# Sedimentologie / Sedimentpetrographie B.Geo.205

WS 2013/14

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

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

Resurrection River, Alaska © Martin Miller, AGI

Hilmar v. Eynatten
Volker Karius
István Dunkl

Sedimentologie/
Umweltgeologie



## LV2 – Laborübungen zur Sedimentologie und Sedimentpetrographie

(5 SWS – Übung Kursnummer 600179)

Vorbesprechung: 06.11.13, 14.15 Uhr, MN16

Der Kurs findet als Kompaktkurs im Anschluss an die Vorlesungszeit statt.
Termin: 10.02. – 21.02.2014

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.

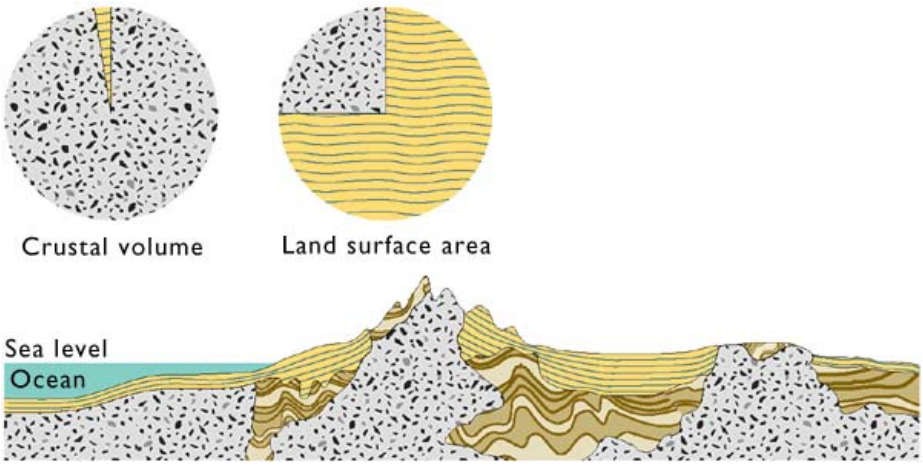
Stow, D.A.V.: Sedimentgesteine im Gelände. Spektrum 2008.

Tucker, M.E.: Techniques in Sedimentology, 1988 (dt. Version 1996).

Tucker, M.E.: Sedimentary Petrology, 3rd edition, 2001.

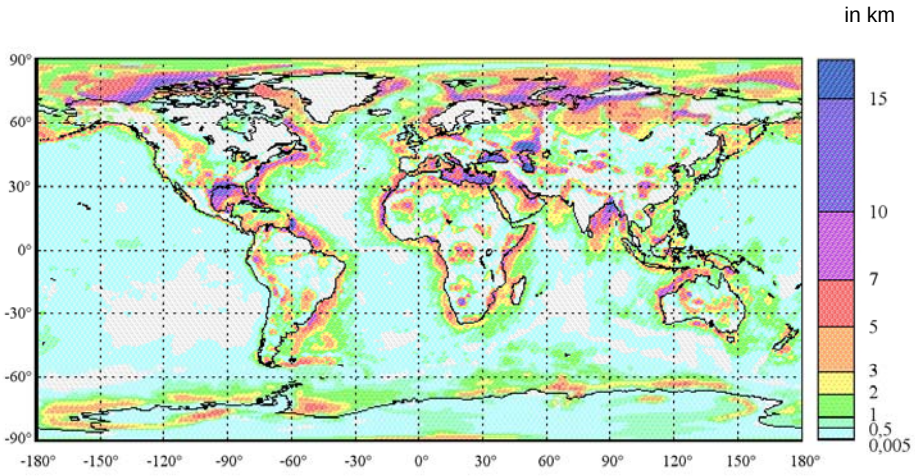



## Verbreitung der Sedimente und Sedimentgesteine




Press & Siever 2001

## Verbreitung der Sedimente und Sedimentgesteine




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

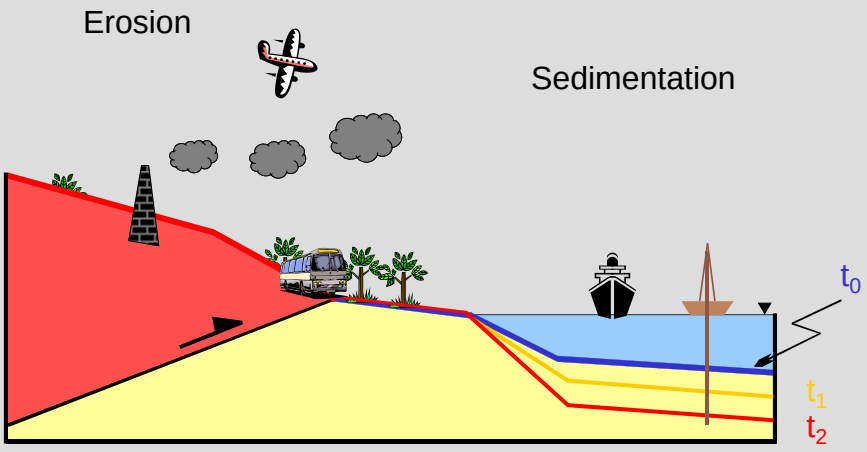
Die wichtigsten Massen-rohstoffe sind sedimentär entstanden

