Organic carbon content in surface and subsurface soil on a toposequence on the Peterson Ranch in Poly Canyon, San Luis Obispo

A senior project presented to the Faculty of the Earth and Soil Science Department

California Polytechnic State University, San Luis Obispo

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for the Degree Bachelor of Science

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Abstract

Soil organic carbon (SOC) is directly related to soil organic matter (SOM), and is important in the functionality and stability of terrestrial ecosystems. Soil organic carbon is also an important pool for C storage and small changes of SOC may cause significant gains and losses in the large scale carbon cycle. The mechanisms by which SOC is transported and stored however are not widely studied. This study was conducted to determine if there is a relationship between toposequence and SOC in a small watershed on the Peterson Ranch, San Luis Obispo, CA. Nine soil pits were dug on various hillslope positions. The soils were described, and samples were taken from the surface and subsurface based on the soil descriptions. The sampled were run in a C and N analyzer for the C and N content and C/N ratio. The SOC increased from bottom to top of the sampling sites in contrast to previous research. A relationship between toposequence and SOC does not seem to exist in this watershed. The SOC is more related to the clay content. The N followed a very similar trend to that of the SOC. Animal burrowing has contributed to the subsurface SOC.

Introduction

Soil organic carbon is an important terrestrial pool for C storage. The total SOC pool is approximately three times greater than the atmospheric pool. Small changes of SOC may cause significant gains and losses in the large scale carbon cycle (Wang et al., 2008). The rise in atmospheric CO_2 has increased interest and research on organic carbon in soils (Saby et al., 2008). Soil organic carbon has a direct relationship with soil organic matter. Soil organic matter is comprised of approximately 50 % organic carbon. The storage and function of SOM is essential to terrestrial ecosystems. Organic matter is a nutrient reserve, improves soil structural stability, reduces surface crusting and compaction, and increases infiltration, percolation, and water holding capacity (McCarthy et al., 2008).

Rangelands occupy approximately 50 % of the world's land area and contain more than one third of the worlds above and below ground C reserves (Ingram et al., 2007). The sustainability of productive rangelands involves the management of soil erosion and SOC movement at field and watershed levels. The loss or redistributions of OC and nutrients from a site is one measure of the stability. Soil C varies as a function of soil phase, topography, and land-use. Carbon distribution in a landscape is related to slope factors. Clay content and mineralogy can produce differences in nutrient distribution between hillslope positions (Rhoton et al., 2006). The next sections of this paper aim to summarize some current studies on the relationship between soil organic carbon and topography.

Organic Carbon and Site Position

Research was conducted in southeastern Arizona to assess the distribution of OC as a function of slope. The relationship between C distribution and other watershed soil properties was investigated. Carbon losses from the system were assessed and related to soil losses and watershed erodibility. The site was located in a zone between the Sonoran and Chihuahuan deserts (Rhoton et al., 2006).

Maximum OC concentrations were observed on steeper slopes. Organic carbon fractions were most concentrated on 9 – 12 %, 13 – 20 %, or >20 % slopes. The clay fraction was distributed similarly to OC fraction. The higher concentrations were found on 13 – 20 % an >20 % slopes. The greater OC on these steeper slopes can be explained by the parent materials. The soils were weathered from andesite and basalt parent materials. These soils were more fertile, had higher clay contents, and higher plant nutrient status than the soils weathered from granite and granodiorite. This leads to a wider variety of vegetation and higher levels of organic matter. Highest OC was found on backslope positions and on north facing slopes. North facing slopes have cooler temperatures and high water contents facilitating greater plant growth (Rhoton et al., 2006).

The organic carbon contents of this study were distributed by differences based on parent material and degree of erosion. Fine textured, higher base status igneous rocks had the highest concentration of OC. Higher OC contents were found on back slope and toe slope reflecting contributions from upslope soil movement. These results were site specific (Rhoton et al., 2006).

Organic Carbon and Slope Concavity

Mechanisms creating the spatial distribution of SOC storage in two coastal California hill slopes were examined. The site was located in Tennessee Valley in Marin County. The second site was located in Black Diamond Regional Preserve, Contra Coast County. Average slopes were 30 % to 25 %.

