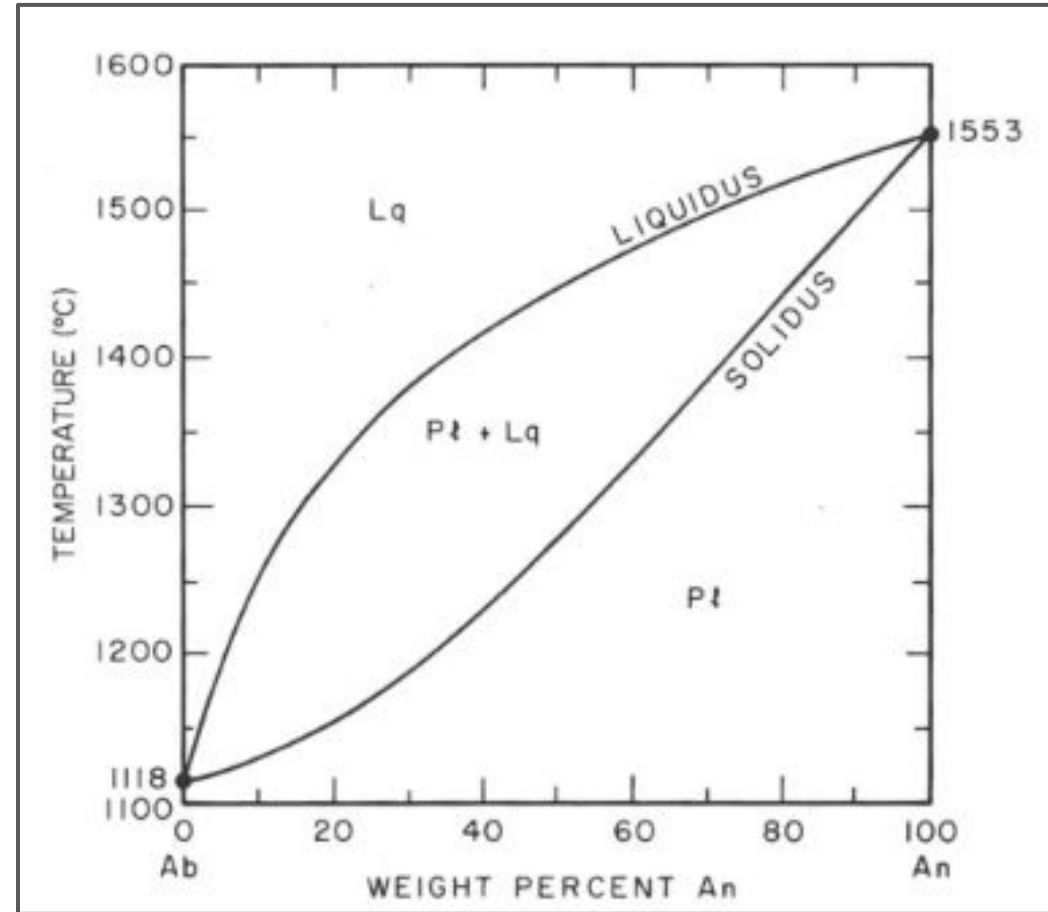
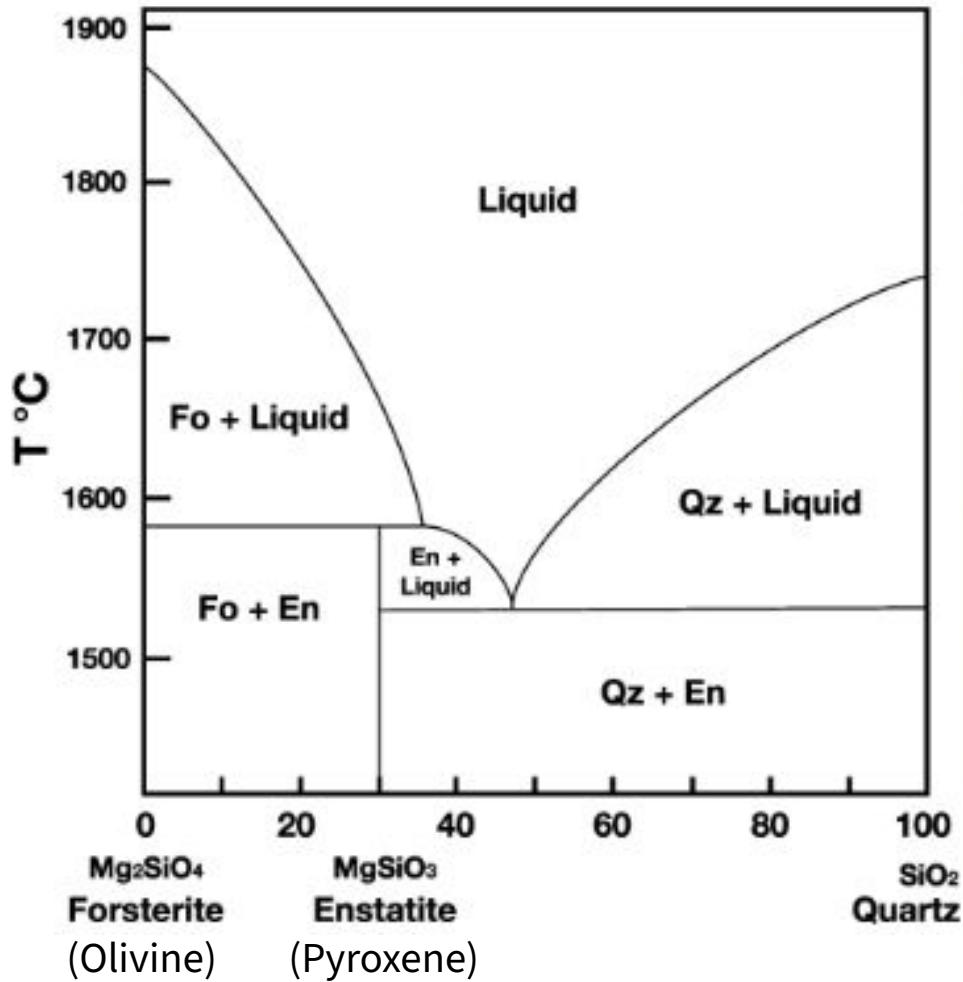


Station 1

1. Identify the **rock**.
2. Give an identifying feature of specimen 1.
3. Identify the **rock**.
4. Looking at the phase diagram on the **LEFT**, which two minerals cannot coexist?
5. Looking at the phase diagram on the **LEFT**, which mineral is the most mafic?
6. Looking at the solid solution diagram on the **RIGHT**, what increases the melting point of a mixture?
7. Based on your answer to 6, under what relative temperature conditions does anorthosite tend to form compared to diorite?

