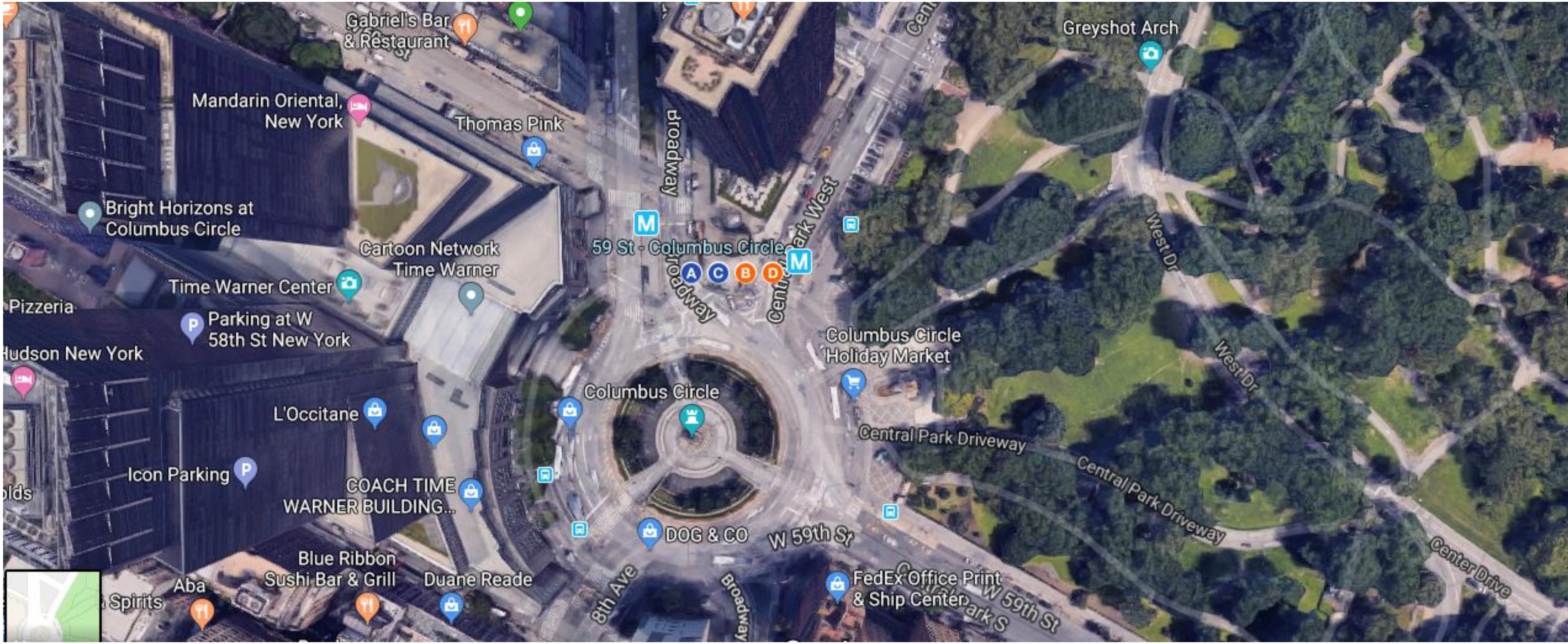
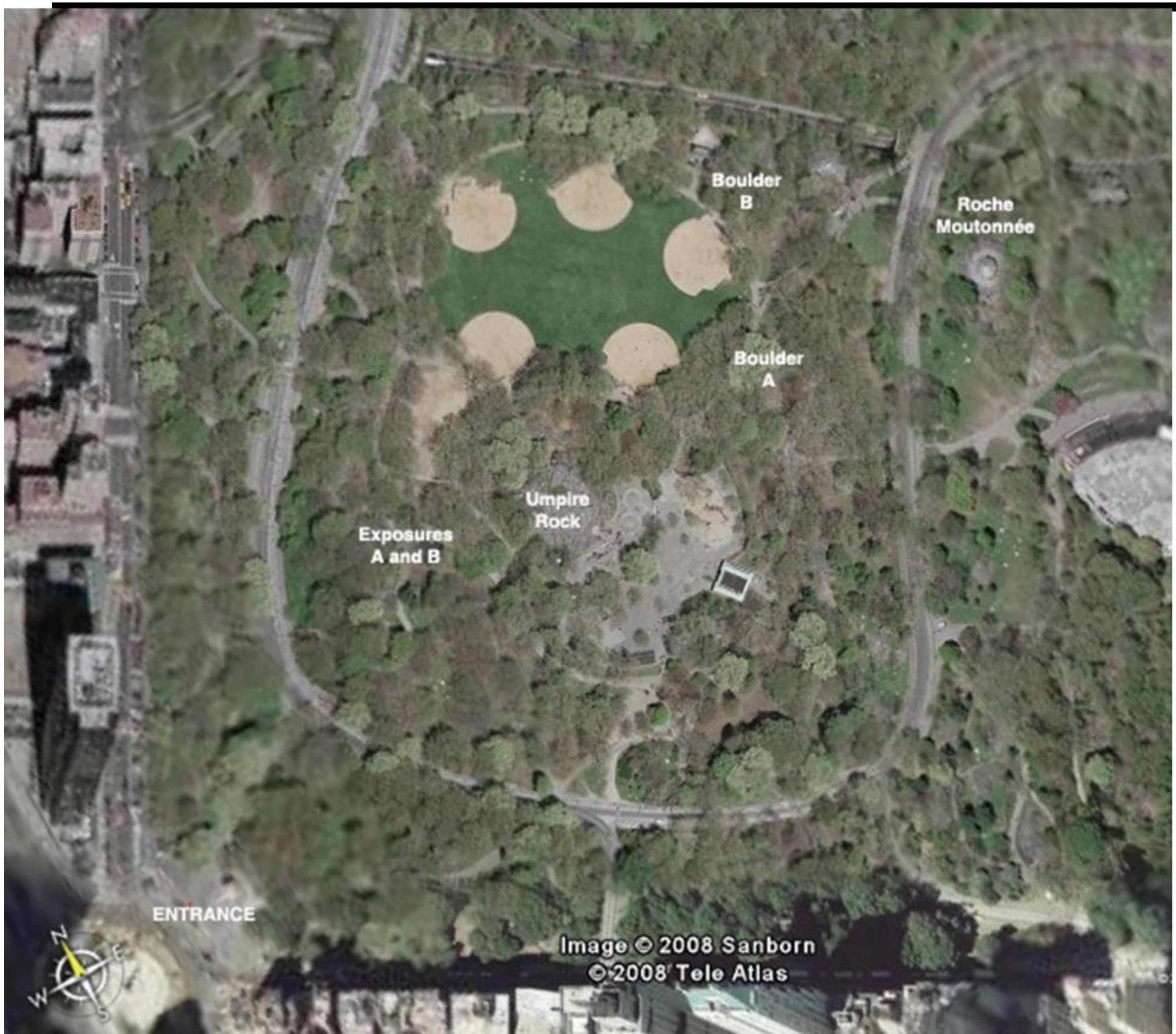
CENTRAL PARK FIELD TRIP



CENTRAL PARK FIELD TRIP



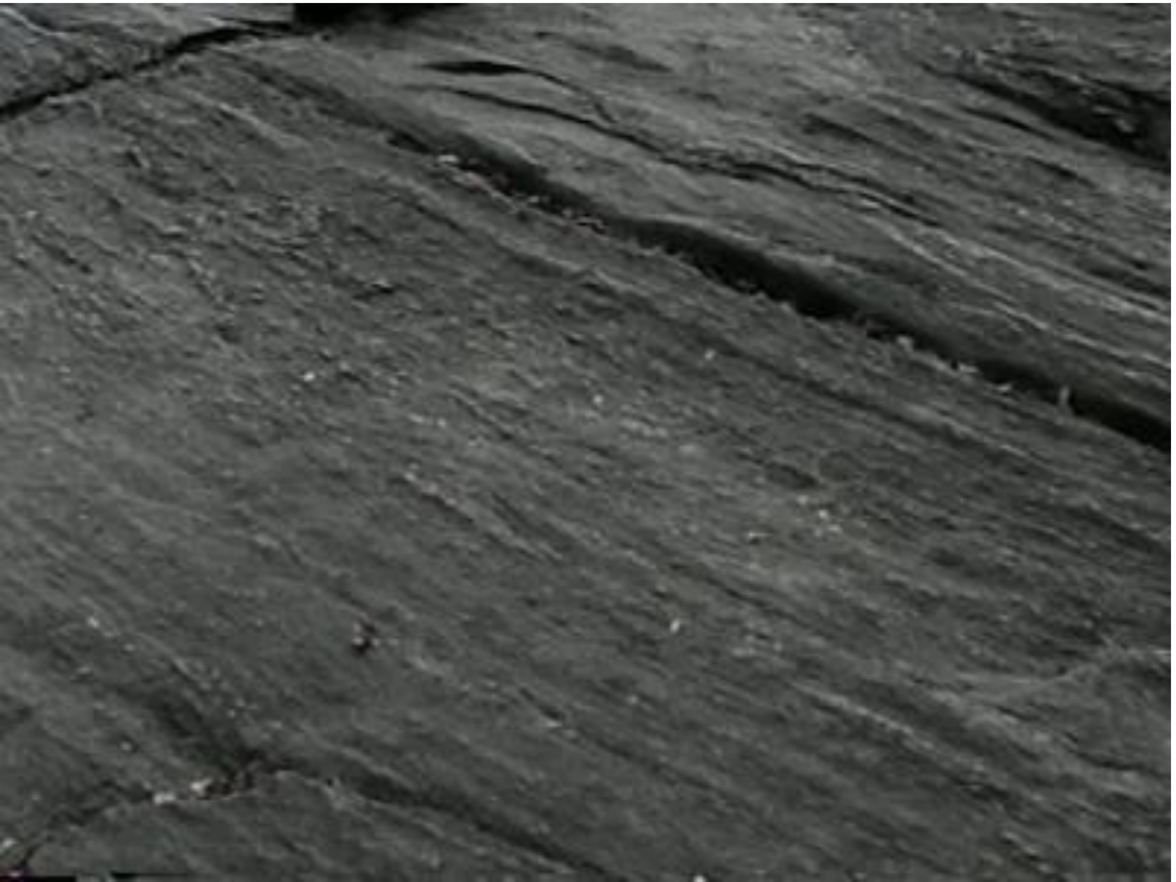
CENTRAL PARK FIELD TRIP

CENTRAL PARK FIELD TRIP

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES A and B. Rock exposure A is 20 yards downtown of Pinebank Arch, and is the first exposure encountered upon walking from Columbus circle. Exposure B is just uptown of A and separated from it by a few feet of soil and grass.

1.Note that the rock is layered. In the area marked "exposure A" in the detail on map 1, draw a series of parallel lines to indicate the direction of layering in exposure B.



CENTRAL PARK FIELD TRIP

ROCK EXPOSURES A and B.

2. In the space below, make a sketch of any feature that suggests the layering in exposure A has been deformed.

CENTRAL PARK FIELD TRIP

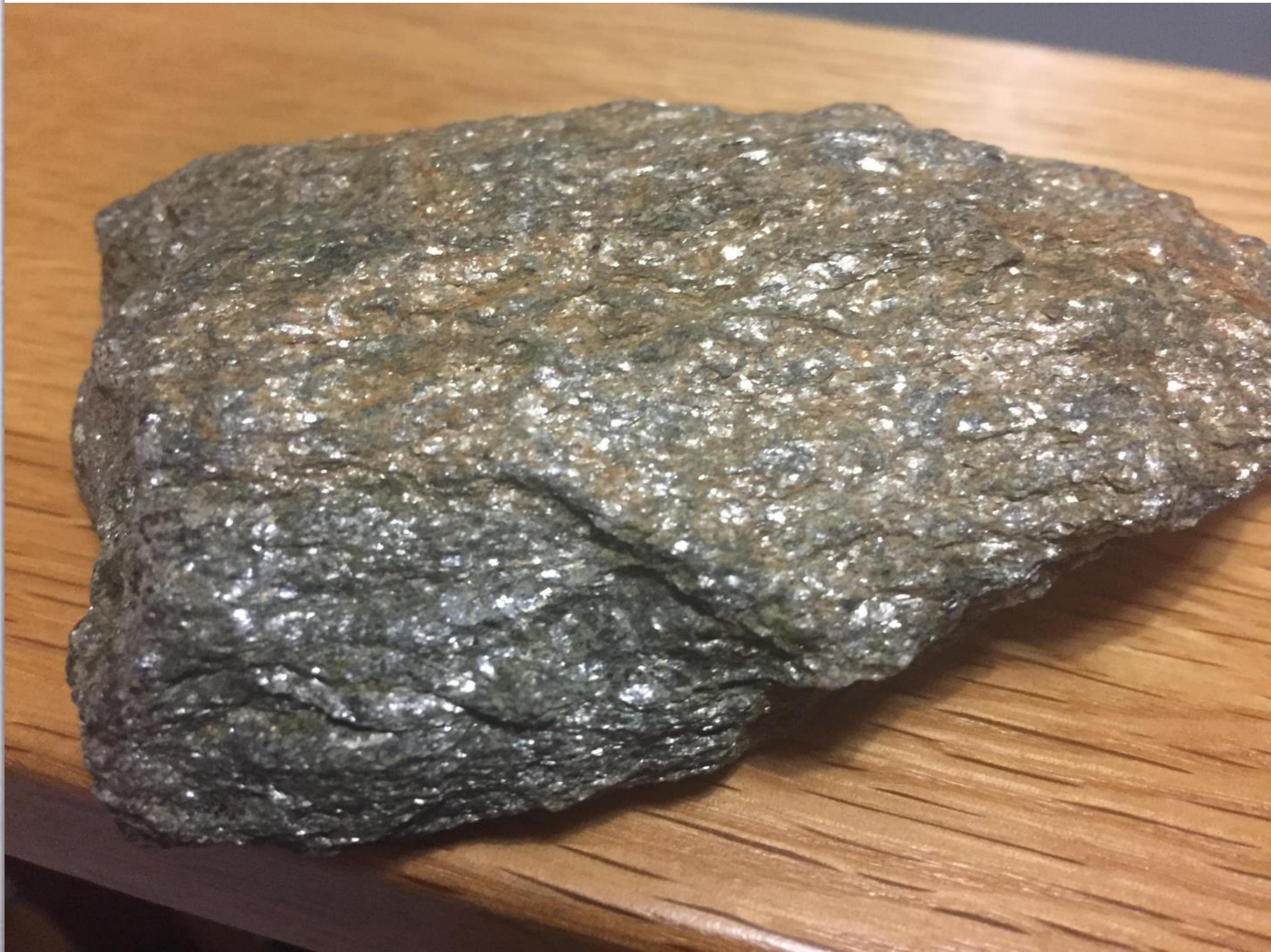
ROCK EXPOSURES A and B.

