

<http://slideplayer.com/slide/2386075/#>

Textures of Igneous rocks

The term **texture** is used to describe the overall appearance of a rock based on the

- I. **size,**
- II. **shape, and**
- III. **arrangement of its mineral grains**

Texture is an important property because it reveals a great deal about the **environment** in which the rock formed.

This fact allows geologists to make inferences about a **rock's origin based on careful observations of grain size and other characteristics of the rock.**

Three factors that influence the textures of igneous rocks are:

- (1) the rate at which molten rock cools;**
- (2) the amount of silica present; and**
- (3) the amount of dissolved gases in the magma**

Among these, the rate of cooling tends to be the dominant factor.

Types of Igneous Textures

Types of Igneous Textures

- 1. Phaneritic (coarse-grained) Texture**
- 2. Aphanitic (fine-grained) Texture**
- 3. Equigranular Texture**
- 4. Inequigranular Texture (Porphyritic Texture)**
- 5. Vesicular Texture**
- 6. Glassy Texture**
- 7. Pyroclastic (fragmental) Texture**
- 8. Pegmatitic Texture**

Grain size is an important clue to cooling history and the environment in which a magma crystallized.

The effect of cooling on rock textures is fairly straightforward. Because **intrusive magmas cool relatively slowly, large crystals commonly grow in plutonic rocks (**coarse-grained rocks**).**

A very large magma body located many kilometers beneath Earth's surface will cool over a period of perhaps **tens to hundreds of thousands of years**. Initially relatively few crystal nuclei form.

Slow cooling permits ions to migrate freely until they eventually join one of the existing crystalline structures.

Consequently, slow cooling promotes the growth of fewer, but larger crystals.

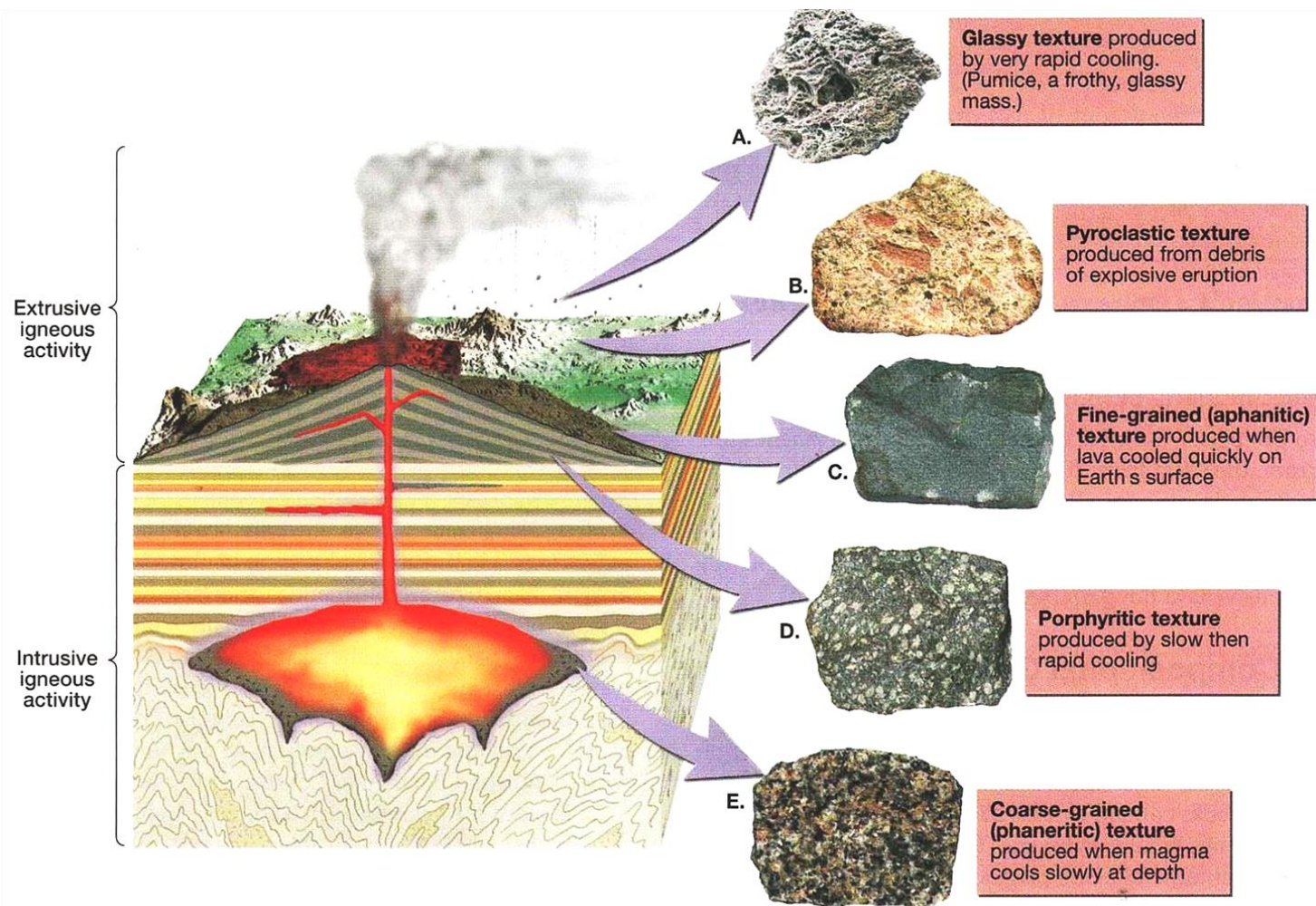


FIGURE 4.5 Igneous rock textures. A. During a volcanic eruption in which silica-rich lava is ejected into the atmosphere, a frothy glass called pumice may form. B. Rocks that exhibit a *pyroclastic texture* are a result of the consolidation of rock fragments that were ejected during a violent volcanic eruption. C. Igneous rocks that crystallize at or near Earth's surface cool quickly and often exhibit a *fine-grained (aphanitic) texture*. D. A *porphyritic texture* results when magma that already contains some large crystals migrates to a new location where the rate of cooling increases. The resulting rock consists of larger crystals (*phenocrysts*) embedded within a matrix of smaller crystals (*groundmass*). E. *Coarse-grained (phaneritic)* igneous rocks form when magma slowly crystallizes at depth. (Photos by E. J. Tarbuck)

Mode of Occurrence and textures

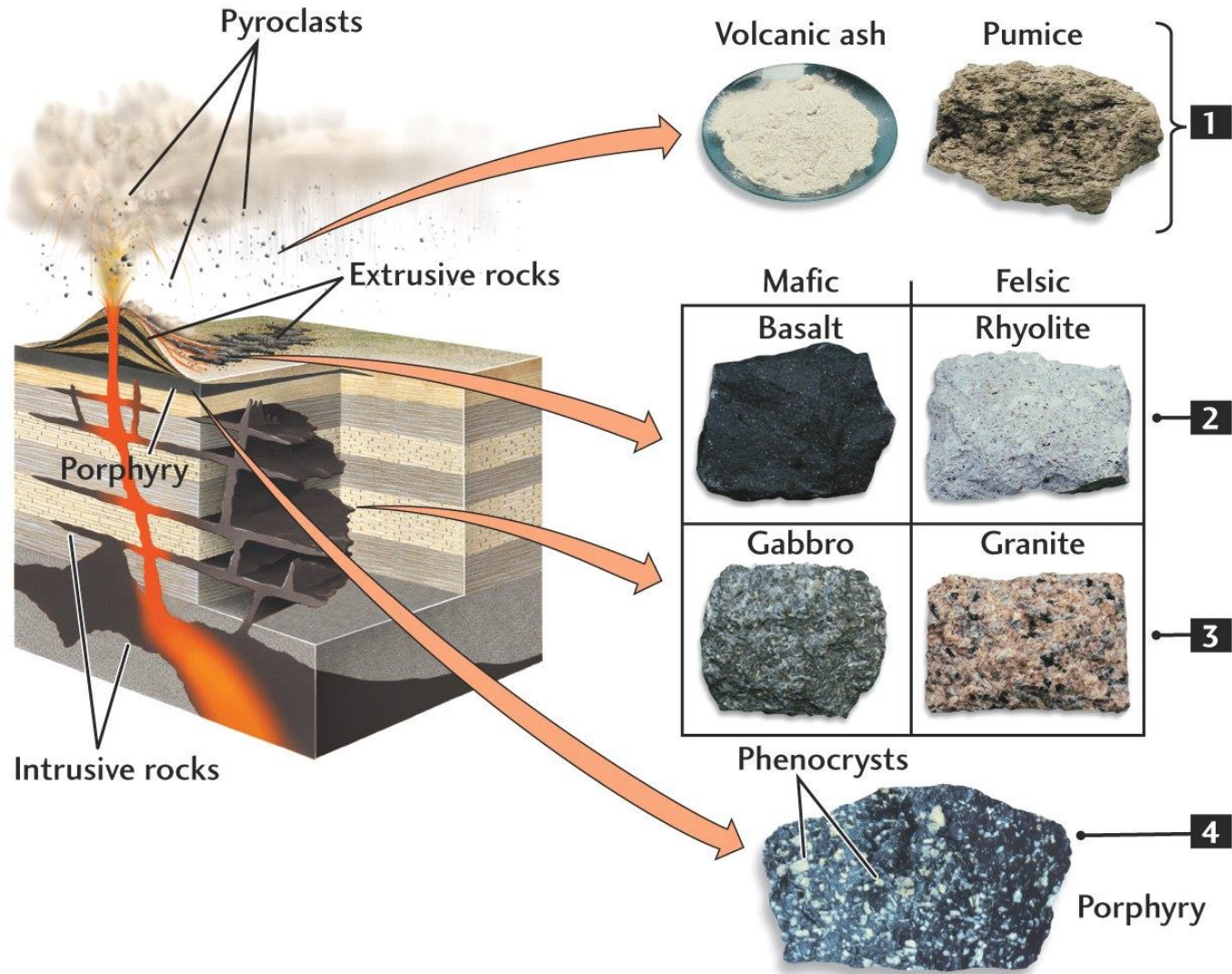




Fig. 4.9: A granite, one of the most common phaneritic igneous rocks.



OESIS 2004



Anorthosite

On the other hand, magmas which reach the earth's surface for example (extrusive igneous rocks), in a thin lava flow—cool rapidly and crystallize.

The ions quickly lose their mobility and readily combine to form **fine-grained crystals and glass.**

It is due to the development of numerous embryonic nuclei, all of which compete for the available ions. The result is a solid mass of tiny **intergrown crystals and glass.**

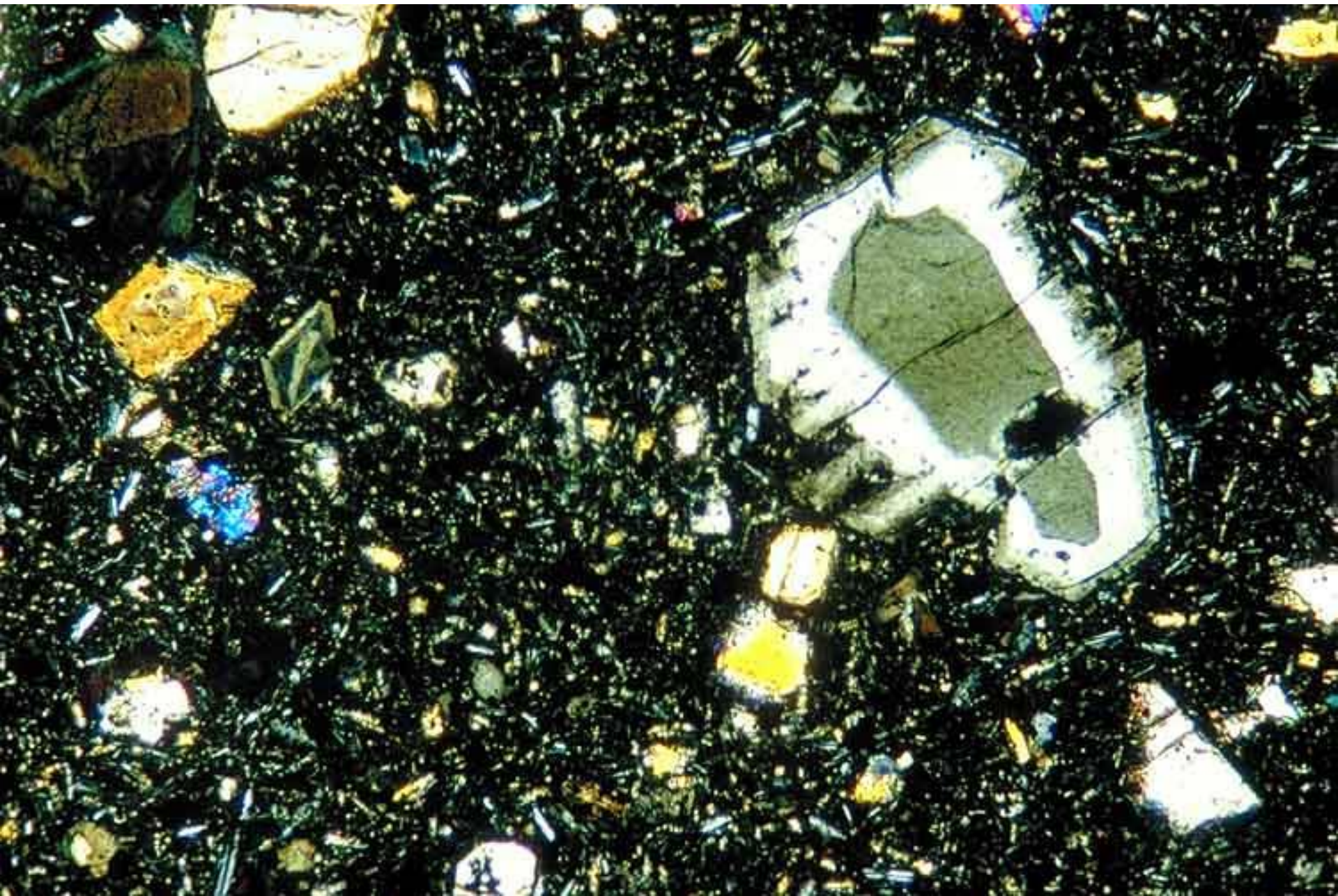
In contrast, magmas which reach the earth's surface cool rapidly and crystallize to form **fine-grained and glassy extrusive igneous rocks.**

Rapid cooling tends to generate small crystals.





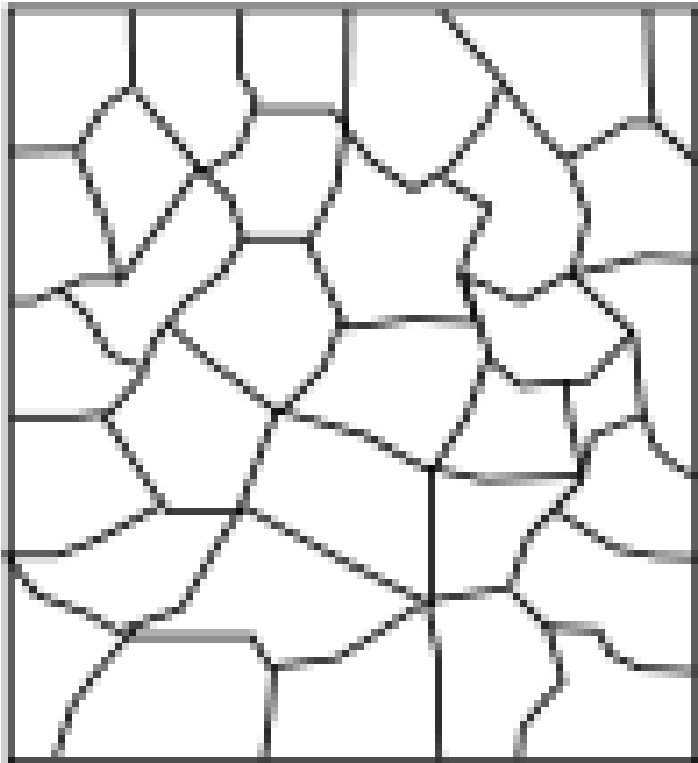
Basalt under microscope



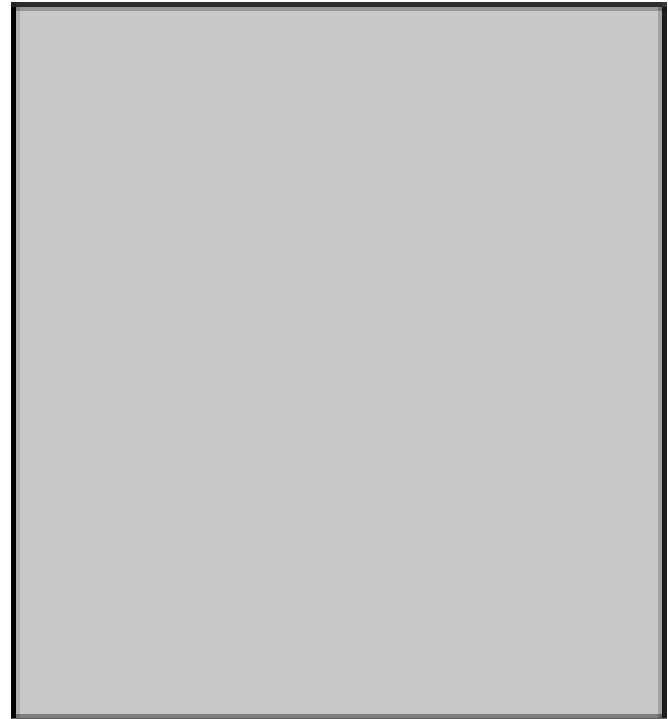
Based on grain size, Igneous textures are divided into two major size categories:

- 1. Phaneritic (coarse-grained) texture**
- 1. Aphanitic (fine-grained) Texture**

Phaneritic Texture



Aphanitic Texture



Phaneritic (coarse-grained) Texture

The rocks contain individual mineral grains which may be observed without the aid of a microscope (larger than 0.062 mm).

When large masses of magma slowly crystallize at great depth, they exhibit a coarse-grained texture described as **phaneritic (phaner = visible).**



Granite



Diorite

Phaneritic (coarse-grained) Textures

Phaneritic Texture

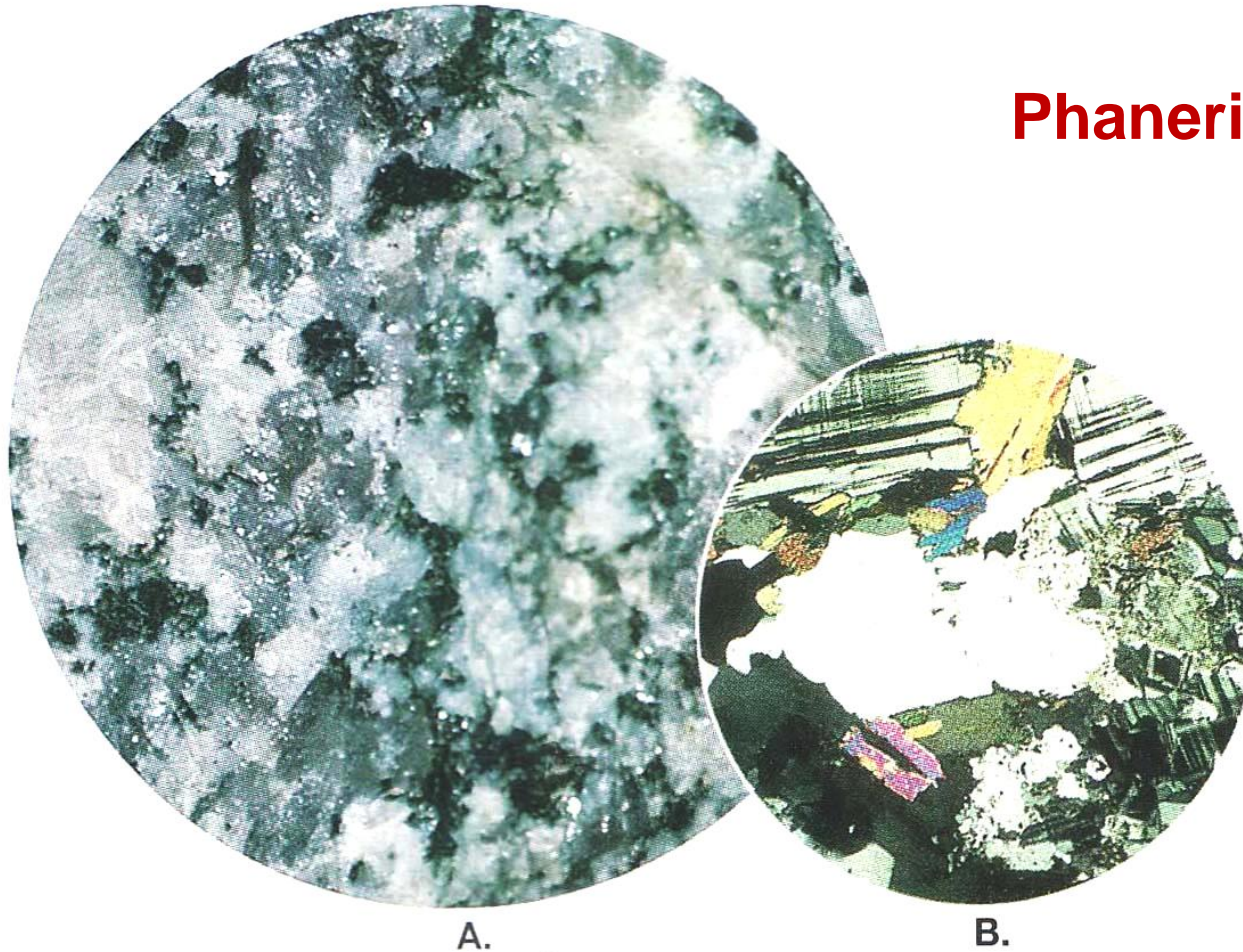
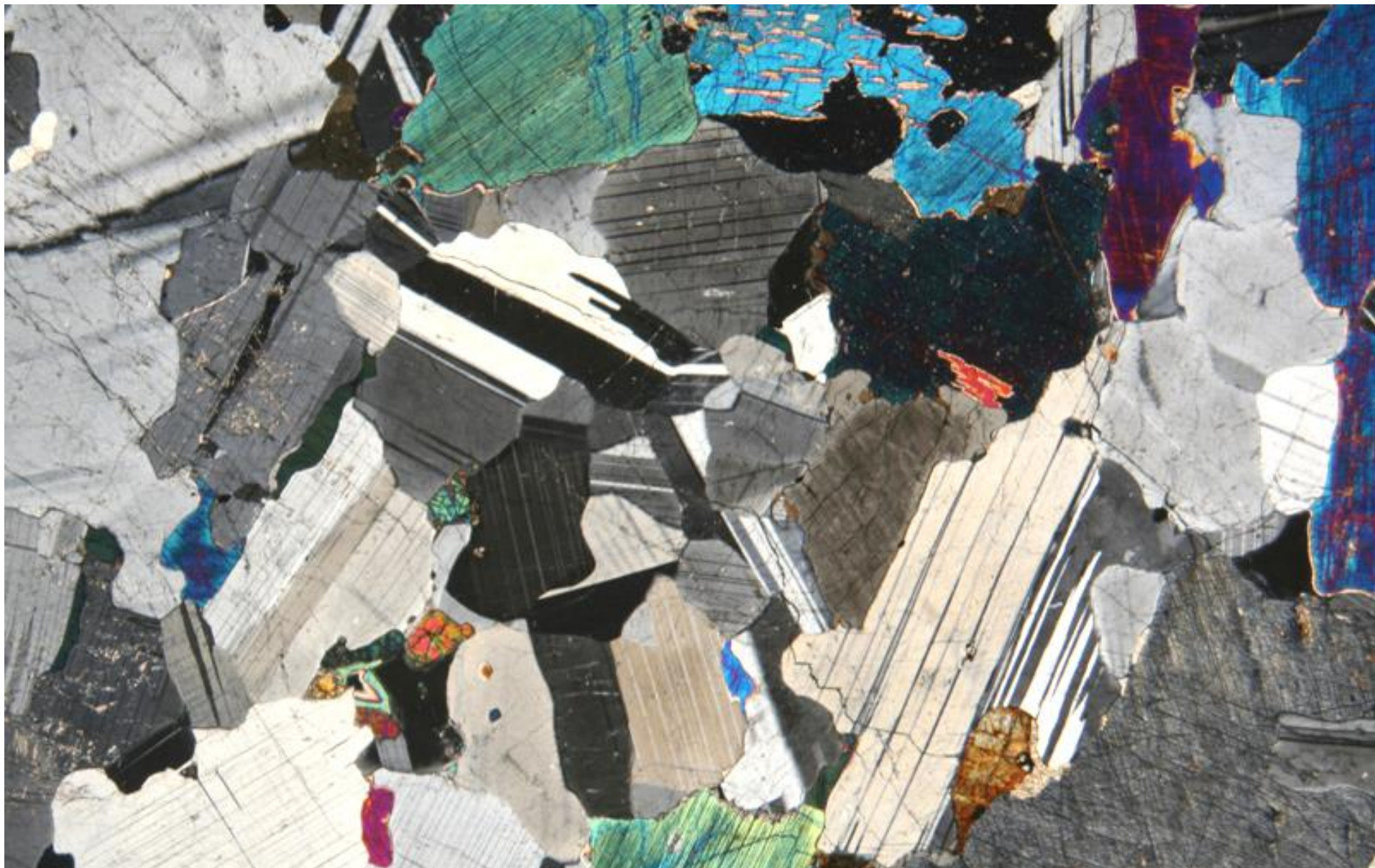


FIGURE 4.2 Igneous rock composed of interlocking crystals. **A.** close-up of interlocking crystals in a coarse-grained igneous rock. The largest crystals are about 2 centimeters in length. **B.** Photomicrograph of interlocking crystals in a coarse-grained igneous rock. (Photos by E. J. Tarbuck)



Igneous rock gabbro. Photomicrograph with crossed polars. The width of the view is approximately 0,5 cm. Main minerals are plagioclase, clinopyroxene and olivine.

Coarse-grained rocks consist of a mass of intergrown crystals which are roughly equal in size and large enough so that the individual minerals can be identified without the aid of a microscope (**Fig 4.5E**).

Small magnifying lens can identify most minerals in a **phaneritic** rock.

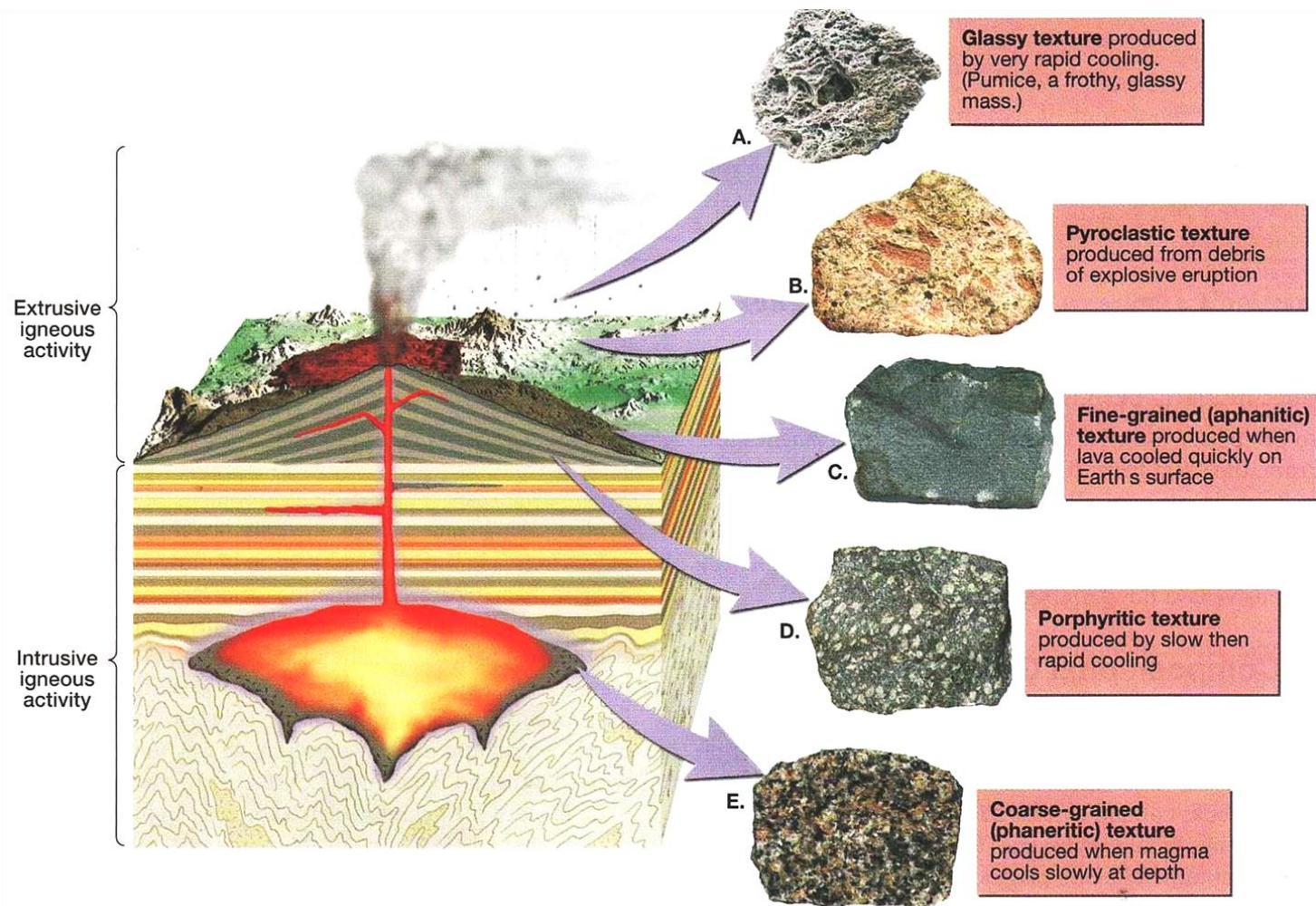


FIGURE 4.5 Igneous rock textures. A. During a volcanic eruption in which silica-rich lava is ejected into the atmosphere, a frothy glass called pumice may form. B. Rocks that exhibit a *pyroclastic texture* are a result of the consolidation of rock fragments that were ejected during a violent volcanic eruption. C. Igneous rocks that crystallize at or near Earth's surface cool quickly and often exhibit a *fine-grained (aphanitic) texture*. D. A *porphyritic texture* results when magma that already contains some large crystals migrates to a new location where the rate of cooling increases. The resulting rock consists of larger crystals (*phenocrysts*) embedded within a matrix of smaller crystals (*groundmass*). E. *Coarse-grained (phaneritic)* igneous rocks form when magma slowly crystallizes at depth. (Photos by E. J. Tarbuck)

Phaneritic textures are further subdivided into three groups on the basis of average size of constituent minerals.

Coarse-grained: Larger than 2 mm

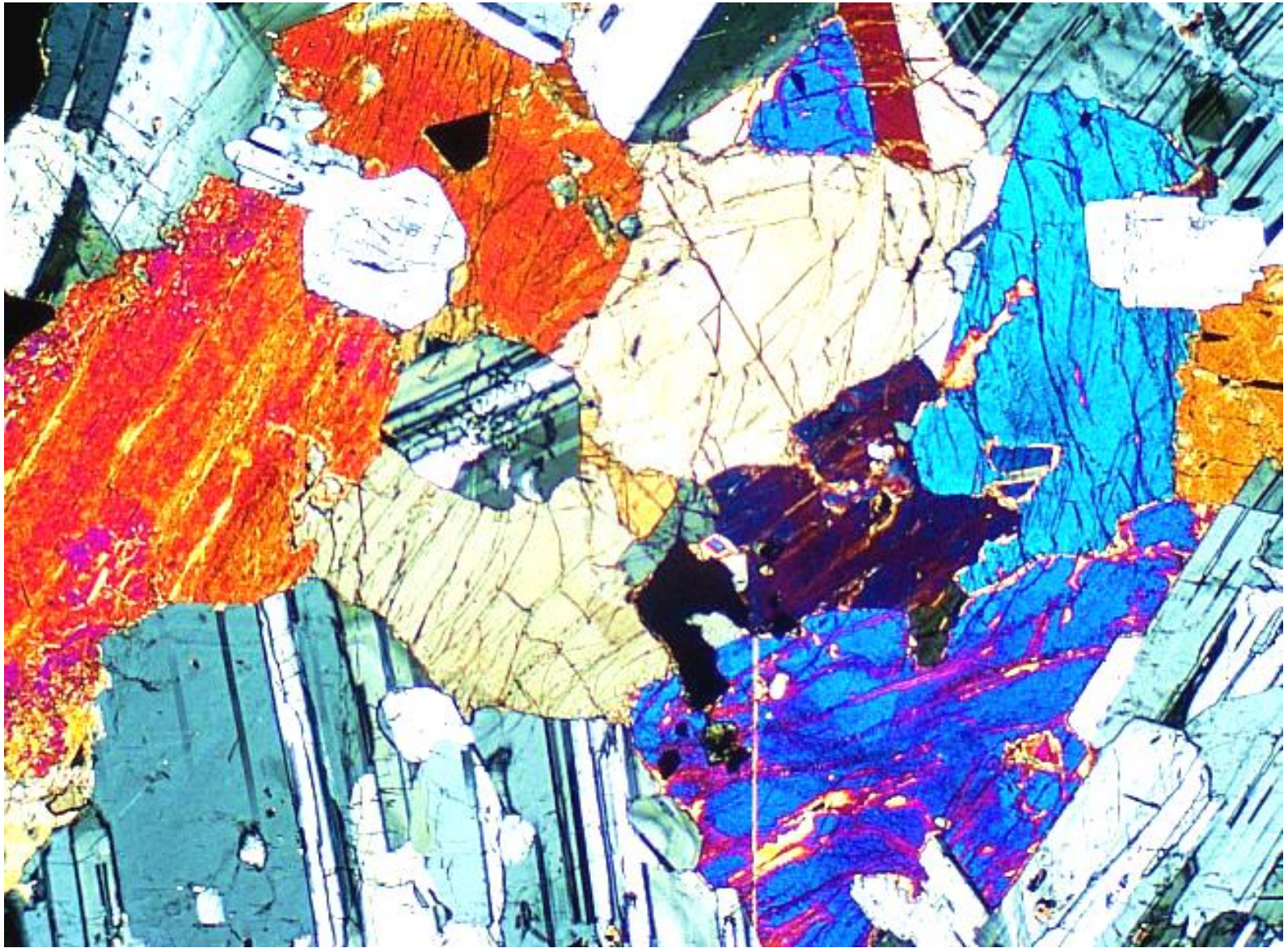
Medium-grained: Between 2 mm and 1 mm

Fine-grained: Between 1 mm and 0.062 mm

Equigranular and inequigranular textures

Equigranular texture

The texture in a phaneritic rocks with grains of more or less equal size is called **Equigranular Texture.**



Equigranular texture

Inequigranular texture (Porphyritic texture) I

It is resulted if the rock contains grains predominantly consisting of two groups of unequal grain sizes. Such a texture is called **porphyritic texture.**

The difference in grain size is rather common in igneous rocks.

A large mass of magma may require tens to hundreds of thousands of years to solidify.

Because different minerals crystallize under different environmental conditions (temp and pressure), it is possible for crystals of one mineral to become quite large before others even begin to form.

Should molten rock containing some large crystals move to a different environment—for example, by erupting at the surface—the remaining liquid portion of the lava would cool more quickly.

The resulting rock, which has large crystals embedded in a matrix of smaller crystals, is said to have a **porphyritic texture (Fig 4.5D).**

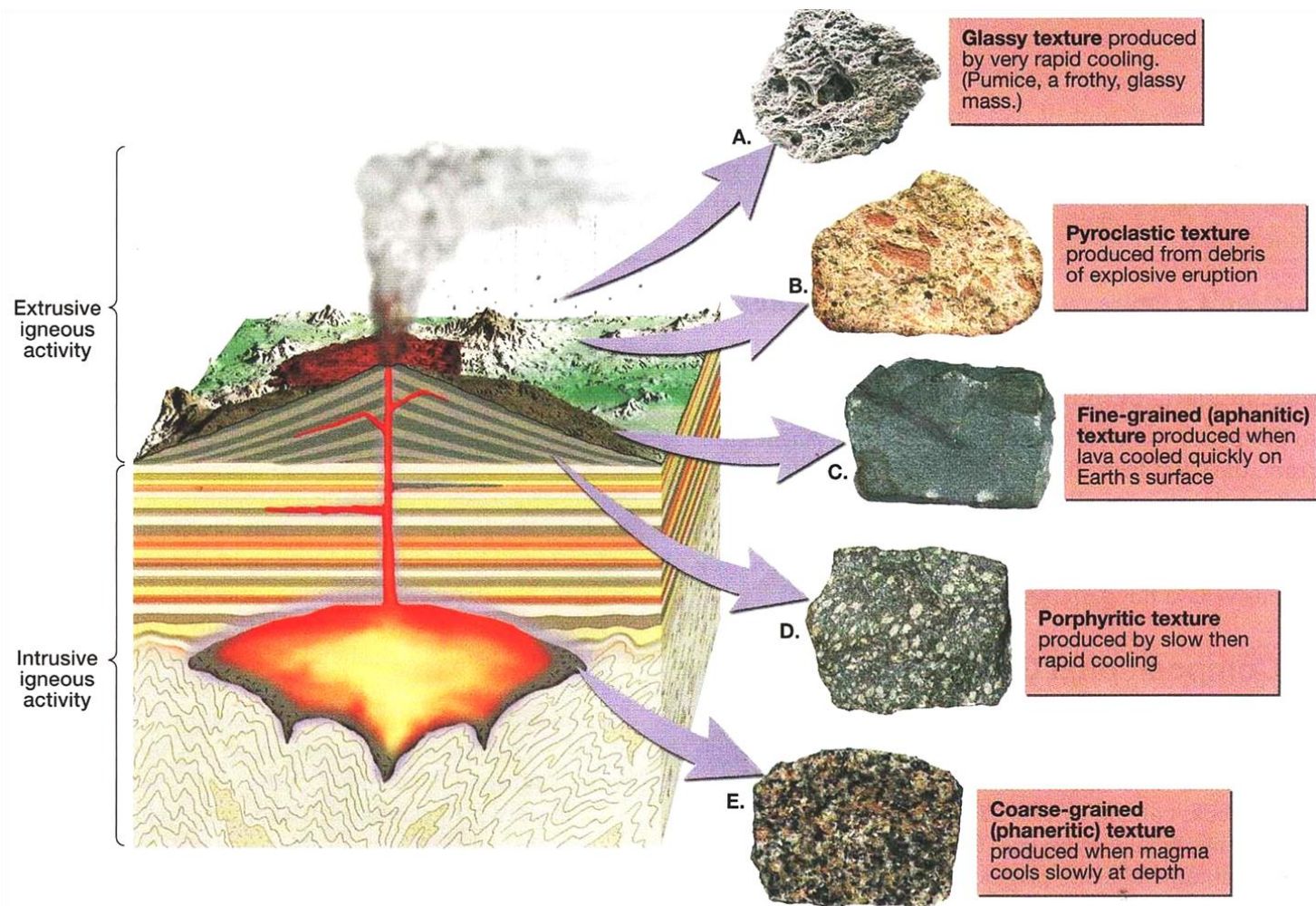
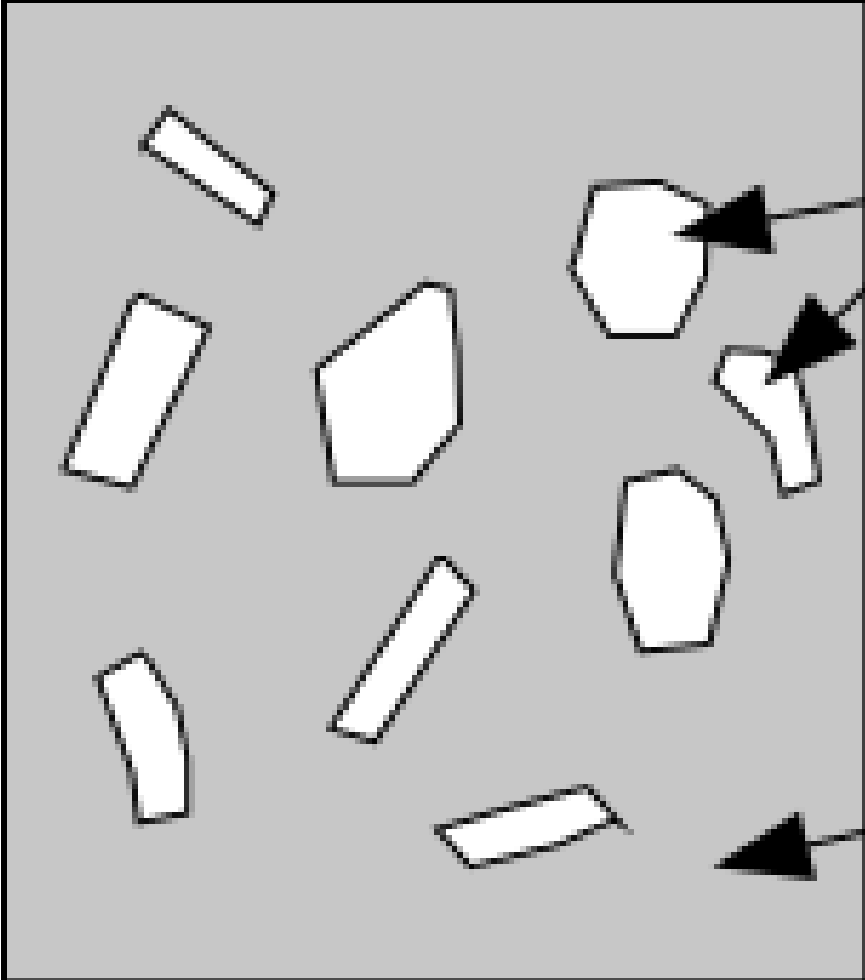
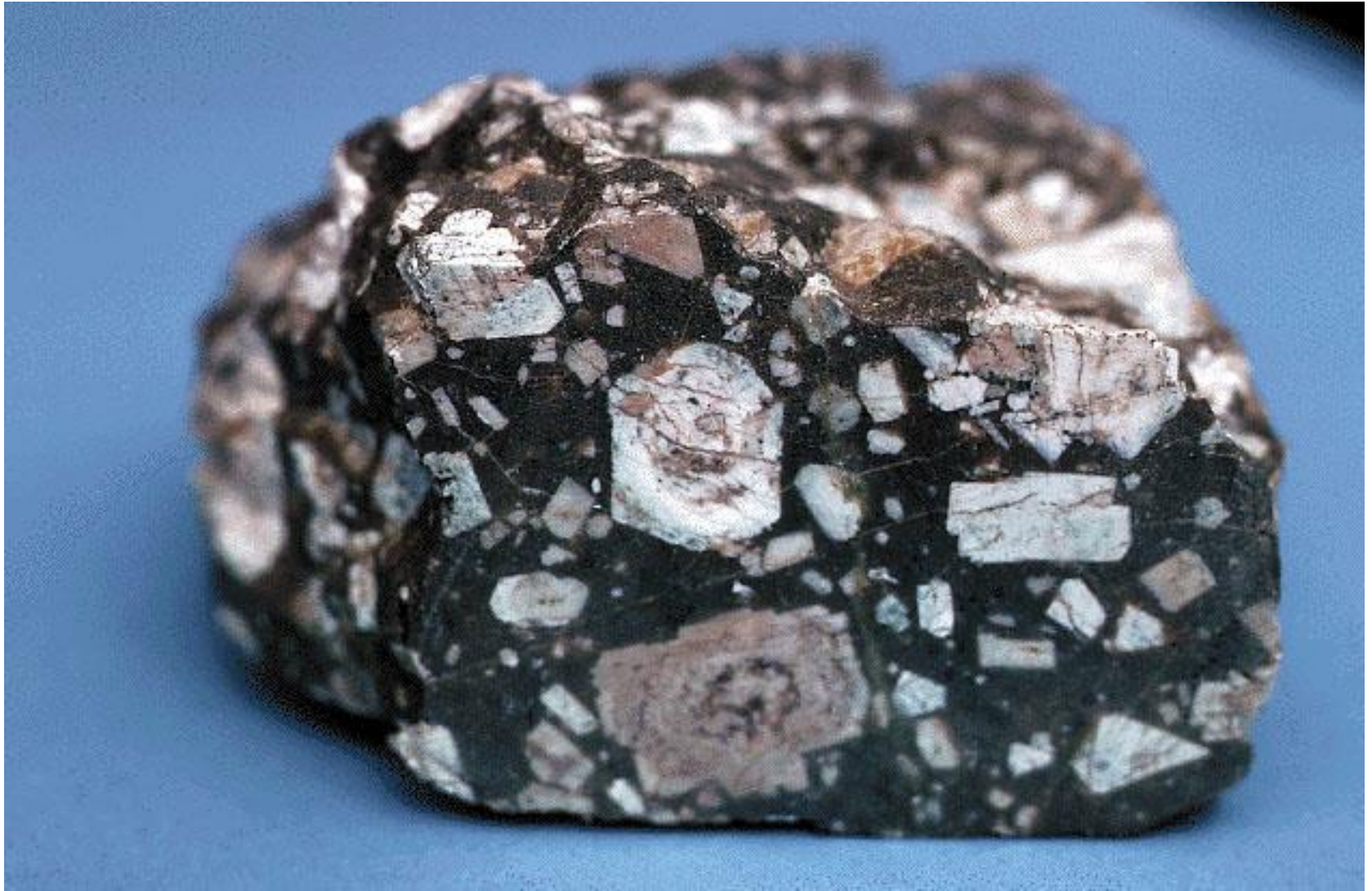


FIGURE 4.5 Igneous rock textures. A. During a volcanic eruption in which silica-rich lava is ejected into the atmosphere, a frothy glass called pumice may form. B. Rocks that exhibit a *pyroclastic texture* are a result of the consolidation of rock fragments that were ejected during a violent volcanic eruption. C. Igneous rocks that crystallize at or near Earth's surface cool quickly and often exhibit a *fine-grained (aphanitic) texture*. D. A *porphyritic texture* results when magma that already contains some large crystals migrates to a new location where the rate of cooling increases. The resulting rock consists of larger crystals (*phenocrysts*) embedded within a matrix of smaller crystals (*groundmass*). E. *Coarse-grained (phaneritic)* igneous rocks form when magma slowly crystallizes at depth. (Photos by E. J. Tarbuck)

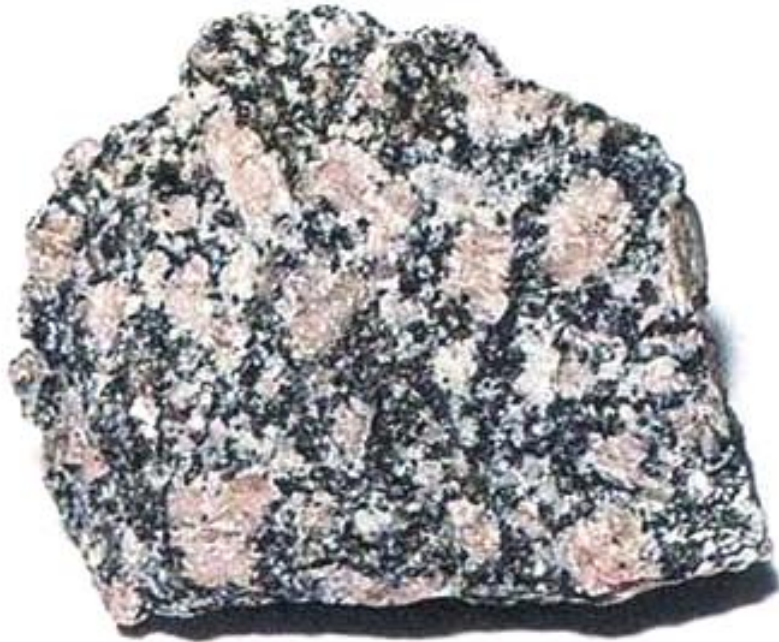


Phenocrysts

Groundmass



An **extrusive** rock that is compositionally the same as **granite** is a **rhyolite**. . This texture of both large crystals (**phenocrysts**) and small crystals, or none, in a **fine-grained matrix (groundmass)** is called **porphyritic**. Therefore this would be a **porphyritic rhyolite**.



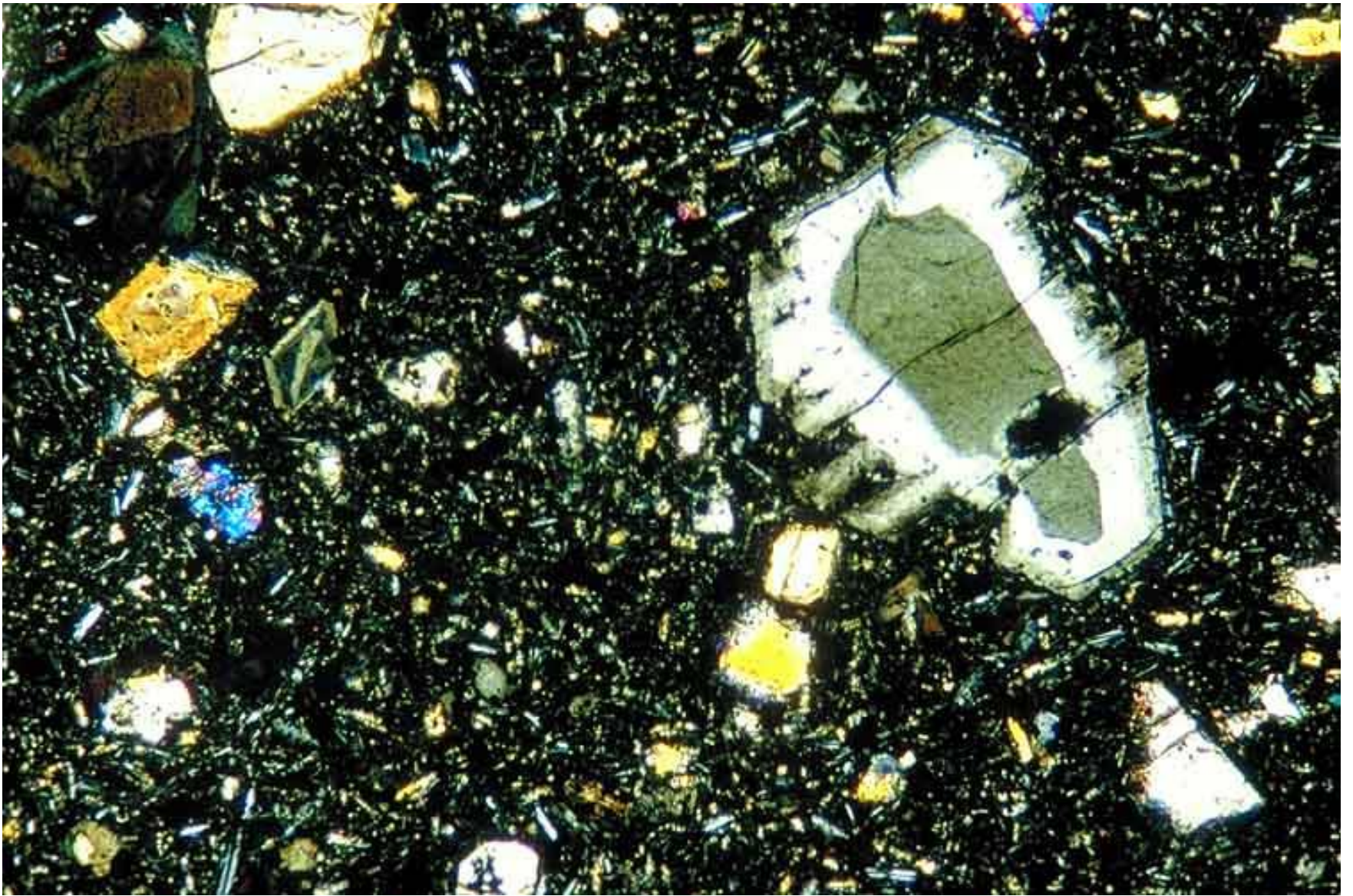
Granite porphyry



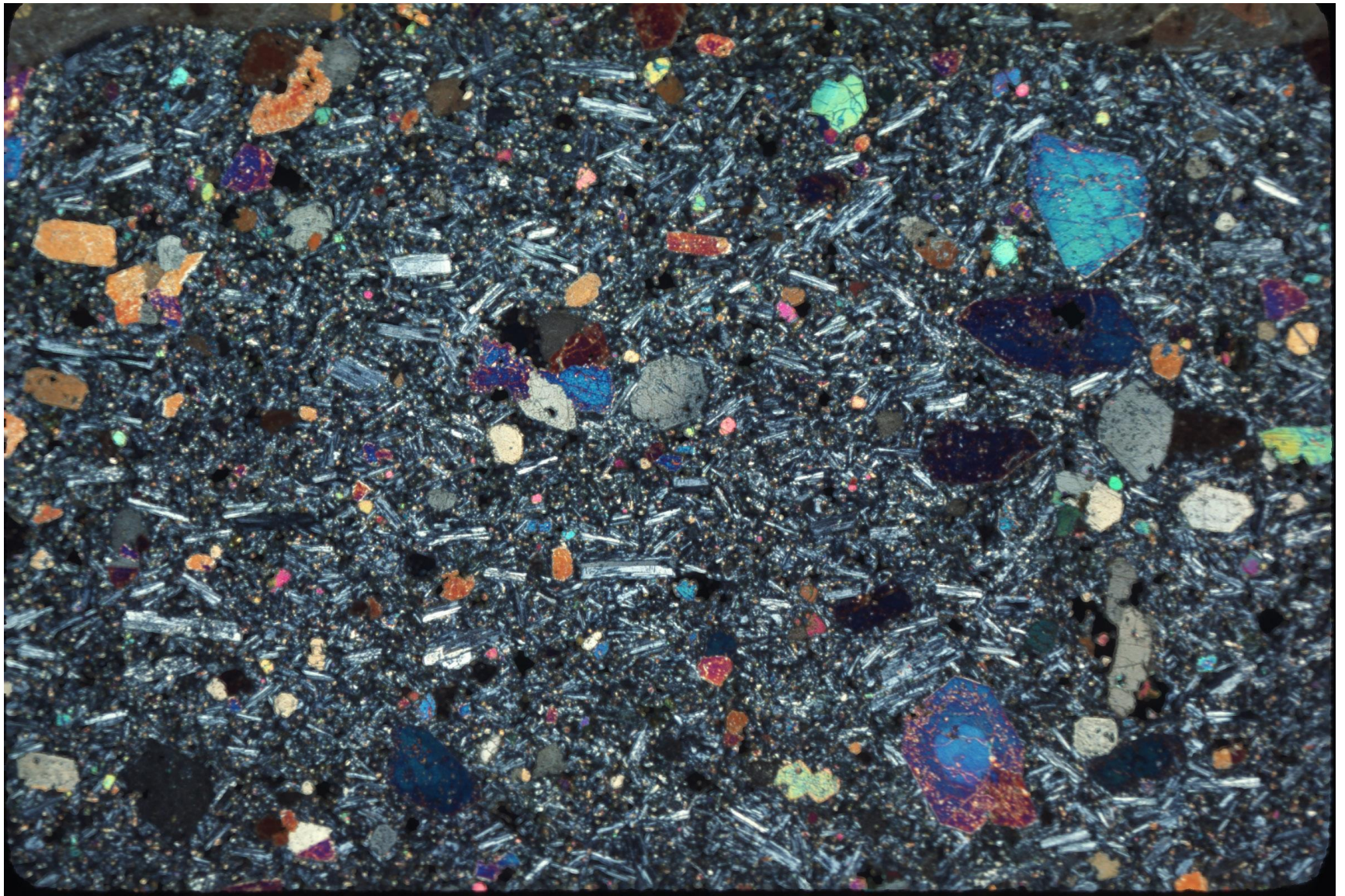
Andesite porphyry

Porphyritic textures





Porphyritic texture



Porphyritic texture



Two crystal sizes — large and very small — we call such igneous rocks **porphyritic**.

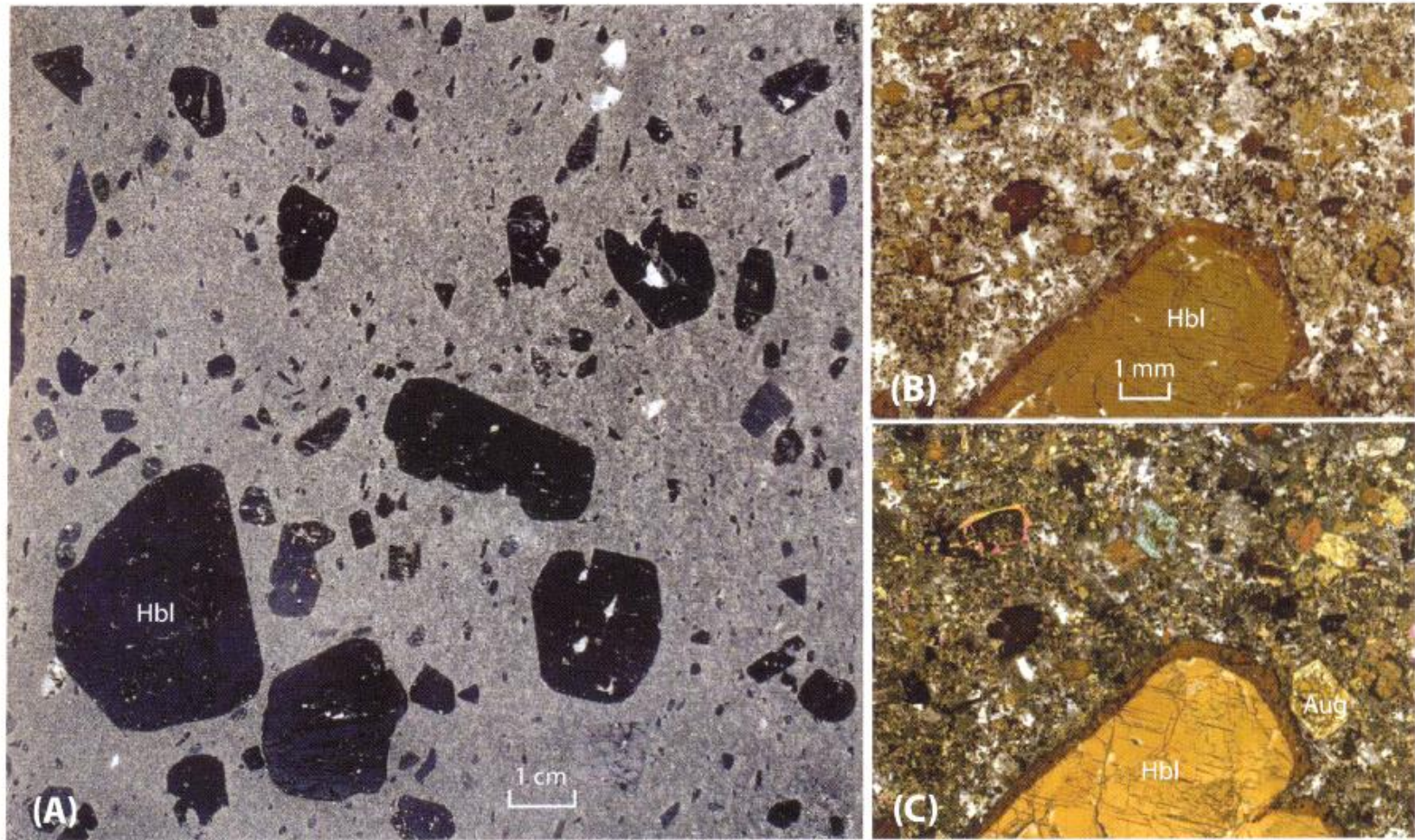


Figure 9.37 (A) Lamprophyric dike rock from Montreal, Quebec, containing large black phenocrysts of hornblende (Hbl). (B) Photomicrograph of a thin section under plane light showing the upper tip of the large hornblende phenocryst in the lower left of (A) in a groundmass of titanium-rich hornblende, titanite (Aug), magnetite, and late crystallizing plagioclase. (C) Same as (B) under crossed polars.

The large crystals in such a rock are referred to as:

phenocrysts (pheno = show, cryst = crystal)

whereas the matrix of smaller crystals is called **groundmass or matrix**.

A rock with a porphyritic texture is termed a **porphyry**.

Aphanitic (fine-grained) Texture

Igneous rocks that form at the surface, or as small intrusive masses within the upper crust where cooling is relatively rapid, exhibit a fine-grained texture termed aphanitic (a = not, phaner = visible).



Closed-up view

Fig. 4.9: Rhyolite, the aphanitic equivalent of granite.



Rhyolite



Basalt

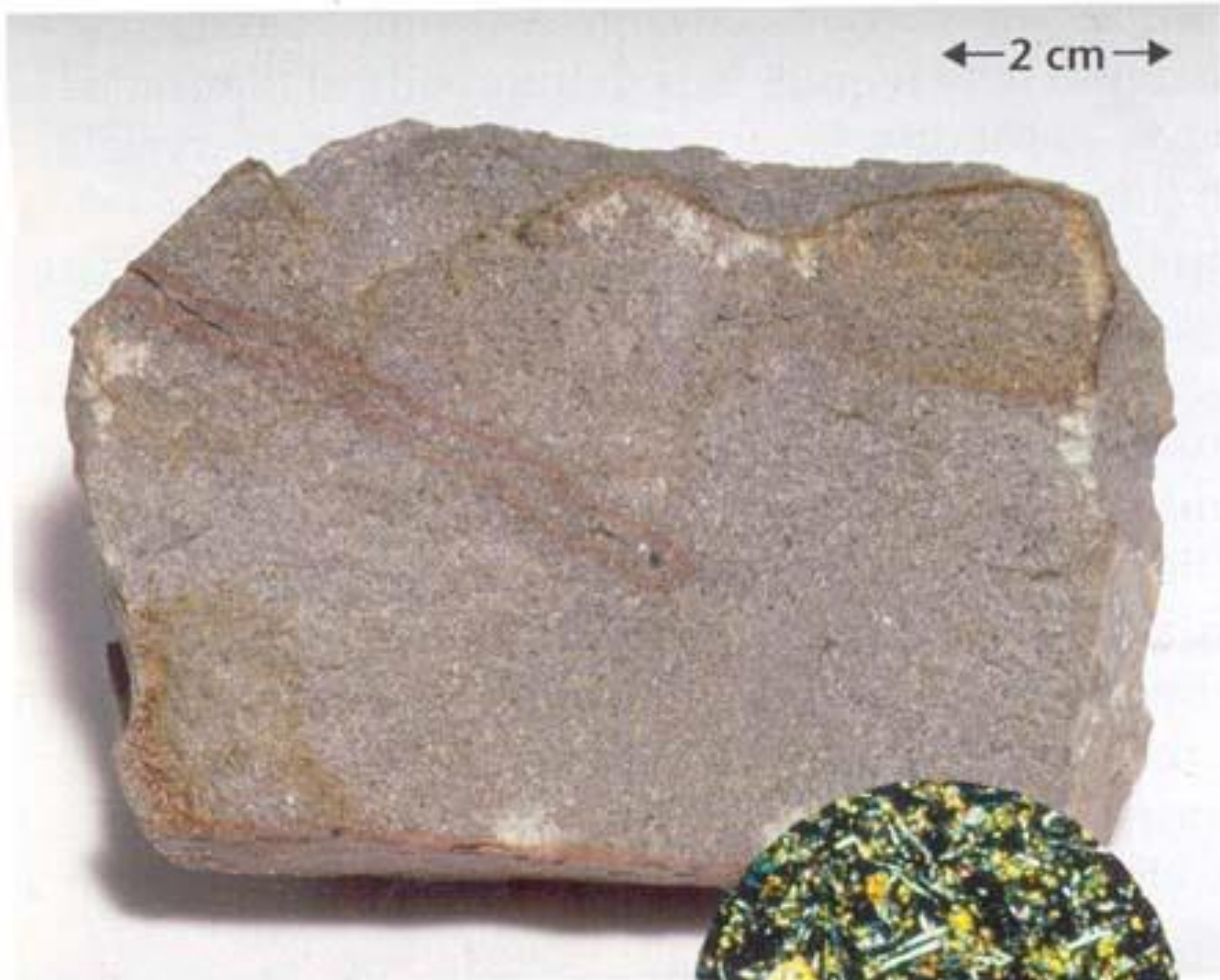
Aphanitic (fine-grained Textures)



Basalt under microscope

By definition, the rocks contain individual mineral grains that make up **aphanitic** rocks are so small that individual minerals can only be distinguished with the aid of a polarizing microscope or other sophisticated techniques,

(generally smaller than **0.062 mm**).



A. Aphanitic





GRANITE

SLOW vs. Fast COOLING

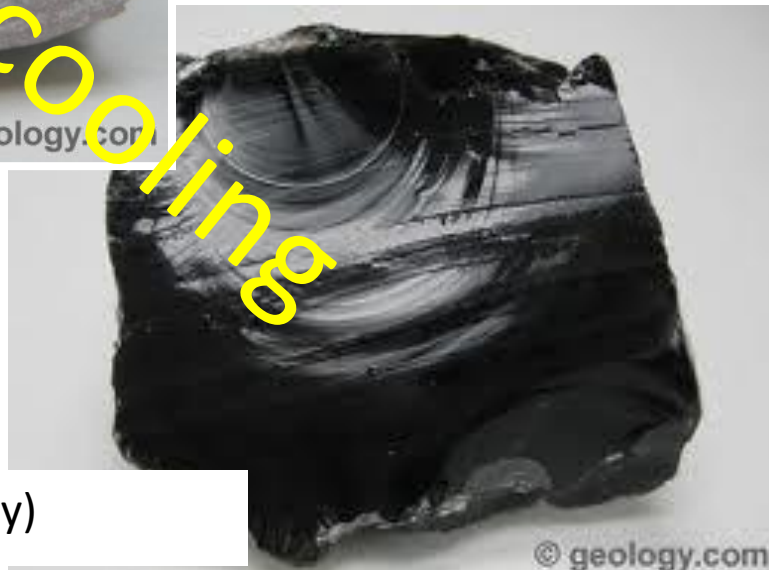
RHYOLITE



coarse-grained
(phaneritic)

fine-grained
(aphanitic)

OBSIDIAN



no crystals (glassy)

© geology.com

© geology.com



GRANITE

Plutonic

coarse-grained
(phaneritic)



RHYOLITE

Volcanic

fine-grained
(aphanitic)

© geology.com

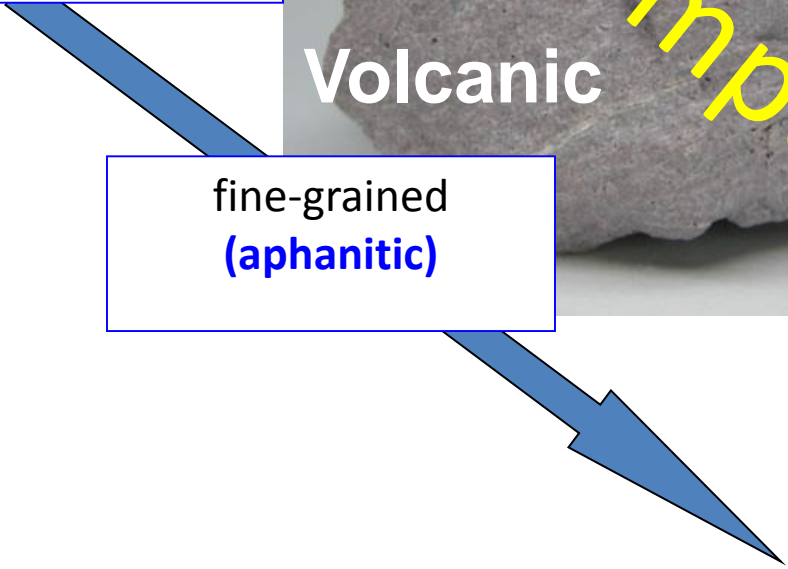


OBSIDIAN

Volcanic

no crystals **(glassy)**

Same composition



Glassy texture and Vesicular texture (structure)

Several unique igneous textures commonly develop under the condition of cooling which are associated with volcanic eruptions. These include:

- 1. Glassy texture and**
- 2. Vesicular texture (structure)**

1. Glassy Texture

When magmas cool very rapidly at the earth's surface there frequently is not sufficient time for atoms to combine and minerals do not nucleate. These hardened magmas are **noncrystalline solids** and have **glassy texture**.

During volcanic eruptions, molten rock is ejected into the atmosphere, where it is **quenched quickly.**

Rapid cooling of this type may generate rocks having a glassy texture (Fig 4.5A**).**

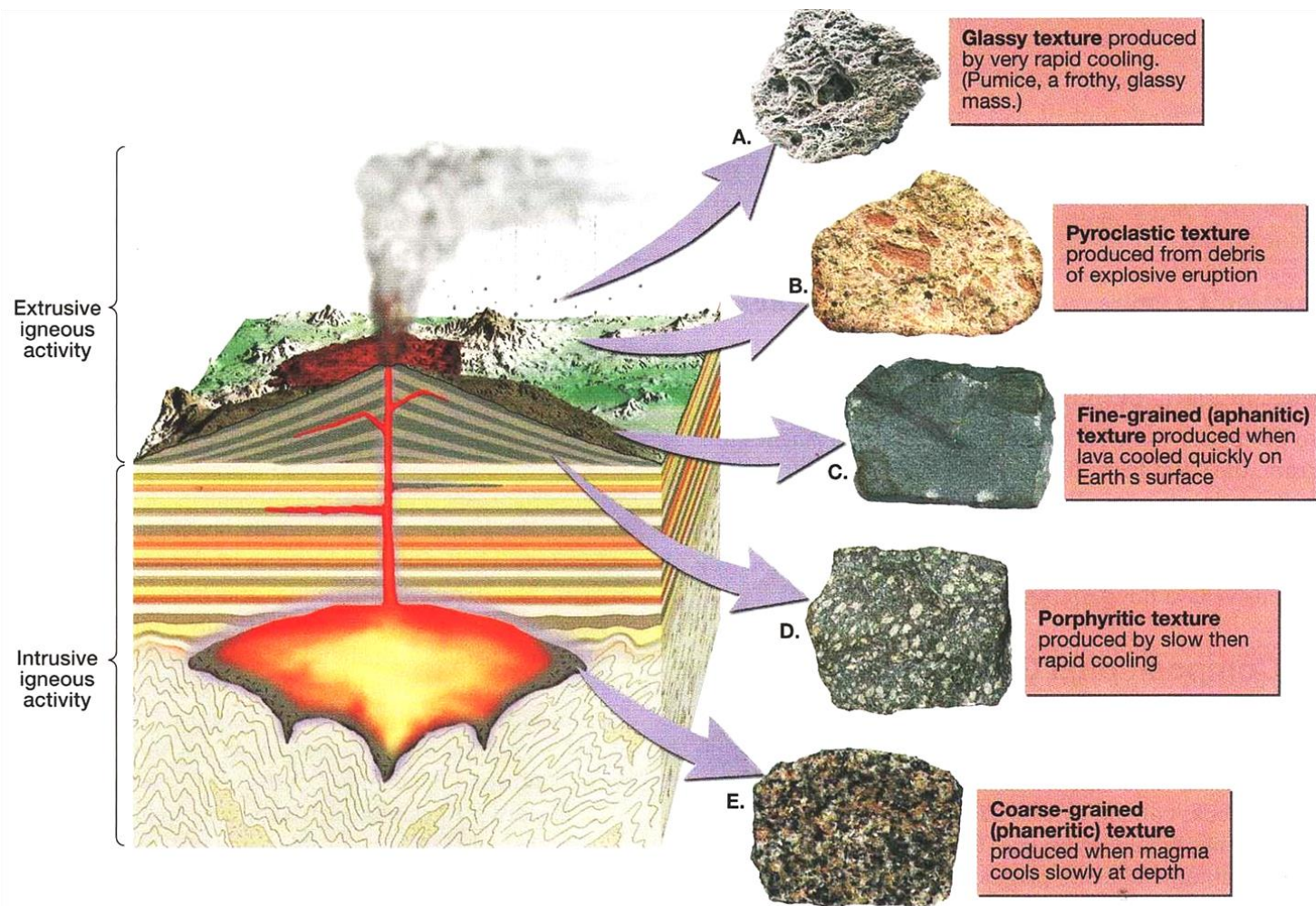


FIGURE 4.5 Igneous rock textures. A. During a volcanic eruption in which silica-rich lava is ejected into the atmosphere, a frothy glass called pumice may form. B. Rocks that exhibit a *pyroclastic texture* are a result of the consolidation of rock fragments that were ejected during a violent volcanic eruption. C. Igneous rocks that crystallize at or near Earth's surface cool quickly and often exhibit a *fine-grained (aphanitic) texture*. D. A *porphyritic texture* results when magma that already contains some large crystals migrates to a new location where the rate of cooling increases. The resulting rock consists of larger crystals (*phenocrysts*) embedded within a matrix of smaller crystals (*groundmass*). E. *Coarse-grained (phaneritic)* igneous rocks form when magma slowly crystallizes at depth. (Photos by E. J. Tarbuck)



D. Glassy

Glass results when unordered ions are “frozen in place” before that are able to unite into an orderly crystalline structure.

Obsidian, a common type of natural glass, is similar in appearance to a dark chunk of manufactured glass (Fig 4.7).

OBSIDIAN — VOLCANIC GLASS (a supercooled liquid)





Obsidian: The specimen shown above is about two inches (five centimeters) across. The curved semi-concentric ridges are breakage marks associated with obsidian's conchoidal fracture. The rock has very sharp edges.

Because of its excellent **conchoidal fracture and ability to hold a sharp, hard edge, obsidian was a prized material from which Native Americans chipped arrowheads and cutting tools.**

2. Vesicular Texture

Magmas often contain a large number of gas bubbles.

If an extruded magma cools rapidly, some bubbles may not be able to escape. The trapped bubbles form holes and produce a spongy or vesicular texture.

Also, some are the **voids left by gas bubbles that escape as lava solidifies.**

These nearly spherical openings are called **vesicles**, and the rocks that contain them are said to have a **vesicular texture**.

▼ **FIGURE 4.4** Vesicular texture displayed on a freshly broken surface of the volcanic rock scoria. Vesicles are small holes left by escaping gas bubbles. (Photo by Michael Collier)



These unusual rocks are named **pumice** if they are light-colored or **scoria** if they are dark-colored.

Rocks that exhibit a **vesicular texture** usually form in the upper zone of a lava flow, where cooling occurs rapidly enough to preserve the openings produced by the expanding gas bubbles.

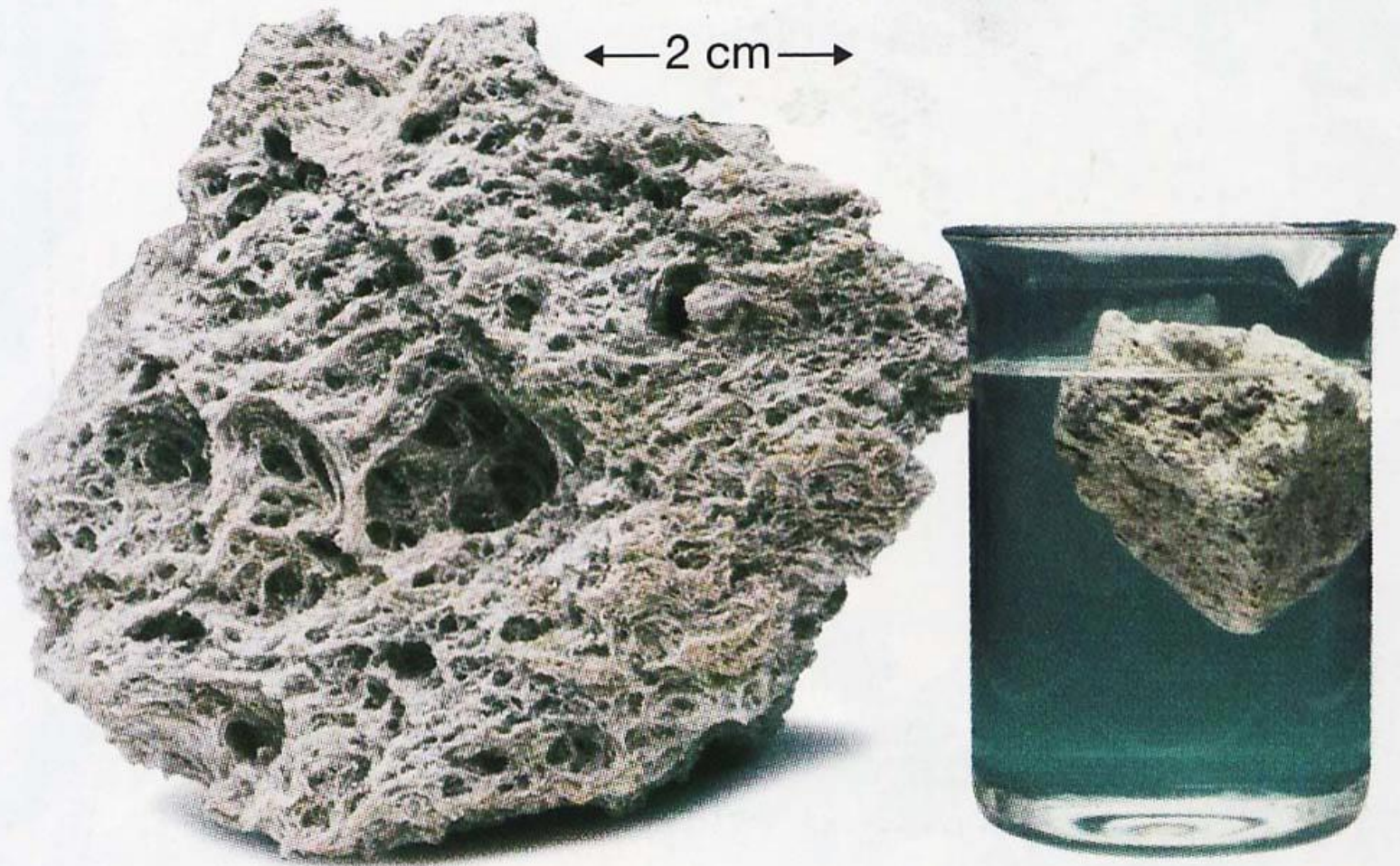
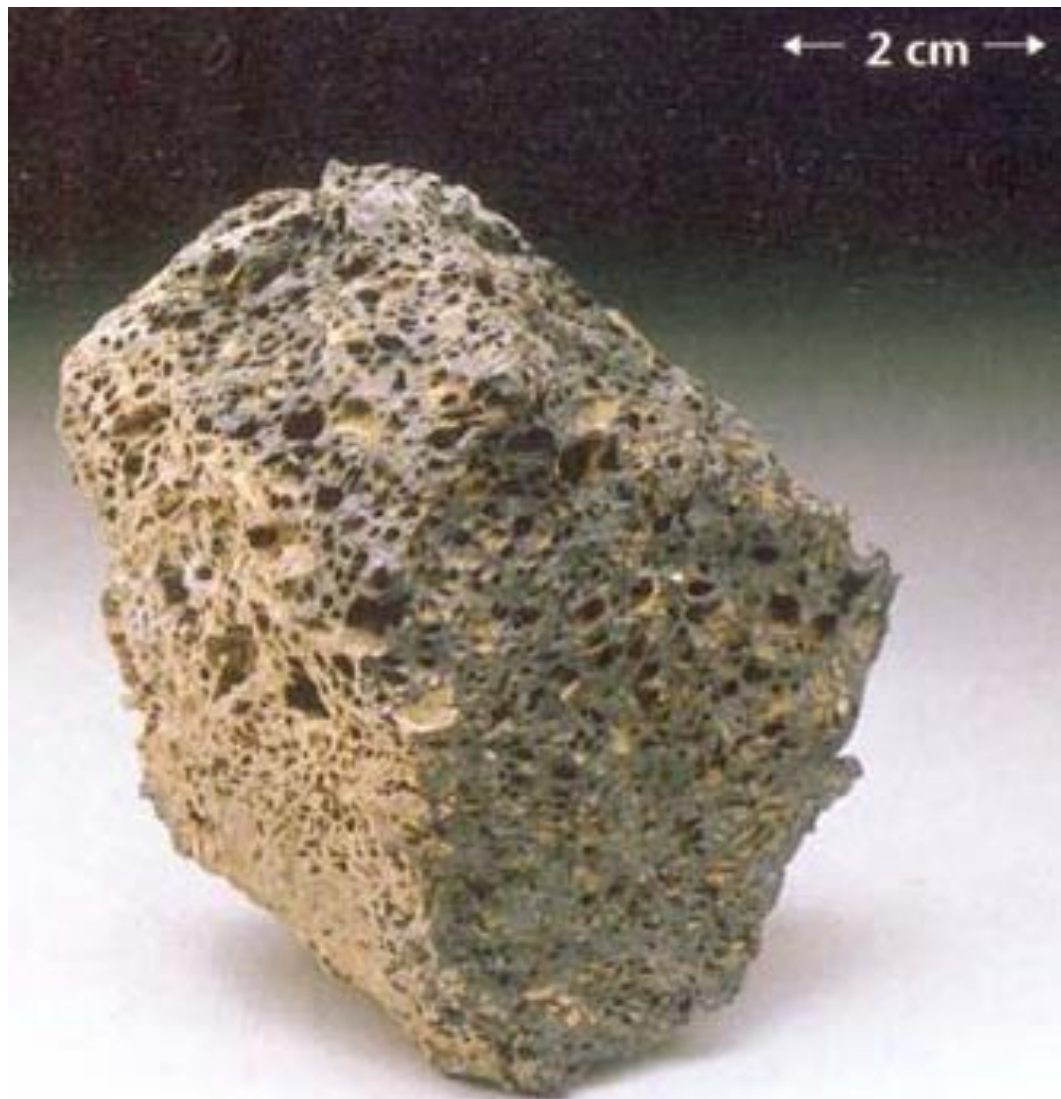
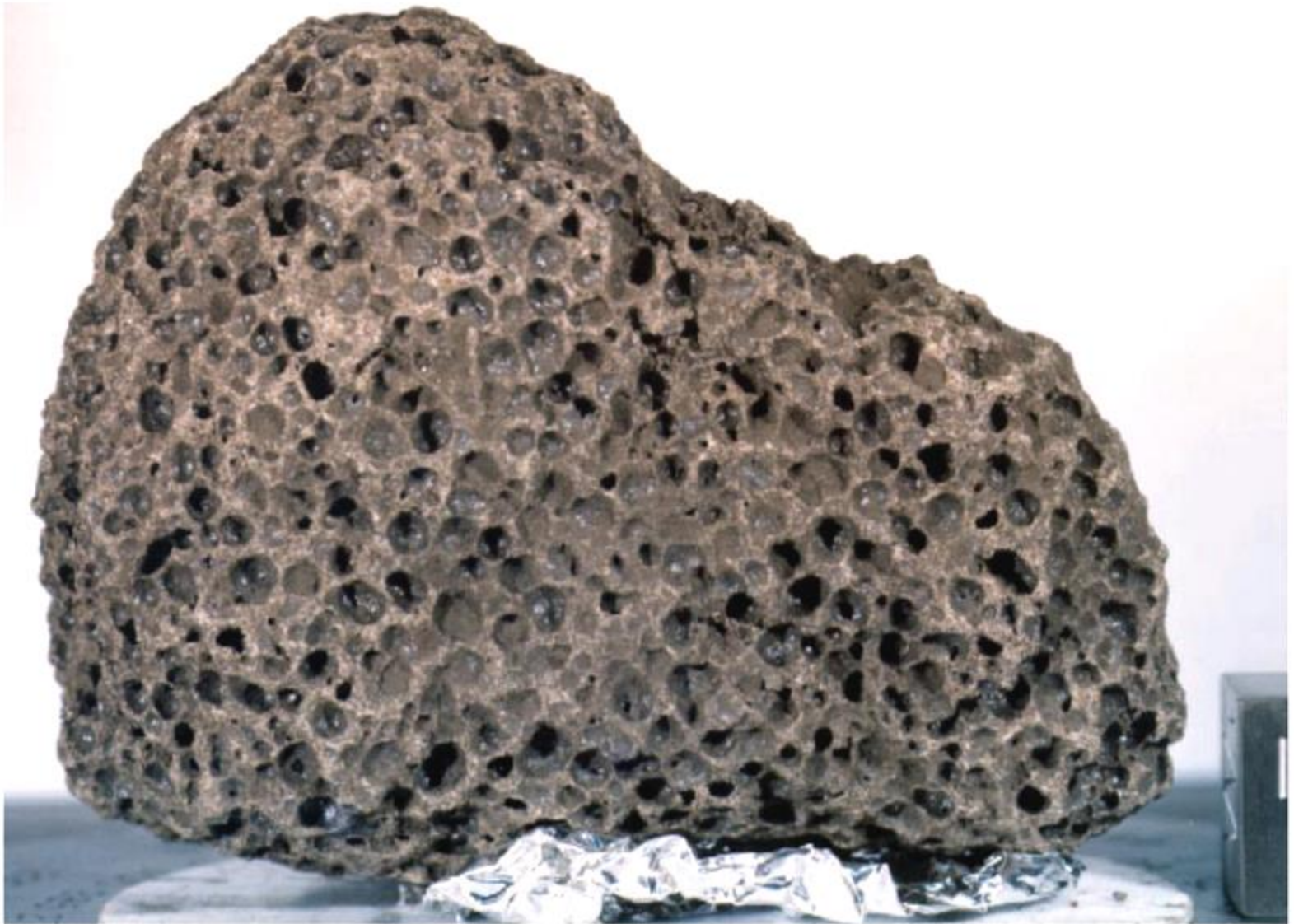


FIGURE 4.14 Pumice, a glassy rock, is very lightweight because it contains numerous vesicles. (Inset photo by Chip Clark)



▲ **FIGURE 5.8** Scoria is a volcanic rock that exhibits a vesicular texture. Vesicles are small holes left by escaping gas bubbles.
(Photo by E. J. Tarbuck)



Vesicular basalt from Moon

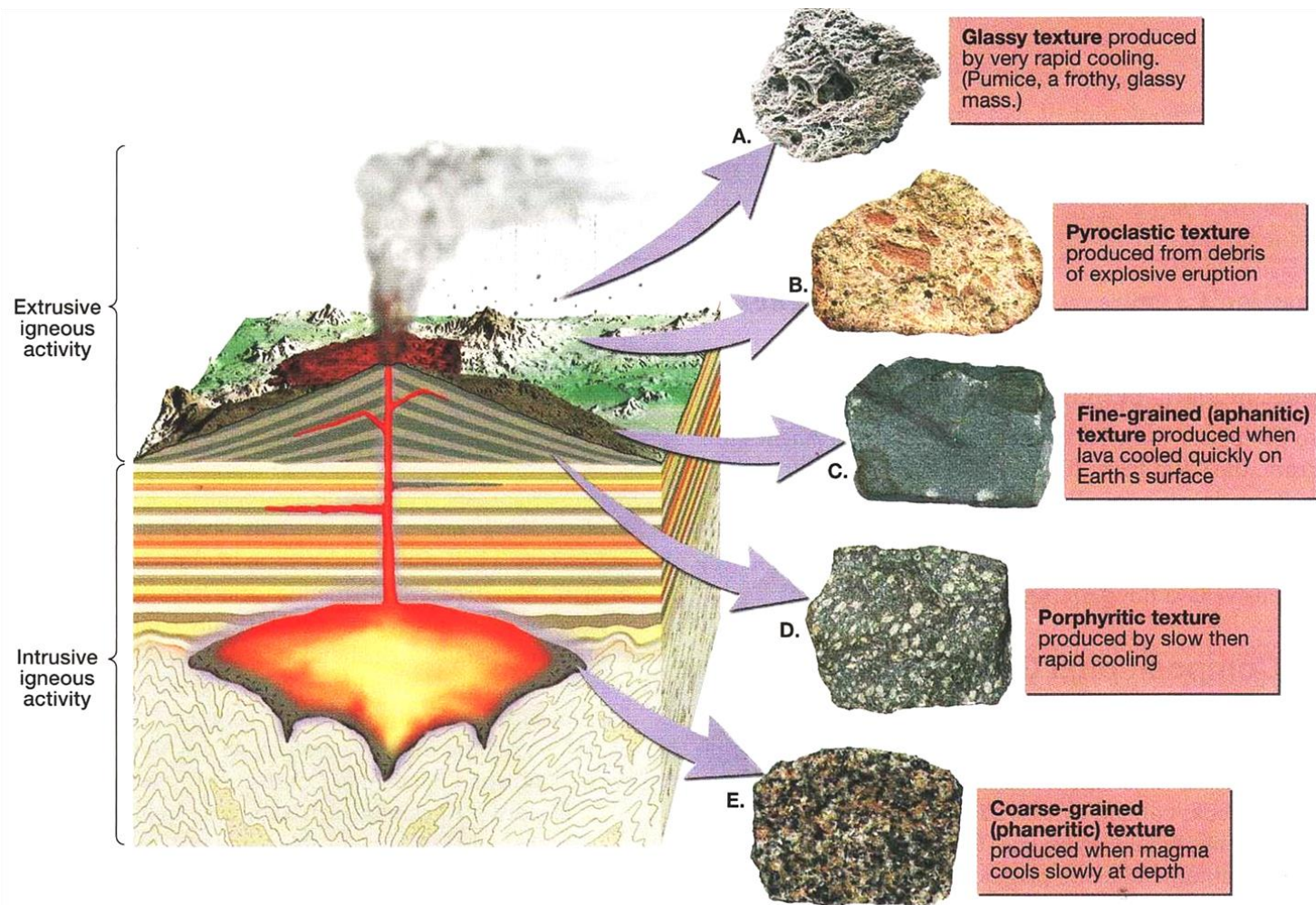


FIGURE 4.5 Igneous rock textures. A. During a volcanic eruption in which silica-rich lava is ejected into the atmosphere, a frothy glass called pumice may form. B. Rocks that exhibit a *pyroclastic texture* are a result of the consolidation of rock fragments that were ejected during a violent volcanic eruption. C. Igneous rocks that crystallize at or near Earth's surface cool quickly and often exhibit a *fine-grained (aphanitic) texture*. D. A *porphyritic texture* results when magma that already contains some large crystals migrates to a new location where the rate of cooling increases. The resulting rock consists of larger crystals (*phenocrysts*) embedded within a matrix of smaller crystals (*groundmass*). E. *Coarse-grained (phaneritic)* igneous rocks form when magma slowly crystallizes at depth. (Photos by E. J. Tarbuck)

Pyroclastic volcanic rocks (literally “fire-fragmental” rocks)

Such rocks include:

- (1) very fine ash formed from the lava droplets (molten blobs) thrown into the air (**volcanic ash**),**
- (2) larger pieces (cinders, bombs), and**
- (3) solid large angular blocks or fragments of the volcano blown apart torn from the walls of the vent during the eruption.**



Volcanic ash and much larger blobs of lava, Iceland “E” volcano



Mt. Etna erupting cinder cone — a pyroclastic volcano

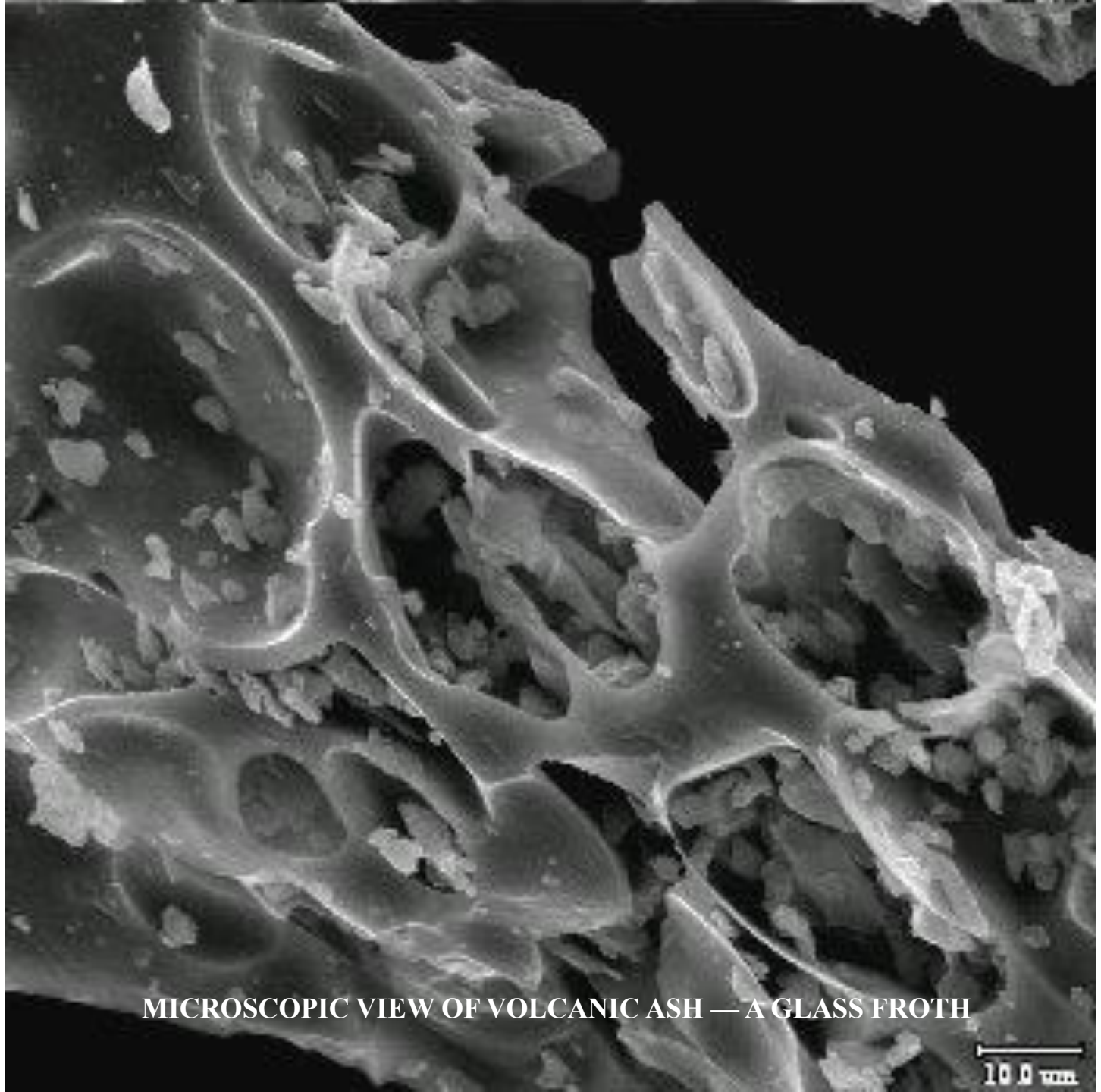




Pyroclastic cloud from Una Una

volcanic ash in Argentina downwind from Puyehue volcano, Chile, 6/2011





MICROSCOPIC VIEW OF VOLCANIC ASH — A GLASS FROTH

100 μm

Pyroclastic (Fragmental) Texture

Another group of igneous rocks is formed from the consolidation of individual rock fragments that are ejected during a violent volcanic eruption.

Igneous rocks composed of these rock fragments are said to have a **pyroclastic or fragmental texture (Fig 4.5B).**

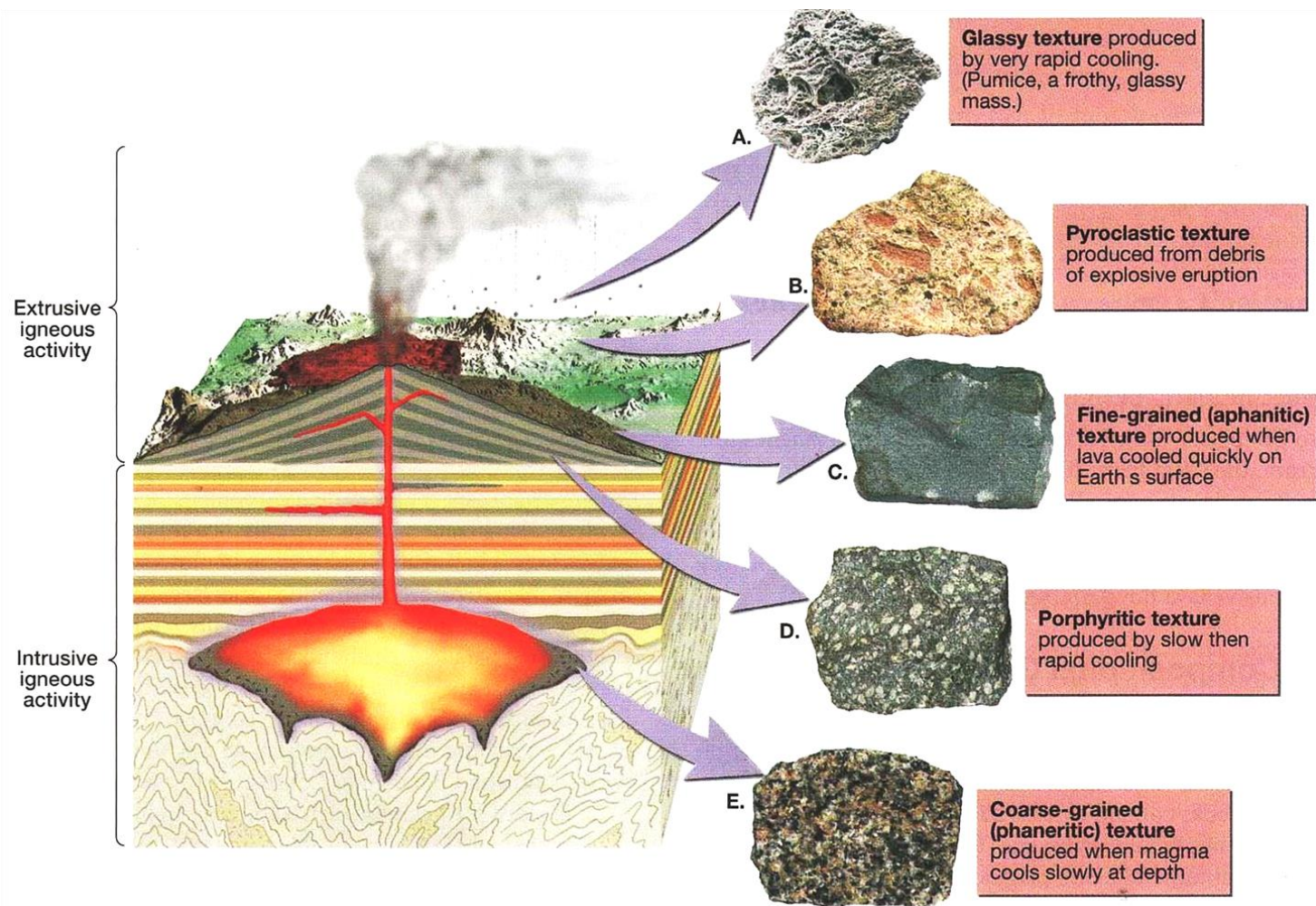


FIGURE 4.5 Igneous rock textures. A. During a volcanic eruption in which silica-rich lava is ejected into the atmosphere, a frothy glass called pumice may form. B. Rocks that exhibit a *pyroclastic texture* are a result of the consolidation of rock fragments that were ejected during a violent volcanic eruption. C. Igneous rocks that crystallize at or near Earth's surface cool quickly and often exhibit a *fine-grained (aphanitic) texture*. D. A *porphyritic texture* results when magma that already contains some large crystals migrates to a new location where the rate of cooling increases. The resulting rock consists of larger crystals (*phenocrysts*) embedded within a matrix of smaller crystals (*groundmass*). E. *Coarse-grained (phaneritic)* igneous rocks form when magma slowly crystallizes at depth. (Photos by E. J. Tarbuck)

A common type of pyroclastic rock, called **welded tuff**, is composed of fine fragments of glass that remained hot enough during their flight to fuse together upon impact.

Other pyroclastic rocks are composed of fragments that solidified before impact and became cemented together at some later time.

Pyroclastic rocks are made of individual particles or fragments rather than interlocking crystals.



The Black Region is Welded Tuff



welded tuff with fine eutaxitic texture; (polished block)

Hunterian Museum Geology collections, catalogue number GLAHM 134788

Pegmatitic Texture

Under special conditions, exceptionally coarse-grained igneous rocks, called **pegmatites, may form.**

These rocks, which are composed of interlocking crystals all larger than **1 cm in diameter, are said to have a pegmatitic texture (Fig 4.9).**



Pegmatite is a very coarse-grained igneous rock. Simple pegmatites are composed of large crystals of ordinary minerals. Here is a sample of alkali feldspar granite pegmatite from Northern Norway which is composed of alkali feldspar (pink), quartz (gray) and biotite (black). Width of view 50 cm.



The term “pegmatite” was first used by a French mineralogist René Haüy for such rocks that we nowadays know as [graphic granites](#). Evje, Norway. Width of sample 9 cm.



1

2

3

1

gneiss

THANK YOU

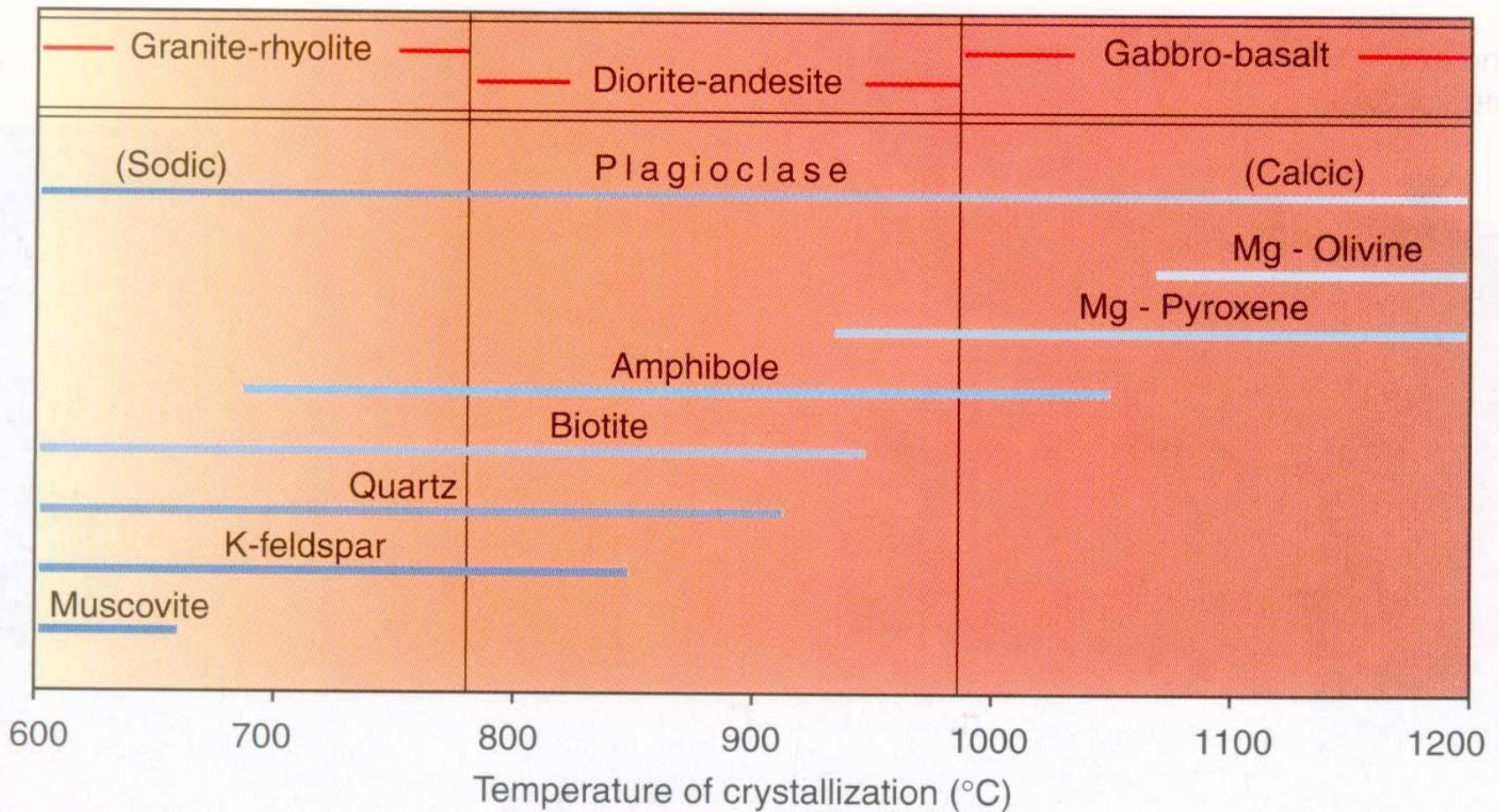


FIGURE 4.22 The order of crystallization of the common rock-forming minerals provides a key to the cooling history of a magma. Olivine, pyroxene, and Ca-plagioclase crystallize at high temperatures in mafic magmas. Amphibole, Na-Ca-plagioclase, and biotite crystallize at intermediate temperatures. Quartz, K-feldspar, Na-plagioclase, and muscovite crystallize at low temperatures in silicic magmas.



Vein of coarse-grained granite in a host rock of fine-grained granite. This decorative rock is used as a tombstone in Baton Rouge, Louisiana, USA. Width of view 25 cm.

Texture and Composition

