3. 地表地質調查

3.1 露頭紀錄與採樣

3.2 地層柱狀圖

3.3 野外素描

3.4 岩石

3.5 地質構造

3.1 Description of outcrops and sampling

The standard method for collecting field data of sedimentary rocks is to construct a **graphic log** (**or stratigraphic column**) of the succession and **sketches** of lateral relationships if appropriate.

Example of a **graphic log**

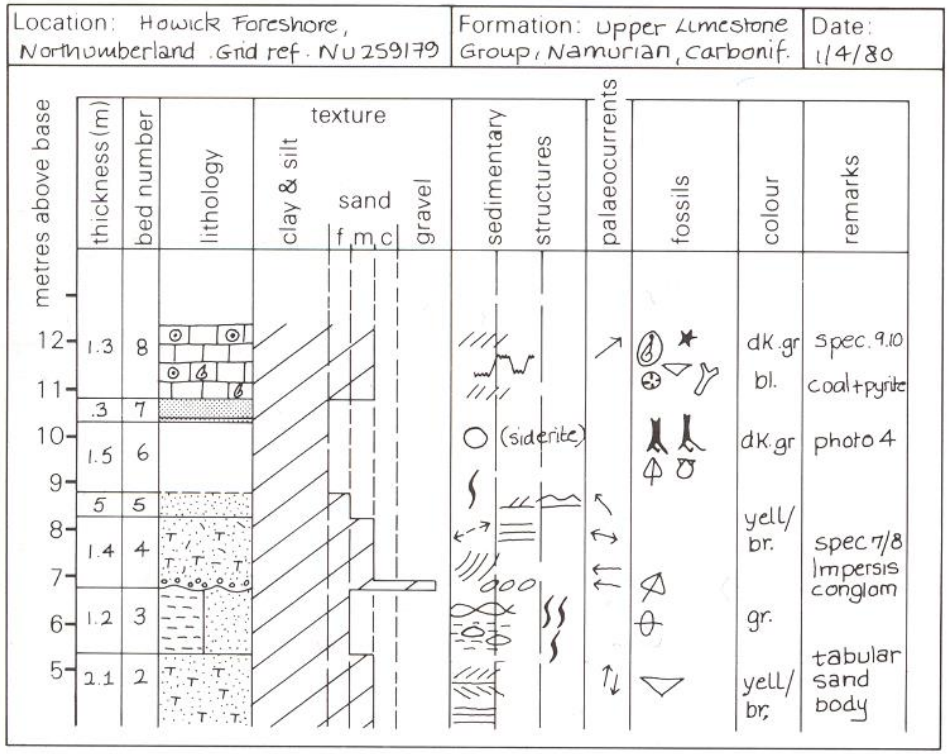
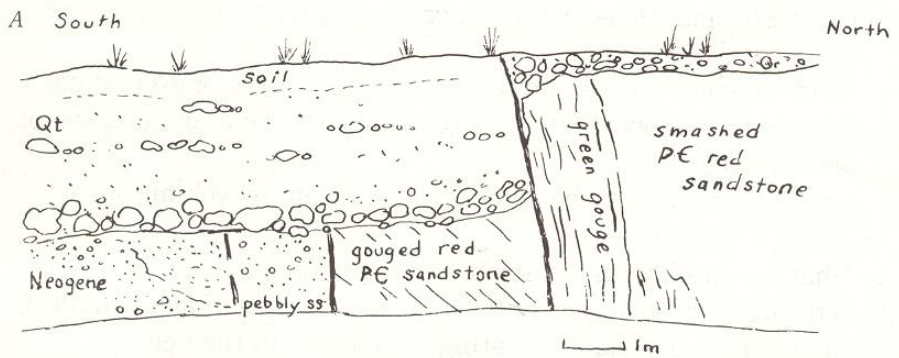


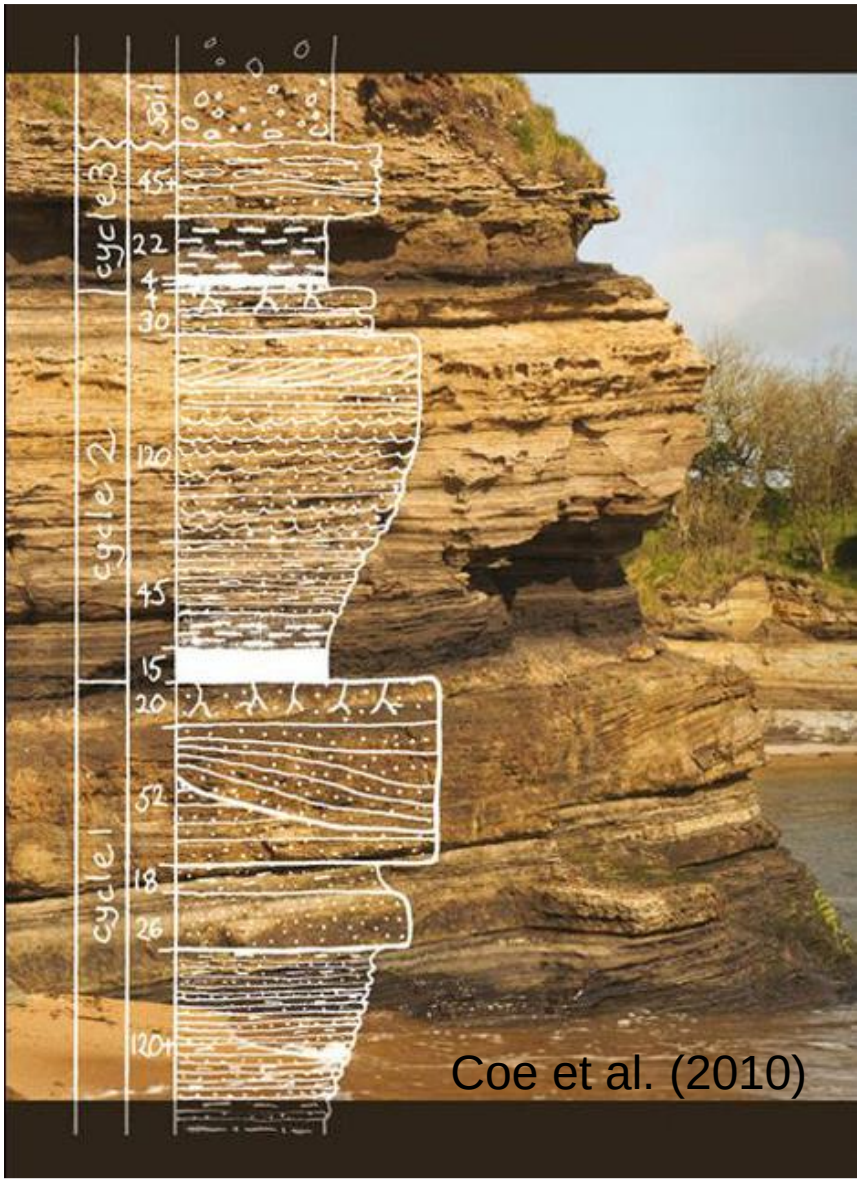
Fig. 2.1 An example of a graphic log. Symbols are explained in Fig. 2.2.

