Attenuated Total Reflection Infrared (ATR-IR) Spectroscopy of Antigorite, Chrysotile and Lizardite

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Distinguishing serpentine minerals antigorite, chrysotile and lizardite from a thin section can be challenging due to the similarity of their optical properties and chemical composition. Infrared spectroscopy (IR) is a method based on the characteristic absorption of infrared radiation by different chemical bonds. Since each serpentine mineral has a distinct crystal structure, infrared spectroscopy can be applied in serpentine mineral identification. Infrared radiation is also particularly strong in polar bonds making IR spectroscopy a powerful tool in studying serpentine mineral hydroxyl groups. Transmission infrared spectroscopy is the most widely used IR method but it requires time-consuming and arduous sample preparation. Using a newer method known as attenuated total reflection infrared spectroscopy (ATR-IR) can significantly reduce the sample preparation time since the measurements can be made directly from the surface of a normal thin section.

We applied the ATR-IR method to characterize antigorite, chrysotile and lizardite from samples from Mt. Shiraga serpentinite body, located in central Shikoku, SW Japan. The ATR-IR method proved to be a reliable and simple method to measure the infrared spectrum of serpentine minerals as there were clear differences in the absorbance band positions of the three serpentine minerals. However, we observed notable differences in the absorbance band positions and absorbance intensities of serpentine minerals between the ATR-IR measurements and transmission IR measurements published in previous studies. These results reflect the fact that the ATR-IR method is susceptible to spectral distortions that are caused by the dependence of absorbance intensity to wavelength and by anomalous dispersion of infrared radiation. On the other hand, spectral mapping is much more convenient in the ATR-IR method as measurements can be done from normal thin sections. We also used the ATR-IR method to map a sample with three co-existing serpentine minerals with interesting reaction textures.

ATR-IR spectroscopy, and especially ATR-IR mapping, has a lot of potential in the field of mineral spectroscopy and it could be applied in the study of a wide variety of serpentinite microstructures, such as veining and faulting. One possible research avenue would be to combine ATR-IR mapping of serpentinite microstructures to quantitative analysis of serpentine mineral hydroxyl group absorbance intensities.

Keywords: Attenuated total reflection infrared (ATR-IR) spectroscopy , Fourier-transform infrared spectroscopy (FTIR), Sanbagawa metamorphic belt, Antigorite, Chrysotile, Lizardite

