

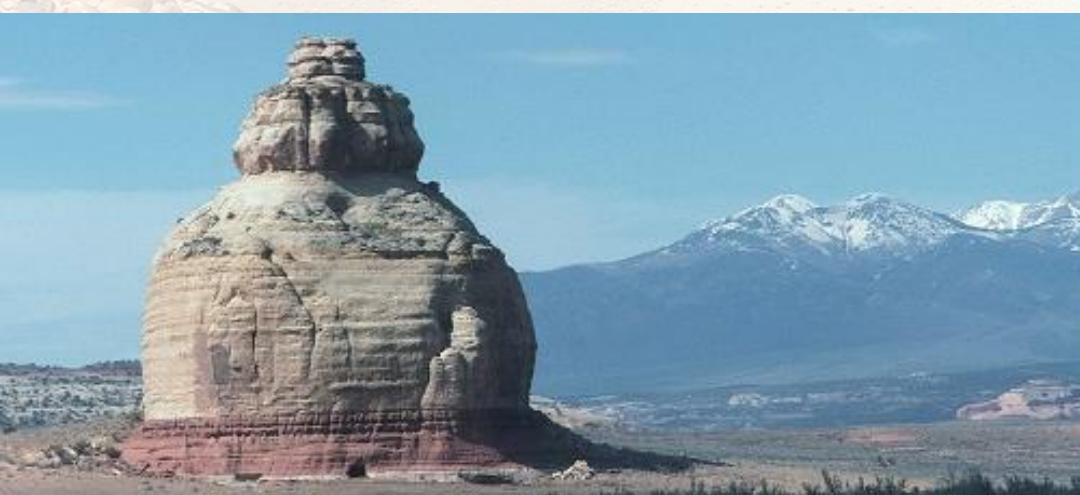
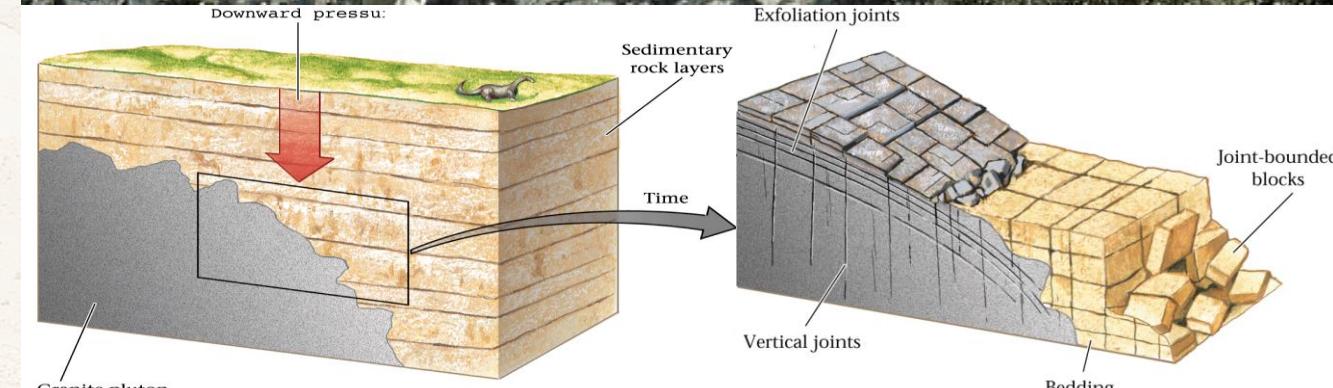
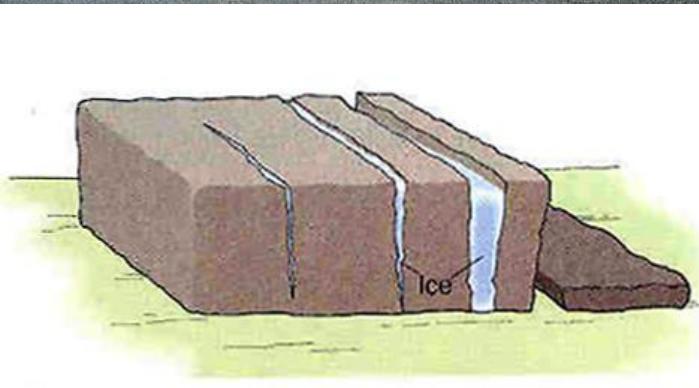
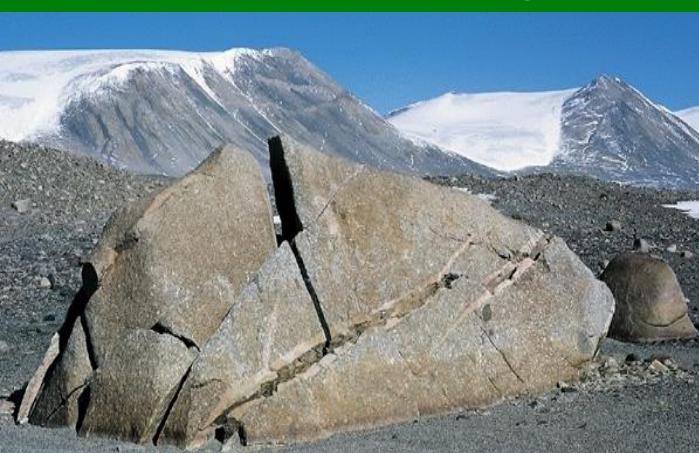
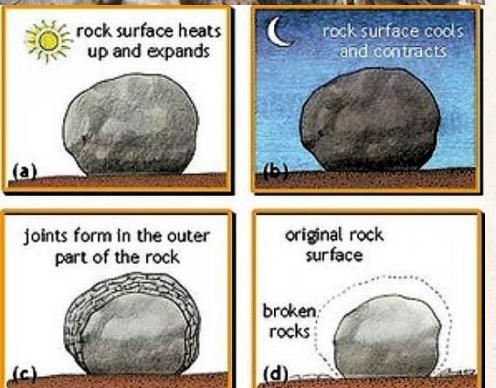