At both sites, SOC storage varied with slope curvature. More SOC was stored on concave slopes. The SOC storage increases with increasing concavity. Biological cycling rather than erosion dictated spatial variations of the % C in these watersheds. Decomposition rates constrained by clay content were a more important mechanism than plant C inputs. The density of cracks due to shrinking and swelling increased in the down slope direction. Increased cracking is hypothesized to decrease plant productivity and accelerate decomposition contributing to a reduction in C %. The biological C cycling is faster than erosion rates in these watersheds. The surface C % was controlled by biological C fluxes but the SOC storage was curvature dependant.

Curvature controls erosion rates and determines losses and soil thickness. Concave slopes were positively related to C depositional rates (Yoo et al., 2006).

Agricultural implications

The relationship between soil translocation in an undulating agricultural field due to water and tillage erosion was examined. The site was located in a loess belt in central Belgium. The highest concentrations on native C in conventional tillage sites were present in the lower depositional areas of the landscape. The lowest concentrations were present on the top of the midslope zone. In minimum tillage, higher concentrations of native C were present on the top of the midslope zone. No difference in native C content of surface samples between conventional tillage and minimal tillage existed except in the concave curvature class. Carbon increased with increasing curvature in the conventional tillage sites. No difference among curvature classes were found under minimum tillage. Under minimum tillage crop residues stay on the surface but are mixed into the plow layer under conventional tillage. Soil organic carbon concentrations are enriched in the top layer of minimal tillage and diluted over the plow layer under conventional tillage. Erosion rates for conventional tillage treatments were higher than those for the minimal tillage treatments. More recent C was present in the depositional areas than erodible areas only for the conventional tillage treatments. There were more OC differences in landscape positions for the conventional tillage treatments. Erosion plays a more important role in conventional tillage than minimal tillage as a mechanism for distributing soil organic carbon (Gryze et al., 2008).

The net transport of erosion has severe impacts on SOM dynamics and spatial distribution. Erosion can concentrate organic C in depositional areas. Landform and tillage management practices can control distribution of SOC. Under minimal tillage, crop residues stay at the surface whereas under conventional tillage crop residues are plowed under. Recent SOC concentrations are enriched in the top layer of minimal tillage and diluted over the plow layer under conventional tillage. Landform did affect recent soil C stocks only in the conventional tillage treatment.

Organic Carbon and Elevation

Spatial and temporal changes in soil organic carbon were investigated in the mountainous region Franche-Comte, France. The elevation ranged from 300 to 1450 meters. Total annual precipitation ranged from 900 to 1700 mm. Land cover comprised of 25 % arable, 25 % pasture, and 45 % forest. This study focused only on SOC stocks under arable land and pasture. In the study area 23, 329 samples were analyzed for soil organic carbon

A decrease in topsoil organic carbon over time was observed. In this region, the main controlling factor on SOC distribution was elevation. The distribution of SOC by elevation is attributed to both temperature and precipitation. SOC is directly proportional to the mean annual precipitation and inversely proportional to the mean annual temperature (Saby et al., 2008).

Summary

SOC is important to the overall functionality of terrestrial ecosystems because of its direct relationship to SOM and because it is a large source of C storage in the C cycle. SOC related to toposequence is not widely studied, and tends to be very site specific. The objective of this introduction was to summarize some current studies on the relationship between soil organic carbon and topography. In Arizona, maximum SOC was found on steeper slopes. The clay distribution was similar to the OC and was related to the andesite parent material in this study. In Marin County, California, more OC was found on concave slopes than convex slopes. In a loess belt in central Belgium, The highest concentrations on native C in conventional tillage sites were present in the lower depositional areas of the landscape. In minimum tillage, higher concentrations of native C were present on the top of the midslope zone. Lastly, in a mountainous region in France, the main controlling factor on SOC distribution was elevation which was related to precipitation and temperature. These studies were conducted all over the world and had vastly different findings and mechanisms by which SOC transport was controlled in their watersheds. This shows how variable SOC can be and how much more SOC could be studied.

