**Step1\_understand benchmark**

Create new benchmark directory

Copy new ogs.exe and cmd.exe into directory for ease

Copy T only benchmark (t-tri) in 2D, run and understand benchmark

Alter output to domain, check time dependent results make sense

**Step 2 create own model**

Create new modelling directory

Copy t-tri into new model (J1) directory, apart from \*.msh and \*.gli

Copy J1.msh and J1.gli into directory

run and check functionality//debug

🡪Time control

🡪Match GLI file names with all calls in models

* \*.bc
* \*.out
* \*.st

debug

* \*.tim -> end time set at 1 second, only one step ran, correct

First successful simulation, heat distribution looks odd ->GINA graphic display challenged, use PARAVIEW

Include vtk file output in \*.out file

Reduce time step size, but aware this is incorrect value as material parameters are not correct presently.

Rerun

->realistic results

Change mmp and msp file to sensible rock mass parameters

->Somebody need a good slapping, the input syntax for the HEAT only model in the msp file is missing control “$” signals, but with control signals it doesn’t work properly. Work around is maintain without control sugnals.

->With realistic parameters in place, time needs to be increased.

18 x 10 days ->180 days heating

->Realisitc results

**Step 3 cyclical heating and cooling**

Alter source term file for cyclical heating using a CURVE

Amend rfd file for curve,

->starting to get cool results

Extend to 2.5 years

->Even cooler results

**Step4 Cyclical T boundaries**

Alter bc file to include cyclical boundary conditions based on constant temperatures

Bc set at 10C, Include second curve 2 so bc is from 10C to 20C

Remove source term (j1.\_st) ..including underscore removes term.

Just for interest include one of the extra stall in the bc file for heating and cooling

Make mesh xz, not xy (use executable)

->rename j1.msh .. in.msh

->double click 2D.exe

->rename out.msh j1.msh

->manually alter j1.gli so points are xz, (sorry, not programmed yet) use excel.

->check number accuracy in excel, more decimal points than numbers

->Point counter is integer

->replace into the gli file, remove tabs with search and replace

Check in GINA that you can see mesh and polylines in xz axis

->seems to be a problem with the last four points in the gli repeated, and linked to the last polyline

->delete last four points and polyline in gli file manually if causing an issue

Apply gradient for initial temperature conditions in \*.ic file

GRADIENT 179 7 0.026896552

In this case , at height 179 a temperature of 7C has been set, with a change of temperature of 0.026896552 every m

->simulate to check

->increased the temperature of the mines to 15C and 30C to see effect better against temperature gradient

**Step\_5\_waterfill**

Using the ability to set subdomains in OGS, we instantaneously fill the mines with water at 30C, and then leave the water to heat the rock up for 180 days

To do this

->in the geo file, include the mine area as a separate material group. Then remesh. Remember to convert to xz coordinates.

In the \*.ic file, include subdomain command and give value

In the \*.bc file, remove the edge of the mine as a boundary, include top of model as a boundary (or elsewhere as appropriate

->I have given the \*.msp properties of them ine fill to be water, and applied an artificially high heat conductivity value to allow some mixing. Usually this would be 0.6w/m, I have set it at 230w/m, being 100 times higher than the rock

Checking stability indicated the time step was a bit long, changed this to 1 day, then allowed 180 days for simulation, but asked only for every 10th step in output file (STEPS 10)

To facilitate the question what happens if we remove all the heated water from the mines after 180 days with cold water, created a restart file after 180 days to use in next simulation.

**Step 6 remove warm water, refill with cold**

\*\*USE new ogs.exe\*\* compiled 6\_05\_2020, necessary to rewrite part of the ogs.exe code to prevent an overwrite of ic.

Reload the heat solution from previous model

Use subdomain command in \*.ic file to overwrite solution for water in mine

Allow model to simulate again 180 days

**Calculate the amount of energy entering or leaving the system**

**Step 7 flux\_across\_polyline**

Check out the output file \*.out

Inclusion of

$DATATYPE

TOTAL\_FLUX

Produces a text file

HEAT\_TRANSPORT\_POLYLINENAME\_TOTAL\_FLUX.txt

This is a balanced nodal flux along the length of the POLYLINE you set it over in the out file.

This is a new function I have integrated, there may be some “further features”. Step 7 models indicates how it is used.

The output is

TIME FACE NORMAL FICK FLUX (J/s) TOTAL FICK FLUX (J/s)

Time is the time step

Face Normal Fick Flux, is the heat diffusive flux normal to the polyline edge

Total Fick Flux, is the magnitude of the flux vector across the polyline

The model “Step7\_flux\_across\_polyline” will show you the difference between these outputs. Calculate for yourself the heat gradient and expected flux. Calcaulte the normal to the face flux and the magnitude of the flux.

**Step 7\_comparison\_heating**

Compare flux to temperature change in a domain

Check out the output file \*.out

Inclusion of

$DAT\_TYPE

ENERGY

This uses the temperature in each material group to calculate the energy at any time step in that material group.

It produces a file

Model\_Name ENERGY\_PER\_MATERIALGROUP.txt

Then per time step a listing of the material groups and the total amount of energy in each material group. Using the

$DATATYPE

TOTAL\_FLUX

$DATATYPE

ENERGY

the Model Step 7\_comparison\_heating allows a comparison of the similarity of the results of flux entering a material group and the overall energy change. The model is run, the results compared in the excel file included in the directory.

**Step 8**

Looking at the flux across the boundary in the mine model. Beware that the normal flux will be negative in some places due to orientation, but the magnitude of the flux vector will always be a positive scaler. That is why there will be a significant difference between the sum of these two across the polyline.