Landscape Evolution

Erosion and Transport

Weathering | Mechanical weathering

GY4027: Landscape Evolution



Weathering | Chemical Weathering

GY4027: Landscape Evolution



Weathering

- Mechanical weathering
- Chemical weathering
- Biological weathering

Physical biological weathering

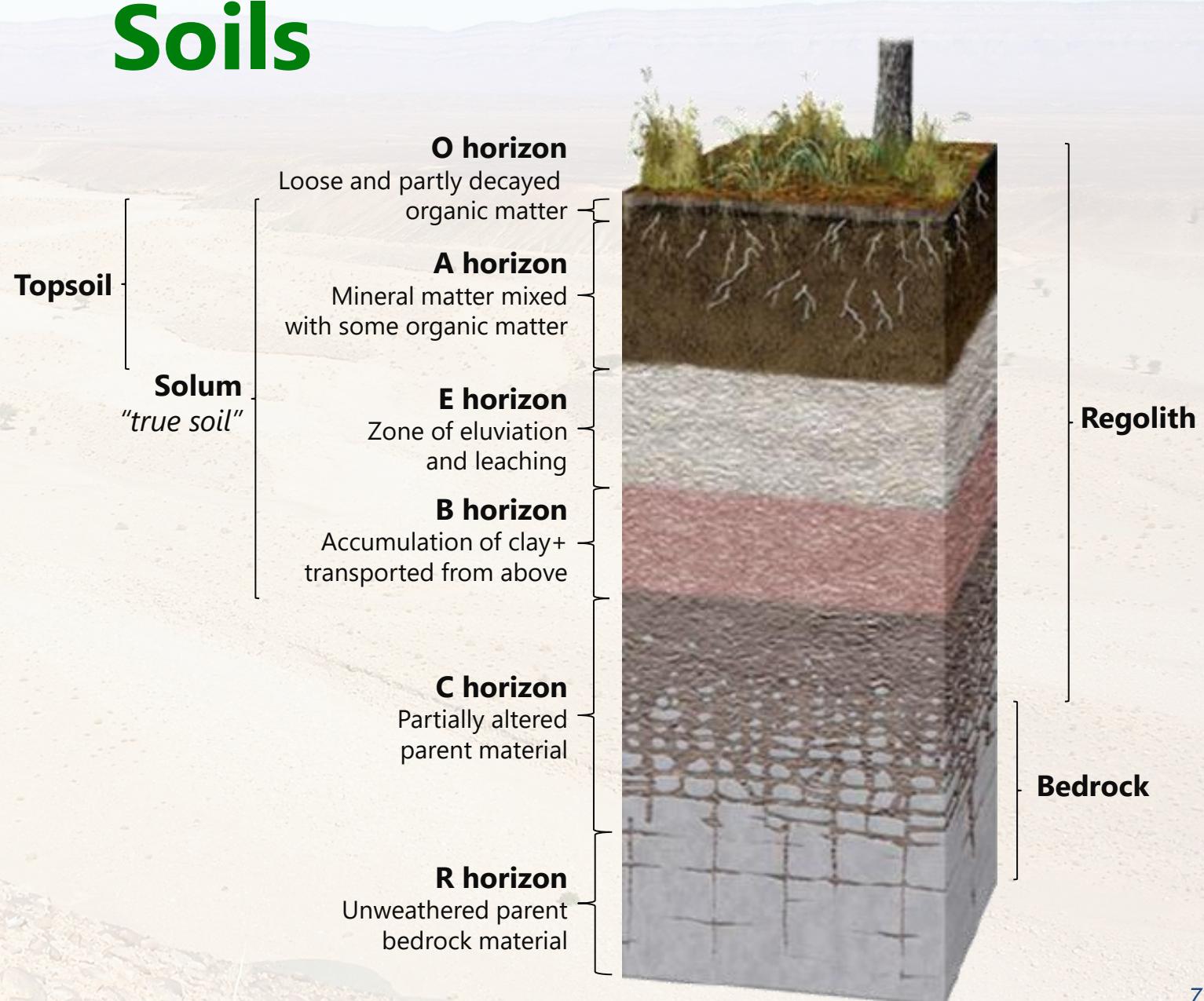


Chemical biological Weathering

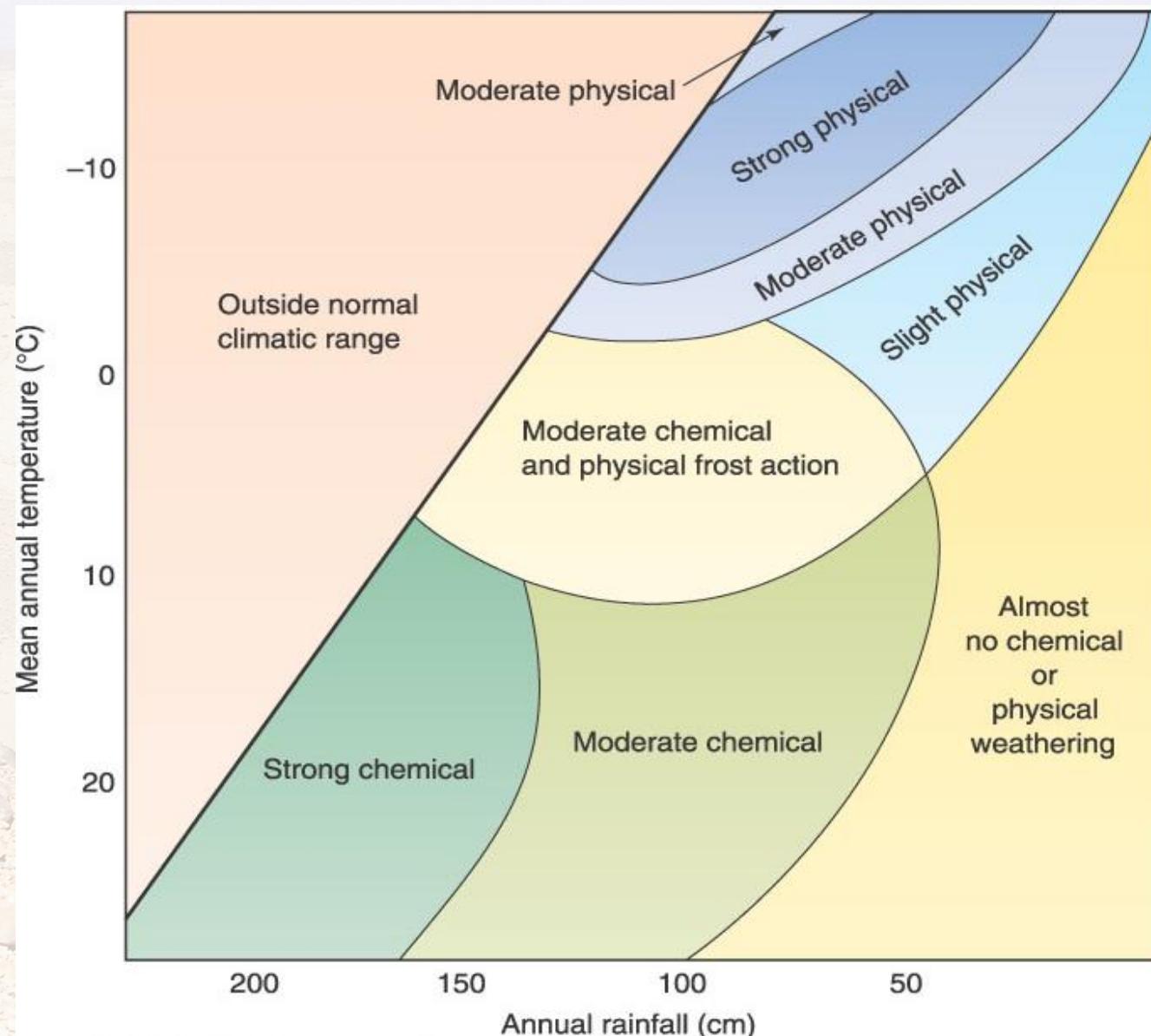




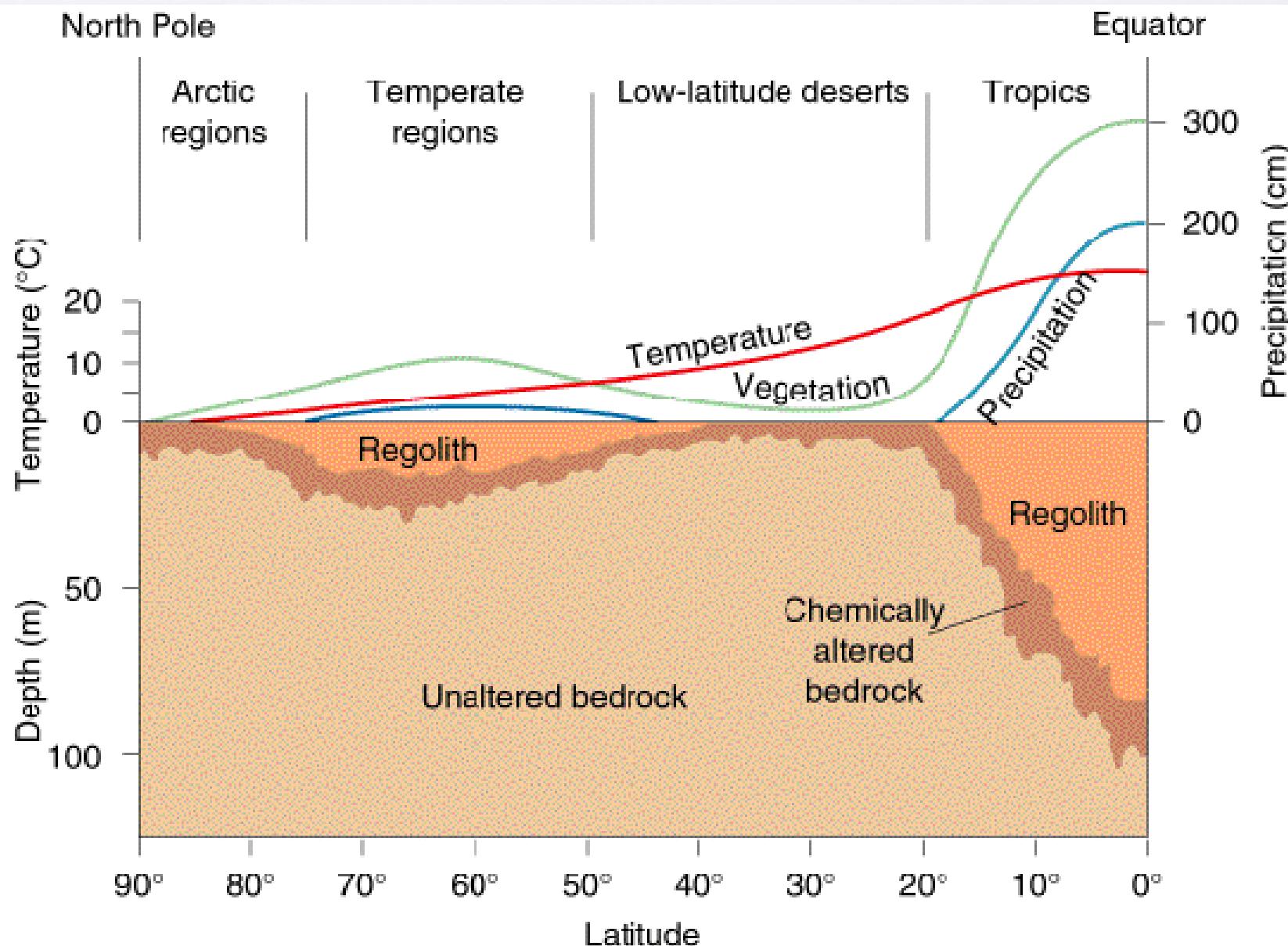
Soils



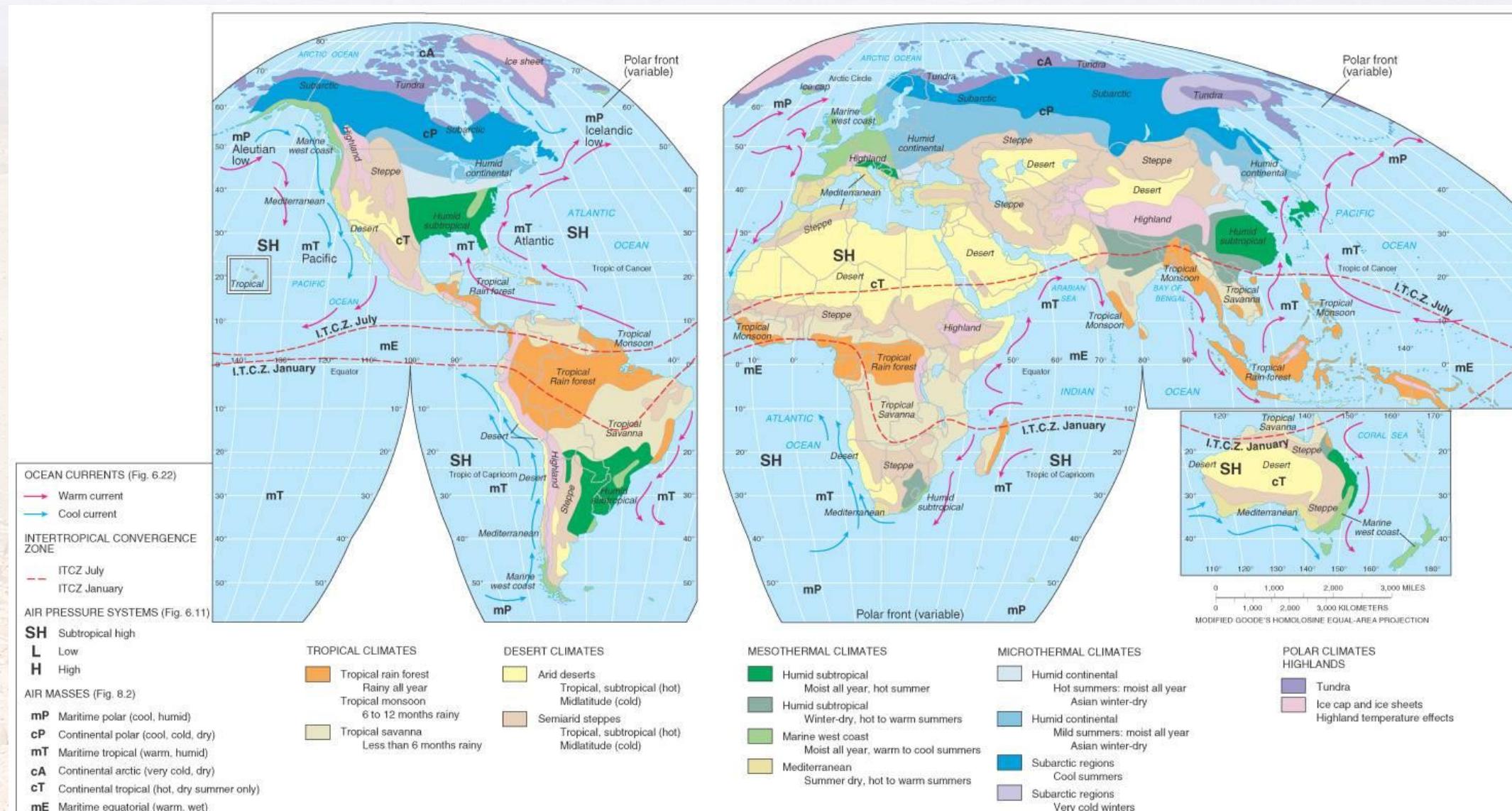
Temperature and Moisture



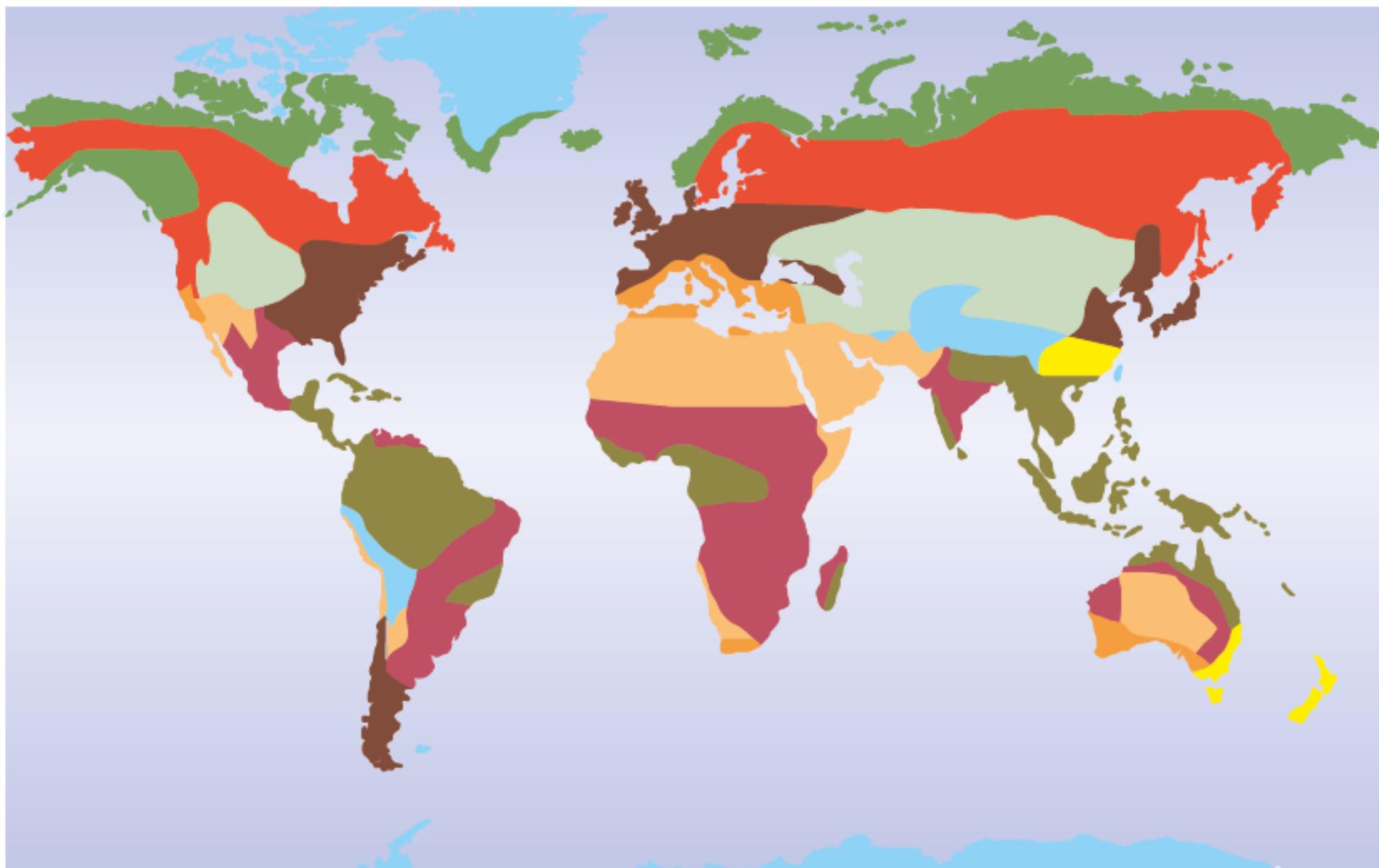
Climate Controls



Climate Zones

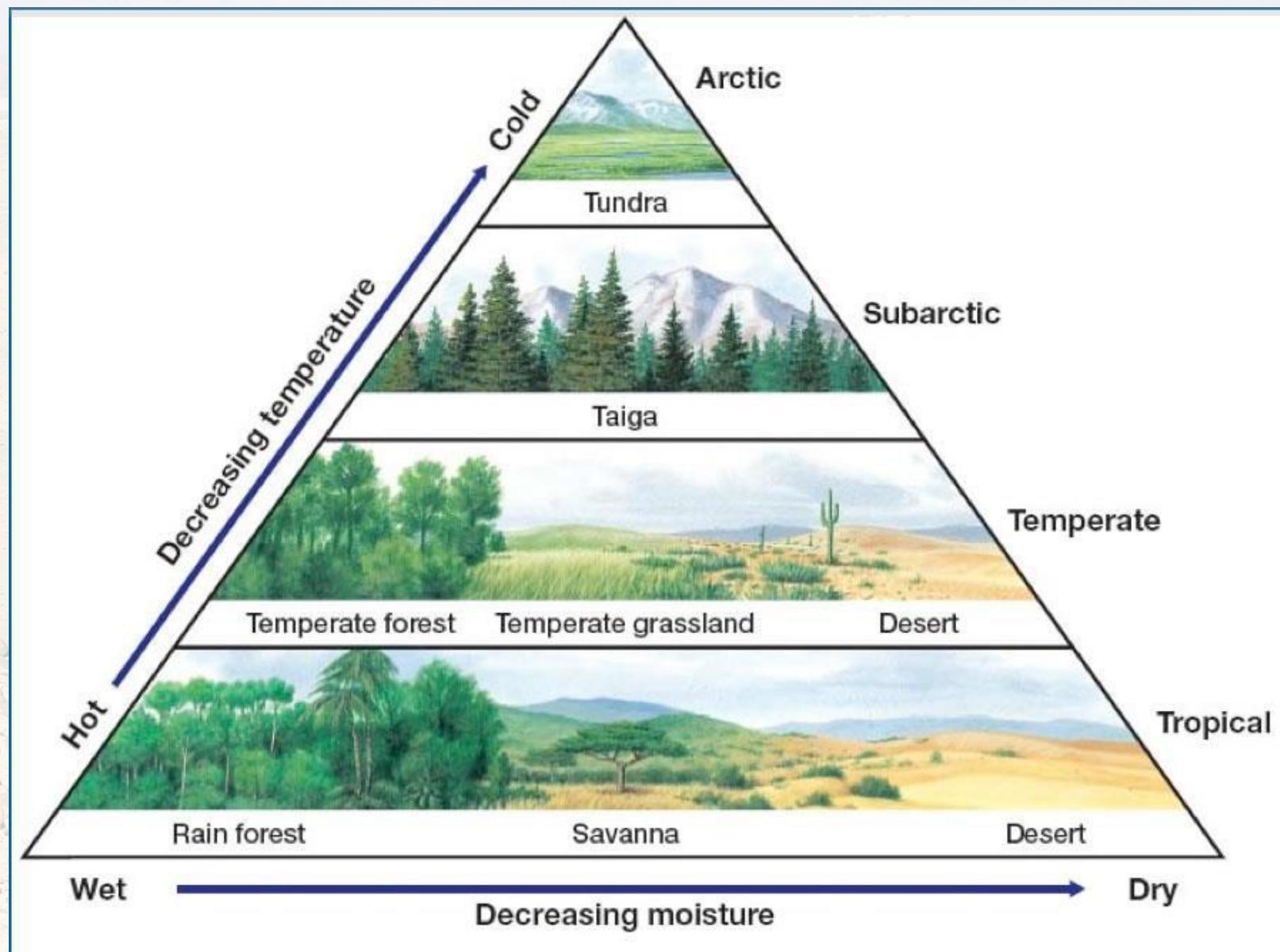


Biomes



TROPICAL BIOMES	
Tropical forests	(Dark Green)
Savanna region	(Maroon)
Hot deserts	(Orange)
TEMPERATE BIOMES	
Mediterranean chaparral	(Orange)
Temperate evergreen	(Yellow)
Temperate deciduous woodland	(Brown)
Temperate grassland	(Light Green)
COLD BIOMES	
Taiga	(Red)
Tundra	(Dark Green)
Ice/Mountains	(Blue)

Biomes



Products of Weathering

- Grains
- Solutions
- Clay Minerals

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- Grains
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Generally components which have not been chemically altered – mainly quartz, heavy minerals, sometimes rock fragments



