The following assignment was completed in RStudio. The scripts created and used can be found at my GitHub account with the following link:

https://github.com/tadler2014/AppliedGeostatistics

Parameter Correlation

Using the Berea Sandstone data set, a scatter plot of water resistivity and permeability for all sample points is created (Figure 1). By calculating pearson's correlation coefficient (r = -0.42), we find the strength of the association between the two variables to be relatively low. The coefficient of correlation is negative indicating that the variables have an inverse relationship, if any. By calculating the covariance (cov = -90.53), we can reaffirm that there is some inverse relationship between the two parameters of interest. Unlike correlation, the strength of association is less clear by calculating the covariance.

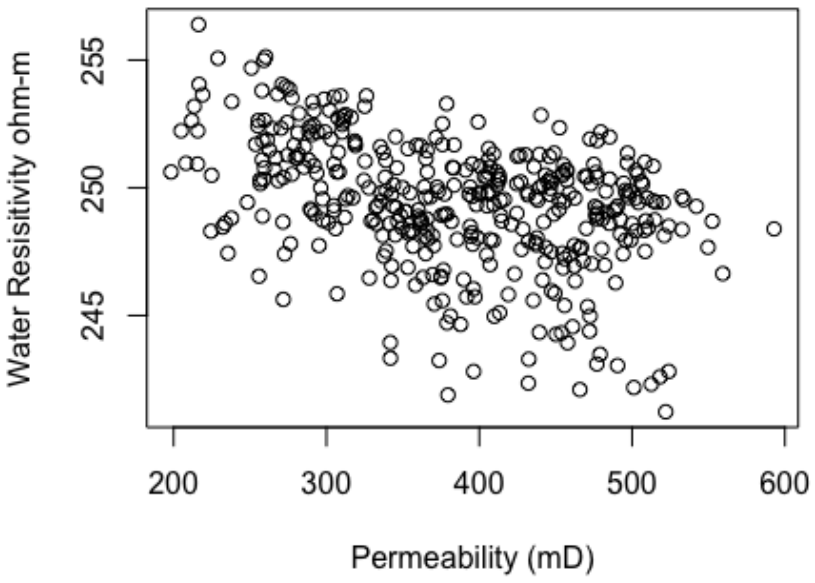

Figure 1: Water resistivity by Permeability

Table 1: Lag Distance Statistics (x-direction)

Lag Distance (x-direction)	Correlation coefficient (r)	Covariance (cov)	Semivariance (g)
3 mm	0.948	5.025	0.270
9 mm	0.873	3.416	0.534
24 mm	0.818	4.645	1.173
36 mm	0.739	4.294	1.758
54 mm	0.581	3.109	2.345
72 mm	0.587	2.689	3.642

Spatial Correlation

For resistivity at lag distances of 3, 9, 24, 36, 54, and 72 mm in the horizontal direction (theta = 0), a number of correlation statistics are found (Table 1). As clearly visualized in Figures 2 and 3, these statistics indicate that as the lag distance between two variables in the horizontal direction increases, the correlation and covariance decrease. Similarly, the semivariance, used to express the degree of relationship between points, increases as the lag distance between two points increases. This fundamentally makes sense considering that we expect two points closer together to be more alike then those farther apart. The results of this assessment get interesting when correlation in the horizontal direction is compared to that of the vertical direction.

Similarly to the horizontal lag distance assessment, correlation based statistical tools are used to assess the resistivity at lag distances of 3, 9, 24, 36, 54, and 72 mm in the vertical direction (Table 2). The results of this assessment, as shown in Figures 4 and 5, indicate that in vertical direction, two data points that are farther away from each other are more dissimilar. This much, as we gathered from our assessment of data in the horizontal direction, is obvious and expected. What truly makes this data truly interesting is that we can see their is a greater correlation and covariance in the horizontal direction in comparison to the vertical direction. This is true for semivariance as well, where we see much lower values in the horizontal direction.

To understand why there is an observable difference in the correlation along the two axes requires that we take a step back to think about the geology of our sample data set. Sandstone, like almost all sedimentary rocks, is made of successive layers of stratified rock we call bedding planes. These bedding planes create preferentially oriented pore structures that affect the permeability and diffusivity anisotropies in a meaningful manner as shown in this analysis. It is therefore to be expected that we observe preferential autocorrelation in the horizontal direction running parallel to the bedding planes.

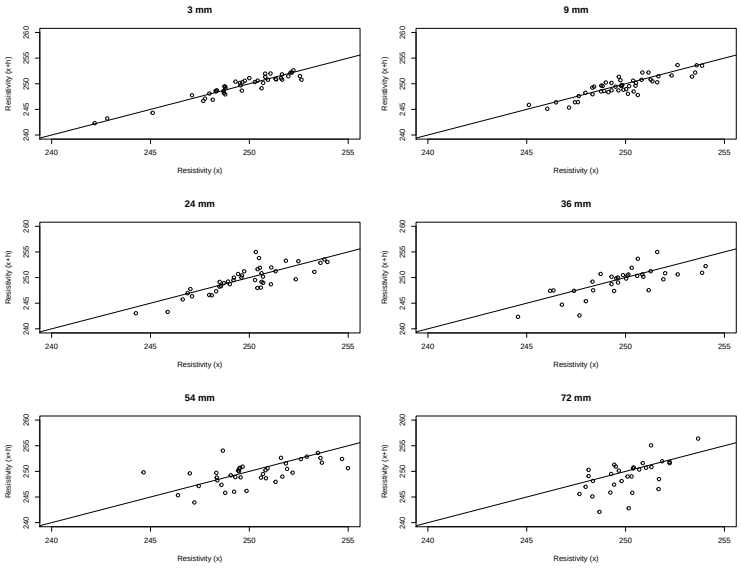

Figure 2: h-Scatter plots for 6 lag distances (x-direction)

