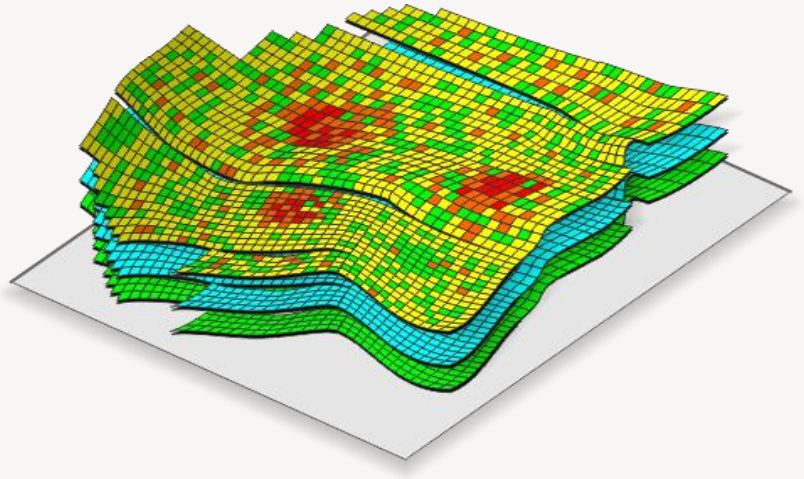
Reservoir Heterogeneity determination using Normal Distribution

	Reservoir 1 (Sandstone)	Reservoir 2 (Carbonate)
Permeability Range	45-50 mD	0.1-100 mD



Sandstone Reservoir

Permeability Range: 45-50 mD

Res 1 =

```
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 [49 47 45 47 47 46 47 49 47 48 45 48 49 49 48 47 47 47 46 45]
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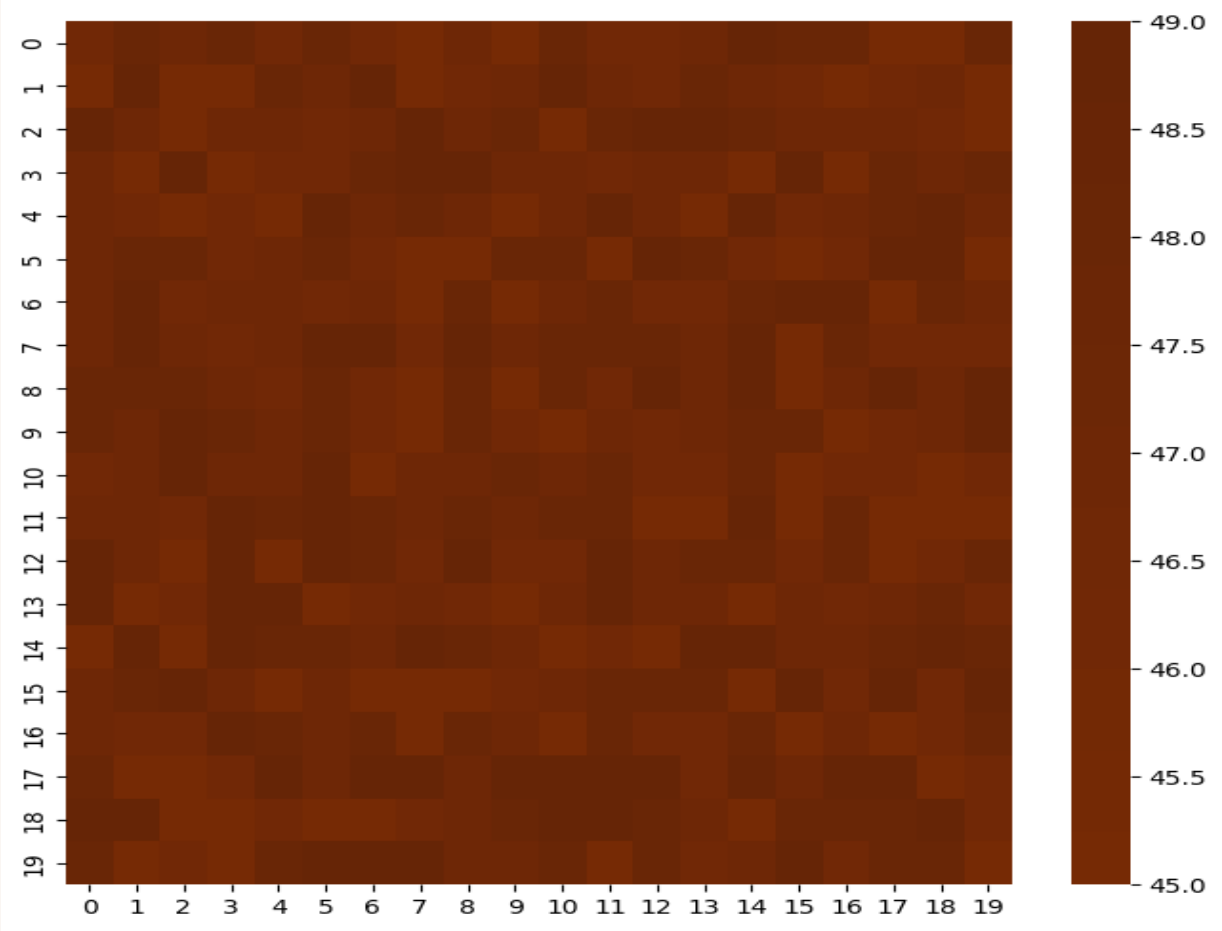


Permeability Distribution 20 x 20 2D Model

Heatmap of Res 1

Mean k = 47.0325 mD

Std_Dev = 1.38976

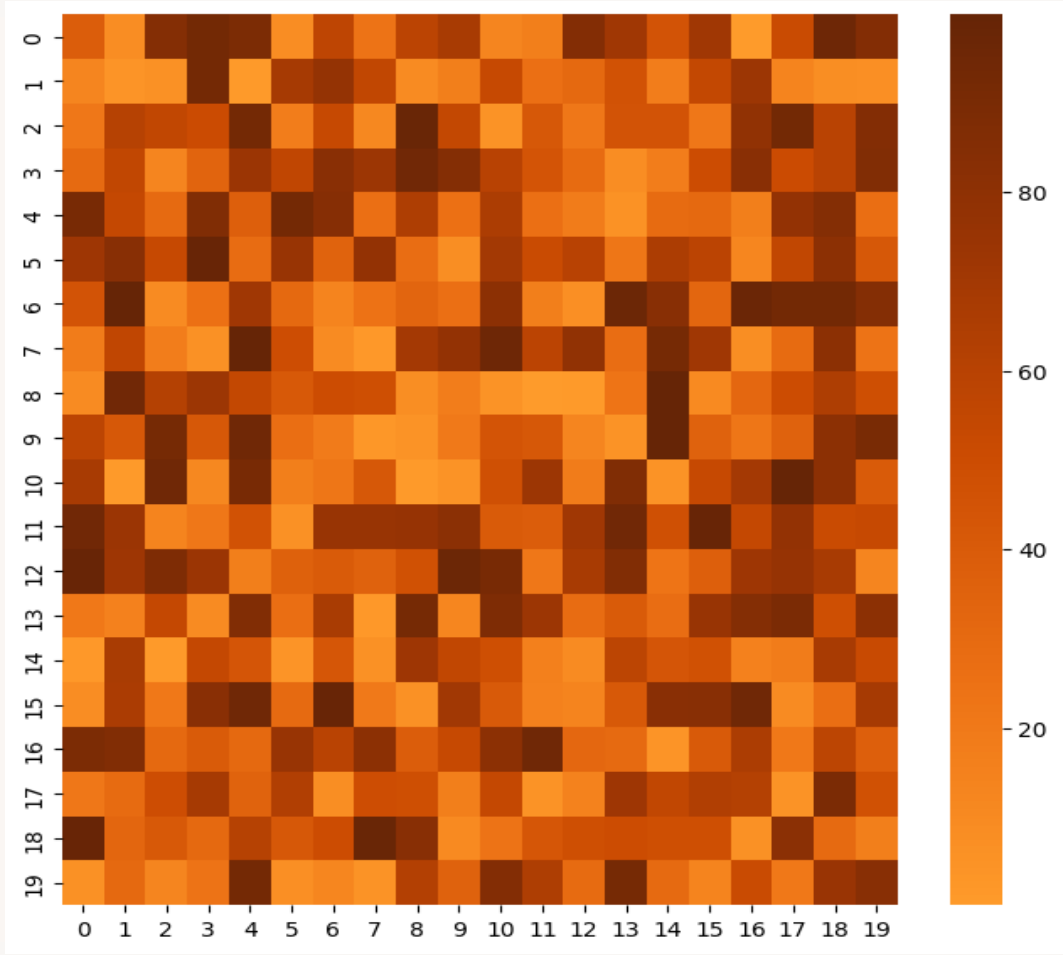
Libraries used – Numpy, Matplotlib, and seaborn

Carbonate Reservoir

Permeability Range: 0.1-100 mD

Res 2 =

```
[[38.74  8.82 84.34 92.94 88.65  8.37 57.42 23.66 58.94 67.59 13.   16.65 85.84 71.63 45.07 71.21  0.3  51.68 96.01 85.39]
 [12.9   4.19  6.12 92.9   0.89 69.12 76.57 55.57  9.68 16.68 52.98 26.3  31.22 45.9  17.74 54.39 73.23 14.03  7.53  7.13]
 [21.93 60.78 55.82 50.95 92.56 17.78 53.52 11.47 98.25 54.93  4.86 41.86 21.64 45.46 45.6  21.7  78.27 93.01 59.43 85.71]
 [29.84 55.26 13.15 33.95 73.62 55.96 82.25 73.22 94.29 84.45 59.94 44.18 29.65  8.32 17.52 49.75 82.44 51.16 59.69 86.39]
 [90.58 53.94 30.09 87.42 36.94 92.54 83.83 26.18 65.08 25.1  65.85 25.85 18.67  5.39 29.22 31.29 16.6  77.45 84.58 26.7 ]
 [72.56 83.29 52.85 98.82 28.56 75.58 35.   77.67 27.44  7.99 70.2  51.76 60.09 22.42 65.59 58.8  12.5  55.1  80.87 42.56]
 [45.16 99.93  9.74 25.67 71.57 31.   13.54 24.6  32.97 26.4  80.67 16.61  6.9  96.16 83.05 32.18 97.21 93.04 93.19 84.48]
 [18.42 55.93 18.03  6.09 99.58 49.32  9.23  1.35 69.21 77.5  95.97 58.73 78.27 27.52 92.09 71.64  7.6  29.32 81.01 24.  ]
 [ 9.43 93.77 61.51 73.17 54.84 41.7  50.21 48.68  8.2  17.45  4.6   0.1   0.65 23.17 99.48 10.24 31.38 50.24 64.74 48.1 ]
 [57.85 42.48 91.83 42.38 94.54 26.96 18.99  2.46  4.93 19.88 44.23 42.38 12.9   4.76 99.71 35.55 22.59 35.56 80.89 90.49]
 [67.71  1.05 94.96 11.66 91.13 16.93 21.98 42.34  1.21  4.9  47.5  72.75 18.35 87.15  4.5  53.31 69.46 99.79 80.9  40.18]
 [93.97 74.19 13.77 21.82 46.34  5.96 75.66 75.14 75.93 81.34 39.92 38.62 71.18 93.99 47.65 98.91 53.86 77.56 51.48 52.96]
 [98.84 72.07 87.96 73.74 16.53 36.26 39.96 35.32 46.59 96.72 91.35 21.63 67.85 86.64 23.22 36.95 71.98 75.98 67.78 12.98]
 [20.84 15.18 54.13  9.63 86.56 27.22 66.82  1.86 91.4  12.18 87.7  72.71 28.49 39.96 27.98 75.44 84.53 89.38 48.79 80.58]
 [ 1.74 66.97  1.22 53.61 43.87  3.71 43.08  6.08 72.26 55.73 48.07 16.06  9.46 58.13 44.15 46.94 15.54 18.06 67.96 52.21]
 [ 8.67 66.29 20.83 82.04 94.67 29.75 99.09 19.62  6.39 70.79 40.3  15.66 13.74 41.55 82.01 83.19 94.79  9.38 27.25 68.49]
 [88.31 86.18 31.08 39.88 30.66 74.98 58.99 80.94 38.54 52.93 80.96 95.02 31.65 30.47  3.91 40.68 65.37 20.78 57.87 37.46]
 [21.26 29.08 49.41 68.68 34.8  63.    8.2  48.98 48.08 17.2  54.26  4.71 14.82 72.07 55.18 63.55 61.36  5.15 89.02 47.03]
 [98.74 32.67 41.06 31.3  60.85 41.95 49.99 97.98 83.25 10.17 23.67 43.   48.75 50.03 48.16 48.83  6.05 81.51 30.49 17.24]
 [ 6.72 30.55 13.24 24.14 92.87  6.95 12.22  5.15 62.12 35.55 85.81 64.67 29.61 91.36 29.79 13.65 51.84 20.45 74.95 83.39]]
```



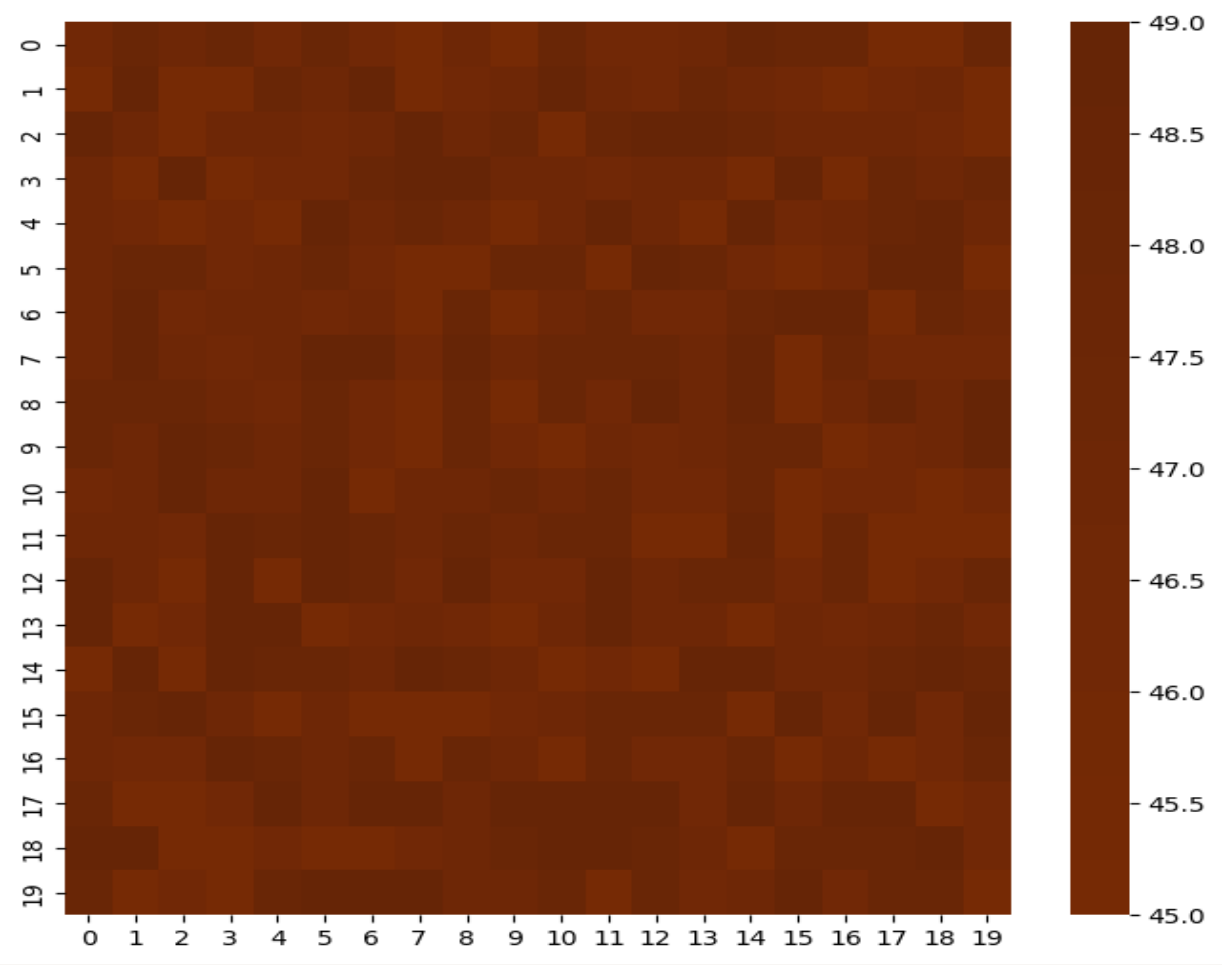
Permeability Distribution 20 x 20 2D Model

Heatmap of Res 2

Mean k = 48.1875 mD

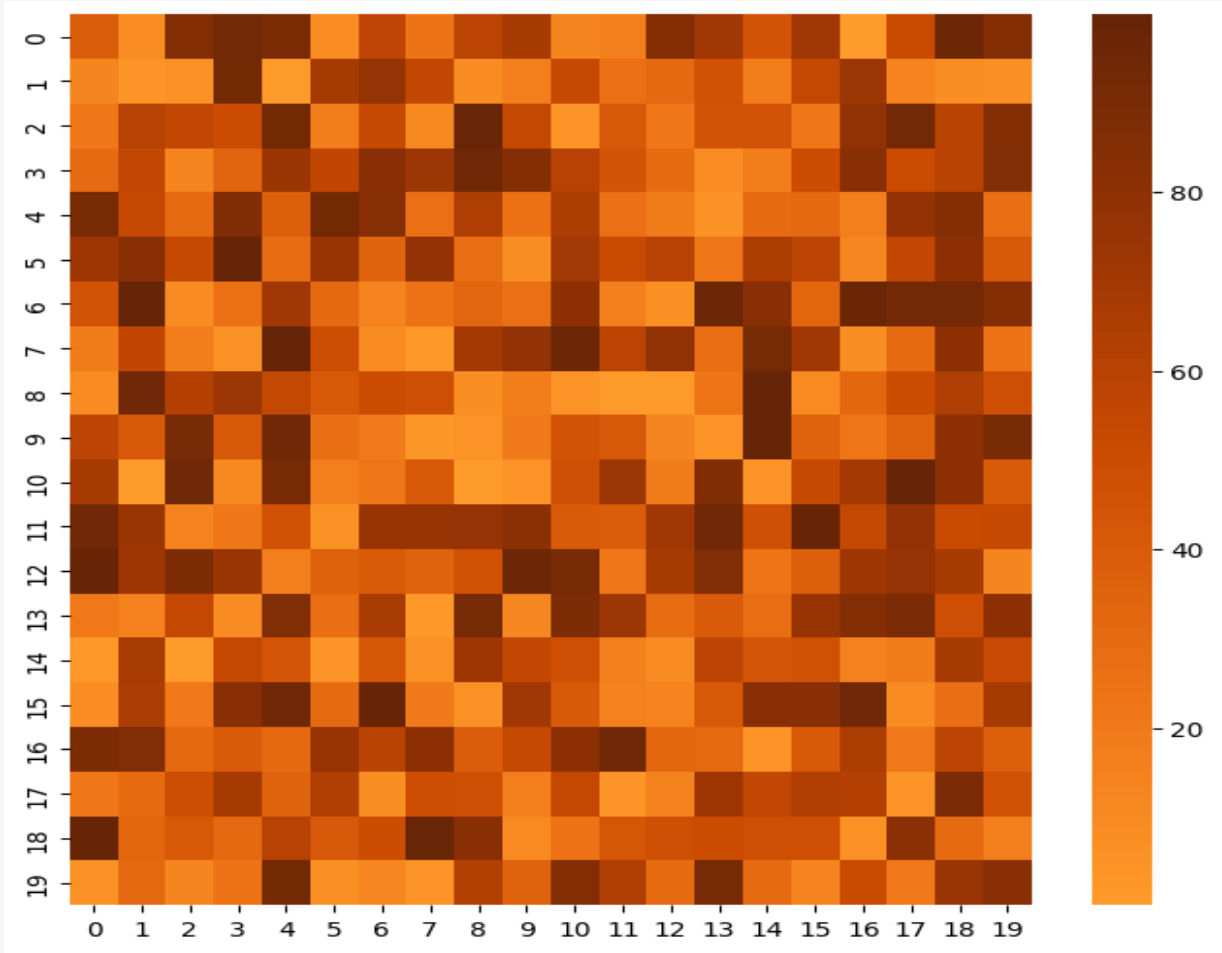
Std_Dev = 29.5338

Res 1 **K:** 45-50 mD



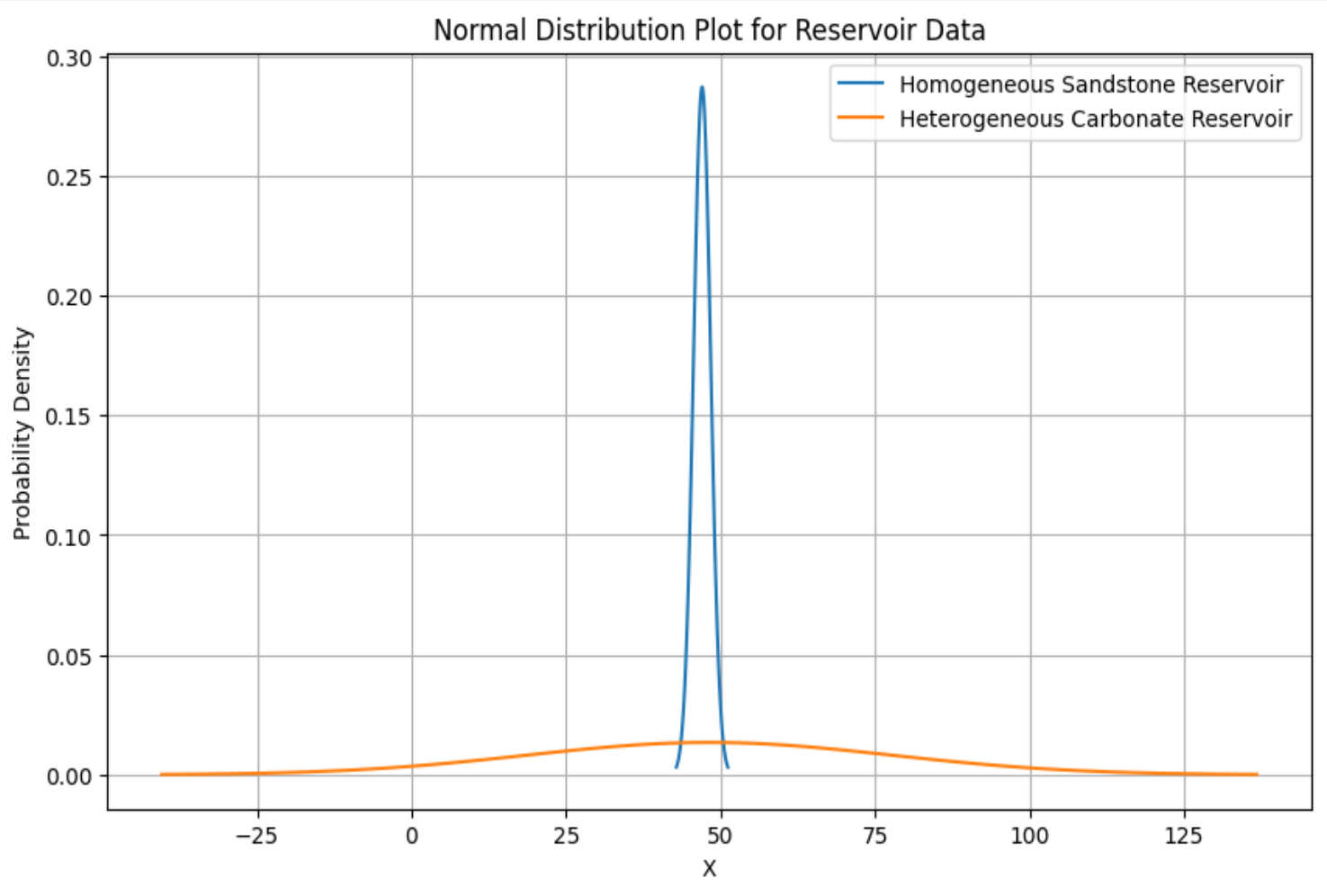
Heatmap of Res 1

Res 2 **K =**0.1-100 mD



Heatmap of Res 2

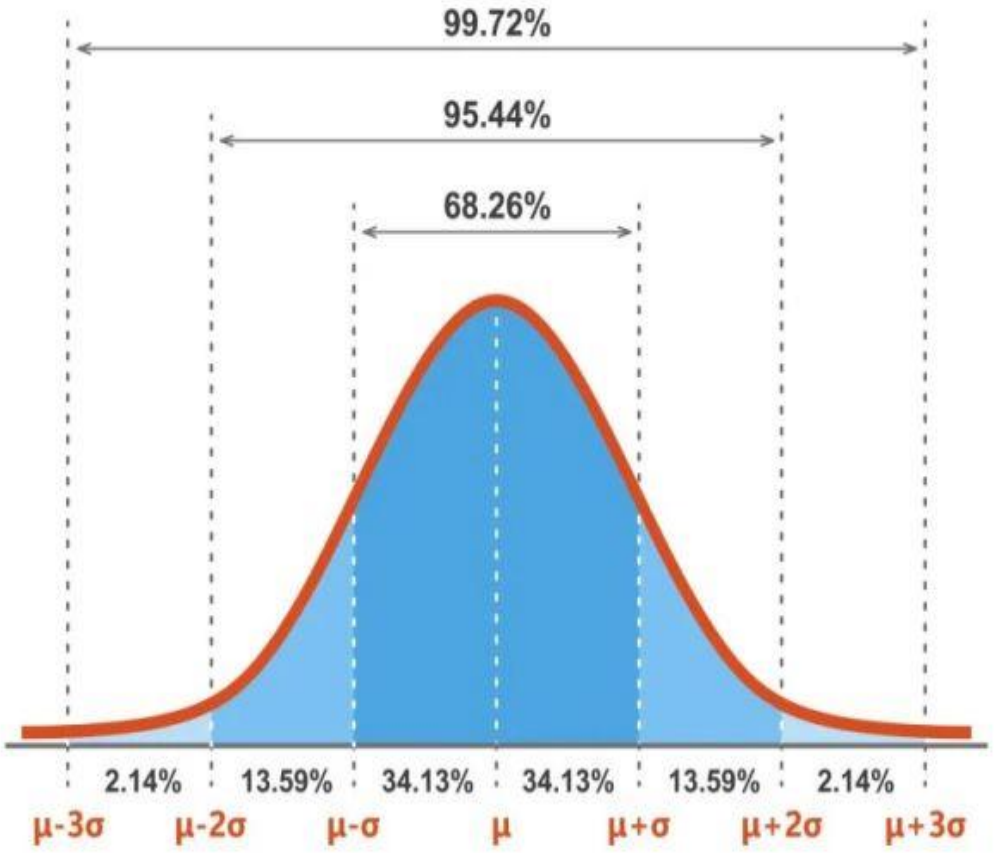
20 x 20 2D Model



Reservoir	Sandstone Reservoir	Carbonate Reservoir
Permeability Range	45-50 mD	0.1-100 mD
Mean K	47.0325 mD	48.187564 mD
Std_Dev	1.38976	29.5338

- **A broader probability distribution curve signifies increased variance, indicating higher heterogeneity within the reservoir.**

- **Sandstone and carbonate reservoirs may share the same mean value.**
- **Higher standard deviation in carbonate reservoirs is a crucial observation that makes it a heterogeneous reservoir.**



$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$$

- **68% Rule:** About 68% of the values fall within one standard deviation from the mean.
- **95% Rule:** Approximately 95% of the values fall within two standard deviations from the mean.
- **99.7% Rule:** Almost 99.7% of the values fall within three standard deviations from the mean.