Name________________

Generating hydroelectric power
Geology of the Qattara Depression
(due Fri., Nov. 16]

Generating Hydroelectric Power

Go to the following web sites, and read about hydroelectric power generation. Be sure to watch the YouTube video on the second site.

http://www.tva.gov/power/hydr.htm
http://www.opg.com/power/hydro/howitworks.asp
http://www.tepco.co.jp/en/energy/ps-engineering/power-e.html
http://www.fhc.co.uk/ffestiniog.htm
good summary of power and energy units: http://www.windpower.org/en/stat/unitsene.htm

Using ***your own words*** (no quotes, no copying), answer the following:

How does a spinning turbine generate electricity?

Explain why the amount of electrical power generated is a function of the magnitude of the drop (the elevation difference upstream and downstream of the dam).

What is a pumped storage hydroelectric power plant, how does it work, and how do you actually gain anything by using electricity that you've already generated to pump water to a location above the power plant so that you generate more power? How do you actually gain anything from the system??

OK – here's some important terminology:

- The unit of electrical power, a **Watt,** is defined as 1 Joule of energy transferred ***in 1 second***.
- 1 GW (gigawatt) = 10^3 MW (megawatts) = 10^6 KW (kilowatts) = 10^9 W (watts).
- Electrical power generation is described in terms of **installed capacity in megawatts (MW).**
- If a power plant is described as having 2000 MW of installed capacity, it means that, if the plant is operating at peak capacity, it generates 2000 MW of energy **per second.**
- **Note that power that is generated cannot be easily stored for future use.** If peak demand for power is, for example, 15,000 MW, the grid must be able to supply that amount of energy per second at peak demand time. If off-peak demand is considerably less, any power generated is wasted if the plant keeps running at peak capacity, which is why it is incredibly valuable to have a system that can generate less electricity at off-peak times and more electricity at peak demand time without costly start-up each day.

And some data:

- A good-sized city in the US typically needs a power generating capacity of 1000 MW (1 GW).
- Total installed capacity in the US is 932,000 MW (32 GW)
- Israel's total installed capacity is 9,900 MW (9.9 GW).
- Egypt's total installed capacity in 2003 was 17,700 MW.

Google the following hydroelectric power projects. For each:

- indicate what the peak capacity is in MW.
- indicate whether the project is a reservoir project, a run-of-the-river project (no dam to raise upstream water levels), or pumped storage.

Aswan High Dam:

Búrfell, Iceland:

Moses-Saunders (St. Lawrence River, Massena, NY):

Akosombo Dam (Lake Volta in Ghana):

Hoover Dam on the Colorado River:

Grand Coulee Dam on the Columbia River:

Three Gorges Dam in China:

Ffestiniog Dam and Stwlan Reservoir in Wales (these are not typos…!):

Qattara Depression Geology

Download the following article from Blackboard:

Aref, M.A.M., El-Khoriby E., and Hamdan, M.A., 2002, The role of salt weathering in the origin of the Qattara Depression, Western Desert, Egypt: Geomorphology, v. 45, p. 181-195.

This is a pretty fascinating article that ties to quite a few different things that we've done this semester. Instead of starting to read the article by plowing through the authors' research results, we'll start with a perspective on groundwater in the Qattara Depression area. ***As you answer the questions in this homework, you MUST use your own words so that I can tell that you know what you're talking about.***

Read section 5 on hydrogeology and hydrochemistry on pages 184-185.
Think about the groundwater model (the ant farm). Why does groundwater in the Western Desert all flow toward the Qattara Depression?

The authors state that groundwater flows into the Depression at the rate of 3.2 m^3/second. How many Bm^3 is that each year? Show your calculations.

If groundwater flows into the Depression at this rate, why isn't there a lake in the bottom of the Depression?

How much does salinity of near surface groundwater in the Moghra Aquifer vary from place to place in the Depression? Where in the Depression does highly saline groundwater intersect the surface? Where does relatively fresh groundwater intersect the surface? **Be sure that you are clear on the geography in the map on page 183.**

What is the difference between *weathering* and *erosion*?

In this article, the authors talk about salt weathering and aeolian deflation.

- salt weathering is the physical breakdown of rocks caused by the growth of salt crystals in spaces within the rock (in pore spaces between grains, along bedding planes, or along fractures).
- aeolian deflation is the removal of weathered material by wind.

Are both of these weathering mechanisms, or is aeolian deflation an erosional mechanism? Explain.

Read sections 8 (page 191) and 9.3 (p. 192) of the article. "Evaporite minerals" are produced by precipitation of minerals out of solution as water evaporates. Halite (NaCl, or rock salt) and gypsum ($CaSO_4 \cdot nH_2O$) are common evaporite minerals. "Brine" is salty water.

What makes the growth of halite and gypsum crystals in fractures and pore spaces an effective physical weathering process for rocks?

How does this relate to the issues that the engineers of the Great Man-Made River Project were concerned about?

Read section 9.5 on pages 192-194. The authors argue for an overall aeolian deflation rate of 9 cm/1000 years (measured vertically, of course) over the past 2 million years. At that rate, how many meters of material could have been removed by wind deflation from the Depression in 2 million years? Show your calculations, and be careful about conversion of units!!

Read sections 2 and 3 on topography and geology on pages 182-184. Note that *b.s.l.* means below sea level.

What rock types are found in the bedrock of the Qattara Depression?

What types of surface sediments are found in the QD?

With all of this as background, read section 9.1 on pages 191-192, 9.4 on page 192, and 10 on p. 194. The author's explanation for deepening of the Qattara Depression involves more than simple growth of evaporite minerals and subsequence aeolian deflation. Cyclic patterns of "wet" and dry periods are crucial to the process of aeolian deflation and deepening of the Depression. Explain why.

Given what you know about Pleistocene and Holocene conditions in North Africa, how wet do suppose "wet" actually is? Explain.

Explain, in your own words, the author's hypothesis for why the Qattara Depression is much deeper in the west than in the east.