Sedimentologie / Sedimentpetrographie

B.Geo.205
WS 2015/16

LV1 – Grundlagen der Sedimentologie und Faziesanalyse
(1 SWS – Vorlesung, Kursnummer 600176)

LV2 – Laborübungen zur Sedimentologie und Sedimentpetrographie
(5 SWS – Übung Kursnummer 600179)

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Sedimentologie/
Umweltgeologie

LV2 – Laborübungen zur Sedimentologie und Sedimentpetrographie

(5 SWS – Übung Kursnummer 600179)

<u>Vorbesprechung: 24.11.15, 10.15 Uhr, MN01</u>

Der Kurs findet als Kompaktkurs im Anschluss an die Vorlesungszeit statt
Termin: 22.02. – 04.03.2016

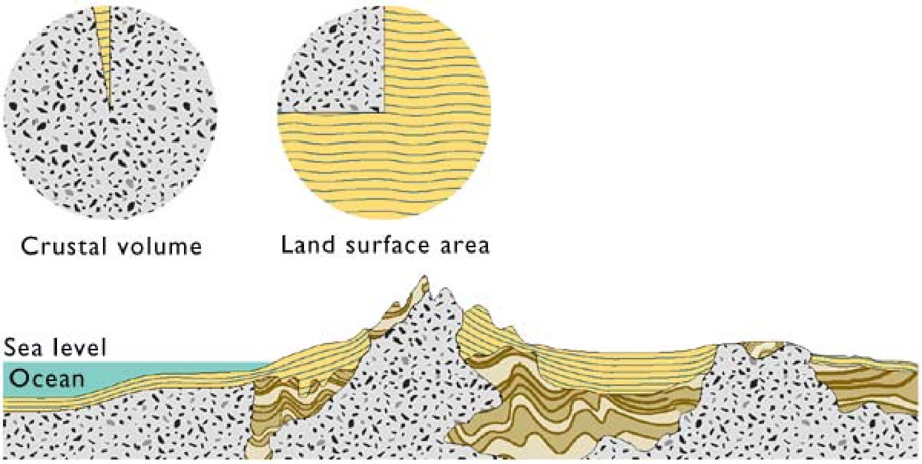
Die Teilnahme an der Vorbesprechung ist verpflichtend.
Bitte tragen Sie sich bereits vorab in die Liste am Schwarzen Brett ein.

Literatur

Füchtbauer, H.: Sedimente und Sedimentgesteine, 1988.
Hsü, K.J.: Physics of Sedimentology. 2nd edition, Springer, 2004.
Miall, A.D.: The Geology of Fluvial Deposits, 1996.
Ricci Lucchi, F.: Sedimentographica – A Photographic Atlas of Sedimentary Structures, 1995.
Stow, D.A.V.: Sedimentgesteine im Gelände. Spektrum 2008.
Tucker, M.E.: Techniques in Sedimentology, 1988 (dt. Version 1996).
Tucker, M.E.: Sedimentary Petrology, 3rd edition, 2001.

http://www.sediment.uni-goettingen.de/skript.html

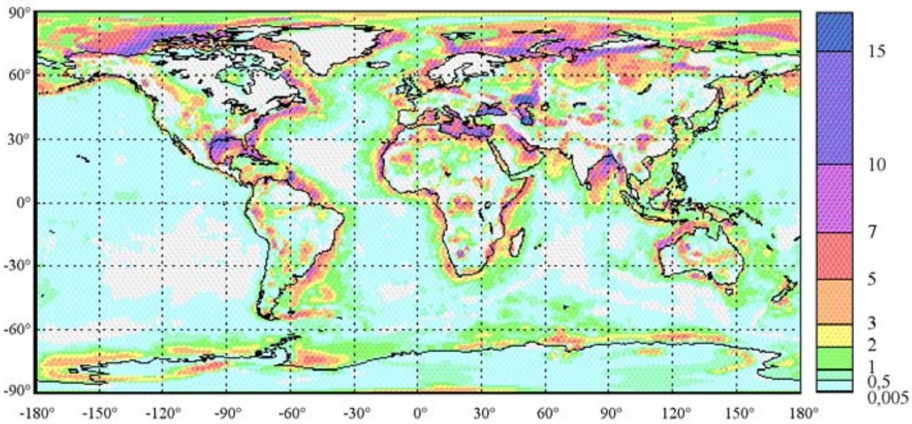
Verbreitung der Sedimente und Sedimentgesteine



Press & Siever 2001

Verbreitung der Sedimente und Sedimentgesteine

in km



Laske & Masters 1997, http://mahi.ucsd.edu/Gabi/sediment.html

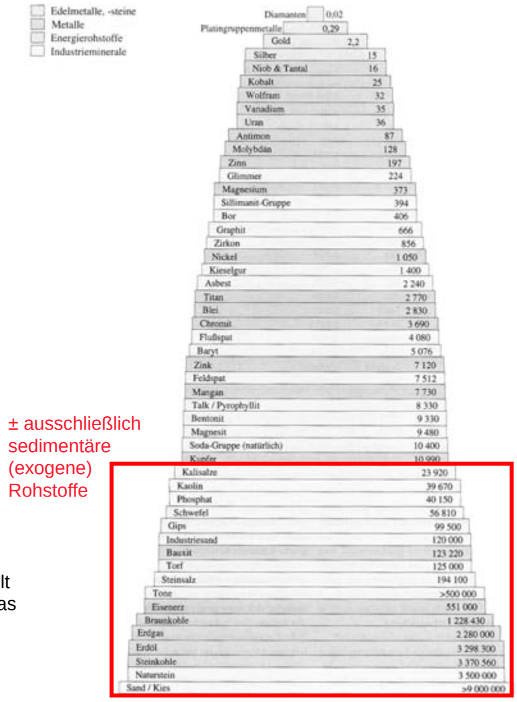
Bedeutung der Sedimente und Sedimentgesteine

- enge Kopplung mit endogenen Prozessen
- sehr gute Klima- und Umwelt- “Archive“

- großer Anteil an den Bodenschätzen
- Grundwasser-Aquifere größtenteils in Sedimenten
- Standorte für Deponien und Endlager

