**Reservoir Model and Model Uncertainty Analysis for the Potential Deep Direct Use Geothermal on the West Virginia University Campus-Morgantown, WV**

The purpose of this document is to describe the contents of information contained within a submission to the Geothermal Data Repository (GDR) node of the National Geothermal Data System (NGDS) in support of Feasibility of Deep Direct-Use Geothermal on the West Virginia University Campus-Morgantown, WV.

**Abstract**: To reduce the geothermal exploration risk, a feasibility study is performed for a deep direct use system proposed at the West Virginia University (WVU) Morgantown campus. This study applies numerical simulations to investigate reservoir impedance and thermal production. Because of the great depth of the geothermal reservoir, few data are available to characterize reservoir features and properties. As a result, the study focuses on the following three aspects: 1. model choice for predicting reservoir impedance and thermal breakthrough: after investigating three potential models (one single permeability model and two dual permeability models) for flow through fractured rock, it is decided only the single permeability model is needed; 2. well placement (horizontal vs. vertical) options: horizontal well placement seems to be more robust to heterogeneity and the impedance is more acceptable; 3. Prediction uncertainty: the most influential parameters are identified using a First-Order-Second-Moment uncertainty propagation analysis, and the uncertain range of the model predictions is estimated by performing a Monte Carlo simulation. Heterogeneity has a large impact on the perdition, therefore, is considered in the predictive model and uncertainty analysis. The numerical model results and uncertainty analysis will be used for further economic studies. The dataset submitted here support the described study.

**Key Words**: Direct Use Geothermal, West Virginia University, Tuscarora Sandstone, reservoir flow model, permeability, matrix, fracture, uncertainty analysis.

**Citation**: When referencing this data, please use the following citation information:

**Title**: Modeling Study of Deep Direct Use Geothermal on the West Virginia University Campus-Morgantown, WV

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**Contents of Submission**:

**Description**: This dataset contains input/output model data used in the model study of the potential deep direct use geothermal on the West Virginia University Campus-Morgantown, WV, and data used in the model uncertainty analysis. The data and result figures are described in the final report (as well as a manuscript). Here we provide a brief description of each set of data:

**SingleK\_Figure3.zip**: contains input/output files for the base case single permeability with vertical well layout model analysis. Figure 3 and part of Figure 2 (the plot for single K) of the manuscript and final report is produced from the output data in this set. This set also contains the post-processing python file to extract data in 2D for plotting purpose.

iTOUGH2 input files: DDU0i, DDU0

iTOUGH2 Output files: DDU0\_eleme\*.tec

Python code to extract 2D: Get2dSlices.py

Plotting files: \*20y\*, \*40y\*, and \*60y\*, 2d slice plot for 20, 40 and 60yrs.

**DualK1.zip and DualK2.zip**: contain the input/output files for the two dual permeability with vertical well layout models described in the manuscript and final report. Part of Figure 2 (the two lines for dual K) the manuscript and final report is produced from the output data in this set.

ITOUGH2 input files: DDUi and DDU (DualK1.zip) and DDUi and DDU2 (DualK2.zip)

iTOUGH2 output files: DDUi.tec for time series (e.g. production temperature over time)

Other \*.tec are pressure temperature for the entire model domain at different times.

**Mtest\_Figure4&5.zip**: contains the input/output files of the Mtest case with vertical well layout described in the manuscript and final report. It also contains the result data files for Figures 4 and 5 in the manuscript and final report.

iTOUGH2 input files: DDUi and DDU3

iTOUGH2 outputs: \*.tec. ResultPlotting folder includes the files for plotting Figures 4 and 5.

**Figure6&7.zip**: contains the input/output files for the single K model with horizontal well layout described in the manuscript and final report. The results from this set of simulation appeared in the final report and manuscript Figure 6 and part of Figure 7.

iTOUGH2 input files: DDU0i, DDU1

iTOUGH2 output files: \*.tec. DDU0i.tec contains temperature over time

Figure7.zip: contains the input/output files for the single K heterogeneous model with horizontal well layout described in the manuscript and final report. The results are used to produce Figure 7.

iTOUGH2 inputs: Het2i and het2

iTOUGH2 outputs: perm.dat – permeability generated and used in permeability plot; het2i.tec contains temperature/pressure at injection/production well over time; other \*.tec files contain pressure/temperature of the entire model at different times. Plot folder contains 2D slice extraction code (\*.py) and 2D slice data files extracted.

**Fosim\_horizontal.zip**: contains input/output files for the FOSM analysis described in input/output files for the single K model with horizontal well layout described in the manuscript and final report. The results are summarized in Table 3.

iTOUGH input files: fosm3 and het

iTOUGH2 outputs: \*.tec for time series

**MC\_allPara2\_input.7z\_AppendixFigure8**: contains input files used in the Monte Carlo simulation analysis described in the manuscript and final report: heti\_all, het

**MC\_allPara2\_output.7z\_AppendixFigure8**: contains output files used in the Monte Carlo simulation analysis. Results are used in generating Figure 8 in the manuscript and final report.

iTOUGH2 direct output file is heti\_all.out. The middle part is extracted into OUTPUT file. Then a python code “stat.py” is used to summarize results into “plot.dat” for plotting.

**BaseCase\_run\_F9.zip, HighG\_run\_F9.zip, LowG\_run\_F9.zip**: contains input/output used in the initial temperature uncertainty analysis described in the manuscript and final report. Results are used in generating Figure 9. HighG represent high geothermal gradient case and LowG represents low geothermal gradient case.

iTOUGH2 input files: het2i, het, het2 and het3

iTOUGH2 outputs: het2i.tec from each folder for comparison.

**References**

Finsterle, S. (2004). Multiphase inverse modeling: review and iTOUGH2 applications. Vadose Zone Journal, 3 (2004), pp. 747-762