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Near infrared spectra of white mica in the Belt Supergroup and implications for metamorphism

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ABSTRACT

The wavelength of the white mica (illite and muscovite) Al-OH absorption band near 2200 nm in 1036 samples from the Belt Supergroup and associated metasedimentary rocks was determined with a portable visible and near infrared reflectance spectrometer. The Al-OH wavelength decreases from 2225 nm in sub-biotite-zone samples to 2194 nm in sillimanite-zone samples; this decrease corresponds with an increase in total Al content of white mica from ~2.0 to ~2.8 atoms per 11 O atoms. These observations indicate that: (1) the frequency of the Al-OH vibration is controlled by the aluminoceladonite exchange reaction [$^{IV}Si+^{VI}(Mg,Fe^{2+}) = {}^{IV}Al+^{VI}Al$], and (2) the reaction proceeds toward more Al-rich composition with increasing metamorphic grade. In these circumstances, Al-OH wavelength provides an indirect monitor of compositional variation and metamorphic grade.

Metamorphic grade in most of the study area is in the biotite zone or lower, yet Al-OH wavelengths in low-grade rocks define systematic patterns that correlate with depth of burial and later structural displacements. In higher grade areas, wavelengths generally decrease from the garnet isograd through the sillimanite zone; however, anomalies occur locally, and it is not clear whether these result from differences in bulk composition and mineral assemblage or whether they point to actual metamorphic or structural discontinuities.

These findings indicate that reflectance spectroscopy can yield valuable information on metamorphic intensity in rocks containing white mica, particularly in low-grade sequences where conventional indicators of metamorphic grade are lacking. Furthermore, this information can be obtained with field-portable spectrometers and the potential exists to obtain comparable results from airborne and spaceborne imaging spectrometers.

Keywords: Belt Supergroup, metamorphism, visible and near infrared spectroscopy, white mica, muscovite, illite, Idaho, Montana, low-grade metamorphism, burial metamorphism