

# **Weathering and karst**



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- 1. Weathering processes**
- 2. Weathering landforms**
- 3. Karst landscapes**





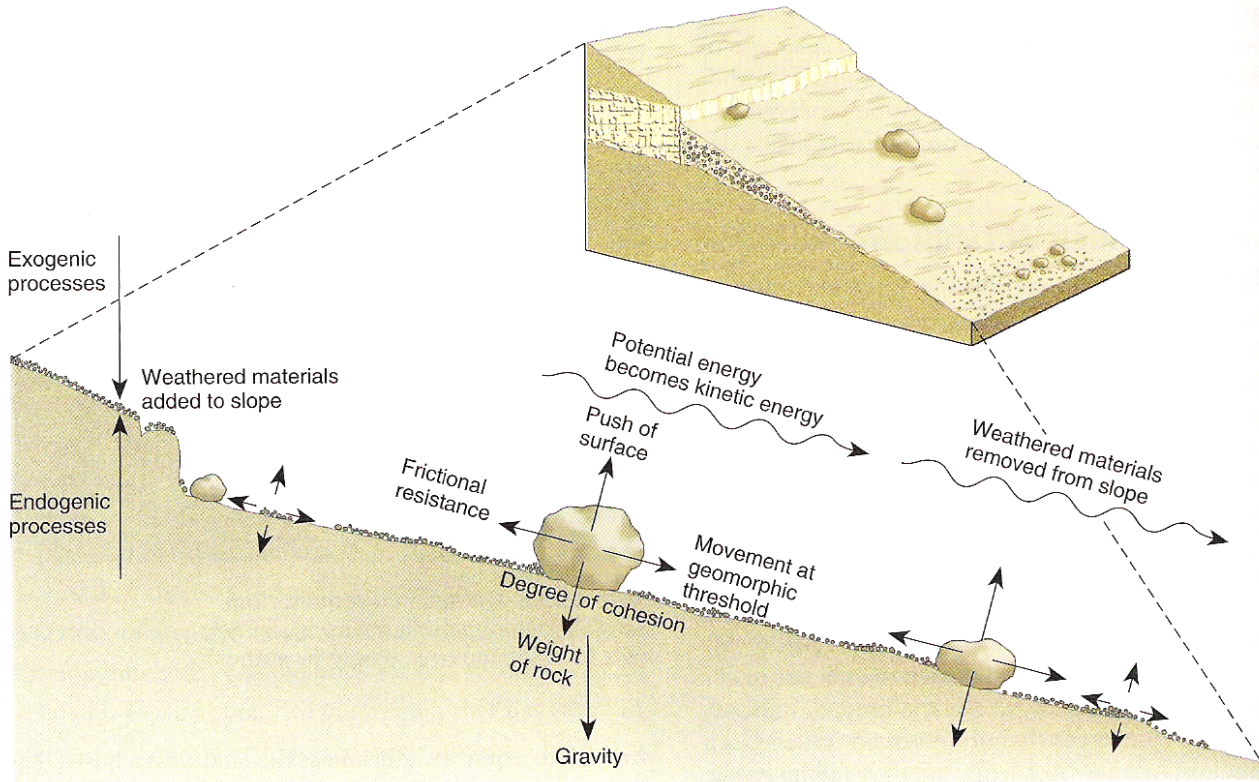




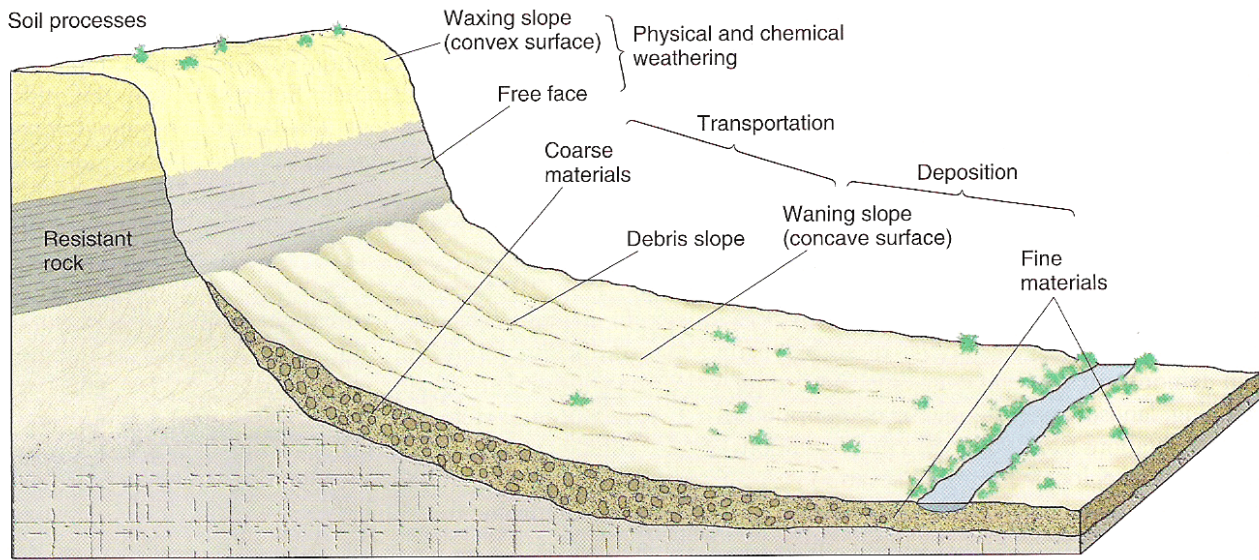
**Landslide, Barton-on-Sea, UK, 19 February 2004**



9 26 '99



(a)



(b)

## Weathering and slope processes



# Weathering

- Changes that occur in sediments and rocks near earth's surface
- Two main types: chemical and physical



