LASER REMOTE OPTICAL GRANULOMETRY (LROG) - A NEW TECHNIQUE TO REMOTELY MEASURE TEXTURAL FEATURES OF SEDIMENTARY SEQUENCES WITH APPLICATION TO MOUNT ST HELENS

HOW LROG WORKS

LROG equipment

Several exposures at MSH are inaccessible or contain a high concentration of blocks, rendering traditional field sampling methods difficult to impossible. In response to this field challenge, in the UASLP-LAIMA laboratory, it was developed the Remote Laser Optical Granulometry (LROG). A new instrument and method that allow for the remote texture study of outcrops of sedimentary deposits based on high-resolution imaging and stereologic techniques. LROG has been used to measure fabric and grain size distributions for hillslope deposits and MSH deposits in areas that are otherwise inaccessible.

The LROG instrument consists of a high-resolution digital camera (7), stand-alone or coupled to a small telescope (5), in parallel to a three laser projection system (9) (calibrated by means of a precision inclinometer). The method consists in taking high-resolution images of the outcrop, which can be several tens of meters away, containing the three laser points that act as a precision reference scale. This scaling system is independent of the distance to the outcrop. During the analysis phase, a set of lines, parallel to the sedimentary deposit, are superimposed to the image which also contains the reference points. The length of the intersection of each line with each particle is measured and tabulated (Sarocchi et al., 2005). Depending on the optical system and the distance to the outcrop, particles as small as 0.1 mm up to several meters can be measured precisely.

Resolution enhancement techniques

High-resolution LROG photography can be deeply affected by atmospheric conditions, especially humidity, as the absorption and scattering properties of the atmosphere are taken from tens or hundreds of meters away. Dry air, which limits the atmospheric turbulence in the day, surface affects, or the presence of structures or noise of the images in order to obtain better resolution. The use of Speckle imaging techniques has proven quite useful. Lasers, and especially CCD cameras, can be used as a source of illumination. This technique for images obtained from a distance is known as ‘Speckle photography’. The short exposure time, from a few milligrams to a few tens of milliseconds, makes it possible to obtain resolutions in the order of the micrometers. The intensity of the speckles is modulated by the surface microstructure, representing the roughness of the surface.

LROG granulometry of Mt. St. Helens Deposits

Study area and samples locations

During the last decade, erosion at Mt. St. Helens has been very intense, generating several new deposit outcrops. Most of the outcrops are made of material with a low degree of consolidation and enormous thicknesses. Granulometric sampling done with traditional methods is difficult and dangerous to perform, and therefore remote sampling is very useful to use the remote method developed in our laboratories (Sarocchi et al., 2011; Moreno-Chavez et al., 2016). In this paper, it is proposed to study the degree of consolidation of the blocks and the thickness of the deposits through the use of remote sensing technologies. The analysis of the samples can be performed using DECOLOG software. The software allows the obtaining of granulometric maps from the main statistical parameters, and the analysis of variances and variances from the measured data. The granulometric analysis is performed by means of LROG optical analysis and is automated. Quantitative image analysis allows to build vertical profiles and optical granulometric maps of the main statistical parameters (Moreno-Chavez et al., 2015; Sarocchi et al., 2016; submitted). The optical granulometric samples are obtained by means of the Optical Block and Ash Flow (BAF) at Colima Volcano: new insights on volcanic granular flows from textural analysis. J. Volcanol. Geotherm. Res. 276, 189–214.

Granulometric areal maps

Vertical Granulometric Profiles

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LROG GRANULOMETRY OF MT. ST. HELENS DEPOSITS

3D Fabric as flow direction indicator

The study of apparent fabric on outcrops (high-resolution images), analyzing thousands of particles, allows to measure texture-related parameters. In this paper, the use of LROG technique to analyze the sample and the degree of consolidation of the deposit and to infer the flow direction is proposed. The degree of orientation, the variance and the variance are introduced as new parameters to analyze the sample and the degree of orientation. The degree of orientation is indicated by the length of the arrow, the degree of elongation, green areas represent the degree of elongation.

REFERENCES

The optical granulometric samples are obtained by means of the Optical Block and Ash Flow (BAF) at Colima Volcano: new insights on volcanic granular flows from textural analysis. J. Volcanol. Geotherm. Res. 276, 189–214.

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The authors wish to thank all the volunteers and people who have contributed to the work done with traditional methodology (Brand et al., 2014; Brand et al., 2016), we conducted three campaigns during the years 2015, 2016 and 2017 using remote sensing techniques. During these campaigns 20 outcrops have been studied (most of them along the main river drain). The outcrops have been obtained at high-resolution speckle images, three vertical granulometric profiles and an integral view analysis of each of the depositional units.