Curvature and regolith calculations from the McDowell Mountain Park Rio burn fire site

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1 Curvature calculations

We use an 1 meter diameter template in the field to survey the central point of interest and 8 points at 50 cm radii every 45° for curvature calculations (Figure 1).

1.1 Synthetic curvature and algorithm testing

Figure 2 shows the survey geometry and synthetic elevation data with surveyed horizontal positions with approximately 45° slopes. The data are these:

My curvature calculation algorithm follows the following steps for each "wheel" of 9 points:

1. Determine distance (*dist*) between central point and ith outer point.
2. For the first four outer points, determine the slope S_i between them and the interior one as: $S_i = \frac{H_0 - H_i}{dist}$ where H_0 is the height of the central point and H_i is that of the ith outer point. For the second set of four outer points, determine the slope between them and the interior one as: $S_i = \frac{H_i - H_0}{dist}$. For the example case shown in Figure 2, the slopes are thus shown in table 1. The slopes are not exactly 1 because the diameter of the circle is not exactly 1 m.
3. Go around the 8 node wheel, determining the four individual curvatures $IC_i$by subtracting the the two slopes that make up each of the four diameters of the wheel and divide by the distance over which that occurs (half the diameter because the slopes are really at the midpoints of each radius): $IC_i = \frac{(slope(i+4) - slope(i))}{(dd(i+4)+dd(i))/2}$. The curvatures in this example are thus:
4. The curvature for that central point is the mean of the 4 individual curvatures calculated above (for the example, -0.9682).

Positive curvature indicates concave up and negative curvature is concave down.

#	e (m)	n (m)	H (m)	Slope
13	999.494	1004.786	0.5	n/a
14	998.987	1004.649	0	0.9520
15	999.047	1005.027	0	0.9846
16	999.377	1005.257	0	1.0303
17	999.745	1005.198	0	1.0364
18	999.982	1004.881	0	-1.0057
19	999.917	1004.496	0	-0.9749
20	999.609	1004.279	0	-0.9618
21	999.21	1004.33	0	-0.9307

Table 1: Surveyed data and synthetic elevations used to calculate slopes and curvature in the example.

#s	Slope1	Slope2	Distance/2	Curvature
14-13-18	0.9520	-1.0057	0.5112	-0.9575
15-13-19	0.9846	-0.9749	0.5103	-0.9599
16-13-20	1.0303	-0.9618	0.5026	-0.9909
17-13-21	1.0364	-0.9307	0.5098	-0.9646

Table 2: Slopes, distances over which they change, and individual “spoke” curvatures.

2 Regolith thickness determination

We determined regolith thickness at the center of each of the surveyed wheels by qualitatively determining the greatest change in induration with depth. This was done using a shovel or screwdriver (Figure 3). Usually, a strong change in color to more reddish below corresponded with the interpreted depth.

3 Results

3.1 Burnt transect from August 4

See Figures 1 and 4 for a view of the transect site and a map respectively of the burnt transect that Tamara Misner and I worked on August 4, 2002. Figure 5 shows the basic measurement distribution for curvature and regolith. The curvature distribution shows a mode in the small negative (convex upward) curvature and a longer tail to the positive (concave upward) curvature side. Mean and standard deviation of the curvature are 0.0231 ± 0.0788. The regolith distribution has a mode between 5 and 10 cm and the mean and standard deviation are 13.2653 cm $\pm$ 7.3308 cm.

No clear trend in the plot of regolith versus curvature is evident (Figure 6). The outlier of high positive curvature and high regolith thickness was measured in a large Paloverde near a channel. The negative curvature measurements show a slightly more clustered regolith distribution and a lower maximum.

3.2 Unburnt transect from August 25

See Figures 7 and 8 for a view of the transect site and a map respectively of the unburnt transect that Caitlin Schrein and I worked on August 25, 2002. Figure 9 shows the basic measurement distribution for curvature and regolith. The curvature distribution shows a mode in the small negative (convex upward) curvature and is not significantly skewed. Mean and standard deviation of the curvature are 0.0197 ± 0.0564. The regolith distribution is centered around 10 cm and the mean and standard deviation are 11.8725 cm $\pm$ 7.3620 cm.

