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MACKAY SCHOOL OF MINES

UNIVERSITY OF NEVADA

RENO, NEVADA

Preliminary Ground Truth Report of the

Mt. Lassen Test Site #56

by

Peter Chapman, Peter Brennan, Jack Quade
Pat Robertson, David Nicolarsen, and David Kirchner
Mackay School of Mines
University of Nevada
Reno, Nevada

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ABSTRACT

The cinder cone area of Mt. Lassen has been selected as a test site because it provides an excellent target for microwave and infrared by eliminating many of the parameters that contribute to the total signal. The almost total absence of vegetation reduces biospheric interference to a minimum, while a variation of approximately 100 feet in topography eliminates slope problems effecting the microwave. Lakes will provide an excellent source for calibration while the usually dry air should reduce total moisture in the ground-to-plane interface which effects the infrared.

The primary purpose of this study will be to observe the effects of surface roughness, porosity, thermal conduction and size distribution characteristics to the total signal on the microwave and infrared portions of the spectra.

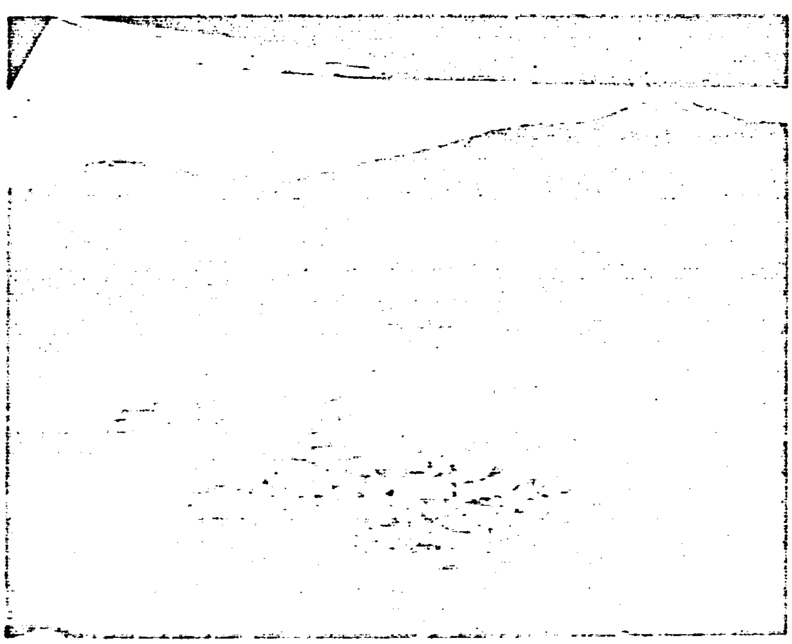
In the infrared portion of the spectra, target surface radiance is measured as surface temperature, but the emission characteristics of the material in its immediate environment is a product of its absorbtion and conduction abilities. The Lassen site provides large homogeneous areas where the emission, absorbtion and conduction characteristics are markedly different while all other parameters remain measurable or constant.

In the microwave portion of the spectra the signal is strongly influenced by the temperature at much greater depths than in the infrared. Subsurface temperatures are strongly dependent on the thermal diffusivity of the target material therefore greater emphasis will be placed on measuring porosity, contained water and thermal resistivity of the rock and soil types.

Another area of prime interest in the microwave portion of the spectra is the emitted signal scattering effect due to surface geometry. In the absence

of large vertical shifts in the topography the problem of interpreting the micro surface roughness characteristics should be greatly simplified.

A test site of varying micro surface geometry and porosity, without undue influence from other parameters has long been overdue in the instrument calibration program. The Mt. Lassen Test Site should provide valuable answers to problems involving the complex study of geologic maps by remote sensing techniques.



Cinder Cone, altered cinders, and black flows as seen from a plane using infrared film. Note the older, smaller cone on the south side of the larger cone.

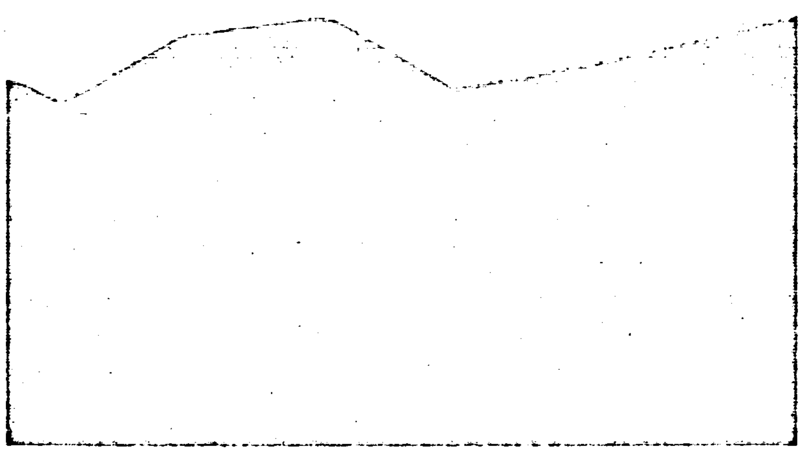
GENERAL GEOLOGY

The volcanic province of which Mt. Lassen Volcanic National Park is a part contains a well exposed series of eruptive rocks at cinder cone, which is about ten miles east-northeast of Lassen Peak. The cinder cone is a product of a series of pyroclastic eruptions beginning several thousand years ago and concluding in 1851. After each eruption there was an effusion of lava from the base of the cinder cone followed by long periods of quiescence. Several other smaller primary cones exist in the southern and northern part of the flows which complicate trying to date and number all the flows, a factor we hope to cast some light on when all the data is available.

