Carbon and Nitrogen Distribution in Geologically Distinct Soils of California

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Background

- California has a diverse collection of geologic parent materials and soil forming environments.
- This diversity can lead to different soil types that can contribute differently to ecosystem health.
- Carbon and nitrogen storage in soil is important to ecosystem health.
  - Also a good indicator of overall soil quality.

Background

- Studies have shown C and N content differs across soil types, but the type of physical and chemical protection by the mineral matrix is not well understood.
- Additionally, the changes in the C and N to mineral matrix associations with depth have not been well explored.

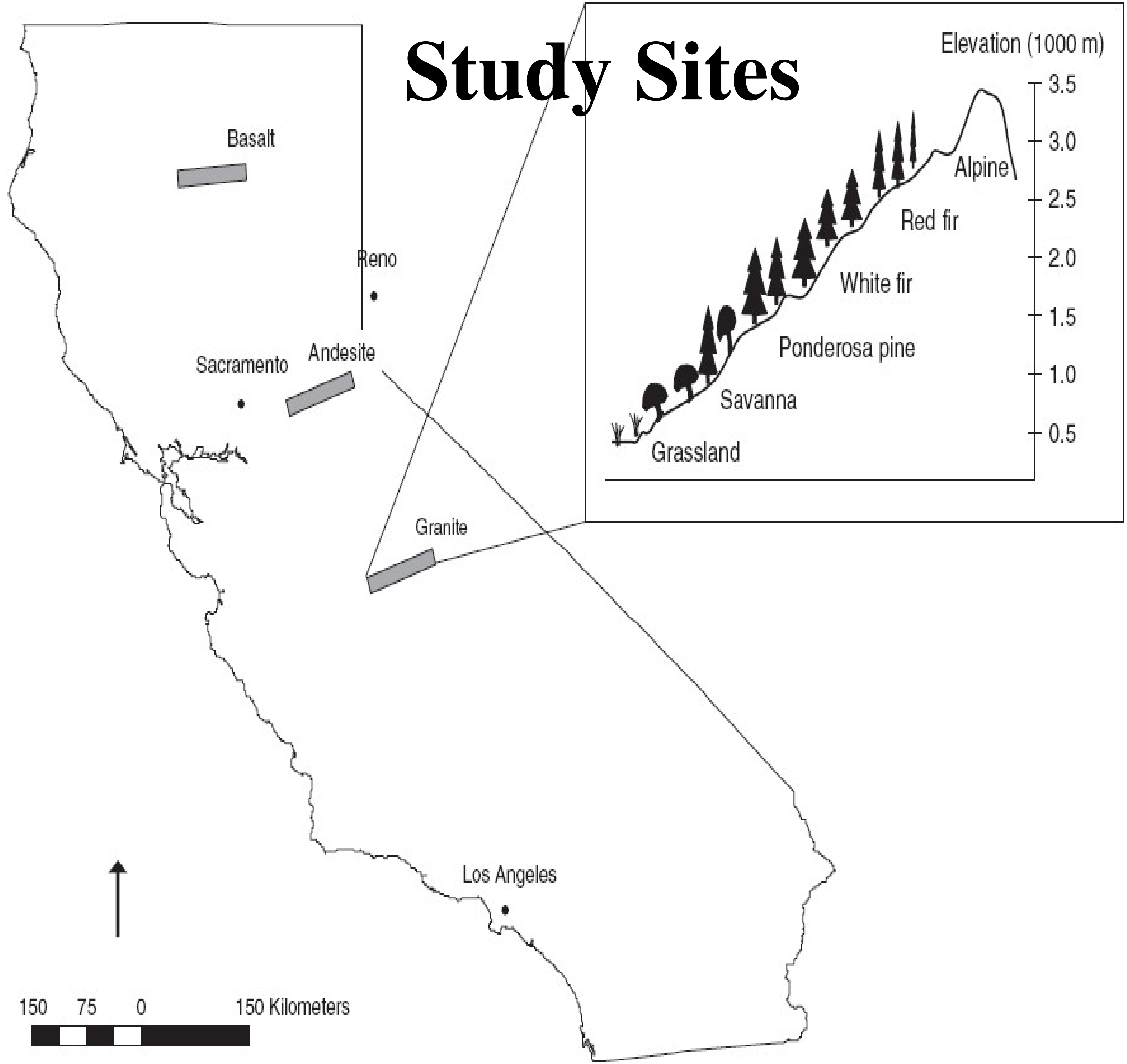
Objectives

- Relate the partitioning of C and N in the soil physical fractions:
  - Light fraction (loose soil organic material)
  - Occluded fraction (soil organic material physically occluded within aggregates)
  - Mineral fraction (soil organic material chemically bound to the mineral matrix)