No clear trend in the plot of regolith versus curvature is evident (Figure 10). The negative curvature measurements show a slightly more clustered regolith distribution.

3.3 Comparisons and preliminary conclusions

Figures 11 and 12 and Table 3.3 compare the two datasets. Qualitatively, they are very similar. Tentatively, I have performed a t-test to see if the means are statistically different (assuming things like the distributions are normal–standard for the t-test). I used an online t-test two sample calculator (`http://ebook.stat.ucla.edu/calculators/`) and used the calculated p-value to evaluate the significance. The null hypothesis in both cases was that the means were equal. “Small p-values suggest that null hypothesis is unlikely to be true.” Rejection of the null hypothesis is usually done at $p<0.05$. The p-value for the regolith comparison is 0.35 and for the curvature comparison, it is 0.81; both are well above the rejection level, implying that with the assumption of normal distributions, the means are likely to be the same.

We might look more deeply at the data and the secondary levels that were noted. That takes away a bit from the relative objectiveness of the current effort, but we don't see much of either internal trends or significant differences between the datasets. We might also look at those points that were deemed sufficiently close to vegetation and do some comparisons with and without.

I do wonder if the grain size distribution will show a difference that is significant?

Regolith	Mean	Standard deviation
Burnt	13.2653	7.3308
Unburnt	11.872	7.3620

Curvature	Mean	Standard deviation
Burnt	0.2306	0.078774
Unburnt	0.019743	0.05642

Table 3: Comparison of datasets.

Figure 1: Surveying along the burnt transect. We used the 1 m template to better control the curvature point survey. We sampled at the central point for regolith and grain size.

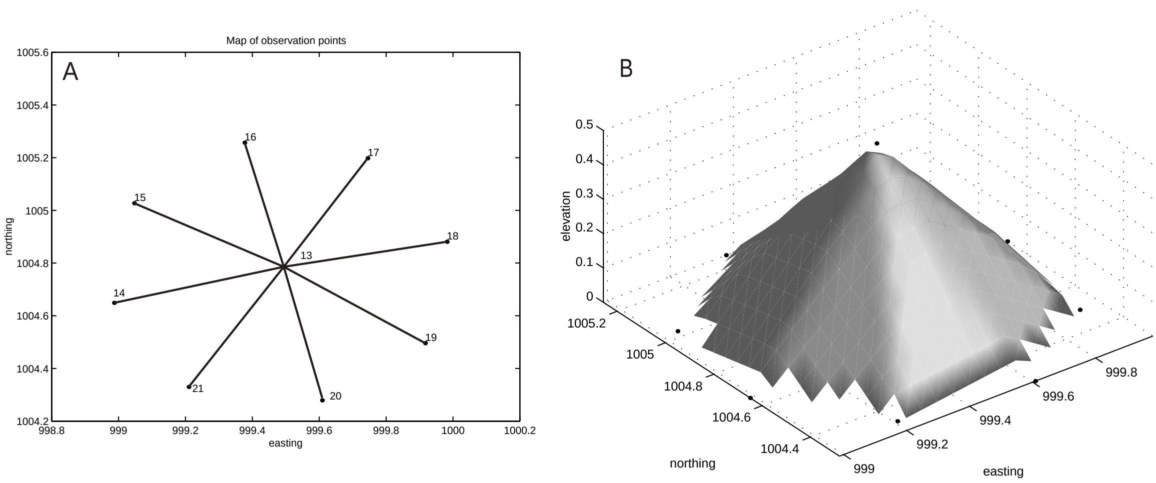

Figure 2: A) Surveyed array for curvature calculations. B) Synthetic elevation data with surveyed horizontal positions with approximately 45° slopes.

Figure 3: Regolith thickness measurements were made in pits like this. We used the shovel or screwdriver to determine the depth of the largest change in induration (screwdriver tip). Sometimes we would note a second level where the induration changed (at the base of the hole in this picture).

