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Feasibility study for using a far-IR spectrometer to detect ore deposits on the Moon

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Lunar sulfides and oxides are a significant source of noble and base metals and will be vital for future human colonies' self-sustainability. Sulfide detection (pyrite and troilite) applies to new solar panel production methods. Ilmenite is the primary iron and titanium ore on the Moon and can provide helium-3 for nuclear fusion and oxygen for rocket fuel. The most important ore minerals have prominent absorption peaks in a narrow far-infrared (FIR) wavelength range of 20–40 µm, much stronger than the spectral features of other common minerals, including significant silicates, sulfates, and carbonates. Our simulations based on the linear mixing of pyrite with the silicates mentioned above indicated that fields containing at least 10–20% pyrite could be detected from the orbit in the FIR range. MIRORES, Multiplanetary far-IR ORE Spectrometer, proposed here, would operate with a resolution down to <5 m, enabling the detection of areas covered by 2–3 m^2 of pyrite (or ilmenite) on a surface of ~17 m^2, creating possibilities for detecting large and local smaller orebodies along with their stockworks. The use of the Cassegrain optical system achieves this capability. MIRORES will measure radiation in eight narrow bands (0.3 µm in width) that can include up to five bands centered on the ore minerals absorption lines, for example, 24.3, 24.9, 27.6, 34.2, and 38.8 µm for pyrite, marcasite, chalcopyrite, ilmenite, and troilite, respectively. The instrument size is 32 x 32 x 42 cm, and the mass is <10 kg, which fits the standard microsatellite requirements.