SUSITNA HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114

DRAFT

CULTURAL RESOURCES INVESTIGATIONS 1979-1985

VOLUME II
APPENDICES B and C

DRAFT

SITY OF ALASKA
M

MAY 1985
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ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

CULTURAL RESOURCES INVESTIGATIONS

1979 - 1985

VOLUME II

APPENDICES B AND C

DRAFT

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May 1985

APPENDIX B - SURVEY LOCALE FORM, SITE SURVEY FORM,
FIELD NOTEBOOK GUIDES,
AND SITE DATA FORM

Page

TABLE OF CONTENTS

Page

LIST OF FIGURES

B.1 - SURVEY LOCALE FORM

SURVEY LOCALE: ____________________

Museum Archeology
University of Alaska
Fairbanks, Alaska 99701

CHECKED BY DAT_

____
____
____
____

SUSITNA HYDROPOWER PROJECT
SURVEY LOCALE EVALUATION FORM

This form is intended to insure that three kinds of data for each locale are recorded. These data will guide additional survey, evaluation of areas that may need no further work, and document areas surveyed and tested on-the-ground. If supplementary information to this form is included in fieldnotes, please note this on the form along with your name(s) and field book page number(s).

I. A field description of the locale is needed. The field description of the locale should include the uniformity and variability of surface morphology. The information which you record will be used to compare this locale with other locales to determine similarity and aid in future locale selection and testing.

a. Describe the surface morphology noting topographic features, drainage, soils, variation in surface slope, etc.

b. What, if any, are the discrepancies between the definition of the geological unit (based on air photo interpretation) and the field observation of the unit? Would you characterize the total area as a single unit based on the homogeneity of surface morphology?

II. Identify areas within the locale that potentially may be eliminated from further archeological survey. Please provide objective criteria in your evaluation such as: 1) areas where testing is not feasible using standard archeological field techniques (areas of standing water, talus rubble); 2) areas where the substrata have been removed by natural erosion (indicate whether these areas have been surface examined for archeological materials); and 3) overly steep slopes. This would include slopes of greater than 15° to horizontal which you deem unlikely for site occurrence (describe and measure slope angle).

III. Identify areas within the locale which may have high archeological potential, based on known site locales from other areas and your field experience, including overlooks, river terrace and bluff edges, lake and stream margins, etc. Describe the location, extent, salient features, and tests (if applicable) for these locales, record these locations on USGS maps.

High archeological potential areas that should be investigated --

IV. Locate on maps where the survey team actually went on-the-ground, and location, number, size, and depth of test pits excavated and natural exposures examined. Describe the topographic setting, and relation to other physical features, such as lakes, streams, rivers, bluff, edges, nearby hills, elevation, etc., for sterile test pits.

Sites found in locale:

Number of shovel tests --

NAMES OF FIELD TEAM: (include relevant pages in fieldbook)

______	Date ______	______	Date ______
______	Date ______	______	Date ______
______	Date ______	______	Date ______
______	Date ______	______	Date ______
______	Date ______	______	Date ______
______	Date ______	______	Date ______

B.2 - SITE SURVEY FORM

ARCHEOLOGY
UNIVERSITY MUSEUM
UNIVERSITY OF ALASKA

AHRS NO.: ____________
SURVEY LOCALE NO.: ____________
UA NO.: ____________

CHECKED BY DATE

____
____
____

SUSITNA HYDROPOWER PROJECT

I. SITE LOCATION

A. USGS QUAD: Talkeetna Mountains ______ Scale: 1:63,360

B. AIR PHOTO REFERENCE: Roll ______ Frames ______

C. TWP ________, RNG ________, Seward Meridian

________ ¼ of the ________ ¼ of the ________ of Section ________

D. UTM: Zone 6 Easting ____________ Northing ____________

E. LATITUDE: ____ ° ____ ' ____ " LONGITUDE: ____ ° ____ ' ____ "

F. GEOLOGICAL UNIT: ________ No. ________

G. REGION: Devil Canyon ______ Watana ______ Other: ________

II. ENVIRONMENT:

A. Site morphology. (See back of form for information required.)

B. Surrounding terrain morphology. (See back of form for information required.)

C. Ecosystem. (See back of sheet for descriptions.)

1. _______ Moist Tundra _______ High Brush _______ Other: ______________

_______ Lowland spruce-hardwood _______ Upland spruce-hardwood

2. Site vegetation and surface description:

3. Vegetation in surrounding area and surface description:

AHRS NO.:______________

III. SITE:

A. Description:

1. Characteristics. (lithic scatter, stratified site, cabin, etc.)

number of shovel tests

number of test pits

(indicate on map)

2. Number, size and spatial relationship of features, etc.

3. Stratigraphy (if relevant):

B. Artifact inventory.

1. Surface:

a. Artifacts collected:

____

____

____

b. Artifacts observed but not collected:

____

____

____

____

2. Systematically excavated artifacts:

____

____

____

____

C. Period: _____ Unknown _____ Precontact

_____ Historic: Native _____ Non-Native _____

D. Size:

1. Observed Size: _____ x _____ meters

Justification for boundaries:

____

____

____

2. Estimated Size: _____ x _____ meters

Justification for boundaries:

____

____

____

E. Site disturbance (current and anticipated). Indicate expected effect of the hydroelectric project on the site.

1. Natural: ______________________________________

____

____

____

2. Human: ______________________________________

____

____

____

AHRS NO.________________

F. What prompted you to survey this location?

____

____

____

____

G. Draw and attach map(s) of site with location of tests and surface features; soi profile(s); and general location and vegetation map.

IV. PHOTOGRAPHIC RECORD: Roll#_____

Frame #	Direction	Content
		Site ID with date and Crew

V. CREW: (include relevant pages in fieldbook)

A. Names: ____________, ____________, ____________

____________, ____________, ____________

____________, ____________, ____________

B. Date(s) visited: ________________________

VI. Field Recommendation for further testing:

____

____

____

____

II. A. Site morphology.

1. What terrain feature is the site on: flat plain, sloping plain, continuous ridge, hill, point, shoreline, terrace, valley, etc.
2. What is the topographic context:
   a. no topographic relief relative to surrounding terrain, higher topographic relief than surrounding terrain, lower topographic relief than surrounding terrain.
   b. give elevation: 1) above sea level; 2) Relative to surrounding terrain.
3. Is the terrain feature continuous or discrete?
4. What is the size, shape and direction of this feature?
5. What is the relative position of the site on this feature?
6. Field of view:
   a. direction and range of view;
   b. what is in view?
   c. would a change in the present vegetation increase or decrease view? How?
7. Describe any special attributes that make this site location unique.
8. Are there other settings similar to that of this site in the unit? Where?

II. B. Surrounding terrain morphology.

Describe surrounding landforms and water features in relation to the site. What is the direction, distance and difference in elevation of surrounding features? The following characteristics should provide a guide:

1. Streams and rivers:
   a. proximity to site
   b. access from site
   c. are any in view from site?
   d. has downcutting created valley wall constriction in this area?
   e. is stream or river (1) shallow with rapids and sandbars, or (2) deep and smooth in this vicinity, etc.
   f. is water clear or turbid?
   g. what is the general width in this vicinity?
   h. is terracing present?
   i. in this area is the river course:
      1. straight;
      2. bending;
      3. serpentine.
   j. are confluences with other streams or rivers nearby? How far?
   k. what kind of terrain does this stream or river drain? (lakes, hills, marsh)

2. Lakes:
   a. size in hectares using template.
   b. inlet present? outlet present?
   c. single lake or part of lake system?
   d. characterize terrain surrounding lake (low, wet, steep, etc.)
   e. is there any evidence that lake size is changing (vegetation overgrowth, old shorelines, etc.)
   f. characteristics of shoreline. Old shorelines present?

ECOSYSTEMS LIKELY TO BE ENCOUNTERED IN PROJECT AREA

MOIST TUNDRA: Moist tundra ecosystems usually form a complete ground cover and are extremely productive during the growing season. They vary from almost continuous and uniformly developed cottongrass tussocks with sparse growth of other sedges and dwarf shrubs to stands where tussocks are scarce or lacking and dwarf shrubs are dominant. Associated species are arctagrostis, bluejoint, tufted hairgrass, mosses, alpine azalea, wood rush, mountain-avens, bistort, low-growing willows, dwarf birch, Labrador tea, green alder, Lapland rosebay, blueberry and mountain cranberry.

HIGH BRUSH: These are dense to open deciduous brush systems. Floodplain thickets: The subsystem is similar from the rivers of the southern coastal areas to the broad-braided rivers north of the Brooks Range. It develops quickly on newly exposed alluvial deposits that are periodically flooded. The dominant shrubs are willows and alders. Associated shrubs are dogwood, prickly rose, raspberry, buffaloberry and high bush cranberry. Birch-alder-willow thickets: This subsystem is found near timberline in interior Alaska. It consists of resin birch, American green alder, thinleaf alder and several willow species. Thickets may be extremely dense, or open and interspersed with reindeer lichens, low heath type shrubs, or patches of alpine tundra ecosystems. Other associated species are Sitka alder, bearberry, crowberry, Labrador tea, spirea, blueberry and mountain cranberry.

UPLAND SPRUCE-HARDWOOD FOREST: This ecosystem is a fairly dense interior forest composed of white spruce, birch, aspen and poplar. Black spruce typically grows on north slopes and poorly drained flat areas. Root depths are shallow. Fire scars are common. White spruce averaging 40 to 80 feet in height and up to 16 inches in diameter occurs in mixed stands on south facing slopes and well drained soils; forms pure stands near streams. Aspen and birch average 50 feet in height. Poplar averaging 80 feet in height and 24 inches in diameter occurs in scattered stands along streams. Undergrowth consists of mosses with grasses on drier sites and with brush on moist slopes. Typical plants are willow, alder, ferns, rose, high and low bush cranberry, raspberry, current and horsetail.

LOWLAND SPRUCE-HARDWOOD FOREST: This ecosystem is a dense to open interior lowland forest of evergreen and deciduous trees, including extensive pure stands of black spruce. Black spruce are slow growing and seldom exceed 8 inches in diameter or 50 feet in height. Cones of this tree open after fire and spread abundant seed, enabling black spruce to quickly invade burned areas. The slow-growing stunted tamarack is associated with black spruce in the wet lowlands. It seldom reaches a diameter of more than 6 inches. Rolling basins and knolls in the lowlands have a varied mixture of white spruce, black spruce, paper birch, aspen and poplar. Small bogs and muskegs are found in the depressions. Undergrowth species include willow, dwarf birch, low bush cranberry, blueberry, Labrador tea, crowberry, bearberry, cottongrass, ferns, horsetail, lichens and a thick cover of sphagnum and other mosses. Large areas burned since 1900 are covered by willow brush and very dense black spruce sapling stands.

AFTER: Major Ecosystems of Alaska. Joint Federal-State Land Use Planning Commission for Alaska. July 1973.

B.3 - FIELD NOTEBOOK GUIDELINES SECTION

Locale/ Site:	SUSITNA HYDROELECTRIC PROJECT	Test:	
Topic:	INDEX	Level:	
Name:	H. TRUMAN	Date:	Page:

PAGE				DATE
	TLM 086			
1	NARRATIVE - SITE ORIENTATION			8-4
2	PLAN MAP	N107 E99	SURFACE	8-4
3	ARTIFACT SUMMARY	N107 E99	0-5 cm	8-4
4-5	SOIL DESCRIPTION	N107 E99	0-5 cm	8-4
6	PLAN MAP	N107 E99	5 cm	8-5
7	NARRATIVE - FEATURES	N107 E99	5-10 cm	8-5
8	ARTIFACT SUMMARY	N107 E99	5-10 cm	8-5
9	SOIL DESCRIPTION	N107 E99	5-10 cm	8-5
	SURVEY LOCALE 127			
10	NARRATIVE - SHOVEL TESTS			8-7
	TLM 269			
11	NARRATIVE - SITE DESCRIPTION			8-7
12	PROFILE - EAST WALL - TEST PIT 1			8-7
13	ARTIFACT SUMMARY - SCATTERS A, B, C			8-7

Figure B.3.1. Example of Index in Field Notebooks

Locale/ Site: S.L. 133

Test:

Level:

Topic: EXAMPLE NARRATIVE

Name: B. SALEEBY

Date: 7/4/83

Page: 10

TERRAIN AND VEGETATION	ARRIVED AT SURVEY LOCALE 133 AT 8:15a WITH BOB, STEVE, & NENA. LZ IN NW CORNER OF LOCALE. TERRAIN ON TOP OF BLUFF IS FAIRLY FLAT AND VEGETATED WITH DWARF BIRCH AND SCATTERED SPRUCE.
SHOVEL TESTS 1-5	PUT IN 5 SHOVEL TESTS ON BLUFF DISTINCT LAYERS OF DEVIL AND WATANA TEPHRAS WERE OBSERVED, WITH ANGULAR GRAVEL INTERSPERSED THROUGHOUT THE SEDIMENT. NO CULTURAL MATERIAL FOUND.
TLM 177	BOB FOUND A GRAY CHERT FLAKE IN A SHOVEL TEST ON THE BLUFF EDGE, SO WE BEGAN TO RECORD THE SITE.

