



Rock and Soil Descriptions for Engineering Purposes

**Introductory Course on Core Logging
8 July 2017**



Description of Rocks and Soils

- **Purpose**
 - To give an indication of the likely engineering properties of the rock and soil
- **Scheme**
 - Geoguide 3: Guide to Rock and Soil Descriptions (GCO, 1988)
 - Mainly based on BS5930 (1981 edition)
 - BS5930 revised in 1999 and 2015
- **Why use a scheme?**
 - Good practice and common ground for reference



Definitions

- **In engineering terms, a “soil” is any naturally formed earth material or fill which can be broken down by hand into its constituent grains.**
- **Conversely, a “rock” cannot be broken down, or may only be partially broken down by hand, depending on its weathered condition.**
- **In geological terms, “superficial deposit” covers any geologically recent, unlithified, transported material of sedimentary origin.**
- **“Rock” refers to any lithified soil material of igneous, sedimentary, pyroclastic or metamorphic origin.**

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Definitions

- **By relating the two schemes, “engineering soils” are defined as all superficial deposits and fill (including rock fill) plus those rocks which have weathered in-situ to the condition of a “soil” in engineering terms.**
- **“Engineering soils” derived from in-situ rock weathering (pp45, Geoguide 3):**
 - **Saprolites** – soils that retain the original texture, fabric and structure of the parent rock
 - **Residual Soils** – soils in which the original rock texture, fabric and structure has been destroyed

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Checklist for Rock Description

1. **Strength**
2. **Colour**
3. **Texture / Fabric**
4. **Structure**
5. **Material Weathering State**
6. **Rock Name**
7. **Discontinuities**
8. **Additional Geological Information**
(Mass Characteristics)

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Checklist for Soil Description

1. **Strength**
2. **Colour**
3. **Particle Shape & Composition**
4. **Soil Name**
5. **Additional Geological Information**

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Rock Strength Terms

Table 2 - Classification of Rock Material Strength

Descriptive Term	Uniaxial Compressive Strength (MPa)	Approximate Point Load Strength Index Values (Is(50)) for Granitic & Volcanic Rocks (MPa)	Field Identification Tests
Extremely weak	< 0.5	} Generally not applicable	Easily crumbled by hand; indented deeply by thumbnail.
Very weak	0.5 - 1.25		Crumbled with difficulty by hand; scratched easily by thumbnail; peeled easily by pocket knife.
Weak	1.25 - 5		May be broken by hand into pieces; scratched by thumbnail; peeled by pocket knife; deep indentations up to 5mm made with point of geological pick; hand-held specimen easily broken by single light blow of geological hammer.
Moderately weak	5 - 12.5	0.2 - 0.5	May be broken with difficulty in two hands; scratched with difficulty by thumbnail; difficult to peel but easily scratched by pocket knife; shallow indentations easily made with point of geological pick; hand-held specimen usually broken by single light blow of geological hammer.
Moderately strong	12.5 - 50	0.5 - 2	Scratched by pocket knife; shallow indentations made by firm blow with point of geological pick; hand-held specimen usually broken by single firm blow of geological hammer.
Strong	50 - 100	2 - 4	Firm blows with point of geological pick cause only superficial surface damage; hand-held specimen requires more than one firm blow to break with geological hammer.
Very strong	100 - 200	4 - 8	Many blows of geological hammer required to break specimen.
Extremely strong	>200	> 8	Specimen can only be chipped by blows of geological hammer.

Note : The very weak and extremely weak classes are applicable to soils derived from insitu weathering of rocks.

(Table 2, Geoguide 3)

Colour Terms

(Table 3, Geoguide 3)

(Table 3, Geoguide 3)

Table 3 - Colour Description Scheme

Lightness	Intensity / Purity	Basic Colour
Value	Chroma	Hue
Light	Pinkish	Pink
Dark	Reddish	Red
	Yellowish	Yellow
	Orangish	Orange
	Brownish	Brown
	Greenish	Green
	Bluish	Blue
	Purplish	Purple
		White
	Greyish	Grey
		Black

Don't add with Chroma and Value

Colour Distribution		
Uniform	Non-uniform	
	Spotted	
	Mottled	
	Dappled	
	Streaked	
	Striped	

Notes : (1) For uniform colour distribution, choose a hue and then supplement it if necessary with a value and/or chroma.
 (2) If the colour distribution is non-uniform, repeat this procedure for the two (or more) components of the distribution, employing the non-uniform descriptor to indicate which component is dominant, e.g. light pinkish grey spotted with black.

