Scripting for Sensitivity

The objective of this exercise is to see how we can use scripting to evaluate the sensitivity of certain logs on Earth Model properties and how to apply that knowledge. For example how a resistivity simulation may depend on layer thickness and how we could use that for an inversion script.

Scripting General

1. When starting the Matlab Based (MB) version of UTAPWeLS there will be 2 variables.
    a. sessionObj: The main utapwels object which must exist while UTAPWeLS is running.
    b. utapCSF: An Initial CSF object (i.e. the current project)
        i. This object will change each time a new project is loaded
        ii. It represents the current Common Stratigraphic Framework, which is essentially the current project.
2. These objects give access to all of UTAPWeLS. You can see what they contain by just entering them in the console window or by entering them with a '.tab' which will display all properties and functions available. For example:

```
>> sessionObj = utapCSF

sessionObj =

  UTAPWeLS with properties:

            UserPreferences: [1×1 struct]
                       rCSF: [1×1 CSF]
        CurrentProjectPath: 'D:\UTAPWeLSprojects\Consort2021NMRDemo\Sensitivity\20210805_sen
         UTAPWeLS_CodePath: 'D:\repos\UTAPWeLS_code\UTAPWeLS_MB\m\Admin\@UTAPWeLS\UTAPWeLS'
      UTAPWeLS_AppDataPath: 'C:\Users\klappauf\AppData\Local\UTAPWeLS'
    UserPreferencesFilePath: 'C:\Users\klappauf\AppData\Local\UTAPWeLS\userPreferences.mat'
                    Version: 5
                ReleaseDate: [2015 7 22]
      Help_WindowDisplayOn: 0
```

Then from this you can get the CSF even if it changes and see the functions with '.tab'

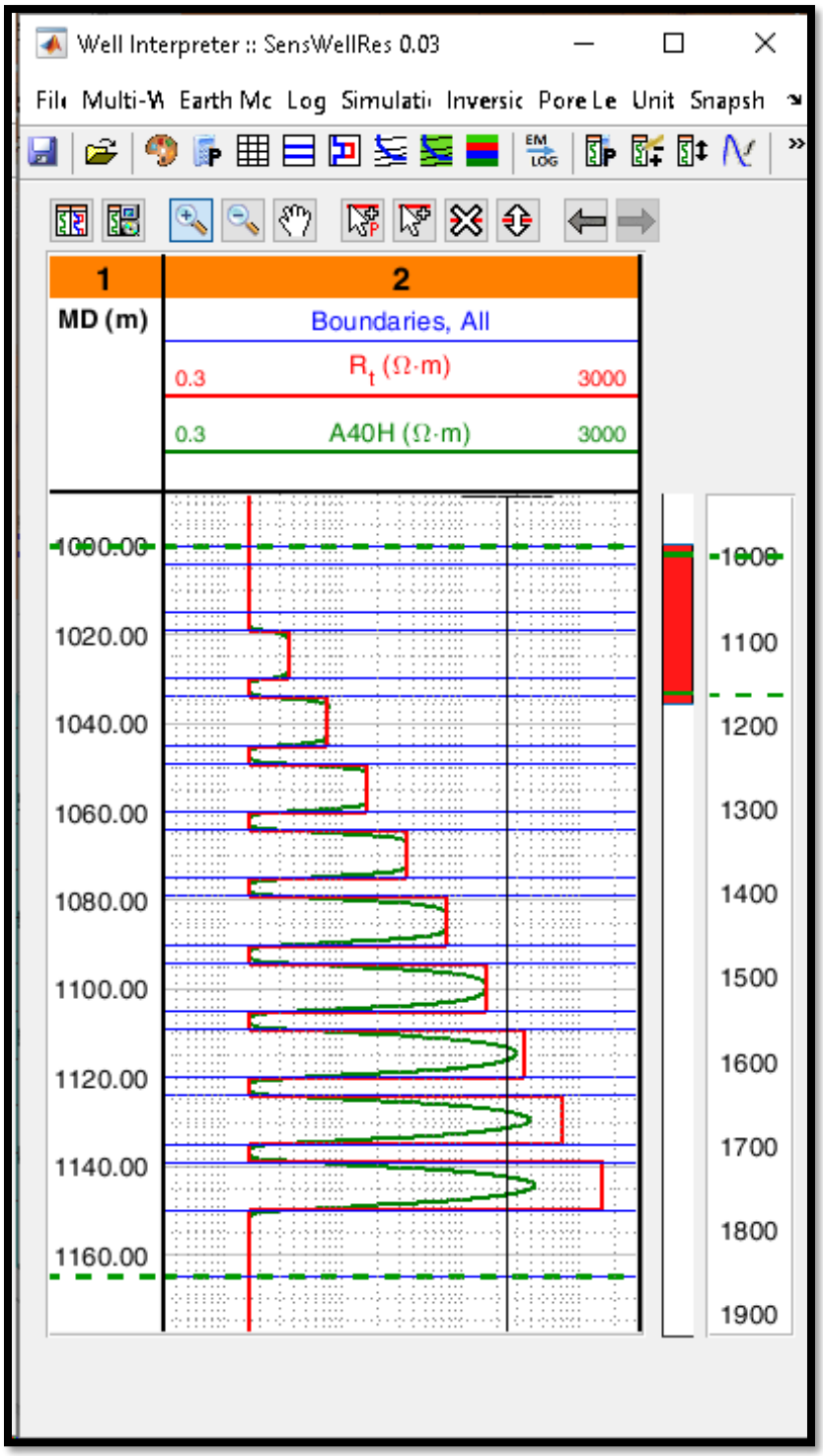
```
>> sessionObj.rCSF.
```

a_SonicTools
a_Surfaces
a_Wells
addNewSonicTool
addNewSurface
addNewWell
copySurface
delete

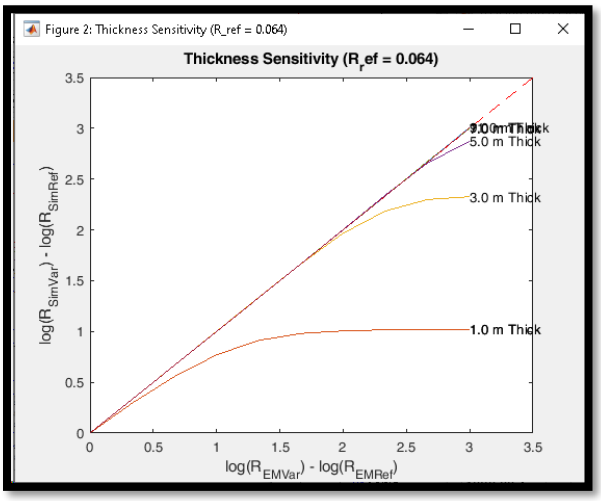
Then from the CSF you can get the wells and the logs as we will see in the example.

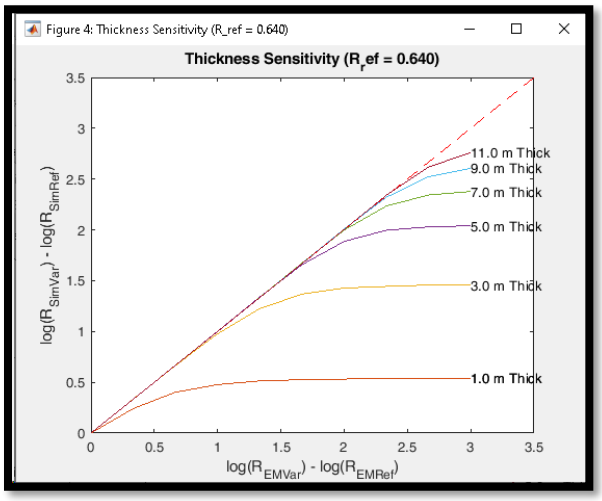
Resistivity Sensitivity Script

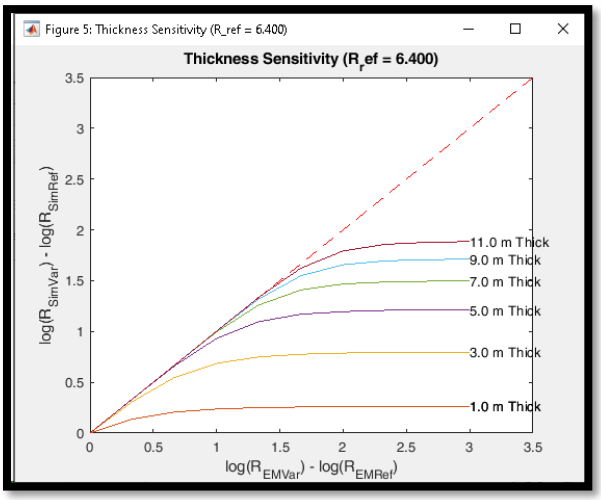
3. In this step we will use the script (a function in this case), “ThicknessSensitivityForRes.m”. We will review how we can use this function to plot the sensitivity of a Resistivity Simulation to the layer thickness.
4. Go over it once to see how it works, and then run it once using Rw of 0.1

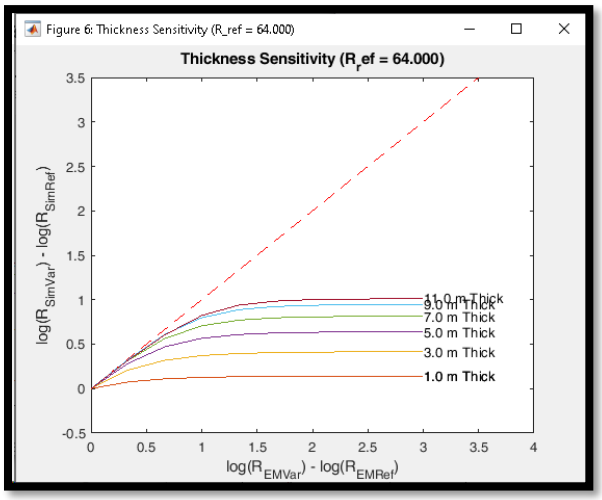


5. Now in the console run the function in a loop that will make plots for [0.001, 0.01, 0.1, 1].
    a. They should look like the plots below









6. What can you say about the sensitivity of simulated resistivity to the Earth Model resistivity as the layer thickness changes
    a. Do you know of a physical reason for this behavior.
    b. Can you quantify it further
7. What lines would you have to change to look at the absolute resistivity vs the difference.
    a. (Hint: the lines are already there)
8. What impact will this have on our inversion of thin layer models with large resistivity variation
    a. Do you expect to have large or small error bars.

Inversion Script

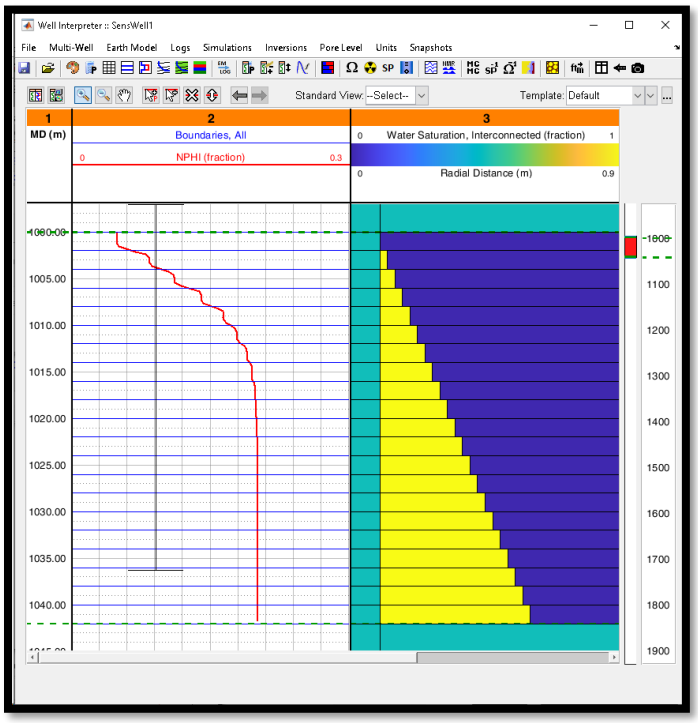
Write your own simple script to invert a set of Earth Model layer resistivity to match a log (similar to what the MCMC inversion does but with a simpler algorithm)

1. Prepare an Earth Model with a synthetic resistivity log
    a. Make and earth model with some thick and some thin layered sections.
    b. Manually set the Earth Model resistivities to whatever you find interesting.
    c. Save this Earth Model as a log for reference.
    d. Select a resistivity simulator that does not take too long to run.
    e. Run this to create a synthetic log and rename so it will not be overwritten by future simulations.
    f. Reset the Earth Model resistivity to a constant value and plot the following in a track:
        i. The current earth model resistivity
        ii. The Earth Model resistivity log that you saved
        iii. The synthetic resistivity log you created with the simulator.
2. Now write a script or function that will read the synthetic log and iteratively update the earth model resistivities so that a new simulation will approximately match the synthetic log.
    a. Can you match the original Earth Model exactly?
    b. If not which layers have the biggest problems.
    c. Can you use the sensitivity analysis done above to improve your results (or at least explain them)

Depth of Investigation Script

Write your own simple script to analyze the depth of investigation of a Nuclear Simulation. NOTE: You can modify a copy of the sensitivity script.

1. Find the depth of investigation of the neutron simulation by creating a model that varies the first radial zone over a set of thick layers (thick enough for the center to not see boundary effects), and recording the center values as a function of the first zone thickness



2. Compare WL to LWD