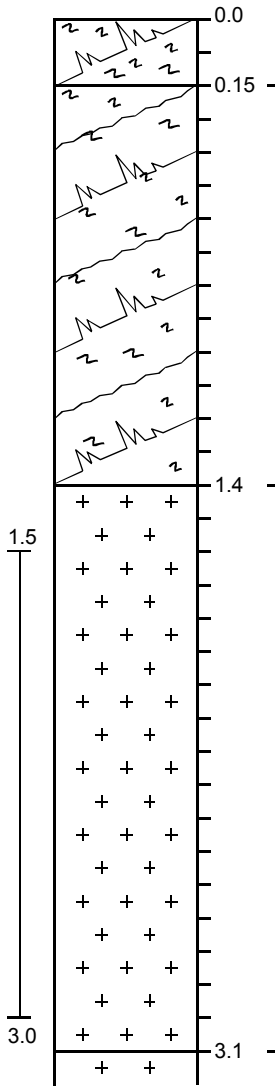
PROFILE SHEET

TP1

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848276
Y -050602



0.0 – 0.15: Very moist, dark grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots.
Topsoil.

0.15 – 1.4: Very moist, dark black grey, <u>soft</u>, shattered, slickensided, CLAY with few roots.
Residual gabbro norite.

1.4 – 3.1: Yellow and grey speckled white, highly weathered, very closely to closely jointed, medium grained, <u>very soft rock</u>, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black and brown.

Becomes <u>soft rock</u> with depth.

Contains pocket of weathered yellow sand in places.

NOTES:
1. Bottom of hole at 3,1 m. Partial refusal on <u>soft rock</u> GABBRO NORITE.
2. No ground water seepage encountered.
3. Bulk sample taken from 1,5 to 3,0 m.
4. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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TP2

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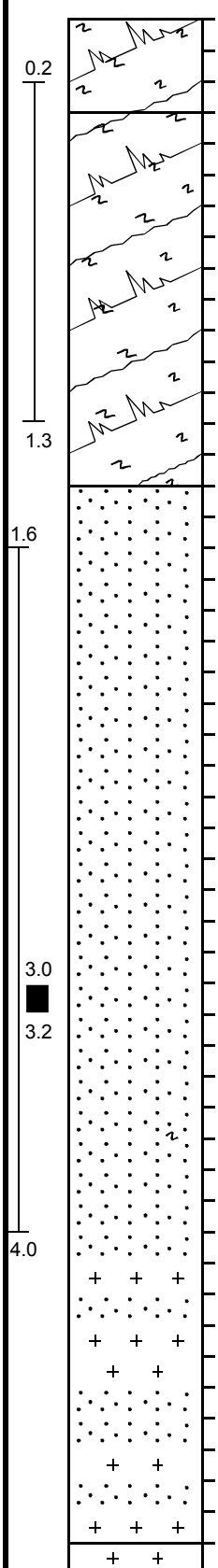
Y -050566



0.0 – 0.3: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.3 – 1.5: Moist to very moist, dark black grey, <u>very soft to soft</u>, shattered, slickensided, CLAY with occasional roots. *Residual gabbro norite.*

1.5 – 5.0: Moist, khaki stained black and brown speckled grey, <u>medium dense</u> becoming <u>dense</u> below 2,0 m, relict jointed, SAND. *Residual gabbro norite.*

Becomes very dense and <u>very soft rock</u> below 4,0 m.

In places rock occurs between the sand and comprises:
Khaki, highly weathered, closely to medium jointed, <u>very soft rock</u>, NORITE.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 05/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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TP2 cont

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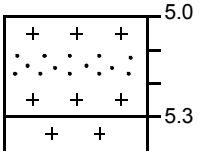

NOTES:
1. Bottom of hole at 5,3 m. Partial refusal on very dense to very soft rock GABBRO NORITE.
2. Very slow water seepage encountered below 2,0 m. Water standing at the bottom of the pit after overnight.
3. Undisturbed sample taken from 3,0 to 3,2 m.
4. Bulk sample taken from 0,2 to 1,3 m and 1,6 to 4,0 m.
5. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 05/04/2011

▽ Water seepage
▼ Standing water
■ Undisturbed sample
● Disturbed sample
I Bulk sample
⊢⊣ *In-situ* test

Ref: 0996/g

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PROFILE SHEET

TP3

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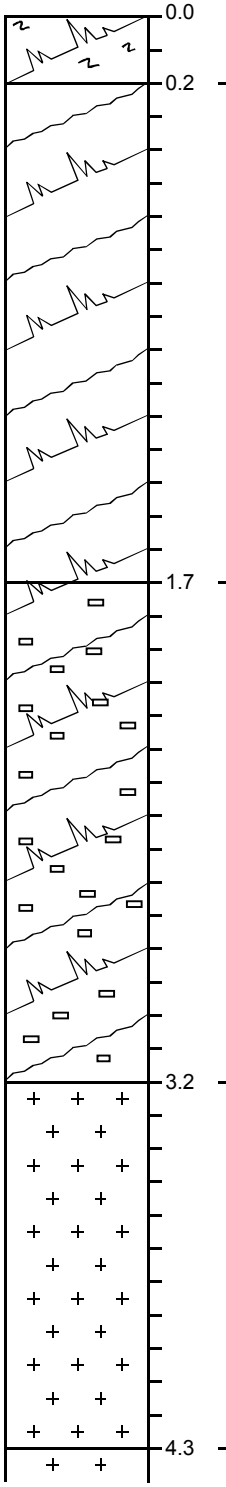

0.0 – 0.2: Very moist, dark black grey, very soft, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 1.7: Very moist, dark black grey, soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.7 – 3.2: Moist, dark brown stained grey, soft, shattered, slickensided, CLAY with minor to abundant calcrete gravels

3.2 – 4.3: Orange brown mottled olive stained black, highly weathered, very closely to closely jointed, medium grained, very soft rock, GABBRO NORITE.

NOTES:
1. Bottom of hole at 4,3 m. Partial refusal on soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 05/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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TP4

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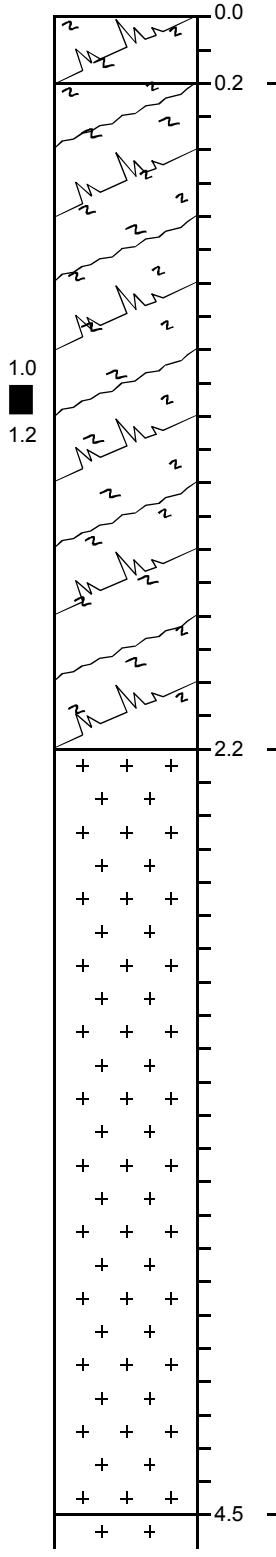

0.0 – 0.2: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 2.2: Very moist, dark black grey, <u>soft</u> becoming <u>soft to firm</u> with depth, shattered, slickensided, CLAY with few roots. *Residual gabbro norite.*

2.2 – 4.5: Orange brown and olive becoming grey olive, stained black, highly weathered, very closely to closely jointed, medium grained, <u>very soft rock</u>, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black and brown.

Becomes <u>soft rock</u> with depth.

In the upper 0,5 m contains pocket of weathered olive sand in places.

NOTES:
1. Bottom of hole at 4,5 m. Partial refusal on <u>very soft rock</u> GABBRO NORITE.
2. No ground water seepage encountered.
3. Undisturbed sample taken from 1,0 to 1,2 m.
4. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 05/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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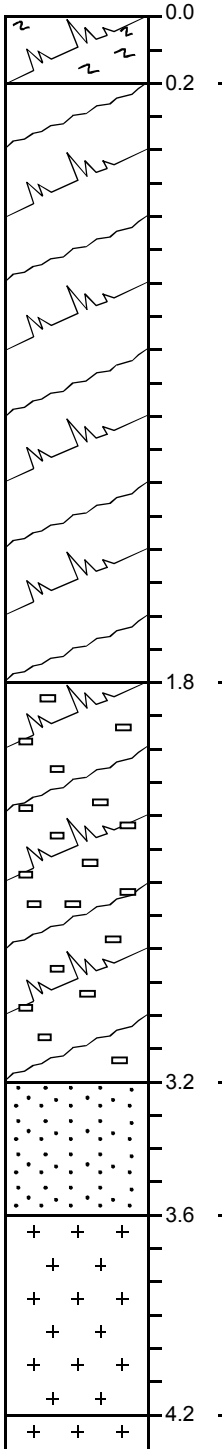

0.0 – 0.2: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 1.8: Very moist, dark black grey, <u>soft</u>, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.8 – 3.2: Moist, dark brown stained grey, <u>firm</u>, shattered, slickensided, CLAY with minor to abundant calcrete gravels. *Residual gabbro norite.*

3.2 – 3.6: Slightly moist, light brown becoming olive speckled dark grey, <u>dense</u>, slightly silty SAND. *Residual gabbro norite.*

3.6 – 4.2: Grey and olive speckled white, highly weathered, very closely to medium jointed, medium grained, <u>very soft rock</u>, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black.

NOTES:
1. Bottom of hole at 4,2 m. Partial refusal on <u>soft rock</u> GABBRO NORITE.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 30/03/2011

▽ Water seepage ▼ Standing water ■ Undisturbed sample ● Disturbed sample I Bulk sample ⊢ *In-situ* test

Ref: 0996/g

Sheet 1 of 1

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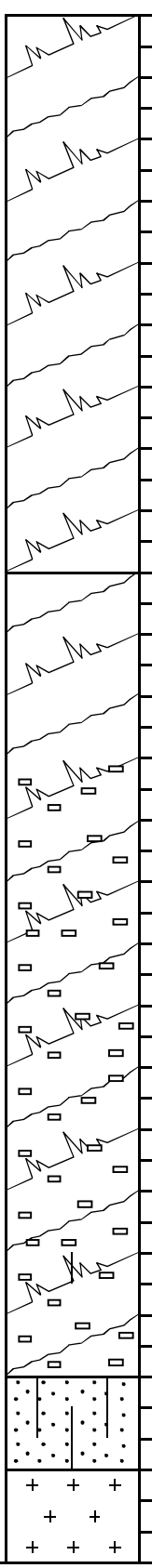

0.0 – 0.2: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 1.8: Very moist, dark black grey, <u>soft</u>, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.8 – 4.3: Very moist, dark brown stained grey, <u>firm</u>, shattered, slickensided, CLAY with pockets of abundant calcrete gravels below 2,4 m. *Residual gabbro norite.*

4.3 – 4.6: Slightly moist, brown and olive speckled white, <u>dense and very soft rock</u> in places, slightly silty SAND. *Residual gabbro norite.*

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 30/03/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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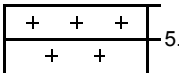

Grey and olive speckled white, highly weathered, very closely to medium jointed, medium grained, very soft rock, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black.

NOTES:
1. Bottom of hole at 5,1 m. Partial refusal on very soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Bulk sample taken from 4,7 to 5,1 m.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 30/03/2011

Water seepage | Undisturbed sample | Bulk sample
Standing water | Disturbed sample | *In-situ* test

Ref: 0996/g

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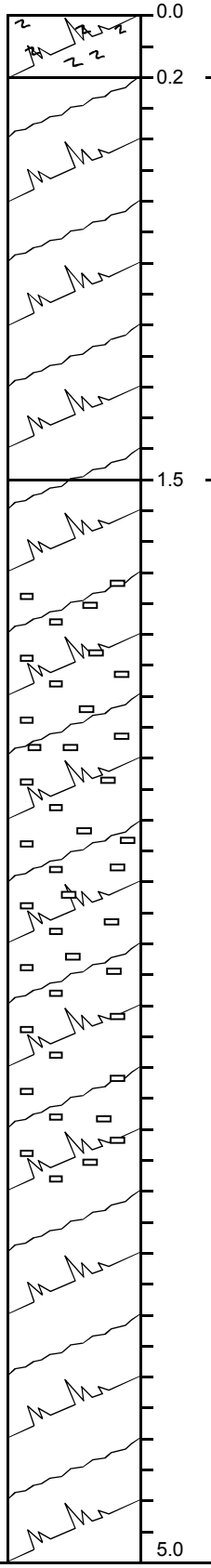
X 2848636
Y -051726



Very moist, dark black grey, very soft, shattered, slickensided, CLAY with many roots. *Topsoil.*

Moist to very moist, dark black grey, soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

Moist, dark brown speckled black speckled and mottled white, firm, shattered, slickensided, CLAY with abundant calcrete gravels between 1,8 to 3,8 m. *Residual gabbro norite.*

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 30/03/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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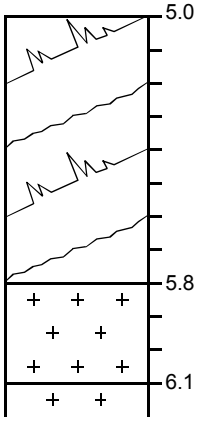
PROFILE SHEET

TP7 cont

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848636
Y -051726



Moist, dark brown speckled black speckled and mottled white, <u>firm</u>, shattered, slickensided, CLAY. *Residual gabbro norite.*

Olive mottled orange, speckled white, highly weathered, very closely, medium grained, <u>very soft rock</u>, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black and brown.

NOTES:
1. Bottom of hole at 6,1 m on <u>very soft rock</u> GABBRO NORITE. Not to refusal.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 30/03/2011

Water seepage ▽ | Standing water ▼ | Undisturbed sample ■ | Disturbed sample ● | Bulk sample I | *In-situ* test ⊢⊣

Ref: 0996/g

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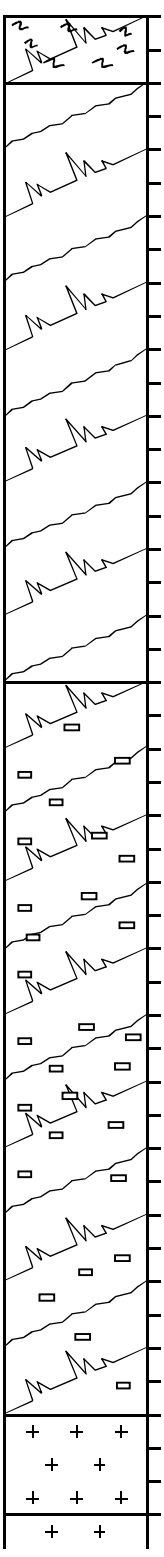
PROFILE SHEET

TP8

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848214
Y -052034



0.0 – 0.2: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 2.0: Very moist, dark black grey, <u>very soft to soft</u>, shattered, slickensided, CLAY. *Residual gabbro norite.*

2.0 – 4.2: Very moist, dark brown speckled white, <u>soft to firm</u> becoming <u>firm</u>, shattered, slickensided, CLAY with minor calcrete gravels in places. *Residual gabbro norite.*

4.2 – 4.5: Olive and grey mottled orange brown stained black speckled white, highly weathered, very closely, medium grained, <u>very soft rock</u>, GABBRO NORITE.

Joints are sub-vertical, stained black.

NOTES:
1. Bottom of hole at 4,5 m. Partial refusal on <u>soft rock</u> GABBRO NORITE.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

▽ Water seepage
▼ Standing water
■ Undisturbed sample
● Disturbed sample
I Bulk sample
⊢ *In-situ* test

Ref: 0996/g

Sheet 1 of 1

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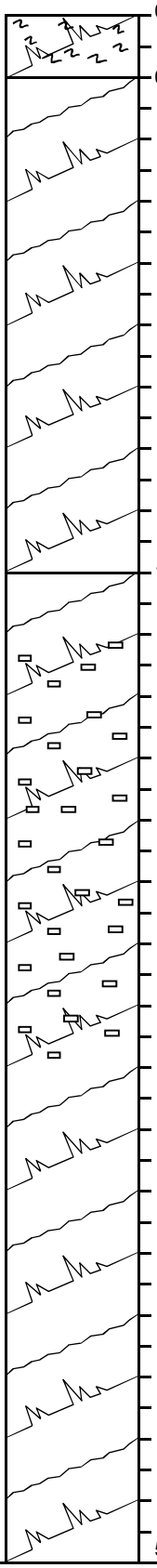
PROFILE SHEET

TP9

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848419
Y -052041



0.0 – 0.2: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 1.8: Very moist, dark black grey, <u>soft</u>, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.8 – 5.0: Very moist, dark brown stained grey speckled white, <u>firm</u>, shattered, slickensided, CLAY containing abundant calcrete gravels between 2,0 to 3,4 m. *Residual gabbro norite.*

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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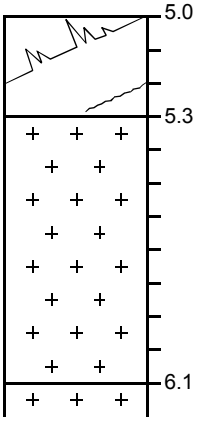
PROFILE SHEET

TP9 cont

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848419
Y -052041



Very moist, dark brown stained grey speckled white, firm, shattered, slickensided, CLAY. *Residual gabbro norite.*

Olive becoming grey, highly weathered, very closely to medium jointed, medium grained, very soft rock, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black.

NOTES:
1. Bottom of hole at 6,1 m. Partial refusal on very soft to soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Undisturbed sample taken from 4,5 to 4,7 m.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage | Undisturbed sample | Bulk sample
Standing water | Disturbed sample | *In-situ* test

Ref: 0996/g

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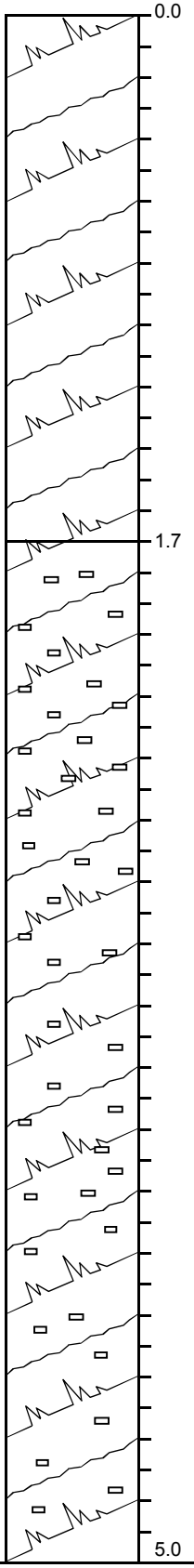
PROFILE SHEET

TP10

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848674
Y -052253



Very moist, dark black grey, soft to firm, shattered, slickensided, CLAY. *Residual gabbro norite.*

Moist to very moist, dark brown stained grey speckled white, firm becoming firm to stiff below 2,5 m, shattered, slickensided, CLAY containing abundant, fine and medium calcrete gravels. *Residual gabbro norite.*

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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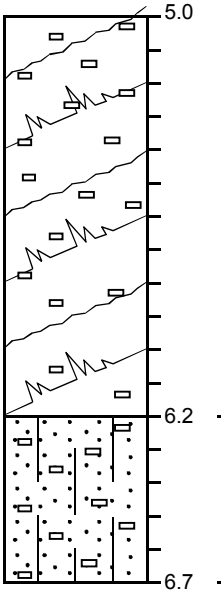
PROFILE SHEET

TP10 cont

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848674
Y -052253



Moist to very moist, dark brown stained grey speckled white, firm becoming firm to stiff below 2,5 m, shattered, slickensided, CLAY containing abundant, fine and medium calcrete gravels. *Residual gabbro norite.*

Slightly moist to moist, brown speckled white, medium dense to dense, slightly clayey SILTY SAND. *Residual gabbro norite.*

Contains pockets of 50 mm thick clay and abundant calcrete gravels.

NOTES:
1. Bottom of hole at 6,7 m on medium dense to dense silty sand and abundant calcrete gravels. Not to refusal.
2. No ground water seepage encountered.
3. Undisturbed sample taken from 4,0 to 4,2 m.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

▽ Water seepage ■ Undisturbed sample I Bulk sample
▼ Standing water ● Disturbed sample ⊢⊣ *In-situ* test

Ref: 0996/g

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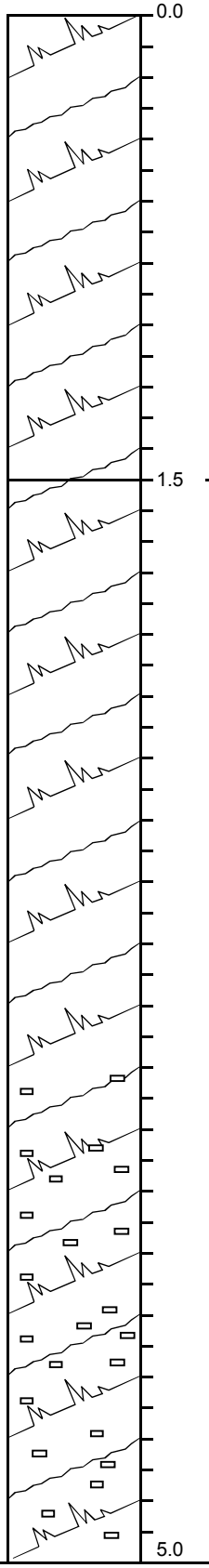
PROFILE SHEET

TP11

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848418
Y -052238



Very moist, dark black grey, very soft becoming soft below 0,5 m, shattered, slickensided, CLAY. *Residual gabbro norite.*

Very moist, dark brown stained grey speckled white, soft to firm, shattered, slickensided, CLAY containing abundant fine and medium calcrete gravels below 3,5 m. *Residual gabbro norite.*

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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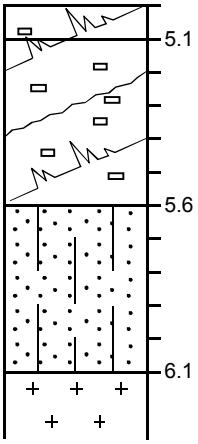
PROFILE SHEET

TP11 cont

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848418
Y -052238



Moist, grey brown stained grey, firm, shattered, slickensided, CLAY with abundant fine, medium and coarse calcrete gravels. *Residual gabbro norite.*

Moist, olive speckled white, mottled orange brown stained black, very dense silty sand. *Residual gabbro norite.*

In places rock occurs between the sand and comprises:
Olive, highly weathered, medium and closely jointed, very soft rock, NORITE.

NOTES:
1. Bottom of hole at 6,1 m on very dense to very soft rock residual GABBRO NORITE.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

▽ Water seepage
▼ Standing water
■ Undisturbed sample
● Disturbed sample
I Bulk sample
⊢⊣ *In-situ* test

Ref: 0996/g

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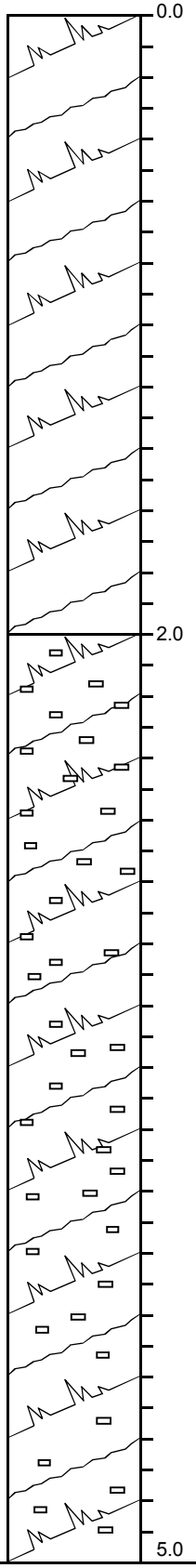
PROFILE SHEET

TP12

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848365
Y -052383



0.0 – 2.0: Very moist, dark black grey, soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

2.0 – 5.0: Very moist, dark brown speckled white, firm, shattered, slickensided, CLAY containing minor becoming abundant calcrete gravels. *Residual gabbro norite.*

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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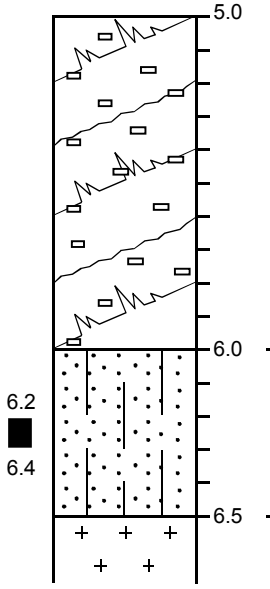
PROFILE SHEET

TP12 cont

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848365
Y -052383



Very moist, dark brown speckled white, <u>firm</u>, shattered, slickensided, CLAY containing minor becoming abundant calcrete gravels. *Residual gabbro norite.*

Moist, olive and grey speckled white stained black, <u>very dense</u>, clayey SILTY SAND. *Residual gabbro norite.*

In places rock occurs abundantly with depth and between the sand and comprises:

Olive and grey, highly weathered, medium and closely jointed, <u>very soft rock</u>, NORITE.