Soil organic carbon (SOC) is fundamental to the maintenance of soil fertility and function. SOC is a key indicator of soil quality and influences a wide range of soil physical, biological and chemical properties (Bhogal et al., 2009). Soil organic carbon is an important terrestrial pool for C storage. The total SOC pool is approximately three times greater than the atmospheric pool. Small changes of SOC may cause significant gains and losses in the large scale carbon cycle (Wang et al., 2008). The rise in atmospheric CO_2 has increased interest and research on organic carbon in soils (Saby et al., 2008). Soil organic carbon has a direct relationship with soil organic matter. The storage and function of SOM is essential to terrestrial ecosystems. Organic matter is a nutrient reserve, improves soil structural stability, reduces surface crusting and compaction, and increases infiltration, percolation, and water holding capacity (McCarthy et al., 2008). Terrestrial carbon storage is influenced by many environmental factors, two of which, topography and landforms, are very important. Knowledge of how SOC distribution can be influenced by topographic and geomorphologic processes can be useful for resource managers and policy makers to develop effective strategies in watershed management (Zhong and Xu, 2009). The sustainability of productive rangelands involves the management of soil erosion and SOC movement at field and watershed levels. The loss or redistributions of OC and nutrients from a site is one measure of the stability. Soil C varies as a function of soil phase, topography, and land-use. Carbon distribution in a landscape is related to slope factors. Clay content and mineralogy can produce differences in nutrient distribution between hillslope positions (Rhoton et al., 2006). The objective of this study was to look at the relationship between soil organic carbon and topography on a small watershed in the Peterson Ranch in Poly Canyon, San Luis Obispo.

Materials and Methods

Materials

Site description

The site is located in a watershed up Brizziolari Creek in Poly Canyon on the Peterson ranch. The site is approximately 10 acres. Vegetation consisted of annual and perennial grasses, forbs, and areas of brush and oaks. Slopes ranged from 29 to 49 % and the average slope was 41 %. The aspects of the sites were SW, SE or NE (Table 1). Bedrock geology consisted of silicious shale, greywacke, or diabase (Table 2). Annual precipitation ranges from 6.3 – 13.8 cm (16 – 35 inches) (NRCS soil survey staff, 1977).

Soil sampling

Soil samples were collected from nine soil pits (Fig. 2). The soil pits were dug on various topographic positions and samples were collected from the surface and subsurface horizons. Landscape positions ranged from backslope, shoulder, or toeslope (Table 1). The predominant land form in this watershed is a hillslope. Samples were collected in one gallon plastic bags and analyzed for particle size distribution, and organic carbon and nitrogen content.

Figure 1. Map of San Luis Obispo and the Brizziolari Creek

Table 1. Slope, elevation, landform, site position, and aspect of the soils sampled on the Peterson Ranch

Site #	Slope (%)	Elevation (ft)	Landform	Landscape Position	Aspect
1	29	525	hillslope	backslope	SW
2	33	703	hillslope	backslope	SW
2a	47	764	hillslope	shoulder	SW
3a	49	1017	hillslope	backslope	SE
3	31	902	hillslope	backslope	SE
4	45	968	hillslope	backslope	SE
4a	39	794	hillslope	toeslope	SE
5	65	742	hillslope	backslope	SE
6	32	678	hillslope	shoulder	NE

Table 2. Parent material and taxonomic classification of the soils sampled on the Peterson Ranch

Site #	Parent material	Taxonomic Class
1	Colluvium over wacke residuum	Fine, mixed, superactive thermic Typic Haploxeroll
2	Siliceous shale residuum	Fine, smectitic, thermic Typic Haploxeroll
2a	Siliceous shale residuum	Loamy, smectitic, thermic Lithic Haploxeroll
3a	Siliceous shale residuum	Fine, smectitic, thermic Typic Haploxeroll
3	Colluvium over siliceous shale residuum	Fine, smectite, thermic Typic Haploxeroll
4	Residuum from Diabase	Coarse-Loamy, smectitic thermic Typic Xerorthent
4a	Residuum from Diabase	Loamy, smectitic, thermic , shallow Typic Xerorthent
5	Shale residuum	Fine, mixed, superactive thermic Typic Haploxeroll
6	Grey wacke residuum	Fine, smectitic, thermic Typic Haploxeroll