2. In the space below, make a sketch of any feature that suggests the layering in exposure A has been deformed.

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES A and B.

3.Name one mineral present in the rock in abundance.



CENTRAL PARK FIELD TRIP

ROCK EXPOSURES A and B.

4.What is the name of the major rock type seen here?

CENTRAL PARK FIELD TRIP

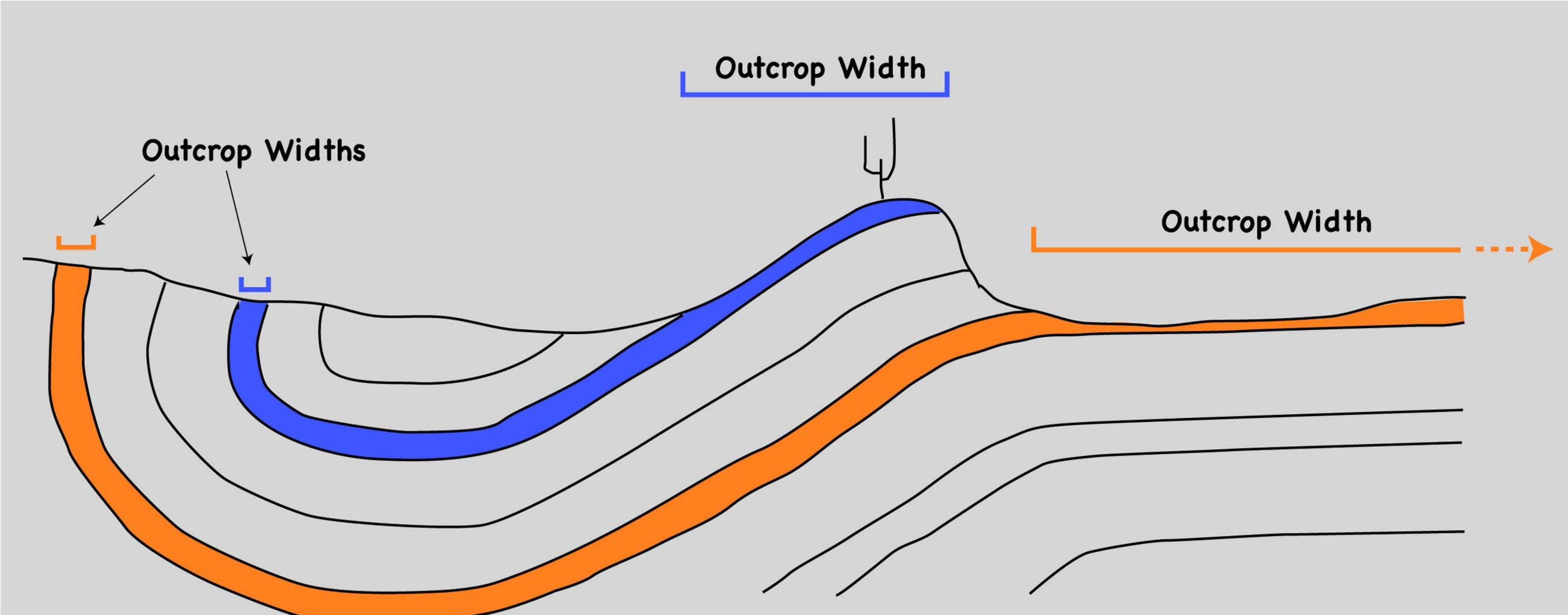
ROCK EXPOSURES A and B.

5.In loose boulders, features such as layering generally do not show any consistency from one boulder to the next. What is there that suggests that, underneath the soil and grass that separates them, rock exposures A and B are joined, and are not just the top of large, buried, loose boulders?

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES A and B.

6.These rock exposures are actually outcrops, places where bedrock (the continuous crust of the earth) appears at the earth’s surface.



CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

1.Stand at the corner of exposure C that is the closest to outcrops A and B. The spot at which you should be standing is marked ‘x’ on Map 1. Observe the general direction of the layering in the area marked "exposure C" on Map 1.

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

1.Stand at the corner of exposure C that is the closest to outcrops A and B. The spot at which you should be standing is marked ‘x’ on Map 1. Observe the general direction of the layering in the area marked "exposure C" on Map 1.

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

2.Is the rock exposure at C an outcrop of bedrock? Evidence? or rock type?

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

3. Map 2 is an enlarged sketch of outcrop C. The area where you are standing is marked C-1. Look again at the layers in this area. Note the numerous "grooves" parallel to the layers that exist where some of the layers have been worn (erode) more deeply than others. Why have they been worn more deeply?

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

5.Go to the area marked C-2. Note the complex folding of the layers in part of this area. Trace the course of an individual folded, contorted layer for as great a distance as possible. Note where you begin to follow the layer and where you finish following it. Now measure the length of that layer in terms of the length of your foot; that is, follow along the layer walking heel-to-toe, heel-to-toe. Write your answer below.

The length of the layer is _________________ footlengths.

Next, walk heel-to-toe in a straight line from where you began your traverse along the layer to where you finished the traverse.

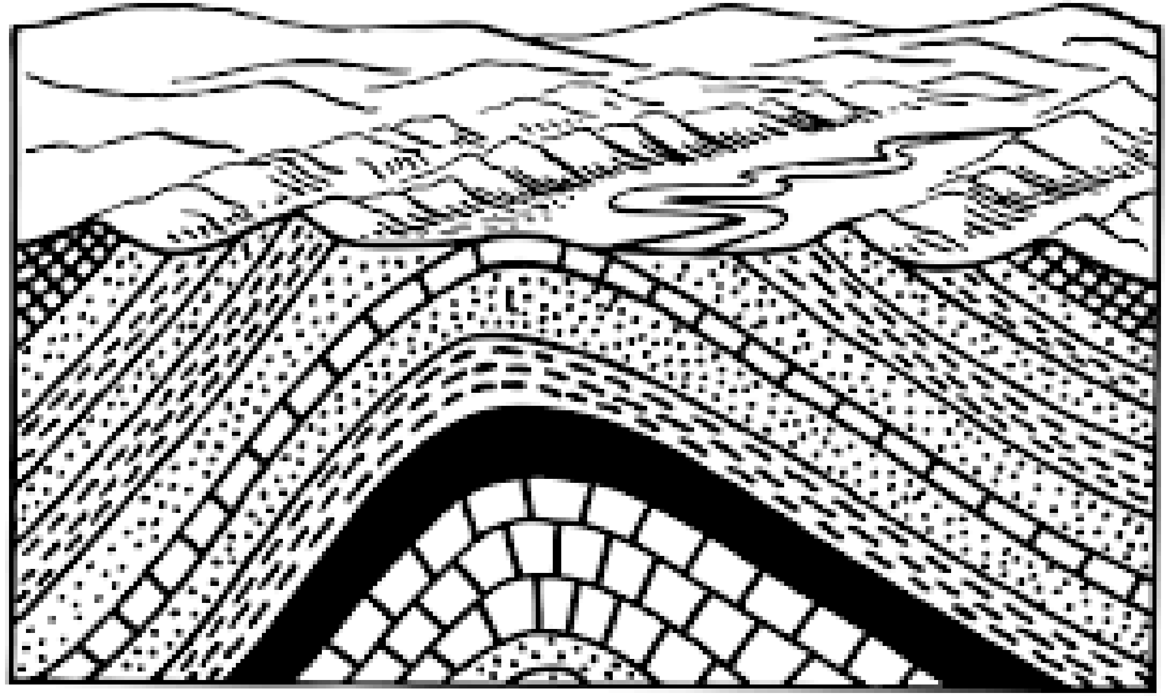
The straight-line distance is _________________ footlengths.

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

If we assume that the layer you followed was originally straight, then the difference between the two measurements you made represent the amount of shortening that the deformation (folding) accomplished. By approximately what percent of its original length was the layer shortened?

Shortening percent = _________________



CENTRAL PARK FIELD TRIP

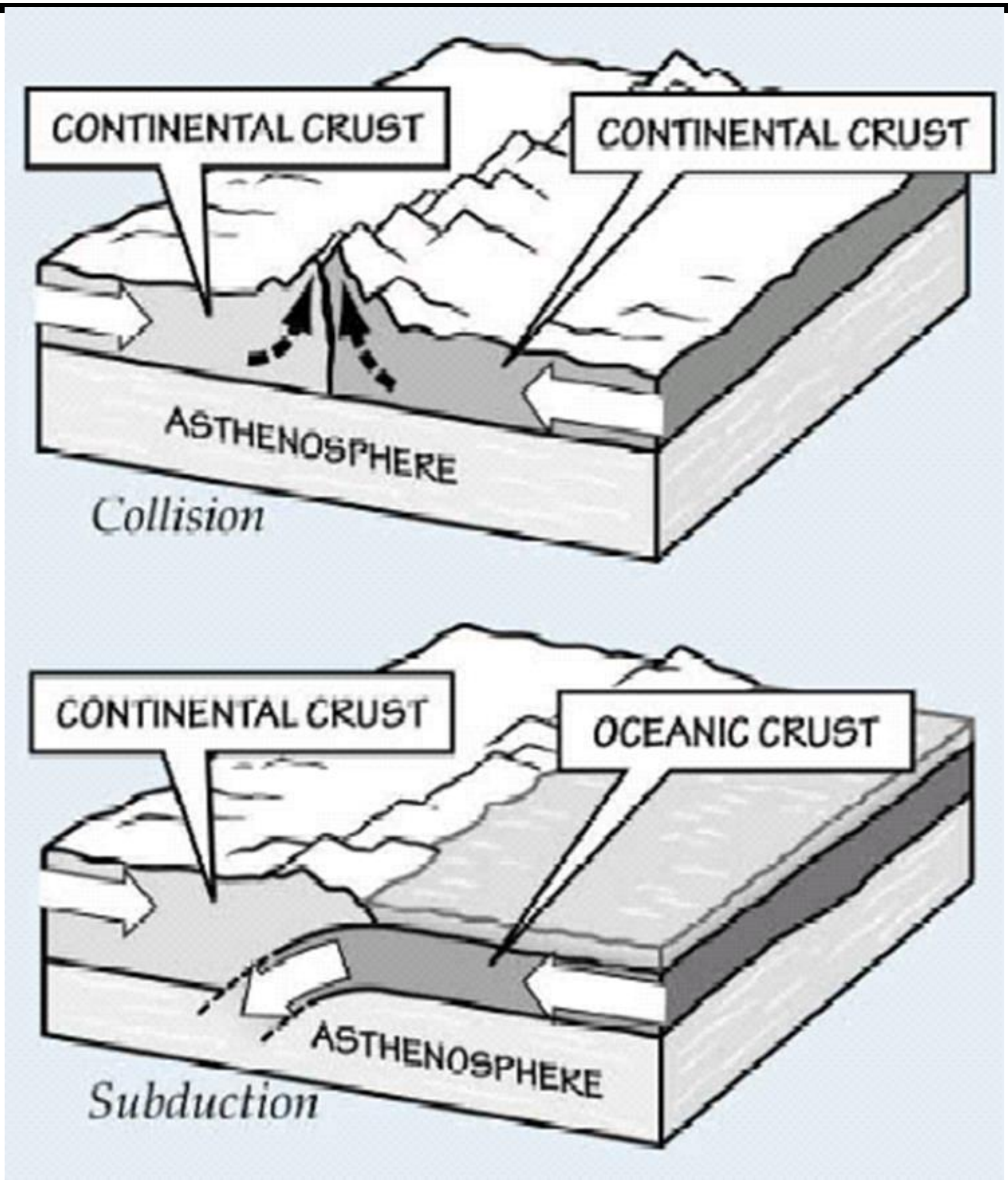
CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

The folding that you see in this area may be understood in terms of the geologic history of the New York City region:

About 400 million year ago, this region was shallow sea floor, off the coast of the American
continent, and was the site of deposition of great thicknesses of sediment derived from the erosion of the nearby land (Fig. 1). During that time, the region was in the central part of the American plate.

