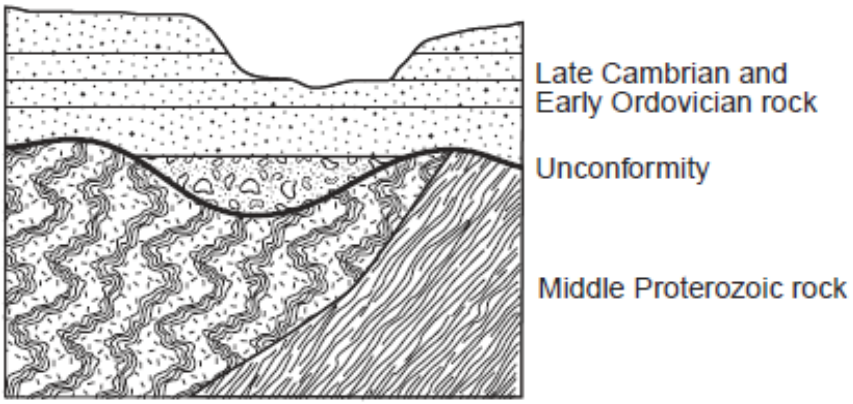
RR#9 - Free Response

Base your answers to questions **1** and **2** on the cross section below and on your knowledge of Earth science. The unconformity is located at the boundary between Middle Proterozoic rock and Late Cambrian and Early Ordovician rock.



1. Identify by name the oldest New York State index fossil that could be found in the Early Ordovician bedrock.

2. Identify *one* geologic process that occurred in this region that produced the unconformity in this outcrop.

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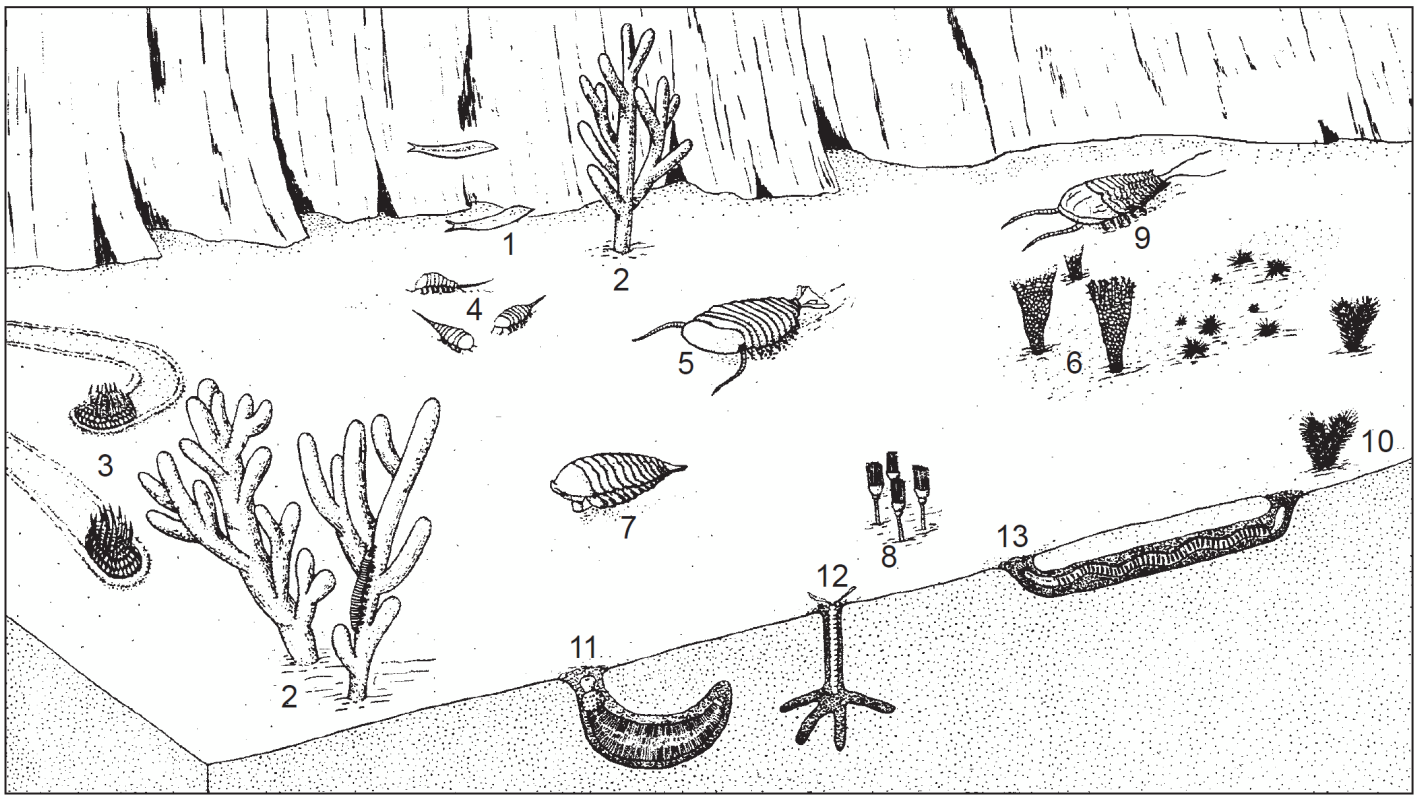
Base your answers to questions **3** through **5** on the passage and diagram below and on your knowledge of Earth science. The diagram represents some of the Burgess shale community of organisms that existed together during part of the Cambrian Period. Thirteen different types of organisms are numbered in the diagram.

Burgess Shale Fossils

The Burgess shale fossil discovery revealed unique Cambrian life-forms, most of which were not present in the previously known fossil record. Normally, soft body parts of dead organisms are destroyed by scavengers and bacteria on the ocean floor. However, in the deep-water depositional environment of the Burgess shale, oxygen was lacking and organisms were buried rapidly, preserving the unique community seen in the diagram. The soft-bodied organisms had previously been unknown. The Burgess shale fossils were originally found in a layer of bedrock in southwestern Canada.



