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Mapping global depth to bedrock based on borehole logs and soil profile data using machine learning

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Understanding the global pattern of underground boundaries such as bedrock occurrence is of continuous interest to Earth and geosciences. This work presents a framework for global estimation of depth to bedrock (DTB). Observations were extracted from a global compilation of soil profile data (ca. 130,000 locations) and borehole data (ca. 1.6 million locations). Additional pseudo-observations generated by expert knowledge were added to fill in large sampling gaps. The model training points were then overlaid on a stack of 155 covariates including DEM-based hydrological and morphological derivatives, lithologic units, MODIS surface reflectance bands and vegetation indices derived from the MODIS land products. Global spatial prediction models were developed using random forests and gradient boosting tree algorithms. The final predictions were generated at the spatial resolution of 250 m as an ensemble prediction of the two independently fitted models. The 10–fold cross-validation shows that the models explain 59% for absolute DTB and 34% for censored DTB (depths deep than 200 cm are predicted as 200 cm). The model for occurrence of R horizon (bedrock) within 200 cm does a good job. Visual comparisons of predictions in the study areas, where more detailed maps of depth to bedrock exist, show that there is a general match with spatial patterns from similar local studies. Limitation of the data set and extrapolation in data spare areas should not be ignored in applications. To improve accuracy of spatial prediction, more borehole drilling logs will need to be added to supplement the existing training points in under-represented areas.

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2-D electrical resistivity survey for cassiterite exploration in parts of Naraguta Area, Nigeria

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Tomography is an imaging technique that makes use of an energy source to probe the subsurface and produce a tomogram which represents a model of the geologic structure that exists below the subsurface. The principles of tomography initially were applied in the medical field and in recent times applied in global and exploration geophysics. The Oru area has no baseline information on the velocity and thickness of the weathered zone in this area. A survey was therefore carried out to obtain these parameters. Measurements were made along a total of 10 profiles evenly distributed within the area. The receivers were placed at 10 m interval; an offset distance of 30 m on both sides of the profile was used. A 10 kg sledge hammer was used to produce the seismic signals while Mark 6 digital 12-channel seismograph was used to record the seismic signals and traces. The Reflexw software was used to process the raw data, while GPS was used to obtain the co-ordinates of the profiles. This research work has established that the distribution of p-wave velocity within the subsurface of this area shows a general increase of velocity with depth and the velocity varying from 400 m/s to 770 m/s. The thickness of this weathered layer was on the average 20.4 m. From these results, the lithology of the area was projected and regions with underground water were delineated. Another parameter calculated from these results was the geological age in years of the weathered layer which is in the order of 10^5 years.

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