CENTRAL PARK FIELD TRIP



CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

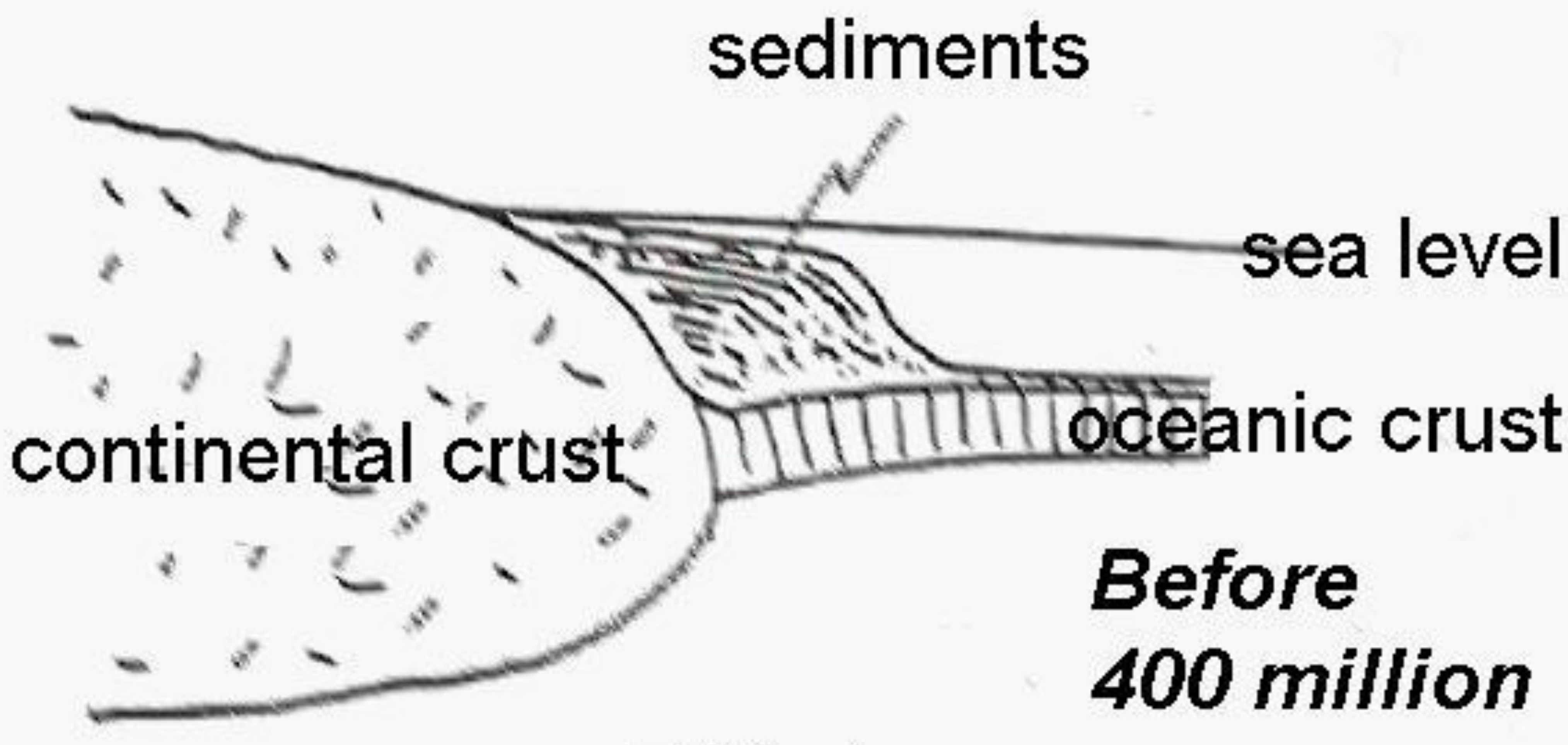
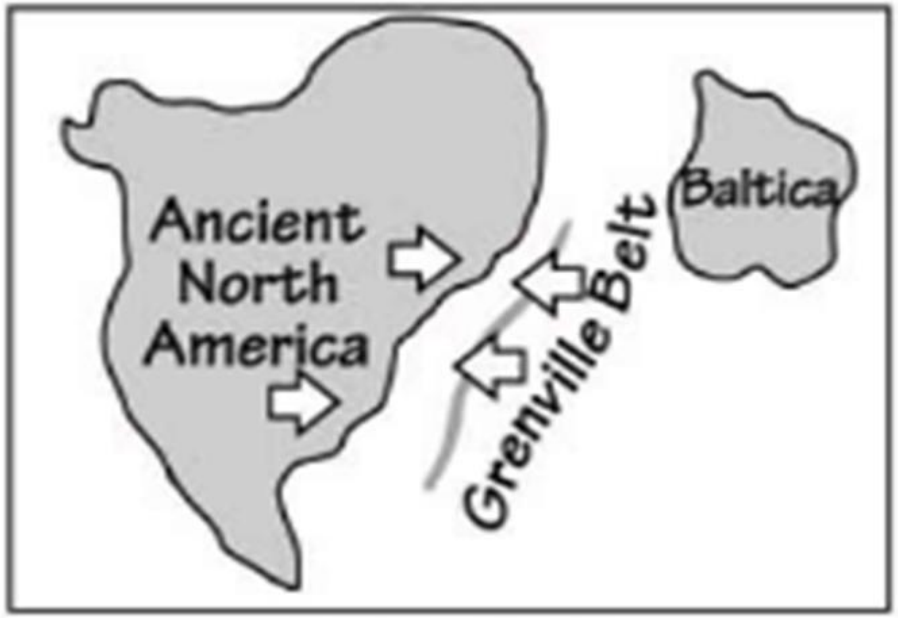
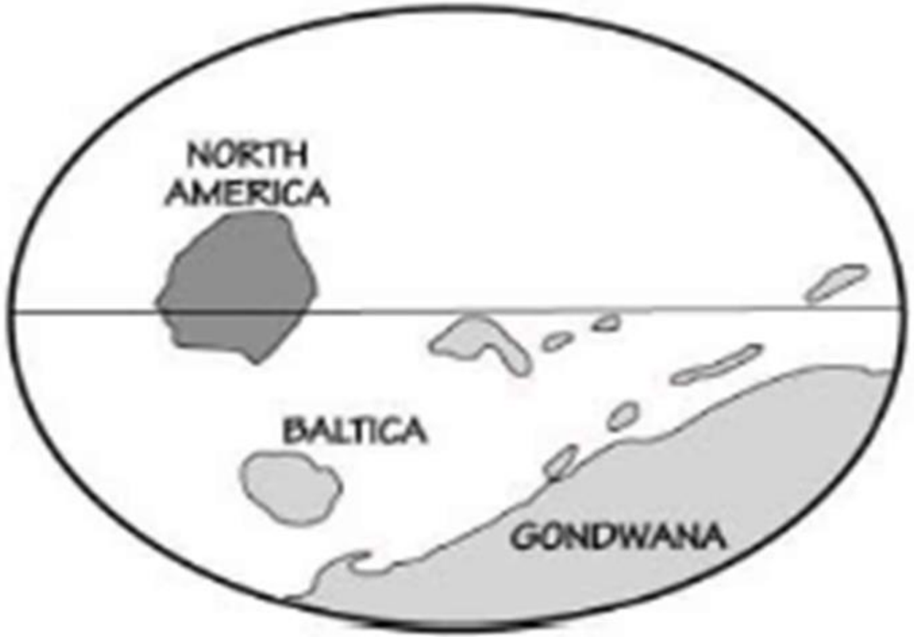


FIG. 1

CENTRAL PARK FIELD TRIP





CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

Later, a new, convergent plate boundary develop here, along which ocean lithosphere was pushed under continental lithosphere (forming a subduction zone). As a result, the region became subject to compression, and a mountain range formed (Fig. 2). From the subduction zone, heat, magma and chemically active fluids penetrated the core of the mountain range, deforming and metamorphosing the sedimentary layers.

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

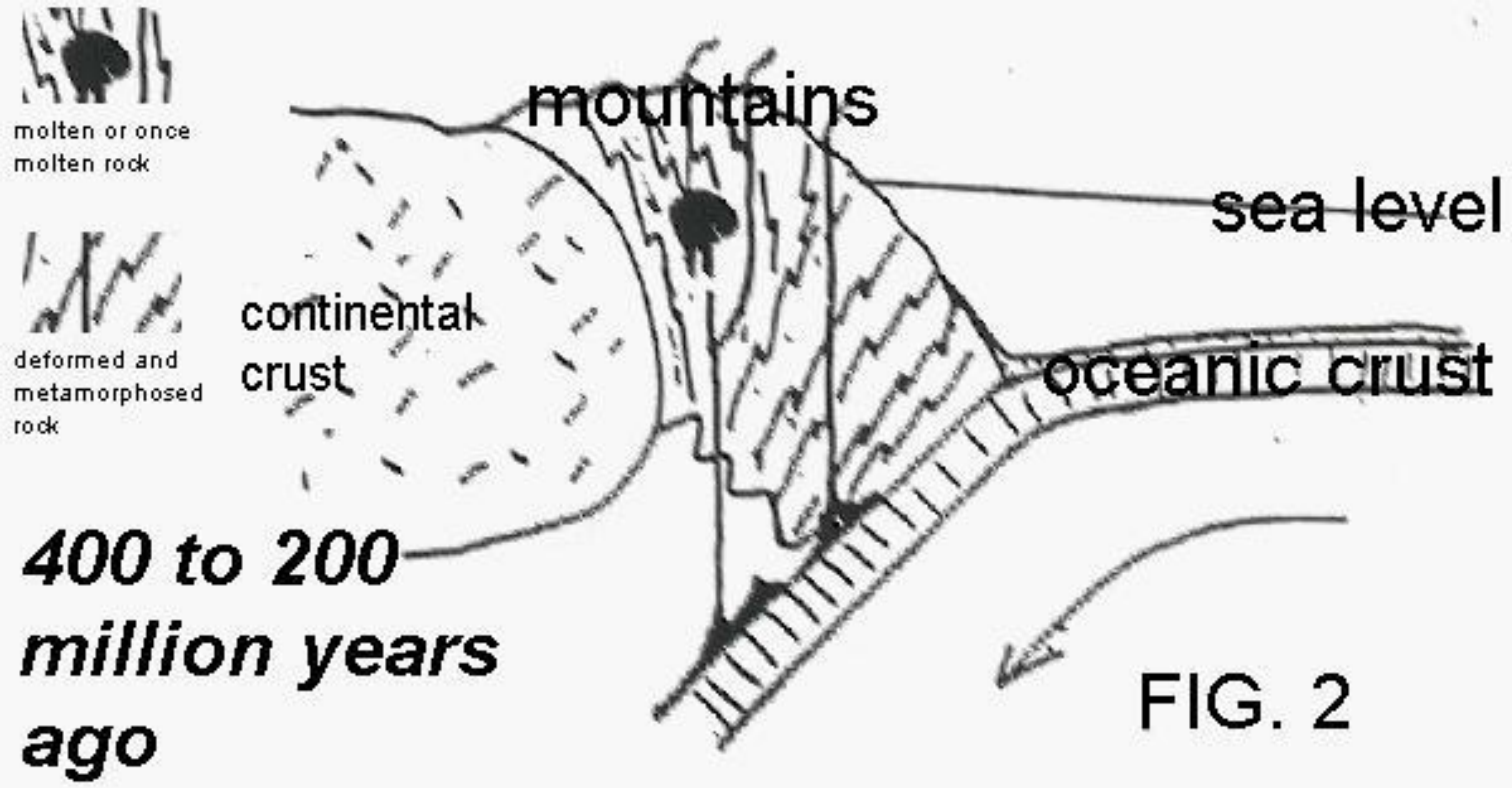
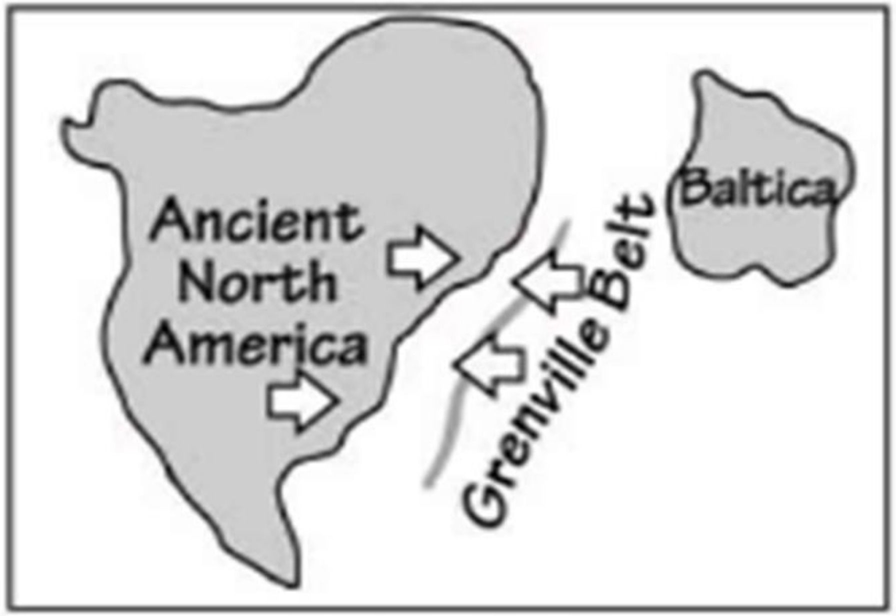
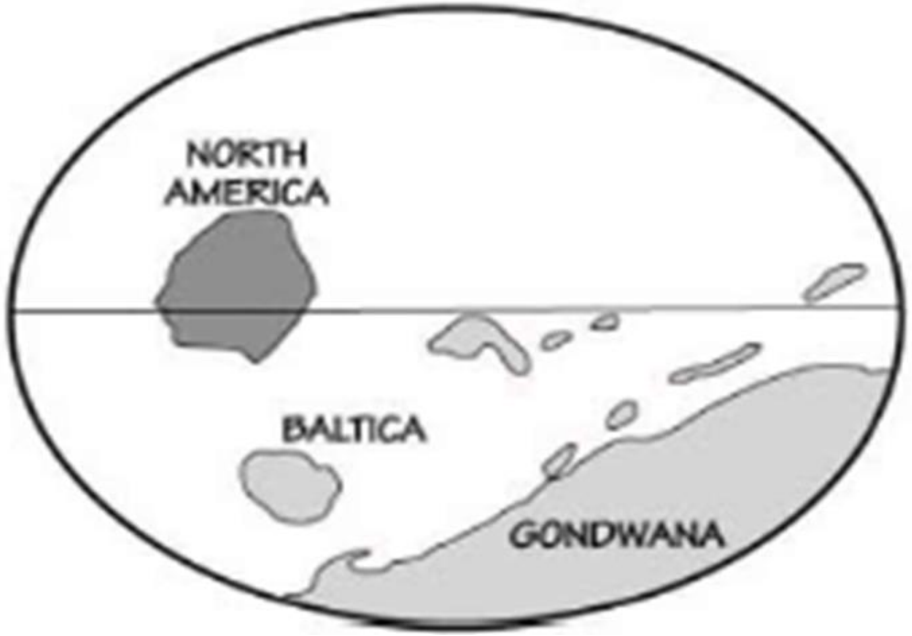
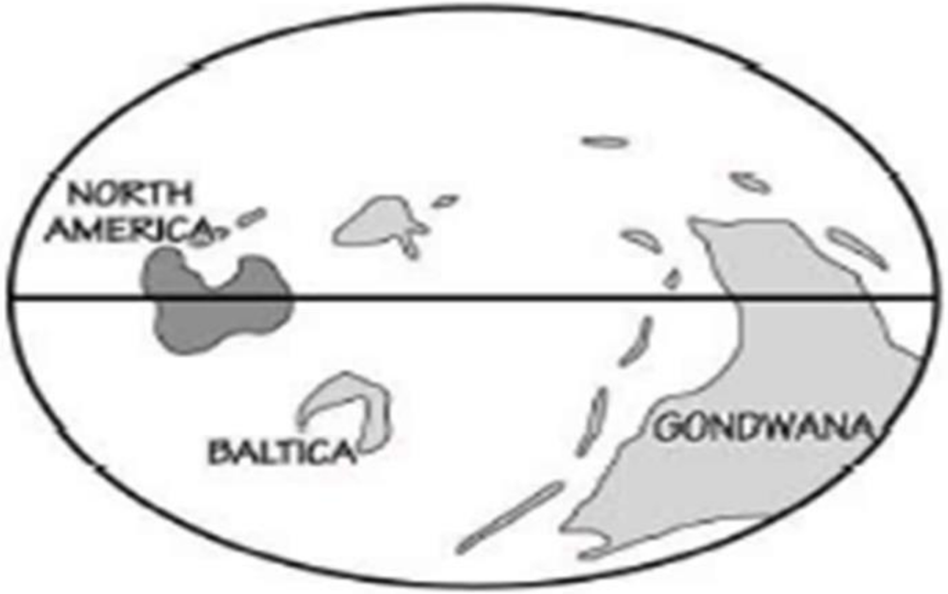


