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SPECIALISTS MANAGING THE EARTH

ENGINEERING GEOLOGY & GEOTECHNICAL MODELS

ENGINEERING GEOLOGY

Basalt – Granite Structures -Weathering

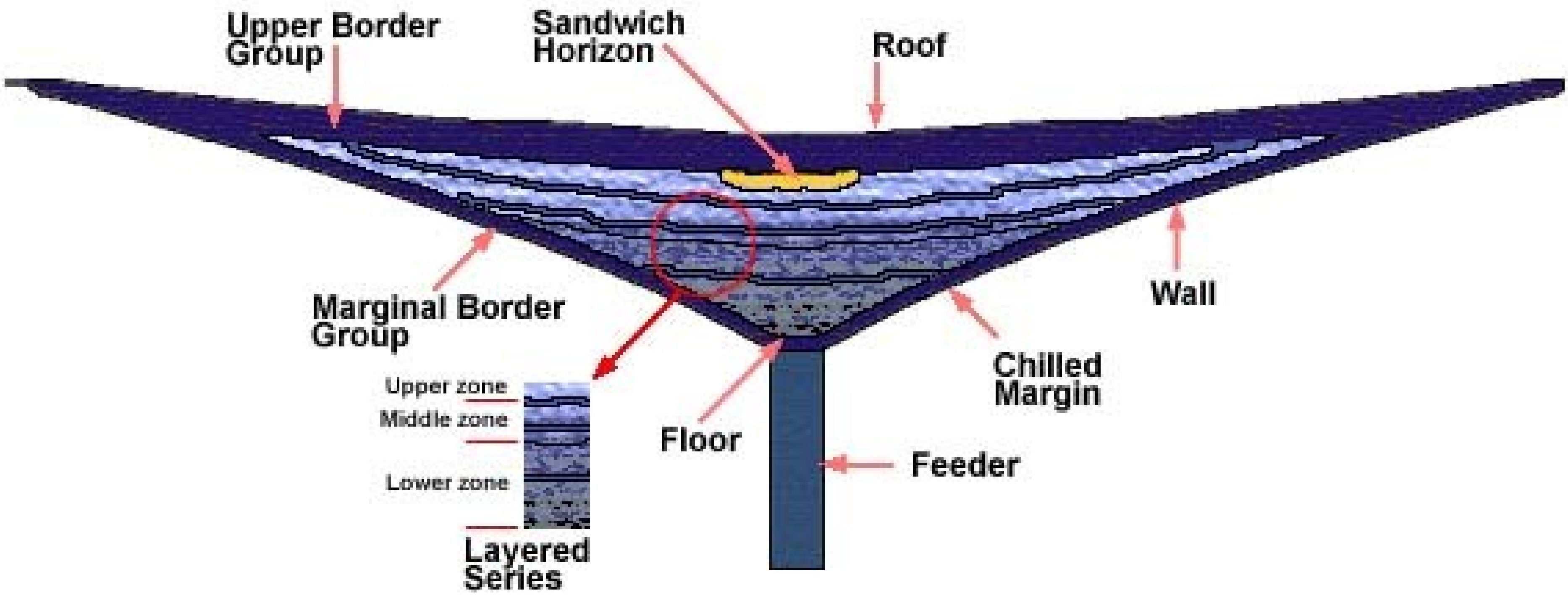
Columnar Jointing

Forms of igneous intrusions

- **pegmatites** – coarse grained intrusions
- **aplites** – fine grained intrusions

Forms of igneous intrusions

- **stratiform complexes –** layered
- **flow bedding –** segregation of layersid
- **lopolith and cone sill –** mineral deposits



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Classification of plutonic rocks Fig 6.6

- **Few common minerals** – their abundance is the basis for classification
- **Basic or Mafic rocks –** contain minerals with a high melting point and silica content of ca 43 – 50%
- **Acidic or Felsic rocks –** contain minerals with low melting point and silica content of 65 – 72%
- **Intermediate –** have silica contents of 50 to 65%

Texture	Felsic (light color)	Intermediate	Mafic (dark color)	Ultramafic
Coarse	Granite	Diorite	Gabbro	Peridotite
Fine	Rhyolite	Andesite	Basalt	
Vesi-cular	Pumice		Scoria	
Glassy	Obsidian			
Minerals Present	QUARTZ K-FELDSPAR NA-PLAG	NA-CA PLAG AMPHIBOLE	CA PLAG PYROXENE	PYROXENE OLIVINE

