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IMPACT OF TIME AND CLIMATE ON QUATERNARY SOILS IN THE YUCCA MOUNTAIN AREA OF THE NEVADA TEST SITE

by

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To the GRADUATE SCHOOL OF THE UNIVERSITY OF COLORADO:

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The final copy of this thesis has been examined by the undersigned, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above discipline.

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May 28 1986
Date

The modern climate and two climatic models of the last glacial maximum were used to generate soil water balances and to calculate evapotranspiration (ET_p). The Papadakis method was used to calculate ET_p. These calculations suggest that translocation of dissolved and solid material in Holocene soils can be attributed chiefly to high-precipitation storm events.

There are several different trends in $CaCO_3$ accumulation in the Holocene soils, and in older soils that have experienced at least one major climatic change. These trends suggest that changes in temperature and (or) seasonality of the precipitation dominated the climatic change associated with the Holocene-Pleistocene boundary. Comparison of actual Holocene soil $CaCO_3$ profiles with those generated by a computer suggest that this climatic change was gradual.

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CHAPTER I

INTRODUCTION AND METHOD OF STUDY

Introduction

Statement of Problem

A high-level nuclear waste site has been proposed for Yucca Mountain on the Nevada Test Site (NTS) (Fig. 1). This waste is the by-product of commercial enterprises and nuclear weapons production. Estimates vary from 1,000 to 100,000 yrs for the duration that this material remains hazardous (Winograd, 1981). To assure prolonged integrity of any nuclear-waste repository, long-term environmental stability of that site needs to be considered, as well as the impact of future climatic change.

This study addresses the problem of characterizing past climatic variability near the proposed nuclear-waste repository site at Yucca Mountain. Climatic changes are considered to be caused by variation in net global solar-energy input, a consequence of the precession of Earth's orbit and the obliquity and eccentricity of its axial position (Imbrie and Imbrie, 1980). Major global climatic change occurs at regular frequencies of 10,000 to 100,000 yrs (Shackleton and Opdyke, 1973). The Holocene Epoch is the most recent in a long series of relatively brief (7,000-20,000 yrs) interglacials, that punctuate much longer (90,000-150,000 yrs)

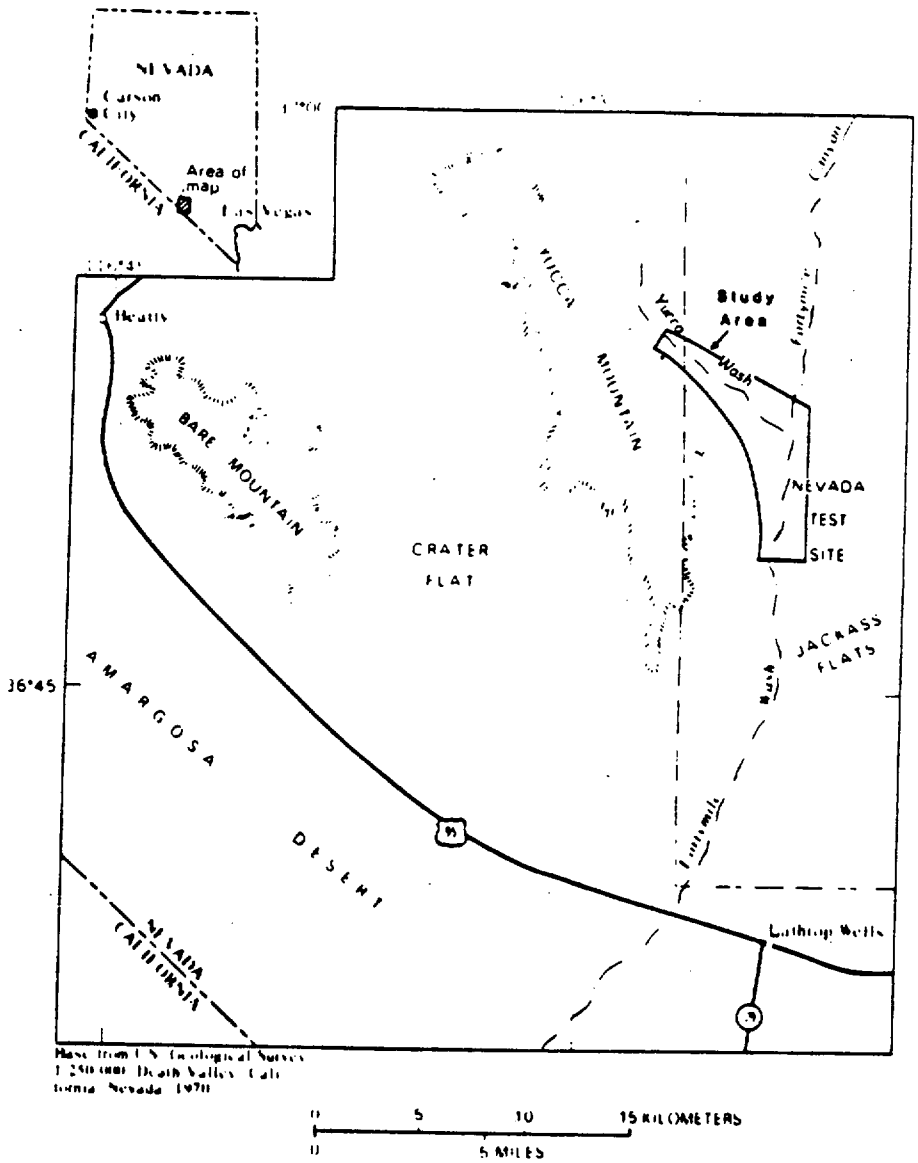


Figure 1. Location of study area.

periods of glaciations. A permanent repository for nuclear waste must be able to withstand the effects of a major climatic change. A climatic change that results in greater effective moisture may cause percolating water to move within the zone of waste material during the time that the material is still hazardous.

Objectives

The objectives of this study are twofold, (1) to document the effects of time and climate on soil developement, and (2) to use soil data to characterize long-term, past climatic variability in the study area. Paleoclimatic reconstructions span the last 2 Ma, emphasizing the last 45,000 yrs because the age control and botanical evidence is best understood during this time. This study is part of a larger study of the paleoclimate of the NTS area. For example, other workers are studying past ground water levels and rates of recharge (Winograd, 1981; Winograd and Doty, 1980), regional lake and playa chronologies (L. V. Benson, U.S. Geological Survey, oral communication, 1985), and radiocarbon-dated plant macro and microfossils from ancient packrat middens (Spaulding, 1983, R. S. Thompson, U.S. Geological Survey, oral communication, 1985). One of the assumptions common to all these studies is that past climates approximate the climates that may occur in the next 100,000 yrs.

Strategy

Soil-geomorphic research can provide data useful for interpreting relative and absolute dating of alluvial deposits, stratigraphic correlation, and paleoclimate. To apply pedologic data to this goal, I use the state-factor approach developed by Jenny (1941, 1980) which defines the independent factors of soil formation as climate, biota, parent material, relief, and time. To understand the impact of a single factor on the development of soils, all other factors must either be held constant, or any variation in one of the factors must have little impact on the single factor that is being studied. The assumption then is made that soil development is chiefly dependent on the single varying factor. In this study two factors have varied--climate and time. When all factors are held constant except time, the soil sequence is defined as a chronosequence. When all factors are held constant except climate, the soil sequence is defined as a climosequence. The study area is particularly suitable for soil-paleoclimatic interpretations because the factors can be identified, key ones can be considered constant, and all pedogenic processes occur well above the present or former ground water table.

Five groups of different aged geomorphic deposits were studied along an elevation transect of 400 m of relief, from 1082 to 1483 m (Fig. 2). Present-day annual precipitation nearly doubles along the transect. For any group of deposits of the same approximate age, one can observe or predict the depth relationships of most soil properties. Soil properties that are much deeper than anticipated suggest climatic change. These properties can be

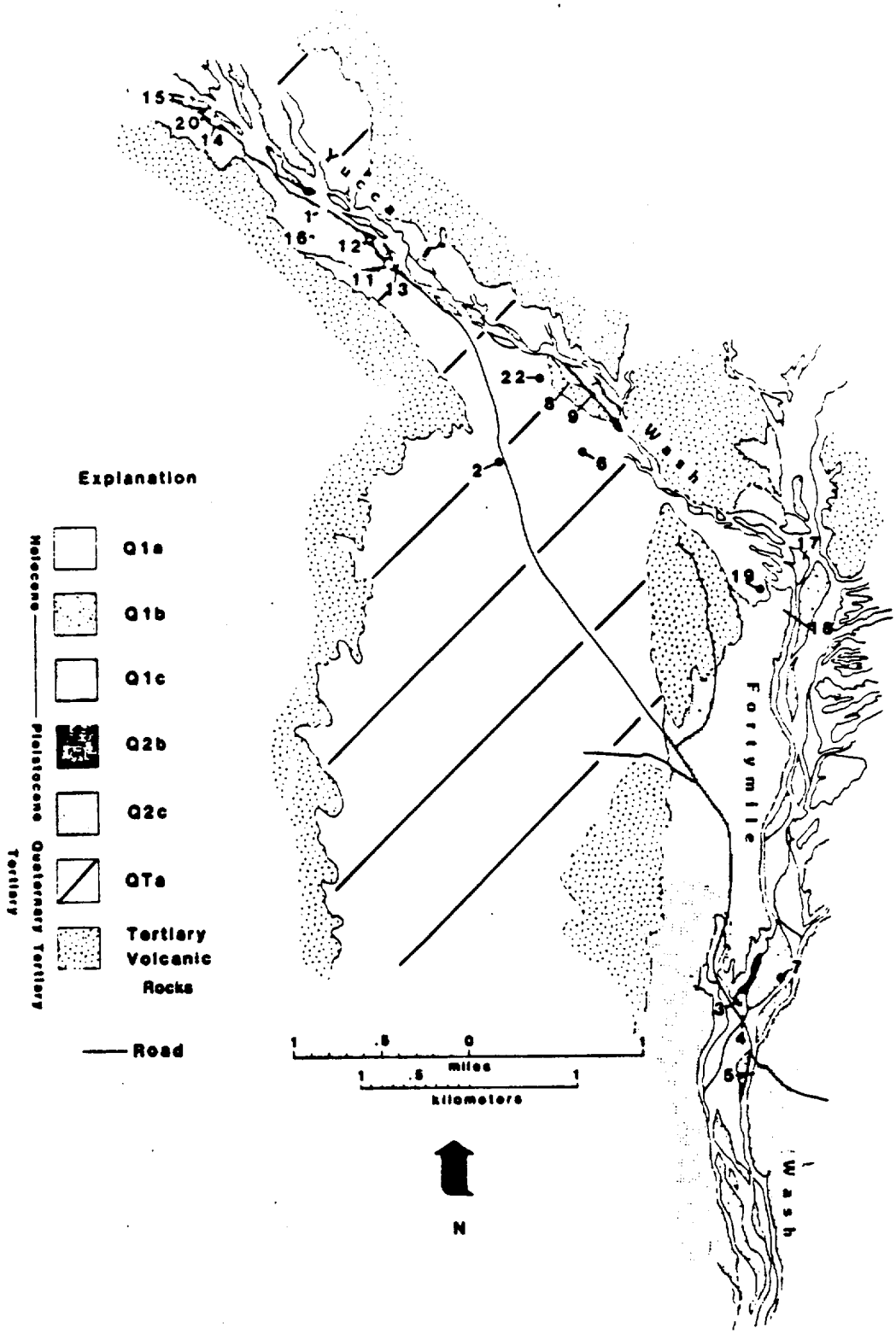


Figure 2. Map of Quaternary deposits, Tertiary bedrock, and trench locations in the study area.

compared to possible climate-models for the glacial maximums. The primary evidence and discussion for the effects of climatic change and time on soil development are based on physical and chemical soil properties.

Location of Study Area

The study area is along Yucca Wash and Fortymile Wash on the east side of Yucca Mountain near the southwest corner of NTS (Fig. 1). This area is in the Basin and Range Province of western North America (Fenneman, 1931), on the southeastern margin of the Great Basin (Morrison, 1965). With respect to the flora, the site is located on the boundary of the Mojave Desert to the south and the Great Basin Desert to the north (Cronquist and others, 1972).

The Quaternary deposits at the upper end of the elevation transect are along Yucca Wash (YW) just northeast of Yucca Mountain. The transect follows Yucca Wash southeastward to its confluence with Fortymile Wash (FW), and proceeds due south to the road crossing across Fortymile Wash. The total transect distance is just over 13 km.

Methods of Field Work and Soil Description

Locating Study Area

The selection of the study area was accomplished with the use of air photos and preliminary surficial geologic maps by D. L. Hoover (U.S. Geological Survey, written communication, 1983). The primary study site was then selected and mapped. Stratigraphic units are defined on the basis of landscape position, surface

morphology, degree of packing and sorting of desert pavement, desert varnish, and soil-profile development.

Description and Sampling

Twenty trenches were excavated by backhoe through the soil into unconsolidated material similar to the parent material. The difference being that in some cases translocated $CaCO_3$ and opaline SiO_2 are present at depths in the soil profile, and not in the unconsolidated alluvium in the modern washes which is comparable to the parent material (Appendix A). Frequently, buried soils were encountered at depths in the soil exposures. Trenches were located on stable parts of terrace or fan surfaces, with the stability measured by the integrity of the pavement and the preservation of the B horizon.

Soil profiles were described according to methods and terminology outlined by the Soil Survey Staff (1951) and Birkeland (1984). I use the horizon descriptor Cuk for horizons that have all the characteristics of unconsolidated parent material with the exception of translocated $CaCO_3$. Soil texture is from laboratory particle-size data after the carbonate and silica cement were removed. Calcic horizon terminology is after Gile and others (1979 and 1981; Bachman and Machette, 1977; Machette, 1985). Greater than 0.20 percent carbonate in the <2 mm fraction is detectable in the field by 10% HCl.

Two to three kg bulk samples, and three to eight peds were collected for each horizon. Bulk samples were sieved and the gravel percent determined on a weight basis in the laboratory.

Measurements were checked with field estimates to make sure that gravel in bouldery deposits was not underestimated. If the precent gravel was thought to have been underestimated, the value was corrected with the field observations.

Pedogenic Silica

Silica-cemented horizons or duripans were identified in the field by first soaking air-dried samples in water, followed by soaking in 10% HCl overnight. Cementation and brittleness are preserved when the predominant cementing agent is silica. Duripans in the study area also have a characteristic pinkish-yellow color, 7.5YR 7/4-6 (dry) and 7.5YR 5-6/6 (moist) Munsell colors, and are extremely hard when dry.

Because of the presence of silica, allophane was suspected. Allophane is a noncrystalline-clay weathering product of volcanic glass and associated with duripan formation. A field test (Fieldes and Perrott, 1966) that determines the presence of amorphous allophane by measuring the change in pH with the addition of NaF, was unsuccessful. A simple, laboratory method, independent of pH (Wada and Kakuto, 1985) was not much more successful. Thirty to 50 mg of air-dried soil (<2mm) is placed on a white spot plate, and 0.4 ml of 0.02% toluidine blue solution is added. If the color of the supernatant remains blue after 15 seconds, it suggests the presence of allophane and imogolite. A larger sample, 50-100 mg, is used for coarse-textured soil. The samples frequently remained blue in horizons that contained opaline SiO_2 cement as well as the eolian vesicular A horizons.

Index of Soil Development

Soil field properties were quantified according to Harden (1982), and Harden and Taylor (1983) (Appendix B). The soil development indices were programmed and calculated with the "LOTUS 1-2-3" spreadsheet on an IBM-PC computer (Nelson and Taylor, 1985a and 1985b).

Micromorphology

Oriented samples of soil peds and gravel were collected. Samples were stained with blue epoxy so that amorphous material could be more easily recognized. Thin sections were cut perpendicular to the soil surface.

Statistical Methods

Statistical techniques used in this study include (1) descriptive statistics that characterize the sample population, (2) bivariate regression and correlation (r^2) analysis of individual properties with time or climate as the dependent variable, and (3) multiple and stepwise regression analyses to test possible predictive models of groups of soil properties with a single soil property as the dependent variable (Till, 1974; Davis, 1973).

The null hypothesis (H_o) for regression analysis is to test whether there is a significant relationship between time or climate, and the independent soil properties. H_o = no association. When $F_{calculated} > F_{critical}$ or $t_{calculated} > t_{critical}$, at the 5% significance level, H_o is rejected and the conclusion is made that there is a significant relationship. Significance is the level of

probability that the described relationship between properties could occur randomly. Thus at 5% there is a 1:20 chance that the relationship is random. The standard error is a measure of the accuracy of prediction. It is an estimate of the standard error of the residuals, or the estimate of the standard error between measured and predicted values of the dependent variable about the regression line. The standard error of B, or the standard deviation regression line. The standard error of B, or the standard deviation due to sampling variability in the slope of the regression, is used to generate the 95% confidence intervals. Residual analysis was used to check multiple regression assumptions. All statistics were done on an IBM-PC computer with the "STATPRO" statistical package.

CHAPTER II

ENVIRONMENTAL SETTING, PAST AND PRESENT

Geologic Setting and Chronology

Yucca Wash originates in an area composed exclusively of Tertiary volcanic rocks (Christiansen and Lipman, 1965; Lipman and McKay, 1965). The alluvium in Yucca Wash is derived from these welded and nonwelded ash-flow tuffs. The alluvium in Fortymile Wash is also derived from similar siliceous volcanic rocks with a small component of basalt. Carbonate and opaline SiO_2-rich eolian dust have been added to these alluvial deposits over time.

Quaternary Stratigraphy

The Quaternary stratigraphic nomenclature used on NTS (Table 1) was modified from that initially described by Bull (1974; Ku and others, 1979; McFadden, 1982) in the Vidal Junction area, California, about 320 km south of NTS. Deposits at Vidal Junction were differentiated mainly on the basis of soil properties. However, the identification of units at NTS is based primarily on geomorphic features, and to a lesser extent on soil properties (Hoover and others, 1981; Swadley, 1983). The main features include preservation of bar-and-swale topography, elevation above modern washes, packing and sorting of desert pavement, desert varnish, and the presence or absence, and thickness of the vesicular A horizon.

Table 1. Quaternary stratigraphy of the Yucca Mountain area, NTS. Modified from Hoover and others (1981; Szabo and others, 1981; and Swadley and Hoover, 1983); soil properties are those of this study. Textures are for the <2 mm fraction and pertain to all soil horizons. Pleistocene deposits have age estimates based on U-Trend dating. Some of the age estimates may be minimum ages. Holocene deposits on the most part have inferred ages. See Appendix G for information on the origin of assigned ages. Units can be combined (e.g. Qla/Qlb) in areas where they cannot be differentiated at a given map scale and (or) where a unit is mantled by a thin, patchy unit.

Stratigraphic Units		Key Properties and Diagnostic Criteria for Recognition
Unit Designation	Estimated Age	
Latest Holocene		
Qla	historic	Fluvial gravel and finer grained over bank deposits on and adjacent to the floors of active washes. No pedogenic alteration. Typically <2 m thick.
Late Holocene		
Qlb	<140 yrs	Fluvial gravel, sheetwash, or debris flows on steep slopes. Fluvial deposits form a terrace 0.5-2 m above active channels; bar-and-swale topography preserved. Thought to date from major episode of arroyo incision considered to have taken place 140 yrs ago (Bryan, 1925). No desert pavement has developed. Soils have a thin A; Cox, Cuk and (or) Cu; stage I $CaCO_3$ (commonly contains reworked gravel with stage II $CaCO_3$ coats); texture S, LS or SL. Usually <2 m thick.
Qle		Eolian sand in active modern dunes in areas away from mountain fronts. No pedogenic alteration; texture S or LS. Locally as much as 50 m thick; typically <10 m thick.

Table 1 continued. Quaternary stratigraphy of the Yucca Mountain Area, NTS.

Stratigraphic Units: Unit Designation	Estimated Age	Key Properties and Diagnostic Criteria for Recognition
Qls	3.3-7 ka	Slope wash or sand sheets. composed primarily of reworked eolian sand and <25 percent gravel; deposited as much as 10 km from mountain fronts. Commonly dissected near active channels. Soils and pavement are similar to those of unit Qlc, except texture is most commonly S. Usually <2 m thick.
Middle to Early Holocene or Late Pleistocene		
Qlc	~10 ka	Primarily terraces formed in fluvial gravel; may include fans, colluvium, or sheetwash. Fluvial deposits form a terrace 1-2 m above active channels. Lacks bar-and-swale topography. Incipient desert pavement development and little or no varnish development. Soils have an A; 10YR Bw, Bkj, Btj and (or) Bqj; stage I-II $CaCO_3$ and (or) stage I SiO_2; texture S, LS, or SL. Commonly <2 m thick.
Late Pleistocene		
Q2a	30-47 ka	Mostly sandy slope wash derived in part from eolian sediment. Commonly contains <25 percent gravel. Typically caps older deposits and is locally covered by Holocene deposits. Usually lacks topographic expression. Soils have an Av; Bt and (or) Bk; stage I $CaCO_3$; texture SL, L, or C. Usually <1.5 m thick.

Table 1 continued. Quaternary stratigraphy of the Yucca Mountain Area, NTS.

Stratigraphic Units: Unit Designation	Estimated Age	Key Properties and Diagnostic Criteria for Recognition
Middle Pleistocene		
Q2b	145-160 ka	Fluvial gravel that forms strath terraces, or debris flow fans. Fluvial deposits form a terrace 5-12 m above active channels. Typically very poorly sorted with large boulders up to 1 m in diameter; commonly contains fluvial sedimentary features. Desert pavement is well sorted, tightly packed and darkly varnished. Soils have an Av; 10YR to 7.5YR Bw, Bt, Bqm, and (or) Bk; stage I-II $CaCO_3$ and (or) stage II-III SiO_2; texture S, LS or SL. Commonly <2 m thick.
Q2c	270-430 ka	Fluvial gravel or debris flows on steep slopes. Fluvial deposits form a terrace 10-21 m above active channels. Desert pavement is well sorted, tightly packed with continuous varnish. Soils have an Av; 7.5YR. Bt, Bqm, B/K and (or) Kqm; stage III-IV $CaCO_3$ (K horizon <1 m thick) and (or) stage III SiO_2; texture S to L. Usually <65 m thick.
Q2e	<738 ka	Eolian sand in inactive dunes and sand ramps at and adjacent to hill and mountain fronts. Desert pavement is well sorted, tightly packed, and darkly varnish. Soils have an Av; Bk, Bkq, B/K and (or) K; stage III-IV $CaCO_3$ and (or) stage III-IV SiO_2; texture LS, SL, or L. Usually <20 m thick.

Table 1 continued. Quaternary stratigraphy of the Yucca Mountain Area, NTS.

Stratigraphic Units: Unit Designation	Estimated Age	Key Properties and Diagnostic Criteria for Recognition
Q2s	<738 ka	Slope wash or sand sheets (tabular bodies of sandy slopewash) down slope from sand ramps. Generally lacks desert pavement. Soils have an Av; Bk, Bkq, B/K and (or) K; stage III-IV $CaCO_3$ and (or) stage III-IV SiO_2; texture LS, SL or L. Usually <2 m thick.
Early Pleistocene		
QTa	1.1-2.0 my	Alluvial fans; usually extremely eroded and overlain by a veneer or mantle of younger deposits. Commonly deposits are adjacent to hills and mountain fronts, 20-30 m above active channels. Lacks depositional form; erosional modification results in ballena or accordant, rounded ridges. Large boulders up to 1 m in diameter may be scattered on the surface. Desert pavement is well-sorted, tightly packed and has continuous dark varnish; commonly contains opaline SiO_2 platelets from the underlying soil. Soils have an A or Av; 7.5YR Bt, Bqm, B/K, Kqm, and (or) Kmq; stage III-IV $CaCO_3$ (K horizon >1 m thick) and stage III-IV SiO_2. Commonly <20 m thick.

The assigned ages for these mapping units are based almost exclusively upon U-trend analyses on soil samples (Rosholt, 1980) (Appendix G).

Several depositional facies are recognized in these deposits. Fluvial deposits are poorly to moderately well sorted and poorly to well bedded; gravel clasts are angular to subrounded. Debris flows are poorly sorted, and poorly stratified to massive. Clasts are matrix supported and are angular to subrounded. Eolian sand and loess are moderately to well sorted, respectively. Sheetwash is moderately well sorted and may have thin bedding.

Features of desert pavement help distinguish some units. Pavement packing tends to change from none to dense with time, sorting increases from poor to well, and varnish changes from none to dull black to shiny purplish-black. Desert pavement features are a useful relative age indicator because they clearly change with time. However, thin layers of eolian and sheetwashed fine-grained deposits tend to blanket most gravelly deposits in the study area, and thus may not preserve the desert pavements.

The expression of fluvial bar-and-swale features become more subdued with time. The obliteration of these features is due primarily to burial by eolian or sheetwash deposits, and (or) to erosion. With time, the surface becomes smoother.

Topographic form of terraces also change in a gross way. Deposits younger than QTa have a good terrace expression. However, erosional modification results in ballenas or accordant, rounded

ridges (Peterson, 1981) that are typical of the QTa unit. These topographic forms represent a distinctive late stage of piedmont dissection.

Ages of Deposits

The ages assigned to the stratigraphic units on NTS and the surrounding area are based primarily on U-trend dating of deposits exposed in trenches excavated to study Quaternary faults (Hoover and others, 1981; Szabo and others, 1981; Swadley and Hoover, 1983) (Appendix G). Other techniques used are the age of assumed channel incision, ^{14}C, and correlation to ash geochronologies. The Quaternary stratigraphy used in the Yucca Mountain area (Table 1) was a product of the above tectonic studies.

Geomorphic Setting

Terrace Formation--Tectonic vs Climatic

The Quaternary landscape in the study area was formed by three major geomorphic processes; (1) fluvial erosion and deposition, (2) eolian erosion and deposition, and (3) hillslope processes. Major influences on these processes are tectonism (basin subsidence and (or) mountain front uplift) and climate. Of most interest here are the fluvial terraces.

The terraces studied are fill terraces (Fig. 3). Although the overall net effect of fluvial activity has been one of downcutting, these were interrupted by periods of aggradation. Subsequent downcutting resulted in fill terraces.

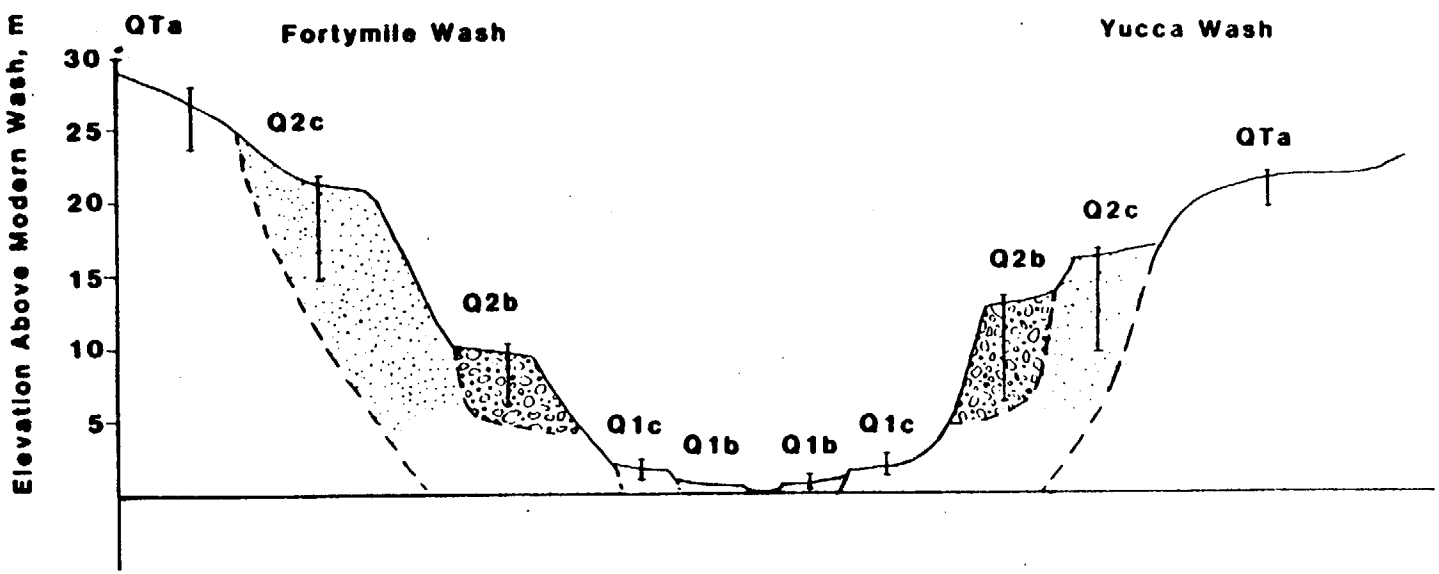


Figure 3. Generalized cross section showing the stratigraphic relationships of Quaternary fluvial deposits along Yucca Wash and Fortymile Wash. Variability in height of terrace surfaces above the modern wash is defined with the vertical bars.

The terraces do not seem to be of tectonic origin. A recent study on the west side of Yucca Mountain suggests that faulting has occurred in the Holocene (J. W. Whitney and R. R. Shroba, U.S. Geological Survey, oral communication, 1985). However there has not been any evidence for faulting of any of the Quaternary fluvial terrace deposits in the study area. In addition, longitudinal profiles of the terraces along Yucca Wash and Fortymile Wash (Fig. 4), although they diverge downstream, do not require tectonism to explain this relationship. Finally, if the terraces have been influenced by tectonic uplifts in the upper reaches of the drainages, cut terraces might be expected rather than fill terraces.

Climatic change may explain the presence of fill terraces in the area. Bull (1979) and Bull and Schick (1979) propose a model for fluvial behavior in arid areas during climatic change. If the climate changes to greater aridity and higher temperatures, the basin characteristics are such that the stream responds by aggrading. As time goes on, sediment availability decreases as erosion exposes bedrock, runoff increases, and erosion of the valley fill takes place. In general, each terrace, therefore could represent a climatic change. In this case, the formation of a terrace could be correlative with the early interglacials.

There have been few paleohydrologic models for the region that the depositional units in the study area may be correlative. Smith (1984) has proposed one for the last 3.2 my, with most of the data taken from a core in Searles Lake, California. The four most recent climatic regimes are of interest here. Regime I (0 - ~10 ka) was dry. Regime II (~10 - 130 ka) was characterized by both dry and

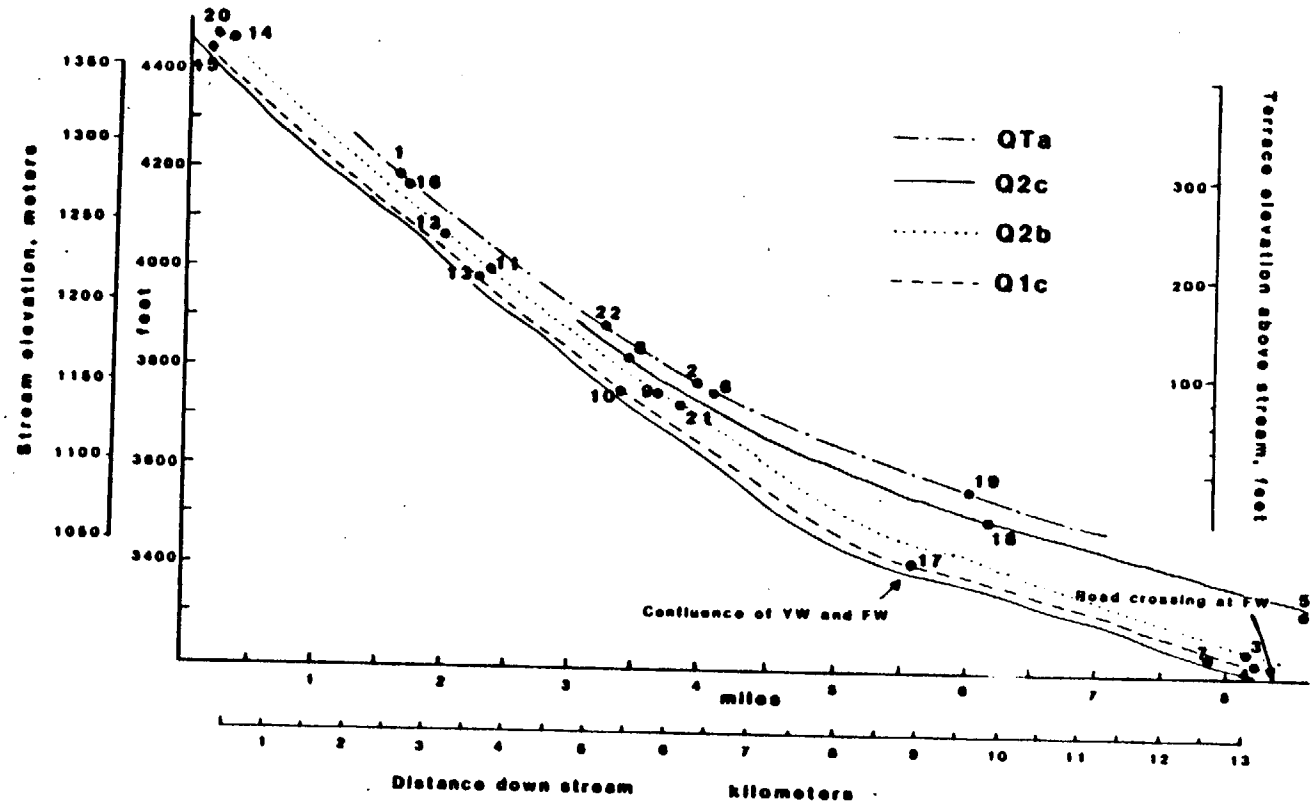


Figure 4. Profiles of terrace deposits along Yucca Wash (YW) and Fortymile Wash (FW). Locations of soil trenches are indicated by dots and numbers.

wet cycles, but long intervals of high lake levels support a relatively wet interval. Regime III (130 - ~310 ka) was similar to but drier than Regime II. Finally, Regime IV (310 - 570 ka) was a long dry period.

Correlation can be made of some of the deposits in the area with the climatic model of Smith (1984). Unit Q1c could correlate with the transition from Regime II to I, and that would follow the Bull and Schick (1979) model. Other deposits may correlate to changes from one regime to another. Unit Q2b is a strath terrace deposit inset into the older Q2c. Therefore, deposits of Q2c age place a minimum age on the major time of incision of Fortymile Wash. Unit Q2b could be correlated with the transition from Regime III to II at 130 ka, and likewise the stabilization of unit Q2c would be correlative with the transition from Regime IV to III at 310 ka. These latter correlations are very tentative and do not follow the Bull (1979) model. Obviously the fluvial response to climatic change is not simple, as the threshold model proposed by Schumm (1977) may also explain terrace formation.

Ground Water Setting

Most ground water flow through the NTS area originates in volcanic highlands to the north; these include Pahute Mesa (35 km NW) and Timber Mountain (15 km N). The remainder of the ground water flow enters from the east as underflow in the regional lower carbonate aquifer (Winograd and Thordarson, 1975; Winograd and Doty, 1980). Flow directions beneath the eastern part of NTS are to the south and west from the highlands, until the water surfaces at the

extensive network of active springs at Ash Meadows in the Amargosa Desert (45 km SE). Evidence exists for somewhat greater spring activity during the last glacial maximum. Fossil tufa deposits occur as high as 40 m above present ground water level in this area (Winograd and Doty, 1980). All pedogenic processes in the Yucca Mountain area are well above the ground water table of the area which is from 490 to 610 m below the surface today.

Modern Climate

Southern Nevada is arid to semiarid. Because average annual precipitation in much of this area is less than 150 mm and there is greater than 10% perennial plant cover, it is actually a semiarid desert (Houghton and others, 1975). Beatty, Nevada is only 24 km due west of the study area. It is at the same elevation as the lowest soil-trench elevation in the study transect (1083 m), and is at the same latitude (37°54′N) (Fig. 1) It is used here as an estimate of the climate of the lower end of the study area. The mean annual precipitation (MAP) at Beatty is 117 mm, and the mean annual temperature (MAT) is 15.3°C (Table 2). At the upper end of the transect, which lies 400 m above the lower end, precipitation is assumed to increase by 70% to about 200 mm. This assumption is based on (1) vegetation change, (2) precipitation data from stations in southern and south-central Nevada that are at similar elevations and latitudes, and (3) Quiring's (1983) regression equation relating MAP and elevation on NTS:

$$y = 1.36x - 0.51 \qquad \textbf{Equation (2.1)}$$

where y = MAP in inches and x = elevation in feet.

Table 2: Temperature, precipitation and potential evapotranspiration data for the Holocene (Present) and two models for the last glacial maximum. Precipitation is divided into the low and high ends of the elevation transect, representing a 70% increase.

1/ U.S. Department of Commerce Weather Bureau, Beatty, Nevada, elevation 1087 m, latitude 36°54′N.

2/ U.S. Department of Commerce Weather Bureau, Pahrump, Nevada, elevation 717 m, latitude 36°12′N.

3/ Thornthwaite (1848) and Van Hylckama (1959).

4/ Blaney and Criddle (1962) - K coefficient from reach 3, Culler and others, 1982, p. 32.

5/ Papadakis (1965) - Mean monthly maximum and minimum temperature used to calculate saturation vapor pressure and dew point according to Linsley and others, (1975, p. 35).

$$\text{Sat Vapor Pressure} = 33.8639\,(0.00738\,T^{o}C + 0.8072)^{8} - 0.000019\,|1.8\,T^{o}C + 48| + 0.001316$$

6/ Pan evaporation summed for growing season (April-October), with total for entire year in parentheses (Farnsworth and others, 1982, p. 1).

HOLOCENE (PRESENT) CLIMATE

Month	Temperature(°C) Mean Monthly			Precipitation (cm)		Pan Evap.	ET_p (cm)		
	avg. 1/	max	min	low	high	(cm) 2/	T 3/	B & C 4/	P 5/
J	4.8	12.4	-2.9	1.80	3.07	5.53	0.71	1.58	5.39
F	6.6	14.6	-1.3	1.78	3.02	7.54	1.17	2.36	6.23
M	9.8	18.7	1.1	1.27	2.16	14.44	2.74	2.83	8.42
A	14.2	23.3	5.0	1.27	2.16	15.14	5.35	4.89	11.18
M	18.4	28.1	8.8	0.84	1.43	26.52	9.06	10.19	15.01
J	23.3	33.5	13.1	0.31	0.52	29.52	13.42	14.72	20.62
J	27.1	37.5	16.7	0.46	0.78	31.64	17.45	16.13	25.61
A	25.9	36.2	15.5	0.51	0.86	27.07	15.17	14.76	23.90
S	22.2	32.5	11.9	0.46	0.78	20.63	10.39	12.17	19.68
O	15.8	25.2	6.4	0.76	1.30	13.34	5.62	8.52	12.62
N	9.7	18.5	0.8	0.91	1.55	6.53	2.22	3.11	8.35
D	5.7	13.5	-2.2	1.32	2.25	5.38	0.91	2.39	5.79
avg or sum	15.3	24.5	6.1	11.68	19.86	163.86 6/ (203.28)	84.21	93.65	162.80

CLIMATE DURING GLACIAL MAXIMUM - Spaulding model

J	-2.2	5.5	-2.9	2.44	4.14	4.98	0.00	0.00	2.32
F	-0.4	7.6	-1.3	2.40	4.08	6.79	0.00	0.00	2.76
M	2.8	11.7	1.1	1.72	2.92	13.00	1.28	0.29	4.02
A	7.2	16.3	5.0	1.72	2.92	13.63	3.73	1.10	5.52
M	11.4	21.1	8.8	1.13	1.92	23.87	6.73	3.22	7.70
J	16.3	26.5	13.1	0.15	0.26	26.57	9.92	5.85	10.99
J	20.1	30.5	16.7	0.23	0.39	28.48	12.58	7.23	13.87
A	18.9	29.2	15.5	0.25	0.43	24.36	11.03	6.39	12.88
S	15.2	25.5	11.9	0.23	0.39	18.57	7.71	4.63	10.51
O	8.8	18.2	6.4	1.03	1.75	12.01	4.07	2.24	6.35
N	2.7	11.5	0.8	1.23	2.10	5.88	1.02	0.30	4.00
D	-1.3	6.5	-2.2	1.78	3.31	4.84	0.00	0.00	2.53
avg or sum	8.3	17.5	6.1	14.31	24.32	147.47 (182.96)	58.07	31.25	83.45

CLIMATE DURING GLACIAL MAXIMUM - Mifflin and Wheat model

J	-0.2	7.5	-2.9	3.03	5.15	4.48	0.00	0.00	3.07
F	1.6	9.6	-1.3	2.99	5.08	6.11	0.40	0.16	3.61
M	4.8	13.7	1.1	2.13	3.63	11.70	1.82	0.50	5.11
A	9.2	18.3	5.0	2.13	3.63	12.27	4.22	1.40	6.92
M	13.4	23.1	8.8	1.41	2.39	21.48	7.33	3.78	9.52
J	18.3	28.5	13.1	0.51	0.87	23.91	10.70	6.56	13.40
J	22.1	32.5	16.7	0.77	1.31	25.63	13.62	7.95	16.82
A	20.9	31.2	15.5	0.85	1.45	21.92	11.93	7.06	15.65
S	17.2	27.5	11.9	0.77	1.31	16.71	8.33	5.24	12.81
O	10.8	20.2	6.4	1.28	2.18	10.81	4.51	2.75	7.91
N	4.7	13.5	0.8	1.54	2.61	5.29	1.47	0.53	5.07
D	0.7	8.5	-2.2	2.22	3.77	4.36	0.15	0.07	3.33
avg or sum	10.3	19.5	6.1	19.63	33.37	132.73 (164.67)	64.48	35.96	103.22

In addition to the orographic influence on precipitation, two basic storm types exist in the area. The two storm types result in precipitation derived from (1) winter cyclonic activity, and (2) intense summer convection (Houghton and others, 1975). As will be shown later, the seasonality of precipitation will influence some of the soil property vs depth relationships.

No long term temperature data exist for the Yucca Mountain area. D. L. Hoover (U.S. Geological Survey, written communication, 1984) however estimates that there is a 3°C difference in MAT in the 400 m elevation change. He bases this on the relationship that,

$$x = 7.48 - 0.004081y \text{ for MAT} \qquad \textbf{Equation (2.2)}$$

where x = MAT in °F and y = elevation in feet.

Paleoclimate in the NTS Region

A large number of data sources exist to reconstruct the paleoclimate in the American Southwest. There are two sources of paleoclimatic information of particular interest in the study area, packrat middens and inferred climates condusive to the formation of pluvial lakes.

Packrat Midden Evidence

Paleoenvironmental data from analyses of plant microfossils remains in packrat (*Neotoma sp.*) middens provide perhaps the most detailed information concerning the timing and nature of climatic changes on the NTS during the late Quaternary (Van Devender and Spaulding, 1979; Spaulding, 1983 and 1985). Plants sensitive to frigid temperatures and those restricted to moist habitats are

missing in the plant microfossil record from 45-10 ka (Spaulding, 1985). Juniper and pinyon pine and Joshua tree were present at lower altitudes in the NTS area. These data suggest milder, wetter winters and cooler, drier summers relative to the present during the last glacial maximum (18 ka). Following the last glacial maximum Spaulding (1985) infers a warming trend from 16-10 ka. After 11-10 ka, the conditions like the present prevailed and juniper and pinyon pine woodland are not present. Elements of desert scrub were present by 15 ka at elevations as high as 990 m Spaulding (1982). The vegetation change was transitional, implying a transitional climatic change from late Pleistocene to Holocene.

Based on evidence from packrat middens, climatic conditions in the Yucca Mountain area during the glacial maximum (18 ka), compared to the present climate, probably had (1) a MAT decrease of 6-7°C, (2) drier summers with a temperature decrease of 7-8°C, and (3) winter precipitation up to 70% greater than present. In all the following discussions this climatic change is referred to as the Spaulding climatic model for the glacial maximum (Table 2).

Pluvial Lake Evidence

The pluvial lake chronologies in the southwestern United States suggest that the effective moisture of the late glacial and early Holocene was much greater than the effective moisture in the modern climate. High lake stands are recorded at 14-11 ka in lakes in both glacial and nonglaciated drainages (Morrison, 1965; Benson, 1978; Lajoie and Robinson, 1982; Wells and others, 1984). The disappearance of juniper and pinyon pine woodland at 11-10 ka is

coincident with the lowering of Lake Mojave from a high stand between 15.5 and 10.5 ka (Wells and others, 1984).

Although the effective moisture was greater, there is little evidence in the northern Mojave Desert for increased annual precipitation during the late Wisconsin (18 ka). Present day playas contained ephemeral lakes or marshes during the full-glacial north of latitude 36° N (Mifflin and Wheat, 1979). Mifflin and Wheat (1979) propose that the MAT was 5°C lower, the MAP 69% greater, and the evaporation 10% less than today. This is referred to in the following discussions as the Mifflin and Wheat glacial maximum climatic model (Table 2).

The reduction of full-glacial summer precipitation in the NTS area, relative to that of today, can be attributed to the dependence of summer precipitation on oceanic air from the Gulf of Mexico. Global cooling weakened these subtropical high-pressure systems and restricted the influence of the oceanic air to very southern regions (Houghton and others, 1975). Summer precipitation also depends upon local convective uplift which is lacking if summer temperature is low.

Summary of the Glacial Climate Models

In the southern Basin and Range and northern Mojave desert regions, the onset of the last major glacial climate began about 45 ka (Spaulding, 1985). The late Wisconsin began about 24 ka, based on dates from Searles Lake (Smith, 1979), and the pollen and lake record from Lake Lahontan (Mehringer, 1967; Benson, 1978), and at 18 ka is thought to have been a full glacial in the western United

States (CLIMAP, 1976). The period from 25 to 11 ka was the maximum development of alpine glaciers, intermittent filling of playa lakes, and expansion of upland vegetation. Physical evidence for paleoclimatic and paleoenvironmental reconstructions for the last glacial vary from a 2-3°C temperature decrease and a 100% increase in precipitation, to a 7-11°C temperature decrease and less precipitation than today (Spaulding and others, 1983; Thompson, 1984). At about 11 ka, there was a significant decrease in the pluvial lake levels, and changes in the vegetation, that mark the end of the late Wisconsin in the southwest (Van Devender and Spaulding, 1979) Transitional plant communities persisted until the early Holocene (7.8 ka) (Spaulding and others, 1983).

CHAPTER III

MAJOR PEDOLOGICAL CHANGES WITH TIME

Morphology

Soils that are formed in alluvium, colluvium and eolian sand of Holocene to early Pleistocene or latest Pliocene(?) age near Yucca Mountain are characterized by distinctive trends in the accumulation of secondary clay, $CaCO_3$, and opaline SiO_2 that correspond with the ages of the surficial deposits.

Pedogenic Opaline Silica

Cementation by pedogenic opaline SiO_2 is common in the study area. Accumulation of opaline SiO_2 is common in soils containing readily weatherable glass from pyroclastic rock or volcanic ash, such as those in the study area. Eolian influx of readily soluble silica-rich dust is also a likely source. Glass tends to weather rapidly and if it is of mafic composition, rich in bases, weathering can liberate silica at a rapid rate. The glass alters to amorphous SiO_2 or semi-crystalline allophane, imogolite and opaline SiO_2 (Bleeke and Parfitt, 1984).

In general, two terms are used for silica and (or) cemented layers: (1) duripan, specifically for pedogenic accumulations (Soil Survey Staff, 1975), and (2) silcrete for geologic-pedologic occurrences (Summerfield, 1983; Nettleton and Peterson, 1983). Both

terms are applied to an indurated product of surficial and (or) near-surface silicification, formed by the cementation and (or) replacement of bedrock, unconsolidated sediments, or soil. The silicification is produced by low temperature physio-chemical processes. Silcretes are not exclusively the product of pedogenic weathering. A few grade laterally into petrocalcic horizons (Summerfield, 1982 and 1983). Silcrete has an arbitrary lower limit of 85% opaline SiO_2 by weight (Summerfield, 1982 and 1983), so it would be a very unusual pedogenic horizon. Silcretes are not present in the study area. Duripans have no specified limits on the content of opaline SiO_2, they vary in the degree of cementation by SiO_2 and commonly contain accessory cements, chiefly $CaCO_3$.

Because silica accumulation produces a unique morphology that varies with age, stages of development recognized in this study have been defined (Table 3). On the basis of horizon morphology, those with stages III-IV morphology would qualify as duripans of the Soil Conservation Service (Soil Survey Staff, 1975, p. 41).

Table 3. General characteristics of pedogenic opaline silica stages.

Stage I	White, yellow, or pinkish scale-like coatings <2 mm thick on the undersides of gravel clasts. Found in some soils on Q1c deposits, may occur at depths on older deposits.
Stage II	Stalactitic or pendant-like features 2-4 mm long extending downward from a coat on the undersides of gravel clasts. Found in soils on Q2b deposits, may occur at depths on older deposits.
Stage III	Opaline SiO_2 cemented horizon, extremely hard when dry. Peds do not slake in water or a weak solution of HCl. The characteristic 7.5YR hue is probably due to clay particles in the silica cement. Found in soils on Q2b, Q2c and QTa deposits, and maximum accumulations tend to form in horizons of maximum $CaCO_3$ accumulation. Frequently in the field stage III appears to be forming above the maximum accumulation of $CaCO_3$ because the whiteness of the $CaCO_3$ masks the precipitated opaline SiO_2.
Stage IV	Stage III morphology along with laminar, indurated opaline SiO_2 platelets, 4-10 mm thick, in the upper part. Maximum $CaCO_3$ accumulation is below maximum opaline SiO_2 induration. Commonly calcareous ooids are precipitated above platelets. Found in soils on Q2c (infrequently and thin) and QTa deposits.

Carbonate and Opaline Silica

At the NTS, soils accumulate secondary $CaCO_3$ and opaline SiO_2 in distinctive trends with increasing ages of the surficial deposits. Soils formed in gravelly alluvium less than 3(?) ka (Q1b) contain little or no secondary $CaCO_3$ or opaline SiO_2. Soils formed in gravelly alluvium 3-20(?) ka (Q1c) and sandy colluvium about 30-40 ka (Q2a) commonly have a Bk horizon about 20-50 cm thick that has thin, discontinuous coatings of $CaCO_3$ (stage I) and (or) opaline SiO_2 scales and pendants on the undersides of stones (stage I-II). Soils formed in gravelly alluvium about 140-160 ka (Q2b) may have a

opaline SiO_2-cemented Btqm horizon (duripan, stage III) about 50 cm thick that overlies or engulfs a $CaCO_3$-enriched Bk/K (stage II-III) horizon about 50-70 cm thick. The secondary opaline SiO_2 in the duripan typically occurs as finely disseminated matrix cement and as coatings and pendants on stones. The secondary $CaCO_3$ in the underlying Bk/K horizon typically occurs as coatings on stones and as bridges between some of the stones in the Bk-layers, and as coatings and finely disseminated matrix cement in the $CaCO_3$-indurated K-lenses. Soils formed in gravelly alluvium about 300-400 ka (Q2c) commonly have a opaline SiO_2-indurated Kqm horizon (stage III) about 50 cm thick that overlies a Bk/K horizon (stage II-III) about 40-50 cm thick. The oldest alluvium, which is >1 Ma (QTa), has soils with a Kqm horizon more than 100 cm thick. Commonly, the upper part of the Kqm horizon consists of platelets, 0.5-1 cm thick, cemented by laminar opaline SiO_2 (stage IV), and it may be overlain by layers of $CaCO_3$ ooids as much as 10 cm thick (stage III).

Carbonate is primarily derived from airborne dust and the opaline SiO_2 from in-place weathering of the parent material, although the addition of silica-rich dust may also be a likely source.

The $CaCO_3$ morphology in the NTS area differs from that described by Gile and others for the Las Cruces area, New Mexico, although both areas have similar climates, soil parent materials, and accumulation rates of modern airborne dust (Gile and others, 1979). In addition, secondary $CaCO_3$ is less abundant in the NTS area than in deposits of similar age in the Las Cruces area. These differences in the amount of secondary $CaCO_3$ may result from

differences in the seasonality of precipitation and the amount of secondary opaline SiO_2. Unlike the Las Cruces area, most precipitation in the NTS area occurs during the cool, winter months at soil moisture temperatures that result in $CaCO_3$ being more soluble (Table 2). Infiltrating soil moisture tends to translocate $CaCO_3$ to the base of the wetting zone, where it forms lenses rather than discrete K horizons as in the Las Cruces area. Thin-section studies of soils in the NTS area indicate that opaline SiO_2 has replaced $CaCO_3$ in some of the older soils. This relationship suggests that opaline SiO_2 accumulation in the NTS soils is favored over that of $CaCO_3$.