Figure B.3.2. Example of Narrative Format Page

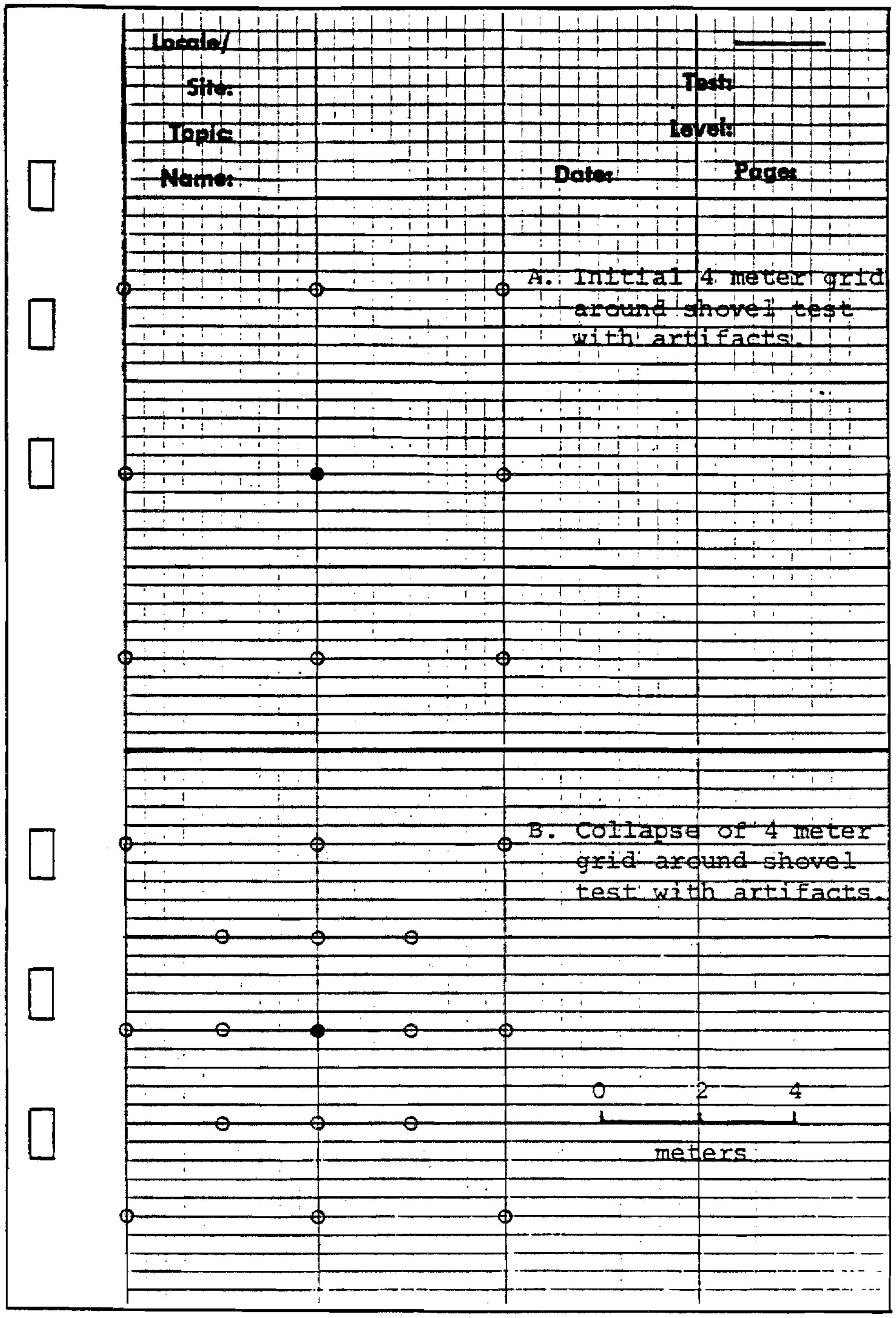


Figure B.3.3. Example of Shovel Test Expansion with Single Shovel Test with Cultural Material

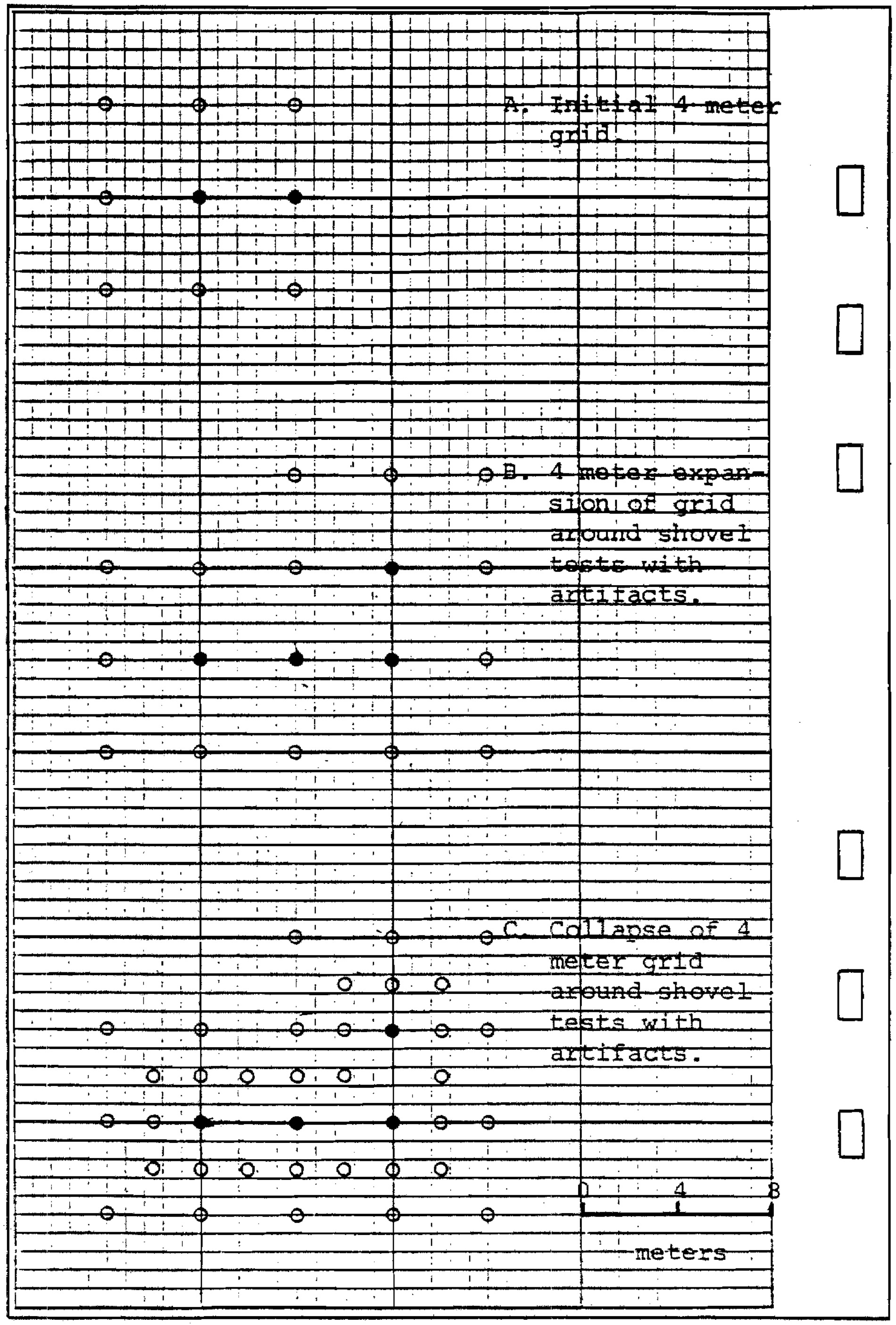
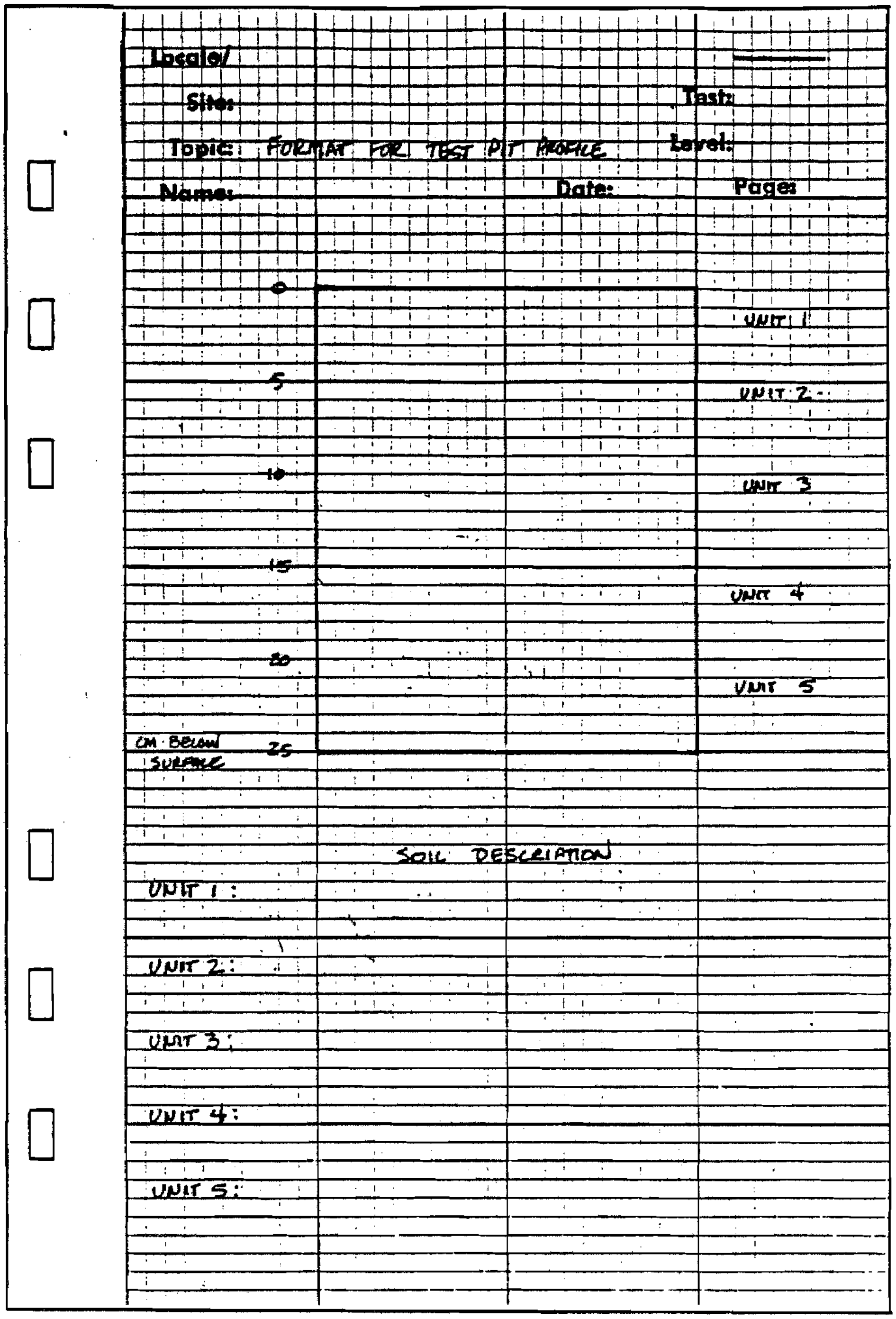


Figure B.3.4. Example of Shovel Test Expansion with Multiple Shovel Tests with Cultural Material



Locale/
Site:
Task:
Topic: FORMAT FOR TEST PIT PROFILE
Level:
Name:
Date:
Page:

0
5
10
15
20
25
CM BELOW SURFACE

UNIT 1
UNIT 2
UNIT 3
UNIT 4
UNIT 5

SOIL DESCRIPTION

UNIT 1:
UNIT 2:
UNIT 3:
UNIT 4:
UNIT 5:

Figure B.3.5. Format for Test Pit Profile

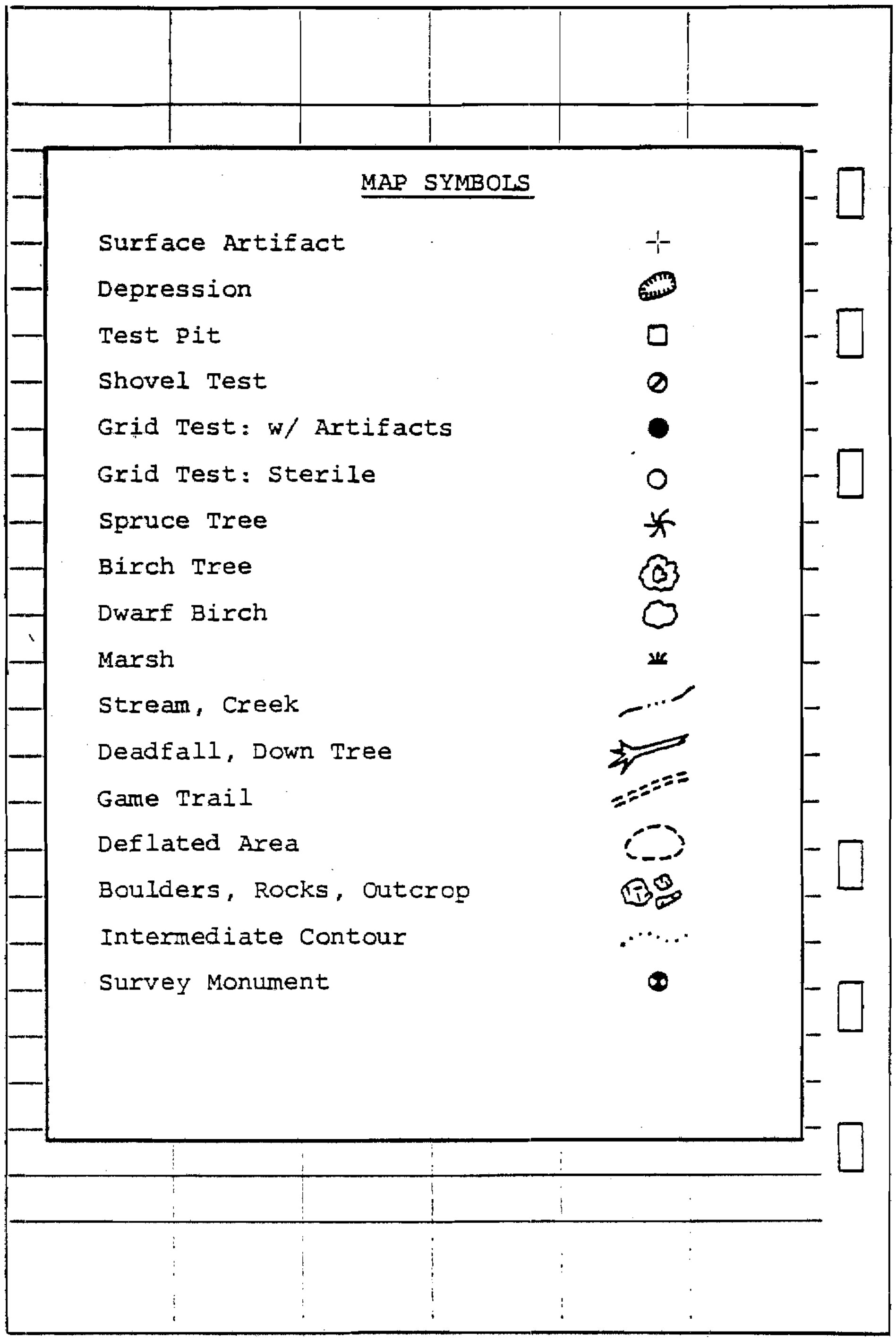


Figure B.3.6. Symbols Used for Survey Site Map

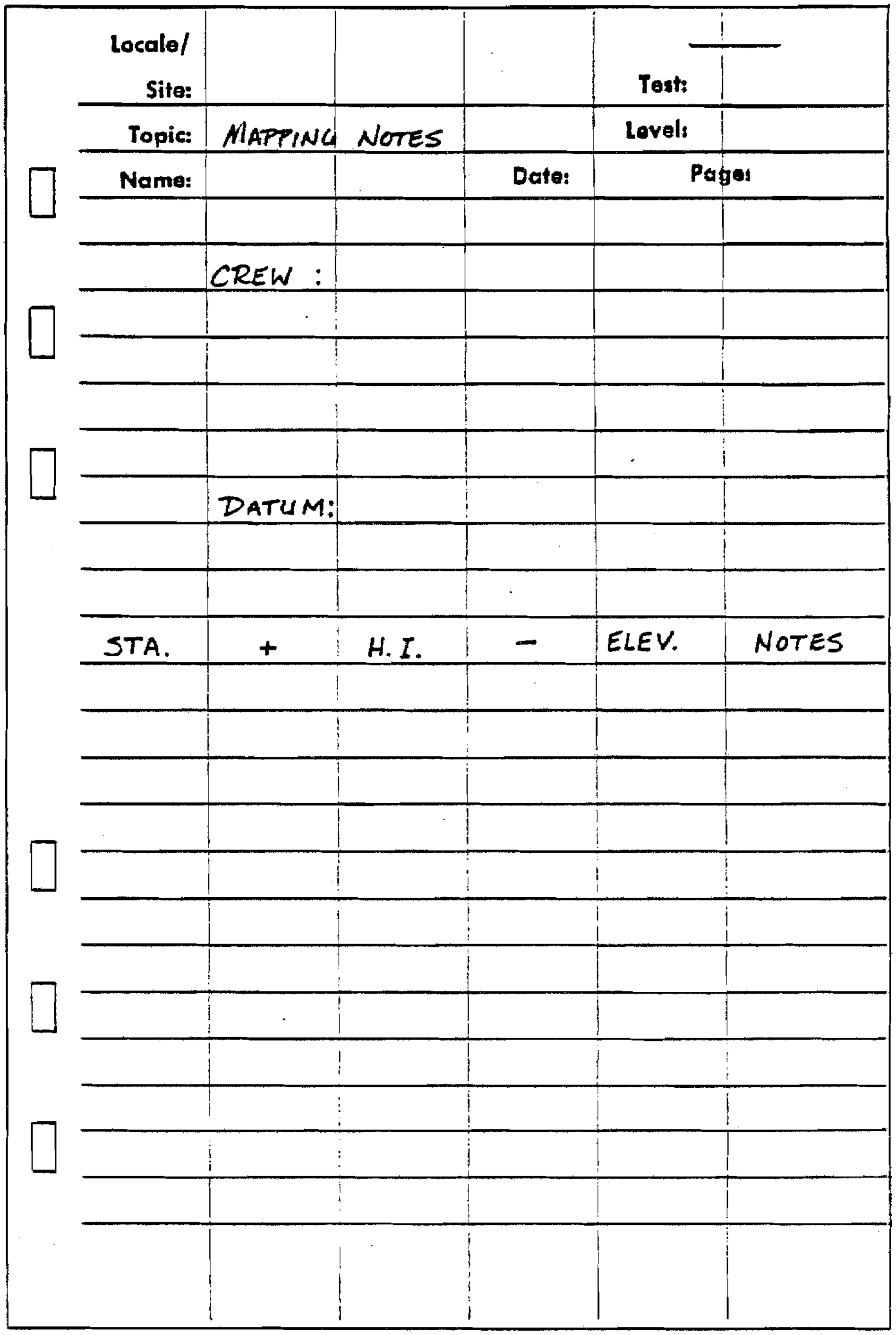


Figure B.3.7. Mapping Notes Format

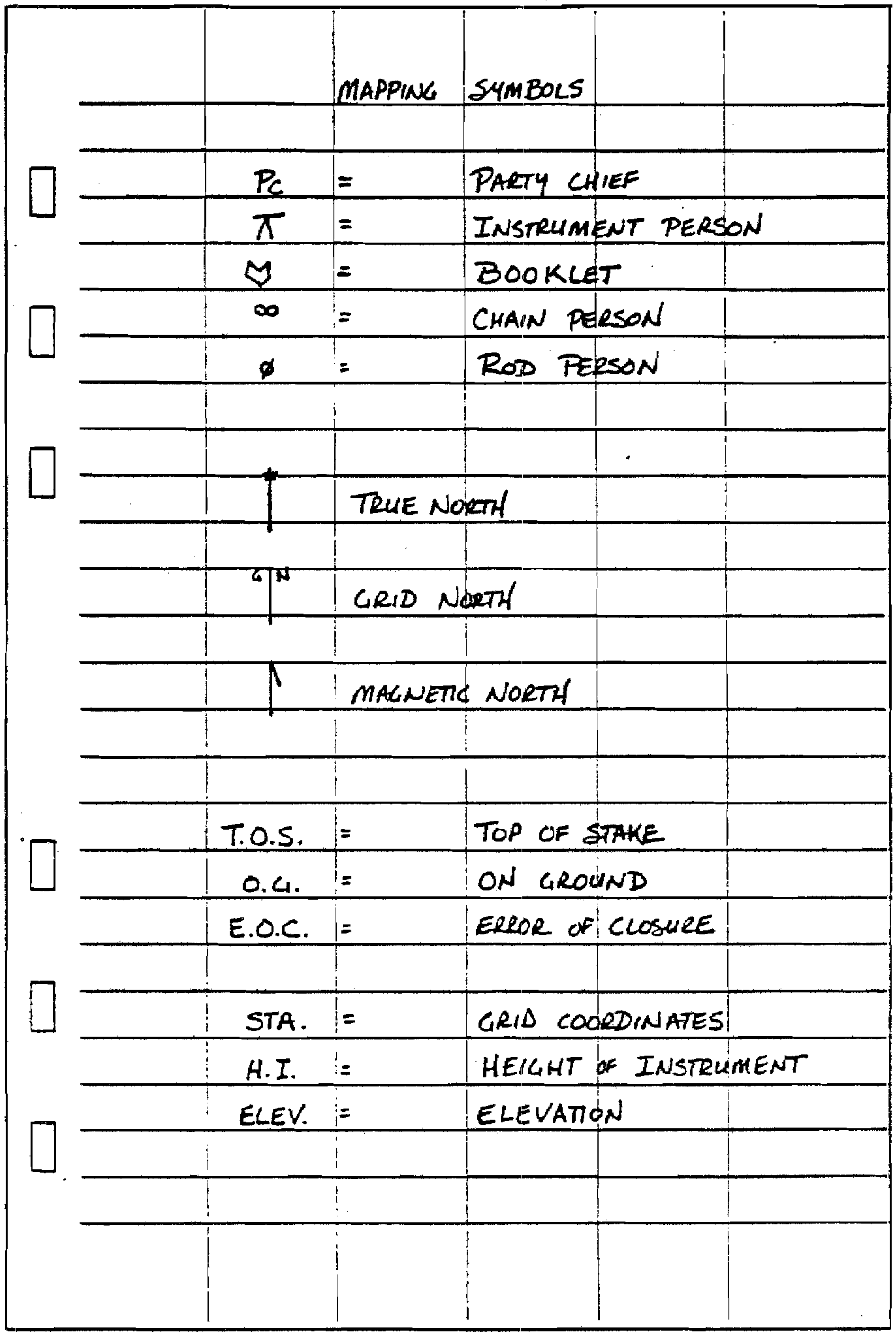


Figure B.3.8. Mapping Notes Symbols

Locale/ Site: TLM 321 | Test:

Topic: MAPPING NOTES | Level:

Name: | Date: | Page:

CREW :

Pc ÷ Ø C. UTERMOHLE

⊼ ÷ ♉ H. MASCHNER

∞ C. HEMPHILL

DATUM : SET AT N100 E100 NAIL IN HUB

GRID NORTH = TRUE NORTH

STA.	+	H.I.	—	ELEV.	NOTES
N100 E100				0^{00}	DATUM
	1^{32}	1^{32}			
N100 E100			1^{47}	-0^{15}	O.G.
N85 E100			3^{87}	-2^{55}	O.G.
N90 E100			2^{55}	-1^{23}	T.O.S.
N90 E100			2^{80}	-1^{48}	O.G.
N100 E100			1^{33}	-0^{01}	DATUM
					E.O.C. = -0^{01}

