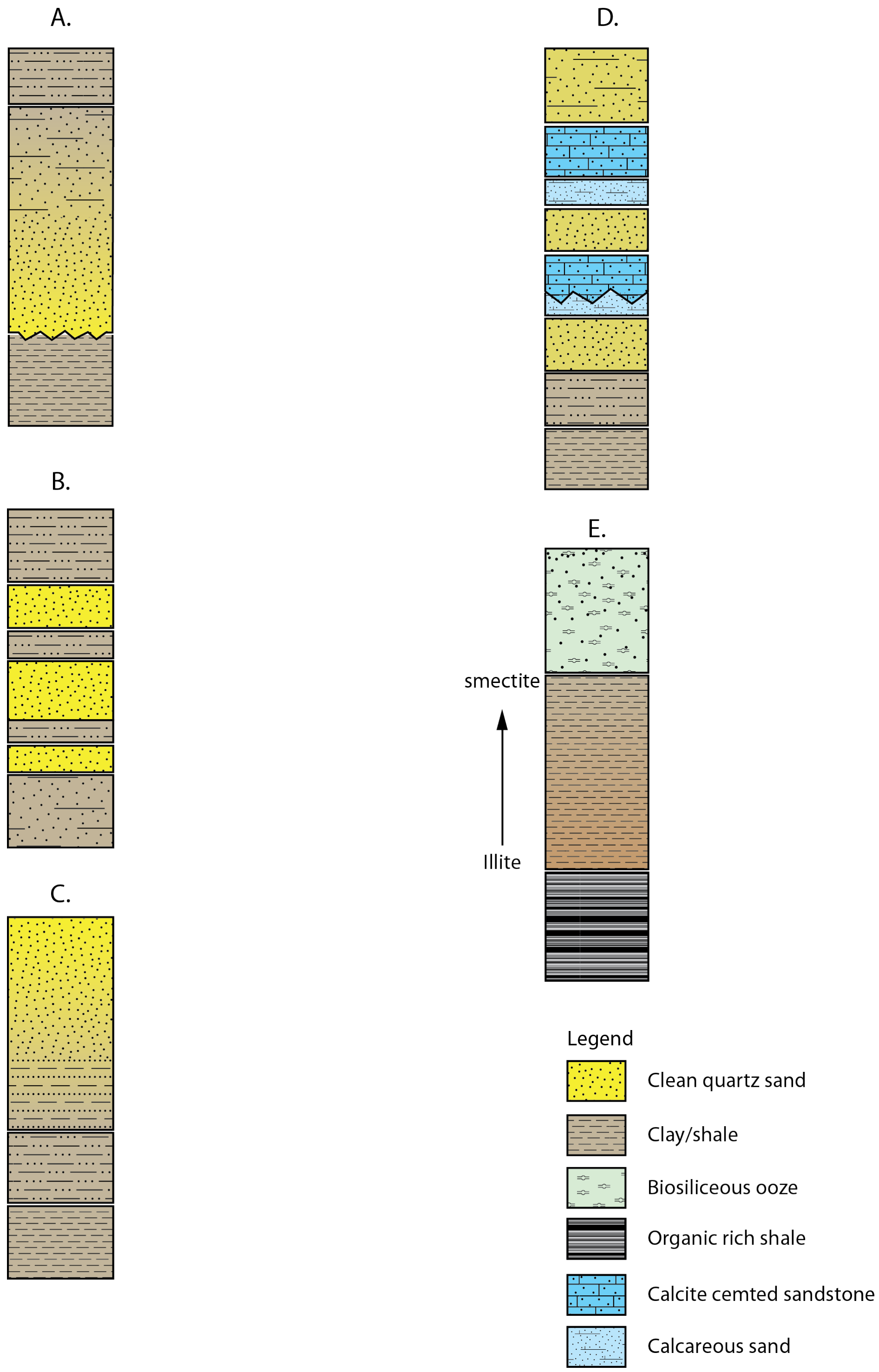
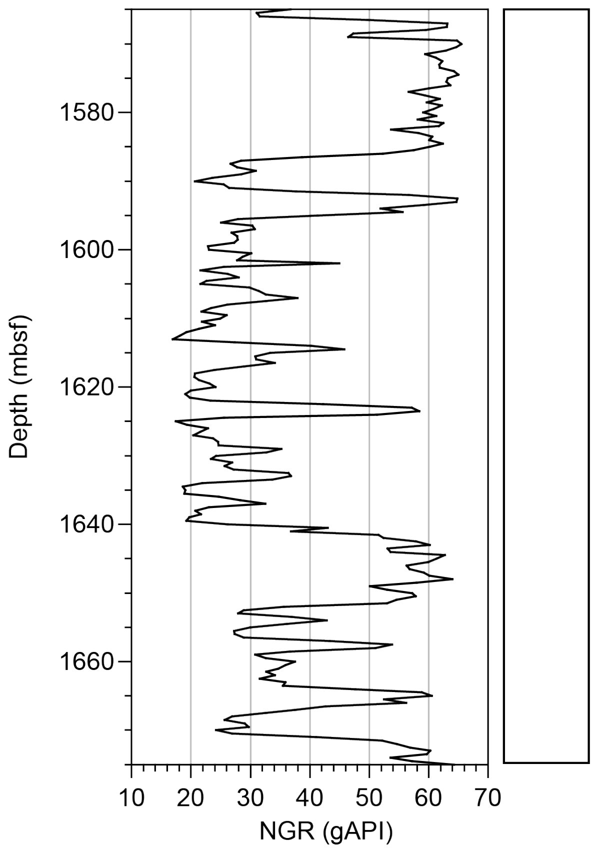
Problem Set Lecture 5: Natural Gamma Ray