± ausschließlich sedimentäre (exogene) Rohstoffe

Produktion mineralischer Rohstoffe in der Welt im Jahr 1996 nach ihrer Menge (1000 t, Erdgas in Mio. $m^3$); 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

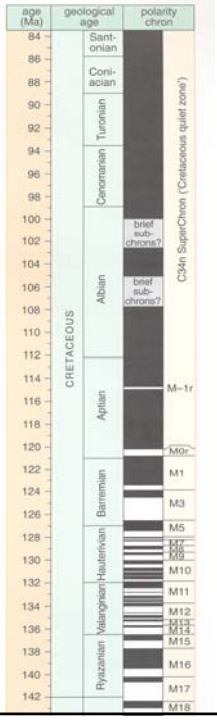



**Figure 2.5** Changes in the Earth's magnetic field through part of the Jurassic and Cretaceous. *(Ogg, 1995.)*

Coe et al. (2003)



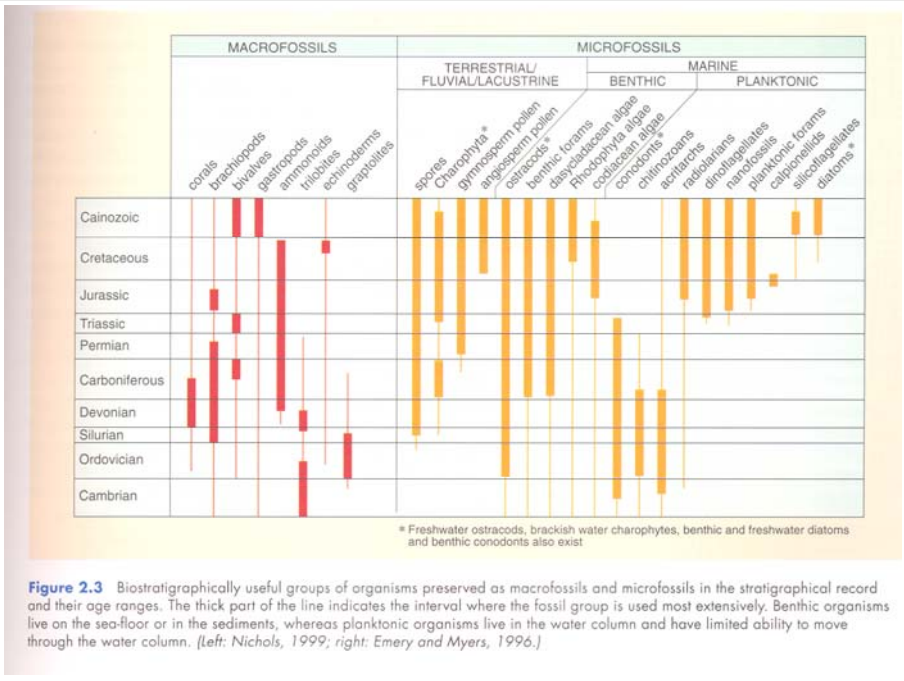



**Figure 2.3** Biostratigraphically useful groups of organisms preserved as macrofossils and microfossils in the stratigraphical record and their age ranges. The thick part of the line indicates the interval where the fossil group is used most extensively. Benthic organisms live on the sea-floor or in 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)

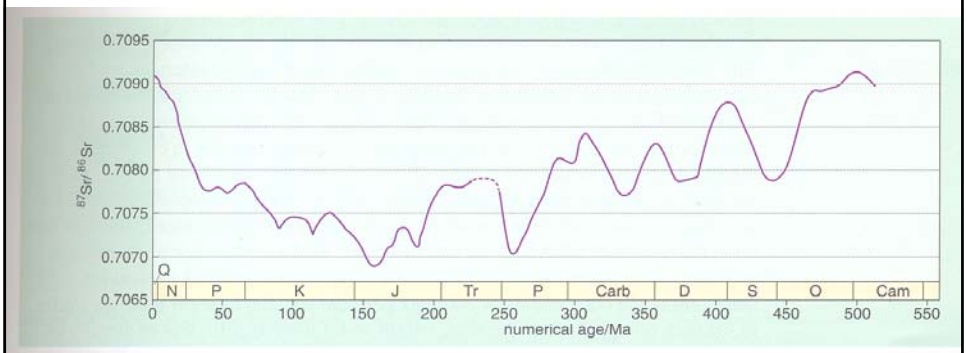



**Figure 2.6** Sr-isotope curve for the Cambrian to Quaternary. Q = Quaternary, N = Neogene, P = Palaeogene, K = Cretaceous, J = Jurassic, Tr = Triassic, P = Permian, Carb = Carboniferous, D = Devonian, S = Silurian, O = Ordovician, Cam = Cambrian. Note that this curve is generalized and does not show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

Coe et al. (2003)



## Aufgabengebiete der Sedimentologie

| | |
|---|---|
| Stratigraphische Aufnahme | Petrographische Aufnahme (makroskopisch/mikroskopisch) |
| Faziesmodell und Paläo-geographische Rekonstruktion | Phasenanalyse, Geochemie |
| „Genetische“ Stratigraphie | Liefergebietsanalyse |
| Beckenanalyse | 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, ...

