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NIR remote identification of phyllosilicates and space weathering

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Sample return missions Hayabusa2 (JAXA) and OSIRIS-REx (NASA) found evidence of hydrated silicates on the surface of C and B-type asteroids Ryugu [1] and Bennu [2]. This detection relied on the study of the Near-IR spectra from remote sensing observations of the asteroids' surfaces. Specifically, the feature is responsible for the OH-stretching mode in hydrated silicates. This feature's position is related to the composition and structure of minerals [3]. However, atmosphere-less bodies in our Solar System, such as Ryugu and Bennu, are affected by space weathering (SpWe). SpWe might alter the structure and composition of the mineral, thus affecting the IR band profile, depth and position, and complicating the interpretation of remote sensing data [4, 5].

We performed ion bombardment experiments on two serpentines and one saponite, to better understand how SpWe affects the remote sensing of hydrated silicates. These two classes of phyllosilicates are particularly abundant in hydrated carbonaceous chondrites [6], which have been used as standards for the surface materials on primitive asteroids [7, 8]. The ion-bombardment experiments were conducted at room temperature in a vacuum chamber (10^{-7}*mbar*) on pellets made from our phyllosilicate samples. We used He^{+} at 40 *keV* and fluences of $1*10^{16}$, $3*10^{16}$ and $6*10^{16}$ *ions/cm*^{2}*.*

We studied the in-situ behaviour of the 2.7 *μm* band as a function of ion fluence. We found that the evolution of the OH-stretching feature in phyllosilicates depends on the phillosilicate's nature. For the saponite sample, the feature's intensity seems to decrease as the band broadens slightly, without changing position. For both serpentine samples, the feature shifts toward longer wavelengths, while peak intensity and width are not strongly affected.

The observed diversity may be explained by the different crystal structure among our two phyllosilicate classes. The observation of a band shift for one of our sample's classes indicates that space weathering can introduce a bias in the interpretation of NIR remote sensing observations of hydrated minerals. The extent of this shift is detectable by the instruments onboard Hayabusa2 and OSIRIS-REx [11, 12].

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