Automated reflectance spectroscopy for deposit discovery

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Visible and near infrared reflectance spectroscopy is an accepted method for identification of pathfinder minerals that serve as exploration vectors. The method is now widely used to assist in new deposit discovery as well as to provide key mineralogical information during mine development. The combination of portable instrumentation and automated analysis methods now allow for real-time identification of pathfinder minerals as well as the determination of associated geochemical and geothermal parameters.

The reflectance spectrum of white micas and chlorite group minerals contain information related to composition, crystallinity and metamorphic grade. The wavelength positions of Al-OH, Fe-OH and Mg-OH absorption features are highly correlated to chemical composition, b unit cell dimension, and Kübler index values. For white micas, both the Na-to-K ratio in interlayer sites and the degree of Fe or Mg substitution for Al in the octahedral layer influence the position and shape of the Al-OH absorption feature. The depth of absorption features associated with structural water in these minerals varies with thermal maturity. With the dehydration associated with increasing metamorphic grade, the ratio of the depth of the water absorption feature to the depth of Al-OH, Fe-OH and Mg-OH features decreases. Together, these parameters enable detailed mapping of geochemical and geothermal gradients, and have contributed to the discovery and development of a wide range of economic deposit types.

In sedimentary basins, clay mineralogy, thermal maturity, and carbonate composition are some of the more useful parameters that are determined using reflectance spectroscopy. All of the dominant phyllosilicate minerals found in sedimentary systems, including smectites, illites, kaolinite, and chlorite, have sufficiently unique spectral signatures to allow for both their identification and characterization. The progressive conversion of smectite to illite is tracked by monitoring the shape of the Al-OH absorption feature as well as the relative depths of water and Al-OH features. Since oil generation takes place simultaneously with the diagenetic transformation of illite/smectite, substitution of NH4 for K in the interlayer sites of illite is often observed if hydrocarbons are present at the time of illitization. It is possible to determine the presence of ammonium illites since ammonium has unique absorption features near 2120 and 2020 nm. The Ca/Mg ratio of carbonates is determined from the position and shape of CO3 absorption feature, and the presence of the Fe2+ or Fe3+ carbonates is similarly determined.

Pathfinder minerals that serve as vectors to economic deposits are present in many economically important geologic systems. Rapid reflectance spectroscopy enables their identification, as well as the determination of their associated compositional, crystallinity, and thermal maturity parameters, and provides the means to map geochemical and geothermal gradients in these systems. In many cases, the relationship between the properties of these minerals and the proximity to the ore zone provides a very useful exploration vector.