Vesicular A Horizons

Well developed vesicular A horizons (Av) have not formed on the coarse gravelly Holocene deposits (Qlc) in the Yucca Mountain area. On the Pleistocene deposits the Av's are typically between 5 and 10 cm thick and there is no relationship between the thickness of the Av horizon and the age of the underlying deposit. Eolian silts and fine sands appear to accumulate only on deposits that have been previously plugged or partly plugged by the addition of fine material into the coarse alluvium. Although McFadden and others (1984) have described the ubiquitous nature of Av's in the Mojave desert on Holocene deposits and volcanic flows, it appears in this area that due to the coarseness of most of the young deposits, available eolian fines are either translocated deeper into the deposit or lost by wind erosion. It is also possible that the eolian material that forms Av horizons has been less abundant during

the Holocene, although this contradicts many of the current ideas on sediment availability associated with the Holocene-Peistocene climatic change (Bull, 1979).

Profile Index Values

Field properties of soils (Appendix A) can be quantified by assigning points for developmental increases in soil properties in comparison to those of the parent material (Harden, 1982; Harden and Taylor, 1983) (Appendix B). Ten field properties are quantified and normalized for each horizon, including two properties that reflect $CaCO_3$ buildup in soils formed in arid environments. The ten properties are rubification (increasing (redder) color hue and (or) chroma), melanization (decreasing (darkening) color value), color paling (decreasing (yellower) color hue and (or) chroma), color lightening (increasing (whitening) color value), total texture (includes texture and wet consistence), clay films, structure, dry consistence, moist consistence, and pH. Unlike the Harden (1982) definition, values for pH were quantified based on the absolute difference in comparison to the parent material. Moist consistence was usually not determined in this study, therefore it was not included in the index calculations.

Soil profile indices were initially calculated two different ways; using all soil properties and (1) rubification and melanization, or (2) color paling and lightening properties. Both ways to calculate the soil profile index include eight properties. I have called the first way to calculate the profile index value rub-mel, and the second pale-light. Rub-mel was developed for a

xeric soil moisture regime, and pale-light for an arid soil moisture regime. According to Harden and Taylor (1983) complete profiles are calculated using either one of the two methods, not combinations for a given profile. Profile indices are calculated using either rubification and melanization, (rub-mel) or color paling and color lightening (pale-light).

Parent material values used to calculate the indices vary with the kind of material. For alluvium they are 10YR 6/2 (dry) and 10YR 4/2 (moist), sand, loose, and non-sticky and non-plastic. In contrast, for the eolian sand and reworked gravels the values are 10YR 6/3 (dry) and 10YR 4/3 (moist), sandy loam, soft, and non-sticky and non-plastic.

Of the ten possible independent properties all were significant with log age at the 5% level, except melanization (r^2=0.01) and color paling (r^2=0.01) (N=20, r^2 critical=0.18) (Fig. 5). The properties most significant in the profile index calculation have the highest r^2 values. They are dry consistence (r^2=0.48), color lightening (r^2=0.45), rubification (r^2=0.40), and structure (r^2=0.37), and are referred to as the four best properties (Fig. 5). The profile index values using the four best properties did not improve the relationship between soil development and time over that using all eight properties with the highest r^2 values (Fig. 6).

Significant trends are apparent when profile index values (Appendix B) are plotted as a function of age (Fig. 6). Profile index values have been calculated using rub-mel and pale-light soil properties (Fig. 6). It makes no difference in the index values vs

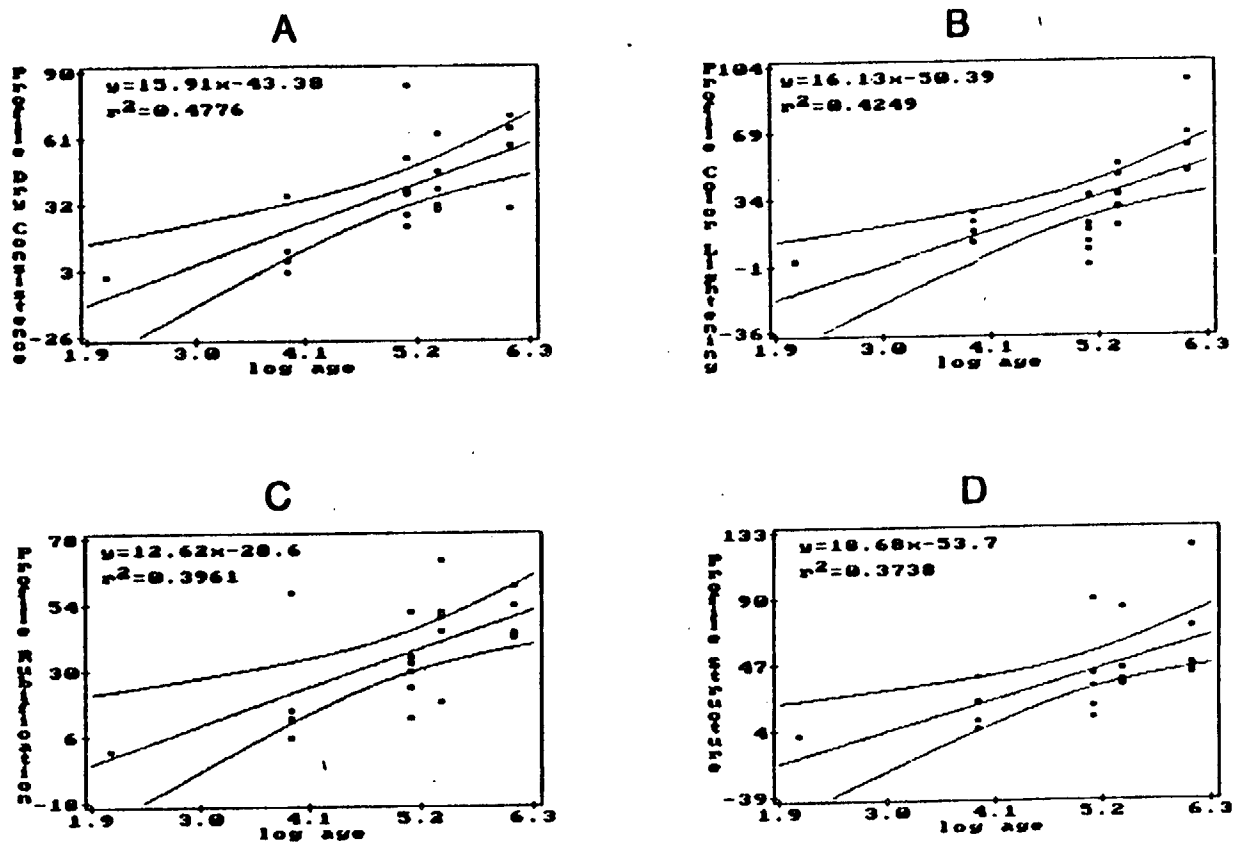


Figure 5. Bivariate regression analyses of significant property profile index values vs time. 95% confidence interval surrounds regression line. (A) dry consistence, (B) color lightening, (C) rubification, (D) structure, (E) texture, (F) clay films.

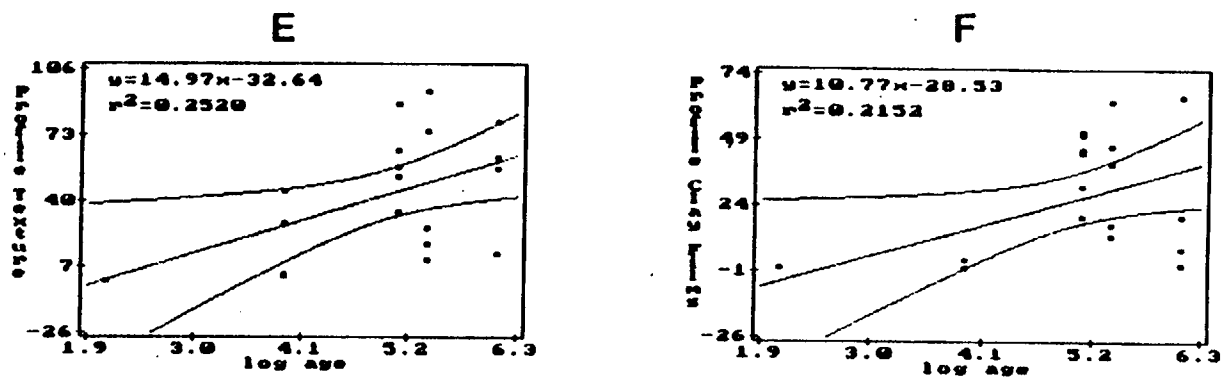


Figure 5 continued. Bivariate regression analyses of significant property profile index values vs time. 95% confidence interval surrounds regression line. (A) dry consistence, (B) color lightening, (C) rubification, (D) structure, (E) texture, (F) clay films.

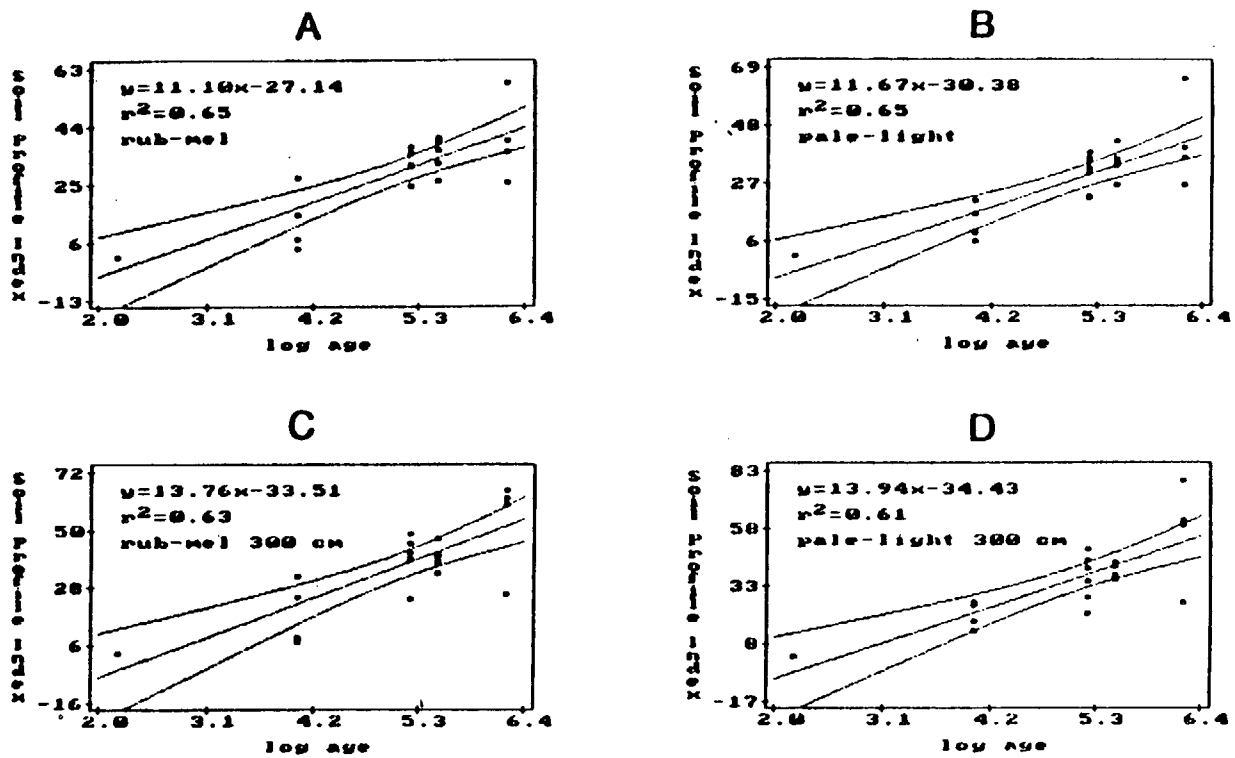


Figure 6. Bivariate regression analyses of soil profile index values vs time. 95% confidence interval limits are above and below the regression line. (A) Rub-mel, all soil properties including rubification and melanization. (B) Pale-light, all soil properties including color lightening and color paling. (C and D) Soil properties for rub-mel and pale-light climatic regime are quantified to an arbitrary maximum depth of 300 cm. (E) Rub-light, all soil properties including rubification and color lightening. (F) Best four properties are dry consistence, color lightening, rubification, and structure.

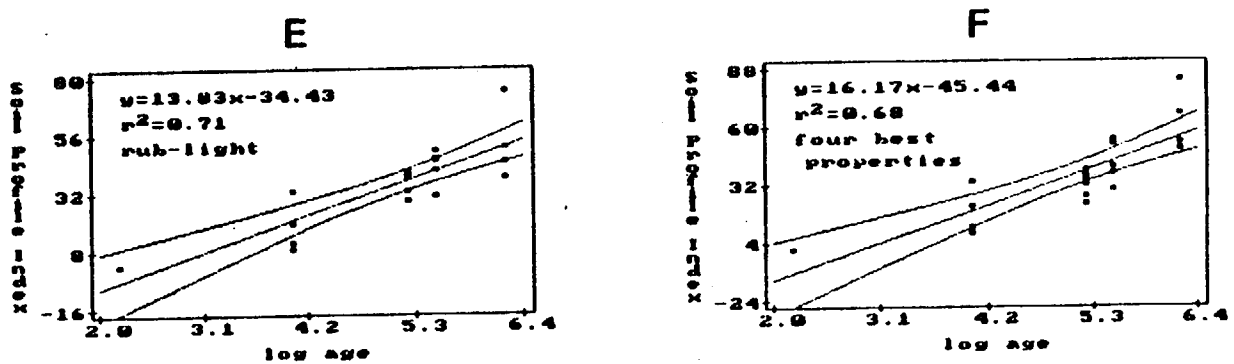


Figure 6 continued. Bivariate regression analyses of soil profile index values vs time. 95% confidence interval limits are above and below the regression line. (A) Rub-mel, all soil properties including rubification and melanization. (B) Pale-light, all soil properties including color lightening and color paling. (C and D) Soil properties for rub-mel and pale-light climatic regime are quantified to an arbitrary maximum depth of 300 cm. (E) Rub-light, all soil properties including rubification and color lightening. (F) Best four properties are dry consistence, color lightening, rubification, and structure.

time if the rub-mel (r^2=0.65) or pale-light (r^2=0.65) properties are for the measured profile thickness, or are for an arbitrary depth of 300 cm for the rub-mel (r^2=0.63) or pale-light (r^2=0.61) properties (Fig. 6).

Because melanization and color paling did not have significant correlations with time, the profile index was calculated using rubification and color lightening. When all soil properties are included with rubification and color lightening the profile index value is called rub-light. The rub-light profile index values vs time increases the r^2 value to 0.71 (Fig. 6).

The increase in the individual profile property values with time (Fig. 5) can be explained by aridic climatic pedogenesis models. Rubification increases both because of the increasing redness of Bt horizons and the accumulation of opaline SiO_2, as the latter results in colors redder than the parent material. Lightening increase with time because A horizons do not get darker, and $CaCO_3$ and opaline SiO_2 accumulating horizons are lighter than the parent material. Dry consistence gets harder over time as clay and cementing agents accumulate and indurate horizons. Structure changes from unconsolidated parent material. Texture, wet consistence, structure, and clay films represent pedogenic accumulations of clay.

There may be a subtle influence of local climate on profile index values. Unit Q1c shows little change with elevation, but weak trends are discernable for units Q2b, Q2c, and QTa with the increase in QTa being much greater than that of the younger units when only the four best properties are used (Fig. 7).

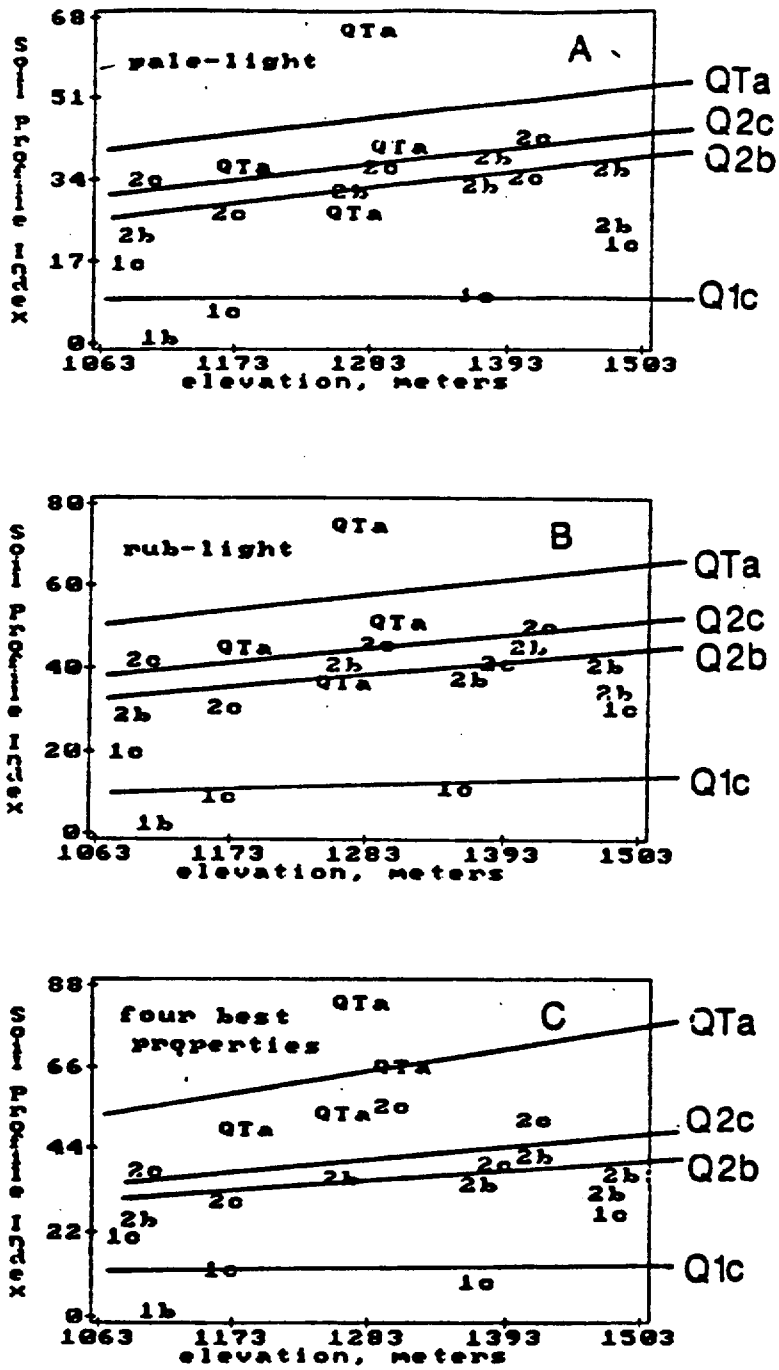


Figure 7. Soil index values vs elevation. The index value plots between the number and letter of each stratigraphic unit. (A) Pale-light field properties including color paling and color lightening. (B) Rub-light properties including rubification and color lightening. (C) Index calculated using four best properties: dry consistence, rubification, color lightening, and structure.

Profile index values for the study area are comparable to index values from the Las Cruces, New Mexico soil chronosequence (Harden and Taylor, 1983) (Table 4). Comparative index values are best when they are based on the four best properties. The older soils in the Las Cruces area have greater values probably because $CaCO_3$ accumulation is greater for deposits of a given age at Las Cruces than at NTS.

Table 4. Comparison of soil profile index values for the study area and Las Cruces, New Mexico.

AGE			INDEX VALUES				
			This Study		Las Cruces	Four Best Properties	
This Study	Las Cruces						
log Age	Age		Pale-light[1]	Rub-light[2]	Pale-light[1]	This Study[3]	Las Cruces[4]
2.18	150 yrs	--	<5	<5		<5	
4.00	10 ka	4-20 ka	6-21	9-32	5-41	9-33	4-35
5.18	150 ka	120 ka	23-38	29-41	22-26	23-39	24-31
5.48	300 ka	290 ka	26-42	31-49	1-56	30-54	29-95
6.18	1.5 my	>500 ka	27-64	38-74	>43	49-83	>110

[1] all properties including color paling and color lightening
[2] all properties including rubification and color lightening
[3] dry consistence, structure, color lightening, rubification
[4] dry consistence, structure, color lightening, color paling

Accumulations of Carbonate, Clay, Silt, and Opaline Silica

The influence of age and climate on soils can be evaluated based on trends in the accumulation of pedogenic $CaCO_3$, clay, silt, and opaline SiO_2 (Gile and others, 1979 and 1981; McFadden, 1982; Machette, 1985). The amounts of these pedogenic constituents can be determined by deducing the initial amount in the soil parent material from that in the present soil.

Method to Calculate Rates of Accumulation

Trends in soil constituents are best when expressed on a mass basis. Secondary accumulation of all constituents can be computed in gm in a vertical column of 1 cm^2 area for the <2mm fraction, for each horizon according to equation 3.1.

Equation (3.1)

$$P = ([(\%P)(BD)_{present} - (\%P)(BD)_{PM}]\text{thickness})(\%<2mm)$$

where P = pedogenic property, BD = bulk density, and PM = parent material.

The profile sum is calculated by summing the horizon values through the profile (Fig. 8), and rates of accumulation are computed by dividing the estimated age into the average profile sum for a unit (Fig. 9). Predicted profile sums are the average $gm/cm^2/10^3$ yr rate for a given unit converted to a yearly number, and multiplied by the soil age (Appendix H). Predicted profile sums are used to check the age assignment for a given unit.

Rates of Accumulation of $CaCO_3$, Clay, Silt, and Opaline SiO_2

Profile sums suggest that $CaCO_3$, clay, silt, and opaline SiO_2 accumulated at a logarithmic rate (Fig. 8). All r^2 values were highest when the log age regression model was used (Table 5). However, these logarithmic rates may be a function of the erosion and soil loss on the older surfaces, and the complete volume of these constituents may not be measured. The long term rates in fact, for properties dependent primarily on eolian additions is probably better expressed as a linear rate.

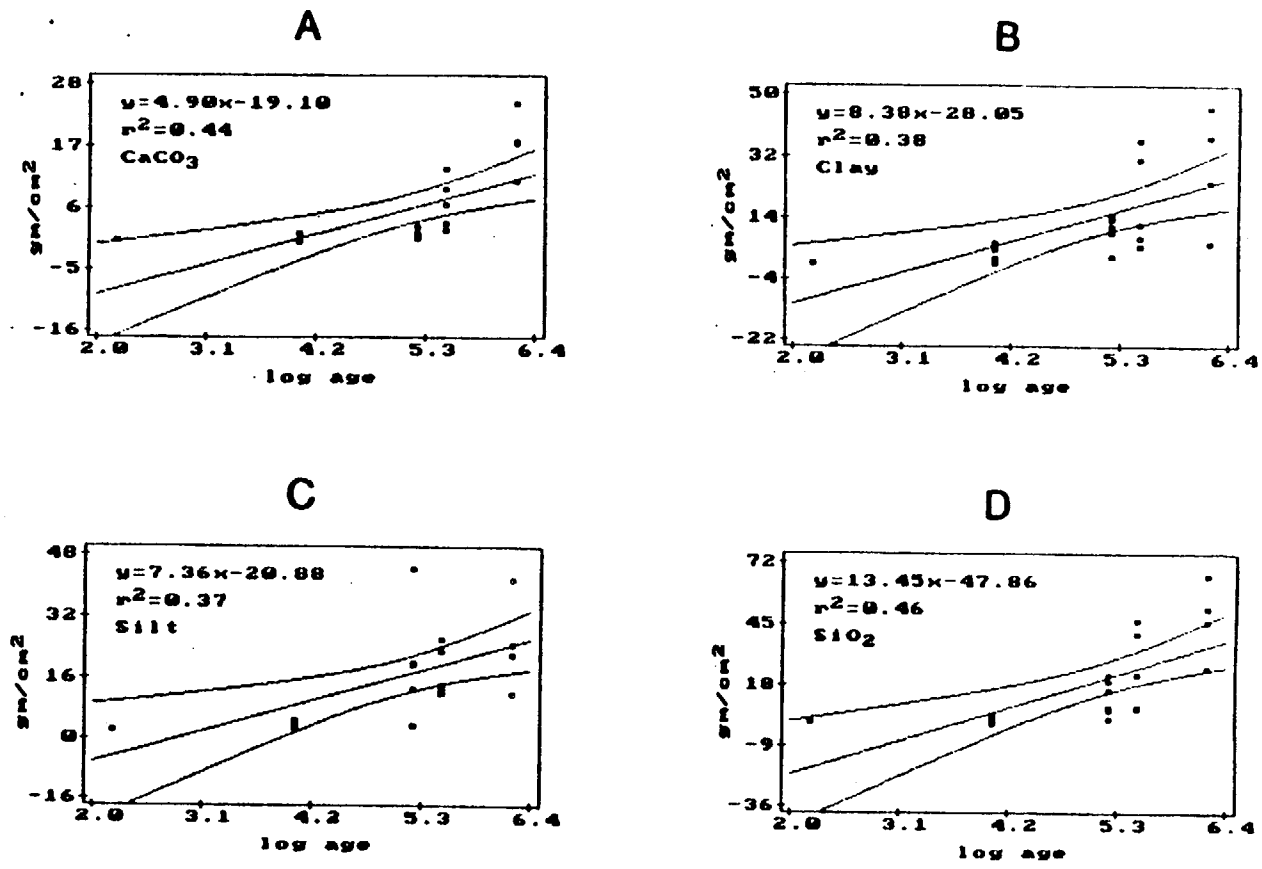


Figure 8. Profile sum of horizon weights vs age for pedogenic $CaCO_3$ (A), clay (B), silt (C), and opaline SiO_2 (D) on soils developed on stratigraphic units Q1c ($10^{4.0}$), Q2b ($10^{5.18}$), Q2c ($10^{5.48}$), and QTa ($10^{6.18}$).

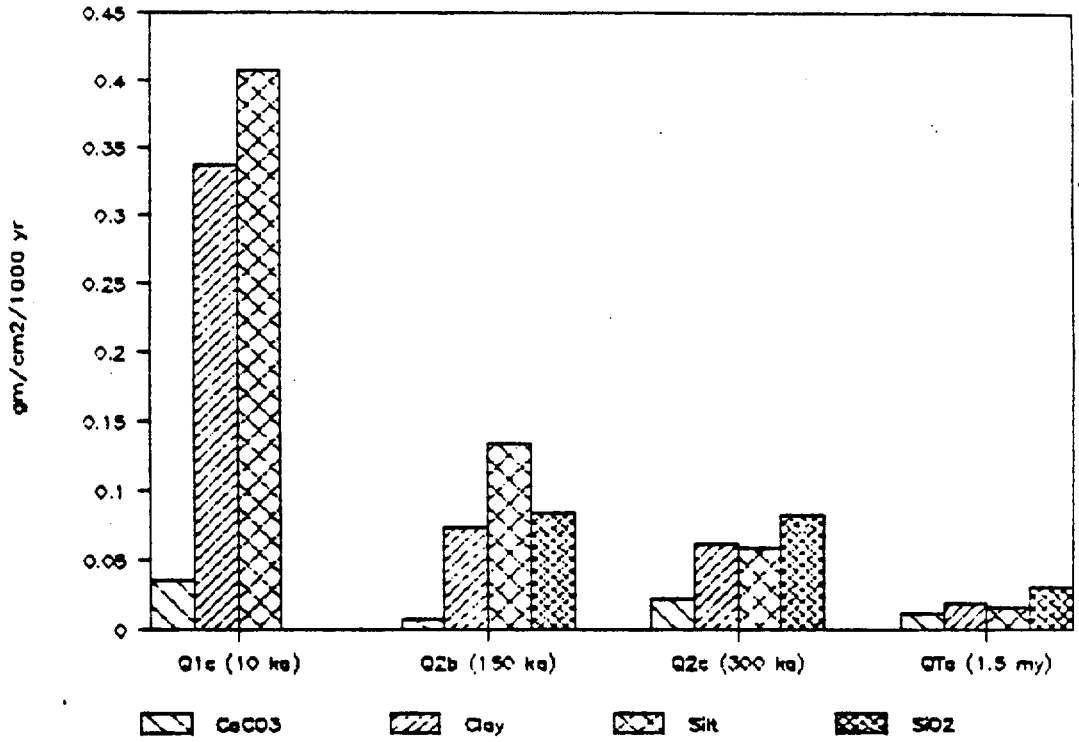


Figure 9. Average rates of accumulation of pedogenic $CaCO_3$, clay, silt, and opaline SiO_2 (profile sums divided by age) based on profile weight sums, on soils developed on stratigraphic units Q1c, Q2b, Q2c and QTa.

Table 5. Correlation coefficients (r^2) for $CaCO_3$, clay, silt, and opaline SiO_2 profile sums vs. linear age and log age. Critical value for r^2 at a 5% probability level is 0.42, and at 1% is 0.54.

	linear age	**log age**
$CaCO_3$	0.39	0.44
Clay	0.12	0.38
Silt	0.02	0.37
SiO_2	0.23	0.46

Holocene soils (Q1c) accumulate $CaCO_3$, clay, and silt at a higher average rate than the older soils. For example, $CaCO_3$ accumulation decreases from an average rate of 0.04 $gm/cm^2/10^3yr$ during the Holocene to 0.01-0.03 $gm/cm^2/10^3yr$ in the older soils (Fig. 9). Clay and silt accumulation rates on the Q1c deposits are considerably higher than on the older deposits. Deposits Q2b and Q2c are the best estimates of long term average rates of accumulation of $CaCO_3$, clay, silt, and opaline SiO_2. The gently rolling topography of QTa is a result of long term erosion. The low rates for all four properties on QTa are a result of the erosion which has formed the ballena topography. The loss of soil results in calculated low accumulation rates (Appendix H).

There are several sources for the $CaCO_3$, clay, silt, and opaline SiO_2 accumulations in soils. One source is weathering and (or) translocation of a constituent in place. Pedogenic opaline SiO_2 forms this way as may some clays. A second source is atmospheric additions, either as ions in solution (in the case of Ca^{++}) or as solid dust particles (clay, silt, and some $CaCO_3$) (Gile and others, 1979).

A generalized model for $CaCO_3$, clay, silt, and opaline SiO_2 accumulation rates is that the rates vary with climate. During interglacials (7,000-20,000 yrs duration) rates are rapid because increased aridity, decreased vegetation cover, and exposed playa surfaces, all contribute to increased airborne transport. Greater areas are exposed and wind has better access to it, resulting in greater accumulation rates. In contrast increased vegetation and more effective precipitation of glacial climates (100,000-150,000 yrs duration) could result in comparatively slow rates of accumulation. Yet another factor is having sufficient precipitation to move atmospheric materials into the soil. For example, accumulation rates of pedogenic $CaCO_3$ in the Mojave Desert during the Holocene are characterized by Machette (1985) as climate or precipitation-limited, suggesting that soils may be accumulating material slower now than in the late Pleistocene because of the lack of sufficient precipitation to move material into the soil via soil-water movement. Therefore during glacial climates there is less available eolian material, but greater precipitation to translocate the material, and during interglacial climates insufficient precipitation to translocate the available eolian dust. Accumulation rates could be the same in both climates, or different.

Rates of $CaCO_3$ accumulation in the study area are extremely low compared to rates calculated by Machette (1985) for the Vidal Junction area, which has a climate similar to that of the study area. The rates also vary with age of stratigraphic unit in the study area (Fig. 9). However, if the Qlc soils actually range in age for 5 to 40 ka, then these reputed Holocene rates may be too

high. If an age of 5,000 yrs is assumed, the rate for $CaCO_3$ accumulation would be 0.08 $gm/cm^2/10^3$ yr, and if an age of 40,000 yrs is assumed, the rate would decrease to 0.01 $gm/cm^2/10^3$ yr. Both rates fall within the range of long term rates. In either case, the decrease in precipitation associated with the climatic change at the Holocene-Pleistocene boundary was not enough to significantly decrease the already extremely low rate of $CaCO_3$ influx. In fact, similar rates of carbonate accumulation during the Holocene and pre-Holocene may suggest that the climatic change was the result of decreased temperatures and not precipitation.

Rates of accumulation of clay and silt respond the same way as $CaCO_3$ to changes in age assessment on the Qlc deposit. If Qlc is estimated to be between 5-40 ka, the rates still remain higher than the long term rates calculated on the older deposits (Fig. 9). For clay the range of accumulations rates is between 0.7-0.09 $gm/cm^2/10^3$ yr, and for silt between 0.8-0.1 $gm/cm^2/10^3$ yr on the Qlc deposit. The long term rate for clay is 0.08-0.07 $gm/cm^2/10^3$ yr, and for silt 0.13-0.06 $gm/cm^2/10^3$ yr. This suggests that precipitation since the stabilization of Qlc is not a limiting factor, and that clay and silt are not being accumulated slower during the Holocene than during glacial climates. This supports the $CaCO_3$ accumulation data that the climatic change was not enough to significantly decrease rates of accumulation.

Rates of accumulation of opaline SiO_2 remain relatively constant over time at about 0.08 $gm/cm^2/10^3$ yr. There is little or no opaline SiO_2 to be measured for soils on the Qlc deposits.

Machette (1985) proposes that it is reasonable to use average profile $CaCO_3$ content of relic soils between about 100,000 and 150,000 yrs old to estimate the ages of still older calcic soils in the same chronosequence. Soils in this age range have experienced a number on glacial-interglacial climatic cycles. Age estimates of soils younger than 100,000 yrs may also be made, but they may be less precise. In this study, no unit consistently best estimated tne age.

In the study area a number of different rates for a given property were used to calculate an estimated profile sum (Appendix H). The difference between the estimated sum and the actual profile sum was calculated. The amount of time to account for the difference was then computed. For example, for deposit Q2c the average profile sum is 6.80 gm/cm^2, but the estimated profile sum is 3.0 gm/cm^2 (0.01 $gm/cm^2/10^3$ yr, the long term rate, X 300,000 yrs). At a rate of 0.01 $gm/cm^2/10^3$ yr it would take 380,000 yrs to accumulate the difference (6.80-3.0=3.80 gm/cm^2). This discrepancy is either (1) an age error of 100%, (2) accumulation rates are off by one half for that age range, this may be accounted for by erosion on deposits that the long term rates are calculated from or (3) represents additions of about two times the potential $CaCO_3$ on the Q2c deposits used in this example.

Depth Functions of Significant Soil Properties

Soil properties that commonly exhibit change with time and (or) climate include clay, $CaCO_3$, and opaline SiO_2. Most of these properties are also strongly influenced by vertical position in the

soil profile, as illustrated for some properties of soils in the Yucca Mountain area (Figs. 10-13).

Soils exhibit increases in clay, $CaCO_3$, and opaline SiO_2 over time. Pedogenic change can be better examined by converting these properties to horizon weights. Pedogenic clay clearly increases with time, although $CaCO_3$ and opaline SiO_2 have higher correlation coefficients with the age of the deposit (Table 6). With the exception of soils formed on deposits of Q2c age, clay, $CaCO_3$, and opaline SiO_2 maximums occur in the same horizon (Figs. 10-13). On Q2c deposits the maximum occurrence of pedogenic clay is immediately above the maximum occurrence of pedogenic $CaCO_3$ and opaline SiO_2. In nearly all soils formed in all deposits, the maximum $CaCO_3$ and opaline SiO_2 occur in the same horizon, and there is more opaline SiO_2 than $CaCO_3$.

Table 6. Correlation coefficients (r^2) for linear age, log age, $CaCO_3$, clay, and opaline SiO_2 for A, B and K, and C horizons, and all horizons combined. No significant opaline SiO_2 was measured on A and C horizons. Critical values for r^2 at the 5% probability level are 0.35 for A horizons, 0.18 for B and K horizons combined, 0.37 for C horizons, and 0.14 for all horizons combined.

	A C	B & K all	A C	B & K all	A C	B & K all	A C	B & K all
	linear age		log age		$CaCO_3$		Clay	
$CaCO_3$	.55	.49	.43	.42				
	.58	.43	.42	.26				
Clay	.21	.44	.18	.42	.40	.55		
	.11	.37	.49	.34	.30	.58		
Opaline SiO_2	-	.52	-	.47	-	.75	-	.85
	-	-	-	-	-	-	-	-

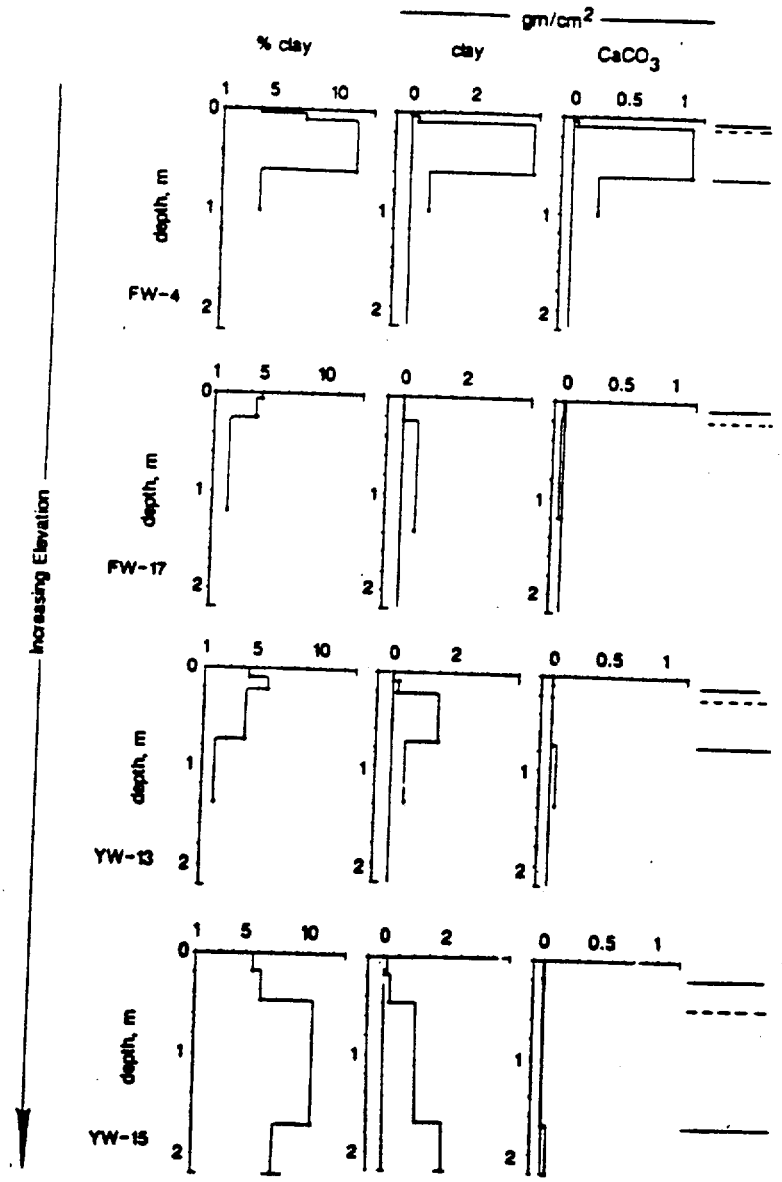


Figure 10. Depth plots of pedogenic clay, $CaCO_3$, and opaline SiO_2 in soils developed on unit Qlc. Lines on the far right represent major horizon and depositional boundaries: solid lines are for A-B or K-C horizons, dashed lines are for depositional boundaries.

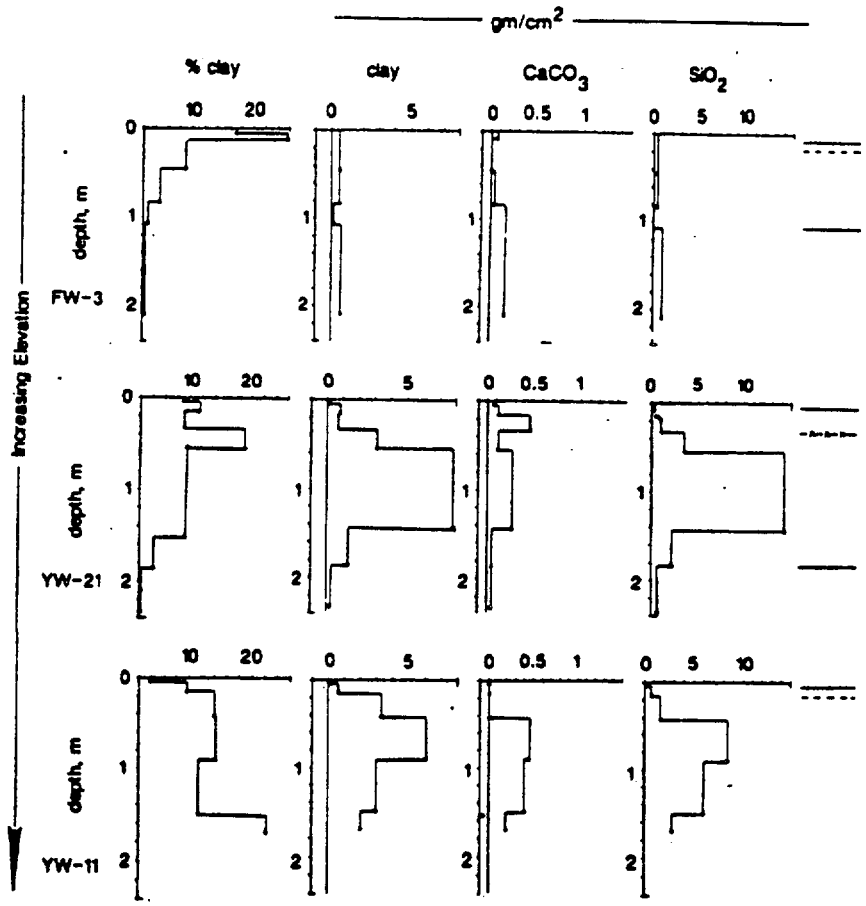


Figure 11. Depth plots of pedogenic clay, $CaCO_3$, and opaline SiO_2 in soils developed on unit Q2b. Lines on the far right represent major horizon and depositional boundaries: solid lines are for A-B or K-C horizons, dashed lines are for depositional boundaries, and dashed lines with x's are for buried soils.

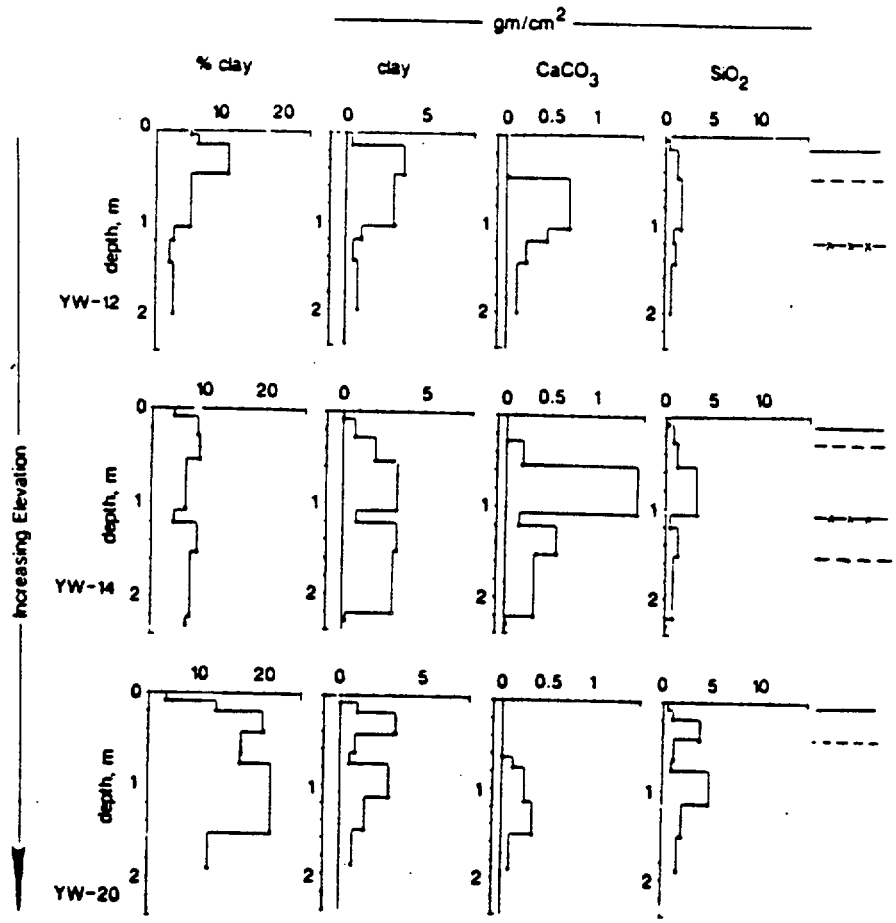


Figure 11 continued. Depth plots of pedogenic clay, $CaCO_3$, and opaline SiO_2 in soils developed on unit Q2b. Lines on the far right represent major horizon and depositional boundaries: solid lines are for A-B or K-C horizons, dashed lines are for depositional boundaries, and dashed lines with x's are for buried soils.

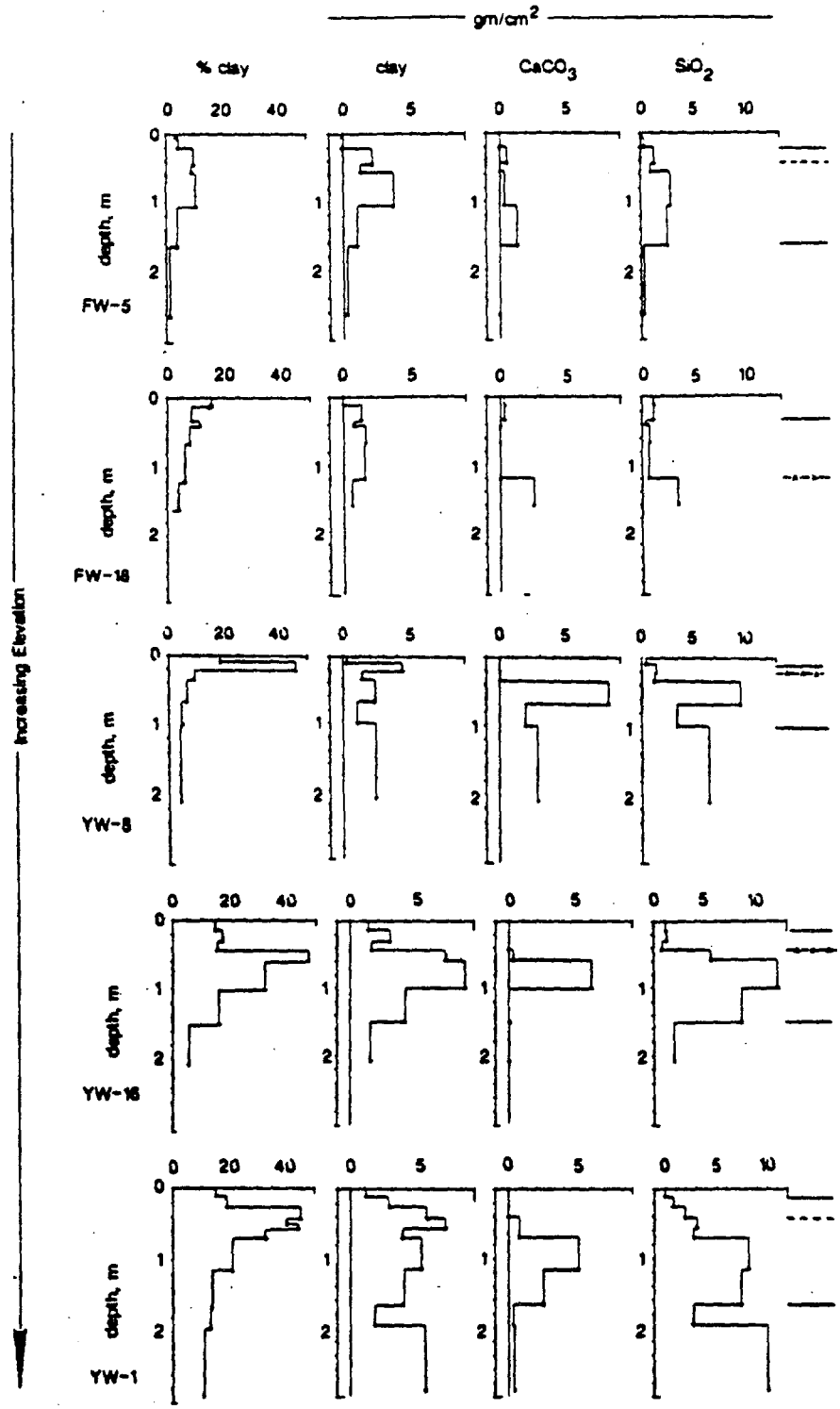


Figure 12. Depth plots of pedogenic clay, $CaCO_3$, and opaline SiO_2 in soils developed on unit Q2c. Lines on the far right represent major horizon and depositional boundaries: solid lines are for A-B or K-C horizons, dashed lines are for depositional boundaries, and dashed lines with x's are for buried soils.

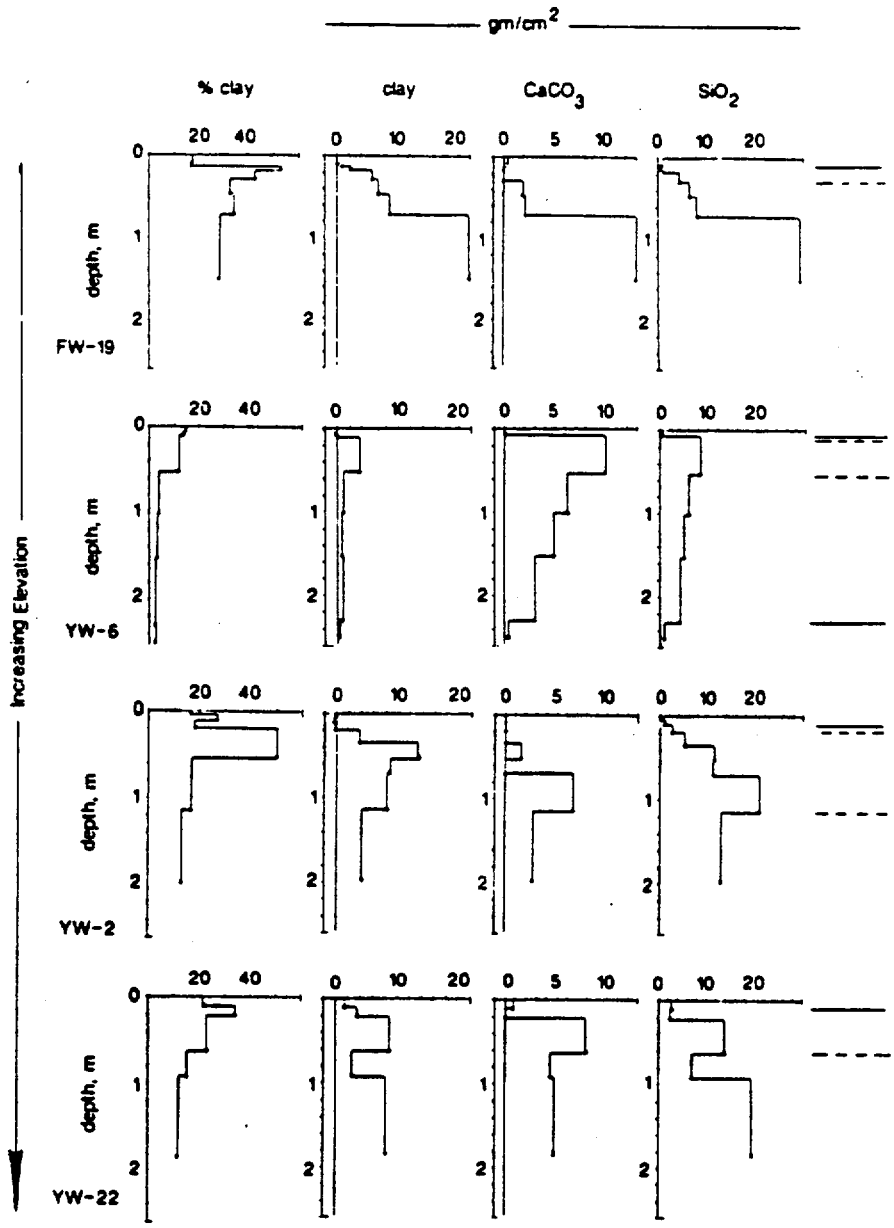


Figure 13. Depth plots of pedogenic clay, $CaCO_3$, and opaline SiO_2 in soils developed on unit QTa. Lines on the far right represent major horizon and depositional boundaries: solid lines are for A-B or K-C horizons, dashed lines are for depositional boundaries, and dashed lines with x's are for buried soils.

Primary and Secondary Minerals Identified by X-ray Diffraction

Quartz, feldspars (primarily plagioclase and orthoclase), are the dominant minerals in the parent material sand and silt fraction. These minerals as well as dolomite dominate the clay fraction. Quartz is the dominant peak in most X-ray diffraction (XRD) traces. The following clays were identified in the soils: tobermorite, weathered mica, a mixed layer group of minerals, and kaolinite (Table 7). There is also XRD evidence for amorphous silica.

Tobermorite [$Ca_5(Si_6O_{18}H_2)\cdot 4H_2O$] is a hydrated calcium silicate found in cement, and rarely occurs in nature (Taylor, 1950; Heller and Taylor, 1951). It has a 2:1 layer structure similar to that of vermiculite (Megaw and Kelsey, 1956; Hamid, 1980), with minor variations in structure due to the chemical composition. Tobermorite displays a sharp peak at 11.6Å when untreated, which shifts to 10.4Å when glycolated (Fig 14). Although it is always reported to shift to 9.35Å when heated to 300°C and collapse at 800°C (Taylor, 1959), in these and other soil samples (Reheis, 1984) it is completely destroyed by heat treatment, and when pedogenic opaline SiO_2 is chemically removed (Appendix D). It has cation-exchange and selectivity properties intermediate between those of clay minerals and zeolites (Komarneni and Roy, 1983). Wollastonite is the stable phase resulting from the destruction of tobermorite at 800°C.

