Holocene Tephrostratigraphy, Southern Kenai Peninsula, Lower Cook Inlet, Alaska

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HOLOCENE TEPHROSTRATIGRAPHY, SOUTHERN KENAI PENINSULA, LOWER COOK INLET, ALASKA

by

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ABSTRACT

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by

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Utah State University, 2000

Major Professor: Dr. Darrell S. Kaufman
Department: Geology

This thesis describes the results of a study of 33 tephra layers found within two peat sections near Anchor Point and Homer, Alaska, on the lower Kenai Peninsula. Numerous lower Cook Inlet volcanoes have been active through the Holocene. Tephra layers found at these two sites provide a partial record of their eruptive activity. The hazards that accompany this activity have increased as populations and commercial activities expand and air traffic over the region increases. The tephras analyzed for this study provide an initial geochemical database for the lower Cook Inlet volcanoes. The database is available in electronic format at the U.S. Geological Survey, Alaska Volcano Observatory.

The Anchor Point and Homer sections contain tephras from Augustine, Iliamna, and possibly other volcanoes in the region. Anchor Point, the principal section for this study, yielded ten ^{14}C ages ranging from 645 ± 85 cal yr BP at a depth of 14 cm to 8810 ± 205 cal yr BP at 270 cm. Seventeen tephra layers from Anchor Point and 16 from Homer were characterized by stratigraphic position, age, and grain-discrete major-element geochemical analysis by electron microprobe. Nine tephra layers are correlated by geochemical analysis between the Anchor Point and Homer sections. Several newly discovered tephra layers have been correlated with source volcanoes, three with Augustine and at least seven with Iliamna Volcano. The average recurrence interval of tephra fall events at Anchor Point is approximately 520 yrs.

(106 pages)

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Kathleen J. Lemke

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PURPOSE AND SCOPE

Objectives

This thesis focuses on two stratigraphic sequences near Homer, Alaska, to address the Holocene eruptive history and subsequent ash fallout from lower Cook Inlet volcanoes. The first goal is to characterize each tephra layer based on its: (1) stratigraphic setting, (2) age, and (3) major-element geochemistry. The second goal is to compile an electronic database of tephra major-element geochemistry from previously published and unpublished reports to compare with the new data presented here in an effort to determine the volcanic source. This study will result in a better understanding of the tephra-fall hazard of several lower Cook Inlet volcanoes. The outcome will be of interest to local communities that face the threat of ash-producing eruptions and to the aviation industry that must avoid aircraft encounters with ash clouds.

Regional Geology Overview

The Aleutian trench defines the boundary between the North American plate and the subducting Pacific plate. As the Pacific plate descends, it fuels new magma that rises to the surface and forms the volcanoes of Cook Inlet and the Aleutian arc. Cook Inlet is the Tertiary forearc basin that lies in the present arc-trench gap of south-central Alaska separating two distinctive geologic provenances (Reger and Petrik, 1993). It is bordered by glacier- and snow-capped peaks of the Alaska Range on the west and coastal Kenai Mountains of the Kenai Peninsula on the east. The Kenai lowlands and the Caribou Hills, east and northeast of Anchor Point, respectively, are physiographic divisions of the Cook Inlet forearc basin (Reger and Petrik, 1993) (fig. 1). Tephra found on the Kenai

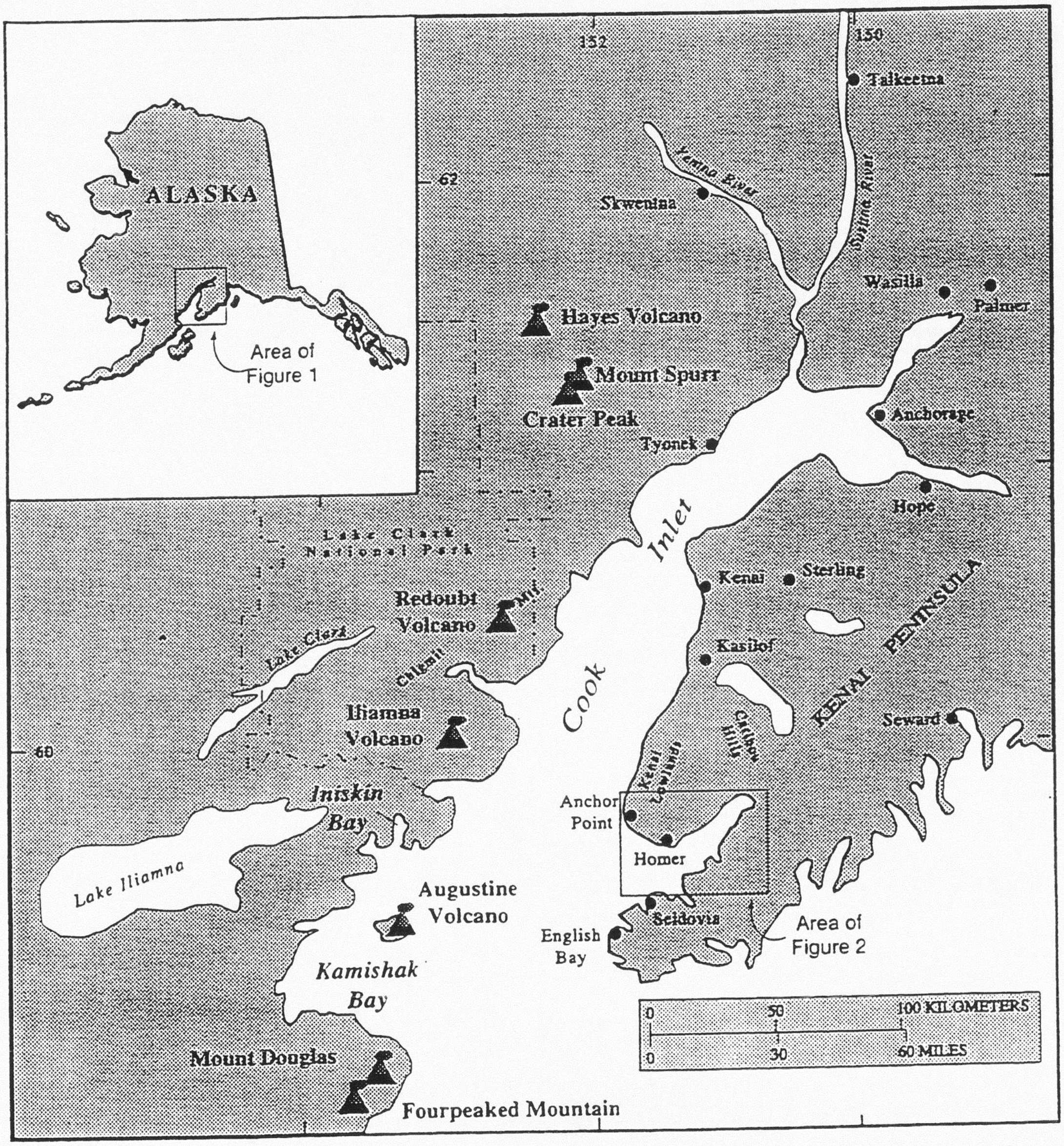

Figure 1. Location of Anchor Point and Homer sites with respect to volcanoes in the Cook Inlet region, Alaska.

Peninsula is derived from the six Quaternary volcanoes built on the continental crust of the eastern half of this Aleutian volcanic arc (Miller and Richter, 1994).

During Holocene times, the Homer area received tephra from several Alaska Peninsula and Cook Inlet volcanoes (Swanson and Kienle, 1988; Begét and Nye, 1994; Reger and Petrik, 1993) (fig. 1). Volcanoes of the Cook Inlet area and their historical eruptions include: Hayes (no historical activity), Spurr/Crater Peak (1953, 1992 – Crater Peak), Redoubt (1902, 1966, 1967?, 1968, 1989-90), Iliamna (no historical activity), Augustine (1812, 1883, 1935, 1963-64, 1976, 1986), and Douglas (no historical activity) (Woods and Kienle, 1990).

The study area is located on the Kenai Peninsula near the town sites of Anchor Point and Homer in south-central Alaska (figs. 1 and 2). This study area was chosen because of its proximity to the Cook Inlet volcanoes, particularly Augustine and Iliamna. It was also anticipated that, because of active coastal retreat, new exposures along the beach cliffs would be accessible for study.

Most of the study area is covered with glacial deposits formed during the Naptowne glaciation approximately 18 to 25 ka (Reger and others, 1996). In the Anchor Point region, the surficial deposits are predominantly till. The till is associated with the coarse-grained, ice-stagnant deposits of a kettled moraine built during the Moosehorne stade of the Naptowne glaciation (Reger and others, 1996). Many swamps, bogs, and kettle lakes formed on the moraine.

The kettles are often infilled with organic-rich sediment. The sediment, characterized by its grey-blue color, is typically overlain by a succession of bedded peat. Paludification, the process of peat formation, in these basins is conducive to preservation

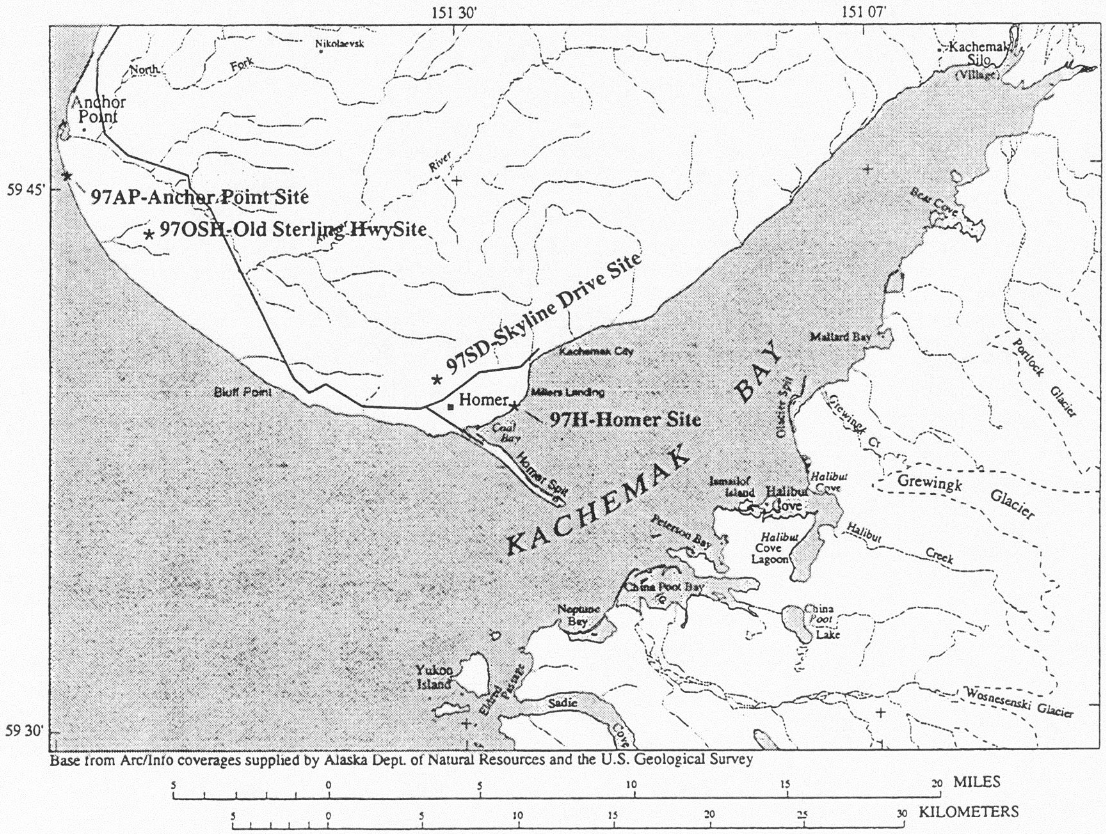

Figure 2. Location of sites studied for tephra on the lower Kenai Peninsula, Alaska. Map location shown in figure 1.

of tephra layers erupted from nearby volcanoes in Cook Inlet and on the Alaska Peninsula. The fibrous consistency of the peat holds the tephra, protecting it from wind and water erosion.

Previous Work

Previous work in the region by Reger and others (1996), Riehle (1985), Riehle and others (1990), and Siebert and others (1995) described multiple tephra layers in the lower Cook Inlet area. Reger and others (1996) used the major-element geochemistry of tephra in the Cook Inlet region to correlate moraine sequences across the Kenai Peninsula. Siebert and others (1995) used geochemical analyses of tephra from Augustine Volcano to establish a frequency of edifice collapse producing debris avalanches and the possible threat of related tsunami to the coastline of Cook Inlet. Riehle (1985) and Riehle and others (1990) studied Holocene tephra using microprobe and petrographic analysis of the tephra layers in the Cook Inlet region. T. Miller (U.S. Geological Survey, unpublished data) analyzed pumiceous lapilli tephra from the flanks of Iliamna Volcano to determine its geochemical composition. R. Waitt (in Riehle and others, 1999) analyzed tephra from three separate exposures on Augustine Island to determine its geochemical composition.

METHODS

Tephrostratigraphy

To reconstruct the prehistoric eruptive history of a volcano, it is necessary to study the stratigraphic record of its tephra deposits. Fallout tephra provides a good marker bed for correlation because it is deposited instantaneously over an area (Fisher and Schmincke, 1984). The study of tephra deposits can lead to a better understanding of a volcano's eruption history and can be used as a guide to its future behavior. Thorarinsson (1980) defined tephrochronology as "a dating method based on the identification, correlation and dating of tephra layers." Tephrochronology is also used as a stratigraphic tool in archaeology, geomorphology, and glacial research.

According to Fisher (1961), tephra is "all ejecta blown through the air or water by explosive volcanic eruption." Distribution of tephra and its subsequent deposition is dependent on amount and size of the particles, amount of aggregation of the particles, plume height, and wind velocity (Fisher and Schmincke, 1984). Subaerial eruptions consist of pyroclasts and expanding gases within the entrained air. The degree of tephra sorting is related to particle-size distribution and density. Tephra with lower silica content contains less glass and pumice and a higher proportion of crystals. With increasing magmatic SiO_2, the explosiveness of the eruption tends to increase (Fisher and Schmincke, 1984). Fractionation occurs within the eruption column when less-dense particles rise higher within the column than particles with higher density (Fisher and Schmincke, 1984). This becomes important when tephra are evaluated for homogeneity within individual layers. Grading within the bed indicates a change in any or all of these:

eruption energy, wind direction and intensity, or column turbulence. A single tephra bed may contain multiple reworked tephra, whereas some are the result of a single eruptive event or an ongoing eruption. The deposits examined for this study are homogeneous distal deposits with no apparent grading. The approach here is to assign tephra to possible source volcanoes, rather than to attempt to identify the specific eruption among the many that have occurred throughout the Holocene.

Tephra Geochemistry

Major-element data have been used successfully to determine source volcanoes for distal tephra deposits (e.g., Sarna-Wojcicki and Davis, 1991; Reger and others, 1996; Riehle, 1985; Siebert and others, 1995; Smith and Westgate, 1969). Major-element analyses are used with confidence to distinguish geochemically similar tephra layers that are from the same source volcano. The most common component of fine tephra used for analysis is volcanic glass. It is the most chemically homogeneous fraction and is common both at the source and at the distal reaches of the tephra plume. Electron microprobe analysis (EMA) is used extensively to measure the major-element composition of tephra, particularly glass (Smith and Westgate, 1969; Sarna-Wojcicki and others, 1984). EMA provides a grain-discrete method that circumvents contamination effects and is preferred over analysis of bulk separates. It permits detection of post-depositional changes such as hydration of the glass. EMA also aids in determining the homogeneity of a tephra layer by identifying glasses from multiple eruptions that might be mixed in a single layer. The method is quick so several grains can be analyzed from each tephra. The small sample-size requirement allows tephra from thin tephra beds (~1 mm thick) to be analyzed.

Although EMA has the advantage of grain-discrete analyses, its disadvantage is that only the major elements, Si, Ca, Na, Al, Fe, and K, and the minor elements, Cl, P, Ti, Ba, Mg, and Mn, are in sufficient concentrations to be measured reliably. According to Sarna-Wojcicki and Davis (1991), of the minor elements, only Cl and Ba are present in high enough concentrations in rhyolitic glasses to be useful. Since silica is generally the most abundant oxide in all of the tephra analyzed, and because silica increases with increasing differentiation, it is used as the principal independent variable in this study (Sarna-Wojcicki and Davis, 1991).

A complication with EMA analysis is the effect of water and post-depositional hydration of the glass (Sarna-Wojcicki and Davis, 1991). Hydration occurs as water molecules penetrate the surface of the unstable volcanic glass shards and pumice fragments during weathering (Steen-McIntyre, 1977; Fisher and Schmincke, 1984). The rate of hydration is dependent on the surface area of the fragment and the time it takes for the water to penetrate the glass and fill the pumice vesicles. For silicic-glass hydration, an alkali ion exchange can occur, but overall chemical changes are initially minor (Fisher and Schmincke, 1984). The microprobe is not capable of analyzing the light elements found in the water. Most natural glass generally contains a small percent of water after eruption and then hydrates with exposure to additional water (Sarna-Wojcicki and Davis, 1991).

Alkali concentrations cause the most concern with probe analysis. Sodium is the most difficult to quantify because of its mobility under the microprobe beam. It tends to "float" from the focal point of the beam, causing an anomalously low value. To compensate for this migration, the beam is scanned over the sample mount (Ken Severin, University of Alaska, Fairbanks, pers. comm., 1998).

Field Methods

During the summer of 1997, numerous stratigraphic sections were studied between Anchor Point and the head of Kachemak Bay (fig. 2). Preliminary work was done on four sections, Old Sterling Hwy (97OSH), Anchor Point (97AP), Skyline Drive (97SD), and Homer (97H) (fig. 2). Each section was photographed and described. The Old Sterling Hwy site was studied previously (Reger and others, 1996). The geochemical data are published in Reger and others (1996). Therefore, no further work was done at this site. The site at Skyline Drive yielded only three major tephra layers and six very thin (< 1 mm) tephra beds, and was not considered further. Tephra deposits from the Anchor Point and Homer sections are the focus of this study. The Anchor Point site serves as an especially well-dated and detailed "reference section" for lower Cook Inlet.

Twenty-one tephra or possible tephra layers were sampled from the Anchor Point section and 17 layers from Homer. They were characterized for thickness, overall color, approximate grain size, and lateral extent within the 2- to 3-m-wide sections. All samples considered for this study were from continuous layers ≥ 1 mm thick. Four possible tephra layers (< 1 mm) were sampled in the upper 10 cm at the Anchor Point site. Because of the thickness of the layers (< 1 mm) they were not considered further. The standard method for sampling peat and wood for conventional radiocarbon (^{14}C) age determinations was used. The exposure was cleaned and measured to determine the stratigraphic relationship of each tephra layer. A minimum of 200 g of peat was collected for each of six samples and 100 g of wood fragments for four others. Dated wood was collected from directly below tephra beds where possible. Organic material samples were kept in cool storage before shipment to Geochron Laboratories, Cambridge, Massachusetts, for analysis.

Laboratory Methods

All preparatory laboratory work was carried out at the U.S. Geological Survey in Anchorage, Alaska. Laboratory procedures for tephra preparation for EMA follow the methodology described by Pinney (1991). Samples were first oven dried at low temperature and then weighed. They were then observed under a microscope to determine glass content. Samples with a significant amount of organic matter were treated with a 20% solution of Clorox® and then ultra-sonicated for 3 minutes. The process was repeated until all organics were removed. The samples were then ultrasonically cleaned for 10 minutes to remove adhering contaminants. The samples were air dried under suspended heat lamps, and then split using a hand-fed chute-riffling box. A one-third split of the raw sample was archived. The remaining fraction was wet sieved and dried under the heat lamp. The coarse fraction (> 0.25 mm) was labeled and archived with no further analysis. The sample fractions between < 0.25 and 0.0625 mm were placed in labeled vials for analysis. A minimum of 0.10 g of tephra was collected without crushing. Tephra samples were mounted on glass slides with quick-drying epoxy and archived. The mineral content was surveyed under a microscope to determine anomalous minerals that could be used for correlation. Grain morphology of each tephra sample, such as bubble-walls, cuspate, and equant shapes, was noted. The sieved sample was passed through a Franz magnetic separator to remove mafic minerals. Mafic minerals removed during this process were combined with the coarse fraction and archived.

Glass was separated using the heavy liquid, sodium polytungstate (SPT). The SPT was prepared to a specific gravity (spg) of 2.42 using calibrated density floats of spg 2.4250 and spg 2.4150. The glass was floated and the heavies were released from the separatory funnel, heat-lamp dried, and archived. Glass shards that were too small for heavy-liquid separation were handpicked from the samples. Slides of handpicked and bulk glass fractions were prepared for microprobe analysis at High Mesa Petrographics, Los Alamos, New Mexico. The polished grains were coated with carbon at the Advanced Instrumentation Laboratory at the University of Alaska, Fairbanks, where I analyzed them by EMP.

The EMP was used for quantitative analysis of major elements in the volcanic glass. This is a nondestructive method in which samples are irradiated with an electron beam, which produces X-rays. The wavelength and intensity of the lines in the X-ray spectrum identify the elements and their concentration (Reed, 1997). The chemical composition of a "spot" on a glass shard can thereby be determined. The concentrations of each element are determined by comparison with standards of known compositions (Reed, 1997).

All samples were analyzed using a Cameca SX-50 EMP with a 15 kV, 10 nA electron beam. The microprobe was calibrated for nine elements: Si, Al, Fe, Ca, K, Na, Mg, Ti, and Cl. The instrument was calibrated three times during the analytical procedure to verify and further calibrate the microprobe using three working standards: CCNM-11 (obsidian), K-411 (National Bureau of Standards glass), and CV-A99 (basaltic glass). The analytical oxide weight % error based on repeat analyses of the standards was as follows: ±0.11% Na, ±0.03% Mg, ±0.13% Al, ±0.33% Si, ±0.03% Cl, ±0.08% K, ±0.05% Ca, ±0.12% Ti, and ±0.15% Fe. Ken Severin, Advanced Instrumentation Laboratory, University of Alaska, Fairbanks, carried out calibration and standardization procedures.