1. Draw the NGR profile (gAPI) you would expect alongside the stratigraphic sections shown below.



2. This gamnma-ray log is from a reservoir sandstone. It crosses intervals of pure shale and sandstone.

   A Draw the sand and shale line on the figure, and sketch a lithologic column on the right.

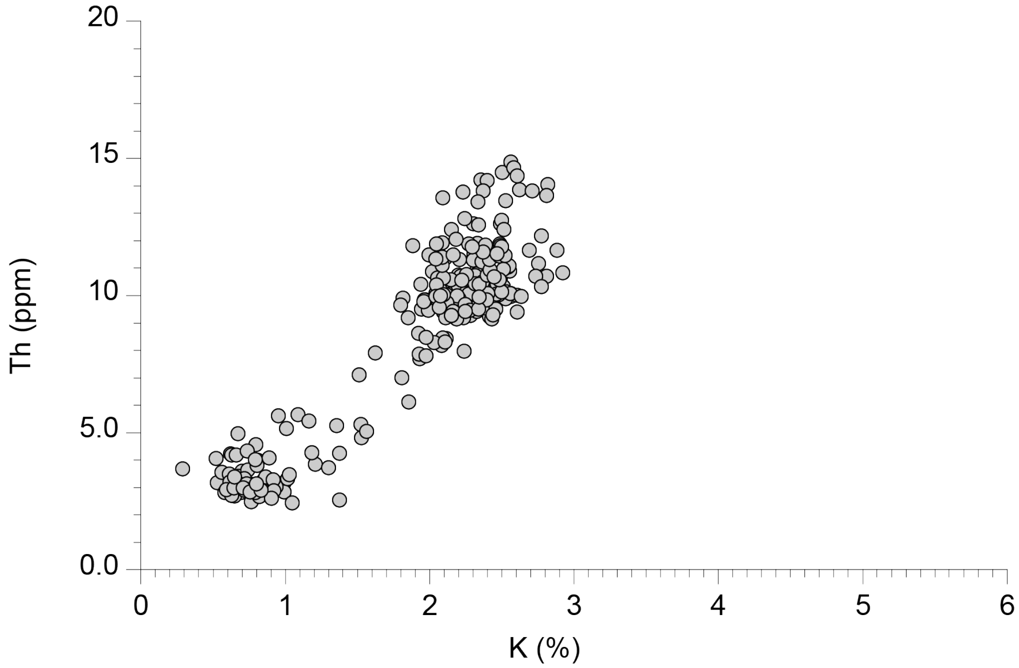


   B. Calculate the shale volume (V_{sh}) in the intervals given in the table below.

Depth	NGR (gAPI)	Vsh
1570	65.5	
1583.5	60.6	
1596.5	30.3	
1613	16.9	
1614.5	45.7	
1627	20.4	
1628	24.5	
1660	37.5	
1674	54.6	

   C. Why can Thorium concentrations from spectral gamma ray logs provide better estimates of the shale volume?

3. Spectral gamma ray data is often used to assess clay mineral variations in a sequence. However, as the textbook discusses, there is no solid framework for these interpretations. Below is a crossplot of K and Th abundances from a borehole in the Arctic Ocean.



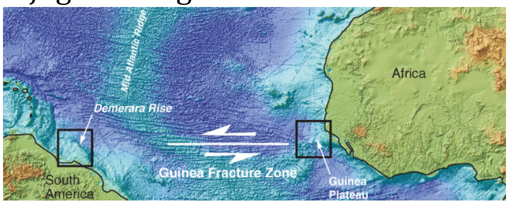
   A. Using figure 8.38 in the textbook as a reference, draw on the lines separating heavy-thorium bearing minerals, chlorite, montmorillonite. Illite, micas and the feldspar line.

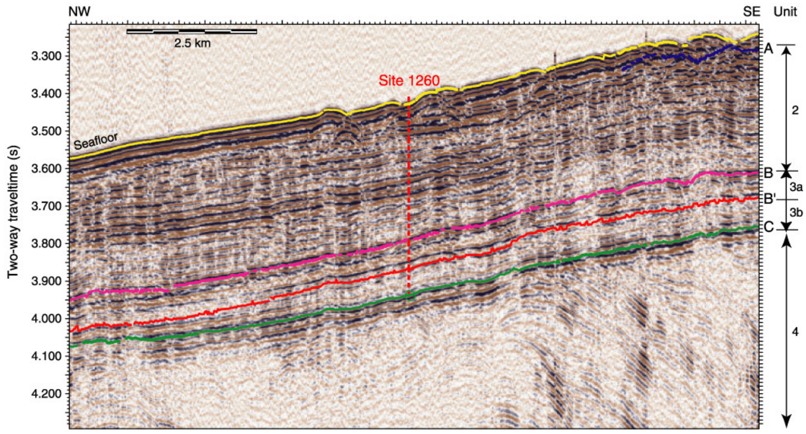
   B. What is the dominant mineralogy of these sediments according the Quirein et al. (1982) scheme?

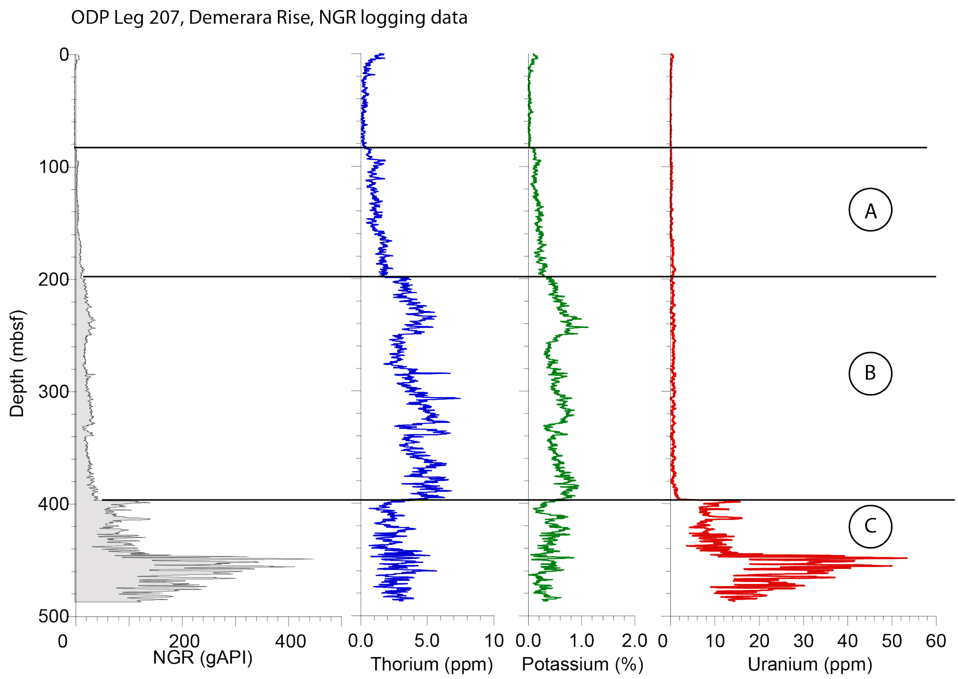
   C. Below is a table of K, U, and Th concentrations of different minerals and rock types (adapted from Schön, J. H., 2004, *Physical Properties of rocks, Fundamentals and Principles of Petrophysics*). Add this data to the figure above, and comment on whether it supports the interpretation or not.

Mineral/Rock	K (%)	Th (ppm)	U (ppm)
Continental crust	2.6	10	2.8
Oceanic crust	0.87	2.8	0.64
Montmorillonite	0-4.9	10-24	2-5
Kaolinite	0-0.6	6-19	1.5-3
Illite	3.5-8.3	10-25	1.5
Chlorite	0-0.3.5	3-5	-
Biotite	6.2-10.1	0.5-50	1-40

4. Ocean Drilling Program Leg 207 visited Demerara Rise, part of the south American continental crust that is a conjugate margin of the Guinea Plateau, separated during the opening of the Atlantic Ocean. Site 1260 was drilled to a late Cretaceous regional seismic reflector (*C*). Using the total counts from the NGR, and the spectral estimates of Th, K and U abundances, compare and describe the possible lithologies in the 3 sections shown on the figure below. Cenozoic sediments in this region are dominated by biogenic (calcareous and siliceous) components.







5. A detailed image of section C (*question 5*) is provided below. It includes resistivity and bulk density measurements. Provide a lithologic explanation for the high frequency cyclic variations through this interval.