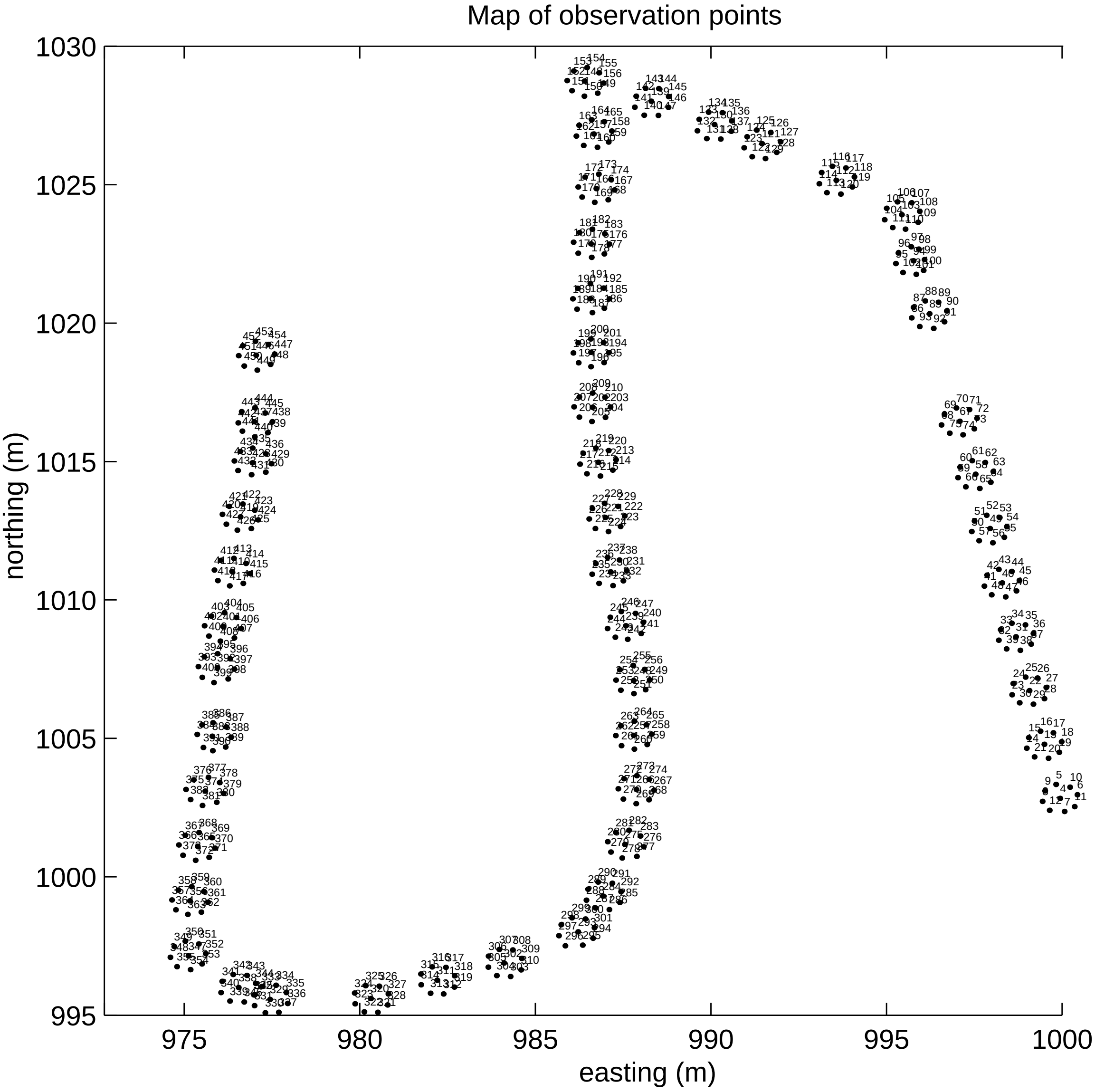

Figure 4: Map of surveyed points for transect in burnt area on August 4, 2002.

