Practical 1 – Viscosity, crystallization orders, mantle melting

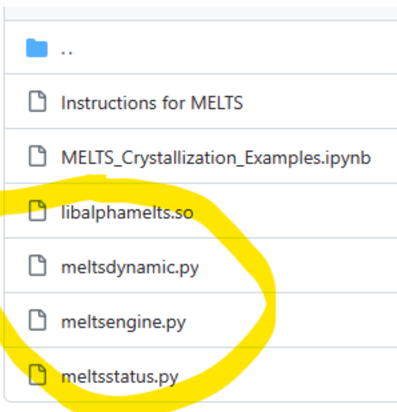
This practical requires you to use Google Colab (if you think you are going to want to use MELTS a lot, I can help you get a local installation, but we are hoping very soon that Paula A at Caltech will have sussed out a way for you to pip install, so it'll get significantly easier in a few months!).

Instructions to follow before class to ensure it is working (you might have to do step again in class if you do days before and it refreshes).

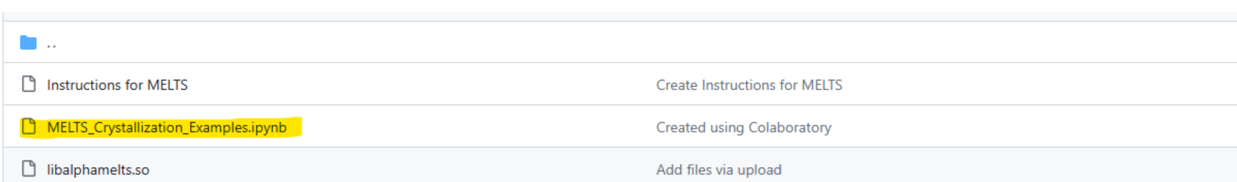
Step 1 - Go here

[EPS-214-Spring-2024/MELTS at main · PennyWieser/EPS-214-Spring-2024 (github.com)]

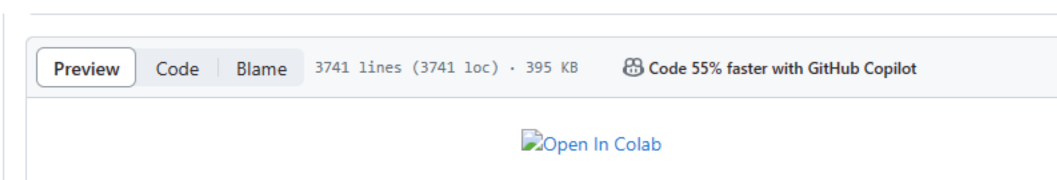
Download these files and put them in your downloads or somewhere sensible (you will use them soon)



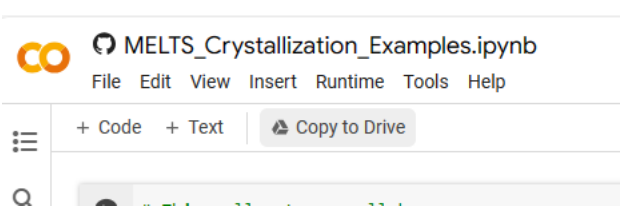
Step 3 - Click this file



Step 4 - Click open in Collab



Step 5 – Click 'Copy to Drive' - This makes a local copy you can edit as you want



Step 6 - In the version in your drive, Run the first cell – this sets up your workspace.

Step 7 – Now upload the 4 files you downloaded from github

Choose Files No file chosen

Run down to here and check it gives you an output

2a - lets find the liquidus for a given compositions

```
Liq=M.findLiq_multi(Model='MELTSv1.0.2', bulk=basalt, T_initial_C=np.array([1200]), P_bar=np.array([5000]),
                    H2O_Liq=0, fO2_buffer=None)
Liq
```

...

--- That's it for homework! We will do the rest in class! -------

Part 1 – What affects viscosity

We are using the Giordano et al. Viscosity model in the python package Thermobar to calculate viscosity.

1a. What is the viscosity of the basaltic composition at 1150C with 0 wt% H2O?

1b. Now increase the water content to 3 wt%. How much does viscosity change?

1c. Now of course, adding water means in reality, the temperature has probably gone down (if you have any crystals around). The liquidus temperature decreases by ~10°C per 1 wt% water added (Putirka, 2008). So now run the calculation again, but adjusting the temperature to account for this. Does decreasing temp cancel out adding water?

1d. Now perform the calculation for the rhyolite, with no water initially

1e. What temperature and/or water contents do you need to get the viscosity back to the 100s of PaS like the basalt? Is this at all plausible?

Part 2 – Calculating melt liquidus temperatures

2a – What is the liquidus temperature and liquidus phase for the basaltic bulk composition with no H2O at 1000 bars?

2b – Now try the same for the rhyolite

2c – How does the liquidus phase change as you change the water content or pressure for the basalt? What traditional petrological diagram could be used to visualize this?

2d –lets use the equilibrate_multi function to look at what phases are present 60 degrees below the liquids you calculated.

2e –Lets calculate the viscosity for this system now!

Part 3 – Lets investigate how phase stability and liquid lines of descent change as a function of H2O content.

We are going to be using the isobaric_crystallization function, Lets run at 0.5, 2, 4 wt % water at 2 kbar.

How does the water content affect the trend you follow on this diagram?

What phases allow you to move up and down the y axis? What phases allow you to move right on the x axis.