Two or more points were analyzed by EMP for each individual glass shard. Generally, 10 to 15 shards were analyzed for each sample. If the total weight percent of elements for a single analysis was >105 or < 95%, the data were discarded. Accidental analysis of microlites could be identified and excluded on the basis of abnormally high concentrations of Al, Mg, or Fe. The weight percent for each element was then converted to weight percent oxide. The cation-oxide values were normalized to 100% to minimize the effects of differential hydration between shards from the same tephra layer (Sarna-Wojcicki and Davis, 1991). Analysis on individual shards produced the following estimates of maximum within-shard oxide weight percent variation: ±0.44% Na_2O, ±0.03% MgO, ±0.26% Al_2O_3, ±0.28% SiO_2, ±0.03% Cl, ±0.08% K_2O, ±0.10% CaO, ±0.12% TiO_2, and ±0.25% Fe_2O_3. Maximum within-shard variation is mostly within analytic precision for five of the nine oxides (SiO_2, MgO, Cl, K_2O, and TiO_2).

Rhyolitic to dacitic glasses with a SiO_2 range of about 78 to 65% have alkali concentrations of 3 to 5% for Na_2O, and 2 to 5% for K_2O (Sarna-Wojcicki and Davis, 1991). Analyses that did not fall within these ranges of alkali concentrations were eliminated from further consideration. Glass shards that contain low concentrations of particular minor oxides (especially Cl, Ti, and Mg), or those that show a high variance, can disproportionately affect the mean composition of the sample and were eliminated (Sarna-Wojcicki and Davis, 1991). Twenty-two percent of the microprobed shards were not assigned to a tephra population because their compositions showed an excessive degree of glass hydration, anomalous oxide concentration, or both. Subdividing the compositional data into discrete populations is often subjective. Weight percent SiO_2 was usually the prime factor in defining groupings within the samples. Where SiO_2 was ambiguous, a somewhat subjective scan of the data was used. Few other researchers have applied quantitative approaches to this problem. Samples composed of more than one population might result from a zoned magma chamber that initially ejects siliceous material, becoming more basaltic over the course of the eruptive phase or post depositional reworking. Using these methods, 31% of the samples were composed of two populations and 69% were composed of a single population.

Similarity Coefficient

The method of Borchardt and others (1972) was used for comparing the geochemical similarity of two tephra deposits. The similarity coefficient (SC), the average ratio of each oxide, with the lesser oxide always the numerator, is an easy and effective way to compare the multivariate similarity of two samples. The SC is given by:

$$SC_{(A,B)} = \frac{\sum_{i=1}^{n} R_i}{n} \qquad (1)$$

where

$SC_{(A,B)} = SC_{(B,A)}$ = similarity coefficient for samples A and B,

i = element number,

n = number of elements analyzed,

R_i = X_iA/X_iB if X_iB X_iA; otherwise X_iB/X_iA,

X_iA = weight % of element i in sample A, and

X_iB = weight % of element i in sample B.

A perfect match between the composition of two samples is represented by a SC = 1.0. The SC decreases as the difference between two samples increases. Similarity coefficient values of 1.0 are never achieved, even when comparing several points on the same grain. Deciding how high the SC needs to be to accept that two samples are geochemically correlative is subjective. Cut-off values for accepting or rejecting a match in this study generally follow those of Riehle (1985). Sample pairs with SC   0.96 are considered highly similar in composition, although not necessarily from the same tephra fall (i.e., a single eruption). Pairs with SC between 0.94 and 0.95 might represent tephra from closely succeeding eruptions (i.e., a "tephra set"); additional criteria such as stratigraphic position and mineralogy are needed to evaluate the likelihood of correlation. The assumption, then, is that each tephra population has a distinct geochemical composition that allows it to be correlated with tephra from the same plume in another location. Complications arise when tephra populations overlap geochemically or when they exhibit geochemical affinity to more than one volcanic source.

RESULTS

Anchor Point

The Anchor Point site (59° 45' 50" N, 151° 52' 00" W) is a wave-cut bluff along the Cook Inlet shore of the lower Kenai Peninsula approximately 2 km south of the mouth of the Anchor River (fig. 2). It is a 270-cm-thick section of peat and tephra beds that accumulated in a kettle basin (figs. 3 and 4). The autochthonous peat is composed of accumulations of partially decomposed plant remains. The outcrop consists of loose to dense fibrous sphagnum peat becoming denser with depth to the basal contact with the underlying inorganic sediment. Peat color deepens from medium to dark brown and intensifies with depth. Peat sharply overlies a light-grey, massive silt that contains medium-grained sand lenses and that continues to an undetermined depth. The basal contact is approximately 3.5 m above sea level (asl). The silt contains a 2- to 3-cm-thick lens of decomposed organic material 20 cm below the peat/sediment contact.

Twenty-one samples were collected at the Anchor Point site (table 1). Of these two were determined later to be too thin (< 1 mm thick) for further consideration, 16 had sufficient glass to microprobe, and two were determined not to be tephra. The section also contains stringers of thin (< 1 mm thick) tephra, both continuous and discontinuous, that were not described or sampled for this study. The tephra beds are uniformly vitric to lithic-vitric, light grey to white, and range in grain size from silt to medium sand. The layers range from 0.1 to 2.5 cm in thickness. Each layer varies in thickness laterally to some degree. Most sampled layers are continuous across the outcrop. They are massive with sharp basal contacts and diffuse to sharp upper contacts. In the field, tephra layers

Figure 3. Anchor Point (97AP) section. Twenty-one layers were sampled and characterized from this 270-cm-thick peat section. Sample identification noted for several of the more visible tephra.

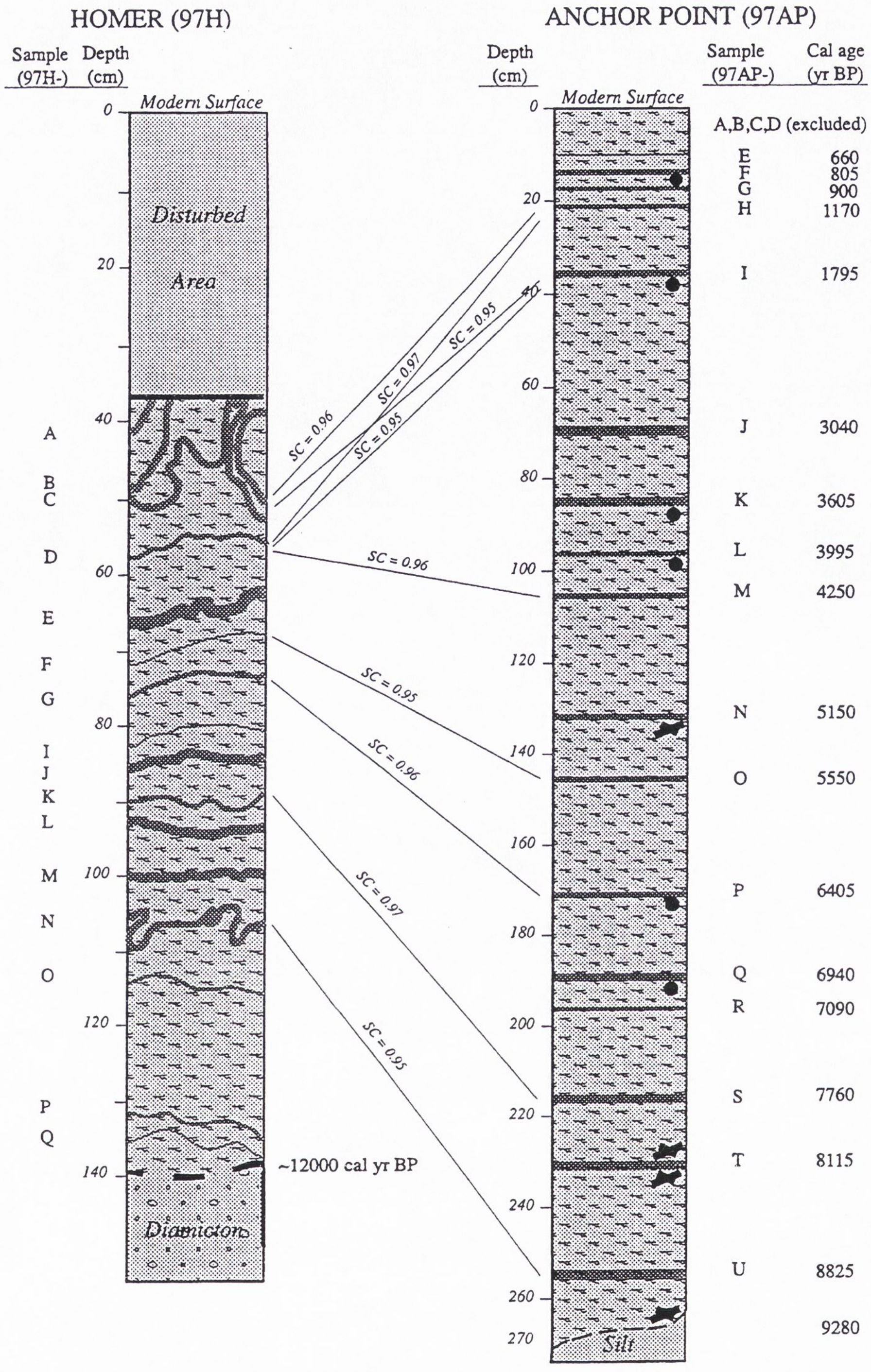

Figure 4. Correlation between tephra at Anchor Point and Homer sections. Anchor Point ages are based on calendar year calibrated ^{14}C age model (eq. 2) described in text. Homer radiocarbon age shown at base of peat is assumed from Reger and others' (1996) age from the base of peat ~ 3.5 km from this site. Summary of tephra geochemistry given in tables 3 and 5. Similarity coefficient (SC) values, after Borchardt and others (1972).

Table 1. Outcrop and laboratory tephra descriptions, Anchor Point.

Field Identification (97AP)	Depth (cm)	Tephra Thickness (cm)	Sample Wt. Raw (g)	Sample Wt. Cleaned (g)	Modeled Ages[1] (cal yr BP)	Comments
A, C						Not a tephra
B, D						Excluded[2]
E	11.0	0.6 - 2.5	17.18	0.43	660	
F	14.0	0.6 - 2.5	6.71	0.19	805	Insufficient glass[3]
G	16.0	0.1 - 0.3	8.02	1.20	900	
H	22.0	0.1 - 0.3	11.44	7.01	1170	
I	37.0	0.3 - 0.6	8.14	2.57	1795	
J	70.0	0.6 - 2.5	6.34	4.04	3040	
K	86.0	0.6 - 2.5	9.81	1.64	3605	
L	97.5	0.1 - 0.3	0.83	0.67	3995	
M	105.0	0.1 - 0.3	3.73	0.98	4250	
N	132.5	0.1 - 0.3	7.34	0.79	5150	
O	145.0	0.1 - 0.3	6.20	0.83	5550	
P	172.5	0.1 - 0.3	9.01	2.12	6405	
Q	190.0	0.3 - 0.6	21.20	14.64	6940	
R	195.0	0.1 - 0.3	5.83	2.19	7090	
S	217.5	0.6 - 2.5	12.15	8.18	7760	
T	227.5	0.6 - 2.5	47.91	24.33	8115	
U	254.0	0.6 - 2.5	22.3	19.34	8825	
Base	270.0				9280	

[1]Calibrated ages based on age model (eq. 2) presented in text.

[2]Tephra layer < 1 mm-thick were not analyzed.

[3]No further analysis.

appear very similar to one another. The individual layers are visually homogeneous.

Under magnification, tephra samples contain clear to light-tan pumice fragments that are equant to slightly elongate with thin vesicle walls. They often contain microlites. The tephra includes Y-shaped colorless to light-tan glass shards and bubble-walled fragments with typical concave trough morphology, a characteristic of magmatic eruptions (Heiken, 1972). Lithic fragments, when present, are rounded and equant. This is typical of abraded fragments that are controlled by the properties of the conduit walls (Heiken, 1972). With an explosive magmatic eruption the fragments may become rounded as they come into contact with each other.

New ^{14}C dates on six peat and four wood samples provide chronological control for the Anchor Point section (table 2). The ^{14}C ages were calibrated to calendar years using the method of Stuiver and Reimer (1993). The calendar-year ages increase with depth from 645 ± 85 cal yr at 14 cm below the surface to 8810 ± 205 cal yr at 270 cm depth. Modeled ages for each tephra were calculated based on a power-function fit to the calibrated ages (fig. 5), rounded to the nearest 5 yr. The modeled age is given by:

$$y = 90.536\, x^{0.827} \qquad (2)$$

where

y = age in cal yr BP, and

x = depth in cm.

I did not attempt to assign an uncertainty to each interpolated age. However, the average ± 1 s.d. uncertainty for the 10 calibrated ages is ± 155 yr, which serves as an approximation of the uncertainty for individual modeled ages. On the basis of the radiocarbon dates, the average accumulation rate for peat at this site is approximately

Table 2. Anchor Point ^{14}C ages obtained in this study.

Field Identification (97AP)	Depth (cm)	Material	Laboratory Identification[1] (GX)	^{14}C age (yr BP)	Calibrated[2] (cal yr BP)
F-12	14.0	Peat	23295	725 ± 110	645 ± 85
I-10	37.0	Peat	23296	2490 ± 75	2550 ± 190
K-09	86.0	Peat	23297	3305 ± 80	3545 ± 90
L-08	97.5	Peat	23298	3570 ± 85	3850 ± 130
N-07	132.5	Wood	23299	4460 ± 90	5085 ± 210
P-06	172.5	Peat	23300	5655 ± 95	6425 ± 110
Q-05	190.0	Peat	23301	6350 ± 180	7225 ± 205
T-03	227.5	Wood	23303	7260 ± 200	8100 ± 230
T-02	229.5	Wood	23302	6790 ± 105	7600 ± 85
V-01	270.0	Wood	23304	7970 ± 115	8810 ± 205

[1]Geochron Laboratories, a division of Krueger Enterprises, Inc. Cambridge, MA.
[2]According to Stuiver and Reimer (1993); midpoint and ± 1/2 of the 1 s.d. range.

0.31 mm/yr.

Results of EMP analysis of Anchor Point tephra show that 10 of the tephra beds (97AP-G, J, K, L, M, O, P, Q, R, and T) are geochemically homogeneous, and six others (97AP-E, H, I, N, S, and U) comprise shards with variable major-element compositions (appendix A). They are separated into two populations based on their geochemistry (see above). A lower case "a" signifies the primary population, lower case "b" indicates the secondary population, and "n" signifies number of shards.

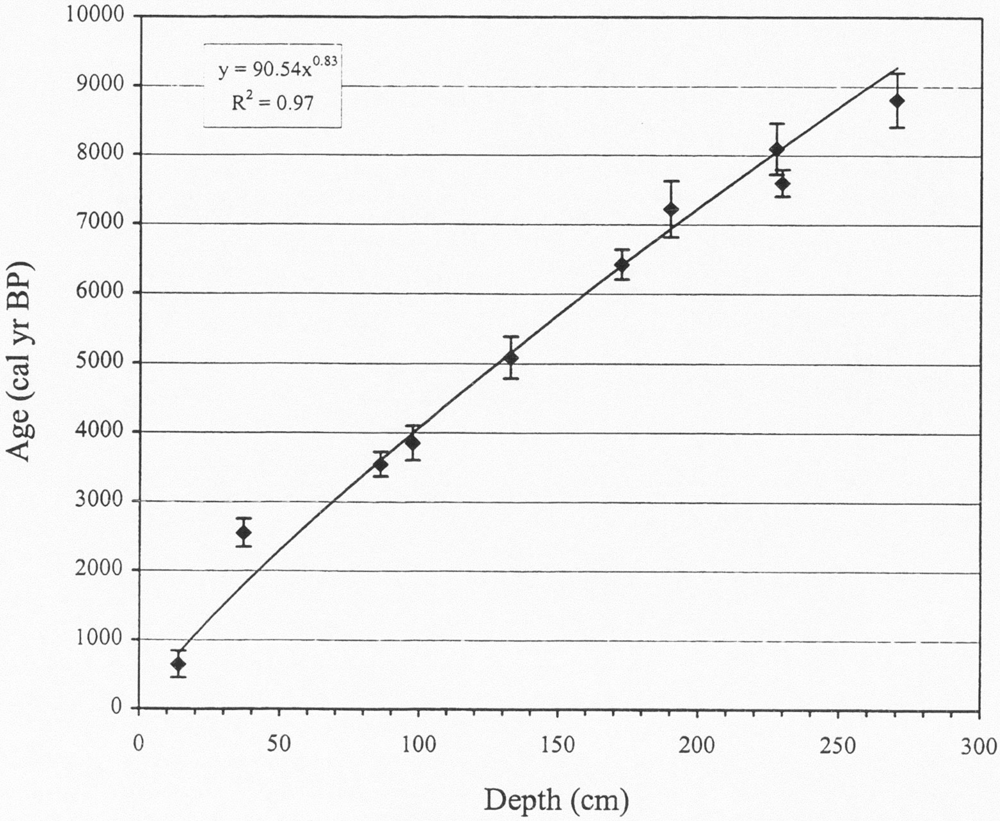

Figure 5. Calibrated age to depth indicating a steady rate of accumulation for part of the Anchor Point section. Error bars are ± ½ of the 1 s.d. range listed in table 2. Calibrations are based on Stuiver and Reimer (1993). The curve is a power function fit of the data and forms the age model (eq. 2).

The mean major-element composition was then calculated for each tephra population (table 3) and plotted on a total alkali silica (TAS) diagram (fig. 6). The TAS composition of individual shards comprising each population is plotted in appendix B. The primary tephra compositions (except 97AP-E-a) are rhyolitic, characteristic of a viscous, silica-rich magma. The mean silica content of the primary population ranges from 74.49 to 78.95% SiO_2. The six samples with secondary populations are andesite,

Table 3. Summary of mean values of normalized weight % oxides of Anchor Point tephra.

Sample[1]	(n)[2]	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	TiO_2	Fe_2O_3	Total
97AP-E-a	8	4.59	1.32	14.81	67.09	0.15	2.59	3.28	0.77	5.39	100
97AP-E-b	7	4.20	2.73	15.73	60.44	0.11	1.72	5.76	1.01	8.30	100
97AP-G	9	4.15	0.23	12.65	77.01	0.19	3.29	1.08	0.21	1.21	100
97AP-H-a	7	4.05	0.32	12.42	77.56	0.23	1.78	1.87	0.21	1.55	100
97AP-H-b	4	4.72	0.08	28.84	54.01	0.01	0.21	11.42	0.06	0.66	100
97AP-I-a	9	4.08	0.36	12.15	77.94	0.25	1.67	1.87	0.21	1.46	100
97AP-I-b	3	5.50	0.10	25.93	58.31	0.06	0.47	8.89	0.06	0.68	100
97AP-J	9	4.22	0.35	12.83	75.14	0.22	3.18	1.87	0.32	1.86	100
97AP-K	9	3.95	0.39	13.43	75.47	0.44	2.57	1.93	0.18	1.64	100
97AP-L	10	4.08	0.54	12.63	76.48	0.15	1.99	2.04	0.22	1.86	100
97AP-M	15	3.94	0.35	12.35	77.83	0.20	1.67	1.91	0.20	1.56	100
97AP-N-a	9	4.23	0.30	13.30	75.67	0.18	2.75	1.69	0.32	1.56	100
97AP-N-b	4	5.90	0.04	26.69	57.24	0.00	0.32	9.29	0.01	0.50	100
97AP-O	12	4.03	0.34	12.52	77.79	0.18	1.56	1.89	0.19	1.49	100
97AP-P	14	4.07	0.30	12.27	77.76	0.19	1.94	1.63	0.26	1.58	100
97AP-Q	6	3.98	0.34	12.91	77.52	0.14	1.57	1.97	0.23	1.34	100
97AP-R	11	3.89	0.30	12.86	77.41	0.47	1.64	2.02	0.20	1.22	100
97AP-S-a	11	4.44	0.45	13.47	74.49	0.26	2.67	1.89	0.32	2.01	100
97AP-S-b	3	5.91	0.04	27.31	56.61	0.00	0.20	9.38	0.00	0.55	100
97AP-T	15	4.07	0.30	13.00	77.48	0.16	1.51	2.09	0.13	1.24	100
97AP-U-a	10	4.03	0.39	12.69	77.95	0.15	1.75	1.68	0.12	1.24	100
97AP-U-b	3	5.97	0.03	26.33	58.29	0.01	0.18	8.94	0.05	0.19	100

[1]a = primary population; b = secondary population.

[2]n = number of shards analyzed.

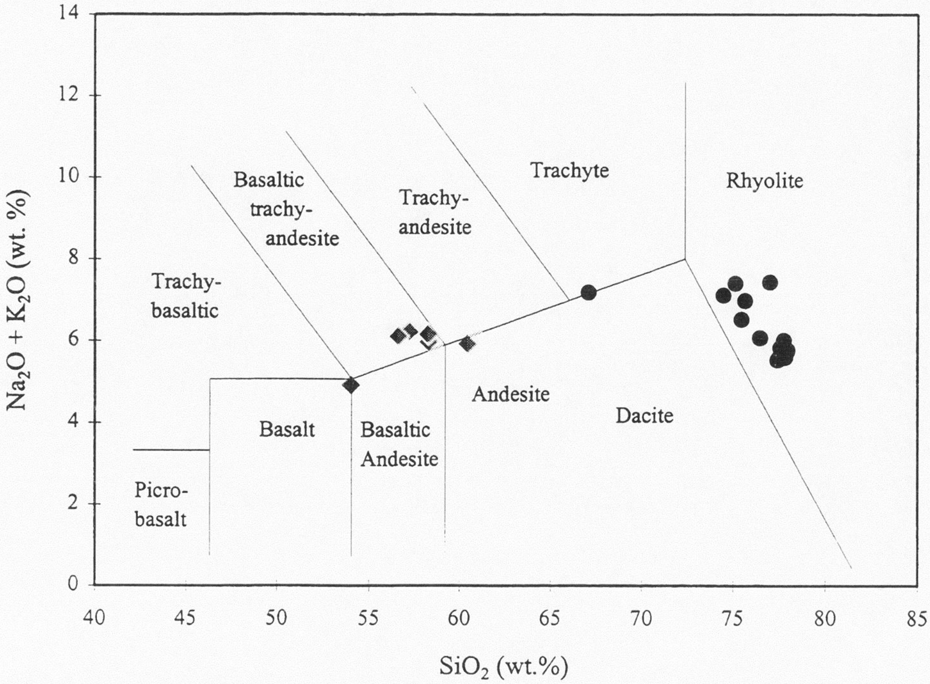

Figure 6. Total alkali-silica (TAS) diagram, after LeBas and others (1986), showing the mean composition of each tephra population from Anchor Point. (black circles = primary populations; gray diamonds = secondary populations)

basalt to basaltic andesite, and basaltic trachyandesite, with the mean silica composition ranging from 54.01 to 60.44% SiO_2 (fig. 6).