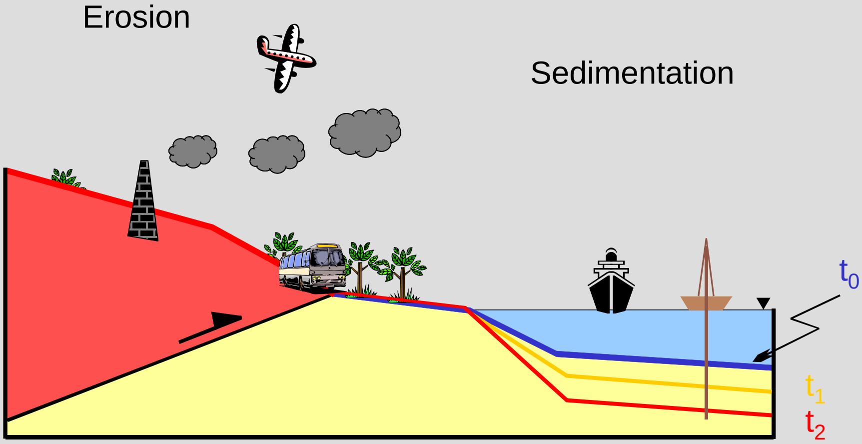
Massenrohstoffe

Die wichtigsten Massen-
rohstoffe sind sedimentär
entstanden



Produktion mineralischer Rohstoffe in der Welt im Jahr 1996 nach ihrer Menge (1000 t, Erdgas in Mio. m³); Wellmer & Becker-Platen (1999)

Sedimente und Sedimentgesteine sind exakte (Zeit-)Zeugen der Ereignisse und Prozesse an der Erdoberfläche



Zeitzeuge ⇒ (möglichst) exakte zeitliche Kalibration

Wie ?

→ Biostratigraphie

→ Radiometrische Datierung

→ Magnetostratigraphie

→ Chemostratigraphie

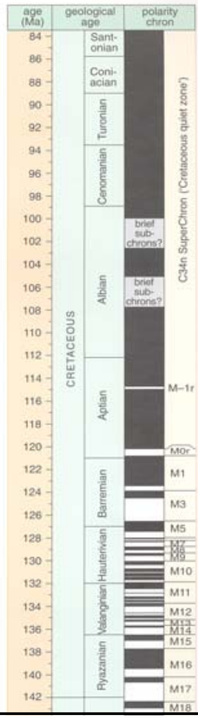


Figure 2.5 Changes in the Earth's magnetic field through part of the Jurassic and Cretaceous. *(Ogg, 1995.)*

Coe et al. (2003)

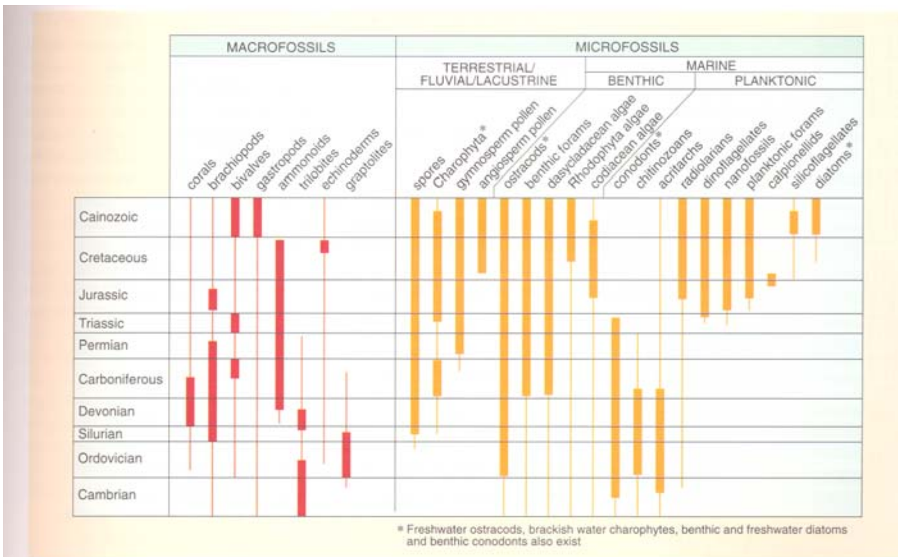


Figure 2.3 Biostratigraphically useful groups of organisms preserved as macrofossils and microfossils in the stratigraphical record and their age ranges. The thick part of the line indicates the interval where the fossil group is used most extensively. Benthic organisms live on the sea-floor or in the sediments, whereas planktonic organisms live in the water column and have limited ability to move through the water column. *(Left: Nichols, 1999; right: Emery and Myers, 1996.)*

Coe et al. (2003)

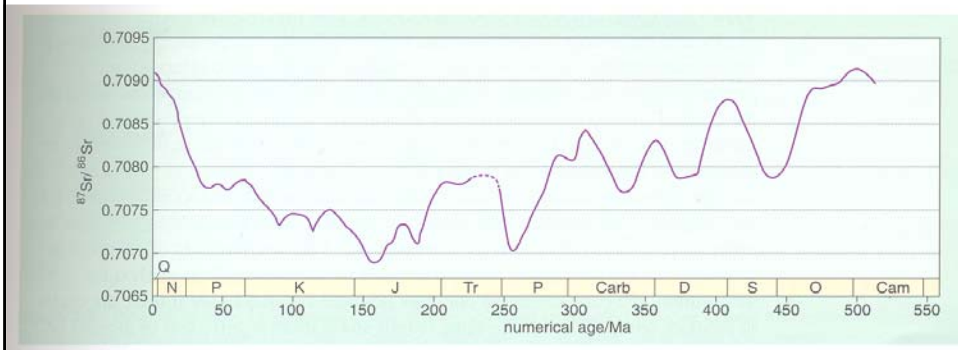


Figure 2.6 Sr-isotope curve for the Cambrian to Quaternary. Q = Quaternary, N = Neogene, P = Palaeogene, K = Cretaceous, J = Jurassic, Tr = Triassic, P = Permian, Carb = Carboniferous, D = Devonian, S = Silurian, O = Ordovician, Cam = Cambrian. Note that this curve is generalized and does not show all the detail. *(McArthur, 2001.)*

Coe et al. (2003)

Aufgabengebiete der Sedimentologie

Stratigraphische Aufnahme

Faziesmodell und Paläo-geographische Rekonstruktion

„Genetische“ Stratigraphie

Beckenanalyse

Petrographische Aufnahme (makroskopisch/mikroskopisch)

Phasenanalyse, Geochemie

Liefergebietsanalyse

Diagenesemodell

→ **Geodynamische Modelle**

Anwendungsgebiete in Erdöl-/Erdgasexploration und –förderung, sonst. Rohstoffexploration, Hydrogeologie, Umweltgeologie, Ingenieurgeologie, ...