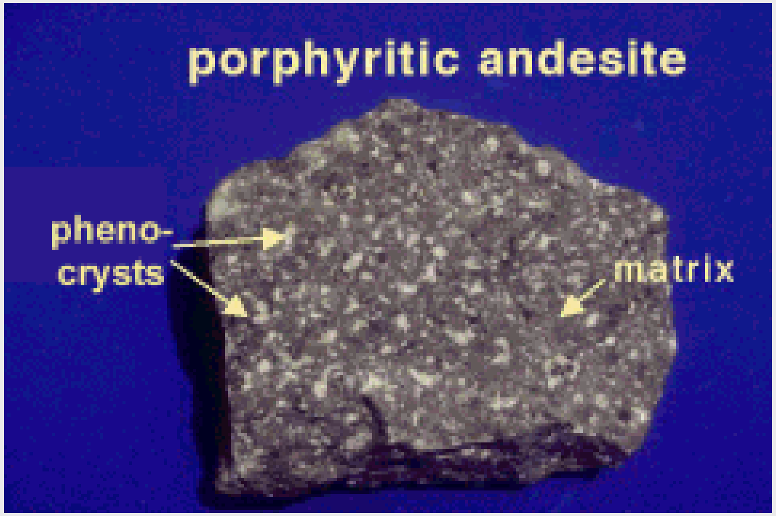
Texture

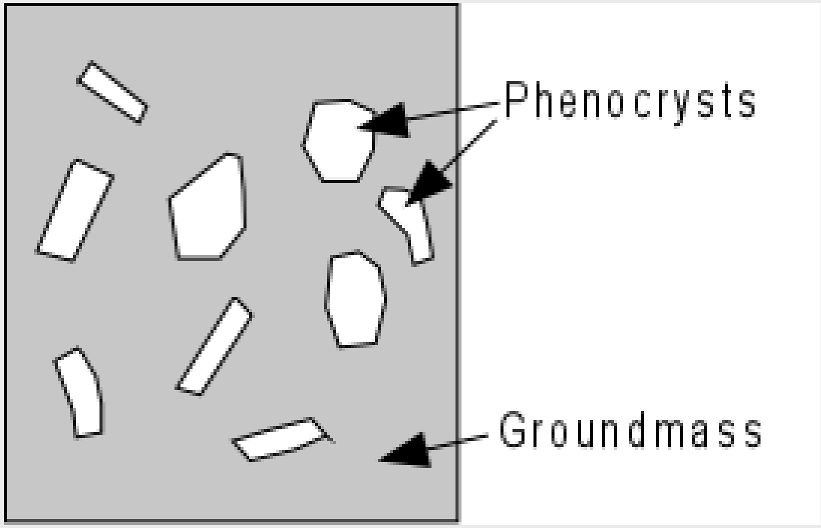
Textures – normal slow cooling produces sand size interlocking crystalline grains

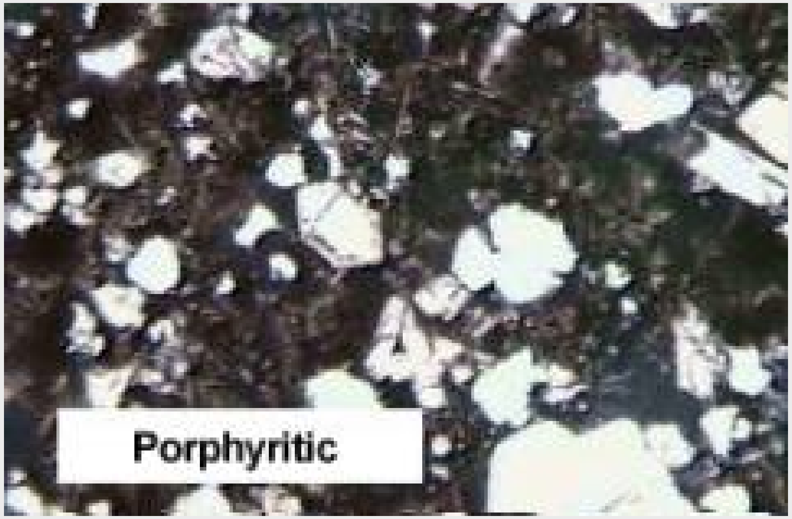
- **Phenocrysts –** coarser grains
- **Porphyry –** contains numerous coarse grains in an otherwise fine grained mass
- **Coarse crystalline –** grains > 2mm
- **Medium crystalline –** grains 0.06-2mm
- **Fine crystalline –** grains < 0.06 mm
- **Aphanitic –** crystals not visible
- **Phaneritic** –visible grains

