Examples of Methods of Control for Vertical Outcrops Applied to Close Range and Drone Photogrammetry in Texas, Oklahoma, and Saudi Arabia

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Abstract

Vertical wall outcrops have been critical to understanding the sedimentary and tectonic history of geological structures. Such outcrops, originally described with hand drawings and later mosaic photography and LiDAR, are now being captured with terrestrial and aerial photogrammetry. Georeferencing of the models poses challenges that can be resolved with typical survey instruments and methods. Outcrops such as road cuts, canyon walls, and cliffs are incised geological features that offer the geologist an excellent cross-section of sedimentary bedding and tectonic deformation. Such features were originally described with hand drawings and later represented with mosaic photographs. Both the drawings and mosaics are 2D representations which limit the information that can be extracted from them. True 3D photorealistic models of such outcrops allow the geologist to make all dimensional and orientation measurements on the models that he could make it in the field with a Brunton compass, Jacob's Staff, and tape measure. In addition, true scale down plunge cross-sections of an outcrop can be easily produced from such 3D models. LiDAR is one means of capturing such models but requires expensive instruments and software to produce useful results. Photogrammetry offers a faster and more cost effective means of capturing and creating 3D models. However, orienting the photogrammetric model of a vertical wall can present challenges that are inherently resolved by the survey nature of a LiDAR instrument. For lower cost aerial drone photogrammetry with a down looking camera, targets are placed over the area to be captured and the targets are surveyed with GPS or with a total station. For a side looking drone configuration or terrestrial photogrammetry, placement of such targets are inconvenient to impractical. A solution to this problem has been demonstrated using a survey instrument such as a total station to locate distinctive features on the outcrop surface that can be readily identified in the camera photographs. The total station surveys its location using reflectors that have been located with GPS and then captures XYZ location of the features on the outcrop wall. Outcrops along I35 in the Arbuckle Anticline of southern Oklahoma, road cuts of the Eagle Ford Shale along US 90, canyon walls along the Rio Grande River near Langtry, TX, which contain archeologically important rock shelters, and rock fall prone road cuts in western Saudi Arabia have captured with either terrestrial or aerial photogrammetry and registered with survey instruments. These photogrammetric models have been compared to LiDAR derived models for an assessment of the accuracy of the models. In addition to the use of survey instruments, the use of on-camera GPS has been explored identifying a serious model orientation problem that results from a linear traverse of camera positions. Such a traverse would be natural for the acquisition of road cut outcrops.