GEOS3102: Global Energy & Resources Labs

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Lab Overview

	Exercises	Weight	Due Date	Submission
Lab 1 (Week 8)	Intro to Global Petroleum Resources and iPython	10%	Thursday May 11 @ 9am	Madsen Dropbox
Lab 2 (Week 9)	Badlands	15%	Thursday May 18 @ 9am	Madsen Dropbox
Lab 3 (Week 10)	Seismic Reflection Surveys	15%	Thursday May 25 @ 9am	Madsen Dropbox
Lab 4 (Week 11)	Well Log Analysis	15%	Thursday June 1 @ 9am	Madsen Dropbox
Lab 5 (Week 12)	Arafura Basin Petroleum Systems	15%	Thursday June 8 @ 9am	Madsen Dropbox
Lab 6 (Week 13)	Tectonic Subsidence and Arafura Basin Report	30%	Thursday June 15 @ 9am	Email amy.ianson@sydney.edu.au

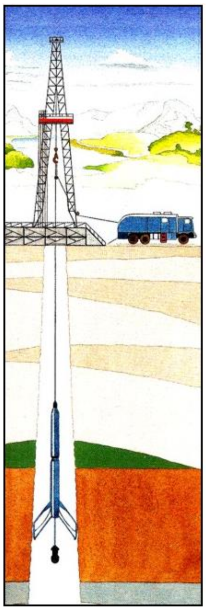
Each week a paper copy of the exercise will be provided for you. Please write neatly and clearly, messy and illegible reports will not be marked. You are also welcome to complete the exercise in the pdf available online. Remember to attach relevant maps and data.

Exercises are shown in grey boxes, answer in the space provided or attach your answer to the lab sheet.

Your assignment is due Thursday the following week at 9am! 10% will be deducted per day late.

Please note: You do not need to include your script for iPython practicals unless a question states "**Include your script**" in which case you only need to include the relevant portion of your script (please do not waste paper and print the entire script).

Lab 4: Well Log Analysis



Well logging is the process of recording various physical, chemical, electrical, or other properties of the rock/fluid mixtures penetrated by drilling a borehole into the earth's crust.

In its most usual form, an oil well log is a record displayed on a graph with the measured physical property of the rock on one axis and depth (distance from a near-surface reference) on the other axis. More than one property may be displayed on the same graph. Well logs are recorded in nearly all oil and gas wells and in many mineral and geothermal exploration and development wells. Although useful in evaluating water wells, few are run for this purpose. Well logs provide insight into the formations and conditions in the subsurface, aimed primarily at detection and evaluation of possibly productive horizons.

The wireline logging operation showing logging truck (right), logging cable strung into the rig, then lowered into the borehole, with logging tools at the end of the cable. Logs are usually recorded while being pulled upward by the winch in the logging truck.

There are three general types of wireline logs;

- Electrical e.g. Spontaneous Potential, Resistivity
- Nuclear e.g. Gamma Ray, Density, Neutron
- Acoustic / Sonic e.g. Transit time

These logs are used for;

- Correlation of zones and stratigraphy across large distances
- Depth of formations and their thicknesses
- Definition of rock properties
    - Lithology
    - Porosity and Permeability
    - Saturation of Oil, Gas, Water
- Determine facies relationships
- Petrophysical Analysis

Rock properties that affect logging measurements include;

- Porosity
- Lithology
- Mineralogy
- Permeability
- Water Saturation
- Resistivity

Because few of these things can be directly measured, wireline logging and interpretation is extremely valuable.

Lab 4 Exercises

NAME: ________________________________ SID: ________________________________

In this lab we will use the wireline logs from the Walakpa 1 (WA1) Well in the National Petroleum Reserve of Alaska. First we will display all the logs in three 'log tracks'. The triple combo display will consist of:

- First track: GR, SP, CALI (Gamma Ray, Spontaneous and Caliper)

- Second track: Resistivities (Various Long and Short Spaced Resistivity Logs)

- Third Track: Density, Sonic and Neutron Porosity Log

> *Q1. Before we begin the lab, we must understand what each of these logs is measuring. Research what each of the following wireline logs measure, the first few have been done for you.* ***http://wiki.aapg.org/Quick-look_lithology_from_logs*** *is a good place to start*

Log	**Unit**	**Explanation**
GR (Gamma Ray)	API	The radioactivity of rocks has been used for many years to help derive lithologies. Natural occurring radioactive materials include the elements uranium, thorium, potassium, radium, and radon, along with the minerals that contain them. Generally higher GR is associated with shales and Lower GR is associated with cleaner sands – however there are plenty of lithology's in the middle so we have to be careful and rely on multiple logs to derive lithology
Spontaneous Log (SP)	mV	The SP curve is a continuous recording vs. depth of the electrical potential difference between a movable electrode in the borehole and a surface electrode. Adjacent to shales, SP readings usually define a straight line known as the shale baseline. Next to permeable formations, the curve departs from the shale baseline
Caliper Log (CALI)	Inches or cm	A recording of the diameter changes in a well made by a tool with mechanical arms that touch the wellbore or a sonic signal bouncing off the borehole wall.
Resistivity Logs (ILD)		
Density Log (RHOB)		
Sonic Log (DT)		
Neutron Porosity Log (NPHI)		

Q2. Plot the formation tops on the well log. Interpret the top of the Pebble Shale and Walakpa Sandstone. Justify the depths you chose based on the Gamma Ray log response and one other log of your choice. Include your image as an appendix.

Formation Name	**Top Depth (ft)**
Pebble Shale	
Walakpa SS	
J-Klingak	2100
Barrow SS	2990
Klingak SH	3102
T-Sag River SS	3324
Shublik	3258
Basement	3633

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Petrophysics is the study of the physical and chemical properties of rocks and their contained fluids. It emphasizes those properties relating to the pore system and its fluid distribution and flow characteristics. A ZONE for petrophysical analysis will be selected from the entire log. Let's display again the logs within the chosen interval with triple_combo_plot function. We are interested in the Barrow Sandstone interval.

Q3. Display the Barrow SS interval on the log. What first pass interpretation can you make from the shape of the gamma ray log (check out http://wiki.aapg.org/Quick-look_lithology_from_logs if you are unsure)

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In petrophysical analysis, shale volume is one of the key answers used later to correct porosity and water saturation for the effects of clay bound water. Clay corrections are applied to porosity logs to determine effective porosity. Since clays contain water, this water must be subtracted from the total porosity as measured by conventional logging tools. There are many methods for determining the volume of clay from well logs.

We will compare the volume of clay derived from three methods, GR, SP and Resistivity.

> *Q4. Run the script to calculate shale volume. You need to input the GR and SP values for clean sand and clay, respectively. Set these at 40, 135API and -60,2mV. Check these values on your plot from Q3. Compare the Volume of Clay derived from each of the methods (VCL logs)*

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Neutron and density logs each react to both lithology and porosity, so by analysing the two logs together, one can begin to distinguish lithology from porosity.

> *Q5. Run the script to calculate porosity from the neutron density logs. From the plot, what can you say about the porosity of the units?*

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Water saturation is the ratio of water volume to pore volume. Water bound to the shale is not included, so shale corrections must be performed if shale is present. We calculate water saturation from the effective porosity and the resistivity log using Archie's equation.

> *Q6. Set a = 1, m = 1.8 and n =2 in the Archie equation. Run the script to calculate water saturation and therefore effective porosity. Include your final interpretation plot as an appendix. Which interval(s) would potentially be the best reservoirs? Which would be the worst? Why? Label these on your plot and explain your answers below.*

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