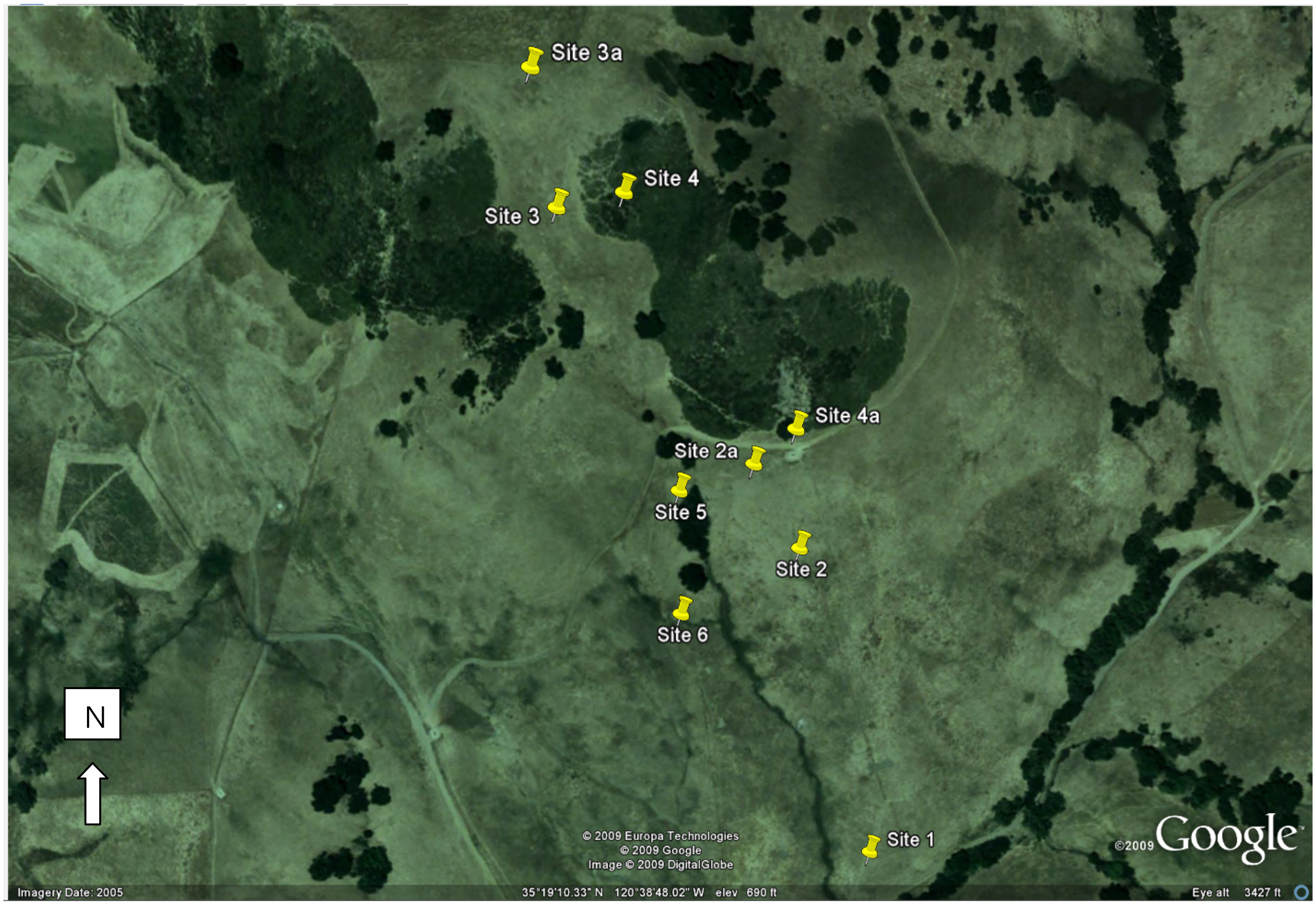

Figure 2. Sampling Locations

Laboratory Methods

Organic carbon

About 1000 mg of each air dried sample was ground using a mortar and pestle and placed in a crucible to be analyzed for carbon using a Variomax CNS analyzer. Carbon and Nitrogen were reported as percentages.

Particle size

Particle size analysis was calculated by the ASTM (American Society for Testing and Materials) method following chemical and mechanical dispersion (Gee and Orr, 2002).