NOTES:
1. Bottom of hole at 6,5 m on <u>very dense to very soft rock</u> residual GABBRO NORITE.
2. No ground water seepage encountered.
3. Undisturbed sample taken from 6,2 to 6,4 m.
4. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

Water seepage | Undisturbed sample | Bulk sample
Standing water | Disturbed sample | *In-situ* test

Ref: 0996/g

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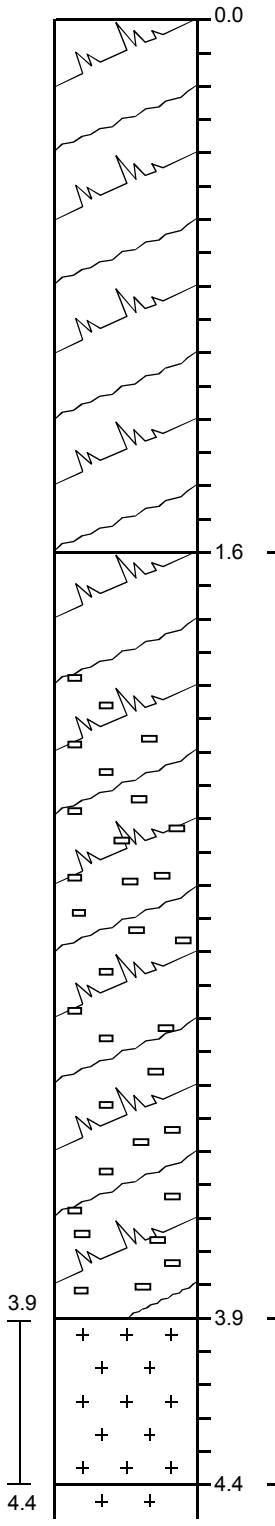
PROFILE SHEET

TP13

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848138
Y -052506



0.0 – 1.6: Very moist, dark black grey, soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.6 – 3.9: Very moist, dark brown speckled white, soft becoming firm with depth, shattered, slickensided, CLAY containing minor becoming abundant calcrete gravels below 2,0 m. *Residual gabbro norite.*

3.9 – 4.4: Yellow olive and grey speckled white, weathered, very closely to closely jointed, medium grained, very soft rock, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black and brown.

NOTES:
1. Bottom of hole at 4,4 m. Partial refusal on very soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Bulk sample taken from 3,9 to 4,4 m.
4. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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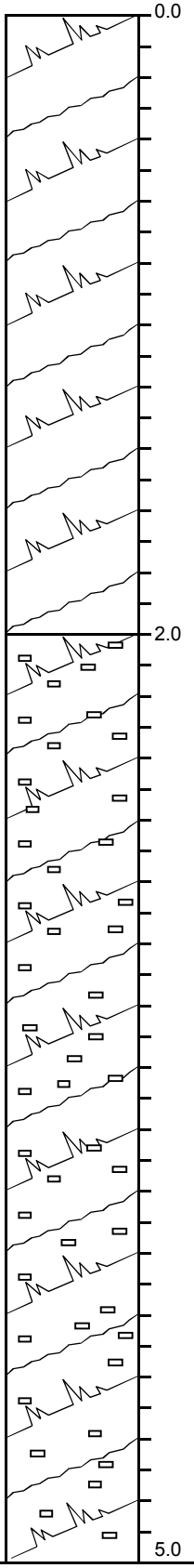
PROFILE SHEET

TP14

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848285
Y -052544



Very moist, dark black grey, soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

Moist to very moist, dark brown stained grey speckled white, firm, shattered, slickensided, CLAY containing minor becoming abundant calcrete gravels. *Residual gabbro norite.*

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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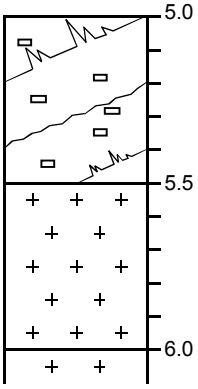
PROFILE SHEET

TP14 cont

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848285
Y -052544



Closely packed, angular and sub-angular, fine, medium and coarse, calcrete GRAVELS and powder in a matrix of moist, dark grey, clay. *Calcrete/Residual gabbro norite.*

Overall consistency is dense.

White and grey stained black and yellow orange, weathered, very closely to medium jointed, medium grained, very soft to soft rock, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black.

NOTES:
1. Bottom of hole at 6,0 m. Partial refusal on soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 31/03/2011

Water seepage | Standing water | Undisturbed sample | Disturbed sample | Bulk sample | *In-situ* test

Ref: 0996/g

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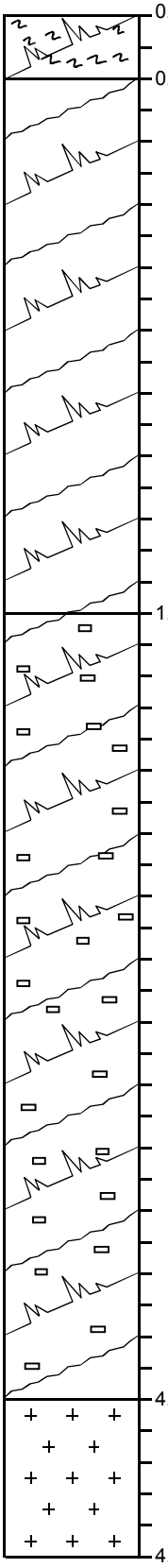
PROFILE SHEET

TP15

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848229
Y -052670



0.0 – 0.2: Very moist, dark black grey, very soft, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 1.9: Very moist, dark black grey, very soft to soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.9 – 4.4: Very moist, dark brown stained grey speckled and mottled white, firm, shattered, slickensided, CLAY containing minor to abundant calcrete gravels. *Residual gabbro norite.*

4.4 – 4.9: Light grey stained orange speckled white, weathered, very closely to medium jointed, medium grained, very soft to soft rock, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained black and brown.

NOTES:
1. Bottom of hole at 4.9 m. Partial refusal on soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Disturbed sample taken from 2,5 to 2,7 m.
4. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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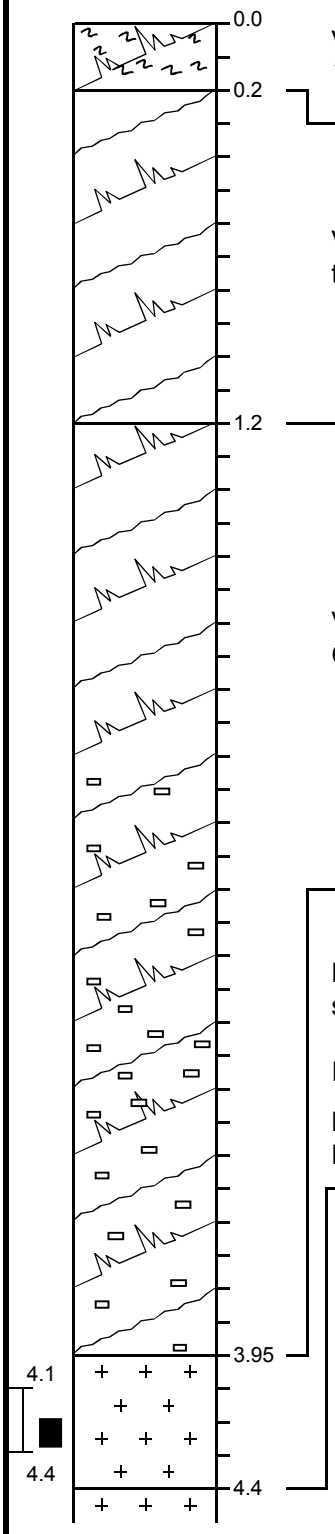
PROFILE SHEET

TP16

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848578
Y -052696



0.0 – 0.2: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 1.2: Very moist, dark black grey, <u>soft</u>, shattered, slickensided, CLAY with many roots on the upper 0,3 m. *Residual gabbro norite.*

1.2 – 3.95: Very moist, dark brown stained grey speckled white, <u>firm</u>, shattered, slickensided, CLAY with abundant calcrete gravels below 2,3 m. *Residual gabbro norite.*

3.95 – 4.4: Dry to slightly moist, khaki speckled grey and black, <u>medium dense to dense</u>, slightly silty SAND.

In places rock occurs abundantly with depth and between the sand and comprises:

Khaki speckled grey, highly weathered, medium and closely jointed, <u>very soft rock</u>, NORITE.

NOTES:
1. Bottom of hole at 4,4 m. Partial refusal on <u>very soft to soft rock</u> GABBRO NORITE.
2. Undisturbed sample taken from 4,1 to 4,3 m.
3. Bulk sample taken from 4,1 to 4,4 m.
4. No ground water seepage encountered.
5. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

Sheet 1 of 1

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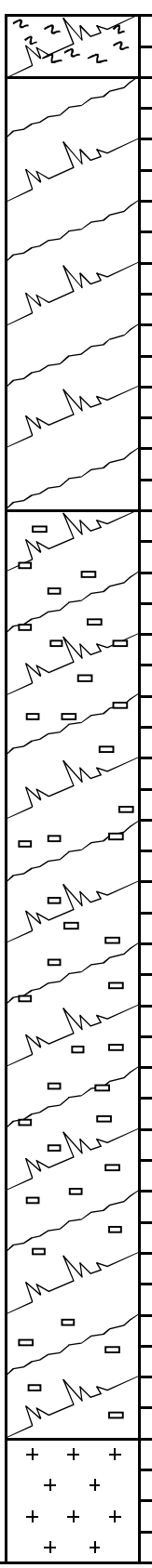
PROFILE SHEET

TP17

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848362
Y -052807



0.0 – 0.2: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 1.6: Very moist, dark black grey, <u>soft</u>, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.6 – 4.6: Very moist, dark brown speckled white, <u>firm</u>, shattered, slickensided, CLAY containing minor becoming abundant calcrete gravels. *Residual gabbro norite.*

4.6 – 5.0: Khaki speckled dark grey, weathered, closely to medium jointed, <u>very soft rock</u>, NORITE.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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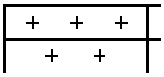
PROFILE SHEET

TP17 cont

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848362
Y -052807



NOTES:
1. Bottom of hole at 5,1 m. Refusal on very soft to soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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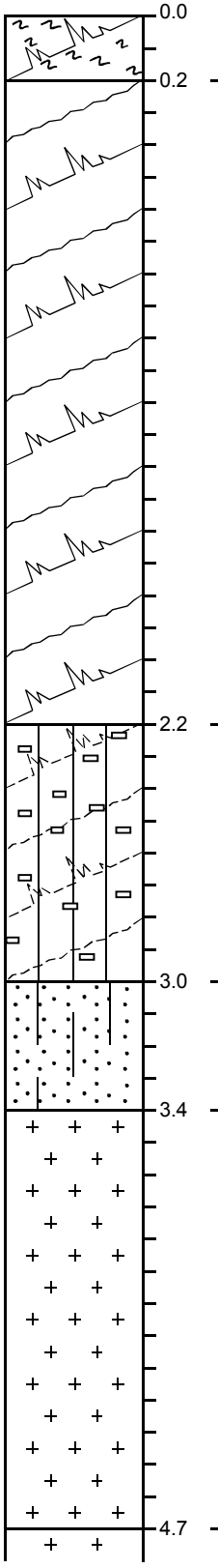
PROFILE SHEET

TP18

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848229
Y -053036



0.0 – 0.2: Very moist, dark black grey, <u>very soft</u>, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 2.2: Very moist, dark black grey, <u>soft to firm</u>, shattered, slickensided, CLAY. *Residual gabbro norite.*

2.2 – 3.0: Slightly moist, light grey mottled white, <u>firm</u>, shattered, slickensided, SILTY CLAY with abundant calcrete gravels. *Residual gabbro norite.*

3.0 – 3.4: Slightly moist, speckled grey, <u>dense</u>, SILTY SAND. *Residual gabbro norite.*

3.4 – 4.7: Orange brown olive and grey stained black, highly weathered, very closely to closely jointed, medium grained, <u>very soft rock</u>, GABBRO NORITE.

NOTES:
1. Bottom of hole at 4,7 m. Not to refusal.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage ▽ | Standing water ▼ | Undisturbed sample ■ | Disturbed sample ● | Bulk sample I | *In-situ* test ⊢⊣

Ref: 0996/g

Sheet 1 of 1

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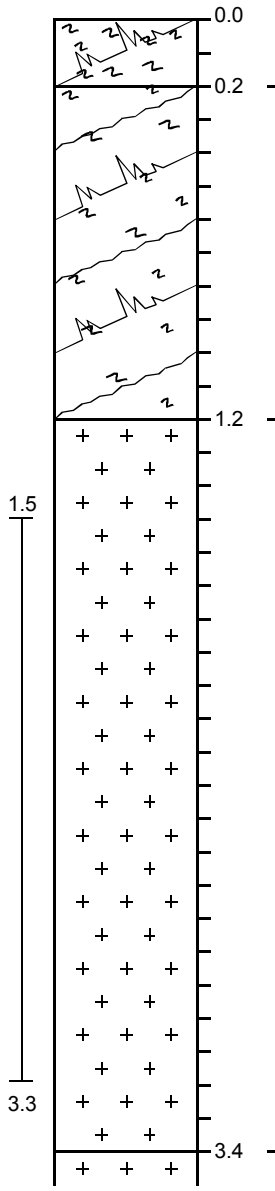
PROFILE SHEET

TP19

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848084
Y -052755



0.0 – 0.2: Very moist, dark black grey, very soft, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.2 – 1.2: Very moist, dark black grey, soft, shattered, slickensided, CLAY with many roots of up to 20 mm in diameter. *Residual gabbro norite.*

Becomes more sandy below 0,9 m.

1.2 – 3.4: Grey speckled white stained orange brown, weathered, closely to medium jointed, medium grained, very soft to soft rock, GABBRO NORITE.

Joints are sub-vertical, stained black and brown.

NOTES:
1. Bottom of hole at 3,4 m. Refusal on very soft to soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Bulk sample taken from 1,5 to 3,3 m.
4. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

Water seepage | Standing water | Undisturbed sample | Disturbed sample | Bulk sample | *In-situ* test

Ref: 0996/g

Sheet 1 of 1

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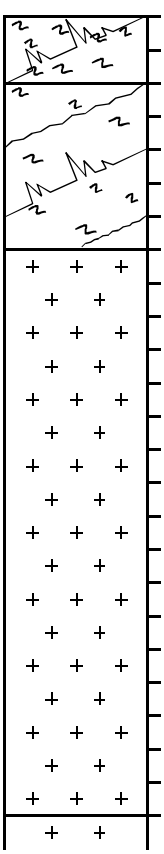
PROFILE SHEET

TP20

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2847993
Y -052959



Very moist, dark black grey, very soft, shattered, slickensided, CLAY with many roots. *Topsoil.*

Very moist, dark black grey, soft, shattered, slickensided, CLAY with roots. *Residual gabbro norite.*

Grey and dark grey stained brown speckled white, weathered, very closely to medium jointed, medium grained, very soft to soft rock, GABBRO NORITE.

Joints are sub-vertical and horizontal, stained brown

NOTES:
1. Bottom of hole at 2,4 m. Partial refusal on soft rock GABBRO NORITE.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: 0
Machine: 0

Profiled by: MC Shuping
Date profiled: 04/04/2011

▽ Water seepage
▼ Standing water
■ Undisturbed sample
● Disturbed sample
I Bulk sample
⊢⊣ *In-situ* test

Ref: 0996/g
Sheet 1 of 1

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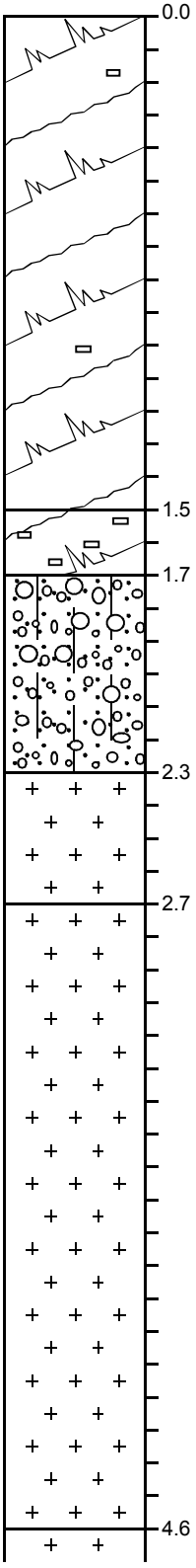
PROFILE SHEET

TP21

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848169
Y -050737



0.0 – 1.5: Very moist, dark black grey, soft becoming soft to firm, shattered, slickensided, CLAY with occasional fine and medium calcrete gravels. *Residual gabbro norite.*

1.5 – 1.7: Moist, dark brown grey speckled white, firm, shattered, CLAY with abundant fine and medium calcrete nodules. *Residual gabbro norite*

1.7 – 2.3: Slightly moist, olive and stained brown in joints, dense to very dense, cemented, SILTY SAND with abundant friable gravels. *Residual gabbro norite.*

2.3 – 2.7: Olive and grey stained black and brown orange, highly weathered, medium grained, very closely to closely jointed, very soft rock. *Gabbro norite.*

2.7 – 4.6: Grey and olive grey stained brown orange, weathered, medium to coarse grained, very closely to medium jointed and occasionally widely jointed, very soft to soft rock. *Gabbro norite.*

Becomes medium hard rock in places below 3,0 m.

NOTES:
1. Bottom of hole at 4,6 m. Refusal on soft to medium hard rock gabbro norite.
2. Ground water seepage encountered below 4,2 m. Water standing at 4,2 m after 24 hours.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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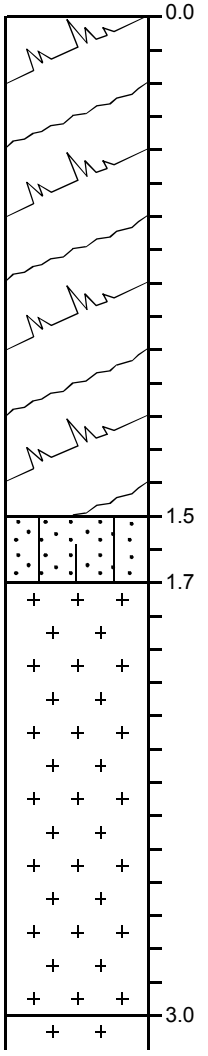
PROFILE SHEET

TP22

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848234
Y -051013



0.0 – 1.5: Very moist, dark black grey, soft, shattered, slickensided, CLAY with minor fine and medium calcrete gravels. *Residual gabbro norite.*

Contains abundant sand and gravels at base.

1.5 – 1.7: Moist, dark grey brown and olive, medium dense, SILTY SAND with abundant weathered friable gravels. *Residual gabbro norite.*

1.7 – 3.0: Olive and grey stained brown orange, weathered, medium and coarse grained, closely to medium jointed, very soft rock. *Gabbro norite.*

Contains medium hard rock in places.

NOTES:
1. Bottom of hole at 3,0 m. Refusal on soft to medium hard rock gabbro norite.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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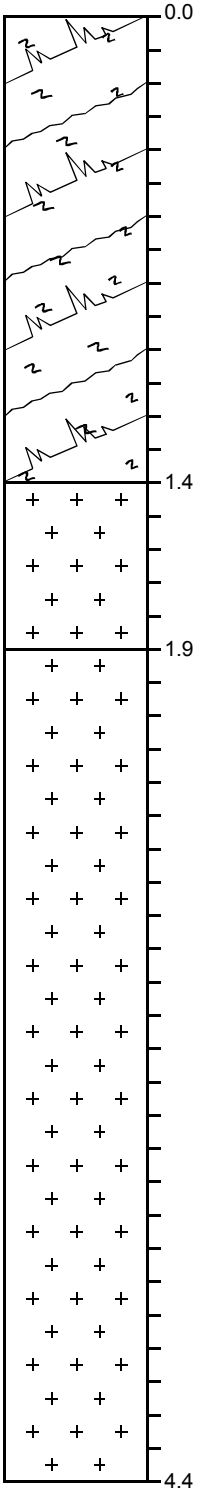
TP23

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848282
Y -051225



0.0 – 1.4: Moist, dark black grey, soft, shattered, slickensided, CLAY with occasional fine roots. *Residual gabbro norite.*

1.4 – 1.9: Olive mottled grey, highly weathered, coarse grained, very closely to closely jointed, very soft rock. *Gabbro norite.*

1.9 – 4.4: Dark grey stained olive, weathered, coarse grained, closely jointed, soft to medium hard rock. *Gabbro norite.*

NOTES:
1. Bottom of hole at 4,4 m. Refusal on soft to medium hard rock gabbro norite.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

Water seepage ▽ | Standing water ▼ | Undisturbed sample ■ | Disturbed sample ● | Bulk sample I | *In-situ* test ⊢

Ref: 0996/g

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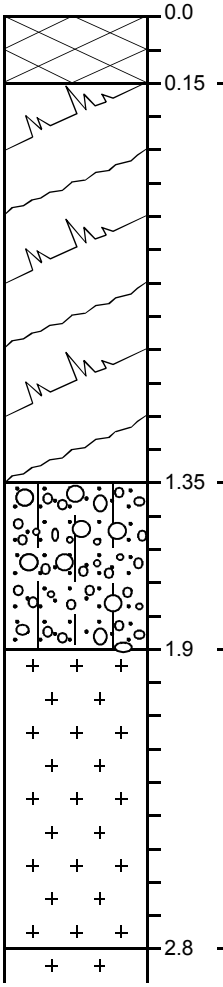
PROFILE SHEET

TP24

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848229
Y -051294



0.0 – 0.15: Moist, brown and dark red brown, SILTY SAND with abundant gravels. *Fill.*

0.15 – 1.35: Very moist, dark black brown, soft, shattered, slickensided, CLAY with minor to abundant calcrete gravels. *Residual gabbro norite.*

Contains abundant sand below 1,2 m.

1.35 – 1.9: Very moist, dark grey and greenish grey, medium dense, relict jointed, SILTY SAND with abundant, weathered, gabbro norite gravels. *Residual gabbro norite.*

1.9 – 2.8: Dark grey stained olive and white, weathered, medium to coarse grained, very closely to closely jointed, very soft to soft rock. *Gabbro norite.*

NOTES:
1. Bottom of hole at 2,8 m. Refusal on soft rock gabbro norite.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

▽ Water seepage
▼ Standing water
■ Undisturbed sample
● Disturbed sample
I Bulk sample
⊢⊣ *In-situ* test

Ref: 0996/g

Sheet 1 of 1

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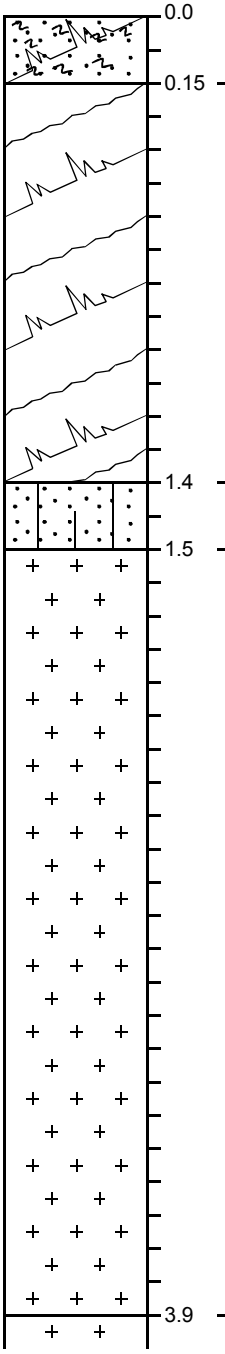
PROFILE SHEET

TP25

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848378
Y -051341



0.0 – 0.15: Very moist, dark black grey, very soft to soft, shattered, slickensided, CLAY with sand and many roots. *Topsoil.*

0.15 – 1.4: Very moist, dark black grey, soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.4 – 1.5: Very moist, dark brown mottled dark grey and brown orange, loose to medium dense, SILTY SAND with occasional pockets of grey clay and fine to medium gravels. *Residual gabbro norite.*

1.5 – 3.9: Grey and olive grey stained brown orange, highly weathered, coarse grained, very closely to closely jointed, very soft to soft rock. *Gabbro norite.*

Becomes dark grey and closely to medium jointed below 2,5 m.

In places contains pockets of olive, medium dense silty sand.

NOTES:
1. Bottom of hole at 3,9 m. Refusal on soft rock gabbro norite.
2. Very slow ground water seepage encountered below 1,0 m.
3. Excavated walls are highly collapsible up to a depth of 1,5 m.
4. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

▽ Water seepage
▼ Standing water
■ Undisturbed sample
● Disturbed sample
I Bulk sample
⊢ *In-situ* test

Ref: 0996/g

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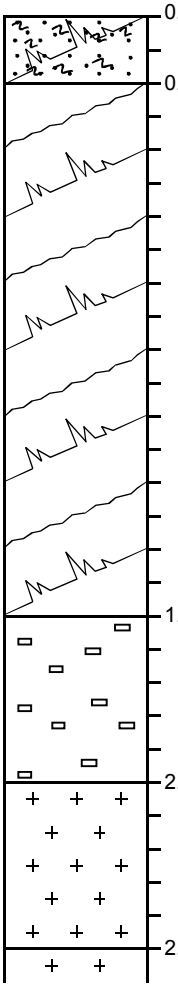
PROFILE SHEET

TP26

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848764
Y -051341



0.0 – 0.1: Very moist, dark black grey, soft, shattered, CLAY with sand and many roots. *Topsoil.*

0.1 – 1.8: Very moist, dark black grey becoming dark brown below 1,5 m, soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.8 – 2.3: Closely packed, sub-angular and sub-rounded, fine and medium, calcrete and gabbro norite GRAVELS and calcrete powder in a matrix of slightly moist, orange brown silty sand. *Calcrete.*

Contains up to 50 mm thick pockets of brown clay and fine ferruginous nodules.