2. Fazies / Faziesanalyse

Was ist Fazies ? Gesteinskörper mit spezifischen Merkmalen

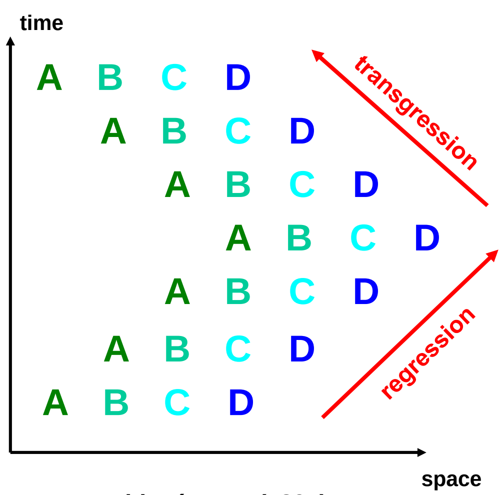
Aufschluß/Bohrkerne: Farbe, Schichtung, Textur, Zusammensetzung
Fossilgehalt, Sedimentstrukturen, ...

→ **Lithofazies** → **Biofazies**

Log Fazies: basiert auf Bohrlochmessungen:
→ akustische, elektrische, radioaktive Eigenschaften

Weitere Verwendung: Tektofazies, „Fluviatile Fazies“ (→ environment), ...

Fazies – Faziesassoziation – Faziessequenz

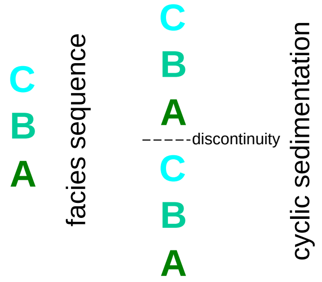


Walther´s Law (1894)

A single facies type

A, B, C, D

→ facies association



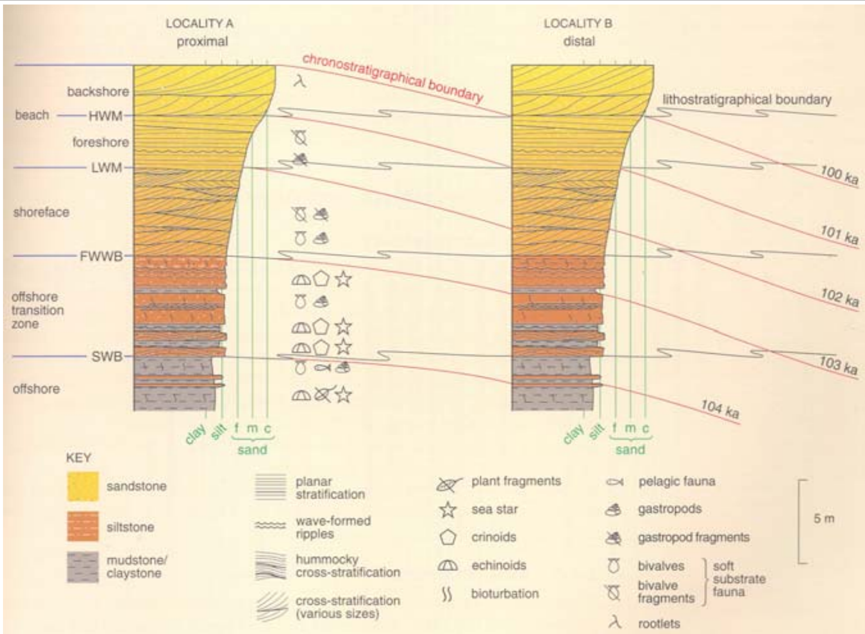
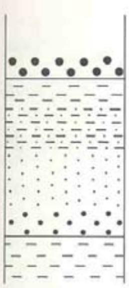


Figure 2.2 The correlation of sedimentary successions at localities A and B using both lithostratigraphical (shown in black) and chronostratigraphical (shown in red) boundaries.

Coe et al. 2003

Fazies - Interpretation



	FLYSCH		ALLUVIAL PLAIN		TIDAL SEAS	
	Pre-1950	Post-1950	Alternative 1	Alternative 2	Alternative 1	Alternative 2
	Normal, deep	Normal, deep	Normal, overbank	Normal, overbank	Normal, settling of mud	Normal, settling of mud
	Normal, shallow	Catastrophic, deep	Normal, in channel	Catastrophic, sheet flood	Normal, diurnal tidal currents	Catastrophic, storm currents and tidal currents
	Normal, deep	Normal, deep	Normal, overbank	Normal, overbank	Normal, settling of mud	Normal, settling of mud
	Rapid alternation of deep & shallow water environments	Constant deep water environment with sudden influxes of sand by turbidity currents	Alternation of environments on flood-plain by river migration	Constant environment on alluvial fan with occasional sheet floods	Constant conditions of alternating tidal currents and deposition from suspension	Catastrophic storm currents imposed on tidal currents

Fig. 2.5. Differing interpretations of graded beds and fining-upwards sequences in flysch, alluvial plains and tidal seas depend on distinction between normal and catastrophic sedimentation.

Reading 1986

Kontrollfaktoren der Faziesentwicklung und -verteilung

- Sedimentäre Prozesse
- Sedimentzufuhr
- Subsidenz (→ Tektonik)
- Meeresspiegelschwankungen
- Klima
- Biologische Aktivität
- Wasserchemie
- Vulkanismus

} Akkomodationsraum

unterschiedliche Bedeutung in unterschiedlichen Ablagerungsmilieus!

