Drone Applications at the NDGS

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Drones are becoming a very prevalent technology in many industries. Earlier this year, the North Dakota Geological Survey (NDGS) purchased a Phantom 4 Pro drone, which has been used to perform a wide array of tasks (Anderson and Maike, 2017). A drone allows NDGS geologists to get glimpses of land from perspectives that could previously only be seen from planes and satellite imagery. Imagery collected from planes is useful; however, it is expensive, time-consuming, and takes strategic planning. Imagery, like that used by Google Earth, is very useful for looking over large areas of land from a plan view (the view of the surface as a horizontal plane with no relief). The National Agriculture Imagery Program (NAIP) produces a type of aerial imagery that is widely used by the NDGS, Google Earth, and many other entities. NAIP 2016 imagery for North Dakota was collected at an altitude 9,800 meters (32,000 feet) and has a ground pixel resolution of 1 meter (3 feet) (NAIP 2016 Metadata, USDA). Google Earth uses plan and oblique views, but the drawback of the imagery is that resolution becomes coarse as you approach a larger scale. Another drawback to satellite imagery is that many image sources may be a year or more old, and therefore of limited value to projects requiring up-to-date information. The NDGS's Phantom 4 Pro is capable of acquiring much higher resolution imagery, in real time, as Federal law allows this type of drone to fly up to 400 feet above Earth's surface.

The NDGS has been using drones to survey and monitor infrastructure throughout the state of North Dakota and the Williston Basin in particular. Aerial imagery is crucial for monitoring geotechnical aspects of well pads, pipelines, and roadways (fig. 1). In western North Dakota, especially in the badlands region, landslides are very common and can sometimes be confused with deposits of colluvium or slopewash. The toes of landslides are very appealing sites for well-pad placement due to their flattened slopes. Although the construction of well-pads is straightforward, when a well-pad is built upon mass movement deposits, such as a landslide, it can create stability issues for both the pad and wells. Oil companies strive to avoid these problems with careful site evaluations prior to well-pad placement, in which drones are proving indispensable. The imagery collected by a drone assists in assessment of the land and helps geologists interpret the geomorphology of the project area. There are instances where drone imagery has played a pivotal role in understanding the morphology in and around a well-pad and orchestrating a plan to mitigate risks.

Figure 1. A drone photograph of a two-pad well site situated in the Little Missouri River badlands in Dunn County. Everything to the right (north) of the pads to the base of the cliff face is comprised of old landslides.

Drone imagery has proved to be an important component of the Rare Earth Element (REE) study being conducted at the NDGS (fig. 2). This study is investigating the concentration of rare earth elements within coal samples in western North Dakota. The drone has been put to a variety of uses within this study including a reconnaissance tool, where the drone is sent out to collect imagery that will enable geologists to get greater context of coal seams and places to target as sampling sites. The drone's imagery is higher resolution than Google Earth's, making it an asset to the study. The imagery can also be brought into Geographic Information Systems (GIS) software, then georeferenced and orthorectified (corrected for distortion) onto the same plane as other imagery to convert it into a more versatile format. Figure 3 displays the NAIP imagery with

Figure 2. The Survey drone (center) was used to explore ravines along the Little Missouri River to determine if geologists could safely descend to measure sections and collect coal samples.

Figure 3. A side by side comparison of NDGS Drone Imagery and 2016 NAIP Imagery, taken from Slope County, North Dakota.

an image acquired the by the NDGS drone overlaid on top. This direct comparison illustrates that the NDGS drone acquired imagery is superior and will greatly assist geologists in their future investigations.

In addition to its image and video capture capabilities, the drone has assisted with the REE study as a safety resource. During field work, researchers often have to climb up steep and sometimes treacherous ravines and outcrops. The drone can be used to scout these areas to make sure they are safe and passable before geologists even begin their ascent. In those areas where climbing would be impossible without proper climbing gear (ropes, carabiners, etc.) the drone can capture close-up images for evaluation by geologists to determine if the area needs to be visited by staff.

Drone technology has become a great asset to the NDGS and will continue to provide geologic information for the state of North Dakota. The NDGS has one drone pilot and the Oil and Gas Division has eight pilots to collect imagery from throughout the state to support the regulatory functions of the Department of Mineral Resources. Since May 2017, the NDGS has collected over 4,500 photos and more than 50 videos of various sites, helping us to better serve our regulatory and mapping endeavors.

References

Anderson, F.J. and Maike, C., 2017, Drones Rising from the Prairie: Geological Applications of Unmanned Aerial Systems: Geo News, v. 44, no. 2, p. 8-14.

Statewide NAIP Aerial Photography 2016: https://gisdata.nd.gov/Metadata/ISO/html/metadata_AerialImage_ND_2016.html#ID0EAGA, (retrieved October 20, 2017).