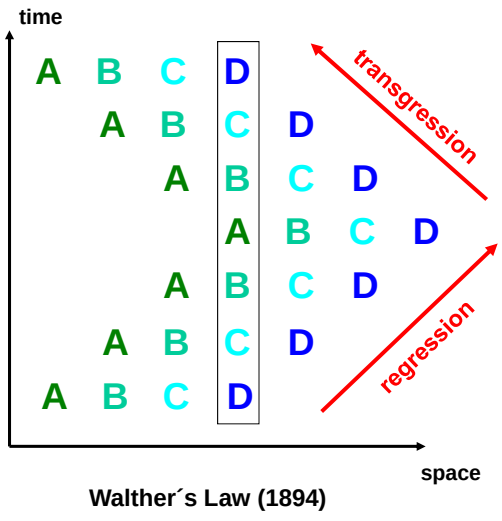
→ **Lithofazies** → **Biofazies**

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

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



## Fazies – Faziesassoziation – Faziessequenz

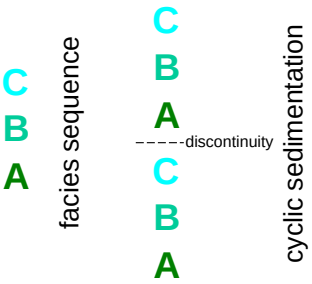



Walther´s Law (1894)

**A** single facies type

**A, B, C, D**

→ facies association



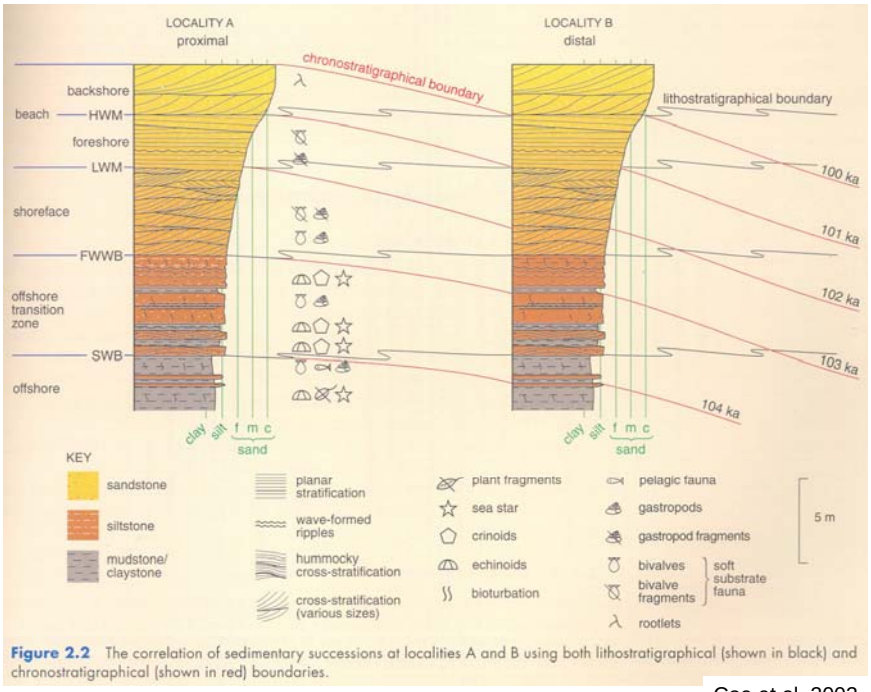
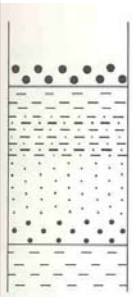



**Figure 2.2** The correlation of sedimentary successions at localities A and B using both lithostratigraphical (shown in black) and chronostratigraphical (shown in red) boundaries.

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

**Akkomodationsraum**

- Klima
- Biologische Aktivität
- Wasserchemie
- Vulkanismus

**unterschiedliche Bedeutung in unterschiedlichen Ablagerungsmilieus!**

→ **Konservierungspotential**



## 3. Lithofazies (Gelände, Bohrkern-Lager)

A) Lithologie / Nomenklatur

Korngrößen

$\Phi = - \log_2 d$

(d = Durchm. in mm)

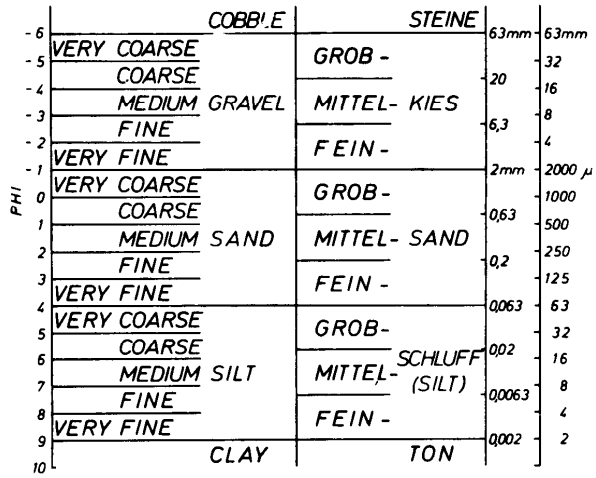



Abb. 4-18. Korngrößenbenennung. Links die Skala nach WENTWORTH (1922) und DOEGLAS (1968), rechts diejenige nach DIN 4022.

