Where precipitation matters: ^{10}Be and ^{26}Al-derived hillslope denudation rates in the Atacama Desert, Chile

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A fundamental goal of geomorphology is to quantitatively understand how landscapes respond to climate. We have quantified denudation rates on gentle, granitic, and semiarid to hyperarid hillslopes in the Atacama Desert, northern Chile, using ^{10}Be and ^{26}Al. Unlike more humid parts of the world, where mean annual precipitation (MAP) seems to exert little control on denudation rate [1], denudation rate increases as a power law function with increasing precipitation, going from 1 m/My at MAP<1 mm/y to 19 m/My at MAP~100 mm/y. This corresponds with a shift in soil formation and transport processes from abiotic (salt shrink-swell) in the hyperarid region to biotic (bioturbation) in the semiarid region.

On hillslopes approaching dynamic steady state, we can calculate rates of physical and chemical erosion using a soil mass balance equation, soil chemistry, and the denudation rates above. This has been done in only a few other locations, including Australia [2, 3] and California [3]. Soil flux (Q) on some hillslopes is proportional to both soil thickness (H) and slope (S): $Q=-K_hHS$. K_h is thought to account for differences in climate and intensity of soil transport processes but has remained essentially a black box. Our data lets us begin opening the box. We calculated K_h for each hillslope and compared it to other K_h values available. We observe an increase in K_h of nearly one order of magnitude with increasing MAP in the Atacama (going from abiotic to biotic hillslopes). However, once bioturbation has become the dominant transport mechanism, K values plateau at 0.0050±0.0005 m/y, regardless of MAP.

[1] Riebe *et al.* (2004) *EPSL* **224**, 547-562. [2] Heimsath *et al.* (2005) *Geology* **33**, 949-952. [3] Yoo *et al.* (2007) *JGR* **112**, F02013.

Toward understanding early Earth evolution: Prescription for approach from terrestrial noble gases and light elements records in lunar soils

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Because of the almost total lack of geological record on the Earth's surface before 4 Ga, the history of the Earth during this period is still enigmatic. Here we describe practical approach to tackle these formidable problems. We propose that examinations of lunar soils for light elements such as He, N, O, Ne, and Ar would shed a new light on this dark period in the Earth history, and resolve some of the most fundamental questions in earth science such as the onset time of the geomagnetic field, the appearance of oxygen atmosphere, and the secular variation of an Earth-Moon dynamical system.

Due to a strong dynamic coupling between the Earth and the Moon, theoretical studies have concluded that the spin-locking between the Earth and Moon took place in a few tens of million years (Ma) after the formation of the Earth-Moon system about 4.5 billion years ago, and hence-forth the Earth has been facing only to the nearside of the Moon (e.g. [1]). Also, theories have suggested that due to tidal energy dissipation, the Moon has been receding from the Earth. Recent theoretical studies concluded that the distance between the Earth and the Moon was about a half of the present distance circa 4 Ga ago (e.g. [2, 3]). These suggest the possibility that there has been interaction between the Earth's atmosphere and the nearside lunar surface in ancient time. Such interaction would further be enhanced [4], if the geomagnetic field were less developed or even absent in ancient times [5]. Therefore, we suggest that close examinations of lunar soils for lighter elements would resolve long standing fundamental problems such as the onset time of the mature geomagnetic field as well as the dynamic evolution of the Earth-Moon system.

[1] Murray & Dermott (1999). [2] Abe & Ooe (2001). [3] Bills & Ray (1999). [4] Ozima *et al.* (2005). [5] Tarduno *et al.* (2007).