Learning Assessment #6 KEY: Geologic Time

Q.1 Using the cross-section diagram, explain the geologic history from the oldest to youngest event for the four different rock units in the outcrops. There are two possible solutions. Use the tables provided below for your answer and be sure to include the following:
- the reasoning for your order of events (i.e. the geologic processes of rock formation and/or the principles of relative geologic time)
- the nature of the contacts between the units if appropriate (i.e. conformable, unconformable, faulted)

Ss = sandstone, Gn = phyllite (the squiggly lines indicate the orientation of the phyllitic foliation). Hints: Thrust faults can follow geologic contacts. Phyllite is a low-grade metamorphic from regional metamorphism, hornfels is a contact metamorphic rock.

Solution #1 – Unconformity boundary between phyllite and sandstone

	Rock Unit	Reasoning for relative time interpretation and/or Principle of relative time used
Oldest	*Phyllite*	*Phyllite is a metamorphic rock and would form at depths of at least a few kilometers in the Earth's crust. Sandstone forms at the surface. In order for a sandstone to be found next to phyllite there would likely have to be an unconformity surface between the two. If this is an unconformity then the phyllite is oldest. It would be a nonconformity.*
	Sandstone	*Sandstone is younger than phyllite (deposited and formed on top of phyllite, therefore younger) but is cut by granite and is therefore older than granite.*
	Granite	*Granite dyke cuts across sandstone and phyllite (therefore younger than both) and then a sill of granite forms parallel to sandstone layer.*
Youngest	*Hornfels*	*The hornfels metamorphic rock would likely have formed from contact metamorphism caused by the granite intrusion. It would be slightly younger than the granite as the granite intrusion would have to form first, but soon afterward (as it was cooling) would impart the heat into the surrounding rock to create the hornfels rock. Protolith of the hornfels would likely be the sandstone.*

Reid et al. (2010)

Solution #2 – Thrust fault boundary between phyllite and sandstone

	Rock Unit	Reasoning for relative time interpretation and/or Principle of relative time used
Oldest	*Sandstone*	*Sandstone is older than phyllite and the surface between the phyllite and the sandstone is a thrust fault, placing older rocks on top of younger rocks*
	Phyllite	*Phyllite is a metamorphic rock and would form at great depths in the Earth's crust, however because the boundary between the two units is a thrust fault, the sandstone could be older than the phyllite and have been placed above the younger phyllite as a result of faulting.*
	Granite	*Granite dyke cuts across sandstone and phyllite (therefore younger than both) and then a sill of granite forms parallel to sandstone layer.*
Youngest	*Hornfels*	*The hornfels metamorphic rock would likely have formed from contact metamorphism caused by the granite intrusion. It would be slightly younger than the granite as the granite intrusion would have to form first, but soon afterward (as it was cooling) would impart the heat into the surrounding rock to create the hornfels rock. Protolith of the hornfels would likely be the sandstone.*

Describe the geologic evidence would you look for in the rock outcrops to determine if your interpretation of the age relationship is correct.

I would look for clasts of the phyllite in the sandstone, further evidence to support that there was erosion of the phyllite and therefore an unconformity.

I would also look for evidence of deformation along and near the boundary between the phyllite and sandstone – the lack of deformation evidence would help support the interpretation that it is an unconformity boundary between the two and not a fault boundary.

Numerical age dating of the sandstone and phyllite could help resolve which age sequence is correct.

Reid et al. (2010)

Q.2: How could numerical ages be determined for the rock units listed below (i.e. what could be numerically dated - minerals in the rock, fossils)? What would numerical ages tell about the timing of geologic events?

Rock Unit	What could be dated?	What geologic process would be dated?
Phyllite	*Metamorphic minerals*	*The age of metamorphism forming the phyllite could be determined from numerically dating a metamorphic mineral that grew during metamorphism.*
Sandstone	*Fossils*	*Would give an age range for when the sandstone was formed / deposited. If younger than phyllite age then would confirm the interpretation of an unconformity.*
Granite	*Igneous mineral*	*Would give an age for the formation of the granite intrusion (i.e. when the mineral being dated in the granite solidified).*
Hornfels	*Metamorphic mineral*	*Would give an age of the formation of contact metamorphism and ensure that it is as a result of the granite.*

THE END

Reid et al. (2010)