UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Empirical Relationship Among Shot Size, Shotpoint Site Condition, and Recording Distance for 1984-1987 U.S. Geological Survey Seismic-Refraction Data

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INTRODUCTION

During a typical refraction experiment, approximately 10 - 50 chemical explosions, ranging in size from 10's to 100's of kilograms, are detonated. To obtain efficient source-ground coupling, the explosive is usually detonated in bore holes or in lakes or ponds. Seismic waves from these explosions are recorded by portable seismographic equipment at distances of 0.1 - 500 km. The site geology at the shotpoint and the amount of explosive detonated are chosen to provide sufficient seismic energy at all recording instruments. If the shot size is too small, or if the coupling is poor, the data will have low signal-to-noise ratio. If the shot size is larger than necessary, time and money will have been wasted in preparing the shot. In this study, data from our Trans-Alaska Crustal Transect (TACT) and Pacific-Arizona Crustal Experiment (PACE) are used to develop an empirical model for the generation and propagation of seismic wave energy, and this model can be used to design cost-effective refraction experiments.

There are many factors which affect the recorded energy from a chemical explosion. Some of these are listed below:

1. Weight of explosives detonated (shot size).

2. Containment of explosion by water (lake or ocean) versus earth (drill hole).

3. Local geology at the shotpoint.

4. Local geology at the recording station.

5. Geometric spreading of seismic waves.

6. Crustal structure, including the presence of reflectors, refractors, and diffracting bodies along the wave travel path, and attenuation.

7. Presence of water in drill hole or surrounding earth.

8. Depth of explosive within drill hole or body of water.

9. Drill hole loading technique. Possible problems include (a) separation of explosive parcels due to obstructions ("bridges") in the hole, (b) loading an explosive too deeply for its specifications ("dead pressing"), and (c) inadequate tamp.

10. Simultaneous shooting of charges. Quarry blasts are designed to fracture rock rather than produce large seismic waves. This is accomplished by firing portions of the explosive at slightly different times.

11. Variations in recording equipment, including electronic tolerances and malfunctions.

12. Type of explosives detonated.

This report deals mainly with factors 1, 2, 3, 5, and 7, while recognizing that others may be important.

The refraction data set chosen for this study was compiled from two U.S.G.S. refraction experiments. The first data set consists of seismic refraction data from the TACT experiment in Alaska, collected in 1984-1987 (Daley and others, 1985; Meador and others, 1986; Page and others, 1986; Wilson and others, 1987). The second data set consists of data from the PACE experiment in California and Arizona, collected in 1985-1987 (Wilson and Fuis, 1987; Larkin and others, 1988). A total of 159 shots were analyzed in the study (Table 1).

Shots were divided into six categories. "Wet alluvium" shots were fired in drill holes in water-saturated alluvium. "Dry alluvium" shots were fired in dry drill holes in unsaturated alluvium. "Hard rock" shots were fired in holes in bedrock; these holes may or may not have contained water. "Lake" shots were fired at the bottom of shallow lakes or ocean bays at depths of 2-60 m. "Ocean" shots were suspended beneath the ocean surface by cables. The following table summarizes the shots used in this study.

	Number of shots		
	TACT	PACE	Total
Wet Alluvium	50	5	55
Dry Alluvium	0	7	7
Hard Rock	24	45	69
Lake	26	0	26
Ocean	2	0	2
Totals	102	57	159

Each shot was recorded by a set of 120 portable cassette (analog) tape recorders with 2-hz, vertical-component seismometers (Healy and others, 1982). The seismometers produce voltages that are proportional to ground velocities.

The data set was supplemented by measurements from our blasting consultant, Wesley L. Bender, who recorded several of the PACE shots (Table 2).

TRACE AMPLITUDE: CONVERSION FROM DIGITAL COUNTS TO GROUND VELOCITY

Each record of a shot, or trace, consists of twenty seconds of data digitized at a sampling interval of 5 milliseconds. The digitized time window was chosen to include about two seconds of ground noise followed by 18 seconds of signal from the shot. In order to estimate signal strength, the maximum peak-to-peak amplitude, in digital counts, for the entire 20 second window was determined for each trace. An estimate of the noise level was obtained by measuring the peak-to-peak amplitude of the first second of the 20 second window.

Trace amplitudes were converted from digital counts to ground velocity using a formula adapted from Berge and others (1986):

$$A_p = \frac{D_m}{L_{REC}\ D_{VCO}\ D_{DSC}\ G_{SA}\ G_{LE}} \qquad (1)$$

where,

A_p is the peak-to-peak velocity in cm/s,

D_m is the measured peak-to-peak amplitude in digital counts,

L_{REC} is the digitizer sensitivity. The system used in this study contains a Digital Equipment Corp ADV11-C analog to digital module with L_{REC} = 4095 counts/10 volts = 409.5 counts/volt. For IBM AT compatible systems using the Data Translation DT2821 A/D module with the software gain set to 2, L_{REC} is also 409.5 counts/volt.

D_{VCO} is the voltage-controlled oscillator (VCO) sensitivity. D_{VCO} = 25 Hz/volt,

D_{DSC} is the discriminator modulation sensitivity. D_{DSC} = 1/(25 Hz/volt),

G_{SA} is the system gain. $G_{SA} = 10^{(G-a)/20}$, where

G is the maximum gain of the USGS J402 amplifier-VCO. G = 104 db,

a is the attenuation setting of the preamplifier, usually 12, 30, or 48 db,

G_{LE} is the effective generator constant of the seismometer and L-pad. This system uses a Mark Products L-4 seismometer (2 hz), with a G_{LE} of 1.0 volts/(cm/s).

After inserting the appropriate constants in equation 1, we obtain:

$$A_p = 1.541 \times 10^{-8}\ 10^{(a/20)}\ D_m, \text{ or}$$

$$a_p = d_m + (a/20) - 7.812,$$

where $d_m = \log_{10}(D_m)$ and $a_p = \log_{10}(A_p)$.

DATA REDUCTION AND MODELING

Computed ground velocities at each recording station for each shot were separated, or binned, into seven distance ranges, which are of equal length on a logarithmic scale (All references to logarithms refer to base 10 logarithms).

Minimum distance (km)	Maximum distance (km)	Minimum log distance	Maximum log distance
0.178	0.562	-0.75	-0.25
0.562	1.778	-0.25	0.25
1.778	5.623	0.25	0.75
5.623	17.783	0.75	1.25
17.783	56.234	1.25	1.75
56.234	177.828	1.75	2.25
177.828	562.341	2.25	2.75

For each shot, the mean log distance was calculated for each distance range, and, in order to minimize the effect of "bad data", such as clipped or dead traces, the median ground velocity for each distance range was computed rather than the mean velocity (Press and others, 1986). These "reduced" data points are used in all further calculations (see Appendix).

To estimate the noise level for each deployment, the average noise of all recording stations for one shot in each deployment was computed (Table 3).[1] If the computed ground velocity for a distance range was less than the noise level plus one standard deviation, the velocity value was not used in further calculations. Also, if there were fewer than three recording stations in a distance range, the velocity value was not used.

The velocity values were modeled in logarithmic units, assuming the following functional form:

$$a_p = b\, x_{ij} + c\, x_{ij}^2 + d\, s_i + g_i \quad (2)$$

[1]For the North Richardson and South Richardson deployments, the average noise was computed for three shots, and a weighted average was used as the estimated noise level for these deployments.

where

b, c and d are constants,

x_{ij} = Logarithm of the distance from shot i to recording station j, in kilometers.

s_i = Logarithm of the size of shot i, in kilograms,

g_i = Logarithm of shot site correction, in cm/s
= g_A or g_D or g_R or g_L or g_O where,

g_A = Wet alluvium correction,
g_D = Dry alluvium correction,
g_R = Hard rock correction,
g_L = Lake correction,
g_O = Ocean correction.

The above functional form was established by assuming that a_p is a polynomial function of both x_{ij} and s_i. The data were first fit with linear functions, and then additional higher order terms were added. An F test was used to determine which high order terms produced a significantly better fit to the data (Bevington, 1969).

Equation 2 can be rewritten in linear units:

$$A_p = X_{ij}**(b + c \log(X_{ij}))\ \ S_i^{\,d}\ \ G_i \qquad (3)$$

where

$X_{ij} = 10**x_{ij}$ = Distance from shot i to recording station j, in kilometers.

$S_i = 10**s_{ij}$ = Size of shot i, in kilograms,

$G_i = 10**g_i$ = Shot site correction in cm/s
= G_A or G_D or G_R or G_L or G_O, where subscripts have the same definition as above.

A_p, S_i, and x_{ij} are observed values, and a, b, c, and g_i are unknowns. The equations were solved using least-squares, with the following results:

Parameter	Value	Standard Deviation
b	-2.2900	0.1359
c	0.3467	0.0540
d	0.4811	0.0673
g_A	-2.2987	0.0397
g_D	-2.7323	0.0704
g_R	-2.6384	0.0328
g_L	-2.2205	0.0383
g_O	-1.6114	0.1612

The total number of data points is 476, and the standard deviation of all points with respect to the model is 0.4646.

To show the dependence of ground velocity on distance, we have plotted velocity vs distance with all shots adjusted as if they were 2000 pound shots detonated in wet alluvium (Figure 1). The curve represents the model and the points are the reduced data observations as described above. Since the data is plotted with respect to log-log axes, the model curve is a quadratic function (equation 2). Ground velocity vs distance plots for each shot are shown in the appendix.

To show the dependence of ground velocity on shot size, we have plotted velocity vs shot size with distances adjusted to 10 kilometers and shots adjusted as if they were detonated in wet alluvium (Figure 2). Since the data is plotted with respect to log-log axes, the model curve is a line with slope 0.48 (equation 2).

For each shot used in the study, a shot-point quality was computed which provides a measure of how efficiently seismic waves were generated by each shot point. We compute the residual, r_{ij}, for each reduced data point as follows,

$$r_{ij} = a_p - b\, x_{ij} - c\, x_{ij}^2 - d\, s_i - g_A.$$

The shot-point quality, in db, is twenty times the average of r_{ij} over all reduced data points for a particular shot point (Table 4).

The ground-velocity model (equation 2) can be used to estimate strong ground motion at locations near a shot point (Table 5). Since there is not much data available at distances of less than one kilometer (Figure 1), the values in table 5 are based on extrapolation of existing data. The velocity values in table 5 (2, 3, 4, 6, and 9 inches per second) were chosen for use in permitting shot points near the Alaska oil and gas pipelines. Shot size values are given for the range of shot sizes commonly used in refraction experiments.

DISCUSSION

The g_i values (equation 2) are measures of the efficiency of each type of shotpoint, and the values are easily referenced to a standard wet alluvium shotpoint by adding 2.2987. Multiplying the result by twenty gives velocities (RV) in db relative to wet alluvium. Fractional ground velocity is the velocity of a shot relative to a shot in wet alluvium of the same size. It is equal to $10^{(RV/20)}$.

	RV (db)	Standard Deviation of RV (db)	Fractional Ground Velocity
Dry Alluvium	-8.67	1.41	0.37
Hard Rock	-6.79	0.66	0.46
Wet Alluvium	0.00	0.79	1.00
Lake	1.56	0.77	1.20
Ocean	13.75	3.22	4.87

The results show that ocean shots are by far the most efficient, wet alluvium and lake shots are next most efficient, and dry alluvium and hard rock shots are the least efficient.

The computed value of d in equation 2 is approximately 0.5, which implies that the ground motion is proportional to the square root of the shot size. If the shot size is increased by a factor of two, the ground velocity increases on the average by 1.4. We have computed two numbers of interest:

1) The shot size relative to a wet alluvium shot necessary to produce the same recorded velocity,

$$ra = (G_A / G_i)^{(1/d)}$$

where i = (A or D or R or L or O).

