Mineralogy of Natural Dust Samples from LWIR Reflectance and Transmission Spectroscopy

Paper Number: A35E-1679

Mohammad R. Sadrian[1,2], Wendy M. Calvin[1], [1]Department of Geological Sciences and Engineering, University of Nevada, Reno, [2]Atmospheric Sciences Ph.D. Candidate, **E-mail: msadrian@Nevada.unr.edu**

Introduction- Materials

Mineral dust particles dominate aerosols mass in the atmosphere, heavily modifying Earth's energy budget through interfering with incoming and outgoing radiation. Airborne minerals contribute to radiative forcing and consequently changing the climate through radiation perturbation including absorption and scattering processes. Physico-chemical characteristics of dust particles (e.g. mineralogical composition) are the main sources of uncertainties and are important to estimate dust radiative impact.

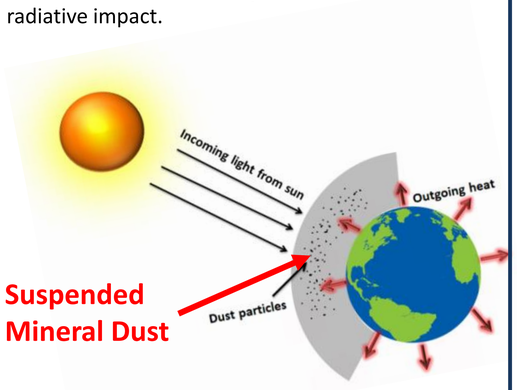

Figure 1. Schematic illustration of mineral dust influences on the atmosphere by blocking the solar and terrestrial radiation.

Background

- 37 dust samples were collected in Ilam city, Iran.
- These dust samples were measured with visible, near infrared (VNIR ~ 0.5 to 2.5 µm) and X-ray diffraction (XRD) (Sadrian et al., 2021):
- VNIR identified diagnostic absorption features for clay minerals along with some manmade materials such as asphalt.
- XRD identified quartz and feldspars and underpredicted clays abundances.
- VNIR does not see quartz and feldspars, therefore we proposed using long-wave infrared (~ 2.5 to 25 µm, LWIR) to identify these minerals in the samples.

Dust Samplers Location

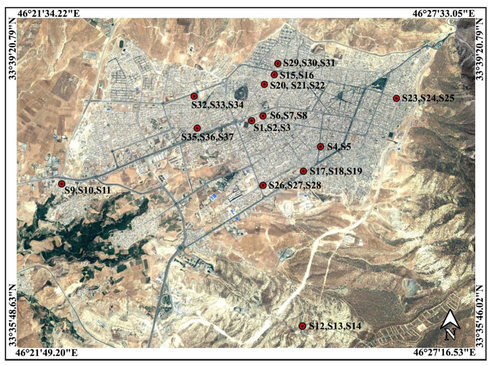

Figure 2. Map from Google Earth shows the distribution of samplers throughout the Ilam city, Iran. Annotations note sample number.

Methods

- This study used long-wave infrared (~ 2.5 to 25 µm, LWIR) and transmission spectroscopy (~ 2.5 to 25 µm, TS) to obtain mineralogy for dust samples:
- We used FTIR instrument for LWIR measurements. All samples reflectance measurements were automatically ratioed to a gold plate reflectance resulting in final reflectance spectra that are solely due to the samples.
- Transmission spectroscopy was performed with means of FTIR and KBr pellets. Pellets contained mixtures 0.5 mg of dust and 200 mg of KBr. Sample transmission measurements were ratioed to blank measurements.

Results-Summary

- **LWIR found calcite and clays in the samples.**
- **Surprisingly, LWIR could not find quartz and feldspars in some samples.**
- **Using transmission spectroscopy, we were able to identify a combination of quartz and other silicates both near 10 µm and at longer wavelengths.**

Identified with all four methods, only identified in VNIR, not identified with VNIR and LWIR, not identified in TS*

Samples	Location	VNIR, LWIR, TS, or XRD identification.
S20	Ilam City	***calcite, illite, montmorillonite*, quartz, kaolinite, albite, asphalt***
S31	Ilam City	***calcite, illite, montmorillonite*, quartz, kaolinite, albite, amphibole*, asphalt***

Measured Spectra

LWIR identifies most common minerals previously identified.

Surprise!! We don't see Si-O features in reflectance, only in transmission!

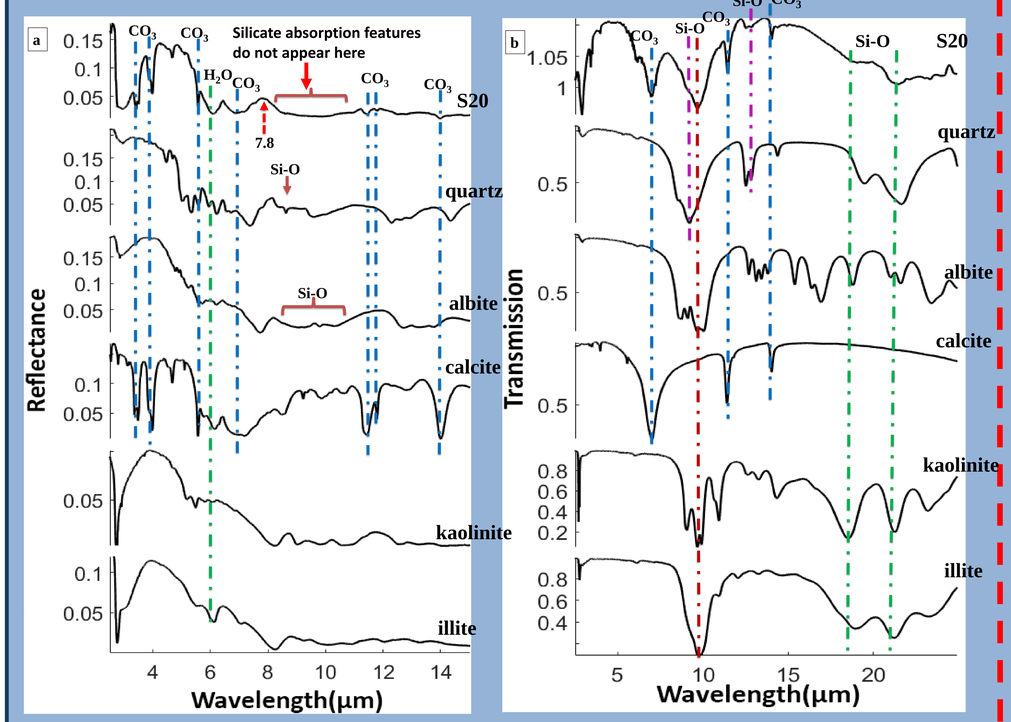

Figure 3. (a) and (b) are LWIR reflectance and transmission spectra of sample S20 and library minerals. Arrows call absorption features related to various minerals in dust samples.

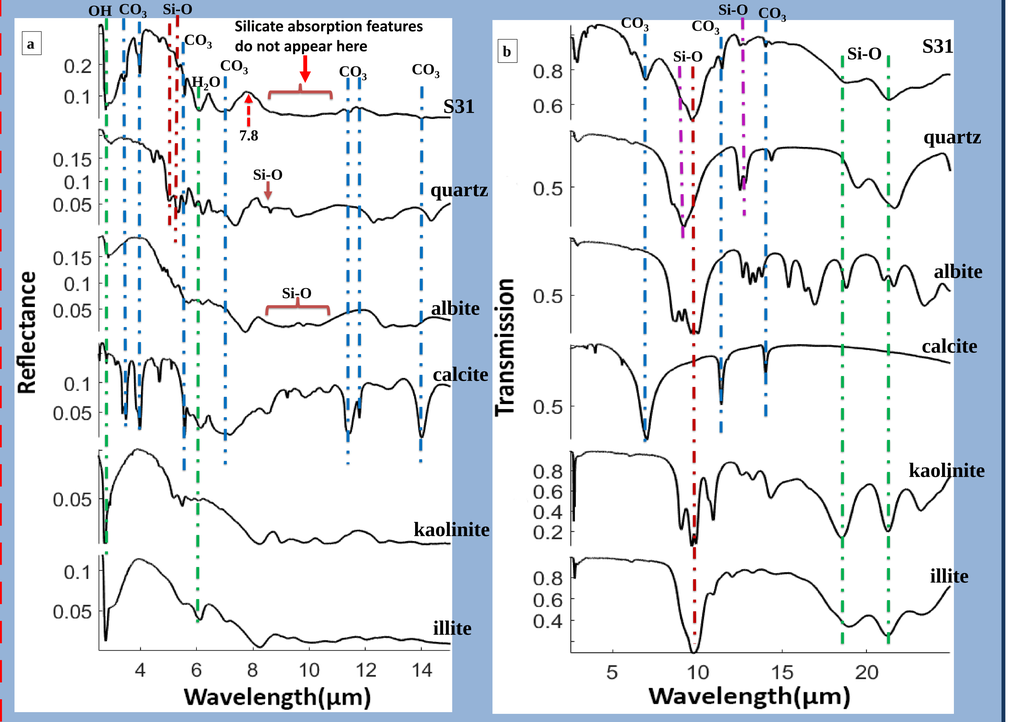

Figure 4. (a) and (b) are LWIR reflectance and transmission spectra of sample S31 and library minerals. Arrows call absorption features related to various minerals in dust samples.

Conclusion

- ✓ We are trying to understand why diagnostic absorption features attributed to silicates (Si-O bands) are not found in the region between 8-12 µm.
- ✓ Transmission spectra could detect quartz and other silicates (feldspars and clays) both in a big envelope around 10 µm and at longer wavelengths (~ 17.9-22.5 µm).
- ✓ We also identified a peak at 7.8 µm which may be attributed to anomalous dispersion or the interaction of very fine grain quartz and calcite in this spectral range.
- ✓ ***We propose that for identification of minerals in dust samples, transmission spectroscopy (TS) should be used to detect the phases that might be missed by LWIR.***
- ✓ ***Next Step:*** ***We will run linear spectral mixing for TS to measure what proportion of each mineral exist in the dust samples.***

Affiliation

Desert Research Institute University of Nevada, Reno

References

- Sadrian, M. R., Mohammadkhan, S., Mashhadi, N., Alavipanah, S. K., and Dashtakian, K., (2012) Analyzing and investigation of dustfall by MDCO (case study: the city of Ilam), International desert research center, University of Tehran.
- Sadrian, M. R., Calvin, W. M., MacCormack, J., Contrasting mineral dust abundance from X-Ray Diffraction and Reflectance Spectroscopy, submitted to Atmos. Meas. Tech.
- Salisbury J. W., Walter L. S., Vergo N., and D. M. D'aria (1991). Infrared (2.1–25 µm) spectra of minerals. Baltimore: Johns Hopkins University Press.