Chemical: minerals are chemically altered or dissolved



Physical: fragmentation



**Physical weathering**



**Chemical weathering**

Physical and chemical weathering go hand in hand

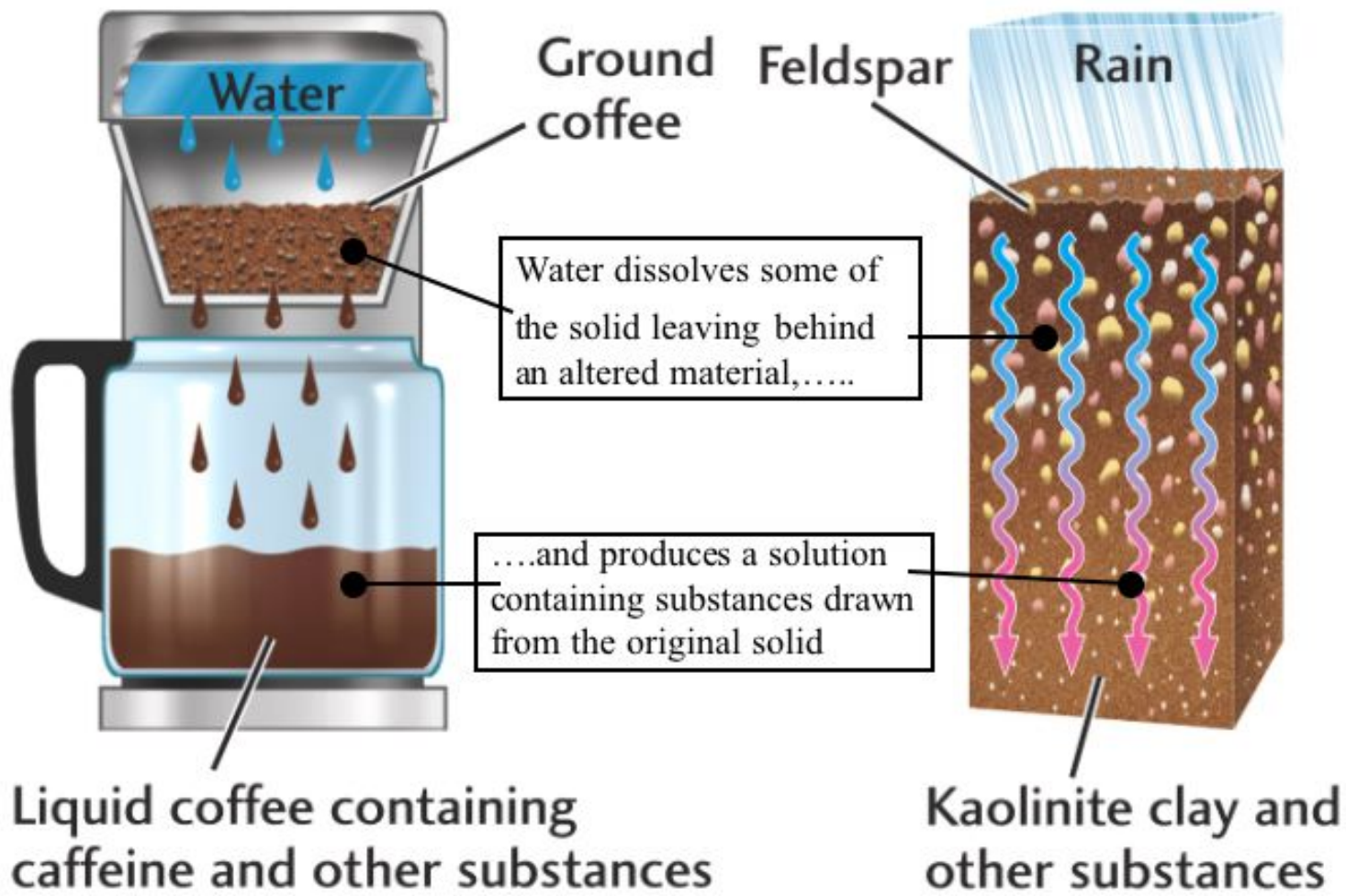




**Differential weathering**

# Chemical weathering

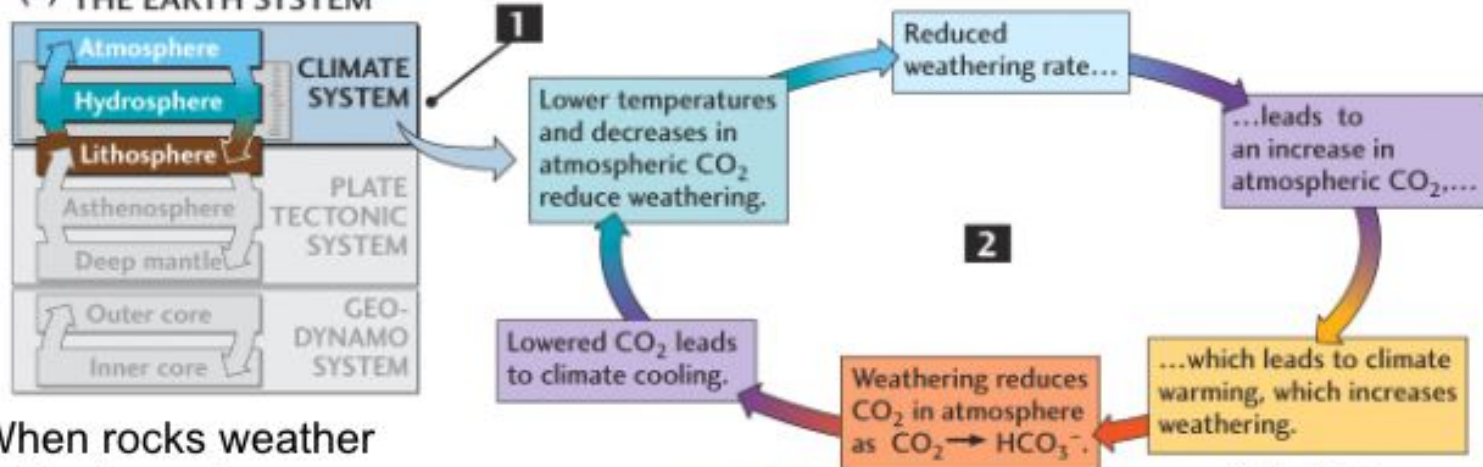
- This process occurs because minerals formed deep in the earth's interior are not stable under surface conditions.
- Stability is generally the reverse of Bowen's reaction series.
- The principle agent of chemical weathering is water +++.
  - *Quartz*: very stable
  - *Feldspars*: form clay minerals
  - *Mafic minerals*: alter to oxides



