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Assessing Potential Rock Outcrop Exposure Using Unsupervised Learning to Support Field Campaigns in Regolith-Covered Terrains

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Introduction

Geological mapping in regions with extensive lateritic cover is often challenging due to limited access to slightly weathered or unweathered outcrops. In Bahia, approximately 25% of the territory is mapped as Cenozoic surficial formations, many of which offer restricted access to outcrops. This study proposes the use of the Outcrop Exposure Index (OEI) as a supporting tool for fieldwork planning.

Method and/or Theory

The OEI is a thematic map that highlights areas with higher probabilities of rock outcrop exposure in regolith-covered terrains. It is generated through unsupervised classification based on the integration of two variables: the Lateritic Index (LI) and Slope. The LI estimates the degree of weathering using airborne gamma spectrometry data, as the radioelements K, Th, and U exhibit characteristic behavior according to the degree of lateritization. The Slope, derived from a digital elevation model, provides information on the local variation in elevation.

To apply the methodology, we used the Oasis Montaj 9.2 software (Sequent) and the Google Earth Engine (GEE) cloud-based platform. The OEI was generated for three Areas of Interest (AOIs). For each AOI, preprocessing steps were carried out to obtain the LI and Slope. The optimal number of classes (K) was then determined using the Elbow method, and the K-means unsupervised classification algorithm was applied to segment the area into zones with similar characteristics in terms of weathering degree and geomorphological context. Furthermore, the different zones are interpreted according to their geomorphological and weathering characteristics. The less weathered regions are considered more favorable for outcrop exposure, while the geomorphological features provide insights into the type of outcrop likely to be encountered.

Results and Conclusions

The first AOI corresponds to the Maracás Sheet, located in the central-eastern portion of Bahia, within the geological context of the Jequié Block. This area features extensive lateritic cover, with various regolith-related materials distributed across different geomorphological settings. It was the subject of systematic geological and regolith mapping campaigns, where the OEI supported field planning. The OEI was highly useful, particularly in identifying plateau areas with thick regolith that were avoided during fieldwork, and in highlighting less weathered zones that became priorities for site visits.

The other two AOIs are the Serra de Jacobina region (Bahia) and a limestone area in western Bahia (Sete Lagoas and Lagoa do Jacaré formations). Both are related to research on dimension stone potential. In these areas, the OEI facilitated the identification of potential dimension stone outcrops. In Serra de Jacobina, the OEI supported the assessment for the dimension stones potential, while in western Bahia, this approach facilitated the identification of two black limestone outcrops characterized by calcite veining, indicating their potential suitability for application as dimension stone.