Kearney Foundation Fellowship
Final Report Summary

Fellowship Recipient's Name: Brittany Smith

Project Title: Climate effects on the retention of dissolved organic carbon in soils

Mentor Professor's Name: Robert Zasoski

Reporting Period: July 1 – September 30, 2007

****

Leaching of dissolved organic matter (DOM) from surface leaf litter into the soil is an important mechanism for the movement and cycling of nutrients. In particular dissolved organic carbon (DOC) affects nutrient cycling and carbon sequestration in soils. DOC can be held in the soil through sorption processes and exits the soil profile by leaching or mineralization. This study investigated the effects of incubation time and temperature during DOM formation on DOC retention in the soil in three California ecosystems: a grassland, an oak woodland, and a conifer forest.

DOM solutions were made by incubating leaf litter in deionized water from each of the three sites for 5, 15, and 96 hours at 4, 20, and 30 ^{o}C. The concentration of DOC in solution generally increased with increased temperature and time, though in some cases leveled off or decreased after 15 hours. Also, aromaticity of the incubated samples, measured by ^{13}C NMR analysis, decreased as time and temperatures increased. Aromaticity was generally highest in DOM from pine litter, while oak and grass litter was lower. Previous experiments have found that aromaticity is correlated with adsorption; due to hydrophobic interactions, aromatic compounds tend to sorb more strongly to the soil surfaces. Therefore, I hypothesize that increased incubation time and temperature will result in lower adsorption of DOC due to lower aromaticity.

Additionally, the concentration of DOC in the soil solution is affected by biodegradation. The conversion of DOC to CO_2 is a microbially mediated process. As microbial activity is typically correlated with temperature, it is expected that an increase in temperature will increase mineralization of DOC.

Objective: To examine the effects of incubation temperature and time on DOM adsorption and mineralization by soils collected from a California grassland, an oak woodland and a conifer forest.

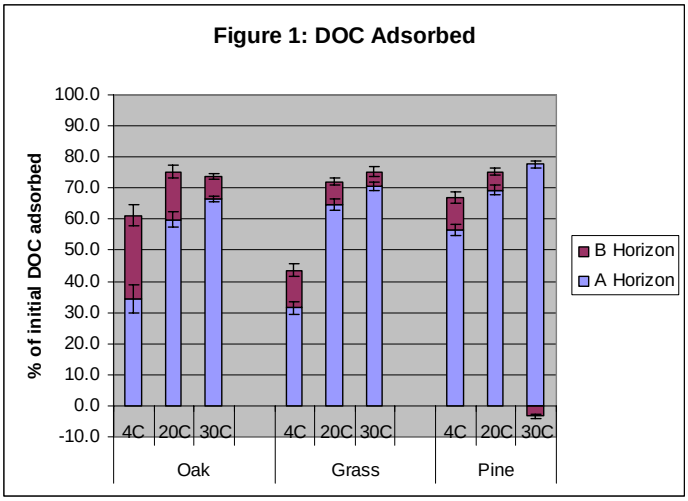
Methods:
Adsorption: Soil samples from the A horizon (0-10 cm) and B_t horizon (40-50 cm) were collected from three field sites: a grassland (Sierra Field Station), an oak woodland (Sierra Field Station) and a mixed conifer forest (Challenge, CA). The A horizon soils

were mixed with DOM solutions made from their corresponding leaf litter, incubated at different times and temperatures as described above. The initial solutions were 18 mg C L^{-1}. After 24 hours, the solution was separated by centrifugation and filtering, and a portion was set aside for DOC measurement. The remaining supernatant was then added to the B horizon soils, so as to mimic the solution moving through the soil profile. After 24 hours the solution was again separated and measured for DOC. The samples were kept at the same temperature at which the solutions were made. Adsorption of DOC by the soils was determined by the difference in initial and final concentrations of DOC.

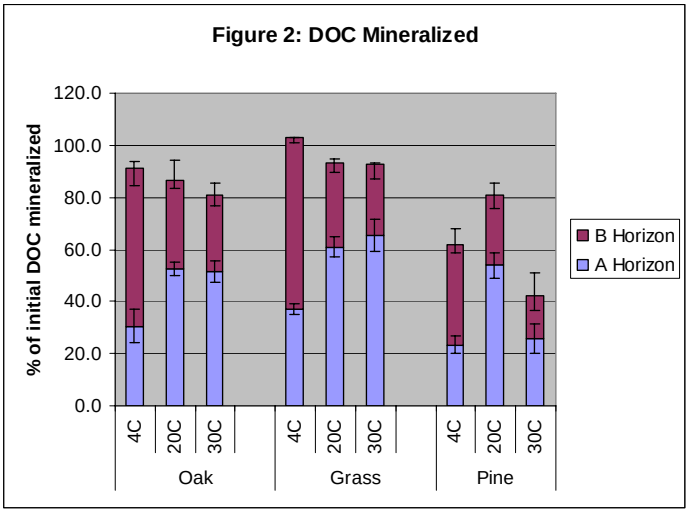
Mineralization: Biodegradable DOC was measured by adding a 50 uL aliquot of soil inoculum to each of the DOC solutions. The A horizon inoculum was added to the original 18 ppm solutions; the B_t horizon inoculum was added to the supernatant from the A horizon adsorption experiment described above. These mixtures were incubated for 7 days, at the temperature in which the solutions had originally been made. Loss of DOC by mineralization was determined by the difference in initial and final concentrations of DOC.

Results and Discussion:

As shown in Figure 1, in all three ecosystems an increase in temperature resulted in a decrease in B horizon adsorption, but an increase in A horizon and total adsorption. This was the opposite of what was expected.



Incubation time was found to not be a factor in adsorption. Time affected the concentration of DOM and not the aromaticity, so didn't affect adsorption because the experiment used a standard initial solution of 18 ppm for all the treatments. The decrease in B horizon adsorption may have been a result of reactions that occurred in the A horizon, and the lower initial concentrations entering the B horizon. Further studies could test this by measuring adsorption isotherms to determine the relationship between initial concentration and adsorption at a constant temperature.



The mineralization experiment showed an increase in A horizon mineralization in the oak and grassland systems, but a decrease in the B horizon and in overall mineralization as temperature increased (Figure 2). This was not expected. The pine ecosystem acted as predicted for 4 and 20 ^{o}C, as it increased biodegradation at higher temperature. The decline of mineralization at 30 ^{o}C could potentially be explained by the differing conditions in the conifer forest; it is at a higher elevation and has a lower average annual temperature than the other two ecosystems, so the microbial community at this site may not be as active at a higher temperature.

The mineralization data show that biodegradation is an important factor in carbon loss from the soil solution. However, this aspect is not controlled in the adsorption experiment. Since the adsorption experiment was only for 24 hours, in contrast to the 7 days of the mineralization experiment, loss of DOC through microbial activity was minimized. However, since it wasn't measured, it is impossible to say the relative importance of the two processes in DOC loss. This weakness could possibly be corrected for in an adsorption experiment that also measured CO_2 evolution.