Example of a **field sketch**



View WNW of roadcut across Qujiang fault about 20 km south of Tonghai — it was on this fault that the 1970 Tonghai (M 7.8) EQ occurred.

Symbols used in graphic logs



Coe et al. (2010)

LITHOLOGY

siliciclastic sediments

- clay, mudstone
- shale
- marl
- siltstone
- sandstone (undiff.)
- quartz arenite
- feldspathic sst (arkose)
- lithic sst (litharenite)
- greywacke
- clayey sst
- calcareous sst
- alternating strata sst/shale
- pebble-supported conglomerate
- matrix-supported conglomerate

carbonates

- limestone
- dolomite
- sandy lst

symbols to add:

- intraclast
- ooid
- oncolite/pisolite >2 mm diam
- peloid
- fossils (undiff.)

for specific symbols see below

others

- chert
- peat
- brown coal (lignite)
- hard coal
- halite
- gypsum-anhydrite
- volcaniclastic sediment

SEDIMENTARY STRUCTURES

- flute cast
- groove cast
- tool marks
- load casts
- shrinkage cracks
- striations/ lineations
- symmetrical ripples
- asymmetrical ripples
- parallel lamination
- cross-lamination
- cross-bedding – planar
- cross-bedding – trough
- cross-bedding –herring-bone
- cross-bedding – low angle
- flaser bedding
- lenticular bedding
- wave-ripple lamination
- normal graded bedding
- reversed graded bedding
- imbrication
- slump structures
- convolute bedding
- nodules
- stylolites
- stromatolites
- slight bioturbation
- intense bioturbation

bed contacts:

- sharp, planar
- sharp, irregular
- gradational

palaeocurrents:

- azimuth
- trend

FOSSILS

- fossils (undifferentiated)
- fossils – broken
- ammonoids
- belemnites
- bivalves
- brachiopods
- bryozoan
- coral-solitary
- coral-compound
- crinoids
- echinoids
- gastropods
- graptolites
- stromatoporoid
- trilobite
- algae
- plant fragments
- roots
- burrows