Figure B.3.9. Example of Mapping Notes

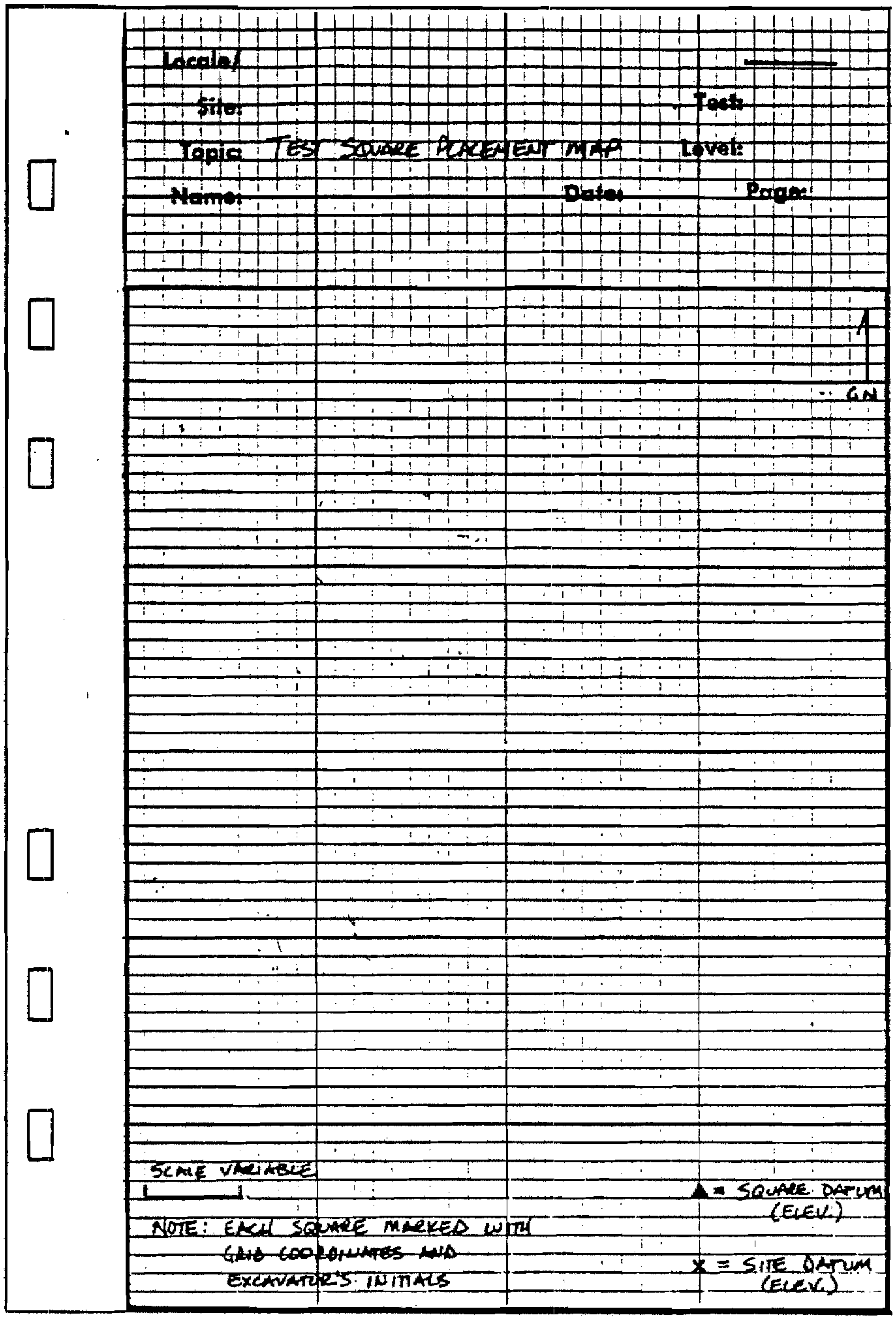


Figure B.3.10 Square Placement and Elevations Format

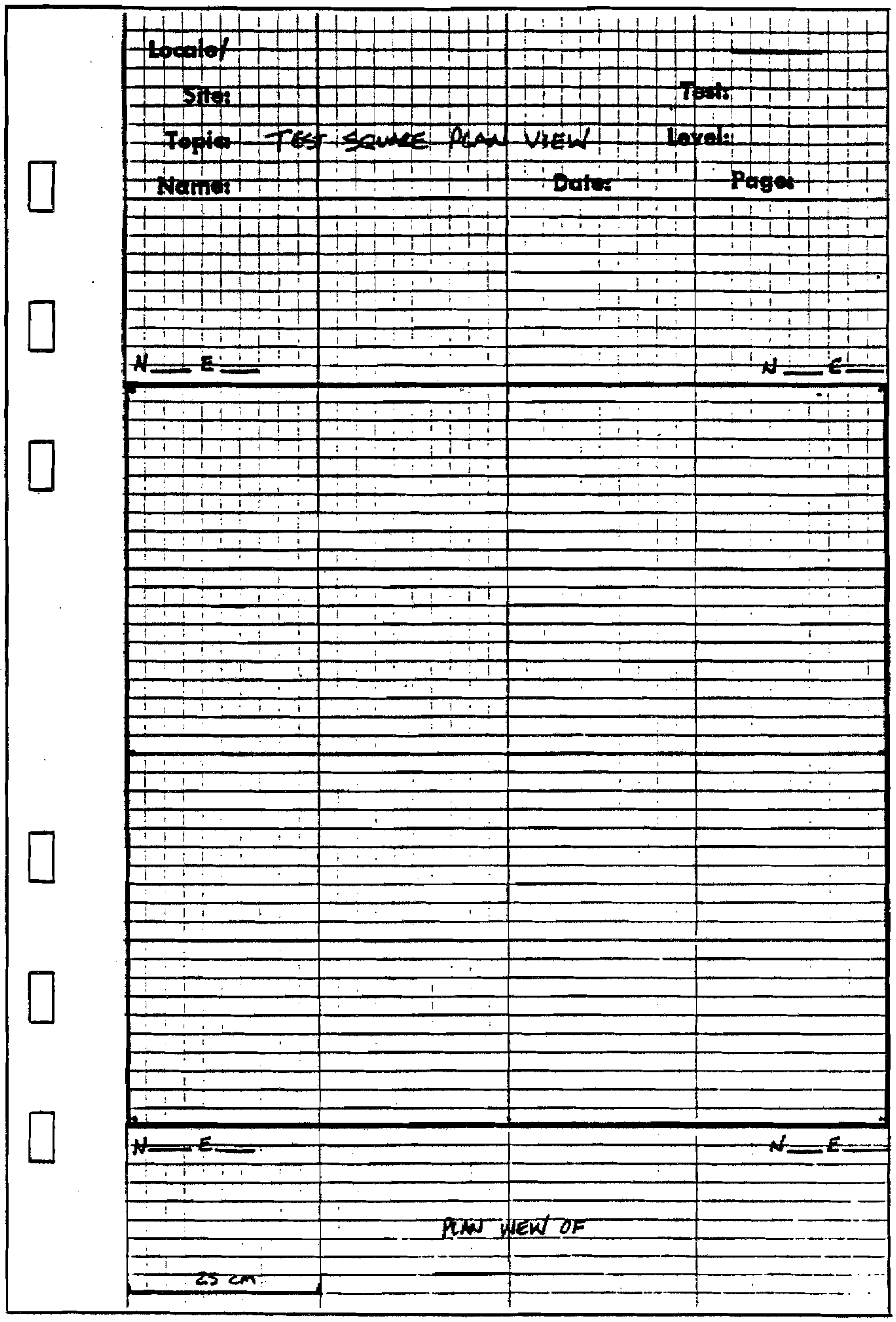


Figure B.3.11. Plan Map Format

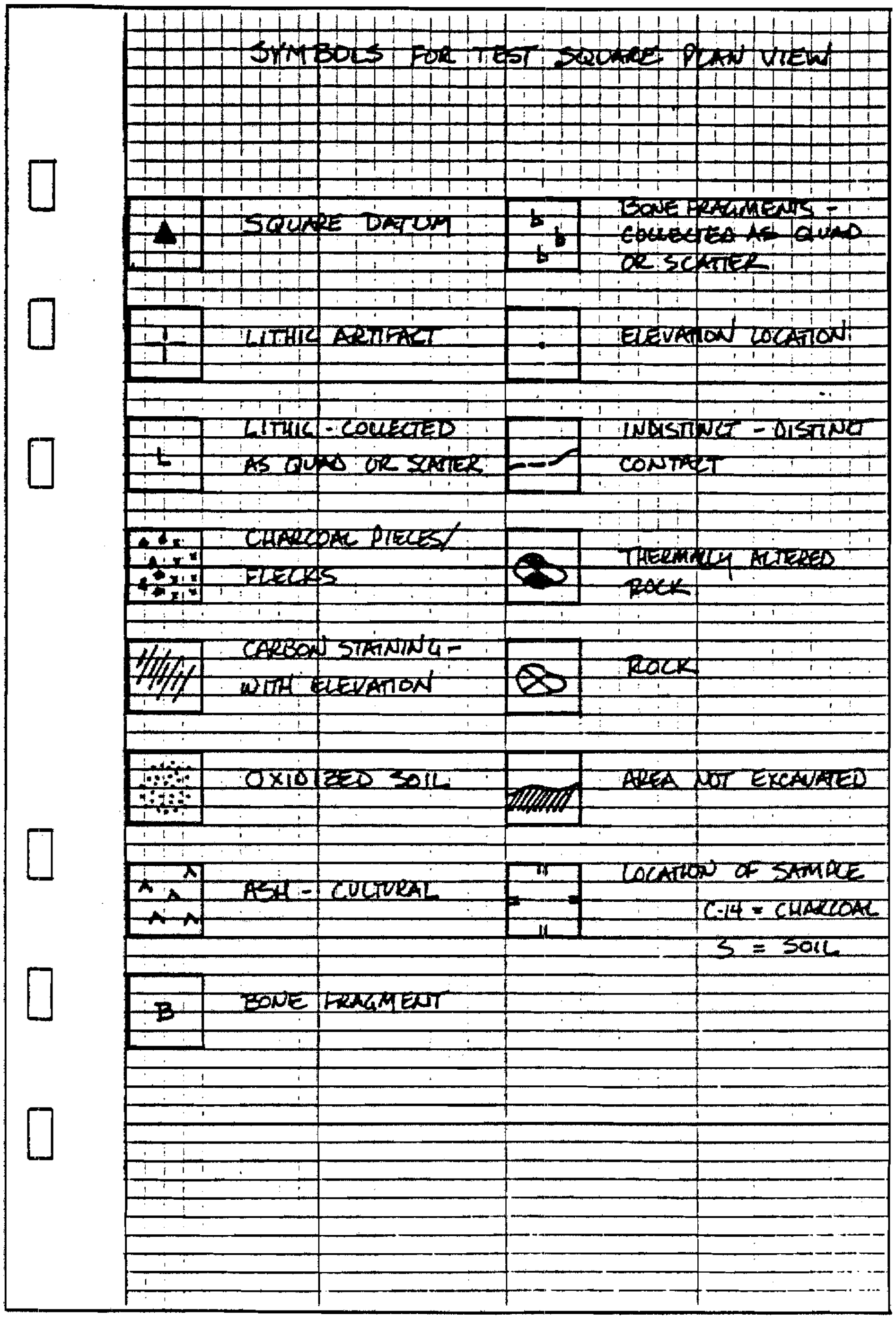


Figure B.3.12. Symbols Used on Plan Map

Locale/ Site:

Test:

Topic: ARTIFACT DESCRIPTION

Level:

Name:

Date:

Page:

PROVENIENCE	RAW MATERIAL	DESCRIPTION

Figure B.3.13. Artifact Description Format

ARTIFACT DESCRIPTION EXPLANATION

PROVENIENCE (IN cm)

N = DISTANCE FROM SOUTH WALL TO CENTER OF ARTIFACT

E = DISTANCE FROM WEST WALL TO CENTER OF ARTIFACT

D = DEPTH OF ARTIFACT AT ITS BASE

RAW MATERIAL	TOOL TYPES
ARGILLITE	UNMODIFIED FLAKES
BASALT	MODIFIED FLAKES
CHALCEDONY	SCRAPERS
CHERT	BLADES
OBSIDIAN	MICROBLADES
QUARTZ	BURINS
QUARTZITE	BURIN SPALLS
RHYOLITE	BIFACES
METAL	PREFORMS
GLASS	NOTCHED POINTS
WOOD	STEMMED POINTS
	LEAF SHAPED POINTS
	LANCEOLATE POINTS

Figure B.3.14. Artifact Description Guidelines

TOOL TYPES

TRIANGULAR POINTS
MICROBLADE CORE
MICROBLADE TABLET
BLADE CORE
REJUVENATION FLAKE
FLAKE CORE
HAMMERSTONES
ABRADERS
NOTCHED PEBBLES

FAUNAL MATERIAL

MAMMAL	COMPLETE	UNBURNED
BIRD	FRAGMENTARY	CALCINED
FISH		HEAVILY BURNED
UNIDENTIFIABLE		

Figure B.3.15. Artifact Description Guidelines (Continued)

Locale/
Site:

Test:

Topic: C-14 SAMPLE RECORD

Level:

Name:

Date:

Page:

FIELD #	SAMPLE DESCRIPTION
C.S. 1	

Figure B.3.16. C-14 Sample Recording Format

C-14 SAMPLE COLLECTION GUIDELINES

DESCRIPTION

A) PROVENIENCE - N, E, D (ALSO PLOTTED ON PLAN MAP) AND STRATIGRAPHIC UNIT

B) SAMPLE DESCRIPTION - i.e., CHARCOAL, BONE, WOOD, PEAT, ETC.; PRESENCE OR ABSENCE OF MATRIX IN SAMPLE.

C) ASSOCIATION WITHIN SQUARE (IN FEATURE, NEAR BONE CLUSTER, ETC.)

D) ESTIMATED AGE - i.e., LESS THAN 1800 B.P. (ABOVE DEVIL TEPHRA)

E) POSSIBLE CONTAMINATION - ROOTS, RODENT BURROW, ETC.

F) ARCHEOLOGICAL AND/OR GEOLOGICAL SIGNIFICANCE, i.e., UPPER LIMITING DATE FOR TEPHRA DEPOSIT, DATES UPPER COMPONENT, ETC.

Figure B.3.17. C-14 Sample Recording Guidelines

Locale/ Site:				Test:	
Topic:	SOIL DESCRIPTION			Level:	
Name:			Date:	Page:	
UNIT #	MUNSELL	UNIT DESCRIPTION			

Figure B.3.18. Soil/Sediment Description Format

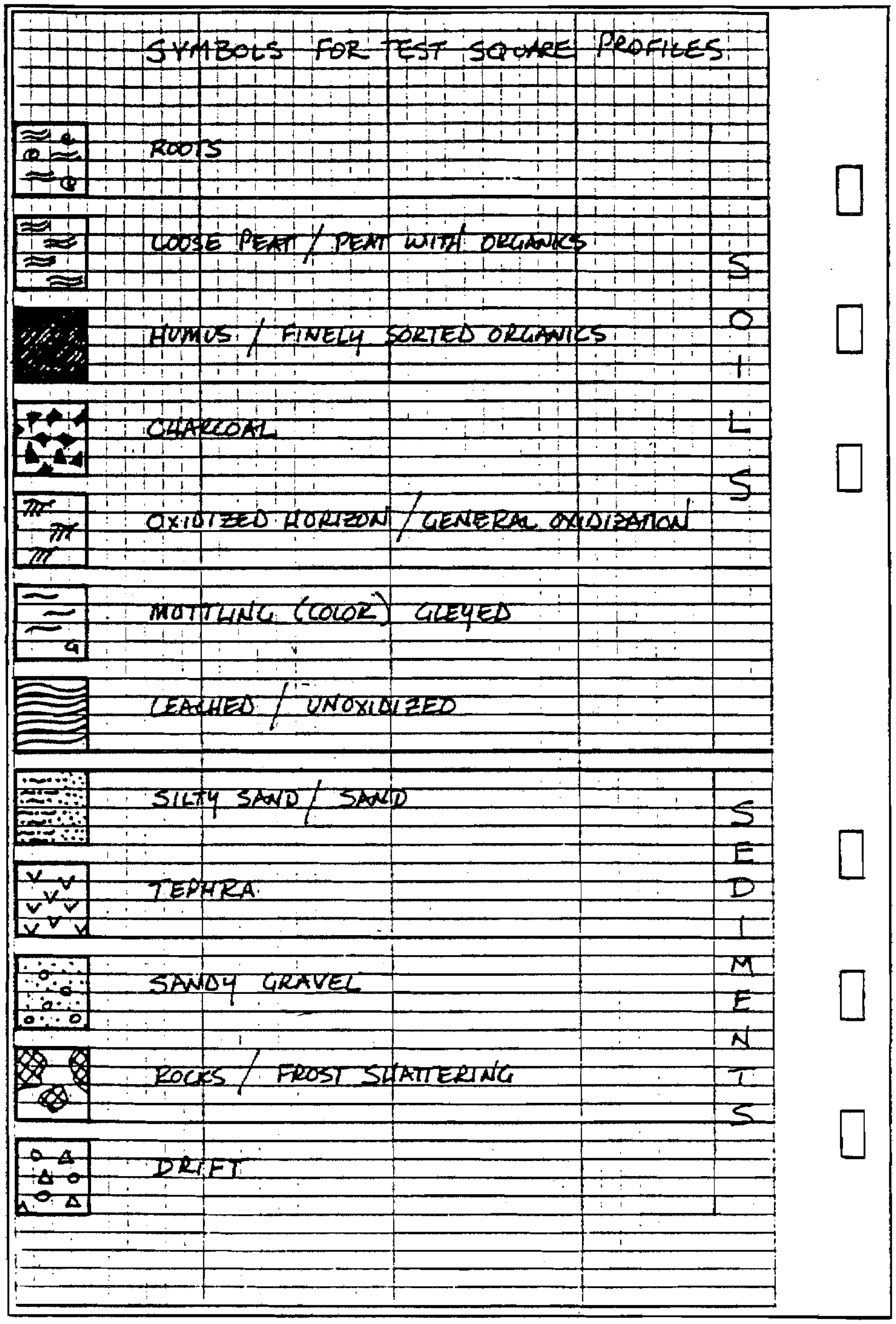


Figure B.3.19. Symbols Used for Wall Profiles

SOIL DESCRIPTION GUIDELINES

VARIABLES

SOIL : WET, DAMP, DRY

LIGHTING: OVERCAST, SUNNY, UNDER TARP

MUNSELL

HUE

VALUE / CHROMA

COLOR DESCRIPTION

DESCRIPTION

PARTICLE SIZE :	CLAY	—
	SILT	.0039 mm
	FINE SAND	.125 mm
	COARSE SAND	.25 mm
	GRANULE	.5 mm
	PEBBLE	2 mm
	COBBLE	65 mm
	BOULDER	250 mm

SOIL MOISTURE

TEXTURE

DEGREE OF SORTING

Figure B.3.20. Soil/Sediment Description Guidelines

NATURE OF CONTACTS:

THICKNESS - ABRUPT, CLEAR, GRADUAL, DIFFUSE

SHAPE - SMOOTH, WAVY, IRREGULAR, BROKEN

EXTENT OF UNITS: CONTINUOUS / DISCONTINUOUS

FROST FEATURES: PRESENT / ABSENT

CONDITION OF COBBLES: GRUS / BOULDERS / FRACTURES / POLISH / MAXIMUM SIZE OF COBBLES OR BOULDERS

ORGANICS (INCLUDING CHARCOAL): PRESENCE / ABSENCE

CULTURAL MATERIAL: PRESENCE / ABSENCE / IN SITU / INTRUSIVE

Figure B.3.21. Soil/Sediment Description Guidelines (Continued)

Locale/ Site:			Test:
Topic:	PHOTO LOG		Level:
Name:		Date:	Page:
	ROLL #	(B&W OR COLOR)	

EXPOSURE #	SITE LOCATION	DIRECTION	SUBJECT

Figure B.3.22. Photo Log Format

Locale/ Site:		Test:
Topic:	CHECKLIST FOR SURVEY LOCALE DATA SHEETS	Level:
Name:	Date:	Page:

DATA SHEET	REFERENCE
NARRATIVE PAGES	
SURVEY LOCALE FORM	
SURVEY LOCALE MAP	
AHRS NUMBER(S)	
ENTERED BY	
CHECKED BY	

Figure B.3.23. Checklist for Survey Locale Data Sheets

Locale/ Site:

Test:

Topic: CHECKLIST FOR SITE DATA SHEETS (SURVEY TESTING)

Level:

Name:

Date:

Page:

DATA SHEET	REFERENCE
NARRATIVE PAGES	
SITE FORM	
SITE MAP	
PROFILE	
DRAFT NARRATIVE	

SITE PLOTTED: UTM MASTER MAP

OTHER MAPS

ENTERED BY

CHECKED BY

Figure B.3.24. Checklist for Site Data Sheets (Survey Testing)

Locale/ Site:				Test:	
Topic:	CHECKLIST FOR SITE DATA SHEETS (SYSTEMATIC TESTING)			Level:	
Name:			Date:		Page:
DATA SHEET					REFERENCE
PLACEMENT & ELEVATION OF TEST SQUARES					
FIELD NUMBERS (CHARCOAL)					
FIELD NUMBERS (TEPHRA / SOIL)					
OTHER					
			ENTERED BY		
			CHECKED BY		

Figure B.3.25. Checklist for Site Data Sheets (Systematic Testing)

Locale/ Site:

Test:

Topic: CHECKLIST FOR TEST SQUARE DATA SHEETS (SYSTEMATIC TESTING)

Level:

Name:

Date:

Page:

STRAT. UNIT	PLAN MAP	NARRATIVE	ARTIFACT DESCRIPTION	C-14 DATA	OTHER
			ENTERED BY		
			CHECKED BY		

Figure B.3.26. Checklist for Test Square Data Sheets

Locale/ Site:				Test:	
Topic:	CHECKLIST FOR PROFILES AND SOIL DESCRIPTIONS (SYSTEMATIC TESTING)			Level:	
Name:			Date:	Page:	

TEST SQUARE	SOIL DESCRIPTION	NORTH WALL	SOUTH WALL	EAST WALL	WEST WALL
			ENTERED BY		
			CHECKED BY		

Figure B.3.27. Checklist for Profiles and Soil/Sediment Descriptions

B.4 - SITE DATA CODING FORM

SITE DATA CODING FORM

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
1				
	1	QUAD	1	Talkeetna Mountains (TLM)
			2	Healy (HEA)
			3	Fairbanks (FAI)
			4	Tyonek (TYO)
			5	Anchorage (ANC)
	2-4	AHRS #	N	Three digits
	5	Locus	N	One digit (1=A, 2=B, ...)
	6	Quad Letter	1	A
			2	B
			3	C
			4	D
	7	Quad Number	N	(e.g., D-5)
	8-13	UTM Easting	N	Six digits
	14-20	UTM Northing	N	Seven digits
	21	Testing Level (highest)	0	AHRS files
			1	Survey
			2	Survey & grid
			3	Systematic
			4	Systematic & grid
	22-25	Elevation	N	Feet
	26	Method	0	Map
			1	Altimeter
	27-31	Observed Site Size	N	Square meters
	32	Method	0	Other than grid testing
			1	Grid testing
	33-36	Estimated Site Size	N	Square meters