Homer

The Homer site (59° 38' 27" N, 151° 28' 21" W) is located approximately 28 km southeast of Anchor Point on the east coast of Cook Inlet along the shore of Kachemak Bay (fig. 2). The wave-cut cliff exposes 140 cm of dense, compact, medium-brown, fibrous sphagnum peat with numerous tephra (figs. 4 and 7). The peat overlies clayey pebble to cobble diamicton of an undetermined thickness. The base of the peat is

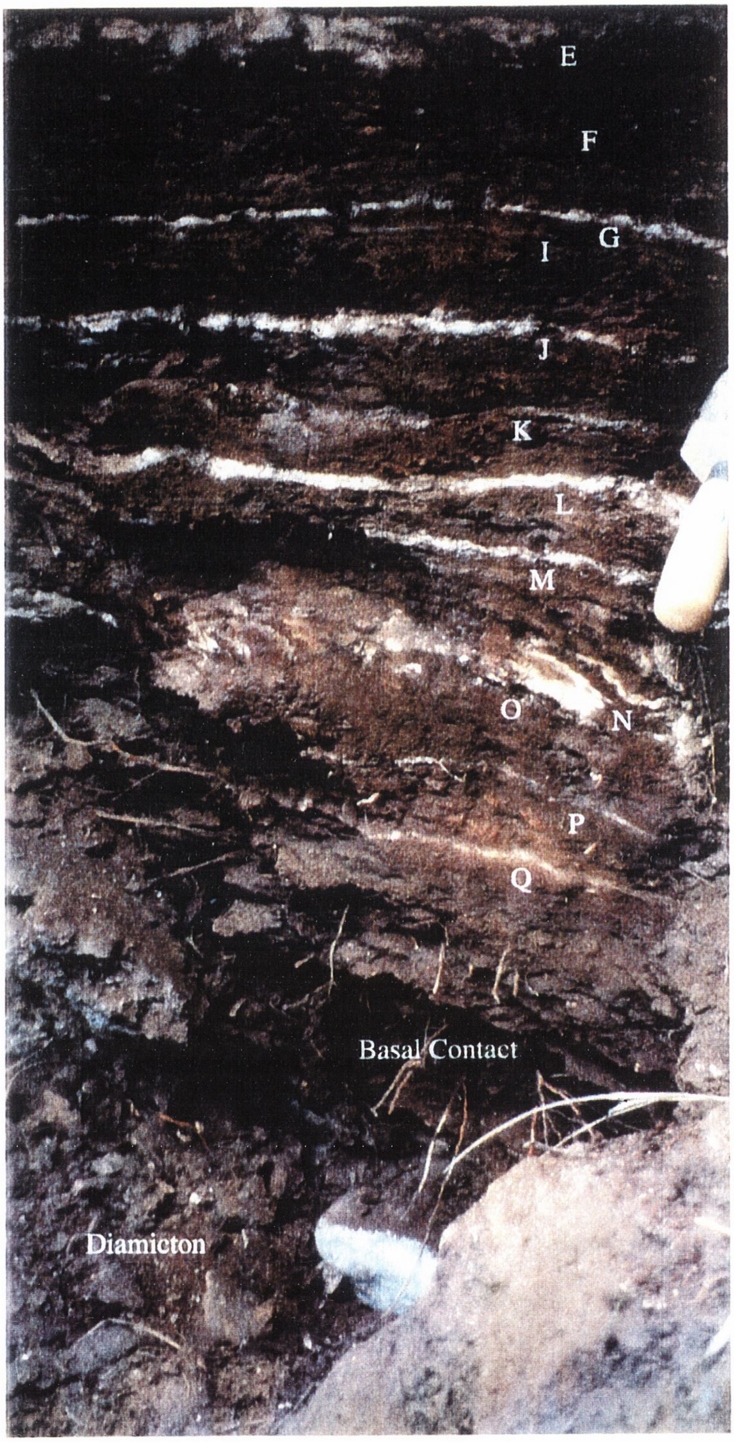

Figure 7. Homer (97H) section. Seventeen layers were sampled and characterized from this 140-cm-thick peat section. Sample identification noted for several of the more visible tephra.

Table 4. Outcrop and laboratory tephra descriptions, Homer.

Field Identification (97H)	Depth (cm)	Tephra Thickness (cm)	Sample Wt. Raw (g)	Sample Wt. Cleaned (g)	Comments
A	38.5	2.5	16.96	1.58	
B	54.0	1.0	8.58	1.40	
C	55.0	1.0	4.72	0.75	
D	57.0	0.5	12.66	0.36	
E	66.0	2.0	30.81	10.18	
F	69.0	0.5	5.07	0.63	
G	74.5	1.5	9.84	2.81	
H	75.5	0.5	9.54	0.16	Insufficient glass[1]
I	81.5	1.5	15.56	5.22	
J	86.5	0.5	2.58	1.76	
K	91.0	1.0	18.10	5.84	
L	94.0	1.0	12.09	6.51	
M	100.5	0.5	22.90	6.67	
N	108.0	1.0	6.85	0.10	
O	114.0	1.0	7.80	0.38	
P	137.0	1.0	15.16	0.37	
Q	140.0	1.0	7.24	0.87	

[1]No further analysis.

approximately 11.5 m asl. From the modern surface to a depth of approximately 34 cm, the deposits are altered by humans and were not described. Only major tephra layers (≥ 1 mm) were sampled and described (table 4). Seventeen samples collected from the Homer site are tephra. One sample (97H-H) had insufficient glass to be analyzed. The tephra layers at Homer are similar in all macro- and microscopic characteristics to those at Anchor Point. The basal contacts for each tephra layer are sharp (<1 mm), except 97H-

A, B, and C, which have diffuse basal contacts 4 to 10 mm thick. The upper contacts are diffuse. Several of the layers are convoluted, probably due to freeze/thaw action. The thickness of the layers ranges from 0.5 to 2.5 cm. Each sampled layer is continuous across the exposure (~2.5 m) and lacks internal sedimentary structures.

No radiocarbon dates were obtained from the Homer site. However, Reger and others (1996) reported an age of 10,310 ± 70 ^{14}C yr BP (12,065 ± 285 cal yr BP; Beta-47180; 91RE1 C-1) from the base of a 2-m-thick peat bed that overlies till ~3.5 km east of the Homer site (their Section 74). Investigation of the beach cliff shows that the tephra-bearing peat unit appears to be continuous along this segment of the coast. An accumulation rate of 0.11 mm/yr was estimated using Reger and others' (1996) date and applying it to the base of the peat at Homer. The exposed base of the Homer site is older than the base of Anchor Point section, based on the basal age at Anchor Point of 7970 ± 115 ^{14}C yr BP (8810 ± 205 cal yr BP). The accumulation rates are correspondingly much lower at Homer than at Anchor Point. Because of the uncertainty in the age of the stratigraphic sequence at Homer, I did not assign ages to tephra at that site.

Four tephra samples from Homer contain two populations (appendix A). Primary populations are similar geochemically to those from the Anchor Point site. The primary populations are rhyolitic to dacitic in composition (fig. 8) with mean silica content of 73.31 to 78.14% SiO_2 (table 5). Sample 97H-O is the only andesitic tephra (61.70% SiO_2). Of the four samples with secondary populations, 97H-J-b is dacite (67.64% SiO_2) and three (97H-B-b, C-b, and G-b) are andesite to trachyandesite and basaltic trachyandesite (56.24 to 62.22% SiO_2) (fig. 8). The TAS composition of individual shards comprising each population is plotted in appendix B.

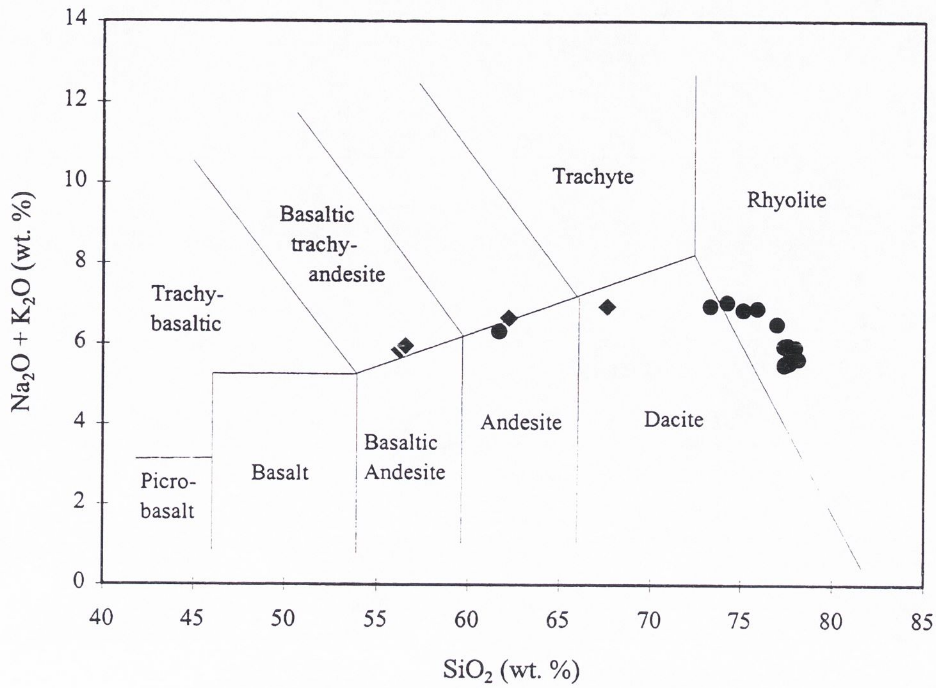

Figure 8. Total alkali-silica (TAS) diagram, after LeBas and others (1986), showing the mean composition of each tephra population from Homer. (black circles = primary populations; gray diamonds = secondary populations)

Table 5. Summary of mean values of normalized weight % oxides of Homer tephra.

Sample[1]	(n)[2]	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	TiO_2	Fe_2O_3	Total
97H-A	19	3.98	0.37	12.19	77.57	0.25	2.00	2.09	0.26	1.31	100
97H-B-a	9	4.02	0.31	12.11	77.98	0.23	1.90	1.74	0.22	1.47	100
97H-B-b	5	5.73	0.06	27.51	56.24	0.02	0.13	9.97	0.02	0.33	100
97H-C-a	9	4.01	0.33	12.18	77.83	0.24	1.87	1.82	0.24	1.49	100
97H-C-b	5	5.73	0.06	27.51	56.24	0.02	0.13	9.97	0.02	0.33	100
97H-D	10	3.89	0.37	12.29	77.77	0.23	1.83	1.82	0.20	1.60	100
97H-E	15	3.89	0.52	12.41	77.40	0.20	1.63	1.98	0.21	1.77	100
97H-F	8	3.89	0.29	12.34	78.14	0.17	1.74	1.85	0.20	1.39	100
97H-G-a	15	3.96	0.31	12.42	77.62	0.22	1.95	1.63	0.23	1.66	100
97H-G-b	3	5.82	0.02	27.43	56.56	0.02	0.14	9.53	0.02	0.46	100
97H-I	13	4.00	0.37	12.89	77.38	0.20	1.48	2.09	0.15	1.43	100
97H-J-a	11	4.35	0.61	14.04	73.31	0.23	2.60	2.21	0.37	2.29	100
97H-J-b	4	4.85	0.86	16.67	67.64	0.26	2.08	3.88	0.58	3.18	100
97H-K	14	4.35	0.45	13.85	74.24	0.28	2.69	1.86	0.29	1.99	100
97H-L	15	3.96	0.39	12.79	77.64	0.16	1.57	1.94	0.17	1.37	100
97H-M	8	4.15	0.34	13.05	77.37	0.24	1.80	1.71	0.13	1.21	100
97H-N	11	3.99	0.30	12.93	77.74	0.16	1.59	1.91	0.12	1.25	100
97H-O	14	4.42	2.27	15.33	61.70	0.12	1.90	4.75	0.95	8.56	100
97H-P	13	3.88	0.46	12.63	75.13	0.21	2.97	1.74	0.44	2.55	100
97H-Q	14	3.93	0.40	12.27	75.90	0.25	2.96	1.58	0.39	2.32	100

[1]a = primary population; b = secondary population.

[2]n = number of shards analyzed.

DISCUSSION: TEPHRA CORRELATIONS

The goal of using the major-element analysis from the EMP is to distinguish tephra layers, taking into consideration that some tephra may have erupted from the same source volcano. In most cases, the major-element composition is sufficient to distinguish between different volcanoes, and possibly between different eruptions of the same volcano. In some cases, however, the geochemistry is ambiguous and indicates two different volcanoes. Trace-element data would help to determine the geochemical boundaries of a particular tephra. According to Christopher Nye (Alaska Volcano Observatory, pers. comm., 1999), tephra trace-element geochemistry is now available for the Cook Inlet volcanoes (e.g., Nye and Turner, 1990).

Correlations Between Anchor Point and Homer

I attempted to correlate tephra between the Anchor Point and Homer sections before comparing the EMP results with other results from the Cook Inlet region. Tephra from these two sites should be readily correlated because they are separated by only 28 km and because I performed all analyses. The major-element composition of each tephra population from Anchor Point was compared with that of each population from Homer, and a matrix of SC values was compiled (table 6). Nine tephra can confidently be correlated between these two sections based on their SC values of 0.95 and on their stratigraphic positions (fig. 4). In addition, numerous tephra pairs have SC values of 0.91 - 0.94; although only somewhat similar geochemically, they might correlate (table 6). On the other hand, only nine out of 16 microprobed tephra at Anchor Point have strongly

Table 6. Matrix comparing similarity coefficient values for Anchor Point and Homer sections.

Sample[1]	97AP-E-a	97AP-E-b	97AP-G	97AP-H-a	97AP-H-b	97AP-I-a	97AP-I-b	97AP-J	97AP-K	97AP-L	97AP-M
97H-A	0.60	0.53	0.79	**0.91**	0.36	**0.93**	0.41	0.86	0.84	0.87	0.90
97H-B-a	0.59	0.52	0.82	**0.96**	0.36	**0.95**	0.41	0.86	0.84	0.86	**0.93**
97H-B-b	0.32	0.35	0.31	0.30	0.69	0.30	0.65	0.30	0.30	0.30	0.30
97H-C-a	0.59	0.48	0.85	0.90	0.36	0.89	0.40	0.85	0.87	0.81	0.87
97H-C-b	0.47	0.52	0.46	0.45	0.59	0.45	0.74	0.43	0.41	0.46	0.46
97H-D	0.59	0.53	0.80	**0.97**	0.35	**0.95**	0.41	0.87	0.87	0.87	**0.96**
97H-E	0.62	0.55	0.78	**0.91**	0.34	0.90	0.40	0.83	0.83	**0.93**	**0.93**
97H-F	0.60	0.55	0.84	**0.93**	0.37	**0.91**	0.43	0.81	0.82	0.86	**0.94**
97H-G-a	0.59	0.53	0.82	**0.95**	0.35	**0.91**	0.40	0.87	0.84	0.87	**0.92**
97H-G-b	0.31	0.35	0.30	0.30	0.65	0.30	0.62	0.29	0.29	0.30	0.30
97H-I	0.59	0.53	0.79	0.90	0.38	**0.91**	0.44	0.82	0.84	0.84	**0.93**
97H-J-a	0.72	0.57	0.71	0.78	0.34	0.77	0.38	0.86	0.79	0.83	0.77
97H-J-b	0.78	0.66	0.57	0.66	0.36	0.66	0.41	0.68	0.63	0.69	0.64
97H-K	0.66	0.52	0.75	0.83	0.34	0.84	0.39	**0.91**	0.86	0.84	0.81
97H-L	0.61	0.55	0.79	0.89	0.37	0.90	0.44	0.81	0.85	0.87	**0.92**
97H-M	0.57	0.53	0.81	**0.91**	0.39	0.90	0.45	0.82	0.82	0.80	0.89
97H-N	0.61	0.55	0.80	0.89	0.38	0.88	0.45	0.80	0.81	0.85	0.90
97H-O	0.79	**0.92**	0.50	0.55	0.35	0.53	0.42	0.54	0.51	0.60	0.55
97H-P	0.68	0.54	0.75	0.79	0.31	0.78	0.36	0.88	0.78	0.81	0.80
97H-Q	0.64	0.52	0.76	0.81	0.31	0.82	0.36	0.89	0.81	0.79	0.80

Table 6. (cont.)

Sample[1]	97AP-N-a	97AP-N-b	97AP-O	97AP-P	97AP-Q	97AP-R	97AP-S-a	97AP-S-b	97AP-T	97AP-U-a	97AP-U-b
97H-A	0.84	0.31	0.88	0.90	0.89	0.86	0.85	0.30	0.85	0.85	0.30
97H-B-a	0.87	0.31	**0.92**	**0.94**	0.90	0.87	0.82	0.29	0.85	0.86	0.30
97H-B-b	0.31	0.70	0.31	0.30	0.32	0.31	0.30	0.67	0.33	0.32	0.72
97H-C-a	0.88	0.30	0.86	0.88	0.85	0.86	0.84	0.29	0.82	0.81	0.29
97H-C-b	0.46	0.66	0.48	0.46	0.51	0.44	0.42	0.58	0.51	0.50	0.54
97H-D	0.85	0.30	**0.93**	0.91	0.89	0.87	0.84	0.29	0.84	0.87	0.30
97H-E	0.81	0.30	0.91	0.87	0.89	0.84	0.83	0.29	0.84	0.84	0.30
97H-F	0.86	0.31	**0.95**	0.91	**0.92**	0.89	0.78	0.30	0.91	0.89	0.30
97H-G-a	0.88	0.30	0.90	**0.96**	0.88	0.85	0.83	0.29	0.84	0.84	0.29
97H-G-b	0.30	0.74	0.30	0.29	0.31	0.30	0.30	0.69	0.32	0.32	0.74
97H-I	0.82	0.32	**0.93**	0.86	0.91	0.85	0.78	0.31	**0.93**	0.89	0.32
97H-J-a	0.83	0.30	0.75	0.77	0.74	0.71	0.90	0.29	0.72	0.71	0.30
97H-J-b	0.65	0.34	0.62	0.65	0.61	0.60	0.73	0.33	0.60	0.60	0.34
97H-K	0.87	0.30	0.79	0.82	0.78	0.76	**0.97**	0.29	0.73	0.75	0.30
97H-L	0.82	0.32	**0.95**	0.86	**0.94**	0.86	0.79	0.30	**0.92**	**0.92**	0.31
97H-M	0.83	0.33	0.88	0.86	0.86	0.86	0.79	0.31	0.91	**0.92**	0.32
97H-N	0.83	0.32	**0.92**	0.87	**0.92**	0.84	0.76	0.30	**0.94**	**0.95**	0.32
97H-O	0.56	0.34	0.55	0.56	0.58	0.51	0.56	0.32	0.55	0.56	0.34
97H-P	0.85	0.28	0.78	0.81	0.76	0.71	0.88	0.27	0.72	0.76	0.27
97H-Q	0.85	0.28	0.78	0.82	0.76	0.73	0.89	0.27	0.71	0.76	0.27

[1]a = primary population; b = secondary population.

similar counterparts at Homer. The reason for such unexpectedly few correlations is not known.

Homer tephra 97H-B-a is probably represented by two tephra at Anchor Point, 97AP-H-a (1170 cal yr) with SC = 0.96 and 97AP-I-a (1795 cal yr) with SC = 0.95. The mean SiO_2 contents are 77.56 and 77.94%, respectively, nearly the same as the 77.98 weight % of SiO_2 in 97H-B-a (tables 3 and 5). However, Homer tephra 97H-D is possibly represented by the same two tephra at Anchor Point, 97AP-H-a (SC = 0.97) and 97AP-I-a (SC = 95). The mean SiO_2 contents are nearly the same (77.56 and 77.94%) as the 77.77 weight % of SiO_2 in 97H-D (tables 3 and 5). Homer tephra 97H-D is geochemically similar and possibly correlative with 97AP-M (SC = 0.96). The mean SiO_2 are 77.77 and 77.83%, respectively. The next correlation is between 97H-F and 97AP-O (5550 cal yr) with SC = 0.95. The mean SiO_2 contents are similar with 78.14 and 77.79%, respectively. In addition, tephra 97H-G-a correlates with 97AP-P (6405 cal yr) with a SC value of 0.96. The SiO_2 percentages are 77.62 and 77.76 weight %, respectively (tables 3 and 5). The correlation between tephra 97H-K and 97AP-S-a (7760 cal yr) has a SC value 0.97. The mean SiO_2 contents are very similar with 74.24 and 74.49 weight %, respectively. The final correlation is between 97H-N and 97AP-U-a (8825 cal yr). The two layers correlate with a SC value of 0.95 (table 6). The SiO_2 contents are 77.73 and 77.95 weight %, respectively (tables 3 and 5).

Correlations with Source Volcanoes

A concerted effort was made to compile previously published and some unpublished data for the Cook Inlet volcanoes. The purpose was to develop the most complete database possible for comparisons. The mean major-oxide compositions of glass shards in each tephra population from the Anchor Point and Homer sites were individually compared with previously published EMP geochemistry of 171 volcanic glass samples from five published reports on Cook Inlet tephra: Riehle and others (1990, 1999), Riehle (1985), Reger and others (1996), Siebert and others (1995). The same suite of elements was not always analyzed in these various studies. Comparing previous analyses with those of this study required removing certain elements such as Cl, Mn, and Mg, and renormalizing the remainder. SC values for each tephra at Anchor Point and Homer were calculated by comparing their major-element composition with that of each tephra in the database (appendix C).

Many of the Anchor Point and Homer tephra cannot be correlated with a specific source volcano. Although some of the previously published data on distal tephra were confidently assigned to a volcanic source by the authors, many were not. Because I do not have an independent and unambiguous means of assessing the source of distal tephra analyzed by pervious workers, I have elected to use only the data from coarse-grained, proximal samples as a basis of comparison when attempting to assign my samples to a source. Unfortunately, only a few studies have been completed on the volcanoes themselves.