2) The shot size in pounds equivalent to a 2000 pound shot in wet alluvium,

$$se = 2000 * ra$$

	ra	se (lbs)
Dry alluvium	7.97	15,933
Hard rock	5.08	10,165
Wet alluvium	1.00	2,000
Lake	0.69	1,376
Ocean	0.04	75

The above table has major implications about the use of explosive

sources in active seismic experiments. An explosion in hard rock or dry alluvium requires over five times as much explosive to produce seismic waves with the same amplitude as shot point in wet alluvium or lakes. Ocean shots are extremely efficient, and only a small amount explosive is required to produce measurable velocities. Since much of the cost of an field experiment is attributable to shot point drilling and explosives, it is clearly worthwhile to choose shot points which will generate the highest amplitude seismic waves using the least amount of explosives.

CONCLUSIONS

1. Amplitude varies as the square root of the shot size. Doubling the shot size increases observed velocities by 1.4.

2. The amplitude-distance relationship cannot be accurately expressed as a simple power law. Amplitude varies as r^{-2} close to the shot (at about 7 km offset) and $r^{-1.5}$ far from the shot (at about 190 km offset).

3. Hard rock and dry alluvium shot points are the least efficient; wet alluvium and lake shot points are better; shots fired in the ocean are the most efficient.

4. The model has a standard deviation of 0.47, which implies that amplitudes for any particular shot can be predicted to only about an order of magnitude. Predictions of velocity can be made on a probabilistic basis; ie., if we fire a shot of a certain shot size at a certain distance, the probability that the velocity will exceed .... is .... percent.

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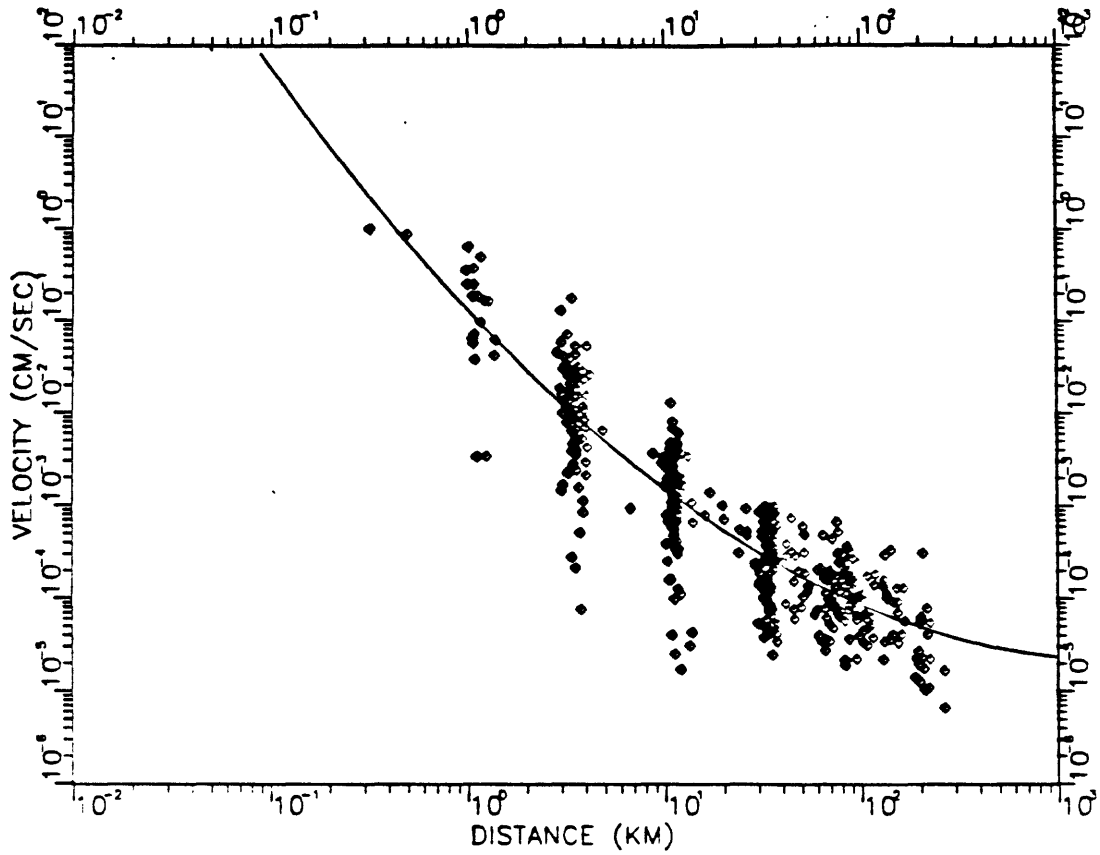

Figure 1. Plot of trace amplitude (ground velocity) versus distance for the entire data set. Plotted curve represents model velocity for a 2000 pound shot detonated at a wet alluvium shot point. Plotted symbols represent reduced samples as described in Data Reduction and Modeling section of this report. All plotted data has been adjusted as if it were from a 2000 pound shot detonated at a wet alluvium shot point.

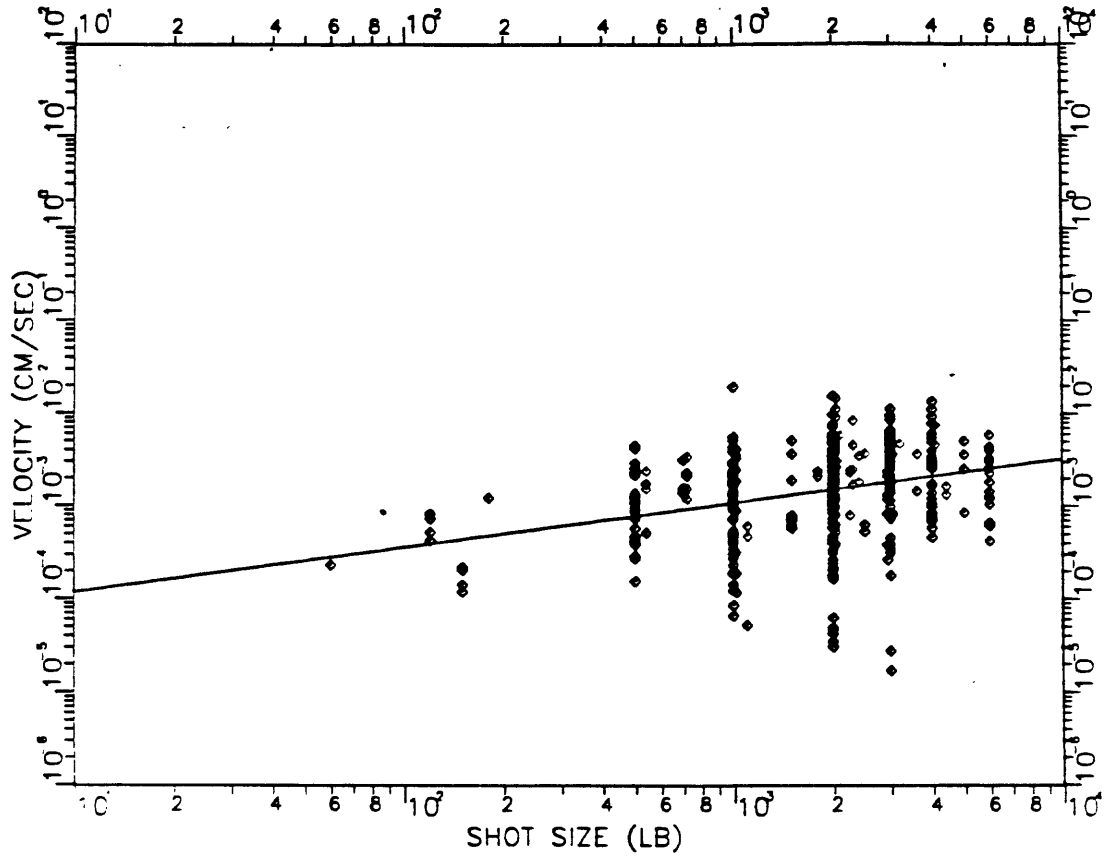

Figure 2. Plot of trace amplitude (ground velocity) versus shot size for the entire data set. Plotted curve represents model velocity for a shot detonated in wet alluvium and recorded at a distance of 10 kilometers. Plotted symbols represent reduced samples as described in Data Reduction and Modeling section of this report. All plotted data has been adjusted as if it were from a shot detonated in wet alluvium at a distance of 10 kilometers.

TABLE 1A
SHOT LIST FOR TACT (ALASKA) 1984 DEPLOYMENTS

Comment Codes:

a: Volcanic debris flow
b: Near lake
c: Metavolcanics
d: Near river
e: Incomplete detonation
f: Phyllite
g: Woodworth glacier
h: Glacial till
i: Artesian
j: Shoup Bay
k: Valdez
l: Bremner
m: Ross Green
o: Alluvium + glacial till
p: Water tamp only
q: Shale

Shot Codes:

R: Hard rock
A: Wet alluvium
L: Lake shot

Shot No.	Shot Pt.	Shot Date	Shot Time	North Latitude (deg,min)	West Longitude (deg,min)	Size (lbs)	Shot Code	Comment Code
1	8	JUN 24, 1984	176:10:00:00.011	61 56.3303	145 16.7487	2000	A	a
2	11	JUN 24, 1984	176:10:03:57.594	61 31.3367	145 13.6217	2000	A	b
3	1	JUN 24, 1984	176:10:06:00.012	63 20.8559	145 42.1500	6000	R	c
4	7	JUN 24, 1984	176:12:00:00.009	62 09.9422	145 24.9930	2000	A	d
5	9	JUN 24, 1984	176:12:02:00.010	61 41.9517	145 09.2683	2000	A	e
6	12	JUN 24, 1984	176:12:03:57.009	61 15.3000	145 17.1100	2000	R	f
7	19	JUN 24, 1984	176:12:06:00.008	61 01.8251	145 15.6821	2000	L	g
8	10	JUN 25, 1984	177:10:00:00.008	61 34.5950	145 13.5833	2000	A	h,i,e
9	17	JUL 2, 1984	184:10:00:00.012	61 09.2574	146 35.9967	3000	L	j
10	18	JUL 2, 1984	184:10:01:59.812	61 09.1038	146 10.2209	2000	L	k
11	19	JUL 2, 1984	184:10:04:00.011	61 01.8251	145 15.6821	2000	L	g
12	20	JUL 2, 1984	184:10:06:00.009	60 57.9442	144 10.2347	3000	L	l
13	21	JUL 2, 1984	184:10:08:00.008	60 43.5173	142 31.0501	6000	L	m
14	1	JUL 8, 1984	191:10:10:00.010	63 20.8559	145 42.1500	2000	R	c
15	3	JUL 8, 1984	191:10:12:00.009	62 54.6586	145 29.8132	2000	A	h,i
16	5	JUL 8, 1984	191:10:14:00.011	62 34.9283	145 27.4631	2040	A	
17	7	JUL 8, 1984	191:10:15:59.810	62 09.9422	145 24.9930	2000	A	d
18	2	JUL 8, 1984	191:12:00:00.011	63 09.8936	145 32.1771	2000	A	b
19	4	JUL 8, 1984	191:12:02:00.010	62 47.4488	145 28.4207	2000	A	
20	6	JUL 8, 1984	191:12:04:00.012	62 29.5123	145 28.0682	2040	A	
21	19	JUL 8, 1984	191:12:06:00.008	61 01.8251	145 15.6821	6000	L	g
22	8	JUL 8, 1984	191:12:07:59.811	61 56.3303	145 16.7487	1100	A	a
25	14	JUL 12, 1984	195:09:02:00.011	62 05.3069	146 19.2361	2300	A	o,p
26	7	JUL 12, 1984	195:09:04:00.010	62 09.9422	145 24.9930	2040	A	d
27	16	JUL 12, 1984	195:09:06:00.009	62 51.1766	143 41.8863	4000	A	d
28	15	JUL 12, 1984	195:11:14:00.011	62 28.1754	144 50.2771	3000	A	d,p
29	13	JUL 14, 1984	196:11:10:00.010	61 52.2237	147 20.6873	2250	R	p,q