→ Konservierungspotential

3. Lithofazies (Gelände, Bohrkern-Lager)

A) Lithologie / Nomenklatur

Korngrößen

$\Phi = -\log_2 d$

(d = Durchm. in mm)

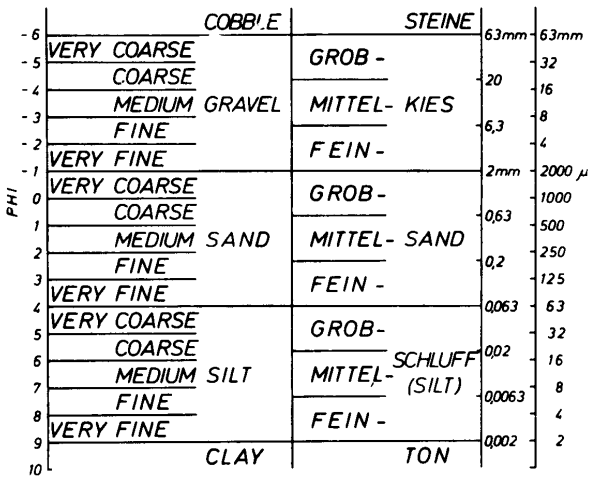


Abb. 4-18. Korngrößenbenennung. Links die Skala nach WENTWORTH (1922) und DOEGLAS (1968), rechts diejenige nach DIN 4022.

Füchtbauer 1988

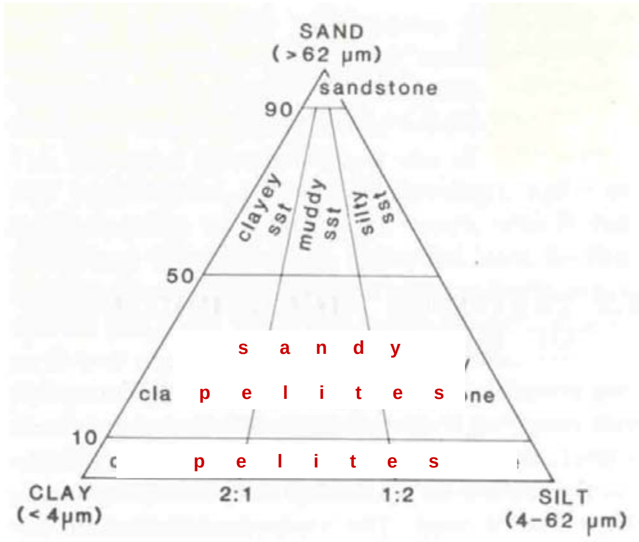


Fig. 3.1 Classification of siliciclastic sediments based on sand, silt and clay content. After Folk (1974).

Tucker 1991

Psammite

Arenite

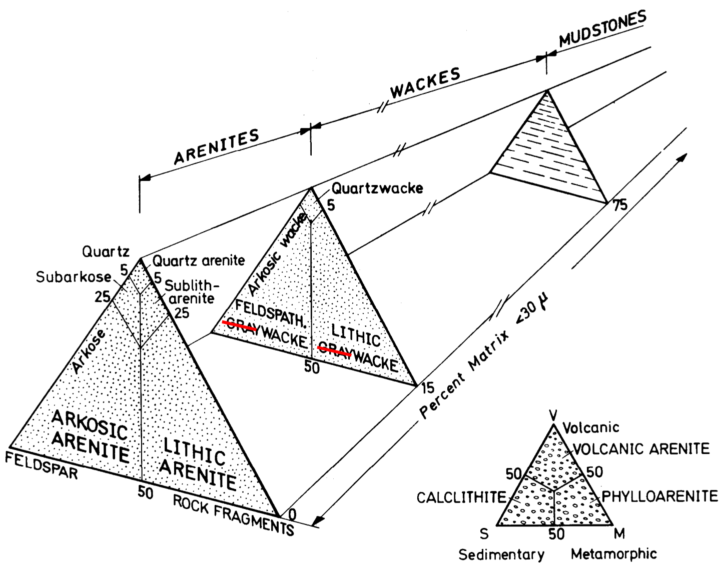
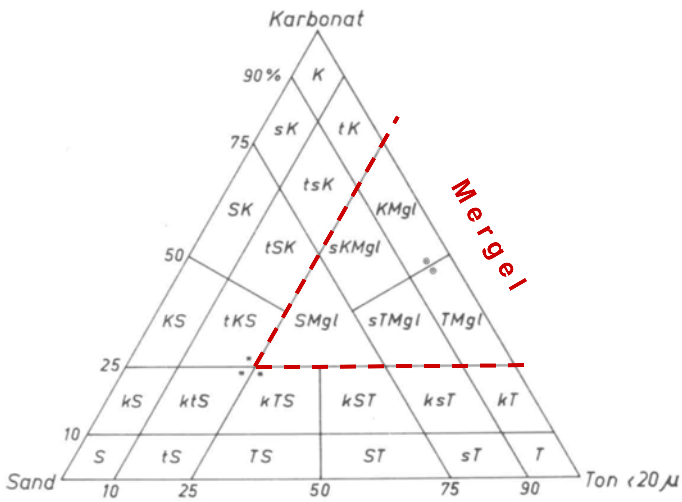


FIGURE 5-1. Classification of terrigenous and sandstones. (Modified from Dott, 1964, Fig. 3)