Note (pp15, Geoguide 3):

Wetting a rock sample decreases the value (i.e. makes the sample darker), but does not change the hue or chroma.
 If unspecified, rock cores are presumed wet when described.

Texture / Fabric Terms



A : Equigranular B : Inequigranular C : Megacrystic

D : Aphanitic E : Porphyritic F : Crystalline

G : Cryptocrystalline

Natural scale

Note : Porphyritic texture represents a special case of megacrystic texture (see Glossary). It is rarely possible to distinguish between the two by observation alone; additional geological information on the composition of the large grains/crystals relative to the matrix is usually required.

Note (pp15-16, pp150, Geoguide 3):

Common textural terms in the left Plate are only applicable to crystalline igneous (e.g. **granite, rhyolite**) and non-foliated metamorphic rocks (e.g. **quartzite, marble**)

Microfractures caused by mechanical weathering, tectonic activity and stress-relief are particularly common on **coarse-grained rocks** → spacing, preferred orientation and aperture should be described in additional geological information

Size, spacing and extent of any other notable features (e.g. **voids, honeycomb/weathering pits**) should be described in additional geological information

(Plate 1, Geoguide 3)

Weathering State



Rock Material		General Characteristics
Description	Grades	
Residual Soil	VI	Original rock texture completely destroyed Can be crumbled by hand and finger pressure into constituent grains
Completely Decomposed	V	Original rock texture preserved Can be crumbled by hand and finger pressure into constituent grains Easily indented by point of geological pick Slakes when immersed in water Completely discoloured compared with fresh rock
Highly Decomposed	IV	Can be broken by hand into smaller pieces Makes a dull sound when struck by geological hammer Not easily indented by point of geological pick Does not slake when immersed in water Completely discoloured compared with fresh rock
Moderately Decomposed	III	Cannot usually be broken by hand; easily broken by geological hammer Makes a dull or slight ringing sound when struck by geological hammer Completely stained throughout
Slightly Decomposed	II	Not broken easily by geological hammer Makes a ringing sound when struck by geological hammer Fresh rock colours generally retained but stained near joint surfaces
Fresh	I	Not broken easily by geological hammer Makes a ringing sound when struck by geological hammer No visible signs of decomposition (i.e. no discolouration)

Note (pp18, Geoguide 3):

Not all general characteristics in the table are applicable to some weaker sedimentary (e.g. siltstone) and metamorphic rocks (e.g. schist).

The grade classification is of very **limited use for description of carbonate rocks** such as limestone and marble. Since pure carbonate material dissolves completely in contact with weakly acidic groundwater, there is **no gradual transition from fresh rock to residual soil.**

However, most carbonate rocks contain ... **non-soluble impurities ... which can accumulate in the form of residual debris** as the surrounding carbonate material is removed in solution

It should be noted that this debris **should not be classified as a true insitu residual soil** since the solution of the carbonate material results in a complete collapse of the original rock fabric.

(modified from Table 4, Geoguide 3)

Weathering State



Form Soil	Coarse-grained Granite	Medium-grained Granite	Fine-grained Granite	Granodiorite	Coarse Ash Tuff	Fine Ash Tuff
VI						
V						
IV						
III						
II						
I						

(modified from Plate 3, Geoguide 3)

Note (pp18-20, pp45, Geoguide 3):

Grade II material can be distinguished from Grade I rock by straining in the vicinity of rock joints.

Grade III rock is usually stained throughout.

Since Grade V materials retain the original rock texture, complete descriptions should be made in rock terms, supplemented where necessary by additional soil terms.

Grade VI residual soils have lost all evidence of the original rock texture. Therefore, a full description can only be made in soil terms.

Rock Discontinuity Terms



Table 7 - Discontinuity Spacing

Descriptive Term	Spacing
Extremely widely-spaced	> 6 m
Very widely-spaced	2 m - 6 m
Widely-spaced	600 mm - 2 m
Medium-spaced	200 mm - 600 mm
Closely-spaced	60 mm - 200 mm
Very closely-spaced	20 mm - 60 mm
Extremely closely-spaced	< 20 mm

(Table 7, Geoguide 3)

Note (pp21, Geoguide 3):

Average joint spacing in igneous rocks tends to increase with increasing grain size. (i.e. coarse-grained granite usually has wider joint spacing)

Compressive strength of fresh igneous and pyroclastic rocks tends to decrease with increasing grain size.