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
1				
	37-38	Terrain Unit	1	Bxu - Unweathered, consolidated bedrock
			2	C - Colluvial deposits
			3	Cl - Landslide deposits
			4	Cs-f - Solifluction deposits
			5	Ffg - Granular alluvial fan
			6	FP - Floodplain deposits
			7	Fpt - Terrace
			8	GFo - Outwash deposits
			9	GFe - Esker deposits
			10	GFk - Kame deposits
			11	Gta - Ablation till
			12	Gtb-f - Basal till (frozen)
			13	O - Organic deposits
			14	L-f - Lacustrines (frozen)
			15	L/Gta-f - Lacustrine sediments over ablation till (frozen)
			16	L/Gtb-f - Lacustrine deposits over basal till (frozen)
			17	Cs-f/Gtb-f - Solifluction deposits (frozen) over basal till (frozen)
			18	Cs-f/Gta - Solifluction deposits (frozen) over ablation till
			19	Cs-f/Fpt - Solifluction deposits (frozen) over terrace sediments
			20	Cs-f/Bxu - Solifluction deposits (frozen) over bedrock
			21	Gtb-f/Bxu - Frozen basal till over bedrock
			22	Gta/Bxu - Ablation till over unweathered bedrock
			23	C/Bxu + Bxu - Colluvium over bedrock and bedrock exposures
			24	C/Bxw + Bxw - Colluvium over weathered, poorly consolidated bedrock
			0 or 25	Unknown

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
1				
	39-40	Vegetation (After UA Experimental Station)	1	R - Rock
			2	MCT - Mat and cushion tundra
			3	SGT - Sedge grass tundra
			4	WSG - Wet sedge grass
			5	OSB - Open black spruce
			6	WSB - Woodland black spruce
			7	OSW - Open white spruce
			8	WSW - Woodland white spruc
			9	CBF - Closed birch forest
			10	OBF - Open birch forest
			11	CP - Closed balsam poplar
			12	OP - Open balsam poplar
			13	CM - Closed mixed forest
			14	OM - Open mixed forest
			15	CTS - Closed tall shrub
			16	OTS - Open tall shrub
			17	B - Birch shrub
			18	W - Willow shrub
			19	LS - Low shrub
			20	G - Grassland
			0 or 21	Unknown
	41-42	Landform	1	Plain - flat
			2	Plain - sloping
			3	Mountain, hill, etc.
			4	Crag and tail
			5	Kame
			6	Esker
			7	Kettle
			8	Moraine
			9	Terrace - river
			10	Terrace - kame
			11	Ridge
			12	Saddle
			13	Valley
			14	Lake shore
			15	Stream margin
			16	Stream confluence
			17	Lake outlet/inlet
			18	Floodplain

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
1				
		Proximity Terrain features within 1 km		
			0	Absent
			1	Present
	43	Lakes	N	
	44	Streams	N	
	45	Rivers and major Tributaries	N	
	46	Wetlands	N	
	47	Mineral licks	N	
	48-50	NOT USED		
	51-52	Land Status	0	U - Unknown
			1	PR - Private
			2	VS - Village Section
			3	VS-Ch - Village Selection Chickaloon
			4	VS-Kn - Village Selection Knik
			5	VS-Ty - Village Selection Tyone
			6	BA - Borough Approved or Patented
			7	SP - State Patented
			8	SS - State Selected
			9	SSS - State Selected Suspended
			10	F-BLM - BLM
			11	F-USAF - U.S. Airforce
			12	F-USAR - U.S. Army
			13	AK - Alaska Railroad
		Testing Frequency		
	53-54	Survey Shovel Tests	N	
	55	Test pits	N	
	56-58	Grid shovel Tests	N	
	59-60	Test Squares	N	

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
1				
		Testing and Accession Numbers		
				Testing Level
			0	Not tested
			1	Survey only
			2	Survey &/ Grid
			3	Sustematic (+/- survey)
			4	Systematic & Grid (+ or - survey)
	61	1980 Testing Level		
	62-64	UA80-	N	Accession Number (3 digits)
	65	1981 Testing Level		
	66-68	UA81-	N	Accession Number (3 digits
	69	1982 Testing Level		
	70-72	UA82-	N	Accession Number (3 digits)
	73	1983 Testing Level		
	74-76	UA83-	N	Accession Number (3 digits
	77	1984 Testing Level		
	78-80	UA84-	N	Accession Number (3 digits

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
2				
	1	Card number	2	
		Stratigraphic Units Present		
			0	Absent
			1	Present
	2	Unknown Surface		
	3	Surface		
	4	Organics (current)		
	5	Organic silt (current)		
	6	Eolian or other		
	7	Organics (buried)		
	8	Organic silt (buried)		
	9	Devil tephra		
	10	Eolian sand or other		
	11	Watana tephra (oxidized or unknown)		
	12	Watana tephra (unoxidized)		
	13	Paleosol, eolian, or other		
	14	Oshetna tephra		
	15	Eolian sand		
	16	Paleosol or other		
	17	Eolian sand		
	18	Drift		
	19	Bedrock		
	20	Unknown subsurface		
		STRATIGRAPHIC POSITION		
		Upper Limit	1	Unknown Surface
	21-22	Unit code	2	Surface
	23-24	/unit code	3	Organics (current)
			4	Organic silt (current)
		Lower Limit	5	Eolian sand or other
	25-26	Unit code	6	Organics (buried)
	27-28	/unit code	7	Organic silt (buried)
			8	Devil tephra
	Note: use same code in both positions if not a contact.		9	Eolian sand or other
			10	Watana tephra (oxidized)
			11	Watana tephra (unoxidized)
			12	Paleosol, eolian, or other
			13	Oshetna tephra
			14	Eolian sand
			15	Paleosol or other
			16	Eolian sand
			17	Drift
			18	Bedrock
			19	Unknown subsurface

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
2				
		Dates from site		
		Upper Limiting Date		
	29-32	B.P.		
	33-35	S.D.		
		Unit Date		
	36-39	B.P.		
	40-42	S.D.		
		Lower Limiting Date		
	43-46	B.P.		
	47-49	S.D.		
		UNIDENTIFIABLE MAMMAL BONES		
		Medium - large mammal		
	50-51	Skull - burned/calcined		
	52-53	" unburned		
	54-55	Axial - burned/calcined		
	56-57	" unburned		
	58-59	Other identified elements - burned/calcined		
	60-61	" " " unburned		
	62-65	Unidentified elements - burned/calcined		
	66-69	" " - unburned		
		Small - medium mammal		
	70-71	Total number of bones burned/calcined		
	72-73	" " " " unburned		
		Mammal (unidentified)		
	74-75	Total number of bones burned/calcined		
	76-77	" " " " unburned		
		Other bones (bird & miscellaneous)		
	78-79	Total number of bones		
	80	First card set for site	0	No
			1	Yes

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
3				
	1	Card Number	3	
		Caribou		
		Skull & antler		
	2-3	Positive - burned/calcined		
	4-5	" - unburned		
	6-7	Tentative - burned/calcined		
	8-9	" - unburned		
		Axial (ribs & vertebrae)		
	10-11	Positive - burned/calcined		
	12-13	" - unburned		
	14-15	Tentative - burned/calcined		
	16-17	" - unburned		
		Shoulder & pelvic girdles		
	18-19	Positive - burned/calcined		
	20-21	" - unburned		
	22-23	Tentative - burned/calcined		
	24-25	" - unburned		
		Limbs		
	26-27	Positive - burned/calcined		
	28-29	" - unburned		
	30-31	Tentative - burned/calcined		
	32-33	" - unburned		
		Extremities		
	34-35	Positive - burned/calcined		
	36-37	" - unburned		
	38-39	Tentative - burned/calcined		
	40-41	" - unburned		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
3				
		MOOSE		
		Skull & antler		
	42	Positive - burned/calcined		
	43	" - unburned		
	44	Tentative - burned/calcined		
	45	" - unburned		
		Axial (ribs & vertebrae)		
	46	Positive - burned/calcined		
	47	" - unburned		
	48	Tentative - burned/calcined		
	49	" - unburned		
		Shoulder & pelvic girdles		
	50	Positive - burned/calcined		
	51	" - unburned		
	52	Tentative - burned/calcined		
	53	" - unburned		
		Limbs		
	54	Positive - burned/calcined		
	55	" - unburned		
	56	Tentative - burned/calcined		
	57	" - unburned		
		Extremities		
	58	Positive - burned/calcined		
	59	" - unburned		
	60	Tentative - burned/calcined		
	61	" - unburned		
		OTHER IDENTIFIABLE MAMMALS		
	62	Number of species		
	63-64	Number of bones		
	65	FLORA		
			0	None
			1	Seeds
			2	Macrofossils
			3	Seeds & macrofossils
			4	Charred seeds
			5	Charred macrofossils (charcoal)
			6	Charred seeds & macrofossils

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
3				
		Non-lithic Artifacts		
	66-67	Bone/antler	N	Number
	68-69	Metal	N	Number
	70-71	Glass	N	Number
	72-73	Wood	N	Number
	74	Other	N	Number
		Features		
			0	Absent
			1	Possibly present
			2	Present
	75	Cultural depression		
	76	Hearth		
	77	Historic structure (e.g., cabin, grave, mine, etc.)		
	78	Stone feature		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
4				
	1	Card Number	4	
		Collected Lithic Artifacts by Raw Material (Greater than 1/8")		
		Unmodified Flakes		
	2-6	Argillite		
	7-11	Basalt		
	12-15	Chalcedony		
	16-19	Chert		
	20-23	Obsidian		
	24-27	Quartz		
	28-31	Quartzite		
	32-34	Rhyolite		
	35	Igneous		
	36	Metamorphic		
	37	Sedimentary		
		Modified Flakes		
	38-39	Argillite		
	40-41	Basalt		
	42-43	Chalcedony		
	44-45	Chert		
	46-47	Obsidian		
	48-49	Quartz		
	50-51	Quartzite		
	52-53	Rhyolite		
	54	Igneous		
	55	Metamorphic		
	56	Sedimentary		
		Scrapers		
	57-58	Argillite		
	59-60	Basalt		
	61-62	Chalcedony		
	63-64	Chert		
	65-66	Obsidian		
	67-68	Quartz		
	69-70	Quartzite		
	71-72	Rhyolite		
	73	Igneous		
	74	Metamorphic		
	75	Sedimentary		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
5				
	1	Card Number	5	
		Blades		
	2-3	Argillite		
	4-5	Basalt		
	6-7	Chalcedony		
	8-9	Chert		
	10-11	Obsidian		
	12-13	Quartz		
	14-15	Quartzite		
	16-17	Rhyolite		
	18	Igneous		
	19	Metamorphic		
	20	Sedimentary		
		Microblades		
	21-22	Argillite		
	23	Basalt		
	24-25	Chalcedony		
	26-28	Chert		
	29-30	Obsidian		
	31	Quartz		
	32	Quartzite		
	33	Rhyolite		
	34	Igneous		
	35	Metamorphic		
	36	Sedimentary		
		Burins		
	37	Argillite		
	38	Basalt		
	39	Chalcedony		
	40	Chert		
	41	Obsidian		
	42	Quartz		
	43	Quartzite		
	44	Rhyolite		
	45	Igneous		
	46	Metamorphic		
	47	Sedimentary		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
5				
		Burin Spalls		
	48	Argillite		
	49	Basalt		
	50	Chalcedony		
	51	Chert		
	52	Obsidian		
	53	Quartz		
	54	Quartzite		
	55	Rhyolite		
	56	Igneous		
	57	Metamorphic		
	58	Sedimentary		
		Bifaces		
	59-60	Argillite		
	61-62	Basalt		
	63-64	Chalcedony		
	65-66	Chert		
	67-68	Obsidian		
	69-70	Quartz		
	71-72	Quartzite		
	73-74	Rhyolite		
	75	Igneous		
	76	Metamorphic		
	77	Sedimentary		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
6				
	1	Card Number	6	
		Preforms		
	2	Argillite		
	3	Basalt		
	4	Chalcedony		
	5	Chert		
	6	Obsidian		
	7	Quartz		
	8	Quartzite		
	9	Rhyolite		
	10	Igneous		
	11	Metamorphic		
	12	Sedimentary		
		Notched Points		
	13-14	Argillite		
	15-16	Basalt		
	17-18	Chalcedony		
	19-20	Chert		
	21-22	Obsidian		
	23-24	Quartz		
	25-26	Quartzite		
	27-28	Rhyolite		
	29	Igneous		
	30	Metamorphic		
	31	Sedimentary		
		Stemmed Points		
	32	Argillite		
	33	Basalt		
	34	Chalcedony		
	35	Chert		
	36	Obsidian		
	37	Quartz		
	38	Quartzite		
	39	Rhyolite		
	40	Igneous		
	41	Metamorphic		
	42	Sedimentary		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
6				
		Leaf-Shaped Points		
	43	Argillite		
	44	Basalt		
	45	Chalcedony		
	46	Chert		
	47	Obsidian		
	48	Quartz		
	49	Quartzite		
	50	Rhyolite		
	51	Igneous		
	52	Metamorphic		
	53	Sedimentary		
		Lanceolate Points		
	54	Argillite		
	55	Basalt		
	56	Chalcedony		
	57	Chert		
	58	Obsidian		
	59	Quartz		
	60	Quartzite		
	61	Rhyolite		
	62	Igneous		
	63	Metamorphic		
	64	Sedimentary		
		Triangular Points		
	65	Argillite		
	66	Basalt		
	67	Chalcedony		
	68	Chert		
	69	Obsidian		
	70	Quartz		
	71	Quartzite		
	72	Rhyolite		
	73	Igneous		
	74	Metamorphic		
	75	Sedimentary		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
7				
	1	Card Number	7	
		Microblade Cores		
	2	Argillite		
	3	Basalt		
	4	Chalcedony		
	5	Chert		
	6	Obsidian		
	7	Quartz		
	8	Quartzite		
	9	Rhyolite		
	10	Igneous		
	11	Metamorphic		
	12	Sedimentary		
		Microblade Tablets		
	13	Argillite		
	14	Basalt		
	15	Chalcedony		
	16	Chert		
	17	Obsidian		
	18	Quartz		
	19	Quartzite		
	20	Rhyolite		
	21	Igneous		
	22	Metamorphic		
	23	Sedimentary		
		Blade Cores		
	24	Argillite		
	25	Basalt		
	26	Chalcedony		
	27	Chert		
	28	Obsidian		
	29	Quartz		
	30	Quartzite		
	31	Rhyolite		
	32	Igneous		
	33	Metamorphic		
	34	Sedimentary		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
7				
		Rejuvenation Flakes		
	35	Argillite		
	36	Basalt		
	37	Chalcedony		
	38	Chert		
	39	Obsidian		
	40	Quartz		
	41	Quartzite		
	42	Rhyolite		
	43	Igneous		
	44	Metamorphic		
	45	Sedimentary		
		Flake Cores		
	46	Argillite		
	47	Basalt		
	48	Chalcedony		
	49	Chert		
	50	Obsidian		
	51	Quartz		
	52	Quartzite		
	53	Rhyolite		
	54	Igneous		
	55	Metamorphic		
	56	Sedimentary		
	57	Hammerstones		
	58	Abraders		
	59	Tci thos		
	60	Notched pebbles		
	61-63	Thermally altered rocks		
	64-66	Ochre		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
7				
		Cobbles and cobble fragments		
	67-68	Argillite		
	69-70	Basalt		
	71	Chalcedony		
	72-73	Chert		
	74	Obsidian		
	75	Quartz		
	76	Quartzite		
	77	Rhyolite		
	78-80	Other		
8				
		Land		
			1 = Present 0 = Absent	
	2	Plain - flat		
	3	Plain - sloping		
	4	Mountain, hill, etc.		
	5	Crag and tail		
	6	Kame		
	7	Esker		
	8	Kettle		
	9	Moraine		
	10	Terrace - river		
	11	Terrace - kame		
	12	Ridge		
	13	Saddle		
	14	Valley		
	15	Lake shore		
	16	Stream margin		
	17	Stream confluence - minor streams		
	18	Lake outlet/inlet		
	19	Floodplain		
	20	River Margin		
	21	Stream & river confluence		
	22	River & river confluence		