Pettijohn et al. 1987

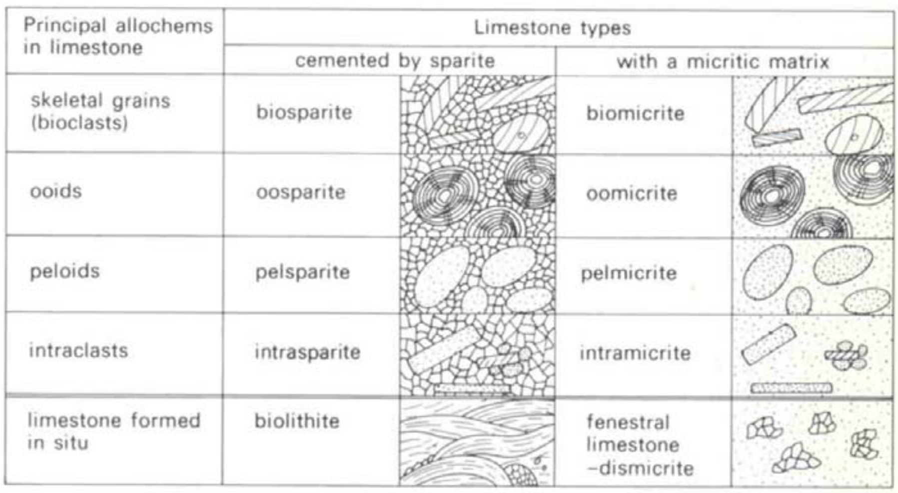
→ **Mergel**

> 25% Ton/Silt
> 25% Karbonat
< 50% Sand



Füchtbauer 1988

Kalksteine



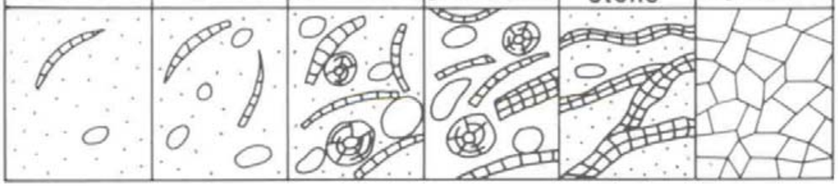
Principal allochems in limestone	Limestone types			
	cemented by sparite		with a micritic matrix	
skeletal grains (bioclasts)	biosparite		biomicrite	
ooids	oosparite		oomicrite	
peloids	pelsparite		pelmicrite	
intraclasts	intrasparite		intramicrite	
limestone formed in situ	biolithite		fenestral limestone –dismicrite	

Tucker 1991

Fig. 4.35 Classification of limestones based on composition. After Folk (1962).

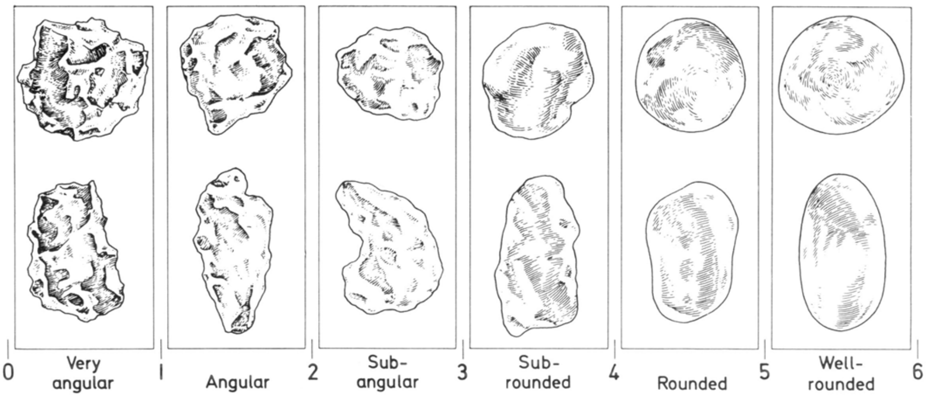
Klassifikation der Kalksteine basierend auf der Textur (nach Dunham 1962):

original components not bound together during deposition				original components bound together	deposit-ional texture not recogniz-able
contains lime mud			lacks mud and is grain supported		
mud-supported		grain-supported			
less than 10% grains	more than 10% grains				crystalline carbonate
mudstone	wackest.	packstone	grainstone	bound stone	crystalline



Tucker 1991

B) Textur



Kornrundung

Einstufung nach Vergleichsbildern in 6 Klassen; die Spalten zeigen Körner gleichen Rundungsgrades, aber unterschiedlicher Sphärizität.

