RESIDUAL ELEVATION ATTRIBUTE MAPPING

3D LiDAR DATA FOR GEOLOGICAL ANALYSIS **March 2018**

A Novel Application of LiDAR Data for Surface Geologic Studies

A topographic surface evolves from a number of processes including, but not limited to, geologic factors. Topographic features such as outcrops, faults, etc., provide direct evidence of the underlying geologic structures.

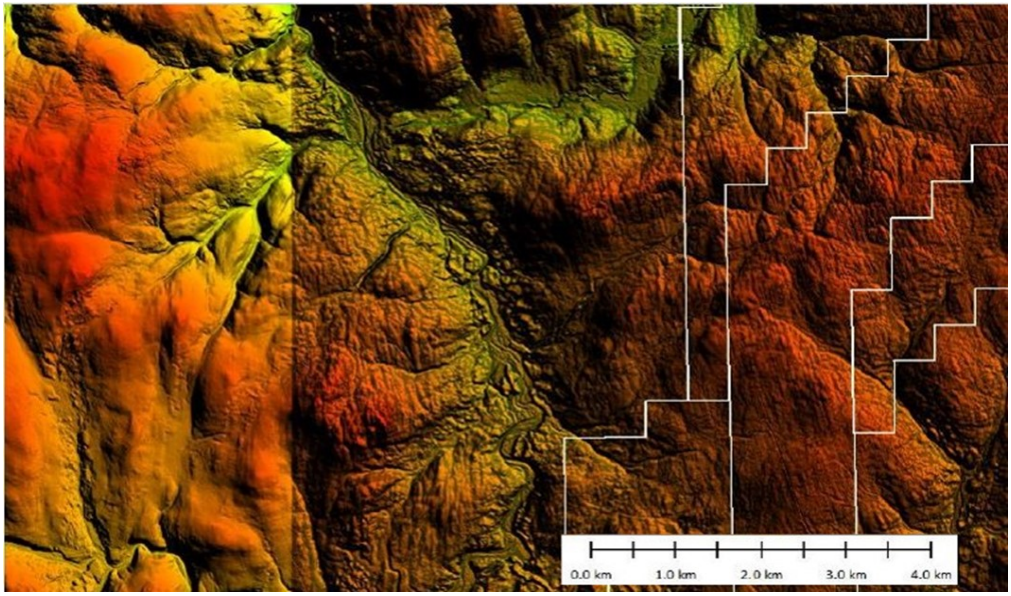
LiDAR terrain models contain a great deal of information, including the elevation of these topographic features. However, if the irregularities related to these features have very small vertical changes, they are unlikely to become visible using currently available software.

LSI's affiliate, Mario Profeta, a geophysicist based in Argentina, has succeeded in highlighting geologic structures that are only weakly reflected within the topographic surface by applying a novel algorithm to LiDAR point cloud data. The outcome of this algorithm is known as Residual Elevation Attributes (REAs).

The use of the word 'attribute' is based on the fact that this algorithm yields a new dimensionless value highlighting a property (or attribute) that is specific to LiDAR measured data. In this case, the highlighted property is the high frequency content of the measured topographic surface. In other words, the algorithm highlights terrain irregularities that simultaneously have small vertical size and limited areal extent in one direction. These irregularities make up the high frequency component referred to above.

Therefore, if geologic structures are represented at the topographic surface to a greater or lesser extent, irregularities resulting from their occurrence – no matter how small these may be – will be displayed as highlighted features on the map created from computed REA values. *See reverse side for further images illustrating this process.*

"We have succeeded in highlighting geologic structures that are only weakly reflected within the topographic surface by applying a novel algorithm to LiDAR point cloud data"
- Mario Profeta