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
9				
		IMPACT ASSESSMENT FOR RESERVOIRS		
	1	Reservoir	0	N/A
			1	Devil
			2	Watana
	2	Proximity	0	N/A
			1	Immediate
			2	Adjacent
	3	Reservoir Zone	0	N/A
			1	1a
			2	1b
			3	2
			4	3
			5	4
			6	5
	4-8	Vertical Distance from Reservoir	#	Feet (else blank)
	9-13	Horizontal Distance from Reservoir	#	Feet (else blank)
		Expected Impact		
	14	Type	0	N/A
			1	Direct Impact
			2	Indirect Impact
			3	Potential Impact
			4	No Impact
	15	Category	0	N/A
			1	Mechanical
			2	Biological
			3	Human & other
	16	Level	0	N/A
			1	Large Scale
			2	Medium Scale
			3	Smale Scale

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
9				

IMPACT ASSESSMENT FOR OTHER PROJECT FEATURES AND FACILITIES

FEATURE AND AREA

0 Other
- 0 - None
- 1 - Found by nonarcheologists
- 2 - Found in association with facility, feature, or area which wasw subsequently modified, relocated, or deleted
- 3 - Found prior to project commencement
- 4 - Found during geoarcheology studies
- 5 - Found by archeologist but not within 1/2 mile of project facilities or features

1 Access Route (AR)
- 0 - (Not required)

2 Access Route Borrow (ARB)
- 0 - (Note required)

3 Borrow (B)
- 1 - Borrow Area C
- 2 - Borrow Area E
- 3 - Borrow Area F
- 4 - Borrow Area H
- 5 - Borrow Area I
- 6 - Borrow Area J

4 Geotechnical Area
- 0 - (Not Required)

5 Recreation Area (RA)
- 1 - Recreation Area D
- 2 - Recreation Area H
- 3 - Recreation Area I
- 4 - Recreation Area J
- 5 - Recreation Area K
- 6 - Recreation Area L
- 7 - Recreation Area Q

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
9				
		6 Railroad 0 - (Not required)		
		7 Transmission Route 1 - Healy to Fairbanks 2 - Willow to Anchorage 3 - Watana Dam to Intertie		
		8 Watana Construction Area 1 - Permanent Airstrip 2 - Watana Construction Camp 3 - Watana Construction Village 4 - Watana Dam		
		Proximity		
			0	N/A
			1	Immediate
			2	Adjacent
		Vertical Distance from Facility or Feature	#	Feet (else blank)
		Horizontal Distance from Facility or Feature	#	Feet (else blank)
		<u>Expected Impact</u>		
		Type	0	N/A
			1	Direct Impact
			2	Indirect Impact
			3	Potential Impact
			4	No Impact
		Category	0	N/A
			1	Mechanical
			2	Biological
			3	Human & other
		Level	0	N/A
			1	Large Scale
			2	Medium Scale
			3	Smale Scale

CARD #	COLUMNS	VARIABLE	CODES	DESCRIPTION
9				
		Feature or Facility 1		
	17	Feature		
	18	Area		
	19	Proximity		
	20-24	Vertical Distance		
	25-29	Horizontal Distance		
	30	Type		
	31	Category		
	32	Level		
		Feature or Facility 2		
	33	Feature		
	34	Area		
	35	Proximity		
	36-40	Vertical Distance		
	41-45	Horizontal Distance		
	46	Type		
	47	Category		
	48	Level		
		Feature or Facility 3		
	49	Feature		
	50	Area		
	51	Proximity		
	52-56	Vertical Distance		
	57-61	Horizontal Distance		
	62	Type		
	63	Category		
	64	Level		
		Feature or Facility 4		
	65	Feature		
	66	Area		
	67	Proximity		
	68-72	Vertical Distance		
	72-77	Horizontal Distance		
	78	Type		
	79	Category		
	80	Level		

APPENDIX C - TEPHRA ANALYSIS

APPENDIX C - TEPHRA ANALYSIS

C.1 - Introduction

Tephra (volcanic ash) layers were identified at most of the sites found during the cultural resources survey. At least three, and possibly four, tephras were identified in the field and samples were collected from various sites within the study area. Analysis was conducted on samples taken from terrestrial settings. Tephras found in lacustrine settings are discussed in Chapter 8.

The petrographic study discussed here was conducted to: 1) determine whether the soil/sediments identified in the field as tephra were, in fact, tephra; 2) characterize the mineralogy and glass shard morphology of the tephra; and 3) determine the number of tephras present. Successful discrimination of the tephras provided a method to correlate and date archeological components within the Susitna River valley.

The 29 samples analyzed were selected from ten systematically tested sites, distributed across 48 km adjacent to the Susitna River (Figure C.1). These specimens provided a representative suite of samples, both stratigraphically and geographically within the project area.(Table C.1). Analysis of these samples should accurately characterize the tephras present in the valley.

C.2 - Analytical Methods

The samples were prepared following the procedure suggested by Steen-McIntyre (1977). The volume of material used and the color of each sample (when moistened) were recorded. The samples were then rinsed several times in distilled water, and the suspended fines and floating organic material were decanted off. Three to five times the sample's volume of sodium hypochlorite (household bleach) was then added to each sample and the mixture heated in a boiling water bath for 15 minutes to remove any organic cementing agents (Steen-McIntyre 1977).

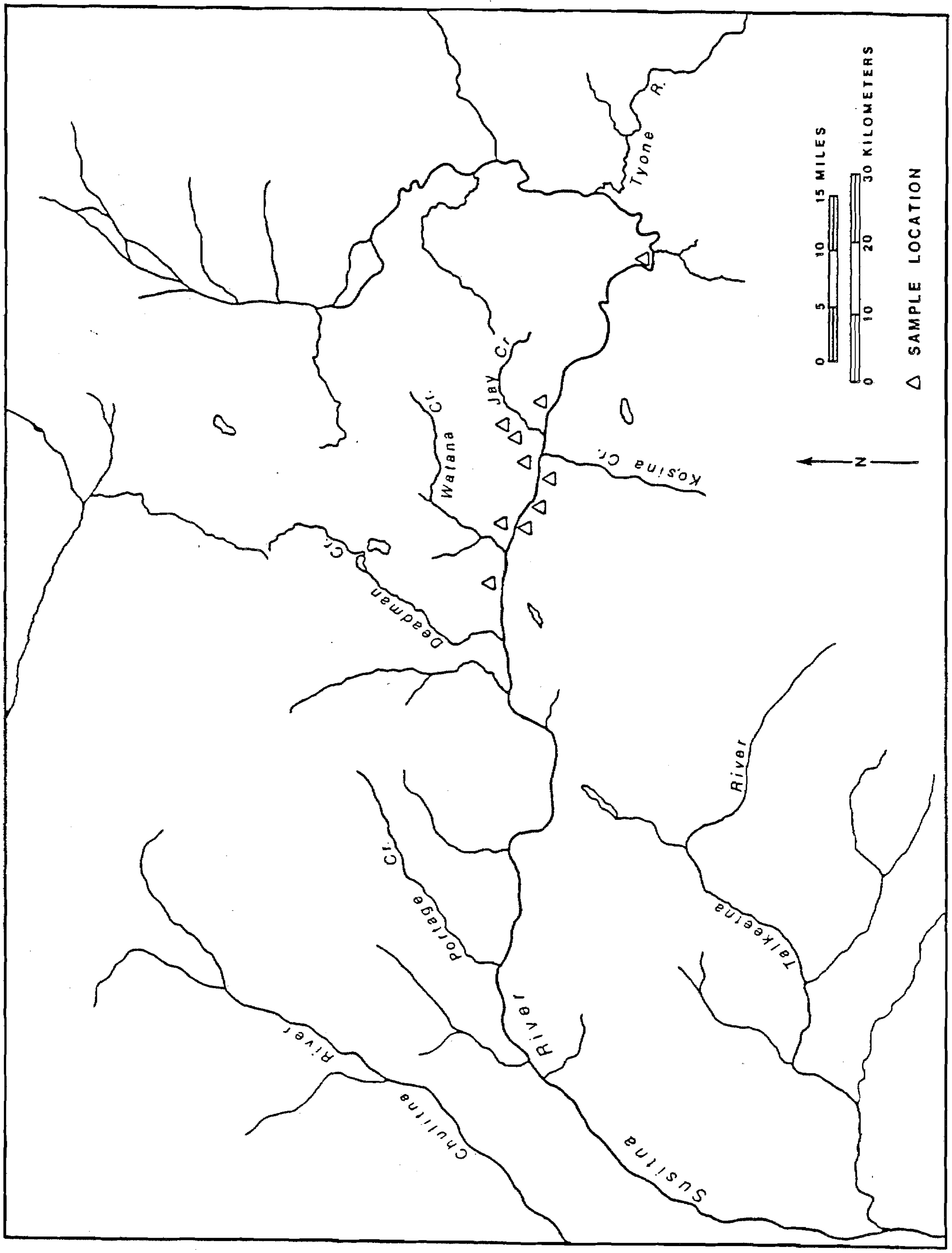


Figure C.1. Sample Location Map

Table C.1

Stratigraphic Location of Samples from the Susitna Tephras

Stratigraphic Location	Sample Sites TLM 039	TLM 040	TLM 042	TLM 043	TLM 046	TLM 062	TLM 069	TLM 128	TLM 130	TLM 143
Devil	X	X		X	X	X		X	X	X
Oxidized Watana	X		X					X	X	X
Unoxidized Watana	X				X		X	X	X	X
Oshetna	X	X		X	X	X	X	X	X	X

The liquid was then decanted off and the sample was rinsed once with distilled water. Suspended fines were again decanted off. A solution of 6 N hydrochloric acid was then added to the samples to dissolve iron oxide cement. After the acid was decanted off, the sample was rinsed twice with distilled water and air dried. After drying, the samples were sieved using 16 mesh (1 mm), 32 mesh (0.5 mm), 60 mesh (0.25 mm), and 250 mesh (0.062 mm) sieves. The volume of each size fraction was recorded. The sample size used in the petrographic analysis consisted of grains between 60 and 250 mesh (0.25 and 0.063 mm). This fraction was washed in distilled water in a sonic cleaner for 10 to 15 minutes. The procedure was then repeated using acetone, and then the sample was air dried. Once dry, this fraction was again screened using a 250 mesh sieve. The -250 mesh fraction was discarded, while the +250 mesh fraction was stored for analysis.

Grain mounts were made by mixing a small portion of each sample with several drops of histoclad on a glass slide, and allowing the histoclad to set. Each sample was mixed thoroughly before a small scoop of it was taken in an attempt to get a representative split.

Each sample was examined under binocular and petrographic microscopes. Four hundred to six hundred grain counts were made of 16 samples using Galehouse's (1969) area method. All grains within the field of view at 100x magnification were counted, and each sample had four fields of view counted. The percentage of mineral grains in each sample was then calculated.

Nineteen samples from the Devil, Oxidized Watana, and Unoxidized Watana tephras had 98 to 160 grain counts of their glass fraction to characterize the glass shard morphology of the tephras. Three samples were counted three times to test the reproducibility of the grain counts. The results are listed in Table C.2 and suggest that the grain counts are accurate to within ±6 percent.

Table C.2

Reproducibility of Glass Shard Counts

Sample	Count 1 % Scoria	Count 1 % Vesic.	Count 2 % Scoria	Count 2 % Vesic.	Count 3 % Scoria	Count 3 % Vesic.	Mean	Standard Deviation
ATC-0006	28.8	71.1	43.8	56.2	42.2	57.8	38.3	6.7
ATC-0015	28.7	71.3	50.5	49.5	51.5	48.5	43.6	10.5
ATC-0019	86.6	13.4	91.1	8.9	89.4	10.6	89.04	1.8

Where % scoria = percent scoriaceous glass shards; % vesic. = percent vesicular glass shards.

Eight samples were examined using a scanning electron microscope (SEM) to make a high magnification study of glass shard morphology. The eight samples were glued to aluminum stubs using a thinned carbon adhesive,and then coated with a thin layer of gold using an SPI sputter coater. The coater was run for eight minutes to reduce the amount of sample charging. Samples were scanned at 100x and then photographs were taken at higher magnification (220x to 1000x).

C.3 - Granulometric Analysis

Granulometric analyses were conducted on 15 samples. Many of the samples were too small (less than 5 milliliters) to conduct acceptable analyses. The results are listed in Table C.3 and are shown graphically in Figure C.2. The small standard deviation of the Oxidized Watana tephra is due to the small number of samples, and not to high precision of the data. The analyses indicate that the tephras are dominated by the fine silt and clay-sized fraction (-250 mesh). The coarse sand fraction generally represented an insignificant portion of the sample.

C.4 - Appearance Under Binocular Microscope

Glass appears as white grains under a binocular microscope. Transparent and translucent grains exhibit both cleavage surfaces and conchoidal fracture, suggesting that a portion of the transparent grains are feldspar.

(a) Devil Tephra

This tephra is dominated by white angular grains, followed in decreasing abundance by transparent and translucent grains, green laths, and opaque minerals. The white glass commonly mantles the green laths.

(b) Oxidized Watana Tephra

White glass shards are the dominant grain followed by transparent and translucent grains, green laths, and opaque minerals. White glass

Table C.3.