Station 1



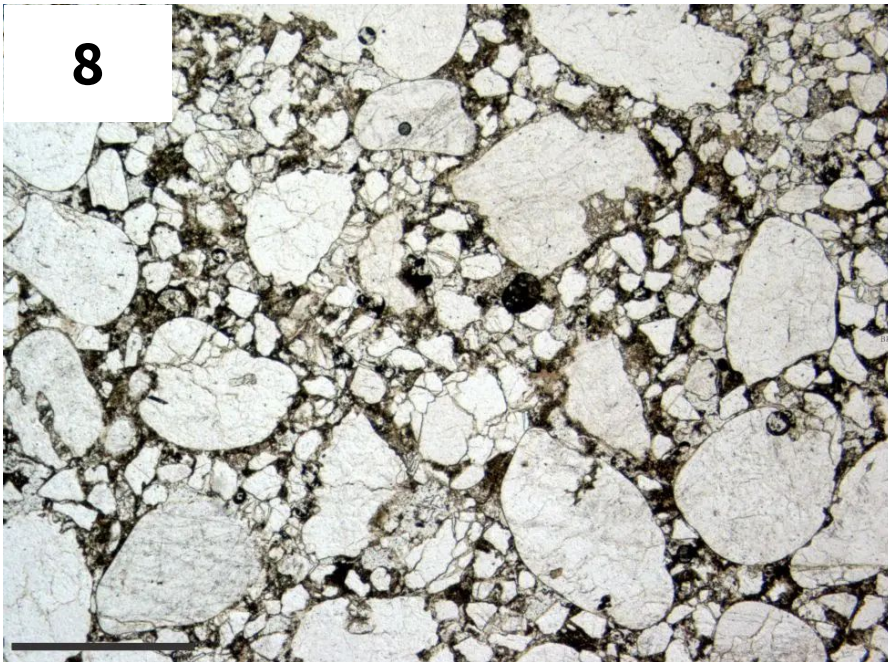
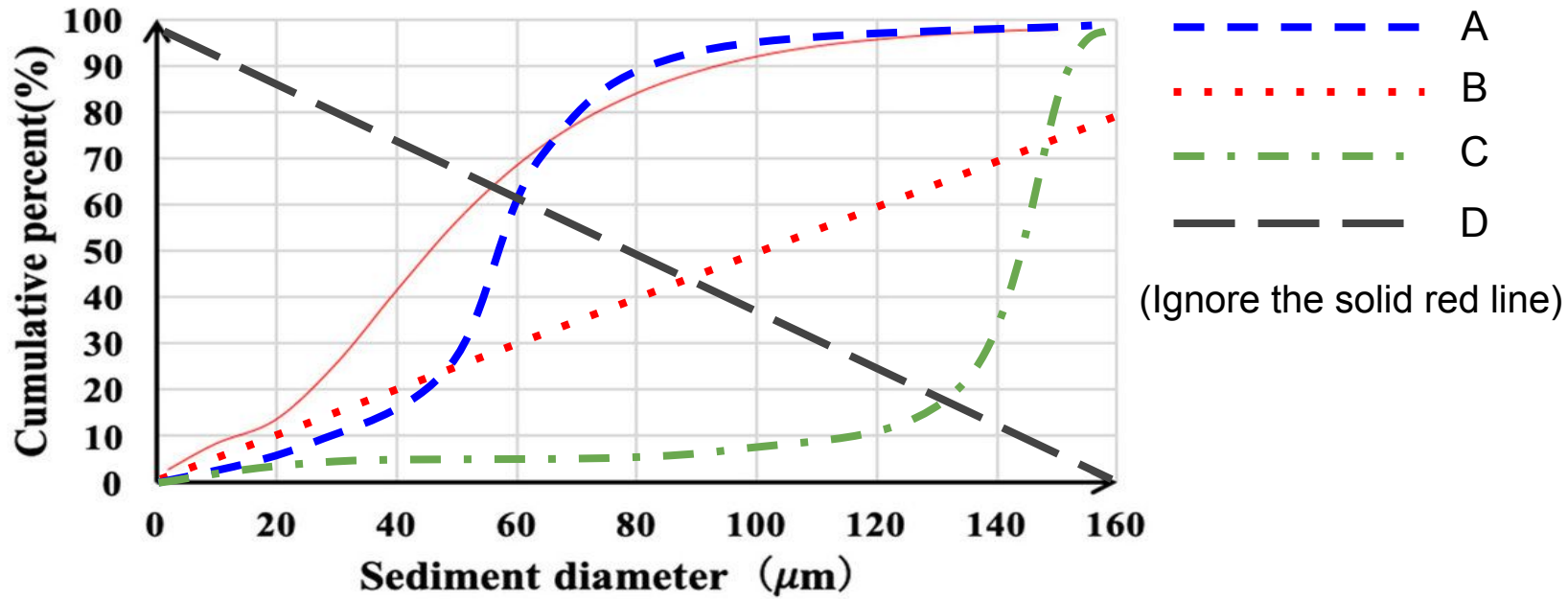
(Albite)

(Anorthite, Ca-feldspar)

Station 2

8. The grains in image 8 are all composed of quartz. What **rock** is shown?
9. The distribution in grain sizes in image 8 best match which curve?
10. A well-graded sediment sample would have a grain size distribution that best matches which curve?
11. The sediment sample in image 11 best matches which curve?
12. Which of the environments in the diagram is closest to where the sediments in image 11 would have deposited?
13. Scott finds a rock that contains a wide range of grain sizes from clay to boulders. Which environment from diagram 12 is most indicative of where it deposited?

