

Svakt omdannede sedimentære bergarter fra mellom- til senordovicisk tid
Low-grade metasedimentary rocks of Middle to Late Ordovician age

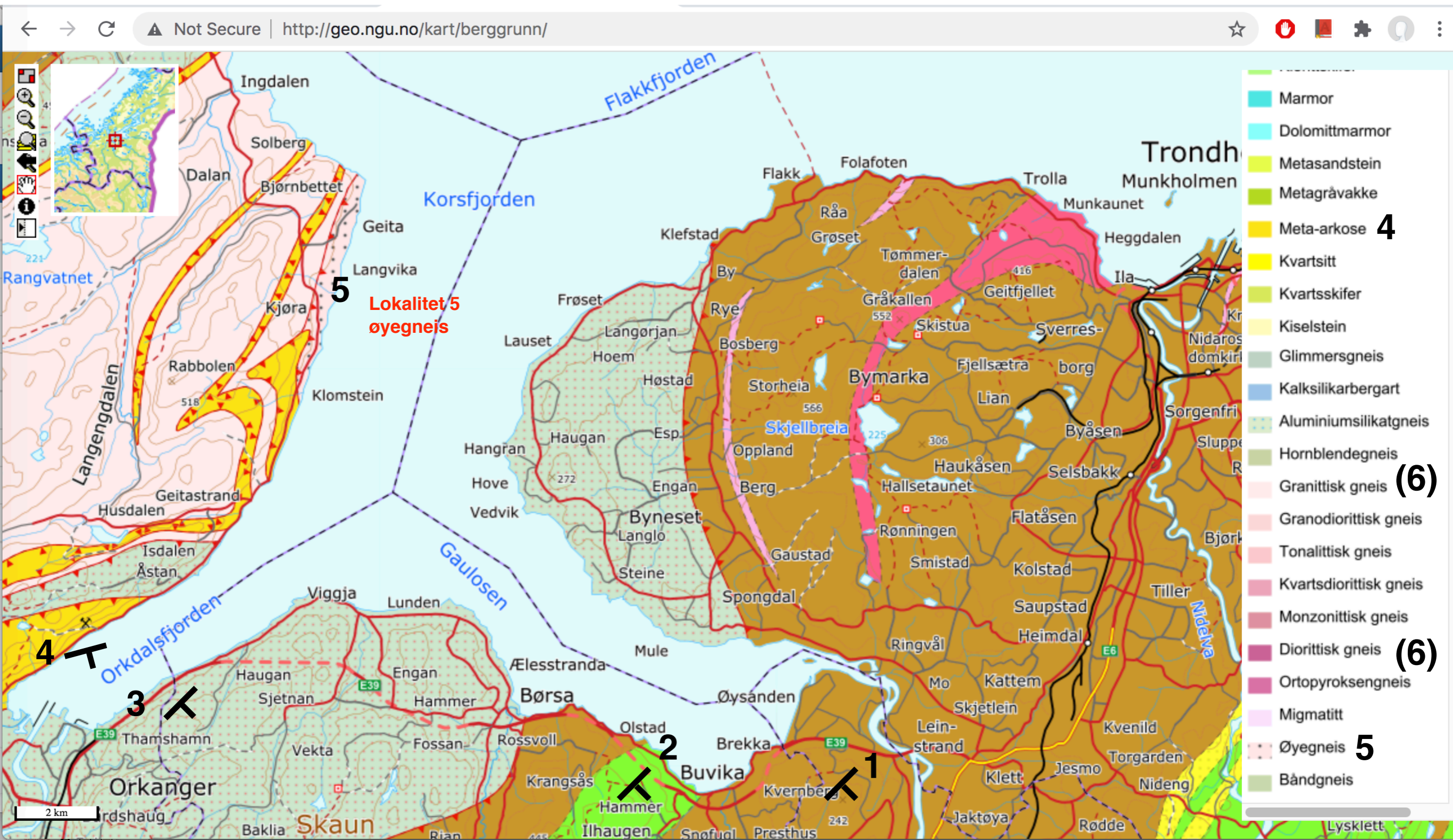
- 2** Fyllitt, grågrønn, med vekslende lag av kalkholdig gråvakke og mørk grå siltstein med svovelkis, stedvis med klaster, eller tynne, linseformede lag med polymikt konglomerat
Phyllite grey-green, with alternating beds of calcareous greywacke and dark grey siltstone with pyrite, in places with scattered pebbles, or thin lenticular beds of polymict conglomerate
- 3** Gråvakke, lagdelt (i dm til m tykke lag), grovkornet, lokalt grusig, stedvis med småbollet konglomerat i bunnen av lagene
Greywacke, bedded (in dm- m-thick beds), coarse-grained to gravelly, in places with small-pebble conglomerate at the base of some of the beds
- 4** Konglomerat, polymikt (klaster av ulike bergarter), stedvis med kantrundete blokker (inntil 1,5 m) fra den underliggende Rissetkalksteinen
Conglomerate, polymict (pebbles of different rock types), in places with subangular blocks (up to 1.5 m) of the subjacent Risset limestone
- 5** Kalkstein, blågrå, lagdelt (i cm til dm tykke lag), stedvis fossiliførende (gastropoder og konodonter), med tynne sjikt av kalkskifer og svart fyllitt (Rissetkalksteinen)
Limestone, blue-grey, bedded (in cm- m-thick beds), in places fossiliferous (gastropods and conodonts), with thin intercalations of calcareous schist and black phyllite (Risset limestone)
- 6** Konglomerat, polymikt, med avlange klaster (opptil 50 cm lange), hovedsaklig av grønnstein og felsitt/plagiogranitt (Helsingplass/Huvakonglomeratet)
Conglomerate, polymict, with elongated clasts (up to 50 cm in length), mainly of greenstone and felsite/plagiogranite (Helsingplassen/Huva conglomerate)

Størensgruppen
Støren Group

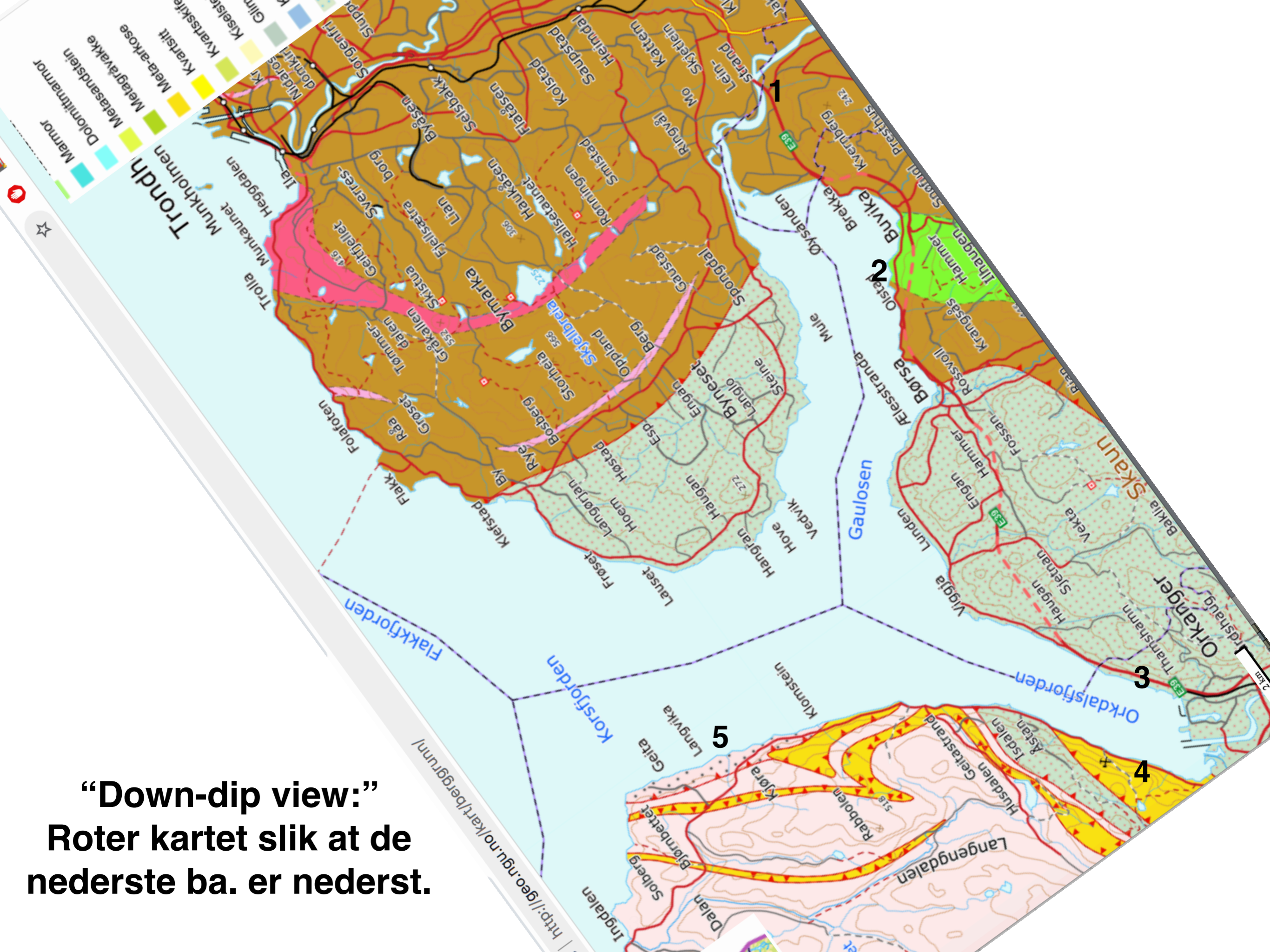
Omdannede magmatiske og sedimentære bergarter fra senkambrisk til tidligordovicisk tid
Metamorphosed magmatic and sedimentary rocks of Late Cambrian to Early Ordovician age

- 7** Grønnstein; omdannet basalt, stedvis med putestruktur, stedvis med tufflag, grønnskifer og lag eller lagganger av finkornet trondhemitt (Fåneskomplekset og Granheimgrønnsteinen)
Greenstone, metabasalt, in places with pillow structures, with sporadic beds of tuff, greenschist and layers or sills of fine-grained trondhemite (Fånes Complex and Granheim greenstone)
- Grønnskifer, kalkskifer, lys grå felsisk tuff, kiselstein (lagdelt i cm tykke lag) og marmor

NGU 1: 250 000 kartserie



Strøk og fall
 “Down-dip” ↙



**“Down-dip view:”
Roter kartet slik at de
nederste ba. er nederst.**

Google images Rapakivi Granitt

trekant diagram
(feltene er ikke pensum):

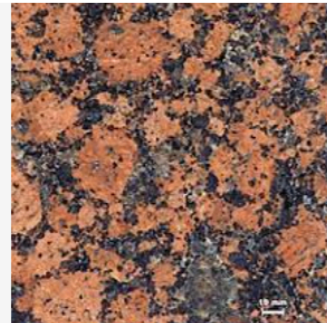
Quartz
Alkali-feltspat
Plagioklas

Google

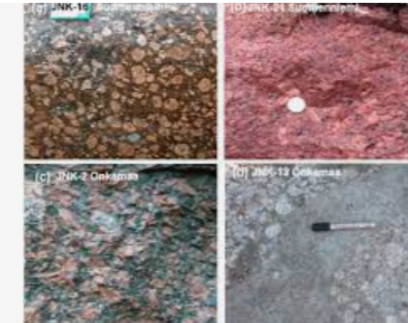
rapakivi granite



Rapakivi granite - Wikipedia
en.wikipedia.org



Rapakivi granite - Wikipedia
en.wikipedia.org



rapakivi granite from Southern Finland ...
researchgate.net



Rapakivi granite-details of t...
researchgate.net



Rapakivi granite - TimeTrek
aikavaellus.fi



Rapakivi
sandatlas.org



Rapakivi
sandatlas.org



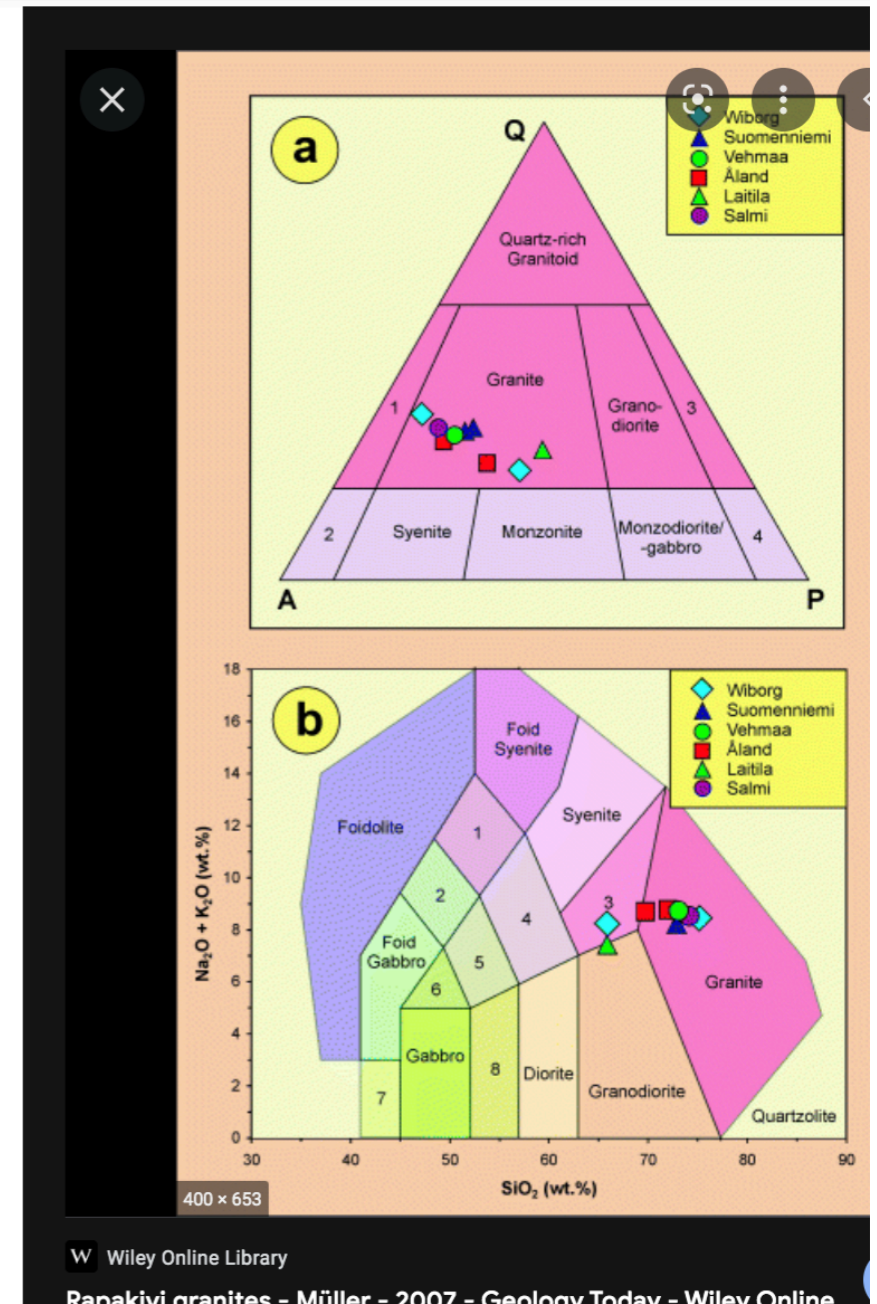
Rapakivi granite - Wikiwand
wikiwand.com