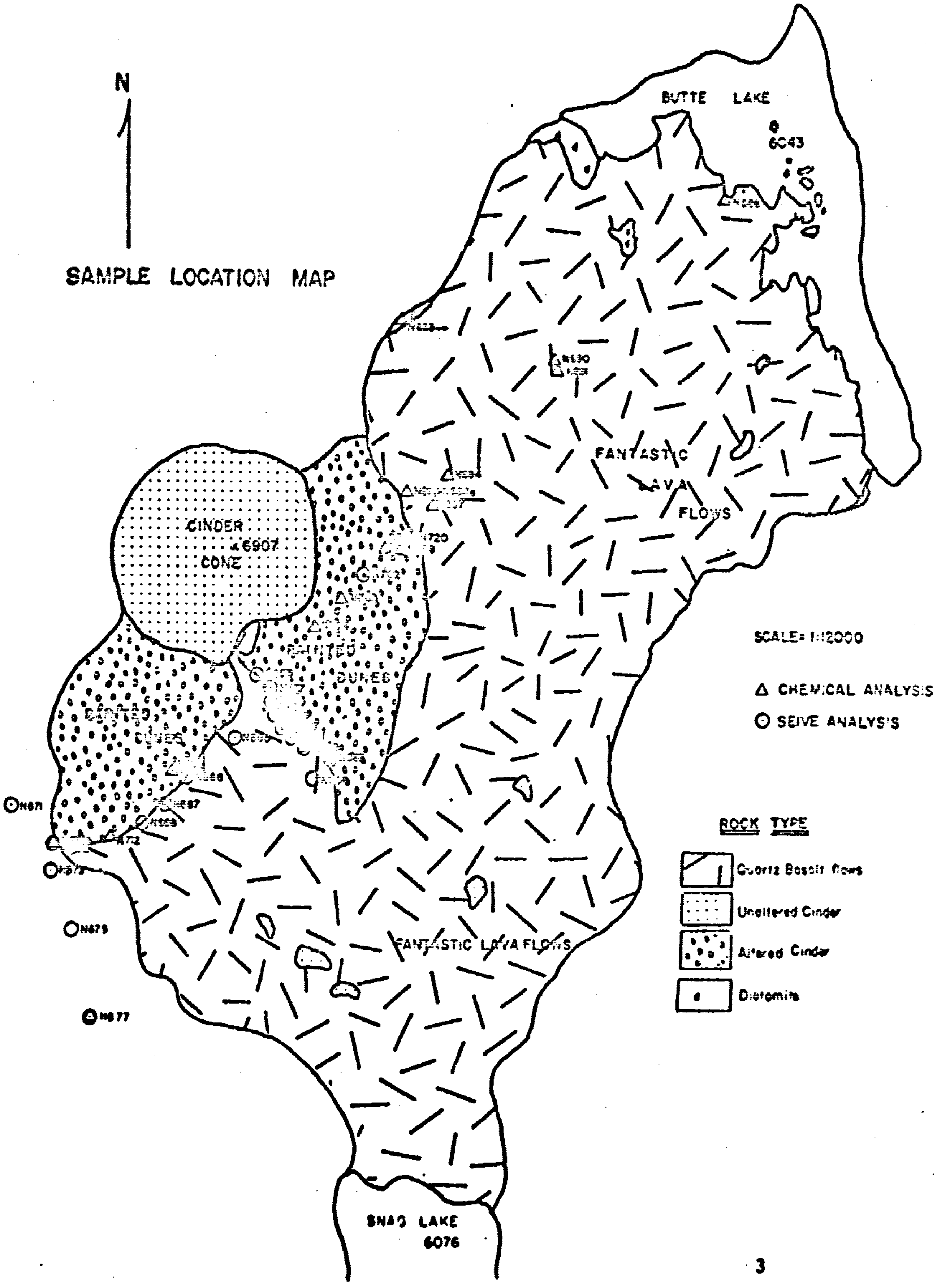
The lava flows have dammed the drainage into Butte Lake, thus forming Snag Lake which is thirty-three feet higher and now supplies water through the porous flows into Butte Lake. Prior to the last lava flows, deposition in the form of diatomaceous earth accumulated in Butte Lake, vestiges of which can still be found along the margins of Butte Lake and the lava flows.

A close inspection of the flows along the flight line revealed a large percentage of blocky lava, some aa and even less Pahoehoe, the latter being associated with the later flows. The last flow which is distinctly black can be easily traced from the breach in the southern end of the cone, while the earlier flows in the immediate vicinity of the cinder cone are more difficult to differentiate in that they have been altered by weathering or fumarolic action and are covered by a thin mantle of ash and cinders. The greatest percentage of flow material along the flight line appears, on first examination, to be homogeneous in texture and chemical composition.

A satisfactory explanation for the presents of quartz as xenoliths and white pumiceous inclusions in the matrix of all the basalt flows has not yet been found; we hope to have more on this phenomena when we have had time to examine the samples petrographically.



View of the lava flows and Cinder Cone as seen from the flight line looking southwest from Butte Lake.


N
SAMPLE LOCATION MAP
BUTTE LAKE
6043
N690
CINDER
6907
CONE
H720
PAINTED
DUNES
PAINTED
DUNES
FANTASTIC
LAVA
FLOWS
H671
H687
H672
H675
H677
FANTASTIC LAVA FLOWS
SNAG LAKE
6076
SCALE= 1:12000
△ CHEMICAL ANALYSIS
⊙ SEIVE ANALYSIS
ROCK TYPE
Quartz Basalt flows
Unaltered Cinder
Altered Cinder
Diatomite

CHEMICAL ANALYSIS

The preliminary chemical analyses were done using NASA's Seimens Universal X-ray Spectrometer. Each of the samples was split and half ground for chemistry and the other half saved for future reference. Specimens were ground to 400 mesh and pressed into pellets under 30,000 psi. They were then analyzed 4 times for each element and the data was compared to G-1 and W-1 before the results were averaged.

The results should be considered preliminary, as statistical evaluation of the data has not yet been made; however, the precision for each of the elements except Aluminum is very good and comparisons between samples from this site are valid.

Further chemical work is planned. It will be included in the final Lassen report to be written later in 1967 or early in 1968. The future work will include doubling the number of analyses, adding Na_2O, MgO and perhaps MnO and rechecking some of the analyses already procured.

Summary of Chemical Analyses

	Unaltered Quartz Basalt[2]	Unaltered Cinder[2]	Altered Cinder (Painted Dunes)[3]
SiO_2	55.55	55.25	53.68
Al_2O_3	15.67	14.55	13.62
K_2O	1.49	1.48	1.29
CaO	9.64	9.21	9.83
TiO_2	.79	.80	.78
Total Iron as Fe_2O_3	8.21	8.00	8.27

* 1. 8 samples; N685, N691, N696, N697, N698, N704, N709, N712.
2. 4 samples; N677, N678, N682, N694
3. 2 samples; N662, N663

In addition to typical samples along the flight lines, several spring deposits and possible hot spring deposits and two stratigraphic sections were analized.

