USING NEW, NOT SO OLD, AND TRADITIONAL GEOLOGICAL TECHNIQUESTO INTERPRET GEOLOGIC SECTIONS IN CRETACEOUS HELL CREEK FORMATION STRATA OF MONTANA

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INTRODUCTION. New and updated techniques are applied to data gathering every day with rapidly changing technology. During the 2008 field season, a team of paleontologists and geologists studying the uppermost Cretaceous Hell Creek Formation in its type area in Garfield County, Montana, had the good fortune to have Flag Butte scanned with Riegl Z390 LiDAR (light detection and ranging) by Peterson and Rice. The objective of the scan was precise placement of observations (made by various means) on this important butte. This report is an initial testament to our effectiveness in correlating GPS (global positional system) data to a LiDAR surface.

METHODS–LiDAR. In badlands terrain, this involved completing a sight survey, followed by the placement of a collection of retro-reflective markers throughout and on the perimeter of the study area. Each reflector is required to be in line-of-sight from several locations. After the reflectors were placed, the Riegel was placed at a location and a scan made to get the precise location of each of the retro-reflective markers. After initializing the retro-reflective markers, a surface scan of point data (in all directions) was made of the area at a resolution of at least 0.1 degree. After scanning was completed at all positions, each scan position was searched and its respective reflector located. This location information was translated into a project coordinate system. Once all of the scans were so linked together, we were able to take WAAS-optimized GPS data from a Garmin Legend® GPS for several of the retro-reflective reference points that we collected and referenced the project coordinate system to a global coordinate system, which, in this case was a UTM coordinate system with a WGS87 datum. Peterson subsequently created the LiDAR surface (at the Museum of the Rockies, with the support of the Museum of the Rockies through the assistance of John Horner). Digital photographs taken from the LiDAR stations were superimposed with the LiDAR surface.

METHODS–GPS AND GIS. Hartman and Burton-Kelly acquired the LiDAR data from Peterson and, with the generous assistance of Sue Martin, Operations Manager/Controller of Riegl USA, Inc., were able to process the data at the University of North Dakota. As part of our learning experience, likely not the most elegant method was chosen in ESRI ArcGIS 9.2 (geographic information systems) to determine the relative elevation difference between the LiDAR surface and our secondary GPS waypoints. Note that LiDAR station control points were located with the Garmin Legend®, but LiDAR surface elevation control was configured with the aid of higher-resolution GPS data collected by Jeremy Riedel and Greg Wilson using a Trimble GeoXT™. These data were taken during a paleomagnetic survey under the supervision of William C. Clyde and Rebecca M. LeCain (University of New Hampshire). GPS waypoints of measured sections and fossil localities were taken by Hartman and Arthur E. Bogan (North Carolina Museum of Natural Sciences) using WAAS-optimized GPS units, including a Garmin GPSmap76 and DeLorme Earthmate® GPS PN-20

Of the 16 GPS section values measured, most of which were taken on the perimeter of the LiDAR scan, the average Earthmate® GPS elevation error recorded in November 2008, was 4.29 m, with a range of 2.13 to 7.01 m. Almost all of the actual GPS readings occur above the scanned LiDAR surface by an average of 9.55 m, ranging in value from -0.69 m (one reading below) to 26.54 m. The four GPSmap76 fossil locality waypoints taken in July 2008 average 7.01 m above the LiDAR surface, with a tight range of 6.65 to 7.64 m (no GPS field measurement error was recorded). Additional Earthmate® GPS observational waypoints were taken within the scanned area in July. These elevations average 3.90 m above the LiDAR surface, ranging from 0.02 to 8.44 m. The GPS receiver error average for these reading was 4.75 m, ranging from 3.05 to 6.40 m.

SUMMARY. The LiDAR method holds great promise to establish a surface "ground" truth for field observations. The current project highlights sources of error that need better control to optimize interpretation of "corrections" to be precisely applied to geological and paleontological elevation field data. The general availability of LiDAR scans will provide a means to precisely transfer low-tech and inexpensively derived field data to all interested parties without loss of fidelity.

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