# SOIL FORMATION ALONG A CLIMATIC TRANSECT (PEDOGENIC GRADIENT) INFLUENCED BY SOIL FORMING PROCESSES

Sabit ERŞAHİN
Washington State Univ. Department of Crops and Soils, Pullman, WA, USA.
Alper DURAK
GOP. Üniv. Faculty of Agriculture, Dept. of Soil Science, Tokat-TÜRKİYE
Mustafa KILIÇ
GOP. Üniv. Faculty of Agriculture, Dept. of Soil Science, Tokat-TÜRKİYE

## ABSTRACT

The purposes of this study were to investigate the role of the soil forming factors in attaining the soil properties, to organize and describe the morphological features of the soil horizons in different soils and to relate these features and horizons to the soil forming processes such as climate, organisms, landscape position, parent material and time. Six different soil series in different climatic zones were evaluated. The study areas were chosen under three climatic zones that rank from drier to wetter in WA, USA. The soils of the study areas are formed from windblown silty dust known as loess.

Walla walla, Endicott and Pataha series formed under low precipitation, have calcic horizons and duripans of which depths are closely related to amount of precipitation. Climate, parent material and topography played had major effect in attaining the soil properties. Sweitberg, Southwick and Vassar soil series formed under high a precipitation. Therefore, these soil series have no calcic horizons and duripans. In Soutwick series, climate, parent material, vegetation; in Vassar series, climate, vegetation and parent material played major role in attaining the soil properties.

## TOPRAK OLUŞUM SÜREÇLERİ TARAFINDAN ETKİLENEN BİR İKLİM HATTI BOYUNCA TOPRAK OLUŞUMU


## ÖZET

Bu çalışmanın amacı toprak oluşum süreçlerinin farklı iklim kuşaklarında oluşmuş, farklı topraklarda morfolojik tanımlamalarda ve horizon özelliklerinin belirlenmesinde oynadıkları rolü saptamaktadır. Bu çalışmada kurudan yaşa değişim gösteren 3 iklim zonunda 6 farklı toprak serisi değerlendirilmiştir. Çalışma alanının toprakları lös olarak bilinen rüzgarlar tarafından taşınmış ince siltli materyalden oluşmuştur.

Araştırma alanında belirlenen Walla Walla, Endicot ve Pataha toprak serilerinin oluşumunda yağışın azlığı kalsik horizon ve sert tabaka (hardpan) oluşumuna neden olmuştur. Çalışma alanının diğer üç toprak serisi olan (Sweitberg, Soutwhick ve Vassar) serilerinde ise fazla yağışlı iklimde oluştuklarından klasik horizon ve hardpan oluşumu görülmemiştir. Bu serilerde derinlik ile yağış miktarı yanında yakın ilişki söz konusu olup; iklim, ana materyal ve topoğrafya toprak oluşum süreçlerinin belirlenmesinde başat rol oynamıştır. Sweitberg serisinde iklim, ana materyal ve tooğrafya, Soutwick serisinde iklim, ana materyal ve bitki örüsü, Vassar serisinde ise iklim, bitki örtüsü ve ana materyal toprak oluşum süreçlerinde başat rol oynamıştır.


## 1. Introduction

The term "soil" has different meaning to users from different branches; however, it can be defined as "the loose mass of broken and chemically weathered rock mixed with organic matter that forms on the earth's surface". The soil formation is a combined effect of additions to the ground surface, transformation within the soil profile, transfers (up or down) within the soil and removal from the soils under soil forming factors such as climate, parent material, topography, vegetation and time. The relative importance of these factors may be different for different soils on the different parts of a landscape (1).

Scientists consider climate as the most important factor affecting the soil properties; therefore, moisture and temperature are the most important factors determining the properties of soils formed on a landscape. While temperature is affecting the rate of chemical and biological processes, moisture affects biological and chemical processes, weathering and leaching conditions with depth in the profile (2). In soils, organic matter influx and decomposition, presence or absence of chelating agents, soil water chemistry, and the leaching depth through the profile are processes that interact with climate.

