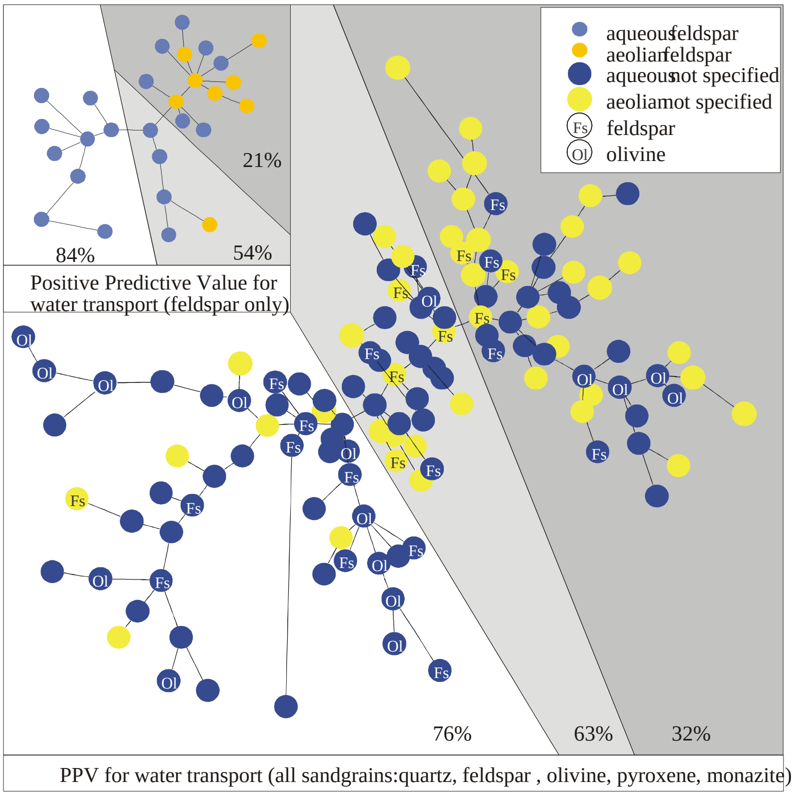
Sand Grains as Indicator for Water on Mars

In the search for aqueous habitats on Mars direct proof for (ancient) flowing water is still lacking although remote sensing has provided indications for young fluvial systems. To demonstrate that such proof can be given we examined surface marks on recent terrestrial sand grains with the atomic force microscope (AFM) and applied quantitative 3d-analysis that can numerically distinguish between aeolian and aquatic transport in sedimentary deposits on Earth.

The surfaces of natural quartz grains as well as olivine, feldspar pyroxene and monazite sands of known origin have been imaged, each image providing a 3d map of the mineral surface. A fully automated analysis of distribution patterns of the structural elements that build up the grain surfaces shows that wind transported quartz grains have linear elements that are short and distributed irregularly on the surface whereas the linear elements on water transported grains are longer with orientations that reflect the mineral symmetry.



Because the surface patterns found on aqueous grains are due to anisotropic etching, they can be used as diagnostic fingerprints for the existence of aqueous transport systems in present or past. We use a cluster analysis of the cross-correlation-distance of distribution patterns in the structures of aeolian and aquatic sand grains to build a minimal spanning tree (see Figure), that provides a map for the relationship of the various sediments found on earth. The analysis shows that the method is highly significant and that water and wind transport can clearly be differentiated.

Feldspar and olivine sands which are typically for Mars contribute an even higher Positive Predictive Value to the discrimination than quartz grains. Simple AFM experiments on a possible Mars lander are capable of proving the existence of flowing water in active runoff systems and to analyse the paleo environments of Mars.

collaboration with A. Kempe, R. Stark and W. M. Heckl.

References:

• Discrimination of Aqueous and Aeolian Paleoenvironments by Atomic Force Microscopy - A Database for the Characterization of Martian sediments. Kempe, A., Jamitzky, F., Altermann, W., Baisch, B., Markert, T. & Heckl, M.W., 2004. Astrobiology 4 (1), 51-64.

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