Study Sites

- Three elevational transects sampled
  - Basaltic parent material (BS transect)
  - Andesitic parent material (AN transect)
  - Granitic parent material (GR transect)

Study Sites



Basalt
Reno
Sacramento
Andesite
Granite
Los Angeles
150 75 0 150 Kilometers
Elevation (1000 m)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Alpine
Red fir
White fir
Ponderosa pine
Savanna
Grassland

Experimental Design

- Three biome/elevational-zone sites sampled along each transect.
  - Lowest elevation: Ponderosa Pine dominated mixed conifer forest (PP site).
  - Mid elevation: White Fir dominated mixed conifer forest (WF site).
  - High elevation: Red Fir dominated mixed conifer forest (RF site).

Methods

- Three pits sampled at each of the three sites along each transect.
  - Pits dug to 1m depth.
  - Profile characterized.
  - Bulk density measured at three depths.
  - Samples of each soil horizon collected.

Sampling Field Sheet

	Component Name:				BS-RF-1				**Date:**		
	Depth		**Horizon**	**Bnd**		**Structure**			**Mottles**		
	(in)	**(cm)**				Grade	Sz	Type	% Sz Cont. Col Mst Shp Loc		
1		0-2	Oi						BD	ST	CB
2		2-11	A	AS		Sg			2	2	5
3		11-25	2AB	AS		WVF-SBK to SG			2	5	15
4		25-65	2Bw1	CS		WVF-MSBK			5	10	20
5		65-100	2Bw2	CS		WVF SBK to Sg			10	10	20

Soil Processing

- Field moist soils subsampled and sieved to 2mm.
- Large roots removed.
- Soil moisture measured (oven dried soil at 60 C).
- Subsampled <2mm oven dried soils.
- Dry color measured (for further characterization).
- Sample of each horizon fumigated with chloroform.

- A representative soil sample of every horizon from all sites sampled.

- Soil profiles from each pit of the red fir, white fir, and ponderosa pine sites along the basalt transect.

- Soil profiles from each pit of the red fir, white fir, and ponderosa pine sites along the andesite transect.

- Soil profiles from each pit of the red fir, white fir, and ponderosa pine sites along the granite transect.

