**Finding Oil Lab**

**Goal:**

The goal of this lab is to practice being a geologist.

Your group is a team of geologists from the consulting firm KGS (Kearney Geological Solutions) hired by BP to find likely oil reserves in the Gulf of Mexico. You will use simulated seismological data from that region, and your knowledge of how oil forms, to recommend a location for your client to drill.

**Part 1:**

You will be given a set of data taken by the KGS field team. They have conducted a seismic survey and processed the data to calculate the speed of sound in various layers of rock.

**Your job:** Calculate the density of the rock at each grid point.

To do this, you need to know how to convert the speed of sound at that grid point to the density at that grid point. Luckily, you know the following:

|  |  |  |
| --- | --- | --- |
|  | **Speed of Sound (m/s)** | **Density (kg/m3)** |
| **Air** | 325 | 1.316 |
| **Water** | 1600 | 1000 |
| **Coal** | 2133 | 1300 |
| **Shale** | 4800 | 2800 |

**Table 1:** *Speed of sound and density for various materials. Shale is a typical “cap rock” and is impermeable to oil and natural gas.*

**Do the following:**

* Plot the speed of sound vs. the density of these materials to find a linear fit. (A “linear fit” is a fancy way to say “draw a straight line through your data points”).
* Using your linear model (that line you just drew), find the density for the following sound speeds:

|  |  |
| --- | --- |
| **Speed of Sound (m/s)** | **Density (kg/m3)** |
| 1500 |   |
| 1600 |   |
| 1700 |   |
| 1800 |   |
| 1900 |   |
| 2000 |   |
| … |   |
| 2500 |   |
| 3000 |   |
| 3500 |   |
| 4000 |   |
| 4500 |   |
| … |   |
| 4600 |   |
| 4700 |   |
| 4800 |   |

**Table 2:** *Sound speed to density conversion worksheet.*

**Part 2:**

Now you are ready to convert the seismic raw data to a meaningful map, which might show where oil has formed and is trapped.

**Your job:** Using the worksheet you just created from the relation between sound speed and density, (Table 2), and also the seismic results from your field team, create four map cross-sections of the exploration region (one for each depth). The maps should show areas where there is dense rock (like a capping stone) and areas where the density is low (like where there is oil). Color areas that are less dense in warm colors, and areas that are more dense in cold colors like the colorbar below.



**More Dense** -------------------------------------------------------- **Less Dense**

Keeping in mind that crude oil density is roughly 900 kg/m3. Outline in RED on each map where you think oil might be located.

Now outline in BLACK where you think there might be rock dense enough to be a capping stone. Keep in mind that shale is a typical capping stone.

**Part 3 (Homework):**

With these cross sections of rock density, you now have enough information to make a proposal to BP about where to drill. Your project manager will write the final report to BP (likely a 100 page document containing detailed images of the proposed site, as well as information on optimal drilling angles, depths, speeds, type of rock and many other important details.)

**Your job:** As the geologists at KGS, you need to write an internal memo to your project manager, providing the essential details needed to draft the full report.

Be sure to include:

* Information regarding the methods used to make your recommendation.
* The location or grid square(s) where you propose to drill
* Why you propose that location
* The depth required to drill to reach the reservoir
* The densities and depths of the rock BP will need to drill through.

Internal memos are usually only about 1 page and are intended to convey detailed information in the most clear and concise way possible. Please make use of the KGS publications department (your English teacher) for assistance.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
|  1 | 3000 | 3000 | 3500 | 4500 | 4000 |
| 2 | 3000 | 3000 | 3500 | 4000 | 4000 |
| 3 | 3000 | 3500 | 3500 | 4000 | 3500 |
| 4 | 3000 | 3000 | 3000 | 3500 | 3500 |
| 5 | 2000 | 2000 | 2000 | 3000 | 3000 |

**Sound Speed at 500m (m/s)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
|  1 | 3000 | 3500 | 4000 | 4700 | 4800 |
| 2 | 3000 | 3500 | 4000 | 4800 | 4600 |
| 3 | 3000 | 3500 | 4000 | 4000 | 4000 |
| 4 | 3000 | 3500 | 3500 | 3500 | 3500 |
| 5 | 2000 | 3000 | 3000 | 3000 | 3000 |

**Sound Speed at 1000m (m/s)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
|  1 | 3500 | 3500 | 1700 | 1700 | 1700 |
| 2 | 3000 | 3500 | 1700 | 1500 | 1700 |
| 3 | 2000 | 2500 | 1500 | 1500 | 1600 |
| 4 | 2000 | 2000 | 1500 | 2000 | 2000 |
| 5 | 2000 | 2000 | 1500 | 3000 | 3000 |

**Sound Speed at 1500m (m/s)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
|  1 | 3000 | 3600 | 3600 | 3000 | 3000 |
| 2 | 3000 | 3600 | 3500 | 2000 | 2500 |
| 3 | 3000 | 3500 | 3000 | 2500 | 3000 |
| 4 | 3000 | 3000 | 3000 | 3000 | 3000 |
| 5 | 3000 | 3000 | 2500 | 3000 | 3000 |

**Sound Speed at 2000m (m/s)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
|  1 | 1700 | 1700 | 2000 | 2800 | 2500 |
| 2 | 1700 | 1700 | 2000 | 2500 | 2500 |
| 3 | 1700 | 2000 | 2000 | 2500 | 2000 |
| 4 | 1700 | 1700 | 1700 | 2000 | 2000 |
| 5 | 1200 | 1200 | 1200 | 1700 | 1700 |

**Density at 500m (kg/m3)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
|  1 | 1700 | 2000 | 2500 | 3400 | 3700 |
| 2 | 1700 | 2000 | 2500 | 3700 | 3110 |
| 3 | 1700 | 2000 | 2500 | 2500 | 2500 |
| 4 | 1700 | 2000 | 2000 | 2000 | 2000 |
| 5 | 1200 | 1700 | 1700 | 1700 | 1700 |

**Density at 1000m (kg/m3)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
|  1 | 2000 | 2000 | 1100 | 1100 | 1100 |
| 2 | 1700 | 2000 | 1100 | 90 | 1100 |
| 3 | 1200 | 1500 | 90 | 90 | 1000 |
| 4 | 1200 | 1200 | 90 | 1200 | 1200 |
| 5 | 1200 | 1200 | 90 | 1100 | 1700 |

**Density at 1500m (kg/m3)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E |
|  1 | 1700 | 2050 | 2050 | 1700 | 1700 |
| 2 | 1700 | 2050 | 2000 | 1200 | 1500 |
| 3 | 1700 | 2000 | 1700 | 1500 | 1700 |
| 4 | 1700 | 1700 | 1700 | 1700 | 1700 |
| 5 | 1700 | 1700 | 1500 | 1700 | 1700 |

**Density at 2000m (kg/m3)**