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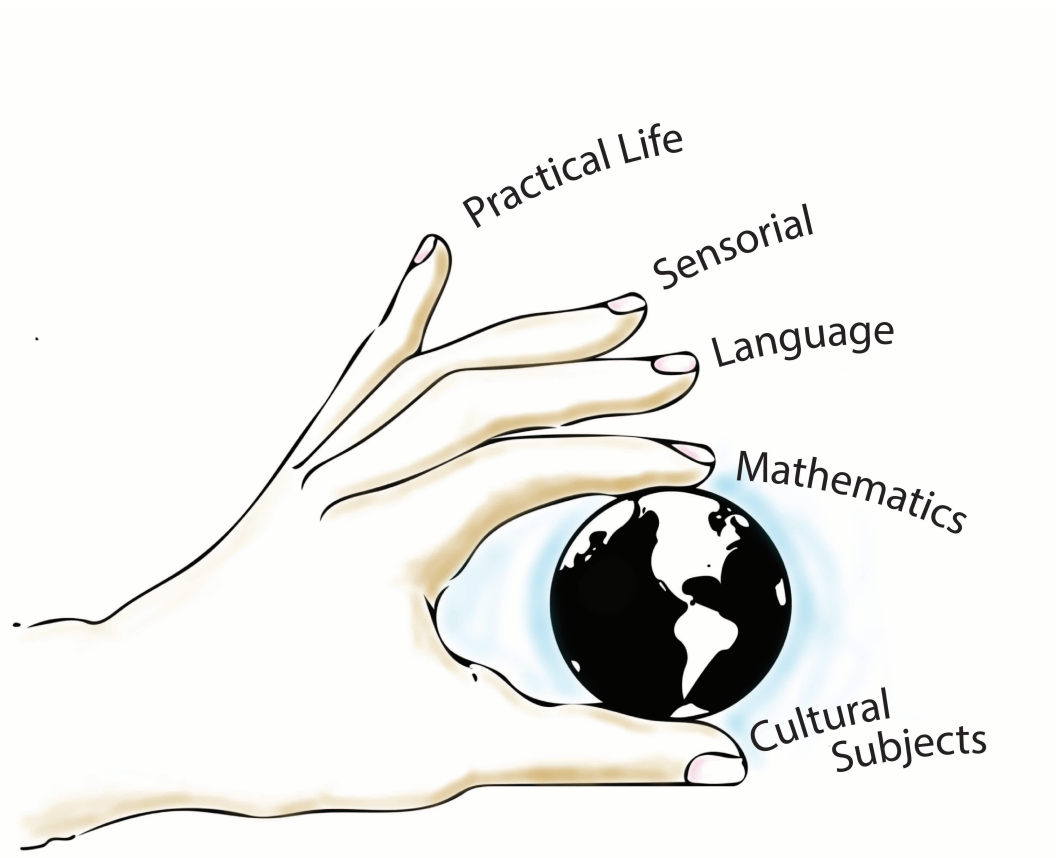

Geography

Early Childhood

Lesson Preparation Materials

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MEI, Inc. Geography Early Childhood

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Diagrams for Earth's Interior	2
Diagrams for Earth's Atmosphere	2
Labels & Information for Earth's Atmosphere	3
Diagrams for Volcanoes	2
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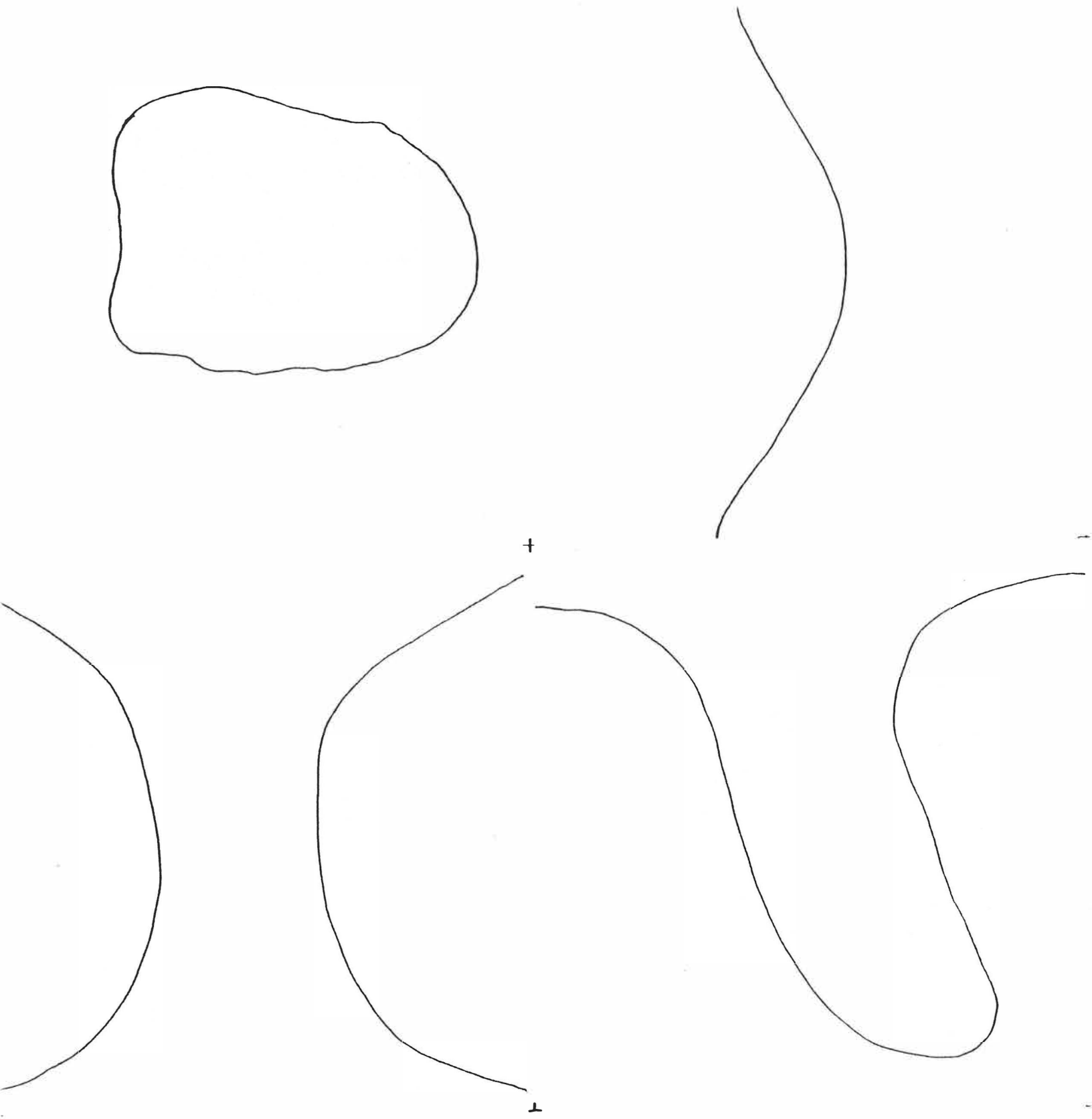

Land and Water Forms

Land and Water Forms	a body of water surrounded by land
lake	
island	
	a land mass surrounded by water
cape	
bay	
gulf	a land mass which juts out into a body of water
peninsula	
isthmus	
	a body of water which juts into a land mass
strait	

a large body of water which extends some distance into a land mass

Cuba

Madagascar

Honshu

Sumatra

a long, narrow land mass extending some distance into a body of water

Greenland

Iceland

Great Britain

New Guinea

a narrow land mass connecting two large land masses

Borneo

Taiwan

Sri Lanka

a narrow body of water connecting two large bodies of water

Cyprus

Ireland

Europe

Asia

Africa

North America

South America

Atlantic Ocean

Pacific Ocean

Arctic Ocean

Indian Ocean

Antarctica

Australasia or Australia

Land and Water Forms
lake
a body of water surrounded by land

island
a land mass surrounded by water

cape
a land mass which juts out into a body of water

bay
a body of water which juts into a land mass

gulf
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peninsula
a long, narrow land mass extending some distance into a body of water

isthmus
a narrow land mass connecting two large land masses

strait
a narrow body of water connecting two large bodies of water

Islands of the World
Cuba
Madagascar Honshu
Sumatra
Greenland
Iceland
Great Britain
New Guinea Borneo
Taiwan
Sri Lanka
Cyprus
Ireland
Luzon
Oahu

Lakes of the World
Lake Victoria
Lake Eyre
Lake Tanganyika
Great Lakes
Lake Titicaca
Lake Baykal
Great Salt Lake
Lake Geneva
Loch Ness

Gulfs of the World
Gulf of Aden
Gulf of Mexico
Persian Gulf
Gulf of Tonkin
Gulf of California
Gulf of Thailand Gulf of Bothnia Gulf of Carpentaria Gulf of Oman

Peninsulas of the World
Alaskan Peninsula
Antarctic Peninsula
Iberian Peninsula
Yucatan Peninsula
Arabian Peninsula Malay Peninsula Kamchatka Peninsula Scandinavian Peninsula Valdes Peninsula

Straits of the World
Torres Strait
Strait of Malacca
Denmark Strait
Strait of Gilbralter
Straits of Florida
Strait of Magellan Bering Strait
Davis Strait
Strait of Dover

Isthmuses of the World
Isthmus of Kra
Isthmus of Suez Isthmus of Panama Isthmus of Tehuantepec

Capes of the World
Cape York
Cape of Good Hope
Cape Verde
Cape Canaveral
Cape Finisterre
Cape Horn
Cape Comorin
Cape Guardafui
North West Cape

Bays of the World
Hudson Bay
Mackenzie Bay
San Francisco Bay
Chesapeake Bay
Bay of Bengal
Bay of Campeche Ballin Bay
Bay of Biscay
St. Helena Bay

Luzon

Oahu

Lake Victoria

Lake Eyre

Lake Tanganyika

Great Lakes

Lake Titicaca

Lake Baykal

Great Salt Lake

Lake Geneva

Loch Ness

Gulf of Aden

Gulf of Mexico

Persian Gulf

Gulf of Tonkin

Gulf of Cailifornia

Gulf of Thailand

Gulf of Bothnia

Gulf of Carpentaria

Gulf of Oman

Alaskan Peninsula

Antarctic Peninsula

Iberian Peninsula

Yucatan Peninsula

Arabian Peninsula

Malay Peninsula

Kamchatka Peninsula

Scandinavian Peninsula

Valcres Peninsula

Torres Strait

Strait of Malacca

Denmark Strait

Strait of Gilbralter

Straits of Florida

Strait of Magellan

Bering Strait

Davis Strait

Strait of Dover

Isthmus of Kra

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Isthmus of Panama

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Cape York

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Cape Verde

Cape Canaveral

Cape Finisterre

Cape Horn

Cape Comorin

Cape Guardafui

North West Cape

Hudson Bay

Mackenzie Bay

San Francisco Bay

Chesapeake Bay

Bay of Bengal

Bay of Campeche

Baffin Bay

Bay of Biscay

St. Helena Bay

Tennessee

The state seal has a plow, a sheaf of wheat and a stalk of cotton to symbolize the importance of agriculture. Commerce is represented by a riverboat. The year 1796 indicates when the first state constitution was approved.

Tennessee is bounded on the north by Kentucky and Virginia, the east by North Carolina, the south by Mississippi, Alabama and Georgia and the west by Arkansas and Missouri. The Mississippi River forms Tennessee's western border.

The state flower is the iris.

The flag of Tennessee has three white stars, united in a circle of blue on a field of red. The stars represent the three grand divisions of the state: East Tennessee, Middle Tennessee and West Tennessee.

The state wild flower is the passion flower.

The state bird is the mockingbird.

The state tree is the tulip poplar.

Chickamauga Indians, a branch of the Cherokee, occupied the southeast part of the state. Chickasaw Indians lived in West Tennessee. A Cherokee Indian village, Tanasie, was the source of the name, Tennessee.

Tennessee is known as the Volunteer State because of the tradition of men in Tennessee to volunteer for military service. This began in 1812 when Tennesseans volunteered to fight the Battle of New Orleans under Andrew Jackson.

In 1540, Hernando de Soto and his band of Spanish explorers came to what is now Tennessee. He was the first European to reach the Mississippi River.

Indians lived in the area of what is now Tennessee as long as 8,000 years ago. Cherokee Indians had their hunting ground in what is now Middle Tennessee.

Spain, France and England claimed the area which is now Tennessee. Trading posts were established to trade with the Indians. After a war, the French gave England all claim to land east of the Mississippi River in 1763.

In 1775, the Transylvania Company purchased the area of Tennessee and Kentucky from the Cherokee Indians. They hired Daniel Boone to blaze a trail through the Cumberland Gap. Settlers entered the area by way of this Wilderness Road.

Fort Nashborough, now Nashville, was built as the center for the settlements of Middle Tennessee about 1779.

The Chickasaw Indians ceded their land in West Tennessee to the federal government in 1818.

Tennessee became a state on June 1, 1796, the 16th state to enter the union.

On June 8, 1861, Tennessee became the last state to secede from the Union and joined the Confederate States. Senator Andrew Johnson was the only senator who did not secede with his state. He remained loyal to the Union.

Many battles of the Civil War were fought in Tennessee. Shiloh and Lookout Mountain were two important battles.

President Lincoln appointed Andrew Johnson military governor of Tennessee. Later, Johnson was elected Lincoln's vice-president. After Lincoln's assassination, Johnson became president April 15, 1865.

Tennessee was the first Confederate state to be re-admitted to the Union on July 24, 1866.

The area of Tennessee is 42,114 square miles. It is 482 miles from the east to west and 116 miles from north to south.

The highest elevation is 6,643 feet above sea level at Clingman's Dome in the Great Smoky Mountains of eastern Tennessee. The lowest point is 182 feet above sea level in Shelby County in the southwest.

There are six main land regions. The Blue Ridge region, averaging 5,000 feet in elevation, is on the state's far eastern boarder. The Appalachian Ridge and Valley region extends about 55 miles west of the Blue Ridge region.

The Cumberland Plateau consists of flat topped mountains about 1,600 feet in elevation. The Highland Rim is a raised plain in the central part of the state. Within the Highland Rim lies the Nashville Basin, an area of lower land.

In the far west of Tennessee is the Gulf Coastal Plain in which lies the low alluvial plain along the Mississippi River called the Mississippi Bottoms.

The Tennessee River cuts through the state between the Cumberland Plateau and the Great Smoky Mountains , then again at the west of the Highland Rim.

The Cumberland River drains the north central part of the Highland Rim. The Mississippi River drains west Tennessee.

The Tennessee Valley Authority (TVA) was established by the federal government in 1933. Dams were built along the Cumberland and Tennessee rivers and their tributaries.

Dams control flooding, improve navigation and provide for the generation of electrical power. The artificial lakes formed by the dams are used for boating and fishing.

About half of Tennessee is covered with forests. The most important trees are hickory, short leaf pine, red oak, white oak and yellow poplar. The wood industry is important to the economy of the state.

The capital of Tennessee is Nashville, the second largest city in the state.

The largest city in Tennessee is Memphis.

Knoxville and Chattanooga are the third and fourth largest cities in the state.

Some colleges and universities in Tennessee are the University of Tennessee System located in many cities throughout the state, Memphis State University, Vanderbilt University, Rhodes College, University of the South and Christian Brothers University.

The population of Tennessee was 4,822,000 in the 1990 census. Tennessee ranks 18th in population among the fifty states. About 3/5 of the population live in urban areas. About 2/5 of the population live in rural areas.

Three presidents of the United States were born in Tennessee. Andrew Jackson, seventh president, lived at the Hermitage, near Nashville. James K. Polk, eleventh president, lived in Columbia. Andrew Johnson, seventeenth president, lived in Greenville.

Tennessee manufactures chemicals, food products, machinery, automobiles and electronic equipment. Only 2 % of the state's gross product comes from agriculture and 1 % from mining coal, zinc and stone.

Davy Crockett and Sam Houston were famous Tennesseans who were heroes of the war against Mexico in 1836.

Interesting places to visit are the American Museum of Atomic Energy, Oak Ridge; Lookout Mountain, Chattanooga; The Hermitage, home of Andrew Jackson, Nashville; Graceland, home of Elvis Presley, Memphis; and The Parthenon, Nashville.

Shelbyville is the walking horse capital.

Nashville is the country music capital.

The Flag

canton
upper quarter of the flag on the side next to the staff, usually containing a design

device
emblem or design, sometimes called a badge

union
design symbolizing unity, appearing as an entire flag or on the canton

field
background color or colors of the flag, also called the ground, outside of the canton

fly
horizontal length of the flag, 1.9 times the hoist in the American flag and twice the hoist in British flags

hoist
vertical width of the flag, also the part of the flag nearest the staff

fly end
unattached end of the flag, farthest from the staff

staff
pole on which the flag is hung, also called mast, flagpole or flagstaff

finial
ornament at the top of the staff

halyard
rope attached to the flag by which it is hoisted or lowered

truck
pulley through which the halyard passes at the top of the staff below the finial

The Flag

canton

device

union

field

fly

hoist

fly end

staff

finial

halyard

truck

upper quarter of the flag on the side next to the staff, usually containing a design

horizontal length of the flag, 1.9 times the hoist in the American flag and twice the hoist in British flags

emblem or design, sometimes called a badge

vertical width of the flag, also the part of the flag nearest the staff

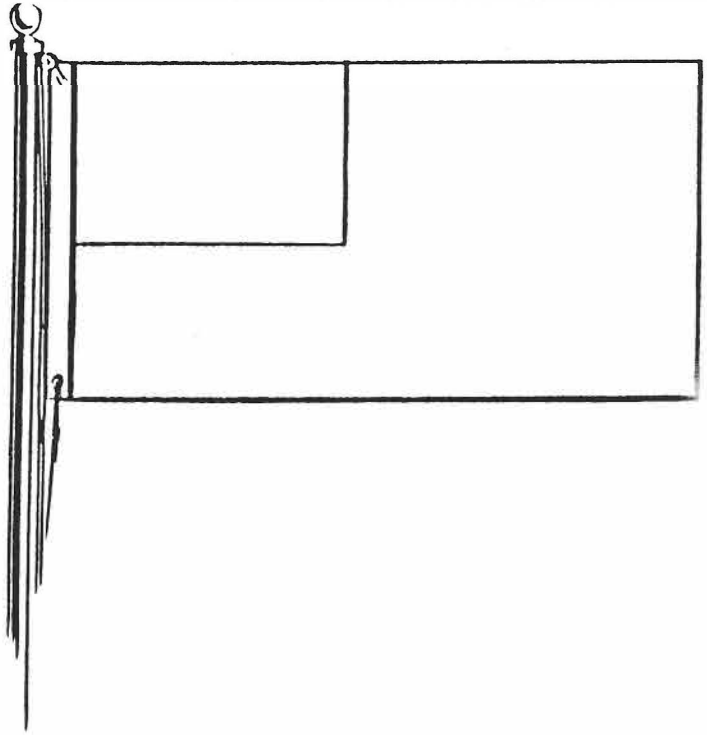
design symbolizing unity, appearing as an entire flag or on the canton

unattached end of the flag, farthest from the staff

background color or colors of the flag, also called the ground, outside of the canton

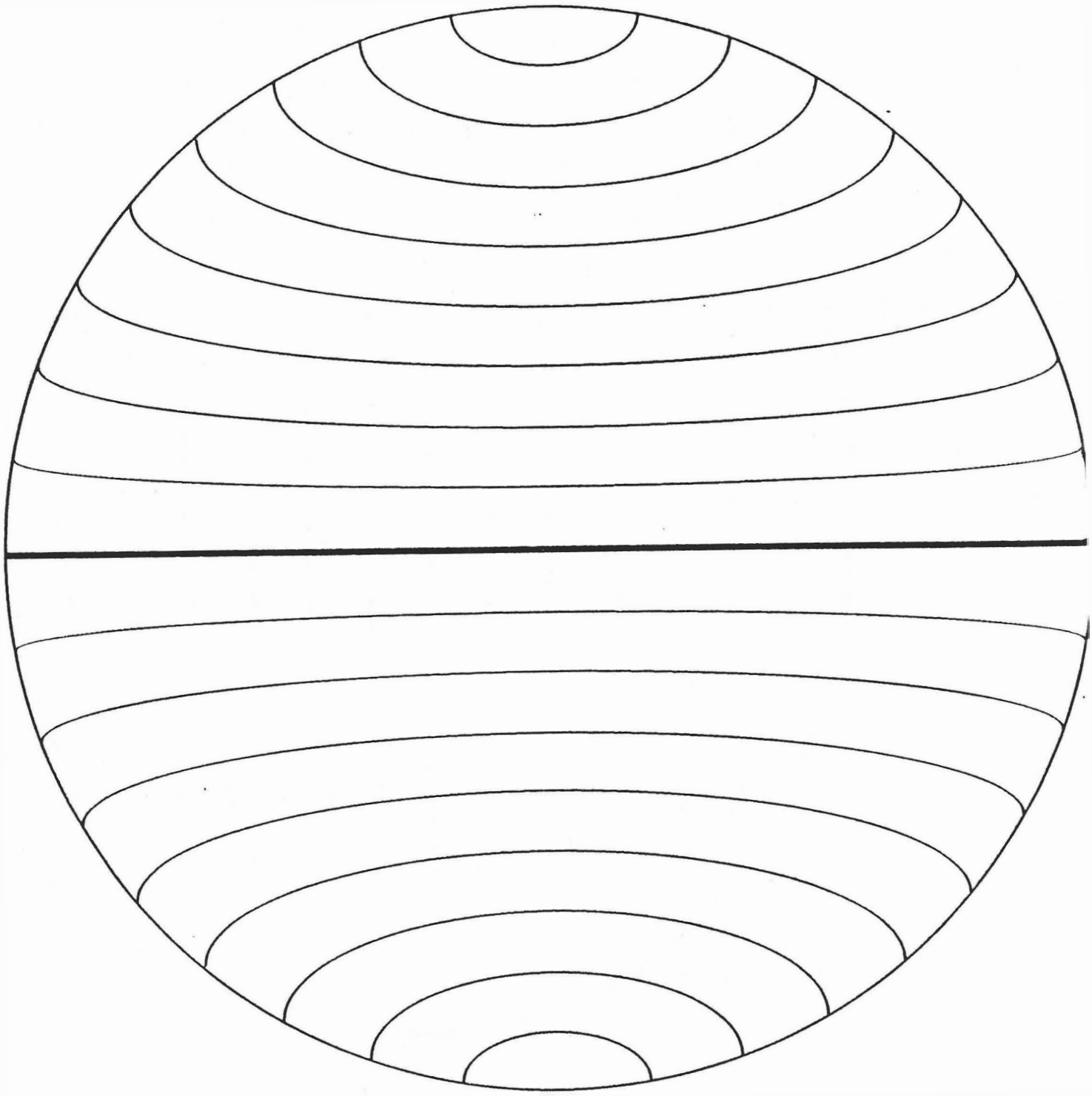
pole on which the flag is hung, also called mast, flagpole or flagstaff

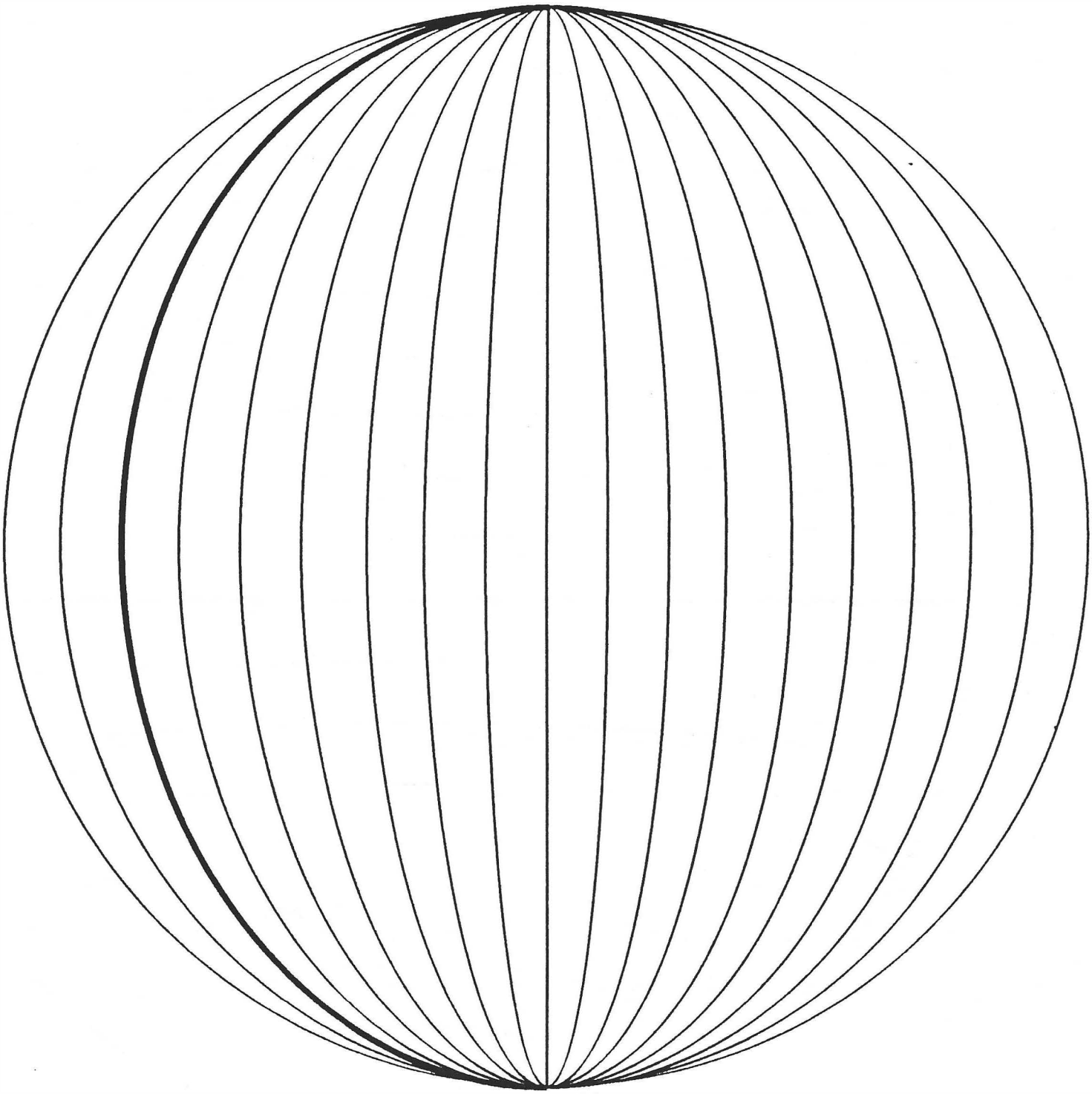
ornament at the top of the staff



rope attached to the flag by which it is hoisted or lowered

pulley through which the halyard passes at the top of the staff below the finial





Position on Earth can be determined by finding latitude and longitude.

latitude lines orparallels of latitude
Latitude is measured by lines parallel to the equator. They are located either north or south of the equator.

longitude lines or meridians
Longitude is measured by lines which go from pole to pole. They are located either east or west of the first or prime meridian.

prime meridian
Prime meridian is at zero degrees longitude. It is also called the Greenwich Meridian because it passes through Greenwich, England. It marks the beginning of Earth's time zones. It is the point for measuring longitude east or west.

equator
Equator is the zero degrees latitude line halfway between the North and South Poles. It is at Earth's greatest circumference. It is the starting point for measuring degrees of latitude north or south. It marks the division between the Northern and Southern Hemispheres.

International Date Line
International Date Line is at 180 degrees longitude, exactly opposite the prime meridian. West of the International Date Line it is one day later than east of it.

latitude lines or parallels of latitude

longitude lines or meridians

prime meridian

equator

International Date Line

pole

pole

Position on Earth can be determined by finding latitude and longitude.

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Longitude is measured by lines which go from pole to pole. They are located either east or west of the first or prime meridian.

It is the starting point for measuring degrees of latitude north or south. It marks the division between the Northern and Southern Hemispheres.

International Date Line is at 180 degrees longitude, exactly opposite the prime meridian. West of the International Date Line it is one day later than east of it.

Commands for latitude and longitude

Place the transparencies for latitude and longitude over the map showing the islands. What islands are located between the 150th and 160th meridian west at the 20th parallel of latitude north?

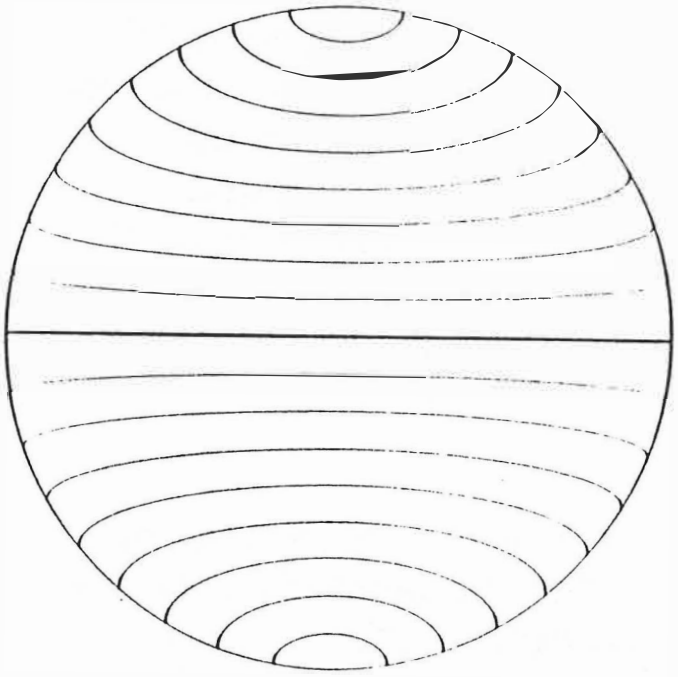
Place the transparencies for latitude and longitude over the map of the Western Hemisphere showing rivers. Find the mouth of the Amazon River by locating the 50th meridian west at the equator.

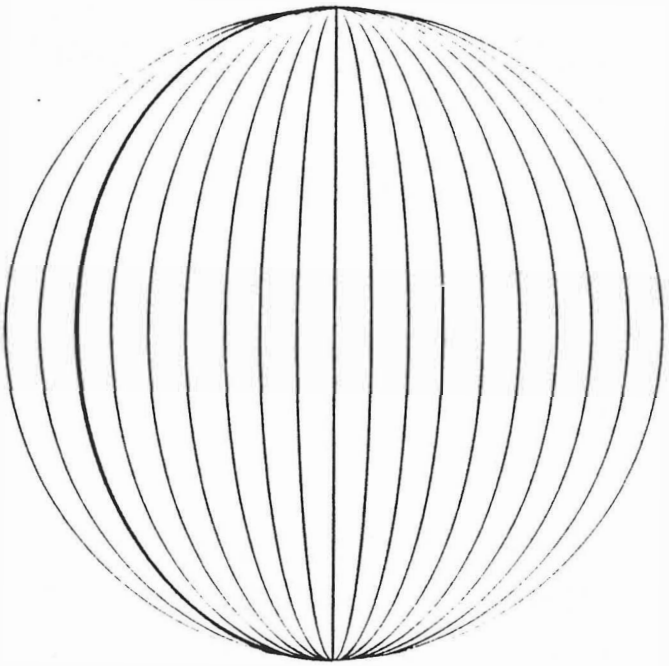
Place the transparencies for latitude and longitude over the map showing the continents. What continent is located between the 110th and 160th meridian east and the 10th and 40th parallels of latitude south?

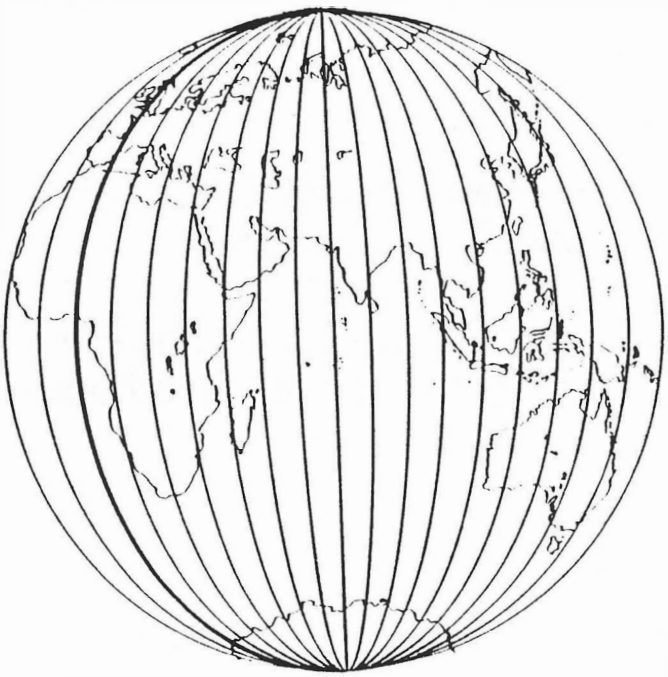
Get an atlas showing latitude and longitude. Find the northwest coast of France by locating the prime meridian at the 50th parallel of latitude north.

Place the transparencies for latitude and longitude over the map showing the cities. Find Cairo, Egypt, and record its latitude and longitude.

Place the transparencies for latitude and longitude over the map showing the isthmuses. Find the Isthmus of Panama and record its approximate latitude and longitude.





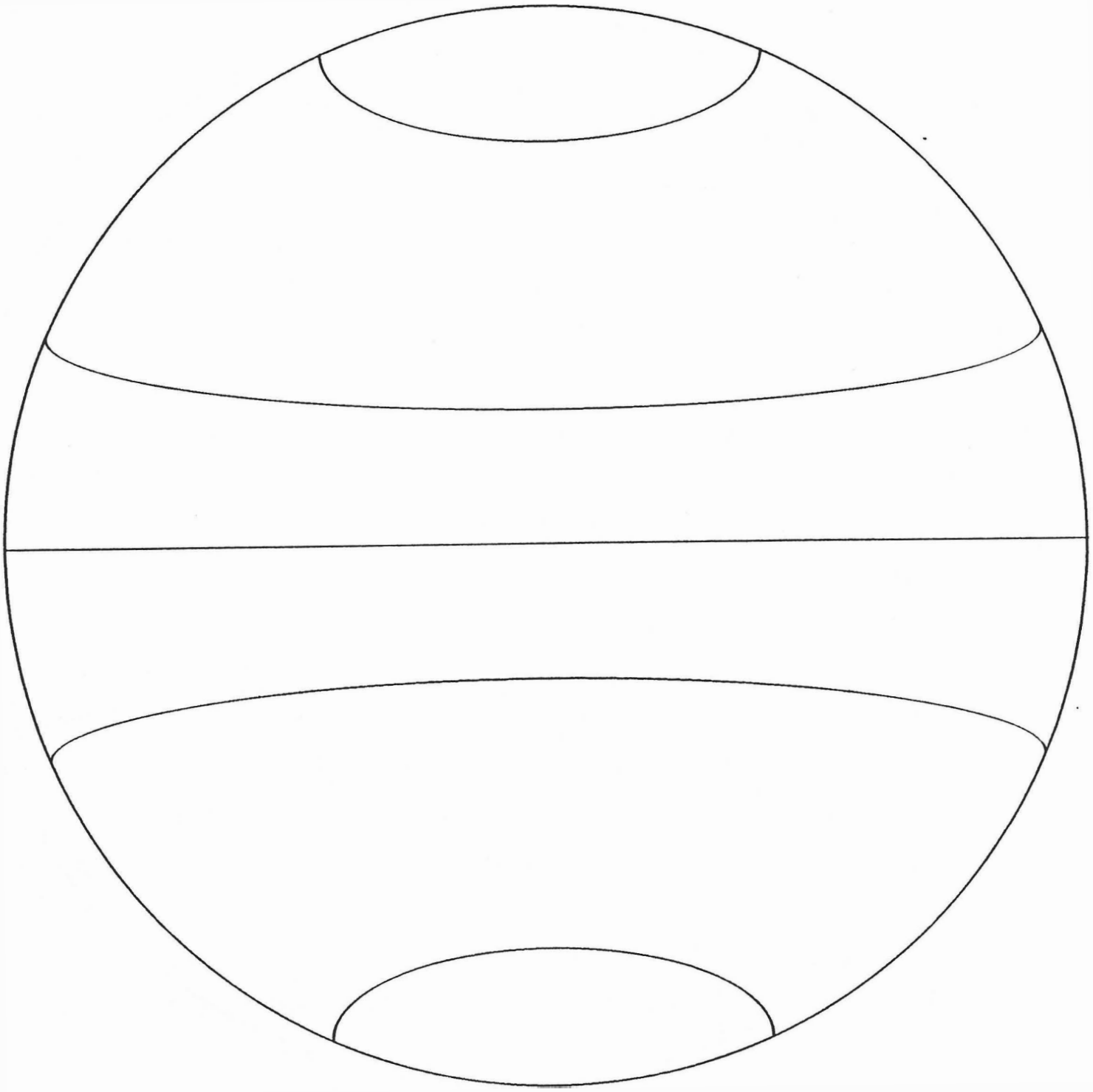


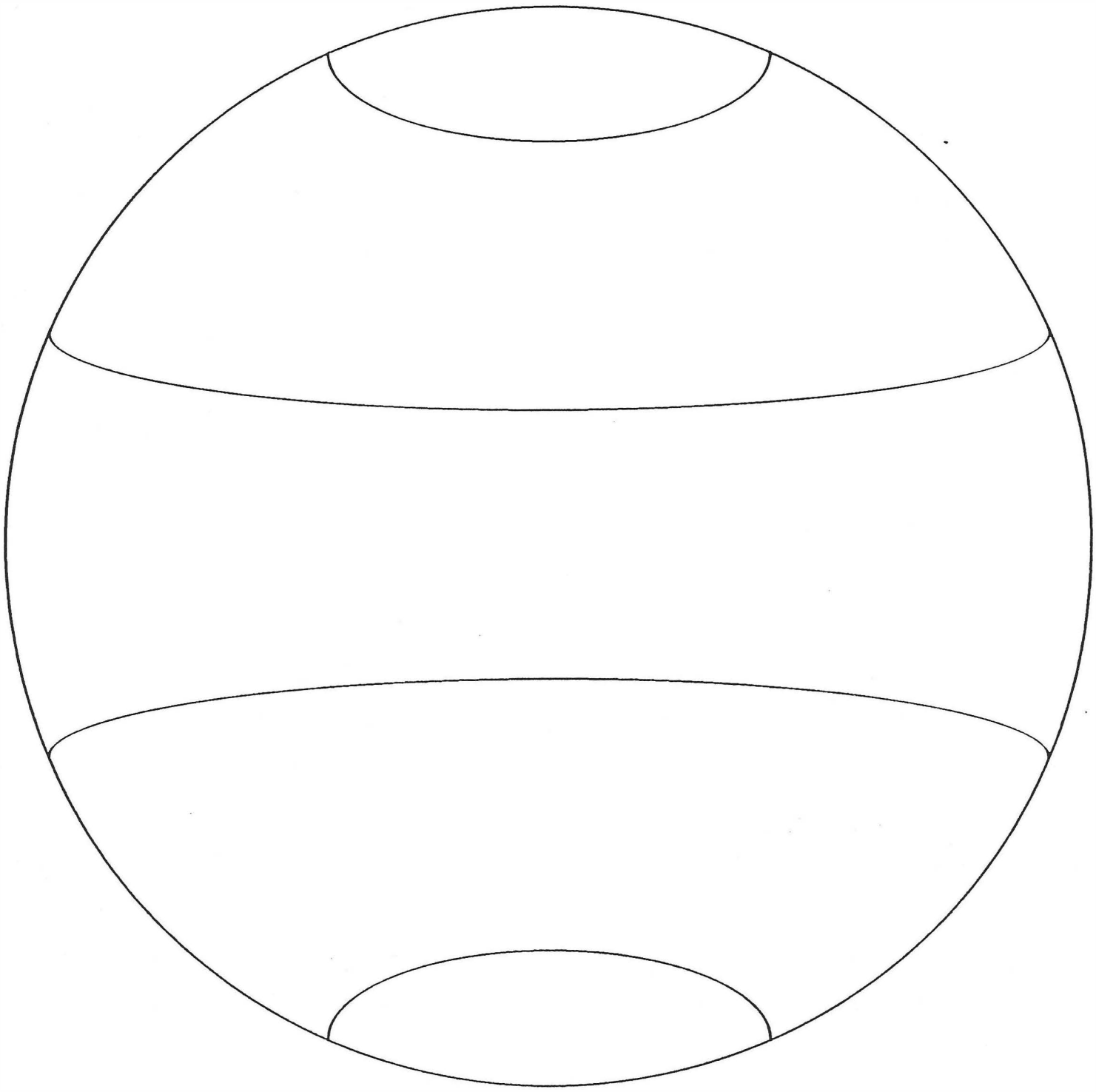
latitude lines or parallels of latitude
equator

longitude lines or meridians

International Date Line

prime meridian





Arctic Circle

South Temperate Zone

Tropic of Cancer

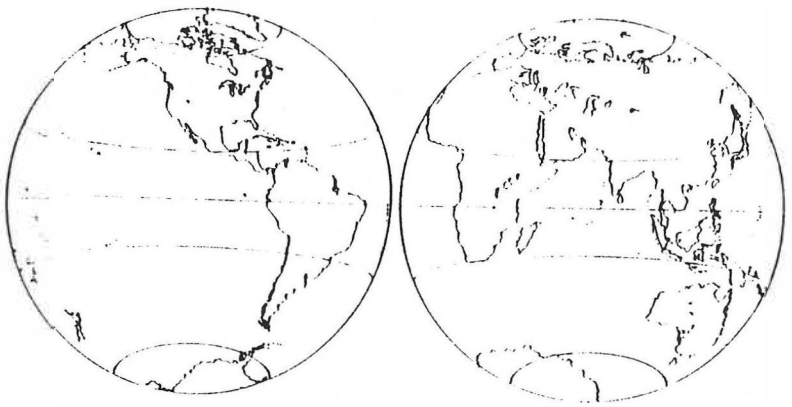
South Frigid Zone

Equator

Tropic of Capricorn

Antarctic Circle

North Frigid Zone



North Temperate Zone

North Torrid Zone

South Torrid Zone

Earth's Five Zones

The North Frigid Zone lies between the Arctic Circle and the North Pole. The climate is generally cold and is known as a polar climate.

The Torrid Zone lies between the Tropic of Capricorn and the Tropic of Cancer. The climate is mostly warm or hot year round. It is known as a tropical climate.

The South Frigid Zone lies between the Antarctic Circle and the South Pole. The climate is generally cold and is known as a polar climate.

The North Temperate Zone lies between the Tropic of Cancer and the Arctic Circle. The climate is warm in summer and cold in winter. It is known as a temperate climate.

The Poles

The South Temperate Zone lies between the Tropic of Capricorn and the Antarctic Circle. The climate is warm in summer and cold in winter. It is known as a temperate climate.

The geographic poles of Earth are the points where the axis of rotation emerge from the surface.

The geographic poles are not fixed. They describe an irregular curve within a radius of about 40 feet.

The angle by which the the magnetic pole deviates east or west of true north is called magnetic declination.

The movement of the geographic poles is due to seasonal changes in the pressure of ice and snow or in barometric pressure. The movement is also due to the shape and composition of Earth.

In addition to geographic poles, there are magnetic poles. The north magnetic pole is the place where the magnetic force is vertically downward. The south magnetic pole is the place where the magnetic force is vertically upward.

Changes in the magnetic poles are due to changes in the Earth's magnetic field.

plain
a broad area of land without much change in elevation

alluvial plain
plain formed from deposits of sediment from streams and rivers

swamp
lowland or coastal area with trees and shrubs where surface water is present for part of the year

mountain
a high elevation of Earth's surface formed by the lifting of Earth's crust or by volcanic action to reach a height of about 2000 feet, and having two or more zones of climate and plant life

volcano
vent from which magma erupts through Earth's crust, eventually forming a cone-shaped mountain

watershed
area of land drained by a river system

divide
regions of high ground separating headwaters of river systems

range
a series of mountains which are connected

landslide
movement of earth or rocks down a slope such as the side of a mountain

strata
horizontal layers of matter such as rock

mesa
elevated flat section of land, higher than its surroundings, which covers a large area

butte
an elevation of land with steep sides and a flat top, smaller than a mesa

plateau
elevated flat section of land, higher than its surroundings, which covers a large area

tableland
elevated flat section of land, higher than its surroundings, which covers a large area

massif
elevated flat section of land, higher than its surroundings, which covers a large area

dome
hemispheric elevation of land on Earth's surface

fold
raised section of land caused by collision of two plates

fault
fracture within Earth's crust along which earthquakes occur due to movement within the crust

valley
lowered section of land between higher elevations such as hills and mountains

cliff
a steep vertical face of land, usually rock

scarp
cliff formed at the surface of a fault

escarpment
a steep vertical face of land, usually on the side of a mountain

slope
land which gradually decreases in elevation

atoll
a ring-shaped coral island surrounding a lagoon

lagoon
a shallow channel or pond near or connected to a larger body of water

archipelago
a group of islands

plain	**mesa**
alluvial plain	**butte**
swamp	**plateau**
mountain	**tableland**
volcano	**massif**
watershed	**dome**
divide	**fold**
range	**fault**
landslide	**valley**
strata	**cliff**

scarp	**a broad area of land without much change in elevation**
escarpment	
slope	
atoll	**plain formed from deposits of sediment from streams and rivers**
lagoon	
archipelago	**lowland or coastal area with trees and shrubs where surface water is present for part of the year**

a high elevation of Earth's surface formed by the lifting of Earth's crust or by volcanic action to reach a height of about 2000 feet, and having two or more zones of climate and plant life

a series of mountains which are connected

vent from which magma erupts through Earth's crust, eventually forming a cone-shaped mountain

movement of earth or rocks down a slope such as the side of a mountain

area of land drained by a river system

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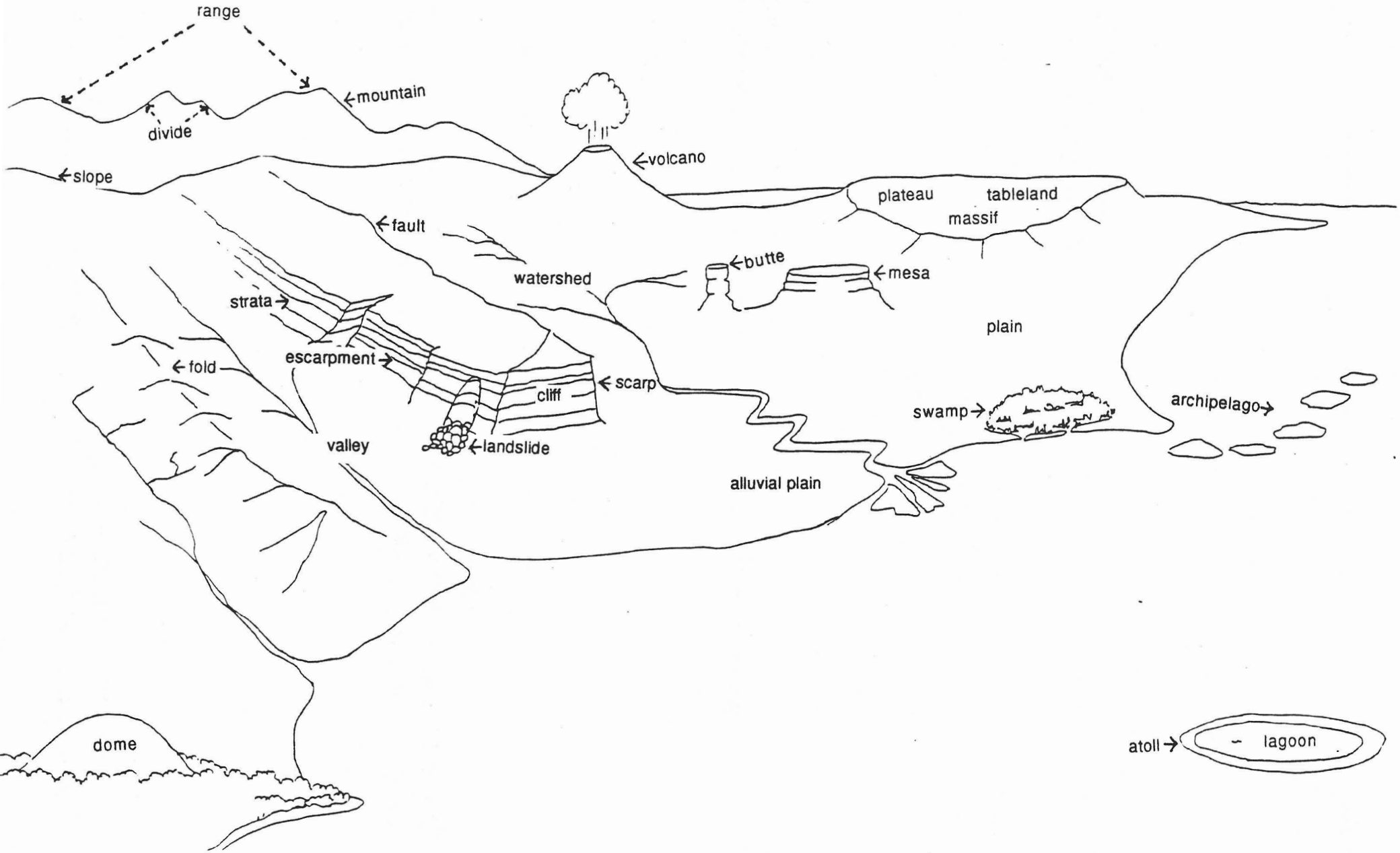
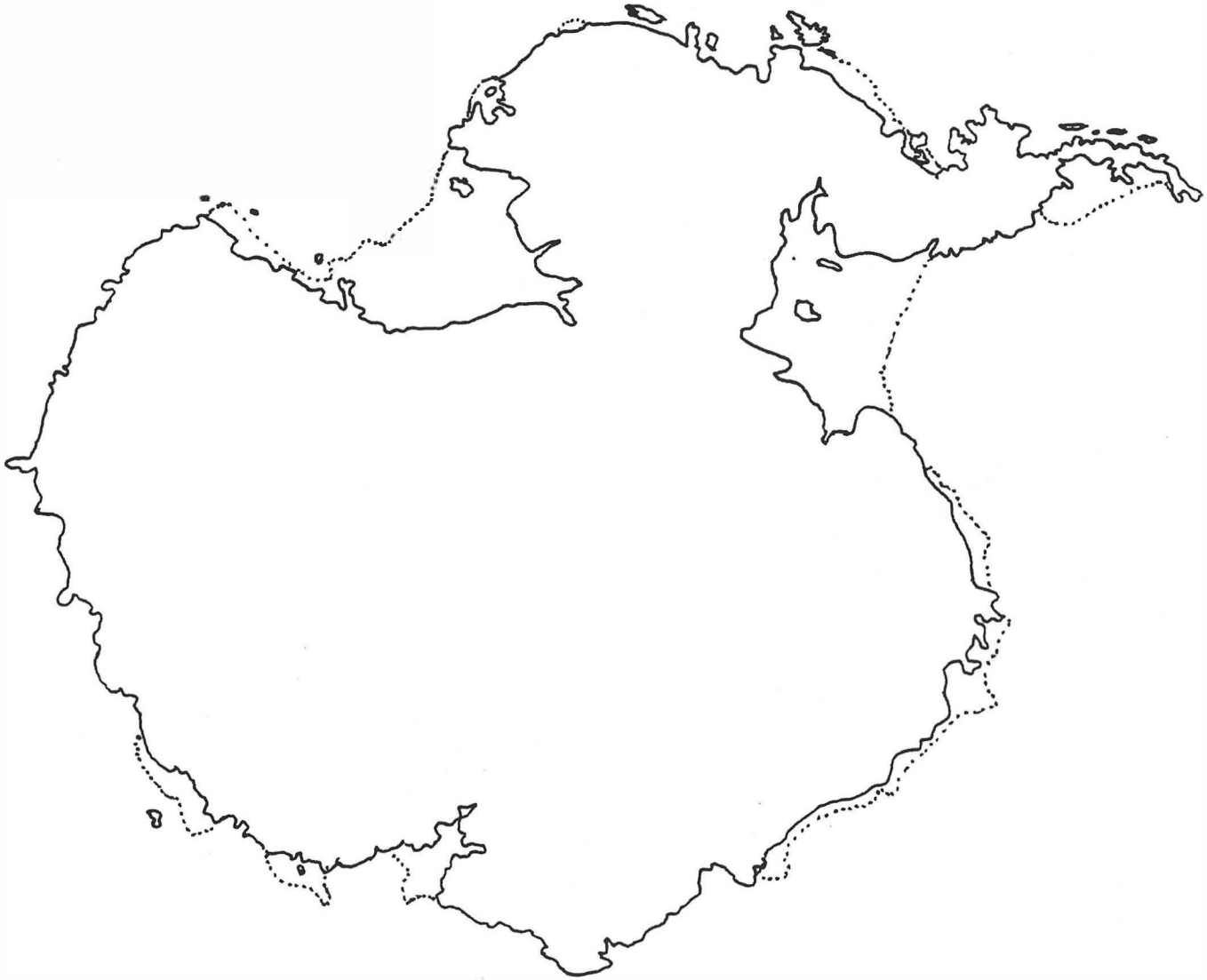
a steep vertical face of land, usually on the side of a mountain

a group of islands

land which gradually decreases in elevation



Control for teachers



Nile	**Irtysh**
Congo	**Ob**
Niger	**Volga**
Yangtze	**Danube**
Lena	**Rhine**
Mekong	**Thames**
Amur	**Mississippi**
Hwango Ho	**Mackenzie**
Yenisei	**Missouri**

Yukon	**Brisbane**
St. Lawrence	**London**
Amazon	**Paris**
Parana	**Berlin**
Darling	**Madrid**
Murray	**Rome**
Melbourne	**Athens**
Sydney	**Moscow**
Adelaide	**Lisbon**

Vienna	**New York**
Amsterdam	**Chicago**
Brussels	**Los Angeles**
Copenhagen	**Miami**
Stockholm	**Boston**
Oslo	**Houston**
Dublin	**Seattle**
Quebec	**Denver**
Vancover	**Atlanta**

Mexico City	**Tokyo**
Buenos Aires	**Bangkok**
Rio de Janeiro	**Bombay**
Santiago	**Kabul**
Lima	**Tehran**
Bogota	**Baghdad**
La Paz	**Manila**
Caracas	**Karachi**
Shanghai	**Seoul**

Beijing	**Asia**
Cairo	**Caucasus**
Tripoli	**Himalayas**
Cape Town	**Carpathians**
Nairobi	**Jura**
Addis Ababa	**Atlas**
Casablanca	**Andes**
Pyrenees	**Rockies**
Alps	**Cascades**

Sierra Nevadas

Sahara

Alleganies

Kalahari

Sierra Madre

Namib

Great Dividing Range

Atacama

Macdonnell Ranges

Death Valley

Musgrave Ranges

Mojave

Hamersley

Gila

Appalachain

Salt Lake

Arabian

Great Sandy

Gibson

Great Victoria

Gobi

An Nafud

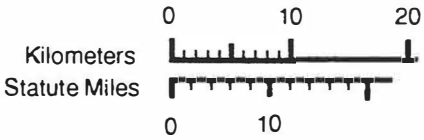
Thar

Taklimaken

Syrian

East Texas Prairie

scale



compass rose

church

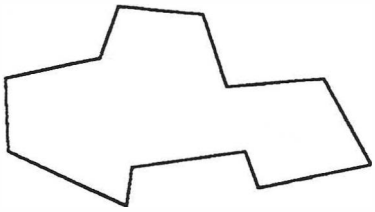
cemetery

lock

lighthouse

boundaries

metropolitan area



capital of country

capital of state

town up to 10,000

town 10,000 - 25,000

town 25,000-100,000 

super highway 

toll road 

four-lane divided highway 

principal highway

other through highway

interstate highway 

U.S. highway 

state highway 

secondary highway 

county trunk highway 

trail .....

tunnel

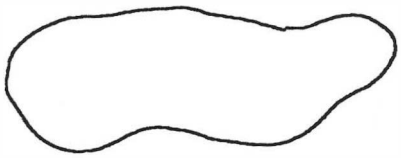
bridge

railroad

airport

river

lake



ruins 

site 

park 

national park 

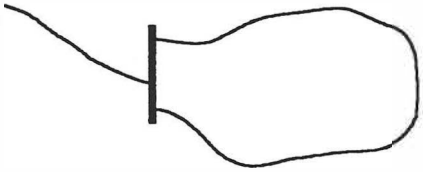
mine 

pass 

rapids

canal

dam



swamp

oil field

battlefield

ferry

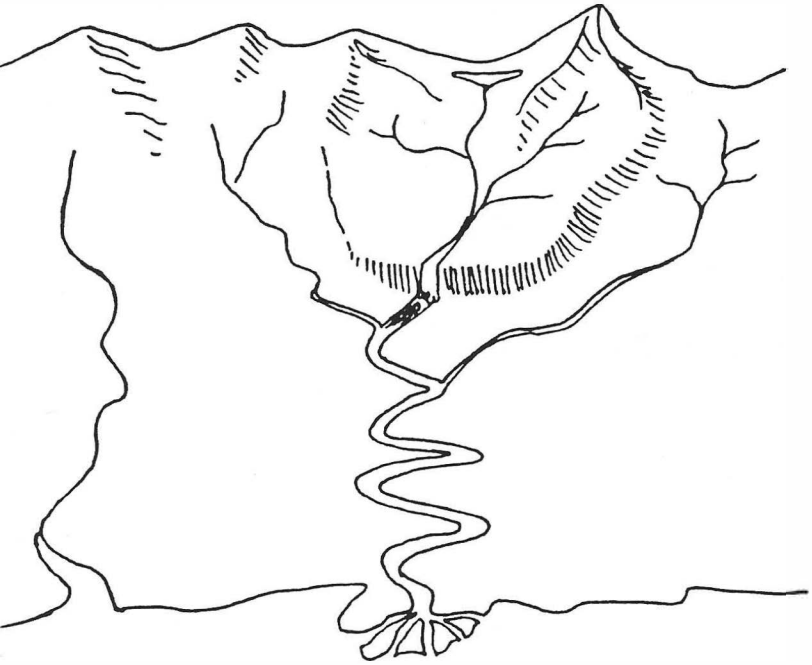
golf course

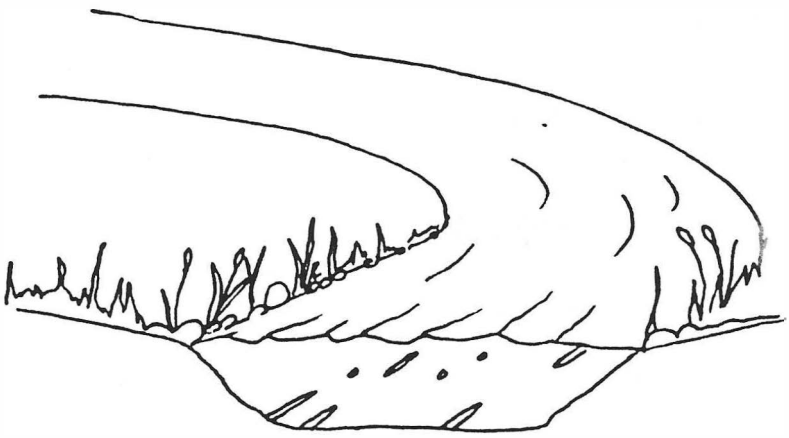
campsite

time zone boundary

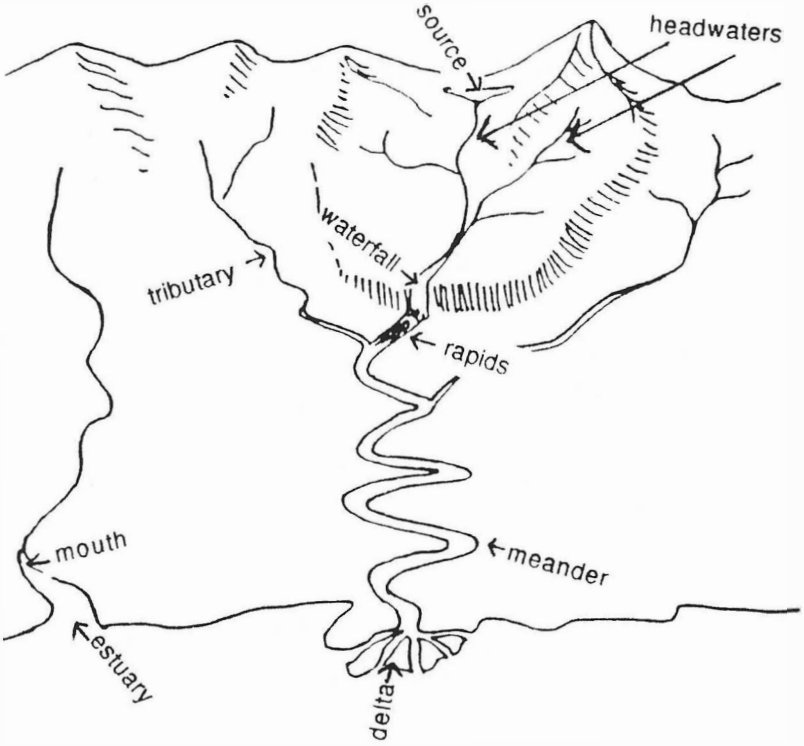
roadside park

mountain peaks



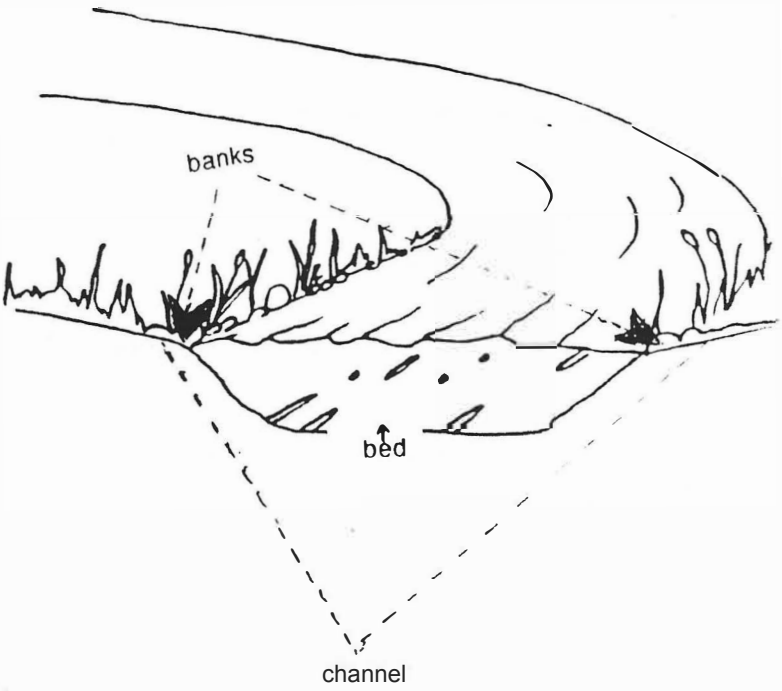


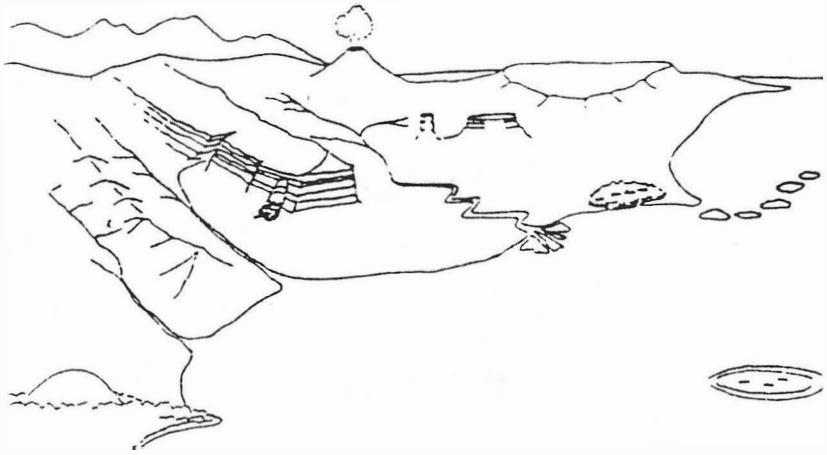
Parts of the River

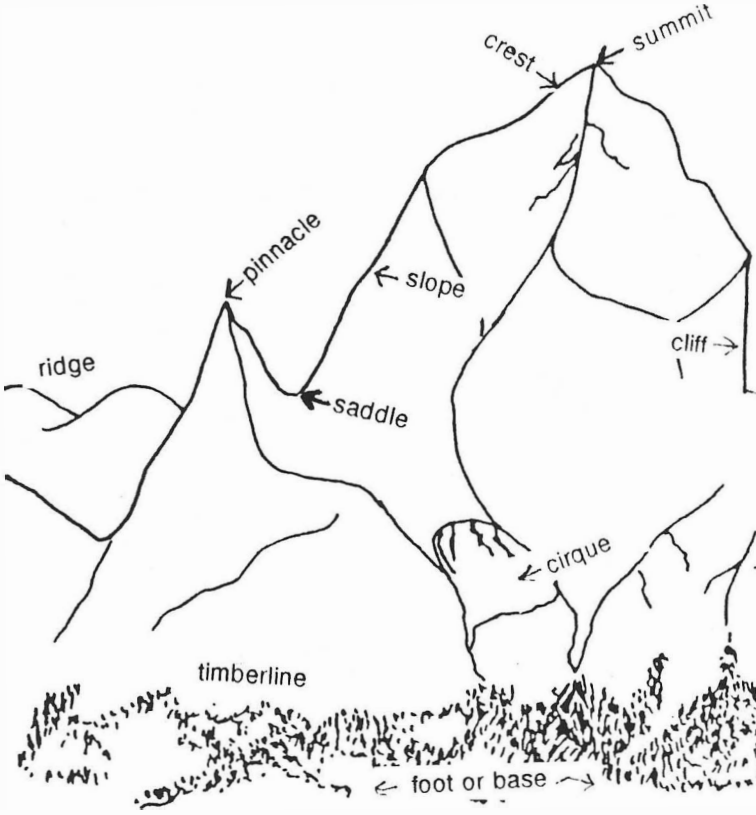


Note: For the river system, color all of the above labeled parts red on a separate drawing.

Parts of the River







Note: For control booklet of advanced land and water forms, reproduce the above drawing for each form and color it in red.

Controls for teacher use.

Parts of the River

source
the highest elevation of a river where it begins from a lake, a spring, a melting glacier or tiny channels called rills

headwaters
various rills, brooks and streams which flow from the river's source

tributary
those sources of water which enter a river, such as a stream or smaller river, sometimes called a branch

channel
land beneath the flowing water and on either side of a river

bed
the bottom of the channel

banks
the edges of the channel

waterfall
place where a river crosses hard, dense rock to fall to a much lower level which has been eroded by action of the water

rapids
place where a river passes through an area that slopes rapidly

meander
bend in the course of a river usually where there is a broad flood plain

mouth
the place where a river meets the sea, a lake or a gulf

delta
body of land built up at the mouth from eroded soil carried by a river

estuary
deep, broad mouth of a river

river system
river and its tributaries

Parts of the River

source

headwaters

tributary

channel

bed

banks

waterfall

rapids

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those sources of water which enter a river, such as a stream or smaller river, sometimes called a branch

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river and its tributaries

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Work of Rivers

Drainage

When it rains, the water not absorbed by the earth drains into ditches. This water flows into streams, then into rivers.

Irrigation

By digging ditches, farmers can divert water from a river into their fields. This allows crops to be raised in areas where there is little rain.

Flooding

When large amounts of rain fall in a short time, rivers can overflow. Flood waters can cause great damage to buildings and anything in its path.

Flood waters can be beneficial to farm land. Rich top soil is carried from one place to another. It is deposited on fields. This improves the quality of crops.

Where flooding causes great damage, dams are built to control the amount of water flowing down the river.

Changing physical features of Earth

The sediment carried by water may be deposited at the mouth of a river. A delta is formed which extends into a large body of water. Islands and sand bars can be formed from the sediment carried by a river.

The force of water currents can change the shape or course of a river. Sometimes a part of the river is cut off, forming a lake. Soil may erode due to the movement of water at the banks of a river.

Providing power
Where dams are built, water may be passed through generators to produce electric power. Water is used to cool atomic generators.

Providing for industrial needs Water from a river is needed in industrial operations. It is mixed with other materials. It is used in cleaning processes and for cooling machinery. At one time, water turned water wheels which operated machinery.

Providing for travel and commerce
Many materials are transported on rivers. Barges carry coal and other raw materials to factories. Cargo can be floated down a river.

Manufactured items are transported to cities located on rivers. People travel on boats from one place to another.

Providing food
Rivers supply food in the form of fish, mussels, crabs and water fowl such as wild ducks.

Providing for recreation

Water sports such as motor boating, sailing, water skiing, canoeing, rafting and swimming can be done on rivers. "Shooting the rapids" is an exciting activity on rivers where the water flows rapidly at different levels.

Fishing is a sport enjoyed by many people.
Rivers may be used for sight-see1 ng.

Location for cities and towns

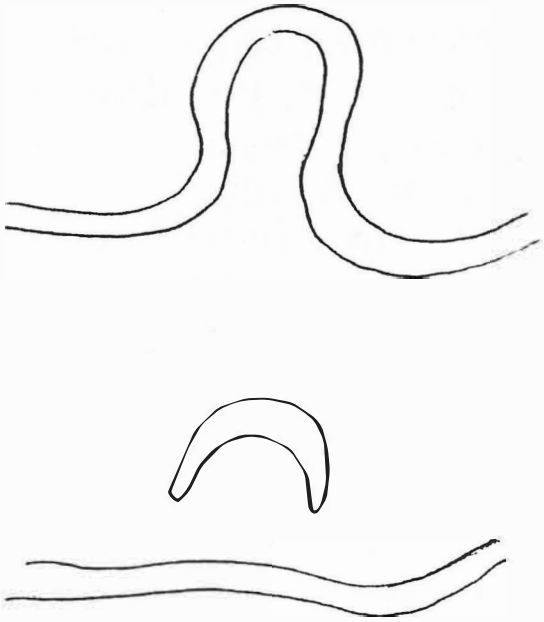
In early times, rivers provided the easiest way to reach places. Explorers and conquerors were followed by traders. They established trading posts for the exchange of goods.

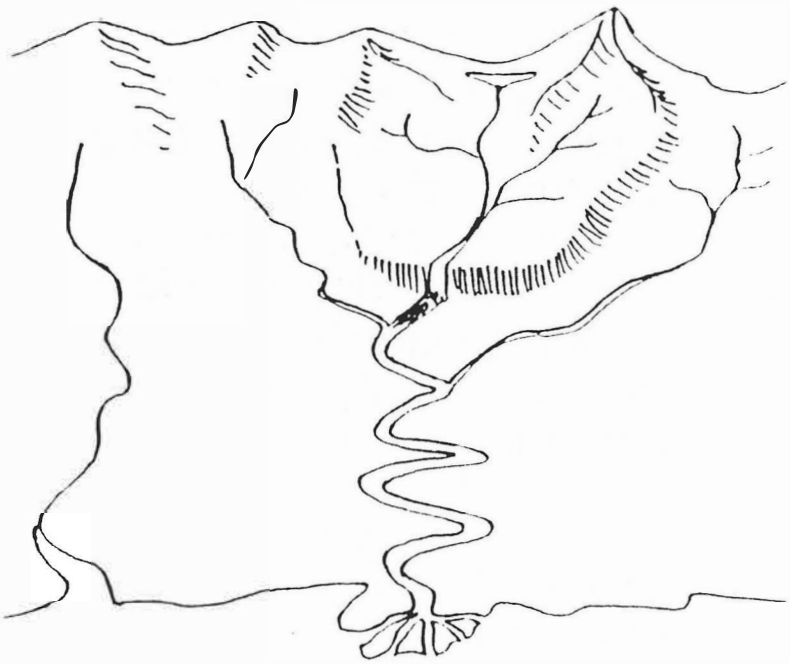
Settlements grew in these locations. Some settlements developed around forts at frontiers of countries. Many cities are at the confluence of two rivers or where rivers meet the sea.

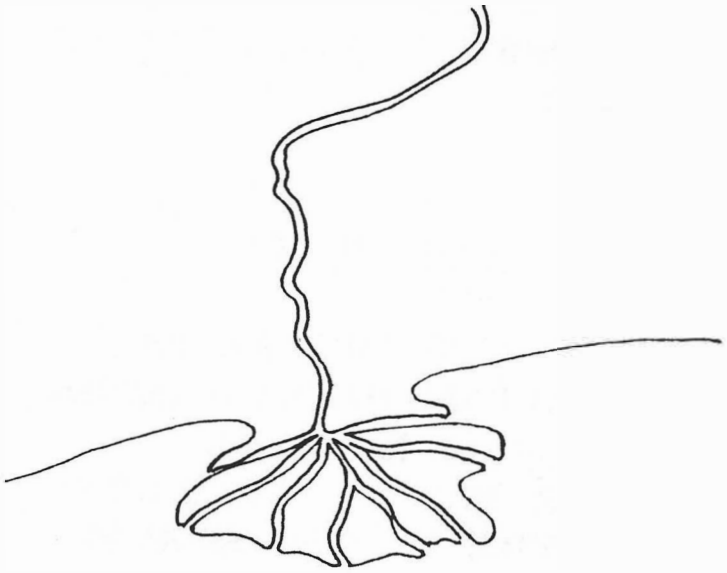
Providing ecological environment

In addition to those animals used for food, rivers are homes for many plants, insects, reptiles, amphibians and other organisms, some too small to be seen.

Rivers must be kept clean and unpolluted so that the balance of life is possible.





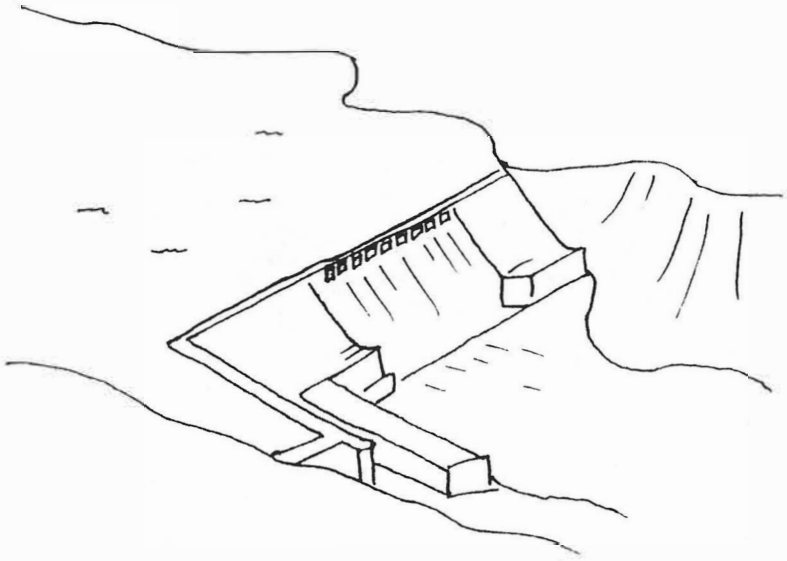


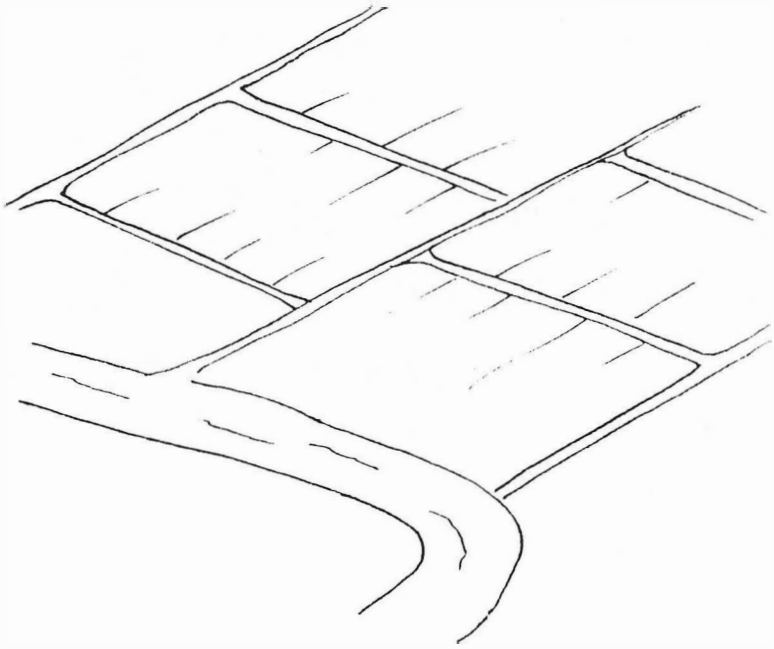
change in course

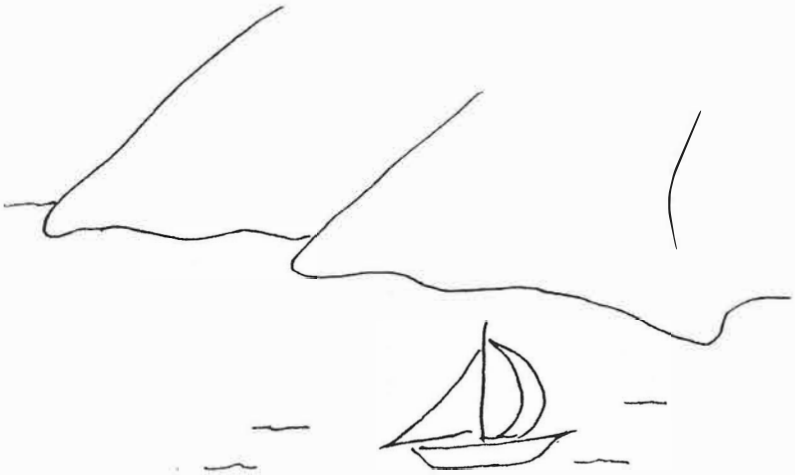
drainage

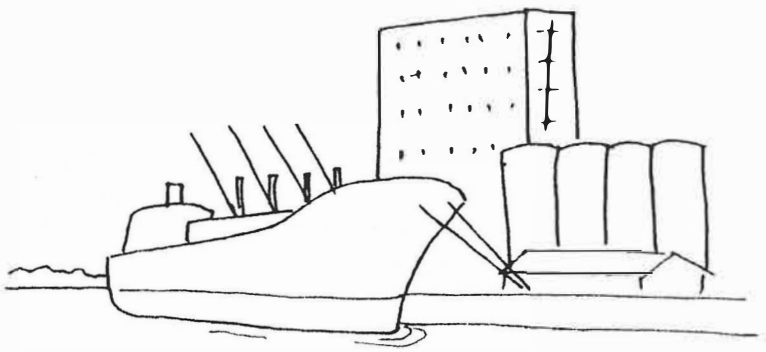
delta

water wheel







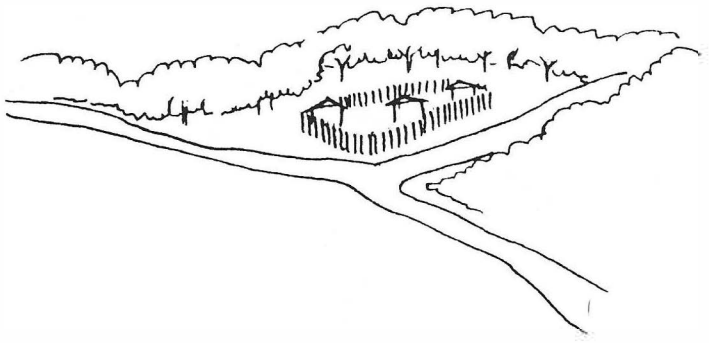


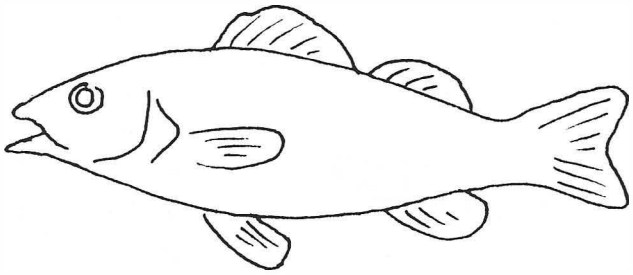
dam (power & flood control)

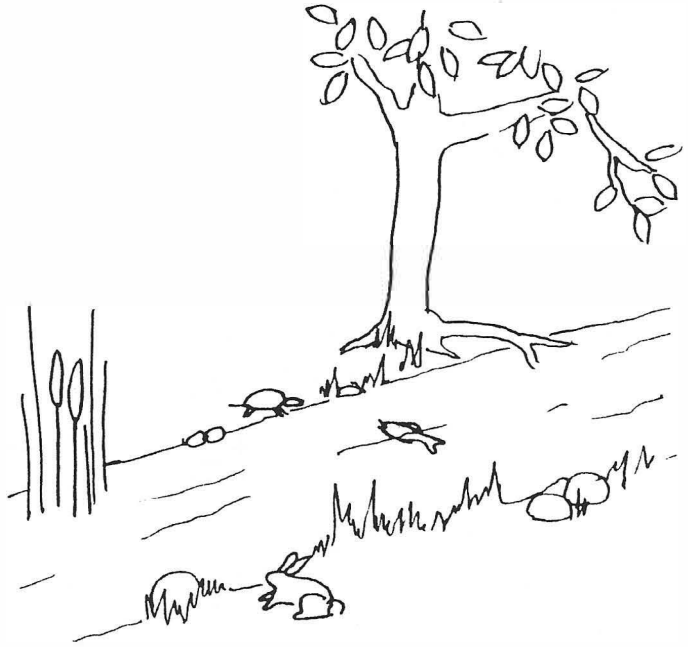
irrigation

recreation

commerce





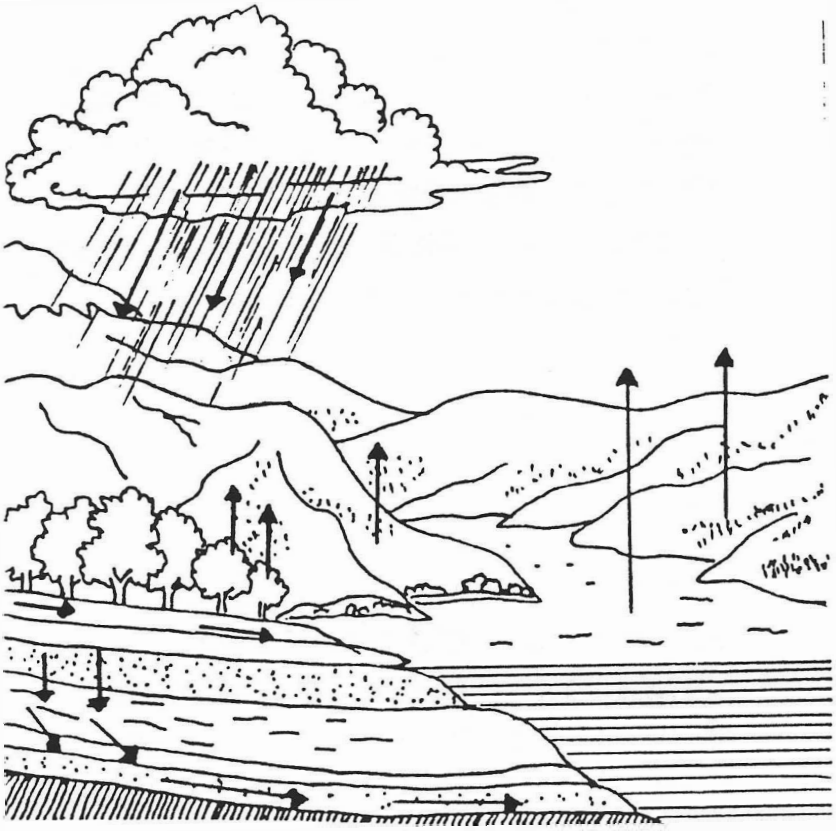


flood

early settlement

fish (food & recreation)

ecological environment



condensation

evaporation

rain

transpiration

infiltration

Hydrologic Cycle

Water evaporates from oceans, lakes, rivers and soil.

When the amount of water vapor becomes greater than the air can support, the tiny drops of water join to make larger drops. Then they fall in the form of rain.

Plants release water into the air by transpiration.

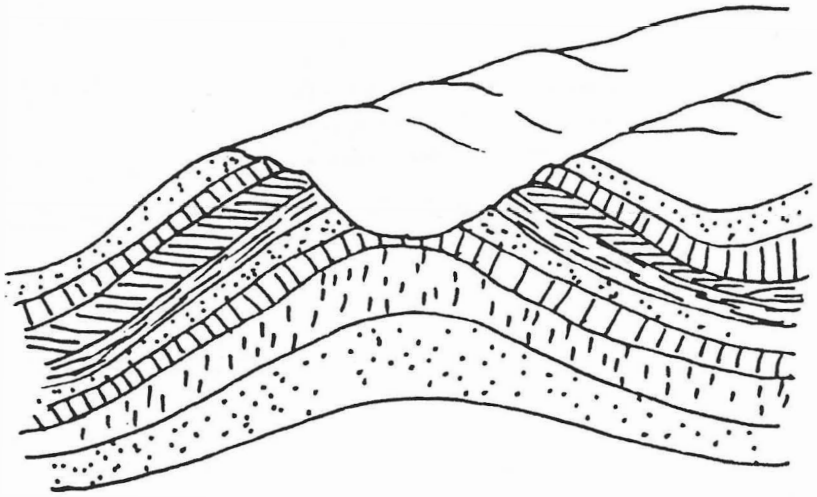
Warm air can hold more water vapor than cold air. If the temperature drops, air cannot support the water vapor. The tiny drops join to make larger drops. Then they fall as rain.

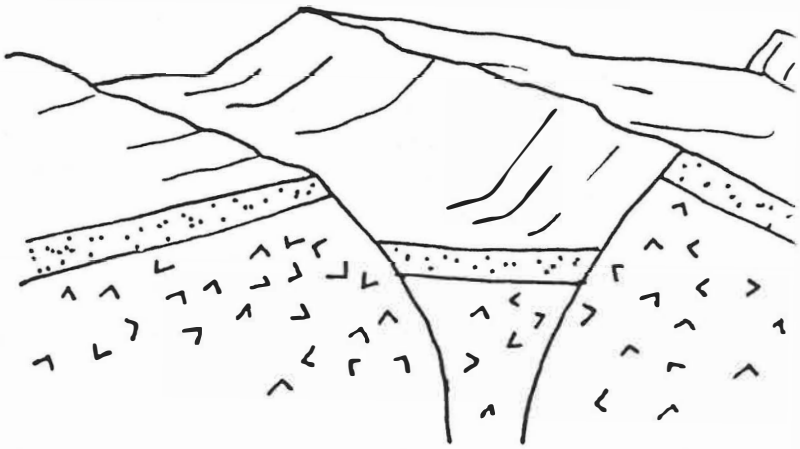
The water that evaporates is called water vapor. It rises into the air and is circulated by wind. Water vapor cannot be seen.

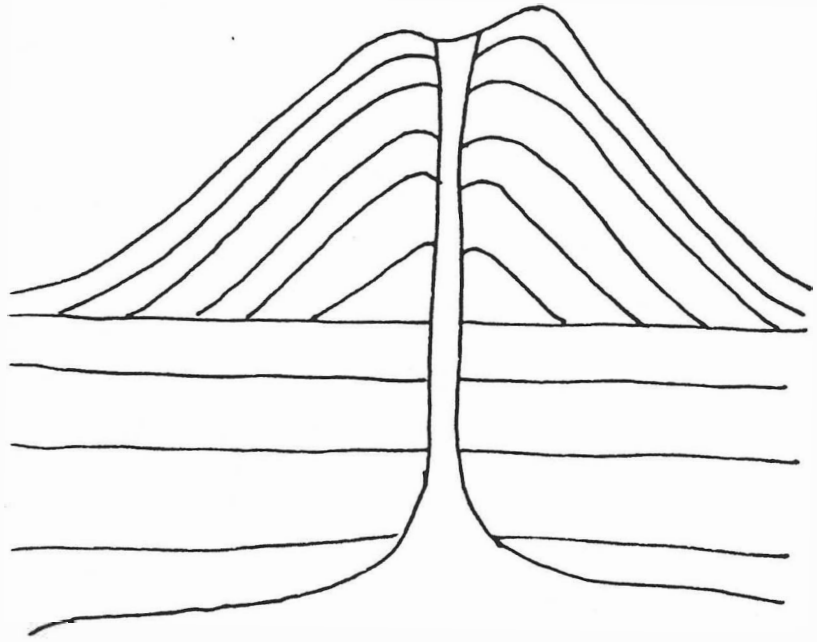
Almost 2/3 of the water that falls as rain evaporates again.

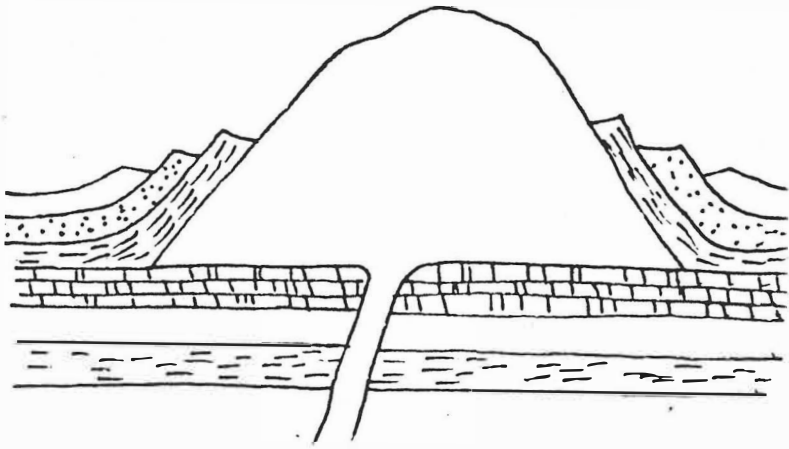
When water vapor is cooled, it condenses into clouds. Clouds are composed of tiny drops of water suspended in the air.

About 1/3 of the rain water runs off into streams, rivers and lakes. It infiltrates the soil and enters the water table.







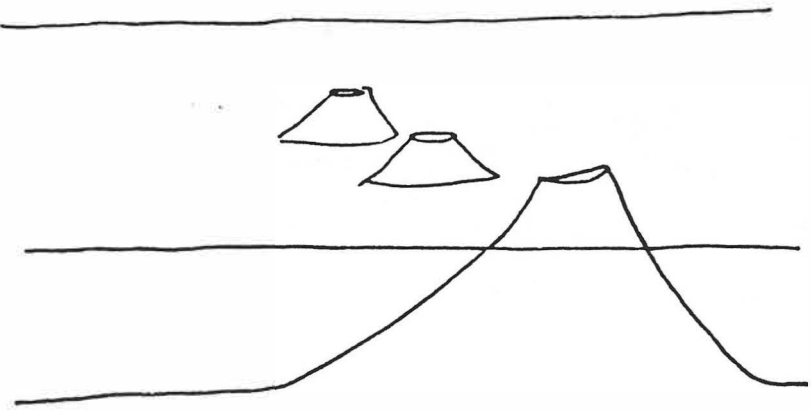


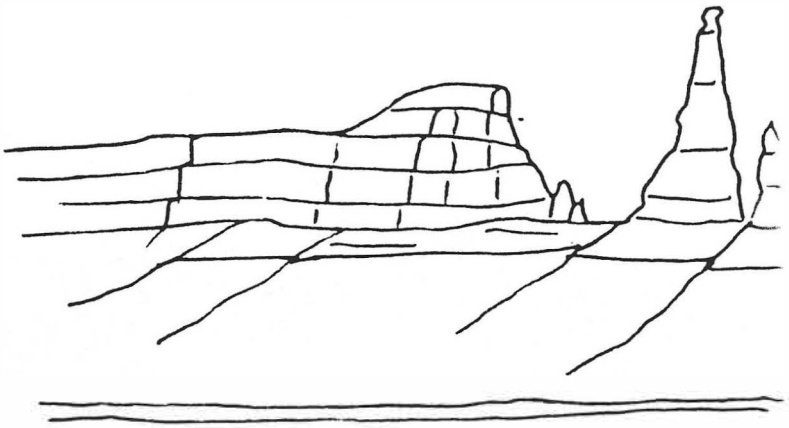
fold mountains

fault-block mountains

volcanic mountains

dome mountains





island arc

erosion mountains

Parts of a Mountain

mountain
the highest part of Earth's surface, usually over 2000 feet above sea level

foot or base
the area where the elevation of the surrounding land begins to rise

slope
the incline or rise of the sides of a mountain

summit
the top of a mountain at its highest point

crest
the steep incline leading to the summit

saddle
a depression, also called a col or a pass, through which passage to the other side of the mountain is possible

cliff
a perpendicular wall or face on a mountain side

cirque
a circular space which may be filled with water or ice in the form of a glacier

ridge
what appears to be the long edge of a mountain or group of mountains

pinnacle
needle-like tower or spire which protrudes sharply upward like a pillar

timberline
point beyond which no trees grow

Types of Mountains

volcanic mountains
formed by the eruption of lava in a subduction zone and composed of mostly igneous rock

island arc
chain of islands formed by volcanic action under the ocean

fold mountains
formed when sections of Earth's crust collide and are composed mostly of sedimentary rock

fault-block mountains
formed when huge sections of Earth's crust are pushed upward along a fault under Earth's surface

dome mountains
formed by the uplifting of Earth's crust in a huge bulge and composed of layers of sedimentary rock covering igneous and metamorphic rock

erosion mountains
formed by the erosion of a deep pile of sedimentary rock, the remains of a plateau which has been eroded by rivers or glaciers so that peaks and valleys were formed

Parts of a Mountain

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foot or base

slope

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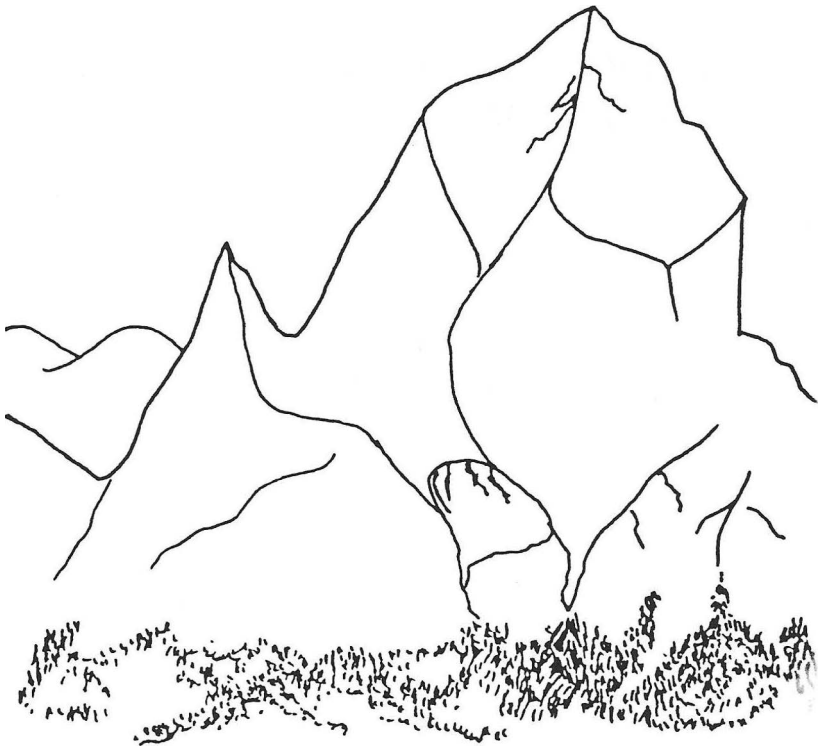

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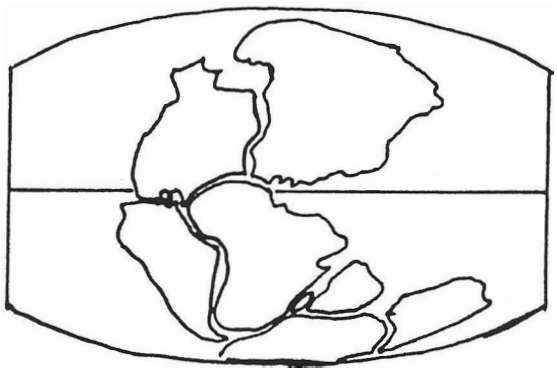
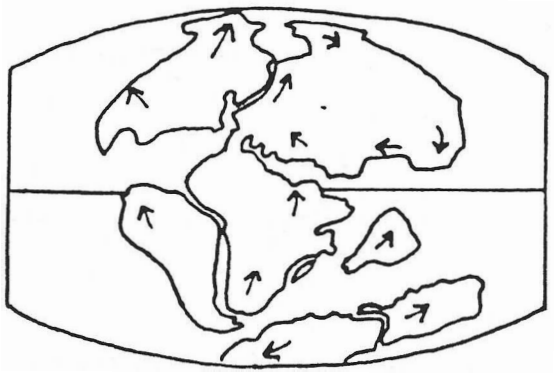
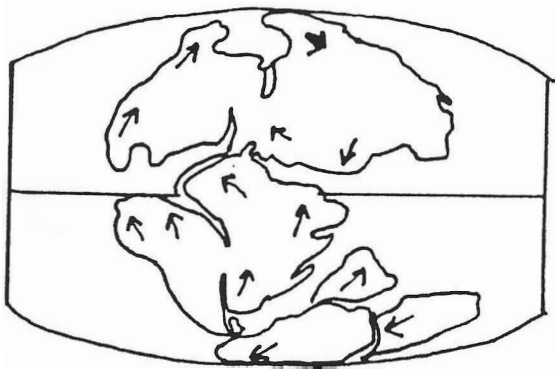
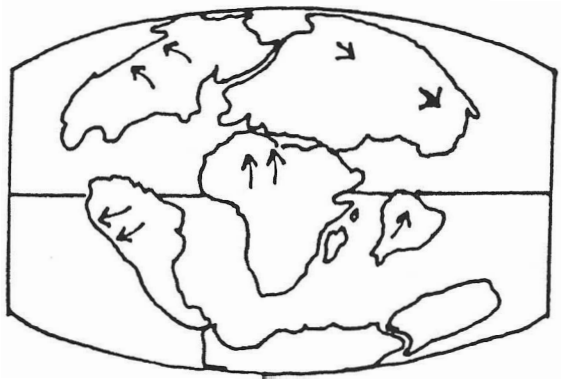






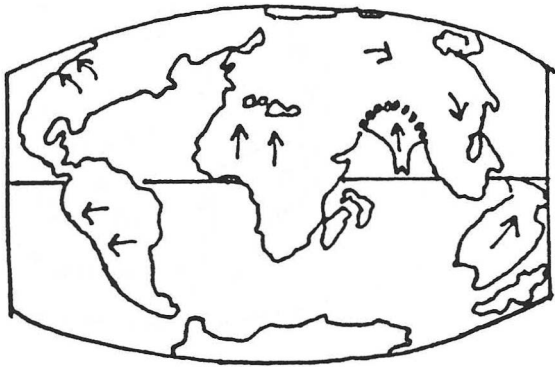
Permian Period
225 million years ago



Triassic Period
200 million years ago

Jurassic Period
135 million years ago

Cretaceous Period
60 million years ago



Cenozoic Era
present

Plate Tectonics

Earth is constantly changing. Some changes can be seen such as erosion, volcanic eruptions and alteration in the course of a river.

Other changes take place inside Earth that cannot be seen because they are so slow. These are the result of movement of plates within Earth. Plate tectonics is the study of these plates and their movement.

Once there was one huge continent named Pangaea. It was surrounded by an ocean named Panthalassa. This was during the Permian Period 225 million years ago. There were ten orders of reptiles. Conifers were the abundant plants.

The one continent was separated by the swelling and opening of the Mid-Ocean Ridge. The two continents were named Laurasia and Gondwana with the Tethys Sea between them. This was during the Triassic Period, 200 million years ago.

There were many invertebrates in the sea. Plants with flowers appeared. Land animals began to change on each continent.

During the Jurassic Period 135 million years ago, there were many dinosaurs. Mammals were small and primitive. There were a few feathered birds.

Mountains formed during the previous period were reduced by erosion. Plate movement built the Rocky Mountains. Earth today is not much different than at the beginning of the Cenozoic Era.

The continents continued to separate. Sedimentary rocks from this period contain marine fossils. Volcanic action took place around the rim of the Pacific Ocean.

The Mediterranean Sea is what remains of Tethys Sea from the Triassic Period. The coast of California moves to the northwest. Rifts open in the eastern part of Africa. The Himalayan Mountains rise about a meter every one hundred years.

About 65 million years ago during the Cretaceous Period, there were six major land masses. The Mid-Ocean Ridge expanded rapidly and raised the sea level.

Lava comes out of ocean ridges. Trenches in the ocean floor are the places where the crust moves under another plate, causing earthquakes.

Mammals became the dominant animals over reptiles. Flowering plants increased in number.

Continents collide and form mountains and volcanic action forms mountains. Earth continues to change as plates move, continents collide.

Permian Period

Cretaceous Period

Pangaea

Cenozoic Era

Panthalassa

Major Plates

Mid-Ocean Ridge

Pacific Plate

Laurasia

Inda-Australian Plate

Gondwana

African Plate

Tethys Sea

American Plate

Triassic Period

Eurasian Plate

Jurassic Period

Antarctic Plate

Minor Plates

Nazca Plate

Philippine Plate

Cocos Plate

Caroline Plate

Juan de Fuca Plate

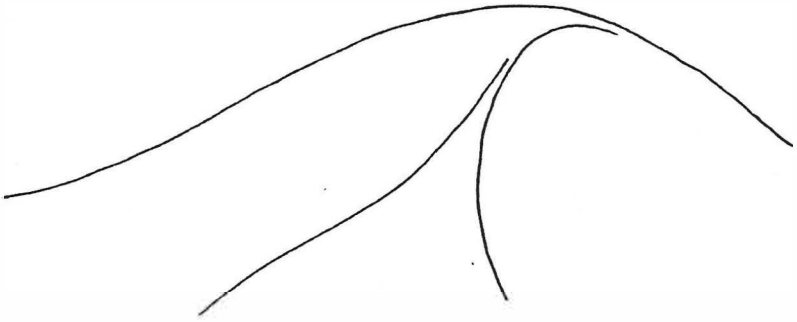
Fiji Plate

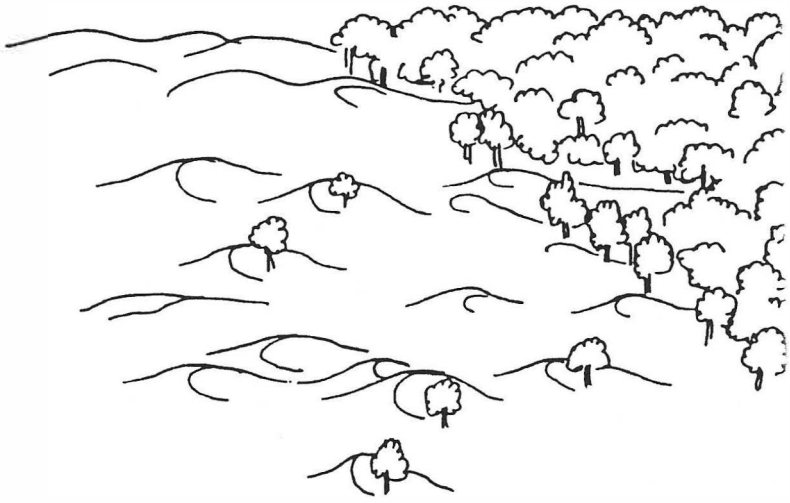
Caribbean Plate

Scotia Plate

Somali Plate

Arabian Plate



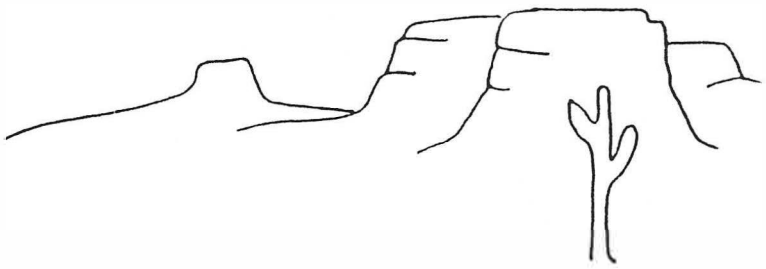


windward
lee

oasis

dune

desertification



cold desert

desert

hot desert

desert
land on which there is not enough vegetation to support humans

cold desert
land on which there is little or no vegetation due to low temperature

hot desert
land on which there is little or no vegetation due to high temperature and lack of rain

lee
side that is sheltered from the wind

windward
side toward the wind

dune
large hill or ridge of sand

oasis
place in a desert where there is a natural source of water that allows plants to grow in a small area

desertification
the changing of land which once supported vegetation into a desert by cutting trees and from overgrazing by animals

desert

cold desert

hot desert

lee

windward

dune

oasis

desertification

land on which there is not enough vegetation to support humans

side toward the wind

land on which there is little or no vegetation due to low temperature

large hill or ridge of sand

land on which there is little or no vegetation due to high temperature and lack of rain

place in a desert where there is a natural source of water that allows plants to grow in a small area

side that is sheltered from the wind

the changing of land which once supported vegetation into a desert by cutting trees and from overgrazing by animals

Deserts

If land cannot grow plants for human and animal food under normal conditions, it is a desert. Irrigation of the desert allows plants to be grown for a while.

Water for irrigation comes from wells, irrigation canals and rivers. After long periods, salt deposits build up in the irrigated soil and plants will grow no longer.

Cold deserts are located where the temperature is too low to allow plants to grow. This can be at high latitudes such as the polar regions. Low temperatures also occur at high altitudes such as high plateaus and mountains.

Hot deserts are located where the temperature is too high and rainfall is too little to allow plants to grow. Hot deserts are found in tropical belts that are hot and dry with high atmospheric pressure.

High elevations of land may have deserts on the lee side. Rain clouds cannot always pass over mountain tops so rain falls on the windward side. Land on the other side of the mountain away from the wind does not receive enough rain to support vegetation.

Rain falls in the desert sometimes, usually during violent cloudbursts. Large amounts of rain wash away soil, causing erosion.

Winds blow the sand and soil of the desert into large hills or ridges called dunes. Sometimes the wind makes wave-like patterns when it blows across the desert.

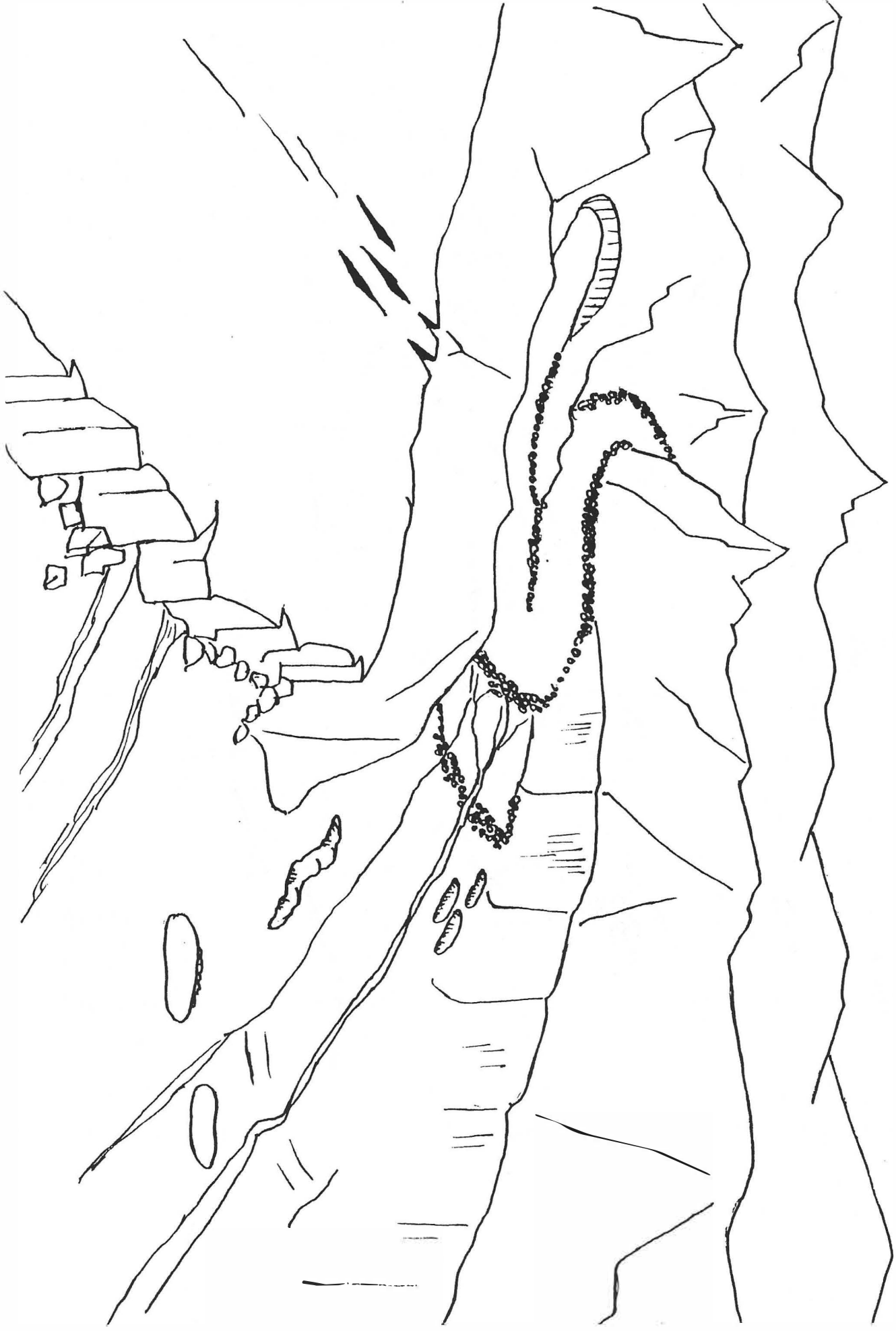
When humans allow cattle, goats and sheep to eat all of the grass and other vegetation in an area, the top soil erodes. No more plants can grow.

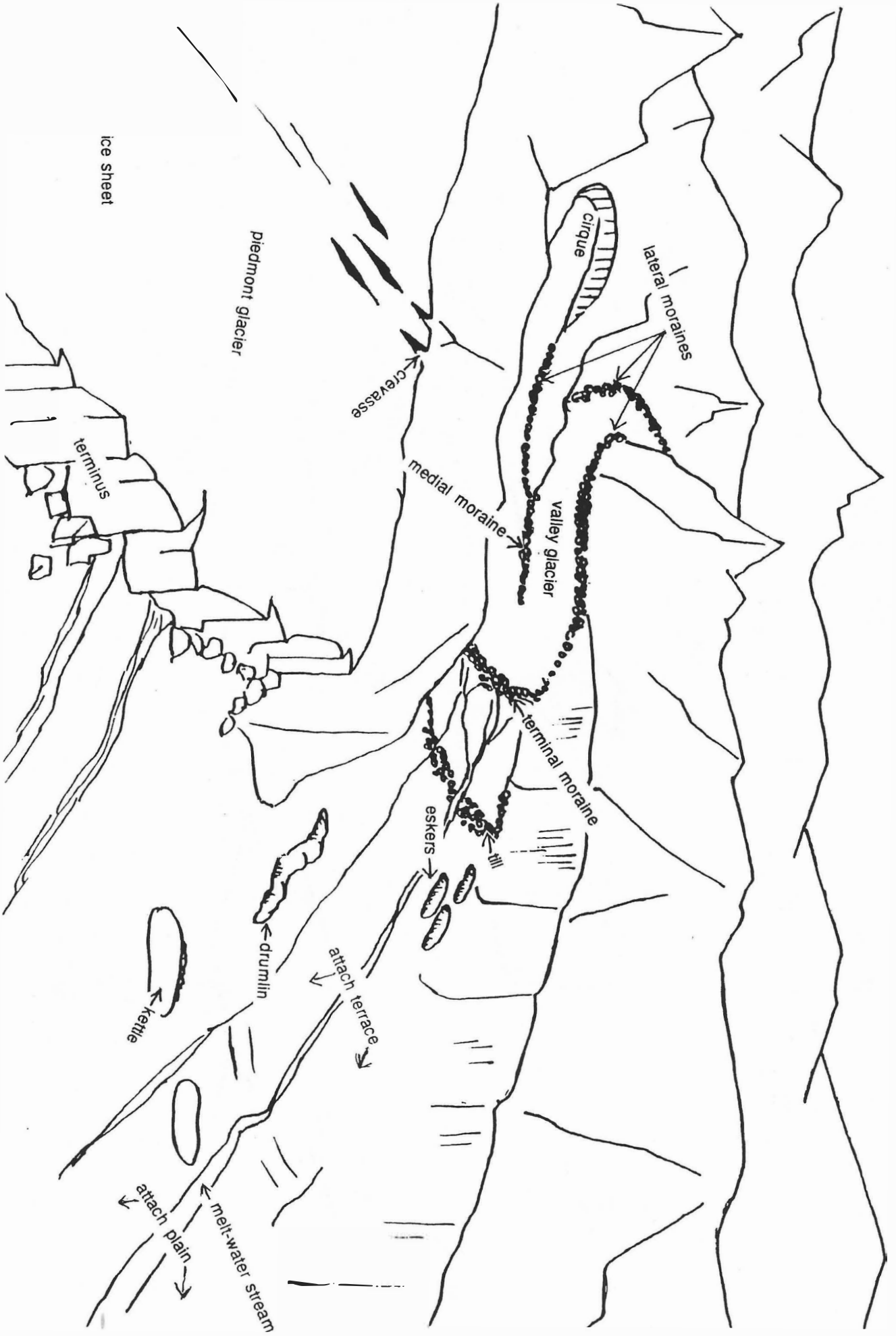
Some deserts have small areas where natural springs of water come to the surface or where wells have been dug. Plants grow in these locations and make an oasis. This is a place where desert travelers can stop for water and shade.

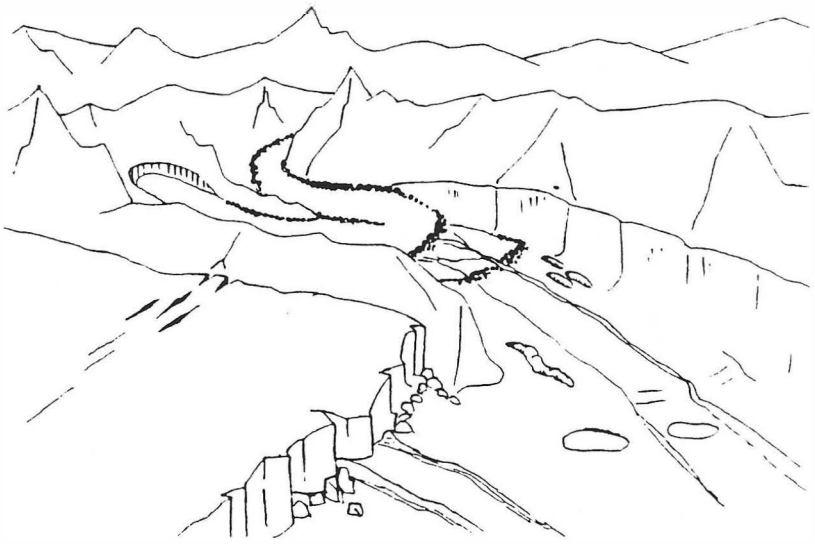
This land becomes a desert. The herdsmen move their animals to another area and the same process occurs again. More and more land becomes desert every year.

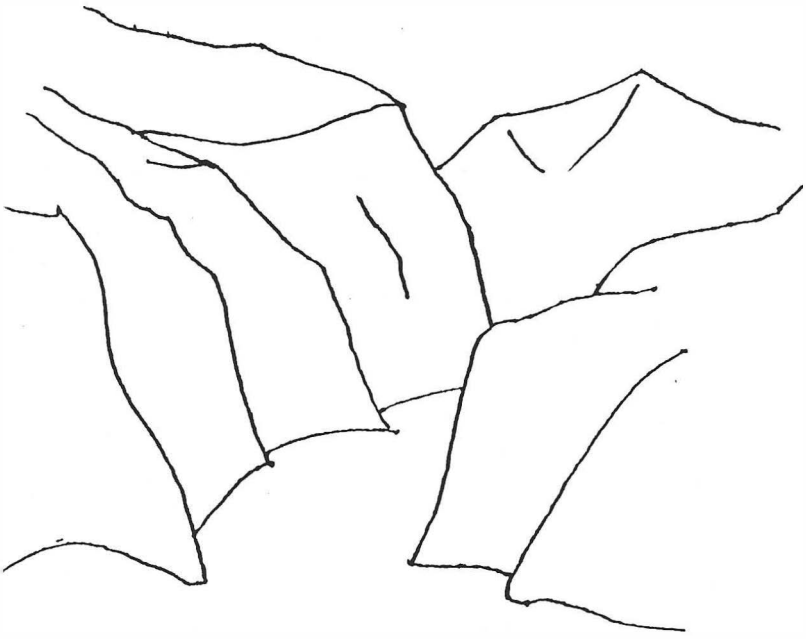
Desertification is caused by lack of concern for the environment and for people and animals living on Earth.

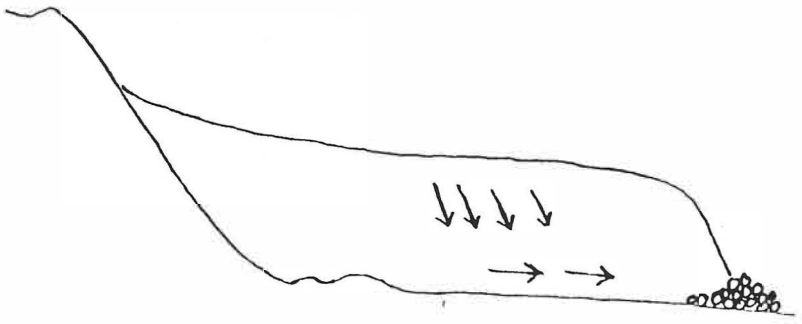
As humans cut more and more trees, the land is destroyed by erosion. Fertile top soil washes away and no plants can grow. This land becomes a desert.









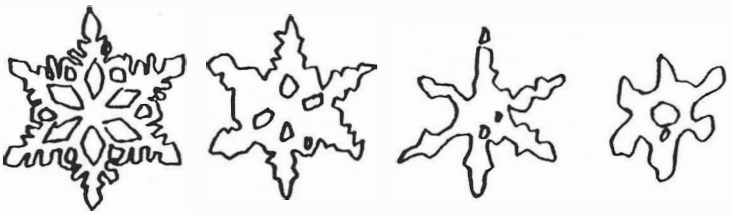


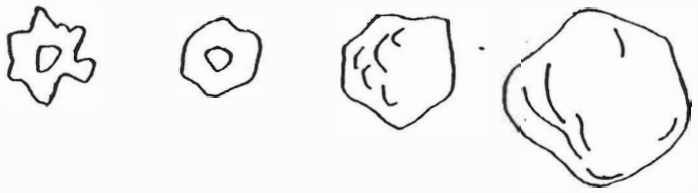
Many lakes in the Northern Hemisphere

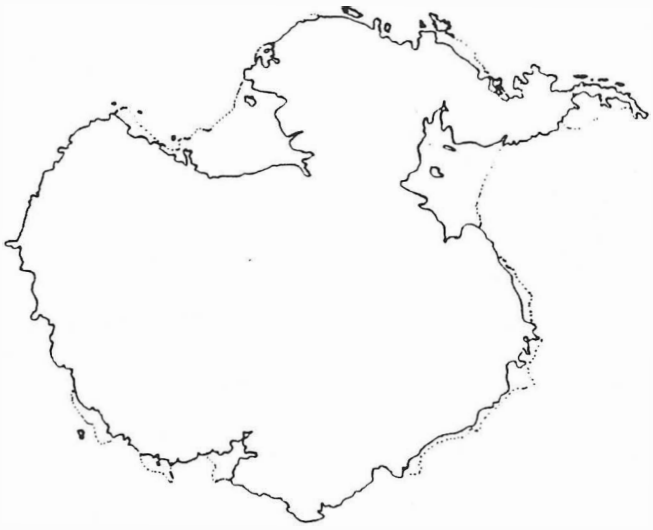
glacier

fiords

Movement







firn

firn

Antarctica

A glacier is a body of ice covering land. Glaciers cover 10% of Earth's land. This is an area almost the size of South America. Glaciers are what is left of ice sheets from the Ice Age or Pleistocene Epoch.

Glaciers are located in polar regions and on high mountains. Most glaciers are in Greenland and Antarctica. All continents except Australia have at least one glacier.

Ice sheets are the largest glaciers. Antarctica is covered by an ice sheet more than a mile thick. Greenland's ice sheet is two miles thick.

Piedmont glaciers spread across lower land at the foot of a valley glacier. An example is the Bering Glacier in Alaska. It covers 1500 square miles.

Valley glaciers are ice streams which move very slowly down valleys between mountains. High mountain ranges contain these glaciers. Beardmore Glacier in Antarctica is the largest. It is 120 miles long and 25 miles wide.

Glacial ice forms from snow. As the surface of snow evaporates, melts, then re-freezes, snow changes into small, rounded granules called firn.

As more snow falls, the firn from past years gets buried deeper and deeper. Pressure from the snow presses all the air out of the firn. It becomes solid crystalline ice.

The highest elevation of a glacier has rigid, brittle ice. It fractures, making long cracks or crevasses.

Pressure causes the ice at the bottom of the glacier to move. Movement is extremely slow. It cannot be seen but it can be measured. In valley glaciers, the flow is faster in the middle.

Fiords are long narrow projections of the sea into land with steep cliffs. Fiords of Alaska and Norway were once glaciated valleys. Now they are partly submerged by the sea.

Glaciers affect land features in many ways. Glaciated mountains have sharp pointed peaks, like the Matterhorn in Switzerland.

As the glacier moves ever so slowly, it grinds away rocks. These are carried along with the moving ice. Some rocks can be as big as a house. Clay particles are carried along also.

Glaciated valleys are U-shaped like Yosemite in California.

Cirques are formed from erosion caused by the movement of glacial ice.

All of this material is laid down when the glacier melts. This deposit is called till or boulder clay. Till at the margins of the ice forms drumlins. These are long hills parallel to the direction of ice flow.

Water from the melting glacier forms melt-water streams. Sand and gravel are carried from the glacier to form attach plains and attach terraces.

The melting ice at the terminus or lower end of the glacier leaves mounds or ridges of rock. This is called terminal moraine.

Large chunks of ice may be buried in outwash plains. When this ice chunk melts, a depression forms. This is called a kettle.

Lateral moraines form between valley walls and the sides of the ice.

Winding ridges of gravel and sand are laid down by streams of melt water under the glacier. These are called eskers.

Medial moraines form where lateral moraines of tributary glaciers meet.

Many lakes in the Northern Hemisphere are the result of glacial erosion. Rivers were formed at the margins of glaciers. Glaciers change Earth's features very slowly.

Glaciers

glacier
a body of ice covering land

ice sheet
the largest type of glacier

valley glacier
ice stream which moves very slowly down a valley

piedmont glacier
glacier which spreads across lower land at the foot of a valley glacier

cirque
circular space with steep walls caused by glacial erosion

crevasse
long crack in brittle ice at the highest elevation of a glacier

till
deposit of boulder clay and rocks carried by glacier

drumlin
long hills of till at the margins of a glacier, parallel to the direction of ice flow

terminus
lower end of a glacier

terminal moraine
mounds or ridges of rock deposited by melting ice at the terminus or lower end of the glacier

lateral moraines
ridges of rock between valley walls and the sides of the ice

medial moraine
ridges of rock where lateral moraines of tributary glaciers meet

melt-water stream
stream fed by water from a melting glacier

attach plain
plain formed by sand and gravel carried by melt-water from a glacier

attach terrace
terrace formed by sand and gravel carried by melt-water from a glacier

kettle
depression formed by melting chunk of ice in attach plain

eskers
winding ridges of gravel and sand laid down by streams of melt water under the glacier

glacier

ice sheet

valley glacier

piedmont glacier

cirque

crevasse

till

drumlin

terminus

terminal moraine	**a body of ice covering land**
lateral moraines	
medial moraine	
	the largest type of glacier
melt-water stream	
attach plain	
attach terrace	**ice stream which moves very slowly down a valley**
kettle	
	glacier which spreads across lower land at the foot of a valley glacier
eskers	

circular space with steep walls caused by glacial erosion

lower end of a glacier

long crack in brittle ice at the highest elevation of a glacier

mounds or ridges of rock deposited by melting ice at the terminus or lower end of the glacier

deposit of boulder clay and rocks carried by glacier

ridges of rock between valley walls and the sides of the ice

long hills of till at the margins of a glacier, parallel to the direction of ice flow

ridges of rock where lateral moraines of tributary glaciers meet

stream fed by water from a melting glacier

winding ridges of gravel and sand laid down by streams of melt water under the glacier

plain formed by sand and gravel carried by melt-water from a glacier

terrace formed by sand and gravel carried by melt-water from a glacier

depression formed by melting chunk of ice in attach plain

Cities

The first cities developed in subtropical climates about 3500 BC. Early cities were located in river valleys such as the Tigris-Euphrates Valley, the Nile Valley, the Yellow River Valley and the Indus Valley.

Cities were built where they could be easily defended from their enemies. Walls surrounded some cities.

Water transportation was more important in earlier times than it is now. Cities grew near bodies of water to become trading centers. Ships from other places brought materials to trade. Most of today's major cities are on waterways.

Some cities are manufacturing centers because they are near sources of materials needed to make items which people want to buy.

Climate encourages growth of cities in areas such as Florida and southern California. Older people like to move to a warm climate when they retire.

Usually cities are located where there is a water supply and where food is available.

The population explosion has caused cities to grow in size. There were about ten million people living during the Neolithic Period. Today the world's population is nearly five billion. Almost half of the world's population lives in cities.

Often cities have problems with government and finances. Many cities are dirty, noisy and have high crime rates. Sometimes people cannot find work or a place to live in cities.

People live in cities because of job opportunities and cultural activities such as those provided by museums and concerts.

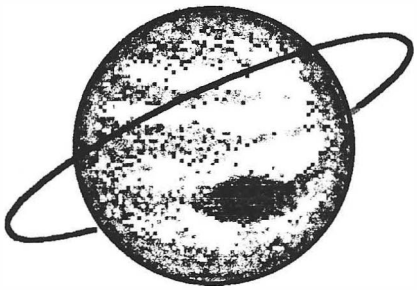
Some cities have existed for thousands of years. Athens, Greece, and Rome, Italy, are examples of present day cities with ancient cultures and artifacts.

Mercury

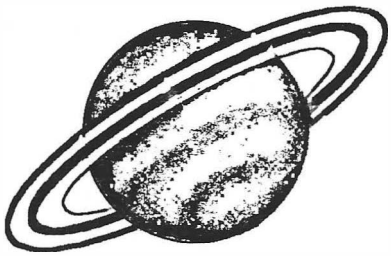
Venus

Earth

Mars



Jupiter

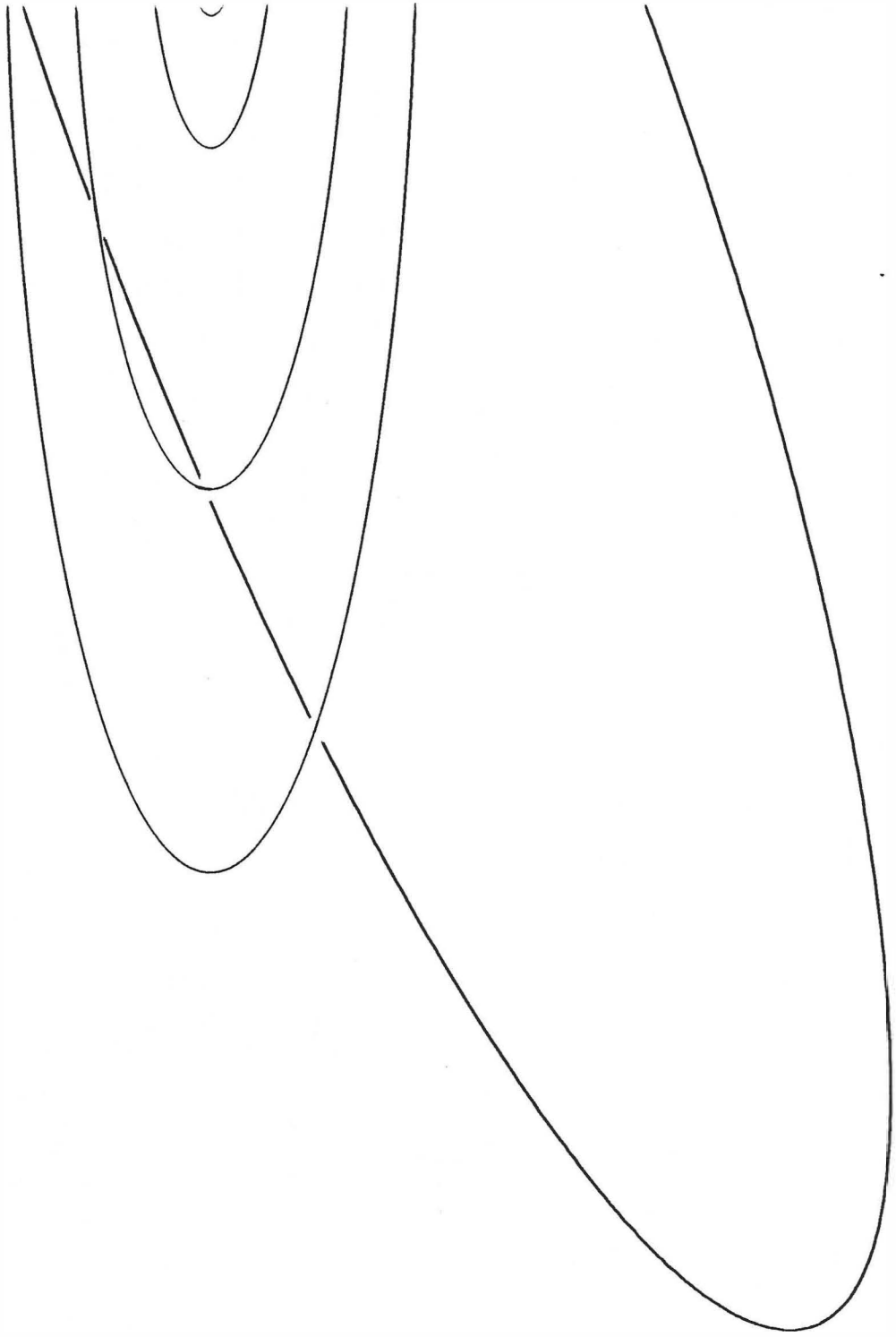


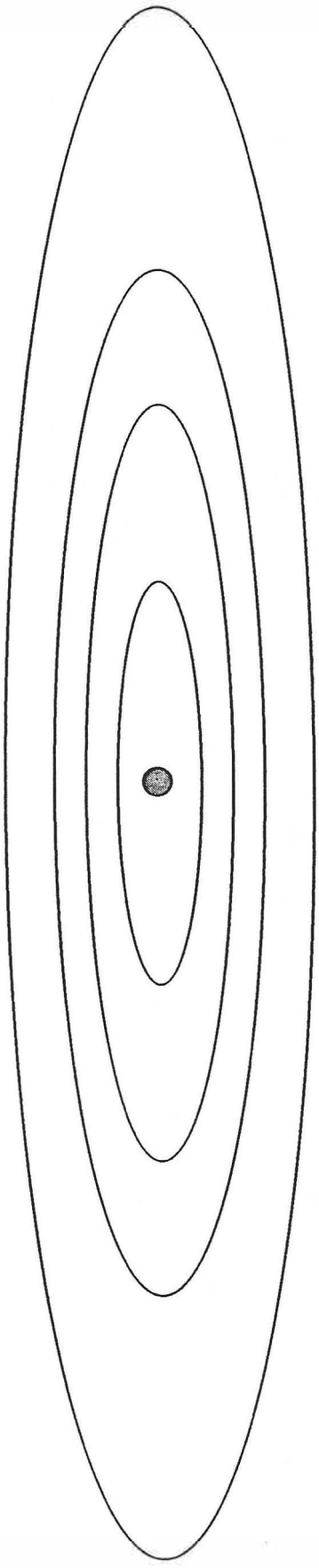
Saturn

Uranus

Neptune

Pluto





Solar System

sun

Mercury

Venus

Earth

Mars

Jupiter

asteroid belt

Saturn

Uranus

Neptune

Pluto

comets

meteors and meteorites

Mercury is the innermost planet in our solar system. It can be as close as 29 million miles from the sun or as far as 43 million miles. Its orbit is elliptical. It has no moons or rings. It was formed about 4.2 billion years ago.

Mercury is 3,100 miles in diameter. It has a rocky surface like Earth's moon. There are large volcanic craters, plains and cliffs or scarps more than a mile high and hundreds of miles long. It is covered with fine dust.

The words for Mercury in different languages are used to name the plains. For example, Suisui in Japanese, Odin in Norwegian, Tir in Persian. Craters are named for authors, composers and artists.

Mercury rotates very slowly on its axis. It turns about 6 miles per hour. One complete rotation takes 59 Earth days.

Mercury orbits the sun at 30 miles per second. It has the fastest orbital speed of any of the planets. One complete orbit of Mercury around the sun takes less than 3 Earth months. This means that a year on Mercury is 88 Earth days.

During the day, the temperature is 800 degrees Fahrenheit. At night, it is minus 350 degrees Fahrenheit. These extremes occur because there is only a trace of atmosphere to help make a uniform temperature.

Venus can be as far as 67.7 million miles from the sun. It can be as close to the sun as 66.8 million miles. It has an elliptical orbit. There are no moons or rings. It is the planet closest to Earth.

The diameter of Venus is 7,700 miles. The surface is covered with flat rocks which are like basalt. This is the type of rock that comes from volcanoes on earth. There are giant volcanoes and a huge canyon.

Venus is the solar system's hottest planet. The temperature is about 900 degrees Fahrenheit. Lead melts at this temperature.

There are two high regions. One is named Aphrodite Terra for the Greek goddess of love. The other is Ishtar Terra, named for the Babylonian goddess of love.

The atmosphere of Venus is 100 times more dense than Earth's atmosphere. This would crush space craft. The atmosphere of Venus is 95% carbon dioxide. In the upper atmosphere there are strong winds, rain and lightning.

One rotation of Venus on its axis takes 243 Earth days. It spins in the opposite direction from the rotation of the Earth.

The dense clouds of Venus are composed of droplets of sulfuric acid. Although Venus rotates slowly, the clouds surrounding it move at 150 miles per hour.

It takes Venus 229 Earth days to revolve once around the sun. This means a Venus year is shorter than a Venus day.

Venus appears so bright in our night sky because these dense clouds reflect sunlight. Venus is called the "morning star" when seen in the morning before sunrise. It is called the "evening star" when seen after sunset. Venus is not a star, but a planet.

The image of Venus changes. It goes through a full set of phases, like Earth's moon. Venus appears larger when it is a crescent because it is closer to Earth than when it is gibbous.

Earth can be as far away from the sun as 94.6 million miles or as close as 91.4 million miles. It is farthest away at the summer solstice on June 21 and at the winter solstice on December 22.

Earth is closest to the sun at the vernal equinox on March 21 and at the autumnal equinox on September 23. Earth's orbit is elliptical.

From outer space, Earth appears bluish in color. Some clouds are always visible. Earth's clouds are composed of water vapor.

Earth and its one moon were formed about 4 1/2 billion years ago. The diameter of Earth is 7,913 miles. About 71 % of its surface is covered with water. The land part of Earth is made up of continents and islands.

One rotation of Earth on its axis takes 24 hours . It rotates from west to east.
One rotation is one day.

It takes Earth 365 days to revolve once around the sun. One revolution around the sun Is one year.

Earth is the only planet in our solar system that can support life as known to us. The atmosphere provides the right amount of oxygen and air pressure. It also helps to keep a moderate temperature.

Part of Mars is covered with giant volcanoes. The largest is Olympus Mons. It is 15 miles high, three times the height of Earth's Mount Everest.

Mars can be as far as 94.6 million miles from the sun. It can be as close to the sun as 91.4 million miles. It has an elliptical orbit. Mars appears red and has two tiny moons.

Other volcanoes are Ascraeus Mons, Pavonis Mons and Arsia Mons. There is a canyon system 3,000 miles long. It is called Valles Marineris.

The diameter of Mars is 4,216 miles. It is about half the size of Earth. The plains of Mars are covered with rocks and reddish dust.

One rotation of Mars on its axis takes 24 hours and 30 minutes. It takes Mars 780 Earth days to revolve once around the sun. A Martian year is more than twice a year on Earth.

Rocks contain limonite, similar to rust. Part of the surface of Mars has dark green regions. The polar caps of Mars are frozen carbon dioxide or "dry ice."

The temperature on Mars ranges from minus 190 degrees to 80 degrees Fahrenheit.

The atmosphere of Mars is 90% carbon dioxide with only traces of oxygen, carbon monoxide and water vapor. It is much thinner than Earth's atmosphere. There is no life on Mars.

Some asteroids are large. There are about 200 with diameters greater than 60 miles. Ceres is the largest, 635 miles in diameter. It was the first to be discovered.

The larger of the Martian moons is 18 miles in diameter. It is named Phobos and orbits Mars every 7 1/2 hours. It is 6,000 miles from Mars.

More than 15 asteroids are in the Apollo Group. This group of asteroids crosses the Earth's orbit. There are other asteroids outside the asteroid belt.

The smaller Martian moon is Deimos which is only 9 miles in diameter. Since it is farther away than Phobos, it takes about 31 hours to orbit Mars.

The moons of Mars are thought to be asteroids which have been captured by the gravitational field of Mars.

Between Mars and Jupiter, more than 27,000 rocks are orbiting. These rocks are called asteroids.

Every hundred million years, an asteroid hits Earth. Huge clouds of dust from the impact hide the sun. It is thought that 65 million years ago, an asteroid caused the extinction of dinosaurs. Without full sunlight, plants and animals died.

Jupiter can be as far away from the sun as 507 million miles or as close as 461 million miles. There are 16 known moons and one wispy, narrow nng.

The diameter of Jupiter is 89,000 miles. It is the largest planet in our solar system. There is a dense inner core of rock and iron that may be as hot as 53,000 degrees Fahrenheit.

Instead of a solid surface, there is a layer of liquid hydrogen 15,000 miles deep. Jupiter's most outstanding feature is the Great Red Spot. It is a giant storm that rotates counterclockwise. It changes size, color and brightness.

There is also a Great White Oval. Jupiter's dark bands are called belts. The lighter bands are called zones.

One rotation of Jupiter on its axis takes 1O Earth hours. This extremely rapid rotation causes the planet to flatten at the poles and bulge at the equator. It takes Jupiter almost 12 years to revolve once around the sun.

Jupiter's atmosphere is about 625 miles deep. It is composed of methane, ammonia, hydrogen, helium and water. The atmosphere reflects sunlight and makes Jupiter appear extremely bright.

There are winds of up to 335 mile per hour and the temperature at the top of the atmosphere is minus 260 degrees Fahrenheit. Great streaks of lightning flash in the upper atmosphere.

Jupiter's two innermost moons are less than 50 miles in diameter. **Next** come two irregularly shaped moons, Amalthea and Thebe.

The four largest moons were discovered by Galileo 350 years ago. These Galilean moons are named Io, Europa, Callisto and Ganymede. Ganymede, the largest moon in our solar system, is larger than the planet Mercury.

The outermost moons probably are captured asteroids. Four revolve in one direction, and four revolve in the opposite direction.

Saturn can be as far as 937 million miles from the sun. It can be as close to the sun as 838 million miles. There are at least 23 moons, but Saturn is famous for its spectacular rings.

The diameter of Saturn is 74,560 miles. Saturn is constructed like Jupiter, a dense center surrounded by liquid hydrogen.

One rotation of Saturn takes 10.1 Earth hours. It takes Saturn 29.5 Earth years to revolve once around the sun.

Saturn's moons have an inner core of rock covered with ice. The largest moon, named Titan, is 3,200 miles in diameter. It is larger than the planet Mercury.

The atmosphere of Saturn is like that of Jupiter except that the temperature is about 100 degrees colder at the top of the atmosphere.

Titan has a dense atmosphere composed of nitrogen and a smaller amount of methane. There are methane clouds and rain, methane seas and glaciers.

The 7 main rings are composed of thousands of tiny ringlets. Some of the rock particles in the rings are very small and some are boulders as large as a car. These rings orbit around Saturn's equator. They are about 158,000 miles in diameter.

Saturn's larger moons are named Mimas, Enceladus, Tethys, Dione, Rhea, Hyperion, Lapetus and Phoebe. Phoebe may be a captured asteroid since it is much farther away than the other moons.

Uranus can be as far as 1860 million miles from the sun. It can be as close to the sun as 1669 million miles.

It takes Uranus 84 years to revolve once around the sun. Because it rotates on its side, the poles have alternating winters of 42 years with darkness and summers of 42 years with light.

The diameter of Uranus is 32,400 miles which is four times the diameter of Earth. Uranus has a dense core of liquid rock.

Uranus has 11 narrow rings. There are five moons that can be seen from Earth, named Miranda, Ariel, Umbriel, Titanis and Oberon. Ten small moons were discovered by Voyager spacecraft. These are black, made of ice and rock.

There is a 5,000 mile deep icy crust of hydrogen and helium. This gradually becomes the atmosphere. The blue-green color of Uranus is caused by methane in the atmosphere.

Neptune can be as far as 2,822 million miles from the sun. It can be as close to the sun as 2,760 million miles.

One rotation of Uranus on its axis takes between 16 and 17 Earth hours. It rotates on its side.

Neptune is 31,000 miles in diameter. Neptune probably is composed of rock and ice. The temperature is minus 353 degrees Fahrenheit.

The blue color is caused by 2 percent methane in its atmosphere. There is a huge stormy vortex called the Great Dark Spot.

The atmosphere of Neptune is mainly hydrogen with 15 percent helium. The upper atmosphere contains wispy, high clouds.

One rotation of Neptune on its axis takes 16.1 Earth hours. Neptune circles the sun every 165 years. It has not made one complete orbit since its discovery in 1846.

Neptune has faint partial rings or arcs and 3 prominent rings. One of Neptune's 8 moons is called Triton. It is nearly the size of Earth's moon and about the same distance away. The temperature on Triton is extremely cold. Triton has a thin atmosphere.

Pluto can be as far as 4,551 million miles from the sun. It can be as close to the sun as 2,756 million miles. At that distance, it is closer to the sun than Neptune.

The diameter of Pluto is 2,000 miles. It is the smallest planet in our solar system. It may be a moon that escaped from Neptune. It has a solid surface of ice with a dark band around its equator. The poles have caps of frozen m·ethane.

One rotation of Pluto on its axis takes 6.4 Earth days. It takes Pluto more than 248 Earth years to revolve once around the sun. Its orbit is extremely elliptical.

Pluto has a moon named Charon. It is made of frozen water and is about 500 miles in diameter. Charon matches Pluto's rotation exactly.

Astronomers had predicted that there was a planet where Pluto is located. It was not discovered until 1930.

Our sun is a star. The 9 planets, asteroids and comets revolve around it. The diameter of our sun is about 864,000 miles.

One rotation of the sun on its axis takes 27 days for the interior, 25 days at the equator and 33 days at the poles.

The center of our sun is 27,000,000 degrees Fahrenheit. Four hydrogen atoms fuse to make one helium atom. This fusion process causes energy to be released as heat, light and radiation, our "sunshine".

The surface of the sun is a layer of gas called the photosphere. It is 10,000 degrees Fahrenheit. There are granules of heat cells. Sunspots are dark, cooler areas.

The inner atmosphere is called the chromosphere. Its temperature is 50,000 degrees Fahrenheit. The outer atmosphere is called the corona. Its temperature is 3,500,000 degrees Fahrenheit.

Solar prominences are eruptions of burning clouds of gas, about 27,000 degrees Fahrenheit. Solar flares send x-rays and particles into space. They can disrupt radio and satellite communications on Earth.

There is always a flow of particles called the solar wind. When these particles enter our atmosphere, their atoms glow. The glowing atoms are seen as northern lghts or aurora borealis.

Our sun and its planets are traveling around our galaxy at about 500,000 miles per hour. Our solar system has made about 20 trips around our galaxy since it was formed, probably 5 billion years ago.

Beyond the orbit of Pluto lies the Oort cloud. It is made up of billions of comet nuclei. Comets are chunks of rock and ice, about 10 miles in diameter. They appear as bright balls of light, reflected from the sun.

If a comet is disturbed, it falls from the Oort Cloud and goes into orbit. These are long period comets, taking longer than 200 years to orbit. They travel beyond Jupiter. The orbits of comets are elliptical.

Short period comets complete their orbits in less than 200 years. Usually they do not travel beyond Jupiter. There are about 150 short period comets.

The most famous short period comet is Halley's comet which returns every 76 years. The largest comet is Chiron. Composed of gas and dust, it is 150 miles in diameter. It orbits between Saturn and Uranus.

Some scientists think Chiron came from the Oort cloud. Others think it came from the Kuiper belt. The Kuiper belt is shaped like a torus. It is made up of icy rubble and orbits beyond Neptune.

Nonperiodic comets orbit at such great distances that their return has not been recorded.

The most spectacular part of the comet is the tail. It can extend millions of miles into space. The sun's energy changes some of the comet's ice into gas. The gas becomes the tail.

There are two tails. One is a bluish gas, the other is dust which looks yellow. Comet tails always point away from the sun. Sometimes the tail goes before the head. Sometimes the tail disconnects from the comet.

Meteors are sometimes called "shooting stars", but they are not stars. They are comet dust or chunks of rock from asteroids. On a clear, dark night, one meteor can be seen every 7 minutes.

When Earth goes through the orbit of a comet, one meteor per minute may be seen. This is called a meteor shower. More meteors can be seen after midnight because that side of Earth is moving into the meteor dust.

Meteor showers are named after the constellations or stars where they originate. The names are Quadrantids, Lyrids, Eta Aquarids, Delta Aquarids, Perseids, Orionids, South Taurids, Leonids, Geminids and Ursids.

Fireballs are the brightest meteors. These glowing chunks of rock are called meteoroids. As the rock goes through the atmosphere of Earth, friction heats the meteoroid and causes it to glow.

Some of the meteoroid gets through Earth's atmosphere and lands on earth. Then it is called a meteorite. Meteorites may be "stony" or "irons." "Irons" have a dark crust. They are made of nickel and iron.

tripod

tripod leg

azimuth coarse-motion clamp

slow-motion control knobs

altitude coarse-motion clamp

eyepiece

eyepiece holder

star diagonal

drawtube

tine focus sleeve

focus knob

viewfinder collimating screw

viewfinder

cradle

telescope maintube

objective cell

dewcap/sunshade

objective lens

The tripod has three legs. It supports the telescope.

The eyepiece is attached to the telescope by the eyepiece holder.

The cradle attaches the telescope to the tripod.

By turning the focus knob, the drawtube moves in or out. This gives a clear image of the object.

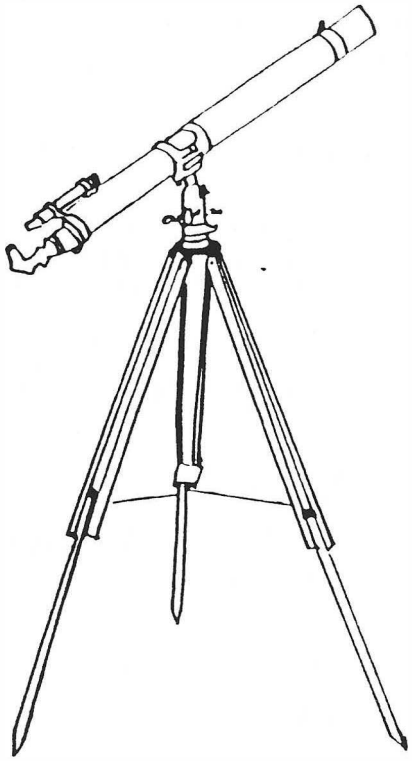
The telescope maintube contains lenses which allows distant objects to be seen closely.

The fine focus sleeve allows a clearer focus.

With the viewfinder collimating screw, the viewfinder locates the object to be seen. It moves the telescope into position so that focusing is possible.

The objective cell holds the lens.

The objective lens concentrates incoming light.



The altitude coarse-motion clamp is used to adjust the vertical position of the telescope.

The slow-motion knobs control the fine tunings of the telescope's two motions.

The azimuth coarse-motion clamp is used to adjust the horizontal position of the telescope.

Earth's Interior

lithosphere
all of the Earth from its surface to the Earth's center

crust
the top layer of Earth, 5 miles thick under the oceans and 25 miles thick under the continents, drifting on the mantle, a semi-melted layer below it

upper mantle
dense layer of semi-melted rock with a temperature about 2700 degrees Fahrenheit upon which Earth's crust rests

lower mantle
layer with a temperature of 5400 degrees Fahrenheit located between upper mantle and outer core, the combined upper and lower mantles being about 1800 miles deep

outer core
molten layer with a temperature of more than 4000 degrees Fahrenheit, about 1400 miles thick, covering the inner core

inner core
extremely hot solid center with a temperature of 9000 degrees Fahrenheit, composed of an iron and nickel alloy, about 800 miles in diameter

Plate Tectonics

plates
moving sections of Earth's crust

boundary
edge of plate where forces of movement are located

subduction zone
area where one plate pushes down under another plate

upwelling
movement of molten material from the mantle which can separate a plate

fault
area of Earth's crust along which movement of plates occurs

upper mantle

lower mantle

outer core

inner core

plates

boundary

subduction zone

upwelling

lithosphere

fault

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all of the Earth from its surface to the Earth's center

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moving sections of Earth's crust

layer with a temperature of 5400 degrees Fahrenheit located between upper mantle and outer core, the combined upper and lower mantles being about 1800 miles deep

edge of plate where forces of movement are located

area where one plate pushes down under another plate

Earth's crust is composed of plates which move on the upper mantle. The major tectonic plates are: Eurasian Plate, Pacific Plate, Indo-Australian Plate, Antarctic Plate, Nazca Plate, North American Plate, South American Plate and African Plate.

movement of molten material from the mantle which can separate a plate

area of Earth's crust along which movement of plates occurs

Smaller tectonic plates are: Philippine Plate, Cocos Plate, Juan de Fuca Plate, Caribbean Plate, Hellenic Plate, Arabian Plate, Caroline Plate, Fiji Plate, and Scotia Plate.

Internal Movements of Earth

As plates slide along each other, the strain is so great that earthquakes occur. The area along the two plates is called a fault. There are as many as a million earthquakes in a year. Most earthquakes take place under the oceans.

Earthquakes cause great damage. Landslides, collapse of buildings and bridges, fires, floods and tidal waves, also known by the Japanese as tsunami, may occur.

Most earthquakes start in the Earth's crust just a few miles down. Some earthquakes originate in the mantle as deep as 450 miles. The amount of energy released by an earthquake is 10,000 times greater than the first atomic bomb.

When two plates move toward each other, one plate slowly slides under the other. This is called subduction. One plate is slowly pushed down into the upper mantle where it melts.

The boundaries of large moving plates in Earth's crust are the locations of volcanoes and earthquakes. Plate activity results from movement in the upper mantle. Volcanoes move molten material from the mantle to Earth's surface.

Some continents are located on plates which are being subducted or pushed under. As the plate is pushed downward, the crust of the continent on the plate moves upward. This upwelling forms mountains.

Seismographs measure the vibrations of Earth when earthquakes occur.

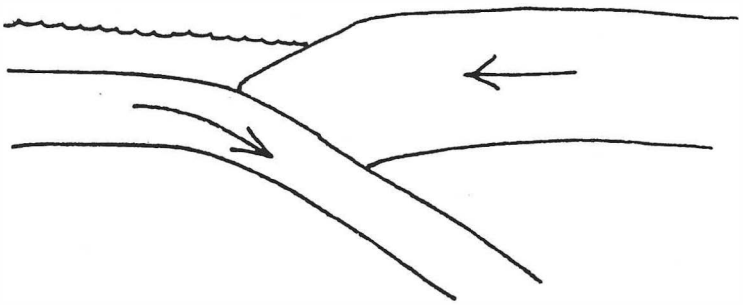
Earth's geomagnetic field results from movement in the fluid outer core.

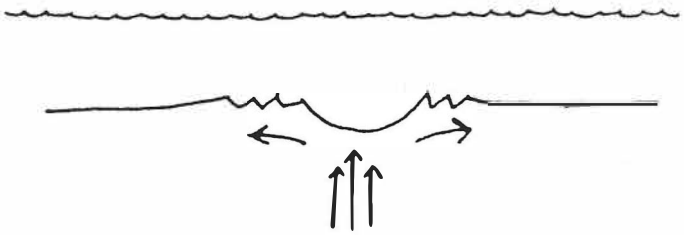
Fossils from the Atlantic coast of North America are like those in Europe. Fossil evidence is present in all continents. Parts of Antarctica contain fossils of marine animals which means that it was once under water.

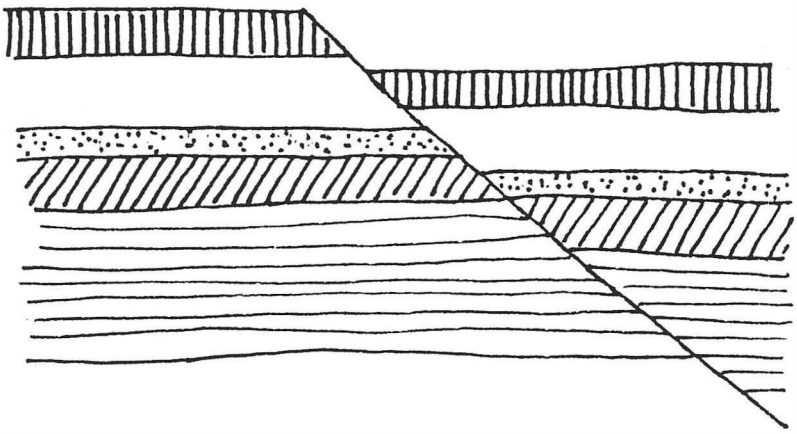
Under the oceans, there are rift valleys and trenches. Trenches are formed by the subduction of one plate under another.

There are ridges and seamounts, some of which show above the ocean's surface.

Earth is constantly changing. The changes are so slow that they must be measured by scientific instruments.





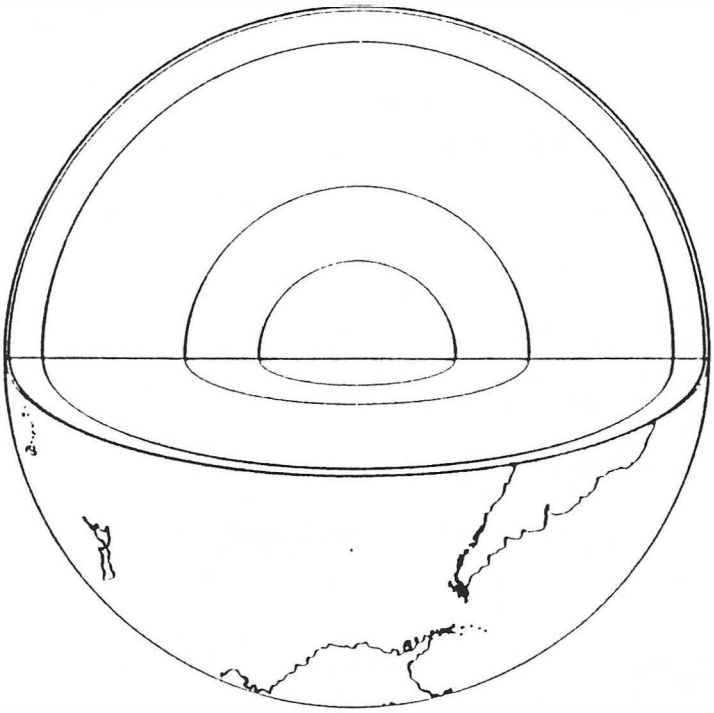


subduction zone

upwelling

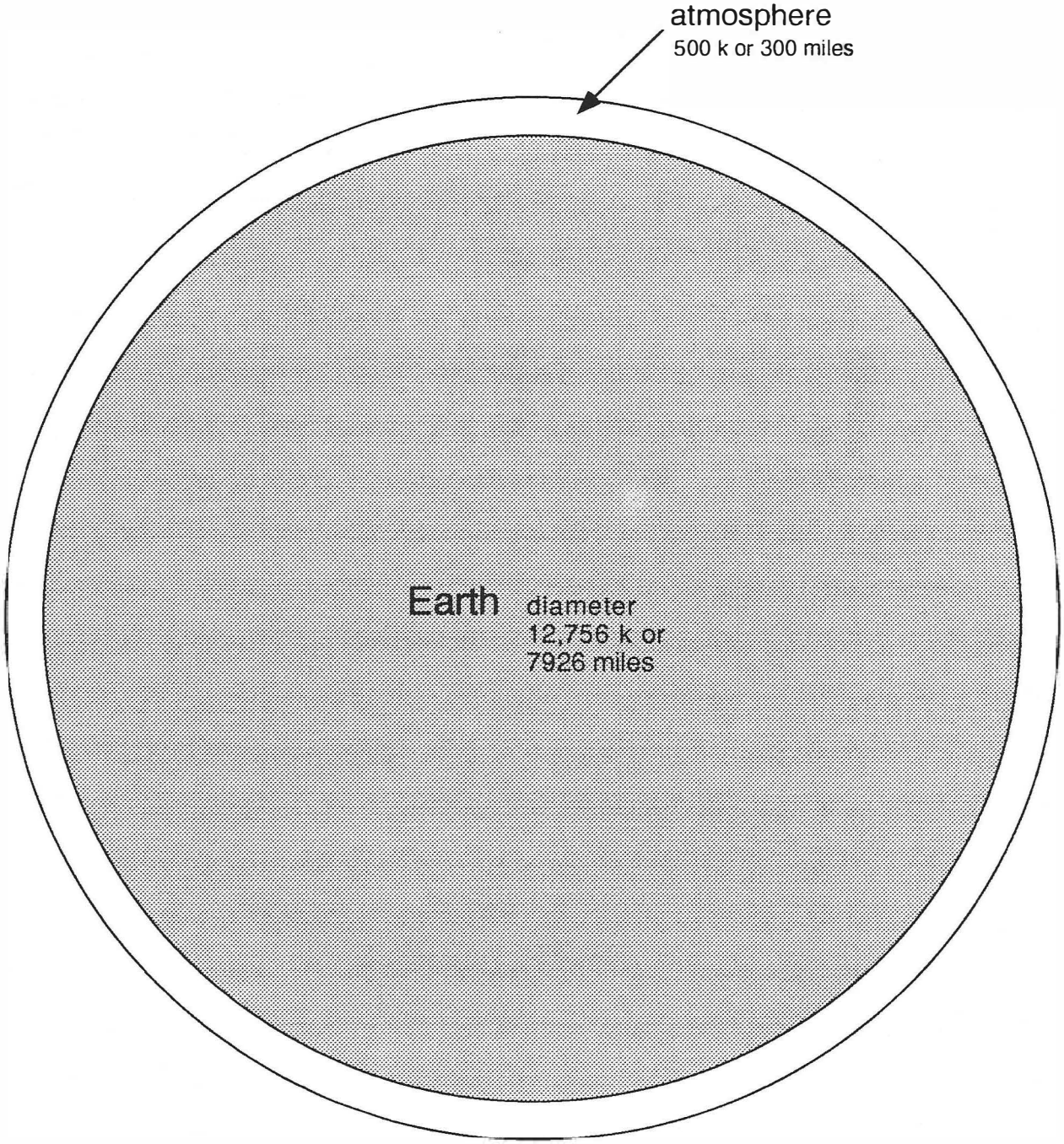
fault

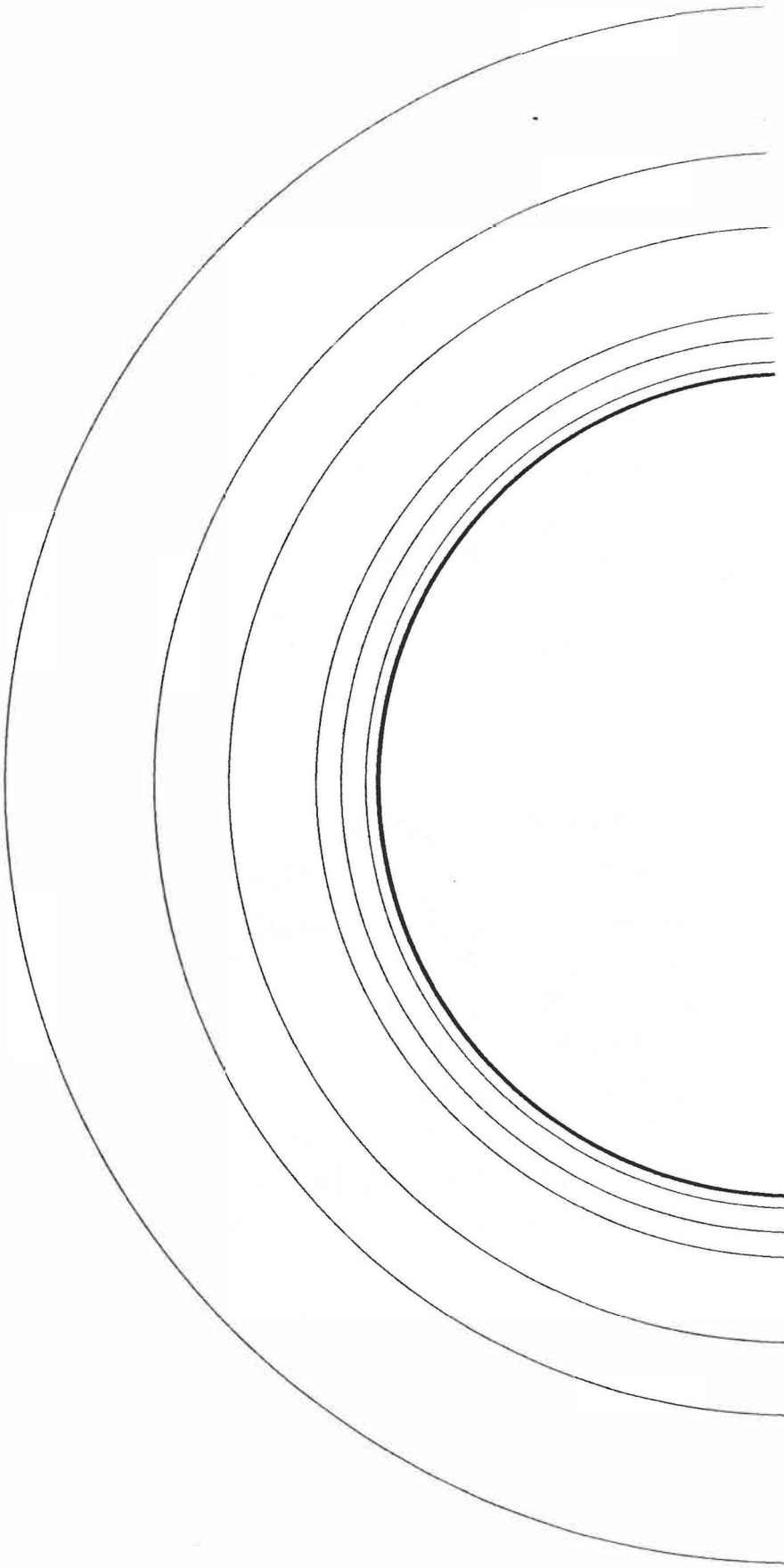
Earth's crust is composed of plates



Earth's Interior

The boundaries of large moving plates in Earth's crust are the locations of volcanoes and earthquakes.





Earth's Atmosphere

Most of the weather occurs in the lowest third of the atmosphere. Half the weight of Earth's air is in the lower fourth of the atmosphere.

Just above the Earth's surface is the troposphere. It is about 5 miles deep at the poles and about 11 miles deep at the equator. The upper boundary of the troposphere is called the tropopause.

The temperature of Earth's atmosphere can range from an average of 72 degrees F at the surface to about -80 degrees F at the top of the tropopause. Temperature decreases with altitude. This is called lapse rate.

Earth's atmosphere is composed of 78% nitrogen, 21% oxygen, 0.9% argon and 0.1% carbon dioxide with traces of many other gases. There is water vapor present, but the amounts change from time to time and place to place. Without oxygen, most life on Earth could not exist.

Above the troposphere is the stratosphere. It extends to about 30 miles from the surface of Earth.

There is an ozone layer in the stratosphere that absorbs ultraviolet radiation from the sun.

Because there is no weather in the stratosphere, it is most suited to long distance flight.

Beyond the mesosphere lies the ionosphere. It extends to about 180 miles above Earth's surface.

Beyond the stratosphere lies the mesosphere. It extends to about 50 miles above Earth's surface.

There are four regions in the ionosphere, labeled D, E, F_1 and F_2. These regions are composed of atoms of the upper mesosphere and the thermosphere which have been stripped of their electrons by radiation.

Most meteors begin to burn up in the mesosphere.

Long-distance radio broadcasts are affected by the ionosphere. A faint airglow is also caused by the ionosphere.

The mesosphere contains noctilucent clouds of ice crystals. Temperatures can be as low as -225 degrees F.

Solar wind particles at the poles cause agitation in the ionosphere. This produces a display of light called the aurora borealis or northern lights at the North Pole, and the aurora australis at the South Pole.

Beyond the ionosphere lies the thermosphere. It extends about 300 miles above Earth's surface.

Beyond the thermosphere is the exosphere. Radiation belts such as the Van Allen radiation zone and magnetic fields exist in this outer area.

troposphere

stratosphere

mesosphere

D region

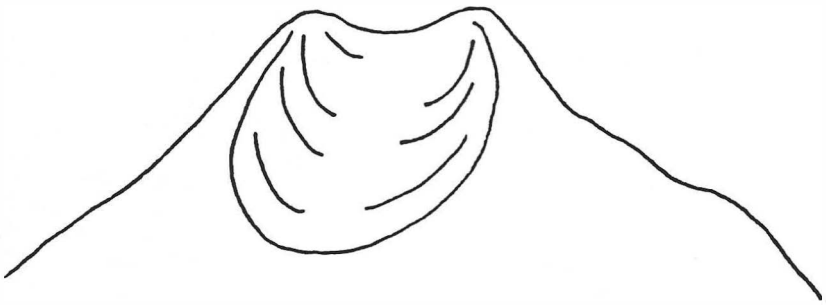
E region

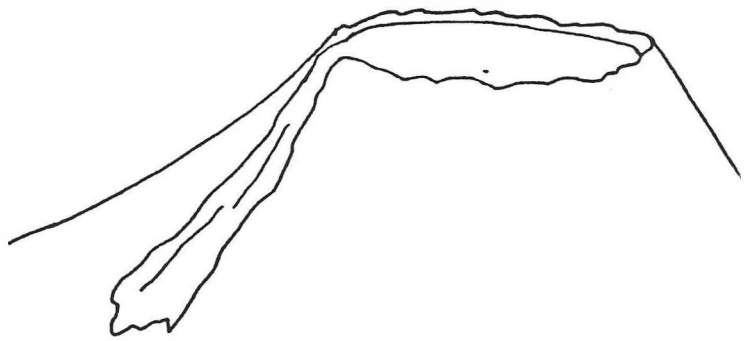
F_1 region

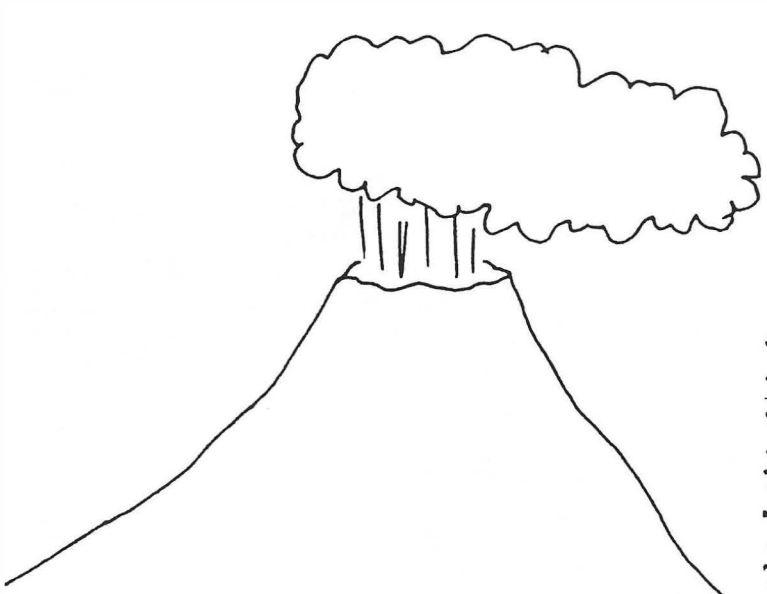
F_2 region

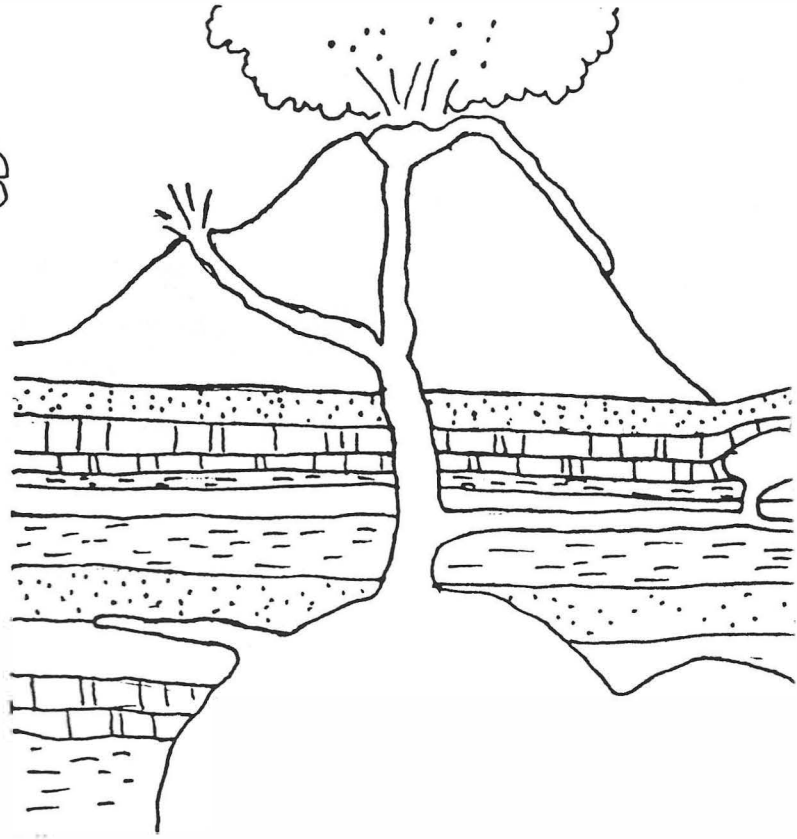
thermosphere

exosphere





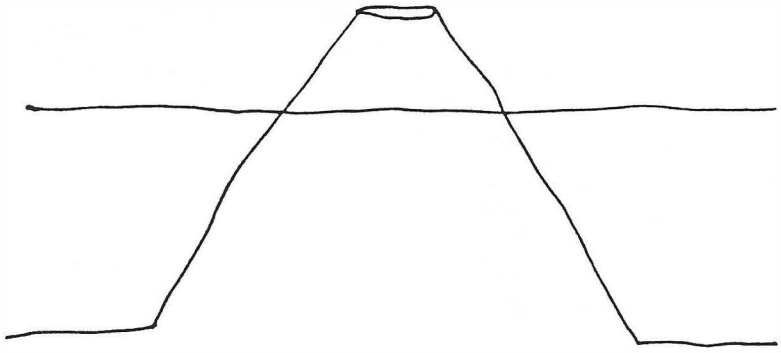


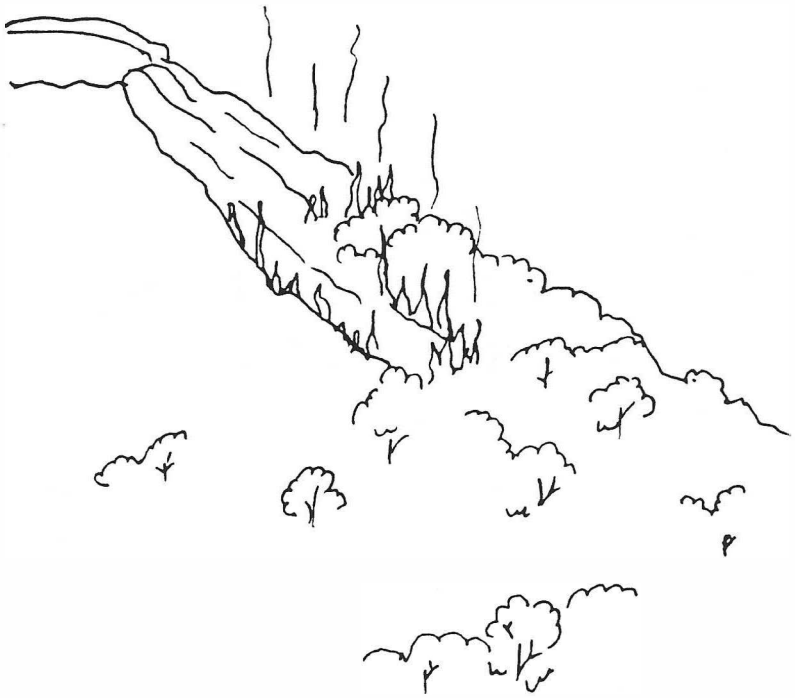


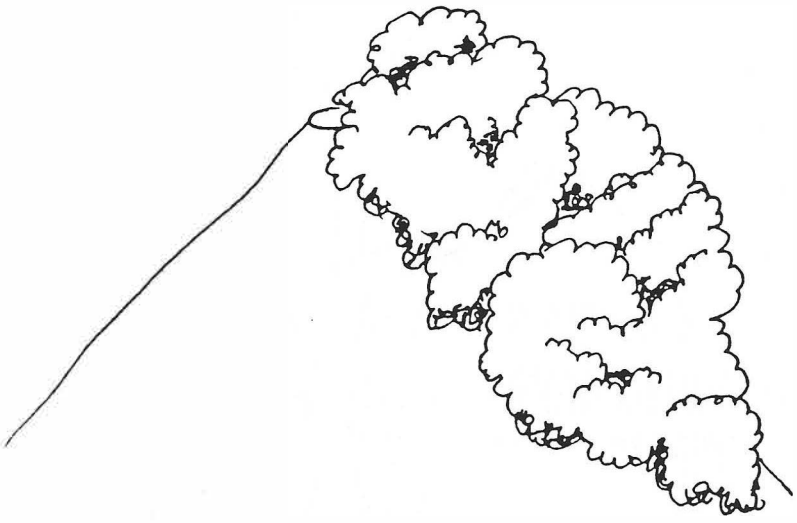
caldera

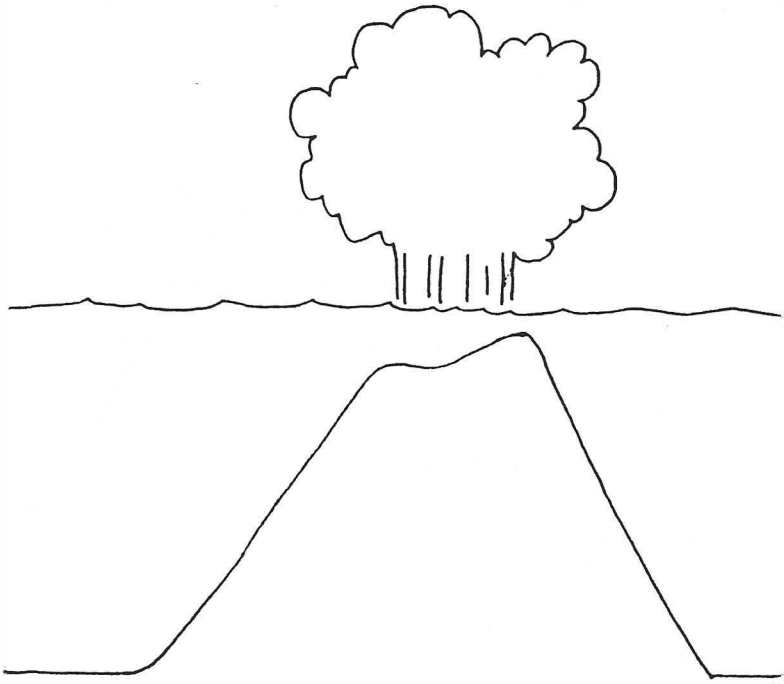
shield volcano

explosive volcano









Hawaii

fires

gases

eruption in ocean

volcano
an opening in Earth's crust from which lava flows or hot ash and gases erupt, sometimes quietly and sometimes explosively, building a mountain or hill

shield volcano
a type of volcano from which lava streams

explosive volcano
a type of volcano from which violent eruptions of ash, lava and cinder take place because the magma contains large amounts of gases

eruption
ejection or outburst of material from within the Earth

cone
cone-shaped formation of ash or cinder from volcanic eruptions

crater
opening, usually at the top of the cone, through which eruptions take place

vent
small, lateral passageways from which lava and gases can erupt when the main conduit is blocked

magma chamber
underground pool or reservoir of hot, molten rock from which magma rises to flow from the volcano

dike
hardened magma, usually granite, which fills cracks in layers of Earth's crust when magma moves from its reservoir without reaching Earth's surface

conduit
passageway formed from pressure of magma which blasts or melts through rock, making a large vent or chimney through which lava, ash and rocks pass from a volcano

lava
magma which moved from within the volcano to flow down the outside

ash
steam and dust composed of fine cinders, giving the appearance of smoke

laccolith
underground dome formed when magma pushes rock layers upward

batholith
huge underground pockets of solidified magma, usually granite

sill
horizontal sheet of solidified underground magma

fumarole
an opening in or near a volcano from which gases and vapors rise

caldera
great depression remaining when a volcano erupts so violently that it is blown completely away or collapses inwardly

an opening in Earth's crust from which lava flows or hot ash and gases erupt, sometimes quietly and sometimes explosively, building a mountain or hill

a type of volcano from which lava streams

a type of volcano from which violent eruptions of ash, lava and cinder take place because the magma contains large amounts of gases

ejection or outburst of material from within the Earth

cone-shaped formation of ash or cinder from volcanic eruptions

hardened magma, usually granite, which fills cracks in layers of Earth's crust when magma moves from its reservoir without reaching Earth's surface

an opening, usually at the top of the cone, through which eruptions take place

passageway farmed from pressure of magma which blasts or melts through rock, making a large vent or chimney through which lava, ash and rocks pass from a volcano

small, lateral passageways from which lava and gases can erupt when the main conduit is blocked

magma which moves from within the volcano to flow down the outside

underground pool or reservoir of hot, molten rock from which magma rises to flow from the volcano

steam and dust composed of fine cinders, giving the appearance of smoke

underground dome formed when magma pushes rock layers upward

great depression remaining when a volcano erupts so violently that it is blown completely away or collapses inwardly

huge underground pockets of solidified magma, usually granite

Earth is changing constantly by movements of its crust which can cause earthquakes and by volcanic action. Islands are built when this volcanic action takes place in the ocean.

horizontal sheet of solidified underground magma

The Hawaiian Islands were formed from lava of active volcanoes under the Pacific Ocean. The bases of these islands on the ocean floor can be five miles below sea level and rise about two miles above sea level.

an opening in or near a volcano from which gases and vapors rise

There are about 850 active volcanoes on Earth. Every continent has at least two volcanoes which have erupted recently.

More than 74% or 3/4 of the volcanoes are within the "ring of fire" around the Pacific Ocean. The boundaries of large moving plates in Earth's crust are the locations of volcanoes.

Some of the pumice and ash spewed from the volcano falls to the ground. Everything around the volcano is covered with a layer as much as 60 feet deep.

When a volcano erupts, lava streaming down its sides destroys everything in its path. Because it is so hot, fires result where lava touches grass, trees or buildings.

Ancient cities have been excavated from under these layers of ash. Buildings, roads, tools and pottery survived in excellent condition. Even unbroken eggs were found.

Clouds of steam, tiny grains of rock and gases that come from an active volcano destroy life. The steam is superheated to 1500 degrees Fahrenheit. The gases are carbon monoxide and hydrogen sulfide which are poisonous when breathed.

In some volcanic eruptions, large quantities of ash and gases are thrown into the upper atmosphere. It can be seen for two years as it orbits. Earth's sunsets are vividly colored as a result.

Tons of tiny grains of very hot rock are suspended in the clouds of steam. These bits of rock cause the cloud to be so heavy that it moves down the sides of the volcano.

Volcanic material in the upper atmosphere can block enough sunlight to reduce the temperature of Earth. When this happens, crops do not grow so there is a shortage of food.

A volcano can erupt so violently that it collapses. This force can cause a tidal wave or tsunami which spreads through the oceans of the world.

In spite of the harm done as a result of volcanic activity, there is some good also. The ash forms fertile soil in which crops can be grown.

volcano

shield volcano

explosive volcano

eruption

cone

crater

vent

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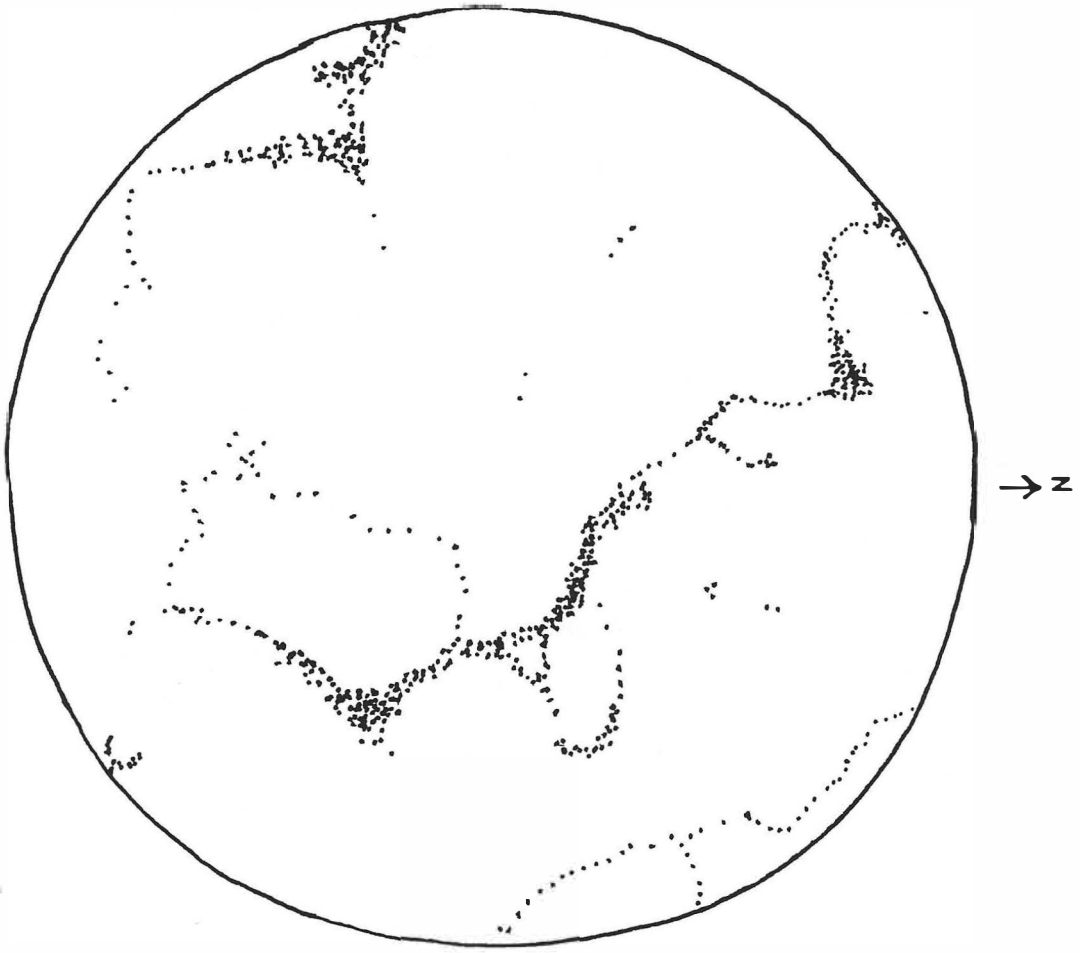

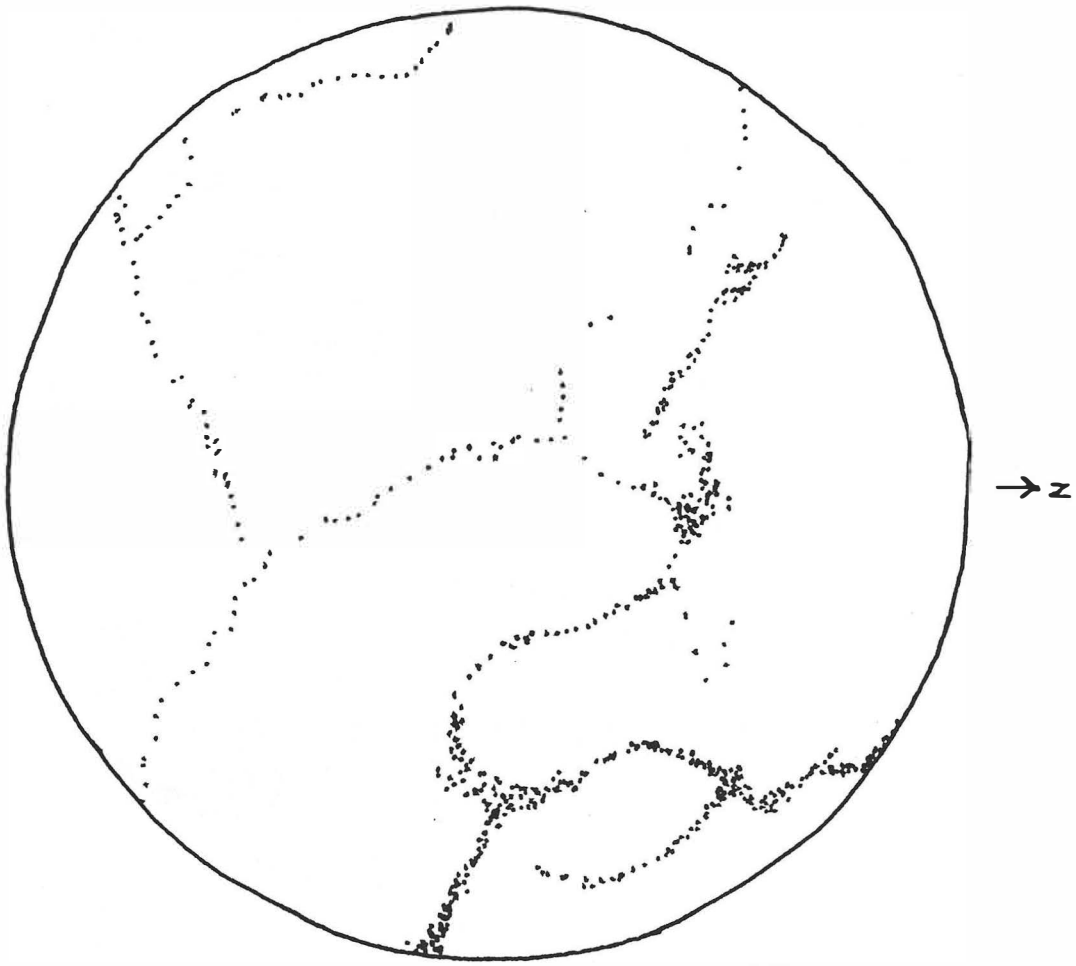

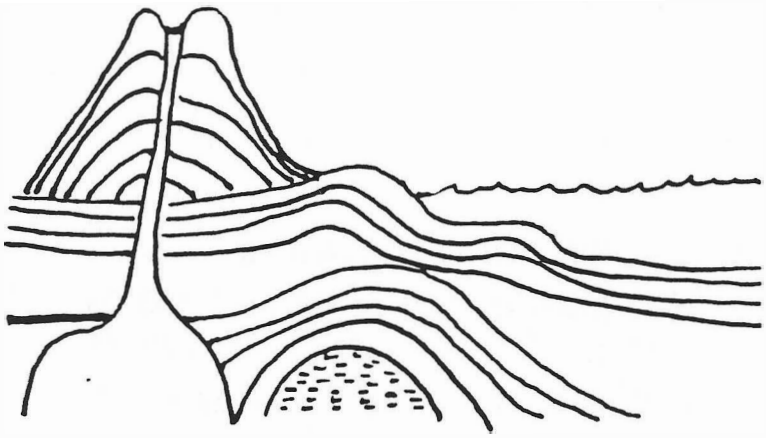

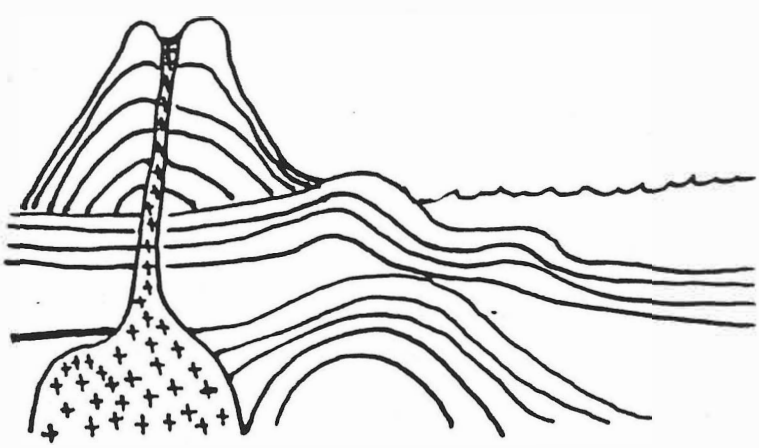

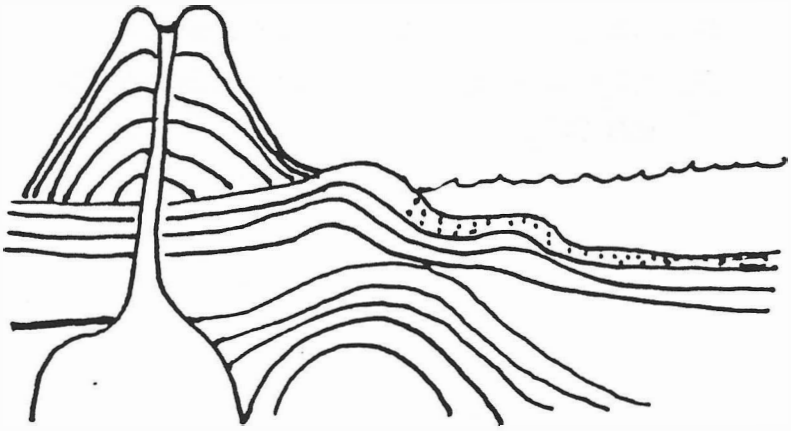

metamorphic

igneous

sedimentary

Rocks

Earth's crust is mostly solid rock. It is covered with soil, vegetation and rock fragments in the form of sand and gravel. In the water, rock is covered with sediment.

Another form of rock is sedimentary. It was formed by layers of clay and sand which washed down into oceans and lakes. Ice and wind may also lay down sediment. Pressure causes layers of sediment to be cemented together.

One type of rock is igneous. Once igneous rock was molten or liquid because it was so hot. It came from deep within the Earth. Molten rock comes from volcanoes. The form taken by the molten rock depends upon how fast it cools. One form is basalt which is smooth rock. A very grainy form is granite.

Sedimentary rocks may be sandstone, shale, limestone and dolomite. Fossils, the remains of ancient plants and animals, are found in shale and limestone.

The third kind of rock is metamorphic. It has been changed in form by heat and pressure deep in the Earth. Clay becomes slate, sandstone becomes quartzite and limestone becomes marble.

Minerals

Minerals are classified by chemical composition and by crystal structure. The way in which atoms are held together determines the structure of crystals. They take the form of geometric solids such as cubes, prisms and other polyhedra.

One classification of minerals includes those containing silicon. The major minerals in granite are silicon compounds.

A second classification contains nonmetallic minerals such as calcium and sulfur.

A third classification includes metal ore minerals such as gold, silver and copper.

A fourth classification is gem minerals. These are colorful and beautiful when cut to show their crystal form. Diamonds, rubies and emeralds are examples of gem minerals.

Methods of Fossil Formation

compression
preservation of imprints of objects through the pressure of layers of sediment

petrification
replacement or filling of cells of plants or animals with minerals dissolved in water from sediment in which the object was buried

incrustations and cast formation
mineral replacement of space or cast left by disintegrated plants or animals in the surrounding sediment

inclusion
entrapment of plant or animal in a substance other than rock which becomes solidified

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Fossils

Even before the first century AD, Greek scholars thought that fossils were evidence of earlier life. Present day scientists study fossils. They learn about changes life has undergone during geologic ages. Paleontology is the study of fossils.

A fossil is an object from past geological ages. It gives evidence of an organism that lived long ago.

Of all the forms of life that have existed, only an extremely small part has been found in fossil remains. Primitive plants such as algae and animals such as sponges have been fossilized.

Deposits such as coal, petroleum, limestone and graphite give evidence of ancient life, but these are not classified as fossils.

Fossils are found in sedimentary rock. Footprints, animal skins and leaves which were in sediment thousands of years ago were buried under more sediment.

Under the weight of more and more layers of sediment, sedimentary rock formed. The impressions are still there. Sometimes the fossilized remains of plants and animals are found. This is called compression.

Petrified wood results when wood cells are replaced with silica, SiO_2. It makes wood like stone after the wood has been buried under layers of sediment for a long time.

Hard parts of plants and animals are those which are preserved. Usually they are petrified. Casts of the plant or animal are formed, but the plant or animal disintegrates.

Fossil amber contains insects from the Tertiary Period, about 58 million years ago. Amber was once resin, the sap from plants, usually trees. Insects or plant parts became trapped in the sticky substance.

Objects become petrified when minerals fill or replace parts of buried plants or animals. Minerals are dissolved in water.

After thousands of years, the resin containing trapped objects turned into hard, clear amber. The object can be seen in the amber. The color of amber can be yellow, reddish or brown.

The primary minerals are calcium carbonate, $CaCo_3$; calcium phosphate, $Ca_3(PO_4)_2$ and silica, SiO_2. This is called petrification.

Fossil evidence of soft-bodied worms is very rare, but some exists. The Burgess shales of British Columbia contain fossil worms from the Cambrian Period 105 million years ago.

Fossils of marine animals are found in sedimentary rocks on mountains. Once this rock was sediment at the bottom of an ancient sea. Through the movement of Earth's plates, these sedimentary rocks have been elevated to heights far above sea level.

There are many layers of sedimentary rock piled one on the other. The layers are called strata. Each layer contains fossils of plants and animals that lived when that layer was formed.

The age of rocks can be determined by examining the fossils in each layer. This is called stratigraphy.

Deposits of oil, coal and minerals such as zinc can be located through the study of stratigraphy. These materials are necessary 1n our civilization.

In addition to fossils, frozen remains of ancient animals can be studied. These are found in places like Siberia but are extremely unusual.

Collections of fossils may be seen in many museums.

There are interesting books about fossils and how to collect them. Collecting fossils is a good hobby for all ages.

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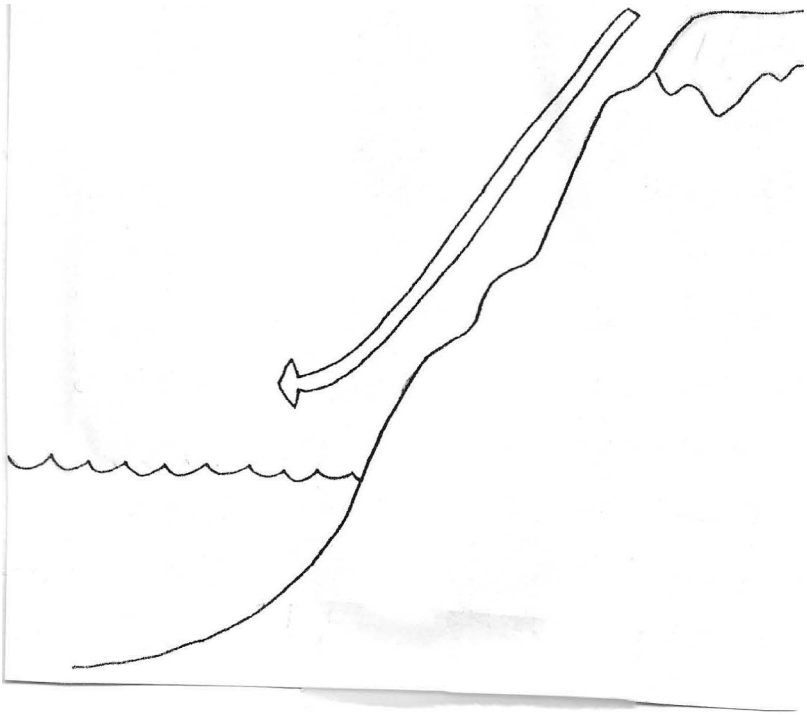
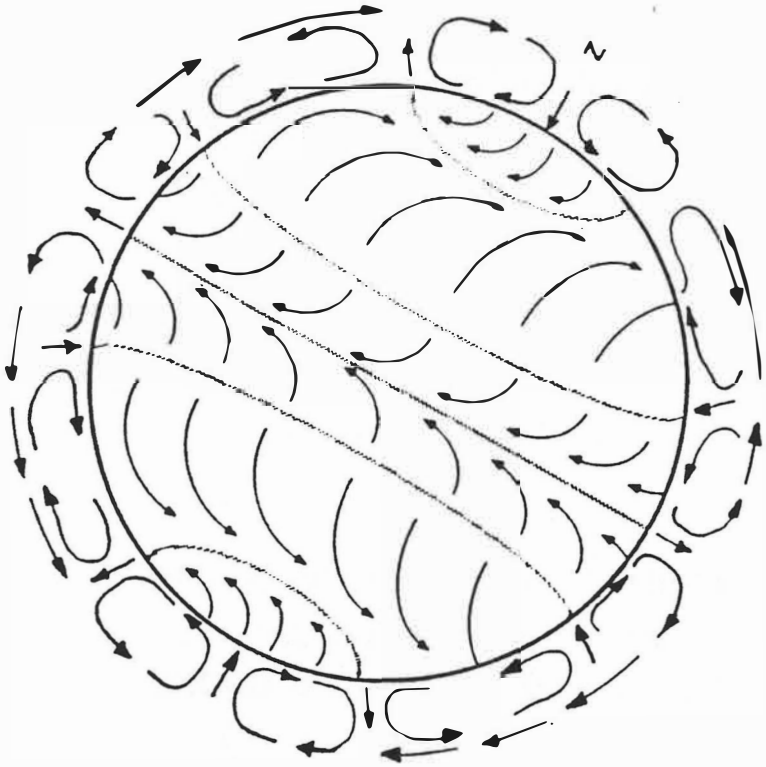
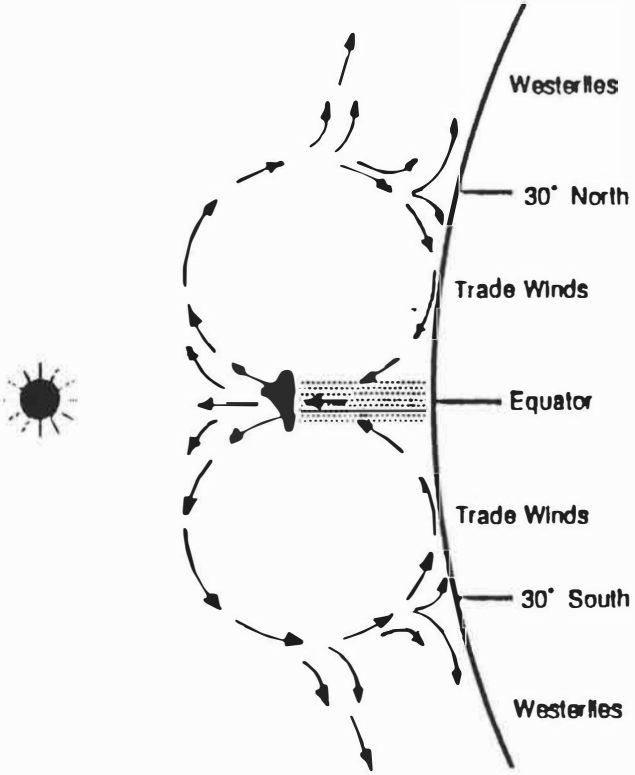
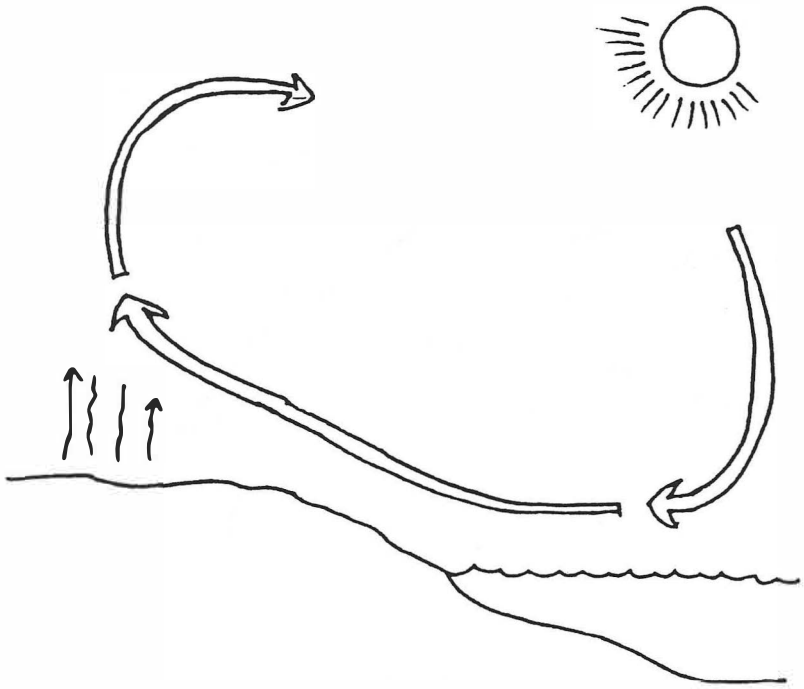


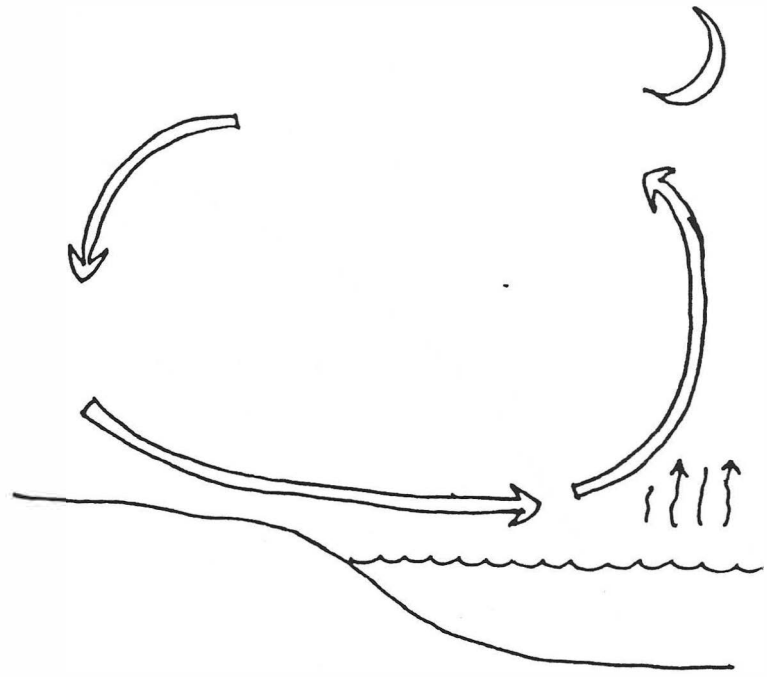




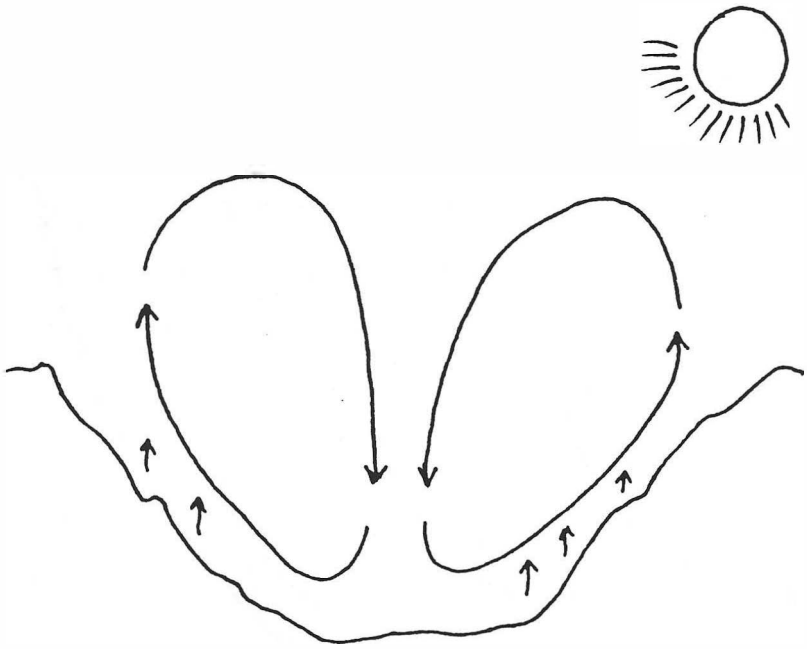
wind



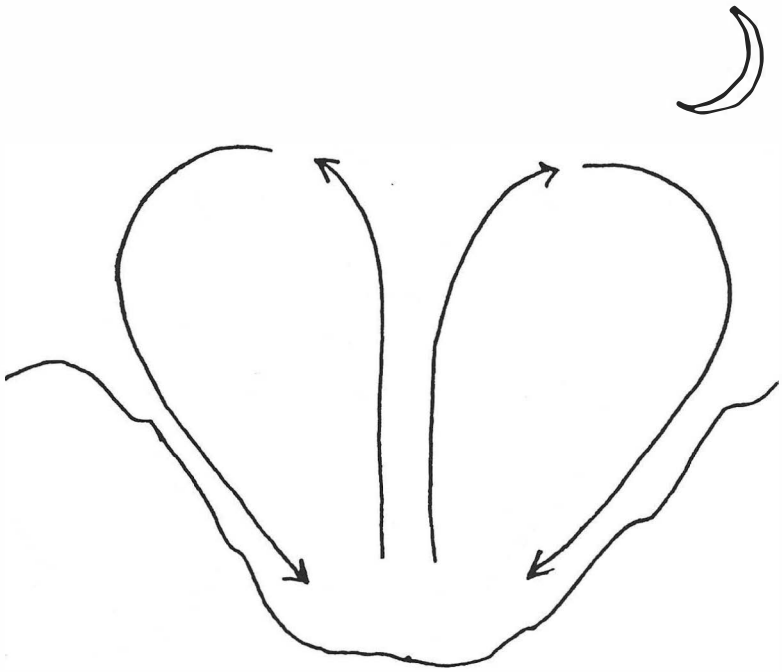
sea-land breezes



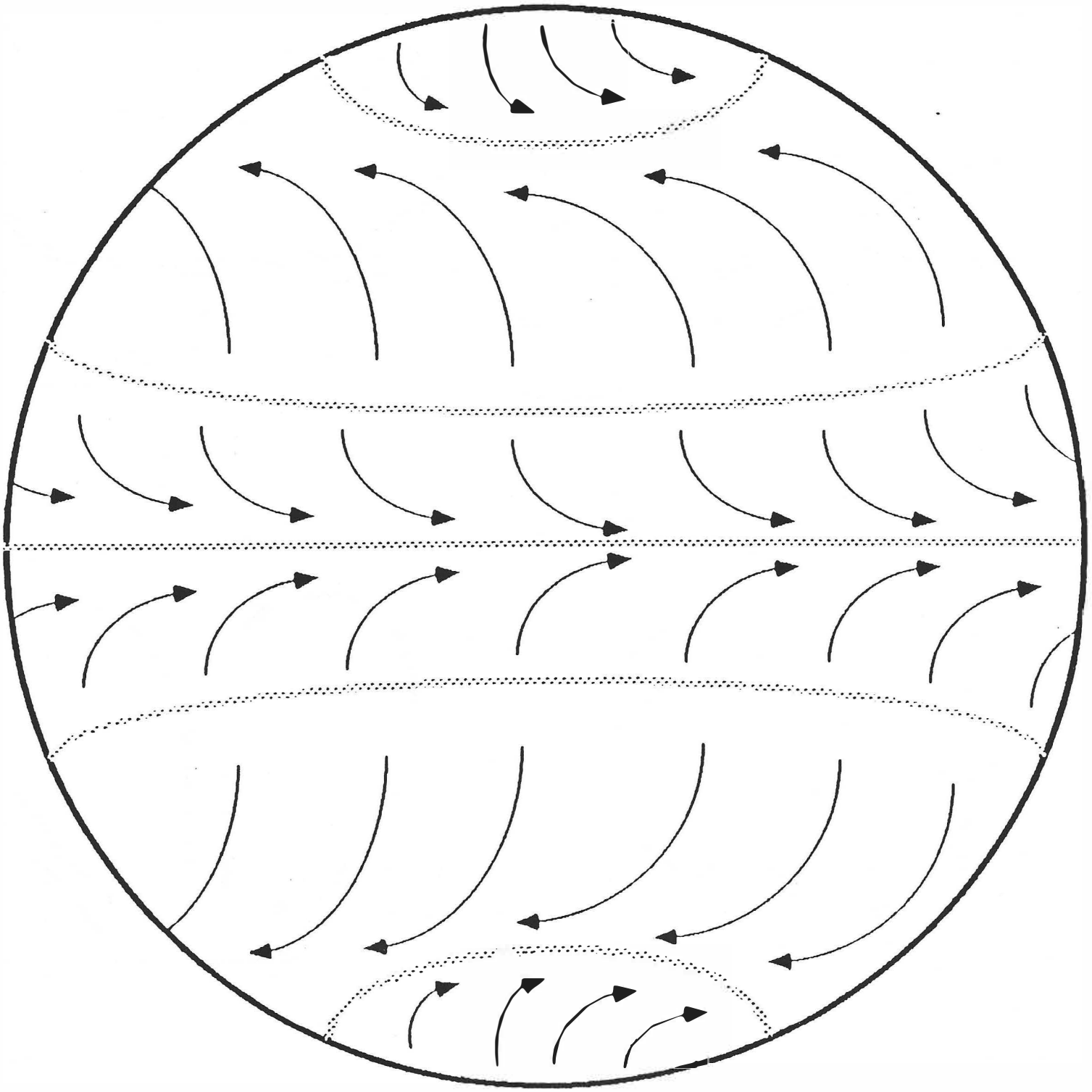
land-sea breezes



valley-mountain winds



mountain-valley winds



wind
air in natural movement in Earth's atmosphere

general circulation of the atmosphere
pattern of winds distributed over Earth's surface due to unequal heating of atmosphere

equatorial calms or doldrums
area of low pressure at the equator where winds are light

trade winds
winds blowing toward the equator from the east between the doldrums and latitudes 30 degrees north or south

horse latitudes of calms
subtropical high-pressure belts with little or light winds at about 30 degrees latitude

westerlies
regions of interaction between cold and warm fronts causing winds from the west between latitudes 35 to 55 degrees

polar easterlies
winds from the east beyond 65 degrees latitude

slope winds
movement of cool, dense air from higher to lower elevations at night and of warm, light air from lower to higher elevations during the day

sea-land breezes
movement of cool sea air toward the land during the day as the warmer air rises above the land

land-sea breezes
movement of cool air toward the sea as the warmer air rises above the sea

mountain-valley winds
movement of air from higher to lower elevations as the valley sides cool during the night

valley-mountain winds
movement of air from higher to lower-elevations as the valley sides are heated during the day

wind

general circulation of the atmosphere

equatorial calms or doldrums

trade winds

horse latitudes of calms

westerlies

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movement of cool, dense air from higher to lower elevations at night and of warm, light air from lower to higher elevations during the day

movement of air from lower to higher elevations as valley sides are heated during the day

Winds

Winds are caused by the unequal heating of the atmosphere at different latitudes and at different altitudes.

The rotation of the Earth causes curving, called the Coriolis effect. Atmospheric pressure contributes to movement of winds.

Over the equator, there is light wind in an area of low pressure known as the doldrums.

Between the latitudes of 30 degrees north and south, winds blow toward the doldrums. In the northern hemisphere, these trade winds are from the northeast. In the southern hemisphere, these trade winds are from the southeast.

Beyond the zone of trade winds are subtropical high-pressure belts in which winds are light. These are called horse latitudes.

Sailing ships had difficulty crossing the sea in the areas with little wind and would become becalmed. Many ships carried horses which had to be destroyed when the water supply was gone.

Between 35 and 65 degrees latitude, prevailing winds are from the west and are known as the westerlies. In these areas, cold and warm fronts interact and low and high pressure centers move.

During the day, winds move upslope as the sun warms the air at lower levels. The convection of warm air causes thermals. Gliders and birds ride the rising air of thermals to high altitudes.

The polar easterlies are the arctic and antarctic winds which blow from the east. They are located from about 65 degrees latitude to the poles.

Sea-land breezes move from the cool sea to the warm land during the day. At night, cooler land breezes blow toward the sea which is warmer.

Gentle downslope winds move from higher to lower elevations at night as the air cools and becomes denser.

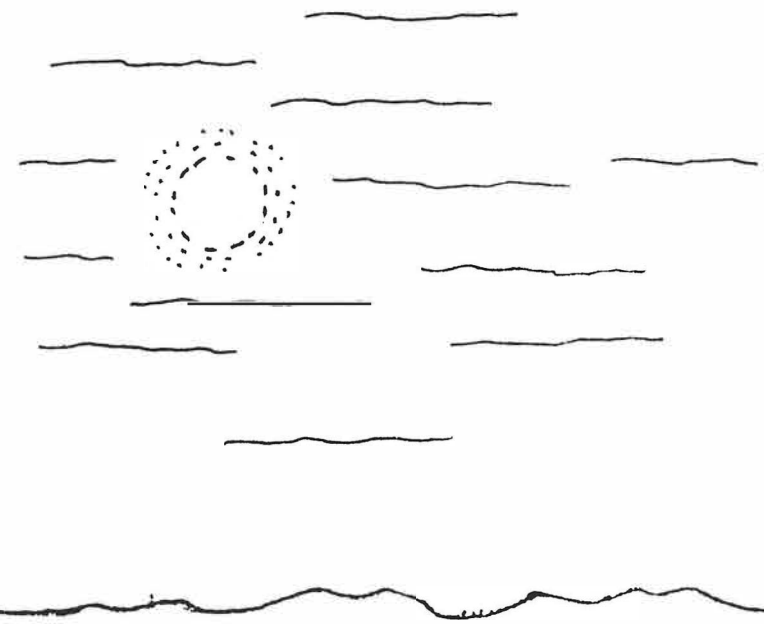
Where there are high snow-covered plateaus or mountains descending steeply into warm seas, strong winds develop. These coastal slope winds are given the name bora. They are given other names in different countries such as Santa Ana winds in southern California.

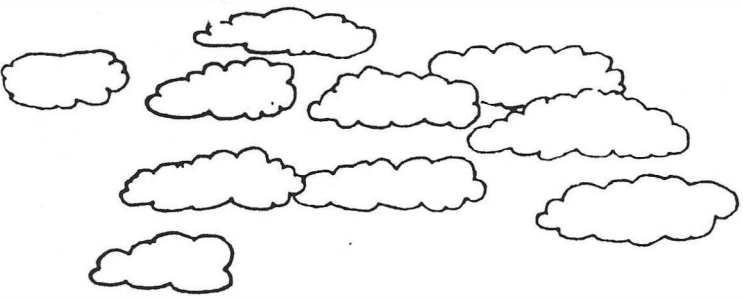
A wind similar to the bora is a mountain-gap wind. It is called Mistral in the Province area of southern France. These extremely strong winds move from the cold Alps to the warm Mediterranean Sea.

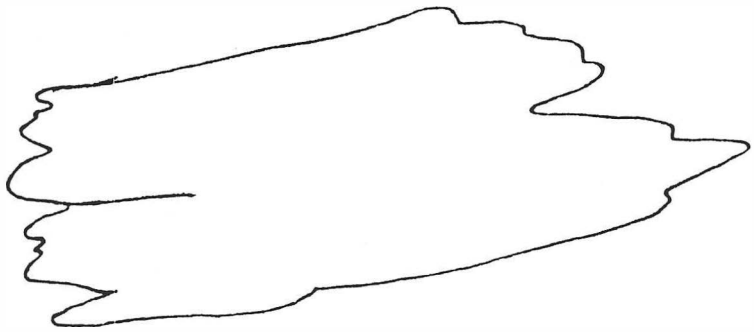
Winds which blow from mountains to lower land, not on the sea side, are hot and dry. The general name is foehn, but different names are used in local areas.

In North America, the wind blowing down the east side of the Rocky Mountains is called chinook.

There are many names for winds. Hot winds are called sirocco in general, but many countries have their own names for this wind: khamsin (Egypt), leste (north Africa), leveche (Spain).





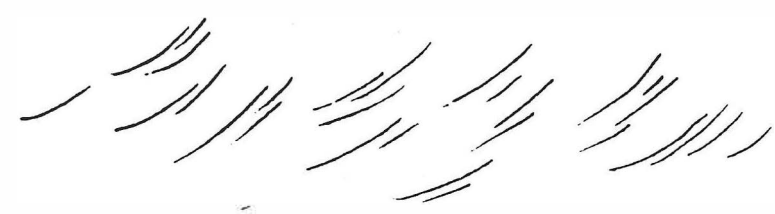


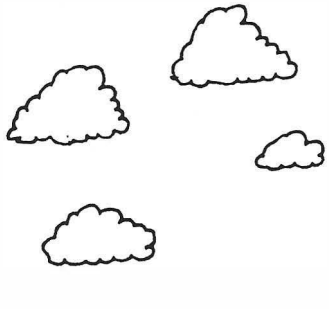
cirrostratus

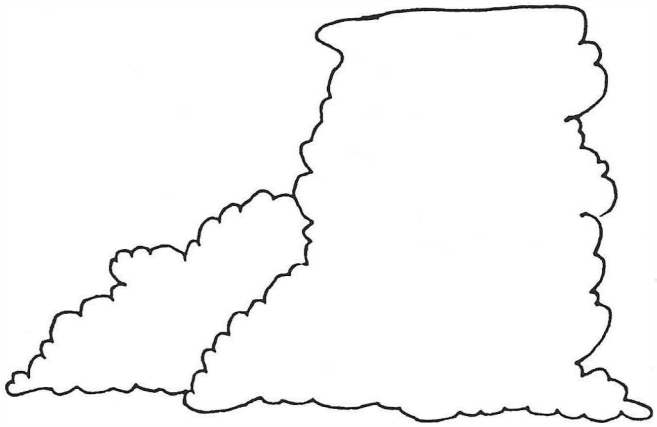
stratus

altocumulus

altostratus





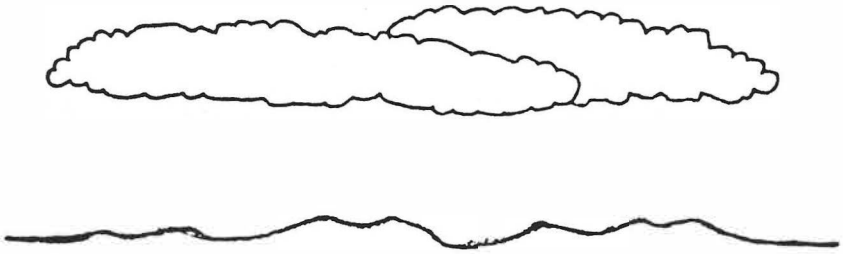


cirrus

cumulus

nimbostratus

cumulonimbus



stratocumulus

stratus

Water evaporates from oceans, rivers and lakes. Water vapor in the air condenses to form clouds.

cirrostratus

altostratus

In winter, clouds usually are lower and travel faster than in summer. There are more clouds in winter.

cirrus

cumulus

altocumulus

Over land, there are more clouds at night than by day.

stratocumulus

cumulonimbus

There are many cloud forms which occur at different distances from the Earth.

nimbostratus

Cirrus, cirrostratus and cirrocumulus clouds are the highest, about 3 to 9 miles above the Earth. They appear light and wispy.

Cirrus and cirrostratus clouds move at more than 100 miles per hour. That is a lot faster than cars move on roads.

When there are cirrostratus clouds, rain probably will fall.

Altostratus and altocumulus clouds are about 1 to 5 miles above the Earth.

Altostratus clouds may be gray or bluish in color.

Altocumulus clouds may be in small and rounded layers.

Altocumulus clouds may be in waves of small clouds, sometimes called "Mackerel sky."

Altocumulus clouds indicate that a front is coming. When altocumulus clouds appear as a solid bank from the south or west, usually it will rain within 12 hours.

The lowest clouds are the stratocumulus, stratus, nimbostratus, cumulus and cumulonimbus.

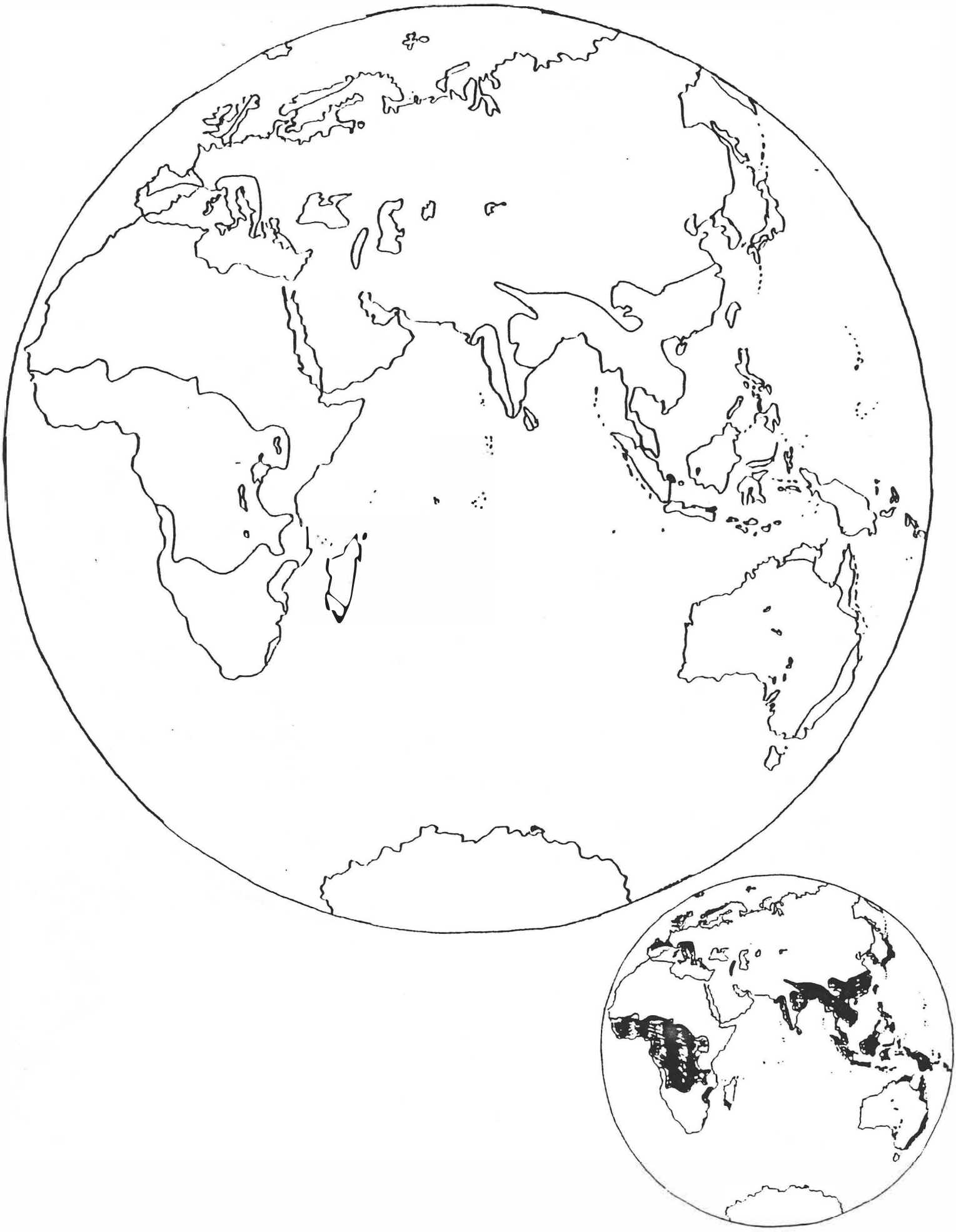
Cumulus clouds look flat on the bottom. The top is dome shaped. Showers are likely when the tops of these clouds dissipate.

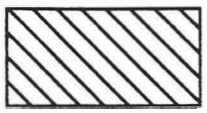
Stratocumulus clouds look like a curtain of rounded forms. These appear in winter. They may indicate dry weather.

The base of cumulonimbus clouds is less than a mile above Earth, but the top may be 10 miles high. These are called thunder clouds. Hail, heavy rain, strong wind, tornadoes, wind shear, lightning and thunder may result.

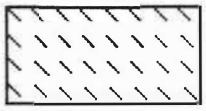
Stratus clouds look like a layer of fog.

Nimbostratus clouds are low and dark. They cover the entire sky and cause a steady rainfall.

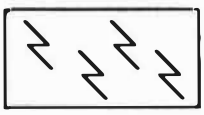




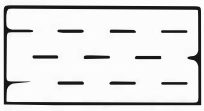
rain



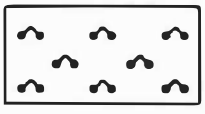
showers



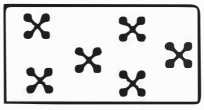
thunderstorms



ice



flurries



snow

cold front

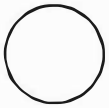
warm front

occluded front

stationary front

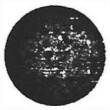
high pressure

low pressure



clear skies

partly cloudy



cloudy

wind direction

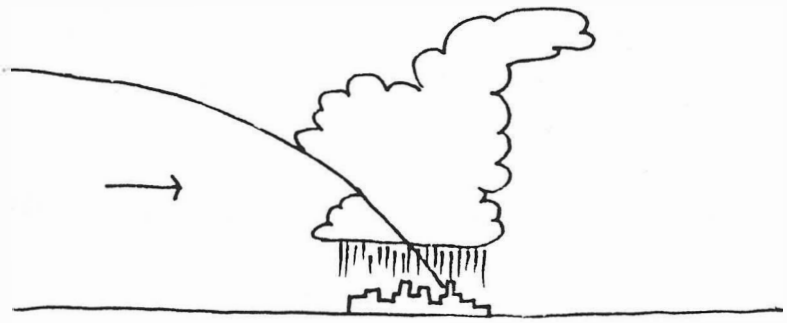
tropical storm

hurricane

49/32

high and low (˚F)
daily temperatures

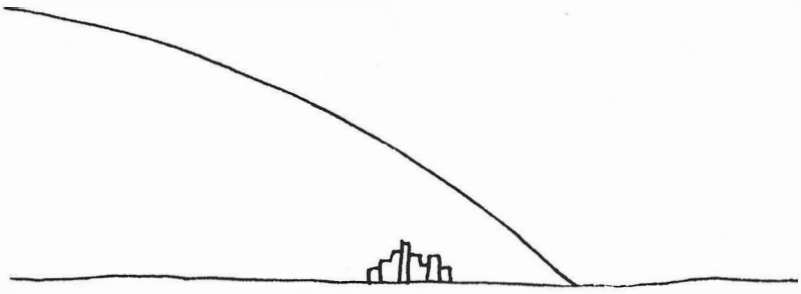
Weather Symbols

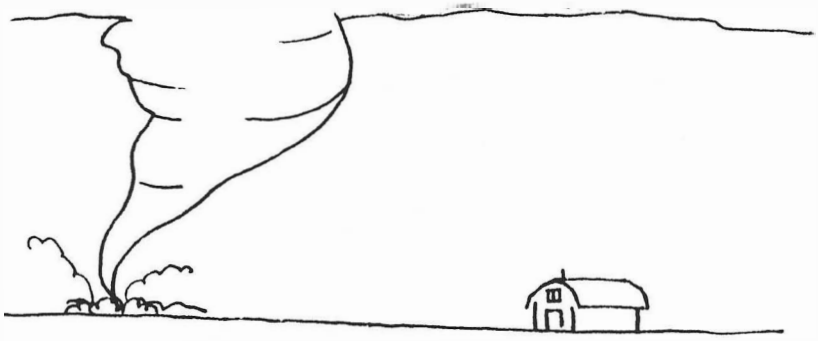


northern southern circulation

When a warm front is overtaken by a cold front, precipitation occurs.

the polar fronts



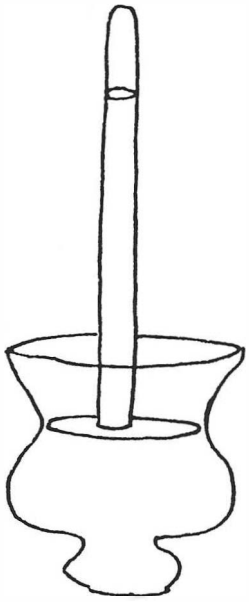


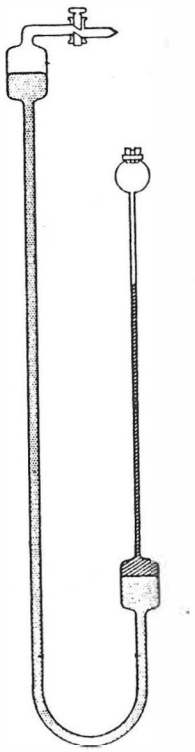
hurricane

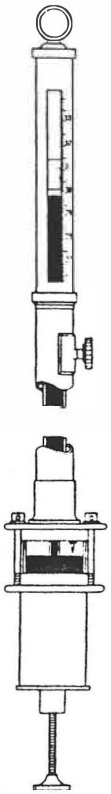
convergence zone

Frontal surfaces slope

tornado





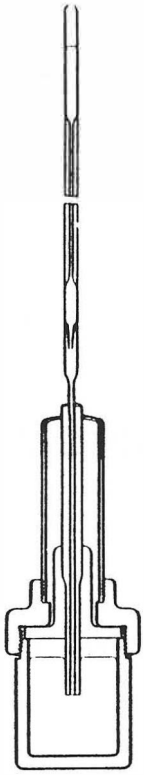


Torricelli

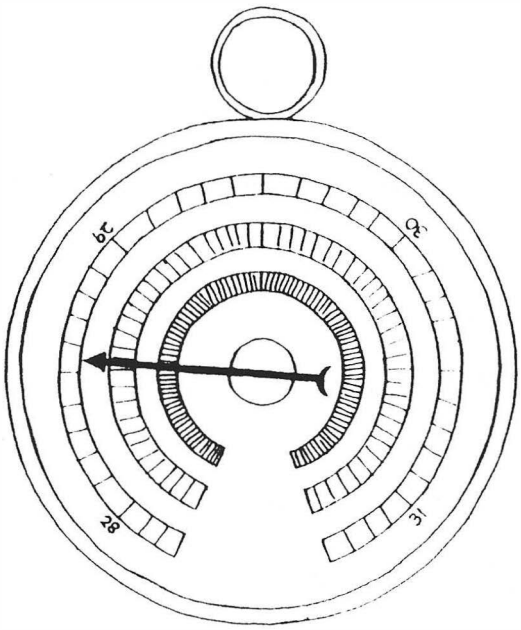
A siphon barometer

A two-liquid

Fortin



The Kew Pattern



aneroid

Weather

front
line where two masses of air contact each other

cold front
cold mass of high-pressure dry air, heavier than warm air, therefore moving under it

warm front
warm mass of low-pressure moist air, lighter than cold air, therefore rising above it

stationary front
east-west line which moves very slowly or not at all, with cold air at the north and warm air at the south of the line

occluded front
line where cold front overtakes a warm front

barometer
instrument for measuring pressure of the atmosphere

millibar
unit of measurement of barometric pressure

area of high pressure
place where barometric pressure is greater than the normal range of 31.1 to 27.3 inches of mercury at sea level

area of low pressure
place where barometric pressure is less than the normal range of 31.1 to 27.3 inches of mercury at sea level

storm
disturbance of normal weather conditions which may include strong winds, rain, snow, hail, sand, dust, thunder and lighting

cyclone
wind circulation which rotates counterclockwise in the northern hemisphere and clockwise in the southern hemisphere

tornado
cyclone with funnel-shaped cloud of violent wind rotating up to 300 miles per hour which moves forward at an average of 30 miles per hour over land

hurricane
cyclone originating over tropical oceans, having circular winds of 75 miles per hour and moving northwest or west at about 15 miles per hour

typhoon
hurricane occurring in the western Pacific Ocean

blizzard
severe snow storm with winds of 35 or more miles per hour lasting 3 hours or longer

severe thunderstorm
violent rainstorm with winds of 38 or more miles per hour and possibly hail 3/4 inch or more in diameter

hail
lumps or balls of ice formed on a snow pellet by contact with supercooled clouds and raindrops

watch
alert issued by the National Weather Service predicting possible severe weather

warning
alert issued by the National Weather Service when a tornado has been sighted or when a hurricane will strike land within 24 hours

Weather

front

cold front

warm front

stationary front

occluded front

barometer

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millibar

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Barometers

In 1643, Torricelli, an Italian, constructed a barometer with mercury, an open container and a glass tube. He predicted that the height of the column of mercury would be lower on a mountain because of less air to exert pressure. He had been Galileo's assistant.

About 1647, a Frenchman, Blaise Pascal, proved that Torricelli's ideas were correct. As a barometer was carried up the mountain, Puy de Dome, the height of the column of mercury decreased because of the lesser amount of air.

Jean Fortin developed a barometer early in the 19th century. It consisted of a leather bag of mercury which allowed the level of mercury to be adjusted to zero on a fixed scale. The inside diameter of the glass tube is not less than 1/4 inch.

A two-liquid, expanded scale barometer can detect very small changes in pressure, for example between the upper and lower floors of a building. Mercury and a lighter liquid are used.

The Kew Pattern barometer measures pressure by the level of mercury in glass tube connected to a cistern of mercury.

The aneroid barometer has a series of corrugated chambers with thin metal walls. All the air has been removed to produce a vacuum.

A siphon barometer consists of a U tube. The short arm is open to the atmosphere. The long arm is closed and has no air in the space above the mercury.

One side of the vacuum box is fastened to a base. The other side is connected to a pointer. When air pressure changes, the side of the vacuum box with the pointer moves.

The pointer changes position on the scale on which pressure can be read. This is also called a holosteric barometer, meaning that it contains no liquids.

Weather

Frontal surfaces slope due to the rotation of Earth. The angle of the slope is greater at higher altitudes.

After 1918, Norwegian meteorologists, V. Bjerknes and his son, J. Bjerknes, were the first to describe and name fronts.

The primary frontal systems are the polar fronts of the northern and southern hemispheres. These extend for thousands of miles.

The movement of cold, dry polar air masses originating at high latitudes and warm, moist tropical air masses originating at lower latitudes produce weather changes.

True fronts are rare near the equator. The general upward movement of air at the equator is known as the intertropical convergence zone.

The intensity of fronts increases near eastern coasts of continents.

When a warm front is overtaken by a cold front, precipitation occurs.

A cyclone is circulation of wind rotating counterclockwise in the northern hemisphere and clockwise in the southern hemisphere. Precipitation usually occurs.

A hurricane is a cyclone which originates over tropical oceans. Winds rotate in a circle or ellipse at 75 miles or more per hour. It can be 500 miles across. Hurricanes move west or north west at about 15 miles per hour.

Examples of cyclones are tornadoes, hurricanes and lows as shown on weather maps.. Size and intensity vary with each type of cyclone.

Direction and speed of a hurricane may change when the center reaches 25 to 30 degrees north latitude. In the western Pacific, these cyclones are called typhoons.

A tornado is a funnel-shaped column of air which comes down from a thundercloud. It rotates violently at speeds up to 300 miles per hour. This causes a roaring noise which sounds like a train.

A stationary front is represented by an east-west line which moves very slowly or not at all, with cold air at the north and warm air at the south of the line.

Where it touches the ground, great destruction occurs. A tornado moves forward at an average of 30 miles per hour.

An occluded front is the line where a cold front overtakes a warm front.

Areas of high pressure are associated with good weather. Areas of low pressure usually mean bad weather will be present.

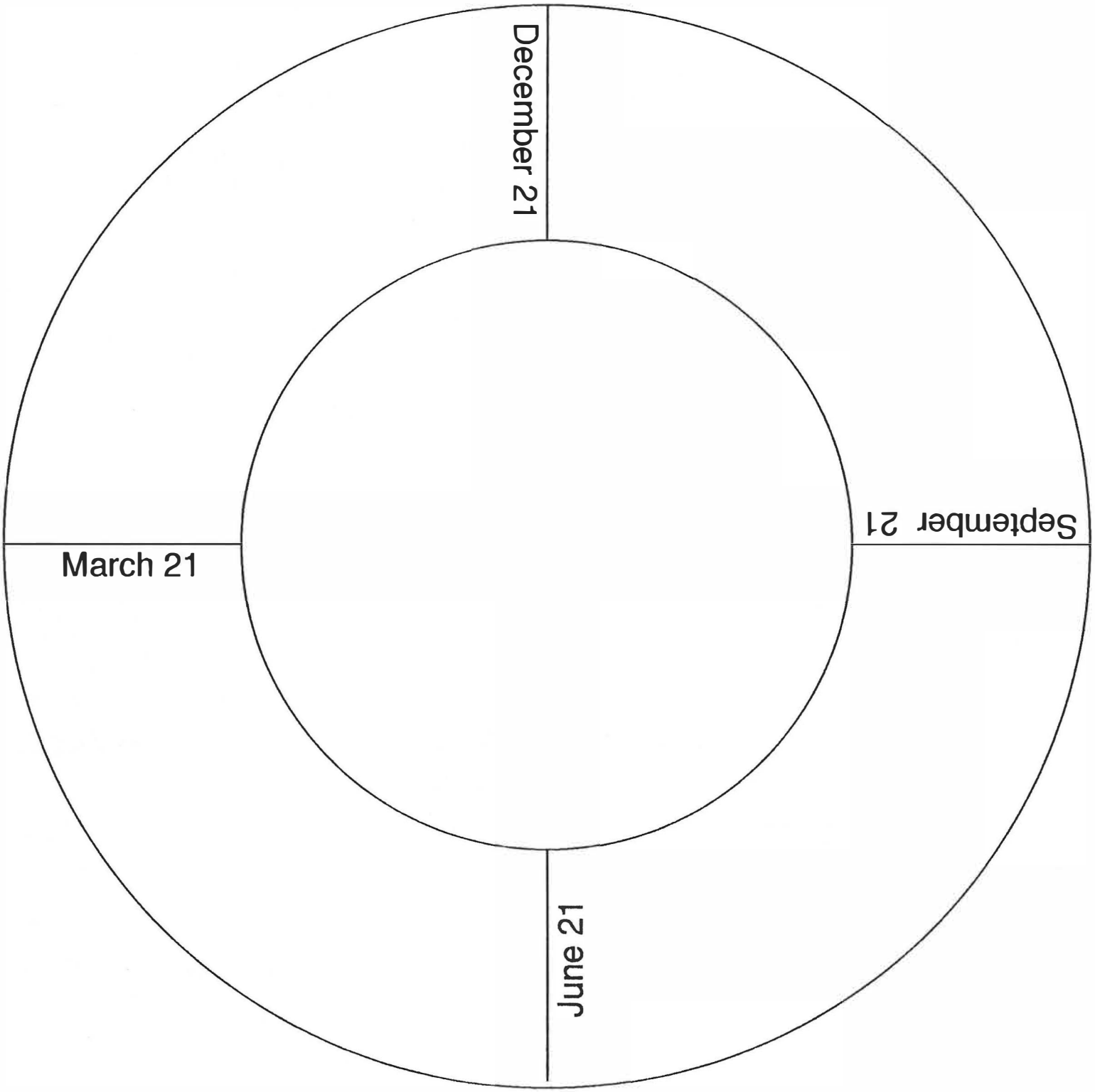
The National Weather Service issues a storm watch when severe weather is forecast. This gives people time to act by preparing their homes or by evacuating the area.

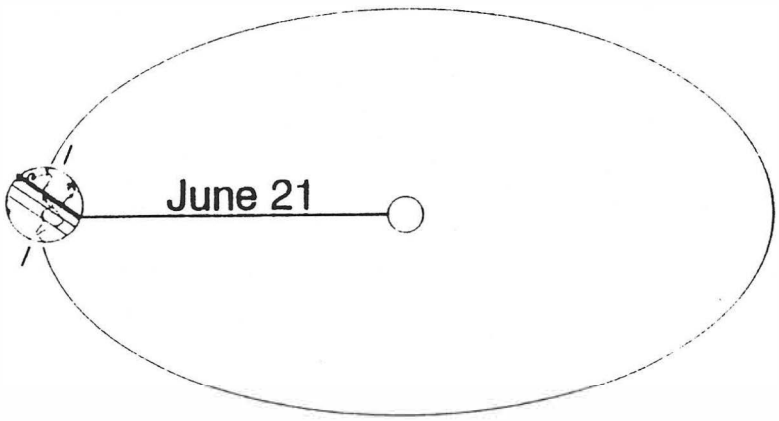
There are many kinds of storms. In dry places, sand and dust storms occur. Rain storms with thunder and lightning can be accompanied by hail. A blizzard is a storm with strong winds over 35 miles per hour and a great amount of snow.

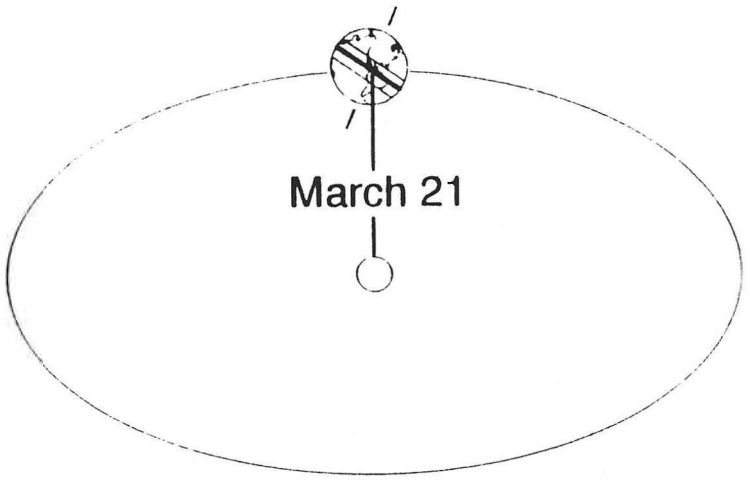
When a snow pellet comes into contact with raindrops and a supercooled cloud, hailstones form. Hailstones can be as large as baseballs, causing damage to crops. airplanes and cars.

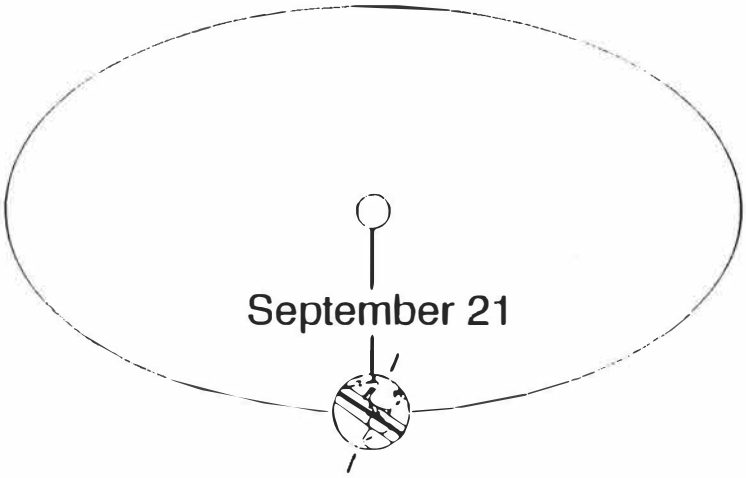
Hail usually occurs during summer at middle latitudes in a continent's interior.

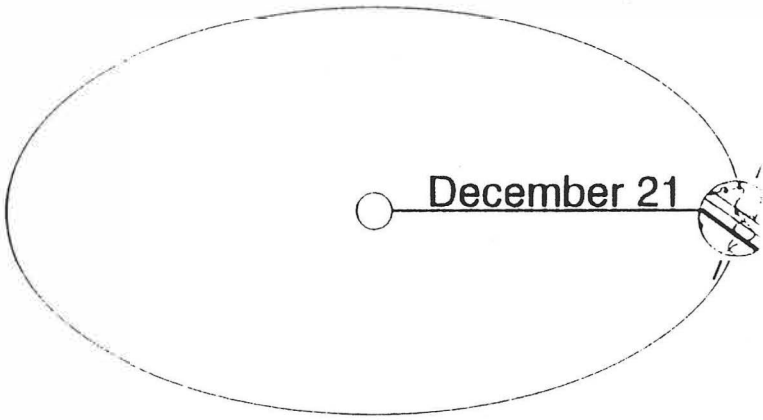
The National Weather Service issues a storm warning when the storm such as a tornado has been sighted. Immediate action must be taken for the sake of safety.











summer

spring

autumn

winter

The Seasons

winter
beginning December 21st, the coldest season of the year in the Northern Hemisphere but the warmest season of the year in the Southern Hemisphere

spring
beginning March 21st, the season of the year between winter and summer

summer
beginning June 21st, the warmest season of the year in the Northern Hemisphere but the coldest season of the year in the Southern Hemisphere

autumn
beginning September 23rd, the season of the year between summer and winter

axis
imaginary line through Earth around which it rotates

pole
invisible point where the axis of rotation cuts Earth's surface

inclination
tilt of Earth's axis from the perpendicular of its orbit

orbit
path of Earth as it revolves around the sun, requiring 365 days, 6 hours, 9 minutes and 9 1/2 seconds

perpendicular
meeting of lines or surfaces to form right angles

equinox
point at which the sun crosses the equator, resulting in equal length of day and night

solstice
point at which the sun is the maximum distance from the equator, resulting in unequal day and night

vernal equinox
March 21st, the day Earth's axis is perpendicular to its orbit, at right angles to the sun, resulting in equal length of day and night

summer solstice
June 21st, the day when there is maximum daylight and minimum night in the Northern Hemisphere

autumnal equinox
September 23rd, the day Earth's axis is perpendicular to its orbit, at right angles to the sun, resulting in equal length of day and night

winter solstice
December 21st, the day when there is minimum daylight and maximum night in the Northern Hemisphere

winter

spring

summer

autumn

axis

pole

inclination

orbit

perpendicular

equinox	beginning December 21st, the coldest season of the year in the Northern Hemisphere but the warmest season of the year in the Southern Hemisphere
solstice	
vernal equinox	beginning March 21st, the season of the year between winter and summer
summer solstice	
autumnal equinox	beginning September 23rd, the season of the year between summer and winter
winter solstice	beginning June 21st, the warmest season of the year in the Northern Hemisphere but the coldest season of the year in the Southern Hemisphere

imaginary line through Earth around which it rotates

meeting of lines or surfaces to form right angles

invisible point where the axis of rotation cuts Earth's surface

point at which the sun crosses the equator, resulting in equal length of day and night

tilt of Earth's axis from the perpendicular of its orbit

point at which the sun is the maximum distance from the equator, resulting in unequal day and night

path of Earth as it revolves around the sun, requiring 365 days, 6 hours, 9 minutes and 9 1/2 seconds

March 21st, the day Earth's axis is perpendicular to its orbit, at right angles to the sun, resulting in equal length of day and night

June 21st, the day when there is maximum daylight and minimum night in the Northern Hemisphere

The axis is an imaginary line around which Earth rotates. The poles are points where Earth's axis of rotation cuts the surface. Neither the North Pole nor the South Pole can be seen. They are just positions on the surface of Earth.

September 23rd, the day Earth's axis is perpendicular to its orbit, at right angles to the sun, resulting in equal length of day and night

The four seasons of the year are determined by the tilt of Earth's axis. This tilt is called inclination. Instead of being perpendicular to its orbit at all times, the axis is tilted 23 degrees 27 minutes away from a perpendicular to its orbit.

December 21st, the day when there is minimum daylight and maximum night in the Northern Hemisphere

Only on March 21st, the vernal equinox, and on September 23rd, the autumnal equinox, is the axis at right angles to the sun. Days and nights are almost equal on those days.

On December 21st, the winter solstice, and on June 21st, the summer solstice, the sun is at maximum distance from the equator. Days and nights are most unequal on those days.

When it is winter in the Northern Hemisphere, it is summer in the Southern Hemisphere. The seasons in the Southern Hemisphere are always the reverse of those in the Northern Hemisphere.

From mid-April to the end of August at the North Pole, the sun is continuously above the horizon and there is no night, During this time at the South Pole, there is only darkness and no daylight.

From mid-October to the end of February, it is always dark at the North Pole. At the South Pole during this same time, it is always light.

Climate

Earth's climate depends upon many conditions. The rotation of Earth affects wind circulation. The movement of wind through the atmosphere affects climate.

The distribution of land masses and bodies of water affects climate. Land is hot in summer and cold in winter in temperate zones. Water is cool during all seasons. These differences in temperature affect air circulation.

Mountain ranges change direction of air currents or cause new ones.

Ocean currents and their temperatures affect climate. The Gulf Stream is a movement of water from the Gulf of Mexico northeastward to the British Isles. The warmth from the Gulf Stream gives those islands a more moderate climate.

The Humboldt Current is a movement of water from Antarctica to the equator. It cools the west coast of South America and the islands of the Pacific Ocean that lie in its path.

The inclination of Earth's axis as it revolves around the sun determines the amount of solar energy received on our planet. The more vertical the sun's rays, the more heat reaches Earth.

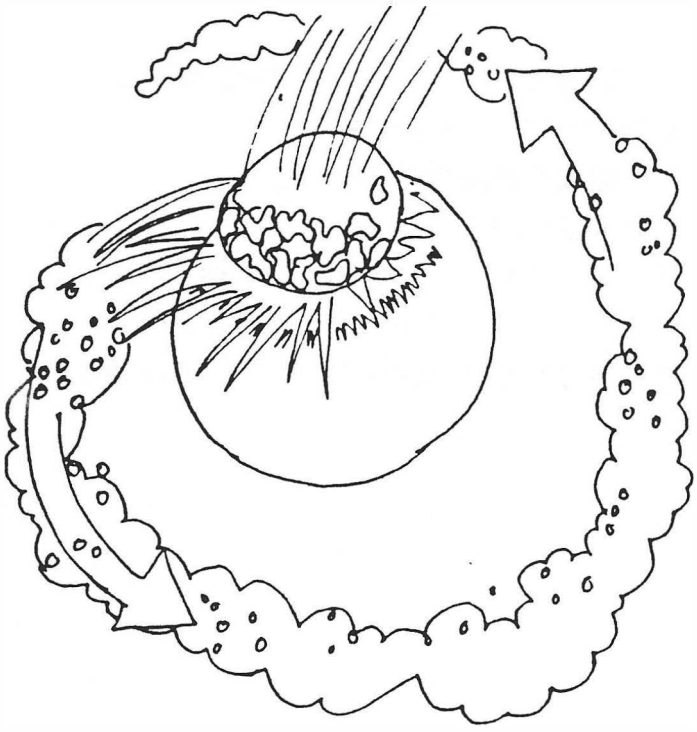
The greater the angle of the sun's rays, the less heat because the rays are spread over a wider area. They also lose energy in having to go a longer way through the atmosphere.

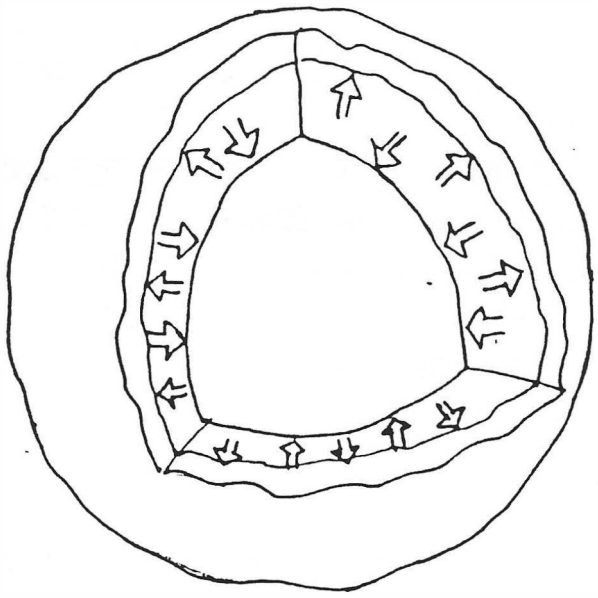
Altitude affects climate. Lower altitudes usually are warmer than higher altitudes. These are vertical variations in temperature.

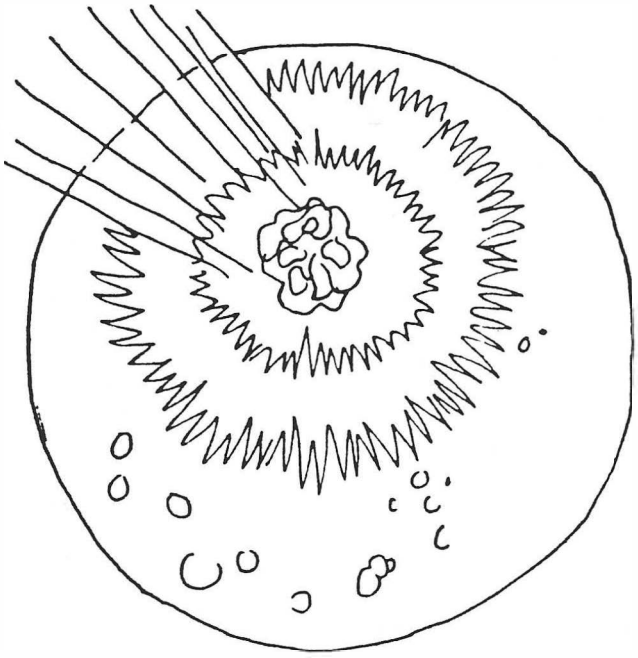
Latitude affects climate. At the equator the temperature is hot and air pressure is low. Going north or south from the equator, the temperature becomes cooler. At the poles the temperature is very cold.

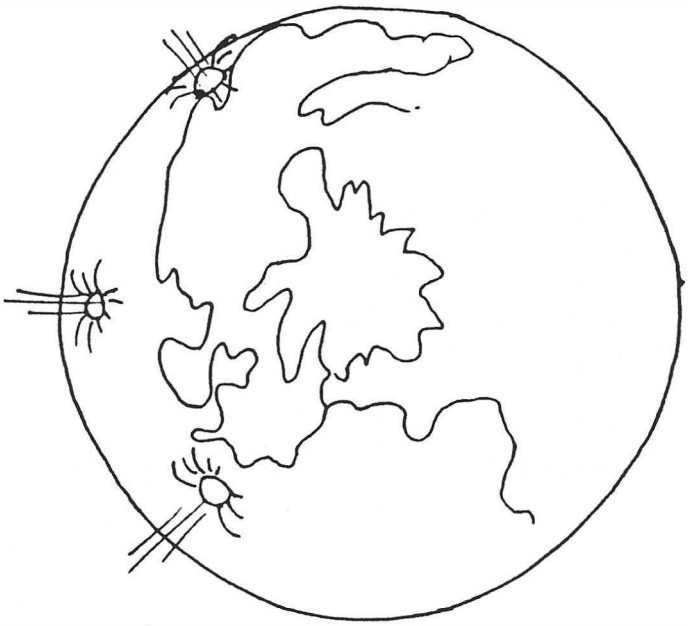
Climate changes over the centuries. During the Pleistocene Epoch, ice sheets covered 28% of the land. The climate was very cold.

Today only 10% of the land is covered with ice. Environmentalists are concerned that Earth's climate is getting warmer. This is due to the "greenhouse effect" caused by pollution of the air.









4.5 billion years ago object strikes Earth

lightweight rocks to surface heavy to lower layers

first 1/2 billion years

3.9 billion years ago

Earth's Moon

Earth's moon is its only natural satellite. All other satellites orbiting Earth were put there by humans for communications and weather forecasting purposes.

No one had ever been on the moon until July 20, 1969. Neil Armstrong and Buzz Aldrin left the *Eagle* and walked on the moon. They collected samples of rocks. Geologists have analyzed these rocks to learn how the moon was formed.

The study of the moon's geology, called selenology, began with Galileo. He invented the telescope in 1610. With it, he saw light-colored highlands with many craters. He also saw darker plains with fewer craters.

These darker plains he named "maria," Latin meaning seas. Just one "sea" is mare, the singular form of maria. These are not really seas for there is no water on the moon.

Humans have always been curious about the moon and how it was formed. A recent hypothesis states that a huge piece of material hit Earth. This piece of space material may have been a planet.

This planet could have been formed at the birth of our solar system. It was about half the size of Earth. This happened four and one half billion years ago.

The solar system was full of rocks and gases. There were no plants or animals on Earth at that time. The impact was so great that a tremendous cloud of vaporized rock was thrown into orbit around Earth.

This cloud formed a spherical moon when the rock particles gravitated together.

The moon's outer layer was magma. Heavy rocks settled into the interior. A small iron core formed. Lighter rocks rose to the surface to form the moon's crust.

The lunar highlands are composed of an igneous rock named anorthosite. It is light in color and in weight. It formed when magma covering the moon's surface cooled slowly.

Astrophysicists have determined the cause of craters on moon's surface. They were formed when meteorites or asteroids hit it.

The oldest parts of the moon's surface have the most craters. The maria, with fewer craters, are the youngest part. The near side of the moon, which we always see, has many maria. The far side, which cannot be seen from Earth, has almost no maria.

Some selenologists thought the maria looked like the Columbia Plateau in Oregon and Washington. That plateau is made of basalt.

The maria is made of basalt, too. It formed from lava flowing from the interior of the moon. This started about four billion years ago. By then, there were not as many large meteorites hitting moon's surface.

Small meteorites hit the moon continuously. The impact causes the basalt to be turned into a fine, dark gray powder with pieces of rock in it. The moon has no atmosphere to protect it from meteorites. Small meteorites burn when entering Earth's atmosphere.

Information about the moon has been gathered by analyzing rocks from its surface. Computer simulations can show how the moon was formed.

Spectrometers attached to telescopes can be used to analyze minerals in rocks on moon's surface.

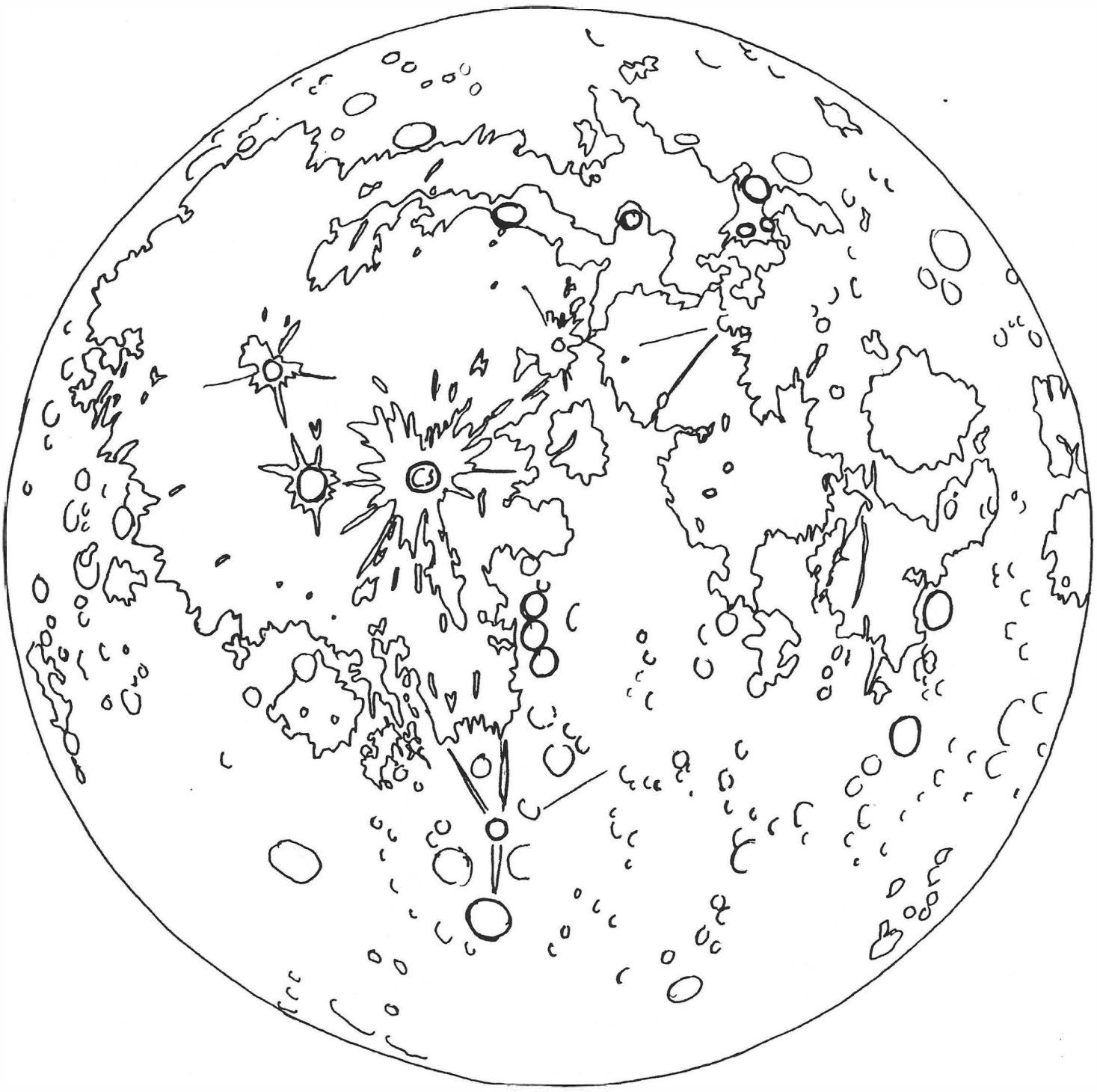
Spacecraft have photographed the far side of the moon. In spite of all this, scientists want more rocks from many different locations to be able to learn more about Earth's moon. Another moon mission is needed.

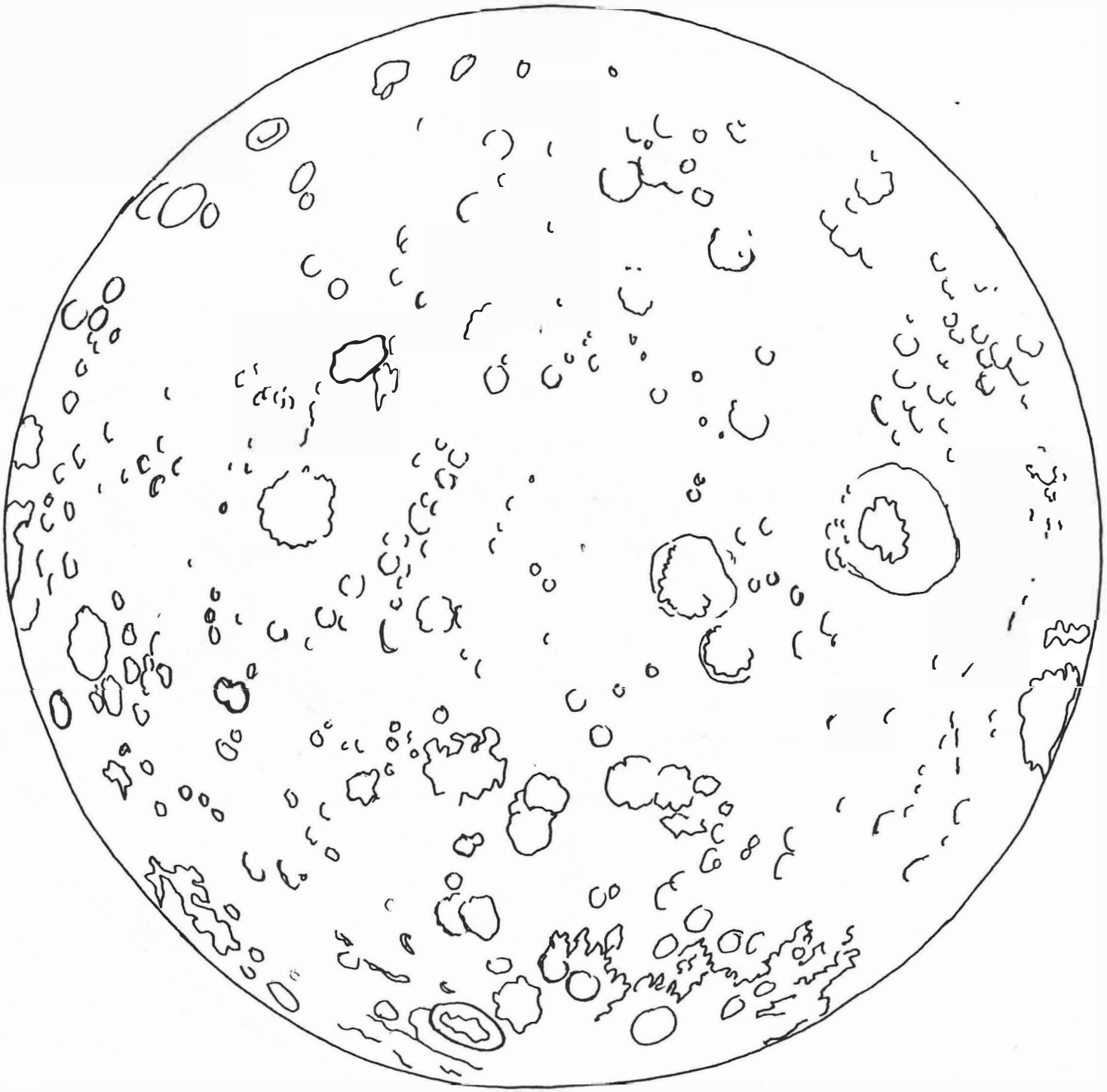
Because there is no air or water on the moon, no plants or animals can exist. When astronauts land on the moon, they must use special equipment to supply them with air to breathe.

The force of gravity of the moon is less than that of Earth. When astronauts are on the moon, they can jump higher and carry heavier objects than on Earth.

A map of the moon's near side, the only one that could be seen before space craft, was made in 1647 by Hevelius, a German astronomer. He gave names to certain regions. Some were geographical and some were from classical mythology.

Later an Italian astronomer, Riccioli, devised a system for astronomers and philosophers for naming features. The dark areas were named as oceans. Today famous scientists have been honored by having areas of the moon named for them.





Names of Lunar Areas

Near Side

Copernicus
Aristarchus
Kepler
Plato
Langrenus
Aristoleles
Endymion
Atlas
Hercules
Petaviuis
Tycho
Clavius
Ptolemaeus
Alphonsus
Arzachel

Mare Crisium Mare
Fecunditatis Mare
Tranquillitatis Mare
Frigoris Mare
Nubium Mare
Humorum Mare
Serenitatis

Far Side

Schrodinger
Hertzsprung
Korolev
Galois
Leibnitz
Mendeleev
von Karman
Tsiolkovsky
Keeler
Oppenheimer
Mach

Mare Orientale
Mare Moscoviense

Copernicus

Aristarchus

Kepler

Plato

Langrenus

Aristoleles

Endymion

Atlas

Hercules

Petavius

Tycho

Clavius

Ptolemaeus

Alphonsus

Arzachel

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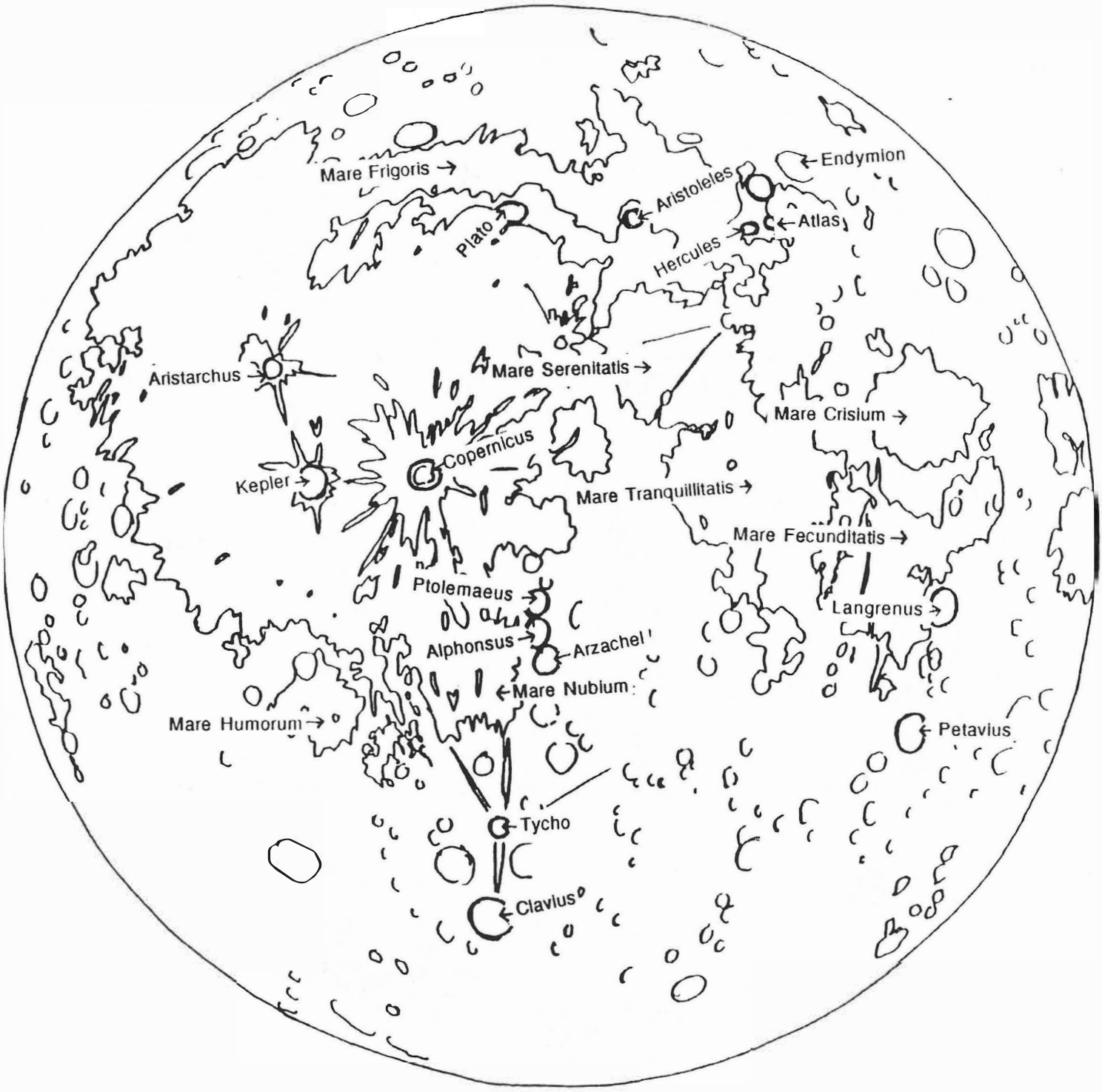

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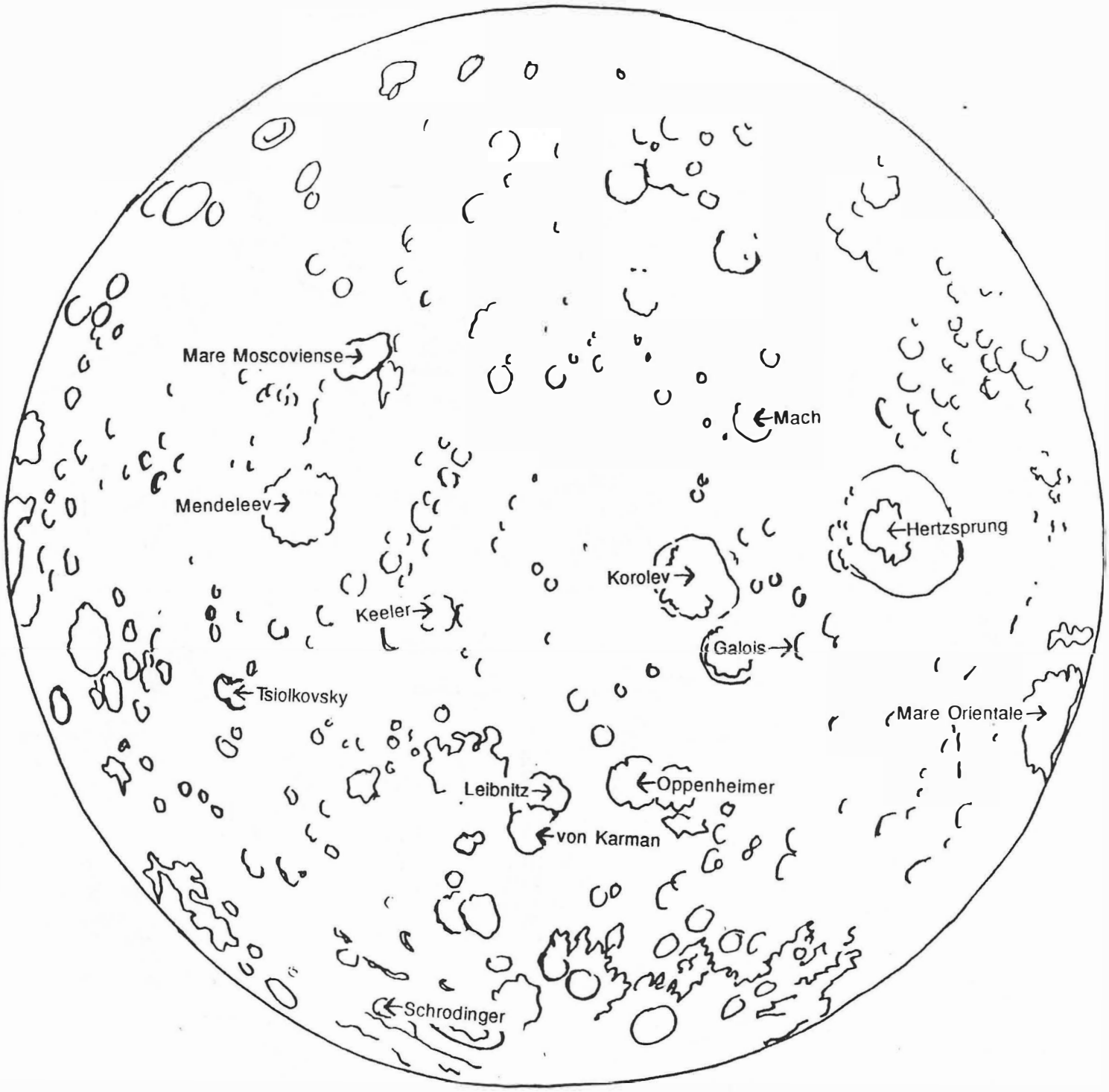
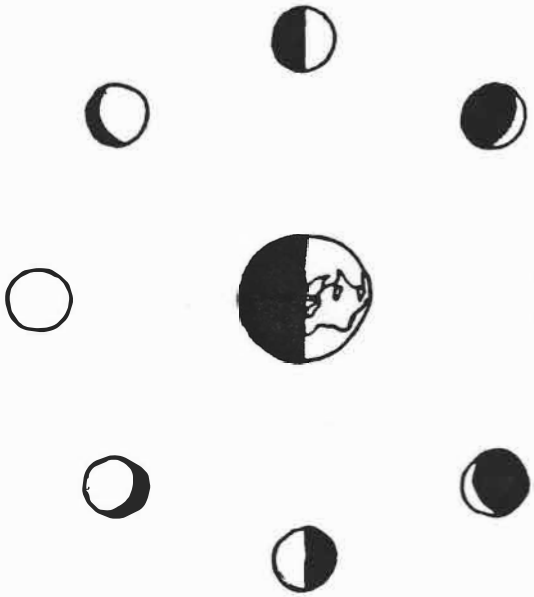


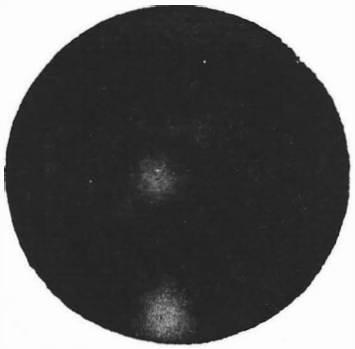
Far Side

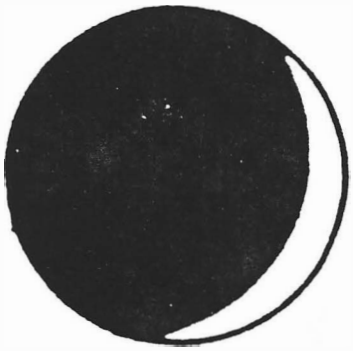


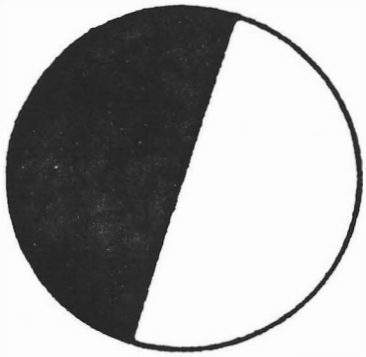
moon's orbit

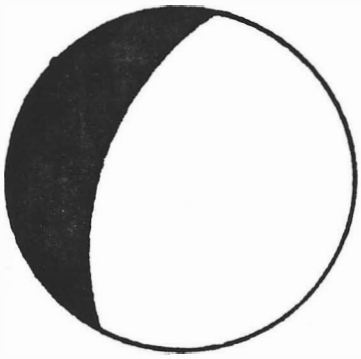
spring tides

neap tides







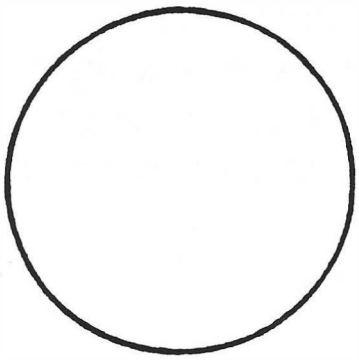


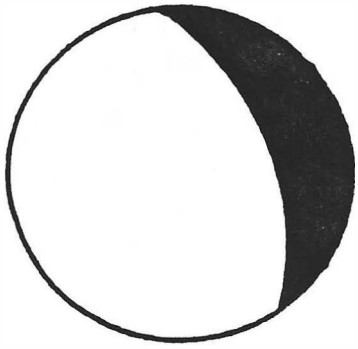
new moon

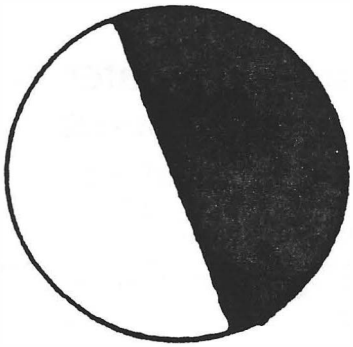
new crescent
or
waxing moon

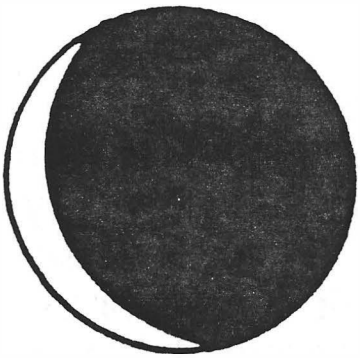
half moon
or
first quarter

new gibbous
or
waxing gibbous









full moon

half moon or third quarter

old gibbous or waning gibbous

old crescent or waning moon

Phases of the Moon

The sun is always shining on one half of the moon. On Earth, not all of the bright side of the moon can always be seen.

It appears as if the moon's shape changes, but it does not. Changes in the area of sunlight reflected from the moon are what we see. These are called phases of the moon.

It takes the moon 27 days, 7 hours 43 minutes to revolve completely around Earth. It takes the same amount of time for us to see all the different phases of the moon.

The phases of the moon start with the new moon. It appears that the moon is totally dark. We cannot see any light reflected. It is on the other side of the moon that the sun is shining.

About three nights after the new moon, the new crescent or waxing moon can be seen. There is a small arc of reflected light on the right side of the moon.

About four nights later, we can see half of the moon's reflected light. It is called the first quarter or half-moon. The reflected light is still on the right side.

About three nights after the half-moon, nearly 3/4 of the moon's reflected light can be seen on the right side of the moon.

Both margins appear convex. It is called new gibbous. Gibbous comes from the Latin word, gibbous, meaning humped.

About three nights after a full moon, nearly 3/4 of the moon's reflected light can be seen. Now the dark part of the moon is on the right. Both margins appear convex. It is called old gibbous.

About two weeks after the new moon, the entire area of the moon facing Earth reflects sunlight. This is the full moon.

About four nights later, we can see half of the moon's reflected light. It is called the third quarter or half-moon. The reflected light is now on the left side.

The full moon closest to the autumnal equinox is called the Harvest Moon. The moon rises soon after sunset. This gives farmers in the temperate zone extra hours of light. They have more time to harvest crops before frost and winter arrive.

About three nights after the third quarter moon, the old crescent or waning moon can be seen. There is a small arc of reflected light on the left side of the moon.

Hunter's Moon is the name given to the next full moon after the Harvest Moon. It does not give as many hours of light as the Harvest Moon.

The phases of the moon begin with a new moon, 27 days 7 hours 43 minutes after the previous one.

Earth's Moon and Tides

On the opposite side of Earth there is a tidal bulge called the **opposite tide.** The moon is pulling Earth away from the ocean on the opposite side. This causes a tidal bulge.

The moon has a gravitational force which affects the Earth. The side of Earth toward the moon is pulled in that direction. The solid part of Earth bulges only a few inches.

Because Earth rotates, there are two high tides each day as the tidal bulges pass by.

Oceans, the liquid part of Earth, make a tidal bulge in the direction of the moon. This is called the **direct tide.**

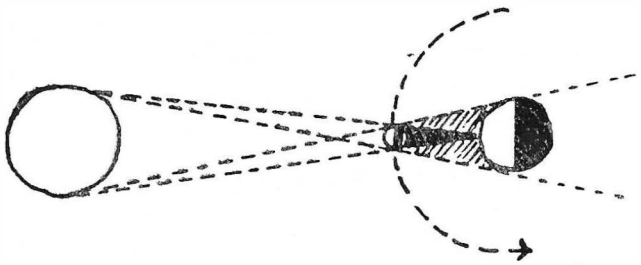
lides are also affected by the sun. The force is much weaker since the sun is a great distance form Earth. Twice each month, at new moon and full moon, the sun and moon are in line with each other.

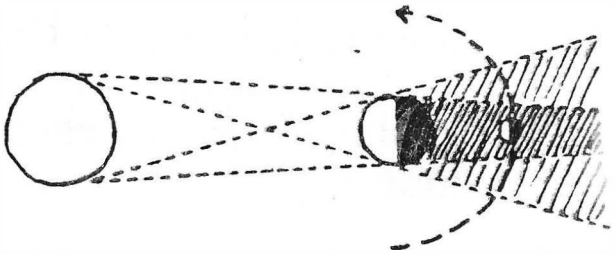
The tidal effect of the sun and moon when aligned causes higher than usual tides. These are known as **spring tides,** occurring at every new moon and full moon.

Tidal bulges of the sun and of the moon cancel each other **when** the **sun and** moon are at right angles to each other. Therefore, tides are lower at first and last quarter of the moon. These are called neap tides.

The distance from Earth changes as the moon revolves around it. When the moon is at perigee, the closest point to Earth at 30,000 miles, the rnoon's gravitational puU is greater. This causes higher tides.

If the moon is in its new or full phase at its closest distance or perigee to Earth, spring tides are much higher than usual. This does not happen very often. It can be predicted so that peopie living in coastal regions can prepare for floods.





solar eclipse

lunar eclipse

Eclipse

An eclipse occurs when light is blocked or when a shadow is cast by one object in space in relation to another object. Eclipses occur on Jupiter and with stars. On Earth, eclipses are seen relative to the moon and the sun.

A solar eclipse is caused by the moon passing between the sun and Earth. The sun appears to become dark.

A lunar eclipse is caused by Earth passing between the sun and the moon. The moon darkens as it passes into Earth's shadow.

During a total eclipse, the moon completely blocks the sun. The blue of the sky appears darker. The corona or outer atmosphere of the sun appears as a very bright halo.

Sometimes it is possible to see bright stars and planets during the total eclipse. An eclipse usually lasts about 2 1/2 minutes. It can last as long as 7 1/2 minutes. There is a path about 170 rniles wide in which a total eclipse can be seen.

Never look directly at the sun. Its radiation, even from the corona, can damage the eyes. Use a pin-hole projector or some other indirect means.

If the entire moon passes through Earth's shadow, there is a total lunar eclipse. This may last for 1 hour 40 minutes. The moon appears red, not totally dark. Light from the sun is bent around Earth by the atmosphere.

If only part of the moon passes through Earth's shadow, there is a partial lunar eclipse.

Almost everyone can see a lunar eclipse at night. No harm is done to the eyes when viewing a lunar eclipse.