2.3 – 2.8: Light grey speckled dark grey stained brown orange, weathered, medium to coarse grained, very closely to closely jointed, very soft rock. *Gabbro norite.*

Becomes closely to medium jointed and soft rock below 2,5 m.

NOTES:
1. Bottom of hole at 2,8 m. Refusal on soft rock gabbro norite.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

▽ Water seepage
▼ Standing water
■ Undisturbed sample
● Disturbed sample
I Bulk sample
⊢⊣ *In-situ* test

Ref: 0996/g

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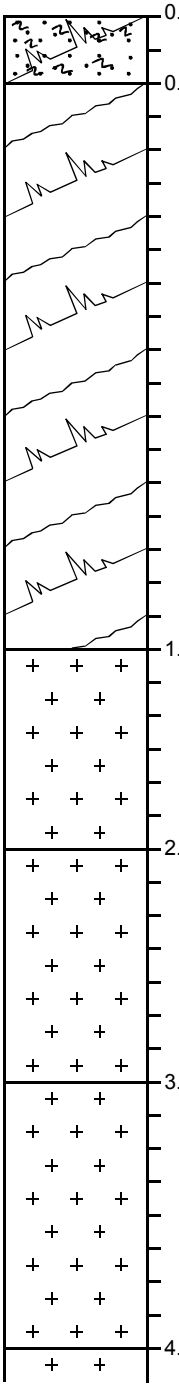
PROFILE SHEET

TP27

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848695
Y -051068



0.0 – 0.1: Very moist, dark black grey, soft, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.1 – 1.9: Very moist, dark black grey, soft, shattered, slickensided, CLAY. *Residual gabbro norite.*

Contains abundant sand and fine to medium gravels at base.

1.9 – 2.5: Olive speckled dark grey stained brown orange and black, highly weathered, medium to coarse grained, very closely to closely jointed, very soft rock. *Gabbro norite.*

2.5 – 3.2: Grey and olive stained brown orange, weathered, medium to coarse grained, closely to medium jointed, very soft becoming soft rock. *Gabbro norite.*

3.2 – 4.0: Light grey speckled dark grey stained brown orange, medium to coarse grained, medium to occasionally widely jointed, medium to hard rock. *Gabbro norite.*

NOTES:
1. Bottom of hole at 4,0 m. Refusal on medium hard rock gabbro norite.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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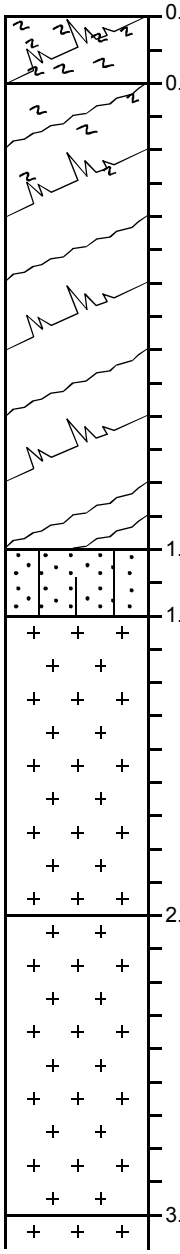
PROFILE SHEET

TP28

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848547
Y -051039



0.0 – 0.1: Very moist, dark grey stained brown, soft, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.1 – 1.6: Very moist, dark black grey, soft, shattered, slickensided, CLAY with many roots above 0,6 m. *Residual gabbro norite.*

Contains minor small core stones and sand at base.

1.6 – 1.8: Slightly moist, olive mottled dark black grey stained black, relict jointed, SILTY SAND with abundant in joints. *Residual gabbro norite.*

1.8 – 2.7: Grey and olive grey stained black and brown orange, medium grained, very closely to closely jointed, very soft to soft rock. *Gabbro norite.*

2.7 – 3.6: Dark grey and olive grey, weathered, medium to coarse grained, closely to medium jointed, soft rock. *Gabbro norite.*

NOTES:
1. Bottom of hole at 3,6 m. Refusal on soft to medium hard rock gabbro norite.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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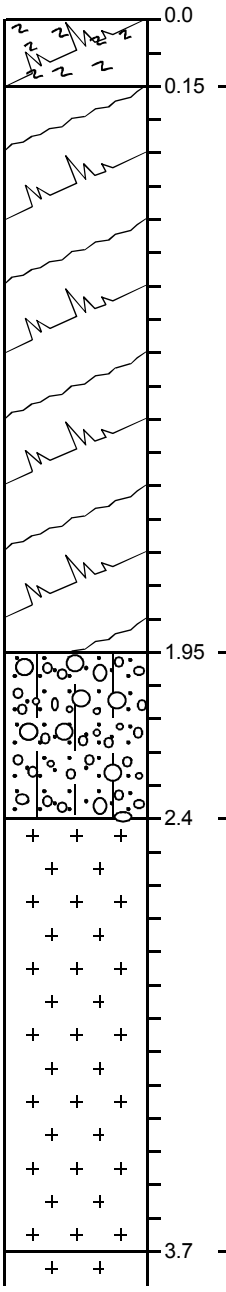
PROFILE SHEET

TP29

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848407
Y -050923



0.0 – 0.15: Very moist, dark black grey, soft, shattered, slickensided, CLAY with many roots. *Topsoil.*

0.15 – 1.95: Very moist, dark black grey, soft becoming firm with depth, shattered, slickensided, CLAY with minor fine and medium calcrete nodules. *Residual gabbro norite.*

1.95 – 2.4: Slightly moist, olive stained brown orange speckled white, dense, SILTY SAND with minor to abundant weathered very soft rock gravels. *Residual gabbro norite.*

2.4 – 3.7: Dark grey stained olive and brown, weathered, medium grained, very closely to medium grained, soft rock. *Gabbro norite.*

NOTES:
1. Bottom of hole at 3,7 m. Not to refusal.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.
1. Bottom of hole at 1,7 m. Not to refusal.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

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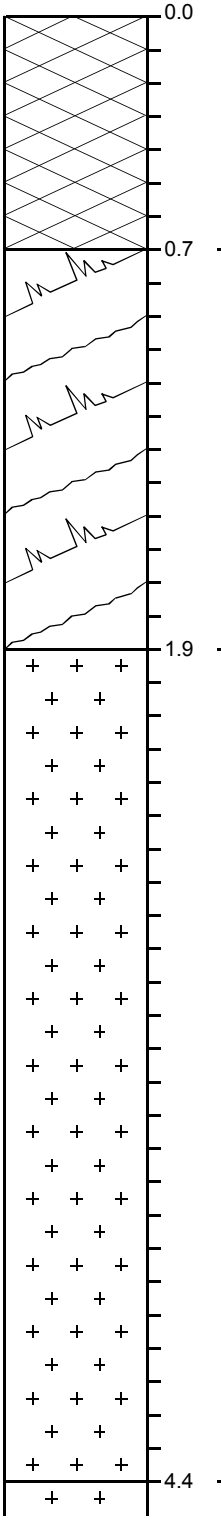
PROFILE SHEET

TP30

Epoch Resources (Pty) Ltd.
Tharisa Minerals Tailings Storage Facilities

X 2848040
Y -050613



0.0 – 0.7: Closely packed, angular and sub-angular, gabbro norite GRAVELS and COBBLES in a matrix of slightly moist, brown dark grey brown, silty and clayey sand. *Fill.*

Overall consistency is dense.

0.7 – 1.9: Very moist, dark black grey, soft to firm, shattered, slickensided, CLAY. *Residual gabbro norite.*

1.9 – 4.4: Dark grey stained olive and light brown, weathered, coarse grained, closely to medium jointed, very soft to medium hard rock. *Gabbro norite.*

NOTES:
1. Bottom of hole at 4,4 m. Refusal.
2. Ground water encountered below 3,6 m. Water standing at 3,6 m after 24 hours.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: MCC
Machine: 0

Profiled by: MC Shuping
Date profiled: 13/06/2011

Water seepage
Standing water
Undisturbed sample
Disturbed sample
Bulk sample
In-situ test

Ref: 0996/g

APPENDIX C

LABORATORY TEST RESULTS

A SANAS accredited testing laboratory No T0062
36/38 Fourth Street, Booysens Reserve, Johannesburg 2091
P O Box 82223, Southdale 2135
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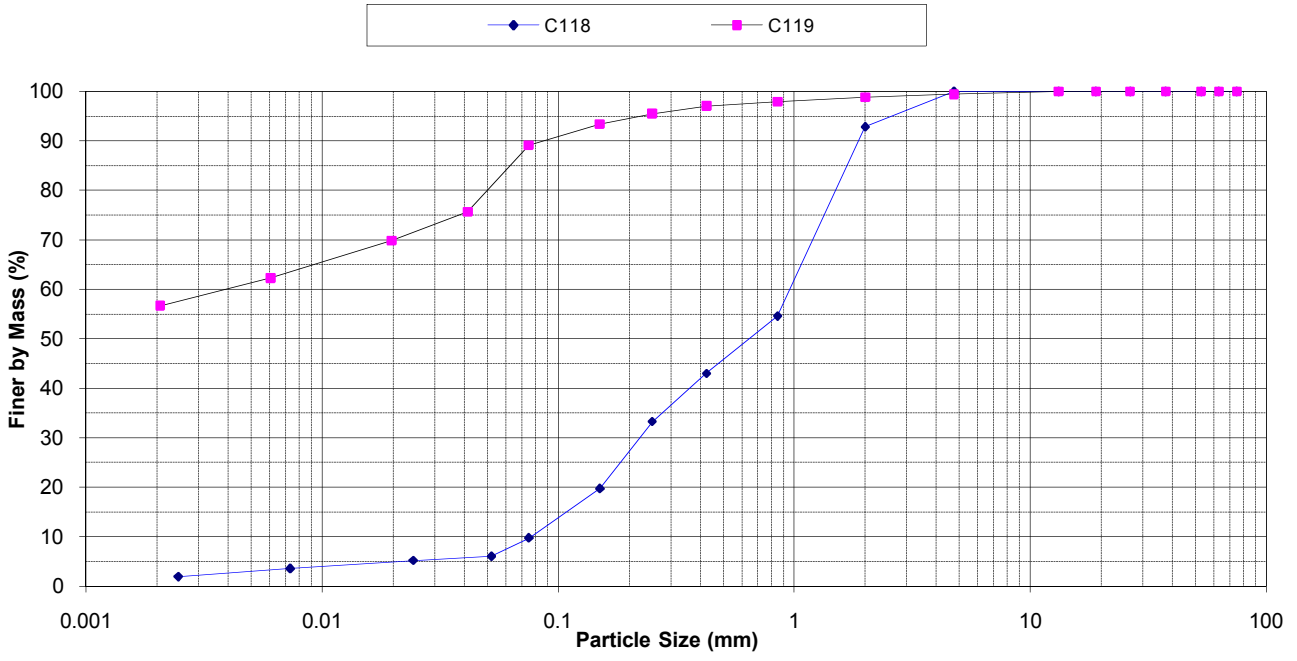
Foundation Indicator Test Data

Project	THARISA MINERALS		
Project No.	1039/F42/04/2011	Date	19 May 2011

Sample No.	C118	C119	
Field Ref. No.	TP 2	TP 4	
Depth	1.6 - 4.0	1.0 - 1.2	
Sieve size	%Passing	% Passing	% Passing
75	100	100	
63	100	100	
53	100	100	
37.5	100	100	
26.5	100	100	
19.0	100	100	
13.2	100	100	
4.75	100	99	
2.00	93	99	
0.85	55	98	
0.425	43	97	
0.250	33	96	
0.150	20	93	
0.075	10	89	
0.04	6	75	
0.02	5	70	
0.006	3	62	
0.002	2	57	

Sample No.	C118	C119	
%Gravel	7	1	
%Sand	85	15	
%Silt	6	28	
%Clay	2	57	
NMC %	Not Tested	Not Tested	
Liquid Limit	NP	63	
Plasticity Index	NP	34	
Linear Shrink.	0.	17.5	
Overall P.I.	NP	33	
Grading Modulus	1.54	0.15	
H.R.B.	A-1-b (0)	A-7-6 (20)	
Unified	SP-SM	CH	
Weston swell (%) at 1 kPa			

Analysis as per method D422 of ASTM of 1985
The results reported relate only to the samples tested.



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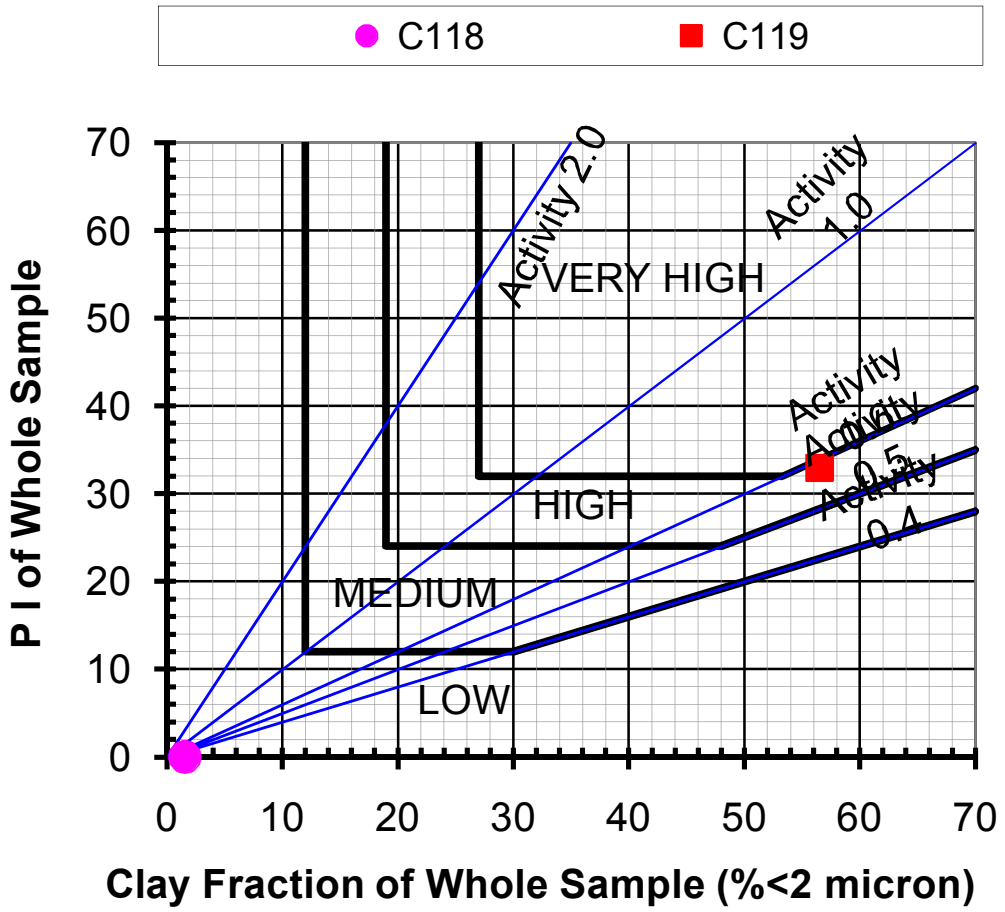
Activity Diagram After D H van der Merwe



Plotted Values:

Sample	Clay Frac	PI
C118	1.6	#VALUE!
C119	56.5	32.9

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Foundation Indicator Test Data

Project	THARISA MINERALS		
Project No.	1039/F42/04/2011	Date	19 May 2011

Sample No.	C120	C120A	C121
Field Ref. No.	TP 6	TP 6	TP 6
Depth	1.0 - 1.2	1.0 - 1.2	4.7 - 5.1
Sieve size	%Passing	% Passing	% Passing
75	100	100	100
63	100	100	100
53	100	100	100
37.5	100	100	100
26.5	100	100	100
19.0	100	100	100
13.2	100	100	100
4.75	100	100	77
2.00	100	100	52
0.85	99	99	27
0.425	99	99	17
0.250	98	98	12
0.150	97	97	7
0.075	96	95	5
0.04	87	87	3
0.02	83	83	2
0.006	74	73	2
0.002	68	67	1

Sample No.	C120	C120A	C121
%Gravel	0	0	48
%Sand	7	7	48
%Silt	25	25	3
%Clay	68	67	1
NMC %	Not Tested	Not Tested	Not Tested
Liquid Limit	60	63	SP
Plasticity Index	32	34	SP
Linear Shrink.	15.	15.	1.
Overall P.I.	31	33	SP
Grading Modulus	0.06	0.06	2.25
H.R.B.	A-7-6 (20)	A-7-6 (20)	A-1-b (0)
Unified	CH	CH	SW-SM
Weston swell (%) at 1 kPa			

Analysis as per method D422 of ASTM of 1985
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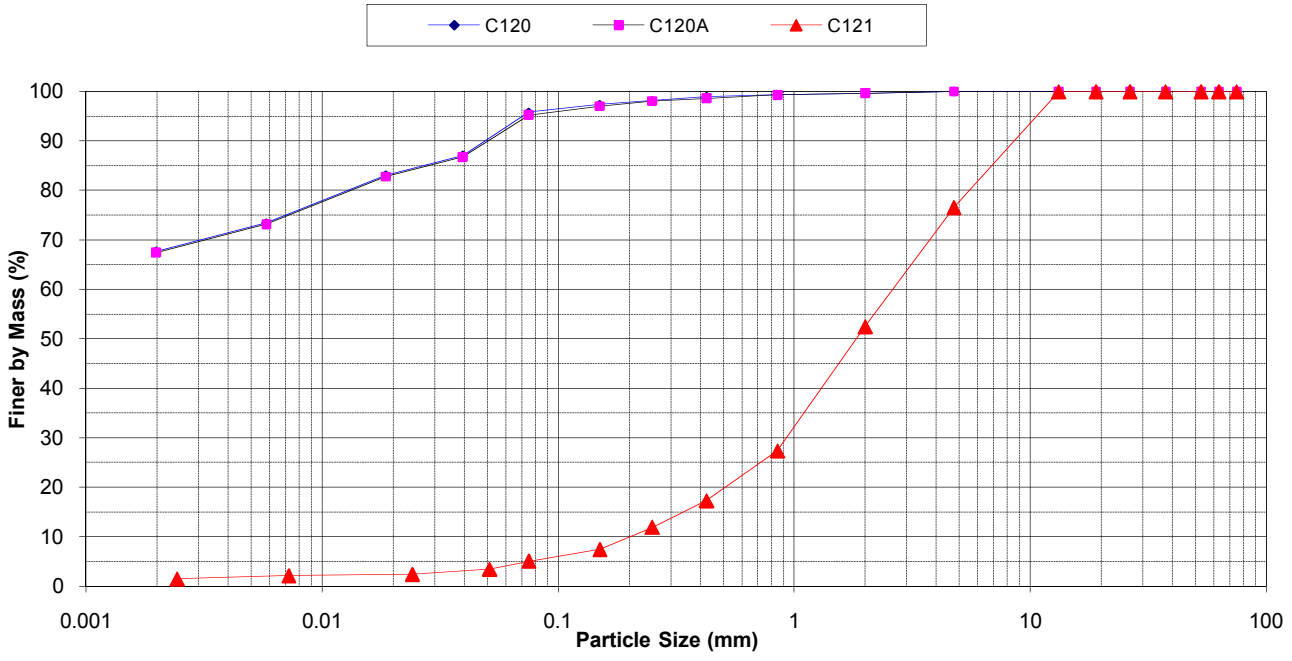

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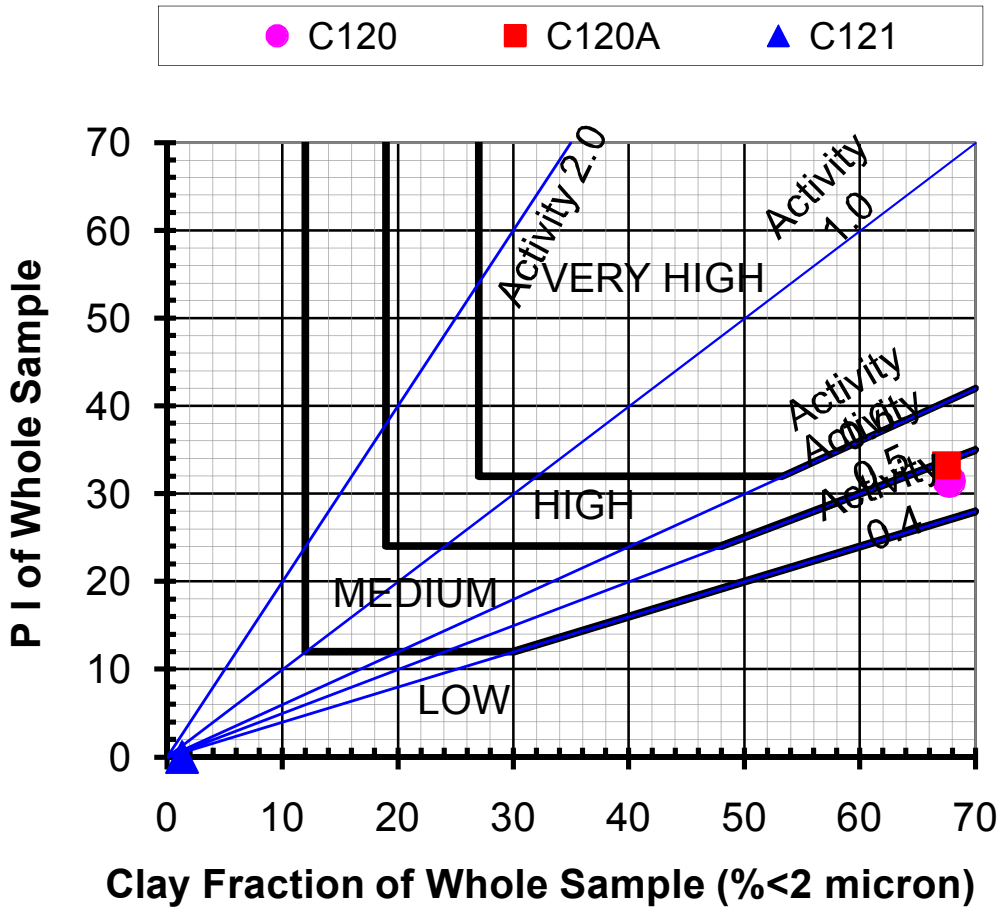

Plotted Values:

Sample	Clay Frac	PI
C120	67.7	31.4
C120A	67.5	33.2
C121	1.3	#VALUE!

