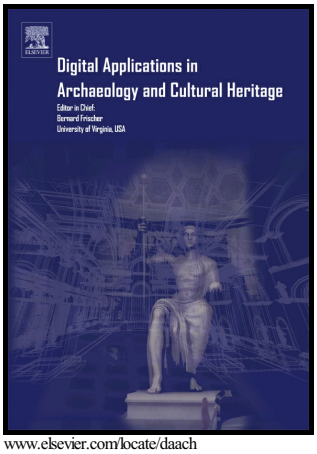

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A New Aerial Photogrammetric Survey Method for Recording Inaccessible Rock Art

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Introduction

Although archaeologists are increasingly deploying Unmanned Aerial Vehicles (UAV's) in their work, the predominant usage has been to collect images for producing Digital Elevation Models (DEM's), Digital Terrain Models (DTM's), and georeferenced orthophotos of archaeological sites and landscapes (Wernke et al 2016; Bikoulis et al 2016). Archaeologists often discuss incorporating UAV's into archaeological survey, but workflows that do so effectively are still uncommon. This is particularly true in regards to surveys targeting smaller objects such as surface artifacts or petroglyphs that are not visible from a distance. In fact, to our knowledge, no such survey has been successfully implemented (see Field et al 2017). In the case of petroglyphs, this objective is often further complicated by surfaces that do not permit horizontal flight paths or pre-programmed flight polygons. In this paper we propose a novel survey method that will produce an analytically viable geospatial registry of petroglyphs with thematic and relational attributes. This method, relying on the use of a UAV, may be particularly useful in contexts with challenging topography or time constraints.

Most efforts to digitally document petroglyphs to date focus on individual rock art panels or even the geometry of individual petroglyphs rather than on the "representational spaces" (Hubbard & Ruppel 2016). A smaller number of studies propose a workflow for digitally modelling the thematic constellations of rock art across a larger geographic expanse (Alexander et al 2015; Jennings et al 2014). These studies, however, have been conducted across relatively flat, accessible areas, with individual petroglyphs documented through pedestrian survey. Aside from being time-consuming endeavors, these research designs are often difficult to implement in contexts where rock art is difficult or dangerous to access, such as a high cliff face (Jennings et al 2017; Mark & Billo 2016) or the sides of a gorge (Fowles & Albert 2016). What is more, effective geospatial analysis of such contexts requires both precise locations of individual petroglyphs and an accurate three-dimensional terrain model. These data are difficult to simultaneously generate with previously proposed workflows. We argue that survey with an unmanned aerial vehicle (UAV) coupled with structure-from-motion photography, or