	Lake deposit (diatomite) between Butte Lake & Painted Dunes[1]	Highly altered sample, spring[2]	Highly altered sample from inactive hot spring south of cinder cone[3]
SiO_2	77.97	33.33	45.77
Al_2O_3	2.99	12.60	19.24
K_2O	.59	.77	.74
CaO	3.35	7.14	5.08
TiO_2	.58	.36	1.40
Total Iron as Fe_2O_3	3.51	9.35	4.36

* 1. 1 sample; N683
  2. 1 sample; N703
  3. 1 sample; N724

One of the two stratigraphic sections, collected half a mile southwest of the cinder cone, cuts through several layers of recent cinder to the light ashy bedrock below. The second section was collected in an altered cinder area one half mile to the east of the cone; it does not reach pre-eruptive material but shows the range of alteration through a thick section of cinder.

Section 1 southwest of cone

Sample No.	SiO_2	Al_2O_3	K_2O	CaO	TiO_2	Fe_2O_3*
N682[1]	55.04	14.96	1.47	9.33	.76	8.08
N678[2]	55.32	14.34	1.57	8.64	.80	7.92
N679[3]	52.47	13.51	.99	10.37	.77	8.72
N680[4]	55.24	18.25	1.85	7.20	.80	7.83
N681[5]	56.63	18.24	1.58	8.27	1.08	7.69

*Total Iron as Fe_2O_3

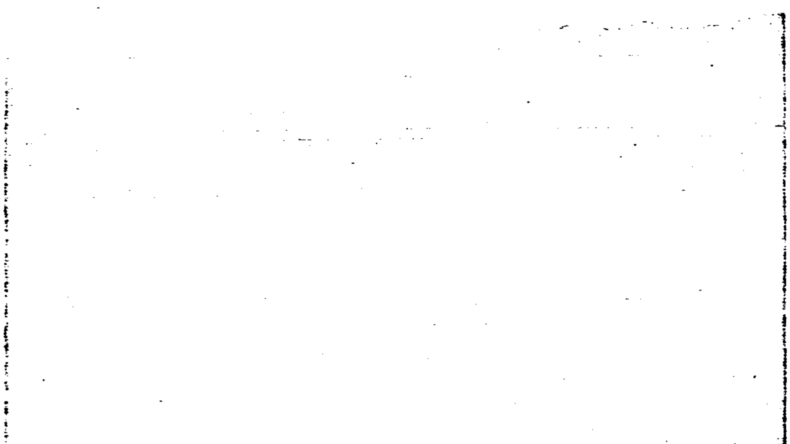
1. unaltered cinder at surface
2. unaltered cinder just below surface
3. unaltered cinder at base of 5' thick cinder section
4. Brownish soil with pebbles - stream deposit
5. Ashy pinkish brown beds

Section of cinder east of cone

Sample No.	SiO_2	Al_2O_3	K_2O	CaO	TiO_2	Fe_2O_3*
N720[1]	53.47	13.01	1.08	10.00	.75	8.49
N719[2]	53.06	13.34	1.08	10.59	.77	8.73
N718[3]	52.86	13.95	1.14	10.22	.75	8.29
N717[4]	55.67	14.77	1.48	9.60	.81	8.17
N716[5]	55.36	13.50	1.45	9.34	.82	8.25
N715[6]	54.95	15.36	1.40	9.94	.85	8.37
N714[7]	54.83	14.84	1.40	9.70	.84	7.98

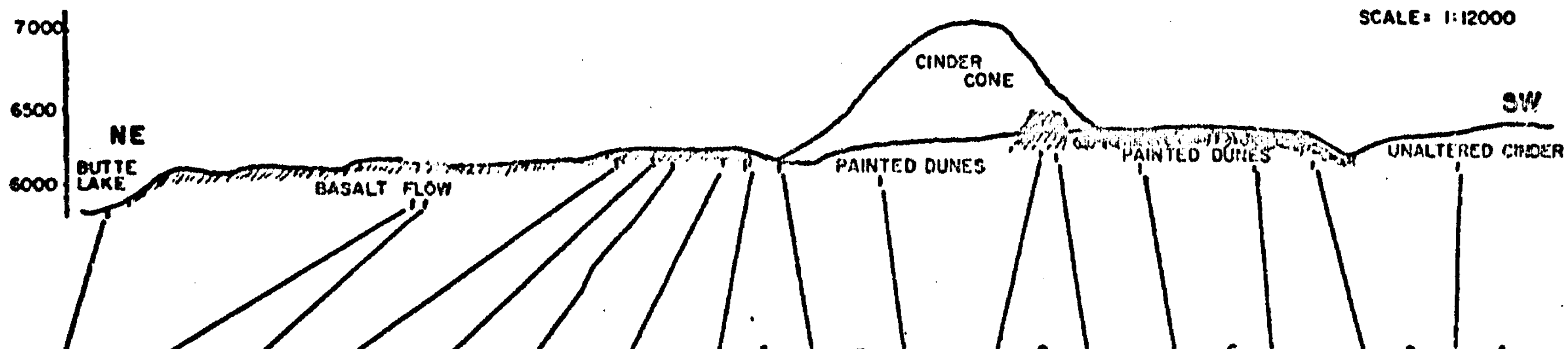
*Total Iron as Fe_2O_3

1. Slightly altered cinder
2. Varigated oxidized cinder
3. Varigated oxidized cinder
4. Unaltered cinder
5. Oxidized cinder
6. Mixed oxidized and unoxidized cinder
7. Mixed oxidized and unoxidized cinder



Butte Lake and the lava flows as seen from the top of the Cinder Cone, looking northeast along the flight line.

CHEMICAL ANALYSES ALONG NE-SW FLIGHT LINE



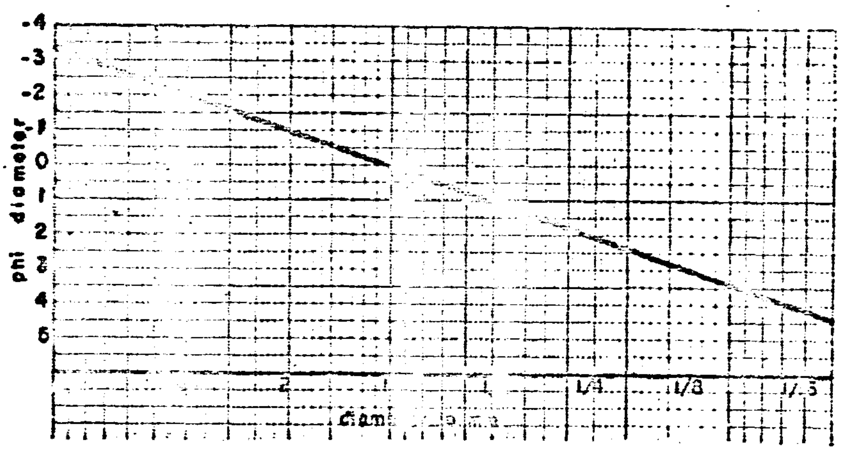
	N686	N690	N691	N694	N697	N696	N698	N720[1]	N703[5]	N704	N663[2]	N662	N709[6]	N712	N682[3]	N677[4]
SiO_2	55.76	56.75	56.01	55.61	52.31	57.05	55.61	53.47	33.33	54.42	53.79	53.57	58.26	55.01	55.04	55.05
Al_2O_3	17.66	15.86	16.06	14.30	13.04	17.17	15.23	13.01	13.60	16.46	13.66	13.58	13.77	15.97	14.96	14.40
K_2O	1.62	1.60	1.58	1.46	1.02	1.70	1.62	1.08	0.77	1.35	1.29	1.29	1.76	1.31	1.47	1.42
CaO	9.67	9.55	9.03	9.15	9.85	9.38	9.79	10.00	7.14	10.18	9.52	10.15	9.06	10.13	9.33	9.72
TiO_2	0.87	0.79	0.84	0.83	0.76	0.81	0.85	0.75	0.36	0.86	0.77	0.79	0.59	0.70	0.76	0.82
*Fe_2O_3	7.81	7.65	8.40	8.03	8.74	8.17	8.11	8.49	0.35	8.39	8.34	8.20	7.50	8.54	8.08	7.98

*Total Iron as Fe_2O_3

1 N720 Column - Chem.
2 N663 - South of NE-SW Flight line
3 N682 Column sieve + chem.
4 N677 South of NE-SW Flight line
5 N720 Atypical alteration of basalt, probably hydrothermal (not entered in averages)
6 N709 Probable secondary silica (not entered in averages)

PARTICLE SIZE ANALYSIS

Particle size analysis was done on a standard set of square root of two series seives. The weights have been reduced by means of a computer program modified from one by Hobson at Northwestern University. The results are recorded as, mean phi diameter, phi standard deviation, skewness (symmetry of the curve), and Kurtosis (peakedness of the curve). From these parameters a mono modal distribution curve may be reconstructed.

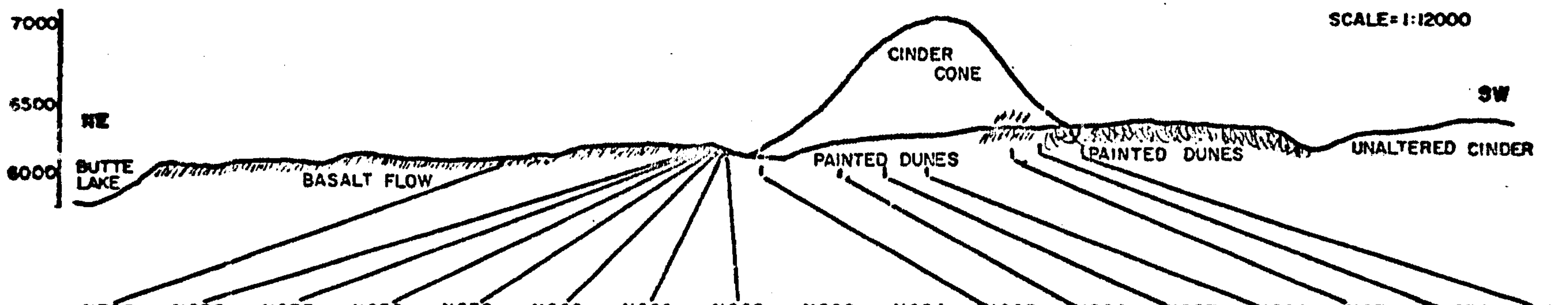


In addition to samples along the flight line and a supplimentary north-south line, the columnar section one half mile southwest of the crater was processed.(see chemical analysis).

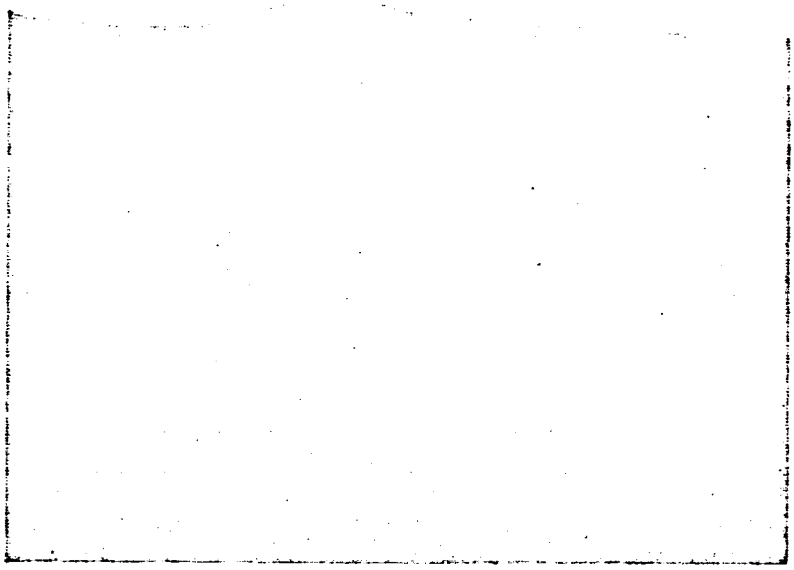
Particle Analysis of
Columnar section southeast of crater

	mean phi diameter	phi standard deviation	skewness	Kurtosis
N682	-1.33	1.09	.43	1.45
N678	+ .39	1.35	.16	.62
N679	-1.52	1.41	.23	-.68
N680	- .65	1.72	-.01	-.91
N681	-1.12	1.77	.50	.70

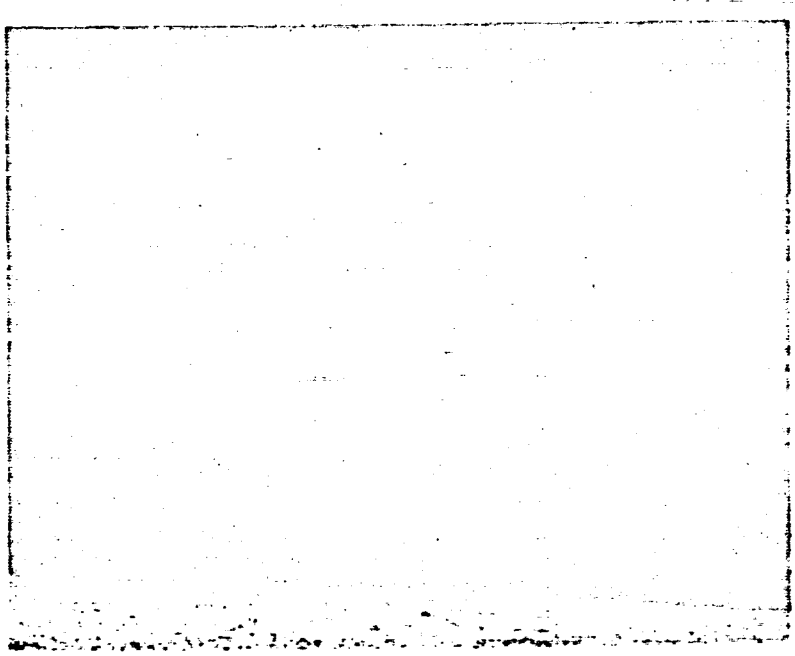
PARTICLE SIZE VARIATIONS ALONG NE-SW FLIGHT LINE



	N702	N656	N657	N658	N659	N660	N661	N662	N663	N664	N665	N666	N667	N668	N671	N673	N675
Phi Mean	-3.25	-2.44	-1.79	-3.01	-1.84	-2.16	-1.39	-2.54	-2.39	-3.61	-2.75	-2.04	-1.56	-0.37	-0.67	-1.19	-2.01
Phi Dev.	1.52	0.73	1.09	0.46	0.81	1.14	0.97	1.03	1.04	0.79	0.60	1.15	0.88	1.25	1.16	1.14	0.99
Skewness	0.53	0.48	0.59	3.29	0.18	0.45	0.10	0.81	0.75	2.23	1.86	0.75	0.04	0.03	0.06	0.23	0.36
Kurtosis	-1.61	5.63	2.23	81.51	1.63	1.35	0.19	4.12	3.35	28.71	31.04	1.54	1.56	0.43	0.33	0.50	0.76



Snag Lake from the top of the Cinder Cone looking south along the flight line. The lighter colored material is altered cinders on top of older flows, while the dark basalt standing in the lower right hand side and curving to the left is the 1851 flow.



Highly altered cinders as seen from the top of the Cinder Cone looking east.

DENSITY AND MOISTURE

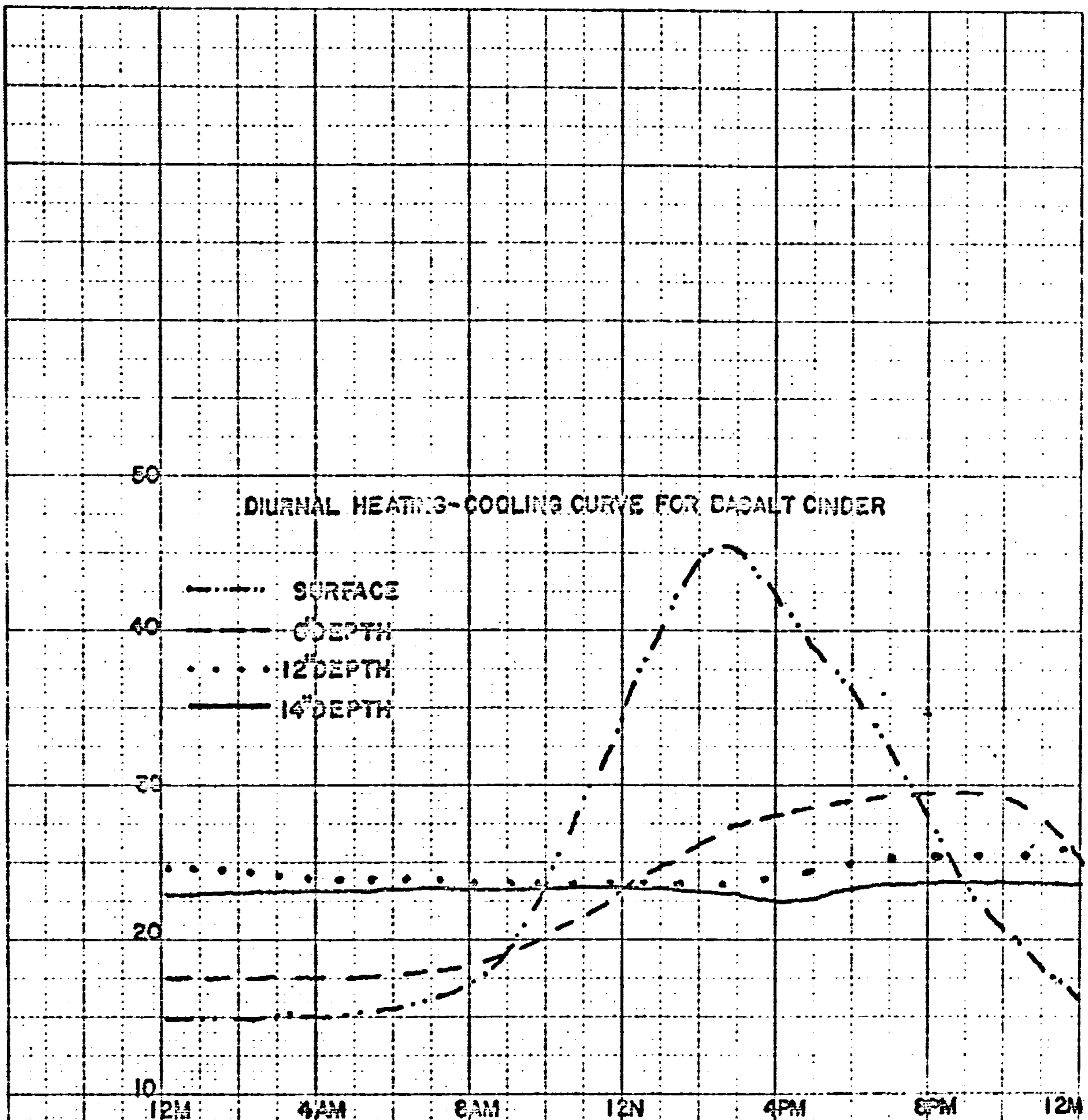
Density and moisture measurements were made using a Nuclear Chicago, gamma-gamma, neutron probe. An area on painted dunes was chosen for the uniformity of loose cinder material and eight locations were checked for consistency.

GAMMA-GAMMA & NEUTRON PROBE DATA FROM PAINTED DUNES

Site No.	Wet Density	Dry Density	Percent water	Percent porocity*
#1[1]	1.35	1.34	1.2	47.8
#2[2]	1.05	1.03	2.5	60.0
#3[3]	1.14	1.11	2.3	56.6
#4[4]	1.16	1.14	2.3	55.6
#5[5]	1.18	1.16	1.2	54.7
#6[6]	1.14	1.09	4.2	57.5
#7[7]	.88	.84	3.6	66.9
#8[8]	1.10	1.06	3.4	58.4
Average	1.13	1.10	2.6	58.2

*calculated on an assumed solid density of 2.7

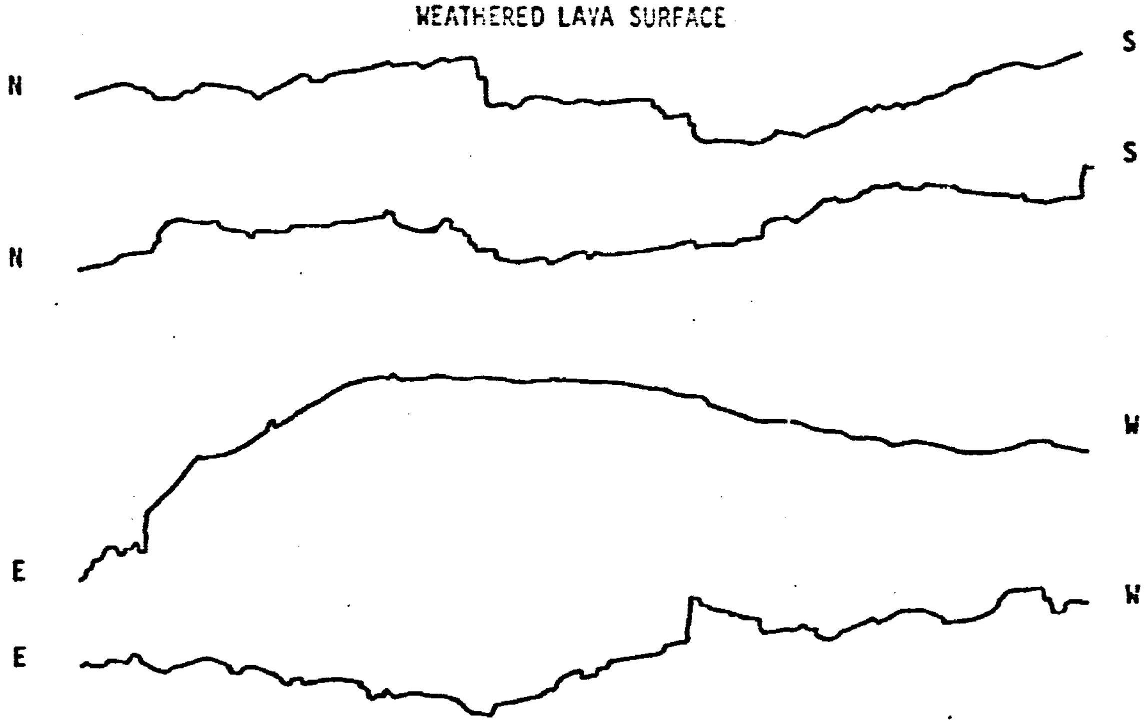
1. Ridge top with cinders over lava
2. Valley adjacent to exposed lava
3. Level cinders
4. 15^{o} slope
5. In cinder depression
6. Dry stream bed
7. Base of cinder knoll
8. 35^{o} slope



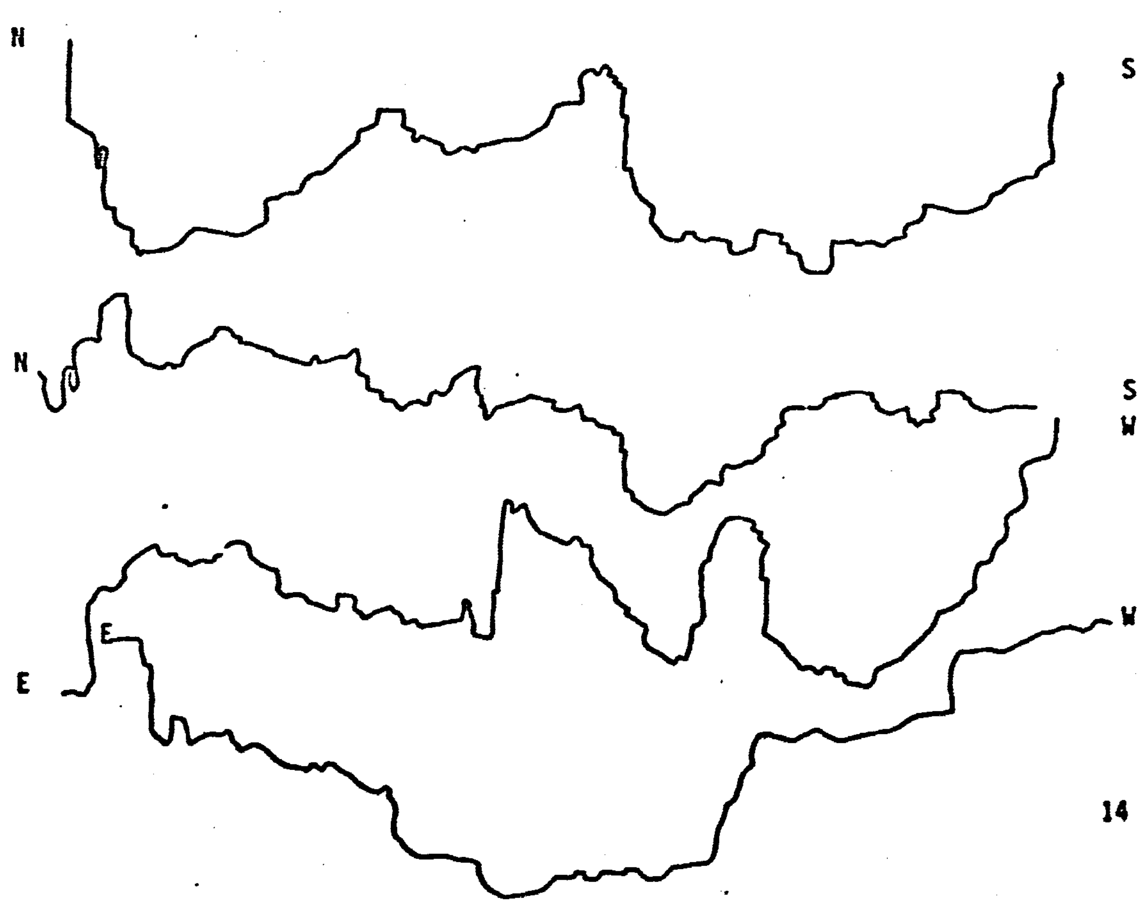
DIURNAL HEATING-COOLING CURVE FOR BASALT CINDER
SURFACE
6" DEPTH
12" DEPTH
14" DEPTH
50
40
30
20
10
12M
4AM
8AM
12N
4PM
8PM
12M

The following is a list of formit measurements of the six principle micro surface types as seen along the flight lines. A map is being prepared along both flight lines that will differentiate the varied surface types.

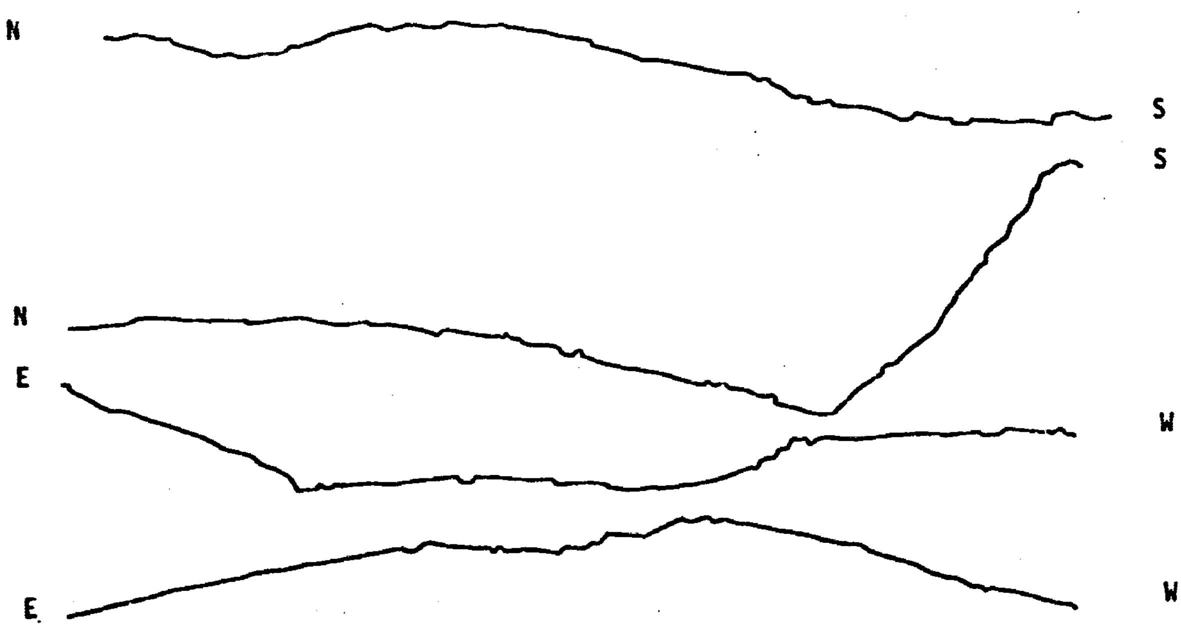
WEATHERED LAVA SURFACE



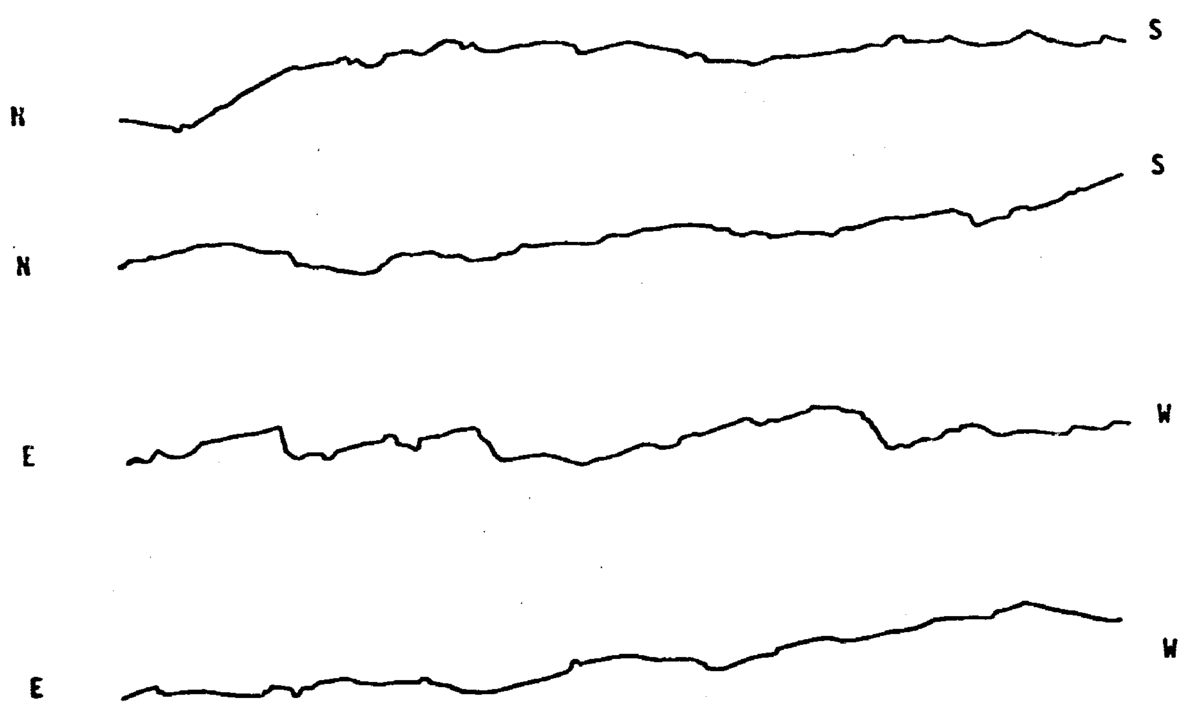
AA LAVA SURFACE



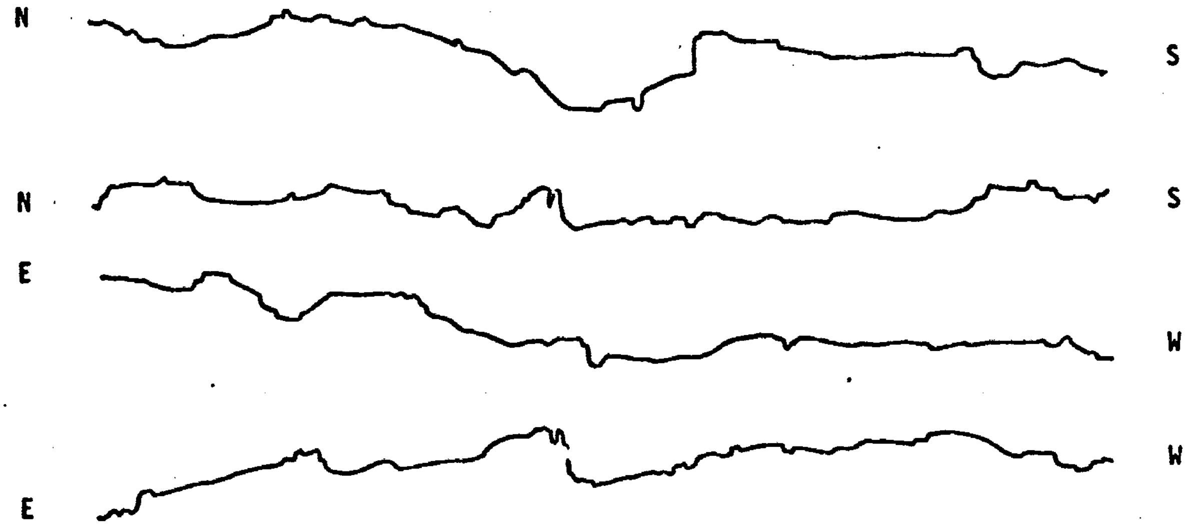
BROKEN BLOCK LAVA



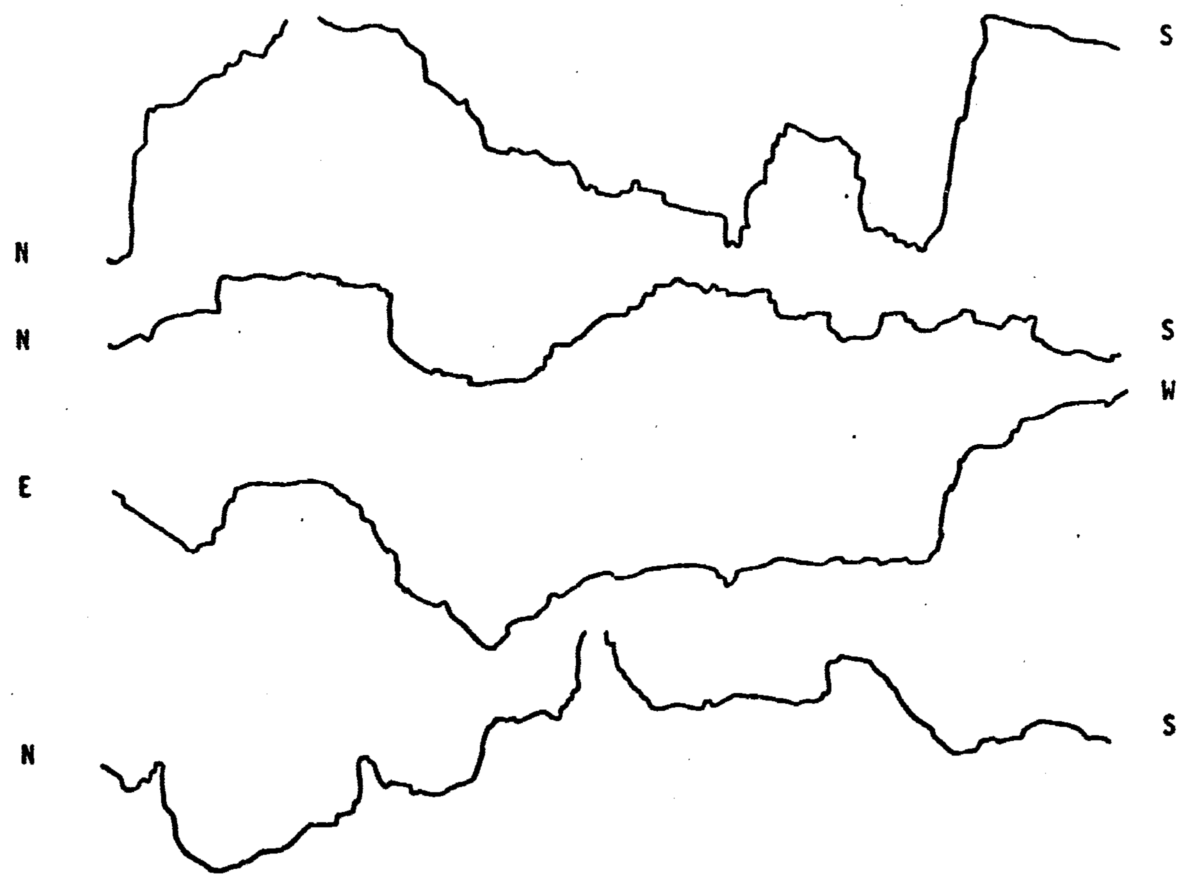
PAHOEHOE SURFACE



MICRO AA LAVA SURFACE



AUTO BRECCIATED LAVA



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