Adapted from: Briggs, et al., *The Fossils of the Burgess Shale*, Smithsonian Institution Press, 1994

3. Identify the number of *one* organism in the diagram that is most likely a trilobite.

4. Explain why so many soft body parts of organisms were preserved in the Burgess shale.

5. During which epoch of the Cambrian Period were the Burgess shale organisms and sediments deposited?

Base your answers to questions **6** and **7** on the data table and information below and on your knowledge of Earth science. The data table shows the radioactive decay of carbon-14 and the age of fossil remains, in years (y). Part of the table has been left blank.

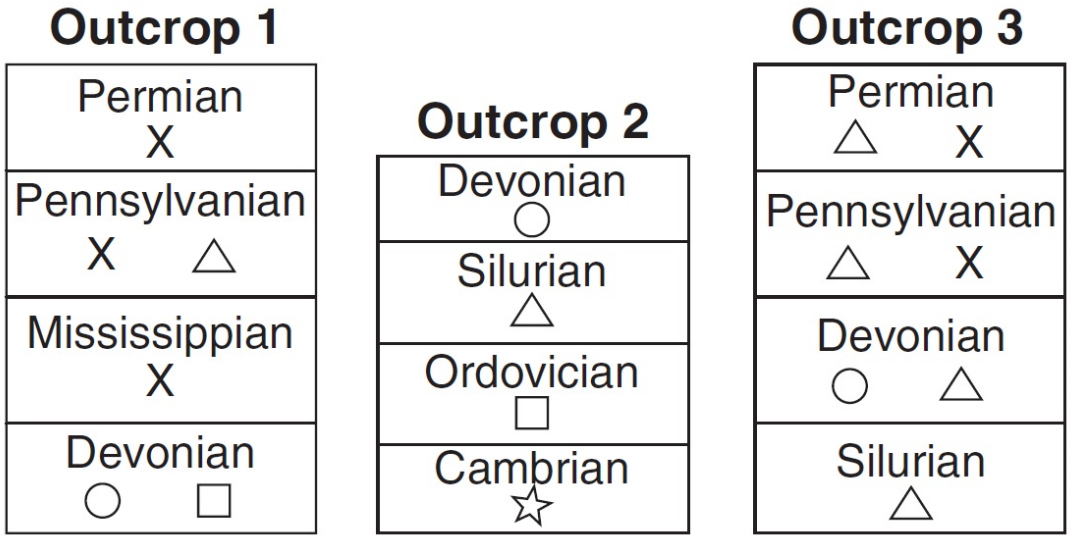
Data Table

Number of Half – Lives	Remaining Carbon – 14 (%)	Age of fossil Remains (y)
0	100	0
1	50	5,700
2	25	11,400
3	12.5	
4	6.25	
5	3.125	

6. The carbon-14 in the fossil remains of a mastodont has undergone five half-lives of radioactive decay. Calculate the age of these fossil remains.

7. Identify the decay product when carbon-14 undergoes radioactive disintegration.

Base your answers to questions **8** through **10** on the cross sections below and on your knowledge of Earth science. The cross sections represent three bedrock outcrops, 1, 2, and 3, found several kilometers apart. The geologic time period when each sedimentary rock layer formed is shown. The symbols (star, circle, cross, square, and triangle) represent fossils of different types of organisms present in the rock layers.

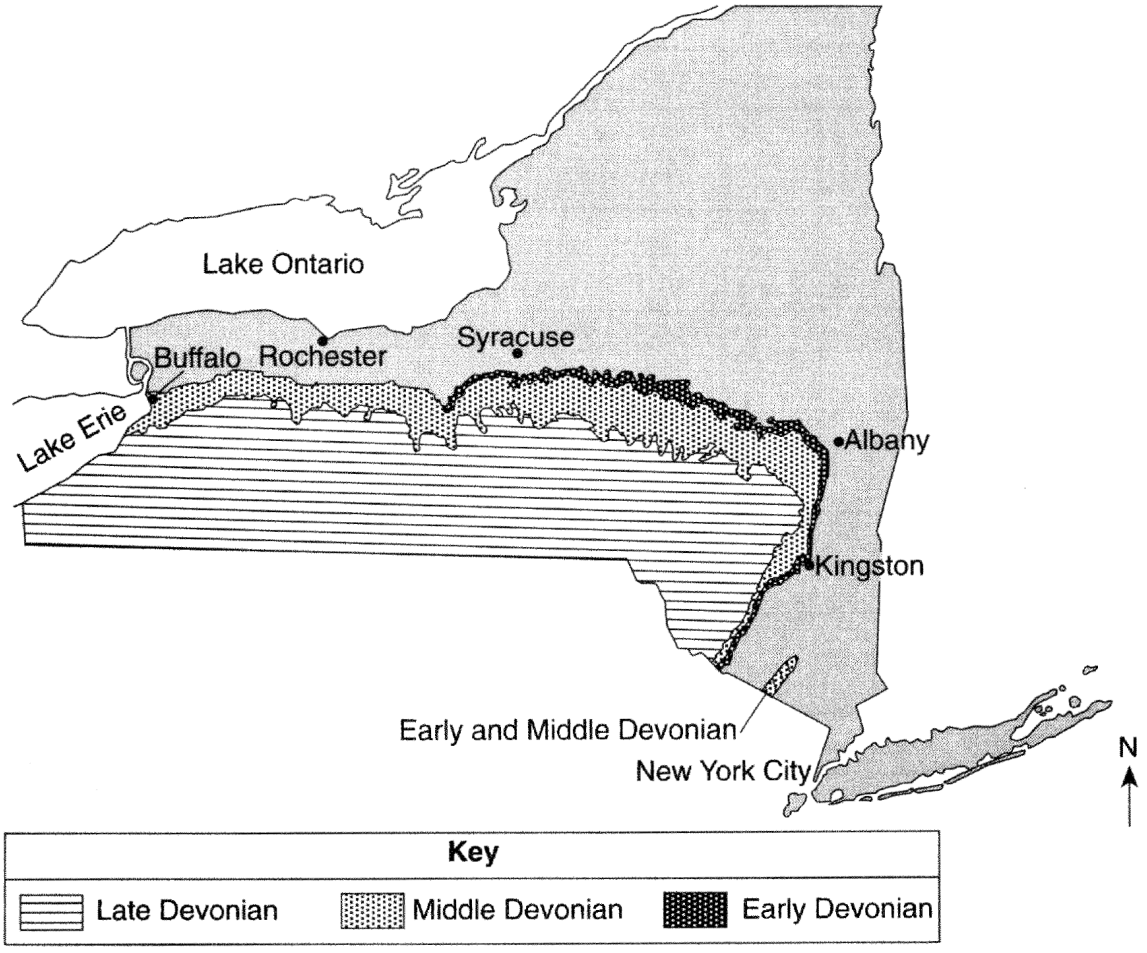


8. Explain why the index fossil *Coelophysis* is *not* preserved in any of the rock outcrops.

9. Explain why the geologic age of these rock layers could *not* be accurately dated using carbon-14.

10. Write the outcrop number of the cross section that could he found in New York State. Describe the evidence that supports your answer.

