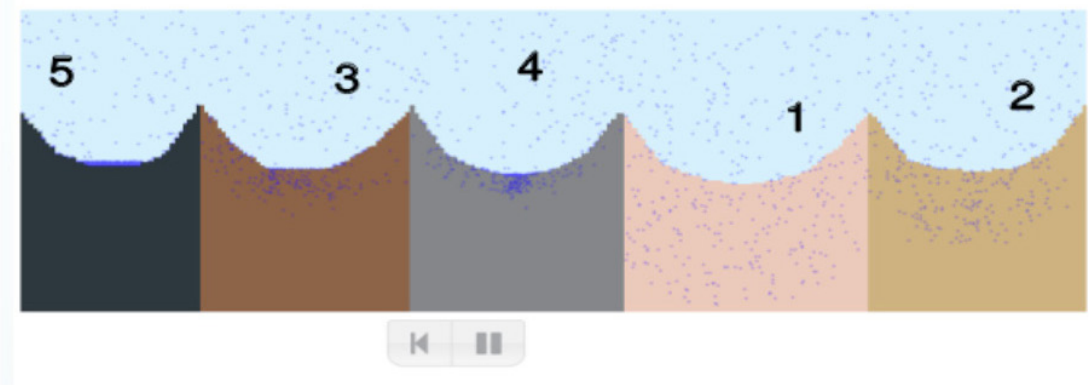
Groundwater Movement Answer Key

1. Why do you think water moves differently through different rocks/sediments? What is the difference between the rocks/sediments?
   Water moves differently though different sediments because the different sediments have different properties. They have different amounts of space between particles.

2. Take a snapshot of the model to show how water moved differently through the different rock/sediment types. Label the snapshot to show which sediment/rock is most permeable to water (easiest flow) and which sediment/rock is least permeable to water (most difficult flow).
   The first one is least permeable, then the third is next most permeable, then the second one is next most permeable, then the fifth one is next most permeable, and finally, the fourth one is the most permeable.



3. Which property varies most between gravel, sand, silt, and clay?
   permeability (allowing water to move through)

4. If a sediment/rock is very porous, is it also very permeable?
   it depends

5. Explain your answer.
   A sediment can be very porous (have a lot of holes), but if the holes aren't connected to each other, then the sediment will not be very permeable. If the holes are not connected then water cannot flow through. If water cannot flow through, it is not very permeable.

6. Based on the picture, what is the likely porosity and permeability of bedrock?
   low porosity and low permeability

7. Explain your answer.
   There do not appear to be many spaces in the bedrock. This makes it not very porous. If there are no spaces, then it cannot be very permeable. There looks to be no way that water can flow through this sample of bedrock.

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Groundwater Movement Answer Key, continued

8. What is the likely porosity of pumice?
   high porosity

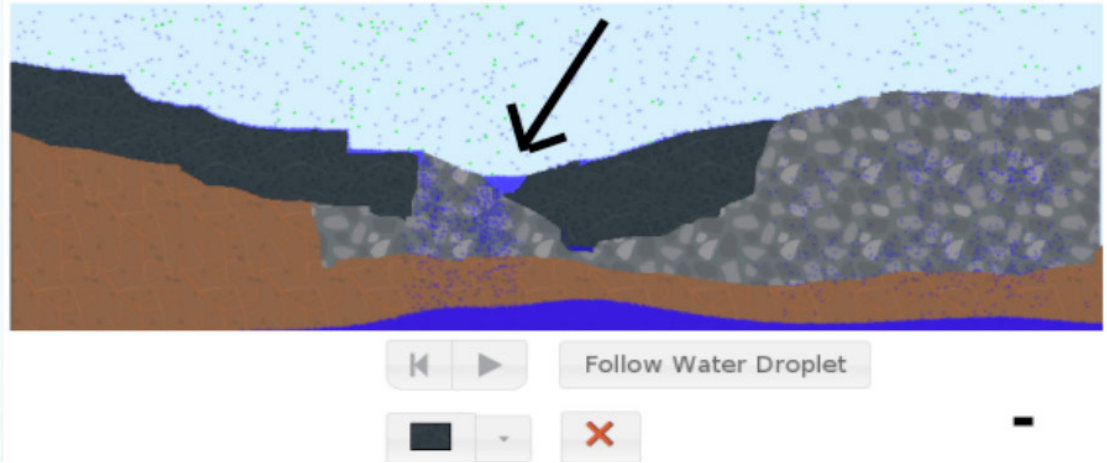
9. What is the likely permeability of pumice?
   low permeability

10. Explain your answers.
    Pumice appears to have high porosity because it floats. There is air trapped in the rock that makes it float in water. Pumice appears to have low permeability because it floats. If the pores were connected, the water would flow through and the pumice would sink. The pumice does not sink, so it must be impermeable.