Results and Discussion

Organic Carbon

The two sites at the top of the watershed, 3 and 3a, contained the highest organic carbon. The organic carbon generally decreases from the top of the watershed to the bottom of the watershed. Site 1 had the third lowest organic carbon content of 1.215 percent (Table 3). Other research has found lower concentrations of soil organic matter (SOM) in the upper slope positions and greater concentrations of SOM in depositional areas on lower slopes (Rhoton et al., 2006). SOM concentrations may differ less by slope position and more by land use and soil texture. High clay contents may be conducive to accumulation of organic carbon due to the surface area. The weathering of finer textured, higher base status igneous rocks are also associated with higher organic carbon contents (Rhoton et al, 2006). Sites 4 and 4a do not fit into the trend of decreasing OC from top to bottom of this watershed. Sites 4 and 4a, however, are in a vegetated sagebrush area. The parent material and percent clay are very different than the rest of the sites. Sites 4 and 4a had 10 percent clay, and textural classes of loamy sand and sandy loam. All other sites had percent clay values double to quadruple sites 4 and 4a (Table 3). The difference in parent material may give rise to this difference in texture and organic carbon content. Sites 4 and 4a were derived from diabase. Diabase is a nonporphyritic phaneritic rock having diabasic texture. Diabasic texture is a special textural rock term applied to dikes and small intrusions. Diabasic texture is composed of tabular plagioclase with smaller interstitial granular pyroxene crystals (Jackson, 1970). The sandier soils in sites 4 and 4a may have been the factor contributing to the lower organic carbon content than the rest of the sites.

Under grasslands, SOC contents near the surface increase with decreasing particle size (Meersmans et al., 2009). The SOC and percent clay had a positive linear relationship (Fig. 4). The outliers are sites 1 and 6. These sites had the highest percent clay (Table 3), and were both the lowest two sample sites in the watershed. Aside from these outliers, the rest of the data follows a general linear pattern. It is hypothesized that the higher surface areas of the clay sized fraction leads to the development of more decomposed organic matter, and thus more organic carbon. The mineralogy of this watershed was largely smectites (Table 3). Smectites are also known to interact with organic matter. Smectites especially have a high surface area, and carry a charge enabling them to bind to, and chemically stabilize organic matter. Smectites can bind to clay minerals forming a complex (Wattel-Koekkoek et al., 2001). This would lead to the conclusion that areas of high smectite clays might have more soil organic matter, and thus more soil organic carbon. Site 6 did not contain smectites (Table 3). Site 1 was not sampled for mineralogy, but I hypothesize that the mineralogy of site 1 is similar to the mineralogy of site 6. Sites 1 and 6 may have had lower SOC even though they had higher clay, due to the mineralogy.

Table 3. Select soil properties of pits

Site Number	C (Surface)	N (Surface)	C/N	% Clay	Textural Class	Parent Material	Phyllosilicate Clay Minerals
1	1.215	0.111	10.95	45	Clay	Wacke	

2	1.72	0.204	8.43	30	Clay Loam	Siliceous Shale	
2a	1.51	0.159	9.5	23	Loam	Siliceous Shale	Hydroxy Interlayered Smectites
3	2.346	0.257	9.13	35	Clay Loam	Siliceous Shale	
3a	2.333	0.276	8.45	43	Silty Clay	Siliceous Shale	tri and di octahedral Smectites
4	0.54	0.048	11.25	10	Loamy Sand	Diabase	
4a	1.134	0.111	10.22	10	Sandy Loam	Diabse	Kaolinite/Smectites
5	1.891	0.181	10.45	24	Clay Loam	Shale	
6	1.14	0.094	12.13	45	Clay	Grey Wacke	Kaolinite/ Hydroxy Interlayered Vermiculites

