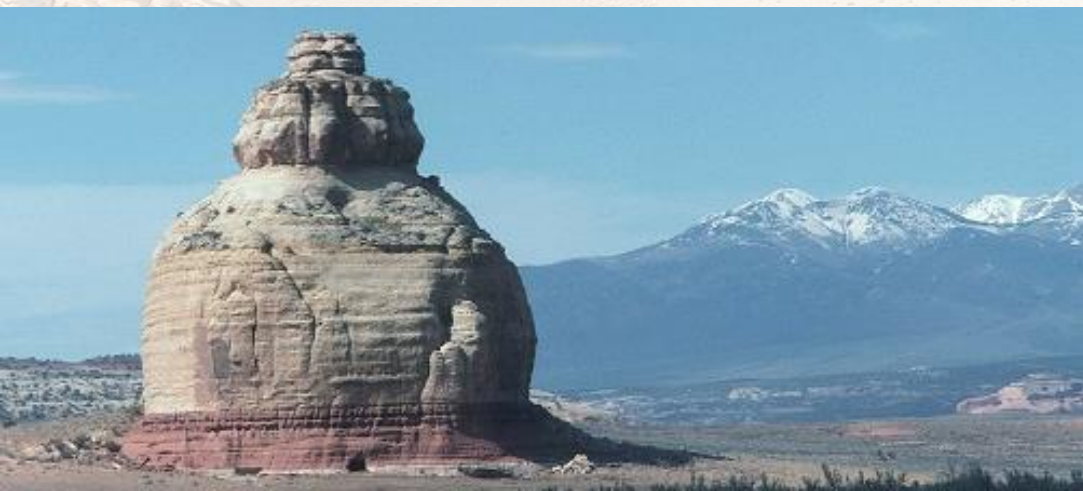
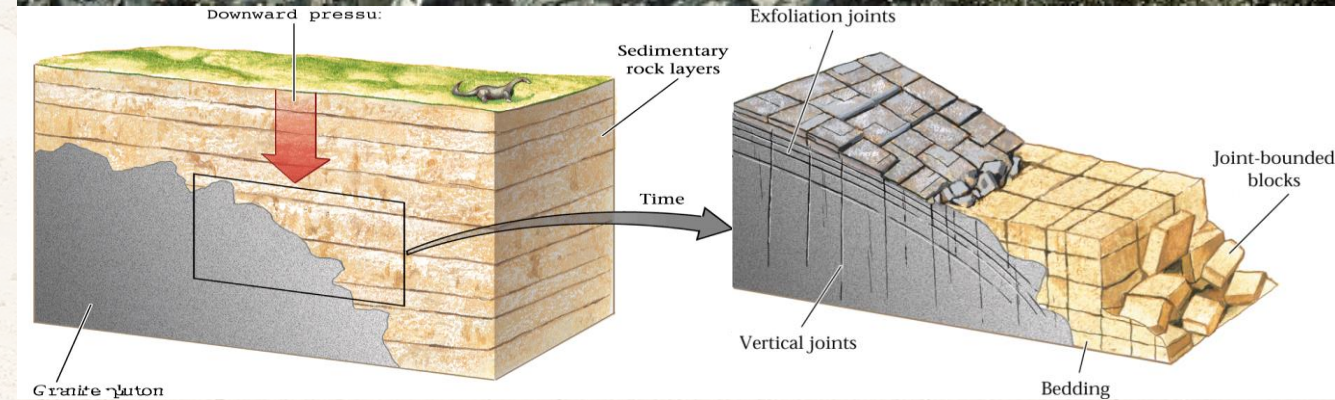
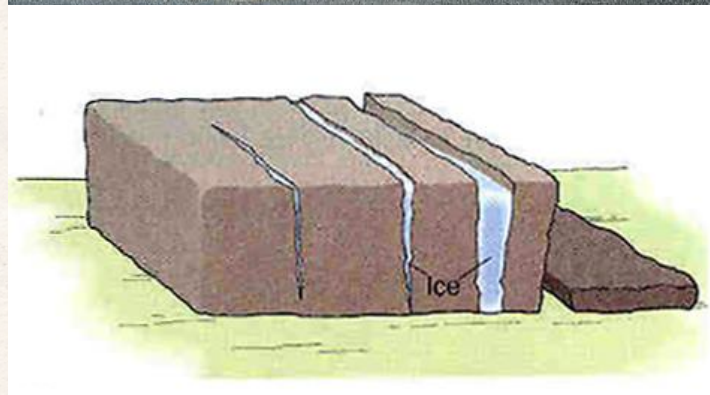
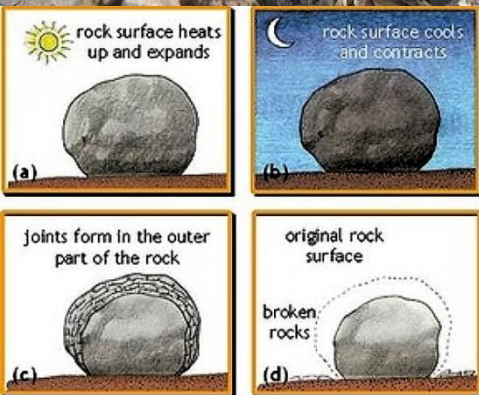