Grain Size Analysis for 15 Susitna Tephras

Sample #	Vol. % +60 mesh	Vol. % -60 +250 mesh	Vol. % -250 mesh	Stratigraphic Location
ATC-0001	3	17.4	79.6	Devil
ATC-0002	3	16.3	81.7	O. Watana
ATC-0003	0.0	22.1	77.9	U. Watana
ATC-0004	34.8	39.1	26.1	Oshetna
ATC-0006	tr	17.9	82.1	O. Watana
ATC-0007	tr	24.1	75.9	U. Watana
ATC-0008	tr	23.8	76.2	U. Watana
ATC-0009	3	23.6	73.4	Oshetna
ATC-0010	tr	20.0	80.0	Devil
ATC-0012	0.0	18.3	81.7	U. Watana
ATC-0013	tr	35.5	64.5	Oshetna
ATC-0017	tr	19.0	81.0	U. Watana

Table C.3. (Continued)

Sample #	Vol. % +60 mesh	Vol. % -60 +250 mesh	Vol. % -250 mesh	Stratigraphic Location
ATC-0019	0.0	36.9	63.1	U. Watana
ATC-0025	4.3	30.2	65.5	Devil
ATC-0028	3	19.8	77.2	Devil

Devil: Mean* = 21.9, Standard Deviation = 4.9
O. Watana: Mean* = 17.0, Standard Deviation = 1.1
U. Watana: Mean* = 24.0, Standard Deviation = 6.2
Oshetna: Mean* = 32.7, Standard Deviation = 6.5

* Mean of Vol. % - 60 ± 250 mesh

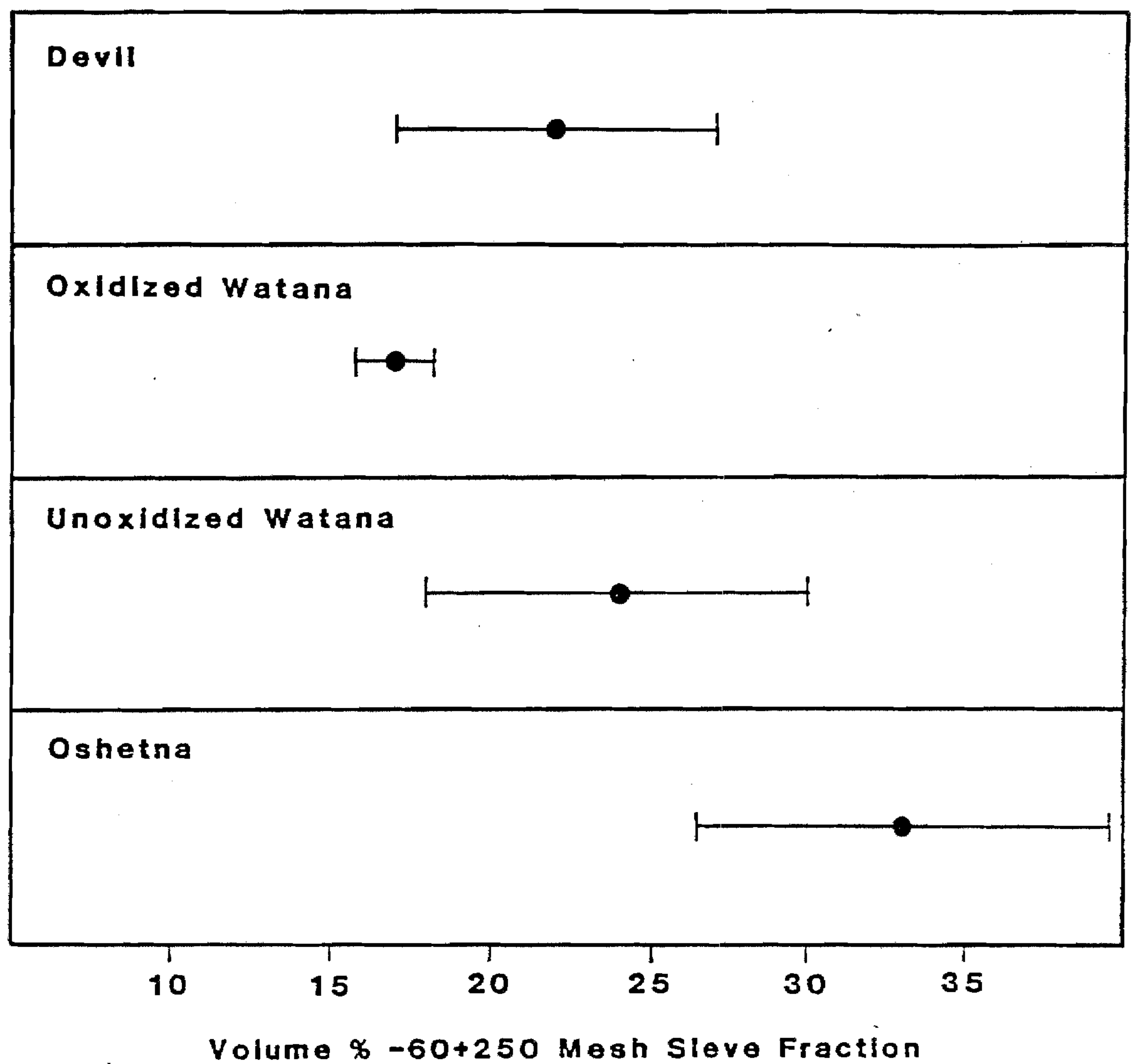


Figure C.2. Granulometric Analysis of Susitna Tephras

(c) Unoxidized Watana Tephra

The Unoxidized Watana appears quite similar to the Oxidized Watana. Biotite is also a minor constituent of this tephra.

(d) Oshetna Tephra

Transparent and translucent fragments are the dominant grains, followed by green crystal fragments, and opaque minerals. White glass is a rare constituent of the tephra. The green crystals are generally short angular flakes without glass mantles. Biotite is more abundant in this tephra than in the others.

C.5 - Mineralogy

(a) Hornblende

Two varieties are present: 1) euhedral to subhedral laths having green to olive green, or dark green pleochroism, and 2) subhedral to anhedral fragments with green to blue-green pleochroism. The euhedral to subhedral green laths are the dominant type in the Devil, Oxidized Watana, and Unoxidized Watana tephras, while the blue-green variety is common only in the Oshetna tephra. The green laths are commonly mantled by glass and usually contain inclusions of opaque minerals. The blue-green variety lacks attached glass, and is generally free of opaque inclusions. Both amphiboles are biaxial negative and exhibit some twinning.

(b) Orthopyroxene

Orthopyroxene occurs as biaxial negative hypersthene. The hypersthene is subhedral to euhedral and is commonly mantled by glass. This is true even in the glass-poor Oshetna tephra. The phenocrysts range between 0.02 and 0.3 mm in length, are length slow, and have either pale green to pink, or pale green to yellow, pleochroism. The hypersthene commonly occurs as interpenetration twins. Inclusions in the phenocrysts include opaque minerals and smaller crystals of orthopyroxene. The mineral is uncommon in the three upper tephras, and only reaches relatively abundant levels in the Oshetna tephra.

(c) Plagioclase

Two populations of the mineral are present. The most abundant variety consists of anhedral, angular to subangular, grains lacking attached glass. The birefringence increases towards the center of these grains indicating a platy habit which is thickest at the middle. Zoning is common, while twinning is not. The lack of albite twins made it impossible to estimate anorthite composition.

The second variety is less common and is characterized by low birefringent euhedral to subhedral grains, mantled by glass, and having albite and carlsbad twins. Concentric and oscillatory zoning are common in this variety of plagioclase. Compositional estimates, using the Michel-Levy method (Kerr 1977), ranged between An_{25} and An_{41} for the Devil tephra, An_{25} and An_{49} for the Oxidized Watana, An_{23} and An_{30} for the Unoxidized Watana, and between An_{30} and An_{32} for the Oshetna tephra.

(d) Opaque Minerals

These minerals generally occur as subhedral to anhedral grains less than 0.2 mm in diameter. Opaque minerals are common inclusions in glass, plagioclase, orthopyroxene, and hornblende. The cubic shape of the grains suggests that they are magnetite.

(e) Quartz

Quartz is present in the tephra in unknown quantities and is recognized by its conchoidal fracture, low birefringence, low relief, and uniaxial positive interference. It appears as anhedral angular grains lacking glass mantles. The similarity in appearance between quartz and the plagioclase lacking glass mantles resulted in the two grains being lumped together in the grain counts.

(f) Minor Accessory Minerals

Biotite occurs as anhedral, subangular to subrounded, red-brown to yellow-brown pleochroic grains. It is a rare mineral in the Oxidized Watana, Unoxidized Watana, and Oshetna tephras. None of the grains seen had any attached glass. Clinopyroxene, zircon, and apatite are also present in trace amounts in the four tephras. The clinopyroxene is characterized by its pale green nonpleochroic color in plane light, its biaxial positive interference and inclined extinction. It is subhedral to anhedral and is most common in the Oshetna tephra. Zircon is present as anhedral to euhedral grains. It is recognized by its very high relief and birefringence, parallel extinction, and its uniaxial positive interference. None of the zircon has any attached glass. Apatite occurs as small inclusions in plagioclase phenocrysts.

C.6 - Grain Count Analyses

Sixteen samples had between 350 and 700 grains counted to get an accurate estimate of the percentage of different minerals in each sample. The samples were grouped according to stratigraphic position and the mean and standard deviation for each mineral were calculated. The mean values are listed in Table C.4. Figures C.3, C.4, and C.5 compare the mean and deviation for each mineral in all four tephras. The only case where the mineralogy is different is in the Oshetna tephra, where the percentage of glass shards is much lower, and the percentages of plagioclase and quartz much higher, than in the other tephras.

C.7 - Glass Shard Morphology

The glass shards in these tephras have morphological characteristics typical of rhyolitic glasses (Heiken 1972). They are vesicular, with the shape of the vesicles controlling the shape of the shards. Two types of glass shards were observed: 1) grains with relatively few vesicles resulting in the glass appearing transparent and angular in plane light, and 2) scoriaceous grains with subangular to subrounded

Table C.4

Mean Percentage Values for Grain Counts of Susitna Tephras

Tephra	Hb	Bio	Opx	Cpx	Opq	Pl/Q	Pl/G	Zirc	Gl	Lith
Devil	14.0	0.1	0.6	0.0	2.5	26.4	7.2	0.2	48.4	0.5
Oxidized Watana	11.4	0.4	0.6	0.1	2.9	41.1	8.5	0.3	34.2	0.5
Unoxidized Watana	15.1	0.1	0.2	0.0	3.1	21.9	12.9	0.0	46.3	0.3
Oshetna	9.4	0.3	2.8	0.3	4.2	75.6	2.3	0.6	3.1	1.3

Hb = Hornblende
Bio = Biotite
Opx = Orthoproxene
Cpx = Clinopyroxene
Opq = Opaque minerals
Pl/Q = Plagioclase and quartz lacking glass mantles
Pl/G = Plagioclase with glass mantles
Zirc = Zircon
Gl = Glass
Lith = Lithic fragments

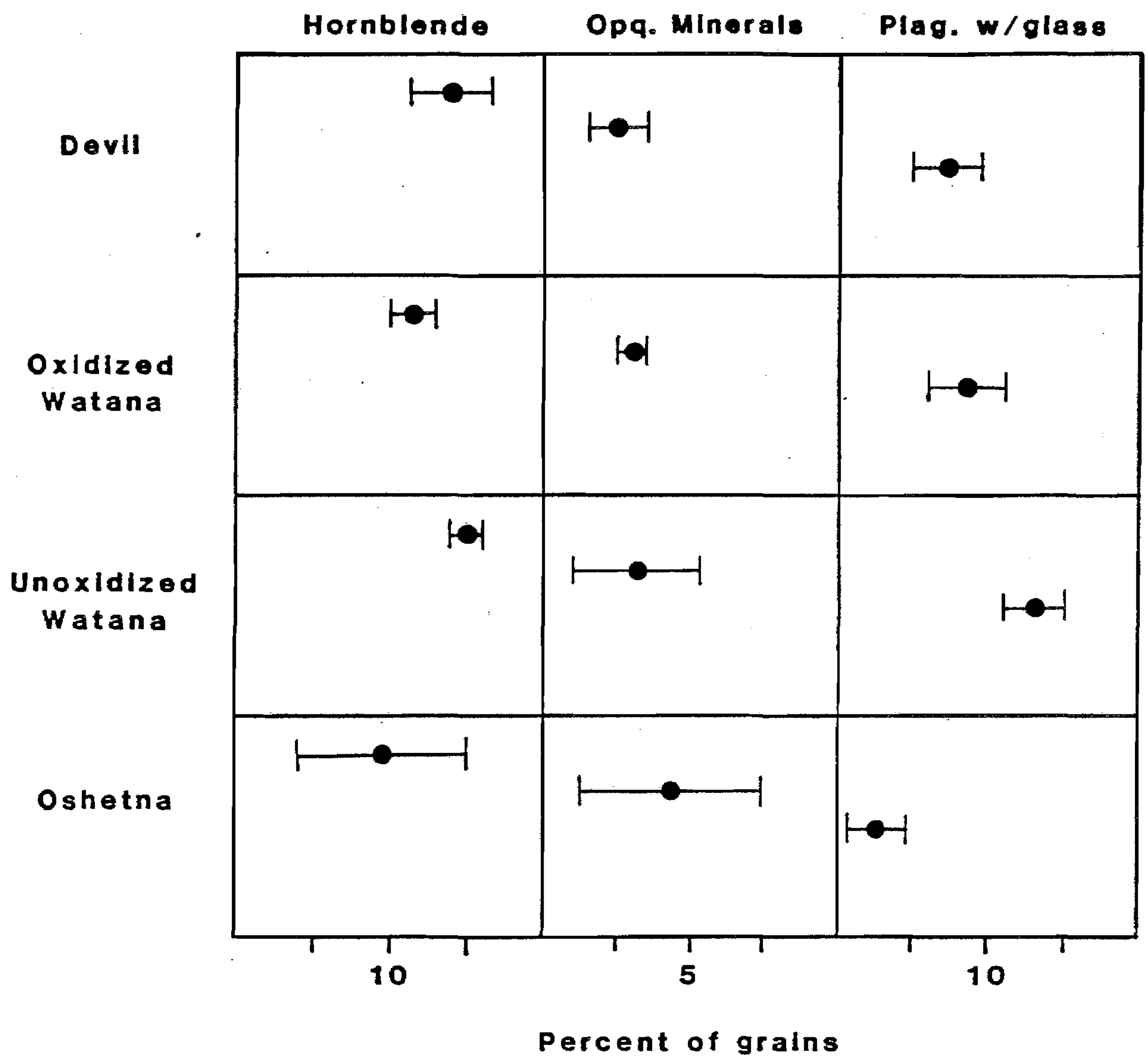


Figure C.3. Percentages of Minerals in the Susitna Tephras

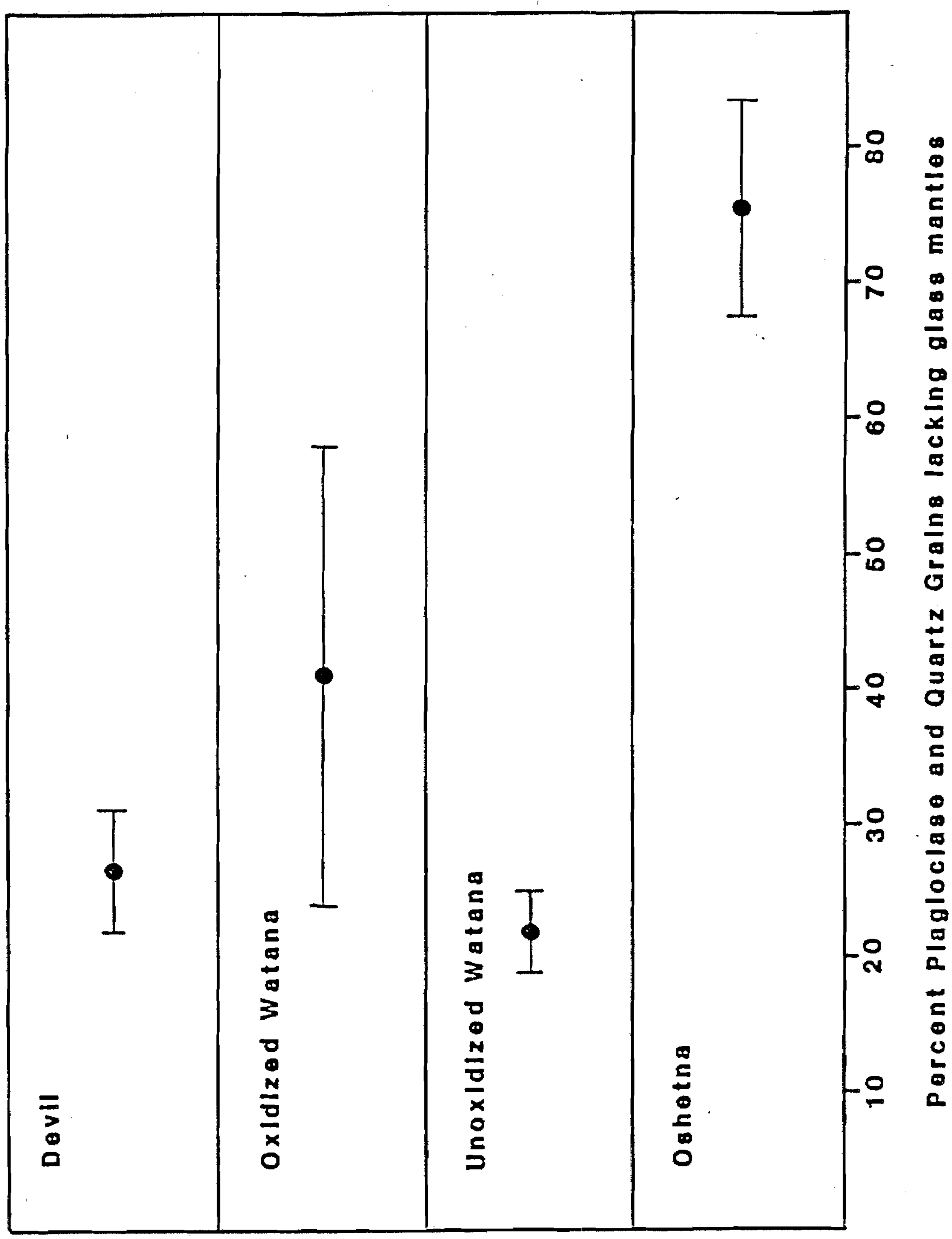


Figure C.4. Percentage of Plagioclase and Quartz Grains Lacking Glass Mantles in the Susitna Tephras

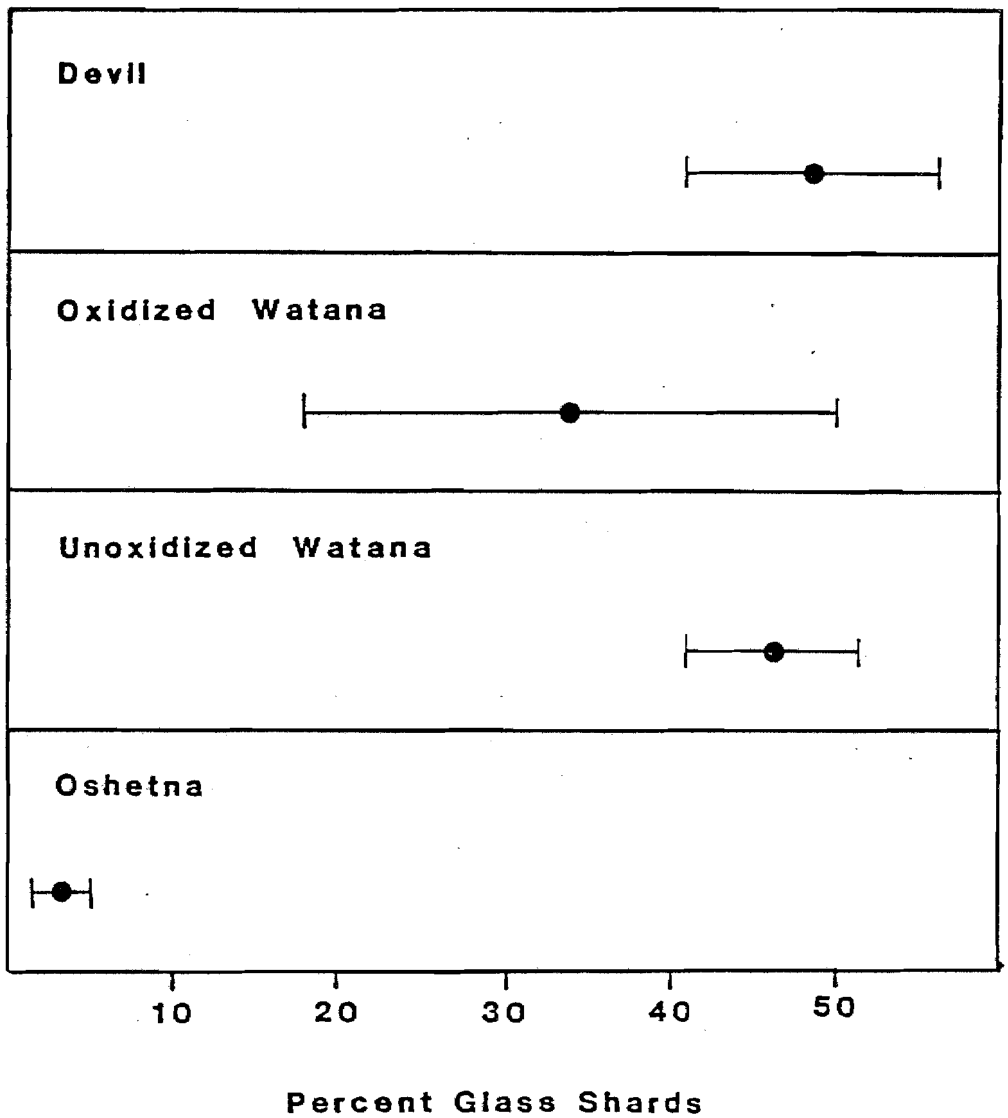


Figure C.5. Percentage of Glass Shards in the Susitna Tephras shapes. This second type of glass shard appears brownish in plane light because the numerous small vesicles tend to refract the light rather than allowing it to pass through relatively undisturbed. Vesicle shapes range from tubelike to spherical.

Point counts of the two glass shard types were conducted on 19 grain mounts and the results are shown in Table C.5. The means and standard deviations for each of the three tephras were calculated, and are listed in Table C.6, and shown in Figure C.6.

The Oshetna tephra was not counted because of the low abundance of glass shards.

Two cases are shown for both Oxidized and Unoxidized Watana tephras. In each group one sample had very low counts of scoriaceous glass, which resulted in the large standard deviations seen in case 1. Removal of these samples resulted in the higher mean values and smaller standard deviations seen in case 2. It is unclear why these samples had such low counts. Examination of the grain mounts does not suggest that they are in any other way unusual.

C.8 - Discussion

The presence of individual glass shards and glass shards adhering to minerals in all 29 samples indicates that the four layers seen in the field are tephras. The tephras are very fine grained, with only a minute portion of the sample coarser than 60 mesh (0.25 mm). The large standard deviations for the sieve analyses do not allow for discrimination of any of the tephras. The mineralogy of the tephras is remarkably uniform and consists of plagioclase, hornblende, opaque minerals, orthopyroxene, quartz, biotite, clinopyroxene, zircon, and apatite in decreasing order of abundance. Two types of plagioclase and hornblende are present in the tephras. Those phenocrysts that have attached glass can be attributed to the tephras, however the origin for the blue-green variety of hornblende and the plagioclase lacking glass mantles is uncertain. The angular shapes of these latter grains do not

Table C.5

Scoriaceous vs. Vesicular Glass Shards

Sample	% Scoriaceous	% Vesicular	Stratigraphic Location
ATC-001	41.9	59.1	Devil
ATC-0002	58.8	41.2	O. Watana
ATC-0003	88.8	11.2	U. Watana
ATC-0005	43.9	56.1	Devil
ATC-0006	40.0	60.0	O. Watana
ATC-0007	88.2	11.8	U. Watana
ATC-0008	54.3	45.7	U. Watana
ATC-0010	14.4	84.6	Devil
ATC-0011	49.5	50.5	O. Watana
ATC-0012	28.0	72.0	U. Watana
ATC-0015	40.0	60.0	Devil
ATC-0017	63.11	36.9	U. Watana
ATC-0018	22.2	77.8	Devil

Table C.5. (Continued)

Sample	% Scoriaceous	% Vesicular	Stratigraphic Location
ATC-0019	83.0	17.0	U. Watana
ATC-0021	28.4	71.6	Devil
ATC-0022	21.3	78.7	O. Watana
ATC-0023	58.4	41.6	U. Watana
ATC-0025	28.9	71.1	Devil
ATC-0027	56.4	43.6	O. Watana

Table C.6

Means and Standard Deviations for Devil, Oxidized Watana, and Unoxidized Watana Tephra Glass Shard Counts

Tephra	No. of Samples Used	Mean	Standard Deviation
Devil	7	31.5	10.0
O. Watana (1)	5	45.2	13.6
O. Watana (2)	4	51.2	7.3
U. Watana (1)	7	66.3	20.5
U. Watana (2)	6	72.6	14.4

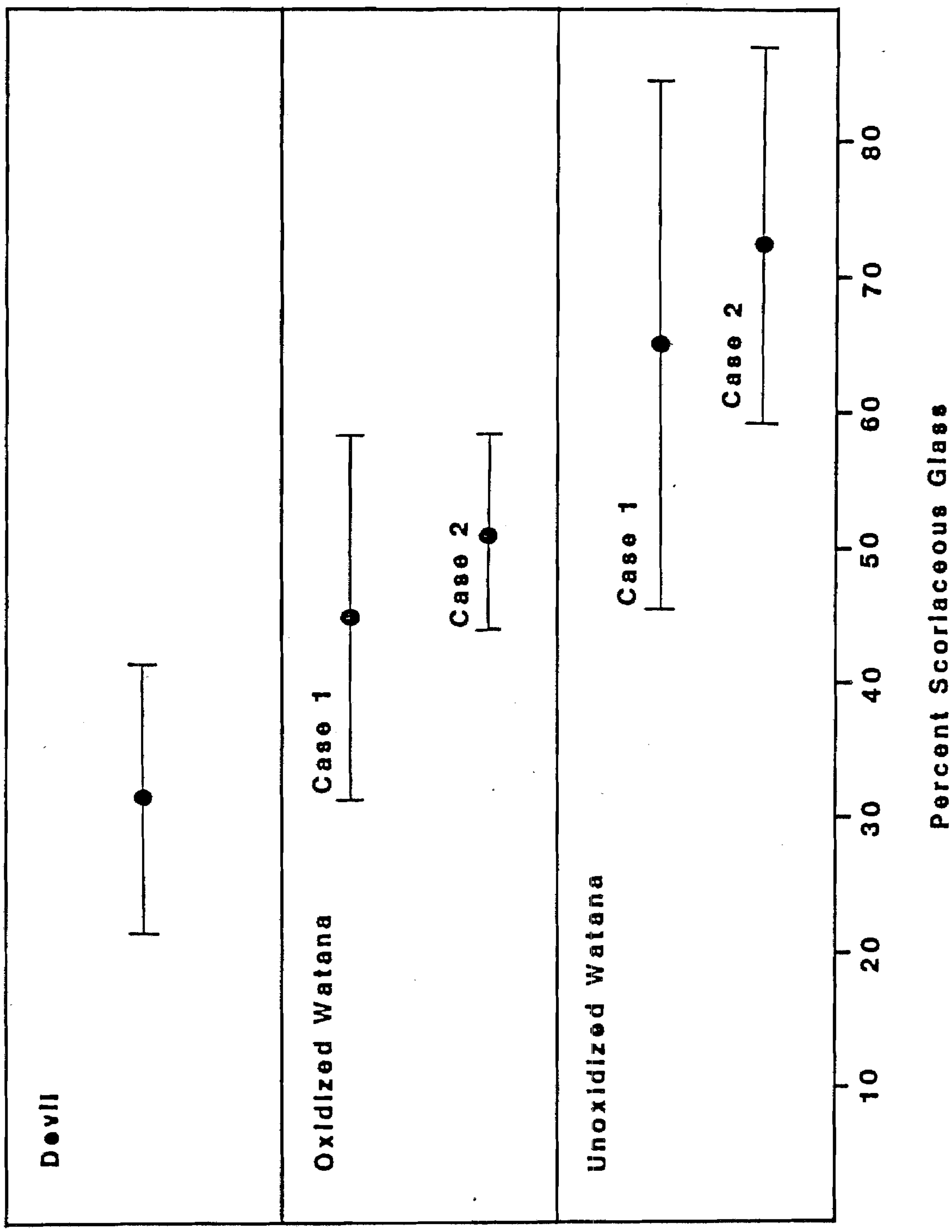


Figure C.6. Percentage of Scoriaceous Glass in the Devil and Watana Tephras indicate much, if any, transport, yet the differences between them and the phenocrysts which do have glass mantles suggest a different origin. Similar problems arise in interpreting the origin of the quartz, zircon, and biotite. Without attached glass it is unclear whether these minerals represent detrital contaminants or primary volcanic material.

Of the four tephras, only the Oshetna can be distinguished on the basis of mineralogy. Figures C.3 and C.4 show that it has a much higher percentage of plagioclase and quartz, and a much lower percentage of glass shards, than any of the other tephras.

Based on glass morphology, the Devil and Unoxidized Watana tephras can be distinguished with a fair degree of confidence. Table C.4 shows that all of the Devil tephra samples have less than 50% scoriaceous glass shards, while 57% of the Unoxidized Watana tephra have greater than 60% soriaceous glass shards, and 86% have greater than 50% soriaceous glass shards. The Oxidized Watana tephra has percentages of scoriaceous glass shards which overlap the fields of the two other tephras.

C.9 - Conclusions

Three out of the four tephras can be distinguished based on this petrographic study. While stratigraphic evidence suggests that the Oxidized Watana tephra is a separate unit from the Unoxidized Watana and the Devil tephras, the petrographic evidence is unclear. The remarkable mineralogic similarities between the three upper tephras suggest that they are derived from the same volcanic vent. If this is the case, geochemical studies of the glass shards and phenocrysts will probably be needed to clarify the distinctions between the three upper tephras. The Oshetna tephra is clearly distinguishable from the other tephras due to the differences in mineralogy and the proportion of glass shards. These differences may be due to its greater age or a different source. It is generally agreed that tephra correlation must be based upon several criteria, and not on a single criterion (Westgate and Gorton 1981). Stratigraphic and petrographic data are now available for the Susitna tephras, and geochemical studies of the tephras would aid in clarifying the distinctions between tephra units. Numerous authors have used geochemistry to distinguish between tephras, as well as identifying several tephras in a layer which was thought to be a single unit (Smith and Westgate 1969; Izett 1970 et al.; Westgate 1977; Scheidegger et al. 1978; Westgate and Evans 1978; and Larsen 1981).

In addition to the geochemical analyses, detailed petrographic work would probably reduce the variance in the analyses that have been conducted and may clarify the distinctions between the three upper tephras.

C.10 - Archeological Significance

The petrographic analysis largely agrees with the field evidence that there are three, and probably four, tephra units in the Susitna River valley. This corroborating evidence should give a high degree of confidence to the correlation of components from different sites which are found between the same tephra units. These analyses may also aid correlation of components associated with tephra in other parts of south-central Alaska, where the tephras can be shown to be identical to the Susitna tephras.