Soil and Rock
FIELD Description

Technical English for Geotechnology

กฤติกา ตระกูลงาม

Standards Used

ISO 14688

International Organization for Standardization (ISO)

Geotechnical investigation and testing — Identification and classification of soil

ISO 14689

International Organization for Standardization (ISO)

Geotechnical investigation and testing — Identification, description and classification of rock

BS 5930: 1999
Amendment 1 (2007)

British Standards Institution

The code of practice for site investigations

Word Order

	Coarse soil	Fine Soil	Rock
1	**Relative Density** (if SPT-N is available)	**Consistency**	**Strength**
2	**Bedding**		
3	**Colour** (Soil color chart)		**Colour** (Rock color chart)
4	**Secondary Constituents** in order of increasing dominance including the following for coarse and very coarse secondary fractions • particle dimensions • shape • sorting • strength • lithology • composition		**Secondary Constituents** • matrix (for clast supported materials) • clasts (for matrix supported materials)
5	**Minor Constituents**	**Minor Constituents**	**Minor Constituents**

Word Order (Cont.)

	Coarse soil	Fine Soil	Rock
6	Particle dimensions, shape, strength, sorting, and lithology of **PRINCIPAL SOIL TYPE**	**PRINCIPAL SOIL TYPE**	**ROCK NAME**
7	Minor Constituents other information	Minor Constituents other information	Minor Constituents other information
8	**GEOLOGICAL FORMATION** including weathering classification		
9	Additional information on principal or secondary constituents	Additional information on principal or secondary constituents	
10	Mass characteristics such as		
	Weathering		Weathering
	Fabric		Discontinuities
	Discontinuities		Fracture state

Consistency (fine soils)

Extremely soft	Finger pushed in easily to full extent; unable to maintain shape.
Very soft	Finger easily pushed in up to 25 mm; exudes between fingers.
Soft	Finger pushed in up to 10 mm; moulded by light finger pressure.
Firm	Thumb makes impression easily; cannot be moulded by finger; rolls to thread.
Stiff	Can be indented slightly by thumb; crumbles, breaks; remoulds to lump.
Very Stiff	Indented by thumbnail; crumbles, does not remould.
Hard	Scratched by thumbnail; brittle behaviour.

Strength (rocks)

Weak	Can be peeled with a pocket knife with difficulty; shallow indentation made by firm blow with point of a geological hammer; rock broken by hammer blows when sample held in hand; thin slabs, corners or edges can be broken off with heavy hand pressure.	Chalk, claystone, potash, marl, siltstone, shale, rocksalt
Medium strong	Cannot be scraped or peeled with a pocket knife; specimen resting on a solid surface can be fractured with a single blow from a geological hammer.	Concrete, phyllite, schist, siltstone
Strong	Specimen resting on a solid surface requires more than one blow of a geological hammer to fracture it.	Limestone, marble, sandstone, schist
Very strong	Specimen requires many blows of a geological hammer to fracture it; specimen chipped by hammer blows.	Sandstone, basalt, gabbro, gneiss, granodiorite, tuff
Extremely strong	Specimen can only be chipped with a geological hammer; can only be broken by sledge hammer; rings on hammer blows.	Fresh basalt, flint, gneiss, granite, quartzite

Bedding Types

Bedded > 20 mm

Laminated < 20 mm

Massive (no beds)

Interbedded

Interlaminated

✜ Thickness

Bedding Thickness

Typical thickness or spacing (mm)	Bedding term
over 2000	Very thickly bedded
2000–600	Thickly bedded
600–200	Medium bedded
200–60	Thinly bedded
60–20	Very thinly bedded
20–6	Thickly laminated
under 6	Thinly laminated

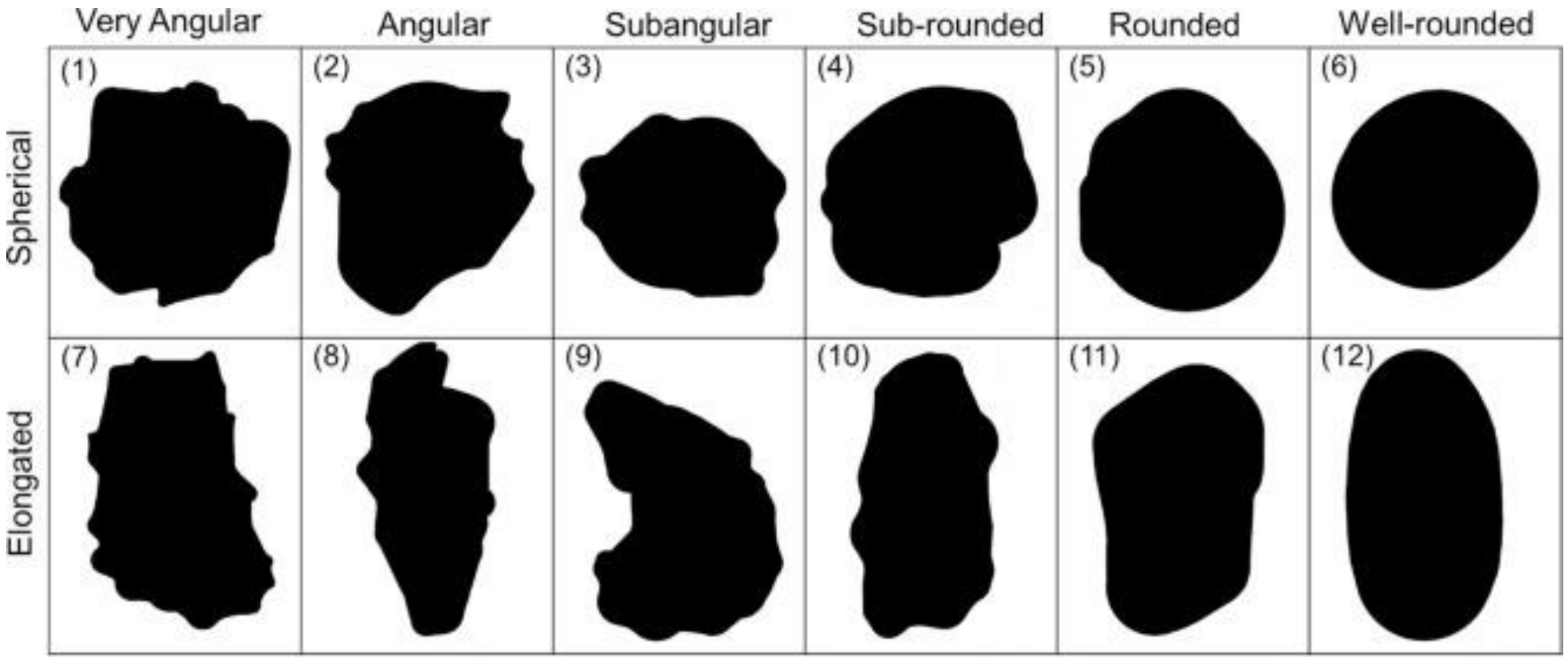
Bedding Description Example

[adj.] ✣ [adj.] ✣ [noun]