Landscape Evolution

Erosion and Transport





Weathering

- Mechanical weathering
- Chemical weathering
- Biological weathering



Physical biological weathering

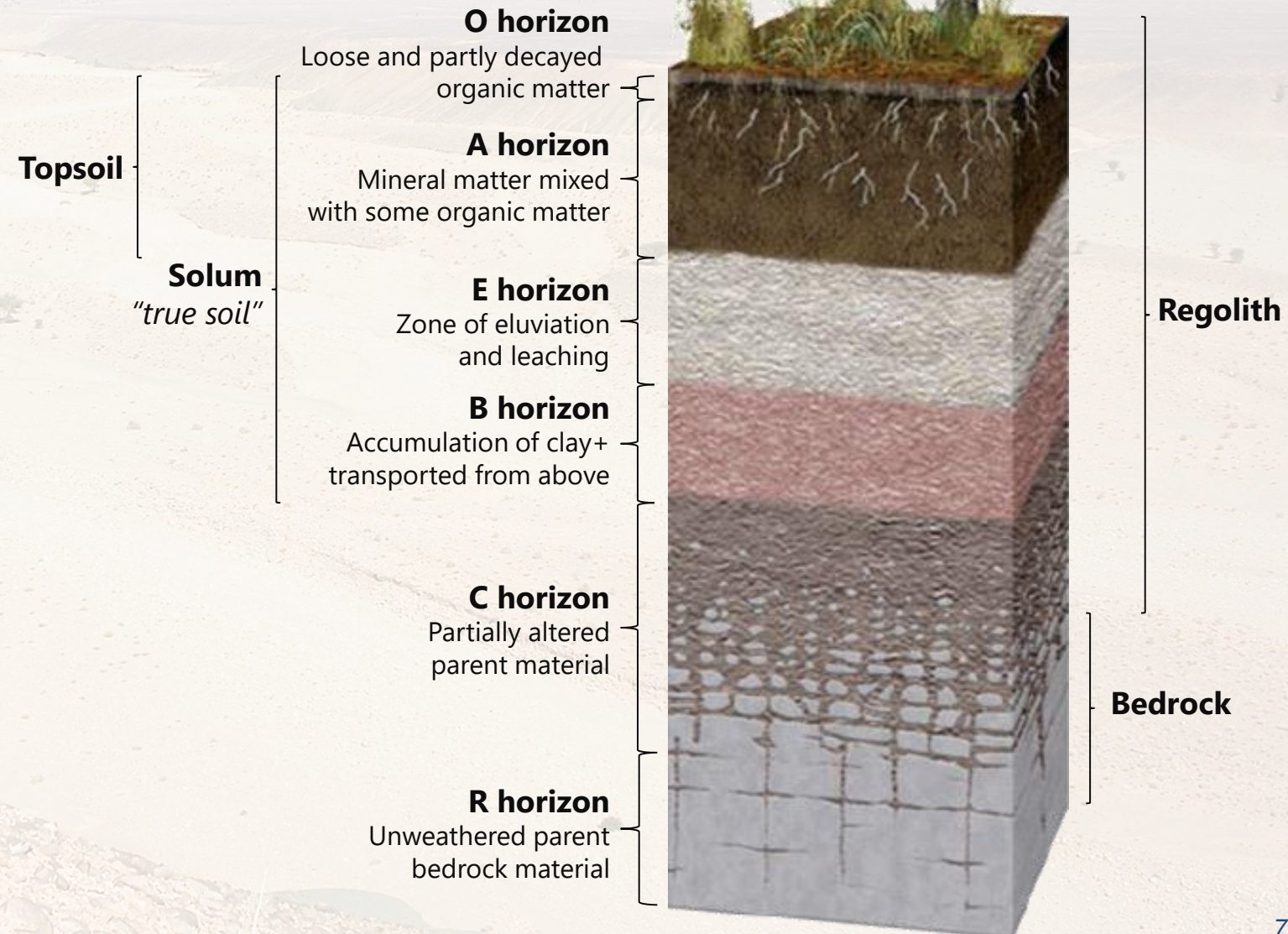


Chemical biological Weathering

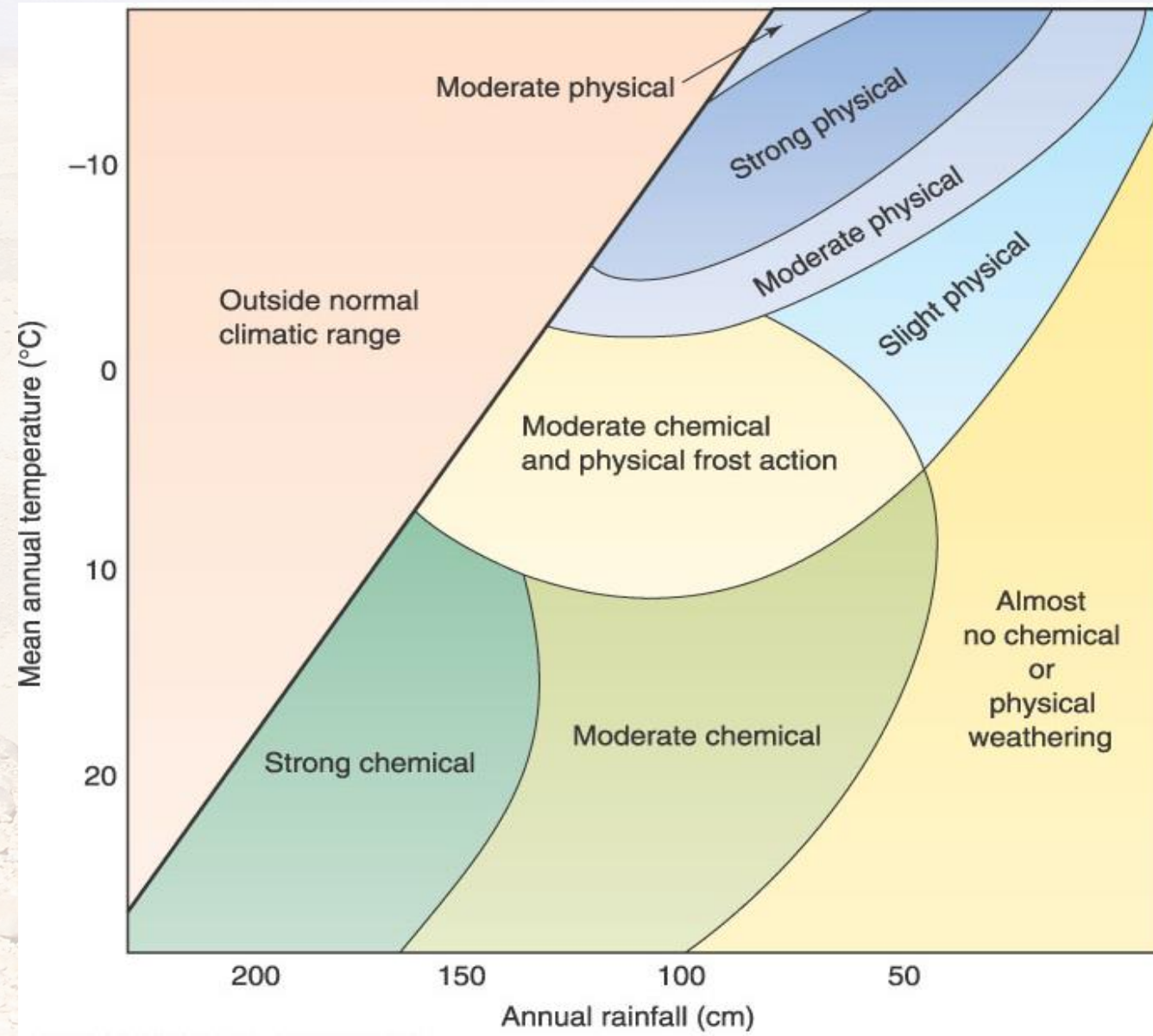




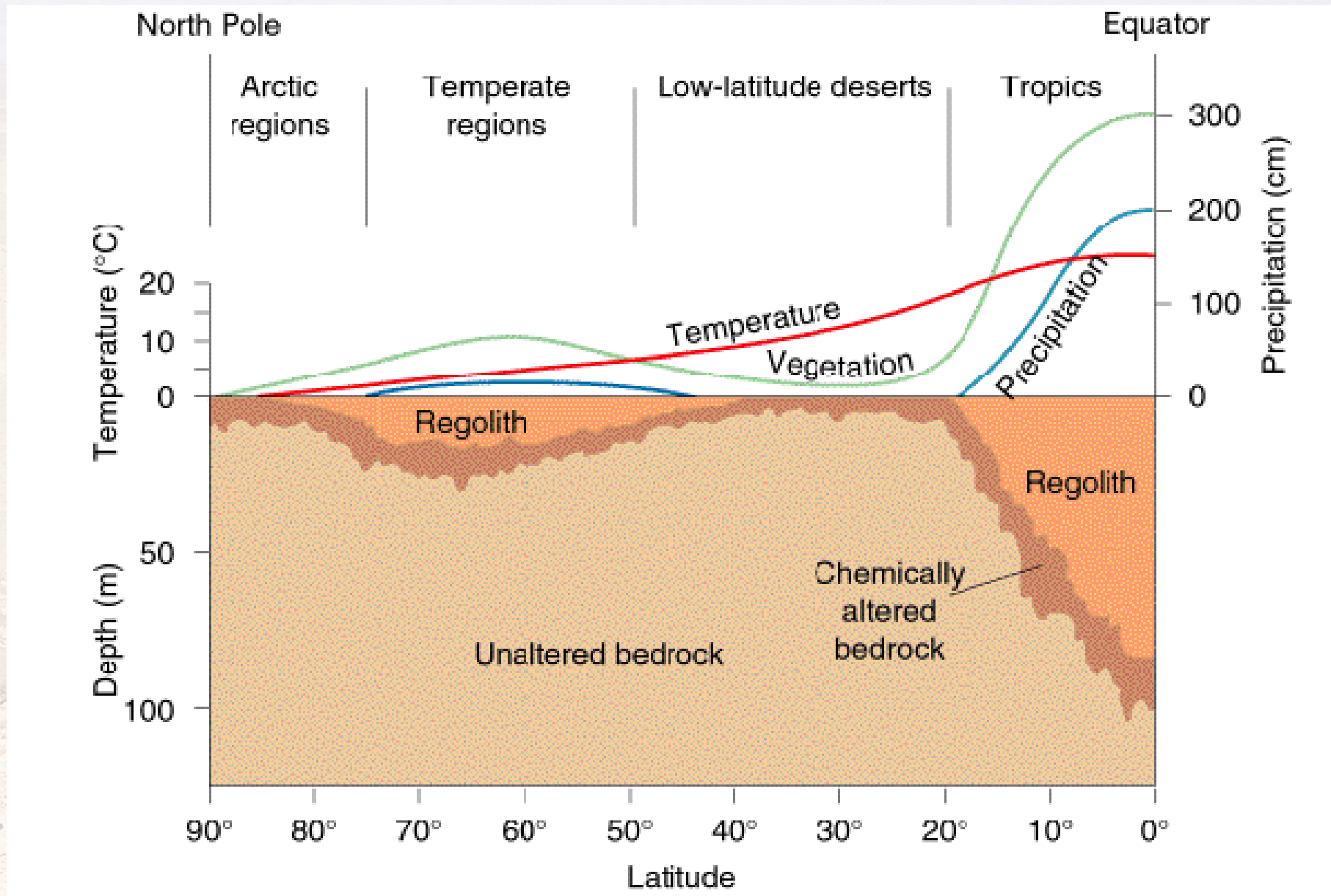
Soils



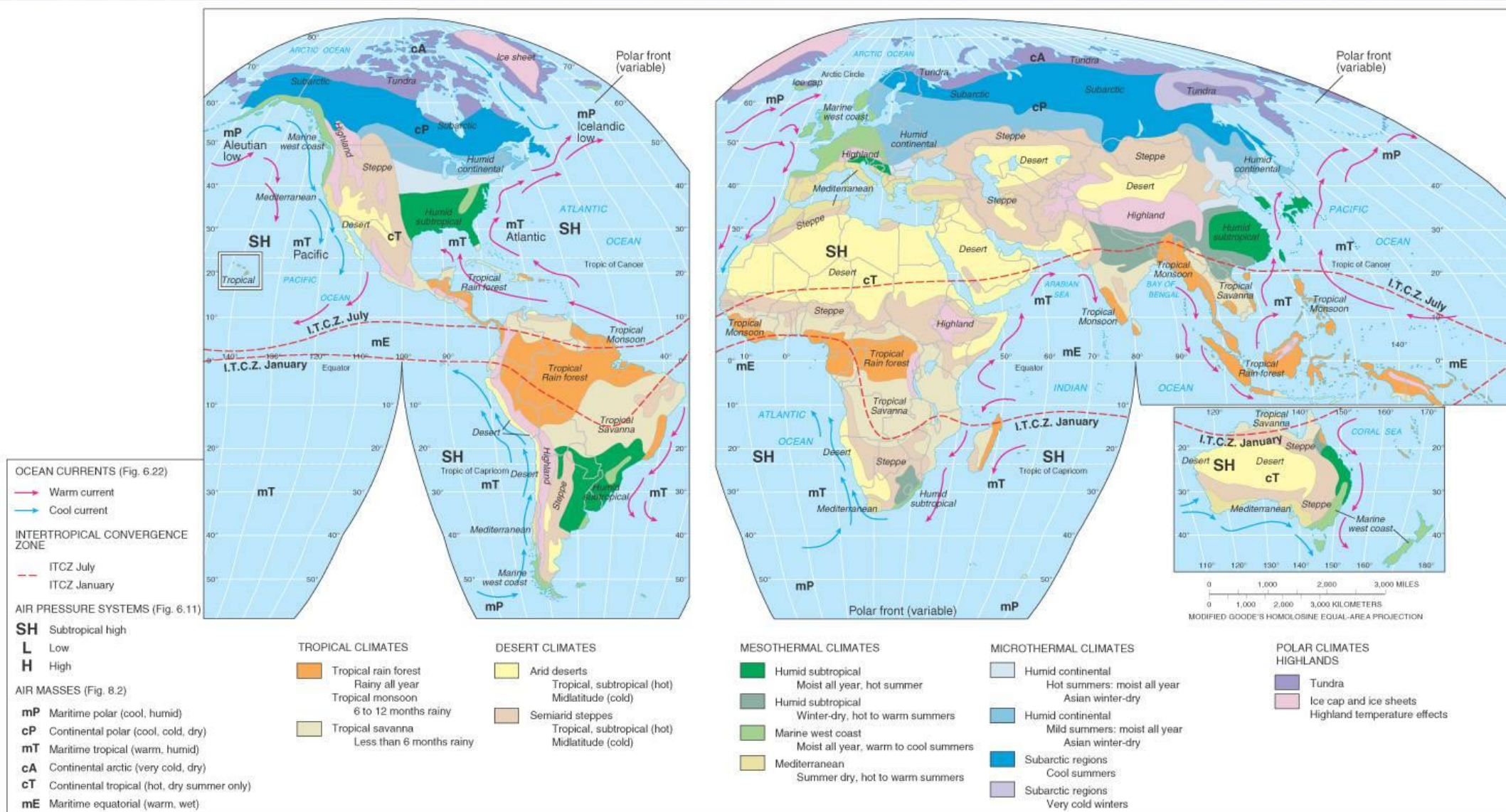
Temperature and Moisture



