K. Kandler[1], N. Benker[1], U. Bundke[2], E. Cuevas[3], M. Ebert[1], P. Knippertz[4], S. Rodríguez[3,5], L. Schütz[4], S. Weinbruch[1]

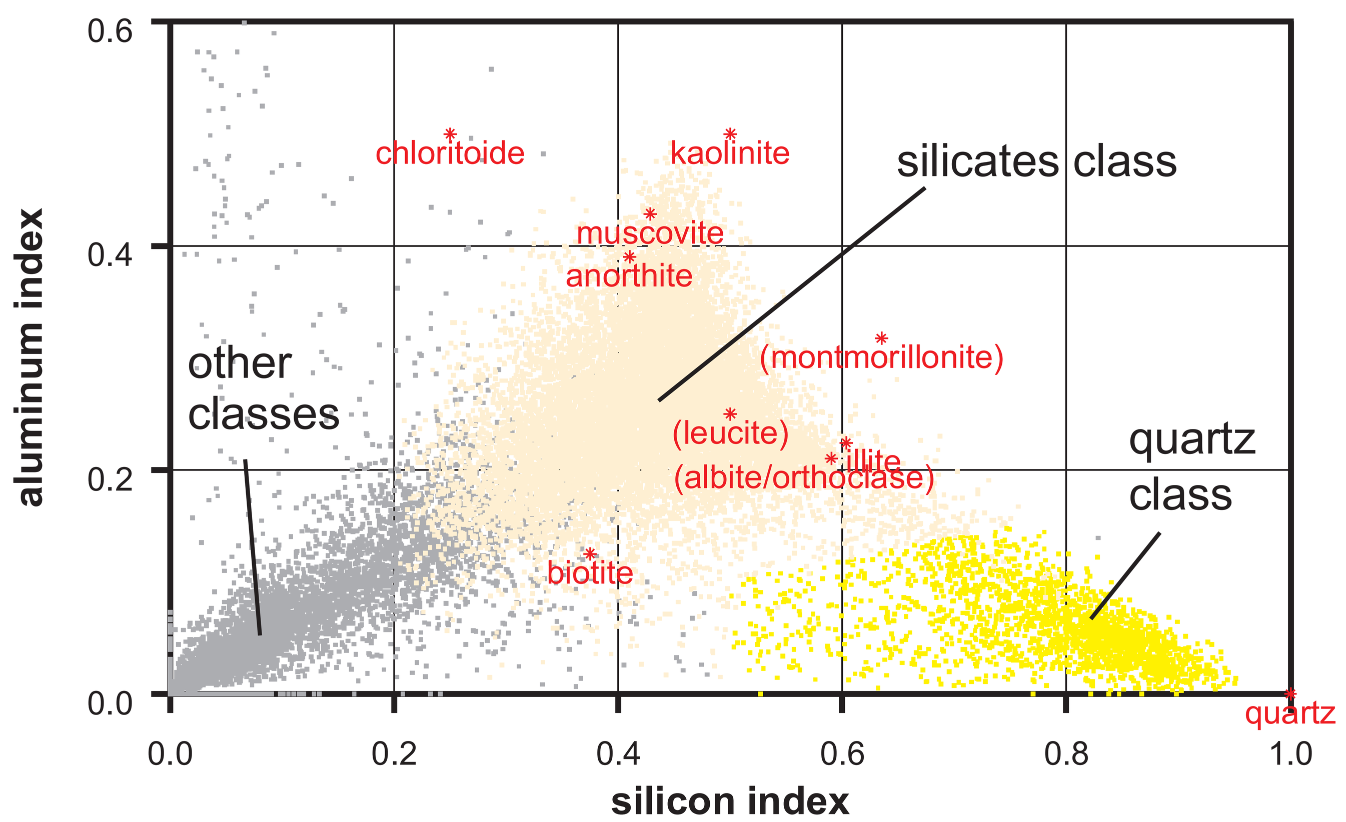
Chemical composition and complex refractive index of Saharan Mineral Dust at Izaña, Tenerife (Spain) derived from electron microscopy

1 Institute of Applied Geosciences, Darmstadt University of Technology, 64287 Darmstadt, Germany
2 Institute for Atmosphere and Environment, Johann Wolfgang Goethe-University, 60325 Frankfurt, Germany
3 Izaña Atmospheric Observatory, Santa Cruz de Tenerife, 38071, Canary Islands, Spain
4 Institute for Physics of the Atmosphere, Johannes-Gutenberg-University, 55099 Mainz, Germany
5 University of Huelva, Depantament of Geology, Huelva, Spain

INTRODUCTION

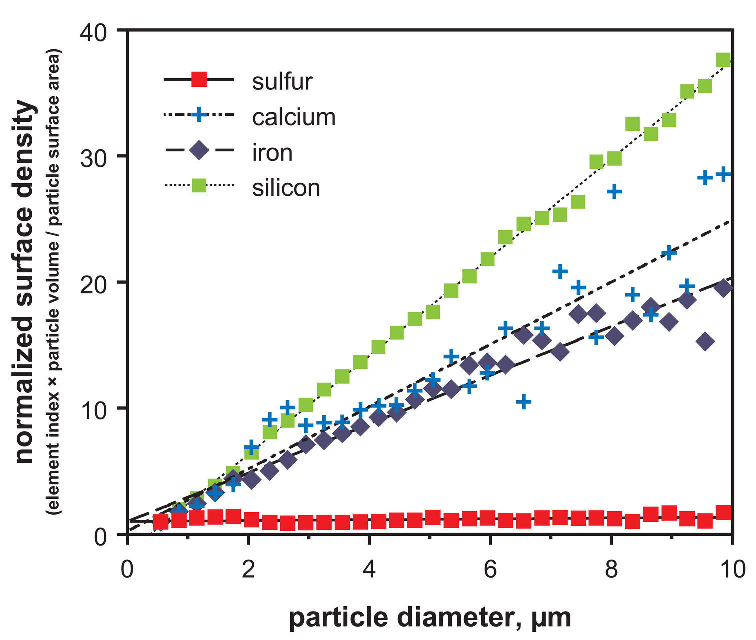
The Saharan Mineral Dust Experiment (SAMUM) is dedicated to the understanding of the radiative effects of mineral dust. A field campaign focused on electron-microscopical investigation of slightly aged Saharan dust was carried out at Izaña (Tenerife, Spain) between July 8th and August 8th, 2005.
Samples from two strong homogeneous Saharan dust plumes reaching Izaña were collected with a miniature impactor system and filter samplers. Size, aspect ratio and chemical composition of more than 22000 individual particles were studied by scanning electron microscopy (SEM). The mineralogical phase composition of about 200 particles was investigated by transmission electron microscopy (TEM).

STATE OF MIXING



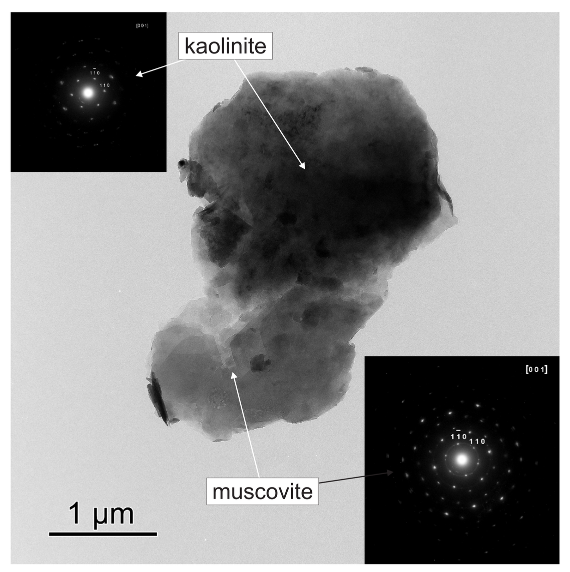
Aluminum versus silicon index for aged Saharan dust at Izaña, Tenerife

The majority of the particles exhibits a complex mineralogical composition. The pure mineral phases, additionally shown in the diagram, do not occur.



Surface density for selected element indices at Izaña, Tenerife

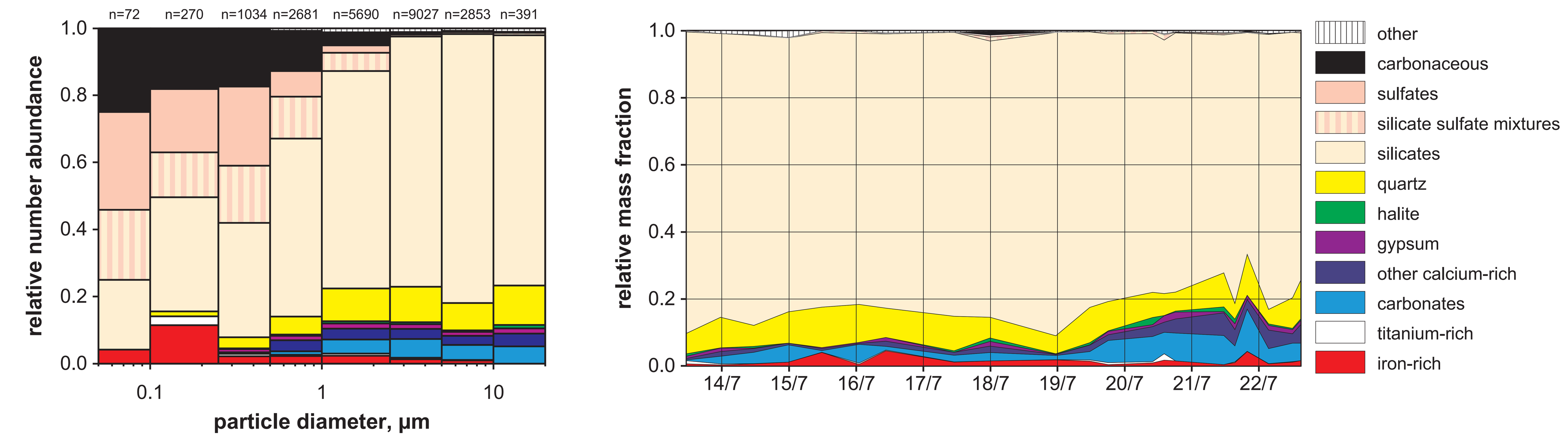
The independence of the sulfur index "surface density" from particle size indicates its presence as coating, whereas other elements appear as volume-building. The thickness of the coating was estimated to be 60 nm, assuming a silicate core and a sodium magnesium sulfate coating.



Kaolinite-muscovite aggregate, Izaña, Tenerife

This simple aggregate illustrates the complex mineralogical composition of the Saharan dust. Phase determination was made in TEM by evaluating the characteristic diffraction pattern.

CHEMICAL COMPOSITION



Left: Relative number abundance of different particle classes at Izaña, Tenerife

The Saharan dust at Izaña is dominated by silicates, quartz and calcite. With decreasing particle size, the abundance of sulfates and sulfate silicate mixture particles increases.

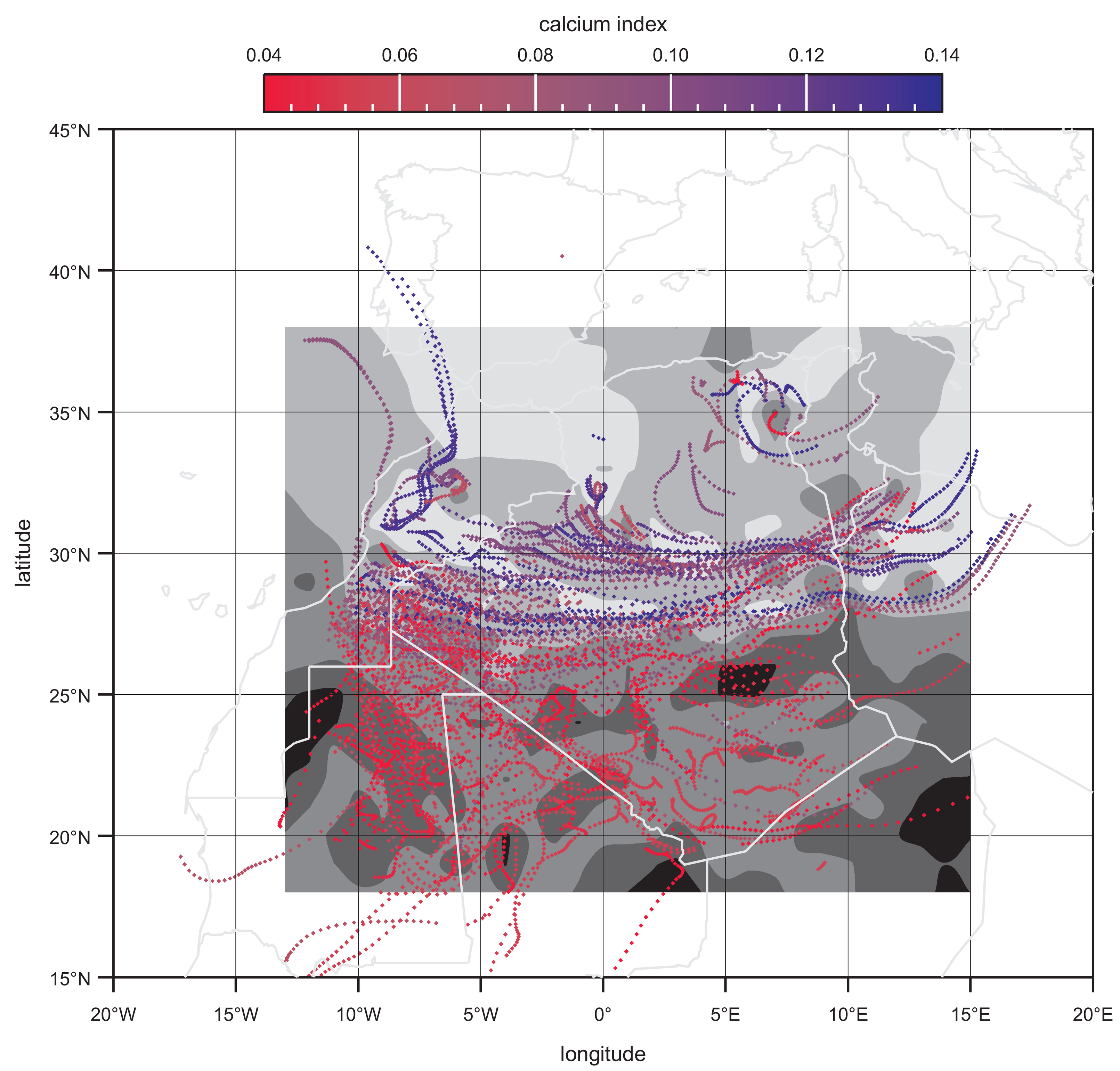
A low amount of iron-rich particles is present for all particles sizes.

Right: Time series of relative mass fraction of different particle classes for Saharan dust arriving at Izaña, Tenerife in July 2005

The dust plume arriving at Izaña was quite homogeneous in its composition. Starting from July 19, the fraction of the calcium-containing particles slightly increases, which may be due to a shift in source region. Looking at the chemical composition, however, the Saharan dust exported over Tenerife appears to be well mixed.

DUST SOURCES

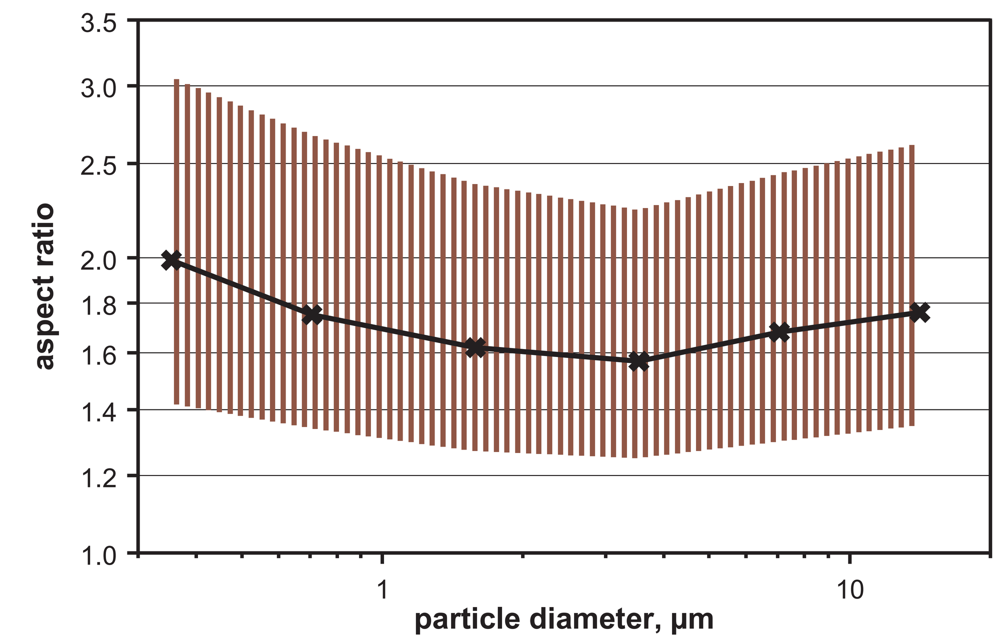
Atmospheric Environment, in review



Potential source regions for Saharan dust arriving at Izaña in July and August 2005, identified by trajectory calculations

The color-coded calcium index shows a decrease from north to south in the Sahara. The grayscale map derived from the trajectory calculations (white means high calcium values, black low ones) shows a more detailed structure, which is generally in good agreement with soil maps of the Sahara.