The emphasis here is on Augustine and Iliamna volcanoes, perhaps the two most likely sources of tephra at Anchor Point and Homer. The proximal tephra from Augustine Island were collected by R. Waitt (U.S. Geological Survey) at three separate exposures (Riehle and others, 1999). And, four silicic pumice lapilli samples were collected from a nunatak on the north or northeast flank of Iliamna Volcano by T. Miller

(U.S. Geological survey, unpublished data). On the basis of these analyses, proximal Augustine tephra contains a mean SiO_2 concentration of 77.17 ±0.15% compared to 75.13 ±0.13% for Iliamna tephra (table 7).

Table 7. Normalized weight % oxides for Augustine and Iliamna Volcano proximal tephra samples.

	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	TiO_2	Fe_2O_3
Augustine[1]									
RBW75A	3.90	0.40	12.70	77.20	n/a	1.90	1.90	0.30	1.72
RBW33B	3.90	0.40	12.90	77.00	n/a	1.80	2.10	0.20	1.70
RBW33D	4.00	0.40	12.80	77.30	n/a	1.90	1.80	0.30	1.64
Mean	3.93	0.40	12.80	77.17	n/a	1.87	1.93	0.27	1.69
s.d.	0.06	0.00	0.10	0.15	n/a	0.06	0.15	0.06	0.04
Iliamna[2]									
116b-28	3.98	0.53	12.64	74.95	0.58	2.48	1.99	0.49	2.36
116-26	4.12	0.48	12.58	75.12	0.63	2.47	1.86	0.46	2.30
116-15	4.18	0.48	12.61	75.20	0.56	2.52	1.84	0.47	2.15
116b-14	3.99	0.44	12.62	75.23	0.66	2.50	1.81	0.42	2.34
Mean	4.07	0.48	12.61	75.13	0.61	2.49	1.88	0.46	2.28
s.d.	0.10	0.04	0.03	0.13	0.04	0.02	0.08	0.03	0.10

[1]Three separated exposures on Augustine Island collected by R.B. Waitt (Riehle and others, 1999).
[2]Four silicic pumice samples from nunatak on north or northeast flank of Iliamna Volcano (T. Miller, U.S. Geological Survey, unpublished data).

Augustine Volcano

Tephra 97AP-H-a (1170 cal yr) is geochemically similar to three tephra layers, 97AP-I-a (SC = 0.96), 97AP-M (SC = 0.96), and 97AP-O (SC = 0.94) within the Anchor Point section (appendix C). Layer 97AP-M (4250 cal yr), in turn, is similar to 97AP-I-a (SC = 0.95) and 97AP-O (SC = 0.97). Tephras 97AP-H-a and 97AP-M are geochemically similar to Riehle and others' (1999) three proximal tephra layers from Augustine, with SC values of 0.94 and 0.95 respectively. The Augustine tephra is also geochemically similar to Reger and others' (1996) Tephra 1A (SC = 0.94 to 0.97) and Tephra 1B (SC = 0.94 to 0.95). Reger and others (1996) assigned Tephra 1A and 1B to Augustine Volcano, and the data presented here support their conclusion.

Although tephras 97AP-P (6405 cal yr) and 97AP-Q (6940 cal yr) are only weakly similar to proximal Augustine tephra (SC = 0.92 and 0.93) (Riehle and others, 1999), they are more similar to Reger and others' (1996) Augustine Tephra 1B (SC = 0.94 to 0.97) and Tephra 1A (SC = 0.95 to 0.98) (appendix C). Tephra 97AP-Q is also similar to Augustine Tephra 1C (Reger and others, 1996) with an SC value of 0.94, which, itself, is geochemically similar to proximal Augustine tephra (SC = 0.94) (Riehle and others, 1999).

Although tephras from Augustine Volcano are present at several levels in the section at Homer, the SC values are lower than those from the Anchor Point site with the exception of one tephra (97H-E) (appendix C). Tephra 97H-E is geochemically similar only to proximal Augustine tephra (SC = 0.94) (Riehle and others, 1999). Based on the geochemical similarity with Reger and others' (1996) Tephra 1A (SC = 0.94 to 0.95) and Tephra 1B (SC = 0.94 – 0.96), and proximal Augustine tephra (Riehle and others, 1999), the following tephra layers probably represent Augustine eruptions: 97H-B-a, 97H-F, 97H-G-a, and 97H-L (appendix C).

The major-element geochemistry of a proximal Augustine tephra collected by Siebert and others (1995) is weakly similar to only one tephra (97AP-N-a) in the Anchor Point section (SC = 0.91). Other tephras analyzed by Siebert and others from the volcano are all geochemically dissimilar to those of Anchor Point and Homer. Low SC values (0.90 to 0.91) are also found when Siebert and others' data are compared with Riehle and others' (1999) proximal samples. The poor correlations might be due to unknown analytical differences and therefore, I do not use Siebert and others' data as a basis for ascribing tephra to Augustine Volcano.

Iliamna Volcano

EMP analyses of four undated, coarse-grained, proximal tephra collected by T. Miller (U.S. Geological Survey, unpublished data) show that the composition of tephra from Iliamna Volcano borders are rhyolitic with SiO_2 mean of 75.13% (table 7). Geochemically similar tephras are present in three stratigraphic positions within the Anchor Point reference section (table 8).

First, tephra 97AP-J (3040 cal yr) has a SC value of 0.99 to Miller's (unpublished data) Iliamna sample 116-15 (appendix C). The high SC values and similar SiO_2 content (75.14 and 75.20%, respectively) strongly indicate 97AP-J is from an Iliamna eruption (appendix C; tables 3 and 7).

Second, tephra 97AP-L (3995 cal yr) is geochemically similar (SC = 0.98 to 0.99) to Iliamna samples 116b-28, 116-26, and 116b-14 (Miller, unpublished data) and has a

Table 8. Overview of proposed major plinian (?) eruptions recorded at Anchor Point and Homer.

Sample	Modeled Ages[1] (cal yr BP)	Possible Source
(97AP)		
H-a	1170	Augustine[2]
J	3040	Iliamna[3]
L	3995	Iliamna[4]
M	4250	Augustine[2]
S-a	7760	Iliamna[3]
(97H)		
E		Augustine[2]
J-a		Iliamna[4]
K		Iliamna[3]
P		Iliamna[4]
Q		Iliamna[4]

[1]Based on modeled age from eq. (2); see text.
[2]Waitt, R. (Riehle and others, 1999) Tephra RBW-33B, 33D, and 75A.
[3]Miller, T. (unpublished) Tephra 116-15.
[4]Miller, T. (unpublished) Tephra 116b-14, 116-26, 116b-28.

SiO_2 content of 76.48% (appendix C; table 3). The high SC values and the similar SiO_2 content indicate tephra 97AP-L was most likely erupted from Iliamna Volcano.

Third, tephra 97AP-S-a (7760 cal yr) is assigned to Iliamna Volcano based on SC values of 0.94 with Miller's (unpublished) sample 116-15 and the SiO_2 content of 74.49 and 75.20%, respectively (appendix C; table C1). This tephra is also geochemically similar to Tephra 3 (SC = 0.94 - 0.96) of Reger and others (1996). Although Reger and others' (1996) suggested that Tephra 3 could have erupted from Augustine Volcano, they were not certain. The SiO_2 content (75.29%) for Tephra 3 is more similar to that of proximal Iliamna tephra (75.13%) than it is Augustine's (77.17%).

At Homer, four tephras can be attributed to Iliamna (table 8). The first tephra (97H-J-a) is geochemically similar (SC = 0.99) to Miller's (unpublished data) Iliamna sample 116b-28, 116-26, and 116b-14 (appendix C). The mean SiO_2 content for 97H-J-a is 73.31%, similar to proximal Iliamna tephra collected by Miller (75.13%) (unpublished data) (table 5 and 7). Because of the high SC values and the similar SiO_2 content, tephra 97H-J-a is probably from Iliamna Volcano.

The second tephra (97H-K) has a SC value of 0.99 with Miller's (unpublished data) Iliamna sample 116.15 (appendix C). The SiO_2 contents are similar (74.24% and 75.20%, respectively) (table 5 and 7). It is also similar to 97AP-S-a (SC = 0.97) at Anchor Point, which, likewise, was attributed to Iliamna Volcano (see above).

The two other tephras at Homer that correlate with Iliamna Volcano are 97H-P and 97H-Q. Tephra 97H-P is compositionally similar (SC = 0.99) to Miller's (unpublished data) Iliamna sample 116b-28, and 97H-Q has a SC value of 0.98 with Miller's 116b-28 and a SC of 0.99 with 116-26 and 116b-14 (appendix C). Even though the geochemical similarity between these two layers at Homer is not strong (SC = 0.93), the high SC values (SC = 0.98 – 0.99) with Miller's data strongly suggest an Iliamna source (appendix C). Based on Reger and others' (1996) ^{14}C age of 10,310 ± 70 ^{14}C yr BP from the base of Holocene peat near Homer, these two correlated Iliamna tephras from near the base of the section at Homer are probably older than any of the correlated Iliamna tephras in the Anchor Point section.

HAZARDS

Explosive eruptions from the lower Cook Inlet volcanoes have an impact on people, businesses, and air traffic over the region (Waythomas and Miller, 1999; Waythomas and Waitt, 1999). The lower Cook Inlet volcanoes are in the direct flight path of jet aircraft flying into the Anchorage International Airport (Casadevall, 1994). Tephra plumes also threaten smaller aircraft flying into the numerous regional airports of the area. Eruptions from these volcanoes are imminent and the effects of tephra fall on the population centers of south-central Alaska can be great.

An average of three to five eruptions per year occur in the Aleutian volcanic arc (Simkin and Siebert, 1994). Ash clouds from these eruptions are transported north, east, or southwest by the prevailing winds (Kienle and others, 1988; Riehle, 1985). Tephra, in the form of fine-grained ash, is dispersed and deposited on the Kenai Peninsula and often beyond. The frequency of the Aleutian volcano eruptions and the prevailing wind direction dispersing ash suggests a tephra record can be found on the Kenai Peninsula. Many of the thin tephra layers, not sampled for this study, deposited at Anchor Point and Homer, may be the result of past eruptions of Cook Inlet and Aleutian volcanic arc volcanoes. The eruptions recorded in the stratigraphic sequences on the Kenai Peninsula aid in interpreting the number of significant tephra fall events for the Anchor Point and Homer sites. They also record the minimum number of eruptions for lower Cook Inlet volcanoes.

No major historical eruptions are represented by tephra beds at Anchor Point and Homer. The thickness of the preserved layers indicates that they record eruptions that delivered more tephra to these sites than those of historical eruptions. Both the depositional environment and the ability of the tephra deposit to stay intact once it has been deposited are other important factors that determine its ultimate preservation. Nonetheless, on the basis of the total number of tephras collected at Anchor Point (17), and on the total length of time represented by the section (8810 ± 205 cal yr), the recurrence interval of tephra fall events at this site averages approximately 520 yr. The tephrostratigraphy indicates that the frequency of major tephra fall events at Anchor Point is not spaced evenly through the last approximately 8800 years. The major tephra falls appear to have been more frequent (about 1 every 300 yr) during the past 1200 yr, compared to previously (~ 1 per 585 yr between 8800 and 1200 yr). The thin (< 1 mm) tephra layers at Anchor Point need to be counted, sampled, and analyzed to further expand the recurrence interval and the stratigraphic record at this site.

CONCLUSIONS

The following conclusions can be made from this study:

1. Thirty-three major tephra layers are interbedded in two peat sections (Anchor Point and Homer) on the Kenai Peninsula, lower Cook Inlet. Nine tephra can confidently ($SC \geq 0.95$) be correlated between Anchor Point and Homer sites. A dated tephrostratigraphic sequence has been developed at the Anchor Point site. Ten peat and wood samples have ^{14}C ages ranging from 645 ± 85 to 8810 ± 205 cal yr BP and provide the basis for assigning interpolated ages for all 17 tephra at Anchor Point. The recurrence interval of major tephra falls at Anchor Point is ~ 520 yr.

2. On the basis of major-element similarities, three tephra were erupted from Augustine and at least seven tephra were erupted from Iliamna Volcano found at both Anchor Point and Homer.

3. A geochemical database has been compiled for the lower Cook Inlet region based on the new data from Anchor Point and Homer sites together with analyses from 171 samples from other workers. All data are housed at the Alaska Volcano Observatory, U.S. Geological Survey, Anchorage, Alaska.

The thin (< 1 mm) tephra layers at the Anchor Point site still need to be counted, sampled, and analyzed to expand the stratigraphic record. Numerous outcrops along the shores of Cook Inlet probably also contain peat sections with both undocumented and correlative tephras. The history of Holocene eruptions of the Cook Inlet volcanoes will improve with the addition of new geochemical data.

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APPENDICES

Appendix A. Mean Values of Normalized wt. % Oxides for Each Anchor Point and Homer Tephra.

Table A1. Mean values of normalized weight % oxides of Anchor Point tephras.

	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	TiO_2	Fe_2O_3	Total
97AP-E-a	4.60	0.97	14.32	67.73	0.17	3.00	2.72	0.80	5.68	100
n = 8	4.51	0.92	14.44	69.14	0.15	2.91	2.53	0.80	4.59	100
	4.44	0.96	14.60	68.68	0.19	3.01	2.51	0.77	4.85	100
	4.47	1.59	15.21	65.30	0.14	2.22	4.04	0.76	6.28	100
	4.63	1.48	14.84	67.10	0.15	2.49	3.42	0.74	5.14	100
	4.91	1.67	15.13	65.02	0.14	2.25	3.80	0.85	6.24	100
	4.59	1.06	14.71	69.34	0.13	2.69	2.80	0.66	4.02	100
	4.60	1.90	15.27	64.43	0.15	2.16	4.40	0.82	6.28	100
Mean	4.59	1.32	14.81	67.09	0.15	2.59	3.28	0.77	5.39	100
s.d.	0.14	0.38	0.36	1.96	0.02	0.36	0.74	0.06	0.87	
97AP-E-b	4.13	2.95	16.14	59.72	0.09	1.59	6.11	1.08	8.19	100
n = 7	4.20	2.65	15.83	60.12	0.11	1.71	5.88	0.93	8.58	100
	4.22	2.74	15.31	60.72	0.09	1.80	5.79	0.92	8.41	100
	4.25	2.57	15.63	61.37	0.05	1.84	5.34	0.83	8.13	100
	4.09	2.98	15.92	59.56	0.10	1.56	5.85	0.91	9.03	100
	4.47	2.32	15.71	61.73	0.14	1.84	5.24	1.15	7.40	100
	4.04	2.94	15.55	59.88	0.20	1.72	6.10	1.25	8.33	100
Mean	4.20	2.73	15.73	60.44	0.11	1.72	5.76	1.01	8.30	100
s.d.	0.14	0.24	0.27	0.85	0.05	0.11	0.34	0.15	0.50	

Table A1. Continued.

97AP-G	4.13	0.16	12.37	77.59	0.15	3.54	0.90	0.10	1.06	100
n = 9	4.06	0.21	12.25	77.64	0.20	3.36	0.95	0.20	1.12	100
	4.18	0.27	12.72	76.51	0.23	3.19	1.14	0.41	1.34	100
	4.21	0.30	13.01	76.29	0.17	3.09	1.31	0.34	1.28	100
	4.19	0.24	12.60	76.69	0.15	3.40	1.13	0.31	1.29	100
	4.28	0.22	13.18	76.33	0.16	3.19	1.17	0.13	1.34	100
	4.37	0.20	12.89	76.53	0.17	3.24	1.12	0.16	1.32	100
	3.86	0.22	12.09	78.62	0.18	3.34	0.82	0.02	0.84	100
	4.05	0.26	12.71	76.85	0.26	3.23	1.19	0.18	1.27	100
Mean	4.15	0.23	12.65	77.01	0.19	3.29	1.08	0.21	1.21	100
s.d.	0.15	0.04	0.36	0.79	0.04	0.13	0.16	0.12	0.17	

Table A1. Continued.

97AP-H-a	4.05	0.30	12.52	77.41	0.20	1.66	1.94	0.17	1.75	100
n = 7	4.06	0.35	12.50	77.23	0.22	1.85	1.91	0.38	1.49	100
	4.21	0.34	12.31	77.43	0.21	1.85	1.85	0.24	1.57	100
	4.01	0.29	12.27	77.70	0.25	1.82	1.85	0.18	1.64	100
	4.10	0.32	12.27	77.66	0.28	1.74	1.92	0.15	1.56	100
	3.89	0.32	12.43	77.90	0.28	1.75	1.81	0.14	1.47	100
	4.00	0.35	12.62	77.60	0.20	1.80	1.84	0.21	1.39	100
Mean	4.05	0.32	12.42	77.56	0.23	1.78	1.87	0.21	1.55	100
s.d.	0.10	0.02	0.14	0.22	0.04	0.07	0.05	0.08	0.12	
97AP-H-b	5.10	0.11	28.23	54.58	0.03	0.24	11.12	0.00	0.60	100
n = 4	4.65	0.10	29.14	53.61	0.00	0.15	11.58	0.11	0.66	100
	4.40	0.05	28.92	54.06	0.01	0.28	11.55	0.07	0.67	100
	4.72	0.05	29.06	53.81	0.00	0.17	11.42	0.05	0.72	100
Mean	4.72	0.08	28.84	54.01	0.01	0.21	11.42	0.06	0.66	100
s.d.	0.29	0.03	0.42	0.42	0.01	0.06	0.21	0.05	0.05	

Table A1. Continued.

97AP-I-a	4.10	0.31	12.06	77.57	0.34	1.91	1.82	0.29	1.61	100
n = 9	4.25	0.53	12.07	76.97	0.39	1.79	1.95	0.16	1.90	100
	4.07	0.38	12.14	77.90	0.26	1.71	1.82	0.26	1.45	100
	4.17	0.37	12.22	77.66	0.27	1.73	1.92	0.28	1.38	100
	4.10	0.33	12.22	77.93	0.28	1.71	1.77	0.21	1.46	100
	3.94	0.37	12.40	77.68	0.24	1.86	1.80	0.19	1.51	100
	3.88	0.35	11.94	78.42	0.22	1.87	1.67	0.15	1.50	100
	3.77	0.34	12.19	78.08	0.26	1.72	1.79	0.29	1.56	100
	4.42	0.24	12.13	79.26	0.02	0.70	2.34	0.10	0.78	100
Mean	4.08	0.36	12.15	77.94	0.25	1.67	1.87	0.21	1.46	100
s.d.	0.20	0.08	0.13	0.63	0.10	0.37	0.19	0.07	0.29	
97AP-I-b	5.08	0.15	25.52	58.61	0.06	0.56	9.06	0.09	0.86	100
n = 3	6.06	0.00	27.43	56.55	0.01	0.11	9.40	0.07	0.37	100
	5.37	0.16	24.82	59.76	0.11	0.73	8.21	0.02	0.81	100
Mean	5.50	0.10	25.93	58.31	0.06	0.47	8.89	0.06	0.68	100
s.d.	0.50	0.09	1.35	1.63	0.05	0.32	0.61	0.03	0.27	

Table A1. Continued.

97AP-J	4.05	0.42	13.22	74.08	0.17	3.45	1.40	0.57	2.63	100
n = 9	3.99	0.36	11.75	73.47	0.40	3.27	4.92	0.14	1.71	100
	4.80	0.28	13.77	74.48	0.20	2.95	1.70	0.28	1.54	100
	4.36	0.56	14.26	73.08	0.17	2.78	2.07	0.40	2.31	100
	4.56	0.56	13.80	73.07	0.20	3.00	2.01	0.53	2.26	100
	4.09	0.25	11.71	78.56	0.18	1.98	1.53	0.20	1.50	100
	3.92	0.20	11.52	77.61	0.22	4.44	0.54	0.34	1.21	100
	4.23	0.29	12.36	76.16	0.21	3.52	1.21	0.31	1.72	100
	3.97	0.24	13.12	75.75	0.25	3.23	1.48	0.08	1.87	100
Mean	4.22	0.35	12.83	75.14	0.22	3.18	1.87	0.32	1.86	100
s.d.	0.30	0.14	1.03	2.00	0.07	0.66	1.23	0.16	0.46	
97AP-K	4.24	0.21	13.75	75.23	0.38	2.48	2.14	0.17	1.39	100
n = 9	3.96	0.47	13.51	75.00	0.46	2.52	2.06	0.16	1.86	100
	3.96	0.30	13.06	76.74	0.26	2.96	1.39	0.12	1.22	100
	4.15	0.45	13.38	74.51	0.45	2.66	2.02	0.23	2.15	100
	3.88	0.36	13.25	75.96	0.44	2.72	1.89	0.11	1.39	100
	3.83	0.40	13.41	75.57	0.47	2.52	1.98	0.21	1.61	100
	3.70	0.46	13.68	74.95	0.50	2.35	2.13	0.21	2.02	100
	4.01	0.40	13.33	75.82	0.46	2.47	1.74	0.29	1.49	100
	3.79	0.49	13.52	75.46	0.52	2.41	2.07	0.11	1.62	100
Mean	3.95	0.39	13.43	75.47	0.44	2.57	1.93	0.18	1.64	100
s.d.	0.17	0.09	0.21	0.66	0.08	0.18	0.24	0.06	0.31	

Table A1. Continued.

97AP-L	4.02	0.24	12.13	77.83	0.17	2.14	1.64	0.21	1.62	100
n = 10	4.29	0.26	12.90	76.74	0.18	1.65	2.10	0.17	1.69	100
	4.03	0.55	12.35	77.27	0.20	1.55	2.13	0.20	1.73	100
	4.32	0.46	12.29	77.66	0.09	1.63	1.76	0.12	1.68	100
	4.16	0.77	11.85	77.10	0.12	1.50	2.15	0.18	2.16	100
	3.90	0.20	12.55	78.26	0.15	1.52	1.93	0.23	1.25	100
	3.86	0.32	12.60	77.50	0.25	1.81	1.94	0.15	1.57	100
	3.80	1.13	12.00	74.49	0.09	3.85	1.43	0.33	2.87	100
	4.21	0.78	13.18	74.23	0.19	2.99	1.84	0.29	2.29	100
	4.18	0.69	14.45	73.71	0.11	1.23	3.51	0.35	1.78	100
Mean	4.08	0.54	12.63	76.48	0.15	1.99	2.04	0.22	1.86	100
s.d.	0.18	0.30	0.75	1.67	0.05	0.82	0.56	0.08	0.46	

Table A1. Continued.

