Emplacement of regional high-silica deposits on Mars

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Surface materials in the mid-to-high latitudes of Mars are higher in silica content compared to other areas of Mars [1, 2]. Silica enhancement is expected for the alteration of mafic Martian crust [3]. The presence of high-silica surfaces in both the northern and southern hemispheres of Mars suggests a genetic link to the recent Martian climate and distribution of near-surface water ice [4]. Silica was likely enriched in these regions by interaction with the cryosphere in recent Martian history. High-silica mineraloids may have been formed in aqueous solutions generated by periodic snowmelt or pedogenic processes in icy soils, forming thin coatings on rocks and particles, consistent with remote sensing observations [4, 5]. While such a model may explain the presence of high-silica materials in both hemispheres, important differences between north and south must be explained. High-silica materials are more concentrated in the northern plains than the southern hemisphere [1]. Also, Fe, K, and Th are enriched in the northern lowlands, while K/Th is similar globally [2].

These hemispheric differences may result largely from the physical redistribution of materials, with mechanical weathering ultimately affecting chemical and mineralogical observations. The high-silica northern hemisphere is dominately in the Vastitas Borealis Formation (VBF), the reworked sedimentary residue of Martian outflows [6]. The chemistry of the northern plains may reflect the nature of VBF sediment source material and its subsequent alteration and weak diagenesis. Silica enrichment in the northern plains may derive from deposition of high-silica phases from flood waters in addition to later cryospheric weathering. The boulders observed in HiRISE images of the VBF may be, in part, sedimentary rocks cemented by flood-produced silica.

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Distribution of ^{230}Th, ^{10}Be and ^{231}Pa in sediment particle classes

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The $^{230}Th_{xs}$-normalization method is a widely used tool for the calculation of vertical fluxes to marine sediments, correcting for the influence of lateral sediment transport. However, the strong particle surface reactivity of thorium may lead to a grain size specific distribution of ^{230}Th. Lateral transport during particle settling might have a sorting effect on particles, thus affecting the sedimentary ^{230}Th signal as well. In this study, the specific distribution pattern of ^{230}Th within different particle classes is investigated in carbonate-rich sediments and opal-rich sediments from the Atlantic Ocean. Sediments were split into distinct particle classes by wet-sieving and settling. The results show a clear preference of ^{230}Th for the smallest particle sizes. Both in carbonate-rich and opal-rich sediment, most of the ^{230}Th is bound within the particle size class <20µm accounting for 60-77% and 90% of the total ^{230}Th inventory, respectively, whereas this size fraction was only 45% and 72% of sediment mass, respectivley. In the opal-rich material, ^{230}Th does not show any preference for opal or non-opaline material.

We also compare similar neighbouring deep-sea sediment cores (PS1768-8 and PS1769-1). While the difference in sedimentation rates is a factor of 2-3, the grain-size distribution in the two cores, as well as the ^{230}Th-distribution between the grain sizes, does not differ significantly. These results indicate that syndepositional sediment redistribution at the sea floor may be a process that does not necessarily have a major impact on the grain size distribution.

In addition, results from ^{10}Be and ^{231}Pa measurements of the same size-fractionated sediment samples will be presented. In contrast to the ^{230}Th, it is expected to find these isotopes preferentially adsorbed on biogenic substances (opal, carbonate). The isotope ratios ^{10}Be/^{230}Th and ^{231}Pa/^{230}Th are used as palaeoproductivity and palaeocirculation proxies. If ^{230}Th, ^{10}Be and ^{231}Pa are bound to different particle types, lateral transport involving particle sorting might affect the isotope ratios.