Products of Weathering

- Grains
- Solutions
- Clay Minerals

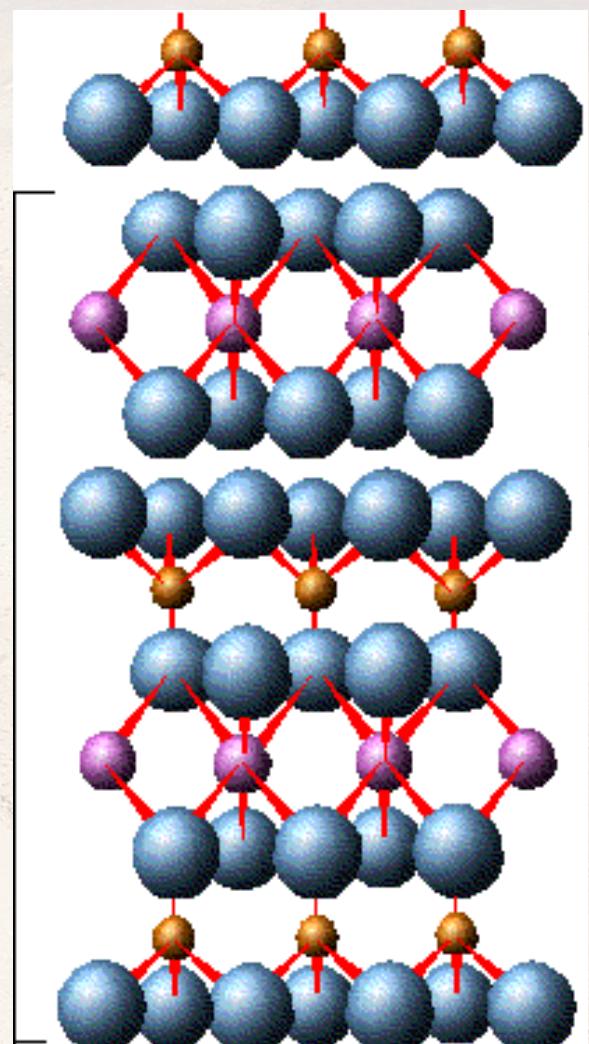
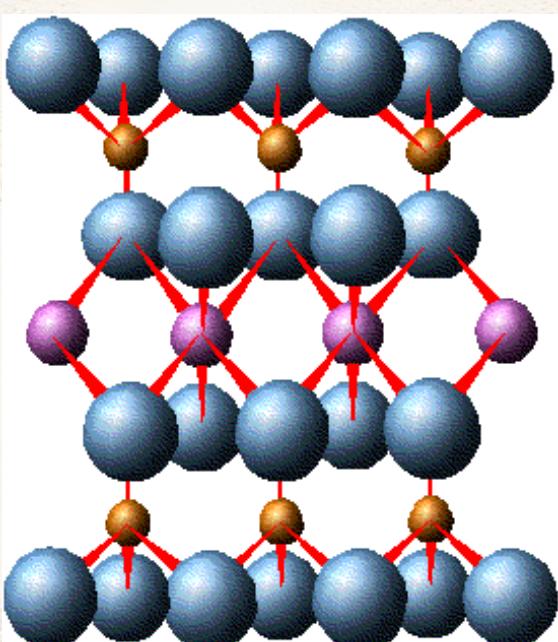
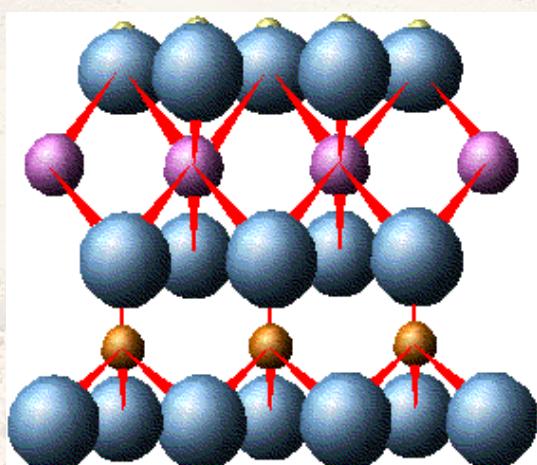
Aqueous fluid with dissolved or hydrolised cations such as K^+ , Mg^{2+}



Products of Weathering

- Grains
- Solutions
- Clay Minerals

Arrangements of atoms in flat sheets loosely bound together which are stable at the Earth's surface



Weathering

e.g. Granite: formed deep underground,
now uplands

As it becomes exposed, changes in:

- Depth
- Temperature
- Pressure

All decrease



Granite: Mourne Mountains, Co. Down, Ireland

Weathering

e.g. Granite: formed deep underground,
now uplands

Granite contains:

- Na-plagioclase feldspar
- K feldspar
- Quartz
- *Biotite*
- *Muscovite*



Granite: Mourne Mountains, Co. Down, Ireland

Weathering

e.g. Granite: formed deep underground,
now uplands

When weathered:

- Feldspars undergo hydrolysis to kaolinite or dickite, releasing K^+ , Na^+ , Ca^{2+} cations
- Biotite hydrolises to clay, and oxidises to iron oxides
- Quartz and muscovite remain as residuals