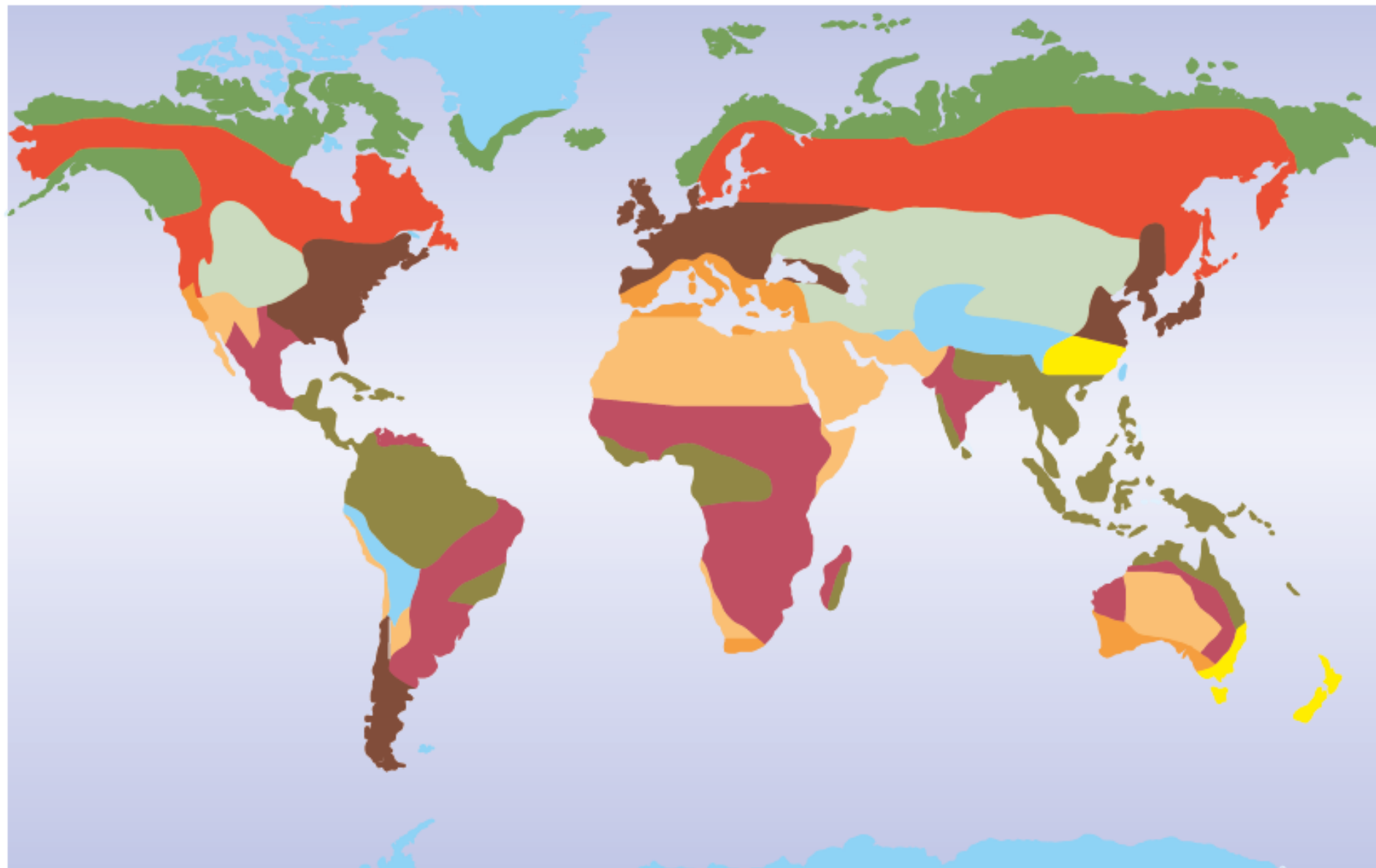
Climate Controls



Climate Zones

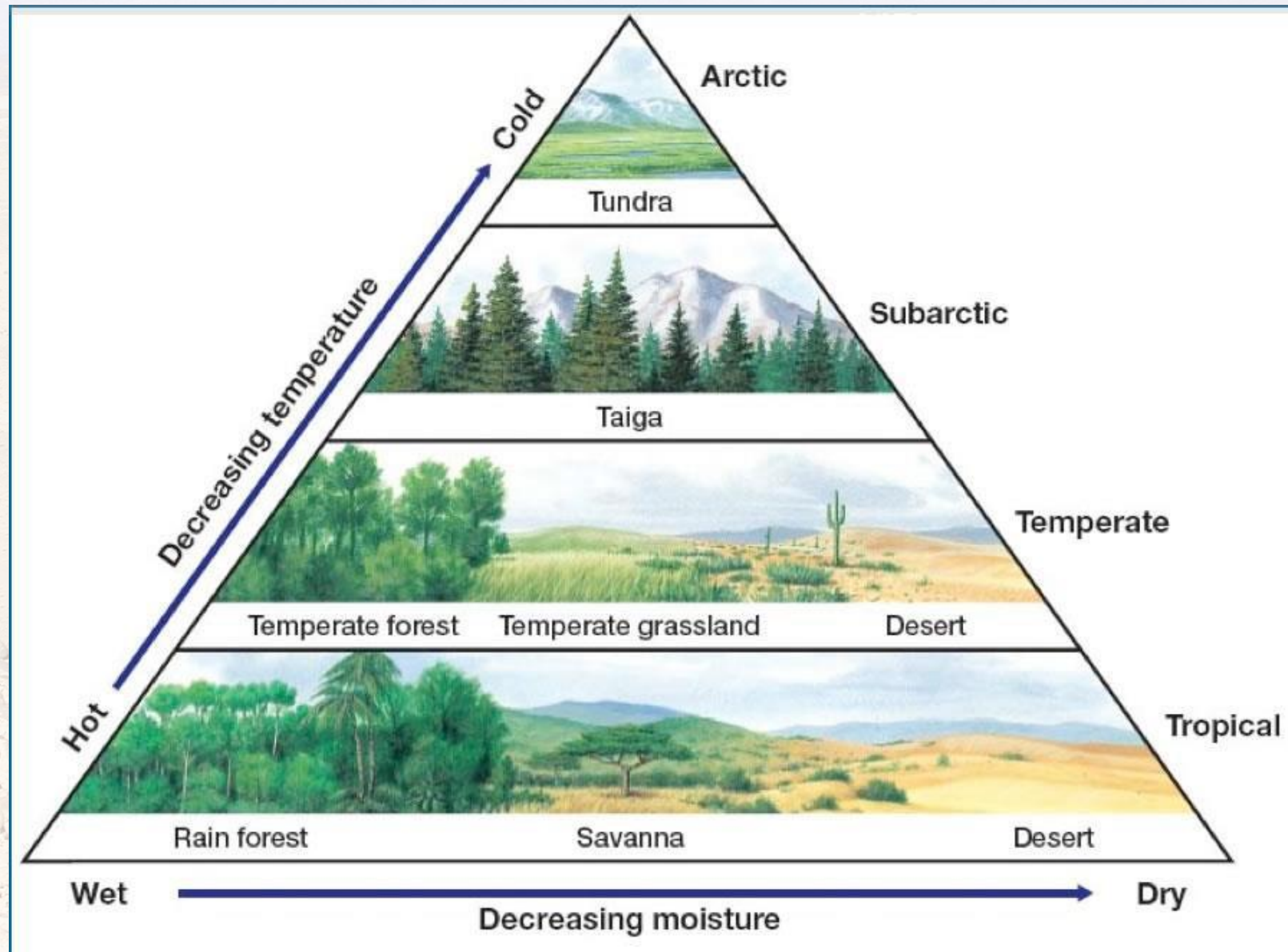


Biomes



- TROPICAL BIOMES**
- Tropical forests
 - Savanna region
 - Hot deserts
- TEMPERATE BIOMES**
- Mediterranean chaparral
 - Temperate evergreen
 - Temperate deciduous woodland
 - Temperate grassland
- COLD BIOMES**
- Taiga
 - Tundra
 - Ice/Mountains