Füchtbauer 1988

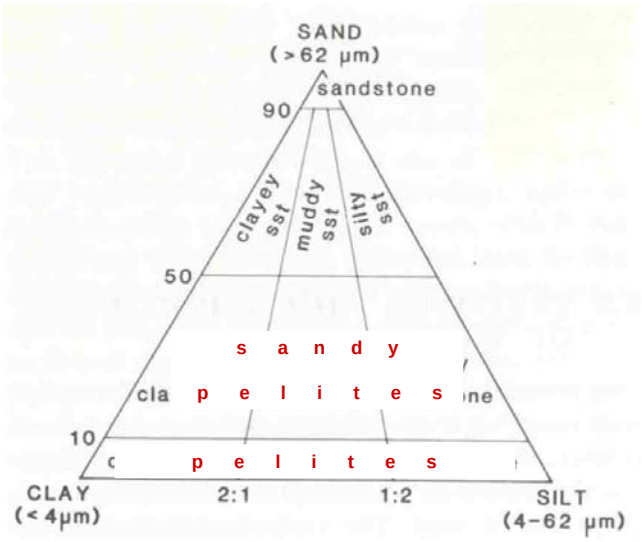



**Fig. 3.1** Classification of siliciclastic sediments based on sand, silt and clay content. After Folk (1974).

Tucker 1991



Psammite

**Arenite**

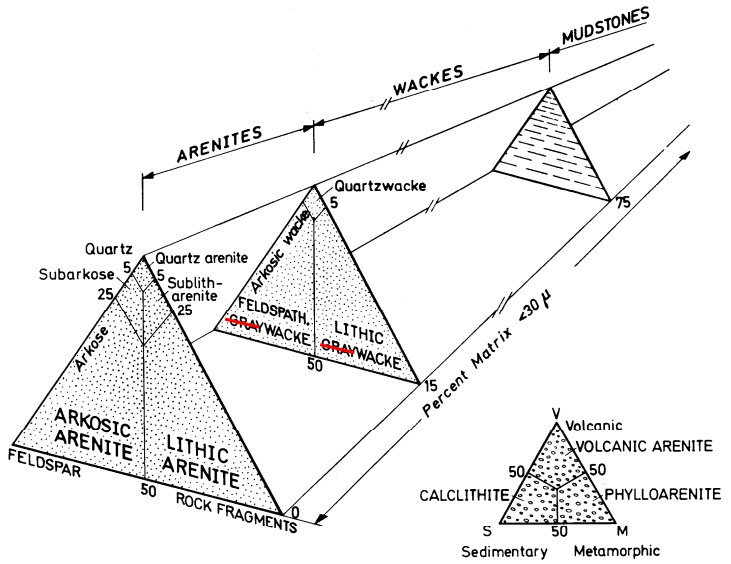
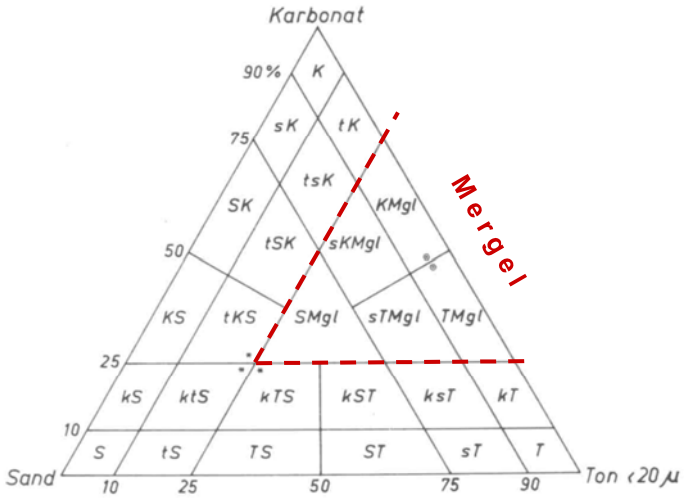



FIGURE 5-1. Classification of terrigenous and sandstones. (Modified from Dott, 1964, Fig. 3)

Pettijohn et al. 1987

→ **Mergel**

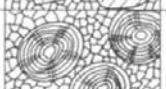
> 25% Ton/Silt
> 25% Karbonat
< 50% Sand




Füchtbauer 1988



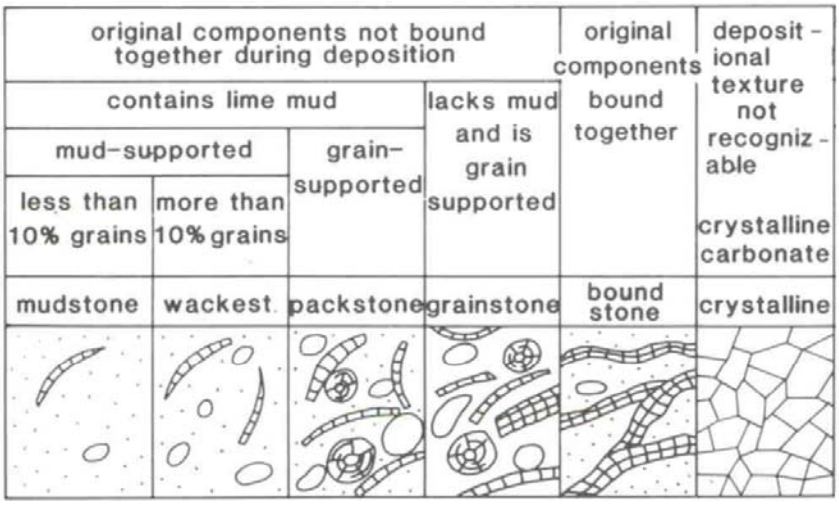
## Kalksteine

| 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).