# The climate system

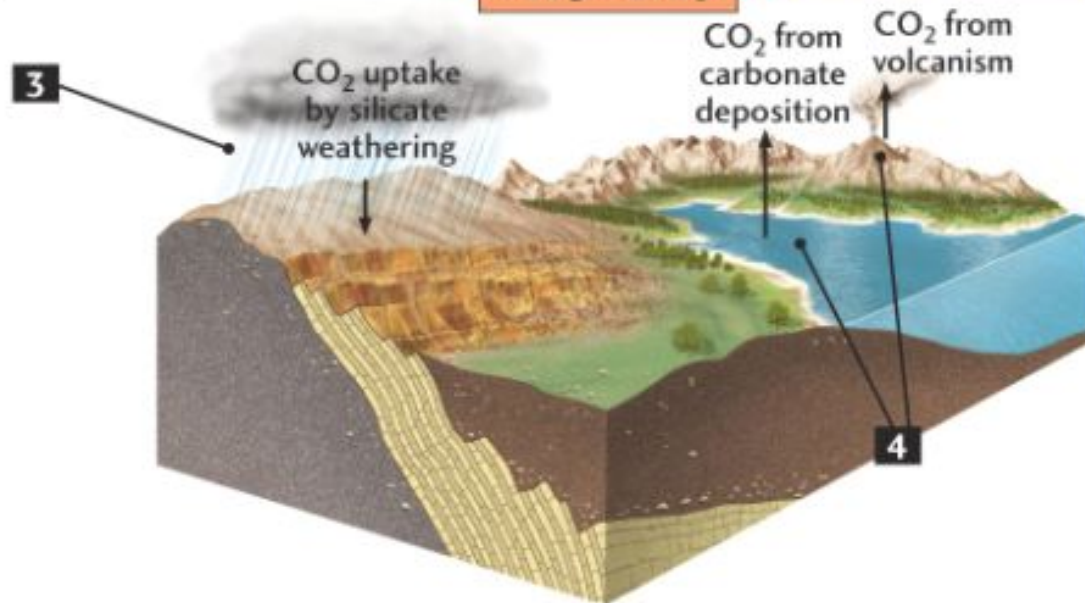
## ATMOSPHERIC CARBON DIOXIDE INFLUENCES WEATHERING AND CLIMATE

### (a) THE EARTH SYSTEM



1. When rocks weather the climate and lithosphere interact

2. Variability in atmospheric carbon dioxide leads to corresponding variability in rate of weathering







Austria

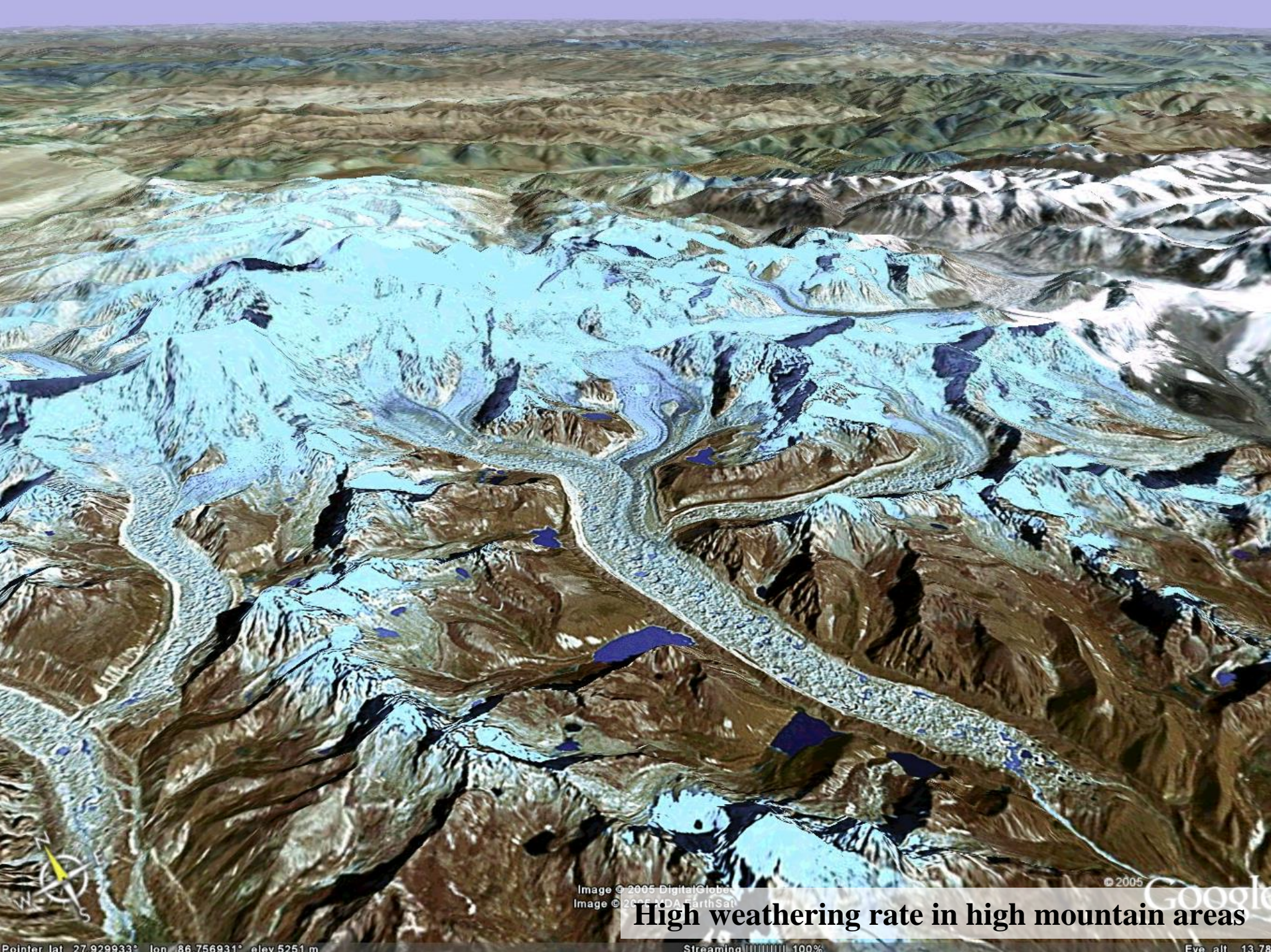


Image © 2005 DigitalGlobe  
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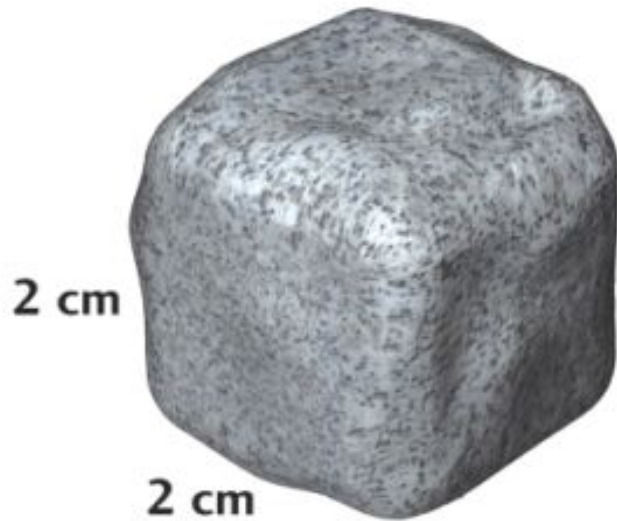
## High weathering rate in high mountain areas

Pointer lat 27.929933° lon 86.756931° elev 5251 m

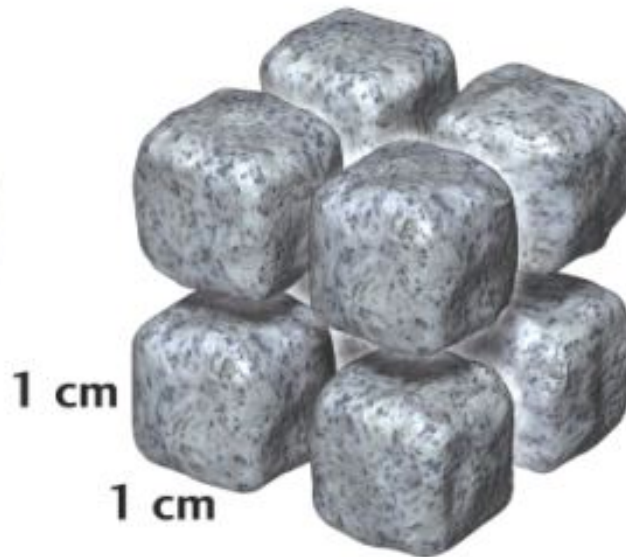
Streaming 100%

Eye alt 13.78

## Importance of fractures



$$\begin{aligned} 2 \text{ cm} \times 2 \text{ cm} &= 4 \text{ cm}^2 \\ 4 \text{ cm}^2 \times 6 \text{ sides} &= 24 \text{ cm}^2 \\ &\text{(surface area)} \end{aligned}$$



$$\begin{aligned} 1 \text{ cm} \times 1 \text{ cm} &= 1 \text{ cm}^2 \\ 1 \text{ cm}^2 \times 6 \text{ sides} &= 6 \text{ cm}^2 \\ 6 \text{ cm}^2 \times 8 \text{ cubes} &= 48 \text{ cm}^2 \\ &\text{(surface area)} \end{aligned}$$



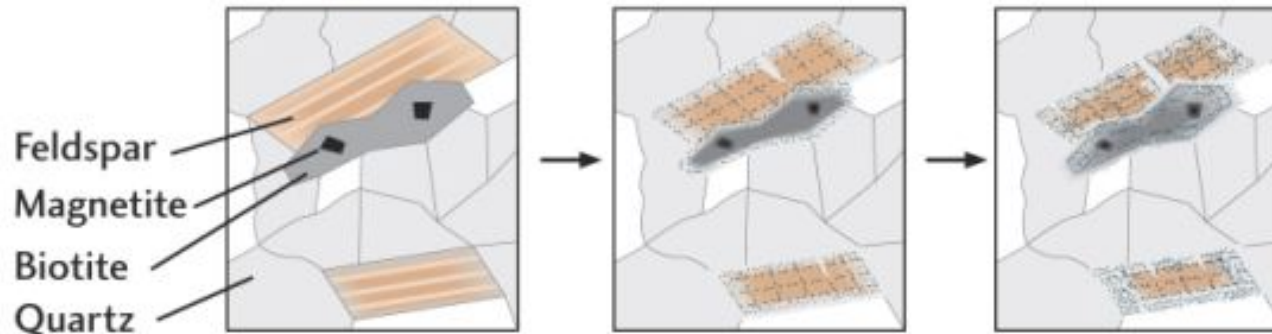
Talus formation at Moraine lake, Rocky Mountains, Canada

## Microscopic view of disintegration of a granite



1. Cracks form along crystal boundaries. Feldspar, biotite and magnetite start to decay, while quartz does not

2. The decay progresses, and as the crack opens, the rock weakens and disintegrates






Regolith (weathered granite) at Guadarrama, central Spain

## Relative stabilities

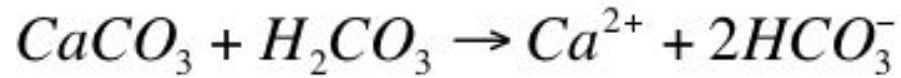
**Table 7.2** Relative Stabilities of Common Minerals Under Weathering