devise others when needed

Graphic logs

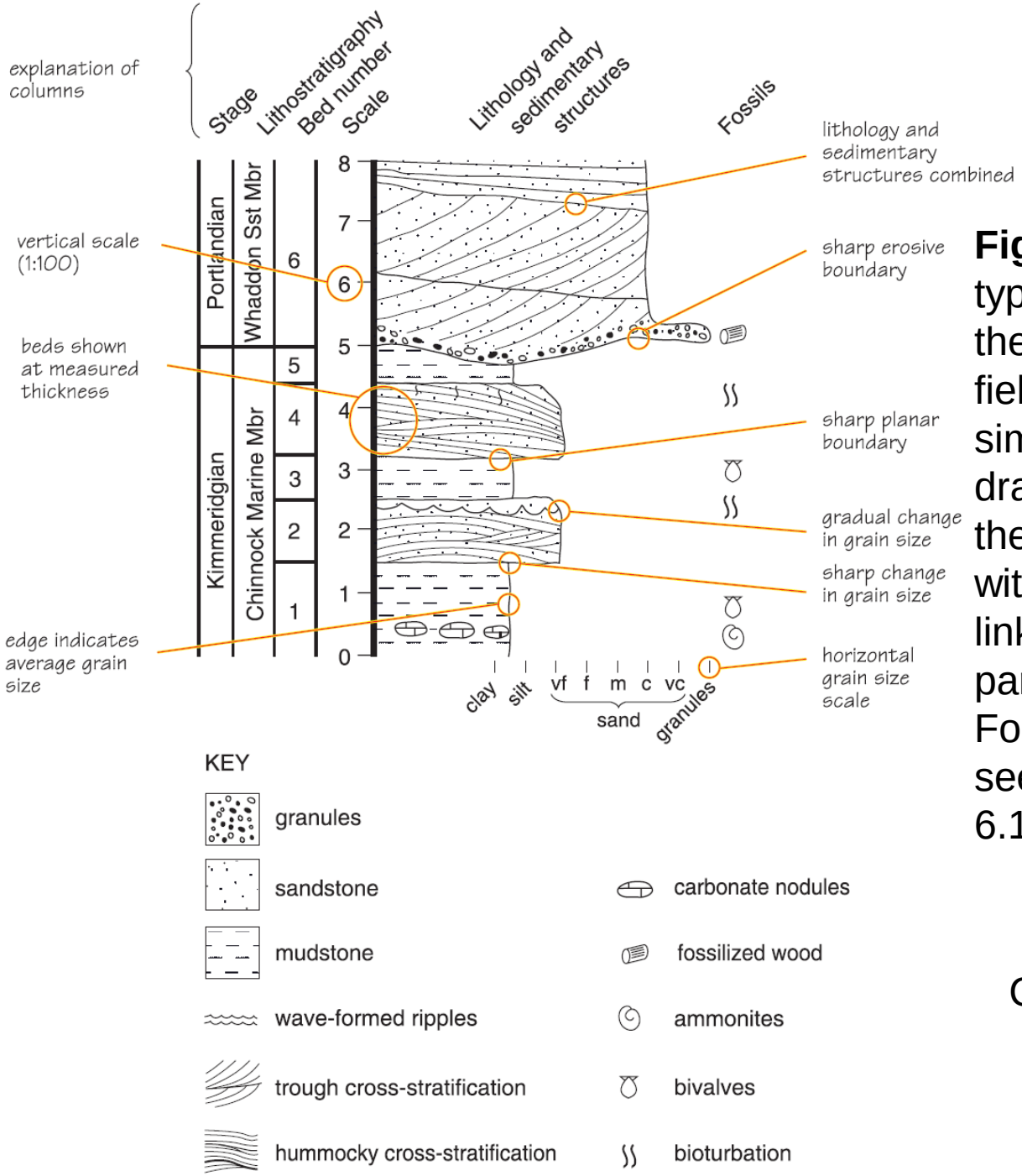
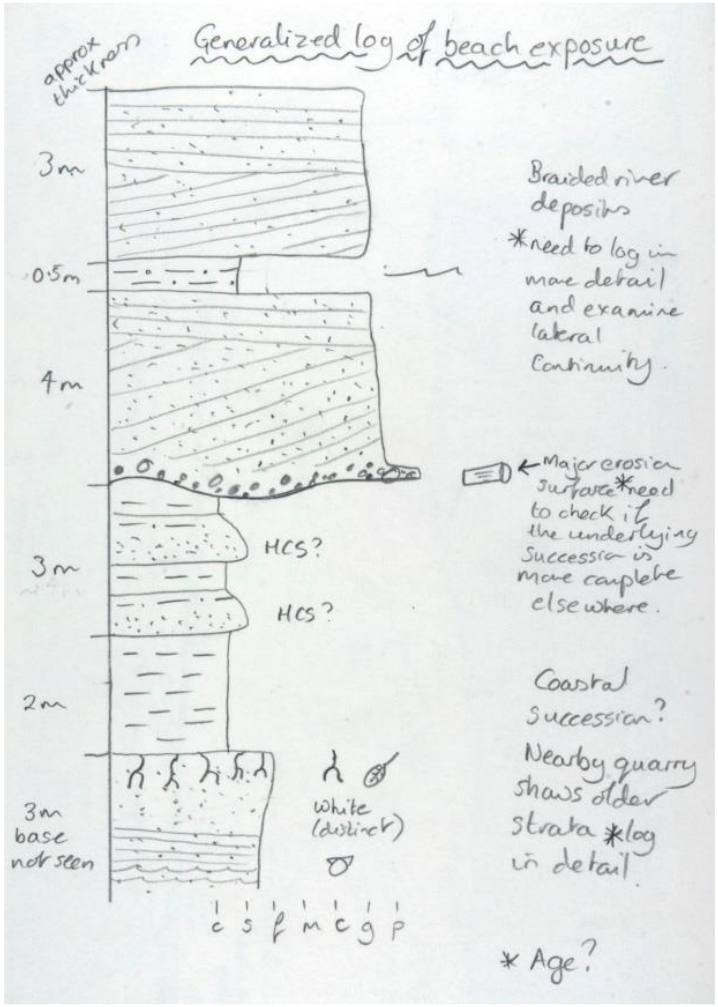
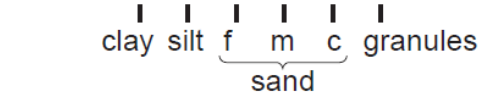


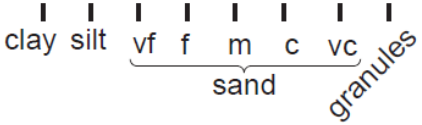
Figure 6.4 A neat version of a typical graphic log with some of the key features labelled. The field version should look very similar except it might not be drawn to scale vertically and there might be other columns with samples, photographs and links to more detailed notes on particular contacts and/or units. For examples of field graphic logs see Figures 4.2 b, 5.10 , 6.9b, 6.11 and the book cover.