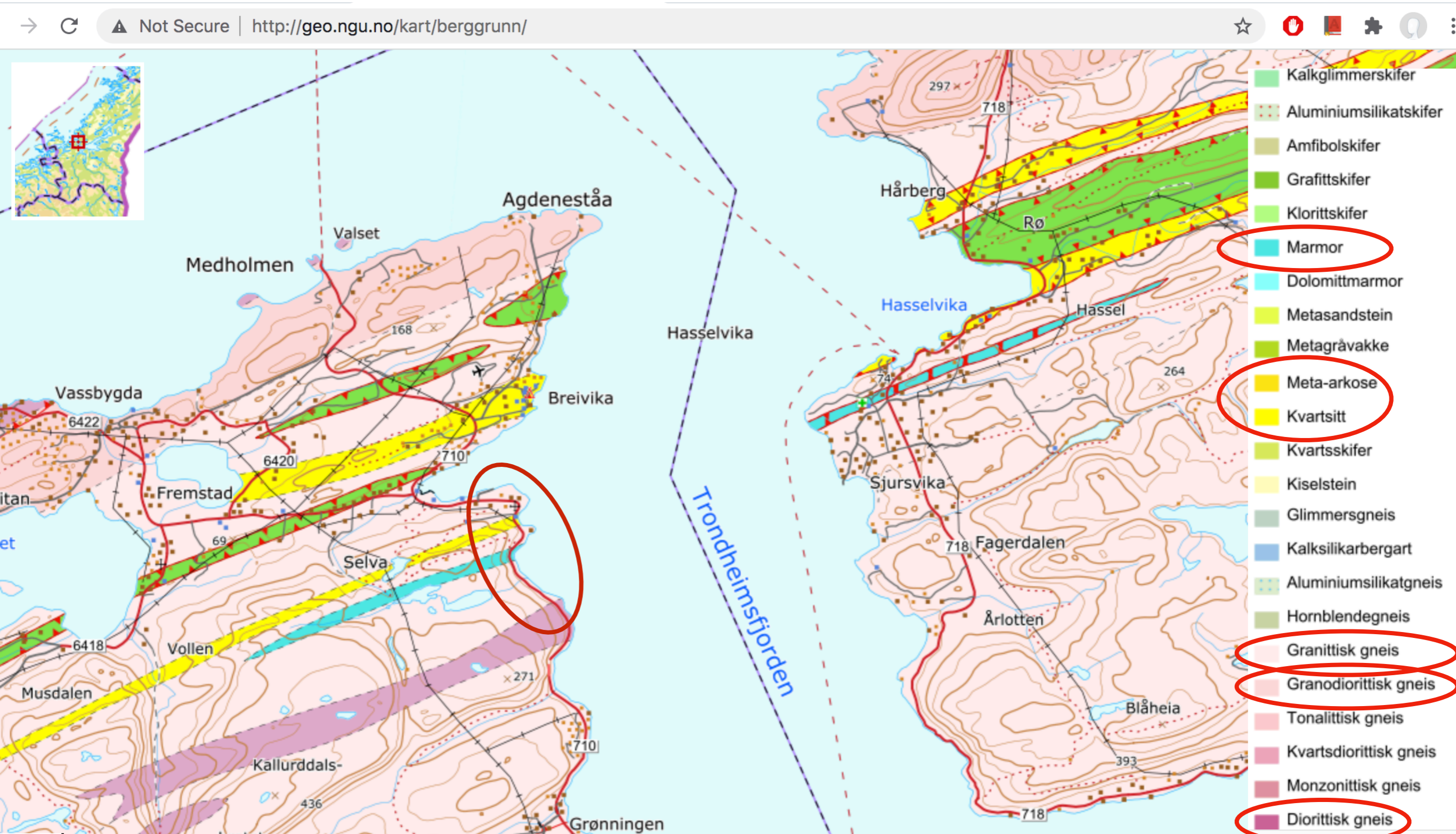
Rapakivi granite in the architecture of ...
lyellcollection.org



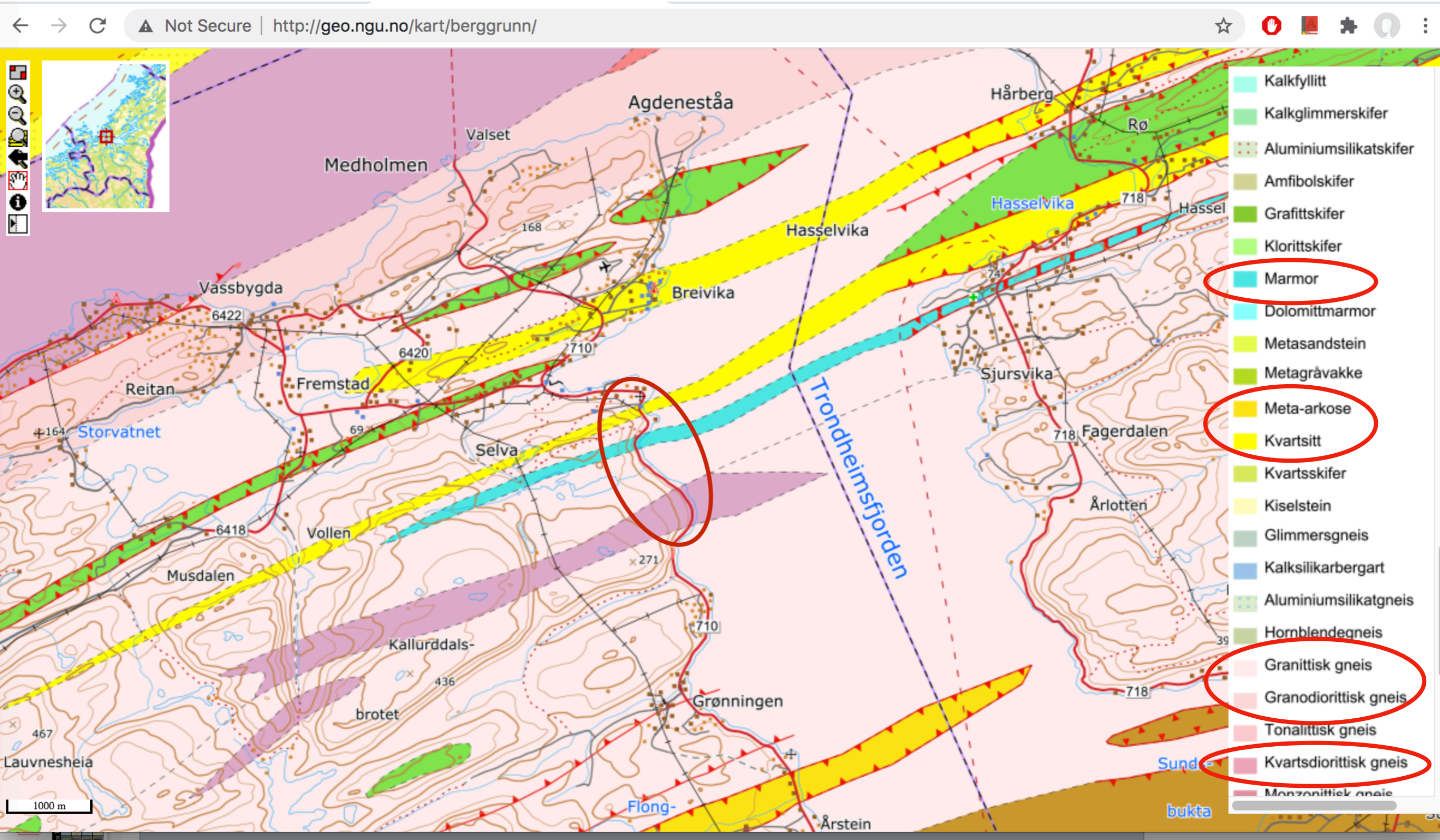
Geo-Files: Rapakivi Granite (E2-S3 ...
youtube.com



Lokalitet 6

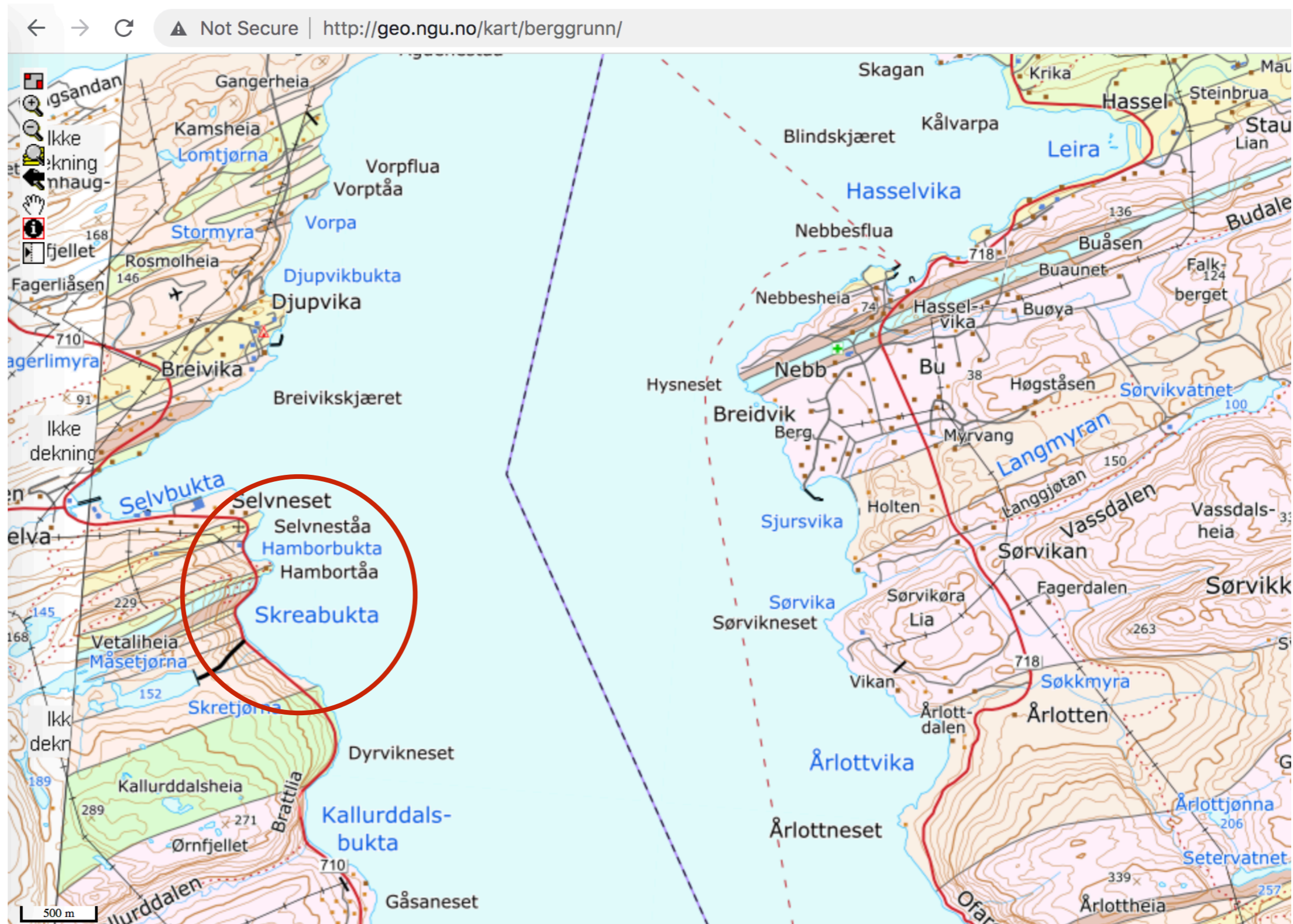


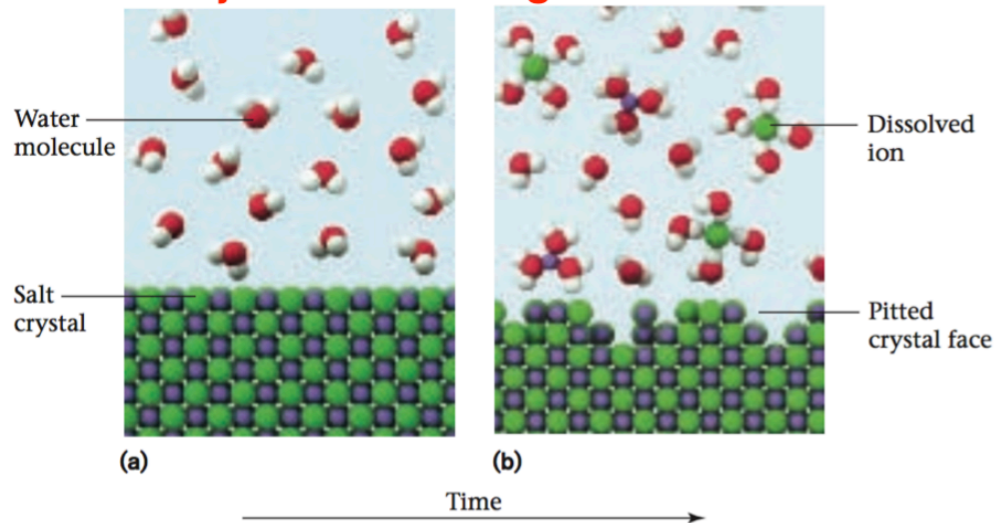
NGU 1: 250 000 kartserie



NGU 1: 50 000 kartserie (mer detaljert)

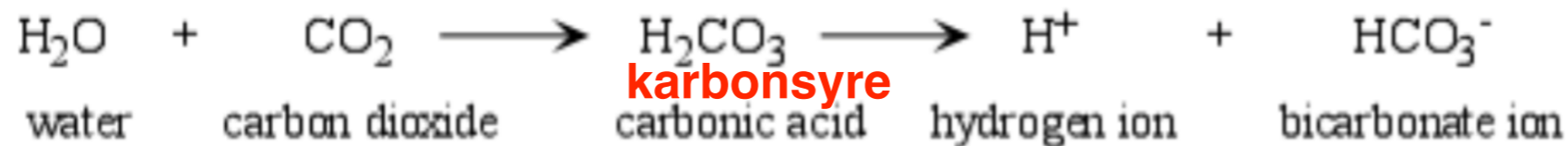
klikk på (i) →
for en
beskrivelse
av hver
enkel bergart



kjemisk forvitring

The main agent responsible for chemical weathering reactions is water and weak acids formed in water.

- An acid is solution that has abundant free H^+ ions.
- The most common weak acid that occurs in surface waters is **karbonsyre** carbonic acid.
- Carbonic acid is produced in rainwater by reaction of the water with carbon dioxide (CO_2) gas in the atmosphere.



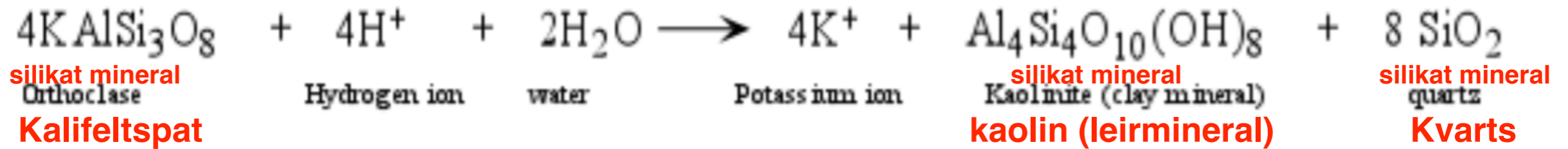
(en liten ion)

H^+ is a small ion and can easily enter crystal structures, releasing other ions into the water.

Types of Chemical Weathering Reactions

- **Oppløsning** - $\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$
Kalsitt

- **Hydrolysis** - H^+ or OH^- replaces an ion in the mineral. Example:



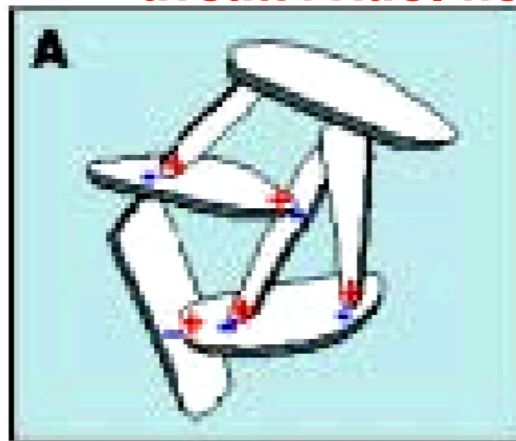
- **Leaching** - ions are removed by dissolution into water. In the example above we say that the K^+ ion was leached. **Utluting** (Hydrolyse og Utluting er to sider av samme sak.)

