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Drone-Based Remote Sensing for Digital Outcrop Modeling Using Photogrammetry Techniques

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ABSTRACT

Oil and gas exploration applies numerical modeling techniques to understand the development of hydrocarbon-bearing basins and to provide quantitative subsurface models. The accuracy of any predictions depends on several factors related to the modeling approach, data acquisition, data interpretation, etc. Unfortunately, in oil and gas exploration the quantity of reliable data available to build models is very limited compared to the size of sedimentary basins. Indeed, only cores collected from relatively few exploration wells provide direct subsurface information. Outcrops are a valuable source of information that should be used to characterize the subsurface. The outcrop, by its areal coverage and direct accessibility to the geologist, provides an excellent analogue to the subsurface that must be quantitatively integrated to the exploration modeling workflow. Unfortunately, we are far from achieving the objective of fully benefiting from outcrops. Indeed, despite the fact that the outcrop is directly accessible, its quantitative modeling remains an issue. The main goal of this work is to investigate alternative technologies for high resolution 3D outcrop modeling (cm to mm scale). High resolution outcrop models will constitute a virtual dataset that the geologist can visit at any time from his desktop, and extract in real time any piece of information/data needed. The proposed solution for this challenge is to develop an integrated workflow for remote geological assessment based on modern unmanned aerial vehicle (UAV) and remote sensing technologies. The general workflow starts with the selection of the area of interest using any geographic information system (GIS) to plan the flight route of the UAV. Then comes the selection of the model type (elevation, mineral composition, etc.) as well as the required resolution. After data acquisition with the UAV equipped with appropriate sensors, we proceed with the data processing, where the acquired data is converted to geological models that the geologist can use to study the outcrop. The need for millimeter-scale resolution requires intensive computational resources to be able to process large data volumes in reasonable amounts of time. Finally, general-purpose software is used for the outcrop model visualization. Specific tools developed for geoscientists facilitate the interaction between the geologist and the virtual outcrop. This workflow has been successfully applied to several outcrops in Saudi Arabia.