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Interactive comment on “A new synthesis for terrestrial nitrogen inputs” *by* B. Z. Houlton and S. L. Morford

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Review of Houlton and Morfort A new synthesis for terrestrial nitrogen inputs Soil 2014-29

The authors provide a nice summary of the sources of reactive nitrogen on the Earth’s land surface, covering the well-known inputs by N-fixation and industrial fertilizer, and focusing on the nitrogen derived from the lesser-known pathway of rock weathering. The latter was recognized by these workers and their colleague, Randy Dahlgren, at UC Davis only within the past couple of decades.

The authors make a strong case for the importance of rock-derived nitrogen in a variety of regional settings. Surprisingly, they do not mention that in the preindustrial world,

rock-derived N (20 TgN/yr) may have been in the same order of magnitude globally as nitrogen from biological fixation (60 TgN/yr; Vitousek et al. 2013)âĂŤa major modification of a paradigm of biogeochemistry. Now, of course, human production of nitrogen fertilizer (~ 140 TgN/yr) and cultivation of leguminous crops (60 TgN/yr) dwarfs both natural sources.

This is an interesting and readable paper that I could easily imagine as an assignment in a graduate class in biogeochemistry. Aside from atrocious misuse of the hyphen, the authors only give me a few points to quibble:

Line 159. With such a robust literature documenting ecotypic differentiation of enzyme temperature optima in plants and soil microbes, I am surprised that the same is not true of nitrogenase. Or at least, that no comment was made on this.

Line 214. Free-living (asymbiotic) N-fixation receives scant treatment in this paper, even though at rates of 1 to 5 kg/ha/yr, it may account for as much as 1/3 of the biological nitrogen-fixation on land. In particular, it would be nice to comment on the importance of free-living nitrogen fixation, especially in certain desert environments and their soil crusts.

Line 223. These cited rates of N-fixation by Ceanothus are similar to rates for Prosopis in southwestern deserts.

Lines 272-273. The increase in rock weathering expected with plant growth at elevated concentrations of atmospheric CO2 may be slight, inasmuch as plants and soil microbes normally maintain pCO2 at high levels in the soil pore space, so the increment with rising atmospheric CO2 is likely to be small, although nevertheless significant over geologic time (Andrews and Schlesinger 2001).

Line 341. Presumably the authors mean “catenae”

Line 354. The huge pool of nitrogen in the Earth’s crust is not so easily interpreted to indicate that N-fixation has exceeded denitrification through geologic time. Some of this nitrogen may have never circulated in the biogeochemical cycles at the Earth's surface. Rather, it would be interesting to estimate the amount of nitrogen being subducted in sedimentary rocks passing into the Earth's mantle versus the amount that is being degassed as juvenile nitrogen by volcanoes. Recent estimates suggest that volcanic emissions (78 to 123 x 109 gN/yr) are less than subduction (330 to 960 x 109 gN/yr), suggesting a net entrainment of N in the Earth's mantle. See Schlesinger and Bernhardt (2013, p. 456) for references.

Line 419. Schlesinger et al. (1998) document phosphorus deficiencies in recent volcanic soils on Krakatau. These do not appear to be related to low P concentrations as much as to a stoichiometric deficiency of P relative to high concentration of N that was accumulated in these soils by cyanobacteria, which are reported to have colonized immediately after the 1883 eruption.

Line 486. These air-borne agricultural losses of N represent an input to ecosystems that are downwind, but globally they merely represent a recycling of N added to the land surface by the application of industrial fertilizer.

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