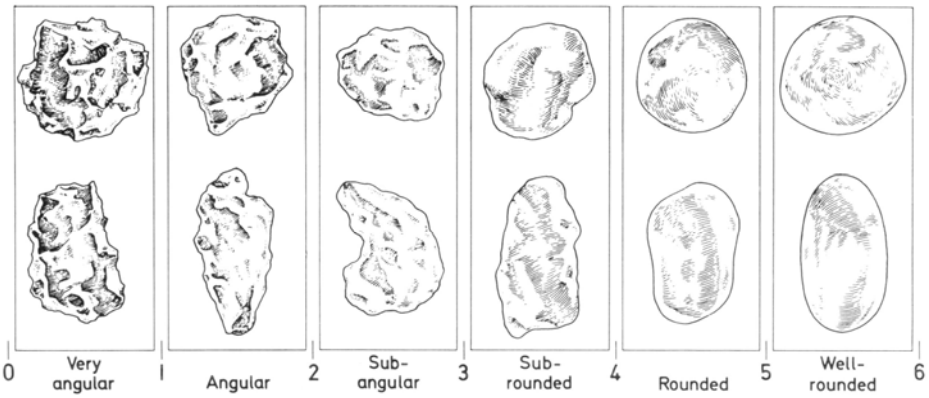
Klassifikation der Kalksteine basierend auf der Textur (nach Dunham 1962):