Base your answers to questions **11** and **12** on the partial geologic map below and on your knowledge of Earth Science. The map shows the geographical distribution of most of the Devonian-age surface bedrock in New York State.



11. State the name of the New York State landscape region that includes most of the Devonian-age surface bedrock shown on the map.

12. On the map, place an **X** at a location where the gastropod fossil *Platyceras* might be found in the surface bedrock.

Base your answers to questions **13** through **17** on the diagram and tables below. The diagram shows a rock sample containing fossils from a location in New York State at 42° N 78° 15' W. Fossils 1, 2, 3, and 4 are labeled. Table A lists the names and rock types of the New York State rock units from the Middle and Late Devonian in this area. The presence of fossil 1, 2, 3, or 4 in a rock unit is indicated by an X in the fossils column in the table. Table B identifies typical rocks formed within different marine (ocean) environments.

Rock Sample

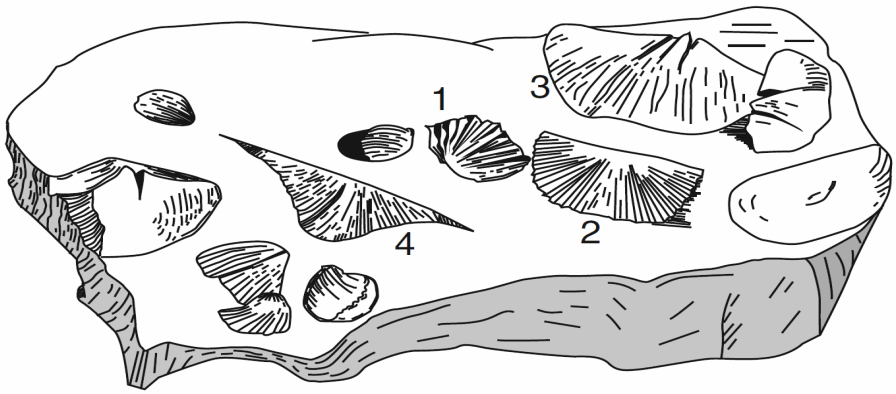
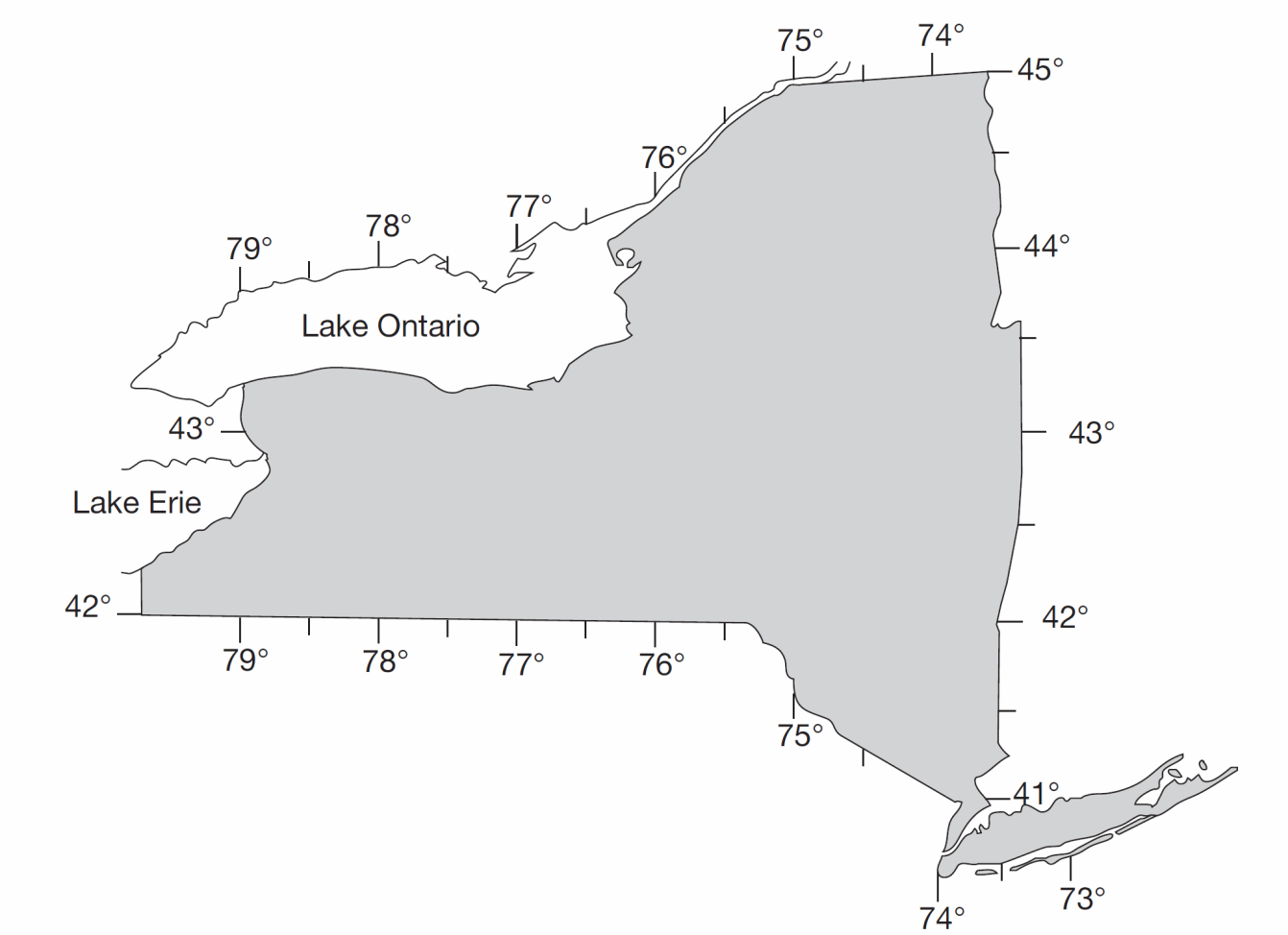


Table A: New York State Rock Units in Area Where the Rock Sample was Found

Geologic Age: Devonian	Name of Rock Unit	Type of Rock Found in Unit	Fossils			
			1	2	3	4
Late	Conewango	shales and sandstones	X	X		X
Late	Conneaut	shales and sandstones	X	X		X
Late	Canadaway	shales and sandstones	X	X	X	X
Late	West Falls	shales and sandstones	X	X	X	
Late	Sonyea	shale	X	X	X	
Late/Middle	Genesee	shale	X	X		
Middle	Tully	limestone	X	X		
Middle	Hamilton	limestone	X	X		
Middle	Onondaga	limestone (includes volcanic ash bed)		X		

Table B: Sedimentary Rock Types Formed in Different Marine Environments

Sedimentary Rocks	Marine Environment
limestones	clear, shallow water
gray shales	muddy, oxygen rich
black shales	muddy, oxygen poor
siltstones and sandstones	silty to sandy bottom
evaporites	very salty, shallow seas
coarse-grained sandstones and conglomerates	tidal shores and deltas



13. According to the tables, in which marine environment was the Tully rock unit deposited?

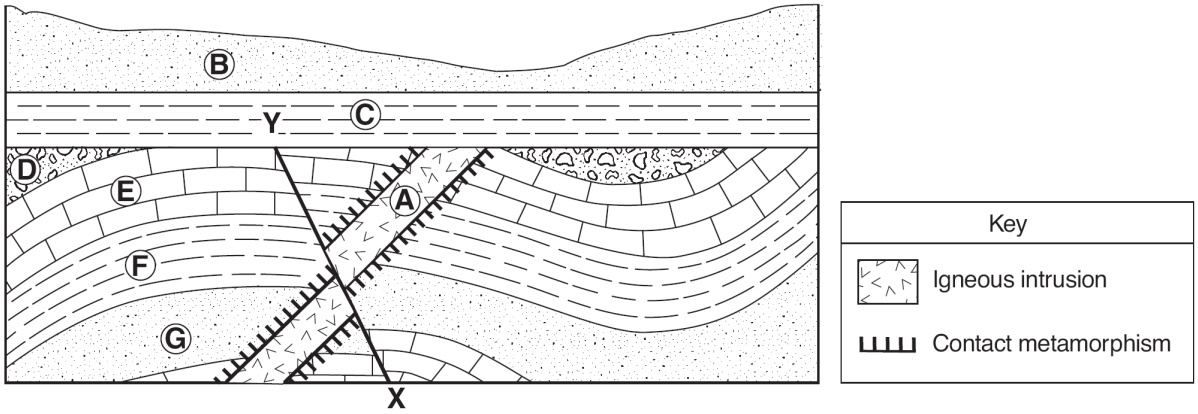
14. Identify the landmass that collided with the eastern coast of North America to create the Acadian mountain range and the basin for the deposition of the Devonian rock units in table *A*.

15. Identify the New York State index fossil group that includes fossil 4 shown on the rock sample.

16. Based on the fossils present, the rock sample shown in the diagram came from which rock unit listed in table *A*?

17. On the map, place an **X** at the location where this rock sample was collected.

Base your answers to questions **18** and **19** on the geologic cross section of bedrock below. Letters *A* through *G* identify rock units and line *XY* represents a fault. The rocks have not been overturned.



18. What evidence indicates that the folded bedrock is older than fault line *XY*?

19. On the cross section above, draw a dark line to indicate the most likely location of an unconformity.

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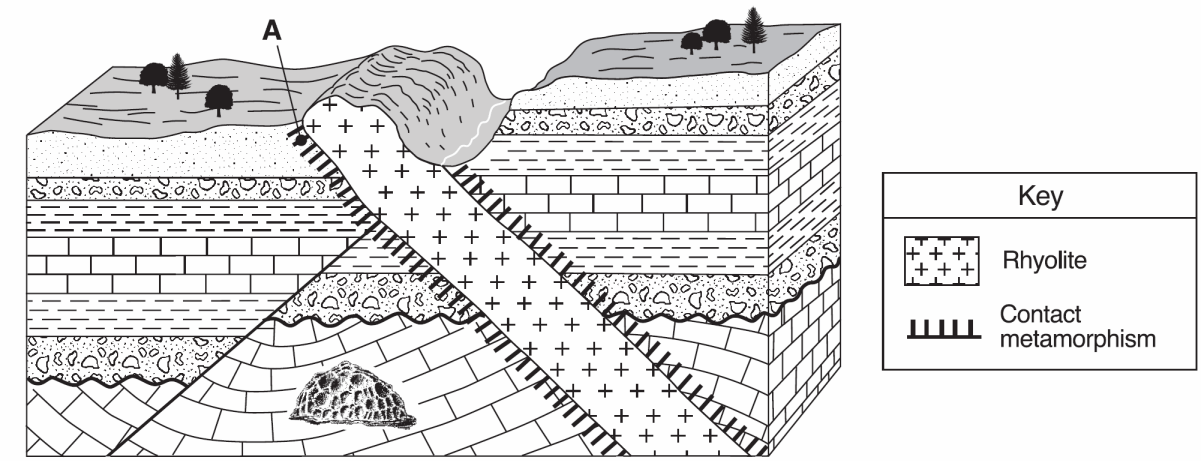
20. Base your answer to the following question on the block diagram below, which shows rock units that have not been overturned. Point *A* is located in the zone of contact metamorphism. A New York State index fossil is shown in one of the rock units.



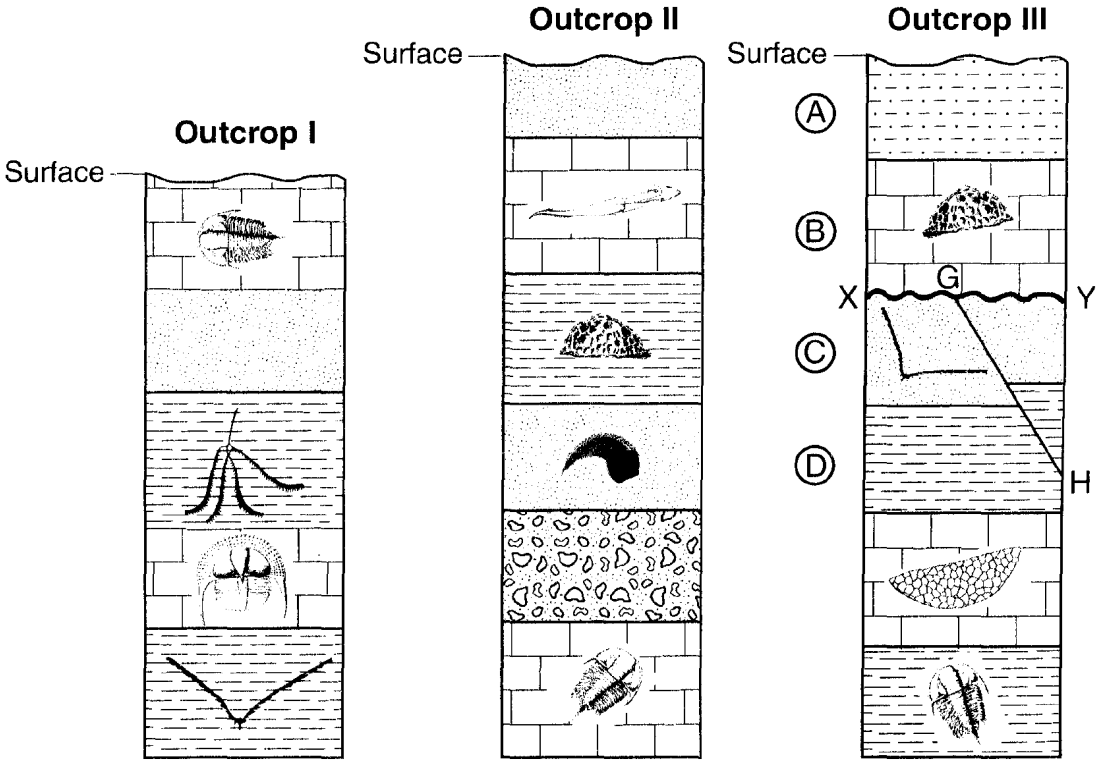
State the evidence shown by the block diagram that supports the inference that the fault is older than the rhyolite.

21. The table below shows information about Earth's geologic history. Letter *X* represents information that has been omitted.

Period	Million Years Ago	Index Fossil Found in Bedrock	Important Geologic Event
Triassic	251 to 200	*Coelophysis*	X

Identify *one* important geologic event that occurred in New York State that could be placed in the box at *X*.

22. Base your answer to the following question on the cross sections below, which show widely separated outcrops labeled I, II, and III. Index fossils are found in some of the rock layers in the three outcrops. In outcrop III, layers *A*, *B*, *C*, and *D* are labeled. Line *XY* represents an unconformity. Line *GH* represents a fault.



List in order, from oldest to youngest, the relative age of the four rock layers, *A*, *B*, *C*, and *D*, fault *GH*, and unconformity *XY* shown in outcrop III.

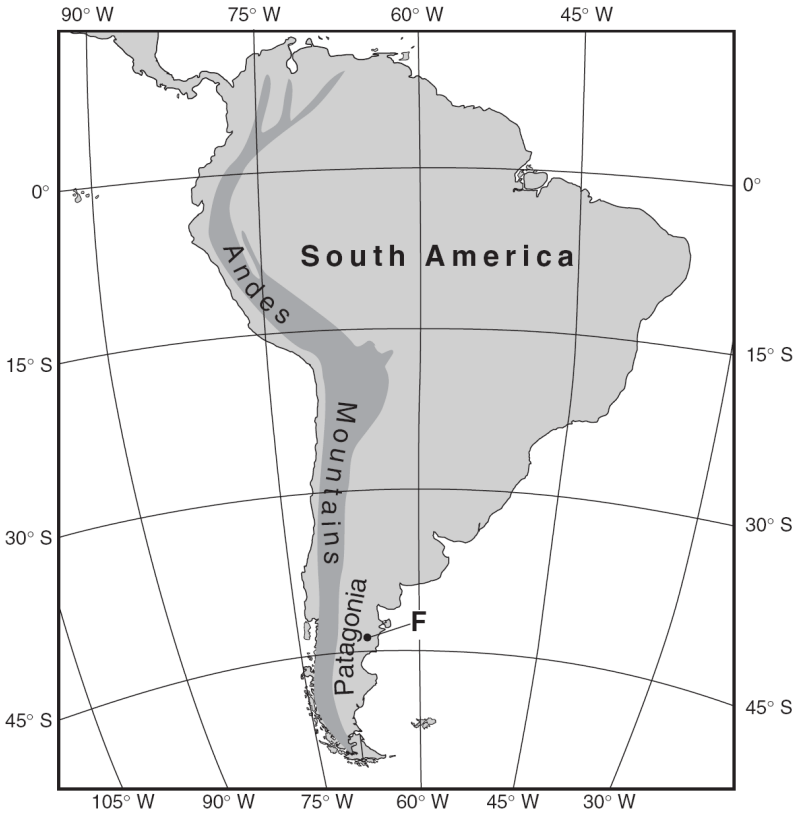
Base your answers to questions **23** through **25** on the passage and map below. Point *F* on the map shows the location where an unusual mammal fossil was found.

Fossil Jaw of Mammal Found in South America

Paleontologists working in Patagonia have found the tiny fossil jaw that may be the first evidence of early mammals in South America.

The fossil, which measures less than a quarter-inch long, is believed to be from the middle or late Jurassic Period. Researchers said it suggests that mammals developed independently in the Southern Hemisphere.

The fossil, named *Asfaltomylos patagonicus*, was discovered in a shale formation in Patagonia. Dinosaurs were the dominant land animal at that time. Mammals were tiny, and hunted insects in the dense tropical vegetation. The now-arid region also has yielded some remarkable dinosaur fossils from the same period in a vast ancient boneyard covering hundreds of square miles.

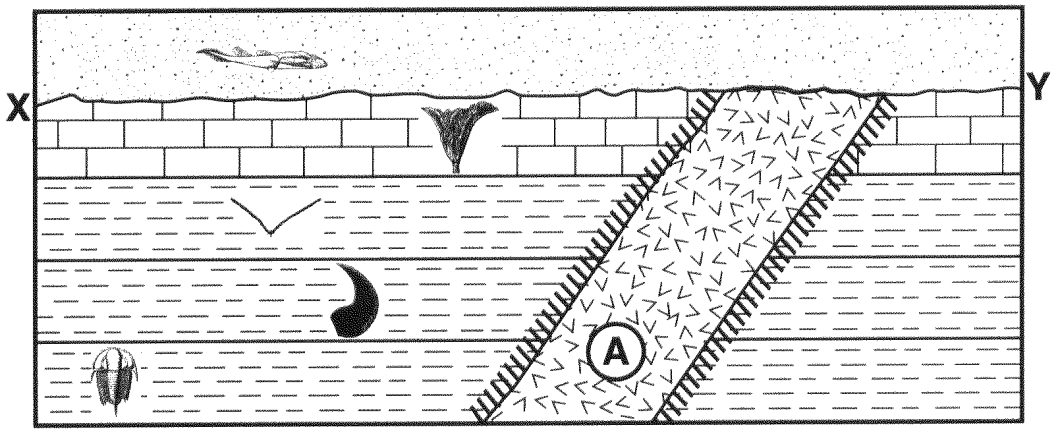


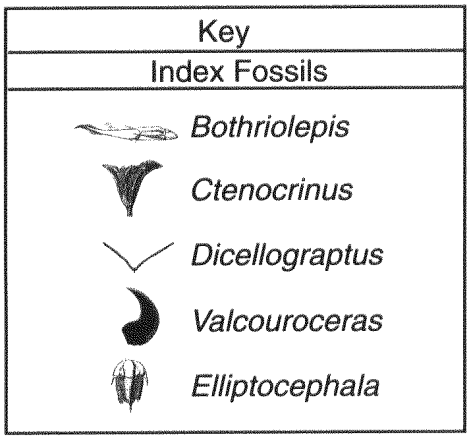
23. State *one* method used by geologists to determine the age of the bedrock in which this ancient mammal fossil was found.

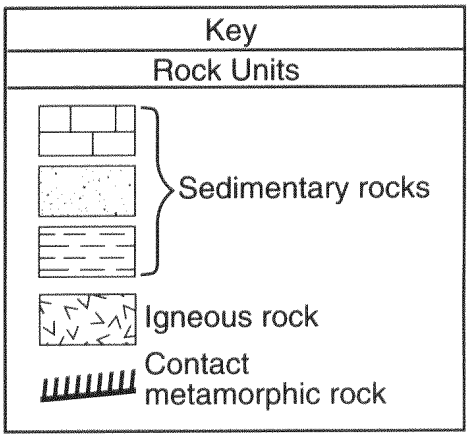
24. What other life-form first appeared on Earth during the geologic period when *Asfaltomylos patagonicus* existed?

25. State the name of the dominant sediment particle that was compacted to form the shale in which this fossil was found.

Base your answers to questions **26** through **28** on the geologic cross section below. The cross section shows Vermont index fossils in rock layers that have not been overturned. Rock unit *A* is an igneous intrusion and line *XY* represents an unconformity.





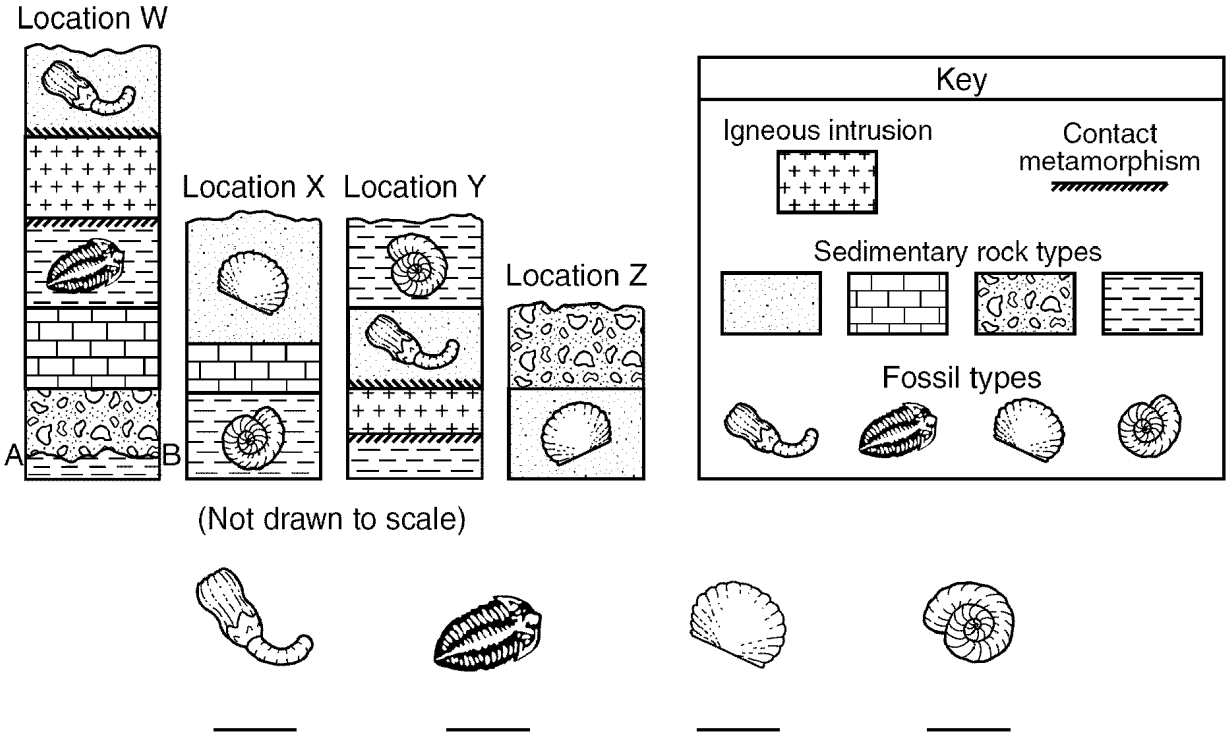


26. Each index fossil existed for a relatively short geologic time interval. State one other characteristic that each fossil must have to be considered an index fossil.