97AP-M	3.79	0.40	12.21	77.72	0.20	1.71	1.95	0.27	1.75	100
n = 15	3.98	0.26	12.41	78.12	0.20	1.44	2.08	0.13	1.39	100
	3.94	0.30	12.42	77.96	0.22	1.63	1.83	0.27	1.44	100
	4.22	0.26	12.99	77.06	0.16	1.35	2.37	0.23	1.36	100
	3.89	0.32	12.59	77.70	0.19	1.59	2.01	0.30	1.43	100
	3.96	0.32	12.27	78.07	0.19	1.68	1.83	0.20	1.47	100
	3.86	0.33	11.99	78.35	0.20	1.57	1.81	0.21	1.68	100
	3.92	0.39	12.17	77.83	0.19	1.79	1.90	0.19	1.62	100
	3.90	0.39	12.67	77.57	0.18	1.58	1.93	0.32	1.48	100
	3.95	0.30	12.37	77.94	0.22	1.59	1.83	0.22	1.58	100
	4.07	0.34	12.39	77.83	0.18	1.83	1.81	0.00	1.56	100
	3.83	0.51	12.03	77.73	0.28	1.88	1.70	0.19	1.85	100
	3.83	0.40	12.40	77.82	0.21	1.74	1.87	0.08	1.64	100
	3.95	0.34	12.39	77.74	0.20	1.70	1.88	0.25	1.57	100
	3.98	0.40	11.94	78.02	0.16	1.92	1.92	0.13	1.53	100
Mean	3.94	0.35	12.35	77.83	0.20	1.67	1.91	0.20	1.56	100
s.d.	0.11	0.07	0.27	0.29	0.03	0.16	0.16	0.08	0.14	

Table A1. Continued.

97AP-N-a	3.96	0.39	13.00	75.97	0.23	2.90	1.37	0.36	1.83	100
n = 9	4.32	0.37	12.76	76.10	0.27	2.72	1.68	0.28	1.52	100
	4.39	0.38	12.87	76.16	0.19	2.69	1.63	0.13	1.55	100
	3.35	0.34	13.03	76.90	0.20	2.67	1.69	0.17	1.65	100
	4.13	0.25	12.05	77.21	0.20	3.09	1.19	0.24	1.64	100
	5.01	0.23	15.15	72.79	0.15	2.20	2.84	0.33	1.29	100
	3.94	0.24	12.67	76.81	0.11	3.02	1.05	0.43	1.73	100
	3.96	0.30	12.70	76.27	0.18	3.27	1.23	0.50	1.59	100
	5.00	0.19	15.49	72.79	0.12	2.23	2.55	0.43	1.20	100
Mean	4.23	0.30	13.30	75.67	0.18	2.75	1.69	0.32	1.56	100
s.d.	0.53	0.07	1.18	1.68	0.05	0.37	0.62	0.13	0.20	
97AP-N-b	6.19	0.06	26.84	57.03	0.00	0.37	8.86	0.02	0.62	100
n = 4	6.26	0.03	25.78	58.57	0.00	0.27	8.63	0.00	0.46	100
	5.93	0.04	26.84	57.29	0.00	0.41	9.04	0.03	0.42	100
	5.24	0.02	27.32	56.07	0.01	0.22	10.61	0.00	0.51	100
Mean	5.90	0.04	26.69	57.24	0.00	0.32	9.29	0.01	0.50	100
s.d.	0.47	0.02	0.65	1.03	0.00	0.09	0.90	0.02	0.09	

Table A1. Continued.

97AP-O	3.98	0.28	12.64	77.58	0.20	1.57	2.00	0.19	1.55	100
n = 12	3.80	0.32	11.95	79.05	0.15	1.57	1.68	0.16	1.32	100
	3.83	0.18	11.56	79.60	0.22	1.77	1.32	0.15	1.36	100
	4.26	0.19	12.66	77.88	0.24	1.39	1.95	0.34	1.11	100
	4.02	0.28	12.07	78.58	0.24	1.65	1.60	0.17	1.39	100
	4.35	0.19	12.42	78.46	0.10	1.55	1.75	0.12	1.05	100
	3.96	0.35	12.46	78.17	0.16	1.57	1.78	0.14	1.40	100
	3.86	0.59	13.33	76.25	0.15	1.54	2.23	0.32	1.73	100
	4.33	0.31	13.22	76.67	0.16	1.50	2.12	0.08	1.62	100
	4.20	0.67	12.98	76.10	0.14	1.46	2.38	0.21	1.87	100
	4.13	0.52	13.18	76.34	0.15	1.50	2.24	0.20	1.74	100
	3.67	0.26	11.82	78.76	0.20	1.71	1.61	0.27	1.70	100
Mean	4.03	0.34	12.52	77.79	0.18	1.56	1.89	0.19	1.49	100
s.d.	0.22	0.16	0.59	1.19	0.04	0.11	0.32	0.08	0.26	

Table A1. Continued.

97AP-P	4.14	0.31	12.16	77.66	0.22	1.87	1.70	0.29	1.65	100
n = 14	3.95	0.28	12.35	77.93	0.21	1.90	1.65	0.20	1.53	100
	4.09	0.28	12.23	77.70	0.23	1.87	1.58	0.29	1.74	100
	4.16	0.32	12.07	77.83	0.25	2.03	1.60	0.25	1.49	100
	4.10	0.34	12.30	77.71	0.17	1.95	1.62	0.29	1.53	100
	4.18	0.35	12.43	77.28	0.16	2.00	1.62	0.32	1.67	100
	4.18	0.27	12.43	77.79	0.10	1.76	1.82	0.25	1.39	100
	3.74	0.26	12.01	78.61	0.21	2.00	1.44	0.30	1.43	100
	4.01	0.36	12.52	77.43	0.21	1.83	1.63	0.33	1.68	100
	4.04	0.32	12.42	77.62	0.21	1.85	1.69	0.23	1.63	100
	4.00	0.33	12.00	78.24	0.19	2.02	1.58	0.10	1.54	100
	4.03	0.24	12.32	77.85	0.13	1.98	1.66	0.32	1.47	100
	4.23	0.24	11.99	77.96	0.19	2.06	1.55	0.17	1.61	100
	4.11	0.33	12.57	77.07	0.16	1.97	1.72	0.25	1.83	100
Mean	4.07	0.30	12.27	77.76	0.19	1.94	1.63	0.26	1.58	100
s.d.	0.12	0.04	0.20	0.38	0.04	0.09	0.09	0.06	0.12	

Table A1. Continued.

97AP-Q	3.76	0.44	12.79	77.60	0.19	1.52	1.81	0.30	1.59	100
n = 6	3.90	0.38	12.90	77.53	0.12	1.52	1.80	0.44	1.42	100
	4.31	0.19	13.55	76.59	0.13	1.53	2.42	0.24	1.05	100
	4.13	0.19	12.91	78.07	0.07	1.83	1.76	0.17	0.86	100
	4.05	0.39	12.55	77.60	0.18	1.50	2.01	0.20	1.52	100
	3.77	0.45	12.77	77.72	0.18	1.51	2.00	0.01	1.60	100
Mean	3.98	0.34	12.91	77.52	0.14	1.57	1.97	0.23	1.34	100
s.d.	0.22	0.12	0.34	0.50	0.05	0.13	0.24	0.14	0.31	
97AP-R	3.83	0.41	12.86	77.63	0.19	1.70	1.85	0.18	1.35	100
n = 11	3.55	0.23	12.60	77.34	1.14	1.61	2.06	0.49	0.98	100
	4.08	0.20	13.72	76.24	0.17	1.73	2.49	0.30	1.08	100
	4.41	0.35	13.70	76.26	0.17	1.56	2.26	0.07	1.21	100
	4.15	0.46	13.64	75.63	0.35	1.67	2.26	0.19	1.64	100
	3.04	0.22	14.07	75.22	2.18	1.59	2.43	0.09	1.17	100
	3.95	0.35	12.58	77.73	0.18	1.61	1.96	0.17	1.47	100
	3.93	0.23	12.61	78.09	0.19	1.67	1.79	0.11	1.37	100
	4.03	0.34	11.46	79.88	0.06	1.31	2.13	0.13	0.68	100
	3.98	0.24	11.64	79.19	0.19	1.84	1.34	0.28	1.31	100
	3.87	0.21	12.59	78.25	0.36	1.74	1.65	0.20	1.14	100
Mean	3.89	0.30	12.86	77.41	0.47	1.64	2.02	0.20	1.22	100
s.d.	0.35	0.09	0.85	1.46	0.64	0.14	0.35	0.12	0.26	

Table A1. Continued.

97AP-S-a	4.55	0.39	13.24	75.12	0.21	2.61	1.75	0.26	1.88	100
n = 11	4.23	0.39	13.54	74.99	0.21	2.77	1.66	0.28	1.93	100
	4.35	0.38	12.98	75.58	0.28	2.76	1.71	0.21	1.75	100
	4.31	0.38	13.34	75.16	0.27	2.74	1.54	0.40	1.85	100
	4.47	0.33	14.51	73.40	0.24	2.41	2.50	0.52	1.62	100
	4.38	0.39	13.45	75.00	0.28	2.70	1.69	0.28	1.84	100
	4.55	0.65	13.66	73.29	0.29	2.57	2.14	0.50	2.34	100
	4.37	0.65	13.83	73.30	0.22	2.54	2.23	0.28	2.58	100
	4.76	0.59	13.59	73.18	0.32	2.44	2.18	0.39	2.55	100
	4.33	0.41	13.14	75.19	0.29	2.93	1.69	0.10	1.92	100
	4.56	0.40	12.90	75.21	0.26	2.88	1.66	0.25	1.89	100
Mean	4.44	0.45	13.47	74.49	0.26	2.67	1.89	0.32	2.01	100
s.d.	0.15	0.12	0.45	0.96	0.04	0.17	0.31	0.12	0.32	
97AP-S-b	6.08	0.04	27.14	56.72	0.00	0.21	9.25	0.00	0.56	100
n = 3	5.66	0.04	27.68	56.05	0.00	0.16	9.75	0.01	0.64	100
	5.98	0.03	27.09	57.08	0.00	0.22	9.15	0.00	0.44	100
Mean	5.91	0.04	27.31	56.61	0.00	0.20	9.38	0.00	0.55	100
s.d.	0.22	0.01	0.33	0.52	0.00	0.03	0.32	0.01	0.10	

Table A1. Continued.

97AP-T	4.17	0.18	14.25	75.79	0.14	1.35	2.75	0.09	1.27	100
n = 15	3.92	0.24	13.31	77.19	0.14	1.60	2.14	0.18	1.28	100
	4.13	0.33	12.60	77.77	0.21	1.54	1.88	0.15	1.39	100
	4.04	0.32	12.56	78.17	0.15	1.52	1.88	0.13	1.24	100
	3.93	0.39	12.56	78.20	0.13	1.52	1.97	0.07	1.24	100
	3.86	0.39	12.45	78.29	0.19	1.64	1.75	0.18	1.25	100
	3.88	0.15	12.19	78.80	0.21	1.89	1.57	0.06	1.25	100
	4.38	0.21	13.11	77.61	0.13	1.27	2.10	0.03	1.16	100
	4.13	0.37	12.82	77.71	0.12	1.49	1.84	0.16	1.35	100
	4.23	0.29	12.54	77.86	0.14	1.43	1.97	0.22	1.32	100
	3.91	0.48	12.75	77.56	0.19	1.62	2.01	0.14	1.34	100
	4.17	0.19	12.64	78.25	0.20	1.37	1.92	0.12	1.12	100
	3.95	0.40	12.65	77.96	0.19	1.56	1.89	0.12	1.29	100
	4.09	0.24	12.72	78.16	0.16	1.73	1.72	0.12	1.07	100
	4.33	0.26	15.82	72.97	0.17	1.15	3.97	0.25	1.06	100
Mean	4.07	0.30	13.00	77.48	0.16	1.51	2.09	0.13	1.24	100
s.d.	0.17	0.10	0.92	1.42	0.03	0.18	0.58	0.06	0.10	

Table A1. Continued.

97AP-U-a	4.15	0.34	12.77	78.15	0.16	1.65	1.72	0.12	0.95	100
n = 10	4.11	0.35	12.86	77.71	0.15	1.74	1.77	0.18	1.14	100
	4.02	0.27	12.15	79.27	0.17	1.76	1.34	0.07	0.95	100
	3.79	0.81	11.97	78.15	0.16	1.85	1.47	0.10	1.70	100
	3.96	0.27	12.58	78.18	0.11	1.88	1.49	0.15	1.38	100
	4.07	0.46	13.02	77.40	0.18	1.71	1.87	0.09	1.20	100
	4.00	0.35	12.96	77.75	0.18	1.65	1.83	0.09	1.19	100
	3.94	0.33	12.71	77.88	0.17	1.80	1.72	0.12	1.32	100
	4.11	0.31	12.98	77.70	0.09	1.73	1.75	0.17	1.17	100
	4.13	0.41	12.91	77.34	0.14	1.70	1.88	0.13	1.35	100
Mean	4.03	0.39	12.69	77.95	0.15	1.75	1.68	0.12	1.24	100
s.d.	0.11	0.16	0.36	0.55	0.03	0.08	0.19	0.03	0.22	
97AP-U-b	6.19	0.01	27.09	57.23	0.00	0.08	9.21	0.06	0.15	100
n = 3	5.37	0.03	25.38	59.59	0.04	0.32	8.88	0.09	0.30	100
	6.36	0.03	26.53	58.05	0.00	0.15	8.75	0.00	0.13	100
Mean	5.97	0.03	26.33	58.29	0.01	0.18	8.94	0.05	0.19	100
s.d.	0.53	0.01	0.87	1.20	0.02	0.12	0.24	0.05	0.10	

Table A2. Mean values of normalized weight % oxides of Homer tephras.

97H-A	4.19	0.28	13.65	76.58	0.14	1.37	2.28	0.27	1.24	100
n = 19	4.04	0.31	12.63	77.52	0.21	1.53	2.14	0.17	1.45	100
	4.46	0.25	13.45	76.47	0.16	1.38	2.46	0.19	1.18	100
	4.02	0.24	12.92	77.53	0.17	1.47	2.20	0.21	1.25	100
	3.94	0.32	12.38	78.31	0.19	1.58	1.80	0.29	1.19	100
	3.97	0.36	12.96	77.62	0.19	1.52	1.91	0.17	1.30	100
	3.93	0.25	12.77	78.12	0.14	1.58	1.86	0.11	1.24	100
	4.32	0.19	13.79	76.44	0.10	1.40	2.47	0.22	1.07	100
	3.78	0.35	12.33	77.80	0.27	1.77	1.86	0.20	1.63	100
	3.43	0.30	12.52	78.11	0.29	1.92	1.75	0.22	1.47	100
	5.09	0.02	13.43	77.39	0.02	0.59	2.62	0.37	0.46	100.00
	3.89	0.37	12.33	77.83	0.29	1.83	1.66	0.34	1.45	100.00
	4.07	0.31	12.47	77.85	0.22	1.81	1.78	0.22	1.27	100.00
	4.06	0.41	12.33	77.47	0.26	1.80	1.92	0.10	1.64	100
	4.24	0.34	12.68	77.02	0.33	1.87	1.70	0.18	1.64	100
	3.25	0.07	12.40	77.38	0.03	5.24	0.39	0.18	1.06	100
	4.19	0.23	12.30	77.87	0.20	1.63	1.94	0.27	1.38	100
	2.53	2.08	1.77	79.18	1.17	5.75	5.15	0.91	1.45	100
	4.12	0.34	12.52	77.26	0.34	1.91	1.78	0.21	1.54	100
Mean	3.98	0.37	12.19	77.57	0.25	2.00	2.09	0.26	1.31	100.00
s.d.	0.51	0.42	2.57	0.67	0.24	1.27	0.87	0.17	0.28	

Table A2. Continued.

97H-B-a	4.02	0.33	12.32	78.00	0.21	1.73	1.75	0.12	1.52	100
n = 9	4.14	0.31	11.99	77.90	0.24	1.87	1.79	0.26	1.51	100
	3.93	0.35	11.83	78.41	0.16	1.91	1.74	0.18	1.49	100
	4.21	0.32	12.20	77.62	0.28	1.67	1.94	0.34	1.41	100
	4.09	0.34	12.15	77.95	0.22	1.86	1.76	0.28	1.35	100
	4.10	0.20	11.61	79.23	0.16	2.20	1.15	0.09	1.25	100
	3.82	0.37	11.98	77.25	0.25	2.48	1.77	0.30	1.76	100
	3.99	0.28	12.55	77.65	0.31	1.73	1.87	0.20	1.41	100
	3.93	0.33	12.38	77.82	0.25	1.69	1.91	0.19	1.50	100
Mean	4.02	0.31	12.11	77.98	0.23	1.90	1.74	0.22	1.47	100
s.d.	0.12	0.05	0.29	0.56	0.05	0.27	0.23	0.08	0.14	
97H-B-b	6.08	0.03	26.61	57.43	0.03	0.11	9.42	0.00	0.28	100
n = 5	5.88	0.06	27.24	56.37	0.03	0.12	9.92	0.00	0.38	100
	5.01	0.04	28.73	54.62	0.00	0.13	11.20	0.00	0.27	100
	5.81	0.06	27.56	56.10	0.02	0.16	9.86	0.00	0.43	100
	5.85	0.10	27.40	56.65	0.04	0.12	9.43	0.11	0.29	100
Mean	5.73	0.06	27.51	56.24	0.02	0.13	9.97	0.02	0.33	100
s.d.	0.41	0.02	0.77	1.03	0.02	0.02	0.73	0.05	0.07	

Table A2. Continued.

97H-C-a	4.10	0.20	11.61	79.23	0.16	2.20	1.15	0.09	1.25	100
n = 9	4.14	0.31	11.99	77.90	0.24	1.87	1.79	0.26	1.51	100
	3.93	0.35	11.83	78.41	0.16	1.91	1.74	0.18	1.49	100
	4.21	0.32	12.20	77.62	0.28	1.67	1.94	0.34	1.41	100
	3.99	0.28	12.55	77.65	0.31	1.73	1.87	0.20	1.41	100
	4.02	0.33	12.32	78.00	0.21	1.73	1.75	0.12	1.52	100
	4.09	0.34	12.15	77.95	0.22	1.86	1.76	0.28	1.35	100
	3.93	0.33	12.38	77.82	0.25	1.69	1.91	0.19	1.50	100
	3.82	0.37	11.98	77.25	0.25	2.48	1.77	0.30	1.76	100
Mean	4.01	0.33	12.18	77.83	0.24	1.87	1.82	0.24	1.49	100
s.d.	0.13	0.03	0.24	0.34	0.05	0.26	0.08	0.07	0.12	
97H-C-b	5.81	0.06	27.56	56.10	0.02	0.16	9.86	0.00	0.43	100
n = 5	5.88	0.06	27.24	56.37	0.03	0.12	9.92	0.00	0.38	100
	5.01	0.04	28.73	54.62	0.00	0.13	11.20	0.00	0.27	100
	6.08	0.03	26.61	57.43	0.03	0.11	9.42	0.00	0.28	100
	5.85	0.10	27.40	56.65	0.04	0.12	9.43	0.11	0.29	100
Mean	5.73	0.06	27.51	56.24	0.02	0.13	9.97	0.02	0.33	100
s.d.	0.41	0.02	0.77	1.03	0.02	0.02	0.73	0.05	0.07	

Table A2. Continued.

97H-D	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	TiO_2	Fe_2O_3	Total
n = 10	4.10	0.38	12.79	76.85	0.24	1.70	2.11	0.19	1.64	100
	4.28	0.24	12.75	77.58	0.12	1.39	2.09	0.24	1.32	100
	3.69	0.11	11.86	78.84	0.29	2.32	1.34	0.31	1.23	100
	3.81	0.12	11.94	79.33	0.25	2.06	1.32	0.18	0.98	100
	3.72	0.31	12.48	78.29	0.20	1.81	1.51	0.18	1.50	100
	4.02	0.35	12.48	77.52	0.18	1.71	1.88	0.10	1.76	100
	3.95	0.29	12.17	77.85	0.28	1.90	1.80	0.18	1.58	100
	3.41	0.12	11.91	79.05	0.38	1.72	1.94	0.04	1.43	100
	4.13	0.28	13.02	76.95	0.19	1.54	2.12	0.35	1.44	100
	3.82	1.47	11.46	75.46	0.17	2.16	2.14	0.24	3.07	100
Mean	3.89	0.37	12.29	77.77	0.23	1.83	1.82	0.20	1.60	100
s.d.	0.25	0.40	0.50	1.18	0.07	0.28	0.32	0.09	0.56	

Table A2. Continued.

97H-E	3.65	0.40	12.97	77.65	0.15	1.55	2.05	0.26	1.31	100
n = 15	3.89	0.33	12.67	77.67	0.21	1.61	1.92	0.07	1.62	100
	3.87	0.38	12.69	77.81	0.14	1.58	1.92	0.15	1.46	100
	3.94	0.40	12.68	77.31	0.14	1.63	2.03	0.25	1.62	100
	3.87	0.34	12.47	78.01	0.23	1.61	1.89	0.15	1.44	100
	3.19	0.41	12.58	78.39	0.18	1.72	1.89	0.26	1.38	100
	4.00	1.96	11.33	75.22	0.12	1.70	1.92	0.26	3.49	100
	3.92	0.34	12.27	77.95	0.17	1.62	2.00	0.08	1.64	100
	4.04	0.36	12.30	77.62	0.23	1.64	1.95	0.23	1.63	100
	4.07	0.35	12.79	77.20	0.15	1.60	2.01	0.28	1.55	100
	3.99	0.41	12.35	77.97	0.16	1.82	1.77	0.15	1.39	100
	4.02	0.54	13.08	76.15	0.20	1.50	2.36	0.16	1.98	100
	3.97	0.82	12.56	75.77	0.31	1.48	2.30	0.30	2.48	100
	3.87	0.37	12.43	77.76	0.21	1.64	1.99	0.11	1.61	100
	4.04	0.39	10.90	78.52	0.32	1.74	1.68	0.44	1.98	100
Mean	3.89	0.52	12.41	77.40	0.20	1.63	1.98	0.21	1.77	100
s.d.	0.22	0.42	0.58	0.95	0.06	0.09	0.17	0.10	0.56	

Table A2. Continued.