The main soil morphological and mineralogical properties that are related to climate are organic matter content, clay content, type of clay, color, chemical extracts, the presence and absence of $CaCO_3$ and soluble salts, and depth of the salt bearing horizon. For example, slight leaching produces 2:1 clays, pedogenic carbonate and gypsum under extreme aridity, increased precipitation and decreased evapotranspiration result fairly thick cover of vegetation and a thick A horizon with high organic matter content. In general, one finds logarithmic relationships with increasing moisture and exponential relationships with rising temperature. In the case of the clay content, linear relationships with moisture and exponential relationships with temperature has been found (2). The water chemistry and leaching rate affect the clay mineral type formed in the soil. In high leaching regions, clays contain less silica because of high precipitation and the leaching rate the amount of silica washed out results in formation of clay minerals with lower value of $SiO_2$:$Al_2O_3$ rations.

Parent material can affect many soil properties in varying degrees. Although its effect are greatest in drier areas, the other factors may overshadow its effects in moist areas. The mineral structure plays a major role in determining the mineral weathering rate. The stability of minerals may be different in sedimentary rocks in varying ages. The parent material, whether mineral or rock, can control the clay minerals that form; however, the micro and macro environments within the soil will have significant effect on the formation of the clay mineral. generally, the parent material will greatly influence the mineralogy of the weathering by-product in soil, characterized by leaching and the influence of the parent rock (2).

"Rock and mineral weathering and development of prominent soil properties are time dependent". In soils while some prominent properties require relatively longer time period to form, others can come to steady-state within short time period. For example, although the formation of a $B_t$ horizon needs relatively long time, the accumulation of humus material in the A horizon may need relatively short time, soil $CaCO_3$ buildup and removal, and development of red color are other time consuming soil properties (2).

Topography or local relief can be important factors affecting soil properties formed in some cases. Soils show differences in properties due to some combination of the microclimate, pedogenic and geological surficial processes. Orientation of the hillslopes on which soil formed and steepness of the slope are two important factors determining soil properties on a hillslope. While former is affecting the microclimate and local vegetation, later affects surface runoff and erosion (2). The microclimate, topography and geological surficial processes may act differently in the different positions. For example, in the Palouse area, soils on the north facing slopes are deeper than those on the south facing slopes (3).

Vegetation may affect the soil properties by means of its two important effects: effect of vegetation on soil morphology and on soil chemistry. Assessment of the direct effect of the vegetation on the soil formation is difficult since it depends on the other soil forming factors such as climate and topography. However, several diagnostic soil properties are closely related to the differences in vegetation. For example, several marked differences in distribution of organic matter at the soil surface, vertical distribution of organic matter in the profile, thickness of A horizon, base saturation, presence of the chelating agents, leaching rate, type of clay and vertical distribution of clay in the profile can be found between forested and grassland soils. The nature of things may be understood better by searching the objects at their natural sites. Therefore, in order to have a better understanding the role of the each soil forming factor in determining the soil properties, three field trip was organized. The objectives of this study were to investigate the role of the soil forming factors in determining the soil properties, to organize and describe the morphological features of the soil horizons in different soils and to relate these features and horizons to the soil forming processes such as climate, organisms, landscape position, parent material and time.

## 2. Materials and Methods

In this study, six different soil series in different climatic zones were evaluated. The study areas were chosen under three climatic zones that rank from drier to wetter. The mean annual precipitation and temperatures on study areas are; 350 mm and 12 degrees C for Whitman County, 533 mm and 7 degrees C for Asotin County and 600-1100 mm and 4.5 degrees C for Latah County (4, 5, 6).

The soils of the study areas are formed from windblown silty dust known as loess. The loess has accumulated from seasonal dust storms during two million years; however, upper 60-150 cm that form the surface soil has accumulated within last 18.000 years (3).

The topography of the study areas is determined by the hills that are gently to extremely steep and have a variety of complex shapes and patterns. The specific variations and the details in the topography in the study areas are due to the complex interplay among factors such as texture of the loess, wind intensity and direction, amount and intensity of precipitation, amount of the seasonal snow accumulation, the frequency and depth of soil freezing and total loess thickness.

The natural vegetation of the study areas are; wheat grass, fescue and bluebunch in driest zone; wheatgrass-fescue in second climatic zone; and coniferous trees, snobbery, wheatgrass, Idaho fescue, western redceder, western white pine and mountain blueberry in the wettest zone (4, 5, 6). Differences in the microclimate and soils across individual hills results changes in native vegetation composition over short distances. Slope directions and positions and the subsoil horizons that control the subsurface water accumulation and flow patterns are of the important factors influencing vegetation patterns in the short distances (3).