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Foundation Indicator Test Data

Project	THARISA MINERALS		
Project No.	1039/F42/04/2011	Date	1 June 2011

Sample No.	C122	C123	
Field Ref. No.	TP 9	TP 10	
Depth	4.5 - 4.7	4.0 - 4.2	
Sieve size	%Passing	% Passing	% Passing
75	100	100	
63	100	100	
53	100	100	
37.5	100	100	
26.5	100	100	
19.0	100	100	
13.2	100	100	
4.75	100	99	
2.00	100	99	
0.85	100	98	
0.425	100	97	
0.250	99	96	
0.150	98	94	
0.075	97	91	
0.04	84	76	
0.02	75	73	
0.006	69	67	
0.002	64	64	

Sample No.	C122	C123	
%Gravel	0	1	
%Sand	8	13	
%Silt	28	22	
%Clay	64	64	
NMC %	Not Tested	Not Tested	
Liquid Limit	105	98	
Plasticity Index	72	64	
Linear Shrink.	22.	20.	
Overall P.I.	72	62	
Grading Modulus	0.04	0.13	
H.R.B.	A-7-5 (20)	A-7-5 (20)	
Unified	CH	CH	
Weston swell (%) at 1 kPa			

Analysis as per method D422 of ASTM of 1985
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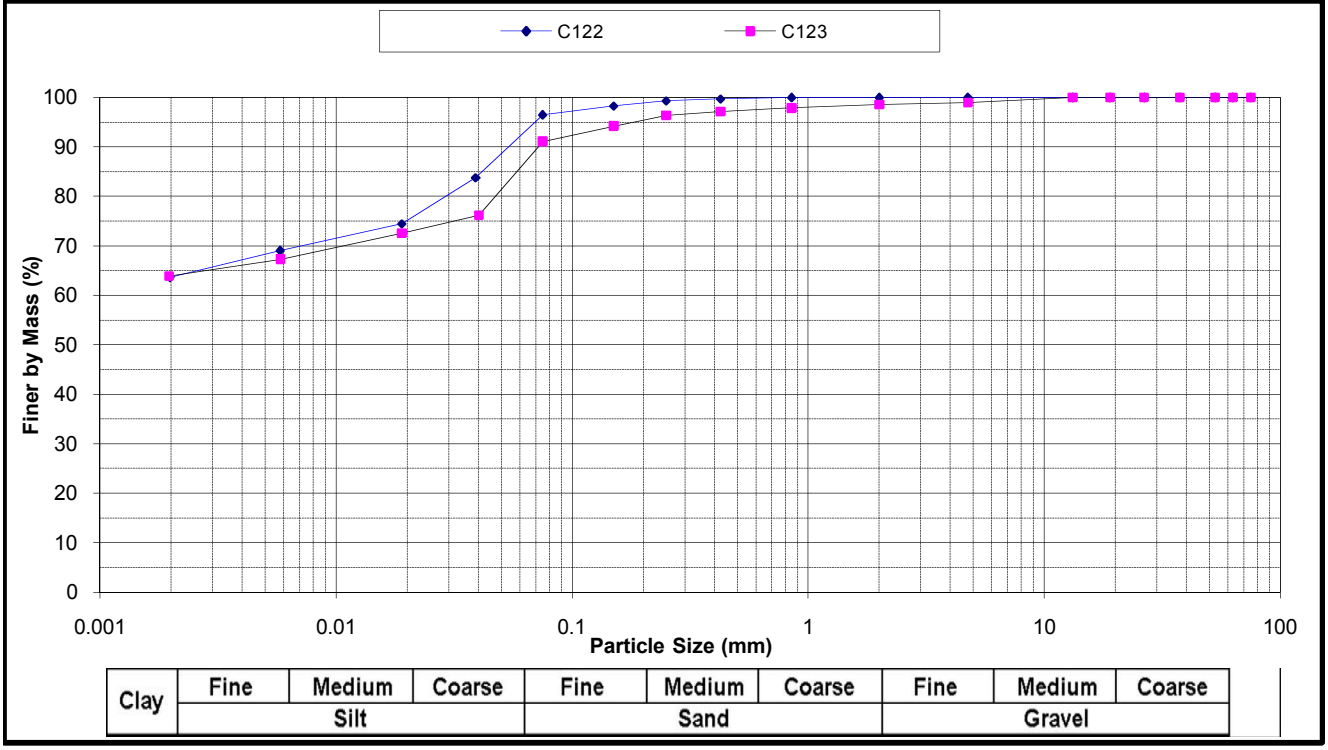

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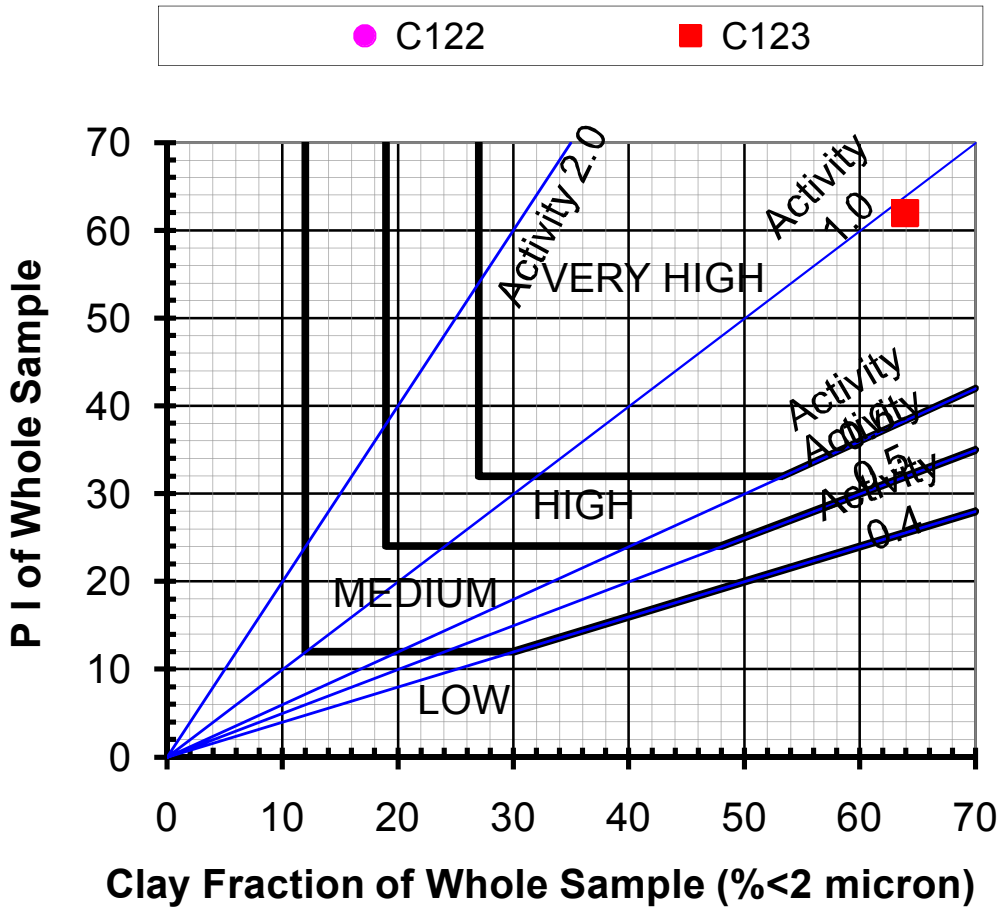

Plotted Values:

Sample	Clay Frac	PI
C122	63.7	71.9
C123	63.9	61.9

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Foundation Indicator Test Data

Project	THARISA MINERALS		
Project No.	1039/F42/04/2011	Date	1 June 2011

Sample No.	C124	C125	
Field Ref. No.	TP 14	TP 19	
Depth	4.0 - 4.2	1.2 - 3.4	
Sieve size	%Passing	% Passing	% Passing
75	100	100	
63	100	100	
53	100	100	
37.5	100	100	
26.5	100	100	
19.0	100	100	
13.2	95	97	
4.75	90	74	
2.00	88	56	
0.85	87	26	
0.425	86	15	
0.250	86	10	
0.150	85	6	
0.075	83	4	
0.04	71	2	
0.02	65	2	
0.006	58	1	
0.002	52	1	

Sample No.	C124	C125	
%Gravel	12	44	
%Sand	9	53	
%Silt	27	2	
%Clay	52	1	
NMC %	Not Tested	Not Tested	
Liquid Limit	93	NP	
Plasticity Index	58	NP	
Linear Shrink.	20.5	0.	
Overall P.I.	50	NP	
Grading Modulus	0.43	2.25	
H.R.B.	A-7-5 (20)	A-1-b (0)	
Unified	CH	SW	
Weston swell (%) at 1 kPa			

Analysis as per method D422 of ASTM of 1985
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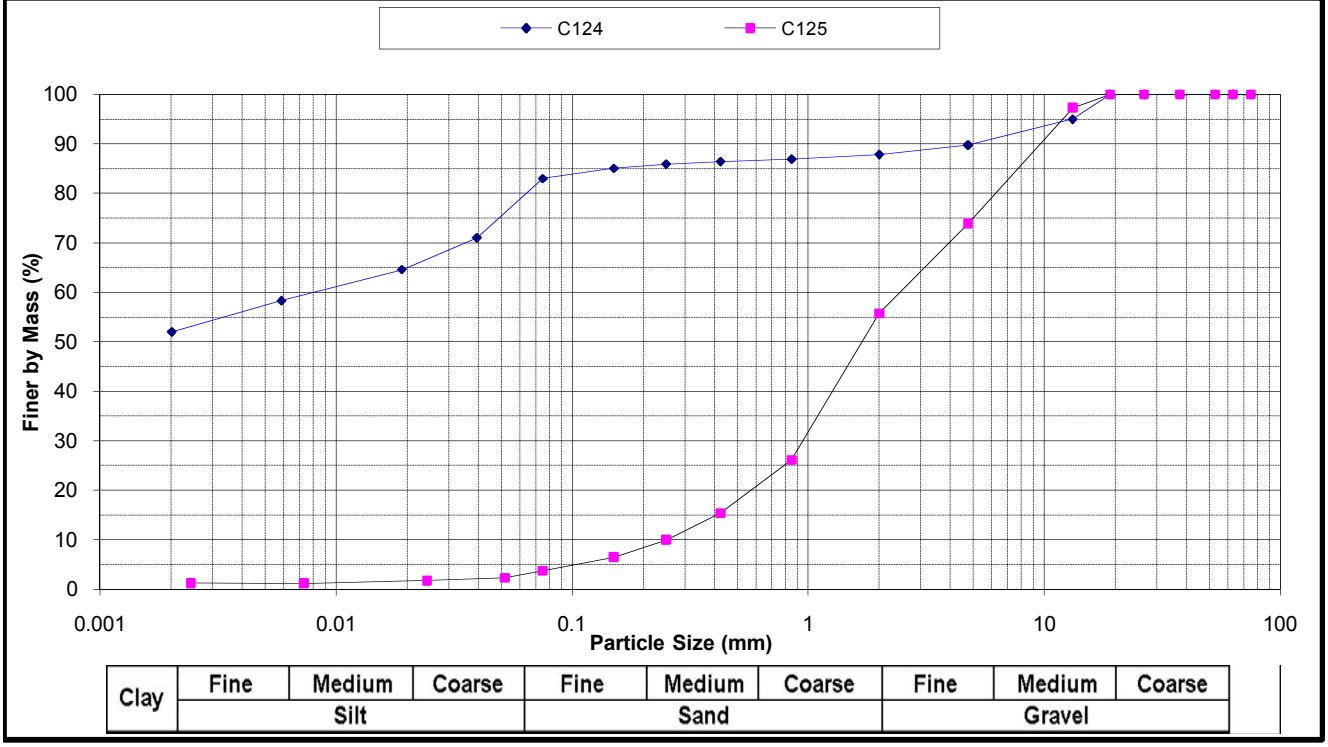

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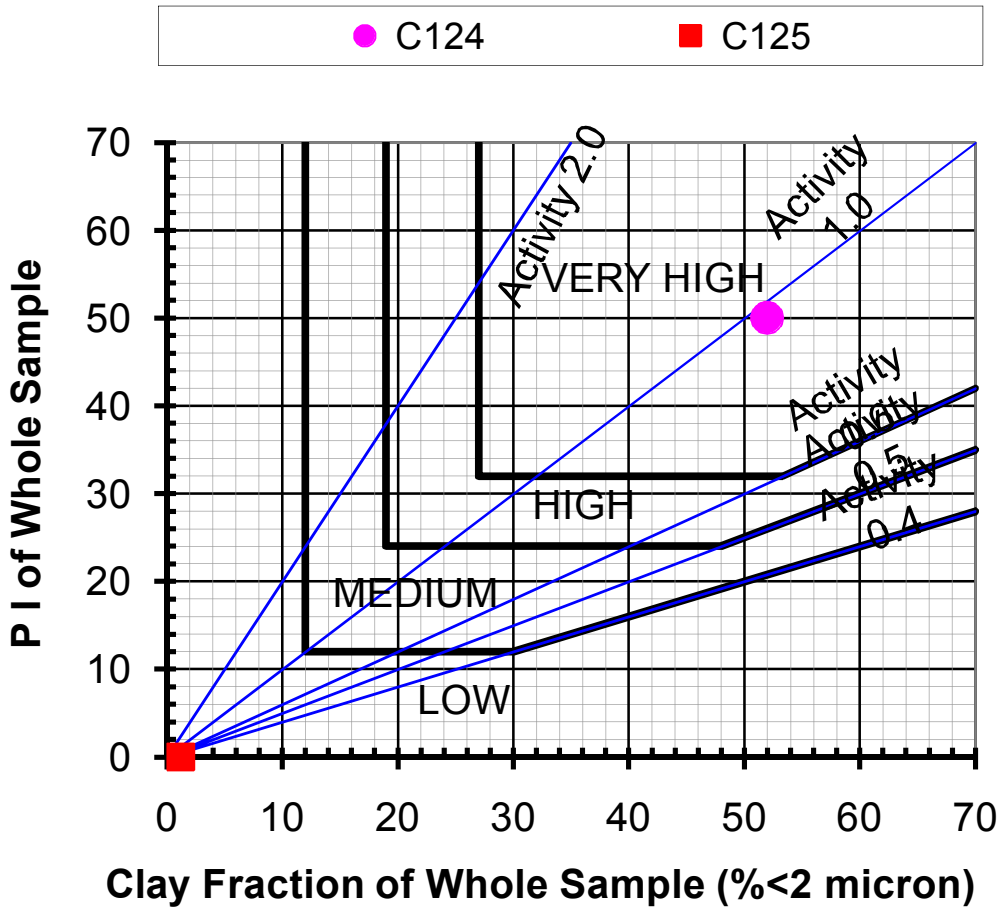

Plotted Values:

Sample	Clay Frac	PI
C124	52.0	50.0
C125	1.2	#VALUE!

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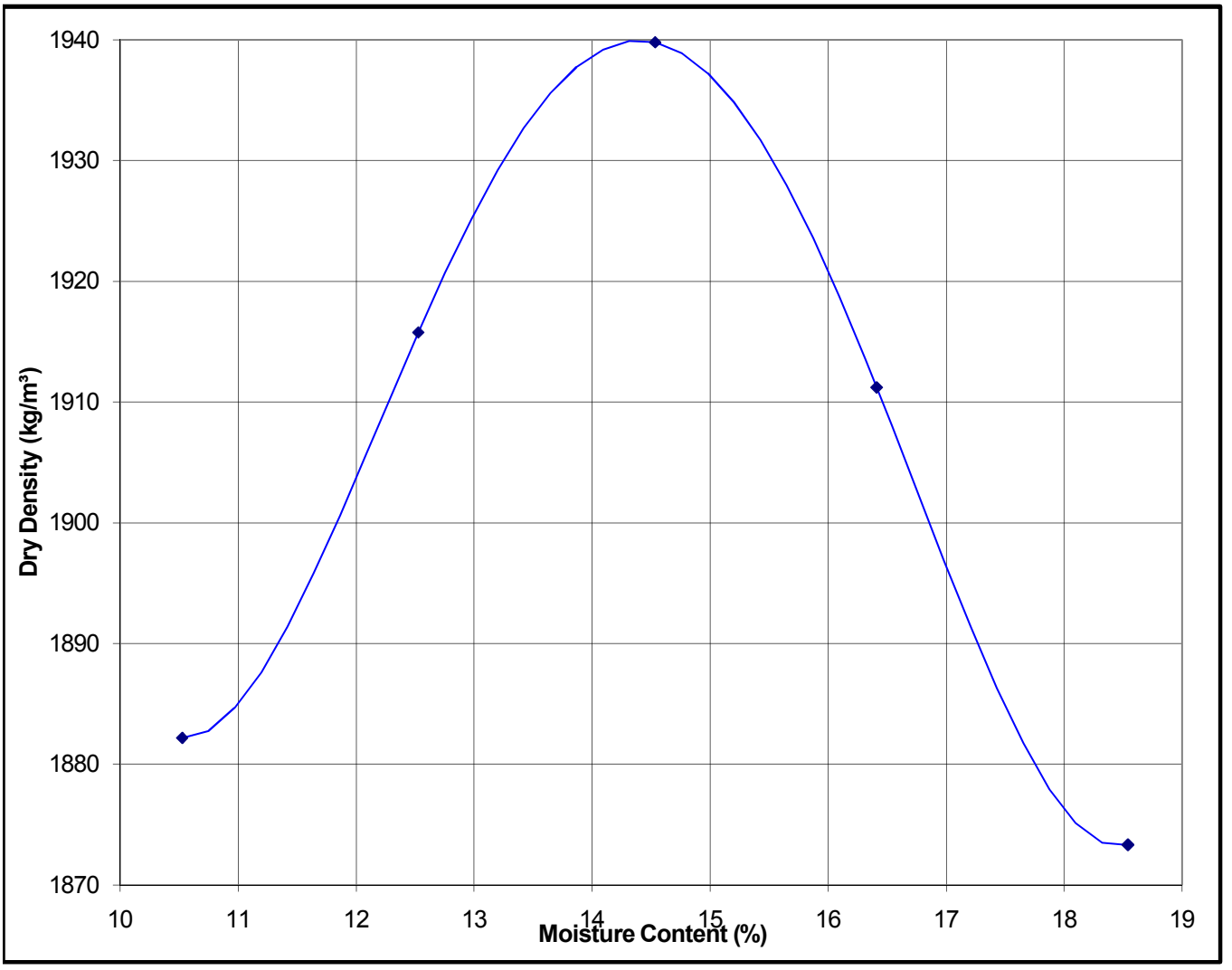
Moisture Density Relationship

Project:	THARISA MINERALS		
Project No.:	1039/F42/04/2011	Date:	20 April 2011
Field Reference:	TP 2	Laboratory Ref.:	C118
Depth (m):	1.6 - 4.0	Remarks:	Untreated
Description:	-		

Compactive Effort: **STD PROCTOR**

Percent Water Content (%):	16.4	18.5	14.5	12.5	10.5				
Dry Density (kg/m^3):	1911	1873	1940	1916	1882				

Maximum Dry Density:	**1940 kg/m^3**	**Optimum Moisture Content:**	**14.3 %**



Analysis according to Method A7 of TMH1 of 1986.
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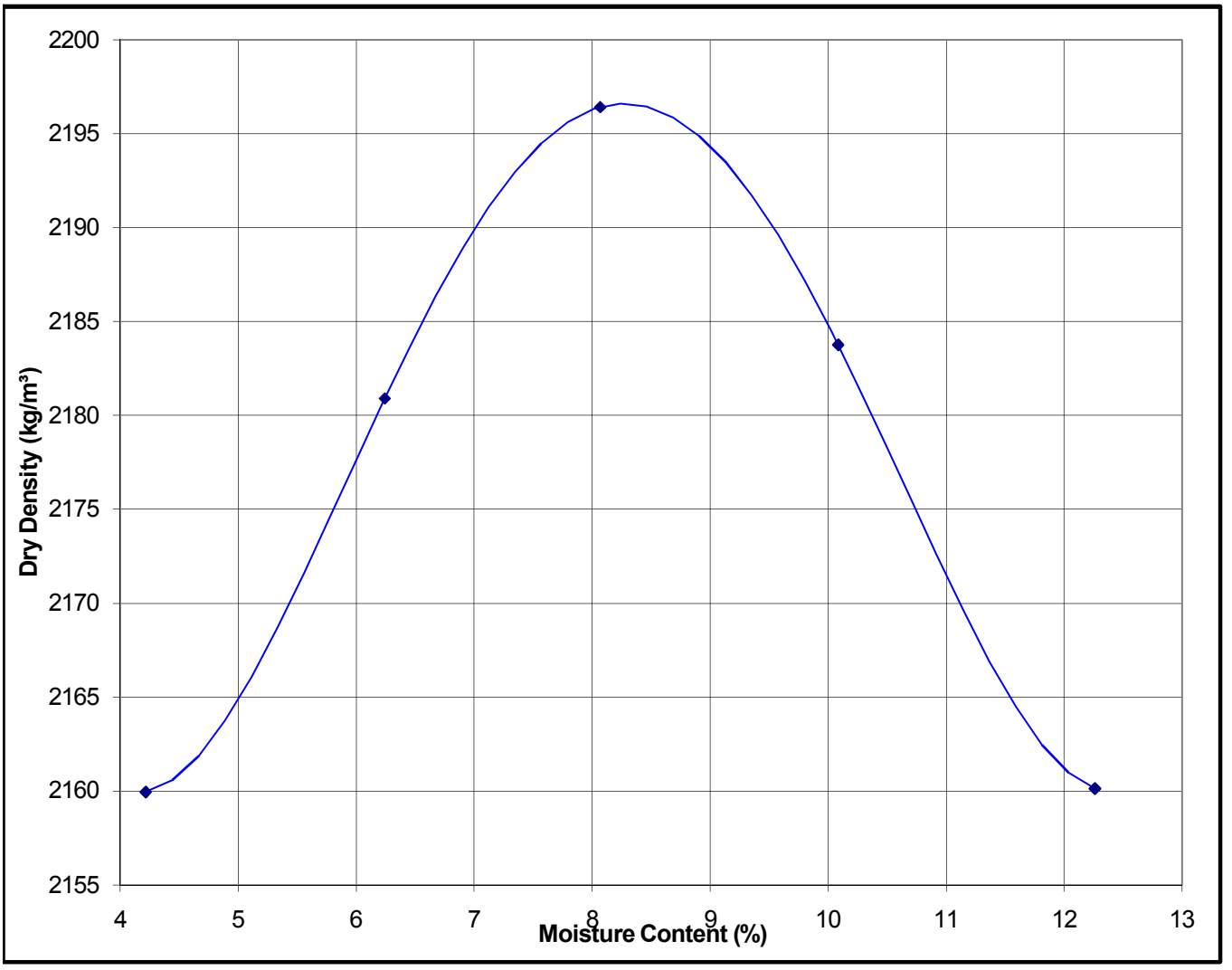
Moisture Density Relationship

Project:	THARISA MINERALS		
Project No.:	1039/F42/04/2011	Date:	20 April 2011
Field Reference:	TP 6	Laboratory Ref.:	C121
Depth (m):	4.7 - 5.1	Remarks:	Untreated
Description:	-		

Compactive Effort: **STD PROCTOR**

Percent Water Content (%):	8.1	10.1	6.2	4.2	12.3				
Dry Density (kg/m^3):	2196	2184	2181	2160	2160				

Maximum Dry Density:	**2197 kg/m^3**	**Optimum Moisture Content:**	**8.2 %**



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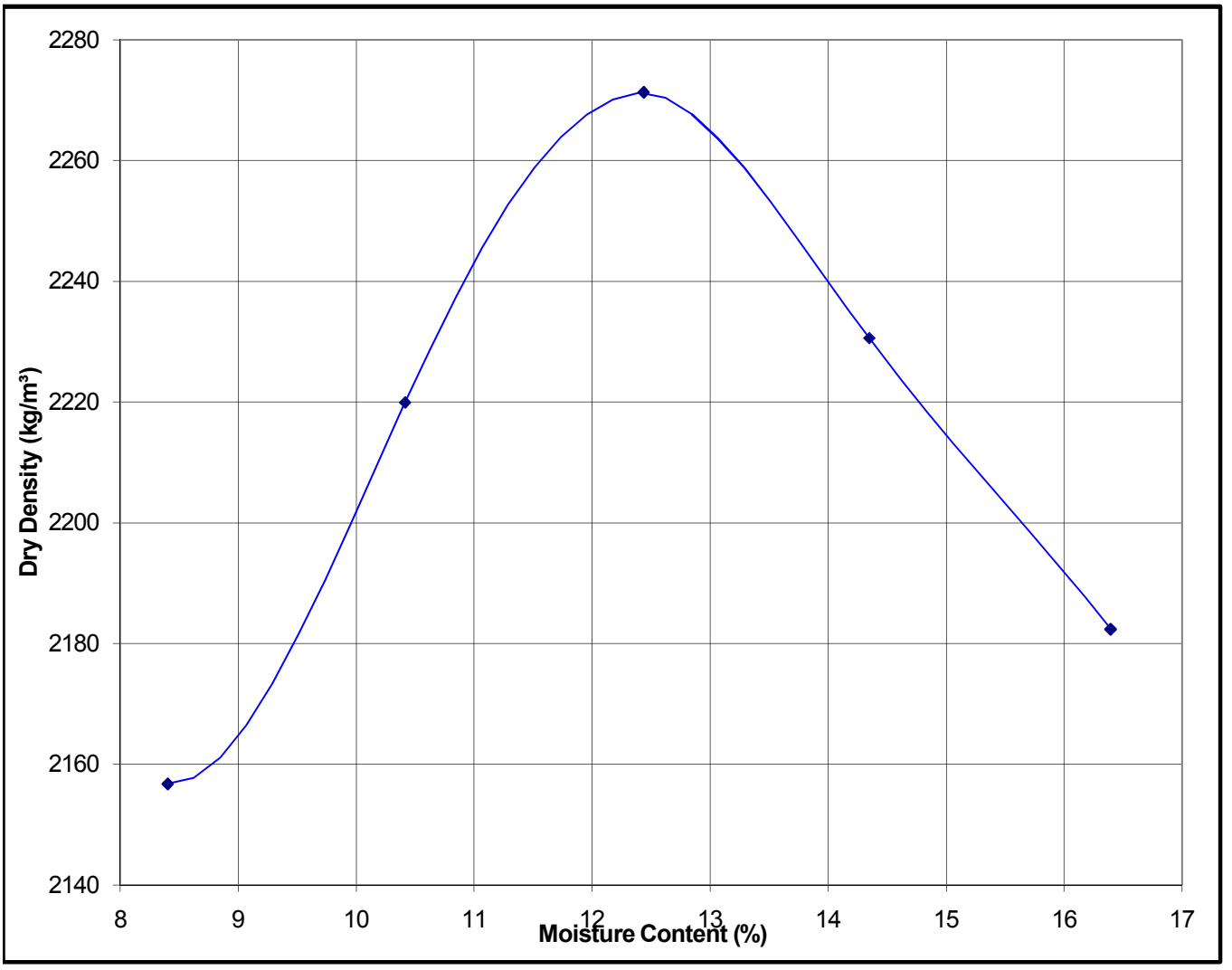
Moisture Density Relationship

Project:	THARISA MINERALS		
Project No.:	1039/F42/04/2011	Date:	20 April 2011
Field Reference:	TP 19	Laboratory Ref.:	C125
Depth (m):	1.2 - 3.4	Remarks:	Untreated
Description:	-		

Compactive Effort: **STD PROCTOR**

Percent Water Content (%):	10.4	12.4	14.3	8.4	16.4				
Dry Density (kg/m^3):	2220	2271	2231	2157	2182				