Material and Mass Characteristics

	Material Characteristics	Mass Characteristics
Rock	uniform pieces of rock and drillcore; discontinuities and other structural features will not normally be considered.	larger volumes of rock that incorporate the usual structure features; they can be fully appreciated only through careful field description.
Soil	Those can be described from visual and manual examination of relatively small volumes of soil in either disturbed or undisturbed samples.	those can only be described satisfactorily if original soil structure remains intact in undisturbed samples or exposures.



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Material and Mass Characteristics

	Rock Material	Rock Mass
Strength	√	
Colour	√	
Texture and fabric	√	
Structure		√
Weathering State	√	√
Rock name	√	
Discontinuities		√



Rock Mass Weathering Profile

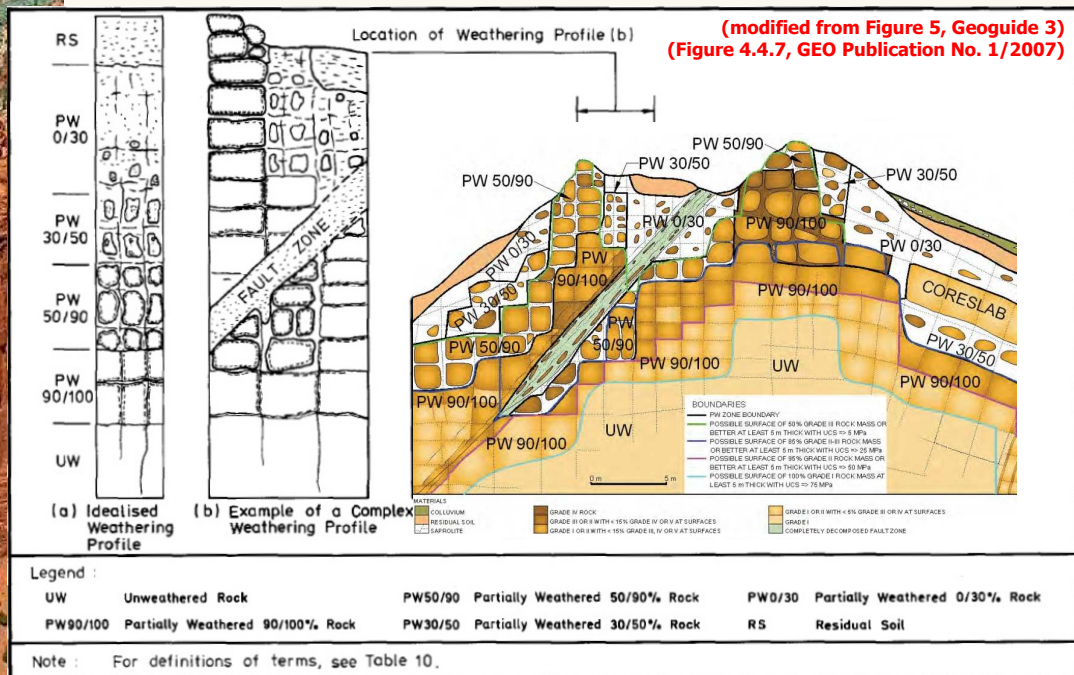


Figure 5 - Mass Weathering Profiles and Zonal Weathering Classification of a Mass Exposure

Application of Rock and Soil Descriptions

- **Logging of:**

- Drillholes
- Trial Pits / Trial Trenches
- Surface Strippings
- Bulk Samples from Various Sources

