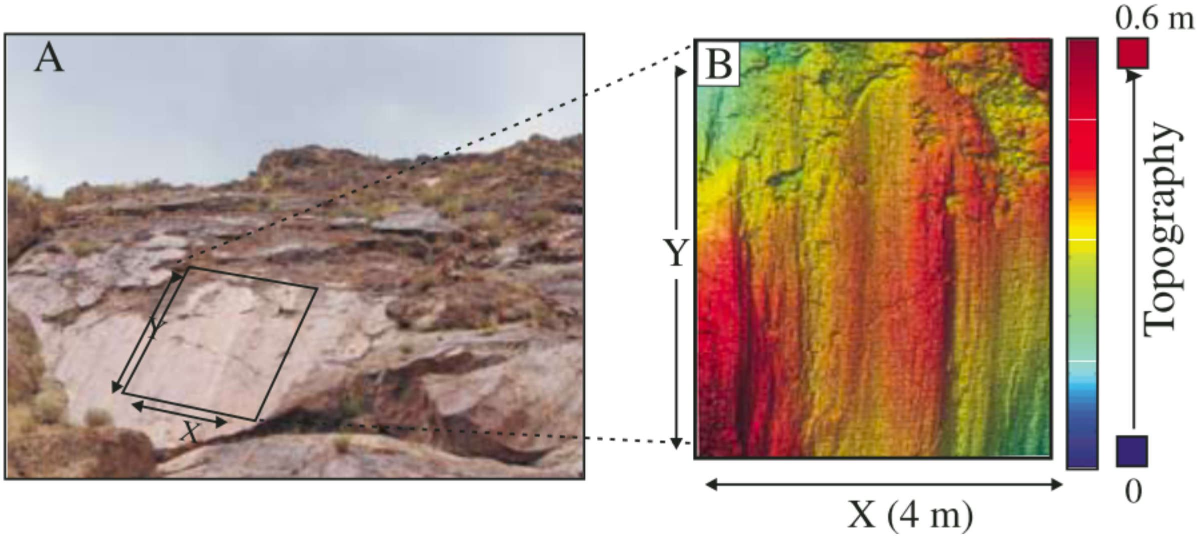
CIVL 8126 / CERI - 8104 –
Analyzing Spatial Data

Fault Roughness



A: Section of partly eroded slip surface at Mirrors locality on Dixie Valley fault, Nevada B: Light detection and ranging (Lidar) fault surface topography as color-scale map, rotated so that X-Y plane is best-fi t plane to surface and mean striae are parallel to Y. From: Sagy, A., Brodsky, E. E., & Axen, G. J. (2007). Evolution of fault-surface roughness with slip. *Geology*, *35*, 283–286.

1. Load and inspect the data file (`fault_roughness.txt`).
2. Remove all nan values by using the following line:
    a. `XYZ = XYZ(~isnan(XYZ(:,3)),:)`
    b. the ~ symbol reverses the boolean array from isnan to anything that is not nan

3. Find the unique elements in X and Y and create a regular spaced grid. Use this grid to interpolate the Z coordinates of the roughness data using
`>> griddata`

4. Create a first plot of the gridded data. Describe your observations and submit the plot together with your report!

5. Now detrend the data by using the function `detrend_2d(ZZ)`. Again describe your observation and submit the figure!

6. You will now compute the power spectral density for each along-slip roughness profile and determine the roughness exponent based on the stacked densities. For this purpose, set up a ‘`for loop`’ over all x-coordinates and get the roughness profiles along the y-direction, that is vertical profiles going from left to right.
    a. Demean and detrend each profile

b. Compute the Fourier transform using `fft(z)`, normalize by the length of the spectrum, *nfft* and multiply by a factor of 2. You can ignore the frequency range of the fft for now. We will later only plot the data for a specific range of wavelength.
c. The power spectral density can be determined using:
$$PSD = |fft(z)|^2 \Delta x$$
d. Plot the average power spectral density over wave length, λ. Instead of limiting the data range for the plot, you can simply limit the x-axis range using `xlim([10, 2000])`.
e. Determine an approximate range over which the plot is linear and compute the roughness exponent by performing a liner regression on the log-transformed data.
f. What is the resulting roughness exponent? What is the range over which the roughness profiles are linear in log-log space and when and why does this linear scaling break down?

g. Save a colormap of the detrended initial roughness scan and a figure of the fitted power spectral density profiles. Add labels to all plots and include the figures in your report for this assignment.
h. Lastly, compute the *rms* roughness and compare it to the corner wavelength of the power-spectral density. Discuss your observations!