Maximum Dry Density:	**2271 kg/m^3**	**Optimum Moisture Content:**	**12.4 %**



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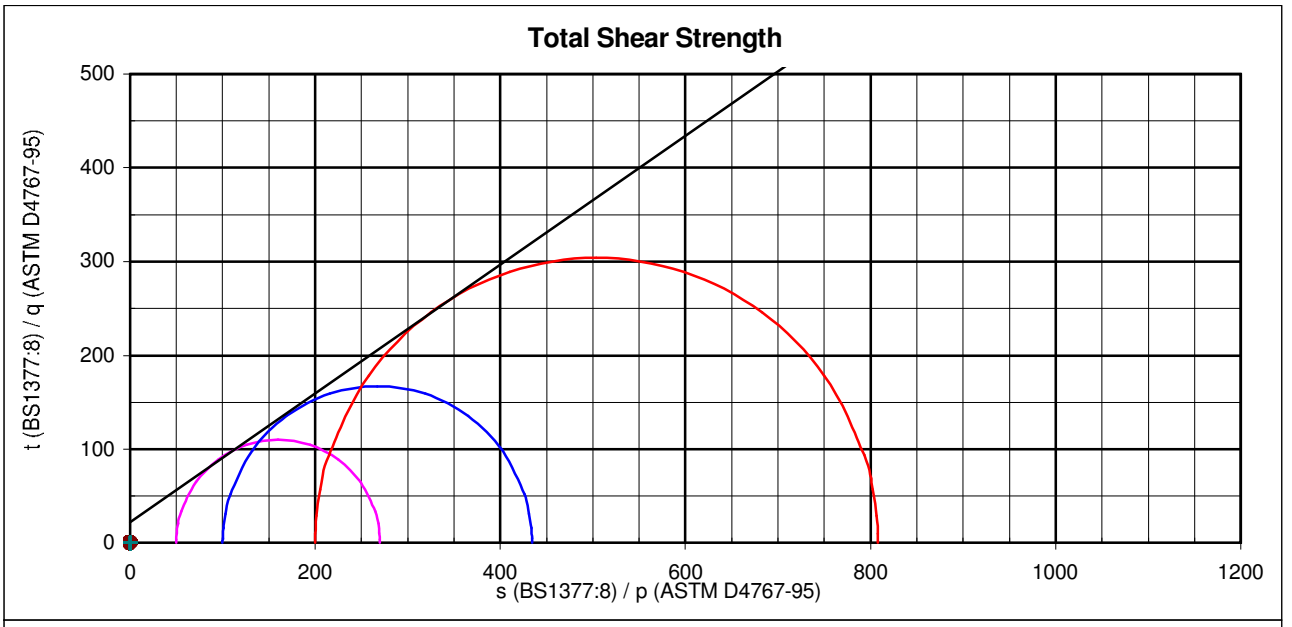
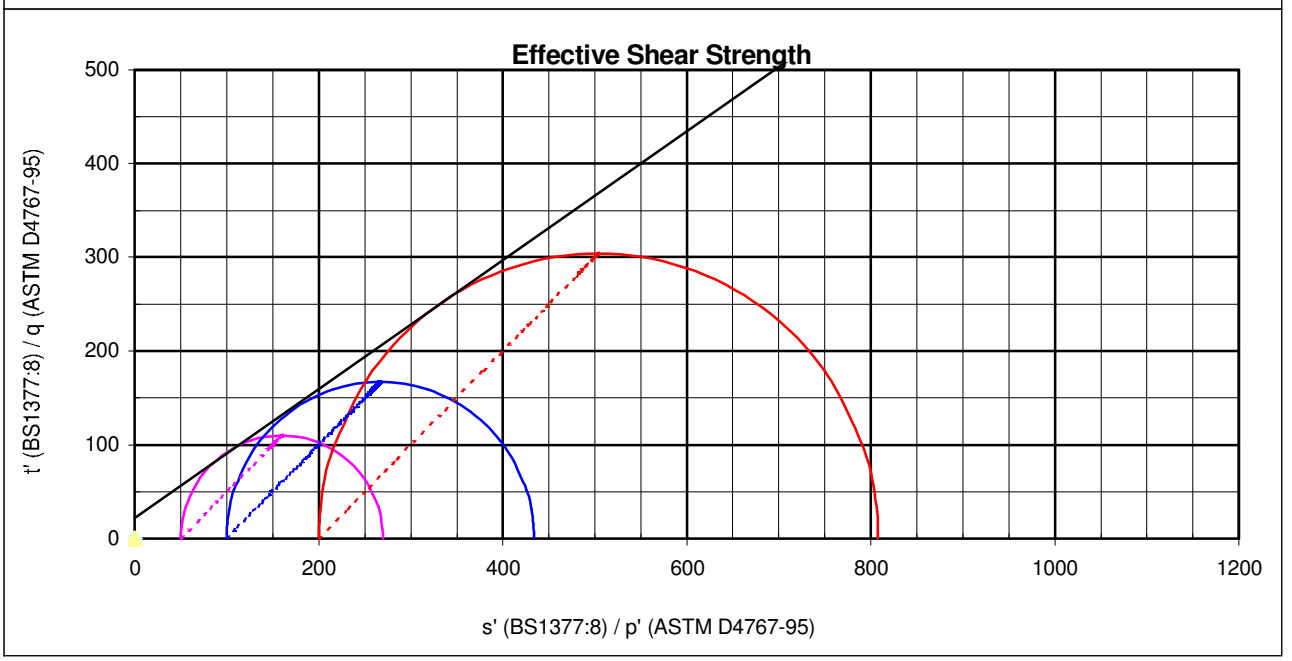
Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	01/06/2011
Proj.No.:	1039/F42/04/2011	Laboratory Number:	C118
Field Sample Reference:	TP 2	Depth (m):	1.6 - 4.0

Mohr Stress Circles

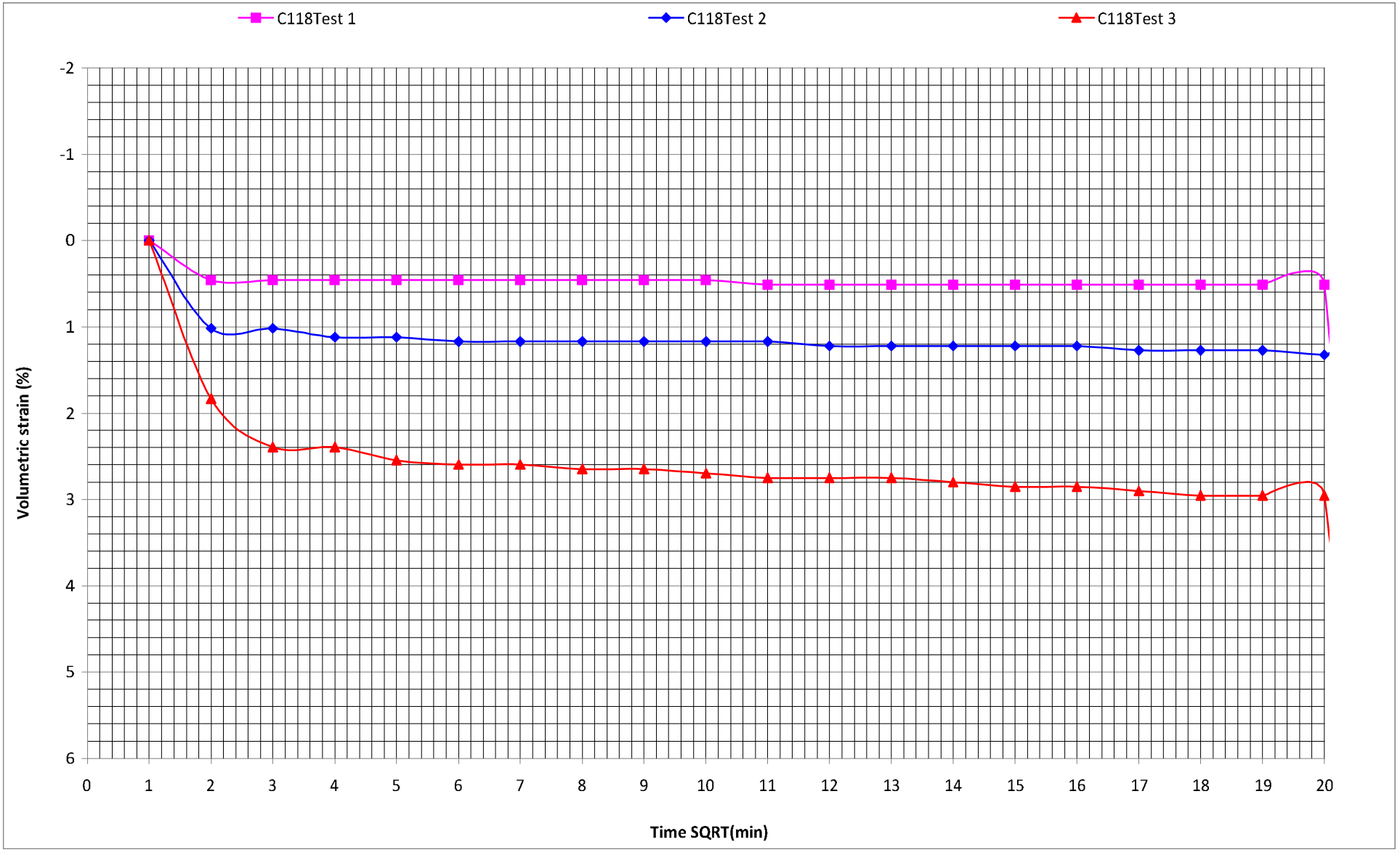
	COHESION (kPa)	FRICTION ANGLE
TOTAL STRESSES	22	35
EFFECTIVE STRESSES	22	35





A Consolidated Drained test on a remoulded sample tested saturated.

Consolidation vs. Square Root Time



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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**01/06/2011**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C118**
Field Sample Number:	**TP 2**	Depth (m):	**1.6 - 4.0**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks: A Consolidated Drained test on a remoulded sample tested saturated.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	550.0	Final back pressure (kPa): 540.0	Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 50.0 t100 (minutes): 0 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 100.00	* 50.00	1963.50	14.6	1.820	0.6827	65	3.062 Determined
CONSOLIDATED	99.83	49.92	1956.83	19.1	1.829	0.6741	87	
FINAL (After shear)	82.06	54.52	2334.27	17.9	1.865	0.6416	85	

Initial pore pressure (kPa): 580.5 Final pore pressure (kPa): 541.4 Pore pressure dissipation: 97%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 9

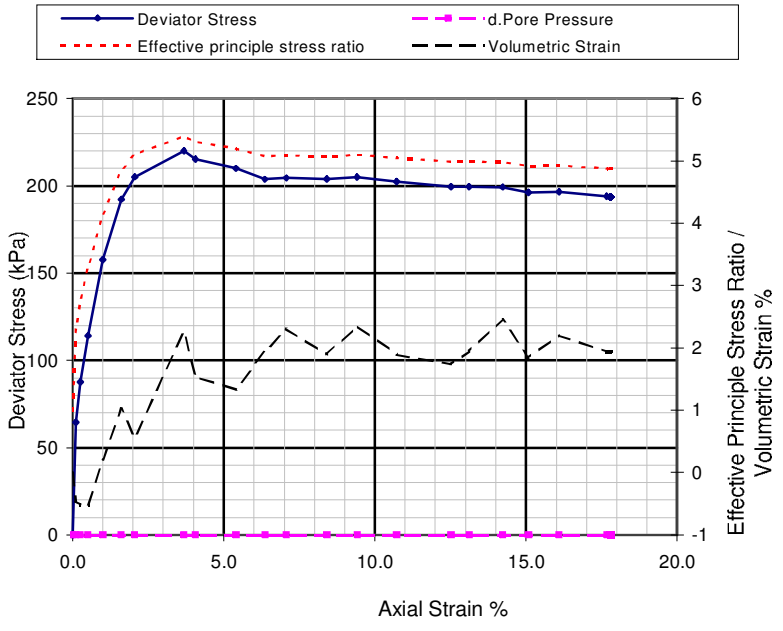
Initial pore pressure (kPa): 541.4 Initial effective stress (kPa): 50.0

Failure Criterion: **Max. Deviator Stress**

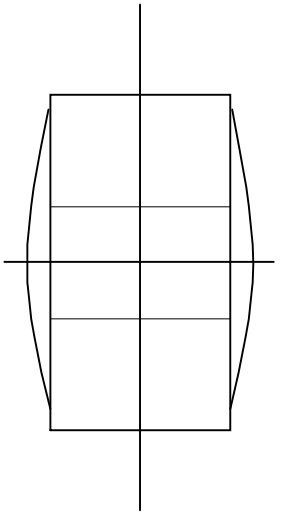
Axial strain (%):	3.68	Volumetric strain (%):	2.25		
Deviator stress (kPa):	219.9	Principle Stresses (kPa)			
Excess pore pressure (kPa):	0.0	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	5.399	269.9	269.9	50.0	50.0

Deviator stress corrections: Membrane correction: 1.14 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure



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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**1900/01/00**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C118**
Field Sample Number:	**TP 2**	Depth (m):	**1.6 - 4.0**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks: A Consolidated Drained test on a remoulded sample tested saturated.

Test No. 2

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	550.0	Final back pressure (kPa): 540.0	Final B parameter: 0.99

CONSOLIDATION DATA

Effective cons. Stress (kPa): 100.0 t100 (minutes): 0 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 100.00	* 50.00	1963.50	15.6	1.813	0.6888	69	3.062 Determined
CONSOLIDATED	99.56	49.78	1946.16	20.0	1.837	0.6665	92	
FINAL (After shear)	79.58	55.64	2431.52	19.7	1.840	0.6642	91	

Initial pore pressure (kPa): 637.1 Final pore pressure (kPa): 545.1 Pore pressure dissipation: 95%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

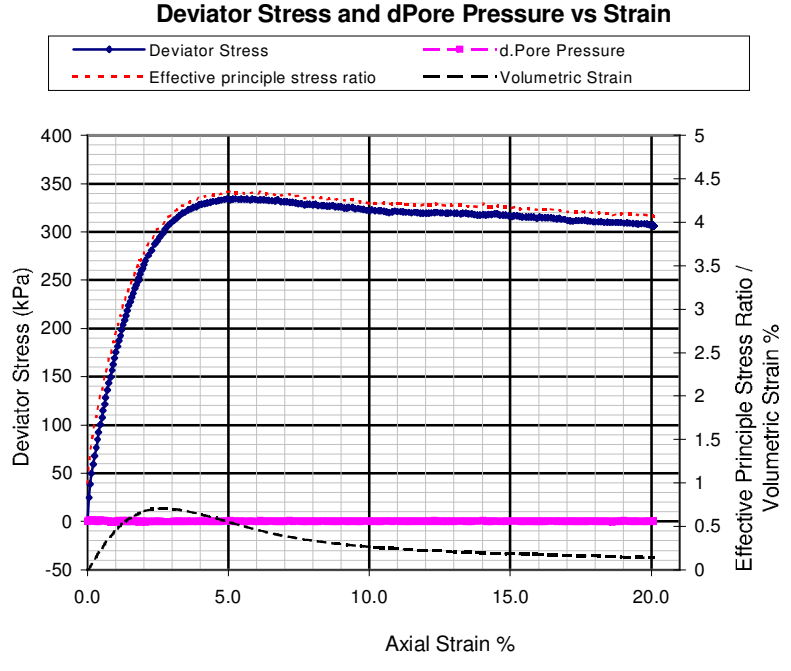
Rate of strain (%/hour): 9

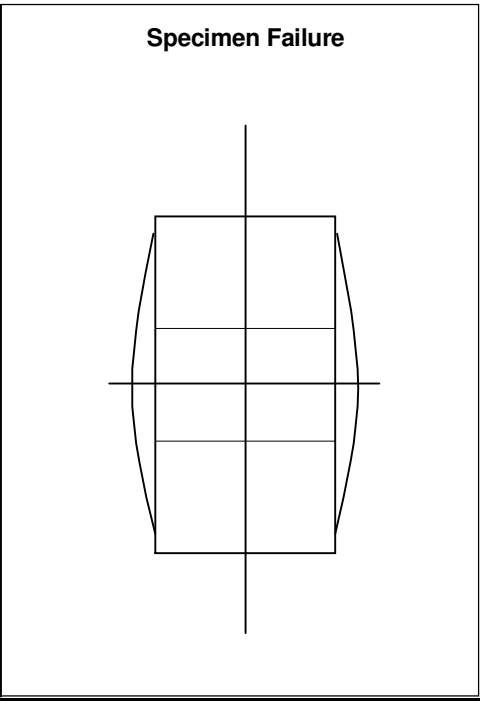
Initial pore pressure (kPa): 543.1 Initial effective stress (kPa): 100.0

Failure Criterion: **Max. Deviator Stress**

Axial strain (%):	4.96	Volumetric strain (%):	0.56		
Deviator stress (kPa):	334.2	Principle Stresses (kPa)			
Excess pore pressure (kPa):	0.2	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	4.349	434.2	433.9	100.0	99.8

Deviator stress corrections: Membrane correction: 1.14 kPa





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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**1900/01/00**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C118**
Field Sample Number:	**TP 2**	Depth (m):	**1.6 - 4.0**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,8

Remarks: A Consolidated Drained test on a remoulded sample tested saturated.

Test No. 3

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	550.0	Final back pressure (kPa): 540.0	Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 200.0 t100 (minutes): 0 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 100.00	* 50.00	1963.50	15.6	1.803	0.6979	69	3.062 Determined
CONSOLIDATED	99.02	49.51	1924.83	14.9	1.858	0.6477	70	
FINAL (After shear)	78.84	57.96	2638.30	19.8	1.702	0.7986	76	

Initial pore pressure (kPa): 733.5 Final pore pressure (kPa): 544.1 Pore pressure dissipation: 98%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 9

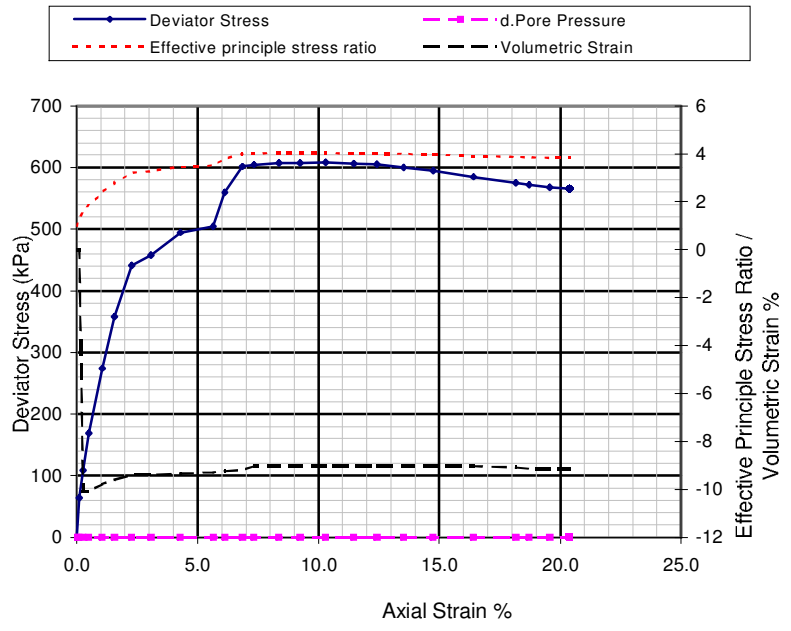
Initial pore pressure (kPa): 544.1 Initial effective stress (kPa): 200.0

Failure Criterion: **Max. Deviator Stress**

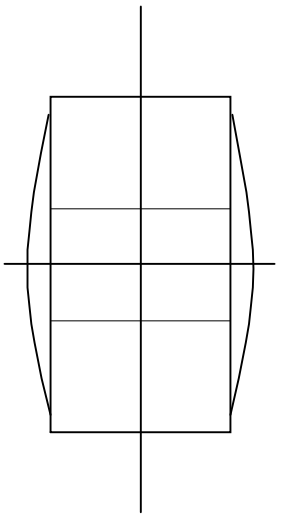
Axial strain (%):	10.30	Volumetric strain (%):	-9.03		
Deviator stress (kPa):	607.9	Principle Stresses (kPa)			
Excess pore pressure (kPa):	0.0	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	4.040	807.9	807.9	200.0	200.0

Deviator stress corrections: Membrane correction: 1.14 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure



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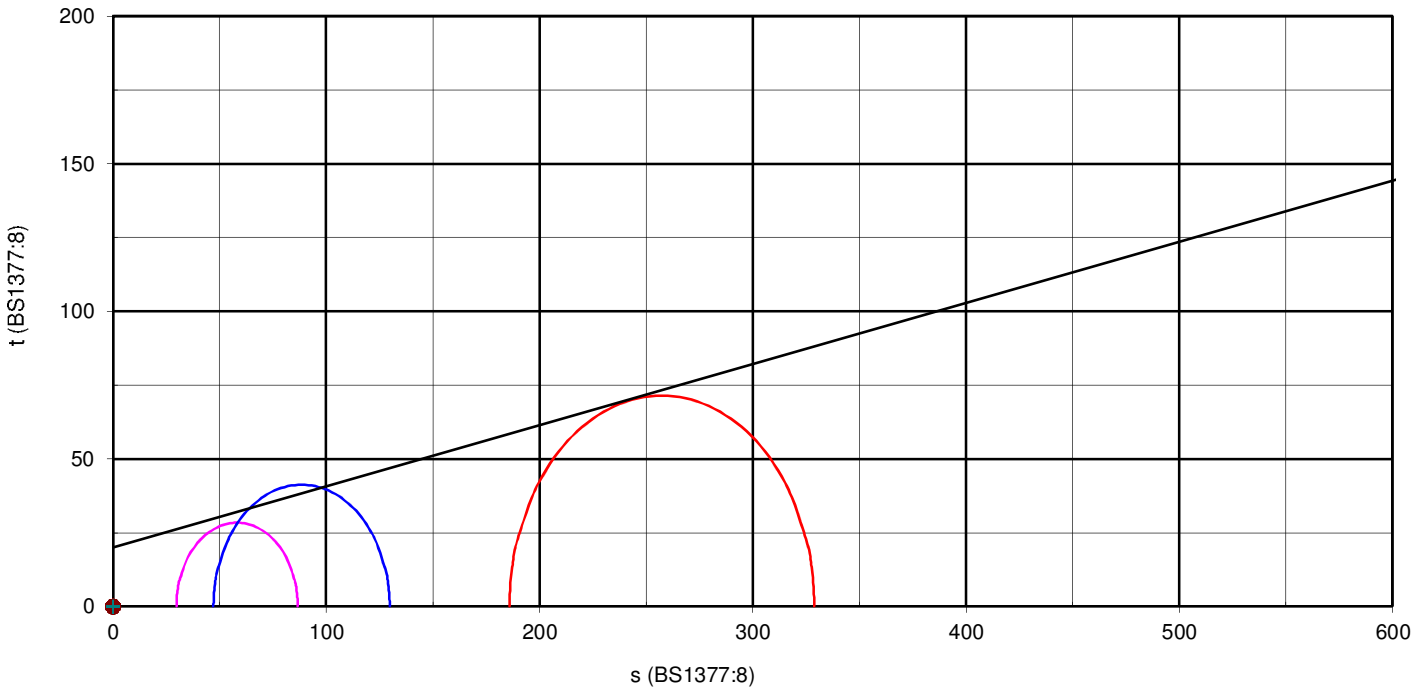
Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	17/06/2011
Proj.No.:	F42/04/11	Laboratory Number:	C119
Field Sample Reference:	TP 4	Depth (m):	1.0-1.2

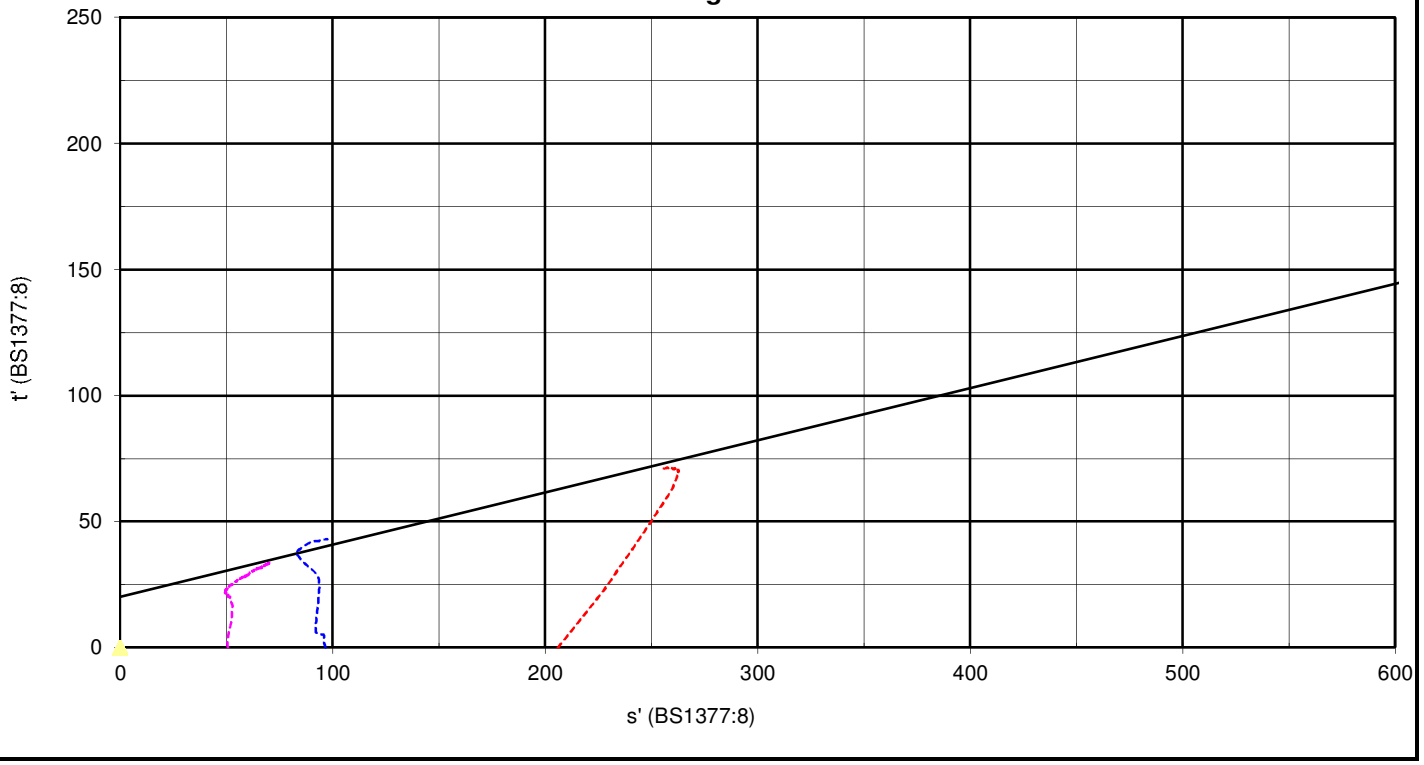
Effective Shear Strength

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	11.6	12.5
Effective	20.1	11.7