Texture

- **Phenocrysts –** coarser grains
- **Porphyry –** contains numerous coarse grains (phenocrysts) in an otherwise fine grained mass







Jointing In Granitic Rocks

- arise from general crustal strain, cooling, and unloading

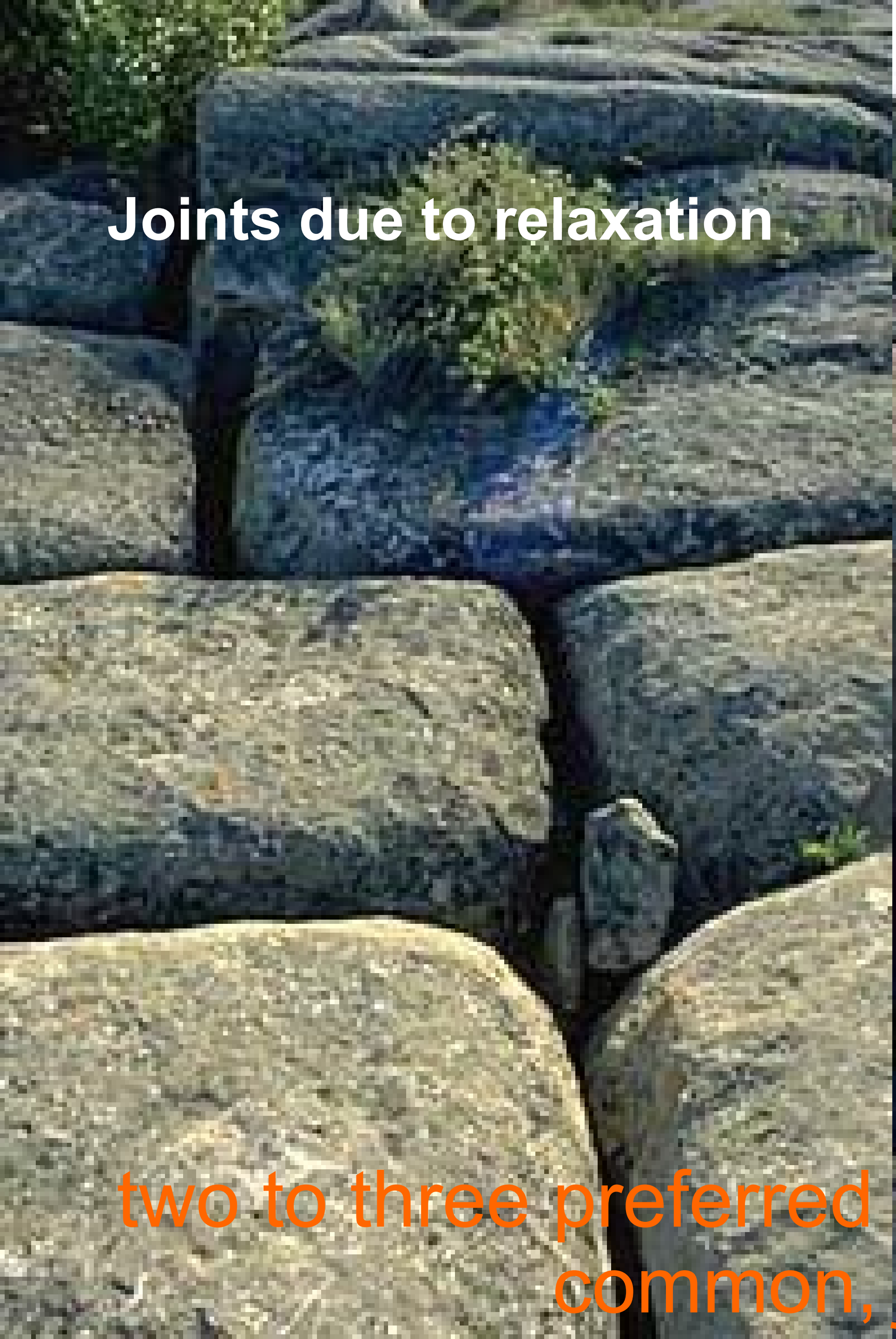
Sheet joints

- typical for igneous rocks, called also exfoliation joints or lift joint
- no sheet joints below 60 m
- Sheet joints conform to the topography,
- slopes steeper than the angle of friction, ca 35 degrees, tensile fractures develop sheet jointing is well developed in igneous rocks, but not exclusive, it also occurs in soils and other rocks to some extent

Sheet weathering due to unconfinement

- Formed –
  - 900 degree C
  - 50 km depth
- Uplift to earth surface
- Enormous decrease in confining pressure

Joints due to relaxation



two to three preferred directions of joints is common, *joint set*

Question

- Sheet jointing more prominent in igneous rocks than other rocks due to unloading.
- Igneous rocks are formed at up to 50 km depth. With 27Mpa/Km times 50 km = 1350 MPa pressure at the time of formation;
- Upon uplift this pressure is reduced and the rocks relax, with a vertical unload stress of 27 MPa.

Unloading

unloading in tunnels – different names for different rocks – for igneous rocks it is called:

- **Popping rock -** is a term used in underground operations where the rock pops off the rock face. This can be very violent and is due to the unloading due to the underground excavation

Weathering in Plutonic Rocks

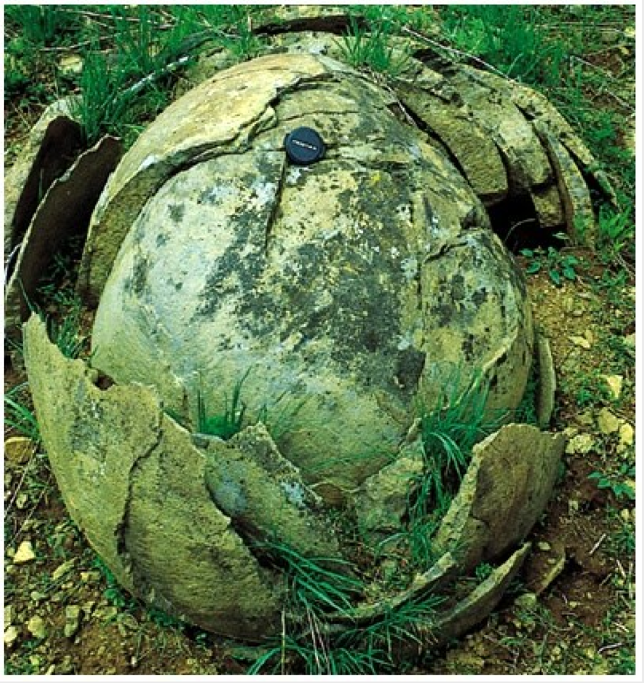
- **physical weathering –** mechanical breakdown of earth material at the earth surface. Ex. Heating/cooling, wetting/drying, plants and animals including man.
- **chemical weathering –** chemical decomposition due to a chemical reaction changing the composition of the earth material, ex carbonic acid replacing silicate minerals, feldspar changing to kaolin, mica changing to limonite and kaolin.

Weathering Profiles

- form relative rapidly in granitic rocks
- a layer of clay minerals forms at the surface
- by the continuous downward percolation of water and carbon dioxide
- in the vadose zone above the water table

Spheroidal weathering

- common in jointed igneous rocks where the
- percolation of water is concentrated to the joints
- the fresh rock delineated by the fractures is slowly effected but
- the corners are more rapidly effected thus spherical shapes are formed



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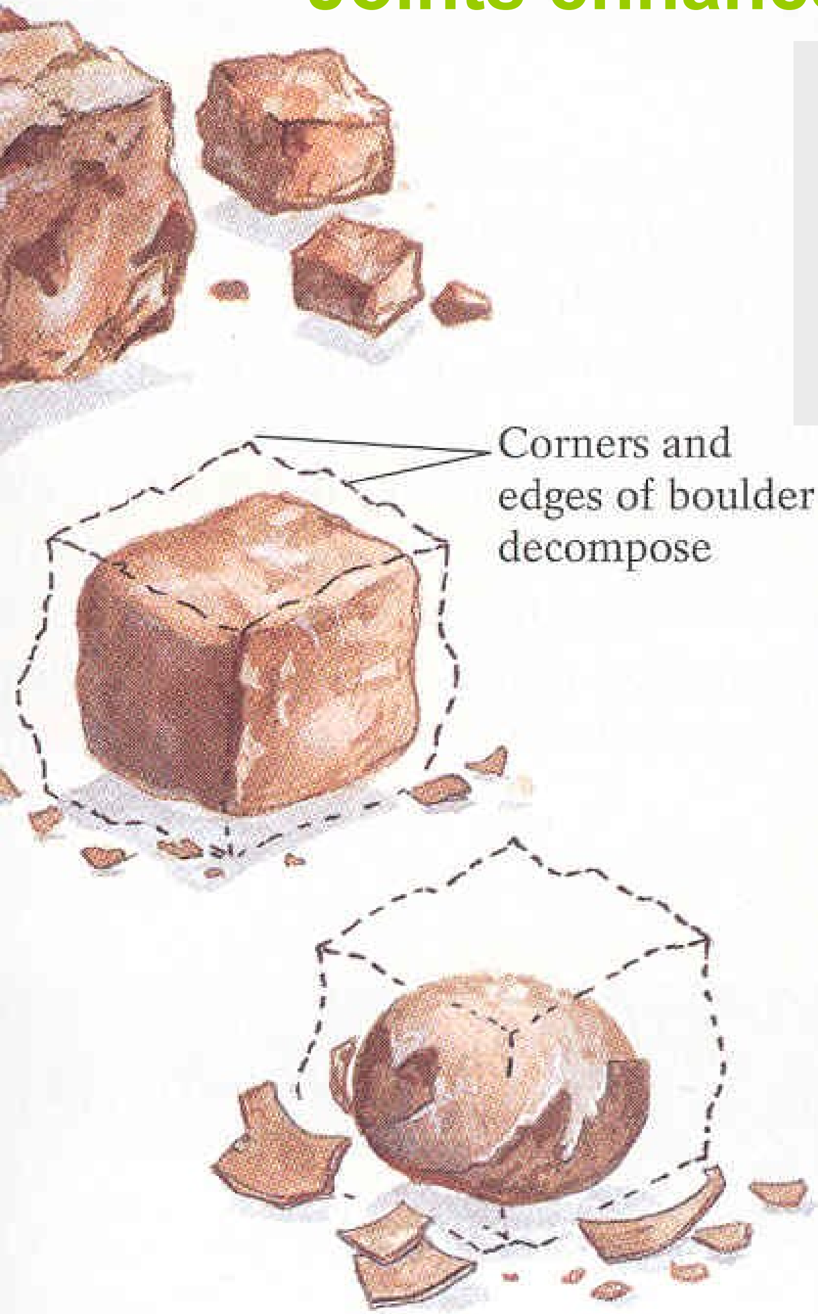
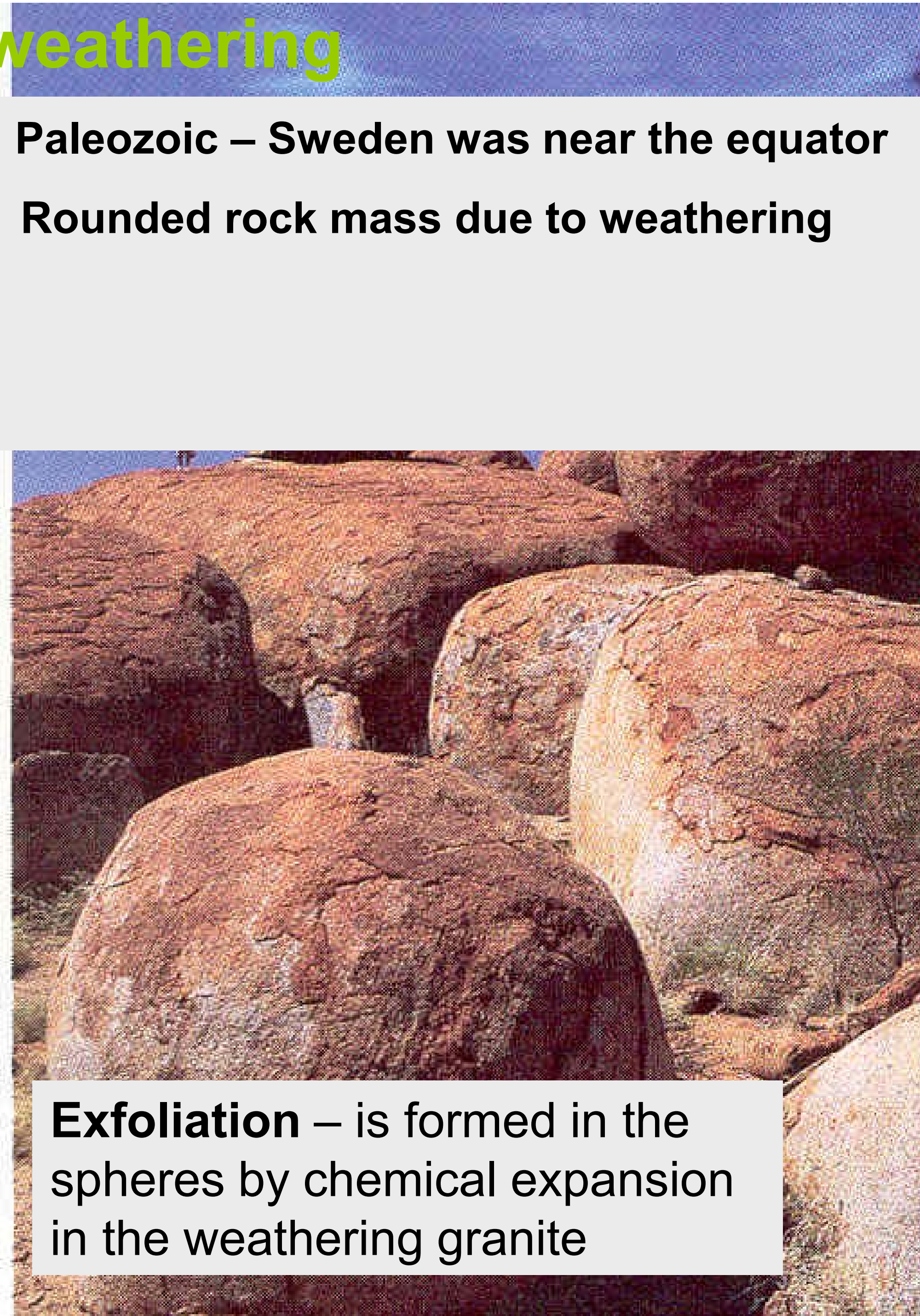
Joints enhance weathering



Paleozoic – Sweden was near the equator

Rounded rock mass due to weathering



Exfoliation – is formed in the spheres by chemical expansion in the weathering granite

- Rounded blocks due to chemical weathering
- Open joints

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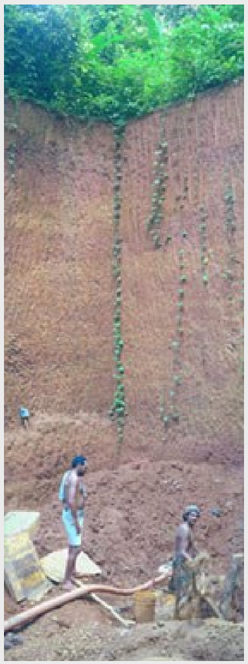
Saprolite

- decomposed granite, residual material formed from weathering resulting in a **residual soil**



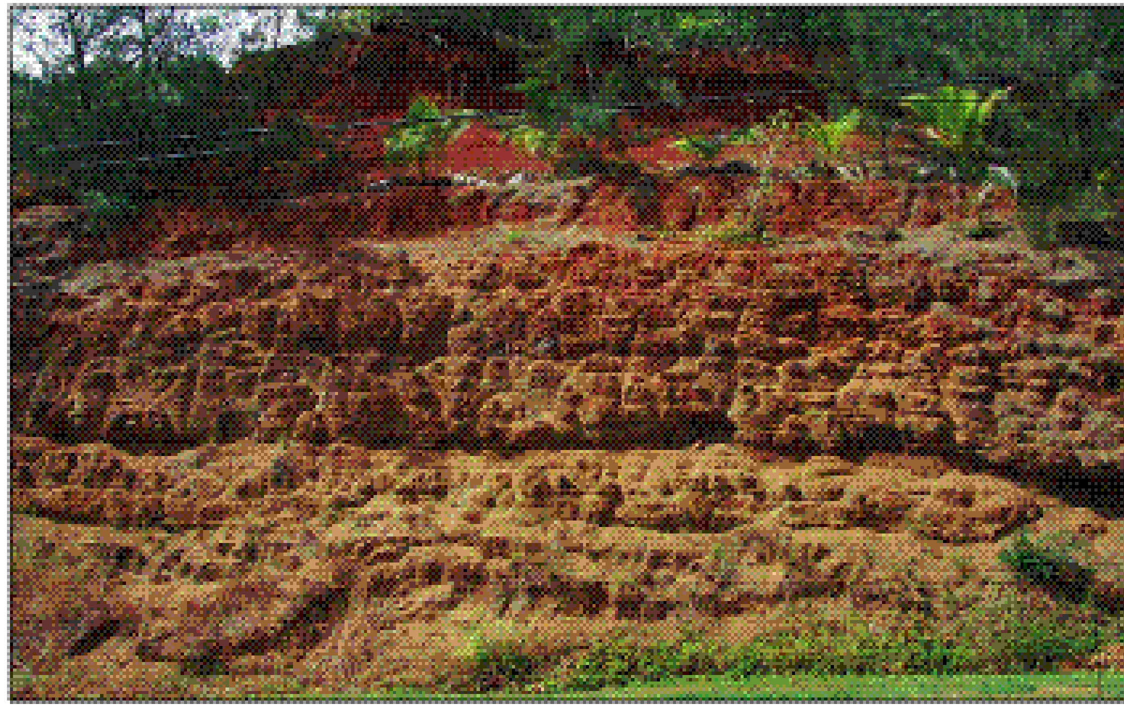


Figure 52. The humid, subtropical climate of Hawaii fosters intense weathering of rock into saprolite that retains the textural features of the original rock. Saprolite can be as much as 300 feet thick in areas that receive the highest rainfall. The sequence of saprolite shown is about 15 feet thick.

Classes of weathering of igneous rocks

- Several different classification systems
- Different authors

All Contain Several Classes

in this case 6 classes

I – fresh (f)

II – slightly weathered (sw)

III – moderately weathered (mw)

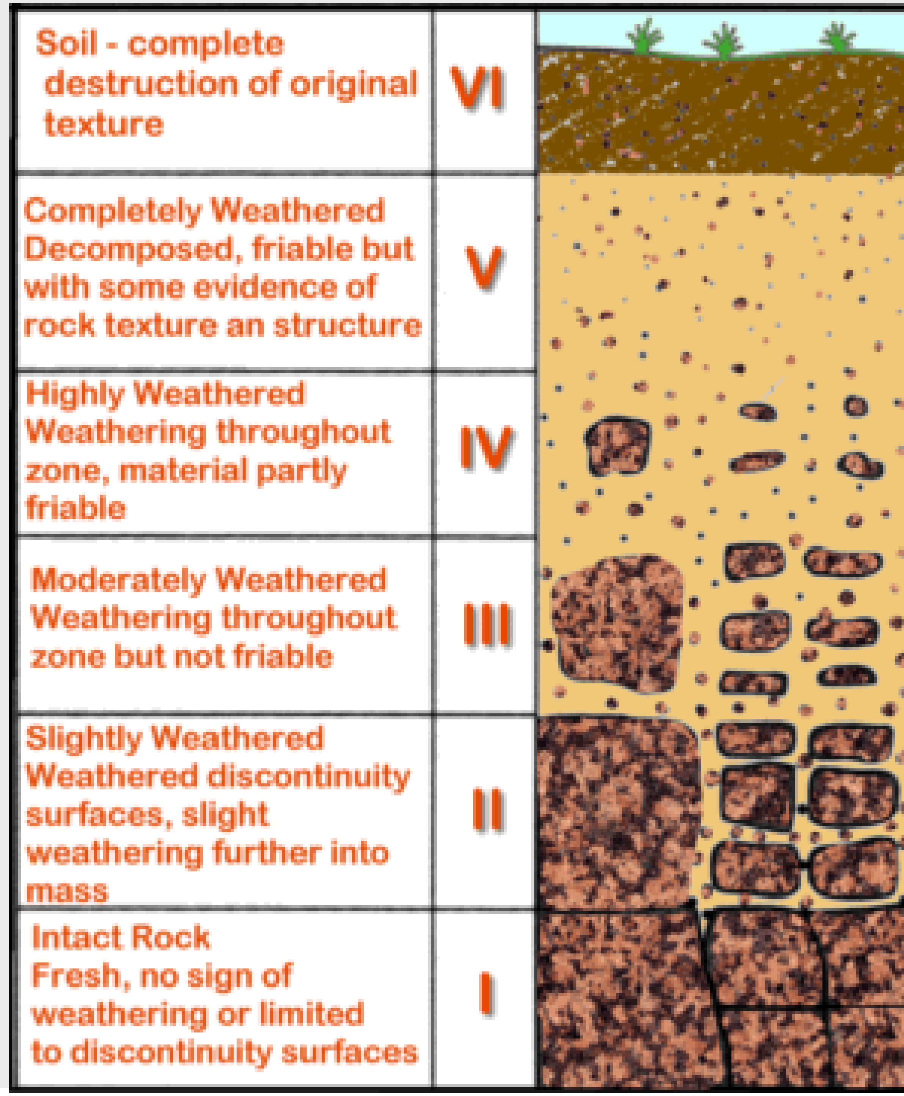
IV – highly weathered (hw)