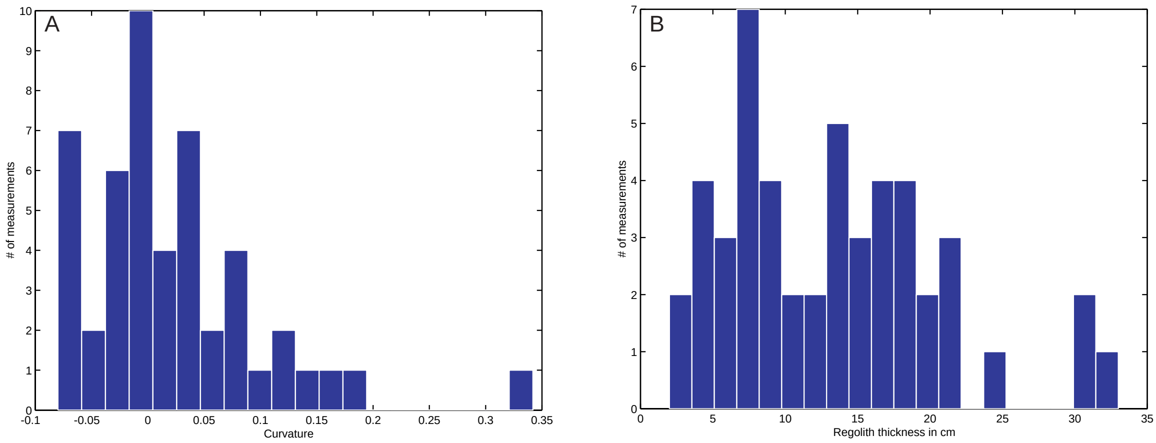

Figure 5: Histograms of August 4, 2002 measurements. A) Curvature distribution shows a mode in the small negative (convex upward) curvature and a longer tail to the positive (concave upward) curvature side. Mean and standard deviation of the curvature are 0.0231±0.0788. B) Regolith distribution has a mode between 5 and 10 and the mean and standard deviation are 13.2653 cm ± 7.3308 cm.