Coe et al. (2010)

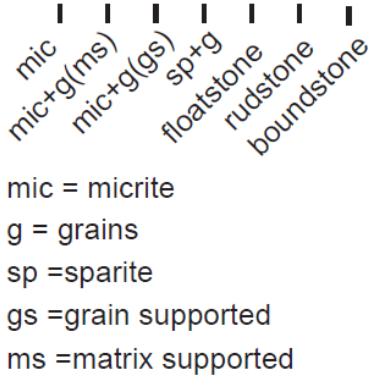




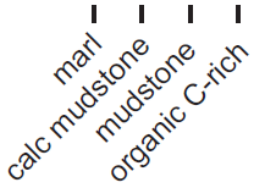
(a)



(b)



(c)



(d)

Figure 6.5 Variety of different grain-size scales. (a) Basic scale for siliciclastic rocks. (b) A more technically correct scale with each of the subdivisions representing a doubling in grain-size diameter for the sand subdivision (but this can be harder to distinguish in the field and does not necessarily add that much more information). (c) Grain-size scale for carbonate rocks. (d) Potential subdivisions based on composition for mudstone successions. For mixed siliciclastic carbonate rocks both grain-size scales are often added to the graphic log.

Dividing outcrop into major units for observation and recording:

- *Nature of the contacts*
- *Lateral changes in thickness*
- *Cross - cutting relationships*
- *Evidence of displacement and deformation*
- *Angular unconformities*

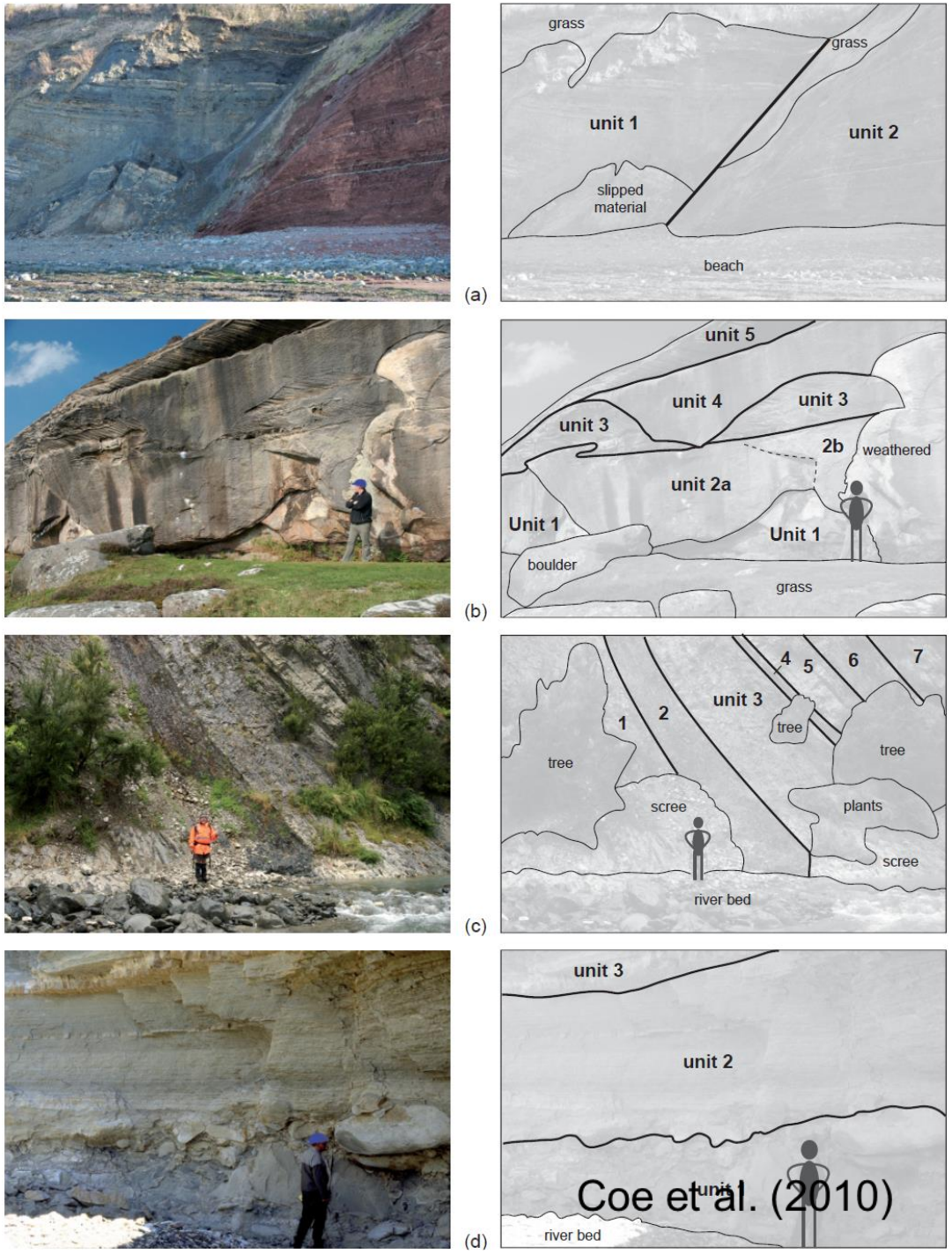
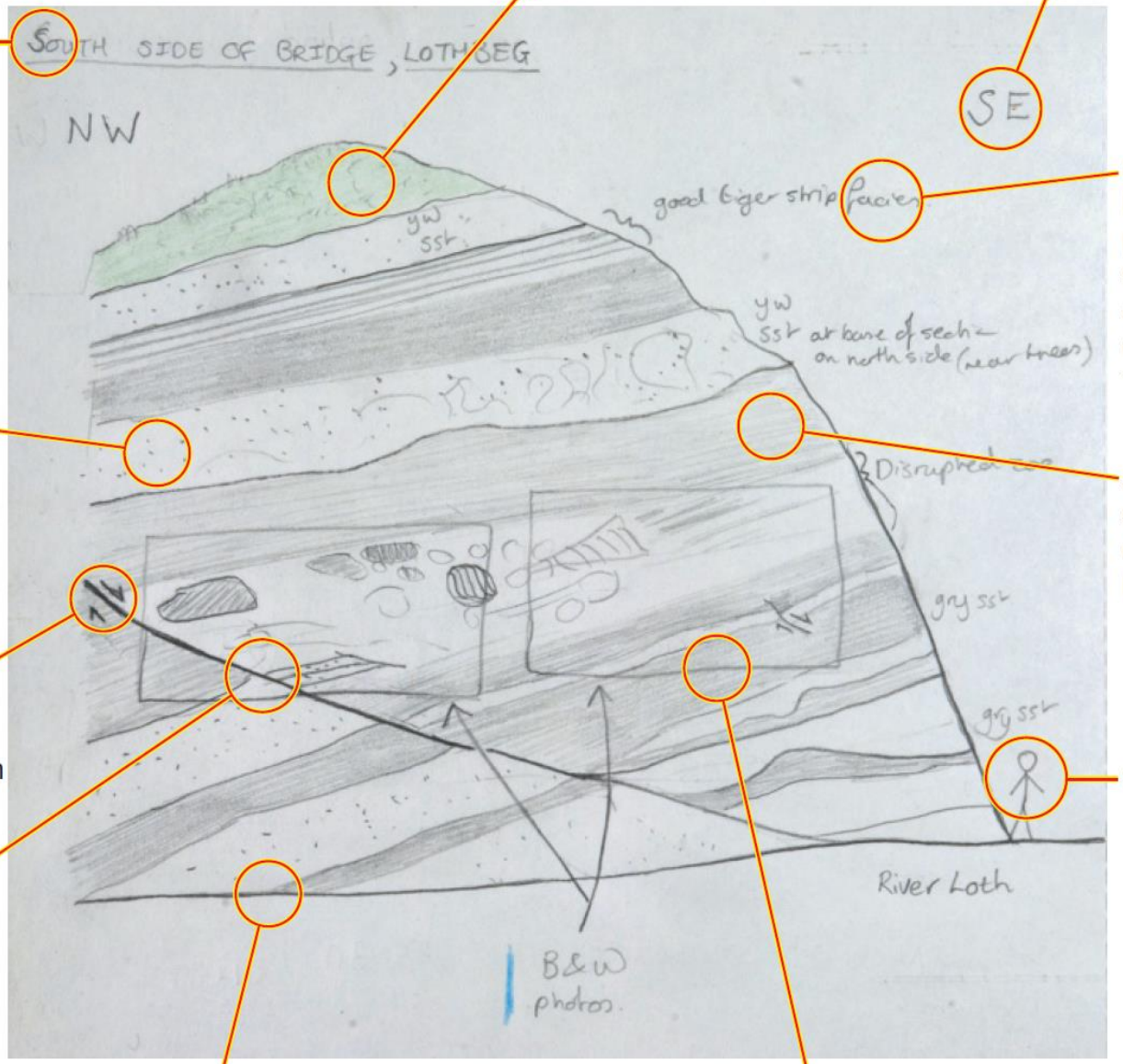