Stability of Minerals	Rate of Weathering	
MOST STABLE	Slowest	
Iron oxides (hematite)		
Aluminum hydroxides (gibbsite)		
Quartz		
Clay minerals		
Muscovite mica		
Potassium feldspar (orthoclase)		
Biotite mica		
Sodium-rich feldspar (albite)		
Amphiboles		
Pyroxene		
Calcium-rich feldspar (anorthite)		
Olivine		
Calcite		
Halite		
LEAST STABLE		Fastest

- Important factors**
- Chemical stability
  - Solubility
  - Rate of dissolution

## Chemical weathering of carbonates

- Easily soluble in water (especially with some acid present)
- Ca and Mg taken into solution





# Mechanical weathering-Cracks

*Exfoliation Cracks- cracks planar to earths surface- cause is not well known*

*Tectonic Forces- forces in rocks cause cracks to grow*

*Frost shattering-growth of ice in small cracks*

*Thermal expansion — differential thermal expansion of minerals creates stress in rocks- fires*

*Organic activity — tree roots to micro-organisms*

*Mineral Growth- growth of salts in cracks*

# Exfoliation Dome in Yosemite



Tony Waltham

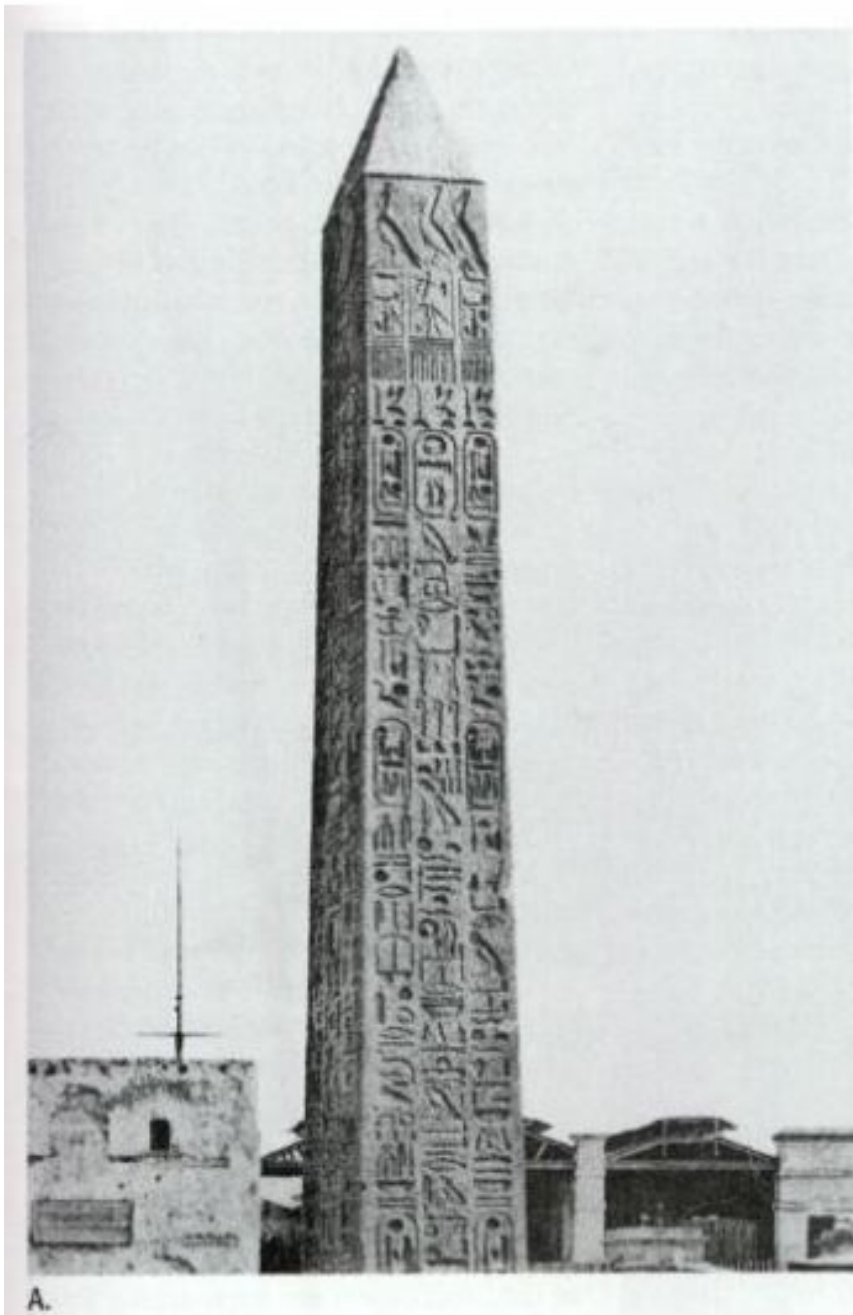
**Fig. 6.14**

# Joint-controlled Weathering

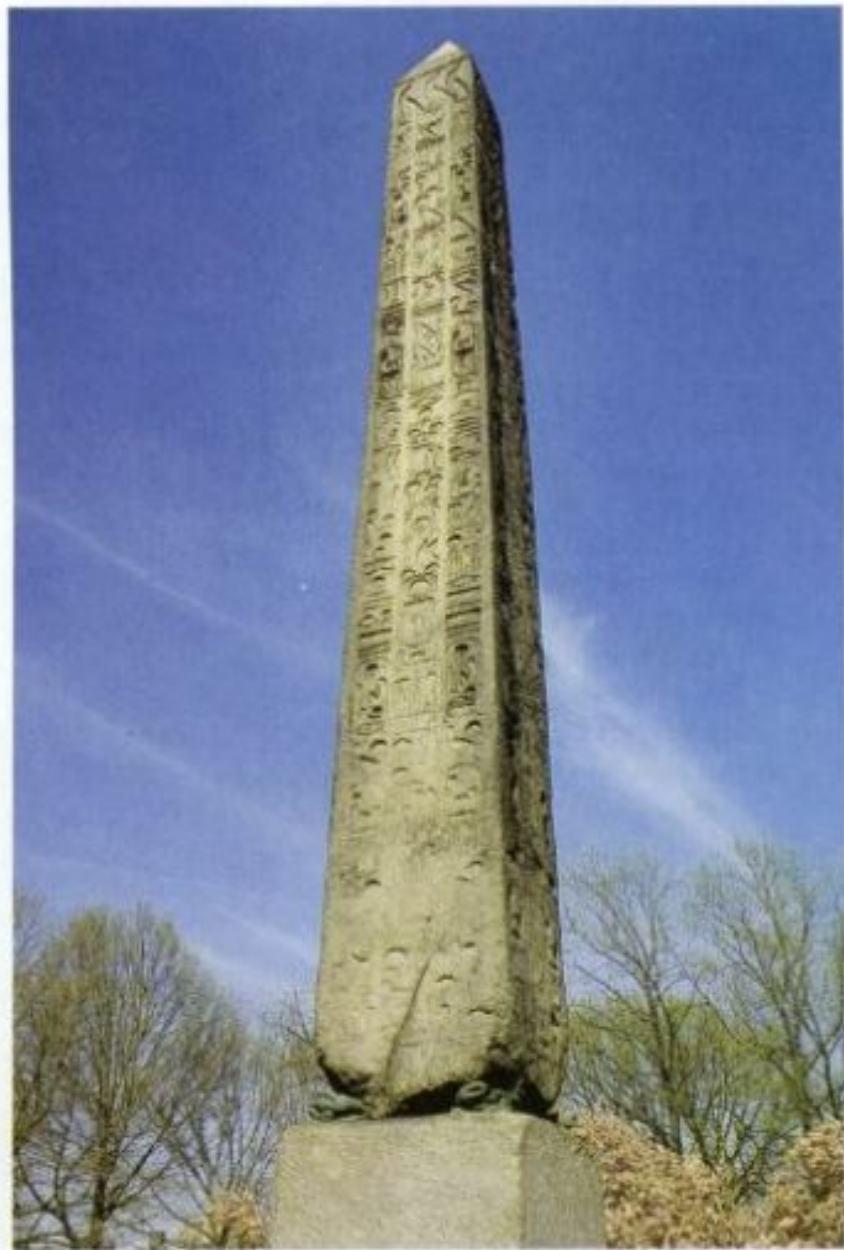


# Salt Weathering

- Salt accumulates in rock pores and cracks
- generally occurs by evaporation
- sources include
  - weathering products in water
  - precipitation-especially near coasts
  - eolian dust



A.