- **Oxidation** - Since free oxygen (O_2) is more common near the Earth's surface, it may react with minerals to change the oxidation state of an ion. This is more common in Fe **Oksidering**

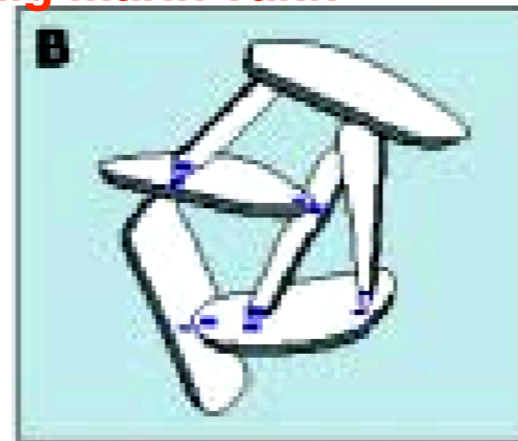
**Leire er en mineral-gruppe (som glimmer-gruppen).
Flak-formete leireminerale som kan plutselig kollapsere.**

Geoteknisk rapport nr. Saltdiffusjon som grunnforsterking i kvikkleire

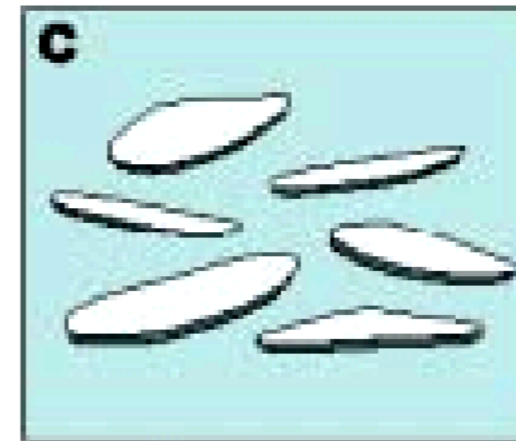
korthus struktur dannes når leireflak er avsatt i NaCl-holdig marin vann



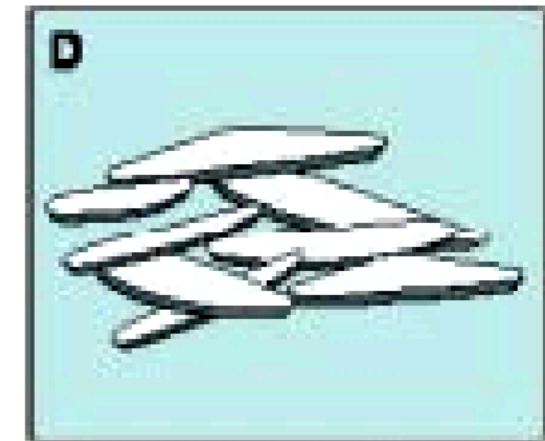
Leire med saltholdig porevann
Tiltrekkende krefter mellom partiklenes kanter og flater. Små frastøtende krefter mellom flatene. Flakformige korn i en åpen, men stabil kornstruktur.



Kvikkleire før ras
Ingen eller små frastøtende krefter mellom kanter og flater. Storre frastøtende krefter mellom flatene. Åpen og ustabil kornstruktur



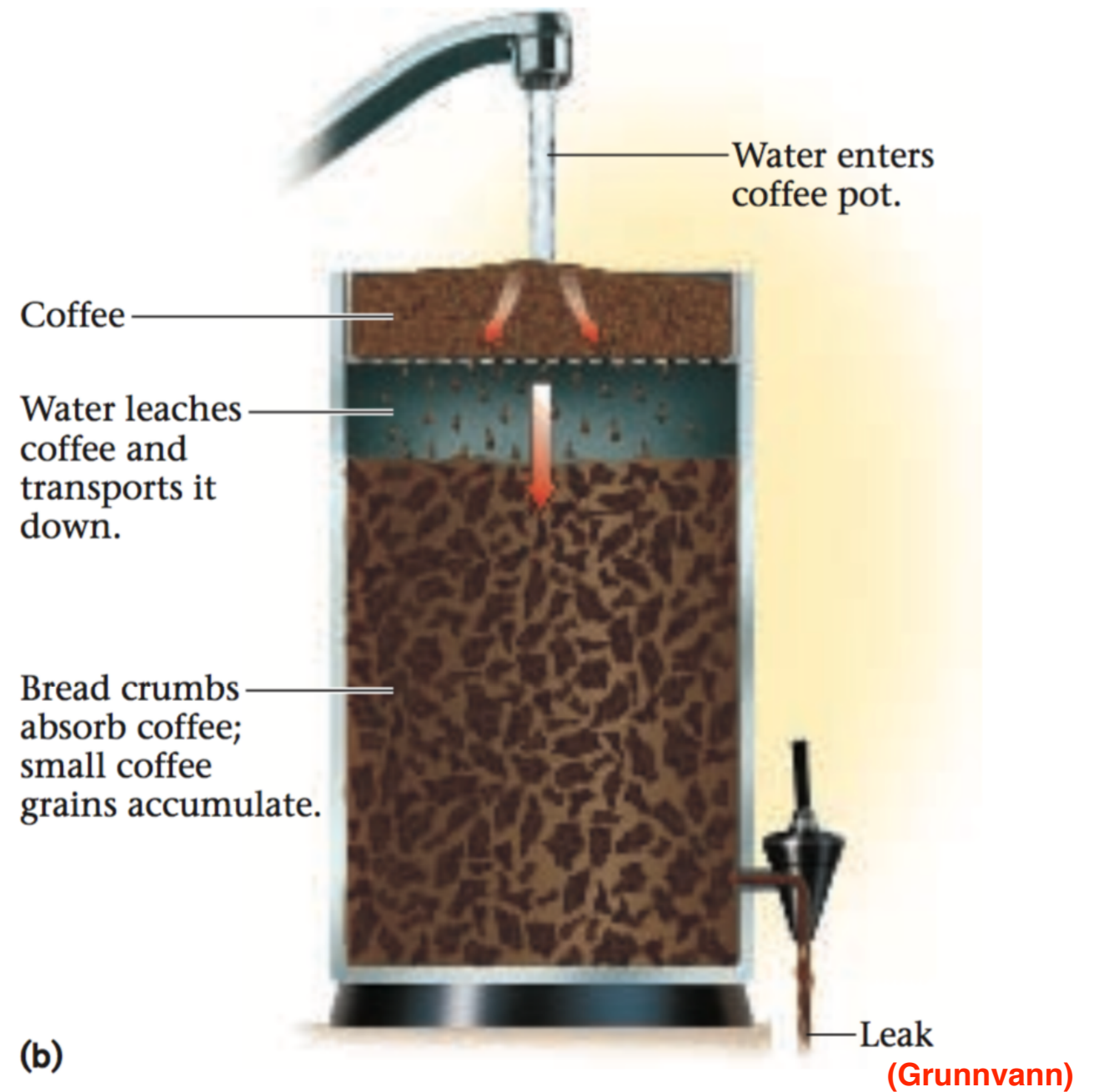
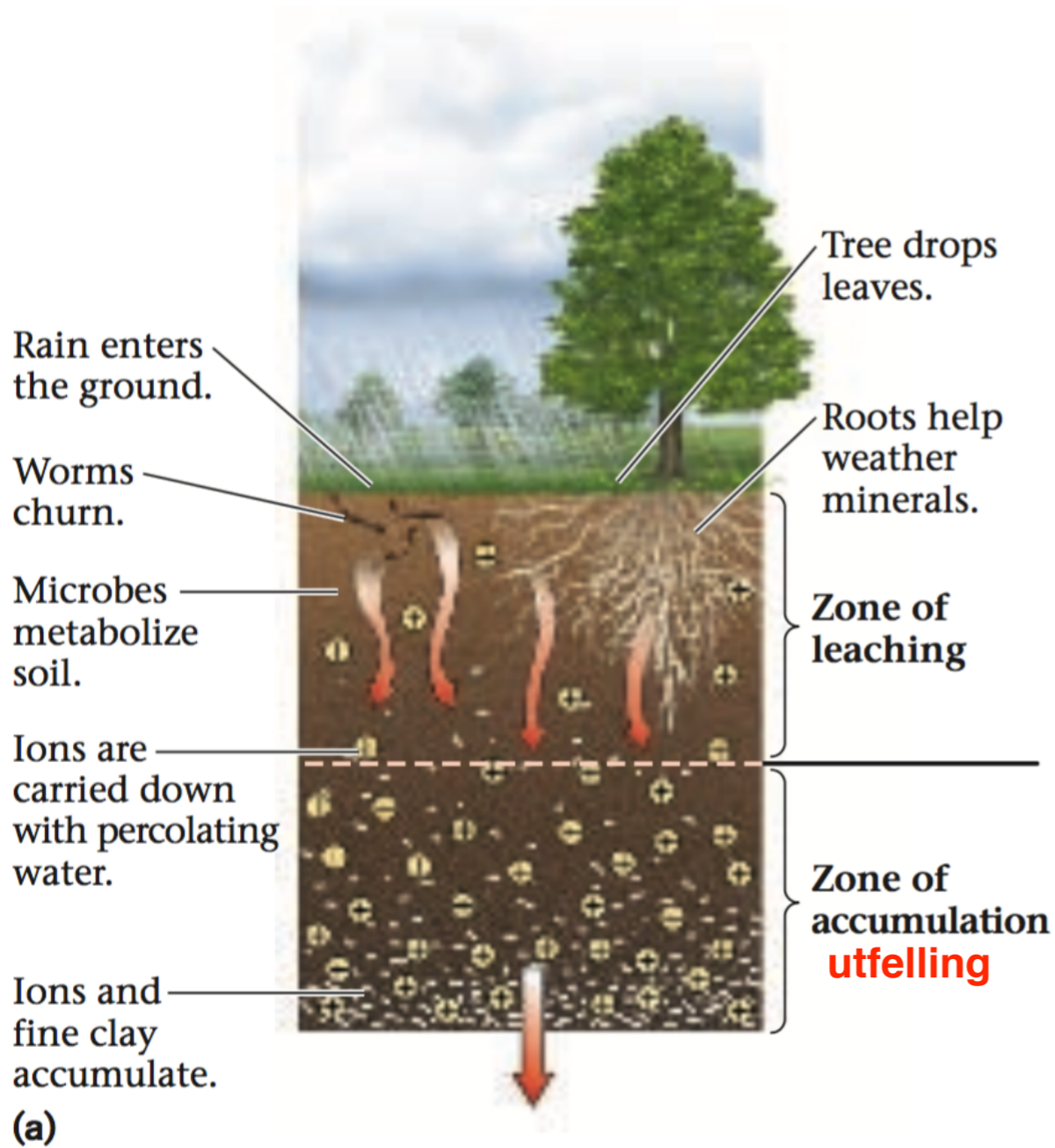
Kvikkleire under ras
Kollaps av kornstruktur. Overskudd av vann. Tyntflytende leirsuppe.



Omrørt leire etter ras
Tettere og mer stabil kornstruktur

Figur 2 Illustrasjon av strukturen til flokkulerte leirpartiklar. Frå Sveian et al. 2002.

FIGURE 7.12 During the formation of soil, the downward percolation of water creates a zone of leaching and a zone of accumulation. **(a)** In soil, the percolating water carries ions and clay downward. Soil formation also involves the metabolism of microbes and fungi and the addition of organic matter at the surface and underground. **(b)** The same process happens when you pour hot water through coffee grounds or tea leaves into a pot containing bread crumbs. Elements in the coffee or tea dissolve in the water and are carried down and collect in the bread crumbs; coffee eventually leaks from the pot.