11. How certain are you about your claim based on your explanation?
    Answers will vary.

12. Explain what influenced your certainty rating.
    Answers will vary. Scientific evidence includes: porosity is the number of spaces in a rock, permeability is the connectedness of those spaces, and pumice floats.

13. Take a snapshot of your model. Add notes to explain why water moved as it did.
    Answers will vary. The arrow points to the pooled water in the middle. The water pooled in the middle because the layers slope toward the middle so water would run off the surfaces to the middle. It stays on the surface because the layers of sediment on the surface are impermeable, preventing the water from infiltrating the ground.



14. How did you get the water to pool in the middle?
    Water will pool in the middle when the slopes of the sides slope towards the middle. The layers should be impermeable so that the water flows along the surface instead of infiltrating into the ground.

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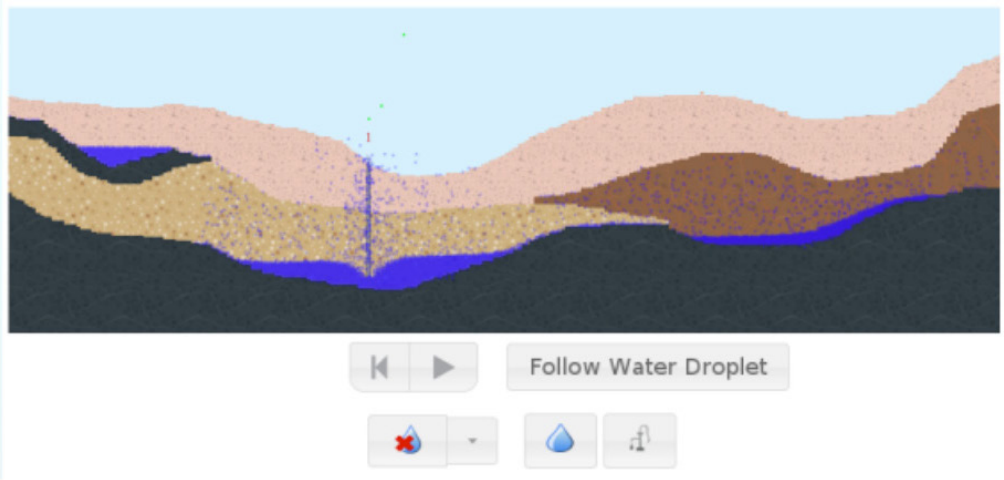
Groundwater Movement Answer Key, continued

15. Take a snapshot of the model showing an aquifer that provided a steady supply of water. Describe why this aquifer provided a steady supply of water.
    This aquifer provided a steady supply of water. The water flowed through the sediment layers just as quickly as it was pulled out by the well. The water flowed steadily because the sediment it was drilled into was permeable, allowing the water to flow easily to the well.



16. Describe the movement of water between precipitation, human-drilled wells into the aquifer, and water recharging the aquifer.
    Precipitation moves water into the ground, if the ground is permeable. The water eventually makes its way to an aquifer. It stops flowing downward at the aquifer because the base of the aquifer is impermeable to water. Humans pull water out of the aquifer via wells. If the sediment is permeable enough, the wells can be recharged by precipitation. If the sediments are not permeable enough, or if the wells withdraw too much water, the aquifer will dry up or at least not be a very good water supply.

17. What properties of the rock/sediment make for an aquifer that produces a steady supply of water?
    The rock/sediment above an aquifer should be very permeable to allow steady recharge of the aquifer by precipitation. If the aquifer is readily recharged, it will provide a good steady supply of water.

18. Why do you need to drill into the bottom of the red layer to get a steady supply of water?
    You need to drill to the bottom of the red layer to get a steady supply of water because it is bounded by an impermeable layer on the bottom. If you don't drill to the bottom, you won't always be near the water pool (depending on how high the water level is in the aquifer).