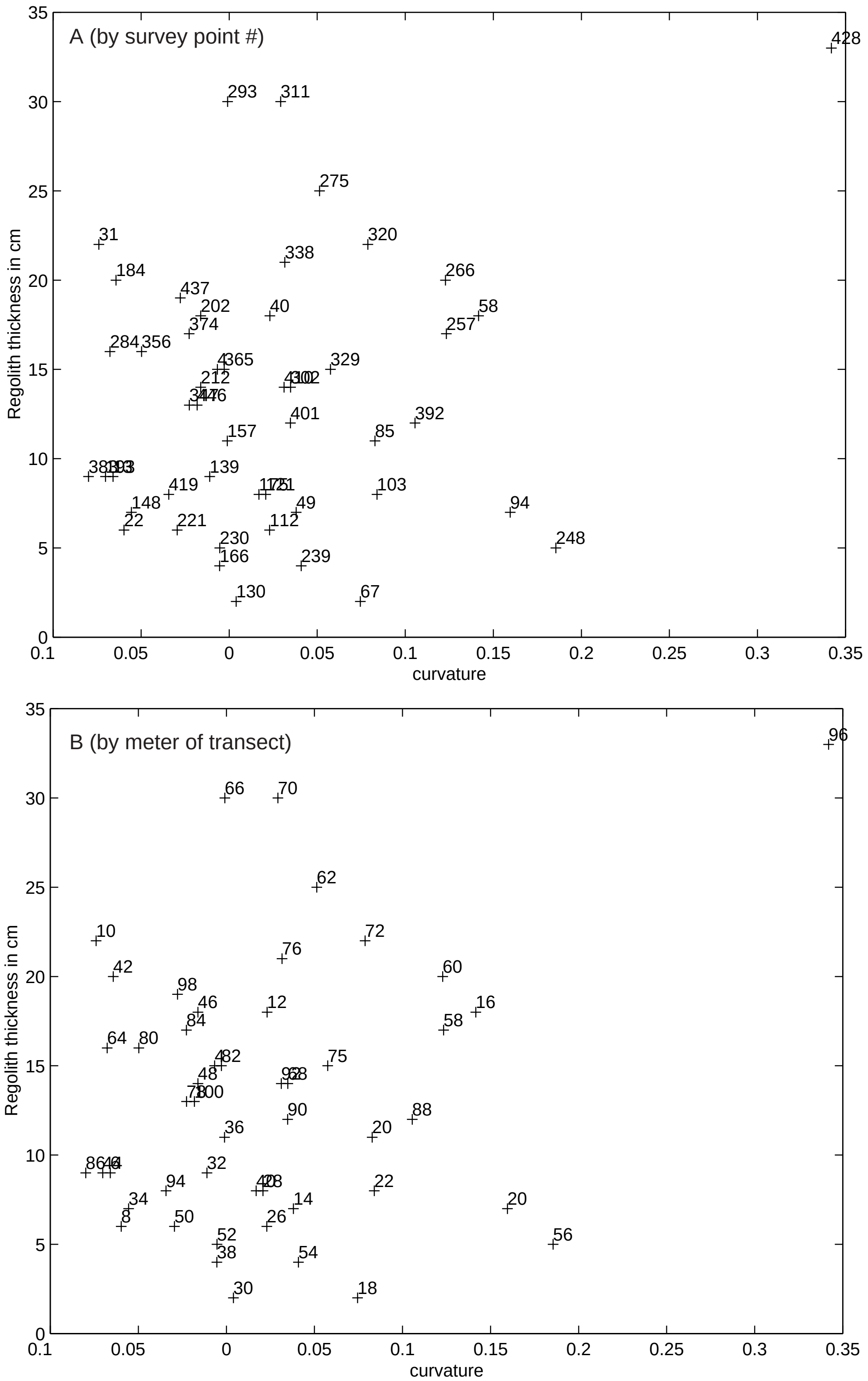

Figure 6: Regolith versus curvature. The outlier of high positive curvature and high regolith thickness was measured in a large Paloverde near a channel. No clear trend is evident. Negative curvature is convex up topography. A) Coded by survey point number. B)Coded by meter of transect.

Figure 7: Surveying in the unburnt transect. Notice the obviously larger amount of vegetation.