	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	TiO_2	Fe_2O_3	Total
97H-F	4.01	0.12	11.73	79.17	0.15	2.23	1.23	0.09	1.26	100
n = 8	4.00	0.34	12.15	78.27	0.22	1.58	1.82	0.21	1.42	100
	3.76	0.31	12.67	77.77	0.22	1.62	2.06	0.22	1.38	100
	3.71	0.24	11.22	79.97	0.15	1.84	1.33	0.30	1.25	100
	4.04	0.24	13.05	76.91	0.10	1.67	2.26	0.25	1.48	100
	3.72	0.36	12.09	78.38	0.17	1.76	1.72	0.10	1.68	100
	3.42	0.49	12.20	78.77	0.15	1.59	1.69	0.24	1.45	100
	4.46	0.21	13.59	75.89	0.18	1.60	2.66	0.17	1.22	100
Mean	3.89	0.29	12.34	78.14	0.17	1.74	1.85	0.20	1.39	100
s.d.	0.31	0.11	0.75	1.29	0.04	0.22	0.47	0.07	0.15	

Table A2. Continued.

97H-G-a	3.99	0.28	12.88	77.17	0.15	1.95	1.59	0.42	1.56	100
n = 15	4.05	0.29	12.64	77.34	0.15	2.01	1.62	0.15	1.75	100
	4.16	0.34	12.59	77.12	0.25	1.91	1.73	0.35	1.56	100
	4.03	0.23	12.74	77.31	0.23	1.93	1.64	0.22	1.66	100
	3.81	0.29	12.75	77.40	0.26	2.02	1.66	0.19	1.62	100
	4.18	0.36	12.85	77.26	0.20	1.99	1.69	0.11	1.37	100
	2.84	0.22	12.31	78.89	0.25	2.01	1.55	0.32	1.61	100
	4.17	0.30	12.19	77.91	0.23	1.99	1.46	0.28	1.46	100
	4.09	0.38	12.56	77.39	0.17	1.82	1.75	0.20	1.64	100
	4.11	0.31	12.24	77.66	0.15	2.03	1.63	0.06	1.81	100
	4.19	0.35	12.62	77.10	0.20	1.97	1.68	0.21	1.68	100
	4.08	0.33	12.44	77.24	0.18	1.79	1.69	0.31	1.93	100
	3.85	0.34	12.58	77.58	0.21	1.87	1.68	0.24	1.66	100
	4.15	0.31	11.65	78.30	0.26	2.10	1.47	0.16	1.61	100
	3.69	0.28	11.26	78.59	0.45	1.84	1.62	0.24	2.04	100
Mean	3.96	0.31	12.42	77.62	0.22	1.95	1.63	0.23	1.66	100
s.d.	0.34	0.04	0.45	0.56	0.07	0.09	0.08	0.10	0.17	
97H-G-b	6.23	0.02	26.77	57.44	0.01	0.15	9.01	0.03	0.33	100
n = 3	5.52	0.00	28.13	55.74	0.05	0.09	9.99	0.00	0.48	100
	5.71	0.02	27.40	56.51	0.01	0.17	9.58	0.02	0.57	100
Mean	5.82	0.02	27.43	56.56	0.02	0.14	9.53	0.02	0.46	100
s.d.	0.37	0.01	0.68	0.85	0.03	0.04	0.49	0.02	0.12	

Table A2. Continued.

97H-I	3.77	0.45	13.25	76.67	0.28	1.45	2.13	0.27	1.74	100
n = 13	4.03	0.44	13.33	76.94	0.23	1.35	2.21	0.02	1.45	100
	4.12	0.27	13.11	77.29	0.11	1.56	2.26	0.00	1.28	100
	3.97	0.38	12.57	77.74	0.21	1.57	1.95	0.17	1.44	100
	4.47	0.29	14.05	75.64	0.13	1.35	2.69	0.10	1.27	100
	3.70	0.17	13.21	78.04	0.15	1.57	2.10	0.17	0.88	100
	4.02	0.43	12.91	77.07	0.23	1.52	2.10	0.18	1.52	100
	3.81	0.37	12.57	77.91	0.18	1.56	1.91	0.14	1.56	100
	3.91	0.55	12.91	76.96	0.20	1.54	1.74	0.18	2.00	100
	3.96	0.38	13.26	77.21	0.22	1.40	2.10	0.18	1.31	100
	4.28	0.36	12.76	77.39	0.16	1.41	2.04	0.24	1.36	100
	4.18	0.32	10.35	79.77	0.20	1.58	1.94	0.14	1.52	100
	3.81	0.37	13.30	77.38	0.27	1.44	1.97	0.20	1.27	100
Mean	4.00	0.37	12.89	77.38	0.20	1.48	2.09	0.15	1.43	100
s.d.	0.22	0.09	0.86	0.94	0.05	0.09	0.23	0.08	0.27	

Table A2. Continued.

97H-J-a	4.64	0.76	14.86	71.08	0.19	2.63	2.69	0.46	2.69	100
n = 11	4.50	0.70	14.23	72.59	0.22	2.66	2.19	0.36	2.55	100
	4.41	0.75	14.19	72.53	0.26	2.56	2.40	0.37	2.52	100
	4.30	0.71	14.07	72.82	0.18	2.60	2.36	0.35	2.61	100
	4.57	0.70	14.40	72.53	0.27	2.42	2.43	0.46	2.22	100
	4.38	0.67	14.17	72.96	0.25	2.57	2.32	0.36	2.32	100
	4.17	0.43	13.79	74.62	0.20	2.73	1.85	0.19	2.02	100
	4.13	0.50	13.54	74.40	0.22	2.68	2.03	0.49	2.00	100
	4.38	0.50	13.86	73.94	0.24	2.73	2.09	0.30	1.97	100
	4.38	0.52	13.76	73.63	0.17	2.55	2.14	0.40	2.45	100
	4.01	0.42	13.59	75.25	0.31	2.51	1.76	0.27	1.88	100
Mean	4.35	0.61	14.04	73.31	0.23	2.60	2.21	0.37	2.29	100
s.d.	0.19	0.13	0.39	1.19	0.04	0.10	0.27	0.09	0.29	
97H-J-b	4.87	0.68	19.06	65.24	0.19	1.68	5.36	0.45	2.48	100
n = 4	4.75	0.86	16.20	68.58	0.28	1.99	3.71	0.48	3.14	100
	5.17	1.18	15.55	67.77	0.34	2.43	3.24	0.54	3.79	100
	4.62	0.72	15.85	68.98	0.22	2.23	3.22	0.84	3.33	100
Mean	4.85	0.86	16.67	67.64	0.26	2.08	3.88	0.58	3.18	100
s.d.	0.23	0.23	1.62	1.68	0.07	0.32	1.01	0.18	0.54	

Table A2. Continued.

97H-K	4.37	0.35	13.17	75.12	0.29	2.80	1.56	0.34	2.00	100
n = 14	4.30	0.39	13.34	75.30	0.17	2.70	1.59	0.30	1.91	100
	4.11	0.35	13.43	75.37	0.22	2.82	1.57	0.24	1.90	100
	4.29	0.41	13.72	74.79	0.28	2.77	1.75	0.17	1.83	100
	4.89	0.44	14.62	72.76	0.50	2.58	1.88	0.30	2.04	100
	4.54	0.69	14.11	72.32	0.32	2.91	2.20	0.41	2.49	100
	4.25	0.39	13.58	75.41	0.27	2.72	1.48	0.21	1.68	100
	3.98	0.34	13.62	75.38	0.21	2.56	1.75	0.34	1.81	100
	4.27	0.34	13.48	75.23	0.19	2.78	1.74	0.23	1.73	100
	4.28	0.41	13.62	75.08	0.30	2.65	1.72	0.29	1.64	100
	4.41	0.58	14.91	72.49	0.14	2.53	2.53	0.31	2.09	100
	4.37	0.39	14.33	73.83	0.22	2.40	2.19	0.29	1.96	100
	4.26	0.50	13.86	74.38	0.31	2.69	1.84	0.18	1.97	100
	4.57	0.72	14.04	71.84	0.51	2.79	2.21	0.51	2.82	100
Mean	4.35	0.45	13.85	74.24	0.28	2.69	1.86	0.29	1.99	100
s.d.	0.22	0.13	0.50	1.32	0.11	0.14	0.31	0.09	0.32	

Table A2. Continued.

97H-L	3.85	0.35	12.60	77.85	0.14	1.79	1.78	0.17	1.46	100
n = 15	3.95	0.42	12.51	78.07	0.17	1.59	1.89	0.08	1.31	100
	3.97	0.40	12.59	77.66	0.20	1.62	1.91	0.15	1.50	100
	4.02	0.36	12.62	77.79	0.18	1.61	1.92	0.20	1.30	100
	3.91	0.39	12.56	77.71	0.20	1.63	1.97	0.22	1.40	100
	3.82	0.35	12.47	78.27	0.15	1.58	1.83	0.07	1.47	100
	3.81	0.56	13.00	77.07	0.12	1.52	2.19	0.17	1.56	100
	3.94	0.44	12.35	77.78	0.12	1.57	1.87	0.26	1.66	100
	3.89	0.40	12.79	77.54	0.18	1.51	1.98	0.22	1.47	100
	4.16	0.37	13.05	77.72	0.15	1.41	1.84	0.07	1.22	100
	4.04	0.39	12.97	77.53	0.23	1.56	1.86	0.08	1.35	100
	3.83	0.37	13.19	77.61	0.17	1.47	2.00	0.28	1.09	100
	4.08	0.36	12.95	77.46	0.21	1.51	1.93	0.25	1.24	100
	4.15	0.35	13.11	77.19	0.14	1.52	2.18	0.16	1.19	100
	4.05	0.38	13.02	77.41	0.12	1.60	1.92	0.10	1.40	100
Mean	3.96	0.39	12.79	77.64	0.16	1.57	1.94	0.17	1.37	100
s.d.	0.12	0.05	0.27	0.31	0.03	0.09	0.12	0.07	0.15	

Table A2. Continued.

97H-M	3.93	0.36	13.17	77.65	0.12	1.77	1.74	0.06	1.21	100
n = 8	4.49	0.32	12.42	78.14	0.14	1.64	1.73	0.02	1.11	100
	4.29	0.27	13.40	76.89	0.22	1.86	1.80	0.04	1.23	100
	4.31	0.34	13.11	77.45	0.19	1.77	1.67	0.09	1.06	100
	4.12	0.36	12.97	77.63	0.14	1.75	1.70	0.26	1.07	100
	4.40	0.38	12.92	77.33	0.24	1.71	1.66	0.00	1.36	100
	3.98	0.36	13.67	76.35	0.55	1.77	1.99	0.26	1.07	100
	3.66	0.38	12.71	77.52	0.29	2.13	1.36	0.35	1.60	100
Mean	4.15	0.34	13.05	77.37	0.24	1.80	1.71	0.13	1.21	100
s.d.	0.28	0.04	0.39	0.54	0.14	0.15	0.18	0.13	0.19	
97H-N	Na_2O	MgO	Al_2O_3	SiO_2	Cl	K_2O	CaO	TiO_2	Fe_2O_3	Total
n = 11	4.00	0.27	13.01	77.91	0.19	1.67	1.71	0.19	1.05	100
	3.84	0.40	13.00	77.65	0.16	1.54	1.85	0.15	1.41	100
	4.01	0.40	12.52	77.82	0.16	1.68	1.95	0.09	1.38	100
	4.31	0.27	13.29	77.37	0.12	1.47	2.04	0.03	1.10	100
	4.25	0.22	13.93	76.62	0.09	1.48	2.11	0.18	1.11	100
	3.72	0.35	11.81	79.06	0.13	1.74	1.58	0.09	1.51	100
	4.05	0.39	12.83	77.46	0.16	1.64	1.83	0.14	1.50	100
	3.82	0.32	12.86	77.68	0.16	1.58	1.97	0.15	1.46	100
	3.88	0.30	13.45	77.28	0.25	1.54	2.41	0.00	0.88	100
	4.02	0.27	12.44	78.42	0.17	1.48	1.72	0.16	1.32	100
	3.95	0.16	13.11	77.90	0.16	1.68	1.85	0.19	0.99	100
Mean	3.99	0.30	12.93	77.74	0.16	1.59	1.91	0.12	1.25	100
s.d.	0.18	0.08	0.56	0.63	0.04	0.09	0.23	0.06	0.22	

Table A2. Continued.

97H-O	4.43	2.20	15.57	61.63	0.14	1.88	4.78	1.09	8.27	100
n = 14	4.62	2.28	15.30	61.62	0.13	1.89	4.73	0.94	8.50	100
	4.76	1.90	15.65	61.89	0.13	2.02	4.67	0.84	8.14	100
	4.40	1.85	15.84	62.97	0.12	2.00	4.37	0.99	7.46	100
	3.50	3.98	11.54	63.15	0.12	2.49	3.74	0.85	10.63	100
	4.35	2.14	15.36	60.85	0.17	1.80	5.15	1.00	9.18	100
	4.15	2.37	15.36	61.12	0.11	1.80	4.86	1.10	9.11	100
	4.47	2.28	15.21	60.94	0.11	1.94	4.94	0.93	9.18	100
	4.49	2.13	15.52	61.70	0.10	1.77	4.71	1.10	8.48	100
	4.85	1.89	15.62	62.73	0.07	2.19	4.15	0.93	7.57	100
	4.45	2.59	14.75	59.97	0.17	1.58	5.50	0.86	10.13	100
	4.82	1.77	17.27	60.75	0.09	1.44	5.72	0.76	7.38	100
	4.42	1.75	16.10	63.83	0.08	1.95	4.25	0.83	6.79	100
	4.19	2.67	15.45	60.67	0.17	1.89	4.87	1.09	8.99	100
Mean	4.42	2.27	15.33	61.70	0.12	1.90	4.75	0.95	8.56	100
s.d.	0.34	0.57	1.23	1.11	0.03	0.25	0.52	0.11	1.07	

Table A2. Continued.

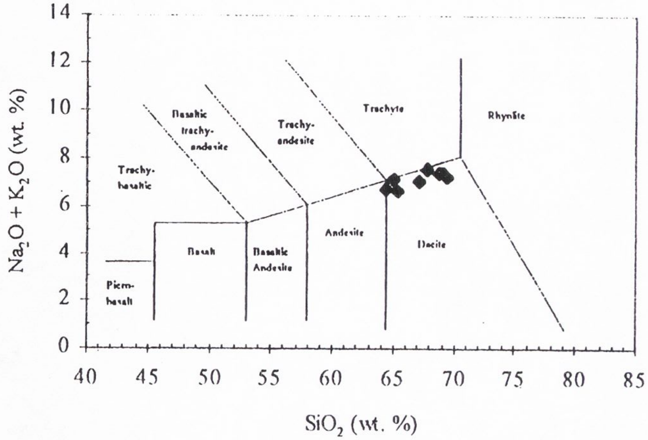
97H-P	3.97	0.37	12.33	75.60	0.19	2.94	1.67	0.45	2.48	100
n = 13	3.88	0.42	12.72	74.90	0.22	2.98	1.94	0.44	2.50	100
	3.79	0.69	13.24	73.11	0.20	2.77	2.26	0.59	3.35	100
	3.74	0.47	12.55	75.40	0.21	2.86	1.67	0.51	2.59	100
	4.25	0.46	13.54	73.94	0.20	2.62	2.15	0.36	2.48	100
	3.77	0.41	12.21	76.01	0.21	3.07	1.68	0.38	2.26	100
	3.65	0.50	11.58	76.17	0.20	4.47	0.88	0.35	2.20	100
	3.99	0.50	13.30	74.30	0.27	2.53	2.12	0.39	2.60	100
	4.07	0.52	12.61	75.09	0.17	2.88	1.66	0.42	2.57	100
	3.82	0.42	12.68	75.37	0.24	2.86	1.69	0.49	2.44	100
	3.66	0.39	12.31	75.85	0.18	2.98	1.57	0.46	2.60	100
	4.02	0.43	12.49	75.52	0.19	2.69	1.64	0.47	2.56	100
	3.79	0.40	12.66	75.40	0.23	2.93	1.66	0.44	2.48	100
Mean	3.88	0.46	12.63	75.13	0.21	2.97	1.74	0.44	2.55	100
s.d.	0.17	0.08	0.51	0.88	0.03	0.48	0.34	0.07	0.27	

Table A2. Continued.

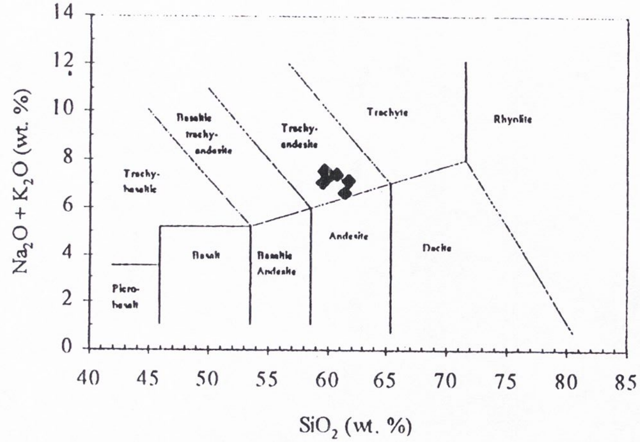
97H-Q	3.92	0.39	12.43	76.20	0.25	2.86	1.59	0.32	2.06	100
n = 14	4.08	0.33	12.23	76.13	0.28	3.10	1.48	0.39	1.98	100
	3.76	0.40	12.62	76.06	0.29	2.82	1.57	0.32	2.16	100
	3.89	0.45	12.54	75.16	0.25	2.89	1.85	0.57	2.40	100
	3.92	0.42	12.56	75.22	0.20	2.98	1.69	0.46	2.55	100
	3.86	0.43	12.20	76.21	0.25	2.91	1.52	0.38	2.24	100
	3.99	0.39	12.63	75.67	0.22	2.71	1.52	0.51	2.37	100
	3.84	0.38	12.23	75.66	0.30	3.23	1.55	0.38	2.42	100
	3.84	0.39	11.99	76.08	0.24	3.12	1.59	0.33	2.43	100
	3.99	0.41	12.11	75.65	0.26	3.01	1.54	0.29	2.75	100
	3.90	0.33	12.03	76.19	0.22	3.00	1.63	0.52	2.18	100
	4.00	0.46	11.99	75.99	0.21	3.08	1.59	0.42	2.26	100
	4.00	0.40	12.23	76.15	0.33	2.80	1.50	0.28	2.31	100
	4.01	0.44	12.05	76.21	0.23	2.86	1.53	0.36	2.32	100
Mean	3.93	0.40	12.27	75.90	0.25	2.96	1.58	0.39	2.32	100
s.d.	0.09	0.04	0.24	0.36	0.04	0.15	0.09	0.09	0.20	

Appendix B. TAS Diagrams (after LeBas and others, 1986) Based on Glass Composition of Shards from Tephra Layers at the Anchor Point and Homer Sections.

