

Types of rocks (depending on how they are formed)

1. Igneous
2. Sedimentary
3. Metamorphic

Igneous rocks

Formed by the cooling & solidification of very hot, molten material called magma or lava, which originates deep inside the Earth.

The word ‘igneous’ comes from the Latin word ‘ignis,’ which means ‘of fire.’



Modern lava flows,
Hawaii





Barren Island

India's only active volcano



Ancient lava flows, Deccan Trap, Maharashtra, 65 Ma

3300 Ma old granite (coarse-grained, light coloured igneous rock), Orissa



Sedimentary rocks

Formed by the deposition of fragments (sediment) that have been eroded and weathered from earlier rocks.

Consist of sand, pebbles & mud carried mechanically by water, wind or ice.

Deposits in rivers, lakes, beaches, deserts, oceans.



Sand &
sandstone

Metamorphic rocks

Formed by the effect of high pressure, temperature or fluids on an earlier rock (igneous, sedimentary or even earlier metamorphic rock) - no melting.

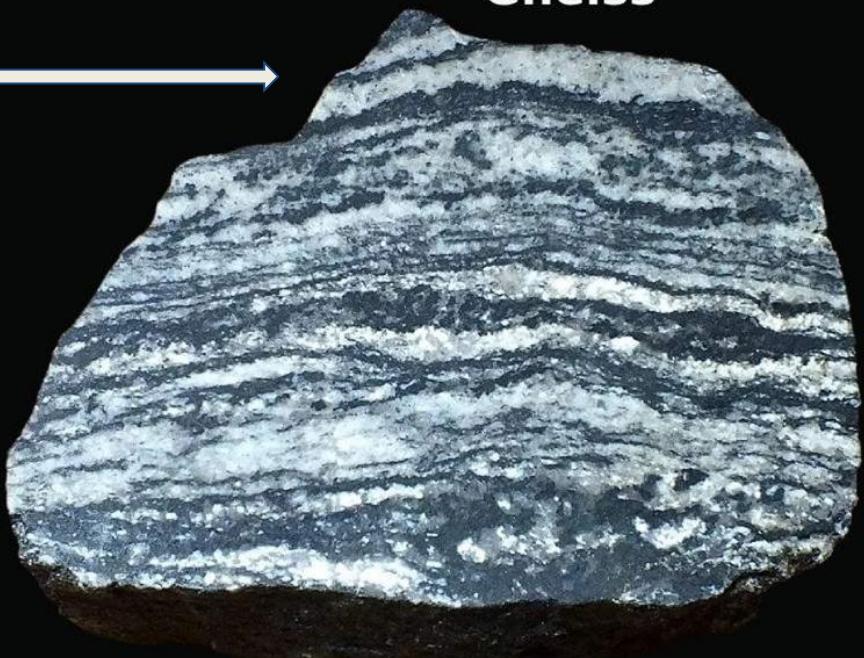
Brings changes in mineralogy, structure and texture of earlier rocks.

Happens due to deep burial, tectonic deformation, igneous intrusion, fluid flow through rocks.

Granite



Gneiss





Limestone



*Recrystallization
(caused by heat)*

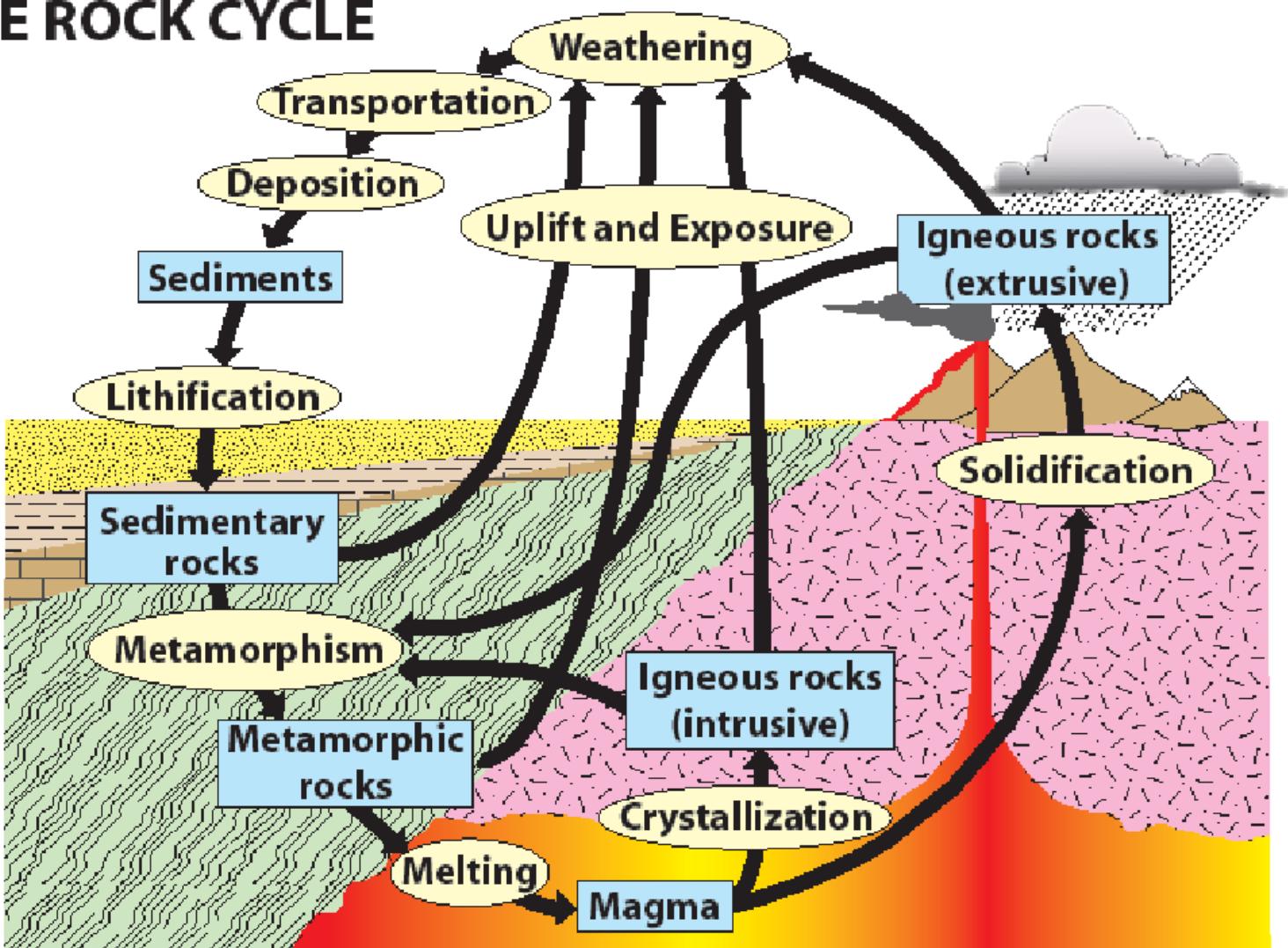


Marble



Makrana marble quarry, Rajasthan

THE ROCK CYCLE



Igneous Rocks -

Rocks that form from the cooling of molten rock (magma). Example: granite and basalt

Sedimentary Rocks -

Rocks that are formed from pieces of other rocks. Example: sandstone, or that are deposited from the ocean by chemical processes. Example: limestone

Metamorphic Rocks -

Rocks that are changed by heat and pressure without melting. Example: gneiss

Igneous rocks formed from Magma and Lava

Magma

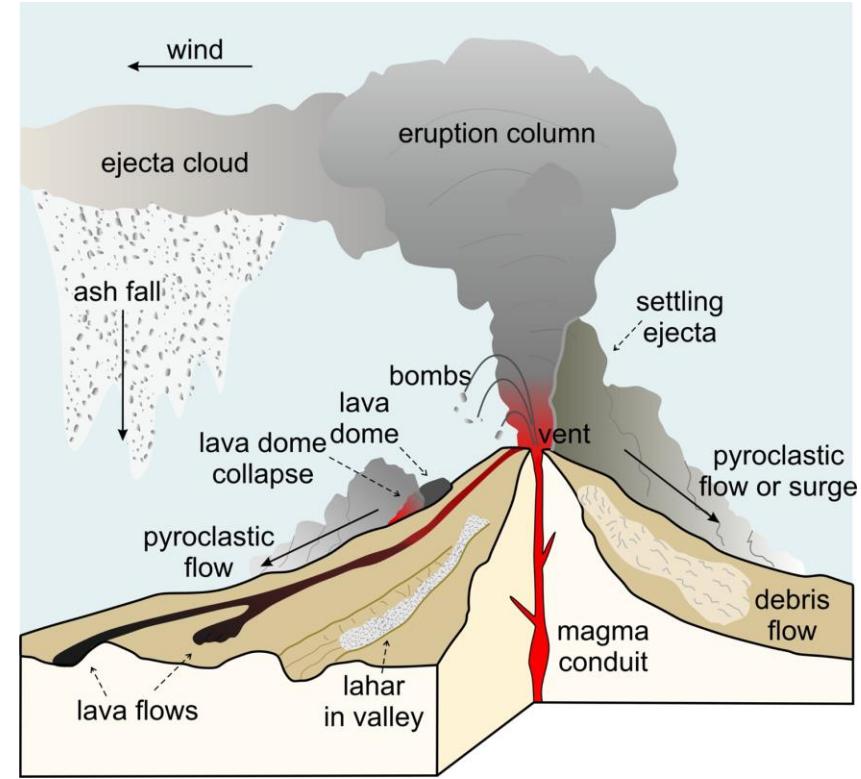
- molten rock below Earth's surface.

Lava

- magma on the Earth's surface.

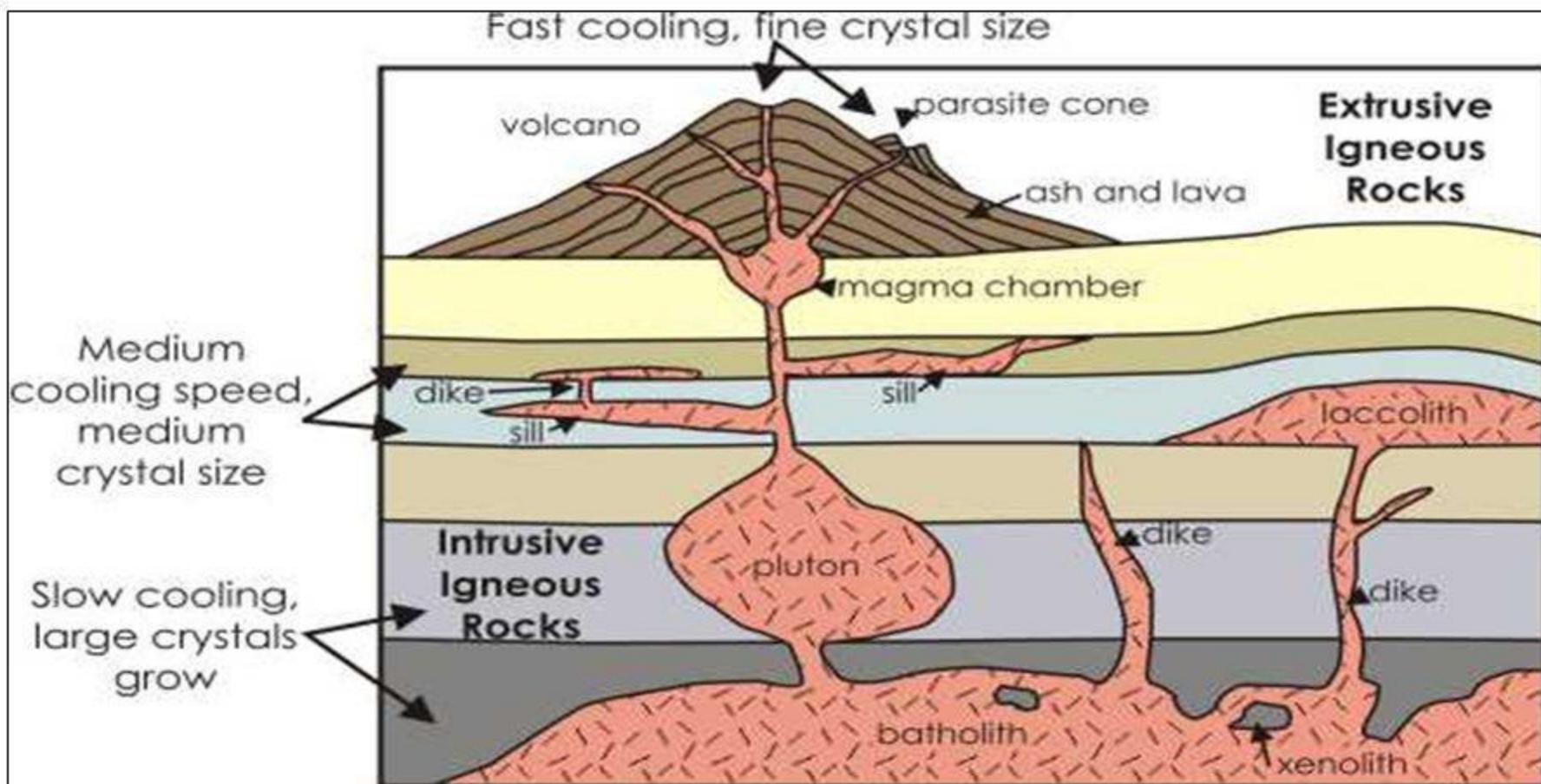
Pyroclastic material

- (*pyro* = fire, *clastic* = debris)
- Airborne lava
 - cools as it falls



Intrusive and Extrusive Igneous Features

1. Intrusive features = parts of volcanic activity found inside the earth



Batholith

A batholith is a large (> 100 sq km across) body of igneous rock formed deep (at >10 Km depth) within the Earth's crust.

