**About Appalachian Basin Temperature-Depth Maps and Structured Data**

**for “Feasibility of Direct District Heating for the Cornell Campus Utilizing Deep Geothermal Energy”**

 **Tier 2 Submission**

**DE-EE0008103, Earth Source Heat: A Cascaded Systems Approach to DDU of Geothermal Energy on the Cornell Campus**

The purpose of this document is to describe the contents contained within a submission to the Geothermal Data Repository (GDR) node of the National Geothermal Data System (NGDS) in support of Earth Source Heat: A Cascaded Systems Approach to DDU of Geothermal Energy on the Cornell Campus.

**Abstract**: This dataset contains shapefiles and rasters that summarize the results of a stochastic analysis of temperatures at depth in the Appalachian Basin states of New York, Pennsylvania, and West Virginia. This analysis provides an update to the temperature-at-depth maps provided in the Geothermal Play Fairway Analysis of the Appalachian Basin (GPFA-AB) Thermal Quality Analysis (GDR repository 879: <https://gdr.openei.org/submissions/879>). This dataset improves upon the GPFA-AB dataset by considering several additional uncertainties in the temperature-at-depth calculations, including geologic properties and thermal properties. A Monte Carlo analysis of these uncertain properties and the GPFA-AB estimated surface heat flow was used to predict temperatures at depth using a 1-D heat conduction model. In this data submission, temperatures are provided for depths from 1-5 km in 0.5 km increments. The mean, standard deviation, and selected quantiles of temperatures at these depths are provided as shapefiles with attribute tables that contain the data. Rasters are provided for the mean and standard deviation data. Figures and maps that summarize the data are also provided. For the pixel corresponding to Cornell University, Ithaca, NY, a .csv file containing the 10,000 temperature-depth profiles estimated from the Monte Carlo analysis is provided. These data are summarized in a figure containing violin plots that illustrate the probability of obtaining certain temperatures at depths below Cornell. Detailed descriptions of the contents of this repository are provided below.

**Key Words**: Appalachian Basin, New York, Pennsylvania, West Virginia, Cornell University, low-temperature geothermal, resource assessment, uncertainty analysis.

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

**Title**: Direct District heating use on the Cornell campus of Deep Geothermal Energy: Appalachian Basin Temperature-Depth Maps and Structured Data

 **Author(s)**: Cornell University

 **Date**: October, 2019

**Note**: On Windows 10 OS and possibly other operating systems, zipped folders need to be unzipped in directories with short names (e.g., in C:\). If not, some files may not be extracted due to “path too long” errors.

**Contents of Submission**:

**Main Folder: CornellDDU\_AppBasinTemps**

 **Contents:**

1. **Folder: AppalachianBasinTemperatureDepthMaps**
	1. **10 folders of the format AppBasinTemperature**

Temperatures are for 1 to 5 km in 0.5 km increments, and also at the basement depth.

Each of these folders contain 9 files:

* + 1. **4 files of the format Quantiles\_Temperature**

These files have extensions .dbf, .prj, .shp, and .shx, and provide the necessary information to plot the data in a GIS software application.

Attribute table columns:

POINT\_X: the easting coordinate in NAD83 UTM 17N (m)

POINT\_Y: the northing coordinate in NAD83 UTM 17N (m)

Qs: the estimated mean surface heat flow from Smith (2016). Available for download on the Geothermal Data Repository (Cornell University, 2016). (mW/m2)

QsErr: the estimated surface heat flow standard deviation from Smith (2016). Available for download on the Geothermal Data Repository (Cornell University, 2016). (mW/m2)

SurfTemp: the average annual ground surface temperature from Gass (1982). Available from the Southern Methodist University Geothermal Laboratory. (°C)

BasementDe: the depth to basement rock. Map available on the geothermal data repository (Cornell University, 2015). (m)

ROME\_ID: Identifier for if the location is in the Rome Trough (1) or not (0)

COSUNA\_ID: ID number for the COSUNA column region – short format.

COSUNAID2: ID number for the COSUNA column region – long format.

NAME: Name of the COSUNA column region

SedRadHeat: average heat generation rate assigned to all sedimentary rocks. (μW/m3)

QMantle: average mantle heat flow rate. Used for calculations in basement rock only. (mW/m2)

CharInd: the grid cell ID number as a character string.

TXkm\_Q: The Qth quantile of the estimated temperature at X km depth, from Smith (2019). Note, temperature at the basement depth is labeled as TBas\_Q. (°C)

* + 1. **Temp1kmQuantiles.png**

Maps of the temperature at 1 km depth. The data to make this file is in the Quantiles\_Temperature attribute table. The coordinate system is NAD83 UTM 17N.

* + 1. **TempXkmMean.tif and corresponding .aux file**

A GeoTIFF file of the predicted mean temperature at X km depth, from Smith (2019).

* + 1. **Temp1kmSD.tif and corresponding .aux file**

A GeoTIFF file of the standard deviation of the predicted mean temperature at X km depth, from Smith (2019).

* 1. **4 files of the format MeanSDmapData**

These files have extensions .dbf, .prj, .shp, and .shx, and provide the necessary information to plot the data in a GIS software application.

Attribute table columns:

The same as for Quantiles\_Temperature file, except the temperature predictions are:

TXkm\_m or TXkm\_mn: The estimated mean temperature at X km depth, from Smith (2019). Note, temperature at the basement depth is labeled as TBas\_m. (°C)

TXkm\_s or TXkm\_sd: The estimated standard deviation of the temperature at X km depth, from Smith (2019). Note, temperature at the basement depth is labeled as TBas\_s. (°C)

1. **Folder: IthacaCornellTemperatureDepthData**
	1. **File: 644572\_CornellTemperatureDepthReplicates.csv**

File containing the 10,000 replicates of temperature-depth estimates for the pixel corresponding to Cornell University in the Appalachian Basin temperature-depth resource assessment by Smith (2019). The number 644572 is the pixel index number on the maps in the Appalachian Basin Temperature Depth Maps folder.

Columns:

rep: the replicate ID number, from 0 – 9999.

TXkm, TXp5 km, TBase: temperature estimated at X km, X.5 km, and basement depth, respectively.

* 1. **File: IthacaTemperaturesAtDepth\_AvgGrad.png**

Violin plots of the temperatures at depth for Ithaca. Data for the violin plots are from the 644572\_CornellTemperatureDepthReplicates.csv file. This figure also includes the average geothermal gradient in red.

**References**

Cornell University. (2016). Appalachian Basin Play Fairway Analysis Thermal Risk Factor and Quality Analyses [data set]. Retrieved from http://gdr.openei.org/submissions/879.

Cornell University. (2015). Appalachian Basin Play Fairway Analysis: Thermal Quality Analysis in Low-Temperature Geothermal Play Fairway Analysis (GPFA-AB) [data set]. Retrieved from http://gdr.openei.org/submissions/638.

Gass, T.E. (1982). The geothermal heat pump. *Geotherm. Resour. Counc. Bull.*,11, 3–8.

Smith, J.D. (2019). Exploratory spatial data analysis and uncertainty propagation for geothermal resource assessment and reservoir models. PhD Thesis, Cornell University, Ithaca, NY.

Smith, J.D. (2016). Analytical and geostatistical heat flow modeling for geothermal resource reconnaissance applied in the Appalachian Basin. MS Thesis, Cornell University, Ithaca, NY.