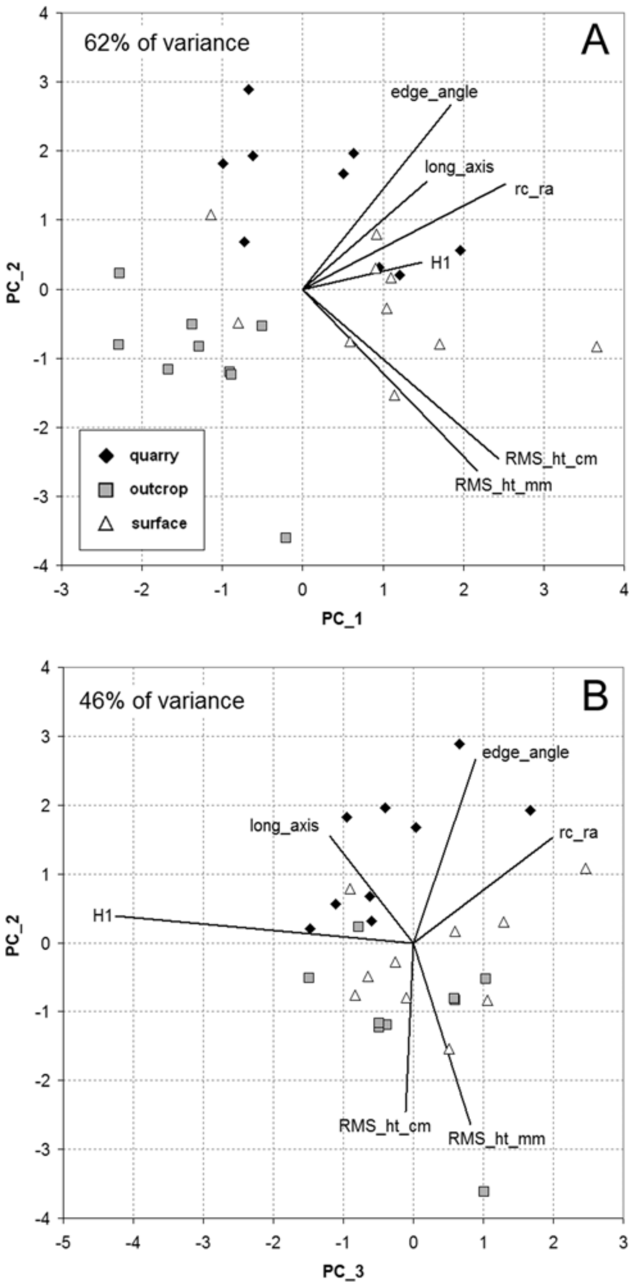

Figure 13. Principal component analysis of Ephrata boulder data with data and original parameters reprojected into component space for (a) component 2 versus component 1 (62% of the variance) and (b) component 2 versus component 3 (46% of the variance). Boulders from each of the three sites tend to plot together and textural parameters and shape parameters account for different types of variation.

[64] These three morphologic boulder populations corresponded to (1) unweathered, flood-transported basalt boulders; (2) flood-transported basalt boulders which had undergone extensive in situ weathering; and (3) talus basalt boulders. All boulders examined had the same lithologic provenance: columnar jointed basaltic flows of the Columbia River Basalt. Shape parameters distinguished flood-transported from talus boulders while surface texture parameters distinguished boulders which had experienced weathering in the surface environment from those which had not. Quantitative morphologic size, shape, and texture parameters distinguished significantly different boulder populations but sedimentological shape metrics did not. This indicates that boulder morphology does preserve identifiable signatures of rock breakdown history, although these require careful measurement rather than visual comparison or qualitative categorization alone.

[65] Insights into morphologic signatures of preservation and destruction were also gained. Inheritance of lithologic characteristics (e.g. the angles of columnar joints) could be identified in all boulders. Also, comparison of in situ weathered versus pristine flood-transported boulders showed that there are limits to the length of time diagnostic rock breakdown features will persist under subsequent process regimes. Relative to quarry boulders, surface boulders had roughened and lost some of their characteristic edges with high curvature and columnar jointing-controlled angles. A recently or presently active surface weathering process is likely generating morphologic signatures which include near perpendicular boulder edge angles and similarly rough RMS height and deviation values for both outcrop and surface boulders. It remains for future research to characterize feature persistence and the rates of erasure of flood transport signatures in surface boulders and to identify the responsible processes at this site.

[66] Employing this parameter set for shape and surface texture at other sites with rocks of different lithologies and breakdown histories will allow further testing and refinement of the parameter set. The set of parameters developed here provides a means for comprehensive, quantitative analysis of boulder form. Measurements are repeatable, objective, and do not rely on qualitative judgments about weathering feature identification and origin before measurement of shape and surface texture characteristics. As such, these parameters are ideal for recording boulder form information across sites by multiple research groups for later cross comparison. By developing an extensive, empirical data set of boulder form from sites with different rock breakdown histories, the natural diversity of boulder form will be more completely captured. Such data, in tandem with existing methods for assessing specific weathering processes, will aid in unraveling which particular boulder morphologic traits are unique indicators of specific processes and which may result from complex interactions of multiple lithological and environmental parameters. These quantitative shape and surface parameters may also be particularly useful in weathering experiments in the lab and in the field, enabling tracking morphologic feature evolution in response to specific variables. By rigorously relating shape and textural parameters to boulder physical parameters and environment, the relationship of boulder form to weathering process can be better modeled and predicted.

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