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Phase changes in Lunar breccia during space weather simulation using Focused Ion beam and Raman spectroscopy

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Geochemistry is thought of as being about the identification of minerals, but it has more than that. The present study illuminates the role of geochemistry in addressing the scientific problems through Raman spectroscopy (RS) and Focused Ion Beam (FIB) technology in when describing the lunar breccia, silicon, magnetite, and pyrite. Through an investigation of the chemical and structural evolution of these compounds, both pre- and post-gallium ion bombardment exposure, this research reveals the dynamics between planetary material and high-energy ion interactions. Initial Raman spectroscopy yielded information regarding the original mineralogical composition, and controlled FIB irradiation induced surface changes that manifested in significant phase transitions, defect structures, and oxidation state changes. Lunar breccia experienced amorphization, and silicon underwent structural damage and ion implantation damage. Iron-bearing minerals such as magnetite and pyrite were modified by oxidation. These observations illustrate the role played by geochemistry in planetary surface processes, including space weathering, and enhance our knowledge of materials' stability under extraterrestrial environments. By combining geochemistry with cutting-edge analytical techniques, this study defies stereotypes, highlighting its contributions to planetary science, materials engineering, and the future of space exploration.