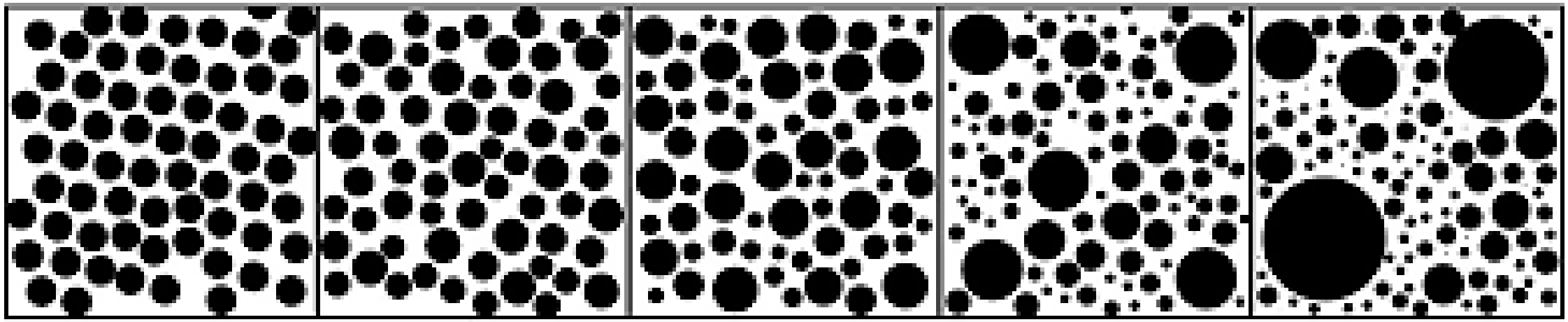
thinly bedded limestone

- thickly interlaminated SAND and CLAY
- massive SANDSTONE

Shape


Very Angular
Angular
Subangular
Sub-rounded
Rounded
Well-rounded
Spherical
Elongated
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)

Sorting


very well sorted
well sorted
moderately sorted
poorly sorted
very poorly sorted

Patterns

Description (adj.) for colour patterns

mottled	เป็นดวง จุด หรือวง ขนาดไม่เท่ากันก็ได้
spotted	เป็นจุด ขนาดค่อนข้างคงที่
stained	มีรอยด่าง รอยเปื้อน
streaked	เป็นสาย หรือเป็นเส้นยาว ไม่จำเป็นต้องขนาน
striped	เป็นเส้นบาง ค่อนข้างขนาน
banded	เป็นแถบ (เส้นหนา) ค่อนข้างขนาน
gleyed	เป็นสีเทา หรือ เทาอ่อน (see glossary)

streaked

orange sandstone with **streaks** of red and orange (iron), blue and green (copper), brown and black (manganese), and white (limonite)

https://www.nps.gov/piro/learn/nature/geologicformations.htm

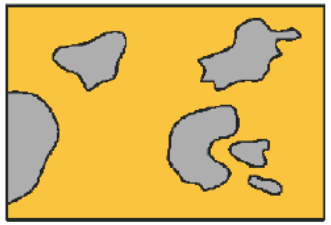
mottled

dark gray (dolomite) **mottled** gray limestone

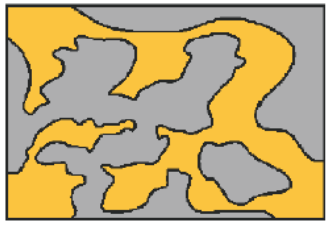
https://www.mdpi.com/2075-163X/13/9/1172

Description of Colour Mottling

Orange



Orange mottled grey

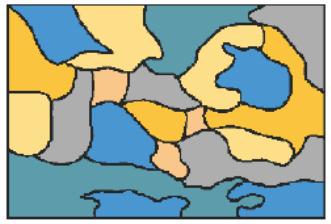


Orange and grey mottled

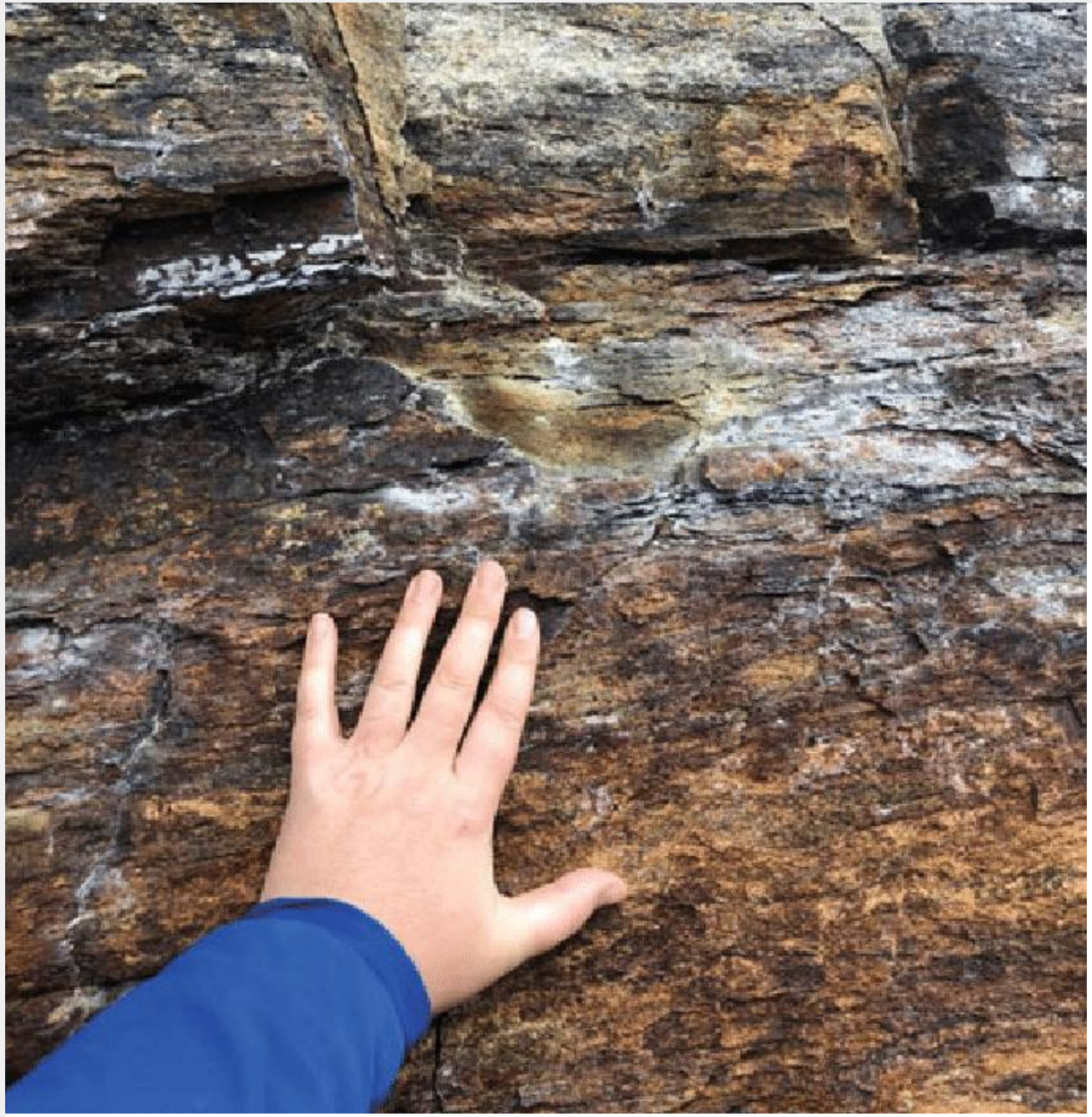
Grey mottled orange

Grey

Grey, blue and orange mottled



Multicoloured



stained

orange (iron) **stained** bluish gray schist

https://www.researchgate.net/publication/347913147_Keynote_Lecture_The_Jettan_Rockslide-An_Engineering_Geological_Overview?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoiX2RpcmVjdCJ9fQ

