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Application of hyperspectral core imaging:
Gold skarn deposits

Introduction

The African continent, rich in mineral resources, is host to numerous styles of gold deposit. A number of these deposits, such as the skarn deposits which occur throughout southern Africa , are hosted within metamorphic terranes. These terranes have been subjected to multiple stages of metamorphism, deformation, and magmatism, causing regional scale alteration.

Mineral assemblages in the alteration halo of skarn deposits depend on the mineralogy of the host rock, and can include actinolite-quartz, garnet-clinopyroxene-potassic feldspar-quartz, and garnet-biotite associations. Where host rocks are carbonate-rich, mineral assemblages can include calcite-talc-tremolite-dolomite associations (Figure 1).

Ore assemblages in skarn deposits are typically polymetallic, and gold mineralisation can be associated with a variety of sulphides, including chalcopyrite, pyrrhotite, sphalerite, arsenopyrite, and bismuth tellurides, to name a few.

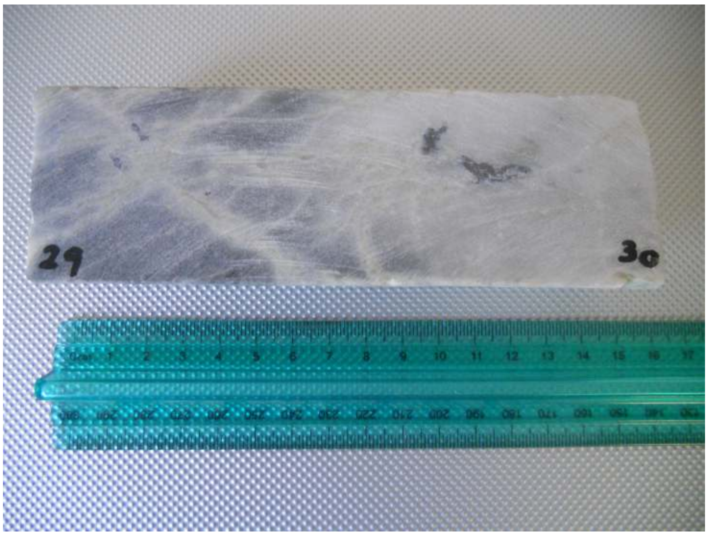

Figure 1: *Mineralised calc-silicate from an African skarn deposit.*

Hyperspectral imaging of drill core from a skarn deposit

Image data for an 8 m intersection across a skarn and marble unit were acquired at a spatial resolution of 0.2 - 1.1 mm using RGB, VNIR, SWIR and LWIR detectors. The data were processed using end-member and classification techniques in order to facilitate the mapping of minerals that typically have poor responses in the infrared, such as sulphides.

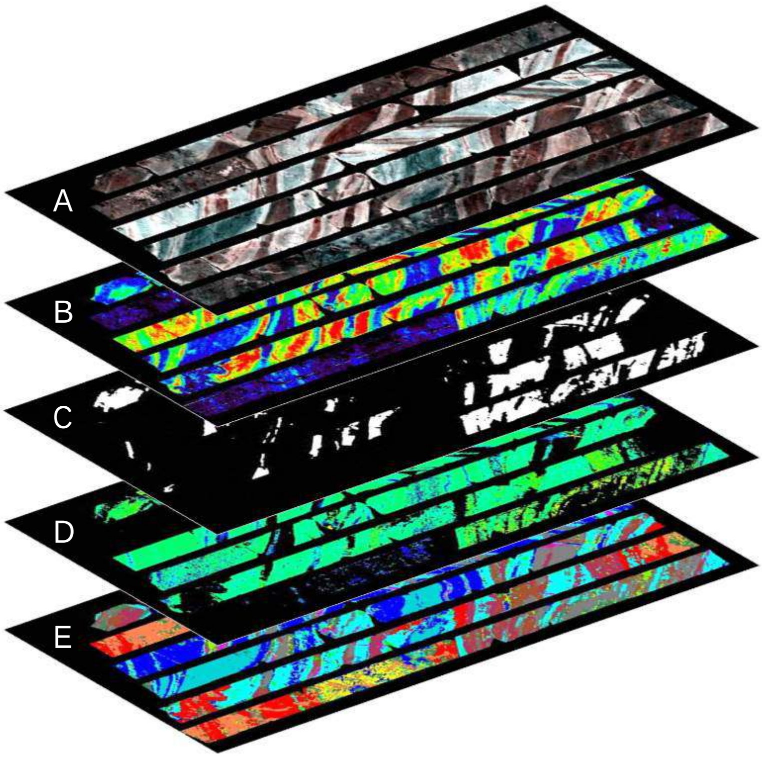

Figure 2: *Images generated from infrared data.*

From the infrared data a series of image products, such as False Colour Composite (FCC), classification, mineral presence and mineral composition maps were generated. These were combined with geochemical data, such as assay results, in order to extract spatial and mineralogical information pertaining to mineralisation in the intersection. Figure 2 illustrates the image products which were extracted from the infrared data.

Discussion and interpretation

The FCC image (Figure 2A) illustrates the abundant spectral variation present in the core. From the spectral data, areas in the core in which certain absorption features in the infrared are dominant can be mapped, thus placing them in a spatial context.

Figure 2B shows where the depth of the 2200 nm AlOH wavelength feature is at its deepest (red areas in Figure 2B) within the core.

This feature is used to infer the presence of AlOH-bearing phases such as sericite (Figure 2C). Compositional variations of a given mineral can also be monitored spatially by assessing changes in the wavelength positions of absorption features (Figure 2D). By combining the information obtained from various infrared image products it becomes possible to map mineralogy, either directly from the spectral data or by inference, at the scale of the drill core tray (Figure 2E).

Mineral mapping shows that there are two types of mineralisation present in the core. The first has a laminated texture where sulphide development occurs within a skarn assemblage of pyroxene and garnet (Figure 3A). The second occurrence of gold-sulphide mineralisation is within quartz veins which cross-cut the foliation of the rock (Figure 3B). When the infrared image data are combined with geochemical data, correlations can be drawn between the overall mineralogy of the drill core and areas of gold and sulphide mineralisation.

Figure 4 illustrates down-hole trends in mineralisation, while the images (infrared, natural and mineral) of core to the left represent a magnification of a 1 m section. Gold mineralisation is concentrated at the base of the section, which, based on mineral mapping, is a garnet-pyroxene-rich skarn zone where calcite and dolomite are subordinate. These associations are common in the core, and are observed throughout the 8 m section analysed, and various mineralised quartz veins are identified throughout the core.

It can also be seen that mineral mapping from the infrared data gives a more detailed indication of exactly where in a given interval mineralisation occurs than assay values over the same interval.

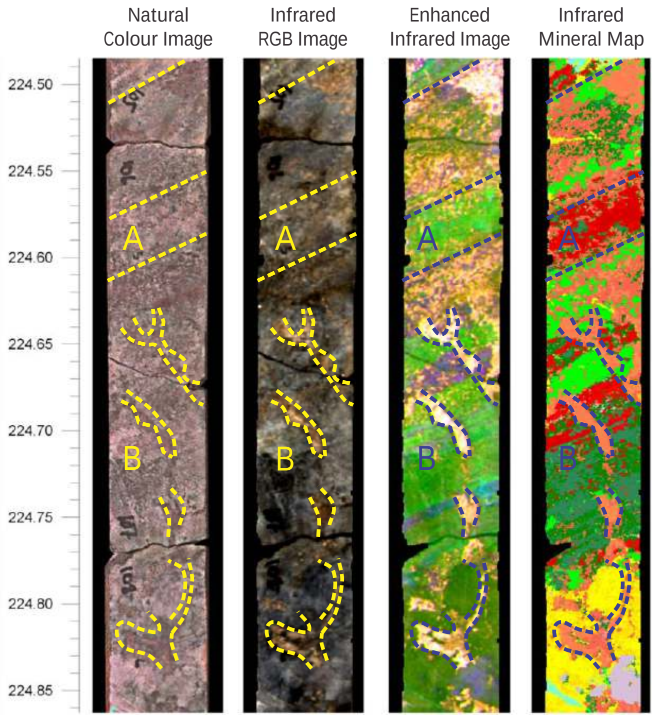

Figure 3: *Multiple generations of mineralisation.*

Conclusions

GeoSpectral Imaging's infrared imaging system provides multi-layer data products which can be combined successfully with geochemical data to provide a spatial context for mineralisation. Using the infrared data, different generations and textures of mineralisation can be identified in greater detail than is provided by conventional assay data alone.

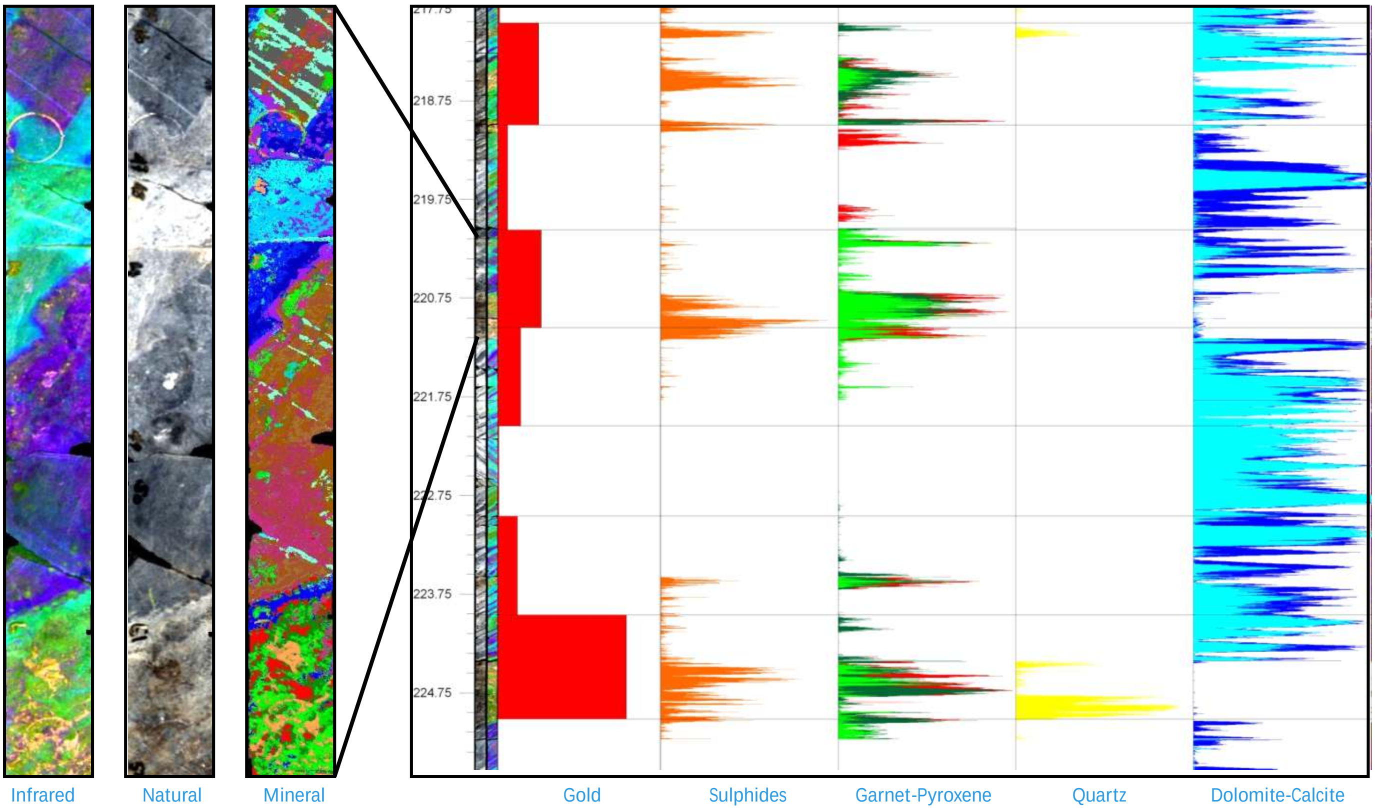

Figure 4: *Combined infrared image products and geochemical data showing mineralisation trends.*