Biomes



Products of Weathering

- Grains
- Solutions
- Clay Minerals



Products of Weathering

- Grains
- Solutions
- Clay Minerals

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



Products of Weathering

- Grains
- Solutions
- Clay Minerals

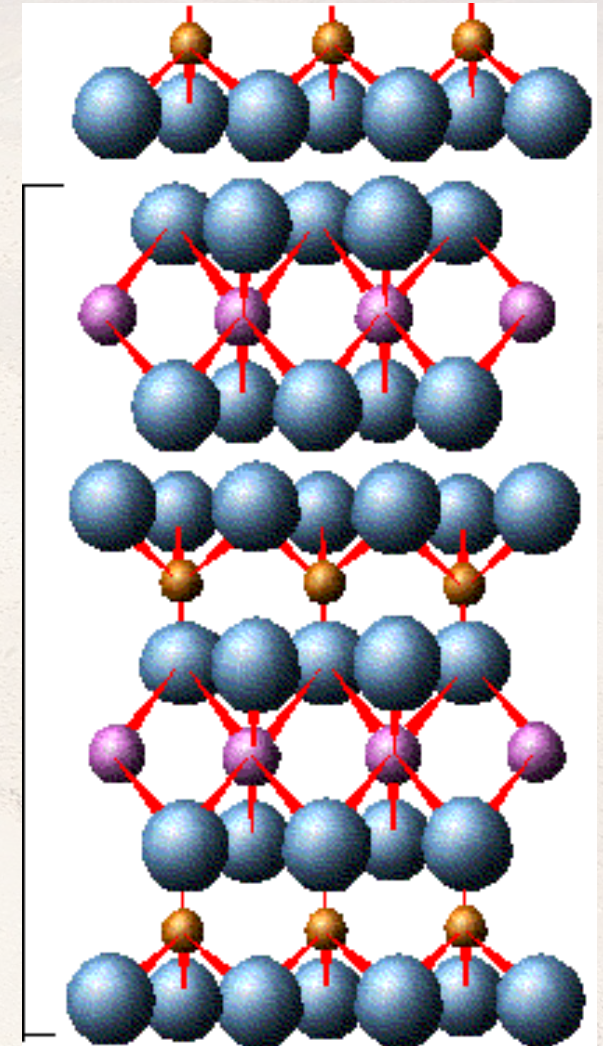
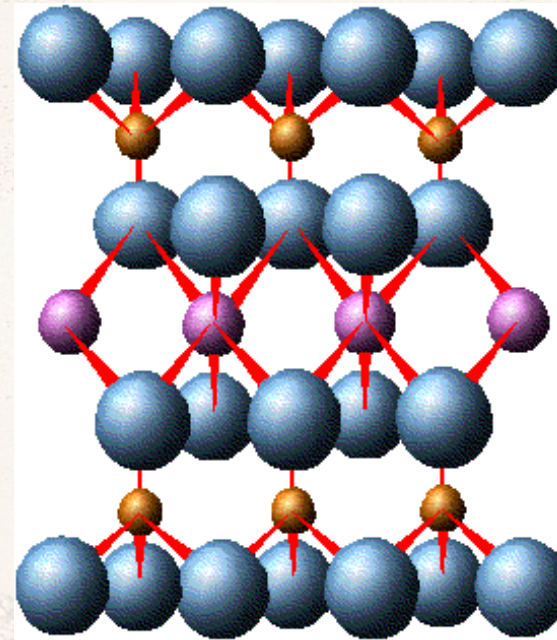
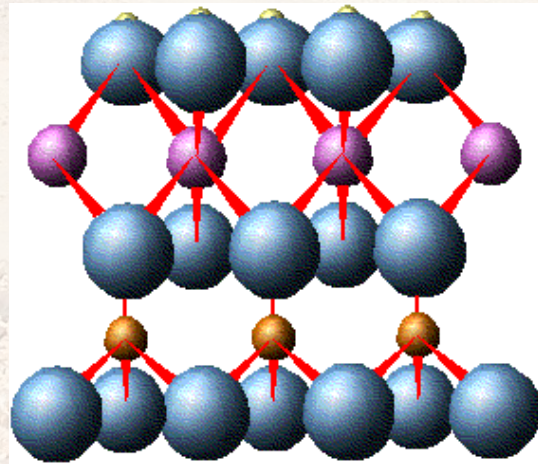
Aqueous fluid with dissolved or hydrolised cations such as K^+ , Mg^{2+}



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 hydrolyses 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