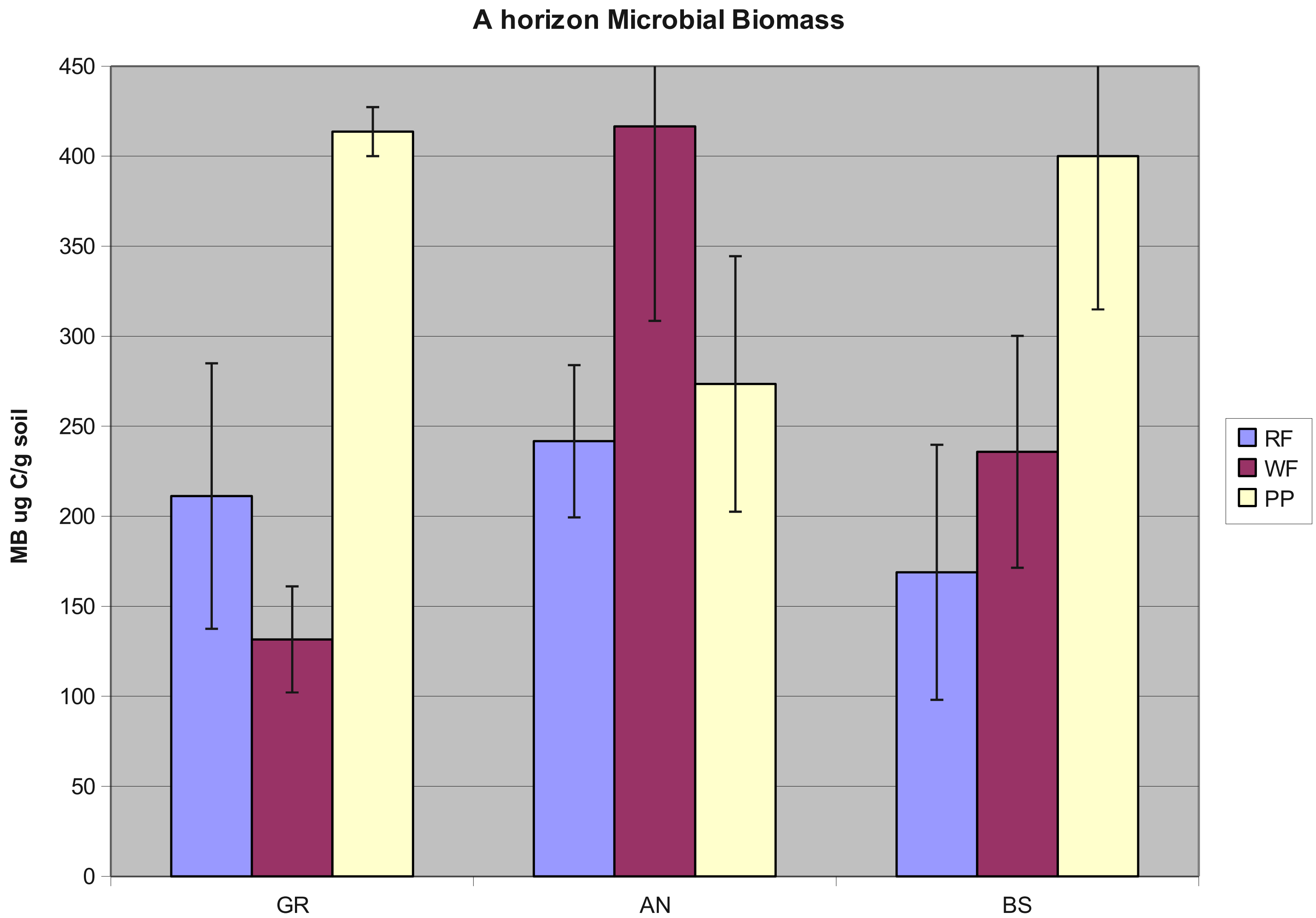
Analyses Performed

- Analyzed whole soils for:
  - Dissolved organic carbon
  - Nitrate
  - Ammonium
  - Total dissolved nitrogen
  - Total nitrogen
  - Total carbon
  - Microbial C/N ratio