PARTICLE SHAPE

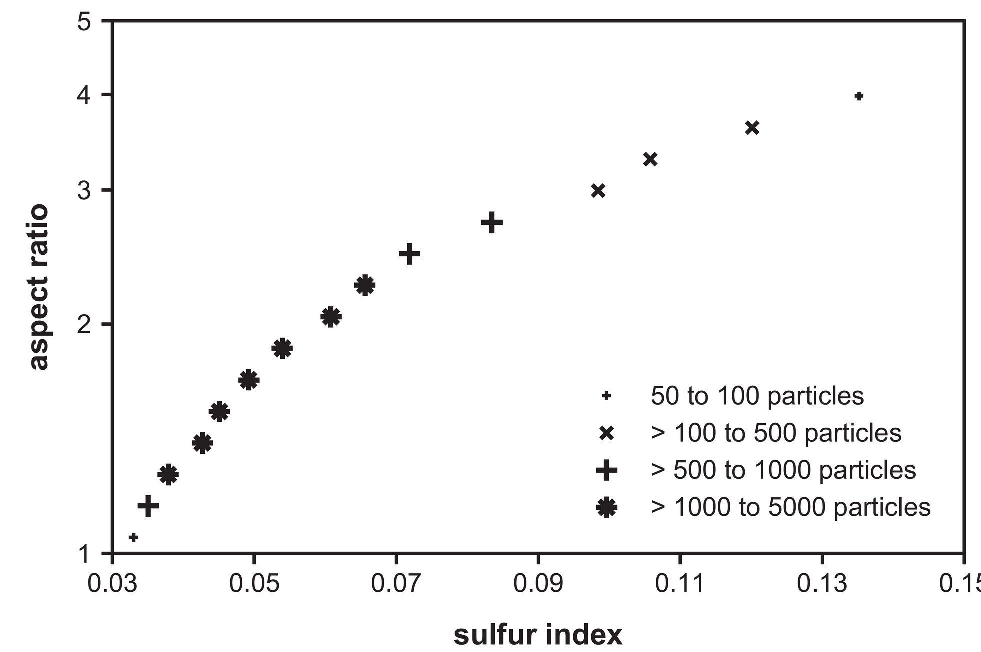


Aspect ratio versus particle size for aged Saharan dust

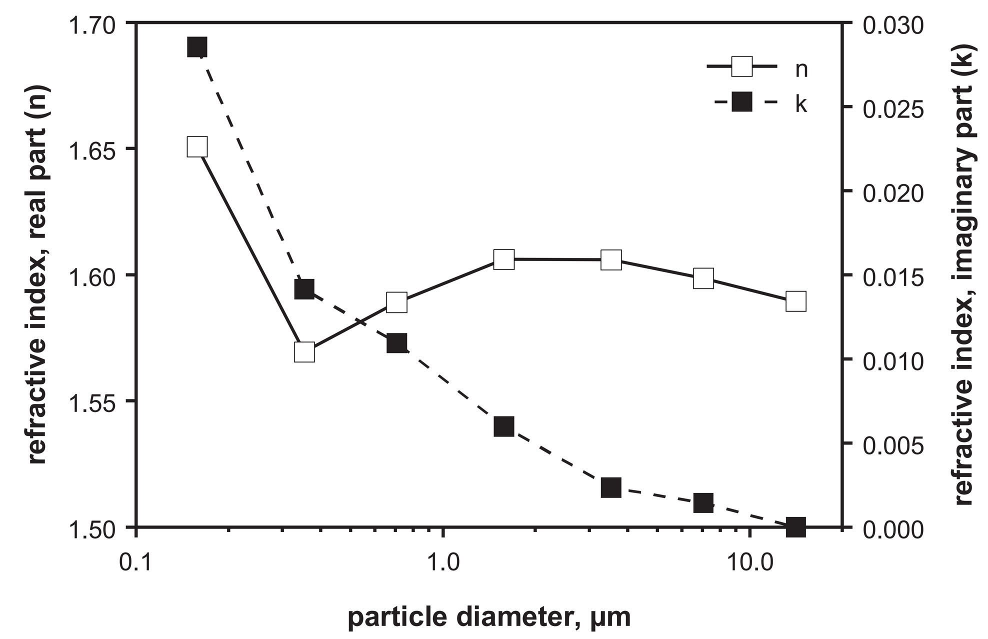
Median aspect ratios between 1.6 and 2 are found in the size range of 200 nm < d < 20 µm.

Aspect ratio versus sulfur index

The high aspect ratio shown by a small number of particles can be explained by their sulfur content, indicating the formation of needle-like particles by sulfate.



REFRACTIVE INDEX



Complex refractive index, derived from mineralogical model composition

For visible light, the imaginary part decreases strongly with particle size. High values for the smallest particles are due to high iron and carbonaceous material contents.

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