Figure 3.1 Four photographs and accompanying line drawings of different exposures showing how they might be divided into major units for recording and further examination. (a) Jurassic strata faulted against Triassic strata at Blue Anchor, Somerset, UK (height of cliff c . 10 m). (b) Carboniferous strata at Bowden Dors, Northumberland, UK. (c) Eocene strata exposed in the Clarence Valley, South Island, New Zealand. (d) Cenozoic strata at Choirokitia gorge, Cyprus.

Field sketches



clear title

colour for vegetation or to distinguish features

orientation

minimal labels positioned so they are not obscuring the sketch

simple ornament to help define the unit

shading to show darker coloured layers

small amount of interpretation

scale

use of different line weights

edge of sketch clearly defined

inset box to show position of higher resolution sketches or position of photographs

Figure 4.4 An annotated example of a fi eld sketch showing some of the key features that can usefully be included in a sketch. This sketch is of Kimmeridgian rocks exposed in northeast Scotland.

What features should be observed/recorded?

A. Locality descriptions
Geographic title, number and name of maps, coordinate, date

B. Description for outcrop as a whole (rocks and structures, features indicating origins and ages)

1) Unit or rock name.
2) Thickness and overall structure or shape of unit.
3) Main rock type and gross characteristics (topographic expression, type and color of soil, vegetation, nature of outcrops).
4) Range of thickness and average thickness of beds.
5) Shapes of beds or other structures (tabular, lenticular, irregular, etc.).

Bed thickness

1 m	very thickly bedded
0.3 m	thickly bedded
0.1 m	medium bedded
0.03 m	thinly bedded
10 mm	very thinly bedded
3 mm	thickly laminated
	thinly laminated