27. Identify the coral index fossil that would most likely be found in the same layer as the index fossil Ctenocrinus.

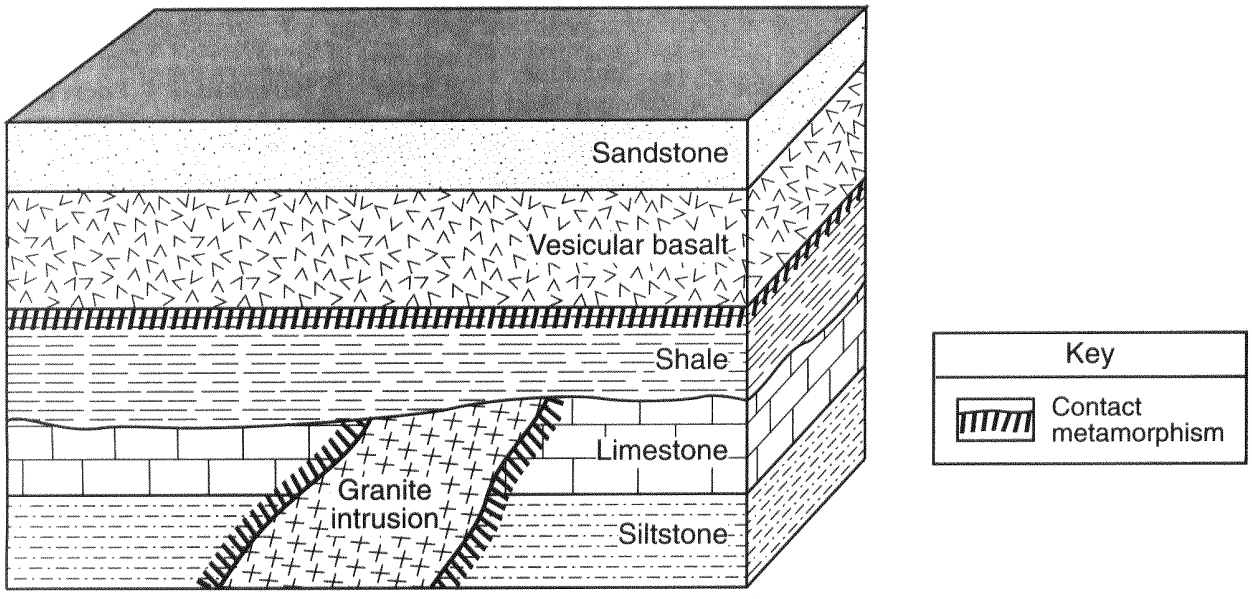
28. Based on fossil evidence, determine the geologic period during which the unconformity formed.

29. Base your answer to the following question on the cross sections below, which show widely separated outcrops at locations *W*, *X*, *Y*, and *Z*. The rock layers have not been overturned. Line *AB* in the cross section at location *W* represents an unconformity. Fossils are shown in some of the layers.



Determine the relative geologic age of the four fossils by correlating the rock layers between these outcrops. Number the fossils from 1 to 4 in order of relative age, with 1 as the oldest and 4 as the youngest.

30. Base your answer to the following question on The geologic cross section below. Radioactive dating indicates that the granite intrusion is 279 million years old and the vesicular basalt is 260 million years old. The rock layers have not been overturned.

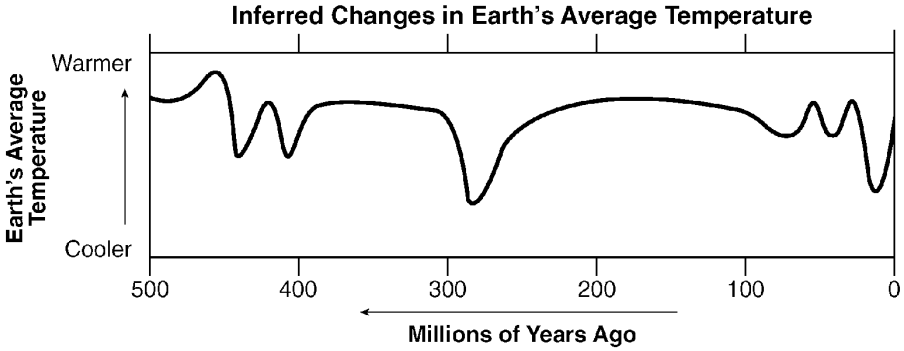


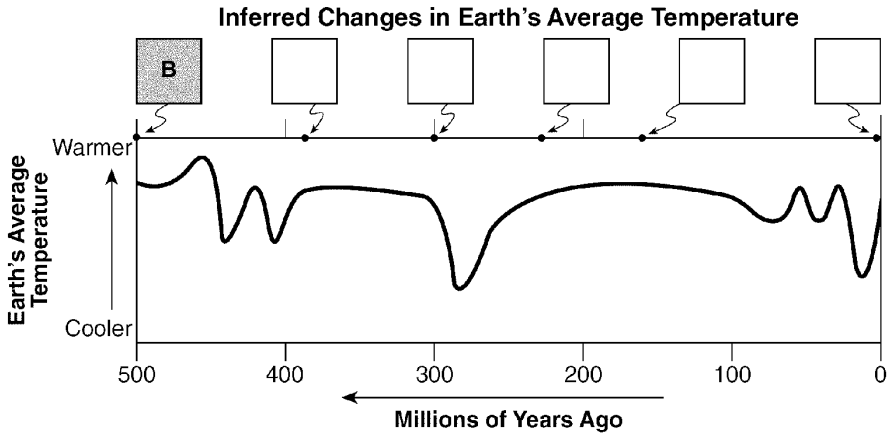
List the six rock units in the order from the oldest to the youngest.