Kornsortierung

Sortierungsgrad

σ

sehr gut sortiert

0.35 ———

gut sortiert

0.50 ———

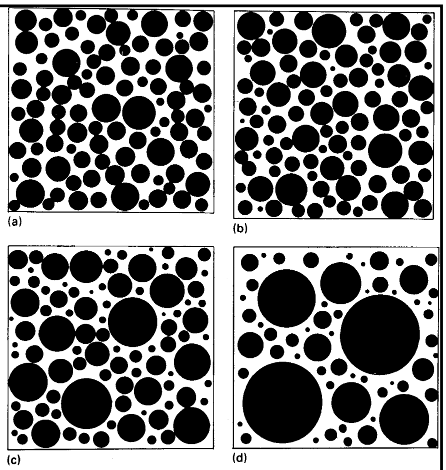
mäßig sortiert

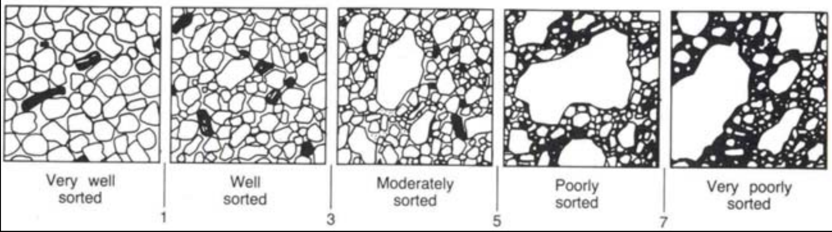
1.00 ———

schlecht sortiert

2.00 ———

sehr schlecht sortiert





Tucker 1991

Transport ⇒ **Korngröße, Rundung, Sortierung**

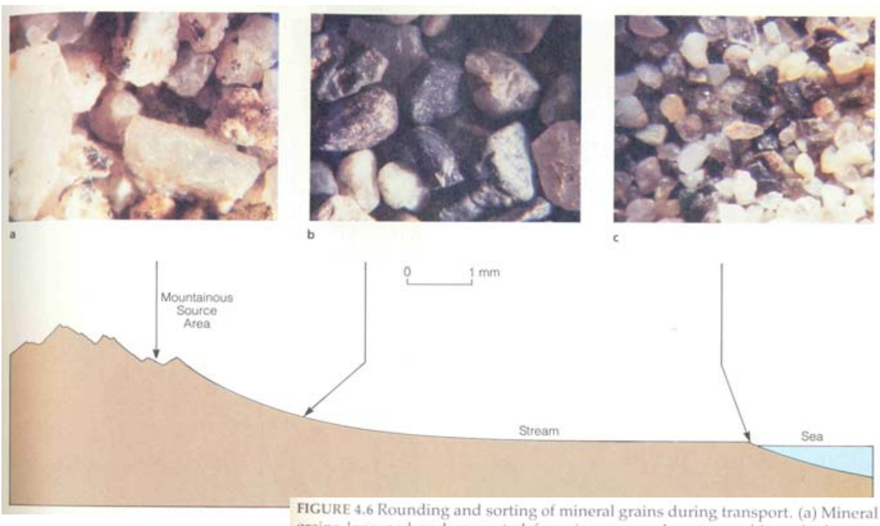
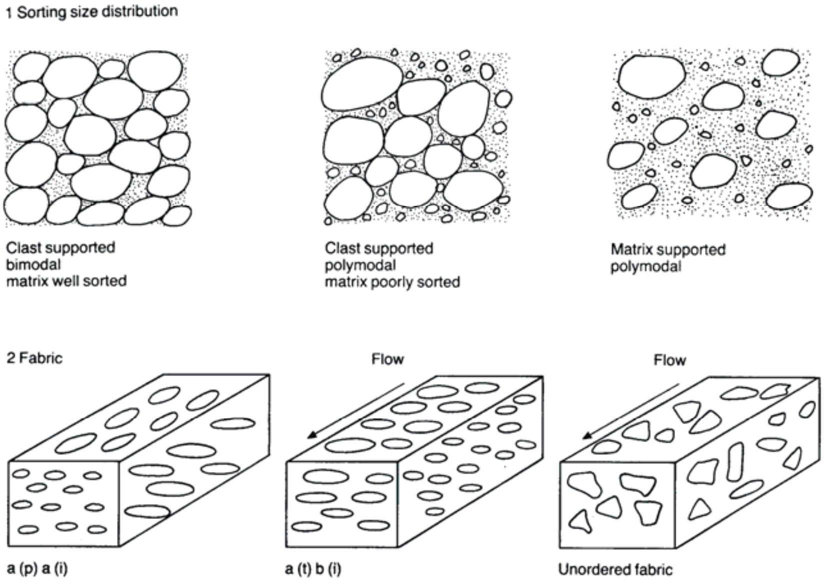


FIGURE 4.6 Rounding and sorting of mineral grains during transport. (a) Mineral grains loosened and separated from igneous and metamorphic rocks by mechanical and chemical weathering have the same angular shapes they assumed when the minerals crystallized in the parent rock. (b) Carried downslope by streams, the sand experiences abrasion and grains become rounder. (c) By the time the sediment reaches the mouth of the stream, it has traveled a great distance and the well-sorted grains have become well rounded.

Skinner & Porter 1989

Korn- bzw. Geröllgefüge



C) Schichtung / Sedimentstrukturen

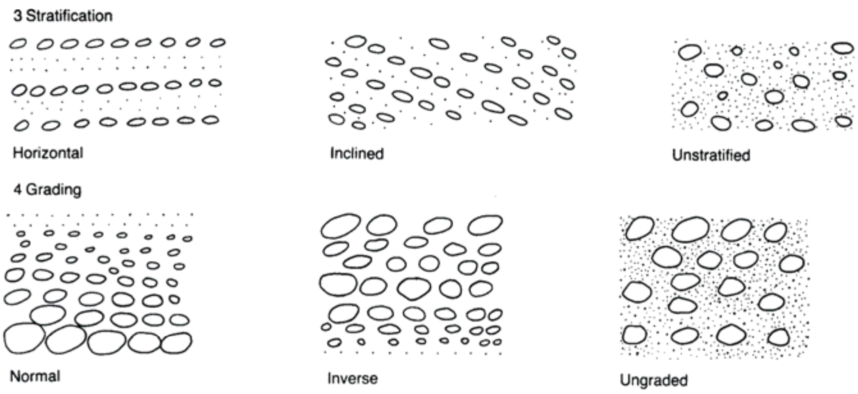


Fig. 2.1. Features used in a textural and structural classification of conglomerate (from Harms, Southard & Walker, 1982). Under fabric, codes a and b refer to long and intermediate axes respectively; p = parallel to flow, t = transverse to flow, i = imbricate. (Reproduced by permission of SEPM.)

Graham1988

Schichtung vs. Lamination

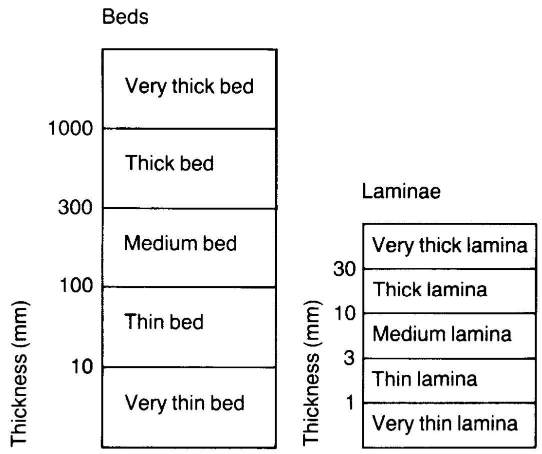
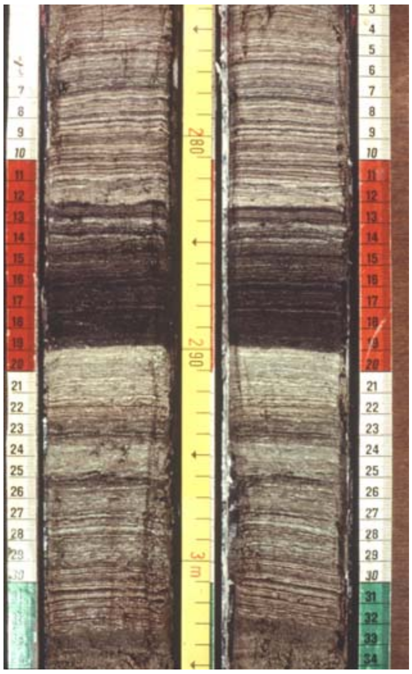
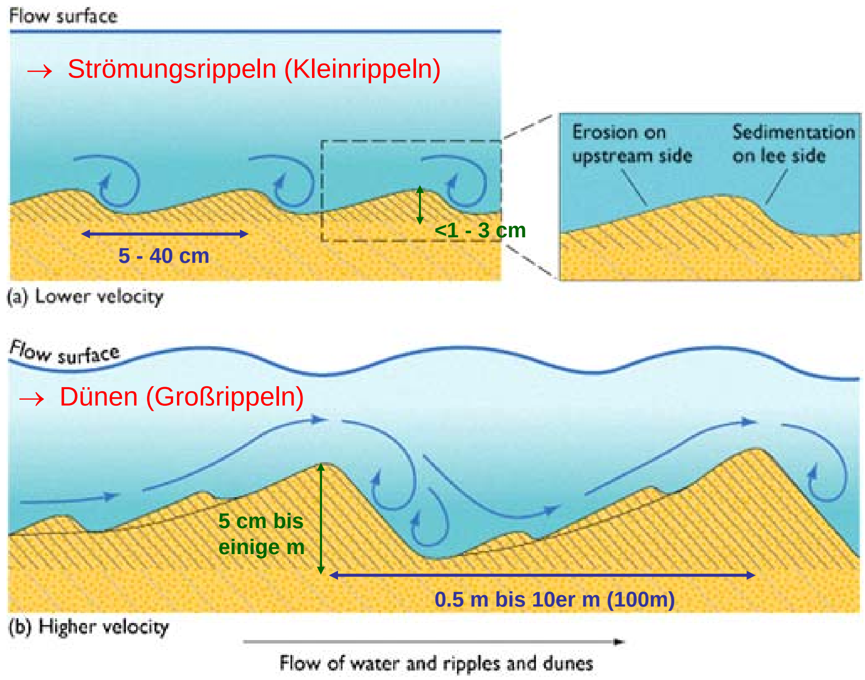