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**

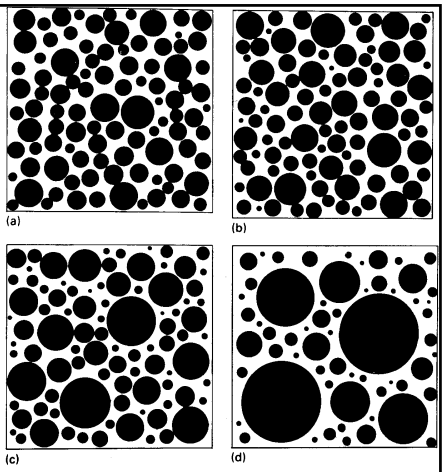
mäßig sortiert

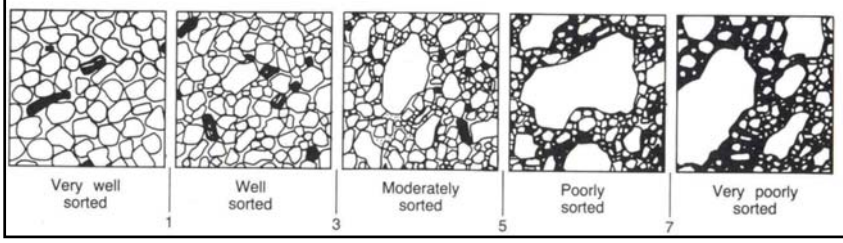
**1.00**

schlecht sortiert

**2.00**

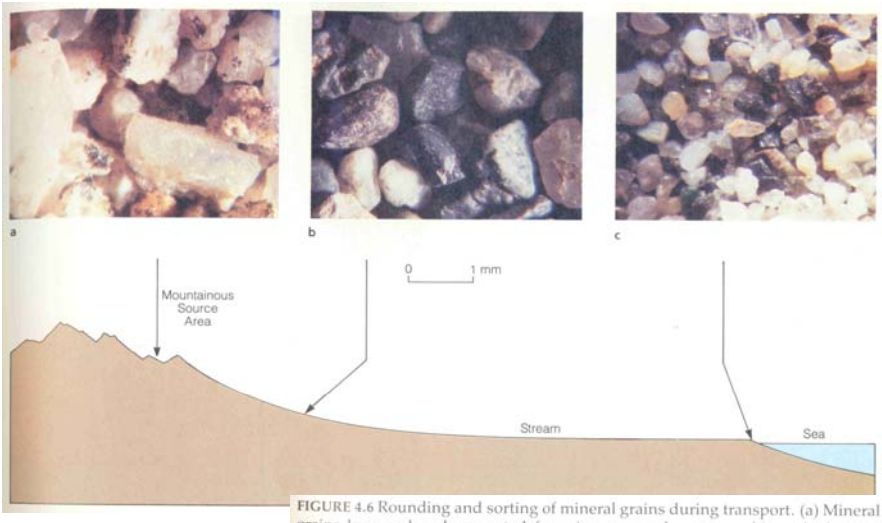
sehr schlecht sortiert




Tucker 1991

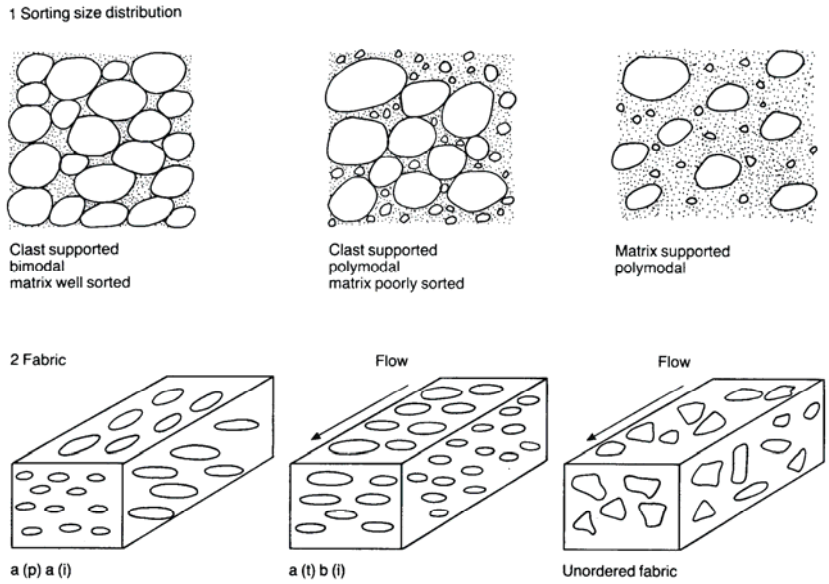
## Transport ⇒ Korngröße, Rundung, Sortierung




Skinner & Porter 1989

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.

## Korn- bzw. Geröllgefüge




HvE /

## C) Schichtung / Sedimentstrukturen

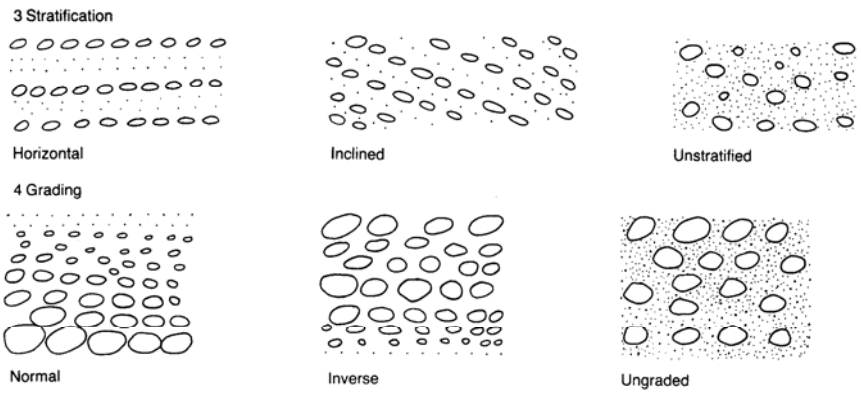



**Fig. 2.1.** Features used in a textural and structural classification of conglomerate (from Harms, Southard & Walker, 1982). Under fabric, codes a and b refer to long and intermediate axes respectively; p = parallel to flow, t = transverse to flow, i = imbricate. (Reproduced by permission of SEPM.)

Graham1988

**HvE /** SED - Grundlagen

## Schichtung vs. Lamination

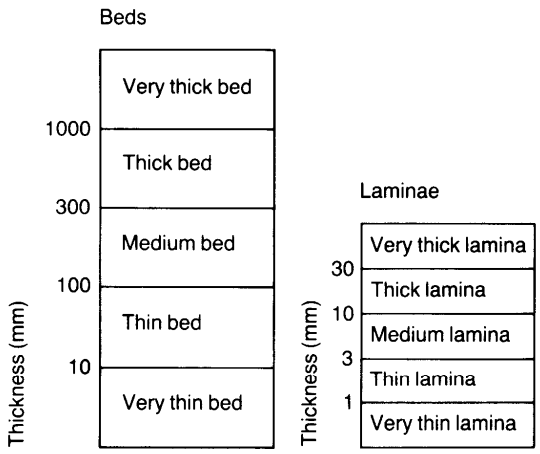
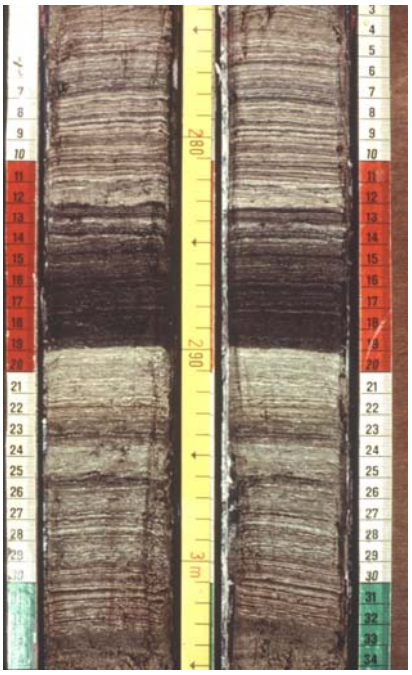