spotted

spotted orange sandstone

https://richardigibson.substack.com/p/spotted-rocks

Grammar rules

[adj.] ✚ [adj.] ✚ [adj.] ✚ [adj.] ✚ [noun]

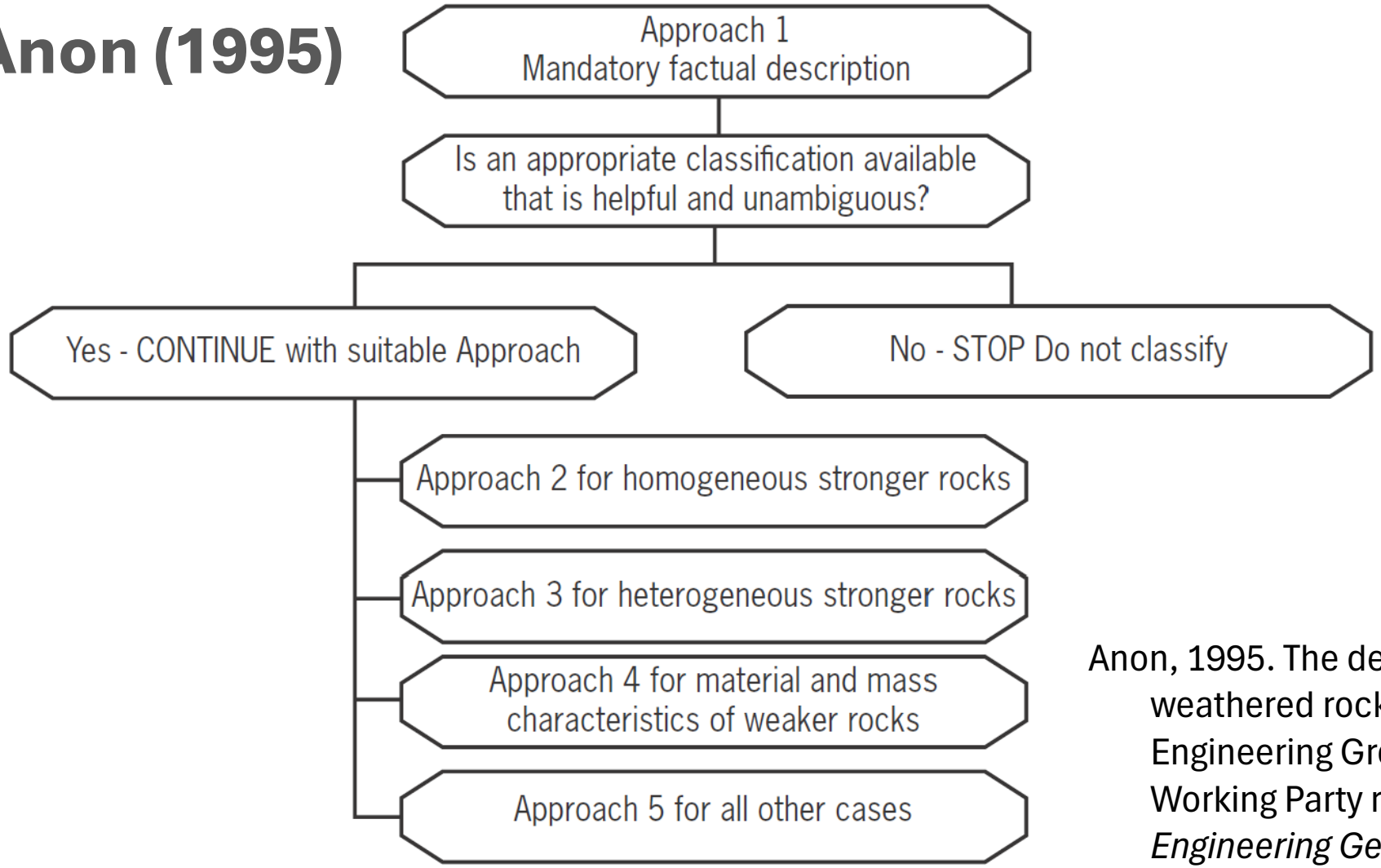
gray spotted reddish brown shale

สีของลวดลาย ลวดลาย สีรอง สีหลัก

- reddish brown (2.5YR 5/3) and gray (2.5Y 6/1) thinly colour-banded sandy CLAY

Approach to Weathering Description

Anon (1995)



Anon, 1995. The description and classification of weathered rocks for engineering purposes. Engineering Group of Geological Society Working Party report. *Quarterly Journal of Engineering Geology, 28,* 207–242

Homogeneous Strong Rocks

Grade	Classifier	Typical characteristics
VI	Residual soil	Soil, retains none of original texture or fabric
V	Completely weathered	Considerably weakened Slakes Original texture apparent
IV	Highly weathered	Does not readily slake when dry sample is immersed in water
III	Moderately weathered	Considerably weakened, penetrative discolouration
II	Slightly weathered	Slight discolouration, weakening
I	Fresh	Unchanged from original state

Heterogeneous Strong Rocks

Zone	Proportions of material grades	Typical characteristics
6	100% G IV to VI (not necessarily all residual soil)	May behave as soil.
5	<30% G I–III >70% G IV–VI	Weak grades control behaviour. Corestones may be significant.
4	30–50% G I–III 50–70% G IV–VI	Rock framework contributes to strength; weathering products (matrix) control stiffness and permeability.
3	50–90% G I–III 10–50% G IV–VI	Rock framework controls strength and stiffness; matrix controls permeability.
2	>90% G I–III <10% G IV–VI	Weak materials along discontinuities affect shear strength, stiffness, permeability.
1	100% G I–III (not necessarily all fresh rock)	Behaves as rock.

