Station 1

1. Identify the **rock**.
2. Identify the **rock**.
3. Identify the **rock**.
4. Which rock is most likely to be found at the structure shown in 4?
5. Which rock is most likely to be found at the structure shown in 5?
6. Using the diagram in 6, in which location would you expect to find the geologic feature shown in 5?
7. Using the diagram in 6, in which location would you expect rocks with the most similar chemical composition to specimen 1?
8. Three equal amounts of specimens 1-3 are melted together. What would be the expected composition of the resulting melt?

Station 2

9. Identify the **MINERAL**. (pink crystal, blue arrow)

Specimen 10 is NOT on the list and you do not need to identify it. Specimen 10 is shown growing on specimen 9 (orange arrows).

10. What crystal system does specimen 10 belong to? Use the options shown in the crystal system diagram.

11. Specimen 10 has two cleavage planes. Based on its crystal system, what angle you expect the two cleavage planes to have?

A. 90° B. 120°/60° C. <90°/>90° (e.g., 83°/97°) D. <60°/>120° (e.g., 122°/58°)

12. Specimen 10 is an oxide. Which of the following does specimen 10 most likely exhibit?

A. React with HCl B. Submetallic Luster C. Low Density D. Conchoidal Fracture

13. What are the lines on specimen 10 (see orange line as example)?

14. Based on the information provided, the white crystals on specimen 10 (circled) are most likely to be what mineral?

15. What habit is specimen 9 exhibiting?

A. Bladed B. Acicular C. Prismatic D. Botryoidal E. Massive

Station 3

All images at this station show inclusions of minerals within gemstones.

16. This is a “negative crystal.” It is a void within a crystal that resembles the crystal itself. Identify the **MINERAL**.

17. This is a small mineral inclusion. What mineral group does the inclusion belong to?
    A. Garnet B. Tourmaline C. Quartz D. Gypsum E. Amphibole

18. This is a small mineral inclusion. What mineral group does the inclusion belong to?
    A. Olivine B. Feldspar C. Pyroxene D. Apatite E. Mica

19. This is a small mineral inclusion. Both images are of the same mineral. What mineral family does the inclusion belong to?

    A. Halide B. Oxide/Hydroxide C. Sulfide D. Silicate E. Carbonate

20. Based on the composition of the inclusions above, which rock type are all these inclusions and host crystals LEAST likely to have formed in?

    A. Igneous B. Metamorphic C. Sedimentary

21. The inclusion in 16 is aligned with the crystal axis of the surrounding crystal. Would you expect the other inclusions to be aligned with the surrounding crystal?

22. Explain your answer to 21.

Station 4

23. Identify the specimen.

24. What is one economic use for specimen 23?

25. Identify the specimen.

26. What is one economic use for specimen 25?

27. Identify the specimen.

28. What is one economic use for specimen 27?

29. Identify the specimen.

30. What is one economic use for specimen 29?

Station 5

31-33: match the mineral to the rock they are most likely to be found in

34. Which two rocks likely have the most similar chemical (albeit different mineral) composition?

35. Which two rocks formed in the most similar way?

36. Severe weathering of rock B is most likely to form which rock?

37. Which rock is most likely to be found forming a large ridge/ledge?

Station 6

38. Identify the specimen.

39. Identify the specimen.

Two images of specimen 40 is shown. It is NOT the same as specimens 38 and 39.

40-42. Fill in the table with the specimens numbers. Match the environment of deposition to the specimen (38-40). **Only fill in three blanks; not all environments will be used.**

43. Looking at 40B, what are the linear features seen in the outcrop?

44. Briefly describe how the sediment changes vertically across the outcrop in 40B.

45. Provide a hypothesis for the cause of the sediment changes in 40B.

Station 7

46. Identify the specimen. (46A and 46B are the same)

47. Identify the specimen. (47A and 47B are the same)

48. A (bad) diagram of a large core sample is shown. It has the ideal sequence for an oil well. Which of the specimens is most likely to be the cap layer?

49. Evaporites are another common rock that is ideal for a cap layer. What property makes them good cap layers?

50. Limestone can also be a cap, but is far less common and less ideal. Why do evaporites typically make a better cap than limestones?