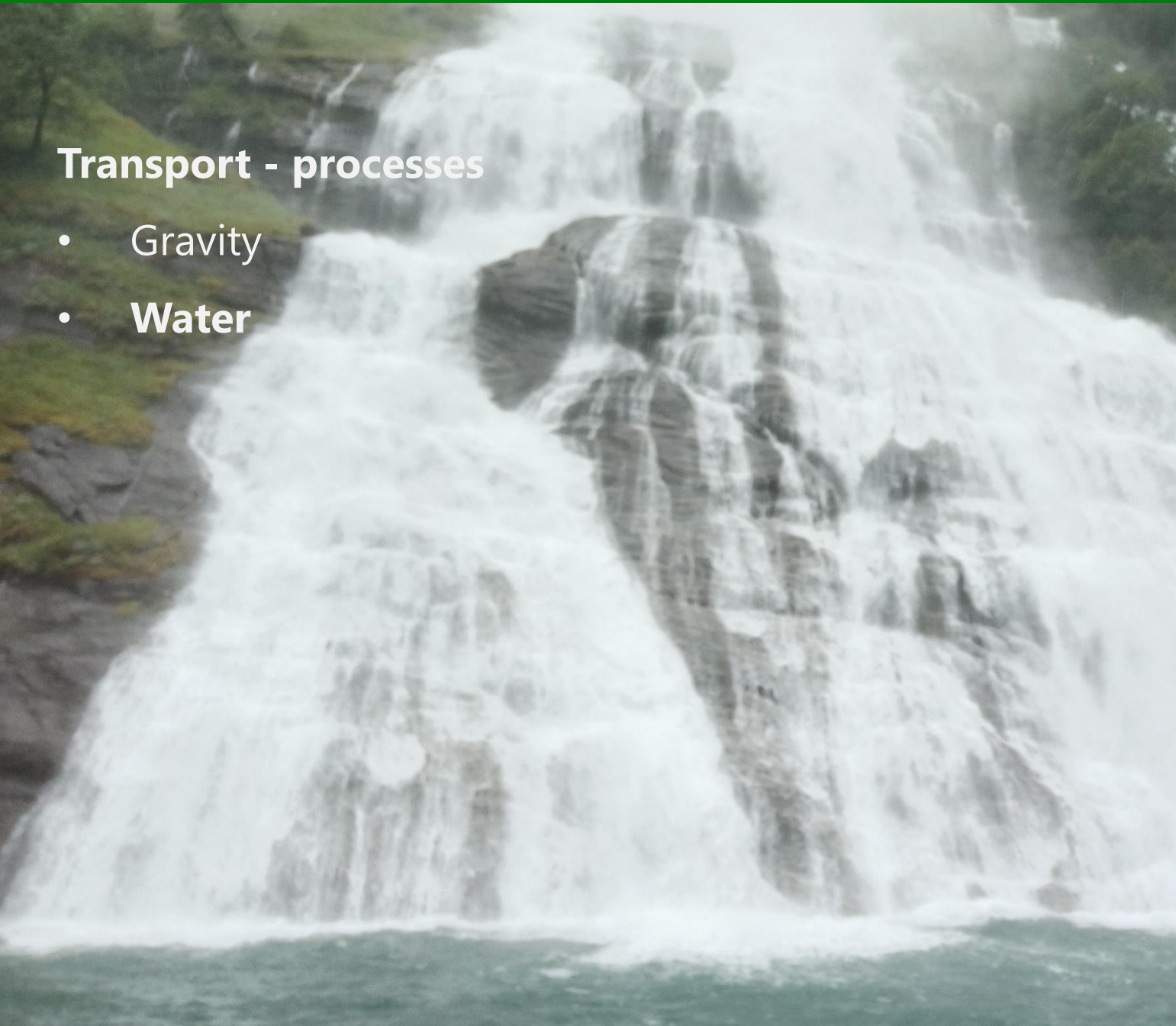
Transport - processes

- Gravity



Transport - processes

- Gravity
- **Water**



Transport - processes

- Gravity
- Water
- Ice



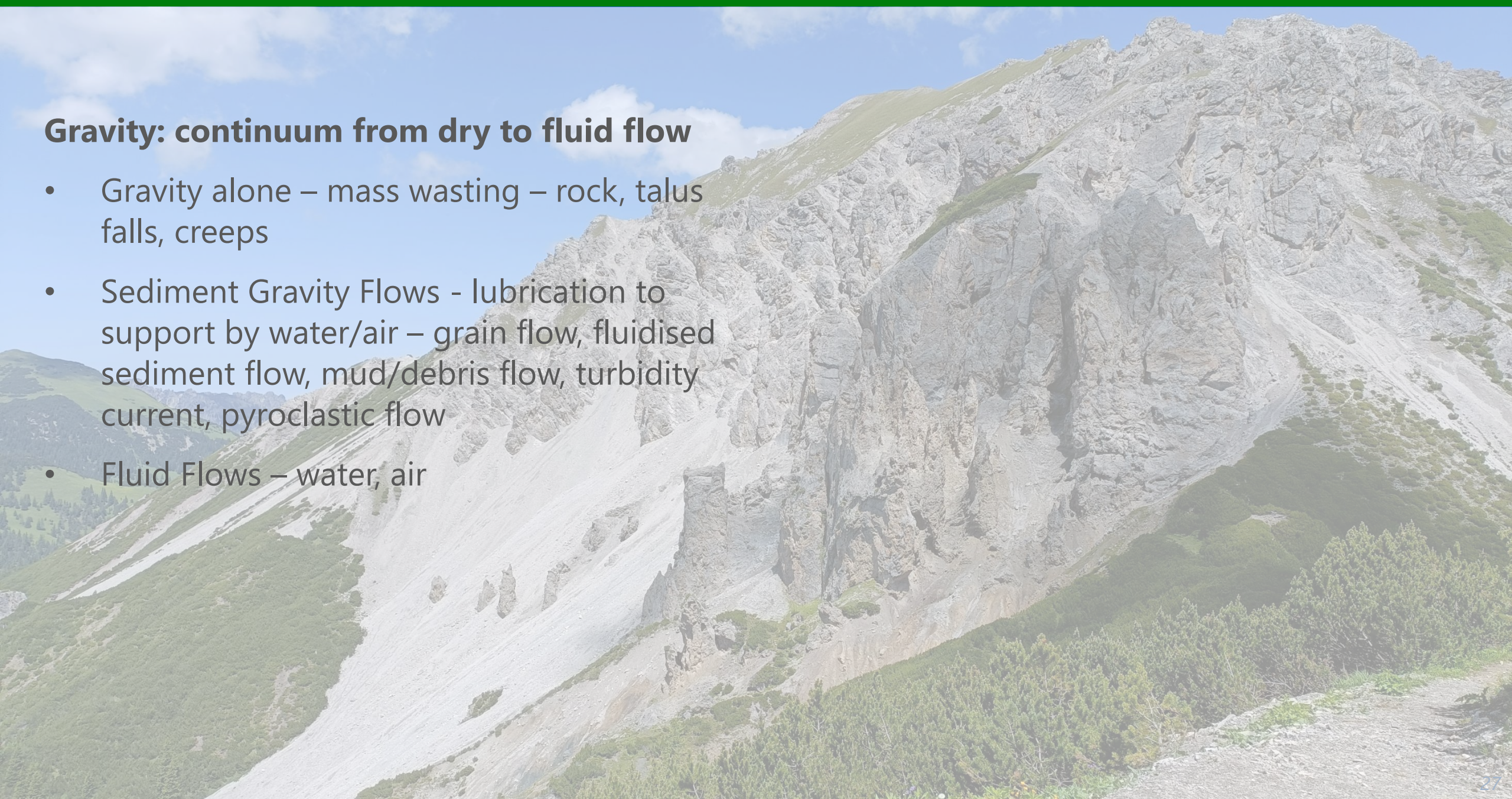
Transport - processes

- Gravity
- Water
- Ice
- **Air**



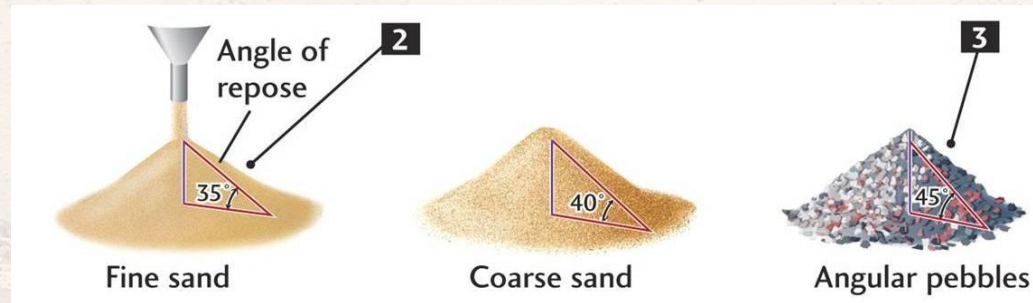
Gravity: continuum from dry to fluid flow

- 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?

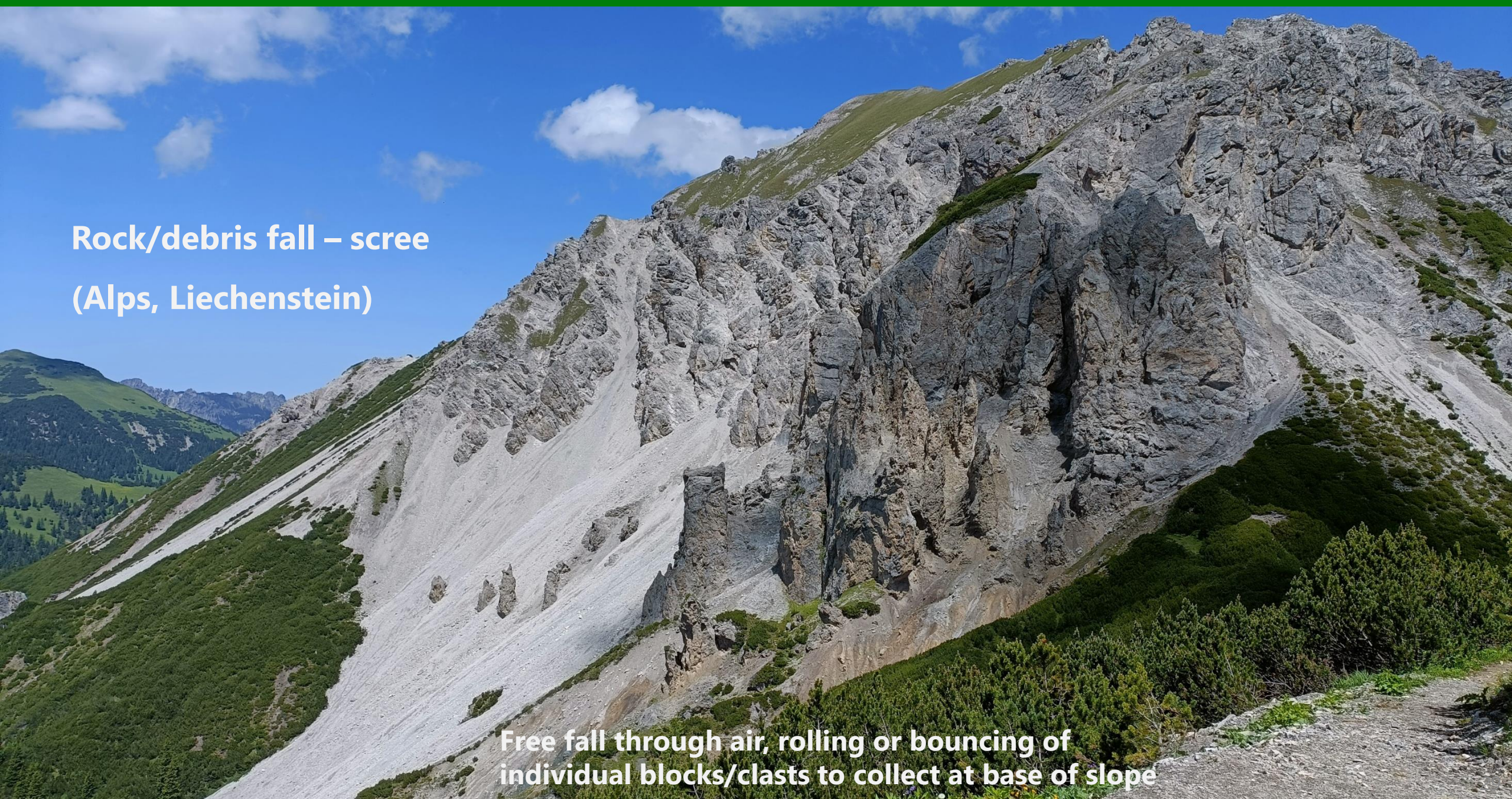


- Is there lubrication by air or water?

Material		ROCK	DEBRIS	EARTH
Movement type				
FALLS		Scar Rock fall Debris	Scar Debris fall Scree Debris cone	Scar Earth fall Fine soil Colluvium Debris cone
		Rock topple	Debris topple Debris cone	Cracks Earth topple Debris cone
SLIDES	Rotational	Single rotational slide (slump) Failure surface	Crown Scarp Head Scarp Minor Scarp Failure surface Toe Multiple rotational slide	Successive rotational slides
	Translational (Planar)	Rock slide	Debris slide	Earth slide
SPREADS	Normal sub-horizontal structure Cap rock Clay shale Thinning of beds Plane of décollement Competent substratum e.g. cambering and valley bulging			Earth spread
FLOWS	Solifluction flows (Periglacial debris flows)	Debris flow	Earth flow (mud flow)	
COMPLEX	e.g. Slump-earthflow with rockfall debris			e.g. composite, non-circular part rotational/part translational slide grading to earthflow at toe

Rock/debris fall – scree
(Alps, Liechtenstein)

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





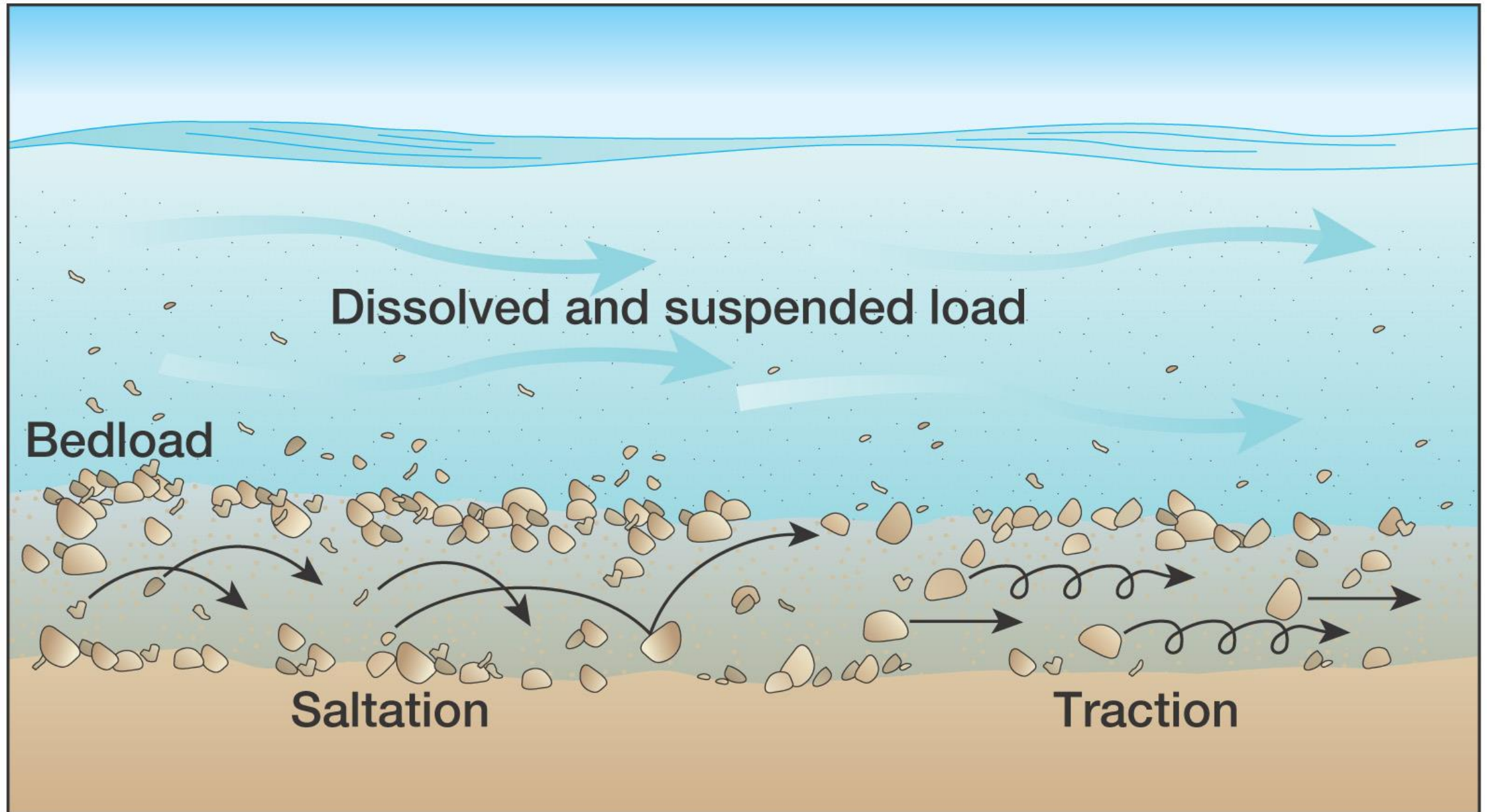
Santiaguita Volcano, Guatemala 14th. Aug. 1989

