MEMO: Geologic Variability Evaluation of the Travis Peak Formation within the Area of Interest

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Related spreadsheet: MEMO SMU DDU GeologicVariability-TravPeak29Jan2019.xlsx

The Travis Peak formation is the most promising geothermal reservoir based on our regional scale analysis of the temperature, thickness, and porosity through the area of interest in East Texas. There were three cross-sections reviewed. For this memo, the A-A' cross-section is provided to show the results of the methodology (Figure 1). The Travis Peak formation, however, is known to have variable hydrocarbon production because the formation was deposited in a braided stream depositional environment (Kosters et al., 1989; Carr, 2018). The geologic nature of the formation means that there are many lenticular sand beds stacked on top of each other, but may not have significant lateral extent, thus limiting the reservoir size potential for any specific sand bed.

The use of the Travis Peak formation as a geothermal reservoir may be less impacted by the lenticular nature of the sand beds because all the sand beds would presumably contain water and all sand beds are then considered part of the total reservoir volume. A vertical well, then, that produces water from the entire Travis Peak would be the equivalent of a sand bed that is tens of feet in height and 1000+ feet in width. The Travis Peak does not vary in total thickness throughout the study area (Figure 2), but there is a possibility that the net sand thickness and porosity vary spatially throughout the study area.

Lateral variability in net sand thickness and porosity are examined by calculating the net sand thickness in wells along the cross sections that contain a gamma ray log and digitizing an average porosity (Figure 3). Net sand thickness is determined by labeling any areas within the Travis Peak formation with a gamma ray count value less than 90 to be a predominantly sandstone layer. The thickness of the predominantly sandstone layers is then summed for the Travis Peak formation within each well. The summation is calculated within IHS Petra and output as total pay thickness. If the net sand thickness does not vary from one end of the cross section to the other, then the effective geothermal reservoir is a consistent thickness within the study area. Similarly, an average porosity log is digitized for the wells on the cross section that include a density porosity and neutron porosity log. The average porosity is assumed to be the average of the density porosity and the neutron porosity logs, which is digitized by visually estimating the average of the two logs. The average porosity for each well is estimated by calculating statistics on the digitized average porosity. A minimum, maximum, average porosity, and standard deviation are calculated for the entire log, which has only been digitized for the Travis Peak formation. Several other statistical values are calculated (Table 1) and included within the Excel file because they are outputs from the statistical calculations run within Petra.