19. If a sediment/rock layer is saturated (completely full of water), is it able to provide a steady supply of water?
    no

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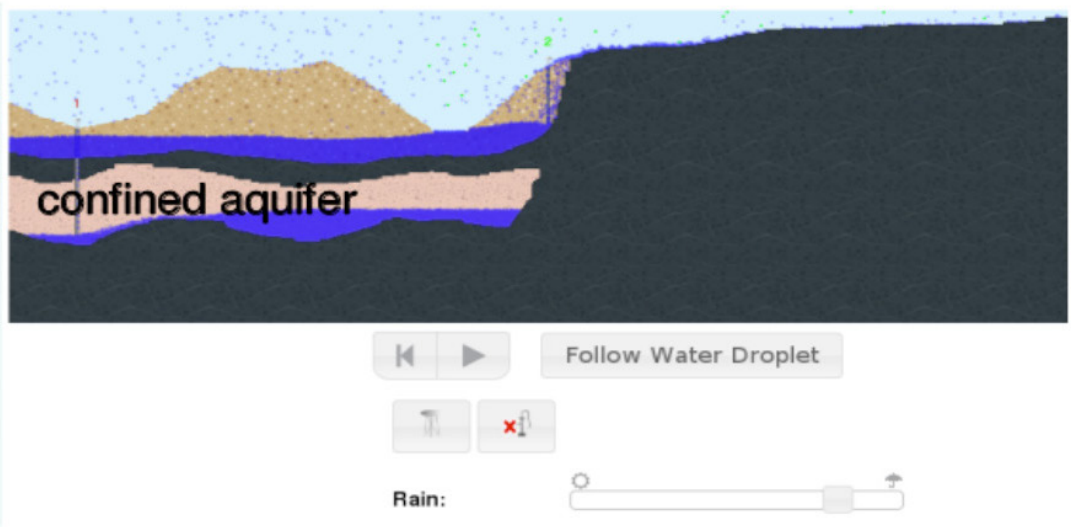
Groundwater Movement Answer Key, continued

20. Explain your answer.
    The ability of a sediment/rock to provide a steady water supply is limited by its permeability, even when fully saturated. If the sediment/rock is permeable, the water will flow easily through the sediment/rock and provide a good supply of water for a well. But if the sediment/rock is impermeable, it doesn't matter how much water is in the sediment/rock--it can't get out of the rock to get to the well in the first place!

21. Take a snapshot and label the confined aquifer. In the caption, explain why confined aquifers are not recharged by rainfall.
    Confined aquifers are not recharged by rainfall because they have an impermeable layer above the aquifer as well as below the aquifer. The water cannot penetrate the impermeable layer, preventing recharge of the confined aquifer.



22. Which type of aquifer could potentially provide a sustainable source of water (a water source that will not run out and consistently supply usable amounts of water)?
    unconfined aquifer

23. Explain your answer.
    Confined aquifers are not recharged by rainfall because they have an impermeable surface covering. If they are not recharged, the water can run out. Therefore, unconfined aquifers stand the best chance of providing a steady supply of water over the long run. Unconfined aquifers do not have an impermeable surface, unlike confined aquifers, so they can be recharged.

24. How certain are you about your claim based on your explanation?
    Answers will vary.

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25. Explain what influenced your certainty rating.
    Answers will vary. Scientific evidence includes: confined aquifers have an impermeable surface covering the top, preventing water infiltration and unconfined aquifers have a permeable surface covering the top, allowing precipitation to recharge the aquifer. Students may state that there could be a crack in the covering of the unconfined aquifer, allowing some recharge or that unconfined aquifer flows out to a larger water body, like a stream that carries the water away.

26. A farmer drills a well to irrigate some nearby fields.Could the well supply a consistent supply of water for irrigation?
    yes

27. Explain your answer.
    The well could supply enough water if the the well is drilled into an unconfined aquifer. Unconfined aquifers are recharged by precipitation (and in this case, by the water falling from the irrigation heads). If the well is drilled into a confined aquifer, it may supply a consistent supply of water, but it may be limited as confined aquifers are not recharged by precipitation. In either case, the well will only provide a good supply of water if the sediments are permeable enough to allow the easy flow of water from the groundwater to the well.

28. How certain are you about your claim based on your explanation?
    Answers will vary.

29. Explain what influenced your certainty rating.
    Answers will vary. Scientific evidence includes: wells supply steady amounts of water only when the sediments into which they're drilled have high permeability and unconfined aquifers are recharged by precipitation. Students may state that the aquifer could be small (or large), or it could be a confined aquifer. Alternatively, they may note that the farmer could withdraw more water than what can be recharged by precipitation and that the plants use some of the water (and some is evaporated) so the irrigation nozzles don't provide much recharge of the (unconfined) aquifer from which it may be drawn.

30. There is a drought in the area of the farmer's fields. Describe what might happen to the aquifer during this period.
    If there is a drought in the area, the aquifer could shrink. But that would only happen with an unconfined aquifer since the surface is permeable. The unconfined aquifer will not be recharged by precipitation in the case of a drought. If the aquifer is a confined aquifer, not much will happen to its level unless there is a well drilled into it. But even then, the confined aquifer would behave the same in a drought as it would in a rainy situation. The surface is impermeable, so it is not recharged by precipitation, even in very rainy years.

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