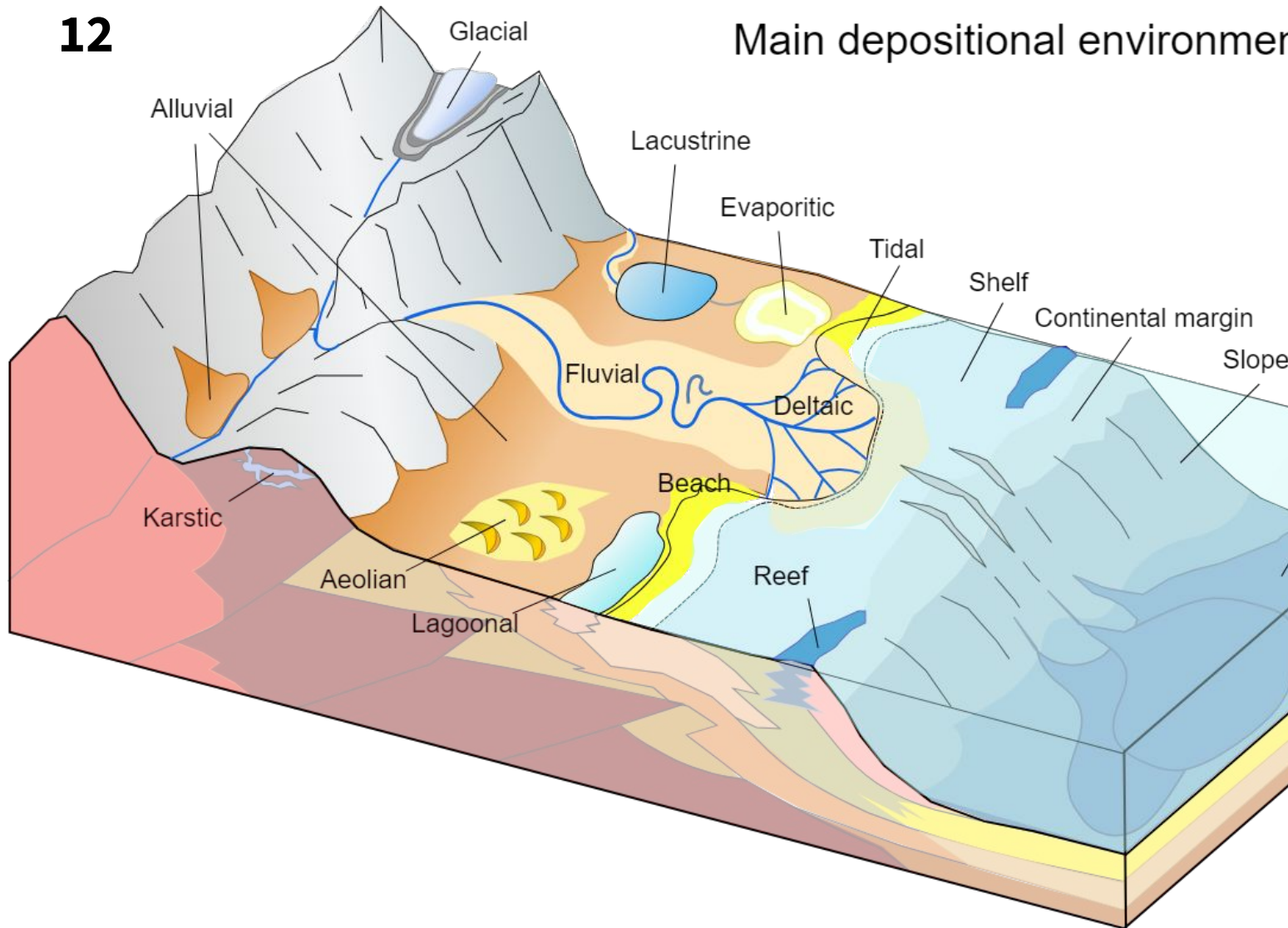
Station 2



Station 2

12

Main depositional environments



Station 3

14. Identify the **mineral**.

15. Give an identifying feature of specimen 14.

16. Identify the **mineral**.

17. Identify the **mineral**.

18. The black sand shown in the image is from a placer deposit in a river. Which of the minerals at this station is NOT likely to be found in this sand? (answer with the specimen number)

19. Other black sand deposits can be found near sources of basalt. Would the black sand formed from minerals at this station be more or less chemically stable than the basalt sand? Briefly explain.

20. Peter gets two of his black sand samples mixed up but he knows that one is basaltic and the other is formed from minerals at this station. Using only common field tools (those you have used at camp) What is one quick way he can differentiate them? (multiple correct answers)

21. Pretend Peter's samples both came from a river near a basalt deposit. Assuming the grain size is similar in both samples, would the basaltic sample likely come from upstream or downstream of the other sample? Briefly explain.

Station 3



Station 4

22. Identify the **rock**.

23. Give an identifying feature of specimen 23.

24. Identify the **rock**.

25. Which of the following minerals are more likely to be found in specimen 24 than in 22?

- a. Biotite
- b. Sillimanite
- c. Chlorite
- d. Garnet

26. Which of the following rocks can be metamorphosed to form specimen 22?

- a. Slate
- b. Hornfels
- c. Granite
- d. Granulite
- e. All of the above

27. Quartzite and hornfels are both non-foliated metamorphic rocks that can form under high heat and low pressure. Briefly explain why/how they are different using how they formed, texture, or mineralogy as appropriate.

Station 5

28. Identify the **rock** in the image.

29. Give an identifying feature of specimen 28.

30. Identify the **rock**.

31. Jason and Aashray are examining specimen 28 and get into a debate: Jason states that the rock is made of its original mineral components while Aashray says it has been altered. Who is most likely correct and why?

32. What primary mineral is 28 most likely made of?

33. Specimen 30 is trapped deep under a mountain as it is built. It experiences partial melting, forming complex fold structures. What rock did it become?

Station 5

28



Station 6

34. Identify the **rock** in the image.

35. Identify the **rock** in the image.

36. Identify the **rock**.

All three rocks exhibit banding. Briefly explain what caused the banding in each of the specimens as indicated below.

37. Specimen 34

38. Specimen 35

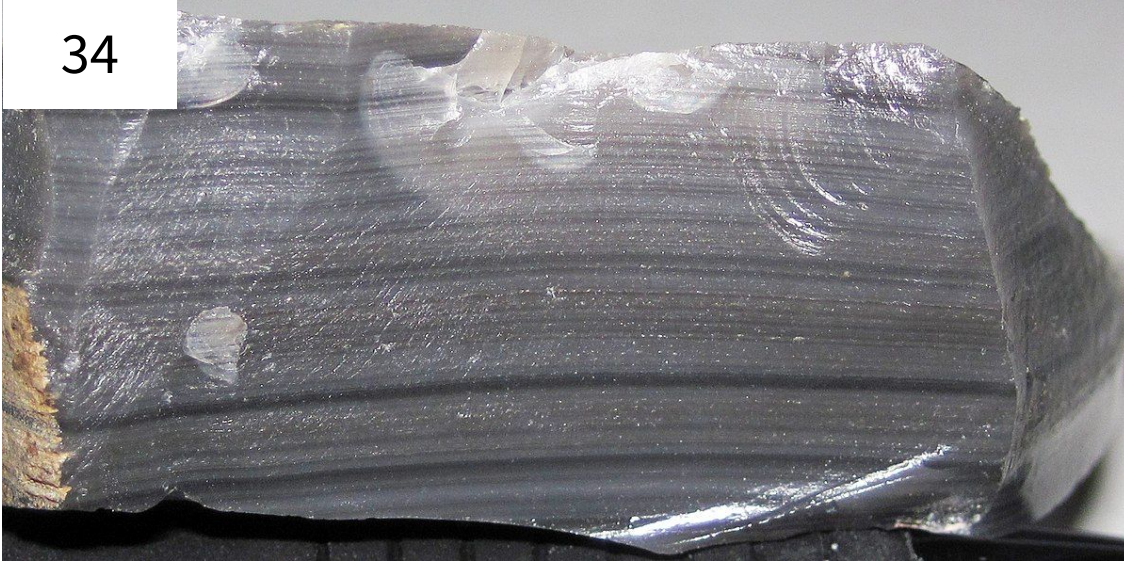
39. Specimen 36

40. Identify the crosshatch pattern on the rock outcrop in the image. Briefly explain how it forms.

41. Greywacke exhibits an interesting phenomenon within distinct “bands.” Briefly explain what this phenomenon is and what causes it.

Station 6

34



35



Station 6

40



Station 7

42. Identify the **mineral**.

43. Identify the **mineral**.

44. Identify the **mineral**.

45. Identify the **mineral**.

46. Identify the **mineral**.

47. Identify the **mineral**.

48. Identify the **mineral**.

49. Identify the **mineral**.

Station 8

50. Identify the **mineral**.

51. What is one economic use for specimen 50?

52. Identify the **mineral**.

53. What is one economic use for specimen 52?

54. Identify the **mineral**.

55. What is one economic use for specimen 54?

Station 9

56. Identify the **mineral**.

57. Give an identifying feature of specimen 56.

58. Identify the **mineral**.

59. The image shows a phenomenon/texture called rapakivi. This is when an alkali (potassium mainly) feldspar core is surrounded by a plagioclase rim. Which formed first, the core or the rim? How do you know?

60. Assume that the core formed first. Would this be the expected order of crystallization? Explain your answer.

61. Looking at an igneous rock, you see the formation shown in the image. Chemically, what changed as the magma cooled to form these minerals?

62. Specimen 56 commonly exhibits zoning. In general terms, what does zoning imply about the environment a crystal formed in?

Station 9

59



61



Station 10

63. Identify the **rock**.

64. Identify the **rock**.

65. Which thin section image best matches the **texture** of 63?

66. Which thin section image best matches the **texture** of 64?

67. Look at the long skinny crystals in image B. Assuming the general shape is representative of the crystal system for the mineral, which crystal system is this mineral LEAST likely to belong to?

- a. Isometric
- b. Orthorhombic
- c. Monoclinic
- d. Triclinic

68. Look at the striations within grains in image D. Assuming that the angles where striations intersect are exactly $60^\circ/120^\circ$, what crystal system does the mineral in the grains most likely belong to?