FIG. 2

CENTRAL PARK FIELD TRIP







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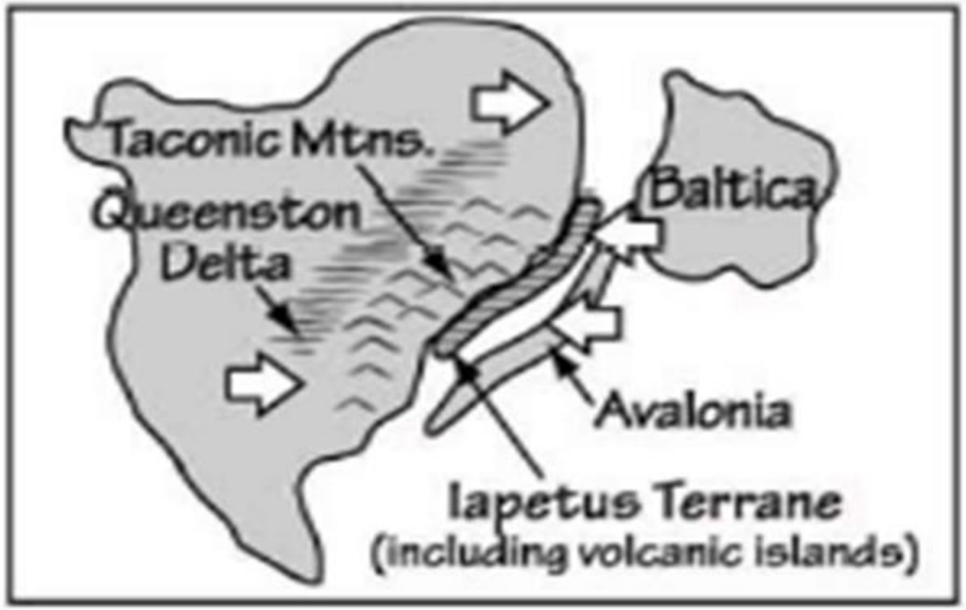

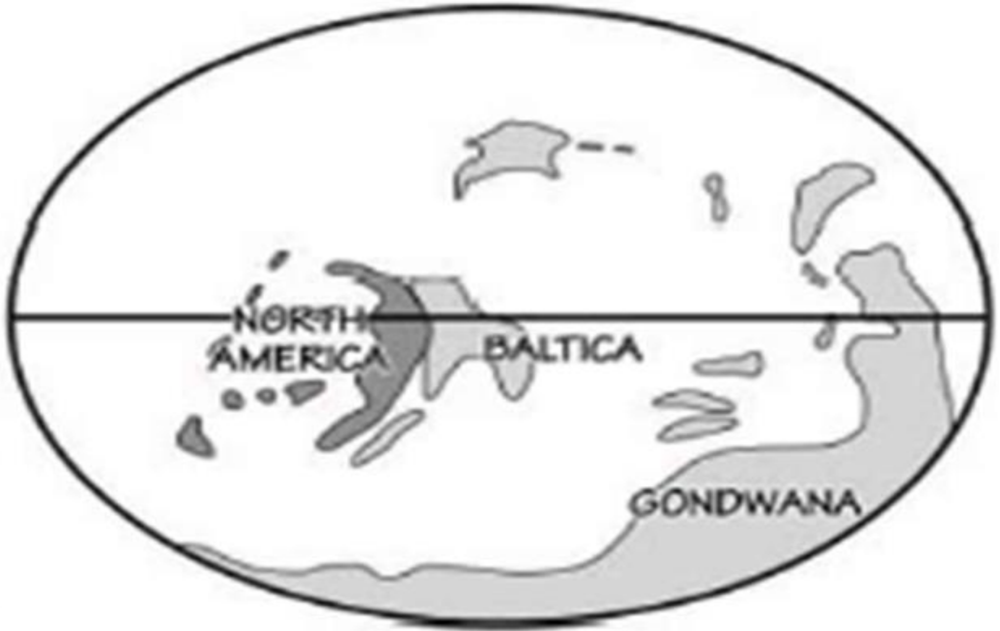

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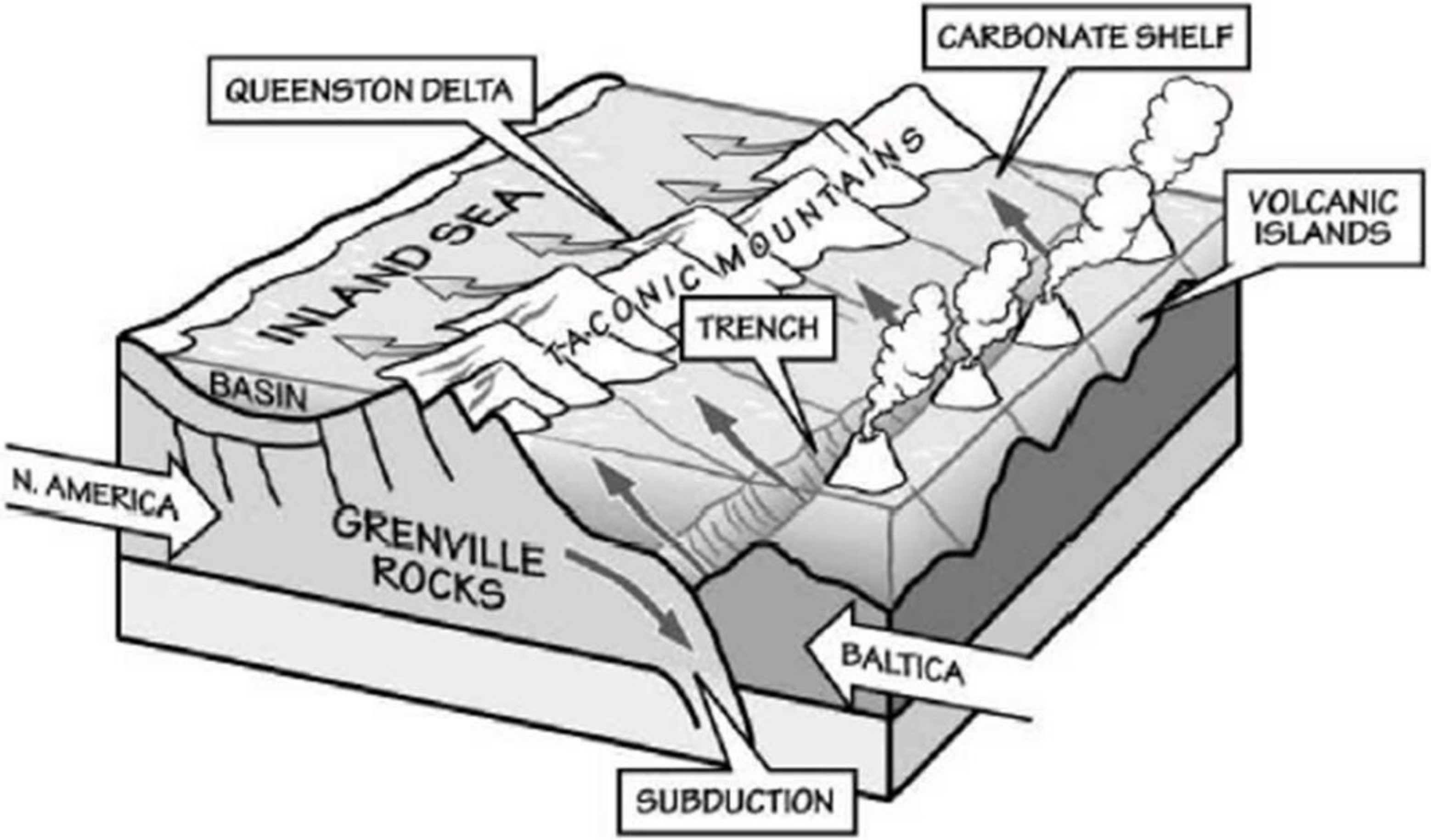


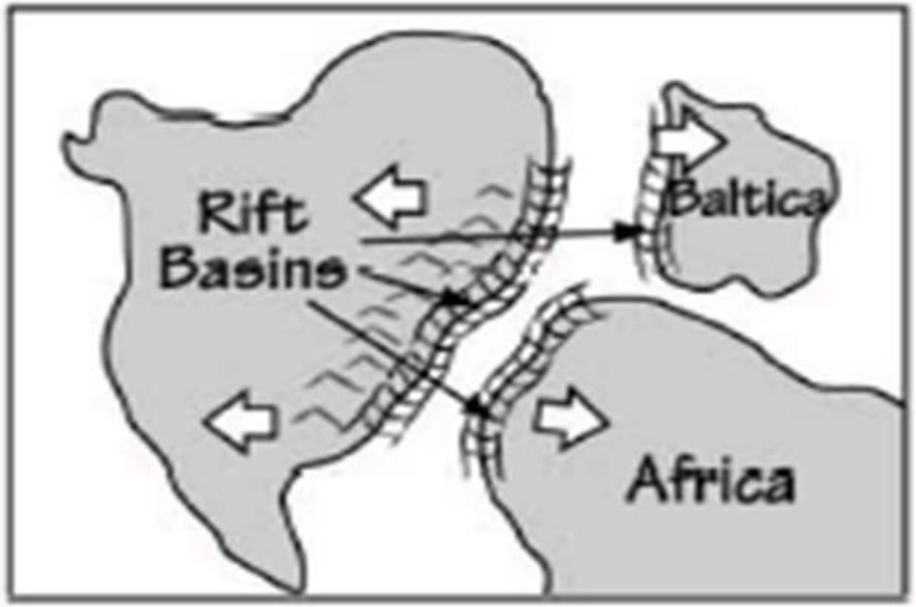
Figure 1.7: Volcanic islands formed where the plates were forced together as the Iapetus Ocean closed. The compression crumpled the crust to form the Taconic Mountains and a shallow inland sea. Figure by J. Houghton.

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

About 200 million years ago, the region ceased being a convergent plate boundary, and active mountain building processes came to a halt. Gradually the mountains were eroded away until the rocks which composed their igneous and metamorphic roots were exposed at the surface (Fig. 3). The deformed rocks at which you are now looking are the roots of that ancient mountain range.

CENTRAL PARK FIELD TRIP



CENTRAL PARK FIELD TRIP

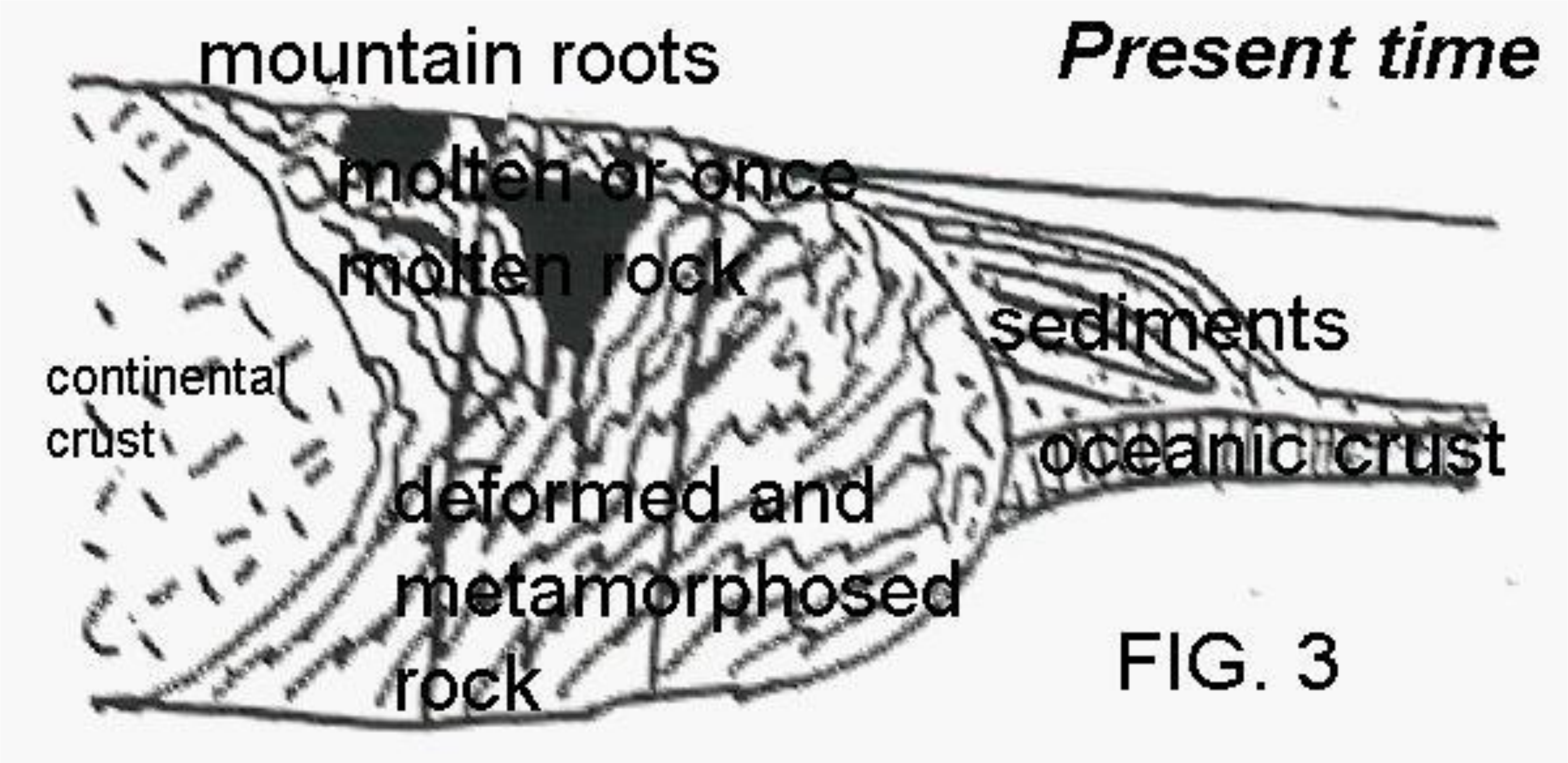


FIG. 3

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

Go to the area marked C-3. In the roots of the mountain range where these rocks formed, pockets of melt developed which were then squeezed and forced (intruded) into the adjacent solid rock. When the melt cooled, it formed bodies of rock called "intrusives". Such intrusives may be seen in this area.