TABLE 1B
SHOT LIST FOR TACT (ALASKA) 1985 DEPLOYMENTS

Comment Codes:

a: Volcanic debris flow
b: Near lake
d: Near river
f: Phyllite
g: Woodworth glacier
i: Artesian
o: Alluvium + glacial till
p: Water tamp only
r: Diabase quarry
s: Near creek
t: Volcanic/Sediments
u: 50' deep lake
v: 40' deep lake
w: 15' deep lake
x: 175' deep lake

Shot Codes:

R: Hard rock
A: Wet alluvium
L: Lake shot
O: Ocean shot

Shot No.	Shot Pt.	Shot Date	Shot Time	North Latitude (deg,min)	West Longitude (deg,min)	Size (lbs)	Shot Code	Comment Code
1	14	JUN 7, 1985	159:00:30:00.012	62 05.3289	146 19.1514	540	A	o
2	7	JUN 7, 1985	159:00:32:00.014	69 09.9417	145 24.9933	1800	A	d
3	15	JUN 9, 1985	161:07:00:00.009	62 28.1750	144 50.2767	2040	A	d
4	16	JUN 9, 1985	161:07:02:00.010	62 51.1855	143 41.8984	3000	A	d,p
5	27	JUN 9, 1985	161:07:04:00.012	62 42.8562	144 19.3936	2040	R	r
6	23	JUN 9, 1985	161:07:06:00.008	61 50.8521	147 20.9492	4000	A	s
7	25	JUN 10, 1985	161:09:00:00.013	62 24.1877	145 02.3975	1020	A	d
8	28	JUN 10, 1985	161:09:02:00.013	62 43.4419	143 56.7529	2000	R	t
9	26	JUN 10, 1985	161:09:04:00.012	62 36.2820	144 37.7842	1020	A	d
10	39	JUN 10, 1985	161:09:06:00.008	62 05.6780	146 15.6182	3000	A	o
11	24	JUN 10, 1985	161:11:00:00.010	62 16.7620	145 26.1504	3000	A	s
12	40	JUN 19, 1985	170:06:30:00.012	61 09.1948	146 35.9717	3600	L	u
13	33	JUN 19, 1985	170:06:32:00.008	60 28.5017	146 13.8154	2000	L	v
14	32	JUN 19, 1985	170:06:34:00.008	60 17.9204	146 55.8896	2040	L	v
15	19	JUN 19, 1985	170:10:30:00.010	61 01.8251	145 15.6821	4400	L	u,g
16	34	JUN 19, 1985	170:10:32:00.008	60 40.1560	145 47.2627	2940	L	u
17	31	JUN 19, 1985	170:10:34:00.009	59 56.4065	147 42.4258	2940	L	u
18	30	JUN 19, 1985	170:12:32:00.018	59 40.7000	148 23.9400	540	O	
19	24	JUN 23, 1985	175:06:30:00.010	62 16.7620	145 26.1504	3060	A	s
20	11	JUN 23, 1985	175:06:32:00.011	61 31.3367	145 13.6217	3000	A	b
21	40	JUN 23, 1985	175:06:34:00.009	61 09.1948	146 35.9717	3600	L	u
22	38	JUN 23, 1985	175:06:36:00.016	60 48.3828	145 16.0215	2040	L	w
23	8	JUN 24, 1985	175:10:30:00.009	61 56.3300	145 16.7483	4080	A	s
24	12	JUN 24, 1985	175:10:32:00.014	61 15.3000	145 17.1100	2040	R	f
25	37	JUN 24, 1985	175:10:36:00.016	60 31.7795	145 21.7637	3000	L	x
26	19	JUN 24, 1985	176:06:30:00.009	61 01.8251	145 15.6821	2040	L	u,g
27	36	JUN 25, 1985	176:16:00:00.335	60 01.1700	145 34.6700	1020	O	

TABLE 1C
SHOT LIST FOR TACT (ALASKA) 1987 DEPLOYMENTS - PART A

Comment Codes:

a: Volcanic debris flow
b: Near lake
c: Metavolcanics
d: Near river
e: Incomplete detonation
g: Woodworth glacier
h: Glacial till
s: Near creek
y: 4-7' deep lake
z: Dud
aa: Fractured rock
bb: Shallow lake

Shot Codes:

R: Hard rock
A: Wet alluvium
L: Lake shot

Shot No.	Shot Pt.	Shot Date	Shot Time	North Latitude (deg,min)	West Longitude (deg,min)	Size (lbs)	Shot Code	Comment Code
1	19	JUL 24, 1987	205:08:00:00.016	61 01.8251	145 15.6821	6000	L	g
2	44	JUL 24, 1987	205:08:02:00.012	63 38.9580	145 53.5938	1000	A	
3	49	JUL 24, 1987	205:08:04:00.007	65 17.8142	146 25.1592	6000	A	d
4	3	JUL 24, 1987	205:08:06:00.010	62 54.6489	145 29.7529	3000	A	h
5	8	JUL 24, 1987	205:08:08:00.008	61 56.0186	145 17.5381	6000	A	a
6	42	JUL 24, 1987	205:08:10:00.005	63 14.5903	145 38.5166	500	L	y
7	48	JUL 24, 1987	205:10:00:00.007	64 54.3909	146 21.7637	4000	R	z
8	1	JUL 24, 1987	205:10:02:00.005	63 20.7825	145 42.1279	2000	R	c,e,z
9	45	JUL 24, 1987	205:10:04:00.012	63 47.3513	145 50.7354	2000	A	h
10	41	JUL 24, 1987	205:10:06:00.010	63 02.2791	145 30.8242	1000	A	s
11	6	JUL 24, 1987	205:12:00:00.076	62 29.5123	145 28.0682	4000	A	
12	2	JUL 24, 1987	205:12:02:00.010	63 09.8657	145 31.9971	2000	A	b
13	46	JUL 24, 1987	205:12:06:00.012	63 55.3264	145 47.6738	3000	A	e,h,z
14	43	JUL 24, 1987	205:12:07:30.005	63 29.3779	145 50.8975	1000	R	e
15	54	JUL 25, 1987	206:10:00:00.008	64 22.0283	146 07.7393	3000	L	
16	46	JUL 25, 1987	206:10:02:00.010	63 55.3264	145 47.6738	3000	A	h,z
17	52	AUG 17, 1987	229:08:02:00.014	63 52.1370	145 12.0078	3000	A	
18	51	AUG 17, 1987	229:08:04:00.008	63 32.3223	144 00.3818	4000	L	
20	56	AUG 17, 1987	229:08:06:00.012	64 32.9590	146 47.9453	2000	R	
21	66	AUG 17, 1987	229:08:08:00.008	65 41.6882	149 11.3193	6000	R	aa,z
22	55	AUG 17, 1987	229:08:10:00.014	64 28.8376	146 35.5137	500	L	bb
23	53	AUG 17, 1987	229:10:00:00.012	64 01.7217	145 34.9180	2000	A	
24	57	AUG 17, 1987	229:10:02:00.012	64 38.6689	147 01.9980	3000	A	
25	73	AUG 17, 1987	229:10:04:00.013	64 22.0188	146 12.4463	700	R	
26	59	AUG 17, 1987	229:12:00:00.009	65 04.7134	147 41.7881	4000	A	
27	47	AUG 17, 1987	229:12:02:00.010	64 13.8621	146 00.8057	2000	A	
28	50	AUG 20, 1987	232:08:00:00.016	62 52.7957	143 05.9893	6000	L	

TABLE 1D
SHOT LIST FOR TACT (ALASKA) 1987 DEPLOYMENTS - PART B

Comment Codes:

d: Near river
q: Shale
aa: Fractured rock
cc: 15-19' deep lake
dd: Sedimentary and volcanic rocks
ee: 10' deep lake
ff: 20' deep lake

Shot Codes:

R: Hard rock
A: Wet alluvium
L: Lake shot

Shot No.	Shot Pt.	Shot Date	Shot Time	North Latitude (deg,min)	West Longitude (deg,min)	Size (lbs)	Shot Code	Comment Code
1	69	AUG 25, 1987	237:08:00:00.007	66 18.2949	150 25.8350	4000	R	
2	62	AUG 25, 1987	237:08:02:00.006	65 19.8508	148 18.4443	2000	A	d
3	54	AUG 25, 1987	237:08:04:00.007	64 22.0283	146 07.7393	5000	L	cc
4	57	AUG 25, 1987	237:08:06:00.157	64 38.6689	147 01.9980	4000	A	
5	65	AUG 25, 1987	237:08:10:00.007	65 34.4724	148 56.3135	4000	A	d
6	67	AUG 25, 1987	237:10:00:00.012	65 47.3628	149 24.8867	3000	R	dd
7	61	AUG 25, 1987	237:10:02:00.006	65 16.8901	148 07.8379	1000	R	
8	70	AUG 25, 1987	237:10:04:00.005	66 36.1152	150 59.1855	4000	L	ee
9	64	AUG 25, 1987	237:10:06:00.011	65 28.7581	148 41.6973	1000	A	
10	66	AUG 25, 1987	237:12:00:00.015	65 41.6882	149 11.3193	2000	R	aa
11	60	AUG 25, 1987	237:12:02:00.005	65 11.9258	148 04.7627	2000	R	
12	59	AUG 25, 1987	237:12:04:00.241	65 04.7134	147 41.7881	3000	A	
13	63	AUG 25, 1987	237:12:06:00.011	65 24.3469	148 25.1367	2000	R	q
14	74	AUG 26, 1987	238:08:00:00.005	65 03.4211	150 11.2627	3000	L	ff
15	63	AUG 26, 1987	238:12:02:00.010	65 24.3469	148 25.1367	1100	R	q
16	61	AUG 28, 1987	240:22:00:00.007	65 16.8901	148 07.8379	180	R	
17	59	AUG 28, 1987	240:22:02:00.009	65 04.7134	147 41.7881	150	A	
18	60	AUG 28, 1987	240:22:30:00.007	65 11.9258	148 04.7627	120	R	
19	60	AUG 28, 1987	241:01:30:00.007	65 11.9258	148 04.7627	60	R	
20	59	AUG 28, 1987	241:01:32:00.009	65 04.7134	147 41.7881	150	A	
21	61	AUG 28, 1987	241:02:00:00.007	65 16.8901	148 07.8379	120	R	

TABLE 1E
SHOT LIST FOR PACE (ARIZONA) 1985 DEPLOYMENTS

Comment codes:

dd: Sedimentary and volcanic rocks
gg: Igneous and metamorphic rocks
hh: Granite (weathered)
ii: Volcanic rocks
jj: Andesite dikes intruding mylonites
kk: Playa lake (wet)
ll: Metasediments
mm: Igneous and metamorphic rocks (weathered)

Shot Codes:

R: Hard rock
A: Wet alluvium
D: Dry hole

Shot No.	Shot Pt.	Shot Date	Shot Time	North Latitude (deg,min)	West Longitude (deg,min)	Size (lbs)	Shot Code	Comment Code
1	8	NOV 5, 1985	309:07:00:00.011	34 01.1915	114 16.0732	3000	R	gg
2	11	NOV 5, 1985	309:07:02:00.009	35 04.6421	115 09.4429	4000	R	hh
3	13	NOV 5, 1985	309:07:04:00.017	33 37.5355	113 58.3179	4000	R	ii
4	9	NOV 5, 1985	309:07:06:00.013	34 31.9558	114 36.7720	4000	R	hh
5	9	NOV 5, 1985	309:07:30:00.014	34 31.9558	114 36.7720	500	R	hh
6	17	NOV 5, 1985	309:09:00:00.011	34 04.4078	114 17.8740	1000	A	
7	10	NOV 5, 1985	309:09:02:00.010	34 48.5139	114 55.9536	3000	R	hh
8	19	NOV 5, 1985	309:09:04:00.007	34 16.0713	114 29.0464	2000	R	jj
9	18	NOV 5, 1985	309:09:06:00.011	34 25.8152	114 32.6694	1000	D	
10	18	NOV 5, 1985	309:09:30:00.013	34 25.8152	114 32.6694	500	D	
11	12	NOV 7, 1985	312:06:00:00.006	34 54.5559	113 34.6748	4000	R	gg
12	11	NOV 7, 1985	312:06:02:00.010	35 04.6421	115 09.4429	2000	R	hh
13	14	NOV 7, 1985	312:06:04:00.008	33 37.0963	114 59.0605	2100	A	kk
14	3	NOV 7, 1985	312:06:06:00.010	34 06.3268	114 31.1450	1000	D	
15	2	NOV 7, 1985	312:06:08:00.013	34 00.1779	114 38.7549	1000	R	hh
16	3	NOV 7, 1985	312:06:30:00.011	34 06.3268	114 31.1450	500	D	
17	2	NOV 7, 1985	312:06:34:00.013	34 00.1779	114 38.7549	500	R	hh
18	7	NOV 8, 1985	312:09:00:00.007	34 41.4065	113 56.3975	3000	R	hh
19	1	NOV 8, 1985	312:09:02:00.006	33 49.8256	114 43.1675	2000	R	ll
20	4	NOV 8, 1985	312:09:04:00.010	34 13.4583	114 25.5533	2000	R	dd
21	15	NOV 8, 1985	312:09:06:00.013	33 57.3845	114 40.0010	500	D	
22	12	NOV 12, 1985	317:06:00:02.930	34 54.5559	113 34.6748	2400	R	gg
23	14	NOV 12, 1985	317:06:02:00.011	33 37.0963	114 59.0605	3200	A	kk
24	5	NOV 12, 1985	317:06:04:00.154	34 21.4211	114 16.7134	1000	R	mm
25	11	NOV 12, 1985	317:06:06:00.010	35 04.6421	115 09.4429	2000	R	hh
26	16	NOV 12, 1985	317:06:08:00.010	34 34.5605	114 01.0605	1000	D	
27	7	NOV 13, 1985	317:09:00:00.008	34 41.4065	113 56.3975	2000	R	hh
28	1	NOV 13, 1985	317:09:02:00.011	33 49.8256	114 43.1675	3000	R	ll
29	4	NOV 13, 1985	317:09:04:00.010	34 13.4583	114 25.5533	2000	R	dd
30	6	NOV 13, 1985	317:09:08:00.010	34 27.9460	114 09.3169	720	R	gg

TABLE 1F
SHOT LIST FOR PACE (ARIZONA) 1987 DEPLOYMENTS

Comment codes:

dd: Sedimentary and volcanic rocks
gg: Igneous and metamorphic rocks
hh: Granite (weathered)
mm: Igneous and metamorphic rocks (weathered)
nn: Kaibab limestone
oo: Mylonite

Shot Codes:

R: Hard rock
A: Wet alluvium
D: Dry hole

Shot No.	Shot Pt.	Shot Date	Shot Time	North Latitude (deg,min)	West Longitude (deg,min)	Size (lbs)	Shot Code	Comment Code
1	37	MAY 29, 1987	152:05:00:00.007	33 28.1461	113 01.3237	2500	R	gg
2	34	MAY 29, 1987	152:05:02:00.012	35 39.2168	111 51.5679	6000	R	nn
3	31	MAY 29, 1987	152:05:04:00.013	34 48.4497	112 53.7158	4000	R	gg
4	20	MAY 29, 1987	152:05:06:00.008	33 29.1606	114 35.7993	2500	A	
5	26	MAY 29, 1987	152:05:08:00.015	34 16.2932	113 37.9619	2000	R	oo
6	33	MAY 29, 1987	152:08:02:00.010	35 23.5544	112 14.1611	6000	R	nn
7	22	MAY 29, 1987	152:08:04:00.007	33 48.9227	114 03.9678	1500	R	gg
8	21	MAY 29, 1987	152:08:06:00.007	33 40.9758	114 16.7080	2000	R	gg
9	24	MAY 29, 1987	152:08:08:00.005	34 05.5299	113 51.9702	1000	R	oo
10	25	MAY 29, 1987	152:09:30:00.005	34 11.3601	113 45.3120	1500	R	oo
11	23	MAY 29, 1987	152:09:32:00.007	33 57.5299	113 59.7930	1000	R	dd
12	28	MAY 29, 1987	152:09:34:00.023	34 27.8904	113 20.7471	3000	R	gg
13	35	MAY 29, 1987	152:09:36:00.010	33 45.2122	114 11.7163	1000	D	
14	27	JUN 2, 1987	155:05:00:00.010	34 18.6804	113 34.2969	1500	R	dd
15	20	JUN 2, 1987	155:05:02:00.005	33 29.1606	114 35.7993	5000	A	
16	31	JUN 2, 1987	155:05:04:00.010	34 48.4497	112 53.7158	2000	R	mm
17	34	JUN 2, 1987	155:05:06:00.012	35 39.2168	111 51.5679	6000	R	nn
18	29	JUN 2, 1987	155:05:08:00.008	34 32.3723	113 13.5576	1000	R	gg
19	26	JUN 2, 1987	155:07:30:00.010	34 16.2932	113 37.9619	2000	R	oo
20	21	JUN 2, 1987	155:07:31:59.881	33 40.9758	114 16.7080	4000	R	gg
21	30	JUN 2, 1987	155:07:34:00.010	34 40.4192	113 05.4985	1000	R	gg
22	33	JUN 2, 1987	155:07:36:00.012	35 23.5544	112 14.1611	4000	R	nn
23	36	JUN 2, 1987	155:07:38:00.007	34 30.7097	113 15.5742	500	R	gg
24	7	JUN 2, 1987	155:10:00:00.010	34 41.4067	113 56.3967	2000	R	hh
25	23	JUN 2, 1987	155:10:01:59.955	33 57.5299	113 59.7930	3000	R	dd
26	32	JUN 2, 1987	155:10:04:00.010	35 04.9451	112 37.3511	3000	R	gg
27	28	JUN 2, 1987	155:10:06:00.007	34 27.8904	113 20.7471	1000	R	gg

TABLE 2
VELOCITY MEASUREMENTS FOR THE PACE 1985 DEPLOYMENTS
PROVIDED BY WESLEY L. BENDER

Axis: T=Transverse V=Vertical L=Longitudinal S=Vector sum

Shot number	Shot point	Distance (km)	Axis	Velocity (cm/s)	Principal frequency (hz)
5	9	0.50	T	0.20	10.0
			V	0.10	10.0
			L	0.14	13.3
			S	0.24	
9	18	0.50	T	0.18	30.3
			V	0.30	11.1
			L	0.40	6.7
			S	0.41	
9	18	1.00	T	0.08	5.0
			V	0.26	4.1
			L	0.26	4.0
			S	0.28	
10	18	0.50	T	0.12	8.3
			V	0.34	11.1
			L	0.30	7.1
			S	0.37	
10	18	1.00	T	0.07	4.5
			V	0.21	3.8
			L	0.16	4.3
			S	0.21	
15	2	0.50	T	0.38	10.0
			V	0.25	7.7
			L	0.41	10.0
			S	0.56	
17	2	0.50	T	0.27	10.0
			V	0.12	7.7
			L	0.25	11.1
			S	0.33	
21	15	0.50	T	0.09	11.8
			V	0.13	12.5
			L	0.12	10.0
			S	0.17	
21	15	1.00	T	0.06	3.3
			V	0.14	2.4
			L	0.09	2.6
			S	0.15	

TABLE 3
NOISE MEASUREMENTS FOR EACH INSTRUMENT DEPLOYMENT

NSAMP: Number of points used in calculation

XVEL: Mean log noise in centimeters/sec

SIGMA: Standard deviation of log noise values

VEL: Mean noise in centimeters/sec x 10^{-7} (= millimicrons/sec)

Experiment	Deployment	Shot Number	Shot Point	NSAMP	XVEL	SIGMA	VEL
TACT 1984	South Richardson	1	8	5	-6.512	0.260	7.05
		2	11	65	-5.648	0.430	22.49
		3	1	95	-5.442	0.397	36.14
TACT 1984	Chugach	9	17	35	-5.677	0.407	21.04
TACT 1984	North Richardson	14	1	68	-5.669	0.409	21.43
		17	7	76	-5.618	0.411	24.10
		22	8	86	-5.675	0.396	21.13
TACT 1984	West Glenn	26	7	22	-5.615	0.403	24.27
TACT 1985	Tok Cut Off	11	24	20	-5.619	0.455	24.04
TACT 1985	Montague	16	34	45	-5.627	0.399	23.60
TACT 1985	Cordova Peak	20	11	30	-5.770	0.383	16.98
TACT 1987A	Alaska Range	13	46	85	-5.602	0.308	25.00
TACT 1987A	Fairbanks South	21	66	107	-5.607	0.419	24.72
TACT 1987B	Fairbanks North	15	63	95	-5.942	0.390	11.43
TACT 1987B	Reflection Line	17	59	107	-5.649	0.446	22.44
PACE 1985	Chemehuevi	10	18	78	-5.873	0.325	13.40
PACE 1985	Vidal	21	15	53	-5.705	0.393	19.72
PACE 1985	Dutch Flat	26	16	74	-5.717	0.378	19.19
PACE 1985	Deployment 1	13	35	82	-6.237	0.151	5.79
PACE 1985	Deployment 2	23	36	54	-6.320	0.123	4.79

TABLE 4A
SHOTPOINT QUALITY FOR TACT (ALASKA) SHOTS

Shot point: Shot point number. One or more shots was detonated at each shot point.

nx: Number of velocity samples for each shot point. Velocity samples are median values over specified distance ranges.

Quality: Velocity relative to the derived model, in db. All values are relative to shots detonated in wet alluvium.

sigq: Sample standard deviation, in db.

Shot point	nx	Quality (db)	sigq	Shot point	nx	Quality (db)	sigq
1	11	-11.44	12.69	38	4	1.60	3.01
2	8	9.16	6.60	39	3	0.59	5.49
3	9	-1.61	11.39	40	2	2.81	5.60
4	4	-9.05	2.69	41	5	3.40	2.93
5	5	-2.76	4.76	42	4	-6.96	3.95
6	6	2.29	9.09	43	2	-22.73	8.71
7	11	3.31	8.46	44	4	10.16	4.75
8	10	2.84	8.36	45	3	-12.11	6.03
9	3	-17.20	1.24	46	8	-20.55	12.19
10	2	-31.50	1.73	47	5	2.21	3.64
11	7	-1.39	9.96	48	1	-10.46	
12	8	-1.32	4.27	49	2	-2.96	4.54
13	3	-6.58	5.42	50	2	6.02	3.98
14	8	7.26	4.21	51	2	5.26	2.56
15	6	8.14	5.53	52	4	3.47	4.09
16	5	4.77	2.95	53	4	-2.42	3.84
17	4	6.92	5.49	54	4	-0.58	5.11
18	4	3.15	4.41	55	4	4.03	2.44
19	16	4.40	5.44	56	3	-3.20	1.11
20	4	7.16	8.17	57	5	2.85	9.29
21	2	5.06	1.71	59	10	-6.45	4.24
23	2	15.32	1.20	60	6	-12.48	7.45
24	6	4.22	5.86	61	6	-13.60	14.90
25	3	-15.13	4.30	62	4	-1.61	2.93
26	4	8.32	3.14	63	2	-35.06	2.15
27	4	0.06	2.54	64	4	2.88	1.89
28	4	-14.32	2.74	65	5	-5.48	3.70
30	2	9.85	0.26	66	4	-30.66	14.19
31	4	-5.95	4.42	67	5	-0.62	1.50
32	3	-9.42	1.52	69	2	-14.93	0.06
33	4	-0.98	1.56	70	2	-7.98	5.10
34	4	-2.65	8.75	73	4	-1.03	3.33
36	2	17.64	8.00	74	1	2.41	
37	4	6.44	4.24				

TABLE 4B
SHOTPOINT QUALITY FOR PACE (ARIZONA) SHOTS

Shot point: Shot point number. One or more shots was detonated at each shot point.

nx: Number of velocity samples for each shot point. Velocity samples are median values over specified distance ranges.