B.

# Role of Organisms in Weathering



Peter Kresam

**Fig. 6.12**

## Frost shattering

- Thought to be dominant in arctic and alpine environments
- occurs by the freezing of water in rock void spaces-cracks

# Gneiss Boulder Fractured by Frost Action



Michael Hambrey





Frost weathering in Haefelekar mountains, Austria



Frost weathering, central Norway



**Weathering forms in karst cave**

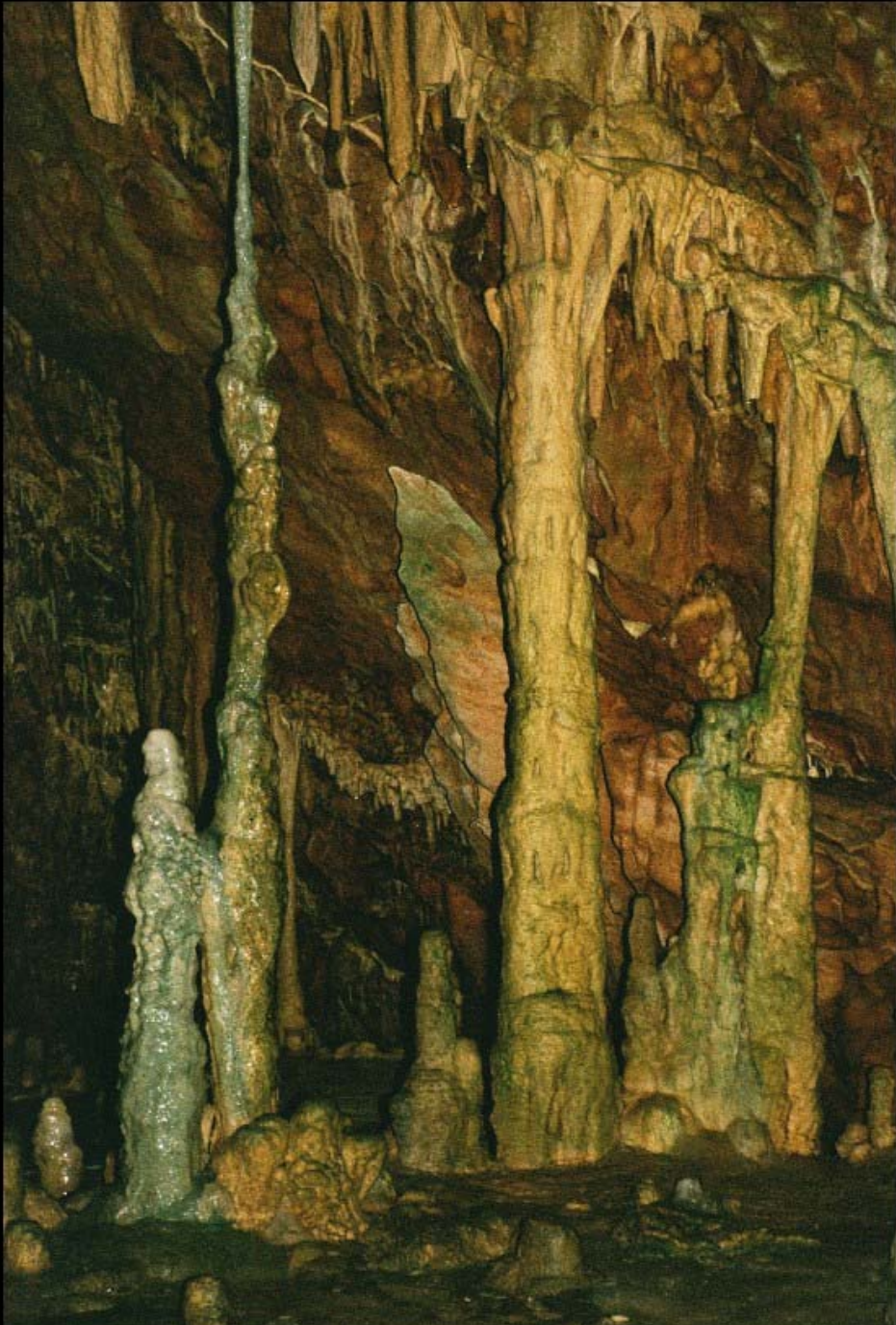


**Karst landscapes**





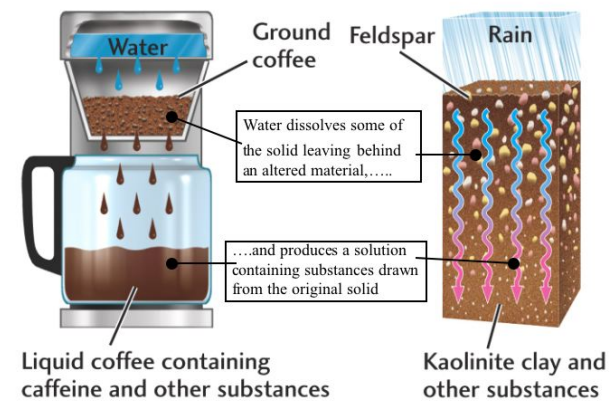
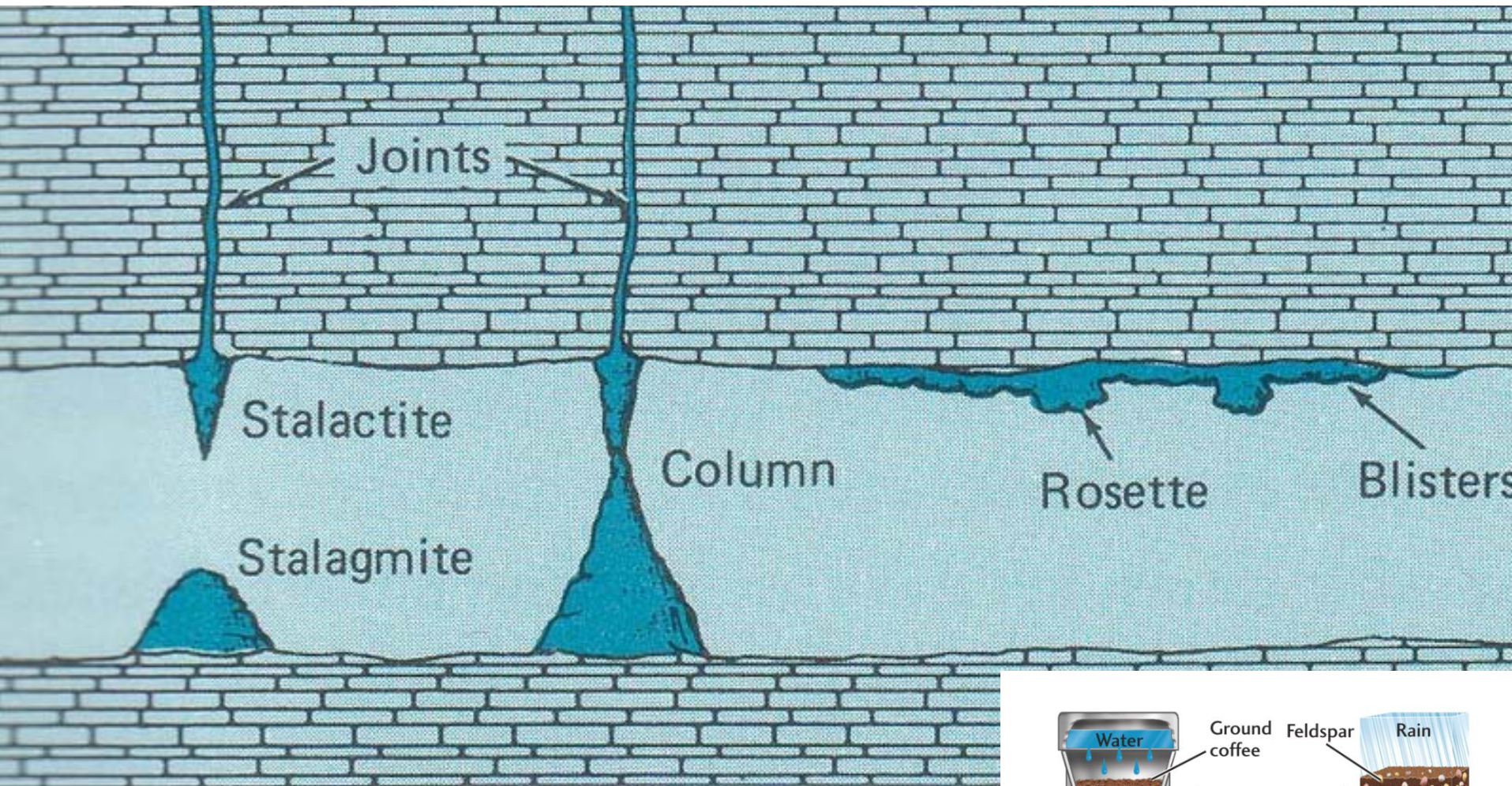
**Karst cave**