Station 10

63

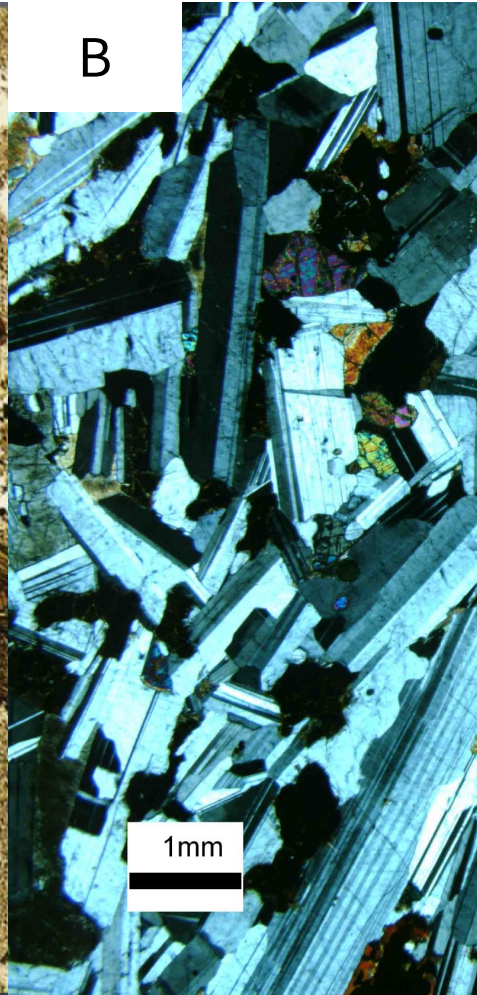


Station 10

A



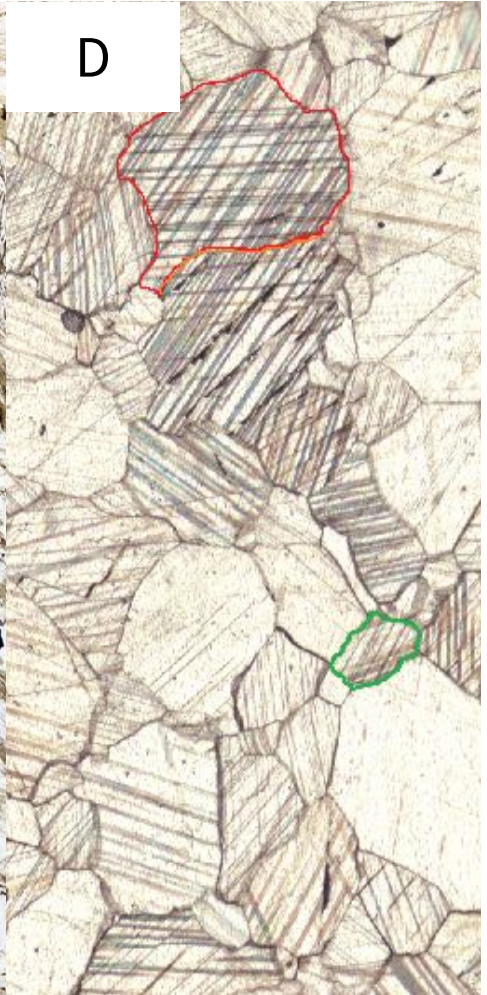
B



C



D



Station 11

69. Identify the **rock**.

70. Give an identifying feature of specimen 69.

71. Identify the **rock**.

72. Give an identifying feature of specimen 71.

73. Which environment of deposition is most likely indicated by specimen 69?

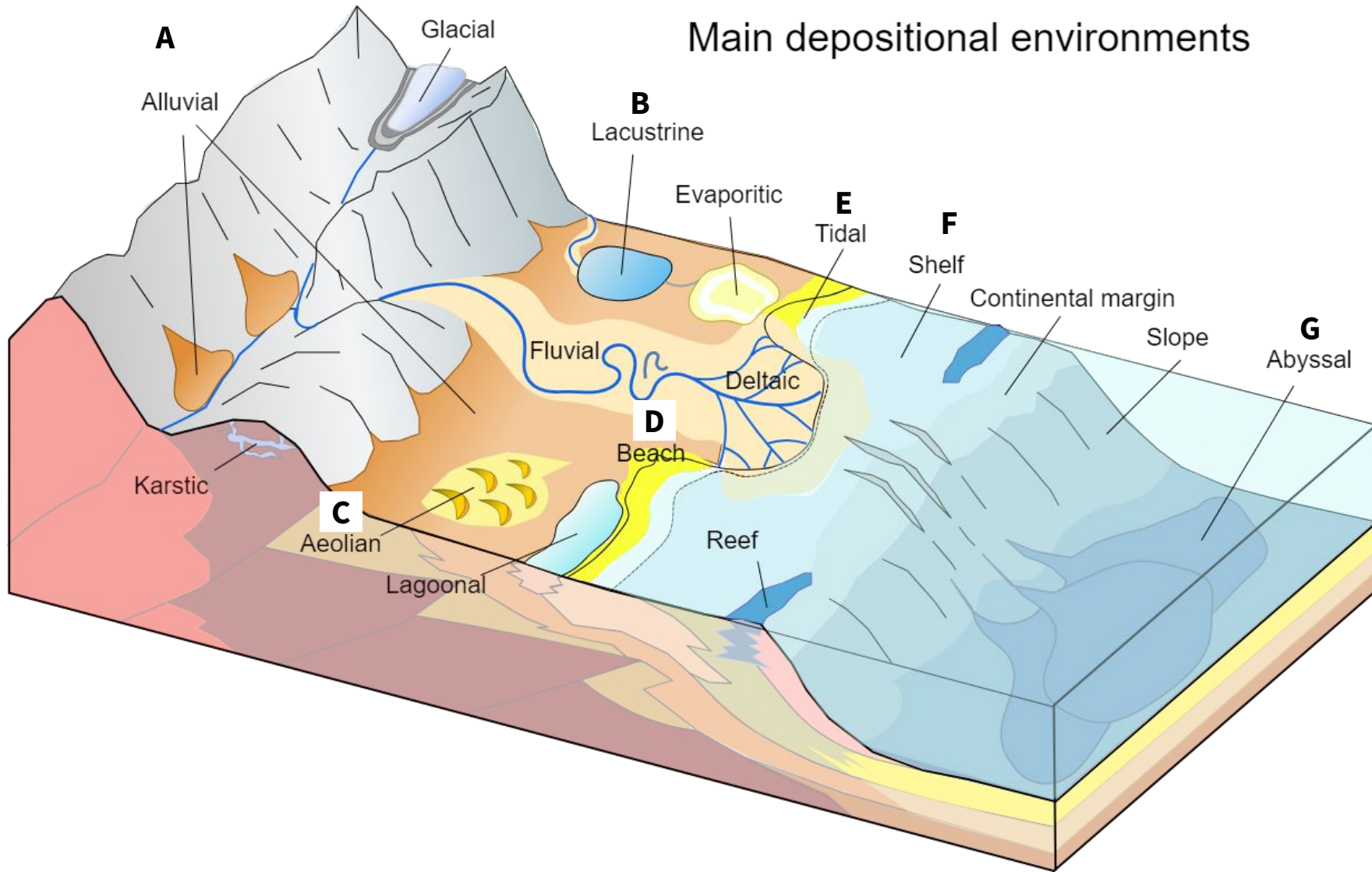
A. B. C. D. E. F. G.

74. Which environment of deposition is most likely indicated by coquina?

A. B. C. D. E. F. G.

Station 11

Main depositional environments



Station 12

75. Identify the **rock**.

76. Give an identifying feature of specimen 75.

77. Identify the **rock**.

78. You find a rock with the same chemical composition as 77, but it also contains small amounts clay and no large biological components (e.g. shells). Is this rock likely to be found deposited directly above specimen 75? Briefly explain.

79. How many (0, 1, or 2) of the specimens would effervesce if HCl was put on it?

80. Reaction to HCl would indicate the presence of what mineral family?

Station 13

81. Identify the **mineral**.

82. Give an identifying feature of specimen 81.

83. Identify the **rock**.

In both igneous and metamorphic rocks, there is a general expected order in which minerals are expected to crystallize. These are Bowen's reaction series and the crystalloblastic series respectively. Answer the questions below regarding these sequences.