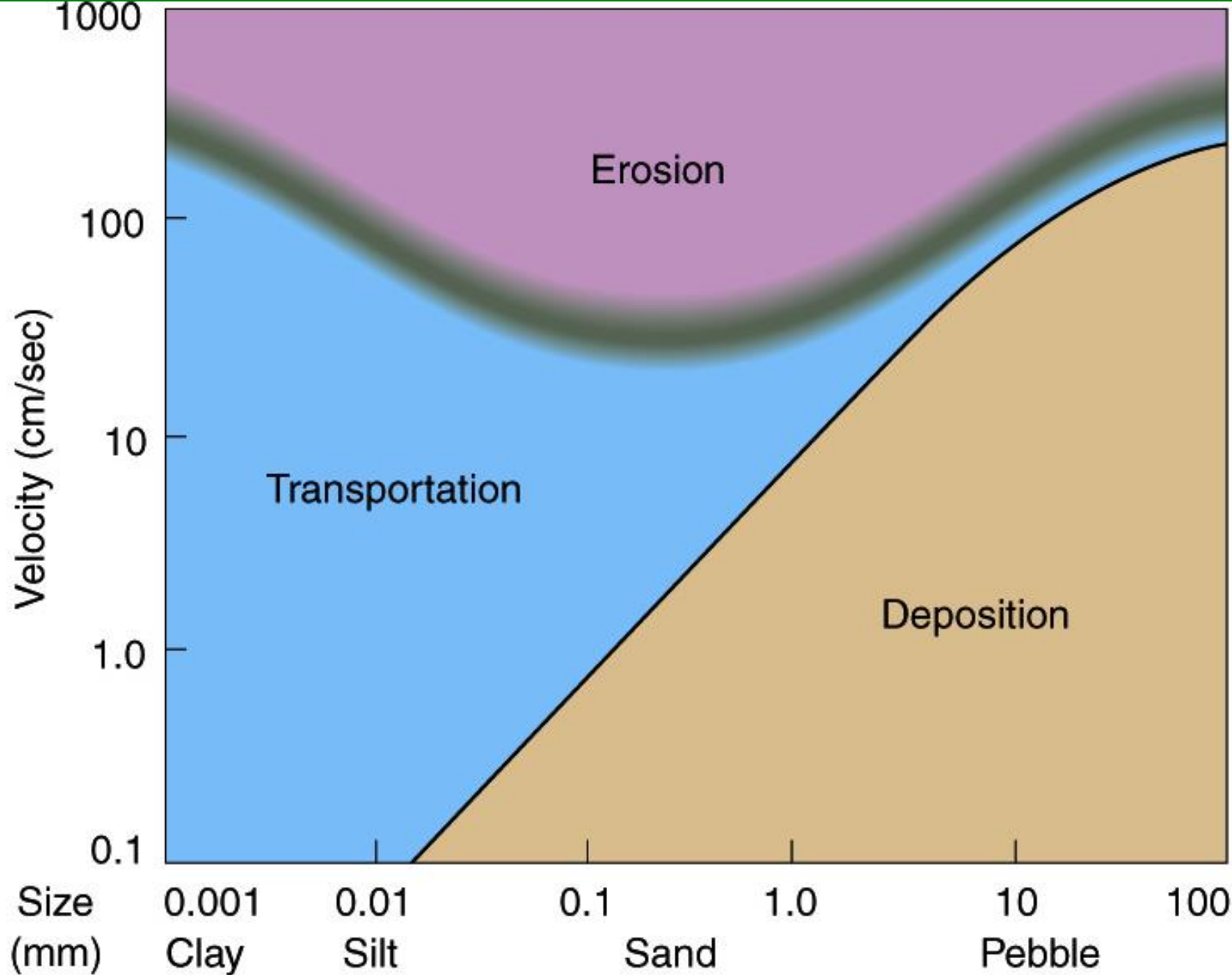
Due to condensation and rain during eruptive phase or reactivated volcanoclastic ashfall later – from water with high sediment yield to mudflow

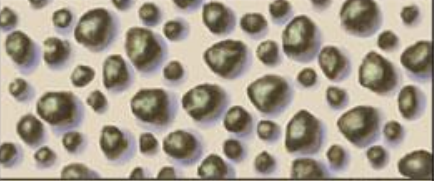
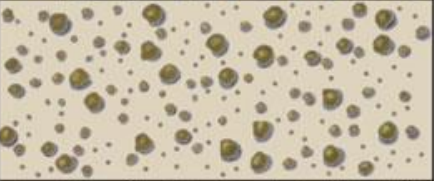
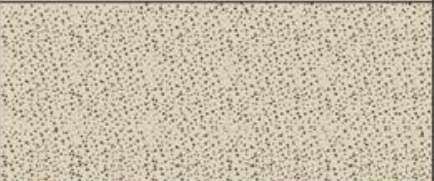
Fluidised sediment flow - lahar

Chicita Volcano, Nicaragua 30th. Oct. 1998



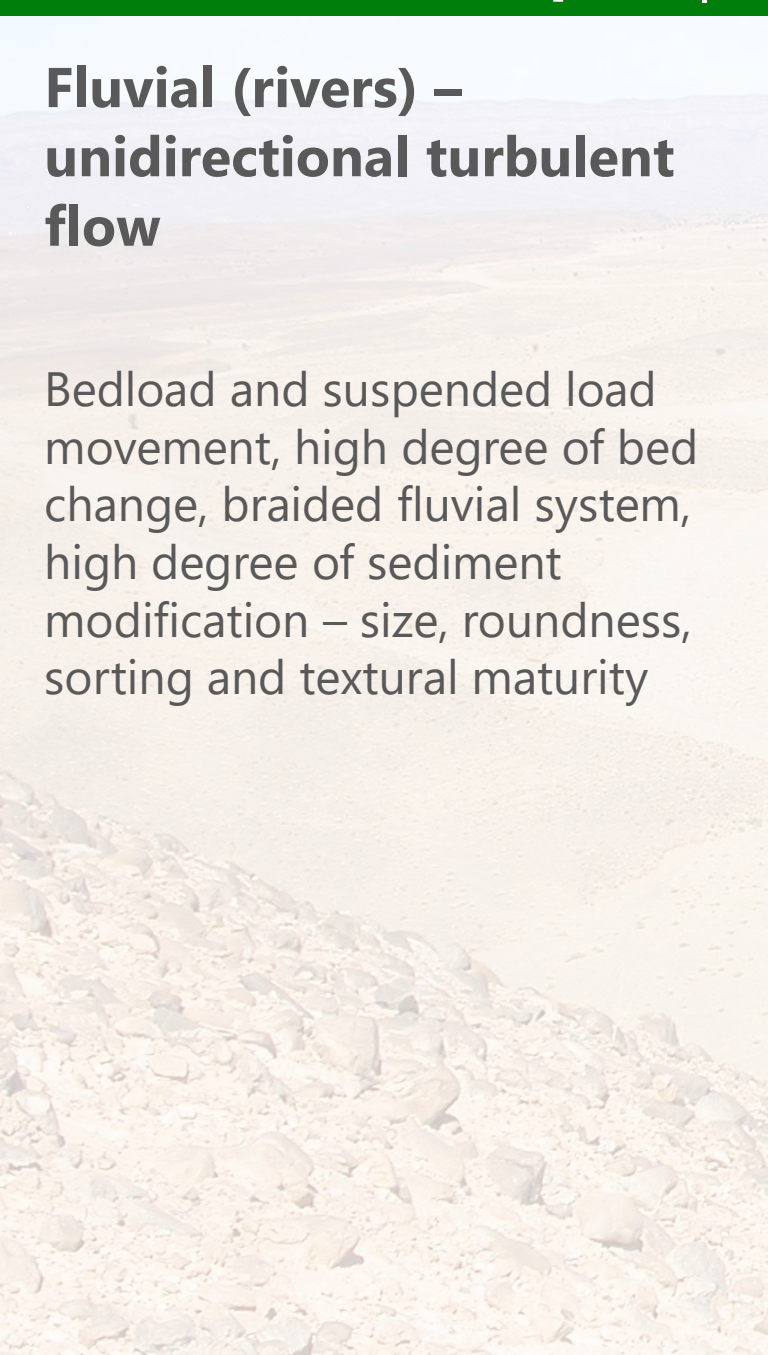




A. Grain size		
"Gravel" > 2mm	Pebbles 4–64 mm	
	Granules 2–4 mm	
	Coarse sand 0.5–2 mm	
	Medium sand 0.25–0.5 mm	
	Fine sand 0.06–0.25 mm	
	Silt 0.004–0.06 mm	
	Clay < 0.004 mm	