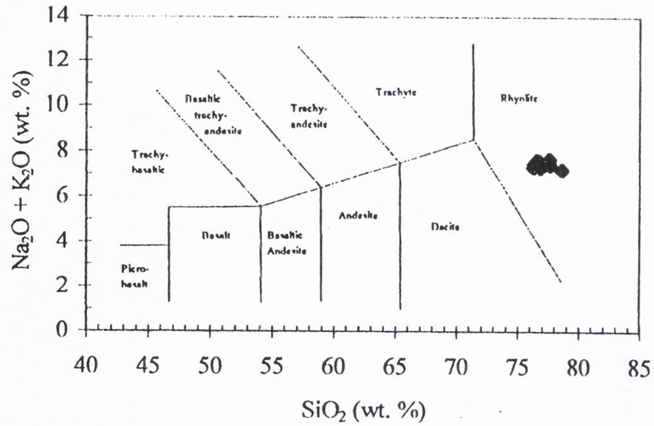
97AP-E-a



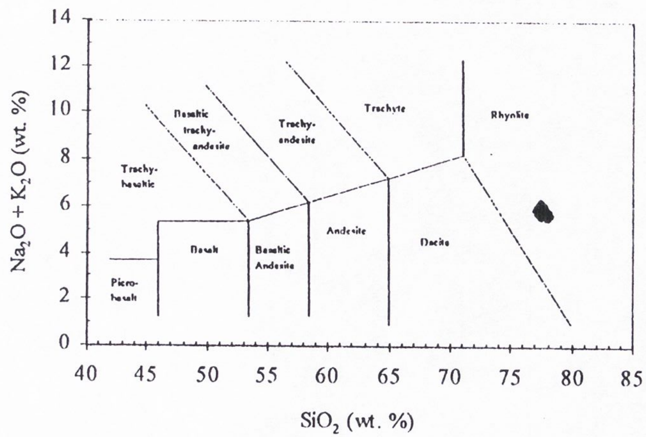
97AP-E-b



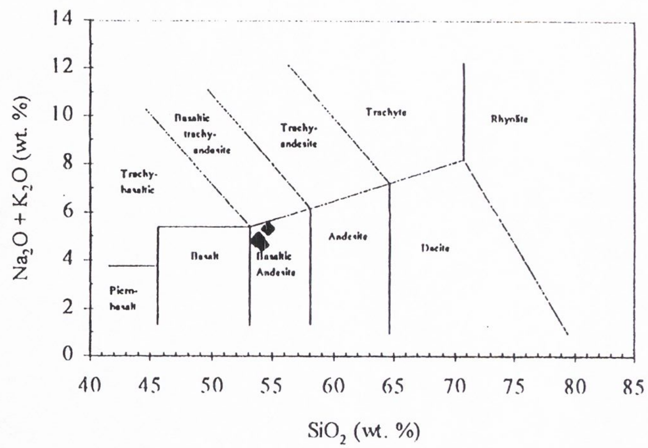
97AP-G



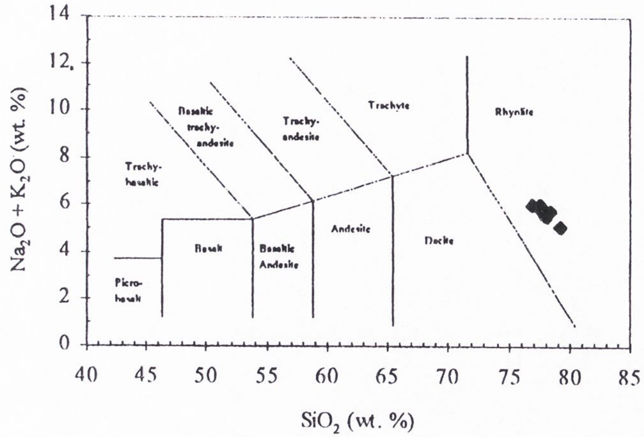
97AP-H-a



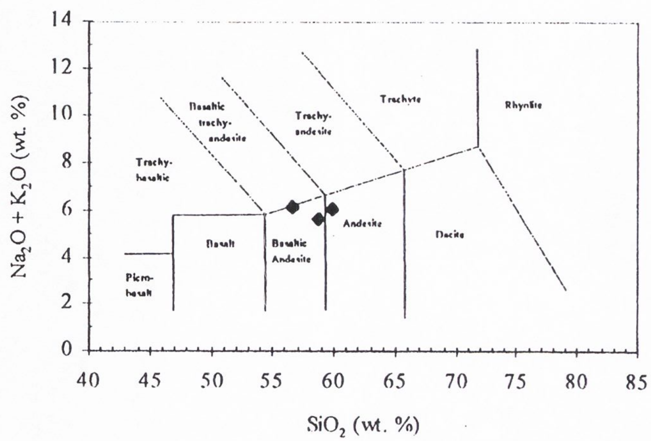
97AP-H-b



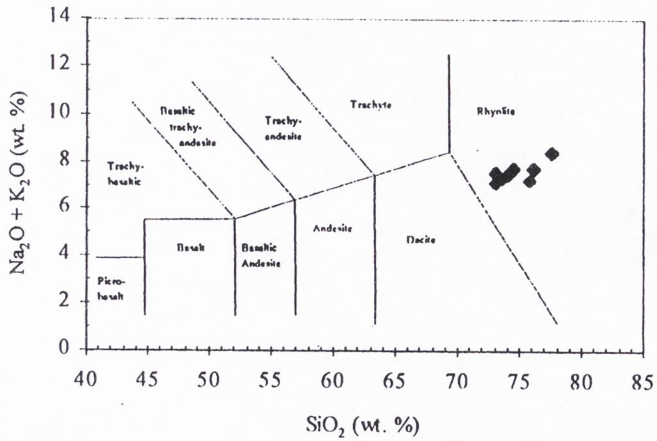
97AP-I-a



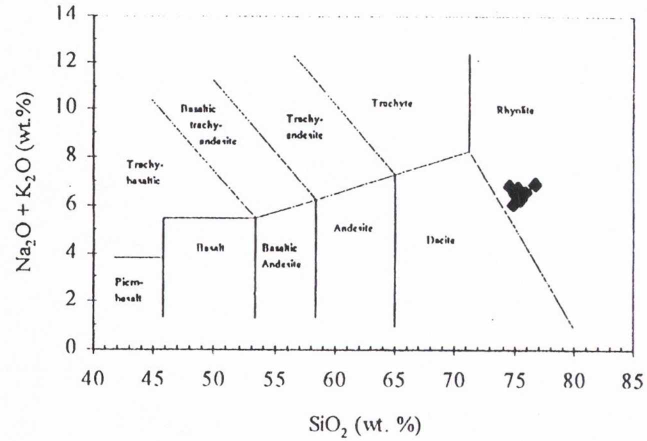
97AP-I-b



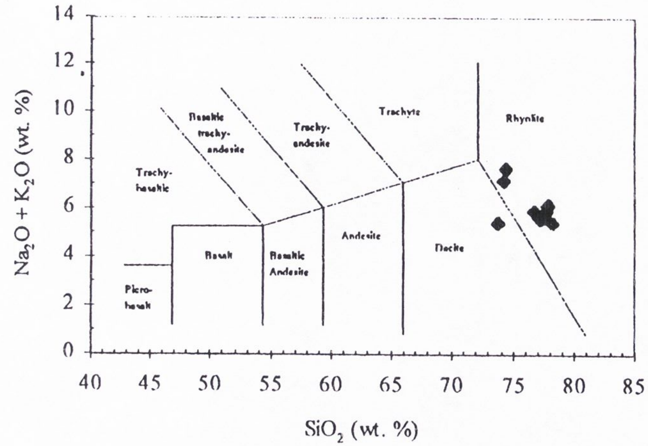
97AP-J



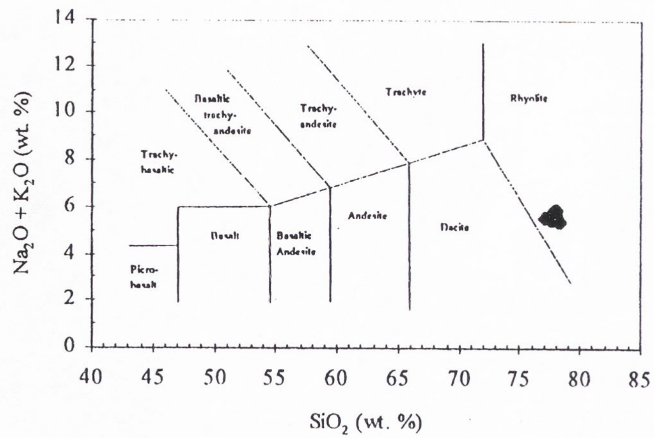
97AP-K



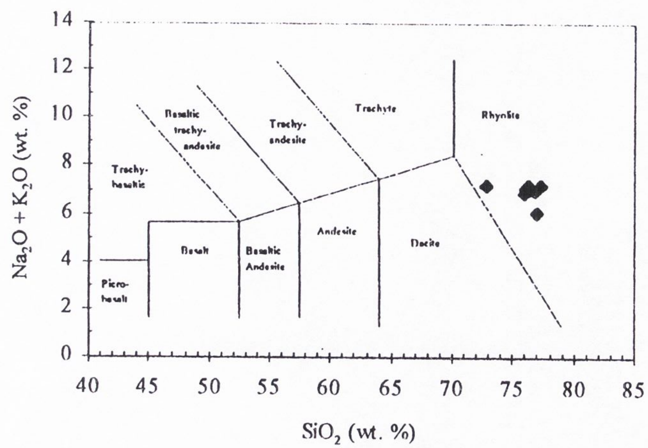
97AP-L



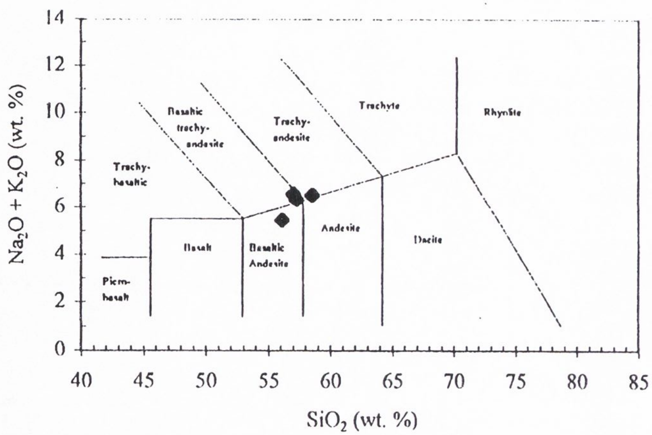
97AP-M



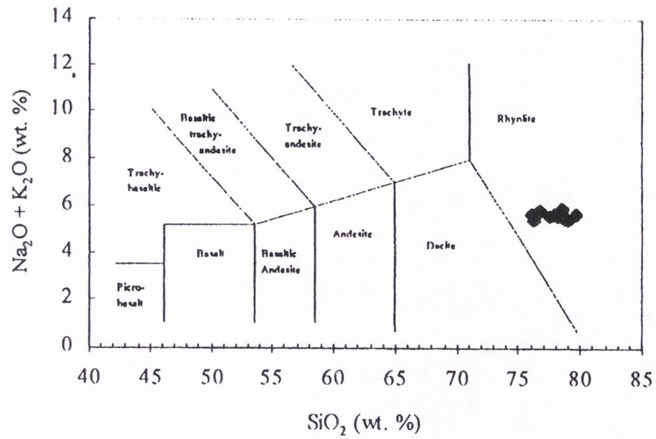
97AP-N-a



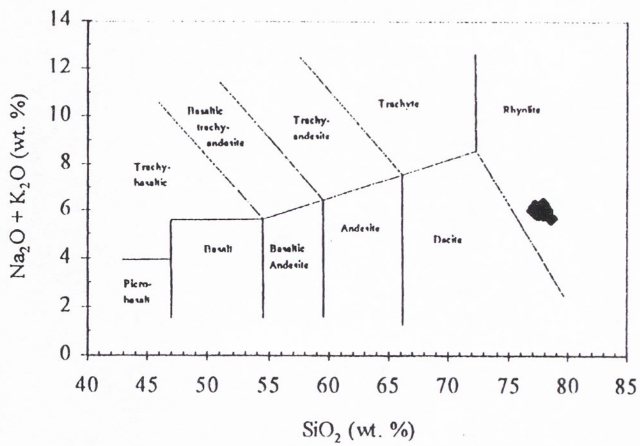
97AP-N-b



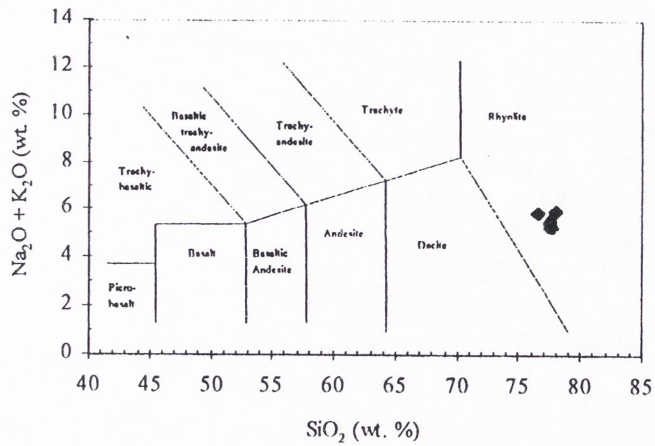
97AP-O



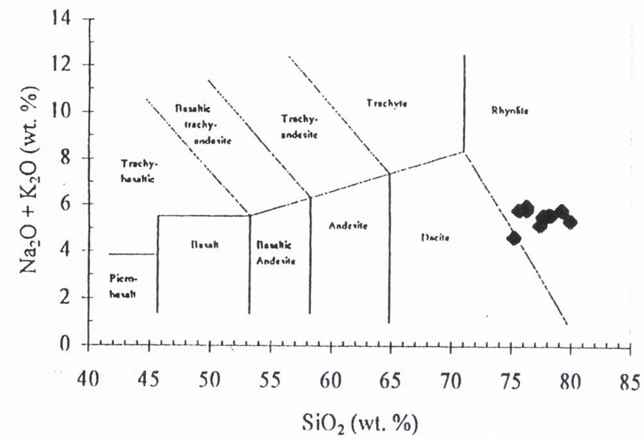
97AP-P



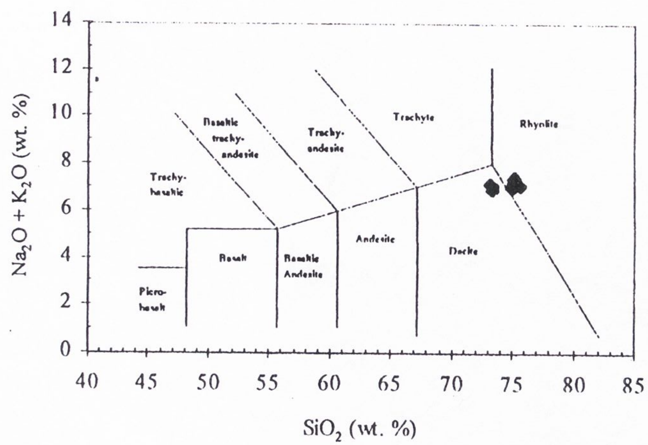
97AP-Q



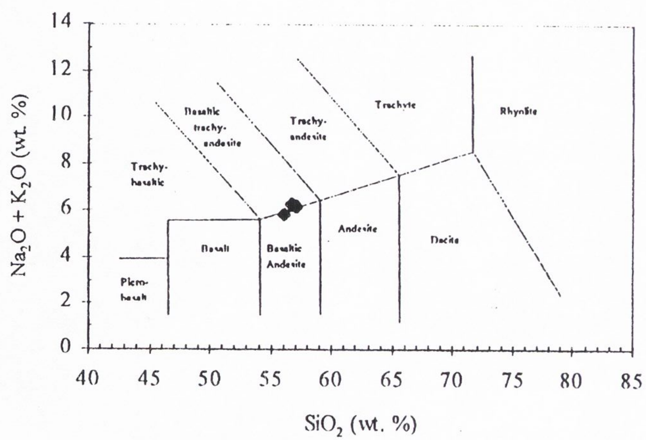
97AP-R



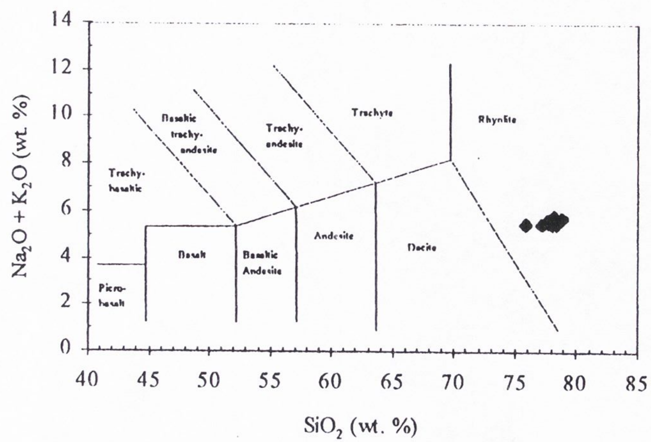
97AP-S-a



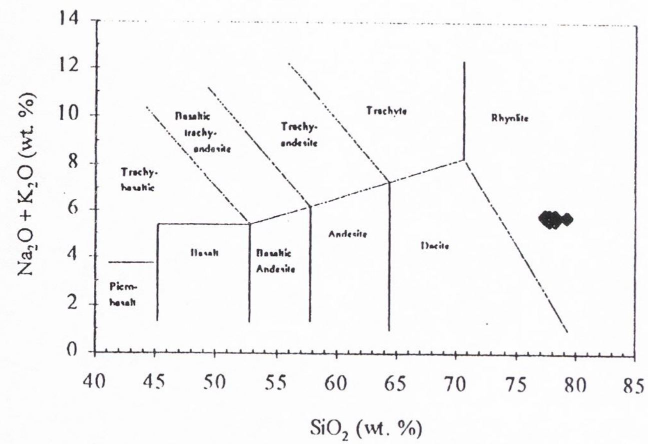
97AP-S-b



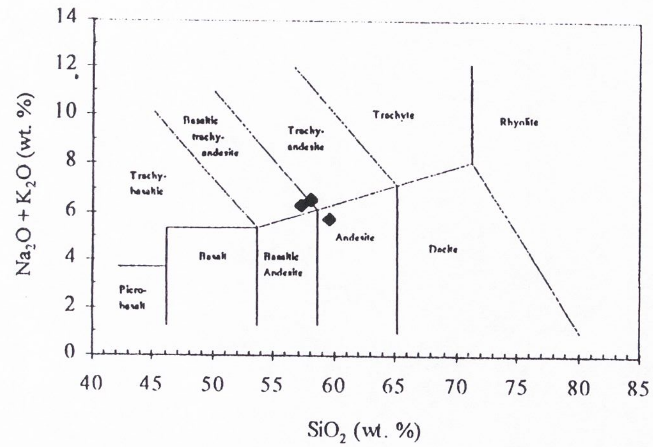
97AP-T



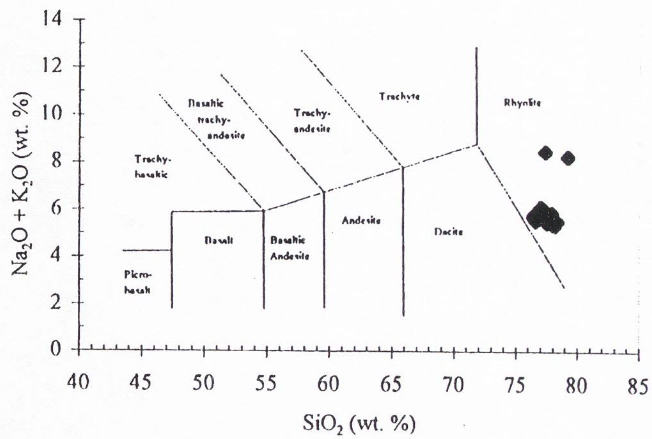
97AP-U-a



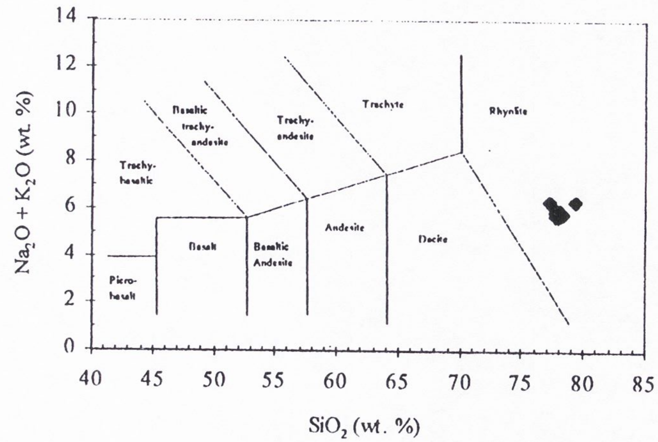
97AP-U-b



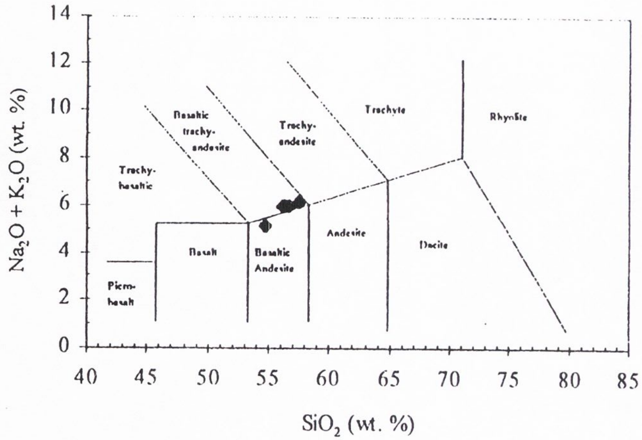
97H-A



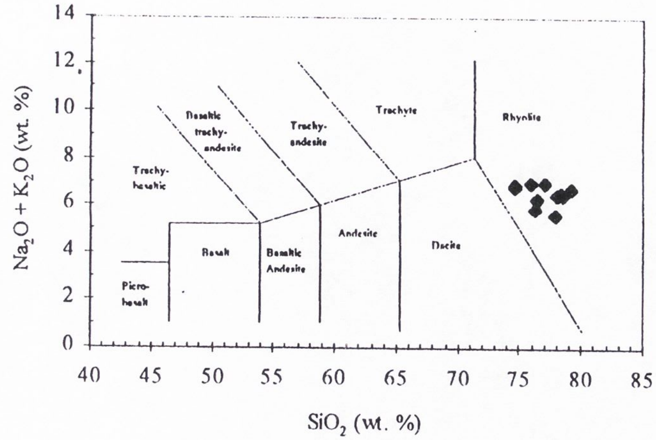
97H-B-a



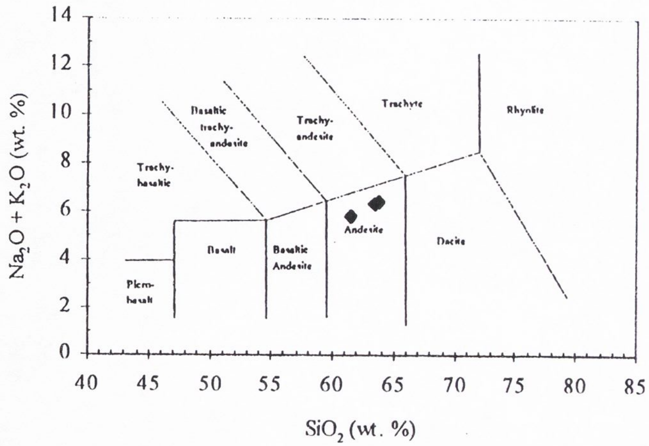
97H-B-b



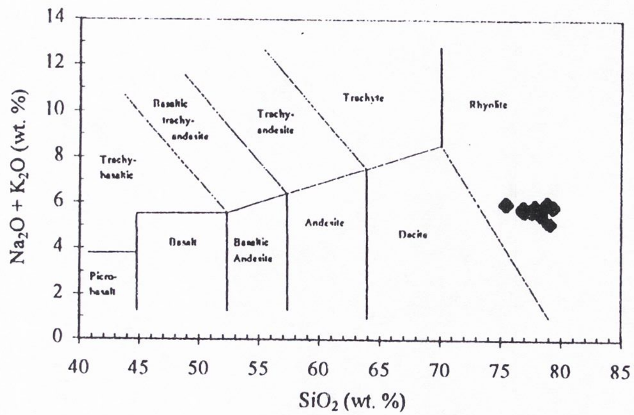
97H-C-a



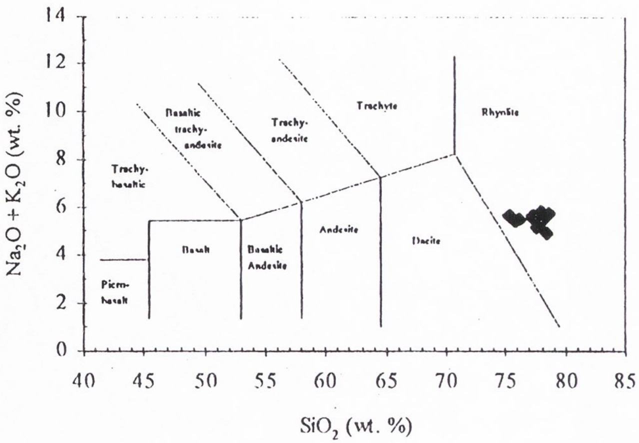
97H-C-b



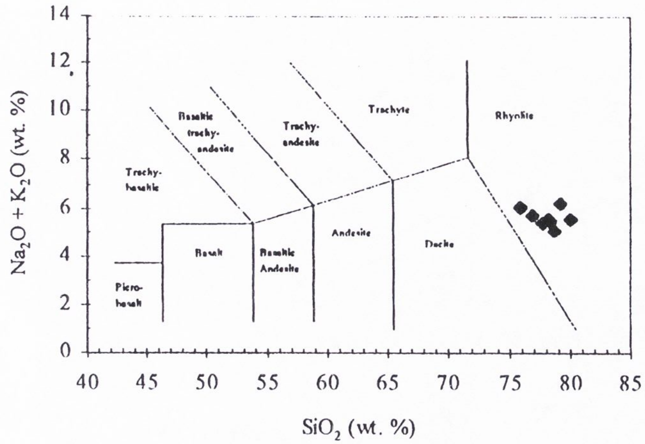
97H-D



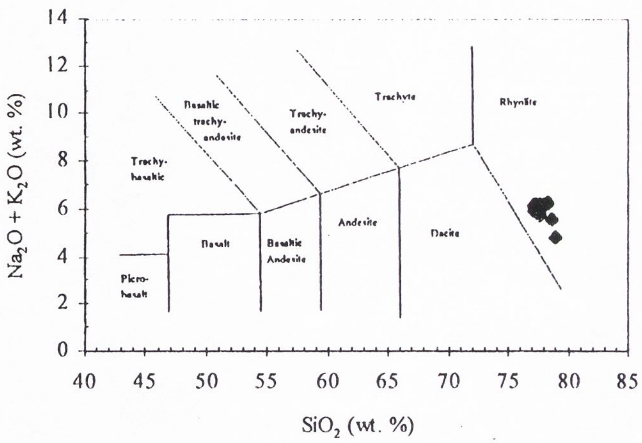
97H-E



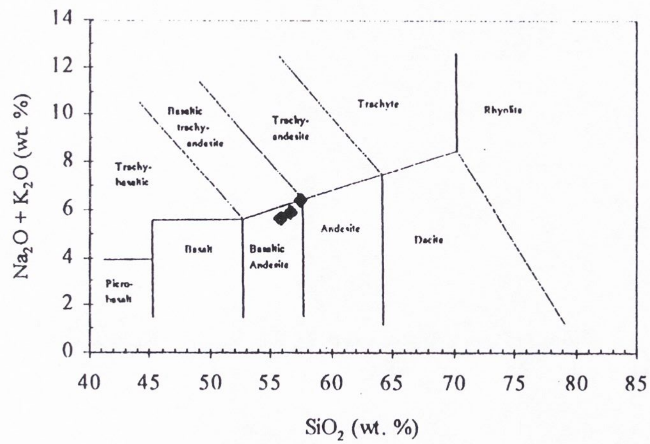
97H-F



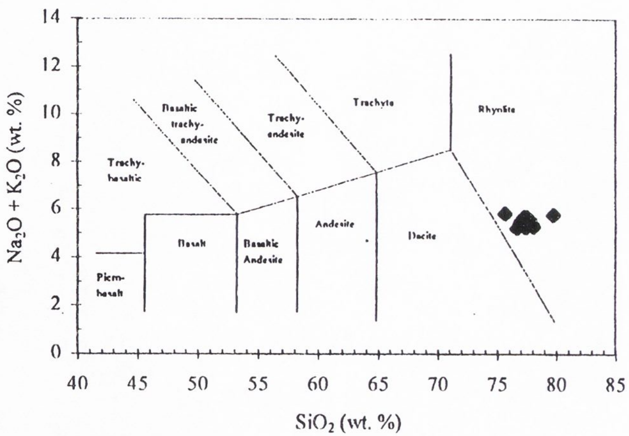
97H-G-a



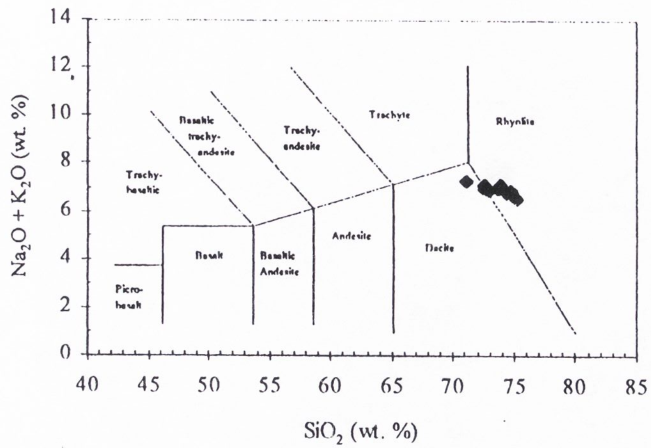
97H-G-b



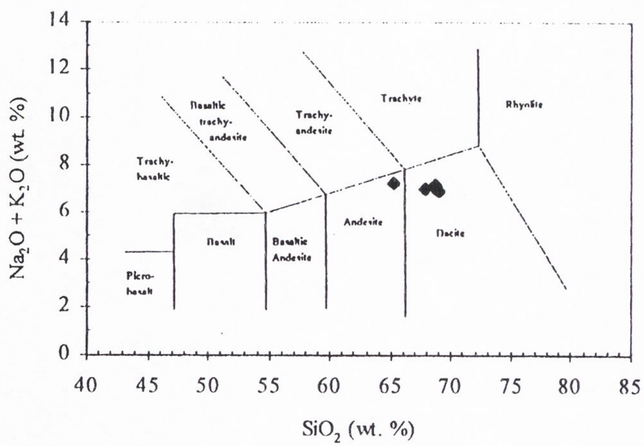
97H-I



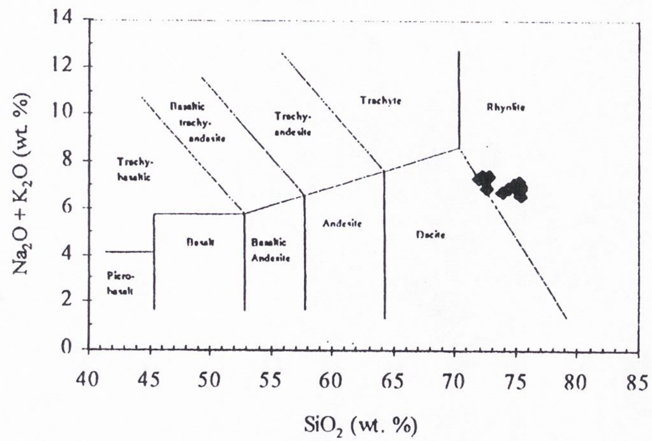
97H-J-a



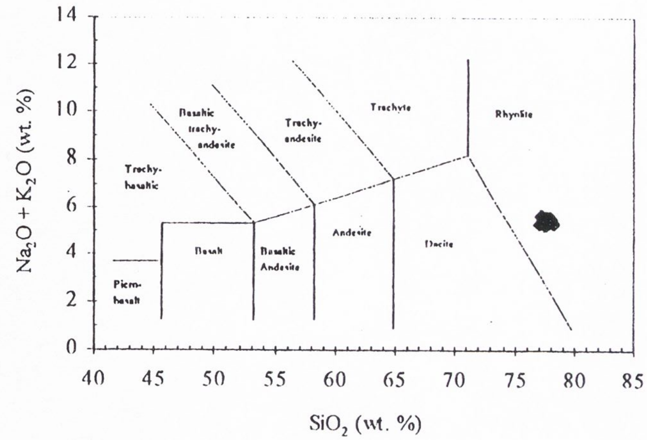
97H-J-b



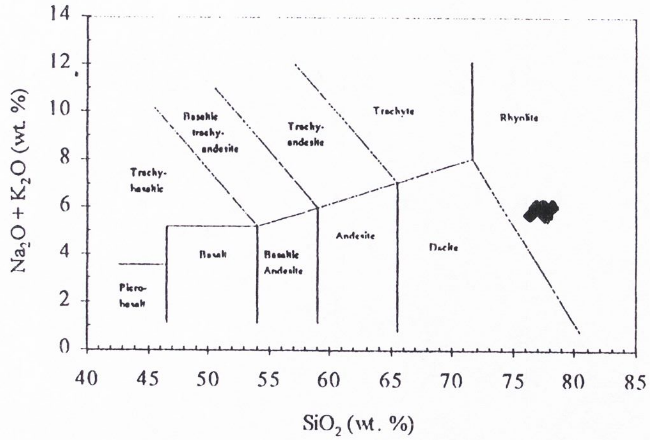
97H-K



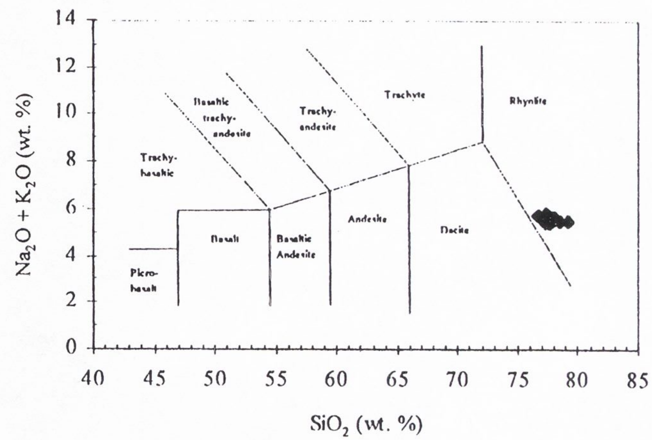
97H-L



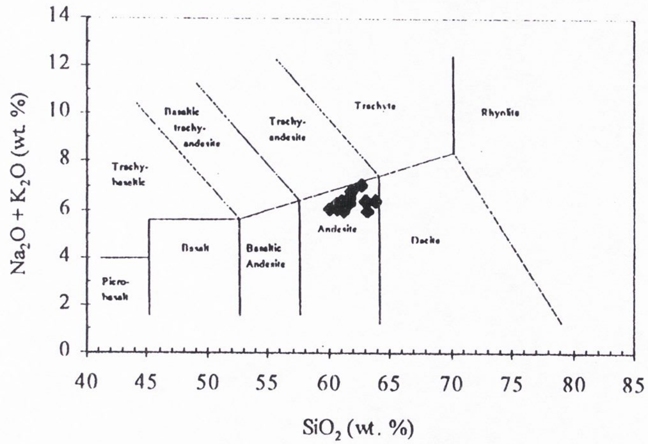
97H-M



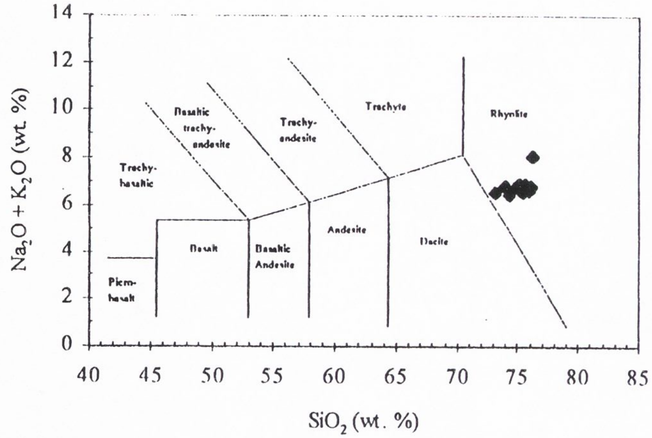
97H-N



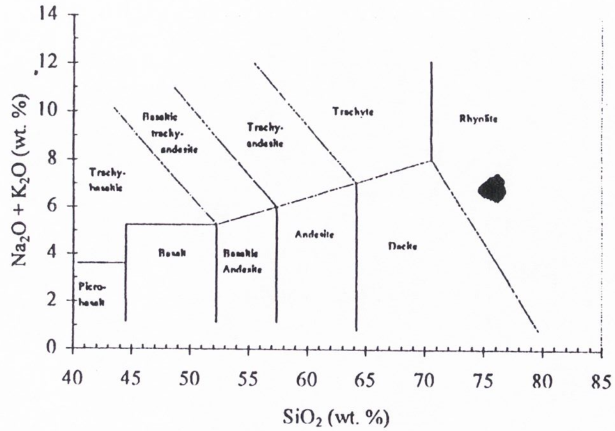
97H-O



97H-P


Na2O + K2O (wt. %)
SiO2 (wt. %)
Trachy-basaltic
Basaltic trachy-andesite
Trachy-andesite
Trachyte
Rhyolite
Picro-basalt
Basalt
Basaltic Andesite
Andesite
Dacite

97H-Q


Na2O + K2O (wt. %)
SiO2 (wt. %)
Trachy-basaltic
Basaltic trachy-andesite
Trachy-andesite
Trachyte
Rhyolite
Picro-basalt
Basalt
Basaltic Andesite
Andesite
Dacite

Appendix C. Similarity Coefficient (SC) Comparison Data for Anchor Point and Homer with Regional Referenced Tephra.

Table C1. Similarity coefficient data of Anchor Point tephras.

Sample	Similar to Sample #:	Similarity Coefficient	By	Source Volcano
97AP-E-a	no correlations			
97AP-E-b	no correlations			
97AP-G	no correlations			
97AP-H-a				
	97AP-I-a	0.96	Lemke (this study)	
	97AP-M	0.96	Lemke (this study)	
	97AP-O	0.94	Lemke (this study)	
	97H-B-a	0.96	Lemke (this study)	
	97H-D	0.97	Lemke (this study)	
	97H-G-a	0.95	Lemke (this study)	
	KL-001	0.97	Reger and others (1996)	Tephra 1A (Augustine)
	KL-040	0.94	Reger and others (1996)	Tephra 1A (Augustine)
	KL-053	0.94	Reger and others (1996)	Tephra 1A (Augustine)
	KL-090	0.94	Reger and others (1996)	Tephra 1A (Augustine)
	KL-091	0.94	Reger and others (1996)	Tephra 1A (Augustine)
	KL-093	0.95	Reger and others (1996)	Tephra 1A (Augustine)
	KL-094p1	0.94	Reger and others (1996)	Tephra 1A (Augustine)
	KL-051	0.94	Reger and others (1996)	Tephra 1B (Augustine)
	KL-062	0.95	Reger and others (1996)	Tephra 1B (Augustine)
	KL-104	0.94	Reger and others (1996)	Tephra 1B (Augustine)
	RBW33B	0.94	Riehle and others (1999)	Augustine
97AP-H-b	no correlations			
97AP-I-a				
	97AP-H-a	0.96	Lemke (this study)	
	97AP-M	0.95	Lemke (this study)	
	97AP-O	0.94	Lemke (this study)	
	97H-B-a	0.95	Lemke (this study)	
	97H-D	0.95	Lemke (this study)	
	KL-001	0.96	Reger and others (1996)	Tephra 1A (Augustine)
	KL-002	0.96	Reger and others (1996)	Tephra 1A (Augustine)
	KL-003	0.94	Reger and others (1996)	Tephra 1A (Augustine)
	KL-020	0.95	Reger and others (1996)	Tephra 1A (Augustine)
	KL-040	0.95	Reger and others (1996)	Tephra 1A (Augustine)
	KL-053	0.95	Reger and others (1996)	Tephra 1A (Augustine)
	KL-090	0.95	Reger and others (1996)	Tephra 1A (Augustine)
	KL-091	0.96	Reger and others (1996)	Tephra 1A (Augustine)
	KL-093	0.97	Reger and others (1996)	Tephra 1A (Augustine)
	KL-094p1	0.95	Reger and others (1996)	Tephra 1A (Augustine)

Table C1. Continued.

	KL-051	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-062	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
97AP-I-b	no correlations				
97AP-J					
	KL-049p2	0.94	Reger and others (1996)	Tephra 3	(Augustine)
	KL-112p3	0.94	Reger and others (1996)	Tephra 3	(Augustine)
	116-15	0.99	Miller (unpublished)	Iliamna	
97AP-K					
	KL-008	0.94	Reger and others (1996)	Unknown	
	KL-112p3	0.94	Reger and others (1996)	Tephra 3	(Augustine)
97AP-L					
	116b-28	0.98	Miller (unpublished)	Iliamna	
	116-26	0.99	Miller (unpublished)	Iliamna	
	116b-14	0.99	Miller (unpublished)	Iliamna	
97AP-M					
	97AP-H-a	0.96	Lemke (this study)		
	97AP-I-a	0.95	Lemke (this study)		
	97AP-O	0.97	Lemke (this study)		
	97H-D	0.96	Lemke (this study)		
	97H-F	0.94	Lemke (this study)		
	KL-001	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-002	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-020	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-040	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-053	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-090	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-091	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-093	0.96	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-094p1	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	RBW33B	0.95	Riehle and others (1999)	Augustine	
97AP-N-a					
	KL-112p3	0.94	Reger and others (1996)	Tephra 3	(Augustine)
97AP-N-b	no correlations				

Table C1. Continued.

97AP-O					
	97AP-H-a	0.94	Lemke (this study)		
	97AP-I-a	0.94	Lemke (this study)		
	97AP-M	0.97	Lemke (this study)		
	97AP-Q	0.94	Lemke (this study)		
	97H-F	0.95	Lemke (this study)		
	97H-L	0.95	Lemke (this study)		