Quality: Velocity relative to the derived model, in db. All values are relative to shots detonated in wet alluvium.

sigq: Sample standard deviation, in db.

Shot point	nx	Quality (db)	sigq	Shot point	nx	Quality (db)	sigq
1	7	-3.19	5.55	20	4	-2.78	7.87
2	8	-5.88	4.37	21	5	-1.80	3.00
3	8	-9.05	6.72	22	4	-6.30	6.77
4	9	-7.40	4.22	23	5	-14.08	9.37
5	4	-1.74	5.16	24	4	-13.70	0.83
6	5	-0.21	3.46	25	4	-11.62	0.45
7	8	-3.21	4.25	26	7	-3.57	3.11
8	4	-2.01	1.33	27	4	-8.57	9.04
9	8	-2.55	3.05	28	5	-13.41	3.71
10	4	2.63	4.72	29	2	3.62	2.13
11	4	1.34	2.72	30	4	-7.89	4.67
12	3	-2.91	2.85	31	4	-3.50	6.46
13	2	-4.04	0.10	32	2	-2.77	0.30
14	3	8.25	3.08	33	2	-17.83	1.82
15	5	-2.22	7.98	34	3	-17.60	5.38
16	4	-8.68	6.48	35	3	-19.79	3.95
17	4	13.20	8.20	36	3	-1.73	3.90
18	8	-8.16	5.20	37	1	0.06	
19	4	3.76	0.73				

TABLE 5A
DISTANCE IN FEET BEYOND WHICH 90% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 2.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	384	504	537	892	357
50	502	663	708	1197	466
100	565	749	800	1362	523
500	747	998	1069	1855	690
1000	844	1133	1215	2126	779
1500	908	1222	1310	2306	837
2000	956	1289	1383	2443	882
2500	995	1344	1443	2556	918
3000	1029	1391	1493	2653	948
4000	1085	1469	1578	2814	999
5000	1130	1533	1647	2947	1041
6000	1169	1587	1706	3061	1076
8000	1233	1678	1804	3251	1134
10000	1285	1752	1884	3407	1182

TABLE 5B
DISTANCE IN FEET BEYOND WHICH 99.87% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 2.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	735	982	1051	1822	679
50	979	1321	1418	2509	903
100	1111	1506	1618	2892	1023
500	1502	2059	2218	4064	1379
1000	1716	2365	2551	4728	1573
1500	1856	2567	2771	5173	1701
2000	1964	2722	2941	5519	1799
2500	2052	2850	3080	5804	1879
3000	2128	2960	3200	6051	1947
4000	2254	3142	3399	6464	2061
5000	2357	3293	3564	6806	2154
6000	2445	3422	3705	7102	2234
8000	2592	3637	3941	7599	2367
10000	2713	3815	4135	8011	2476

TABLE 5C
DISTANCE IN FEET BEYOND WHICH 90% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 3.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	335	437	466	768	312
50	436	574	612	1025	405
100	490	646	690	1164	454
500	645	858	917	1576	596
1000	727	972	1040	1801	672
1500	781	1046	1120	1950	722
2000	822	1103	1181	2064	759
2500	855	1149	1231	2157	790
3000	884	1188	1274	2237	816
4000	930	1253	1344	2370	858
5000	969	1307	1402	2480	893
6000	1001	1352	1452	2573	923
8000	1055	1428	1533	2729	972
10000	1099	1490	1600	2857	1013

TABLE 5D
DISTANCE IN FEET BEYOND WHICH 99.87% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 3.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	634	844	902	1548	587
50	841	1130	1211	2119	777
100	953	1285	1378	2435	879
500	1281	1746	1878	3394	1178
1000	1460	1999	2153	3935	1341
1500	1577	2166	2335	4296	1447
2000	1667	2295	2475	4575	1529
2500	1740	2400	2589	4805	1596
3000	1803	2490	2688	5004	1653
4000	1907	2640	2851	5336	1747
5000	1993	2764	2986	5611	1825
6000	2066	2870	3101	5848	1891
8000	2187	3046	3294	6245	2001
10000	2287	3191	3453	6574	2091

TABLE 5E
DISTANCE IN FEET BEYOND WHICH 90% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 4.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	304	396	422	692	283
50	395	518	552	920	367
100	443	583	622	1043	411
500	581	771	824	1406	539
1000	655	872	933	1605	606
1500	703	938	1004	1735	650
2000	739	989	1058	1835	684
2500	769	1029	1102	1917	711
3000	794	1064	1140	1987	734
4000	836	1122	1202	2103	772
5000	870	1169	1253	2199	803
6000	899	1209	1297	2280	829
8000	947	1276	1369	2416	873
10000	986	1330	1428	2528	909

TABLE 5F
DISTANCE IN FEET BEYOND WHICH 99.87% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 4.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	573	759	811	1382	530
50	757	1013	1084	1883	700
100	856	1150	1232	2159	790
500	1146	1556	1672	2995	1055
1000	1304	1778	1913	3463	1199
1500	1407	1925	2072	3775	1293
2000	1486	2037	2194	4016	1365
2500	1551	2129	2294	4215	1424
3000	1606	2208	2380	4386	1474
4000	1698	2339	2523	4671	1557
5000	1773	2447	2640	4908	1625
6000	1837	2539	2740	5111	1683
8000	1943	2692	2908	5451	1780
10000	2030	2819	3046	5733	1859

TABLE 5G
DISTANCE IN FEET BEYOND WHICH 90% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 6.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	266	345	367	598	248
50	344	450	479	791	320
100	386	505	538	895	358
500	504	666	710	1201	467
1000	567	751	803	1367	525
1500	608	807	863	1476	563
2000	638	849	908	1559	591
2500	664	884	946	1627	614
3000	685	913	977	1686	634
4000	720	962	1030	1782	666
5000	749	1002	1073	1862	692
6000	774	1036	1109	1929	715
8000	814	1092	1170	2042	752
10000	847	1137	1219	2134	782

TABLE 5H
DISTANCE IN FEET BEYOND WHICH 99.87% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 6.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	496	655	699	1181	460
50	653	870	930	1599	605
100	737	985	1055	1829	682
500	982	1326	1423	2519	906
1000	1115	1512	1624	2904	1027
1500	1202	1634	1757	3159	1106
2000	1268	1727	1858	3356	1166
2500	1322	1804	1941	3518	1216
3000	1368	1869	2012	3657	1258
4000	1445	1978	2130	3889	1327
5000	1507	2067	2227	4080	1384
6000	1561	2143	2310	4245	1433
8000	1649	2270	2447	4520	1513
10000	1722	2374	2561	4748	1579

TABLE 5I
DISTANCE IN FEET BEYOND WHICH 90% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 9.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	233	302	320	518	218
50	301	391	416	682	280
100	336	439	467	771	313
500	438	576	614	1028	406
1000	491	648	692	1168	456
1500	526	696	743	1259	488
2000	553	732	782	1329	512
2500	574	761	813	1386	532
3000	592	786	840	1435	548
4000	622	827	884	1515	576
5000	647	861	920	1581	598
6000	667	889	951	1638	618
8000	702	936	1002	1731	649
10000	730	975	1044	1808	675

TABLE 5J
DISTANCE IN FEET BEYOND WHICH 99.87% OF SHOTS WILL PRODUCE SHAKING VELOCITY LESS THAN 9.0 IN/SEC

Shot Size (lb)	Distance (feet) Hard Rock	Wet Alluvium	Lake	Ocean	Dry Alluvium
10	431	567	604	1012	400
50	565	749	800	1362	524
100	637	847	905	1554	589
500	844	1134	1215	2127	780
1000	956	1289	1383	2444	882
1500	1029	1392	1494	2654	949
2000	1085	1469	1578	2815	999
2500	1130	1533	1647	2948	1041
3000	1169	1588	1706	3062	1076
4000	1233	1678	1804	3252	1135
5000	1285	1752	1885	3408	1182
6000	1330	1815	1953	3542	1223
8000	1404	1920	2068	3766	1290
10000	1465	2007	2161	3951	1346

APPENDIX

Logarithmic Plots of Amplitude-Distance

Each plot contains velocity data for one shot. The two comment lines near the top of each plot give information about the shot. The fields are defined as follows:

Comment line 1:

Shot sequence number
Shot point number
Shot code symbol:
- R: Hard rock
- A: Wet alluvium
- L: Lake shot
- O: Ocean shot
- D: Dry hole

Shot date (month, day, year)
Shot time (julian day, hour, minute, second)
Shot point latitude (degrees and minutes)
Shot point longitude (degrees and minutes)
Charge size (pounds)

Comment line 2 contains other notes about the shot.

Small "plus" symbols indicate observed amplitudes for each seismic recorder. Larger octagonal symbols represent the median amplitude for each distance range. Octagons are plotted at the mean distance for observations within each distance range. Dotted lines repesent minimum and maximum estimated ground noise levels for the shot. Data represented by octagons which are greater than the maximum estimated noise level are used in the least-squares analysis. The curved line represents the model velocity for a shot of this size and ground type.

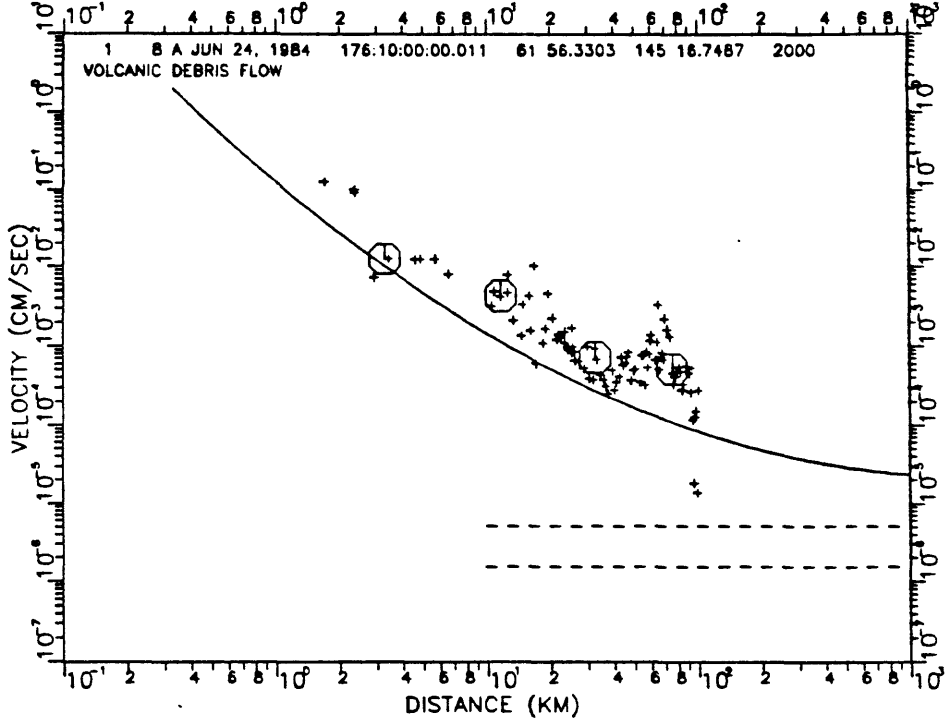

Figure A1. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 1, shot point 8. See page A1 for complete description.

