Introduction

Sadiola Hill is an ~8 Moz gold deposit located in western Mali within a ca. 2200-2050 Ma tectonic window known as Kibidougou-Käniaiba Inlier (KKI), exposing the Western African craton. The deposit is hosted in a metasedimentary package made up of impure carbonate rocks, wackes, and arenites intruded by three distinct igneous phases. A N-S-trending Sadiola shear zone, related to the local Senegal-Malian shear zone, and NNE-trending third order fault splays acted as conduits for auriferous hydrothermal fluid flow (Hein and Tshibubudze 2007; Cameron 2010; Maurel et al. 2017). This study determined that gold is associated with ferroan dolomite-carbonate-ankerite-muscovite to Al-rich muscovite-phlogopite, carbonates with sulphide precipitation. The intensity of white mica replacement of biotite, and abundance of Fe-bearing carbonates in association with phlogopite, are good predictors of gold mineralization. Within well-mineralized samples phlogopite occurs as gangue silicate that recrystallized after sulphidation reactions took place. In addition to this, the greywacke is dolomite in the impure marble unit and attains ferroan dolomite-ankerite composition in the greywacke and diorite. The intensity in the Fe content between the ore stage carbonates expressed in different rock types can be explained by progressive rock-buffering with the surrounding Fe-rich minerals within the diorite and greywacke. Since the intensity of these minerals is Mg-rich, the ore-stage dolomite consistently shows low Fe-content. Furthermore, Fe in biotite was preferentially consumed by sulphidation reactions, leaving no residual iron for the dolomite. Muscovite and Al-rich illite/muscovite occur in all host rocks and are associated with gold grade in the impure carbonate and the greywacke. White mica is consistently more aluminous and attains higher crystallinity values in igneous units, while cogenetic white mica within the greywacke is Al-poor lithf. Phengite (Al-rich 2H2O Al at ~225nm) occurs in the system as a minor post-mineral alteration phase.

Geological Background

Sadiola Hill is a shear-hosted system located within a Paleoproterozoic granite-greenstone belt within the West African craton. Hosted in metasedimentary package comprised of impure carbonate rocks, wackes, and arenites intruded by three distinct igneous phases. Sadiola shear zone and NNE-trending second order fault splays acted as conduits for auriferous hydrothermal fluid flow. Long-lived hydrothermal system with complex poly-phase hydrothermal alteration. Alteration assemblages consist of silicification, potassic Bt, Kspar, chloride, sericite, albite, haematite, scapolite, tourmaline, and carbonate. Research Workflow

- Scanning of rap samples from 6 diamond drill holes with Specim hyperspectral camera at 0.2nm resolution for initial classification followed by high-resolution scanning at 0.5nm pixel size
- Conversion of raw images into calibrated hyperspectral cube with X, Y, and Z values representing pixel’s spatial position within the sample, X- values representing a stack of the hyperspectral bands
- Classification of images with decision trees developed for project-specific mineralogy
- Validation and refining of spectral classes with petrographic observations and electron microprobe studies
- SWIR Methodology
- Image calibration with dark and white references followed by calculation of total reflectance (albedo image)
- Wavelength positions are calculated as interpolation between collected bands with second order polynomial fit. Wavelength bands are generated to capture position and depth of absorption features relative to continuum removed spectra
- Endmember selection and development of project-specific decision trees

Summary

- Ore stage dolomites show minor addition of Fe to the second cation site and occur over Fe drop of range 1.0 – 1.3. The Fe content in dolomites was calculated in a range of 0.01-0.15 apfu. Carbonate feature is centered at 2320nm
- Ferrous dolomite are characterized by medium-high to very-high Fe drop values in carbonate spectra (1.3 - 1.5) corresponding to Fe content of 0.3-0.35 apfu in the second cation site. Position of carbonate feature is at 2320nm
- Ankerite is less abundant than ferroan dolomite. The ankerite attains the highest Fe content in the crystal structure reaching 0.46 apfu. Carbonate feature is centered at 2331nm
- White micas are more aluminous in the greywacke and igneous units
- At microscopic position of the Al-OH bond often shifts to the longer wavelength when illite is replacing biotite

Conclusions

- Decision tree classified hyperspectral maps are objective and reproducible
- Hyperspectral methods are in principle non-destructive Systematically trace chemical composition of alteration minerals (white mica composition and carbonate species)
- Misidentification of mineral mixtures (e.g. chlorite-white mica mix) is minimized when combined with petrographic analysis
- Extrapolation of the results to core scanned at lower resolution is possible.