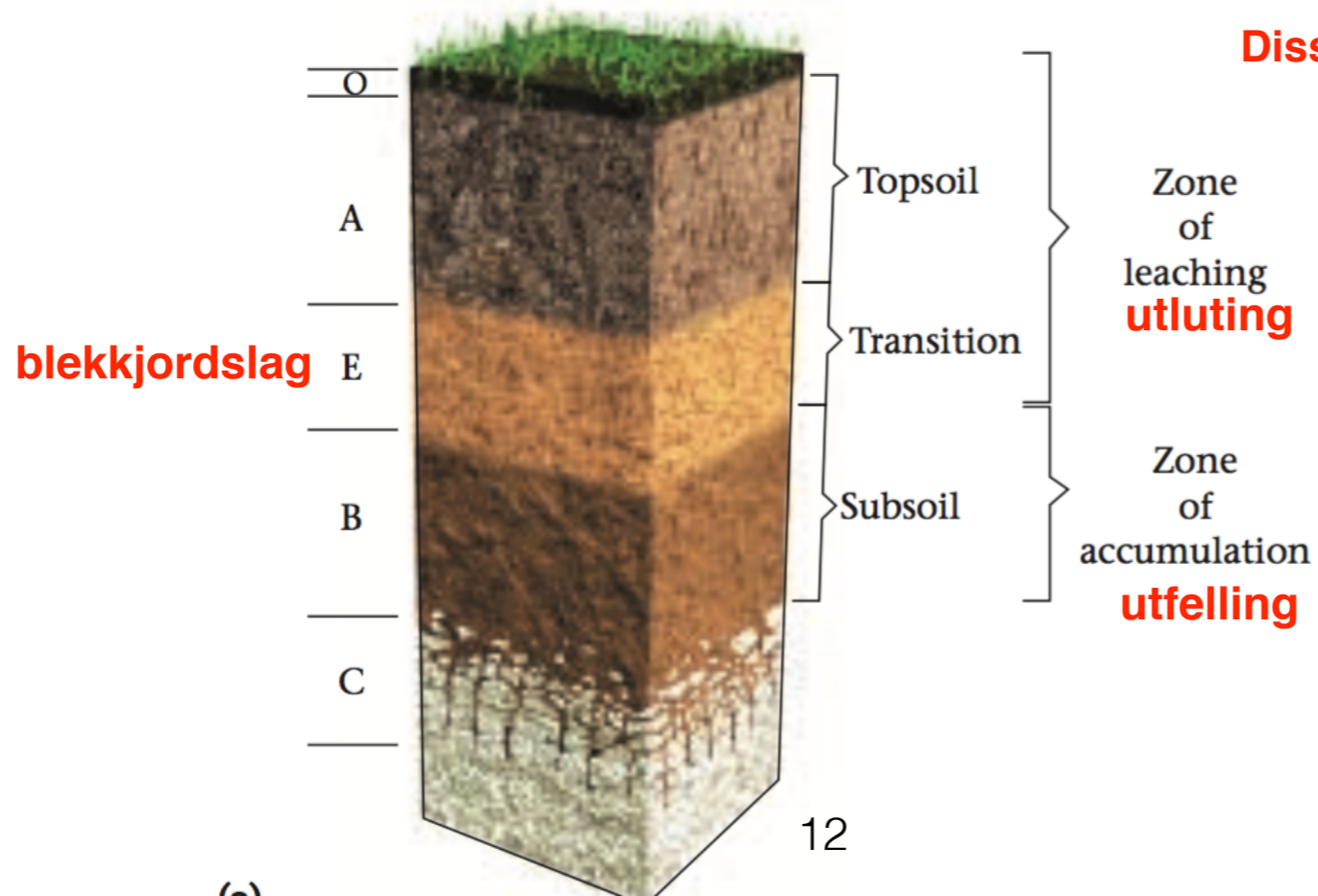


**Kaffetrakter modell.
Veldig god modell for jordsmonn.**

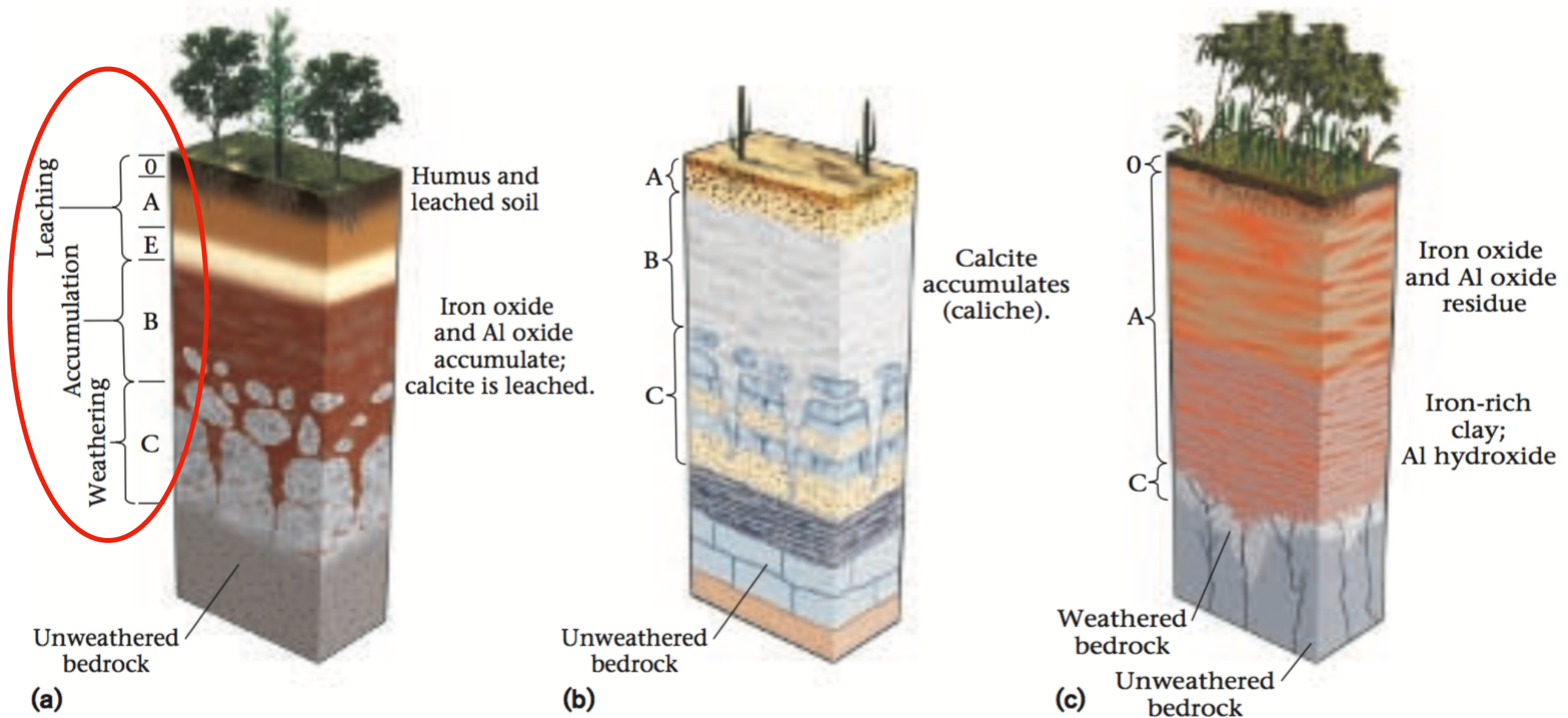


jordsmonn (soil)

Disse ulike fargene er ikke opprinnelige.
Bergarten var ikke lagdelt.



blekkjordslag



Ulike typer jordsmonn, og jordsmonnprofiler

(Det finnes kanskje hundre ulike typer jordsmonn, og alle har vitenskapelige navn)

De fleste har noen slags O-lag, A-lag, B-lag, C-lag

(O står for 'organisk')

kanskje hundre ulike typer jordsmonn !

Ulike typer jordsmonn, og jordsmonnprofiler

(ikke pensum for oss!)

USDA THE 12 ORDERS OF SOIL TAXONOMY

United States Department of Agriculture



Alfisols are soils in temperate to moist areas. These soils result from weathering processes that leach clay minerals and other constituents out of the surface layer and into the subsoil, where they can bind and supply moisture and nutrients to plants. They formed primarily under forest or mixed vegetation cover and are productive for most crops. Alfisols make up about 10% of the world's known land surface.



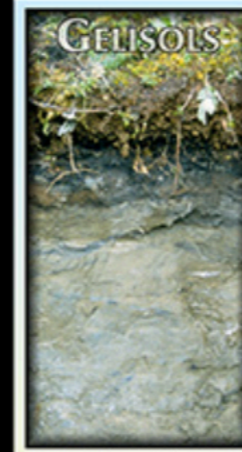
Andisols form from weathering processes that generate minerals with little acidic cation exchange. These minerals can result in unusually high water and nutrient holding capacity. As a group, Andisols tend to be highly productive soils. They include weakly weathered soils with much volcanic glass as well as more strongly weathered soils. They are common in moist areas with moderate to high precipitation, especially those areas associated with volcanic materials. Andisols make up about 1% of the world's known land surface.



Aridisols are soils that are too dry for the growth of mesophytic plants. The lack of moisture greatly restricts the intensity of weathering processes and limits soil development processes in the upper part of the soil. Aridisols often contain gypsum, salt, calcium carbonate, and other materials that are easily leached from soils in more humid environments. Aridisols are common in the deserts of the world. Aridisols make up about 12% of the world's known land surface.



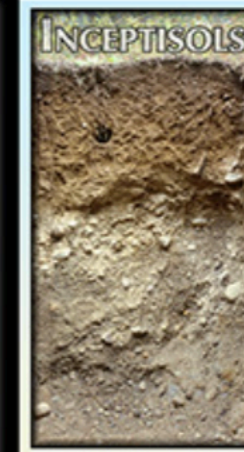
Entisols are soils that show little or no evidence of pedogenic feature development. Entisols occur in areas of recently deposited parent materials or in areas where erosion or depositional rates are faster than the rate of soil development, such as dunes, steep slopes, and flood plains. They occur in many environments. Entisols make up about 16% of the world's known land surface.



Gelisols are soils that have permafrost near the soil surface and/or have evidence of cryoturbation (soil churning) within ice segregation. Gelisols are common in the higher latitudes or at high elevations. Gelisols make up about 9% of the world's known land surface.



Histosols have a high content of organic matter and no permafrost. Most are saturated year round, but a few are freely drained. Histosols are commonly called bogs, moors, peats, or marshes. Histosols form in decomposed plant remains that accumulate in water, forest litter, or peat bogs that they decay. If these soils are drained and exposed to air, microbial decomposition is accelerated and the soils may subside dramatically. Histosols make up about 1% of the world's known land surface.



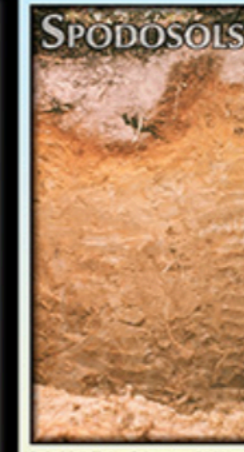
Inceptisols are soils of temperate to humid environments that generally exhibit only moderate degrees of soil weathering and development. Inceptisols have a wide range of characteristics and occur in a wide variety of climates. Inceptisols make up about 8% of the world's known land surface.



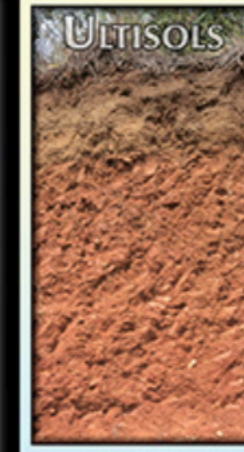
Mollisols are soils that have a dark colored surface horizon relatively high in content of organic matter. The soils are low in drought and therefore are quite fertile. Mollisols characteristically form under grass in climates that have a moderate to pronounced amount of moisture deficit. They are extensive soils on the steppes of Europe, Asia, North America, and South America. Mollisols make up about 7% of the world's known land surface.



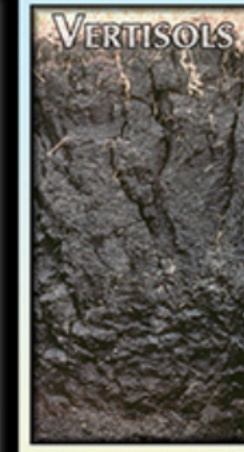
Oxisols are highly weathered soils of tropical and subtropical regions. They are dominated by low activity minerals, such as quartz, kaolinite, and iron oxides. They tend to have indistinct horizons. Oxisols characteristically occur on level surfaces that have been stable for a long time. They have low natural fertility as well as a low capacity to retain additions of lime and fertilizer. Oxisols make up about 8% of the world's known land surface.



Spodosols formed from weathering processes that strip organic matter combined with aluminum (leach) or without iron (leach) from the surface horizon and deposit them in the subsoil. In undisturbed areas, a gray eluvial horizon that has the color of oxidized quartz overlies a reddish brown or black subsoil. Spodosols commonly occur in areas of temperate forested biotopes under conditions known as forest regions. They tend to be acid and infertile. Spodosols make up about 4% of the world's known land surface.



Ultisols are soils in humid areas. They formed from fairly intense weathering and leaching processes that result in a clay enriched subsoil dominated by minerals, such as quartz, kaolinite, and iron oxides. Ultisols are typically acid soils in which most nutrients are concentrated in the upper few inches. They have a moderately low capacity to retain additions of lime and fertilizer. Ultisols make up about 8% of the world's known land surface.



Vertisols have a high content of expanding clay minerals. They undergo pronounced changes in volume with changes in moisture. They have cracks that open and close periodically and that show evidence of soil movement in the profile. Because they swell when wet, vertisols present water entry slowly and have undergone little leaching. They tend to be fairly high in natural fertility. Vertisols make up about 2% of the world's known land surface.

Weathering of Common Rocks

Rock	Primary Minerals	Residual Minerals* <small>kaffegrut</small>	Leached Ions <small>kaffe</small>
Granite	Feldspars <small>som kaffepulver</small>	Clay Minerals <small>kaffe grut</small>	Na ⁺ , K ⁺
	Micas <small>som litt fuktig kaffepulver</small>	Clay Minerals	K ⁺
	Quartz <small>som sand i kaffe-trakter modell</small>	Quartz (endres ikke)	---
	Fe-Mg Minerals <small>som jern spiker</small>	Clay Minerals + Hematite + Goethite <small>rusten spiker</small>	Mg ⁺²
Basalt	Feldspars	Clay Minerals	Na ⁺ , Ca ⁺²
	Fe-Mg Minerals	Clay Minerals	Mg ⁺²
	Magnetite	Hematite, Goethite	---
Limestone	Calcite <small>som sukker eller saltkorn</small>	None (oppløses fullstendig)	Ca ⁺² , CO ₃ ⁻² CO₂

*Residual Minerals = Minerals stable at the Earth's surface and left in the rock after weathering. restmineraler

Weathering of Common Rocks

Rock	Primary Minerals	restmineraler Residual Minerals*	utluttet ioner Leached Ions
Granite	Feldspars	Clay Minerals (Al ⁺ blir igjen i leire)	Na ⁺ , K ⁺
	Micas	Clay Minerals (Al ⁺ blir igjen i leire)	K ⁺
	Quartz	Quartz (endres ikke)	---
	Fe-Mg Minerals	Clay Minerals + Hematite + Goethite	Mg ⁺²
Basalt	Feldspars	Clay Minerals (Al ⁺ blir igjen i leire)	Na ⁺ , Ca ⁺²
	Fe-Mg Minerals	Clay Minerals (Al ⁺ blir igjen i leire)	Mg ⁺²
	Magnetite	Hematite, Goethite	---
Limestone	Calcite	None (opløses fullstendig)	Ca ⁺² , CO ₃ ⁻²

*Residual Minerals = Minerals stable at the Earth's surface and left in the rock after weathering.

Leire (består av leiremineraller og vann) brukes for å utvinne aluminiumsmetall.

Al-rik leire fra tropiske land fraktes til Norge, der norsk hydroelektrisk strøm brukes til å fjerne oksygen og vann og lage metallisk aluminium, som eksporteres. Dette er en måte å eksportere norsk hydroelektrisk strømenergi.

Leire som brukes for å utvinne aluminiumsmetall.

Al-rik leire fra tropiske land fraktes til Norge, der norsk hydroelektrisk strøm brukes til å fjerne oksygen og vann og lage metallisk aluminium, som eksporteres. Dette er en måte å eksportere norsk hydroelektrisk strømenergi.



Sunndalsøra aluminium

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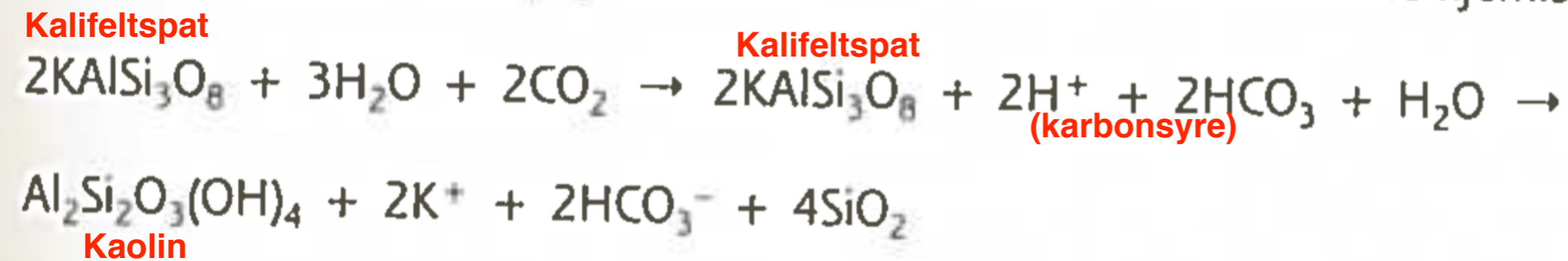


Sunndal aluminium plant | Norsk Hydr...
flickr.com



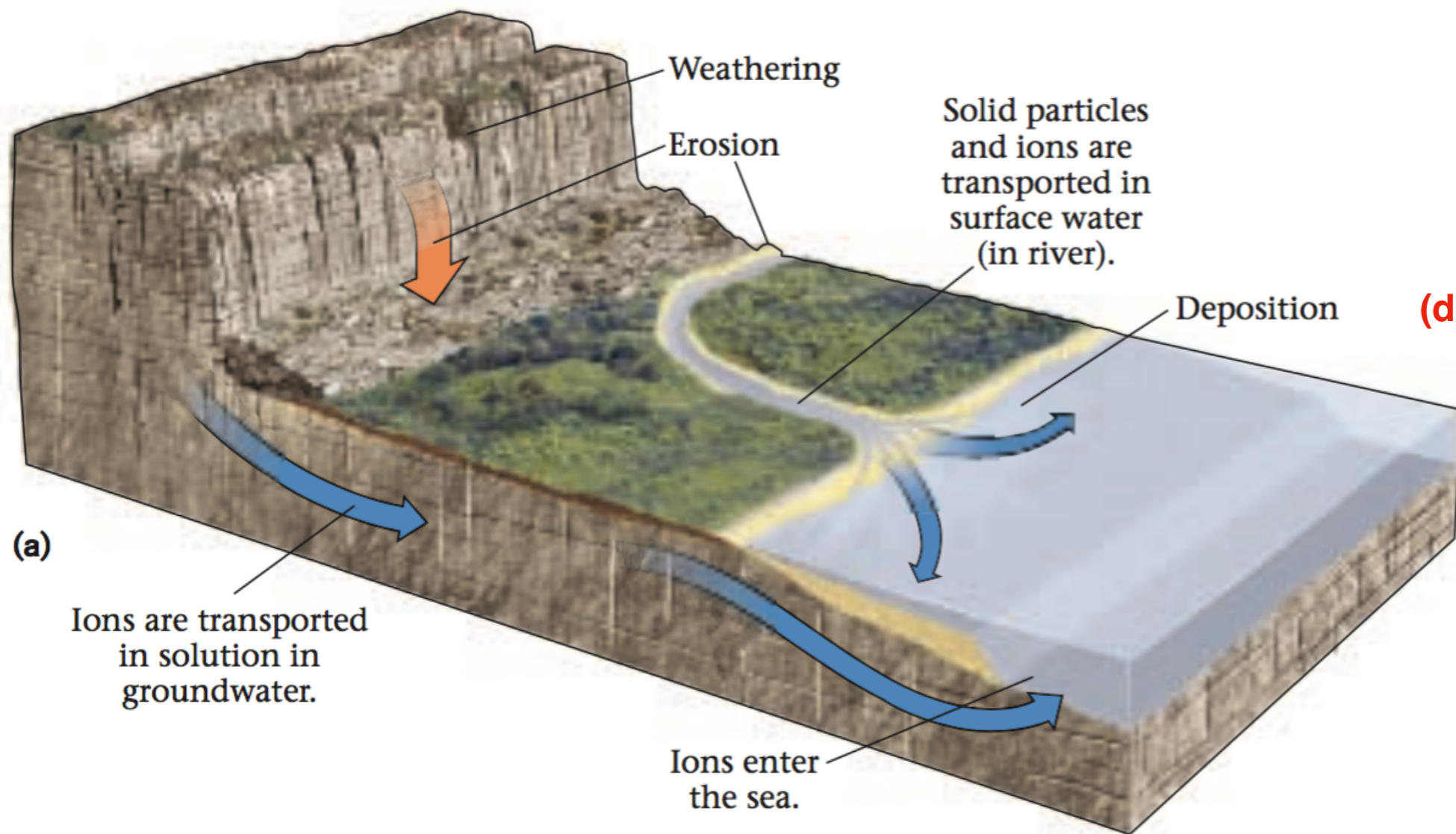
Hydro Aluminium, Sunndalsøra | Mannvit
mannvit.no

ionet (H^+) angriper direkte det krystalline nettverket i silikatmineralene og omdanner dem til leirmineraler, for eksempel kaolinitt. Denne kjemiske omdannelsen av silikatmineraler, for eksempel ortoklas ($KAlSi_3O_8$) til leirmineraler, kan illustreres i denne kjemiske reaksjonslikningen:



De dannede kaolinmineralene ($Al_2Si_2O_5(OH)_4$) inngår i bergarten som blir igjen, mens kaliumionet (K^+) sammen med oppløst SiO_2 kan føres bort med grunnvannet. Kalium inngår som næringsstoff for planter, mens oppløst SiO_2 andre steder kan danne bekkenes fylling.