31. Base your answer to the following question on the table and graphs below. The table labeled "Animal Key" shows symbols to represent various animal groups that exist on Earth. The graph shows inferred changes in Earth's average temperatures over the last 500 million years.

Animal Key

Letter	Picture	Animal Group
A		Birds
B		Fish
C		Amphibians
D		Mammals
E		Humans
F		Reptiles





On the graph provided above, indicate when each of the life-forms in the table is believed to have first appeared on Earth by placing the letter for *each* animal group in the correct box. The correct location for earliest fish, letter *B,* has already been plotted above the graph.

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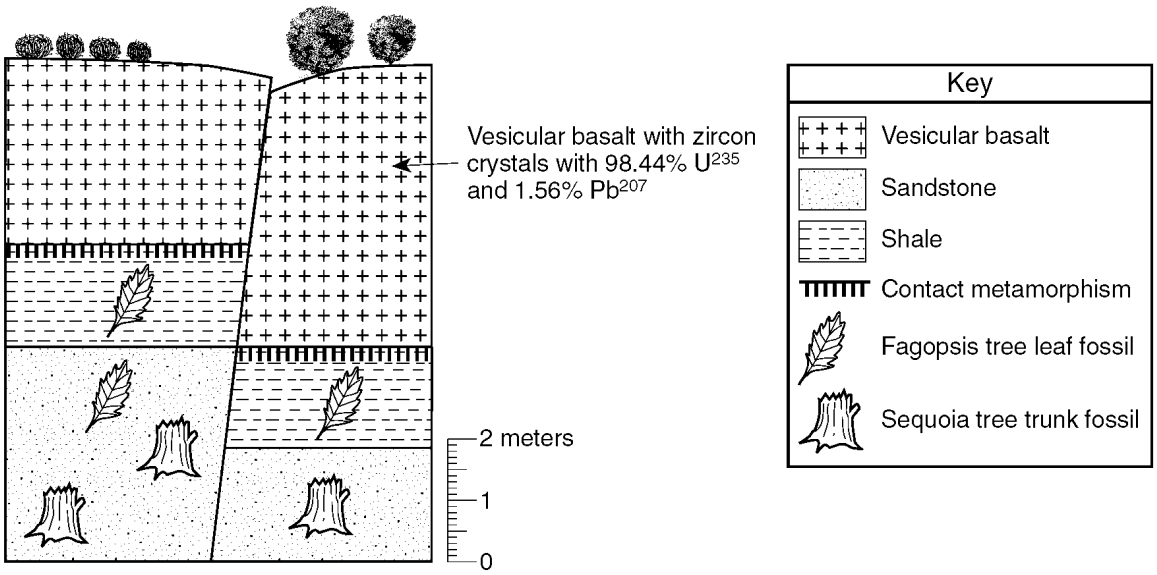
Base your answers to questions **32** and **33** on the geologic cross section and graph provided below, which represents an outcrop of various types of bedrock and bedrock features in Colorado.

Percent of U-235 Remaining	Percent Decayed to Pb-207	Half-Lives Elapsed
99.22	0.78	$\frac{1}{64}$
98.44	1.56	$\frac{1}{32}$
96.88	3.12	$\frac{1}{16}$
93.75	6.25	$\frac{1}{8}$
87.50	12.5	$\frac{1}{4}$
75.0	25.0	$\frac{1}{2}$
50.0	50.0	1
37.5	62.5	$1\frac{1}{2}$
25.0	75.0	2
12.5	87.5	3
6.25	93.75	4



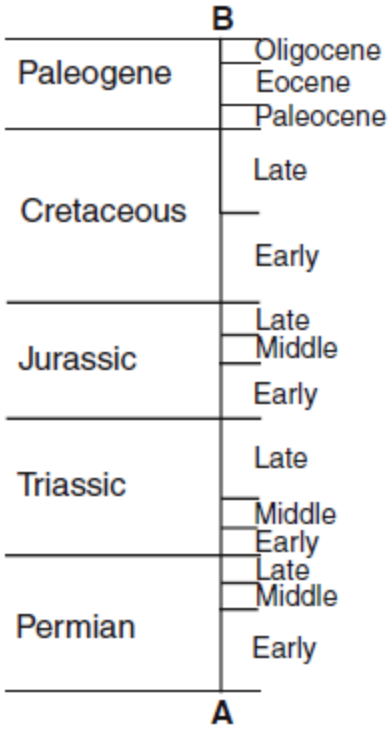
32. The vesicular basalt includes zircon crystals containing the radioactive isotope U-235, which disintegrates to the stable isotope Pb-207. The zircon crystals have 98.44% of the original U-235 remaining, and 1.56% has decayed to Pb-207. Based on the table below, how many half-lives have elapsed since the formation of these crystals?

33. The shale and sandstone layers both contain fossilized leaves from the *Fagopsis* tree, an index fossil for the Oligocene Epoch. State a possible age for these rock layers, in million years.

Base your answers to questions **34** and **35** on he passage below and on your knowledge of Earth science.

Dinosaur Fossils

Bones of juvenile long-necked sauropod dinosaurs, *Abydosauros mcintoshi*, have recently been found in 105-million-year-old sandstone at the Dinosaur National Monument in Utah. The remains of four individual dinosaurs were found, including two intact skulls. This find is unusual because the softer tissue holding the thin sauropod dinosaur skull bones together usually disintegrates, allowing the skull bones to separate. Only 8 of 120 types of sauropods discovered have complete skull specimens. These dinosaurs were herbivores, with large number of sharp teeth that were probably replaced five to six times each year. These teeth allowed only for the harvesting of plant material, but not for chewing it afterward. The plant-harvesting teeth and long neck identify *Abydosauros mcintoshi* as a descendant of the brachiosaurs.



34. State a natural event that is inferred by most scientists to be the cause of extinction of the last of the dinosaurs.

35. Identify *one* group of organisms that was a likely food source for *Abydosauros mcintoshi*.