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Probing Nanoindentation-Induced Strain in Fayalite by Raman Spectroscopy

Nanoindentation has become a powerful tool for investigating the mechanical properties of minerals at the microscale, providing quantitative information on hardness, elastic modulus, deformation mechanisms, and fracture behavior. In recent years, this technique has been increasingly applied to geological and planetary materials [1]. However, the localized structural modifications induced by nanoindentation require complementary characterization techniques capable of probing changes in crystal structure and deformation state. Raman spectroscopy is particularly well suited for investigating deformation processes and detecting possible pressure-induced phase transitions. In this work, we investigate the effects of nanoindentation on fayalite $[(\text{Fe,Mg})_2\text{SiO}_4]$ by using Raman spectroscopy. Indentations were performed under different applied loads (up to 200 mN) in order to evaluate the evolution of strain within and around the deformed regions and to assess whether the applied stresses are sufficient to induce phase transformations. Raman spectra acquired from the indented areas reveal systematic shifts of the main vibrational bands toward higher wavenumbers as the applied load increases (see Fig. 1). The observed behavior is indicative of strain accumulation associated with the nanoindentation process. No evidence of pressure-induced phase transitions was observed.

References

- [1] P. Grèbol-Tomàs et al., *Geosciences Frontiers*, 16 (2025) 102110.

Figures

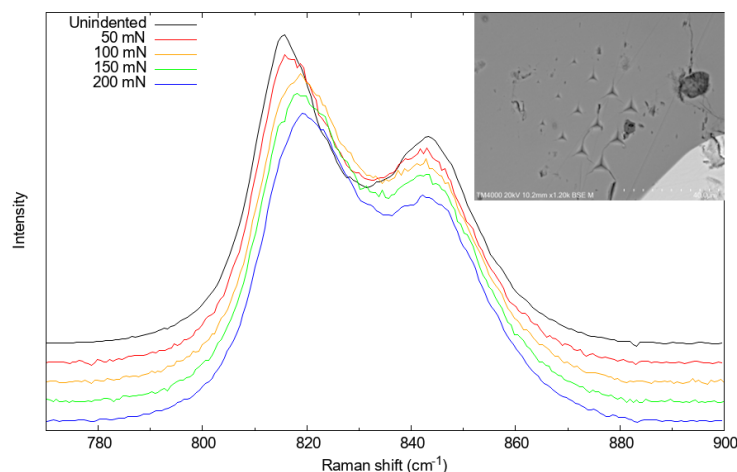


Figure 1: Raman spectra of nanoindented fayalite (see inset) as a function of the applied load.