

Project Outcomes Report:
*Acquisition of Next Generation Terrestrial Laser Scanning Systems
for Community Earth and Polar Science Research*
NSF EAR-1261653

Terrestrial Laser Scanning (TLS) is an imaging technique that relies on light detection and ranging (lidar) technology to generate three dimensional sub-centimeter-resolution imagery of topographic and other surfaces, including rock or ice outcrops, caves, trees and vegetation, and cultural objects. TLS instruments are extremely precise, reasonably portable, relatively easy to operate, and have been used successfully in a variety of environments to support a wide range of geoscience investigations, including detailed mapping of fault scarps, geologic outcrops, exposed fault-surface roughness, frost polygons, volcano edifice morphology, lava lakes, dikes, fissures, glaciers, columnar joints, hillslopes, and surficial drainage feature morphology. Moreover, repeat TLS surveys allow the imaging and measurement of surface changes through time, arising, for example, from fluvial erosion or landslides, volcanic deformation, ice flow, beach morphology transitions, and post-seismic fault slip. TLS is applicable to problems with length scales from the 10s of meters to kilometers. Concurrent GPS measurements are used to georeference the TLS data in absolute 3D coordinates. Coincident high-resolution digital photography allows for the generation of photorealistic 3D images and enhanced visualizations of the scan data.

UNAVCO, Inc., a non-profit university-governed consortium that facilitates geoscience research and education using geodesy based in Boulder, Colorado, provides Terrestrial Laser Scanning (TLS) support to Earth science researchers in the UNAVCO community. We maintain a pool of TLS scanners, as well as supporting ancillary field equipment (e.g., GPS systems, tripods), software, and staff trained in best practices for operation of these systems. The pool of TLS instruments provides a suite of capabilities in terms of instrument range (10 cm to >2 km), size and portability, scan speed, field of view, and multi-return and full waveform data capture. This diversity of instruments allows UNAVCO to support a wide range of Earth science applications. UNAVCO is also a nexus for community activities such as workshops, short courses, and education and outreach.

This project - *Acquisition of Next Generation Terrestrial Laser Scanning Systems for Community Earth and Polar Science Research* – was funded through the NSF EAR-IF program to acquire two new terrestrial laser scanning (TLS) instrument systems for the UNAVCO community equipment pool. These TLS systems are a shared resource managed by the Geodesy Advancing Geosciences and EarthScope (GAGE) Facility operated by UNAVCO for the NSF under a Cooperative Agreement (EAR-1261833) from 2013-2018 and integrated into UNAVCO's ongoing support for NSF Divisions of Polar Programs (PLR) and Earth Sciences (EAR) projects. The new TLS instruments are critical resources for the Geodetic Imaging group within the Geodetic Infrastructure program under the GAGE Facility. Considering the expense of TLS equipment and the expertise needed for successful operation, this approach represents the most cost effective means of maximizing return on investment and making this technology accessible to the NSF Earth science and Polar research communities. Related services also provided by UNAVCO EAR and PLR include access to the GPS instrument pool, project planning, logistical support, field support and training, data management and archiving, post-field project follow-up and data processing assistance, and research and development work for supporting new applications.

Through this award two new TLS systems were acquired: A Riegl VZ1000 and a Riegl VZ2000. An open RFQ process was used to select and acquire the instruments. Funds from this award were

also used to upgrade other TLS instruments, and to acquire supporting equipment such as new GPS receivers.

During the course of the award, the new Riegl VZ1000 and VZ2000 TLS systems were used to support 27 TLS field projects in both Earth and Polar sciences. These instruments were used for projects in volcanology, glacial dynamics and climate change, biological sciences, geomorphology, sea-level rise and coastal processes, archeology, and geodetic field education. As part of UNAVCO's GAGE equipment pool, these TLS instruments, and ancillary equipment and associated software resources, will continue to be used for to support NSF PLR and EAR projects by members of the UNAVCO community.