Source and genesis of loessitic dust in Late Paleozoic Western Tropical Pangaea

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Loess (terrestrial eolian silt) is abundant today, primarily in mid- to high-latitude regions, and well recognized as a high-fidelity archive of climate change. Much of this 'Quaternary' loess is linked to glacial processes, as these are highly effective in generating the characteristic silt size. Long neglected in the pre-Quaternary record, loess(ite) is increasingly well recognized in the late Paleozoic (latest Devonian through Permian) of western equatorial Pangaea (western North America), around the greater Ancestral Rocky Mountains. Both true 'loessite' and eolian silt deposited in a variety of continental and marine environments occur here, with individual deposits reaching at least 700 m, and possibly >1 km in thickness. Atmospheric 'dustiness' clearly varied on a high-frequency scale, evinced by m-scale loessite-paleosol couplets or by variations in silt content of glacioeustatic (glacial-interglacial) carbonate platform cycles. These deposits commonly exhibit remarkable mineralogical and geochemical immaturity, distinguished by a feldspar-rich composition and low Chemical Index of Alteration (CIA) values (mean=59; skewed toward low values) [1]. The CIA values match those calculated for a crustal model of the western U.S. [2], indicating the loessite is only slightly weathered from source basement that cored paleo-uplifts of the Ancestral Rocky Mountains. Detrital zircon data confirm significant first-cycle derivation from Precambrian basement. The great volume, mineralogical and geochemical immaturity, basement derivation, and the timing that coincides with pulses of major Gondwanan cold (glacial) episodes are all most readily reconciled with silt genesis via glacial and associated cold-weathering processes. Such a concentration of loess in the tropics is remarkably nonuniformitarian and, we hypothesize, reflects a tropical climate system at times oddly cold and semiarid. The late Paleozoic interval may well rank as the dustiest in Earth history, and yield important insights to causes and consequences of mineral aerosols in the Earth System.

[1] Soreghan & Soreghan (2007) *EPSL* **255**, 117-132.
[2] Condie & Selverstone (1999) *J. Geol.* **107**, 387-397.

Paleo-atmospheric circulation inferences from geochemistry and sedimentology of Paleozoic loess: Examples from western Pangaea

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Rock-magnetic, sedimentologic, whole-rock geochemical and geochronologic data have been collected from a number of loessites (lithified loess) deposited across low-latitude, western Pangaea (western U.S.) during the late Paleozoic. The accumulation of these loessites spans the timing of maximum continental glaciation associated with the late Paleozoic ice-house, and also the onset of monsoonal circulation that established itself during the late Paleozoic and extended into the Mesozoic. Individual deposits are thick (100 to >700 m) and intercalated with paleosols on a 1-10 m scale. Magnetic susceptibility variations and weathering indices (CIA) collected on numerous loessite-paleosol profiles suggest they record temporal, high-frequency changes in relative humidity over a large region of the Pangaean tropics. Further, grain-size analysis coupled with provenance derived from trace-elements and geochronology of detrital zircons, suggest that low-latitude atmospheric circulation patterns varied either in response to or as a cause of this variation in tropical aridity. Periods in which loessite accumulated are inferred to reflect drier, windier times likely associated with glacial maxima in which monsoonal circulation with attendant westerly winds predominated. Periods in which aggradational paleosols formed are inferred to reflect wetter, less windy times likely associated with glacial minima (but not necessarily interglacials) during which zonal circulation in low-latitudes predominated over monsoonal circulation. Sedimentology and geochemistry are common tools used for inferring regional atmospheric circulation patterns from Quaternary loess. We suggest these same analyses are possible in very ancient loess and provide the same level of inference for paleo-atmospheric circulation.