Figure 3. Organic carbon contents in the surface horizon

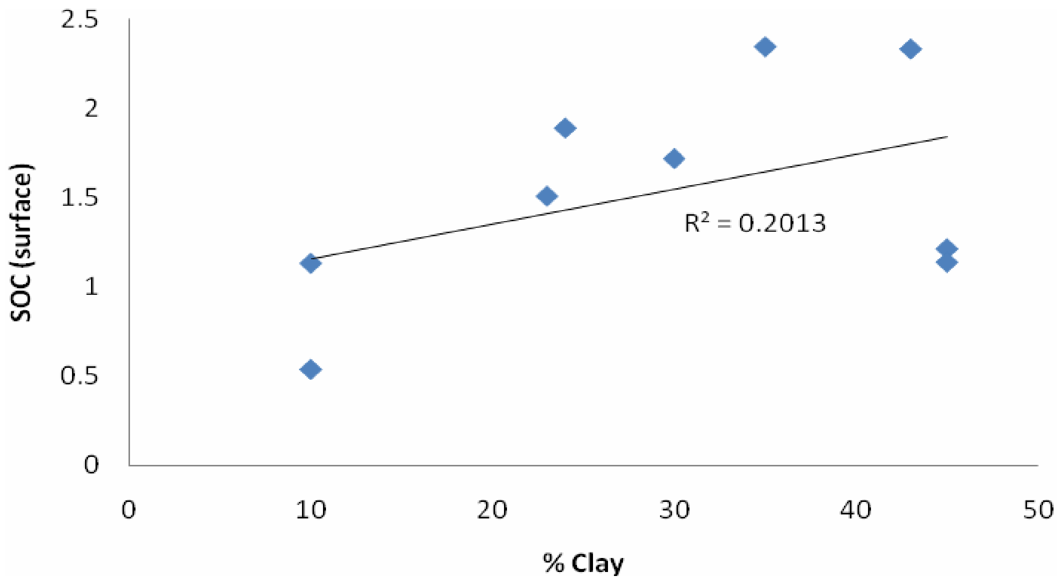

Figure 4. The relationship between percent clay and SOC in the soils sampled on the Peterson Ranch

Subsurface Organic Carbon

A clear trend exits between the surface and subsurface horizons in this watershed. For all sites sampled at the subsurface, the organic carbon content was lower than that of the surface (Table 4). Organic carbon does not seem to translocate down through the soil profile in this watershed. The upper layers of soil generally have more favorable conditions for microbial activity in the processes of OM decomposition (Hernandez et al., 2009). Therefore the upper horizons of soil are more favorable for SOC accumulation. Under grassland ecosystems, the majority of living organic material is stored below ground in a well developed root system. This is an important source of SOC input (Meersmans et al., 2009). The burrowing of animals may also have contributed to the subsurface OC in this watershed. A number of gopher holes were observed on the day of sampling.

Soil Nitrogen

The soil nitrogen follows a similar trend to that of the soil carbon. A general increase of nitrogen from the bottom of the watershed to the top of the watershed exists. The nitrogen also decreases in the subsurface akin to the SOC (Table 4). No clear trend existed between the C/N ratio and the site position.

Table 4. Comparison of surface and subsurface organic carbon in the Peterson Ranch Watershed

Site Number	% C (Surface)	% C (Subsurface)	% N (Surface)	% N (Subsurface)	C/N ratio (Surface)	C/N ratio (Subsurface)
1	1.215	1.028	0.111	0.075	10.95	13.71
2	1.72	1.09	0.204	0.108	8.43	10.09
2a	1.51	2.5 (Cr)	0.159	2.531 (Cr)	9.5	26.64
3	2.346	1.179	0.257	0.137	9.13	8.61
3a	2.333	0.274 (Cr)	0.276	0.274 (Cr)	8.45	2.82
4	0.54	not sampled	0.048	not sampled	11.25	not sampled
4a	1.134	0.772	0.111	0.074	10.22	10.43
5	1.891	not sampled	0.181	not sampled	10.45	not sampled
6	1.14	0.671	0.094	0.062	12.13	10.82