## 3. Results and Discussions

The field data and their evaluations for the related soil series are given in the appendices, and the soil properties that would be affected importantly by different soil forming processes in different conditions are listed in Table 1.

It is seen from the Table 1 and profile descriptions that, in general, soils formed under low total precipitation have calcic horizon and duripans of which depth are closely related to the amount of precipitation. However, in Pataha series the depth of calcic horizon and duripan are less than those in Walla Walla and Endicott. This phenomenon may be associated with greater affect of accelerated erosion and differences in loess deposition with respect to changes in landscape and wind blown extend and directions (3).

The color of a soil, particularly its redness, is generally related to climate (2). In general, the redness of the soils increases parallel to increasing temperature and rainfall. Here, temperature would be more important than precipitation in determining the redness of the soils because of its significant effects on the rate of the weathering of the iron bearing primary minerals.

The combined effect of temperature, rainfall, and vegetation may be significant factors for low redness of A horizons in Sweitberg and Pataha and high redness in Vassar series.

The position for the Bt horizon, its color, the amount of the clay, the type of the clay minerals are closely related to climatic history (2). The depth and the thickness of the Bt horizon would be a good indicator of water holding capacity of soils and amount of precipitation infiltrating into the profile. Generally, the thickness and depth of Bt horizon formed under high leaching rates and hot humid environment is high. We see almost the same relationships in our case when we look at the Table 1; therefore, there are regular increases in the Bt horizon depth and thickness depending on the amount of precipitation; however, we do not see the same relationships for Vassar series formed under forest cover, which would be due to the parent material and its weathering rate found in upper horizons. Time is another important factor affecting the formation and position of the Bt horizon fairly long time period is needed to get the process complete.

Table 1. The Soil Series and Their Properties That Would Be Affected By The Most Important Soil Forming Agents.

| Name of the Series, Mean Annual Precipitation and Average Annual Temperatures (Degrees C) | The type and thickness of B horizon (cm) | Thickness of the A horizon (cm) | Redness of the A and B horizons | Depth to top of the carbonate accumulation horizon or hardpan (cm) | The soil forming factors that would be the most important in attaining soil properties |
|---|---|---|---|---|---|
| Walla Walla<br>350 mm-12 | Bw-31<br>Bk1-21<br>Bk2 | 58 | 10YR 3/2<br>10 YR 5/4 | 89(Carbonate)<br>110(hardpan) | climate,<br>parent material,<br>topography |
| Endicott<br>340 mm-12 | Bw-44<br>Bqm1-22<br>Bqm2 | 68 | 10YR 3/2<br>10YR 3/4 | 68(Carbonate)<br>112(hardpan) | climate,<br>parent material,<br>topography |
| Pataha<br>mat.<br>406 mm-8 | Bk1-15<br>Bk2 | 49 | 10YR 2/1<br>10YR 3/3 | 49(Carbonate)<br>64(hardpan) | climate, parent<br>topography |
| Sweitberg<br>533 mm-7 | Bt1-17<br>Bt2-24 | 54 | 10YR 2/1<br>10YR 4/4 | | climate, parent mat.<br>topography |
| Southwich<br>548 mm-10 | B-25<br>Btb | 40 | 10YR 3/2<br>10YR 3/3 | | climate, parent mat.<br>topography |
| Vassar<br>1143 mm-4.4 | Bw1-21<br>Bw2-40<br>2B-16 | 28 | 10YR 3/4<br>10YR 3/2 | | climate, vegetation,<br>parent material |

In contrast to Bt horizon, vegetation and topography may be the most important factors determining the properties of A horizon in some cases. Table 1 shows that the thickness of A horizons are decreasing with increasing precipitation. This may be due to the effect of rainfall on the accelerated erosion and differences in deposition of the loess material by wind. On a same hill there would be a market difference in the properties of A horizons that found on south-facing slope and north-facing slope because of the differences in rate and extension of the accelerated erosion on two different faces. For example, in Palouse area, the north-facing slope has thicker A horizons than south facing slopes (3, 4). This may be the results of the differences in the snow melting rates which would be faster on the south facing slope than north-facing one, and texture and amount of the parent materials that would show some differences. Table 1 shows that the thickness of the A horizon under grass vegetation is higher than that of under forest cover. This would be associated with different bioclimates under two vegetation covers (the bioclimate in forest would be more important). We have a thin decomposed O horizon over forested A horizon. The forested A horizon is relatively thinner than grassland A horizon. This would be due to the type of organic matter entering into the horizons and differences in the base saturations. The base saturation of the grassland A horizon is higher which indicates relatively lower leaching rates than forested A horizon (the pH of forested A horizon is 6.0). This can also be due to low PAR (potential evapotranspiration rate), presence of the more chelating agents and acid leaching water under forest canopy.