Se i formelen hvor mye Al det er i Kaolin. Kaolin er som kaffegrut.



nøkkelord:
forvitring
transport
 (disse 2 utgjør erosjon)

avsetning
overleiring
kompaksjon
sementering
litifisering

FIGURE 7.16 (a) The basic steps during the development of a sedimentary rock: weathering → erosion → transportation → deposition → lithification. **(b)** As sediment moves from its source to the site of deposition, it becomes finer grained.

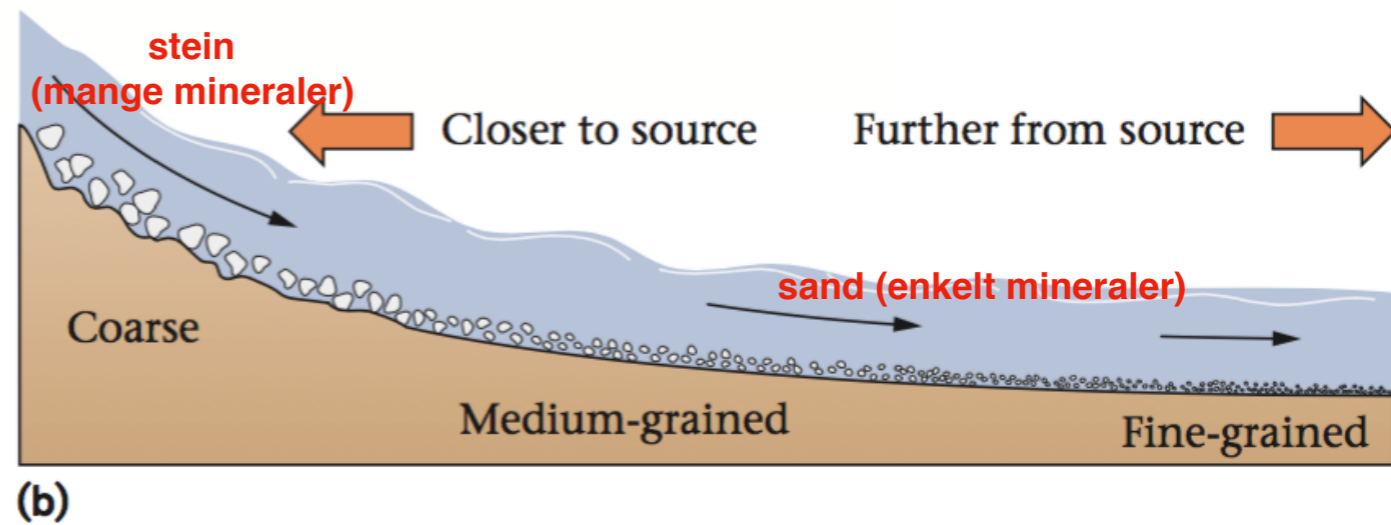
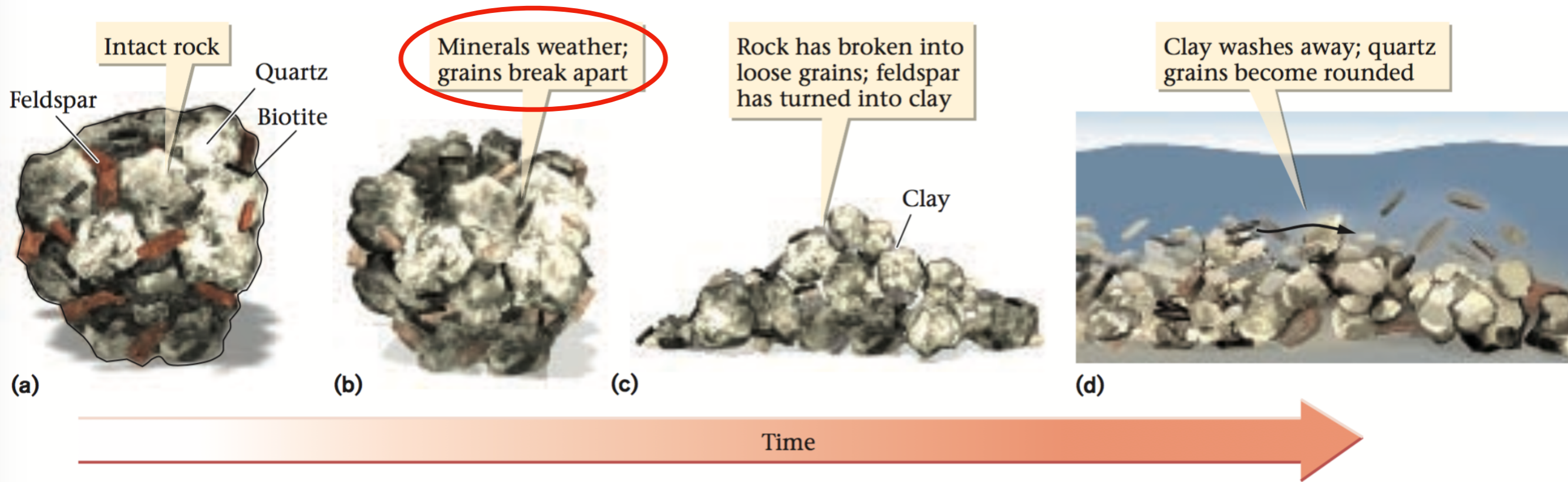


FIGURE 7.9 Chemical weathering aids physical weathering by weakening the attachments between grains. **(a)** This rock is solid. **(b)** Susceptible minerals have started to weather. **(c)** The rock crumbles. **(d)** Weaker minerals break up or react to form clay and wash away.



Hvis kjemisk forvitring er betydelig, blir den opprinnelige kornstørrelsen avgjørende for sediment kornstørrelser. Fordi mineralene faller fra hverandre helt fra starten.

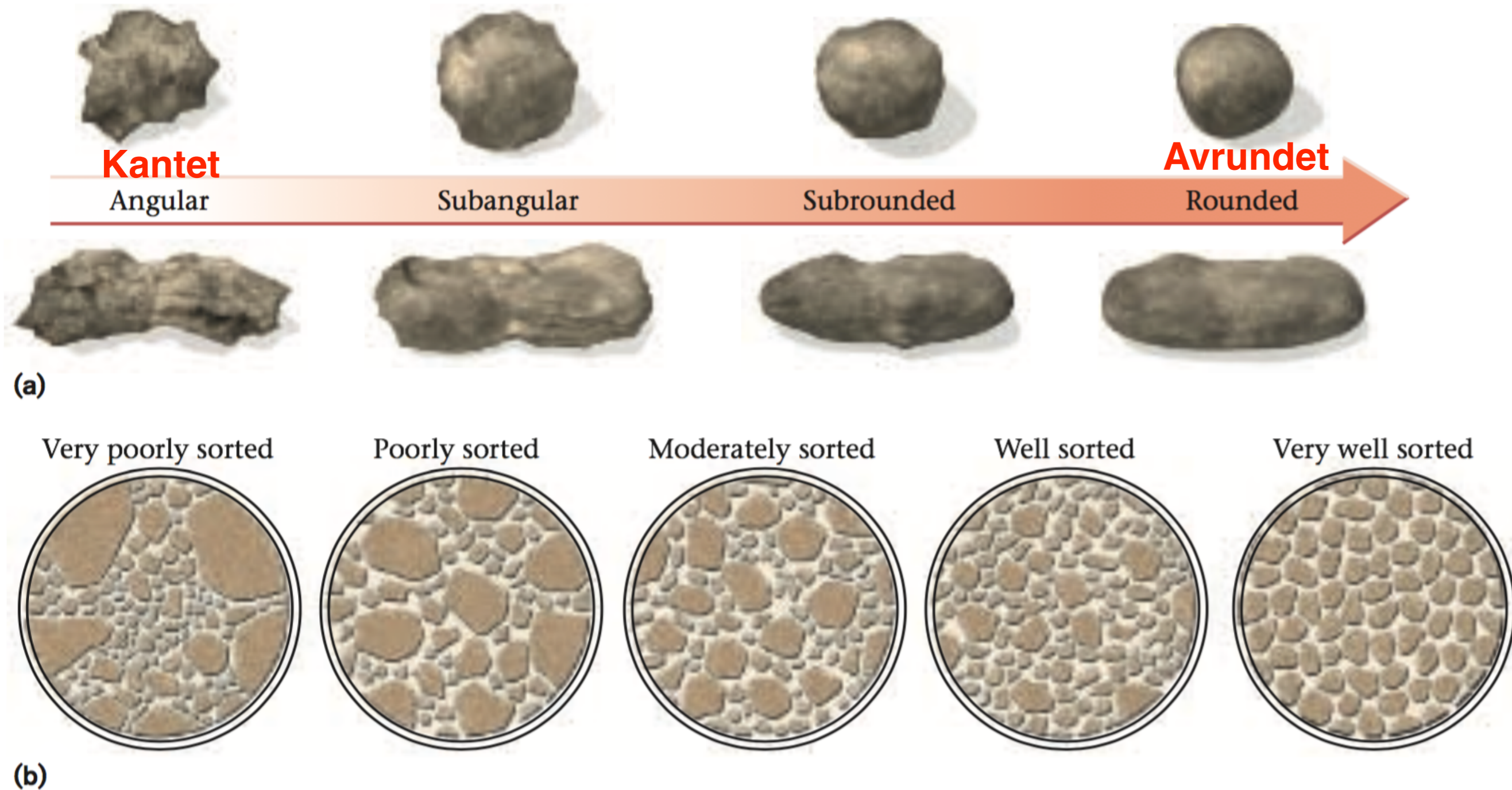
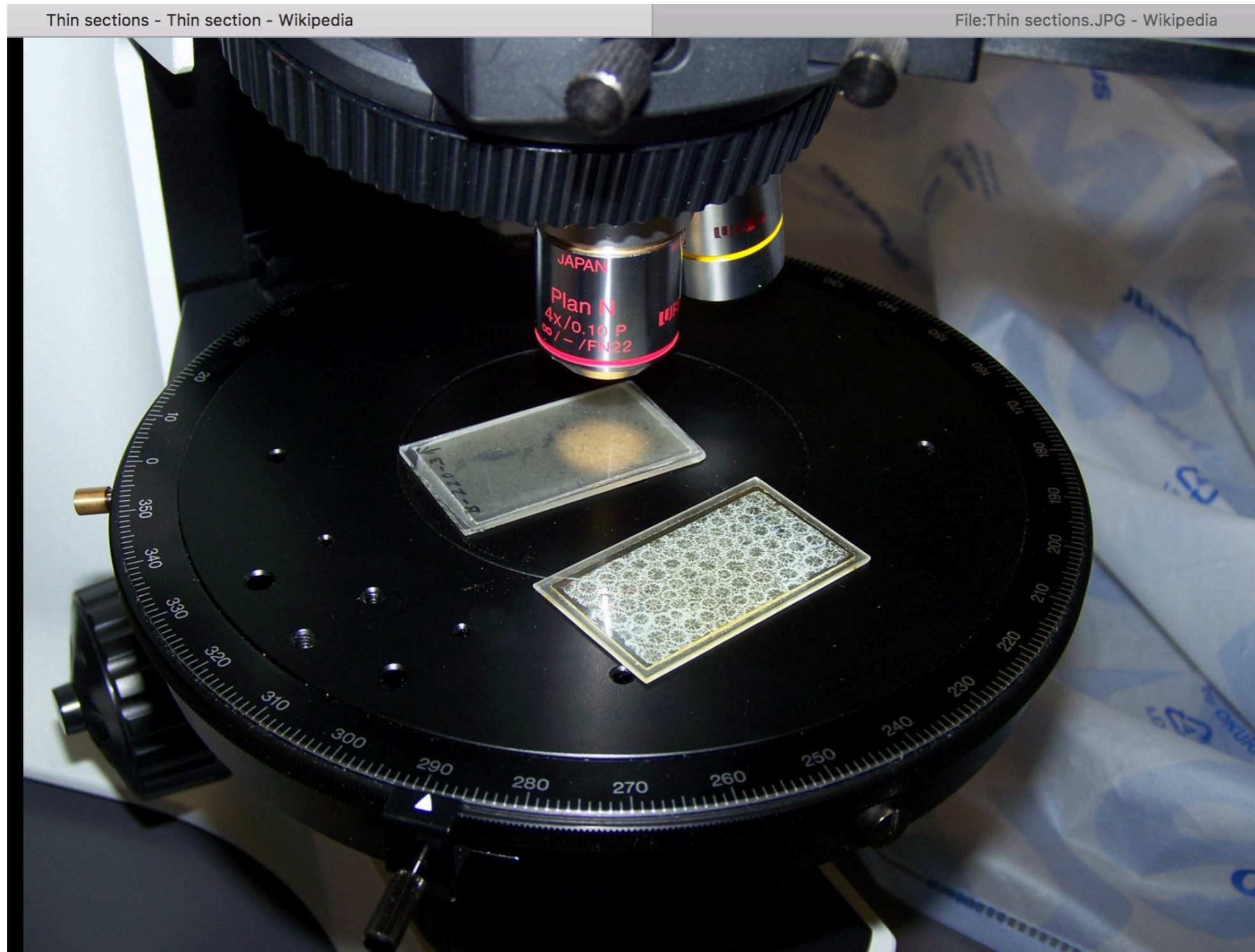


FIGURE 7.18 (a) A grain with high sphericity (top row) has roughly the same length in all directions, whereas one with low sphericity is elongate or flattened (bottom row). Sphericity is independent of angularity, which refers to whether the grain has sharp corners or edges or not. Grains on the left are more angular than grains on the right. **(b)** In a poorly sorted sediment, there is a great variety of different clast sizes, whereas in a well-sorted sediment, all the clasts are the same size.