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

a. Find the pegmatite intrusion. Note its sharp contacts with the surrounding rock. Sketch the pegmatite on the map.

b. Find another intrusive body (a fine-grained granite) that intersects the pegmatite. Carefully sketch it on the map too, paying special attention to its contact with the pegmatite.

c. Which intrusive, the pegmatite or the granite, is older?

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

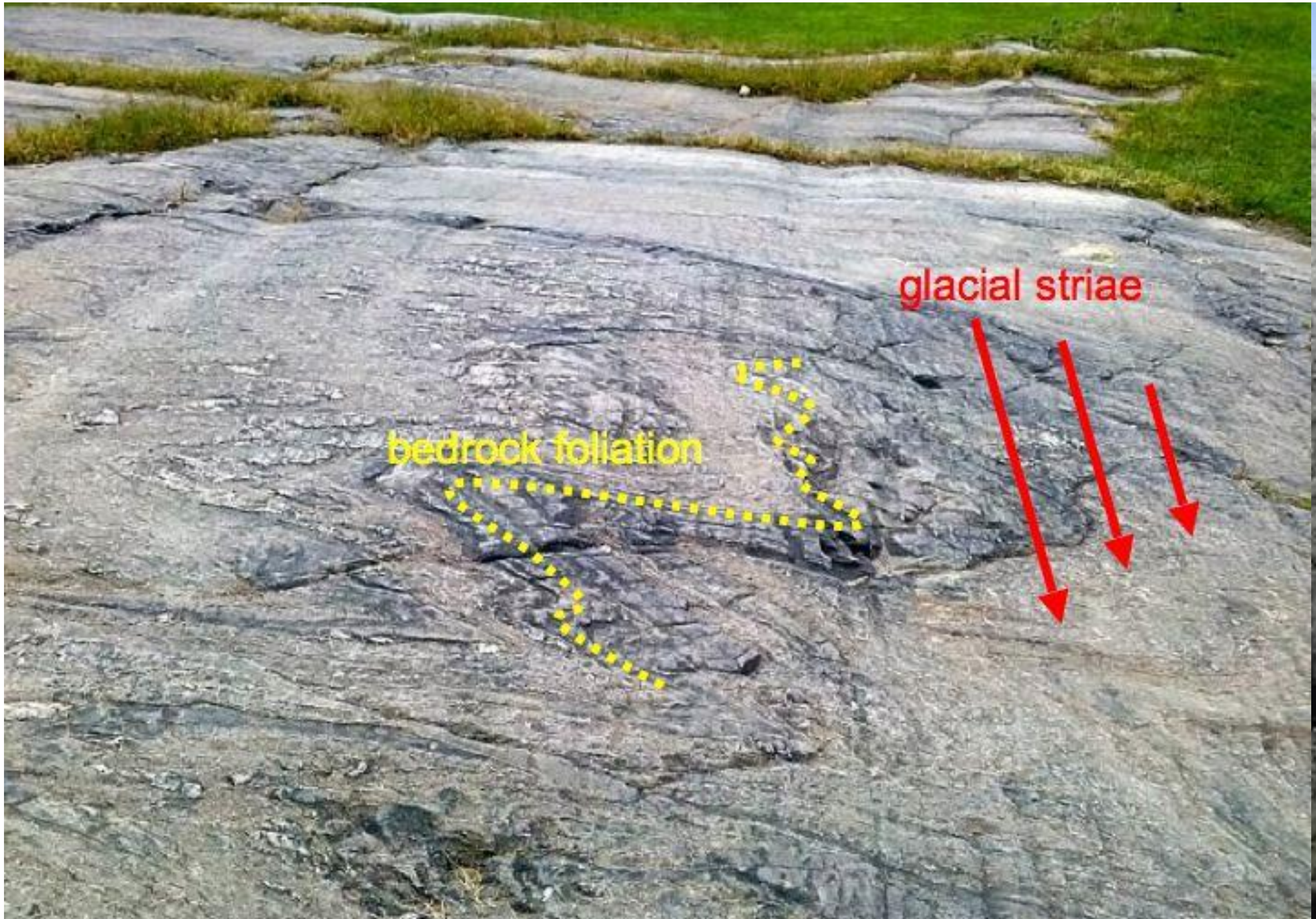
CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)
Go to the area marked C-4, stand on the soil or grass, and look at the rock face that slopes gently down toward you. Locate the foot-or-so wide, parallel grooves that extend for ten yards or so up the outcrop.



CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)



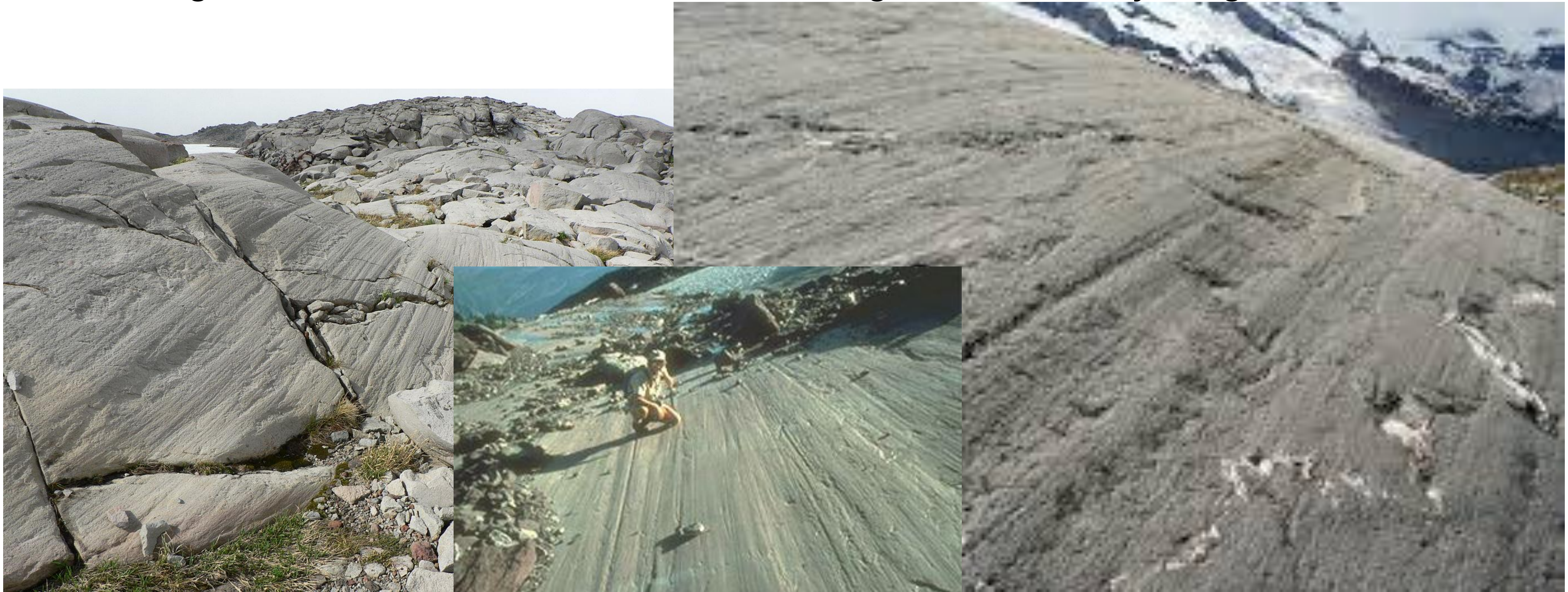
CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

a. Are the grooves parallel to the layering in the rock?

b. Could they be due to differential erosion of the layering in the rock?

c. Did the grooves form before or after the folding of the rock layering?



CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

The origin of the grooves may be explained in terms of the Glacial Theory. About 15 thousands years ago, a giant body of flowing ice (a glacier) covered this area. Embedded in the ice at the bottom of the glacier were large boulders. As the ice pressed down on these boulders and dragged them over the underlying bedrock, grooves were carved in the bedrock. Smaller particles of rock that were dragged along created smaller grooves called "striations".

CENTRAL PARK FIELD TRIP

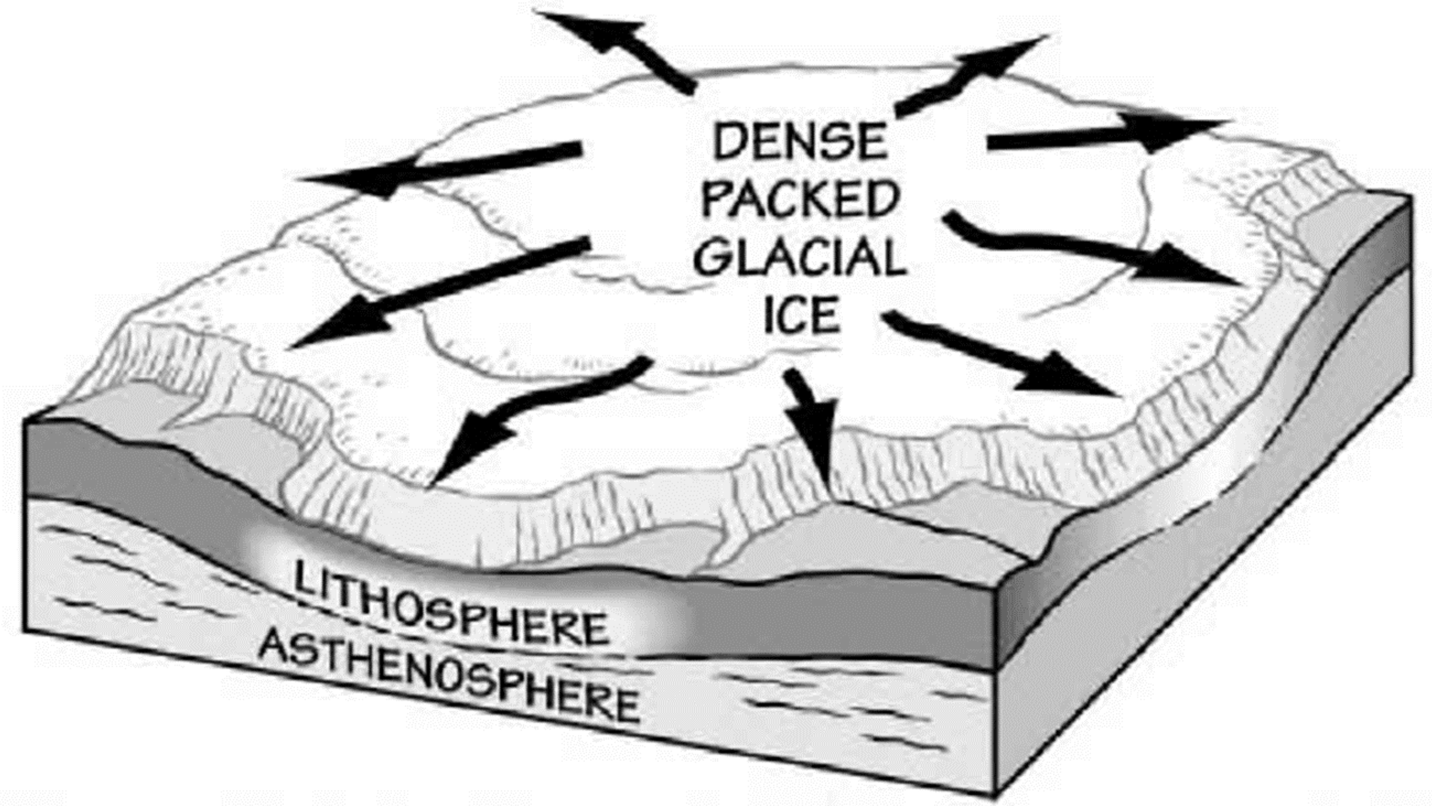


Figure 1.27: The movement of the ice sheet over North America. Figure by J. Houghton.

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

https://www.nytimes.com/2018/06/05/science/how-the-ice-age-shaped-new-york.html

CENTRAL PARK FIELD TRIP

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

d.Find some striations. What is their orientation with respect to the grooves?

e.Sketch the grooves in area C-4 on your map.