V – completely weathered (cw)

VI – residual soil (rs)

Hong Kong – zones of weathering p. 225, zones A (residual soil), B, C, D and Fresh rock

Profile development in Hong Kong – figures 6.18 1-4, 6.19 a-f!



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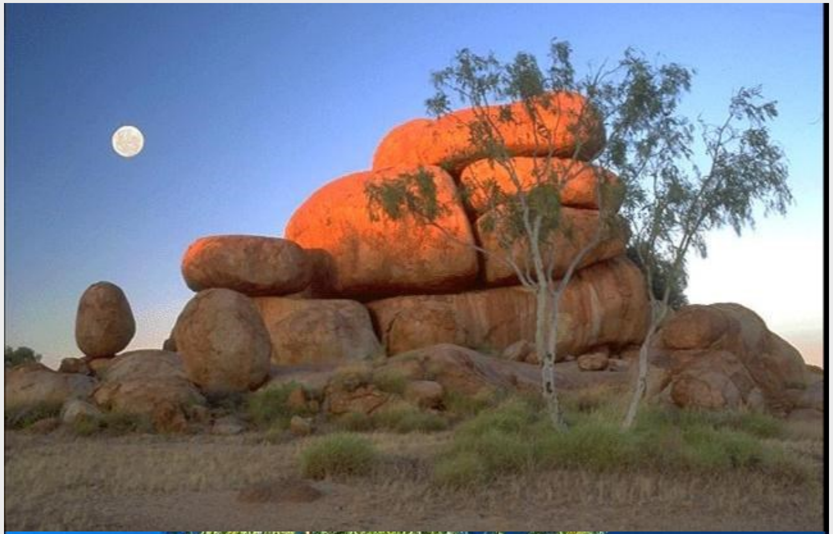
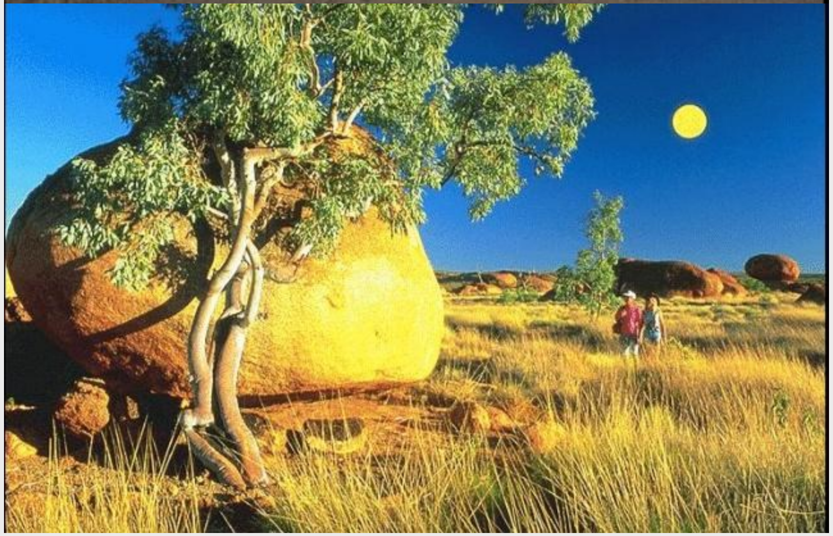

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Chemically Weathered Granite

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