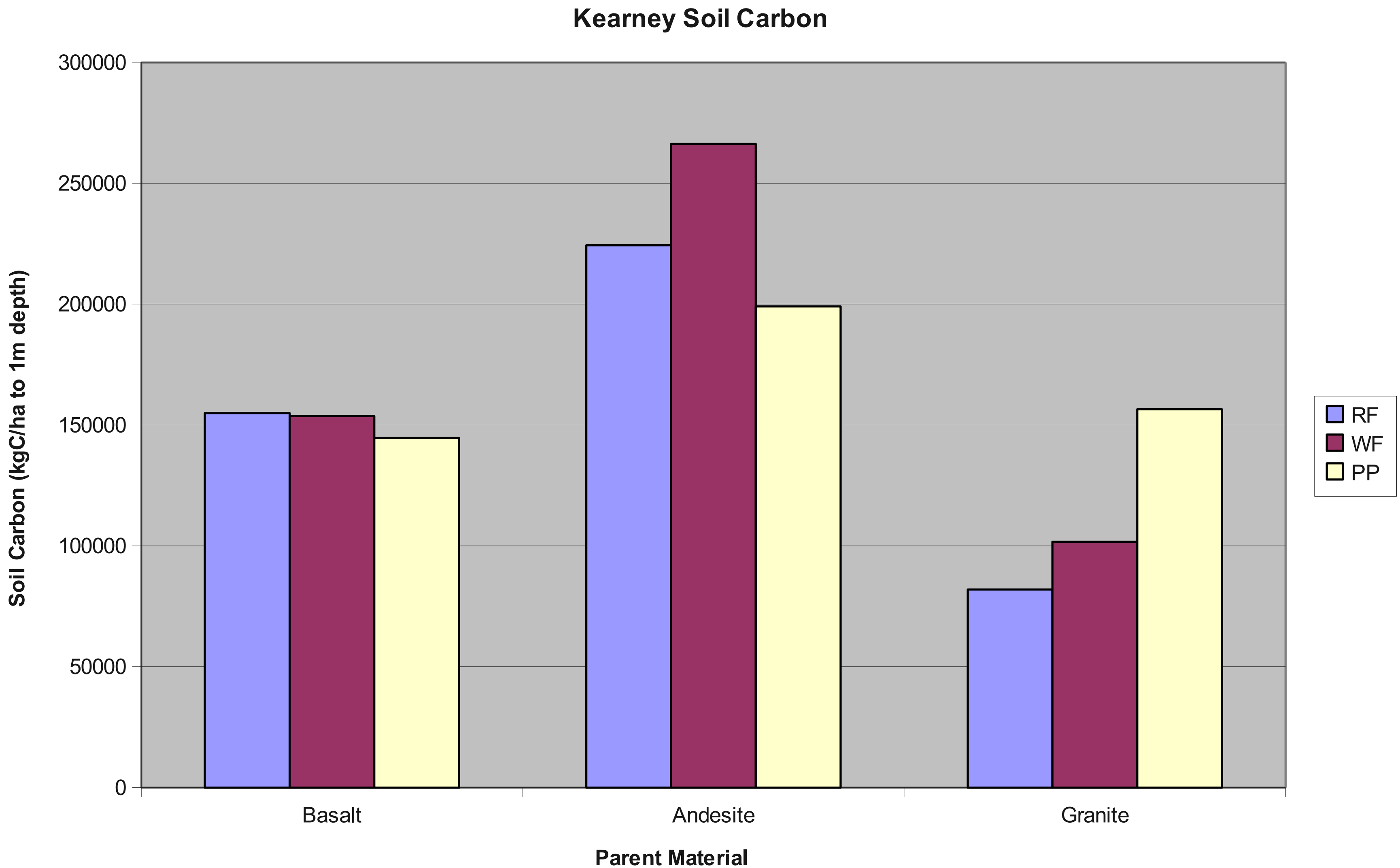
Density Fractionation

- Physically fractioned a surface and a subsurface horizon from each pit into three physical fractions (light, occluded, mineral) using the sodium polytungstate density fractionation method.
- Individual fractions then analyzed for C and N.

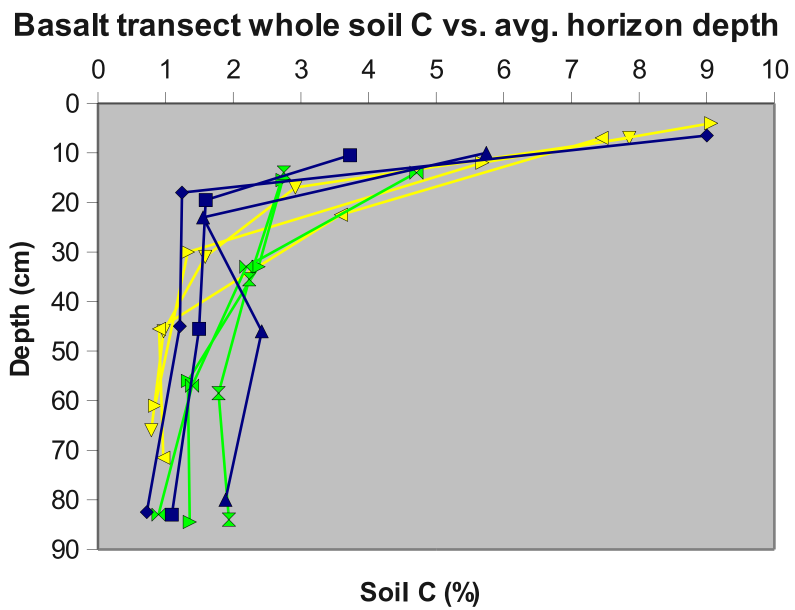
Results so far...