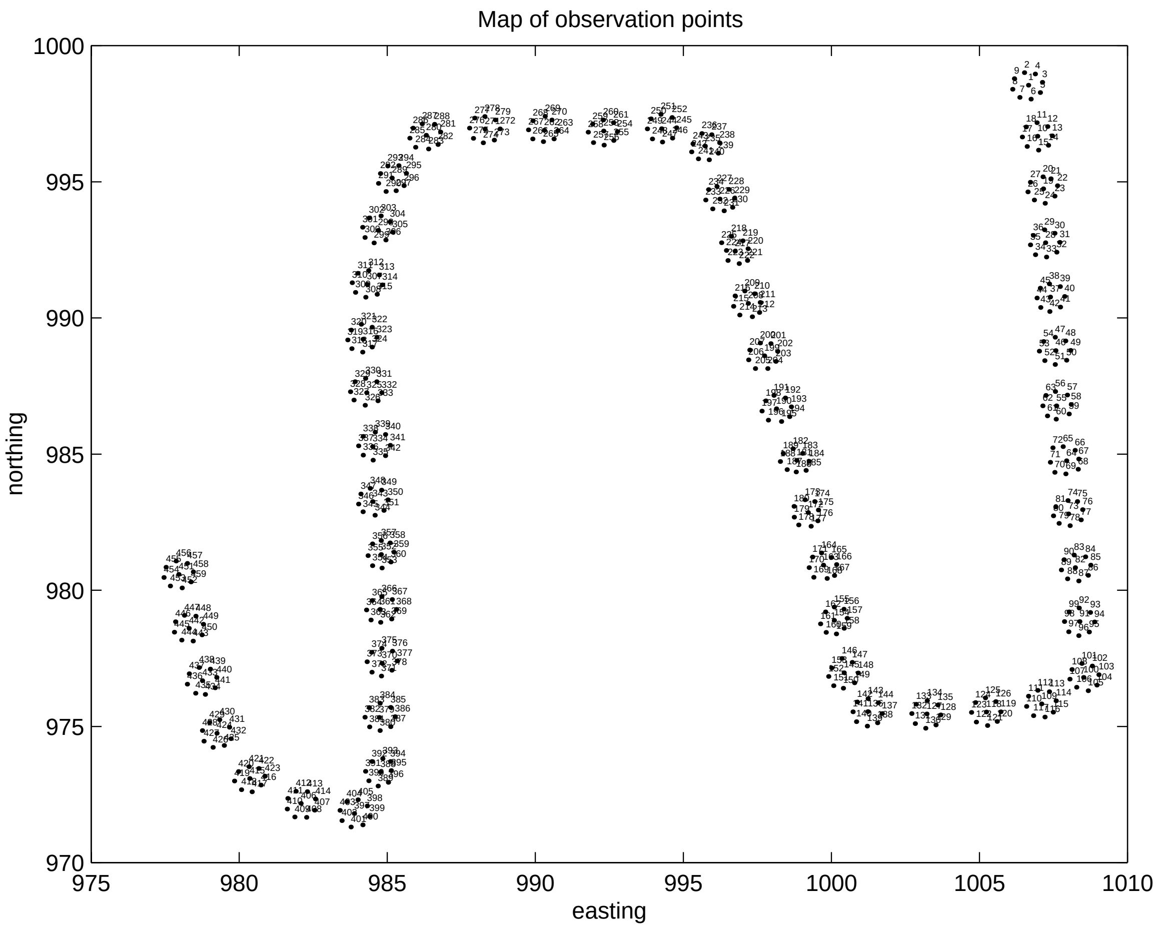

Figure 8: Map of surveyed points for transect in unburnt area on August 25, 2002.

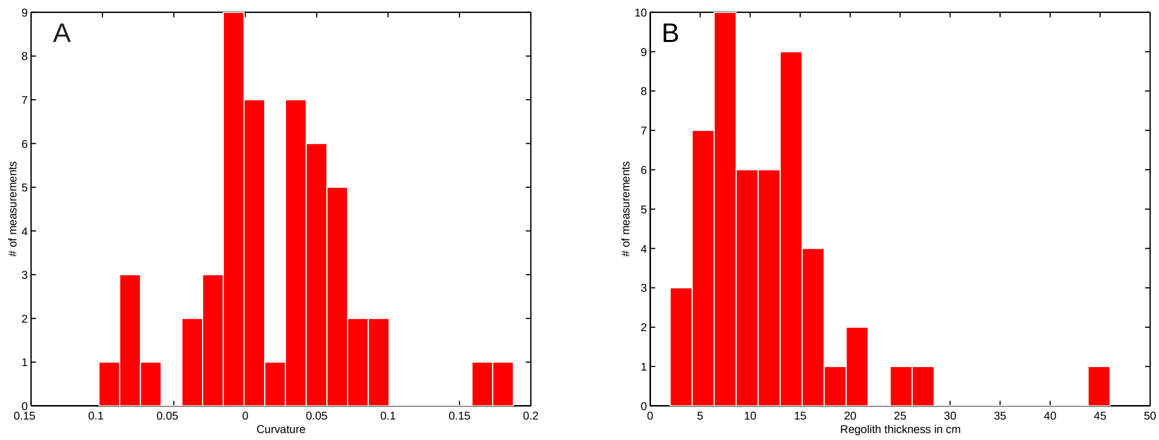

Figure 9: Histograms of August 25, 2002 measurements. A) Curvature distribution shows a mode in the small negative (convex upward) curvature and is not significantly skewed. Mean and standard deviation of the curvature are 0.0197±0.0564. B) Regolith distribution is centered around 10 cm and the mean and standard deviation are 11.8725 cm ± 7.3620 cm.