Weak Rocks

Class	Classifier	Typical characteristics
E	Reworked or residual	Matrix with occasional altered random or 'apparent' lithorelicts, bedding destroyed. Classed as reworked when foreign inclusions are present as a result of transportation
D	Destructured	Greatly weakened, mottled, ordered lithorelicts in matrix becoming weakened and disordered, bedding disturbed
C	Distinctly weathered	Further weakened, much closer fracture spacing, grey reduction colours
B	Partially weathered	Slightly reduced strength, slightly closer fracture spacing, weathering penetrating in from fractures, brown oxidation colours
A	Unweathered	Original strength, colour and fracture spacing

Typical Weathering Features of Overconsolidated Clayey Soil

Weathering class	Physical weathering processes										Observable effects			Chemical weathering processes	Observable effects
Reworked	Fissure formation by stress relief	Fissure formation by ice lensing	Old subvertical contraction cracks	Modern desiccation cracks	Deep shearing by periglacial processes	High angle shearing by periglacial heave/collapse	Subhorizontal shearing by solifluction	Random accommodation shearing by solifluction	Moisture content and volume changes associated with stress relief, periglacial and chemical processes	Periodic moisture content and volume changes	• Occasional randomly orientated lithorelicts • Occasional included foreign material	Solifluction shears	No original bedding	Increasing leaching Increasing reduction (gleying)	• Brown and light grey mottled clay • Gypsum crystals rare or absent.
Destructured											• Frequent randomly orientated lithorelicts		Bedding increasingly disturbed		• Brown and light grey mottled clay • Centre of relicts and fissure blocks brown • Gypsum crystals common
Weathered								Fabric disturbance from chemical weathering			• Numerous horizontally aligned lithorelicts • Lensoidally fissured	Increasing likelihood of polished shear surfaces	Bedding undisturbed		• Brown clay with light grey gleying on fissures • Gypsum crystals common
Partially weathered														Oxidation complete	• Brown clay • Gypsum crystals common
											• Fissure spacing decreases • Increasing likelihood of occasional slightly polished fissures			Increasing oxidation	• Brown clay around fissures • Centre of fissure blocks grey • Occasional gypsum crystals
															• Grey clay with brown staining • Rare gypsum crystals on fissures
Unweathered											• Original fissured clay				• Grey clay

Weathering Description Example

Soils

- Firm to stiff lensoidally fissured and cracked brown mottled light grey CLAY. Lensoidal fissuring is extremely closely spaced (3/5/10). Contraction cracks are subvertical medium to closely spaced rough light grey gleyed. Occasional gypsum crystals (destructured LONDON CLAY)
- Stiff fissured brown mottled grey slightly sandy CLAY with occasional rounded gravel size lithorelicts of very weak mudstone. Fissures are randomly orientated very closely spaced (weathered CARBONIFEROUS MUDSTONE).

Weathering Description Example

Rocks

- Strong thinly bedded light and dark grey medium grained SANDSTONE (CARBONIFEROUS SANDSTONE).
  Weathering:
  discontinuities heavily stained black;
  with light orange brown discolouration penetrating up to 30 mm;
  slight loss of strength on discontinuity walls up to 10 mm penetration;
  extremely closely spaced random fractures in 40 mm thick zones around joints;
  occasional sand infill up to 0.5 mm in joints.

Fabric (Soil & Sedimentary rock)

Describes features of (or inside) the soil mass

(Noun)
Laminae
Lenses
Desiccation cracks
Lithorelics
Root tracks
Bioturbation
Cryoturbation

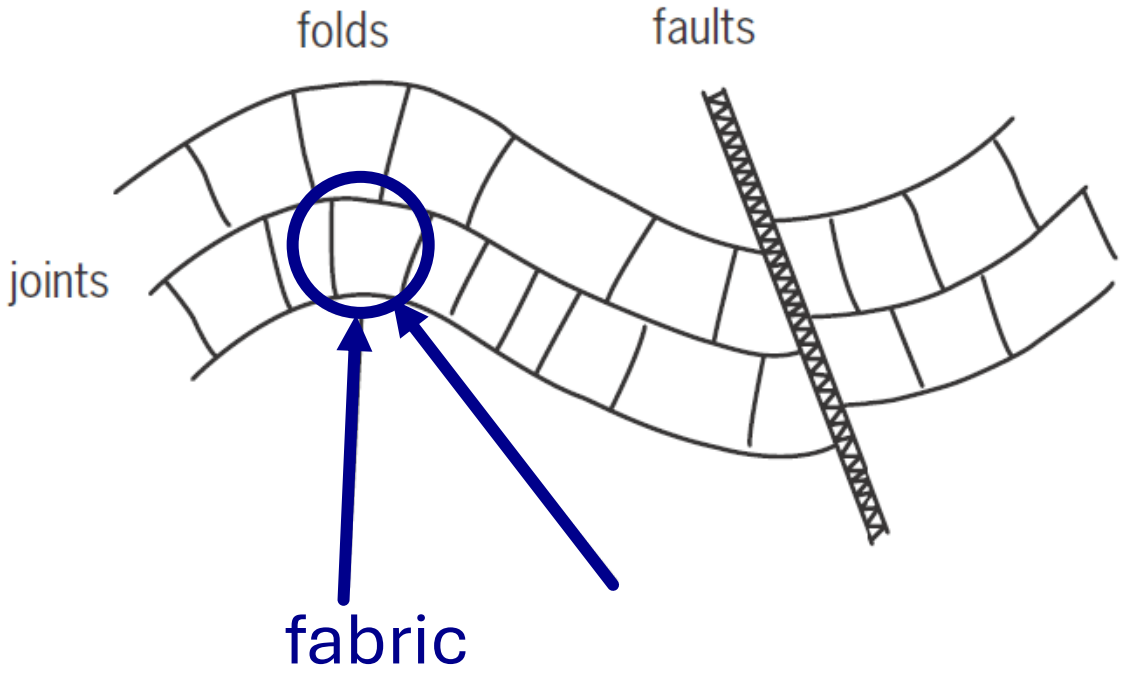
✚

Size or Spacing

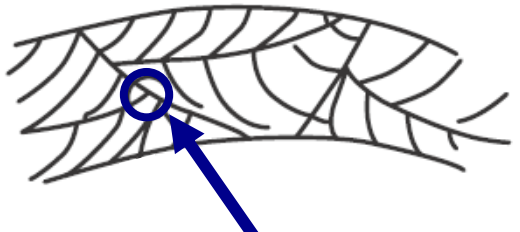
- CLAY with closely spaced lenses (5 by 10 to 15 by 20 mm) of peat
- CLAY with widely spaced thin laminae of sand
- MUDSTONE with closely spaced desiccation cracks (25/100/220)

Structure/Fabric/Texture Comparison

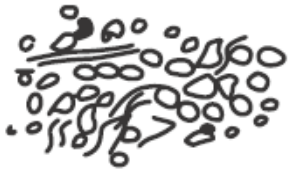
Structure



Fabric



Texture



petrographic – grains and relationships

Discontinuities (soil & rock)

Discontinuity Type (Noun)	Description
Incipient fractures	orientation
Induced fractures	spacing
Cleavage	persistence
Cleavage fracture	termination
Joints (for rock)	roughness
Fissures (for soil)	wall strength
Shear surfaces	aperture size
Faults	infilling
	seepage
	number of sets

Discontinuity Spacing

Typical thickness or spacing (mm)	Discontinuity term
over 2000	Very widely spaced
2000–600	Widely spaced
600–200	Medium spaced
200–60	Closely spaced
60–20	Very closely spaced
20–6	Extremely closely spaced
under 6[1]	Extremely closely spaced