CENTRAL PARK FIELD TRIP

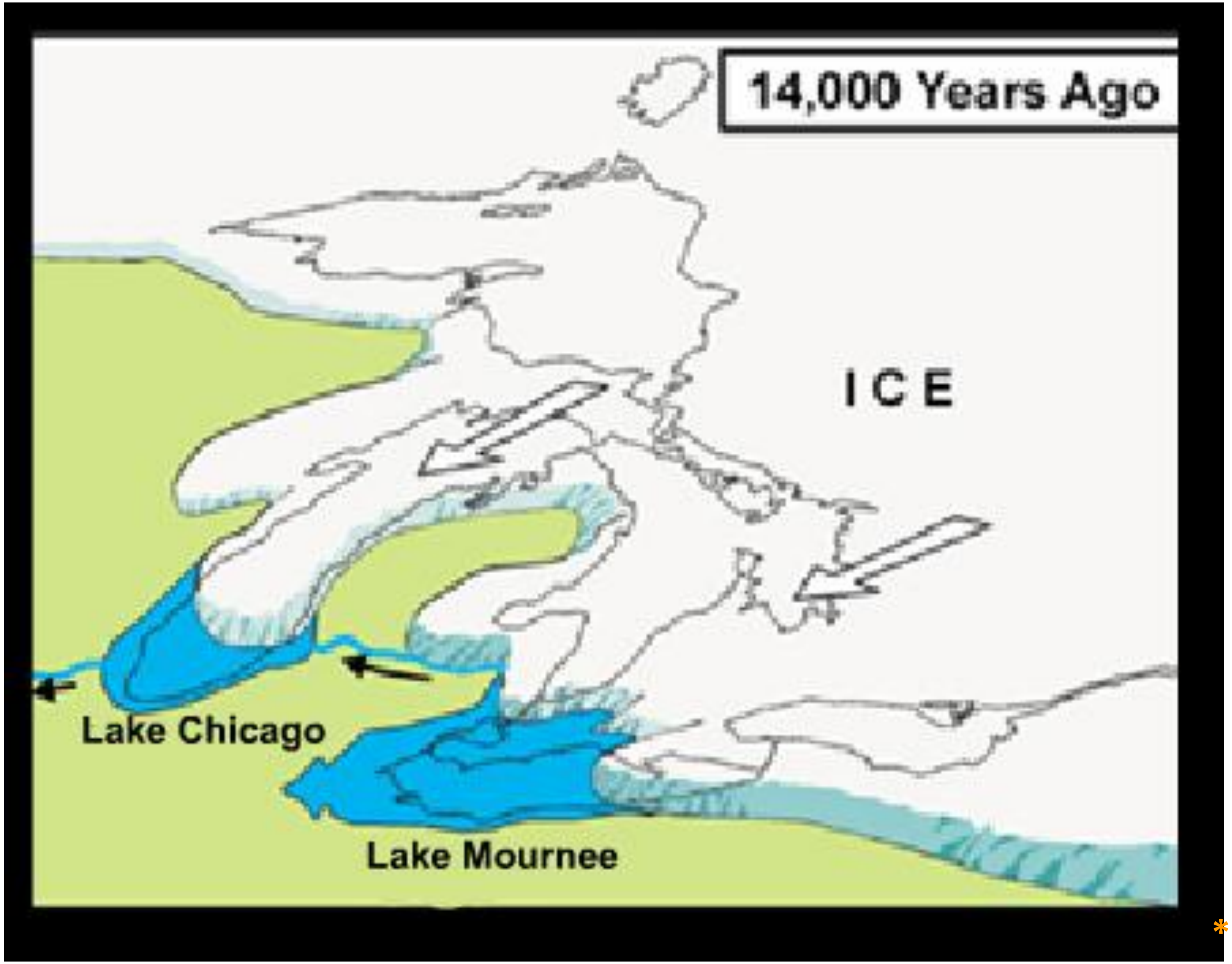
ROCK EXPOSURES C (Umpire Rock)

f.What are the possible direction from which the glaciers may have come to this area? (See map for true north.)

Direction 1 ___________________ Direction 2 ___________________

At a later outcrop we shall determine which of these two possible directions is most likely.

AND THE TIME INBETWEEN…

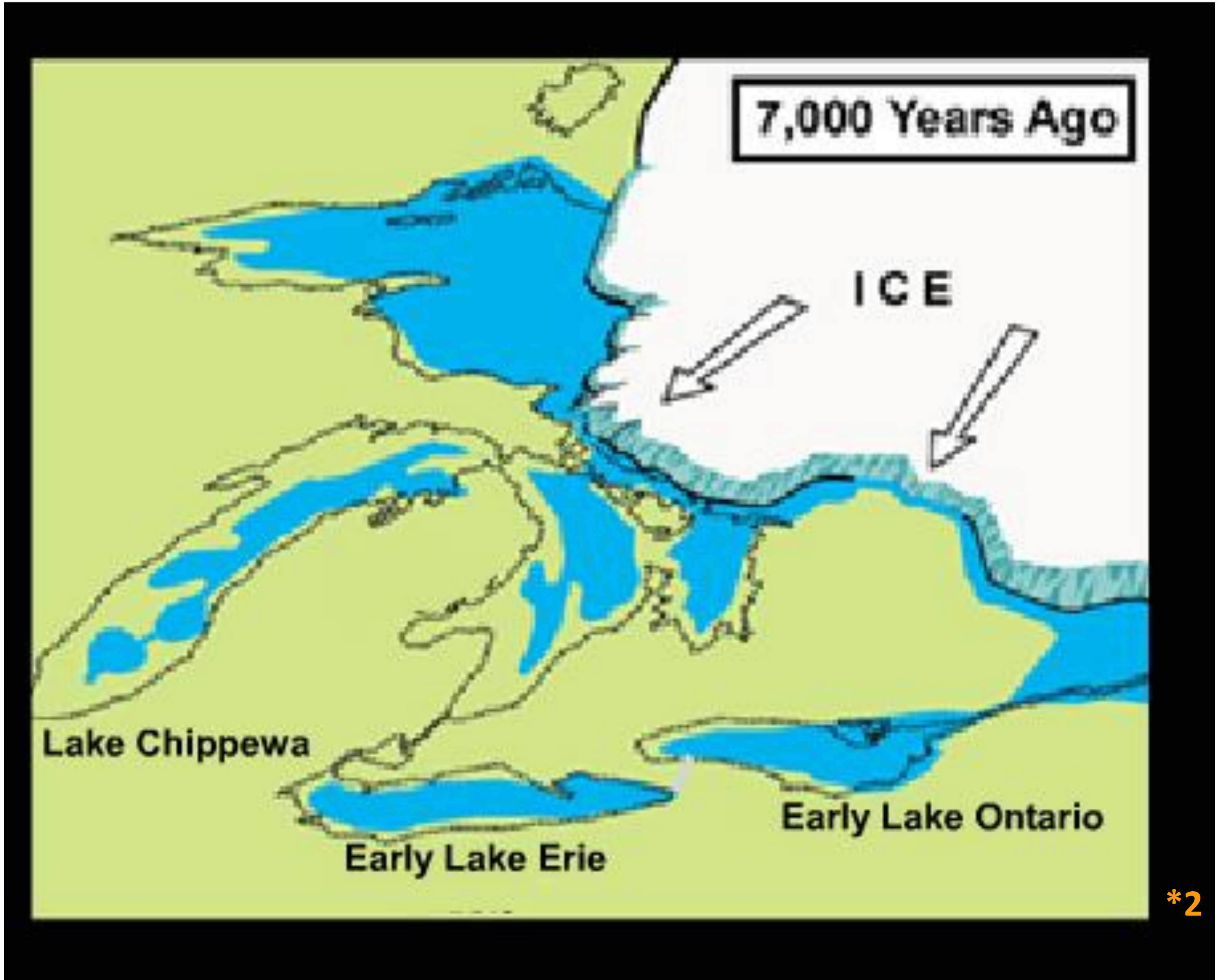


*2

AND THE TIME INBETWEEN…

*2

AND THE TIME INBETWEEN…



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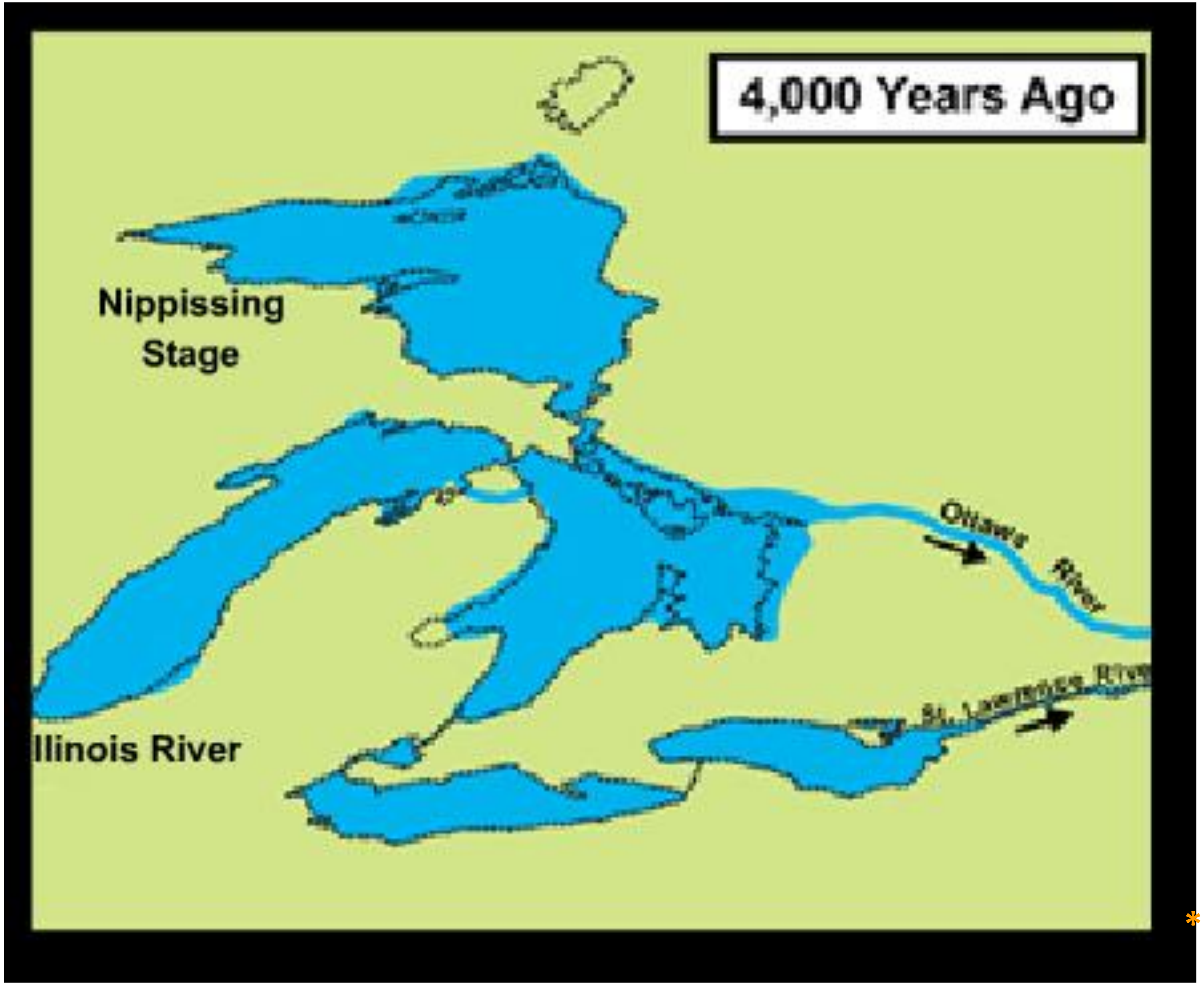
AND THE TIME INBETWEEN…

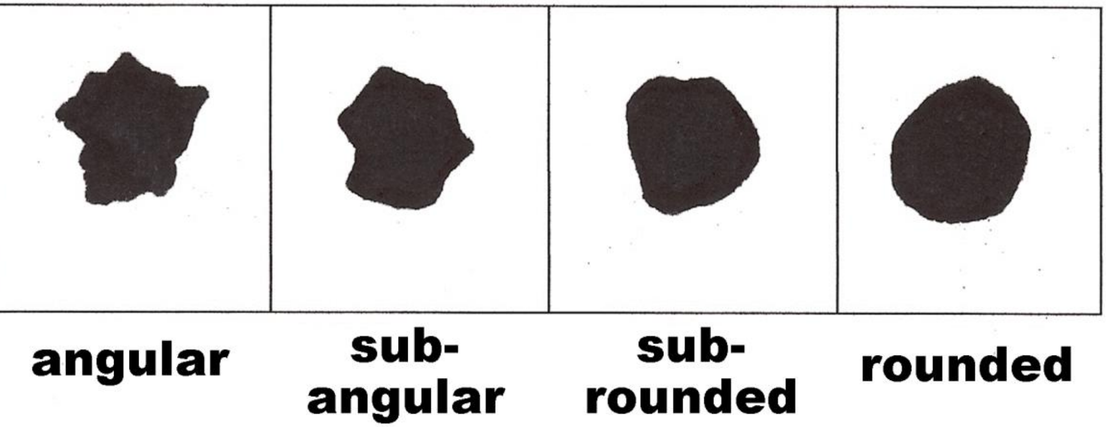


*2

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

Go to the area marked C-5 on your map. Examine the small boulders that lie scattered at the base of the small cliff. At least two different rock types are represented, one layered, one unlayered.



CENTRAL PARK FIELD TRIP

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

Identify two rock types.

a) Layered ________________ b) Unlayered ________________

CENTRAL PARK FIELD TRIP

ROCK EXPOSURES C (Umpire Rock)

Explain how each of the rock types might have arrived at its present location, citing the appropriate evidence, including the degree to which the boulders are rounded or angular.

a)

b)

CENTRAL PARK FIELD TRIP

YOUR INSTRUCTOR WILL NOW REVIEW C-5

Area D. Walk with your instructor to the large boulder perched on the hill. There is a similar large boulder in the distance to the left of the carousel. These boulders are called ‘erratics’.

CENTRAL PARK FIELD TRIP

YOUR INSTRUCTOR WILL NOW REVIEW C-5

1. What is the general grain size?
2. Name three minerals present in the boulder.

____________________ ____________________ ____________________

CENTRAL PARK FIELD TRIP

CENTRAL PARK FIELD TRIP

YOUR INSTRUCTOR WILL NOW REVIEW C-5

3.What rock type is the boulder?

4.What is the rock type upon which the boulder rests?