	KL-001	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-002	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-020	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-053	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-091	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-093	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-094p1	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-004	0.94	Reger and others (1996)	Tephra 1C	(Augustine)
97AP-P					
	97H-B-a	0.94	Lemke (this study)		
	97H-G-a	0.96	Lemke (this study)		
	KL-015p1	0.96	Reger and others (1996)	Unknown	
	KL-016	0.96	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-044p1	0.97	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-051	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-060	0.95	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-062	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-104	0.95	Reger and others (1996)	Tephra 1B	(Augustine)
97AP-Q					
	97AP-O	0.94	Lemke (this study)		
	97H-L	0.94	Lemke (this study)		
	KL-001	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-002	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-003	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-020	0.98	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-040	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-053	0.96	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-090	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-091	0.98	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-093	0.96	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-094p1	0.98	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-051	0.94	Reger and others (1996)	Tephra 1B	(Augustine)

Table C1. Continued.

	KL-062	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-004	0.94	Reger and others (1996)	Tephra 1C	(Augustine)
	KL-044p2	0.94	Reger and others (1996)	Tephra 1C	(Augustine)
	KL-123	0.94	Reger and others (1996)	Tephra 1C	(Augustine)
	KL-025	0.95	Reger and others (1996)	Stampede	
	KL-082	0.94	Reger and others (1996)	Stampede	
	KL-083	0.94	Reger and others (1996)	Stampede	
97AP-R					
	KL-001	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-091	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
97AP-S-a					
	97H-K	0.97	Lemke (this study)		
	KL-013p1	0.95	Reger and others (1996)	Tephra 3	(Augustine)
	KL-048	0.95	Reger and others (1996)	Tephra 3	(Augustine)
	KL-049p2	0.96	Reger and others (1996)	Tephra 3	(Augustine)
	KL-112p3	0.94	Reger and others (1996)	Tephra 3	(Augustine)
	116-15	0.94	Miller (unpublished)	Iliamna	
97AP-S-b	no correlations				
97AP-T					
	97H-N	0.94	Lemke (this study)		
97AP-U-a					
	97H-N	0.95	Lemke (this study)		
97AP-U-b	no correlations				

Table C2. Similarity coefficient data for Homer tephras.

Sample	Similar to Sample #:	Similarity Coefficient	By	Source Volcano	
97H-A					
	KL-001	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-093	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
97H-B-a					
	97AP-H-a	0.96	Lemke (this study)		
	97AP-I-a	0.95	Lemke (this study)		
	97AP-P	0.94	Lemke (this study)		
	97H-D	0.95	Lemke (this study)		
	97H-G-a	0.96	Lemke (this study)		
	KL-015p1	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-001	0.95	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-093	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-016	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-044p-1	0.96	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-051	0.95	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-060	0.95	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-062	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-104	0.96	Reger and others (1996)	Tephra 1B	(Augustine)
97H-B-b	no correlations				
97H-C-a	no correlations				
97H-C-b.	no correlations				
97H-D					
	97AP-H-a	0.97	Lemke (this study)		
	97AP-I-a	0.95	Lemke (this study)		
	97AP-M	0.96	Lemke (this study)		
	97H-B-a	0.95	Lemke (this study)		
	97H-G-a	0.94	Lemke (this study)		
97H-E					
	RBW33B	0.94	Riehle and others (1999)	Augustine	

Table C2. Continued.

97H-F					
	97AP-M	0.94	Lemke (this study)		
	97AP-O	0.95	Lemke (this study)		
	KL-015p1	0.94	Reger and others (1996)	Unknown	
	KL-001	0.96	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-093	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
97H-G-a					
	97AP-H-a	0.95	Lemke (this study)		
	97AP-P	0.96	Lemke (this study)		
	97H-B-a	0.96	Lemke (this study)		
	97H-D	0.94	Lemke (this study)		
	KL-015p1	0.94	Reger and others (1996)	Unknown	
	KL-016	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-044p1	0.95	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-060	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
	KL-104	0.94	Reger and others (1996)	Tephra 1B	(Augustine)
97H-G-b	no correlations				
97H-I					
	97H-L	0.95	Lemke (this study)		
	KL-004	0.94	Reger and others (1996)	Tephra 1C	(Augustine)
97H-J-a					
	J	0.94	Riehle (1985)	Redoubt	
	KL-015p2	0.94	Reger and others (1996)	Tephra 5	(Redoubt)
	KL-129p1	0.96	Reger and others (1996)	Tephra 5	(Redoubt)
	116b-28	0.99	Miller (unpublished)	Iliamna	
	116-26	0.99	Miller (unpublished)	Iliamna	
	116b-14	0.99	Miller (unpublished)	Iliamna	
97H-J-b	no correlations				

Table C2. Continued

97H-K					
	97AP-S-a	0.97	Lemke (this study)		
	116-15	0.99	Miller (unpublished)	Iliamna	
97H-L					
	97AP-O	0.95	Lemke (this study)		
	97AP-Q	0.94	Lemke (this study)		
	97H-I	0.95	Lemke (this study)		
	K-002	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-093	0.94	Reger and others (1996)	Tephra 1A	(Augustine)
	KL-004	0.95	Reger and others (1996)	Tephra 1C	(Augustine)
	KL-049p1	0.94	Reger and others (1996)	Tephra 1C	(Augustine)
	KL-123	0.95	Reger and others (1996)	Tephra 1C	(Augustine)
97H-M					
	97H-N	0.94	Lemke (this study)		
97H-N					
	97AP-T	0.94	Lemke (this study)		
	97AP-U-a	0.95	Lemke (this study)		
97H-O	no correlations				
97H-P					
	116b-28	0.99	Miller (unpublished)	Iliamna	
97H-Q					
	116b-28	0.98	Miller (unpublished)	Iliamna	
	116-26	0.99	Miller (unpublished)	Iliamna	
	116b-14	0.99	Miller (unpublished)	Iliamna	