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

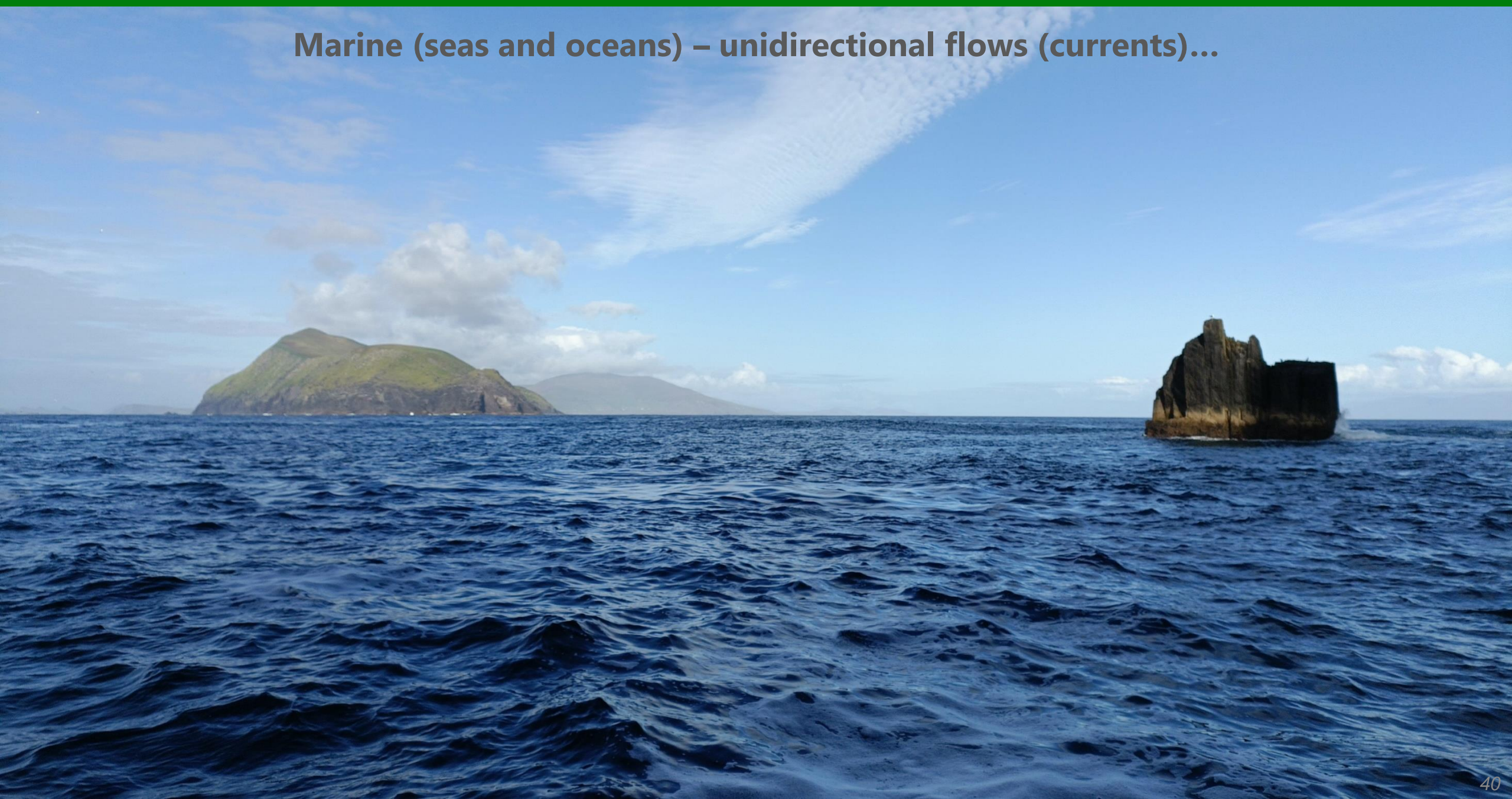


Fluvial (rivers) – unidirectional turbulent flow

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)...



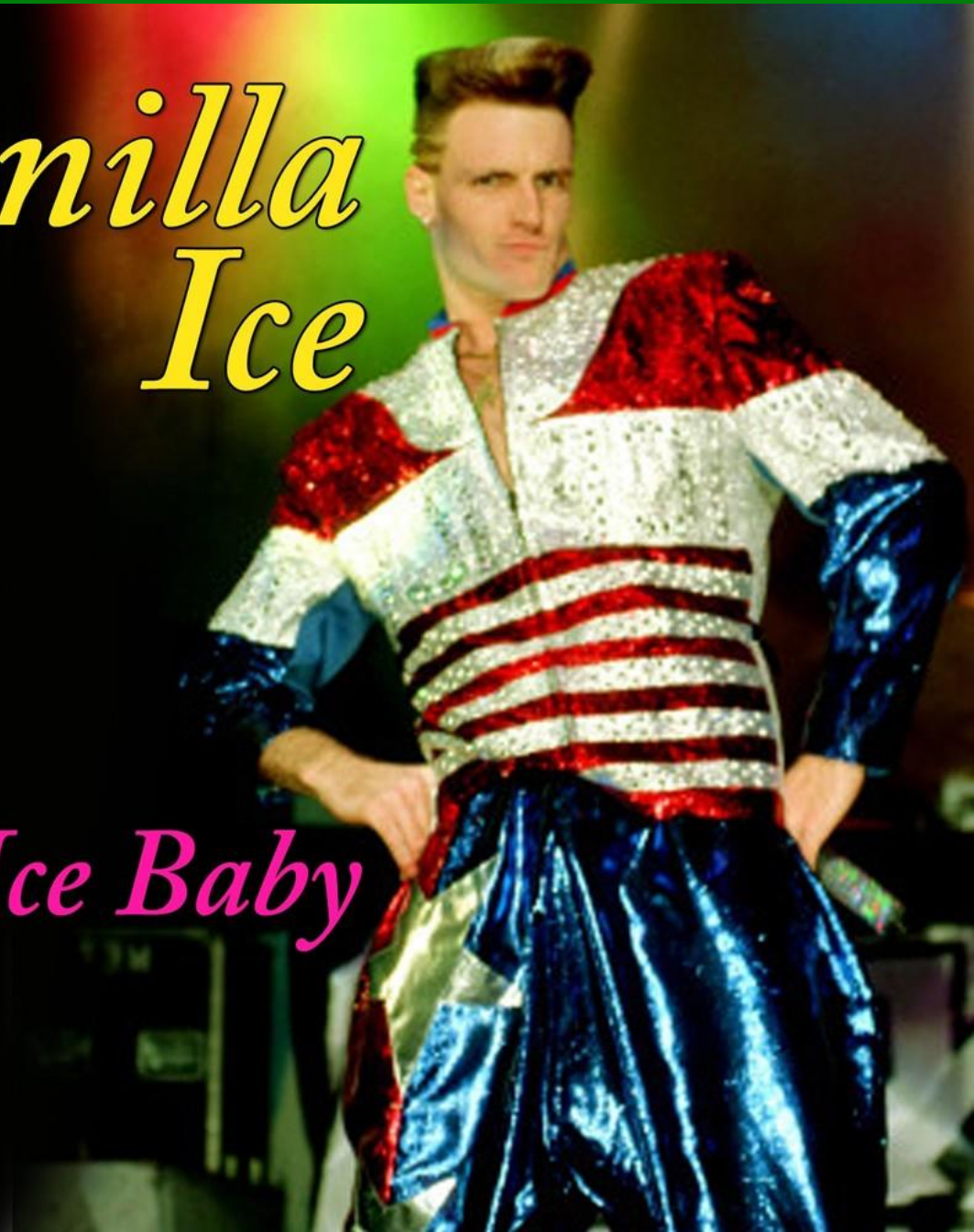
Marine (seas and oceans) – unidirectional flows (currents)...
...and bidirectional flows (waves, tides)