Fig. 2.13. Terminology for thickness of beds and laminae (modified after Ingram, 1954, Campbell, 1967 and Reineck & Singh, 1975). (Reproduced by permission of Springer.)

Graham 1988

Beispiel Lamination





Press & Siever 2001

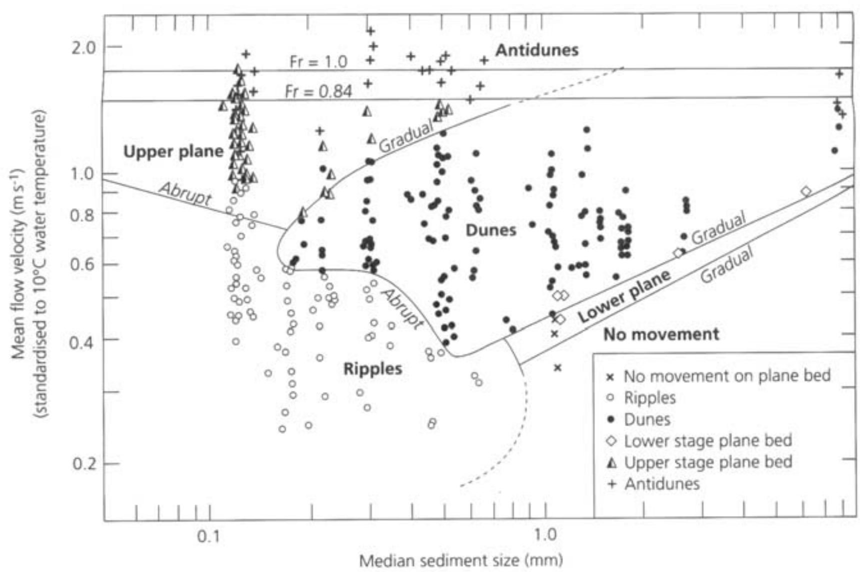


Fig. 5.17 Plot of mean flow velocity against median sediment size (both standardized to 10°C water temperature) for a mean flow depth of 0.25–0.40 m to show the existence fields of bedforms. After Southard (1991) [31].

Allen 1997

Kammformen vs Schrägschichtungstypen

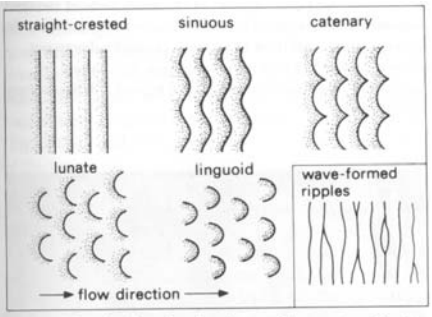


Fig. 2.19 Terminology for the shape of the crests of ripples and dunes formed by unidirectional currents. For comparison, the tyical crest pattern of wave-formed ripples is also shown.

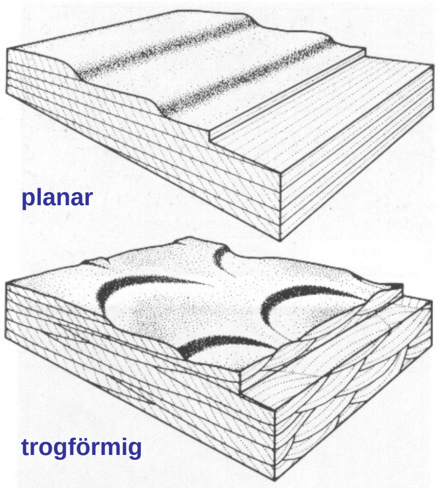


Fig. 2.21 Block diagrams showing the two common types of cross stratification: planar and trough. Above: planar cross stratification, chiefly formed through the migration of straight-crested (i.e. two-dimensional) ripples, producing planar cross lamination, and straight-crested dunes, producing planar cross bedding. Below: trough cross stratification, chiefly formed through migration of three-dimensional bedforms, especially lunate and sinuous dunes, producing trough cross bedding (illustrated here). Linguoid ripples give a trough cross lamination.