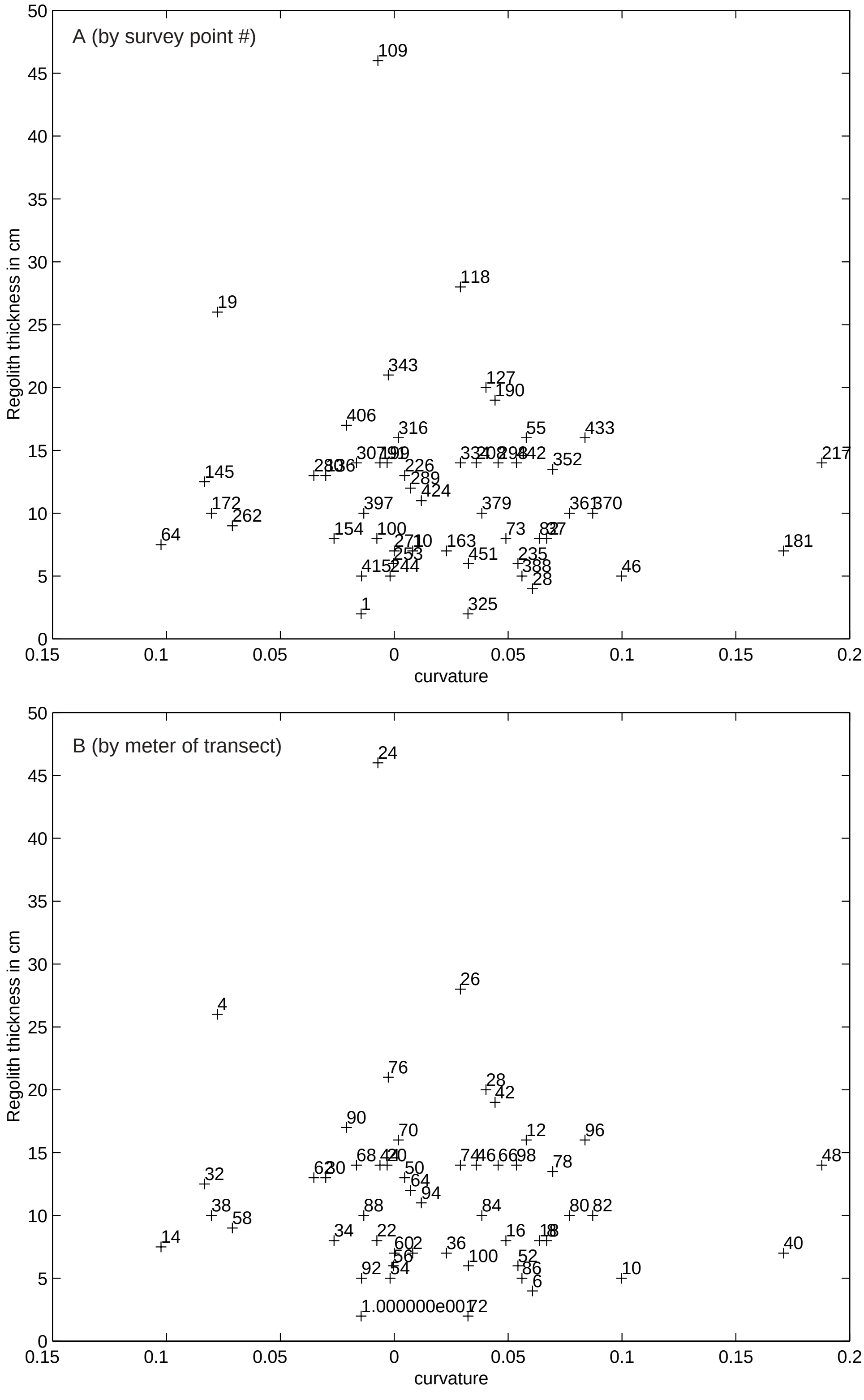

Figure 10: Regolith versus curvature. No clear trend is evident. Negative curvature is convex up topography. A) Coded by survey point number. B)Coded by meter of transect.

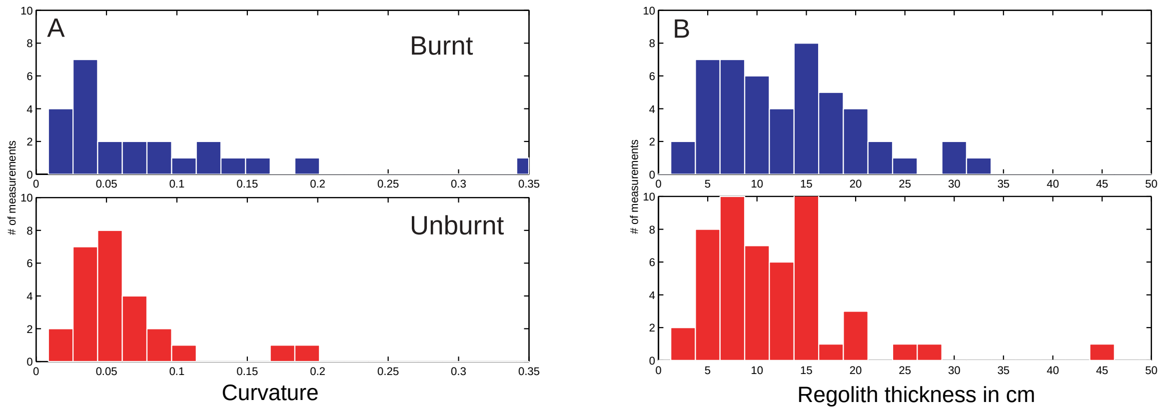

Figure 11: Comparison of burnt and unburnt curvature (A) and regolith (B) distributions.

