Paper ID: 102165
student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Ms. Rohini Parthasarathy
International Space University, France

Ms. Maria Volosatov
International Space University, France

GEOFERRA — UTILIZING CONCENTRATED ML & AI MODEL FOR MARTIAN IRON LOCALIZATION

Abstract

As milestones in lunar exploration are rapidly met and the establishment of research stations receives growing attention from international governmental and private actors, Martian exploration presents a natural next step. As with lunar regolith, there is significant interest in developing an in-situ resource utilization (ISRU) cycle for Martian regolithic constituents, particularly iron. Identification of iron deposits on Earth rely on geological surveys and field mapping, yet recent advancements in Machine Learning (ML) and Artificial Intelligence (AI) technologies are rapidly transforming mineral identification and mapping in tandem with remote sensing techniques. Martian exploration has significantly benefited from satellite imagery missions collecting visual band mineral spectroscopy data, auroral spectral analysis, and electromagnetic field data parameters which identified localized iron deposits. The development of GeoFerra, a model leveraging neural networking through deep learning architectures, incorporates concepts like CNNs for recognizing patterns visually, GNNs for spatial anomalies, and spectral-temporal analysis. Based on literature studies, we have correlated the localization of ferromagnetic ores based on magnetic field data collected by the Mars Global Surveyor with the occurrence of localized ionospheric emission events (discrete auroral arcs). Through regressive learning, the model identifies auroral discrete arcs caused by crustal remnant magnetism within ferromagnetic ores. With the help of precision-recall metrics, it enhances the subsurface deposit mapping using geomagnetic field data. This semi-supervised algorithm ensures the deployment of the model while accounting for Martian terrain variability. The model performance showcases enhanced accuracy that recalls other conventional geological surveys. GIS-integrated visualization tools along with GeoFerra's adaptability to real time variation facilitates dynamic Martian mineral prospecting, enabling automated planning for missions. This concept stands as a scalable, cost-effective and reliable sustainable solution for Martian ISRU.