84. Emmanuel discovers a new mineral in an igneous rock! The grains of this mineral are extremely well formed crystals. Would you expect this mineral to have a high or low melting point? Explain.

85. Would you expect the overlapping minerals between Bowen's and the crystalloblastic series to generally form in the same order? Explain.

Station 14

86. Identify the **mineral**.

87. Give an identifying feature of specimen 86.

88. Identify the **mineral**.

89. In general, these minerals are not commonly found together. If you found a rock with crystals of mineral 88 and a matrix (surrounding rock) of relatively large grained mineral 86, what type of rock, **igneous/metamorphic/sedimentary**, would you expect it to be?

90. Explain your answer to 89.

91. If a large crystal of 88 was found in igneous rock, what rock would it mostly be found in?

Station 15

92. Identify the **mineral**.

93. Give an identifying feature of specimen 92.

94. Identify the **mineral**.

95. Give an identifying feature of specimen 94.

96. Which of the following metamorphic environments is likely to create rocks composed largely of specimen 92?

- a. Large mountains
- b. Hot spots/igneous intrusions
- c. Subduction zones
- d. Region buried by a thick layer of sediment

97. Which of the following metamorphic environments is likely to create rocks with crystals of 94?

- a. Large mountains
- b. Hot spots/igneous intrusions
- c. Subduction zones
- d. Region buried by a thick layer of sediment

Station 16

98. Identify the **rock**.

99. Give an identifying feature of specimen 98.

100. Identify the **rock**.

101. SydneyBlu claims that if 98 had cooled more quickly that it would form obsidian. Is this correct? Why or why not?

102. Malachi is unsure about SydneyBlu's claim, but thinks that specimen 100 has a similar composition to specimen 98. Is this likely? Why or why not?

103. If specimen 98 was cooled more slowly, what rock would form?

Station 17

104. Identify the **rock**.

105. Identify the **mineral**.

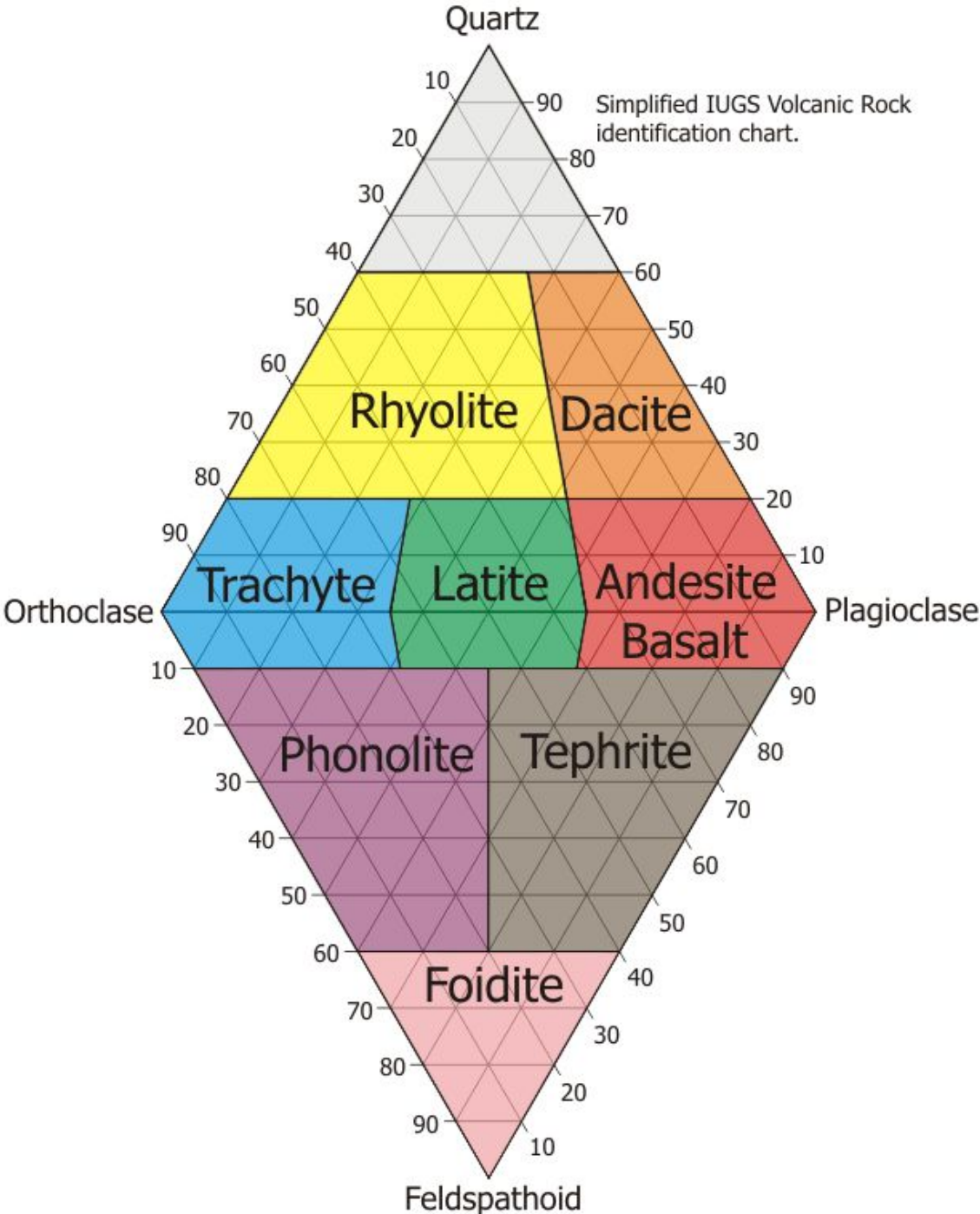
106. Identify the **mineral**.

107. Specimen 104 contains quartz. If the quartz were instead replaced with specimen 105 (or minerals of similar composition) what rock would form? Use the given QAPF diagram.

108. If the rock from 107 was instead cooled more slowly, what rock would form?

109. Looking at the QAPF, the vertical axis (from Q to F) is equivalent to the relative amount of what specific chemical component of the minerals?

