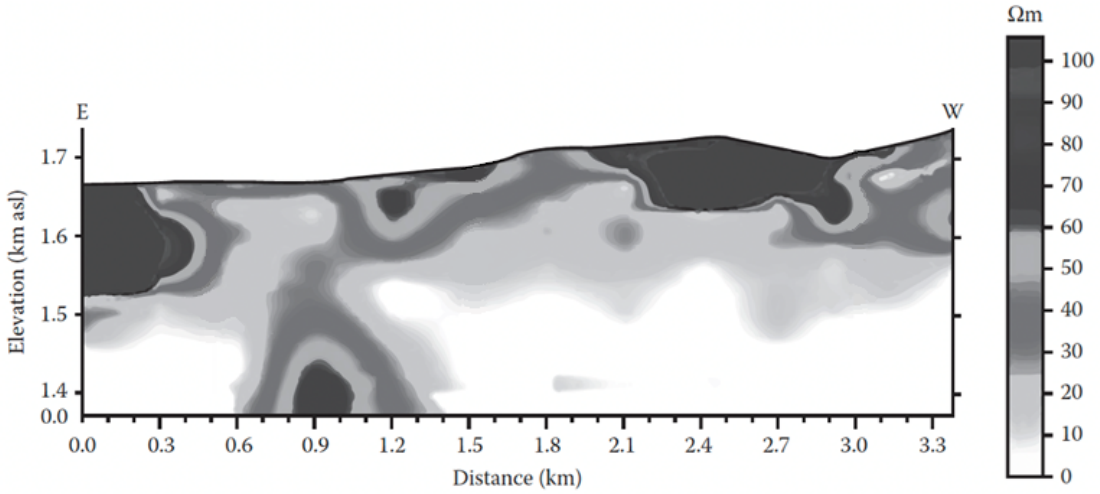
GRD – Weeks 6, 7, 8 – Exercises

Due November 20, 2024.

Exploration approaches: Geophysical methods:

1a. In the Boku Volcanic Geothermal Region cross section below, where would you drill wells that would have a probability of accessing geothermal fluids? Explain your reasoning.



1b. Propose a block model of the subsurface of the Boku geothermal region.

1c. Provide expected relative gravity and reduced to pole magnetic anomaly profiles for this cross section.

Resource assessment:

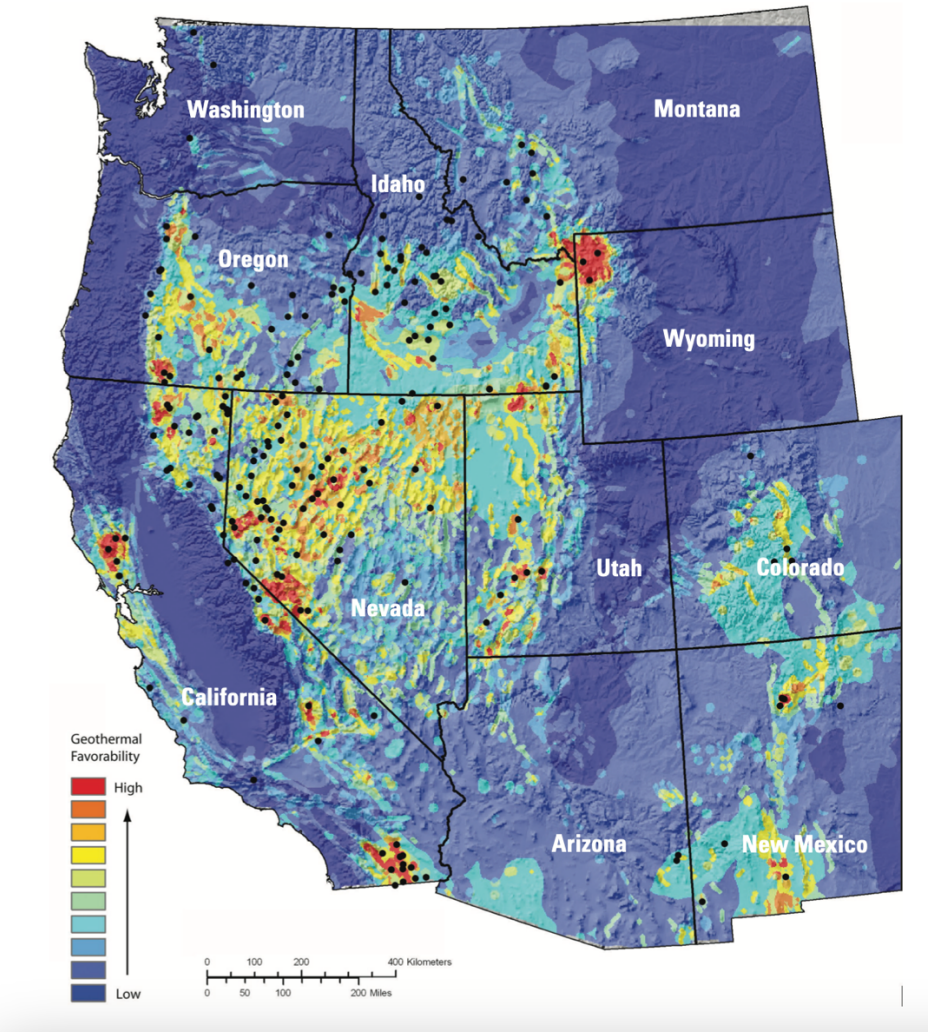
2. Identify three issues that influence whether a geothermal site would be considered a reserve and discuss how those factors can change over time.

3. Chemical processes can result in limestone being replaced by quartz. If 40 vol% of a limestone were replaced by quartz, how would this affect the heat content of the limestone.

4a. Propose tectonic processes that have resulted in the concentration of potentially favourable geothermal sites in California, Oregon, Wyoming, and New Mexico.

4b. Provide geothermal plays for these geological environments. Justify your classifications.

4c. If you were to undertake reconnaissance exploration efforts, what specific area would you target and why?



From: Williams et al., Assessment of moderate- to high-temperature geothermal resources of the United States, US Geological Survey Fact Sheet 2008-3082, 4, 2008

Power generation:

5a. What is a dry steam resource and why is it favoured over other types of geothermal resources?

5b. Assume that steam entering a turbine is at 235°C and 30 bars, has a flow rate of 5 kg/s, leaves the turbine at 35°C, and has 84% efficiency. What is the power output of the turbine, assuming an ideal process?

6. Assume that the pressure at the top of a hydrothermal reservoir is 35 MPa, at a depth of 3000 m. The reservoir contains 235°C. If the fluid is flowing in the well at 3 m/s and has a density of 850 kg/m^3, at what depth will the fluid flash to steam? Assume that the well pipe walls have a roughness of 45 microns, that the diameter of the well hole is 20 cm, and that the absolute viscosity of water is under reservoir conditions is 1.22 x 10^{-4} Pa.s. The pressure at the top of the well hole is 3.8 MPa.

7. What factors determine the sustainability of a geothermal resource? What operational strategies can be employed to enhance the sustainability?

8a. What is an Organic Rankine cycle? Why are the environmental benefits of such systems?

8b. What is the approximate minimum temperature for a useful geothermal power generation system that employs a binary technology? Why are binary technologies necessary in these cases?