Discontinuities Example

- firm fissured and sheared CLAY. Fissures are generally subvertical very closely spaced. Shears are subhorizontal (175/05 to 200/10) up to 500 mm persistence smooth undulating straight striated highly polished.
- very closely jointed very thinly bedded SANDSTONE. Joints are undulating rough tight and clean.
- extremely closely sheared laminated MUDSTONE. Shears dip up to 5-10° planar smooth polished and lightly striated.
- fissures are randomly orientated very closely spaced

Boundaries (soil & rock)

Boundary distinctness

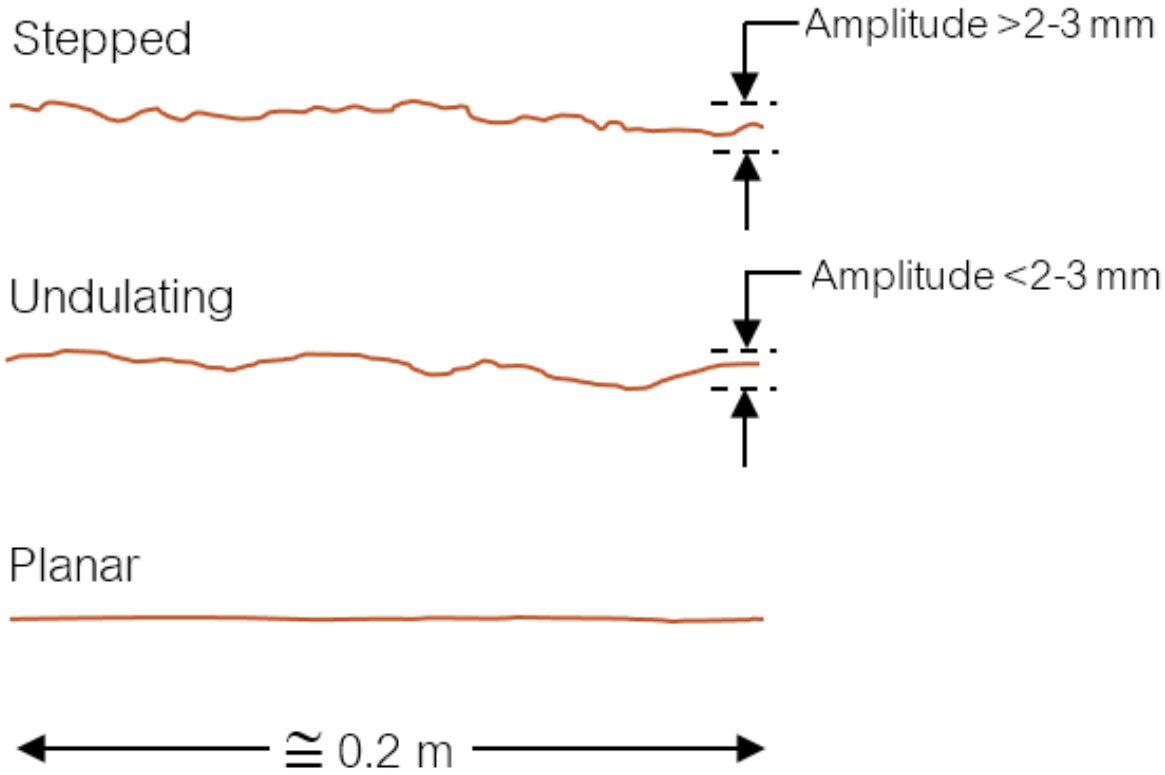
Class	Boundary thickness	Term
1	<5	Sharp
2	5–25	Abrupt
3	25–60	Clear
4	60–130	Gradual
5	>130	Diffuse

Boundary form

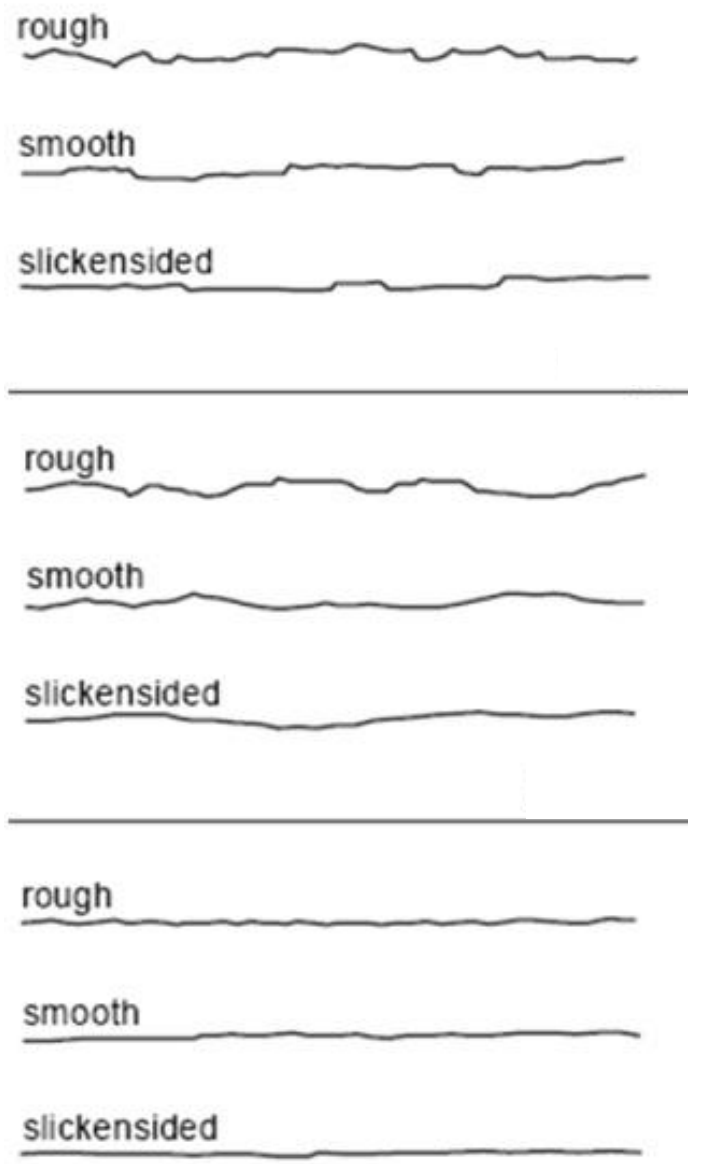
Class	Description	Term
1	Boundary form is a plane with few or no irregularities and is usually at the same depth across the exposure.	Smooth
2	Boundary has broad, shallow, regular pockets.	Wavy
3	Boundary has pockets which are deeper than the width.	Irregular
4	At least one of the horizons is discontinuous and the boundary is interrupted.	Broken