- **Mapping of:**

- Soil and Rock Slopes
- Soft Ground / Mix Ground / Rock Tunnels
- Landslides

DRILLHOLE RECORD										HOLE NO.	DH 4			
CONTRACT NO. :										SHEET	2 OF 3			
PROJECT														
METHOD		Rotary		CO-ORDINATES				W. O. NO.						
MACHINE & NO.		VBM20		E 837457.39		N 827451.42		DATE : 16/02/2015 to 03/03/2015						
FLUSHING MEDIUM		Water		ORIENTATION		Vertical		GROUND LEVEL + 4.64 mPD						
Drilling Progress	Core Log	Water Level (m) Shift start / end	Return	T.C.R. %	S.C.R. %	R.Q.D. %	FI	Tests	Samples	Reduced Level	Depth	Legend	Grade	Description
								100(95m)	No. Type Depth	-5.36	10.00		V	
								17	10.00	-5.36	10.00		V	Extremely weak, yellowish brown, dappled white and dark grey, completely decomposed coarse grained GRANITE. (Slightly fine to coarse SAND with some angular fine to medium gravel)
								18	11.00	-5.36	11.00		V	
								19	11.85	-5.36	11.85		V	
								20	12.15	-5.36	12.15		V	
								21	12.60	-7.06	12.60		N	Very weak to weak, brown, dappled white and dark grey, highly decomposed coarse grained GRANITE. (Slightly sandy angular fine to medium GRAVEL)
								22	13.00	-7.06	13.00		N	
								23	13.80	-7.06	13.80		N	
								24	14.15	-7.06	14.15		N	
								25	14.60	-9.36	14.60		N	Weak to moderately weak, brown, dappled white and dark grey, highly decomposed coarse grained GRANITE. (Angular COBBLES with some sandy angular medium to coarse gravel)
								26	15.00	-9.36	15.00		N	
								27	15.30	-12.31	15.30		N	Very weak to weak, brown, mottled light grey, highly decomposed coarse grained GRANITE. (Slightly sandy angular fine to coarse GRAVEL)
								28	16.00	-12.31	16.00		N	
								29	17.00	-13.06	17.00		N	Weak to moderately weak, pinkish brown, highly decomposed coarse grained GRANITE. (Angular COBBLES with some sandy angular fine to coarse gravel)
								30	18.00	-13.06	18.00		N	
								31	18.50	-13.06	18.50		N	Moderately strong to strong, pinkish brown, moderately decomposed coarse grained GRANITE. (Angular COBBLES with some sandy angular fine to coarse gravel)
								32	19.00	-14.36	19.00		N	Joints are closely spaced, locally very closely spaced, rough planar and rough stepped, extremely narrow, iron and manganese stained, dipping 0° to 10°, 10° to 20° and occasional 20° to 80°
								33	19.40	-14.36	19.40		N	
								34	19.55	-15.11	19.55		N	From 19.00m to 19.10m: Weak to moderately weak, pinkish brown, highly decomposed coarse grained GRANITE. (Sandy angular fine to coarse GRAVEL)
								35	19.70	-15.11	19.70		N	
								36	19.90	-15.11	19.90		N	

Format of Drillhole Log

1. Orientation
2. Flushing Medium
3. Water Level
4. Samples
5. Field Tests
6. Core Recovery
7. Fracture Index
8. Soil Descriptions
9. Rock Descriptions
10. Legend and Decomposition Grade
11. Logged by / Checked by

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TCR, SCR, RQD, FI

- **Total Core Recovery, TCR (%) =**
 - total core recovered / total length of core run
- **Solid Core Recovery, SCR (%) =**
 - "solid core" recovered / total length of core run
- **Rock Quality Designation, RQD (%) =**
 - total length of "solid core" (>100mm) recovered / total length of core run
- **Fracture Index, FI =**
 - number of natural fracture per metre run

Solid Core = core with at least 1 full diameter (but not necessarily a full circumference) measured along the core axis between 2 natural fractures

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TCR, SCR, RQD, FI

a single 1.5m core run

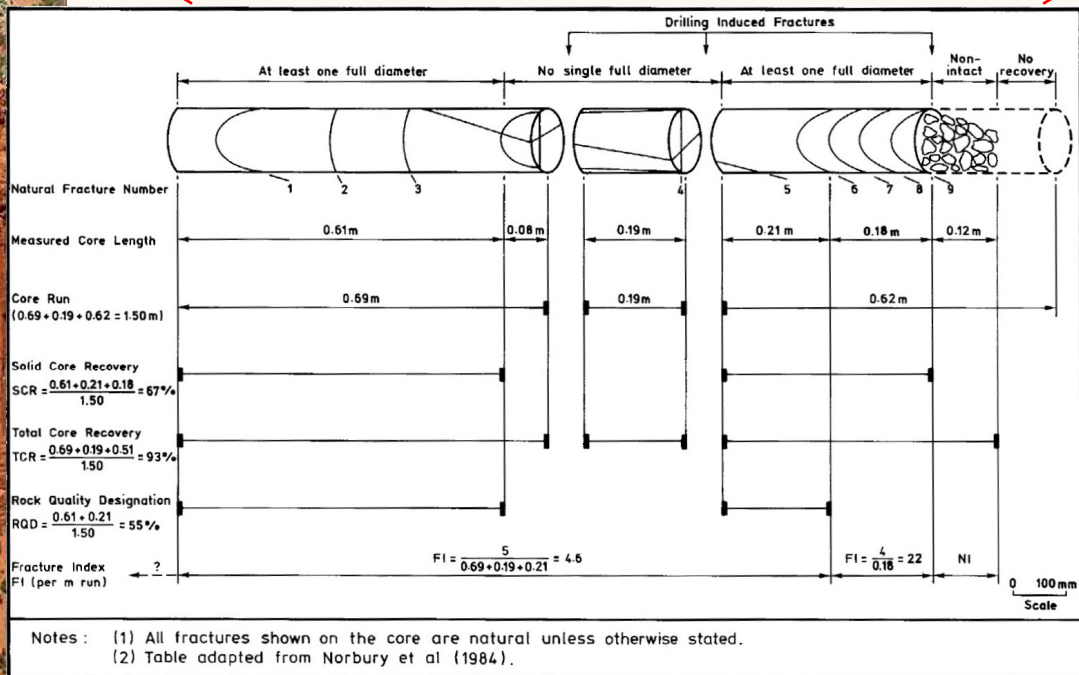
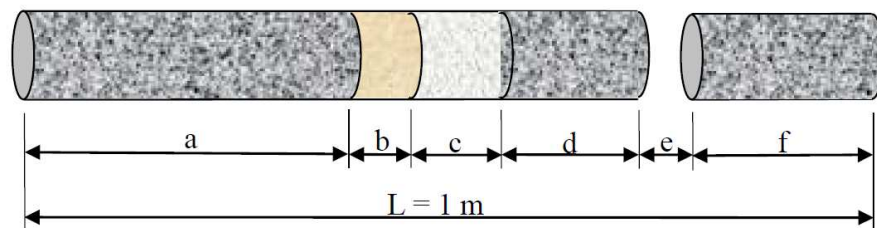