Tobermorite is usually found in zones of intense hydrothermal alteration (Heddle, 1880; McConnell, 1954; Harvey and

Table 7. Clay Minerals Identified and their Diagnostic Features

Clay Mineral	TREATMENT						Probable Source
	Air Dry	I 1/	Glycolated	300°C	500°C	Silica Removed	
Tobermorite	11.3-11.4 2/ (002)	s	10.6	d 3/	d	d	parent material and pedogenic
Weathered Mica	10.2-10.3 (001)	m-w, b	nc 4/	nc	nc	nc	pedogenic
Mixed Layer	10.5-12.0 (001)	b	nc	nc	peak intensifies (s)	nc	pedogenic
Kaolinite	7.1-7.3 (001)	s-w, b	nc	nc	d	nc	parent material

1/ Intensity of Peak: s, strong or sharp spike; m, moderate spike; w, weak spike; b, broad or spread out.

2/ All values are in Å.

3/ d, peak disappeared

4/ nc, no change in peak intensity or width.

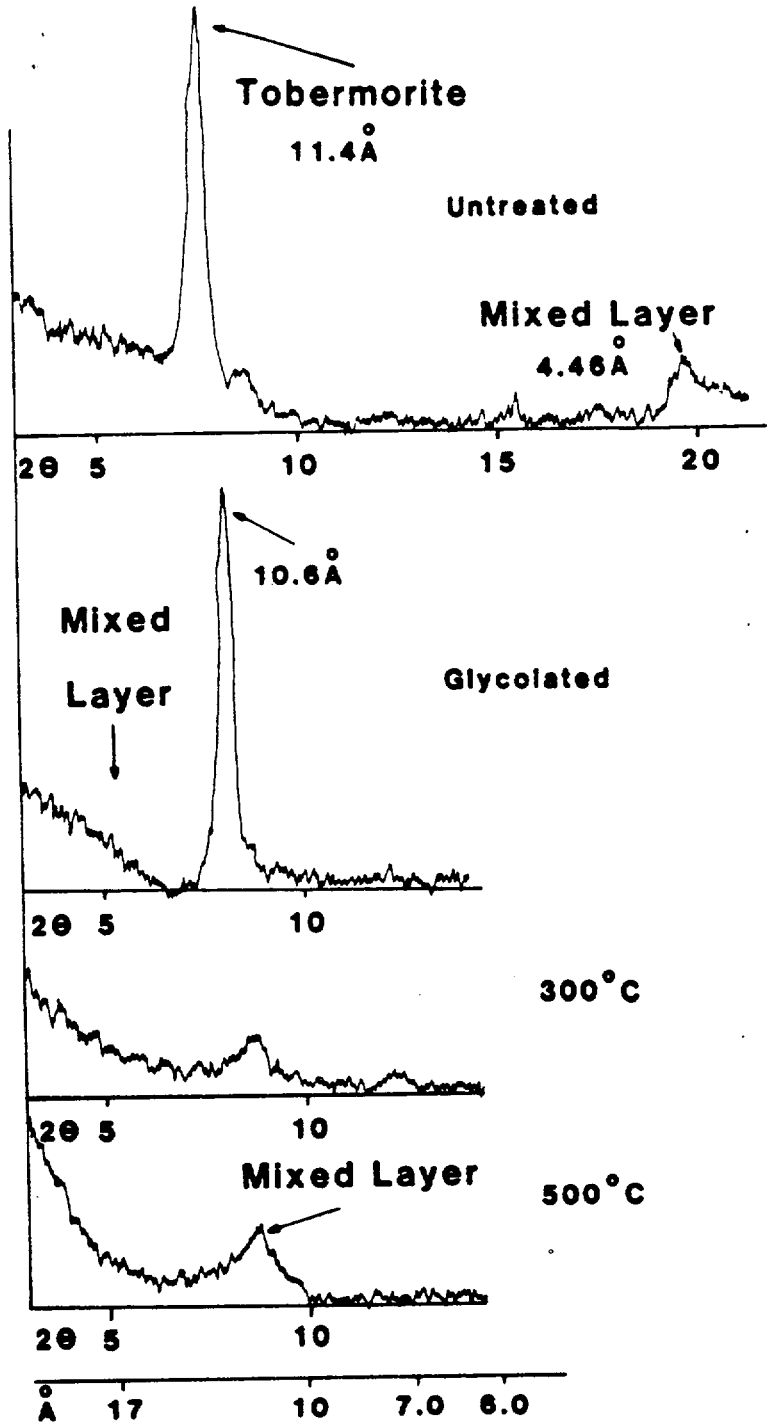


Figure 14. Representative XRD traces of tobermorite and mixed-layer clays: untreated, glycolated, and heated traces.

Beck, 1960; Gross and others, 1967: Webb, 1971; Kusachi and others, 1984). It has also been reported in contact metamorphic limestones (Eakle, 1917). In some cases it is completely replaced by calcite. In all cases tobermorite is of secondary origin. Reheis (1984) reported the presence of tobermorite in Montana soils, that it was pedogenic in origin, and that the amount increased with age.

Tobermorite with an 11Å primary peak has been synthesized hydrothermally and at low temperatures from many different starting materials such as mixtures of lime or portland cement with either quartz or amorphous silica (Heller and Taylor, 1951; Mitsuda, 1970; Snell, 1975; Mitsuda and Taylor, 1978; Komarneni and Roy, 1983).

It is difficult to know whether the source of the tobermorite is from the parent material (Harvey and Beck, 1960), or formed in place. In the soils studied, tobermorite tends to be most abundant in two places: (1) at the surface where eolian materials are abundant, and (2) at depth in horizons with the greatest amount of secondary opaline SiO_2 and $CaCO_3$ in older soils developed on deposits Q2c and QTa. The origin of tobermorite at the surface seems to be from the eolian materials, but that at depth could be pedogenic and formed in place or translocated eolian material.

Weathered mica has a poorly defined broad peak (10.0 Å) and is not effected by glycolation. (Appendix D). Upon heat treatment the peak intensifies.

Mixed-layer illite-montmorillonite clays are recognized by distinct shoulders on diffraction peaks at about 10.5 or 12 Å, suggesting incipient, poorly developed intergrades of layer-lattice clays (Vanden Heuvel, 1966). The intensity and consistency of the

high order (004) 4.5Å peak, and low-2θ angle background levels, reflects random interstratification common in a weathering environment (Jones, 1983). Because of the complete collapse of smectitic layers at 500°C, this treatment produces a sharp, well-defined peak at 10.2Å (Figs. 14). These mixed-layer clay minerals are common in volcanic parent materials in southwestern Nevada (Jones, 1983).

Kaolinite (7.2 Å) in the study area is poorly crystalline, with a low height to width ratio (Appendix D). Because the same peak appears in most samples including unweathered alluvium, it is likely that it is derived from the parent material.

Palygorskite (10.7Å and 5.4Å) and sepiolite (12.3Å and 2.68Å) were never identified even though they are abundant in calcic soils in the southwestern U.S. (Vanden Heuvel, 1966; Gardner, 1972; Bachman and Machette, 1977; Hay and Higgins, 1980; Jones, 1983). Most of the above workers attribute the formation of palygorskite and sepiolite to the alteration of detrital mixed-layer illite-montmorillonite. The one speculation that can be made for the absence of these Mg-rich silicate clay minerals is that Ca-rich silicates (tobermorite) may form preferentially in this environment.

Amorphous silica can be identified on the XRD traces (Table 8, Figure 15). Jones and Segnit (1971, 1972) have subdivided opaline SiO_2 (poorly crystalline naturally occurring hydrous silica with >1% water) into three classes based on XRD and the amount of disorder of crystal stacking. In order of increasing amorphous state they are Opal-C, Opal-CT, and Opal-A. Each is associated with a unique environment of formation (Jones and Segnit, 1971).

Table 8. X-ray Diffraction Classification of Opaline Silica (Jones and Segnit, 1971).

Classification	Temperature of Formation	Environment of Formation	Source in Soil Environment	XRD Peaks (Å)
Opal-C	high	lava flows.	parent material	4.0, 2.5, and 2.8
Opal-CT (most common)	low	silica associated with secondary clays, biogenic skeletons, volcanic ash, and infrequently gem-quality opal.	primarily pedogenic	4.3, 4.1, 3.9, and 2.5 definition and spacing is variable based on order, water content, and age.
Opal-A	low	gem-quality opal, biogenic skeletons, material and volcanic ash, silica gels, and some silica associated with clays.	parent material ane pedogenic	diffuse peak centered at 4.1

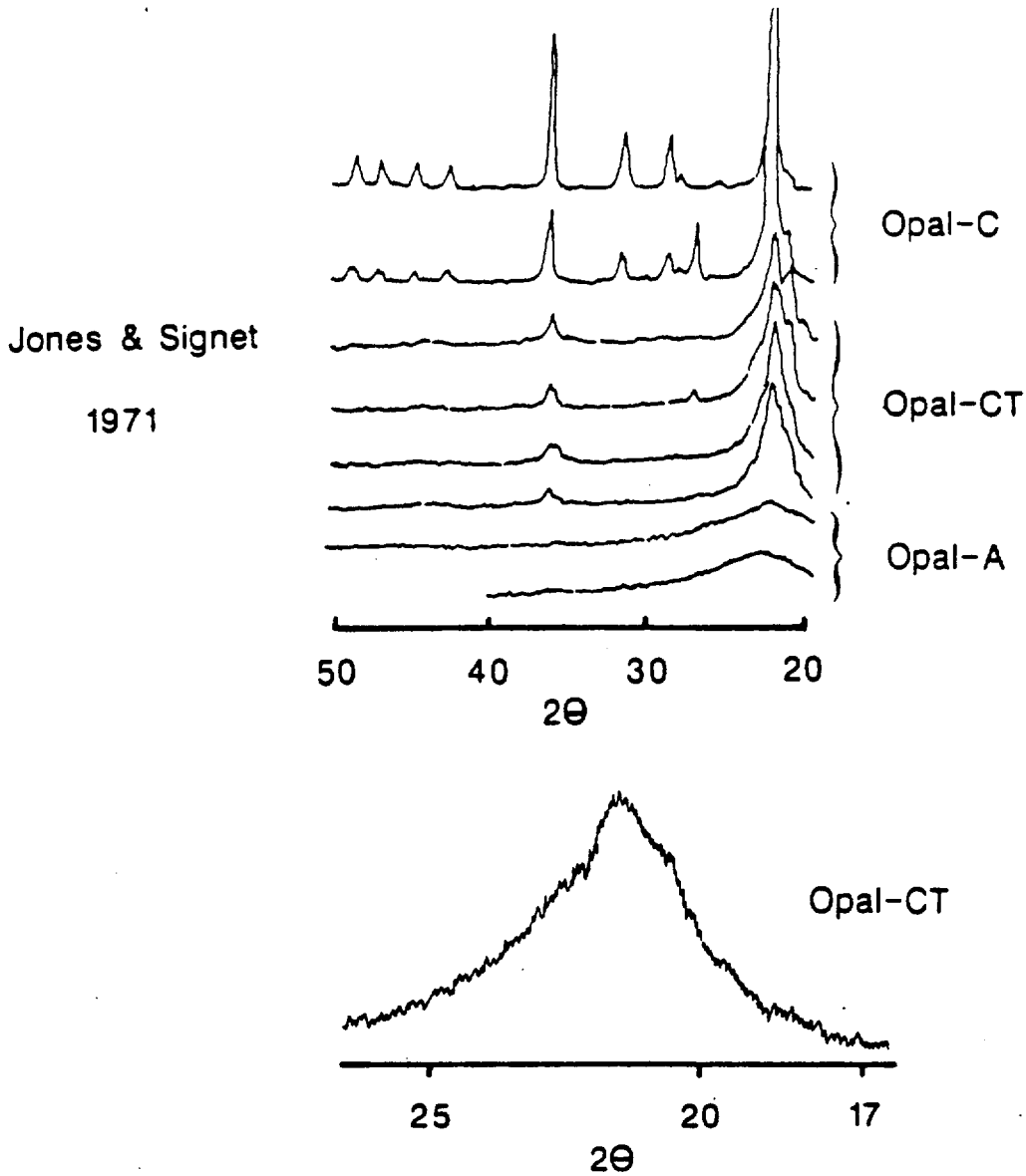
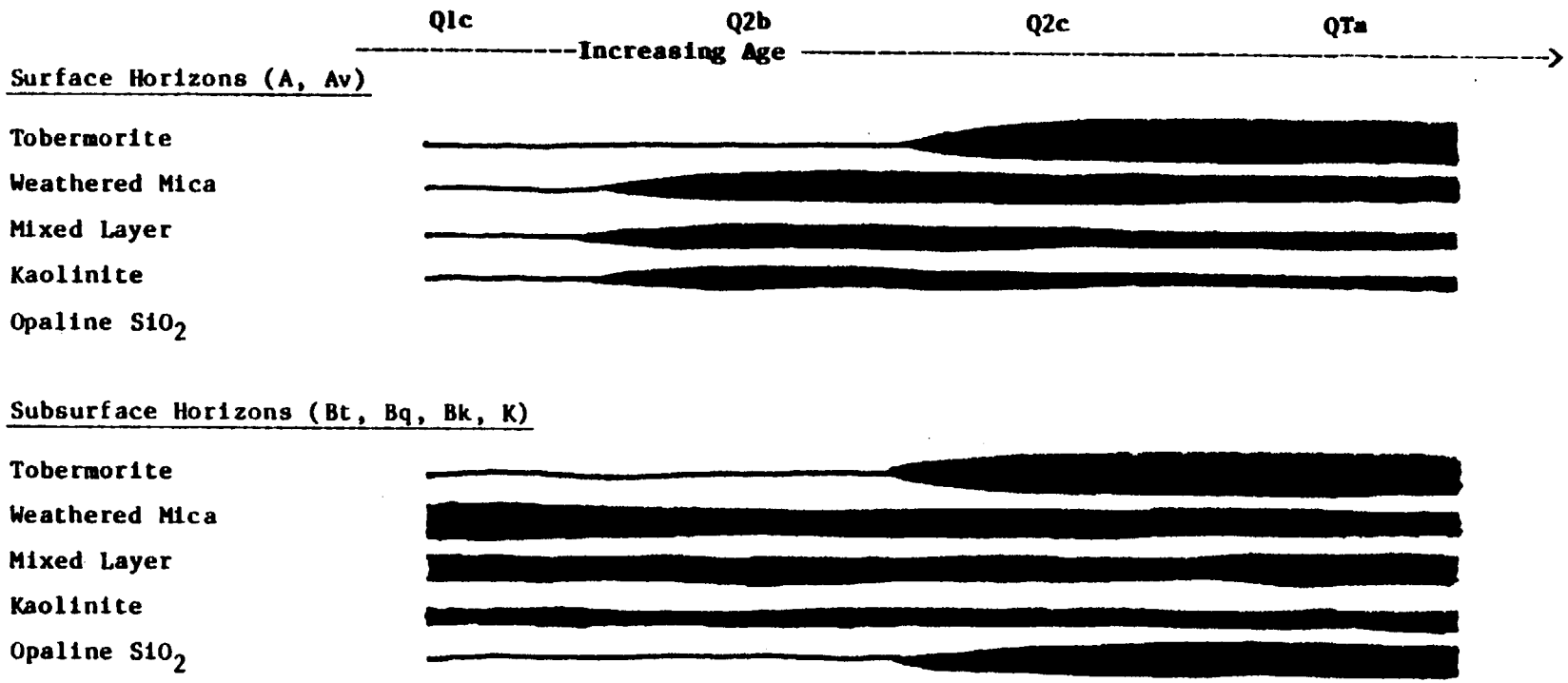


Figure 15. Representative XRD trace of Opal-CT vs the three opal classes of Jones and Signet (1971).

Diffractograms of several of the mixed-layer illite-smectite-dominated soils do have broad, but sharply spiked peaks centered between 4.1-4.3Å, suggesting the presence of Opal-CT (Figure 15). Peaks are not effected by heat treatment, but are absent after pedogenic silica is removed.

The clay mineralogy and relative abundance is strongly related to the climate, but also changes with the time and with depth in the profile (Birkeland, 1974 and 1984). Time-related changes in clay mineralogy are related to the stability of the various clays in the local soil environment, however Birkeland (1974 and 1984) believed that the clay minerals of soils developed in low-clay parent material change little with time. The uniformity of the clay minerals present in the study area suggest the latter, that there has been little change in either environment or in the mineralogy over time. However, the relative abundances increase with time (Fig. 16).

Figure 16. Relative abudance of clay minerals on the soils formed on deposits Q1c, Q2b, Q2c, and QTa. Width of bars equals approximate abundance.



CHAPTER IV

USING SOIL DATA TO ASSESS PALEOCLIMATE

Soil Water Balance and Leaching Index

The relationship between soils and climate can be approximated by evaluating soil water balance and leaching indices (Arkley, 1963, 1967). If the available water-holding capacity (AWC) of a soil is known, the amount of water that will potentially percolate through each soil horizon or depth increment can be calculated. Sometimes the word recharge is used by pedologists instead of percolation, but to clearly distinguish between the hydrologic application of recharge, I use percolation. Knowing the frequency of wettings per year, and assuming (a) that downward movement of water takes place only when field capacity for that part of the soil has been reached, and (b) that moisture is removed from the soil by evapotranspiration until the permanent wilting point is reached, one can construct curves depicting water movement (Arkley, 1963; Birkeland, 1984). In order to forecast soil water movement it is necessary to know the precipitation (P) and approximate potential evapotranspiration (ET_p). ET_p is the amount of water lost by evaporation and vegetative transpiration as long as sufficient soil moisture is available (Thornthwaite, 1948).

Water balance calculations predict the status of soil moisture on a mean annual basis. Critical to this study are those months when water is stored in various depths in the soil at moisture values above permanent wilting point; this happens when P is greater than ET_p. This water is available for plant growth, weathering reactions, and if the water is moving, it can translocate dissolved or solid material within the soil. In contrast, water is lost from the soil system when $P<ET_p$ until the soil reaches water contents approaching permanent wilting point. One of the key elements to this approach is to get an accurate measurement of ET_p

Seven methods of calculating ET_p show a wide range of values (Table 9). All are based on empirical formulas. Of the Penman (1956) and Ritchie (1982, Williams, 1984) methods to calculate ET_p, the latter is recommended by the Soil Conservation Service; these were estimated from data in similar climatic regions, because of the lack of necessary data. The methods were selected because they compare favorably with lysimeter measurements in arid regions (Stanhill, 1961; Omar, 1968; McGuinness and Bordne, 1972; Farnsworth and others, 1982).

Pan evaporation data for the growing season only (Apr-Oct) from Pahrump, Nevada, about 30 km south of Yucca Mountain, are used here as a reasonable approximation of ET_p. Pan evaporation data come closest to the lysimeter-derived measurements of 150-200 cm from similar arid regions. Nevada currently has only four stations that measure pan evaporation, and Pahrump (203 cm/yr) is the nearest such station to NTS. Longer term pan evaporation records exist for Boulder City, adjacent to Lake Mead, but because of its proximity to

Table 9. Comparison of methods to calculate potential evapotranspiration using Beatty, Nevada weather information (Table 2)

Method and Calculated Annual ET_p Variables	Limitations
1) Thornthwaite (1948) - 84 cm latitude mean monthly temperature (T) day length factor	Underestimates in an arid environment by as much as 150%.
2) Blaney & Criddle (1962) - 94 cm latitude mean monthly T % daytime hours vegetation consumptive use coefficient	Underestimates in an arid environment, and vegetation factor must estimated for nonirrigated soil.
3) Penman (1956) - ~100 cm mean monthly T mean monthly min T daily solar radiation wind movement (mi/day)	Limited number of solar radiation stations, and a large amount of error in wind movement data due to variability in height of monitoring stations.
4) Ritchie (1972), Williams (1984) - ~100 cm mean monthly maximum and and minimum T daily solar radiation and albedo soil cover and biomass indices	Same as Penman, and data are not available for most areas
5) Kohler and others (1955) - 127 cm mean monthly T mean water surface T wind movement (mi/day) pan evaporation	Data are not always available.
6) Pan Evaporation for the growing season only (Apr-Oct) - 164 cm cm of water loss	Data are sparse, may overestimate amount due to the influence of wind, and assumes no ET during cold months.
7) Papadakis (1965) - 163 cm saturation vapor pressure and dew point that can be derived respectively from the mean monthly maximum and minimum T	May overestimate amount

the lake, the pan evaporation values are extremely high compared to lysimeter-derived measurements from areas similar to NTS. The average monthly long term values for pan evaporation from Pahrump was summed for the growing season only, April to October (164 cm), because it is assumed that little or no evapotranspiration occurs during the winter months. The Papadakis method for estimating ET_p is used in this study because it best approximated the pan evaporation data summed for the growing season only from Pahrump.

Water budget plots for several different climatic models for the study area indicate significant soil-moisture differences between glacial and interglacial climates. The data for Beatty (Table 2) is used to approximate the Holocene climate (Fig. 17) and two different models for climates during the last glacial maximum are presented (Figs. 18 and 19). The climatic models for the glacial maximum are (1) Spaulding's (1983 and 1985) with a decrease in MAT of 7°C, an increase MAP of 35%, and a decrease in summer precipitation of 50% and (2), Mifflin and Wheats' (1976) with a decrease in MAT of 5°C, an increase of MAP of 68% and, a decrease in evaporation of 10% (Table 2). These three climatic conditions were evaluated at the low end of the elevation transect, and again at the high end where the modern climate has 70% greater MAP than at the low end of the elevation transect (Quiring, 1983).

When the Papadakis method is used to estimate ET_p, the Holocene climate (Beatty) shows that $ET_p > P$ and no soil water percolation occurs in the soil when monthly climate data are used (Fig. 17). Translocation of dissolved and solid material within the soil can be attributed to periodic high-precipitation storm

Figure 17. Soil water budget for Beatty, Nevada, which is assumed to approximate the Holocene climate. A and B are comparisons of four methods to calculate ET_p including pan evaporation (+), Thornthwaite (△), Blaney and Criddle (◇), and Papadakis (x) at the lower end (A) and higher end (B) of the elevation transect. C and D are the Papadakis method only at the lower (C) and upper (D) ends of the transect. Temperature is plotted as (●) and precipitation as (□).

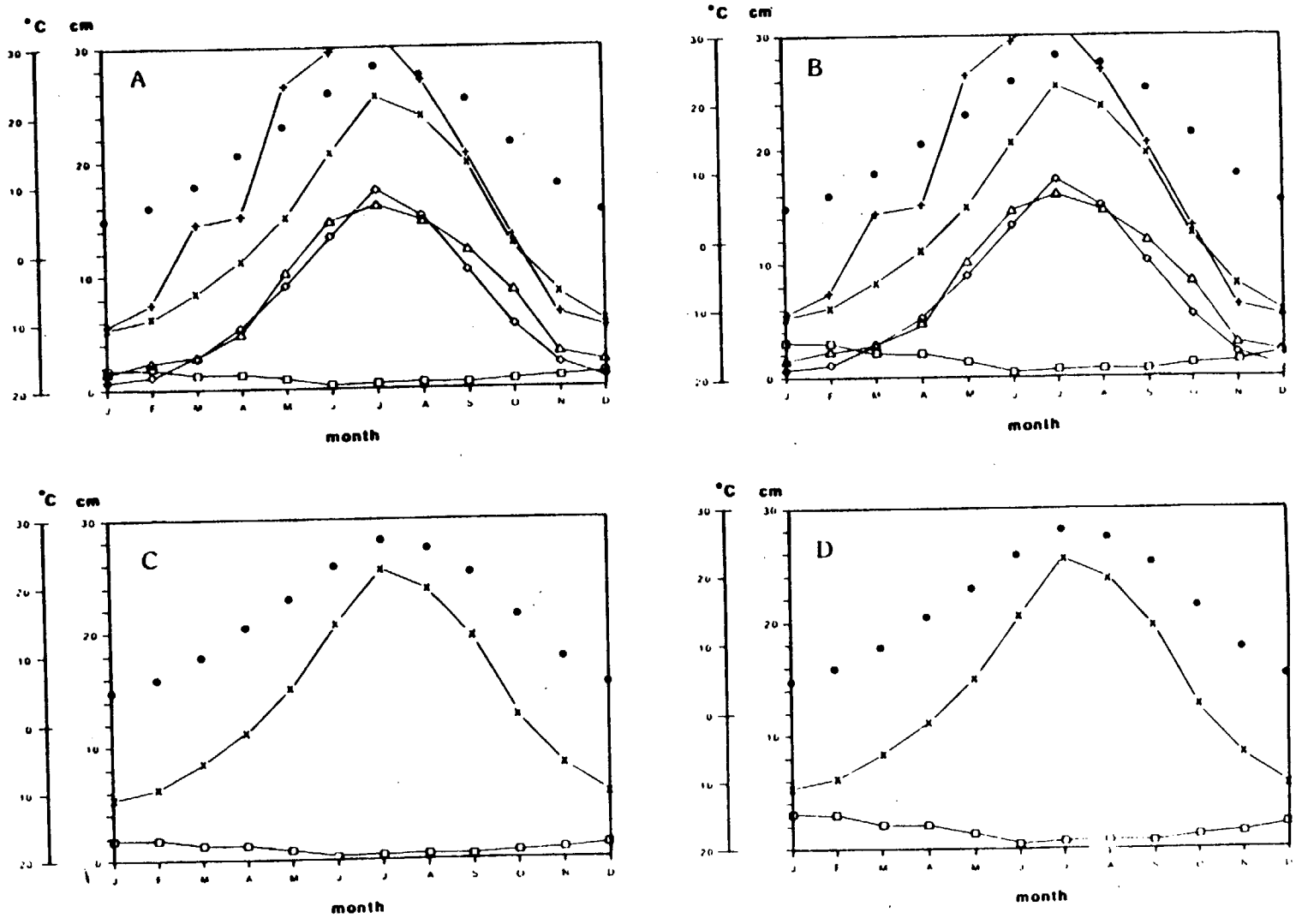

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Figure 18. Soil water budget for the glacial maximum climate--Spaulding model. A and B are comparisons of four methods to calculate ET_p including pan evaporation (+), Thornthwaite (△), Blaney and Criddle (◇), and Papadakis (x) at the lower end (A) and higher end (B) of the elevation transect. C and D are the Papadakis method only at the lower (C) and upper (D) ends of the transect. Temperature is plotted as (●) and precipitation as (□).

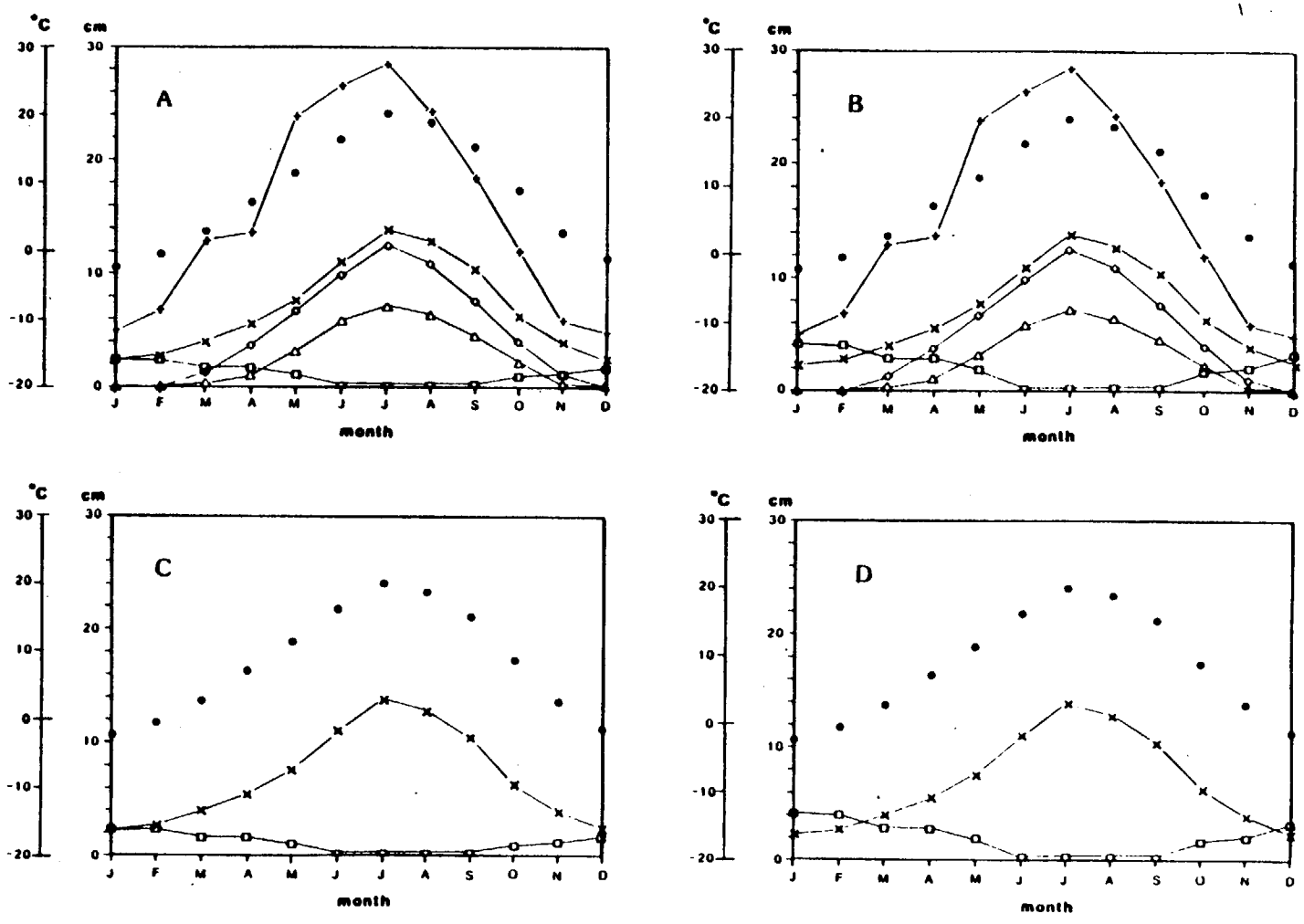
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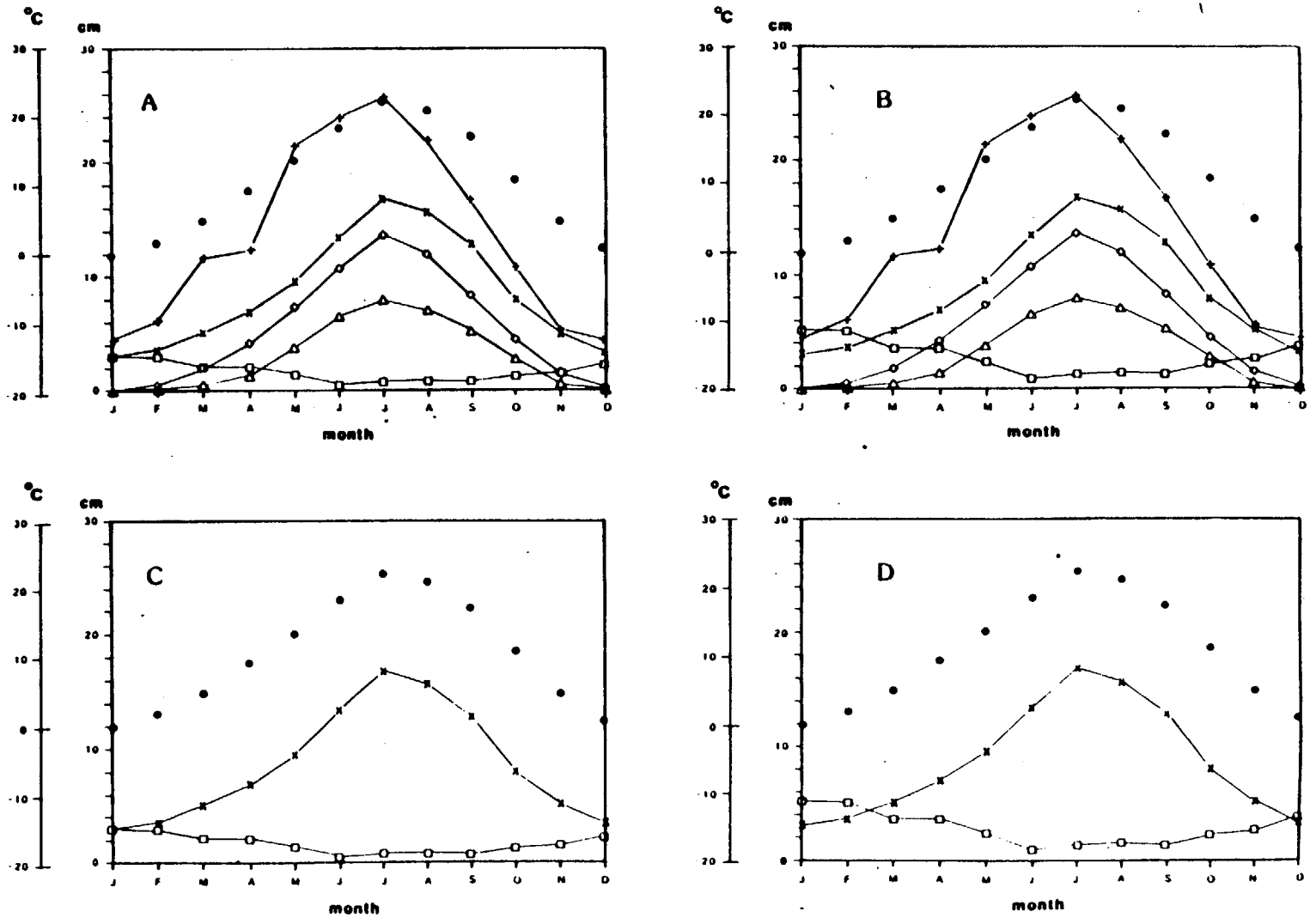
Figure 19. Soil water budget for the glacial maximum climate--Mifflin and Wheat model. A and B are comparisons of four methods to calculate ET_p including pan evaporation (+), Thornthwaite (△), Blaney and Criddle (◇), and Papadakis (x) at the lower end (A) and higher end (B) of the elevation transect. C and D are the Papadakis method only at the lower (C) and upper (D) ends of the transect. Temperature is plotted as (●) and precipitation as (□).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events. This is true for both ends of the elevation transect. In contrast, if the Thornthwaite or Blaney-Criddle methods of calculating ET_p had been used, soil water percolation would have been predicted during one or more winter months (Fig. 17).

The two glacial climatic models give very similar water balance plots (Figs. 18 and 19). Soil water balance calculations of the glacial maximum climate using the Papadakis method of calculating ET_p predict that soil water percolation can occur only at the upper end of the elevation transect during January and February (Figs. 18 and 19). It is concluded that translocation could occur during these months in addition to both winter and summer high precipitation storm events. The other models for calculating ET_p predict even longer periods of soil water percolation as well as greater amounts.

Both soil water balance calculations of the glacial maximum predict soil water percolation during the cooler winter months at the upper end of the elevation transect, and not at the lower end. On similar aged deposits there should be a response to the increased available moisture on the dissolved and solid material that is translocated in the soils.

Carbonate Translocation

When moisture is available for translocation, soluble salts and $CaCO_3$ move downward and precipitate at a depth approximated by the wetting front (Arkley, 1963; McFadden and Tinsley, 1985). The percentage of $CaCO_3$ decreases with elevation in the Holocene soils (Qlc, Fig. 20), thus following the suggested difference in leaching

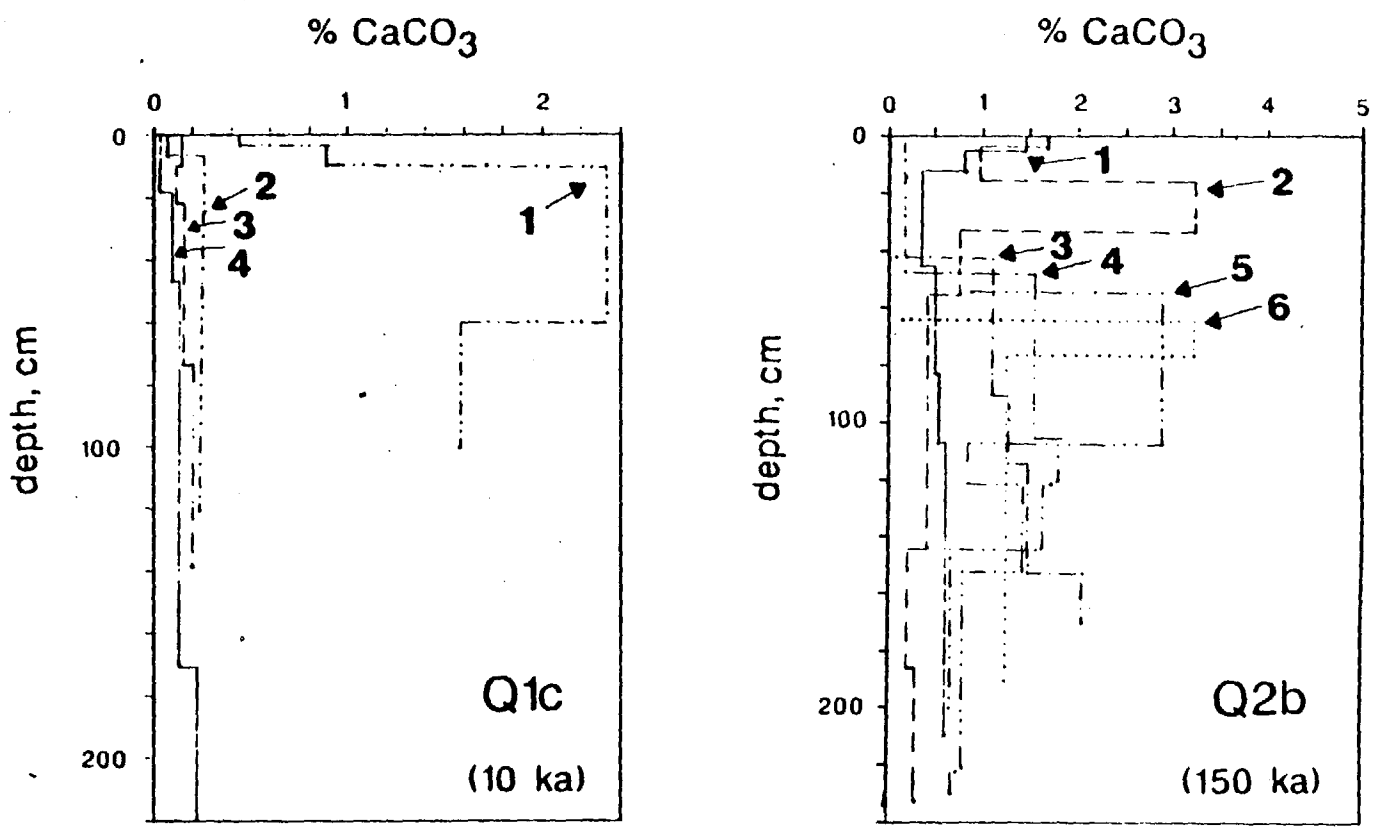

Figure 20. Percent $CaCO_3$ vs depth for soils formed on deposits Q1c (A) and Q2b (B). Numbers 1 to 6 are in order of lowest to highest soil profile elevation up the transect.

with elevation. The Q1c soil at the lowest elevation in the transect has over 2% $CaCO_3$ accumulation at 9-60 cm, whereas at greater elevations on the transect, the $CaCO_3$ accumulation is much less (<0.3%). In addition the depth at which the maximum $CaCO_3$ occurs in each profile, is deeper with higher elevation. Therefore, with increasing precipitation the $CaCO_3$ decreases in amount and the depth of maximum accumulation increases. The increase in frequency and amount of precipitation in the modern climate at the upper end of the transect is sufficient to translocate the $CaCO_3$, but insufficient at the lower end.

If the climate in the past has been similar to the Holocene, $CaCO_3$ accumulation should occur at similar depths along the transect in the older soils. Significant variations in the $CaCO_3$ depths observed in older soils should reflect differences in amounts of effective moisture.

The $CaCO_3$ in the soils formed on Q2b deposits does not have the predicted response. Generally $CaCO_3$ increases rather than decreases in amount, and increases to depth of maximum accumulation with increasing elevation (Fig. 20). The $CaCO_3$ in soils formed on Q2c deposits has a similar response with some reversals, however the two highest soils are nearly at the same elevation (Fig. 21). Although, generally the soils at lower elevations have far less $CaCO_3$ (1-2%) than the soils at higher elevations (18-23%), and the depth to maximum accumulation increases with elevation. The soils formed on QTa deposits do not show an obvious trends with increasing elevation (precipitation) (Fig. 21). Irrespective of elevation, detectable $CaCO_3$ first occurs at a depth of 10 to 30 cm. This could

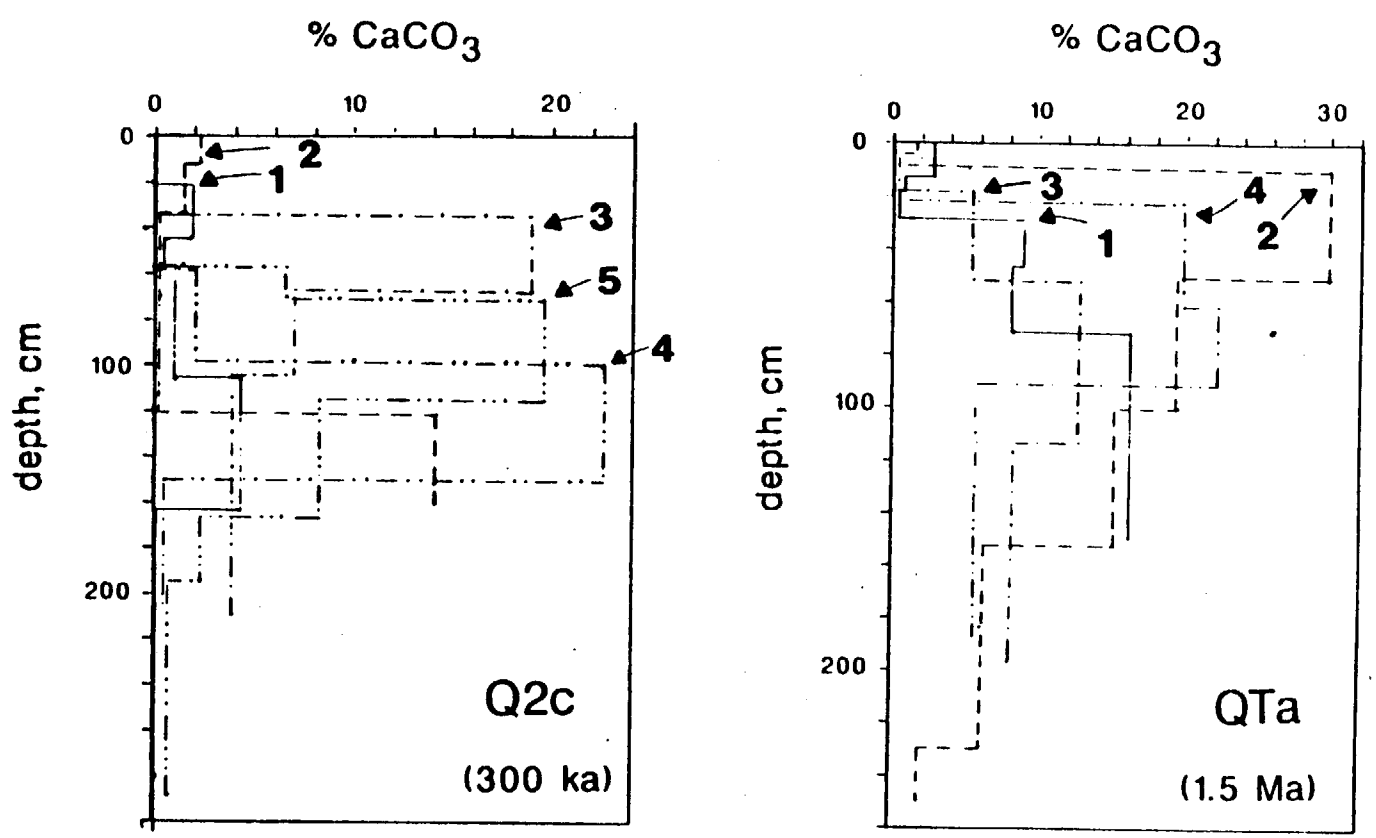

Figure 21. Percent $CaCO_3$ vs depth for soils formed on deposits Q2c (A) and QTa (B). Numbers 1 to 5 are in order of lowest to highest soil profile elevation up the transect.

be due to the influence of a greater number of climatic changes, and the erosion on the QTa deposits. Soils of extreme age tend to reflect the leaching of occasional wet years.

During the modern climate storm events tend to flush the soil system and translocate any available $CaCO_3$ (Fig. 20). In comparison, soils that have been exposed to one or more glacial events are "more efficient at accumulating $CaCO_3$". This accumulation effect could be due to two climatic influences. First, based on the soil water budgets during the glacial maximum (Figs. 18 and 19) predictable soil water percolation occurs using monthly climate data at the upper end of the transect. The constant wetting and drying may be more efficient at precipitating $CaCO_3$. Secondly, effective precipitation could have actually been less during glacial climatic conditions than during the Holocene, and as a result moisture was not available to translocate soluble $CaCO_3$ deeper. In the both cases the regional climatic change associated with the Holocene-Pleistocene boundary would not be associated with changes in precipitation, but primarily changes in temperature. Without changing the amount of precipitation during the glacial maximum, $CaCO_3$ can be translocated deeper by simply increasing the temperature of available moisture and thus the solubility of $CaCO_3$. This temperature increase of the available moisture may represent increased precipitation during the warmer summer months.

Some pre-Holocene soil profiles have a bimodal distribution of $CaCO_3$ (Figs. 20 and 21). The bimodal nature of soil can be explained by climatic change, much the same way McFadden (1982) did. The deeper accumulation represent periods of greater

leaching. In contrast, the shallower accumulation is similar enough to that of the Qlc soils to suggest an origin during the Holocene.

Computer Generated Model for Carbonate Translocation

Computer models can be generated to approximate $CaCO_3$ distribution in the soils of NTS. Basically they follow those of McFadden and Tinsley (1985). Climate can be related directly to the change in soil moisture throughout the year. The calculation of soil water movement (Arkley 1963, 1967) is based on the concept that the net excess of P over ET_p for those months in which $P>ET_p$ represents the total moisture available to wet the soil, but this is surely a simplification of natural conditions. This value, defined as the leaching index, may be calculated two different ways. In one method the excess of P over ET_p during the months in which $P>ET_p$ is summed. In the other method the average P for the wettest month is used if the maximum P for a given month is greater than the summed difference of $P>ET_p$. For arid and semiarid regions the second method gives a higher leaching index than does the first method. Both the Spaulding and Mifflin and Wheat climatic models along the Fortymile Wash and Yucca Wash transect have a leaching index less than the average January precipitation, and thus the second method is appropriate. The latter value is used in the computer model.

The computer-generated compartment model for $CaCO_3$ translocation generates "synthetic" distributions showing the translocation of $CaCO_3$ as a function of soil depth, time, and climate (Mayer and others, 1985). Different scenarios can be simulated, including abrupt or gradual changes in climate. The

variables utilized in the model are the leaching index value, calcic-dust influx, parent material $CaCO_3$ content, and partial pressure of soil (PCO_2), texture, initial water content, and soil temperature (Appendix I).

Various parameters were used in the model. Fresh alluvium is the parent material. The following parameters were used: a $CaCO_3$ dust flux of $0.1 gm/cm^2/10^3 yrs$, no parent material carbonate, the PCO_2 at the surface of $10^{-3.5}$, increasing to $10^{-2.5}$ at the maximum rooting depth, and decreasing with depth to $10^{-3.4}$, a sand texture, an initial moisture content of 0.02% with a permanent wilting point of 0.018%, and a soil temperature at the surface of 16.5 ^{o}C which levels off to 19.3 ^{o}C at 50 cm. (Appendix I). The calculated precipitation for the two extremes along the transect were used for the Holocene climate, and the glacial maximum climate used is the model proposed by Spaulding (Table 2). The program was run for 30,000 yrs of glacial climate, followed by 10,000 yrs of Holocene climate. Two climatic scenarios were considered for the Pleistocene-Holocene climatic change, abrupt and gradual (Fig. 10).

The abrupt climatic change model predicts a bimodal $CaCO_3$ distribution, whereas the gradual climatic change model does not (Fig. 22). The $CaCO_3$ translocation modeled is compared to data from soils on Q2b deposits because they have experienced at least one glacial climate. At the low end of the transect there is a bimodal distribution of $CaCO_3$, in contrast at higher elevations the distribution is gradual (Fig. 20). So which climatic model is most closely predicting the expected distribution: the abrupt model for the lower elevations and the trend climatic model for the higher

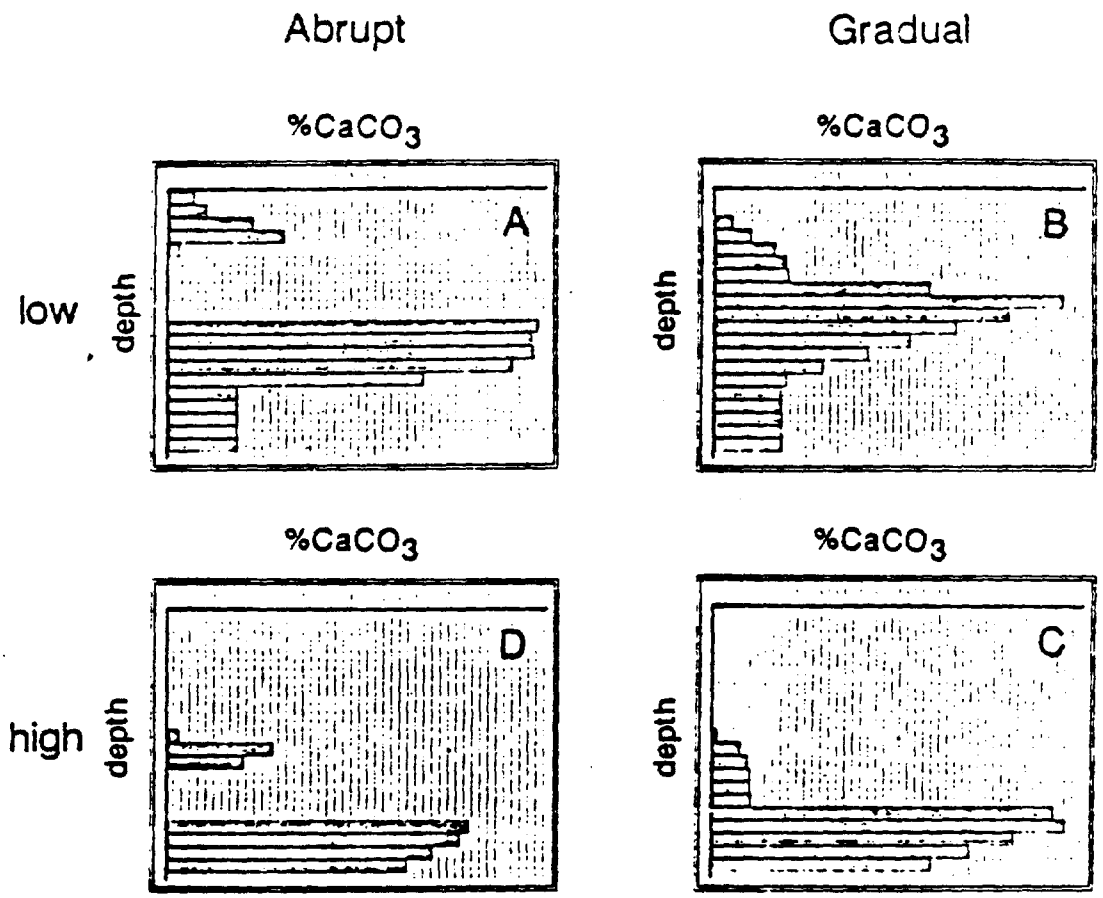

Figure 22. Modeled $CaCO_3$ accumulation for 30,000 yrs of glacial climate with either an abrupt (A and C) or gradual (B and D) change to the Holocene for 10,000 yrs for the low (A and B) and high (C and D) ends of the elevation transect.

elevations? Based on the $CaCO_3$ translocation on Qlc (Fig. 8A), $CaCO_3$ is not being moved out of the soil at lower elevations. The bimodal distribution in the lower soils is considered to be a function of the Holocene climate, and the best long term prediction is that climatic change is gradual, not abrupt.

Pedogenic Silica Morphology as a Climatic Indicator

Duripans are silica-cemented pedogenic horizons which form whenever silica is released by mineral weathering and not subsequently combined with secondary clay minerals or leached from the soil profile.

The chemistry and morphology of duripans are different in areas of arid and subhumid climates (Summerfield, 1983; Chadwick, 1985). In subhumid climates duripans contain Fe and Al as accessory cements along with oriented clays and high concentrations of resistant TiO_2 compared to more soluble cations. They also have prismatic structure. Colloform features and glaebules dominate the micromorphology of subhumid duripans (Brewer, 1964). The matrix silica is well crystallized quartz rather than opaline silica.

The micromorphology of arid-soil silica concentrations are characterized by length-slow chalcedony in vughs or voids. The secondary fill is microquartz and megaquartz. These void fills are diagnostic of silicification at a high a pH (Folk and Pittman, 1971). Some argue the formation of silica in arid climates is related to the replacement of carbonates (West, 1973; Jacka, 1974; Milner, 1976). Glaebules of clay are absent or inherited. The primary fabric is floating, and the secondary fabric is grain and

(or) matrix supported (Brewer, 1964). Opaline silica is the primary matrix component. The structure associated with the maximum duripan development is massive to platy.

Silica cemented horizons in the study area have no characteristics associated with duripans formed in subhumid climates. There is a lack of evidence for deep weathering in the profile. $CaCO_3$ is the accessory cement with little or no secondary clay accumulation. In the absence of effective precipitation or drainage to remove newly dissolved silica, it is precipitated elsewhere within the calcrete horizon, or $CaCO_3$ preferentially precipitates after opaline silica bonds adjacent soil grains without necessarily plugging intervening pore spaces (Chadwick, 1985). The complimentary solubility relationship with respect to pH between calcite and quartz is a highly alkaline environment (>pH 9). This suggests that localized zones could develop across a pH gradient in which calcite and silica were simultaneously precipitating. This kind of model implies contemporaneous calcrete and duripan development as a function of local variations in pH related to topography and soil-moisture conditions.

CHAPTER V

SUMMARY, CONCLUSIONS, AND FUTURE STUDIES

A high level nuclear waste site has been proposed in the Yucca Mountain area of the Nevada Test Site. A permanent repository for nuclear waste must be able to withstand the effects of a major climatic change. A climatic change that results in greater effective moisture may cause percolating water to move within the zone of waste material during the time that the material is still hazardous. The objectives of this study are to document the effects of time and climate on the soil development and to use soil data to characterize long-term past climatic variability.

Five groups of different-aged deposits were studied along an elevation transect of 400 m, from 1082 to 1483 m (Fig. 2). Present day annual precipitation nearly doubles along the transect from 120 to 200 mm (Table 2).

No definitive evidence exists regarding any climatic or tectonic influences on the formation of the terraces in the study area. The terraces studied are fill terraces (Fig. 3), and are not likely to be of tectonic origin. Although longitudinal profiles of the terraces diverge downstream (Fig. 4), tectonics are not required to explain this relationship. Climatic change may account for the formation of the terraces.

Soils that formed in alluvium and eolian fines of Holocene to early Pleistocene or latest Pliocene (?) age near Yucca Mountain are characterized by distinctive trends in the accumulation of secondary clay, $CaCO_3$, and opaline SiO_2 that correspond with the ages of the surficial deposits. Both $CaCO_3$ and opaline SiO_2 appear initially as coatings on the underside of clasts and over time form cemented and indurated horizons (Table 3). There is no macro- or micromorphological evidence that suggests that the silica cementation occurred under climatic conditions cooler and (or) wetter than those of the present climate. Vesicular A (Av) horizons have not formed on the coarse, gravelly Holocene deposits in the Yucca Mountain area. On the older deposits where Av horizons have formed, there is no relationship between the thickness of the Av horizon and age of the underlying deposit. The Av horizons are consistently between 5 and 10 cm thick.

Quantified field properties, by the Harden method, vs log age of the deposit are are all significant at the 5% level except melanization and color paling (Fig. 5). The profile indices also clearly slow a relationship with log age of the deposit (Fig. 6). When the four properties with the highest r^2 values vs log age are combined and compared to the same field properties on similar-aged deposits from the Las Cruces, New Mexico area, the index values are very similar in the two areas on similar aged deposits. This suggests that compared to an area with independently-dated deposits the age estimates for the deposits in the Yucca Mountain area, based on field properties, are not unreasonable (Table 4).

The accumulation of secondary $CaCO_3$, clay, silt, and opaline SiO_2 is determined on a horizon basis by deducing the initial amount assumed to have been in the soil parent material from that in the present soil horizon. Profile sums of horizon weights of these components suggest that $CaCO_3$, clay, silt, and opaline SiO_2 accumulate at a logarithmic rate (Table 5). However, these rates may be primarily a function of the erosion and of secondary material loss from the older soils, and the volumes determined for these constituents may only be minimum values. The long term rates for properties dependent primarily on eolian additions is probably better expressed by linear rate.

Holocene aged soils (Qlc) have accumulated $CaCO_3$, clay, silt, and opaline SiO_2 at a higher average rate than the older soils (Fig. 9). Accumulation rates are dependent upon the availability of eolian material on the soil surface and sufficient precipitation to move the material into the soil. Increased rates of accumulation of $CaCO_3$, clay, silt, and opaline SiO_2 during the Holocene can be attributed to several possible climatic scenarios associated with the Holocene-Pleistocene climate change. The accumulation rates suggest that precipitation since the stabilization of Qlc has not been a limiting factor, and that climatic change was not sufficient to significantly decrease rates of accumulation. This suggests that the climatic change was the result of decreases in temperature rather than precipitation.

No one long term rate of accumulation approximates the actual profile sum for $CaCO_3$, clay, silt, or opaline SiO_2 for a given aged deposit. The predicted profile sums using rates from

deposits that are known to have experienced at least one cycle of climatic change tend to underestimate the actual profile sums. These discrepancies in estimating the actual age are either (1) age errors on the deposits, (2) long term accumulation rates are off for that age range, this may be accounted for by erosion on the deposits that the long term rates are calculated from, or (3) represent much greater additions or $CaCO_3$, clay, silt, or opaline SiO_2 than the potential rates of accumulation predicts.

Soil properties that commonly exhibit changes with time and (or) climate include clay, $CaCO_3$, and opaline SiO_2. Most of these properties are strongly influenced by vertical position in the soil profile. With the exception of soils formed on deposits of Q2c age, clay, $CaCO_3$, and opaline SiO_2 maximums occur in the same horizon. On Q2c deposits the maximum amount of pedogenic clay is in a zone immediately above the zone with the maximum amount of pedogenic $CaCO_3$ and opaline SiO_2. In nearly all of the soils in this study, the maximum amounts of $CaCO_3$ and opaline SiO_2 occur in the same horizon, and in these horizons opaline SiO_2 is more abundant than $CaCO_3$.

The mineralogy and relative abundance of soil-clay minerals are strongly related to the climate, but they also changes with the time and with depth in the profile. The pedogenic clays in the Yucca Mountain soils have developed in very low-clay parent materials. There has been little change in the soil-clay mineralogy over time, in spite of climatic changes that have occurred since the stabilization of these deposits and initiation of soil development (Fig. 16).

The relationship between soils and climate can be approximated by evaluating soil water balance and leaching indices. Two climatic models of the glacial climate, one based on packrat midden evidence and a second on pluvial lake chronologies, were used along with modern climate data from Beatty, Nevada to calculate the soil water balance (Figs. 17-19). The Papadakis method of calculating potential evapotranspiration was used in this study (Table 9). The Holocene soil water balance calculations suggest that no soil water will percolate to depths using climatic data on a mean monthly basis. Translocation of dissolved and solid material within the soil can be attributed to periodic high-precipitation storm events. Both models of the glacial-maximum climate predict that at the high end of the elevation transect soil water percolation will occur during the cooler winter months, as well as during high-precipitation storm events.

When moisture is available for translocation, soluble salts and $CaCO_3$ move downward in solution and precipitate at depths approximated by the estimated depth of the wetting front. Depth plots of percent $CaCO_3$ for soils formed in Q1c-aged deposits suggest that near the upper end of the transect the modern-climatic soil moisture conditions are sufficient to translocate the available $CaCO_3$ (Fig. 20). Carbonate accumulates near the surface on the Q1c-aged deposits at the low end of the elevation transect, but appears to be translocated to greater depths, below the base of the soil, at higher elevations where precipitation is greater.

With increasing elevation, soils on the Q2b deposits that have experienced at least one climatic change have different $CaCO_3$

depth plots than the Q1c deposits (Fig. 20). Generally with increasing elevation and precipitation in the Q2b soils, $CaCO_3$ increases rather than decreases in amount, and increases in amount to the depth of maximum $CaCO_3$ accumulation with increasing elevation and precipitation (Fig. 20). The older soils tend to reflect the effects of leaching during occasional wetter years much more than do the younger soils. As a result, the older soils do not show trends in the accumulation of $CaCO_3$ with elevation (Fig. 21).

The different trends in accumulation in $CaCO_3$ on the Q1c and Q2b soils could be due primarily to two climatic influences: (1) additional moisture during a glacial maximum as determined from the water balance calculations, and (2) the likely changes in the effective precipitation during a glacial maximum. With only modest increases in the precipitation, the depth to which $CaCO_3$ would be translocated and deposited in a soil would be greatly increased. Without change in precipitation, $CaCO_3$ can be translocated deeper by merely decreasing the temperature of the soil water and thus increasing the solubility of $CaCO_3$. This temperature increase of available moisture may represent increased precipitation during the warmer summer months during a glacial maximum.

A computer model was used to generate an approximate vertical $CaCO_3$ distribution in the soils in the Yucca Mountain area. Parameters used to generate the model describe the physical characteristics of the deposit, $CaCO_3$ influx rates, and climate. The model was run using the Spaulding (1985) glacial-maximum climate model for 30,000 yrs followed by 10,000 yrs of the modern climate (Fig. 22). This climatic change was generated both abruptly and

gradually. By comparing the computer-generated model to field data for the depths and distributions of $CaCO_3$, the model-generated data suggest that the climatic change at the Holocene-Pleistocene boundary was gradual.

Several future studies of the soils in the Yucca Mountain area have been planned in order to expand and clarify the findings of this study. They include the following: (1) soil thin-section analyses and total chemistry in order to help determine the genesis of the silica-cemented horizons; (2) a relative dating study of the degree of preservation of bar-and-swale topography, degree of rounding and size of surface boulders, and degree or sorting and packing of desert pavements; (3) evapotranspiration measurements with weighing lysimeters and evaporative pans with the Water Resources Division of the U.S. Geological Survey; (4) stable oxygen and carbon isotopes in the pedogenic silica and opal phytoliths for paleoclimatic indicators; (5) the relative abundance and distribution of tobermorite (?) and its relationship to mixed layer clays, palygorskite and sepiolite; (6) a more refined and complete stratigraphy for the surficial deposits in the NTS area.

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APPENDICES

Appendix A. Soil field descriptions for the Yucca Wash and Fortymile Wash area, Nevada Test Site.

Map Unit, elev (m) (m >stream)	Sample number	Horizon	Basal depth cm	Lower boundary	Color dry	Color moist	Texture 1/	% gravel	Structure	pH	Consistence Dry	Consistence Moist	Consistence Wet	$CaCO_3$	Clay Films	SiO_2	Parent Material
Qlb	FW-7	Ak	1.5	--	10YR7/2	10YR4/2	S	18	1 vf pl	7.75	so	so,po		0	0	0	eolian & overbank
		Cox	18	--	10YR6.5/2	10YR3/3	S	12	m	7.80	lo	so,po		0	0	0	eolian & overbank
1030		2Ckox	100+	--			S	63	eg	8.15	lo	so,po		weak I dlss	0	0	fluvial gravel
(0.6)																	
Qlc	FW-4	Ak	3	as	10YR6/3	10YR4/3	LS	5	1 f pl 2° 2 f abk	7.30	so	so,vps		0, e in places		0	overbank fines mixed w/ gravel component
1006		Btj	9	aw	10YR7/2.5	10YR5/4	LS	7	1 m pl 2° 2 f-m abk-sbk	7.35	sh	so,ps		I, cw	3 m br	0	"
(1.2)	2/	2Btk	60	gl	10YR7/3	10YR5/4	SL	28	3 co-vco abk	7.60	sh	so,ps		ev II-	0	0	fluvial gravel
		2Cuk	100+	--	10YR6.5/3	10YR5/4	LS	67	eg	7.80	lo	so,po		I+	0	0	fluvial gravel
Qlc	FW-17	A	6	cl	10YR6/3	10YR4/3	LS	40	1 f pl 2° 1 m-c abk	7.50	so	so,po		0	0	0	pebbly overbank sand
1079		Buk	24	cw	10YR7/3	10YR4.5/3	LS	40	m in places 2° 1 m-c abk	8.00	so	so,po		0	0	0	pebbly overbank sand
(1.8)		2Cuk	120+	--	10YR7/3	10YR5/3	S	75	eg	8.10	lo	so,po		e	0	0	fluvial gravel
Qlc	YW-13	A	9	cw	10YR5/2	10YR3/2	LS	53	3m gr, 2° eg	6.80	so	so,po		0	0	0	pebbly overbank sand
		Bw	21	cw	10YR6/2	10YR4/2	SL	33	1 f-m abk 2° eg	7.10	so	so,po		0	0	0	pebbly overbank sand
1266		2Bqj	73	aw	10YR6/3	10YR4.5/3	S	48	eg	7.40	so	so,po		0	0	I	fluvial gravel
(0.9)		2Ckqn	138+	--	10YR6/1	10YR5/2	S	67	eg	7.60	lo	so,po		I+, cw	0	I-	fluvial gravel
Qlc	YW-15	A	18		10YR5/2	10YR4/2	LS	55	2 m gr	7.20	so	so,ps		0	0	0	fluvial gravel
		Bw	46		10YR6/3	10YR3.5/3	LS	62	2 m gr	7.30	so-sh	so-sp, ps		0	0	0	fluvial gravel
1378		(46-108 & 108-170)															
(1.2)		2Bqk	170		7.5YR6.5/4	7.5YR4/4	SL	78	eg	7.60	sh	so,po		I+, cw	0	I+	fluvial gravel
		2Cuk	220+	--	7.5YR6.5/4	7.5YR5/4	LS	63	eg	7.95	so	so,po		lenses I	0	0	fluvial gravel
Q2b	FW-3 2/ 3/	Avk	5	as	10YR7/2.5	10YR4/3	L	10	2 c pl 2° 2 co abk	7.75	so-sh	so,ps		e-ee in places	0	0	eolian and sheetwash
1012		Btk	12	aw	10YR7/3	10YR4/3.5	L	33	2 m-co abk	7.65	sh	s,p		e I	I mk pf & po	0	eolian and sheetwash
(4.6)	2/	2Btk	45	cw	7.5YR6/4	7.5YR4/4	SL	82	eg 2° 1 m abk	7.65	sh	s,p		I-	3 m po & br	I	fluvial gravel
		2Bqmk1	83	cw	7.5-10YR7/5 7.5YR5/5	7.5-10YR5/6 7.5YR4/4	LS (grav)	81	m	7.60	h	so,po in veins		e, I+	3m gr	II	fluvial gravel
	3/ 4a/	2Bqmk2	107	gw	10YR7/4	7.5YR5/6	S	83	m	7.60	h	so,po		1,pods of II	1-2 m gr	II ~1mm thick on bottom of clasts	fluvial gravel
	4b/	2Ckqn	210+	--	10YR5/2	10YR3/2	S	80	eg	7.90	lo	so,po		I	0	I	fluvial gravel

Map Unit, elev (m) (m >stream)	Sample number	Horizon	Basal depth cm	Lower boundary	Color dry	Color moist	Texture 1/	% gravel	Structure	pH	Consistence Dry	Consistence Moist	Consistence Wet	Clay Films	$CaCO_3$	SiO_2	Parent Material
Q1c and Q2b over Q2c	YW-21	Avk	4	as	10YR7/3	10YR4/3	SL+	19	3 co abk	8.00	so-sh	so,p	sv	2 n po	0		eolian, sheetwash and gravel
		Btjk	15	aw	10YR6/3	10YR4/3	SL+	17	2 t pl 2° 1 f abk	7.50	sh	so,ps	sv	3 mk br	0		
1173 (12.8)		Bk	33	dl	10YR6.5/3	10YR4/3	SL	47	eg	7.45	so	so,po	II es dins	0	0		channel gravel
		2Btqkb1	55	cl	10YR5.5/3	10YR3.5/3	SL	54	2 m abk	7.50	h	so,ps	I,matrix 0	3 m gr & br	III		channel gravel
		2Btqmkb1	144	as	10YR6/4	10YR4/4	SL	59	m	8.10	sh	so,po-po	leases	1 m gr in places	III		channel gravel
		3Bqmkb2	186	cw	7.5YR-10YR 7/4	7.5YR-10YR 4/4	LS	48	m	7.35	sh	so,po	III, none 0				
	4b/	3Ckqmb2	233+	--			S	79	eg	7.30	sh-so	so,po	I,matrix 0	1 m gr	III		fluvial gravel
Q2b	YW-11	Av	4	as	10YR6/3	10YR4/3	LS	40	3 m pl 2° 2 m abk	7.00	so	so,ps	0	0	0		sheetwash & eolian
1274 (7.3)		Bt1	15	as	10YR6/3	10YR4/3	SL	27	1 m abk	7.20	so	so,ps	0	0	0		sheetwash & eolian
		2Bt2	42	aw	10YR6/4	10YR4/4	SL	39	2 m abk	7.05	h	so,ps	0	1 m gr	0		sheetwash & eolian
		2Btqmk	90	cb	10YR6.5/4	10YR4/4	SL	48	m in place 2° 2 f-m abk	7.90	sh	s,ps	I+,gr pf matrix 0	2 m br & po	II & III		channel gravel
		2Bkq	150	al-b	10YR8/2 10YR7/4	10YR6/4 (pf) 10YR5/4	SL	75	m-eg	7.95	lo	so,po	II	1 m br	I		channel gravel
	4a/	2Kqmk	170+	--	10YR8/2 10YR7/3	10YR6/4 10YR5/6 (SiO_2)	SL	73	m	8.00	sh	so,po	III	0	0		debris flow
Q1c over Q2b	YW-12	Av1	4	as	10YR6/3	10YR3.5/3	SL	35	1-2 vt-t pl	7.20	so	so,ps	0	0	0		sheetwash & eolian
		Av2	14	cw	10YR6/3	10YR4/3	SL	25	1-2 t pl 2° 2 co abk	7.80	so	so,ps	0	0	0		sheetwash & eolian
1283 (6.1)		Bt	47	cl	10YR6.5/3	10YR4/3	SL	26	3 m-co abk	7.50	sh	s,ps	0	0	0		sheetwash & eolian
		2Bk1	105	gw	10YR7/2 10YR6/3	10YR4.5/3 10YR4/3	SL-	56	2 m-co abk 2° 2 f abk	7.80	sh-h	so,ps	II+ pf & grav	2 m po & br	0		channel gravel
		2Bk2	120	aw	10YR6/4	10YR4/4	LS	10	eg	8.00	so	so,po	II, cw	2 m po & br	III		channel gravel
		2Bqmkb	130		10YR6/4	10YR4/6	S	66	3 m abk	7.95	sh	so,po	s-	2 m pf & gr	IV-		channel gravel
			146	cw	10YR8/2	10YR7/3	LS-		3 m abk		sh	so,po	III in places	0	0		cemented gravel
		2Bqkb	200+	--			LS	80	eg	7.85		so,po	s dins,I	0	I		channel gravel
Q1c over Q2b(?)	YW-14	A	8	cs	10YR7/3	10YR4/3	SL	32	2 vf pl	7.15	so	so,ps	0	0			eolian & sheetwash
		Bt	28	gw	10YR6/3	10YR4/3	SL	24	1 co-vco abk	7.15	so	ss-so, ps	0	0			eolian & sheetwash
1369 (12.2)		2Bk	54	gw	10YR6/3	10YR4/3	SL	35	2 m abk	7.80	so	so,ps	sI+ dins	0	0		colluvium
		2Bkq	107	cw	10YR7/3	10YR4.5/3	SL	42	eg	8.05	lo	so,ps	svII dins	0	I		colluvium
		3Bkjb	121	aw	10YR5.5/3	10YR3/3.5	SL-	19	2 m abk	8.05	sh-h	so,po	so pf I 0 in ped	2m gr	0		fluvial gravel
		3Bqmkib	152	gw	10YR6/3	10YR3/3	SL	30	m, 2° 3 f-vf abk	8.00	sh	so,po	I, III in veins	1 m pf	III		fluvial gravel
		4Bqmk2b	221	cw	10YR6/3	10YR4/3	SL-	63	m-eg	8.00	vh	ss,ps	so I	1 m pf & gr	III		fluvial gravel
		4Bkjb	230+	--	7.5YR5/4	7.5YR4/4	SL-LS	80	eg	8.50	lo	so,po	I dins	2 mk pf	I		fluvial gravel

Map Unit, elev (m) (m >stream)	Sample number	Horizon	Basal depth cm	Lower boundary	Color dry	Color moist	Texture 1/	% gravel	Structure	pH	Consistence Dry	Consistence Moist	Consistence Wet	$CaCO_3$	Clay Films	SiO_2	Parent Material
Q2b(?)	YW-20	Av	8	cs	10YR6/3	10YR3/4	SL	38	1 m-co abk	6.90	sh	so,po		0	0	0	sheetwash & eolian
1373		Bt1	19	cs	10YR	10YR4/3.5	SL	24	3 co-vco abk	6.90	sh	so,po		0	3 mk po	0	sheetwash & eolian
(10.7)		Bt2	42	gw	10YR6/4	7.5YR4/4	L	39	2 m-co abk	6.75	sh fr	so,po		0	0	I	sheetwash & eolian
		2Bq	64	gv	7.5YR5/4	7.5YR4/4	SL	84	1-2 m abk	7.30	sh	so,po		0	2 m hr	I	fluvial gravel
		2Bqk1	76	ab	7.5YR5/4	7.5YR4/4	SL	84	1-2 m abk	7.80	sh	so,po		I+ - II	1 m gr	I-III	fluvial gravel
		2Bqk2-1	114		7.5YR5/4	7.5YR4/4	SL	68	m-sg	7.95		so,po		diss	2 m hr	III	bedded fluvial gravel
		2Bqk2-2	152		7.5YR6/4	7.5YR4/4	SCL-	89		8.00				II	0	I-II	
		2Bqk2-3	190+		7.5YR6/4	7.5YR4/4	SL	89		8.00				I, diss	0	II	
Q1c over Q2c	YW-5 3/	A	5	as	7.5YR7/3	7.5YR4/3	S	25	1 vf pl 2° vf-f abk	7.55	so	so,po		0	0	0	sheetwash
1021		AB	20	aw	10YR6/3	10YR3/3	S	9	1 m abk	7.30	so-sh	so,po		0	1 m gr	0	sheetwash
(13.4)		Bck	45	aw-b	10-7.5YR7/2	10YR4/3	SL	14	m, 2° 1co abk	7.45	sh	so,po		II-ev cw	1 m gr	I	sheetwash
		2Bckb	56	as-d	7.5YR5.5/4	7.5YR4/4	SL	18	3 m abk	7.55	h	so,po		0	2 mk-k pf & po	I	fluvial gravel
		2Btqmkb	106	cw	7.5YR6/4	7.5YR5/6	SL	60	m	7.50	vh	so,po		II pf	2 mk br	III	fluvial gravel
		2Kqb	164	aw	7.5YR7/4	7.5YR5/6	S	71	m, 2° 2m abk	7.60	vh (ca)	so,po		lenses	3 m br	I+	fluvial gravel
					7.5YR8/2	7.5YR7/4 ($CaCO_3$)					sh (SiO_2)			of III 5-7 cm thick			
		2Cqm	263+		10YR6/1	10YR4/2	S	72	sg	7.50	lo	so,po		0 & lenses of I	0	II	fluvial gravel
Q2c over QTa	FW-18	Avk	11	as	10YR7/3	10YR4.5/3	L	13	3 co abk 2° 1 co-vc pl	8.10	sh	so,po		e diss		0	sheetwash & eolian
1085		Ak	33	cs	10YR7/3	10YR6.5/3	SL	24	sg	8.00	lo	so,vpo		ev diss	0	0	sheetwash & eolian
(21.3)		Bckj	40	cw	10YR6/4	10YR4/4	SL	30	2 m-co pl 2° 1 f abk			so,po		e diss	2 mk po	0	sheetwash & eolian
		2Btqkj1	66	cw	7.5-10YR6/4	7.5YR4/4	SL-	53	1 co pl 2° 3 vc abk	7.55	h	so,po		I pf	2 k po & br, It pf	I-II	fluvial gravel
		2Btqkj2	120	aw	10YR6/3	10YR4/4	LS	72	m	7.25	h	so,po		II+ lenses	2 k br	II	fluvial gravel
	4a/	3Kb	160+	--	white 6/	10YR8/4	S	76	m	7.20	sh			III	0	0	fluvial gravel
Q2a over Q2c	YW-8	Av	11	cw	10YR6/3	10YR4/3	L	13	3 co abk	7.40	sh fr	so,p		0	3 k po 3 m br	0	eolian & sheetwash
1198		Bt1	21	cw	7.5YR4/4	5YR4/6	C	13	2 f pr 2° 2 f abk	7.30	so	vs,vp		0	4 k pf	0	eolian & reworked gravel
(18.0)		2Bt2b	35	cw	7.5YR7/6	7.5YR5/6	SL	27	3 m-co abk	7.45	vh	so,po		0	pods of 4 k pf	0	fluvial gravel
		2Kqmb	68	as	7.5YR7/6	7.5YR6/6	LS	18	2 co-vco abk 3 vco pl in places	7.90	vh	so,po		II-III	3 mk br & gr	III	fluvial gravel
		2Kb	100	cl	10YR8/2 ($CaCO_3$)	7.5YR7.5/6	S	52	1 f pl 3 f-co abk	8.15	h	so,po		III in lenses	0	0	fluvial gravel
		2Cukb	210+	--	10YR7/3	10YR4/3	S	62	sg	7.75	lo	so,po		II	0	0	fluvial gravel

Map Unit, elev (m) (m >stream)	Sample number	Horizon	Basal depth cm	Lower boundary	Color dry	Color moist	Texture 1/	% gravel	Structure	pH	Consistence Dry	Consistence Moist	Consistence Wet	$CaCO_3$	Clay Films	SiO_2	Parent Material
Q2a over Q2c	YW-16	Av	13	as	10YR5/3	10YR3/3	SL		1 m abk	7.05	lo	s,p	0		1m gr&po	0	eolian
		Bt1	30	aw	10YR5.5/4	10YR4/4	L		1 m abk	7.55	so	s,p	0		1m gr	0	eolian
1311		Bt2	43	aw	7.5-10YR5/4	7.5-10YR4/4	SL		2 vco abk to abk	7.60	so	s,p	0		3m gr	0	eolian
(10.7)		2Btqkb	58	si	7.5YR7/5	7.5YR5/6	SL	44	1 c pl 2° 2 m abk	7.70		s,po	II		3 mk pf	III	fluvial gravel
		2Kqb	100	cw	7.5YR8/2 white 4/	7.5YR7/7 ($CaCO_3$)	LS	57	m	7.90	sh	so,po	III+		0	IV	fluvial gravel
		2Bqmkb	150	cw	7.5-10YR6/4	7.5YR4/4	LS	70	m 2° 2 f abk	7.65	h-vh	so,po	lenses III		0	III	fluvial gravel
		2Ckqmb	207+	--	10YR6/4 white 4/	10YR3.5/4 ($CaCO_3$)	S	71	mg	7.90	lo-sh	so,po	lenses III		0	II	fluvial gravel
Q1c over Q2c	YW-1M	A	10	cs	10YR6/3	10YR4/2	SL	27	1 m-c abk 2° mg	7.25	so	so,po			1 m gr		eolian & sheetwash
1317		Bt	25	c-aw	10YR5.5/3	10YR4/3	SL+	15	1 m abk 2° 2 f-m abk	7.20	so	so,po			0		eolian & sheetwash
(12.5)	2/	2Btqkj1b	42	as	7.5YR5/4	10YR6/3	C-	47	2 co abk	7.30	sh fi	s,p			2m-k pf	II	eolian & fluvial gravel
		2Btqkj2b	56	cw	7.5YR5/4	7.5YR6/4	C-	30	2 co abk	7.40	sh vfi	s,p			2 k pf	II	eolian & fluvial gravel
		3Kb	70+	cw	7.5YR6/4	7.5YR5/4	C-	46	1 c pl	7.70	h vfi	s,po	III-IV-		0		eolian & fluvial gravel
Q1c over Q2c	YW-1E	Spoil	30														
		2Btkjqb	50		7.5YR6/6	7.5YR5/4	C-	32	1-2 m abk	7.60	h vfr	s,p	0		0	II	colluvium
(con't 1M)		2Btqmkb	56	aw	7.5YR7/4-5	7.5YR6/4	C-	38	1-2 m pl 2° 1 m abk	8.10	v-sh fi	so,po	0		0	IV	colluvium
	4a/	3Kqm1b	70	cw	10YR8/2	10YR7/2	SCL+	50	2 vc pl	8.15	sh fr	po,po	IV-		0	IV	debris flow
1317		4Kqm2b	115	cw			SCL	61	m	8.40	vh fr	so,po	III-IV-		0	III	debris flow
(12.5)		5Bkb	167	dw	7.5YR7/6		SL	66	mg	8.10			lenses IV-		0		fluvial gravel
		5Cmkb	195	dw	7.5YR7/4	7.5YR5/4	SL	70	mg	8.40	lo lo	so,po	diss		0		fluvial gravel
		5Cmb	290+	--	7.5YR7/4 7.5YR6/2-3	7.5YR5/4	LS+	67	mg	8.40	lo lo	so,po	diss		0		fluvial gravel
QTa	YW-19	Avk1	4	as	10YR7/2	10YR3.5/3	L		3 m-co abk	8.45	so fr	so,po	so		0	0	sheetwash
		Avk2	9	aw	10YR	10YR4/3	SL	5	3 co abk	8.45	h	s,pp	so		1 m po	0	sheetwash
1093		Bk	13	aw	7.5YR7/4	7.5YR5/4	L	13	1 m abk	8.15	so	s,po	sv cw		0	0	sheetwash
(28.0)		Btk	17	as	7.5YR6.5/4	7.5YR4/4	L	3	1 f-vf abk 1 f pl	7.80		so,po	0		0	0	sheetwash
		Btqmkj	29	cw	7.5YR6.5/4	7.5YR5/5	L	11	3 m pl	7.70	sh	so,po	II on pf		3 m br	III+	fluvial gravel
	4a/	2Kqd1	47	cw	10YR8/2 7.5YR7/4	7.5YR7/3 7.5YR5/6	L L		3 vc pl 2° 3 c abk	7.30	sh	so,po	III		3-4k pf	III	fluvial gravel debris flow?
	4a/	2Kqm2	72	cw	10YR8/3	7.5YR7/6	L	34	m 2° 2 f-vf abk & vf pl	7.40	vh	so,po	III		0	III	fluvial gravel
	4a/	2Kqm3	150+	--	10YR7/4	10YR5/6	SL	40	m	7.60	vh	so,po	III		0	III	fluvial gravel

Map Unit, elev (m) (m >stream)	Sample number	Horizon	Basal depth cm	Lower boundary	Color dry	Color moist	Texture 1/	% gravel	Structure	pH	Consistence Dry	Consistence Moist	Consistence Wet	$CaCO_3$	Clay films	SiO_2	Parent Material
QTe	YW-6	Avk	6	cs		10YR4/3	L	24	3 vco abk	7.70	fr	ss,ps	s dlss	0	0		eolian & sheetwash
	5/	Btk	10	as		7.5YR5/6	L	14	2 m abk	7.60	fr	s,p	s dlss	2 m pf	0		eolian & sheetwash
1170	4a/	2Kmq	52	as	7.5YR7/6	7.5YR6/6	SL		3 vco pl	7.75		so,ps	IV	0	IV		fluvial gravel
(19.8)					7.5YR8/2	white 6/ (CaCO3)											
		3Kqm	101	gw	7.5YR7/4	7.5YR5/6	S	59	m	7.80	sh	so,ps	III	0	II		fluvial gravel
					white 6/	(CaCO3)							lenses				
		3Kqy	153	gw	10YR8/2	10YR6/3	S	67	sg	7.60	so	so,ps	II with	0	II		fluvial gravel
													lenses of III				
		3Bkq	230	--	7.5YR7/4	10YR4/3	S	63	sg	7.60	lo	so,ps	I	0	II		fluvial gravel
		3Ckqm	250+				S	41		7.70							
QTe	YW-2W	Avk	3	as	10YR7/3	10YR4/3	L	6	3 co abk	7.95	sh	so,p	sv	0	0		eolian & sheetwash
		Ak	10	cw	10YR7/4	10YR3.5/3	L	9	1 m abk-sg	7.95	so	so,p	s	0	0		eolian & sheetwash
1180		Bty	19	ai	10YR5.5/3	10YR3/4	L	12	2 vf abk-sg	7.60	so	s,p	s	0	0		eolian & sheetwash
(21.3)	2/ 4a/	2Btqmky	34	ci	10YR7/4	10YR3/3	L-	23	3 co pl	7.50	sh		1-2 mm	2 m gr	III		fluvial gravel
					7.5YR6/6	7.5YR4/4							lenses	& br			
					(SiO_2)								II on pf top				
		2Btqmy	70+	--	7.5YR5.5/6	7.5YR4/4	L-	33	2 co pl	7.50	sh	so,po-ps	lenses on pf top	4 m pf	III		fluvial gravel
									2° f-m abk								
QTe	YW-2E	Spoil	4														
		Btk	19		7.5YR6/4	7.5YR4/4	CL	13	2 m-co abk	8.20	so	ss,p	sv	2 m gr			eolian & sheetwash
1180	3/ 4a/	2Ktqm	52		7.5YR8/6	7.5YR7/6	C	39	3 vco pl	8.20	sh	so,ps	III-IV	1 m gr	IV		fluvial gravel
(21.3)					(internal pede)								conts pede	2 mk pf			
					10YR8/4	10YR7/6											
					pf white 6/	(CaCO3)											
		2Kqm	114		white 6/	(CaCO3)	SCL-	48	2 vco pl	8.00	h-sh	so,ps	IV in	1 m gr	IV		fluvial gravel
													places	& br			(debris flow?)
		3Kq	197+	--	10YR8/2	10YR6/3	SL	76	m	7.55	so	so,ps	III,				fluvial gravel
													veiny on pebbles				
QTe	YW-22	Avk	10	sw	10YR7/3	10YR5/3	CL	5	2 vco abk	8.50	so-sh	s,ps	s	1 m po	0		eolian & sheetwash
									2° 1 m-co pl								
1209		Btk	21	sw	7.5YR5.5/6	7.5YR4/4	CL+	20	2 f-m abk	8.00	so	s,p	s	2mk brágr	0		eolian & reworked gravel
(19.2)	4a/	Kqm	62	as	7.5YR8/4	7.5YR7/6	SCL	42	2 vo pl & m	7.90	sh	so,po	IV	0	IV		eolian & reworked gravel
		2Kmq	92	cw	10YR8/3	7.5YR6.5/6	SL	54	m	7.65	sh	so,po	III	0	III?		fluvial gravel
					white 6/	(CaCO3)											
		2Bkqm	184+	--	7.5YR7/4	7.5YR5/4	SL	52	1 m abk	7.65	h	so,ps	II	0	II		fluvial gravel

Key to Appendix A *

Horizon Boundary

Distinctness		Topography	
va	very abrupt	s	smooth
a	abrupt	w	wavy
c	clear	i	irregular
g	gradual	b	broken
d	diffuse		

Soil Texture

co	coarse	S	sand	SCL	sandy clay loam
f	fine	LS	loamy sand	CL	clay loam
vf	very fine	SL	sandy loam	SiCL	silty clay loam
		L	loam	SC	sandy clay
		SiL	silt loam	C	clay
		Si	silt	SiC	silty clay

Soil Structure

Grade		Size		Type	
m	massive	vf	very fine (v thin)	gr	granular
sg	single grained	f	fine (thin)	pl	platey
1	weak	m	medium	pr	prismatic
2	moderate	co	coarse (thick)	cpr	columnar
3	strong	vco	very coarse (v thick)	abk	angular blocky
				sbk	subangular blocky

If two structures - listed as primary and secondary (2°)

Soil Consistence

Dry		Moist		Wet	
lo	loose	lo	loose	so,po	non-sticky or plastic
so	soft	vfr	very friable	ss,ps	slightly sticky or plastic
sh	slightly hard	fr	friable	s,p	sticky or plastic
h	hard	fi	firm	vs,vp	very sticky or plastic
vh	very hard	vfi	very firm		
eh	ex hard	efi	extremely firm		

Clay Films

Frequency		Thickness		Morphology	
vf	very few	n	thin	pf	ped face coating
1	few	mk	moderately thick	br	bridging grains
2	common	k	thick	po	pore linings
3	many			gr	gravel coats

$CaCO_3$

Effervescence on matrix

0 - none in matrix.
diss - disseminated, discontinuous.
e - slightly, bubbles are readily observed.
es - strongly, bubbles form a low foam.
ev - violently, thick foam "jumps" up.

Key to Appendix A (continued)

* For more information, see Soil Survey Staff 1951 and 1975

1/ Texture is based on lab analyses

2/ Sampled for phytolith and pollen analyses

3/ Sampled for U-trend dating

4a/ Soil ped thin section

4b/ Rock thin section

5/ Sampled for ^{36}Cl analyses

6/ White carbonate is whiter than 10YR8/0

Appendix B. Soil Profile Index Values

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)	RUBIFICATION (maximum=190) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
FWA-1			0.00	0.00	0.00	0.00		
FWA-2			0.00	0.00	0.00	0.00		
FWA-3			0.00	0.00	0.00	0.00		
FWA-4			0.00	0.00	0.00	0.00		
TWA-1			0.00	0.00	0.00	0.00		
TWA-2			0.00	0.00	0.00	0.00		
7.01	A	0 1.5	0.00	0.00	0.00	0.00	0.87	0.01
7.02	Cox	2 18	10.00	0.00	0.05	0.87		
7.03	2Cxca	18 100	0.00	0.00	0.00	0.00		
4.01	A	0 3	20.00	0.00	0.11	0.32	15.47	0.15
4.02	Bk1	3 9	25.00	0.00	0.13	0.79		
4.03	2Bk2	9 60	30.00	0.00	0.16	8.05		
4.04	2Ckn	60 100	30.00	0.00	0.16	6.32		
17.01	A	0 6	20.00	0.00	0.11	0.63	12.63	0.11
17.02	Bw	6 24	20.00	0.00	0.11	1.89		
17.03	2Cxn	24 120	20.00	0.00	0.11	10.11		
13.01	A	0 9	0.00	0.00	0.00	0.00	5.47	0.04
13.02	Bw	9 21	0.00	0.00	0.00	0.00		
13.03	2Bqj	21 73	20.00	0.00	0.11	5.47		
13.04	2Ckqn	73 138	0.00	0.00	0.00	0.00		
15.01	A	0 18	0.00	0.00	0.00	0.00	57.89	0.26
15.02	Bw	18 46	20.00	0.00	0.11	2.95		
15.03	2Bqk	46 170	60.00	0.00	0.32	39.16		
15.05	2Cxn	170 220	60.00	0.00	0.32	15.79		
3.01	Av	0 5	0.00	0.00	0.00	0.00	34.45	0.16
3.02	Avkj	5 12	5.00	0.00	0.03	0.18		
3.03	2Btkj	12 45	60.00	0.00	0.32	10.42		
3.04	2Btjqmk1	45 83	80.00	70.00	0.39	15.00		
3.05	2Btjqmk2	83 107	70.00	0.00	0.37	8.84		
3.06	2Ckqm	107 210	0.00	0.00	0.00	0.00		
21.01	Av	0 4	0.00	0.00	0.00	0.00	32.11	0.14
21.02	Bw	4 15	0.00	0.00	0.00	0.00		
21.03	Bk	15 33	0.00	0.00	0.00	0.00		
21.04	2Btjqkjb1	33 55	20.00	0.00	0.11	2.32		
21.05	2Btjqmkb1	55 144	40.00	0.00	0.21	18.74		
21.06	3Bqmkb2	144 186	50.00	0.00	0.26	11.05		
21.07	3Ckqn	186 233	999.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		RUBIFICATION (maximum=190) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
11.01	Av	0	4	0.00	0.00	0.00	0.00	29.58	0.17
11.02	A	4	15	0.00	0.00	0.00	0.00		
11.03	2Btj	15	42	40.00	0.00	0.21	5.68		
11.04	2Btqmi	42	90	40.00	20.00	0.16	7.58		
11.05	2Bkq	90	150	40.00	0.00	0.21	12.67		
11.06	3Krqmkb	150	170	20.00	50.00	0.18	3.68		
12.01	Av1	0	4	0.00	0.00	0.00	0.00	12.16	0.06
12.02	Av2	4	14	0.00	0.00	0.00	0.00		
12.03	Bt	14	47	0.00	0.00	0.00	0.00		
12.04	2Bk1	47	105	10.00	20.00	0.08	4.58		
12.05	2Bk2	105	120	40.00	0.00	0.21	3.16		
12.06	2Btqmkb	120	144	60.00	10.00	0.18	4.42		
12.07	Bqkb	144	200	999.00	0.00	0.00	0.00		
14.01	A	0	8	0.00	0.00	0.00	0.00	23.53	0.10
14.02	Bw	8	28	0.00	0.00	0.00	0.00		
14.03	2Bk	28	54	20.00	0.00	0.11	2.74		
14.04	2Btjkq	54	107	20.00	0.00	0.11	5.58		
14.05	3Bkjb	107	121	25.00	0.00	0.13	1.84		
14.06	3Bqmk1b	121	152	20.00	0.00	0.11	3.26		
14.07	4Bqmk2b	152	221	20.00	0.00	0.11	7.26		
14.08	4Bkjb	221	230	60.00	0.00	0.32	2.84		
20.01	Av1	0	8	10.00	0.00	0.05	0.42	51.08	0.27
20.02	Av2	8	19	5.00	0.00	0.03	0.29		
20.03	Bw	19	42	30.00	0.00	0.16	3.63		
20.04	2Btjq	42	64	60.00	0.00	0.32	6.95		
20.05	2Btjqk1	64	76	60.00	0.00	0.32	3.79		
20.06	2Btjqk2-1	76	114	60.00	0.00	0.32	12.00		
20.07	2Btjqk2-2	114	152	60.00	0.00	0.32	12.00		
20.08	2Btjqk2-3	152	190	60.00	0.00	0.32	12.00		
5.01	A	0	5	20.00	0.00	0.11	0.53	44.03	0.17
5.02	Bw	5	20	0.00	0.00	0.00	0.00		
5.03	Bk	20	45	5.00	0.00	0.03	0.66		
5.04	2Btb	45	56	60.00	0.00	0.32	3.47		
5.05	2Btqmkb	56	106	80.00	0.00	0.42	21.05		
5.06	2Btqb	106	164	80.00	40.00	0.32	18.32		
5.07	2Cqm	164	263	0.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		RUBIFICATION (maximum=190) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
18.01	Av	0	11	0.00	0.00	0.00	0.00	18.21	0.11
18.02	A	11	33	0.00	0.00	0.00	0.00		
18.03	Bt	33	40	20.00	0.00	0.11	0.74		
18.04	2Btqk1	40	66	55.00	0.00	0.29	7.53		
18.05	2Btqk	66	120	40.00	30.00	0.18	9.95		
18.06	3kt	120	160	999.00	0.00	0.00	0.00		
8.01	Av	0	9	0.00	0.00	0.00	0.00	50.85	0.24
8.02	Bt1	9	21	70.00	0.00	0.37	4.42		
8.03	2Bt2	21	35	100.00	0.00	0.53	7.37		
8.04	2kqm	35	68	110.00	0.00	0.58	19.11		
8.05	2k	68	100	50.00	0.00	0.26	8.42		
8.06	2Ck	100	210	20.00	0.00	0.11	11.58		
16.01	Av	0	13	0.00	0.00	0.00	0.00	70.00	5.83
16.02	Bw	13	30	20.00	0.00	0.11	1.79		
16.03	Bt	30	43	30.00	0.00	0.16	2.05		
16.04	2Btqk	43	58	90.00	0.00	0.47	7.11		
16.05	2kq	58	100	70.00	0.00	0.37	15.47		
16.06	2Bqm (nc)	100	150	60.00	0.00	0.32	15.79		
16.07	2Bqm	100	150	60.00	0.00	0.32	15.79		
16.08	2Ckqm	150	207	40.00	0.00	0.21	12.00		
1.01	A	0	10	0.00	0.00	0.00	0.00	49.28	0.17
1.02	Bt	10	25	0.00	0.00	0.00	0.00		
1.03	2Btqb1	25	42	40.00	0.00	0.21	3.58		
1.04	2Btqb2	42	56	60.00	0.00	0.32	4.42		
1.08	3kqmb1	56	70	0.00	0.00	0.00	0.00		
1.09	4kqmb2	70	115	999.00	0.00	0.00	0.00		
1.10	5Bk	115	167	50.00	0.00	0.26	13.68		
1.11	5Cnk	167	195	60.00	0.00	0.32	8.84		
1.12	5Cn	195	290	60.00	15.00	0.20	18.75		
19.01	Av1	0	4	0.00	0.00	0.00	0.00	43.37	0.00
	Av2	4	9	0.00	0.00	0.00	0.00		
19.03	Bk	9	13	40.00	0.00	0.21	0.84		
19.04	Bw	13	17	40.00	0.00	0.21	0.84		
19.05	Btqm	17	29	70.00	0.00	0.37	4.42		
19.06	2ktqm	29	47	20.00	80.00	0.26	4.74		
19.07	2kqm1	47	72	60.00	0.00	0.32	7.89		
19.08	2kqm2	72	150	60.00	0.00	0.32	24.63		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		RUBIFICATION (maximum=199) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
6.01	Av	0	6	0.00	0.00	0.00	0.00	53.42	0.00
6.02	Bt	6	10	80.00	0.00	0.42	1.68		
6.03	2tqm	10	52	100.00	10.00	0.29	12.16		
6.04	3kmq	52	101	80.00	0.00	0.42	20.63		
6.05	3kq	101	153	10.00	0.00	0.05	2.74		
6.06	3Dkq	153	230	40.00	0.00	0.21	16.21		
6.07	3Dkq+	230	300	999.00	0.00	0.00	0.00		
2.01	Av	0	3	0.00	0.00	0.00	0.00	41.87	0.21
2.02	A	3	10	10.00	0.00	0.05	0.37		
2.03	Bv	10	19	10.00	0.00	0.05	0.47		
2.04	2Bqmgy	19	34	30.00	80.00	0.29	4.34		
2.05	2Btqgy	34	70	80.00	0.00	0.42	15.16		
2.07	ktqm	19	52	100.00	60.00	0.42	13.89		
2.08	Kq	52	114	10.00	0.00	0.05	3.26		
2.09	2k	114	197	10.00	0.00	0.05	4.37		
22.01	Av	0	10	0.00	0.00	0.00	0.00	60.42	0.33
22.02	Bw	10	21	80.00	0.00	0.42	4.63		
22.03	K	21	62	80.00	0.00	0.42	17.26		
22.04	km	62	92	60.00	0.00	0.32	9.47		
22.05	Bkqm	92	184	60.00	0.00	0.32	29.05		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		MELANIZATION (maximum=85) Color #1	Color #2	Normalized property	% thickness	Profile property	Weighted mean
11.01	Av	0	4	0.00	0.00	0.00	0.00	0.00	0.00
11.02	A	4	15	0.00	0.00	0.00	0.00		
11.03	2Btj	15	42	0.00	0.00	0.00	0.00		
11.04	2Btqmk	42	90	0.00	0.00	0.00	0.00		
11.05	2Bkq	90	150	0.00	0.00	0.00	0.00		
11.06	3Kqmkb	150	170	0.00	0.00	0.00	0.00		
12.01	Av1	0	4	5.00	0.00	0.06	0.24	0.24	0.00
12.02	Av2	4	14	0.00	0.00	0.00	0.00		
12.03	Bt	14	47	0.00	0.00	0.00	0.00		
12.04	2Bk1	47	105	0.00	0.00	0.00	0.00		
12.05	2Bk2	105	129	0.00	0.00	0.00	0.00		
12.06	2Btqmkb	129	144	0.00	0.00	0.00	0.00		
12.07	3qkb	144	200	0.00	0.00	0.00	0.00		
14.01	A	0	8	0.00	0.00	0.00	0.00	0.00	0.00
14.02	Bw	8	28	0.00	0.00	0.00	0.00		
14.03	2Bk	28	54	0.00	0.00	0.00	0.00		
14.04	2Btjkq	54	107	0.00	0.00	0.00	0.00		
14.05	3Bkjb	107	121	0.00	0.00	0.00	0.00		
14.06	3Bqmk1b	121	152	0.00	0.00	0.00	0.00		
14.07	4Bqmk2b	152	221	0.00	0.00	0.00	0.00		
14.08	4Bkjb	221	230	0.00	0.00	0.00	0.00		
20.01	Av1	0	8	10.00	0.00	0.12	0.94	4.94	0.03
20.02	Av2	8	19	0.00	0.00	0.00	0.00		
20.03	Bw	19	42	0.00	0.00	0.00	0.00		
20.04	2Btjq	42	64	10.00	0.00	0.12	2.59		
20.05	2Btjqk1	64	76	10.00	0.00	0.12	1.41		
20.06	2Btjqk2-1	76	114	0.00	0.00	0.00	0.00		
20.07	2Btjqk2-2	114	152	0.00	0.00	0.00	0.00		
20.08	2Btjqk2-3	152	190	0.00	0.00	0.00	0.00		
5.01	A	0	5	0.00	0.00	0.00	0.00	2.41	0.01
5.02	Bw	5	20	10.00	0.00	0.12	1.76		
5.03	Bk	20	45	0.00	0.00	0.00	0.00		
5.04	2Btb	45	56	5.00	0.00	0.06	0.65		
5.05	2Btqmkb	56	106	0.00	0.00	0.00	0.00		
5.06	2Ktqb	106	164	0.00	0.00	0.00	0.00		
5.07	2Cqn	164	263	0.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		MELANIZATION (maximum=85) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
18.01	Av	0	11	0.00	0.00	0.00	0.00	0.00	0.00
18.02	A	11	33	0.00	0.00	0.00	0.00		
18.03	Bt	33	40	0.00	0.00	0.00	0.00		
18.04	2Btgkj	40	66	0.00	0.00	0.00	0.00		
18.05	2Btgk	66	120	0.00	0.00	0.00	0.00		
18.06	3kb	120	160	0.00	0.00	0.00	0.00		
8.01	Av	0	9	0.00	0.00	0.00	0.00	2.82	0.01
8.02	Bt1	9	21	20.00	0.00	0.24	2.82		
8.03	2Bt2	21	35	0.00	0.00	0.00	0.00		
8.04	2kqm	35	68	0.00	0.00	0.00	0.00		
8.05	2r	68	100	0.00	0.00	0.00	0.00		
8.05	2Ck.	100	210	0.00	0.00	0.00	0.00		
16.01	Av	0	13	20.00	0.00	0.24	3.06	5.59	0.47
16.02	Bw	13	30	5.00	0.00	0.06	1.00		
16.03	Bt	30	43	10.00	0.00	0.12	1.53		
16.04	2Btqk	43	58	0.00	0.00	0.00	0.00		
16.05	2kq	58	100	0.00	0.00	0.00	0.00		
16.06	2Bqm (nc)	100	150	0.00	0.00	0.00	0.00		
16.07	2Bqm	100	150	0.00	0.00	0.00	0.00		
16.08	2Ckqm	150	207	0.00	0.00	0.00	0.00		
1.01	A	0	10	0.00	0.00	0.00	0.00	4.53	0.02
1.02	Bt	10	25	5.00	0.00	0.06	0.88		
1.03	2Btqb1	25	42	10.00	0.00	0.12	2.00		
1.04	2Btqb2	42	56	10.00	0.00	0.12	1.65		
1.08	3Kqmb1	56	70	0.00	0.00	0.00	0.00		
1.09	4Kqmb2	70	115	0.00	0.00	0.00	0.00		
1.10	5Bk	115	167	0.00	0.00	0.00	0.00		
1.11	5Cnk	167	195	0.00	0.00	0.00	0.00		
1.12	5Cn	195	290	0.00	0.00	0.00	0.00		
19.01	Av1	0	4	5.00	0.00	0.06	0.24	0.24	0.00
	Av2	4	9	0.00	0.00	0.00	0.00		
19.03	Bk	9	13	0.00	0.00	0.00	0.00		
19.04	Bw	13	17	0.00	0.00	0.00	0.00		
19.05	Btqm	17	29	0.00	0.00	0.00	0.00		
19.06	2ktqm	29	47	0.00	0.00	0.00	0.00		
19.07	2kqm1	47	72	0.00	0.00	0.00	0.00		
19.08	2kqm2	72	150	0.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		MELANIZATION (maximum=85) Color #1	Color #2	Normalized property	% thickness	Profile property	Weighted mean
6.01	Av	0	6	10.00	0.00	0.12	0.71	0.71	0.00
6.02	Bt	6	10	0.00	0.00	0.00	0.00		
6.03	2kqm	10	52	0.00	-40.00	0.00	0.00		
6.04	3kmq	52	101	0.00	0.00	0.00	0.00		
6.05	3kq	101	153	0.00	0.00	0.00	0.00		
6.06	3Ckq	153	230	0.00	0.00	0.00	0.00		
6.07	3Ckq+	230	300	0.00	0.00	0.00	0.00		
2.01	Av	0	3	0.00	0.00	0.00	0.00	5.88	0.03
2.02	A	3	10	5.00	0.00	0.06	0.41		
2.03	By	10	19	15.00	0.00	0.18	1.59		
2.04	2Bqmky	19	34	10.00	0.00	0.12	1.76		
2.05	2Btqmy	34	70	5.00	0.00	0.06	2.12		
2.07	Ktqm	19	52	0.00	0.00	0.00	0.00		
2.08	kq	52	114	0.00	0.00	0.00	0.00		
2.09	2k	114	197	0.00	0.00	0.00	0.00		
22.01	Av	0	10	0.00	0.00	0.00	0.00	0.65	0.00
22.02	Bw	10	21	5.00	0.00	0.06	0.65		
22.03	k	21	62	0.00	0.00	0.00	0.00		
22.04	km	62	92	0.00	0.00	0.00	0.00		
22.05	Bkqm	92	184	0.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)	COLOR-PALING (maximum=60) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
FWH-1			0.00	0.00	0.00	0.00		
FWH-2			0.00	0.00	0.00	0.00		
FWH-3			0.00	0.00	0.00	0.00		
FWH-4			0.00	0.00	0.00	0.00		
YWH-1			0.00	0.00	0.00	0.00		
YWH-2			0.00	0.00	0.00	0.00		
7.01	A	0 1.5	0.00	0.00	0.00	0.00	0.00	0.00
7.02	Cox	2 18	0.00	0.00	0.00	0.00		
7.03	2Ckox	18 100	0.00	0.00	0.00	0.00		
4.01	A	0 3	0.00	0.00	0.00	0.00	0.00	0.00
4.02	Bk1	3 9	0.00	0.00	0.00	0.00		
4.03	2Bk2	9 60	0.00	0.00	0.00	0.00		
4.04	2Ckn	60 100	0.00	0.00	0.00	0.00		
17.01	A	0 6	0.00	0.00	0.00	0.00	0.00	0.00
17.02	Bw	6 24	0.00	0.00	0.00	0.00		
17.03	2Ckn	24 120	0.00	0.00	0.00	0.00		
13.01	A	0 9	0.00	0.00	0.00	0.00	10.83	0.06
13.02	Bw	9 21	0.00	0.00	0.00	0.00		
13.03	2Bqj	21 73	0.00	0.00	0.00	0.00		
13.04	2Ckqn	73 138	10.00	0.00	0.17	10.83		
15.01	A	0 18	0.00	0.00	0.00	0.00	0.00	0.00
15.02	Bw	18 46	0.00	0.00	0.00	0.00		
15.03	2Bqj	46 170	0.00	0.00	0.00	0.00		
15.05	2Ckn	170 220	0.00	0.00	0.00	0.00		
3.01	Av	0 5	5.00	0.00	0.08	0.42	0.42	0.00
3.02	Avkj	5 12	0.00	0.00	0.00	0.00		
3.03	2Btkj	12 45	0.00	0.00	0.00	0.00		
3.04	2Btjqmk1	45 83	0.00	0.00	0.00	0.00		
3.05	2Btjqmk2	83 107	0.00	0.00	0.00	0.00		
3.06	2Ckqn	107 210	0.00	0.00	0.00	0.00		
21.01	Av	0 4	0.00	0.00	0.00	0.00	0.00	0.00
21.02	Bw	4 15	0.00	0.00	0.00	0.00		
21.03	Bk	15 33	0.00	0.00	0.00	0.00		
21.04	2Btjqkjb1	33 55	0.00	0.00	0.00	0.00		
21.05	2Btjqmkb1	55 144	0.00	0.00	0.00	0.00		
21.06	3Bqmkb2	144 186	0.00	0.00	0.00	0.00		
21.07	3Ckqn	186 233	999.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		COLOR-PALING (maximum=60) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
11.01	Av	0	4	0.00	0.00	0.00	0.00	0.00	0.00
11.02	A	4	15	0.00	0.00	0.00	0.00		
11.03	2Btj	15	42	0.00	0.00	0.00	0.00		
11.04	2Btqmk	42	90	0.00	0.00	0.00	0.00		
11.05	2Bkq	90	150	0.00	0.00	0.00	0.00		
11.06	3Kqmkb	150	170	0.00	0.00	0.00	0.00		
12.01	Av1	0	4	0.00	0.00	0.00	0.00	0.00	0.00
12.02	Av2	4	14	0.00	0.00	0.00	0.00		
12.03	Bt	14	47	0.00	0.00	0.00	0.00		
12.04	2Bk1	47	105	0.00	0.00	0.00	0.00		
12.05	2Bk2	105	120	0.00	0.00	0.00	0.00		
12.06	2Btqmkb	120	144	0.00	0.00	0.00	0.00		
12.07	Bqkb	144	200	-999.00	0.00	0.00	0.00		
14.01	A	0	8	0.00	0.00	0.00	0.00	0.00	0.00
14.02	Bw	8	28	0.00	0.00	0.00	0.00		
14.03	2Bk	28	54	0.00	0.00	0.00	0.00		
14.04	2Btjkq	54	107	0.00	0.00	0.00	0.00		
14.05	3Bkjb	107	121	0.00	0.00	0.00	0.00		
14.06	3Bqmk1b	121	152	0.00	0.00	0.00	0.00		
14.07	4Bqmk2b	152	221	0.00	0.00	0.00	0.00		
14.08	4Bkjb	221	230	0.00	0.00	0.00	0.00		
20.01	Av1	0	8	0.00	0.00	0.00	0.00	0.00	0.00
20.02	Av2	8	19	0.00	0.00	0.00	0.00		
20.03	Bw	19	42	0.00	0.00	0.00	0.00		
20.04	2Btjq	42	64	0.00	0.00	0.00	0.00		
20.05	2Btjqk1	64	76	0.00	0.00	0.00	0.00		
20.06	2Btjqk2-1	76	114	0.00	0.00	0.00	0.00		
20.07	2Btjqk2-2	114	152	0.00	0.00	0.00	0.00		
20.08	2Btjqk2-3	152	190	0.00	0.00	0.00	0.00		
5.01	A	0	5	0.00	0.00	0.00	0.00	20.67	0.08
5.02	Bw	5	20	0.00	0.00	0.00	0.00		
5.03	Bk	20	45	10.00	0.00	0.17	4.17		
5.04	2Btb	45	56	0.00	0.00	0.00	0.00		
5.05	2Btqmkb	56	106	0.00	0.00	0.00	0.00		
5.06	2Ktqb	106	164	0.00	0.00	0.00	0.00		
5.07	2Cqn	164	267	10.00	0.00	0.17	16.50		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)	COLOR-PALINS (maximum=60) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
18.01	Av	0 11	0.00	0.00	0.00	0.00	0.00	0.00
18.02	A	11 33	0.00	0.00	0.00	0.00		
18.03	Bt	33 40	0.00	0.00	0.00	0.00		
18.04	2Btqb1	40 66	0.00	0.00	0.00	0.00		
18.05	2Btqb	66 120	0.00	0.00	0.00	0.00		
18.06	3Bc	120 160	999.00	0.00	0.00	0.00		
8.01	Av	0 9	0.00	0.00	0.00	0.00	0.00	0.00
8.02	Bt1	9 21	0.00	0.00	0.00	0.00		
8.03	2Bt2	21 35	0.00	0.00	0.00	0.00		
8.04	2kqm	35 68	0.00	0.00	0.00	0.00		
8.05	2k	68 100	0.00	0.00	0.00	0.00		
8.05	2Ck	100 210	0.00	0.00	0.00	0.00		
16.01	Av	0 13	0.00	0.00	0.00	0.00	0.00	0.00
16.02	Bw	13 30	0.00	0.00	0.00	0.00		
16.03	Bt	30 43	0.00	0.00	0.00	0.00		
16.04	2Btqb	43 58	0.00	0.00	0.00	0.00		
16.05	2kq	58 100	0.00	0.00	0.00	0.00		
16.06	2Bqm (nc)	100 150	0.00	0.00	0.00	0.00		
16.07	2Bqm	100 150	0.00	0.00	0.00	0.00		
16.08	2Ckqm	150 207	0.00	0.00	0.00	0.00		
1.01	A	0 10	10.00	0.00	0.17	1.67	36.33	0.13
1.02	Bt	10 25	0.00	0.00	0.00	0.00		
1.03	2Btqb1	25 42	0.00	0.00	0.00	0.00		
1.04	2Btqb2	42 56	0.00	0.00	0.00	0.00		
1.08	3Kqmb1	56 70	0.00	0.00	0.00	0.00		
1.09	4kqmb2	70 115	999.00	0.00	0.00	0.00		
1.10	5Bk	115 167	40.00	0.00	0.67	34.67		
1.11	5Cnk	167 195	0.00	0.00	0.00	0.00		
1.12	5Cn	195 290	0.00	0.00	0.00	0.00		
19.01	Av1	0 4	10.00	0.00	0.17	0.67	1.50	0.00
	Av2	4 9	10.00	0.00	0.17	0.83		
19.03	Bk	9 13	0.00	0.00	0.00	0.00		
19.04	Bw	13 17	0.00	0.00	0.00	0.00		
19.05	Btqm	17 29	0.00	0.00	0.00	0.00		
19.06	2ktqm	29 47	0.00	0.00	0.00	0.00		
19.07	2kqm1	47 72	0.00	0.00	0.00	0.00		
19.08	2kqm2	72 150	0.00	0.00	0.00	0.00		

Sample	Horizon	Depth (cm)	COLOR-FALING (maximum=60) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean
6.01	Av	0 6	0.00	0.00	0.00	0.00	0.00	0.00
6.02	Bt	6 10	0.00	0.00	0.00	0.00		
6.03	2Kqa	10 52	0.00	0.00	0.00	0.00		
6.04	3Keq	52 101	0.00	0.00	0.00	0.00		
6.05	3Kq	101 153	0.00	0.00	0.00	0.00		
6.06	3Dkq	153 230	0.00	0.00	0.00	0.00		
6.07	3Dkqr	230 300	999.00	0.00	0.00	0.00		
2.01	Av	0 3	0.00	0.00	0.00	0.00	0.00	0.00
2.02	A	3 10	0.00	0.00	0.00	0.00		
2.03	Bv	10 19	0.00	0.00	0.00	0.00		
2.04	2Bqmry	19 34	0.00	0.00	0.00	0.00		
2.05	2Btqmv	34 70	0.00	0.00	0.00	0.00		
2.07	Ktqm	19 52	0.00	0.00	0.00	0.00		
2.08	kq	52 114	0.00	0.00	0.00	0.00		
2.09	2k	114 157	0.00	0.00	0.00	0.00		
22.01	A.	0 10	0.00	0.00	0.00	0.00	0.00	0.00
22.02	Bw	10 21	0.00	0.00	0.00	0.00		
22.03	t	21 62	0.00	0.00	0.00	0.00		
22.04	km	62 92	0.00	0.00	0.00	0.00		
22.05	Bkqr	92 184	0.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)	COLOR-LIGHTENING (maximum=80) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean pp
FWA-1			0.00	0.00	0.00	0.00		
FWA-2			0.00	0.00	0.00	0.00		
FWA-3			0.00	0.00	0.00	0.00		
FWA-4			0.00	0.00	0.00	0.00		
YWA-1			0.00	0.00	0.00	0.00		
YWA-2			0.00	0.00	0.00	0.00		
7.01	A	0 1.5	10.00	0.00	0.13	0.19	1.22	0.01
7.02	Cox	2 18	5.00	0.00	0.06	1.03		
7.03	2Ckox	18 100	0.00	0.00	0.00	0.00		
4.01	A	0 3	0.00	0.00	0.00	0.00	21.75	0.22
4.02	Bk1	3 9	20.00	0.00	0.25	1.50		
4.03	2Bk2	9 60	20.00	0.00	0.25	12.75		
4.04	2Ckn	60 100	15.00	0.00	0.19	7.50		
17.01	A	0 6	0.00	0.00	0.00	0.00	27.38	0.27
17.02	Bw	6 24	15.00	0.00	0.19	3.38		
17.03	2Ckn	24 120	20.00	0.00	0.25	24.00		
13.01	A	0 9	0.00	0.00	0.00	0.00	11.36	0.08
13.02	Bw	9 21	0.00	0.00	0.00	0.00		
13.03	2Bqj	21 73	5.00	0.00	0.06	3.25		
13.04	2Ckqn	73 138	10.00	0.00	0.13	8.13		
15.01	A	0 18	0.00	0.00	0.00	0.00	17.13	0.08
15.02	Bw	18 46	0.00	0.00	0.00	0.00		
15.03	2Bqk	46 170	5.00	0.00	0.06	7.75		
15.05	2Ckn	170 220	15.00	0.00	0.19	9.38		
3.01	Av	0 5	10.00	0.00	0.13	0.63	17.00	0.08
3.02	Avkj	5 12	10.00	0.00	0.13	0.88		
3.03	2Btkj	12 45	0.00	0.00	0.00	0.00		
3.04	2Btjqmk1	45 83	20.00	0.00	0.25	9.50		
3.05	2Btjqmk2	83 107	20.00	0.00	0.25	6.00		
3.06	2Ckqn	107 210	0.00	0.00	0.00	0.00		
21.01	Av	0 4	10.00	0.00	0.13	0.50	6.88	0.03
21.02	Bw	4 15	0.00	0.00	0.00	0.00		
21.03	Bk	15 33	5.00	0.00	0.06	1.13		
21.04	2Btjqkjb1	33 55	0.00	0.00	0.00	0.00		
21.05	2Btjqmkb1	55 144	0.00	0.00	0.00	0.00		
21.06	3Bqmkb2	144 186	10.00	0.00	0.13	5.25		
21.07	3Ckqn	186 233	999.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		COLOR-LIGHTENING (maximum=80) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean pp
11.01	Av	0	4	0.00	0.00	0.00	0.00	36.00	0.21
11.02	A	4	15	0.00	0.00	0.00	0.00		
11.03	2Btj	15	42	0.00	0.00	0.00	0.00		
11.04	2Btqmk	42	90	5.00	40.00	0.28	13.50		
11.05	2Bkq	90	150	20.00	0.00	0.25	15.00		
11.06	3Bqmkb	150	170	40.00	20.00	0.38	7.50		
12.01	Av1	0	4	0.00	0.00	0.00	0.00	20.44	0.10
12.02	Av2	4	14	0.00	0.00	0.00	0.00		
12.03	Bt	14	47	5.00	0.00	0.06	2.06		
12.04	2Bk1	47	105	15.00	0.00	0.19	10.88		
12.05	2Bk2	105	120	0.00	0.00	0.00	0.00		
12.06	2Btqmkb	120	144	0.00	50.00	0.31	7.50		
12.07	Bqkb	144	200	999.00	0.00	0.00	0.00		
14.01	A	0	8	10.00	0.00	0.13	1.00	10.94	0.05
14.02	Bw	8	28	0.00	0.00	0.00	0.00		
14.03	2Bk	28	54	0.00	0.00	0.00	0.00		
14.04	2Btjkq	54	107	15.00	0.00	0.19	9.94		
14.05	3Bkjb	107	121	0.00	0.00	0.00	0.00		
14.06	3Bqmk1b	121	152	0.00	0.00	0.00	0.00		
14.07	4Bqmk2b	152	221	0.00	0.00	0.00	0.00		
14.08	4Bkjb	221	230	0.00	0.00	0.00	0.00		
20.01	Av1	0	8	0.00	0.00	0.00	0.00	0.00	0.00
20.02	Av2	8	19	0.00	0.00	0.00	0.00		
20.03	Bw	19	42	0.00	0.00	0.00	0.00		
20.04	2Btjq	42	64	0.00	0.00	0.00	0.00		
20.05	2Btjqk1	64	76	0.00	0.00	0.00	0.00		
20.06	2Btjqk2-1	76	114	0.00	0.00	0.00	0.00		
20.07	2Btjqk2-2	114	152	0.00	0.00	0.00	0.00		
20.08	2Btjqk2-3	152	190	0.00	0.00	0.00	0.00		
5.01	A	0	5	10.00	0.00	0.13	0.63	35.38	0.17
5.02	Bw	5	20	0.00	0.00	0.00	0.00		
5.03	Bk	20	45	10.00	0.00	0.13	3.13		
5.04	2Btb	45	56	0.00	0.00	0.00	0.00		
5.05	2Btqmkb	56	106	10.00	0.00	0.13	6.25		
5.06	2Btqb	106	164	20.00	50.00	0.44	25.38		
5.07	2Cqn	164	263	0.00	0.00	0.00	0.00		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		COLOR-LIGHTENING (maximum=80) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean pp
18.01	Av	0	11	15.00	0.00	0.19	2.06	19.69	0.12
18.02	A	11	33	15.00	0.00	0.19	4.13		
18.03	Bt	33	40	0.00	0.00	0.00	0.00		
18.04	2Btqb1	40	66	0.00	0.00	0.00	0.00		
18.05	2Btqb	66	120	20.00	0.00	0.25	13.50		
18.06	3Cb	120	160	999.00	0.00	0.00	0.00		
8.01	Av	0	9	0.00	0.00	0.00	0.00	51.63	0.25
8.02	Bt1	9	21	0.00	0.00	0.00	0.00		
8.03	2Bt2	21	35	20.00	0.00	0.25	3.50		
8.04	2kqm	35	68	30.00	0.00	0.38	12.38		
8.05	2k	68	100	55.00	0.00	0.69	22.00		
8.06	2Cr	100	210	10.00	0.00	0.13	13.75		
16.01	Av	0	13	0.00	0.00	0.00	0.00	30.00	2.50
16.02	Bw	13	30	0.00	0.00	0.00	0.00		
16.03	Bt	30	43	0.00	0.00	0.00	0.00		
16.04	2Btqk	43	58	20.00	0.00	0.25	3.75		
16.05	2kq	58	100	50.00	0.00	0.63	26.25		
16.06	2Bqm (nc)	100	150	0.00	0.00	0.00	0.00		
16.07	2Bqm	100	150	0.00	0.00	0.00	0.00		
16.08	2Ckqn	150	207	0.00	0.00	0.00	0.00		
1.01	A	0	10	0.00	0.00	0.00	0.00	46.00	0.16
1.02	Bt	10	25	0.00	0.00	0.00	0.00		
1.03	2Btqb1	25	42	0.00	0.00	0.00	0.00		
1.04	2Btqb2	42	56	0.00	0.00	0.00	0.00		
1.08	3kqmb1	56	70	50.00	0.00	0.63	8.75		
1.09	4kqmb2	70	115	999.00	0.00	0.00	0.00		
1.10	5Bk	115	167	10.00	0.00	0.13	6.50		
1.11	5Cnk	167	195	20.00	0.00	0.25	7.00		
1.12	5Cn	195	290	20.00	0.00	0.25	23.75		
19.01	Av1	0	4	10.00	0.00	0.13	0.50	47.63	0.00
	Av2	4	9	10.00	0.00	0.13	0.63		
19.03	Bk	9	13	20.00	0.00	0.25	1.00		
19.04	Bw	13	17	5.00	0.00	0.06	0.25		
19.05	Btqm	17	29	15.00	0.00	0.19	2.25		
19.06	2ktqm	29	47	50.00	20.00	0.44	7.88		
19.07	2kqm1	47	72	50.00	0.00	0.63	15.63		
19.08	2kqm2	72	150	20.00	0.00	0.25	19.50		

SOIL PROFILE INDEX VALUES

Sample	Horizon	Depth (cm)		COLOR-LIGHTENING (maximum=60) Color #1	Color #2	Normalized property	X thickness	Profile property	Weighted mean pp
6.01	Av	0	6	0.00	0.00	0.00	0.00	61.50	0.00
6.02	Bt	6	10	10.00	0.00	0.13	0.50		
6.03	2kqm	10	52	30.00	20.00	0.31	13.13		
6.04	3kmq	52	101	20.00	0.00	0.25	12.25		
6.05	3kq	101	153	40.00	0.00	0.50	26.00		
6.06	3Ckq	153	230	10.00	0.00	0.13	9.63		
6.07	3Ckq+	230	300	999.00	0.00	0.00	0.00		
2.01	Av	0	3	10.00	0.00	0.13	0.38	96.25	0.49
2.02	A	3	10	10.00	0.00	0.13	0.88		
2.03	By	10	19	0.00	0.00	0.00	0.00		
2.04	2Bqmky	19	34	10.00	0.00	0.13	1.88		
2.05	2Btqmy	34	70	0.00	0.00	0.00	0.00		
2.07	Ktqm	19	52	50.00	50.00	0.63	20.63		
2.08	Kq	52	114	40.00	0.00	0.50	31.00		
2.09	2t	114	197	40.00	0.00	0.50	41.50		
22.01	Av	0	10	20.00	0.00	0.25	2.50	68.00	0.37
22.02	Bw	10	21	0.00	0.00	0.00	0.00		
22.03	K	21	62	50.00	0.00	0.63	25.63		
22.04	Km	62	92	45.00	0.00	0.56	16.88		
22.05	Bkqm	92	134	20.00	0.00	0.25	23.00		

Sample	Horizon	Depth (cm)	Total texture (maximum=90) ----------> Normalized property	X thickness	Profile property	Weighted mean pp
FWA-1			0.00	0.00		
FWA-2			0.11	0.00		
FWA-3			0.00	0.00		
FWA-4			0.00	0.00		
YWA-1			0.00	0.00		
YWA-2			0.00	0.00		
7.01	A	0 1.5	0.00	0.00	0.00	0.00
7.02	Cox	2 18	0.00	0.00		
7.03	2Ckox	18 100	0.00	0.00		
4.01	A	0 3	0.17	0.50	28.94	0.29
4.02	Bk1	3 9	0.22	1.33		
4.03	2Bk2	9 60	0.44	22.67		
4.04	2Ckn	60 100	0.11	4.44		
17.01	A	0 6	0.22	1.33	3.33	0.03
17.02	Bw	6 24	0.11	2.00		
17.03	2Ckn	24 120	0.00	0.00		
13.01	A	0 9	0.11	1.00	2.33	0.02
13.02	Bw	9 21	0.11	1.33		
13.03	2Bqj	21 73	0.00	0.00		
13.04	2Ckqn	73 138	0.00	0.00		
15.01	A	0 18	0.22	4.00	44.89	0.20
15.02	Bw	18 46	0.28	7.78		
15.03	2Bqk	46 170	0.22	27.56		
15.05	2Ckn	170 220	0.11	5.56		
3.01	Av	0 5	0.56	2.78	34.44	0.16
3.02	Avkj	5 12	0.78	5.44		
3.03	2Btkj	12 45	0.67	22.00		
3.04	2Btjqmk1	45 83	0.11	4.22		
3.05	2Btjqmk2	83 107	0.00	0.00		
3.06	2Ckqn	107 210	0.00	0.00		
21.01	Av	0 4	0.56	2.22	52.28	0.22
21.02	Bw	4 15	0.44	4.89		
21.03	Bk	15 33	0.33	6.00		
21.04	2Btjqkjb1	33 55	0.44	9.78		
21.05	2Btjqmkb1	55 144	0.28	24.72		
21.06	3Bqmkb2	144 186	0.11	4.67		
21.07	3Ckqn	186 233	0.00	0.00		

Sample	Horizon	Depth (cm)	Total texture (maximum=90) Normalized property	X thickness	Profile property	Weighted mean pp
11.01	Av	0 4	0.33	1.33	64.89	0.38
11.02	A	4 15	0.44	4.89		
11.03	2Btj	15 42	0.44	12.00		
11.04	2Btqm1	42 90	0.56	26.67		
11.05	2Bkq	90 150	0.22	13.33		
11.06	3Bqmkb	150 170	0.33	6.67		
12.01	Av1	0 4	0.33	1.33	56.67	0.28
12.02	Av2	4 14	0.33	3.33		
12.03	Bt	14 47	0.56	18.33		
12.04	2Bk1	47 105	0.44	25.78		
12.05	2Bk2	105 120	0.11	1.67		
12.06	2Btqmkb	120 144	0.00	0.00		
12.07	Bqkb	144 200	0.11	6.22		
14.01	A	0 8	0.33	2.67	88.22	0.38
14.02	Bw	8 28	0.39	7.78		
14.03	2Bk	28 54	0.44	11.56		
14.04	2Btjkq	54 107	0.44	23.56		
14.05	3Bkjb	107 121	0.22	3.11		
14.06	3Bqmk1b	121 152	0.22	6.89		
14.07	4Bqmk2b	152 221	0.44	30.67		
14.08	4Bkjb	221 230	0.22	2.00		
20.01	Av1	0 8	0.11	0.89	51.89	0.27
20.02	Av2	8 19	0.22	2.44		
20.03	Bw	19 42	0.33	7.67		
20.04	2Btjq	42 64	0.33	7.33		
20.05	2Btjqk1	64 76	0.33	4.00		
20.06	2Btjqk2-1	76 114	0.22	8.44		
20.07	2Btjqk2-2	114 152	0.33	12.67		
20.08	2Btjqk2-3	152 190	0.22	8.44		
5.01	A	0 5	-0.22	-1.11	10.33	0.04
5.02	Bw	5 20	-0.22	-3.33		
5.03	Bk	20 45	0.00	0.00		
5.04	2Btb	45 56	0.33	3.67		
5.05	2Btqmkb	56 106	0.22	11.11		
5.06	2Btqb	106 164	0.00	0.00		
5.07	2Cqn	164 263	0.00	0.00		

Sample	Horizon	Depth (cm)	Total texture (maximum=90) Normalized property	X thickness	Profile property	Weighted mean pp
18.01	Av	0 11	0.33	3.67	18.22	0.11
18.02	A	11 33	0.06	1.22		
18.03	Bt	33 40	0.22	1.56		
18.04	2Btqk1	40 66	0.22	5.78		
18.05	2Btqk	66 120	0.11	6.00		
18.06	2Kb	120 160	0.00	0.00		
8.01	Av	0 9	0.44	4.00	26.33	0.17
8.02	Bt1	9 21	1.00	12.00		
8.03	2Bt2	21 35	0.22	3.11		
8.04	2Kqm	35 68	0.11	3.67		
8.05	2K	68 100	0.11	3.56		
8.05	2Ck	100 210	0.00	0.00		
16.01	Av	0 13	0.33	4.33	74.89	6.24
16.02	Bw	13 30	0.33	5.67		
16.03	Bt	30 43	0.33	4.33		
16.04	2Btqk	43 58	0.89	13.33		
16.05	2Kq	58 100	0.44	18.67		
16.06	2Bqm (nc)	100 150	0.22	11.11		
16.07	2Bqm	100 150	0.22	11.11		
16.08	2Cxqn	150 207	0.11	6.33		
1.01	A	0 10	0.22	2.22	95.11	0.33
1.02	Bt	10 25	0.22	3.33		
1.03	2Btqb1	25 42	1.00	17.00		
1.04	2Btqb2	42 56	1.00	14.00		
1.08	3Kqmb1	56 70	0.33	4.67		
1.09	4Kqmb2	70 115	0.33	15.00		
1.10	5Bk	115 167	0.22	11.56		
1.11	5Cnk	167 195	0.22	6.22		
1.12	5Cn	195 290	0.22	21.11		
19.01	Av1	0 4	0.33	1.33	61.89	0.00
	Av2	4 9	0.44	2.22		
19.03	Bk	9 13	0.33	1.33		
19.04	Bw	13 17	0.33	1.33		
19.05	Btqm	17 29	0.56	6.67		
19.06	2Ktqm	29 47	0.33	6.00		
19.07	2Kqm1	47 72	0.33	8.33		
19.08	2Kqm2	72 150	0.44	34.67		

Sample	Horizon	Depth (cm)	Total texture (maximum=90) Normalized property	X thickness	Profile property	Weighted mean pp
6.01	Av	0 6	0.33	2.00	13.56	0.00
6.02	Bt	6 10	0.56	2.22		
6.03	2tqs	10 52	0.22	9.33		
6.04	3kaq	52 101	0.00	0.00		
6.05	3kq	101 153	0.00	0.00		
6.06	3Dkq	153 230	0.00	0.00		
6.07	3Dkq+	230 300	0.00	0.00		
2.01	Av	0 3	0.44	1.33	79.83	0.41
2.02	A	3 10	0.44	3.11		
2.03	Bv	10 19	0.56	5.00		
2.04	2Bqmxv	19 34	0.39	5.83		
2.05	2Btqmv	34 70	0.39	14.00		
2.07	Ktqm	19 52	0.56	18.33		
2.08	Kq	52 114	0.22	13.78		
2.09	2K	114 197	0.22	18.44		
22.01	Av	0 10	0.56	5.56	56.11	0.30
22.02	Bw	10 21	0.89	9.78		
22.03	r	21 62	0.33	13.67		
22.04	km	62 92	0.22	6.67		
22.05	Bkqm	92 184	0.22	20.44		

Sample	Horizon	Depth (cm)	STRUCTURE (maximum=60) Normalized property	X thickness	Profile property	Weighted mean
FWA-1			0.00	0.00		
FWA-2			0.00	0.00		
FWA-3			0.00	0.00		
FWA-4			0.00	0.00		
YWA-1			0.00	0.00		
YWA-2			0.00	0.00		
7.01	A	0 1.5	0.25	0.38	0.38	0.00
7.02	Cox	2 18	0.00	0.00		
7.03	2Ckox	18 100	0.00	0.00		
4.01	A	0 3	0.50	1.50	38.50	0.39
4.02	Bk1	3 9	0.50	3.00		
4.03	2Bk2	9 60	0.67	34.00		
4.04	2Ckn	60 100	0.00	0.00		
17.01	A	0 6	0.42	2.50	5.50	0.05
17.02	Bw	6 24	0.17	3.00		
17.03	2Ckn	24 120	0.00	0.00		
13.01	A	0 9	0.67	6.00	10.00	0.07
13.02	Bw	9 21	0.33	4.00		
13.03	2Bqj	21 73	0.00	0.00		
13.04	2Ckqn	73 138	0.00	0.00		
15.01	A	0 18	0.50	9.00	23.00	0.10
15.02	Bw	18 46	0.50	14.00		
15.03	2Bqk	46 170	0.00	0.00		
15.05	2Ckn	170 220	0.00	0.00		
3.01	Av	0 5	0.67	3.33	12.33	0.06
3.02	Avkj	5 12	0.50	3.50		
3.03	2Btkj	12 45	0.17	5.50		
3.04	2Btjqmk1	45 83	0.00	0.00		
3.05	2Btjqmk2	83 107	0.00	0.00		
3.06	2Ckqn	107 210	0.00	0.00		
21.01	Av	0 4	0.67	2.67	20.08	0.09
21.02	Bw	4 15	0.58	6.42		
21.03	Br	15 33	0.00	0.00		
21.04	2Btjqkjb1	33 55	0.50	11.00		
21.05	2Btjqmkb1	55 144	0.00	0.00		
21.06	3Bqmkb2	144 186	0.00	0.00		
21.07	3Ckqn	186 233	0.00	0.00		

STRUCTURE (maximum=60)

Sample	Horizon	Depth (cm)		Normalized property	X thickness	Profile property	Weighted mean
11.01	Av	0	4	0.83	3.33	32.50	0.19
11.02	A	4	15	0.33	3.67		
11.03	2Btj	15	42	0.50	13.50		
11.04	2Btqmk	42	90	0.25	12.00		
11.05	2Bkq	90	150	0.00	0.00		
11.06	3Kqmkb	150	170	0.00	0.00		
12.01	Av1	0	4	0.33	1.33	88.67	0.44
12.02	Av2	4	14	0.58	5.83		
12.03	Bt	14	47	0.67	22.00		
12.04	2Bk1	47	105	0.75	43.50		
12.05	2Bk2	105	120	0.00	0.00		
12.06	2Btqmkb	120	144	0.67	16.00		
12.07	Bqkb	144	200	0.00	0.00		
14.01	A	0	8	0.42	3.33	40.33	0.18
14.02	Bw	8	28	0.33	6.67		
14.03	2Bk	28	54	0.50	13.00		
14.04	2Btjkq	54	107	0.00	0.00		
14.05	3Bkjb	107	121	0.50	7.00		
14.06	3Bqmk1b	121	152	0.33	10.33		
14.07	4Bqmk2b	152	221	0.00	0.00		
14.08	4Bkjb	221	230	0.00	0.00		
20.01	Av1	0	8	0.33	2.67	32.83	0.17
20.02	Av2	8	19	0.67	7.33		
20.03	Bw	19	42	0.50	11.50		
20.04	2Btjq	42	64	0.33	7.33		
20.05	2Btjqk1	64	76	0.33	4.00		
20.06	2Btjqk2-1	76	114	0.00	0.00		
20.07	2Btjqk2-2	114	152	0.00	0.00		
20.08	2Btjqk2-3	152	190	0.00	0.00		
5.01	A	0	5	0.42	2.08	33.08	0.13
5.02	Bw	5	20	0.33	5.00		
5.03	Bt	20	45	0.17	4.17		
5.04	2Btb	45	56	0.67	7.33		
5.05	2Btqmkb	56	106	0.00	0.00		
5.06	2Ktqb	106	164	0.25	14.50		
5.07	2Cqn	164	263	0.00	0.00		

STRUCTURE (maximum=60)

Sample	Horizon	Depth (cm)	Normalized property	% thickness	Profile property	Weighted mean
18.01	Av	0 11	0.79	8.71	34.46	0.22
18.02	A	11 33	0.00	0.00		
18.03	Bt	33 40	0.58	4.08		
18.04	2Btqkj	40 66	0.83	21.67		
18.05	2Btqk	66 120	0.00	0.00		
18.06	3Kb	120 160	0.00	0.00		
8.01	Av	0 9	0.67	6.00	83.25	0.40
8.02	Bt1	9 21	0.92	11.00		
8.03	2Bt2	21 35	0.67	9.33		
8.04	2Kqm	35 68	0.92	30.25		
8.05	2K	68 100	0.83	26.67		
8.06	2Ck	100 210	0.00	0.00		
16.01	Av	0 13	0.33	4.33	43.50	3.63
16.02	Bw	13 30	0.33	5.67		
16.03	Bt	30 43	0.75	9.75		
16.04	2Btqk	43 58	0.75	11.25		
16.05	2Kq	58 100	0.00	0.00		
16.06	2Bqm (nc)	100 150	0.25	12.50		
16.07	2Bqm	100 150	0.00	0.00		
16.08	2Ckqn	150 207	0.00	0.00		
1.01	A	0 10	0.33	3.33	36.92	0.13
1.02	Bt	10 25	0.58	8.75		
1.03	2Btqb1	25 42	0.50	8.50		
1.04	2Btqb2	42 56	0.50	7.00		
1.08	3Kqmb1	56 70	0.67	9.33		
1.09	4Kqmb2	70 115	0.00	0.00		
1.10	5Bk	115 167	0.00	0.00		
1.11	5Cnk	167 195	0.00	0.00		
1.12	5Cn	195 290	0.00	0.00		
19.01	Av1	0 4	0.67	2.67	46.92	0.00
	Av2	4 9	0.67	3.33		
19.03	Bk	9 13	0.33	1.33		
19.04	Bw	13 17	0.58	2.33		
19.05	Btqm	17 29	0.83	10.00		
19.06	2Ktqm	29 47	1.17	21.00		
19.07	2Kqm1	47 72	0.25	6.25		
19.08	2Kqm2	72 150	0.00	0.00		

STRUCTURE (maximum=60)

Sample	Horizon	Depth (cm)	Normalized property	X thickness	Profile property	Weighted mean
6.01	Av	0 6	0.67	4.00	41.00	0.00
6.02	Bt	6 10	0.50	2.00		
6.03	2Bqm	10 52	0.83	35.00		
6.04	3Bmq	52 101	0.00	0.00		
6.05	3Bq	101 153	0.00	0.00		
6.06	3Ckq	153 230	0.00	0.00		
6.07	3Ckq+	230 300	0.00	0.00		
2.01	Av	0 3	0.67	2.00	123.17	0.63
2.02	A	3 10	0.33	2.33		
2.03	By	10 19	0.50	4.50		
2.04	2Bqmky	19 34	0.83	12.50		
2.05	2Btqmy	34 70	0.92	33.00		
2.07	Ktqm	19 52	0.83	27.50		
2.08	Kq	52 114	0.67	41.33		
2.09	2K	114 197	0.00	0.00		
22.01	Av	0 10	0.75	7.50	71.00	0.39
22.02	Bw	10 21	0.50	5.50		
22.03	K	21 62	0.67	27.33		
22.04	Km	62 92	0.00	0.00		
22.05	Brqm	92 184	0.33	30.67		

Sample	Horizon	Depth (cm)	DRY CONSISTENCE (maximum=100) Normalized property	X thickness	Profile property	Weighted mean pp
FWA-1			0.00	0.00		
FWA-2			0.00	0.00		
FWA-3			0.00	0.00		
FWA-4			0.00	0.00		
YWA-1			0.00	0.00		
YWA-2			0.00	0.00		
7.01	A	0 1.5	0.10	0.15	0.15	0.00
7.02	Cox	2 18	0.00	0.00		
7.03	2Ckox	18 100	0.00	0.00		
4.01	A	0 3	0.10	0.30	11.70	0.12
4.02	Bk1	3 9	0.20	1.20		
4.03	2Bk2	9 60	0.20	10.20		
4.04	2Ckn	60 100	0.00	0.00		
17.01	A	0 6	0.10	0.60	2.40	0.02
17.02	Bw	6 24	0.10	1.80		
17.03	2Ckn	24 120	0.00	0.00		
13.01	A	0 9	0.10	0.90	7.30	0.05
13.02	Bw	9 21	0.10	1.20		
13.03	2Bqj	21 73	0.10	5.20		
13.04	2Ckqn	73 138	0.00	0.00		
15.01	A	0 18	0.10	1.80	35.80	0.16
15.02	Bw	18 46	0.15	4.20		
15.03	2Bqk	46 170	0.20	24.80		
15.05	2Ckn	170 220	0.10	5.00		
3.01	Av	0 5	0.15	0.75	27.35	0.13
3.02	Avkj	5 12	0.20	1.40		
3.03	2Btkj	12 45	0.20	6.60		
3.04	2Btjqmk1	45 83	0.30	11.40		
3.05	2Btjqmk2	83 107	0.30	7.20		
3.06	2Ckqn	107 210	0.00	0.00		
21.01	Av	0 4	0.15	0.60	83.75	0.36
21.02	Bw	4 15	0.20	2.20		
21.03	Bk	15 33	0.10	1.80		
21.04	2Btjqkjb1	33 55	0.30	6.60		
21.05	2Btjqmkb1	55 144	0.50	44.50		
21.06	3Bqmkb2	144 186	0.50	21.00		
21.07	3Ckqn	186 233	0.15	7.05		

Sample	Horizon	Depth (cm)		DRY CONSISTENCE (maximum=100) Normalized property	X thickness	Profile property	Weighted mean pp
11.01	Av	0	4	0.10	0.40	37.60	0.22
11.02	A	4	15	0.10	1.10		
11.03	2Btj	15	42	0.30	8.10		
11.04	2Btqmk	42	90	0.50	24.00		
11.05	2Bkq	90	150	0.00	0.00		
11.06	3Kqmkb	150	170	0.20	4.00		
12.01	Av1	0	4	0.10	0.40	36.00	0.18
12.02	Av2	4	14	0.10	1.00		
12.03	Bt	14	47	0.20	6.60		
12.04	2Bk1	47	105	0.25	14.50		
12.05	2Bk2	105	120	0.10	1.50		
12.06	2Btqmkb	120	144	0.50	12.00		
12.07	Bqkb	144	200	0.00	0.00		
14.01	A	0	8	0.10	0.80	52.00	0.23
14.02	Bw	8	28	0.10	2.00		
14.03	2Bk	28	54	0.10	2.60		
14.04	2Btjkq	54	107	0.00	0.00		
14.05	3Bkjb	107	121	0.25	3.50		
14.06	3Bqmk1b	121	152	0.50	15.50		
14.07	4Bqmk2b	152	221	0.40	27.60		
14.08	4Bkjb	221	230	0.00	0.00		
20.01	Av1	0	8	0.10	0.80	22.40	0.12
20.02	Av2	8	19	0.10	1.10		
20.03	Bw	19	42	0.10	2.30		
20.04	2Btjq	42	64	0.20	4.40		
20.05	2Btjqk1	64	76	0.20	2.40		
20.06	2Btjqk2-1	76	114	0.10	3.80		
20.07	2Btjqk2-2	114	152	0.10	3.80		
20.08	2Btjqk2-3	152	190	0.10	3.80		
5.01	A	0	5	0.00	0.00	38.15	0.15
5.02	Bw	5	20	0.05	0.75		
5.03	Bk	20	45	0.10	2.50		
5.04	2Btb	45	56	0.30	3.30		
5.05	2Btqmkb	56	106	0.40	20.00		
5.06	2Ktqb	106	164	0.20	11.60		
5.07	2Cqn	164	203	0.00	0.00		

Sample	Horizon	Depth (cm)	DRY CONSISTENCE (maximum=100) Normalized property	X thickness	Profile property	Weighted mean pp
18.01	Av	0 11	0.10	1.10	45.80	0.29
18.02	A	11 33	0.00	0.00		
18.03	Bt	33 40	0.10	0.70		
18.04	2Btqb1	40 66	0.30	7.80		
18.05	2Btqb2	66 120	0.30	16.20		
18.06	3Kb	120 160	0.50	20.00		
8.01	Av	0 9	0.10	0.90	29.30	0.14
8.02	Bt1	9 21	0.00	0.00		
8.03	2Bt2	21 35	0.40	5.60		
8.04	2Kqm	35 68	0.40	13.20		
8.05	2K	68 100	0.30	9.60		
8.06	2Bk	100 210	0.00	0.00		
16.01	Av	0 13	0.00	0.00	62.20	5.18
16.02	Bw	13 30	0.00	0.00		
16.03	Bt	30 43	0.00	0.00		
16.04	2Btqk	43 58	0.20	3.00		
16.05	2Kq	58 100	0.50	21.00		
16.06	2Bqm (nc)	100 150	0.35	17.50		
16.07	2Bqm	100 150	0.30	15.00		
16.08	2Ckqm	150 207	0.10	5.70		
1.01	A	0 10	0.00	0.00	31.20	0.11
1.02	Bt	10 25	0.00	0.00		
1.03	2Btqb1	25 42	0.20	3.40		
1.04	2Btqb2	42 56	0.20	2.80		
1.08	3Kqmb1	56 70	0.50	7.00		
1.09	4Kqmb2	70 115	0.40	18.00		
1.10	5Bk	115 167	0.00	0.00		
1.11	5Cnk	167 195	0.00	0.00		
1.12	5Cn	195 290	0.00	0.00		
19.01	Av1	0 4	0.00	0.00	57.20	0.00
	Av2	4 9	0.20	1.00		
19.03	Bk	9 13	0.00	0.00		
19.04	Bw	13 17	0.00	0.00		
19.05	Btqm	17 29	0.50	6.00		
19.06	2ktqm	29 47	0.50	9.00		
19.07	2kqm1	47 72	0.40	10.00		
19.08	2kqm2	72 150	0.40	31.20		

Sample	Horizon	Depth (cm)		DRY CONSISTENCE (maximum=100) Normalized property	X thickness	Profile property	Weighted mean pp
6.01	Av	0	6	999.00	0.00	29.70	0.00
6.02	Bt	6	10	999.00	0.00		
6.03	2kqm	10	52	999.00	0.00		
6.04	3kmq	52	101	0.50	24.50		
6.05	3kq	101	153	0.10	5.20		
6.06	3Ckq	153	230	0.00	0.00		
6.07	3Ckq+	230	300	0.00	0.00		
2.01	Av	0	3	0.10	0.30	70.30	0.36
2.02	A	3	10	0.00	0.00		
2.03	By	10	19	0.00	0.00		
2.04	2Bqmxy	19	34	0.40	6.00		
2.05	2Btqmy	34	70	0.40	14.40		
2.07	Ktqm	19	52	0.50	16.50		
2.08	Kq	52	114	0.40	24.80		
2.09	2k	114	197	0.10	8.30		
22.01	Av	0	10	0.05	0.50	64.70	0.35
22.02	Bw	10	21	0.10	1.10		
22.03	K	21	62	0.50	20.50		
22.04	Km	62	92	0.50	15.00		
22.05	Bkqm	92	184	0.30	27.60		

Sample	Horizon	Depth (cm)	MOIST CONSISTENCE (maximum=100) -----> Normalized property	% thickness	Profile property	Weighted mean pp
FWA-1			999.00	0.00		
FWA-2			999.00	0.00		
FWA-3			999.00	0.00		
FWA-4			999.00	0.00		
YWA-1			999.00	0.00		
YWA-2			999.00	0.00		
7.01	A	0 1.5	999.00	0.00	0.00	0.00
7.02	Cox	2 18	999.00	0.00		
7.03	2Ckox	18 100	999.00	0.00		
4.01	A	0 3	999.00	0.00	0.00	0.00
4.02	Bk1	3 9	999.00	0.00		
4.03	2Bk2	9 60	999.00	0.00		
4.04	2Ckn	60 100	999.00	0.00		
17.01	A	0 6	999.00	0.00	0.00	0.00
17.02	Bw	6 24	999.00	0.00		
17.03	2Ckn	24 120	999.00	0.00		
13.01	A	0 9	999.00	0.00	0.00	0.00
13.02	Bw	9 21	999.00	0.00		
13.03	2Bqj	21 73	999.00	0.00		
13.04	2Ckqn	73 138	999.00	0.00		
15.01	A	0 18	999.00	0.00	0.00	0.00
15.02	Bw	18 46	999.00	0.00		
15.03	2Bqk	46 170	999.00	0.00		
15.05	2Ckn	170 220	999.00	0.00		
3.01	Av	0 5	999.00	0.00	0.00	0.00
3.02	Avkj	5 12	999.00	0.00		
3.03	2Btkj	12 45	999.00	0.00		
3.04	2Btjqmk1	45 83	999.00	0.00		
3.05	2Btjqmk2	83 107	999.00	0.00		
3.06	2Ckqn	107 210	999.00	0.00		
21.01	Av	0 4	999.00	0.00	0.00	0.00
21.02	Bw	4 15	999.00	0.00		
21.03	Bk	15 33	999.00	0.00		
21.04	2Btjqkjb1	33 55	999.00	0.00		
21.05	2Btjqmkb1	55 144	999.00	0.00		
21.06	3Bqmkb2	144 186	999.00	0.00		
21.07	3Ckqn	186 233	999.00	0.00		

Sample	Horizon	Depth (cm)	MOIST CONSISTENCE (maximum=100) ----> Normalized property	X thickness	Profile property	Weighted mean PP
11.01	Av	0 4	999.00	0.00	0.00	0.00
11.02	A	4 15	999.00	0.00		
11.03	2Btj	15 42	999.00	0.00		
11.04	2Btqmk	42 90	999.00	0.00		
11.05	2Bkq	90 150	999.00	0.00		
11.06	3Kqmkb	150 170	999.00	0.00		
12.01	Av1	0 4	999.00	0.00	0.00	0.00
12.02	Av2	4 14	999.00	0.00		
12.03	Bt	14 47	999.00	0.00		
12.04	2Bk1	47 105	999.00	0.00		
12.05	2Bk2	105 120	999.00	0.00		
12.06	2Btqmkb	120 144	999.00	0.00		
12.07	Bqkb	144 200	999.00	0.00		
14.01	A	0 8	999.00	0.00	0.00	0.00
14.02	Bw	8 28	999.00	0.00		
14.03	2Bk	28 54	999.00	0.00		
14.04	2Btjkq	54 107	999.00	0.00		
14.05	3Bkjb	107 121	999.00	0.00		
14.06	3Bqmk1b	121 152	999.00	0.00		
14.07	4Bqmk2b	152 221	999.00	0.00		
14.08	4Bkjb	221 230	999.00	0.00		
20.01	Av1	0 8	999.00	0.00	0.00	0.00
20.02	Av2	8 19	999.00	0.00		
20.03	Bw	19 42	999.00	0.00		
20.04	2Btjq	42 64	999.00	0.00		
20.05	2Btjqk1	64 76	999.00	0.00		
20.06	2Btjqk2-1	76 114	999.00	0.00		
20.07	2Btjqk2-2	114 152	999.00	0.00		
20.08	2Btjqk2-3	152 190	999.00	0.00		
5.01	A	0 5	999.00	0.00	0.00	0.00
5.02	Bw	5 20	999.00	0.00		
5.03	Bk	20 45	999.00	0.00		
5.04	2Btb	45 56	999.00	0.00		
5.05	2Btqmkb	56 106	999.00	0.00		
5.06	2Ktqb	106 164	999.00	0.00		
5.07	2Cqn	164 263	999.00	0.00		

Sample	Horizon	Depth (cm)	MOIST CONSISTENCE (maximum=100) -----> Normalized property	X thickness	Profile property	Weighted mean pp
18.01	Av	0 11	999.00	0.00	0.00	0.00
18.02	A	11 33	999.00	0.00		
18.03	Bt	33 40	999.00	0.00		
18.04	2Btqm	40 66	999.00	0.00		
18.05	2Btqm	66 120	999.00	0.00		
18.06	3Kb	120 160	999.00	0.00		
8.01	Av	0 9	999.00	0.00	0.00	0.00
8.02	Bt1	9 21	999.00	0.00		
8.03	2Bt2	21 35	999.00	0.00		
8.04	2kqm	35 68	999.00	0.00		
8.05	2k	68 100	999.00	0.00		
8.05	2Ck	100 210	999.00	0.00		
16.01	Av	0 13	999.00	0.00	0.00	0.00
16.02	Bw	13 30	999.00	0.00		
16.03	Bt	30 43	999.00	0.00		
16.04	2Btqk	43 58	999.00	0.00		
16.05	2kq	58 100	999.00	0.00		
16.06	2Bqm (nc)	100 150	999.00	0.00		
16.07	2Bqm	100 150	999.00	0.00		
16.08	2Ckqn	150 207	999.00	0.00		
1.01	A	0 10	999.00	0.00	11.80	0.04
1.02	Bt	10 25	999.00	0.00		
1.03	2Btqb1	25 42	999.00	0.00		
1.04	2Btqb2	42 56	999.00	0.00		
1.05	3kqmb1	56 70	0.20	2.80		
1.09	4Kqmb2	70 115	0.20	9.00		
1.10	5Ek	115 167	0.00	0.00		
1.11	5Cnk	167 195	0.00	0.00		
1.12	5Cn	195 290	0.00	0.00		
19.01	Av1	0 4	999.00	0.00	0.00	0.00
	Av2	4 9	999.00	0.00		
19.03	Bk	9 13	999.00	0.00		
19.04	Bw	13 17	999.00	0.00		
19.05	Btqm	17 29	999.00	0.00		
19.06	2ktqm	29 47	999.00	0.00		
19.07	2kqm1	47 72	999.00	0.00		
19.08	2kqm2	72 150	999.00	0.00		

Sample	Horizon	Depth (cm)		MOIST CONSISTENCE (maximum=100) -----> Normalized property	X thickness	Profile property	Weighted mean pp
6.01	Av	0	6	0.20	1.20	2.00	0.00
6.02	Bt	6	10	0.20	0.80		
6.03	2Kqm	10	52	999.00	0.00		
6.04	3kmq	52	101	999.00	0.00		
6.05	3kq	101	153	999.00	0.00		
6.06	3Ckq	153	230	999.00	0.00		
6.07	3Ckq+	230	300	999.00	0.00		
2.01	Av	0	3	999.00	0.00	0.00	0.00
2.02	P	3	10	999.00	0.00		
2.03	By	10	19	999.00	0.00		
2.04	2Bqmky	19	34	999.00	0.00		
2.05	2Btqmy	34	70	999.00	0.00		
2.07	Ktqm	19	52	999.00	0.00		
2.08	kq	52	114	999.00	0.00		
2.09	2k	114	197	999.00	0.00		
22.01	Av	0	10	999.00	0.00	0.00	0.00
22.02	Bw	10	21	999.00	0.00		
22.03	k	21	62	999.00	0.00		
22.04	km	62	92	999.00	0.00		
22.05	Bkqm	92	184	999.00	0.00		

Sample	Horizon	Depth (cm)	pH (maximum=3.5) Normalized property	X thickness	Profile property	Weighted mean
FWA-1			0.04	0.00		
FWA-2			0.06	0.00		
FWA-3			0.05	0.00		
FWA-4			0.21	0.00		
YWA-1			0.06	0.00		
YWA-2			0.19	0.00		
7.01	A	0 1.5	0.06	0.09	5.30	0.05
7.02	Cox	2 18	0.05	0.75		
7.03	2Ckox	18 100	0.05	4.45		
4.01	A	0 3	0.19	0.57	8.69	0.09
4.02	Bk1	3 9	0.17	1.05		
4.03	2Bk2	9 60	0.10	5.25		
4.04	2Ckn	60 100	0.05	1.83		
17.01	A	0 6	0.13	0.79	4.83	0.04
17.02	Bw	6 24	0.01	0.21		
17.03	2Ckn	24 120	0.04	3.84		
13.01	A	0 9	0.33	2.96	20.94	0.15
13.02	Bw	9 21	0.25	2.95		
13.03	2Bqj	21 73	0.16	8.32		
13.04	2Ckqn	73 138	0.10	6.69		
15.01	A	0 18	0.22	3.91	23.86	0.11
15.02	Bw	18 46	0.19	5.28		
15.03	2Bqk	46 170	0.12	14.53		
15.05	2Ckn	170 220	0.00	0.14		
3.01	Av	0 5	0.06	0.30	11.99	0.06
3.02	Avkj	5 12	0.09	0.62		
3.03	2Btkj	12 45	0.09	2.92		
3.04	2Btjqmk1	45 83	0.10	3.91		
3.05	2Btjqmk2	83 107	0.10	2.47		
3.06	2Ckqn	107 210	0.02	1.77		
21.01	Av	0 4	0.01	0.05	26.75	0.11
21.02	Bw	4 15	0.13	1.45		
21.03	Bk	15 33	0.15	2.62		
21.04	2Btjqkjb1	33 55	0.13	2.89		
21.05	2Btjqmkb1	55 144	0.04	3.56		
21.06	3Bqmkb2	144 186	0.17	7.32		
21.07	3Ckqn	186 233	0.19	8.86		

Sample	Horizon	Depth (cm)		pH (maximum=3.5) Normalized property	X thickness	Profile property	Weighted mean
11.01	Av	0	4	0.27	1.10	11.73	0.07
11.02	A	4	15	0.22	2.39		
11.03	2Btj	15	42	0.26	7.02		
11.04	2Btqmk	42	90	0.02	0.82		
11.05	2Bkq	90	150	0.00	0.17		
11.06	3kqmkb	150	170	0.01	0.23		
12.01	Av1	0	4	0.22	0.87	10.31	0.05
12.02	Av2	4	14	0.05	0.46		
12.03	Bt	14	47	0.13	4.34		
12.04	2Bk1	47	105	0.05	2.65		
12.05	2Bk2	105	120	0.01	0.17		
12.06	2Btqmkb	120	144	0.00	0.07		
12.07	Bqkb	144	200	0.03	1.76		
14.01	A	0	8	0.23	1.85	11.92	0.05
14.02	Bw	8	28	0.23	4.63		
14.03	2Bk	28	54	0.05	1.19		
14.04	2Btjkq	54	107	0.03	1.36		
14.05	3Bkjb	107	121	0.03	0.36		
14.06	3Bqmk1b	121	152	0.01	0.35		
14.07	4Bqmk2b	152	221	0.01	0.79		
14.08	4Bkjb	221	230	0.15	1.39		
20.01	Av1	0	8	0.30	2.42	19.38	0.10
20.02	Av2	8	19	0.30	3.33		
20.03	Bw	19	42	0.35	7.95		
20.04	2Btjq	42	64	0.19	4.15		
20.05	2Btjqk1	64	76	0.05	0.55		
20.06	2Btjqk2-1	76	114	0.00	0.11		
20.07	2Btjqk2-2	114	152	0.01	0.43		
20.08	2Btjqk2-3	152	190	0.01	0.43		
5.01	A	0	5	0.12	0.59	33.07	0.13
5.02	Bw	5	20	0.19	2.83		
5.03	Bt	20	45	0.15	3.64		
5.04	2Btb	45	56	0.12	1.29		
5.05	2Btqmkb	56	106	0.13	6.57		
5.06	2ktqb	106	164	0.09	5.14		
5.07	2Cqn	164	263	0.13	13.01		

Sample	Horizon	Depth (cm)		pH (maximum=3.5) Normalized property	x thickness	Profile property	Weighted mean
18.01	Av	0	11	0.04	0.44	19.20	0.12
18.02	A	11	33	0.01	0.23		
18.03	Bt	33	40	0.12	0.82		
18.04	2Btqk1	40	66	0.26	5.27		
18.05	2Btqk	66	120	0.22	11.73		
18.06	3kb	120	169	0.02	0.69		
8.01	Av	0	9	0.16	1.44	14.65	0.07
8.02	Bt1	9	21	0.19	2.26		
8.03	2Bt2	21	35	0.15	2.04		
8.04	2kqm	35	68	0.02	0.57		
8.05	2k	68	100	0.05	1.74		
8.06	2Ck	100	210	0.06	6.60		
16.01	Av	0	13	0.26	3.38	14.81	1.23
16.02	Bw	13	30	0.12	1.99		
16.03	Bt	30	43	0.10	1.34		
16.04	2Btqk	43	58	0.07	1.11		
16.05	2kq	58	100	0.02	0.72		
16.06	2Bqm (nc)	100	150	0.03	4.43		
16.07	2Bqm	100	150	0.02	0.86		
16.08	2Ckqm	150	207	0.02	0.98		
1.01	A	0	10	0.20	2.03	34.69	0.12
1.02	Bt	10	25	0.22	3.26		
1.03	2Btqb1	25	42	0.19	3.21		
1.04	2Btqb2	42	56	0.16	2.24		
1.08	3kqmb1	56	70	0.05	0.76		
1.09	4kqmb2	70	115	0.13	5.66		
1.10	5Bk	115	167	0.04	2.08		
1.11	5Cnk	167	195	0.13	3.52		
1.12	5Cn	195	290	0.13	11.94		
19.01	Av1	0	4	0.14	0.56	17.97	0.00
	Av2	4	9	0.14	0.70		
19.02	Bk	9	13	0.05	0.22		
19.04	Bw	13	17	0.05	0.18		
19.05	Btqm	17	29	0.07	0.89		
19.06	2ktqm	29	47	0.19	3.39		
19.07	2Kqm1	47	72	0.16	4.00		
19.08	2Kqm2	72	150	0.10	8.02		

Sample	Horizon	Depth (cm)	pH (maximum=3.5) Normalized property	x thickness	Profile property	Weighted mean
6.01	Av	0 6	0.07	0.45	24.05	0.05
6.02	Bt	6 10	0.10	0.41		
6.03	2Bqm	10 52	0.06	2.52		
6.04	2Bmq	52 101	0.05	2.24		
6.05	2Bq	101 153	0.10	5.35		
6.06	3Bxq	153 230	0.10	7.92		
6.07	3Bxqm	230 300	0.07	5.30		
2.01	Av	0 3	0.00	0.01	20.35	0.10
2.02	A	3 10	0.00	0.02		
2.03	By	10 19	0.10	0.93		
2.04	2Bqmxy	19 34	0.13	1.97		
2.05	2Btqmv	34 70	0.13	4.73		
2.07	Btqm	19 52	0.07	2.26		
2.08	Bq	52 114	0.01	0.71		
2.09	2r	114 157	0.12	9.72		
22.01	Av	0 10	0.15	1.54	13.19	0.07
22.02	Bw	10 21	0.01	0.13		
22.03	B	21 62	0.02	0.70		
22.04	Bm	62 92	0.09	2.66		
22.05	Bxqm	92 184	0.09	8.15		

br, bridge; po,pore; pf,ped face; cl,clast

Sample	Horizon	Depth (cm)	br #1	br #2	po #1	po #2	pf #1	pf #2	cl #1	cl #2	Normal prop	% thick	Profile prop	Weigh mean
			CLAY FILM INDEX											
FWA-1			0	0	0	0	0	0	0	0	0.00	0.00		
FWA-2			0	0	0	0	0	0	0	0	0.00	0.00		
FWA-3			0	0	0	0	0	0	0	0	0.00	0.00		
FWA-4			0	0	0	0	0	0	0	0	0.00	0.00		
TWA-1			0	0	0	0	0	0	0	0	0.00	0.00		
TWA-2			0	0	0	0	0	0	0	0	0.00	0.00		
7.01	A	0	1.5	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
7.02	Cox	2	18	0	0	0	0	0	0	0	0	0.00	0.00		
7.03	2Ckox	18	100	0	0	0	0	0	0	0	0	0.00	0.00		
4.01	A	0	3	0	0	0	0	0	0	0	0	0.00	0.00	3.23	0.03
4.02	BK1	3	9	70	0	0	0	0	0	0	0	0.54	3.23		
4.03	2Bk2	9	60	0	0	0	0	0	0	0	0	0.00	0.00		
4.04	2Ckn	60	100	0	0	0	0	0	0	0	0	0.00	0.00		
17.01	A	0	6	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
17.02	Bw	6	24	0	0	0	0	0	0	0	0	0.00	0.00		
17.03	2Ckn	24	120	0	0	0	0	0	0	0	0	0.00	0.00		
13.01	A	0	9	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
13.02	Bw	9	21	0	0	0	0	0	0	0	0	0.00	0.00		
13.03	2Bqj	21	73	0	0	0	0	0	0	0	0	0.00	0.00		
13.04	2Ckqn	73	138	0	0	0	0	0	0	0	0	0.00	0.00		
15.01	A	0	18	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
15.02	Bw	18	46	0	0	0	0	0	0	0	0	0.00	0.00		
15.03	2Bqk	46	170	0	0	0	0	0	0	0	0	0.00	0.00		
15.05	2Ckn	170	220	0	0	0	0	0	0	0	0	0.00	0.00		
3.01	Av	0	5	0	0	0	0	0	0	0	0	0.00	0.00	50.54	0.24
3.02	Avkj	5	12	0	0	0	50	60	0	0	0	0.46	3.23		
3.03	2Btkj	12	45	0	70	60	0	0	0	0	0	0.69	22.85		
3.04	2Btjqmk1	45	83	0	0	0	0	0	0	60	0	0.46	17.54		
3.05	2Btjqmk2	83	107	0	0	0	0	0	0	45	0	0.29	6.92		
3.06	2Ckqn	107	210	0	0	0	0	0	0	0	0	0.00	0.00		
21.01	Av	0	4	0	0	50	0	0	0	0	0	0.35	1.38	20.00	0.05
21.02	Bw	4	15	80	0	0	0	0	0	0	0	0.62	6.77		
21.03	Bk	15	33	0	0	0	0	0	0	0	0	0.00	0.00		
21.04	2Btjqkjb1	33	55	70	0	0	0	0	0	0	0	0.54	11.85		
21.05	2Btjqmkb1	55	144	0	0	0	0	0	0	0	0	0.00	0.00		
21.06	3Bqmkb2	144	186	0	0	0	0	0	0	0	0	0.00	0.00		
21.07	3Ckqn	186	233	0	0	0	0	0	0	0	0	0.00	0.00		

br, bridge; po,pore; pf,ped face; cl,clast

Sample	Horizon	Depth (cm)		br #1	br #2	po #1	po #2	pf #1	pf #2	cl #1	cl #2	Normal prop	% thick	Profile prop	weigh mean
				CLAY FILM INDEX											
11.01	Av	0	4	0	0	0	0	0	0	0	0	0.00	0.00	44.31	0.26
11.02	A	4	15	0	0	0	0	0	0	0	0	0.00	0.00		
11.03	2Btj	15	42	0	0	0	0	0	0	0	0	0.00	0.00		
11.04	2Btqk1	42	90	50	0	0	50	0	0	0	0	0.54	25.85		
11.05	2Bkq	90	150	50	0	0	0	0	0	0	0	0.31	18.46		
11.06	3Bqgkb	150	170	0	0	0	0	0	0	0	0	0.00	0.00		
12.01	Av1	0	4	0	0	0	0	0	0	0	0	0.00	0.00	52.23	0.26
12.02	Av2	4	14	0	0	0	0	0	0	0	0	0.00	0.00		
12.03	Bt	14	47	0	0	0	0	0	0	0	0	0.00	0.00		
12.04	2Bk1	47	105	0	60	50	0	0	0	0	0	0.54	31.23		
12.05	2Bk2	105	120	0	60	50	0	0	0	0	0	0.54	8.08		
12.06	2Btqgkb	120	144	0	0	0	0	60	0	0	50	0.54	12.92		
12.07	Bqkb	144	200	0	0	0	0	0	0	0	0	0.00	0.00		
14.01	A	0	8	0	0	0	0	0	0	0	0	0.00	0.00	45.42	0.20
14.02	Bw	8	28	0	0	0	0	0	0	0	0	0.00	0.00		
14.03	2Bw	28	54	0	0	0	0	0	0	0	0	0.00	0.00		
14.04	3Btjkq	54	107	0	0	0	0	0	0	0	0	0.00	0.00		
14.05	3Bkjb	107	121	0	0	0	0	0	0	50	0	0.35	4.85		
14.06	3Bqgkjb	121	152	0	0	0	0	50	0	0	0	0.31	9.54		
14.07	4Bqgkjb	152	221	0	0	0	0	50	0	0	40	0.38	26.54		
14.08	4Bkjb	221	230	0	0	0	0	70	0	0	0	0.50	4.50		
20.01	Av1	0	8	0	0	0	0	0	0	0	0	0.00	0.00	31.31	0.16
20.02	Av2	8	19	0	0	70	0	0	0	0	0	0.54	5.92		
20.03	Bw	19	42	0	0	0	0	0	0	0	0	0.00	0.00		
20.04	2Btjq	42	64	60	0	0	0	0	0	0	0	0.42	9.31		
20.05	2Btjqk1	64	76	0	0	0	0	0	0	0	0	0.00	0.00		
20.06	2Btjqk2-1	76	114	60	0	0	0	0	0	0	0	0.42	16.08		
20.07	2Btjqk2-2	114	152	0	0	0	0	0	0	0	0	0.00	0.00		
20.08	2Btjqk2-3	152	190	0	0	0	0	0	0	0	0	0.00	0.00		
5.01	A	0	5	0	0	0	0	0	0	0	0	0.00	0.00	63.42	0.24
5.02	Bw	5	20	0	0	0	0	0	0	0	0	0.00	0.00		
5.03	Bk	20	45	0	0	0	0	0	0	0	0	0.00	0.00		
5.04	2Btb	45	56	0	0	0	65	75	0	0	0	0.65	7.19		
5.05	2Btqgkb	56	106	70	0	0	0	0	0	0	0	0.50	25.00		
5.06	2Ktqb	106	164	70	0	0	0	0	0	0	0	0.54	31.23		
5.07	2Cqn	164	263	0	0	0	0	0	0	0	0	0.00	0.00		

br, bridge; po,pore; pf,ped face; cl,clast

Sample	Horizon	Depth (cm)	br #1	br #2	po #1	po #2	pf #1	pf #2	cl #1	cl #2	Normal prop	X thick	Profile prop	Weigh mean
			CLAY FILM INDEX											
18.01	Av	0	11	0	0	0	0	0	0	0	0	0.00	0.00	39.58	0.25
18.02	A	11	33	0	0	0	0	0	0	0	0	0.00	0.00		
18.03	Bt	33	40	0	0	60	0	0	0	0	0	0.42	2.96		
18.04	2Btqk1	40	66	0	0	70	0	0	0	0	0	0.77	20.00		
18.05	2Btqk	66	120	0	0	0	0	50	0	0	0	0.31	16.62		
18.06	3kb	120	160	0	0	0	0	0	0	0	0	0.00	0.00		
8.01	Av	0	9	0	70	80	0	0	0	0	0	0.77	6.92	46.62	0.22
8.02	Bt1	9	21	0	0	0	0	100	0	0	0	0.81	9.69		
8.03	2Bt2	21	35	0	0	0	0	90	0	0	0	0.69	9.69		
8.04	2kqm	35	68	80	0	0	0	0	0	0	0	0.62	20.31		
8.05	2k	68	100	0	0	0	0	0	0	0	0	0.00	0.00		
8.06	2Ck	100	210	0	0	0	0	0	0	0	0	0.00	0.00		
16.01	Av	0	13	0	0	0	40	0	0	0	0	0.23	3.00	12.23	1.02
16.02	Bw	13	30	0	0	0	0	0	0	0	0	0.00	0.00		
16.03	Bt	30	42	0	0	0	0	0	0	0	0	0.00	0.00		
16.04	2Btqk	42	58	0	0	0	0	80	0	0	0	0.62	9.23		
16.05	2kq	58	100	0	0	0	0	0	0	0	0	0.00	0.00		
16.06	2Bqm (m2)	100	150	0	0	0	0	0	0	0	0	0.00	0.00		
16.07	2Bqm	100	150	0	0	0	0	0	0	0	0	0.00	0.00		
16.08	2Ckqm	150	207	0	0	0	0	0	0	0	0	0.00	0.00		
1.01	A	0	10	0	0	0	0	0	0	0	0	0.00	0.00	16.58	0.06
1.02	Bt	10	25	0	0	0	0	0	0	0	0	0.00	0.00		
1.03	2Btqb1	25	42	0	0	0	0	70	0	0	0	0.50	8.50		
1.04	2Btqb2	42	56	0	0	0	0	80	0	0	0	0.58	8.08		
1.05	3Kqmb1	56	70	0	0	0	0	0	0	0	0	0.00	0.00		
1.09	4Kqmb2	70	115	0	0	0	0	0	0	0	0	0.00	0.00		
1.10	5Bk	115	167	0	0	0	0	0	0	0	0	0.00	0.00		
1.11	5Cnk	167	195	0	0	0	0	0	0	0	0	0.00	0.00		
1.12	5Cn	195	290	0	0	0	0	0	0	0	0	0.00	0.00		
19.01	Av1	0	4	0	0	0	0	0	0	0	0	0.00	0.00	19.73	0.00
	Av2	4	9	0	0	40	0	0	0	0	0	0.23	1.15		
19.03	Bk	9	13	0	0	0	0	0	0	0	0	0.00	0.00		
19.04	Bw	13	17	0	0	0	0	0	0	0	0	0.00	0.00		
19.05	Btqm	17	29	70	0	0	0	0	0	0	0	0.54	6.46		
19.06	2Ktqm	29	47	0	0	0	0	85	0	0	0	0.67	12.12		
19.07	2Kqm1	47	72	0	0	0	0	0	0	0	0	0.00	0.00		
19.08	2Kqm2	72	150	0	0	0	0	0	0	0	0	0.00	0.00		

br, bridge; po,pore; pf,ped face; cl,clast

Sample	Horizon	Depth (cm)	br #1	br #2	po #1	po #2	pf #1	pf #2	cl #1	cl #2	Normal prop	X thick	Profile prop	Weigh mean
			CLAY FILM INDEX											
6.01	Av	0	6	0	0	0	0	0	0	0	0	0.00	0.00	1.69	0.00
6.02	Bt	6	10	0	0	0	0	60	0	0	0	0.42	1.69		
6.03	2Btqm	10	52	0	0	0	0	0	0	0	0	0.00	0.00		
6.04	3Btmq	52	101	0	0	0	0	0	0	0	0	0.00	0.00		
6.05	3Btq	101	153	0	0	0	0	0	0	0	0	0.00	0.00		
6.06	3Bkq	153	230	0	0	0	0	0	0	0	0	0.00	0.00		
6.07	3Bkq+	230	300	0	0	0	0	0	0	0	0	0.00	0.00		
2.01	Av	0	3	0	0	0	0	0	0	0	0	0.00	0.00	65.46	0.33
2.02	A	3	10	0	0	0	0	0	0	0	0	0.00	0.00		
2.03	Bv	10	19	0	0	0	0	0	0	0	0	0.00	0.00		
2.04	2Bqmv	19	34	0	60	0	0	0	0	0	0	0.42	6.35		
2.05	2Btqm	34	70	0	0	0	0	80	0	0	0	0.65	23.54		
2.07	kbqm	19	52	0	0	0	0	0	70	0	0	0.50	16.50		
2.08	kq	52	114	0	50	0	0	0	0	0	0	0.31	19.08		
2.09	2k	114	197	0	0	0	0	0	0	0	0	0.00	0.00		
22.01	Av	0	10	0	0	40	0	0	0	0	0	0.23	2.31	7.81	0.04
22.02	Bw	10	21	70	0	0	0	0	0	0	0	0.50	5.50		
22.03	K	21	62	0	0	0	0	0	0	0	0	0.00	0.00		
22.04	kq	62	92	0	0	0	0	0	0	0	0	0.00	0.00		
22.05	Bkqm	92	184	0	0	0	0	0	0	0	0	0.00	0.00		

INDEX VALUE - RUBIFICATION & MELANIZATION ---/

Sample	Horizon	Depth (cm)	Horizon Index (Sum normalized prop/# prop)		% horizon thickness	Profile Index	Weighted Mean
Fwh-1			0.04	0.01	0.00		
Fwh-2			0.17	0.02	0.00		
Fwh-3			0.05	0.01	0.00		
Fwh-4			0.21	0.03	0.00		
Ywh-1			0.06	0.01	0.00		
Ywh-2			0.19	0.03	0.00		
7.01	A	0 1.5	0.41	0.06	0.09	1.23	0.01
7.02	Cox	2 18	0.22	0.03	0.51		
7.03	2Ckox	18 100	0.05	0.01	0.64		
4.01	A	0 3	1.06	0.15	0.45	15.22	0.15
4.02	Bk1	3 9	1.77	0.25	1.51		
4.03	2Bk2	9 60	1.57	0.22	11.45		
4.04	2Ckn	60 100	0.31	0.04	1.80		
17.01	A	0 6	0.98	0.14	0.84	4.10	0.03
17.02	Bw	6 24	0.49	0.07	1.27		
17.03	2Ckr	24 120	0.13	0.02	1.99		
13.01	A	0 9	1.44	0.21	1.86	6.88	0.05
13.02	Bw	9 21	0.79	0.11	1.35		
13.03	2Bqj	21 73	0.37	0.05	2.71		
13.04	2Ckqn	73 138	0.10	0.01	0.96		
15.01	A	0 18	1.16	0.17	2.98	27.03	0.12
15.02	Bw	18 46	1.28	0.18	5.12		
15.03	2Bqk	46 170	0.86	0.12	15.15		
15.05	2Ckn	170 220	0.53	0.06	3.78		
3.01	Av	0 5	1.43	0.20	1.02	24.44	0.12
3.02	Avrj	5 12	2.05	0.29	2.05		
3.03	2Btkj	12 45	2.13	0.30	10.04		
3.04	2Btjqmk1	45 83	1.37	0.20	7.44		
3.05	2Btjqmk2	83 107	1.06	0.15	3.63		
3.06	2Ckqn	107 210	0.02	0.00	0.25		
21.01	Av	0 4	1.73	0.25	0.99	34.85	0.15
21.02	Bw	4 15	1.97	0.28	3.10		
21.03	Bk	15 33	0.58	0.08	1.49		
21.04	2Btjqkjb1	33 55	2.14	0.31	6.72		
21.05	2Btjqmkb1	55 144	1.03	0.15	13.07		
21.06	3Bqmkb2	144 186	1.05	0.15	6.29		
21.07	3Ckqn	186 233	0.34	0.07	3.18		

INDEX VALUE - RUBIFICATION & MELANIZATION --->

Sample	Horizon	Depth (cm)		Horizon Index (Sum normalized prop/# prop)		% horizon thickness	Profile Index	Weighted Mean
11.01	Av	0	4	1.54	0.22	0.88	31.51	0.19
11.02	A	4	15	1.09	0.16	1.72		
11.03	2Btj	15	42	1.71	0.24	6.61		
11.04	2Btqmk	42	90	2.02	0.29	13.84		
11.05	2Bkq	90	150	0.74	0.11	6.37		
11.06	3Bqmkb	150	170	0.73	0.10	2.06		
12.01	Av1	0	4	1.04	0.15	0.60	37.07	0.19
12.02	Av2	4	14	1.06	0.15	1.52		
12.03	Bt	14	47	1.55	0.22	7.32		
12.04	2Bk1	47	105	2.11	0.30	17.46		
12.05	2Bk2	105	120	0.97	0.14	2.08		
12.06	2Btqmkb	120	144	1.89	0.27	6.49		
12.07	Bqkb	144	200	0.14	0.02	1.60		
14.01	A	0	8	1.08	0.15	1.24	37.35	0.16
14.02	Bw	8	28	1.05	0.15	3.01		
14.03	2Bk	28	54	1.20	0.17	4.44		
14.04	2Btjkq	54	107	0.58	0.08	4.36		
14.05	3Bkjb	107	121	1.48	0.21	2.95		
14.06	3Bqmk1b	121	152	1.48	0.21	6.55		
14.07	4Bqmk2b	152	221	1.35	0.19	13.27		
14.08	4Bwjb	221	230	1.19	0.17	1.53		
20.01	Av1	0	8	1.02	0.15	1.16	30.55	0.16
20.02	Av2	8	19	1.86	0.27	2.92		
20.03	Bw	19	42	1.44	0.21	4.72		
20.04	2Btjq	42	64	1.91	0.27	6.01		
20.05	2Btjqk1	64	76	1.35	0.19	2.31		
20.06	2Btjqk2-1	76	114	1.06	0.15	5.78		
20.07	2Btjqk2-2	114	152	0.76	0.11	4.13		
20.08	2Btjqk2-3	152	190	0.65	0.09	3.53		
5.01	A	0	5	0.42	0.06	0.30	32.07	0.12
5.02	Bw	5	20	0.47	0.07	1.00		
5.03	Bk	20	45	0.44	0.06	1.57		
5.04	2Btb	45	56	2.45	0.35	3.84		
5.05	2Btqmkb	56	106	1.67	0.24	11.96		
5.06	2ktqb	106	164	1.39	0.20	11.54		
5.07	2Cqm	164	263	0.13	0.02	1.86		

Sample	Horizon	Depth (cm)		INDEX VALUE - RUBIFICATION & MELANIZATION ---> Horizon Index (Sum normalized prop/# prop)		% horizon thickness	Profile Index	Weighted Mean
18.01	Av	0	11	1.27	0.18	1.99	26.25	0.16
18.02	A	11	33	0.07	0.01	0.21		
18.03	Bt	33	40	1.55	0.22	1.55		
18.04	2Btqk1	40	66	2.62	0.37	9.72		
18.05	2Btqk	66	120	1.12	0.16	8.64		
18.06	3Kb	120	160	0.52	0.10	4.14		
8.01	Av	0	9	2.14	0.31	2.75	36.27	0.17
8.02	Bt1	9	21	3.52	0.50	6.03		
8.03	2Bt2	21	35	2.65	0.38	5.31		
8.04	2Kqm	35	68	2.64	0.38	12.44		
8.05	2r	68	100	1.56	0.22	7.14		
8.06	2Cx	100	210	0.17	0.02	2.60		
16.01	Av	0	13	1.79	0.20	2.59	40.46	3.37
16.02	Bw	13	30	0.95	0.14	2.30		
16.03	Bt	30	43	1.46	0.21	2.71		
16.04	2Btqk	43	58	3.00	0.43	6.43		
16.05	2Kq	58	100	1.33	0.19	7.98		
16.06	2Bqm (nc)	100	150	1.23	0.18	8.76		
16.07	2Bqm	100	150	0.86	0.12	6.11		
16.08	2Ckqm	150	207	0.44	0.06	3.57		
1.01	A	0	10	0.76	0.11	1.08	38.97	0.13
1.02	Bt	10	25	1.08	0.15	2.32		
1.03	2Btqb1	25	42	2.72	0.39	6.60		
1.04	2Btqb2	42	56	2.87	0.41	5.74		
1.08	3Kqmb1	56	70	1.75	0.22	3.07		
1.09	4kqmb2	70	115	1.06	0.18	7.94		
1.10	5Bk	115	167	0.53	0.07	3.41		
1.11	5Cnk	167	195	0.66	0.08	2.32		
1.12	5Cn	195	290	0.55	0.07	6.48		
19.01	Av1	0	4	1.20	0.17	0.69	35.33	0.00
	Av2	4	9	1.68	0.24	1.20		
19.03	Bk	9	13	0.93	0.13	0.53		
19.04	Bw	13	17	1.17	0.17	0.67		
19.05	Btqm	17	29	2.87	0.41	4.92		
19.06	2ktqm	29	47	3.12	0.45	8.04		
19.07	2kqm1	47	72	1.46	0.21	5.21		
19.08	2Kqm2	72	150	1.26	0.18	14.07		

INDEX VALUE - RUBIFICATION & MELANIZATION ---)

Sample	Horizon	Depth (cm)		Horizon Index (Sum normalized prop/# prop)		% horizon thickness	Profile Index	Weighted Mean
6.01	Av	0	6	1.39	0.20	1.19	25.44	0.00
6.02	Bt	6	10	2.20	0.31	1.26		
6.03	2kqm	10	52	1.41	0.23	9.84		
6.04	3kmq	52	101	0.97	0.14	6.77		
6.05	3kq	101	153	0.26	0.04	1.90		
6.06	3Dkq	153	230	0.31	0.04	3.45		
6.07	3Dkqt	230	300	0.07	0.01	1.04		
2.01	Av	0	3	1.21	0.17	0.52	58.12	0.30
2.02	A	3	10	0.89	0.13	0.89		
2.03	Bv	10	19	1.39	0.20	1.78		
2.04	2Bqmky	19	34	2.58	0.37	5.54		
2.05	2Btqmy	34	70	2.97	0.42	15.28		
2.07	ktqm	19	52	2.88	0.41	13.57		
2.08	kq	52	114	1.66	0.24	14.71		
2.09	2k	114	197	0.49	0.07	5.83		
22.01	Av	0	10	1.74	0.25	2.49	39.12	0.21
22.02	Bw	10	21	2.46	0.35	3.90		
22.03	k	21	62	1.94	0.28	11.35		
22.04	km	62	92	1.13	0.16	4.83		
22.05	Bkqm	92	184	1.26	0.18	16.56		

INDEX VALUE - COLOR PALING & COLOR LIGHTENING

Sample	Horizon	Depth (cm)	Horizon Index (Sum normalized prop/# prop)		% horizon thickness	Profile Index	Weighted Mean
FWA-1			0.04	0.01	0.00		
FWA-2			0.17	0.02	0.00		
FWA-3			0.05	0.01	0.00		
FWA-4			0.21	0.03	0.00		
YWA-1			0.06	0.01	0.00		
YWA-2			0.19	0.03	0.00		
7.01	A	0 1.5	0.54	0.08	0.11	1.01	0.01
7.02	Cox	2 18	0.11	0.02	0.26		
7.03	2Ckox	18 100	0.05	0.01	0.64		
4.01	A	0 3	0.96	0.14	0.41	16.12	0.16
4.02	Bk1	3 9	1.88	0.27	1.62		
4.03	2Bk2	9 60	1.66	0.24	12.12		
4.04	2Ckn	60 100	0.34	0.05	1.97		
17.01	A	0 6	0.87	0.12	0.75	6.21	0.05
17.02	Bw	6 24	0.58	0.08	1.48		
17.03	2Ckn	24 120	0.25	0.04	3.98		
13.01	A	0 9	1.21	0.17	1.55	8.97	0.06
13.02	Bw	9 21	0.79	0.11	1.35		
13.03	2Bqz	21 73	0.32	0.05	2.40		
13.04	2Ckqn	73 138	0.39	0.06	3.66		
15.01	A	0 18	1.04	0.15	2.67	20.67	0.09
15.02	Bw	18 46	1.12	0.16	4.47		
15.03	2Bqk	46 170	0.60	0.09	10.66		
15.05	2Ckn	170 220	0.40	0.06	2.87		
3.01	Av	0 5	1.64	0.23	1.17	22.01	0.10
3.02	Avkj	5 12	2.15	0.31	2.15		
3.03	2Btkj	12 45	1.81	0.26	8.55		
3.04	2Btjqmk1	45 83	1.23	0.18	6.65		
3.05	2Btjqmk2	83 107	0.94	0.13	3.23		
3.06	2Ckqn	107 210	0.02	0.00	0.25		
21.01	Av	0 4	1.85	0.26	1.06	30.87	0.13
21.02	Bw	4 15	1.97	0.28	3.10		
21.03	Bk	15 33	0.64	0.09	1.65		
21.04	2Btjqkjb1	33 55	1.91	0.27	6.02		
21.05	2Btjqmkb1	55 144	0.82	0.12	10.40		
21.06	3Bqmkb2	144 186	0.91	0.13	5.46		
21.07	3Ckqn	186 233	0.34	0.07	3.18		

INDEX VALUE - COLOR PALING & COLOR LIGHTENING

Sample	Horizon	Depth (cm)		Horizon Index (Sum normalized prop/# prop)		X horizon thickness	Profile Index	Weighted Mean
11.01	Av	0	4	1.54	0.22	0.88	32.43	0.19
11.02	A	4	15	1.09	0.16	1.72		
11.03	2Btj	15	42	1.50	0.21	5.80		
11.04	2Btqmk	42	90	2.14	0.31	14.69		
11.05	2Bkq	90	150	0.78	0.11	6.71		
11.06	3kqmkb	150	170	0.92	0.13	2.63		
12.01	Av1	0	4	0.98	0.14	0.56	38.22	0.19
12.02	Av2	4	14	1.06	0.15	1.52		
12.03	Bt	14	47	1.62	0.23	7.62		
12.04	2Bk1	47	105	2.22	0.32	18.36		
12.05	2Bk2	105	120	0.76	0.11	1.63		
12.06	2Btqmkb	120	144	2.02	0.29	6.93		
12.07	Bqkb	144	200	0.14	0.03	1.60		
14.01	A	0	8	1.21	0.17	1.38	35.55	0.15
14.02	Bw	8	28	1.05	0.15	3.01		
14.03	2Bk	28	54	1.09	0.16	4.05		
14.04	2Btjkq	54	107	0.65	0.09	4.98		
14.05	3Bkjb	107	121	1.34	0.19	2.69		
14.06	3Bqmk1b	121	152	1.37	0.20	6.09		
14.07	4Bqmk2b	152	221	1.24	0.18	12.23		
14.08	4Bkjb	221	230	0.88	0.13	1.13		
20.01	Av1	0	8	0.85	0.12	0.97	22.54	0.12
20.02	Av2	8	19	1.83	0.26	2.88		
20.03	Bw	19	42	1.28	0.18	4.20		
20.04	2Btjq	42	64	1.48	0.21	4.65		
20.05	2Btjqk1	64	76	0.91	0.13	1.56		
20.06	2Btjqk2-1	76	114	0.75	0.11	4.06		
20.07	2Btjqk2-2	114	152	0.44	0.06	2.41		
20.08	2Btjqk2-3	152	190	0.33	0.05	1.81		
5.01	A	0	5	0.44	0.06	0.31	33.44	0.13
5.02	Bw	5	20	0.35	0.05	0.75		
5.03	Bk	20	45	0.70	0.10	2.51		
5.04	2Btb	45	56	2.07	0.30	3.25		
5.05	2Btqmkb	56	106	1.36	0.20	9.85		
5.06	2Ktqb	106	164	1.51	0.22	12.55		
5.07	2Cqn	164	263	0.30	0.04	4.22		

INDEX VALUE - COLOR PALING & COLOR LIGHTENING

Sample	Horizon	Depth (cm)		Horizon Index (Sum normalized prop/# prop)		% horizon thickness	Profile Index	Weighted Mean
18.01	Av	0	11	1.45	0.21	2.28	26.46	0.17
18.02	A	11	33	0.25	0.04	0.80		
18.03	Bt	33	40	1.45	0.21	1.45		
18.04	2Btqkj	40	66	2.33	0.33	8.65		
18.05	2Btqk	66	120	1.19	0.17	9.15		
18.06	3kb	120	160	0.52	0.10	4.14		
8.01	Av	0	9	2.14	0.31	2.75	35.97	0.17
8.02	Bt1	9	21	2.91	0.42	4.99		
8.03	2Bt2	21	35	2.38	0.34	4.75		
8.04	3kqm	35	68	2.44	0.35	11.48		
8.05	3k	68	100	1.99	0.28	9.08		
8.06	3Ck	100	210	0.19	0.03	2.91		
16.01	Av	0	13	1.16	0.17	2.15	33.95	2.83
16.02	Bw	13	30	0.78	0.11	1.90		
16.03	Bt	30	43	1.19	0.17	2.20		
16.04	2Btqk	43	58	2.78	0.40	5.95		
16.05	2kq	58	100	1.59	0.23	9.52		
16.06	2Bqm (nc)	100	150	0.91	0.13	6.51		
16.07	2Bqm	100	150	0.54	0.08	3.85		
16.08	2Ckqm	150	207	0.23	0.03	1.66		
1.01	A	0	10	0.93	0.13	1.32	42.34	0.15
1.02	Bt	10	25	1.02	0.15	2.19		
1.03	2Btqb1	25	42	2.39	0.34	5.80		
1.04	2Btqb2	42	56	2.44	0.35	4.87		
1.08	3kqmb1	56	70	2.38	0.30	4.16		
1.09	4kqmb2	70	115	1.06	0.18	7.94		
1.10	5Bk	115	167	1.05	0.13	6.85		
1.11	5Cnk	167	195	0.60	0.07	2.09		
1.12	5Cn	195	290	0.60	0.07	7.10		
19.01	Av1	0	4	1.43	0.20	0.82	36.12	0.00
	Av2	4	9	1.97	0.26	1.41		
19.02	Br	9	13	0.97	0.14	0.55		
19.04	Bw	13	17	1.02	0.15	0.59		
19.05	Btqm	17	29	2.69	0.38	4.61		
19.06	2ktqm	29	47	3.30	0.47	8.48		
19.07	2kqm1	47	72	1.77	0.25	6.32		
19.08	2kqm2	72	150	1.20	0.17	13.34		

INDEX VALUE - COLOR PALING & COLOR LIGHTENING

Sample	Horizon	Depth (cm)		Horizon Index (Sum normalized prop/# prop)		X horizon thickness	Profile Index	Weighted Mean
6.01	Av	0	6	1.27	0.18	1.09	26.52	0.00
6.02	Bt	6	10	1.91	0.27	1.09		
6.03	2kqm	10	52	1.43	0.24	10.00		
6.04	3kmq	52	101	0.82	0.11	5.57		
6.05	3kq	101	153	0.70	0.10	5.22		
6.06	3Bkq	153	230	0.23	0.03	2.51		
6.07	3Bkq+	230	300	0.07	0.01	1.04		
2.01	Av	0	3	1.34	0.19	0.57	65.05	0.33
2.02	A	3	10	0.91	0.13	0.91		
2.03	Bv	10	19	1.16	0.17	1.49		
2.04	2Bqmv	19	34	2.30	0.33	4.93		
2.05	2Btqmv	34	70	2.49	0.36	12.81		
2.07	2Btqm	19	52	3.08	0.44	14.53		
2.08	2q	52	114	2.11	0.30	18.67		
2.09	2k	114	197	0.94	0.13	11.14		
22.01	Av	0	10	1.99	0.25	2.84	40.11	0.22
22.02	Bw	10	21	2.00	0.29	3.14		
22.03	K	21	62	2.14	0.31	12.55		
22.04	Km	62	92	1.37	0.20	5.89		
22.05	Bkqm	92	184	1.19	0.17	15.69		

Appendix C. Laboratory Methods--particle size distribution (PSD), bulk density, percent carbonate, gypsum and soluble salts, percent organic carbon and loss on ignition (LOI), pH, silica, and clay mineralogy.

Particle Size Distribution (PSD)

Percent gravel (>2 mm) was measured on a weight basis by sieving the bulk sample in the laboratory. Measurements were checked with field estimates to make sure that gravel in bouldery deposits was not underestimated. If percent gravel was thought to have been underestimated, the value was corrected with field observations.

Carbonate, organic matter and then silica were removed before particle size analyses (Day, 1965). Carbonate was removed with 1N NaOAc or 10% HCl, and organic matter with either dilute H_2O_2 or "Clorox" bleach. Samples were heated in a water bath to just below boiling until the reaction was complete and subsequently rinsed before the next pretreatment. Pedogenic silica was removed by heating the sample in a 5% Na_2CO_3 solution to just below boiling. One hundred ml of solution was used for each 25 gm sample. Each sample was treated for about one hour, then rinsed. Treatment was repeated three times. However, samples from horizons that were well-cemented were treated up to 12 hours before being rinsed. PSD size fractions were measured in phi units, but will be reported in USDA size classes (Table 1). Sand, silt, and clay boundaries are equal in both methods; the major discrepancy is in the silt size fraction.

Table 1: Particle Sizes in Phi units and USDA Size Classes

mm	Measured US Std sieve mesh number	Phi unit	Reported USDA Size Classes
2.0			
1.0	18	0	very coarse sand (2.0-1.0 mm)
0.5	35	1	coarse sand (1.0-0.5 mm)
0.25	60	2	medium sand (0.5-0.25 mm)
0.125	120	3	fine sand (0.25-0.10 mm)
0.053	270	4.25	very fine sand (0.10-0.05 mm)
<0.031	pipet	5	co + med silt (0.05-0.02 mm)
<0.0156	"	6	fi + vfi silt (0.02-0.002 mm)
<0.00195	"	9	co + med clay (0.002-0.0005 mm)
<0.00049	"	11	fine clay (<0.0005 mm)
2.0-0.053		0-4.25	**total sand** (2.0-0.5 mm)
0.053-0.00195		5-6	**total silt** (0.05-0.002 mm)
<0.00195		9-11	**total clay** (<0.002 mm)

Bulk Density

Three to eight bulk density (BD) measurements were made on paraffin-coated ped samples from each horizon (Chleborad and others, 1975). After the density was measured, each ped was opened to assure that gravel was not present. In horizons where large percentages of gravel were unavoidable in the ped samples, measured bulk density was adjusted to account for the bulk density of the gravel. Equation (1.1) was used for gravelly ped samples to estimate the bulk density of the <2 mm fraction. The assumption is made that the known percent gravel measured from the bulk sample, not the ped sample, has a bulk density of 2.6 gm/cm^3

$$BD_{<2mm} = \frac{(\text{gm} < 2\text{ mm})}{(\text{cm}^3\text{ total volume}) - ((\text{gm} > 2\text{ mm})/(2.6\text{ gm/cm}^3))} \quad \textbf{Equation (1.1)}$$

The excavation method and Equation (1.1) were used to determine the bulk density of the fresh alluvium samples for Fortymile Wash and Yucca Wash alluvium. A shallow hole in the surface of the fresh alluvium was lined with a plastic bag, then filled with water to determine the volume. The weight of the > and <2 mm fractions were measured in the laboratory. Bulk density means and standard deviations were calculated for each horizon. When the standard deviation exceeded 0.1 gm/cm^3, the outlying density values were omitted.

Percent Carbonate, Gypsum and Soluble Salts

Pedogenic carbonate was measured on a Chittick apparatus (Dreimanis, 1962). Gypsum and soluble salts were measured in solution by electro-conductivity (Marith Reheis, U.S. Geological Survey, written communication, 1984).

Percent Organic Carbon and Loss on Ignition (LOI)

Organic carbon was measured using the Walkley-Black titration procedure (Allison, 1965). Loss on ignition (LOI) was calculated by the difference in weight loss at heat treatments of 105°C for 4 hours (soil moisture factor) and 540°C for 1 hour.

pH

pH was measured in a ratio of 1:1 soil:water slurry. After 1 hour of equilibration, samples were stirred with the electrode, allowed to stand for 1 minute, and then the pH was read.

Silica

The weight loss after the removal of carbonate, organic matter and silica cement is used to estimate the percent extractable pedogenic silica (Appendix C). The known percent of carbonate and organic matter are used to calculate the weight loss of these materials, and the remaining weight loss assumed to approximate the percent silica. Although this estimate is referred to as a percentage, it is at best an index or trend that correlates to field observations in relative amounts of pedogenic silica.

Clay Mineralogy

X-ray diffraction traces (CuK alpha radiation) were run on oriented samples of the clay and silt fractions on a 'MINIFLEX' defractometer. Samples were run air-dried, glycolated, and heated to 300°C and 500°C each for one hour. Tiles were placed face down on a glycol-saturated towel, instead of saturating in a desiccator.

Appendix D. Effects on the particle size distribution and clay mineralogy after the removal of opaline silica.

All of the particle size fractions were effected by the removal of silica. Particle size distribution for YW-16 was compared before and after silica removal (Table 1). The surface soil at YW-16 is late Pleistocene to early Holocene and due to the lack of silica cement, responded very differently to treatment than did the underlying buried mid-Pleistocene soil. Percentages of sand and clay increase or are virtually unchanged in the younger soil, whereas the percentage of silt decreases. This is probably due to (1) dissolving silica-cemented aggregates in the silt fraction, and (2) total or partial dissolving of silt particles high in silica. The latter could be the major cause as much of the ash and phytoliths are silt size. In contrast, the same treatment of samples of the buried soil results in major losses in the sand fraction and corresponding gains in the clay-size fraction (Table 1, Fig. 1). This seems to be due to the dissolution of the silica cement.

There are problems related to the above assumption that only the dissolution of pedogenic silica influences the PSD results. X-ray diffraction proves that some clays, notably tobermorite, are destroyed (Fig. 2). However this alone may not noticeably effect the abundance of clay-size fraction unless the mineral is abundant and is dissolved.

Synthetic Nepheline (Nepheline (syn)) were produced in the laboratory after samples were dispersed with sodium hexametaphosphate and (or) treated with sodium hydroxide to remove pedogenic silica cement. Nepheline has not been recognized in any of the rocks in the study area (Quinlivan and Byers, 1977).

Table 1. Comparison of sand, silt and clay before (1) and after (2) silica removal on soil profile YW-16. +'s represent a relative gain in the size fraction after the removal of opaline SiO_2, and -'s a relative loss.

Horizon		% sand	% silt	%clay	texture
Av	(1)	59.60	28.90	11.60	SL
	(2)	68.88	16.39	14.73	SL
		+9.28	-12.51	+3.13	
Bt1	(1)	48.37	40.30	11.30	L
	(2)	66.15	16.57	17.28	SL
		+17.78	-23.73	+5.98	
Bt2	(1)	57.00	26.30	16.60	SL+
	(2)	62.77	21.73	15.50	SL+
		+5.77	-4.57	-1.10	
2Btqkb	(1)	63.48	32.30	4.08	SL
	(2)	31.01	21.54	47.45	C
		-32.47	-10.76	+43.37	
2Kqb	(1)	80.30	14.50	5.20	LS
	(2)	42.93	24.88	32.18	CL
		-37.37	+10.38	+26.98	
2Bqmkb-1	(1)	82.74	16.00	1.10	LS
	(2)	69.16	14.68	16.17	SL
		-13.56	-1.32	+15.07	
2Bqmkb-2	(1)	74.60	22.90	2.60	LS
	(2)	56.24	24.11	19.65	SL+
		-18.36	+1.21	+17.05	
2Ckqnb	(1)	87.00	11.30	1.51	S
	(2)	82.16	12.31	5.53	LS
		-4.84	+1.01	+4.02	

Table 1 continued.

depth	% v co s before	% v co s after	% v co s % change	% co s before	% co s after	% co s % change
13	7.9	3.3	-4.6	6.0	3.8	-2.2
30	3.5	3.0	-0.5	4.3	3.1	-1.2
43	5.2	3.1	-2.1	5.2	3.0	-2.2
58 *	18.9	4.1	-14.8	14.8	4.4	-10.4
100 *	24.4	7.1	-17.3	18.8	5.2	-13.6
150 (1)*	20.2	9.8	-10.4	17.3	10.4	-6.9
150 (2)*	14.6	6.8	-7.8	14.8	5.0	-9.8
207+ *	40.5	18.0	-22.5	26.6	20.0	-6.6

depth	% med s before	% med s after	% med s % change	% fi s before	% fi s after	% fi s % change
13	6.4	7.4	1.0	37.8	31.0	-6.8
30	4.9	6.8	1.9	35.6	28.8	-6.8
43	6.4	6.2	-0.2	39.3	26.5	-12.8
58 *	10.4	4.3	-6.1	19.3	9.0	-10.3
100 *	13.0	6.0	-7.0	19.7	12.3	-7.4
150 (1)*	13.8	11.8	-2.0	31.4	20.2	-11.2
150 (2)*	13.9	7.9	-6.0	30.1	17.9	-12.2
207+ *	9.0	17.2	8.2	10.4	15.6	5.2

depth	% v fi s before	% v fi s after	% v fi s % change
13	1.5	23.4	21.9
20	0.1	24.4	24.3
43	0.9	24.0	23.1
58 *	0.1	9.1	9.0
100 *	4.4	12.4	8.0
150 (1)*	0.0	17.0	17.0
150 (2)*	1.2	18.6	17.4
207+ *	0.5	11.3	10.8

* Field recognizable silica accumulations

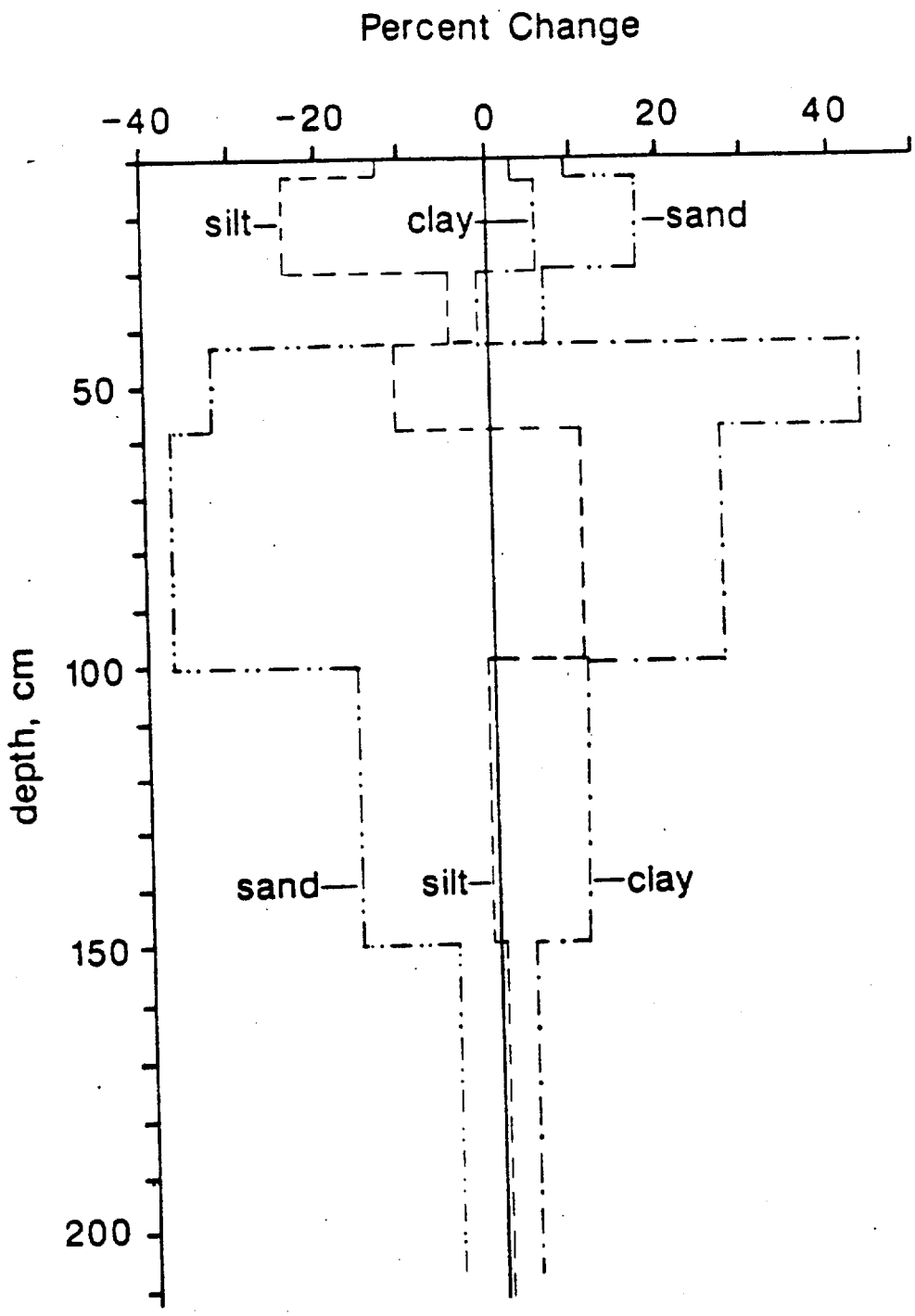

Figure 1. Percent change in particle size classes due to the removal of pedogenic silica cement in profile YW-16. Total % sand, % silt, and % clay are plotted vs depth.

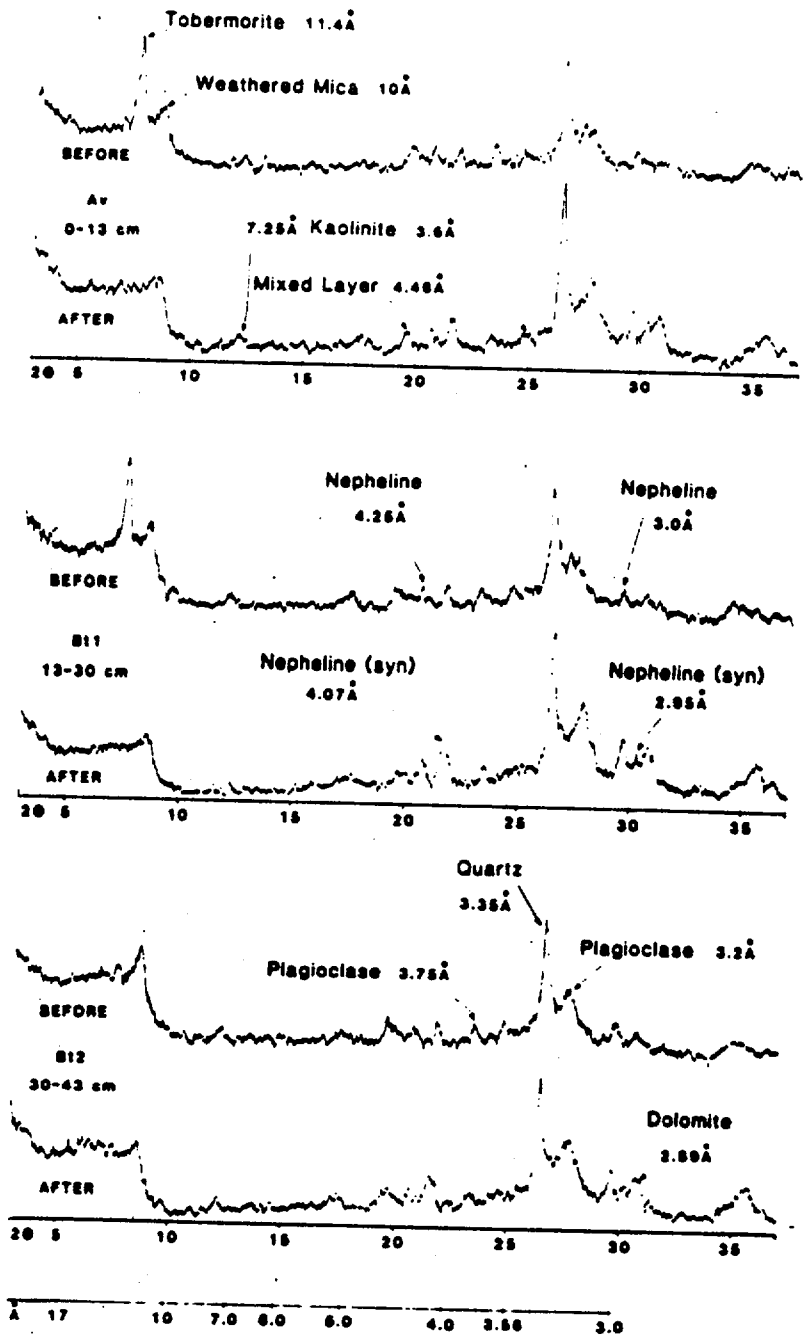

Figure 2. An example of clay mineralogy alteration owing to the removal of pedogenic silica. Traces are for profile YW-16 before and after the removal of pedogenic silica. The three horizons in a depth sequence all have approximately 15% clay, with a net gain or loss of +5 to -1% after treatment (Table 1). Tobermorite is the only clay mineral destroyed by the treatment.

Appendix E. Laboratory procedure for measuring pedogenic opaline silica using a spectrophotometer.

Introduction

There is little agreement on the best method to extract and measure pedogenic silica (Jackson, 1969; Yuan and Breland, 1969; Elgawhary and Lindsay, 1972; Torrent and others, 1980; Hallmark and others, 1982). A summary of the literature and subsequent laboratory tests produced an extraction and colorimetric determination to most accurately measure pedogenic silica

This procedure is based on the reaction of dissolved silica and ammonium molybdate in an acid medium (pH 1.0-2.0) to form the yellow silicomolybdate complex which is subsequently reduced by sodium sulfite to form blue molybdosilicate (Mo-blue). Because phosphate produces a similar molybdate complex that absorbs in the same wavelength range, oxalic acid is added to suppress phosphate interference.

All reactions when possible should be carried out in Ni, stainless steel, or plastic (polypropylene or nalgene) containers to avoid Si contamination from glass. Where plastic is specifically stated, either of the other two container types can be used. Glassware is used for dilutions, prolonged contact (>2 hours) with glass is not recommended.

Summary of Procedure

1) Grind, oven-dry, then weigh 1.0 gm soil sample for Si extraction.

2) Disperse by sonication

3) Remove both cementing agents $CaCO_3$ and iron-oxides, and organic matter.

4) Mix all the necessary reagents and working standard.

5) Extract soil silica.

6) Pipet working standard and sample aliquots into volumetric flasks.

7) Add reagents.

8) Run samples on spectrophotometer - consider time to warm up spectrophotometer if necessary.

Soil Sample Preparation

1) Sieve soil and crush to desired size. The size should vary with the largest particle size of your sample. A suggested size would be slightly larger that the dominant size fraction in fine-grained deposits (e.g., medium sand for a loess parent material), and ground finer in coarse-grained deposits. Only 1.0 gm of sample is required for the procedure.

2) Oven dry sample for one hour at 105°C, then lightly crush in an agate mortar to break up aggregates.

3) Weigh 1.0 gm of sample.

4) Wash sample with distilled water into a plastic centrifuge tube or bottle, filling to half the volume. Disperse by sonication (Busacca and others, 1984) for 10 minutes. Choose the sonicator setting that produces the most cavitation bubbles within the sample. To find that setting, simulate the sonication step with water only and same container so you can see the bubble action. Starting from the zero setting, as you

turn the dial, the number of bubbles is the setting to use for you samples. It is important to stir the sample while it is being sonicated, otherwise the grains just pack together at the bottom of the container and do not get the full benefit of the treatment. Since conventional stirrers do not fit inside the centrifuge tubes, Sharon Feldman (Dept. of Agronomy and Soils, Washington State University, Pullman, written communication, 1984) suggests blowing air into the sample. This is simply done with tygon tubing connected to the lab bench air valve. Blow in just enough air to keep the soil in suspension. Once the sonicator is on, it does not take much air to keep the soil in suspension.

5) Remove carbonate then organic matter with the same procedures used in grain size analysis, but do not remove the sample from the plastic tube. It is not necessary to remove organic matter from soils that contain very little of it (e.g., arid environment soils with <1% organic matter). If appreciable amounts of free iron oxides are present, they should also be removed by the dithionite method (Jackson, 1969).

6) Wash samples with distilled water. Centrifuge for a half an hour at a setting between 2500 and 3000 rpm, or until the supernatant is clear. Repeat if necessary. The time may vary for individual samples.

Reagents

6 N HCl - Dilute 50 ml concentrated HCl (37% or 12.1 N) to 100 ml.

Ammonium molybdate solution - Dissolve 100 gm ammonium paramolybate tetrahydrate (**ammonium molybdate**) [$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$] in 600 ml H_2O, warm and stir to obtain complete dissolution. When cool, transfer to a volumetric flask, adjust pH to 7-8 with concentrated **NaOH** and dilute to 1.0 liter. 2 ml/sample is used.

Oxalic acid solution - Dissolve 100 gm **oxalic acid** ($C_2H_2O_2 \cdot H_2O$) and dilute to 1.0 liter. 2 ml/sample is used.

Reducing Agent - Dissolve 0.5 gm **1-amino-2-napthol-4-sulfonic acid** and 1 gm **anhydrous sodium sulfite** (Na_2SO_3) in 50 ml water. Dissolve 30 gm **sodium bisulfite** ($NaHSO_3$) in 150 ml water. Mix the two solutions in a plastic bottle and allow the reagent to sit for a few hours in the refrigerator. The supersaturated solution should form a precipitate that must be filtered before use. If the precipitate is not allowed to form before using, it will form a white precipitate in your colored samples. If this happens throw the samples out and start again with a reducing agent that has formed a precipitate and has been filtered. Refrigerate this reagent when not in use; it is unstable and should be made fresh every week. Total volume 200 ml. 2 ml/sample is used.

Silica Extraction

1) Amorphous soil silica is extracted with **0.5 N KOH or 0.5 N NaOH.** Sharon Feldman (Dept. of Agronomy and Soils, Washington State University, Pullman, written communication, 1984) prefers to use KOH because it is less damaging to the silicate clay minerals. See Jackson (1969, Sec. 11-27) for quantitative measure of the kaolinite and halloysite peaks following NaOH extraction of Si. Dissolve 2.3 gm reagent grade KOH pellets, or 2.0 gm NaOH pellets, in 100 ml of H_2O ia a plastic container, or dilute stock KOH or NaOH solutions to 0.5 N.
2) Soil:solution ratio is 1:50 (1 gm/50 ml or 0.5 gm/25 ml). Perform the entire extraction procedure under a fume hood.
3) Prepare a boiling water bath. It is important that the temperature remain stable. Heat the 0.5 N KOH (or NaOH) solution to 100°C.
4) Place the room temperature sample in a plastic container, in the bath, and add the correct amount of heated 0.5 N KOH (or NaOH). Allow reaction to continue for exactly 2.5 minutes (Torrent and others, 1980).
5) Remove from hot bath, and cool rapidly in an ice water bath. Remove and centrifuge the sample for 10 minutes at 1600 rpm, then immediately decant the 50 ml of supernatant into a 100 ml volumetric flask.
6) Add 10 ml room temperature 0.25 N KOH (or NaOH) per 1.0 gm sample to centrifuge tube. Mix well. Centrifuge and decant into the 100 ml volumetric flask containing the original 50 ml of extract. This completes the removal of amorphous Si.

7) Dilute to volume with distilled H_2O.

Standard Silica Solution

Stock Solution (use 1 or 2)

1) Clean pure **quartz crystal** in concentrated HCl for one hour, then rinse. Grind quartz to pass through a 100 mesh sieve. Heat quartz to redness in a crucible for a brief period to dry. Cool and store in an air tight vial. Add 0.1070 gm ground quartz to a Ni crucible containing 2.0 gm **solid NaOH**. Cover crucible and heat to a dull red for at least 10 minutes. After melt is cooled, dissolve in 50 ml of water and allow to sit overnight. The next day acidify with 1 N H_2SO_4 to a pH of 1.5. Transfer to a 1.0 liter volumetric flask and dilute to volume. Resulting stock solution is 50 mg Si/l (ug/ml or ppm). Store in a plastic bottle.

2) Use atomic absorption **silicon standard** available through American Scientific Products (1984-85 Cat # S7385-14, $13.91), 500 ml of 1000 mg Si/l.

Working Stock

1) Dilute 20 ml of the 50 mg Si/l standard stock (1) to 200 ml for a final concentration of 5 mg Si/l.

2) Dilute 1 ml of the 1000 mg Si/ l standard stock (2) to 200 ml. (1000 ug Si/ml)(1 ml/200 ml) = (5 ug Si/ml) = 5 mg Si/l.

Procedure

1) Add 1.0 ml 6 N HCl to a 50 ml volumetric flask and bring to volume with distilled H_2O.

Standard Curve Development

2) Pipette 1, 5, 10, 15, 20, (30, 40, 50) ml of the working stock into the 50 ml volumetric flasks. Use distilled water for your zero standard. When they are brought to volume (see instructions below), these standards will contain 0, 0.1, 0.5, 1.0, 1.5, 2.0, (3.0, 4.0, 5.0) mg Si/l. Label them.

Sample Color Development

3) Add a 1 ml aliquot of sample solution, from the silica extraction, to the volumetric flasks.

This next section applies to all standards and samples. Best results are obtained if the same period of time is allowed for color development in the standards and samples. Be careful to label everything.

4) Wash sides of flasks down carefully and dilute to 30 ml.
5) Add 2.0 ml ammonium molybdate solution
6) Swirl to mix and allow to react for 20 minutes. Yellowish color develops if Si is present.
7) Add 2.0 ml oxalic acid solution. Mix and let stand 10 minutes to complex any phosphates which may be present. Do not allow to stand much more that 10 minutes or low Si results will be obtained.

8) Add 2.0 ml reducing solution and take to volume with distilled water.

9) Wait 20 minutes for complete reaction. It will be blue if Si is present. NOTE: If a sample solution develops to a darker blue than the highest standard (2.0 or 5.0 mg Si/l), either 1) make a higher standard >2.0 mg Si/l, 2) redo it with a smaller sample aliquot, or 3) dilute the original (unknown) Si extract and use a 1.0 ml or larger aliquot.

10) Mix the solutions well. Measure the absorbence with a red phototube at 625 um. Adjust the sensitivity multiplier to position 2. The first cruvette should always contain the 0 standard. Measure standards at least three times.

11) If you have to redo any number of samples make up a new set of standards. They should be stable over the one half to one hour it take to do the initial reading, but no longer.

Comments

1) Aging of reagents changes the standard curve. Always run standard solutions with samples as a check.

2) Variation in sample temperature shows little colorimetric effect. Permissible range is 18-29°C (65-85°F)

Calculations

Determine the mg of Si in each sample from a regression on the absorbences of the standards:

1) Calculate the linear regression for the standards where

$$x = \text{mg Si/l of standard}$$

$$y = \text{absorbence reading}$$

The correlation (r^2 between x and y should approximate 1.0.

2) Take the calculated linear regression and solve for the curve value.

$$\text{absorbence} = b(\text{curve value}) + a$$

$$\text{curve value} = (\text{absorbence} - a)/b$$

3) Use this equation to determine the curve value of the Si in mg Si/l.

4)

$$\% \text{ Si} = \frac{\left(\frac{\text{mg Si}}{\text{ml}}\right)\left(\frac{\text{ml Mo-blue soln}}{\text{ml sample aliquot}}\right)(\text{ml diluted extract})\ 1000}{\text{gm oven-dried soil}}$$

(1000 combines conversion of mg Si to gm Si and conversion to %)

If you 1) use 50 ml volumetric flasks for Mo-blue solution, 2) dilute 50 ml Si extract to 100 ml, 3) use a 1 ml sample aliquot for Mo blue determination, and 4) use 1.0 gm soil, the calculation is:

$$\% \text{ Si} = \frac{\left(\frac{\text{mg Si}}{1}\right)\left(\frac{50 \text{ ml}}{1.0 \text{ ml}}\right)(100 \text{ ml})\ 1000}{1.0 \text{ gm}}$$

Appendix F. Laboratory Analyses--particle size, bulk density, carbonate, gypsum, soluble salts, organic carbon, oxidizable organic matter, loss on ignition, pH, and silica by weight. Starred (*) bulk density values are estimations.

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	Gravel %	SAND vco	SAND co	SAND med	SAND fi	SAND vfi	SILT co+m	SILT fi+vfi	CLAY co+med	CLAY fi
D1a	FWA-1		FWA-1				51	12.76	14.25	27.16	26.76	13.44	3.58	0.94	0.51	0.60
	FWA-2		FWA-2				0	0.57	2.29	9.97	24.56	37.39	11.31	1.91	0.96	1.04
	FWA-3		FWA-3				41	19.47	33.75	31.80	10.11	3.41	0.60	0.26	0.17	0.43
	FWA-4		FWA-4				60	23.17	30.57	28.83	10.46	2.59	1.61	1.15	0.35	1.27
D1a	YWA-1		YWA-1				67	29.44	40.69	22.67	5.52	0.82	0.25	0.17	0.08	0.74
	YWA-2		YWA-2				58	17.08	34.09	31.02	12.97	3.13	0.43	0.51	0.26	0.51
D1b	FW-7	3380	7.01	Ak	0	2	18	7.24	12.70	23.60	28.50	21.33	4.23	0.69	0.57	1.14
			7.02	Cox	2	18	12	6.79	9.37	19.58	31.09	24.00	5.50	1.03	1.26	1.76
			7.03	2Cox	18	100	63	20.86	26.91	25.69	14.81	7.14	2.12	1.12	0.45	0.87
D1c	FW-4	3300	4.01	Al	0	3	19	2.33	3.49	7.79	32.62	40.32	6.65	2.72	1.66	2.42
			4.02	Btjk	3	9	7	1.60	3.25	9.16	34.42	33.32	5.07	5.58	4.39	3.21
			4.03	2Btk	9	60	28	3.39	4.76	8.89	22.27	32.11	11.97	5.00	6.97	4.65
			4.04	2Cuk	60	100	67	8.56	8.27	12.82	21.91	30.47	10.45	3.43	1.63	2.45
D1c	FW-17	3540	17.01	A	0	6	40	9.12	8.60	10.77	17.98	23.60	21.05	4.00	1.91	2.56
			17.02	Bwl	6	24	40	9.32	10.16	13.26	18.84	24.61	15.65	3.66	1.67	2.53
			17.03	2Cuk	24	120	75	19.59	27.06	20.82	15.11	10.13	3.75	1.25	0.68	1.59
D1c	YW-13	4155	13.01	A	0	9	53	12.77	14.30	15.95	18.33	20.40	9.84	3.94	1.79	2.68
			13.02	Bw	9	21	33	8.27	10.29	15.74	21.44	24.82	9.71	3.75	2.56	3.41
			13.03	2Bqj	21	73	48	17.01	19.53	18.47	16.65	15.90	5.45	2.73	1.53	2.73
			13.04	2Cqn	73	138	67	15.85	25.78	21.06	16.39	13.28	3.31	1.60	1.03	0.51
D1c	YW-15	4520	15.01	A	0	18	55	19.73	16.07	10.51	13.17	18.88	10.99	5.07	2.37	3.21
			15.02	Bw	18	46	62	22.55	17.57	10.94	12.28	16.54	8.85	5.03	2.43	3.52
			15.03	2Bqk	46	170	78	13.49	13.64	11.51	14.43	17.91	10.02	8.62	5.28	5.10
			15.06	2Bqk (1)	46	108	74	18.21	19.25	15.96	14.76	12.17	6.74	5.22	3.87	3.71
			15.04	2Bqk (2)	108	170	85	9.62	9.35	9.14	13.43	19.81	13.94	11.82	6.71	6.18
			15.05	2Cuk	170	220	63	18.40	20.51	18.40	15.83	12.20	4.01	3.32	3.65	3.66
D2b	FW-3	3320	3.01	Avk	0	5	10	1.63	1.84	3.93	14.80	19.90	15.85	24.99	12.58	4.48
			3.02	Btk	5	12	33	3.42	2.84	4.00	11.05	13.79	14.40	24.89	18.13	7.47
			3.03	2Btk	12	45	82	23.41	19.77	14.66	10.42	8.71	6.38	7.78	5.14	3.74
			3.04	2Bqmk1	45	83	81	19.98	26.20	23.32	10.24	5.97	4.29	5.29	[illegible]	[illegible]
			3.05	2Bqmk2	83	107	83	27.52	36.79	22.76	5.31	2.03	1.14	1.60	0.91	1.54
			3.06	2Cqn	107	210	80	26.63	35.68	23.53	6.56	2.93	0.80	1.48	0.8[illegible]	[illegible]
D1c and D2b over D2c	YW-21	3850	21.01	Avk	0	4	19	2.15	3.88	6.76	18.18	21.27	16.81	22.12	6.37	2.46
			21.02	Btjk	4	15	17	2.51	4.87	8.27	18.32	20.62	15.02	19.09	7.95	[illegible]
			21.03	Bk	15	33	47	7.83	7.72	9.99	19.28	22.36	11.67	12.04	6.20	2.92
			21.04	2Btqlb1	33	55	54	6.56	9.27	12.73	20.11	15.57	6.81	10.01	8.73	[illegible]
			21.05	2Btqmlb1	55	144	59	17.47	17.34	16.41	16.10	10.01	3.36	7.56	4.62	7.14
			21.06	2Bqmlb2	144	186	48	14.28	17.47	18.83	19.20	14.49	4.77	6.71	1.54	[illegible]
			21.07	2Cqnb2	186	233	79	18.98	27.44	24.87	15.60	7.70	1.47	1.70	0.69	1.58

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	Gravel %	SAND vco	SAND co	SAND med	SAND fi	SAND vfi	SILT co+m	SILT fi+vfi	CLAY co+med	CLAY fi
O2b	YW-11	4180	11.01	Av	0	4	40	8.45	8.87	7.94	22.99	31.91	10.45	5.57	1.22	2.61
			11.02	Bt1	4	15	27	7.20	9.31	9.31	22.33	23.97	8.94	9.29	5.54	4.11
			11.03	2Bt2	15	42	39	6.45	8.10	8.58	20.51	23.07	9.36	9.90	8.10	5.94
			11.04	2Btqmk	42	90	48	4.23	5.78	9.08	21.27	22.89	12.18	10.29	6.51	7.77
			11.05	2Bl q	90	150	75	13.28	10.31	12.24	20.82	18.11	7.18	6.53	4.35	7.16
			11.06	3l qml b	150	170	73	15.47	15.47	13.75	13.32	8.38	4.11	7.26	6.29	15.96
O1c over O2b	YW-12	4210	12.01	Av1	0	4	35	6.15	7.28	7.49	21.51	28.25	13.29	8.56	4.19	3.28
			12.02	Av2	4	14	25	4.76	6.02	7.38	20.78	30.41	12.19	9.97	5.36	3.14
			12.03	2Bt	14	47	26	5.34	6.85	8.17	19.50	23.80	11.32	11.80	8.77	4.46
			12.04	2Bl 1	47	105	56	12.75	12.03	13.21	18.99	17.39	10.11	8.19	4.01	3.31
			12.05	2Bl 2	105	120	10	18.24	18.60	16.45	15.67	12.10	7.43	6.72	2.12	2.65
			12.06	2Blqml b	120	144	66	24.97	21.02	19.59	14.77	8.39	3.38	3.70	1.45	2.74
			12.07	2Bql b	144	200	80	26.39	21.02	14.61	13.39	10.10	4.98	4.83	1.90	2.78
O1c over O2b(?)	YW-14	4490	14.01	A	0	8	32	4.31	3.85	5.00	17.75	33.73	21.44	8.45	2.97	2.50
			14.02	Bt	8	28	24	3.00	3.38	4.34	16.68	36.36	17.93	9.06	5.07	4.17
			14.03	2Bl	28	54	35	4.35	5.03	5.86	15.97	29.90	19.10	10.26	5.30	4.24
			14.04	2Bl q	54	107	42	6.07	6.68	8.32	18.28	26.65	16.63	9.98	3.88	3.51
			14.05	3Bl jb	107	121	19	10.22	9.16	11.29	21.29	23.37	11.76	7.40	2.66	2.85
			14.06	3Bqml 1b	121	152	30	6.55	6.04	7.00	17.77	25.79	13.89	13.71	4.80	4.46
			14.07	4Blqml 2b	152	221	63	12.45	11.80	12.15	18.65	18.75	8.61	9.46	3.68	4.22
			14.08	4Bl jb	221	230	80	16.81	13.37	11.80	16.96	17.98	7.70	7.87	3.59	3.97
O2b(?)	YW-20	4505	20.01	Av	0	8	38	5.42	5.15	5.36	21.56	34.72	15.06	8.07	1.97	2.65
			20.02	Bt1	8	19	24	3.06	4.57	5.48	18.59	26.38	13.97	15.24	7.98	4.72
			20.03	Bt2	19	42	39	5.12	4.76	5.41	13.09	19.58	16.08	15.87	9.65	10.45
			20.04	2Bq	42	64	84	12.44	13.74	11.64	15.34	15.83	7.49	6.87	6.45	10.19
			20.05	2Bql 1	64	76	84	18.61	12.74	9.57	13.00	12.87	8.02	8.69	6.24	10.25
			20.06	2Bql 2-1	76	114	68	18.77	18.45	11.84	12.23	10.29	5.68	7.65	5.68	9.40
			20.07	2Bql 2-2	114	152	89	7.30	9.75	9.40	13.82	16.35	11.14	10.90	7.58	13.23
			20.08	2Bql 2-3	152	190	89	15.10	13.94	12.52	17.74	15.87	6.97	6.32	4.14	7.41
O1c over O2c	FW-5	3350	5.01	A	0	5	25	4.62	8.11	15.62	33.65	26.54	5.20	2.60	1.38	2.25
			5.02	Ab	5	20	9	1.85	6.40	14.68	37.84	26.31	4.87	3.96	1.67	2.47
			5.03	Btb	20	45	14	3.13	6.82	19.50	26.94	16.57	8.14	8.84	6.07	3.99
			5.04	2Bt1b	45	56	18	3.80	6.52	16.19	23.69	17.97	11.00	11.67	5.17	4.09
			5.05	2Btqml b	56	106	60	11.21	12.28	13.63	17.13	15.73	8.55	10.55	5.09	5.6.
			5.06	2l qb	106	164	71	24.28	24.70	24.49	11.13	5.19	2.86	3.40	1.07	2.86
			5.07	3Cqn	164	263	72	21.96	36.29	28.27	10.25	2.31	0.39	0.29	0.19	1.06
O2c over O1a	FW-18	3560	18.01	Avb	0	11	13	1.22	2.87	5.64	13.35	16.17	18.87	26.23	9.70	5.97
			18.02	Ab	11	33	24	6.13	9.38	11.65	18.56	18.40	13.06	14.28	5.40	3.13
			18.03	Btbj	33	40	30	9.33	10.58	11.84	15.20	15.95	10.50	15.08	6.95	4.57
			18.04	2Btqlj1	40	66	53	10.52	14.88	18.24	17.95	13.63	6.66	10.20	4.25	3.68
			18.05	2Btqlj2	66	120	72	23.10	22.87	23.14	12.06	4.80	2.05	5.82	3.08	3.09
			18.06	3l b	120	160	76	21.69	27.30	26.26	9.62	4.54	2.28	3.69	1.93	2.28

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	Gravel %	SAND vco	SAND co	SAND med	SAND fi	SAND vfi	SILT co+m	SILT fi+vfi	CLAY co+med	CLAY fi
D2a over D2c	YW-8	3930	8.01	Av	0	9	13	1.67	2.19	4.79	19.99	16.71	14.77	21.44	12.30	6.15
			8.02	Bt1	9	21	13	1.82	2.73	3.74	9.89	7.27	5.60	23.29	25.81	19.86
			8.03	2Bt2b	21	35	27	9.89	14.60	17.35	18.06	12.16	7.49	11.32	5.29	3.83
			8.04	2Bqmb	35	68	18	23.08	20.63	16.78	13.66	9.09	4.14	6.21	2.82	3.58
			8.05	2Ib	68	100	52	25.76	19.23	18.11	16.10	8.16	3.59	4.34	2.08	2.64
			8.06	2Culb	100	210	62	13.67	14.58	18.76	24.31	17.10	4.26	3.24	1.36	2.73
D2a over D2c	YW-16	4300	16.01	Av	0	13		3.27	3.82	7.36	31.03	23.39	7.18	9.21	9.02	5.71
			16.02	Bt1	13	30		2.98	3.08	6.84	28.82	24.43	6.88	9.70	10.58	6.70
			16.03	Bt2	30	43		3.06	3.01	6.22	26.48	24.00	6.41	15.32	8.73	6.77
			16.04	2Btqlb	43	58	44	4.12	4.44	4.28	9.04	9.12	5.18	16.36	18.54	28.91
			16.05	2Iqb	58	100	57	7.07	5.21	5.99	12.28	12.38	7.30	17.58	12.61	19.58
			16.06	2Bqmb (nc)	100	150	56	9.80	10.38	11.78	20.18	17.01	5.72	8.95	7.21	8.95
			16.07	2Bqmlb	100	150	85	6.79	5.02	7.93	17.89	18.60	10.72	13.40	8.93	10.72
			16.08	2Cl qnb	150	207	71	18.02	20.02	17.22	15.59	11.31	5.17	7.14	3.21	2.32
D1c/D2c	YW-1W	4310	1.01	A	0	10	27	3.86	4.57	4.96	19.51	28.76	11.72	11.54	7.82	7.26
			1.02	Bt	10	25	15	2.48	3.40	4.75	18.52	23.97	13.13	14.77	10.94	8.02
			1.03	2Btqlj1b	25	42	47	3.27	4.52	4.91	9.76	11.20	7.74	13.49	15.48	29.63
			1.04	2Btqkj2b	42	56	30	4.16	5.04	5.77	9.94	11.15	6.80	12.93	14.74	29.48
			1.05	3Ib	56	70	46	5.47	7.50	8.34	9.88	10.80	5.68	13.02	13.50	25.81
D1c/D2c	YW-1E	4310	1.06	2Btljqb		50	32	3.89	4.28	5.12	13.61	14.25	6.35	12.25	14.22	26.04
			1.07	2Btqmlb	50	56	38	4.57	5.20	4.92	9.76	9.83	5.46	14.23	13.05	32.98
			1.08	3Iqmlb	56	70	50	9.95	8.81	7.44	10.02	9.95	5.38	15.38	11.28	21.79
			1.09	4Iqm2b	70	115	61	13.19	13.19	12.66	12.28	10.31	5.12	12.28	7.42	13.56
			1.10	5Blb	115	167	66	15.41	18.37	16.89	13.36	9.95	4.99	7.59	4.77	8.67
			1.11	5Cln1b	167	195	70	15.21	15.34	14.80	13.65	11.56	6.39	10.04	4.79	8.22
			1.12	5Cln2b	195	290	67	19.74	25.64	20.61	9.64	4.74	2.39	6.60	4.21	6.45
D1a	FW-19	3585	19.01	Avl1	0	9	5	0.65	1.56	5.87	16.47	16.95	15.81	25.26	12.72	4.72
			19.03	Bt	9	13	13	2.73	3.20	14.12	28.23	14.33	7.62	12.76	12.94	4.08
			19.04	Btl	13	17	3	0.82	1.29	6.67	13.54	7.14	3.68	13.79	23.50	29.18
			19.05	Btqmkj	17	29	11	0.79	1.57	9.79	21.15	10.00	3.62	10.38	16.65	26.06
			19.06	2Iqm1	29	47		4.05	5.77	9.15	16.72	10.87	7.09	13.68	13.68	18.99
			19.07	2Iqm2	47	72	34	2.60	2.67	9.35	18.32	13.20	6.76	13.03	14.53	19.54
			19.08	2Iqm3	72	150	40	3.71	4.51	8.36	19.70	17.59	6.87	11.29	10.06	17.52
D1a	YW-6	3840	6.01	Avl	0	6	24	2.08	2.91	6.46	21.71	17.38	16.42	18.23	10.01	4.81
			6.02	Bt1	6	10	14	4.05	4.11	6.32	14.16	14.84	15.64	19.02	11.38	10.49
			6.03	2Imq	10	52		14.30	14.20	15.99	15.69	11.56	7.07	9.25	6.06	5.89
			6.04	3Iqm	52	101	59	24.01	18.62	18.17	16.59	10.42	4.15	3.97	1.51	2.47
			6.05	3Iq	101	153	67	23.02	18.35	18.07	18.77	12.47	3.47	2.68	0.95	2.21
			6.06	3Iq	153	220	63	20.13	22.59	20.99	17.11	11.11	3.51	1.0[illegible]	0.81	1.62
			6.07	3Clqn	220	250	41	23.77	31.08	19.11	11.17	7.22	2.76	1.80	0.60	1.68

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	% Total by Summation sand	silt	clay	Density (od) gm/cc	CaCO3 %	(Gypsum) EC mho/cm	%	(Soluble Salts) EC mho/cm	%
D1a	FWA-1		FWA-1				94.37	4.52	1.11	1.75	0.43				
	FWA-2		FWA-2				84.78	13.22	2.00	1.31	0.51				
	FWA-3		FWA-3				98.55	0.85	0.60	1.40	0.34				
	FWA-4		FWA-4				95.63	2.76	1.61	#1.32	0.31				
D1a	YWA-1		YWA-1				99.16	0.42	0.42	1.35	0.15				
	YWA-2		YWA-2				98.30	0.94	0.77	1.35	0.16				
D1b	FW-7	3780	7.01	Al	0	2	93.37	4.92	1.71	#1.35	0.40				
			7.02	Cox	2	18	90.83	6.53	2.64	#1.33	0.19				
			7.03	2Cl ox	18	100	95.42	3.24	1.34	#1.35	0.72				
D1c	FW-4	3300	4.01	Al	0	3	86.55	9.37	4.08	1.45	0.44	0.00000	0.00	0.00008	0.03
			4.02	Btjk	3	9	81.75	10.64	7.60	1.36	0.90	0.00002	0.01	0.00009	0.03
			4.03	2Btk	9	60	71.42	16.97	11.61	1.48	2.34	0.00003	0.02	0.00012	0.04
			4.04	2Cuk	60	100	82.03	13.88	4.08	#1.42	1.59	0.00004	0.02	0.00010	0.03
D1c	FW-17	3540	17.01	A	0	6	70.07	25.06	4.87	#1.35	0.07				
			17.02	Bwk	6	24	76.19	19.32	4.50	1.50	0.27				
			17.03	2Cuk	24	120	92.73	5.00	2.27	#1.42	0.24				
D1c	YW-13	4155	13.01	A	0	9	81.75	13.78	4.47	1.42	0.14				
			13.02	Bw	9	21	80.57	13.46	5.96	#1.42	0.12				
			13.03	2Bqj	21	73	87.56	8.18	4.26	1.61	0.15				
			13.04	2Cl qn	73	138	93.15	4.91	1.94	1.81	0.22				
D1c	YW-15	4520	15.01	A	0	18	78.36	16.06	5.58	#1.40	0.02				
			15.02	Bw	18	46	79.88	13.88	6.25	#1.40	0.09				
			15.03	2Bqk	46	170	70.98	18.64	10.38	#1.48	0.13				
			15.06	2Bqk (1)	46	108	80.46	11.96	7.58	#1.42	0.21				
			15.04	2Bqk (2)	108	170	61.35	25.77	12.88	#1.40	0.20				
			15.05	2Cuk	170	220	85.35	7.33	7.33	#1.60	0.24				
D2b	FW-3	3320	3.01	Avk	0	5	42.10	40.84	17.06	1.62	1.49	0.00005	0.01	0.00010	0.02
			3.02	Btk	5	12	35.11	39.29	25.60	1.72	0.85	0.00001	0.01	0.00011	0.02
			3.03	2Bt1	12	45	76.96	14.16	8.87	#1.80	0.38	0.00000	0.00	0.00018	0.04
			3.04	2Bqm1 1	45	83	85.71	9.58	4.72	1.94	0.54	0.00001	0.01	0.00016	0.05
			3.05	2Bqm1 2	83	107	94.40	2.74	2.85	2.00	0.57	0.00001	0.01	0.00021	0.07
			3.06	2Cl qn	107	210	95.34	2.27	2.39	#1.80	0.70	0.00002	0.01	0.00017	0.0
D1c and D2b over D2c	YW-21	3850	21.01	Avk	0	4	52.23	38.92	8.85	1.37	1.73				
			21.02	Btjk	4	15	54.58	34.11	11.31	1.39	1.03				
			21.03	Bk	15	33	67.17	23.71	9.12	1.52	3.32				
			21.04	2Btqlb1	33	55	64.23	16.82	18.95	1.71	0.79				
			21.05	2Bqmlb1	55	144	77.33	10.92	11.76	1.95	0.48				
			21.06	2Bqmlb2	144	186	84.28	11.48	4.24	1.79	0.24				
			21.07	2Clqnb2	186	233	94.57	3.16	2.26	#1.80	0.26				

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	% Total by Summation sand	silt	clay	Density (od) gm/cc	CaCO3 %	(Gypsum) EC mho/cm	%	(Soluble Salts) EC mho/cm	%
D2b	YW-11	4180	11.01	Av	0	4	80.15	16.02	3.83	1.57	0.25				
			11.02	Bt1	4	15	72.12	18.23	9.65	1.59	0.18				
			11.03	2Bt2	15	42	66.71	19.25	14.04	1.54	0.20				
			11.04	2Bt qml	42	90	63.25	22.47	14.28	1.61	1.14				
			11.05	2Bt q	90	150	74.75	13.71	11.53	1.87	1.55				
			11.06	3Bqmlb	150	170	66.38	11.37	22.25	1.82	2.13				
D1c over D2b	YW-12	4210	12.01	Av1	0	4	70.68	21.85	7.47	1.56	0.07				
			12.02	Av2	4	14	69.34	22.16	8.50	1.40	0.20				
			12.03	2Bt	14	47	63.64	23.12	13.23	1.64	0.19				
			12.04	2Bt1	47	105	74.38	18.30	7.32	1.85	1.61				
			12.05	2Bt2	105	120	81.06	14.16	4.78	1.89	1.86				
			12.06	2Bqmlb	120	144	88.73	7.08	4.18	1.77	1.68				
			12.07	2Bqlb	144	200	85.51	9.81	4.68	#1.75	0.73				
D1c over D2b(?)	YW-14	4490	14.01	A	0	8	64.64	29.89	5.48	1.36	0.20				
			14.02	Bt	8	28	63.77	26.99	9.24	1.26	0.19				
			14.03	2Bk	28	54	61.10	29.35	9.55	1.39	0.92				
			14.04	2Bkq	54	107	65.99	26.61	7.39	1.65	2.98				
			14.05	2Bqjb	107	121	75.34	19.16	5.50	1.62	0.91				
			14.06	3Bqmlb	121	152	63.14	27.60	9.26	1.83	1.53				
			14.07	4Bqmlb	152	221	73.82	18.07	8.11	1.67	0.87				
			14.08	4Bkjb	221	230	76.91	15.56	7.52	#1.75	0.74				
D2b(?)	YW-20	4505	20.01	Av	0	8	72.21	23.13	4.66	1.51	0.06				
			20.02	Bt1	8	19	58.08	29.22	12.70	1.53	0.09				
			20.03	Bt2	19	42	47.96	31.95	20.09	1.56	0.10				
			20.04	2Bq	42	64	69.00	14.36	16.64	#1.65	0.19				
			20.05	2Bqb1	64	76	66.79	16.72	16.49	1.96	3.31				
			20.06	2Bqb2-1	76	114	71.58	13.37	15.08	1.72	1.32				
			20.07	2Bqb2-2	114	152	56.63	22.04	21.33	#1.72	4.77				
			20.08	2Bqb2-3	152	190	75.16	13.29	11.55	#1.72	1.30				
D1c over D2c	FW-5	3750	5.01	A	0	5	88.53	7.80	3.67	1.51	0.29	0.00001	0.00	0.00006	0.02
			5.02	AB	5	20	87.07	8.82	4.11	1.44	0.13	0.00000	0.00	0.00005	0.02
			5.03	Btk	20	49	72.97	16.98	10.05	1.64	1.94	0.00003	0.01	0.00011	0.03
			5.04	2Btlb	49	56	68.16	22.67	9.17	1.66	0.39	0.00000	0.00	0.00009	0.07
			5.05	2Btqmlb	56	106	69.98	19.10	10.92	1.78	1.18	0.00008	0.04	0.00054	0.16
			5.06	2Bqb	106	164	89.80	6.27	3.94	1.86	4.51	0.00016	0.08	0.00091	0.29
			5.07	2Bqn	164	263	98.07	0.67	1.25	#1.80	0.19	0.00006	0.03	0.00045	0.14
D2c over D1a	FW-18	3560	18.01	Avk	0	11	39.27	45.10	15.63	1.72	2.34				
			18.02	Ak	11	33	64.13	27.34	8.53	1.69	1.61				
			18.03	Btlj	33	40	62.90	25.58	11.52	1.81	0.19				
			18.04	2Btqbj1	40	66	75.22	16.85	7.93	1.79	0.22				
			18.05	2Btqbj2	66	120	85.97	7.87	6.16	#1.80	0.17				
			18.06	3b	120	160	89.61	5.97	4.42	1.82	14.42				

Surface Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	% Total by Summation sand	silt	clay	Density (od) gm/cc	CaCO3 %	Gypsum EC mho/cm	Gypsum %	(Soluble Salts) EC mho/cm	(Soluble Salts) %
O2a over YW-8 O2c	3930	8.01	Av	0	9	45.33	36.21	18.46	1.65	0.00				
		8.02	Bt1	9	21	25.44	28.88	45.67	1.52	0.07				
		8.03	2Bt2b	21	35	72.07	18.81	9.13	1.64	0.11				
		8.04	2Iqmb	35	68	83.24	10.36	6.40	1.56	19.41				
		8.05	2Ib	68	100	87.35	7.93	4.72	1.70	7.53				
		8.06	2Cu1b	100	210	88.42	7.49	4.09	1.75	4.08				
O2a over YW-16 O2c	4300	16.01	Av	0	13	68.88	16.39	14.73	1.26	0.00	0.00001	0.01	0.00013	0.04
		16.02	Bt1	13	30	66.15	16.57	17.28	1.49	0.05	0.00000	0.00	0.00007	0.02
		16.03	Bt2	30	43	62.77	21.73	15.50	1.48	0.07	0.00001	0.01	0.00005	0.02
		16.04	2Btqlb	43	58	31.01	21.54	47.45	1.76	2.18	0.00010	0.05	0.00012	0.04
		16.05	2Iqb	58	100	42.93	24.88	32.18	1.48	22.93	0.00001	0.01	0.00014	0.04
		16.06	2Bqmb (nc)	100	150	69.16	14.68	16.17	1.70	0.19	0.00001	0.01	0.00016	0.05
		16.07	2Bqm1b	100	150	56.24	24.11	19.65	1.70	1.01	0.00000	0.00	0.00015	0.05
		16.08	2C1qnb	150	207	82.16	12.31	5.53	1.84	0.07	0.00003	0.02	0.00008	0.02
O1c/O2c YW-1W	4310	1.01	A	0	10	61.66	23.26	15.07	1.47	0.06				
		1.02	Bt	10	25	53.13	27.90	18.97	1.52	0.14				
		1.03	2Btqlj1b	25	42	33.66	21.23	45.11	1.40	0.22				
		1.04	2Btqlj2b	42	56	36.06	19.73	44.22	1.62	0.24				
		1.05	3Ib	56	70	41.99	18.70	39.30	1.32	0.40				
O1c/O2c YW-1E	4310	1.06	2Btljqb		50	41.14	18.60	40.26	1.47	0.25				
		1.07	2Btqm1b	50	56	34.28	19.69	46.03	1.49	1.52				
		1.08	3Iqm1b	56	70	46.16	20.77	33.07	1.64	6.79				
		1.09	4Iqm2b	70	115	61.61	17.40	20.99	1.48	20.05				
		1.10	5Ib	115	167	73.98	12.58	13.45	1.71	8.58				
		1.11	5C1n1b	167	195	70.56	16.43	13.01	1.75	2.51				
		1.12	5C1n2b	195	290	80.36	8.98	10.66	1.75	0.92				
OTa FW-19	3585	19.01	Av1	0	9	41.49	41.07	17.45	1.61	3.30				
		19.03	Bt	9	13	62.61	20.38	17.01	1.75	2.96				
		19.04	Btk	13	17	29.46	17.46	53.08	1.24	1.12				
		19.05	Btqmkj	17	29	43.30	13.99	42.71	1.43	0.27				
		19.06	2Iqm1	29	47	46.57	20.77	32.67	1.59	8.99				
		19.07	2Iqm2	47	72	46.14	19.79	34.07	1.59	8.36				
		19.08	2Iqm3	72	150	53.85	18.16	27.98	1.72	16.33				
OTa YW-6	3840	6.01	Av1	0	6	50.53	34.65	14.82	1.46	1.97	0.00002	0.01	0.00010	0.03
		6.02	Bt1	6	10	43.47	34.66	21.86	1.31	0.95	0.00002	0.01	0.00010	0.03
		6.03	2Imq	10	52	71.74	16.32	11.95	1.59	30.22	0.00004	0.02	0.00015	0.04
		6.04	3Iqm	52	101	87.81	8.22	3.97	1.60	19.58	0.00006	0.03	0.00058	0.18
		6.05	3Iq	101	153	90.69	6.15	3.15	1.84	15.27	0.00080	0.43	0.00193	0.61
		6.06	3Iq	153	230	92.03	5.54	2.43	1.73	6.18	0.00024	0.13	0.00120	0.38
		6.07	3C1qn	230	250	93.15	4.57	2.28	1.77	2.01	0.00054	0.29	0.00165	0.5[illegible]

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	% Total by Summation sand	silt	clay	Density (od) gm/cc	CaCO3 %	(Gypsum) EC mho/cm	%	(Soluble Salts) EC mho/cm	%
DTa	YW-2W	3870	2.01	Avk	0	3	43.44	40.24	16.32	1.53	1.72				
			2.02	Ak	3	10	46.67	39.63	13.70	1.52	0.51				
			2.03	Bty	10	19	42.19	39.83	17.98	1.30	0.21				
			2.04	2Btqmly	19	34	48.92	32.32	18.76	1.80	0.29				
			2.05	2Btqmy	34	70	50.41	28.79	20.80	1.79	0.11				
DTa	YW-2E	3870	2.06	Btk	4	19	35.17	27.47	37.36	1.31	1.19				
			2.07	2Btqm	19	52	22.57	27.33	50.10	1.36	5.64				
			2.08	2Bqm	52	114	66.21	17.18	16.61	1.63	12.90				
			2.09	3Bq	114	197	66.04	20.94	13.02	1.73	7.96				
DTa	YW-22	3965	22.01	Avk	0	10	42.81	30.61	26.58	1.58	5.26				
			22.02	Btk	10	21	44.88	21.30	33.82	1.37	0.08				
			22.03	kqm	21	62	56.31	20.76	22.93	1.66	20.10				
			22.04	2Bmq	62	92	67.88	17.05	15.07	1.42	22.36				
			22.05	2Bqm	92	184	73.63	15.00	11.37	1.75	6.18				

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	Carbon % org	Carbon % oxid UM	%LOI	P Pa mg %	pH 1:1H2O	Iron Fe-d %	Iron Fe-o %	Iron Feo/Fed %	SiO2 % by wt
O1a	FWA-1		FWA-1				0.05	0.08	0.44		8.10				1.80
	FWA-2		FWA-2				0.17	0.20	0.67		7.75				3.11
	FWA-3		FWA-3				0.03	0.05	0.31		8.15				1.27
	FWA-4		FWA-4				0.07	0.11	0.44		8.70				2.09
O1a	YWA-1		YWA-1				0.01	0.02	0.32		7.75				0.49
	YWA-2		YWA-2				0.02	0.03	0.30		7.30				1.06
O1b	FW-7	3380	7.01	Ak	0	2	0.18	0.31	0.30		7.75				2.02
			7.02	Cox	2	18	0.09	0.16	0.32		7.80				2.58
			7.03	2Clox	18	100	0.10	0.17	0.25		8.15				2.14
O1c	FW-4	3300	4.01	Ak	0	3	0.09	0.16	0.46		7.30				2.70
			4.02	Btjk	3	9	0.25	0.43	0.42		7.35				2.95
			4.03	2Bt1	9	60	0.11	0.20	0.48		7.60				6.26
			4.04	2Cuk	60	100	0.07	0.12	0.46		7.80				4.60
O1c	FW-17	3540	17.01	A	0	6	0.35	0.61	0.54		7.50				4.37
			17.02	Bwk	6	24	0.18	0.31	0.40		8.00				2.78
			17.03	2Cul	24	120	0.09	0.15	0.36		8.10				1.13
O1c	YW-13	4155	13.01	A	0	9	0.61	1.05	0.48		6.80	0.48	0.023	0.05	6.16
			13.02	Bw	9	21	0.25	0.43	0.47		7.10	0.51	0.021	0.04	3.80
			13.03	2Bqj	21	73	0.12	0.20	0.35		7.40	0.45	0.019	0.04	2.68
			13.04	2Clqn	73	138	0.06	0.10	0.25		7.60	0.42	0.017	0.04	2.18
O1c	YW-15	4520	15.01	A	0	18	0.56	0.96	0.71		7.20				4.48
			15.02	Bw	18	46	0.39	0.68	0.55		7.30				2.76
			15.03	2Bqk	46	170	0.21	0.36	0.75		7.55				3.49
			15.06	2Bql(1)	46	108	0.14	0.25	0.40		7.75				3.08
			15.04	2Bqk(2)	108	170	0.29	0.51	0.76		7.65				4.56
			15.05	2Cul	170	220	0.09	0.16	0.35		7.95				1.85
O2b	FW-3	3320	3.01	Avk	0	5	0.08	0.14	0.47		7.75				6.61
			3.02	Btk	5	12	0.07	0.13	0.67		7.65				6.27
			3.03	2Btk	12	45	0.11	0.19	0.45		7.65				3.90
			3.04	2Bqml1	45	83	0.07	0.12	0.37		7.60				2.75
			3.05	2Bqml2	83	107	0.04	0.07	0.25		7.60				1.32
			3.06	2Clqn	107	210	0.05	0.08	0.21		7.90				2.59
O1c and O2b over O2c	YW-21	3850	21.01	Avk	0	4	0.11	0.19	0.32		8.00				6.08
			21.02	Btjk	4	15	0.13	0.22	0.40		7.50				5.74
			21.03	Bt	15	33	0.22	0.38	0.39		7.45				7.69
			21.04	2Btqlb1	33	55	0.07	0.11	0.38		7.50				20.62
			21.05	2Btqmlb1	55	144	0.03	0.05	0.34		8.10				20.19
			21.06	3Bqmlb2	144	186	0.06	0.10	0.34		7.35				3.61
			21.07	3Clqnb2	186	233	0.03	0.05	0.22		7.20				2.63

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	Carbon % org	Carbon % oxid OM	Carbon %LOI	P Pa mg %	pH 1:1H2O	Iron Fe-d %	Iron Fe-o %	Iron Feo/Fed %	SiO2 % by wt
D2b	YW-11	4180	11.01	Av	0	4	0.20	0.34	0.36		7.00				5.05
			11.02	Bt1	4	15	0.12	0.21	0.41		7.20				5.24
			11.03	2Bt2	15	42	0.19	0.33	0.57		7.05				6.46
			11.04	2Btqmk	42	90	0.07	0.12	0.76		7.90				18.70
			11.05	2Bkq	90	150	0.18	0.31	0.86		7.95				21.39
			11.06	3Bqmkb	150	170	0.07	0.13	0.75		8.00				29.38
D1c over D2b	YW-12	4210	12.01	Av1	0	4	0.58	0.99	0.73		7.20	0.61	0.040	0.07	6.43
			12.02	Av2	4	14	0.27	0.46	0.46		7.80	0.65	0.042	0.06	4.56
			12.03	2Bt	14	47	0.20	0.35	0.48		7.50	0.68	0.039	0.06	3.41
			12.04	2Bk1	47	105	0.23	0.39	0.41		7.80	0.54	0.023	0.04	3.69
			12.05	2Bk2	105	120	0.23	0.40	0.47		8.00	0.51	0.025	0.05	3.36
			12.06	2Bqmkb	120	144	0.14	0.24	0.57		7.95	0.46	0.030	0.07	7.80
			12.07	2Bqkb	144	200	0.11	0.19	0.42		7.85	0.47	0.027	0.06	3.27
D1c over D2b(?)	YW-14	4490	14.01	A	0	8	0.29	0.50	0.38		7.15				3.29
			14.02	Bt	8	28	0.22	0.37	0.45		7.15				4.32
			14.03	2Bk	28	54	0.26	0.45	0.59		7.80				5.25
			14.04	2Bkq	54	107	0.22	0.38	0.48		8.05				6.51
			14.05	3Bkjb	107	121	0.14	0.25	0.45		8.05				2.57
			14.06	3Bqmk1b	121	152	0.11	0.18	0.46		8.00				3.25
			14.07	4Bqmk2b	152	221	0.11	0.19	0.53		8.00				1.85
			14.08	4Bkjb	221	230	0.10	0.18	0.44		8.50				1.82
D2b(?)	YW-20	4505	20.01	Av	0	8	0.17	0.29	0.28		6.90				5.57
			20.02	Bt1	8	19	0.16	0.28	0.36		6.90				7.82
			20.03	Bt2	19	42	0.18	0.31	0.41		6.75				17.19
			20.04	2Bq	42	64	0.25	0.44	0.49		7.30				19.12
			20.05	2Bqk1	64	76	0.27	0.47	0.44		7.80				24.86
			20.06	2Bqk2-1	76	114	0.07	0.13	0.31		7.95				22.91
			20.07	2Bqk2-2	114	152	0.34	0.59	0.56		8.00				27.45
			20.08	2Bqk2-3	152	190	0.06	0.10	0.25		8.00				22.42
D1c over D2c	FW-5	3350	5.01	A	0	5	0.20	0.34	0.41		7.55				1.31
			5.02	AB	5	20	0.13	0.22	0.35		7.30				1.67
			5.03	Bt1	20	45	0.13	0.22	0.33		7.45				3.74
			5.04	2Bt1b	45	56	0.09	0.16	0.42		7.55				6.52
			5.05	2Btqmkb	56	106	0.05	0.09	0.46		7.50				7.71
			5.06	2Cqb	108	164	0.08	0.14	0.42		7.65				7.91
			5.07	2Cqn	164	265	0.02	0.03	0.22		7.50				0.55
D2c over D1a	FW-18	3560	18.01	Avk	0	11	0.09	0.16	0.50		8.10				7.14
			18.02	Ak	11	33	0.10	0.18	0.36		8.00				3.96
			18.03	Btj	33	40	0.08	0.13	0.38		7.55				4.53
			18.04	2Btqjj1	40	66	0.08	0.13	0.45		7.25				3.74
			18.05	2Btqjj2	66	130	0.06	0.11	0.48		7.20				2.27
			18.06	3Cb	130	160	0.17	0.29	0.64		7.90				19.21

Surface	Profile	Elevation ft	Soil No	Horizon	Depth cm top	Depth cm base	Carbon % org	Carbon % oxid OM	Carbon %LOI	P Ha mg %	pH 1:1H2O	Iron Fe-d %	Iron Fe-o %	Iron Feo/Fed %	SiO2 % by wt
DTa	YW-2W	3870	2.01	Avl	0	3	0.04	0.08	0.58		7.95				9.09
			2.02	Ak	3	10	0.04	0.07	0.32		7.95				9.19
			2.03	Bty	10	19	0.04	0.07	0.29		7.60				25.06
			2.04	2Btqmky	19	34	0.07	0.13	0.32		7.50				25.12
			2.05	2Btqmy	34	70	0.04	0.07	0.33		7.50				26.26
DTa	YW-2E	3870	2.06	Btk	4	19	0.26	0.44	0.50		8.20				31.28
			2.07	2Btqm	19	52	0.26	0.45	0.66		8.20				42.20
			2.08	2Bqm	52	114	0.10	0.18	0.32		8.00				39.95
			2.09	3Bq	114	197	0.07	0.12	0.36		7.55				37.81
DTa	YW-22	3965	22.01	Avl	0	10	0.17	0.30	0.73		8.50				18.50
			22.02	Btk	10	21	0.24	0.41	0.87		8.00				19.28
			22.03	Bqm	21	62	0.22	0.37	1.05		7.90				35.01
			22.04	2Bmq	62	92	0.13	0.23	0.96		7.65				35.73
			22.05	2Bbqm	92	184	0.08	0.13	0.67		7.65				25.47

Appendix G. Representative Dates for the Quaternary deposits, NTS

Stratigraphic Unit	Material Dated	Age[1] (ka)	Method	Location
Q1b		140 years		channel trenching correlation (Bryan, 1925)
Q1c	Charcoal in fluvial gravel	8.3±0.075	^{14}C	Amargosa River, Beatty NV
Q2a	Slopewash	40±10	U-trend	Crater Flat Trench 3, NTS
	Slopewash	41±10	U-trend	Yucca Mountain Trench 13, NTS
	Fluvial gravel	47±10	U-trend	Yucca Mountain Trench 2, NTS
Q2b	Fluvial gravel	145±25	U-trend	Yucca Mountain Trench 3, NTS
	Fluvial gravel	160±18	U-trend	Gravel Pit, Shoshone CA
	Colluvium	160±90	U-trend	Yucca Mountain Trench 13, NTS
Q2s	Fluvial sand	160±90	U-trend	Jackass Flat ETS Trench, NTS
Q2c (younger)	Fluvial gravel	270±30	U-trend	Crater Flat Trench 3, NTS
	"	270±30	U-trend	Jackass Divide Trench, NTS
	Fluvial gravel	310±30	U-trend	Rock Valley Trench 1, NTS
Q2c (older)	Fluvial gravel	430±40	U-trend	Jackass Divide Trench, NTS
	"	430±60	U-trend	Crater Flat S Trench, Beatty
Q2e	Bishop Ash	738±3	Geochemical correlation	Jackass Flat and Amargosa Desert, NV
QTa	Basalt Ash (older than)	1.11±0.3 my	Geochemical correlation	Yucca Mountain Trench 8, NTS, and Crater Flat Trench 1, Beatty NV
	Ash (younger than)	2.1±0.4 my	Fission track	Carson Slough, Amargosa Desert

[1] Analyzed by:

^{14}C: S. W. Robinson, U.S. Geological Survey, Menlo Park, CA.
U-trend: J. N. Rosholt, U.S. Geological Survey, Denver, CO.
Geochemical correlation on Bishop Ash:
G. A. Izett, U.S. Geological Survey, Reston, VA.
Geochemical correlation on Basalt Ash:
D. Vaniman, Los Alamos National Laboratory, Los Alamos, NM.
Fission track on Zircon:
C. W. Naeser, U.S. Geological Survey, Menlo Park, CA.

Appendix J. Use of pollen, spores, and opal phytoliths from three different aged deposits as paleoclimatic indicators.

Three soil horizons from different aged deposits (Table 1) were submitted to the University of Kansas Palynology Laboratory to evaluate the potential for stratigraphic and paleoenvironmental use of Quaternary pollen, spores and opal phytoliths. Samples were selected at depth in an attempt to look at pollen and phytoliths deposited with the unit and out of the range of modern infiltration. The analyses were preformed by Glen Fredlund, Wakefield Dort, Jr., and William C. Johnson, and completed in January of 1985.

Table 1. Samples analyzed For pollen, spores and opal phytoliths

Sample No.	Unit	Age	Profile No.	Horizon	depth
1	Q1c	10 ka	FW-4	2Btk	9-60 cm
2	Q2a	40 ka	YW-1W	2Btqkjlb	25-42 cm
3	Q2b	150 ka	FW-3	2Btk	12-45 cm

Pollen

The pollen count in the soil horizons was low compared to similar aged lake sediments, but not insignificantly so. The major problems in interpretation are associated with redeposition of older pollen and post-depositional translocation from the surface. An additional problem is the predicted slow response of vegetation in arid environments to climatic change (Thompson, 1984). Evidence from the comparison of packrat midden microfossils and pollen data suggest that pollen is a much more continuous record of vegetation change, but does not offer the very local taxanomically precise discontinuous records of packrat middens (Thompson, 1984).

Taking these limitations of pollen data interpretation into consideration, the three samples do suggest some interesting preliminary results. Consistently Sample 2 biotically represents a wetter and (or) cooler environment than Samples 1 and 3.

Very little aboreal pollen (AP) including pine (P) which indicates a wetter or cooler climate, were present in the three samples (Fig. 1). The greatest amount is found in Sample 2, and where no other AP is found in Samples 1 and 3, a small amount is present in Sample 2.

Nonaboreal pollen (NAP) taxa dominates the three pollen assemblages (Fig. 1). All of the species identified are currently present in the study area. Therefore at best these data can be used to interpret wetter and (or) cooler climatic conditions, than indicators of aridity. Of major interest, is the fact that in most cases or subdivisions of the NAP, Samples 1 and 3 are similar and Sample 2 has more or less than the other like samples.

The final subdivision of pollen is either deteriorated or mechanically damaged. There is significantly a greater amount in Sample 1 (~10 ka) which could be associated with the increased eolian activity due to decreased vegetative cover associated with the Holocene climate.

In summary, the 40 ka Sample 2 is probably correlative to the onset of cooler and (or) wetter glacial climatic conditions in the NTS area. Samples 1 and 3 represent warmer and (or) drier interglacials.

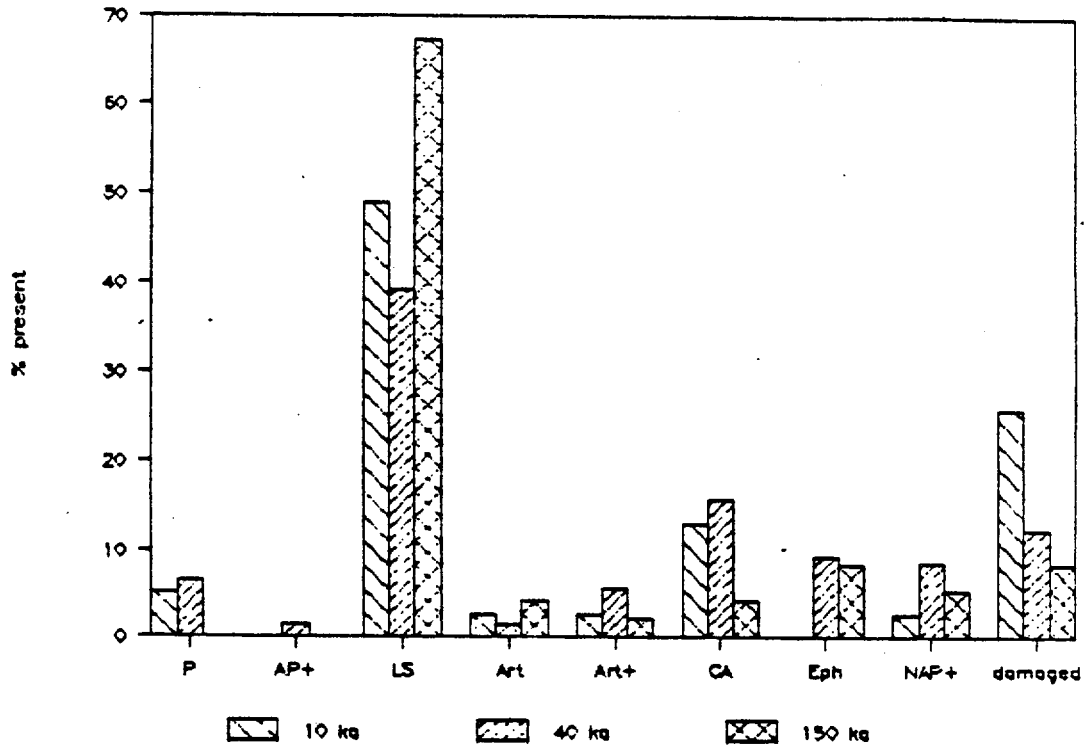

Figure 1. Relative frequency of pollen in three different aged soil horizons. Sample 1 is 10 ka, Sample 2 is 40 ka and Sample 3 is 150 ka. (**P**) Pinus sp. or Pine; (**AP+**) other aboreal pollen primarily Juniperus sp. and Quercus sp.; (**LS**) low spined Asteraceae or ragweed; (**Art**) Artemisia sp. or sage; (**Art+**) other Artemisia sp.; (**CA**) Chenopodiaceae-Amaranthaceae or Cheno-Am primarily Atriplex sp. or saltbush; (**Eph**) Ephedra sp. or Morman tea; (**NAP+**) other nonaboreal pollen including grasses; (**damaged**) deteriorated, mechanically damaged or indeterminate pollen.

Opal phytoliths, aquatic organisms and ash.

Other information on paleoclimate could come from the examination of opal phytoliths and aquatic organisms in the same samples used for pollen analyses. Heavy-liquid fractionation permits recovery of other light silicates along with opal phytoliths. Opal phytoliths are formed by the precipitation of silica in and among the living cells of plants. These silicate bodies maintain their morphological consonance after the death and decay of the plant. A simple morphological classification of these bodies is the grass family (Poaceae) and non-grass families (Twiss and others, 1969; Twiss, 1983) (Fig. 2). Aquatic organisms recovered include diatoms, sponge spicules and chrysomonad cysts. Volcanic ash shards were also retrieved.

There is no significant difference in the percent of grass and non-grass phytoliths present with age of the sample (Fig. 2). The major difference between samples occurs in the aquatic organisms and ash. Aquatic organisms do not necessarily represent a local wet environment because they are easily wind-transported great distances from dry playas. Ash can be derived both from the eolian component and *in situ* weathering of the parent material. The greater amount of aquatic organisms and ash in Sample 2 could be interpreted as (1) a drier climate increasing the possibility that playa sediments are susceptible to eolian transport, or (2) a wetter climate capable of translocating aquatic organisms and ash into the soil profile. I favor the latter of the two mechanisms.

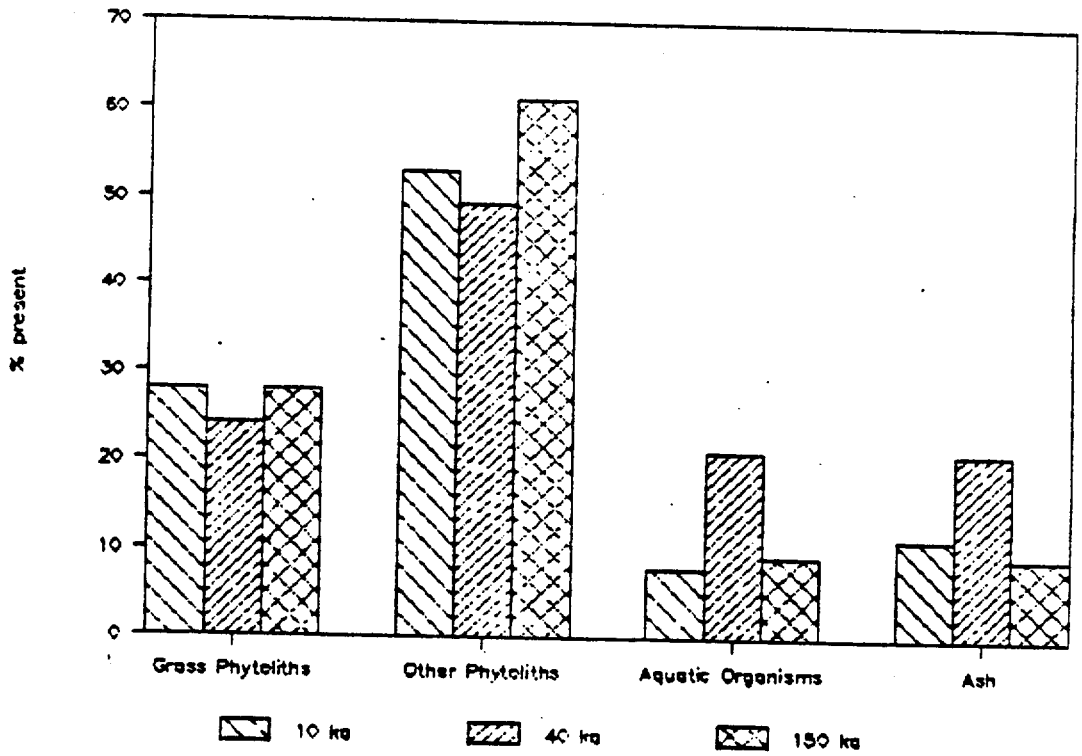

Figure 2. Relative frequency of opal phytoliths, aquatic organisms and volcanic ash in three different aged soil horizons. Sample 1 is 10 ka, Sample 2 is 40 ka and Sample 3 is 150 ka. **Grass Phytoliths** - total Poaceae family phytoliths; **Other Phytoliths** - irregular, aberrant and unique phytoliths; **Aquatic Organisms** including diatoms, sponge spicules and chrysomonad cysts; **Ash** - 'light' volcanic glass shards.

Grass Phytoliths

In order to look at the paleoclimate in more detail the grass phytoliths were subdivided to the tribe level (Fig. 3). Each tribe exhibits a unique adaptive propensity reflecting the regional climate. Festuceae grasses are associated with cooler sagebrush steppes like the Snake River Plateau today, Chlorideae are short-grasses and associated with warmer and more arid regions like the American Southwest today, and Paniceae is associated with the native tall-grasses of the true prairie vegetation in the Eastern Great Plains today. Phytoliths in the elongate catagory have no subfamily implications and occur in other monocots as well as grasses (Fig. 3).

The data indicate that grass phytoliths from Sample 2 are from a slightly wetter and (or) cooler climate than that of the other two samples. The presence of greater amounts of Festuceae suggests that during the formation of these phytoliths the climate was more temperate, like that in northern Nevada today. Samples 1 and 3 are more alike and indicate drier and (or) warmer conditions than that of during the deposition of Sample 2 (Fig. 3).

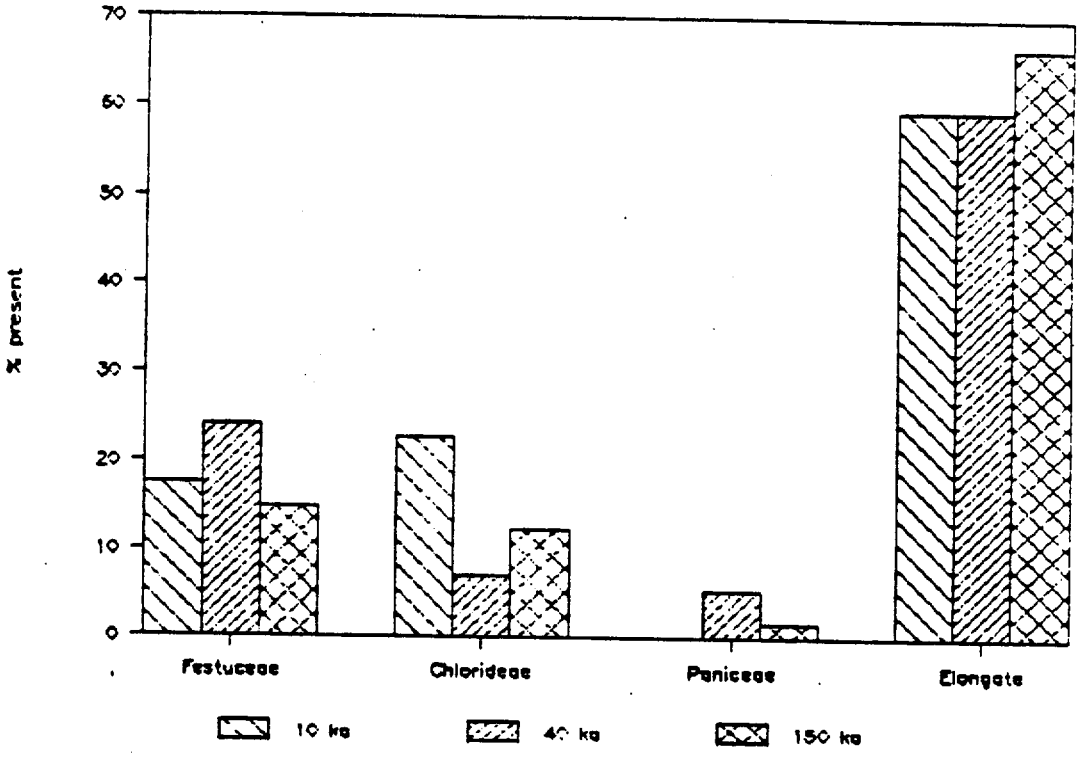

Figure 3. Relative frequency of grass (Poaceae) phytoliths in three different aged soil horizons. Sample 1 is 10 ka, Sample 2 is 40 ka and Sample 3 is 150 ka.

Appendix I: Soil parameters used to model calcic soil development. Parameters define a fresh alluvial sample with a sand texture and minimum vegetation. The maximum rooting depth is between 40 and 60 cm.

Twenty compartments each 10 cm thick. Particulate carbonate equals 0.1 $gm/cm^2/10^3 yr$. Climatic data are in Table 3.

Compartment	Moisture Content AWC 1/	Present	Permanent Wilting Point	Parent Material $CaCO_3$	PCO_2 2/ 10^{-exp}	Soil Temperature 3/ °C	ET Index 4/
1	0.049	0.02	0.018	0.27	3.50	16.5	0.25
2	0.049	0.02	0.018	0.27	3.20	17.9	0.20
3	0.049	0.02	0.018	0.27	3.00	18.8	0.15
4	0.049	0.02	0.018	0.27	2.70	19.0	0.10
5	0.049	0.02	0.018	0.27	2.50	19.3	0.10
6	0.049	0.02	0.018	0.27	2.50	19.3	0.10
7	0.049	0.02	0.018	0.27	2.55	19.3	0.05
8	0.049	0.02	0.018	0.27	2.60	19.3	0.05
9	0.049	0.02	0.018	0.27	2.63	19.3	0
10	0.049	0.02	0.018	0.27	2.66	19.3	0
11	0.049	0.02	0.018	0.27	2.68	19.3	0
12	0.049	0.02	0.018	0.27	2.70	19.3	0
13	0.049	0.02	0.018	0.27	2.75	19.3	0
14	0.049	0.02	0.018	0.27	2.80	19.3	0
15	0.049	0.02	0.018	0.27	2.90	19.3	0
16	0.049	0.02	0.018	0.27	3.00	19.3	0
17	0.049	0.02	0.018	0.27	3.10	19.3	0
18	0.049	0.02	0.018	0.27	3.20	19.3	0
19	0.049	0.02	0.018	0.27	3.30	19.3	0
20	0.049	0.02	0.018	0.27	3.40	19.3	0

1/ Calculated for sand from Salter and Williams (1965).

2/ Atmospheric PCO_2 at surface, decreasing until the maximum rooting depth between 40 and 60 cm, and again gradually increasing with depth.

3/ Actual soil temperature values from Rock Valley, NTS, averaged from 3/67 to 12/72 (Romney and others, 1973).

4/ Estimated percent of total evapotranspiration occuring in each compartment.

Appendix H. Horizon weights of carbonate, clay, silt, and opaline silica.

Soil no	linear age	thickness %	Gravel	Bulk Density	% Carbonate lab	FM	gm/cm2	prof sum	rate of acc per 1k yr	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.01	D1c rate 0.04 10ka	D1c rate 0.02 20ka	Act prof sum avg
											Estimated profile sum avg			
FWA-1	0	0	51	1.35	0.43	0.35	0.00							
FWA-2	0	0	0	1.31	0.51	0.35	0.00							
FWA-3	0	0	41	1.40	0.34	0.35	0.00							
FWA-4	0	0	60	1.32	0.31	0.35	0.00	0.00	0.00					
YWA-1	0	0	67	1.35	0.15	0.15	0.00			(aluv)		Alluvium		(aluv)
YWA-2	0	0	58	1.35	0.16	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.01	150	2	18	1.35	0.40	0.35	0.00							
7.02	150	17	17	1.33	0.19	0.35	-0.03			(D1b)	(D1b)	(D1b)	(D1b)	(D1b)
7.03	150	82	63	1.35	0.72	0.35	0.15	0.12	0.81	0.81	0.00	0.01	0.00	0.12
4.01	10000	3	19	1.45	0.44	0.35	0.00							
4.02	10000	6	7	1.36	0.90	0.35	0.04							
4.03	10000	51	28	1.48	2.34	0.35	1.10							
4.04	10000	40	67	1.42	1.59	0.35	0.24	1.39	0.14					
17.01	10000	6	40	1.35	0.07	0.35	-0.01							
17.02	10000	18	40	1.50	0.27	0.35	-0.01							
17.03	10000	96	75	1.42	0.24	0.35	-0.03	-0.06	-0.01					
13.01	10000	9	53	1.42	0.14	0.15	0.00							
13.02	10000	12	33	1.42	0.12	0.15	-0.00							
13.03	10000	52	48	1.61	0.15	0.15	0.01							
13.04	10000	65	67	1.81	0.22	0.15	0.04	0.05	0.01					
15.01	10000	18	55	1.40	0.02	0.15	-0.01							
15.02	10000	28	67	1.40	0.09	0.15	-0.01							
15.03	10000	124	78	1.48	0.13	0.15	-0.00							
15.06	10000	62	74	1.42	0.21	0.15	0.02							
15.04	10000	62	85	1.40	0.20	0.15	0.01			(D1c)	(D1c)	(D1c)	(D1c)	(D1c)
15.05	10000	50	63	1.60	0.24	0.15	0.03	0.03	0.00	0.04	0.08	0.35	0.18	0.35
3.01	150000	5	10	1.62	1.49	0.35	0.09							
3.02	150000	7	33	1.72	0.85	0.35	0.05							
3.03	150000	33	82	1.80	0.38	0.35	0.01							
3.04	150000	38	81	1.94	0.54	0.35	0.04							
3.05	150000	24	83	2.00	0.57	0.35	0.03							
3.06	150000	103	80	1.80	0.70	0.35	0.16	0.38	0.00					
21.01	150000	4	19	1.37	1.73	0.15	0.07							
21.02	150000	11	17	1.39	1.03	0.15	0.11							
21.03	150000	18	47	1.52	3.32	0.15	0.46							
21.04	150000	22	54	1.71	0.79	0.15	0.12							
21.05	150000	89	59	1.95	0.48	0.15	0.27							
21.06	150000	42	48	1.79	0.24	0.15	0.05							
21.07	150000	47	79	1.80	0.36	0.15	0.05	1.12	0.01					

Soil no	linear age	thickness %	gravel	Bulk Density	% Carbonate lab	FM	um/cm2	prof sum	rate of acc per M yr	Unit Avg	AVERAGE PROFILE SUM USING O2b rate 0.01 Estimated profile	O1c rate 0.04 10la sum avg	O1c rate 0.02 20la	Act prof sum avg
11.01	150000	4	40	1.57	0.23	0.15	0.00							
11.02	150000	11	27	1.59	0.18	0.15	0.01							
11.03	150000	27	39	1.54	0.10	0.15	0.02							
11.04	150000	48	48	1.81	1.14	0.15	0.46							
11.05	150000	69	75	1.87	1.55	0.15	0.40							
11.06	150000	29	73	1.82	2.13	0.15	0.20	1.09	0.01					
12.01	150000	4	35	1.56	0.07	0.15	-0.00							
12.02	150000	10	25	1.40	0.20	0.15	0.01							
12.03	150000	33	26	1.64	0.19	0.15	0.03							
12.04	150000	58	56	1.85	1.61	0.15	0.70							
12.05	150000	15	10	1.89	1.86	0.15	0.45							
12.06	150000	24	66	1.77	1.68	0.15	0.22							
12.07	150000	56	80	1.75	0.73	0.15	0.12	1.52	0.01					
14.01	150000	8	32	1.36	0.20	0.15	0.00							
14.02	150000	20	24	1.26	0.19	0.15	0.01							
14.03	150000	26	35	1.39	0.92	0.15	0.18							
14.04	150000	53	42	1.65	2.58	0.15	1.44							
14.05	150000	14	19	1.62	0.91	0.15	0.14							
14.06	150000	31	30	1.83	1.53	0.15	0.56							
14.07	150000	69	63	1.67	0.87	0.15	0.32							
14.08	150000	9	80	1.75	0.74	0.15	0.02	2.67	0.02					
20.01	150000	8	38	1.51	0.06	0.15	-0.01							
20.02	150000	11	24	1.53	0.09	0.15	-0.01							
20.03	150000	23	39	1.56	0.10	0.15	-0.01							
20.04	150000	22	84	1.65	0.19	0.15	0.00							
20.05	150000	12	84	1.96	3.31	0.15	0.12							
20.06	150000	38	68	1.72	1.32	0.15	0.25							
20.07	150000	38	69	1.72	4.77	0.15	0.34			(O2b)	(O2b)	(O2b)	(O2b)	(O2b)
20.08	150000	38	89	1.72	1.30	0.15	0.08	0.78	0.01	0.01	1.26	5.31	3.65	1.1-
5.01	300000	5	25	1.51	0.29	0.35	-0.00							
5.02	300000	15	9	1.44	0.13	0.35	-0.04							
5.03	300000	25	14	1.64	1.94	0.35	0.58							
5.04	300000	11	18	1.66	0.39	0.35	0.02							
5.05	300000	50	60	1.78	1.18	0.35	0.33							
5.06	300000	58	71	1.86	4.51	0.35	1.31							
5.07	300000	99	72	1.80	0.19	0.35	-0.04	2.16	0.01					
18.01	300000	11	13	1.72	2.34	0.35	0.74							
18.02	300000	22	24	1.69	1.61	0.35	0.38							
18.03	300000	7	30	1.81	0.19	0.35	-0.01							
18.04	300000	26	53	1.79	0.22	0.35	-0.01							
18.05	300000	54	72	1.80	0.17	0.35	-0.03							
18.06	300000	40	76	1.82	14.42	0.35	2.47	3.16	0.01					

Soil no	linear age	thickness	% Gravel	Bulk Density	% Carbonate lab	FM	gm/cm2	prof sum	rate of arc per 1K yr	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.01	D1c rate 0.04 10ka	D1c rate 0.02 20ka	Act prof sum avg
											Estimated profile sum avg			
8.01	300000	9	13	1.65	0.00	0.15	-0.02							
8.02	300000	12	13	1.52	0.07	0.15	-0.01							
8.03	300000	14	27	1.64	0.11	0.15	-0.00							
8.04	300000	33	18	1.56	19.41	0.15	8.16							
8.05	300000	32	52	1.70	7.53	0.15	1.92							
8.06	300000	110	62	1.75	4.08	0.15	2.86	12.91	0.04					
16.01	300000	13	15	1.26	0.00	0.15	-0.02							
16.02	300000	17	10	1.49	0.05	0.15	-0.02							
16.03	300000	13	25	1.48	0.07	0.15	-0.01							
16.04	300000	15	44	1.76	2.18	0.15	0.31							
16.05	300000	42	57	1.48	22.93	0.15	6.10							
16.06	300000	50	56	1.70	0.19	0.15	0.03							
16.07	300000	50	85	1.70	1.01	0.15	0.11							
16.08	300000	57	71	1.04	0.07	0.15	-0.01	6.49	0.02					
1.01	300000	10	27	1.47	0.06	0.15	-0.01							
1.02	300000	15	15	1.52	0.14	0.15	0.00							
1.03	300000	17	47	1.40	0.22	0.15	0.01							
1.04	300000	14	30	1.62	0.24	0.15	0.02							
1.08	300000	14	50	1.64	6.79	0.15	0.77							
1.09	300000	45	61	1.48	20.05	0.15	5.11							
1.10	300000	52	66	1.71	8.58	0.15	2.57							
1.11	300000	28	70	1.75	2.51	0.15	0.35			(D2c) 0.02	(D2c) 2.52	(D2c) 10.61	(D2c) 5.31	(D2c) 6.80
1.12	300000	95	67	1.75	0.92	0.15	0.45	9.27	0.03					
19.01	1500000	9	5	1.61	3.30	0.15	0.44							
19.03	1500000	4	13	1.75	2.96	0.15	0.17							
19.04	1500000	4	3	1.24	1.92	0.15	0.05							
19.05	1500000	12	11	1.43	0.27	0.15	0.02							
19.06	1500000	18	25	1.59	8.99	0.15	1.90							
19.07	1500000	25	34	1.59	8.36	0.15	2.15							
19.08	1500000	78	40	1.72	16.33	0.15	13.00	17.72	0.01					
6.01	1500000	6	24	1.46	1.97	0.15	0.12							
6.02	1500000	4	14	1.31	0.95	0.15	0.04							
6.03	1500000	42	48	1.50	30.32	0.15	9.89							
6.04	1500000	49	59	1.60	19.58	0.15	6.26							
6.05	1500000	52	67	1.84	15.27	0.15	4.84							
6.06	1500000	77	63	1.73	6.18	0.15	2.96							
6.07	1500000	20	41	1.77	2.01	0.15	0.39	24.49	0.02					
2.01	1500000	3	6	1.53	1.72	0.15	0.07							
2.02	1500000	7	9	1.52	0.51	0.15	0.04							
2.03	1500000	9	12	1.30	0.21	0.15	0.01							
2.04	1500000	15	25	1.00	0.29	0.15	0.04							
2.05	1500000	36	23	1.79	0.11	0.15	-0.00							
2.07	1500000	33	39	1.36	5.64	0.15	1.50							
2.08	1500000	62	40	1.63	12.90	0.15	6.69							
2.09	1500000	83	76	1.73	7.96	0.15	2.66	11.00	0.01					

Soil no	linear age	thickness	% Gravel	Bulk Density	% Carbonate lab	FM	gm/cm²	prof sum	rate of acc per 11 yr	Unit Avg	AVERAGE PROFILE SUM USING 02b rate 0.01	01c rate 0.04 10ka	01c rate 0.02 20ka	Act prof sum avg
											Estimated profile sum avg			
22.01	1500000	10	5	1.58	5.26	0.15	0.77							
22.02	1500000	11	20	1.37	0.88	0.15	0.09							
22.03	1500000	41	42	1.66	20.10	0.15	7.96							
22.04	1500000	30	54	1.42	22.36	0.15	4.[illegible]			(DTa)	(DTa)	(DTa)	(DTa)	(DTa)
22.05	1500000	92	52	1.75	6.18	0.15	4.68	17.82	0.01	0.01	12.60	53.06	16.52	17.76

Soil no	CLAY lab	CLAY FM	gm/cm2	prof sum	rate of acc per 1 yr	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.07 Estimated profile sum avg	D1c rate 0.34 10 a	D1c rate 0.17 20 a	Act prof sum avg
FWA-1	1.11	1.00	0.00							
FWA-2	2.00	1.00	0.00							
FWA-3	0.60	1.00	0.00							
FWA-4	1.61	1.00	0.00	0.00	0.00					
YWA-1	0.42	1.00	0.00			(aluv)		Alluvium		(aluv)
YWA-2	0.77	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.01	1.71	1.00	0.01							
7.02	2.64	1.00	0.31			(D1b)	(D1b)	(D1b)	(D1b)	(D1b)
7.03	1.34	1.00	0.14	0.46	3.09	3.09	0.01	0.05	0.03	0.46
4.01	4.08	5.00	-0.02							
4.02	7.60	5.00	0.20							
4.03	11.61	5.00	3.87							
4.04	4.08	1.00	0.59	4.64	0.46					
17.01	4.87	5.00	-0.01							
17.02	4.50	5.00	0.00							
17.03	2.27	1.00	0.46	0.45	0.05					
13.01	4.47	5.00	-0.02							
13.02	5.96	5.00	0.14							
13.03	4.26	1.00	1.51							
13.04	1.94	1.00	0.46	2.09	0.21					
15.01	5.58	5.00	0.09							
15.02	6.25	5.00	0.21							
15.03	10.38	5.00	2.37							
15.06	7.58	5.00	0.65							
15.04	12.88	5.00	1.07			(D1c)	(D1c)	(D1c)	(D1c)	(D1c)
15.05	7.33	1.00	1.91	6.29	0.63	0.34	0.74	3.37	1.68	3.37
3.01	17.06	20.00	0.03							
3.02	25.60	20.00	0.80							
3.03	8.87	5.00	0.53							
3.04	4.72	1.00	0.57							
3.05	2.85	1.00	0.18							
3.06	2.39	1.00	0.62	2.73	0.02					
21.01	8.85	5.00	0.17							
21.02	11.31	5.00	0.82							
21.03	9.12	5.00	0.60							
21.04	18.95	1.00	3.13							
21.05	11.76	1.00	7.89							
21.06	4.24	1.00	1.37							
21.07	2.26	1.00	0.27	14.33	0.10					

Soil no	CLAY lab	CLAY FM	gm/cm2	prof sum	rate of acc per ll yr	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.07 Estimated profile sum avg	D1c rate 0.34 10ka	D1c rate 0.17 20ka	Act prof sum avg
11.01	3.87	5.00	-0.02							
11.02	9.65	5.00	0.69							
11.03	14.04	1.00	3.34							
11.04	14.28	1.00	6.08							
11.05	11.53	1.00	3.03							
11.06	22.25	1.00	2.09	15.22	0.10					
12.01	7.47	5.00	0.13							
12.02	8.50	5.00	0.39							
12.03	13.23	5.00	3.64							
12.04	7.32	1.00	3.09							
12.05	4.78	1.00	1.04							
12.06	4.18	1.00	0.49							
12.07	4.68	1.00	0.77	9.54	0.06					
14.01	5.48	5.00	0.04							
14.02	9.24	5.00	0.75							
14.03	9.55	1.00	2.00							
14.04	7.39	1.00	3.32							
14.05	5.50	1.00	0.86							
14.06	9.26	1.00	3.36							
14.07	8.11	1.00	3.08							
14.08	7.52	1.00	0.21	13.60	0.09					
20.01	4.66	5.00	0.01							
20.02	12.70	5.00	1.06							
20.03	20.09	5.00	3.45							
20.04	16.64	1.00	0.94							
20.05	16.49	1.00	0.59							
20.06	15.08	1.00	3.00							
20.07	21.33	1.00	1.50			(D2b)	(D2b)	(D2b)	(D2b)	(D2b)
20.08	11.55	1.00	0.76	11.31	0.08	0.07	11.12	50.52	25.26	11.12
5.01	3.67	5.00	-0.05							
5.02	4.11	5.00	-0.11							
5.03	10.05	5.00	2.09							
5.04	9.17	1.00	1.26							
5.05	10.92	1.00	3.62							
5.06	3.94	1.00	0.99							
5.07	1.25	1.00	0.26	8.05	0.03					
18.01	15.63	20.00	-0.01							
18.02	8.57	5.00	1.29							
18.03	11.52	5.00	0.69							
18.04	7.93	1.00	1.57							
18.05	6.16	1.00	1.47							
18.06	4.22	1.00	0.61	5.63	0.02					

Soil no	CLAY lab	CLAY FM	gm/cm2	prof sum	rate of acc per 10. yr	Unit Avg	AVERAGE PROFILE SUM USING Q2b rate 0.07	Q1c rate 0.34 10ka	Q1c rate 0.17 20ka	Act prof sum avg
							Estimated profile sum avg			
8.01	18.46	20.00	0.27							
8.02	45.67	20.00	4.43							
8.03	9.13	1.00	1.39							
8.04	6.40	1.00	2.34							
8.05	4.72	1.00	1.02							
8.06	4.09	1.00	2.40	11.85	0.04					
16.01	14.73	5.00	1.31							
16.02	17.28	5.00	2.89							
16.03	15.50	5.00	1.58							
16.04	47.45	1.00	6.92							
16.05	32.18	1.00	8.37							
16.06	16.17	1.00	5.80							
16.07	19.65	1.00	2.43							
16.08	5.53	1.00	1.47	30.77	0.10					
1.01	15.07	5.00	1.13							
1.02	18.97	5.00	2.84							
1.03	45.11	1.00	5.56							
1.04	44.22	1.00	6.91							
1.08	33.07	1.00	3.73							
1.09	20.99	1.00	5.16							
1.10	13.45	1.00	3.84							
1.11	13.01	1.00	1.78			(D2c)	(D2c)	(D2c)	(D2c)	(D2c)
1.12	10.66	1.00	5.50	36.45	0.12	0.06	22.24	101.04	50.52	18.55
19.01	17.45	20.00	0.10							
19.03	17.01	5.00	0.80							
19.04	53.08	5.00	2.28							
19.05	42.71	5.00	5.78							
19.06	32.67	1.00	6.81							
19.07	34.07	1.00	8.67							
19.08	27.58	1.00	21.80	46.25	0.03					
6.01	14.82	20.00	-0.25							
6.02	21.86	20.00	0.06							
6.03	11.95	1.00	3.62							
6.04	3.97	1.00	1.00							
6.05	3.15	1.00	0.77							
6.06	2.43	1.00	0.80							
6.07	2.28	1.00	0.32	6.33	0.00					
2.01	16.32	20.00	-0.06							
2.02	13.70	20.00	-0.29							
2.03	17.98	20.00	-0.29							
2.04	18.76	1.00	3.72							
2.05	20.80	1.00	8.66							
2.07	50.10	1.00	13.41							
2.08	16.61	1.00	8.27							
2.09	13.02	1.00	4.15	57.48	0.02					

Soil no	CLAY lab	CLAY FM	gm/cm2	prof sum	rate of acc per ft yr	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.07 Estimated profile sum avg	D1c rate 0.34 10la	D1c rate 0.17 20la	Act prof sum avg
22.01	26.58	20.00	1.41							
22.02	23.82	5.00	3.50							
22.03	22.93	1.00	8.81							
22.04	15.07	1.00	2.75			(D1a)	(D1a)	(D1a)	(D1a)	(D1a)
22.05	11.37	1.00	8.17	24.65	0.02	0.02	111.22	505.22	25[illegible].61	28.67

Soil no	SILT lab	PM	gm/cm2	prof sum	rate of acc per 1k y	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.13	D1c rate 0.41 10ka	D1c rate 0.20 20ka	Act prof sum avg
							Estimated profile sum avg			
FWA-1	4.52	1.00	0.00							
FWA-2	13.22	1.00	0.00							
FWA-3	0.85	1.00	0.00							
FWA-4	2.76	1.00	0.00	0.00	0.00					
YWA-1	0.42	1.00	0.00			(aluv)		Alluvium		(aluv)
YWA-2	0.54	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.01	4.92	1.00	0.07							
7.02	6.53	1.00	1.07			(D1b)	(D1b)	(D1b)	(D1b)	(D1b)
7.03	3.24	1.00	0.91	2.04	13.63	13.63	0.02	0.06	0.03	2.04
4.01	9.37	15.00	-0.16							
4.02	10.64	15.00	-0.32							
4.03	16.97	15.00	1.83							
4.04	13.88	1.00	2.45	3.80	0.38					
17.01	25.06	15.00	0.49							
17.02	19.32	15.00	0.95							
17.03	5.00	1.00	1.40	2.84	0.28					
13.01	13.78	15.00	-0.03							
13.02	13.46	15.00	-0.09							
13.03	8.18	1.00	3.24							
13.04	4.91	1.00	1.59	4.71	0.47					
15.01	16.06	15.00	0.18							
15.02	13.88	15.00	-0.09							
15.03	18.64	15.00	2.02							
15.06	11.96	15.00	-0.52							
15.04	25.77	15.00	1.50			(D1c)	(D1c)	(D1c)	(D1c)	(D1c)
15.05	7.33	1.00	1.91	5.00	0.50	0.41	1.34	4.09	2.04	4.09
3.01	40.84	40.00	0.54							
3.02	39.29	40.00	0.64							
3.03	14.16	15.00	0.30							
3.04	9.58	1.00	1.25							
3.05	2.74	1.00	0.17							
3.06	2.27	1.00	0.58	3.49	0.02					
21.01	38.92	15.00	1.07							
21.02	34.11	15.00	2.48							
21.03	23.71	15.00	1.50							
21.04	16.82	1.00	2.76							
21.05	10.92	1.00	7.29							
21.06	11.48	1.00	4.21							
21.07	3.16	1.00	0.43	19.75	0.13					

Soil no	SILT lab	SILT FM	gm/cm2	prof sum	rate of acc per 11 y	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.13	D1c rate 0.41 101a	D1c rate 0.20 201a	Estimated profile sum avg	Act prof sum avg
11.01	16.02	15.00	0.12								
11.02	18.23	15.00	0.70								
11.03	19.25	1.00	4.67								
11.04	22.47	1.00	9.77								
11.05	17.71	1.00	3.64								
11.06	11.37	1.00	1.03	19.92	0.13						
12.01	21.85	15.00	0.36								
12.02	22.16	15.00	0.81								
12.03	23.12	15.00	4.30								
12.04	18.30	1.00	8.22								
12.05	14.16	1.00	5.43								
12.06	7.08	1.00	0.91								
12.07	9.81	1.00	1.79	19.83	0.13						
14.01	29.89	15.00	1.10								
14.02	26.99	15.00	2.10								
14.03	29.35	1.00	6.62								
14.04	26.61	1.00	15.01								
14.05	19.16	1.00	3.36								
14.06	27.60	1.00	10.59								
14.07	18.07	1.00	7.28								
14.08	15.56	1.00	0.46	44.52	0.30						
20.01	23.13	15.00	0.72								
20.02	29.22	15.00	2.04								
20.03	31.95	15.00	4.15								
20.04	14.36	1.00	0.80								
20.05	16.72	1.00	0.60								
20.06	13.33	1.00	2.63								
20.07	22.04	1.00	1.55								
20.08	13.29	1.00	0.89	13.38	0.09	(D2b) 0.13	(D2b) 20.15	(D2b) 61.31	(D2b) 30.66	(D2b) 20.15	
5.01	7.80	15.00	-0.32								
5.02	8.82	15.00	-1.03								
5.03	16.98	15.00	1.63								
5.04	22.67	1.00	3.39								
5.05	19.10	1.00	6.55								
5.06	6.27	1.00	1.71								
5.07	0.67	1.00	-0.04	11.78	0.04						
18.01	45.10	40.00	2.25								
18.02	27.34	15.00	4.37								
18.03	25.58	15.00	1.28								
18.04	16.85	1.00	3.53								
18.05	7.87	1.00	1.94								
18.06	5.97	1.00	0.92	14.29	0.05						

Soil no	SILT lab	SILT FM	gm/cm.²	prof sum	rate of Acc per 11 y	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.13	D1c rate 0.41 10la	D1c rate 0.20 20la	Act prof sum avg
							Estimated profile sum avg			
8.01	36.21	40.00	0.46							
8.02	28.88	40.00	-1.06							
8.03	18.81	1.00	3.01							
8.04	10.36	1.00	4.02							
8.05	7.93	1.00	1.85							
8.06	7.49	1.00	4.86	13.13	0.04					
16.01	16.39	15.00	0.05							
16.02	16.57	15.00	0.67							
16.03	21.73	15.00	1.16							
16.04	21.54	1.00	3.08							
16.05	24.88	1.00	6.42							
16.06	14.68	1.00	5.24							
16.07	24.11	1.00	3.00							
16.08	12.31	1.00	3.54	23.16	0.08					
1.01	23.26	15.00	1.03							
1.02	27.90	15.00	2.85							
1.03	21.23	1.00	2.55							
1.04	19.73	1.00	3.01							
1.08	20.77	1.00	2.30							
1.09	17.40	1.00	4.24							
1.10	12.58	1.00	3.58							
1.11	16.43	1.00	2.27							
1.12	8.98	1.00	4.57	26.40	0.09	(02c) 0.06	(02c) 40.30	(02c) 122.63	(02c) 61.31	(02c) 17.75
19.01	41.07	40.00	1.05							
19.02	20.38	15.00	0.54							
19.04	17.46	15.00	0.05							
19.05	13.99	15.00	-0.03							
19.06	20.77	1.00	4.26							
19.07	19.79	1.00	4.94							
19.08	18.16	1.00	13.93	24.75	0.02					
6.01	34.65	40.00	-0.16							
6.02	34.66	40.00	-0.30							
6.03	16.32	1.00	5.05							
6.04	8.22	1.00	2.37							
6.05	6.15	1.00	1.73							
6.06	5.54	1.00	2.32							
6.07	4.57	1.00	0.79	11.81	0.01					
2.01	40.24	40.00	0.22							
2.02	39.63	40.00	0.41							
2.03	39.83	40.00	-0.19							
2.04	32.32	1.00	6.53							
2.05	28.79	1.00	12.11							
2.07	27.33	1.00	7.19							
2.08	17.18	1.00	8.57							
2.09	20.94	1.00	6.84	41.68	0.03					

Soil no	SILT lab	SILT FM	gm/cm2	prof sum	rate of acc per 10 y	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.13 Estimated profile	D1c rate 0.41 10la	D1c rate 0.20 20la sum avg	Act prof sum avg
22.01	30.61	40.00	-0.55							
22.02	21.30	15.00	0.79							
22.03	20.76	1.00	7.94							
22.04	17.05	1.00	7.14			(DTa)	(DTa)	(DTa)	(DTa)	(DTa)
22.05	15.00	1.00	10.97	22.30	0.01	0.02	201.49	613.13	306.56	25.14

Soil no	est % SiO2 lab	est % SiO2 FM	est % SiO2 gm/cm2	prof sum	rate of acr per 1K yr	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.08 Estimated profile sum avg	D1c rate 0.22 10la	D1c rate 0.16 20la	Act prof sum avg
FWA-1	1.80	0.00	0.00							
FWA-2	3.11	0.00	0.00							
FWA-3	1.27	0.00	0.00							
FWA-4	2.09	0.00	0.00	0.00	0.00					
YWA-1	0.49	0.00	0.00			(aluv)		'Alluvium		(aluv)
YWA-2	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.01	2.02	0.00	0.03							
7.02	2.58	0.00	0.50			(D1b)	(D1b)	(D1b)	(D1b)	(D1b)
7.03	2.14	0.00	0.87	1.40	9.36	9.36	0.01	0.05	0.02	1.40
4.01	2.70	0.00	0.09							
4.02	2.95	0.00	0.22							
4.03	6.26	0.00	3.43							
4.04	4.60	0.00	0.87	4.62	0.46					
17.01	4.37	0.00	0.21							
17.02	2.78	0.00	0.45							
17.03	1.13	0.00	0.39	1.06	0.11					
13.01	6.16	0.00	0.37							
13.02	3.88	0.00	0.44							
13.03	2.68	0.00	1.18							
13.04	2.18	0.00	0.83	2.83	0.28					
15.01	4.48	0.00	0.51							
15.02	2.76	0.00	0.41							
15.03	3.49	0.00	1.42							
15.06	3.08	0.00	0.70							
15.04	4.56	0.00	0.61			(D1c)	(D1c)	(D1c)	(D1c)	(D1c)
15.05	1.85	0.00	0.54	4.19	0.42	0.32	0.04	3.17	1.59	3.17
3.01	6.61	0.00	0.48							
3.02	6.27	0.00	0.51							
3.03	3.90	0.00	0.41							
3.04	2.75	0.00	0.39							
3.05	1.32	0.00	0.11							
3.06	2.59	0.00	0.98	2.88	0.02					
21.01	6.08	0.00	0.27							
21.02	5.74	0.00	0.73							
21.03	7.69	0.00	1.11							
21.04	20.62	0.00	3.56							
21.05	20.19	0.00	14.39							
21.06	5.61	0.00	2.20							
21.07	1.63	0.00	0.47	22.73	0.15					

Soil no	est % SiO2 lab	FM	gm/cm2	prof sum	rate of acc per 1k yr	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.08	D1c rate 0.32 10ka	D1c rate 0.16 20ka	Act prof sum avg
							Estimated profile sum avg			
11.01	5.05	0.00	0.19							
11.02	5.24	0.00	0.67							
11.03	6.46	0.00	1.64							
11.04	18.70	0.00	8.40							
11.05	21.39	0.00	6.00							
11.06	29.30	0.00	2.86	19.76	0.13					
12.01	6.43	0.00	0.26							
12.02	4.56	0.00	0.48							
12.03	3.41	0.00	1.36							
12.04	3.69	0.00	1.73							
12.05	3.76	0.00	0.86							
12.06	7.80	0.00	1.12							
12.07	3.27	0.00	0.65	6.45	0.04					
14.01	3.29	0.00	0.24							
14.02	4.32	0.00	0.83							
14.03	5.25	0.00	1.22							
14.04	6.51	0.00	3.29							
14.05	2.57	0.00	0.47							
14.06	3.25	0.00	1.28							
14.07	1.85	0.00	0.78							
14.08	1.82	0.00	0.06	8.16	0.05					
20.01	5.57	0.00	0.41							
20.02	7.82	0.00	1.00							
20.03	17.19	0.00	3.76							
20.04	19.12	0.00	1.13							
20.05	24.86	0.00	0.93							
20.06	22.91	0.00	4.81							
20.07	27.45	0.00	2.00			(D2b)	(D2b)	(D2b)	(D2b)	(D2b)
20.08	22.42	0.00	1.59	15.63	0.10	0.08	12.60	47.59	23.79	12.60
5.01	1.31	0.00	0.07							
5.02	1.67	0.00	0.33							
5.03	3.74	0.00	1.32							
5.04	6.52	0.00	0.98							
5.05	7.74	0.00	2.75							
5.06	7.91	0.00	2.44							
5.07	0.55	0.00	0.28	8.17	0.03					
18.01	7.14	0.00	1.18							
18.02	3.96	0.00	1.13							
18.03	4.53	0.00	0.40							
18.04	3.34	0.00	0.73							
18.05	2.37	0.00	0.62							
18.06	19.21	0.00	3.37	7.43	0.02					

Soil no	est % SiO2 lab	est % SiO2 FM	est % SiO2 gm/cm2	prof sum	rate of acr per 1k yr	Unit Avg	AVERAGE PROFILE SUM USING D2b rate 0.08 Estimated profile sum avg	D1c rate 0.32 10k a	D1c rate 0.16 20k a	Act prof sum avg
8.01	3.38	0.00	0.44							
8.02	8.93	0.00	1.42							
8.03	7.39	0.00	1.24							
8.04	22.70	0.00	9.60							
8.05	13.72	0.00	3.45							
8.06	9.06	0.00	6.54	22.69	0.08					
16.01	8.28	0.00	1.16							
16.02	5.38	0.00	1.22							
16.03	5.68	0.00	0.82							
16.04	37.47	0.00	5.55							
16.05	45.65	0.00	12.22							
16.06	32.74	0.00	12.36							
16.07	43.22	0.00	5.57							
16.08	6.27	0.00	1.92	40.81	0.14					
1.01	9.47	0.00	1.02							
1.02	8.84	0.00	1.72							
1.03	23.68	0.00	2.98							
1.04	26.10	0.00	4.19							
1.08	33.18	0.00	3.83							
1.09	36.25	0.00	9.31							
1.10	28.20	0.00	8.56							
1.11	25.97	0.00	3.77							
1.12	20.10	0.00	11.18	46.58	0.16	(D2c) 0.08	(D2c) 25.21	(D2c) 95.18	(D2c) 47.59	(D2c) 25.13
19.01	7.86	0.00	1.09							
19.03	5.92	0.00	0.36							
19.04	26.80	0.00	1.28							
19.05	29.92	0.00	4.55							
19.06	31.15	0.00	6.67							
19.07	31.49	0.00	8.22							
19.08	36.59	0.00	29.34	51.51	0.03					
6.01	7.65	0.00	0.51							
6.02	8.57	0.00	0.39							
6.03	25.61	0.00	8.39							
6.04	19.01	0.00	6.11							
6.05	16.39	0.00	5.23							
6.06	8.68	0.00	4.23							
6.07	4.64	0.00	0.96	25.83	0.02					
2.01	9.09	0.00	0.39							
2.02	9.19	0.00	0.89							
2.03	25.06	0.00	2.59							
2.04	25.12	0.00	5.19							
2.05	26.28	0.00	11.34							
2.07	42.20	0.00	11.52							
2.08	39.95	0.00	20.93							
2.09	37.81	0.00	12.82	65.70	0.04					

Soil no	est % SiO2 lab	FM	gm/cm2	prof sum	rate of acc per 1k yr	Unit Avg	AVERAGE PROFILE SUM USING O2b rate 0.08	O1c rate 0.32 10 a	O1c rate 0.16 20 a	Act prof sum avg
							Estimated profile sum avg			
22.01	18.50	0.00	2.76							
22.02	19.38	0.00	2.35							
22.03	35.01	0.00	13.95							
22.04	35.73	0.00	6.96							
22.05	25.47	0.00	19.63	45.65	0.03	(DTa) 0.03	(DTa) 126.03	(DTa) 475.90	(DTa) 237.95	(DTa) 47.17