

Calibration of IC-SWIR to Fluid Inclusion Trapping Temperatures in Hydrothermal Systems

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Illite crystallinity of white mica measured by short wavelength infra-red spectroscopy (IC-SWIR) is a rapid, non-destructive geothermometer applicable to the exploration of hydrothermal mineral deposits. IC-SWIR roughly correlated with illite crystallinity by X-ray diffraction (IC-XRD), expressed as the Kübler Index (KI; Kübler & Jaboyedoff, 2000), that is believed to be related to temperatures. While IC-XRD is well-established, it requires time-intensive sample preparation and laboratory instrumentation, whereas IC-SWIR offers a field portable alternative capable of acquiring many measurements rapidly. Although empirically it is believed that higher IC-SWIR indicates higher temperature, no numerical calibration between IC-SWIR values and temperatures is available yet.

This study presents a calibration of IC-SWIR to temperatures measured by fluid inclusion (FI) studies. We measured the IC values of 127 samples from intermediate epithermal deposits and selected 12 with suitable IC values and quartz and/or sphalerite in veins or breccia cement that have primary FIs. IC values were measured on spots right next to veins or breccia cement. The temperature is the highest average homogenization temperatures of a FI assemblage (FIA) in quartz and sphalerite in the adjacent vein/breccia cement.

The dataset comprises 12 samples spanning formation temperatures of 255–368°C and IC-SWIR values of 0.9–3.0. The IC values and the temperatures show a linear positive correlation in these ranges, with a correlation coefficient (R^2) of 0.90. This positive correlation supports IC-SWIR as a viable temperature proxy in epithermal and hydrothermal systems formed in this temperature range. It will be a rapid thermal vectoring tool in mineral exploration.

To use this technique, the SWIR spectrum for IC calculation should not contain any minerals having absorption peaks at ~1900 nm and ~2200 nm to avoid interferences with such features of white mica. The common interfering minerals include chlorite, carbonates (including malachite), Cu oxides, and kaolinite group minerals.