Effective Shear Strength - Mohr circles at failure



Effective Shear Strength - Stress Paths



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Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	17/06/2011
Batch No.:	F42/04/11	Laboratory Number:	C119
Field Sample Number:	TP 4	Depth (m):	1.0-1.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	357.0	Final back pressure (kPa):	347.0	Final B parameter:	0.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 50.7 t100 (minutes): 10.24 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100	*50	1963.50	35.6	1240	1.1369	83	2.65 Determined
CONSOLIDATED	99.49	49.74	1943.50	39.4	1259	1.1042	95	
FINAL (After shear)	79.50	55.65	2432.06	39.4	1259	1.1043	95	

Initial pore pressure (kPa): 383.7 Final pore pressure (kPa): 345.1 Pore pressure dissipation: 88%

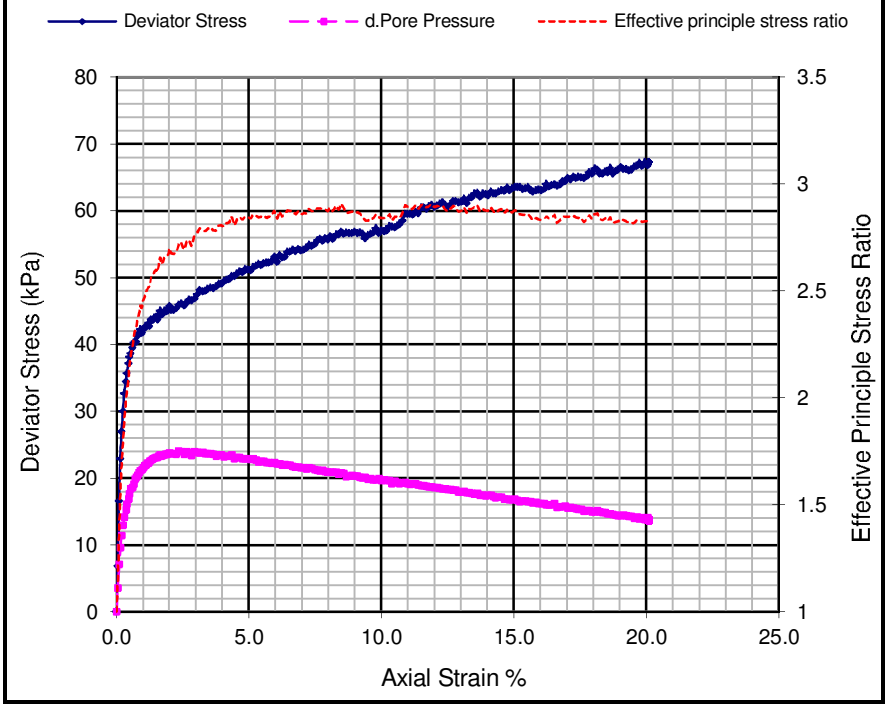
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	9				
Initial pore pressure (kPa):	346.3	Initial effective stress (kPa):	50.7		
Parameters at failure:					
Failure Criterion:	Max. Effective Principle Stress Ratio				
Axial strain (%):	8.49				
Deviator stress (kPa):	56.9	Principle Stresses (kPa)			
Excess pore pressure (kPa):	20.8	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.907	107.5	86.7	50.7	29.8

Deviator stress corrections: Membrane correction: 1.1 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure

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Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	17/06/2011
Batch No.:	F42/04/11	Laboratory Number:	C119
Field Sample Number:	TP 4	Depth (m):	1.0-1.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 2

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	357.0	Final back pressure (kPa):	347.0	Final B parameter:	0.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 96.7 t100 (minutes): 7.02 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100	*50	1963.50	33.7	1259	1.1040	81	2.65 Determined
CONSOLIDATED	98.74	49.37	1914.16	37.0	1309	1.0247	96	
FINAL (After shear)	78.44	55.39	2409.52	37.0	1308	1.0254	96	

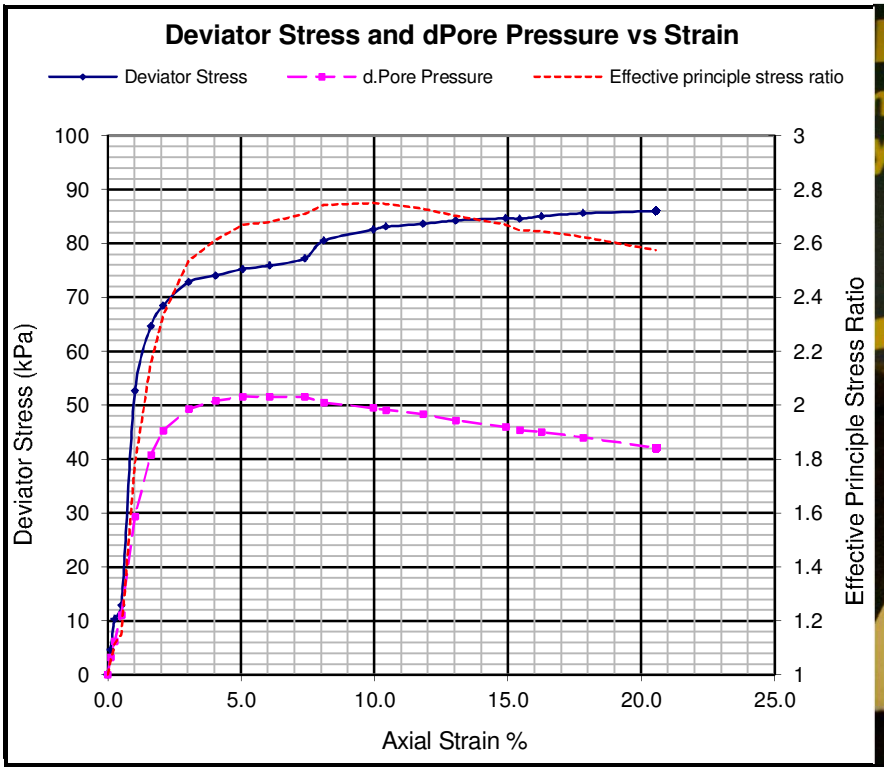
Initial pore pressure (kPa): 434.0 Final pore pressure (kPa): 345.0 Pore pressure dissipation: 95%

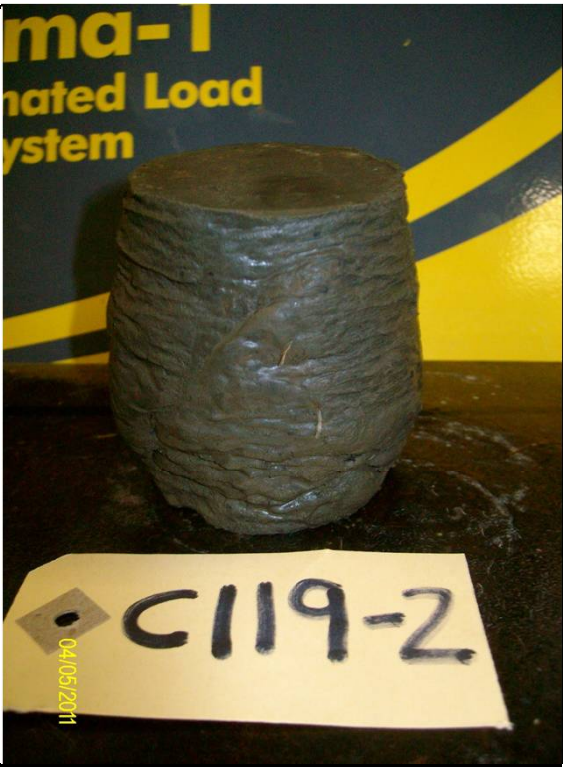
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	9				
Initial pore pressure (kPa):	350.3	Initial effective stress (kPa):	96.7		
Parameters at failure:					
Failure Criterion:	Max. Effective Principle Stress Ratio				
Axial strain (%):	9.97				
Deviator stress (kPa):	82.6	Principle Stresses (kPa)			
Excess pore pressure (kPa):	49.5	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.750	179.3	129.8	96.7	47.2

Deviator stress corrections: Membrane correction: 1.1 kPa





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Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	17/06/2011
Batch No.:	F42/04/11	Laboratory Number:	C119
Field Sample Number:	TP 4	Depth (m):	1.0-1.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 3

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	357.0	Final back pressure (kPa):	347.0	Final B parameter:	0.00

CONSOLIDATION DATA

Effective cons. Stress (kPa): 206.0 t100 (minutes): 31.4 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*74	*38	1134.11	33.7	1099	1.4121	63	2.65 Determined
CONSOLIDATED	71.41	36.65	1054.84	37.1	1227	1.1592	85	
FINAL (After shear)	65.41	38.29	1151.60	37.1	1224	1.1651	84	

Initial pore pressure (kPa): 532.0 Final pore pressure (kPa): 343.0 Pore pressure dissipation: 98%

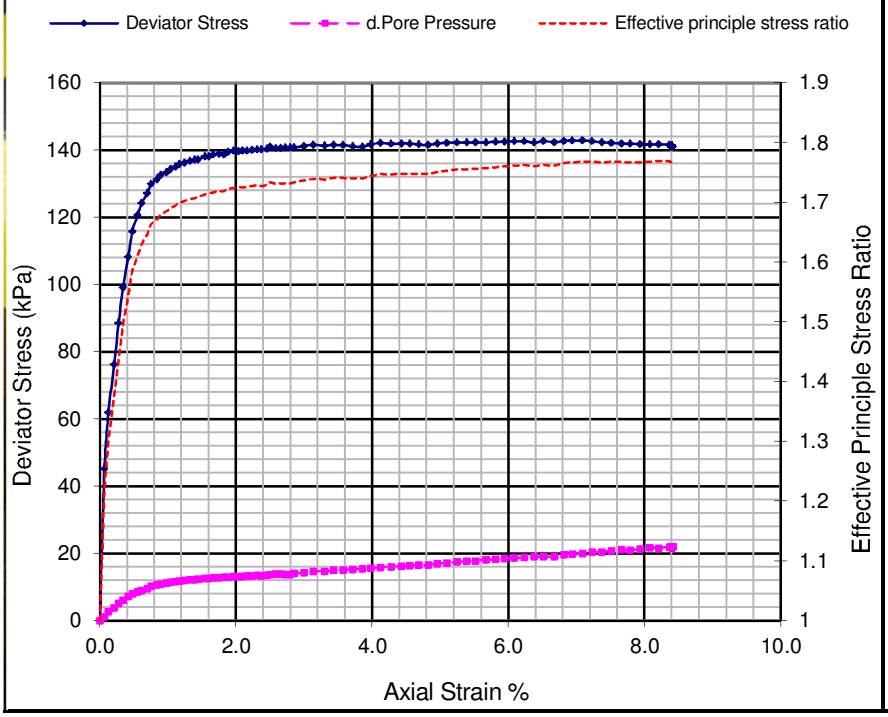
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	9				
Initial pore pressure (kPa):	341.0	Initial effective stress (kPa):	206.0		
Parameters at failure:					
Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	7.09				
Deviator stress (kPa):	142.9	Principle Stresses (kPa)			
Excess pore pressure (kPa):	20.0	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	1.768	348.8	328.8	206.0	186.0

Deviator stress corrections: Membrane correction: 0.1 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure

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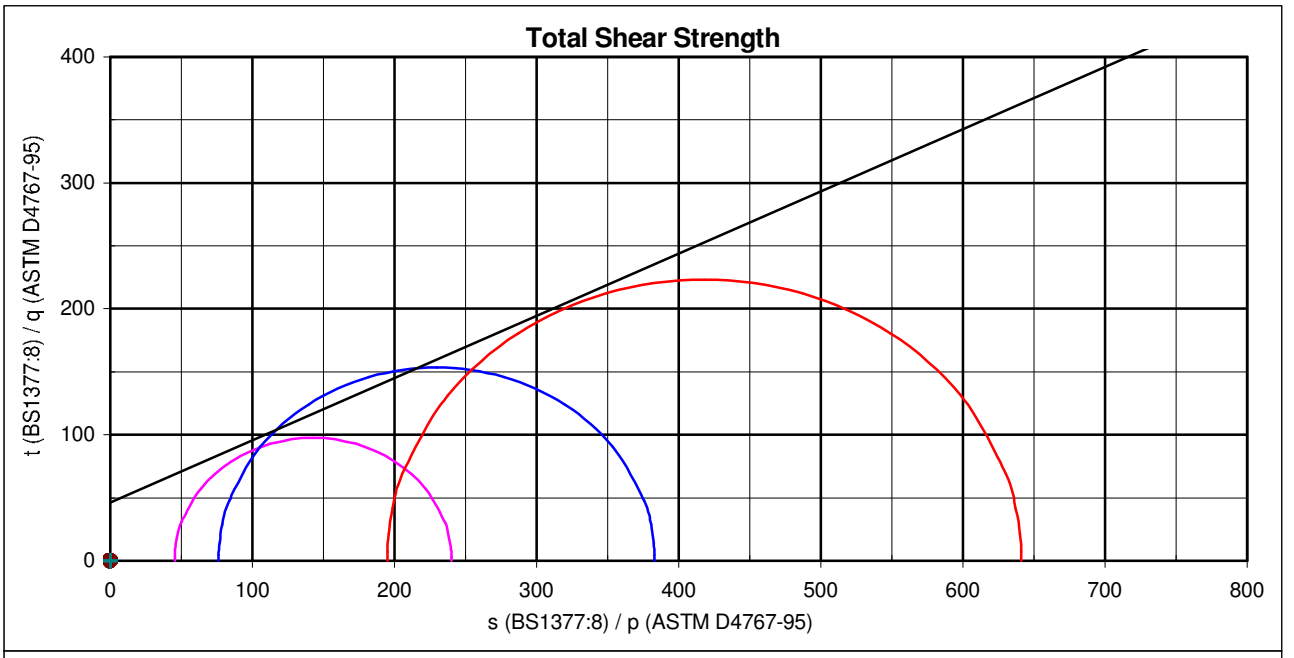
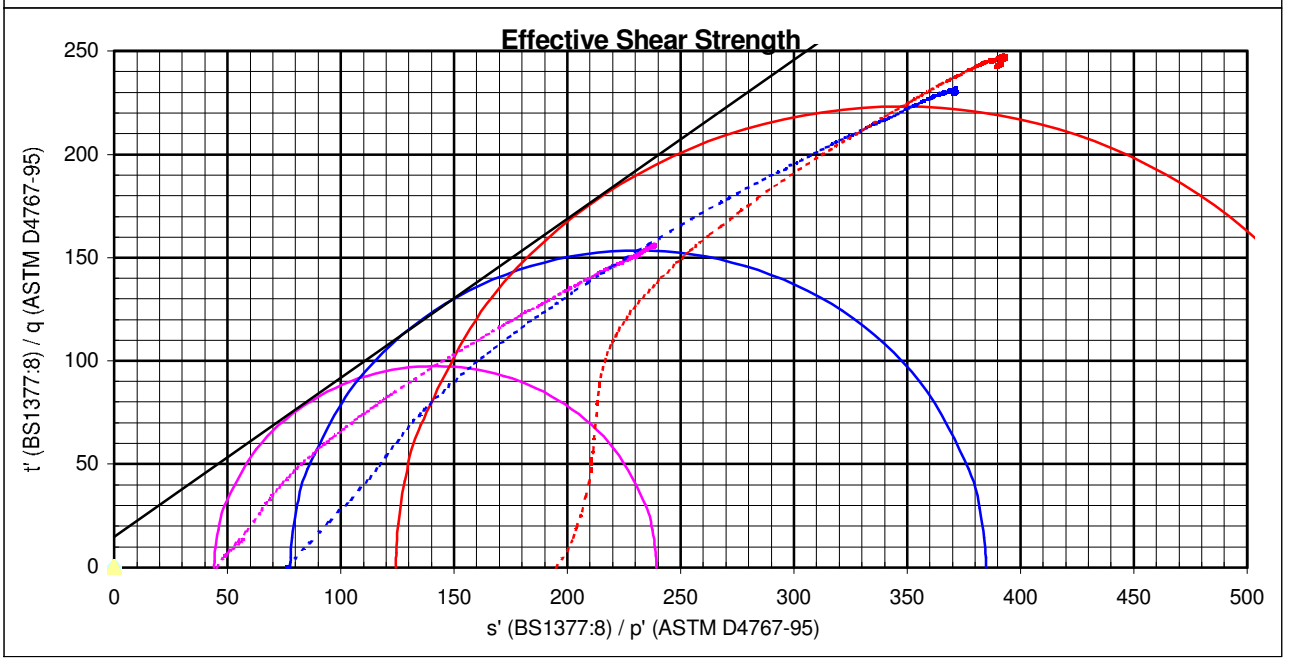
Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	31/05/2011
Proj.No.:	1039/F42/04/2011	Laboratory Number:	C121
Field Sample Reference:	TP 6	Depth (m):	4.7 - 5.1

Mohr Stress Circles

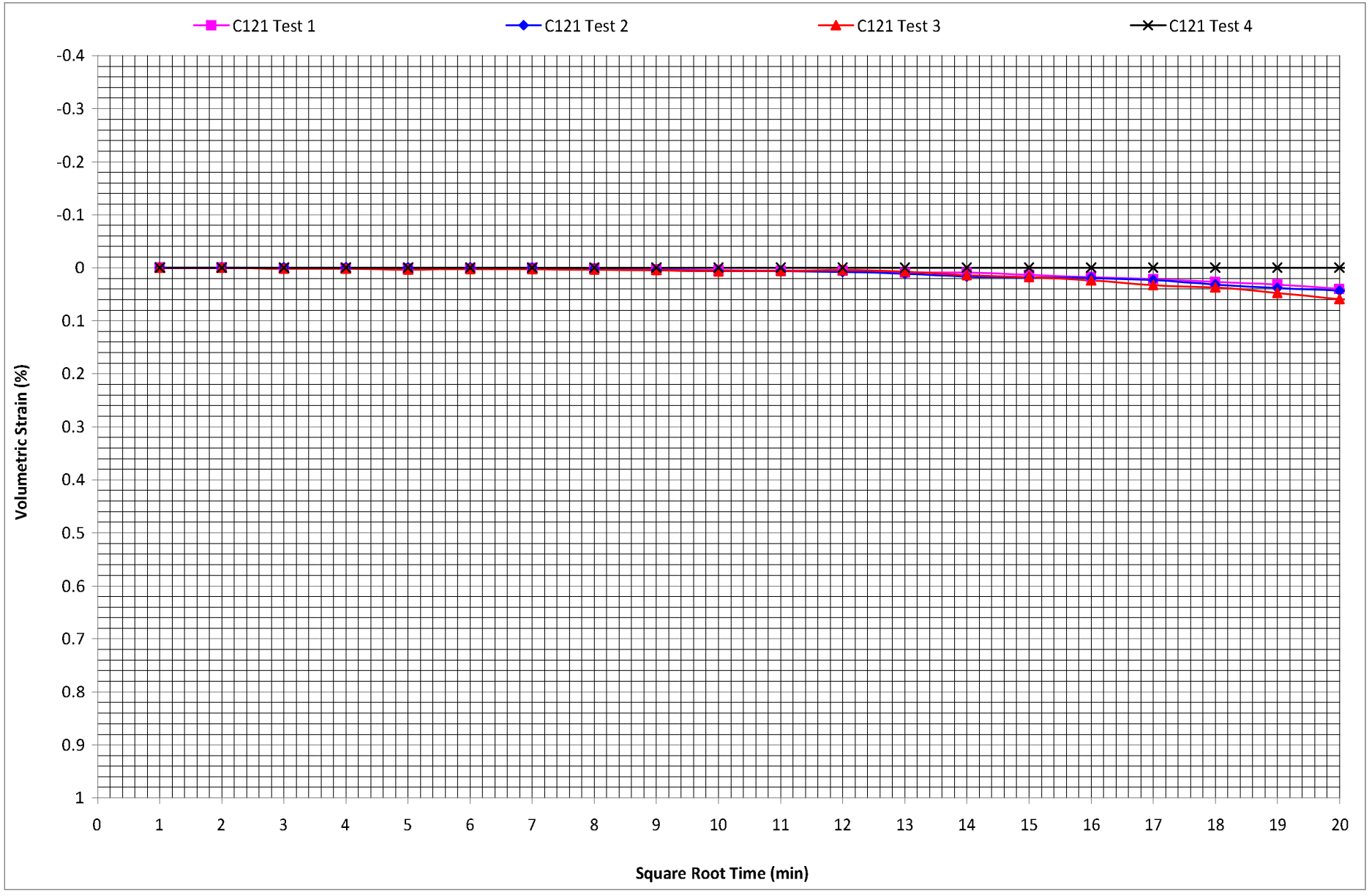
	COHESION (kPa)	FRICTION ANGLE
TOTAL STRESSES	46	26
EFFECTIVE STRESSES	15	38





A Consolidated Undrained test on a remoulded sample tested saturated.

Consolidation vs Square Root Time



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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**31/05/2011**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C121**
Field Sample Number:	**TP 6**	Depth (m):	**4.7 - 5.1**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested saturated.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100		Differential pressure (kPa): 10.0
Final cell pressure (kPa): 350.0	Final back pressure (kPa): 340.0		Final B parameter: 0.99

CONSOLIDATION DATA

Effective cons. Stress (kPa): 45.3 t100 (minutes): 30 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 100.00	* 50.00	1963.50	9.5	2.051	0.6418	50	3.368 Determined
CONSOLIDATED	99.39	49.69	1939.50	10.7	2.090	0.6117	59	
FINAL (After shear)	84.97	53.74	2268.59	10.7	2.090	0.6118	59	

Initial pore pressure (kPa): 346.0 Final pore pressure (kPa): 346.0 Pore pressure dissipation: 0%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 9

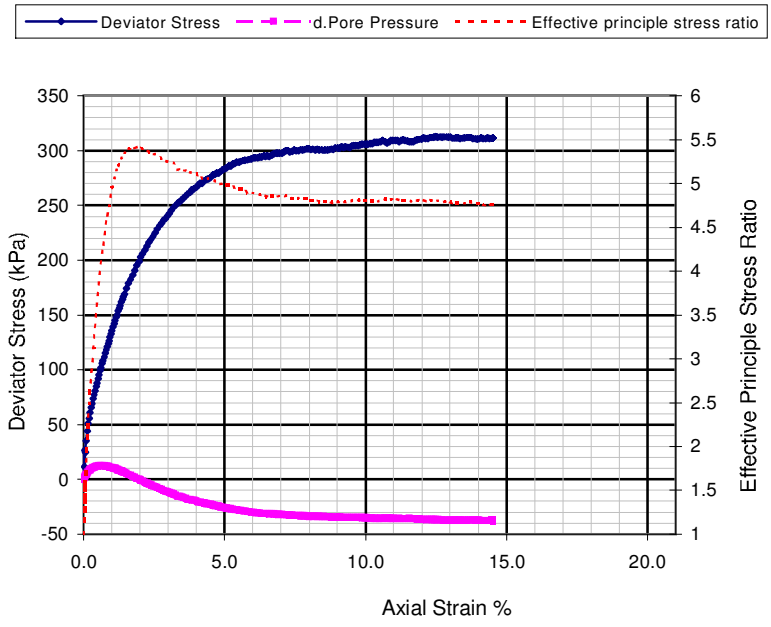
Initial pore pressure (kPa): 345.6 Initial effective stress (kPa): 45.3

Failure Criterion: **Max. Effective Principle Stress Ratio**

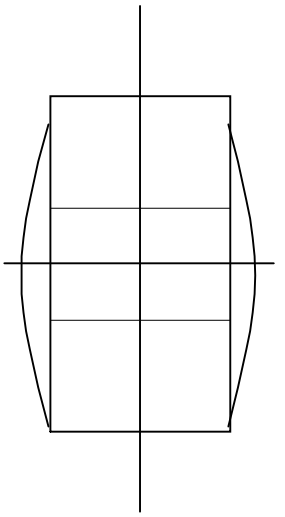
		Principle Stresses (kPa)			
Axial strain at failure (%):	1.88				
Deviator stress (kPa):	195.1	σ_1	σ_1'	σ_3	σ_3'
Excess pore pressure (kPa):	1.1	240.4	239.3	45.3	44.1
Effective principle stress ratio:	5.420				

Deviator stress corrections: Membrane correction: 1.14 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure



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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**31/05/2011**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C121**
Field Sample Number:	**TP 6**	Depth (m):	**4.7 - 5.1**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested saturated.

