Hyperspectral core scan and application to Zijinshan epithermal high-sulfidation Cu-Au deposit

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Hyperspectral imaging is a useful tool for mineral identification, alterationmineralmapping, 3D mineral modeling, as well as detectingchanges in mineral composition. More than 60 thousand meters of diamond drill core from the Zijinshan epithermal high-sulfidation Cu-Au deposit were scanned by Hyperspectral Core Mineral Scanner (CMS). A 3D mineral model was built based on the core scan data, which was used for detailed study of the alteration zones, development of indicesfor exploration, ore fluid tracing, and geometallurgical applications.

The Zijinshan Cu-Au mine comprises an underground copper mine and open pit gold mine, which at one time wasthe largest gold mine in China. It is a typical high sulfidation deposit with the gold orebodies hosted in an upper oxide zone and the copper orebodies hosted in a lower advanced argillic zone of hydrothermal breccias. The orebodies are located to the northwest of the Zijinshan volcanic edifice. Copper mainly occursas digenite, covellite, with minor enargite and trace chalcopyrite and bornite. Gangue minerals are mainly quartz, kaolinite, dickite, alunite, sericite, and pyrophyllite. According to previous studies, copper ore bodies are closely associated with alunite and dickite alteration. However, it is difficult to develop a quantitative alteration mineral index for exploration since it is not easy to identify these fine-grained minerals during traditional logging.

VNIR-SWIR spectroscopy is a well-established technique for mapping mineralogy as well as variations in mineral composition in hydrous and carbonate minerals. CMS combined VNIR-SWIR reflectance spectrometers with a robotic sampling system was used in this study, which was invented by Nanjing Zhongdi Instrument Company. 95 drill cores from the Zijinshan deposit were measured by CMS and the spectral results were interpreted by TSG software, which can provide consistent, objective and representativedata for the whole deposit. 100 project-specific reference samples were measured by X-ray diffraction and chemical analysis as well.

A 3D minerals model for the Zijinshan alteration system was completed, which provided the detailed distribution and the abundances of alunite, dickite, pyrophyllite and muscovite. The model defined distinct alteration zones related to mineralization. The relationship between alunite abundance and high-grade copper mineralization was quantified, and used for discoveringnew orebodies. The variation of absorption feature position at approximately 1480nm of alunite reflects the variation of K and Na abundances of alunite, which in turn reflects the formation temperature. A statistic based on more than 90 thousand spectral data of alunite was developed, which indicatesthat the formation temperature of alunite gradually declined from proximal to the volcanic edifice to distal towards the northwest, and the highest temperature is presentat0-100m elevations. The abundances of dickite, kaolinite, alunite and muscovite may be related to the grindability of the ores. The sampling for geometallurgy study and grinding optimization will be based on this mineral model.