**Karst cave**





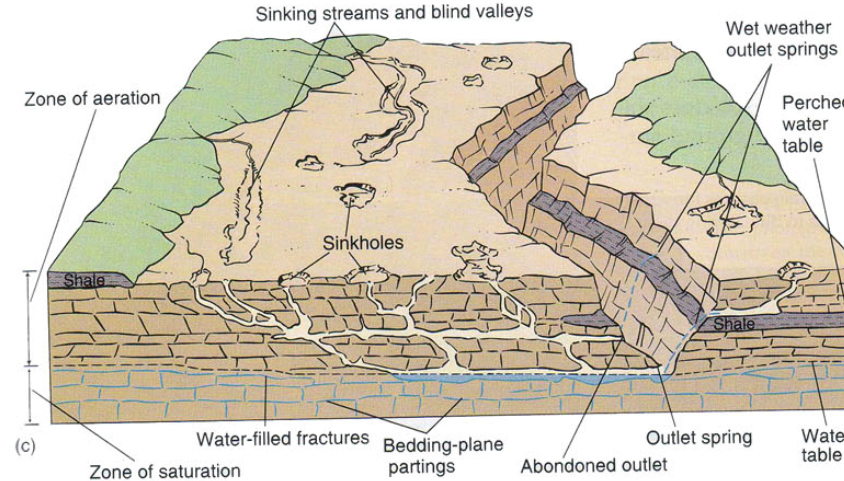
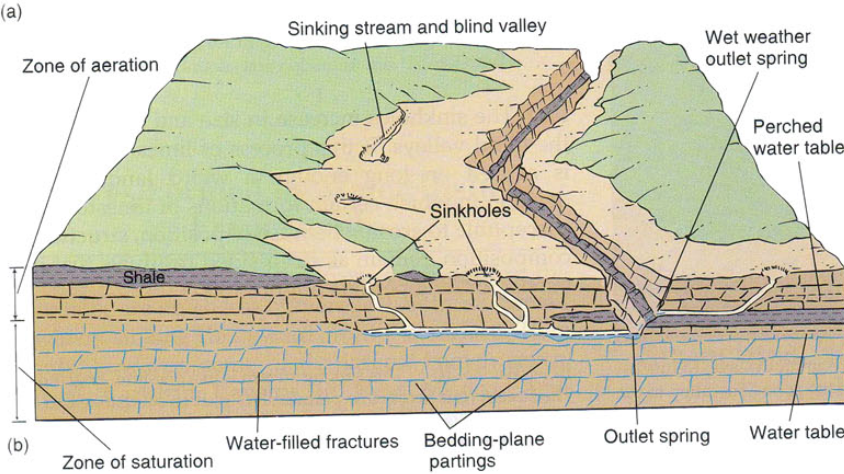
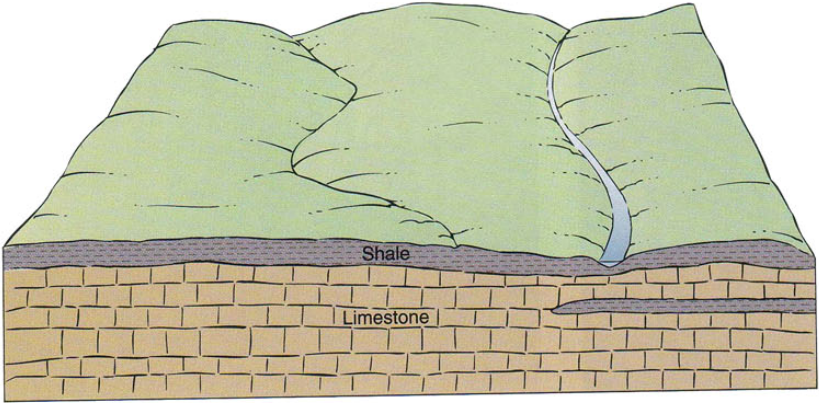