Station 17



Station 18

110. Looking at the map of the US, which region (letter, A-E) is most likely to contain soil profile A?

111. Explain your answer to 110.

112. Which soil profile would you expect to have a lower pH? Explain your answer.

113. What type of vegetation is most likely to grow in soil B?

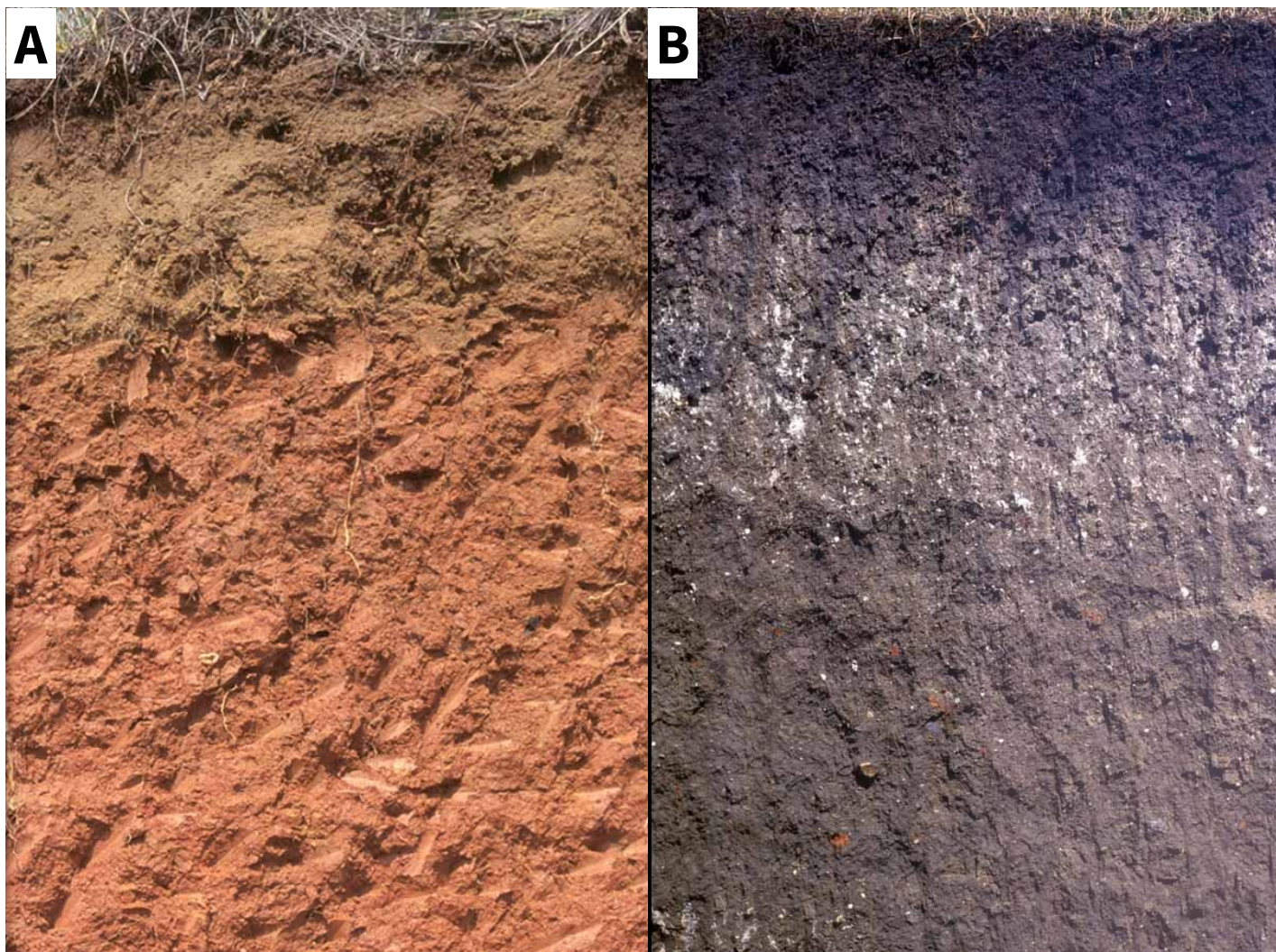
- a. Deciduous forest
- b. Sparse shrubs
- c. Conifers
- d. Grasses