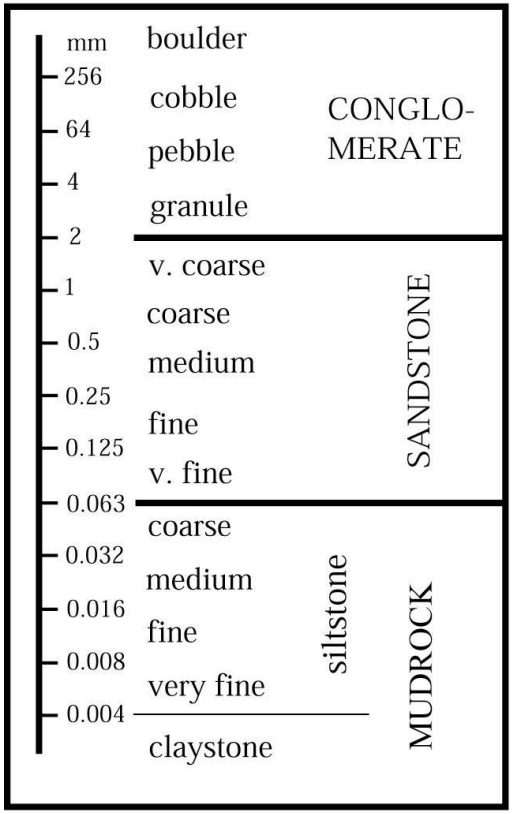
C. Description for individual bed (texture)

a. thickness and shapes of bed, nature of bed contacts (sharp or gradational).
b. color, fresh and weathered (of wet or dry rock).
c. induration (of weathered or dry rock).
d. grain sizes (range of sizes and principal or median size).
e. degree of sorting.
f. shapes of grains.
g. orientations or fabric of shaped grains, especially in relation to rock structures.
h. nature and amount of cement, matrix, or groundmass, if any.
i. nature and amount of pores and any indications.
j. constitution of grains (mineral, lithic, fossil, glass) and their approximate percent by volume.

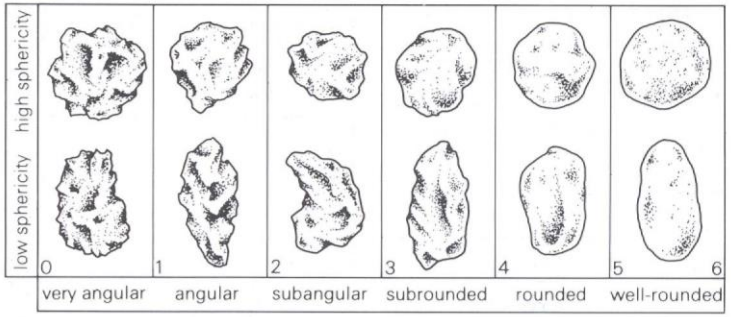
Induration

Unconsolidated:	loose, no cement whatsoever.
Very friable:	crumbles easily between fingers.
Friable:	rubbing with fingers frees numerous grains; gentle blow with hammer disintegrates sample.
Hard:	grains can be separated from sample with a steel probe; breaks easily when hit with hammer.
Very hard:	grains are difficult to separate with a steel probe; difficult to break with hammer.
Extremely hard:	sharp hard hammer blow required; sample breaks across most grains.