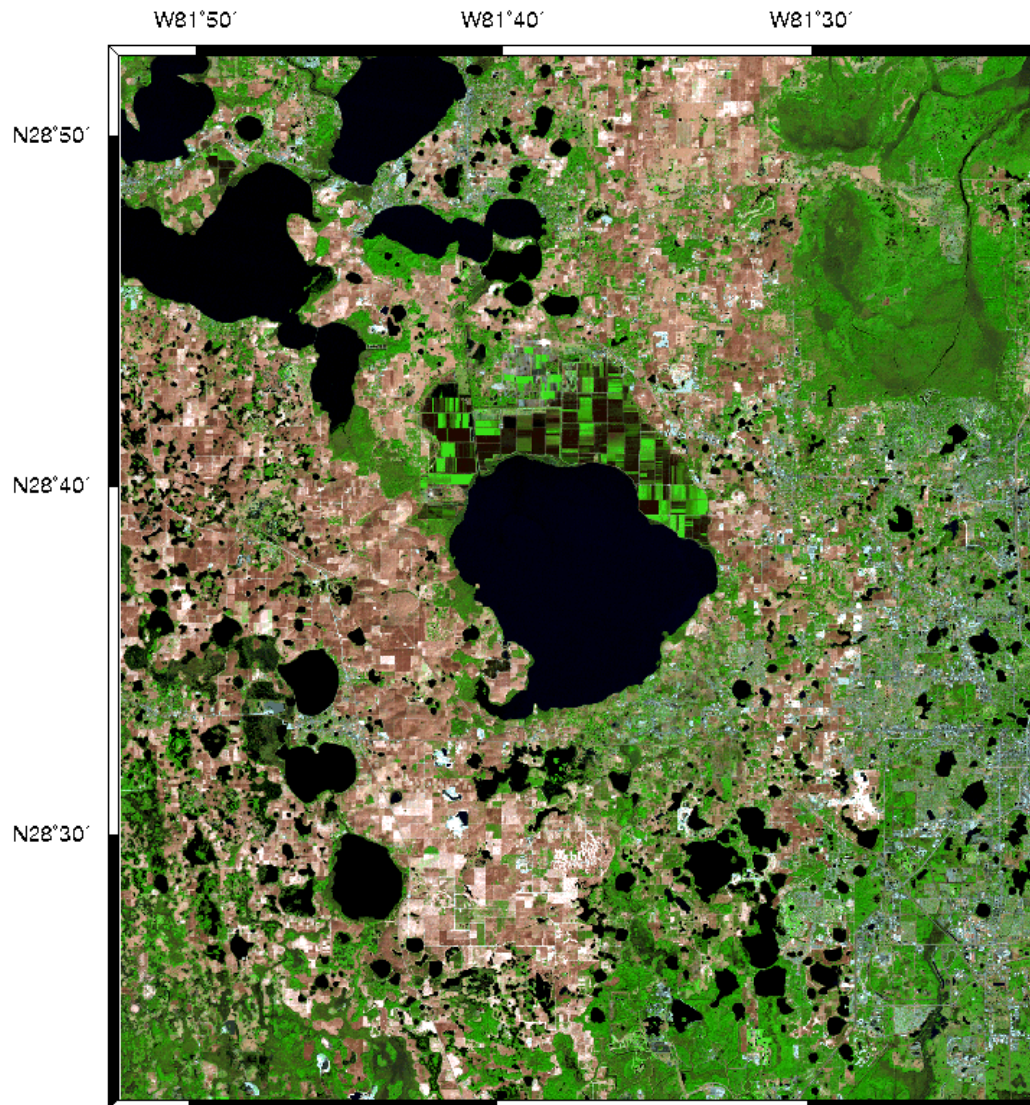


**Karst sinkholes in Svalbard**

# Karst landscape development

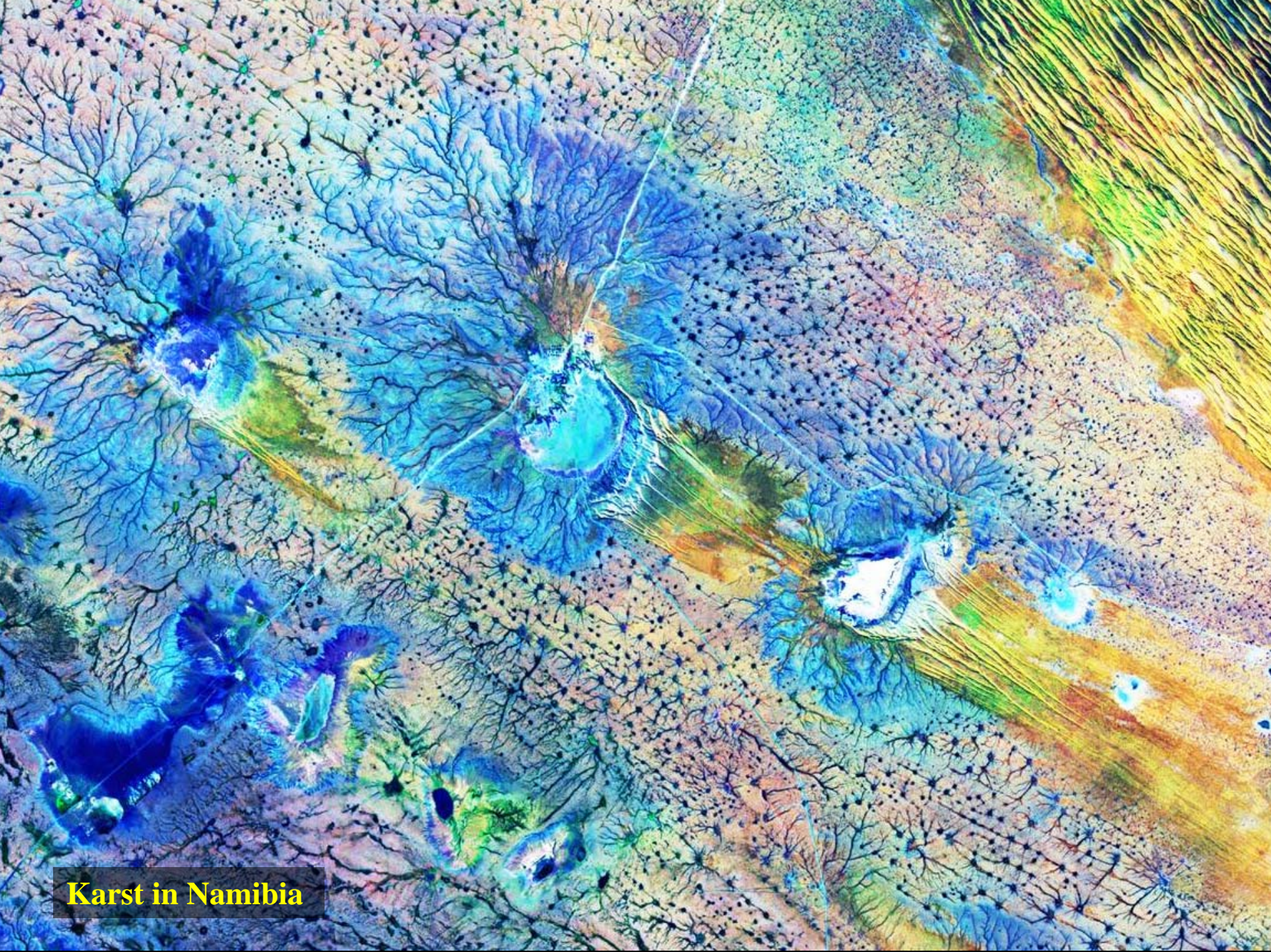


# Central Florida Karst Topography

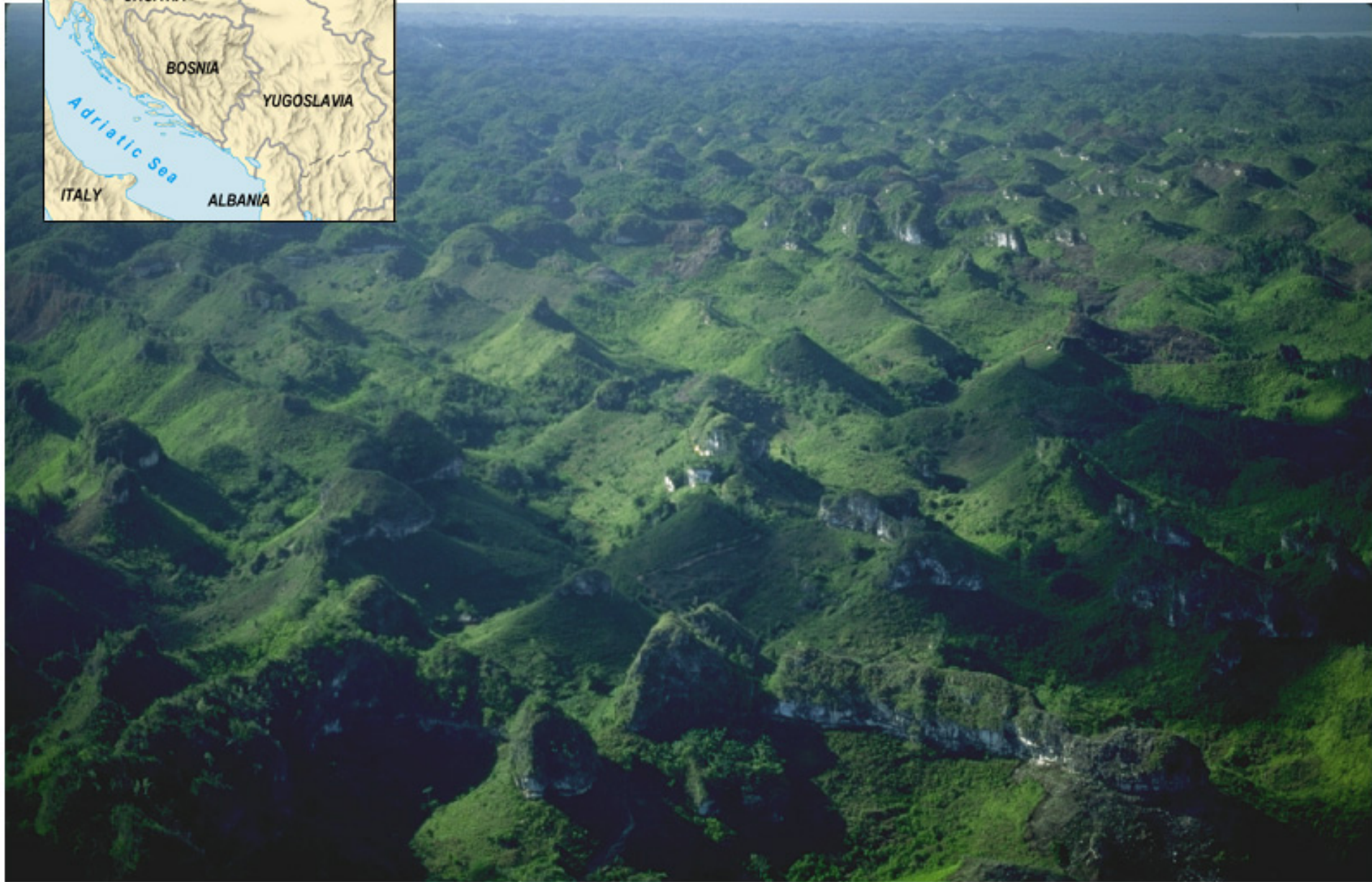


Landsat Thematic Mapper P16 R 40  
Bands 3,4,5

**Sink hole in central Florida**



**Karst in Namibia**

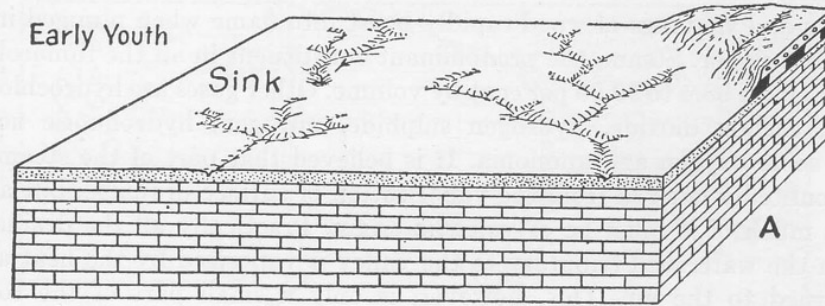