**I granitt eller gneis er mineralene “kantet” når de løsner.
De blir avrundet av sedimentære prosesser.**

Tynnslip. Anbefaler at du leser denne Wikipediaside (men ikke pensum):

https://en.wikipedia.org/wiki/Thin_section



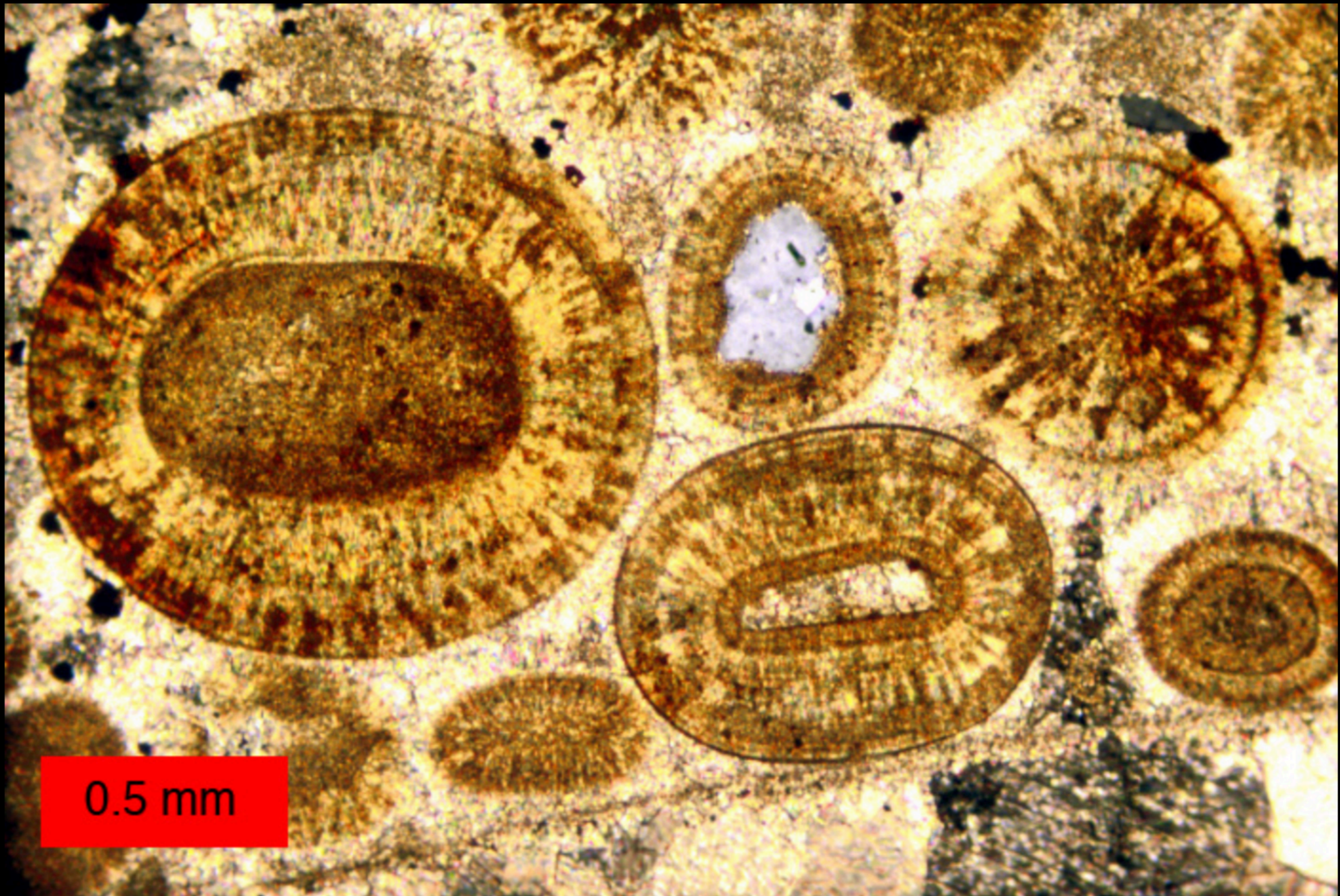
Gabbro (grå er plagioklas, blå og grønn med kløv er pyroksen, korn uten kløv er olivin)



Ooider (kalsitt sandkorn med overvekst av brun-gul kalsitt) og lys kalsitt sement

CarmelOoids - Thin section - Wikipedia

File:Thin sections.JPG - Wikip



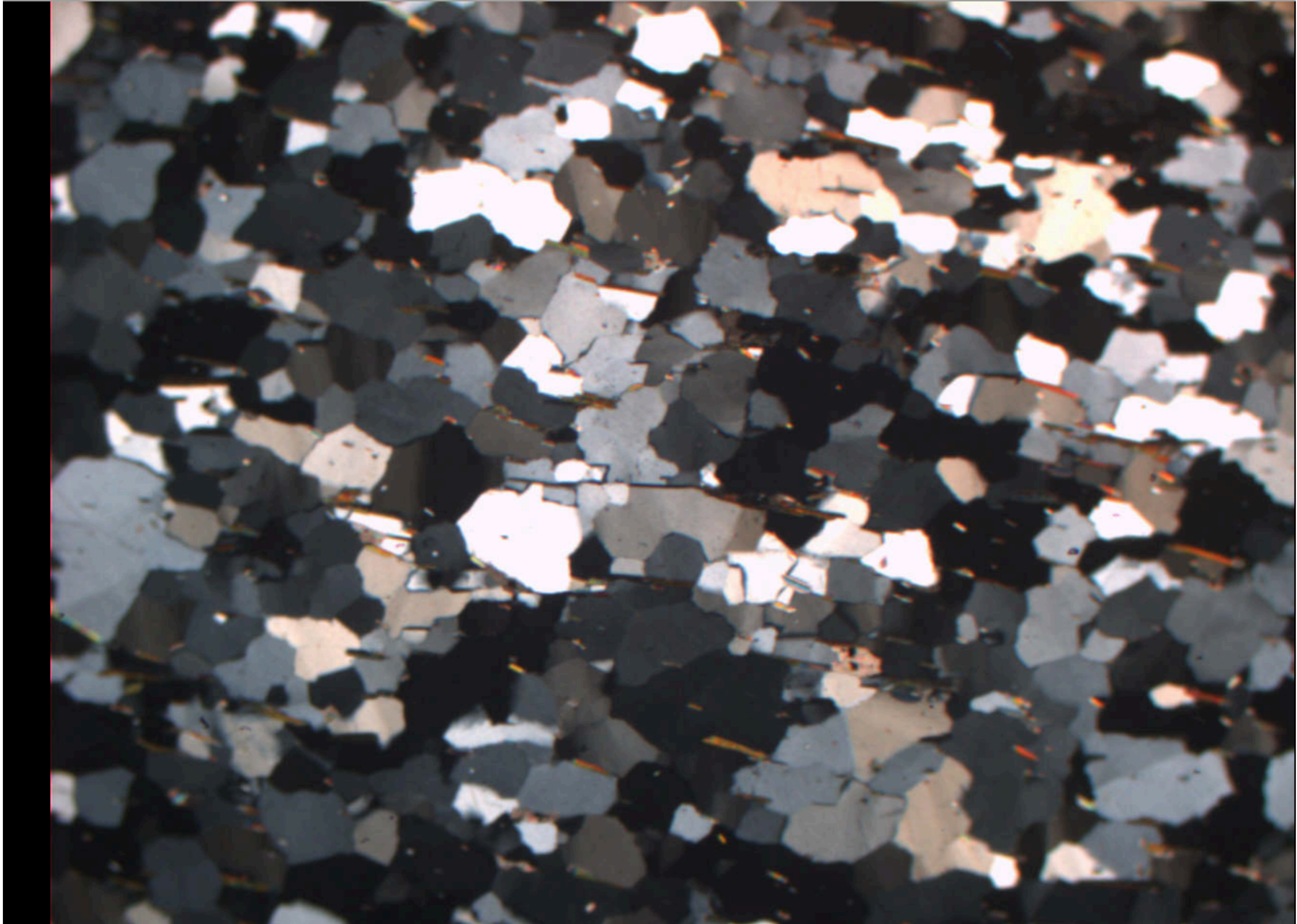
0.5 mm

Metamorf sandstein (kvartsitt)

Alle korn her er kvarts.

Thin section image of quartzite - Thin section - Wikipedia

File:Thin sections.JPG - Wikipedia



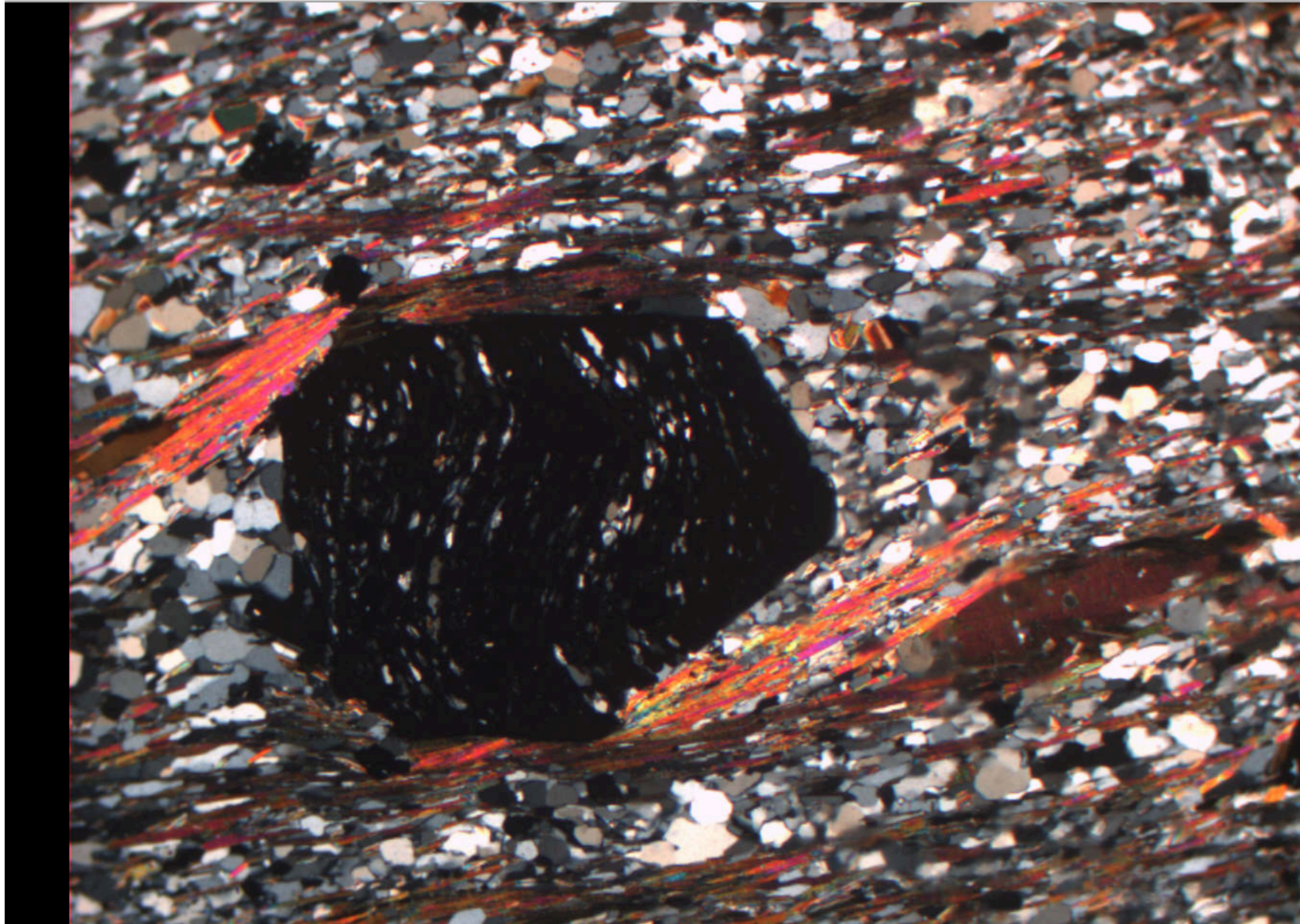
Glimmerskifer.

De hvite og grå korn er mest kvarts.

I tillegg ser man glimmer foliasjon og en granat som har rullet med klokka og har inneslutninger av kvarts og glimmer fra fyllitt, fra når kornstørrelsen var mindre.)

Thin section of garnet-mica-schist - Thin section - Wikipedia

File:Thin sections.JPG - Wikipedia



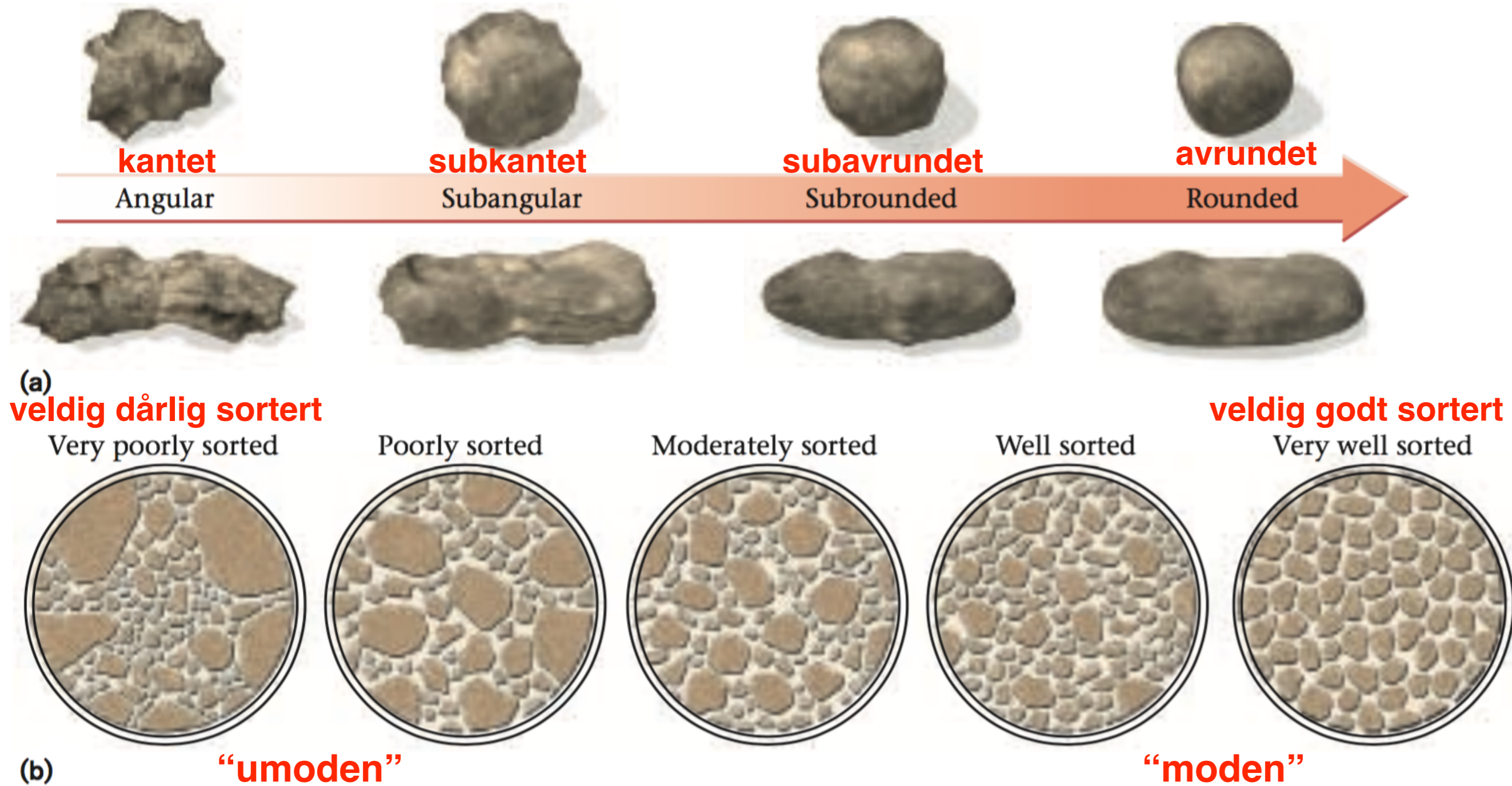
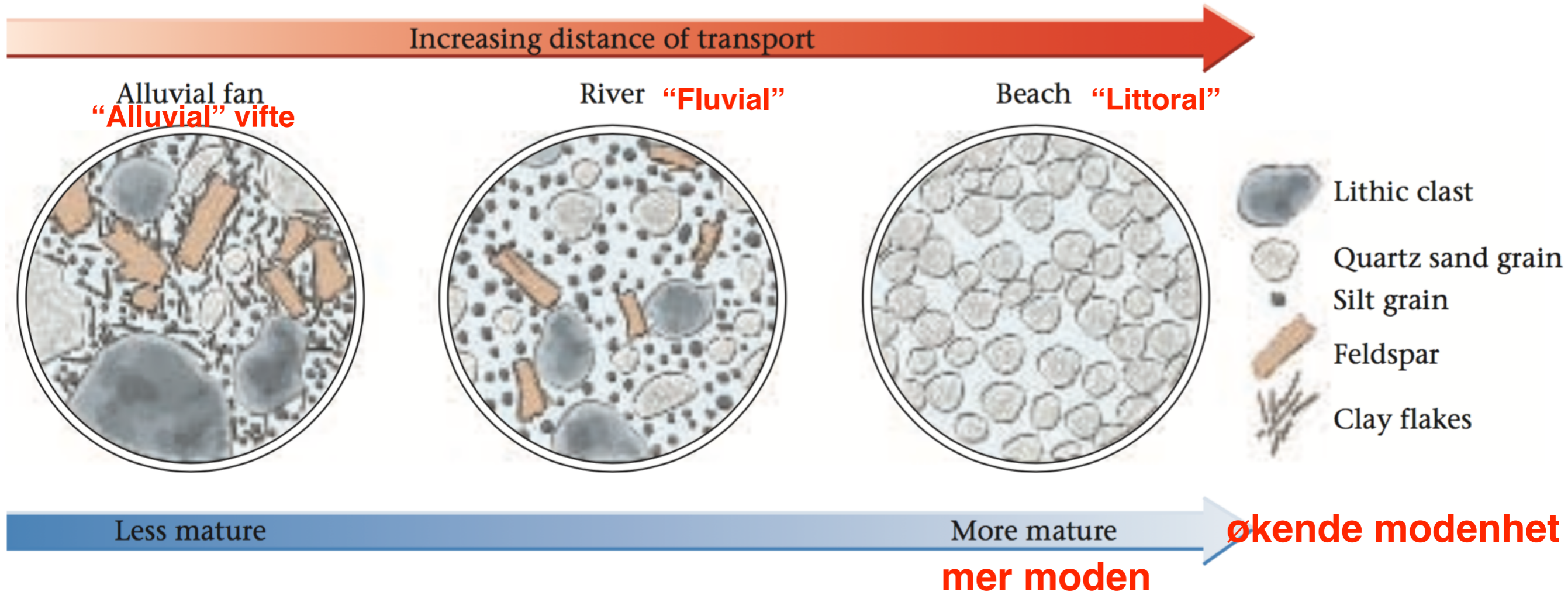