Test No. 2

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	350.0	Final back pressure (kPa): 340.0	Final B parameter: 0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 76.2 t100 (minutes): 55 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 100.00	* 50.00	1963.50	9.7	2.044	0.6479	51	3.368 Determined
CONSOLIDATED	99.13	49.57	1929.50	15.7	2.098	0.6051	87	
FINAL (After shear)	79.25	55.44	2413.64	15.7	2.098	0.6054	87	

Initial pore pressure (kPa): 341.0 Final pore pressure (kPa): 341.0 Pore pressure dissipation: 0%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 9

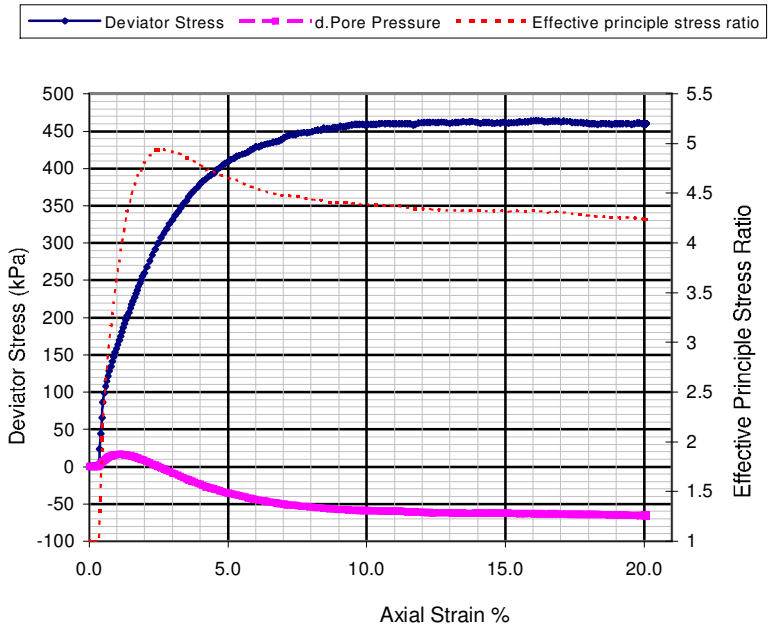
Initial pore pressure (kPa): 363.3 Initial effective stress (kPa): 76.2

Failure Criterion: **Max. Effective Principle Stress Ratio**

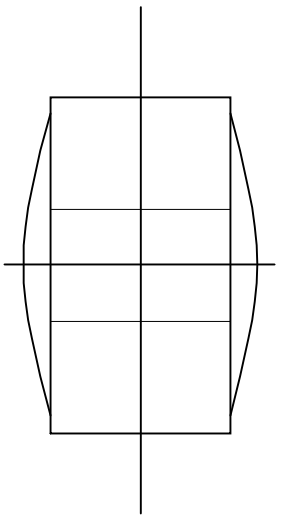
		Principle Stresses (kPa)			
Axial strain at failure (%):	2.59				
Deviator stress (kPa):	306.9	σ_1	σ_1'	σ_3	σ_3'
Excess pore pressure (kPa):	-1.6	383.2	384.7	76.2	77.8
Effective principle stress ratio:	4.946				

Deviator stress corrections: Membrane correction: 1.14 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure



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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**31/05/2011**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C121**
Field Sample Number:	**TP 6**	Depth (m):	**4.7 - 5.1**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested saturated.

Test No. 3

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	350.0	Final back pressure (kPa): 340.0	Final B parameter: 0.99

CONSOLIDATION DATA

Effective cons. Stress (kPa): 194.9 t100 (minutes): 150 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 100.00	* 50.00	1963.50	9.7	2.053	0.6401	51	3.368 Determined
CONSOLIDATED	98.44	49.21	1902.16	15.6	2.154	0.5633	93	
FINAL (After shear)	78.65	55.06	2380.75	15.6	2.153	0.5641	93	

Initial pore pressure (kPa): 344.9 Final pore pressure (kPa): 345.2 Pore pressure dissipation: -6%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 3.48

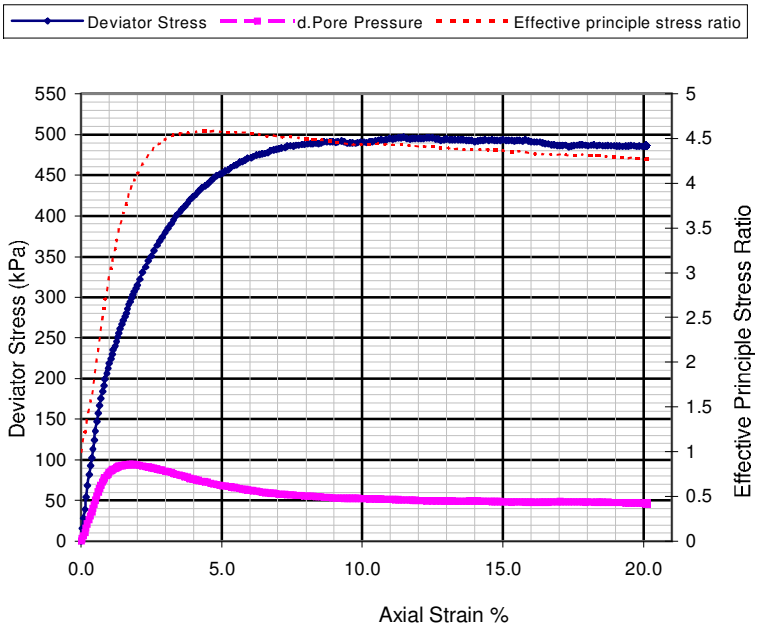
Initial pore pressure (kPa): 344.7 Initial effective stress (kPa): 194.9

Failure Criterion: **Max. Effective Principle Stress Ratio**

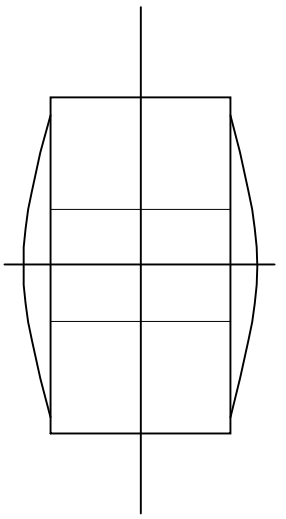
		Principle Stresses (kPa)			
Axial strain at failure (%):	4.72				
Deviator stress (kPa):	446.4	σ_1	σ_1'	σ_3	σ_3'
Excess pore pressure (kPa):	70.5	641.2	570.8	194.9	124.4
Effective principle stress ratio:	4.589				

Deviator stress corrections: Membrane correction: 1.14 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure



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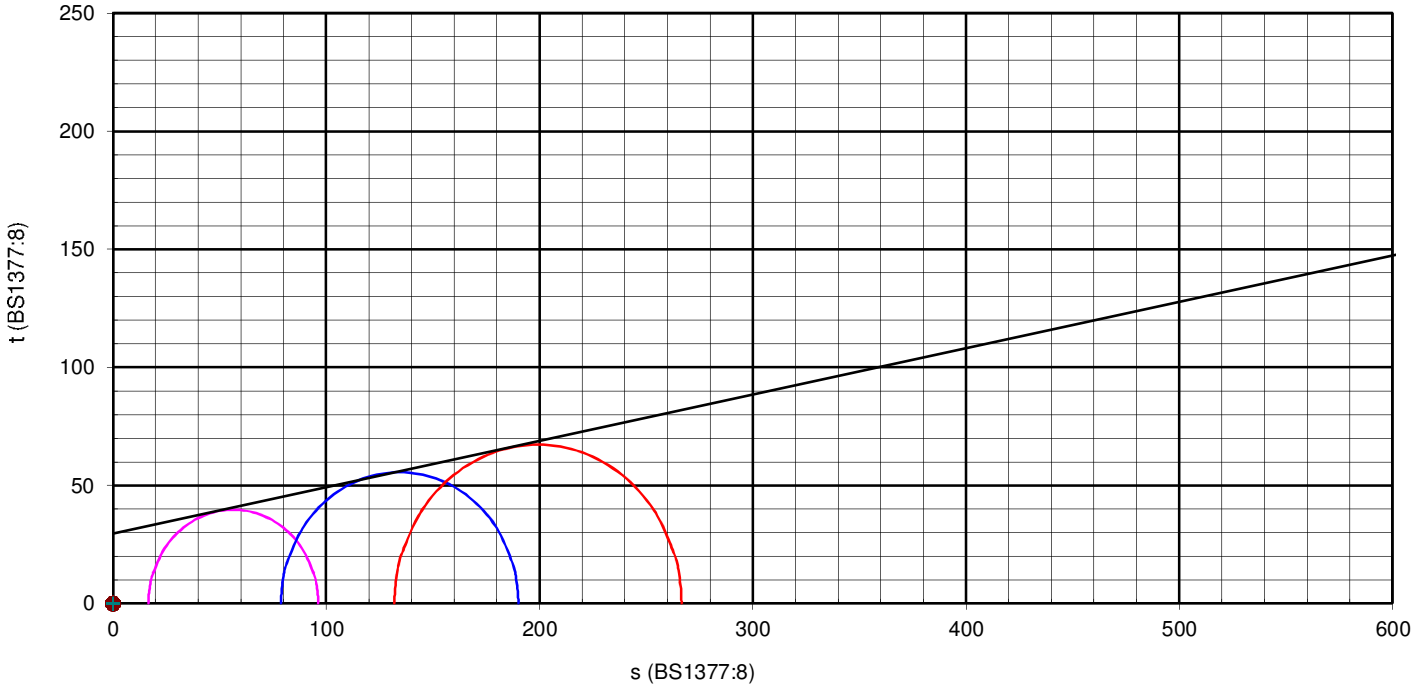
Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	24/06/2011
Proj.No.:	F42/04/11	Laboratory Number:	C123
Field Sample Reference:	TP 10	Depth (m):	4.0-4.2

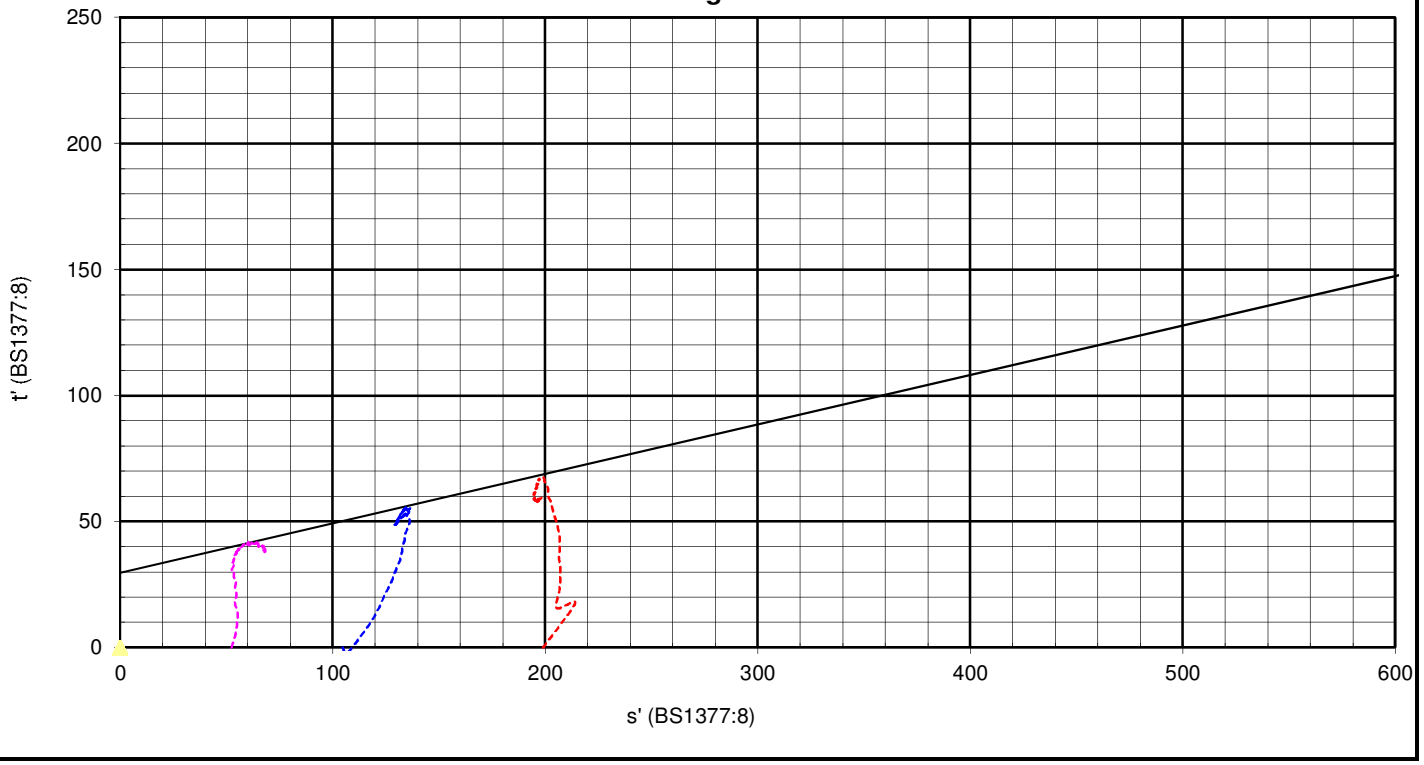
Effective Shear Strength

Stresses	Cohesion (kPa)	Internal friction (Degrees)
Total	28.0	8.8
Effective	29.7	11.1

Effective Shear Strength - Mohr circles at failure



Effective Shear Strength - Stress Paths



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Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	24/06/2011
Batch No.:	F42/04/11	Laboratory Number:	C123
Field Sample Number:	TP 10	Depth (m):	4.0-4.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	357.0	Final back pressure (kPa):	347.0	Final B parameter:	0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 52.4 t100 (minutes): 75 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*100	*50	1963.50	38.4	1299	1.0405	98	2.65 Assumed
CONSOLIDATED	99.64	49.82	1949.45	48.6	1313	1.0186	127	
FINAL (After shear)	92.62	51.67	2097.21	48.6	1313	1.0187	127	

Initial pore pressure (kPa): 344.0 Final pore pressure (kPa): 344.0 Pore pressure dissipation: 0%

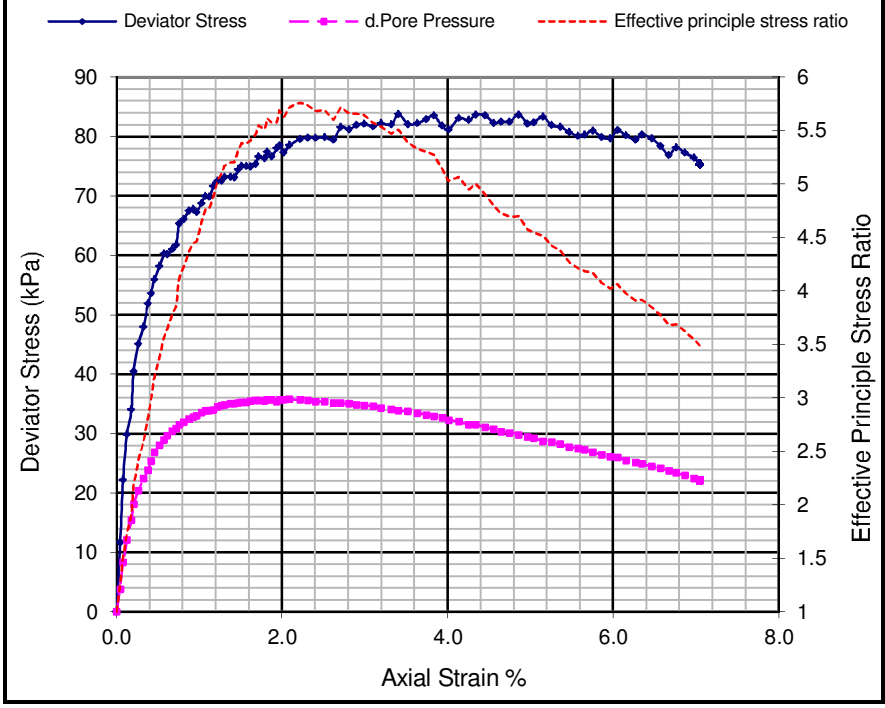
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	7.6				
Initial pore pressure (kPa):	344.6	Initial effective stress (kPa):	52.4		
Parameters at failure:					
Failure Criterion:	Max. Effective Principle Stress Ratio				
Axial strain (%):	2.22				
Deviator stress (kPa):	79.6	Principle Stresses (kPa)			
Excess pore pressure (kPa):	35.7	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	5.759	132.0	96.3	52.4	16.7

Deviator stress corrections: Membrane correction: 1.1 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure

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Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	24/06/2011
Batch No.:	F42/04/11	Laboratory Number:	C123
Field Sample Number:	TP 10	Depth (m):	4.0-4.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated. Multistage Loading.

Test No. 2

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure				
Pressure increments applied (kPa):	50,70,100,100,100			Differential pressure (kPa):	10.0
Final cell pressure (kPa):	357.0	Final back pressure (kPa):	347.0	Final B parameter:	0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 104.7 t100 (minutes): 250 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*94.45	*51.67	2097.21	38.4	1287	1.0585	96	2.65 Assumed
CONSOLIDATED	93.61	51.21	2059.91	48.6	1323	1.0036	128	
FINAL (After shear)	88.44	52.69	2180.31	48.6	1322	1.0040	128	

Initial pore pressure (kPa): 344.0 Final pore pressure (kPa): 344.0 Pore pressure dissipation: 0%

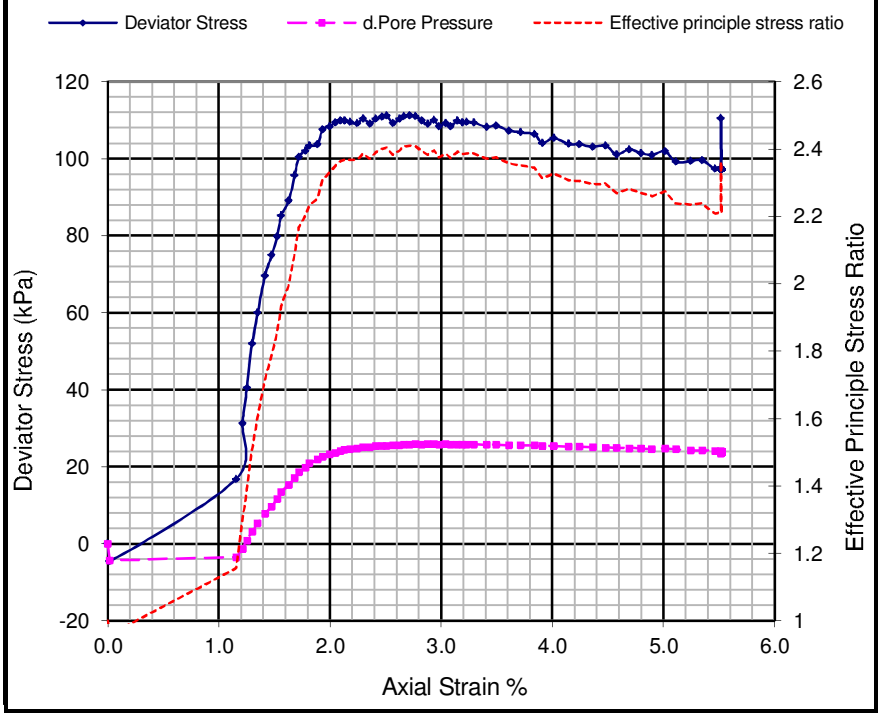
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	2.3				
Initial pore pressure (kPa):	342.3	Initial effective stress (kPa):	104.7		
Parameters at failure:					
Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	2.72				
Deviator stress (kPa):	111.2	Principle Stresses (kPa)			
Excess pore pressure (kPa):	25.8	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.410	215.9	190.1	104.7	78.9

Deviator stress corrections: Membrane correction: 0 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure

See Test No.2

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Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	24/06/2011
Batch No.:	F42/04/11	Laboratory Number:	C123
Field Sample Number:	TP 10	Depth (m):	4.0-4.2

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on an undisturbed sample tested saturated. Multistage Loading.

Test No. 3

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	357.0	Final back pressure (kPa): 347.0	Final B parameter: 0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 199.0 t100 (minutes): 750 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Density kg/m^3	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	*87.61	*52.69	2180.31	38.4	1335	0.9851	103	2.65 Assumed
CONSOLIDATED	86.92	52.27	2145.84	48.6	1367	0.9381	137	
FINAL (After shear)	81.02	54.14	2302.21	48.6	1367	0.9383	137	

Initial pore pressure (kPa): 345.0 Final pore pressure (kPa): 345.0 Pore pressure dissipation: 0%

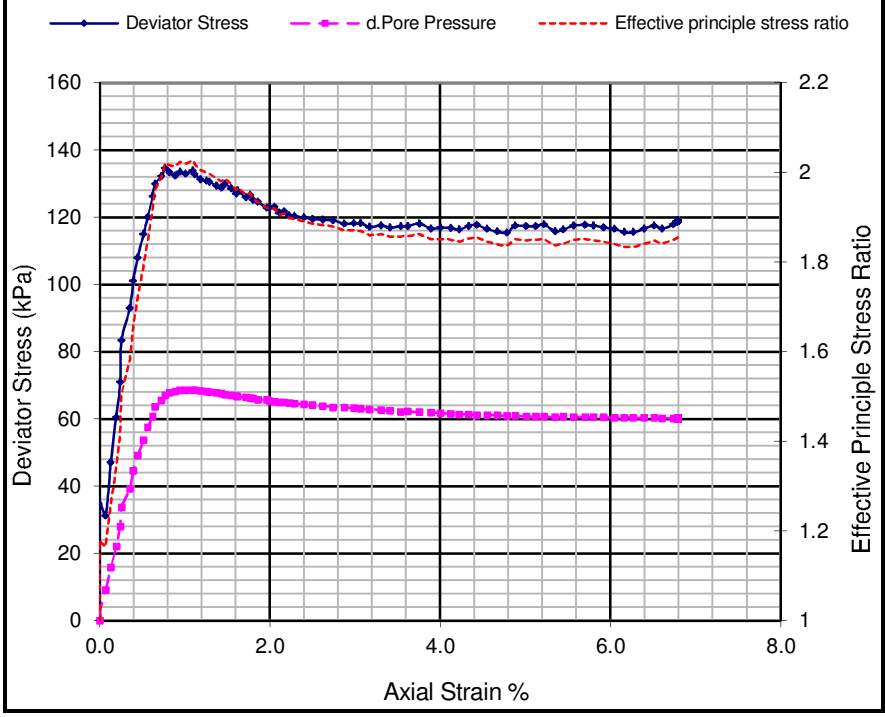
*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour):	0.8				
Initial pore pressure (kPa):	348.0	Initial effective stress (kPa):	199.0		
Parameters at failure:					
Failure Criterion:	Max. Deviator Stress				
Axial strain (%):	0.77				
Deviator stress (kPa):	134.6	Principle Stresses (kPa)			
Excess pore pressure (kPa):	66.9	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	2.019	333.5	266.6	199.0	132.0

Deviator stress corrections: Membrane correction: 1.1 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure

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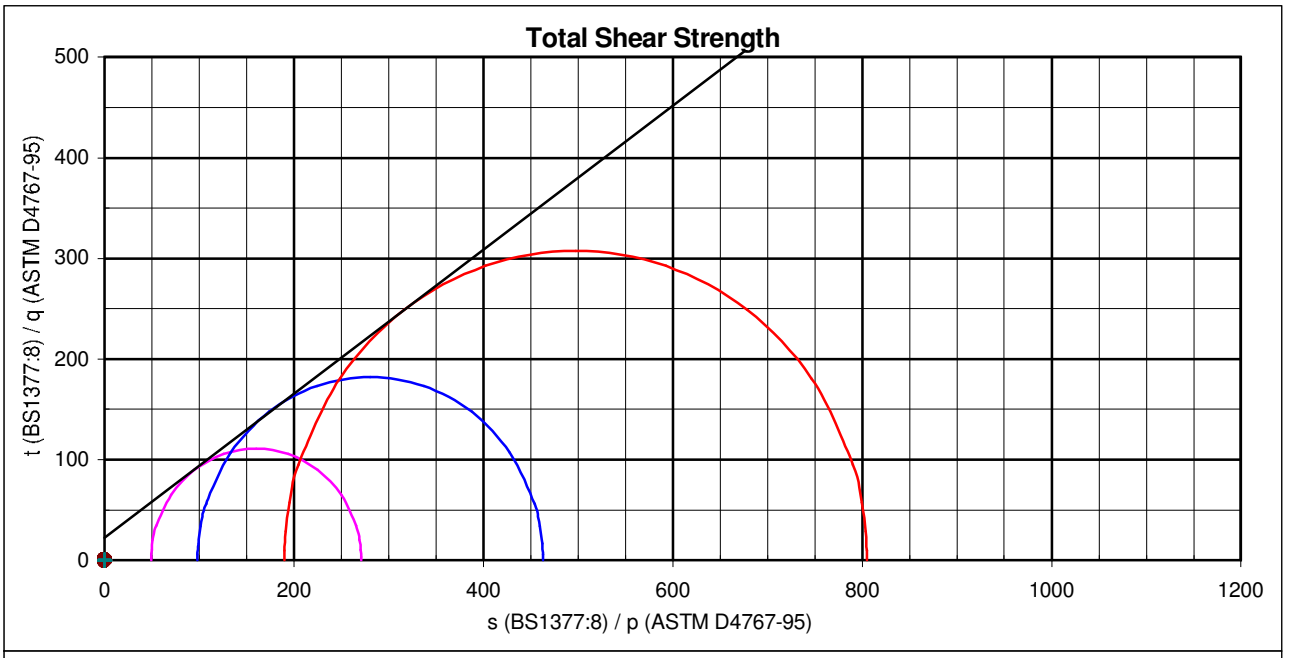
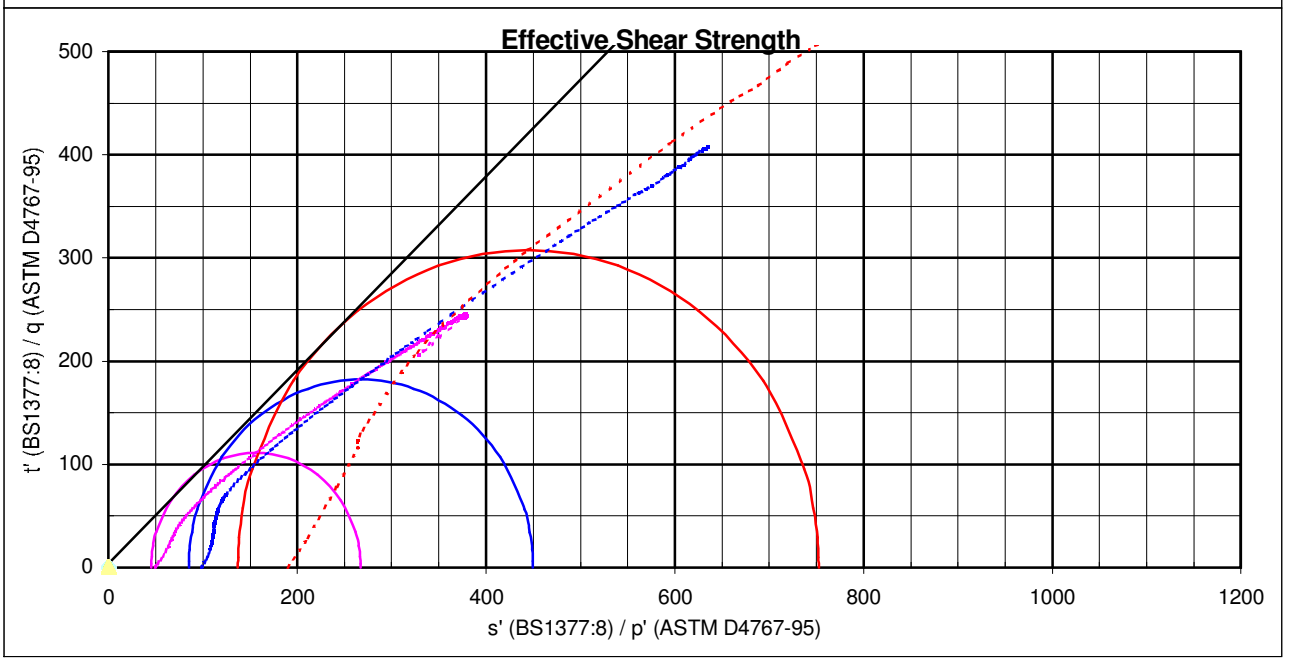
Triaxial Compression Test Results

Project:	THARISA MINERALS	Date Tested:	31/05/2011
Proj.No.:	1039/F42/04/2011	Laboratory Number:	C125
Field Sample Reference:	TP 19	Depth (m):	1.2 - 3.4

Mohr Stress Circles

	COHESION (kPa)	FRICTION ANGLE
TOTAL STRESSES	22	36
EFFECTIVE STRESSES	3	43





A Consolidated Undrained test on a remoulded sample tested at OMC.

Consolidation vs Square Root Time

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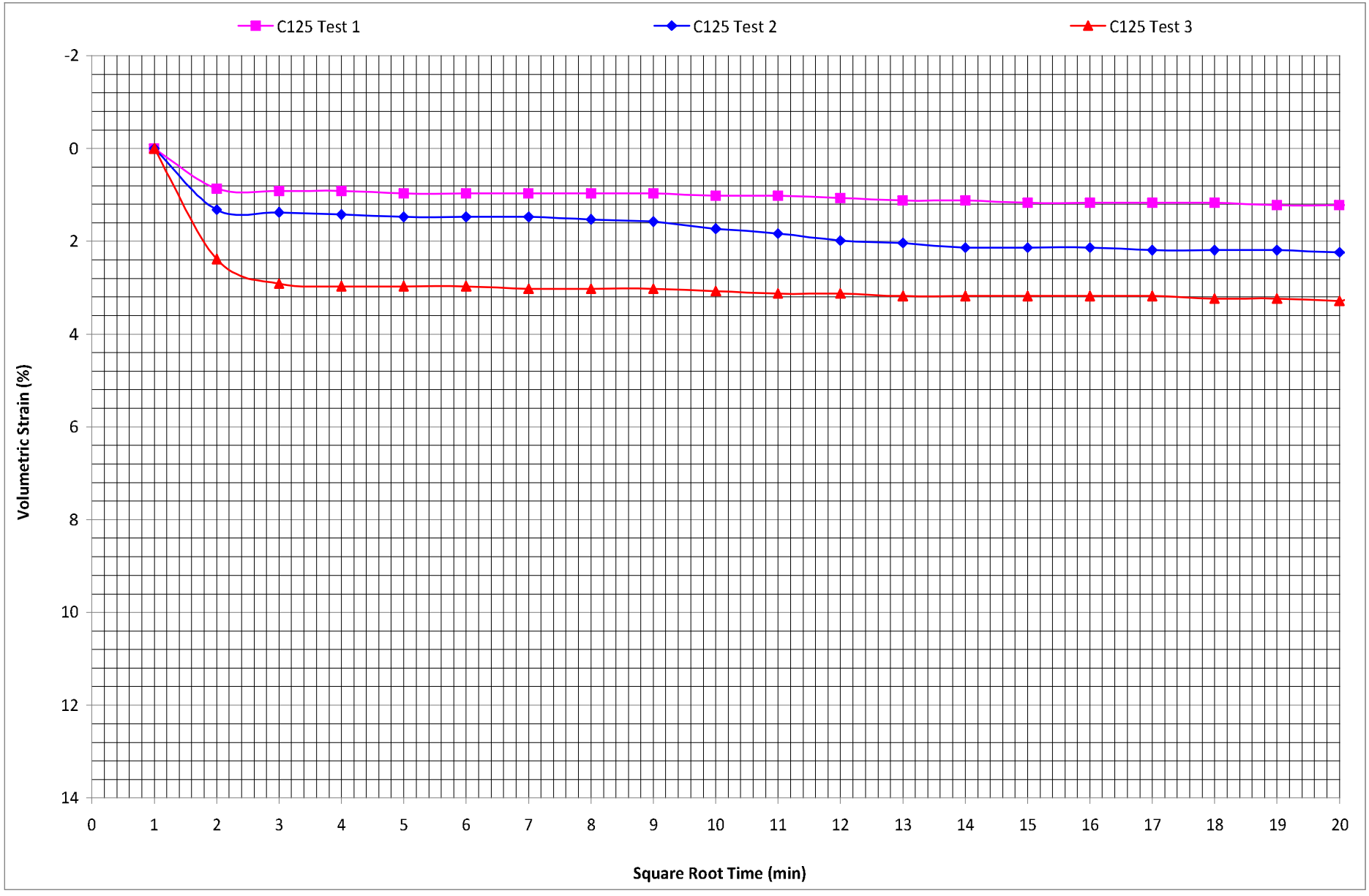

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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**31/05/2011**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C125**
Field Sample Number:	**TP 19**	Depth (m):	**1.2 - 3.4**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested at OMC.

Test No. 1

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	350.0	Final back pressure (kPa): 340.0	Final B parameter: 0.96

CONSOLIDATION DATA

Effective cons. Stress (kPa): 49.0 t100 (minutes): 38.4 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 100.00	* 50.00	1963.50	14.0	1.994	0.6430	72	3.276 Determined
CONSOLIDATED	99.58	49.79	1946.83	17.7	2.020	0.6221	93	
FINAL (After shear)	79.68	55.66	2433.08	17.7	2.020	0.6222	93	

Initial pore pressure (kPa): 382.9 Final pore pressure (kPa): 342.1 Pore pressure dissipation: 95%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 9

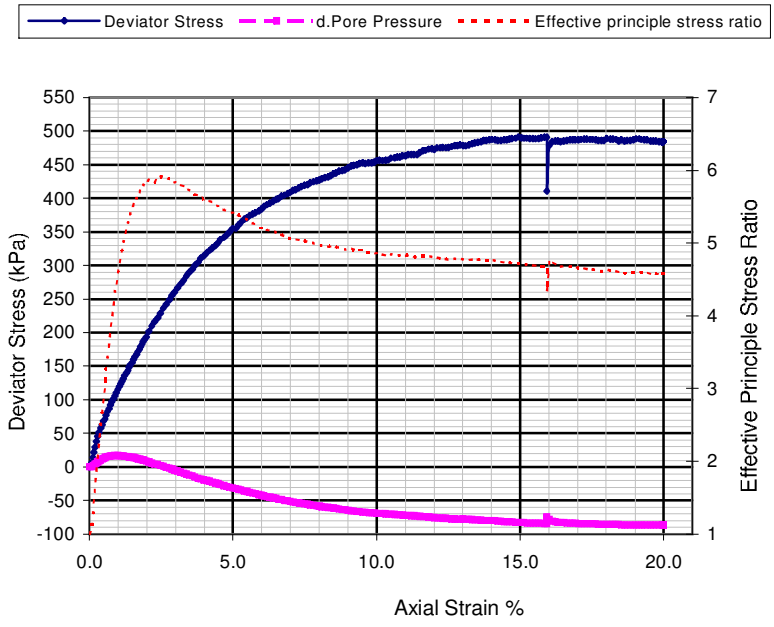
Initial pore pressure (kPa): 341.0 Initial effective stress (kPa): 49.0

Failure Criterion: Max. Effective Principle Stress Ratio

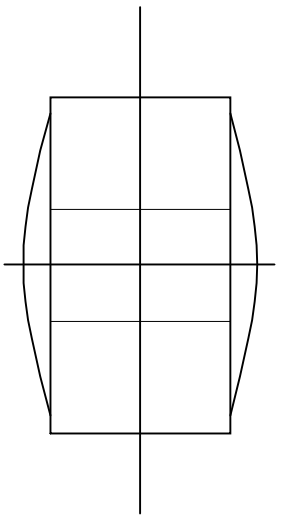
		Principle Stresses (kPa)			
Axial strain at failure (%):	2.37				
Deviator stress (kPa):	222.0	σ_1	σ_1'	σ_3	σ_3'
Excess pore pressure (kPa):	3.9	271.0	267.1	49.0	45.1
Effective principle stress ratio:	5.923				

Deviator stress corrections: Membrane correction: 1.14 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure



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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**31/05/2011**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C125**
Field Sample Number:	**TP 19**	Depth (m):	**1.2 - 3.4**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested at OMC.

Test No. 2

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	350.0	Final back pressure (kPa): 340.0	Final B parameter: 0.97

CONSOLIDATION DATA

Effective cons. Stress (kPa): 98.3 t100 (minutes): 50.4 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 100.00	* 50.00	1963.50	12.7	2.020	0.6215	67	3.276 Determined
CONSOLIDATED	99.24	49.62	1933.50	15.5	2.068	0.5843	87	
FINAL (After shear)	79.36	55.48	2417.66	15.5	2.068	0.5845	87	

Initial pore pressure (kPa): 433.0 Final pore pressure (kPa): 343.6 Pore pressure dissipation: 96%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 9

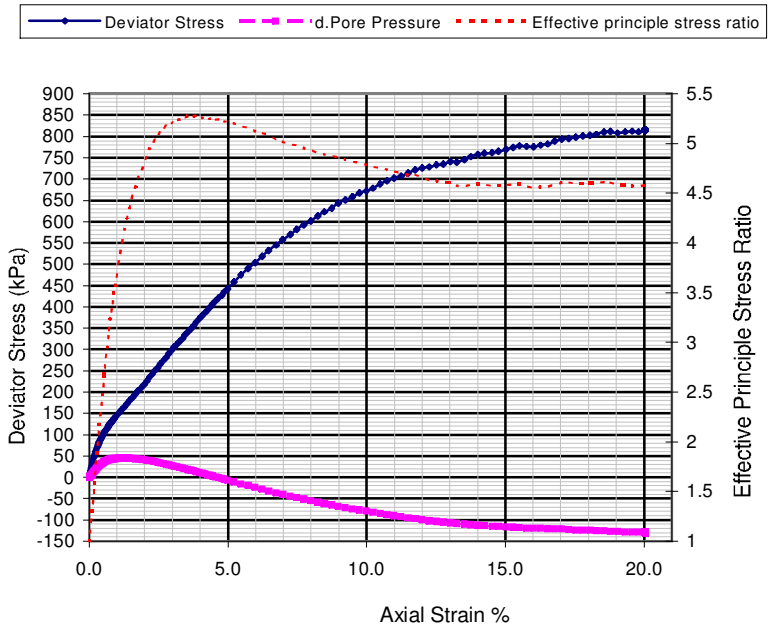
Initial pore pressure (kPa): 341.5 Initial effective stress (kPa): 98.3

Failure Criterion: **Max. Effective Principle Stress Ratio**

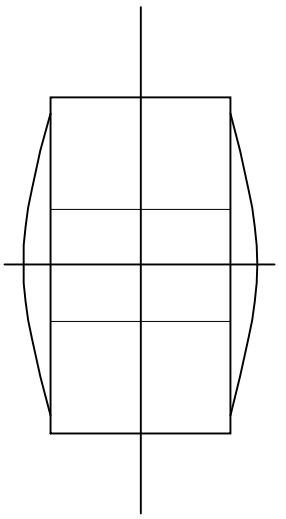
		Principle Stresses (kPa)			
Axial strain at failure (%):	3.85				
Deviator stress (kPa):	364.5				
Excess pore pressure (kPa):	13.2	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	5.283	462.8	449.6	98.3	85.1

Deviator stress corrections: Membrane correction: 1.14 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure



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Triaxial Compression Test Results

Project:	**THARISA MINERALS**	Date Tested:	**31/05/2011**
Batch No.:	**1039/F42/04/2011**	Laboratory Number:	**C125**
Field Sample Number:	**TP 19**	Depth (m):	**1.2 - 3.4**

This test was carried out in accordance with BS 1377:Part 8:1990 Clause 4,5,6,7

Remarks: A Consolidated Undrained test on a remoulded sample tested at OMC.

Test No. 3

SATURATION DATA

Saturation method:	Alternating increments of cell- & back pressure		
Pressure increments applied (kPa):	50,70,100,100,100	Differential pressure (kPa):	10.0
Final cell pressure (kPa):	350.0	Final back pressure (kPa): 340.0	Final B parameter: 0.98

CONSOLIDATION DATA

Effective cons. Stress (kPa): 189.7 t100 (minutes): 4.41 Side drains fitted: No

	Height mm	Diameter mm	Area mm^2	Moisture Content %	Dry Unit Weight	Void Ratio	Saturation %	Specific Gravity
INITIAL (Before saturation)	* 96.00	* 50.00	1963.50	14.5	2.075	0.5789	82	3.276 Determined
CONSOLIDATED	94.83	49.39	1915.58	15.0	2.154	0.5211	94	
FINAL (After shear)	74.43	55.74	2440.62	15.0	2.153	0.5216	94	

Initial pore pressure (kPa): 537.5 Final pore pressure (kPa): 345.1 Pore pressure dissipation: 97%

*: Measured dimensions; all other dimensions are calculated.

SHEAR DATA

Rate of strain (%/hour): 9

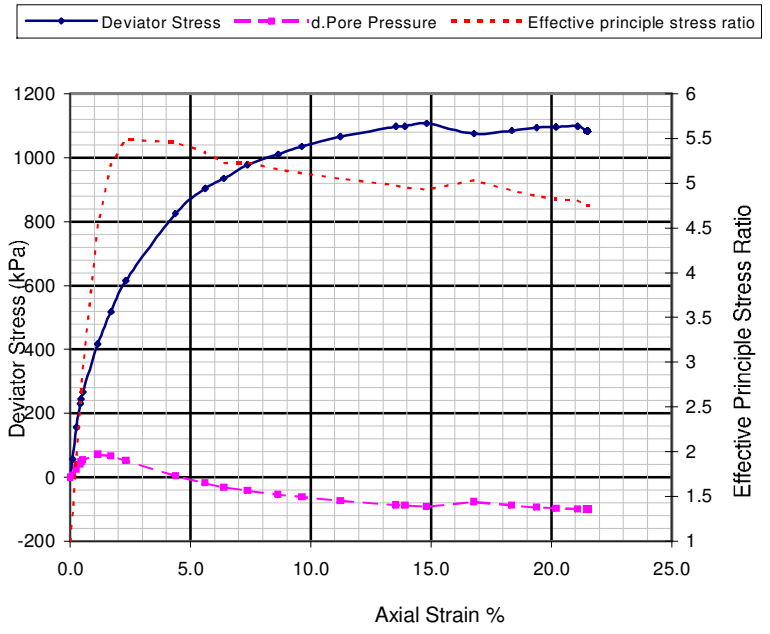
Initial pore pressure (kPa): 350.3 Initial effective stress (kPa): 189.7

Failure Criterion: **Max. Effective Principle Stress Ratio**

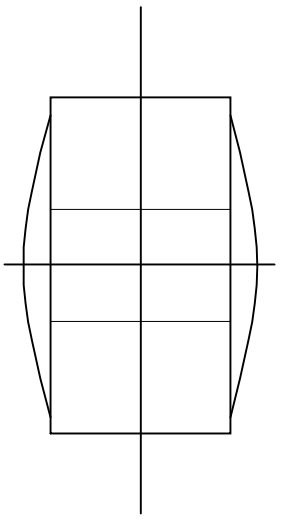
		Principle Stresses (kPa)			
Axial strain at failure (%):	2.32				
Deviator stress (kPa):	615.4				
Excess pore pressure (kPa):	52.7	σ_1	σ_1'	σ_3	σ_3'
Effective principle stress ratio:	5.492	805.1	752.4	189.7	137.0

Deviator stress corrections: Membrane correction: 1.14 kPa

Deviator Stress and dPore Pressure vs Strain



Specimen Failure



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Flexible Wall Constant Head Permeability Test Results

PROJECT:	THARISA MINERALS	DATE :	31/05/2011
PROJECT No.:	F42/04/2011		

Field Sample Number	Sample Depth in metres	Moisture Content (%) Before Test	Moisture Content (%) After Test	Dry Density (Kg/m^3)	Co-efficient of Permeability (m/s) Range Minimum	Range Maximum	Average
TP 2 (C118)	1.6 - 4.0	14.1	20.2	1830	3.8E-06	5.5E-06	**4.5E-06**
TP 4 (C119)	1.0 - 1.2	33.7	37.0	1259	7.6E-10	1.1E-09	**9.1E-10**
TP 6 (C120)	1.0 - 1.2	36.4	36.6	1298	1.0E-10	7.8E-10	**4.7E-10**
TP 6 (C121)	4.7 - 5.1	10.6	14.5	1933	1.0E-07	6.2E-07	**3.0E-07**
TP 9 (C122)	4.5 - 4.7	38.2	48.4	1222	6.5E-10	1.9E-09	**1.0E-09**
TP 14 (C124)	4.0 - 4.2	45.2	46.3	1121	2.2E-10	1.1E-09	**5.4E-10**

REMARKS : Undisturbed samples
Effective cell pressure 100kPa.
Pressure Difference = 20 kPa

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Flexible Wall Constant Head Permeability Test Results

PROJECT:	THARISA MINERALS	DATE :	31/05/2011
PROJECT No.:	F42/04/2011		

Field Sample Number	Sample Depth in metres	Moisture Content (%) Before Test	Moisture Content (%) After Test	Dry Density (Kg/m^3)	Co-efficient of Permeability (m/s) Range Minimum	Range Maximum	Average
TP 19 (C125)	1.2 - 3.4	16.9	18.9	2209	2.6E-06	2.8E-06	**2.7E-06**

REMARKS : Undisturbed samples
Effective cell pressure 100kPa.
Pressure Difference = 20 kPa

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Foundation Indicator Test Data

Project	THARISA MINERALS		
Project No.	2013-B-1782	Date	3 December 2013

Sample No.	1782-1	1782-2	
Field Ref. No.	TP1	TP2	
Depth	1.7	1.8	
Sieve size	%Passing	% Passing	% Passing
75	100	100	
63	100	100	
53	100	100	
37.5	100	100	
26.5	100	100	
19.0	100	100	
13.2	94	100	
4.75	86	100	
2.00	82	99	
0.85	78	98	
0.425	74	95	
0.250	74	94	
0.150	71	92	
0.075	70	89	
0.04	67	80	
0.02	65	76	
0.006	63	71	
0.002	58	65	

Sample No.	1782-1	1782-2	
%Gravel	19	1	
%Sand	13	13	
%Silt	11	21	
%Clay	58	65	
NMC %	Not Tested	Not Tested	
Liquid Limit	86	74	
Plasticity Index	56	42	
Linear Shrink.	20.5	20.	
Overall P.I.	42	40	
Grading Modulus	0.75	0.18	
H.R.B.	A-7-6 (18)	A-7-5 (20)	
Unified	CH	CH	
Weston swell (%) at 1 kPa			

Analysis as per method D422 of ASTM of 1985
The results reported relate only to the samples tested.
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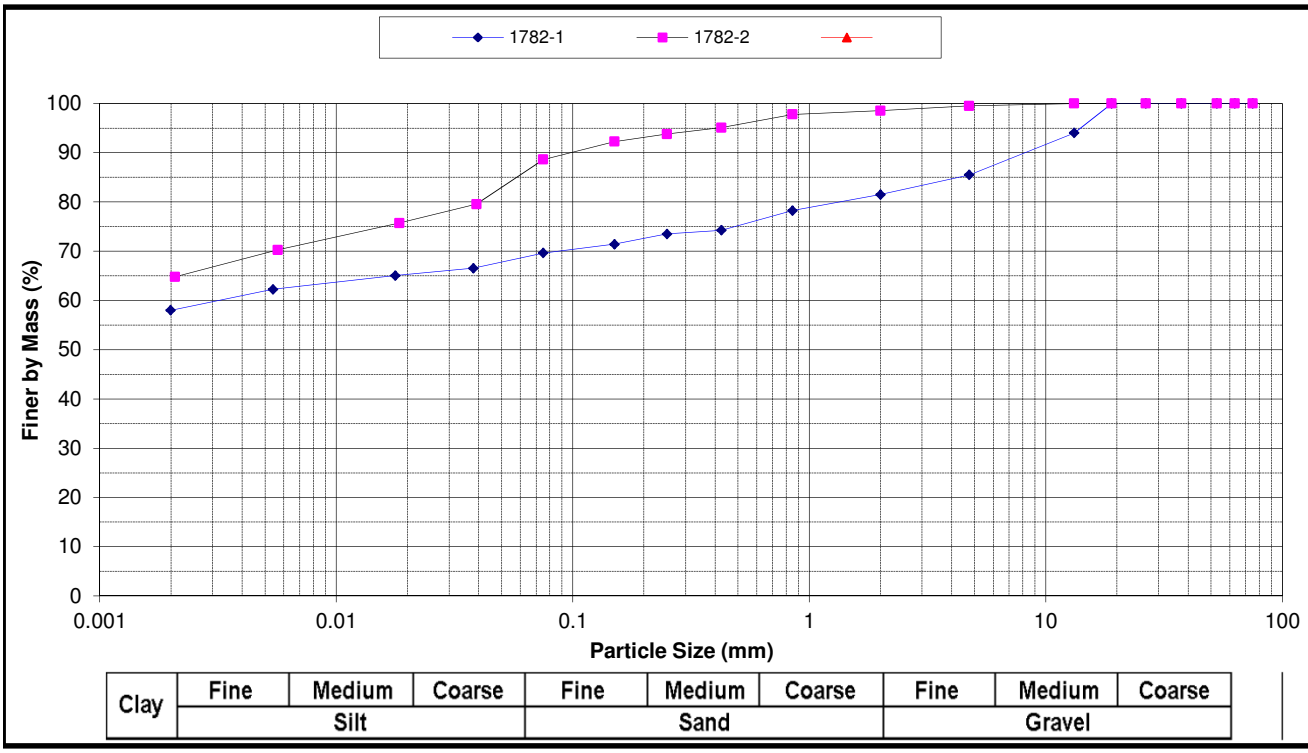

Remarks: