EARTH SCIENCE
LAB & REVIEW BOOK
PART 2

Name:_____ Date:_____

Weather
Topic 7 - Vocabulary

Air mass: _____

_____

Air pressure gradient: _____

_____

Anemometer: _____

_____

Atmospheric pressure (Air pressure): _____

_____

Atmospheric transparency: _____

_____

Barometer: _____

_____

Cloud cover: _____

_____

Cold front: _____

_____

Cyclone: _____

_____

Cyclonic storm: _____

_____

Name:_____ Date:_____

Dew point: _____

_____

Front: _____

_____

Humidity: _____

_____

Isobar: _____

_____

Jet stream: _____

_____

Monsoon: _____

_____

Occluded front: _____

_____

Planetary wind belt: _____

_____

Polar front: _____

_____

Precipitation: _____

_____

Probability: _____

_____

Name:_____ Date:_____

Psychrometer: _____

Relative humidity: _____

Stationary front: _____

Station model: _____

Troposphere: _____

Visibility: _____

Warm front: _____

Water vapor: _____

Weather variables: _____

Name _____

Earth Science

Air Masses

Air Masses →

Source Region →

	Symbol	Origin (Where it formed)	Description of Air Mass
Continental			
Maritime			
Tropical			
Polar			
Arctic			

Combinations of Air Masses

Symbol	Name of Air Mass	Description of Air Mass
cT		
mT		
cP		
mP		
cA		

Name _____ Date _____

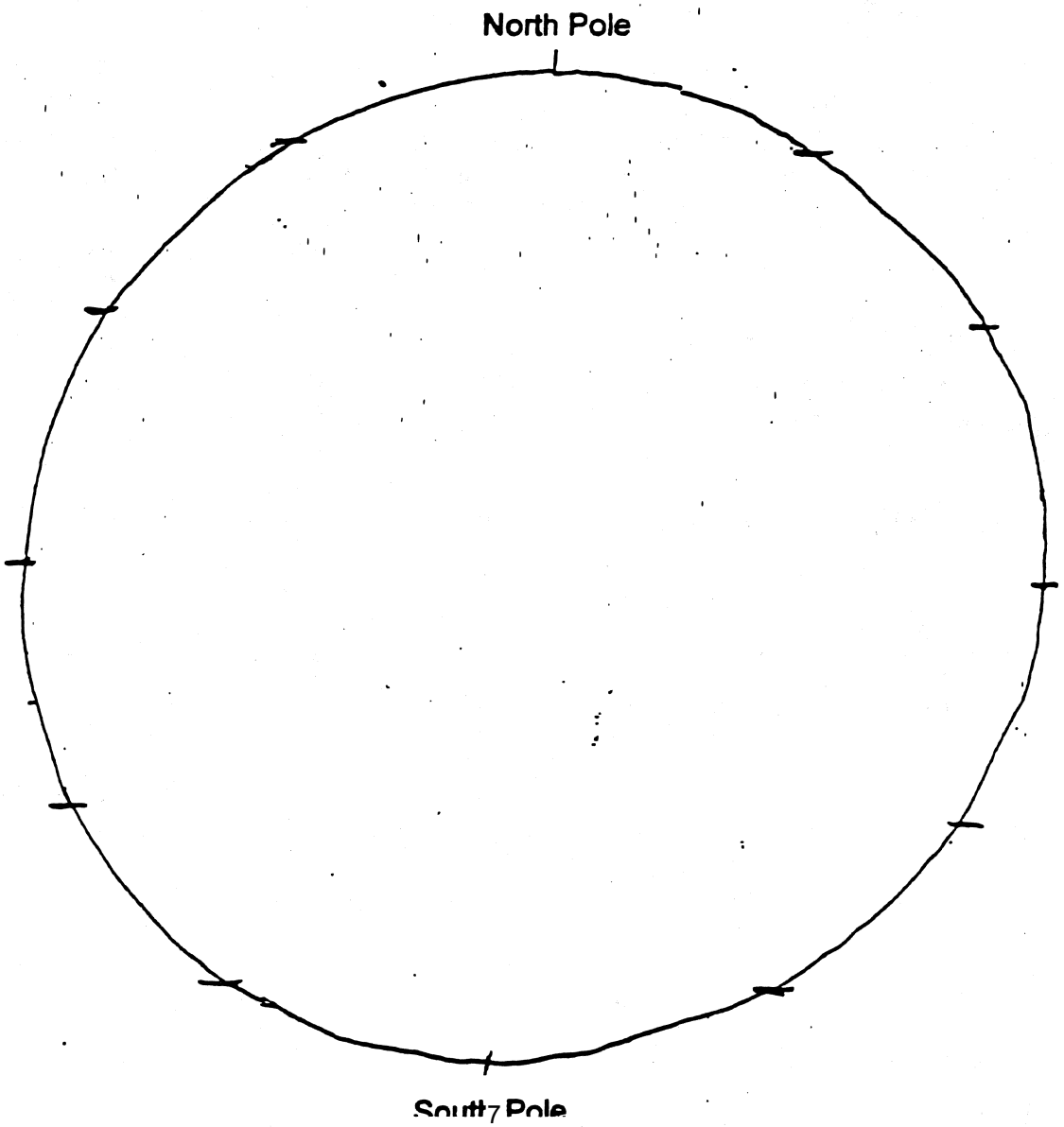
Lab: Planetary Winds

Purpose: To draw the Earth's Planetary Wind Belts by carefully following a set of directions.

Materials: Ruler
Colored Pencil
Earth Science Reference Tables

Directions:

1) On the circle below, connect the tick-marks on both the left and right sides of the "Earth" with a pencil and a ruler.



Name _____ Date _____

2) In the right margin of your paper label the lines with the following latitude numbers:

0, 30 N, 30 S, 60 N, 60 S, 90 N, 90 S

3) Write the word "LOW" directly on the line representing the equator. This identifies the equator as an area of warm low pressure.

4) Using the words "High" and "Low", continue identifying the rest of the latitude lines you drew on your circle. Alternate the words, beginning at the Equatorial Low, then working your way both North, then South, towards each pole.

5) Draw 3 arrows in each of the 6 sections on your globe. Make the arrows point from lines representing high {Cold} areas to low {Warm} areas.

6) Now, using a colored pencil, deflect each of the arrows to show how Earth's rotation would affect wind direction.

Remember: winds are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

(Hint: Look ***DOWN*** the arrow ***TOWARDS*** the point and *then* deflect it in the appropriate direction)

7) Using the names that appear below label each of the 6 sections containing deflected arrows to identify that region as one of Earth's "wind belts". Write the label within each different section on the circle.

- Remember: Winds are named according to the direction *FROM **WHICH*** they come.

  - **Polar easterlies** (Northern and Southern Hemispheres)
  - ***Northeast trade winds***
  - ***Southeast trade winds***
  - ***Prevailing (South) Westerlies***
  - ***Prevailing (North) Westerlies***

8) Use a colored pencil to indicate where the "mean position of Polar Jet stream" is for both the Northern and Southern Hemispheres.

9) On the right side of your globe, draw a convection current showing the pattern of air flow between the 30 N and 60 N latitudes.

Name _____ Date _____

QUESTIONS

Place your Answer to the following questions on the "Answer Sheet".

1) The deflection of wind, ocean water and objects flying through the air is known as the:

2) This deflection is caused by:

3) Tell what causes "winds"?

4) On a molecular level, explain why cold air is heavier, (more dense) and therefore, exerts more pressure than warm air.

5) Why then do winds blow from areas of cold, high pressure to areas of low, warm pressure?

6) Describe the air mass characteristics (temperature and humidity), for each of the following:

   a) The equatorial low (0^0):

   b) The 30 N & 30^0S subtropical highs:

   c) The 60^0N &6O S sub polar lows:

7) Why is air drier at the 30^0N & 30^0S and 90^0N & 90^0S latitudes, while it is wetter at the 60^0N & 60^0S and 0 latitudes?

8a) This drawing represents the location of wind belts at the time of the Equinoxes. What will happen to the positions of the Earth's wind belts during the Summer and winter seasons?

8b) Give a good reason why this will happen.

Name _____ Date _____

Answer Sheet

1. _____

2. _____

3. _____

4. _____

5. _____

6. a) _____ & _____

   b) _____ & _____

   c) _____ & _____

7. _____

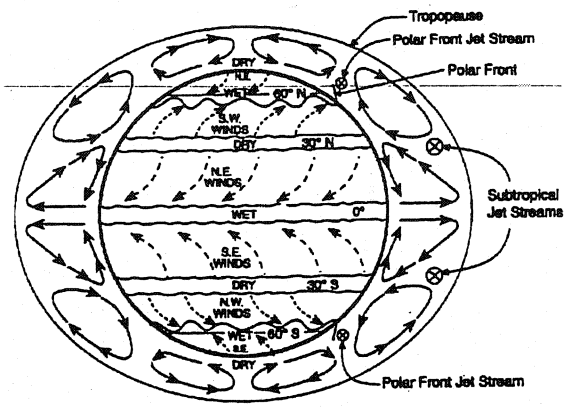
   _____

8. a. _____

   b. _____

Name:

Planetary Winds



Using the diagram above, your knowledge of Earth Science, and pages 113-115 in the review book answer the following questions:

1. Which method of energy transfer occurs in the atmosphere?

2. Describe how a convection current occurs?

3. Winds are caused by the uneven heating of the Earth's atmosphere. Explain why this causes winds to blow. (refer to temperature differences and pressure differences)

4. Winds blow from areas of _____ pressure to areas of _____pressure.

5. What causes the Coriolis effect and explain what it is.

6. In which direction will winds blowing North flow towards in the Northern Hemisphere?

7. Describe air movement in a High Pressure area.

8. What type of weather is associated with areas of High Pressure?

9. What type of pressure forms over the equator?

10. What type of pressure system forms over 30 degrees South latitude?

11. New York is located at approximately 42 degrees North Latitude. In which direction do the winds blow across New York State?

12. How is the air moving at the Poles? Is this air movement causing an area of high or low pressure?

13. This diagram represents the Earth on the equinox. How might this diagram change if it were drawn for June 21?

14. What effect does the planetary winds have on ocean currents?

Name _____ Date _____

Dew Point Lab

Objective:
In this lab you will determine the dew point temperature.

Materials:
sling psychrometer
Earth Science Reference Tables

Vocabulary:

Dew Point Temperature_____

Psychrometer_____

Wet bulb depression_____

Procedure:
1. Open up the Earth Science Reference Tables to page 12.

2. What is the wet bulb depression if the dry bulb temperature is 20°C and the wet bulb is 17°C?

3. What is the dew point temperature if the dry bulb is 15°C and the wet bulb depression is 5°C?

4. What is the dew point temperature if the dry bulb temperaure is 25°C and the wet bulb temperature is 20°C?

5. Fill in the table below given the following information:

	Location 1	Location 2	Location 3
Dry Bulb	24°C	4°C	25°C
Wet Bulb	12°C	-2°C	18°C
Wet bulb depression			
Dew Point Temperature			
Relative Humidity %			

Name _____ Date _____

6. Use the sling psychrometer to measure the wet and dry bulb temperatures. Record these temperatures in the table below. Complete the table by using the Earth Science Reference Tables.

Dry Bulb Temperature	
Wet Bulb Temperature	
Wet Bulb Depression	
Dew Point Temperature	
Relative Humidity %	

Analysis and Conclusion:
Answer all questions in complete sentences on the answer sheet.

1. What relationship would you expect to find between the air temperature and dew point temperature at ground level if the area is covered by fog?

2. What happens to the air temperature of descending air?

3. What happens to the dew point temperature of a descending mass of air?

4. Explain why a descending air mass would tend to become drier.

Name _____ Date _____

Answer sheet for Dew Point Lab

1. _____

2. _____

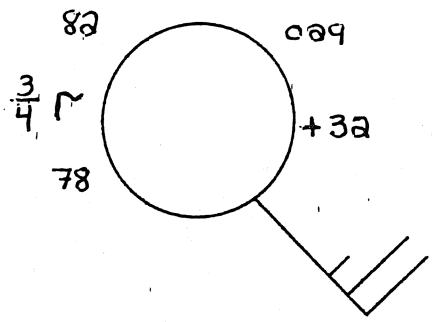
3. _____

4. _____

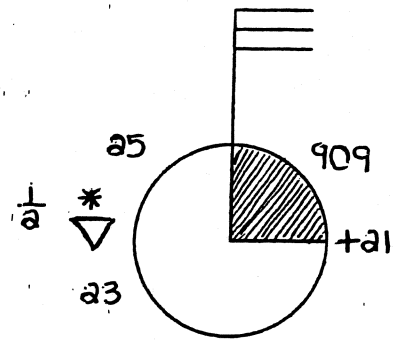
Name:_____ Date:_____

Station Models

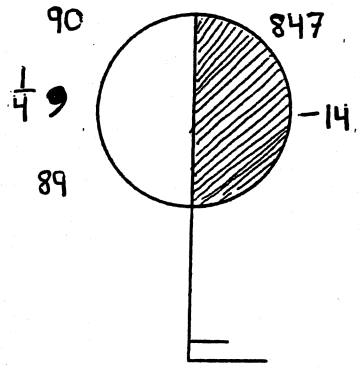
Station A



Station B



Station C



Station	A	B	C
Temperature			
Present Weather			
Visibility			
Dew Point			
Wind Direction			
Air Pressure			
Barometric Trend			
Cloud Cover			
Pressure 3 hrs. ago			

Name:

Using your Earth Science Reference Table - Weather

Use the reference table to make the following temperature conversions

Fahrenheit		68			-5
Celsius	0			30	
Kelvin			373		

At what temperature will water freeze in degrees Celsius?

At what temperature will water boil in degrees Fahrenheit?

Use the reference table to make the following pressure conversions

Inches	Millibars	Station Model Code
30.00		
	984.0	
		000
		806

Draw the symbol for thunderstorms.

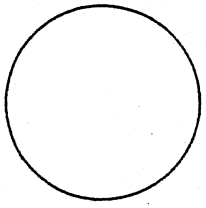
Draw the symbol for a Hurricane.

Draw the symbol for an occluded front.

What does mP stand for?

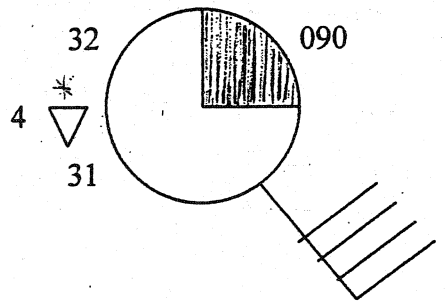
Place the following information on the station model below

Temperature	89 F
Dewpoint	88 F
Cloud Cover	75%
Wind Direction	NE
Wind Speed	30 knots
Air Pressure	990.8 mb
Present Weather	Haze
Visibility	1 mile



Determine the following information from the station model

Temperature	
Dewpoint	
Cloud Cover	
Wind Direction	
Wind Speed	
Air Pressure	
Present Weather	
Visibility	



Use the Reference table to complete the following chart

Dry Bulb (°C)	Wet Bulb (°C)	Difference	DewPoint (°C)	Relative Humidity %
4	1			
28		8		
		10	14	
20				58
2	-2			

As altitude above sea level increase in the troposphere what happens to temperature?

As altitude increases what happens to air pressure?

As altitude increase what happens to the amount of water vapor?

In which layer of the atmosphere is the ozone layer located?

How many miles above sea level is the Stratopause?

Name:_____ Date:_____

Lab: Weather Variables

Background Information

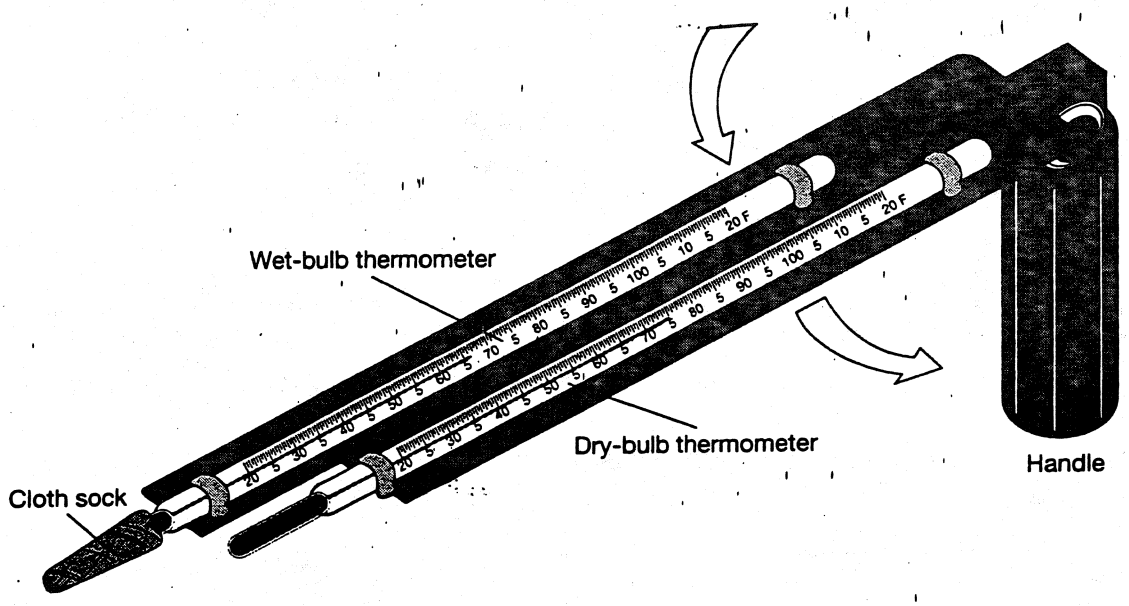
The term weather is generally interpreted as the state of the atmosphere and its effects on human activity. Our ability to measure the various weather elements has improved considerably since the invention of the thermometer, around 1600, followed by the barometer in 1643. Other weather variables studied by meteorologists include humidity, precipitation, wind, and cloud cover. Meteorologists analyze these weather variables in order to make forecasts. For weather studies, an understanding of the following weather variables is necessary:

- Air temperature is a measure of the heat energy of the atmosphere, measured in degrees Celsius or Fahrenheit.
- Air pressure is the weight of overlying air and is measured in inches of mercury or millibars (mb).
- Humidity is the measure of the amount of water vapor in the air. Relative humidity is a measure of the amount of water vapor the air is holding compared with the amount it could hold at that temperature.
- The Dew point is the temperature at which condensation will take place, or when the air is saturated.
- Wind is the motion of air past a given point. It is measured in terms of speed and direction. A wind is named for the direction from which it is coming. A west wind is blowing from the west toward the east. Wind speed is measured in knots or miles per hour.

Procedure

1. Figure 1 shows the basic design of a sling psychrometer. The instrument consists of two thermometers, one of which has cloth sock on the bulb. This is known as the wet-bulb side. The other thermometer has no cloth sock and is known as the dry bulb side. The dry bulb temperature is equivalent to the existing air temperature. The cloth sock is wet, and the psychrometer is swung until the wet bulb temperature stops dropping. If the surrounding air is saturated, no evaporation will take place from the wet bulb. Since evaporation is a cooling process, the greater the evaporation from the wet bulb, the greater the temperature difference between the wet- and dry-bulb temperatures, which is known as the wet bulb depression. Generally, the greater the wet-bulb depressions, the lower the relative humidity. The dew point is a direct measure of water vapor pressure, or the contribution that water vapor makes to the total atmospheric pressure.

Name:_____ Date:_____



2. Using the sling psychrometer shown in Figure 1, record the following temperatures:

Dry-bulb temperature _____ °F _____ °C

Wet-bulb temperature _____ °F _____ °C

Subtract the wet-bulb temperature from the dry-bulb temperature. This value is the wet-bulb depression. Record this value in the space provided.

Wet-bulb depressions _____ °C

3. Calculate the dew point temperature, or saturation point, using the dew-point temperature chart provided in the *Earth Science Reference Tables.*

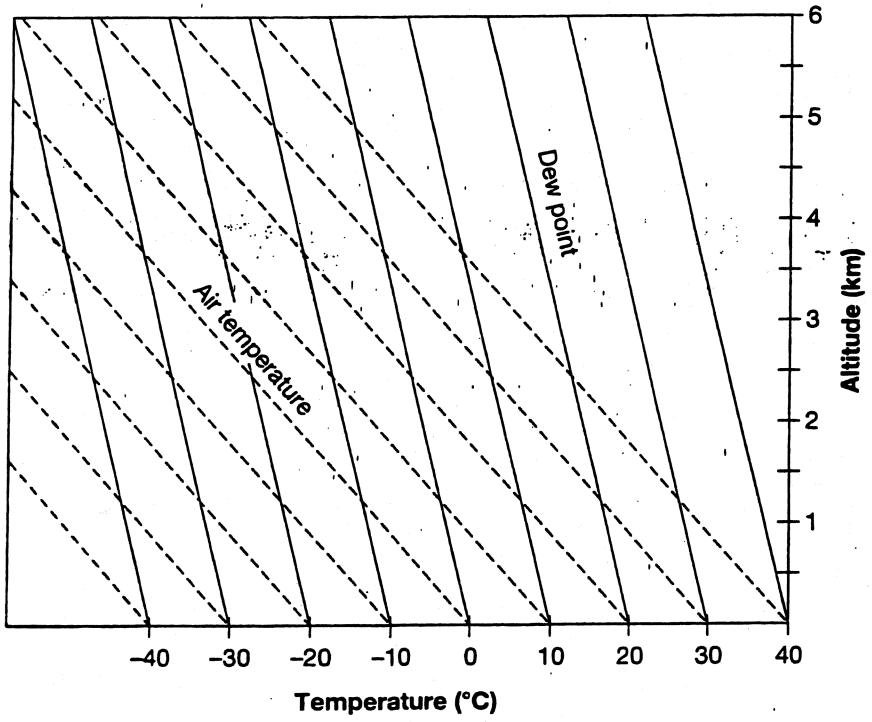
Dew-point temperature _____ °C

4. Calculate the relative humidity using the chart provided in the *Earth Science Reference Tables.* Note that relative humidity is expressed as a percent.

Relative Humidity _____ %

Name:_____ Date:_____

5. Clouds are major atmospheric features that are a direct result of the dew-point temperature being reached. As air rises it expands. This expansion causes air to cool and is referred to as an adiabatic temperature change. In the reverse of this process, air that sinks is compressed and warms. These temperature changes occur independently of external heat loss or gain. Other factors, such as the presence of condensation nuclei, or particles that allow water vapor molecules to collect or coalesce, aid in cloud formation. These nuclei are often particles of sea salt, soil, aerosols, or volcanic ash.
Figure 2 shows how dew point and air temperature change with an increase in altitude. For example, if the surface temperature is 20°C and the dew point is -10°C, at what altitude would clouds begin to form? Find 20°C on the horizontal axis of the graph and follow the dashed line for air temperature until it intersects with the solid line for dew point which is -10°C. Read from the intersection point across to the vertical axis to find the cloud base height, or altitude where the clouds would begin to form, 3.6 km.



Use this method to calculate cloud base heights for dry-bulb, or air temperature, and dew-point temperature from procedure 2 and 3. Record the data in the spaces provided.

Surface air temperature (dry bulb) _____°C

Surface dew point _____°C

Calculated cloud base height _____km

Name _____ Date _____

LAB – Weather Patterns

INTRODUCTION: A basic principle in the earth sciences is that energy is constantly bringing about changes, In order to understand the changing earth, we must understand the energy systems at play within the environment which cause those changes.

The study of energy interactions within the atmosphere leads to the identification of systems that can be mapped as field quantities. A series of composite maps showing these atmospheric variables provides a picture of past and present conditions. Such a composite map is called a "synoptic" map. Weather forecasting is based on a series of synoptic maps.

OBJECTIVE: You will construct field maps and learn to identify patterns that can be used to predict weather.

VOCABULARY:

Isotherm:

Air pressure:

Barometer:

Isobar:

Convergence:

Divergence:

Cyclonic system:

Name _____ Date _____

PROCEDURE A:

1. On Map A use a pencil to lightly draw isotherms at 10 degree intervals.
2. Check carefully to be sure that the isotherms are correct, then darken them.

DISCUSSION QUESTIONS: (Answer in complete sentences)

1. How does the temperature change from north to south on this map?

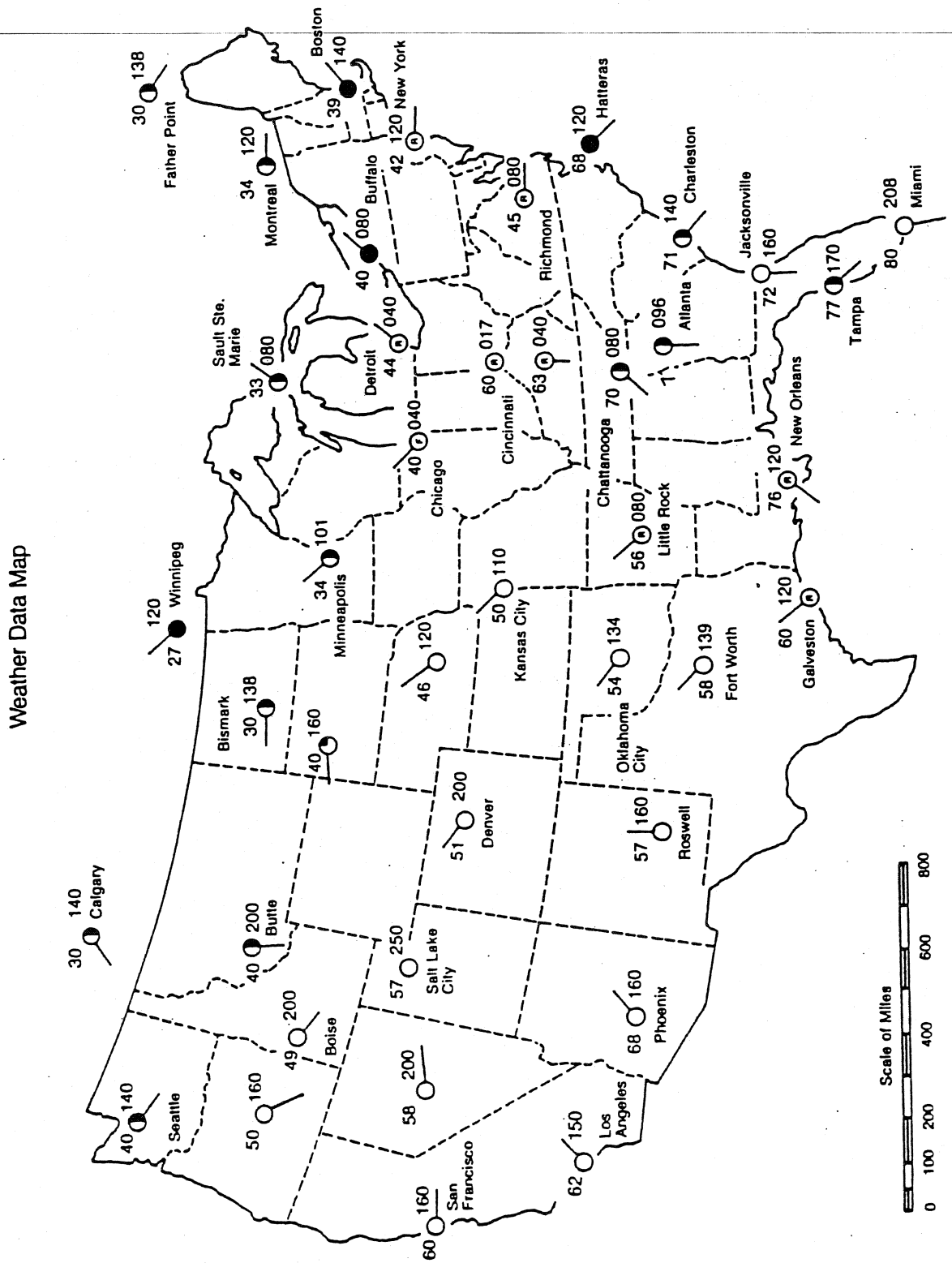
2. Near which cities is the temperature gradient the greatest? Explain.

3. Write the equation for gradient.

4. Calculate the temperature gradient between Galveston and Kansas City. SHOW ALL WORK AND LABEL UNITS PROPERLY.

5. Calculate the temperature gradient between Cincinnati and Chicago. SHOW ALL WORK AND LABEL UNITS PROPERLY.

MAP A: TEMPERATURE PATTERNS



Name _____ Date _____

Procedure B:
1. On Map B use a pencil to draw isobars between points of equal atmospheric pressure. Use a
4-millibar interval. Start counting at 1000.0 millibars. (000).

2. Label the center of high and low pressure areas using a capital H and L.

Answer the following in complete sentences:
1) What is the general appearance of the isobars on this map?

2) Which city is the low pressure center near? _____

3) Which city is the high pressure center near? _____

4) What is the highest air pressure on this map? _____

5) What is the highest value for an isobar on this map? _____

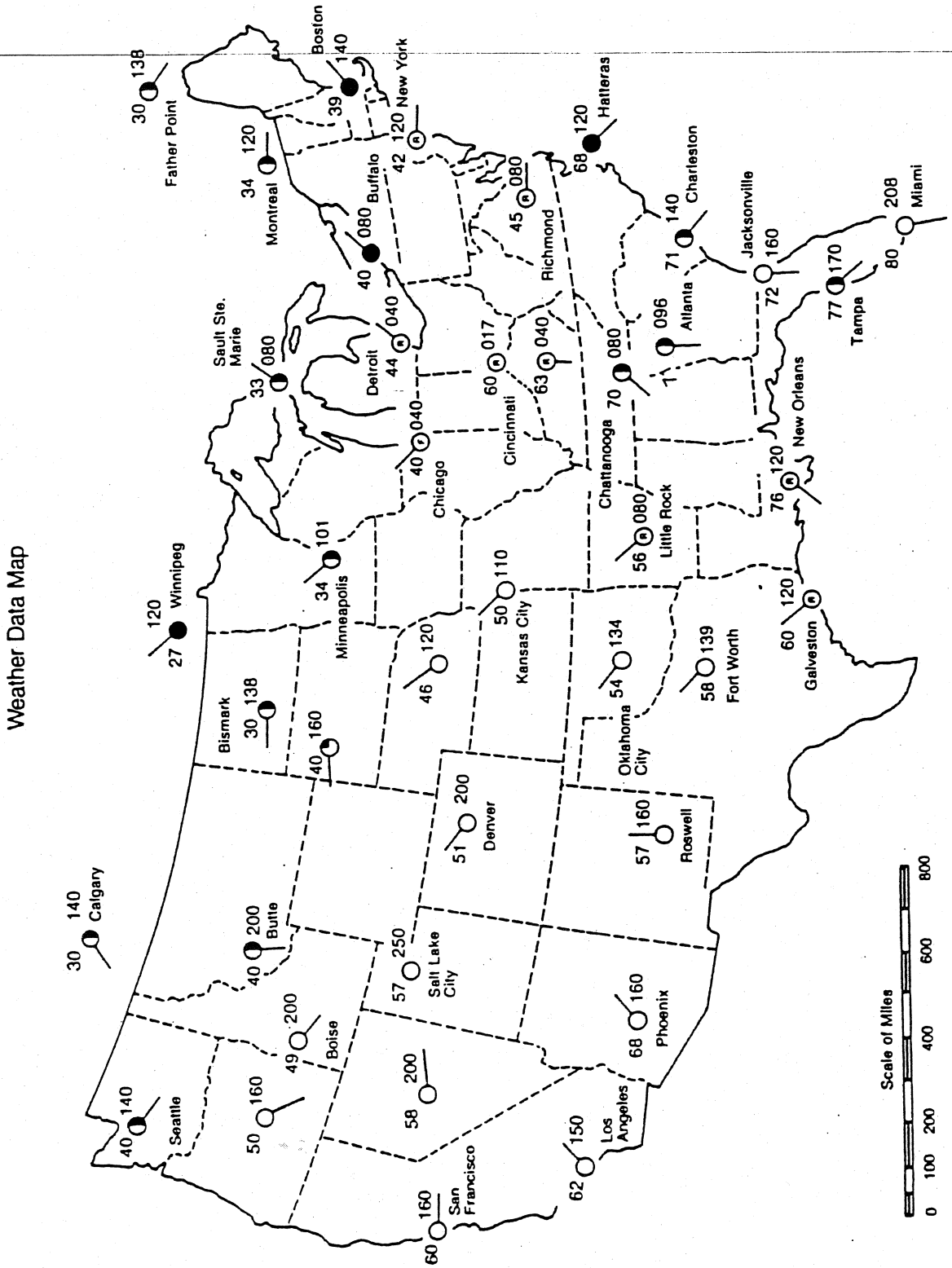
6) As you travel from Salt Lake City to Los Angeles, what change in atmospheric pressure would you observe?

7) Calculate the pressure gradient between Little Rock and Galverson. Show all work and label your answer with the proper units.

8) Describe the general weather conditions associated with high pressure areas in terms of temperature and precipitation.

9) Describe the general weather conditions associated with a low pressure center in terms of temperature and precipitation.

MAP B: BAROMETRIC PRESSURE PATTERNS



Name _____ Date _____

Procedure C: Look back at Map B. The map uses the symbol of an "R" inside the station circle to indicate rain.

1. On this map label the areas of continental polar and maritime tropical air masses using the appropriate symbols.

2. Draw a line around the area on this map where there is precipitation and lightly shade the area where precipitation occurs.

3. Draw in cold and warm fronts with the proper symbols.

Answer the following in complete sentences:

1) Where is precipitation occurring relative to the continental polar and maritime tropical air masses?

2) With respect to the cold front, where does precipitation occur?

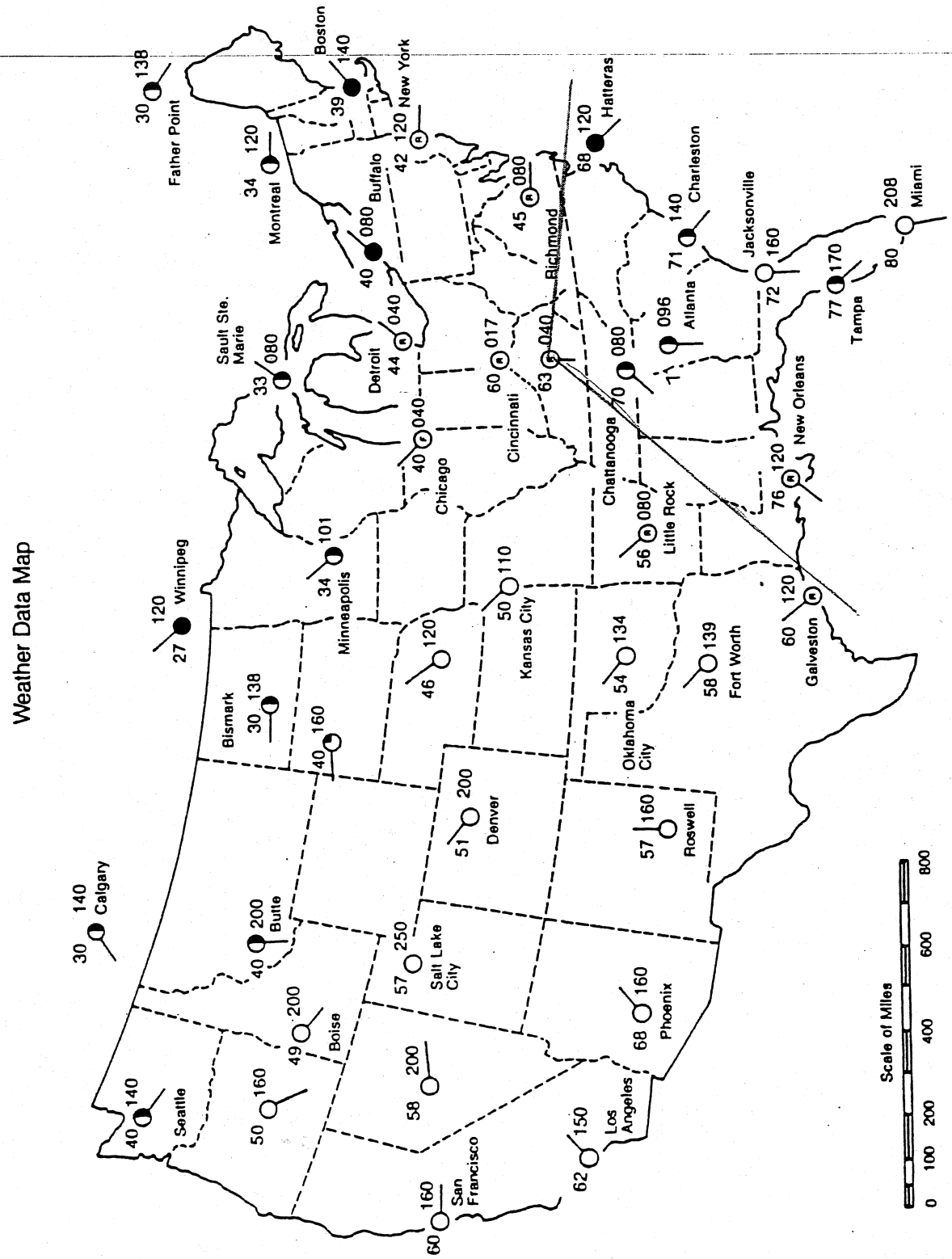
3) With respect to the warm front, where does precipitation occur?

4) Compare the following conditions on either side of the cold front:

A) Temperature:

B) Air Pressure:

Map C: Weather Patterns



Meteorology

CYCLONIC WEATHER SYSTEMS

INTRODUCTION: The United States Weather Service is a division of the National Oceanic and Atmospheric Administration (NOAA). Data is received from about 600 stations in the United States, as well as from foreign countries and from ships at sea. This information is transmitted to centers every three hours, beginning at 1 A.M. The centers then plot the information on synoptic maps which are used to predict any weather changes.

Various hazardous weather conditions are threats to different geographic areas of the United States. The National Severe Storm Forecast Center in Kansas City, Missouri studies and monitors tornadoes while hurricanes are watched by the National Hurricane Center in Miami, Florida. In addition to using traditional synoptic maps to forecast these violent weather conditions, these centers also employ technologies such as GOES Next satellites and Nexrad doppler radar.

OBJECTIVE: Using a series of synoptic weather maps you will determine the track of a weather system and make a 24 hour prediction for a given location. You will use storm tracks of a hurricane and a tornado to compare the characteristics of these severe storms.

VOCABULARY:

prevailing westerlies:

trade winds:

jet stream:

storm track:

storm surge:

hurricane:

tornado:

Saffire/Simpson Scale:

Fujita Scale:

PROCEDURE A: SYNOPTIC MAP STORM TRACK

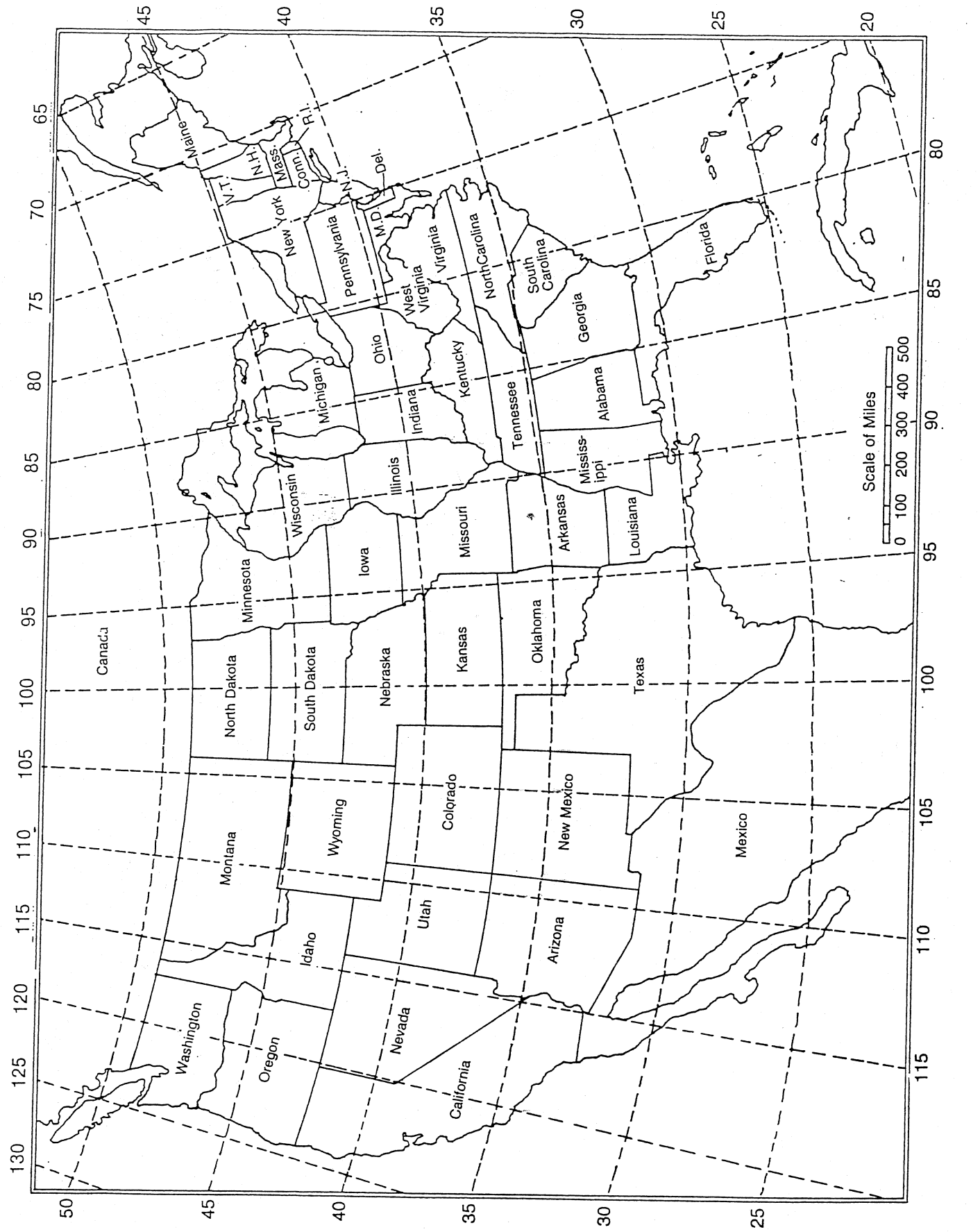
1. Examine the sequence of synoptic weather maps provided by your instructor.
2. On MAP A: STORM TRACKS, plot an "L" in the location of the low pressure center for the first map of the sequence. Label its date.
3. Repeat Procedure 2 for each of the other maps provided.
4. Using the scale at the bottom of MAP A, calculate the average velocity of the low pressure center in miles per day. SHOW ALL WORK AND LABEL PROPERLY.

   CALCULATIONS: _____

5. Using the scale at the bottom of MAP A, calculate the average velocity of the low pressure center in miles per hour. SHOW ALL WORK AND LABEL PROPERLY.

   CALCULATIONS: _____

MAP A: STORM TRACKS



6. Predict the location of the low pressure center on the day following the date of the last map of the series. Plot this in red on MAP A.

PROCEDURE B: HURRICANE ANDREW

1. Using the HURRICANE ANDREW DATA CHART plot the positions of the tropical cyclone from August 20th through August 27th on MAP B.
2. For each position label the date and time.
3. Using the wind information in the DATA CHART and the Saffir/Simpson Hurricane Scale, determine the tropical cyclone's category for each position. Label each position using the following abbreviations: TD = Tropical Depression; TS = Tropical Storm; H-I = Category I; H-II = Category II; H-III = Category III; H-IV = Category IV.
4. Connect each position with a solid line.
5. Draw an arrow along the solid line showing the cyclone's direction of movement.
6. Referring to the Planetary Wind diagram in the Appendix:
   a) Draw a large arrow on MAP B representing the trade winds (between O° and 30° N Latitude). Position it over the Gulf of Mexico.
   b) Draw a large arrow on MAP B representing the prevailing southwesterly winds (between 30° and 60° N Latitude). Position it over the continental United States.

PROCEDURE C: WICHITA-ANDOVER TORNADO

1. Determine the direction of the tornado's movement.

   _____

2. Determine the distance in miles the tornado was on the ground.

   _____

3. Determine the total time the tornado was on the ground.

   _____

4. Using the information from Procedures 2 and 3 determine the tornado's average rate of movement in miles per hour. SHOW WORK AND LABEL PROPERLY.

   _____

5. Determine the width of the tornado's path at:
   a) Clearwater at 5:57 P.M. CDT

   _____

   b) Golden Spur Mobile Home Park

   _____

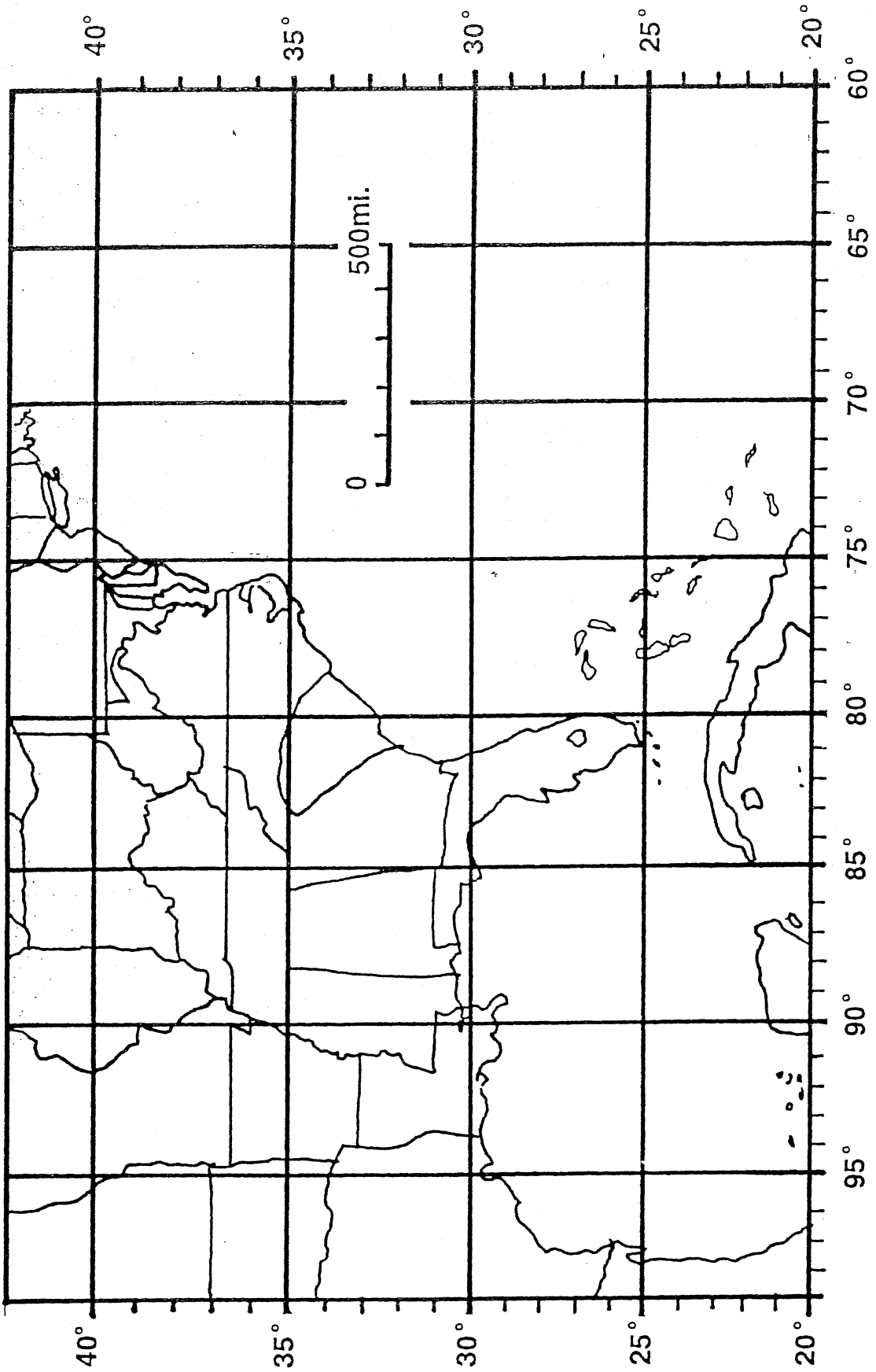
HURRICANE ANDREW DATA CHART
(AUGUST, 1992)

DATE/TIME (E.S.T)	LAT. (N)	LONG.(W)	PRESSURE (mb)	WIND (MPH)
20/8 pm	23.0	62.5	1014	52
21/8 am	24.5	64.0	1007	58
8 pm	25.5	66.0	1000	69
22/8 am	26.0	68.5	981	81
8 pm	25.5	71.0	961	104
23/8 am	25.5	74.0	933	138
8 pm	25.5	77.5	930	144
24/8 am	25.5	81.0	951	127
8 pm	26.0	85.0	943	132
25/8 am	27.0	88.0	946	132
8 pm	28.5	90.5	937	138
26/8 am	30.0	91.5	973	92
8 pm	31.5	91.0	995	40
27/8 am	33.0	89.5	998	35
8 pm	34.5	86.5	1000	23

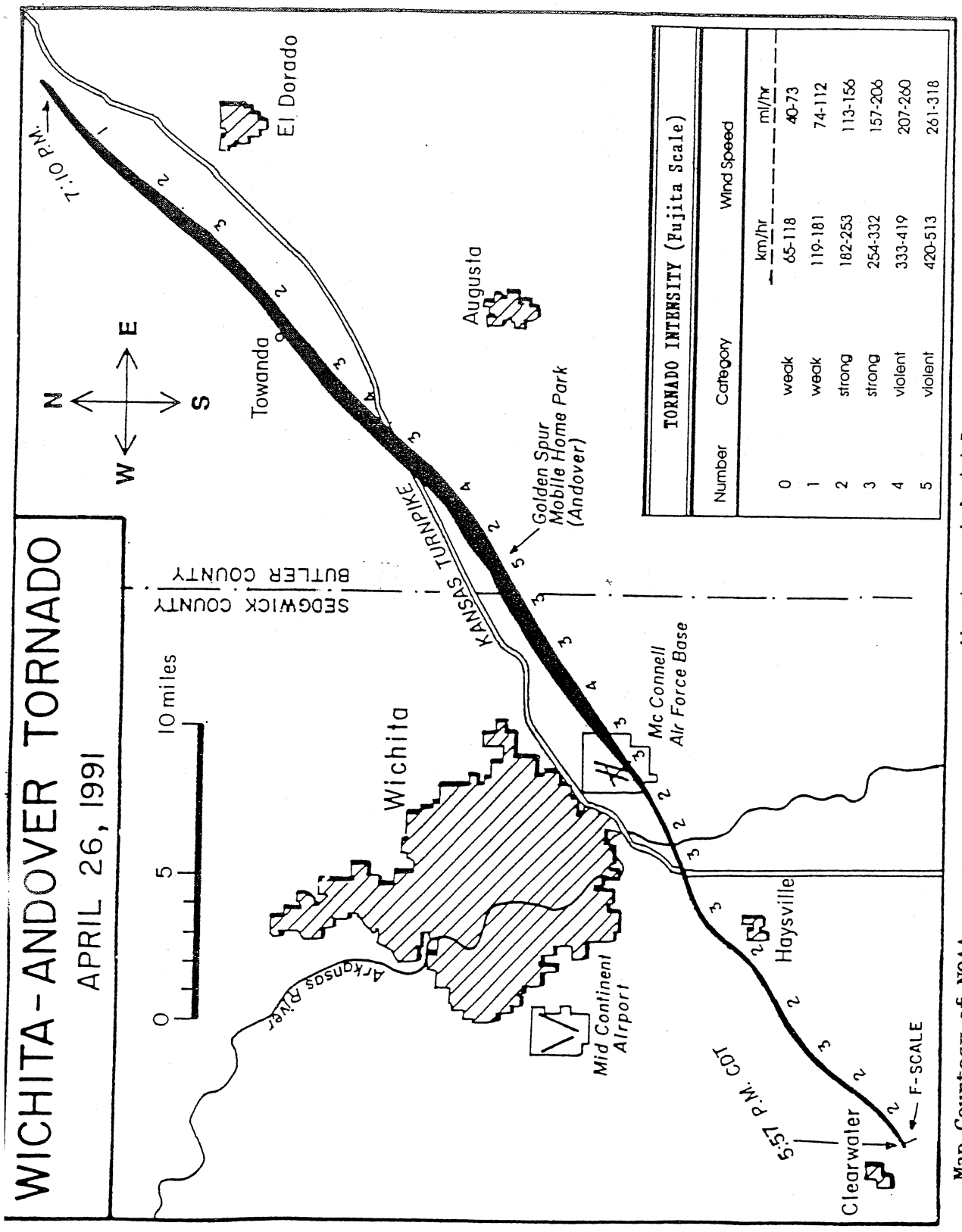
SAFFIR/SIMPSON HURRICANE SCALE

SCALE NUMBER (CATEGORY)	PRESSURE (millibars)	WINDS (mph)	STORM SURGE (ft)	DAMAGE
TROP. DEPRESSION	— —	<38	— —	— —
TROPICAL STORM	— —	39–73	— —	— —
I	>979	74–95	4–5	Minimal
II	965–979	96–110	6–8	Moderate
III	945–964	111–130	9–12	Extensive
IV	920–944	131–155	13–18	Extreme
V	<920	>155	>18	Catastrophic

MAP B: HURRICANE ANDREW



MAP C: WICHITA-ANDOVER TORNADO



Map Courtesy of NOAA

Mapping and Aerial Damage Survey by Brian E. Smith, NSSFC

DISCUSSION QUESTIONS: (Answer in Complete Sentences.)

1. What is the general direction of the track of a low pressure center in the United States?

2. What factors are responsible for the general direction in which low pressure centers move across the contiguous United States?

3. How can a series of synoptic weather maps be used to predict the future location of a low pressure center?

4. According to the HURRICANE ANDREW DATA CHART, what is the relationship between air pressure and wind velocity in a tropical cyclone?

5. Compare the distance the hurricane traveled in equal times between August 25 from 8 am to 8 pm and August 26 from 8 am to 8 pm.

6. Compare the pressure and wind velocity on August 25 (from 8 am to 8 pm) to the pressure and wind velocity from 8 am to 8 pm on August 26.

7. Considering your answers to questions five and six, what might be a source of a hurricane's energy?

8. According to the Saffir/Simpson Scale, what storm surge and type of damage was most likely experienced in Homestead, Florida which was directly in the path of the hurricane on the east coast?

9. If a hurricane moved along Florida's east coast north of 30° N latitude, what general direction would it most probably travel?

10. Based on Procedure C, what appears to be the relationship between a tornado's width and its intensity on the Fujita scale (F-Scale)?

11. Compare the duration of the Wichita-Andover tornado to that of Hurricane Andrew.

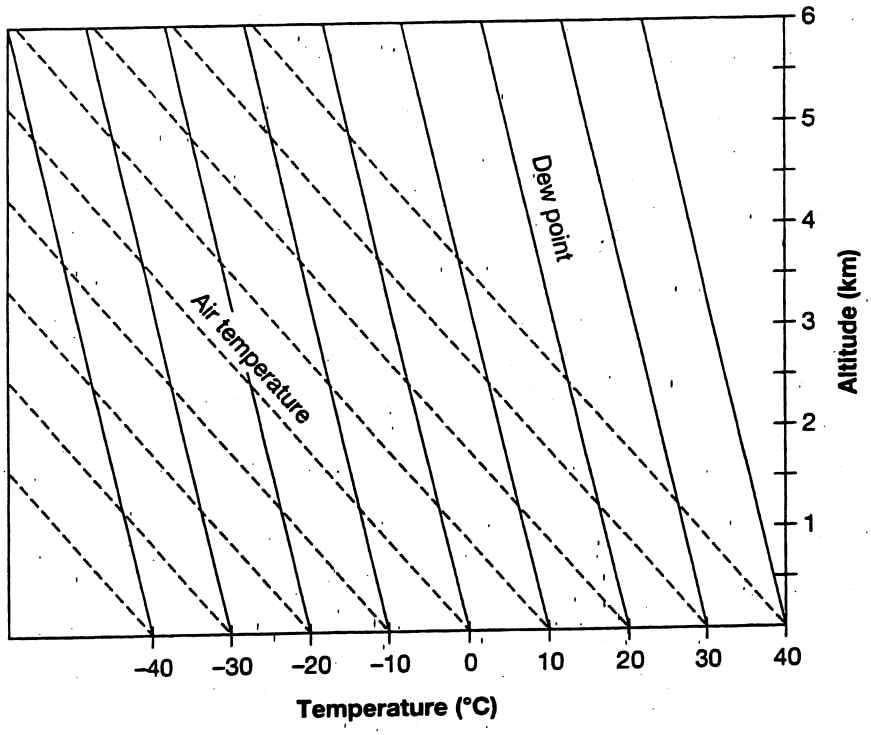
12. Thirteen of the 19 lives lost due to the Wichita-Andover Tornado were at the mobile home park in Andover. Even though there was some advanced warning, what could explain the relatively high death toll at this location?

CONCLUSION: What information is required to provide advanced warnings of severe weather conditions?

Name: Date:

Cloud Base Chart

Use the figure below and your Earth Science Reference Tables to answer the following questions



1. If the air temperature is 10°C and a student measures the wet bulb temperature to be 5°C, what is the dew point temperature?

2. Using the information from question 1, calculate the cloud base height.

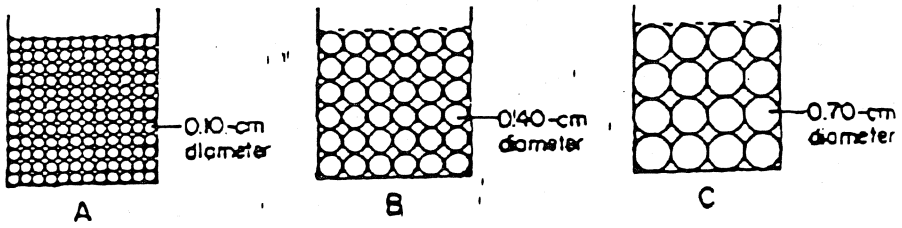
3. Explain how rising air reaches the dew point temperature.

4. What is necessary for water to condense?

Name _____ Date _____

Activity: Groundwater

Use the diagrams below to answer the following:



1) Which diagram has the greatest

A) Capillarity _____

B) Water retention _____

C) Porosity _____

D) Permeability _____

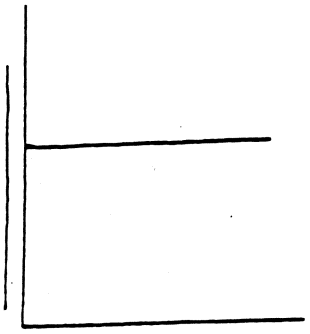
2) Label the Y axis in each of the graphs below by picking from the following:

Capillarity

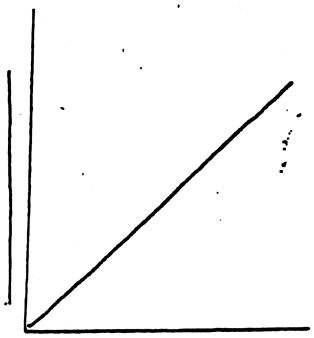
Water Retention

Porosity

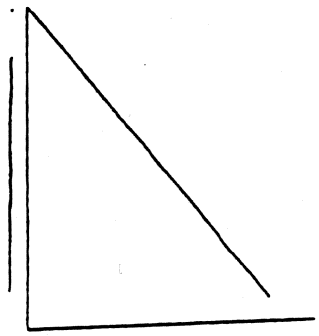
Permeability



Increasing Particle Size



Increasing Particle Size



Increasing Particle Size

Water Cycle Review Sheet

Water is recycled between the oceans, atmosphere, and land in a process called the _____.

Two ways water can enter the atmosphere is:
1.
2.
When precipitation falls back to Earth's surface it can:
1.
2.
3.
Water that infiltrates the ground is called _____.

The amount of water in the ground and the movement of water through the ground are controlled by the characteristics of the soil and rock found near the surface.

Factors that cause water to move along the surface (run off) instead of entering the ground are:
1.
2.
3.
4.
5.

Water will infiltrate (move into) the ground if the surface is _____ & _____.

Porosity

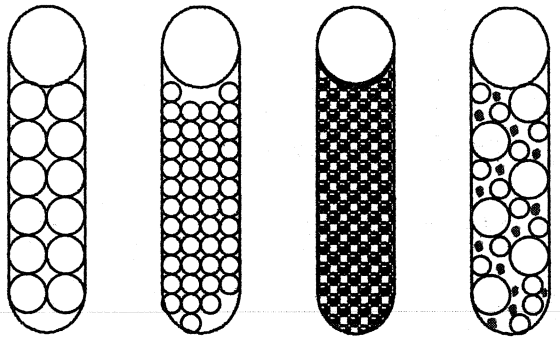
Porosity, or the percentage of empty space between the particles, determines how much water a sample of rock can hold.
The porosity of a material depends on:
1. Packing-
2. Sorting-
3. Shape-

Permeability

Permeability, the ability of a soil to transmit water, determines how fast water will infiltrate into the ground.
The permeability of a material depends on:
1. Packing-
2. Sorting-
3. Shape-
4. Size-

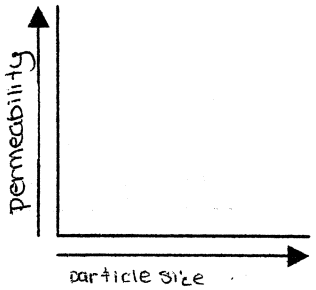
Capillarity

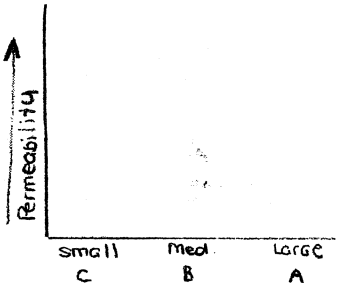
Capillarity is the ability of a soil to draw water upward into tiny spaces between soil grains.
The capillarity of a material depends on:
1. Size-



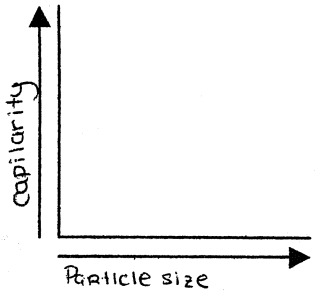
1. Which sample would have the highest permeability? _____
2. Which sample would have the highest capillarity? _____
3. Which sample would have the lowest porosity? _____
4. Which sample would have the lowest rate of infiltration? _____
5. Which sample would have the highest porosity? _____
6. Which sample would cause the most runoff during a heavy rainstorm? _____

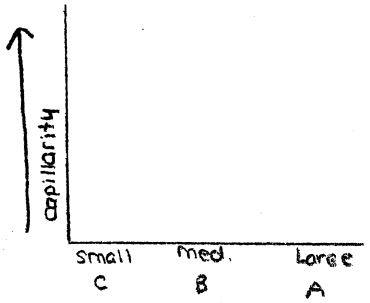
As particle size increase permeability _____



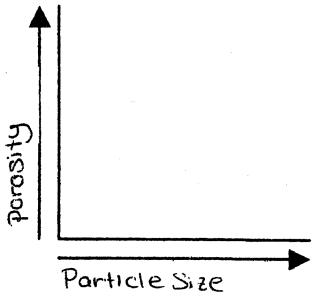


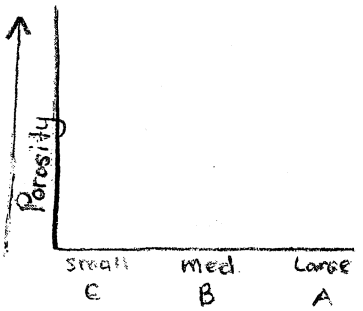
As particle size increase capillarity _____





As particle size increase porosity _____





Name _____ Date _____

Lab Exercise: The Mystery Continent

Purpose: To figure out the climate of an area based on geographic features.

Materials: Earth Science Reference Tables and your knowledge of Earth Science.

Procedure: On the Mystery Continent found on the next page, do the following:

1) Label the Equator.

2) Draw thin arrows to indicate the wind direction at each latitude. (Make sure your arrows are curved in the correct direction.)

3) Label each latitude as either high or low pressure. You may use an H for high pressure and an L for low pressure. In addition, indicate by labeling, if the latitude is considered wet or dry.

4) Draw the ocean currents flowing near the shores of the mystery continent. Remember that ocean currents flow in opposite directions in the Northern and Southern Hemisphere.

5) On the Mystery Continent, draw in and label the Tropic of Cancer and The Tropic of Capricorn.

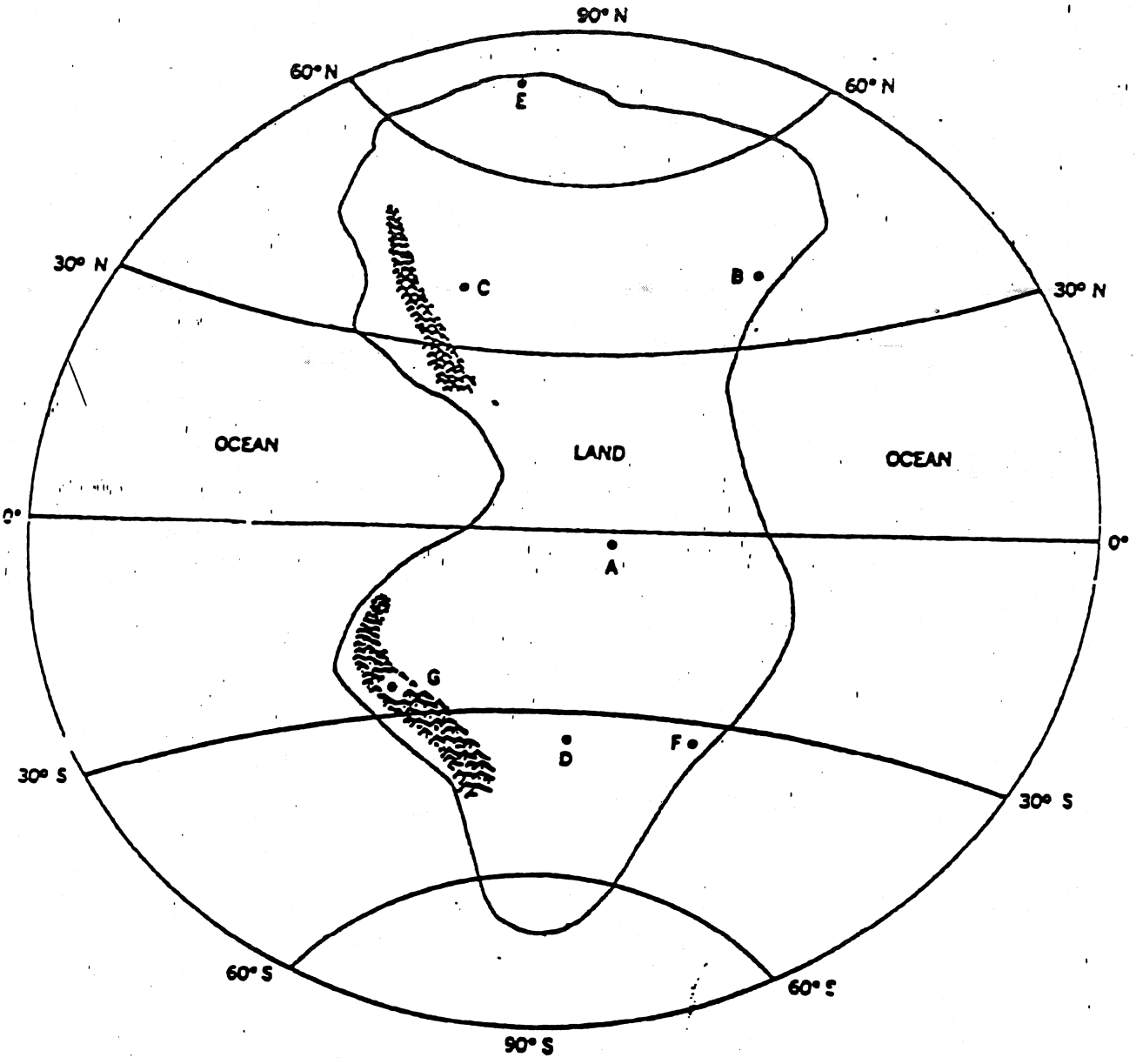
6) For locations A,B,C,D,E,F, and G do the following:
   A) List the closest latitude.
   B) Describe the climate as being either moderate or severe. Make sure to explain how you reached your conclusion.

Location A:
1)

2)

Location B:
1)

2)


90° N
60° N
60° N
E
30° N
C
B
30° N
OCEAN
LAND
OCEAN
0°
0°
A
G
30° S
D
F
30° S
60° S
60° S
90° S

Name _____ Date _____

Location C:

1)

2)

Location D:

1)

2)

Location E:

1)

2)

Location F:

1)

2)

Location G:

1)

2)

Name _____ Date _____

Conclusion:

1) Locations D,F,and G are at the same latitude. What factors cause D,F, and G to have different climates?

2) How much difference would there be between the overall climate of locacation C and B? Explain.

Name _____ Date _____

LAB: EXERCISE CLIMATE FACTORS MOUNTAINS AND RAINFALL

Purpose To compare the rainfall on the windward and leeward sides of a mountain range.

Background: Seattle, Washington and Spokane, Washington are in almost the exact same latitude about 48' North, in the prevailing southwesterly wind belt. Seattle, which is nearer to the Pacific, is about 200 miles west of Spokane and is separated from it by the north south running Cascade Mountains. Seattle is on the western or windward side of the mountain range. Spokane is on the eastern or leeward side of the mountain range.

Materials 1) Special graphs on next page, 2) Wall map of the United States.

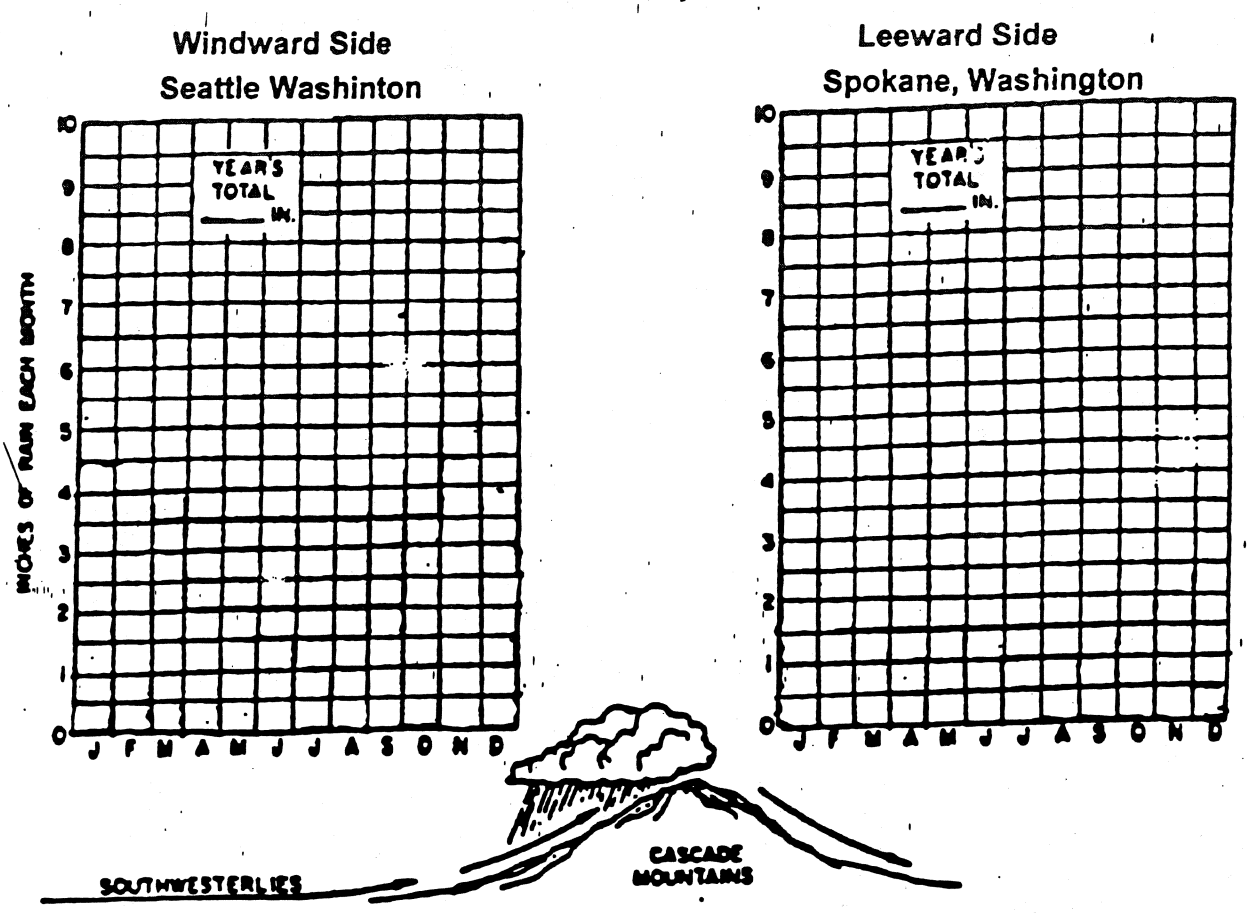
PROCEDURE

Use the data table below to plot the rainfall of both Seattle and Spokane. Record the data as bar graphs on the blank graphs provided for this exercise. Estimate tenths of inches of rain as closely as possible. Each box represents 0.5 of an inch of rain.

Average Monthly Rainfall (in Inches)		
Name	**Seattle, Washington**	**Spokane, Washington**
Location	48'N, 122'W	48'N, 1IS'W
January	4.5	1.7
February	3.7	1.5
March	3.1	1.3
April	3.9	1.0
May	3.6	1.0
June	1.2	1.2
July	0.5	0.4
August	0.9	0.5
September	1.6	0.9
October	3.1	1.3
November	4.5	1.9
December	5.3	2.2
Total for the year		

Name _____ Date _____

Mountains and Rainfall



QUESTIONS

1) Using the table, add up the monthly rainfall to find the total rainfall for the year : For Spokane _____, _____, For Seattle _____. Enter these totals in both the table and the graph.

2) Which side of the mountain, windward or leeward, receives greater rainfall?

_____

_____

3) Why should more rain fall on the windward side of a mountain than on the leeward side?_____

_____

4) Which six months does it rain the most in Seattle?_____

_____

What seasons do these include ?_____

Why do these seasons have more rain than the other two?

(Compare temperatures of land and sea) _____

_____

5) Though Spokane's rainfall is much less than that of Seattle, its distribution though the year parallels Seattle's. Why should this be? _____

_____

_____

6) Why does air cool as it rises and warm as it descends? Explain.

_____

_____

Name _____ Date _____

Climatic Factors: Altitude and Temperature Lab

Objective:
To observe how the year round temperatures of a city are related to its altitude.

Materials:
Wall maps of World, Asia, South America, and United States

Background Information:
In order to study the effects of altitude on temperature, it is necessary for us to exclude other factors such as latitude, distance from the sea, etc. In other words, we must compare places which are as much alike as possible in all respects affecting temperature except altitude. Then if there are differences in temperature, we can attribute them largely to differences in altitude.

In this exercise we shall study two pairs of cities. The first pair, Singapore Malaya, and Quito, Ecuador, are both on the equator, Singapore is 10 feet above sea level, while the altitude is Quito is 9350 feet.

The second pair of cities are Denver, Colorado, and Kansas City, Missouri. They are both located at about 39° North latitude in the interior of the United States. The elevation of Kansas City is 750 feet, while Denver is 5290 feet above sea level.

Procedure:

1. Mark the months of the year (at a interval of 5 spaces) along the base line of the X-axis.

2. Mark the temperature from 0°F to 90°F along the Y-axis.

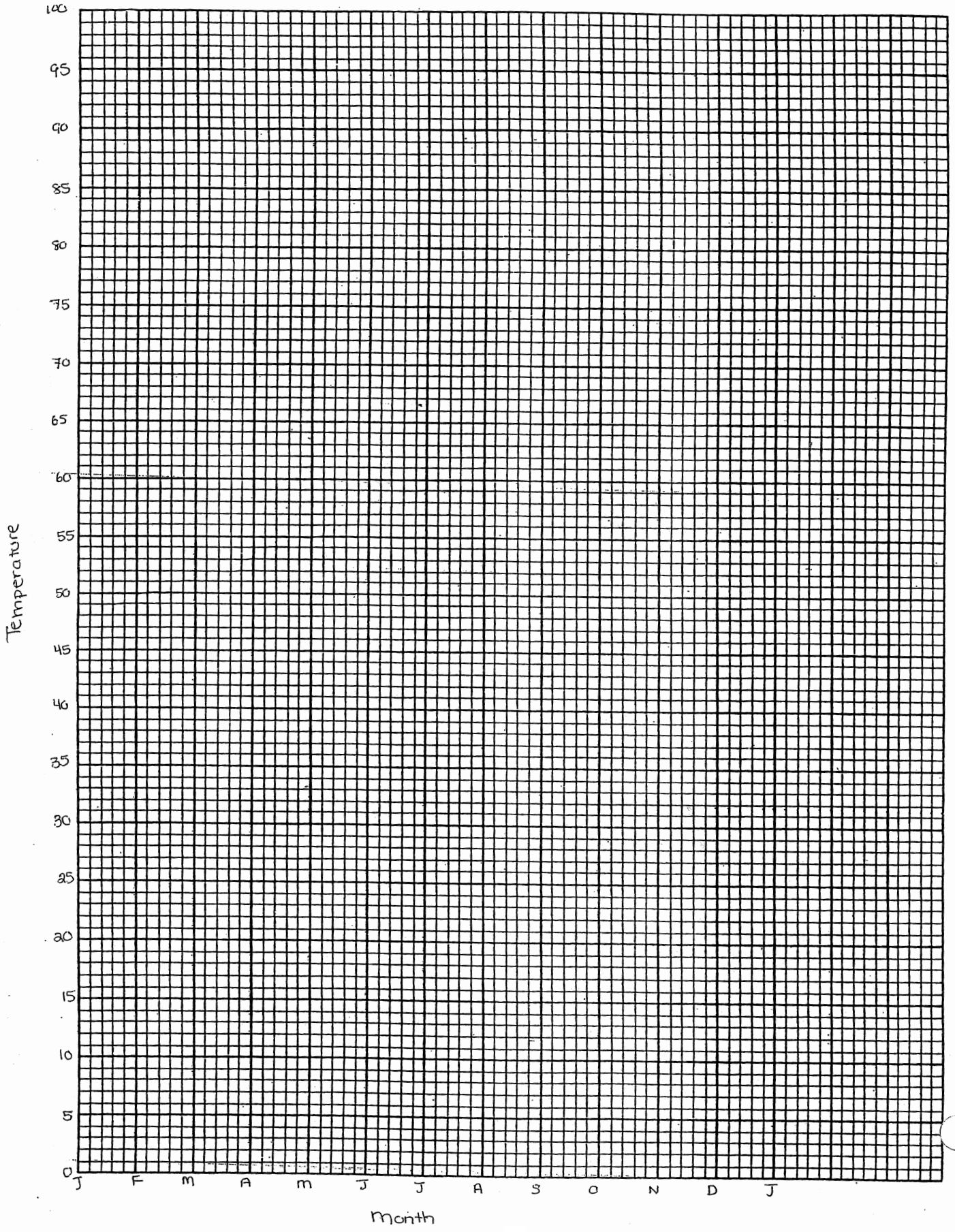
3. Use the data table on the next page to plot the temperature curves month by month for all of the cities. Label each curve.

Name _____ Date _____

City	Singapore, Malaya	Quito, Ecuador	Kansas City, Missouri	Denver, Colorado
Latitude	2°N	0	39°N	40°N
Altitude	10 feet	9350 feet	750 feet	5290 feet
January	80	55	30	31
February	80	55	35	34
March	81	55	44	39
April	82	55	56	49
May	82	55	65	57
June	81	55	75	67
July	81	55	81	74
August	81	55	79	72
September	81	55	71	64
October	81	55	60	53
November	81	54	44	41
December	80	55	34	34
January	80	55	30	31
Year's Average	**81**	**55**	**59**	**50**
Year's Range				

Key: Singapore ☐
Quito ☐
Kansas ☐
Denver ☐

Altitude vs Temperature



Name _____ Date _____

Analysis and Conclusion

Answer each question in complete sentences on the answer sheet.

1. Compare the average annual temperatures of Singapore and Quito. Is the difference due to latitude or altitude?

2. State the relationship between altitude and average temperature for Singapore and Quito.

3. Compute the year's range for Singapore and Quito. Enter these numbers into the data table. Is the difference between the ranges of the cities large or small?

4. Does altitude appear to have much effect on range in this case?

5. What accounts for the very small range in both cities?

6. How much lower is the average yearly temperature of Quito than that of Singapore?

7. How much higher above sea level is Quito?

8. Compare the average annual temperatures of Denver and Kansas City. What relation exists between altitude and average temperature?

9. How much lower is the average yearly temperature of Denver than Kansas City?

10. In which season (a three month period) are the temperatures of Denver and Kansas City almost identical?

Name _____ Date _____

Answer sheet for Climatic Factors: Altitude and Temperature

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

Name _____ Date _____

10. _____

Name _____ Date _____

Topic 8 Review Sheet
Moisture, Energy Budgets and Environmental Change

Answer the following review questions and STUDY them for your test!!!!

1) Which has more infiltration, a paved road or a large patch of grass?

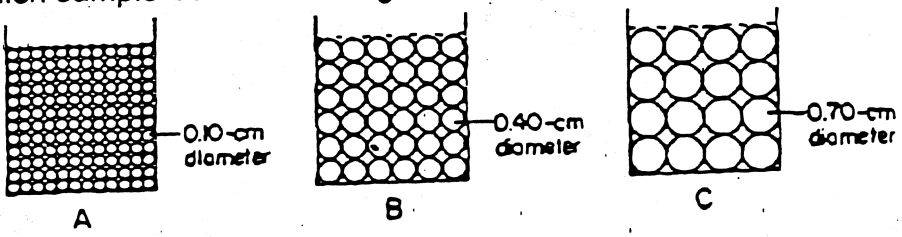
2) In order for infiltration to occur, what properties does the soil need to have?

3) How does size affect porosity?

4) How does size affect permeability?

5) Which sample below has the greatest permeability?

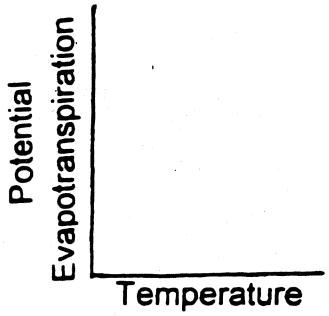
Which sample below has the greatest capillarity?

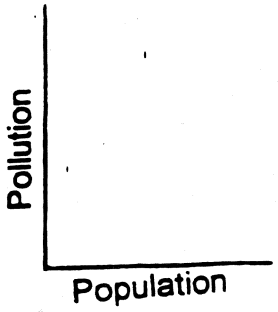


6) If a soil is saturated and there is heavy rain, what happens to the rainwater?

7) List three factors that cause an increase in runoff.

8) Draw a line in each of the graphs and explain the relationship between X and Y.





9) Why is bacteria harmful to a lake?

10) Why is precipitation so important to the local water budget?

11) What would cause an area to flood?

12) What is insolation?

13) During which season do we have the greatest intensity and duration of insolation?

Name _____ Date _____

14) What would cause an area to become flooded?

15) During which season do we have the most potential evapotranspiration? Why?

16) What is the maximum amount of water that can be in storage on a water budget?

17) When computing a water budget, how would we determine there is a deficit?

How would we determine there is a surplus?

18) What is the relationship between actual evapotranspiration (Ea) and potential evapotranspiration (Ep)?

19) If there is more precipitation than evapotranspiration, will there be a surplus or a deficit?

20) During which season is it likely that New York would have more precipitation than evapotranspiration?

21) Which season is more likely to have stream discharge; spring or summer? Why?

22) What two factors on a water budget are compared to determine climate?

23) What type of climate does the Equator have?

24) What type of climate does the North and South Pole have?

25) List three factors that have an affect on a locations climate?

26) What happens to a locations temperature as you go North of the Equator?

27) Compare the climate of a location found on the windward side of a mountain with the a climate of a location found of the leeward side of a mountain.

28) How does living near a large body of water affect a persons climate?

29) What type of pressure is found at the equator? What type of pressure is found at the poles?

30) Which will be more arid, 30 South or 60 South? How come?

31) Which direction does weather travel in the United States?

Name:_____ Date:_____

Weathering and Erosion
Topic 9 - Vocabulary

Abrasion: _____

_____

Breaking waves: _____

_____

Chemical weathering: _____

_____

Delta: _____

_____

Erosion: _____

_____

Finger lake: _____

_____

Flood plain: _____

_____

Glacial groove: _____

_____

Glacier: _____

_____

Mass movement: _____

_____

Name:_____ Date:_____

Meander: _____

_____

Physical weathe ng: _____

_____

Sandbar: _____

_____

Sandblasting: _____

_____

Sediment: _____

_____

Stream: _____

_____

Stream abrasion: _____

_____

Stream channel shape: _____

_____

Tributary: _____

_____

U-shaped valley: _____

_____

Name:_____ Date:_____

V-shaped valley: _____

_____

Watershed: _____

_____

Weathering: _____

_____

Name _____ Date _____

Weathering and Soil Review

1) What must water do in order for frost action to occur?

2) Why doesn't the North Pole have frost action?

3) What is the difference between physical and chemical weathering?

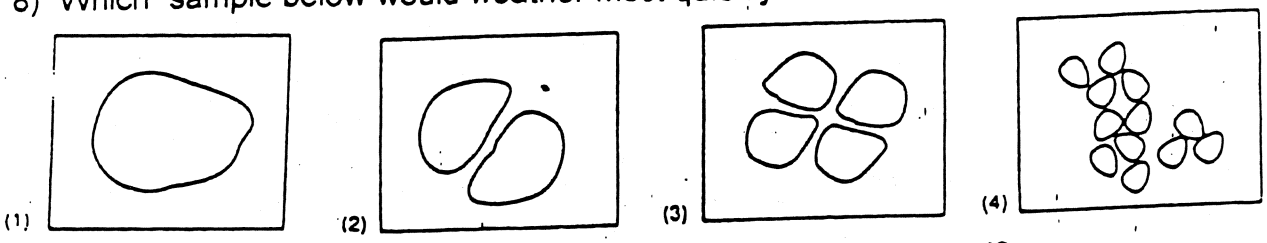
4) Explain how weathering and erosion are different.

5) What type of climate favors physical weathering?

6) What type of climate favors chemical weathering?

7) Where is weathering more likely to occur; above ground or below ground? Why?

8) Which sample below would weather most quickly? How come?



9) Why does a rock weather more quickly after it has been crushed?

10) What climate factor will increase the rate of weathering?

11) What happens to the shape of minerals after they have been shaken in a container?

12) Of the three samples used in the lab, (limestone, marble, and halite/salt), which sample dissolved in water?

13) What is another word for layer when talking about soils?

14) What process turns rock into soil?

15) When salt is carried in a stream, is it carried as bedload, in suspension, or in solution?

16) What causes soil to be thick and develop at a faster rate?

17) Which layer of the soil has the most biological activity?

Name _____ Date _____

Activity : Weathering and Erosion Review Sheet

1. What is the difference between physical and chemical erosion?.

2. What must water do in order for frost action to take place?

3. List and describe three factors that have an affect on the rate of erosion.

4. How can we determine that sediments have been eroded by wind?

5. What is the primary force of erosion?

6. Define discharge.

7. What is the primary agent of erosion?

8. How can we determine that bedrock has been eroded by a glacier?

9. List an example of a dissolved mineral.

10. List two examples of colloids.

Name _____ Date _____

11. Which type of sediment is carried as bedload?

_____

12. How does the velocity of a pebble compare to the velocity of the stream that is carrying the pebbie?

_____

_____

13. Explain the difference between transported and residual soil.

_____

_____

_____

14. How could someone determine whether a soil is transported or residual?

_____

_____

15. What two factors have the greatest affect on the velocity of a stream?

_____

16. Why does rock weather faster when it is broken up?

_____

_____

17. Which is going to weather more quickly, a rock containing quartz, or a rock containing gypsum? Why?

_____

_____

_____

18. Sediments carried in solution are know as

_____.

19. Examples of sediments carried in suspension are

_____.

20 Another name for soil layers is soil _____.

21. What type of climate favors chemical weathering?

_____

22. What is the shape of sediments that get rolled around in water ?

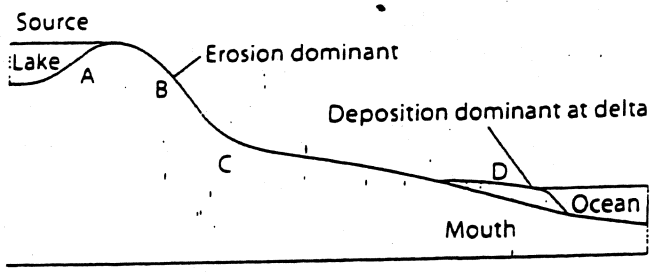
_____

Name _____ Date _____

23. Use your reference tables (page 6) to answer the following:

* What is the range in size of silt particles ? _____
* What is the range in size of pebbles ? _____
* What is the range is size of clay particles ? _____
* Which particles are the smallest ? _____
* Which particles are the largest ? _____
* What is the slowest velocity a stream can flow in order to carry cobbles ? _____
* What velocity must be maintained in order to carry sediments that are .2cm?_____
* What velocity must be maintained in order to carry sediments that are 25.6 cm? _____
* What must happen to a streams velocity in order to hold onto the larger sediments?_____

24. Where in the stream is the greatest potential energy?
Where in the stream is the greatest kinetic energy?
Where is the stream moving fastest, A, B or C? Why?



Name:_____ Date:_____

Deposition
Topic 10 - Vocabulary

Barrier island: _____

_____

Deposition: _____

_____

Drumlin: _____

_____

Kettle lake: _____

_____

Moraine: _____

_____

Outwash plain: _____

_____

Sand dune: _____

_____

Sorted sediments: _____

_____

Unsorted sediments: _____

_____

Name _____ Date _____

Activity: Depositon Review Sheet

Answer the following:

1. How does particle size affect the rate of deposition?

2. How does particle shape affect the rate of deposition?

3. What does the stream need to do if it wants to drop its particles?

4. What is the difference between horizontal sorting and vertical sorting?

5. In horizontal sorting, which sediments are deposited first? Why?

6. What is graded bedding?

7. How is glacial till different from outwash?

8. What is the mouth of the stream ?

9. Is there a lot of kinetic energy at the mouth or only a little bit ?

10. What is the source of the stream?

Name _____ Date _____

11. What type of energy is found at the source of the stream?

_____

12. If you were to find a pile of unsorted deposit, what do you assume made that deposit?

_____

_____

13. Do particles have kinetic energy during erosion or during depostion?

_____

_____

_____

14. Which of the following will settle the quickest? ____ How come ?

_____

a) a rock with a density of 23g/cm
b) a marble with a density of 45g/cm
c) a peanut with a density of1g/cm

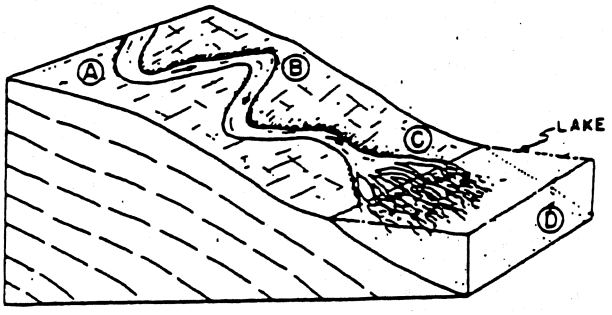
15. How do we know that a stream is in dynamic equalibrium?

_____

_____

_____

16. The following questions pertain to the picture below:
   a) Where is deposition taking place?
   b) Which letter is closest to the source of the river?
   c) What process is occurring at letters A and B?
   d) What is happening to the amount of overall energy as the stream travels from letter A to letter D?



Name _____ Date _____

LAB: RIVER PROFILES

PURPOSE: To observe the changes in gradient that occur on a large river by using a profile.

MATERIALS: Enclosed graph paper and map of the United States.

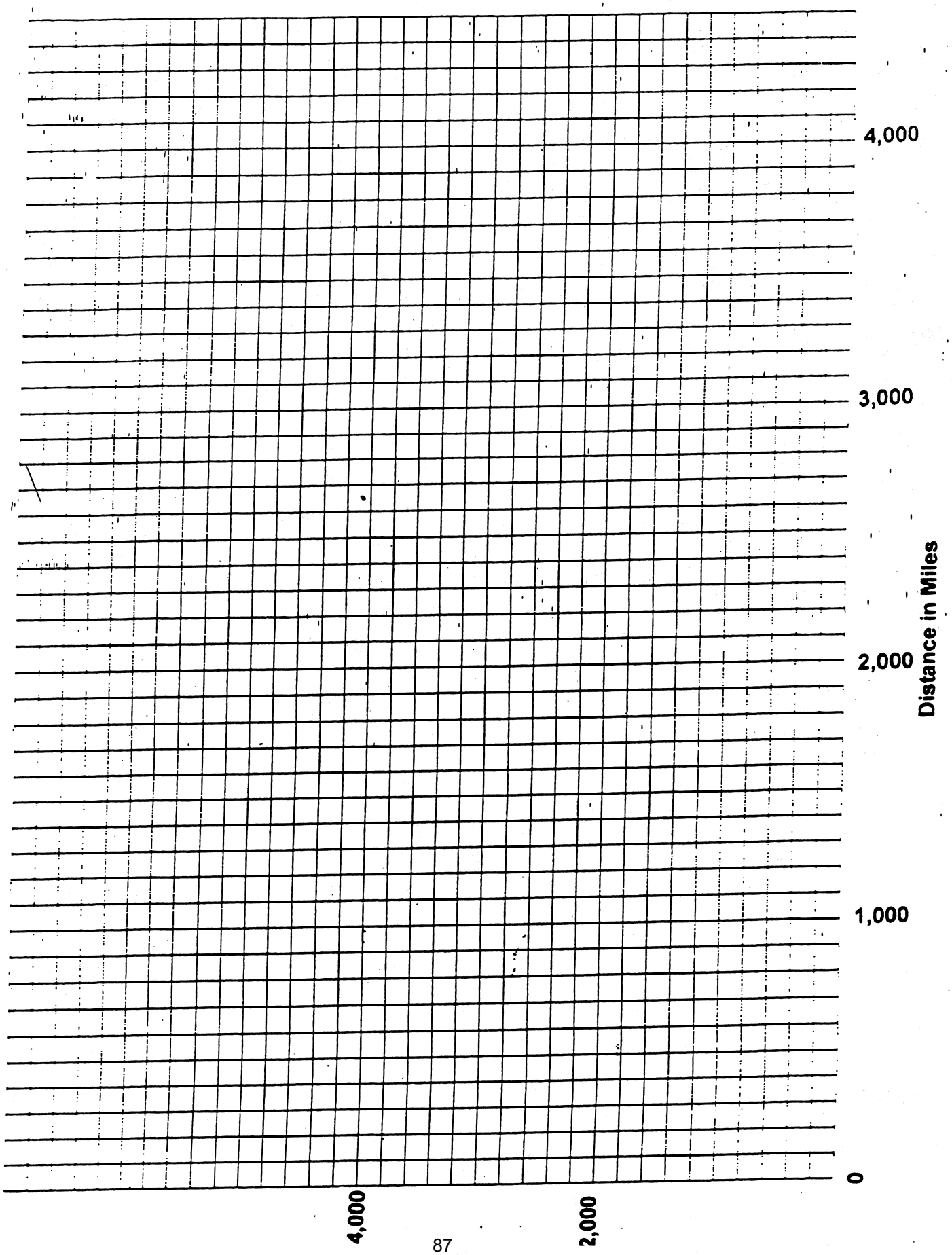
PROCEDURE:

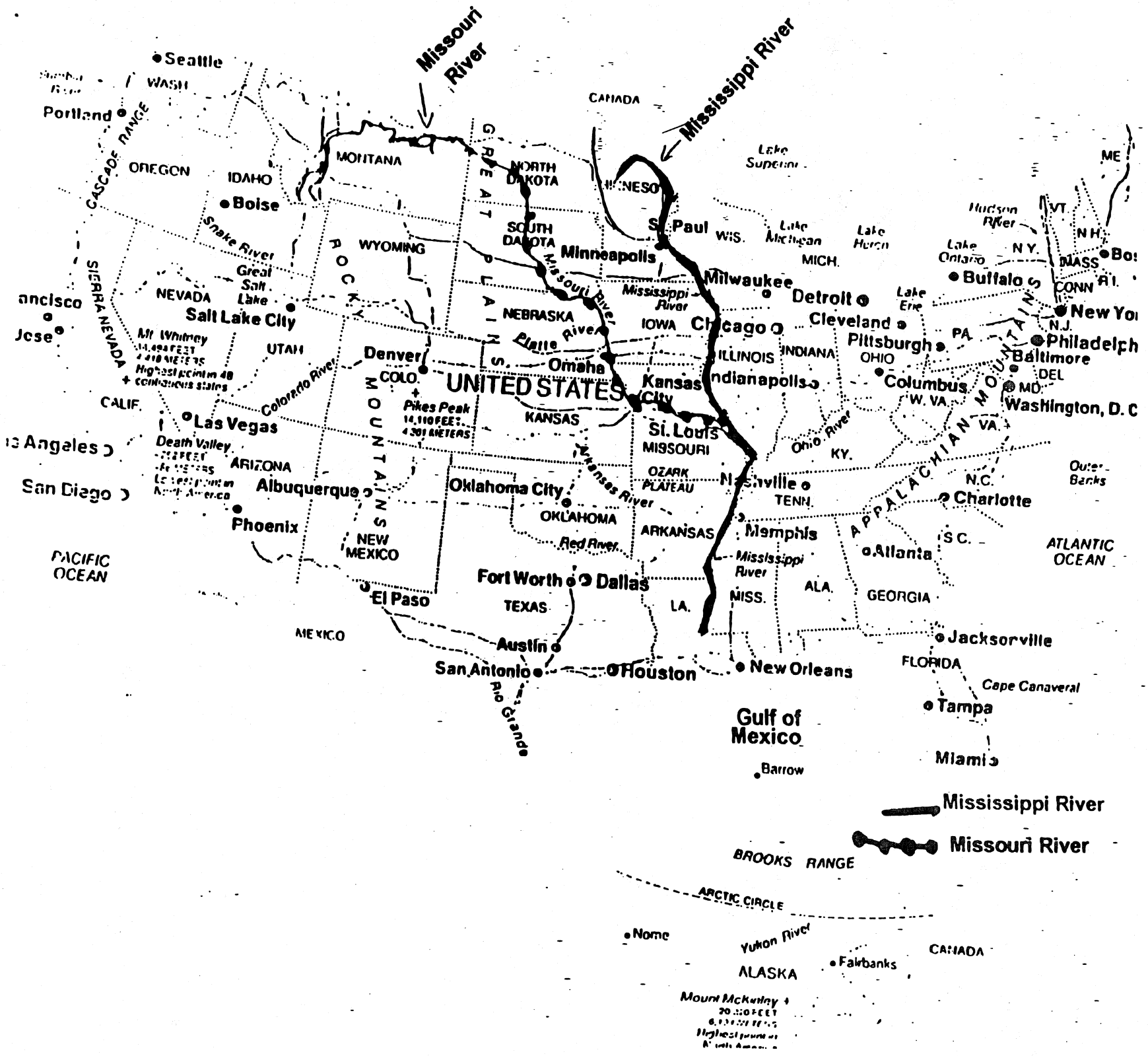
1. Plot the points from the table below onto the graph paper.
2. Connect the dots to form a profile of the rivers.
3. Indicate which profile represents the Mississippi River and which profile represents the Missouri River.
4. Label the source and the mouth of each river.

Mississippi River			Missouri River		
Station	**Miles from mouth**	**Altitude In feet**	**Station**	**Miles from Mouth of Mississippi**	**Altitude in feet**
Mouth	0	0	Mouth	1290	400
Mouth of Red River	350	35	Kansas City, Missouri	1680	715
Mouth of Arkansas River	550	120	Omaha, Nebraska	1950	960
Mouth of Ohio River	1090	275	Yankton. South Dakota	2190	1160
Mouth or Missouri River	1290	400	Mouth of Yellowstone	2800	1855
Burlington. Iowa	1490	500	River	3365	2565
La Crosse, Wisconsin	1790	630	Fort Benton. Montana	3400	3300
St. Paul. Minnesota	1935	685	Great F311s. Montana		
Minneapolis. Minnesota	1950	800	Source or Missouri River	3650	4060
Lake Itasca, Minnesota	2350	1460	(Three Forks. Montana)		

0BSERVATIONS:
Use attached sheet.

Name _____ Date _____




Missouri River
Mississippi River
Seattle
Portland
WASH
OREGON
IDAHO
Boise
MONTANA
CANADA
NORTH DAKOTA
SOUTH DAKOTA
Minneapolis
St. Paul
WYOMING
Snake River
Great Salt Lake
Salt Lake City
NEVADA
UTAH
Denver
COLO.
Omaha
NEBRASKA
Platte River
IOWA
Chicago
Milwaukee
Detroit
Cleveland
Buffalo
New York
Philadelphia
Baltimore
Washington, D.C.
Pittsburgh
Columbus
Indianapolis
Kansas City
St. Louis
MISSOURI
ILLINOIS
INDIANA
OHIO
KENTUCKY
W. VA.
VA.
N.C.
TENN.
Charlotte
Nashville
Memphis
ARKANSAS
OKLAHOMA
Oklahoma City
Albuquerque
Phoenix
Las Vegas
Death Valley
Mt. Whitney
Pikes Peak
14,110 FEET
4,301 METERS
Highest point in 48 contiguous states
ARIZONA
NEW MEXICO
CALIF.
Los Angeles
San Diego
San Francisco
Jose
Colorado River
Arkansas River
Red River
Mississippi River
Ohio River
OZARK PLATEAU
Fort Worth
Dallas
El Paso
TEXAS
Austin
San Antonio
Houston
LA.
MISS.
ALA.
GEORGIA
S.C.
Atlanta
Jacksonville
FLORIDA
Cape Canaveral
Tampa
Miami
New Orleans
Gulf of Mexico
Barrow
Nome
Yukon River
ALASKA
Fairbanks
Mount McKinley
20,320 FEET
Highest point in North America
BROOKS RANGE
ARCTIC CIRCLE
CANADA
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Hudson River
MICH.
WIS.
N.Y.
PA.
N.J.
MASS.
VT
N.H.
ME
R.I.
CONN
DEL
MD.
Outer Banks
ATLANTIC OCEAN
PACIFIC OCEAN
MEXICO
Rio Grande
CASCADE RANGE
SIERRA NEVADA
ROCKY MOUNTAINS
GREAT PLAINS
APPALACHIAN MOUNTAINS
Mississippi River
Missouri River

Name _____

Date _____

Name _____ Date _____

CONCLUSION QUESTIONS: Answer the following in complete sentences. All gradient questions must be completed using the following 3 steps:

a) Write the formula for gradient
b) Substitute the data into the equation
c) Label your answer with the proper units

1. Between which stations of the Missouri River is the profile the steepest?

2. Calculate the gradient in feet per mile for this section of the river:

A) gradient =
B) gradient =
C) gradient =

3. Between which stations of the Mississippi River is the profile the steepest?

4. Calculate the gradient in feet per mile for this section of the river:

A) gradient =
B) gradient =
C) gradient =

5. Between which two stations of the Mississippi is the gradient the least?

Name _____ Date _____

6. Calculate the gradient for this section of the river:

A) gradient =
B) gradient =
C) gradient =

7. In which section of the Mississippi River is the greatest amount of erosion occurring? Explain why.

8. In which section of the Mississippi is the greatest amount of deposition occurring? Explain why.

9. In which direction does the Missouri River flow? _____

10. In Which direction does the Mississippi River flow? _____

11. In which state does the Mississippi River begin?

12. In which state does the Mississippi River end?

13. Where does the water from the Mississippi River go?

14. Where does the Missouri River start?

15. In what state does the Missouri River end?

Name:_____ Date:_____

Earth Materials - Minerals, Rocks, and Mineral Resources
Topic 11 - Vocabulary

Bioclastic sedimentary rocks: _____

_____

Chemical sedimentary rocks: _____

_____

Clastic sedimentary rocks: _____

_____

Cleavage: _____

_____

Contact metamorphism: _____

_____

Crystal shape: _____

_____

Crystal structure: _____

_____

Extrusive igneous rock: _____

_____

Foliation: _____

_____

Fossil: _____

_____

Name:_____ Date:_____

Fracture: _____

_____

Hardness: _____

_____

Igneous rock: _____

Inorganic: _____

_____

Intrusive igneous rock: _____

_____

Luster: _____

_____

Magma: _____

_____

Metamorphic rock: _____

_____

Mineral: _____

_____

Mineral resources: _____

_____

Organic: _____

_____

Name:_____ Date:_____

Precipitation of minerals: _____

_____ _____

Regional metamorphism: _____

_____

Rock cycle: _____

_____

Sedimentary rocks: _____

_____

Streak: _____

_____

Texture: _____

_____

Name _____ Date _____

Lab: Moh's Hardness Scale

PURPOSE: To become familiar with the property of hardness, as a characteristic of minerals.

MATERIALS: A piece of window glass, steel nail, copper penny, and the following minerals: QUARTZ, GYPSUM, CALCITE, CORUNDUM, TALC, APATITE, TOPAZ, FLOURITE, and ORTHOCLASE FELDSPAR.

PROCEDURE - OBSERVATIONS:

In order to determine the hardness of each mineral you will be using the Moh's Hardness Scale which ranges from 1 - 10. 1 is the softest and 10 is the hardest.

The following will assist you in determining the hardness of each mineral :

Thumbnail = hardness of approximately 2.5
List the minerals scratched by your thumbnail :

Penny = hardness of approximately 3
List the minerals scratched by a penny :

Steel nail = hardness of approximately 5
List the minerals scratched by a steel nail :

Plate glass = hardness of approximately 5.5
List the minerals that are able to scratch the plate glass :

Name _____ Date _____

Place the minerals in the correct order of hardness from 1 - 9 using your observations.

1)

2)

3)

4)

5)

6)

7)

8)

9)

10) Diamond

Conclusion:

1) Which is harder; Quartz or Corundum? How did you figure it out?

2) Which is harder; talc or Gypsum? How did you figure it out?

3) Quarz and calcite look very alike. How can you tell which mineral is which?

Name _____ Date _____

Mineral Identification Lab

Each group should have the following materials:
1) Plastic box containing minerals, a streak plate, and a glass plate.
2) Mineral Identification Chart in your Earth Science Reference Table.

Directions: Examine each mineral one at a time. Determine the correct physical characteristics for each mineral, and then check them off on this sheet. Use the Mineral Identification Chart to help you determine the name of each mineral.

1
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

2
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

3
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

4
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

5
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

6
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

7
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

8
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

Name _____ Date _____

9
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

10
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

11
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

12
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

13
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

14
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

15
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

16
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

17
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

18
Cleavage ___ Fracture ___
Streak _____
Metallic ___ Nonmetallic ___
Harder than glass _____
Softer than glass _____
Color _____
Special features _____
Name _____

Name _____ Date _____

Observation and Conclusion:

1) Several of the mineral samples are white in color. What were some of the properties that helped you tell them apart?

2) How were you able to tell the difference between calcite and halite?

3) Explain the difference between cleavage and fracture.

4) What causes each mineral to have their own unique physical properties?

Name _____ Date _____

LAB: IGNEOUS ROCKS

PURPOSE: To Become more familiar with igneous rocks.

MATERIALS:
1. Rock samples including; granite, basalt, pumice, scoria, andesite, and rhyolite.
2. Earth Science Reference Tables
3. Magnifying glass

PROCEDURE:
Examine each of the igneous rocks and fill in the report sheet. After you have completed the report sheet, answer the questions.

CONCLUSION QUESITONS:

1) Do intrusive igneous rocks cool quickly or slowly?
2) How does the rate of cooling affect grain size?
3) Which rocks have grains or crystals of at least two different minerals that can be identified with the eye or with the magnifying glass?
4) Identify the minerals of each of the rocks you named in the previous question.
5) When magma cools on the Earth's surface as lava, does it form intrusive or extrusive rocks?
6) What do you notice about the appearance of the crystal grains in extrusive igneous rocks?
7) Which rocks are uniform in color and have little to know visible crystals?
8) What causes some rocks to have a glassy texture?
9) Which rock specimen has a glassy texture?
10) What kind of fracture does this glassy specimen have?
11) How are holes formed in some igneous rocks?

Name _____ Date _____

12) Although the rocks with holes look porous, what type of texture to they have?

13) Which rock specimens have holes?

14) What do the escaping gases found in the rocks previously described do to their density?

15) Do any of your specimens have a density that is less than 1g/cm (lighter than water)?

16) Name three rock samples that are felsic.

17) What do you notice about the color of all the felsic rock samples? Are they light or dark in color?

18) Which minerals make up the light colored rocks?

19) Which minerals make up the dark colored rocks?

20) Which minerals make up the medium colored rocks?

21) Which rock samples probably formed deepest within the Earth? How do you know?

22) Which rock samples formed the most quickly? How do you know?

23) Continental crust is made from granite, and oceanic crust is made from basalt. What does this suggest about the density of continental crust compared to the density of oceanic crust?

IGNEOUS ROCK OBSERVATION CHART

Name	Grain Size	Texture	Environment of Formation	Color	Mineral Composition

Name _____ Date _____

Answer Sheet

1. _____
2. _____
3. _____, _____, _____
4. _____ _____
   _____ _____
   _____ _____
5. _____
6. _____
7. _____, _____, _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____ and _____
14. _____
15. _____
16. _____, _____, _____
17. _____
18. _____
19. _____
20. _____

Name _____ Date _____

21. _____

_____

22. _____

_____

23. _____

_____

Name _____ Date _____

Lab: Sedimentary Rocks

Introduction: Sedimentary rocks are an accumulation of rock particles that settle into horizontal layers and slowly unite together into rocks. These rock fragments may be deposited by wind, water, ice, or other means.

Objective: To examine the physical features of sedimentary rocks.

Materials: Chart and sedimentary rock samples.

Procedure: Do the following:

1) Carefully examine each rock sample one at a time.

2) Fill in the Sedimentary Rock Observation Chart. Use the terms clastic, crystalline, or bioclastic to describe texture.

3) Use the term light, medium, and heavy to designate relative weight.

4) Make sure your sketches show features of sedimentary rocks.

Conclusion Questions:

1) Name any clastic sedimentary rock you examined today.

2) Name any rock that you observed today that was formed by biological processes.

3) Name any chemical sedimentary rock you examined today.

Name _____ Date _____

4) What is a special feature of conglomerate?

5) Pick up sandstone; describe how it feels to you?

6) How are chemical limestone and fossil limestone similar?

7) How are chemical limestone and fossil limestone different?

8) What is a special feature of shale?

9) Which rock is made up of the largest particles?

10) Which rock is made up of the smallest particles?

11) What is the name of the smallest particles?

12) Which of the rocks that you observed today were formed by precipitation of evaporating water?

13) Which of the rocks that you observed today are land derived rocks?

14) What characteristic would help you determine the difference between conglomerate, sandstone and shale?

Sedimentary Rock Observation Chart

Name	Texture	Grain Size	Composition	Comments

Name _____ Date _____

Lab: Metamorphic Rock Observation

Introduction: Metamorphic rocks are rocks whose original form has been changed by heat, pressure, or chemical action. When a rock undergoes metamorphism, its texture and mineral composition may undergo a change also.

Objective: To examine the physical features of metamorphic rocks.

Materials: Chart, pencil or pen, hand lens or magnifier, scraping tool, and metamorphic rock samples.

Procedure: Do the following:

1. Carefully examine each rock sample, one at a time.
2. Fill in the Metamorphic Rock Observation Chart. Use the terms *foliated* and *nonfolicxted* to describe texture. Here is a brief description of these terms:

   Foliated: Mineral crystals or grains form in parallel layers or bands. The rock splits readily or peels along these layers or bands.

   Nonfoliated: Rocks without layers or bands

In addition, use the terms *light, medium,* and *heavy* to designate relative weight.

Lastly, make sure your sketches show features of metamorphic rocks.

Conclusion Questions:

1) How do metamorphic rocks form?

2) Which metamorphic rock that you observed today shows light and dark banding?

3) Which metamorphic rock that you observed today shows foliation?

4) Gneiss is a metamorphic rock that is formed from granite. Compare gneiss and granite:

Similarities Differences

Name _____ Date _____

5) Which sedimentary rock is slate formed from?

6) Which is denser, shale or slate? Why?

7) Which sedimentary rock is marble made from?

8) What is a special property of marble?

9) What is the main difference between igneous, sedimentary, and metamorphic rocks?

10) What characteristic provides the best evidence about the environment in which a rock is formed?

Metamorphic Rock Observation Chart

Name	Texture	Grain Size	Composition	Comments

Name:_____ Date:_____

Earth's Dynamic Crust and Interior
Topic 12 - Vocabulary

Asthenosphere: _____

_____

Continental crust: _____

_____

Convergent plate boundary: _____

_____

Crust: _____

_____

Divergent plate boundary: _____

_____

Earthquake: _____

_____

Epicenter: _____

_____

Faulted: _____

_____

Folded: _____

_____

Hot spot: _____

_____

Name:_____ Date:_____

Inner core: _____

_____

Island arc: _____

_____

Lithosphere: _____

_____

Mantle: _____

_____

Mid-ocean ridge: _____

_____

Moho: _____

_____

Oceanic crust: _____

_____

Ocean trench: _____

_____

Original horizontality: _____

_____

Outer core: _____

_____

Name:_____ Date:_____

P-waves: _____

Plate tectonic theory: _____

Plate (lithospheric plate): _____

S-waves: _____

Seismic wave: _____

Subduction: _____

Transform plate boundary: _____

Tsunami: _____

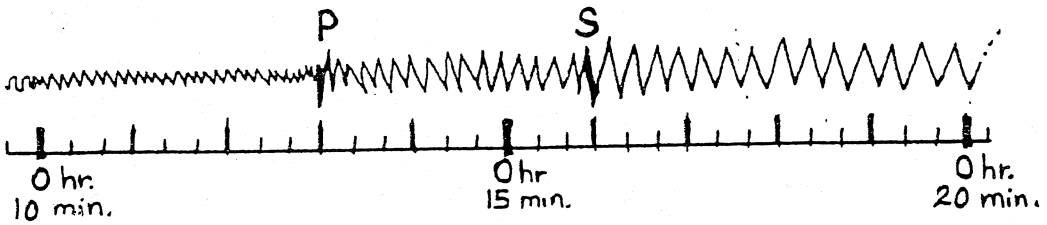
Uplifted: _____

Volcanic eruption: _____

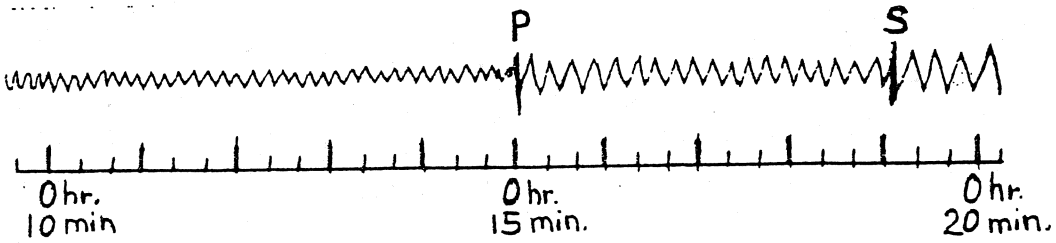
Volcano: _____

Earthquake Epicenters

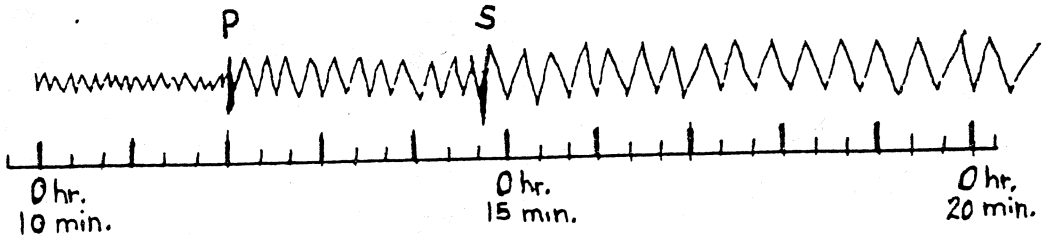
1. Houston, Texas



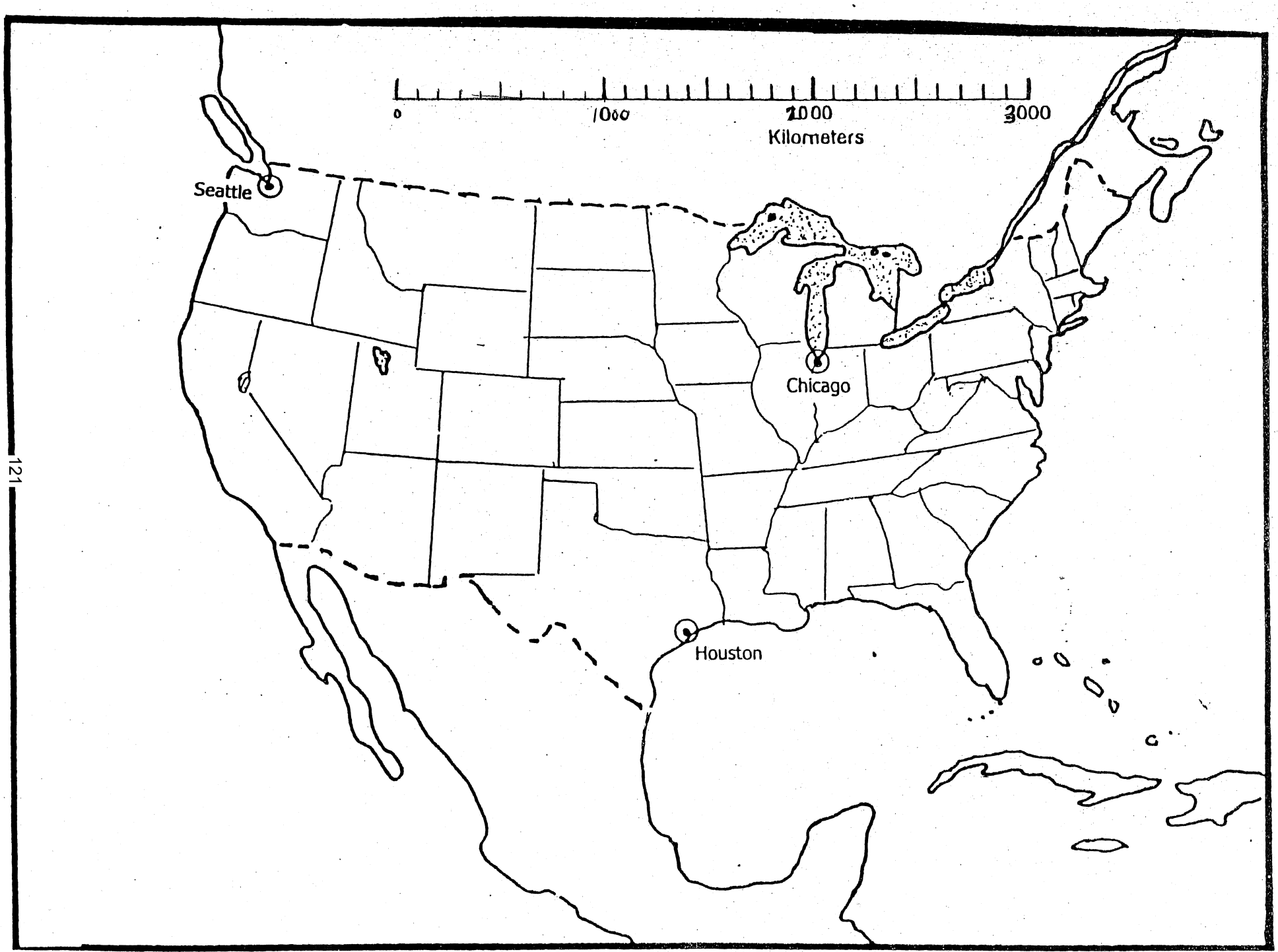
2. Chicago, Illinois



3. Seattle, Washington



SEISMOGRAPH STATION	ARRIVAL TIME P-wave	S-wave	DIFFERENCE IN ARRIVAL TIME	DISTANCE TO EPICENTER


0
1000
2000
3000
Kilometers
Seattle
Chicago
Houston

Name _____ Date _____

LAB: FINDING EPICENTERS

INTRODUCTION: Earthquakes occur when there is movement along a fault. The friction between rock masses rubbing against one another generates shock waves which travel through Earth. These shock waves (seismic waves) created by the earthquake are radiated in every direction from the focus, the point in the Earth where the actual movement takes place.

An earthquake occurs every 30 seconds, day after day. Most of these are so weak they would go unnoticed without the use of sensitive modern instruments called seismographs.

While seismologists use many stations, in this lab you will use seismograms from three distant stations to locate the epicenter, the point on Earth's surface directly above the focus.

OBJECTIVE: You will learn to interpret a seismogram and, using differences in seismic waves, locate the epicenter of an earthquake.

VOCABULARY: Define the following in your own words.

fault:

epicenter:

focus:

P-wave:

S-wave:

seismograph:

seismogram:

Name _____ Date _____

Procedure A

The diagram, Finding Epicenters, illustrates the method of using the difference in arrival times of P and S waves to determine the distance to the epicenter. Using the three seismograms provided and the Earthquake P-wave and S-wave Time Travel" graph in the Appendix, calculate the following for each city: (Enter on the Report Sheet.)

1. The arrival times for P and S waves.
2. The difference in the arrival time between P and S-waves.
3. The distance (in km) of the epicenter from each city.
4. The length of time it took for the P-wave to travel from the epicenter to each city.
5. Since you now know when the P-wave arrived at a city and how long it had to travel, calculate the time at which the P-wave started. (Origin Time)

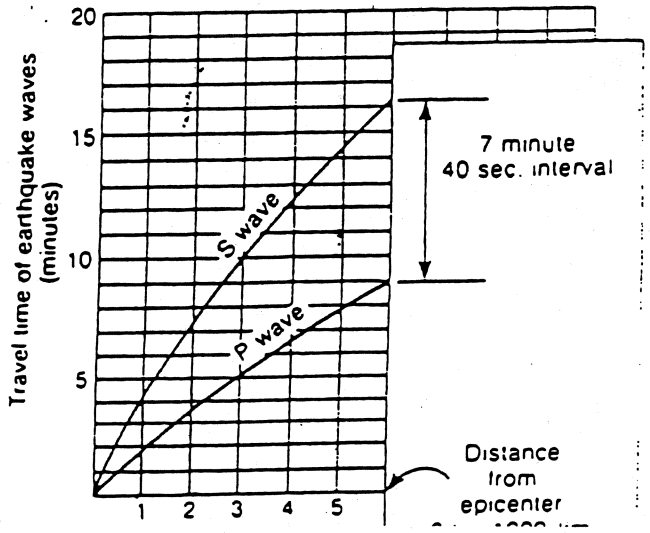
PROCEDURE B:

1. A. To locate the epicenter on the map, for each city construct a circle whose radius is equal to the distance from the city to the epicenter.

   B. Use the scale of distance of your map to set the drawing compass at the correct radius.

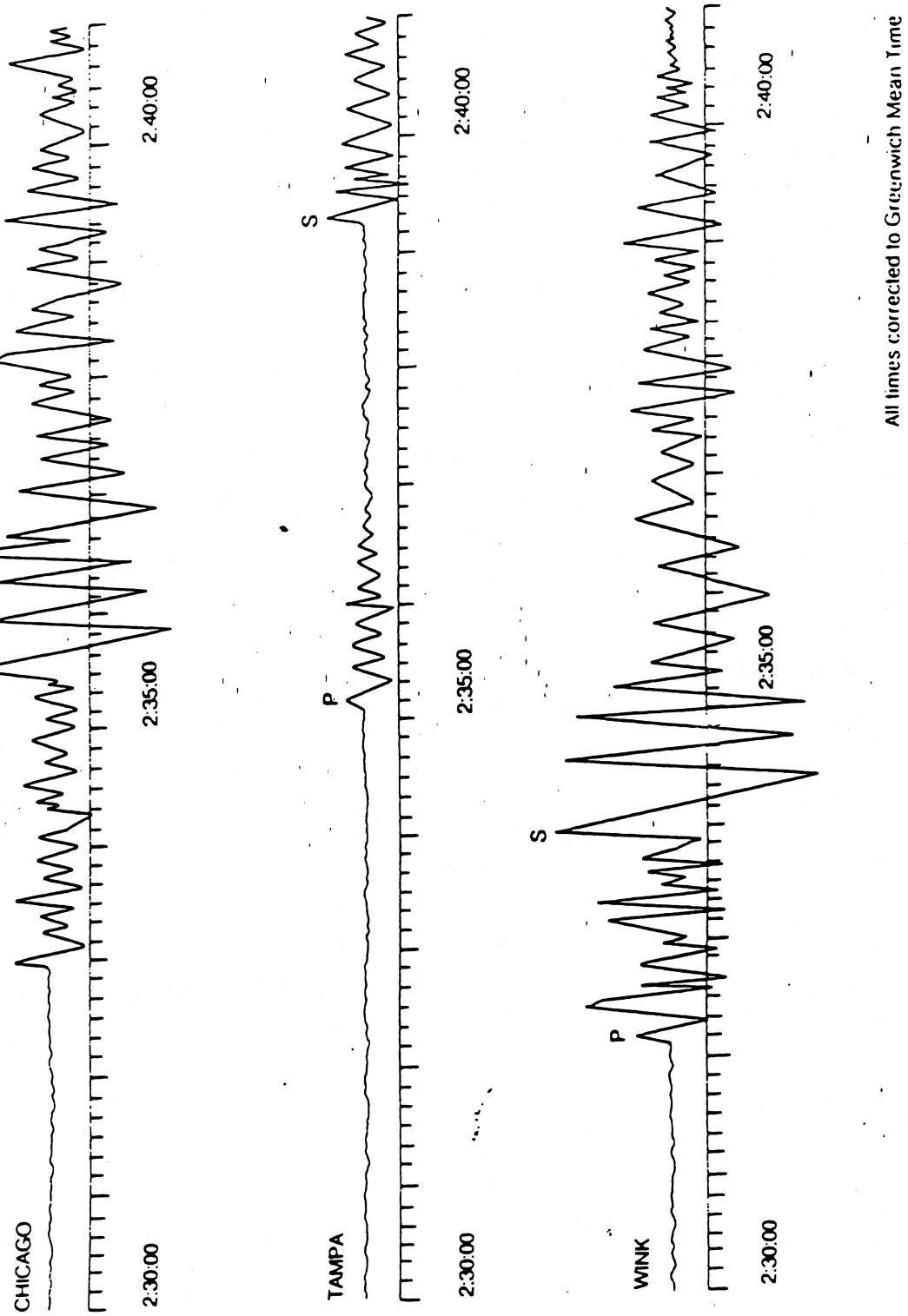
2. Mark and label the epicenter on the map where all three circles intersect.

FINDING EPICENTERS



Name _____ Date _____

SEISMOGRAMS



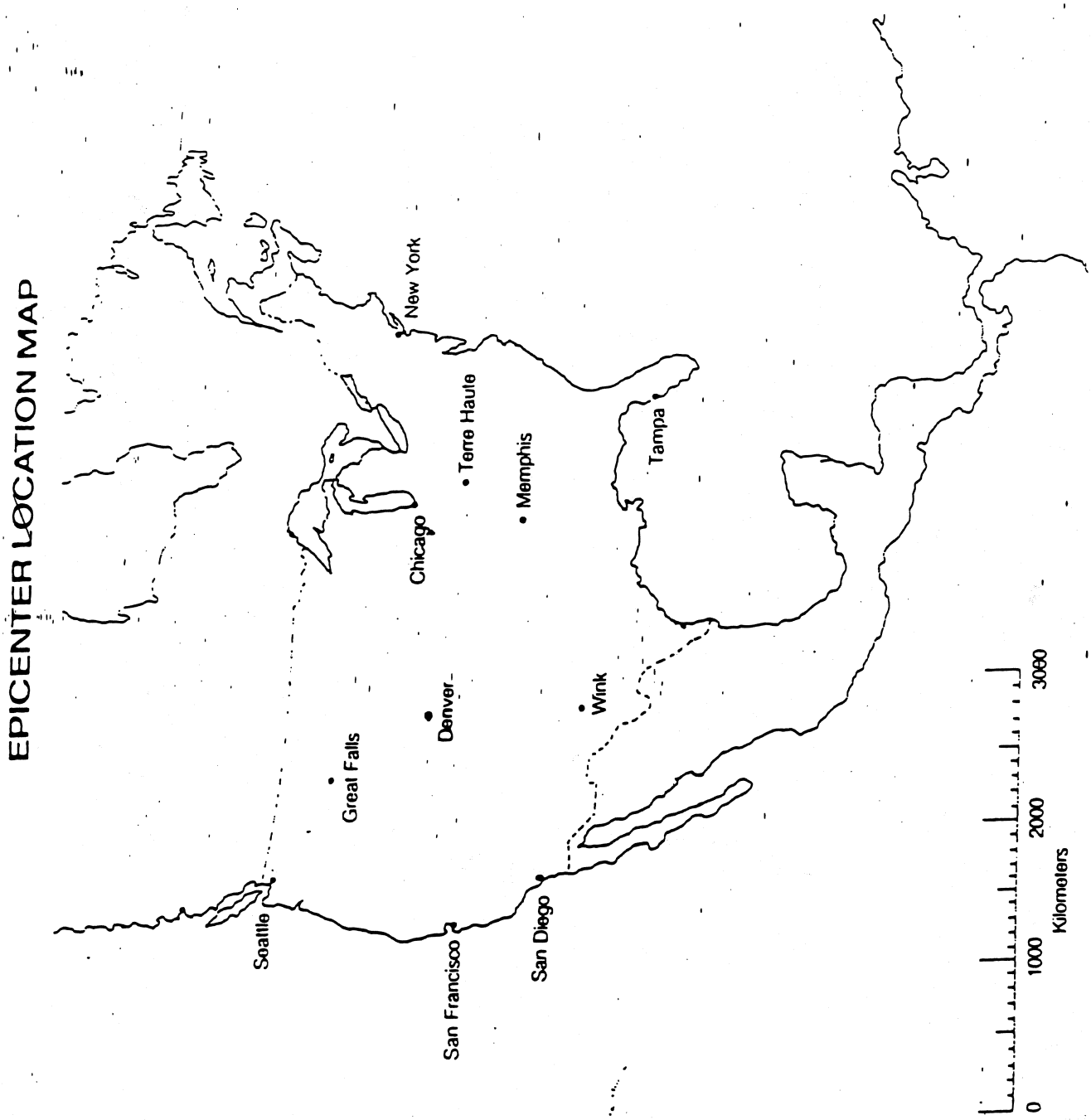
All times corrected to Greenwich Mean Time

Name _____ Date _____

REPORT SHEET

SEISMOGRAPH STATION	Arrival (clock time)		Difference in Arrival Time (min. and sec.)	Distance to Epicenter (km)	"P" Wave Travel Time (min. and sec.)	Time of Origin (hr., min. and sec.)
	"P" Wave	"S" Wave				
CHICAGO						
TAMPA						
WINK						

Name _____ Date _____


EPICENTER LOCATION MAP
New York
Terre Haute
Memphis
Tampa
Chicago
Denver
Great Falls
Wink
Seattle
San Francisco
San Diego
0
1000
2000
3000
Kilometers

Name _____ Date _____

Discussion Questions (Answer in complete sentences)

1. How do P-waves and S-waves differ?

2. What was the approximate location of the epicenter of this earthquake?

3. Why is three the minimum number of stations necessary to locate an epicenter?

4. Why does the time between the arrivals of the P-wave an S wave become greater and greater as you get farther away from the epicenter?

Conclusion:

1) Describe, step by step, how the epicenter of an earthquake can be located.

Name _____ Date _____

Earthquake P-wave and S-Wave travel time worksheet

1. Convert the following from scientific notation

   4×10^3

   3.2×10^3

2. Convert the following into scientific notation

   5,600

   10,000

3. Fill in the chart below

P-wave travel time	Distance from epicenter		S-wave travel time	Distance from epicenter
	2,000 km		12 min 40 sec	
11 min 20 sec				1,000 km
	6,800 km		2 min 20 sec	
8 min 40 sec				7,600 km

4. The difference between the P-wave and S-wave arrival time is given below. Find the distance to the epicenter.

Difference in arrival times	Distance to epicenter
3 min 20 sec	
5 min 40 sec	
7 min 00 sec	
9 min 50 sec	

5. The distance to the epicenter is given below. Find the difference in arrival time of the P-wave and S-wave.

Distance to epicenter	Difference in arrival times
2,000 km	
4,800 km	
7,200 km	

6. Find the origin time or the arrival time for the following scenarios.

Type of Wave	Distance to Epicenter	Arrival Time of Wave	Origin Time of Earthquake
P	1,000 km	3:10:30 PM	
P	5,2000 km		5:55:45 PM
S	3,800 km	5:05:45 PM	
S	6,600 km		1:02:58 PM

7. Find the distance to the epicenter for the following scenarios.

Type of Wave	Distance to Epicenter	Arrival Time of Wave	Origin time of Earthquake
P		3:40:55 AM	3:35:20 AM
P		7:20:40 PM	7:18:55 PM
S		10:15:38 PM	10:09:49 PM
S		2:02:38 PM	1:58:02 PM

8. How many epicenter distances must you plot in order to locate the location of the epicenter?

9. What can you determine if you know the arrival time of the P-wave and S-wave at a seismic station?

10. Are earthquakes cyclic?

Name _____ Date _____

LAB: CONTINENTAL DRIFT

INTRODUCTION: Since the early 19th Century, people have thought about the jigsaw fit of the continents. South America and Africa appear as though they could fit together.

Geologists have collected data that indicate that the continents are on separate "plates" of Earth's crust. Direct measurements of the relative motions of the continents have now shown that these semi-rigid plates are able to move toward or away from each other. They may also rotate. These motions are often associated with new crust (such as at the mid-Atlantic ridge) or they may force one plate to be consumed under another (for example, where the Pacific plate is being over-ridden by the Andes Mountains).

OBJECTIVE: You will see how the "jigsaw puzzle" pattern of the outline of the continents support the theory of Continental Drift.

VOCABULARY: Define the following in your own words

sea-floor spreading:

subduction:

San Andreas Fault:

rift zone:

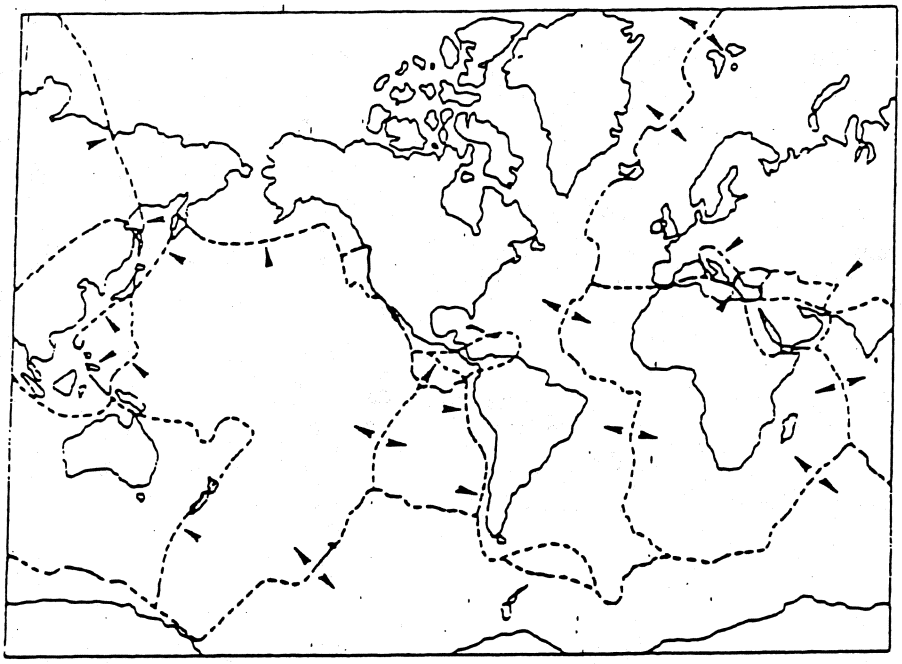
Pangaea:

PROCEDURE:

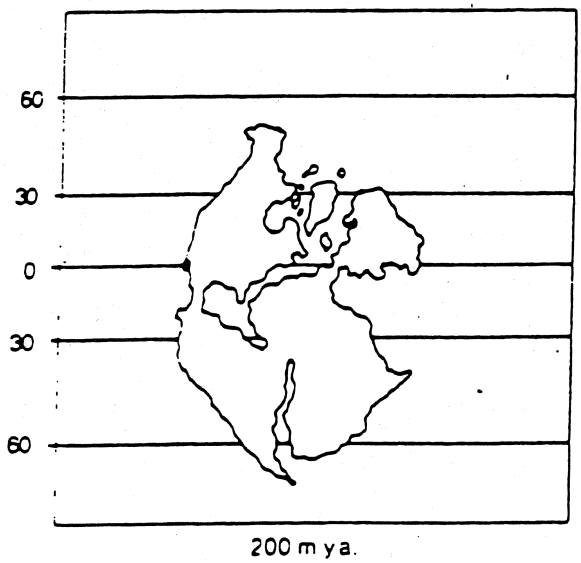
1. On the Cut-out page" cut out the continents along the dotted lines.
2. On a separate paper. fit them together to form one large landmass. Lines A and B should match up with their counterparts on the other continent.
3. Glue or tape the continents to the separate paper.

Name _____ Date _____

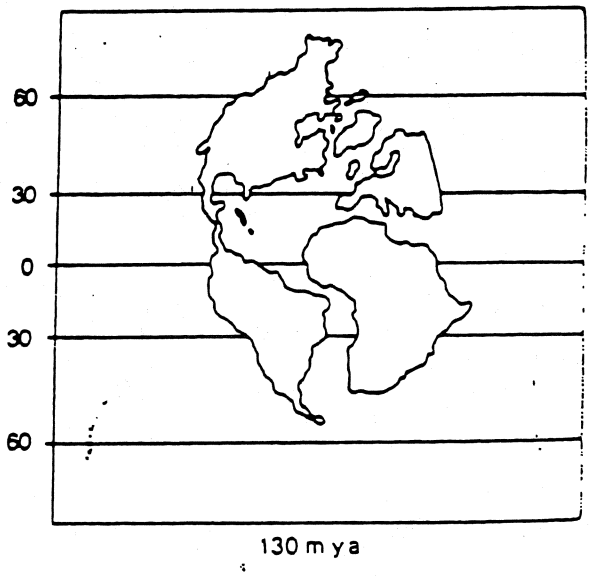
TECTONIC PLATES



CONTINENTAL DRIFT SEQUENCE



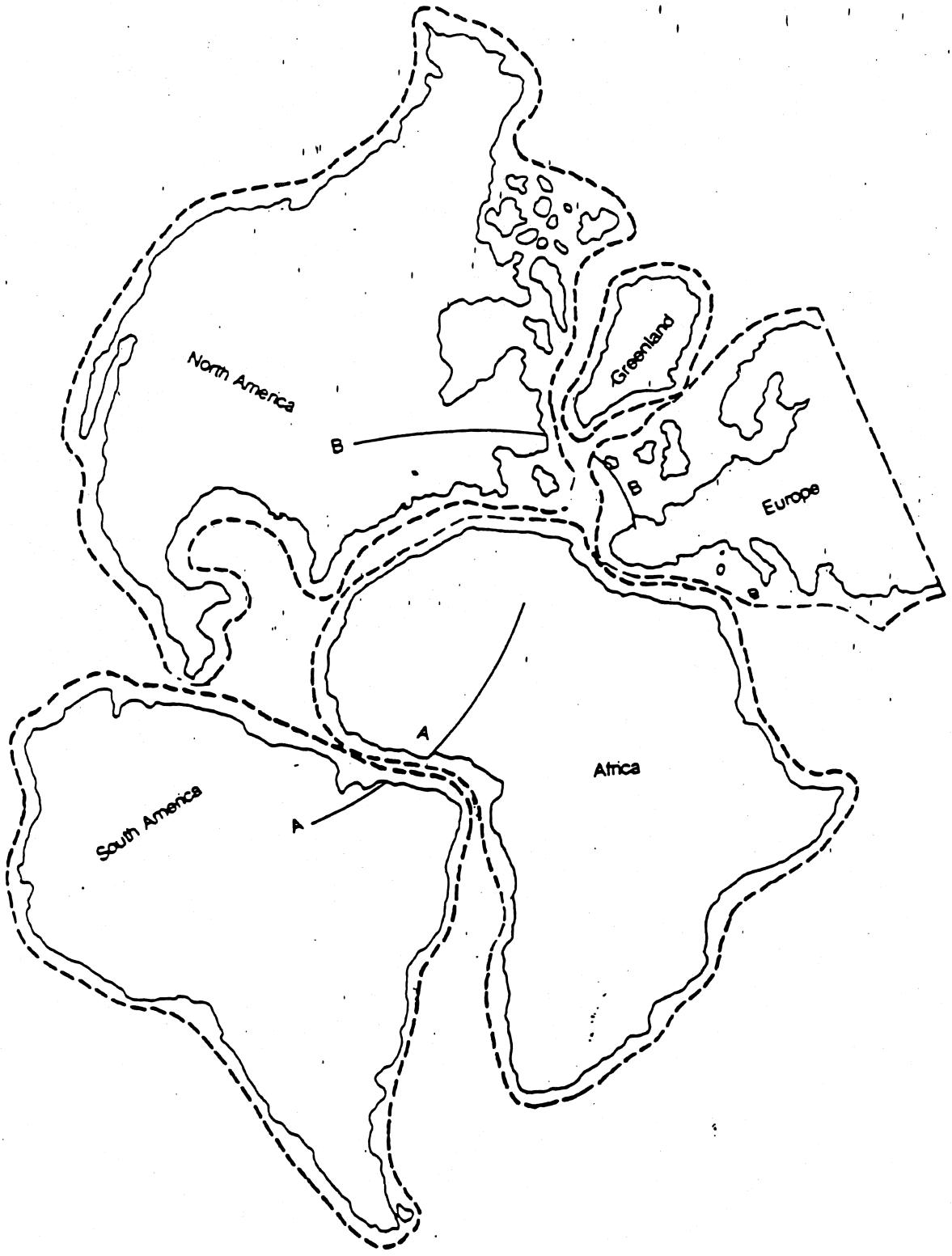
200 m y a.



130 m y a

The diagram on the left represents the continent 200 million years ago and the diagram to the right represents the inferred positions 130 million years ago.

Name _____ Date _____



Name _____ Date _____

DISCUSSION QUESTIONS: *(Answer in Complete Sentences)*

1. According to this lab, what was the inferred motion of North America relative to Africa that occurred 200 to 130 million years ago.

2. According to the maps of continental drift sequences, how has the position of North America relative to the equator changed over the last 200 million years?

3. Referring to the maps of continental drift sequences, compare the climate of the northeastern United States 200 million years ago to that of today.

4. Where in the United States is there measurable evidence that the continents are moving relative to one another?

5. What could explain the existence of coal deposits in Antarctica?

CONCLUSION: What evidence is there that the present-day continents were once a single landmass (Pangaea)?

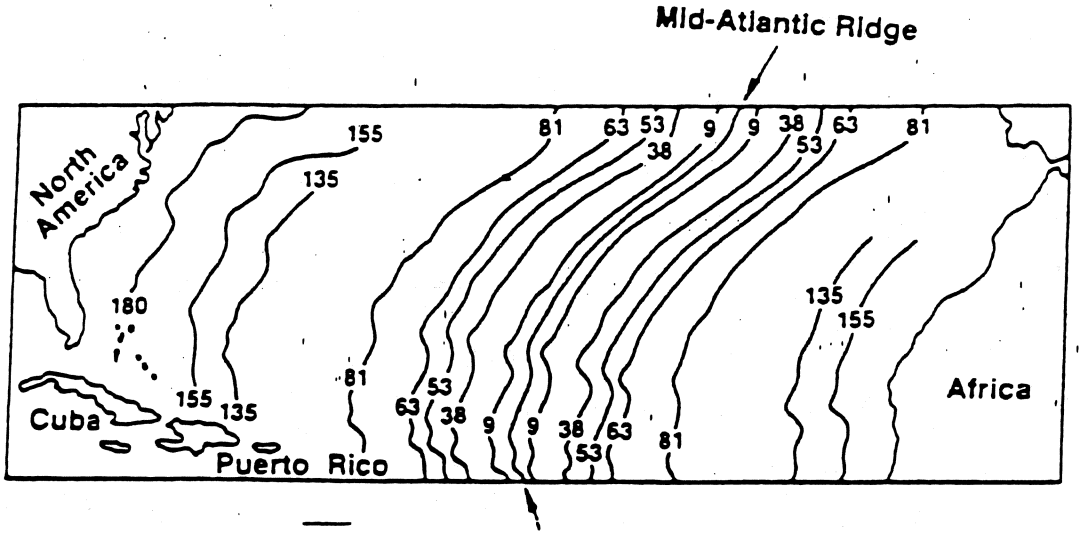
Name _____ Date _____

Lab: Evidence of Sea Floor Spreading

Directions: The diagram below shows a section of the ocean floor in the North Atlantic. The numbers represent the age in millions of years of the rocks found on the ocean floor. Use the diagram to answer the following questions.

Purpose: To become more familiar with sea floor spreading.

Materials: Colored pencils and your Earth Science Reference Tables.



Scale: 1 cm = 650 km

1) Locate the Mid-Atlantic Ridge and highlight it in red.

2) Highlight the age bands as follows:

9 million years - Yellow

63 million years - Light Blue

38 million years - Dark blue

81 million years - Orange

53 million years - Green

3) What happens to the age of the rocks on the seafloor as distance from the Mid-Atlantic Ridge increases?

Name _____ Date _____

4) Where are the oldest rock of the sea floor found?

5) What part of the ocean floor contains the youngest rock?

6) What type of rock is the ocean floor made up of?

7) What is occurring at the Mid-Atlantic Ridge that explains the pattern of ages in the rocks found on the ocean floor?

8) What type of boundary is found at the Mid-Atlantic Ridge?

9) Use your reference table and list 3 converging boundaries and 2 diverging boundaries.

Coverging	Diverging
1)	1)
2)	2)
3)	

Name _____ Date _____

LAB ACTIVITY:
DETERMINING HOW FAST A LITHOSPHERIC PLATE MOVES

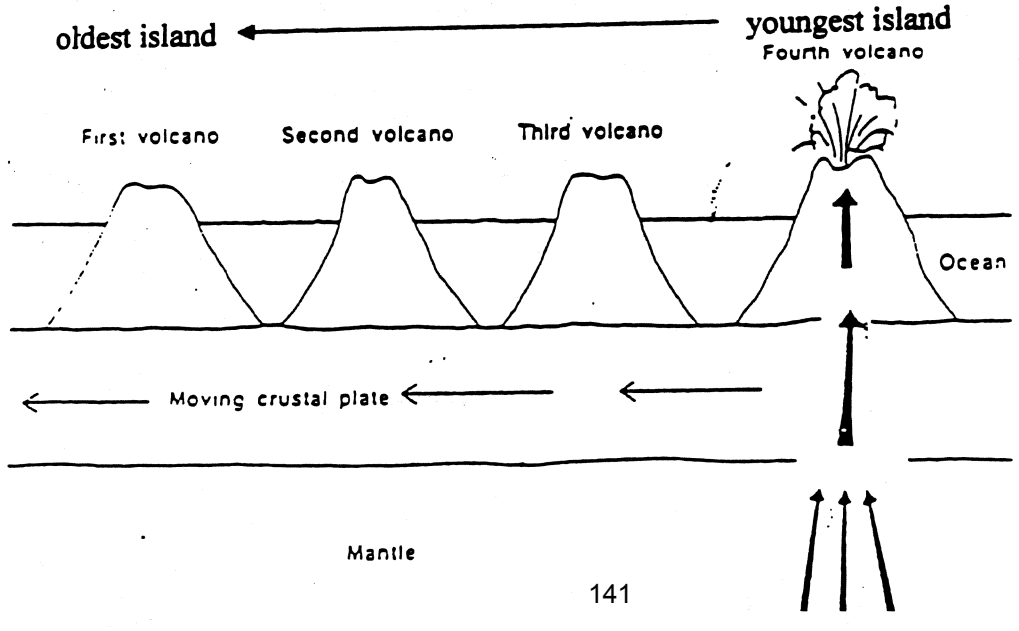
Read the following before beginning the written portion of this lab!

According to the theory of plate tectonics, the Earth's lithosphere, or outermost layer consisting of the crust and part of the mantle, is made of interlocking pieces, much like the cracked shell of a hard-cooked egg. The pieces of the lithosphere are known as lithospheric plates. The plates float across the surface of the hot, soft, flexible layer of the mantle that lies beneath them. (Scientists call this underlying layer the asthenosphere.)

Most of the Earth's volcanoes are found at the boundaries of the plates. But a few volcanoes are found, surprisingly, in the center of the plates. Such volcanoes are thought to be caused by "hot spots" located deep within the Earth—perhaps in the lower parts of the mantle or even in the core itself. Superheated molten material rises from a hot spot and 'burns through" the plate, creating a volcano.

Because hot spots are stationary, a chain of volcanic islands may be formed as an oceanic plate moves over a hot spot. SEE THE DIAGRAM BELOW. By determining when the islands in the chain were formed, it is possible to calculate how fast the plate is moving over a hot spot.

In this activity you will determine how fast the Pacific plate is moving over the hot spot that formed the Hawaiian Islands. The Hawaiian Islands are the most recent additions to the Hawaiian Island chain of volcanoes, which extends 3500 km northwesterly across the floor of the Pacific Ocean.

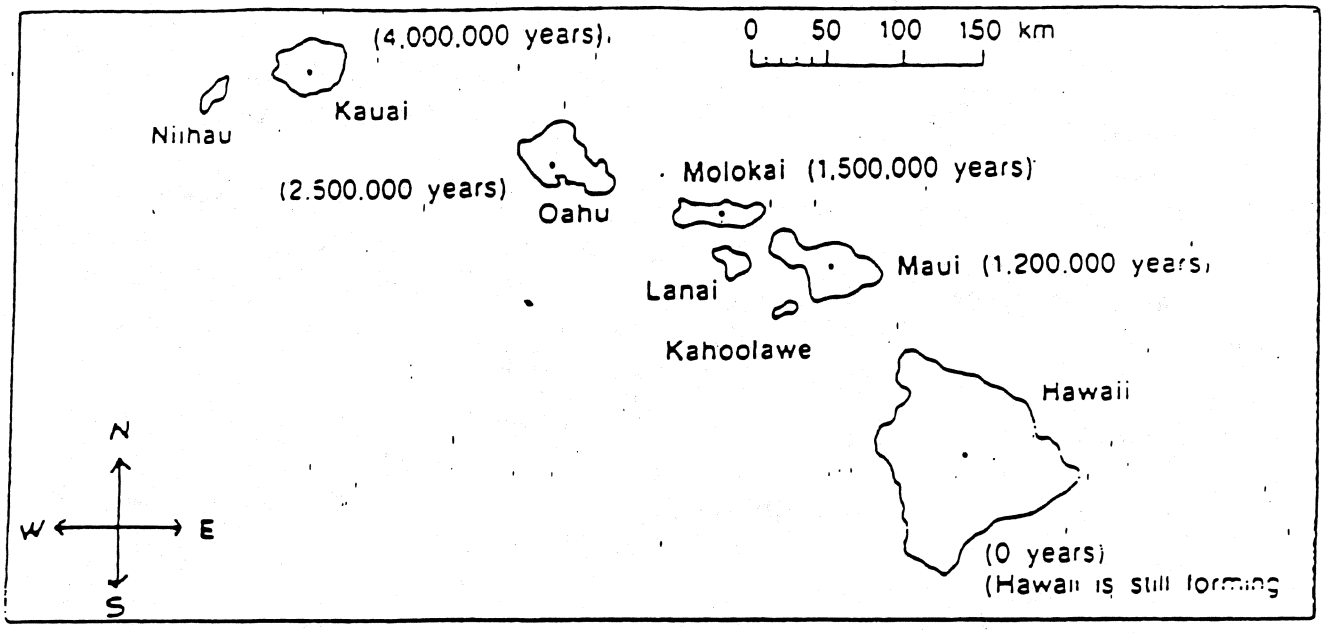


Name _____ Date _____

Directions:

1. Using the scale (in km) shown on the diagram, determine the distance between the five major islands and enter your answers in the first column in Data Table 1.

MEASURE THE DISTANCE BETWEEN THE DOTS PLACED AT THECENTER OF THE MAJOR ISLANDS.



DATA TABLE 1

Islands	Distance between the two islands		Difference in approximate Ages of the Two Islands (Years)
	(km)	(cm)	
Hawaii and Maui			
Maui and Molokai			
Molokai and Oahu			
Oahu and Kauai			

Name _____ Date _____

2: Convert each distance from kilometers to centimeters by multiplying the value in kilometers by 100,000. Enter the new data in the second column in Data Table 1.

Example: To convert 52 km to centimeters, one would do the following:
52 km x 100,000 = 5,200,000 cm (Add 5 zeros to the 52)

3. Calculate the approximate age differences between the islands and enter the data in the third column of Data Table 1. (Remember, when subtracting Hawaii from Maui, Hawaii is considered to be "0 years old" and still forming.)

4. Using the following formula, calculate the approximate speed at which the crustal plate was moving between the times that each of the islands formed. Enter your data in Data Table 2.

$$\text{Speed of crustal movement} = \frac{\text{Distance between the two islands (in centimeters)}}{\text{Difference in approximate ages of the two islands}}$$

(Use the information you entered in the second and third columns of Data Table 1 in order to complete Data Table 2).

DATA TABLE 2

Islands	Speed of Crustal Movement(cm/yr)
Hawaii and Maui	
Maui and Molokai	
Molokai and Oahu	
Oahu and Kauai	

Name _____ Date _____

5. Now that you have calculated the speed of crustal movement between the plates in Data Table 2, you will calculate the AVERAGE speed of crustal movement for the Pacific plate in centimeters/year.

- Remember, to find an average, add all 4 speeds in Data Table 2 and divide by 4.

Average speed of crustal movement = _____ cm/yr

CONCLUSION QUESTIONS:

1a. In which direction was the crustal plate apparently moving when the Hawaiian Islands were formed? _____

1b. Explain how you determined your answer : _____

_____

2a. Did the Pacific plate always move at the same speed? _____

2b. How do you know? _____

_____

_____

3. As the Pacific plate continues to move over the hot spot, predict what will happen southeast of the island of Hawaii in future geologic times.

_____

_____

_____

Name:_____ Date:_____

Interpreting Geologic History
Topic 13 - Vocabulary

Absolute age: _____

_____

Bedrock: _____

_____

Carbon-14 dating: _____

_____

Correlation: _____

_____

Extrusion: _____

_____

Fossil: _____

_____

Geologic time scale: _____

_____

Half-life: _____

_____

Inclusion: _____

_____

Index fossil: _____

_____

Name:_____ Date:_____

Intrusion: _____

_____

Isotope: _____

_____

Organic evolution: _____

_____

Outgassing: _____

_____

Principle of superposition: _____

_____

Radioactive dating: _____

_____

Radioactive decay: _____

_____

Species: _____

_____

Unconformity: _____

_____

Uranium-238: _____

_____

Volcanic ash: _____

_____

Name _____ Date _____

LAB: SEQUENCE OF EVENTS

INTRODUCTION: The geologist works to develop a model of Earth's history and attempts to put events in order of what happened first, what second, and so on. When the relative age of a rock or event is determined, this information can be diagramed as a cross-section showing the vertical distribution of geologic rock units.

This lab will not consider the actual or absolute age that an event occurred or the rock was formed.

OBJECTIVE: Using cross-sections you will infer a logical sequence of geologic events and establish a probable relative age for a series of rock layers.

VOCABULARY: Define the following in your own words

relative age:

unconformity:

erosional surface:

subsidence:

uplift:

emergence:

submergence:

uniformitarianism:

superposition:

original horizontality:

PROCEDURE:

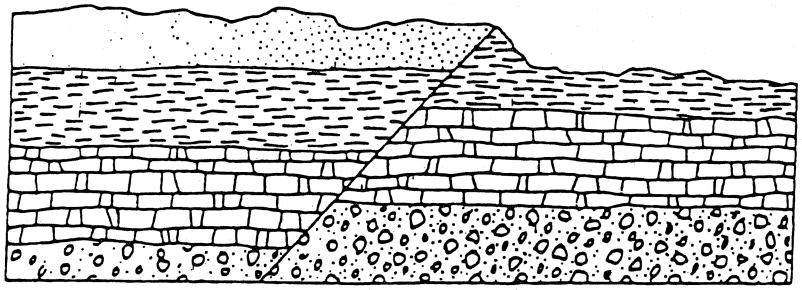
For each of the diagrams provided, determine which layer is the oldest and then tell what events took place in the proper order.

1. Use SEPARATE LINED PAPER and title it "Report Sheet".
2. Briefly describe the events that occurred in *numbered* steps. Start with the formation or deposition of the oldest layer. Be sure to indicate when any emergences or subsidences of the area must have occurred

Name _____ Date _____

GEOLOGIC CROSS-SECTIONS

1.



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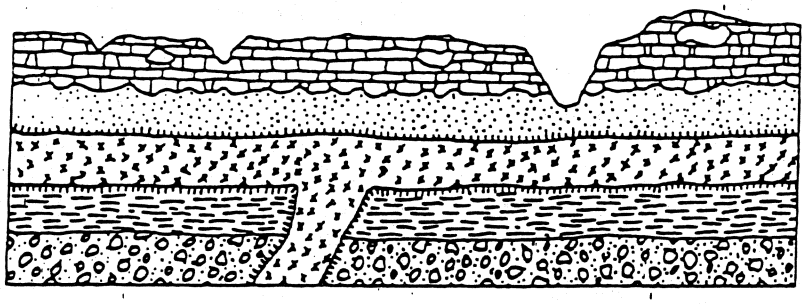

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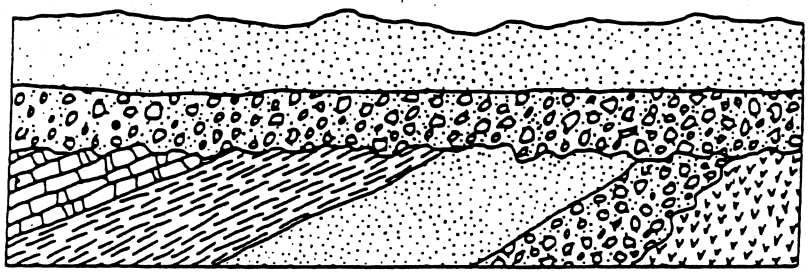
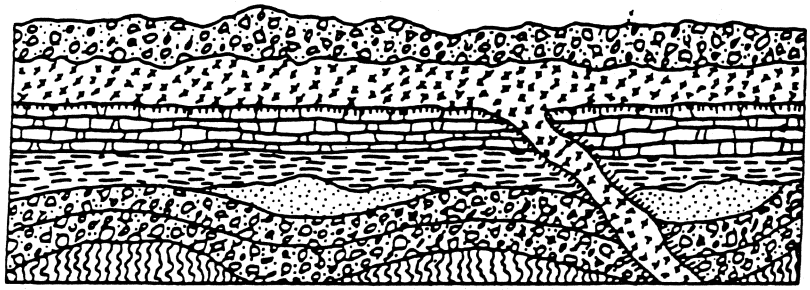


4.



KEY

- Limestone
- Sandstone
- Shale
- Conglomerate
- Basalt
- Granite
- Schist
- Contact Metamorphism

Name _____ Date _____

DISCUSSION QUESTIONS: *(Answer in Complete Sentences)*

1. Describe how the Principle of Superposition was used in determining the relative ages of the cross-sections.

2. In a cross-section suppose you find older rock layers on top of younger layers. Explain a probable cause for this exception to the Principle of Superposition.

3. Why is an igneous intrusion younger than the rocks in which it is found?

4. Explain why the age of a fault is younger than the rocks in which it is found?

5. In Diagram 1. explain why there is a difference in the surface topography on either side of the fault line.

6. In Diagram 2, how can you tell that the sandstone was not deposited on top of the basalt layer?

Name _____ Date _____

7. Explain why, in diagram 3, the most recent unconformity indicates that a long time has passed.

8. What evidence in diagram 4 is there to suggest there was a surface basalt flow rather than an intrusion?

CONCLUSION:What are the guidelines used to determine the relative ages of the rocks and events shown by a geologic cross-section? (List all forms of evidence)

Name _____ Date _____

LAB: A GEOLOGIC MAP

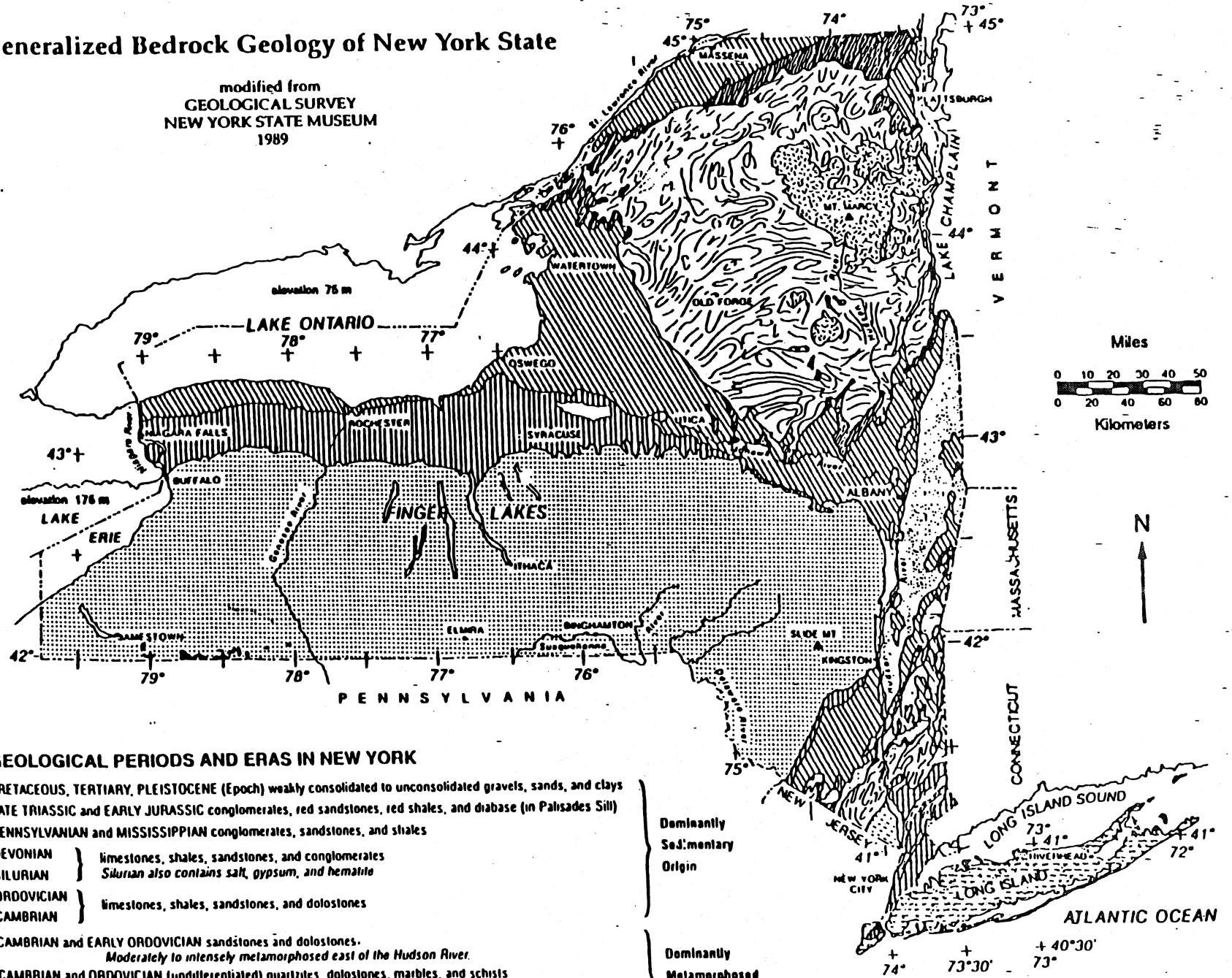
PURPOSE:
To have you become familiar with a geologic map, which is a map representing rock layers on the surface of the earth.

MATERIALS:
Colored pencils: light and dark blue, orange, red, pink, purple, yellow, black, light and dark green.
Earth Science Reference Tables

PROCEDRE:
1. Using the chart on the next page (Lithology of New York State Formations), and the map of New York State provided in the observations section of the exercise, color both the legend and the map with the colors listed on the chart. These colors are the standard colors used on geologic maps of all regions. Be careful not to color the legend so heavily that you cannot make out the pattern of the rocks represented on the map.
2. Use your reference table to help you in coloring.

Generalized Bedrock Geology of New York State

modified from
GEOLOGICAL SURVEY
NEW YORK STATE MUSEUM
1989



GEOLOGICAL PERIODS AND ERAS IN NEW YORK

- CRETACEOUS, TERTIARY, PLEISTOCENE (Epoch) weakly consolidated to unconsolidated gravels, sands, and clays
- LATE TRIASSIC and EARLY JURASSIC conglomerates, red sandstones, red shales, and diabase (in Palisades Sill)
- PENNSYLVANIAN and MISSISSIPPIAN conglomerates, sandstones, and shales
- DEVONIAN, SILURIAN — limestones, shales, sandstones, and conglomerates; *Silurian also contains salt, gypsum, and hematite*
- ORDOVICIAN, CAMBRIAN — limestones, shales, sandstones, and dolostones

Dominantly Sedimentary Origin

- CAMBRIAN and EARLY ORDOVICIAN sandstones and dolostones. *Moderately to intensely metamorphosed east of the Hudson River.*
- CAMBRIAN and ORDOVICIAN (undifferentiated) quartzites, dolostones, marbles, and schists. *Intensely metamorphosed; includes portions of the Taconic Sequence and Cortlandt Complex*
- TACONIC SEQUENCE sandstones, shales, and slates. *Slightly to intensely metamorphosed rocks of CAMBRIAN through MIDDLE ORDOVICIAN ages*
- MIDDLE PROTEROZOIC gneisses, quartzites, and marbles. *Lines are generalized structure trends*
- MIDDLE PROTEROZOIC anorthositic rocks

Dominantly Metamorphosed Rocks

Intensely Metamorphosed Rocks (regional metamorphism about 1,000 m y a)

Name _____ Date _____

Name _____ Date _____

Lithology of New York State Formations

*Time unit**	*Age, millions of years ago*	*Lithology (type of rock)*	*Comments*
Early Precambrian (blue)	1,100 to 570	anorthosite	intensely metamorphosed
Late Precambrian (orange)	more than 570	gneiss, marble, quartzite	intensely metamorphosed
Cambrian and Ordovician (red)	570 to 435	intensely folded and faulted shale, slate, sandstone, limestone, schist, gneiss, marble	slightly to moderately metamorphosed
Cambrian (pink)	570 to 500	sandstone, dolostone	dominantly sedimentary
Ordovician (purple)	500 to 435	shale, sandstone, limestone	dominantly sedimentary
Silurian (yellow)	435 to 395	sandstone, dolostone, limestone, shale, salt beds, conglomerate	dominantly sedimentary
Devonian (light green)	395 to 345	shale, sandstone, limestone, siltstone	dominantly sedimentary
Pennsylvanian and Mississippian (black)	345 to 270	sandstone, conglomerate	dominantly sedimentary
Triassic (dark green)	205 to 195	red sandstone, shale conglomerate, with diabase intrusion	dominantly sedimentary—palisades sill intruded
Cretaceous Tertiary Pleistocene epoch* (dark blue)	100 to 65 65 to now 2 to now	glacial sediments: clay, sand, gravel	dominantly sedimentary—unconsolidated sediments

* All time units are geologic periods except where noted.

Name _____ Date _____

Analysis and Conclusion

Use the generalized landscape regions map and the geologic map to answer the following questions.

1 Which geologic eras (Precambrian. Paleozoic, Mesozoic, Cenozoic) arc represented on the map?

2 Which periods are represented in each era?

3) Which periods are missing from the map of New York?

4) Which type of rock covers the largest amount of New York State? _____

5) Why are certain periods missing from the rock record? _____

6) In which landforms of New York State do the oldest rocks occur?

7) In Which landform of New York State do the most sedimentary rocks occur?

Name _____ Date _____

8) In which landforms of New York State are most of the metamorphic rocks found?

9) Which formations would probably contain the most fossils?

10) Which landform contains igneous rocks?

11) Which landform contains the youngest rocks?

12) In general, what type of rock is found in the plains (lowlands) region?

13) In general, what type of rock is found in the plateau regions (uplands)?

14) Where would a person have to go in order to find marble?

15) Which rock formation is found in the smallest quantities in New York State?

Location	Latitude & Longitude	Generalized Bedrock/Geological Period or Era	Generalized Landscape Region
Plattsburgh			
Elmira			
Slide MT			
Rochester			
Watertown			
Old Forge			
Massena			
Lawrence			

Name _____ Date _____

LAB: MATCHING ROCK LAYERS

INTRODUCTION: Geologists can determine the relative ages of the rock layers in a rock formation. But how do they determine whether the rocks or geologic events occurring at one location *are* of the same age as those at another location? The process of showing that rocks or geologic events occurring at different locations are of the same age is called CORRELATION.

Geologists have developed a system for correlating rocks by looking for similarities in composition and rock layer sequences at different locations. Certain fossils, called INDEX FOSSILS, existed for a very short time and were distributed over a large geographic area. They aid the geologist in correlating sedimentary rock layers.

OBJECTIVE: You will be able to construct a geologic history of a region by observing rock layers in different localities.

VOCABULARY: Define the following terms in your own words.

Absolute age:

Index fossil:

Correlation:

PROCEDURE A:

The first set of four diagrams represent 4 outcrops at different locations in New York State.

1. Reconstruct the complete sequence of events. Assume that the oldest rocks are on the bottom and the youngest are on top.
2. Draw in the layers on the appropriate column of the Report Sheet.

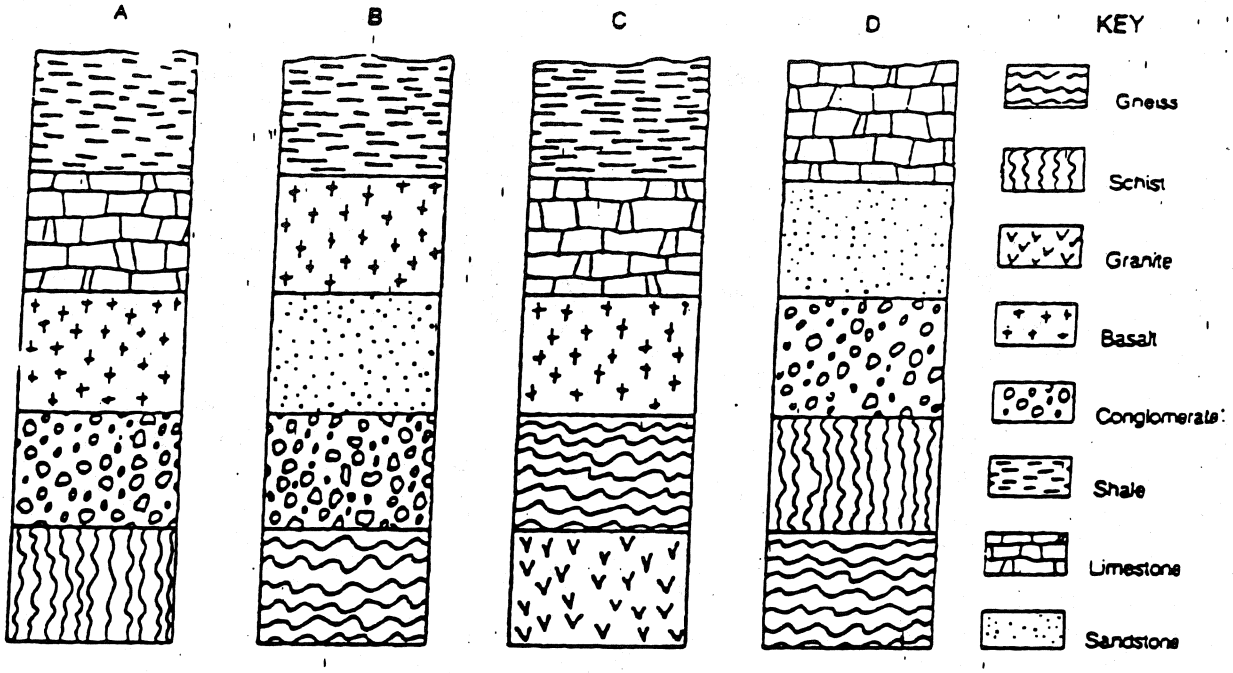
PROCEDURE B:

The second set of diagrams identifies four types of index fossils and shows four columns of fossil bearing rock strata.

1. Reconstruct the complete sequence of events and draw the layers (with the fossils it present) on, the appropriate column of your Report Sheet.
2. By referring to your Reference Tables, identity any layer for which you have enough evidence to determine its age. On the Report Sheet, label its age and period/epoch. The abbreviation "mybp" stands for millions of years before present. It may be expressed as a range of several million years.

Name _____ Date _____

A: OUTCROPS FROM FOUR LOCATIONS



INDEX OF DIFFERENT GEOLOGIC PERIODS

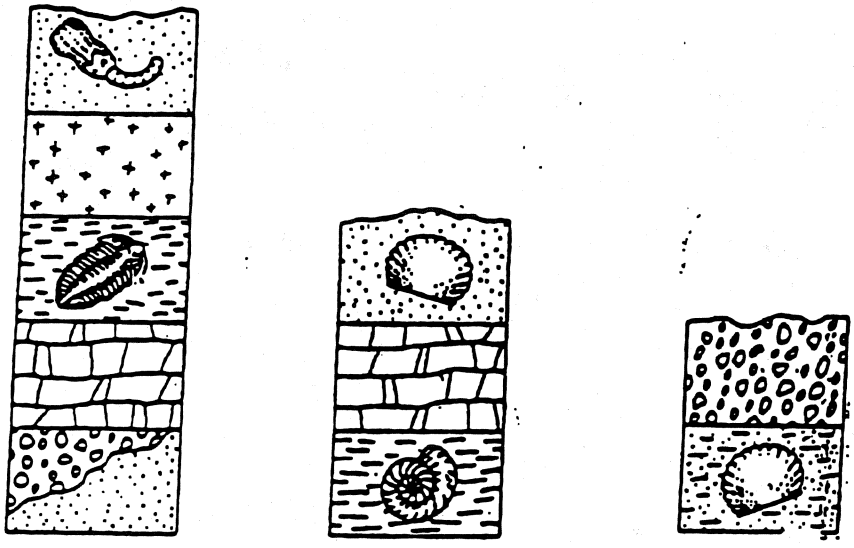
PECTEN
(Tertiary Period)

CRINOID
(Mississippian Epoch)

AMMONITE
(Cretaceous Period)

TRILOBITE
(Devonian Period)

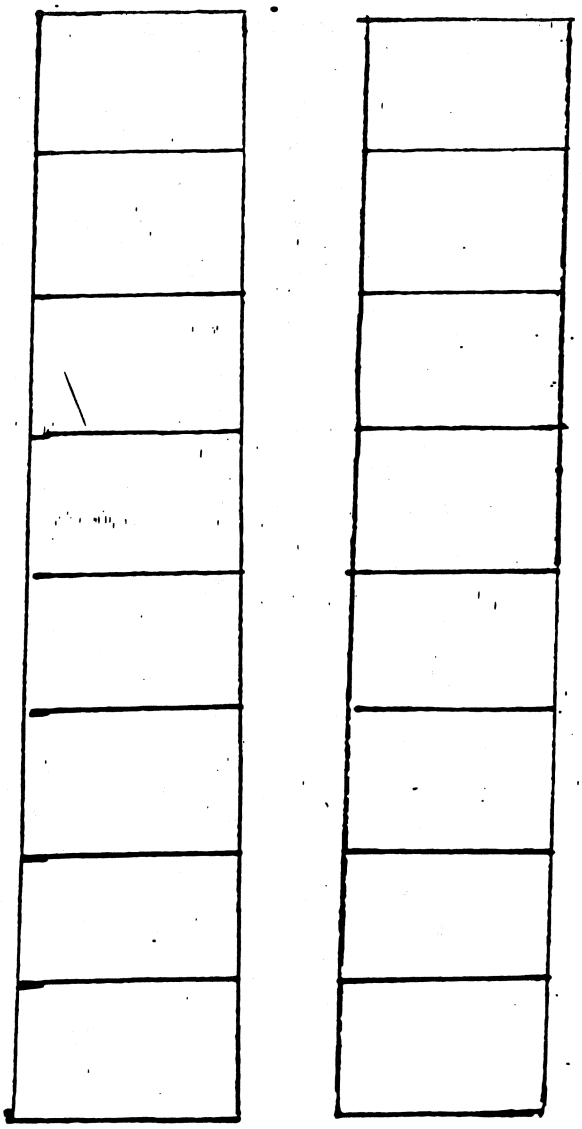
B: ROCK STRATA CONTAINING INDEX FOSSILS



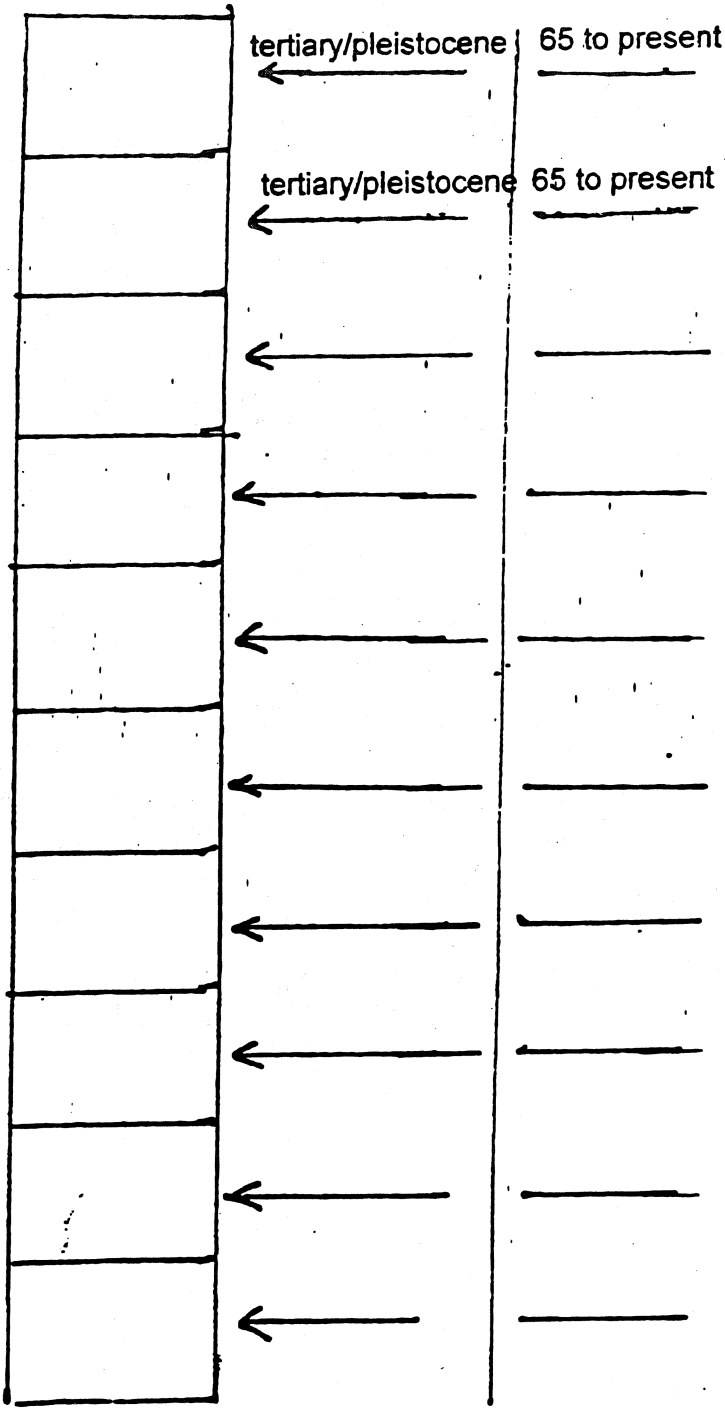
Report Sheet

Procedure A

Reconstruct the sequence of events. Assume the oldest rocks are on the bottom and the youngest rocks are on the top.



Procedure B



Name _____ Date _____

Answer the following questions in complete sentence:

1) Explain why some rock layers can be missing from the sequence in some outcrops.

2) What does a field geologist look for in rock outcrops to help identify the different rock layers?

3) Why is it easier for you to correlate diagrams than it is for a geologist in the field to reconstruct a sequence of events?

4) What is the approximate age of the rock stratum at the very bottom of the fossil bearing sequence? (Procedure B)

5) Approximately how many years are represented between the deposition of the bottom and top layers? (Procedure B)

6) Explain how it is possible that a given type of fossil may be found in a rock stratum at one outcrop, but missing from that same layer in another outcrop.

7) Why is it necessary to observe the rock layers of several different localities in order to obtain a complete sequence of events?

Name_____ Date_____

Radioactive Decay of Carbon-14 to Nitrogen-14

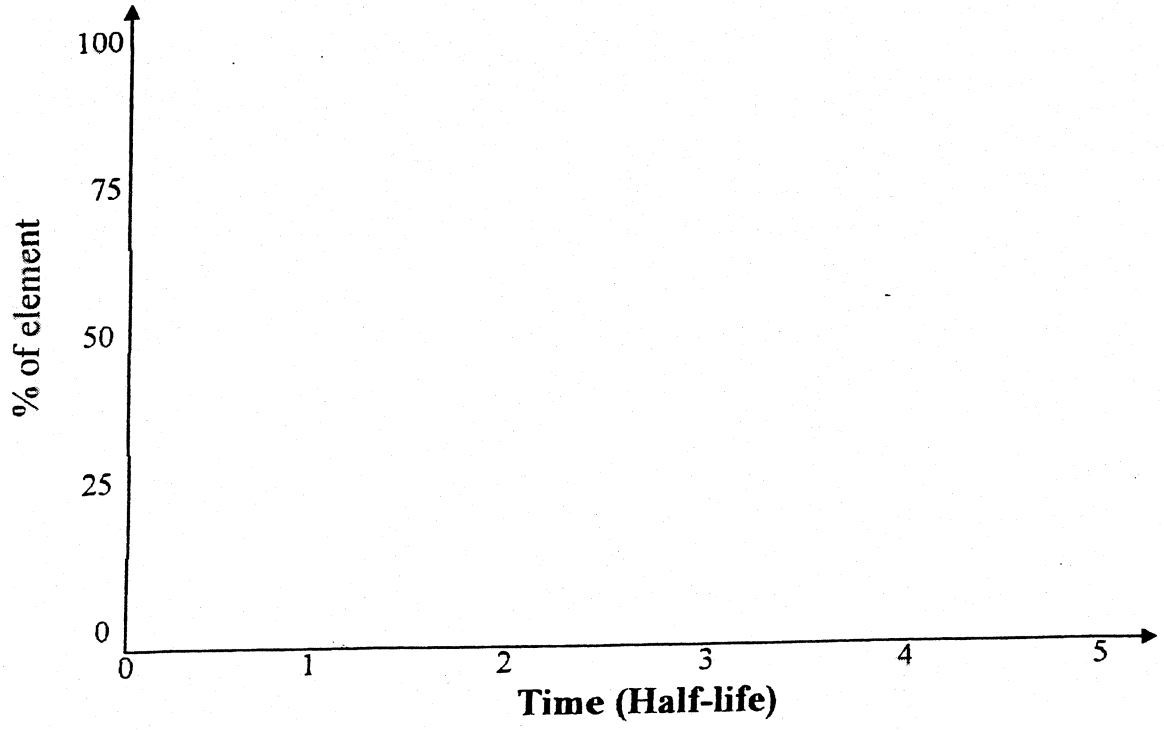
Carbon-14 half life: _____

# of Half lives	Parent %	Parent Fraction	Daughter %	Daughter Fraction	Ratio	# of years

Graph the Parent - Daughter % of decay

Parent – Carbon-14 ▭

Daughter – Nitrogen-14 ▭



Name:_____ Date:_____

Lab - The Half-Life of Hershium

PURPOSE:
To demonstrate the half-life of the imaginary atom, Hershium.

HYPOTHESIS:
How many trials do you estimate it would take to decrease the amount of Hershium you begin with by fifty percent?

MATERIALS:
100 M & M's
100 Skittles
plastic bag
paper towel
graph paper
calculator

PROCEDURE:
1. Take a plastic bag with 100 M & M's in it. The M & M's represent atoms of a radioactive isotope called Hershium.
2. Gently shake the bag of M & M's. Empty the contents of the bag onto the paper towel.
3. The pieces that have the "M & M" writing face-up represent the atoms which have undergone radioactive decay to form the stable isotope Candium. Count them and record your amount in the data table.
4. Replace the M & M's removed with the skittles which represent the stable isotope Candium. Dispose the M & M's removed in the safest way possible – Eat Them!
5. Put the skittles, which represent the new stable isotope, back into the plastic bag. Also place the M & M's that do not show the writing back into the plastic bag. These represent the nuclei which have not yet undergone radioactive decay.
6. Repeat steps 2 through 5. Each time there should be fewer M & M's and more skittles placed back into the bag.
7. Continue until your are only left with skittles in the bag.
8. Make a line graph of the results. Label the Y-axis: Number of Radioactive Nuclei at the Start of Each Trial. It should go up to 100. Label the X-axis: Trial Number

Name:_____ Date:_____

DATA TABLE:

Trial Number	Number of M&M's Started With	Number of M &M's Decayed (Removed)	Number of Stable Isotopes (Skittles)	Number of M & M's Still Radioactive

Name:_____ Date:_____

Analysis and Conclusion Questions

1. What is the definition of half-life?

2. What is the relationship between the number of half-lives and the amount of radioactive substance remaining?

3. What is the relationship between the amount of radioactive substance and the decay product?

4. Which radioactive isotope is most useful in dating geologically recent organic objects?

5. What is the half-life of Potassium in years (not in scientific notation)?

6. Which radioactive element has under gone one half live since the origin of the Earth?

Name:_____ Date:_____

Landscape Development and Environmental Change
Topic 14 - Vocabulary

Escarpment: _____

_____

Landscape: _____

_____

Landscape region: _____

_____

Mountain: _____

_____

Plain: _____

_____

Plateau: _____

_____

Ridges: _____

_____

Stream drainage pattern: _____

_____

Uplifting forces: _____

_____

Name: _____ Date: _____

Reference Table Work Sheet

Answer the following questions using your Earth Science Reference Table.

1. Which Radioactive isotope has the longest half-life? Shortest?
2. Which material has the highest specific heat? Lowest?
3. How much energy does water release when it is frozen?
4. How much energy does water need to gain when it vaporizes?
5. What is the formula for percent deviation and eccentricity?
6. What is the New York State fossil?
7. During which geologic period was the Allegheny Plateau formed?
8. What type of generalized bedrock makes up the Tug Hill Plateau?
9. What are the coordinates for Buffalo, NY?
10. Where would you find the youngest generalized bedrock in New York State?
11. What warm water current affects the east coast of Asia?
12. What cool water current affects the west coast of North America?
13. What cool water current encircles the Earth at 60°S?
14. What type of fault/plate boundary is the Mid-Atlantic ridge?
15. What type of plate boundary is formed between the Eurasian plate and the Indian-Australian plate?
16. What can be found at 20°N, 155°W on the tectonic plates table?
17. How can a sedimentary rock become igneous rock?
18. List two different ways that metamorphic rock can become sedimentary rock.
19. How fast must a stream move in order to move a 1.0 cm pebble?
20. What is the largest particle diameter that a stream velocity of 300 cm/sec can move?

Name: _____ Date: _____

21. An extrusive fine grain Igneous rock that is made of plagioclase feldspar, pyroxene, olivine, and amphibole is _____?

22. The term clastic means ?

23. The metamorphic rock that is foliated, has medium grains, and has mica cyrstals from the metamorphism of clay is ?

24. During which period were the invertebrates dominant?
How many years ago was that?

25. Could humans have had dinosaurs as pets? Explain your answer using page 8 + 9 of your reference table.

26. What element is most abundant in the hydrosphere?

27. What element is most abundant in the crust by volume?

28. How many degrees C is 60 F?

29. How many degrees F is 37.5 C?

30. At what temperature does ice melt in Kelvin?

31. 1013.2 mb is how many inches of Hg?

32. 29.44 inches of Hg is how many mb?

33. An air mass that is labeled as mT has what characteristics?

34. Draw the symbol for warm front.

35. Thunderstorms are shown on a station model by ____.

36. Where on a station model is the temperature located?

37. Where on a station model is air pressure located?

38. What is the density of the mantle?

39. What layer of the Earth has a pressure of 2 million atmospheres?

40. How many Km below the surface does the outer core start?

41. In which layer of the atmosphere is all the water vapor located?

Name: _____ Date: _____

42. What is the temperature in degrees C of the Stratopause?

43. What is the altitude of the Mesopause in miles?

44. What happens to atmospheric pressure as you increase your altitude?

45. What type of Electromagnetic energy has the shortest wavelength?

46. Which color of the visible spectrum has the longest wavelength?

47. What type of Electromagnetic energy has a wavelength of .00001cm?

48. In the Northern Hemisphere in which direction are planetary winds deflected?

49. What type of moisture belt occurs at 30 degrees N latitude?

50. What is the temperature of our star, the sun?

51. Which type of stars have the lowest temperature and the lowest luminosity?

52. Where so most stars fall on the temperature and luminosity chart?

53. Which type of stars burn the hottest and are the most massive?

54. What color do the coolest stars burn?

55. Which planet has a day that is longer than its year?

56. Which planet is the most dense?

57. Which planet has the most circular orbit?

58. Which mineral is composed entirely of carbon?

59. Which mineral is an ore of iron?

60. Which mineral has a hardness of 7 and is used in electronics?

Name:_____ Date:_____

Reference Table Answer Sheet

1. _____ _____
2. _____ _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____ _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
_____
18. _____
19. _____
20. _____
21. _____

Name:_____ Date:_____

22._____

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23._____

24._____ _____

25._____

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31._____

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33._____

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36._____

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38._____

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40._____

41._____

Name:_____ Date:_____

42. _____

43. _____

44. _____

45. _____

46. _____

47. _____

48. _____

49. _____

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51. _____

52. _____

53. _____

54. _____

55. _____

56. _____

57. _____

58. _____

59. _____

60. _____

101 WAYS TO PASS THE EARTH SCIENCE REGENTS

1. The same substance has the _____ density.
2. As pressure increases, density

   _____.
3. As temperature increases, density

   _____.
4. Water expands when it _____ causing density to

   _____.
5. Most changes are _____.
6. Water is densest at _____ degrees Celsius, when it is a

   _____.
7. The true shape of the earth is an _____

   _____.
8. The best model of the earth's shape is a

   _____.
9. The altitude of Polaris equals your

   _____
10. _____ Lines go east-west just like the equator but measure distances _____ and _____
11. _____ Lines go north south but measure east and west
12. Longitude is based on observations of the _____.
13. Use the Reference Tables.
14. The closer the isolines (contour, isobar, isotherm) the _____ the slope (gradient).
15. The earth _____ from west to east (24 hours)

16. The earth _____ counterclockwise(365 1/4 days)

17. All celestial objects appear to move _____ to _____.

18. The moon has phases because it _____ around the _____. (Remember half is always lit)

19. Summer solstice is _____

20. Winter solstice_____

21. Equinoxes are _____ and _____

22. The equator always has _____ hours of daylight

23. The lower the altitude of the sun, the _____ the shadow.

24. Foucault's pendulum and Coriolis effect prove the earth _____

25. The Earth is closer to the sun during the _____ season.

26. The closer a planet is to the sun, the _____ it orbits.

27. _____model is earth centered.

28. _____model is sun centered.

29. _____ absorbs _____ reflects.

30. _____ transfers energy by direct contact (solids)

31. _____ transfers energy due to density differences in fluids. (gases and liquids)

32. Energy moves from source to sink, _____ to _____.

33. _____energy is energy of motion

34. _____ energy is stored energy

35. There is NO _____ change during a phase change.

36. _____ is heat energy that is re-radiated by the earth.

37. Liquid water heats up _____ than land because of its higher _____ _____

38. Carbon dioxide, water vapor and methane absorb _____radiation.

39. Good absorbers of radiation are also good _____.

40. The hottest time of the year is after _____ (give date)

41. Hottest part of the day is after _____

42. As temperature increases, air pressure _____.

43. As moisture content increases, air pressure _____.

44. Air pressure decreases with _____ altitude.

45. Highs are _____ & _____ , lows are _____ & _____

46. _____ is due to air pressure differences

47. Wind blows from _____ to _____ pressure

48. Winds are named for the direction they

_____.

49. Highs blow _____ and _____wise.

50.

51) Lows blow _____ and _____wise.

51.

52) Weather patterns (in the U.S) move from _____ to

_____.

52. _____ front _____ front

53. _____ fronts move the fastest.

54. The closer the air temperature is to the dew point the greater the chance for _____

55. Porosity _____ _____ depend on particle size.

56. As particle size _____ permeability

_____

57. Capillarity increases when particle size _____.

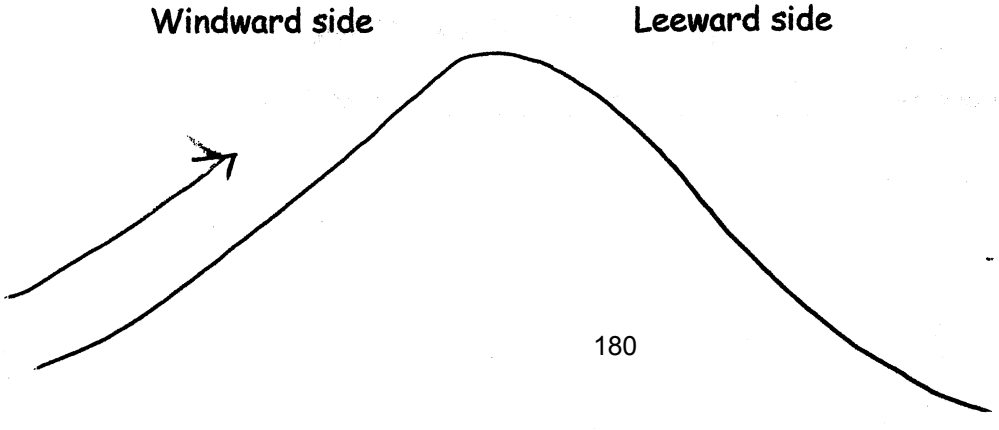
58. Ep (potential evapotranspiration) depends on

_____.

59. Large bodies of water _____ temperatures.

60. Air _____ as it rises.

61. Orographic effect (label the diagram)



62. _____ is the force behind all erosion.

63. _____ _____ is the primary agent of erosion.

64. Stream velocity depends on _____ and _____.

65. Velocity is faster on the _____ of a meander. (bend)

66. Heavy-dense-round particles settle _____ in water.

67. Graded bedding (vertical sorting) _____ sediments are on the bottom

68. Glacial sediments are _____, scratched and form _____shaped valleys.

69. Stream deposits are _____, round, and form _____ shaped valleys.

70. Sedimentary rocks-strata-flat layers- most likely to have _____.

71. When igneous rocks cool fast, _____ crystals form.

72. When igneous rocks cool slowly, _____ crystals form.

73. _____ rocks may be foliated.

74. Mineral properties depend on _____ _____ of the molecules.

75. Silicon-oxygen _____ is the basic unit of minerals.

76. Mid-ocean ridges are where _____ is created.

77. _____ crust is thin and made of basalt

78. _____ crust is thick and made of granite

79. Mountains form by _____

80. Dynamic equilibrium means _____

81. Trenches are where _____ is destroyed. (recyled)

82. P-waves travel _____ than S-waves.

83. P waves travel through _____ & _____, but S- waves through _____ only

84. You need _____ seismic stations to plot an epicenter.

85. Undisturbed strata - bottom layer is _____.

86. Intrusions and faults are _____ than the rock they are in.

87. An _____ means erosion

88. An arid landscape has _____ slopes with _____ angles

89. A humid landscape has _____ slopes with _____ angles

90. _____ weathering occurs mostly in warm, humid climates

91. _____ weathering occurs mostly in cold, humid climates (good for frost wedging)

92. Uranium-238 dates _____ rocks.

93. Carbon-14 dates _____, once living objects.

94. The half-life of a radioactive element _____ be changed

95. _____ _____ are good time markers (widely spread, lived a short time)

96. Apparent diameter of objects (sun, moon) gets larger when _____ to Earth

97. Vertical rays (overhead sun) can only occur between _____°N & _____°S

98. The red shift (Doppler Effect) is evidence that the universe is _____.

99. Our sun is a medium size star in the galaxy called the _____ _____.

100. The theory of the formation of the universe is called the _____ _____theory.

101. Terrestrial (rocky) planets are _____ dense than Jovian (gaseous) planets..

READ CAREFULLY & CIRCLE KEY WORDS ... USE YOUR _____ _____

The University of the State of New York • THE STATE EDUCATION DEPARTMENT • Albany, New York 12234 • www.nysed.gov

Reference Tables for Physical Setting/EARTH SCIENCE

Radioactive Decay Data

RADIOACTIVE ISOTOPE	DISINTEGRATION	HALF-LIFE (years)
Carbon-14	$^{14}C \rightarrow {}^{14}N$	5.7×10^3
Potassium-40	$^{40}K \rightarrow {}^{40}Ar$, $^{40}K \rightarrow {}^{40}Ca$	1.3×10^9
Uranium-238	$^{238}U \rightarrow {}^{206}Pb$	4.5×10^9
Rubidium-87	$^{87}Rb \rightarrow {}^{87}Sr$	4.9×10^{10}

Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

Equations

$$\text{Eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

$$\text{Gradient} = \frac{\text{change in field value}}{\text{distance}}$$

$$\text{Rate of change} = \frac{\text{change in value}}{\text{time}}$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Properties of Water

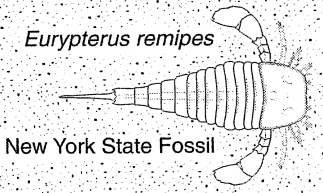
Heat energy gained during melting	334 J/g
Heat energy released during freezing	334 J/g
Heat energy gained during vaporization	2260 J/g
Heat energy released during condensation	2260 J/g
Density at 3.98°C	1.0 g/mL

Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume	Percent by volume	Percent by volume
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.91	0.07	1.0	1.0

2010 EDITION

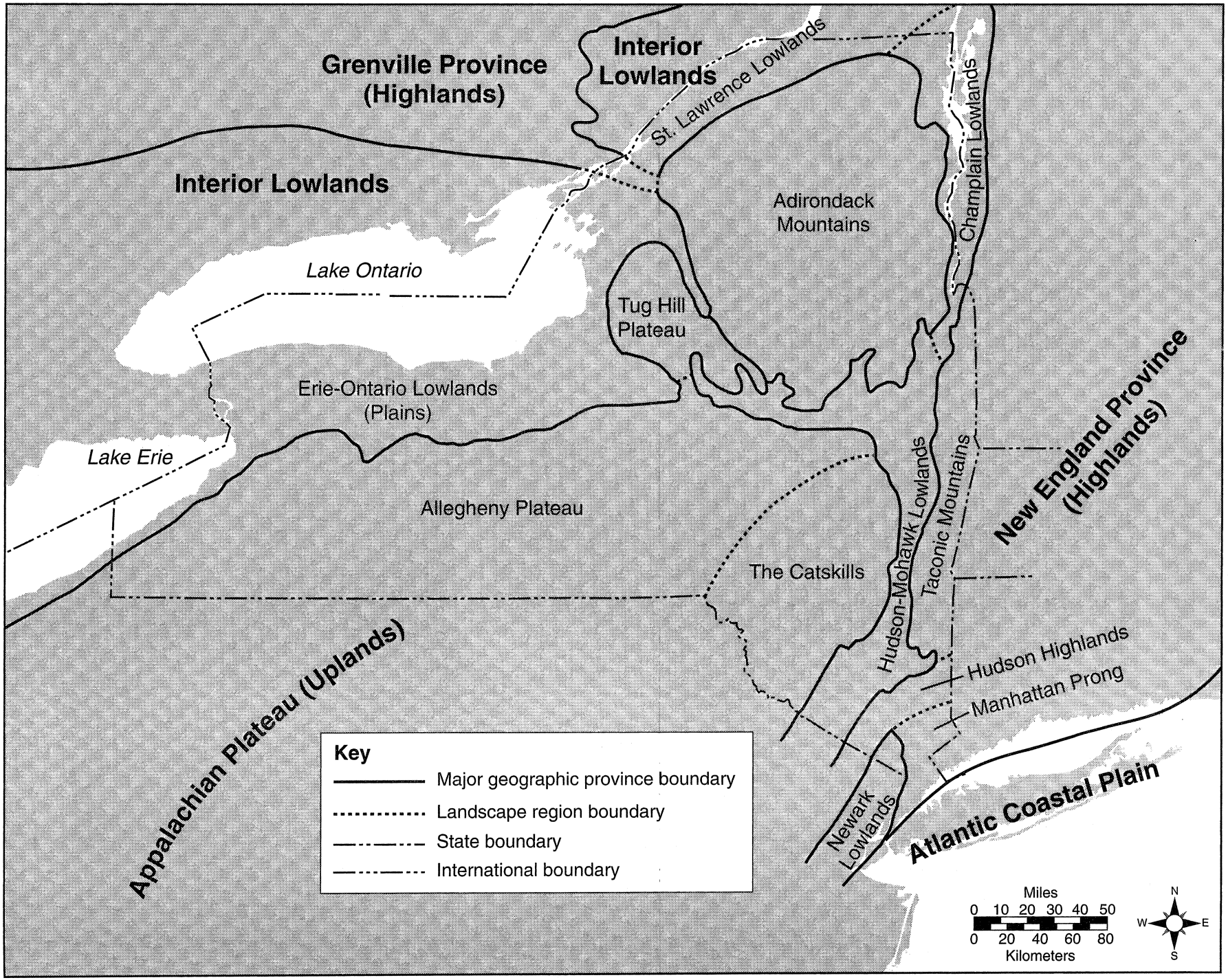
This edition of the Earth Science Reference Tables should be used in the classroom beginning in the 2009–2010 school year. The first examination for which these tables will be used is the January 2010 Regents Examination in Physical Setting/Earth Science.



Eurypterus remipes

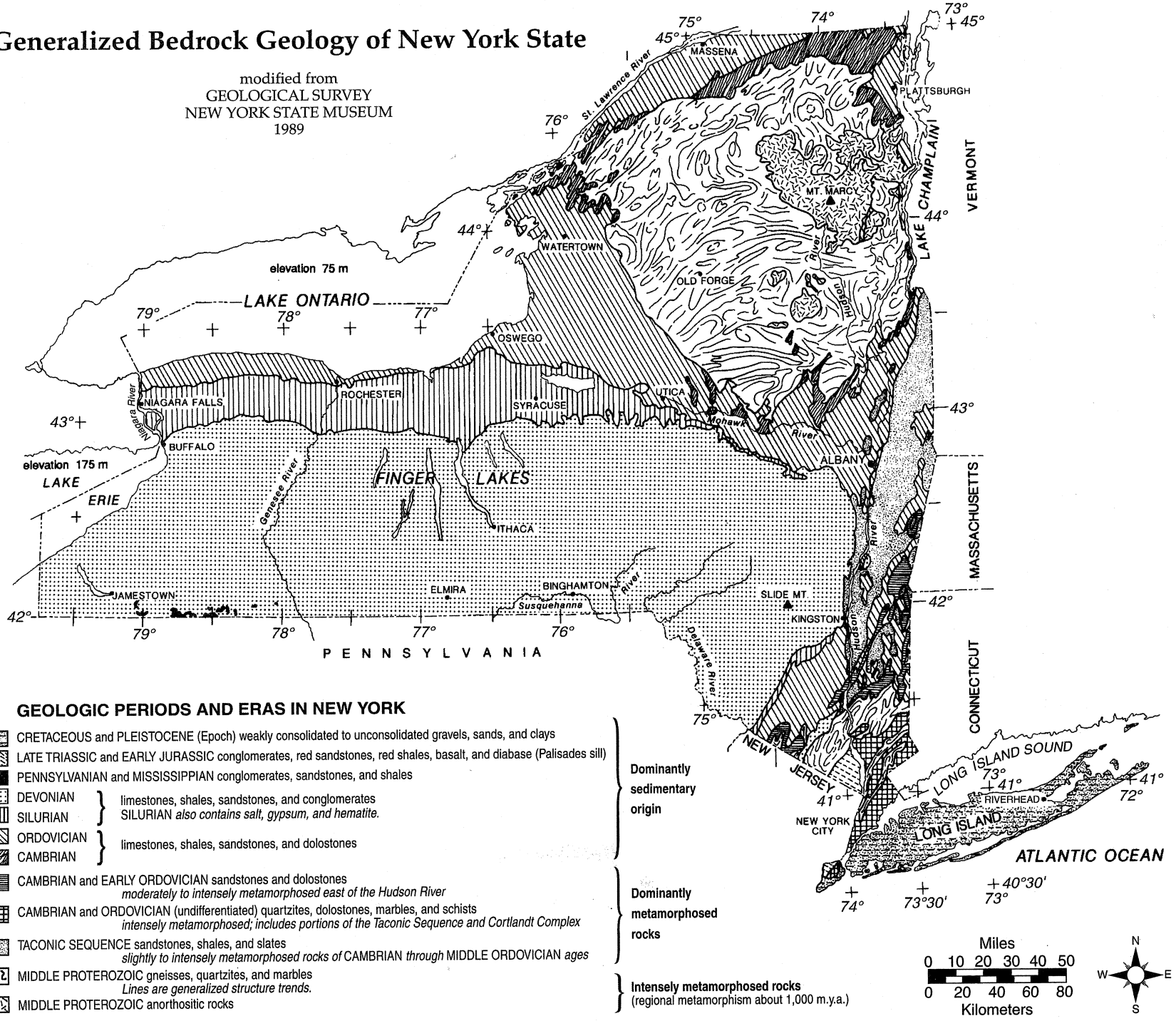
New York State Fossil

Generalized Landscape Regions of New York State



Generalized Bedrock Geology of New York State

modified from
GEOLOGICAL SURVEY
NEW YORK STATE MUSEUM
1989



GEOLOGIC PERIODS AND ERAS IN NEW YORK

Dominantly sedimentary origin

- CRETACEOUS and PLEISTOCENE (Epoch) weakly consolidated to unconsolidated gravels, sands, and clays
- LATE TRIASSIC and EARLY JURASSIC conglomerates, red sandstones, red shales, basalt, and diabase (Palisades sill)
- PENNSYLVANIAN and MISSISSIPPIAN conglomerates, sandstones, and shales
- DEVONIAN, SILURIAN — limestones, shales, sandstones, and conglomerates; SILURIAN *also contains salt, gypsum, and hematite.*
- ORDOVICIAN, CAMBRIAN — limestones, shales, sandstones, and dolostones

Dominantly metamorphosed rocks

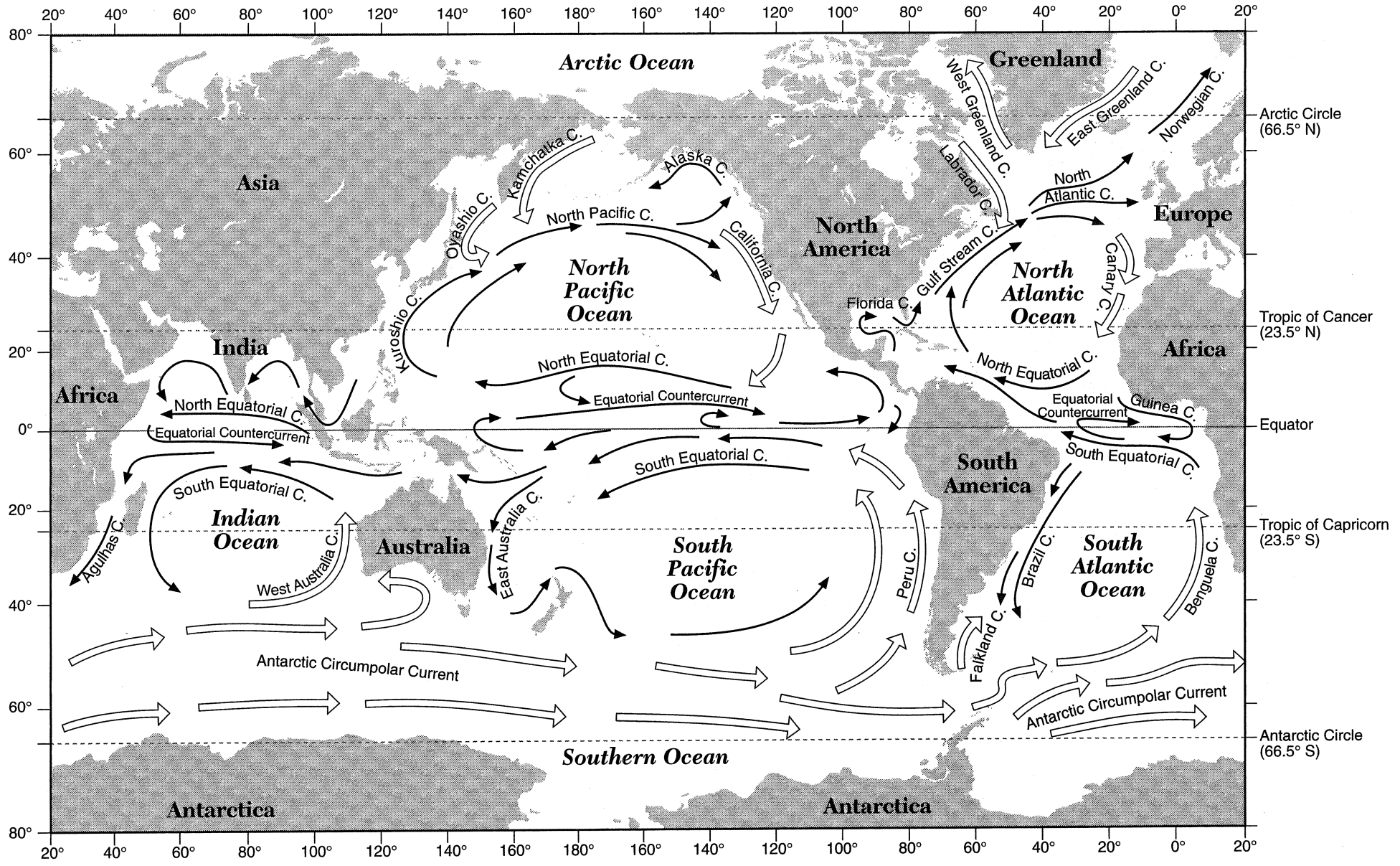
- CAMBRIAN and EARLY ORDOVICIAN sandstones and dolostones
  moderately to intensely metamorphosed east of the Hudson River
- CAMBRIAN and ORDOVICIAN (undifferentiated) quartzites, dolostones, marbles, and schists
  intensely metamorphosed; includes portions of the Taconic Sequence and Cortlandt Complex
- TACONIC SEQUENCE sandstones, shales, and slates
  slightly to intensely metamorphosed rocks of CAMBRIAN *through* MIDDLE ORDOVICIAN *ages*
- MIDDLE PROTEROZOIC gneisses, quartzites, and marbles
  Lines are generalized structure trends.
- MIDDLE PROTEROZOIC anorthositic rocks

Intensely metamorphosed rocks
(regional metamorphism about 1,000 m.y.a.)

Miles
0 10 20 30 40 50
0 20 40 60 80
Kilometers

N
W E
S

Surface Ocean Currents

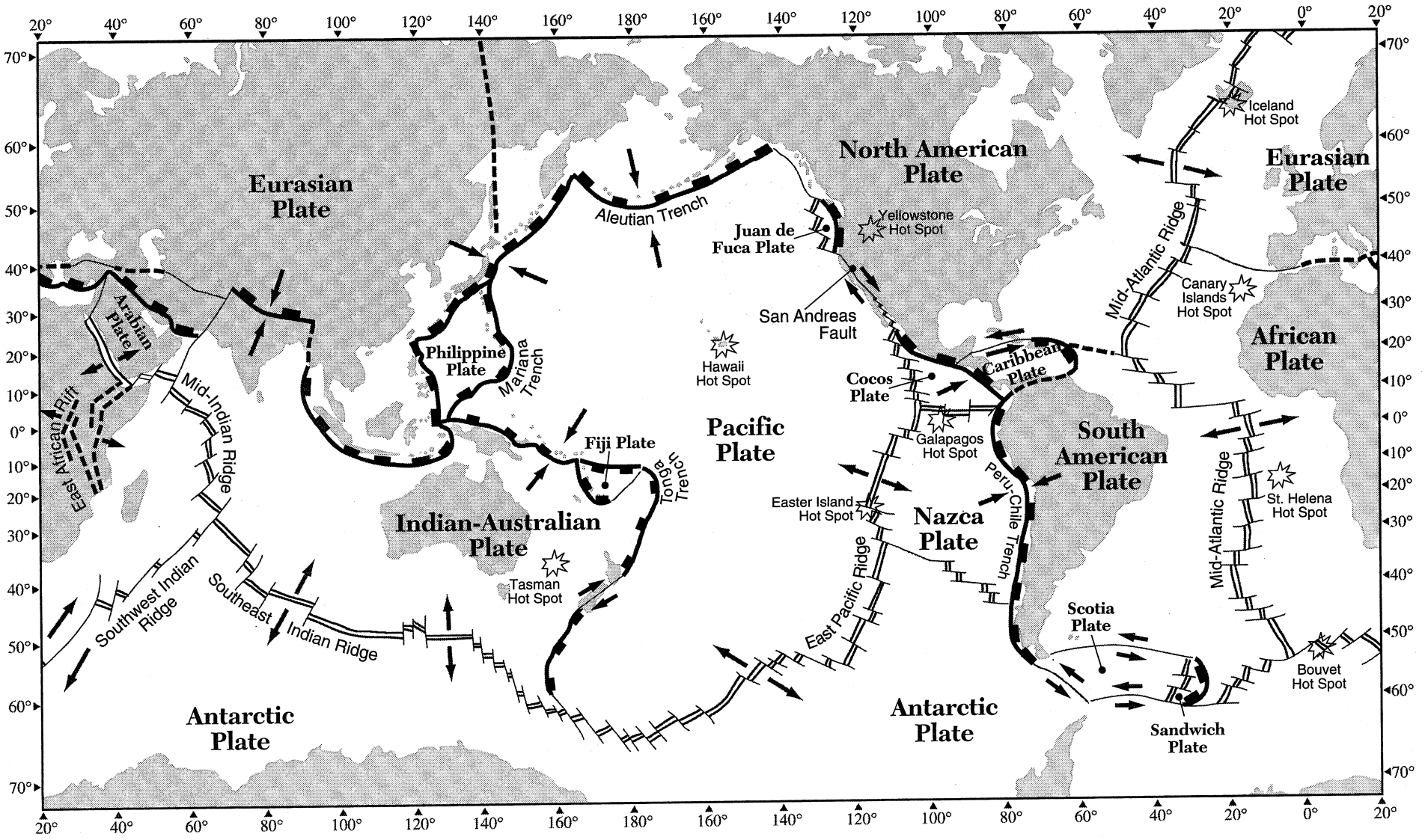


NOTE: Not all surface ocean currents are shown.

Key

- Warm currents
- Cool currents

Tectonic Plates

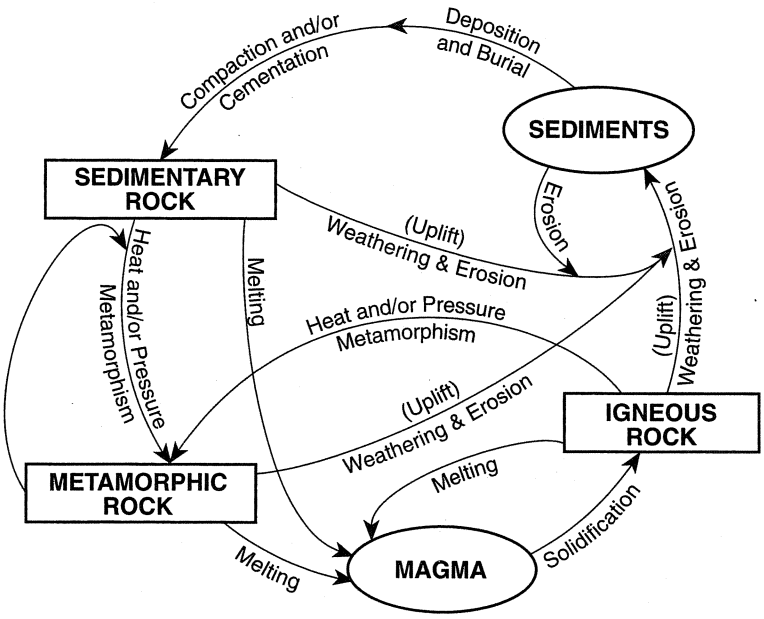


Key

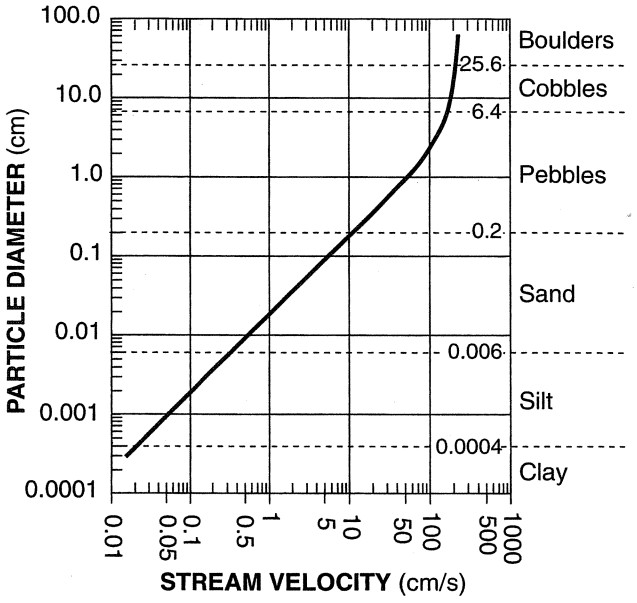
- Relative motion at plate boundary
- Transform plate boundary (transform fault)
- Divergent plate boundary (usually broken by transform faults along mid-ocean ridges)
- Convergent plate boundary (subduction zone): overriding plate, subducting plate
- Complex or uncertain plate boundary
- Mantle hot spot

NOTE: Not all mantle hot spots, plates, and boundaries are shown.

Rock Cycle in Earth's Crust



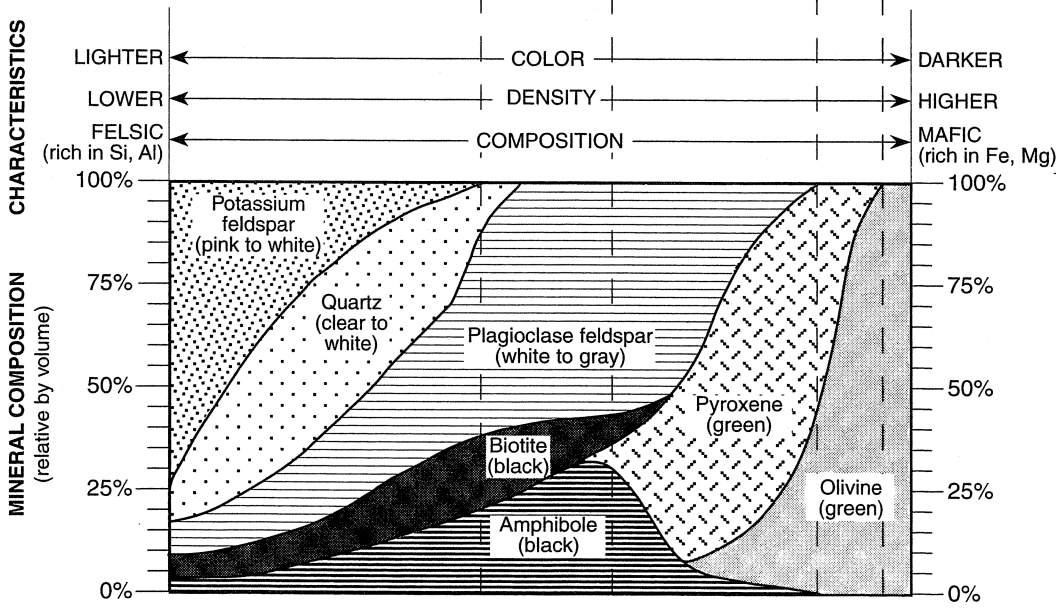
Relationship of Transported Particle Size to Water Velocity



This generalized graph shows the water velocity needed to maintain, but not start, movement. Variations occur due to differences in particle density and shape.

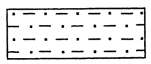
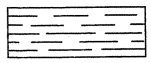
Scheme for Igneous Rock Identification

IGNEOUS ROCKS	ENVIRONMENT OF FORMATION	CRYSTAL SIZE	TEXTURE			
	EXTRUSIVE (Volcanic)	Obsidian (usually appears black)		Basaltic glass		non-crystalline	Glassy	Non-vesicular
		Pumice		Scoria		non-crystalline	Glassy	Vesicular (gas pockets)
		Vesicular rhyolite	Vesicular andesite	Vesicular basalt		less than 1 mm	Fine	Vesicular (gas pockets)
		Rhyolite	Andesite	Basalt		less than 1 mm	Fine	Non-vesicular
				Diabase	Peridotite / Dunite	1 mm to 10 mm	Coarse	Non-vesicular
	INTRUSIVE (Plutonic)	Granite	Diorite	Gabbro	Peridotite / Dunite	1 mm to 10 mm	Coarse	Non-vesicular
		Pegmatite				10 mm or larger	Very coarse	Non-vesicular

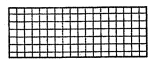
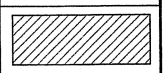
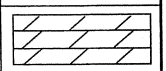
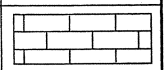


Scheme for Sedimentary Rock Identification

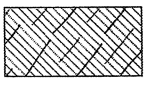
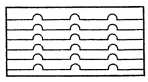
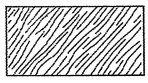
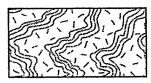
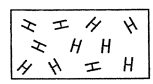
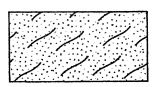
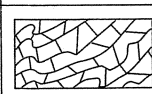
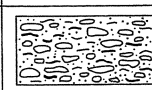
INORGANIC LAND-DERIVED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

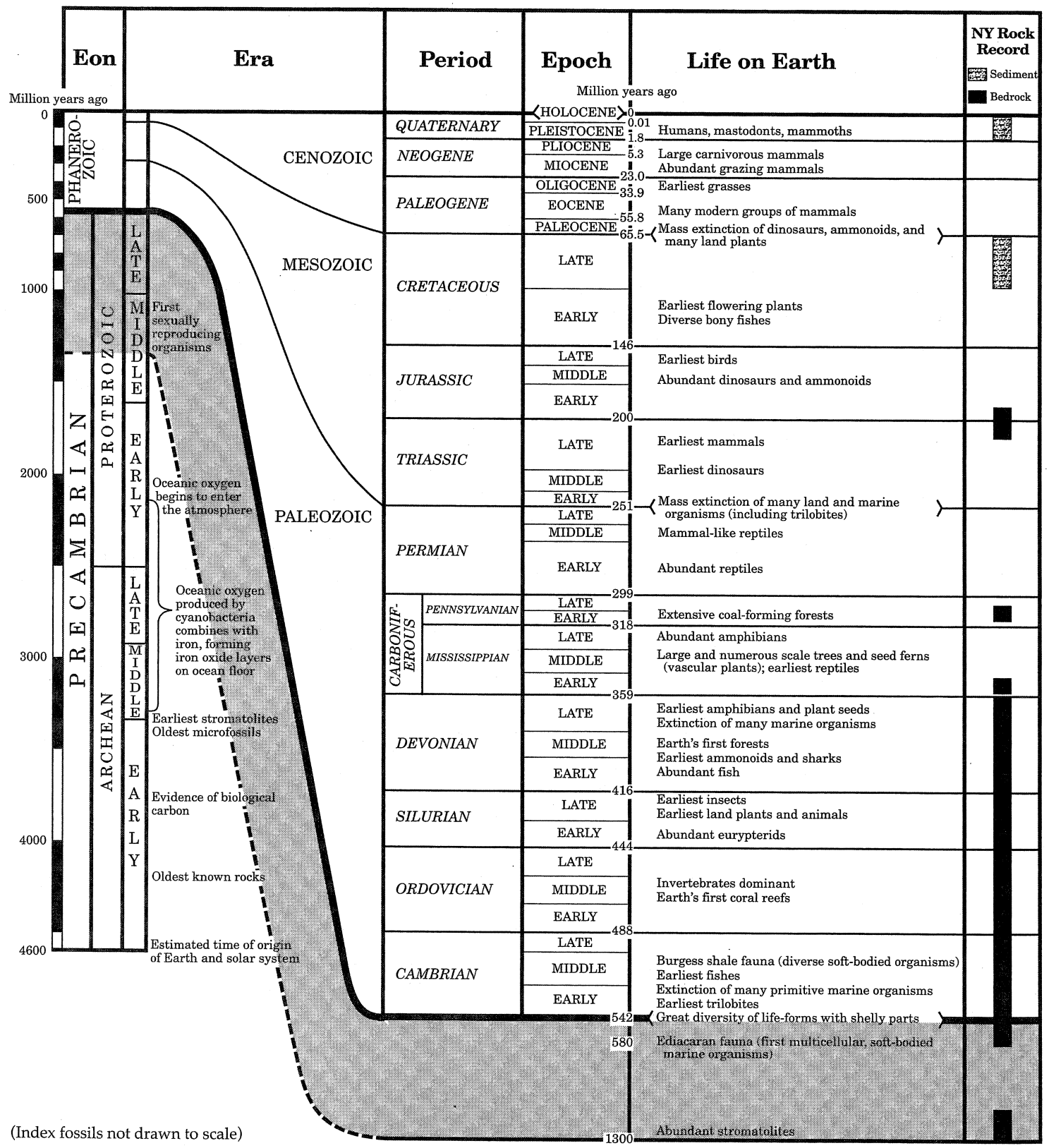
CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

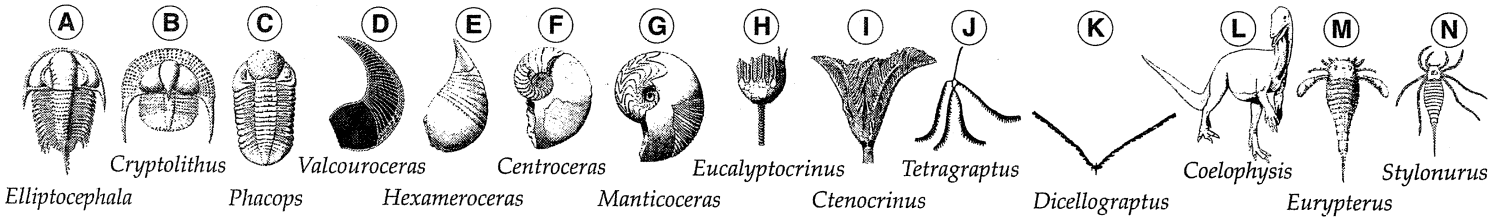
Scheme for Metamorphic Rock Identification

TEXTURE		GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED	MINERAL ALIGNMENT	Fine	MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET, PYROXENE	Regional (Heat and pressure increases)	Low-grade metamorphism of shale	**Slate**	
		Fine to medium			Foliation surfaces shiny from microscopic mica crystals	**Phyllite**	
					Platy mica crystals visible from metamorphism of clay or feldspars	**Schist**	
	BAND-ING	Medium to coarse			High-grade metamorphism; mineral types segregated into bands	**Gneiss**	
NONFOLIATED		Fine	Carbon	Regional	Metamorphism of bituminous coal	**Anthracite coal**	
		Fine	Various minerals	Contact (heat)	Various rocks changed by heat from nearby magma/lava	**Hornfels**	
		Fine to coarse	Quartz	Regional or contact	Metamorphism of quartz sandstone	**Quartzite**	
			Calcite and/or dolomite		Metamorphism of limestone or dolostone	**Marble**	
		Coarse	Various minerals		Pebbles may be distorted or stretched	**Metaconglomerate**	

GEOLOGIC HISTORY



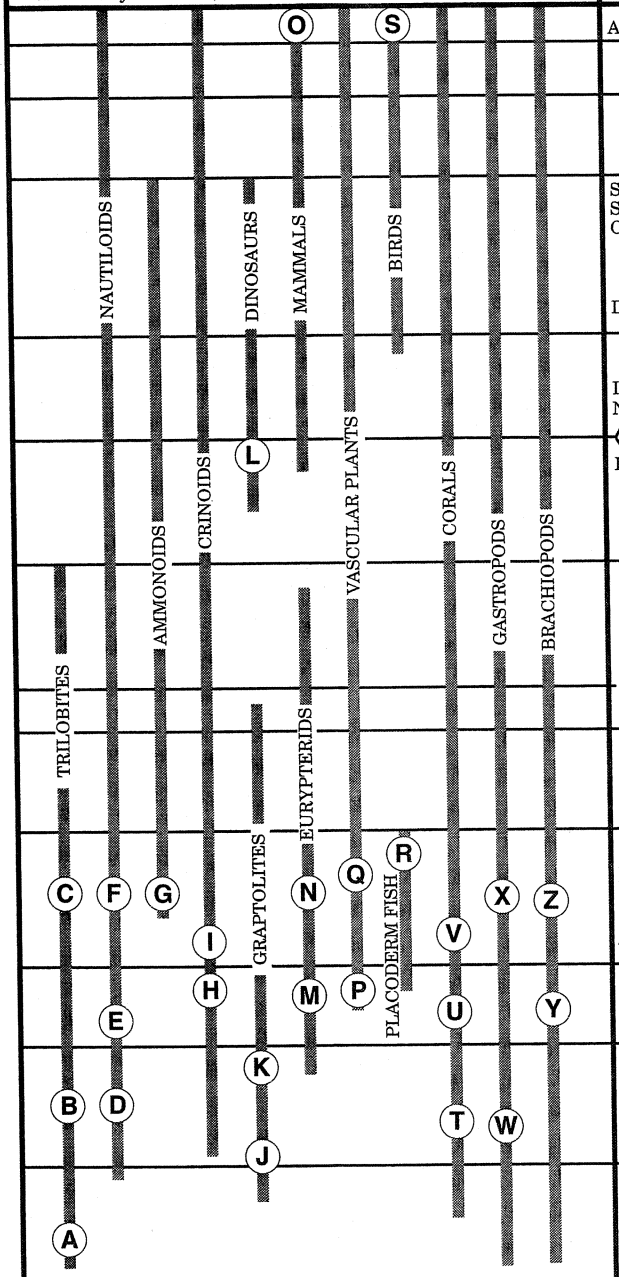
(Index fossils not drawn to scale)



OF NEW YORK STATE

Time Distribution of Fossils (including important fossils of New York)

The center of each lettered circle indicates the approximate time of existence of a specific index fossil (e.g. Fossil (A) lived at the end of the Early Cambrian).



