

## Absorbing aerosol radiative effects in the limb-scatter viewing geometry

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We use the fully 3-D radiative transfer code SASKTRAN to simulate the sensitivity of limb-scatter viewing Odin/OSIRIS satellite measurements to absorbing mineral dust and carbonaceous aerosols, and to sulfate aerosol and ice in the upper troposphere.

At short wavelengths (337 nm, 377 nm, 452 nm), we found that the addition of any aerosol species to an air only atmosphere caused a decrease in single-scattered radiation due to an extinction of Rayleigh scattering in the direction of OSIRIS. The reduction was clearly related to particle size first, with absorption responsible for second-order effects only. Multiple-scattered radiation could either increase or decrease in the presence of an aerosol species, depending both on particle size and absorption. The combined effect led to complex total radiance signatures that generally could not unambiguously distinguish absorbing versus non-absorbing aerosols. However, we found that scene darkening above the aerosol layer is unambiguously due to absorption whereas scene darkening within and below the aerosol layer can simply be the result of a reduction in single-scattered radiance. However, the effect did not exceed 0.2% of the total radiance due to air only for medium-sized carbonaceous aerosols.

A fortuitous, unexpected implication of our analysis is that limb-scatter retrievals of aerosol extinction are insensitive to external information about aerosol absorption.

## Stable Sr isotope fractionation in synthetic barite

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Barite (BaSO<sub>4</sub>) is a highly stable and widely distributed mineral that incorporates many elements (e.g., Sr, Ca, Ra) in its crystal lattice making it useful as an archive for geochemical and isotopic signals of environmental change. Abiotic precipitation of barite commonly occurs with mixing of sulfate and barium rich solutions. Barite can also precipitate in association with biological processes, such as bacterial sulfide oxidation. We present stable Sr isotope results ( $\delta^{88}\text{Sr}$ ) from synthetically precipitated barite to elucidate the parameters (e.g., temperature, barite saturation state, solution Sr/Ba) influencing mass dependent Sr isotopic fractionation under abiotic conditions. This work will constrain future studies of stable Sr isotopic fractionation in natural biologically-influenced barite precipitation.

We precipitated barite from solution by adding sulfate to a Sr-Ba solution under various conditions (solution Sr/Ba, temperature, and barite saturation state) that may influence equilibrium and/or kinetic mass dependent stable Sr isotopic fractionation. Isotopic measurements were made on a Thermo Neptune Plus MC-ICPMS at the University of South Carolina using a standard-sample bracketing technique that corrects for instrumental mass bias relative to a Zr reference ratio. All barite samples were less enriched in <sup>88</sup>Sr relative to the solutions from which they precipitated similar to other isotope systems (e.g., Ca).

In our experiments, Sr isotopic fractionation is influenced by both barite saturation state and temperature. However, neither dominantly controls Sr isotopic fractionation under our experimental conditions. Temperature dependent isotopic fractionation of Sr under our experimental conditions was very weak and negative (-0.0032‰/°C), however the variation of the isotopic data is largely within the analytical uncertainty of the measurement over the temperature range of our experiments, 5 to 40°C. The relationship between  $\Delta^{88/86}\text{Sr}_{\text{barite-aq}}$  for all experiments and  $D_{\text{Sr}}$  was not significant, but was affected by the solution initial barite saturation state, which likely influences precipitation rate. At a constant initial barite saturation state, the relationship is significant and appears to be independent of temperature and (Sr/Ba) ratio.