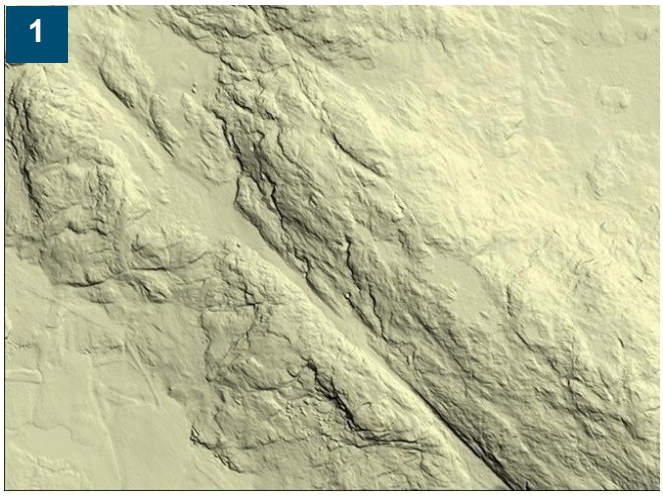
REA Example

- Far left: LiDAR Digital Elevation Model
- Centre and far right: DEM with the REA algorithm applied
- REA data is draped over the DEM at 50% transparency
- A high frequency orthogonal fracture set is very well displayed compared to the non-treated area

Residual Elevation Attributes from 3D LiDAR

If geologic structures are represented at the topographic surface to a greater or lesser extent, irregularities resulting from their occurrence – no matter how small these may be – will be displayed as highlighted features on the map created from computed Residual Elevation Attribute values. The images on this page illustrate this process.

900 m

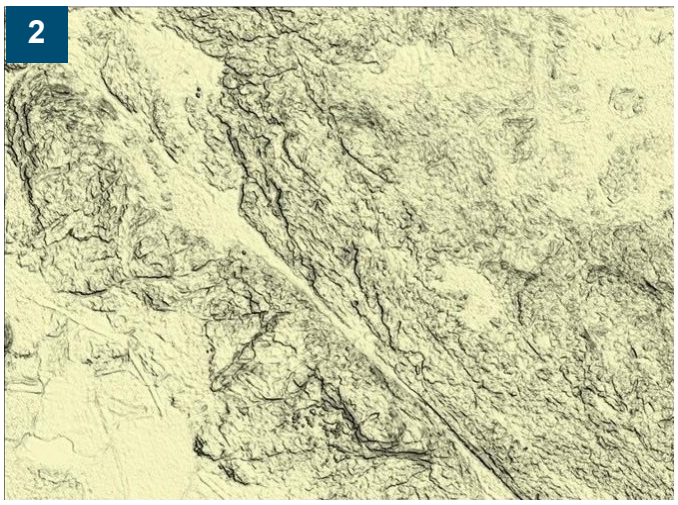


In **Figure 1**, a terrain model (in "shaded relief" mode) of a sample topographic surface was created from LiDAR data for an area in Canada.

The respective Residual Elevation Attribute map (also in "shaded relief" mode) created from the LiDAR data in Figure 1 is shown in **Figure 2.** Several features that are weakly displayed on the map shown in Figure 1 are better displayed in **Figure 2**.

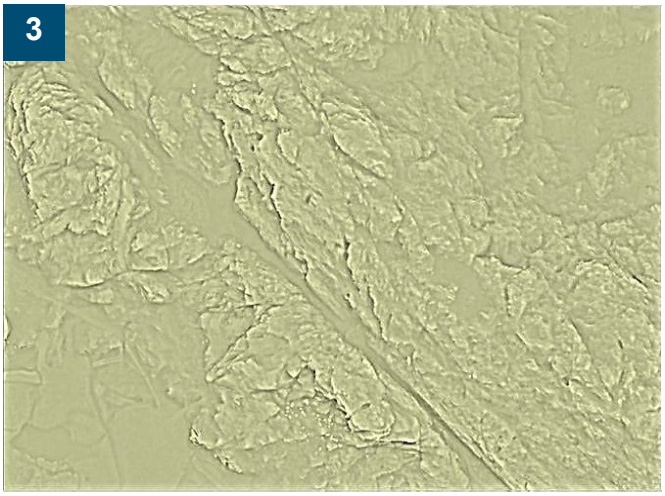
The resultant Residual Elevation Attribute map (in "image" mode) created from the same LiDAR data is shown in **Figure 3**.

900 m



This novel Residual Elevation Attribute process can be employed in surface geologic studies for mining, oil, and geotechnical projects as it highlights any weak occurrence in the topographic relief. It can also be employed to study subtle man-made changes in topography.

900 m



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