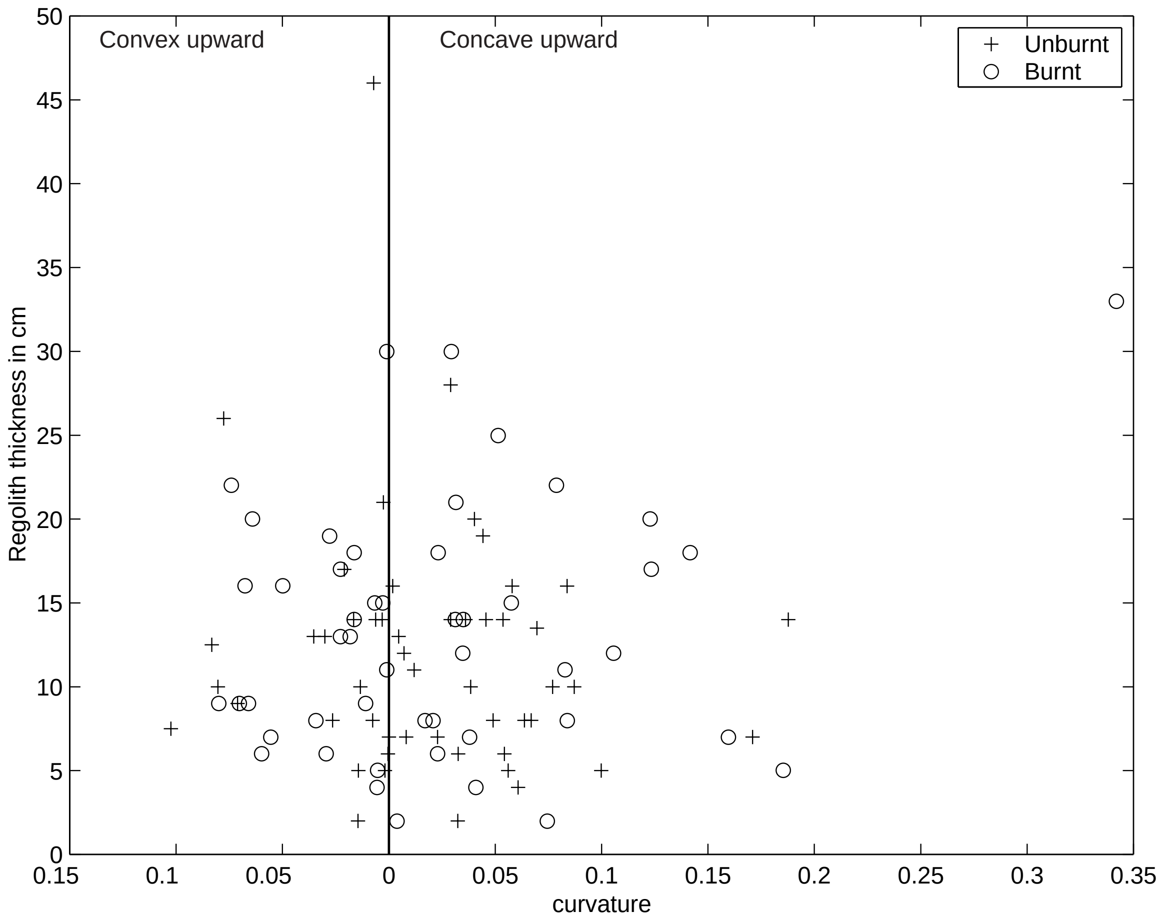

Figure 12: Comparison of burnt and unburnt regolith versus curvature.