51. 47B is dark in color. Was it this color when it deposited? If so, what causes the color? If not, how did it become this color?

52. In which layer would you expect to find 47B?

Station 8

*NOTE: DON'T BE STUPID AND ACTUALLY TASTE THESE SPECIMENS

53. In order for minerals to be tasted, they must be somewhat soluble in saliva (predominantly water). What group of minerals is least likely to be tastable?

A. Carbonates B. Halides C. Silicates D. Phosphates E. Sulfides

54. This is a specimen which has chemical formula $Na_8(Al_6Si_6O_{24})Cl_2$. Ignoring the requirement in question 53, what would you expect specimen 54 to taste like?

55. Identify the specimen.

56. Ignoring the requirement in question 53, what would you expect specimen 55 to taste like?

57. Identify the specimen.

58. Ignoring the requirement in question 53, what would you expect specimen 57 to taste like?

59. Identify the specimen.

60. Ignoring the requirement in question 53, what would you expect specimen 59 to taste like?

Station 8

Chemical	Taste	MCQ Option
Heavy Metal Cations	Sweet	A
Transition Metal Cations	Metallic	B
Alkali Cations	Bitter	C
Sulfates	Bitter	

Station 9

61. Identify the rock.

62. What rock is typically the protolith and through what method of metamorphism does this rock form?

63. Identify the rock.

64. What type of metamorphism typically creates this rock?

65. What type of rock would be created if specimen 63 was heated even further and underwent partial melting?

66. Identify the rock.

67. Which of the specimens has the highest metamorphic grade?

68. Would you expect to find serpentinite on Mars? Provide one reason as to why/why not.

Station 10

69. Identify the **rock**.

70. What type of melt composition does specimen 69 typically form from?

71. What type of fracture/cleavage does specimen 69 display?

72. The white section on specimen 69 began crystallizing at about 1600°C. The specimen formed under normal conditions for this rock. Using the phase diagram of quartz, what mineral do you expect this to be?

73. Using the difference in volumes between solid and liquid phases, qualitatively explain why the melting point of quartz increases with increasing pressure.

74. What minerals are at locations A and B on the phase diagram of andalusite, respectively?

75. This is a specimen of andalusite with a black “X” of some phase of carbon included in it. Given the formation conditions of andalusite, what phase of carbon is this? (1 GPa = 10^9 Pa)

76. Both diamond and the phase of silicon dioxide displayed on specimen 69 are not stable at standard room temperature and pressure. What term describes these type of mineral phases?

Station 11

77. Identify the specimen.

78. Identify the specimen.

79. Identify the specimen.

80. Identify the specimen.

81. Identify the specimen.

82. Identify the specimen.

83. Identify the specimen.

84. Identify the specimen.

Station 12

85. Identify the specimen.

86. Identify the specimen.

87. What texture does specimen 85 exhibit?

88. The two specimens have similar overall chemical compositions. Why do they differ so drastically in texture?

89. Specimen 86 is heated such that only the mineral with the lowest melting point is melted and removed. What mineral would remain (in the largest quantity)?

90. Similar to the previous question, specimen 86 is heated such that it just barely melts (partial melting). The resulting melt is removed. What rock would this melt form when cooled quickly at the surface?

91. The picture is of an outcrop in Antarctica. What structures are the two blue arrows pointing to?
HINT: The lighter rock is sandstone. The thicker band of dark rock is the same structure but larger.

92. The picture shows vertical lineations/structures in the dark rock indicated by the orange line. What are these lineations and why did they form vertically as opposed to horizontally?

Station 13

93. Identify the mineral.

94. Identify the mineral.

95. Identify the mineral.

96. Identify the mineral.

97. Identify the mineral.

98. Specimen 96 can be found in evaporite deposits. Would you expect to find specimen 96 near the **Red Sea** or **Death Valley**? Briefly explain your answer.

99. While uncommon, specimen 95 can pseudomorph after another mineral. Based on its chemical composition, which mineral is it most likely to form a pseudomorph after?

