Biogeosciences Discussions, 1, S197–S200, 2004
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Biogeosciences Discussions

Interactive comment on "Animal-sediment interactions: the effect of ingestion and excretion by worms on mineralogy" *by* S. J. Needham et al.

Anonymous Referee #1

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General comments The most serious flaw in this paper is the lack of replication. The design is to split one container in half, with a control and an experimental side. Thus there is only one experiment and one control. I dislike the term "pseudoreplication" in the oft-cited paper about this issue by Hurlbert. There just isn't any replication. Multiple samples from one side of the aquarium over time should be analyzed by a procedure like repeated-measures ANOVA once there are some genuine replicates. Although I believe that the authors' interpretations that the worms caused clay mineral changes likely are correct and will hold up under replication, the manuscript fails to convince me that the mechanisms have been identified. They don't know whether the changes are due to acid in the gut, surfactants in the gut, organic ligands in the gut, or to cyclic Eh changes either in or outside the gut. By subducting material, the worms cause external Eh changes in the particle environment in addition to their more obvious gut environment effects. Some or most of the changes equally well could be due to bacterial associates of the worms, inside or out of the gut. The experiment is very much a black box. It would be much more interesting to try to narrow down the

mechanisms.

Moreover a quick read of the abstract reminded me very much of the abstract in: McIlroy, D., Worden, R. H., and Needham, S. J.: Faeces, clay minerals and reservoir potential: J. Geol. Soc., 160, 489-493, 2003. The biggest difference I can see is that earthworms are included in the present paper. It's an important addition, but there is still a great deal of overlap. The editors will have a difficult decision as to whether there is sufficient novelty, and I would argue not until replication assures the solidity of the results. The prior work was also unreplicated, so in a sense the package of two papers is one set of replicates for lugworms. I have no background in clay mineralogy, however, and so cannot judge the geological novelty of the slightly different X-ray results in the slightly different experiments. I do think that the authors understate prior work on effects of gut passage and biota generally on clay mineralogy, e.g.:

TI: Effects of gut chemistry in marine bivalves on the assimilation of metals from ingested sediment particles AU: Griscom, SB; Fisher, NS; Aller, RC; Lee, B-G SO: Journal of Marine Research [J. Mar. Res.]. Vol. 60, no. 1, pp. 101-120. Jan 2002.

TI: Conversion of diatoms to clays during early diagenesis in tropical, continental shelf muds AU: Michalopoulos, P; Aller, RC; Reeder, RJ SO: Geology [Geology]. Vol. 28, no. 12, pp. 1095-1098. Dec 2000.

TI: Rapid clay mineral formation in Amazon Delta sediments: Reverse weathering and oceanic elemental cycles AU: Michalopoulos, P; Aller, RC* SO: Science (Washington) [SCIENCE (WASH.)], vol. 270, no. 5236, pp. 614-617, 1995

TI: Biogeochemical processes in Amazon Shelf sediments AU: Aller, RC; Aller, JY; Blair, NE; Mackin, JE; Rude, PD; Stupakoff, I; Patchineelam, S; Boehme, SE; Knoppers, B SO: Oceanography, vol. 4, no. 1, pp. 27-32, 1991

Specific comments by section: p. 538, line 1. Hostility is in the eye of the beholder, and this sentence paints a very anthropomorphic picture. There are many symbionts

BGD

1, S197–S200, 2004

that cannot live outside guts and many more that grow best there. The review of gut environments appears selective, in that the authors have singled out pH and chosen a subset of the literature on deposit feeders. Publications by L.M. Mayer and coworkers at the University of Maine suggest that larger animals have less intense digestion, e.g.: Mayer, L.M., L. Schick, R. Self, P. Jumars, R. Findlay, Z. Chen and S. Sampson. 1997. Digestive environments of benthic macroinvertebrate guts: enzymes, surfactants and dissolved organic matter. J. Mar. Res.55: 785-812. Chen, Z., L.M. Mayer, C. Quétel, O.F.X. Donard, R.F.L. Self, P.A. Jumars, and D.P. Weston. 2000. High concentrations of complexed metals in the guts of deposit-feeders. Limnol. Oceanogr. 45: 1358-1367. Plante's review paper in fact suggests that marine deposit-feeder guts are not very chemically severe compared to terrestrial and freshwater counterparts: Plante, C.J., P.A. Jumars and J.A. Baross 1990. Digestive associations between marine detritivores and bacteria Ann. Rev. Ecol. Syst. 21: 93-127.

p. 539, line 23. Lugworms are relatively non-selective compared to most other deposit feeders, but they do show selection as work published by R.F.L. Self has shown: Self, R.F.L., and P.A. Jumars. 1988. Cross-phyletic patterns of particle selection by deposit feeders. J. Mar. Res. 46: 119-143. The structure is not a proboscis. It is an eversible pharynx.

p. 543, line 23. Polychaetes don't have probosces. The structure is an eversible pharynx. And it is quite capable of selection cf. the Self reference above.

p. 545, line 19. What is relevant is the pH of A. marina and L. terrestris guts. I don't know of anyone who in recent measurements has found a pH near 5.4 in A. marina. The Ahrens work is in much smaller worms that have need of much more intense digestion. L. terrestris has near-neutral pH, and a number of oligochaetes have basic gut pH in at least part of the gut. Here is one recent paper that includes pH measurements for L. terrestris:

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BGD

1, S197–S200, 2004

Interactive Comment

69, No. 3 0099-2240/03/$08.00 0 DOI: 10.1128/AEM.69.3.1662-1669.2003 The Earthworm Gut: an Ideal Habitat for Ingested N2O-Producing Microorganisms Marcus A. Horn, Andreas Schramm, and Harold L. Drake

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Interactive comment on Biogeosciences Discussions, 1, 533, 2004.