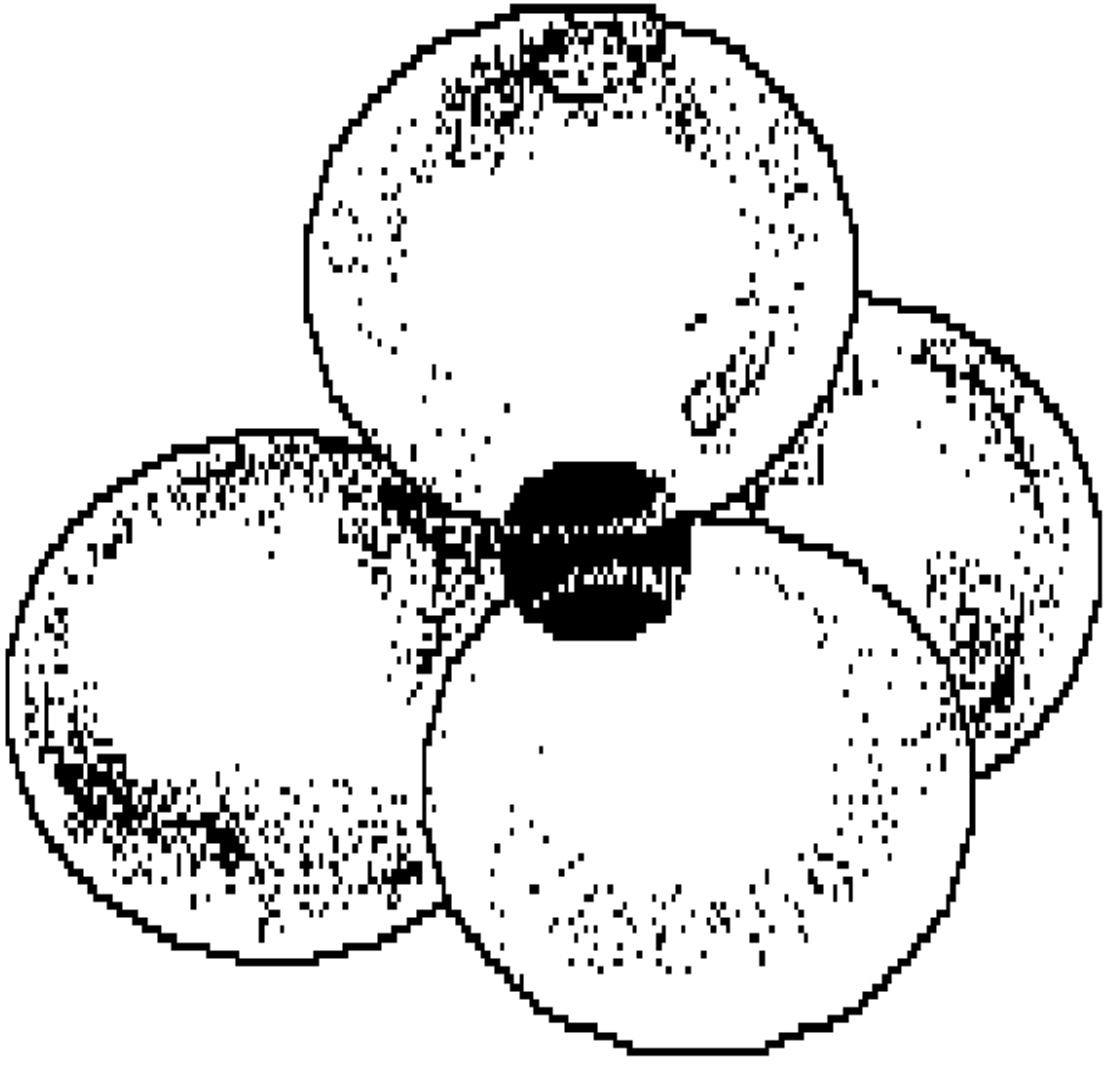
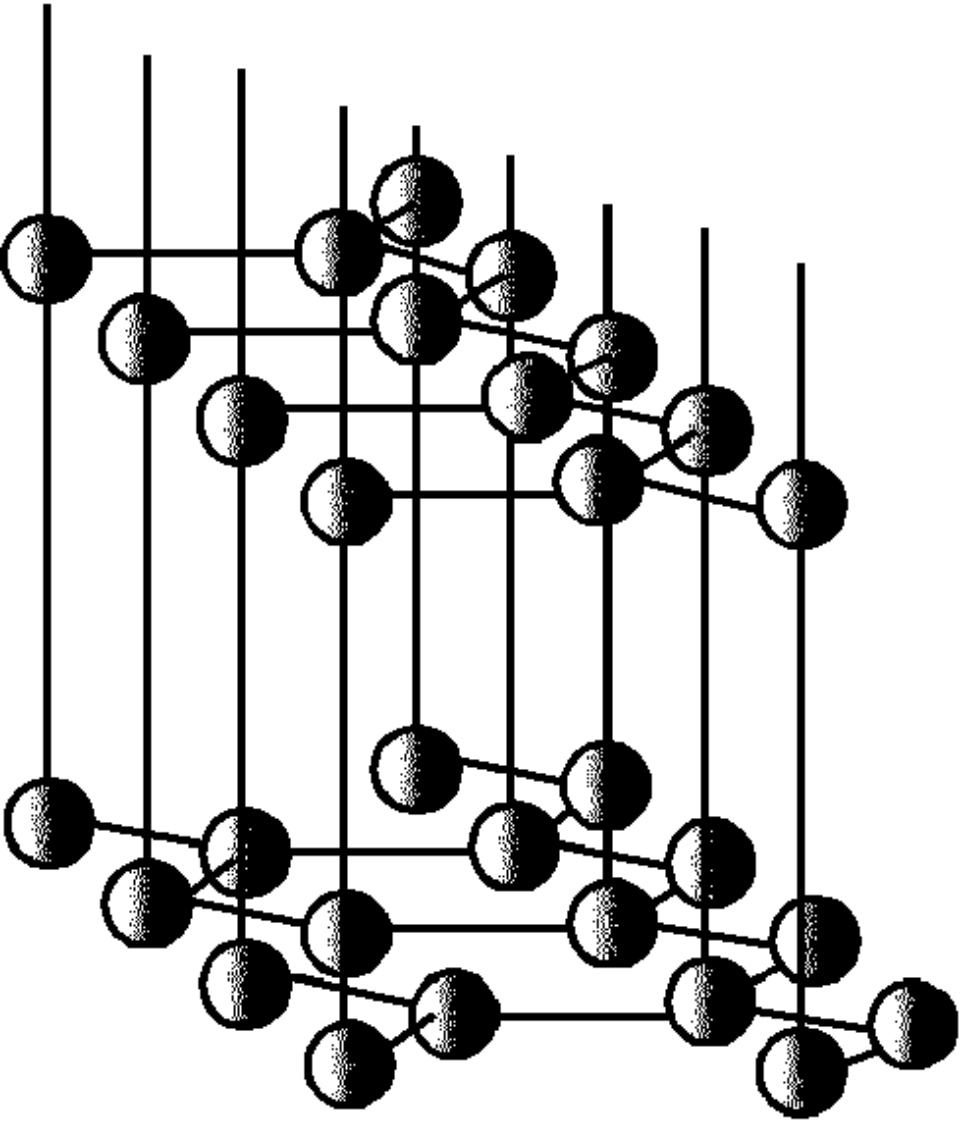


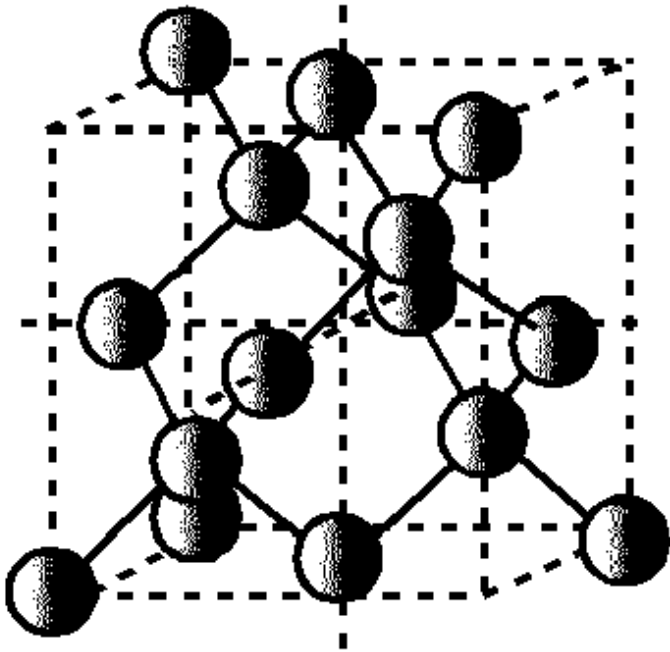
KEY:

Silicon Atom

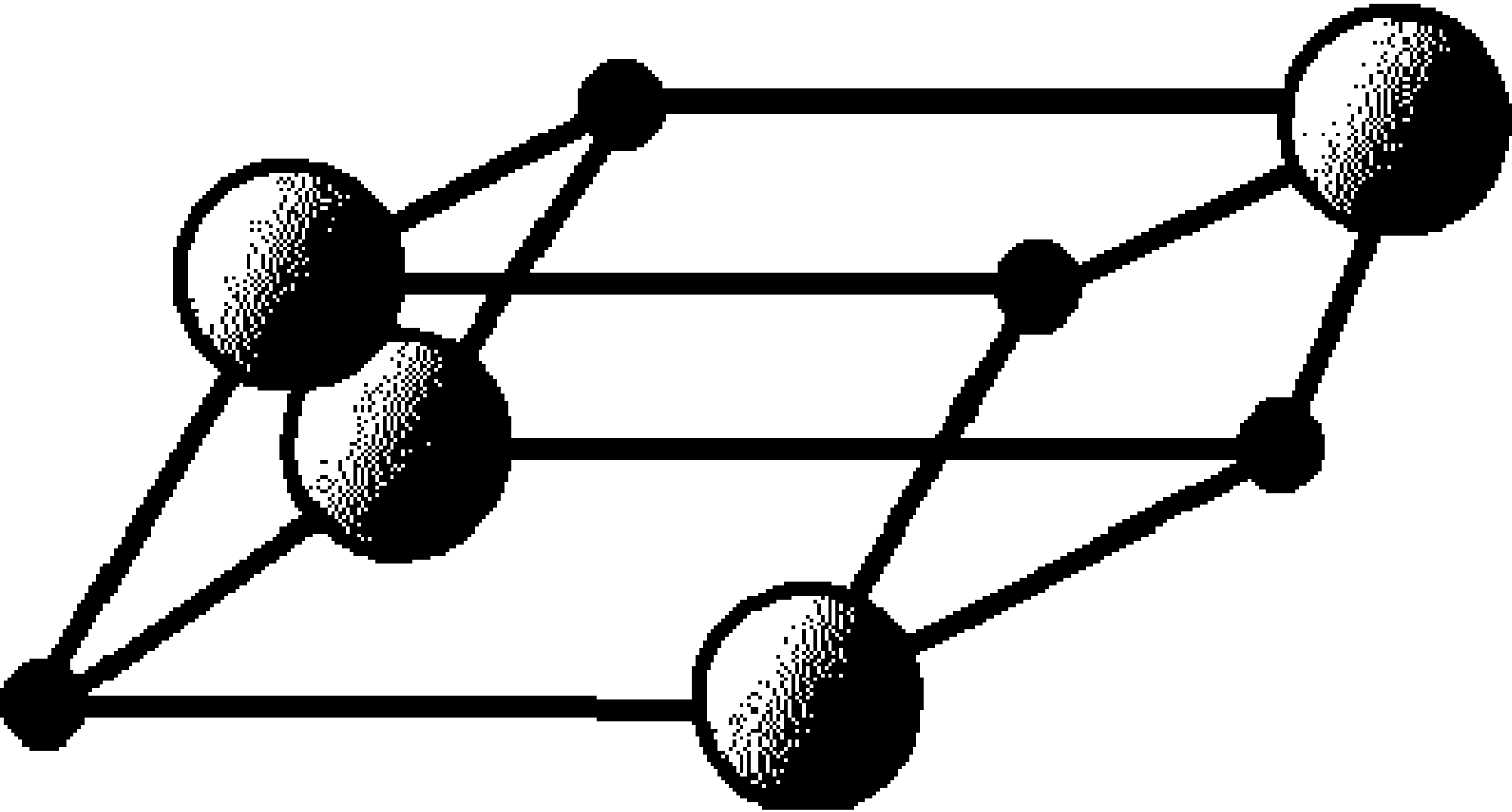
Oxygen Atom

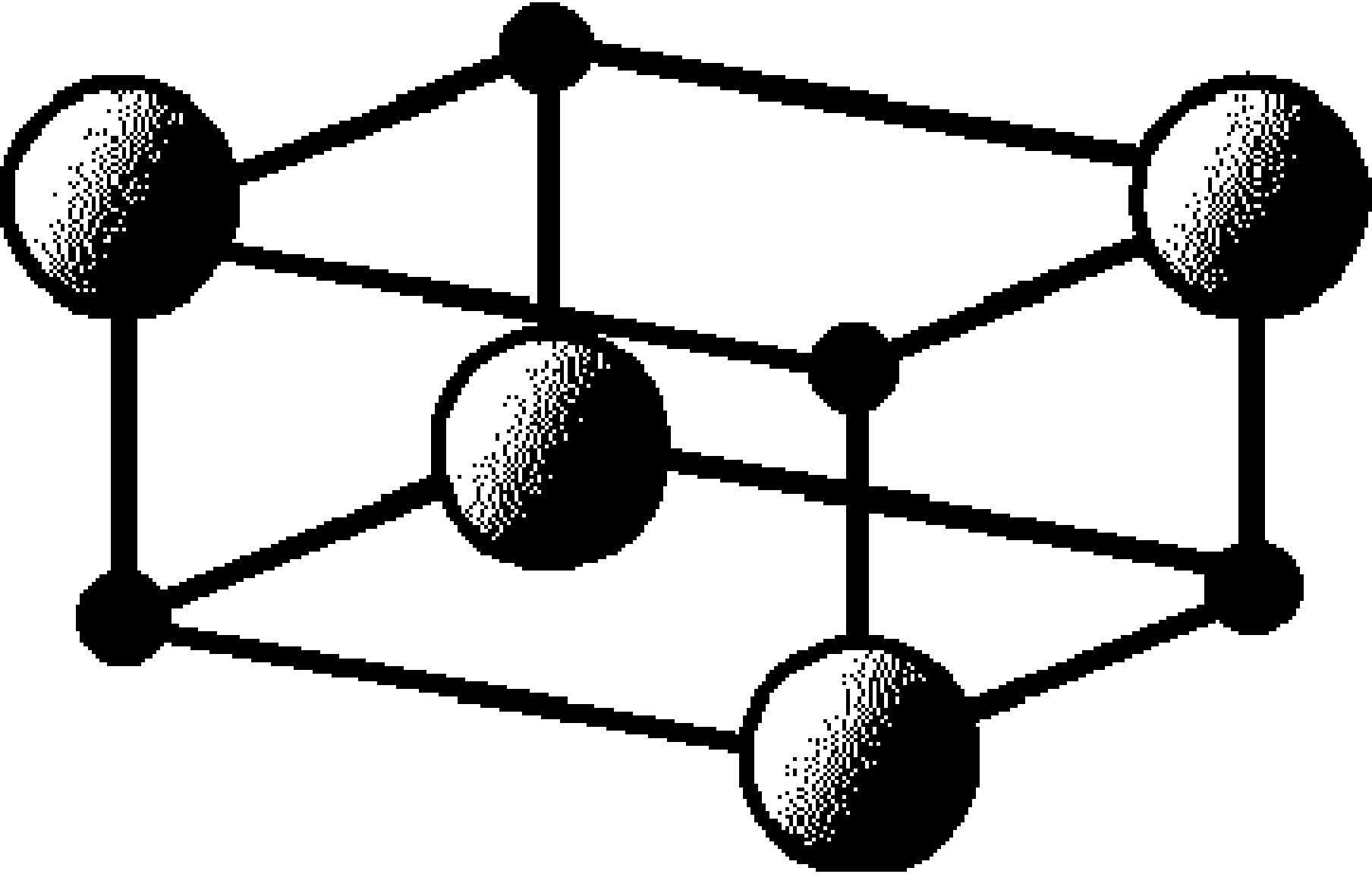


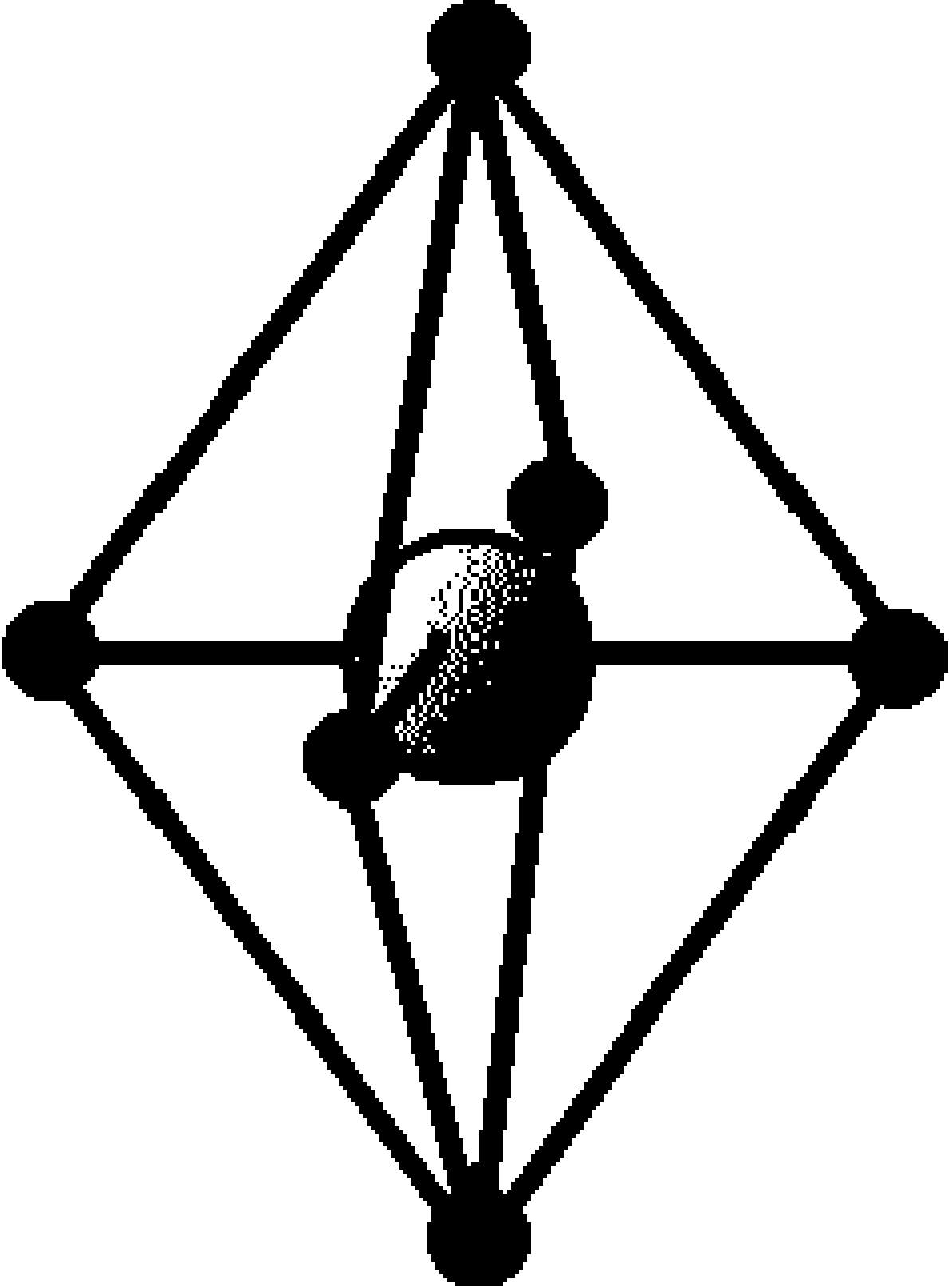
Graphite



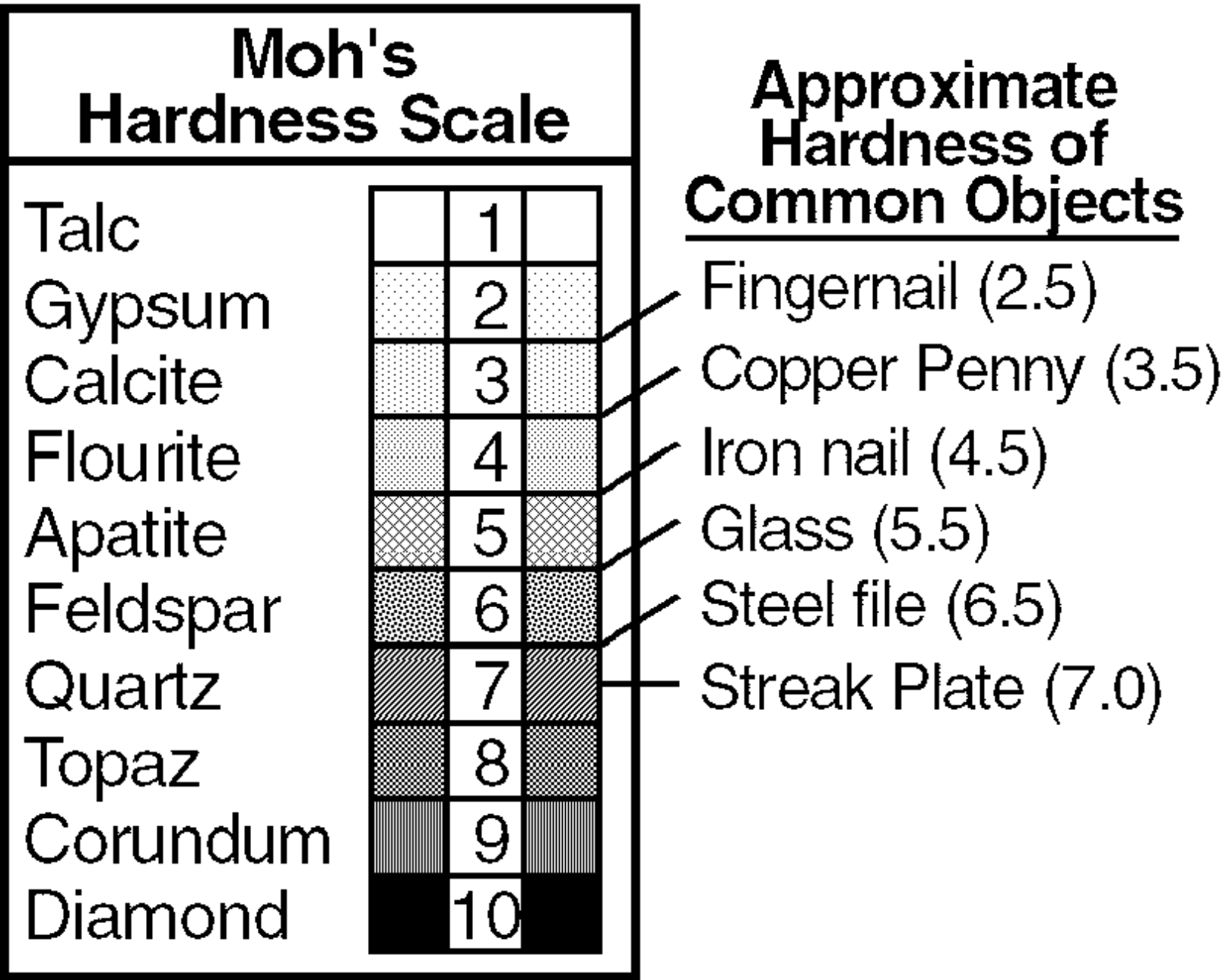
Diamond

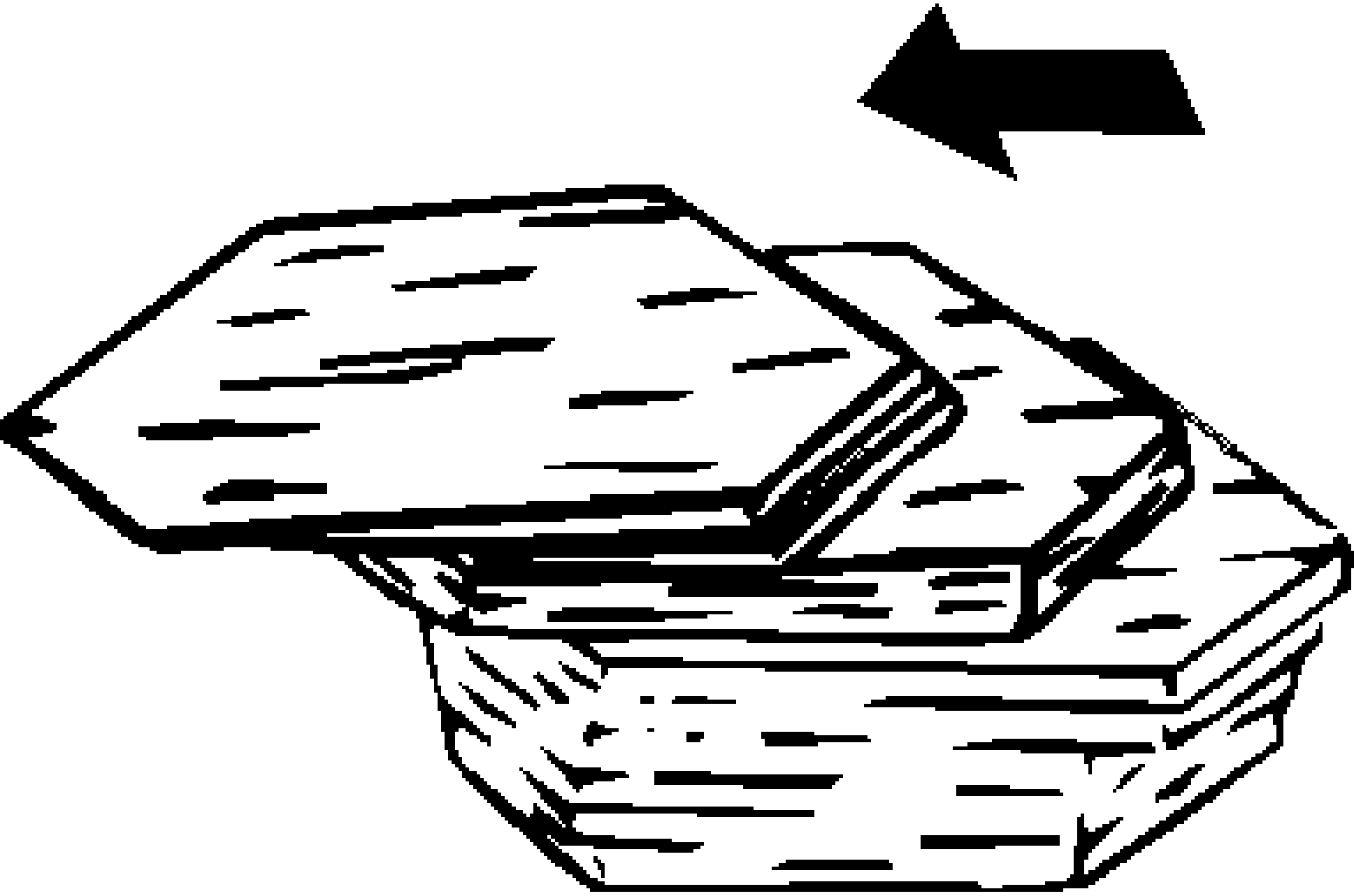


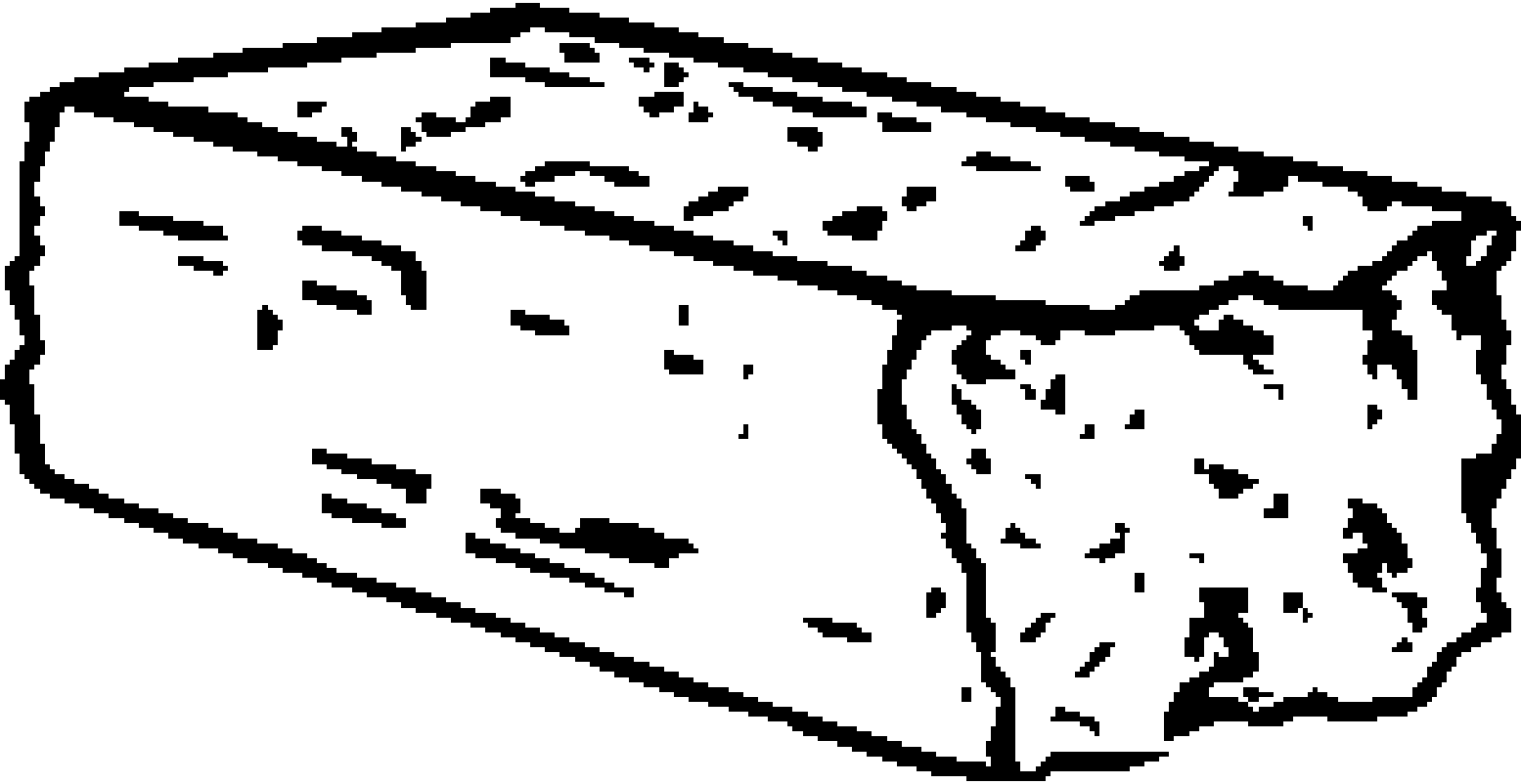




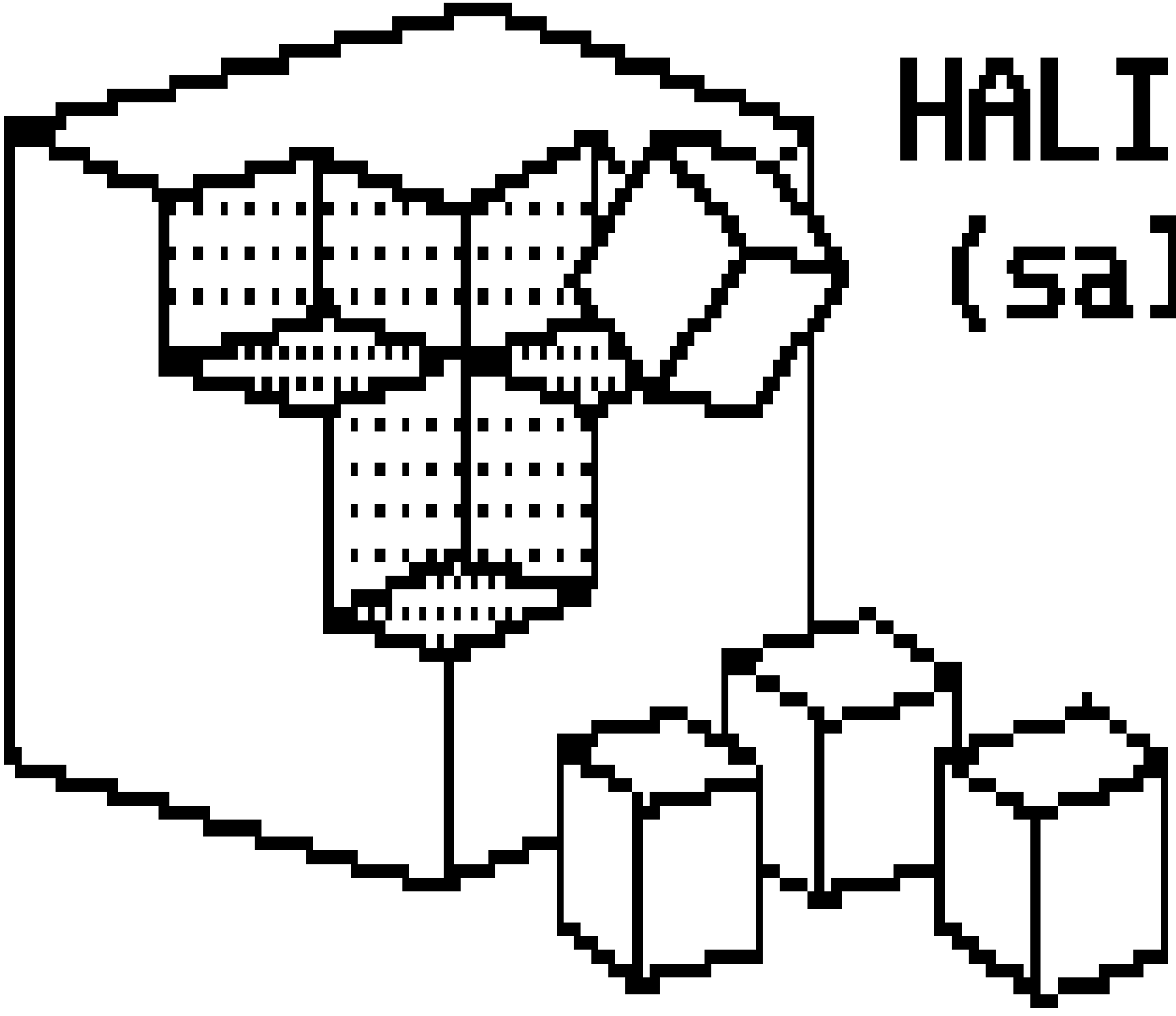
MINERAL HARDNESS







Mineral	Cleavage	Hardness	Density (g/cm^3)	Other Properties
Pyroxene (a complex family of minerals; augite is most common)	Two flat planes at nearly right angles	5–6	3.2–3.9	Found in igneous and metamorphic rocks; augite is dark green to black; other varieties are white to green



HALITE
(salt)

MINERAL	COLOR	LUSTER	STREAK	HARD-NESS	DENSITY (g/mL)	CHEMICAL COMPOSITION
biotite mica	black	glassy	white	soft	2.8	$K(Mg,Fe)_3(AlSi_3O_{10})(OH_2)$
diamond	varies	glassy	colorless	hard	3.5	C
galena	gray	metallic	grey-black	soft	7.5	PbS
graphite	black	dull	black	soft	2.3	C
kaolinite	white	earthy	white	soft	2.6	$Al_4(Si_4O_{10})(OH)_8$
magnetite	black	metallic	black	hard	5.2	Fe_3O_4
olivine	green	glassy	white	hard	3.4	$(Fe,Mg)_2SiO_4$
pyrite	brass yellow	metallic	greenish-black	hard	5.0	FeS_2
quartz	varies	glassy	colorless	hard	2.7	SiO_2

Definitions:

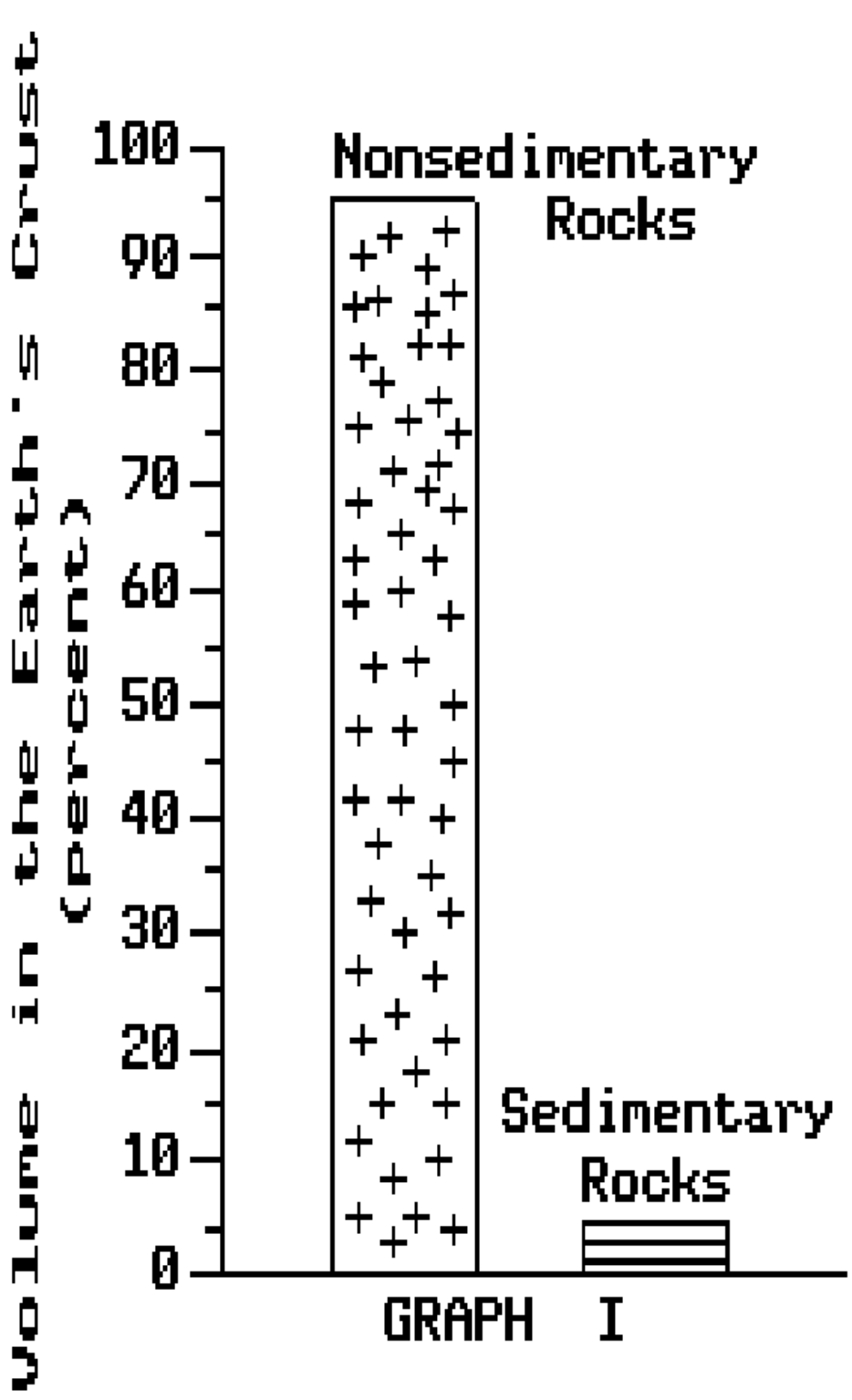
LUSTER: the way a mineral's surface reflects light

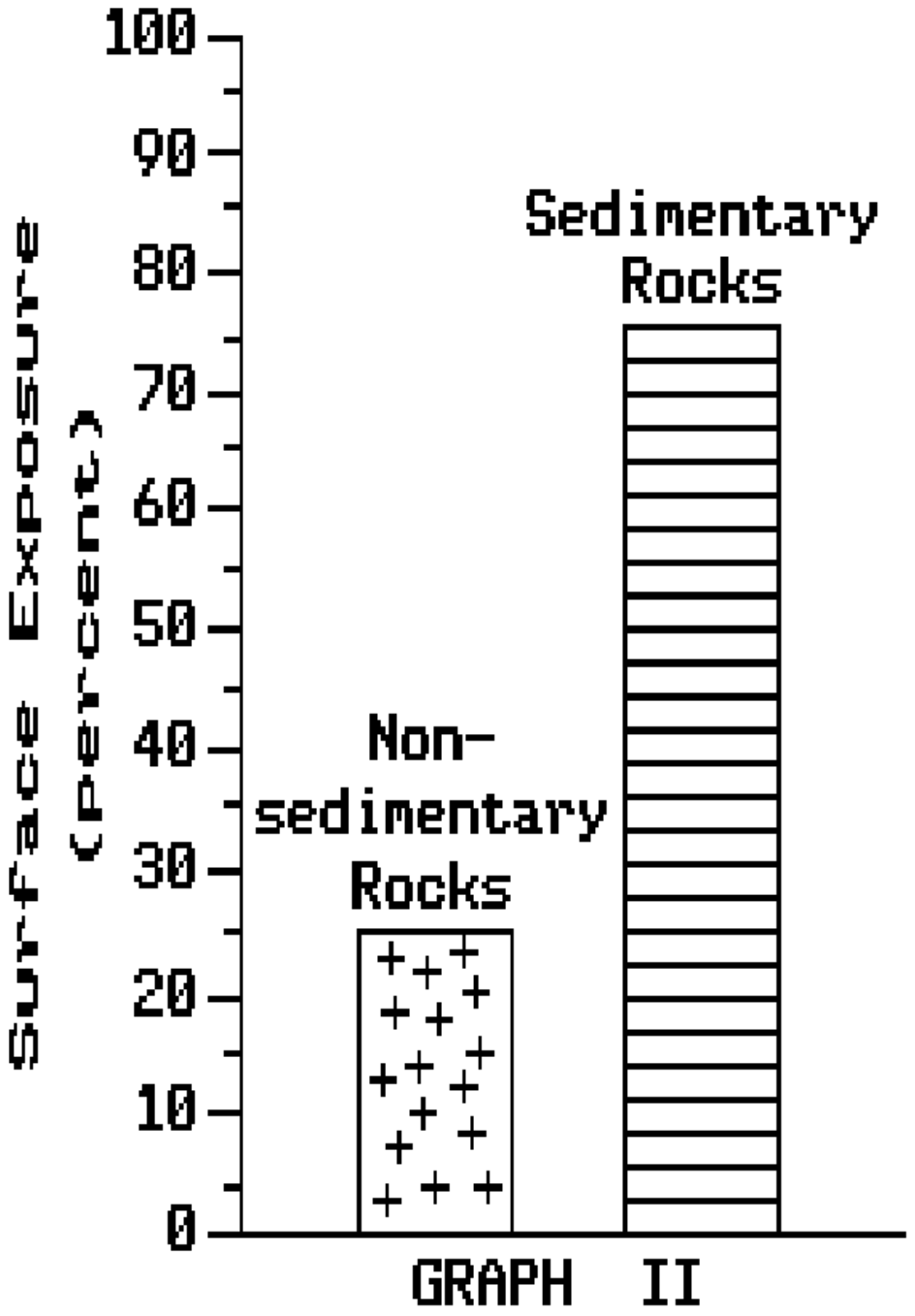
STREAK: color of a powdered form of the mineral

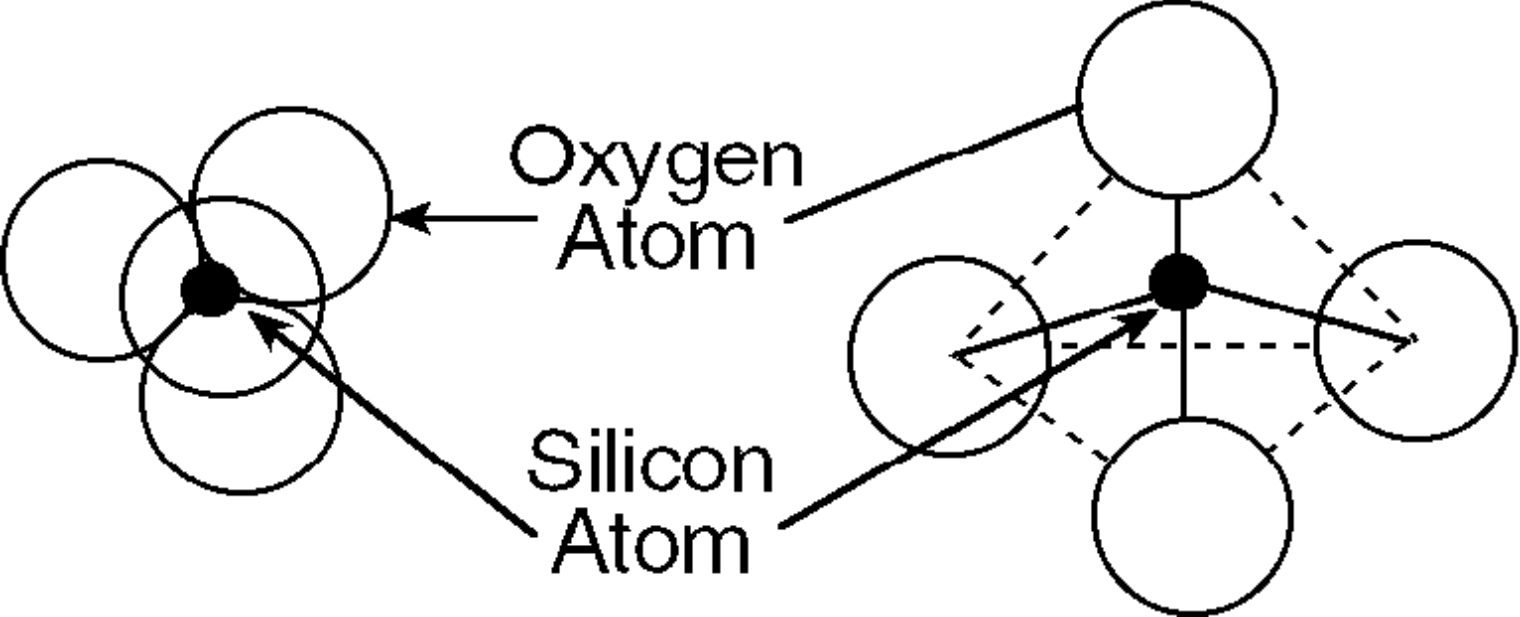
HARDNESS: resistance of a mineral to being scratched (soft-easily scratched; hard-not easily scratched)

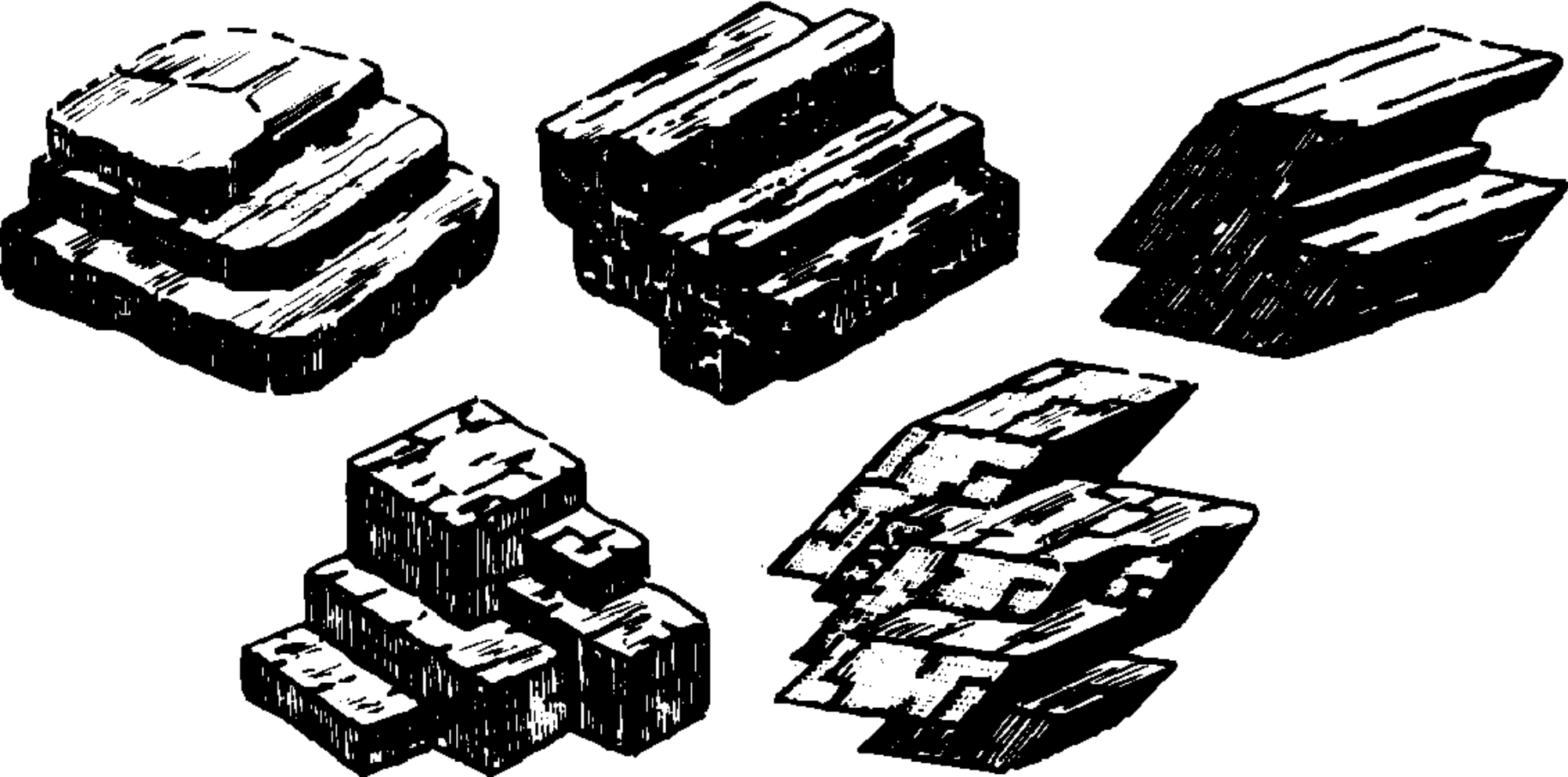
Chemical Symbols

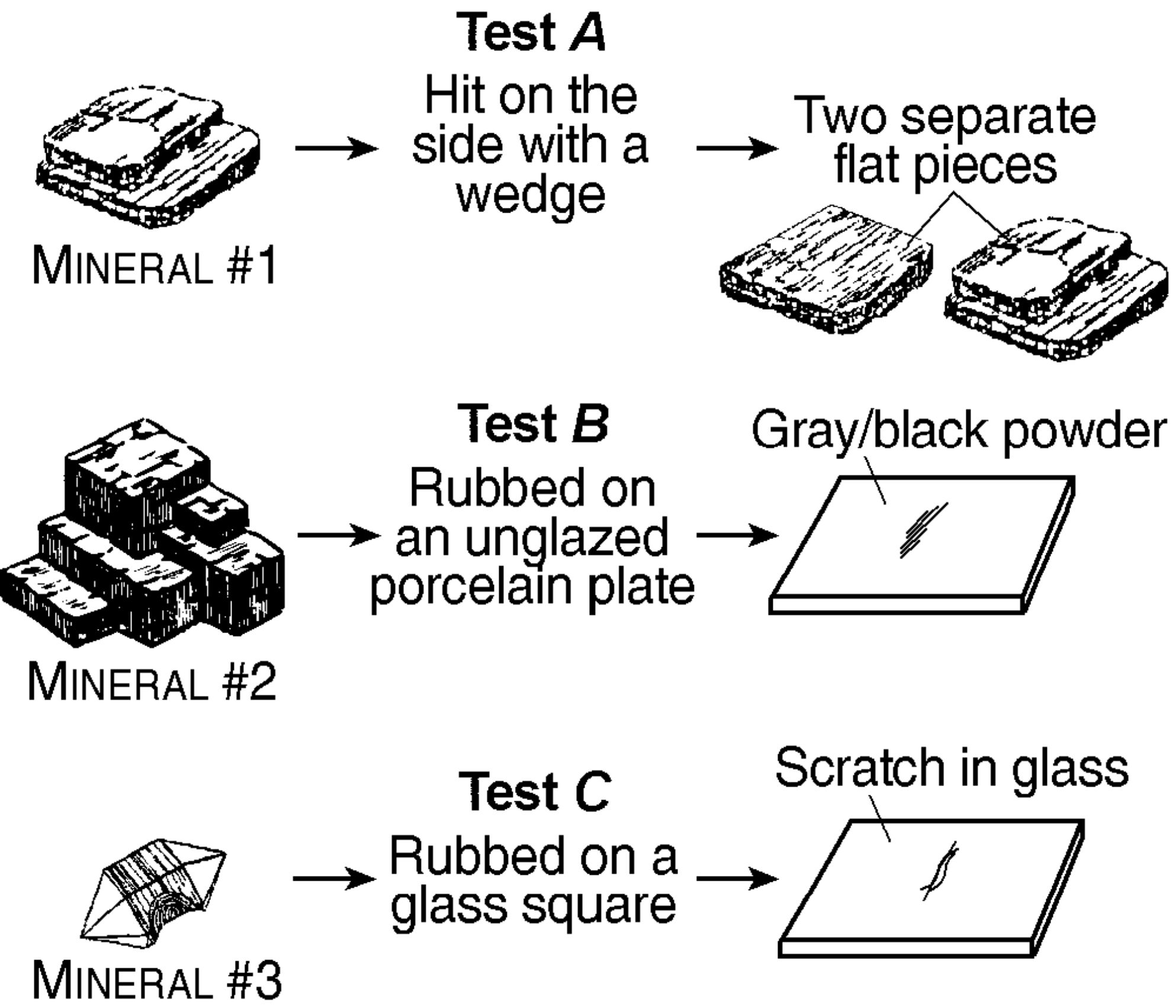
Al - Aluminum	Pb - Lead
C - Carbon	Si - Silicon
Fe - Iron	K - Potassium
H - Hydrogen	S - Sulfur
Mg - Magnesium	O - Oxygen

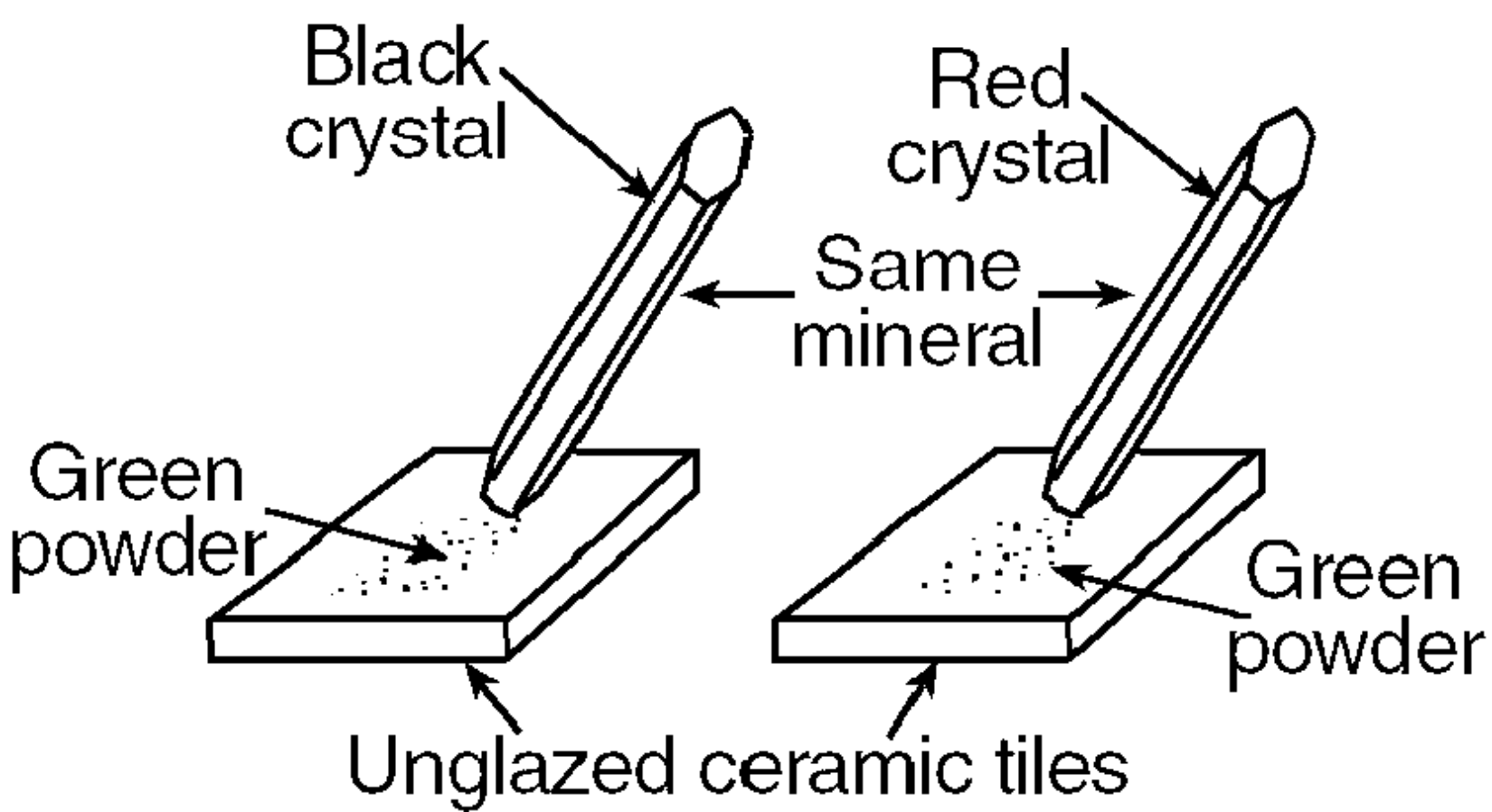

Volume in the Earth's Crust
(percent)
100
90
80
70
60
50
40
30
20
10
0
Nonsedimentary
Rocks
Sedimentary
Rocks
GRAPH I

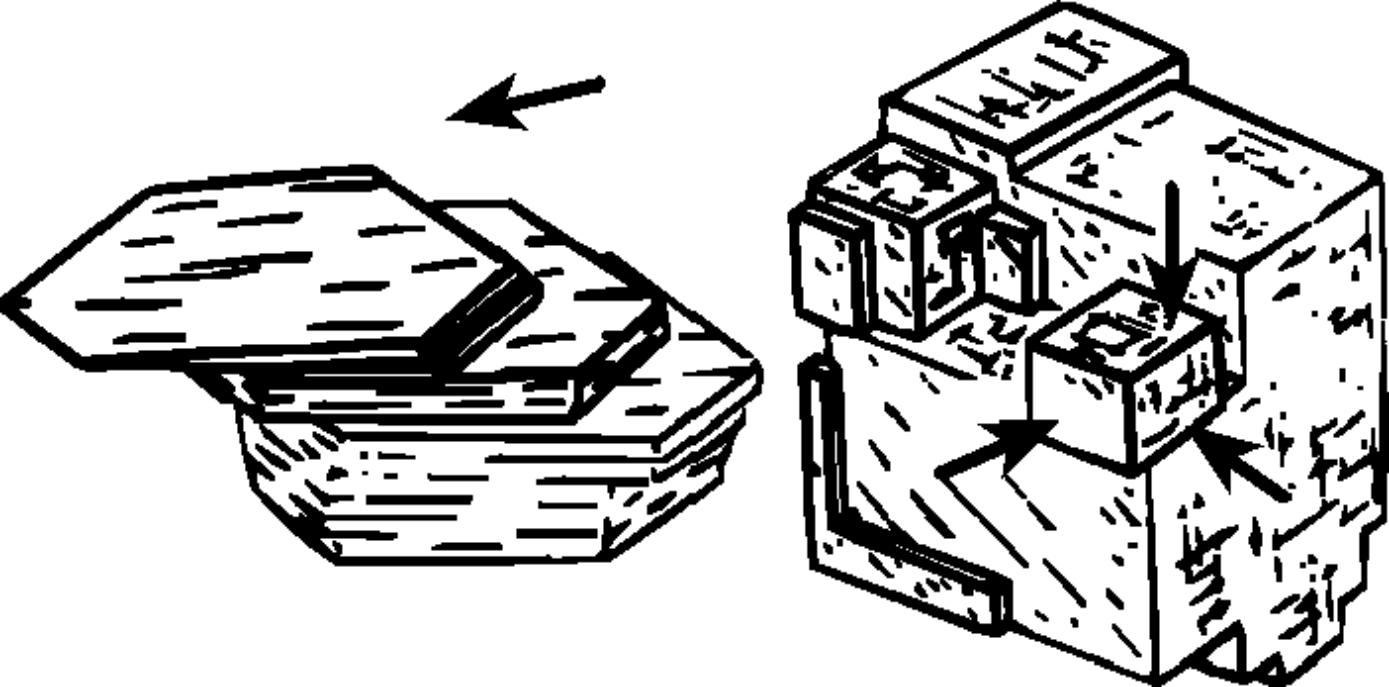

Surface Exposure
(percent)
100
90
80
70
60
50
40
30
20
10
0
Non-
sedimentary
Rocks
Sedimentary
Rocks
GRAPH II

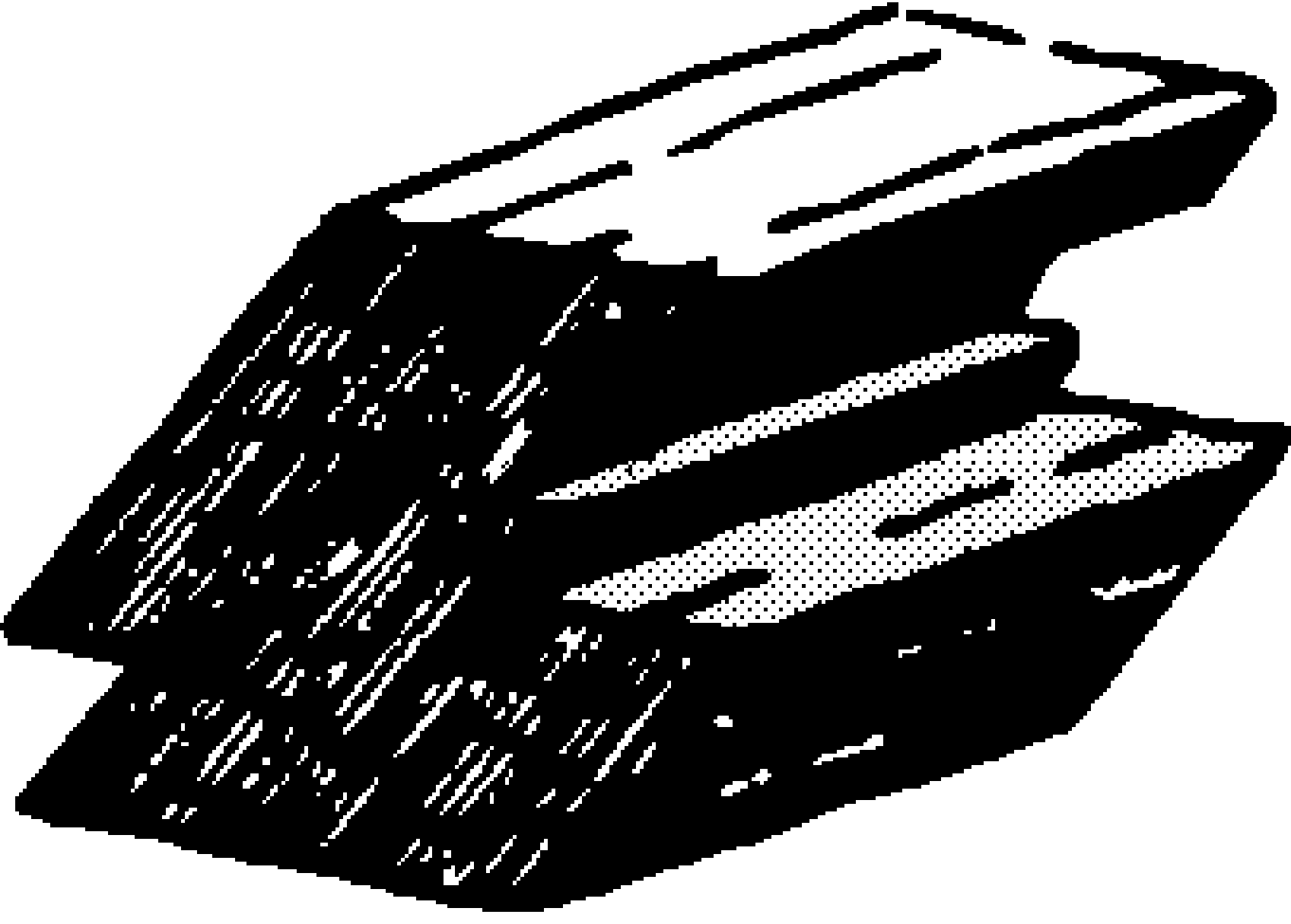

Oxygen
Atom
Silicon
Atom

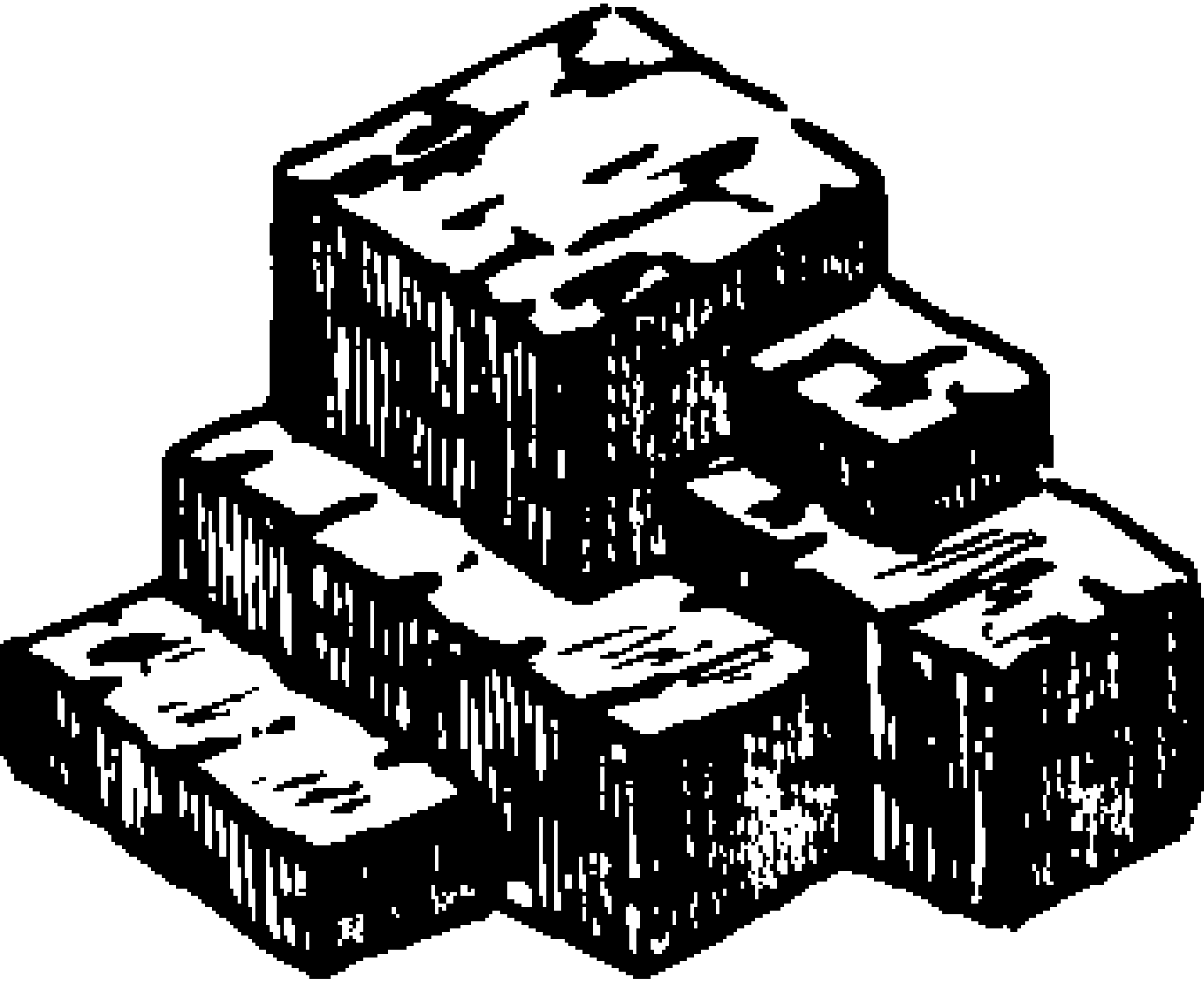


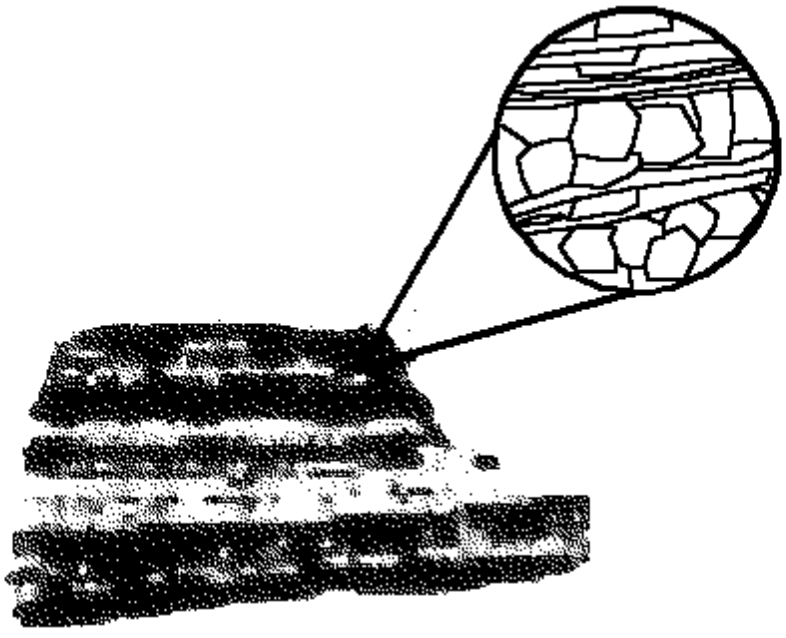

Test A
Hit on the side with a wedge
Two separate flat pieces
MINERAL #1
Test B
Rubbed on an unglazed porcelain plate
Gray/black powder
MINERAL #2
Test C
Rubbed on a glass square
Scratch in glass
MINERAL #3


Black crystal
Red crystal
Same mineral
Green powder
Green powder
Unglazed ceramic tiles

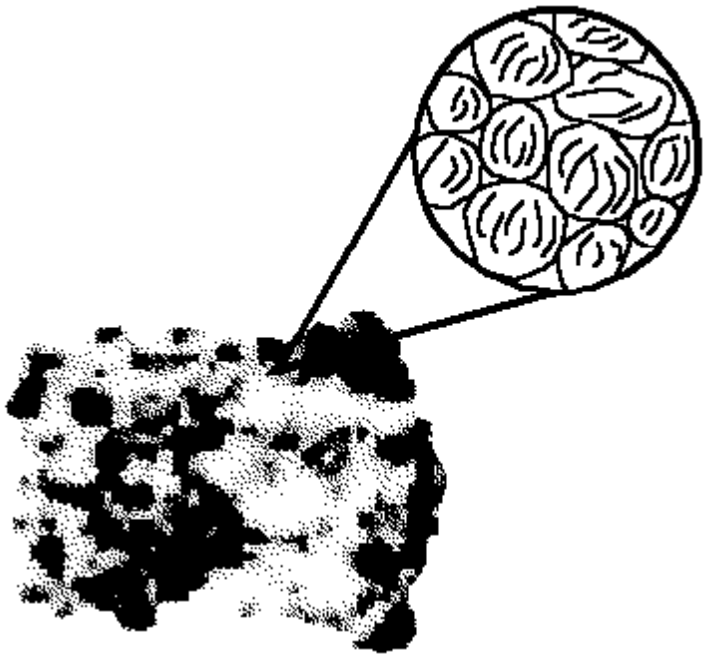




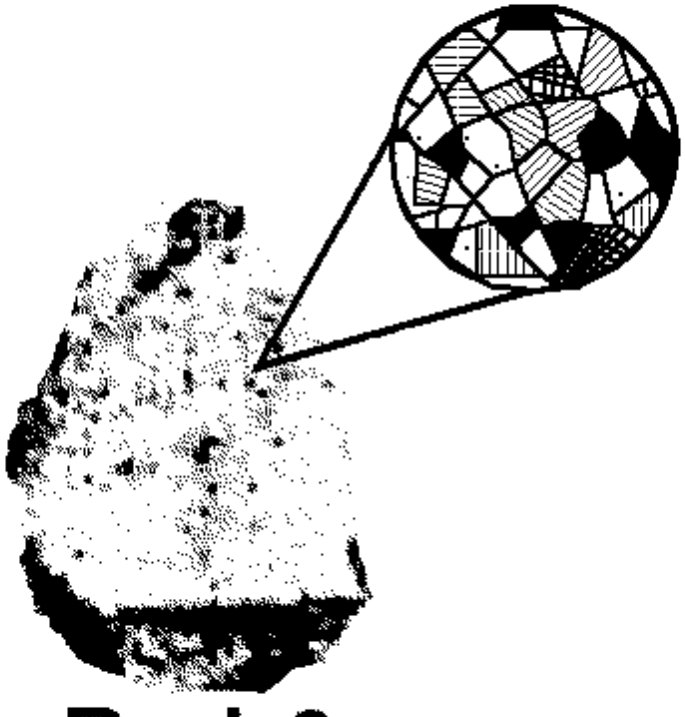




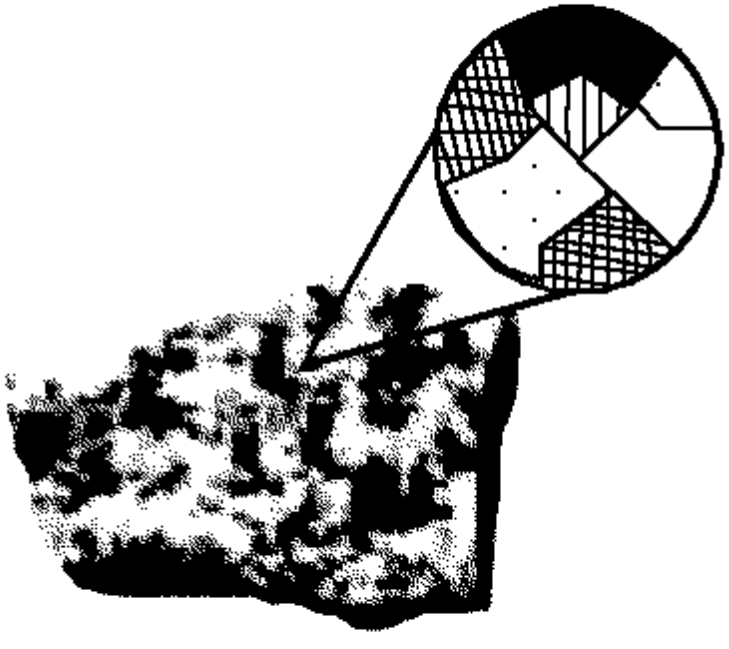
Rock 1
Bands of coarse intergrown crystals of various sizes



Rock 2
Particles of 0.01-cm to 1.0-cm size cemented together

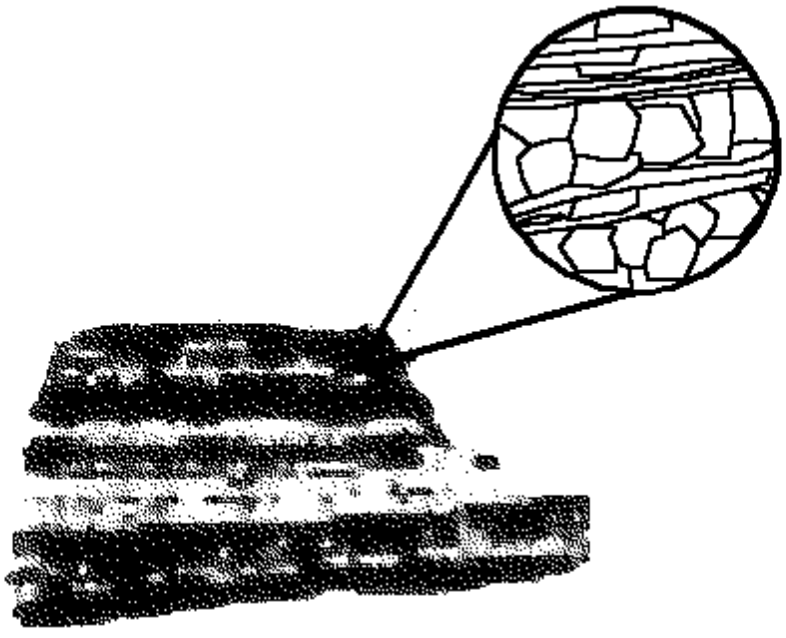


Rock 3
Intergrown crystals less than 0.1 cm in size

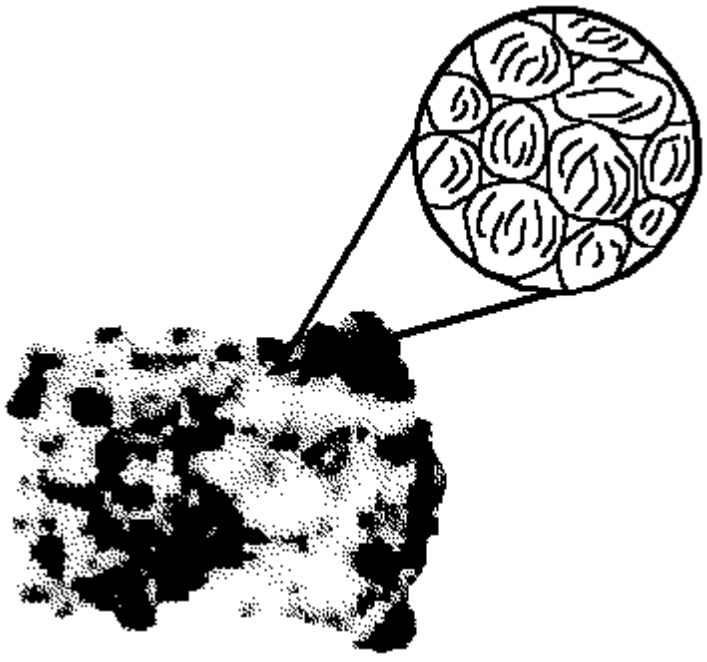


Rock 4
Intergrown crystals mostly 2.0 cm in size

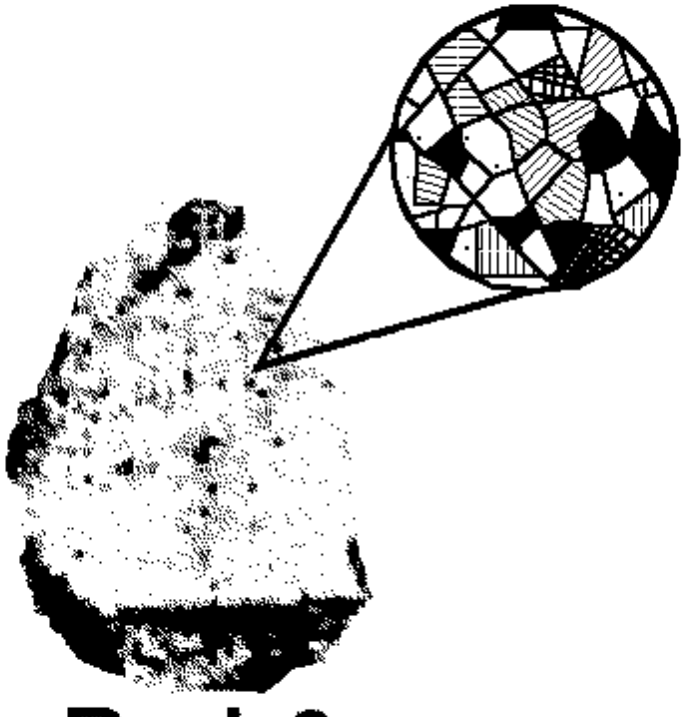
MINERAL	COMPOSITION
Mica	$KAl_3Si_3O_{10}$
Olivine	$(FeMg)_2SiO_4$
Potassium feldspar	$KAlSi_3O_8$
Plagioclase	$NaAlSi_3O_8$
Pyroxene	$CaMgSi_2O_6$
Quartz	SiO_2



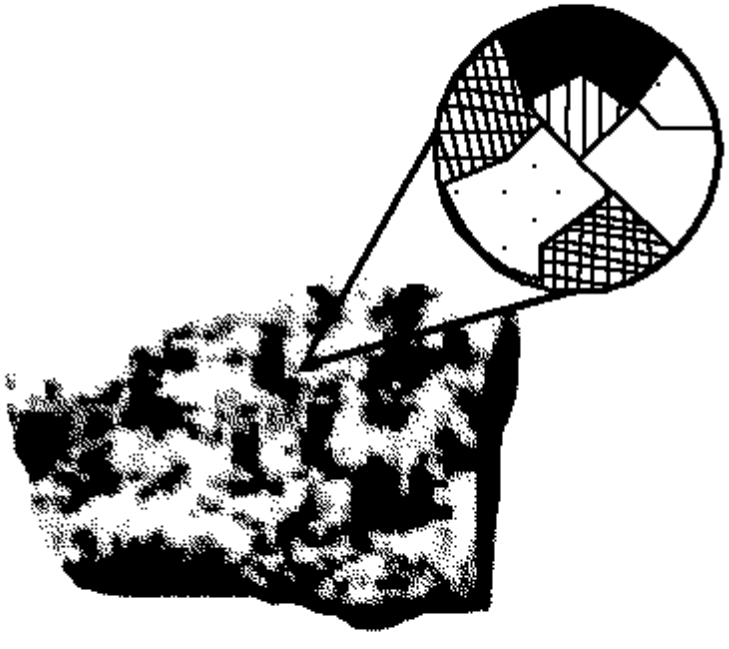
Rock 1
Bands of coarse intergrown crystals of various sizes



Rock 2
Particles of 0.01-cm to 1.0-cm size cemented together

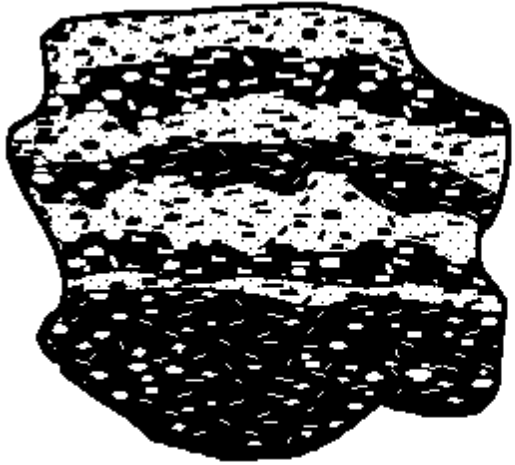


Rock 3
Intergrown crystals less than 0.1 cm in size

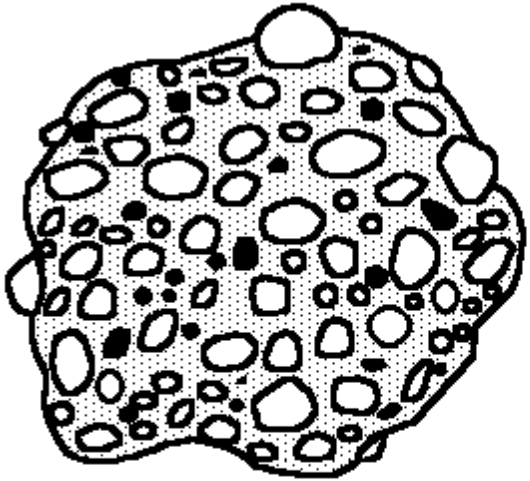


Rock 4
Intergrown crystals mostly 2.0 cm in size

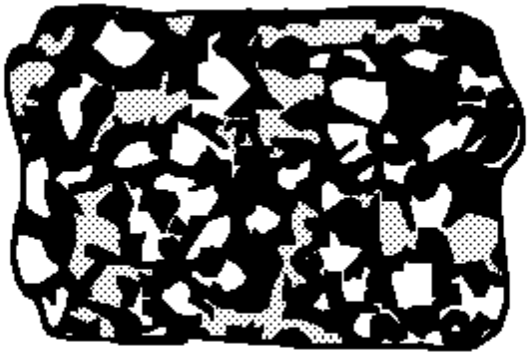
Basalt



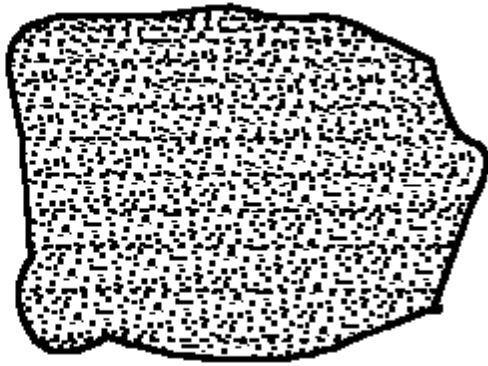
Gneiss
(metamorphic)



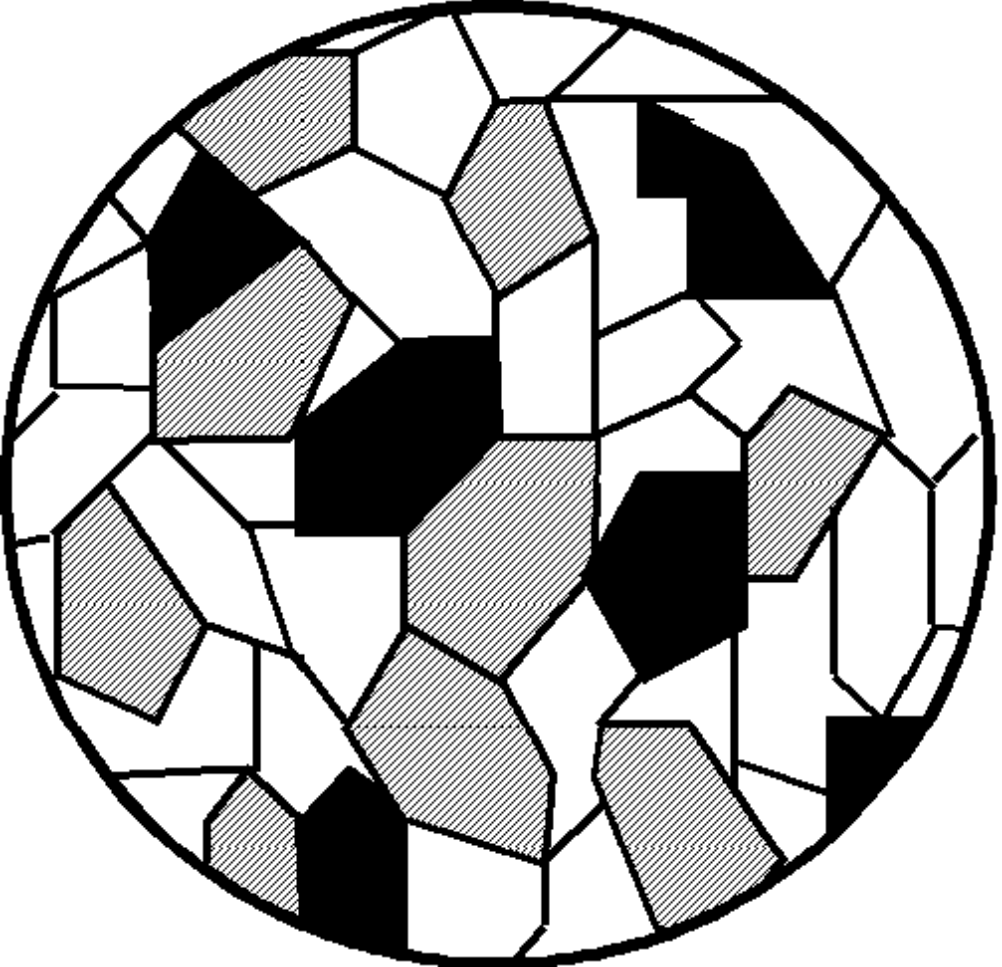
Conglomerate



Granite

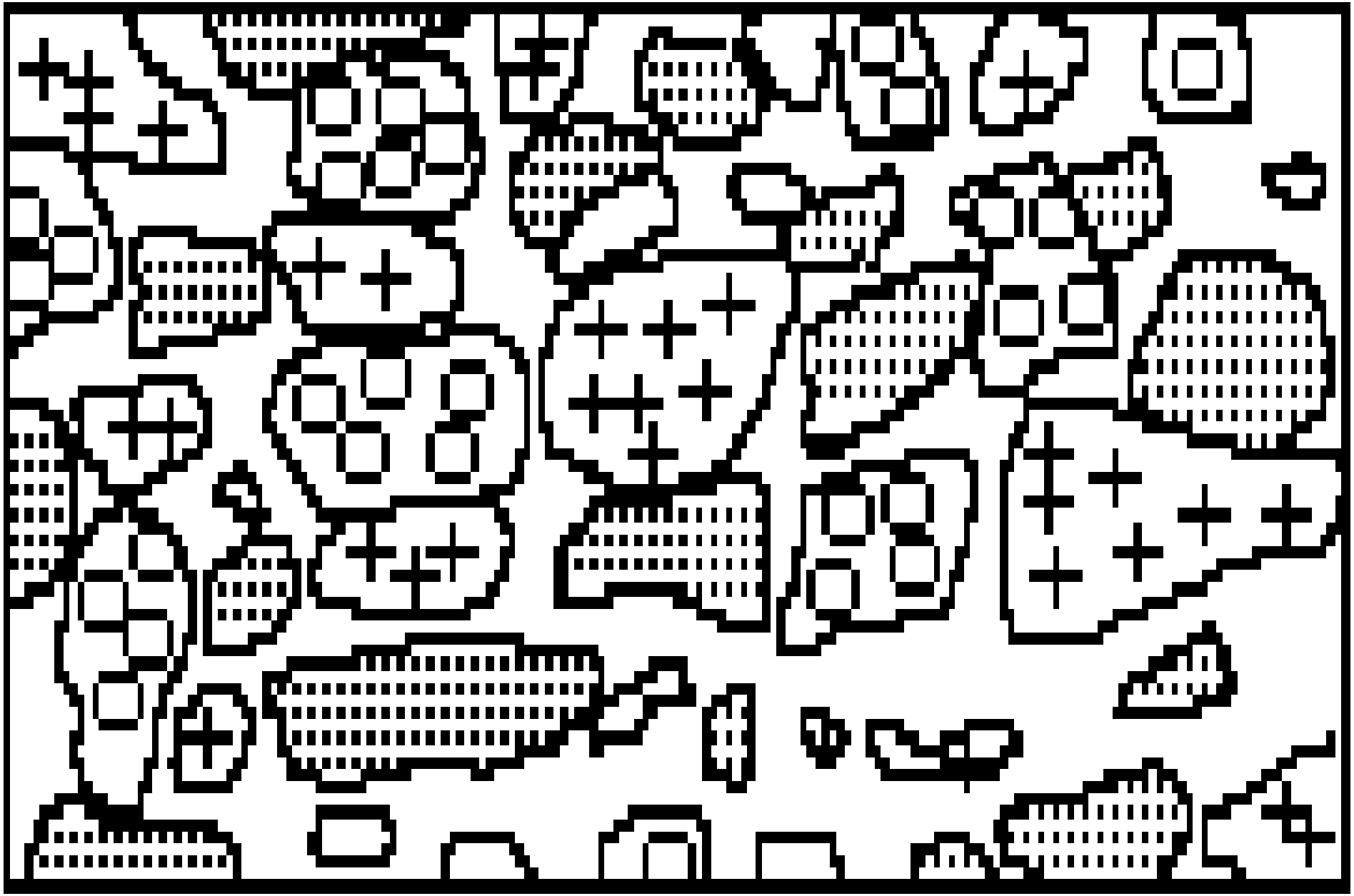


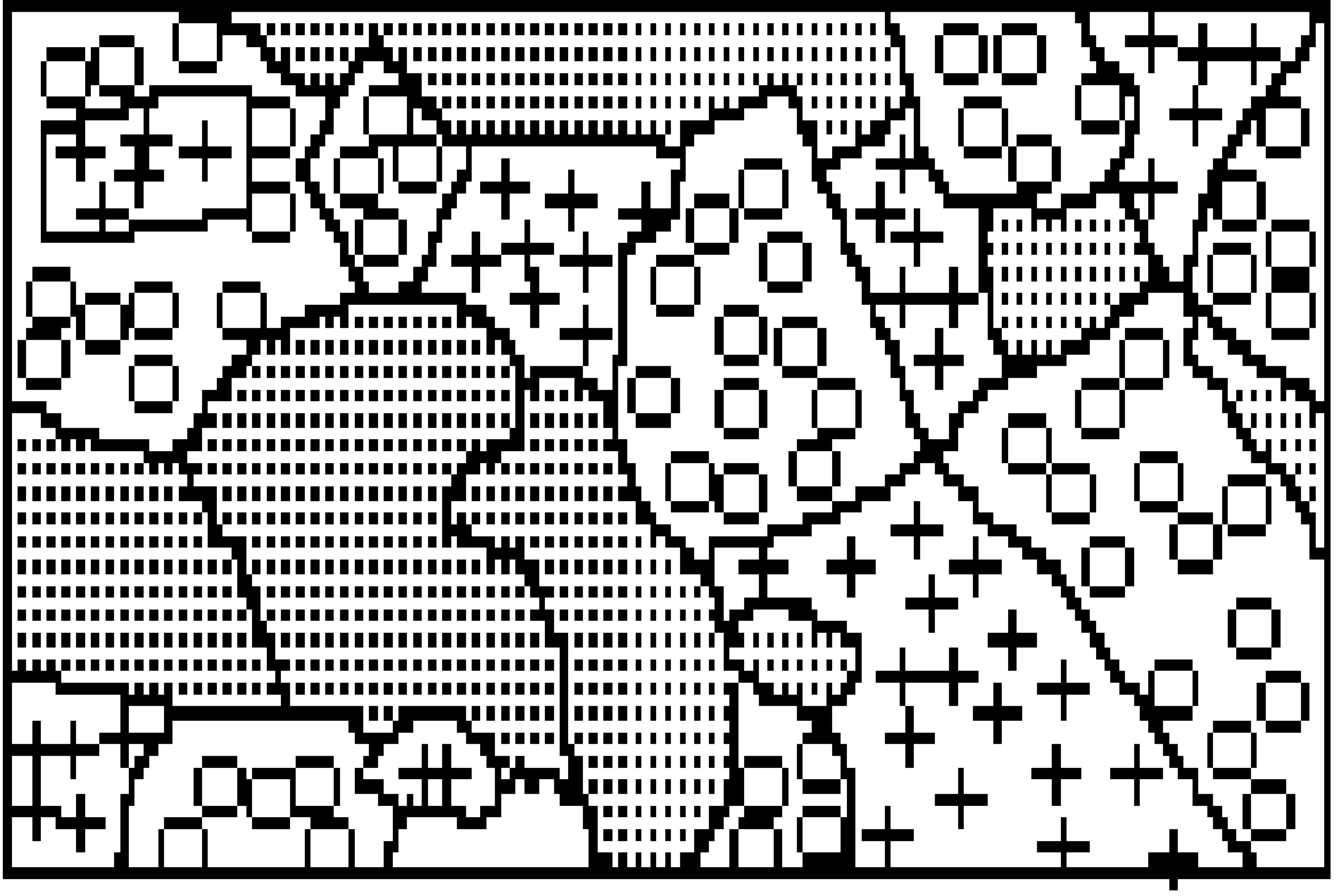
Sandstone

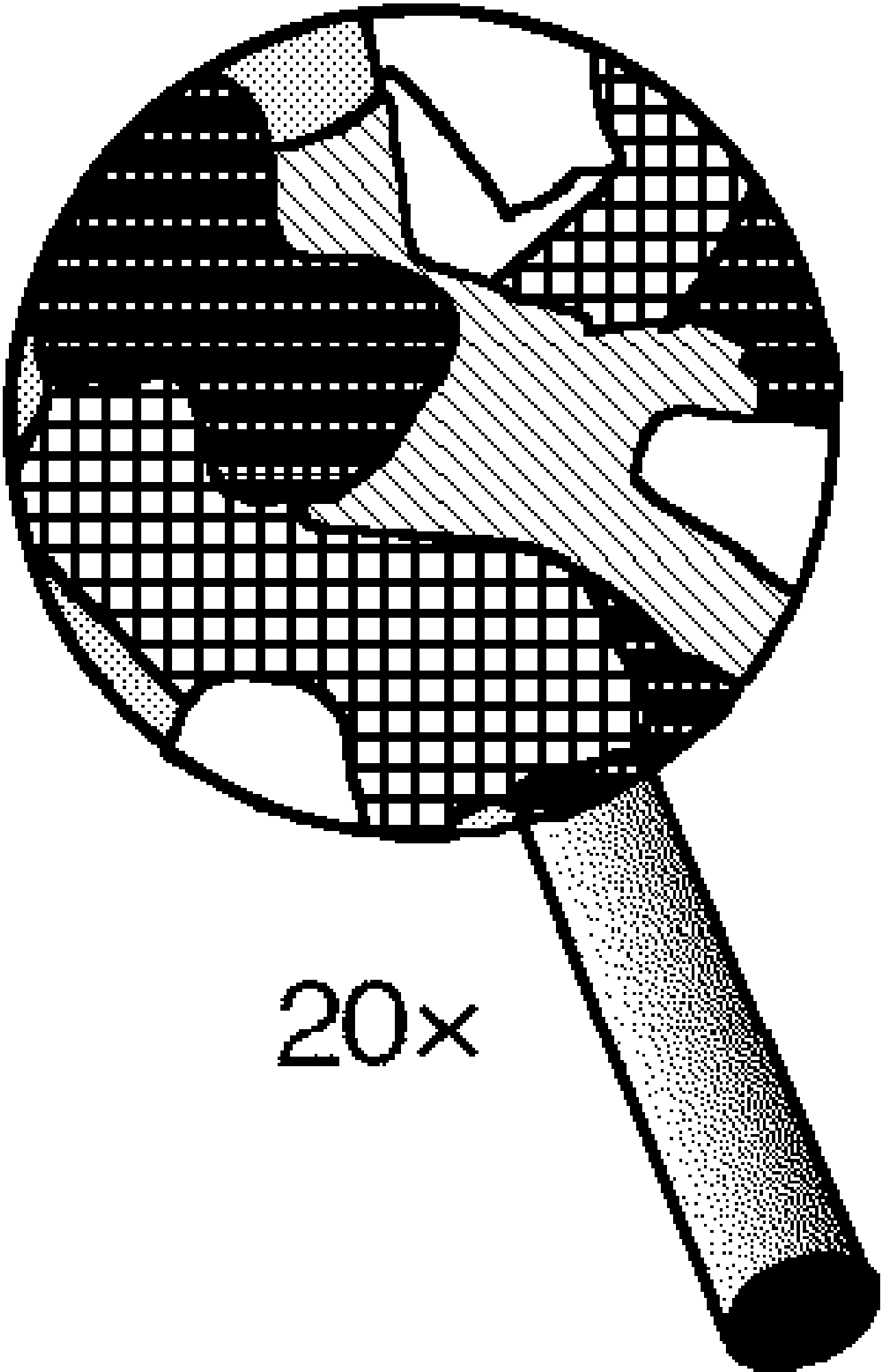


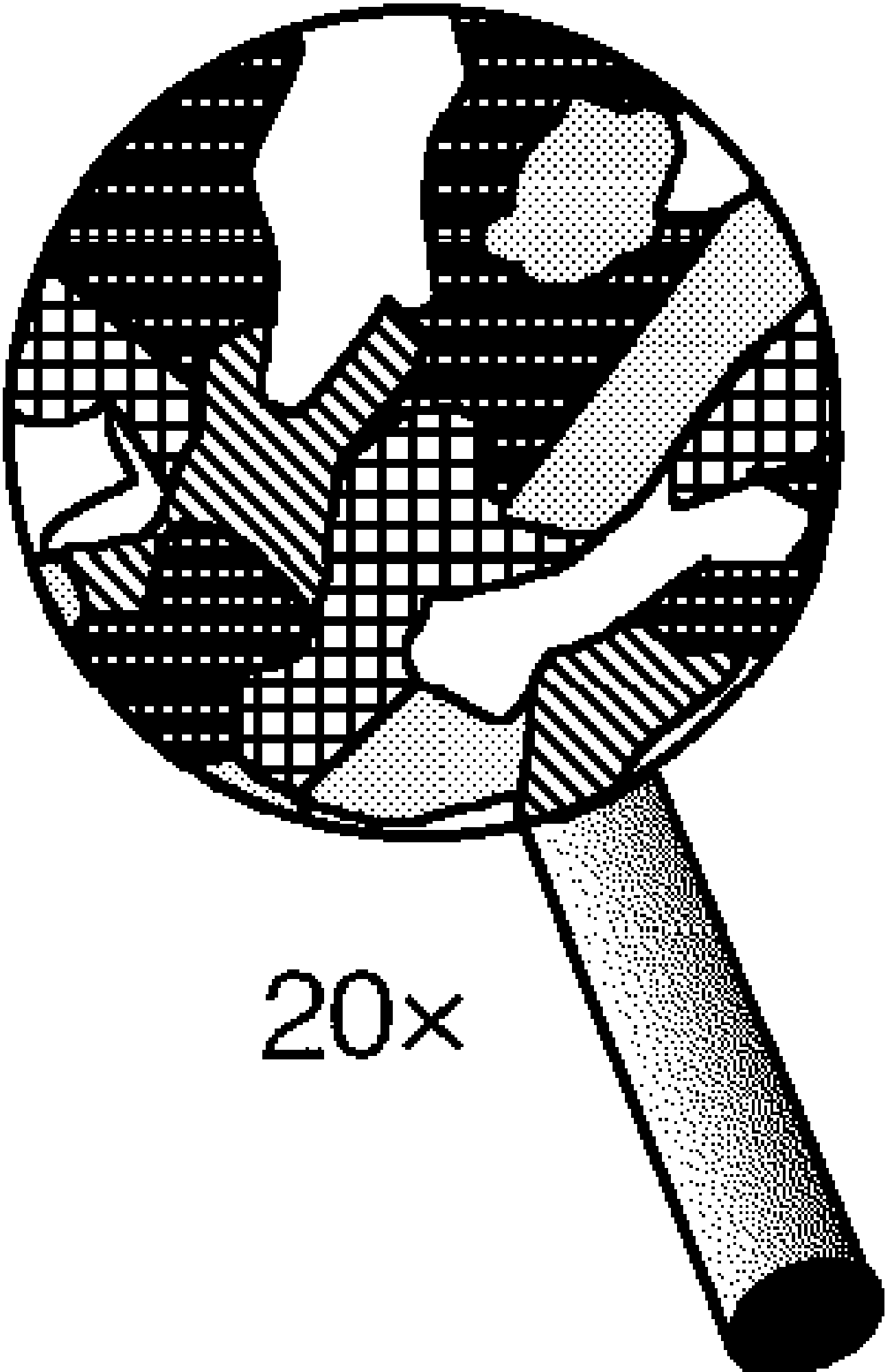
KEY TO MINERALS:

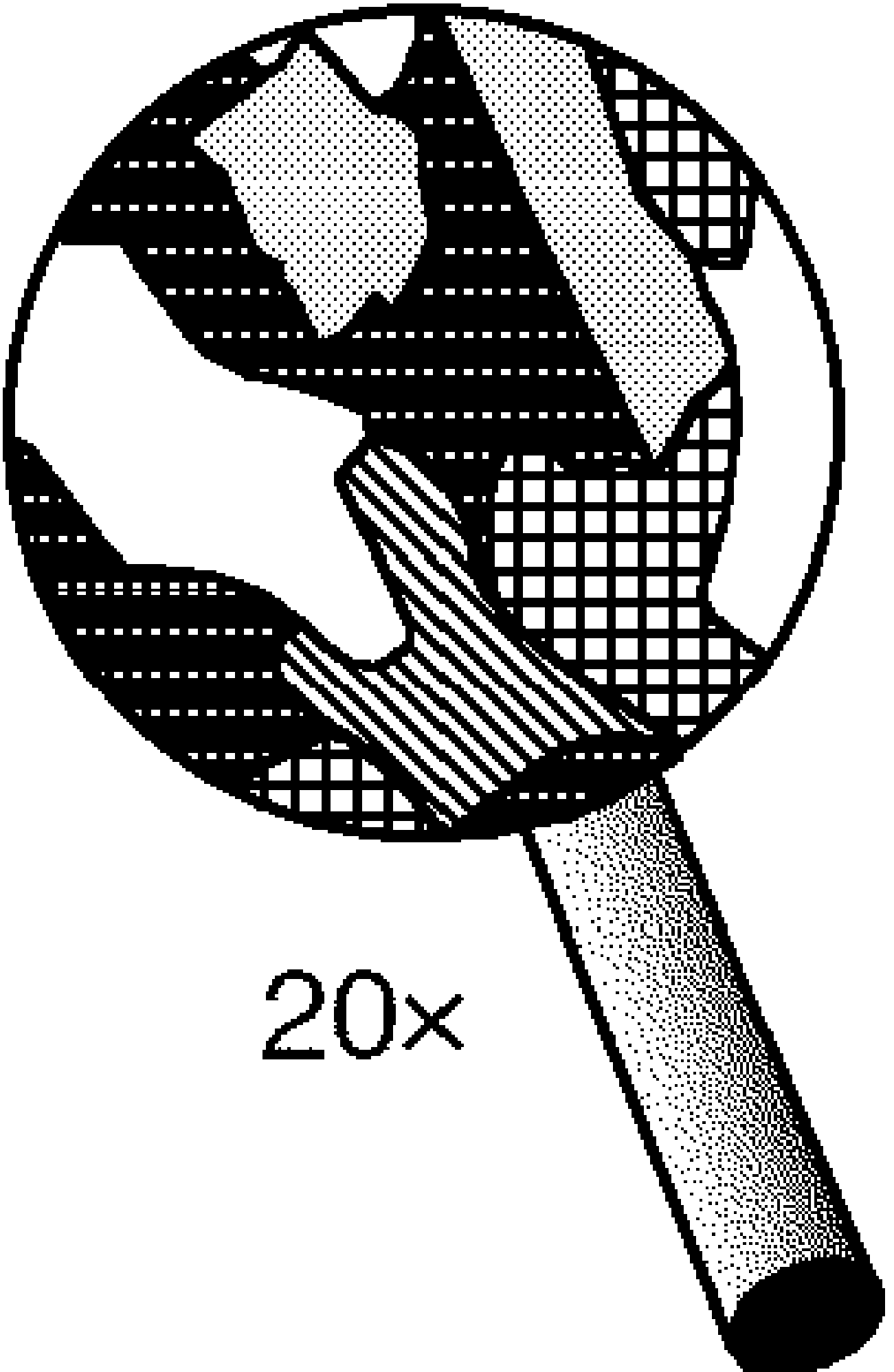
- Pyroxene
- Plagioclase Feldspar
- Hornblende

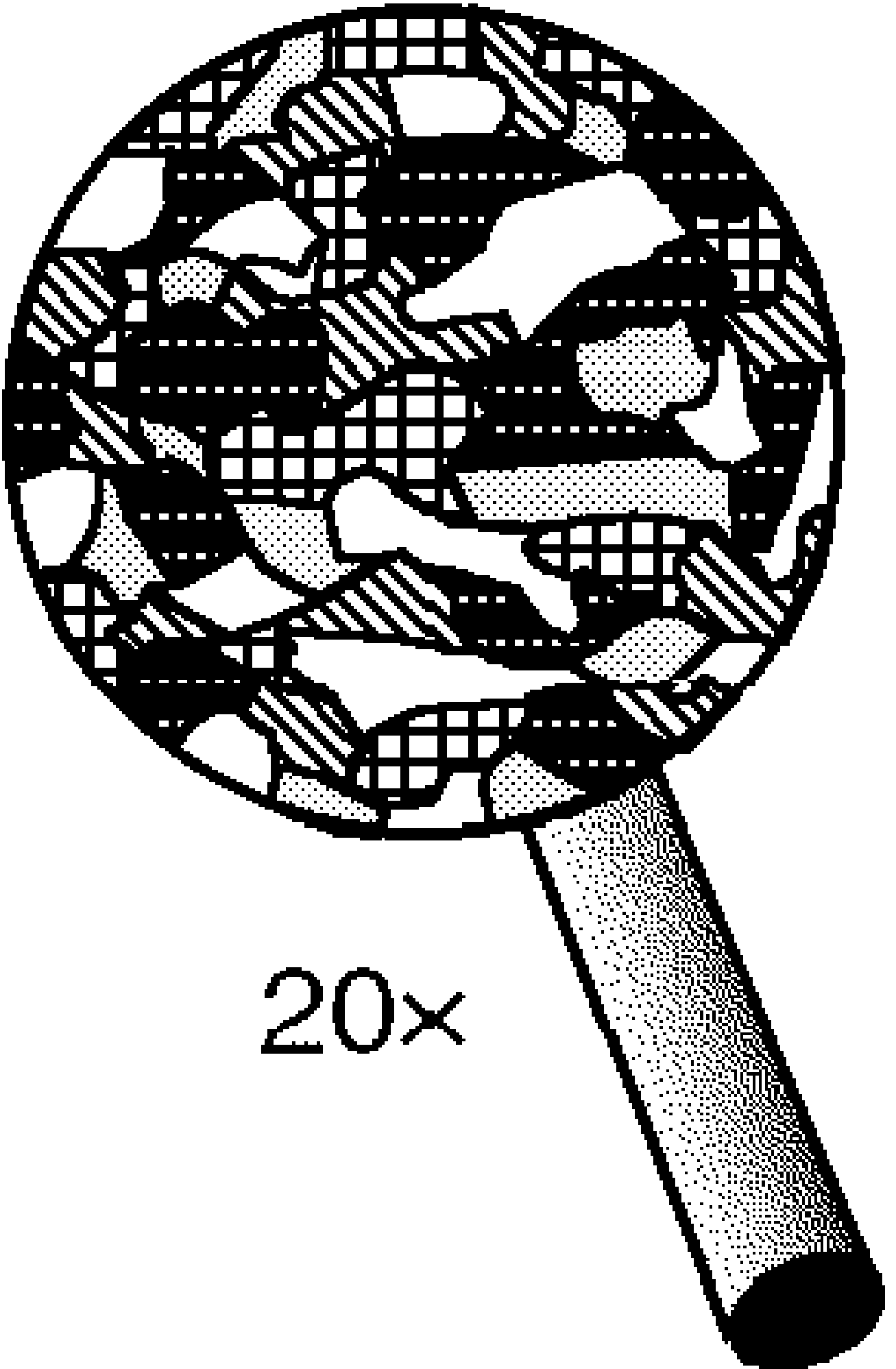


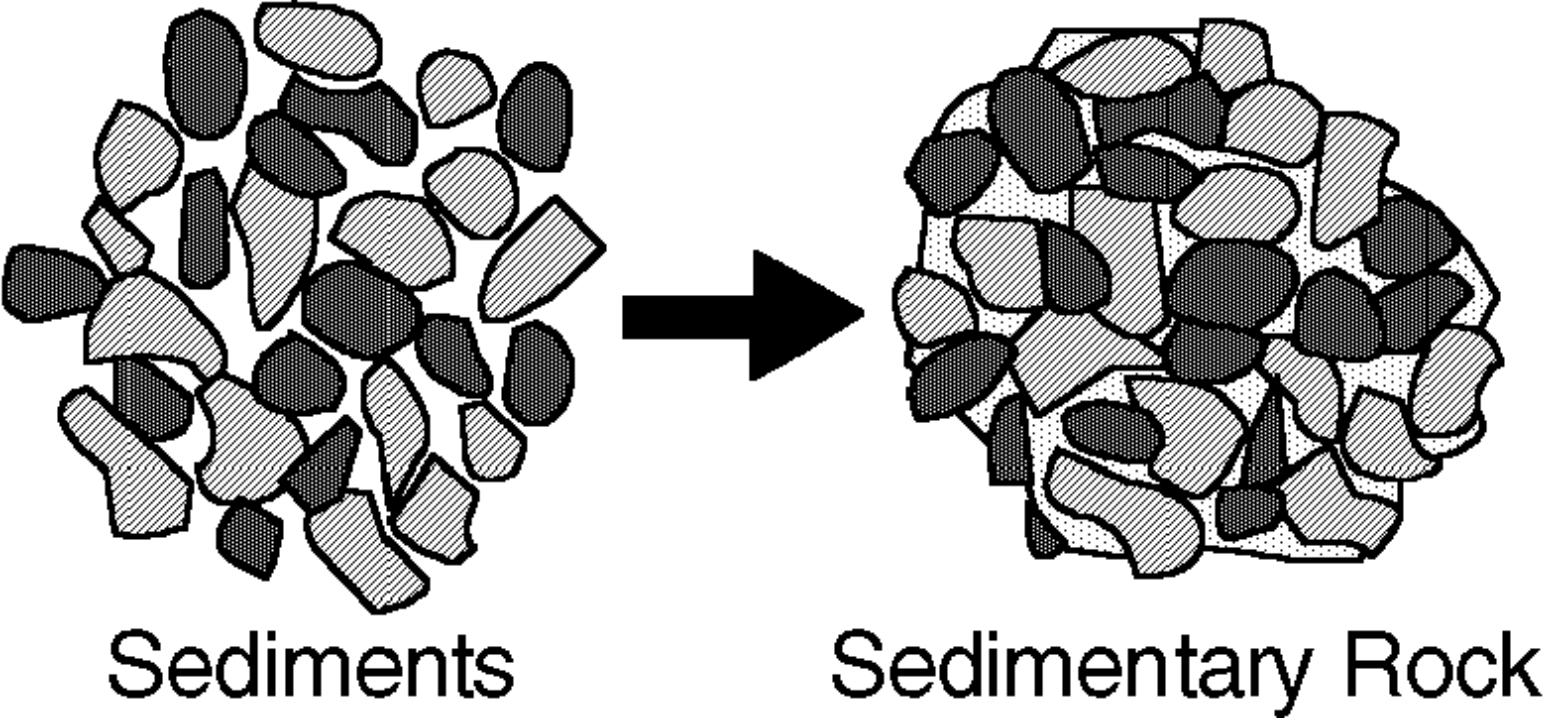


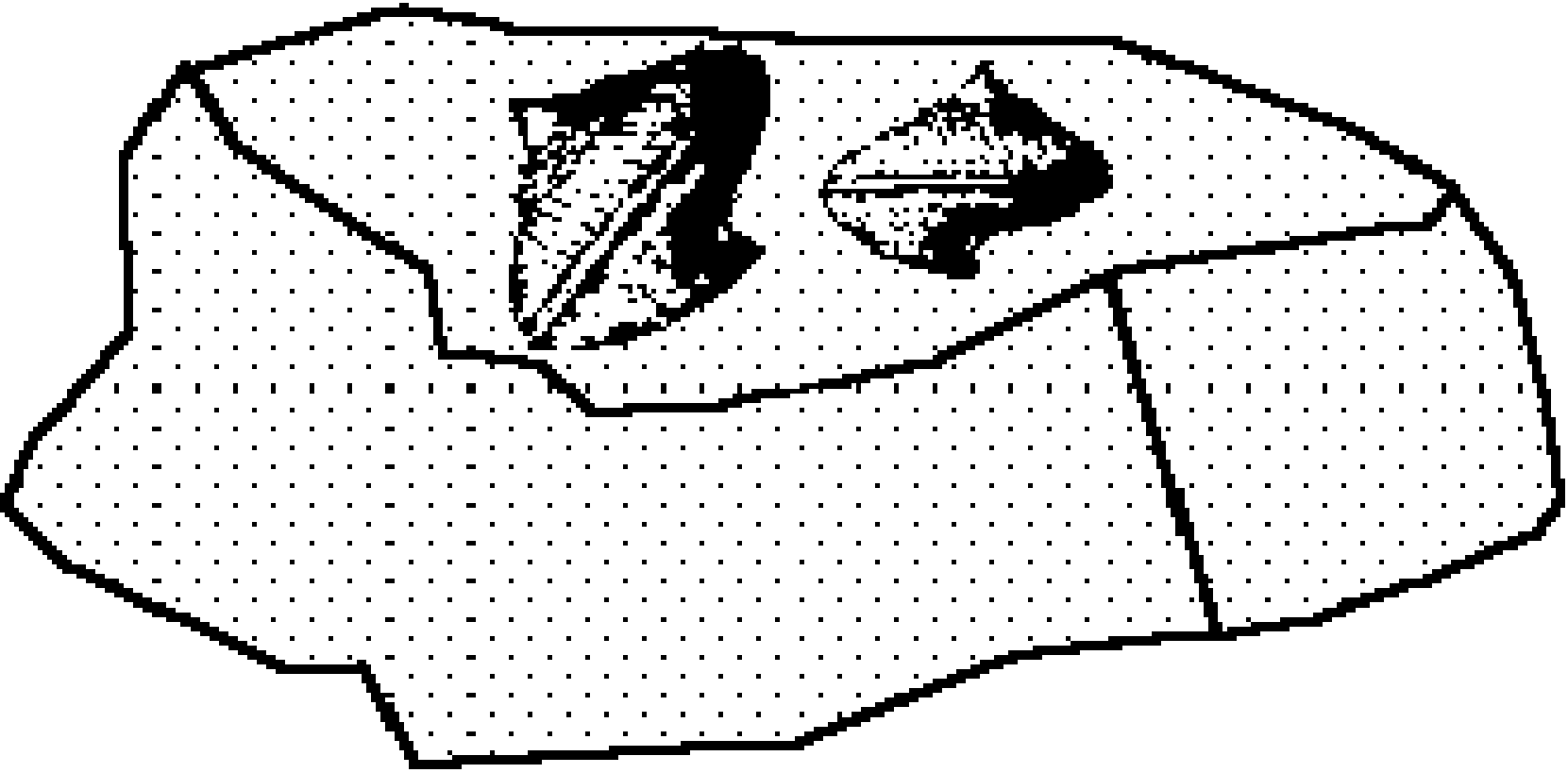

20×


20×


20×

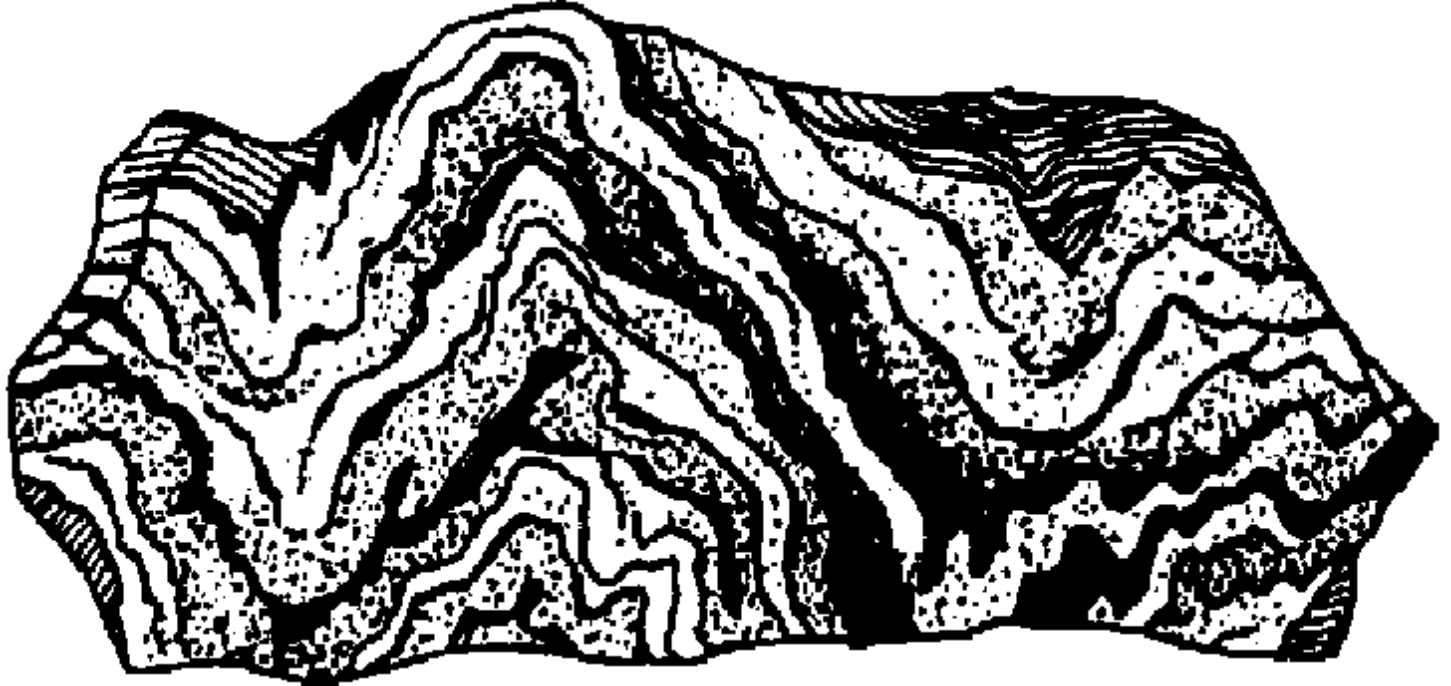

20×

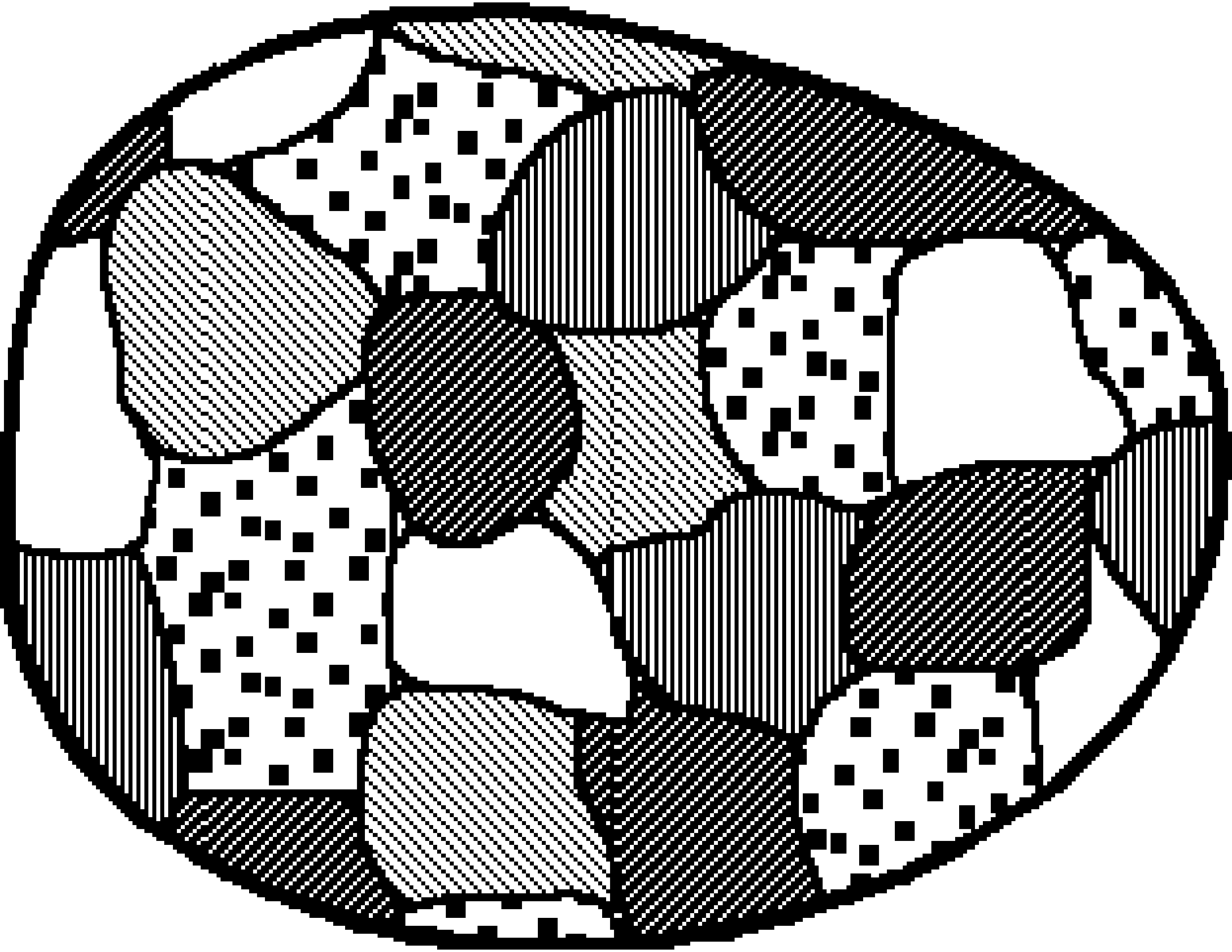

Sediments
Sedimentary Rock

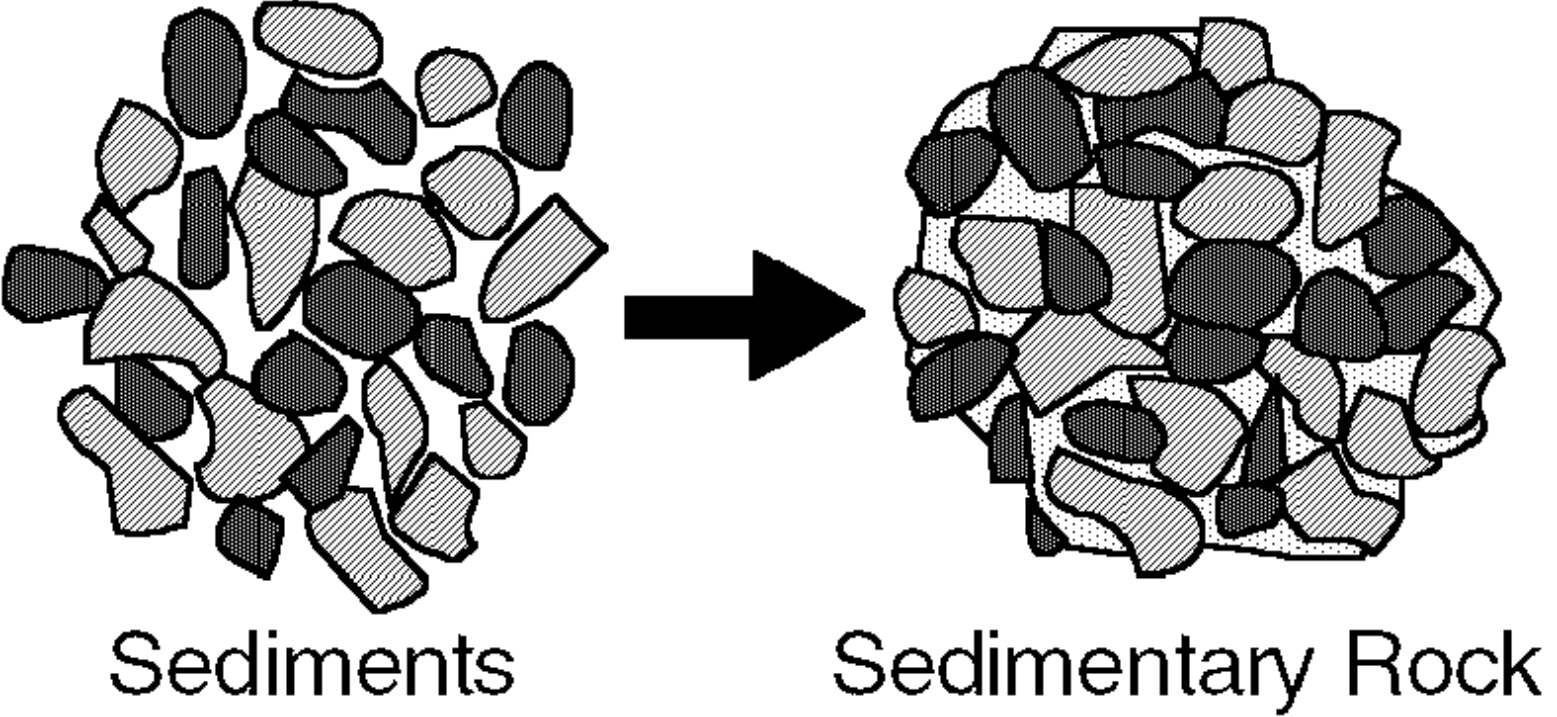


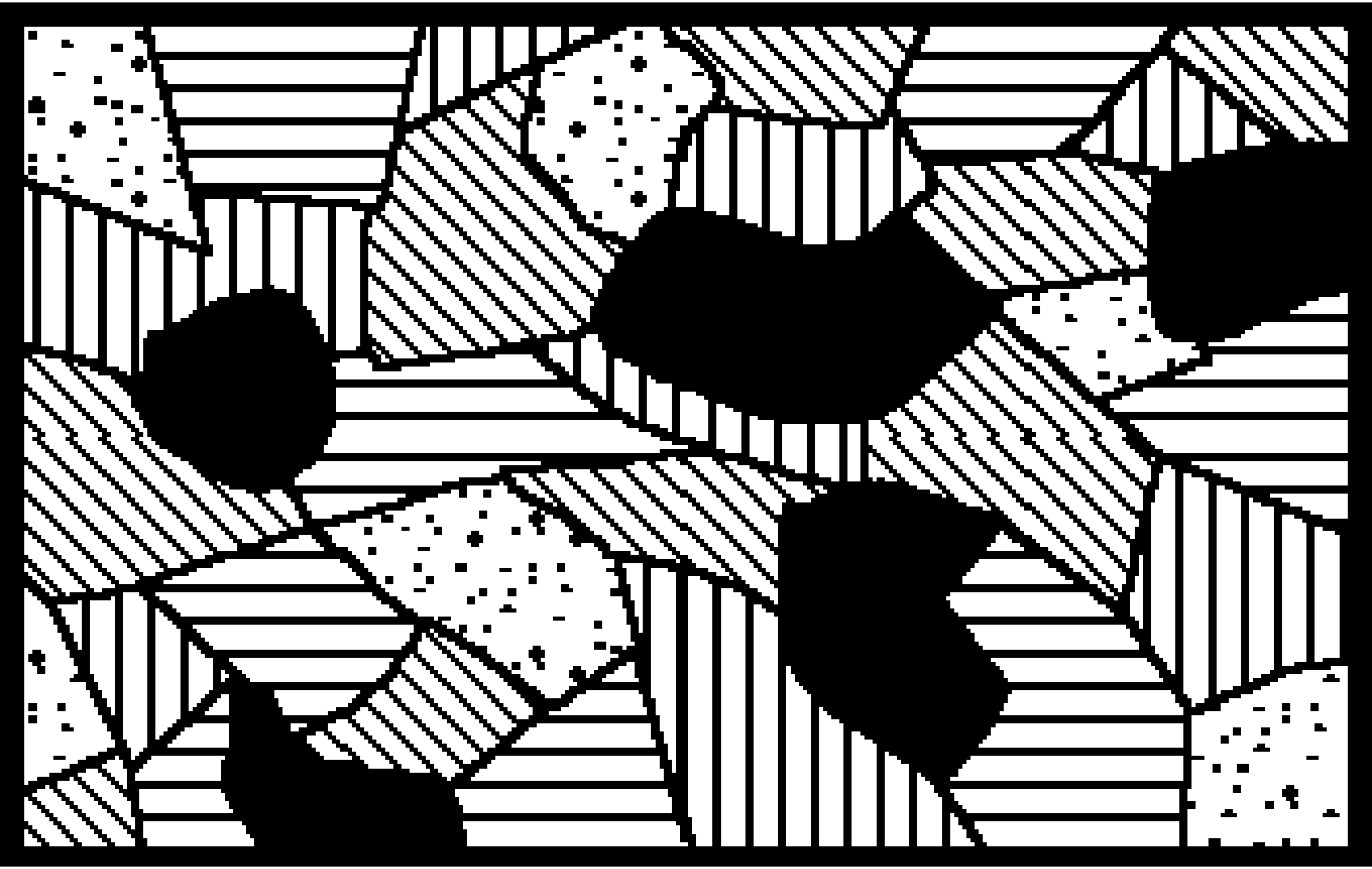
Mineral	Composition (%)
Pyroxene	50
Plagioclase feldspar	40
Olivine	3
Amphibole	5
Unidentified minerals	2

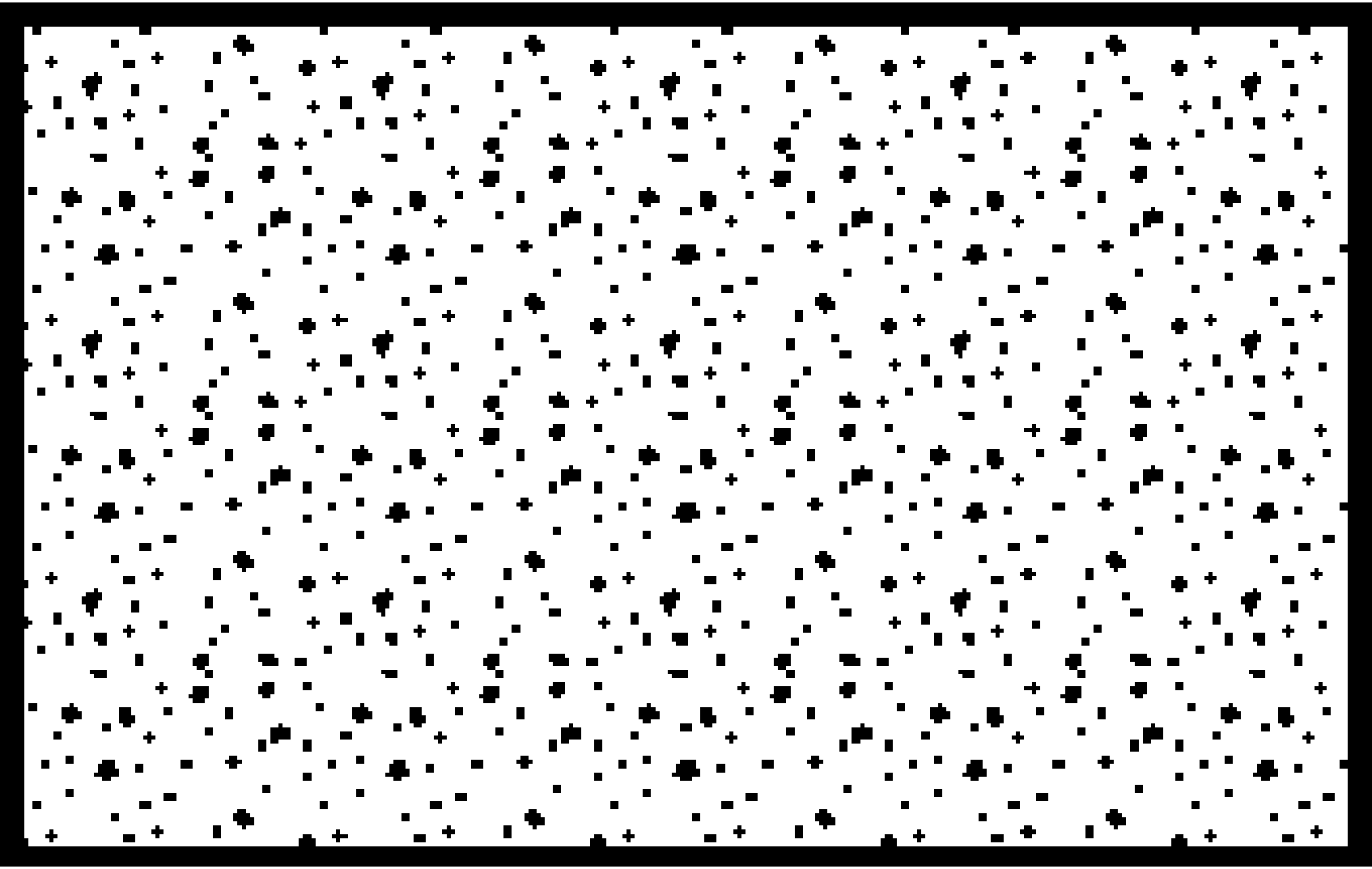
Group *A*	Group *B*	Group *C*
Granite	Shale	Marble
Rhyolite	Sandstone	Schist
Gabbro	Conglomerate	Gneiss

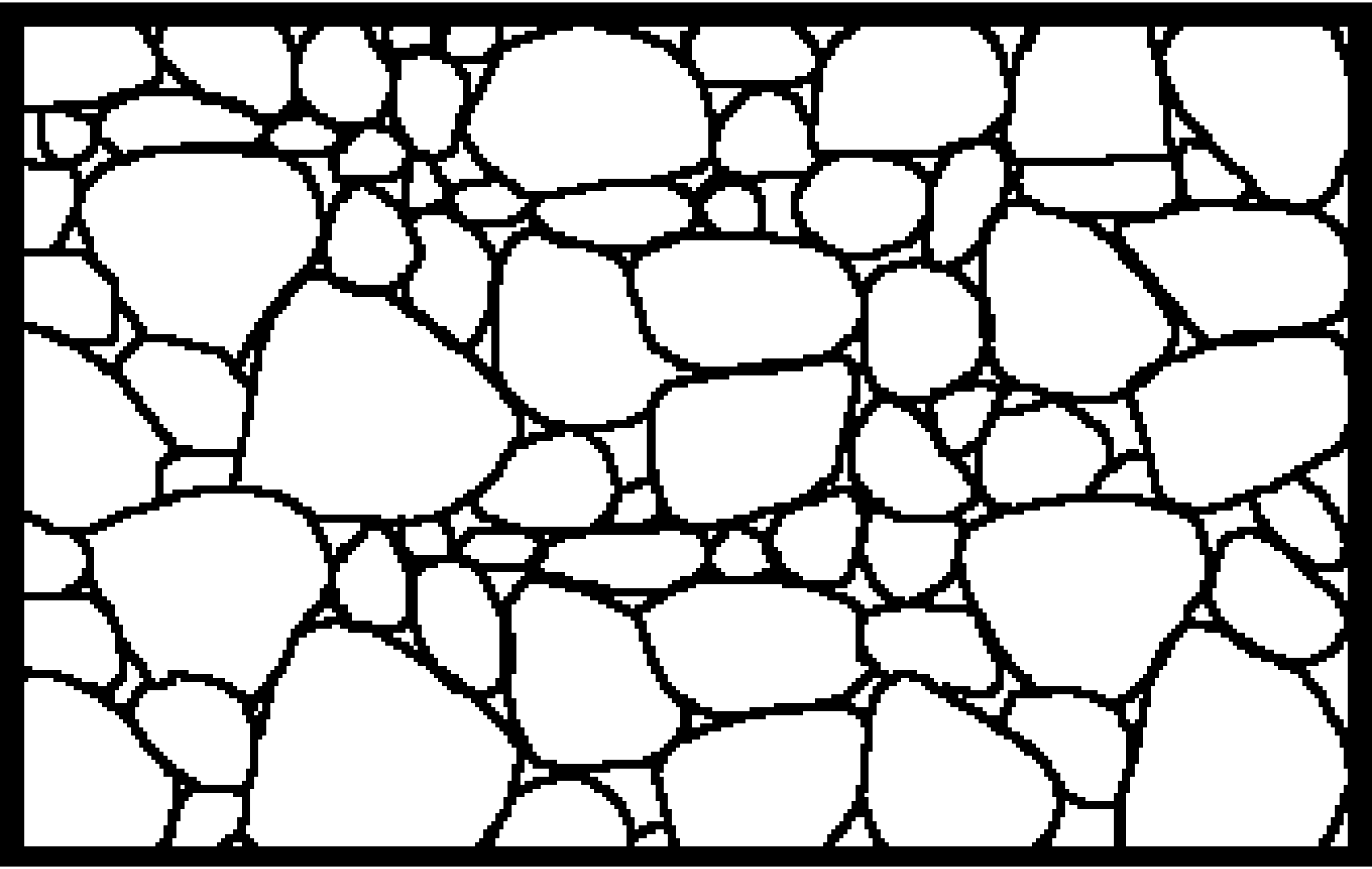


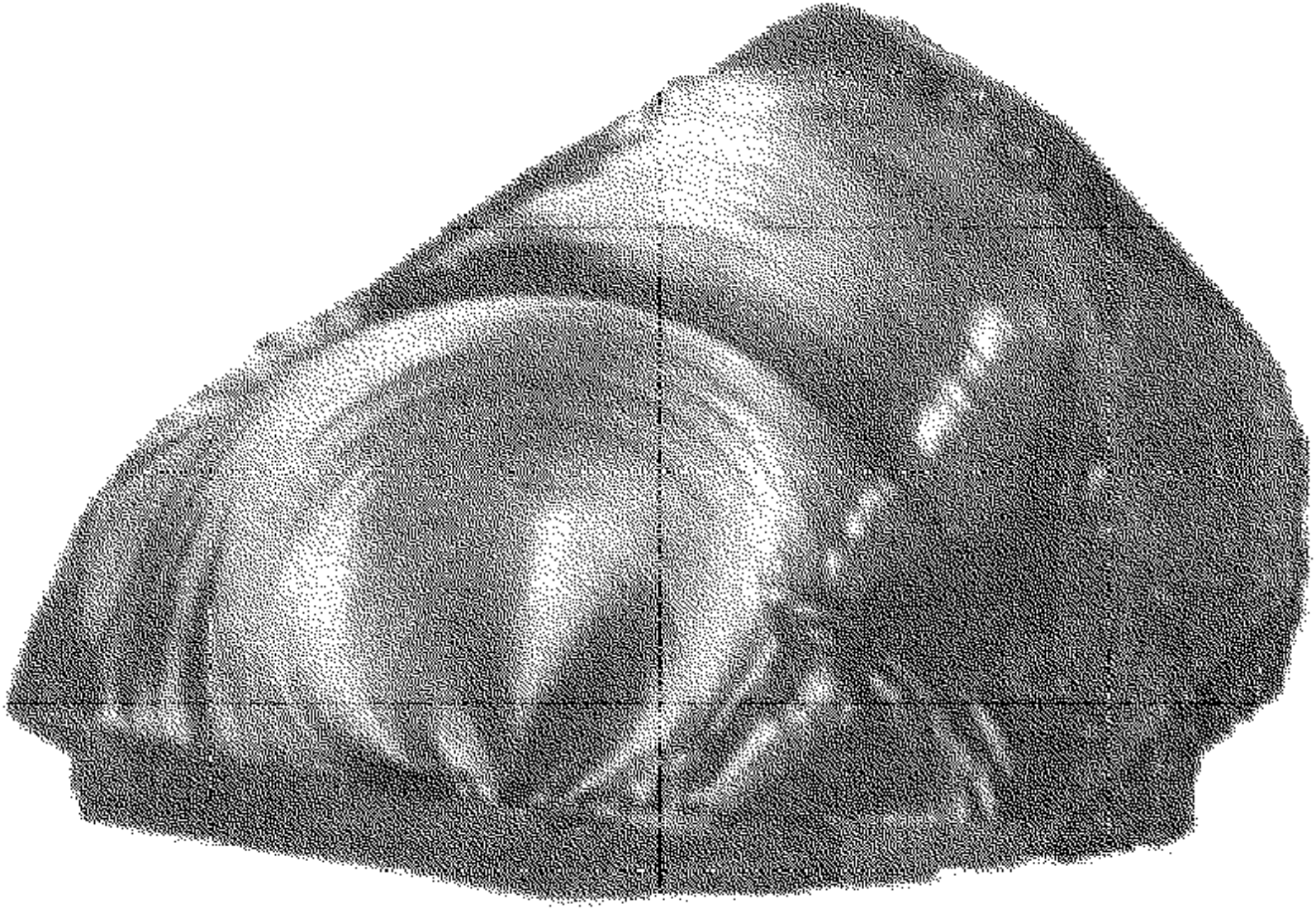


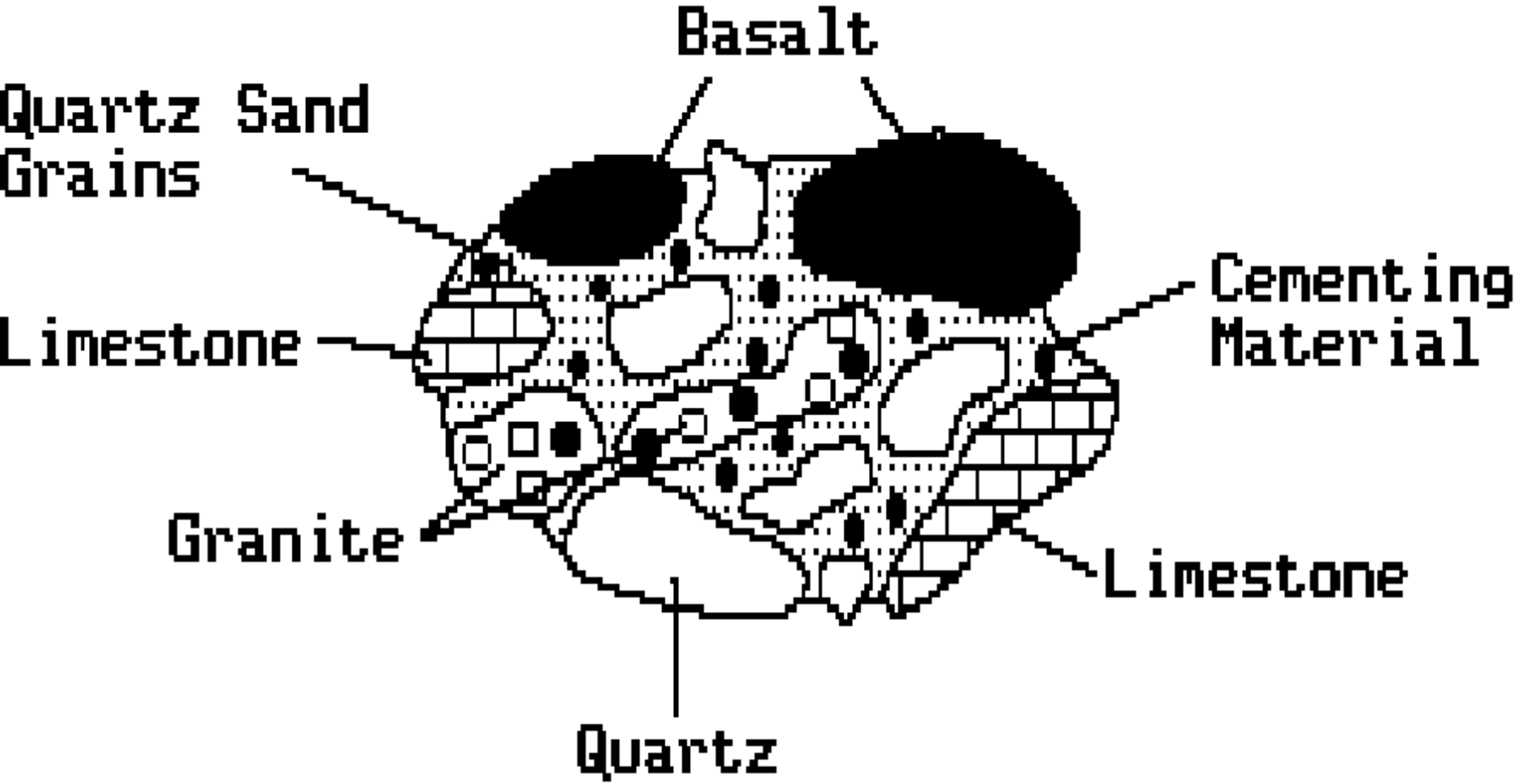

Sediments
Sedimentary Rock

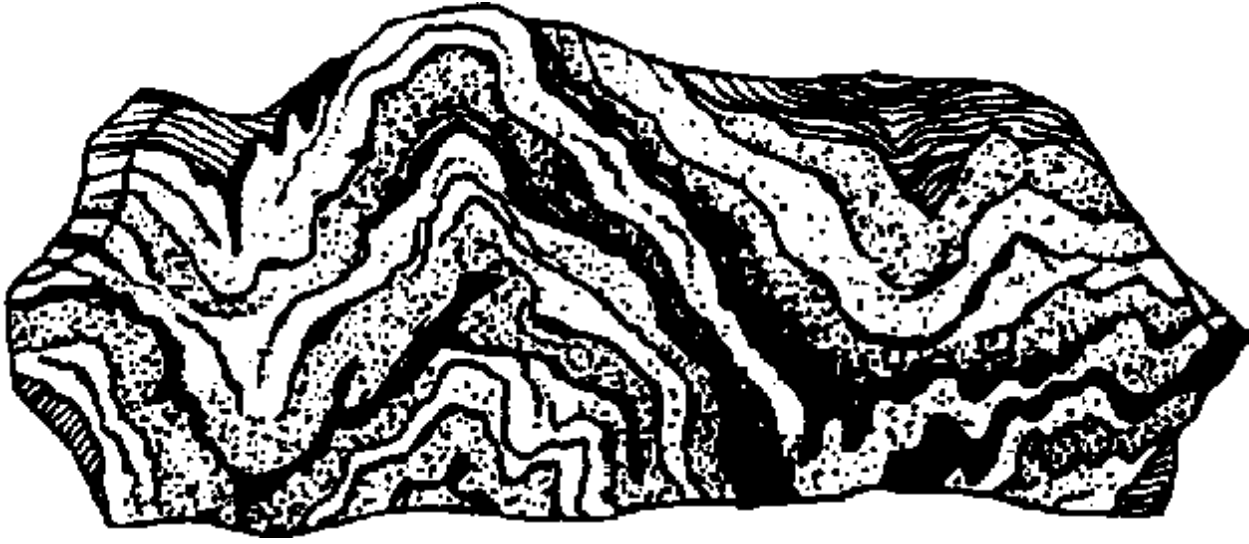


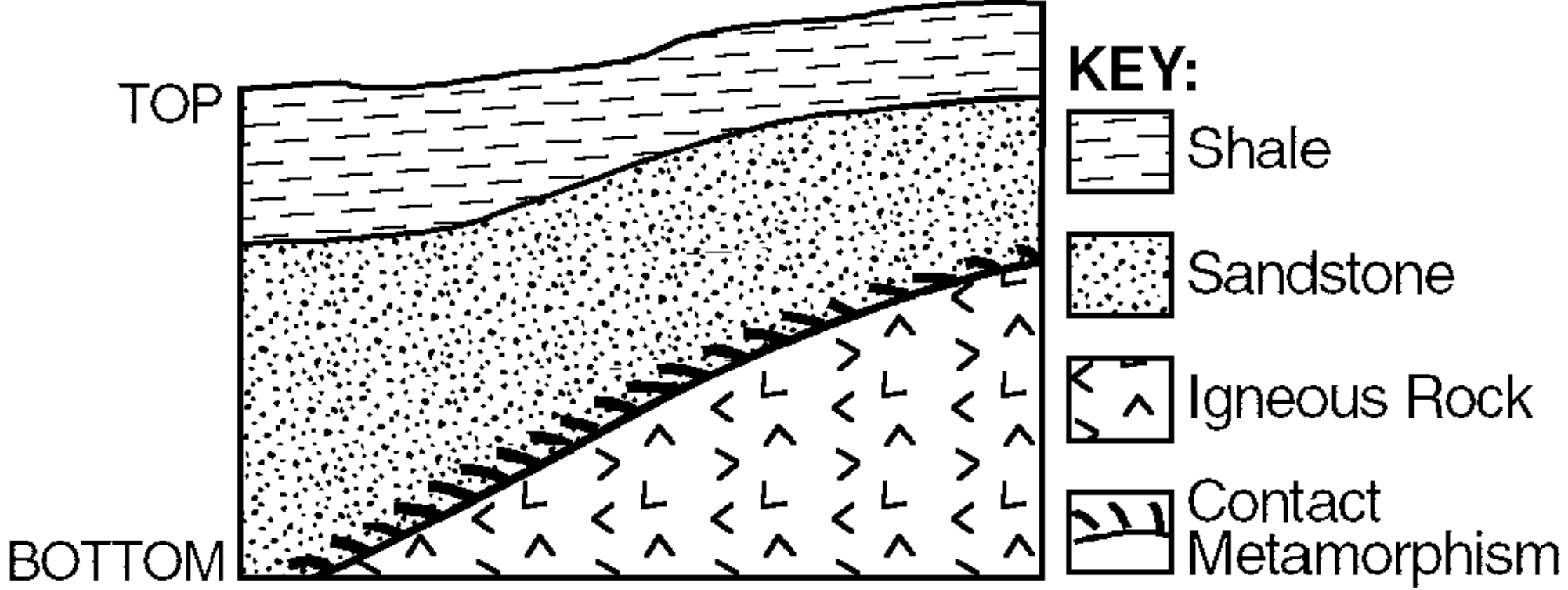


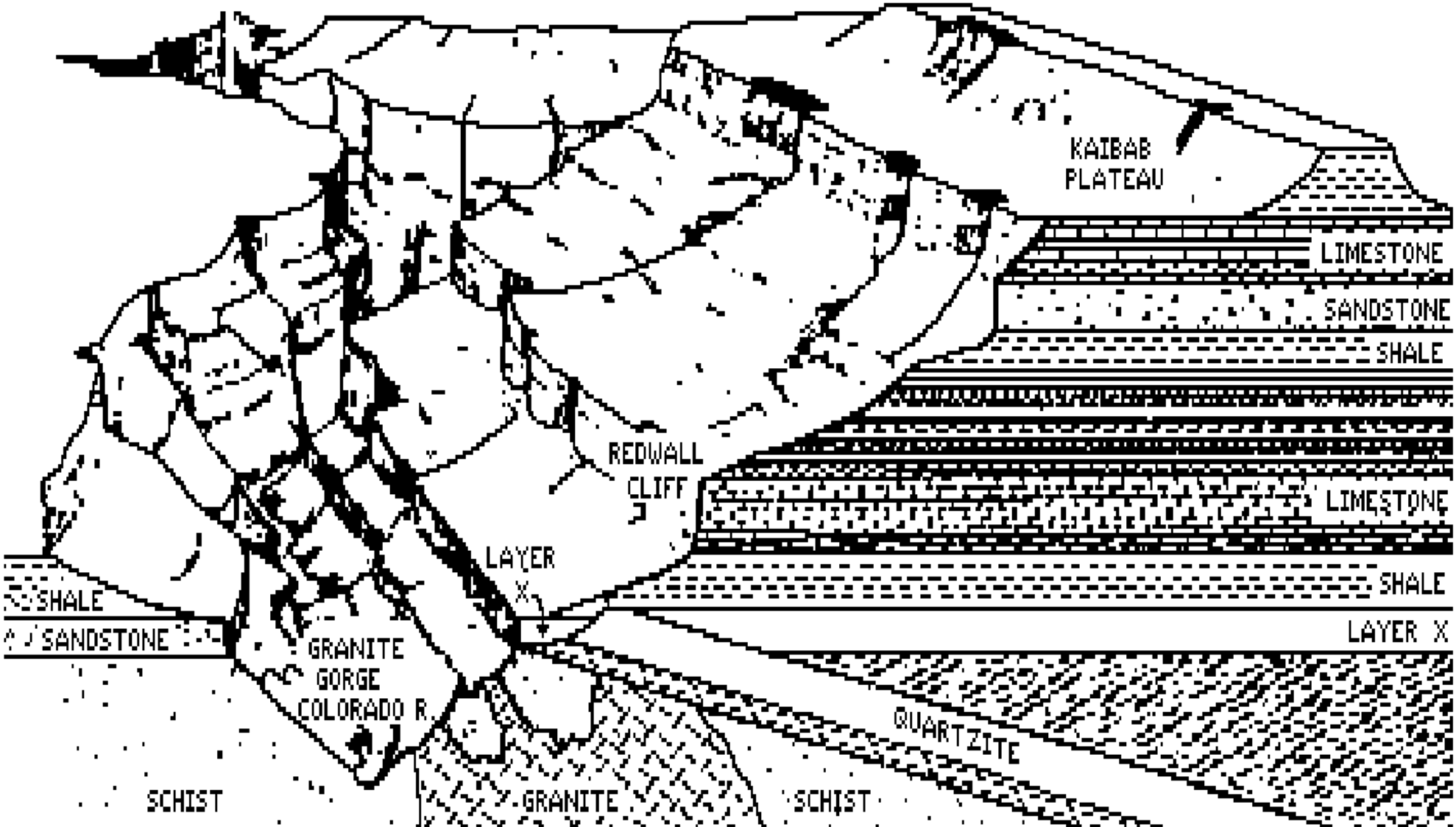


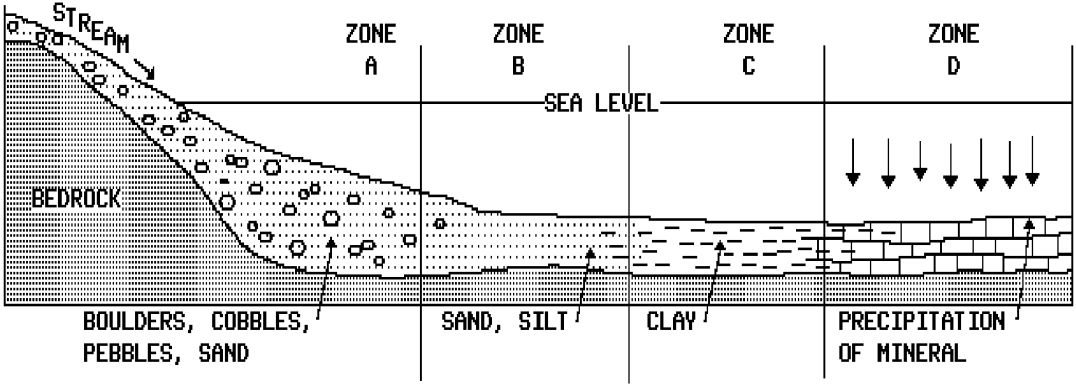



Basalt
Quartz Sand Grains
Cementing Material
Limestone
Granite
Limestone
Quartz

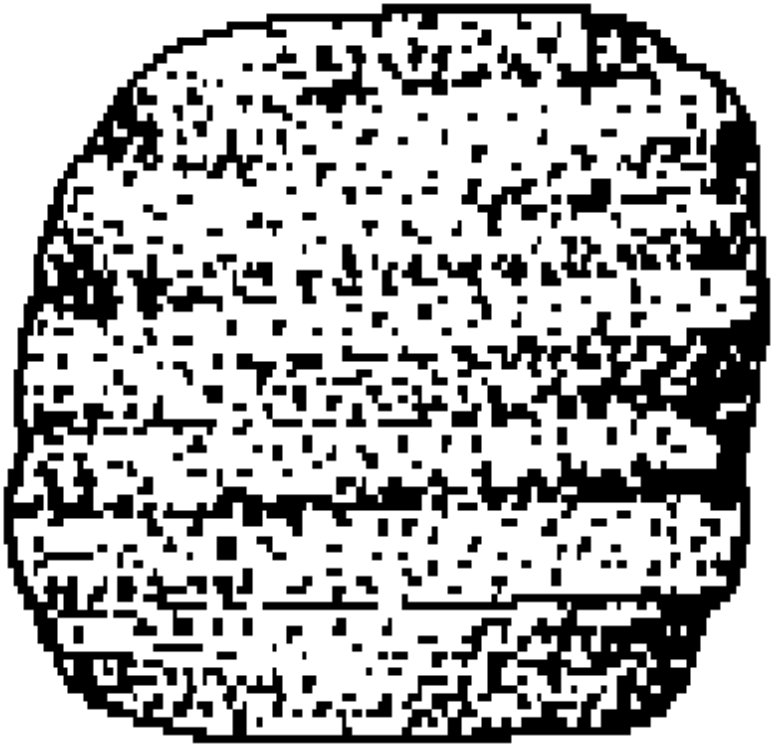



TOP
BOTTOM
KEY:
Shale
Sandstone
Igneous Rock
Contact Metamorphism

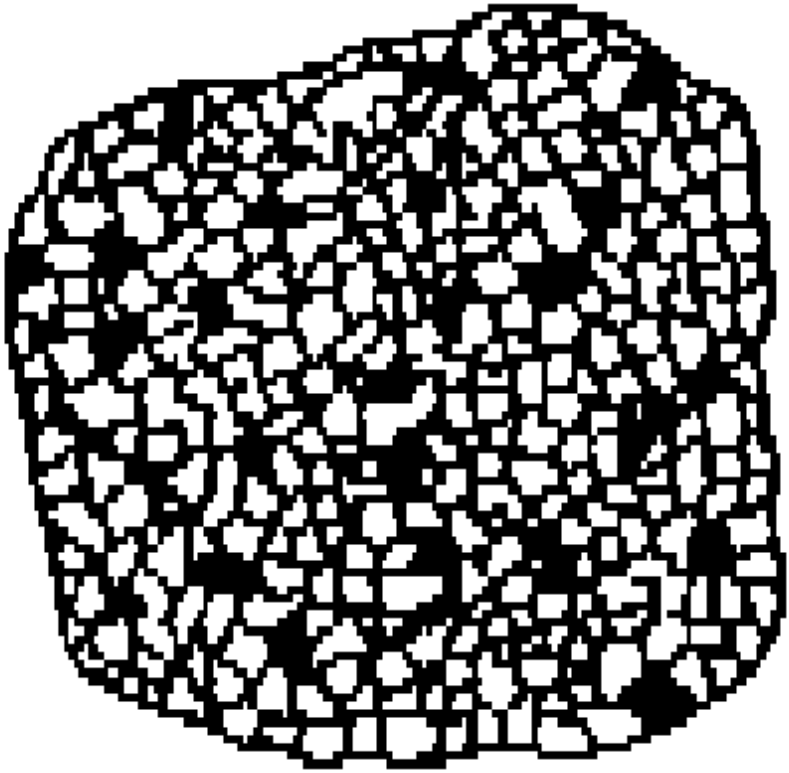

KAIBAB
PLATEAU
LIMESTONE
SANDSTONE
SHALE
REDWALL
CLIFF
LIMESTONE
LAYER
X
SHALE
SHALE
SANDSTONE
LAYER X
GRANITE
GORGE
COLORADO R.
QUARTZITE
SCHIST
GRANITE
SCHIST


STREAM
ZONE A
ZONE B
ZONE C
ZONE D
SEA LEVEL
BEDROCK
BOULDERS, COBBLES, PEBBLES, SAND
SAND, SILT
CLAY
PRECIPITATION OF MINERAL

Easily split layers of 0.0001-cm-diameter particles cemented together

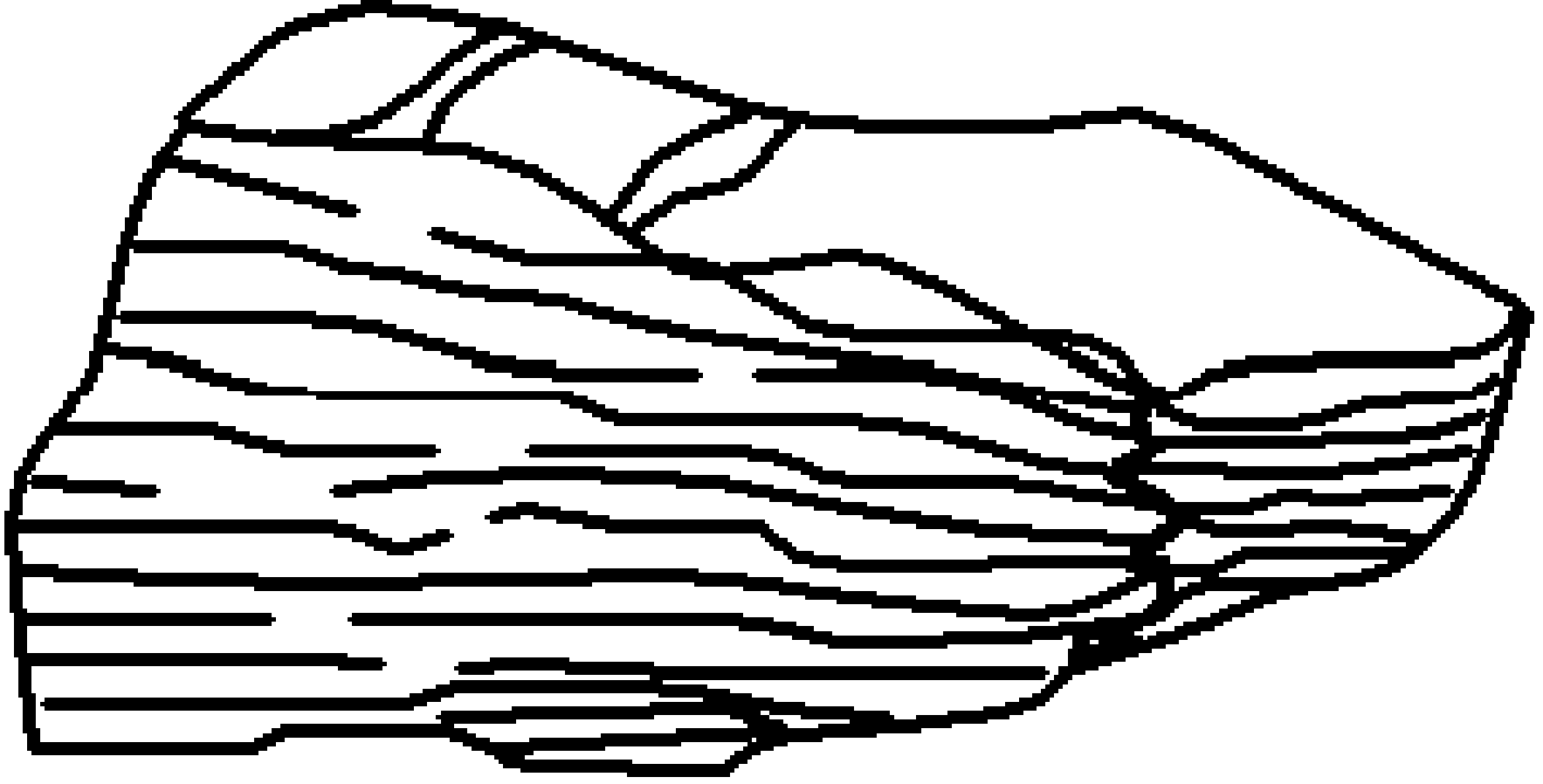


Bands of alternating light and dark minerals



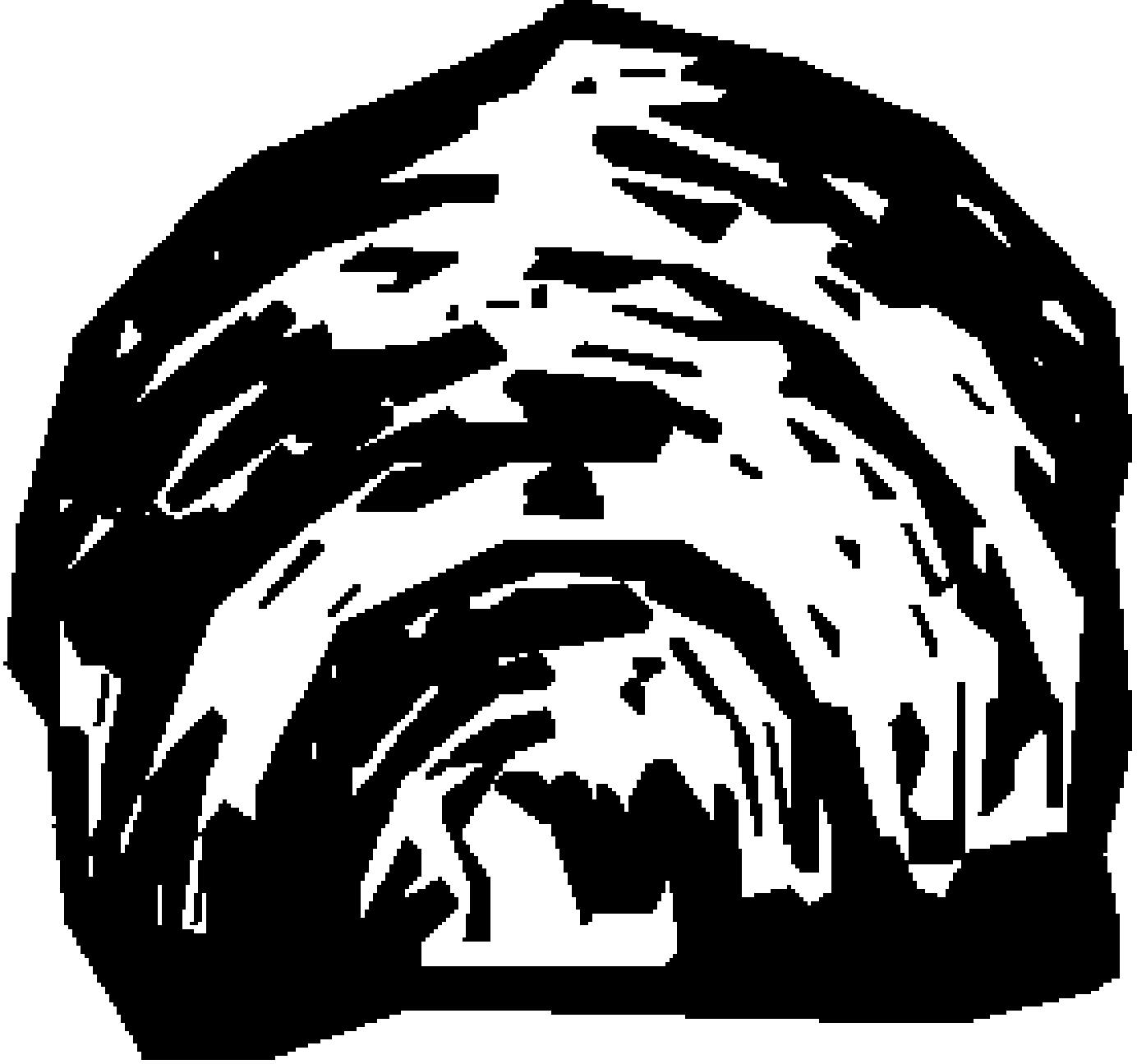
Interlocking
0.5-cm-diameter
crystals of various colors

Glassy black rock that breaks with a shell-shape fracture

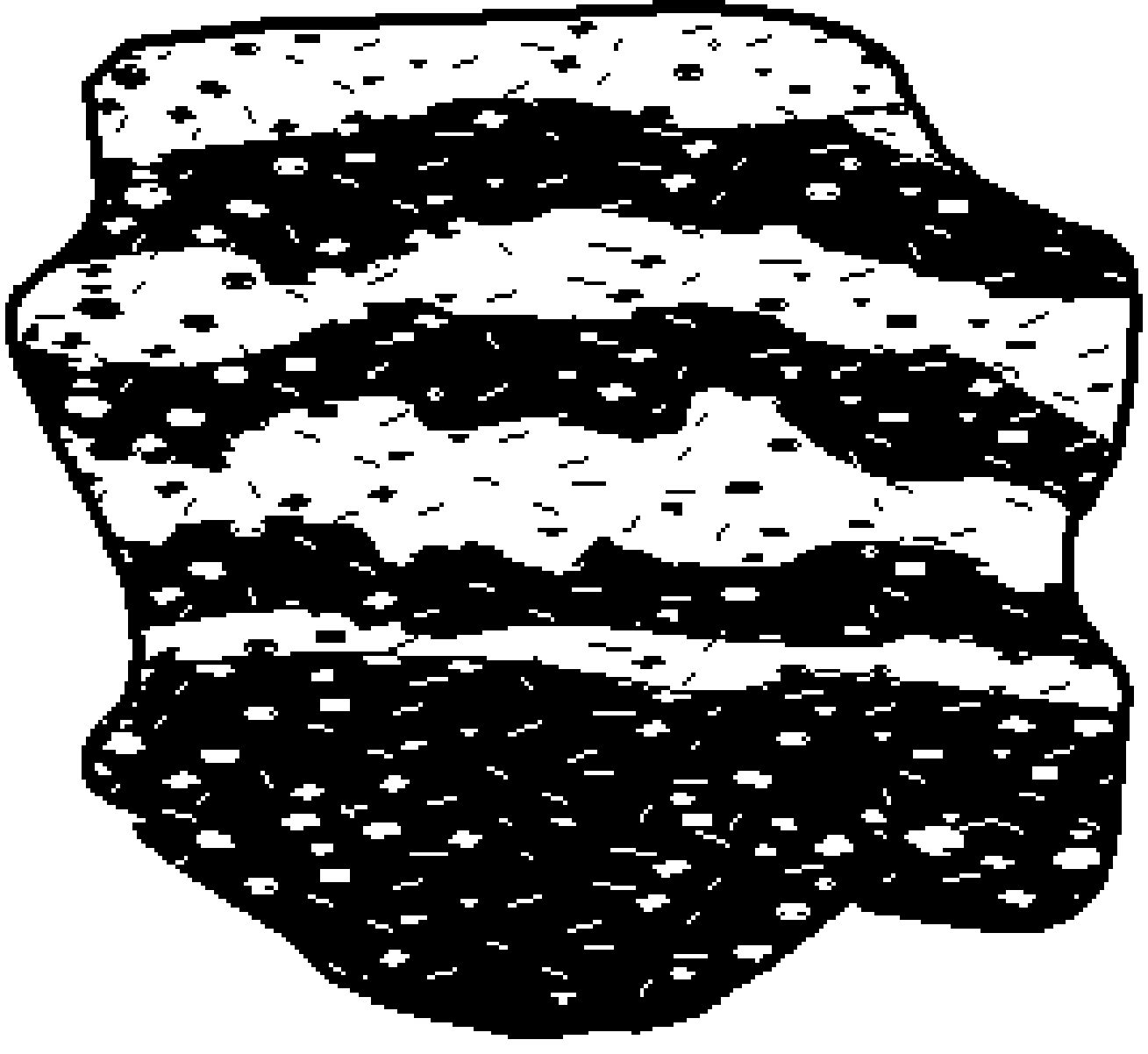


Easily split layers of 0.0001-cm-diameter particles cemented together

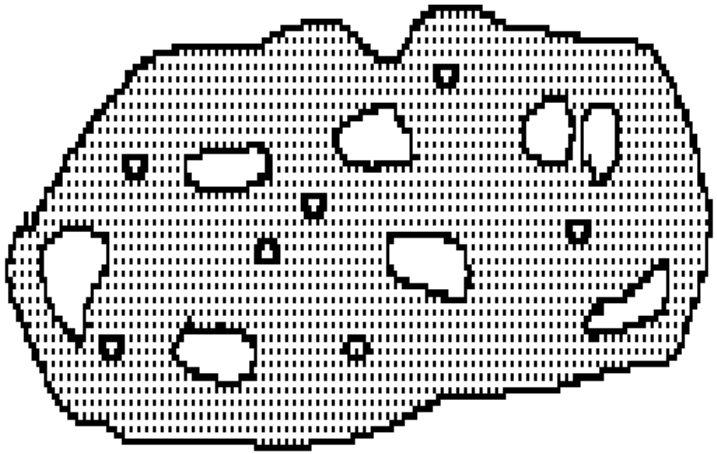
Interlocking 0.5-cm-diameter crystals of various colors



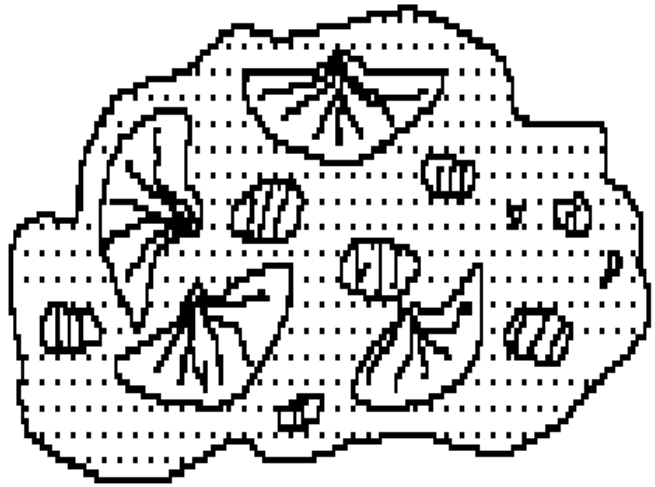
Glassy black rock that breaks with a shell-shape fracture



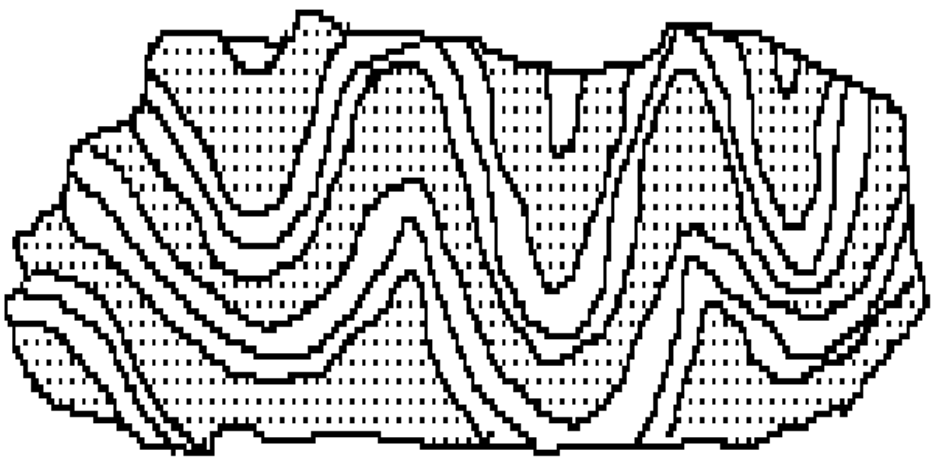
Bands of alternating light and dark minerals



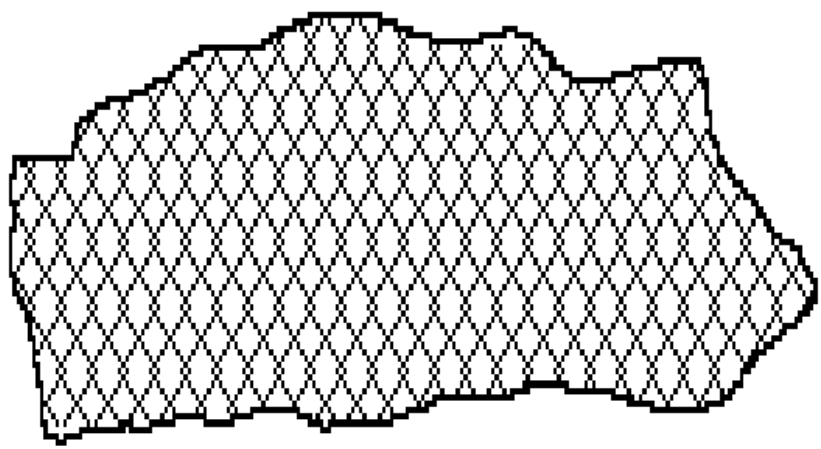
A



C



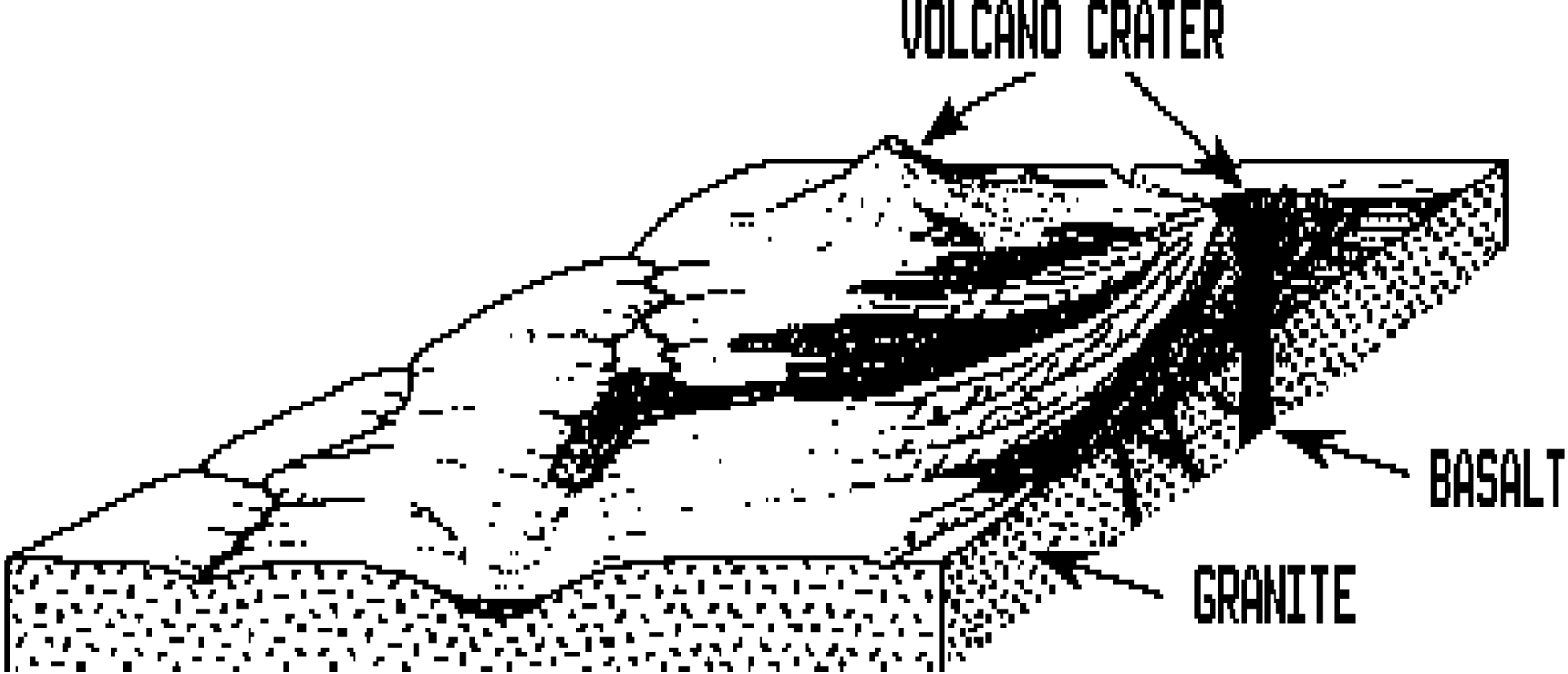
B

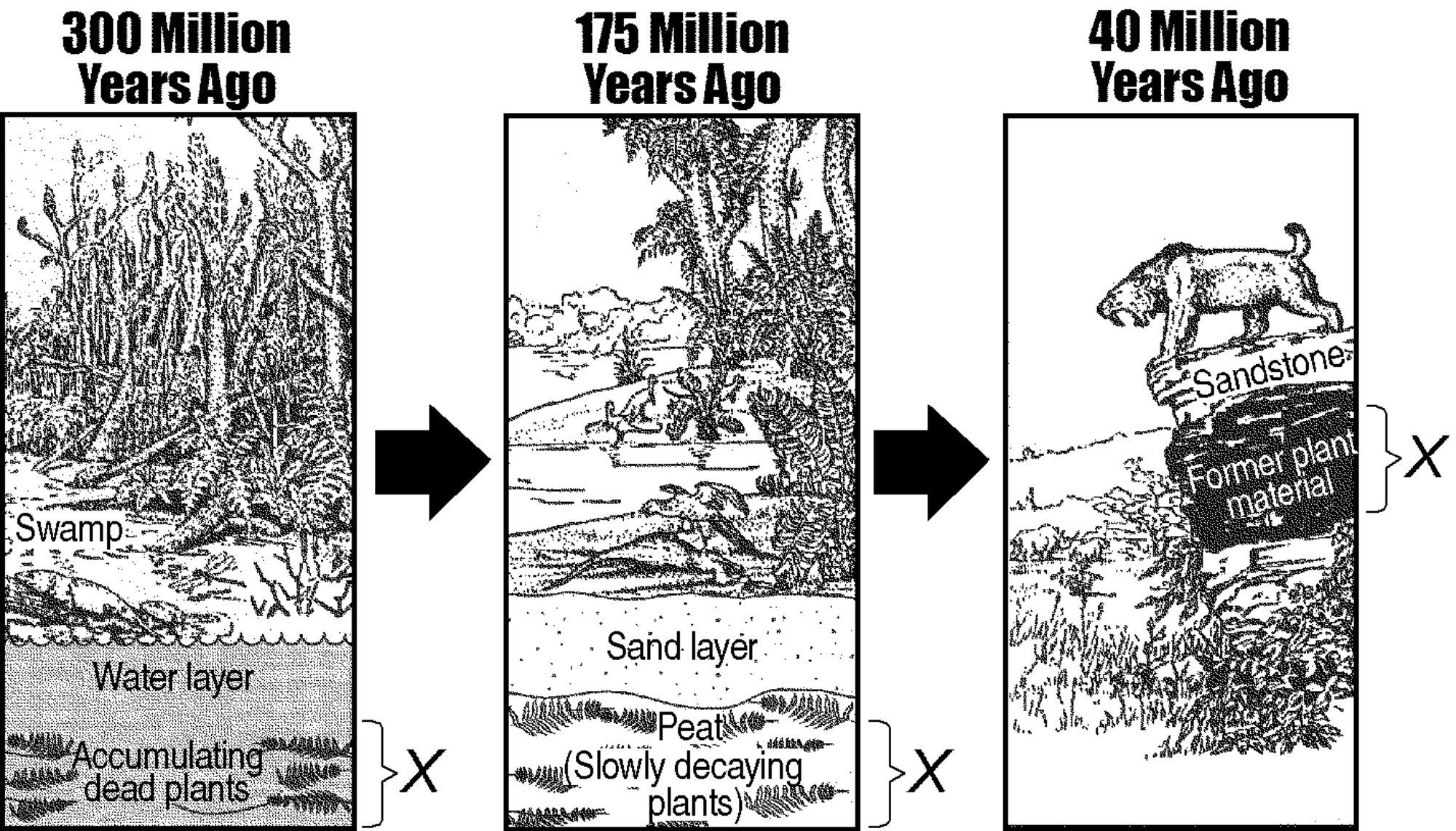


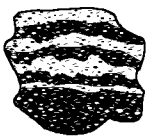
D

IGNEOUS ROCKS

Rock	Description	Minerals in Rock	Method of Formation	Use
Granite	Light colored, gray to pink	***A***	Intrusive	Building stone, monuments
Pumice	Light to gray	Feldspar and quartz	Extrusive	Scouring powders and soaps
B	Dark colored, gray to black, coarse grained	Feldspar and pyroxene	Intrusive	Building stone
Basalt Scoria	Dark colored, fine grained	Feldspar and pyroxene	Extrusive	Building stone, railway ballast
Obsidian (volcanic glass)	Dark colored	Feldspar and quartz	Extrusive	Ornaments, arrowheads

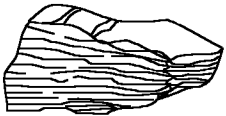

VOLCANO CRATER
BASALT
GRANITE


300 Million Years Ago
Swamp
Water layer
Accumulating dead plants
X
175 Million Years Ago
Sand layer
Peat (Slowly decaying plants)
X
40 Million Years Ago
Sandstone
Former plant material
X



Bands of alternating light and dark intergrown minerals

A

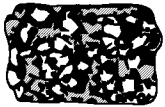


Easily split layers of 0.0001-cm-diameter particles cemented together

B

Glassy black rock that breaks with a shell-shape fracture

C

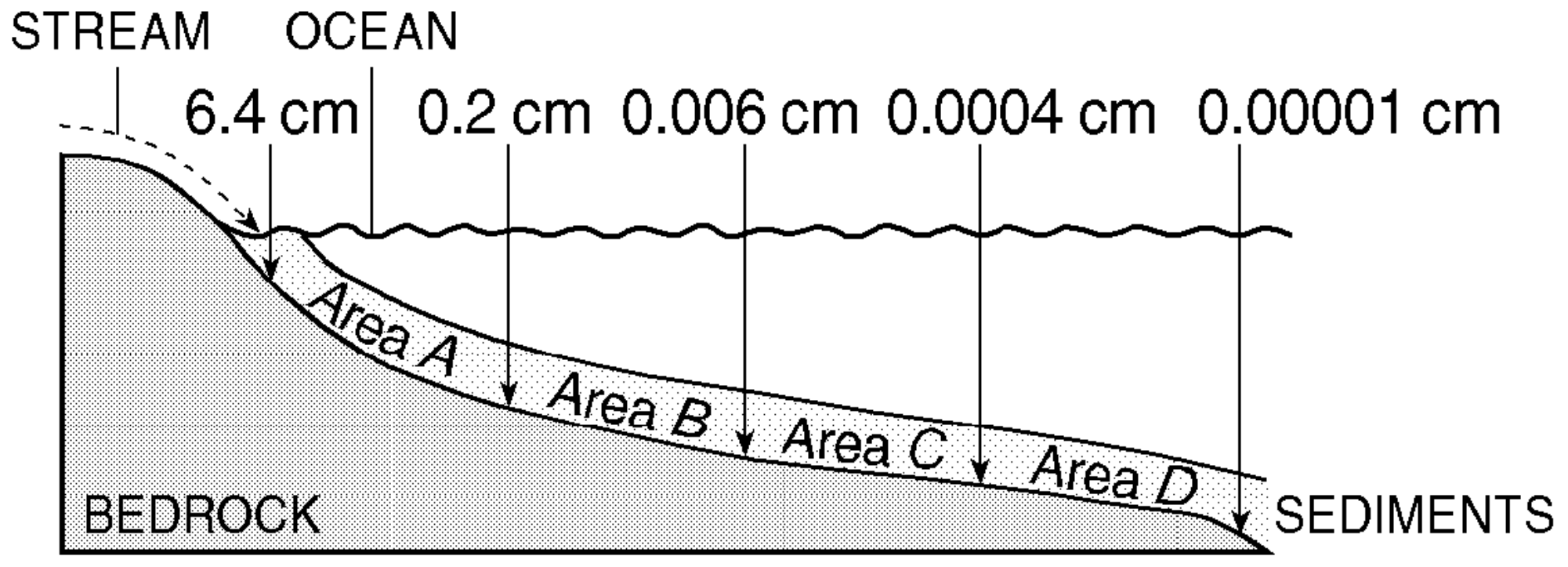


Intergrown 0.5-cm-diameter crystals of various colors

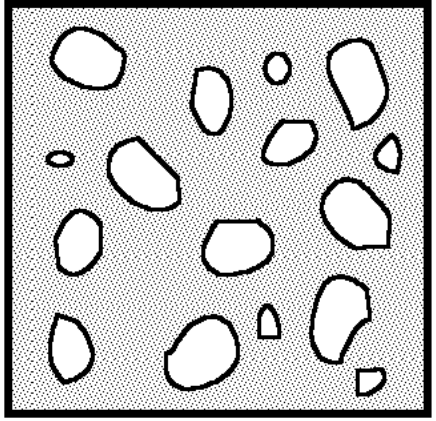
D

Sand and pebbles cemented together

E


STREAM
OCEAN
6.4 cm
0.2 cm
0.006 cm
0.0004 cm
0.00001 cm
Area A
Area B
Area C
Area D
BEDROCK
SEDIMENTS

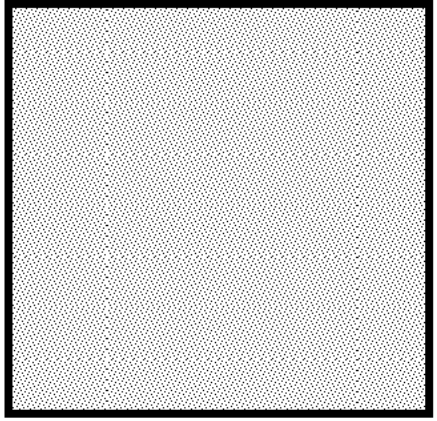
TOP



BOTTOM

ROCK *A*:
cemented sand and rounded pebbles

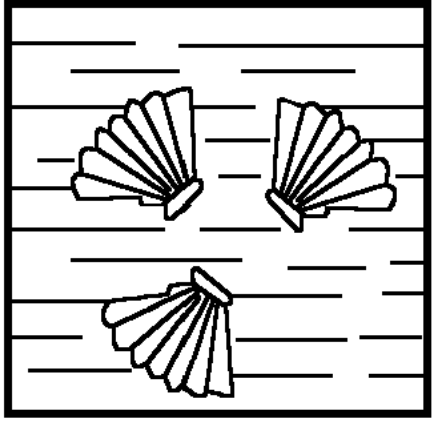
TOP



BOTTOM

ROCK *B*:
uniform smooth sand grains firmly cemented together

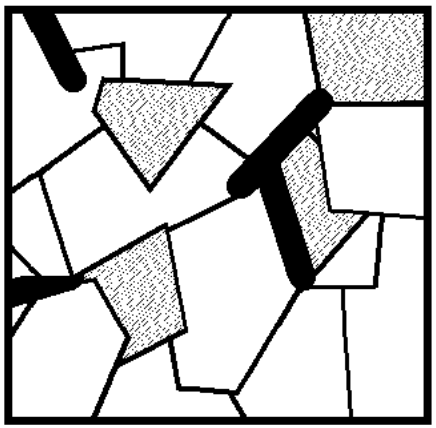
TOP



BOTTOM

ROCK *C*:
a matrix of fine colloidal-sized particles with shell fossils

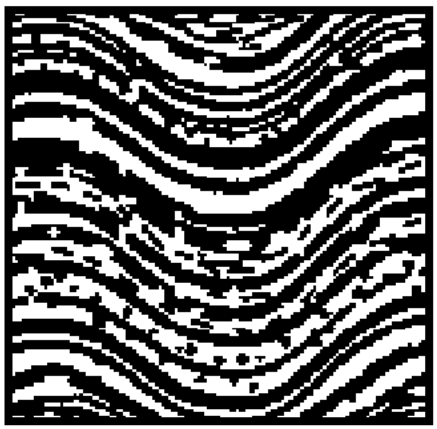
TOP



BOTTOM

ROCK *D*:
large intergrown mineral crystals

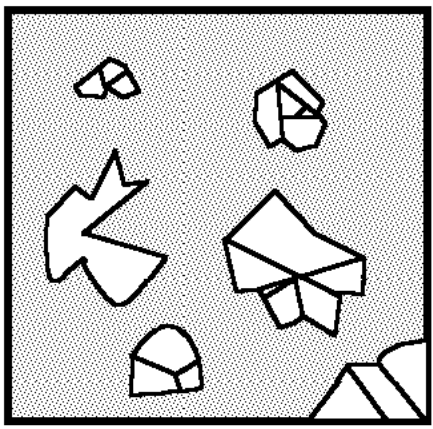
TOP



BOTTOM

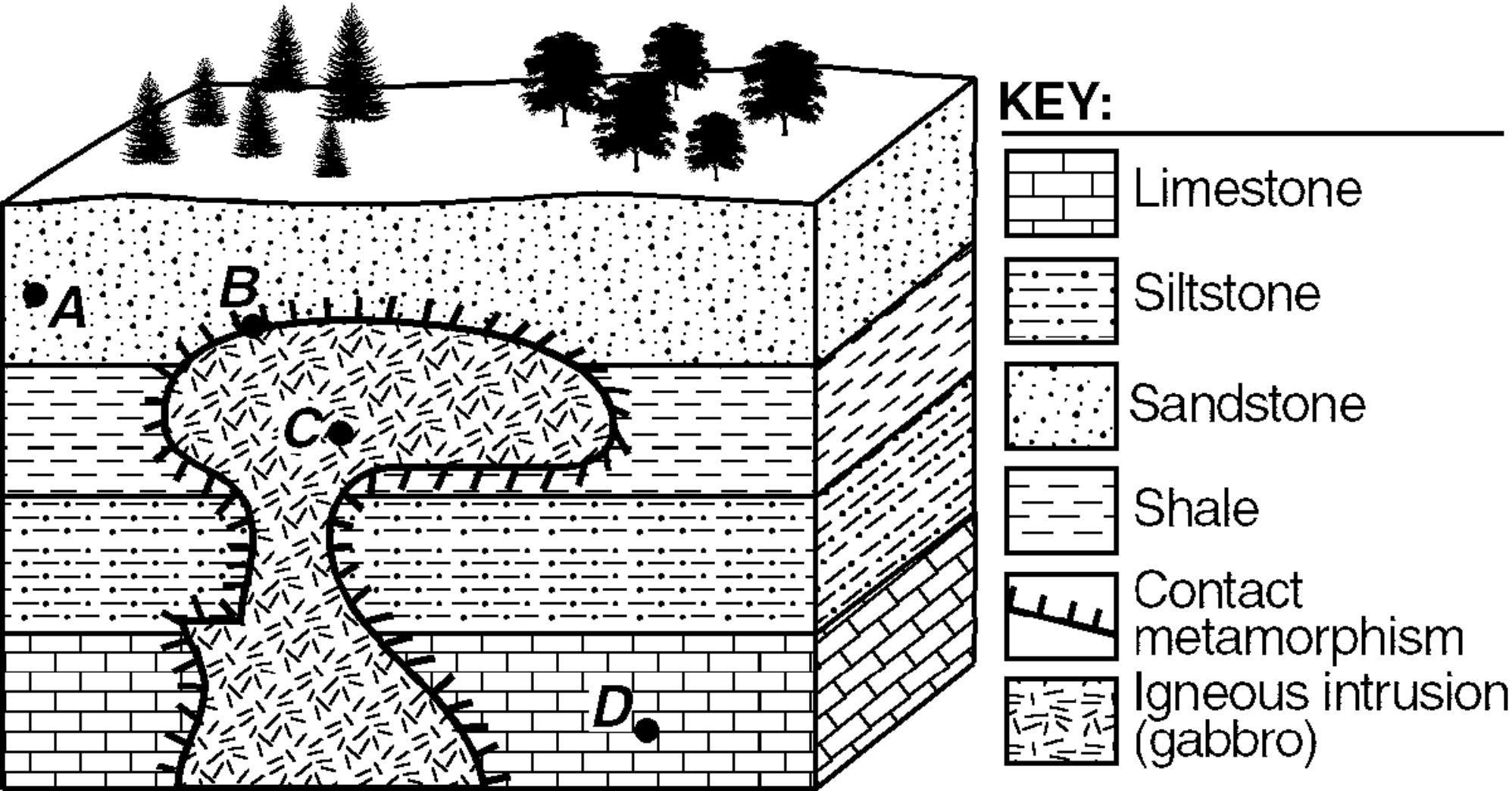
ROCK *E*:
crumpled distorted bands of different minerals

TOP



BOTTOM

ROCK *F*:
cemented sand and angular rock fragments


A
B
C
D
KEY:
Limestone
Siltstone
Sandstone
Shale
Contact metamorphism
Igneous intrusion (gabbro)

SEDIMENTARY ROCKS

Rock	Composition	Formation	Use
Conglomerate	Cobbles, pebbles, sand, and silt; chief mineral is quartz (silica)	Sediments accumulate and are cemented together	Building material
Sandstone	Grains of sand; chief mineral is quartz (silica)	Grains are cemented by silica, lime, or iron oxide	Building stone
Shale	Very fine particles of mud or clay; chief mineral is kaolinite	***A***	Building material
B	Mud or remains of marine animal life; chief mineral is calcite	Shells or fossils accumulate and are cemented together; also formed by chemical precipitation	Plaster, cement
C	Chiefly carbon	Plant life such as ferns decomposes; impurities are driven off, leaving carbon	Fuel

MINERAL	COLOR	LUSTER	STREAK	HARD-NESS	DENSITY (g/mL)	CHEMICAL COMPOSITION
biotite mica	black	glassy	white	soft	2.8	$K(Mg,Fe)_3(AlSi_3O_{10})(OH_2)$
diamond	varies	glassy	colorless	hard	3.5	C
galena	gray	metallic	grey-black	soft	7.5	PbS
graphite	black	dull	black	soft	2.3	C
kaolinite	white	earthy	white	soft	2.6	$Al_4(Si_4O_{10})(OH)_8$
magnetite	black	metallic	black	hard	5.2	Fe_3O_4
olivine	green	glassy	white	hard	3.4	$(Fe,Mg)_2SiO_4$
pyrite	brass yellow	metallic	greenish-black	hard	5.0	FeS_2
quartz	varies	glassy	colorless	hard	2.7	SiO_2

Definitions:

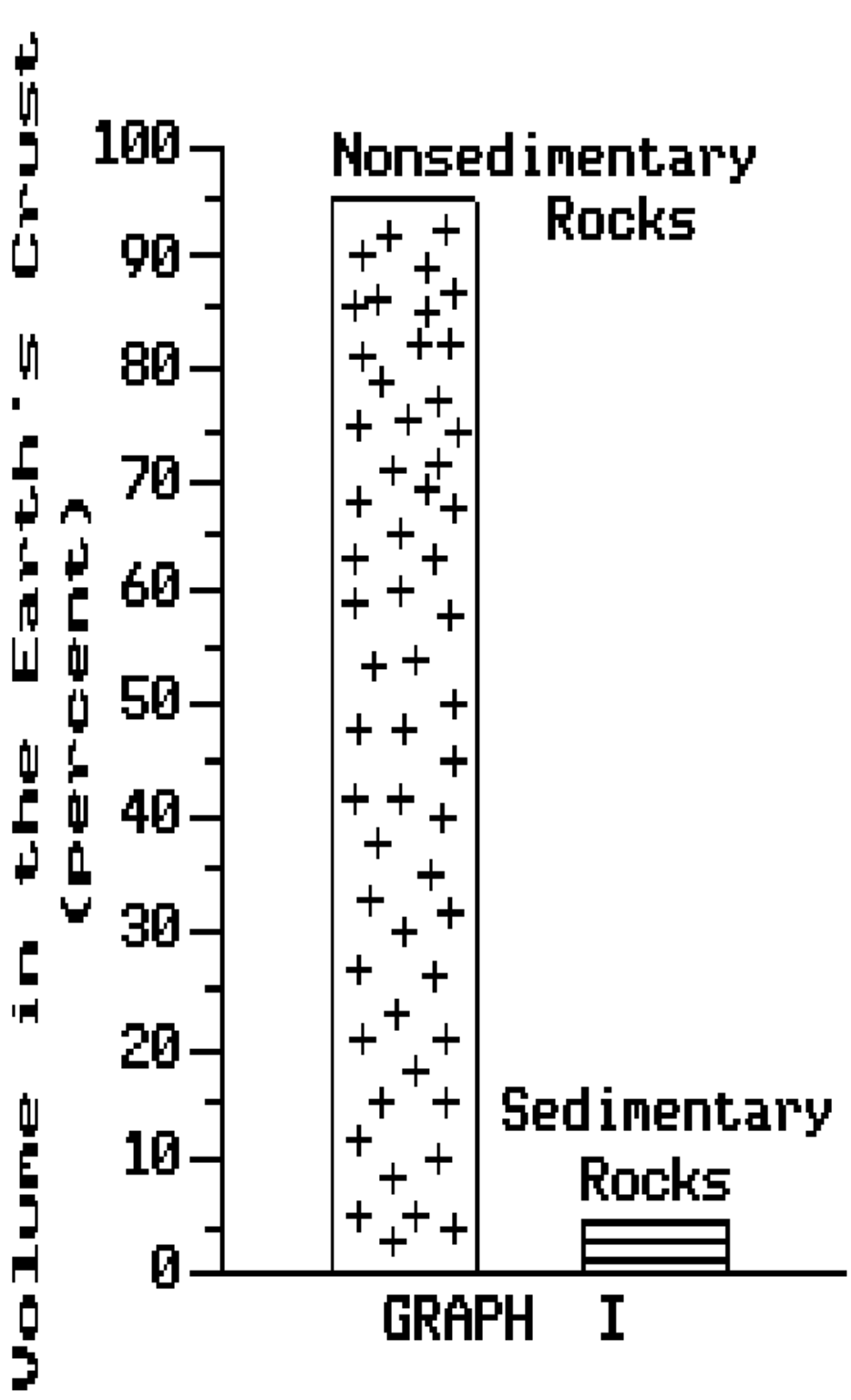
LUSTER: the way a mineral's surface reflects light

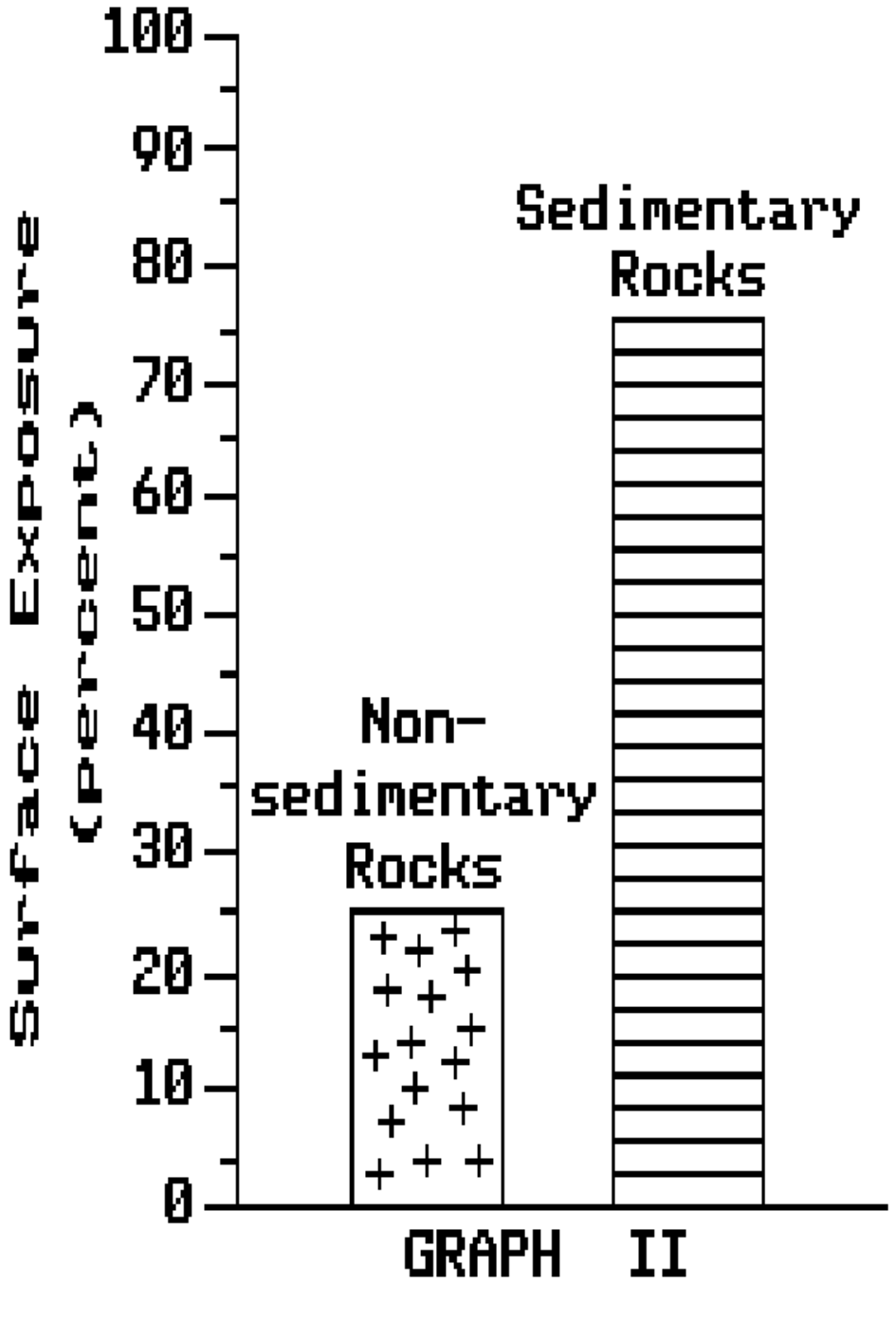
STREAK: color of a powdered form of the mineral

HARDNESS: resistance of a mineral to being scratched (soft-easily scratched; hard-not easily scratched)

Chemical Symbols

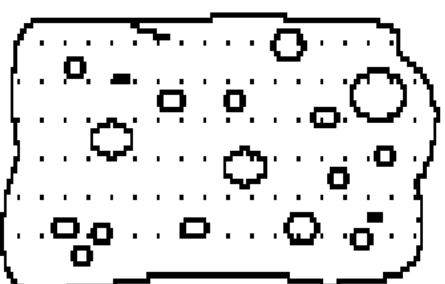
Al - Aluminum	Pb - Lead
C - Carbon	Si - Silicon
Fe - Iron	K - Potassium
H - Hydrogen	S - Sulfur
Mg - Magnesium	O - Oxygen


Volume in the Earth's Crust
(percent)
100
90
80
70
60
50
40
30
20
10
0
Nonsedimentary
Rocks
Sedimentary
Rocks
GRAPH I

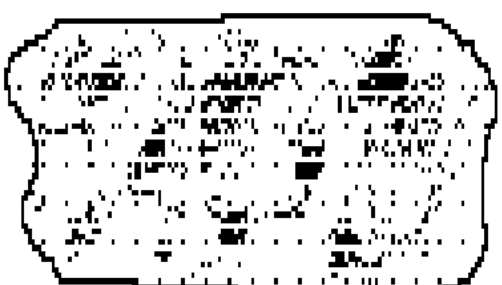

Surface Exposure
(percent)
100
90
80
70
60
50
40
30
20
10
0
Non-
sedimentary
Rocks
Sedimentary
Rocks
GRAPH II

Basalt

Gneiss

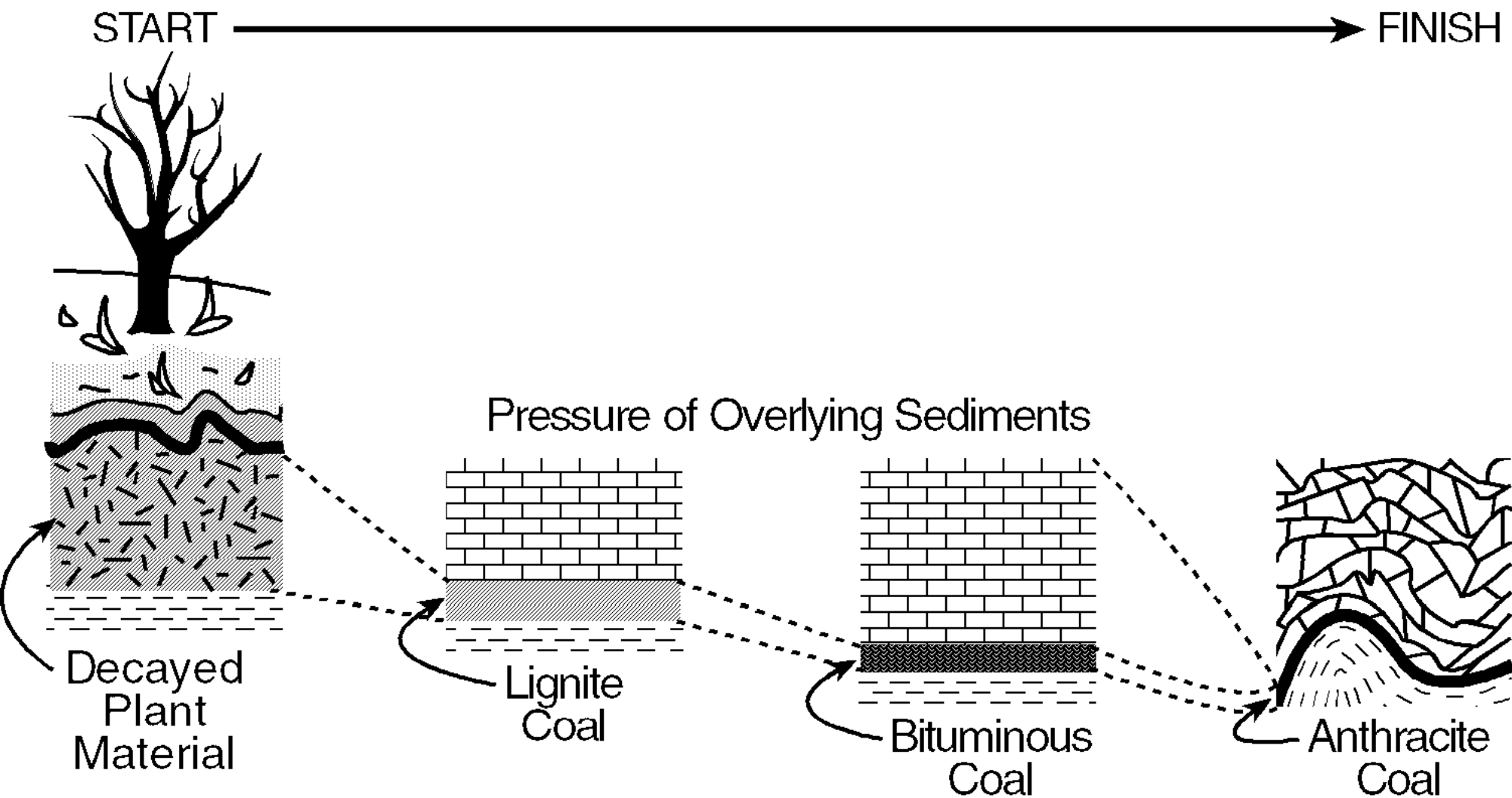


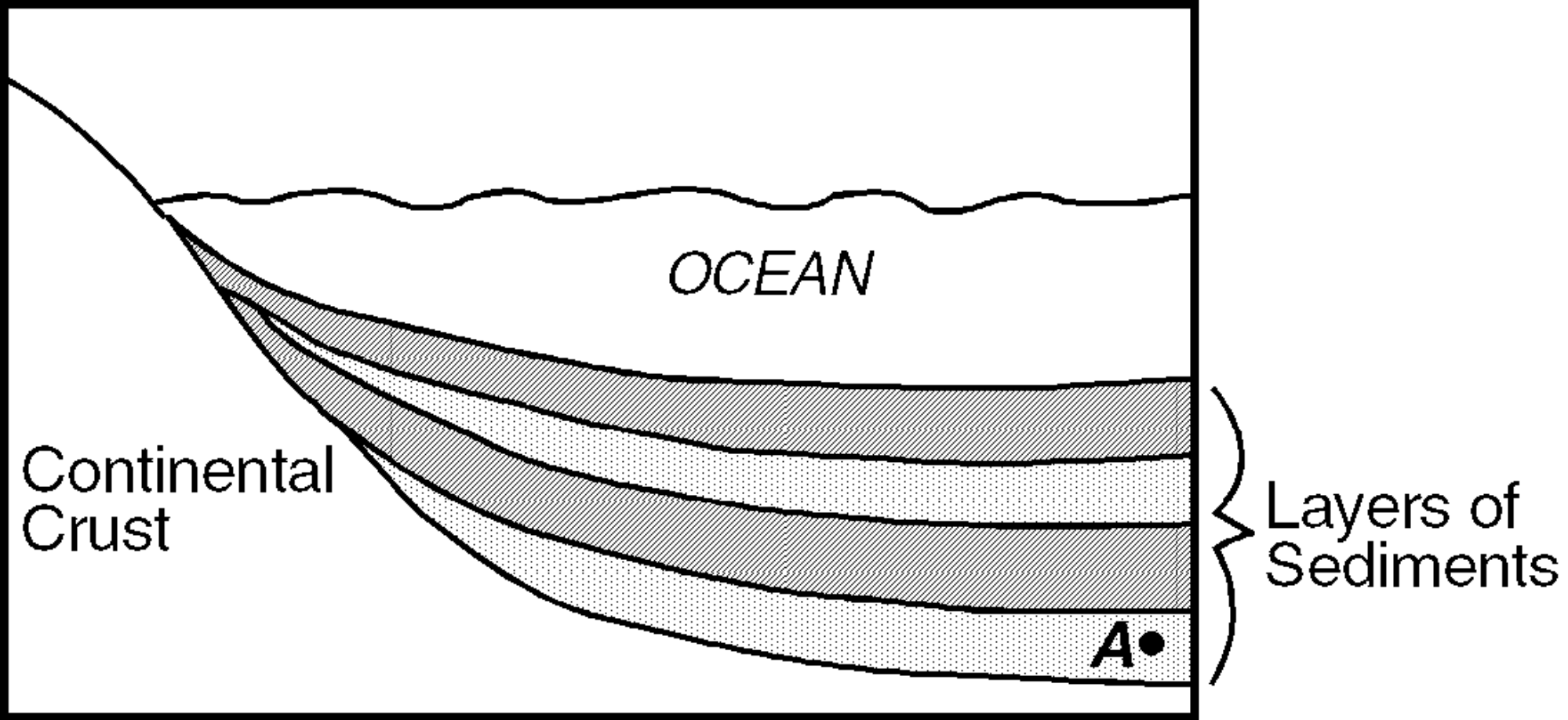
Conglomerate



Granite

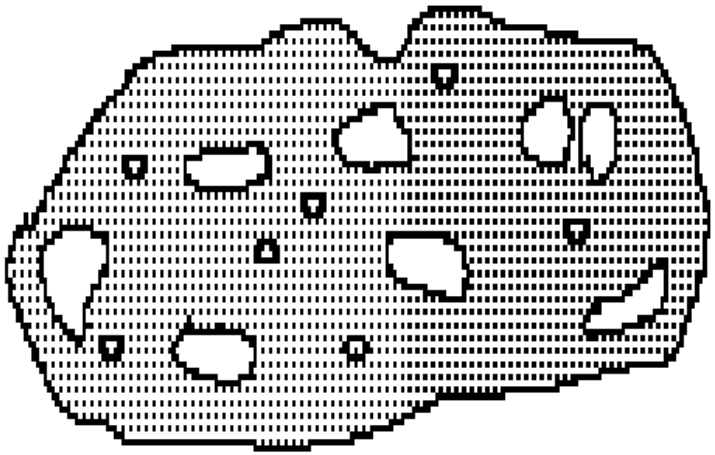
Sandstone


START
FINISH
Pressure of Overlying Sediments
Decayed Plant Material
Lignite Coal
Bituminous Coal
Anthracite Coal

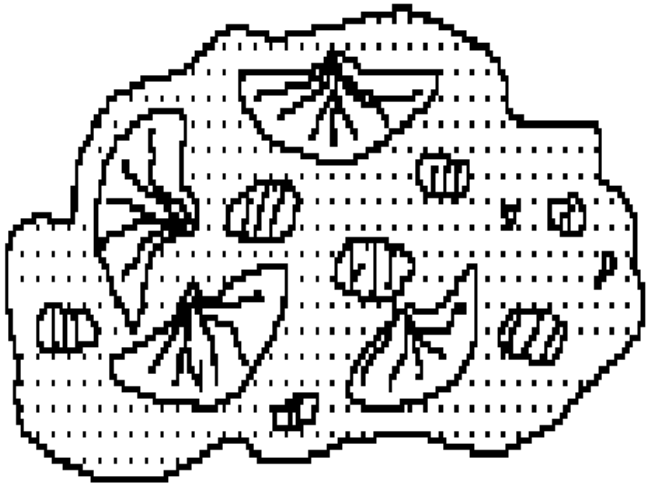

OCEAN
Continental Crust
Layers of Sediments
A

METAMORPHIC ROCKS

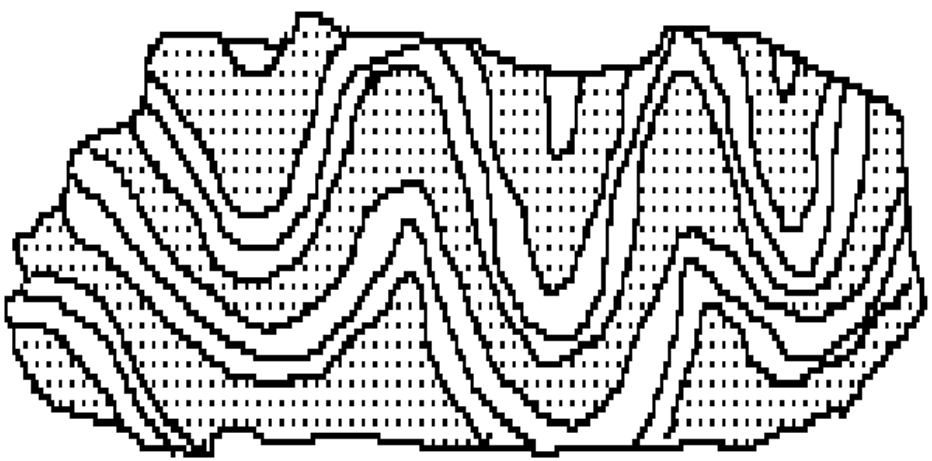
Rock	Composition	Formed From	Characteristics	Use
Gneiss	Quartz, feldspar, mica	Various rocks	Minerals are arranged in parallel bands (foliated)	Monuments, buildings
Quartzite	Chiefly quartz	Sandstone	Grains of sand are fused (not porous)	Buildings
Marble	Calcite	Limestone	***A***	Buildings, statues, monuments
B	Mud and clay	Shale	Splits into thin sheets	Roofs, sidewalks
Anthracite Coal	Chiefly carbon	Bituminous coal	Harder and shinier than bituminous coal	Fuel
Schists	Variable, quartz plus other minerals	Igneous or sedimentary rock	Parallel bands of minerals; flakes of mica, talc, and chlorite may be visible	Various uses



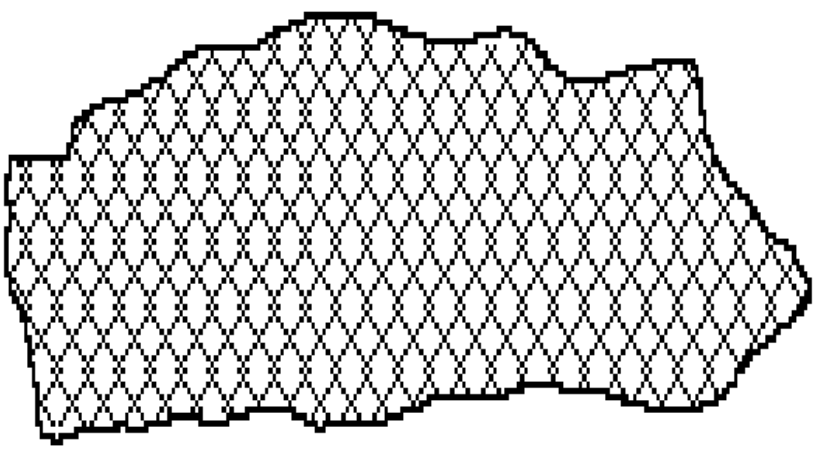
A



C



B



D