**Karst, Croatia**

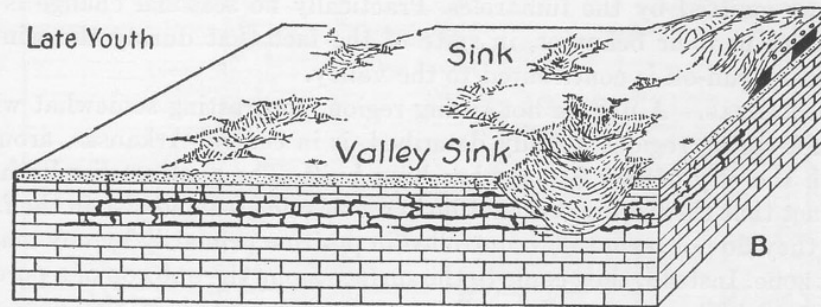


**Karst landscape  
erosional cycle**

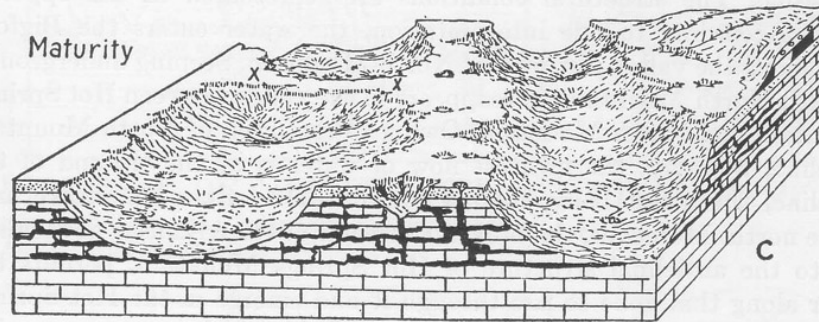
Early Youth



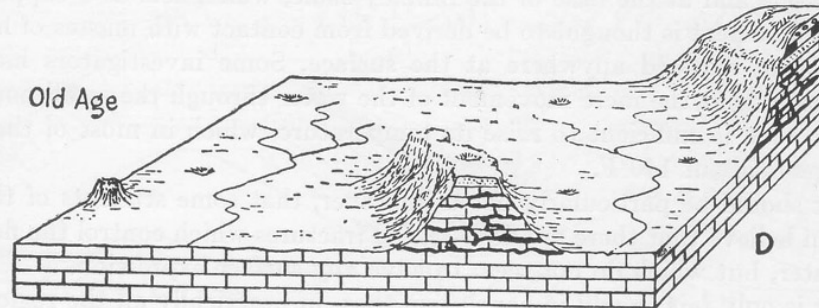
Late Youth

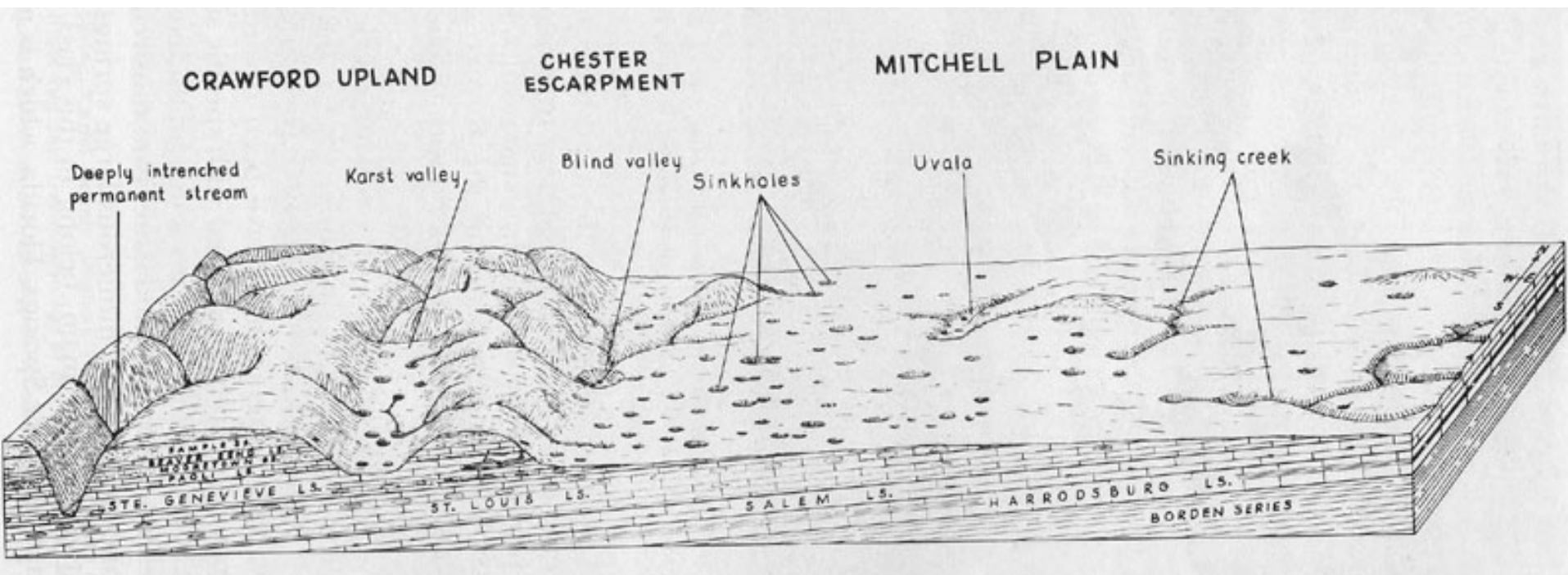


Maturity



Old Age





**Karst landscape features**