FIGURE 7.18 **(a)** A grain with high sphericity (top row) has roughly the same length in all directions, whereas one with low sphericity is elongate or flattened (bottom row). Sphericity is independent of angularity, which refers to whether the grain has sharp corners or edges or not. Grains on the left are more angular than grains on the right. **(b)** In a poorly sorted sediment, there is a great variety of different clast sizes, whereas in a well-sorted sediment, all the clasts are the same size.

svært nyttig å se tynnslip i mikroskop



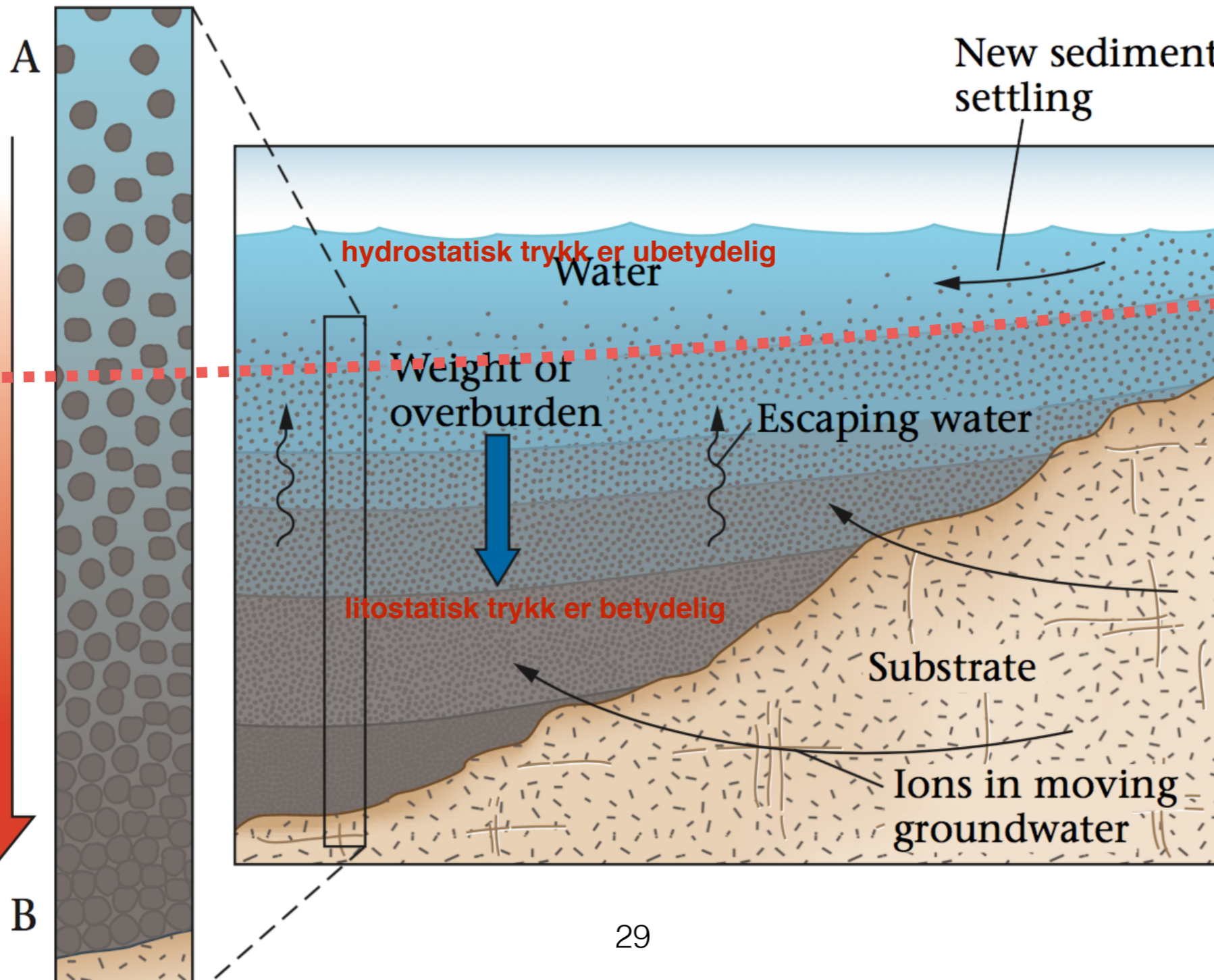
I et “modent” sediment, ustabile mineraler mangler, og de mer stabile mineraler er avrundet og sortert.

litifisering

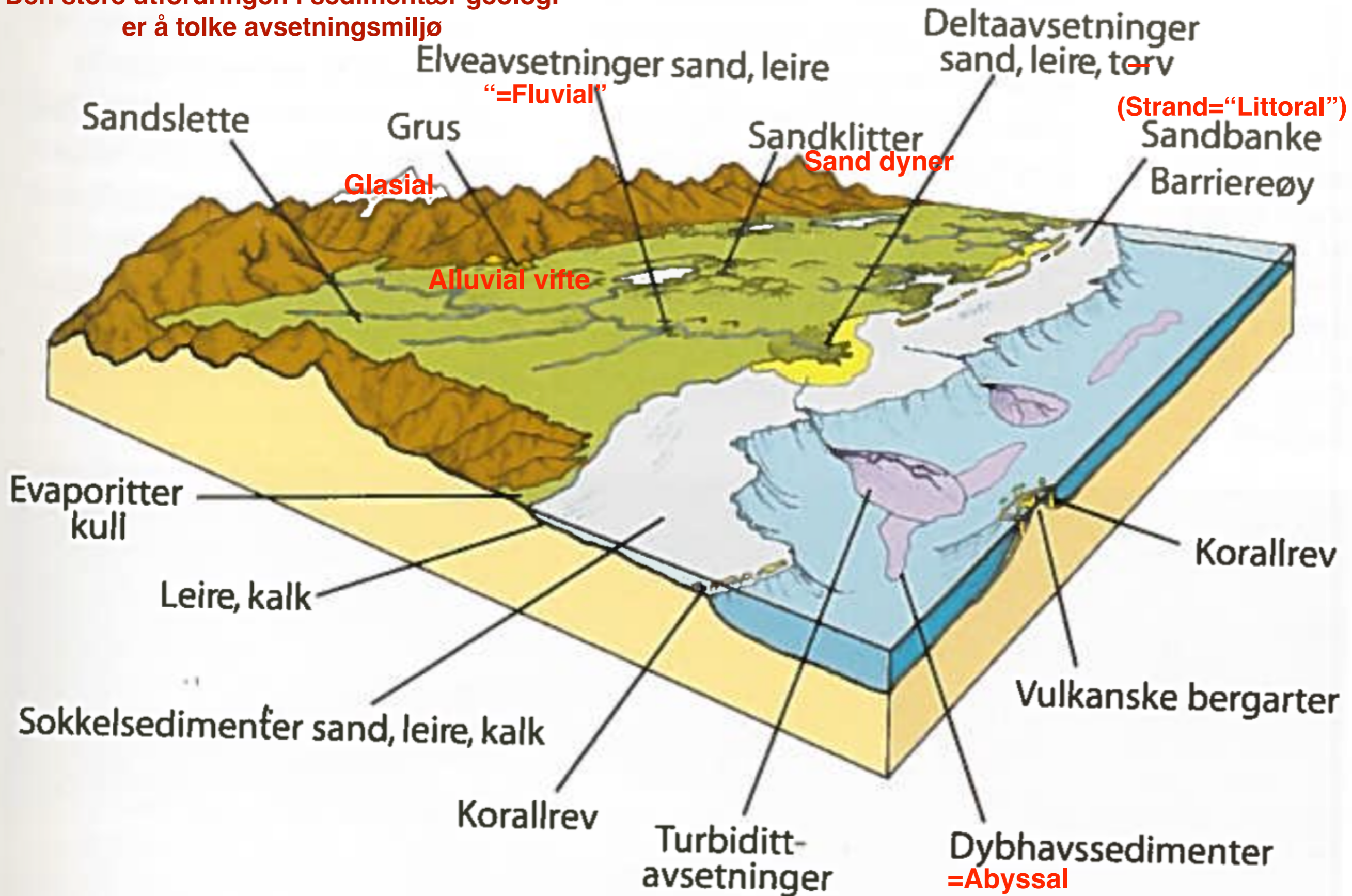
FIGURE 7.17 The process of lithification. As sediment is buried, it becomes compacted (expelling the water between the grains), and the grains pack tightly together. Groundwater passing through the rock precipitates ions to form mineral cements that bind the grains together. If there is clay in the rock, weak chemical bonds may cause the clay grains to stick to each other.

forvitring
transport
(erosjon)
avsetning
overleiring
kompaksjon
sementering
litifisering

grense?
Increasing pressure and
increasing compaction
kompaksjon
sammenpressing



Den store utfordringen i sedimentær geologi er å tolke avsetningsmiljø



Sedimentær facies

(Vitenskapsfolk er glade i *faguttrykk* som bare eksperter forstår)

Abyssal (dyphav)

Alluvial (avsatt av periodisk bekkevann)

Eolisk (vindavsatt)

Fluvial (elv)

Glacial (isbre)

Lakustrin (innsjø)

Littoral (havstrand)

Pelagisk (åpen hav uten påvirkning fra land)

Marin (har med havet å gjøre)

Terrestrisk (Ikke-marin)

Tabellen her gjelder “klastiske” eller “detritiske” sedimentær ba.

(*klast* betyr fragment)

(*detritus* betyr avfall, noe som ligger løst)

Størrelsesbegrep: blokk, stein, grus, grov sand, mellom sand, fin sand, silt, leire.

(clastic only)

Marshak.pdf (page 227 of 957)

TABLE 7.3 Common Types of Sedimentary Rock

Clast Size*	Clast Character	Rock Name (Alternate Name)
Coarse to very coarse	Rounded pebbles and cobbles boller avrundet	Conglomerate
	Angular clasts kantet	Breccia breksje
	Large clasts ¹ in muddy matrix ² (2 størrelser)	Diamictite diamiktitt (betyr 2-miks)
Medium to coarse	Sand-sized grains	Sandstone
	▪ quartz grains only	▪ quartz sandstone (quartz arenite)
	▪ quartz and feldspar sand	▪ arkose
	▪ sand-sized lithic clasts	▪ lithic sandstone
	▪ sand and lithic clasts in a clay-rich matrix	▪ wacke (informally called graywacke)
Fine	Silt-sized clasts	Siltstone
Very fine	Clay and/or very fine silt	Shale (if it breaks into platy sheets)
		Mudstone (if it doesn't break into platy sheets)

Norske ord er omtrent lik engelsk, men:
Leirskifer / shale (mulig å dele i plater)
Slamstein / mudstone
Slam = mud. En blanding av silt og leire.

Marshak har glemt:
Claystone / Leirstein

Konglomerater er spesiell fordi mye kan bestemmes uten mikroskop



Konglomerat. De avrundete **bollene** av kartsitt og **(kvartsitt)** gneis er 5–10 cm store. (Biskopåsen, Ringsaker)

Geologer kaller rullestein i konglomerat “boller” (De kalles ikke “rullestein”)

disse to bilder viser “polymikt, steinbårete” konglomerater

**“Monomikt” / monomict kun 1 bolletyp
“Polymikt” / polymict mange bolletyper**



Konglomerat tilhørende sparagmittene rundt Østerdalen (Biskopåsen, Ringsaker)

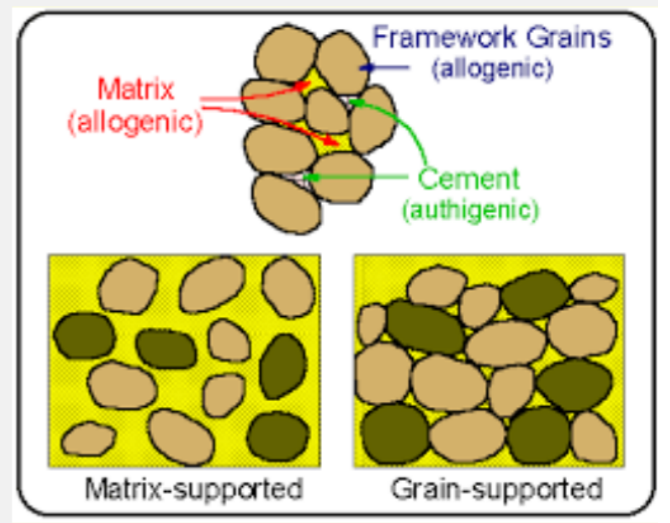
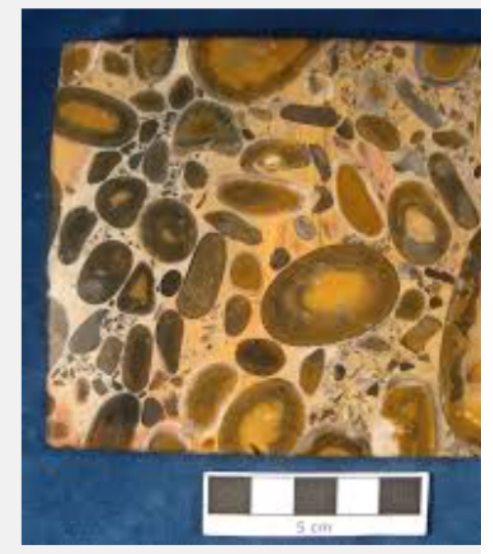
(“Sparagmitt” er et gammelt norsk begrep for sandsteiner i sørøst Norge.)



Matrix Supported Conglomerate
(Glacial/Landslide Deposits)

“Modern”
Glacial Sediments

2.2 Gyr Conglomerate



Breksje

Det er flere typer breksje, som er en utfordring å tolke



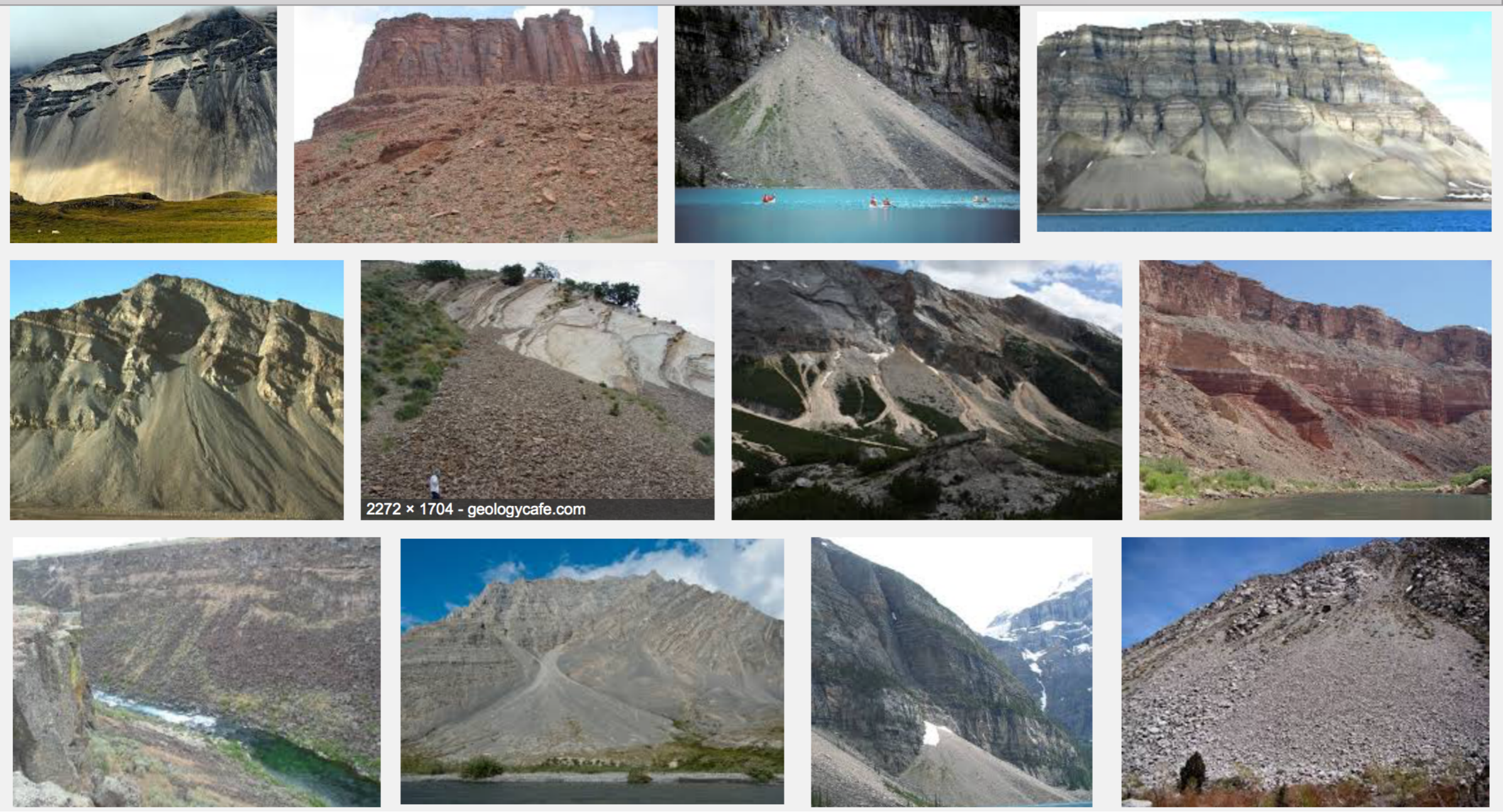
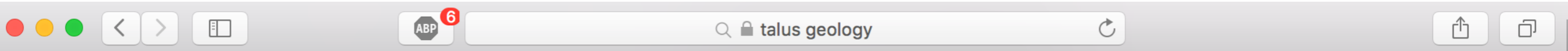
Schou Jensen.pdf (page 76)



Talusbreksje
dannet ved
sementering av
løst nedrast mate-
riale ved foten av
en fjellvegg (West-

talus = ur

Ur / talus



**Blir til sedimentær breksje (Jensen sier "talusbreksje").
Alle klaster kommer fra fjell like over. Ikke fra en bekk eller bekkedal.**

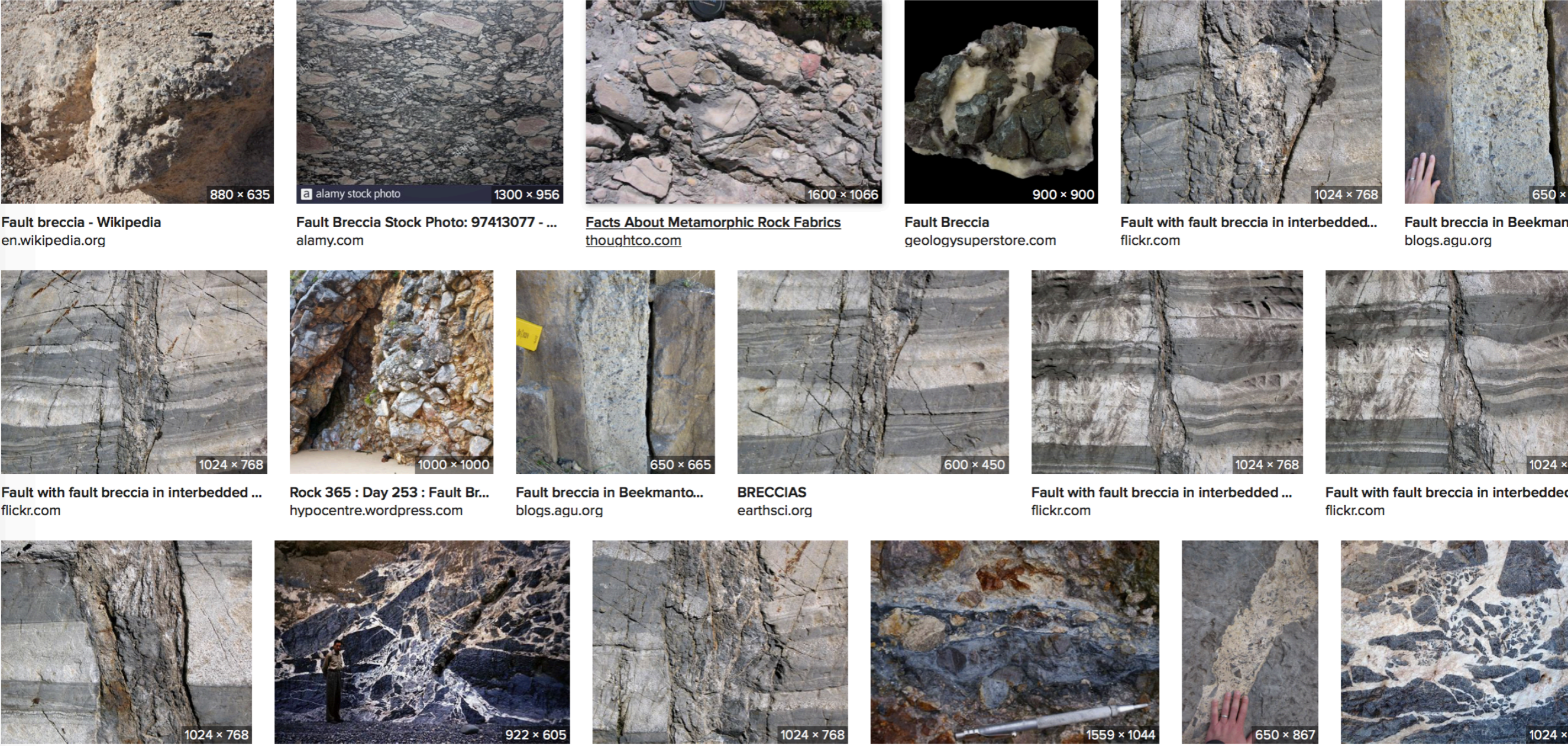
forkastningsbreksje

fault breccia

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en.wikipedia.org

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Facts About Metamorphic Rock Fabrics
thoughtco.com

Fault Breccia
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Fault with fault breccia in interbedded...
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Fault breccia in Beekmant...
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Rock 365 : Day 253 : Fault Br...
hypocentre.wordpress.com

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BRECCIAS
earthsci.org

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Faults
myweb.facstaff.wvu.edu

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Ok Tedi Cu-Au Mine. Papua Mew Guinea, ...
users.monash.edu.au

Montoya Group fo...
blogs.agu.org

Panoramio - Photo of Fault Breccia in
panoramio.com

**I forkastningsbreksje ser man klaster fra begge sider av en forkastningsssone.
(Ingen klaster av bergarter som er langtransportert.)**

Breksje



Talusbreksje
dannet ved
sementering av
løst nedrast mate-
riale ved foten av
en fjellvegg (West-

Det finnes flere breksje typer, blant annet:

Sedimentær breksjer (for eks. talusbreksje, rasbreksje)

Forkastningsbreksje

Pyroklastisk breksje (vulkansk)

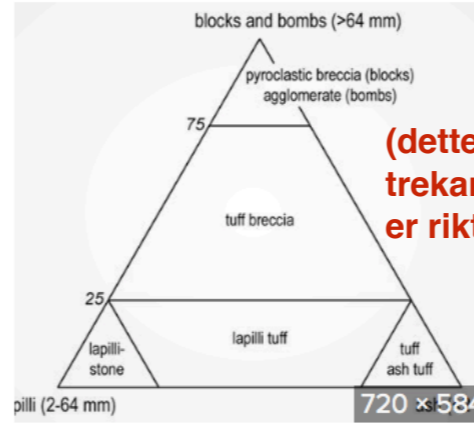
Meteoritt nedslags breksje



Patterns in Pyroclastic Breccia near ... natureinfocus.blog



Patterns in Pyroclastic Breccia near ... natureinfocus.blog



(dette trekantdiagram er riktig)

Igneous rocks sandatlas.org



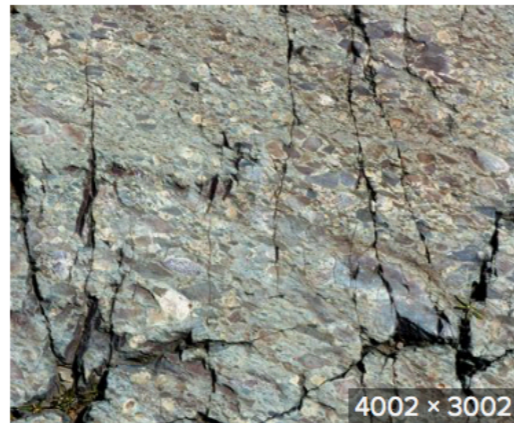
Patterns in Pyroclastic Breccia near ... natureinfocus.blog



Pattu



Pyroclastic Breccia Patterns 34 – J... natureinfocus.blog



Patterns in Pyroclastic Breccia near ... natureinfocus.blog



Pyroclastic Breccia Patterns 2 – Jes... natureinfocus.blog



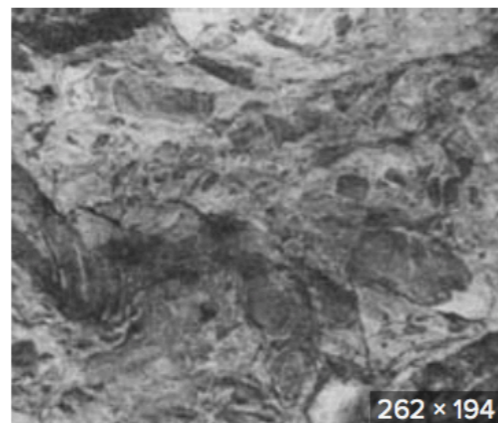
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Pat



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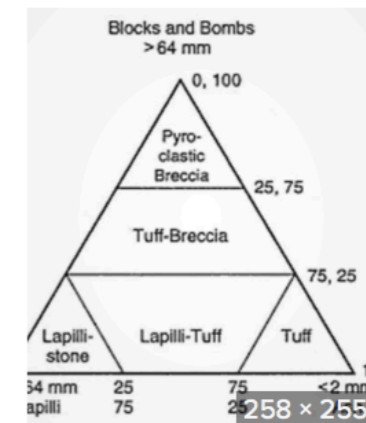
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(a, c) pyroclastic la... researchgate.net



Patterns in Pyroclastic Breccia ne... natureinfocus.blog

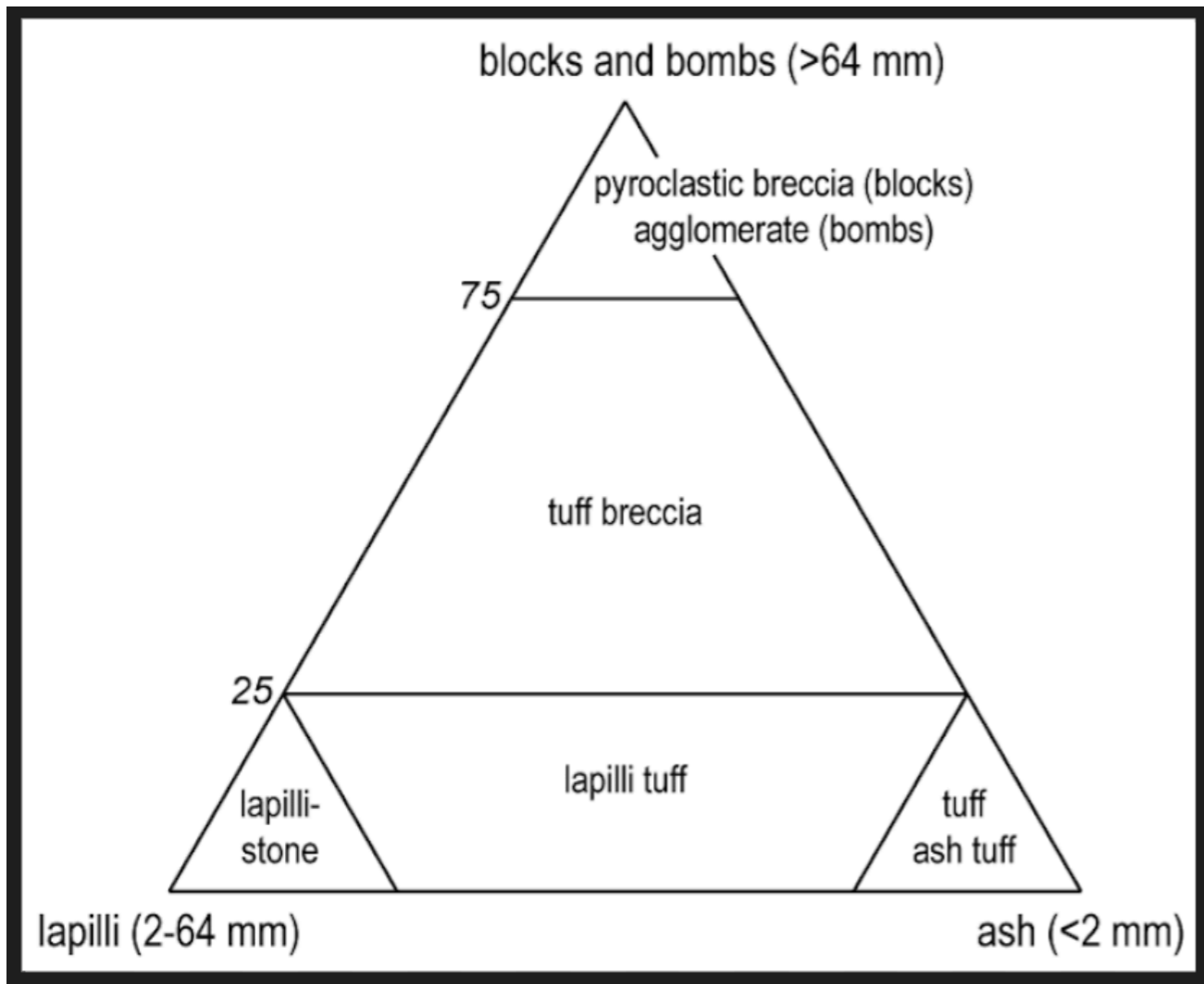


(ser du at dette trekantdiagram er feiltegnet?)

Volcanology and Geoth... publishing.cdlib.org

(Disse begrep og procenter er ikke pensum for oss, men hvordan trekant procenter avleses er pensum.)

riktig



feil !