A. Augite B. Dolomite C. Gypsum D. Sphalerite E. Talc

100. Which of the following is the **most** definitive for differentiating specimens 95 and 97?

A. Flame test B. Hardness C. Density/Heft D. Streak E. Crystal System

Station 14

101. Identify the sedimentary structure exhibited in the upper section of layer B.

102. Is section 2 (shown by the bracket at right) overturned?

103. Explain your answer to 102.

104. The triangular wedges of C in the bottom section of layer B are mudcracks filled in by sediment. Is section 1 overturned?

105. Explain your answer to 104.

106. Is layer G older than layer A? How can you tell?

107. The image shows a sequence of rocks. What does there sequence suggest about sea levels during their deposition?

108. Explain your answer to 107.

Station 15

Oh no! Scott's rock collection got mixed up! Help him match the thin sections to his rocks.

109. Match the thin section to the letter of the specimen. Note the scale in the bottom right.

110. What is the typical protolith for rock 109?

111. Match the thin section to the letter of the specimen. Note the scale in the bottom right.

112. In which direction(s) is the axis of maximum stress directed in specimen 111? Take the top of the page to be "north" and answer to the nearest pair of the 8 cardinal directions.

113. Match the thin section to the letter of the specimen. **Testing with HCl shows the rock effervesces.** Note the scale in the bottom right.

114. Besides calcite, what other mineral on the USESO list is most likely to be the primary constituent of rock 113's protolith?

115. Match the thin section to the letter of the specimen that is the same type of rock. **Testing with HCl shows the rock does not effervesce.** Note the scale in the bottom right.

116. The primary mineral in rock 115 has what value of hardness on the Mohs scale?

Station 16

All of the given soil profiles have the same scale (indicated on right).

117. Which soil profile is most likely to have formed on a flood plain?

118. Would you expect the soil in a flood plain to be **thicker** or **thinner** than soil on land above the flood plain? Briefly explain.

119. Which soil profile is most likely to have formed in a tropical environment from volcanic ash, rocks, etc.?

120. Briefly explain your answer to 119.

121. Which soil profile is most likely from a region that experienced relatively “recent” (Pleistocene, ~15,000 year ago) glaciation?

122. Briefly explain your answer to 121.

123. Which soil profile likely experiences the most expansion during/after rainfall?

124. Which soil profile has the shallowest ‘E’ horizon?

Station 17

125. Identify the specimen.

126. Identify the **rock**.

127. Identify the specimen.

128. Specimen 125 is found to be the bedrock in an area with relative shallow soil. Would you expect the soil to be **acidic** or **basic**? Briefly explain.

129. Would you expect to find specimen 127 in the soil above 125, **yes** or **no**? Briefly explain your answer.

130. Would you expect a region with specimen 127 as the bedrock to be **well-drained** or **poorly-drained**? Briefly explain.

131. What is the letter of the soil horizon shown beneath the yellow line (indicated by arrow)?

132. Does the soil shown in 131 appear to be formed from specimen 125 and/or specimen 126? **Select all that apply.**

Station 18

133-135. Using the depositional locations in the image, provide the depositional location described by each of the rows in the table.

136. In which of the locations in the diagram would you expect the structure in image 136 to form in?

137. Identify the specimen.

138. Identify the specimen.

139. What type of sedimentary rock is specimen 137?

A. Clastic B. Chemical C. Evaporite D. Biogenic E. Volcaniclastic

140. Explain the formation process of specimen 138. At which of the locations in the diagram would you expect it to form?

Station 19

141. Identify the specimen.

142. Identify the specimen.

143. Identify the **rock**.

144. Malachi finds a sample of gneiss and discovers that it has grains of specimen 142, staurolite, and almandine. Using the diagram, what facies (red circles, e.g. blueschist) does this rock belong to?

145. Based on your answer to 144, would you correct Malachi and reclassify rock? Explain your answer.

146. Assume that specimen 143 has some chloritoid and kyanite grains. What is the maximum temperature (°C) and minimum depth (km) under which it could have formed?

147. Edlyn decides to run an experiment and buries specimen 141 under about a kilometer of sediment/rock. What process does it undergo and what does it form?

Station 20

148. Identify the rock.

149. Identify the rock.

150. Identify the rock.

151. Identify the rock.

152. Identify the rock.

153. Identify the rock.

154. Identify the rock.

155. Identify the rock.

156. Identify the rock.