Roughness

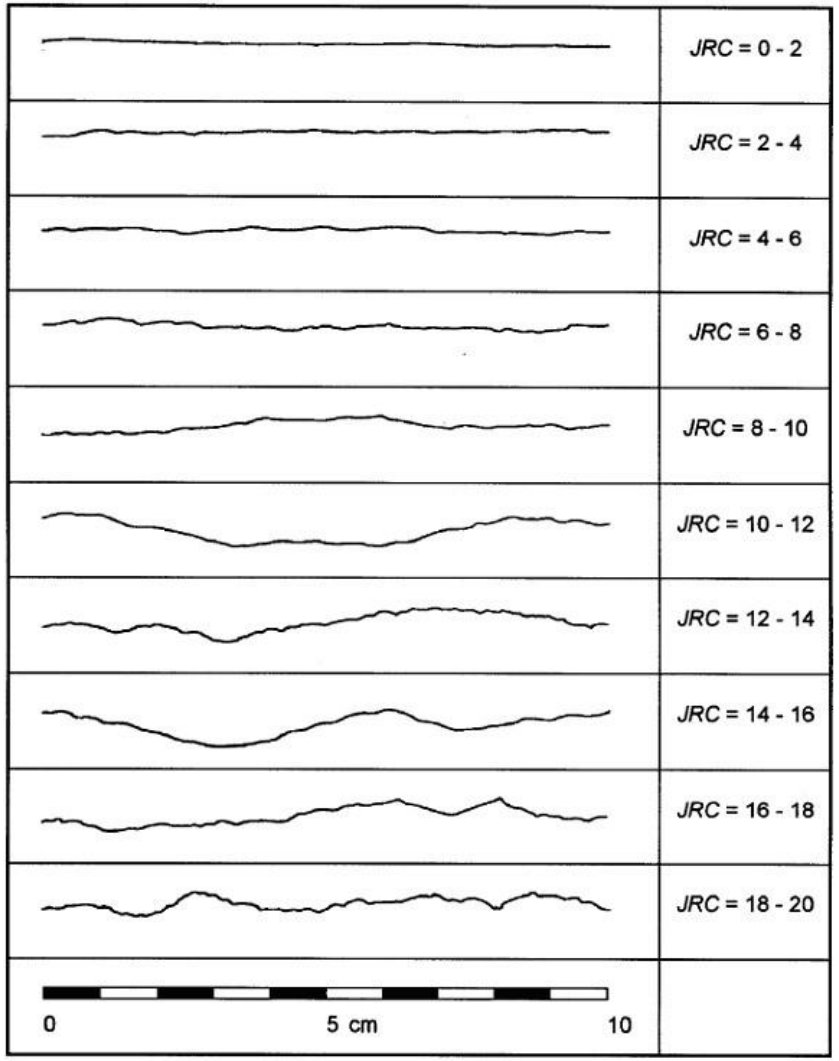
Amplitude (3 types)



Surface (3 Types)



Joint Roughness Coefficient



Joint Filling

1. Non-existent
2. Surface staining
3. Non-cohesive
4. Clay
5. Cemented (cement type)
6. Chlorite, talc or gypsum
7. Others (specify)

Examples – Coarse Soils

Loose orangish brown gravelly fine to coarse SAND. Gravel is rounded fine and medium of quartz (RIVER TERRACE DEPOSIT)

Dense brown slightly sandy sub-rounded fine to coarse GRAVEL of various lithologies with low cobble content. Cobbles are subrounded of strong sandstone (FLUVIO GLACIAL DEPOSIT)

Medium dense brownish grey medium to coarse sandy slightly clayey subrounded fine GRAVEL of medium grained sandstone (GLACIAL TILL)

Examples – Coarse Soils

Grey and light grey very medium to coarse sandy subangular tabular fine and medium weak mudstone GRAVEL *or*

Very sandy GRAVEL. Gravel is grey subangular tabular fine and medium of weak mudstone. Sand is light grey medium to coarse (RIVER CHANNEL/ WEATHERED BEDROCK?)

Examples – Fine Soils

Stiff reddish brown and greyish green slightly sandy gravelly CLAY with low cobble content. Gravel and cobbles are fine of siltstone (MERCIA MUD-STONE GROUP)

Firm very thinly bedded brown silty CLAY

Firm greyish brown SILT

Stiff dark bluish grey thickly laminated dark grey slightly fine sandy SILT. Colour changes to light grey quickly on drying (ESTUARINE DEPOSITS)

Soft thickly laminated grey CLAY with closely spaced thin laminae of grey fine sand with dust-ings of brown silt. Occasional pockets (up to 10 mm) of peat (ALLUVIUM)

Examples – Fine Soils

Very stiff fissured and sheared thinly bedded dark grey mottled orangish brown CLAY with frequent shell fragments. Fissures are generally subvertical very closely spaced smooth planar grey gleyed. Shears are subhorizontal (175/05 to 200/10) up to 500 mm persistence smooth undulating straight striated highly polished (Weathered LIAS CLAY)

Firm to stiff greyish brown slightly fine sandy slightly gravelly CLAY with occasional lenses (5 by 15 to 15 by 50 mm) of yellow silty sand. Gravel is subangular to subrounded fine and medium of various lithologies (GLACIAL TILL)

Examples – Materials at the soil/rock boundary

FINE

Very stiff to extremely weak fissured thickly laminated brownish grey and yellowish brown mottled CLAY/MUDSTONE. Fissures are generally subvertical very closely spaced smooth planar with low polish (Weathered LONDON CLAY)

COARSE

Light grey fine to medium SAND with occasional fine gravel size fragments of extremely weak light grey sandstone (D2 SHERWOOD SANDSTONE)