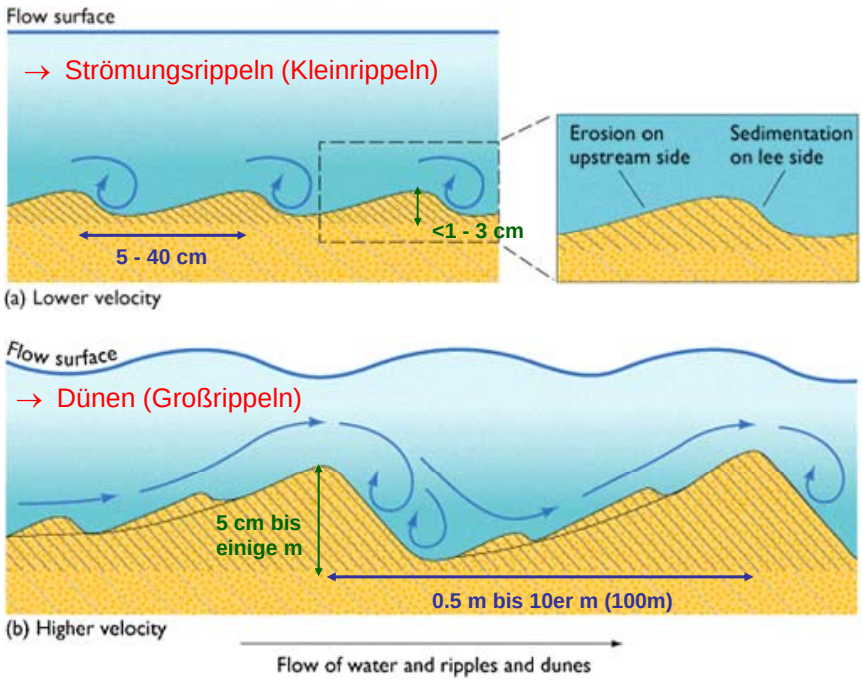

**Fig. 2.13.** Terminology for thickness of beds and laminae (modified after Ingram, 1954, Campbell, 1967 and Reineck & Singh, 1975). (Reproduced by permission of Springer.)

**Graham 1988**



## Beispiel Lamination






HvE / SED - Grundlagen

Press & Siever 2001

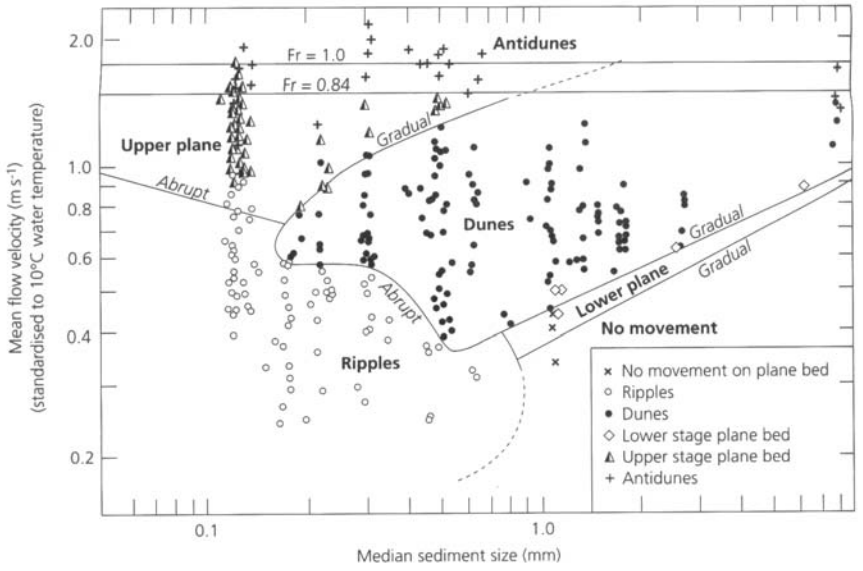



**Fig. 5.17** Plot of mean flow velocity against median sediment size (both standardized to 10°C water temperature) for a mean flow depth of 0.25–0.40 m to show the existence fields of bedforms. After Southard (1991) [31].

Allen 1997

HvE / SED - Grundlagen

## Kammformen vs Schrägschichtungstypen

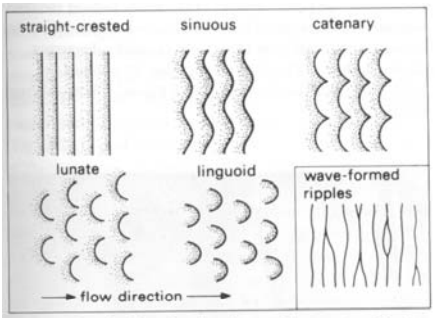



Fig. 2.19 Terminology for the shape of the crests of ripples and dunes formed by unidirectional currents. For comparison, the tyical crest pattern of wave-formed ripples is also shown.

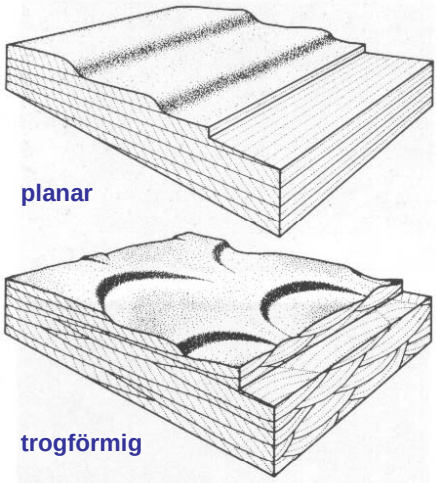



Fig. 2.21 Block diagrams showing the two common types of cross stratification: planar and trough. Above: planar cross stratification, chiefly formed through the migration of straight-crested (i.e. two-dimensional) ripples, producing planar cross lamination, and straight-crested dunes, producing planar 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

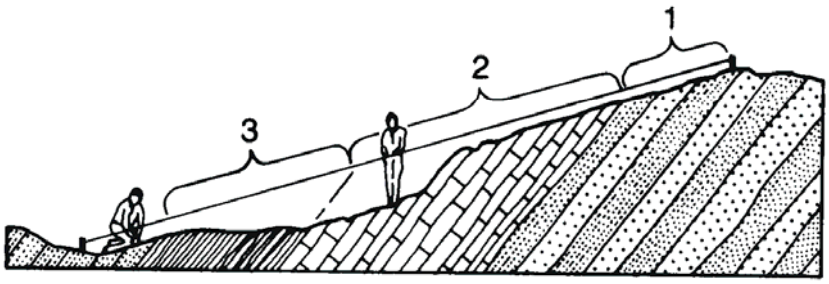



**Fig. 2.18.** Measurement of strata on a slope by reference to a stretched tape. Note the projection of contact between units (2) and (3) to the tape (from Compton, 1962). (Reproduced by permission of Wiley.)

