The Use of COCONet to Support Ground-based and Airborne LIDAR Assessment of Glassy and Vesicular Lava Textures on Caribbean Volcanoes

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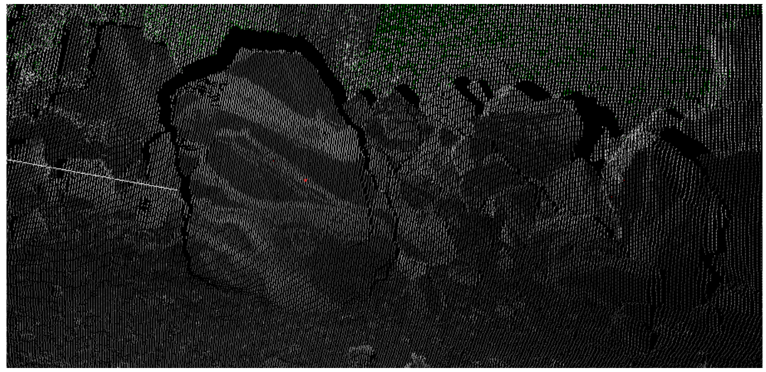
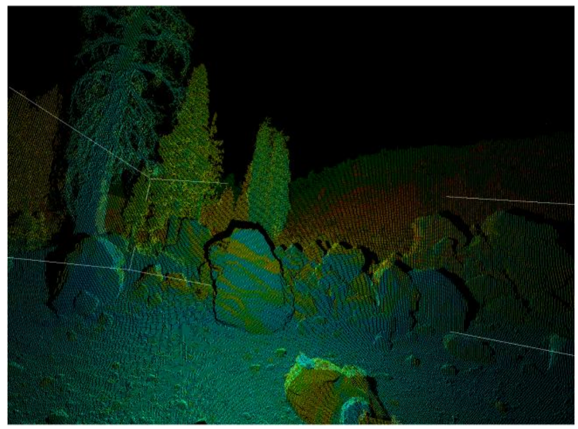
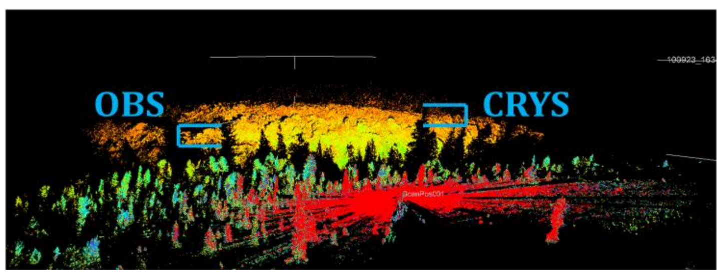
Many hazards associated with volcanic eruptions in the Caribbean are associated with the emplacement of silicic lava domes, such as those that have formed at Soufriere Hills (Montserrat), Mt. Pelee (Martinique), and Soufriere (St. Vincent). The distribution of vesicular and glassy textures on silicic lava dome surfaces provides insights regarding degassing processes occurring during emplacement, and indicates the volatile content of lava upon eruption. Scoriaceous and pumiceous carapaces are commonly observed on domes with lava water contents sufficient to cause surface vesiculation, and suggest that volatile contents remain high during emplacement. Smooth or glassy textures are typically found on episodically-emplaced domes where a strong surface crust forms through extensive cooling, favoring endogenous growth and more thorough near-surface degassing. However, determining the vesicularity remotely is difficult, typically requiring field confirmation which is not always safe or practical during emplacement. Vesicularity estimates made with thermal remote sensing are possible, although the resolution of the datasets are typically too coarse to show detailed patterns of glassy and vesicular textures, repeat measurements during eruption are not always possible depending on the platform used to deploy the instrument, and processing times may preclude using these data for monitoring purposes. Terrestrial and airborne LIDAR have increased resolution and potential for better temporal coverage than current thermal remote sensing options, and new full waveform LIDAR scanning has the potential to detect vesicularity differences on lava surfaces. Scan times typically require only minutes, allowing for repeated scans over short time spans, and processing times are less than an hour. We have developed a new full-waveform LIDAR setup with a co-registered FLIR sensor capable of providing thermal values to the XYZ data. We are investigating the potential of this system to detect vesicularity differences on lava domes by acquiring and analyzing scans of the textural and compositionally diverse Inyo Domes in California. We find that the strength of the returned 1550 nm wavelength pulse is affected by both the vesicularity and crystallinity of the lava, providing a method for acquiring topographic, thermal and textural data at sub-decimeter resolutions from distant (100's of meters) scan positions.



Above: Photograph of a magma-mixing in a talus block at Glass Creek dome. Above right: Image of reflectance of same block clearly showing bright obsidian and darker crystalline material. Right: Image showing amplitude of reflected radiation, which is also texture-dependent.





Above right: Photograph of Glass Creek dome. The crystalline section of the dome is near the range limit of our LiDAR system (500m). Above left: 16-bit distance-calibrated reflectance image of returned LiDAR signal. Magma mixing can be seen in transition zone between OBS and CRYS

The range and cost of our instrument still precludes use in many active dome settings, although a new generation of scanners with increased range may quickly make this technology an attractive option. The COCONet array is essential for providing the geodetic control necessary to tie these high-spatial resolution data sets to real-world coordinate systems required for acquiring precise measurements in hazardous areas.