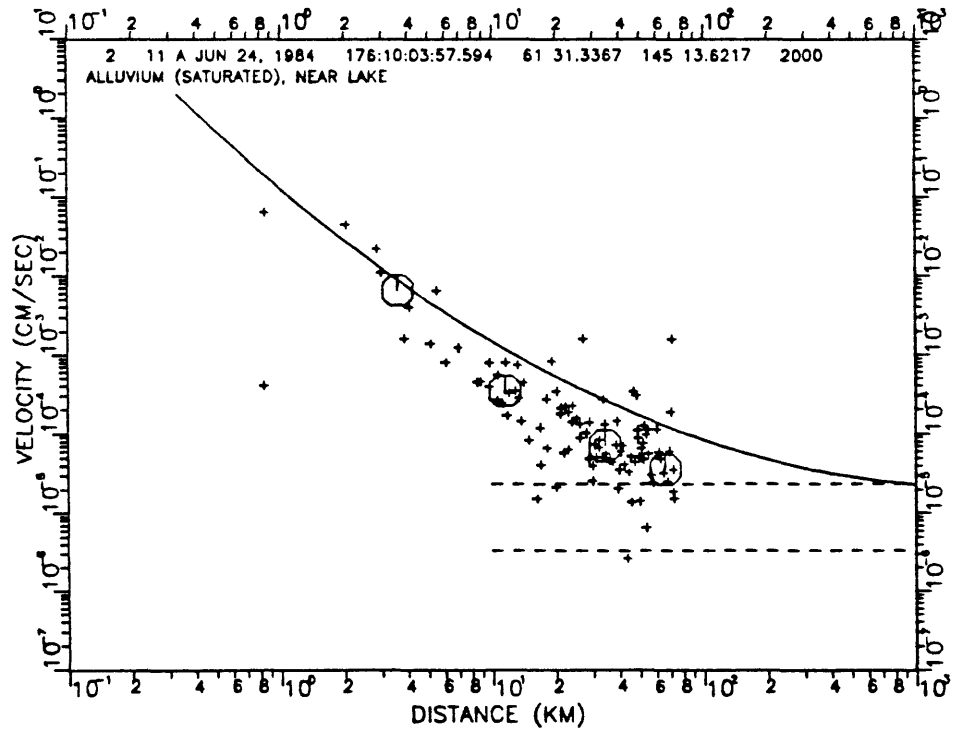

Figure A2. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 2, shot point 11. See page A1 for complete description.

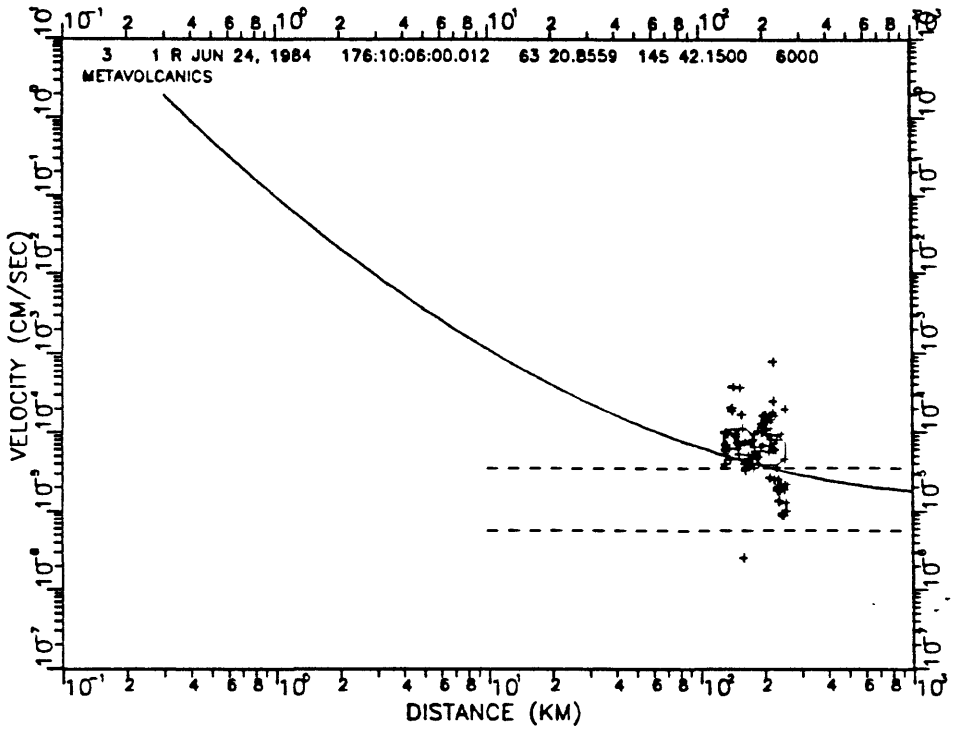

Figure A3. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 3, shot point 1. See page A1 for complete description.

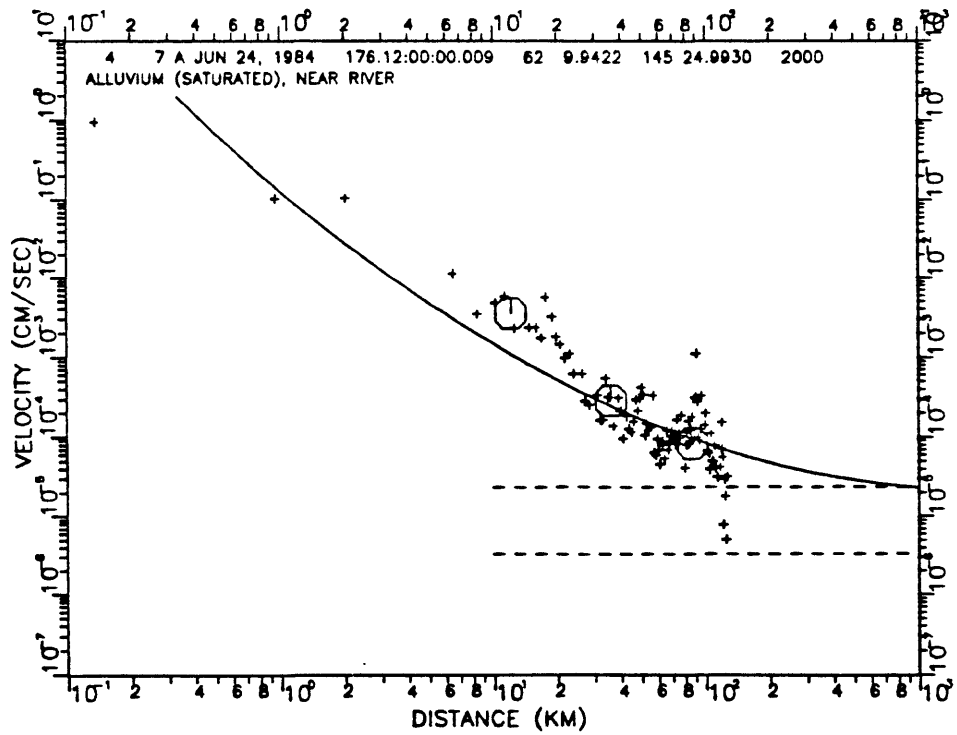

Figure A4. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 4, shot point 7. See page A1 for complete description.

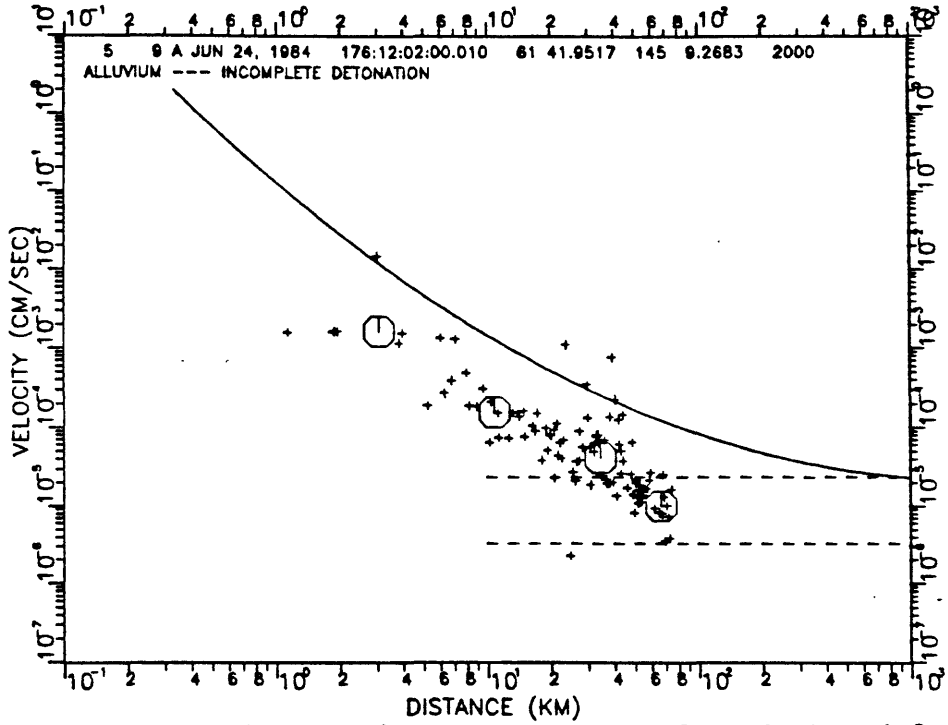

Figure A5. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 5, shot point 9. See page A1 for complete description.

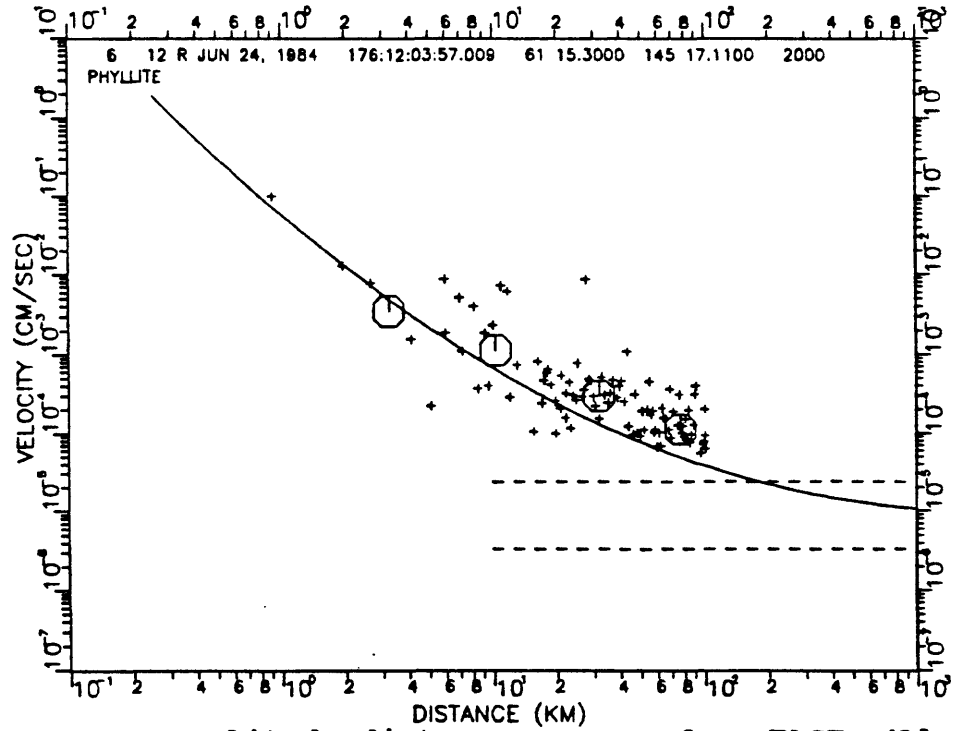

Figure A6. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 6, shot point 12. See page A1 for complete description.