114. Which soil horizon is not shown in either profile?

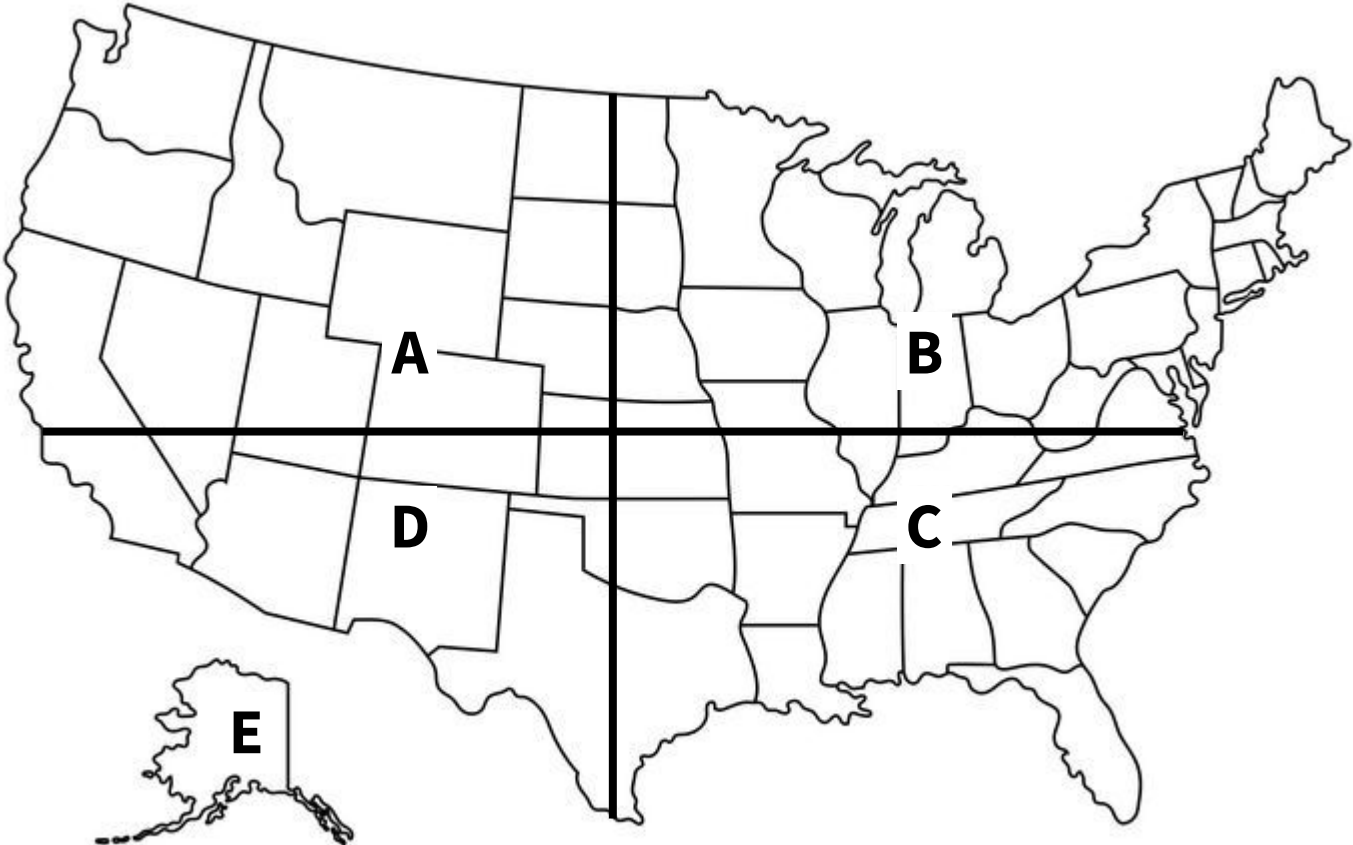
- a. A
- b. B
- c. C
- d. O

115. Are either of these profiles likely to be seen in an arid environment? Explain.

Station 18



Station 18



Station 19

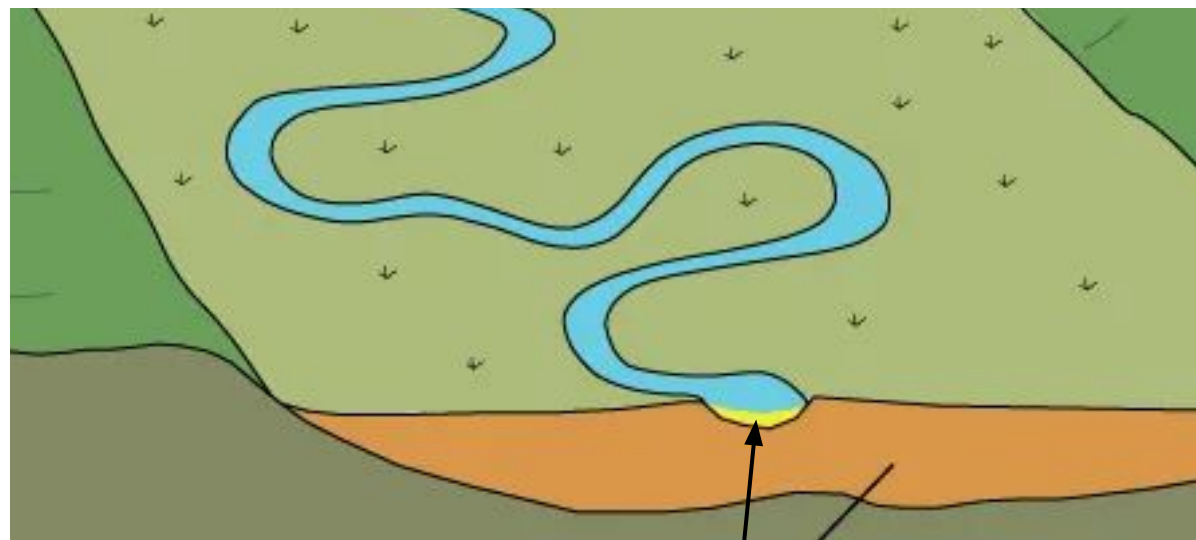
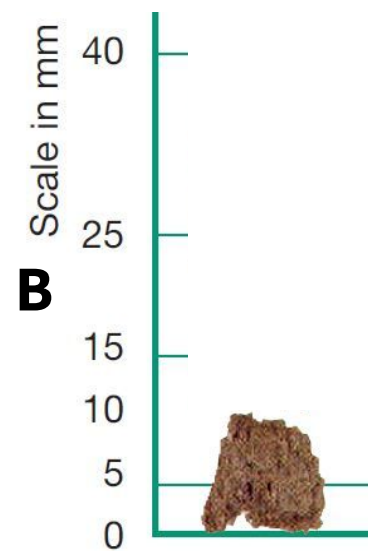
115. Which ribbon test, **A** or **B**, has a higher proportion of clay? Explain.

116. A soil sample is taken from the location in the diagram. Which ribbon test result would you expect to get? Explain.

117. Katherine is designing a landfill. Which ribbon test is closest to the soil conditions Katherine would prefer to locate the landfill in? Explain.

118. Assume both soils are each completely uniform in grain size and that these grains are completely spherical. Which soil has the higher porosity (higher proportion of empty space compared to grains)? Explain.

Station 19



116

Station 20

USES0 alumni are doing field work and found some rocks and minerals they could not identify. Using their descriptions, identify the rock/mineral.

119. While relaxing in a hot spring, Marissa finds a light grey stone with thin wavy layers. It reacts with HCl.

120. David is walking on the University of Tulsa campus and finds a large flat rock on the ground. It is grey with slight sheen in the sunlight but with no visible grains.

121. In Stanford's rock collection, Yuchen spots a dark mineral grain that broke off of an igneous rock. It has two cleavage planes at about right angles and is not sparkly.

122. Chloe is taking a vacation at Death Valley. While there, she finds a fibrous mineral that exhibits chatoyance. It is white and can be scratched with a fingernail.

123. Chelsea wants to find a prize for the USESO art/poetry competition. She ends up picking a small transparent crystal with a boxy shape. It scratches quartz and is slightly brown/peach.