A Dual Sensor Machine Learning Approach to Sulfur Quantification in Lignite Coal

Kagiliery, Julia (School: Episcopal School of Jacksonville)

Coal accounts for 38% of global power production. Lignite is the lowest rank of coal, containing 25% to 35% carbon with low energy potential. Sulfur appears in coal in two forms; elemental form and pyritic form. Pyrite is an iron sulfur compound (FeS_2) with a gold color which is not homogenous throughout coal. When highly sulfuric coal is burned, it forms sulfur dioxide (SO_2) which is released into the air where it becomes sulfuric acid (H_2SO_4). This alters the pH of ecosystems. Mines use dry combustion analysis to quantify sulfur content which is expensive and time consuming. The goal of this experiment was to create 15 different models to predict sulfur content in lignite coal, using optical color sensing and portable X-ray fluorescence (PXRF). For the study, 249 lignite samples were collected from four different mines in North Dakota. Each sample was ground, dried, and subject to dry combustion analysis. Samples were scanned using optical color sensing and PXRF. Random Forest regressions were generated utilizing samples from all four mines or individual mines along with different combinations of the sensors. 75% of samples were used to calibrate the model, while 25% of samples were used to validate it. The R squared values of models for each mine A, B, C, and D using a combination sensor approach were 0.81, 0.19, 0.34, and 0.46 respectively. Comparatively, when all mines were used to generate a model, the R squared value was 0.85, meaning the model accurately predicts the sulfur content of the lignite with mg/kg resolution 85% of the time. The most accurate model was a combination of all four mines and both sensors, which is preferable to traditional analysis because it is a faster, more cost efficient approach to sulfur quantification with minimal lab preparation.