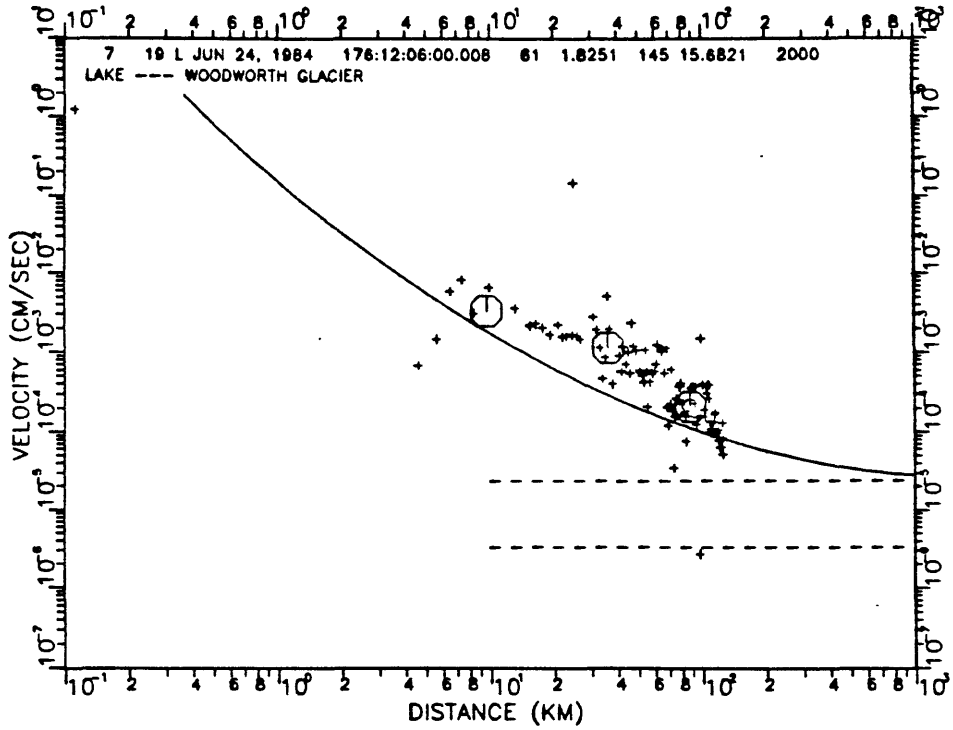

Figure A7. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 7, shot point 19. See page A1 for complete description.

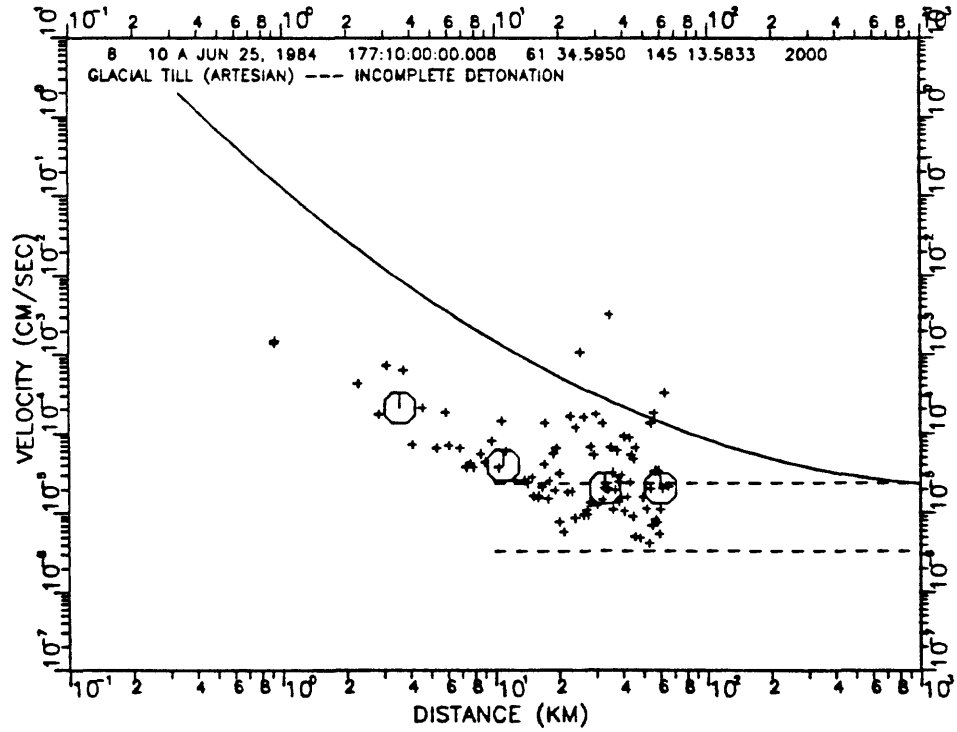

Figure A8. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 8, shot point 10. See page A1 for complete description.

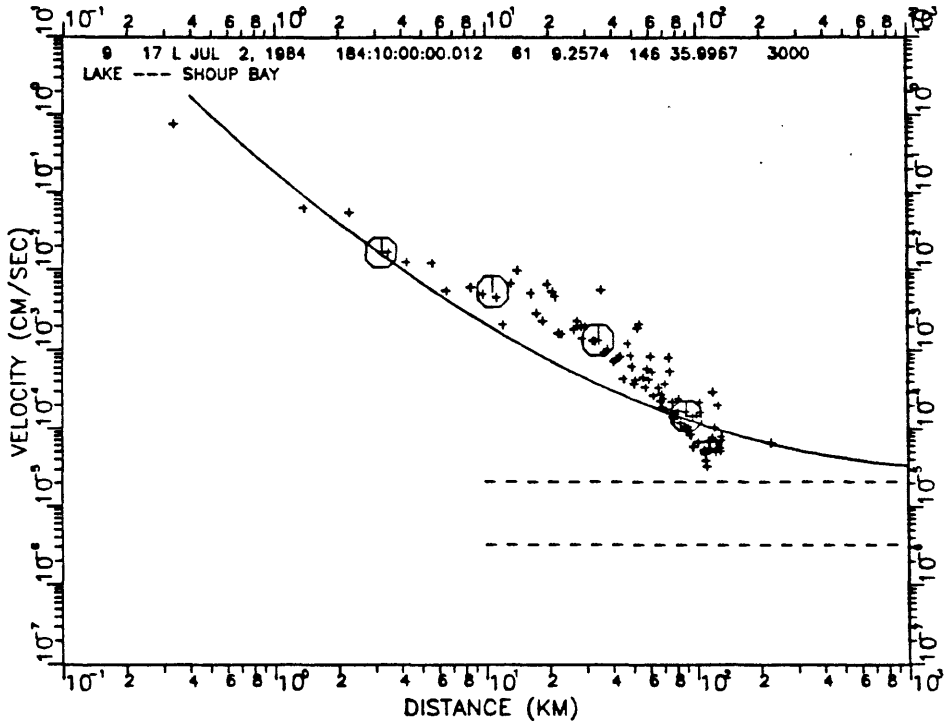

Figure A9. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 9, shot point 17. See page A1 for complete description.

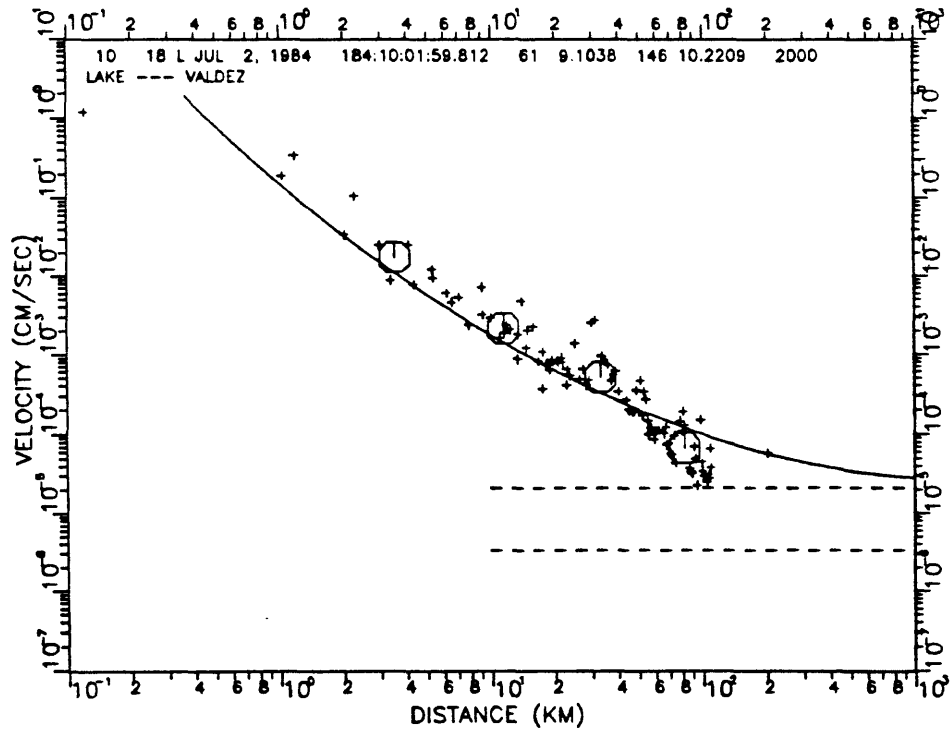

Figure A10. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 10, shot point 18. See page A1 for complete description.

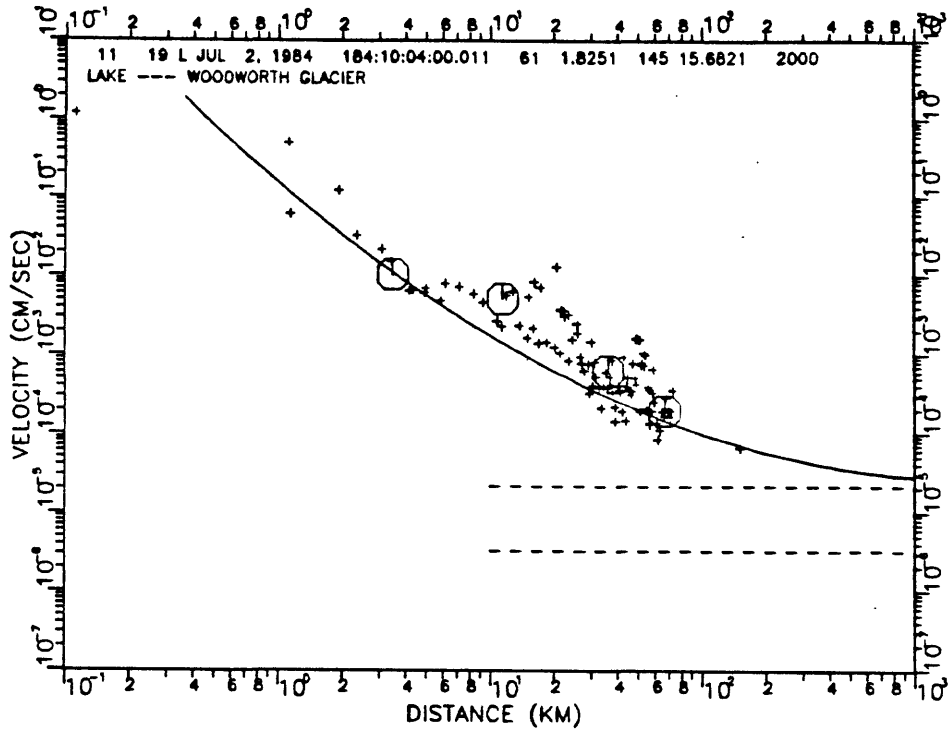

Figure A11. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 11, shot point 19. See page A1 for complete description.