Graham1988



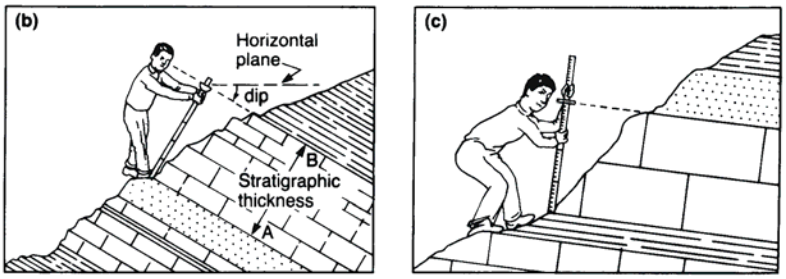
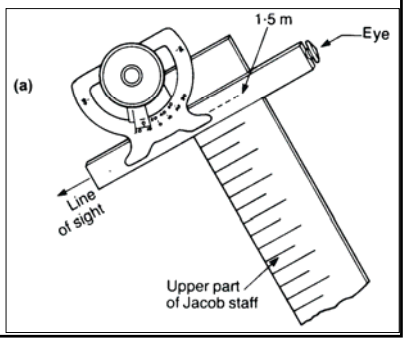
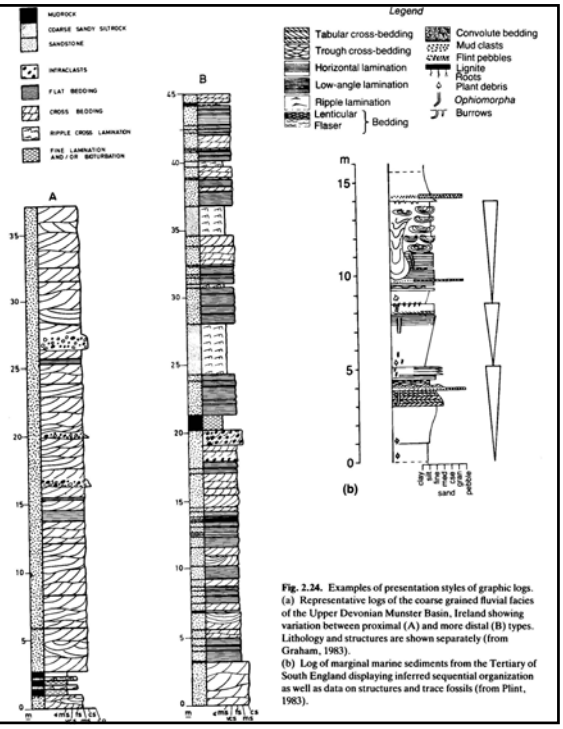



**Fig. 2.20.** Use of the Jacob staff for measuring sections (from Kottlowski, 1965).
(a) Setting dip on clinometer of Abney hand level used with a Jacob staff.
(b) Measuring stratigraphic thickness AB.
(c) Measuring a unit with thickness less than the length of a Jacob staff.
(Reproduced by permission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

Graham1988



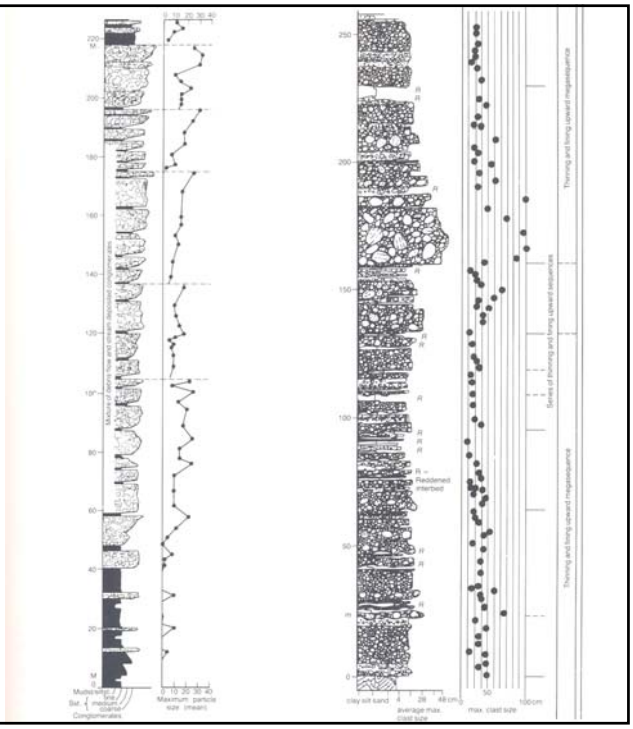
## Beispiele von Profilaufnahmen und Bohrlochaufnahmen




Graham 1988 (in Tucker, *Ed*.)



## Beispiele von Profilaufnahmen und Bohrlochaufnahmen



Graham 1988
(in Tucker, *Ed*.)