Figure 4 - Schematic Illustration of Fracture Logging Terms

(Figure 4, Geoguide 3)

TCR of the Designated Grade



- Notes:
1. $TCR \text{ of the designated grade} = (a+c+d+f)/L$.
 2. a, c, d and f are materials of the designated grade or better.
 3. b are materials inferior than the designated grade.
 4. e are materials washed away during drilling.
 5. The maximum continuous length of materials washed away/inferior to the designated grade, b+e, should not be greater than 300mm
 6. TCR of the designated grade should not be confused with TCR of the core run shown in the site investigation report, which is equal to $(a+b+c+d+f)/L$

Figure 2.1 Definition of TCR of the Designated Grade

(Figure 2.1, Code of Practice for Foundations 2017)

Example of Drillhole Logs and Photos

Saprolite in rock description
(with soil description in blanket)

Samples	Reduced Level	Depth (m)	Legend	Grade	Description
No. Type Depth	-5.36	10.00		V	
17	10.60	-5.98		V	Extremely weak, yellowish brown, dappled white and dark grey, completely decomposed coarse grained GRANITE. (Silty fine to coarse SAND with some angular fine to medium gravel)
18	11.60				
19	11.70				
20	12.10				
20	12.15				
21	12.60	-7.98		IV	Very weak to weak, brown, dappled white and dark grey, highly decomposed coarse grained GRANITE. (Slightly sandy angular fine to medium GRAVEL)
22	13.70				
23	13.80				
24	14.10				
24	14.15				
25	14.60	-9.98		IV	Weak to moderately weak, brown, dappled white and dark grey, highly decomposed coarse grained GRANITE. (Angular COBBLES with some sandy angular medium to coarse gravel)
25	15.60				
25	15.70				
26	16.70				
26	16.80				
26	16.85				
27	16.80	-12.16		IV	Very weak to weak, brown, mottled light grey, highly decomposed coarse grained GRANITE. (Slightly sandy angular fine to coarse GRAVEL)
28	17.70	-13.06		IV	Weak to moderately weak, pinkish brown, highly decomposed coarse grained GRANITE. (Angular COBBLES with some sandy angular fine to coarse gravel)
28	18.30				
28	18.30				
T2(OI)	18.52	-13.88		III	Moderately strong to strong, pinkish brown, moderately decomposed coarse grained GRANITE. Joints are closely spaced, locally very closely spaced, rough planar and rough stepped, extremely narrow, iron and manganese stained, dipping 0° to 10°, 10° to 20° and occasional 70° to 80°.
T2(OI)	19.00	-14.36		IV	From 19.00m to 19.16m : Weak to moderately weak, pinkish brown, highly decomposed coarse grained GRANITE. (Sandy angular fine to coarse GRAVEL)
T2(OI)	19.16	-14.52		II	
T2(OI)	19.55	-15.11		III	
T2(OI)	19.75	-15.24		III	
T2(OI)	19.85	-15.44		III	



Grade III rock in rock description

Joint spacing, roughness, aperture, staining and orientation behind rock description