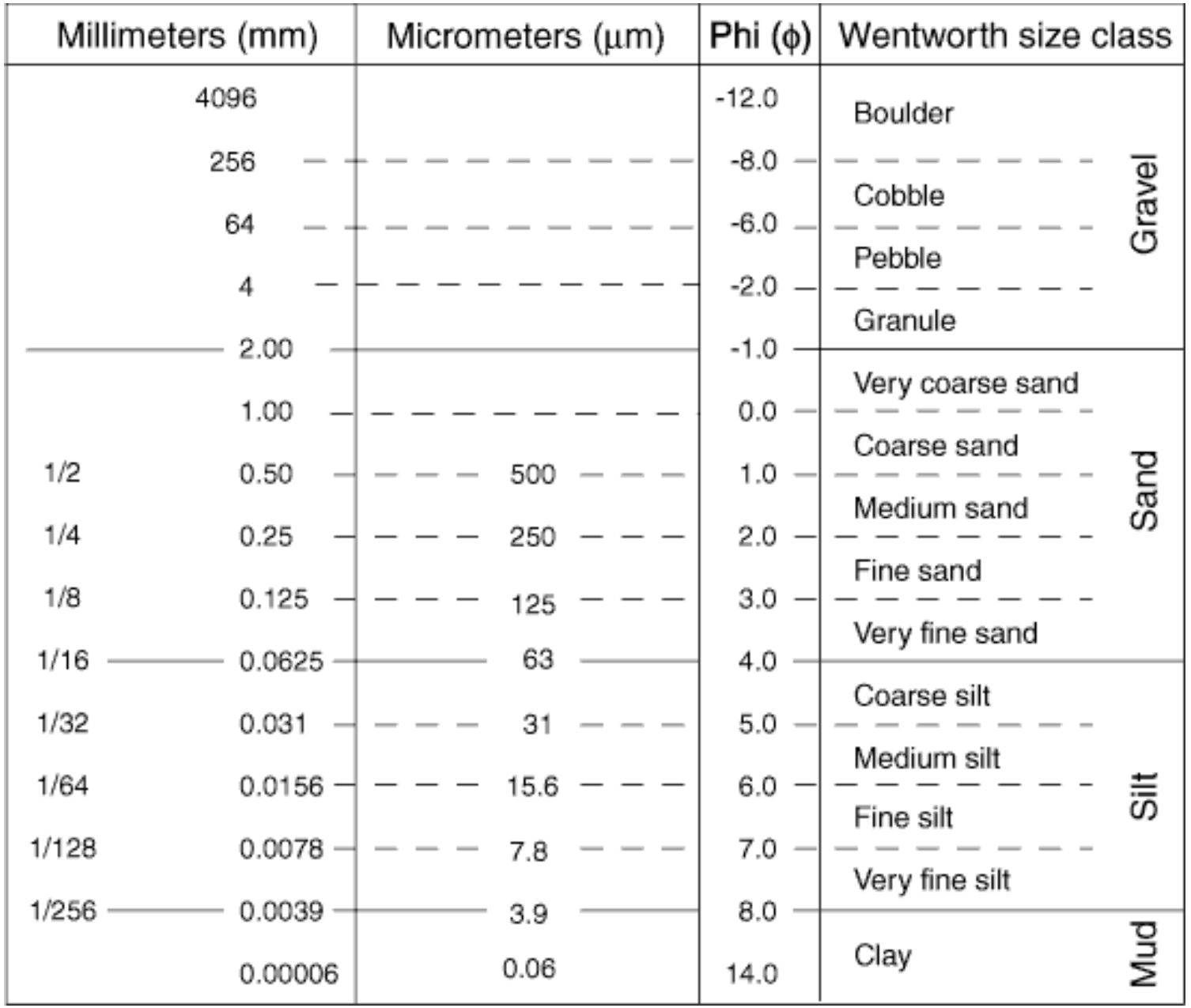
Examples – Rocks

Strong thickly bedded brown medium grained dolomitic LIMESTONE (CADEBY FORMATION). Small but steady increase in strength with depth; colour mottled at top of stratum, effects due to weathering

Very weak to weak thickly laminated to thinly bedded light brown fine and medium grained micaceous SANDSTONE (partially weathered SHERWOOD SANDSTONE). No weathering effects apart from staining. Joints: dipping 45°, widely spaced, smooth planar stained

Grain Size

Wentworth (1922)



Sedimentary Structures

bioturbations

mudcracks

ripple marks

sole marks

scour marks

flute casts

groove casts

load casts

imbrications

geopetal structures

cross bedding

cross lamination

graded bedding (e.g. fining upwards, coarsening upwards)

Igneous Rock Types and Textures

Intrusive	Extrusive	Texture
granite	rhyolite	phaneritic
diorite	andesite	aphanitic
gabbro	basalt	porphyritic
diabase	dacite	glassy
pegmatite	obsidian	pyroclastic
peridotite	pumice	pegmatitic
	scoria	
	tuff	

Metamorphic Rock Types

Rock Name	Texture	Grain Size	Comments	Parent Rock
Slate	Foliated	Very fine	Excellent rock cleavage, smooth dull surfaces	Shale, mudstone, or siltstone
Phyllite	Foliated	Fine	Breaks along wavey surfaces, glossy sheen	Slate
Schist	Foliated	Medium to Coarse	Micas dominate, scaly foliation	Phyllite
Gneiss	Foliated	Medium to Coarse	Compositional banding due to segregation of minerals	Schist, granite, or volcanic rocks
Marble	Nonfoliated	Medium to coarse	Interlocking calcite or dolomite grains	Limestone, dolostone
Quartzite	Nonfoliated	Medium to coarse	Fused quartz grains, massive, very hard	Quartz sandstone
Anthracite	Nonfoliated	Fine	Shiny black organic rock that may exhibit conchoidal fracture	Bituminous coal