CENTRAL PARK FIELD TRIP

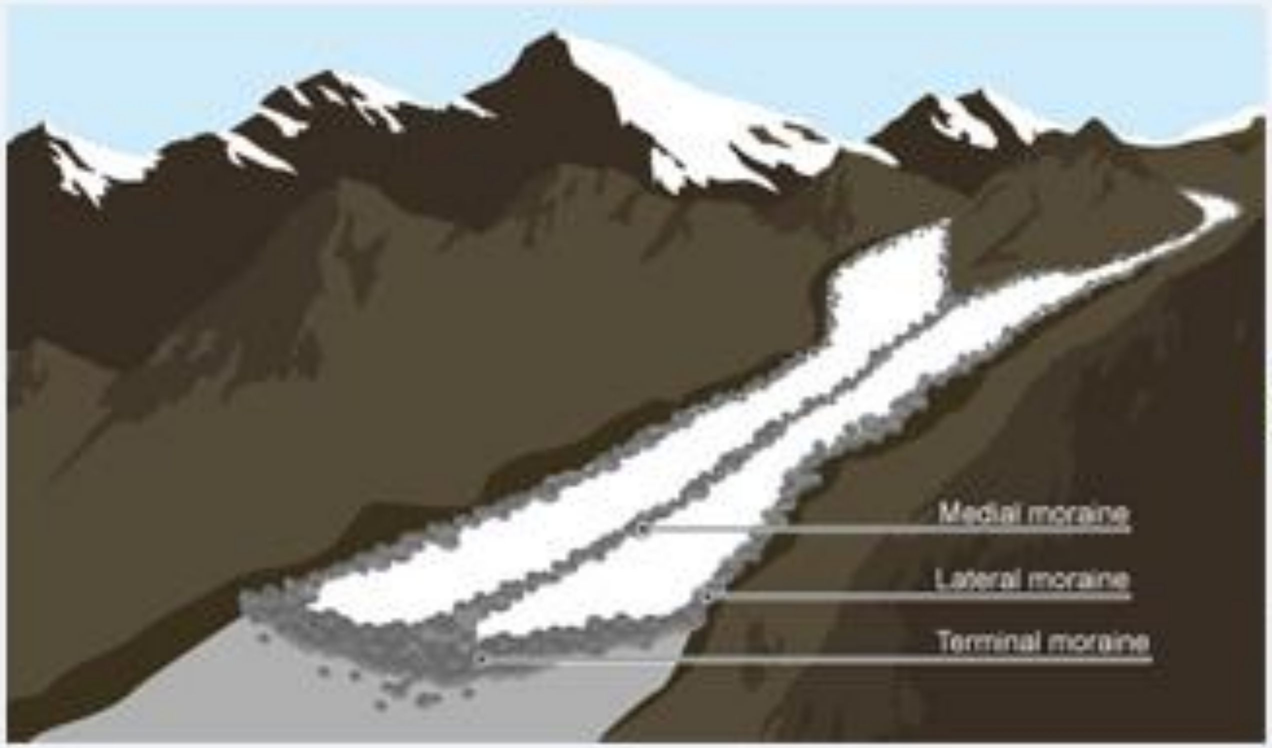
YOUR INSTRUCTOR WILL NOW REVIEW C-5

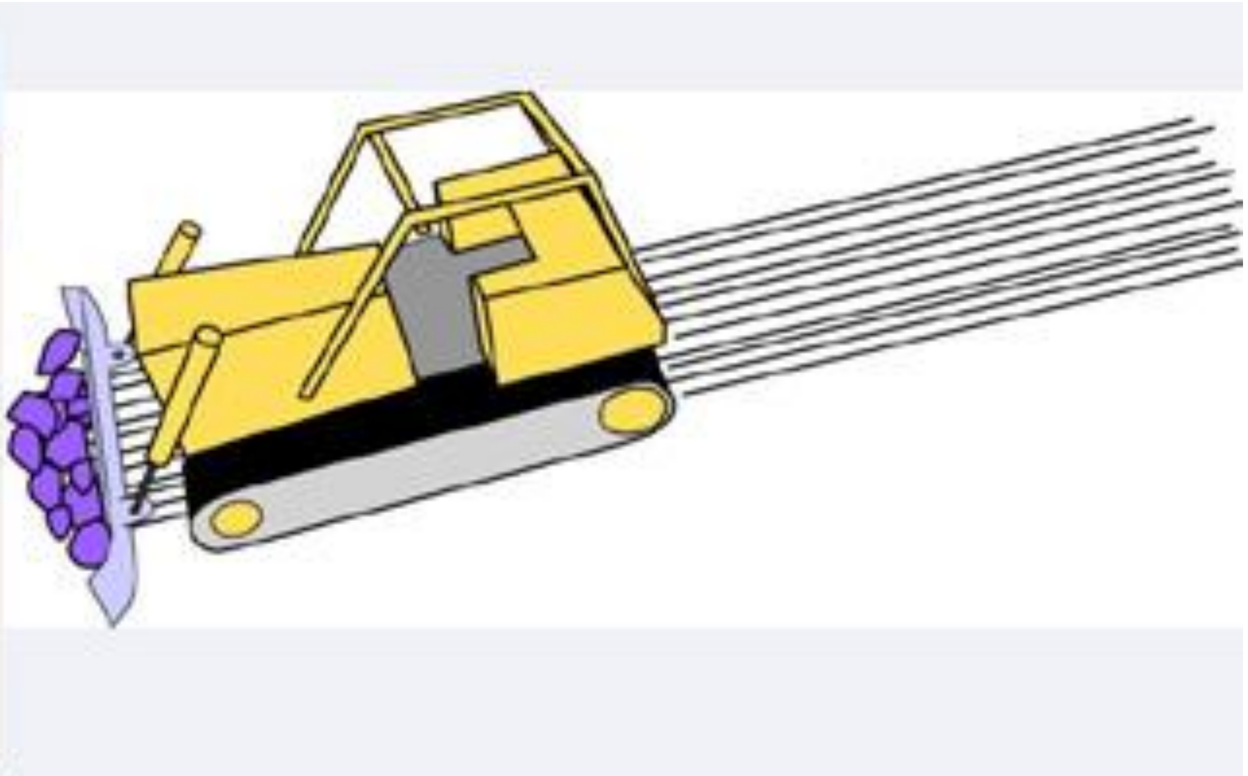
5.Explain how the boulder got to its present position. (It was <u>not</u> placed there by people)

CENTRAL PARK FIELD TRIP

YOUR INSTRUCTOR WILL NOW REVIEW C-5

5.Explain how the boulder got to its present position. (It was <u>not</u> placed there by people)

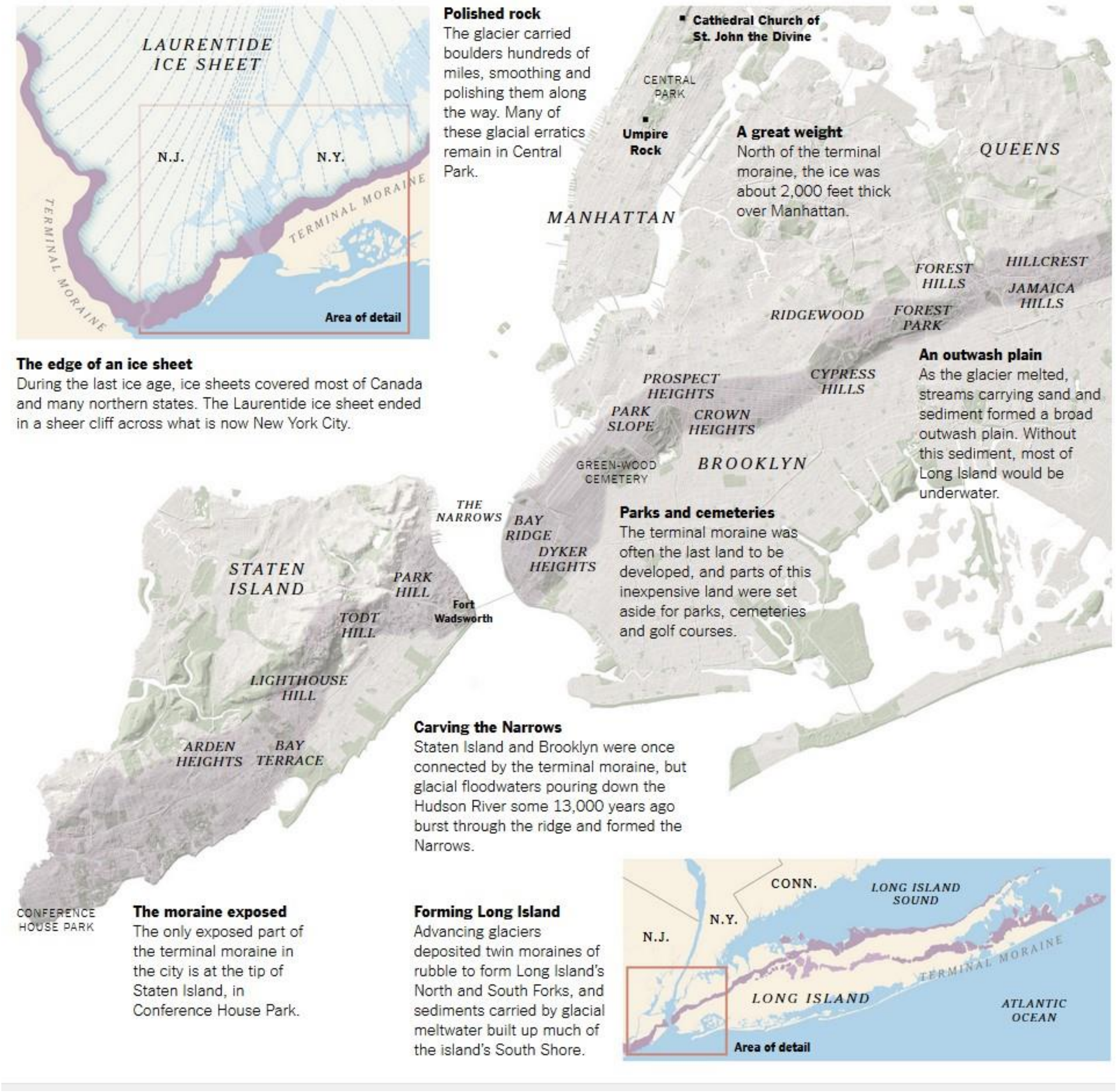




CENTRAL PARK FIELD TRIP

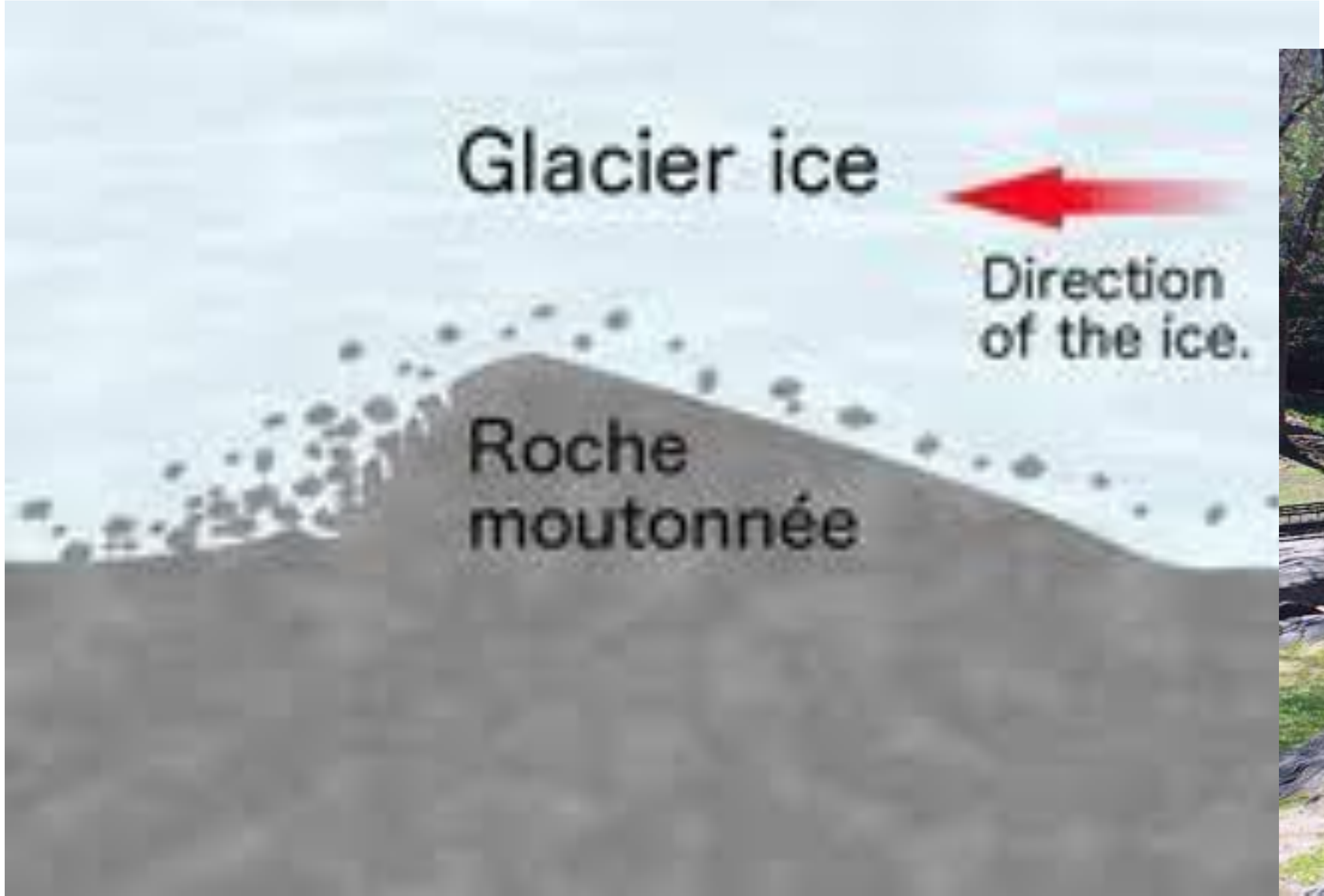
The glacier acted like bulldozer and formed the terminal moraine and then after as the glacier was melting millions of tons of sediment started to accumulate forming what is today Brooklyn and Queens.