## Management

Walla Walla, Endicott and Pataha soil series have calcic and cemented calcic horizons (paleosols) at different depths that would be a problem in determining effective rooting depth. Most paleosols are more dense, less permeable, and fertile than the modern soils due to the clay texture, lime and silica (3). Moreover, the most limiting factor to the crop production may be resistance of duripans to the root penetration; therefore, the position of the paleosol would be the most important factor affecting production potential of a soil in some areas. In some local areas on the landiscape the poleosols can be found at very shallow depths (10-15cm) This can be the case in ridgetop and backslope positions where both geologic and accelerated erosions are severe. In the other parts of the landscape such as north-facing footslopes and toeslopes they may be more than a meter below the surface . For the soil series of Sweitberg, Soutwick and Vassar erosion would be the most important limiting factor for plant production; however, the hazard of the erosion may be minimized by using some of the practices such as fertilization in the steeper areas, and conservation tillage especially for Vassar series, pasture rotation and restricted grazing during the wet season would be good practices to protect soils from erosion (4, 5, 6). Also, variations in soil properties associated with local landscape should be considered in determining management practices.

## APPENDICES

## WALLA WALLA SERIES

The walla walla series consists of moderately deep, well rained and moderately eroded soils on the uplands. Soils formed in loess and volcanic ash. The runoff is moderate. The elevation is about 380 m. Slope is 5 to 10 percent. The native vegetation consist of wheat grass, fescue, bluebunch. The average annual precipitation is 300-400 mm, the average annual temperature is about 12 degrees C and the frost-free period is 130-155 days.

*TAXONOMIC CLASS:* Coarse silt, mixed, mesic typic Haploxeroll.

*TYPICAL PEDON :* WALLA WALLA silt loam-on North facing 5 to 10 percent slope at the elevation of 380 m, under a wheat field (colors are for moist soil unless otherwise noted).

| Horizon | Depth (cm) | Block Description |
|---|---|---|
| A | 0-33 | Brownish block (10 YR 3/2) silt; moderate medium platy structure; very friable; very fine roots. |
| AB | 33-58 | Dark brown (10 YR 3/3) silt loam; fine blocky structure; very friable; very fine roots; gradual irregular boundary. |
| $B_w$ | 58-89 | Dull-yellowish brown (10 YR 5/4) silt loam; fine blocky structure; friable; fine roots; clear wavy boundary. |
| $B_{k1}$ | 89-110 | Dark brown (10 YR 3/3) silt loam; moderate, medium blocky structure; friable; fine roots; slightly effervescent; gradual irregular boundary. |
| $B_{k2}$ | >110 | Dull yellowish brown (10 YR 4/3) silt loam; moderate medium block structure; friable; strongly effervescent; clear irregular boundary. |

## ENDICOTT SERIES

The Endicott series consists of moderately deep, well drained and moderately eroded soils on the uplands. Soils formed in loess and volcanic ash. The runoff is moderate. The elevation is about 658 m. Slope is 10 to 15 percent. The native vegetation, consists of wheat grass, Idaho fescue, bluebunch. The average annual precipitation is 305-380 mm, the average annual temperature is about 12 degrees C and the frost-free period is 130-155 days.

*TAXONOMIC CLASS :* Coarse, silty mesic haplic Durixeroll.

*TYPICAL PEDON :* Endicott silt loam-on a East facing 10 to 15 percent slope at the elevation of 658 m under a wheat field (colors are for moist soil unless otherwise noted).

| **Horizon** | **Depth (cm)** | **Block Description** |
|---|---|---|
| A | 0-14 | Brownish black (10 YR 3/2) silt loam; fine blocky structure; very fine roots; clear smooth boundary. |
| AB | 14-38 | Brownish black (10 YR 2/2) silt loam; moderate prismatic structure; very fine roots; gradual smooth boundary. |
| $B_w$ | 38-68 | Dark brown (10 YR 3/4) silt clay; moderate prismatic structure; very fine roots; gradual smooth boundary. |
| $B_{kqm1}$ | 68-112 | Brown (10 YR 4/4) silt clay; weak coarse block structure; few very fine roots; strongly effervescent; gradual smooth boundary. |
| $B_{kqm2}$ | 112-134 | Dull Yellow Orange (10 YR 6/3) silt loam; weak fine platy structure; weak fine roots; effervescent; clear smooth boundary. |
| $B_{kqm3}$ | >134 | Dull Yellow orange (10 YR 6/3) silt loam; moderate medium block structure; effervescent; gradual broken boundary. |