Tucker 1991

Beschreibung

- Farbe (Farbtafeln), z.B. GSA
- Korngröße (DIN 4022 bzw. Wentworth 1922)
- Kornform
- Kornrundung
- Kornsortierung
- Korngefüge, Klasteneinregelung (Imbrikation)
- Schichtung bzw. Lamination
- Zusammensetzung der Komponenten (qualitativ & semiquantitativ)
- Zusammensetzung von Matrix und/oder Zement
- Festigkeit, Bruchverhalten
- Verwitterungs-/ Alterationsmerkmale
- Sonstige Merkmale / Besonderheiten
- Gesteinsname (Klassifikationen)

D) Profil- bzw. Log-Aufnahme

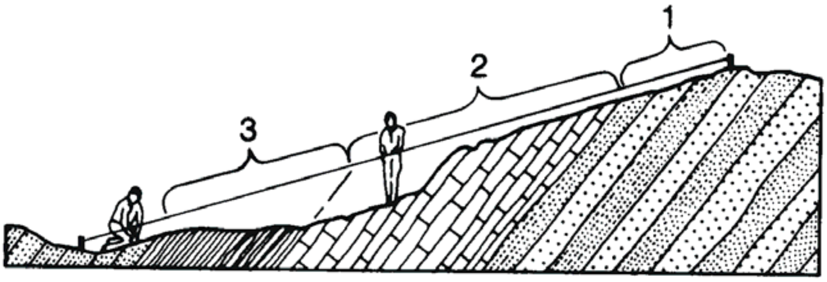


Fig. 2.18. Measurement of strata on a slope by reference to a stretched tape. Note the projection of contact between units (2) and (3) to the tape (from Compton, 1962). (Reproduced by permission of Wiley.)

Graham1988

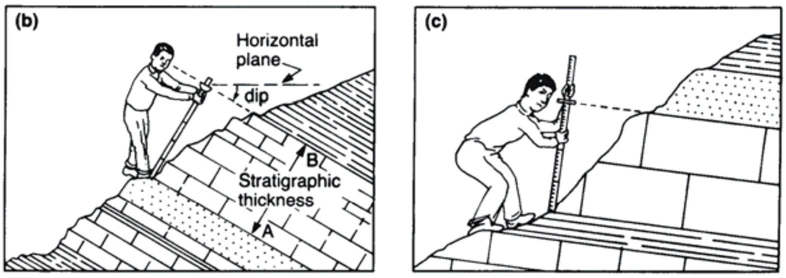
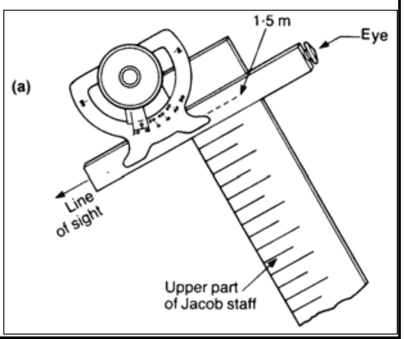


Fig. 2.20. Use of the Jacob staff for measuring sections (from Kottlowski, 1965).
(a) Setting dip on clinometer of Abney hand level used with a Jacob staff.
(b) Measuring stratigraphic thickness AB.
(c) Measuring a unit with thickness less than the length of a Jacob staff.
(Reproduced by permission of CBS.)



Graham1988

Beispiele von Profilaufnahmen und Bohrlochaufnahmen

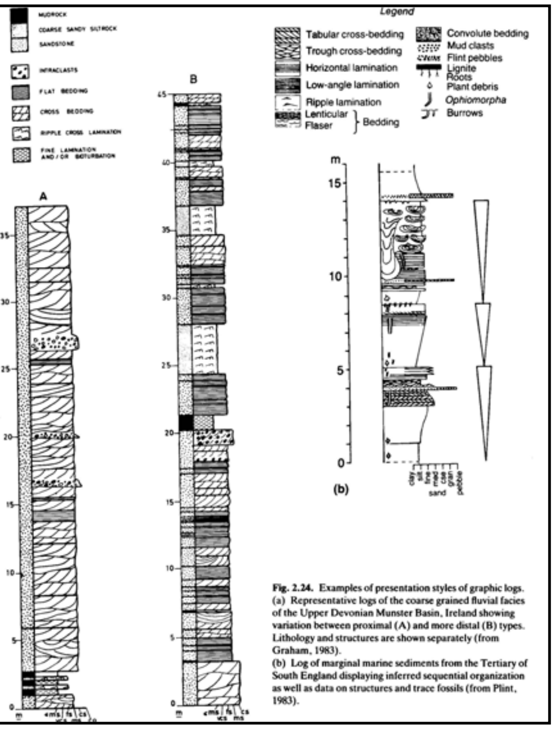
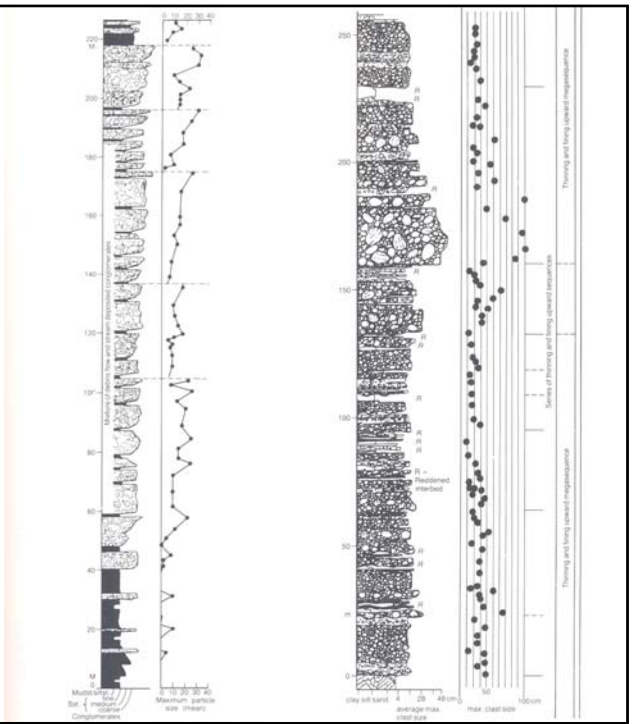


Fig. 2.24. Examples of presentation styles of graphic logs. (a) Representative logs of the coarse grained fluvial facies of the Upper Devonian Munster Basin, Ireland showing variation between proximal (A) and more distal (B) types. Lithology and structures are shown separately (from Graham, 1983). (b) Log of marginal marine sediments from the Tertiary of South England displaying inferred sequential organization as well as data on structures and trace fossils (from Plint, 1983).

Graham 1988 (in Tucker, *Ed.*)

Beispiele von Profilaufnahmen und Bohrlochaufnahmen



Graham 1988
(in Tucker, *Ed.*)