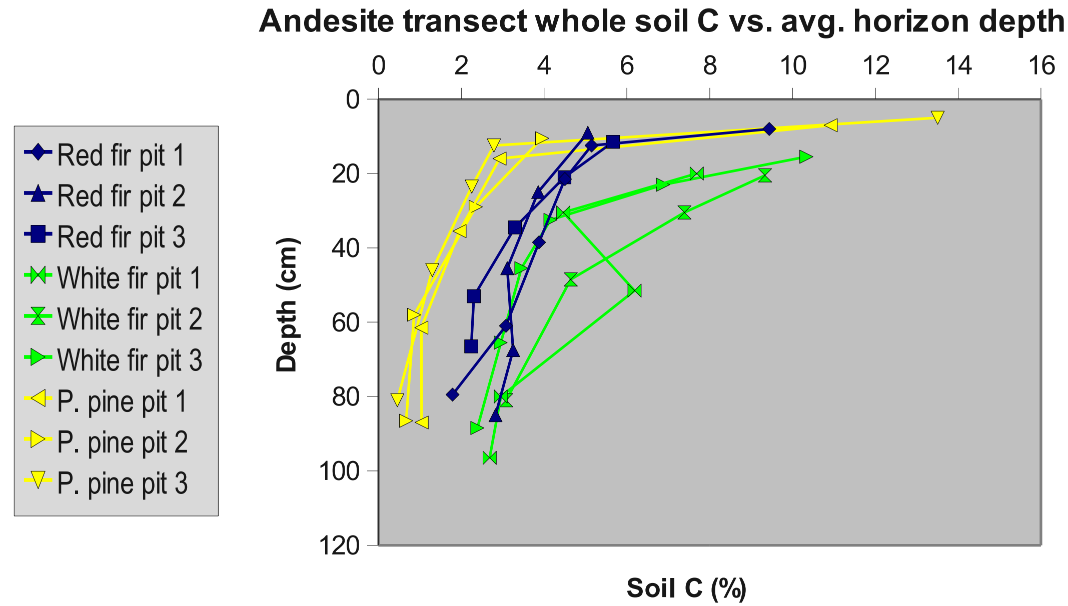


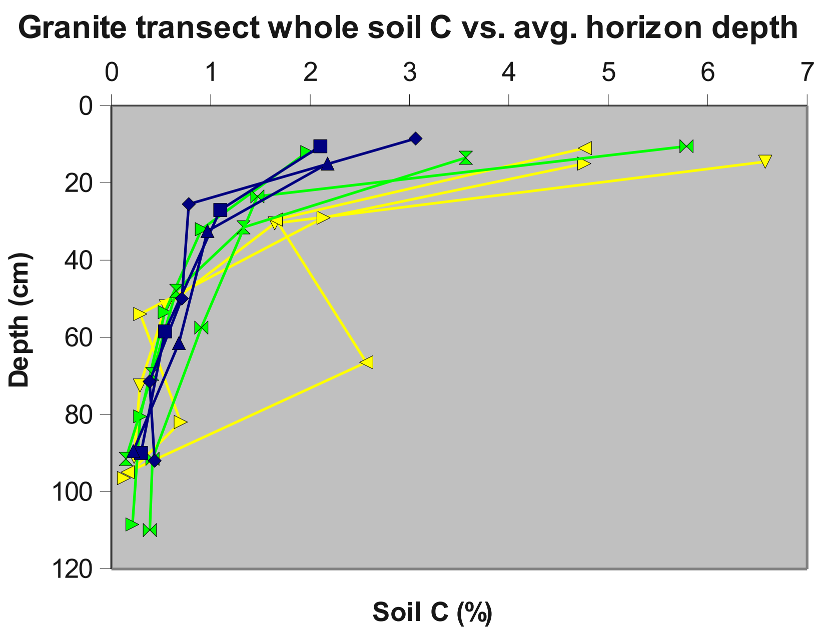
- Microbial biomass in the white fir site of the andesite transect is higher at the time of sampling than the red fir and ponderosa pine sites of the same transect, while in the other two transects the microbial biomass in the white fir site is not the highest.
  - Possibly related to high amount of short range order compounds at this site.