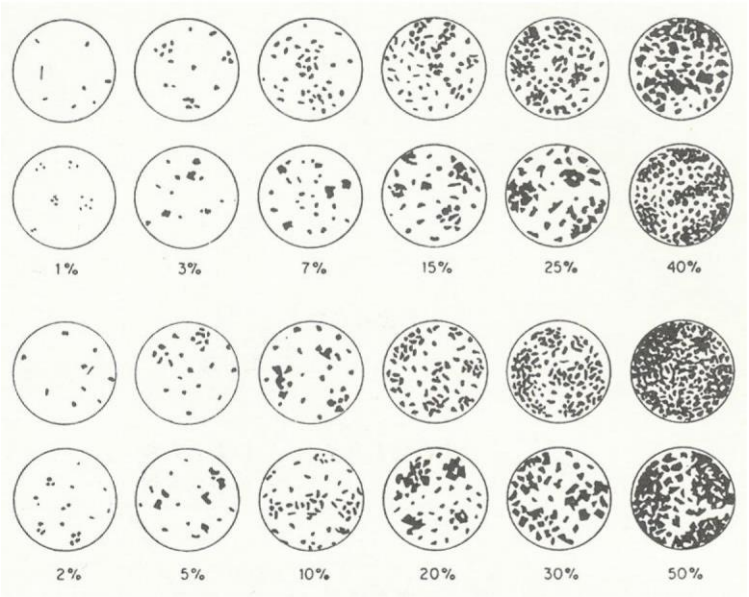
Grain-size scale



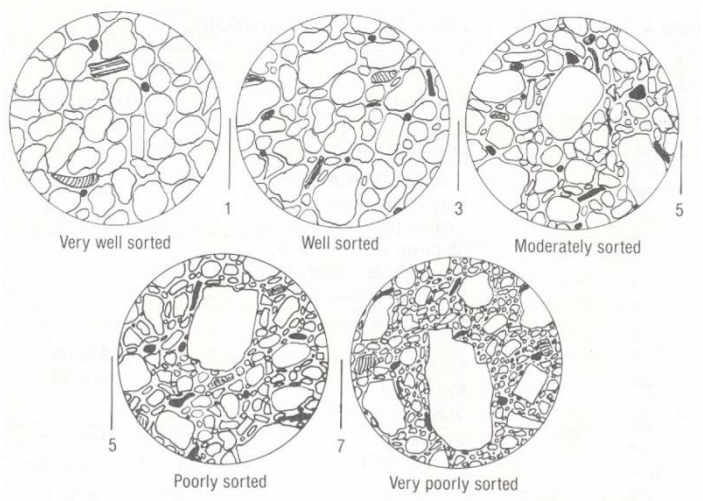
Angularity chart

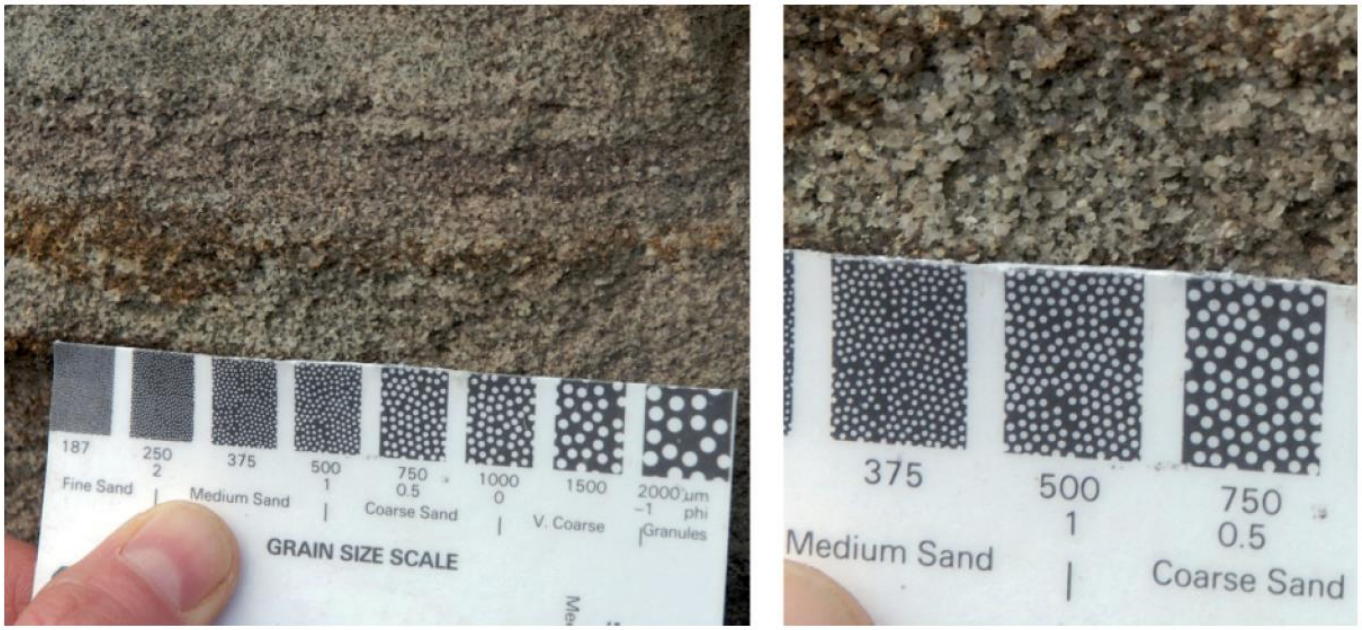


Percentage esitmation



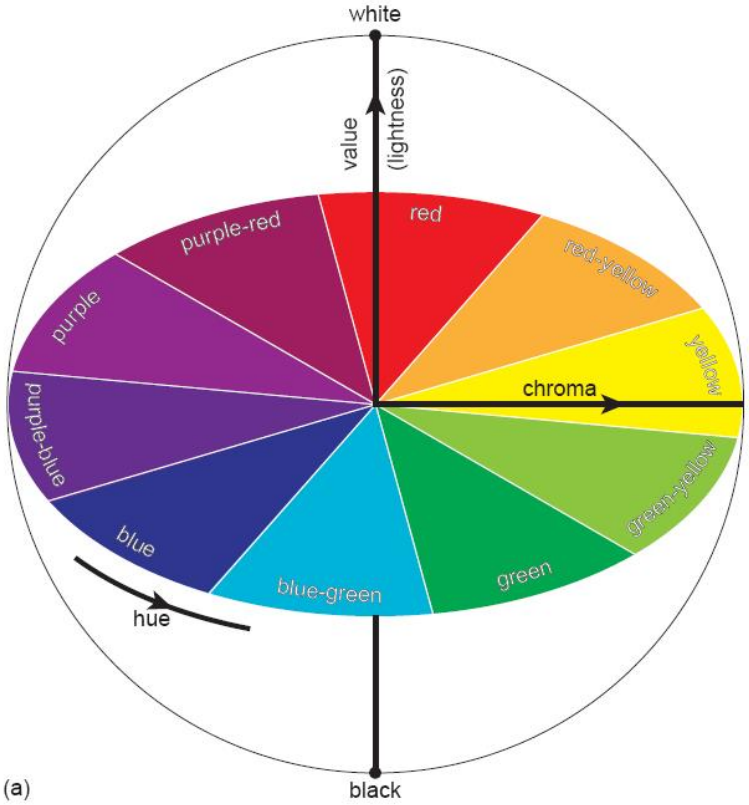
Sorting

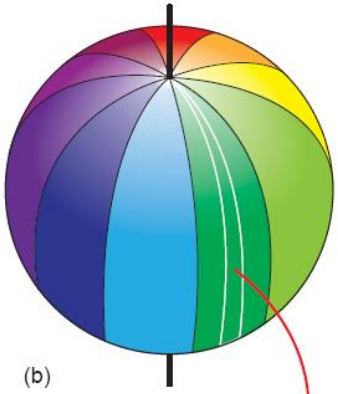


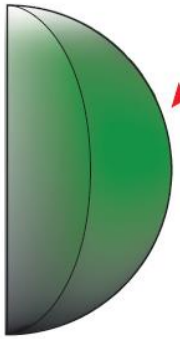


(a) (b)

Figure 2.16 Use of a grain - size chart to determine the average grain size. (a) In this case the average grain size is 500 μ m. The grain size varies between 375 and 750 μ m. (b) Close up view of (a).







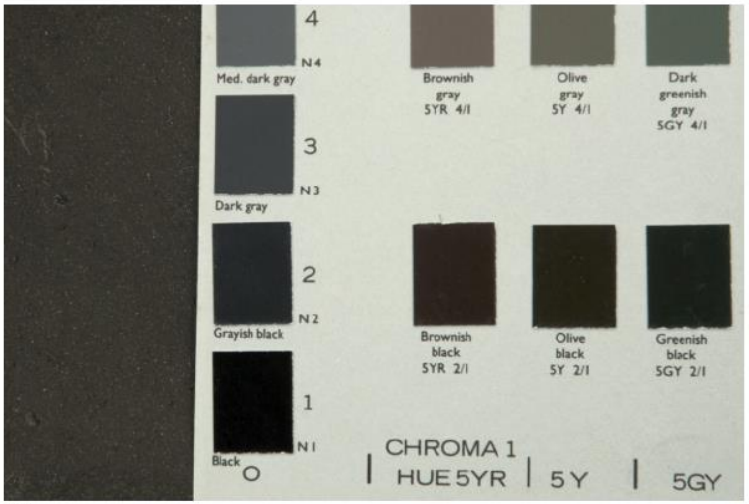


Figure 2.17 Highly simplifi ed three - dimensional representation of Munsell colours. (a) The axes for value, hue and chroma within a sphere. The 10 hues are shown but for simplicity the 10 subdivisions within each hue are not shown and neither is the chroma. (b) Sphere of colour with the colours becoming lighter towards the top (increase in value). (c) Part of one segment showing very generally the increase in value towards the top and the increase in chroma towards the outer edge of the segment. (d) Part of a Munsell colour chart specially designed for rocks. In this case the grey organic - rich mudstone sample on the left has a Munsell colour of 5Y 2/1 (olive black).

D. Description for individual bed (primary sedimentary structures)

a. structures within beds: internal features of a bed may be internally homogeneous (or massive), graded, or laminated; cross-bedding, cross-laminations, climbing ripples, plane bed, bioturbation, imbricated (gravels), syn-sedimentary deformation (folding, contorted beds), hummocky cross stratification (HCS), dish structures.

b. structures on surfaces between beds (or on bedding planes)

(b1) upper bedding surface
ripple marks: current ripples (asymmetric); wave ripples (symmetric).
Shrinkage cracks, parting lineation

(b2) lower bedding surface
- flute casts - elongated in current direction, have a roughly triangular, spoon-like, or beak-like shape, with the more prominent or pointed end directed upstream.
- groove casts - single, elongate features that give only current orientation.
- load casts

(b3) bioturbation (animal markings)

E. Palaeocurrent measurements

F. Characteristic secondary structures, especially cleavage and prominent weathering effects.

G. Fossils (especially if a lithologic characteristic of unit).

a. distribution of fossils.

b. special characteristics of fossiliferous rocks.

c. position and condition of fossils (growth position, fragmental, rounded, pitted or fluted by solution, external or internal molds, etc.).

Rock sample collections

1) Standarize names and descriptions.
2) Representative samples.
3) Suites of samples rather than a single average sample.
4) Taken from outcrops.
5) Unweathered samples.
6) Size 10x8x3 cm.
7) Marking directions.

Fossil collections

Numbering and marking
- on specimens.
- with a adhesive paper.
- with string or a rubber band.
- same no. or mark on notes and maps.

Table 2.2 Typical sampling equipment. See also Chapter 13.

Sampling equipment
Geological hammer
Sample bags
Paper, cling film or bubble wrap to wrap delicate samples
Marker pens/tile scribe/correction fluid for labelling
Chisels and other hammers
Trowel and/or spade for soft sediments and pyroclastic deposits

Coe et al. (2010)

觀察露頭的步驟

•遠距觀察：露頭的主要岩性與層態；本露頭與其他露頭的關係(斷層、侵入岩體…)。

•中距觀察：以岩層 (bed) 為單位將露頭分成數層；各岩層的幾何形狀 (tabular, irregular, lenticular …)、大約厚度與側向變化；各岩層間的接觸關係 (sharp or gradational?)、幾何形狀 (planar parallel, wavy parallel, curved parallel, planar non-parallel, wavy, non-parallel, curved non-parallel…)與顏色變化；是否有哪一層含有粗粒材料。

•敲下石頭觀察：用放大鏡觀察風化面與新鮮面的岩石；膠結程度(unconsolidated, very friable, friable, hard, very hard)；岩石的組成礦物或顆粒；顆粒的大小(cobble, pebble, coarse sand …)；形狀(tabular, spherical, bladed, prolate)；使用稀鹽酸(必要時)；所含化石種類；顆粒所佔體積；決定岩石名稱。

•觀察單一岩層的沉積構造：觀察岩層的頂面、下面與垂直層面等三面。
•觀察可指示古水流方向的構造(cross bedding, current ripples, flute cast…)。
•觀察岩層是否受變形：看平板面(planar structure，如層面、岩脈)是否扭曲。如沒有可見的褶皺，可觀察是否有葉理(foliations)、劈理(cleavages)、線理(lineations)等指示褶皺的構造。
•觀察是否有被變形的顆粒
•觀察斷層：斷層帶(breccia, gouge)、斷層位移方向、斷層發生時序。
•觀察節理：不同岩層之節理的發生間隔(spacing)與方位。
•有系統的紀錄與量測露頭：地層柱與素描。
•採標本

Describe the outcrop given below (sedimentary rocks).

八里灣層(秀姑巒溪)