## PATAHA SERIES

The Pataha series consists of moderately deep, slightly eroded, well drained soils on plateaus at the elevation of 792-1036 m. These soils formed in loess material on the basalt. Slopes are 3 to 15 percent. The native vegetation is mainly grasses. The average annual precipitation is 381-432 mm and the average annual temperature is about 8 degrees C. The average frost-free period is 125 to 135 days.

*TAXONOMIC CLASS :* Fine loamy, mixed, mesic calcic pachic Haploxeroll.

*TYPICAL PEDON :* Pataha silt loam-on a SE facing 3 to 8 percent slopes at 944 m elevation under a wheat cultivated field (colors are for moist soils unless otherwise noted).

| **Horizon** | **Depth (cm)** | **Block Description** |
|---|---|---|
| $A_1$ | 0-35 | Very dark brown (10 YR 2/1) silt loam; weak fine subangular blocky structure; hard, very friable, slightly plastic; many fine roots; many fine pores; high biological activity; clear smooth boundary. |
| $A_2$ | 35-49 | Dark brown (10 YR 3/2) silt clay loam; moderate medium subangular blocky structure; hard, very friable, slightly plastic common fine roots; common fine pores; very slightly effervescent; gradual wavy boundary. |
| $B_{k1}$ | 49-64 | Dark brown (10 YR 3/3) silt loam; moderate medium subangular blocky structure; slightly hard, very friable, slightly plastic; common fine roots; fine pores; slightly effervescent; clear smooth boundary. |
| $B_{k2}$ | >64 | Light gray (10 YR 7/4), very gravely, loam; weak fine subangular blocky structure; slightly hard, friable, plastic; few fine roots; many fine tubular pores; strongly effervescent. |

## SWEITBERG SERIES

The Sweitberg series consists of moderately deep, well drained, slightly eroded soils on the plateaus at the elevation of 1036-1250 m. These soils formed in loess on the basalt. The native vegetation is mainly grasses. Slopes are 3 to 15 percent. The average annual precipitation is about 508-559 mm, the annual average temperature is 6.6 degrees C, and the average frost-free period is 90 to 115 days.

TAXONOMIC CLASS: Fine-montmorillonitic, frigid Pachic Argixeroll.

TYPICAL PEDON: Sweitberg silt clay loam-on a north facing 3 to 8 percent slopes at the elevation of 1127 m under grasses (colors are for moist soil unless otherwise noted).

| Horizon | Depth (cm) | Block Description |
| --- | --- | --- |
| $A_I$ | 0-24 | Very dark brown (10 YR 2/1) silt loam; moderate medium granular and weak medium subangular blocky structure; very friable, plastic; many medium and many fine roots; many fine pores; high biological activity; gradual wavy boundary. |
| $A_2$ | 24-54 | Dark brown (10 YR 4/3) silt clay loam; moderate medium prismatic structure; very friable, plastic; common medium and very fine roots; many medium pores; gradual wavy boundary. |
| $B_{k1}$ | 54-71 | Dark brown (10 YR 4/4) clay loam; moderate medium prismatic structure; firm, plastic; common medium roots; many medium tubular pores; clear wavy boundary. |
| $B_{k2}$ | 71-95 | Dark brown (10 YR 3/6) clay loam; moderate medium subangular blocky structure; firm, very plastic; common fine roots; common fine tubular pores; clear smooth boundary. |
| $C_r$ | >95 | Grayish brown (10YR 4/6) moist, clay loam, dark brown (10 YR 4/4) moist; massive; firm, plastic; few very fine roots; common very fine pores. |

## SOUTHWICK SERIES

The Southwick series consists of moderately deep, moderately well drained and moderately eroded soils on the uplands. Soils formed in loess. The runoff is moderate. The elevation is about 792 m. Slope is 3 to 4 percent. The native vegetation consists of coniferous trees, panderose pine, snobbery, blue bunch, wheat grass and Idaho fescue. The average annual precipitation is about 584 mm, the average annual temperature is about 9-10 degrees C and the frost-free period is about 135 days.

*TAXONOMIC CLASS :* Fine-silt, mixed, mesic, Argiaquic Xeric Argialbolls.

*TYPICAL PEDON :* Southwick silt loam-on a East facing 3 to 4 percent slope at the elevation of 1036 m under a wheat field (colors are for moist soil unless otherwise noted).

| Horizon | Depth (cm) | Block Description |
|---|---|---|
| A | 0-16 | Very dark grayish brown (10 YR 3/2) loam; moderate medium granular structure; loose, slightly plastic; many fine roots; many fine pores; mildly alkaline (pH=7.5); high microbial activity; clear smooth boundary. |
| AB | 14-40 | Dark brown (7.5 YR 3/2) loam; weak fine blocky and moderate fine granular structure; loose, slightly plastic; many fine roots; many fine medium pores; neutral gradual wavy boundary. |
| $B_t$ | 40-65 | Dark brown (10 YR 3/3) silt loam; moderate medium blocky structure; loose, slightly plastic; common fine roots; many medium pores; common distinct organic matter cutans on ped faces; neutral (pH=6.5); clear wavy boundary. |
| $E_b$ | 65-89 | White (10 YR 8/2) silt loam, grayish brown (10 YR 5/3) moist; moderate common blocky structure, loose, friable, plastic; few cutans lining tubular pores; neutral (pH=7.0); clear smooth boundary. |
| $B_{tb}$ | >89 | Dark brown (10 YR 4/3) silt clay, dark yellowish brown (10 YR 4/4) wet; moderate medium granular structure; hard, firm, plastic few medium and common fine roots; few fine pores; few distinct skeleton cutans on the ped faces, few distinct organic matter cutans lining tubular pores, few distinct manganese cutans on the ped faces and many distinct clay cutans on the ped faces; neutral (pH=7.0). |

## VASSAR SERIES

The Vassar series consists of deep, well drained, highly eroded soils on the mountain toeslopes. The soils formed in volcanic ash that is underlain by residuum derived from granite. The elevation is about 1280 m and the slope is about 15 percent. The native vegetation consists of western redcedar, western white pine, pachystima and mountain blueberry. The soil is presently covered by a forest. The average annual precipitation is about 1143 mm, the average annual temperature is about 4,4 degrees C and the frost-free period is about 75 days.

*TAXONOMIC CLASS :* Medial over loamy mixed Typic Vitricryand.

*TYPICAL PEDON :* Vassar Silt Loam, 15 percent slope about at the elevation of 1280 m under forest cover (colors are for moist soil unless otherwise noted).

| Horizon | Depth (cm) | Block Description |
|---|---|---|
| $O_e$ | 0-4 | Black (10 YR 2/1) moderately decomposed organic matter; abrupt smooth boundary. |
| A | 0-7 | Dark yellowish brown (10 YR 3/4) loam; weak fine blocky structure; loose, slightly plastic; many fine roots; common fine and few coarse pores; few, distinct organic matter cutans lining tubular pores; medium acid (pH=6.0) clear wavy boundary. |
| $B_{w1}$ | 7-28 | Dark yellowish brown (10 YR 4/6) loam; weak medium blocky structure; loom slightly plastic; many fine and fex fine and few coarse pores; very few distinct and few faint organic matter cutans lining tubular pores; slightly acid (pH=6.0); clear wavy boundary. |
| $B_{w2}$ | 28-68 | Yellowish brown (10YR 5/4) silt loam; moderate medium blocky structure; friable, plastic; few common and common medium roots; few fine pores; very few distinct skeletal cutans on the ped faces, very few distinct clay cutans lining interstitial pores, very few distinct organic matter cutans occur as bridges holding mineral grains together; slightly acid (pH=6.0) clear wavy boundary. |
| 2 $B_t$ | 68-84 | Yellowish brown (10 YR 5/4) silt loam; weak medium blocky structure; friable, slightly plastic; few coarse roots; common fine and few coarse pores; very few distinct organic matter cutans lining tubular pores; slightly acid (pH=6.0): clear smooth boundary. |
| 2 $C_r$ | >84 | Very pale brown (10 YR 7/4) loam sand; weak medium blocky structure; very friable, non plastic; few medium and few coarse roots; common fine pores; few distinct clay cutans lining tubular pores; slightly acid (pH=6.0). |

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