Granite: Mourne Mountains, Co. Down, Ireland

Residual minerals

e.g. grains of quartz: sand



New minerals

e.g. clays



Solutes

e.g. sea salt



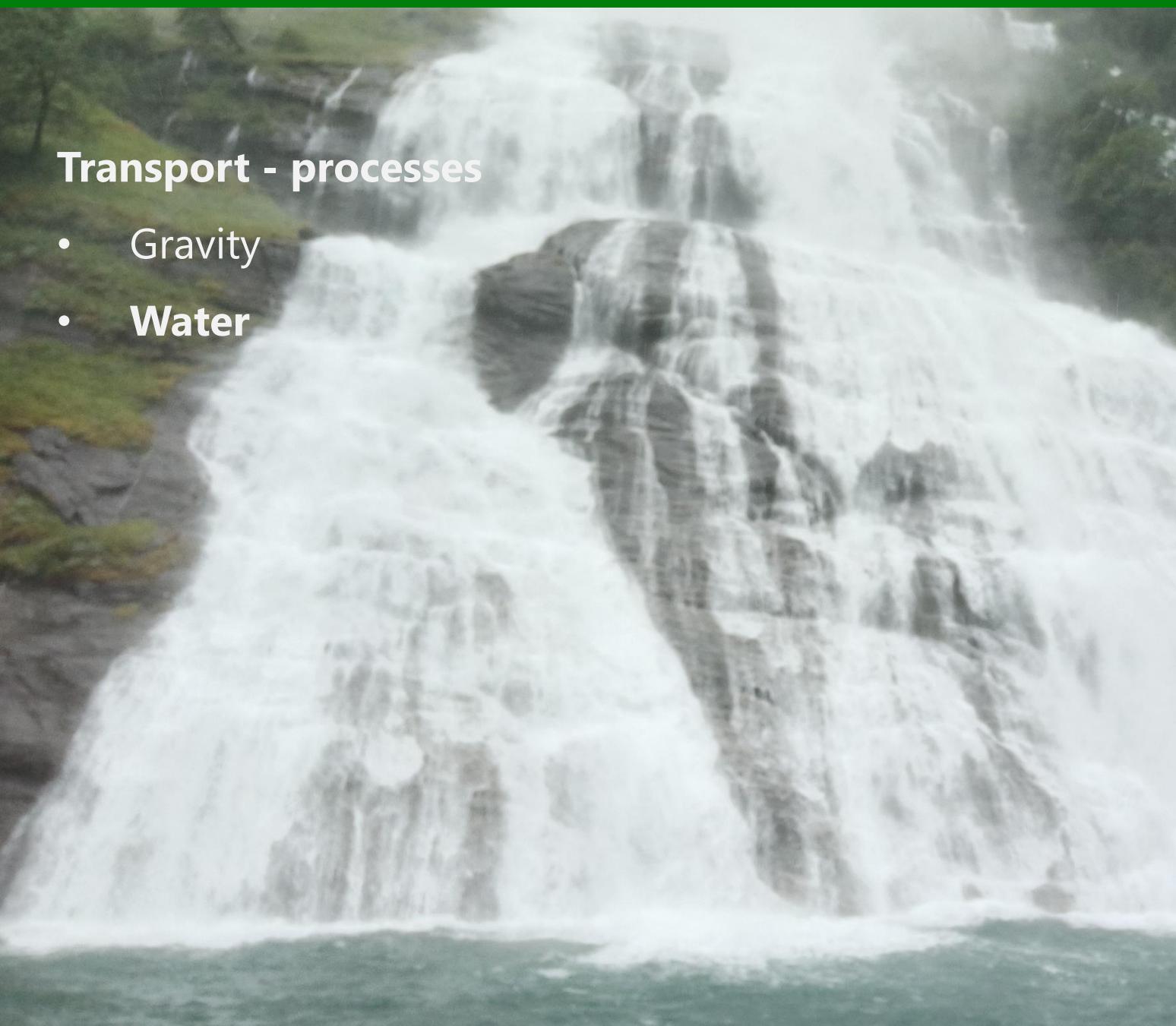
Transport - processes

- Gravity



Transport - processes

- Gravity
- Water



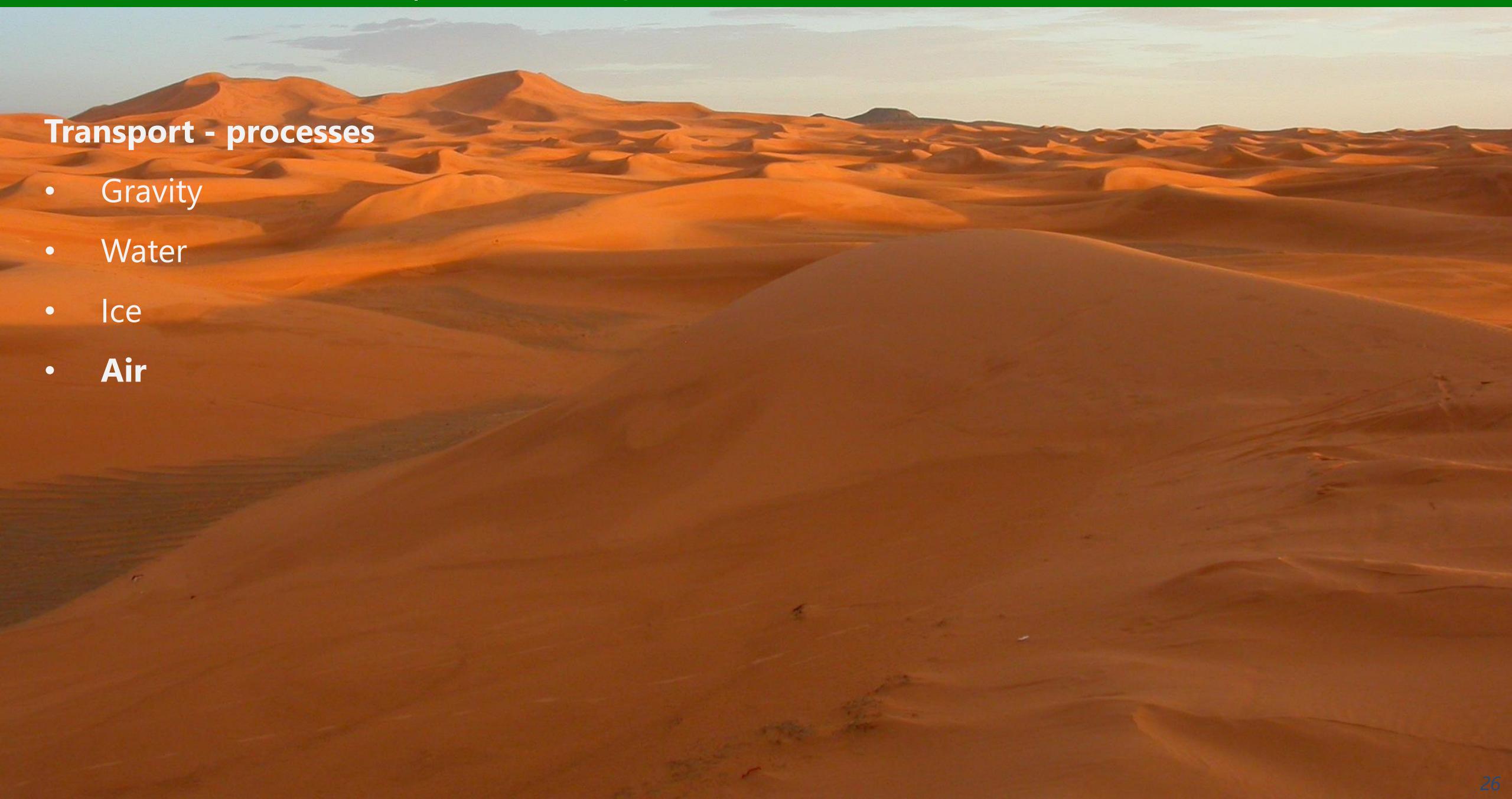
Transport - processes

- Gravity
- Water
- Ice



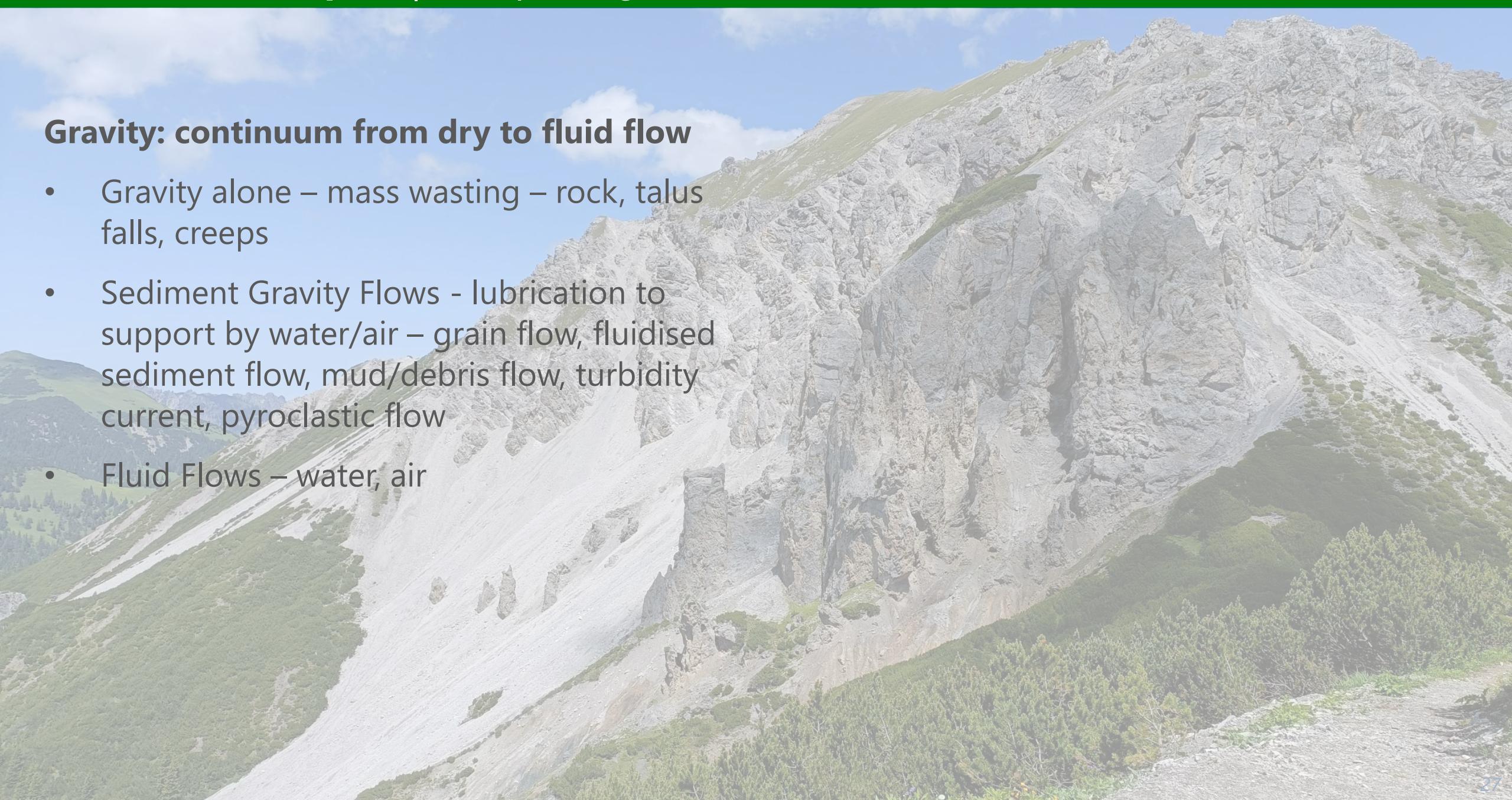
Transport - processes

- Gravity
- Water
- Ice
- Air



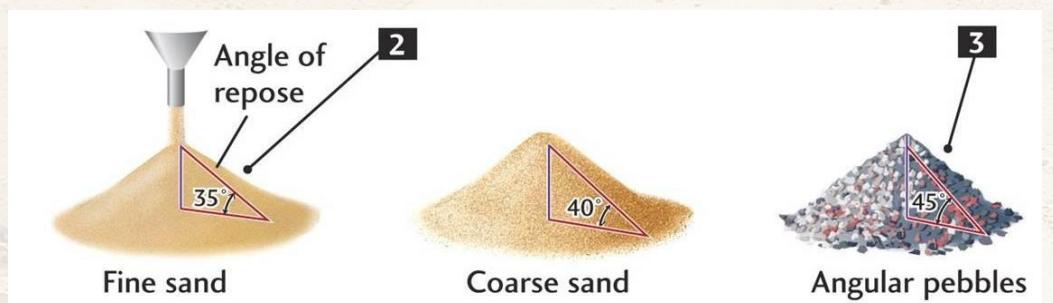
Gravity: continuum from dry to fluid flow

- Gravity alone – mass wasting – rock, talus falls, creeps
- Sediment Gravity Flows - lubrication to support by water/air – grain flow, fluidised sediment flow, mud/debris flow, turbidity current, pyroclastic flow
- Fluid Flows – water, air



Types of gravity mass movement

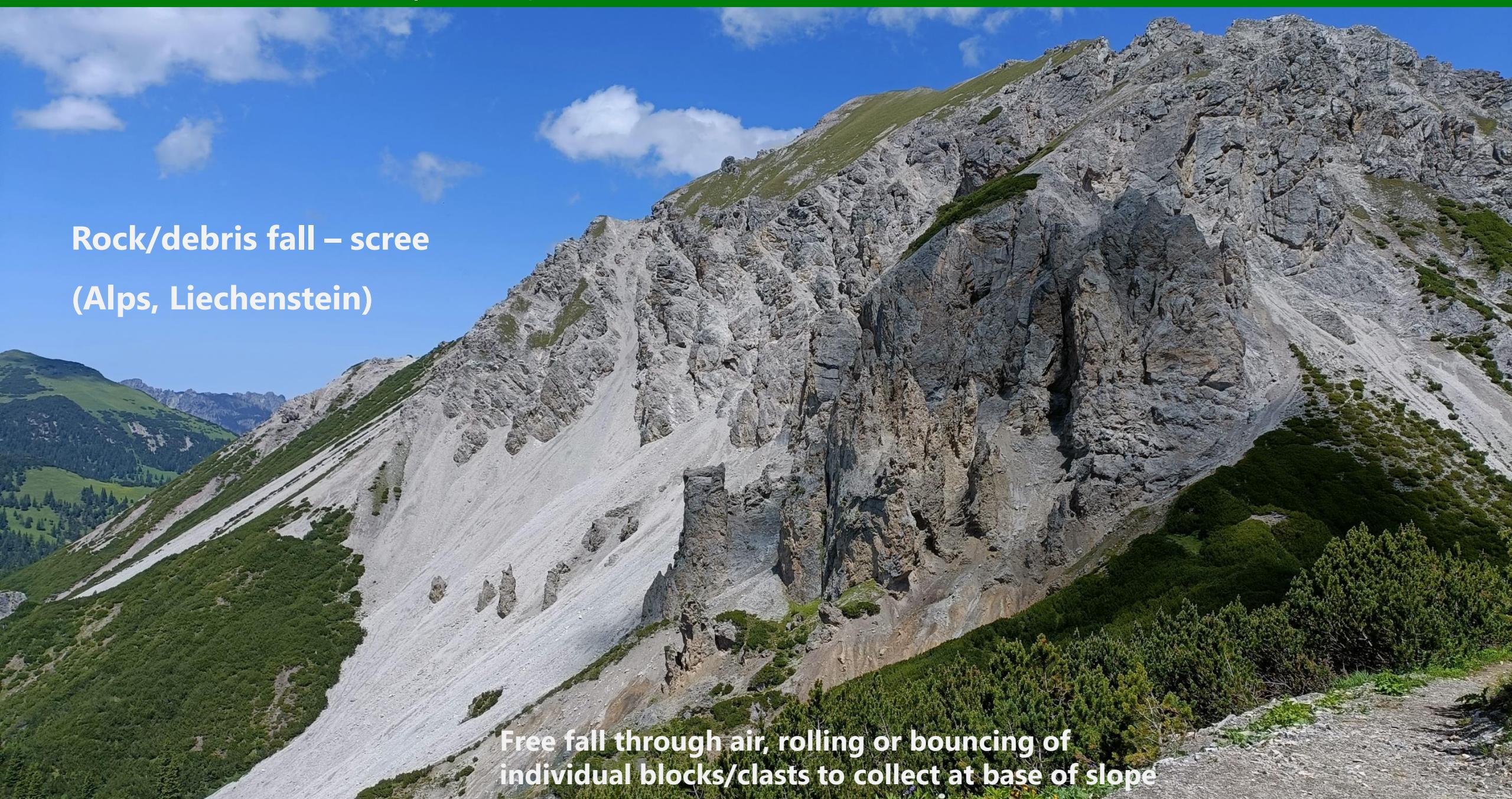
- What is being transported – rock, grains, soil?
- How much gravity – what's the slope profile?



- Is there lubrication by air or water?

Material	ROCK	DEBRIS	EARTH
Movement type			
FALLS	<p>Rock fall</p>	<p>Scarp Debris fall Scree Debris cone</p>	<p>Fine soil Rock Colluvium Debris cone</p>
TOPPLES	<p>Rock topple</p>	<p>Debris topple Debris cone</p>	<p>Cracks Earth topple Debris cone</p>
SLIDES	<p>Rotational</p> <p>Single rotational slide (slump) Failure surface Crown Scarp Head</p>	<p>Minor Scarp Failure surface Toe Multiple rotational slide</p>	<p>Successive rotational slides</p>
	<p>Translational (Planar)</p> <p>Rock slide</p>	<p>Debris slide</p>	<p>Earth slide</p>
SPREADS	<p>Cap rock Clay shale Normal sub-horizontal structure Gully Camber slope Dip and fault structure Valley bulge (planed off by erosion) Thinning of beds Plane of decollement Competent substratum</p>		
FLOWS	<p>Solifluction flows (Periglacial debris flows)</p>	<p>Debris flow</p>	<p>Earth flow (mud flow)</p>
COMPLEX	<p>e.g. Slump-earthflow with rockfall debris</p>		<p>e.g. composite, non-circular part rotational/part translational slide grading to earthflow at toe</p>

Rock/debris fall – scree
(Alps, Liechenstein)

A photograph of a steep mountain slope. The upper portion is composed of light-colored, angular rock fragments and talus. Below this, a green, scrub-covered area follows the slope's curve. The sky is blue with scattered white clouds.

Free fall through air, rolling or bouncing of individual blocks/clasts to collect at base of slope



Flow landslide – A85 Glen Ogle, Scotland

Rapid sediment movement due to high rainfall and concentrated surface runoff



Flow landslide – Minnis North, Co. Antrim



Slow sediment movement due to high rainfall and mudrocks



Rotational landslide

Mam Tor, Derbyshire, England

Slow sediment
movement due to
high rainfall and
mudrocks

Grain flow – creep, solifluction

Slow, insidious grain by grain movement downslope – aided by water, ice crystal growth heating and contraction and continued weathering processes, possibly surface loading also





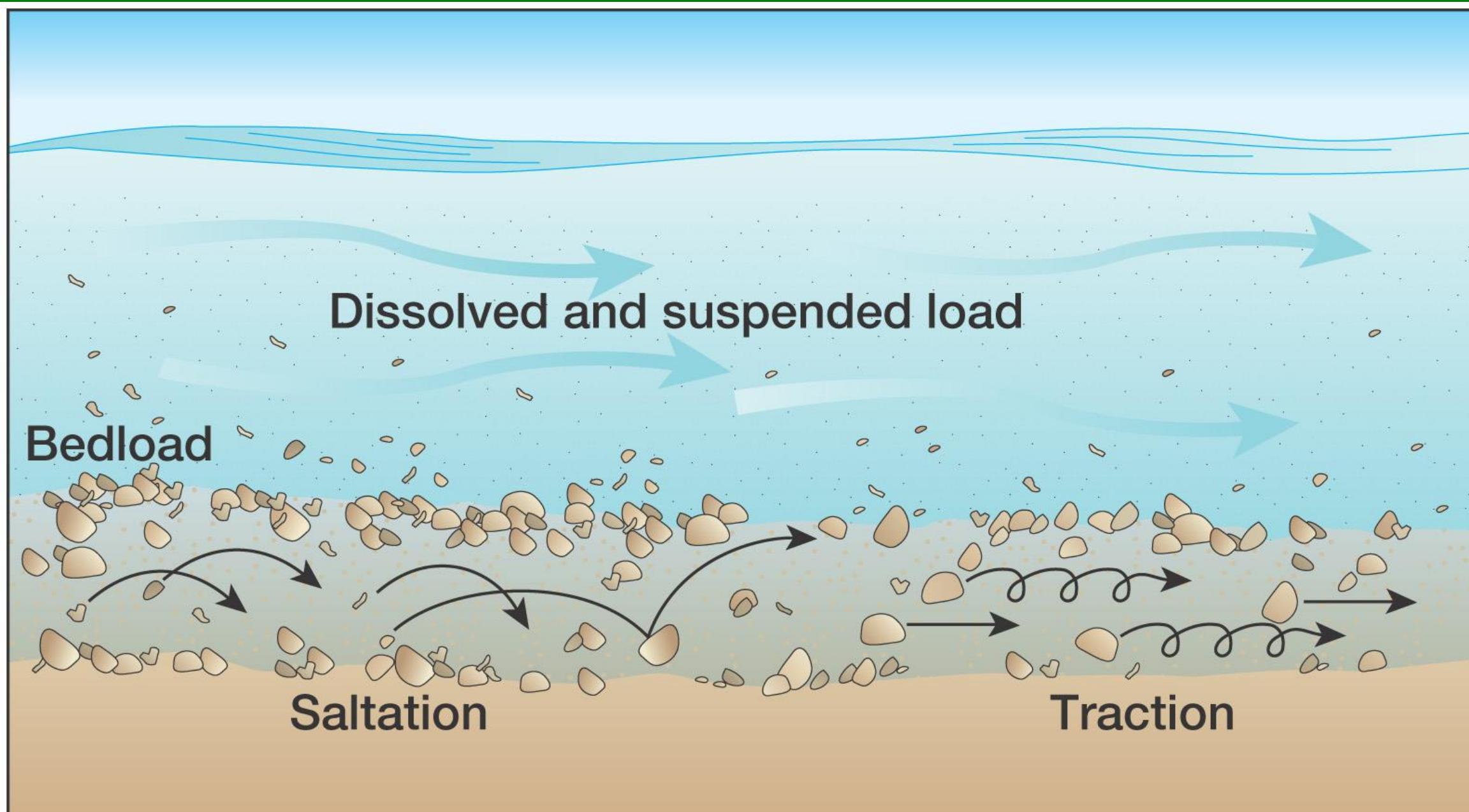
Santiaguito Volcano, Guatemala 14th. Aug. 1989

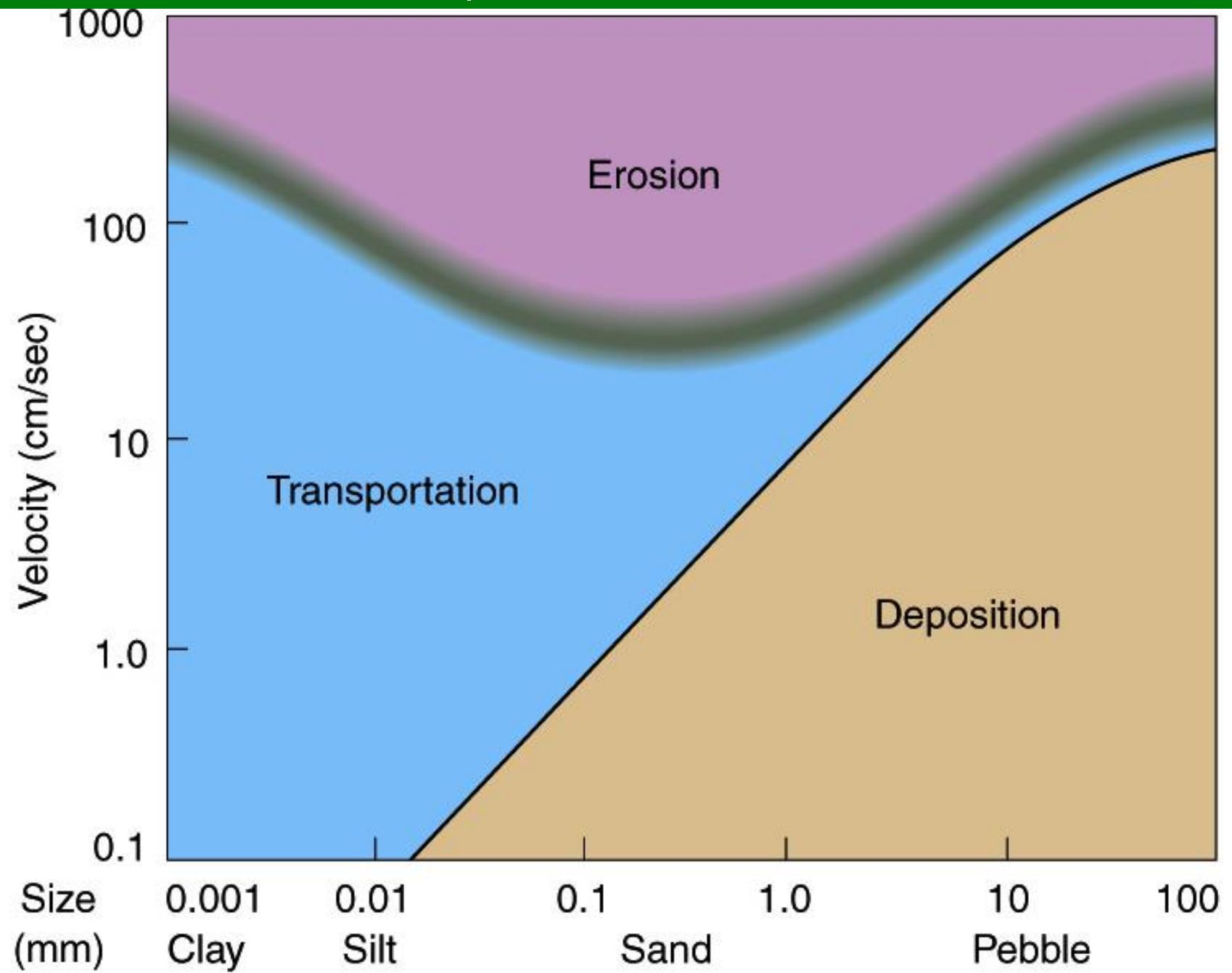
Due to condensation and rain during eruptive phase or reactivated volcaniclastic ashfall later – from water with high sediment yield to mudflow