CENTRAL PARK FIELD TRIP



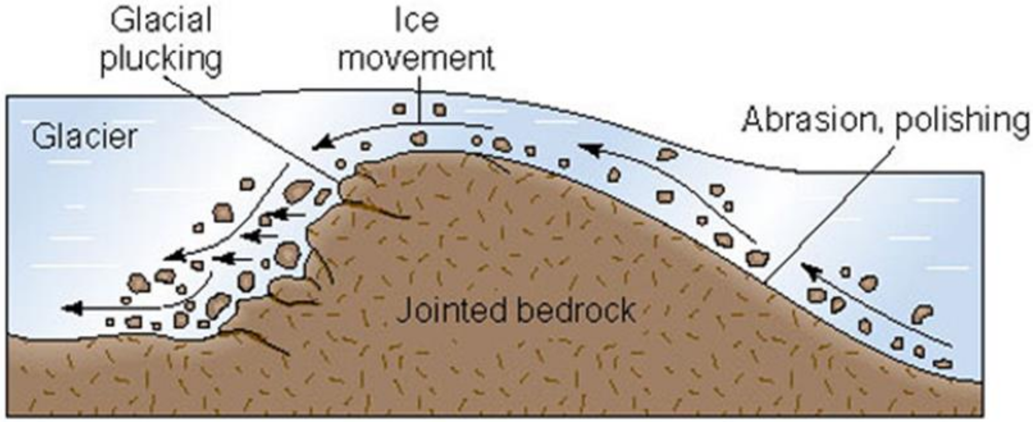
CENTRAL PARK FIELD TRIP

OUTCROP E. Go with your instructor through the underpass to the right of the carousel. Upon emerging from the underpass, follow the path a short distance to outcrop E on the right. The outcrop is just below the red brick octagonal building. Stand so that beyond the outcrop, on the horizon, you can see the sign for the Essex Hotel.



CENTRAL PARK FIELD TRIP

(a)



(b)

CENTRAL PARK FIELD TRIP

OUTCROP E.

Note the glacial grooves that run from right to left across the outcrop.

2.Look at the right end of the outcrop where its slopes down to the soil and grass. Now look at the left end of the outcrop. In profile, which end, the right or the left, looks steep and abruptly "cut off"? Which ends looks more "streamlined"?

Steep ___________________________ Streamlined __________________________

<u>CENTRAL PARK FIELD TRIP</u>

OUTCROP E.

The asymmetry of this outcrop provides an ambiguous answer to the question "from which direction did the glacial ice advance?" As glacial ice moves over bedrock that is hilly, it tends to carve the "upstream" end of the hill into a smooth, streamlined shape. At the same time, as the ice flows over and then leaves the hill, it tends to "grab" at any loose, fractured parts of the bedrock and remove them, causing that end of the hill to have a steep, cliff-like profile (see Fig. 4). The resulting asymmetric hill is called a 'roche moutonnee'.

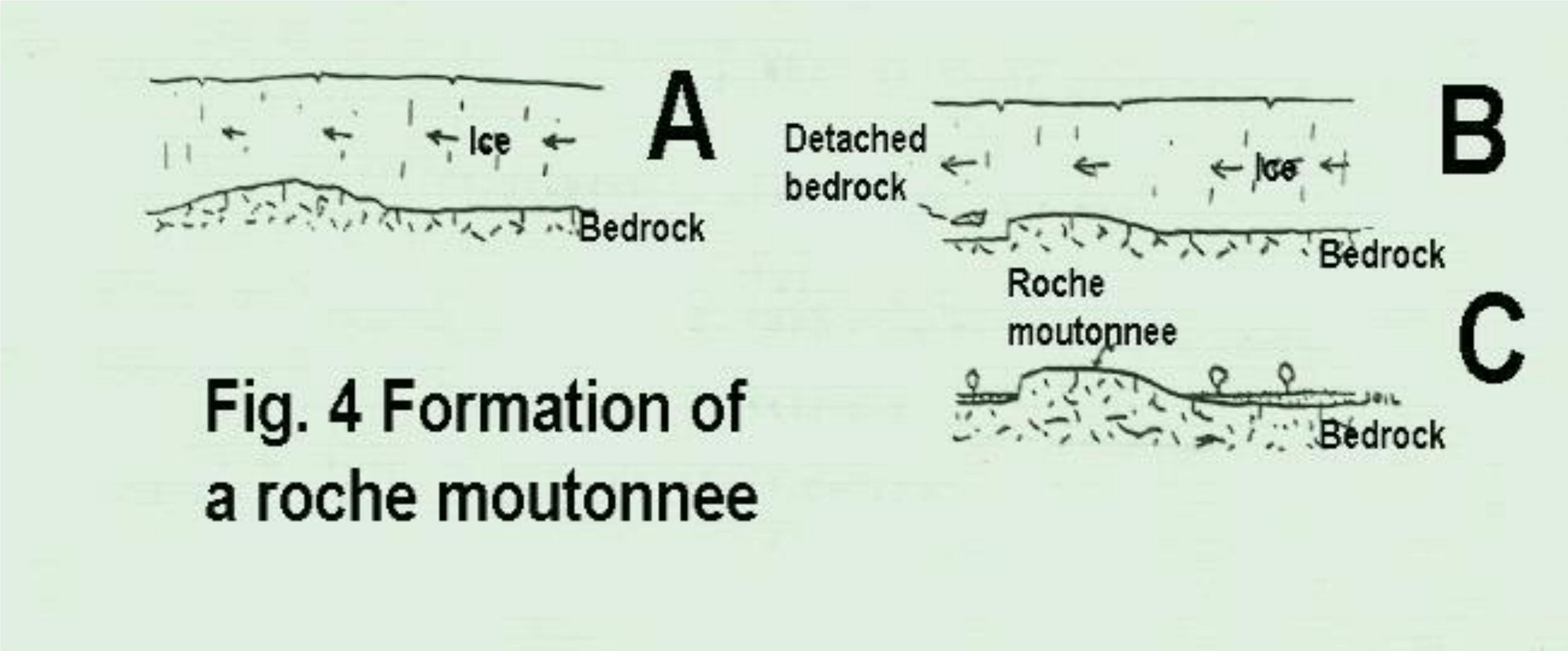
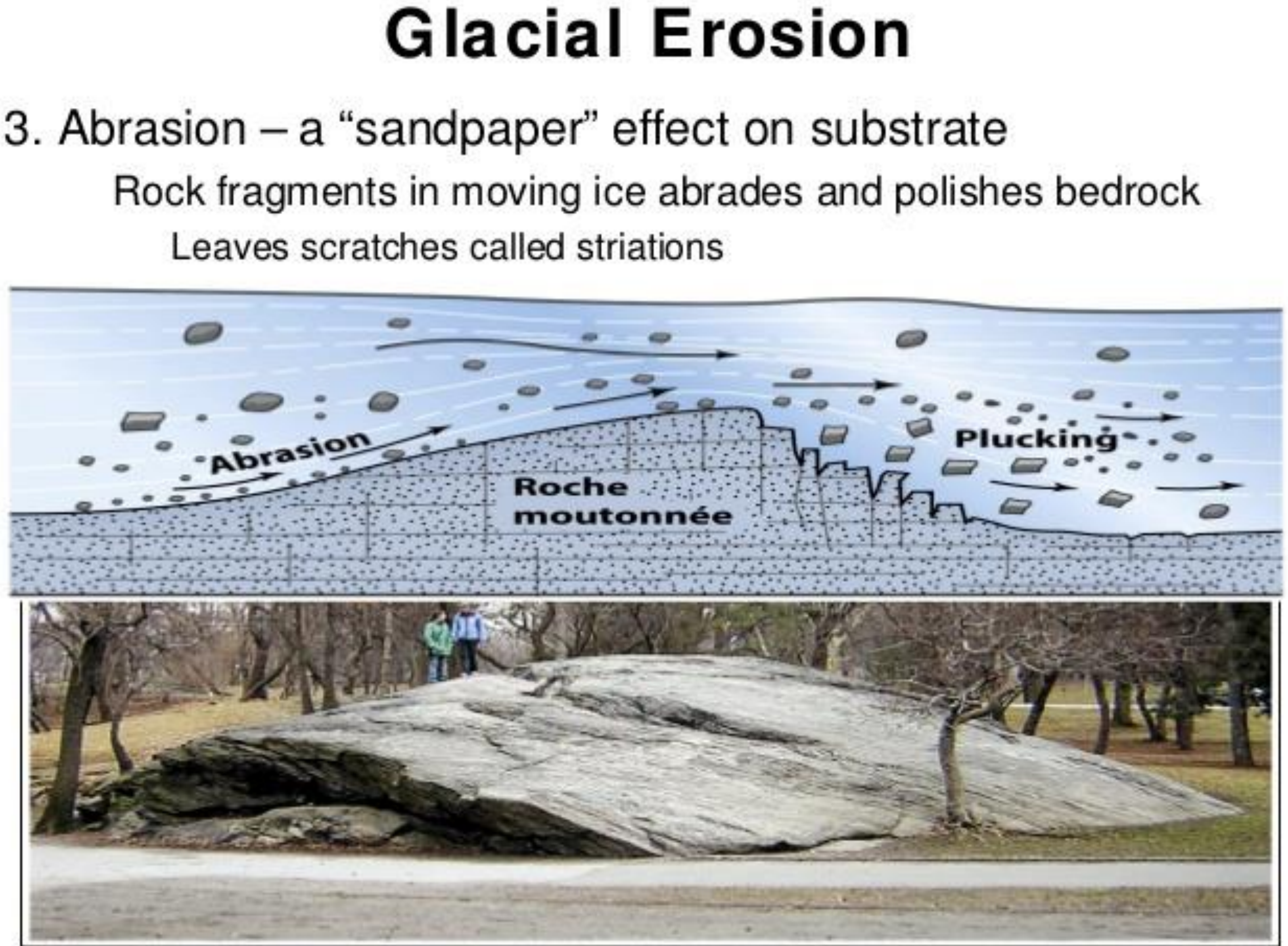


Fig. 4 Formation of a roche moutonnee

CENTRAL PARK FIELD TRIP

OUTCROP E.

3.From your examination of the roche moutonnee before you, from which direction did the glacial ice advance?



CENTRAL PARK FIELD TRIP

OUTCROP E.

In Fig. 4, note the piece of detached bedrock embedded in the ice. What other erosional glacial feature that you have seen might be caused by such fragments?

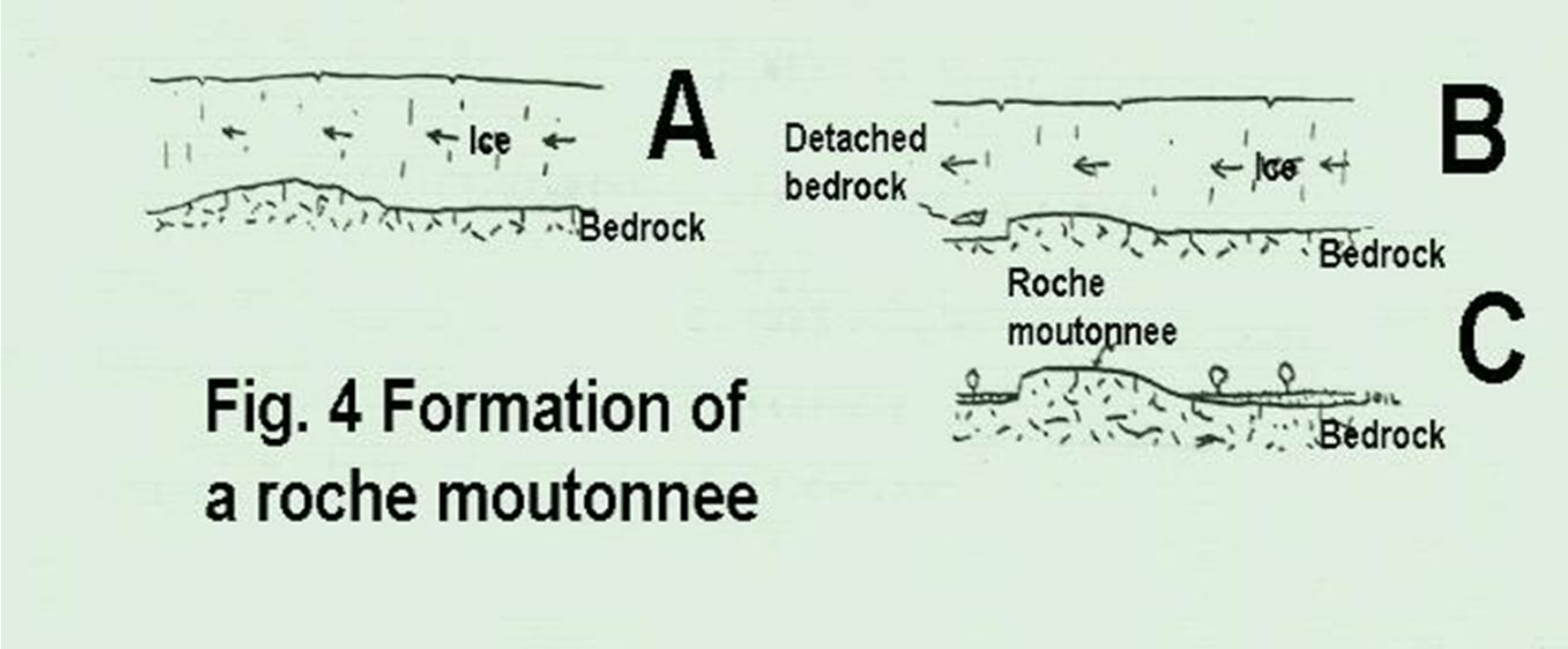


Fig. 4 Formation of a roche moutonnee

CENTRAL PARK FIELD TRIP

OUTCROP E.

What effect does this have on the angularity of the fragment?

If the fragment is not destroyed , what feature that you have observed might it become when the ice ultimately melts?

CENTRAL PARK FIELD TRIP

OUTCROP E.

5.To verify the direction of glacial movement indicated by the roche mountonee, where would you go and what would you look for? (Hint: Consider your hypothesis concerning the origin of the erratic boulders.)