Important Geologic Events in New York

Advance and retreat of last continental ice

Sands and clays underlying Long Island and Staten Island deposited on margin of Atlantic Ocean

Dome-like uplift of Adirondack region begins

Initial opening of Atlantic Ocean
North America and Africa separate

⟨ Intrusion of Palisades sill ⟩

Pangaea begins to break up

Alleghenian orogeny caused by collision of North America and Africa along transform margin, forming Pangaea

Catskill delta forms
Erosion of Acadian Mountains

Acadian orogeny caused by collision of North America and Avalon and closing of remaining part of Iapetus Ocean

Salt and gypsum deposited in evaporite basins

Erosion of Taconic Mountains; Queenston delta forms

Taconian orogeny caused by closing of western part of Iapetus Ocean and collision between North America and volcanic island arc

Widespread deposition over most of New York along edge of Iapetus Ocean

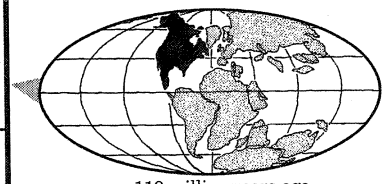
Rifting and initial opening of Iapetus Ocean

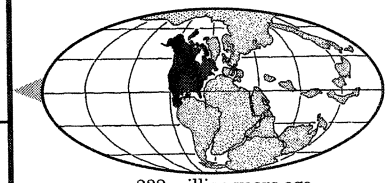
Erosion of Grenville Mountains

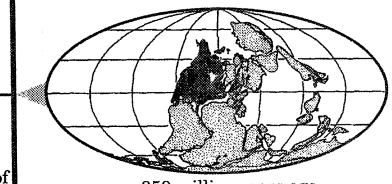
Grenville orogeny: metamorphism of bedrock now exposed in the Adirondacks and Hudson Highlands

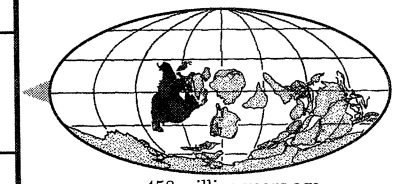
Inferred Positions of Earth's Landmasses

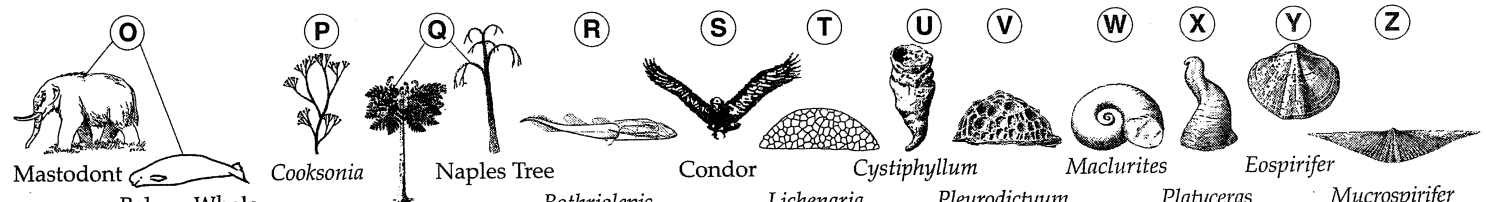

59 million years ago


119 million years ago


232 million years ago

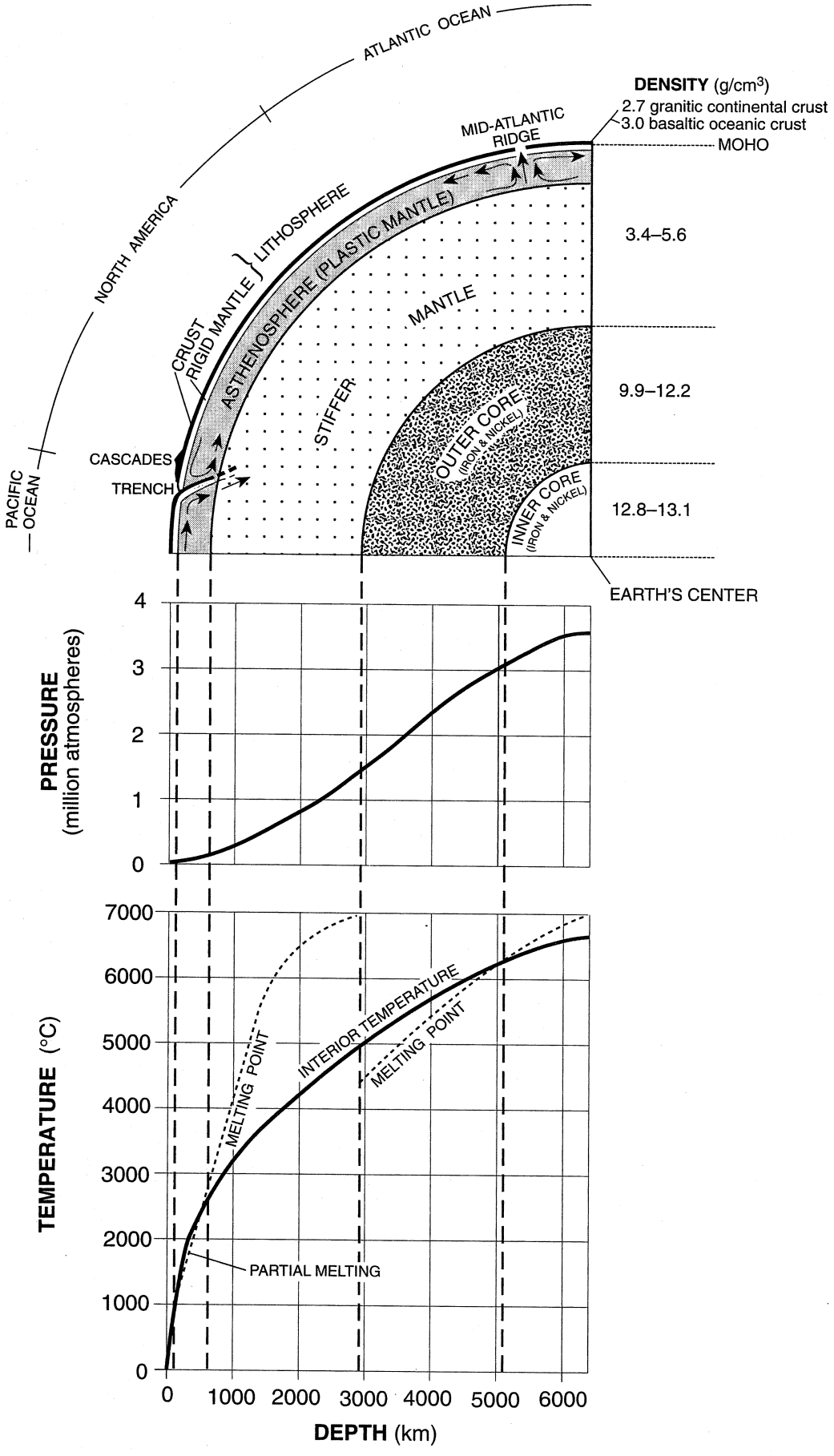

359 million years ago


458 million years ago

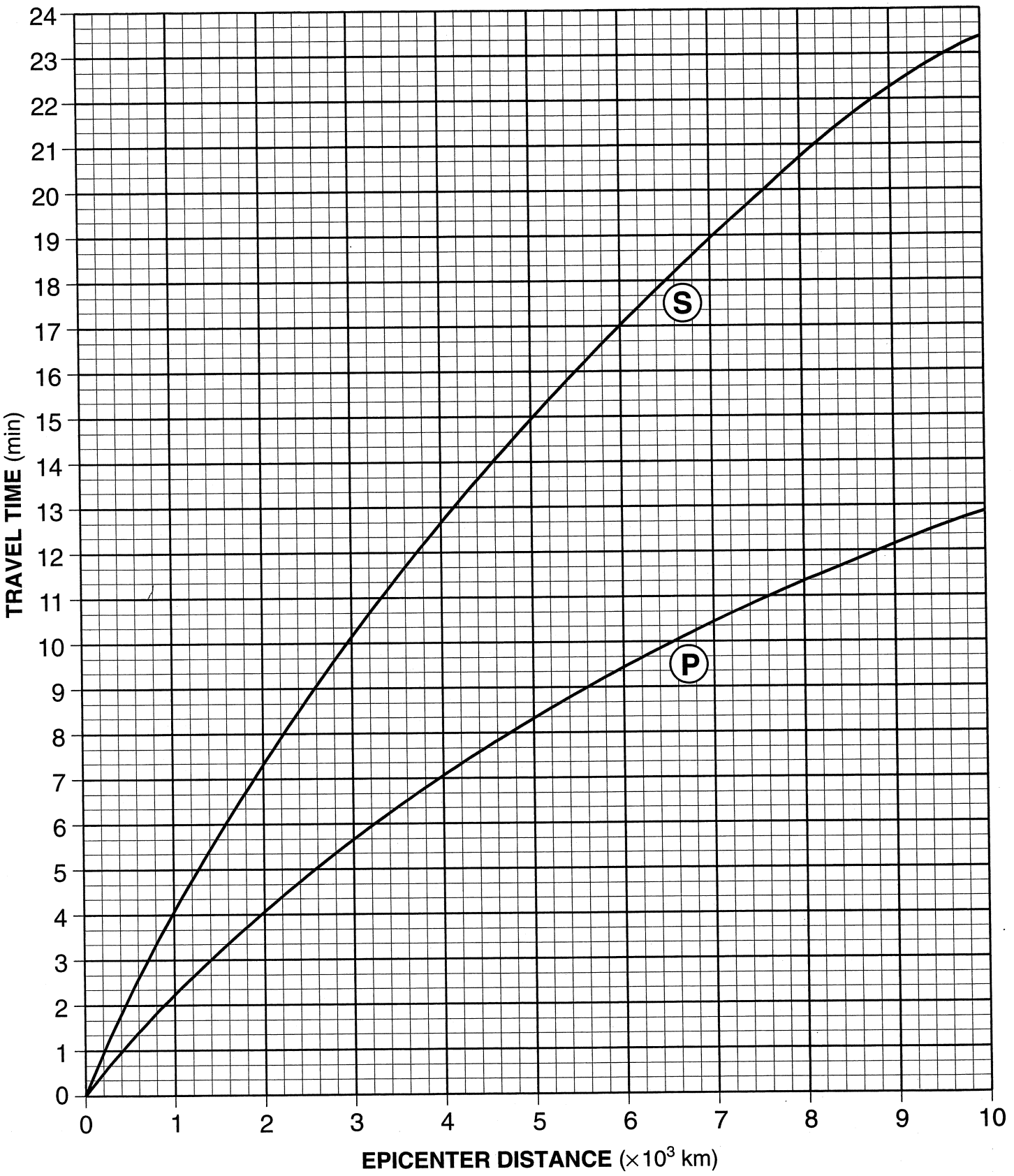


ESC/BW/TN (2009)

Inferred Properties of Earth's Interior



Earthquake P-Wave and S-Wave Travel Time



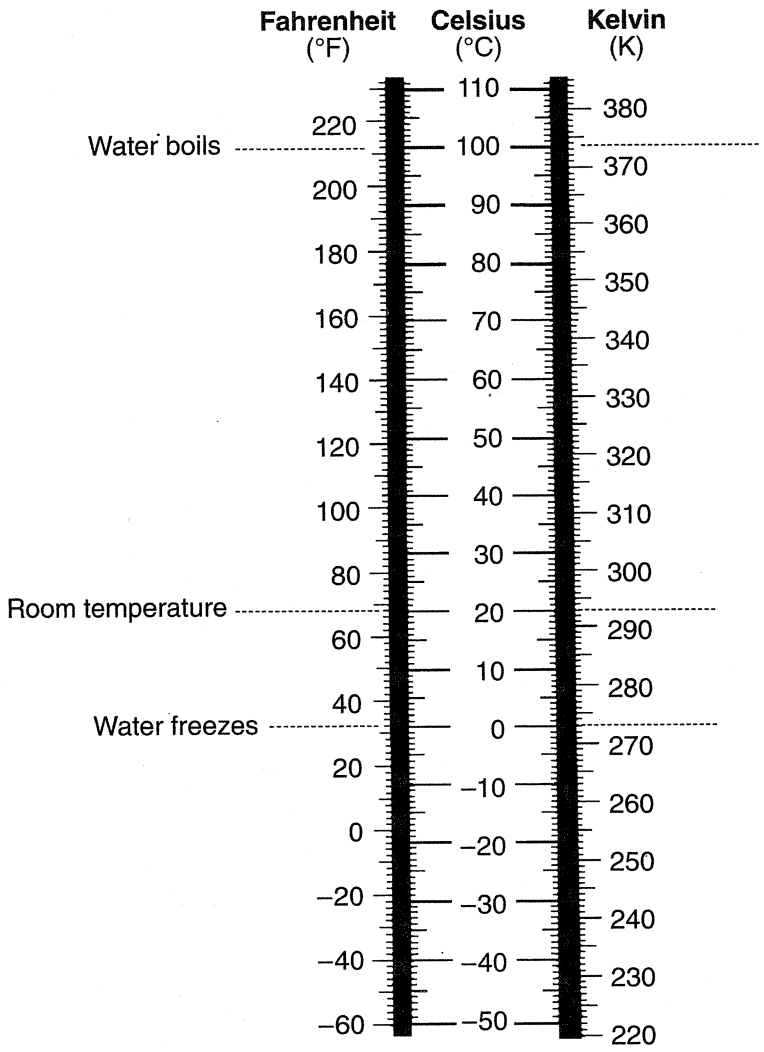
Dewpoint (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	−20	−33														
−18	−18	−28														
−16	−16	−24														
−14	−14	−21	−36													
−12	−12	−18	−28													
−10	−10	−14	−22													
−8	−8	−12	−18	−29												
−6	−6	−10	−14	−22												
−4	−4	−7	−12	−17	−29											
−2	−2	−5	−8	−13	−20											
0	0	−3	−6	−9	−15	−24										
2	2	−1	−3	−6	−11	−17										
4	4	1	−1	−4	−7	−11	−19									
6	6	4	1	−1	−4	−7	−13	−21								
8	8	6	3	1	−2	−5	−9	−14								
10	10	8	6	4	1	−2	−5	−9	−14	−28						
12	12	10	8	6	4	1	−2	−5	−9	−16						
14	14	12	11	9	6	4	1	−2	−5	−10	−17					
16	16	14	13	11	9	7	4	1	−1	−6	−10	−17				
18	18	16	15	13	11	9	7	4	2	−2	−5	−10	−19			
20	20	19	17	15	14	12	10	7	4	2	−2	−5	−10	−19		
22	22	21	19	17	16	14	12	10	8	5	3	−1	−5	−10	−19	
24	24	23	21	20	18	16	14	12	10	8	6	2	−1	−5	−10	−18
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	−4	−9
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1	−3
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5	1

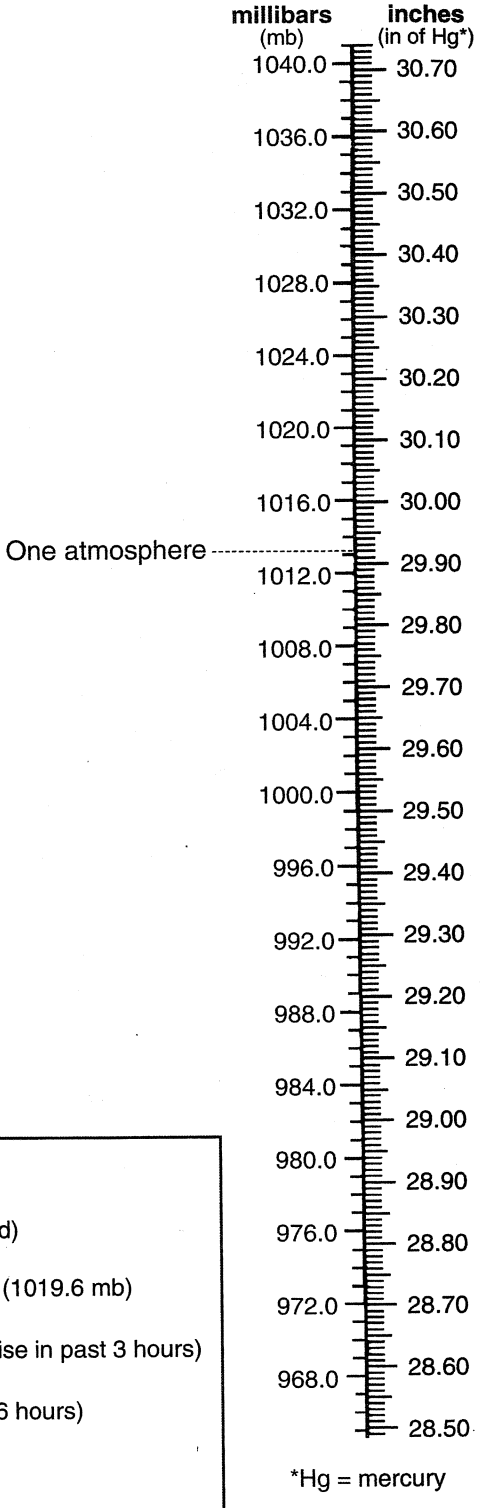
Relative Humidity (%)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
−20	100	28														
−18	100	40														
−16	100	48														
−14	100	55	11													
−12	100	61	23													
−10	100	66	33													
−8	100	71	41	13												
−6	100	73	48	20												
−4	100	77	54	32	11											
−2	100	79	58	37	20	1										
0	100	81	63	45	28	11										
2	100	83	67	51	36	20	6									
4	100	85	70	56	42	27	14									
6	100	86	72	59	46	35	22	10								
8	100	87	74	62	51	39	28	17	6							
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16

Temperature



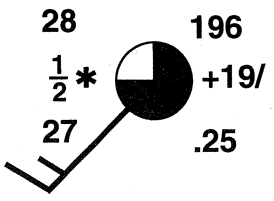
Pressure



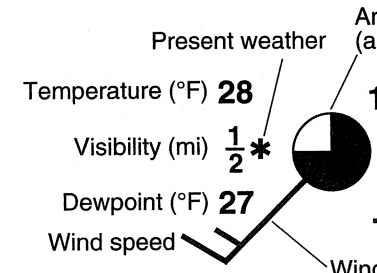
*Hg = mercury

Key to Weather Map Symbols

Station Model



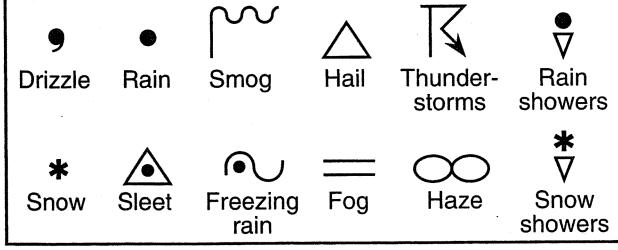
Station Model Explanation



whole feather = 10 knots
half feather = 5 knots
total = 15 knots

(1 knot = 1.15 mi/h)

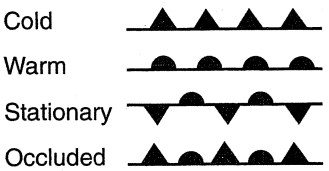
Present Weather



Air Masses

cA	continental arctic
cP	continental polar
cT	continental tropical
mT	maritime tropical
mP	maritime polar

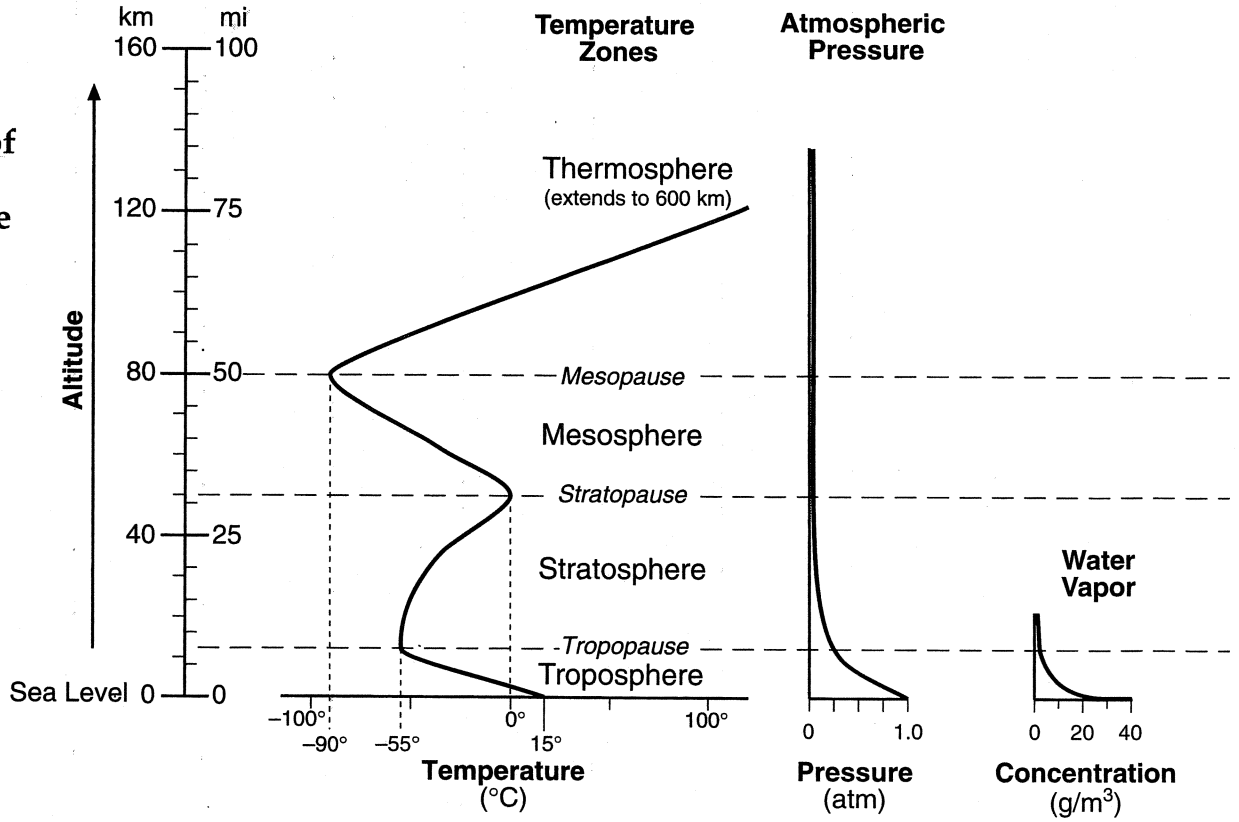
Fronts



Hurricane

Tornado

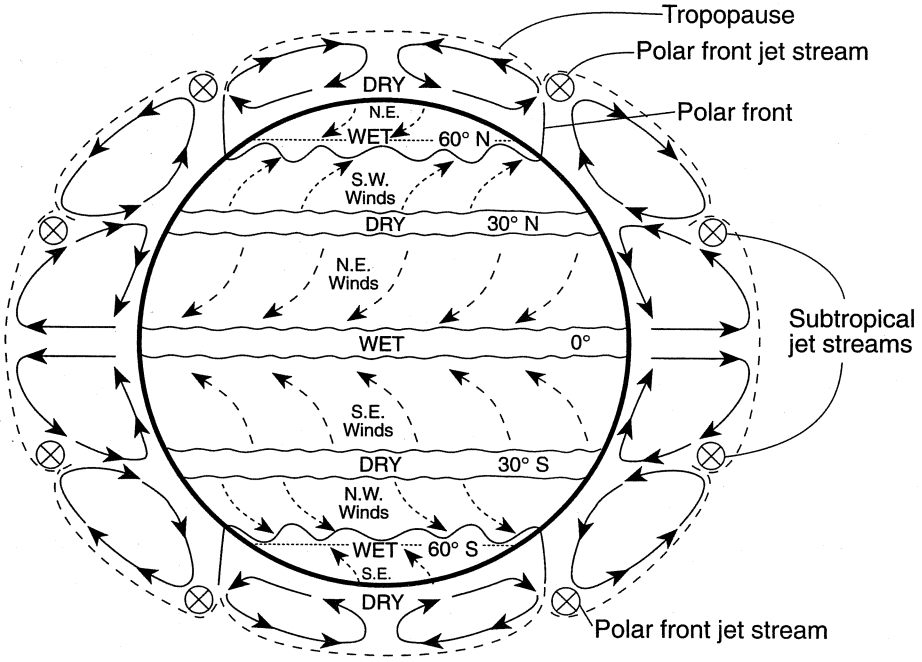
Selected Properties of Earth's Atmosphere



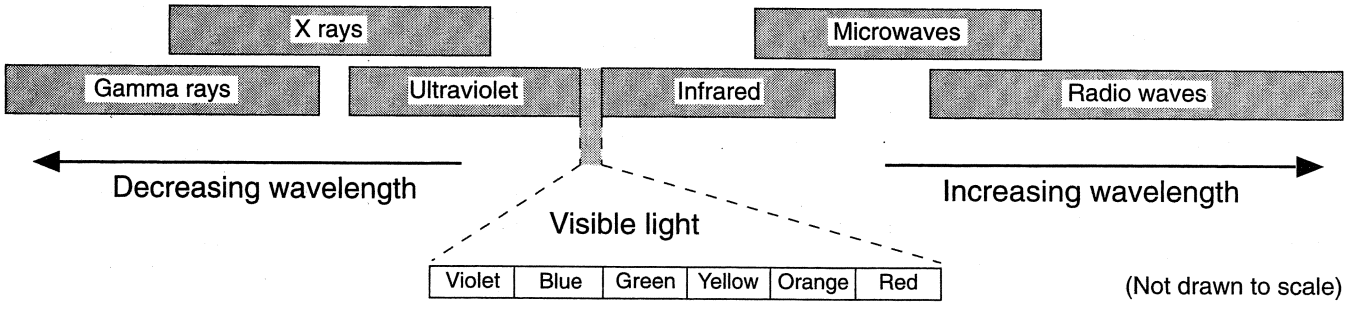
Planetary Wind and Moisture Belts in the Troposphere

The drawing on the right shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the Sun's vertical ray. In the Northern Hemisphere, the belts shift northward in the summer and southward in the winter.

(Not drawn to scale)



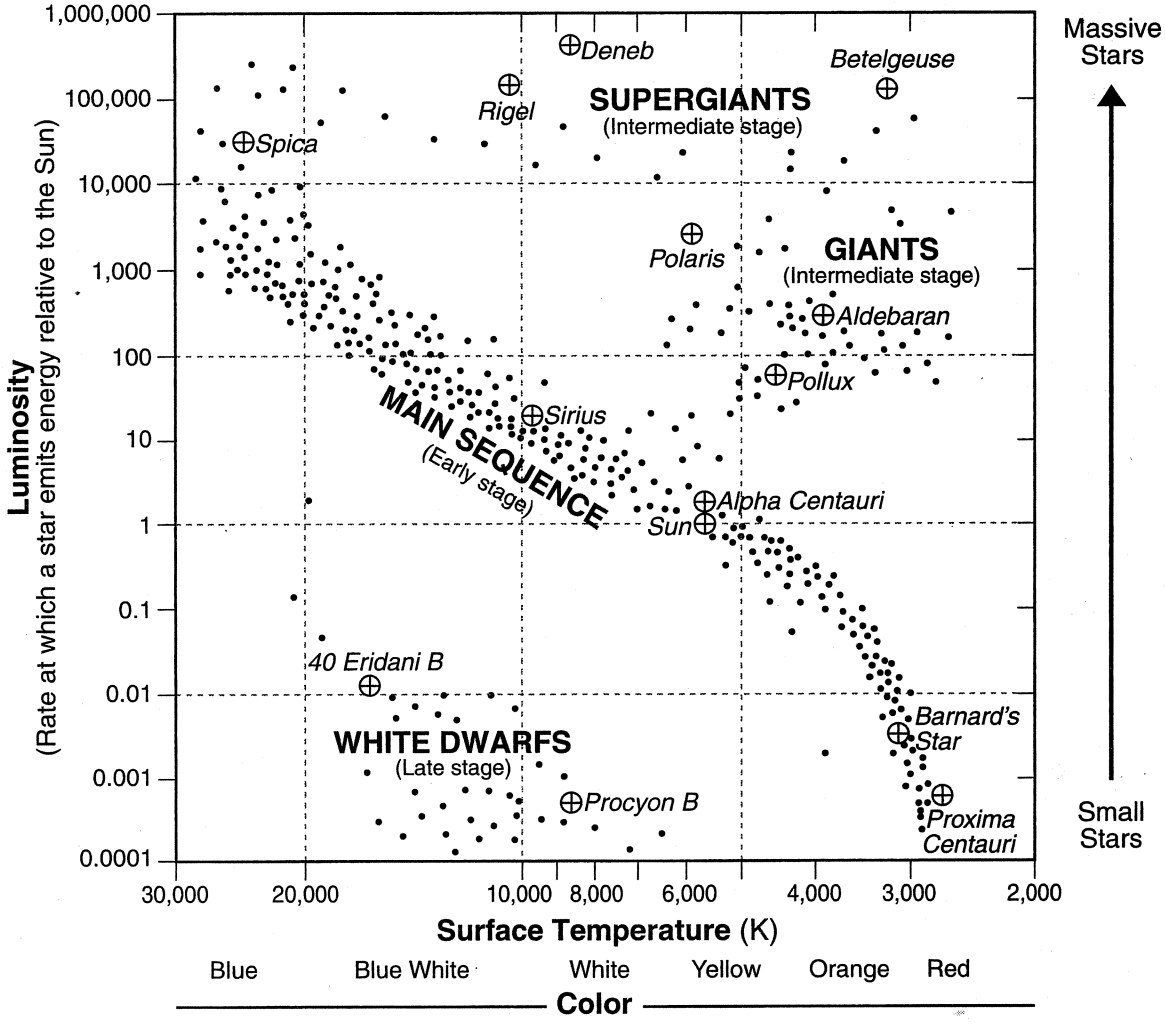
Electromagnetic Spectrum



(Not drawn to scale)

Characteristics of Stars

(Name in italics refers to star represented by a ⊕.)
(Stages indicate the general sequence of star development.)



Solar System Data

Celestial Object	Mean Distance from Sun (million km)	Period of Revolution (d=days) (y=years)	Period of Rotation at Equator	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm^3)
SUN	—	—	27 d	—	1,392,000	333,000.00	1.4
MERCURY	57.9	88 d	59 d	0.206	4,879	0.06	5.4
VENUS	108.2	224.7 d	243 d	0.007	12,104	0.82	5.2
EARTH	149.6	365.26 d	23 h 56 min 4 s	0.017	12,756	1.00	5.5
MARS	227.9	687 d	24 h 37 min 23 s	0.093	6,794	0.11	3.9
JUPITER	778.4	11.9 y	9 h 50 min 30 s	0.048	142,984	317.83	1.3
SATURN	1,426.7	29.5 y	10 h 14 min	0.054	120,536	95.16	0.7
URANUS	2,871.0	84.0 y	17 h 14 min	0.047	51,118	14.54	1.3
NEPTUNE	4,498.3	164.8 y	16 h	0.009	49,528	17.15	1.8
EARTH'S MOON	149.6 (0.386 from Earth)	27.3 d	27.3 d	0.055	3,476	0.01	3.3

Properties of Common Minerals

LUSTER	HARDNESS	CLEAVAGE	FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	COMPOSITION*	MINERAL NAME
Metallic luster	1–2	✔		silver to gray	black streak, greasy feel	pencil lead, lubricants	C	**Graphite**
	2.5	✔		metallic silver	gray-black streak, cubic cleavage, density = 7.6 g/cm^3	ore of lead, batteries	PbS	**Galena**
	5.5–6.5		✔	black to silver	black streak, magnetic	ore of iron, steel	Fe_3O_4	**Magnetite**
	6.5		✔	brassy yellow	green-black streak, (fool's gold)	ore of sulfur	FeS_2	**Pyrite**
Either	5.5 – 6.5 or 1		✔	metallic silver or earthy red	red-brown streak	ore of iron, jewelry	Fe_2O_3	**Hematite**
Nonmetallic luster	1	✔		white to green	greasy feel	ceramics, paper	$Mg_3Si_4O_{10}(OH)_2$	**Talc**
	2		✔	yellow to amber	white-yellow streak	sulfuric acid	S	**Sulfur**
	2	✔		white to pink or gray	easily scratched by fingernail	plaster of paris, drywall	$CaSO_4 \cdot 2H_2O$	**Selenite gypsum**
	2–2.5	✔		colorless to yellow	flexible in thin sheets	paint, roofing	$KAl_3Si_3O_{10}(OH)_2$	**Muscovite mica**
	2.5	✔		colorless to white	cubic cleavage, salty taste	food additive, melts ice	NaCl	**Halite**
	2.5–3	✔		black to dark brown	flexible in thin sheets	construction materials	$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	**Biotite mica**
	3	✔		colorless or variable	bubbles with acid, rhombohedral cleavage	cement, lime	$CaCO_3$	**Calcite**
	3.5	✔		colorless or variable	bubbles with acid when powdered	building stones	$CaMg(CO_3)_2$	**Dolomite**
	4	✔		colorless or variable	cleaves in 4 directions	hydrofluoric acid	CaF_2	**Fluorite**
	5–6	✔		black to dark green	cleaves in 2 directions at 90°	mineral collections, jewelry	$(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$	**Pyroxene** (commonly augite)
	5.5	✔		black to dark green	cleaves at 56° and 124°	mineral collections, jewelry	$CaNa(Mg,Fe)_4(Al,Fe,Ti)_3Si_6O_{22}(O,OH)_2$	**Amphibole** (commonly hornblende)
	6	✔		white to pink	cleaves in 2 directions at 90°	ceramics, glass	$KAlSi_3O_8$	**Potassium feldspar** (commonly orthoclase)
	6	✔		white to gray	cleaves in 2 directions, striations visible	ceramics, glass	$(Na,Ca)AlSi_3O_8$	**Plagioclase feldspar**
	6.5		✔	green to gray or brown	commonly light green and granular	furnace bricks, jewelry	$(Fe,Mg)_2SiO_4$	**Olivine**
	7		✔	colorless or variable	glassy luster, may form hexagonal crystals	glass, jewelry, electronics	SiO_2	**Quartz**
	6.5–7.5		✔	dark red to green	often seen as red glassy grains in NYS metamorphic rocks	jewelry (NYS gem), abrasives	$Fe_3Al_2Si_3O_{12}$	**Garnet**

*Chemical symbols:

Al = aluminum	Cl = chlorine	H = hydrogen	Na = sodium	S = sulfur
C = carbon	F = fluorine	K = potassium	O = oxygen	Si = silicon
Ca = calcium	Fe = iron	Mg = magnesium	Pb = lead	Ti = titanium

✔ = dominant form of breakage