- The andesite transect has more C per area to 1m depth than the other two transects.
- The andesite transect white fir site has higher C content than the red fir and p. pine sites of the same transect, which correlates to the high microbial biomass in the AN-WF site as seen in the preceding graph.







- With a few exceptions, C content decreases with depth.
- C content of the andesite transect is generally higher than the basalt and granite transects throughout the soil profile.
- Correlation of C content to depth is less uniform in the andesite transect (especially the white fir site) than in the basalt or granite transects.
  - Possibly due to C protection mechanisms differing due to short range order compounds in andesite transect soils.

Example of Fractionation Results

Sample ID	Fraction	Sample wt. (g)	Fraction wt. (g)	% wt.	Final total wt. (g)	% recovery
BS-RF-1 A	Whole	20.291			20.162	99.36%
	LF		2.076	10.23%		
	OF		0.132	0.65%		
	MF		17.954	88.48%		
BS-RF-1 2Bw1	Whole	20.744			20.466	98.66%
	LF		0.302	1.46%		
	OF		0.028	0.13%		
	MF		20.136	97.07%		
AN-RF-1 A1	Whole	20.34			20.002	98.34%
	LF		7.352	36.15%		
	OF		0.264	1.30%		
	MF		12.386	60.89%		
AN-RF-1 Bw1	Whole	20.179			19.993	99.08%
	LF		1.530	7.58%		
	OF		0.197	0.98%		
	MF		18.266	90.52%		
GR-RF-1 A	Whole	20.219			18.589	91.94%
	LF		sample lost	0.00%		
	OF		0.120	0.59%		
	MF		18.469	91.34%		
GR-RF-1 Bw	Whole	20.124			19.994	99.35%
	LF		0.329	1.63%		
	OF		0.027	0.13%		
	MF		19.638	97.58%		

Example of Fractionation C & N

Sample ID	Fraction	Sample wt. (mg)	N wt. (mg)	%N	C wt. (mg)	% C	C/N
BS-RF-1 A	LF	8.151	0.115	1.411	2.584	31.703	22.470
	OF	6.515	0.117	1.803	2.385	36.615	20.385
	MF	46.031	0.021	0.047	0.298	0.647	14.190
BS-RF-1 2Bw1	LF	8.526	0.039	0.457	1.377	16.151	35.308
	OF	sample too small to analyze					
	MF	79.197	0.051	0.064	0.782	0.988	15.333
AN-RF-1 A1	LF	8.802	0.054	0.616	1.898	21.56	35.148
	OF	6.939	0.058	0.843	2.517	36.268	43.397
	MF	86.113	0.067	0.078	1.241	1.441	18.522
AN-RF-1 Bw1	LF	8.19	0.051	0.618	1.912	23.351	37.490
	OF	6.329	0.047	0.745	2.332	36.849	49.617
	MF	95.474	0.096	0.101	1.546	1.619	16.104
GR-RF-1 A	LF	8.651	0.052	0.605	2.538	29.336	48.808
	OF	6.337	0.068	1.065	2.619	41.333	38.515
	MF	Analysis not yet complete					
GR-RF-1 Bw	LF	8.429	0.031	0.369	2.23	26.454	71.935
	OF	3.837	0.022	0.569	1.943	50.629	88.318
	MF	Analysis not yet complete					

Future Work

- Analyze remaining soil fractions for carbon and nitrogen content.
- Compile all soil fraction carbon data and analyze for trends that may correlate soil forming environment and soil parent material to soil carbon and nitrogen storage.

Conclusion

- The andesite transect's white fir site stands out from this preliminary data.
  - Whole soil C is higher than all other sites.
  - Microbial biomass at time of sampling was higher than the other sites, with the ponderosa pine sites of the basalt and granite transect being the exception.

Picture/Figure Credits

- Slide 6: Rasmussen, C., Southard, R.J., Horwath, W.R. 2006. Mineral control of organic carbon mineralization in a range of temperate conifer forest soils. Global Change Biology 12. pg. 836.
- All other photos/figures: Travis Wilson