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A size control for quartz silt (making particulates at planetary surfaces)

Commentary

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Abstract: Quartz silt is widespread in terrestrial sediments [1]. Its ubiquity has led to its neglect as a geomaterial, and studies of silt as such are relatively rare, but it presents an interesting and continuing petrological problem. Is silt a specific geological material, is it defined by a formation process, and a set of size parameters? In the world of clastic quartz sedimentology there are obvious mode sizes; there is a sand mode at around 300-500 μm and a silt mode, an order of magnitude smaller, at 30-50 μm. Are these both defined by specific geological processes?

Keywords: quartz silt • formation mechanism • Mars sediments

It has been known for almost 50 years that the formation mechanism for quartz sand produces a specific size range, determined by the eutectic-type reaction in the parent quartz-bearing rock [2]. We propose a specific mechanism, related to sand formation, that provides a defined range of silt particles. Two important mechanisms are involved in sand formation [1] a eutectic-type reaction in the parent granitic rock determines the universal size of quartz sand and [2] the cooling quartz goes through a displacive transformation from high quartz to low quartz which produces tensile stresses in the system. These aid in the particle breakout process as the weathering front proceeds through the parent rock. This high-low transformation also produces defects in the sand grains. These have become known as 'Moss defects' after A. J. Moss who first studied them in detail [3].

The silt forming mechanism depends on the Moss defects. The concentration of Moss defects depends on the level of stress generated by the high-low transformation. A lower stress would produce less subsequent breaking in the sand particles, a greater stress would produce a smaller product particle size. The general stress in the default granite is at just the right level to produce a defect network which generates 30-50 μm particles, so these predominate in the sedimentological system, and quartz clastics are, by and large, either sand or silt. This size distinction is being observed, and sophisticated attempts are still being made to explain observed bimodalities in terms of transportation processes [4].

The proto-sand particle in the granite is constrained for size by the eutectic-like reaction, and the stress level

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is regulated by the diffference in density between high quartz and low quartz, so there is a certain constancy in the silt product. Quartz sand and silt are universal continental detrital materials. The making of silt particles for loess deposits, particularly in deserts [5, 6], is still discussed, but the basic control on silt size appears to lie with the sand forming event in the quartzose parent rock. Quartz silt **is** a specific material, not just a chosen size range in a complete range of all sizes; quartz sand and silt are defined materials.

All of the above presents a strictly terrestrial scenario. Producing silt on Mars requires different processes [7]. Mars lacks quartz; in fact Martian lithology may lack a well-placed eutectic reaction to establish some size control on finer particle sizes. Without a better knowledge of Martian lithologies it is impossible to define active particle forming mechanisms on that planet. It may be that Earth, besides being a uniquely wet planet, is also a uniquely particulate planet. The essential question appears to be: are there rock systems on Mars wherein the formation mechanism has introduced stresses which can be exploited when the weathering process occurs? A combination of stresses may be essential for efficient particle production, as occurs in the recently appreciated mechanism [7] for the production of small quartz dust from sand sea deposits.

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