Magma cools slowly - coarse grained.

Extends to an unknown depth.

The exposed Sierra Nevada Batholith, USA.
650 x 100 km



Pluton

A relatively small intrusive body (a few to 10's of km across).

A batholith may be composite and consists of many plutons.



Granite plutons, Ramanagaram, near Bangalore

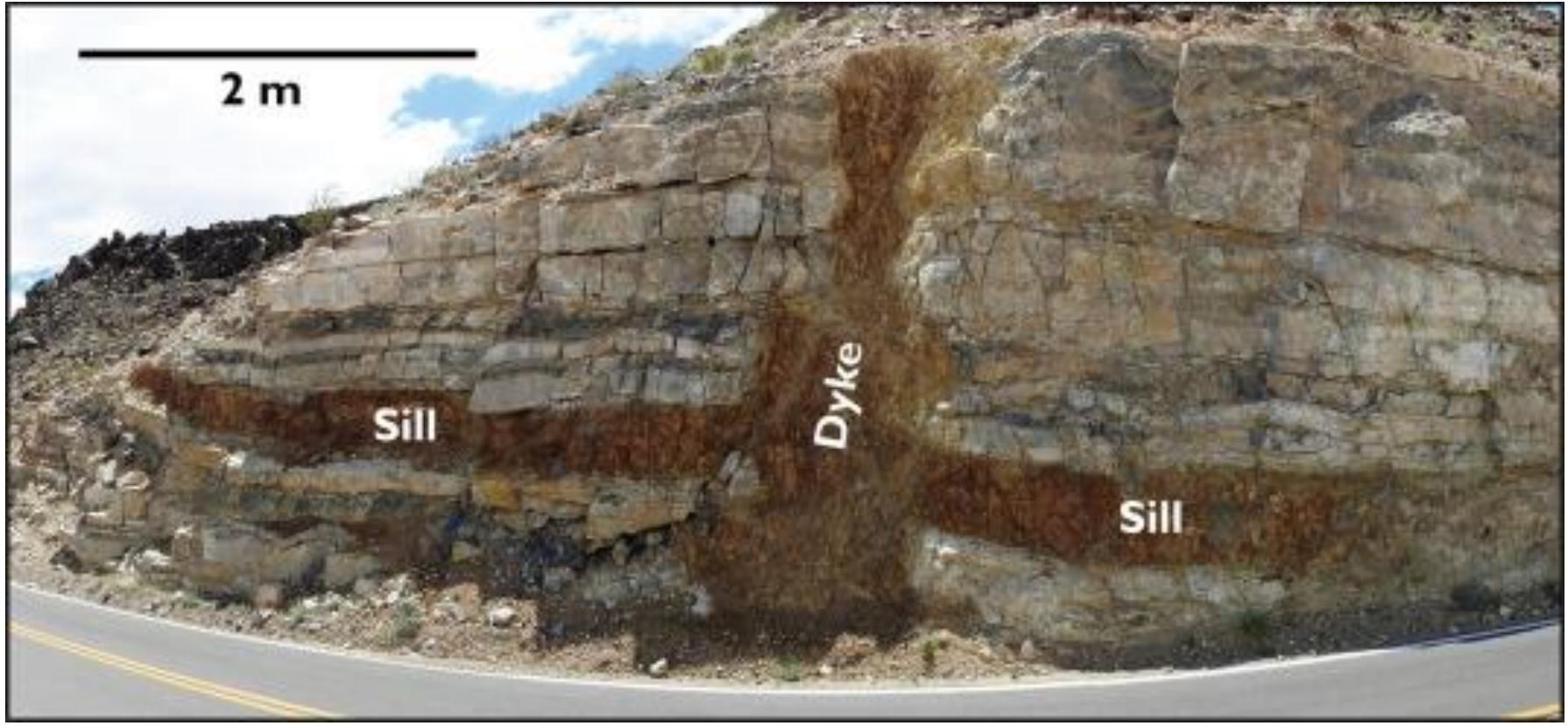
Dike or Dyke

A tabular or sheet-like body of igneous rock that cut through and across the layering of country rocks.





Dykes



A sill is a concordant intrusion that runs parallel to the layers or structure in the country rock.

Magma followed the path of weakness between the layers.



Sill

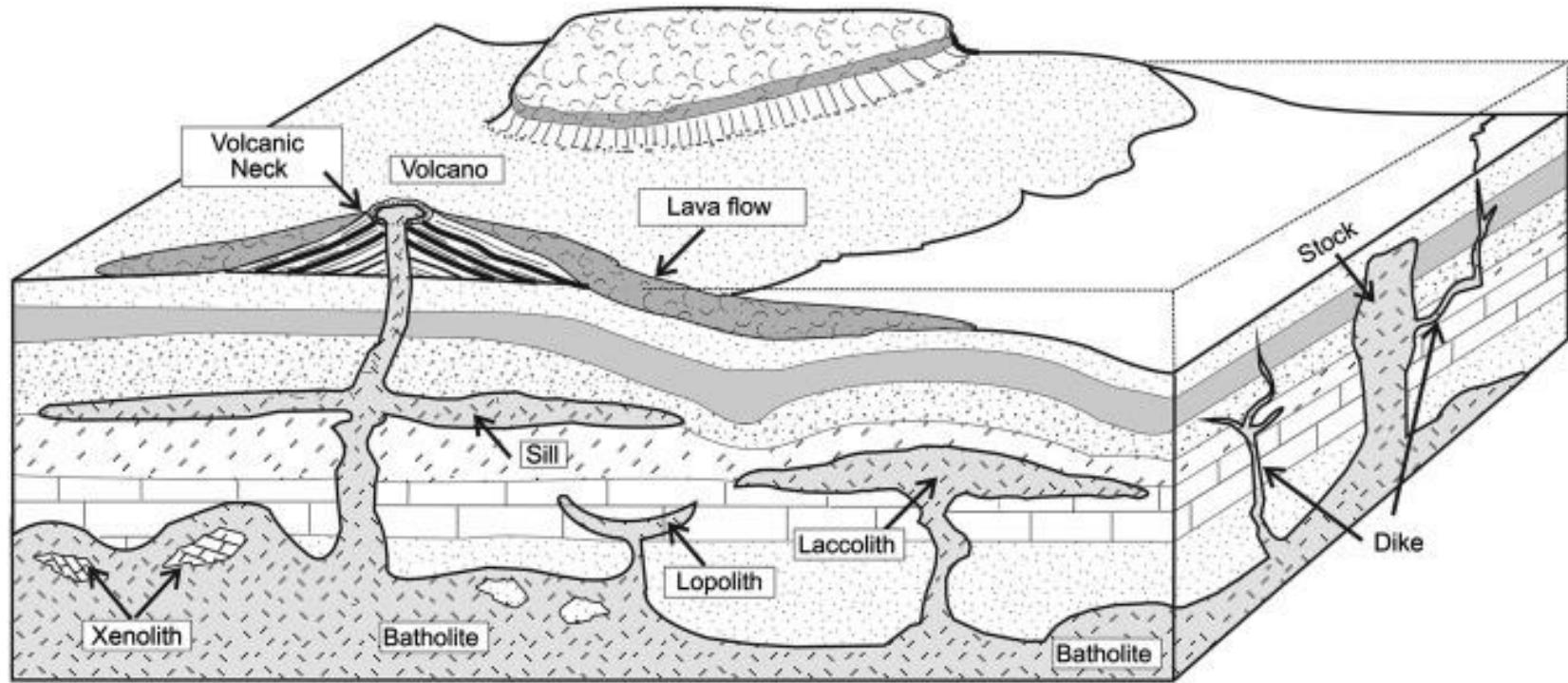
Laccolith

A dome shaped igneous intrusion, convex upper roof, flat base.

Concordant with the stratification or banding in the host rock.

Circular in plan.

Magma pushed upward and also spreads laterally.

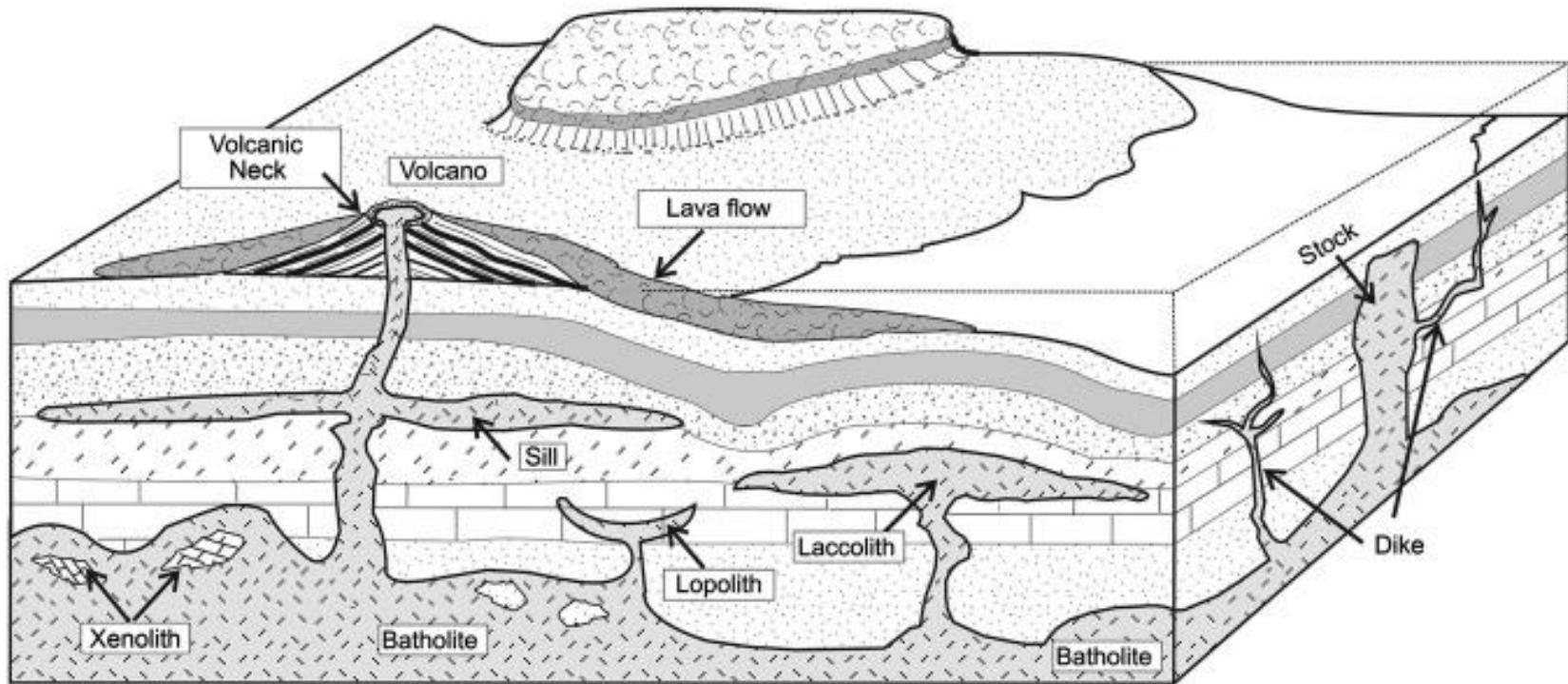




An exposed laccolith

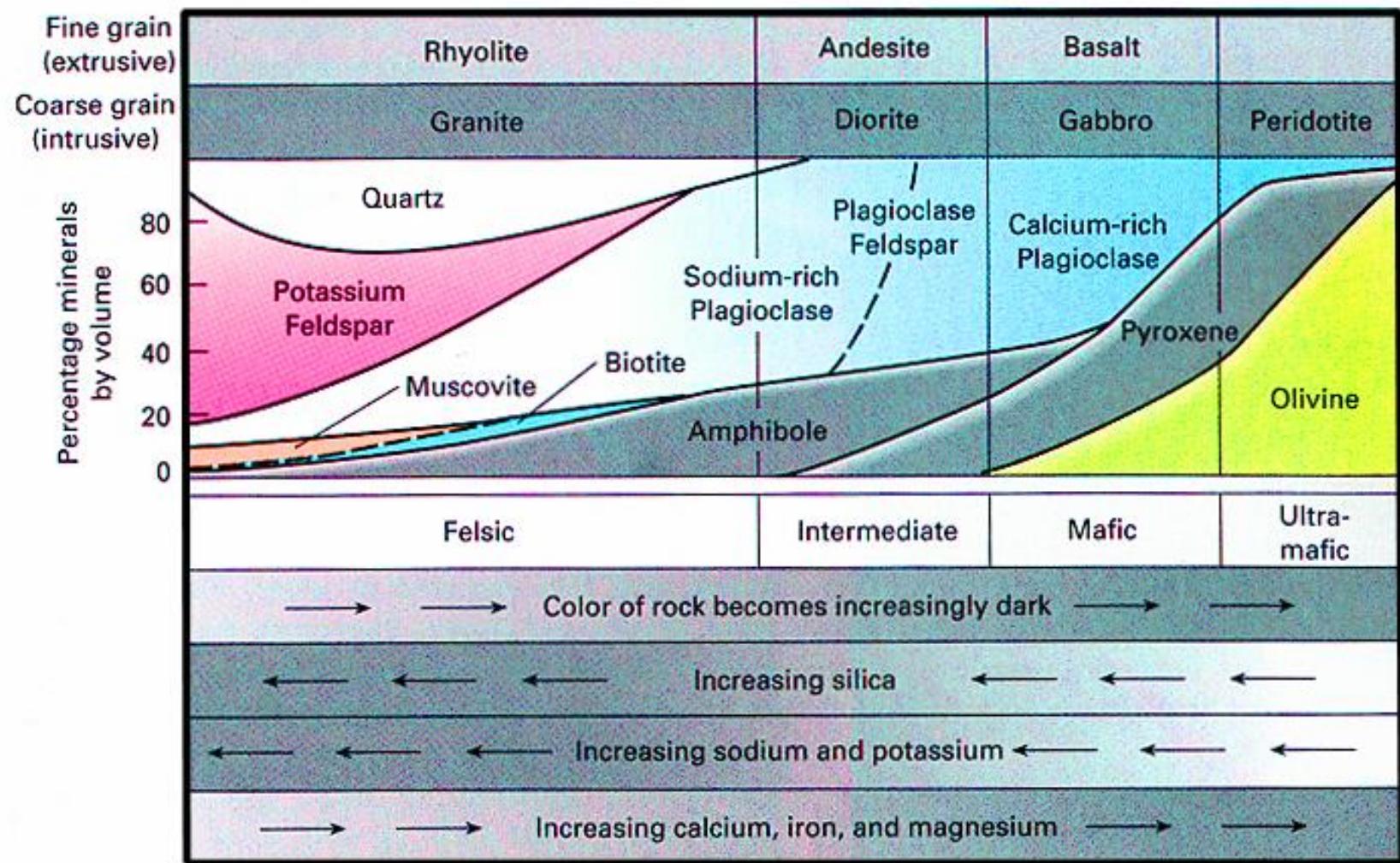
Lopolith

A concordant igneous intrusion of planoconvex or lenticular shape that is sunken in its central part because of sagging of the underlying country rock.

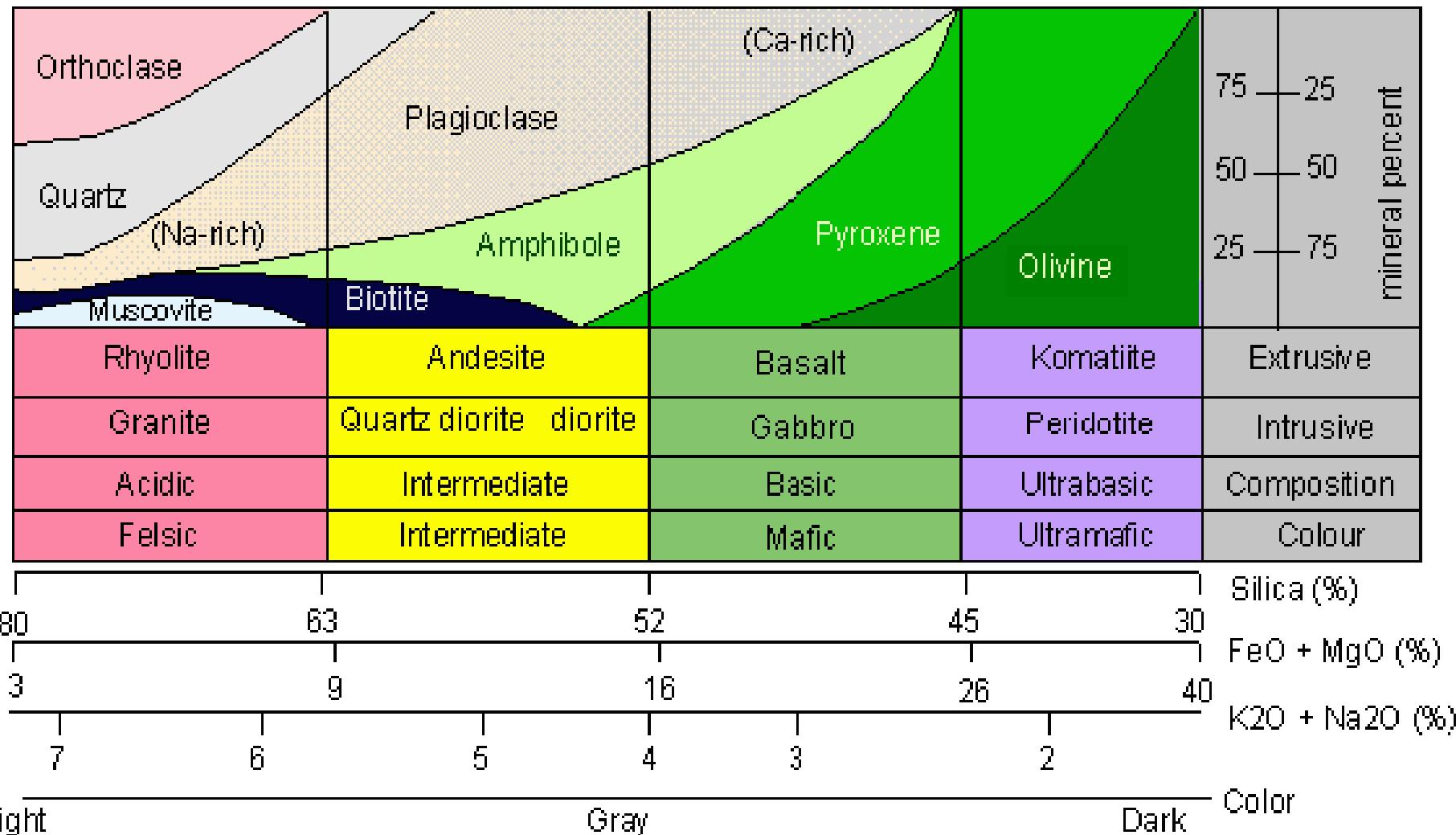


Igneous rock names

- determined by texture
 - size and arrangement of mineral grains
- AND by mineral composition
 - minerals affect rock color and indicate temperature of creation



Classification of Igneous rocks



Texture

The texture of a rock is the size, shape, and arrangement of and the relationships between neighboring grains (for sedimentary rocks) or crystals (for igneous and metamorphic rocks).

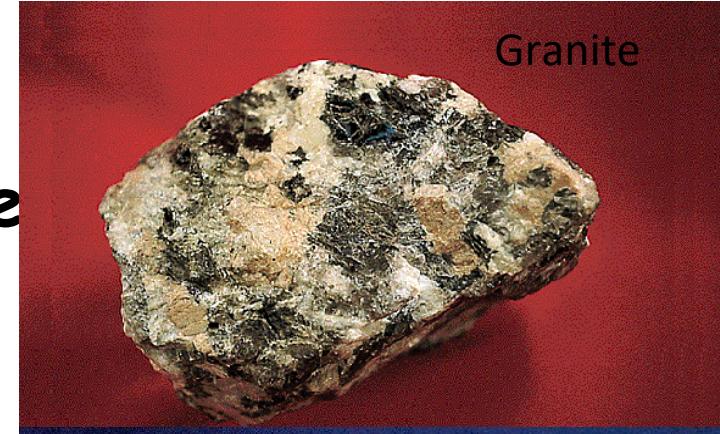
Types of Igneous textures

- Types of igneous textures
 - Aphanitic (fine-grained) texture
 - Rapid rate of cooling of lava or magma
 - Microscopic crystals
 - May contain vesicles (holes from gas bubbles)
 - Phaneritic (coarse-grained) texture
 - Slow cooling
 - Crystals can be identified without a microscope

Categories of Igneous rocks

Intrusive rocks

- cool beneath Earth's surface
- cool very slowly
- higher P & T
 - Phaneritic textures



Granite

Extrusive rocks

- cool on the Earth's Surface
- cool relatively fast
- lower T & P
 - Aphanitic textures
 - Pyroclastic textures



Rhyolite

Complex

- Partially cools below and above
 - Porphyritic textures



Basalt
porphyry



El volcán de La Palma en detalle a 18 de octubre de 2021

Infografía aproximada con objeto divulgativo. La escala no es real.

la palma volcano
18 october 2021

crater 3 send out
column of ashes

crater 1 send out
or release lava,
lava flow and
gasses

Cráter 1
Emite lavas,
coladas y gases

Cráter 3
Emite columna
de cenizas.

crater 2 send
out lava and
piroclastos

Cráter 2
Emite lava y
piroclastos

secondary
mouth???exit.
send out water
steam, gasses
and ashes

Boca secundaria
Emite vapor de agua,
gases y cenizas.

eruptive fissure or
crack

Fisura eruptiva

Aportación de Magma profundo

magma
contribution of
deep magma

200 m

300 m



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Spain: La Palma volcanic eruption intensifies, engulfs more homes

Volcano that began erupting on September 19 has destroyed more than 800 buildings, forced evacuation of about 6,000 people.





La Palma

Texture

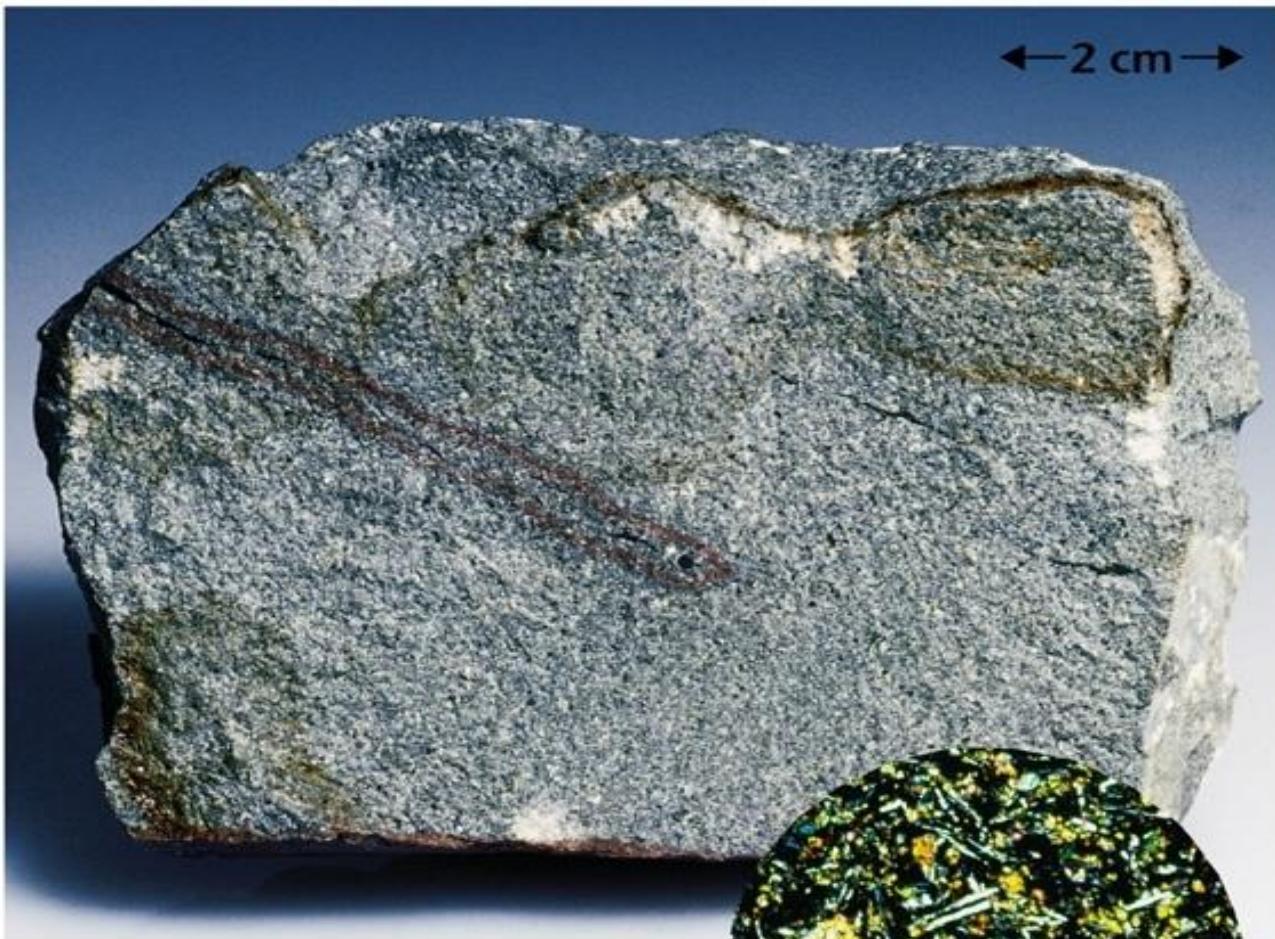
- Igneous minerals vary greatly in grain size.
- Phenocrysts are grains in an igneous rock that are larger than the other grains that make up the rest of the rock.

Grain Size Categories		Grain Size Divisions
fine grained	=	< 1 mm
medium grained	=	1 mm < 5 mm
coarse grained	=	5 mm < 3 cm
very coarse-grained	=	\geq 3 cm

Porphyritic Texture

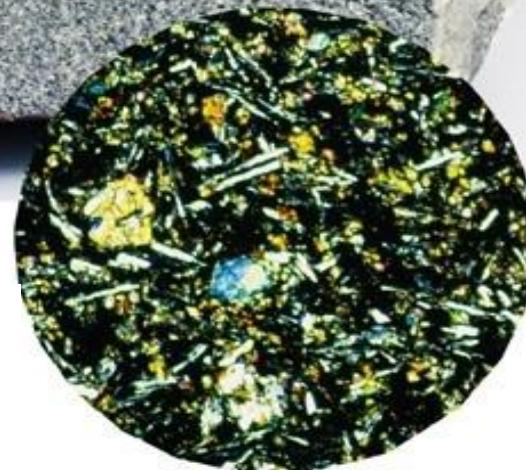
microphenocrysts	=	0.03 mm – 0.3 mm
phenocrysts	=	0.3 mm – 5 mm
megaphenocrysts	=	> 5 mm

Aphanitic texture



A. Aphanitic

Fine grained because it cooled quickly at the surface

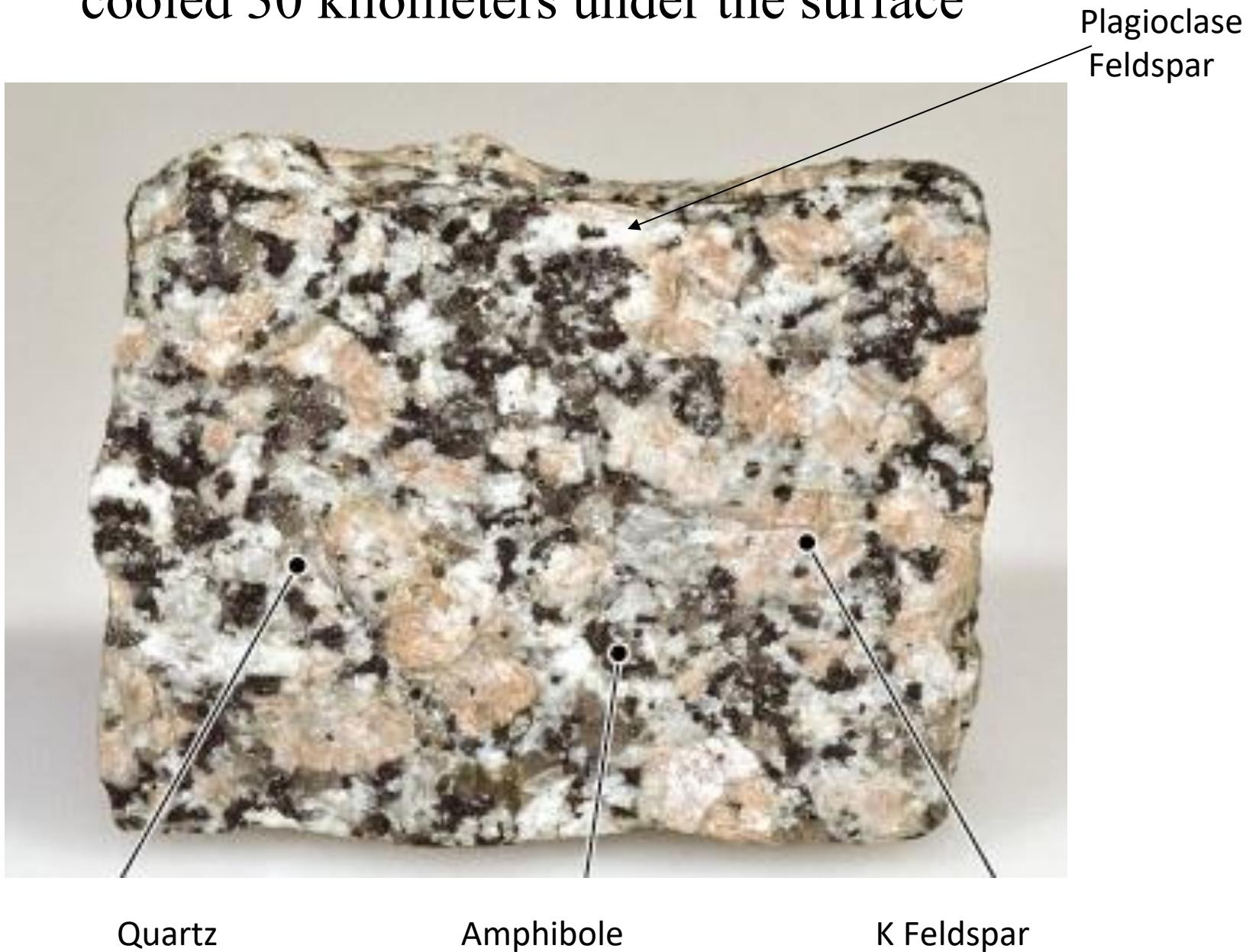


Phaneritic texture



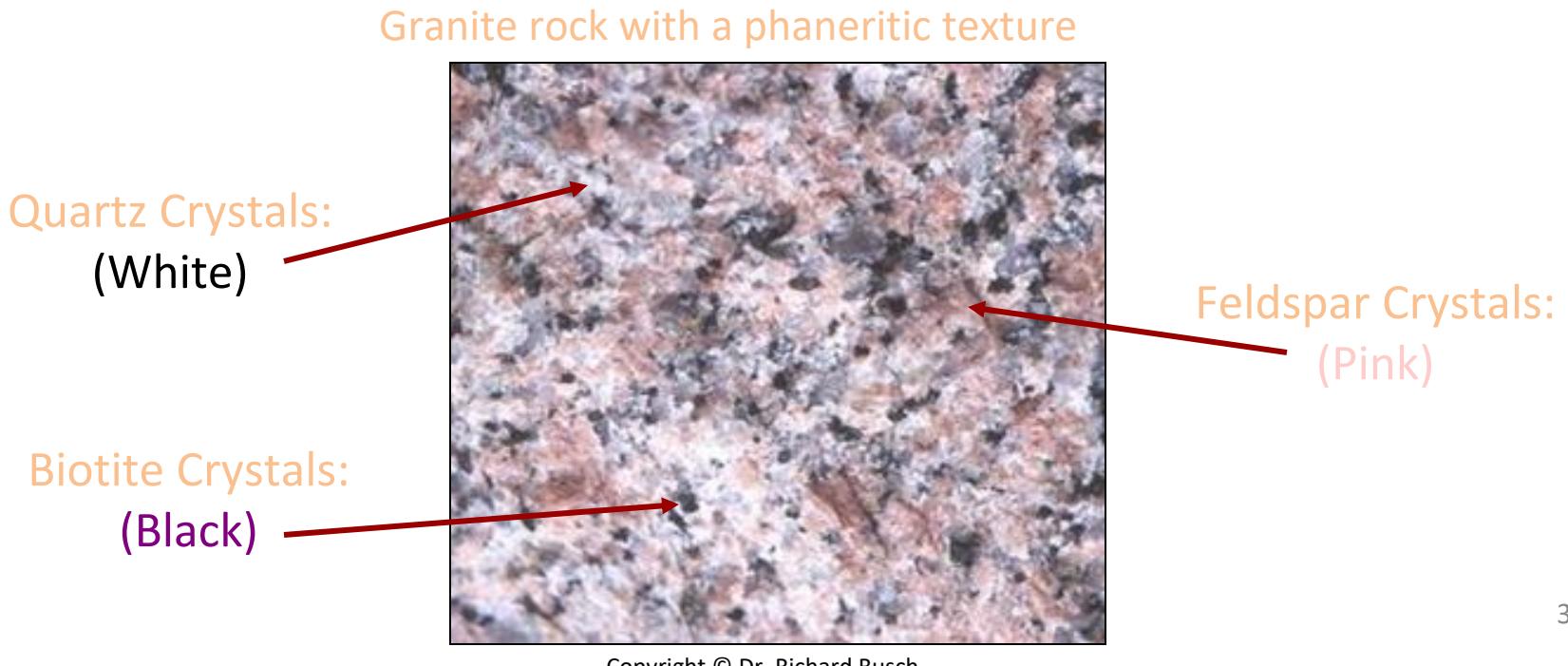
B.
Coarse crystals cooled slowly at
great depth

Intrusive Igneous Rock (Granite) – This granite cooled 30 kilometers under the surface



Phaneritic Texture

- Phaneritic (Intrusive)
 - Phaneritic rocks are coarse-grained rocks which form below the Earth's surface.
 - The individual crystals are relatively even-sized and large enough for scientists to identify the different mineral grains that compose the rock.

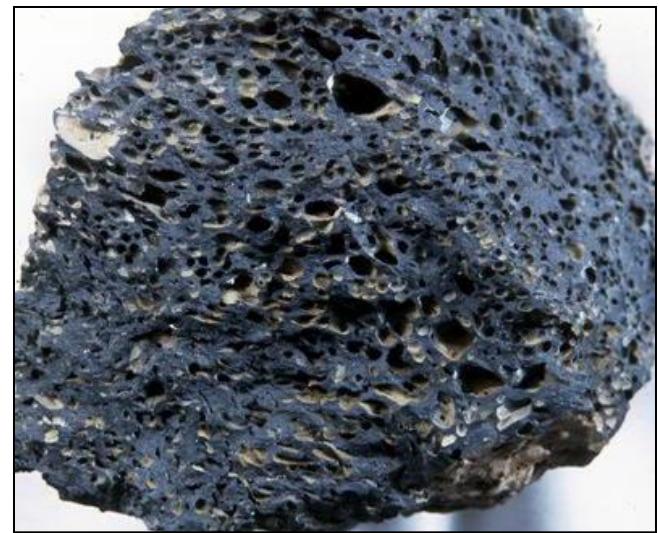


Aphanitic Texture

- **Aphanitic (Extrusive)**

- Very fine-grained and contain crystals that are too small to distinguish without the aid of a magnifying lens.
- Described by how light or dark the rock appears. Lighter colored aphanitic rocks contain mostly non-ferromagnesian silicate minerals. Darker colored aphanitic rocks contain mostly ferromagnesian silicate minerals.
- Aphanitic rocks may also contain vesicles of remnant gas that give the rock a vesicular texture. Vesicles form when the rock cools very quickly and preserves the openings formed by the expansion of trapped gas bubbles.

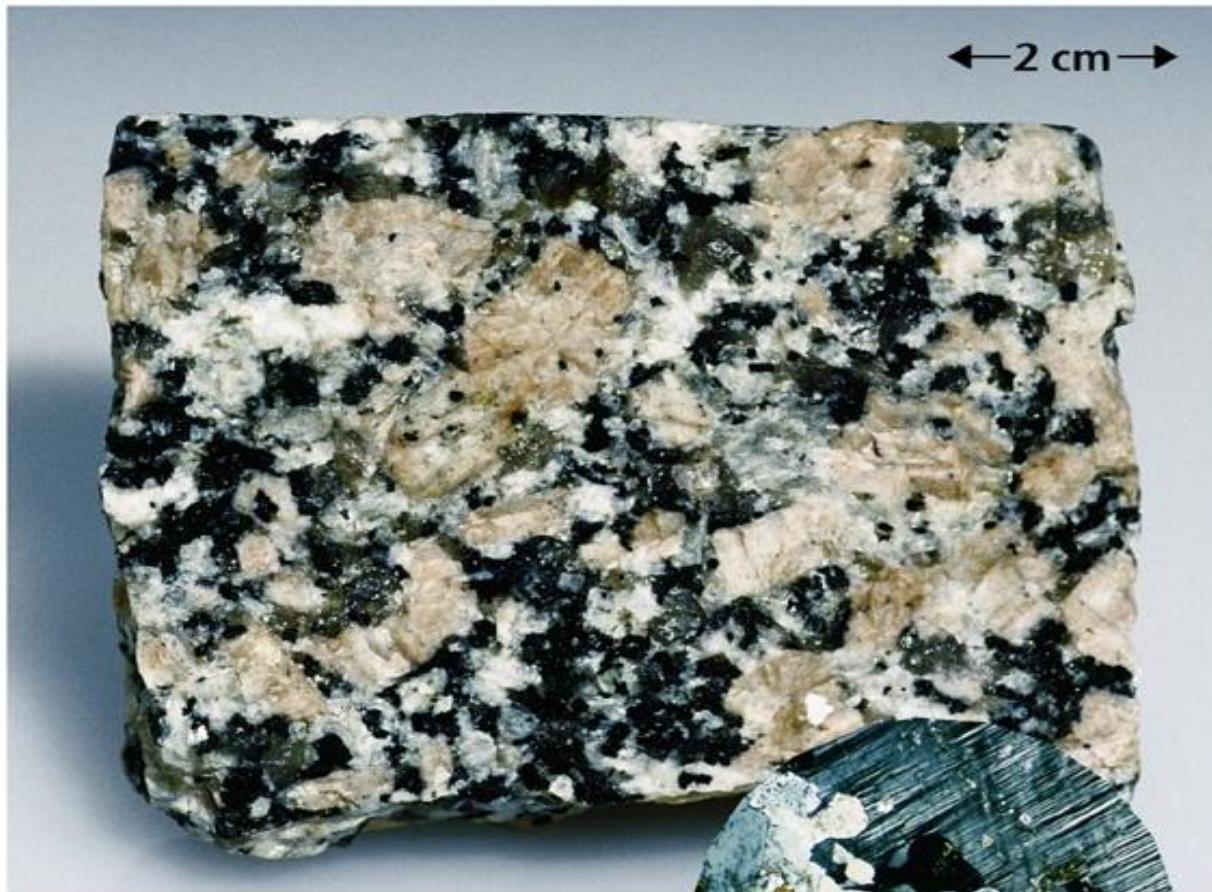
Basalt rock with an aphanitic and vesicular texture



Igneous textures

- Types of igneous textures
 - Porphyritic texture
 - Minerals form at different temperatures as well as differing rates
 - Large crystals, called phenocrysts, are embedded in a matrix of smaller crystals, called the groundmass
 - Glassy texture
 - Very rapid cooling of molten rock
 - Resulting rock is called obsidian

Porphyritic texture

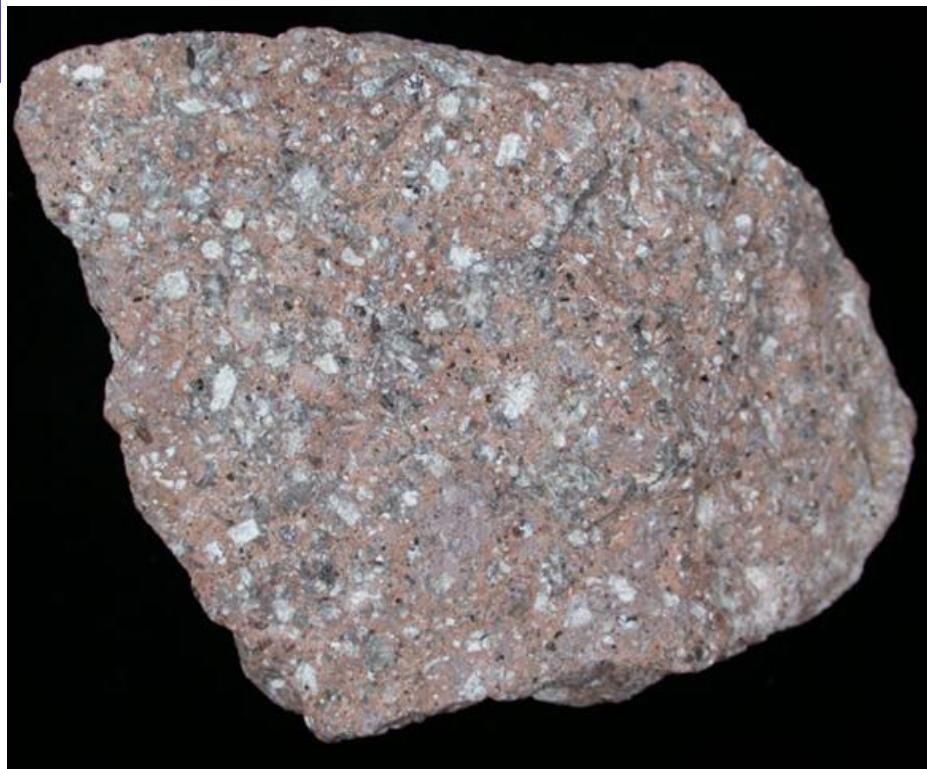


C. Porphyritic

Granite

Two-stage cooling?





↔ 2 cm →

Glassy texture

Fast cooling



D. Glassy



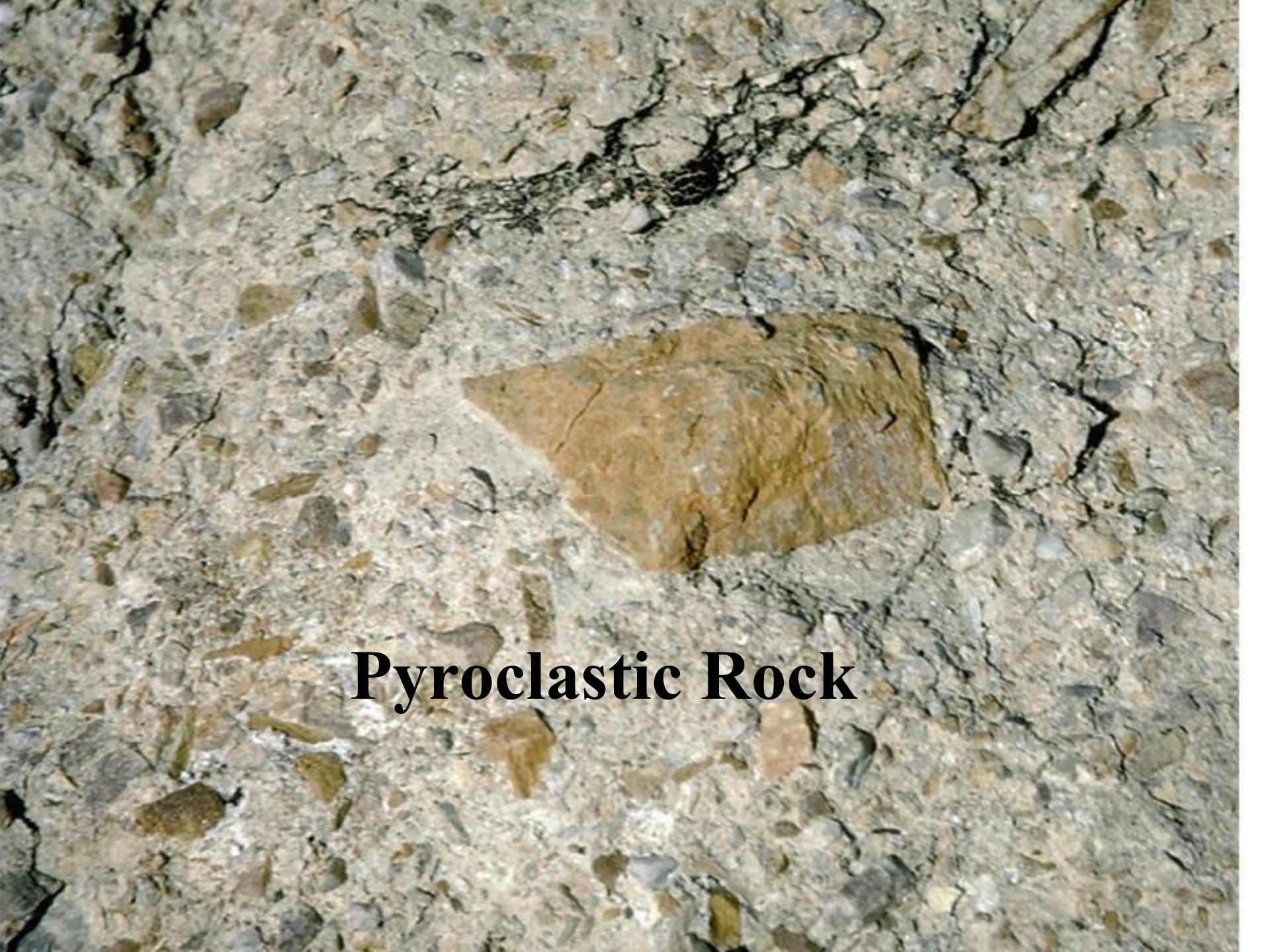
Obsidian

Magmas that cool rapidly, or that were erupted at relatively low temperatures, may not be able to form crystals before they solidify, and so remain in the form of a silicate glass.

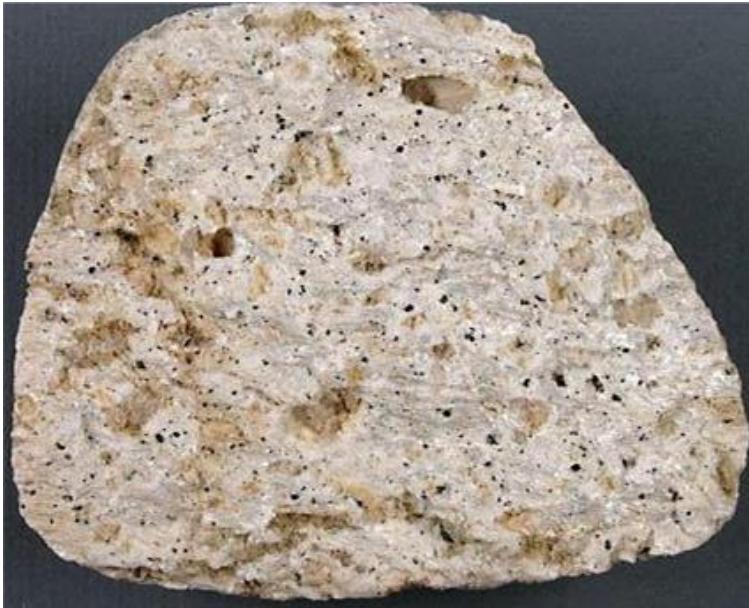
More types of Igneous textures

- Types of igneous textures
 - Pyroclastic texture
 - Various fragments ejected during a violent volcanic eruption
 - Textures often appear to more similar to sedimentary rocks





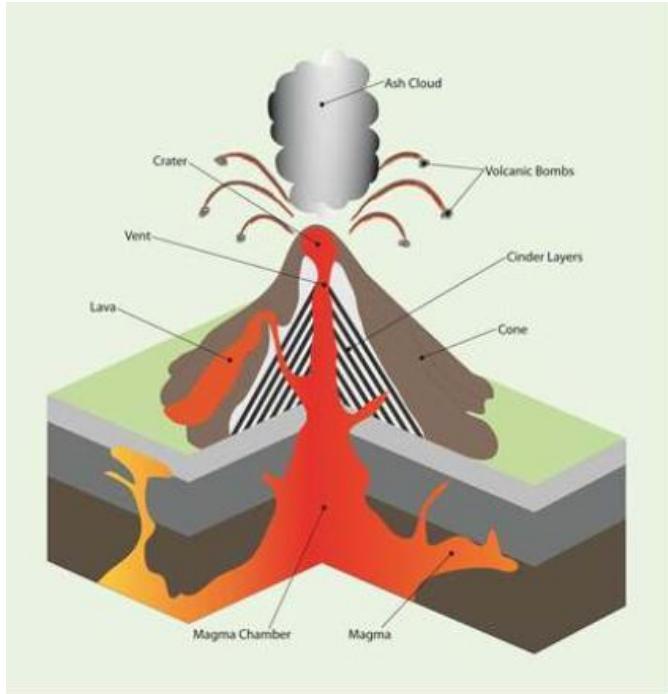
Pyroclastic Rock



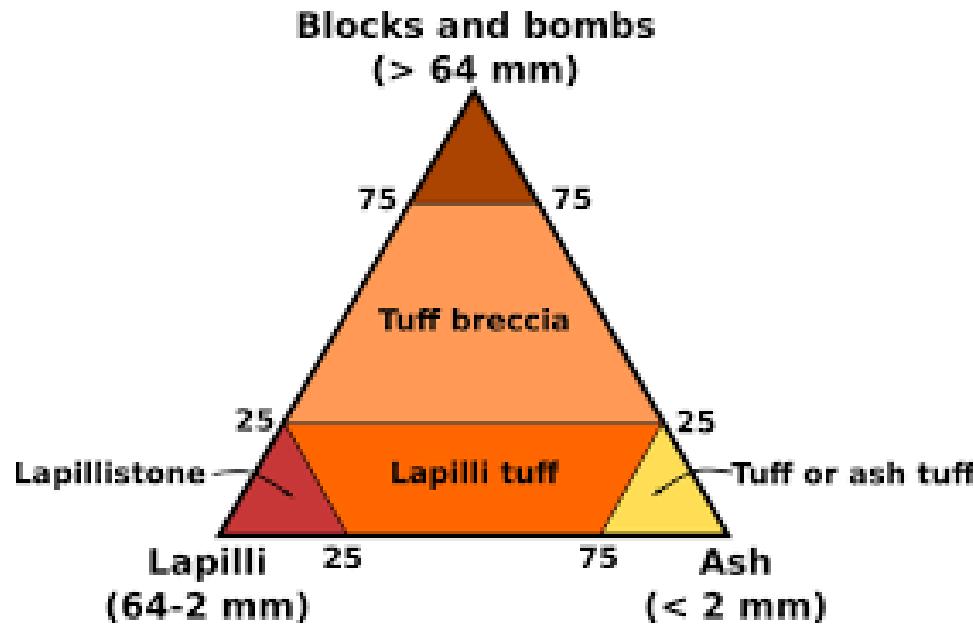
Pumice is a light-colored, extremely porous igneous rock that forms during explosive volcanic eruptions



Agglomerate or
Volcanic breccia



Lapilli tuff and lapillistone refer to a pyroclastic rock formed from predominantly lapilli-sized (2-64 mm) pyroclasts ejected during an explosive volcanic eruption.



Igneous compositions

- Naming igneous rocks – basaltic (mafic) rocks:
Fine-grained

- Basalt

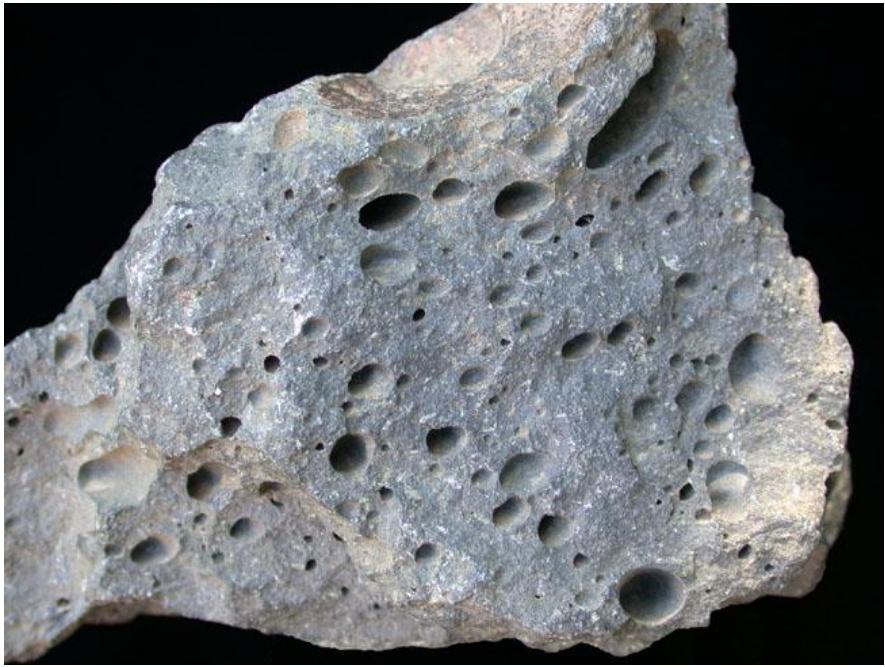
- Volcanic origin
- Aphanitic texture



- Composed mainly of pyroxene, some olivine and also calcium-rich plagioclase feldspar
- Most common extrusive igneous rock

Basalt





Vesicular basalt

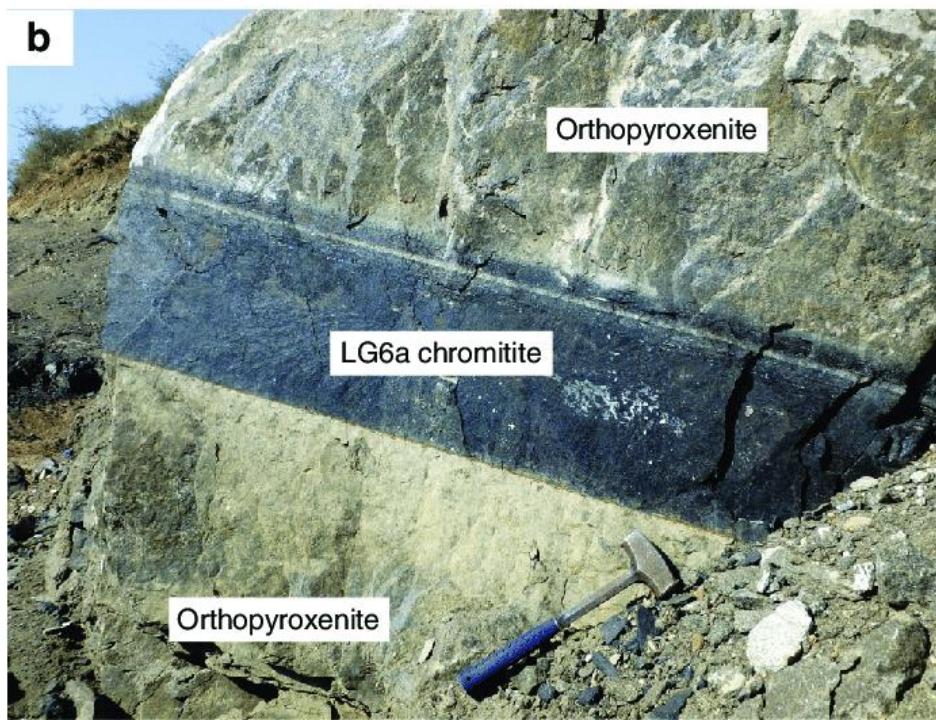
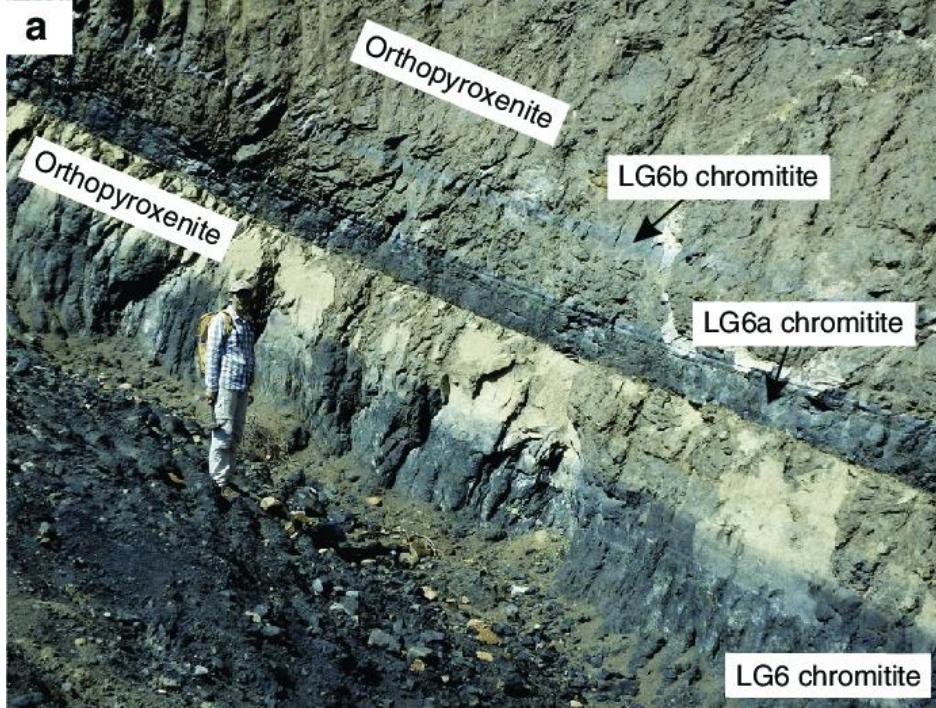


Amygdaloidal basalt

Magmas generally contain dissolved gas, which can form bubbles in the magma as the pressure is released on eruption. These bubbles can get trapped in the solidified rock. After some time, groundwater or hot solutions connected with the volcanic activity pass through the porous lava and deposit crystals in the open cavities, which gradually fill up with quartz, calcite or other minerals. Filled cavities in lavas are called *amygdales*, and a rock full of them can be called *amygdaloidal*.



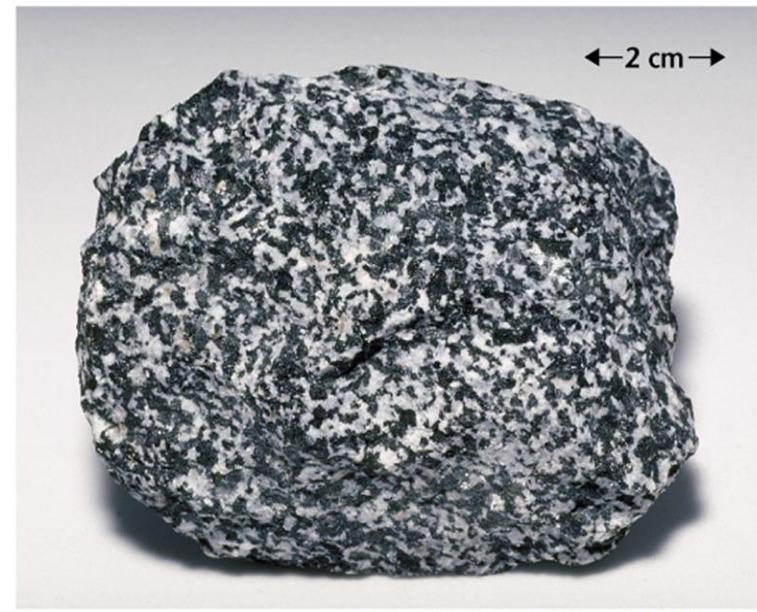
Gabbro



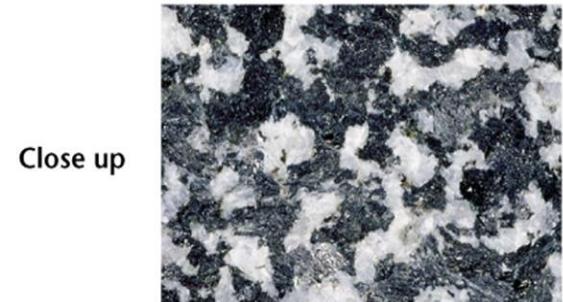
Igneous compositions

- Intermediate rocks

- Diorite
 - Plutonic equivalent of andesite
 - Coarse grained
 - Intrusive
 - Composed mainly of intermediate feldspar and amphibole



Diorite



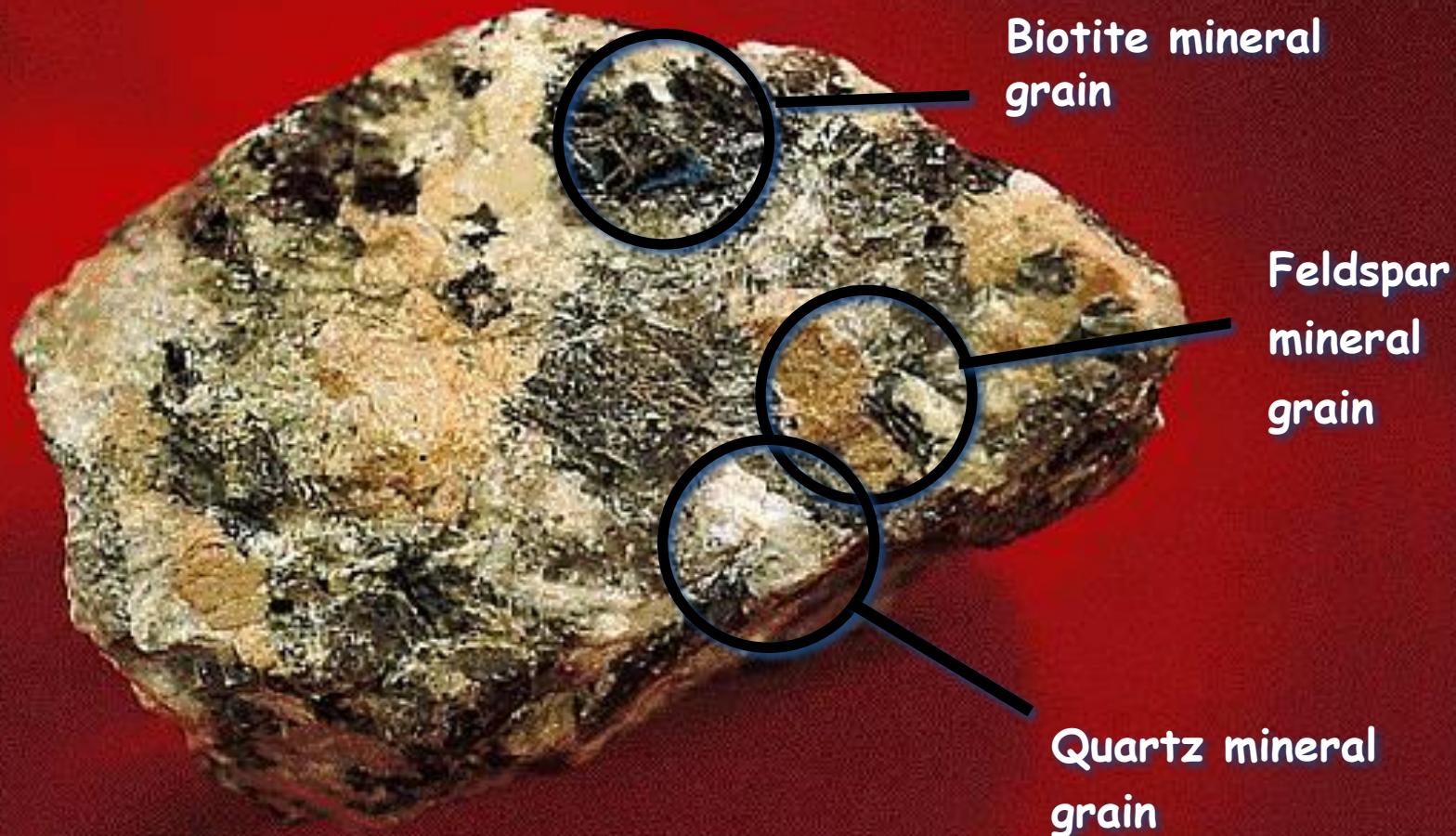
Close up

Pegmatite

A Pegmatite is a very coarse-grained igneous rock.

Crystals are >2 cm, often larger.

Most are granitic, although mafic pegmatites can form.





*Tourmaline
pegmatite.*

*Tourmaline is black,
white is plagioclase,
gray is quartz.*

Haapaluoma, Finland.

*Width of sample 15
cm.*

A pegmatite is a holocrystalline intrusive igneous rock composed of interlocking phaneritic crystals usually larger than 2.5cm in size. Pegmatites form during the final stage of a magma's crystallization. They contain exceptionally large crystals and sometimes contain minerals that are rarely found in other types of rocks.



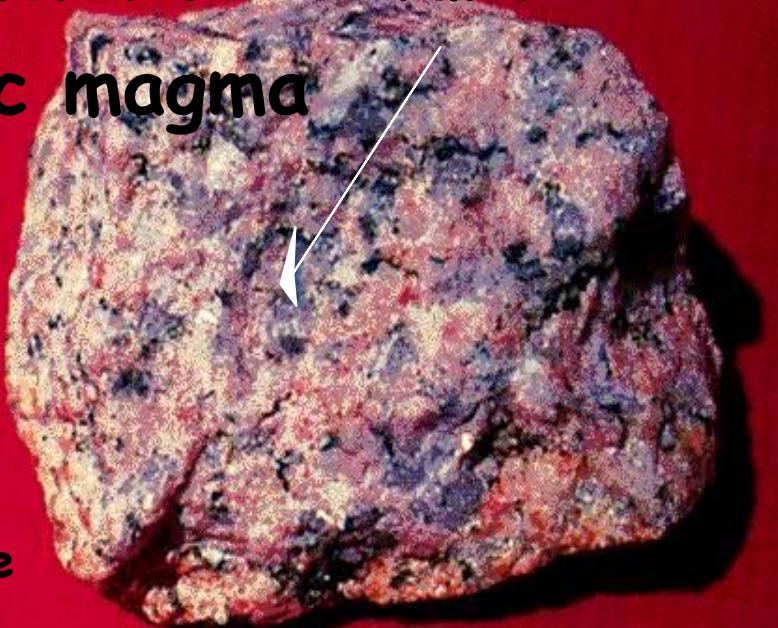


© www.pegmatite.ru

Granite & Rhyolite

Phaneritic Texture

Felsic magma

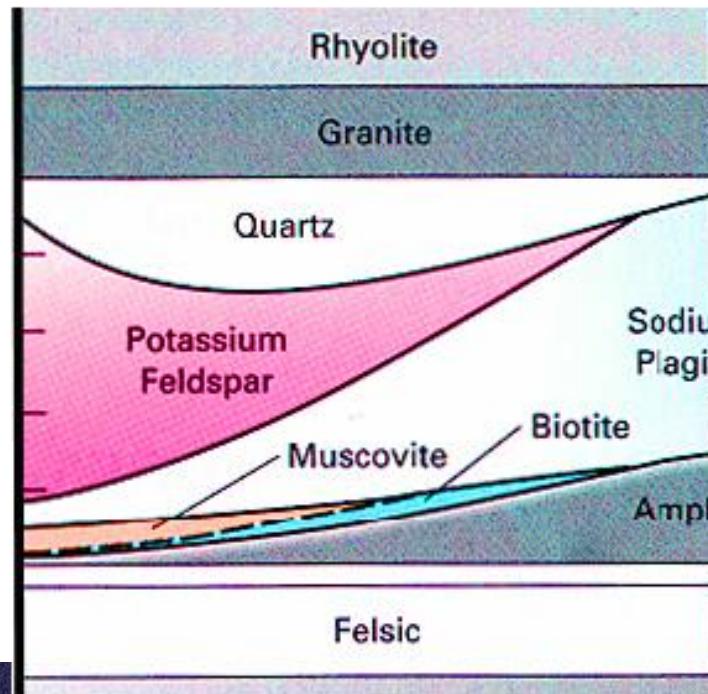


Granite

Aphanitic Texture
Felsic magma



Rhyolite







Granite gneiss



Granite gneiss



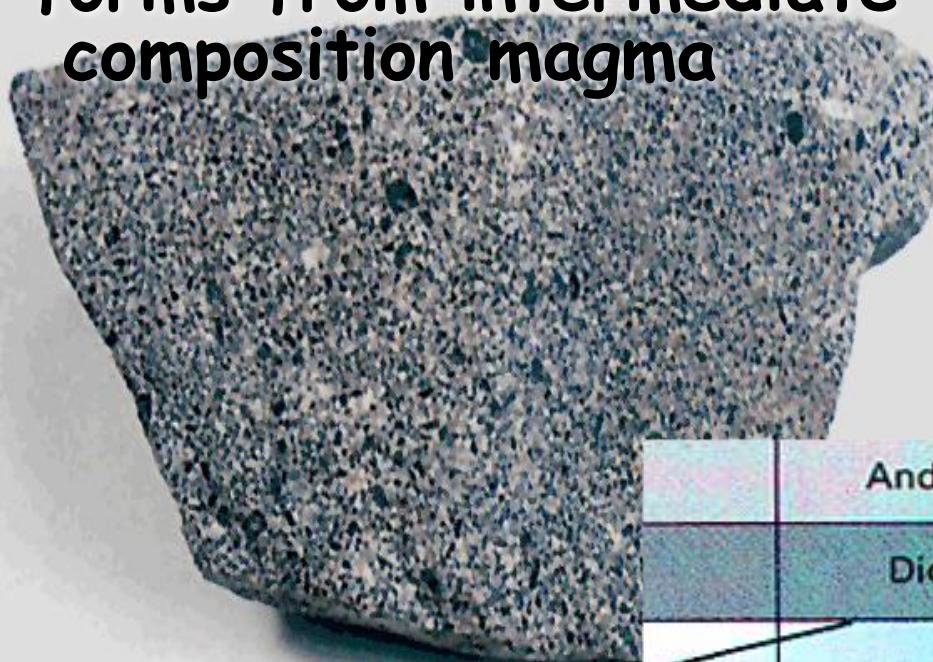
Granite gneiss



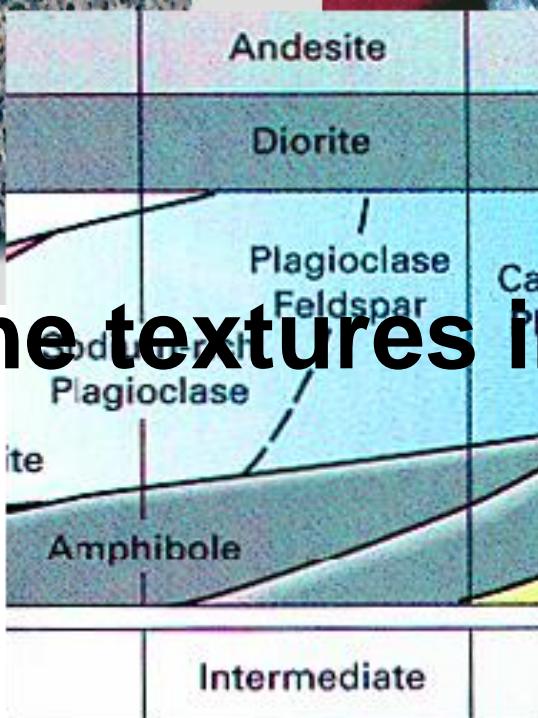
Basalt

Andesite & Diorite

Aphanitic texture
forms from intermediate
composition magma



Phaneritic texture
- forms from intermediate
composition magma



What are the textures in these two rocks ?

Basalt & Gabbro

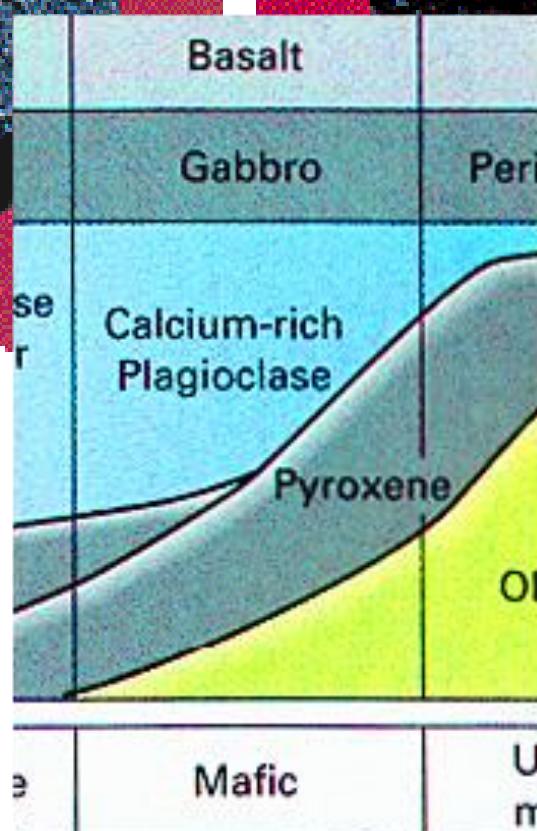
aphanitic
tformse from mafic
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Basalt



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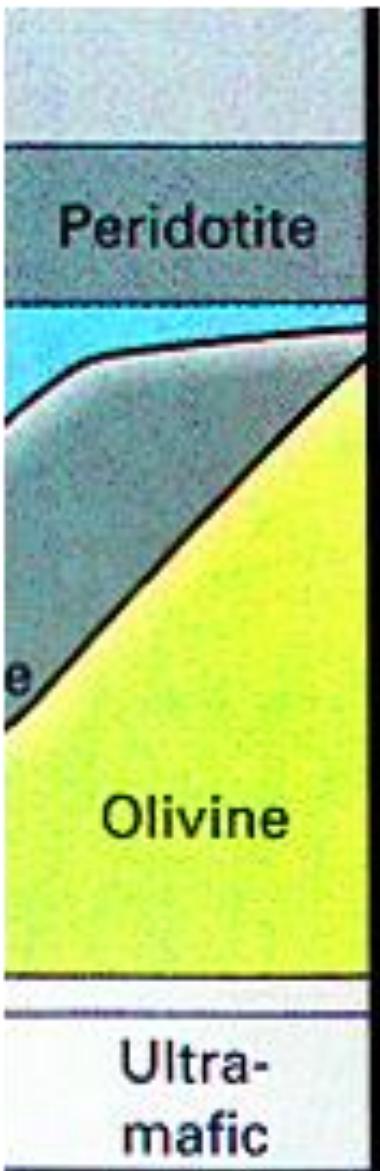




Porphyritic andesite lava

Andesite is a volcanic rock intermediate in composition between basic and acid. It is lighter coloured than basalt. Many andesites show *porphyritic* texture, where larger, well-shaped crystals are set in a finer matrix. Here the large crystals are of plagioclase feldspar. They crystallized relatively slowly in a magma chamber below the surface. When the magma was erupted onto the surface, the rest of the melt crystallized much more rapidly, forming tiny interlocking crystals in the matrix that cannot be distinguished by the naked eye.

Dunite is an ultramafic plutonic rock that is composed almost exclusively of olivine. “Ultramafic” means that mafic minerals form more than 90% on the rocks composition



As the rock take on a green
color

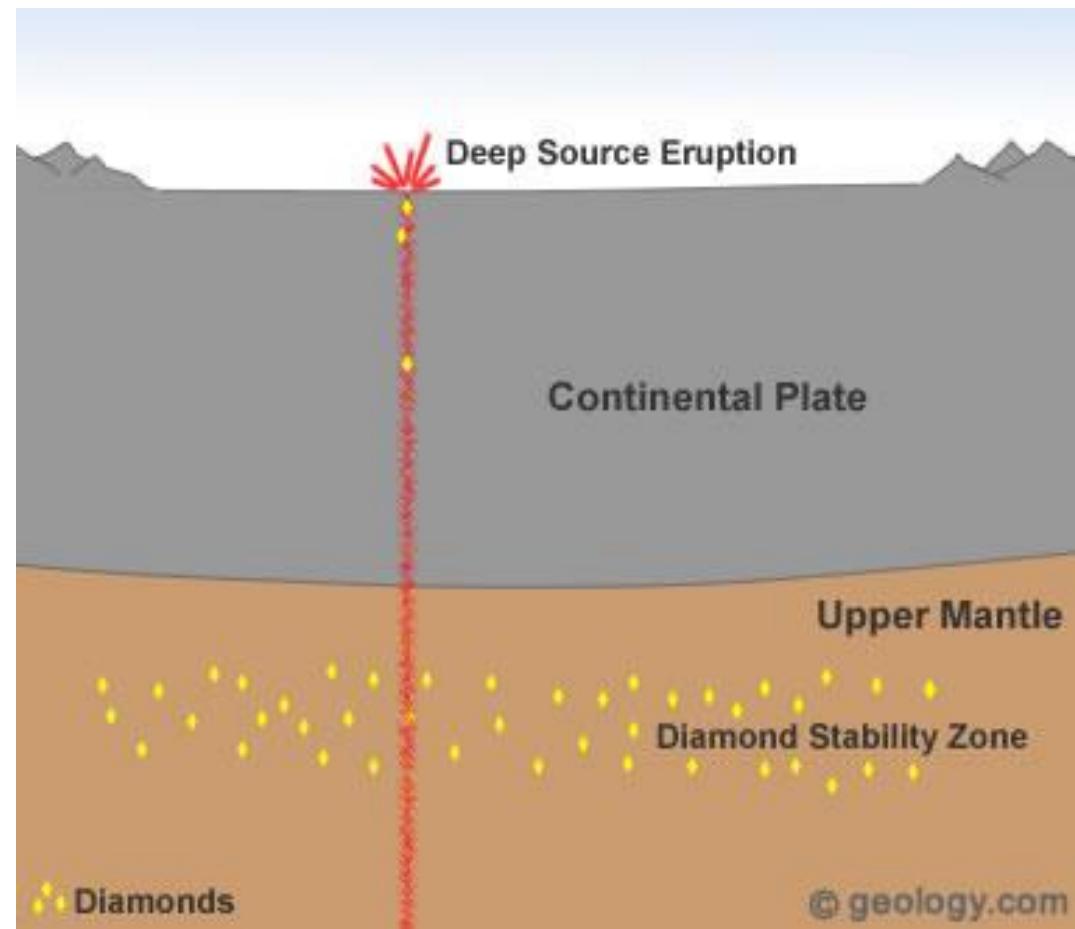




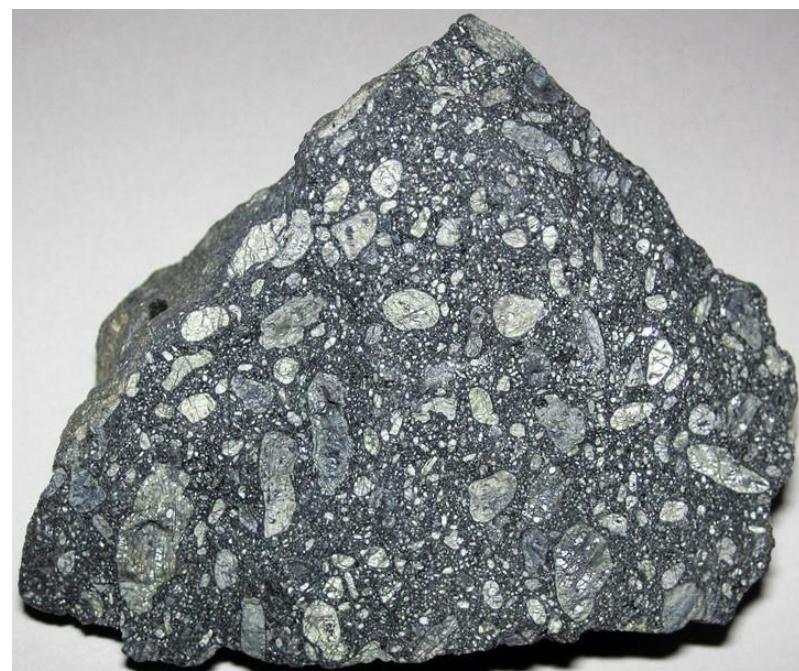
Dunite



Peridotite is a dense, coarse-grained igneous rock consisting mostly of the minerals olivine and pyroxene.



Kimberlite





Identify the minerals

Points to study

1. Colour
2. Felsic, mafic or intermediate
3. Grain size – fine, medium, coarse, grain size range, equigranular, inequigranular
4. Minerals (quartz, K-feldspar, plagioclase, biotite, muscovite, hornblende, etc)
5. Shape of coarse mineral grains (tabular, needle shaped, equant, rounded, etc)
6. Texture – aphanitic, porphyritic, glassy, pegmatitic, pyroclastic, vesicular, amygdaloidal
7. Rock nomenclature
8. Cooling history, extrusive vs. intrusive, plutonic, hypabyssal or volcanic