SEG 2022 Conference: Minerals For Our Future

Machine Learning to Boost Hyperspectral Imaging

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The digitization and automation of the raw material sector are required to attain the targets set by the Paris Agreements and support the sustainable development goals defined by the United Nations. While many aspects of the industry will be affected, most of the technological innovations will require smart imaging sensors. In this respect, hyperspectral imaging (HSI) is becoming prevalent in the extractive industry. The ability to image and characterize key minerals at different scales is beneficial in exploration, beneficiation, metallurgy, and monitoring (post-)mining activities. HSI is usually considered as an image or in a spectroscopic workflow (target fingerprints). We have recently developed a series of machine learning tools that can boost the impact of HSI on geometallurgy and monitoring. After proper denoising and fusion, HSI data can be classified to produce maps that can be used to support decision-making. For example, we developed efficient unsupervised approaches based on deep-learning (Auto Encoder architecture) to cluster large HSI datasets and display information in augmented reality. We also demonstrated that HSI data allow the upscaling of mineralogical and geochemical information. We used an automatic high-resolution mineralogical imaging system (i.e., scanning electron microscopy-mineral liberation analysis) to generate training labels. We adopted a soft labeling strategy and then used random forest and support vector machines to map the entire drill-cores. In another example, we used resolution enhancement as the spatial sampling of hyperspectral drill core scanning sensors does not allow rendering the textural and mineral diversity required to map minerals with low abundances or fine structures such as veins and faults. We proposed an algorithm based on coupled non-negative matrix factorization, using hyperspectral and RGB images to increase the spatial resolution of HSI data and improve mineral and structure mapping.