

Interactive comment on “Spatial variation in soil active-layer geochemistry across hydrologic margins in polar desert ecosystems” by J. E. Barrett et al.

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Response to Reviews on “Spatial variation in soil active-layer geochemistry across hydrologic margins in polar desert ecosystems” by J. E. Barrett et al.

Responses to F. Ugolini

Ugolini raised a number of question related to the physical nature of the soils/sediments. First off, he asked how we distinguished between soils and sediments. This is a purely operational distinction to recognize that much of the mineral substrate we examined is strongly influenced by lentic or lotic processes and would be

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traditionally considered sediments rather than soil (i.e., they are intermittently saturated or submerged). This point has been added to the first paragraph of the discussion.

Our results presented here show that there are significant differences in chemistry across this saturated to dry gradient, but previous results have shown that there are no differences in particle size distribution between near-shore sediments and up-gradient dry soils (Northcott et al. 2009). No continuous trench was excavated, but soil pits were excavated at various distances across these soil moisture transects; chemistry data are presented in Figure 4. Additional description of the physical properties of these soils/sediments is available in Northcott et al. 2009.

Ugolini also asks about the potential for differential transport of ions and cations in Antarctic soils and sediments. We have added some additional text to the discussion to bolster our arguments for abiotic control of most solute movement, and mentioned the low exchange capacity of soils low in organic matter and clay. However, it is notable that ammonium and phosphate are the exceptions to these trends, perhaps related to the low solubility of phosphate at these pHs and the high charge to mass ratio of ammonium.

Ugolini also mentions the unfrozen water present in mineral and salt films even during times when ambient temperatures are far below freezing. We recognize the importance of such films in solute transport, and indeed in the potential for biogeochemical cycling in general in these systems. Temporal variation in temperature was not a consideration in this study, and most of this work was conducted at a time of the year when temperatures were above freezing for most of the day, but we draw the reviewers attention to a recent paper examining the microclimate of these hydrological gradients: Ikard et al. 2009. Permafrost and Periglacial Processes, in press.

Responses to Reviewer 2

Reviewer 2 suggests that this is an excellent system to look at groundwater movements between boundaries of streams and lakes and soils because of the closed nature of

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the system. This is an excellent point and one that we have added to the end of our introduction. We've done a little work on controls over water movement (Gooseff et al. 2007 reference in citation list), however, we haven't considered the role of patterned ground in groundwater movement and associated hydrogeological processes. Visually, it is obvious that patterned ground extends into the shallow sediments of lakes in Taylor Valley (and perhaps elsewhere), and clearly water content is instrumental in their formation. Further, the influence of patterned ground on surface microtopography and soil particle size distribution would in principle influence water movement; however we have no information on this. We've added some language in the discussion to suggest that this may be an important area of future study.

Responses to Reviewer 3

Reviewer 3 suggests that we include additional pedological information (for example soil texture and mineralogical information). We do not have any information on the soil mineralogy per se, but textural distributions have been published separately for these sites (Northcott et al. 2009). Surprisingly, little difference occurred in soil texture across the moisture gradients in general, though there were site by site differences in soil texture, probably influenced by till composition, and differences in lake history. Previous results have shown that these site by site differences may influence differences in evaporative wicking of moisture and solutes among lake basins, but these differences were difficult to tease apart from the influence of geomorphology and topography (Gooseff et al. 2007).

We don't include information on soil types for our sites. This is partly due to the absence of soil maps for the region. Admittedly, we could have made more detailed description of the soils to place within Bockheim's soil classifications for this region. Unfortunately, we did not collect these descriptions. Related, placing these results into a more detailed consideration of the geomorphology would have strengthened our interpretations and contributed to a more general understanding of the system. In addition to Reviewer 2's comments about the influence of patterned ground, this could be a fruitful subject

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of future inquiry. Additional discussion about this topic has been added to page 12 of the manuscript.

In response to the reviewer's question about free vs. tension held water, only the soils in the sampling positions closest to the streams or lakes were typically saturated. We did collect pore water from samples on which we measured D and ^{18}O signatures (Northcott et al. 2009), but unfortunately little volume was left over to look at the chemistry of pore water as originally anticipated.

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