Table 2: Lag Distance Statistics (y-direction)

Lag Distance (y-direction)	Correlation coefficient (r)	Covariance (cov)	Semivariance (g)
3 mm	0.908	6.792	0.735
9 mm	0.674	5.081	2.405
24 mm	0.635	4.405	3.770
36 mm	0.534	3.726	3.158
54 mm	0.463	2.352	7.111
72 mm	0.042	0.218	8.052

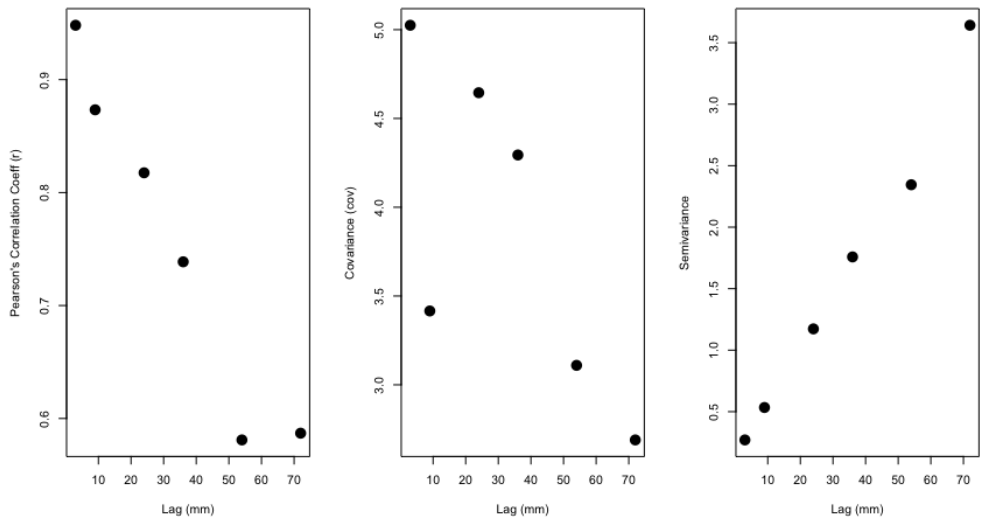

Figure 3: Horizontal Direction Lag Statistics (x-direction)

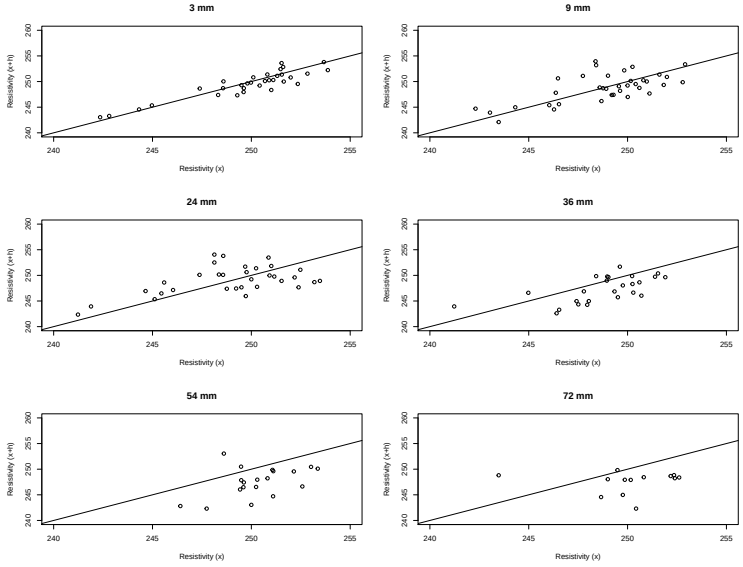

Figure 4: h-Scatter plots for 6 lag distances (y-direction)

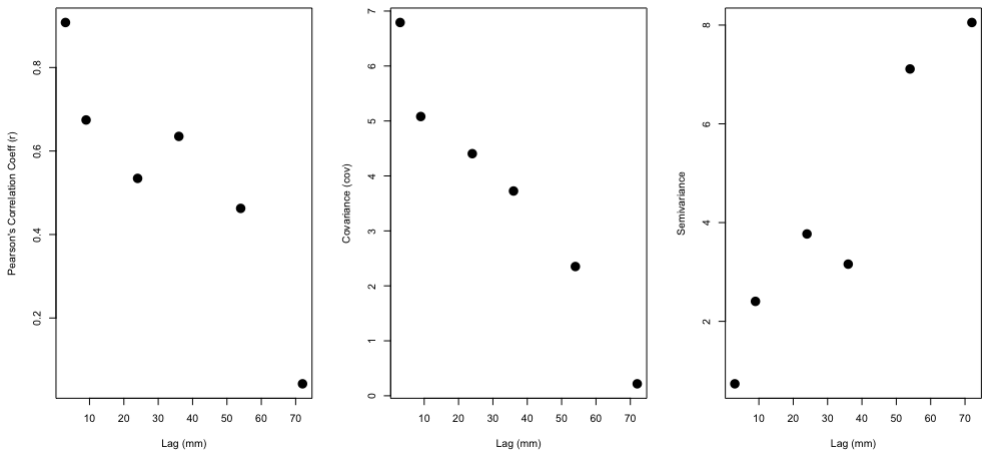

Figure 5: Vertical Direction Lag Statistics (y-direction)