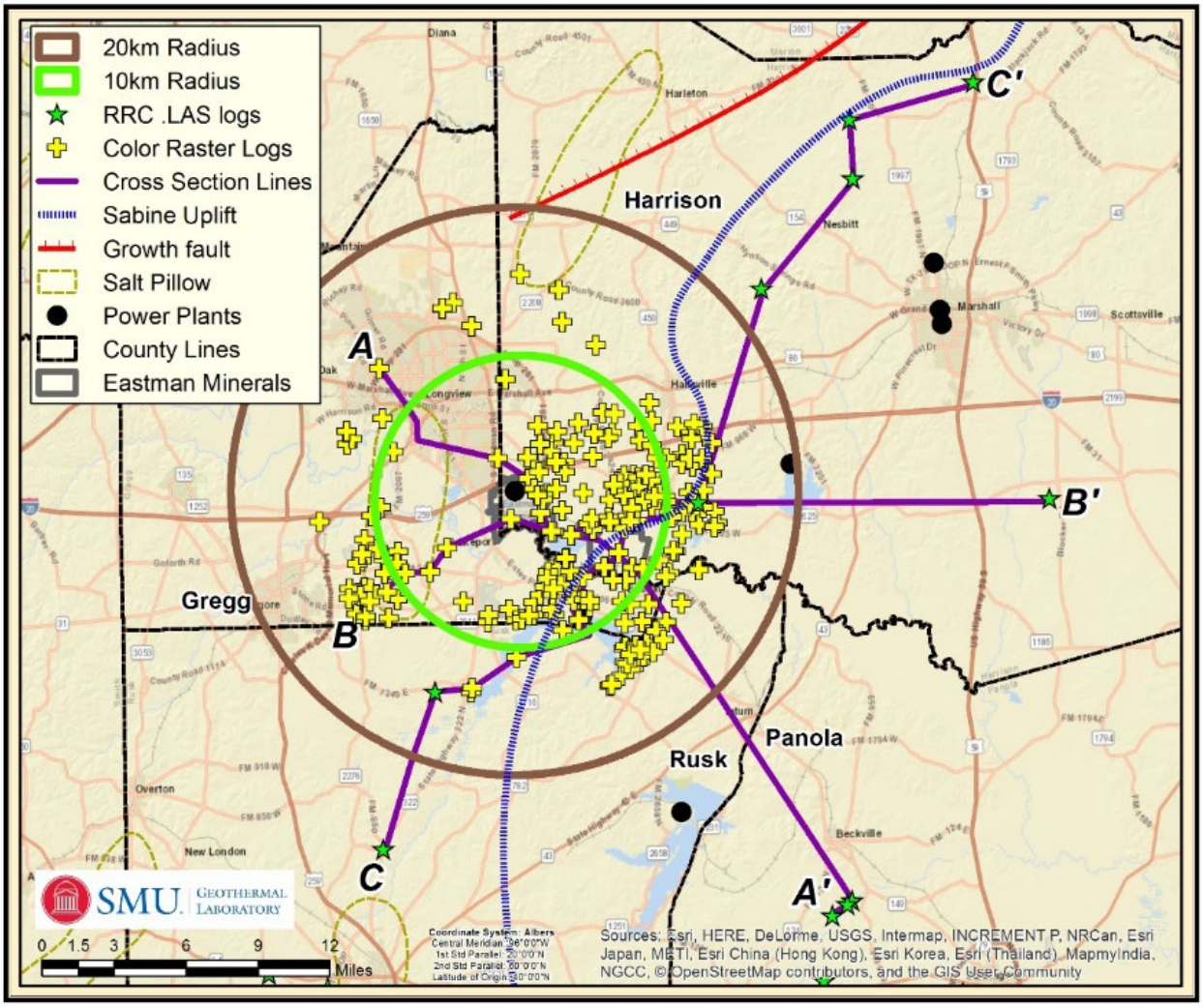

Figure 1. Cross-section lines through the Area of Interest. This is Figure 6 in Batir et al., 2018 GRC paper available through the link https://gdr.openei.org/files/1073/2018%20GRC%20Batir%20Richards%20DDU%20East%20Texas.pdf. Green stars locate publicly available digital LAS geophysical logs and yellow crosses are well sites with colored raster geophysical logs. These wells of interest were used to determine cross-section lines A-A', B-B' and C-C" that are being considered for further evaluation of the possible reservoirs. The cross-section lines extend beyond the 20 km circle to review the broad geologic context of our study area and that of near-by power plants.

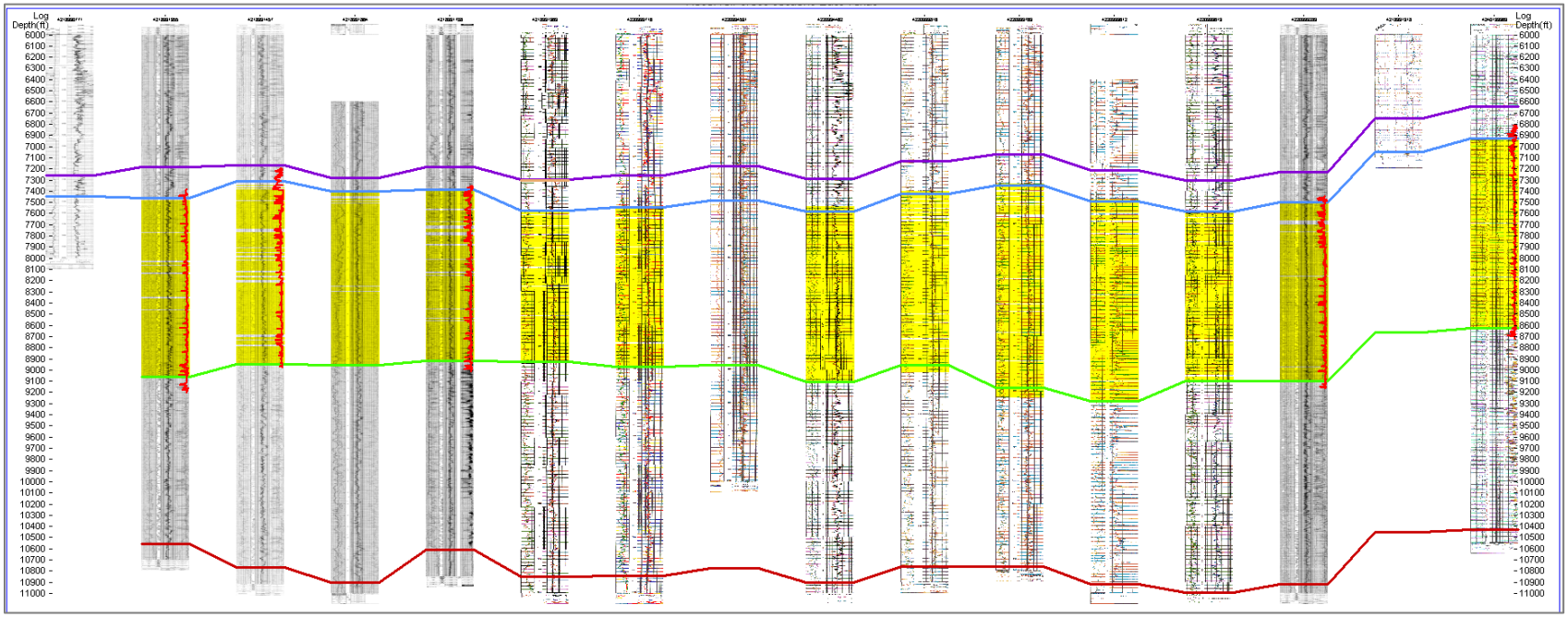

Figure 2. A-A' Cross Section following near the northern border of the Eastman Chemical Company property. The Travis Peak formation (the area between the blue and green lines) does not vary significantly within the study area. Net sand thickness (yellow highlighted well log sections) and average porosity (red highlighted well logs) have been examined to see how reservoir properties vary within the study area.

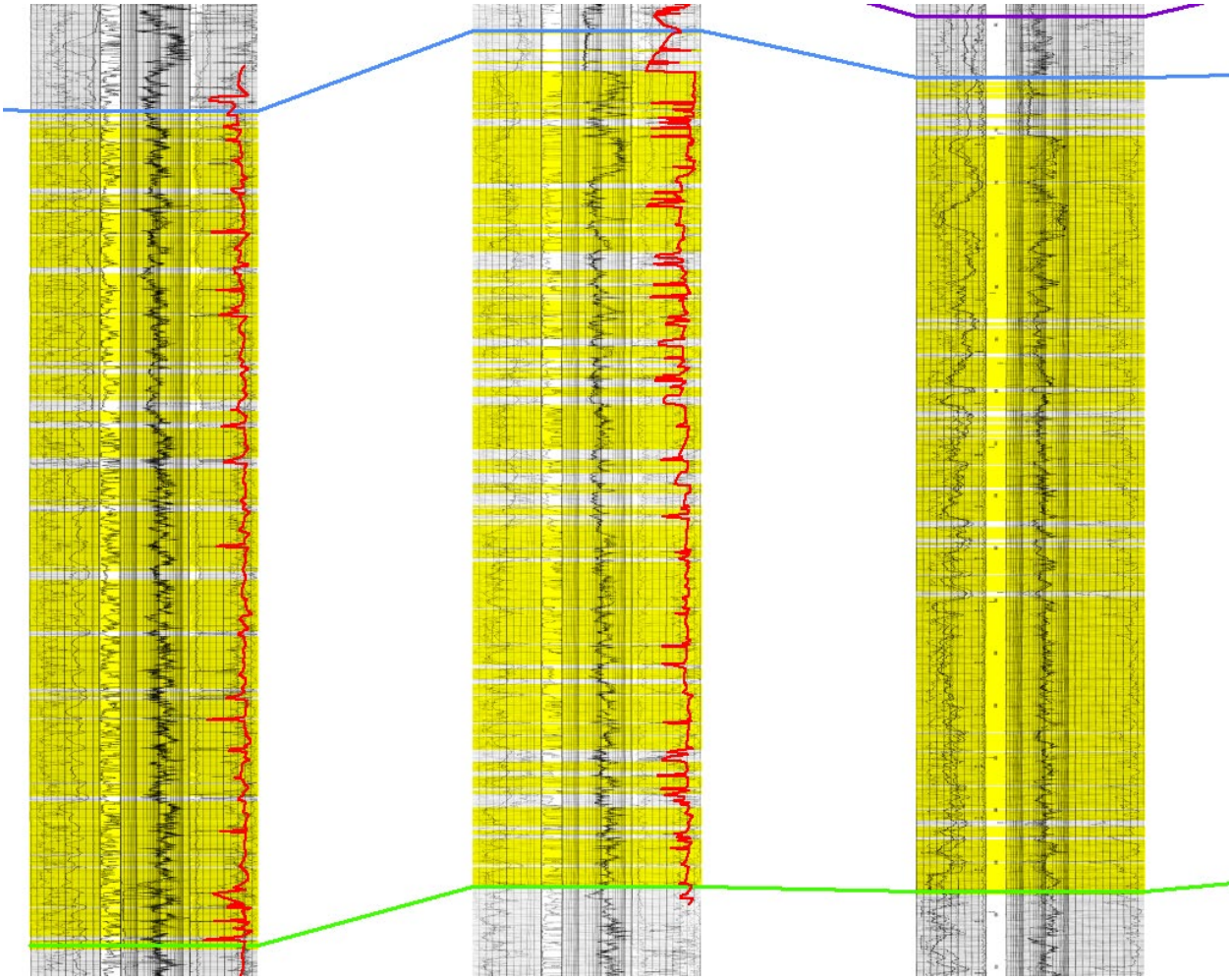

Figure 3. Detailed Travis Peak section from A-A'. Sand dominant beds are highlighted in yellow and calculated as sections within the Travis Peak that have a gamma ray count of less than 90, and an average porosity has been digitized where available (red colored logs) by taking the visual average of the density porosity and neutron porosity. Variability in vertical position of individual sand beds can be seen and variability in porosity from well to well is also observable.

The variability of the Travis Peak Formation was analyzed along two cross sections, one running N-S through the study area, and one running W-E. In total, net sand thickness was calculated for 28 wells and a porosity average for 8 wells (Table 2). There is minor variability of the porosity of the Travis Peak Formation. The average porosity is 9 ± 5%. All average porosity values are within the ±5% standard deviation. The most significant variability within the porosity values is in the difference in maximum porosity values observed when comparing the digitally collected well logs versus hand digitized logs. The digital well logs consistently predict a higher maximum porosity as opposed to the hand digitized logs. We interpret this to be an artifact of the higher accuracy of digital well logs compared to the accuracy of hand digitizing.

Table 1. Name and Description of values in the Geologic Variability Excel file

Column Name	Parameter	Description
UWI/API	API number	Well identifier
SURFLAT	Surface Latitude	NAD27
SURFLON	Surface Longitude	NAD27
CUMOIL	Cumulative Oil	Total oil production from the given well
CUMGAS	Cumulative Gas	Total gas production from the given well
CUMWAT	Cumulative Water	Total water production from the given well
MIN_DENNEUAV	Minimum Density-Neutron Average	Minimum average porosity value within the Travis Peak
MAX_DENNEUAV	Maximum Density-Neutron Average	Maximum average porosity value within the Travis Peak
MEAN_DENNEUA	Mean Density-Neutron Average	Mean average porosity value within the Travis Peak
SD_DENNEUAV	Standard Deviation Density-Neutron Average	Standard Deviation for the entire average porosity log within the Travis Peak
PC10DENNEUAV	10^{th} Percentile Density-Neutron Average	10^{th} percentile of average porosity value within the Travis Peak
PC90DENNEUAV	90^{th} Percentile Density-Neutron Average	90^{th} percentile average porosity value within the Travis Peak
MOD_DENNEUAV	Mode Density-Neutron Average	Mode of the entire average porosity log within the Travis Peak
MED_DENNEUAV	Median Density-Neutron Average	Median of the entire average porosity log within the Travis Peak
TOTPAYTHK,ft	Total Travis Peak Pay Thickness, ft	The summation of all the sand bodies within the Travis Peak within a given well
	Total Travis Peak Formation Thickness, ft	Total thickness of the Travis Peak formation in a given well
	Percent Travis Peak Pay Thickness	The total sand thickness divided by the total Travis Peak thickness in a given well

The net sand thickness and total formation thickness varies between well locations more significantly than the porosity. On average, the net sand will be 83 ± 7% of the total thickness of the Travis Peak Formation, but the percent net sand varied from 67 to 99 percent of the total formation thickness. The total thickness of the formation varied between 1348 and 1868 ft, with an average of 1669 ±129 ft. The

potential variability in net sand, then, is up to 600 ft within the study area. Most wells were close to the average total formation thickness and the resulting net sand thickness as seen by the low standard deviations; however, these results show there is potential for a low net sand thickness for any given well because there is a high variability in both total formation thickness and net sand thickness.

Table 2. Average values of Porosity and Net Sand Thickness for the Travis Peak Formation.

Value	Average	Standard Deviation	Minimum	Maximum
Min Avg Porosity n = 8	0.01	0.00	0.01	0.02
Max Avg Porosity n = 8	0.35	0.11	0.26	0.59
Mean Avg Porosity n = 8	0.09	0.01	0.07	0.10
Std Dev. Avg Porosity n = 8	0.05	0.01	0.03	0.06
PC10 Avg Porosity n = 8	0.05	0.01	0.04	0.06
PC90 Avg Porosity n = 8	0.14	0.02	0.11	0.17
Mode Avg Porosity n = 8	0.07	0.01	0.05	0.08
Median Avg Porosity n = 8	0.07	0.01	0.06	0.08
Net Sand, ft n = 27	1393	177	1072	1659
Total Formation Thickness, ft n = 27	1669	129	1348	1868
Percent Sand Thickness n = 27	83	7	67	99

References

Batir, Joseph, Richards, M. and Schumann, H. (2018). Reservoir Analysis for Deep Direct-Use Feasibility Study in East Texas. GRC Transactions, Vol. 42, 20 pp.

Carr, J. (2018). Personal Communication: Discussion of East Texas Geology.

Kosters, E. C., *et al*. (1989). East Texas (Railroad Commission of Texas Districts 5 and 6). *In* Atlas of Major Texas Gas Reservoirs. Bureau of Economic Geology.