Conclusions

Soil organic carbon is an important indicator of soil fertility and function. As yet, the distribution of organic carbon in watersheds and ecosystems, and the mechanisms by which organic carbon moves has not been widely studied. In addition, of the studies present, organic carbon distribution seems to be very site specific. The purpose of this project was to study the organic carbon as a function of topography in a watershed in the Peterson Ranch, San Luis Obispo, California. In this watershed, more organic carbon was found higher up in the toposequence, as opposed to the lower positions. The mechanism for this seems to be particle size. Less organic carbon was found in the sites containing less clay and more sagebrush vegetation (sites 4 and 4a) in contrast to the sites with perennial and annual grasses. The organic carbon content was lower in all subsurface samples taken therefore organic carbon does not seem to move downward in the soil profile in this watershed. The SOC seems more closely related to the percent clay in this watershed (Fig. 4). Although sites 3 and 3a were the highest up in the sampling pattern, they were not on a summit. Sites 3 and 3a were still on backslope positions (Table 1). Backslope positions typically accumulate sediments through erosion and colluvial processes. I hypothesize that the SOC in this watershed is related to mineralogical processes in the clay fraction in the soil. Sites 1 and 6 were the lowest topographically, and had the highest amount of clay indicating sediment accumulation and downward erosional processes. However both these sites had relatively lower OC in comparison to the other sites with lower percent smectite clay. The OC may be binding to the smectite clays in this watershed. The SOC does not seem to translocate downward through the profile. Instead, I hypothesize that the burrowing of animals has contributed to the SOC in the subsurface. The decomposition of deep fibrous monocot roots may also contribute to the subsurface SOC in the grassland portion of this watershed. This may also account for some of the differences in the C/N ratios between the surface and subsurface. The shoot on the surface of the soil contains nitrogen. When the shoot dies, this nitrogen may accumulate near the surface giving the surface soil higher percent nitrogen and a lower C/N ratio. The roots are underground, and do not contain chlorophyll or nitrogen. When these roots decompose they would not release nitrogen in the subsurface soil, thus the percent nitrogen would be lower, and the C/N ratio would be higher. The C/N ratio of sites 4 and 4a changed very little. This may be a result of the sandier texture. Other research has shown little vertical transport of OC in finer textured soils. The vertical transport of SOC can increase with increasing sand content (Meersmans et al., 2009). This could be due to larger pore size and higher permeability. Site 4a had one of the lowest percent OC in the surface, and one of the highest percent OC in the subsurface (Table 4). This higher percent OC in the subsurface may account for the smaller change in the C/N ratio.

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Appendix A- Raw Data

Soil Profile Description Form
California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 1
Latitude ___W 120 38.627'
Longitude __N 35 19.124' Elevatic 525 ft
Vegetation or Crop __ grassland, anise
Parent Material _ colluvium over very weathered wacke residuum
Landform _____ hillslope Site Position __ backslope
% Slope 29
Aspect _ S200 W

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	---	G	W	10YR 4/2	10YR 3/2	---	clay	45	2	M	Gr	VH/Fr	VP/VS	C	F	---	---	---	---	---	5
A2	---	C	W	10YR 4/2	10YR 3/2	---	clay	48	2	C	SBK	VH/FI	VP/MS	F	F	---	---	---	---	---	6
Bt	---	C	W	10YR 5/2	10YR 4/4	---	sandy clay	38	2	VC	SBK	EH/EF	VP/MS	---	---	Y	Sl	---	M	D	6.5
2Bt	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	y	Sl	---	---	---	
2Cr																					

Comments:

Soil Profile Description Form
California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 2a
Latitude ___W 120 38.689'
Longitude __N 35 19.279' Elevatic 764 ft
Vegetation or Crop __ grassland, mustard, filaree
Parent Material _ residuum silicious shale
Landform _____ hillslope Site Position __ shoulder
% Slope 47
Aspect _ S200 W

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	15	C	W	10YR 3/2	10YR 3/2	---	CL	34	3	F	Gr	SH/Fr	VP/SS	F	VF	---	---	---	---	---	
Cr	28													F	VF						

Comments:

Soil Profile Description Form
California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 2
Latitude ___W 120 38.666'
Longitude __N 35 19.247' Elevatic 703 ft
Vegetation or Crop __ grassland
Parent Material _ residuum weathered from shale
Landform _____ hillslope Site Position __ backslope
% Slope 33
Aspect _ S180 W

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	23	C	D	10YR 5/2	10YR 4/2	---	CL	30	3	M	Gr	MH/FI	MP/SS	M	VF	---	---	---	---	---	6.5
Bk1	50	G	D	10YR 6/2	10YR 4/2	---	CL	36	2	M-VC	SBK	MH/Fr	VP/SS	M	F	Y	C	APF	---	---	
Bk2	74	G	D	10YR 5/2	10YR 4/2	---	C	40	2	M-VC	SBK	Fr/VFr	VP/MS	C	F	Y	C	APF	---	---	
Bk3	150	---	---	10YR 6/2	10YR 4/2	---	CL	35	1	M	SBK	FI/Fr	VP/Ms	---	---	y	C	APF	---	---	

Comments:

Soil Profile Description Form
California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 3a
Latitude ___W 120 38.788'
Longitude ___N 35 19.412' Elevatic 1017 ft
Vegetation or Crop __ grassland, mustard, thistle
Parent Material _residuum silicious shale
Landform _____ hillslope Site Position __ backslope
% Slope 49
Aspect _S160 E

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	24	C	W	10YR 5/2	10YR 4/2	---	CL	35	2	VF-M	Gr-SBK	Ha/Vfi	VP/MS	M	VF	---	---	---	---	---	
Cr	59													C	VF						

Comments:

Soil Profile Description Form
California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 3
Latitude ___W 120 38.779'
Longitude ___N 35 19.369' Elevatic 902 ft
Vegetation or Crop __ grassland, mustard, filaree
Parent Material _ colluvium from shale
Landform _____ hillslope Site Position __ backslope
% Slope 31
Aspect _S140 E

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	8	g	W	10YR 5/2	10YR 3/2	---	CL	35	2	VC	Gr	SH/Fi	Mp/SS	C	VF	---	---	---	---	---	
Bt1	58	G	W	10YR 3/2	10YR 2/2	---	C	38	2	M-Co	SBK	S/VFr	MP/MS	C	VF	---	---	---	---	---	
Bt2	73	---	---	10YR 4/2	10YR 3/2	---	C	42	2	M-VC	SBK	SH/Fr	VP/MS	F	F	---	---	---	---	---	

Comments:

Soil Profile Description Form
California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 4
Latitude ___W 120 38.749'
Longitude ___N 35 19.374' Elevatic 968 ft
Vegetation or Crop __ sticky monkey sage brush, rosemary
Parent Material _residuum from diabase
Landform _____ hillslope Site Position __ backslope
% Slope 45
Aspect _S145 E

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	27	C	W	10YR 5/4	10YR 4/4	---	LS	10	2	M-C	SBK	S/VFR	MP/MS	2	VC	---	---	---	---	---	
Cr	62																				

Comments:

Soil Profile Description Form

California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 4a
Latitude ___W 120 38.670'
Longitude __N 35 19.292'
Elevatic 794 ft
Vegetation or Crop __ oak tree, sticky monkey flower
Parent Material _ residuum from diabase
Landform _____ hillslope
Site Position __ toeslope
% Slope 39
Aspect _S165 E

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	12	g	W	10YR 5/6	10YR 4/6	---	LS	8	2	VF	Gr	S/VFr	So/Po	C	VF	---	---	---	---	---	
A2	55	G	W	10YR 5/6	10YR 4/6	---	LS	8	2	F-M	SBK	S/VFr	So/Po	C	VF	---	---	---	---	---	
Cr	173																				

Comments:

Soil Profile Description Form
California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 5
Latitude ___W 120 38.724'
Longitude __W 120 38.269'
Elevatic 742 ft
Vegetation or Crop __ grassland, willows, anise
Parent Material _ residuum from shale
Landform _____ hillslope
Site Position __ backslope
% Slope 65
Aspect _S120 E

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	13	C	W	10YR 4/2	10YR 3/2	Gr	CL	24	3	M	Gr	SH/Fr	Mp/MS	C	VF	---	---	---	---	---	
Cr	42													C	VF						

Comments:

Soil Profile Description Form
California Polytechnic State University
San Luis Obispo, CA

General Locatior Site 6
Latitude ___W 120 38.723'
Longitude __N 35 19.222'
Elevatic 678 ft
Vegetation or Crop __ grassland, mustard, golden bush
Parent Material _ grey wacke residuum
Landform _____ hillslope
Site Position __ shoulder
% Slope 32
Aspect _N 60 E

Horizon	Boundary			Color		Texture			Structure			Consistence		Roots		Carbonates			Clay Films		pH
	Depth	Dist.	Topo.	Dry	Moist	RF Mod	Class	% Clay	Grade	Size	Type	Dry/Mst	Pl/St	Amt.	Size	Efferv.	Amt.	Type	Amt.	Dist.	
A1	22	C	W	10YR 3/1	10YR 2/1	---	C	42	3	M	Gr	SH/Fr	MS/MP	C	VF	---	---	---	---	---	
Bt	74	C	W	10YR 6/1	10YR 5/1	---	C	43	2	M	SBK	SH/Fr	VS/VP	C	VF				C	D	
Cr	100													C	VF						

Comments: