SOIL, LANDSCAPE AND VEGETATION INTERACTIONS IN A SMALL SEMI-ARID DRAINAGE BASIN: SEVILLETA NATIONAL WILDLIFE REFUGE, NEW MEXICO

By

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Abstract

Slope aspect-related microclimatic factors can induce distinct contrasts in vegetation, particularly where the contrasted slopes have north vs. south orientations. The initial driving force for these contrasts is the variation in solar radiation inputs, with the north-facing slopes receiving less direct winter sunlight than the south-facing slopes. However, an investigation of the vegetation, soils and surface topography on opposing slopes of a small drainage basin suggests that the vegetation itself, as well as the microtopography and soils affect a feedback to each surface, enhancing the vegetation contrasts through time.

The study area, a small first-order drainage basin with north-south oriented sideslopes, on the Sevilleta National Wildlife Refuge in west-central New Mexico, contains distinct vegetation patterns across the basin. The south-facing slopes are occupied by Creosote grassland with 14% total grass cover while the North facing slopes host a Juniper grassland with 21% total grass cover. Similar contrasts are observed in the soils data, where the north-facing slope soils have significantly finer textures and a higher percentage of organic carbon in the profiles. Investigation of the microtopography and surface-runoff features across the basin suggests that the greater density of grasses on the north-facing slopes may help to dissipate runoff energy and more effectively retain surface water,

organic matter, carbonate dust, silt and clay. The retention of silt and clay, as well as carbonate dust and organic matter has the effect of increasing the moisture-holding capacity of the soils which, in turn, can support greater biomass production on those slopes.

These observations suggest that while the initial driving forces for the vegetation contrast are exogenic factors, such as variations in solar radiation, the extent of the contrast increases through time as a function endogenic feedback mechanisms such as pedogenesis and the evolution of surface microtopography.

Acknowledgements

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Table of Contents

INTRODUCTION....................1

METHODS....................8

Study area....................8

Soils....................14

Profile mass of organic matter and carbonate....................15

Water retention....................16

Vegetation....................16

Geomorphology....................18

Solar radiation assessment....................19

Soil moisture variability....................20

RESULTS....................22

South-facing slope soils....................22

North-facing slope soils....................26

Headslope soils....................33

Moisture flux through soils....................36

Soil water retention....................41

Vegetation patterns across study site....................43

Surface runoff characteristics....................49

Relationships between soils and vegetation....................51

Solar radiation and evapo-transpiration....................58

Relationships between soils and solar radiation....................60

Spatial and temporal variation in soil moisture................63

DISCUSSION..72

Soil-vegetation-landscape interactions............................ 72

Controls on soil spatial variability....................................73

Slope aspect...73

Headslope soils..79

Catenary relationships.. 83

Summary of soil spatial variability..........................85

Soil moisture..86

Controls on vegetation distribution..................................88

CONCLUSIONS...93

FUTURE WORK...95

References...97

Appendix A: Soil morphology..102

Appendix B: Soil laboratory data summaries........................118

Appendix C: Chloride profiles..122

Appendix D: Vegetation species list and transect data...........124

Appendix E: E-M survey data tables.....................................132

Table of figures

Figure 1. Schematic cross sectional diagram of drainage basin illustrating the role of soils in modifying the effects of slope aspect-induced vegetation contrasts.

Figure 2. Location of study area within the Sevilleta National Wildlife Refuge in west-central New Mexico.

Figure 3. Arial photograph of study area showing sampling locations and survey transects.

Figure 4. Vegetation map of study area. The Juniper grassland community (JG) and the Creosote grassland community represent the north-facing and south-facing slopes respectively.

Figure 5. Landscape map of study area. Landscape elements derive from Peterson (1981) with further distinction of landscape elements is made based on slope orientations.

Figure 6. Yearly average SolarFlux grid for the study area. Color classes represent predicted values of annual solar radiation as a function of variations in landscape orientation.

Figure 7. Soil profile SL-5. Profile is representative of soil development on the south-facing slope.

Figure 8. Soil profile SL-6. Soil reveals strong carbonate accumulations in the original stratigraphy (Kb horizon).

Figure 9. Soil profile SL-2. Profile is representative of soils on the north-facing slope.

Figure 10. Variation of profile mass of calcium carbonate across sideslopes of the drainge basin.

Figure 11. Soil profile SL-4. The thick carbonate horizon in this profile may represent a welded soil, where actively-forming carbonate is superimposed on antecedent carbonate of the original stratigraphy.

Figure 12. Variation in profile mass of silt and clay between sideslopes of the drainage basin.

Figure 13. Profile mass of organic matter across sideslopes of drainage basin. Organic matter contents determined by loss on ignition.

Figure 14. Profile mass of calcium carbonate along a contour of the headslope.

Figure 15. Profile mass of calcium carbonate for soils in the headslope axis catena.

Figure 16. Profile mass of organic matter along a contour of the headslope.

Figure 17. Soluble salt profiles for north-facing slope soils.

Figure 18. Soluble salt profiles for south-facing slope soils.

Figure 19. Water retention curves calculated for comparable depth soil horizons from each sideslope.

Figure 20. Bar graph showing the contrast in vegetation types between the two sideslopes. Black grama grass is the only species with significant cover on both slopes.

Figure 21. Variation in grass cover along a contour of the drainage basin.

Figure 22. Mean values of the elevation range of occurrence throughout the southwest for prominent grass species found in the drainage basin.

Figure 23. Graph of obstruction size vs. Flow space along transects on the two sideslope surfaces.

Figure 24. Relationship between vegetation and depth to carbonate. Vegetation communities are aligned in order from most mesophytic to most xerophytic.

Figure 25. Relationship between vegetation and profile mass of carbonate.

Figure 26. Relationship between vegetation and profile mass of organic matter.

Figure 27. Relationship between vegetation and profile mass of clay.

Figure 28. Differences in Monthly PET values for representative sites on the north and south aspects. (a) Graph of changes in PET values for each site throughout the year. (b) Graph of the differences in absolute PET values.

Figure 29. Regression analysis of SOLARFLUX values vs. depth to carbonate.

Figure 30. Regression analysis of SOLARFLUX values vs. profile mass of organic matter.

Figure 31a. Map of Vertical EM survey values for June 24, 1996.

Figure 31b. Map of Horizontal EM survey values for June 24, 1996.

Figure 31c. Map of Vertical EM survey values for September 20, 1996.

Figure 31d. Map of Horizontal EM survey values for September 20, 1996.

Figure 31e. Map of Vertical EM survey values for April 20, 1997.

Figure 31f. Map of Horizontal EM survey values for April 20, 1997.

Figure 31g. Map of Vertical EM survey values for October 14, 1997

Figure 31h. Map of Horizontal EM survey values for October 14, 1997.

Figure 32. Photograph of the microtopographic features controlling surface flow on the north-facing slope.

Figure 33. Photograph of the microtopographic features controlling surface flow on the south-facing slope.

Figure 34. Bar graphs showing changes in soil properties along a contour connecting the two sideslopes. (A) variation in profile mass of clay; (b) variation in depth to carbonate, and (c) Variation in profile mass of Organic matter.

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INTRODUCTION

The fundamental premise of this study rests in the understanding that slope orientation results in microclimatic and vegetation differences, and that these factors affect differences in soils (Birkeland, 1984). Given the strong influence of both vegetation and climate on soil development in this area, soil patterns are expected to reflect the topographic and vegetation patterns across the landscape (Jenny, 1958). It is therefore the primary objective of this investigation to identify how soils in a semi-arid climatic regime vary with landscape position and vegetation in a small drainage basin. It is the secondary objective of this investigation to assess how variations in soil properties may exercise a feedback influence on vegetation and the landscape.

It has long been observed in the desert Southwest that vegetation types on the south side of a mountain occur at higher elevations than on the north side of the (Watson, 1912). This relationship is commonly understood to be a function of differential solar radiation, where south-facing slopes receive greater amounts of sunlight, resulting in higher daytime temperatures at the surface. The higher temperatures, in turn affect greater amounts of direct evaporation as well as higher transpiration from plants (Dick-Peddie, 1993). This same relationship exists on the sideslopes of small, low-relief catchments throughout New Mexico. However, given the lack of significant relief in these drainages we do not see the same vegetation occurring at higher elevations on opposing slopes. Rather, what we see is a distinct contrast across the central drainage channel, with xerophytic vegetation on the south-facing slope, and more mesophytic vegetation on the north-facing slope. As such, the opposing slopes of small catchments permit us to locally observe ecological boundaries that would otherwise occur over thousands of feet of relief.

First order drainage basins are the most fundamental landscape systems, and may be considered the building blocks of the landscape as a whole (Ruhe and Walker, 1968; Huggett, 1975). The various components of the drainage basin operate in an integrated manner to move water and material through and out of the system (Ruhe and Walker, 1968). Given the downslope movement of water and materials and the array of slope orientations, soils within small drainage basins may respond to both aspect and catenary controls. It is, therefore, through investigating soil and vegetation patterns within small drainage basins that the effects of varying microclimatic conditions can be assessed in the context of a continuum of landscape positions and surface geometries.

Some studies have investigated how topographically-induced microclimatic patterns influence vegetation distribution in the landscape in a semi-arid setting. Slope orientation was identified as the primary controlling factor of vegetation variability on hillslopes in Texas, with soils as a secondary factor (Aide and Van Auken, 1985). However, the assessment of soil type by Aide and Van Auken

(1985) addressed only the parent material (limestone vs. basalt) and failed to consider the ages or degree of development of the soils.

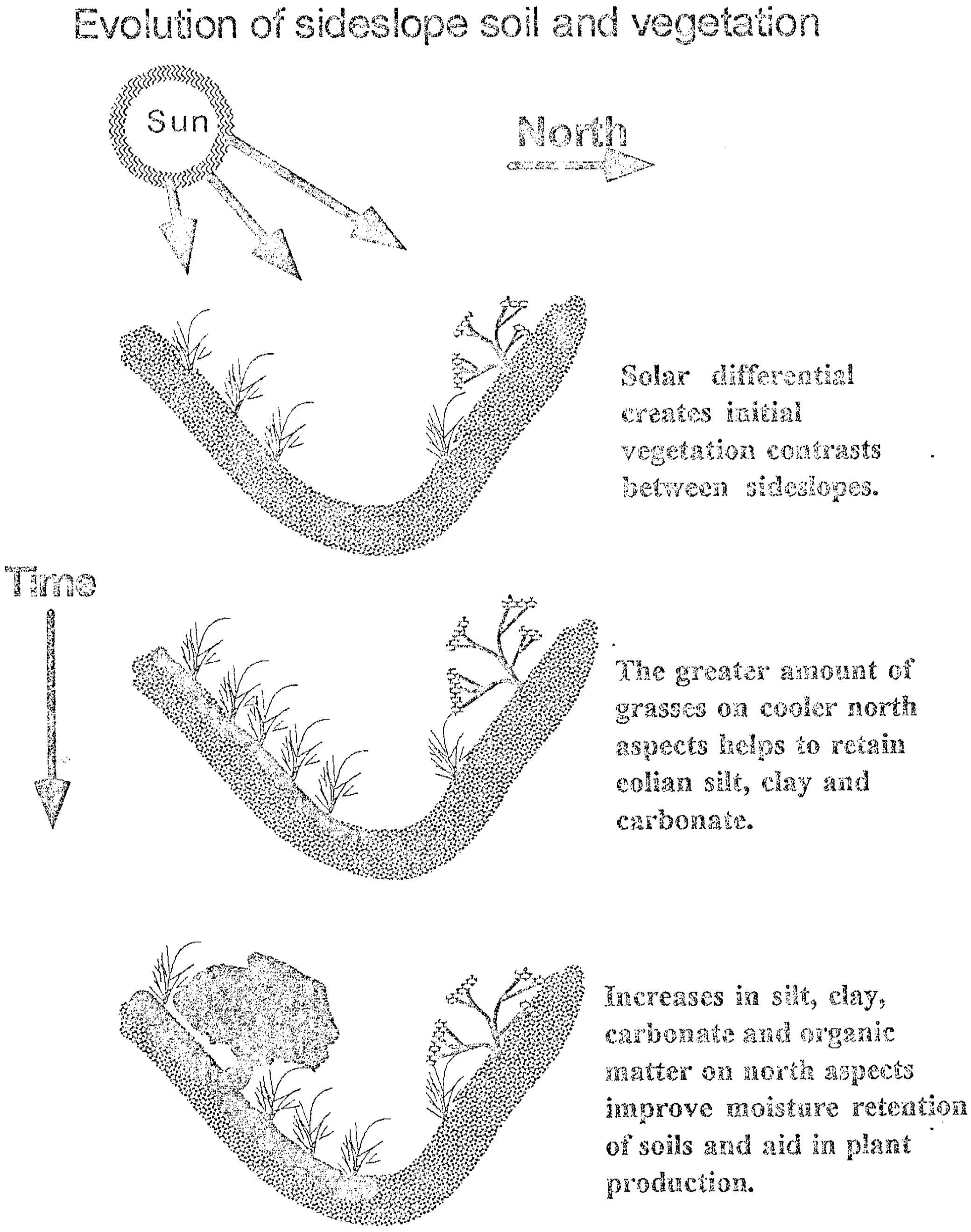
Other studies have investigated the effect of slope orientation and the resulting microclimate on soil development in more humid, temperate settings. A study of soils on NW-SE-trending valleys in Ohio revealed higher surface temperatures on SW-facing slopes and higher soil moisture contents on NE-facing slopes (Finney, 1962). In the same study, it was also noted that vegetation varied considerably between the two slopes and may be a strong factor affecting soil development. Another study in eastern Washington found similarly strong variations in soils as a function of slope orientation between NE and SW facing slopes (Lotspeich and Smith, 1953). However, while both of these examples illustrate the strong control of aspect on pedogenesis, and recognize vegetation as a key factor, there is little focus on either the effect of vegetation on soil development or the feedback influence of soils over vegetation. Moreover, these studies restrict their focus to the sideslopes and fail to investigate the curvilinear slope elements of a drainage basin, which can provide a more complete picture of the full range of soil variability throughout the landscape (Huggett, 1975).

Small variations in slope geometry can affect both the lateral and downslope re-distribution of water and material, thereby strongly influencing patterns in soil development (Ruhe and Walker, 1968). In addition to convergent and divergent flow lines that illustrate differences in surface hydrology within a drainage basin, the gradual changes in slope orientation along a contour permit the observation of subtle changes in the microclimatic variables between two sideslope endmembers.

One of the ways that slope orientation can effect soil development is through the type and density of vegetation that develops under the resulting microclimatic conditions. Many researchers have demonstrated how such differences in vegetation type and density can affect soil development (Jenny, 1958; Secor et al., 1983; Wilcox et al., 1988; Ludwig, 1996). Still others have identified how vegetation is affected by soil physical characteristics (Sala et al., 1992; Secor et al., 1983). However, few researchers have taken an integrated approach to identifying how these factors interact within an arid or semi-arid landscape system (Aide and Van Auken, 1985; Wondzell et al., 1996).

Therefore, in addition to identifying linear pathways of cause and effect between individual factors, we must consider how the system components may evolve concurrently and influence the other landscape components along the way. Clements (1916) emphasized the role of climate in influencing successional vegetation changes up to some climax vegetation community for that climatic condition. Implicit in this philosophy is the conception of soils as a dynamic, evolving component of the ecosystem, but without an understanding of the rates of pedogenic processes or their specific influence on vegetation expression. While there are many factors that influence vegetation production, there is widespread agreement that the most critical controls on vegetation type in arid and semi-arid areas are related to available moisture (Watson, 1912; Howard and Mitchell, 1985; Wondzell and Ludwig, 1995). It is thus, through identifying changes in the soil factors that influence soil moisture that we may be able to assess the influence of pedogenesis on vegetation distribution.

Soil evolution in arid and semi-arid environments primarily progresses through the incorporation of eolian silt, clay, and calcium carbonate. (Gile et al., 1981; Machette, 1985; McFadden and Tinsley, 1985). The rate at which these materials accumulate and are incorporated into the soil is related to the amount of rain, the dust flux and the retentive effects of vegetation (Gile et al., 1981; Machette, 1985; Ludwig, 1996). In turn, as soil properties develop through time, the soil hydrological conditions are altered, and the influence of climatic conditions on the ecosystem can also be modified (Figure 1). In general, increases in both silt and clay decrease the infiltration rate and increase the moisture retention of the soil, particularly in a coarse, gravelly or sandy parent material (McDonald, 1994; Rendig, 1989). Calcium carbonate, depending on its density and degree of induration may either increase or impede the moisture retention of a soil (Shreve and Mallery, 1933).



Solar differential creates initial vegetation contrasts between sideslopes.

The greater amount of grasses on cooler north aspects helps to retain eolian silt, clay and carbonate.

Increases in silt, clay, carbonate and organic matter on north aspects improve moisture retention of soils and aid in plant production.

Figure 1. Schematic cross sectional diagrams of the drainage basin illustrating the role of soils in modifying the effects of slope aspect-induced vegetation contrasts. As fine material accumulates on north-facing slopes, the moisture retention of the soil is increased. Thus, over time the surface can support more mesophytic vegetation than a young surface under similar climatic conditions.

Time is a major factor in the development of soils, and the duration of pedogenesis can determine the degree of influence that soils exercise over vegetation. McAuliffe (1994) identified relationships between surface ages and vegetation community composition on alluvial fans in Arizona, suggesting that changes in soil properties through pedogenesis can influence vegetation patterns. However, on the sloping surfaces within simple, first-order drainage basins, such as our study area, there is no strong temporal control on the soil landscape. It is merely through time that the differences in other soil forming factors, such as microclimate and vegetation, are able to reflect the greatest contrast in soils between sites.

Given these complex interactions, this study investigates how the development of soil, as a function of landscape position within a drainage basin, may serve to influence the distribution of vegetation communities. The first step is to characterize the nature of soil variability over the landscape. With these observations, we can then address the causal mechanisms responsible for spatial variations in soil properties within a uniform parent material. Finally, the role that individual soil properties may play in affecting soil moisture and vegetation patterns within the drainage basin can be addressed.

The study area was selected to assess the influence of widely-varying microclimatic conditions in a uniform substrate and under consistent regional climatic conditions. The drainage was selected for investigation based on the distinct north-south slope orientations and the equally distinct vegetation contrast that exists between the two slopes. The headslope of the drainage, which is contained within the study area, allows the investigation of a more gradual transition in both soils and vegetation between the two sideslope end members. A uniform parent material of fan alluvium, with its coarse texture, permits the evaluation of subtle differences in soil texture between sampling locations.

Ultimately, our understanding of how a landscape system may respond to changes in external variables, such as climate, depends on our understanding of how the system components interact and evolve under the antecedent and present conditions. It is through identifying the controls operating between the individual components of such well-constrained catchments, that we may be able to expand our understanding of these interactions to more complex landscape systems.

METHODS

Study area

The study site is a small first-order drainage basin in the northeast corner of the Sevilleta National Wildlife Refuge in central New Mexico (34^0 24' Latitude 106^0 59' Longitude) (Figure 2). Lying at the boundary of three major regional biomes: the Great Plains Grassland, Chihuahuan Desert Shrubland and Pinon-Juniper Woodland (Dick-Peddie, 1993), the Sevilleta refuge is an ideal place for the study

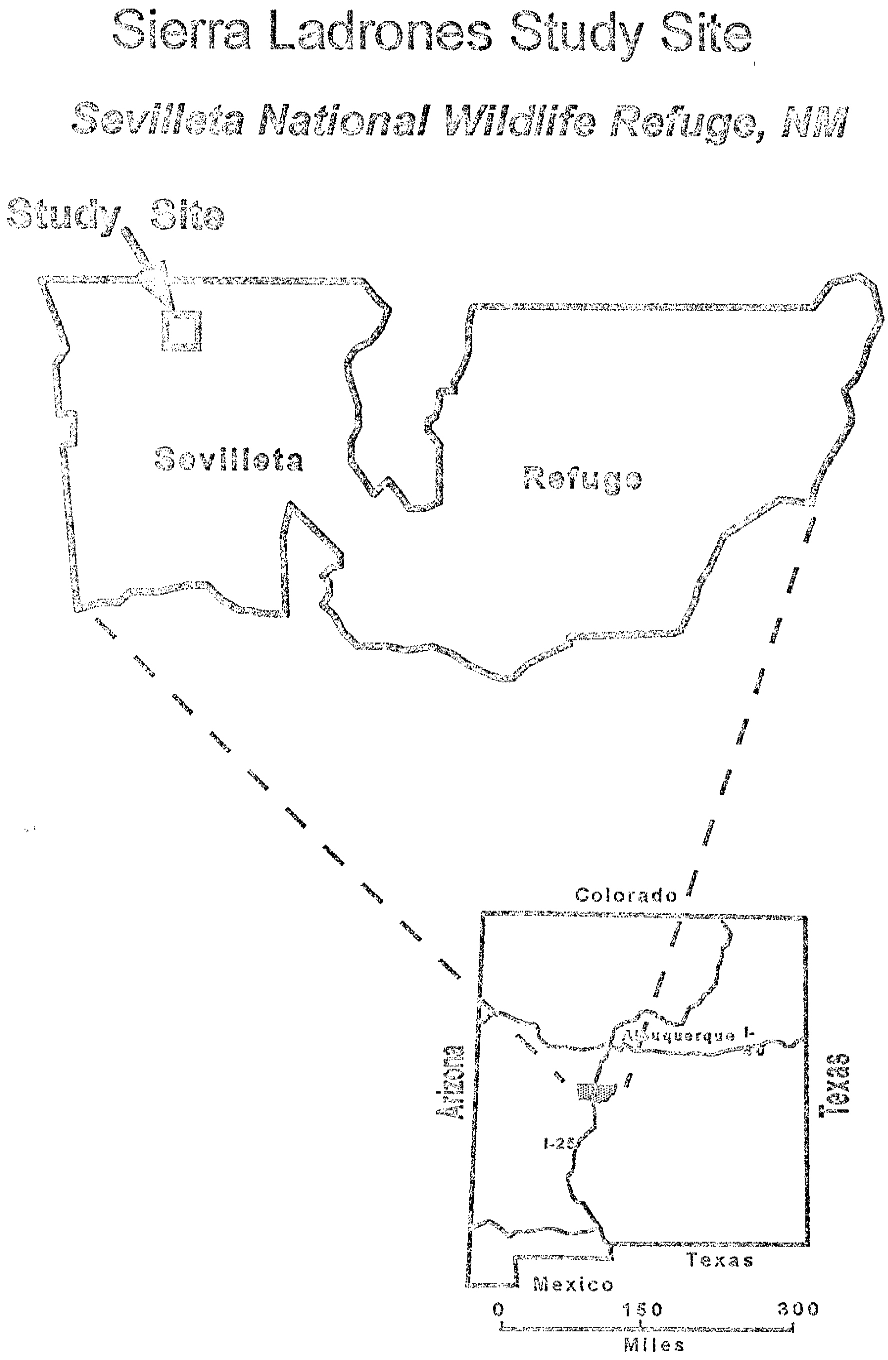


Figure 2. Location of study area within the Sevilleta NationalWildlife Refuge in west-central New Mexico.

of ecosystem dynamics. The refuge is currently the site of a Long Term Ecological Research (LTER) program conducted by the Biology Department of the University of New Mexico. The selected basin has a catchment area of $0.034\ Km^2$, an east-flowing central drainage and distinct north-south oriented sideslopes (Figure 3). The table surface above the drainage basin is at an elevation of 5,600 feet and represents most stable part of the landscape within the study area. The drainage is cut into coarse, flat-lying alluvial fan deposits of the Plio-Pleistocene Sierra Ladrones Formation, composed primarily of schist and quartzite clasts with a coarse sandy matrix. The Loma Pelada Fault, mapped by Machette (1978), trends in a north-south direction within 100 meters from the western margin of the study area. The down-to-the-east normal fault now has a reverse aspect owing to the less resistant Popatosa lake bed sediments in the foot wall and the highly-resistant, coarse conglomerate in the down-thrown fill space, on which the study site is located.

The drainage was selected for investigation based on the distinct north-south slope orientations and the equally distinct vegetation contrast that exists between the two slopes. The basin is representative of other first order stream catchments on the east flank of the Ladron Mountains. The uniform parent material and its coarse texture permits the evaluation of subtle differences in soil texture between sampling locations. One of the confounding features within the parent material of the study site is the presence of strong calcium carbonate accumulations in the original

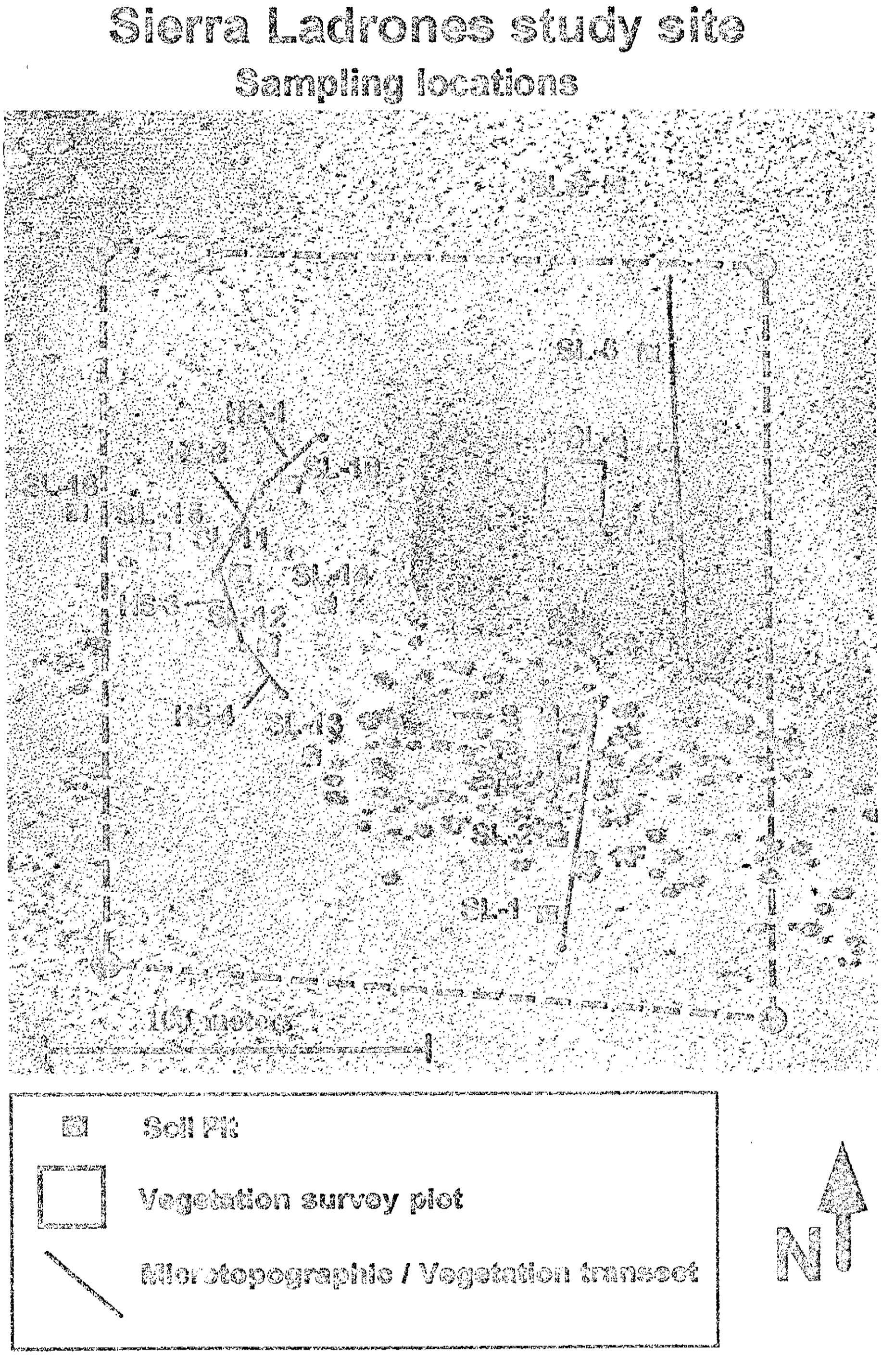


Figure 3. Arial photograph of the study area showing soil sampling locations and survey transects. The outer boundary represents E-M survey limits.

alluvial fan stratigraphy. Gile et al., (1981) noted similar carbonate accumulations deep within alluvial fans in the Desert Project area near Las Cruces NM, associating their occurrence with laterally moving groundwater.

The presence of these accumulations was confirmed in a road cut 200 meters northwest of the study area were stage III carbonate can be seen irregularly distributed throughout the exposure. As such, one of the tasks within this study has been to distinguish antecedent carbonates from the actively-forming pedogenic carbonate associated with the current surface. On the sloping surfaces, this distinction is made based on the orientation of the carbonate horizons, where current surface carbonate mimics the surface slope and antecedent carbonate maintains a generally horizontal orientation.

In general, the vegetation within the basin is representative of the three regional biomes. Creosotebush/grassland communities, representing Chihuahuan Desert Shrubland, occupy the south-facing slope and the table surface, which are known to have the greatest exposure to sunlight. One Seed Juniper/Black Grama grassland, representing Pinon-Juniper Woodland, occupies the more shadowed areas on the north-facing slopes. Finally, the grasses of the headslope represent the great plains transition between the two endmember communities (Figure 4).

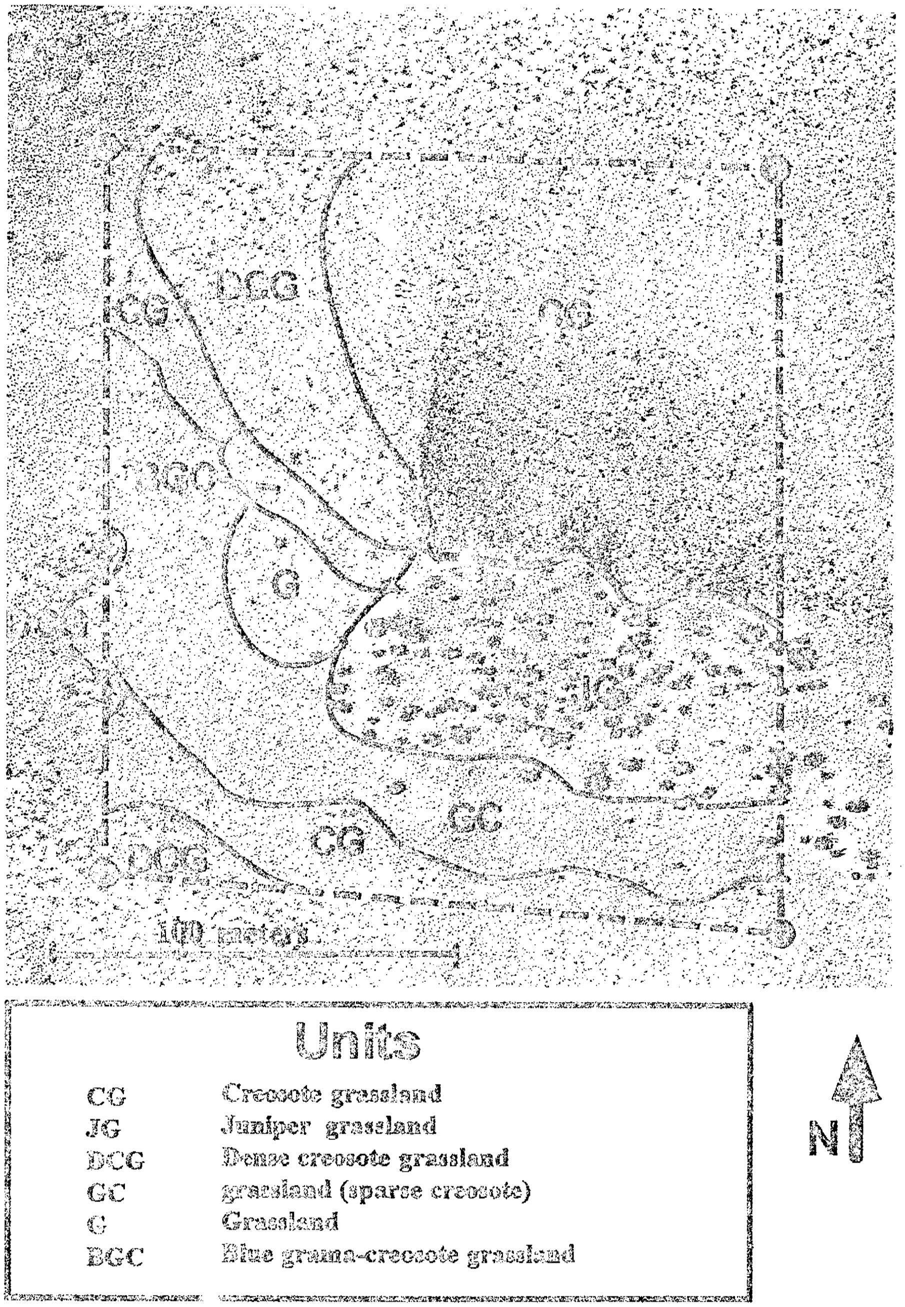


Figure 4. Vegetation map of study area. The Juniper grasland community (JG) and the creosote grassland community (CG) represent the north and south-facing slopes respectively.

Soils

Soil sampling locations were selected to reflect potential systematic trends in soil characteristics across the landscape. Figure 3 illustrates the distribution of sampling sites throughout the study area. Two soil pits were placed on the table surface above the drainage basin, representing the oldest, most stable part of the landscape. A series of four soil pits oriented parallel to the maximum slope were placed on each of the sideslopes in order to characterize both the contrast in soil characteristics between the slopes and catenary trends along the gradient of each slope. In the head slope of the drainage, a series of four soil pits were placed along a contour line connecting the north and south-facing slopes. A central pit in the head slope contour series (SL-11) lies within the axis of the headslope and is paired with two additional soil pits, both above and below, to form a catena of soils within the hollow of the headslope. All soil pits were excavated through the K horizon and into either the C or Ck horizon to obtain a complete picture of the depth of soil development and to assess the maximum accumulation of pedogenic carbonate.

Soil profiles at each location were described in accordance with Birkeland (1991) and average volume percent gravels was estimated for each horizon in the field. Bulk soil samples were collected, dried, split and sieved for <2mm fraction. Samples were analyzed for particle size distribution, calcium carbonate content, soluble salt content (by electrical conductivity), and bulk density by standard procedures outlined in Singer and Janitzky (1986).

Soil organic matter was determined by Loss on Ignition. Samples of the fine soil fraction were oven dried at 100° C to remove residual soil moisture, and were weighed before ignition. Samples were then baked for four hours in a furnace at 500° C. Soil water chloride concentrations were determined for select soil profiles as an indicator of moisture flux. Chloride analyses were performed according to procedures outlined in McGurk and Stone (1985).

Profile mass of organic matter and carbonate

Total profile mass of both organic matter and calcium carbonate were calculated by the following means: $HM = \%P * BD * V * T$

$PM = \Sigma HM$

Where:

HM = Horizon mass of a property (g/cm^2)

PM = Profile mass of a property / cm^2 (g/cm^2)

$\%P$ = weight percent of a property determined for the <2mm fraction

BD = Bulk density of soil determined by horizon (g/cm^3)

V = Total volume percentage of <2mm fraction*

T = Horizon thickness (cm)

*Volume percentages of gravel were estimated visually in the field.

Water retention

Water retention curves were estimated for soils across the study area in order to assess the degree of variability in available moisture as a function of soil textural differences. Calculations were made in accordance with Saxon et al., (1986) using the following equations:

$\Psi = A\Theta^{B}$

$A = \exp\ [a + b\ (\%C) + (\%S)^{2} + d\ (\%S)^{2}\ (\%C)]100$

$B = e + f\ (\%C)^{2} + g\ (\%S)^{2} + g\ (\%S)^{2}\ (\%C)$

Where:

Ψ = water potential (Kpa)

Θ = water content (m^{3}/m^{3})

$a = -4.396$; $b = -0.071$; $c = -4.880 \times 10^{-4}$; $d = -4./285 \times 10^{-5}$; $e = -3.140$

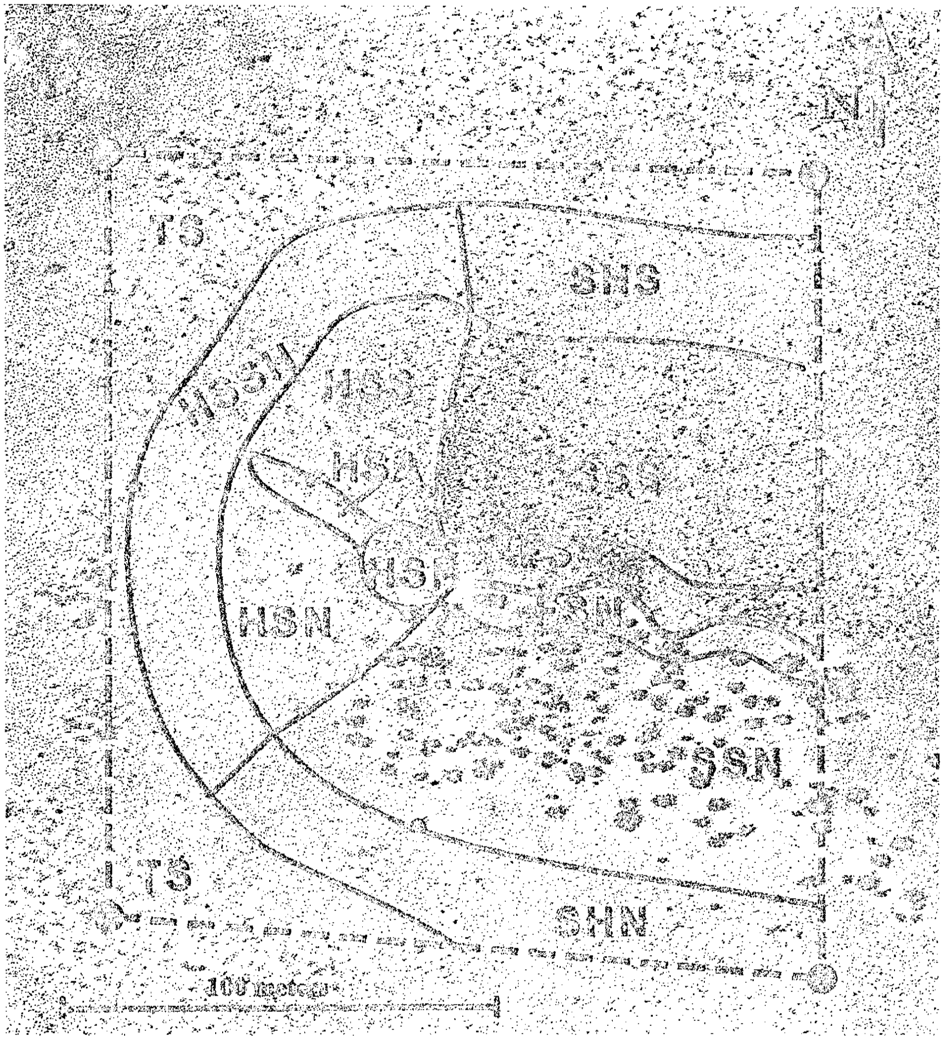
$f = -2.22 \times 10^{-3}$; $g = -3.484 \times 10^{-5}$

The curves were then adjusted for soil gravel content by the following equation:

$\Theta = (1 - \%\text{gravel})\ (\Psi/A)^{1/B}$

Vegetation

Vegetation surveys were conducted along 20-meter transects using a 50 x 20 cm quadrat frame at one-meter intervals, with the long axis of the quadrat normal to the transect line. Each sampling location along a transect was evaluated for percent canopy cover by species. Transect lines on each of the sideslopes were run



Map units

TS	Table surface	FSS	Footslope, south facing
SHN	Shoulder, north facing	HSN	Headslope, north facing
SHS	Shoulder, south facing	HSS	Headslope, south facing
SSN	Sideslope, north facing	HSSH	Headslope shoulder
SSS	Sideslope, south facing	HSA	Headslope focus
FSN	Footslope, north facing	HSF	Headslope axis

Figure 5. Landscape map of study area. Landscape elements derive largely from Peterson (1981). Further distinction is made based on slope orientations.

perpendicular to contour lines, from the shoulder to the foot slope, within representative sections of the sideslope vegetation communities. In the headslope of the study area, four transects were run end to end along a general contour line in order to characterize the nature of the vegetation variation across the headslope. Additionally, a reconnaissance vegetation map was produced for the entire study area based on the end-member vegetation communities, with further sub-divisions of map units based on variations in species density from those communities (figure 4). In order to assess the relationship between soils and vegetation throughout the study area, the vegetation map units were arranged to form a continuum from the most xerophytic to the most mesophytic. Systematic changes in selected soil characteristics along this vegetation gradient were analyzed. The soil parameters, depth to carbonate, profile mass of carbonate, profile mass of organic matter, and profile mass of silt and clay, were selected based on their implications for or influence over plant-available moisture.

Geomorphology

The study of the land surface itself was conducted on both a micro and a macro-scale. On the macro-scale, a map of primary landscape elements for the drainage basin was produced. Map units were based on the heirarchical classification of landforms by Peterson (1981). In addition to Peterson's distinction of slope elements, further distinction was made based on slope orientation (figure 5).

Landscape units were then used for analysis of systematic variations in soil morphological properties, vegetation and soil moisture.

At the micro-scale, the two sideslopes were assessed for their surface water runoff/erosion dynamics (at the sub-meter scale) based on an approach described by Ludwig (1996). In this approach, straight line transects were run perpendicular to the contours on each of the two sideslopes. Distances along the transect were logged as either free flow space (fetch length) or obstructions to flow (patches). The size, regularity and spacing of patches is used to assess differences in runoff characteristics between the slopes. Closely spaced obstructions correspond to low surface runoff energy and a higher capacity for trapping water, sediments and litter, while long fetch lengths correspond to high erosion potential by either water runoff or wind erosion (Ludwig, 1996). For the purpose of this investigation, "obstruction" refers to any boulder, grass clump or shrub litter mound that can arrest or deflect surface runoff.

Solar radiation assessment

The spatial variability of incoming solar radiation across the study area was estimated using the SOLARFLUX model developed by Paul Rich at the University of Kansas. SOLARFLUX grids were generated for the refuge by the Long Term Ecological Research (LTER) program at the University of New Mexico Biology Department. SOLARFLUX is a GIS-based program for modeling incoming solar radiation based on surface orientation, solar angle, shadowing due to topographic features, and atmospheric attenuation (Rich et al., 1995). The grid of yearly average solar radiation values presented for the Sierra Ladrones study site (Figure 6) was clipped from a larger solar radiation map generated for the entire Sevilleta Wildlife Refuge. The values are based on a USGS 30-meter (contour interval) digital elevation map (DEM) of the refuge.

Soil moisture variability

Sheets and Hendrickx (1995) demonstrated the effectiveness of electromagnetic induction for the measurement of total soil water content. Electomagnetic induction is a non-intrusive technique that measures the apparent electrical conductivity of the soil. The measured value of soil electrical conductivity is a function of soil texture, salinity, water content and soil temperature. Four electromagnetic induction surveys were conducted at the site during the study period between June 1996 and October 1997 to assess both spatial and temporal variability in soil moisture. Since the salt content and soil texture in the drainage basin does not change seasonally, the changes in apparent electrical contuctivity between survey dates are mainly a function of soil water content and temperature.

Readings were taken with the Geonics EM-38 Ground Conductivity Meter approximately every seven meters in both the vertical and horizontal modes, which correspond to depths of 1.5 and 0.75 meters respectively (Sheets and Hendrickx,

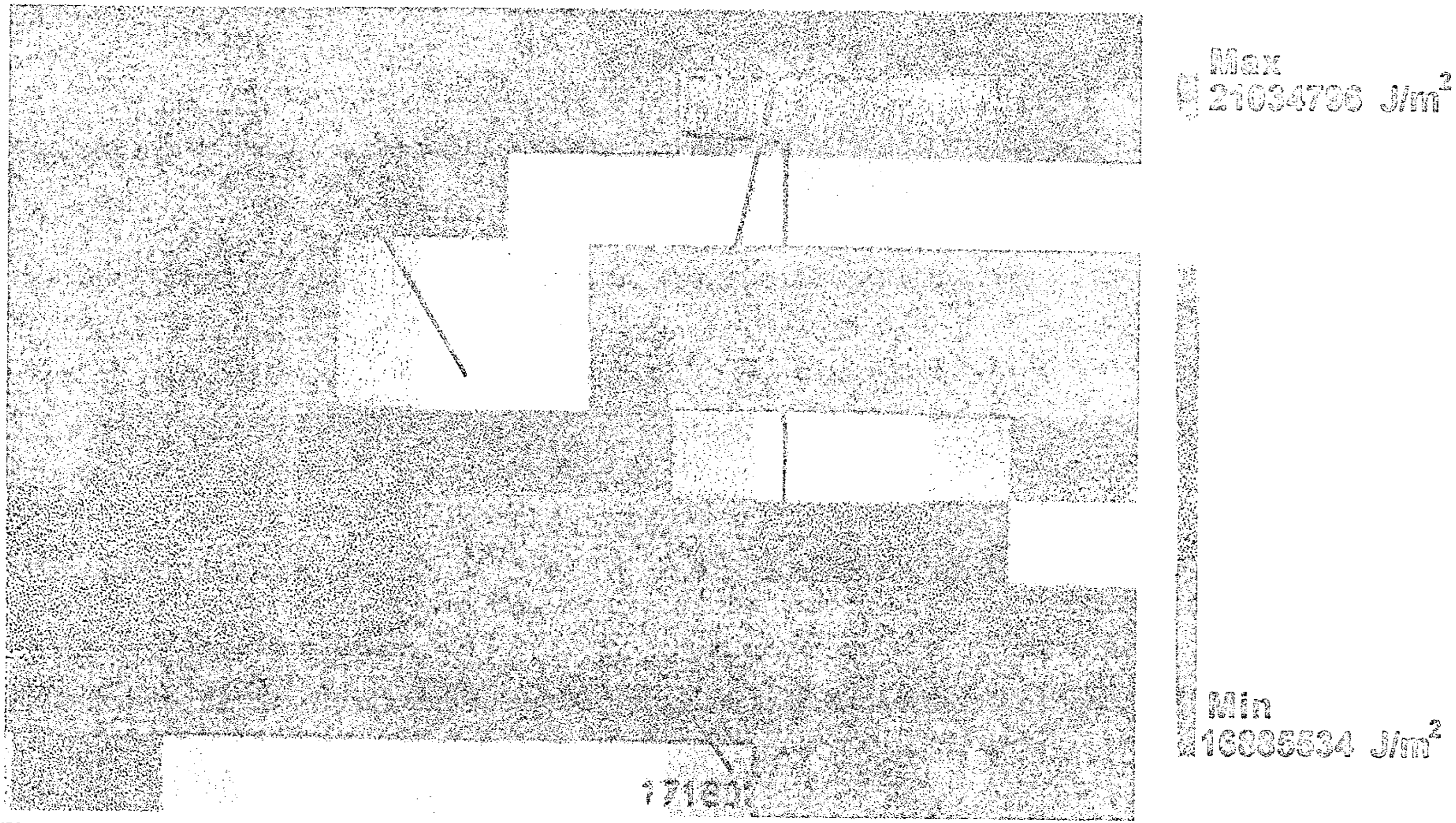


Figure 6. Yearly average SOLARFLUX grid for the study area. Color classes represent predicted values of annual solar radiation averaged over a 30 x30 meter square area. The image was generated by the UNM Biology Department, LTER program, using SOLARFLUX software developed by Paul Rich at the University of Kansas. Image was clipped from a larger SOLARFLUX grid generated for the entire Sevilleta Refuge. The grid illustrates the strong contrast in solar radiation across the drainage basin as well as intermediate values along the headslope.

1995). Two of the surveys were performed during the dry season (usually between December and June) and two surveys were performed during the monsoonal season (usually between July and October). The surveys were conducted along eighteen north-south trending transect lines spaced 10 meters apart and averaging 190 linear meters long. The study area boundary (Figure 3) represents the areal extent of the surveys. Survey results were contour mapped by kriging method in Surfer (1994) to represent changes in soil moisture both with depth and with landscape position.

In order to assess the primary controls on soil moisture in the drainage basin, the EM grids were superimposed on both the landscape and vegetation maps, as well as the Solar Flux grids. Each EM data point for all four surveys was assigned to the appropriate map units and solar flux image class. Statistical analyses were conducted on the data set to determine the degree of correlation between the distribution of map units and the soil moisture variability estimated with the EM-38.

RESULTS

South-facing slope soils

The soils on the south facing slopes are characterized by very thin, low-organic A horizons, little or no Bw or Bt horizons and very shallow and irregularly distributed secondary carbonate accumulations.

Average calcium carbonate content for soils on this slope is less than 10 g/cm^2, forming primarily as clast rinds and local, discrete accumulations of inter-clast cementation. Carbonate stage for soils on this surface is generally Stage II+. The distribution of carbonate is irregular, with considerable zones of carbonate-poor matrix (Figure 7). The average depth to carbonate for these soils is 5 cm.

In two of the profiles on the south-facing slope, strong calcium carbonate accumulations appear below the Ck horizon, representing second, distinct carbonate horizons (Figure 8). Where there is a clear separation, these lower carbonate accumulations were distinguished from the active surface soil and identified as antecedent carbonate within the original alluvial fan deposits. The distinction is made based on the horizontal attitude with which these antecedent carbonate layers intersect the sloping surface. Actively-forming pedogenic carbonate, by contrast, approximately parallels the current surface (Gile et al., 1981). However, it is likely that some of the calcic horizons in this study represent welded soils where current pedogenic carbonate is overprinted on older carbonate within the parent material.

Analyses of particle size distribution for the soils reveals a slight catenary relationship, with an overall decrease in silt content down the slope. The amount of silt decreases from about 12 g/cm^2 on the shoulder location (SL-5) to 9 g/cm^2 at the lowest location on the sideslope (SL-8). However, there is little variation in clay

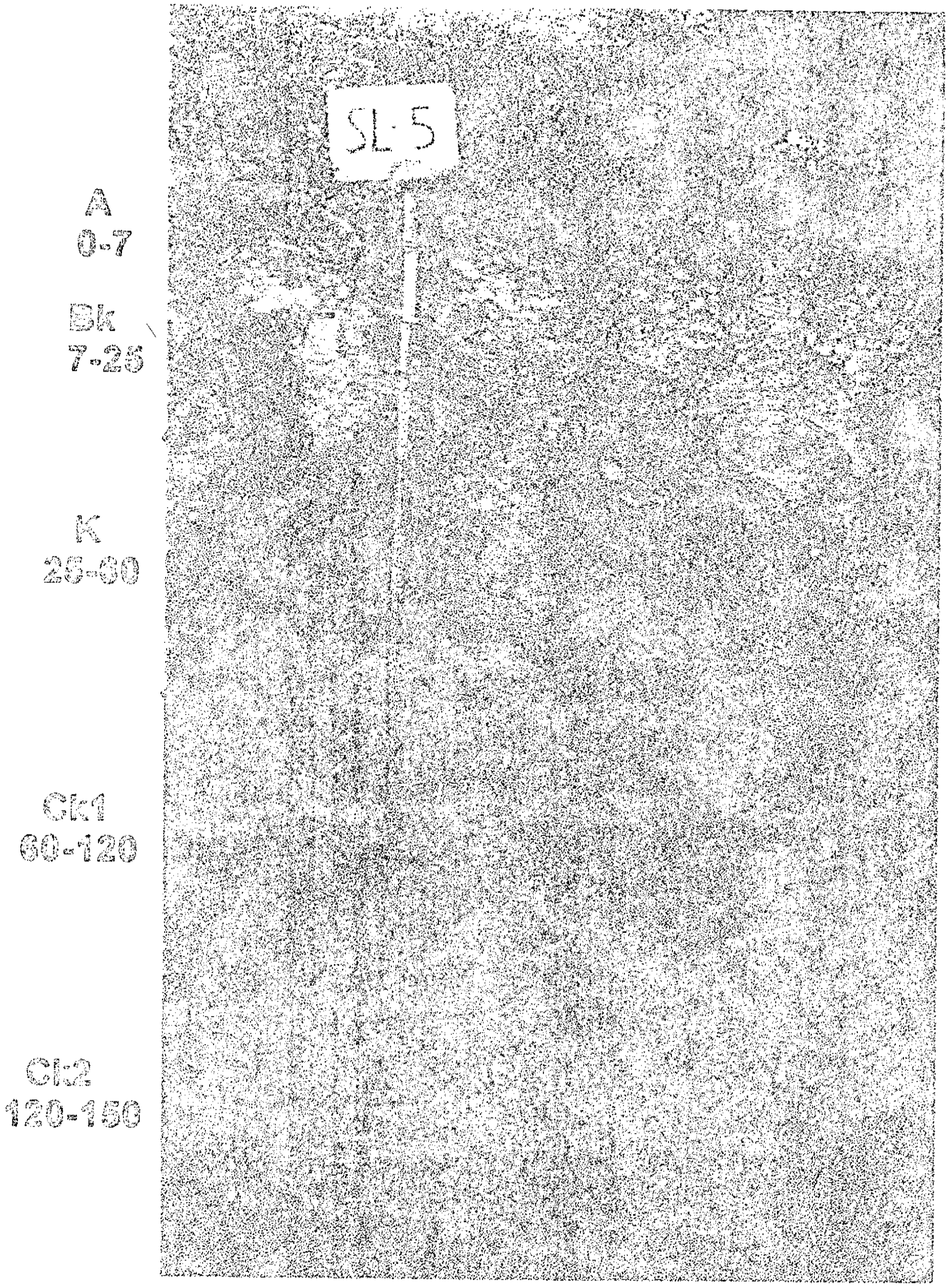


Figure 7. Soil profile SL-5. Profile is representative of soil development on the south-facing slope. Weak A horizon development, shallow carbonate and overallirregular distribution of carbonate in the profile, are characteristic of these soils. Level of carbonate development is Stage II+.

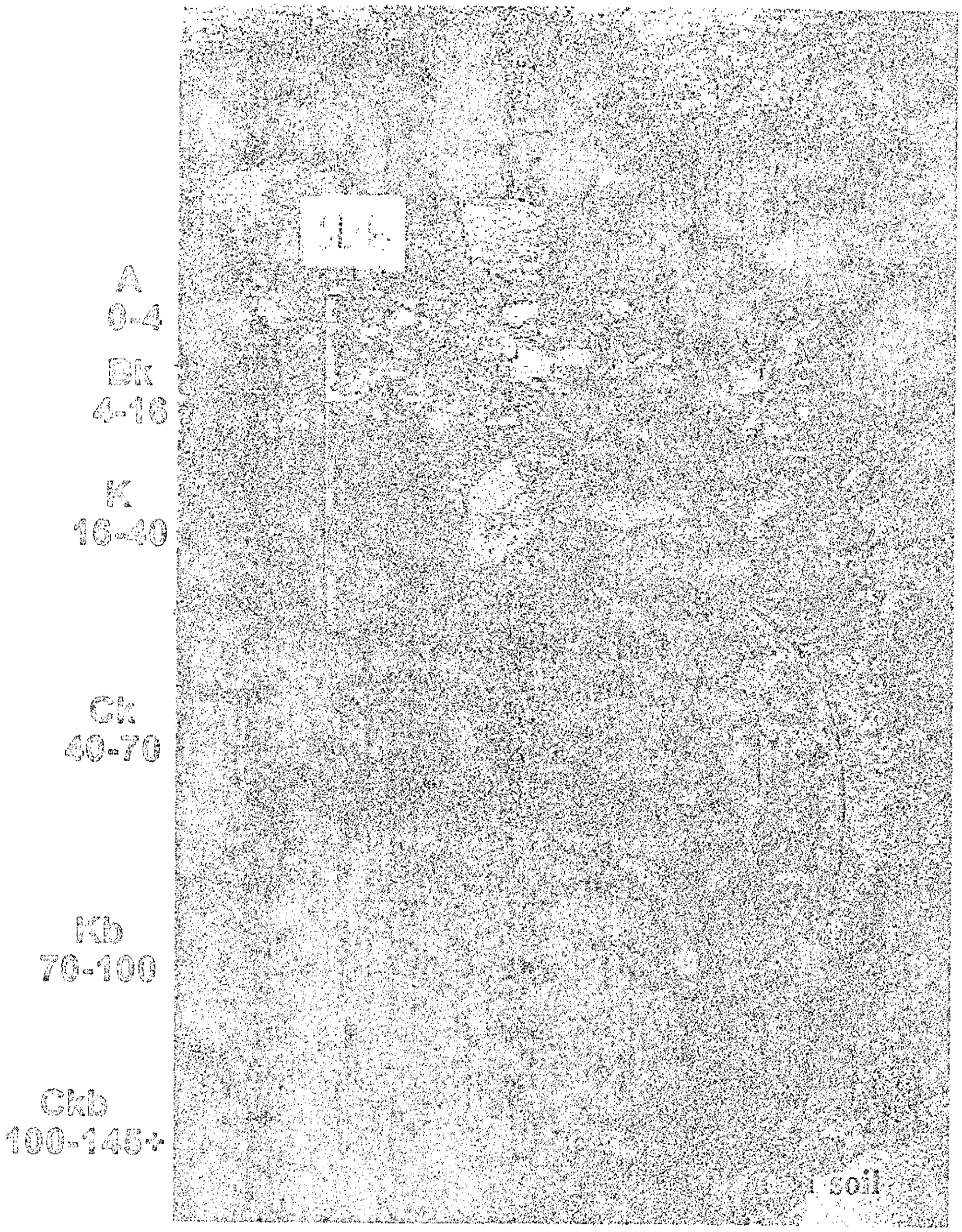


Figure 8. Soil profile SL-6. Soil reveals strong carbonate accumulations in the original stratigraphy (Kb horizon). The generally flat-lying antecedent carbonate zone converges with the pedogenic carbonate horizon of the slope surface toward the front of the pit.

content down the slope, with all soils averaging about 7 g/cm^2. Soil organic matter is generally very low for all the soils on this slope, with an average profile mass of 0.15 g/cm^2. There is no consistent trend in the amounts of organic matter down slope, with the highest value of 0.2 g/cm^2 at the lowest slope position and the two lowest values (approximately 0.13) at the mid-slope locations.

North-facing slope soils

North-facing slope soils are characterized by more organic matter in the upper horizons, distinctly more silt and clay in the B horizons, strong carbonate development and clearly-defined horizon boundaries (Figure 9).

The calcium carbonate horizons within these soils have grown displacively and the carbonate is uniformly distributed through the horizon with an average profile mass of 15 g/cm^2. The carbonate is generally poorly indurated, with only a slightly-hard dry consistency. There are no laminar carbonates within the profile, and the plant roots ranging from coarse to fine are seen throughout and beneath the carbonate horizon. The average depth to maximum carbonate is approximately 30 cm with an overall catenary trend of increasing depth in the down-slope direction. This trend is significant in that it suggests increasing effective precipitation (the amount of water infiltrated) in the downslope direction (Gile et al., 1981).

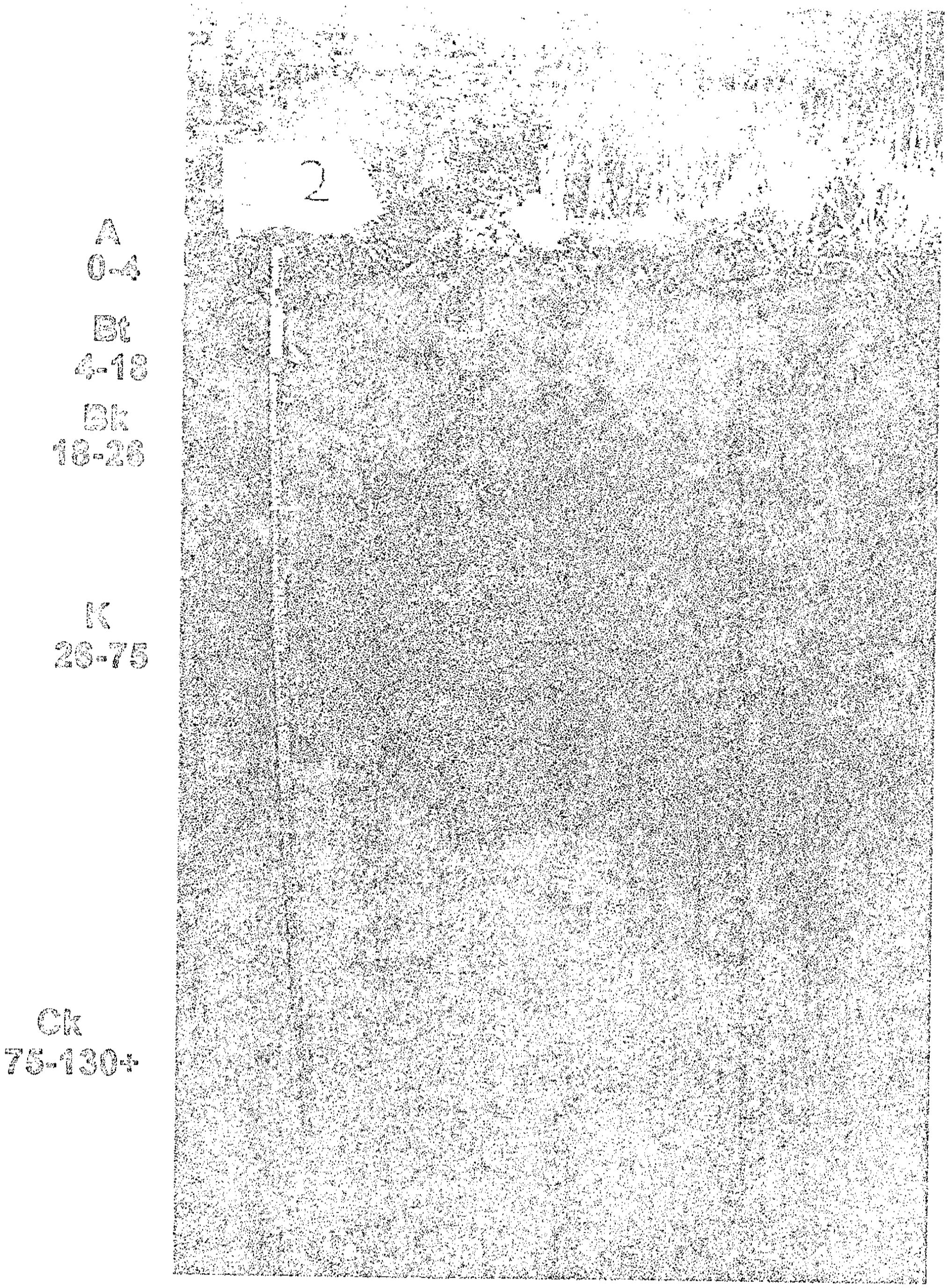


Figure 9. Soil profile SL-2. Profile is representative of soils on the north-facing slope. Soil has a more humic A horizon, pronounced B horizon and pervasive stage III carbonate horizon.

The profile mass of pedogenic carbonate within these soils is significantly higher than those of the South-facing slope soils (Figure 10). While the contrast in the amount of carbonate across the basin is striking, there is no consistent trend in the mass of carbonate down the north-facing slope slope. However, the SL-4 soil (the lowest slope position), has a calcic horizon that is thicker than those of the other three soils on this surface (Figure 11). It may be a welded soil, where the actively-forming soil carbonate is superimposed upon pre-existing carbonate accumulations in the original stratigraphy.

The upper soil horizons on the north-facing slopes have more silt and clay than their south-facing counterparts (Figure 12). There is a subtle catenary relationship, with an increase in both silt and clay toward the lower slope positions. Clays increase from 9 g/cm^2 on the shoulder position (SL-1) to about 12 g/cm^2 at the lowest position on the slope (SL-4). In general, however, the clay content of soils on the north-facing slope is not enormously greater than that on the south-facing slope. The silt content of the upper soil horizons on this surface averages 18g/cm^2 and accounts for the distinct contrast in soil texture between the two slopes.

Profile mass of soil organic matter on the north-facing slope is significantly greater than that of the south-facing slope (Figure 13). Soils on this slope average nearly 0.5 g/cm^2 of organic matter, with a very slight, increase down slope. Values range

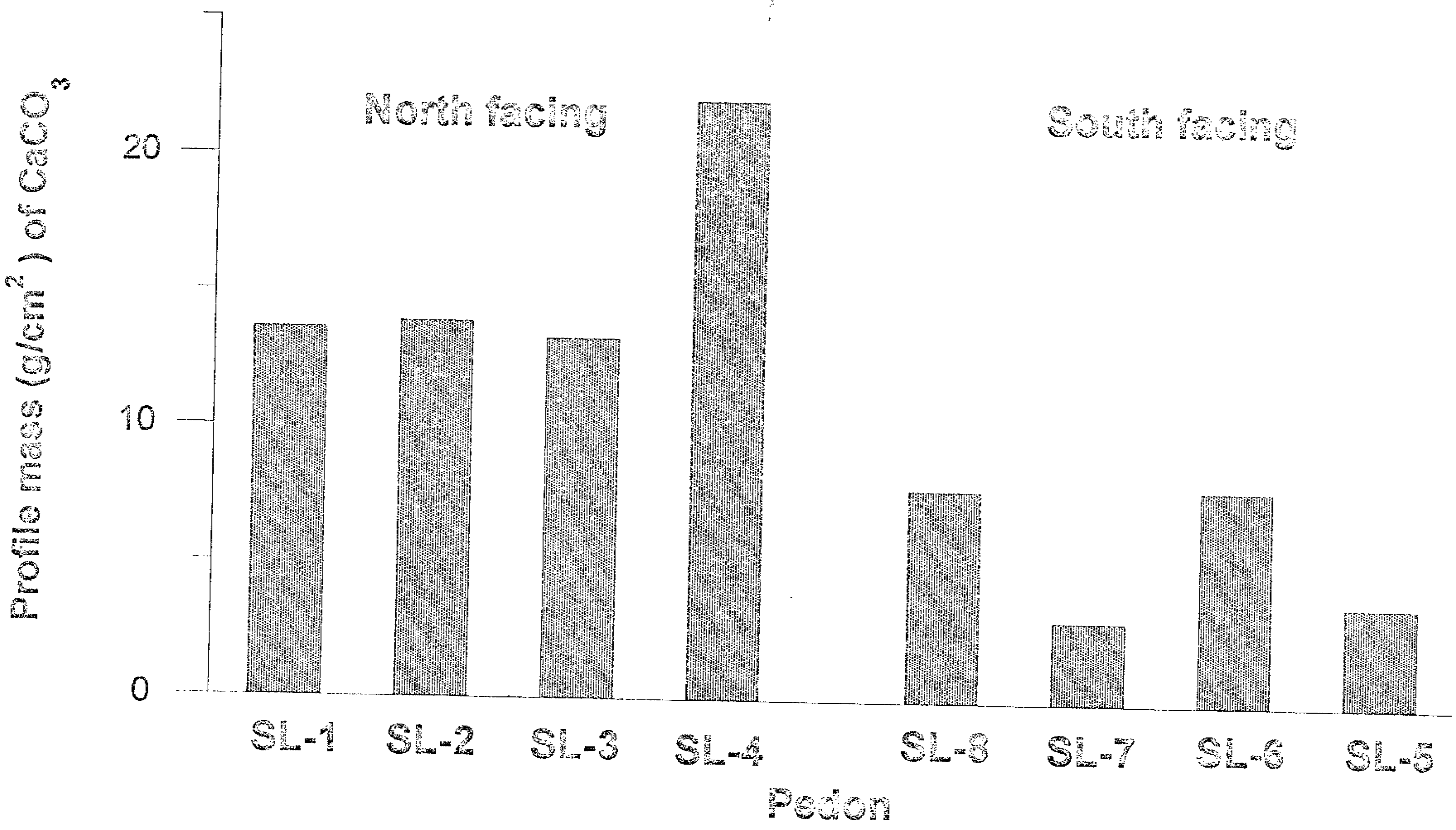


Figure 10. Variation of profile mass of calcium carbonate across sideslopes of drainage basin. North-facing slopes have higher calcium carbonate contents than south-facing slopes. The value for SL-4 may represent a welded soil.

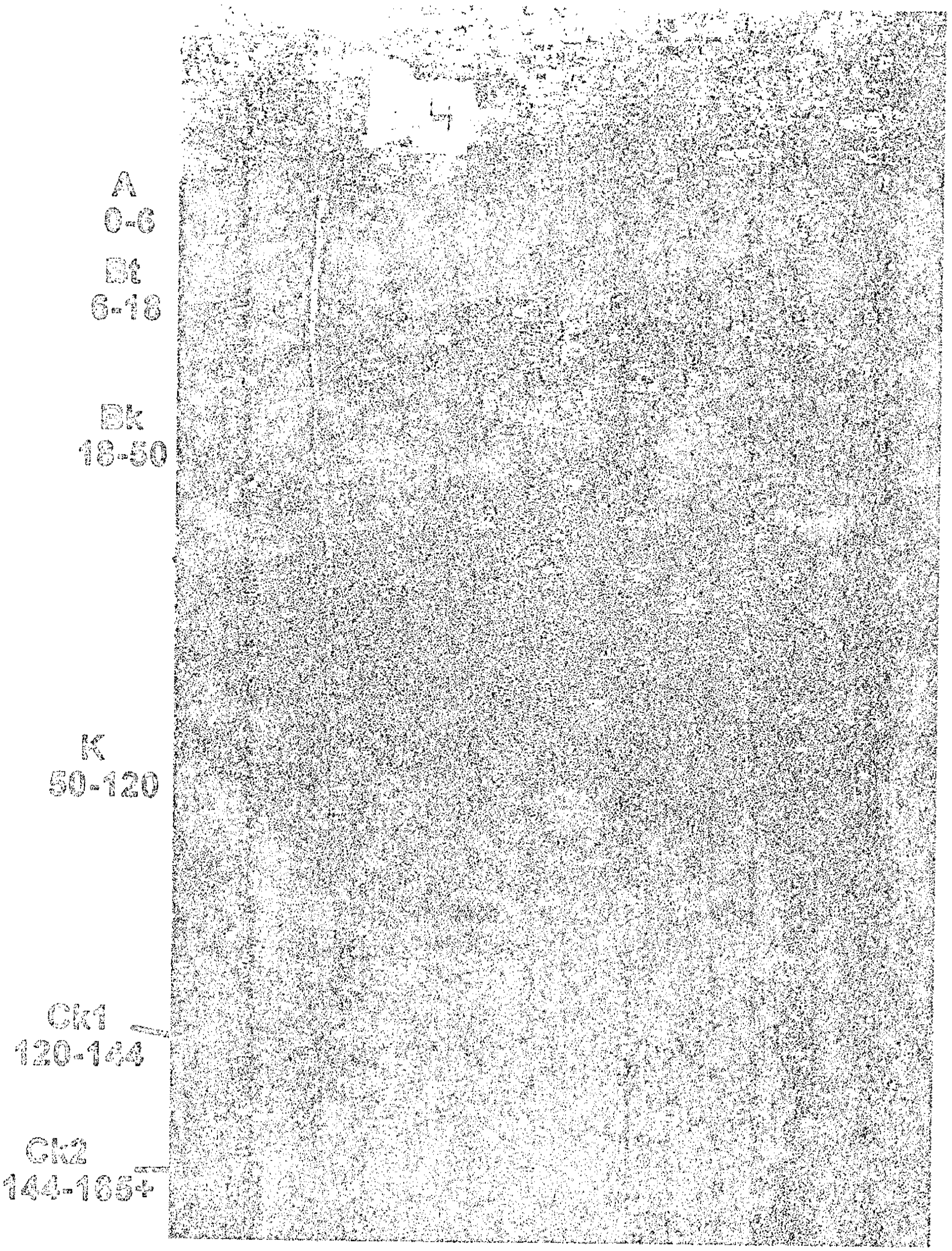


Figure 11. Soil profile SL-4. The thick carbonate horizon in this profile may represent a welded soil, where actively-forming carbonate is superimposed on antecedent carbonate of the original stratigraphy.

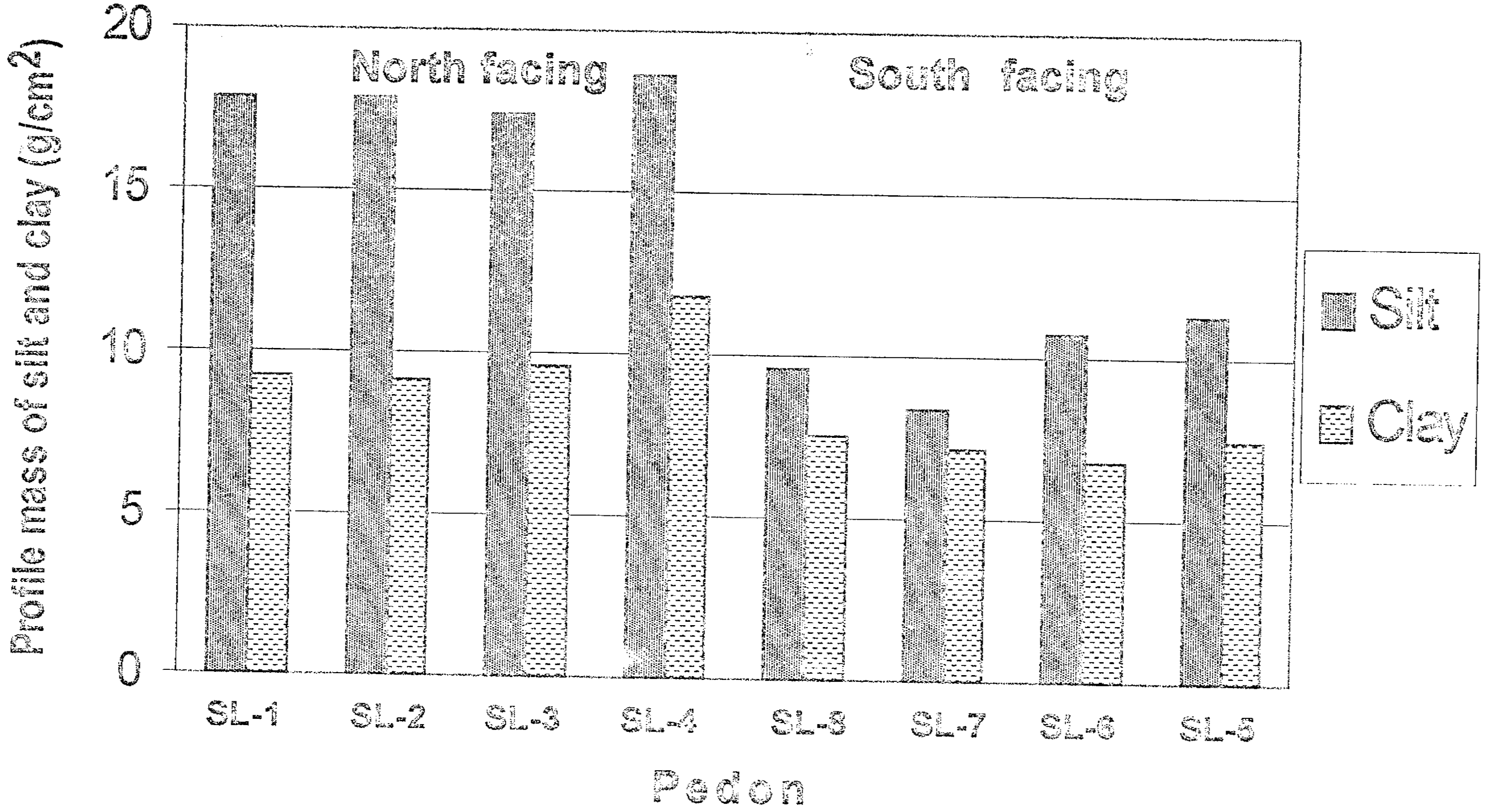


Figure 12. Variation in profile mass of silt and clay between sideslopes of the drainage basin. Values are normalized to 50cm depth. There is more of both silt and clay in the soils of the north-facing slope, however, the difference in texture is largely defined by the silt content of the soils.

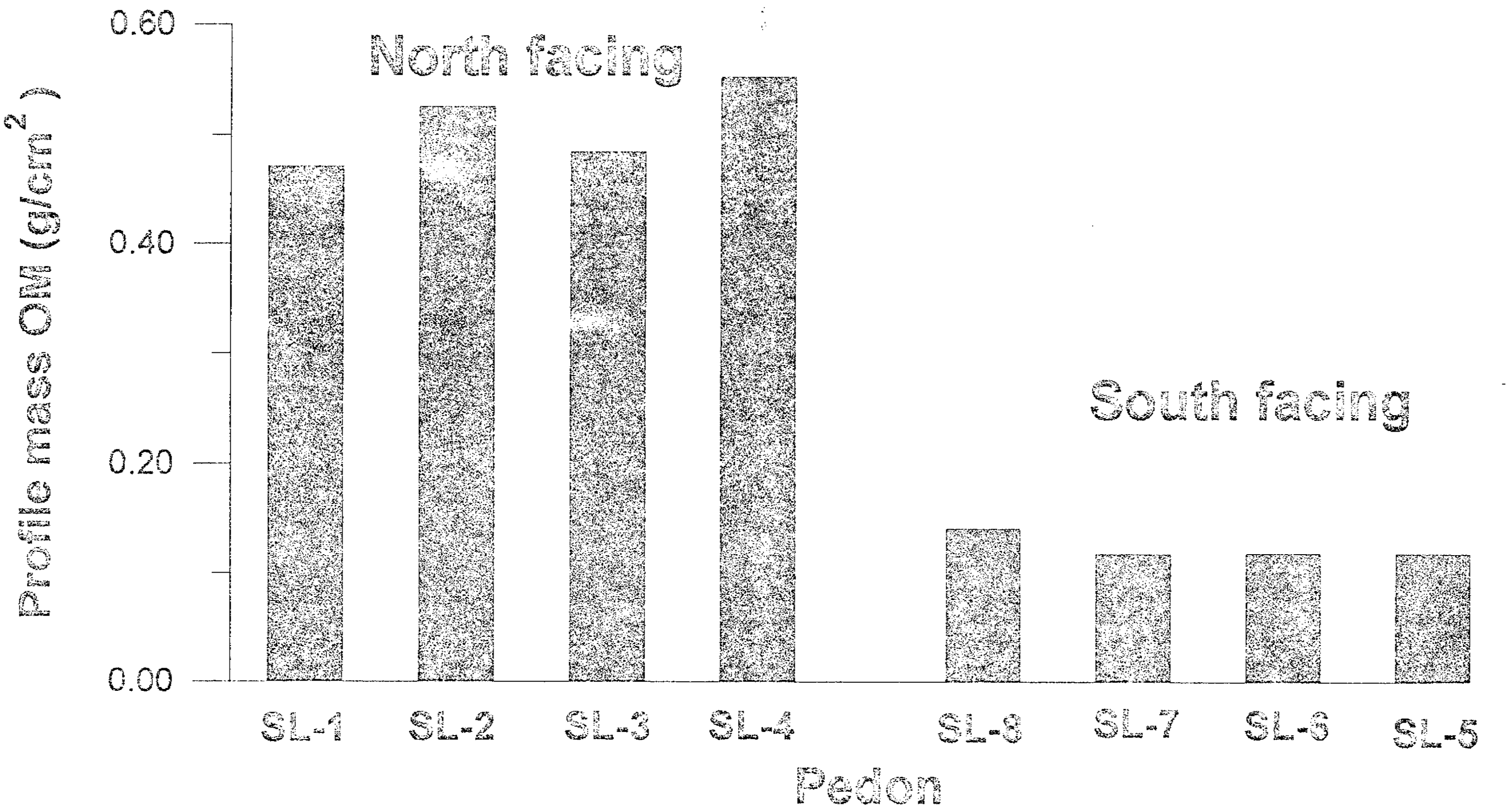


Figure 13. Profile mass of organic matter across sideslopes of drainage basin. Organic matter contents determined by loss on ignition.

from 0.47 g/cm^2 at the shoulder slope position (SL-1) to 0.55 g/cm^2 at the lowest slope position (SL-4).

Headslope soils

Two series of soil pits were excavated along the headslope of the drainage. One along the contour connecting the north and south sideslopes and another along the axis of the headslope, in line with the central drainage channel (Figure 3).

Overall, calcium carbonate content of soils in the headslope increases along a contour extending from the southeast-facing portion to the northeast-facing portion (Figure 14). Soils within the headslope axis, however, are distinct from either of the two sideslopes. There is a trend of decreasing profile mass of carbonate (Figure 15) as well as a trend of increasing depth to carbonate down the catena along the headslope axis. The depth to carbonate in the catena ranges from a minimum of 30 cm at the shoulder slope location (SL-15) to 76cm at the mid-slope position (SL-11). The lowest position along the slope (SL-14) contains no pedogenic carbonate. Horizontally-oriented carbonate layer is encountered at 110cm. However, this is interpreted as antecedent carbonate based on its horizontal orientation. These trends in both mass of carbonate and depth suggest that there is a dramatic increase in moisture down the catena, which limits carbonate accumulation. There is also a strong trend of decreasing soil organic matter down the slope, with a profile mass

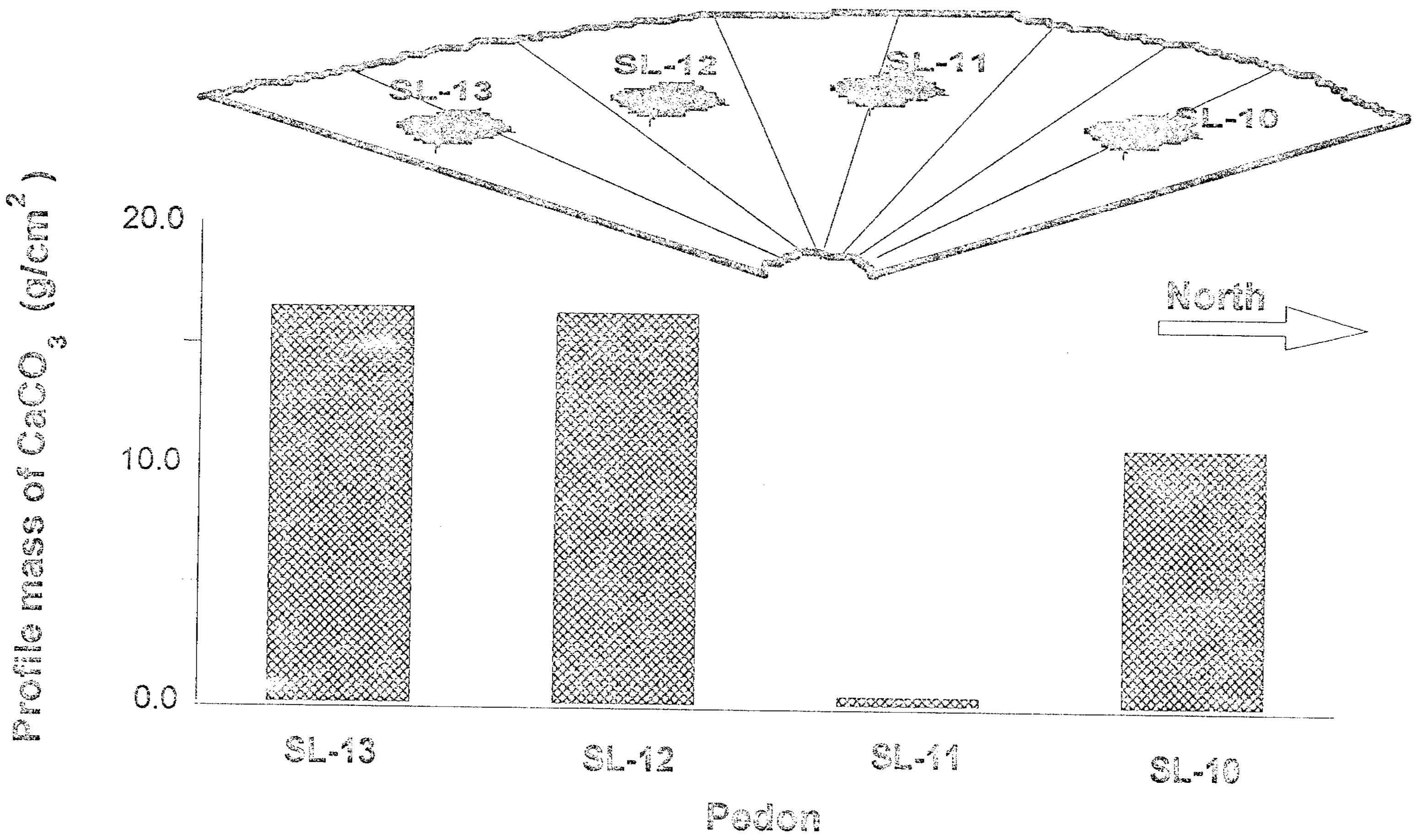


Figure 14. Profile mass of calcium carbonate along a contour of the headslope. SL-12 and 13, as well as SL-10 have values consistent with their respective adjacent sideslopes. The low carbonate content in the SL-11 soil reflects the higher moisture conditions within the headslope axis.

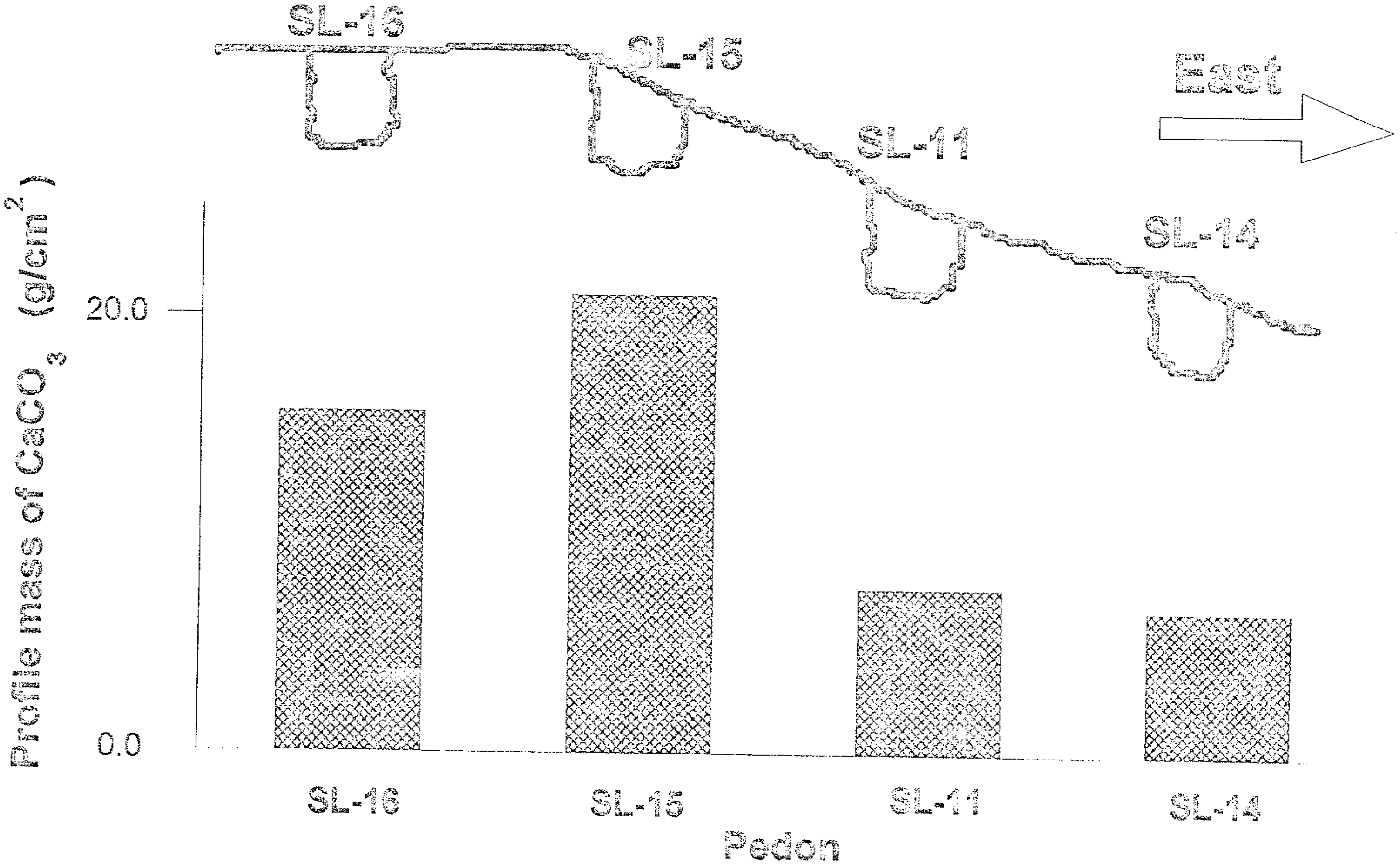


Figure 15. Bar graph of profile mass of carbonate for soils in the headslope axis catena. Carbonate mass decreases dramatically downslope, and is not present in the lowest soil of the catena.

ranging from more than .40 g/cm^2 on the shoulder to 0.17 g/cm^2 at the lowest slope position (Figure 16).

Moisture flux through soils (Chloride and soluble salt results)

Chemically based natural tracers, such as chloride, are useful for the estimation of water movement in desert soils (Liu et. al., 1995). Chloride, a constituent of rainwater, is highly soluble and mobile, and is concentrated in the soil solution as a function of evaporative and transpirative losses of soil water. As such, there is an inverse relationship between chloride concentrations and moisture flux through soils (Scanlon, 1991). Soils across the study area show generally low concentrations of chloride, with discrete peaks or rises in chloride concentration at various levels in the profiles. The maximum concentration of soil water chloride for the depths of soils sampled was 31 mg/L for the SL-16 location. However, there were no notable relationships between patterns in the chloride profiles and those of either soils or vegetation. The bulges in chloride concentrations tend to begin below 1 meter, but seem to function independently of calcium carbonate concentrations. In general, low soil water chloride concentrations are indicative of high moisture fluxes through the soil (Scanlon, 1991). The observed small peaks in chloride concentration at various levels in the profiles are interpreted as pulses of recharge water moving through the profile and evacuating short-term residual soil-water chloride. However, it should be noted that the upper 1 meter of soil is the most hydrologically active, characterized by seasonal variations between

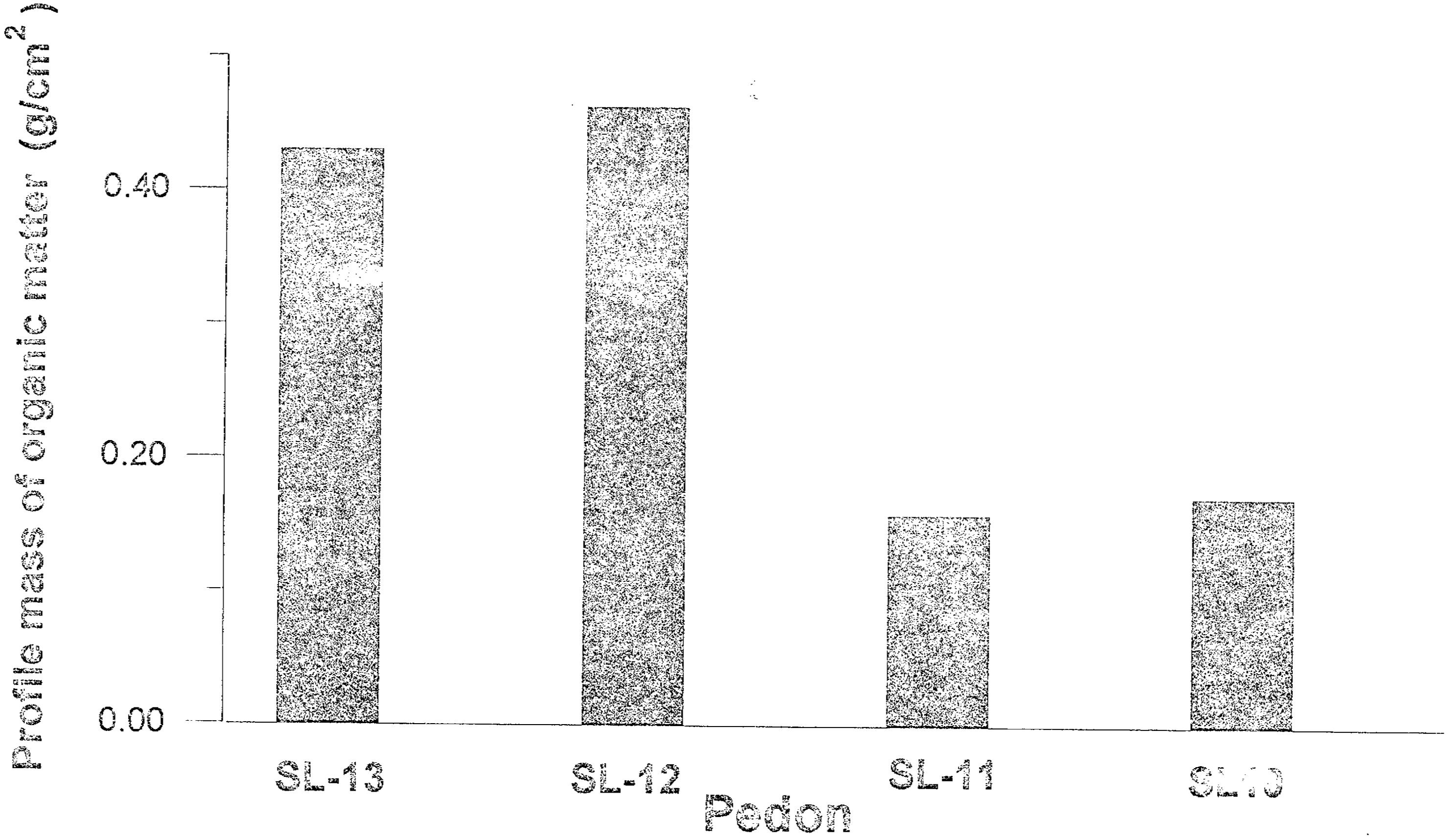


Figure 16. Profile mass of organic matter along a contour of the headslope. SL-10, 12 and 13 have values generally similar to their respective adjacent sideslopes. The lower value for SL-11 may reflect its postion in the headslope axis, and the resulting increases in concentrated runoff.

downward and upward moisture flux (Liu et al., 1995). Thus, the depths of the profiles sampled may be too shallow to provide definitive proof of the overall downward moisture flux in this vadose zone. Chloride and soluble salt profiles are available in Appendix C.

Soluble salts are also concentrated in desert soils as a result of evapotranspiration, and may be used as a qualitative indicator of the degree of leaching in a soil. Depth profiles of soluble salts across the study site yielded low values, ranging between 0.01% and 0.05% by weight. Throughout the profile depth sampled, North-facing slope soils generally have their highest soluble salt values within the first 30 cm (Figure 17), while South-facing slope soils have soluble salt peaks between 50 and 80cm (Figure 18). On the south-facing slope the most leached soil is that of SL-8, the footslope location, where salt values decline steadily down to 50 cm and hold a constant value of about 0.01 wt. % thereafter. The maximum soluble salt values in the north-facing slope soils is consistent with the depth of highest silt and clay contents and suggests that the upper soil horizons are slowing infiltration and retaining moisture for evaporation and transpiration. In general, though, such overall low concentrations of salts suggests a relatively high net downward water flux through the depth of soil sampled

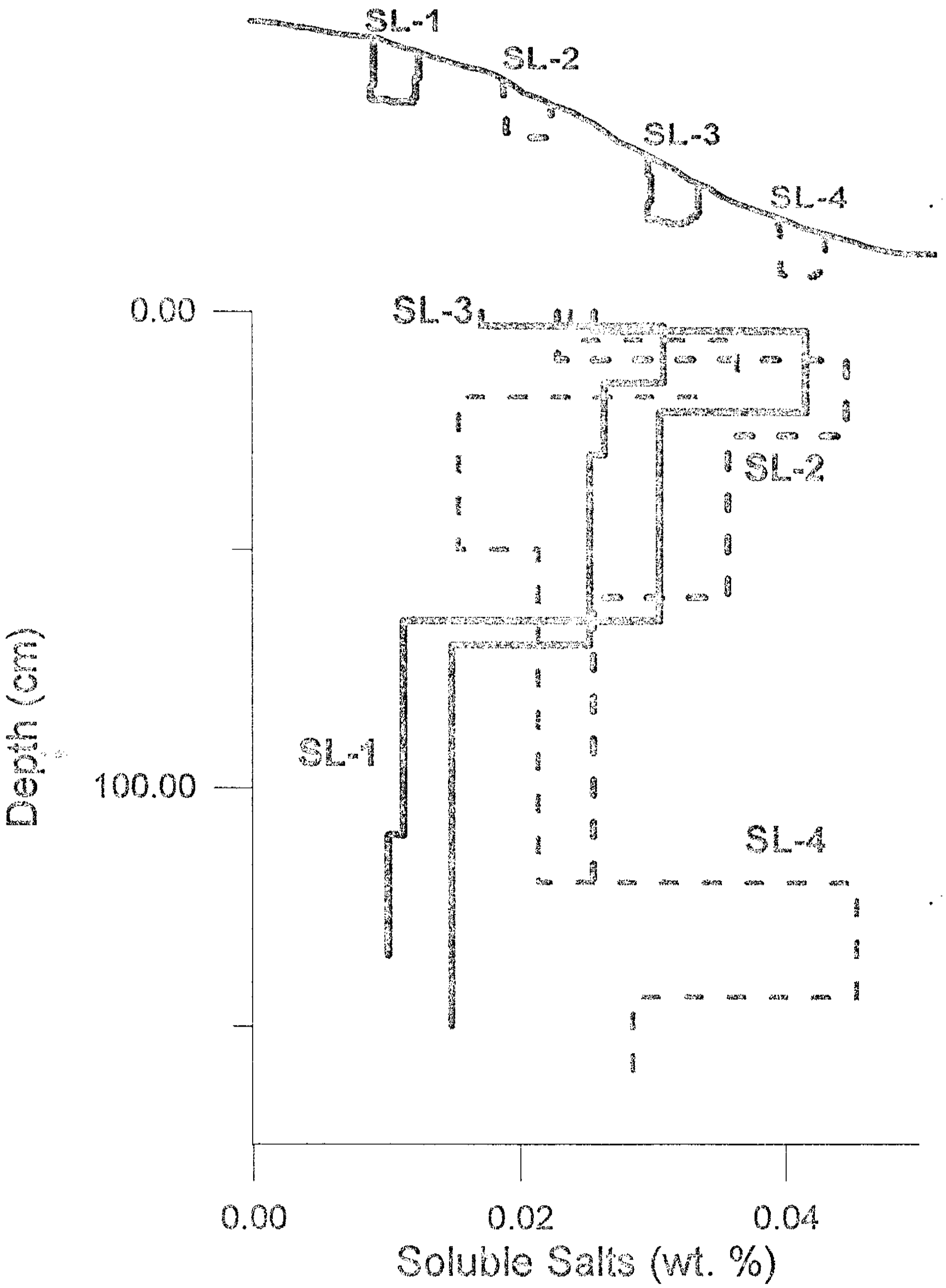


Figure 17. Soluble salt profiles for north-facing slope soils. Low overall salt concentrations indicate significant leaching. The higest concentrations are generally in the upper 20cm of the profile.

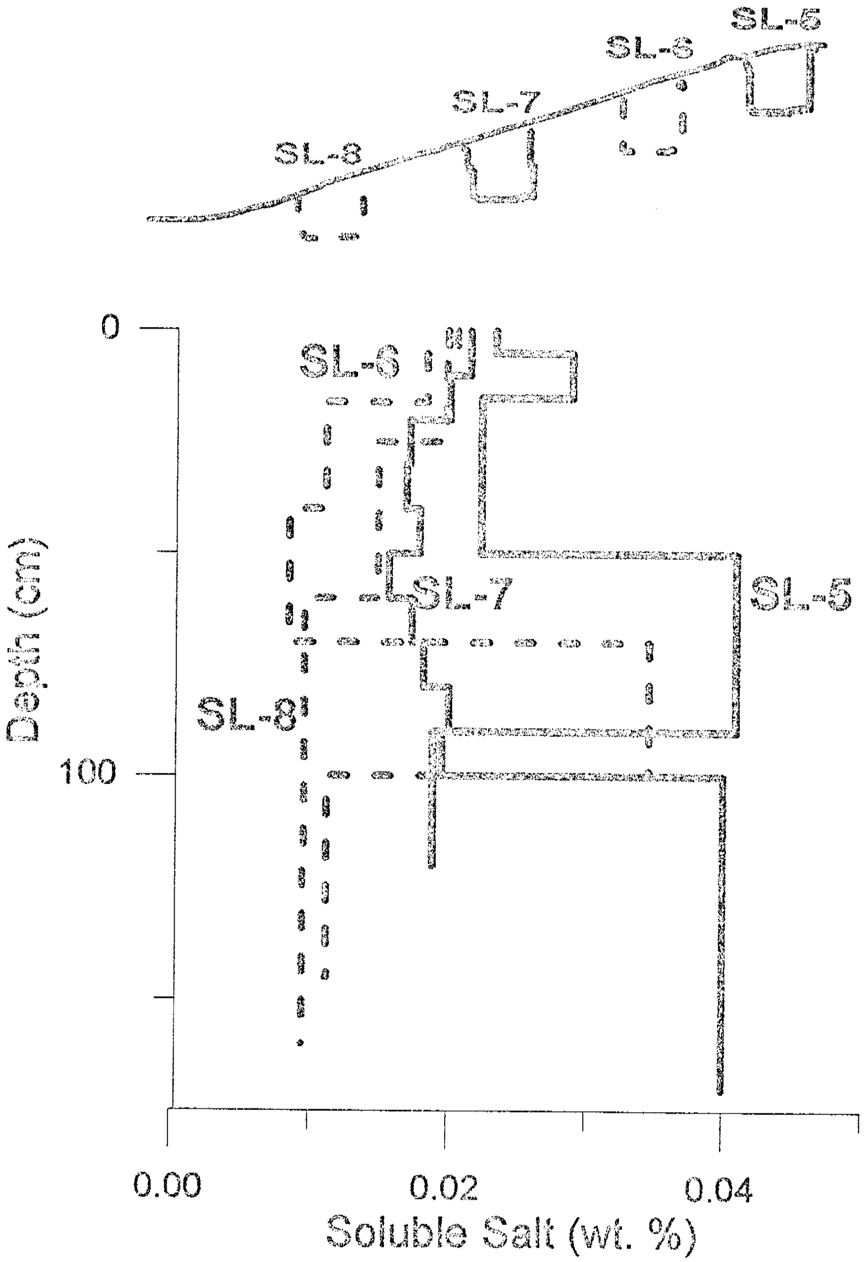


Figure 18. Soluble salt profiles for the south-facing slope soils. The peaks in salt content are generally found low in the profile, consistent with zones of carbonate accumulation.

Soil water retention

Soil moisture retention and movement are strongly related to the surface area per unit volume of soil mass, which is largely a function of clay and organic matter content (Birkeland, 1984). As soil water content is decreased, the tension with which the remaining water is held to in the soil increases as a function of such factors as particle size, clay content, gravel content, organic matter and bulk density. Water retention curves have been used to illustrate the relationship between soil water content and soil water tension for a range of soil types, showing that for a given soil water tension, clay soils have significantly higher moisture contents than sandy soils (Hendrickx, 1990; Wosten, 1987).

Water retention curves were calculated for soil horizons within the average rooting depth of grasses (5-30 cm). There was significantly greater moisture retention in the soils of the north-facing sideslope and north-east facing portion of the headslope (Figure 19). For an equivalent water potential of 50 KPa, the water content of the north-facing slope soil is more than double that of the south-facing slope soil. The greater moisture retention values in the north-facing slope soil is a function of higher silt, clay and organic matter contents of those soils as well as lower gravel contents.

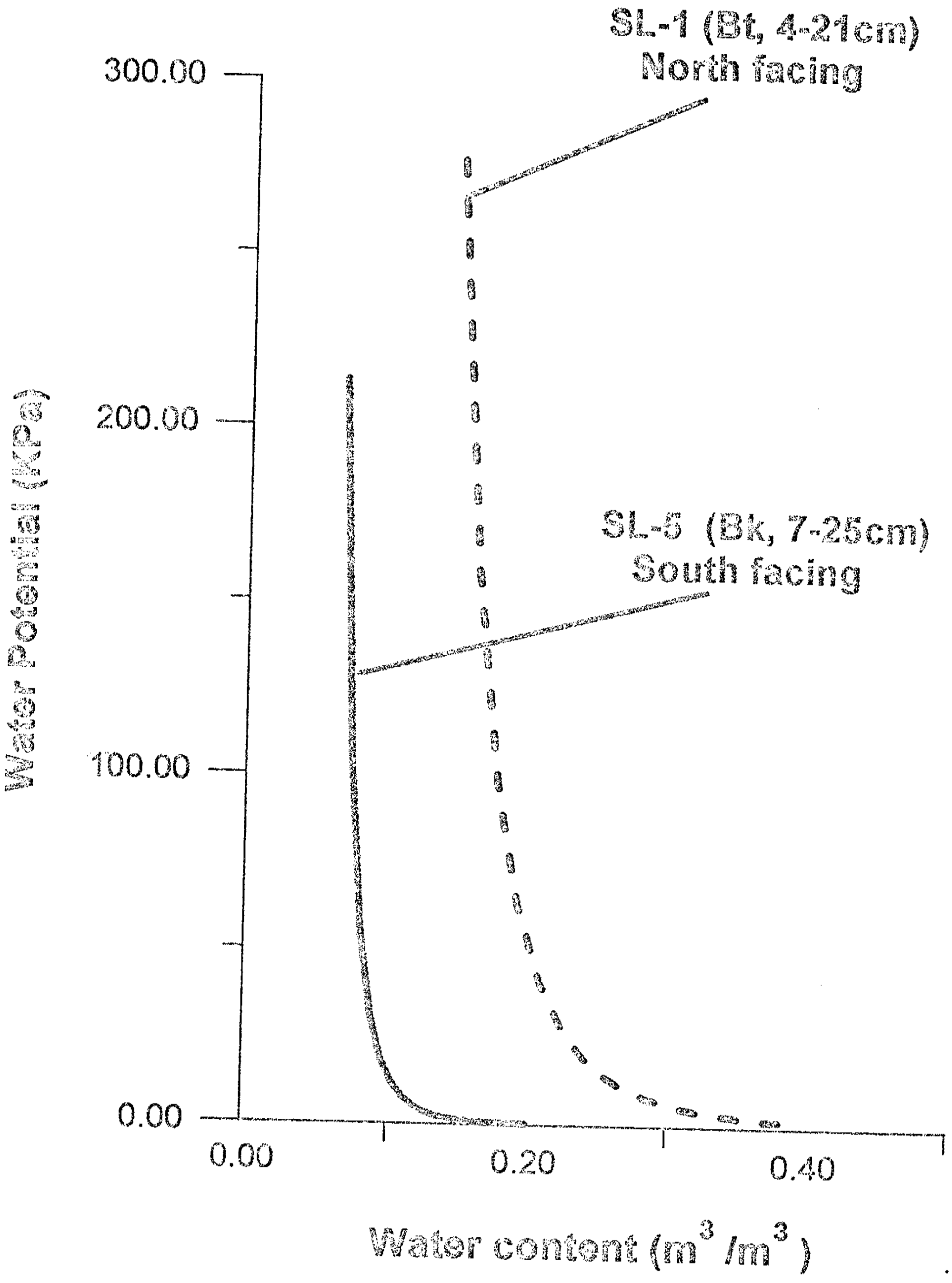


Figure 19. Water retention curves calculated for comparable depth soil horizons from each sideslope. SL-1 (North facing) demonstrates higher moisture retention as a function of higher silt and clay contents as well as lower gravel content.

Vegetation patterns across the study site

The most striking vegetation change that takes place in the study area is that which occurs across the central drainage channel separating the north and south-facing sideslopes. While grasses are prominent on both of the slopes, the two slope communities represent opposing ends of the grassland spectrum. The south-facing slope, with total shrub cover slightly greater than the total grass cover, borders on a desert shrubland. The north-facing slope, by contrast, is a grassland bordering on a Juniper savanna.

In addition to the dramatic shift from desert shrubs to Juniper trees, there is a significant change in both species composition and the total percent cover of grasses between the two slopes (Figure 20). On the south-facing slope the principal grass cover species are fluff grass (*Erioneuron pulchellum*) and slim tridens (*Tridens muticus*). Fluff grass is a shallow-rooted perennial species often associated with rocky soils or areas of low productivity. Both fluff grass and slim tridens occur elswhere in the Southwest at elevation ranges notably lower than most of the other grass species in the study area (Table 1). Creosotebush (*Larrea tridentata*) and mariola (*Parthenium incanum*) are the prominent shrubs of the south-facing slopes with 7.8% and 6.6% cover respectively. Qualitatively, the upper table surface in the margin of the study site is more heavily dominated by Creosote than the south-facing slope and appears to support less grasses, although no detailed surveys were conducted there.

Species name	Common name	low elev	high elev	Avg. elev	Transect (> 4% cover)
Bouteloua gracilis	blue grama	2000	8200	5100	HS-4
Bouteloua eriopoda	black grama	2500	6500	4500	NF; HS-1, 3 & 4
Bouteloua hirsuta	hairy grama	2200	6500	4350	NF
Erioneuron pulchellum	fluffgrass	2000	6000	4000	SF; HS-1 & 2
Sporobolis cryptandrus	sand dropseed	1300	6500	3900	HS-4
Tridens muticus	slim tridens	1100	5800	3450	SF

Table 1: List of grasses arranged according to average elevation of occurance throughout the Southwest. Grass elevation ranges derived from Powell (1994). Associated transects represent greater than 4 percent cover of a species in that transect.

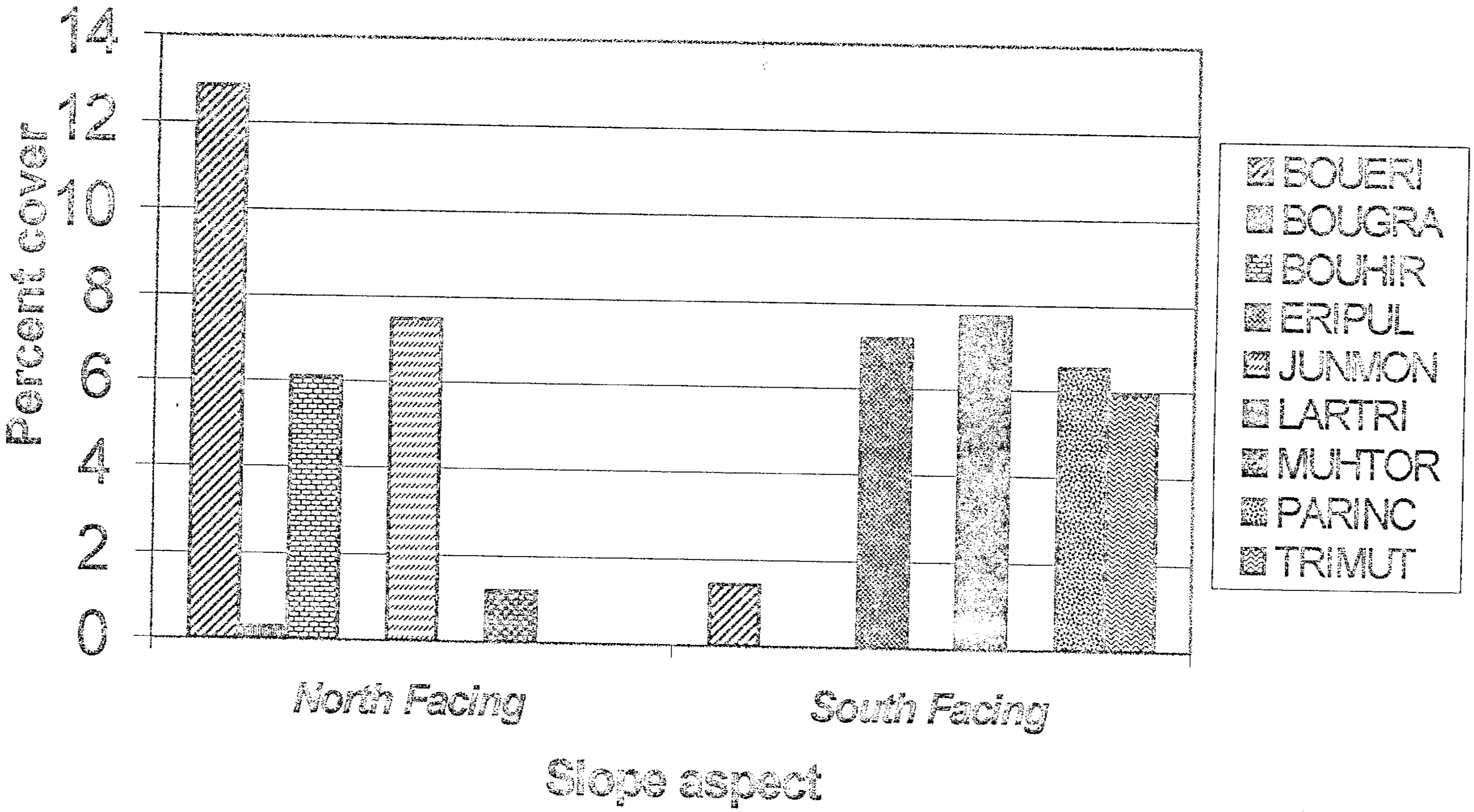


Figure 20. Bar graph showing the contrast in vegetation types between the two sideslopes. The grasses, black grama (BOUERI) and hairy grama (BOUHIR) and the juniper trees (JUNMON) define the north-facing slope community. The south facing slope is dominated by the shrubs, creosote bush (LARTRI) and mariola (PARINC) as well as the grasses, fluff grass (ERIPUL) and slim tridens (TRIMUT). Black grama is the only species with significant cover on both slopes.

The north-facing slope is dominated by black grama (*Bouteloua eriopoda*) and hairy grama (*Bouteloua hirsuta*) and scattered one-seed junipers (*Juniperus monosperma*). The elevation ranges of occurrence in the southwest for both black grama and hairy grama are considerably higher than those of the south-facing slope grasses (table 1). This is indicative of their more mesic character. In addition to a change in species type, the total grass cover increases going from the south-facing slope (14% cover) to the north-facing slope (21% cover). One-seed juniper is the only tree species on the north facing slope, which, although conspicuous on the slope, has a low cover value of 7.5%.

The vegetation pattern is generally more complex within the headslope of the basin. The changes in cover of individual grass species between transect segments demonstrates that the transition across the axis of the headslope is not simple and that the communities within the headslope are somewhat distinct from either of the two sideslopes (Figure 21). The southeast-facing portion of the headslope continues to support fluff grass, black grama, creosotebush and mariola, similar to that of the South-facing slope, but with an overall increase in creosotebush cover and average shrub height.

The ecotone, or transition from predominantly shrubland (south facing) to predominantly grassland (north facing), is abrupt and occurs within a 10-meter-wide zone within the headslope axis. The boundary between the two middle headslope vegetation transect segments (HS-2 and HS-3) falls within this ecotone

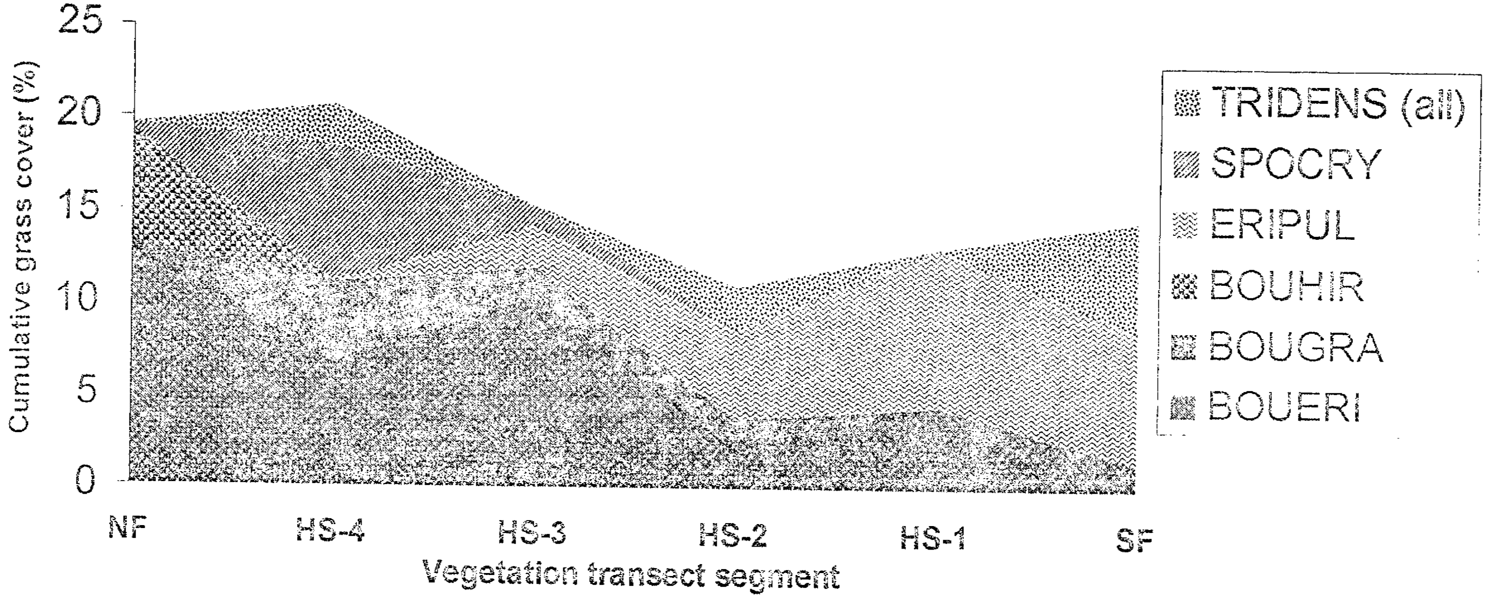


Figure 21. Variation in grass cover along a contour of the drainage basin. The graph illustrates the transition in percent cover of dominant grass species as well as an increase in the total cover of grasses along the contour from south-facing to north-facing slope.

(Figures 3 and 4). The resulting change in dominant vegetation between the two segments is indicated by an abrupt decline in creosotebush and an equally abrupt increase in black grama grass.

The northeast-facing portion of the headslope (HS-3 and HS-4) is grass-dominated, with sparse shrubs. Within this zone, black grama, sand dropseed (*Sporobolus cryptandrus*) and blue grama (*Bouteloua gracilis*) grasses dominate, with the blue grama and sand dropseed increasing from HS-3 to HS-4 (Figure 21). The sand dropseed as well as red threeawn (*Aristida purpurea*), which appears in trace amounts in the HS-4 segment, are considered to be disturbance species. Where the grasses are concerned, the northeast-facing portion of the headslope represents the most mesophytic assemblage within the drainage basin, largely due to the abundance of blue grama there. Also present within this zone, although not recognized in the transects, is New Mexico needlegrass (*Stipa neomexicana*), a cool season grass. All of the other grasses identified in the study area are warm season varieties.

The average grass cover for the northeast-facing portion of the headslope grades from primarily black grama near the axis of the headslope to a more even distribution of sand dropseed, black grama and blue grama in the last segment of the vegetation transect (HS-4). The transition from the northeast-facing portion of

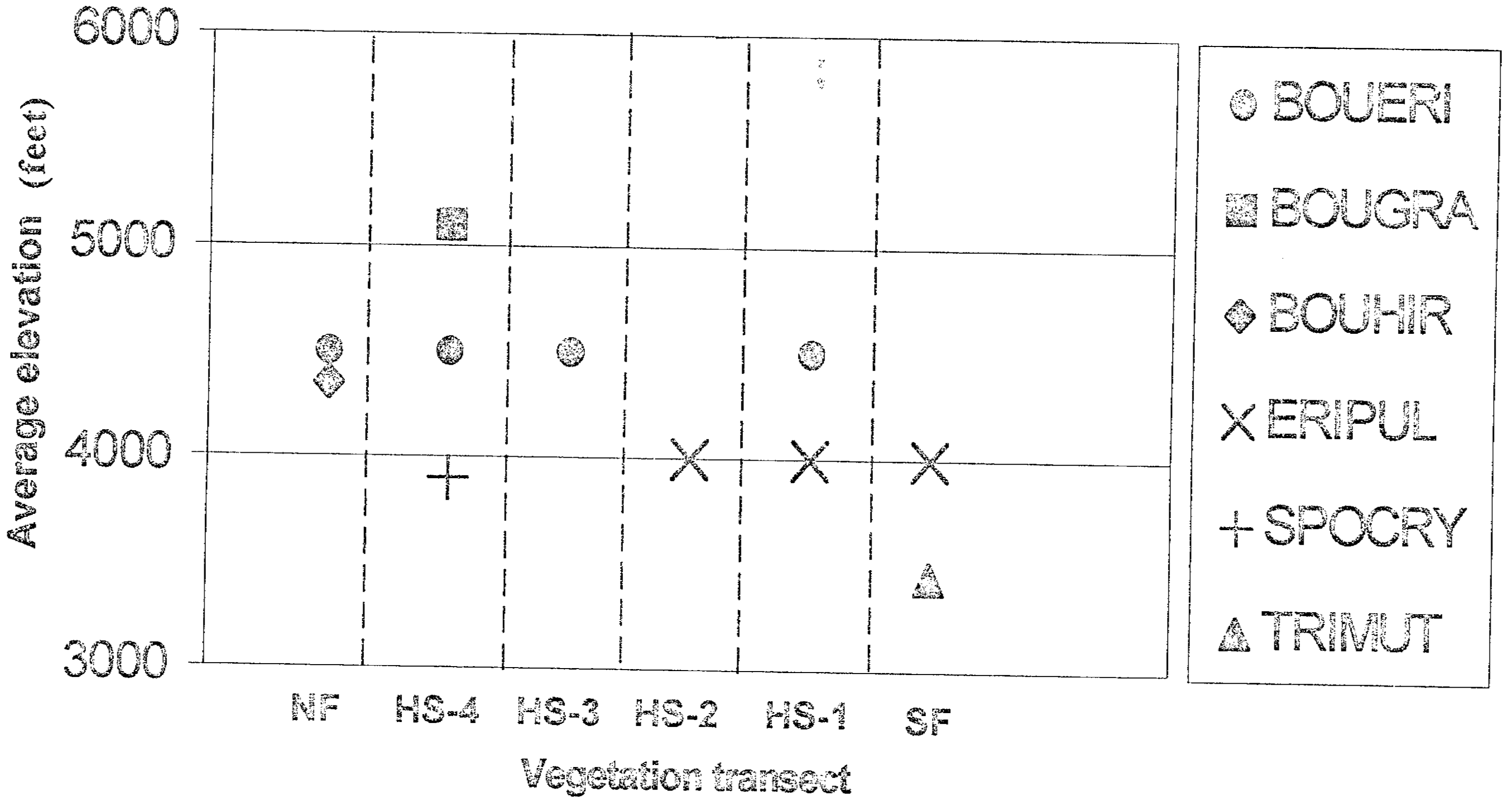


Figure 22. Mean values of the elevation range of occurrence throughout the southwest for prominent grass species found in the drainage basin. Values are plotted over transects where they occur with at least 4% cover. Graph demonstrates a trend toward grasses typical of higher elvation sites going along a contour from south facing to north facing slopes. Data for the elevation range of occurrence of grasses were derived from Powell (1994). Vegetation species list with acronyms in appendix D.

Relationships between soils and vegetation

In order to assess the relationship between soils and vegetation, vegetation communities were ranked in order of moisture affinity and then plotted against soil properties that influence available moisture. This approach yielded a positive relationship between vegetation and depth to carbonate, profile mass of carbonate, profile mass of organic matter, and profile mass of silt and clay. The arrangement of vegetation units along a gradient from most xerophytic to most mesophytic is: Creosotebush/grassland (CG), Dense Creosotebush/grassland (DCG), Grassland (G) and Juniper/grassland (JG) (Figure 4).

While there is a notable relationship between the soil characteristics and the relative moisture affinity of vegetation communities, the greatest differences in soils seem to be reflected in the change from overall shrubland to overall grassland communities. Where the parameters depth to carbonate, profile mass of carbonate and profile mass of organic matter are concerned, the abrupt change between the two community types is unequivocal. The depth to carbonate in shrubland soils ranges between 3 and 12cm while the grassland soils have visible carbonate initiating deeper, between 15 and 22 cm (Figure 24). The profile mass of pedogenic carbonate in the shrubland soils ranges from 3 to 12 g/cm^2, while that of the grassland soils is greater, and ranges from 13 to 22 g/cm^2 (Figure 25). Values for profile mass of organic matter range from 0.12 to 0.21 g/cm^2 in the shrubland soils and from 0.41 to 0.65 g/cm^2 in the grassland soils (Figure 26). With respect to soil texture, the profile mass of clay (within the upper 50 cm of the profiles)

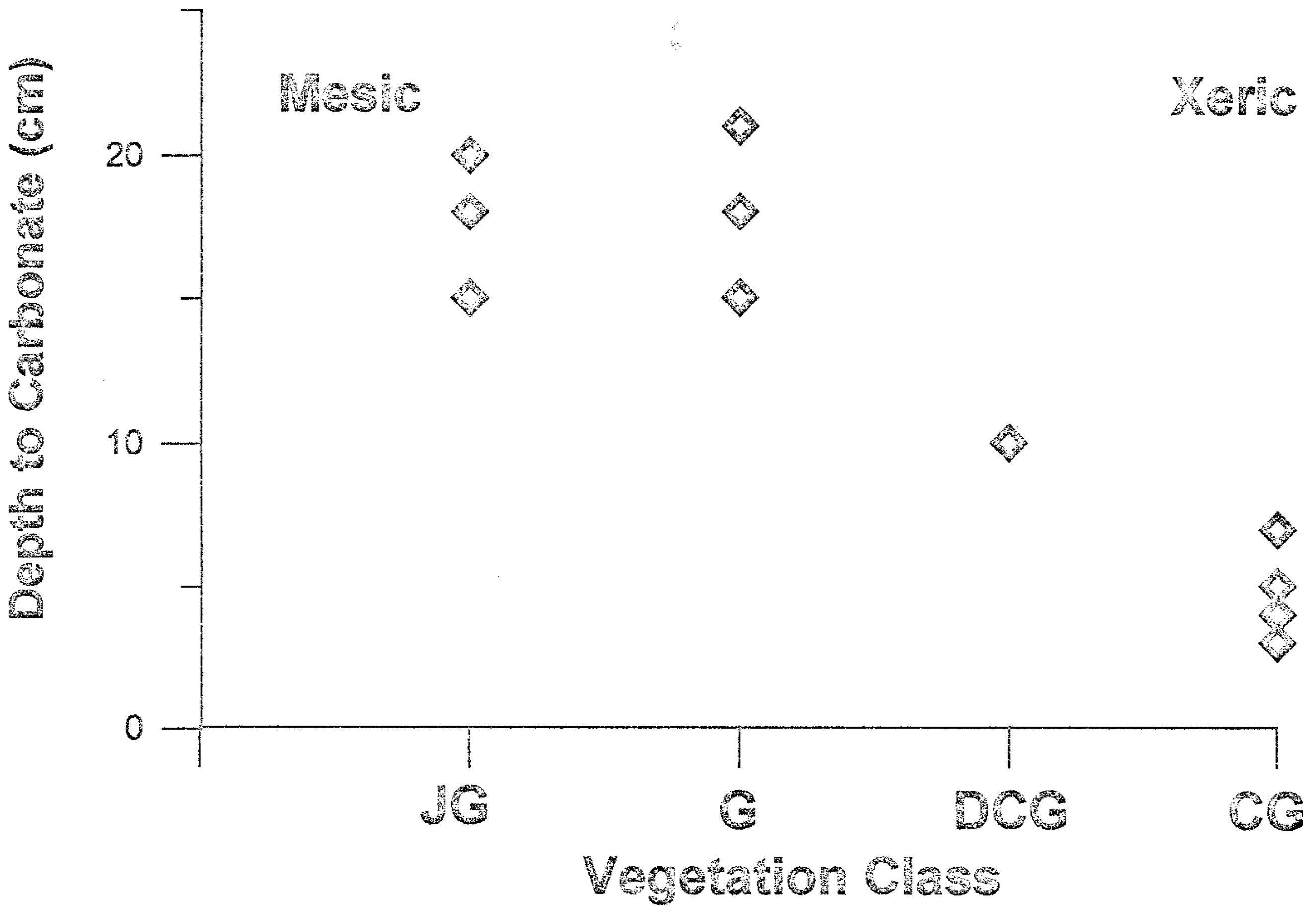


Figure 24. Relationship between vegetation and depth to carbonate. Vegetation communities are arranged in order from most mesophytic to most xerophytic. Depth to carbonate is plotted for each soil under their associated vegetation class. Results show distinct clustering of values between soils in overall shrubland areas and those in grassland areas.

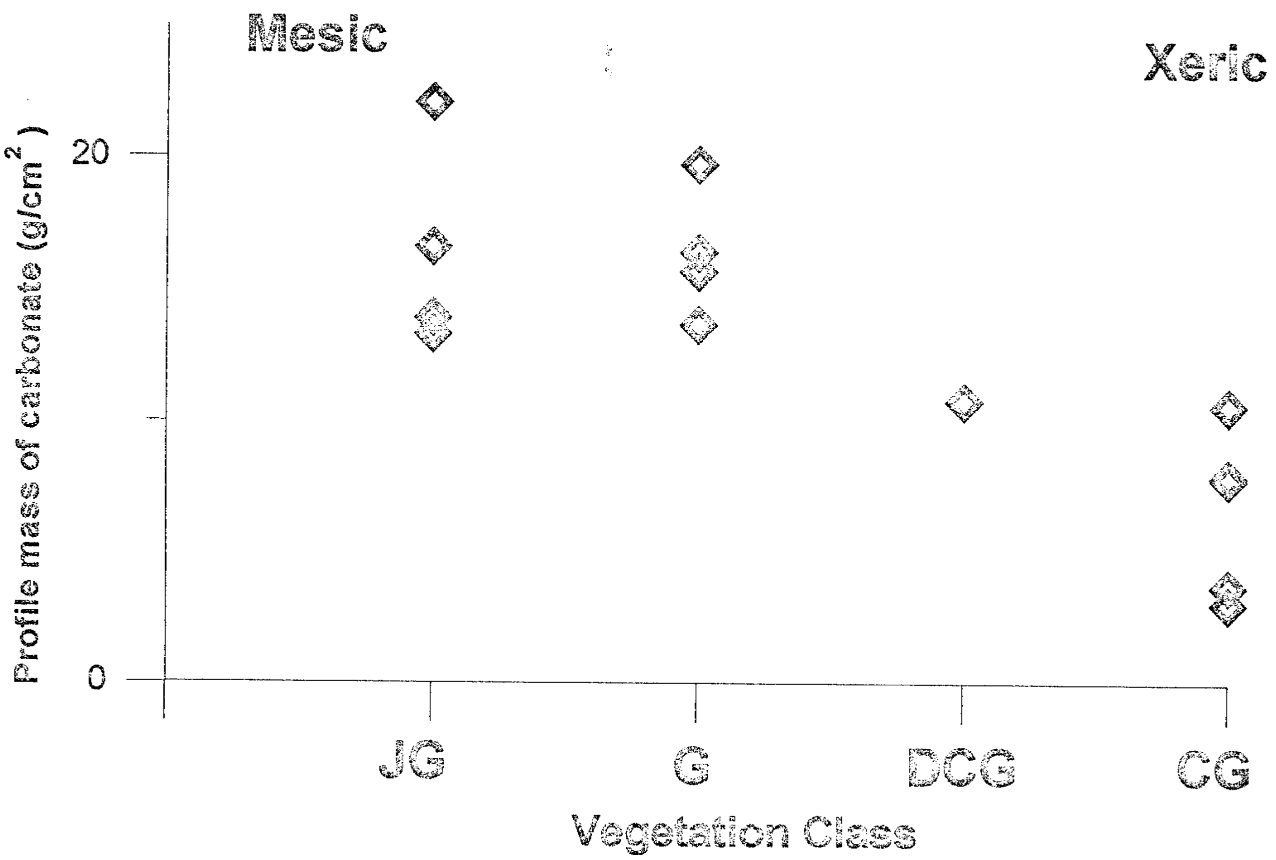


Figure 25. Relationship between vegetation and profile mass of carbonate. Results show that mass of calcium carbonate increases from shrubland to grassland soils.

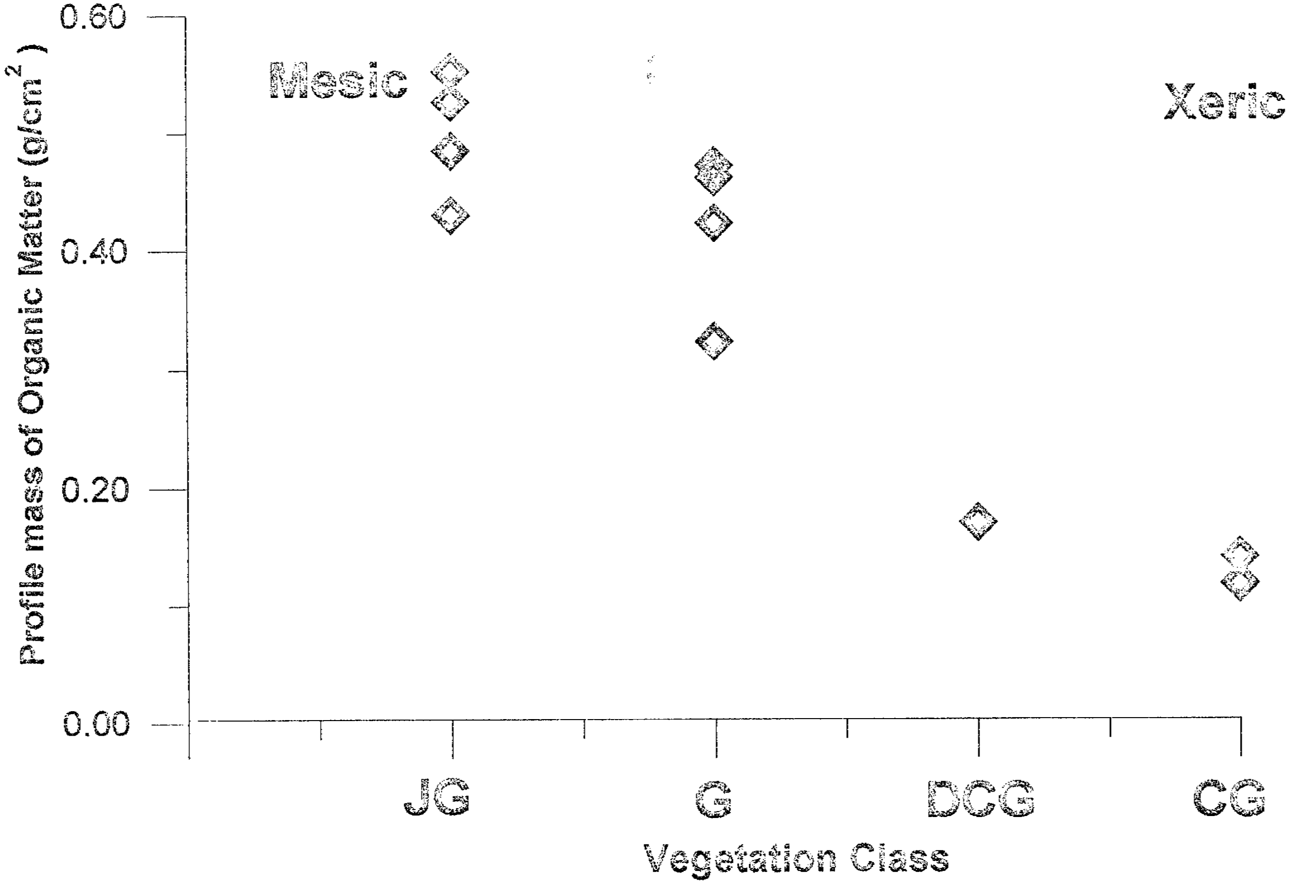


Figure 26. Relationship between vegetation and profile mass of organic matter. Results show a sharp increase in organic matter content from shrubland to grassland soils.

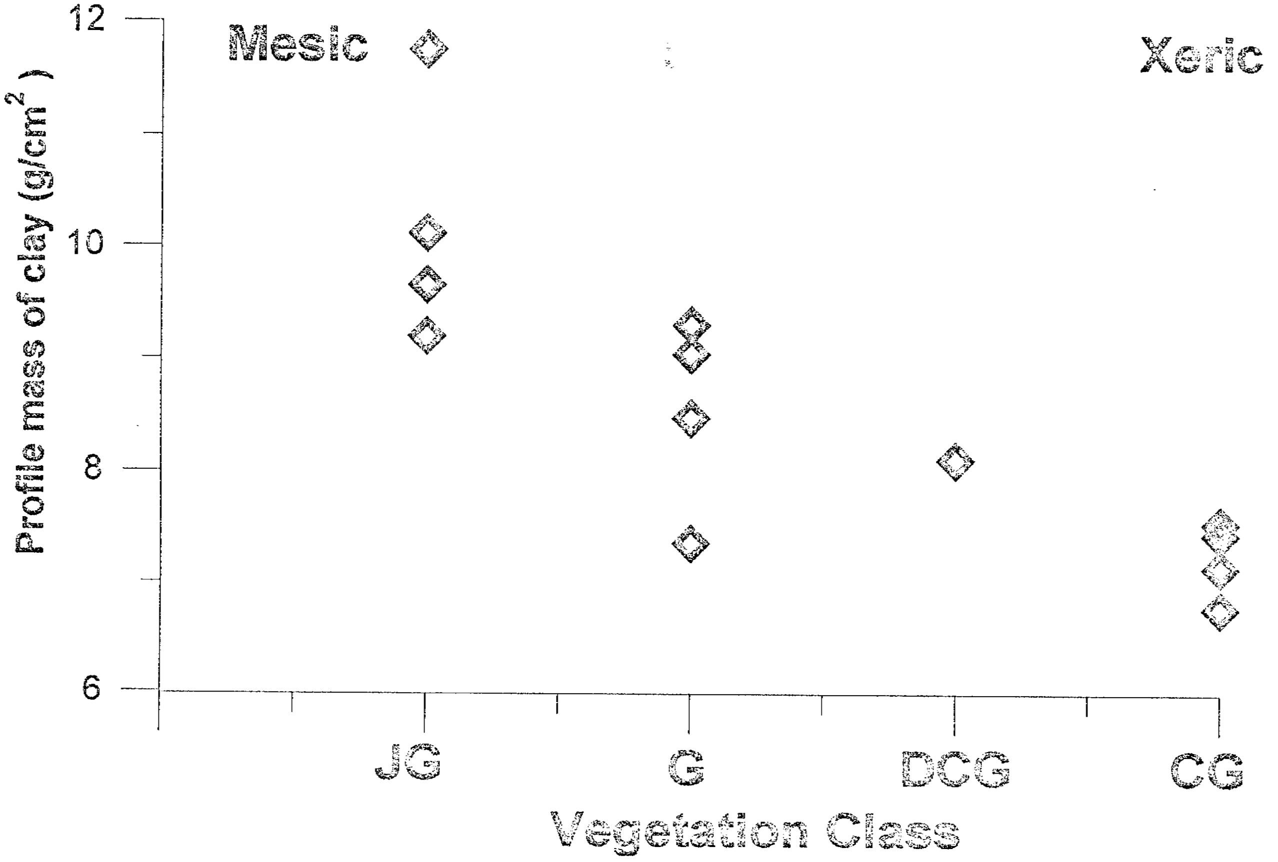


Figure 27. Relationship between vegetation and profile mass of clay. Values are normalized to 50cm depth. Results indicate a gradual increase in clay content going from xerophytic to mesophytic vegetation.

showed the strongest relationship to vegetation type (Figure 27). Profile mass of silt also demonstrated a strong relationship to vegetation. However, SL-10, a shrubland site has one of the highest silt values while SL-16 (a grassland site), has one of the lowest clay values. When silt and clay are combined, SL-16 is consistent with the other grassland soils, but SL-10 remains significantly higher than the other shrubland soils.

Solar radiation and evapo-transpiration across study area

Modeling of variations in solar radiation throughout the study area has shown systematic changes in this microclimatic variable as a function of topographic position. The grid of yearly average SolarFlux for the study area demonstrates that north facing slopes receive approximately 20% less solar radiation annually than south-facing slopes. On the yearly average, the north-facing slope receives approximately 17,000,000 J/m^2 as compared to 21,000,000 on south-facing slope (Figure 6). The table surface and headslope area have yearly averages that are intermediate between those of the two sideslopes.

The most important result of these patterns is reflected in the differences in potential evapo-transpiration (PET) between slopes. Monthly values of PET generated from the monthly SOLARFLUX grids using the the Jensen –Haise method demonstrate that the greatest differences in PET occur during the winter months. In the summer months of June and July, when PET is the greatest, the percentage difference between the two slopes is lowest (Figure 28a). As such, at the peak of the winter season north aspects have nearly 50% less PET than south aspects. By contrast, in June there is less than a one percent difference in the PET between the two slopes.

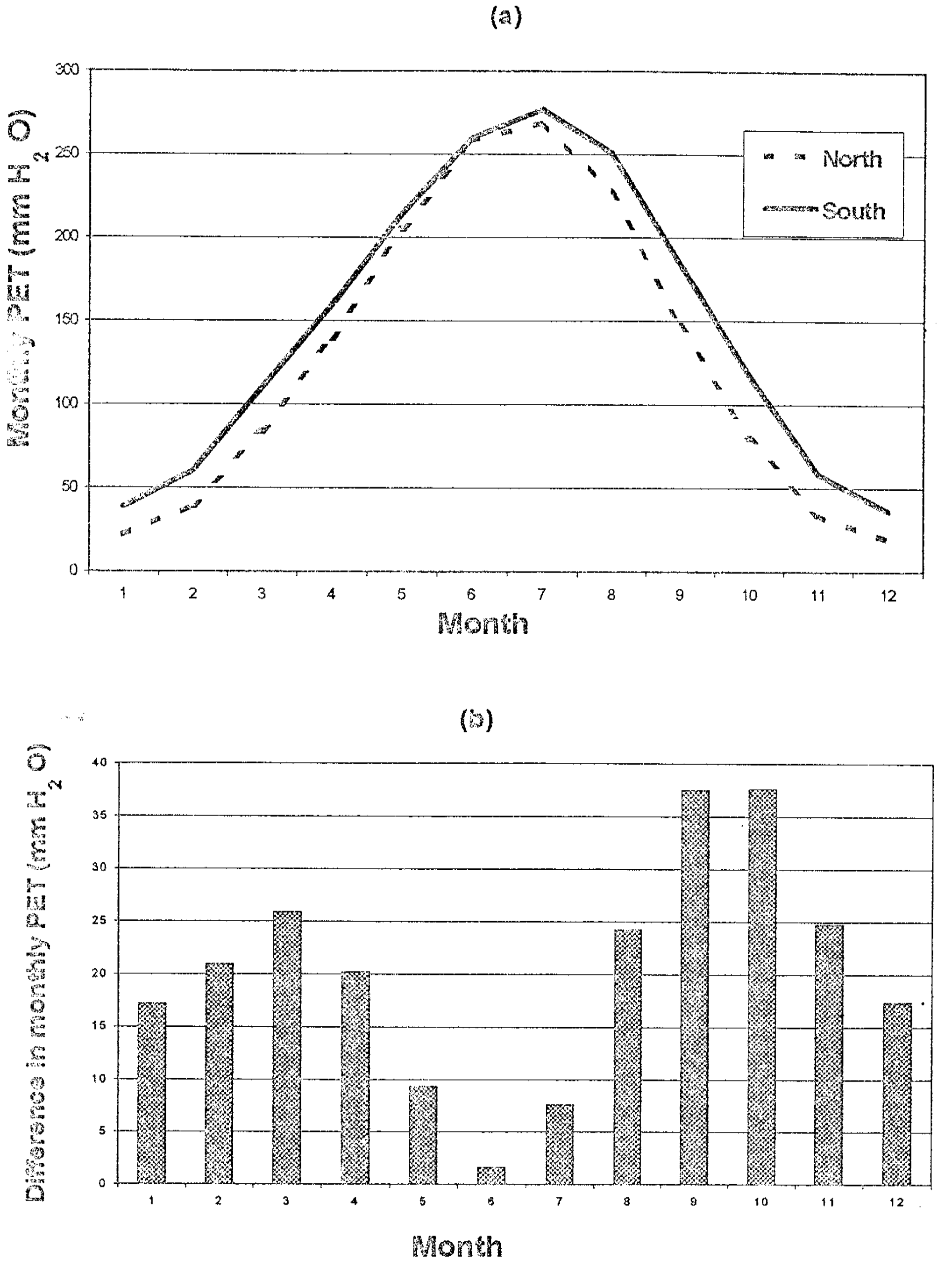


Figure 28. Differences in monthly PET values for representative points on the north and south aspects. Values were calculated from monthly average SOLARFLUX values at each location using the Jensen-Haise method. (a) Graph showing changes in PET values for each slope throughout the year. (b) Graph showing difference in absolute PET values, demonstrating that the greatest differences occur in Spring and Fall.

However, PET values are overall very low in the winter. Thus, while the percentage difference between slopes is greatest in the winter, the difference in absolute PET values between the slopes is very low. It is, therefore, during both the Fall and the Spring that the differences in the absolute values (mm H2O) is greatest between the slopes (Figure 28b).

Relationships between soils and solar radiation

Solar Flux modeling of the study site, while coarse, with 30-meter pixels, still reveals a distribution that mimics the patterns in vegetation across the study site. Yearly average SOLARFLUX pixel values for each sampling site were compared with soil properties that influence plant-available moisture: depth to carbonate, profile mass of carbonate, profile mass of organic matter, and profile mass of silt and clay. The correlation is strongest with depth to carbonate (Figure 29) and profile mass of organic matter (Figure 30), where both properties increase with decreasing yearly average solar radiation. Profile mass of carbonate, however, shows an inverse relationship to solar radiation down to 19,200,000 j/m^2 and then begins to decrease with decreasing solar radiation. In all three graphs there is a sharp break in the continuum of values which occurs between 19,000,000 and 19,500,000 j/m^2, similar to the observed shift in soil properties between grassland and shrubland sites. This occurrence is not surprising in that there appears to be a genetic link between solar radiation values and vegetation patterns. However, it is significant in that the solar flux units are mapped at a finer scale and distributed

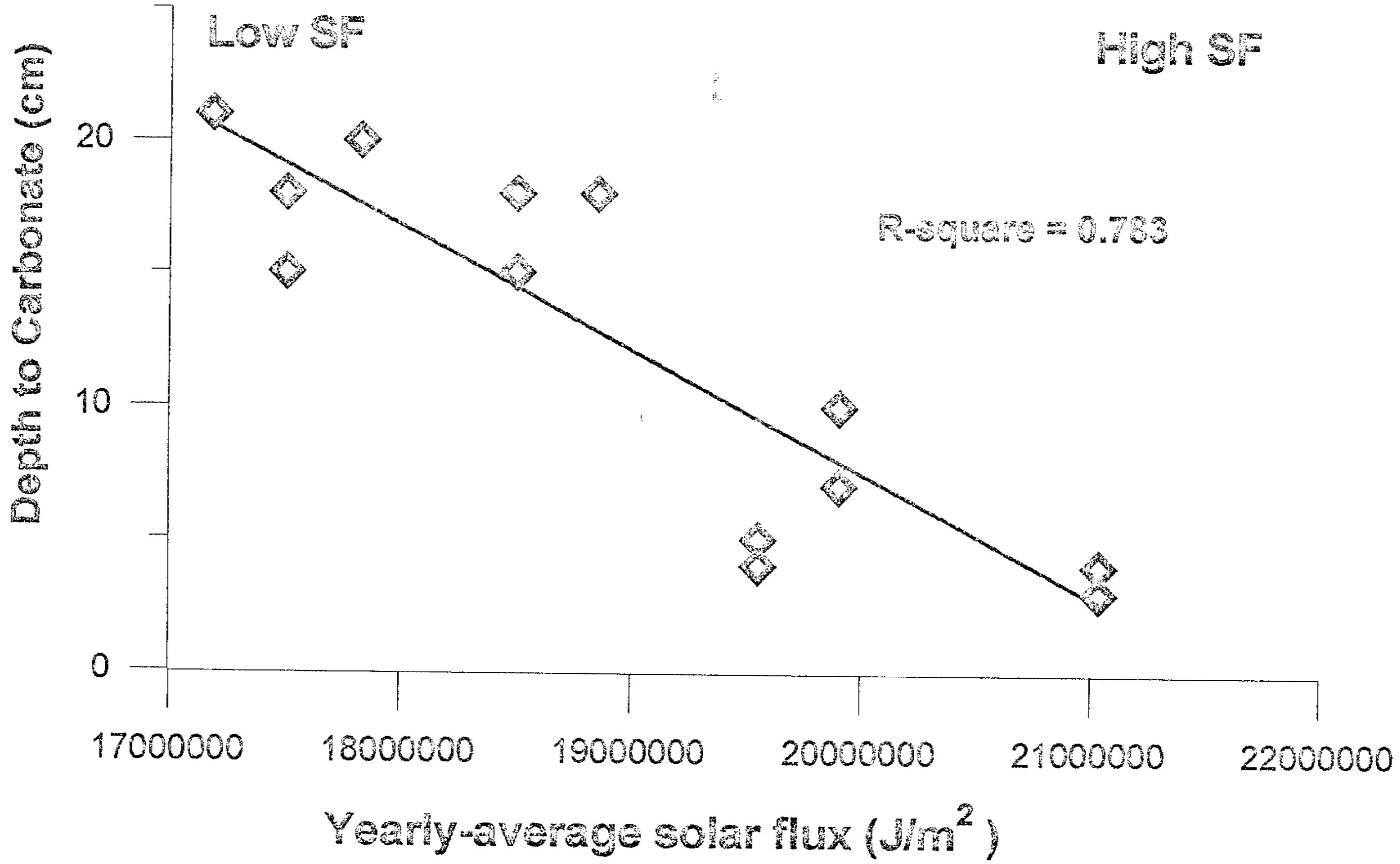


Figure 29. Regression analysis of SOLARFLUX values vs. depth to carbonate. Without the two lowest soils of the headslope axis catena (SL-11 and 14), there is a very strong correlation between yearly average solar radiation and depth to carbonate. Trend shows depth to carbonate increasing with decreasing solar radiation, yielding an R-square of 0.783

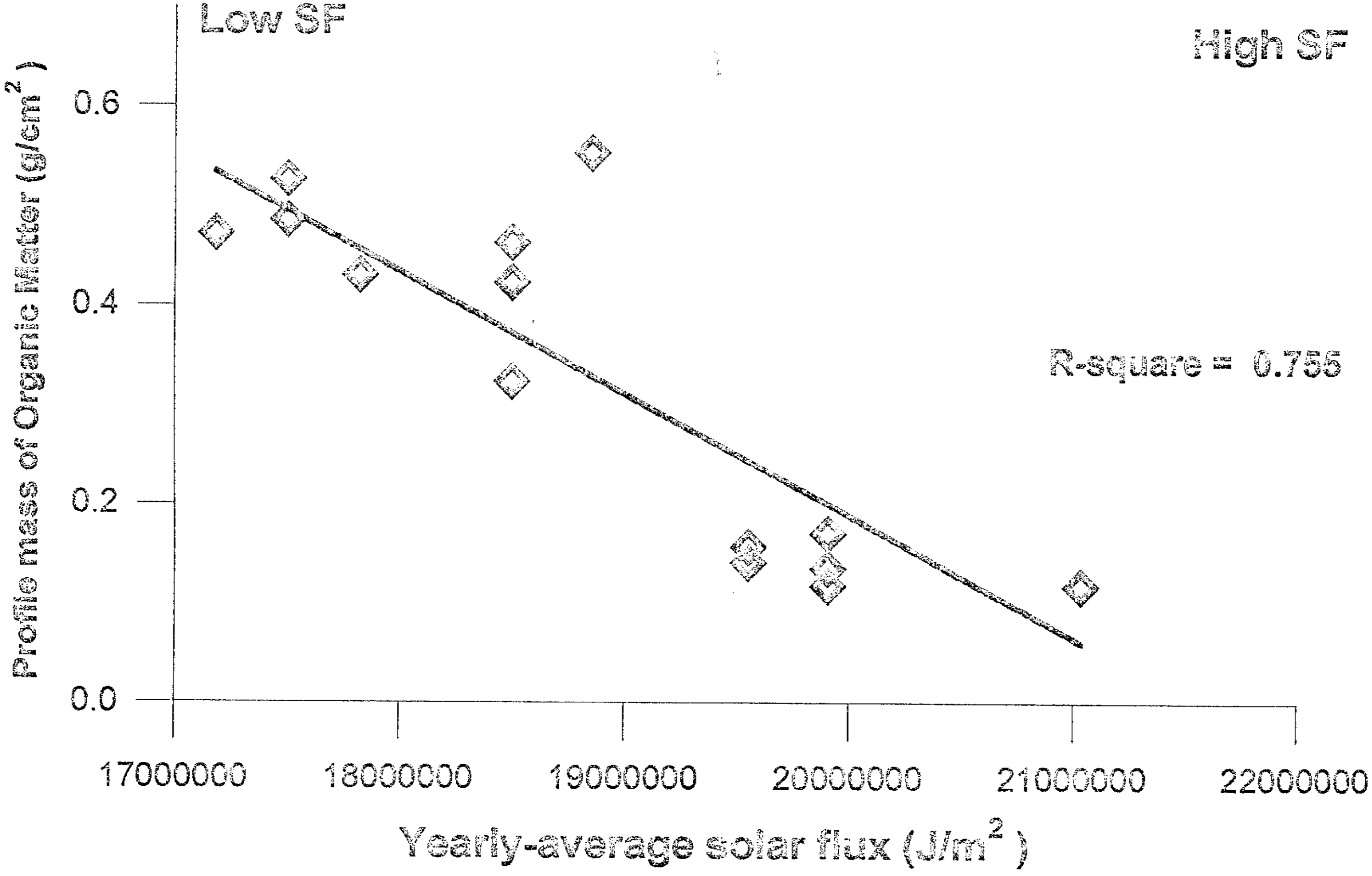


Figure 30. Regression analysis of SOLARFLUX values vs. profile mass of organic matter. Results demonstrate a strong correlation between the two variables, where organc matter increases with decreasing yearly average solar radiation. Regression yields an R-square of 0.755.

over a wider range of values (there are 12 solar flux pixel classes within the study area). Also, unlike vegetation map units, Solar flux image classes are quantitative variables.

Spatial and temporal variation in soil moisture

Electromagnetic induction can be an effective tool in the measurement of variability in soil water over large areas (Sheets and Hendrickx, 1995). However, in order to employ the instrument for quantitative results, it must be calibrated in the field with neutron probes. In this phase of the investigation, there was no measurement of soil moisture for calibration, and the results obtained from the EM-38 represent only relative amounts of soil moisture.

Through the duration of the study, there were notable, repeated spatial patterns in soil moisture across the study area. The two sideslopes show slight, but consistent contrast in EM readings for each of the survey dates. However, the highest readings (probably representing the highest soil moisture) for each of the dates is found in the north-northeast facing portion of the headslope. (Figure 31, a-h).

Statistical analysis of the correlation of EM values with the independent variables of vegetation, landscape position, solar flux and survey date, showed that the greatest amount of variability could be explained by Landscape position and survey date. Those two variables yielded an R-square of 0.64. Among the

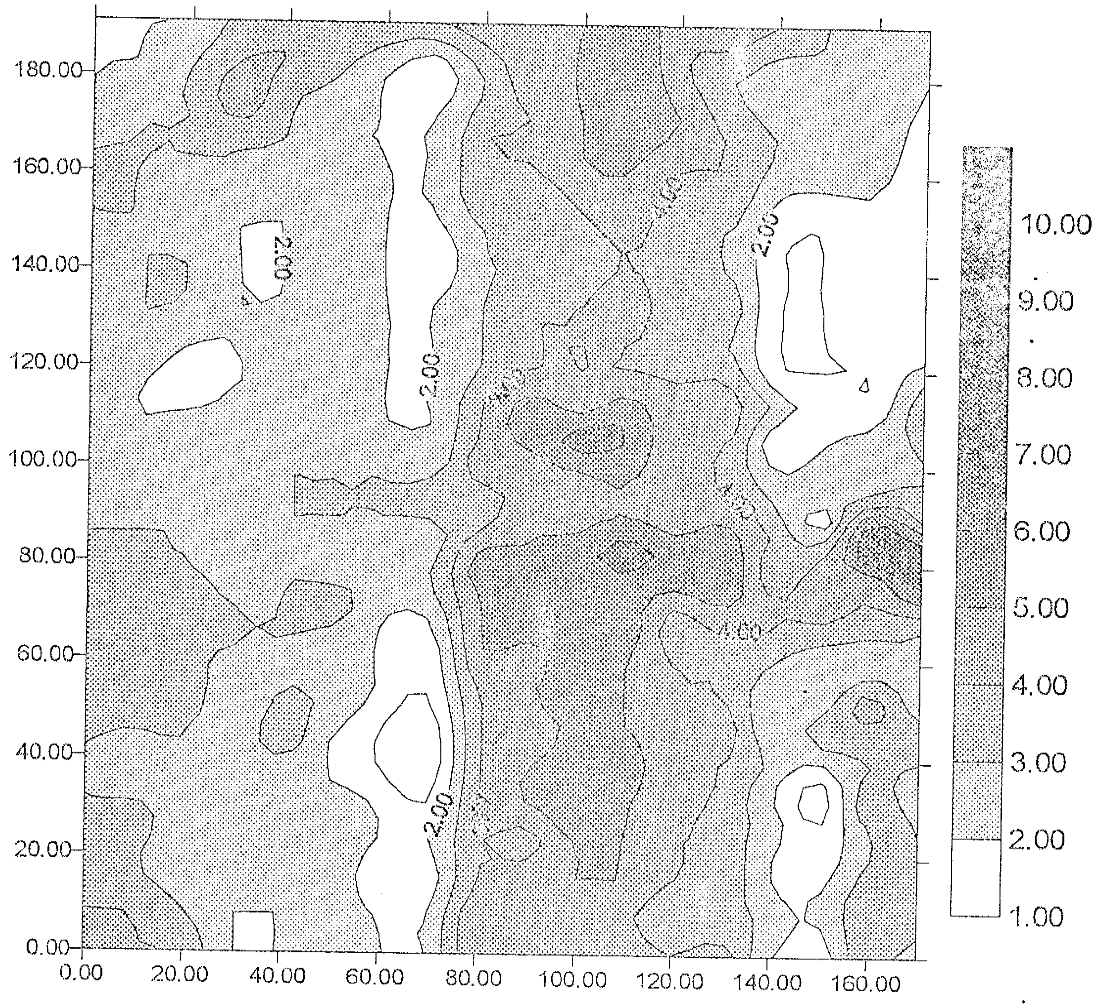


Figure 31a. Map of vertical E-M survey values for June 24, 1996.

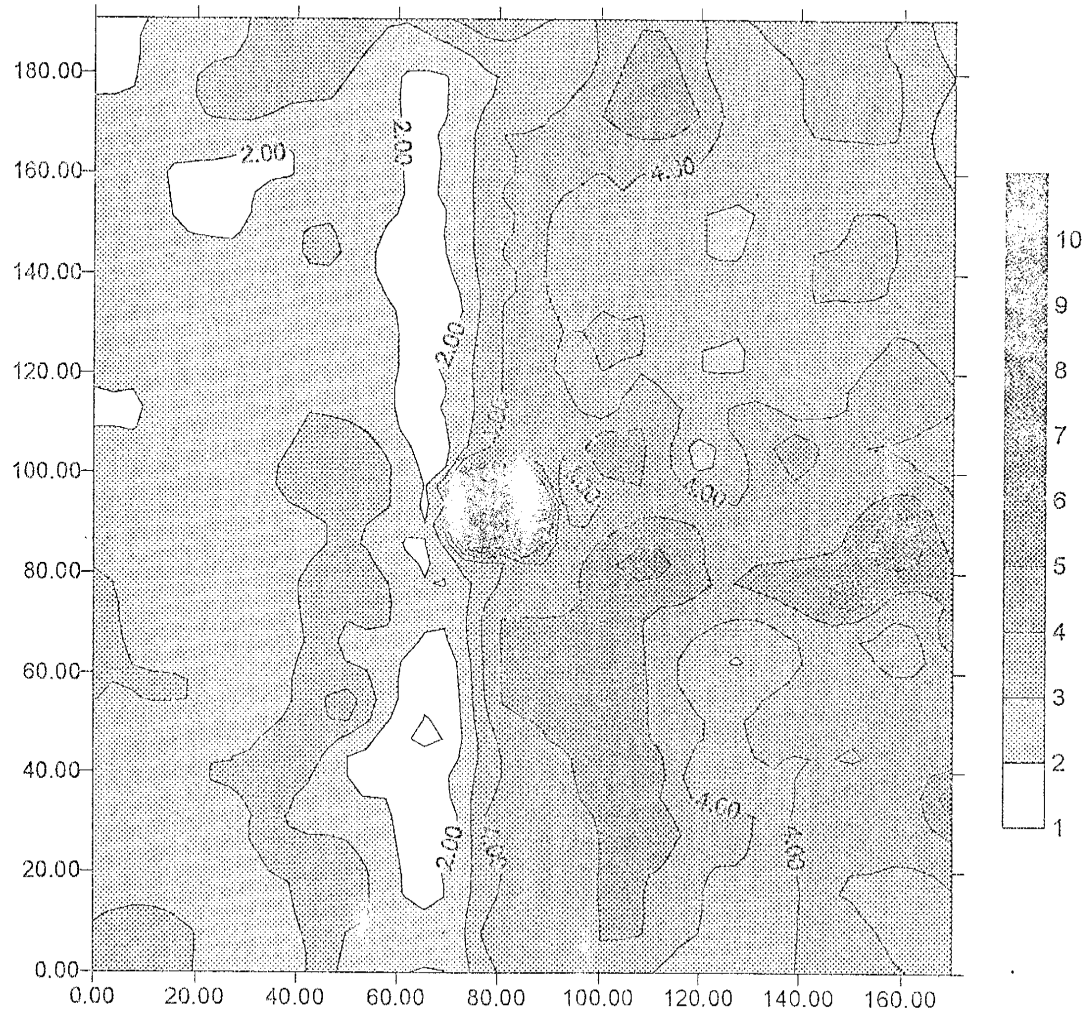


Figure 31b. Map of horizontal E-M survey resluts for June 24, 1997.

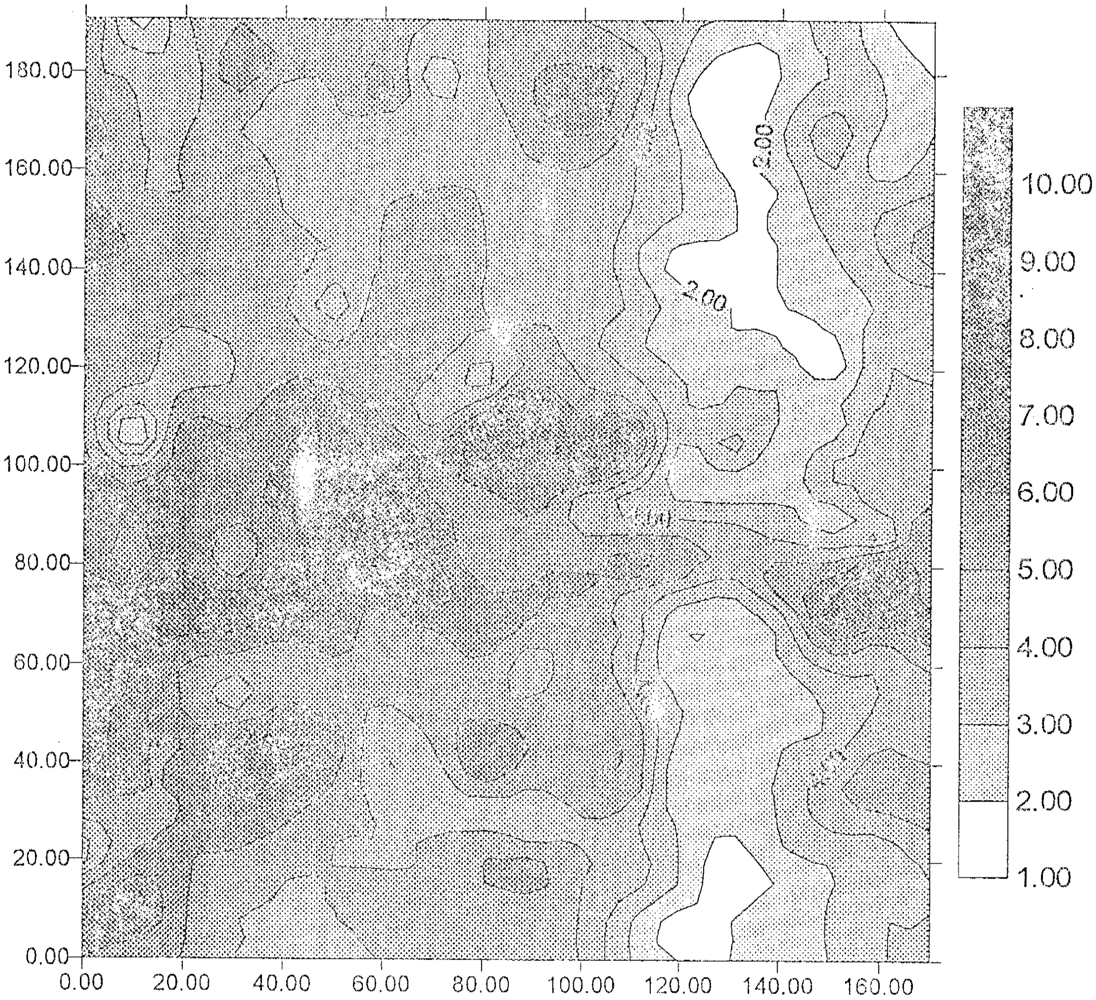


Figure 31c. Map of vertical E-M survey values for September 20, 1996.

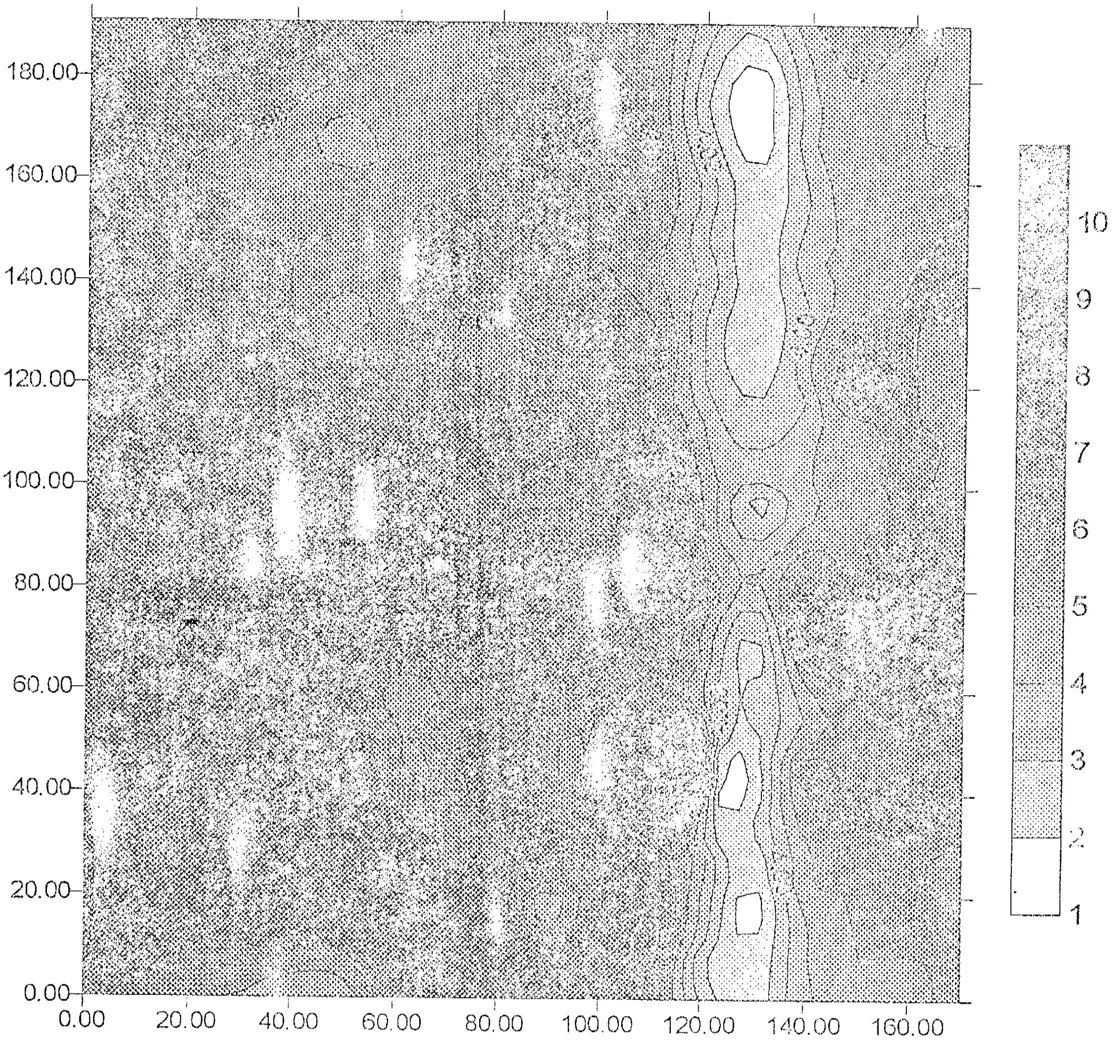


Figure 31d. Map of horizontal E-M survey values for September 20, 1996.

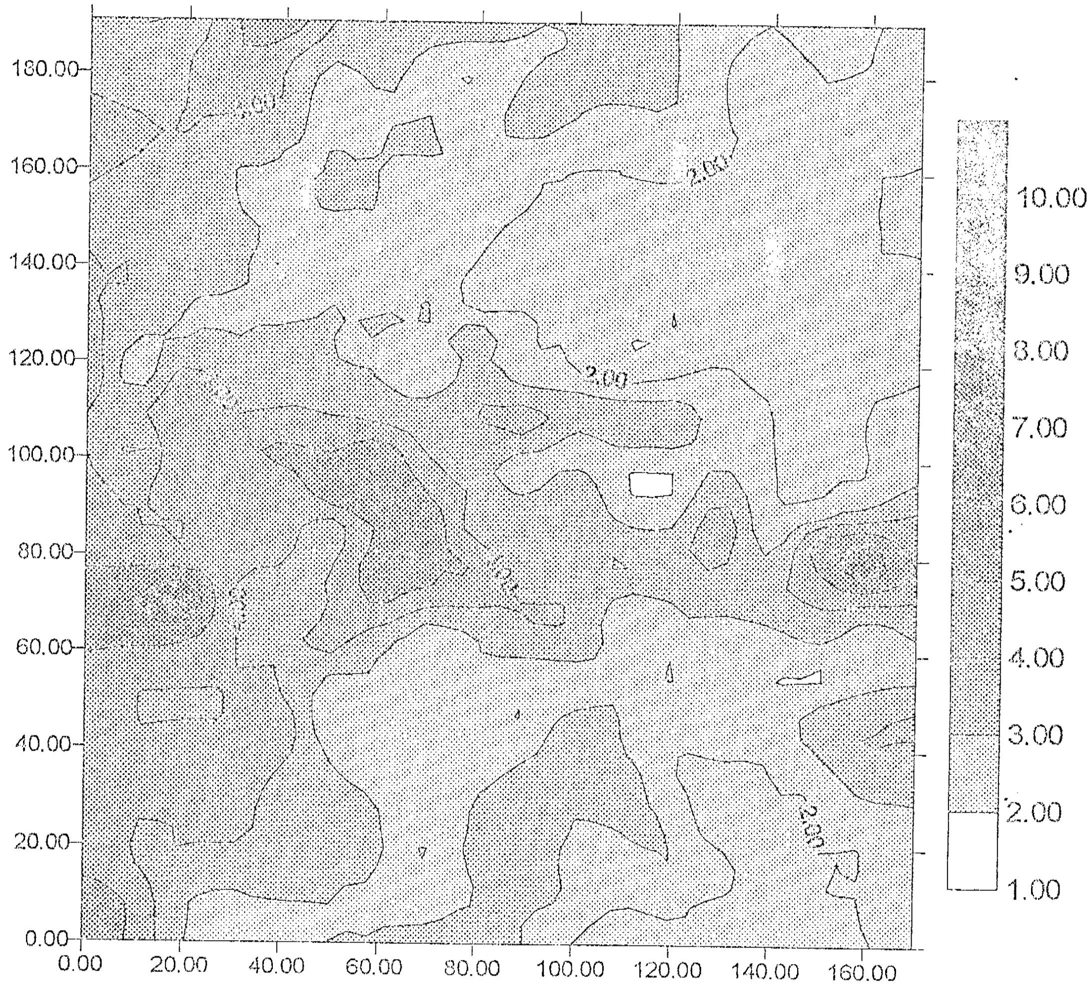


Figure 31e. Map of vertical E-M survey values for April 20, 1997.

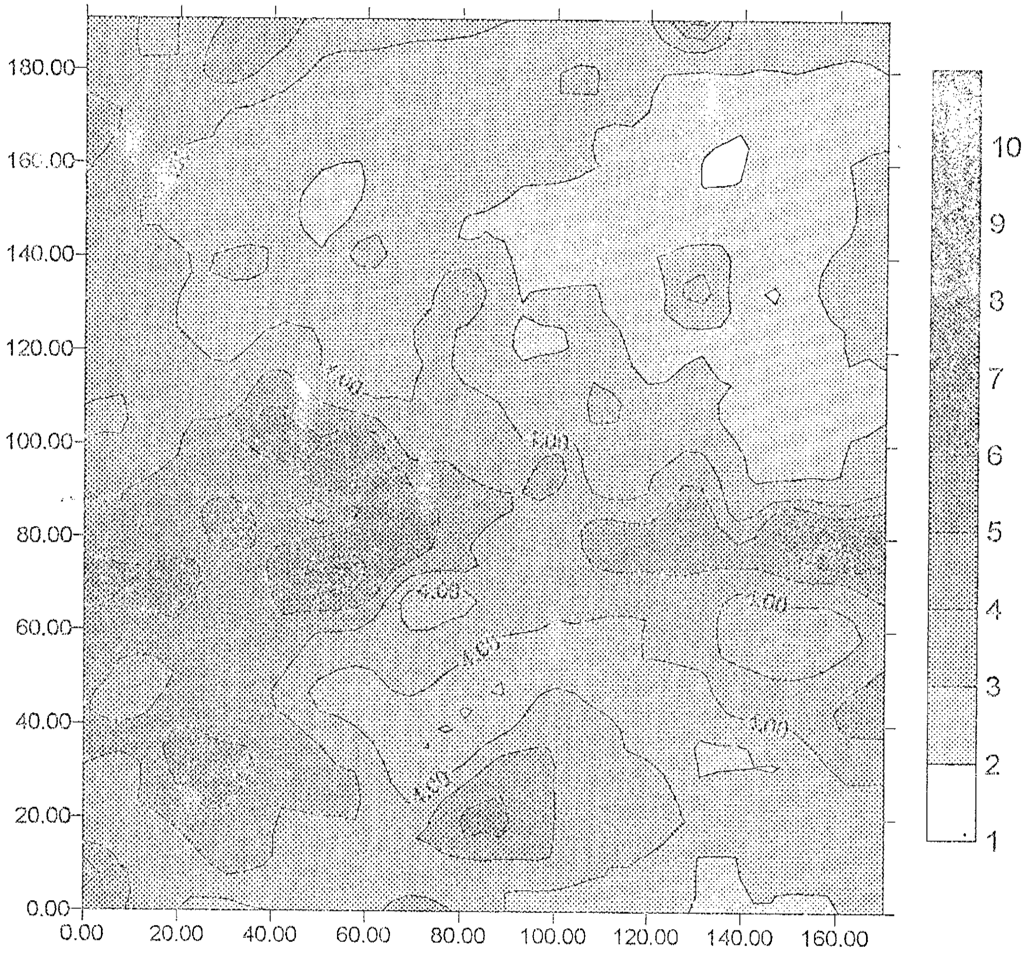


Figure 31f. Map of horizontal E-M survey values for April 20, 1997.

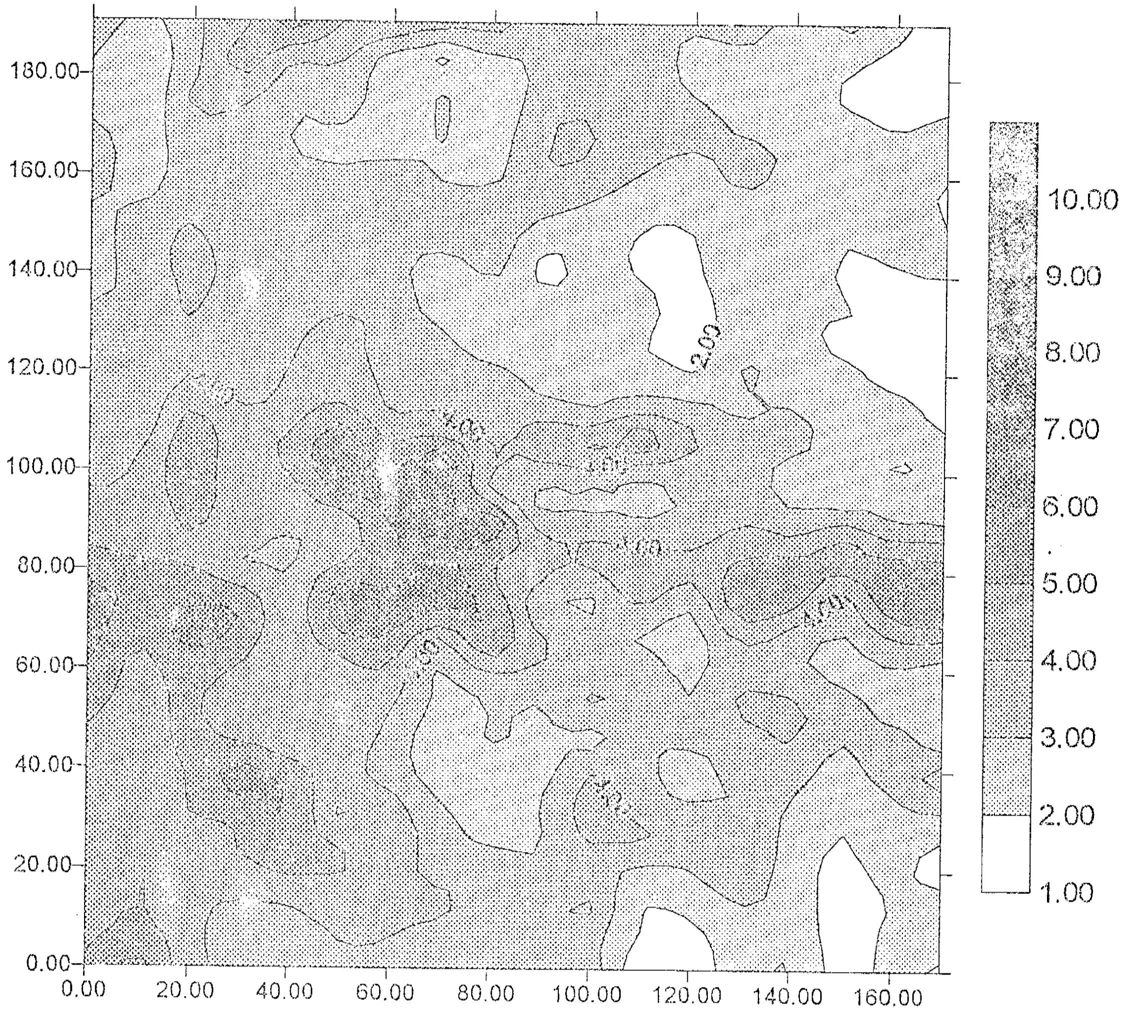


Figure 31g. Map of vertical E-M survey values for October 14-1997

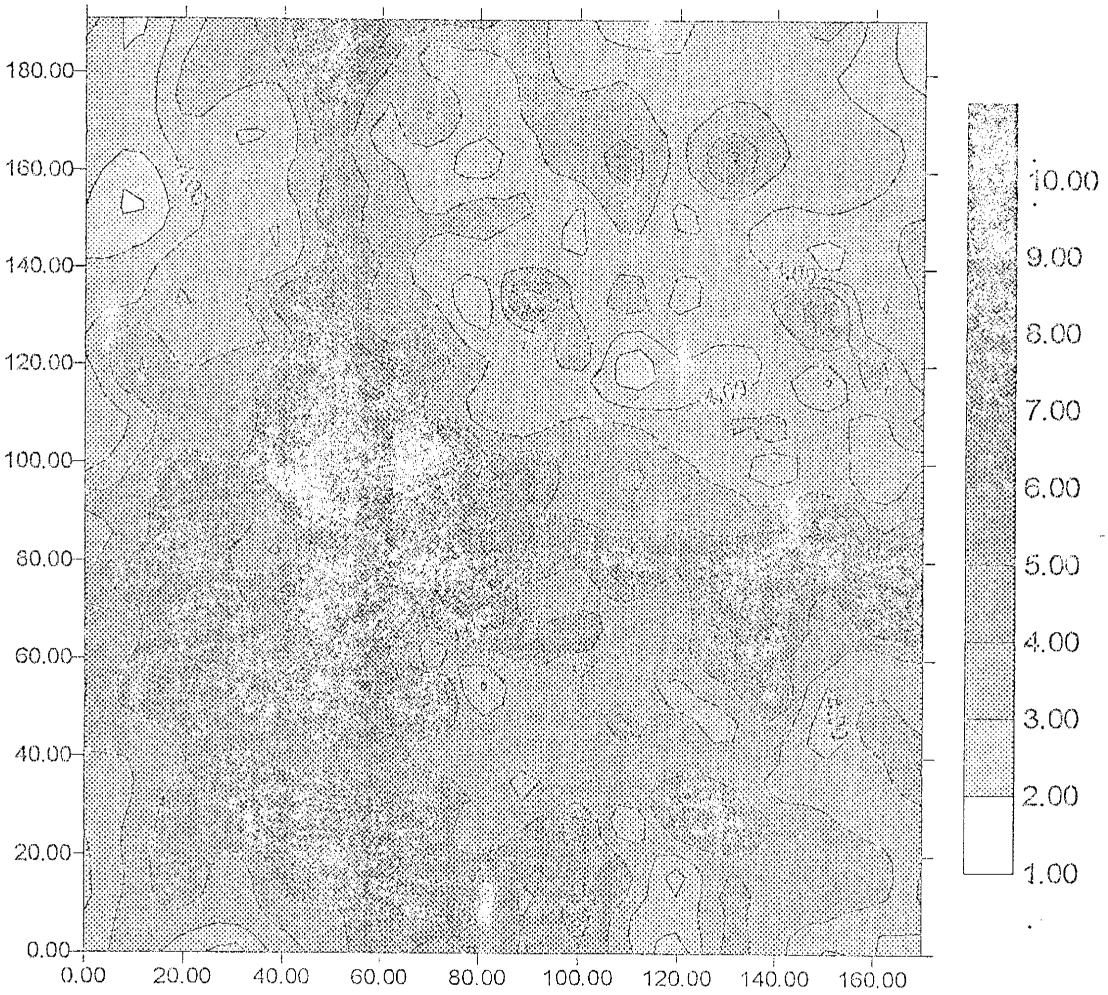


Figure 31h. Map of horizontal E-M survey for October 14, 1997.

individual survey dates, the highest R-square values were obtained for the survey taken in April, 1997. For that date, the independent variable groupings of landscape with solar flux and vegetation with landscape in both vertical and horizontal runs all yielded moderate R-square values ranging between 0.48 and 0.49. F-values from the same group of independent variables were also the highest for the April, 1997 survey. The four highest f-values, ranging from 31.5 to 47.6, were obtained for the April 1997 survey from runs with the single independent variables of vegetation and landscape position for both vertical and horizontal EM readings. By contrast, the lowest correlations were obtained for the survey conducted in September, 1996. This suggests that soil moisture varies most systematically with landscape position and vegetation during the portions of the year when the solar differential is greatest.

DISCUSSION

Soil-vegetation-landscape interactions

The close relationship noted between selected soil characteristics, landscape position and vegetation type suggest a strong interplay between the three factors. Because of the complexity of the feedback mechanisms in this ecosystem, the discussion of causes and effects can follow a circuitous route and raise questions of whether the vegetation creates its soil environment or whether the soil conditions influence the establishment and survival of the vegetation. In either event, it is important to note that soils with such a high level of development as those in the study area have formed over tens of thousands of years (Machette, 1985). As such, they are not so much a reflection of the current vegetation community as they are of the antecedent conditions, and therefore reflect the concurrent and integrated evolution of the entire soil, vegetation and landscape system.

As a general rule, soil moisture is greatly influenced by topography and is often the dominating influence on the distribution of plant species in arid environments (Howard and Mitchell, 1985). As soils evolve through time, their hydrological responses to additions of moisture can vary considerably. Additions of silt, clay and calcium carbonate, which are characteristic of desert soil development, can result in reduced permeability and increased moisture retention, particularly in coarse parent materials (Gile et al., 1981; Machette, 1985; McDonald, 1994). Thus, given these changes in soil hydrological properties through pedogenesis, soils can exercise an influence over spatial vegetation patterns that increases with time. While the interplay between soils and vegetation likely proceeds in numerous directions and with complex feedbacks, it is important to identify the component parts in order to better understand the system as a whole.

Controls on soil spatial variability

Slope aspect

Slope aspect appears to exercise the greatest control over soil variability within the drainage basin. This is demonstrated by, the striking contrast in soil characteristics between the two sideslopes as well as the strong relationship noted between solar radiation values and various soil properties (Figures 29 and 30). North facing slopes have more organic matter, more calcium carbonate and more silt and clay than the south-facing slopes. Also, on the south-facing slope, there is a much shallower depth to carbonate, the distribution of carbonate is highly irregular, and overall the horizon boundaries are poorly defined. Climate and vegetation are the primary avenues though which slope aspect influences soil development across the basin. However, climate may be considered the ultimate control, the effects of which are manifest through its influence over vegetation. While the regional climate is constant, the microclimate induced by differential solar radiation varies dramatically across the drainage basin. The variability in solar radiation has been assessed through Solar Flux modeling of the study area, which shows a yearly average of about 20% more solar radiation on the south-facing slopes than the north-facing slopes (Figure 5). The amount of direct solar radiation affects direct evaporation from the surface, as well as the rate of transpiration of plants, thus strongly influencing the type and amount of vegetation on a surface (Œtherington, 1975; Howard and Mitchell, 1985). . It has also been suggested that trees and shrubs can induce their own microlimatic heterogeneities at yet a smaller scale (Barth and Klemmedson, 1978). However, this study has not endeavored to assess the variability in soils at this finer scale.

The close association between aspect-induced solar radiation differences and vegetation expression strongly suggests that soil spatial variability is significantly influenced by both microclimate and vegetation. Howard and Mitchell (1985) summarized the affect of vegetation on soil and landforms: *By binding the soil surface, vegetation keeps it in place. Thus their total effect is to increase soil depth and diminish its physical movement. Plants provide organic matter, assist soil structure and aeration and facilitate the infiltration and circulation of groundwater. This has the effect of diminishing surface runoff and erosion, and of smoothing landscapes.* Vegetation also reduces erosion-causing runoff, and increases the capacity of soils to absorb precipitation McAuliffe (1995).

The capacity for vegetation to retain both surface water and soil material varies largely as a function of type and density of vegetation. In general, perennial grasses have a much higher capacity to impede runoff and erosion than an equivalent cover of shrubs (Ludwig, 1996). The difference in soil retention as a function of type and density of vegetation is evidenced on the ground surfaces of the two sideslopes, where the ratio of soil to gravel or rock cover is greatest on the north-facing slope, coincident with the higher percentage of grasses.

The relative abilities of the two slopes to retain soil material and water is illustrated by the microtopographic transects conducted down each of the two sideslopes. Most of the obstructions to flow noted for either of the slopes represent vegetation in the form of grasses and shrubs. There is close spacing of obstructions (mostly grasses) on the north-facing slope (figure 32). This further suggests that grasses, rather than shrubs, are more effective at impeding runoff and retaining surface material (Ludwig, 1996). By contrast, the greater spacing between obstructions on the south-facing slope, suggests a greater potential for overland flow (Figure 33).

There is an even more striking association beneath the surfaces, where the percentages of silts and clays, organic matter and calcium carbonate are all greatest in the grassland and Juniper grassland sampling locations (north aspect). The silt and clay, as well as calcium carbonate, in the soils are considered to be of atmospheric origin. Given the minimal weathering features on clasts within the study area, such increases in silt and clay as a result of in-situ weathering are unlikely. As such, the variable amounts of these materials in the soils may be considered largely a function of their effective retention by perennial grasses.

Calcium carbonate within the soils also may have derived from dry and wet atmospheric inputs (Gile et al., 1981). The relative abundance calcium carbonate in soils on north-facing slopes (coincident with higher grass cover) supports the idea that grass cover may be more effective at retaining airborne fines and facilitating infiltration of precipitation than the shrubland communities. A similar relationship between total vegetation cover and the infiltrability of a sloping surface was

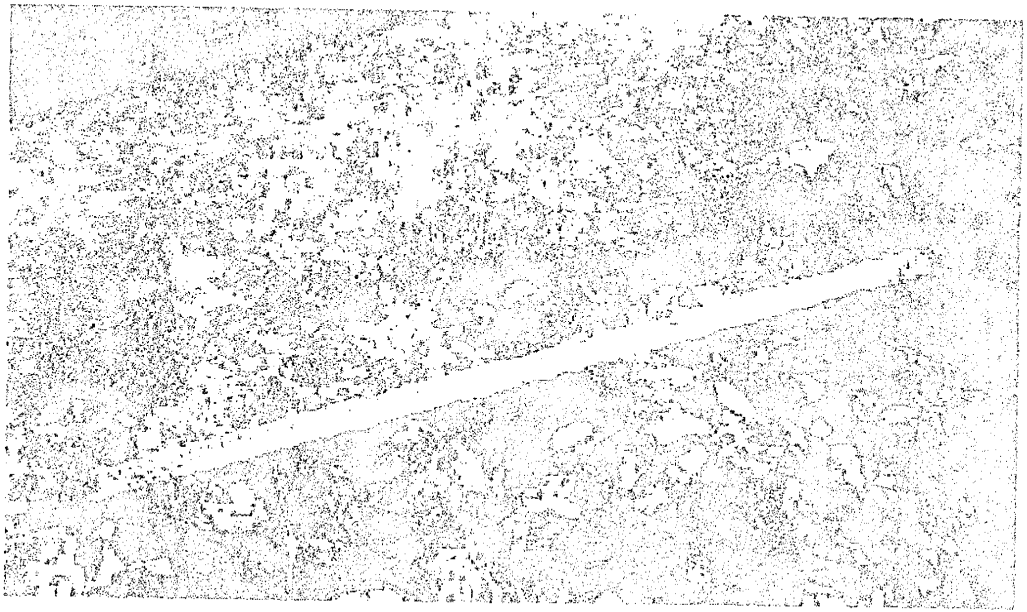


Figure 32. Photograph of the microtopographic features controlling surface flow on the north-facing slope. Obstructionsare generally in the form of grass tussocks, and flow spaces average about 30cm along the transect. Meter stick for scale.

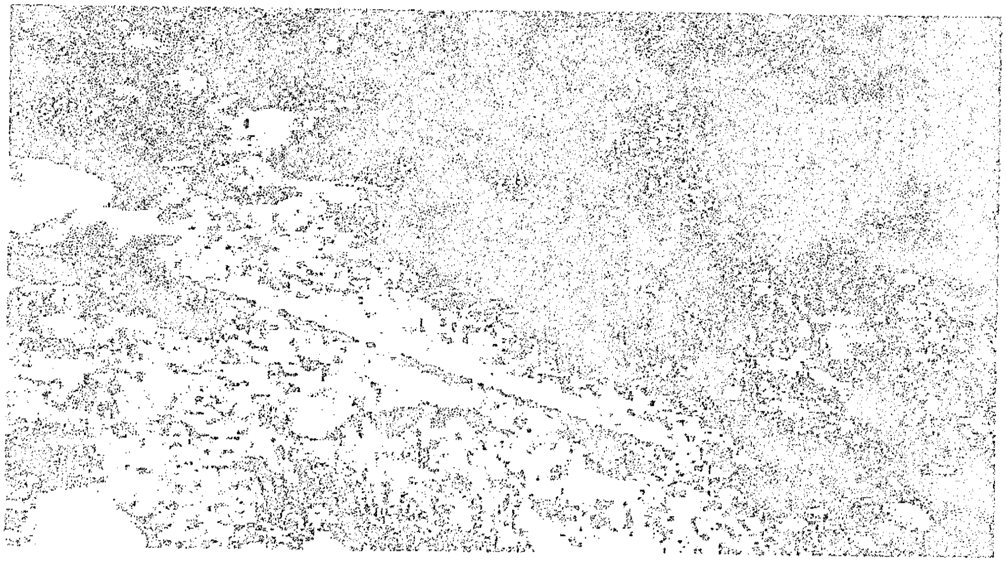


Figure 33. Photograph of microtopographic features controlling surface flow on the south-facing slope. Obstructions are in the form of grass tussocks and shrub mounds, and flow spaces average more than 70cm along the transect. Long flow spaces permit more powerful runoff flows, and consequently more erosion. Meter stick for scale.

identified through the use of rainfall simulators by Wilcox et al. (1988) in the Guadalupe Mountains of New Mexico.

The distinct contrast in depth to carbonate between north and south-facing slopes is further evidence of the difference in moisture inputs between the two sideslopes. Depth of soil carbonate has been correlated to precipitation, with greater depth to carbonate in areas of higher precipitation (Arkley, 1963; Gile et. al., 1981; Dan and Yaalon, 1982). However, rainfall monitoring during the 1996 field season showed no notable differences in precipitation between the two surfaces. The observed difference in depth to carbonate must then be a function of "effective" precipitation (moisture that is infiltrated into the soil profile). Therefore, the relative difference in effective precipitation between the two slopes at least partly represents the relative difference in surface runoff as well as differences in evaporation. The possible higher amount of surface runoff on the south-facing slope may be the mechanism for the removal of eolian fines, and carbonate dust before they can be translocated and incorporated into the soil profile. Given these inferred high runoff conditions, the lack of significant catenary relationship on the south-facing slope suggests that overland flow is sufficiently strong to evacuate soil material completely from the slope.

Another factor that may significantly influence soil development as a function of slope orientation within the drainage basin is the differential deposition of eolian fines (particularly silts). Secor et al. (1983) suggested that wind may have been a prominent factor in affecting spatial variabilities in soil textures in the Los Medanos area of southeastern New Mexico. However, this factor was not addressed in the current investigation, but should be considered as a potential influence on some of the variations in soil texture across the study area. Machette (1978) mapped sand dunes with a northeast transport direction in the San Acacia quadrangle to the south of the study site. The sediment source for the dunes is the Rio Salado, an ephemeral stream with a broad, sandy channel. With a southwesterly prevailing wind direction, the north-facing slope represents the lee side of the topographic obstruction to eolian transport and may serve as a more effective trap for eolian materials than the south-facing counterpart. This issue may be addressed through the deployment of dust collectors on the opposing slopes as part of a future investigation.

Headslope soils

The headslope surface varies in orientations from northeast to southeast, with SOLARFLUX values, and microclimatic conditions intermediate between the two sideslope surfaces. The soils may thus be expected to follow a similarly smooth transition across the headslope. However, while the headslope soils do demonstrate transitional properties in some respects, they do not represent a clear continuum between the two end-members. In fact, the soils of the headslope axis catena are unique from all the other soils in the drainage basin and thus appear to respond to controls other than slope orientation. As such, the axis soils are ignored in the discussion of aspect transition and treated separately in the context of catenary trends along the axis.

The transitional nature of headslope soils is suggested by the profile mass of clay, where the value for SL-10 (southeast-facing) is greater than the south-facing sideslope soils, but still less than that of SL-12 (northeast facing). The SL-12 soil, in turn, has still less clay than the soils of the adjacent north-facing slope (Figure 34a). Also, while SL-10 has greater depth to carbonate than the adjacent south-facing slope soils, SL-12 and SL-13 (northeast facing) show no variation from the cluster of values for north-facing slope (Figure 34b). Correspondingly, the two soils from the north-east-facing portion of the headslope reflect organic matter contents intermediate between the two sideslopes. However, SL-10 has the lowest mass or organic matter of all the soils, further suggesting that the headslope soils may not represent a simple case of gradual transition in soil properties (Figure 34c).

While there is some support for the transitional natureof soils across the headslope, the relationship is not abundantly clear. Most properties of soils on either side of the headslope axis tend to hold values that closely resemble those of the adjacent sideslope soils. The transition between these two soil types occurs in the hollow or axis of the headslope, a narrow zone (<10m wide) extending parallel to the slope and possibly narrowing in the downslope direction. There is, thus, a general

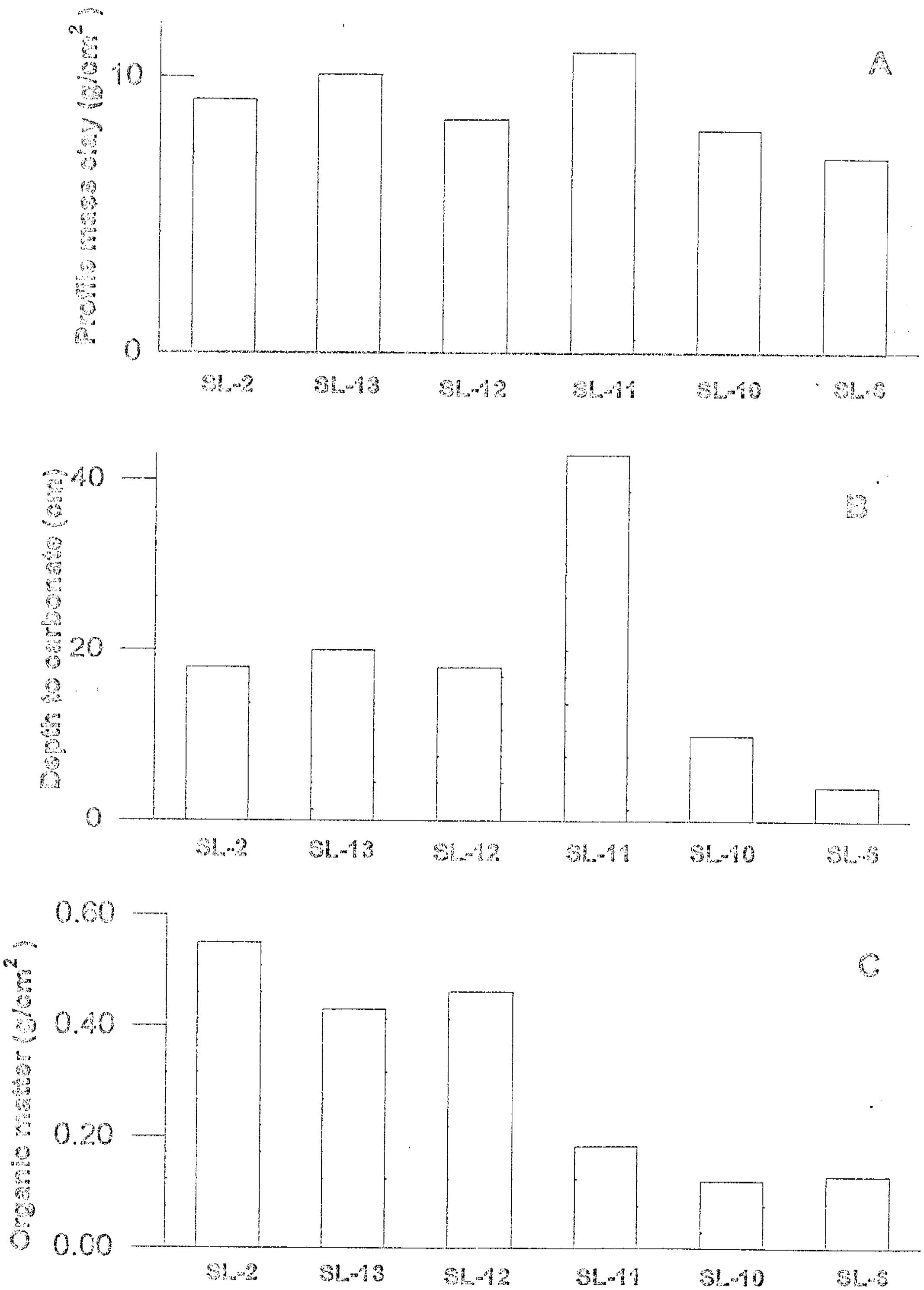


Figure 34. Bar graphs showing changes in soil properties along a contour connecting the two sideslopes. From left to right, data points follow contour from north-facing to south-facing slopes. (A) Variation in profile mass of clay; (B) Variation in depth to carbonate, and (C) Variation in mass of organic matter. A backslope soil was selected from each sideslope catena to represent that slope.

distinction in the drainage basin between those soils with an overall north aspect and those with an overall south aspect.

The soils that lie within the headslope axis (particularly SL-11 and SL-14) reveal a striking departure from the expected trend in soil properties with changing slope orientation. The distinction of headslope axis soils from other soils in the drainage basin is most apparent in the carbonate morphology. The highest soil in the catena (SL-15), which lies on the shoulder of the headslope axis, has a Stage III carbonate horizon, whereas the lowest soil (SL-14) has no pedogenic carbonate in the profile. The middle soil in the catena (SL-11) has only a stage I carbonate which initiates very low in the profile (45cm).

Given the association between precipitation and depth to carbonate (Dan and Yaalon, 1982), the depth to carbonate of soils in the headslope axis represent high effective precipitation there. Further support for higher effective precipitation in this zone is found in the repeatedly-high E-M readings in the lower portion of the headslope axis, which reflect high soil moisture contents.

The most likely control on soil moisture, and hence soil development within the headslope axis is the slope geometry. The slope concavity, which becomes accentuated in the downslope direction and results in the convergence of flow lines, can concentrate moisture in that zone through both runoff and throughflow (Ruhe and Walker, 1968). Within the axis, there is a general concavity to the slope, which becomes accentuated in the down slope direction, serving as potential focus for moisture collection. The abrupt change in soils within the headslope axis appears to result from the convergence of moisture and material in the concave portion of the headslope (Huggett, 1975). Therefore, the hydrologic complexities within the headslope of the drainage may preclude a reasonable assessment of the effects of gradual changes in slope orientation on soil development. As such, a more valid assessment of soil variability over a full range of transitional slope orientations, may require soil investigations in other drainage basins with intermediate sideslope orientations.

Catenary Relationships:

Catenary relationships, downslope trends in soil properties that reflect transfers of water and material along the gradient of a slope, were investigated on each of the two sideslopes and within the axis of the headslope. The two sideslopes are generally rectilinear along both the width and length of the slopes. The flow lines are parallel, grade directly to the central drainage channel with little, or no, toe slope development. By contrast, the headslope axis is curvilinear along both the length and width, representing flow lines converge in the down-slope direction. It is apparent from investigation of soils along each of the slopes that the strongest catenary relationship is found within the curvilinear slope geometry of the headslope axis.

Within the headslope axis catena, profile mass of clay and depth to carbonate increase downslope, while the profile mass of both carbonate and organic matter decrease. The dramatic changes that characterize this catena suggest that the trends are controlled by more than just two dimensional flow down the thalweg of the slope. Rather, the increasing slope concavity in the downslope direction appears to operate as focal point for moisture collection and potential runoff generation. The soils in the headslope axis therefore represent a three-dimensional catena, where the convergent flow lines facilitate the concentration of moisture and material through both runoff and interflow (Huggett, 1976). The apparent cumulic soil within the lower axis soils, as indicated by deep clay bulges in the depth profiles of particle size distribution, suggest that runoff may be more prominent of the two mechanisms.

On the sideslopes, however, catenary relationships are not well developed, indicating that relief on the slope may not be a strong control on soil development. Overall, sideslope soils have their greatest similarities with others of the same slope suggesting that aspect remains the strongest control. There are, however, some faint trends that can be noted for the sideslope catenas. There is a slight increase in soil organic matter content downslope on the north aspect, but no pattern at all for the south-facing slope (Figure 13). Also, three of the four soils on the north-facing slope reflect a trend of increasing depth to carbonate downslope. On the south-facing slope catena, three of the four soils reflect a downslope trend of increasing silt content, but with no significant change in clay content. Thus the combination of high runoff conditions and weak catenary relationships on the south-facing slope suggests that the slope operates as an open system, moving material entirely off the slope during large runoff events (Ruhe and Walker, 1968; Huggett, 1975).

Summary of soil spatial variability

Within the drainage basin, the most prominent control on soil spatial variability is slope orientation. The effect of slope aspect on soil development is manifest primarily through the induced microclimate and the resulting vegetation expression. The distinct characteristics of headslope axis soils suggest that small scale topographic variability such as concave and convex slope components may also account for significant local soil variability. Finally, catenary association may be considered the least significant control on soil spatial variability within the drainage. The lack of strong catenary trends (particularly on the sideslope soils) suggests that there is not a significant amount of material redistribution on the slopes. Given the indicators of strong surface runoff on the south facing slopes, the lack of significant catenary trends on that slope suggest that runoff events move material completely through the system and into the central channel. Therefore, slope position, or relief, does not appear to play an important role at this scale.

Soil moisture

Soil moisture is highly variable throughout the drainage basin, as suggested by the EM surveys. The controls on this variability may be seen both in the very factors that influence soil patterns and in the characteristics of the soil itself. In the discussion of soil variability, the controls on variable inputs of moisture to the soils was addressed. Effective precipitation, the amount of moisture infiltrated, varies as a function of vegetation type and density, sunlight exposure, slope geometry and surface soil texture. However, as soils evolve through time, their effect on both infiltration and retention of moisture will also change (Gile et al., 1981). Therefore soil spatial variability must also be considered in an assessment of soil moisture patterns.

The development of soils in arid and semi-arid environments primarily progresses through additions of silt and clay, and calcium carbonate as well as the accumulation of organic matter (Gile et al., 1981; Machette, 1985). Increases in silt and clay can have the effect of reducing the infiltration rate as well as increasing the moisture-holding capacity of a soil (McDonald, 1984; Selby, 1982). Water retention curves calculated for comparable soils on each of the sideslopes demonstrates how small changes in soil texture can significantly alter the water retention capability of the soil (Figure 19). Organic matter also greatly enhances the moisture holding capacity (Birkeland, 1984). Calcium carbonate content may either limit soil moisture-holding capacity or enhance it depending on the consistency and bulk density (Shreve and Mallery, 1933). Soils within the study area generally have soft consistencies and low bulk densities (ranging from 1.3 to 1.5) suggesting that increases in calcium carbonate in these coarse soils can enhance moisture retention.

Given these associations, it may be expected that the highest soil moisture contents will be on the north-facing slope, where moisture inputs are highest and where the soil properties contributing to moisture retention are most well developed. E-M measurements across the drainage basin demonstrate that soil moisture contents are higher on the north-facing slope than the south-facing slope. However, the highest soil moisture contents indicated by E-M surveys are typically found in the northeast-facing portion of the headslope. Thus, while both slope orientation and soil type may both be exercising a control over soil moisture, there are clearly additional factors, such as slope geometry, that must be considered.

The variability in soil moisture also appears to be influenced by temporal factors such as the time of year of a survey. The survey conducted in April, 1997 had the highest correlation with the independent variables landscape position, SOLARFLUX, and vegetation. Various paired combinations of these variables yielded R-square values ranging from 0.48-0.49. By contrast, the Septemper, 1996 survey had some of the lowest correlations with independent variables. These associations are significant in that April comes at the end of the Winter season, when the solar radiation differential across the basin is at its greatest. Therefore, the influence of slope aspect on microclimate would have been most prominent during the preceding months. By contrast, the September survey comes at the close of the Summer season when sunlight is most evenly distributed across the drainage basin. These findings suggest that the variability in soil moisture across the landscape is more responsive to slope orientation during portions of the year when landscape position exercises its greatest control over solar radiation.

Controls on vegetation distribution

Vegetation patterns can develop as a result of precipitation, the effectiveness of moisture retention, and the degree of shielding from the drying effects of wind and sun Watson (1912). In New Mexico, generally the vegetation changes on an available moisture gradient ranging (lower to higher) from scrubland to grassland to woodland to forest (Dick-Peddie, 1993). Of these, three are represented in the 3.2 hectares of the study area, although the Juniper stand, with 7.5 percent cover may be considered only the most marginal of woodlands. Therefore, given the generally even distribution of rainfall over the study area, internal factors must control the availability of water for vegetation production.

Within the study area, there is a strong relationship between vegetation type and yearly-average solar flux values. Additionally, several soil properties which influence moisture retention vary systematically with solar flux values. Silt and clay, calcium carbonate, and organic matter contents of soils all increase with decreasing average solar radiation. These associations suggest that exposure to sunlight and soil moisture-holding capacity may be the controlling factors in vegetation distribution within this drainage basin.

This is in agreement with a study of vegetation variability on limestone and basalt hillslopes in West Texas which showed that soil and aspect were both important factors in determining vegetation composition (Aide and Van Auken, 1985). In their study, Aide and Van Auken found that vegetation communities were most dissimilar between north and south-facing slopes regardless of parent material compostion. However, their assessment of soil type addressed only the parent material and did not identify hydrologic properties. Yair, (1981) found that north-facing slopes of the Sede Boquer experiment site contained soils that had properties similar to those of areas three-times more humid than the studysite. Thus, these changes in soils with aspect illustrate the importance of considering soil development for its modifying effect on aspect-related vegetation patterns.

While the influence of solar radiation exposure on vegetation type is clear and easily identified at the surface, the influence of soils in modifying the vegetation expression is more complex, and less easily quantified. Wondzell and Ludwig (1995) suggested that water availability so strongly controls production and composition in arid ecosystems that differences in soil texture and topographic position among landforms can account for vegetation patterns. It is therefore through assessing the influence of soil properties on moisture availability that we can identify the feedback effect of pedogenesis on vegetation patterns.

McAuliffe (1995) emphasized the effect of soil development on vegetation distribution by indicating the importance of the age of alluvial surfaces to the understanding of grassland composition. In that case the "time" factor was the principal influence on the development of soils. In addition to the duration of pedogenesis, Stewart and Harrison (1987) further recognized that variable rates of soil development between landscape elements and the relative stability of surfaces also exercise a strong influence on vegetation communities.

Within the study area, the difference in pedogenesis between landscape elements has affected distinctly different soil characteristics, which have strong implications for plant-available water. One such factor is the difference in soil texture, which varies significantly between grassland and shrubland sites. The higher silt and clay contents in the soils associated with grassland areas correspond to more effective retention of moisture in the upper soil horizons and greater availability of that moisture to shallow grass roots. By contrast, the coarser textures and higher gravel contents associated with shrubland areas provide less storage for uptake by grasses (McAuliffe, 1995). This contrast in plant available moisture between sites is illustrated in the moisture retention curves (Figure 19). In coarse textured soils water is more easily obtained by plants, but is also more quickly depleted, while finer soils release moisture more gradually, allowing shallow-rooted plants, like perennial grasses, to endure between wetting events. (Etherington, 1982). Calculations of water retention curves for representative soils from each of the two sideslopes reveals significanly higher water retention for soils on the north-facing slope (Figure 19).

While it is useful to identify how topography and soil may influence species composition, it is important to note that the relationships between these factors and plant available moisture may not be consistent between wet and dry years or even between large and small storm events (Wondzell and Ludwig, 1995). For example, grassland surfaces might have higher runoff potential during high-intensity rainfall events as a function of the finer soil textures and the resultant lower permeability there. However, soils in the grassland areas have their highest silt and clay contents at depths 5 to 7 cm, allowing significant storage from single events in the overlying A horizon. Furthermore, it has been noted by Gile et al. (1981) that the most favorable soil conditions for plant growth are surficial horizons of sand or loamy sand to maximize infiltration, and slightly finer textured horizon like sandy loam below the surface to capture and hold infiltrated moisture. Conversely, there might also be support for more effective infiltration of water on shrubland surfaces during short duration, low intensity events, where the coarse soil might allow more rapid and deeper infiltration, and consequently less moisture loss to direct evaporation (Alizai and Hulbert, 1970, Secor et al., 1983). In spite of these possible arguments, the indicators of soil and water dynamics within the study area suggest that such scenarios are not prevalent. The smooth overall surface topography and strong accumulation of organic matter and fines in the grassland areas suggests that surface runoff is not a prominent factor there. In the shrubland areas, the low soil water chloride concentrations suggest that there may be some deep infiltration through the depth of soils sampled.

Another soil factor which is highly variable within the study area, and has strong implications for plant production, is calcium carbonate content. In general, the portions of the study area with the greatest abundance of grasses (ie: the most mesophytic) correspond to sites with the highest profile masses of pedogenic calcium carbonate. It is possible that this relationship is due to the high moisture holding capacity of the calcium carbonate, which is soft, easily friable and poorly indurated. Shreve and Mallery (1933) demonstrated the positive effect of this type of calcium carbonate on plant production by mixing various percentages of calcium carbonate with a range of soil textures. In the series where carbonate and sand were combined, the greatest plant growth was attained from a mixture of sand with 50% calcium carbonate. The increased moisture-holding capacity offered by the accumulation of carbonate is only significant with a coarse, sandy parent material (Shreve and Mallery, 1933). There is no evidence indicating that such accumulations would assist plant production in soils with fine parent materials. In addition to its capacity for moisture retention, a further benefit of the thicker, pervasive carbonate accumulations in these coarse soils may be their capacity to provide surfaces on which mineral nutrients can be retained (Rendig and Taylor, 1989).

CONCLUSIONS

Soils within this small, first order, drainage basin vary systematically in relation to landscape position and vegetation. Aspect appears to exercise the strongest control over soils. In general, north aspects have higher amounts of calcium carbonate, organic matter and silt and clay. South aspects have very little organic matter, shallow and irregularly distributed calcium carbonate and greater surface gravel cover.

The primary vehicles by which aspect influences the spatial distribution of soils in this drainage basin are the amount of solar radiation a surface receives and the type and amount of surface vegetation cover. Both of these factors are genetically linked and are not easily dismantled for analysis. The amount of solar radiation delivered to a surface influences the amount of direct evaporation from the soil as well as the type and abundance of vegetation. The vegetation, in turn, influences the capacity of a surface to impede runoff and retain both soil materials and moisture. As this interaction evolves, key soil properties change, and can exercise a stronger influence over the vegetation composition. It is clearly apparent, however, that none of these variables of soil, vegetation or topography operate independently of the others.

Within this particular setting, there is a strong self-enhancing feedback mechanism in motion. Increasing moisture-holding capacity of soils on the north-facing slope is driven by both physical and biological parameters, evolving a soil environment that is even more conducive to mezophytic vegetation. Thus, through the divergence in soil properties across the basin, the vegetation may also be driven to greater divergence between the sideslopes (Figure 1).

While slope orientation exercises the strongest influence over soil and vegetation patterns, it is clearly not the only factor. Slope geometry, particularly concave slope elements such as we see in the headslope, can exercise a strong local control on soil and vegetation through the concentration of water and soil material. Clay contents are increased in the concave slope element likely as a result of lateral and downslope transfers along the surface. Organic matter and carbonate are reduced in concave slope positions possibly owing to the concentration of moisture in the hollow. The increased moisture may result in concentrated surface runoff, which can remove organic matter, and a high downward moisture flux that can preclude the precipitation of soil carbonate.

Overall, the research conducted here suggests that within this mosaic of microclimatic settings are predictable trends in soil development through time. Given a uniform parent material, position within the landscape as well as patterns in vegetation can be useful indicators of specific soil conditions. Increasing our knowledge of the interplay between these variables at the drainage basin scale will improve our understanding of ecosystem function, and may aid in the development of more effective land management practices at a larger scale.

FUTURE WORK

Future efforts at expanding on this work should address the nature of this relationship in a variety of different parent materials. While the changes in moisture-holding capacity are significant in the coarse alluvium in this study, they may not prove to be a significant factor in other, finer lithologies.

In order to decipher the nature of the plant-soil-landscape interactions for slope orientations intermediate between the pure north-south contrast, attention should be focused on other sideslope settings of intermediate orientation outside of the immediate study area. The attempt in this study to address the continuum within the same drainage basin, introduced significant complexities as a result of the differing surface hydrologic properties of the concave headslope surfaces.

For on-going work within the study area itself, the primary efforts in coming years should be directed at obtaining empirical data on fluctuations in soil moisture and dust accumulation across the study area. It is recommended that TDR probes be installed at various depths on each of the sideslopes and within the intermediate portions of the headslope. Dust collectors should be installed at mid-slope positions on each of the sideslopes.

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Appendix A: Soil Morphology

Sample Site: SL-1

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope shoulder
Aspect: North
Vegetation: Juniper grassland
Date described: 3/05/96

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A	0-4	10YR5/3	10YR3/2	40	Sg	Lo	SS, PS	L	CS				
Bt	4-21	10YR6/4	10YR3/2	20	2m, 2f sbk	So	S, P	CL	CW			2f, 2vf	
K	21-65	10YR7/3	10YR6/5	20	1m nodular	S-Sh	SS, PS	SL	Gl	III	Pervasive, powdery	1f,2vf	1f
Ck1	65-110	10YR6/3	10yr5/3	75	Sg	Lo	SO, PO	LS	Gl	I+	Irregular, 10-20cm lenses	2vf	
Ck2	110-135	10YR6/4	10YR5/4	75	Sg	Lo	SO, PO	LS		0.5	Slight, localized whitening	1vf	

Appendix A: Soil Morphology

Sample Site: SL-2

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope backslope
Aspect: North
Vegetation: Juniper grassland
Date described: 8/05/96

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A	0-4	10YR5/3	10YR4/2	50	Sg	Lo	S, P	L	CS				
Bt	4-18	10YR5/3	10YR3/2	30	2m, 2f sbk	So	S, P	L	GW			2f, 2vf	
Bk	18-26	10YR7/3	10YR6/3	20	2f sbk	So	SS, PS	SL	GW	I	Lt. clast coatings,	2c,2m, 2f	
K	26-75	7.5YR8/4	7.5YR7/3	25	m	Sh	SS, PS	SL	GW	III	Pervasive, powdery	1c, 2m, 1f	2f
Ck	75-120	7.5YR8/4	7.5YR8/3	20	2m-c nodular	Sh	SO, PO	S		0.5	Thin stringers	1m, 2f	

Appendix A: Soil Morphology

Sample Site: SL-3

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope backslope
Aspect: North
Vegetation: Juniper grassland
Date described: 8/05/98

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A	0-4	10YR5/3	10YR3/2	40	Sg	Lo	SS, P	SIL	CS				
Bw	4-15	7.5YR4/3	7.5YR4/3	25	2m sbk	Sh	S, P	CL	GS			2f, 2vf	
Bk	15-30	10YR6/3	10YR5/3	40	sh	Lo	S, P	SCL	CW	I+	Coatings on clast bottoms	1c, 2m, 2f	
K	30-70	10YR7/3	10YR6/3	40	1c-m sbk, (nodular)	Sh-h	SS, PS	L	GI	III	Clasts covered, pervasive in matrix	1c, 2m, 2f	
Ck1	70-105	7.5YR6/4	7.5YR5/3	75	Sg	Lo	SO, PO	S	GI\	I	irregular, lt. clast coatings.	1m, 1f	
Ck2	105-130	5YR5/5	5YR4/3	75	Sg	Lo	SO, PO	S		0.5	faint, local whitening	1f	

Appendix A: Soil Morphology

Sample Site: SL-4

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope footslope
Aspect: North
Vegetation: Juniper grassland
Date described: 8/06/96

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A	0-6	10YR5/5	10YR3/2	40	Sg	Lo	S, P	CL	CS			2f	
Bt	6-18	10YR4/2	10YR3/2	25	2m, 2f, sbk	Sh	VS, VP	CL	CW			1m3f	2f
Bk	18-50	10YR6/3	10YR5/3	70	2f sbk	Sh-h	S, P	CL	GW	I+	Thin clast coatings	1c,1m 2f	
K	50-120	10YR8/2	10YR7/2	60	M	Sh-h	S, P	SCL	GI	III	Thick (5-10mm) rinds, displacive	1c,2m 2f	1m, 2f
Ck1	120-144	7.5YR8/2	7.5YR6/3	50	nodular, Sg	So	SS PS	L	GI	II	30 % of clasts coated	1f, 1vf	
Ck2	144-165	7.5YR6/3	7.5YR5/3	70	Sg	Lo	SO, PO	LS		I	Irregular, light coatings	1vf	

Appendix A: Soil Morphology

Sample Site: SL-5

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope shoulder
Aspect: South
Vegetation: Creosote grassland
Date described: 8/07/96

Horizon	Depth (cm)	Color		gravel vol. %	Structure	Consistence		Txt.	Bound	Carbonate		Roots	Pores
		Dry	Moist			Dry	Wet			Stage	Distribution/ Concentration		
A/B	0-7	10YR6/3	10YR4/2	60	Sg	Lo	SO, PO	SL	GW			1-2f	
Bk	7-25	10YR7/3	10YR5/3	60	1f sbk	So	SS, PS	L	GI	II	clast coatings, irregular	2f, 2vf	
K	25-60	10YR8/3	10YR6/3	70	Sg (w/ nodules)	Lo-h	SS, PS	L	GI	II	clast coatings, irregular	2f, 2vf	
Ck1	60-120	7.5YR8/4	7.5YR5/3	80	Sg	Lo-sh	SO, PO	S	GI	I	discrete nodules	1f	
Ck2	120-160	7.5YR8/4	7.5YR5/3	70	Sg	Lo	SO, PO	S		I	discrete nodules	1f	

Appendix A: Soil Morphology

Sample Site: SL-6

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope backslope
Aspect: South
Vegetation: Creosote grassland
Date described: 8/07/96

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A	0-4	10YR5/3	10YR4/2	50	Sg	Lo	SO, PO	LS	CS			2f	1f
Bk	4-16	7.5YR7/2	7.5YR4/3	50	1f sbk	S0-sh	SS, PS	LS	GW	I	Lt. clast coatings, irregular	2f, 2vf	
K	16-40	7.5YR7/1	7.5YR6/2	75	Nodular	H	SS, PS	LS	CW	II+	Strong local cementation	1m, 2f, 2vf	
Ck	40-70	7.5YR6/4	7.5YR4/4	70	Sh	Sh	SO, PO	S	AI	0.5	Lt. clast coatings, irregular	2f	2f
Kb	70-100	7.5YR8/1	7.5YR7/3	20	M	Eh	S, P	SC	GW	III	Pervasive, indurated	1m, 1f	
Ckb	100-145	7.5YR6/3	7.5YR4/4	70	Sg	Lo	SO, PO	S		0.5	Lt. clast coatings, irregular	1f	

Appendix A: Soil Morphology

Sample Site: SL-7

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope backslope
Aspect: South
Vegetation: Creosote grassland
Date described: 8/03/96

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A	0-3	10YR6/3	10YR4/2	50	Sg	Lo	SS, SP	L	CS			1f	1-2f
Bjk	3-15	10YR6/3	10YR5/3	60	2f sbk	So	S, P	SCL	GW	0.5	LT. coatings, 30% of clasts	2f, 2vf	1f
Bk	15-33	10YR7/3	10YR6/3	50	2m sbk (nodules)	So	S, P	SCL	GW	I+	50% clasts coated, some nodules	2f, 3vf	
K	33-80	10YR7/2	10YR6/3	50	2m sbk (nodules)	Sh	SS, PVS	SL	DW	II	75% clasts coated, many nodules	2f, 2vf	
Ck1	80-130	7.5YR7/4	7.5YR6/4	50	Sg	Lo	SO, PO	LS	GW	I	Lt. clast coatings	2f, 1vf	
Ck2	130-160	7.5YR6/4	7.5YR5/4	50	Sg	Lo	SO, PO	LS		0.25	faint whitening	1f, 1vf	

Appendix A: Soil Morphology

Sample Site: SL-8

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope footslope
Aspect: South
Vegetation: Creosote grassland
Date described: 8/06/96

Horizon	Depth (cm)	Color		gravel vol. %	Structure	Consistence		Txt.	Bound	Carbonate		Roots	Pores
		Dry	Moist			Dry	Wet			Stage	Distribution/ Concentration		
A	0-5	10YR6/3	10YR4/2	50	Sg	Lo	SVS, PVS	SL	CS			2f	
Bjk	5-15	10YR6/3	10YR5/2	50	2f sbk	Sh	S, P	SCL	GI	I	Lt clast coatings, matrix whitening	2f, 2vf	
K	15-50	10YR7/3	10YR6/3	60	2f sbk	Sh	S, P	SCL	GI	II	Strong local cementation	2m, 2f, 2vf	
Ck	50-60	7.5YR6/4	7.5YR4/4	70	Sg	Lo	SO, PO	LS	GI	I	Lt. clast coatings	2f	
Kb	60-90	10YR8/2	10YR6/3	20	M	Vh	S, P	CL	CW	III	Pervasive cementation	1m, 1f, 1vf	
Ckb	90-120	7.5YR6/4	7.5YR4/4	75	Sg	Lo	SO, PO	S		I	Lt. clast coatings	1vf	

Appendix A: Soil Morphology

Sample Site: SL-9

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Table surface
Aspect: N/A
Vegetation: Dense Creosote grassland
Date described: 4/18/07

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A	0-4	10YR5/3	10YR4/3	30	1f pl, 1f sbk	S	SO, PVS	LS	CS			2f, 2vf	2f
A/Bk	4-10	10YR6/3	10YR4/3	50	1m, 2f sbk	S	S, P	LS	CW	I	30% clast coatings	1m, 2f, 2vf	1f
K1	10-22	10YR7/3	10YR5/3	50	2f sbk	Sh	SS, P	LS	DW	III	Pervasive	1m, 1f	
K2	22-45	10YR8/2	10YR7/2	50	M	H	SS, PS	SL	CI	III	Pervasive	1m, 1f	
Ck	45-63	7.5YR6/4	7.5YR5/4	75	Sg	So	SO, PS	SL	CW	0.5	Local stringers	1f, 2vf	
Kb	63-84	7.5YR8/2	7.5YR7/3	40	2m pl	H	S, P	CL	CI	III	Pervasive, indurated	1m, 1f, 1vf	1-2f
C	84-105	7.5YR6/4	7.5YR5/4	75	Sg	Lo-So	SO, PO	S					

Appendix A: Soil Morphology

Sample Site: SL-10

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Headslope
Aspect: Southeast
Vegetation: Dense Creosote grassland
Date described: 10/09/97

Horizon	Depth (cm)	Color		gravel vol. %	Structure	Consistence		Txt.	Bound	Carbonate		Roots	Pores
		Dry	Moist			Dry	Wet			Stage	Distribution/ Concentration		
A	0-4	10YR6/2	10YR5/2	60	Sg	Lo	SO, PO	SL	CS			2f	
A/B	4-10	10YR4/2	10YR3/2	70	1m-f sbk	So	SS, PS, G	SiL	GW			2m, 2f	1f
BWK	10-22	10YR6/2	10YR5/2	60	1f sbk	So	SO, PO	SL	CI	I+	Strong local clast coatings	1m, 2f, 2vf	
K1	22-62	10YR8/1	10YR8/2	60	M	H-vh	SS, PS	L	GW	III	Pervasive, indurated	1f, 2vf	1f
K2	62-87	10YR8/1	10YR8/2	60	M	Sh-h	SS, PS	L	GI	II	Variable and localized	1f, 1vf	
Ck	87-120	7.5YR6/4	7.5YR5/4	60	Sg	Lo	SO, PO	LS	CW	I	Nodular	1f	
Kb	120-130+	10YR6/1	10YR8/2	40	M	H	SO, PO	L		III	Pervasive, indurated		

Appendix A: Soil Morphology

Sample Site: SL-11

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Headslope (axis)
Aspect: East
Vegetation: shrubland-grassland ecotone
Date described: 10/02/97

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A1	0-6	10YR5/4	10YR3/4	50	1m sbk	So	SO, PO	SL	CS			3f, 2vf	
A2	6-18	10YR4/2	10YR3/2	60	1m, 2f sbk	Vsh	SS, PS	L	CS			2f, 2vf	1-2f
Bw	18-43	7.5YR5/3	7.5YR4/3	75	1f, sbk	So	S, P, G	SCL	CW			2f	
Bk	43-66	7.5YR6/3	7.5YR4/5	60	Sg	So	SS, PS, G	L	CW	I	Stringers, lt. matrix whitening	1f, 1vf	
Ck	66-78	7.5YR6/4	7.5YR5/4	60	Sg	Lo	SO, PO	LS	CW	0.25	Faint fizz	1f, 2vf	
Kb	78-120	7.5YR8/2	7.5YR7/3	60	M	Eh	S, P	SCL	GW	III+	Pervasive, some laminar carbonates	1f	
Ckb	120-178	7.5YR5/4	7.5YR6/4	60	Sg	Lo	SO, PO	LS		0.5	Pockets of white matrix	2f, 2vf	

Appendix A: Soil Morphology

Sample Site: SL-12

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Headslope
Aspect: east-northeast
Vegetation: Grassland
Date described: 3/10/97

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
A	0-7	10YR4/3	10YR3/2	30	1f sbk	So	SS, PS	L	CS			2f	
A/B	7-18	2.5YR3/2	2.5YR3/2	30	2m sbk	H	VS, P	CL	GW			2f, 2vf	1f
BWK	18-30	2.5YR6/2	2.5YR4/3	60	1m sbk	Sh	S, P, G	CSC L	CW	II	30% clast coatings, lt. matrix whitening	2f	1f
K1	30-70	10YR8/2	10YR7/3	60	M	Vh	SS, PVS, G	L	GI	IV-	Laminar carbonates	2vf	1f
K2	70-95	10YR8/3	10YR7/3	60	M	H	SV, PV, G	CL	DI	III	Powdery, pervasive carbonate	2c, 2m, 2f	
CK	95-120	7.5YR5/4	7.5YR4/5	70	Sg	Lo	SS, PS	LS		0.5	irregular, local whitening	2f	

Appendix A: Soil Morphology

Sample Site: SL-13

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Headslope
Aspect: Northeast
Vegetation: Juniper grassland-grassland
Date described: 5/07/97

Horizon	Depth (cm)	Color		gravel vol. %	Structure	Consistence		Txt.	Bound	Carbonate		Roots	Pores
		Dry	Moist			Dry	Wet			Stage	Distribution/ Concentration		
A	0-5	10YR5/3	10YR3/2	40	2f sbk	So	SS, PS	SiL	CS			2vf	
Bt	5-20	7.5YR5/3	7.5YR4/3	30	2c, 2m, 1f sbk	So	S, P	SiCL	CS			2f, 2vf	
Bk	20-32	10YR7/2	01YR5/3	40	1f sbk	So	SO, PO	L	GW	II	Clast coatings	2f, 2vf	
K1	32-50	10YR8/1	10YR8/2	40	M	So	SVS, PVS	L	GW	III	Powdery, pervasive	2vf	
K2	50-64	10YR8/1	10YR8/2	40	2c Pl (laminae)	H	SVS, PVS	L	GI	III+	Laminar carbonate,	1f,2vf	
Ck	64-85	7.5YR7/3	7.5YR4/4	50	Sg	Lo	SS, PS	L	GI	I+	Lt. clast coatings	1vf	
Kb	85-120	10YR8/1	10YR8/3	40	Sg	Lo	SVS, PVS	L		III	Powdery, pervasive	1vf	

Appendix A: Soil Morphology

Sample Site: SL-14

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: headslope (axis)
Aspect: East
Vegetation: Shrubland-grassland ecotone
Date described: 5/07/97

		Color				Consistence				Carbonate			
Horizon	Depth (cm)	Dry	Moist	gravel vol. %	Structure	Dry	Wet	Txt.	Bound	Stage	Distribution/ Concentration	Roots	Pores
Av	0-8	10YR5/3	10YR3/2	50	1m pl	So	SVS, PVS	L	CS			2f	2m
A/B	8-23	10YR4/2	10YR4/2	60	1m, 2f sbk	So	SO, PO	SL	CS			3f, 2vf	
Bwt	23-110	7.5YR5/4	7.5YR5/4	80	1f sbk	Sh	S, P, G	SCL	CW			2f, 2vf	
Kb	110-150	10YR8/1	10YR8/1	70	M	H	SS, PS	L		III	Pervasive, indurated		

Appendix A: Soil Morphology

Sample Site: SL-15

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Sidslope (axis-shoulder)
Aspect: East
Vegetation: Grassland
Date described: 6/10/97

Horizon	Depth (cm)	Color		gravel vol. %	Structure	Consistence		Txt.	Bound	Carbonate		Roots	Pores
		Dry	Moist			Dry	Wet			Stage	Distribution/ Concentration		
A	0-6	10YR4/3	10YR3/2	40	1f, 1vf sbk	So	SS, PS	SL	CS			2f	
Bw	6-15	10YR3/2	10YR3/2	40	2m, 2f sbk	Sh	S, P	SCL	GW			2f, 3vf	
Bwk	15-25	10YR5/3	10YR4/3	60	1m, 2f sbk	Sh	S, P	SCL	GW	I	25% clast coatings	2f, 3vf	
K1	25-60	7.5YR6/2	7.5YR5/3	50	M	So	S, P, G	SCL	DI	II	Strong local cementation	1m, 1f, 3vf	
K2	60-95	10YR7/2	10YR6/3	40	M	Sh	S, P, G	SCL	GI	III	V. Coarse nodules, pervasive	1m, 1f, 2vf	
Ck	95-125	10YR6/4	10YR5/3	70	Sg	Lo	SO, PO	LS				1vf	

Appendix A: Soil Morphology

Sample Site: SL-16

Location: Sierra Ladrones Study Site
La Joya NW quadrangle

Landform: Table surface (swale)
Aspect: N/A
Vegetation: Grassland
Date described: 3/18/97

Horizon	Depth (cm)	Color		gravel vol. %	Structure	Consistence		Txt.	Bound	Carbonate		Roots	Pores
		Dry	Moist			Dry	Wet			Stage	Distribution/ Concentration		
A	0-6	10YR4/3	10YR3/3	40	2m sbk	So	SS, PS	SiL	CS			3f, 2vf	2f
Bw	6-15	7.5YR4/4	7.5YR4/4	40	2f sbk	So	SS, PS	L	CW	0.5	Lt. clast coatings	2d, 2vf	1f
K1	15-35	7.5YR7/2	7.5YR6/4	50	M	Vh	SS, PS	SL	GW	II+	Strong cementation between clasts	1m, 1f, 2vf	2vf
K2	35-65	7.5YR7/2	7.5YR6/4	50	M	So-Sh	SS, PS	L	CW	III	Soft, pervasive	1f, 2vf	
Ck	65-90	7.5YR6/4	7.5YR5/4	60	Sg	Lo	SO, SVS	LS	GW	0.5	Irregular, nodular	2vf	
C	90-100	7/5YR6/4	7.5YR4/4	80	Sg	Lo	SO, PO	LS				1vf	

Appendix B: Laboratory data

Table B: Soil laboratory data summary

Sample	Depth (cm)	vol. % gravel	wt. % sand	wt. % silt	wt. % clay	wt. % carbonate	wt. % organic
SL-1-1	4	40	48.127	41.342	10.531	0.03	1.706
SL-1-2	21	20	37.977	41.392	20.631	4.05	2.696
SL-1-3	65	40	67.689	19.898	12.412	21.87	1.111
SL-1-4	110	75	75.432	14.547	10.021	3.27	N/A
SL-1-5	135	75	89.087	6.215	4.698	0.66	N/A
SL-2-1	4	50	50.061	40.644	9.295	0.10	1.294
SL-2-2	18	30	48.826	33.168	18.005	8.11	2.717
SL-2-3	26	20	66.747	20.712	12.541	20.68	2.145
SL-2-4	75	20	76.394	12.358	11.248	14.39	N/A
SL-2-5	120	25	84.035	9.066	6.899	3.79	N/A
SL-3-1	4	40	48.540	41.128	10.332	0.24	1.654
SL-3-2	15	25	43.573	37.816	18.611	3.91	2.497
SL-3-3	30	40	52.057	30.597	17.345	16.22	1.419
SL-3-4	70	40	67.448	18.991	13.561	16.62	N/A
SL-3-5	105	75	72.738	14.892	12.380	2.68	N/A
SL-3-6	130	75	77.844	10.871	11.285	1.37	N/A
SL-4-1	6	40	53.392	35.300	11.309	0.04	1.223
SL-4-2	18	25	41.233	38.975	19.792	0.37	2.694
SL-4-3	50	70	49.780	28.210	22.010	4.73	0.859
SL-4-4	120	60	62.008	23.756	14.236	18.80	N/A
SL-4-5	144	50	72.485	15.457	12.057	11.27	N/A
SL-4-6	165	70	73.234	14.615	12.150	2.39	N/A
SL-5-1	7	60	67.746	22.007	10.247	4.46	0.839
SL-5-2	25	60	64.968	19.904	15.127	11.38	0.857
SL-5-3	60	70	71.988	13.916	14.096	7.24	0.388
SL-5-4	120	70	82.271	7.192	10.538	2.97	N/A
SL-5-5	160	80	67.191	18.199	14.610	1.11	N/A
SL-6-1	4	50	65.490	25.268	9.242	2.98	1.073
SL-6-2	16	50	65.816	20.563	13.621	6.25	0.945
SL-6-3	40	75	70.391	14.122	15.488	6.25	0.367
SL-6-4	70	70	83.499	7.387	9.114	0.79	N/A
SL-6-5	100	70	55.955	24.234	19.811	11.00	N/A
SL-6-6	145	70	87.881	7.323	4.796	0.74	N/A
SL-7-1	3	50	70.648	19.694	9.658	2.80	0.687
SL-7-2	15	60	65.184	21.972	12.844	3.92	0.603
SL-7-3	33	60	65.987	21.426	12.587	4.97	0.682
SL-7-4	80	60	72.900	15.387	11.713	6.50	N/A
SL-7-5	130	60	78.282	11.473	10.245	4.33	N/A
SL-7-6	160	60	78.300	10.857	10.843	1.81	N/A

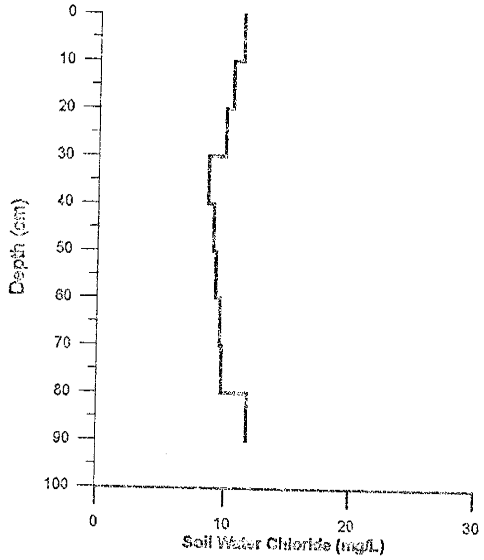
Table B: Soil laboratory data summary

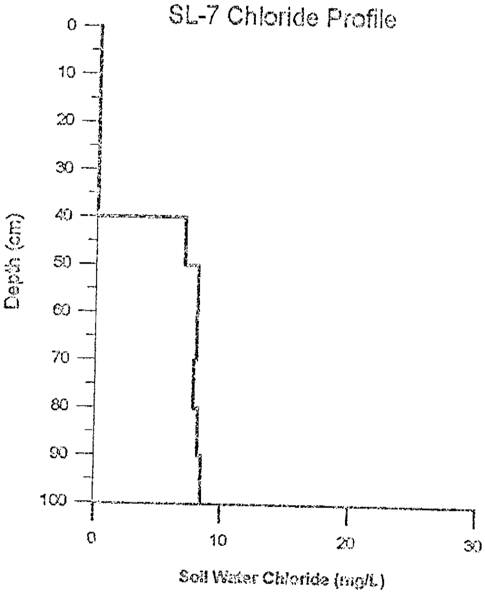
Sample	Depth (cm)	vol. % gravel	wt. % sand	wt. % silt	wt. % clay	wt. % carbonate	wt. % organic matter
SL-8-1	5	50	63.084	25.459	11.457	3.69	0.677
SL-8-2	15	50	60.485	25.085	14.431	7.13	0.940
SL-8-3	50	60	66.281	19.343	14.376	7.39	0.662
SL-8-3a	60	70	78.282	11.473	10.245	0.79	N/A
SL-8-4	90	20	55.721	23.652	20.627	27.89	N/A
SL-8-5	120	75	76.398	14.749	8.853	1.70	N/A
SL-9-1a	5	30	66.732	28.661	4.607	4.35	1.625
SL-9-1b	10	50	59.081	31.380	9.539	5.99	1.449
SL-9-2	20	50	60.443	25.115	14.441	9.36	1.500
SL-9-3	30	50	58.673	28.555	12.772	15.41	1.190
SL-9-4	40	50	60.519	26.974	12.507	18.10	N/A
SL-9-5	50	50	67.708	20.562	11.730	15.43	N/A
SL-9-6	60	75	78.089	10.811	11.100	3.37	N/A
SL-9-7	70	75	78.147	10.928	10.925	3.35	N/A
SL-9-8	80	40	62.608	19.135	18.257	17.95	N/A
SL-9-9	90	40	76.968	10.831	12.201	6.42	N/A
SL-9-10	100	75	N/A	N/A	N/A	1.88	N/A
SL-10-1	10	60	57.060	38.293	4.648	3.23	1.177
SL-10-2	20	70	56.663	35.474	7.863	2.55	0.902
SL-10-3	30	60	53.278	36.521	10.201	3.71	1.297
SL-10-4	40	60	56.117	30.353	13.530	9.62	N/A
SL-10-5	50	60	51.016	31.190	17.794	20.23	N/A
SL-10-6	60	60	57.992	29.448	12.559	23.74	N/A
SL-10-7	70	60	79.410	12.769	7.822	8.81	N/A
SL-10-8	80	60	70.901	17.708	11.391	14.39	N/A
SL-10-9	90	60	81.440	13.567	4.993	9.94	N/A
SL-10-10	100	60	80.157	11.624	8.219	7.86	N/A
SL-10-	105	60	80.025	13.843	6.132	5.30	N/A
SL-10-	110	*60*	*80.688*	*12.385*	*6.927*	N/A	N/A
SL-10-12	120	60	79.900	13.160	6.940	6.42	N/A
SL-10-13	130	60	59.701	26.297	14.001	20.87	N/A
SL-11-1	10	50	56.848	29.778	13.374	0.08	1.415
SL-11-2	20	50	90.113	5.816	4.070	0.04	1.246
SL-11-3	30	60	54.853	26.096	19.050	0.31	0.580
SL-11-4	40	75	62.768	21.713	15.520	0.48	N/A
SL-11-6	60	75	58.198	20.934	20.868	0.53	N/A
SL-11-8	80	60	67.824	18.949	13.227	11.05	N/A
SL-11-10	100	60	70.792	20.485	8.723	7.05	N/A
SL-11-12	120	60	76.939	16.538	6.523	10.00	N/A
SL-11-14	140	60	61.390	22.875	15.735	0.00	N/A

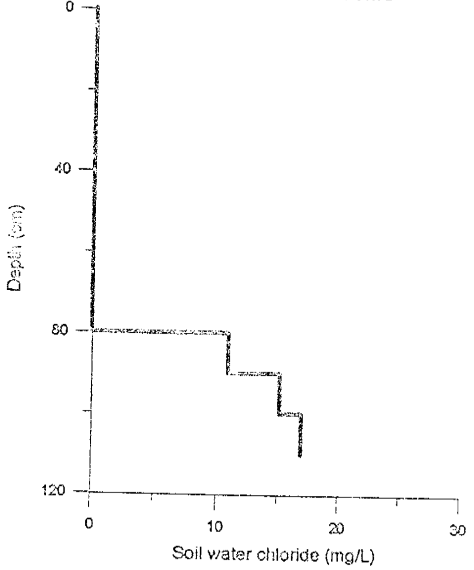
Table B: Soil laboratory data summary

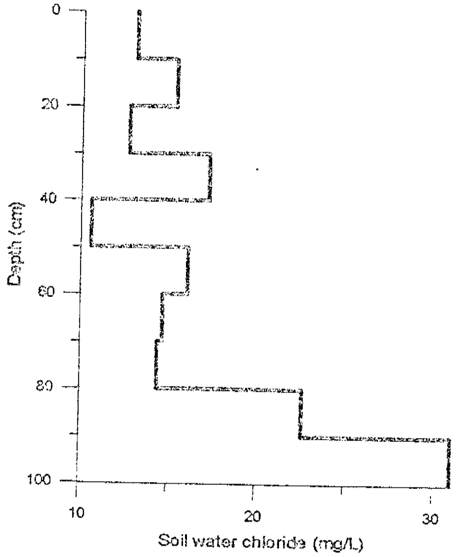
Sample	Depth (cm)	vol. % gravel	wt. % sand	wt. % silt	wt. % clay	wt. % carbonate	wt. % organic matter
SL-16-1	10	40	50.439	39.834	9.727	0.60	2.014
SL-16-2	20	40	58.203	24.025	17.772	9.26	1.672
SL-16-3	30	50	61.154	28.131	10.715	25.11	1.337
SL-16-4	40	50	67.140	24.125	8.735	23.19	N/A
SL-16-5	50	50	70.624	23.598	5.778	17.90	N/A
SL-16-6	60	50	64.824	24.675	10.501	21.20	N/A
SL-16-7	70	60	56.106	28.911	14.984	12.67	N/A
SL-16-8	80	60	70.067	19.346	10.587	5.44	N/A
SL-16-9	90	60	75.683	16.447	7.870	4.64	N/A
SL-16-10	100	80	54.223	40.333	5.445	1.47	N/A

Appendix C: Soil water chloride Profiles

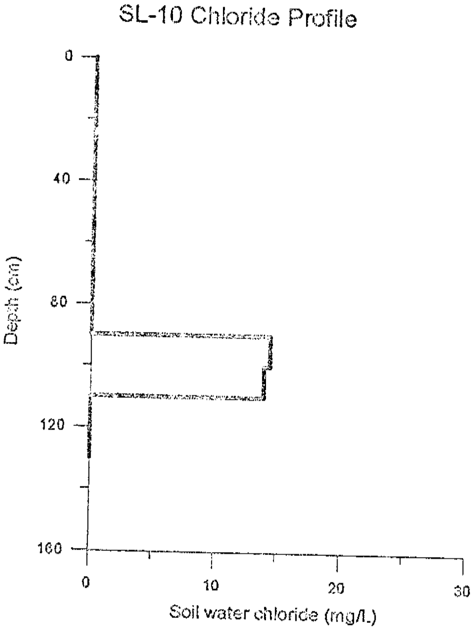

SL-3 Chloride Profile

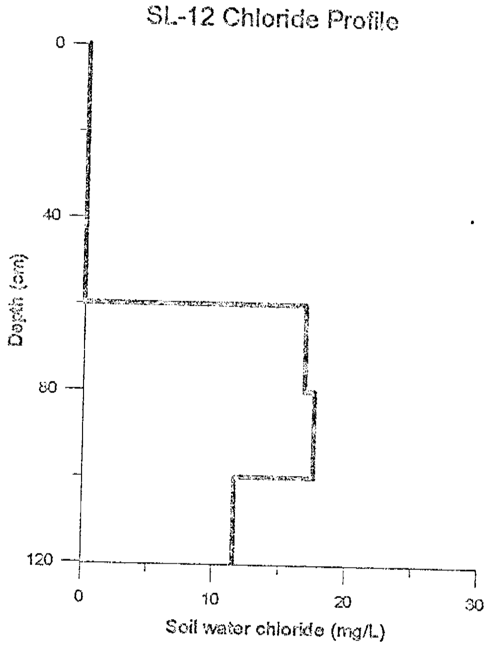

SL-7 Chloride Profile

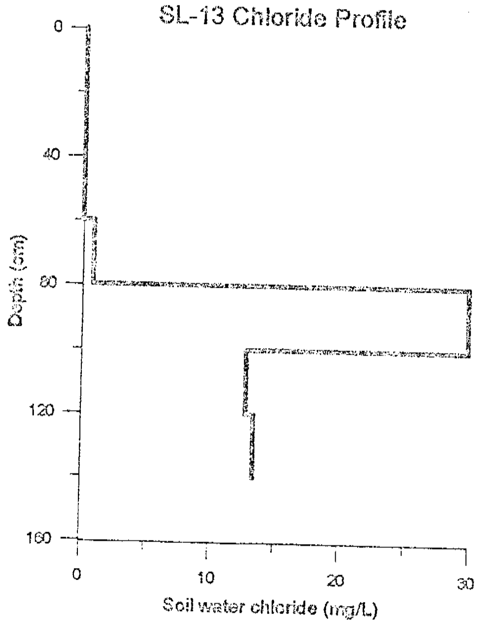

SL-9 Chloride Profile

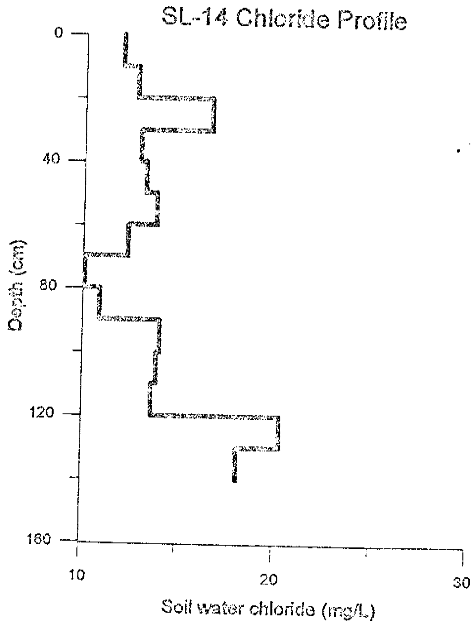

SL-16 Chloride Profile

Appendix C (continued)


SL-10 Chloride Profile


SL-12 Chloride Profile


SL-13 Chloride Profile


SL-14 Chloride Profile

Appendix D: Vegetation species list and transect data

Table D-1: Vegetation species list

ACRONYM	Family	Species Name	AUTHOR	Common Name	LF
ARISTIDA	Poaceae	Aristida spp.			
ASTRAG	Fabaceae	Astragalus spp.	L.	milkvetch spp.	4
BAHABS	Asteraceae	Bahia absinthifolia	Benth.	hairyseed bahia	4
BOUERI	Poaceae	Bouteloua eriopoda	(Torr.) Torr.	black grama	3
BOUGRA	Poaceae	Bouteloua gracilis	(Willd. ex Kunth) Lag. ex Griffiths	blue grama	3
BOUHIR	Poaceae	Bouteloua hirsuta	Lag.	hairy grama	3
CORVIV	Cactaceae	Corypantha vivapara	(Nutt.) Britt. & Rose.		
DALEA	Fabaceae	Dalea spp.	L.	prairieclover spp.	4
ENNDES	Poaceae	Enneapogon desvauxii	Beauv.	nineawn pappusgrass	3
ERIPUL	Poaceae	Erioneuron pulchellum	(Kunth) Tateoka	fluffgrass	3
ERIWRI	Polygonaceae	Eriogonum wrightii	Torr. ex Benth.	Wright's buckwheat	4
GUTSAR	Asteraceae	Gutierrezia sarothrae	(Pursh) Britt. & Rusby	broom snakeweed	2
HEDEOMA	Labiatae	Hedeoma spp.			
JUNMON	Cupressaceae	Juniperus monosperma	(Engelm.) Sarg.	oneseed juniper	1
LARTRI	Zygophyllaceae	Larrea tridentata	(Sesse & Moc. ex DC.) Coville	creosotebush	2
LESGOR	Brassicaceae	Lesquerella gordonii			
LESQUE	Brassicaceae	Lesquerella spp.	S. Wats.	bladderpod spp.	4
MELLEU	Asteraceae	Melampodium leucanthum	Torr. & Gray	plains blackfoot	4
MUHPOR	Poaceae	Muhlenbergia porteri	Scribn. ex Beal	bush muhly	3
MUHTOR	Poaceae	Muhlenbergia torreyi	(Kunth) Hitch. ex Bush	ring muhly	3
MUSTARD1	Brassicaceae				
OPUPHA	Cactaceae	Opuntia phaeacantha	Engelm.	tulip pricklypear	2
PANHAL	Poaceae	Panicum hallii	Vasey	Hall's panicgrass	3
PARINC	Asteraceae	Parthenium incanum	Kunth	mariola	2
PECTIS	Asteraceae	Pectis spp.	L.	cinchweed	4
SENLON	Asteraceae	Senecio longilobus			
SOLELA	Solanaceae	Solanum elaeagnifolium	Cav.		

Appendix D: Vegetation species list and transect data

Table D-1: Vegetation species list

SPHAERA	Malvaceae	Sphaeralcea spp.			
SPOCRY	Poaceae	Sporobolus cryptandrus	(Torr.) Gray	sand dropseed	3
STEPHA	Asteraceae	Stephanomeria spp.	Nutt.	wirelettuce spp.	4
STINEO	Poaceae	Stipa neomexicana	(Thurb.) Scribn.	New Mexico needlegras	3
THYACE	Asteraceae	Thymophylla acerosa	(DC.) Strother	pricklyleaf dogweed	2
TRIMUT	Poaceae	Tridens muticus	(Torr.) Nash	slim tridens	3
TRIPIL					
UNID1					
UNID2					
UNID3					
UNID4					
UNID5					
UNID6					
YUCGLA	Agavaceae	Yucca glauca	Nutt.	soaptree yucca	2

Table D-2: Vegetation transect data

Transect	Quadrat	Acronym	% Cover
NF	1	BOUERI	5
NF	1	BOUGRA	12
NF	2	BOUERI	8
NF	2	MUHTOR	3
NF	2	BOUHIR	20
NF	3	BOUERI	7
NF	3	MUHTOR	10
NF	3	BOUHIR	8
NF	4	BOUERI	1
NF	4	BOUHIR	20
NF	5	BOUERI	7
NF	5	BOUHIR	20
NF	5	CORVIV	1
NF	6	BOUERI	10
NF	6	MUHTOR	15
NF	6	BOUHIR	4
NF	7	BOUERI	30
NF	8	BOUERI	20
NF	9	BOUERI	10
NF	9	BOUHIR	15
NF	9	YUCGLA	8
NF	10	BOUERI	12
NF	10	BOUHIR	1
NF	11	BOUERI	5
NF	11	BOUHIR	20
NF	12	BOUHIR	20
NF	13	BOUERI	7
NF	13	BOUHIR	25
NF	14	BOUERI	2
NF	14	BOUHIR	20
NF	15	BOUERI	2
NF	15	BOUHIR	12
NF	16	BOUERI	10
NF	16	BOUHIR	10
NF	17	BOUERI	8
NF	17	BOUHIR	8
NF	18	BOUERI	15
NF	18	BOUHIR	5
NF	19	BOUERI	40
NF	20	BOUERI	10
NF	20	BOUHIR	5
NF	21	BOUERI	40
NF	21	BOUHIR	0.01
NF	21	ASTRAG	1
NF	22	BOUERI	5
NF	22	JUNMON	100
NF	23	JUNMON	100
NF	24	JUNMON	100
NF	25	SPOCRY	3
NF	25	MUHTOR	20
NF	25	THYACE	1
NF	26	BOUERI	15
NF	27	BOUERI	15
NF	27	SPOCRY	1
NF	28	BOUERI	25
NF	29	BOUERI	15
NF	30	BOUERI	8
NF	30	SPOCRY	5
NF	30	BOUHIR	5
NF	31	LESGOR	1
NF	31	SPOCRY	4
NF	31	BOUHIR	10
NF	32	BOUERI	30
NF	32	SPOCRY	1
NF	32	MUHTOR	0.01
NF	32	BOUHIR	2
NF	32	ASTRAG	2
NF	33	BOUERI	10
NF	33	STINEO	2
NF	34	BOUERI	30
NF	35	BOUERI	20
NF	35	GUTSAR	0.01
NF	36	BOUERI	20
NF	37	BOUERI	35
NF	38	BOUERI	10
NF	38	BOUHIR	10
NF	39	BOUERI	12
NF	40	BOUERI	15
NF	40	BOUHIR	5
SF	1	ERIPUR	8
SF	1	BAHABS	3
SF	1	ERIWRI	3
SF	2	ERIPUR	30
SF	2	TRIMUT	1
SF	2	ERIWRI	1
SF	3	ERIPUR	15

Table D-2: Vegetation transect data

Transect	Quadrat	Acronym	% Cover	Transect	Quadrat	Acronym	% Cover
SF	3	TRIMUT	1	SF	15	LARTRI	70
SF	3	DALEA	1	SF	15	HEDEON	10
SF	3	PECTIS	0.01	SF	16	ERIPUR	5
SF	3	LESQUE	5	SF	16	TRIMUT	10
SF	3	UNID1	0.01	SF	16	PECTIS	1
SF	4	BOUERI	1	SF	16	LESQUE	10
SF	4	TRIMUT	4	SF	17	BOUERI	10
SF	4	ERIWRI	7	SF	17	ERIPUR	2
SF	4	PECTIS	3	SF	17	TRIMUT	10
SF	5	ERIPUR	5	SF	18	ERIPUR	6
SF	5	TRIMUT	1	SF	18	TRIMUT	7
SF	5	PARINC	40	SF	18	PECTIS	5
SF	5	GUTSAR	3	SF	18	PARINC	15
SF	5	LARTRI	40	SF	18	UNID1	2
SF	5	HEDEON	6	SF	19	ERIPUR	10
SF	6	BOUERI	3	SF	19	PECTIS	5
SF	6	ERIPUR	2	SF	19	LARTRI	45
SF	6	TRIMUT	7	SF	19	HEDEON	15
SF	6	PARINC	30	SF	20	ERIPUR	8
SF	7	BOUERI	10	SF	20	TRIMUT	10
SF	7	ERIPUR	5	SF	20	ERIWRI	3
SF	7	TRIMUT	5	SF	20	HEDEON	5
SF	7	PARINC	15	SF	21	TRIMUT	20
SF	8	ERIPUR	6	SF	21	HEDEON	1
SF	8	BAHABS	2	SF	21	UNID1	1
SF	8	PARINC	10	SF	22	TRIMUT	10
SF	9	ERIPUR	15	SF	22	PECTIS	5
SF	9	BAHABS	10	SF	22	UNID2	5
SF	10	ERIPUR	15	SF	23	BOUERI	15
SF	10	BAHABS	3	SF	23	TRIMUT	8
SF	10	PARINC	20	SF	23	BAHABS	1
SF	11	BOUERI	2	SF	23	PARINC	10
SF	11	ERIPUR	15	SF	23	LARTRI	15
SF	11	TRIMUT	10	SF	23	HEDEON	8
SF	12	ERIPUR	15	SF	23	UNID2	1
SF	12	TRIMUT	4	SF	24	BOUERI	5
SF	13	TRIMUT	7	SF	24	ERIPUR	8
SF	13	PARINC	35	SF	24	TRIMUT	15
SF	13	LARTRI	40	SF	24	ERIWRI	10
SF	14	ERIPUR	20	SF	24	PARINC	2
SF	14	TRIMUT	2	SF	25	BOUERI	1
SF	15	ERIWRI	8	SF	25	TRIMUT	12
SF	15	PARINC	30	SF	25	UNID2	2

Table D-2: Vegetation transect data

Transect	Quadrat	Acronym	% Cover	Transect	Quadrat	Acronym	% Cover
SF	26	TRIMUT	5	SF	39	TRIMUT	8
SF	26	UNID3	1	SF	39	BAHABS	5
SF	27	BOUERI	5	SF	39	LARTRI	40
SF	27	ERIPUR	2	SF	39	UNID1	5
SF	27	TRIMUT	5	SF	40	TRIMUT	7
SF	27	BAHABS	10	SF	40	LARTRI	15
SF	27	PECTIS	3	SF	40	MELLEU	20
SF	28	ERIPUR	5	HS-1.	1	BOUERI	4
SF	28	TRIMUT	10	HS-1.	1	ERIWRI	7
SF	28	PARINC	5	HS-1.	1	UNID2	12
SF	29	ERIPUR	5	HS-1.	2	LARTRI	90
SF	29	TRIMUT	10	HS-1.	2	UNID2	10
SF	30	TRIMUT	10	HS-1.	2	UNID3	10
SF	30	BAHABS	2	HS-1.	3	ERIPUL	5
SF	30	LESQEU	2	HS-1.	3	ERIWRI	8
SF	31	TRIMUT	10	HS-1.	3	LARTRI	2
SF	31	LARTRI	20	HS-1.	3	UNID4	2
SF	32	ERIPUR	15	HS-1.	4	BOUERI	20
SF	32	TRIMUT	5	HS-1.	4	ERIWRI	10
SF	32	PARINC	15	HS-1.	4	OPUPHA	20
SF	33	ERIPUR	15	HS-1.	5	BOUERI	10
SF	33	PARINC	5	HS-1.	5	ERIWRI	5
SF	33	UNID3	1	HS-1.	5	PARINC	20
SF	34	ERIPUR	5	HS-1.	6	BOUERI	2
SF	34	BAHABS	2	HS-1.	6	BAHABS	15
SF	34	DALEA	5	HS-1.	7	BOUERI	10
SF	34	PARINC	30	HS-1.	7	ERIPUL	7
SF	34	UNID1	0.01	HS-1.	7	BAHABS	8
SF	35	ERIPUR	12	HS-1.	7	LARTRI	5
SF	35	TRIMUT	4	HS-1.	7	LESGOR	7
SF	35	DALEA	5	HS-1.	8	BOUERI	5
SF	36	ERIPUR	20	HS-1.	8	ERIPUL	20
SF	36	TRIMUT	2	HS-1.	8	UNID5	0.01
SF	36	LARTRI	25	HS-1.	9	ERIPUL	15
SF	37	BOUERI	5	HS-1.	9	LARTRI	5
SF	37	ERIPUR	2	HS-1.	9	UNID5	20
SF	37	TRIMUT	10	HS-1.	10	ERIPUL	15
SF	37	ERIWRI	10	HS-1.	10	LARTRI	70
SF	37	UNID1	1	HS-1.	10	MUHPOR	20
SF	38	ERIPUR	15	HS-1.	11	ERIPUL	10
SF	38	TRIMUT	8	HS-1.	11	BAHABS	2
SF	38	BAHABS	2	HS-1.	11	LARTRI	10
SF	39	ERIPUR	2	HS-1.	11	UNID5	25

Table D-2: Vegetation transect data

Transect	Quadrat	Acronym	% Cover	Transect	Quadrat	Acronym	% Cover
HS-1.	12	ERIPUL	30	HS-2.	25	ERIPUL	12
HS-1.	12	ERIWRI	5	HS-2.	25	TRIMUT	4
HS-1.	13	BOUERI	5	HS-2.	25	BAHABS	5
HS-1.	13	ERIPUL	15	HS-2.	25	ERIWRI	10
HS-1.	13	ERIWRI	0.01	HS-2.	25	LARTRI	50
HS-1.	14	BAHABS	10	HS-2.	26	BOUERI	15
HS-1.	14	ERIWRI	8	HS-2.	26	ERIPUL	1
HS-1.	15	ERIPUL	6	HS-2.	26	ERIWRI	3
HS-1.	15	BAHABS	15	HS-2.	26	LARTRI	70
HS-1.	15	ERIWRI	8	HS-2.	26	LESGOR	7
HS-1.	16	BOUERI	2	HS-2.	27	BOUERI	3
HS-1.	16	ERIPUL	12	HS-2.	27	ERIPUL	5
HS-1.	16	BAHABS	15	HS-2.	27	LARTRI	10
HS-1.	16	ERIWRI	10	HS-2.	27	TRIPIL	4
HS-1.	17	BOUERI	5	HS-2.	28	BOUERI	8
HS-1.	17	BAHABS	15	HS-2.	28	ERIPUL	10
HS-1.	17	ERIWRI	5	HS-2.	28	TRIMUT	2
HS-1.	17	UNID2	2	HS-2.	28	BAHABS	2
HS-1.	18	BOUERI	7	HS-2.	28	LESGOR	5
HS-1.	18	ERIPUL	0.01	HS-2.	29	BOUERI	5
HS-1.	18	ERIWRI	5	HS-2.	29	ERIPUL	8
HS-1.	18	LESGOR	25	HS-2.	29	TRIMUT	7
HS-1.	19	BOUERI	12	HS-2.	29	BAHABS	5
HS-1.	19	ERIPUL	12	HS-2.	29	ERIWRI	2
HS-1.	20	BOUERI	7	HS-2.	29	TRIPIL	3
HS-1.	20	ERIPUL	25	HS-2.	30	BOUERI	5
HS-2.	21	ERIPUL	1	HS-2.	30	ERIPUL	12
HS-2.	21	TRIMUT	3	HS-2.	30	UNID4	10
HS-2.	21	GUTSAR	5	HS-2.	31	UNID4	0.01
HS-2.	21	LARTRI	100	HS-2.	31	TRIPIL	5
HS-2.	21	UNID2	1	HS-2.	32	ERIPUL	2
HS-2.	21	UNID4	1	HS-2.	32	BAHABS	50
HS-2.	21	TRIPIL	4	HS-2.	33	BOUERI	8
HS-2.	22	BOUERI	5	HS-2.	33	BAHABS	70
HS-2.	22	ERIPUL	8	HS-2.	34	BOUERI	2
HS-2.	22	TRIMUT	8	HS-2.	34	ERIPUL	4
HS-2.	23	TRIMUT	7	HS-2.	34	BAHABS	5
HS-2.	23	PARINC	5	HS-2.	34	LARTRI	20
HS-2.	23	LARTRI	80	HS-2.	34	UNID4	0.01
HS-2.	24	BOUERI	5	HS-2.	35	BOUERI	40
HS-2.	24	ERIPUL	2	HS-2.	35	ERIPUL	10
HS-2.	24	MELLEU	8	HS-2.	35	BAHABS	15
HS-2.	25	BOUERI	2	HS-2.	36	ERIPUL	20

Table D-2: Vegetation transect data

Transect	Quadrat	Acronym	% Cover	Transect	Quadrat	Acronym	% Cover
HS-2.	36	BAHABS	3	HS-3.	51	UNID3	5
HS-2.	36	UNID3	15	HS-3.	51	PANHAL	15
HS-2.	37	BAHABS	30	HS-3.	52	BOUERI	15
HS-2.	37	ERIWRI	25	HS-3.	52	LESQUE	1
HS-2.	38	BOUERI	10	HS-3.	52	UNID3	5
HS-2.	38	ERIPUL	3	HS-3.	53	BOUERI	8
HS-2.	38	BAHABS	60	HS-3.	53	ERIPUL	2
HS-2.	39	BOUERI	8	HS-3.	53	GUTSAR	10
HS-2.	39	BAHABS	5	HS-3.	53	PANHAL	8
HS-2.	39	PANHAL	7	HS-3.	54	BOUERI	10
HS-2.	40	BOUERI	5	HS-3.	54	LARTRI	30
HS-2.	40	BOUGRA	35	HS-3.	54	LESGOR	7
HS-3.	41	BOUERI	10	HS-3.	55	BOUERI	40
HS-3.	41	BAHABS	40	HS-3.	55	UNID3	5
HS-3.	41	LESGOR	8	HS-3.	56	BOUERI	5
HS-3.	41	STEPHA	12	HS-3.	56	ERIPUL	2
HS-3.	42	ERIPUL	12	HS-3.	56	GUTSAR	1
HS-3.	42	BAHABS	5	HS-3.	56	SPOCRY	10
HS-3.	42	ERIWRI	5	HS-3.	57	BOUERI	15
HS-3.	42	LESQUE	15	HS-3.	57	GUTSAR	2
HS-3.	42	LESGOR	3	HS-3.	57	LESGOR	4
HS-3.	42	BOUGRA	1	HS-3.	57	BOUGRA	3
HS-3.	43	BOUERI	15	HS-3.	58	ERIPUL	8
HS-3.	43	ERIPUL	20	HS-3.	58	GUTSAR	10
HS-3.	44	BOUERI	10	HS-3.	58	UNID3	3
HS-3.	44	ERIPUL	2	HS-3.	58	SPOCRY	7
HS-3.	44	BAHABS	3	HS-3.	58	ENNDES	1
HS-3.	44	LARTRI	20	HS-3.	59	BOUERI	5
HS-3.	45	LARTRI	15	HS-3.	59	BOUGRA	10
HS-3.	45	UNID3	5	HS-3.	59	ENNDES	15
HS-3.	45	BOUGRA	10	HS-3.	60	ERIWRI	3
HS-3.	46	BOUERI	8	HS-3.	60	UNID3	3
HS-3.	46	LARTRI	60	HS-3.	60	BOUGRA	10
HS-3.	46	PANHAL	7	HS-3.	60	SOLANU	0.01
HS-3.	47	BOUERI	7	HS-3.	60	SPOCRY	3
HS-3.	48	BOUERI	50	HS-4.	61	BOUERI	7
HS-3.	48	PANHAL	2	HS-4.	61	BOUGRA	15
HS-3.	48	SOLANU	1	HS-4.	62	PANHAL	8
HS-3.	49	BOUERI	7	HS-4.	62	BOUGRA	7
HS-3.	49	BAHABS	15	HS-4.	62	SPOCRY	5
HS-3.	49	PANHAL	0.01	HS-4.	63	BOUERI	20
HS-3.	50	PANHAL	10	HS-4.	64	BOUERI	8
HS-3.	51	BAHABS	7	HS-4.	64	UNID3	0

Table D-2: Vegetation transect data

Transect	Quadrat	Acronym	% Cover
HS-4.	64	UNID4	2
HS-4.	64	SPOCRY	0.01
HS-4.	64	MUHTOR	15
HS-4.	64	SENLON	2
HS-4.	65	BOUERI	10
HS-4.	65	BOUGRA	8
HS-4.	65	SPOCRY	5
HS-4.	66	LESGOR	2
HS-4.	66	TRIPIL	2
HS-4.	66	BOUGRA	60
HS-4.	67	ERIPUL	1
HS-4.	67	TRIMUT	10
HS-4.	67	UNID2	3
HS-4.	67	SPOCRY	4
HS-4.	68	BOUERI	40
HS-4.	68	TRIPIL	7
HS-4.	68	SPOCRY	3
HS-4.	69	BOUERI	5
HS-4.	69	SPOCRY	15
HS-4.	69	SPHAERA	15
HS-4.	70	PANHAL	5
HS-4.	70	SOLANU	1
HS-4.	70	SPOCRY	25
HS-4.	71	BOUERI	7
HS-4.	71	GUTSAR	1
HS-4.	71	SPOCRY	10
HS-4.	71	SPHAERA	2
HS-4.	72	SPOCRY	7
HS-4.	72	MUHTOR	8
HS-4.	72	SPHAERA	2
HS-4.	72	UNID6	0.01
HS-4.	73	BOUERI	15
HS-4.	73	SPOCRY	15
HS-4.	74	BOUERI	8
HS-4.	74	TRIMUT	2
HS-4.	74	USTARD	3
HS-4.	74	SPOCRY	5
HS-4.	75	BOUERI	10
HS-4.	75	LESGOR	2
HS-4.	75	SPOCRY	25
HS-4.	76	BOUERI	3
HS-4.	76	GUTSAR	5
HS-4.	76	UNID4	0.01
HS-4.	76	TRIPIL	10
HS-4.	76	SPHAERA	2
HS-4.	77	UNID4	15
HS-4.	77	TRIPIL	5
HS-4.	77	SPOCRY	2
HS-4.	77	ARISTIDA	2
HS-4.	78	UNID4	5
HS-4.	78	TRIPIL	6
HS-4.	78	PANHAL	15
HS-4.	78	SPOCRY	5
HS-4.	79	BAHABS	5
HS-4.	79	UNID4	1
HS-4.	79	SPOCRY	12
HS-4.	79	ARISTIDA	5
HS-4.	80	TRIMUT	2
HS-4.	80	UNID4	0.01
HS-4.	80	PANHAL	2
HS-4.	80	SPOCRY	7
HS-4.	80	ARISTIDA	20
HS-4.	81	SPOCRY	10
HS-4.	81	ARISTIDA	35

Appendix E: Tables of EM survey data

Explanation of tabulated data

Location data: (X and Y)

-X and Y = Coordinate distances (east and north respectively).
-Distances in meters from southwest corner of survey area (Figure 3).

EM data: (V and H)

-Raw E-M values given in mS/s.
-V = vertical mode (1.5m depth)
-H = horizontal mode (0.75m depth)

Remarks (REM): Reference points along N-S transect lines across basin.

A – North end of transect
B – Mid-point on northern half of transect
C – Survey point north of drainage channel
D – Survey point south of drainage channel
E – Mid-point on southern half of transect
F – Southern end of transect
Axis – Hollow portion of headslope (roughly in line with central channel).

Note: points A,B,E and F marked by pin flags on ground surface

Vegetation (Veg.) Vegetation map units associated with survey points. Map units derived from Figure 4.

cg - Creosote grassland (co-dominance of creosote and grasses)
dcg - Dense creosote grassland (thick creosote bush cover)
gc - Grassland with sparse creosote bush
g - Grassland
bg - Blue grama grass and creosote bush (transitional between g and dcg)
jg - Juniper grassland

Landscape (LS): Landscape elements within study area.

-Units derive from Landscape map of study area (Figure 5).
-Units are based on landscape elements of Peterson (1981).
-Further distinction of map units is based on slope aspect.

SOLARFLUX (SF): Yearly average solar radiation values associated with each survey point.

-Values given in J/m^2.
-Values interpolated from SOLARFLUX 30 meter Pixel values (Figure 6).

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
0	0.00	4	3	F	dcg	ts	18146414
0	10.60	4	3	.	dcg	ts	18146414
0	21.20	3	2	.	dcg	ts	18146414
0	31.80	3	3	.	cg	ts	18146414
0	42.40	3	2	.	cg	ts	18146414
0	53.00	4	3	E	dcg	ts	18146414
0	61.00	4	3	.	cg	ts	18146414
0	69.00	4	4	.	cg	ts	18146414
0	77.00	4	4	.	cg	ts	18146414
0	85.00	3	2	.	dcg	ts	18850200
0	93.00	3	3	.	cg	ts	18850200
0	101.00	3	3	.	dcg	ts	18850200
0	109.00	3	2	.	cg	ts	18850200
0	117.00	2	2	.	cg	ts	18498308
0	125.00	3	3	.	cg	ts	18498308
0	133.00	2	2	B	cg	ts	18498308
0	141.29	2	2	.	cg	ts	18498308
0	149.57	3	2	.	cg	ts	18146414
0	157.86	3	3	.	cg	ts	18146414
0	166.14	3	3	.	cg	ts	18146414
0	174.43	2	2	.	cg	ts	17501106
0	182.71	2	2	.	cg	ts	17501106
0	191.00	2	2	A	cg	ts	17501106
10	0.00	4	3	F	cg	ts	18146414
10	8.83	4	4	.	cg	ts	18146414
10	17.67	3	2	.	cg	ts	18146414
10	26.50	4	3	.	cg	ts	18146414
10	35.33	2	2	.	cg	ts	18146414
10	44.17	3	2	.	cg	ts	18146414
10	53.00	3	3	E	cg	ts	18146414
10	61.89	3	3	.	cg	ts	18146414
10	70.78	4	2	.	cg	ts	18850200
10	79.67	3	2	.	dcg	hssh	18850200
10	88.56	3	2	.	dcg	hssh	18850200
10	97.44	2	2	.	dcg	hssh	18850200
10	106.33	2	2	.	cg	hssh	18498308
10	115.22	2	2	.	cg	hssh	18498308
10	124.11	3	2	.	cg	hssh	18498308
10	133.00	3	3	B	cg	ts	18498308
10	142.67	3	2	.	cg	ts	18146414
10	152.33	3	3	.	cg	ts	18146414
10	162.00	3	2	.	cg	ts	18146414
10	171.67	3	2	.	cg	ts	18146414
10	181.33	2	2	.	cg	ts	17501106

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
10	191.00	2	2	A	cg	ts	17501106
20	0.00	4	3	F	cg	ts	18146414
20	8.83	3	3	.	cg	ts	18146414
20	17.67	2	2	.	cg	ts	18146414
20	26.50	2	2	.	cg	ts	18146414
20	35.33	3	3	.	cg	hssh	18146414
20	44.17	3	3	.	cg	hssh	18146414
20	53.00	4	3	E	cg	hssh	18498308
20	61.89	3	3	.	cg	hssh	18498308
20	70.78	4	3	.	cg	hssh	18498308
20	79.67	3	2	.	cg	hssh	18498308
20	88.56	3	3	.	cg	hssh	19553987
20	97.44	3	3	.	cg	hssh	19553987
20	106.33	3	3	.	cg	hssh	19553987
20	115.22	1	2	.	dcg	hssh	19553987
20	124.11	2	3	.	dcg	hssh	19553987
20	133.00	3	2	B	dcg	hssh	19553987
20	142.67	3	3	.	dcg	hssh	19553987
20	152.33	2	1	.	dcg	hssh	18498308
20	162.00	3	2	.	dcg	ts	18498308
20	171.67	3	3	.	dcg	ts	18498308
20	181.33	3	3	.	dcg	ts	17823760
20	191.00	2	2	A	dcg	ts	17823760
30	0.00	2	2	F	dcg	ts	18146414
30	8.83	2	2	.	dcg	ts	18146414
30	17.67	3	3	.	dcg	ts	18146414
30	26.50	2	3	.	cg	hssh	18146414
30	35.33	3	3	.	cg	hssh	18146414
30	44.17	2	3	.	cg	hssh	18498308
30	53.00	2	2	E	cg	hssh	18498308
30	61.89	3	3	.	g	hsn	18498308
30	70.78	3	2	.	g	hsn	18498308
30	79.67	2	2	.	g	hsn	19553987
30	88.56	2	2	.	g	hsn	19553987
30	97.44	2	2	axis	cg	hsn	19553987
30	106.33	3	2	.	cg	hsn	19553987
30	115.22	2	2	.	dcg	hssh	19553987
30	124.11	2	2	.	dcg	hssh	19553987
30	133.00	2	2	B	dcg	hssh	19553987
30	141.29	2	2	.	dcg	hssh	19553987
30	149.57	2	2	.	dcg	hssh	18498308
30	157.86	3	2	.	dcg	ts	18498308
30	166.14	3	2	.	dcg	ts	18498308
30	174.43	5	4	.	cg	ts	17823760

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
30	182.71	4	3	A	cg	ts	17823760
40	0.00	2	3	F	dcg	ts	18146414
40	8.83	2	3	.	dcg	ts	18146414
40	17.67	3	3	.	dcg	ts	18146414
40	26.50	2	3	.	cg	hssh	18146414
40	35.33	2	3	.	cg	hssh	18146414
40	44.17	4	4	.	cg	hssh	18146414
40	53.00	3	3	E	cg	hsn	18498308
40	61.89	3	3	.	g	hsn	18498308
40	70.78	3	3	.	g	hsn	18498308
40	79.67	3	3	.	g	hsn	18498308
40	88.56	3	2	.	g	hsn	19553987
40	97.44	3	4	.	bg	hsa	19553987
40	106.33	3	3	axis	bg	hsa	19553987
40	115.22	2	3	.	cg	hss	19553987
40	124.11	3	3	.	dcg	hss	19553987
40	133.00	2	2	B	dcg	hss	19553987
40	141.29	2	3	.	dcg	hss	19553987
40	149.57	2	3	.	dcg	hss	18498308
40	157.86	2	2	.	dcg	hssh	18498308
40	166.14	3	2	.	dcg	hssh	18498308
40	174.43	3	3	.	cg	ts	17823760
40	182.71	4	4	A	cg	ts	17823760
50	0.00	3	3	F	cg	ts	17501106
50	8.83	3	3	.	cg	ts	17501106
50	17.67	3	4	.	cg	hssh	17501106
50	26.50	3	3	.	cg	hssh	17501106
50	35.33	2	2	.	cg	hssh	17823760
50	44.17	2	2	.	cg	hssh	17823760
50	53.00	3	5	E	g	hsn	17823760
50	61.89	2	3	.	g	hsn	18498308
50	70.78	4	3	.	g	hsn	18498308
50	79.67	2	4	.	g	hsn	18498308
50	88.56	3	3	.	bg	hsa	19905882
50	97.44	3	4	axis	bg	hsa	19905882
50	106.33	2	4	.	dcg	hsa	19905882
50	115.22	3	2	.	dcg	hss	19905882
50	124.11	3	3	.	dcg	hss	19905882
50	133.00	3	3	B	dcg	hss	19905882
50	144.60	3	3	.	dcg	hss	19202093
50	156.20	3	3	.	dcg	hssh	19202093
50	167.80	2	3	.	dcg	hssh	19202093
50	179.40	3	3	.	cg	ts	18146414
50	191.00	4	4	A	cg	ts	18146414

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
60	0.00	2	2	F	cg	ts	17501106
60	7.57	2	3	.	cg	ts	17501106
60	15.14	1	2	.	cg	hssh	17501106
60	22.71	2	2	.	gc	hssh	17501106
60	30.29	2	2	.	gc	hssh	17823760
60	37.86	1	2	.	gc	hsn	17823760
60	45.43	1	1	.	gc	hsn	17823760
60	53.00	2	2	E	g	hsn	17823760
60	61.00	2	2	.	g	hsn	18498308
60	69.00	2	3	.	g	hsn	18498308
60	77.00	3	3	.	g	hsn	18498308
60	85.00	3	2	.	g	hsn	19905882
60	93.00	3	3	.	bg	hsa	19905882
60	101.00	3	3	axis	bg	hsa	19905882
60	109.00	2	2	.	dcg	hss	19905882
60	117.00	2	2	.	dcg	hss	19905882
60	125.00	2	2	.	dcg	hss	19905882
60	133.00	2	2	B	dcg	hss	19905882
60	142.67	2	1	.	dcg	hss	19905882
60	152.33	2	2	.	dcg	hssh	19202093
60	162.00	2	2	.	dcg	hssh	19202093
60	171.67	2	2	.	dcg	hssh	19202093
60	181.33	2	2	.	cg	ts	18146414
60	191.00	4	3	A	cg	ts	18146414
70	0.00	2	2	F	cg	ts	17501106
70	7.57	2	2	.	cg	shn	17501106
70	15.14	1	2	.	cg	shn	17501106
70	22.71	2	2	.	gc	shn	17501106
70	30.29	1	1	.	gc	ssn	17823760
70	37.86	0	2	.	jg	ssn	17823760
70	45.43	0	1	.	jg	ssn	17823760
70	53.00	1	1	E	jg	ssn	17823760
70	61.00	1	1	.	jg	ssn	18498308
70	69.00	2	2	.	g	ssn	18498308
70	77.00	3	2	.	g	hsf	18498308
70	85.00	2	3	.	g	hsf	18498308
70	93.00	4	3	axis	cg	hsf	19905882
70	101.00	2	2	.	cg	hsf	19905882
70	109.00	2	2	.	cg	hsf	19905882
70	117.00	2	2	.	cg	hsf	19905882
70	125.00	2	2	.	cg	hss	19905882
70	133.00	2	1	B	cg	hss	19905882
70	142.67	1	2	.	cg	hss	19905882
70	152.33	2	2	.	cg	hss	19202093

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
70	162.00	2	2	.	cg	hssh	19202093
70	171.67	2	2	.	cg	hssh	19202093
70	181.33	1	2	.	cg	ts	18146414
70	191.00	4	4	A	cg	ts	18146414
80	0.00	5	4	F	cg	ts	18146414
80	7.57	5	5	.	gc	ts	17501106
80	15.14	4	4	.	gc	shn	17501106
80	22.71	4	4	.	gc	shn	17501106
80	30.29	4	5	.	jg	ssn	17501106
80	37.86	4	4	.	jg	ssn	17501106
80	45.43	4	4	.	jg	ssn	17501106
80	53.00	4	5	E	jg	ssn	17501106
80	59.67	5	5	.	jg	ssn	17501106
80	66.33	5	5	.	g	ssn	18498308
80	73.00	5	5	.	g	hsf	18498308
80	79.67	6	4	.	g	hsf	18498308
80	86.33	4	5	.	g	hsf	18498308
80	93.00	3	5	D	cg	hsf	19905882
80	99.67	5	4	C	cg	hsf	19905882
80	106.33	4	5	.	cg	hsf	19905882
80	113.00	4	4	.	cg	hsf	19905882
80	119.67	3	4	.	cg	hss	20158734
80	126.33	3	4	.	cg	hss	20158734
80	133.00	3	4	B	cg	sss	20158734
80	144.60	3	4	.	cg	sss	19202093
80	156.20	4	4	.	cg	sss	19202093
80	167.80	4	4	.	cg	shs	19202093
80	179.40	3	3	.	cg	shs	18146414
80	191.00	5	5	A	cg	ts	18146414
90	0.00	4	5	F	cg	ts	18146414
90	7.57	4	4	.	cg	shn	17501106
90	15.14	5	5	.	gc	shn	17501106
90	22.71	3	4	.	gc	ssn	17501106
90	30.29	5	4	.	gc	ssn	17501106
90	37.86	5	4	.	jg	ssn	17501106
90	45.43	4	5	.	jg	ssn	17501106
90	53.00	5	5	E	jg	ssn	17501106
90	60.27	4	5	.	jg	ssn	18498308
90	67.55	6	6	.	jg	ssn	18498308
90	74.82	5	4	.	jg	ssn	18498308
90	82.09	5	5	D	jg	fsn	18498308
90	89.36	5	5	C	cg	fss	19905882
90	96.64	4	4	.	cg	sss	19905882
90	103.91	5	4	.	cg	sss	19905882

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
90	111.18	6	5	.	cg	sss	19905882
90	118.45	4	4	.	cg	sss	19905882
90	125.73	4	4	.	cg	sss	20158734
90	133.00	4	4	B	cg	sss	20158734
90	142.67	3	4	.	cg	sss	20158734
90	152.33	3	4	.	cg	sss	19202093
90	162.00	4	4	.	cg	shs	19202093
90	171.67	4	4	.	cg	shs	19202093
90	181.33	5	3	.	cg	shs	19202093
90	191.00	4	4	A	cg	ts	18146414
100	0.00	5	5	F	cg	ts	18146414
100	7.57	4	5	.	cg	shn	18146414
100	15.14	5	5	.	gc	shn	17501106
100	22.71	5	5	.	gc	shn	17501106
100	30.29	6	5	.	gc	ssn	17501106
100	37.86	6	6	.	gc	ssn	17501106
100	45.43	5	5	.	gc	ssn	17501106
100	53.00	6	6	E	jg	ssn	17501106
100	59.67	6	6	.	jg	ssn	18498308
100	66.33	5	5	.	jg	ssn	18498308
100	73.00	5	5	.	jg	fsn	18498308
100	79.67	6	6	D	jg	fss	18498308
100	86.33	5	5	C	gc	sss	18498308
100	93.00	4	4	.	cg	sss	19905882
100	99.67	5	5	.	cg	sss	19905882
100	106.33	7	6	.	cg	sss	19905882
100	113.00	4	3	.	cg	sss	19905882
100	119.67	4	4	.	cg	sss	20158734
100	126.33	4	4	.	cg	sss	20158734
100	133.00	4	4	B	cg	sss	20158734
100	142.67	3	3	.	cg	sss	20158734
100	152.33	4	4	.	cg	sss	19202093
100	162.00	5	4	.	cg	sss	19202093
100	171.67	5	5	.	cg	sss	19202093
100	181.33	5	4	.	cg	shs	19202093
100	191.00	5	4	A	cg	shs	18146414
110	0.00	5	4	F	cg	ts	18146414
110	6.63	4	5	.	gc	shn	17180386
110	13.25	5	5	.	gc	shn	17180386
110	19.88	5	5	.	gc	ssn	17180386
110	26.50	5	6	.	gc	ssn	17180386
110	33.13	5	5	.	gc	ssn	17501106
110	39.75	6	6	.	jg	ssn	17501106
110	46.38	5	5	E	jg	ssn	17501106

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
110	60.27	5	5	.	jg	ssn	17501106
110	67.55	6	5	.	jg	ssn	19202093
110	74.82	5	5	.	jg	ssn	19202093
110	82.09	7	7	D	jg	fsn	19202093
110	89.36	5	5	C	jg	fss	19202093
110	96.64	5	5	.	cg	sss	20696674
110	103.91	6	5	.	cg	sss	20696674
110	111.18	6	5	.	cg	sss	20696674
110	118.45	4	4	.	cg	sss	20696674
110	125.73	4	4	.	cg	sss	21034796
110	133.00	5	4	B	cg	sss	21034796
110	142.67	4	4	.	cg	sss	21034796
110	152.33	5	4	.	cg	sss	19905882
110	162.00	5	4	.	cg	sss	19905882
110	171.67	6	6	.	cg	shs	19905882
110	181.33	6	6	.	cg	shs	18850200
110	191.00	6	5	A	cg	shs	18850200
120	0.00	4	3	F	cg	ts	18146414
120	7.57	3	4	.	gc	shn	17180386
120	15.14	4	4	.	gc	shn	17180386
120	22.71	4	4	.	gc	shn	17180386
120	30.29	5	5	.	gc	ssn	17180386
120	37.86	4	3	.	gc	ssn	17501106
120	45.43	4	4	.	jg	ssn	17501106
120	53.00	4	4	E	jg	ssn	17501106
120	60.27	4	3	.	jg	ssn	17501106
120	67.55	3	4	.	jg	ssn	19202093
120	74.82	5	5	.	jg	ssn	19202093
120	82.09	6	5	D	jg	fsn	19202093
120	89.36	4	5	C	cg	fss	19202093
120	96.64	4	4	.	cg	sss	20696674
120	103.91	4	2	.	cg	sss	20696674
120	111.18	4	4	.	cg	sss	20696674
120	118.45	4	3	.	cg	sss	20696674
120	125.73	3	3	.	cg	sss	21034796
120	133.00	3	4	B	cg	sss	21034796
120	142.67	3	3	.	cg	sss	21034796
120	152.33	3	3	.	cg	sss	19905882
120	162.00	4	4	.	cg	shs	19905882
120	171.67	5	5	.	cg	shs	19905882
120	181.33	4	4	.	cg	shs	18850200
120	191.00	4	4	A	cg	ts	18850200
130	0.00	5	4	F	cg	ts	18146414
130	6.63	3	3	.	gc	shn	18146414

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
130	13.25	4	4	.	gc	shn	17180386
130	19.88	4	4	.	gc	ssn	17180386
130	26.50	3	4	.	jg	ssn	17180386
130	33.13	4	4	.	jg	ssn	17180386
130	39.75	4	4	.	jg	ssn	17501106
130	46.38	5	4	.	jg	ssn	17501106
130	53.00	4	4	E	jg	ssn	17501106
130	60.27	4	3	.	jg	ssn	19202093
130	67.55	4	3	.	jg	ssn	19202093
130	74.82	6	5	.	jg	fsn	19202093
130	82.09	6	5	D	cg	fsn	19202093
130	89.36	5	4	C	cg	fss	20696674
130	96.64	4	4	.	cg	sss	20696674
130	103.91	4	4	.	cg	sss	20696674
130	111.18	5	5	.	cg	sss	20696674
130	118.45	4	3	.	cg	sss	21034796
130	125.73	3	3	.	cg	sss	21034796
130	133.00	4	3	B	cg	sss	21034796
130	144.60	3	3	.	cg	sss	21034796
130	156.20	4	3	.	cg	shs	19905882
130	167.80	4	3	.	cg	shs	19905882
130	179.40	3	3	.	cg	ts	19905882
130	191.00	5	4	A	cg	ts	18850200
140	0.00	2	4	F	cg	ts	18146414
140	6.63	3	4	.	cg	shn	18146414
140	13.25	2	4	.	gc	shn	17180386
140	19.88	2	4	.	gc	ssn	17180386
140	26.50	3	4	.	gc	ssn	17180386
140	33.13	2	4	.	jg	ssn	17180386
140	39.75	3	4	.	jg	ssn	17823760
140	46.38	2	4	E	jg	ssn	17823760
140	53.00	2	5	.	jg	ssn	17823760
140	59.67	3	4	.	jg	ssn	17823760
140	66.33	4	4	.	jg	ssn	19553987
140	73.00	4	5	.	jg	fsn	19553987
140	79.67	3	6	D	jg	fsn	19553987
140	86.33	4	4	C	cg	fss	19553987
140	93.00	3	5	.	cg	fss	21034796
140	99.67	2	5	.	cg	sss	21034796
140	106.33	1	6	.	cg	sss	21034796
140	113.00	3	3	.	cg	sss	21034796
140	119.67	1	4	.	cg	sss	21034796
140	126.33	1	4	.	cg	sss	21034796
140	133.00	1	4	B	cg	sss	21034796

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
140	144.60	1	4	.	cg	sss	21034796
140	156.20	2	3	.	cg	sss	19905882
140	167.80	3	4	.	cg	shs	19905882
140	179.40	2	4	.	cg	shs	19905882
140	191.00	4	5	A	cg	ts	19553987
150	0.00	1	5	F	cg	shn	18146414
150	6.63	2	5	.	cg	shn	18146414
150	13.25	2	4	.	cg	shn	17180386
150	19.88	1	4	.	gc	ssn	17180386
150	26.50	1	5	.	gc	ssn	17180386
150	33.13	0	5	.	gc	ssn	17180386
150	39.75	2	4	.	jg	ssn	17823760
150	46.38	4	4	.	jg	ssn	17823760
150	53.00	2	4	E	jg	ssn	17823760
150	60.27	2	5	.	jg	ssn	17823760
150	67.55	4	4	.	jg	ssn	17823760
150	74.82	5	7	D	jg	fsn	19553987
150	82.09	4	5	C	jg	fss	19553987
150	89.36	1	5	.	cg	sss	19553987
150	96.64	3	4	.	cg	sss	21034796
150	103.91	2	4	.	cg	sss	21034796
150	111.18	2	4	.	cg	sss	21034796
150	118.45	1	4	.	cg	sss	21034796
150	125.73	1	3	.	cg	sss	21034796
150	133.00	1	4	B	cg	sss	21034796
150	142.67	1	4	.	cg	sss	21034796
150	152.33	1	4	.	cg	sss	21034796
150	162.00	3	3	.	cg	shs	19905882
150	171.67	2	5	.	cg	shs	19905882
150	181.33	3	4	.	cg	ts	19905882
150	191.00	3	4	A	cg	ts	19553987
160	0.00	4	4	F	cg	shn	18146414
160	10.60	4	3	.	gc	shn	18146414
160	21.20	3	4	.	gc	shn	17180386
160	31.80	4	4	.	jg	ssn	17180386
160	42.40	3	4	.	jg	ssn	17823760
160	53.00	5	5	E	jg	ssn	17823760
160	59.15	2	4	.	jg	ssn	17823760
160	65.31	3	3	.	jg	ssn	19553987
160	71.46	4	4	.	jg	fsn	19553987
160	77.62	4	5	D	jg	fsn	19553987
160	83.77	8	7	C	cg	fss	19553987
160	89.92	6	7	.	cg	fss	21034796
160	96.08	2	5	.	cg	sss	21034796

Table E-1: June 24, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
160	102.23	3	4	.	cg	sss	21034796
160	108.38	2	4	.	cg	sss	21034796
160	114.54	1	5	.	cg	sss	21034796
160	120.69	1	5	.	cg	sss	21034796
160	126.35	2	4	.	cg	sss	21034796
160	133.00	2	4	B	cg	sss	21034796
160	144.60	2	4	.	cg	sss	21034796
160	156.20	2	4	.	cg	shs	19905882
160	167.80	3	4	.	cg	shs	19905882
160	179.40	3	4	.	cg	shs	19905882
160	191.00	2	4	A	cg	ts	19553987
170	0.00	2	4	F	cg	shn	18146414
170	8.83	4	4	.	cg	shn	18146414
170	17.67	3	4	.	gc	shn	17501106
170	26.50	3	5	.	gc	ssn	17501106
170	35.33	2	7	.	gc	ssn	17501106
170	44.17	4	4	.	jg	ssn	17501106
170	53.00	2	5	E	jg	ssn	18146414
170	60.27	3	4	.	jg	ssn	18146414
170	67.55	3	6	.	jg	fsn	18146414
170	74.82	6	5	D	jg	fsn	19905882
170	82.09	7	5	C	cg	fss	19905882
170	89.36	4	4	.	cg	sss	19905882
170	96.64	3	4	.	cg	sss	19905882
170	103.91	3	3	.	cg	sss	21034796
170	111.18	4	4	.	cg	sss	21034796
170	118.45	3	4	.	cg	sss	21034796
170	125.73	1	3	.	cg	sss	21034796
170	133.00	2	3	B	cg	sss	21034796
170	144.60	1	3	.	cg	sss	21034796
170	156.20	1	3	.	cg	sss	19905882
170	167.80	1	2	.	cg	shs	19905882
170	179.40	2	3	.	cg	shs	19905882
170	191.00	2	2	A	cg	ts	19553987

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
0	0.00	7	9	F	dcg	ts	18146414
0	10.60	7	9	.	dcg	ts	18146414
0	21.20	3	11	.	dcg	ts	18146414
0	31.80	6	9	.	dcg	ts	18146414
0	42.40	8	12	.	dcg	ts	18146414
0	53.00	7	8	E	dcg	ts	18146414
0	61.89	8	9	.	dcg	ts	18146414
0	70.78	8	10	.	dcg	ts	18146414
0	79.67	7	8	.	dcg	ts	18146414
0	88.56	7	10	.	dcg	ts	18850200
0	97.44	7	9	.	gc	ts	18850200
0	106.33	6	8	.	gc	ts	18850200
0	115.22	6	8	.	gc	ts	18850200
0	124.11	6	9	.	gc	ts	18498308
0	133.00	5	8	B	gc	ts	18498308
0	144.60	7	9	.	gc	ts	18498308
0	156.20	6	9	.	gc	ts	18146414
0	167.80	7	9	.	gc	ts	18146414
0	179.40	5	9	.	cg	ts	18146414
0	191.00	7	8	A	cg	ts	17501106
10	0.00	6	7	F	dcg	ts	18146414
10	10.60	9	10	.	dcg	ts	18146414
10	21.20	6	9	.	dcg	ts	18146414
10	31.80	6	8	.	dcg	ts	18146414
10	42.40	6	9	.	gc	ts	18146414
10	53.00	7	10	E	gc	ts	18146414
10	61.89	7	9	.	gc	ts	18146414
10	70.78	9	11	.	gc	ts	18146414
10	79.67	5	9	.	gc	hssh	18146414
10	88.56	6	6	.	gc	hssh	18850200
10	97.44	6	9	.	gc	hssh	18850200
10	106.33	1	10	.	dcg	hssh	18850200
10	115.22	5	8	.	dcg	hssh	18850200
10	124.11	6	9	.	dcg	hssh	18498308
10	133.00	5	8	B	dcg	ts	18498308
10	144.60	6	7	.	dcg	ts	18146414
10	156.20	5	7	.	dcg	ts	18146414
10	167.80	5	8	.	dcg	ts	18146414
10	179.40	5	7	.	dcg	ts	17501106
10	191.00	2	6	A	dcg	ts	17501106
20	0.00	6	7	F	dcg	ts	18146414
20	10.60	6	8	.	dcg	ts	18146414
20	21.20	6	8	.	dcg	ts	18146414
20	31.80	6	8	.	dcg	hssh	18146414

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
20	42.40	6	10	.	gc	hssh	18146414
20	53.00	6	10	E	gc	hssh	18146414
20	61.89	6	9	.	gc	hssh	18498308
20	70.78	8	11	.	gc	hssh	18498308
20	79.67	7	9	.	gc	hssh	18498308
20	88.56	7	9	.	gc	hssh	19553987
20	97.44	7	10	.	gc	hssh	19553987
20	106.33	7	9	.	bg	hssh	19553987
20	115.22	5	8	.	bg	hssh	19553987
20	124.11	4	7	.	dcg	hssh	19553987
20	133.00	6	8	B	dcg	hssh	19553987
20	144.60	5	8	.	dcg	hssh	19553987
20	156.20	5	7	.	dcg	ts	18498308
20	167.80	5	7	.	dcg	ts	18498308
20	179.40	4	8	.	dcg	ts	18498308
20	191.00	5	9	A	dcg	ts	17823760
30	0.00	5	7	F	dcg	ts	18146414
30	10.60	5	8	.	dcg	ts	18146414
30	21.20	6	10	.	dcg	ts	18146414
30	31.80	7	10	.	gc	hssh	18146414
30	42.40	8	10	.	gc	hssh	18146414
30	53.00	4	9	E	gc	hssh	18146414
30	61.89	6	10	.	gc	hssh	18498308
30	70.78	8	11	.	g	hsn	18498308
30	79.67	5	9	.	g	hsn	18498308
30	88.56	6	11	.	g	hsn	18498308
30	97.44	6	8	.	gc	hsn	19553987
30	106.33	6	8	.	gc	hsn	19553987
30	115.22	5	8	.	dcg	hssh	19553987
30	124.11	5	8	.	dcg	hssh	19553987
30	133.00	6	8	B	dcg	hssh	19553987
30	144.60	5	7	.	dcg	hssh	19553987
30	156.20	6	7	.	dcg	ts	18498308
30	167.80	5	7	.	dcg	ts	18498308
30	179.40	7	8	.	dcg	ts	18498308
30	191.00	6	8	A	dcg	ts	17823760
40	0.00	5	6	F	dcg	ts	18146414
40	8.83	5	8	.	dcg	ts	18146414
40	17.67	5	9	.	dcg	hssh	18146414
40	26.50	6	9	.	gc	hssh	18146414
40	44.17	7	11	.	g	hsn	18146414
40	53.00	6	10	E	g	hsn	18146414
40	61.00	5	12	.	g	hsn	18498308
40	69.00	7	10	.	g	hsn	18498308

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
40	77.00	8	11	.	g	hsn	18498308
40	85.00	6	10	.	g	hsn	18498308
40	93.00	8	11	.	g	hsa	19553987
40	101.00	7	10	axis	bg	hsa	19553987
40	109.00	7	10	.	bg	hsa	19553987
40	117.00	6	8	.	dcg	hss	19553987
40	125.00	6	8	.	dcg	hss	19553987
40	133.00	5	7	B	dcg	hss	19553987
40	141.29	6	7	.	dcg	hss	19553987
40	149.57	5	7	.	dcg	hssh	18498308
40	174.43	4	7	.	dcg	hssh	18498308
40	182.71	6	8	.	dcg	ts	18498308
40	191.00	5	10	A	dcg	ts	17823760
50	0.00	4	6	F	dcg	ts	17501106
50	8.83	5	8	.	dcg	ts	17501106
50	26.50	5	8	.	gc	hssh	17501106
50	35.33	6	10	.	gc	hssh	17501106
50	44.17	7	10	.	gc	hssh	17823760
50	53.00	5	9	E	g	hsn	17823760
50	61.00	6	10	.	g	hsn	18498308
50	69.00	7	10	.	g	hsn	18498308
50	77.00	6	11	.	g	hsn	18498308
50	85.00	7	10	.	g	hsa	18498308
50	93.00	8	10	axis	bg	hsa	19905882
50	101.00	8	10	.	bg	hsa	19905882
50	109.00	6	8	.	dcg	hss	19905882
50	117.00	6	8	.	dcg	hss	19905882
50	125.00	5	7	.	dcg	hss	19905882
50	133.00	3	5	B	dcg	hss	19905882
50	144.60	5	7	.	dcg	hssh	19905882
50	156.20	4	7	.	dcg	hssh	19202093
50	167.80	5	5	.	dcg	ts	19202093
50	179.40	5	7	.	dcg	ts	19202093
50	191.00	6	7	A	dcg	ts	18146414
60	0.00	5	9	F	dcg	ts	17501106
60	7.57	6	9	.	dcg	ts	17501106
60	15.14	5	9	.	gc	ts	17501106
60	22.71	5	11	.	gc	hssh	17501106
60	30.29	5	10	.	gc	hssh	17823760
60	37.86	4	8	.	jg	hsn	17823760
60	45.43	4	7	E	jg	hsn	17823760
60	61.00	6	6	.	g	hsn	18498308
60	69.00	5	10	.	g	hsn	18498308
60	77.00	8	12	.	g	hsn	18498308

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
60	85.00	9	12	.	g	hsa	18498308
60	93.00	8	10	axis	bg	hsa	19905882
60	101.00	8	13	.	bg	hsa	19905882
60	109.00	6	8	.	dcg	hss	19905882
60	117.00	6	8	.	dcg	hss	19905882
60	125.00	6	7	.	dcg	hss	19905882
60	133.00	6	7	B	dcg	hss	19905882
60	140.25	5	7	.	cg	hss	19905882
60	147.50	5	6	.	cg	hssh	19905882
60	154.75	5	7	.	cg	hssh	19202093
60	162.00	4	6	.	cg	Hssh	19202093
60	169.25	4	7	.	dcg	ts	18146414
60	176.50	7	7	A	dcg	ts	18146414
70	0.00	6	9	F	cg	ts	17501106
70	8.83	5	9	.	cg	shn	17501106
70	17.67	5	8	.	cg	shn	17501106
70	26.50	5	8		jg	ssn	17501106
70	35.33	4	7	.	jg	ssn	17823760
70	44.17	5	7	.	jg	ssn	17823760
70	53.00	6	8	E	jg	ssn	17823760
70	60.27	5	7	.	gc	ssn	18498308
70	67.55	6	8	.	gc	ssn	18498308
70	74.82	8	13	.	g	hsf	18498308
70	82.09	7	11	.	g	hsf	18498308
70	89.36	7	11	.	g	hsf	18498308
70	96.64	5	5	.	cg	hsf	19905882
70	103.91	6	8	.	cg	hsf	19905882
70	111.18	4	8	.	cg	hsf	19905882
70	118.45	5	8	.	cg	hsf	19905882
70	125.73	6	7	.	cg	hss	19905882
70	133.00	5	7	B	cg	hss	19905882
70	144.60	6	10	.	cg	hss	19905882
70	156.20	5	7	.	cg	hss	19202093
70	167.80	5	6	.	cg	hssh	19202093
70	179.40	3	7	.	cg	hssh	19202093
70	191.00	5	7	A	dcg	ts	18146414
80	0.00	6	9	F	dcg	ts	18146414
80	7.57	5	8	.	dcg	ts	17501106
80	15.14	6	9	.	gc	shn	17501106
80	22.71	6	9	.	gc	ssn	17501106
80	30.29	4	7	.	gc	ssn	17501106
80	37.86	7	9	.	gc	ssn	17501106
80	45.43	7	10	.	gc	ssn	17501106
80	53.00	5	8	E	jg	ssn	17501106

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
80	61.00	6	8	.	jg	ssn	17501106
80	69.00	7	9	.	jg	ssn	18498308
80	77.00	6	11	.	g	hsf	18498308
80	85.00	5	11	.	g	hsf	18498308
80	93.00	5	8	D	g	hsf	18498308
80	101.00	9	9	C	cg	hsf	19905882
80	109.00	6	8	.	cg	hsf	19905882
80	117.00	3	8	.	cg	hss	19905882
80	125.00	5	6	.	cg	hss	20158734
80	133.00	5	7	.	cg	hss	20158734
80	144.60	5	7	.	cg	sss	20158734
80	156.20	5	7	.	cg	sss	19202093
80	167.80	4	8	.	cg	shs	19202093
80	179.40	5	7	.	dcg	shs	19202093
80	191.00	5	7	A	dcg	ts	18146414
90	0.00	6	9	F	dcg	ts	18146414
90	8.83	5	10	.	dcg	shn	17501106
90	17.67	7	4	.	gc	shn	17501106
90	26.50	4	9	.	gc	ssn	17501106
90	35.33	5	8	.	jg	ssn	17501106
90	44.17	6	8	.	jg	ssn	17501106
90	53.00	5	8	E	jg	ssn	17501106
90	60.27	4	8	.	jg	ssn	17501106
90	67.55	6	9	.	jg	ssn	18498308
90	74.82	6	8	.	jg	ssn	18498308
90	82.09	6	11	D	jg	fsn	18498308
90	89.36	6	8	C	cg	fss	18498308
90	96.64	7	7	.	cg	sss	19905882
90	103.91	6	8	.	cg	sss	19905882
90	111.18	9	9	.	cg	sss	19905882
90	118.45	5	7	.	cg	sss	19905882
90	125.73	6	8	.	cg	sss	20158734
90	133.00	4	8	B	cg	sss	20158734
90	142.67	5	8	.	cg	sss	20158734
90	152.33	4	9	.	cg	sss	19202093
90	162.00	5	8	.	cg	shs	19202093
90	171.67	6	8	.	cg	shs	19202093
90	181.33	6	8	.	dcg	shs	19202093
90	191.00	5	8	A	dcg	ts	18146414
100	0.00	5	8	F	dcg	ts	18146414
100	7.57	5	8	.	gc	shn	17501106
100	15.14	5	8	.	gc	shn	17501106
100	22.71	5	8	.	gc	shn	17501106
100	30.29	5	8	.	jg	ssn	17501106

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
100	37.86	6	9	.	jg	ssn	17501106
100	45.43	5	8	.	jg	ssn	17501106
100	53.00	6	8	E	jg	ssn	17501106
100	59.67	6	9	.	jg	ssn	17501106
100	66.33	5	8	.	jg	ssn	18498308
100	73.00	6	9	.	jg	ssn	18498308
100	79.67	6	10	.	jg	fsn	18498308
100	86.33	5	8	D	jg	fss	18498308
100	93.00	4	7	C	cg	sss	18498308
100	99.67	8	8	.	cg	sss	19905882
100	106.33	7	8	.	cg	sss	19905882
100	113.00	5	7	.	cg	sss	19905882
100	119.67	5	7	.	cg	sss	19905882
100	126.33	4	8	.	cg	sss	20158734
100	133.00	5	8	B	cg	sss	20158734
100	142.67	5	7	.	cg	sss	20158734
100	152.33	5	7	.	cg	sss	19202093
100	162.00	5	7	.	cg	sss	19202093
100	171.67	7	9	.	cg	shs	19202093
100	181.33	6	8	A	cg	shs	18146414
110	0.00	3	8	F	dcg	ts	18146414
110	8.83	3	9	.	gc	shn	17180386
110	17.67	5	9	.	gc	shn	17180386
110	26.50	4	9	.	jg	ssn	17180386
110	35.33	6	9	.	jg	ssn	17501106
110	44.17	6	88	.	jg	ssn	17501106
110	53.00	5	7	E	jg	ssn	17501106
110	59.67	4	8	.	jg	ssn	17501106
110	66.33	5	9	.	jg	ssn	19202093
110	73.00	4	7	.	jg	ssn	19202093
110	79.67	7	11	D	jg	fsn	19202093
110	86.33	5	9	C	cg	fss	19202093
110	93.00	3	10	.	cg	sss	20696674
110	99.67	6	8	.	cg	sss	20696674
110	106.33	8	11	.	cg	sss	20696674
110	113.00	5	7	.	cg	sss	20696674
110	119.67	4	7	.	cg	sss	20696674
110	126.33	3	8	.	cg	sss	21034796
110	133.00	4	7	B	cg	sss	21034796
110	142.67	3	6	.	cg	sss	21034796
110	152.33	4	7	.	cg	sss	21034796
110	162.00	4	7	.	cg	sss	19905882
110	171.67	5	7	.	cg	shs	19905882
110	181.33	6	7	.	cg	shs	18850200

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
110	191.00	4	7	A	cg	shs	18850200
120	0.00	2	4	F	cg	ts	18146414
120	6.63	1	3	.	cg	shn	17180386
120	13.25	3	5	.	gc	shn	17180386
120	19.88	3	5	.	gc	shn	17180386
120	26.50	3	6	.	gc	ssn	17180386
120	33.13	2	4	.	jg	ssn	17501106
120	39.75	2	5	.	jg	ssn	17501106
120	46.38	3	6	E	jg	ssn	17501106
120	59.67	2	5	.	jg	ssn	17501106
120	66.33	2	6	.	jg	ssn	19202093
120	73.00	3	6	.	jg	ssn	19202093
120	79.67	6	8	.	jg	fsn	19202093
120	86.33	5	6	D	jg	fsn	19202093
120	93.00	3	6	C	cg	fss	19202093
120	99.67	2	6	.	cg	fss	20696674
120	106.33	3	5	.	cg	sss	20696674
120	113.00	3	5	.	cg	sss	20696674
120	119.67	3	4	.	cg	sss	20696674
120	126.33	2	4	.	cg	sss	21034796
120	133.00	3	4	B	cg	sss	21034796
120	141.29	1	5	.	cg	sss	21034796
120	149.57	3	4	.	cg	shs	19905882
120	157.86	3	5	.	cg	shs	19905882
120	166.14	3	4	.	cg	shs	18850200
120	174.43	2	3	A	cg	ts	18850200
130	0.00	2	2	F	cg	ts	18146414
130	8.83	2	2	.	gc	shn	17180386
130	17.67	1	1	.	gc	shn	17180386
130	26.50	2	2	.	jg	ssn	17180386
130	35.33	3	3	.	jg	ssn	17501106
130	44.17	2	2	.	jg	ssn	17501106
130	53.00	3	3	E	jg	ssn	17501106
130	60.27	3	3	.	jg	ssn	17501106
130	67.55	2	2	.	jg	ssn	19202093
130	74.82	3	3	.	jg	fsn	19202093
130	82.09	5	5	D	jg	fsn	19202093
130	89.36	4	4	C	cg	fss	20696674
130	96.64	2	2	.	cg	fss	20696674
130	103.91	5	5	.	cg	sss	20696674
130	111.18	3	3	.	cg	sss	20696674
130	118.45	3	3	.	cg	sss	20696674
130	125.73	2	2	.	cg	sss	21034796
130	133.00	2	2	B	cg	sss	21034796

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
130	144.60	2	2	.	cg	sss	21034796
130	156.20	2	2	.	cg	shs	21034796
130	167.80	1	1	.	cg	shs	19905882
130	179.40	1	1	.	cg	ts	19905882
130	191.00	3	3	A	cg	ts	18850200
140	0.00	2	5	F	cg	ts	18146414
140	7.57	3	5	.	gc	shn	18146414
140	15.14	2	5	.	gc	shn	17180386
140	22.71	3	6	.	jg	ssn	17180386
140	30.29	3	6	.	jg	ssn	17180386
140	37.86	3	7	.	jg	ssn	17823760
140	45.43	3	8	.	jg	ssn	17823760
140	53.00	2	5	E	jg	ssn	17823760
140	61.00	3	6	.	jg	ssn	17823760
140	69.00	3	8	.	jg	fsn	19553987
140	77.00	6	9	D	jg	fsn	19553987
140	85.00	4	7	C	cg	fss	19553987
140	93.00	3	5	.	cg	fss	19553987
140	101.00	2	5	.	cg	sss	21034796
140	109.00	3	5	.	cg	sss	21034796
140	117.00	3	4	.	cg	sss	21034796
140	125.00	2	5	.	cg	sss	21034796
140	133.00	2	4	B	cg	sss	21034796
140	144.60	2	5	.	cg	sss	21034796
140	156.20	2	4	.	cg	sss	19905882
140	167.80	3	5	.	cg	shs	19905882
140	179.40	2	5	.	cg	shs	19905882
140	191.00	2	6	A	cg	ts	19553987
150	0.00	3	5	F	cg	shn	18146414
150	6.63	3	6	.	gc	shn	18146414
150	13.25	3	6	.	gc	shn	17180386
150	19.88	3	6	.	jg	ssn	17180386
150	26.50	4	6	.	jg	ssn	17180386
150	33.13	5	7	.	jg	ssn	17823760
150	39.75	4	7	.	jg	ssn	17823760
150	46.38	3	6	E	jg	ssn	17823760
150	59.15	4	7	.	jg	ssn	17823760
150	65.31	6	9	.	jg	fsn	17823760
150	71.46	8	11	D	jg	fsn	19553987
150	77.62	6	8	C	cg	fss	19553987
150	83.77	4	5	.	cg	fss	21034796
150	89.92	2	6	.	cg	sss	21034796
150	96.08	4	5	.	cg	sss	21034796
150	102.23	4	6	.	cg	sss	21034796

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
150	108.38	2	5	.	cg	sss	21034796
150	114.54	3	6	B	cg	sss	21034796
150	120.69	1	10	.	cg	sss	21034796
150	144.60	3	5	.	cg	sss	21034796
150	156.20	4	6	.	cg	shs	19905882
150	167.80	5	6	.	cg	shs	19905882
150	179.40	3	6	.	cg	shs	19905882
150	191.00	4	7	A	cg	ts	19553987
160	0.00	4	5	F	cg	shn	18146414
160	8.83	4	6	.	cg	shn	18146414
160	17.67	3	7	.	gc	shn	17180386
160	26.50	4	6	.	gc	ssn	17180386
160	35.33	6	8	.	jg	ssn	17823760
160	44.17	5	7	.	jg	ssn	17823760
160	53.00	4	7	E	jg	ssn	17823760
160	59.67	4	9	.	jg	ssn	17823760
160	66.33	5	8	.	jg	ssn	17823760
160	73.00	8	11	.	jg	fsn	19553987
160	79.67	8	10	D	jg	fsn	19553987
160	86.33	2	8	C	cg	fss	19553987
160	93.00	5	7	.	cg	fss	19553987
160	99.67	4	6	.	cg	sss	21034796
160	106.33	5	7	.	cg	sss	21034796
160	113.00	4	6	.	cg	sss	21034796
160	119.67	4	6	.	cg	sss	21034796
160	126.33	4	6	.	cg	sss	21034796
160	133.00	3	6	B	cg	sss	21034796
160	142.67	4	6	.	cg	sss	21034796
160	152.33	4	5	.	cg	shs	21034796
160	162.00	2	5	.	cg	shs	19905882
160	171.67	3	5	.	cg	shs	19905882
160	181.33	3	5	.	cg	ts	19905882
160	191.00	2	6	A	cg	ts	19553987
170	0.00	4	7	F	cg	shn	18146414
170	8.83	4	6	.	gc	shn	17501106
170	17.67	4	6	.	gc	shn	17501106
170	26.50	5	5	.	jg	ssn	17501106
170	35.33	6	7		jg	ssn	17501106
170	44.17	4	6	.	jg	ssn	18146414
170	53.00	5	6	E	jg	ssn	18146414
170	60.27	5	8	.	jg	ssn	18146414
170	67.55	7	9	.	jg	ssn	18146414
170	74.82	5	8	.	jg	fsn	19905882
170	82.09	6	8	D	jg	fsn	19905882

Table E-2: September 20, 1996 survey

X	Y	V	H	Rem	Veg	LS	SF
170	89.36	6	6	C	cg	fss	19905882
170	96.64	4	6	.	cg	sss	19905882
170	103.91	4	5	.	cg	sss	21034796
170	111.18	4	6	.	cg	sss	21034796
170	118.45	4	5	.	cg	sss	21034796
170	125.73	3	5	.	cg	sss	21034796
170	133.00	3	6	B	cg	sss	21034796
170	144.60	6	7	.	cg	sss	21034796
170	156.20	4	6	.	cg	sss	21034796
170	167.80	3	5	.	cg	shs	19905882
170	179.40	2	5	.	cg	shs	19905882
170	191.00	1	4	A	cg	ts	19553987

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
X	Y	V	H	Re	Veg	LS	SF
0	0.00	5	5	F	dcg	ts	18146414
0	8.83	6	7	.	dcg	ts	18146414
0	17.67	4	4	.	dcg	ts	18146414
0	26.50	5	4.5	.	dcg	ts	18146414
0	35.33	4	5.5	.	dcg	ts	18146414
0	44.17	5	5	.	dcg	ts	18146414
0	53.00	5	6	E	dcg	ts	18146414
0	61.00	5	5	.	dcg	ts	18146414
0	69.00	6	7	.	dcg	ts	18146414
0	77.00	5	6	.	dcg	ts	18146414
0	85.00	4	5	.	dcg	ts	18850200
0	93.00	4.5	5	.	gc	ts	18850200
0	101.00	4	4	.	gc	ts	18850200
0	109.00	4	4	.	gc	ts	18850200
0	117.00	5	5	.	gc	ts	18498308
0	125.00	4.5	5	.	gc	ts	18498308
0	133.00	4	4	B	gc	ts	18498308
0	141.29	4	4	.	gc	ts	18498308
0	149.57	4	5	.	gc	ts	18146414
0	157.86	4	5	.	gc	ts	18146414
0	166.14	5	5.5	.	cg	ts	18146414
0	174.43	4	5	.	cg	ts	17501106
0	182.71	4	5	.	cg	ts	17501106
0	191.00	4	5	A	cg	ts	17501106
10	0.00	5	5	F	dcg	ts	18146414
10	7.57	5	5	.	dcg	ts	18146414
10	15.14	4	4	.	dcg	ts	18146414
10	22.71	4	5	.	dcg	ts	18146414
10	30.29	4	4.5		gc	ts	18146414
10	37.86	4	5.5	.	gc	ts	18146414
10	45.43	4	4	.	gc	ts	18146414
10	53.00	4	5	E	gc	ts	18146414
10	61.00	5	5	.	gc	ts	18146414
10	69.00	6	7	.	gc	ts	18146414
10	77.00	5	5	.	gc	hssh	18146414
10	85.00	4	5	.	gc	hssh	18850200
10	93.00	4	5	.	gc	hssh	18850200
10	101.00	2.5	4	.	dcg	hssh	18850200
10	109.00	4	4	.	dcg	hssh	18850200
10	117.00	2	4	.	dcg	hssh	18498308
10	125.00	3	4	.	dcg	hssh	18498308
10	133.00	4	5	B	dcg	ts	18498308
10	142.67	4	4	.	dcg	ts	18498308

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
10	152.33	3	4	.	dcg	ts	18146414
10	162.00	4	4.5	.	dcg	ts	18146414
10	171.67	4	5	.	dcg	ts	18146414
10	181.33	3	4	.	dcg	ts	17501106
10	191.00	3	4	A	dcg	ts	17501106
20	0.00	3	4	F	dcg	ts	18146414
20	8.83	3	4	.	dcg	ts	18146414
20	17.67	4	5	.	dcg	ts	18146414
20	26.50	4	6	.	dcg	ts	18146414
20	35.33	5	6.5	.	gc	hssh	18146414
20	44.17	4	5.5	.	gc	hssh	18146414
20	53.00	4	5	E	gc	hssh	18146414
20	61.89	5	6	.	gc	hssh	18498308
20	70.78	7.5	7	.	gc	hssh	18498308
20	79.67	4	5	.	gc	hssh	18498308
20	88.56	4	5.5	.	gc	hssh	19553987
20	97.44	5	5	.	gc	hssh	19553987
20	106.33	5	5	.	bg	hssh	19553987
20	115.22	5	5	.	bg	hssh	19553987
20	124.11	3	4	.	dcg	hssh	19553987
20	133.00	3	4	B	dcg	hssh	19553987
20	141.29	3.5	4	.	dcg	hssh	19553987
20	149.57	4	4	.	dcg	hssh	18498308
20	157.86	3	4	.	dcg	ts	18498308
20	166.14	4	4	.	dcg	ts	18498308
20	174.43	4	5	.	dcg	ts	18498308
20	182.71	4	4	.	dcg	ts	17823760
20	191.00	3	4	A	dcg	ts	17823760
30	0.00	2.5	3.5	F	dcg	ts	18146414
30	7.57	3	5	.	dcg	ts	18146414
30	15.14	3	6	.	dcg	ts	18146414
30	22.71	4.5	6	.	dcg	ts	18146414
30	30.29	5	7	.	gc	hssh	18146414
30	37.86	4	5.5	.	gc	hssh	18146414
30	45.43	4	5.5	.	gc	hssh	18146414
30	53.00	4	5	E	gc	hssh	18146414
30	61.00	4	5	.	gc	hssh	18498308
30	69.00	4	5	.	gc	hsn	18498308
30	77.00	4	6	.	gc	hsn	18498308
30	85.00	5	7	.	gc	hsn	18498308
30	93.00	4	5	.	gc	hsn	19553987
30	101.00	5	6	.	gc	hsn	19553987
30	109.00	4	4	.	dcg	hsn	19553987
30	117.00	3	4	.	dcg	hssh	19553987

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
30	125.00	3	3	.	dcg	hssh	19553987
30	133.00	3	4	B	dcg	hssh	19553987
30	142.67	3	4	.	dcg	hssh	19553987
30	152.33	3	3	.	dcg	hssh	18498308
30	162.00	3	4	.	dcg	ts	18498308
30	171.67	4	4	.	dcg	ts	18498308
30	181.33	5	6	.	dcg	ts	17823760
30	191.00	5	5	A	dcg	ts	17823760
40	0.00	2.5	4	F	dcg	ts	18146414
40	8.83	3	5	.	dcg	ts	18146414
40	17.67	4	5	.	dcg	ts	18146414
40	26.50	3	5	.	gc	hssh	18146414
40	35.33	4	6	.	gc	hssh	18146414
40	44.17	5	5	.	gc	hssh	18146414
40	53.00	4	5.5	E	gc	hsn	18146414
40	61.00	4	6	.	gc	hsn	18498308
40	69.00	3	6	.	g	hsn	18498308
40	77.00	4	6	.	g	hsn	18498308
40	85.00	4.5	5.5	.	g	hsn	18498308
40	93.00	4	5	.	g	hsa	19553987
40	101.00	5.5	7	axis	bg	hsa	19553987
40	109.00	4	6	.	bg	hsa	19553987
40	117.00	4	5	.	dcg	hss	19553987
40	125.00	3	4	.	dcg	hss	19553987
40	133.00	3	4	B	dcg	hss	19553987
40	141.29	3	4	.	dcg	hss	19553987
40	149.57	3	4	.	dcg	hss	18498308
40	157.86	3	4	.	dcg	hssh	18498308
40	166.14	3	3	.	dcg	hssh	18498308
40	174.43	4	4	.	dcg	hssh	18498308
40	182.71	4	5	.	dcg	ts	17823760
40	191.00	6	6	A	dcg	ts	17823760
50	0.00	3	4	F	dcg	ts	17501106
50	7.57	3	5	.	dcg	ts	17501106
50	15.14	3	4	.	dcg	hssh	17501106
50	22.71	4	5.5	.	gc	hssh	17501106
50	30.29	3.5	5	.	gc	hssh	17501106
50	37.86	3	5	.	gc	hssh	17823760
50	45.43	2	3.5	.	gc	hssh	17823760
50	53.00	2.5	4.5	E	g	hsn	17823760
50	61.00	4.5	5	.	g	hsn	18498308
50	69.00	4	7.5	.	g	hsn	18498308
50	77.00	4	7	.	g	hsn	18498308
50	85.00	3	4	.	g	hsn	18498308

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
50	93.00	6	7	.	bg	hsa	19905882
50	101.00	5	6	axis	bg	hsa	19905882
50	109.00	4	5	.	dcg	hsa	19905882
50	117.00	3	4	.	dcg	hss	19905882
50	125.00	3	4	.	dcg	hss	19905882
50	133.00	3	3	B	dcg	hss	19905882
50	141.29	2	3	.	dcg	hss	19905882
50	149.57	3	2	.	dcg	hssh	19202093
50	157.86	3	3	.	dcg	hssh	19202093
50	166.14	3	3.5	.	dcg	hssh	19202093
50	174.43	2	3.5	.	dcg	ts	19202093
50	182.71	3	4	.	dcg	ts	18146414
50	191.00	4	4.5	A	dcg	ts	18146414
60	0.00	3	4.5	F	dcg	ts	17501106
60	7.57	3	4.5	.	dcg	ts	17501106
60	15.14	3	5	.	dcg	hssh	17501106
60	22.71	3	5	.	gc	hssh	17501106
60	30.29	3	5	.	gc	hssh	17501106
60	37.86	2	4	.	gc	hssh	17823760
60	45.43	2.5	3.5	.	jg	hsn	17823760
60	53.00	3	4	E	jg	hsn	17823760
60	61.00	3	5	.	jg	hsn	18498308
60	69.00	5	7	.	g	hsn	18498308
60	77.00	6	7	.	g	hsn	18498308
60	85.00	5	6	.	g	hsa	18498308
60	93.00	6	7	axis	bg	hsa	19905882
60	101.00	6	7	.	bg	hsa	19905882
60	109.00	3.5	4	.	dcg	hss	19905882
60	117.00	3	3.5	.	dcg	hss	19905882
60	125.00	3	4	.	dcg	hss	19905882
60	133.00	3	3	B	dcg	hss	19905882
60	140.25	2	5	.	cg	hss	19905882
60	147.50	3	3.5	.	cg	hss	19905882
60	154.75	3	3	.	cg	hssh	19202093
60	162.00	3	3	.	cg	hssh	19202093
60	169.25	3	4	.	cg	hssh	19202093
60	176.50	3	3	.	dcg	Hssh	19202093
60	183.75	4	4	.	dcg	ts	18146414
60	191.00	4	5	A	dcg	ts	18146414
70	0.00	4	6	F	cg	ts	17501106
70	7.57	2	4	.	cg	shn	17501106
70	15.14	3	5	.	cg	shn	17501106
70	22.71	3	4	.	cg	shn	17501106
70	30.29	2	3	.	jg	ssn	17501106

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
70	37.86	3	3	.	jg	ssn	17823760
70	45.43	2	4	.	jg	ssn	17823760
70	53.00	3	5	E	jg	ssn	17823760
70	59.67	2	4	.	gc	ssn	18498308
70	66.33	3	3	.	gc	ssn	18498308
70	73.00	5	5.5	.	g	hsf	18498308
70	79.67	5	7	.	g	hsf	18498308
70	86.33	6	6	.	g	hsf	18498308
70	93.00	5	6	axis	gc	hsf	19905882
70	99.67	4	4	.	gc	hsf	19905882
70	106.33	3.5	4	.	gc	hsf	19905882
70	113.00	3	4	.	gc	hsf	19905882
70	119.67	2	4	.	cg	hsf	19905882
70	126.33	3	4	.	cg	hss	19905882
70	133.00	3	3	B	cg	hss	19905882
70	142.67	3	3	.	cg	hss	19905882
70	152.33	2	4	.	cg	hss	19202093
70	162.00	3	4	.	cg	hssh	19202093
70	171.67	3	4	.	cg	hssh	19202093
70	181.33	2	3	.	dcg	ts	18146414
70	191.00	4	5	A	dcg	ts	18146414
80	0.00	4	5	F	dcg	ts	18146414
80	7.57	3	4	.	dcg	shn	17501106
80	15.14	3	6	.	cg	shn	17501106
80	22.71	3	6	.	cg	shn	17501106
80	30.29	3	4	.	cg	ssn	17501106
80	37.86	2	3	.	cg	ssn	17501106
80	45.43	2	3	.	cg	ssn	17501106
80	53.00	3	4	E	jg	ssn	17501106
80	59.67	3	5	.	jg	ssn	17501106
80	66.33	3	3	.	jg	ssn	18498308
80	73.00	5	5.5	.	g	hsf	18498308
80	79.67	5	5	.	g	hsf	18498308
80	86.33	3	6	.	g	hsf	18498308
80	93.00	4	5	D	jg	hsf	19905882
80	99.67	3	5	C	cg	hsf	19905882
80	106.33	4	5	.	cg	hsf	19905882
80	113.00	4	4	.	cg	hsf	19905882
80	119.67	3	4	.	cg	hss	19905882
80	126.33	4	4	.	cg	hss	20158734
80	133.00	1	5.5	B	cg	sss	20158734
80	141.29	2	3	.	cg	sss	20158734
80	149.57	2.5	3	.	cg	sss	20158734
80	157.86	3	3.5	.	cg	sss	19202093

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
80	166.14	3	3.5	.	cg	shs	19202093
80	174.43	2	4		dcg	shs	19202093
80	182.71	2	3	.	dcg	shs	18146414
80	191.00	4	5	A	dcg	ts	18146414
90	0.00	3	4	F	dcg	ts	18146414
90	7.57	3	4	.	dcg	shn	17501106
90	15.14	4	6	.	gc	shn	17501106
90	22.71	4	6	.	gc	ssn	17501106
90	30.29	4	6	.	jg	ssn	17501106
90	37.86	3	4	.	jg	ssn	17501106
90	45.43	2	3	.	jg	ssn	17501106
90	53.00	2	3	E	jg	ssn	17501106
90	59.15	3	4	.	jg	ssn	17501106
90	65.31	4	5	.	jg	ssn	18498308
90	71.46	4	5	.	jg	ssn	18498308
90	77.62	3	4	.	jg	ssn	18498308
90	83.77	3	5	D	jg	fsn	18498308
90	89.92	4	5	C	cg	fss	18498308
90	96.08	2	4	.	cg	sss	19905882
90	102.23	3	4	.	cg	sss	19905882
90	108.38	5	4	.	cg	sss	19905882
90	114.54	3	3	.	cg	sss	19905882
90	120.69	2	3	.	cg	sss	19905882
90	126.85	2	3	.	cg	sss	20158734
90	133.00	2	3	B	cg	sss	20158734
90	142.67	1	3	.	cg	sss	20158734
90	152.33	2	3	.	cg	sss	19202093
90	162.00	2	3	.	cg	shs	19202093
90	171.67	4	4	.	cg	shs	19202093
90	181.33	3	3	.	dcg	shs	19202093
90	191.00	3	4	A	dcg	ts	18146414
100	0.00	2	3	F	dcg	ts	18146414
100	8.83	3	5	.	gc	shn	17501106
100	17.67	2.5	5	.	gc	shn	17501106
100	26.50	3	5	.	gc	ssn	17501106
100	35.33	3	5	.	jg	ssn	17501106
100	44.17	4	5	.	jg	ssn	17501106
100	53.00	2	3	E	jg	ssn	17501106
100	58.33	3	4	.	jg	ssn	17501106
100	63.67	4	4	.	jg	ssn	18498308
100	69.00	4	5	.	jg	ssn	18498308
100	74.33	4	4	.	jg	ssn	18498308
100	79.67	3	4	.	jg	ssn	18498308
100	85.00	4	5	D	jg	fsn	18498308

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
100	90.33	4	5	C	cg	fss	18498308
100	95.67	4	6	.	cg	sss	19905882
100	101.00	2	4	.	cg	sss	19905882
100	106.33	3	3	.	cg	sss	19905882
100	111.67	4	3.5	.	cg	sss	19905882
100	117.00	2	4	.	cg	sss	19905882
100	122.33	2	2	.	cg	sss	20158734
100	127.67	2	4	.	cg	sss	20158734
100	133.00	2	3	B	cg	sss	20158734
100	142.67	1	2	.	cg	sss	20158734
100	152.33	2	2.5	.	cg	sss	19202093
100	162.00	2	4	.	cg	sss	19202093
100	171.67	3	4	.	cg	sss	19202093
100	181.33	3	4	.	cg	shs	19202093
100	191.00	3	4	A	cg	shs	18146414
110	0.00	1	3	F	dcg	ts	18146414
110	6.63	2	4	.	gc	shn	17180386
110	13.25	2	4	.	gc	shn	17180386
110	19.88	3	4	.	gc	ssn	17180386
110	26.50	3	4	.	jg	ssn	17180386
110	33.13	4	4	.	jg	ssn	17180386
110	39.75	3	5	.	jg	ssn	17501106
110	46.38	3	3	.	jg	ssn	17501106
110	53.00	3	4	E	jg	ssn	17501106
110	59.67	3	4	.	jg	ssn	17501106
110	66.33	2	4	.	jg	ssn	19202093
110	73.00	3	5	.	jg	ssn	19202093
110	79.67	4.5	6	D	jg	fsn	19202093
110	86.33	3	4.5	C	cg	fss	19202093
110	93.00	2	3	.	cg	sss	20696674
110	99.67	2	3	.	cg	sss	20696674
110	106.33	4	4.5	.	cg	sss	20696674
110	113.00	3	4	.	cg	sss	20696674
110	119.67	1	4	.	cg	sss	20696674
110	126.33	1	3	.	cg	sss	21034796
110	133.00	2	3	B	cg	sss	21034796
110	141.29	1	3	.	cg	sss	21034796
110	149.57	1.5	2	.	cg	sss	21034796
110	157.86	2	3	.	cg	sss	19905882
110	166.14	2	2.5	.	cg	sss	19905882
110	174.43	3	4	.	cg	shs	19905882
110	182.71	4	4	.	cg	shs	18850200
110	191.00	3	3	A	cg	shs	18850200
120	0.00	2	3	F	cg	ts	18146414

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
120	6.63	2	4	.	cg	shn	17180386
120	13.25	3	4	.	gc	shn	17180386
120	19.88	3	5	.	gc	shn	17180386
120	26.50	3	5	.	gc	ssn	17180386
120	33.13	2	4	.	jg	ssn	17180386
120	39.75	2	3	.	jg	ssn	17501106
120	46.38	2	3	.	jg	ssn	17501106
120	53.00	3	4	E	jg	ssn	17501106
120	59.67	3	4	.	jg	ssn	17501106
120	66.33	3	4	.	jg	ssn	19202093
120	73.00	3	5	.	jg	ssn	19202093
120	79.67	4	6	D	jg	fsn	19202093
120	86.33	3	4	C	cg	fss	19202093
120	93.00	2	4	.	cg	sss	20696674
120	99.67	2	3	.	cg	sss	20696674
120	106.33	4	4	.	cg	sss	20696674
120	113.00	3	3	.	cg	sss	20696674
120	119.67	1.5	2	.	cg	sss	20696674
120	126.33	1	3	.	cg	sss	21034796
120	133.00	1	2	B	cg	sss	21034796
120	141.29	2	3	.	cg	sss	21034796
120	149.57	1	2	.	cg	sss	21034796
120	157.86	2	3	.	cg	sss	19905882
120	166.14	3	3	.	cg	shs	19905882
120	174.43	3	3	.	cg	shs	19905882
120	182.71	3	3	.	cg	shs	18850200
120	191.00	3	4	A	cg	ts	18850200
130	0.00	2	3	F	cg	ts	18146414
130	6.63	1	3	.	cg	shn	18146414
130	13.25	3	3	.	gc	shn	17180386
130	19.88	2	4	.	gc	ssn	17180386
130	26.50	1	3	.	jg	ssn	17180386
130	33.13	2	3	.	jg	ssn	17180386
130	39.75	2	3	.	jg	ssn	17501106
130	46.38	3	3.5	.	jg	ssn	17501106
130	53.00	3	4	E	jg	ssn	17501106
130	59.67	2.5	5	.	jg	ssn	17501106
130	66.33	2.5	4.5	.	jg	ssn	19202093
130	73.00	4	5	.	jg	ssn	19202093
130	79.67	4	6	.	jg	fsn	19202093
130	86.33	5	6	D	jg	fsn	19202093
130	93.00	4	5	C	cg	fss	20696674
130	99.67	3	4	.	cg	fss	20696674
130	106.33	2	3	.	cg	sss	20696674

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
130	113.00	3	3.5	.	cg	sss	20696674
130	119.67	2	3	.	cg	sss	20696674
130	126.33	1.5	3	.	cg	sss	21034796
130	133.00	1	5	B	cg	sss	21034796
130	142.67	2	3	.	cg	sss	21034796
130	152.33	1	2	.	cg	sss	21034796
130	162.00	2	2	.	cg	shs	19905882
130	171.67	2	2.5	.	cg	shs	19905882
130	181.33	2	3	.	cg	ts	19905882
130	191.00	2.5	7	A	cg	ts	18850200
140	0.00	2	3	F	cg	ts	18146414
140	7.57	1	3	.	gc	shn	18146414
140	15.14	1	3	.	gc	shn	17180386
140	22.71	2	4	.	jg	ssn	17180386
140	30.29	2	3	.	jg	ssn	17180386
140	37.86	2	3	.	jg	ssn	17823760
140	45.43	2	5	.	jg	ssn	17823760
140	53.00	2	4	E	jg	ssn	17823760
140	59.67	2	3	.	jg	ssn	17823760
140	66.33	3	3.5	.	jg	fsn	19553987
140	73.00	4	5	D	jg	fsn	19553987
140	79.67	3	5	C	cg	fss	19553987
140	86.33	2	3	.	cg	fss	19553987
140	93.00	2	3	.	cg	sss	21034796
140	99.67	2	3	.	cg	sss	21034796
140	106.33	2	2.5	.	cg	sss	21034796
140	113.00	2	3	.	cg	sss	21034796
140	119.67	1	2	.	cg	sss	21034796
140	126.33	2	3	.	cg	sss	21034796
140	133.00	1	2	B	cg	sss	21034796
140	144.60	2	3	.	cg	sss	21034796
140	156.20	1	2	.	cg	sss	19905882
140	167.80	2	2	.	cg	shs	19905882
140	179.40	1	3	.	cg	shs	19905882
140	191.00	2	3	A	cg	ts	19553987
150	0.00	1	3	F	cg	shn	18146414
150	6.63	2	3	.	gc	shn	18146414
150	13.25	2	4	.	gc	shn	17180386
150	19.88	2	4		jg	ssn	17180386
150	26.50	2	3		jg	ssn	17180386
150	33.13	2	3	.	jg	ssn	17180386
150	39.75	3	4	.	jg	ssn	17823760
150	46.38	4	5	.	jg	ssn	17823760
150	53.00	2	3	E	jg	ssn	17823760

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
150	59.67	2	3	.	jg	ssn	17823760
150	66.33	4	4	.	jg	ssn	17823760
150	73.00	4	5	.	jg	fsn	19553987
150	79.67	5	6	D	jg	fsn	19553987
150	86.33	2	3	C	cg	fss	19553987
150	93.00	2	3	.	cg	fss	21034796
150	99.67	2	2	.	cg	sss	21034796
150	106.33	2	2	.	cg	sss	21034796
150	113.00	1	3	.	cg	sss	21034796
150	119.67	1	2	.	cg	sss	21034796
150	126.33	2	2	.	cg	sss	21034796
150	133.00	1	2	B	cg	sss	21034796
150	144.60	1	2	.	cg	sss	21034796
150	156.20	1	3	.	cg	sss	19905882
150	167.80	2	2	.	cg	shs	19905882
150	179.40	2	3	.	cg	shs	19905882
150	191.00	3	4	A	cg	ts	19553987
160	0.00	2	3	F	cg	shn	18146414
160	7.57	2	3	.	cg	shn	18146414
160	15.14	2	3	.	gc	shn	17180386
160	22.71	2	4	.	gc	ssn	17180386
160	30.29	3	4	.	gc	ssn	17180386
160	37.86	4	5	.	jg	ssn	17823760
160	45.43	4	5	.	jg	ssn	17823760
160	53.00	3	4	E	jg	ssn	17823760
160	59.15	2	3.5	.	jg	ssn	17823760
160	65.31	2.5	4	.	jg	ssn	17823760
160	71.46	4	5	.	jg	ssn	19553987
160	77.62	7	8	.	jg	fsn	19553987
160	83.77	6	5	D	jg	fsn	19553987
160	89.92	3	3	C	cg	fss	19553987
160	96.08	2	3	.	cg	fss	19553987
160	102.23	2	3	.	cg	sss	21034796
160	108.38	2	2	.	cg	sss	21034796
160	114.54	2	3	.	cg	sss	21034796
160	120.69	1	3	.	cg	sss	21034796
160	126.85	2	3	.	cg	sss	21034796
160	133.00	1	4	B	cg	sss	21034796
160	142.67	2	3	.	cg	sss	21034796
160	152.33	2	2.5	.	cg	shs	21034796
160	162.00	2	3	.	cg	shs	19905882
160	171.67	1	2.5	.	cg	shs	19905882
160	181.33	2	3	.	cg	ts	19905882
160	191.00	2	3	A	cg	ts	19553987

Table E-3: April 20, 1997 survey

X	Y	V	H	e	Veg	LS	SF
170	0.00	2	3	F	cg	shn	18146414
170	7.57	3	4	.	cg	shn	18146414
170	15.14	2	4	.	gc	shn	17501106
170	22.71	3	3	.	gc	ssn	17501106
170	30.29	3	4.5	.	jg	ssn	17501106
170	37.86	3	5		jg	ssn	17501106
170	45.43	4.5	5.5	.	jg	ssn	18146414
170	53.00	3	5	E	jg	ssn	18146414
170	59.67	3	4	.	jg	ssn	18146414
170	65.31	3	5	.	jg	ssn	18146414
170	71.46	4	5.5	.	jg	fsn	19905882
170	77.62	5	7	D	jg	fsn	19905882
170	83.77	4.5	5.5	C	cg	fss	19905882
170	89.92	4	4	.	cg	fss	19905882
170	96.08	3	3	.	cg	sss	19905882
170	102.23	2	3.5	.	cg	sss	21034796
170	108.38	3	2.5	.	cg	sss	21034796
170	114.54	2	3	.	cg	sss	21034796
170	120.69	2	3	.	cg	sss	21034796
170	126.85	2	3	B	cg	sss	21034796
170	142.67	2	3	.	cg	sss	21034796
170	152.33	2	4	.	cg	sss	21034796
170	162.00	2	3	.	cg	sss	19905882
170	171.67	2	3	.	cg	shs	19905882
170	181.33	1	3	.	cg	shs	19905882
170	191.00	2	3.5	A	cg	ts	19553987

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
0	0.00	5.1	4.5	F	dcg	ts	18146414
0	10.60	4.2	3.7	.	dcg	ts	18146414
0	21.20	4.1	3.8	.	dcg	ts	18146414
0	31.80	4.6	4.2	.	cg	ts	18146414
0	42.40	5.6	5.2	.	cg	ts	18146414
0	53.00	5.3	4.8	E	dcg	ts	18146414
0	61.00	6.1	5.1	.	cg	ts	18146414
0	69.00	6.6	6.4	.	cg	ts	18146414
0	77.00	6.1	4.8	.	cg	ts	18146414
0	85.00	4.9	4.4	.	dcg	ts	18850200
0	93.00	4.3	5.4	.	dcg	ts	18850200
0	101.00	3.6	3	.	dcg	ts	18850200
0	109.00	3.7	3.1	.	cg	ts	18850200
0	117.00	3.6	3.3	.	cg	ts	18498308
0	125.00	3.9	4.1	.	cg	ts	18498308
0	133.00	3	3.2	B	cg	ts	18498308
0	141.29	2.6	3	.	cg	ts	18498308
0	149.57	2.6	3	.	cg	ts	18146414
0	157.86	3.4	3.4	.	cg	ts	18146414
0	166.14	3.6	4.1	.	cg	ts	18146414
0	174.43	2.6	4	.	cg	ts	17501106
0	182.71	3	3.5	.	cg	ts	17501106
0	191.00	3.8	4.7	A	cg	ts	17501106
10	0.00	6.5	5.5	F	cg	ts	18146414
10	7.57	5.2	5.5	.	cg	ts	18146414
10	15.14	5.1	5.2	.	cg	ts	18146414
10	22.71	5.1	5.5	.	cg	ts	18146414
10	30.29	4.6	5	.	cg	ts	18146414
10	37.86	4	4.9		cg	ts	18146414
10	45.43	4.6	5.5	.	cg	ts	18146414
10	53.00	4.7	6.8	.	cg	ts	18146414
10	61.00	4.6	5.9	E	cg	ts	18146414
10	69.00	5.3	5.6	.	cg	ts	18146414
10	77.00	6	6.8	.	cg	ts	18850200
10	85.00	4.3	5.2	.	dcg	hssh	18850200
10	93.00	4.3	5.5	.	dcg	hssh	18850200
10	101.00	4.1	4.9	.	dcg	hssh	18850200
10	109.00	3.2	3.8	.	cg	hssh	18498308
10	117.00	3	6.3	.	cg	hssh	18498308
10	125.00	4	6.1	.	cg	hssh	18498308
10	133.00	3.1	3.7	B	cg	ts	18498308
10	141.29	3.5	3.5	.	cg	ts	18146414
10	149.57	3.6	1.7	.	cg	ts	18146414
10	157.86	2.4	1.8	.	cg	ts	18146414

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
10	166.14	2.6	3.2	.	cg	ts	18146414
10	174.43	2.2	3	.	cg	ts	17501106
10	182.71	2.1	3	.	cg	ts	17501106
10	191.00	2.7	2.5	A	cg	ts	17501106
20	0.00	4.5	4.4	F	cg	ts	18146414
20	7.57	4.4	5.8	.	cg	ts	18146414
20	15.14	4.3	7.3	.	cg	ts	18146414
20	22.71	4.4	6.5	.	cg	ts	18146414
20	30.29	5	6.9	.	cg	hssh	18146414
20	37.86	5	5.7	.	cg	hssh	18146414
20	45.43	5.3	6.4	.	cg	hssh	18498308
20	53.00	5.2	6.1	E	cg	hssh	18498308
20	60.27	5.4	6.8	.	cg	hssh	18498308
20	67.55	6.7	7.7	.	cg	hssh	18498308
20	74.82	5.6	6.6	.	cg	hssh	18498308
20	82.09	4.8	8		cg	hssh	19553987
20	89.36	5.2	6.8		cg	hssh	19553987
20	96.64	5.6	7.2	.	cg	hssh	19553987
20	103.91	5.9	5.8	.	cg	hssh	19553988
20	111.18	5.3	5.9	.	cg	hssh	19553987
20	118.45	4	5.1	.	dcg	hssh	19553987
20	125.73	3.7	3.8	.	dcg	hssh	19553987
20	133.00	4.2	5.3	B	dcg	hssh	19553987
20	141.29	4.3	4.7	.	dcg	hssh	19553987
20	149.57	4.1	3.5	.	dcg	hssh	18498308
20	157.86	3.6	4.1	.	dcg	ts	18498308
20	166.14	3.5	4.6	.	dcg	ts	18498308
20	174.43	4.3	5.6	.	dcg	ts	18498308
20	182.71	3.7	5.1	.	dcg	ts	17823760
30	191.00	3.9	5.6	A	dcg	ts	17823760
30	0.00	3.5	3.3	F	dcg	ts	18146414
30	7.57	3.4	5.6	.	dcg	ts	18146414
30	15.14	4.2	4.8	.	dcg	ts	18146414
30	22.71	5	6.2	.	cg	ts	18146414
30	30.29	4.9	6.9	.	cg	hssh	18146414
30	37.86	6.9	8	.	cg	hssh	18146414
30	45.43	4.8	6.4	.	cg	hssh	18498308
30	53.00	4	6.7	E	cg	hssh	18498308
30	59.67	4.9	8.6	.	g	hsn	18498308
30	66.33	5.7	7.3	.	g	hsn	18498308
30	73.00	6.3	7.5	.	g	hsn	18498308
30	79.67	3.9	5.4	.	gc	hsn	19553987
30	86.33	4.4	6.6	.	gc	hsn	19553987
30	93.00	4.6	6.5	.	gc	hsn	19553987

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
30	99.67	4	5.9	.	gc	hsn	19553987
30	106.33	4.4	4.7	.	gc	hsn	19553987
30	113.00	4	5.6	.	dcg	hssh	19553987
30	119.67	3.1	6	.	dcg	hssh	19553987
30	126.33	3	4	.	dcg	hssh	19553987
30	133.00	3.3	4.8	B	dcg	hssh	19553987
30	141.29	3.7	4.5	.	dcg	hssh	19553987
30	149.57	3.2	4.2	.	dcg	hssh	18498308
30	157.86	3.2	4.7		dcg	ts	18498308
30	166.14	3.1	3.8	.	dcg	ts	18498308
30	174.43	4.1	4.8	.	cg	ts	18498308
30	182.71	5.7	5.8	.	cg	ts	17823760
30	191.00	4.7	5.6	A	cg	ts	17823760
40	0.00	3.3	5.5	F	dcg	ts	18146414
40	7.57	3.3	6.5	.	dcg	ts	18146414
40	15.14	4.4	7.7	.	dcg	ts	18146414
40	22.71	5.7	7.8	.	cg	hssh	18146414
40	30.29	6	9.2	.	cg	hssh	18146414
40	37.86	6	6.3	.	cg	hssh	18146414
40	45.43	4.1	6.4	.	g	hsn	18146414
40	53.00	4.2	8.4	E	g	hsn	18498308
40	60.27	4.1	7	.	g	hsn	18498308
40	67.55	4.3	6.2	.	g	hsn	18498308
40	74.82	4.2	7	.	g	hsn	18498308
40	82.09	3.8	4.6	.	gc	hsn	19553987
40	89.36	4.2	6	.	gc	hsn	19553987
40	96.64	4.6	9	.	bgc	hsa	19553987
40	103.91	5.6	7.9	axis	bgc	hsa	19553987
40	111.18	4.4	7	.	bgc	hsa	19553987
40	118.45	4.2	6.5	.	dcg	hss	19553987
40	125.73	3.9	4.9	.	dcg	hss	19553987
40	133.00	3.6	7.2	B	dcg	hss	19553987
40	141.29	3	4	.	dcg	hss	19553987
40	149.57	3.8	4	.	dcg	hss	18498308
40	157.86	3.2	5	.	dcg	hssh	18498308
40	166.14	3	4.1	.	dcg	hssh	18498308
40	174.43	3	4.4	.	dcg	hssh	18498308
40	182.71	3.8	5.9	.	cg	ts	17823760
40	191.00	6.8	6.8	A	cg	ts	17823760
50	0.00	3.8	6.5	F	cg	ts	17501106
50	7.57	4.1	6.4	.	cg	ts	17501106
50	15.14	4.7	8.2	.	cg	hssh	17501106
50	22.71	5.2	8	.	cg	hssh	17501106
50	30.29	3.8	8.2	.	cg	hssh	17501106

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
50	37.86	4.4	6.7	.	cg	hssh	17823760
50	45.43	4.5	7.3	.	cg	hssh	17823760
50	53.00	4.6	9.3	E	g	hsn	17823760
50	59.15	4.3	9.3	.	g	hsn	18498308
50	65.31	5.6	9.4	.	g	hsn	18498308
50	71.46	6.7	10.5	.	g	hsn	18498308
50	77.62	6.1	11	.	g	hsn	18498308
50	83.77	4.4	7.2		g	hsn	19905882
50	89.92	4	9.3		cg	hsn	19905882
50	96.08	6.5	11.1		bgc	hsa	19905882
50	102.23	6.9	10.6	axis	bgc	hsa	19905882
50	108.38	6.3	10	.	bgc	hsa	19905882
50	114.54	4.8	8.8	.	dcg	hss	19905882
50	120.69	4.3	8.1	.	dcg	hss	19905882
50	126.85	4.4	7.9	.	dcg	hss	19905882
50	133.00	3.9	8.1	B	dcg	hss	19905882
50	141.29	3.4	6	.	dcg	hss	19905882
50	149.57	3.8	7.1	.	dcg	hssh	19202093
50	157.86	3.4	6.2	.	dcg	hssh	19202093
50	166.14	2.6	6.8	.	dcg	hssh	19202093
50	174.43	3.6	7.8	.	dcg	ts	19202093
50	182.71	4	9.3	.	cg	ts	18146414
50	191.00	5	8	A	cg	ts	18146414
60	0.00	3.8	7.9	F	cg	ts	17501106
60	6.63	4	7.9	.	cg	ts	17501106
60	13.25	4.6	8.3	.	cg	ts	17501106
60	19.88	4.8	9.6	.	cg	hssh	17501106
60	26.50	4.5	8.4	.	gc	hssh	17501106
60	33.13	4.5	6	.	gc	hssh	17823760
60	39.75	3.5	6.3	.	gc	hssh	17823760
60	46.38	3.8	7.2	.	gc	hsn	17823760
60	53.00	4.2	8	E	g	hsn	17823760
60	59.67	4.9	6.8	.	g	hsn	18498308
60	66.33	5.9	9	.	g	hsn	18498308
60	73.00	6.8	9.5	.	g	hsn	18498308
60	79.67	5.1	9	.	g	hsn	18498308
60	86.33	6	7.3	.	gc	hsn	19905882
60	93.00	6.3	9	.	bgc	hsa	19905882
60	99.67	6	11	axis	bgc	hsa	19905882
60	106.33	4.8	6.3	.	bgc	hsa	19905882
60	113.00	3.7	8.5	.	dcg	hss	19905882
60	119.67	3.8	7.6	.	dcg	hss	19905882
60	126.33	3.3	5.2	.	dcg	hss	19905882
60	133.00	4	5.3	B	dcg	hss	19905882

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
60	141.29	3.3	6.2	.	dcg	hss	19905882
60	149.57	3.2	5	.	dcg	hss	19202093
60	157.86	3.9	6	.	dcg	hssh	19202093
60	166.14	2.5	4.2	.	dcg	hssh	19202093
60	174.43	2.4	4.8	.	dcg	hssh	19202093
60	182.71	2.1	6.5	.	cg	ts	18146414
60	191.00	5.3	7.6	A	cg	ts	18146414
70	0.00	3.3	6.1	F	cg	ts	17501106
70	6.63	3.4	8.4	.	cg	shn	17501106
70	13.25	4.6	7.1	.	cg	shn	17501106
70	19.88	3.2	5.6	.	cg	shn	17501106
70	26.50	3.8	7.7	.	gc	shn	17501106
70	33.13	3.1	7		gc	ssn	17823760
70	39.75	2.3	5.3	.	jg	ssn	17823760
70	46.38	2.3	6.3	.	jg	ssn	17823760
70	53.00	2.8	10.9	E	jg	ssn	17823760
70	59.15	2.8	3.9	.	jg	ssn	18498308
70	65.31	3.4	4.9	.	cg	ssn	18498308
70	71.46	6	8.9	.	g	hsf	18498308
70	77.62	7	11.8	.	g	hsf	18498308
70	83.77	5.6	9.3	.	g	hsf	18498308
70	89.92	6.3	6.9	.	g	hsf	19905882
70	96.08	6	7.4	.	bgc	hsf	19905882
70	102.23	7.5	14.8	.	bgc	hsf	19905882
70	108.38	4.1	5.8	.	bgc	hsf	19905882
70	114.54	4	5.8	.	cg	hsf	19905882
70	120.69	3.1	6.9	.	cg	hsf	19905882
70	126.85	3.3	6.4	.	cg	hss	19905882
70	133.00	2.3	5.3	B	cg	hss	19905882
70	140.25	2.1	4.2	.	cg	hss	19905882
70	147.50	3.6	5.2	.	cg	hss	19202093
70	154.75	3.2	4.7	.	cg	hss	19202093
70	162.00	2.8	4.2	.	cg	hss	19202093
70	169.25	3.2	6.5	.	cg	hssh	19202093
70	176.50	3.2	5.6	.	cg	hssh	19202093
70	183.75	1.7	4.3	.	cg	ts	18146414
70	191.00	4.6	6.4	A	cg	ts	18146414
80	0.00	4.2	7.4	F	cg	ts	18146414
80	5.30	3.1	6.2	.	cg	ts	17501106
80	10.60	3.2	8.4	.	gc	shn	17501106
80	15.90	4	7.1	.	gc	shn	17501106
80	21.20	3.7	5.7	.	gc	shn	17501106
80	26.50	2.6	4.8	.	gc	shn	17501106
80	31.80	2.2	6.2	.	gc	ssn	17501106

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
80	37.10	2.4	5.2	.	jg	ssn	17501106
80	42.40	2.7	5	.	jg	ssn	17501106
80	47.70	3.3	5.6	.	jg	ssn	17501106
80	53.00	2.9	3.2	E	jg	ssn	17501106
80	59.15	3.8	5	.	jg	ssn	17501106
80	65.31	6.1	7.5	.	jg	ssn	18498308
80	71.46	6.2	9.4	.	g	hsf	18498308
80	77.62	5.1	8.4	.	g	hsf	18498308
80	83.77	5.1	6.4	.	bgc	hsf	18498308
80	89.92	7.6	8.2	D	bgc	hsf	19905882
80	96.08	3.4	5.1	C	bgc	hsf	19905882
80	102.23	4.3	6.6	.	cg	hsf	19905882
80	108.38	3.4	4.4	.	cg	hsf	19905882
80	114.54	3.5	4.8	.	cg	hss	19905882
80	120.69	3.1	5.5	.	cg	hss	20158734
80	126.85	2.6	3.9	.	cg	hss	20158734
80	133.00	2.4	2.5	B	cg	sss	20158734
80	142.67	3.6	4.7	.	cg	sss	20158734
80	152.33	3.5	5.7	.	cg	sss	19202093
80	162.00	2.6	2.9	.	cg	sss	19202093
80	171.67	2.2	4.6	.	cg	shs	19202093
80	181.33	2.4	4.2	.	cg	shs	18146414
80	191.00	4.6	6.6	A	cg	ts	18146414
90	0.00	3.2	5.8	F	cg	ts	18146414
90	6.63	3.3	5.9	.	cg	shn	17501106
90	13.25	3.7	5.5	.	gc	shn	17501106
90	19.88	3.2	7	.	gc	ssn	17501106
90	26.50	2.8	5.9	.	gc	ssn	17501106
90	33.13	3	4.6	.	gc	ssn	17501106
90	39.75	2.5	5.3	.	jg	ssn	17501106
90	46.38	3	6.1	.	jg	ssn	17501106
90	53.00	2.8	5.9	E	jg	ssn	17501106
90	59.67	3.8	6.2	.	jg	ssn	18498308
90	66.33	4.2	6.4	.	jg	ssn	18498308
90	73.00	2.9	4.3	.	jg	ssn	18498308
90	79.67	4.4	8	D	jg	fsn	18498308
90	86.33	4.4	5.7	C	cg	fss	18498308
90	93.00	2.6	6.3	.	cg	sss	19905882
90	99.67	3.2	7.3	.	cg	sss	19905882
90	106.33	5.4	4.6	.	cg	sss	19905882
90	113.00	3	4.2	.	cg	sss	19905882
90	119.67	2.9	4.2	.	cg	sss	19905882
90	126.33	2.5	3.8	.	cg	sss	20158734
90	133.00	2.2	9.4	B	cg	sss	20158734

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
90	142.67	1.6	3.9	.	cg	sss	20158734
90	152.33	3.1	5.3	.	cg	sss	19202093
90	162.00	4.1	4.8	.	cg	shs	19202093
90	171.67	3.9	5.2	.	cg	shs	19202093
90	181.33	3.2	5.3	.	cg	shs	19202093
90	191.00	3.1	5.3	A	cg	ts	18146414
100	0.00	3.7	7	F	cg	ts	18146414
100	6.63	3.3	7.5	.	cg	shn	18146414
100	13.25	4.5	7.4	.	gc	shn	17501106
100	19.88	3.2	6.3	.	gc	shn	17501106
100	26.50	4.2	8	.	gc	ssn	17501106
100	33.13	4.5	5	.	gc	ssn	17501106
100	39.75	4	5.9	.	gc	ssn	17501106
100	46.38	2.4	5.3	.	gc	ssn	17501106
100	53.00	4.4	5.5	E	jg	ssn	17501106
100	58.71	3.36	4.6	.	jg	ssn	18498308
100	64.43	4.2	7.4	.	jg	ssn	18498308
100	70.14	3	6	.	jg	ssn	18498308
100	75.86	2.8	4.7	.	jg	fsn	18498308
100	81.57	4.2	7.2	D	jg	fss	18498308
100	87.29	4	6.2	C	gc	sss	18498308
100	93.00	2.7	5.4	.	cg	sss	19905882
100	98.71	3.2	5.5	.	cg	sss	19905882
100	104.43	5.3	5.7	.	cg	sss	19905882
100	110.14	3.7	5	.	cg	sss	19905882
100	115.86	2.3	3.9	.	cg	sss	19905882
100	121.57	2.3	6.2	.	cg	sss	20158734
100	127.29	2.4	5.2	.	cg	sss	20158734
100	133.00	2.5	4.3	B	cg	sss	20158734
100	142.67	2.3	3.8	.	cg	sss	20158734
100	152.33	2.6	3.8	.	cg	sss	19202093
100	162.00	3.9	5.5	.	cg	sss	19202093
100	171.67	4	5.3	.	cg	sss	19202093
100	181.33	3.6	4.5	.	cg	shs	19202093
100	191.00	3.7	4.4	A	cg	shs	18146414
110	0.00	1.3	5.4	F	cg	ts	18146414
110	6.63	2	4.7	.	gc	shn	17180386
110	13.25	2	6.6	.	gc	shn	17180386
110	19.88	2.6	6	.	gc	ssn	17180386
110	26.50	4.4	3.4	.	gc	ssn	17180386
110	33.13	3.5	5.8	.	gc	ssn	17180386
110	39.75	3.4	5.2	.	gc	ssn	17501106
110	46.38	3	6.8	.	jg	ssn	17501106
110	53.00	3.8	5.2	E	jg	ssn	17501106

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
110	59.67	4	5.2	.	jg	ssn	17501106
110	66.33	2.7	5.1	.	jg	ssn	19202093
110	73.00	4	6.1	.	jg	ssn	19202093
110	79.67	5.4	8.7	D	jg	fsn	19202093
110	86.33	3.8	5	C	cg	fss	19202093
110	93.00	2.6	5	.	cg	sss	20596674
110	99.67	2.8	4.8	.	cg	sss	20596674
110	106.33	6.3	5.8	.	cg	sss	20596674
110	113.00	3.5	3.4	.	cg	sss	20596674
110	119.67	2.3	1.8	.	cg	sss	20596674
110	126.33	2	3.5	.	cg	sss	21034796
110	133.00	2.3	6	B	cg	sss	21034796
110	142.67	1.8	4.8	.	cg	sss	21034796
110	152.33	2.1	6.1	.	cg	sss	19905882
110	162.00	3.1	6.7	.	cg	sss	19905882
110	171.67	3.6	5.5	.	cg	shs	19905882
110	181.33	4.1	4.9	.	cg	shs	18850200
110	191.00	3	2.9	A	cg	shs	18850200
120	0.00	1.1	3	F	cg	ts	18146414
120	7.57	1.7	4.5	.	gc	shn	17180386
120	15.14	2.5	3.2	.	gc	shn	17180386
120	22.71	3.2	5.8	.	gc	shn	17180386
120	30.29	3.7	8.3	.	gc	ssn	17180386
120	37.86	2.2	5.2	.	gc	ssn	17501106
120	45.43	3.2	5.7	.	jg	ssn	17501106
120	53.00	3	4.4	E	jg	ssn	17501106
120	60.27	2.7	5.8	.	jg	ssn	17501106
120	67.55	2.4	5.2	.	jg	ssn	19202093
120	74.82	3.2	5.2	.	jg	ssn	19202093
120	82.09	4.4	6.3	D	jg	fsn	19202093
120	89.36	3.2	5.8	C	cg	fss	19202093
120	96.64	3.2	5.4	.	cg	sss	20696674
120	103.91	4	4.9	.	cg	sss	20696674
120	111.18	3.8	4	.	cg	sss	20696674
120	118.45	2	3.4	.	cg	sss	20696674
120	125.73	1.8	5.2	.	cg	sss	21034796
120	133.00	1.6	3.4	B	cg	sss	21034796
120	142.67	1.9	4.1	.	cg	sss	21034796
120	152.33	2.1	3.6	.	cg	sss	19905882
120	162.00	2.5	4.5	.	cg	shs	19905882
120	171.67	3.7	4.3	.	cg	shs	19905882
120	181.33	2.2	4.1	.	cg	shs	18850200
120	191.00	3.2	3.7	A	cg	ts	18850200
130	0.00	2.7	6.6	F	cg	ts	18146414

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
130	6.63	2.5	6.1	.	gc	shn	18146414
130	13.25	3	6.6	.	gc	shn	17180386
130	19.88	3.6	5.5	.	gc	ssn	17180386
130	26.50	4.2	8.5	.	jg	ssn	17180386
130	33.13	2.8	6	.	jg	ssn	17180386
130	39.75	3.6	5.4	.	jg	ssn	17501106
130	46.38	3.2	4.5	.	jg	ssn	17501106
130	53.00	4.4	5.4	E	jg	ssn	17501106
130	59.67	3.6	7.3	.	jg	ssn	19202093
130	66.33	4	7.5	.	jg	ssn	19202093
130	73.00	5.8	8.2	.	jg	fsn	19202093
130	79.67	5.8	9	D	cg	fsn	19202093
130	86.33	4.1	5.2	C	cg	fss	20596674
130	93.00	4.1	5.8	.	cg	fss	20596674
130	99.67	3.5	3.8	.	cg	sss	20596674
130	106.33	3.9	5.3	.	cg	sss	20596674
130	113.00	2.5	4.5	.	cg	sss	20596674
130	119.67	3.4	2.6	.	cg	sss	21034796
130	126.33	2.4	4.5	.	cg	sss	21034796
130	133.00	2.5	4.4	B	cg	sss	21034796
130	142.67	2.7	4.5	.	cg	sss	21034796
130	152.33	2.3	4.4	.	cg	sss	21034796
130	162.00	3.7	7.9	.	cg	shs	19905882
130	171.67	2.6	5.2	.	cg	shs	19905882
130	181.33	1.9	4.8	.	cg	ts	19905882
130	191.00	4	4.7	A	cg	ts	18850200
140	0.00	3.1	5.4	F	cg	ts	18146414
140	6.63	2.8	5.2	.	cg	shn	18146414
140	13.25	2.7	5.6	.	gc	shn	17180386
140	19.88	2.6	5.2	.	gc	ssn	17180386
140	26.50	2.7	6	.	gc	ssn	17180386
140	33.13	3	4.5	.	jg	ssn	17180386
140	39.75	3.3	5.3	.	jg	ssn	17823760
140	46.38	4.1	5.5	.	jg	ssn	17823760
140	53.00	4.3	8	E	jg	ssn	17823760
140	59.67	3.3	5.4	.	jg	ssn	17823760
140	66.33	3.2	7.9	.	jg	ssn	19553987
140	73.00	5.2	7.6	.	jg	fsn	19553987
140	79.67	6.1	7.6	D	jg	fsn	19553987
140	86.33	4.1	5.9	C	cg	fss	19553987
140	93.00	3	4.8	.	cg	fss	21034796
140	99.67	2.1	2.6	.	cg	sss	21034796
140	106.33	3.6	5.9	.	cg	sss	21034796
140	113.00	3	4.3	.	cg	sss	21034796

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
140	119.67	2.6	4.4	.	cg	sss	21034796
140	126.33	2.3	4.2	.	cg	sss	21034796
140	133.00	2.2	5.2	B	cg	sss	21034796
140	144.60	2.8	3.2	.	cg	sss	21034796
140	156.20	2.3	4.3	.	cg	sss	19905882
140	167.80	2.7	5	.	cg	shs	19905882
140	179.40	2.3	4.5	.	cg	shs	19905882
140	191.00	2.3	4	A	cg	ts	19553987
150	0.00	1.6	3.8	F	cg	shn	18146414
150	8.83	1.5	5.4	.	cg	shn	18146414
150	17.67	1.6	5.7	.	cg	shn	17180386
150	26.50	1.9	5.2	.	gc	ssn	17180386
150	35.33	2.5	4.8	.	gc	ssn	17180386
150	44.17	2.7	3.1	.	jg	ssn	17823760
150	53.00	3.8	3.5	E	jg	ssn	17823760
150	58.71	2.7	5.2	.	jg	ssn	17823760
150	64.43	2.6	5.7	.	jg	ssn	17823760
150	70.14	3.3	5.2	.	jg	ssn	19553987
150	75.86	3.6	6	.	jg	fsn	19553987
150	81.57	5.6	9.2	D	jg	fsn	19553987
150	87.29	5.2	8.2	C	cg	fss	19553987
150	93.00	2.8	5.2	.	cg	fss	21034796
150	98.71	2.7	4.5	.	cg	sss	21034796
150	104.43	2.5	4.4	.	cg	sss	21034796
150	110.14	2.5	4.5	.	cg	sss	21034796
150	115.86	2.2	2.3	.	cg	sss	21034796
150	121.57	2.2	4.3	.	cg	sss	21034796
150	127.29	1.6	6.6	.	cg	sss	21034796
150	133.00	2.1	7.2	B	cg	sss	21034796
150	141.29	1.8	2.2	.	cg	sss	21034796
150	149.57	2.1	3.8	.	cg	sss	21034796
150	157.86	3	4.9	.	cg	shs	19905882
150	166.14	2.9	4.7	.	cg	shs	19905882
150	174.43	1.9	4.2	.	cg	shs	19905882
150	182.71	2.1	4.1	.	cg	ts	19905882
150	191.00	3.3	6.1	A	cg	ts	19553987
160	0.00	2.2	4.2	F	cg	shn	18146414
160	6.63	2.2	3.9	.	gc	shn	18146414
160	13.25	2	6	.	gc	shn	17180386
160	19.88	2.3	5.7	.	gc	ssn	17180386
160	26.50	2.6	4.3	.	jg	ssn	17180386
160	33.13	2.7	4.3	.	jg	ssn	17180386
160	39.75	3.4	4.6	.	jg	ssn	17823760
160	46.38	3.9	6.2	.	jg	ssn	17823760

Table E-4: October 14, 1997 survey

X	Y	V	H	Rem	Veg	LS	SF
160	53.00	2.3	5.1	E	jg	ssn	17823760
160	59.15	2.8	3.7	.	jg	ssn	17823760
160	65.31	3.6	6.2	.	jg	ssn	19553987
160	71.46	5.2	7.4	.	jg	fsn	19553987
160	77.62	6.2	8.1	D	jg	fsn	19553987
160	83.77	5	4.7	C	cg	fss	19553987
160	89.92	2.9	4.7	.	cg	fss	19553987
160	96.08	2.5	2.8	.	cg	sss	21034796
160	102.23	1.8	4.1	.	cg	sss	21034796
160	108.38	2.5	3.2	.	cg	sss	21034796
160	114.54	2.2	5.5	.	cg	sss	21034796
160	120.69	1.7	5.7	.	cg	sss	21034796
160	126.85	1.8	3.2	.	cg	sss	21034796
160	133.00	1.8	2.7	B	cg	sss	21034796
160	142.67	2	3.5	.	cg	sss	21034796
160	152.33	2.6	3.8	.	cg	shs	21034796
160	162.00	2.8	4.4	.	cg	shs	19905882
160	171.67	1.7	4	.	cg	shs	19905882
160	181.33	1.4	3.4	.	cg	ts	19905882
160	191.00	2.4	3.6	A	cg	ts	19553987
170	0.00	1.9	3	F	cg	shn	18146414
170	6.63	2.3	4.6	.	cg	shn	18146414
170	13.25	2.7	3.6	.	gc	shn	17501106
170	19.88	1.4	4.2	.	gc	ssn	17501106
170	26.50	2	3.8	.	jg	ssn	17501106
170	33.13	3.2	5.7	.	jg	ssn	17501106
170	39.75	4.8	6.3		jg	ssn	18146414
170	46.38	2.1	4.6	.	jg	ssn	18146414
170	53.00	2	4.1	E	jg	ssn	18146414
170	59.15	2.4	4.7	.	jg	ssn	18146414
170	65.31	3.5	7	.	jg	fsn	18146414
170	71.46	5.8	8.6	D	jg	fsn	19905882
170	77.62	5.7	8.1	C	cg	fss	19905882
170	83.77	4.9	7.4	.	cg	fss	19905882
170	89.92	3	4.9	.	cg	sss	19905882
170	96.08	2	4.5	.	cg	sss	21034796
170	102.23	2.3	3.6	.	cg	sss	21034796
170	108.38	2	5.7	.	cg	sss	21034796
170	114.54	1.8	3.8	.	cg	sss	21034796
170	120.69	1.6	3	.	cg	sss	21034796
170	126.85	1.8	3.5	.	cg	sss	21034796
170	133.00	1.9	4.2	B	cg	sss	21034796
170	144.60	2.1	4.7	.	cg	sss	21034796
170	156.20	1.8	3.5	.	cg	sss	19905882
170	167.80	2.4	3.9	.	cg	shs	19905882
170	179.40	1.7	2.6	.	cg	shs	19905882
170	191.00	1.2	2.3	A	cg	ts	19553987