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Perspectives for ore prospecting in space: Multiplanetary far-IR ORE Spectrometer (MIRORES)

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Sulfides and oxides are major sources of noble and base metals and will, therefore, be vital for the self-sustainment of future martian or lunar colonies. Martian and lunar meteorites are rich in sulfides (Fitt et al., this session), and this is also reflected in analyzes of surface martian rocks by the Spirit and Curiosity rovers. However, on Mars, the only high-resolution (18 m/pixel) infrared (IR) spectrometer, the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), onboard the MRO (Zalewska et al., this session), is not suited for detecting ore minerals. Spectral interferences with the most common martian silicates impede ore mineral detection in the 0.4–3.9 μm CRISM range. The most important ore minerals on have prominent absorption peaks in a narrow far-IR (FIR) wavelength range of 22–28 μm. Our simulations based on linear mixing of pyrite with the aforementioned silicates indicated that fields containing 10–20% pyrite could be detected from the orbit in the far-IR range. However, ore deposits including massive pyrite on Earth are maximally hundreds of meters by hundreds of meters large (Ciazela M. et al., this session). Therefore, active space FIR spectrometers with spatial resolutions down to ~3 km are not sufficient for searching ore mineralization. Thus, we have designed a new instrument suitable for sulfide identification in the FIR range called MIRORES. The field view of 16.5 x 19.9 m enables detection of areas covered by 33–66 m^2 of pyrite on a surface of ~330 m^2 creating possibilities for detecting large and moderate-size orebodies and probably also their stockworks. MIRORES will measure radiation in six 0.3–0.4-μm-wide bands including those centered at 23.2 μm for marcasite, 24.3 μm for pyrite, 27.6 μm for chalcopyrite, and three reference bands (21.5, 26.0, and 29.0 μm). Troilite (23.8 μm) or ilmenite (22.7 μm) abundant on the Moon can also be measured instead of other minerals. The most advanced, martian version of the instrument should be integrated into a satellite planned to be launched to Mars in 2028. Creation and testing of the MIRORES prototype are scheduled for 2022–2023 within an ESA project no. AO/1-10824/21/NL/RA, supported by an NCN project no.