Fluidised sediment flow - lahar

Chicita Volcano, Nicaragua 30th. Oct. 1998







A. Grain size	
Pebbles 4–64 mm	
Granules 2–4 mm	
Coarse sand 0.5–2 mm	
Medium sand 0.25–0.5 mm	
Fine sand 0.06–0.25 mm	
Silt 0.004–0.06 mm	
Clay < 0.004 mm	

Fluvial (rivers) – unidirectional turbulent flow

Bedload and suspended load movement, high degree of bed change, braided fluvial system, high degree of sediment modification – size, roundness, sorting and textural maturity

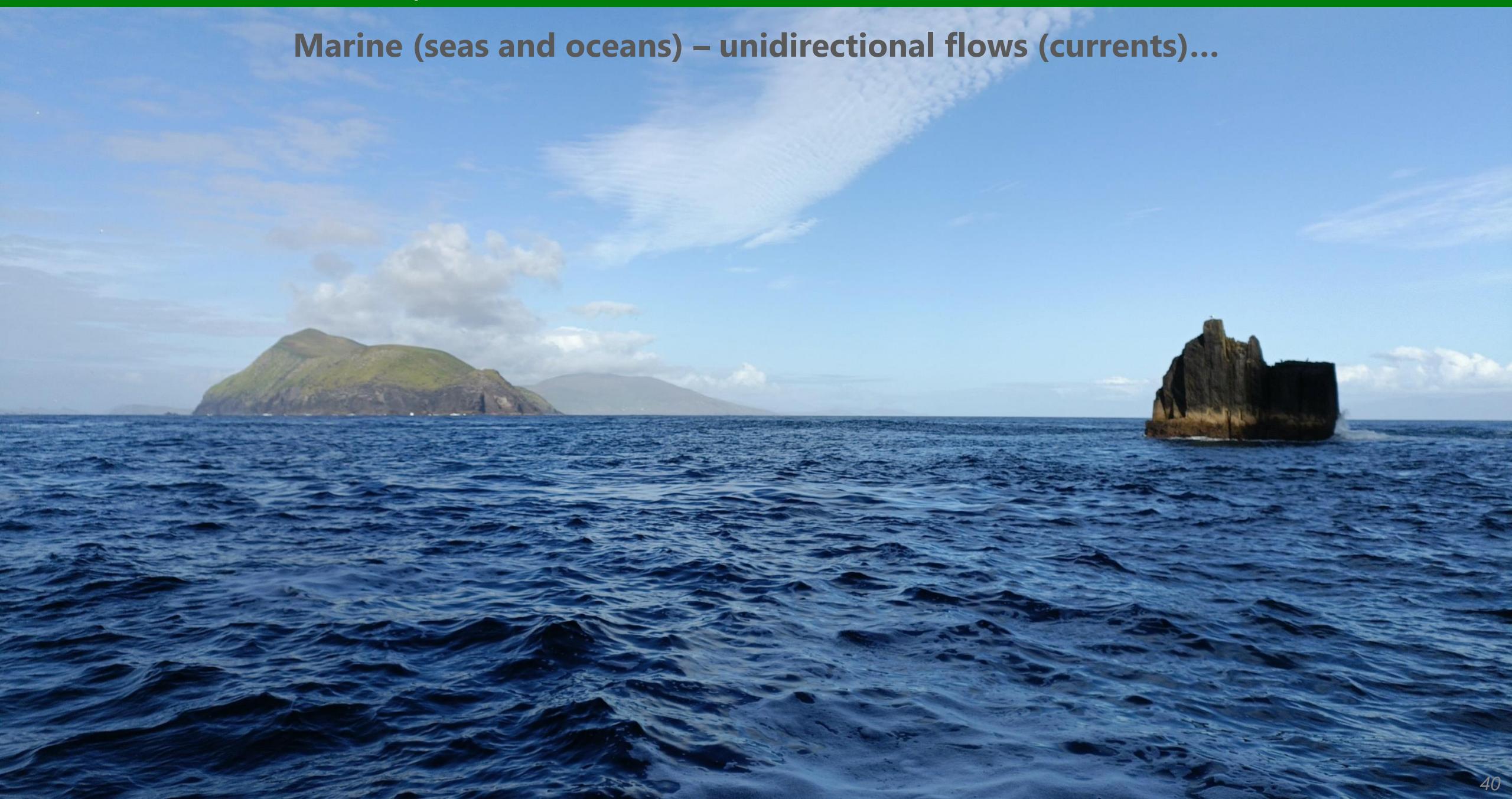


Fluvial (rivers) – unidirectional turbulent flow

Bedload and suspended load movement, erosional bed, meandering fluvial system, high degree of sediment modification – size, roundness, sorting and textural maturity

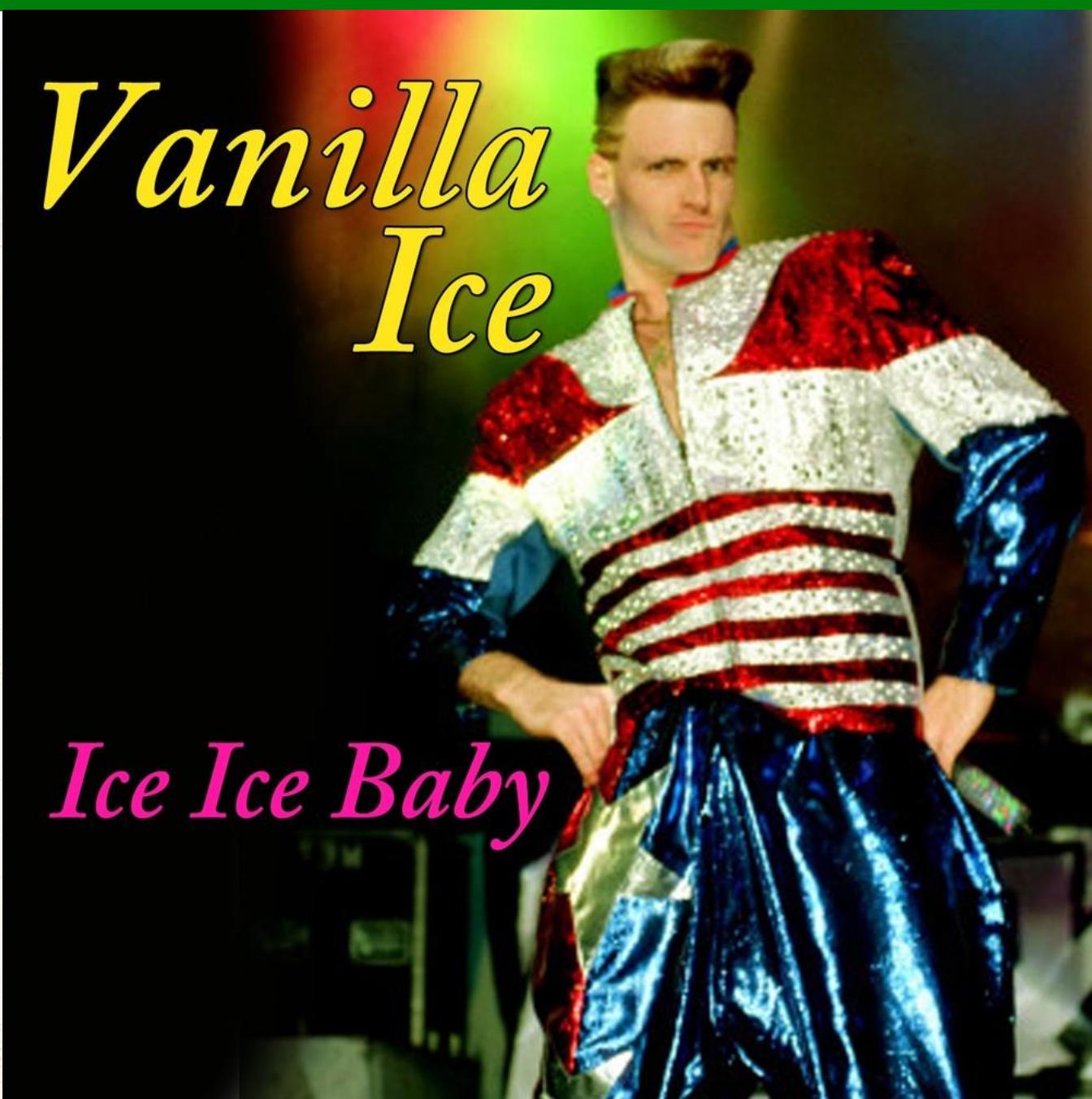


Marine (seas and oceans) – unidirectional flows (currents)...



Marine (seas and oceans) – unidirectional flows (currents)...
...and bidirectional flows (waves, tides)





Ice in glaciers is solid
but plastic – it flows



Supraglacial transport

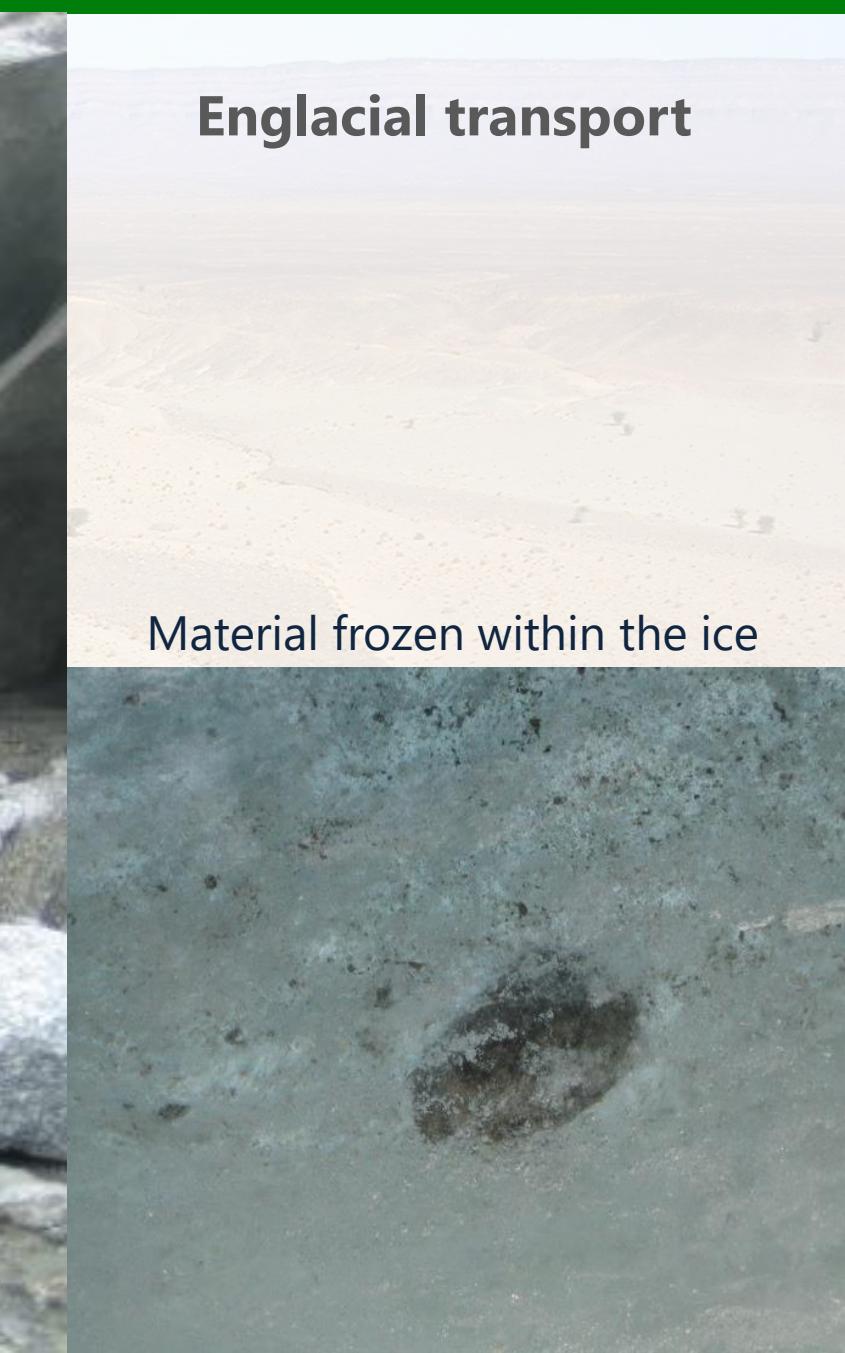


Passive transport of
material which falls on
top of the glacier





Englacial transport



Material frozen within the ice

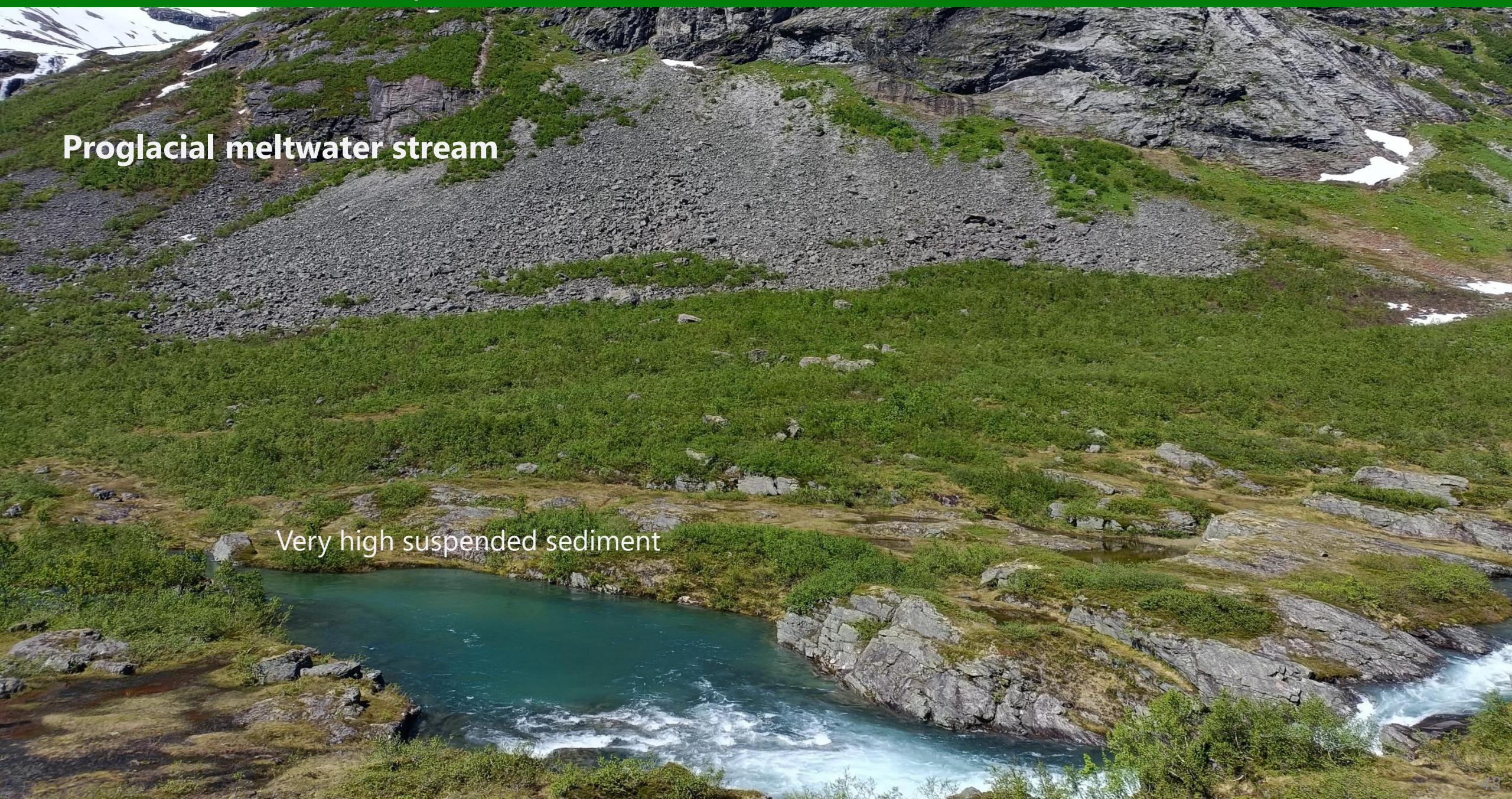


Subglacial transport

Massive pressures at the base of the glacier

Meltwater transport – supraglacial and subglacial



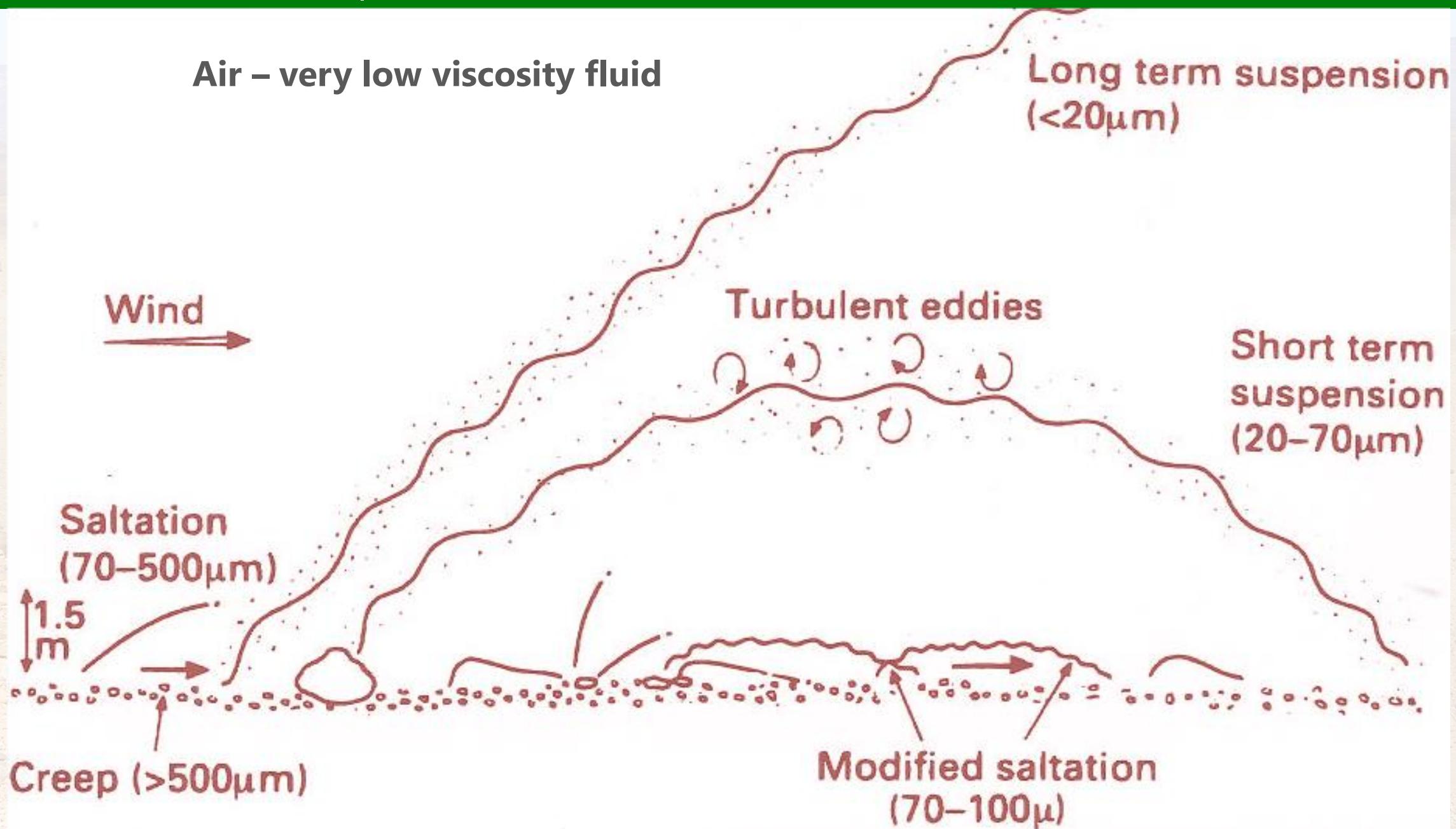


Traction and saltation across a beach



A wide, sandy beach with hills in the background.

Traction and saltation across a beach





**Point source but wide
dispersal pattern of
very fine material
(area sources also –
e.g. Sahara)**

**Short and long-term
suspension – volcanic ash
(Etna)**