Increasing Metamorphism

Metamorphic Rock Texture

Foliated

Schistose texture

Gneissic texture

Non-foliated

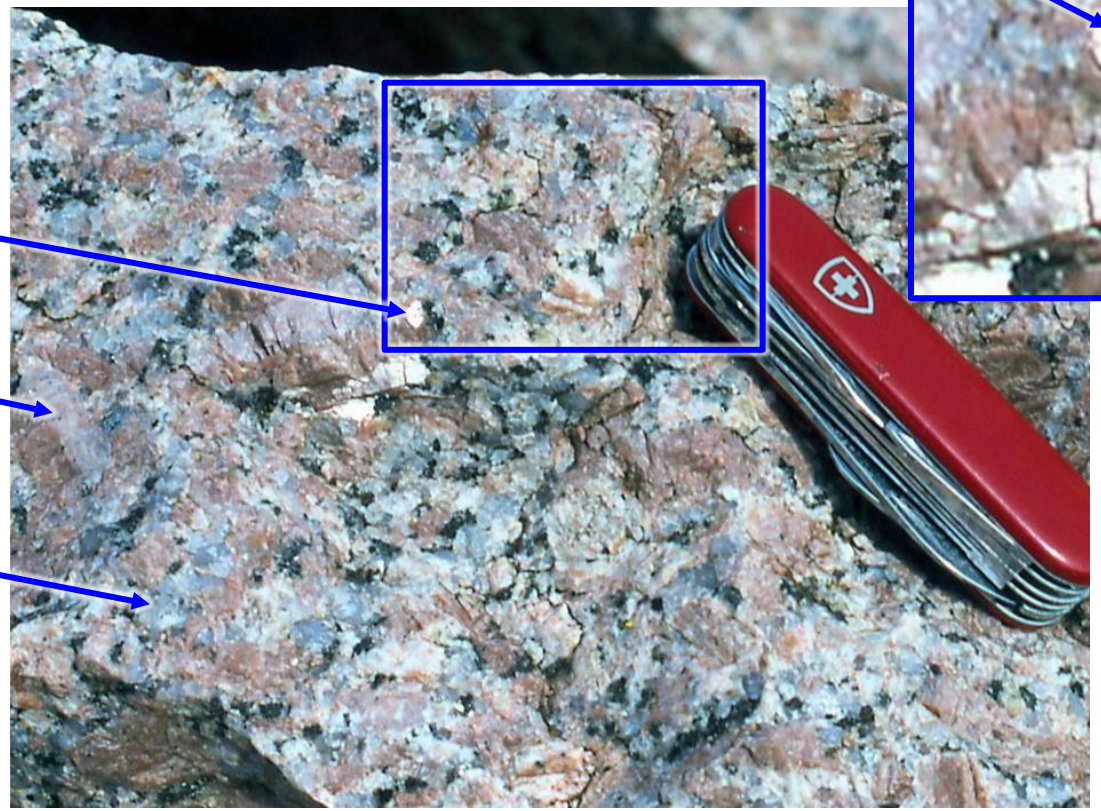
Granoblastic texture

Hornfelsic texture

Cataclastic texture

Sugary texture

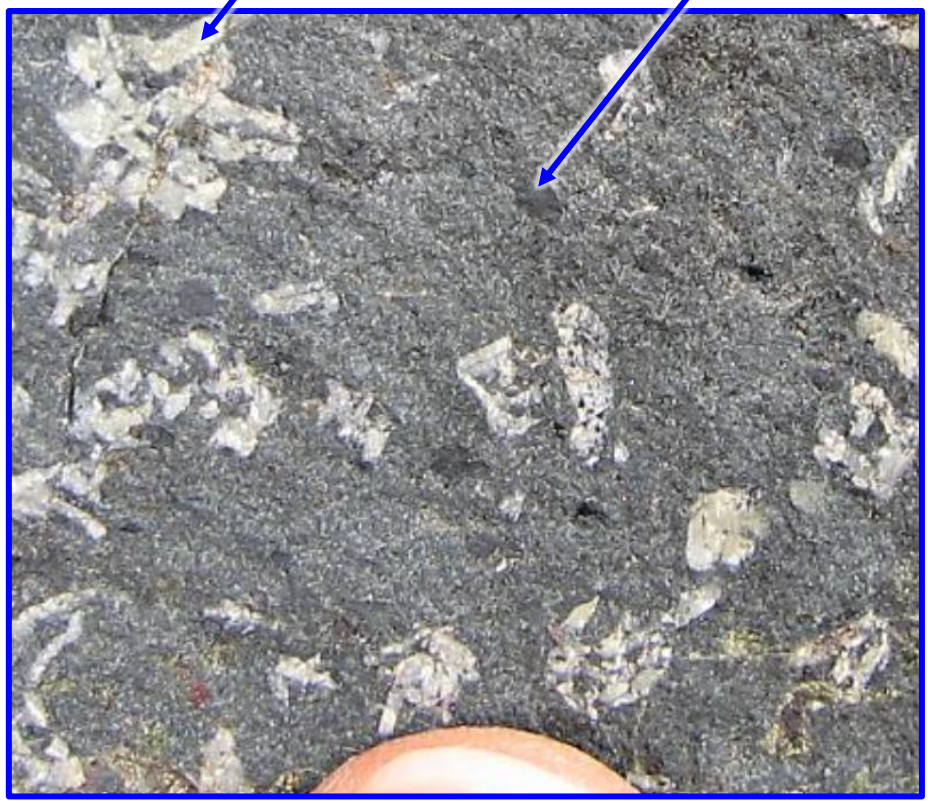
Specimen 1


Plagioclase
K-Feldspar
Quartz
5 cm


Biotite
Plagioclase
1 cm

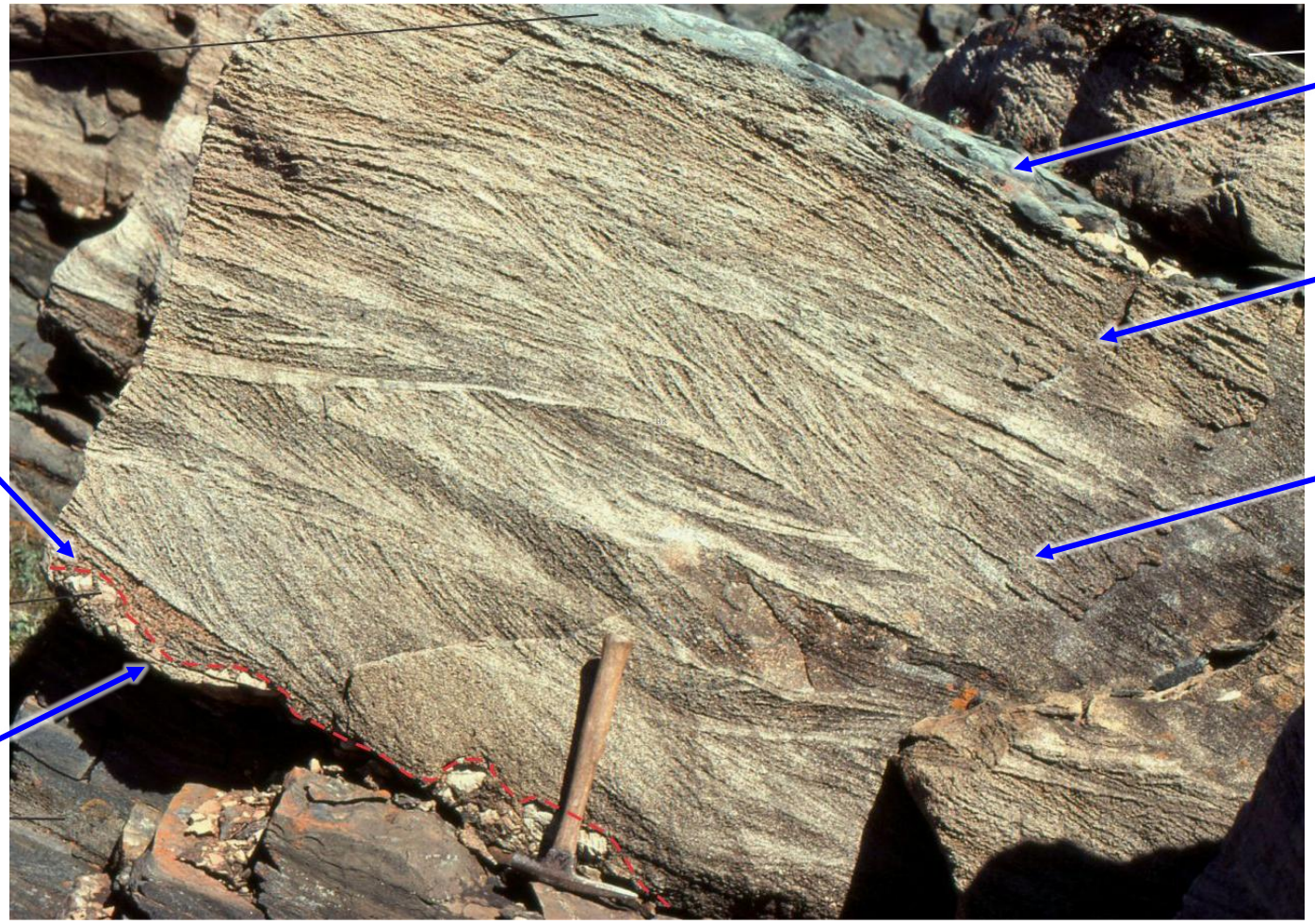
Specimen 2

5 cm



5 mm

Specimen 3


ripple marks
fine grained sandstone
trough crossbedding
sandstone matrix & mudstone clast:
4×7 to 5×13 mm angular
load cast
30 cm

Specimen 4

Glossary

Cryoturbation	mixing of materials from different soil horizons due to freezing and thawing
Gleyed	discoloration of soil due to permafrost
Partings	horizontal discontinuities in soil (only the spacing is described)
Fissures	tensile discontinuities in soil