*Vanilla
Ice*

Ice Ice Baby



Ice in glaciers is solid but plastic – it flows



Supraglacial transport

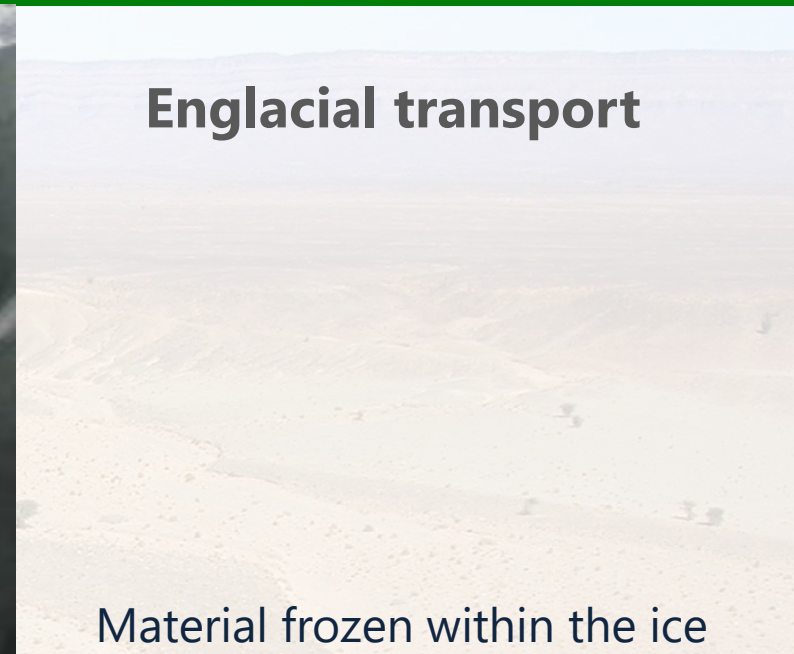


Passive transport of
material which falls on
top of the glacier

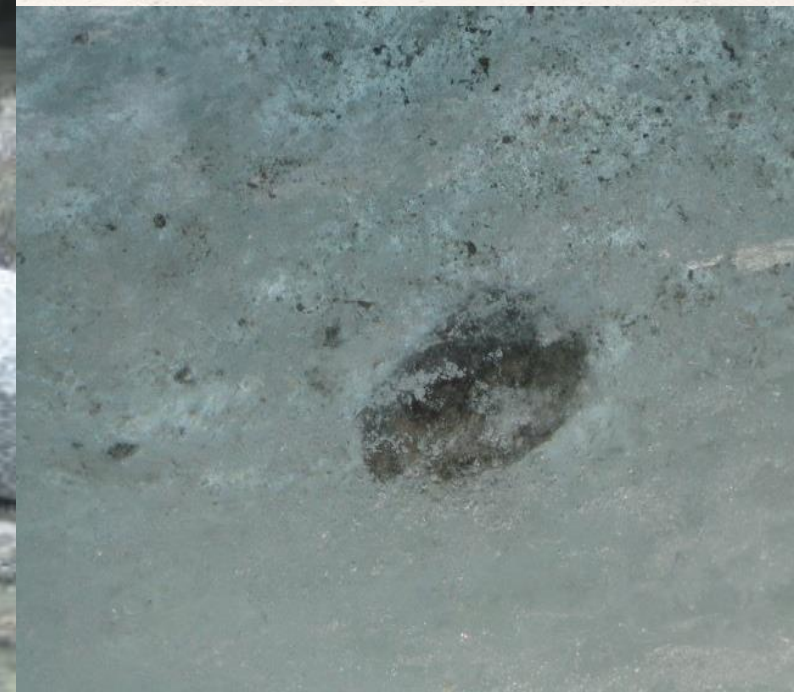




Englacial transport



Material frozen within the ice





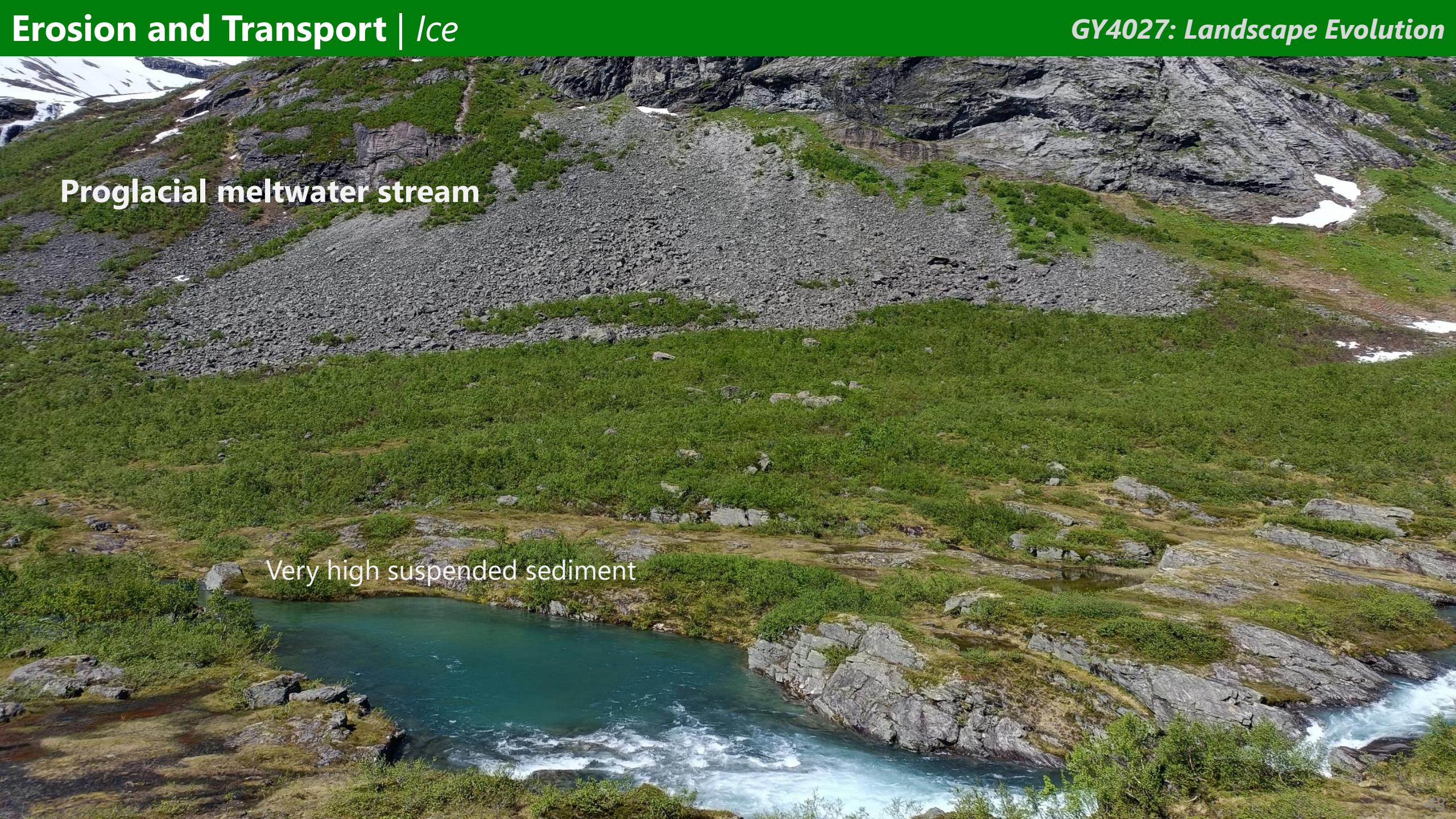
Subglacial transport



Massive pressures at the base of the glacier

Meltwater transport – supraglacial and subglacial





Proglacial meltwater stream

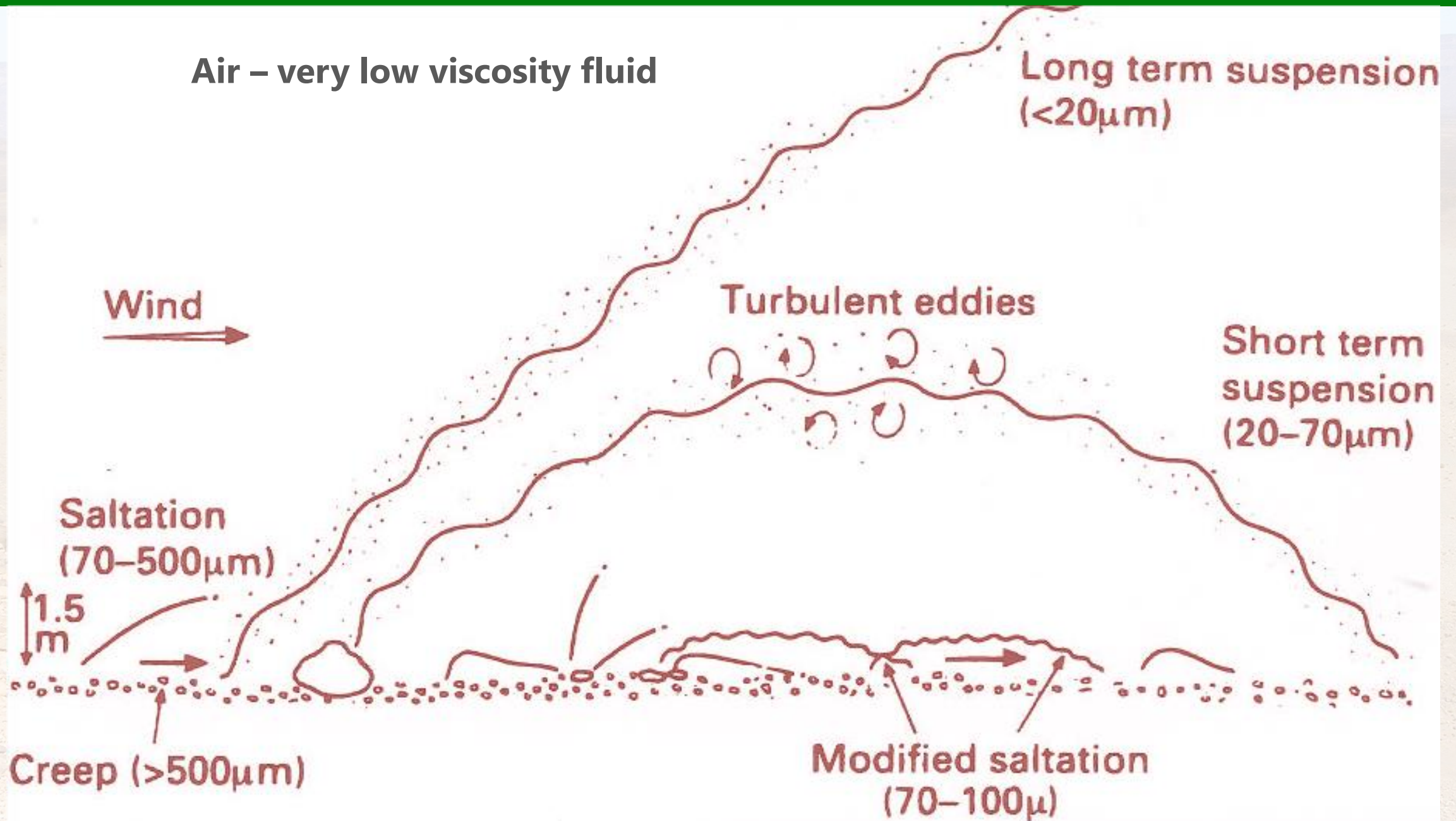
Very high suspended sediment

Traction and saltation across a beach



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)