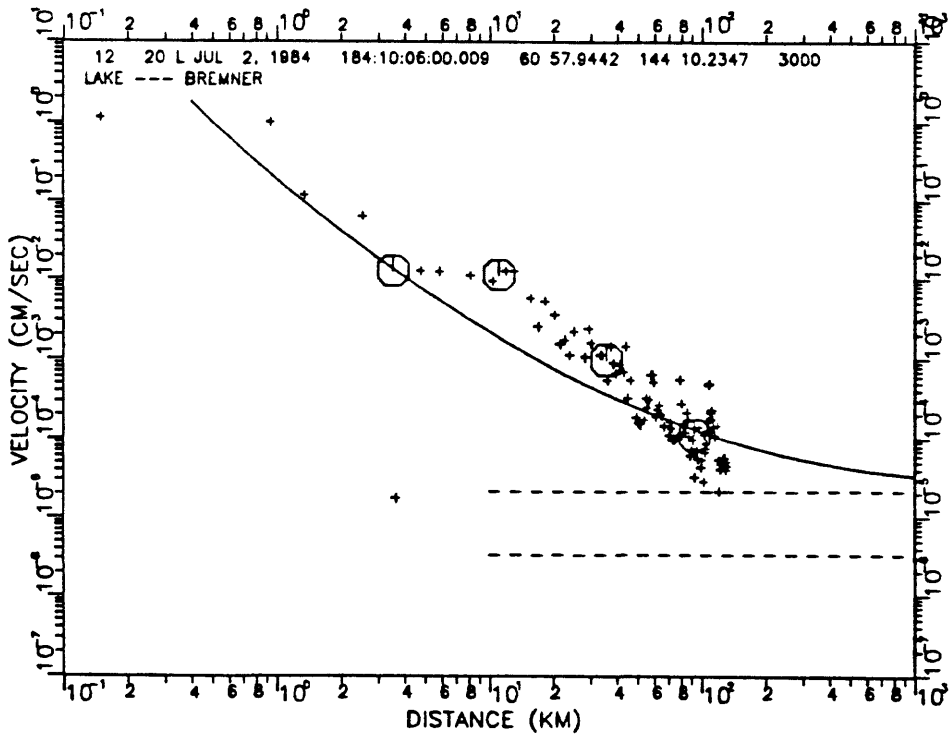

Figure A12. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 12, shot point 20. See page A1 for complete description.

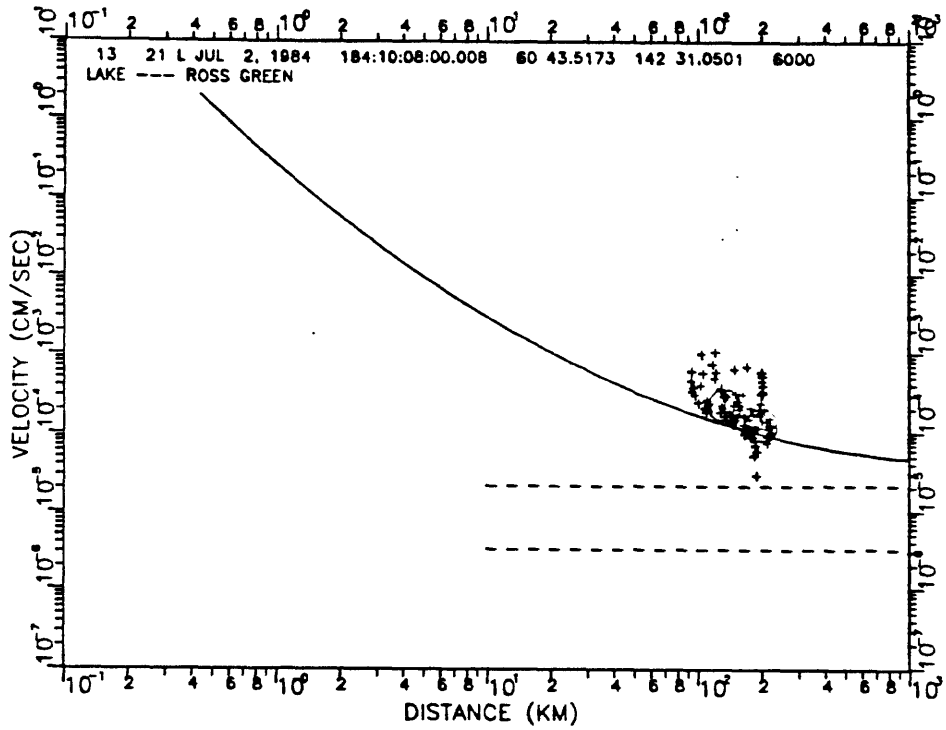

Figure A13. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 13, shot point 21. See page A1 for complete description.

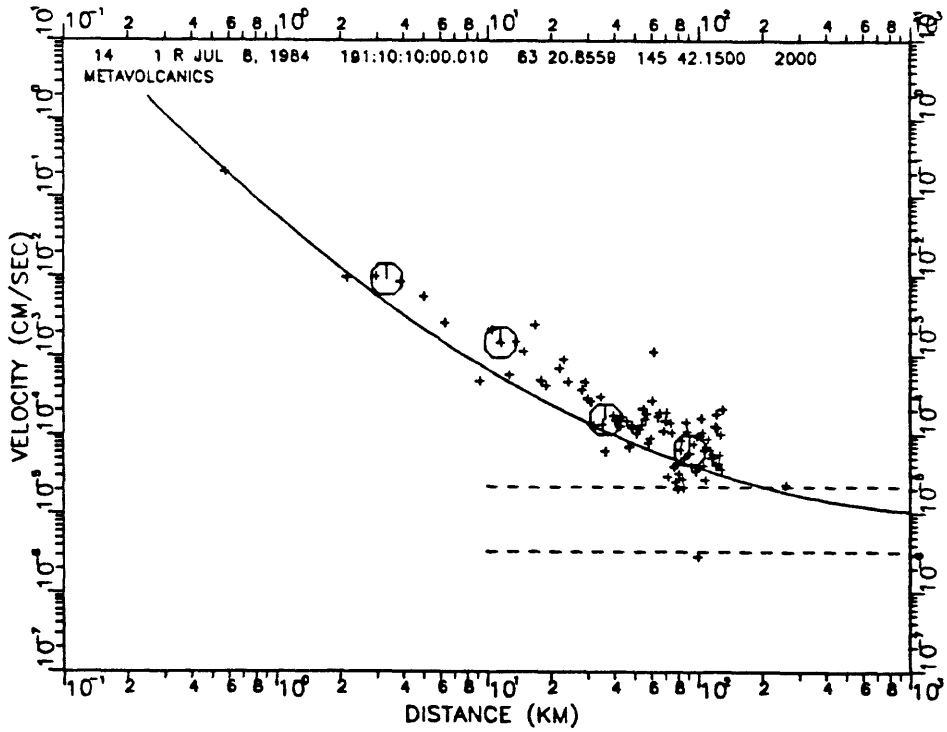

Figure A14. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 14, shot point 1. See page A1 for complete description.

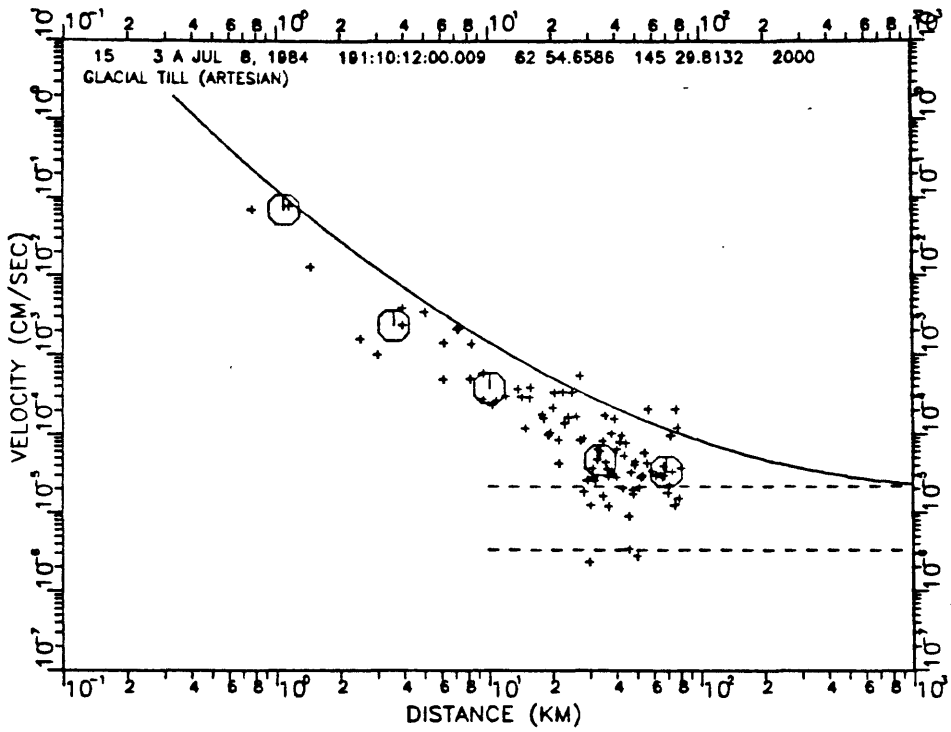

Figure A15. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 15, shot point 3. See page A1 for complete description.

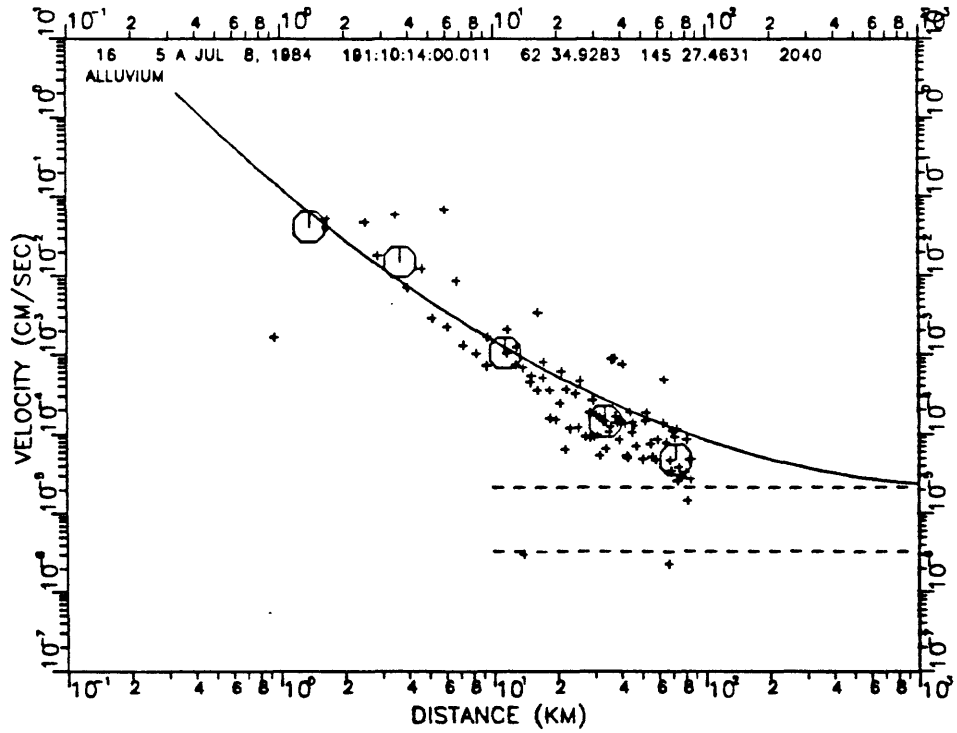

Figure A16. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 16, shot point 5. See page A1 for complete description.

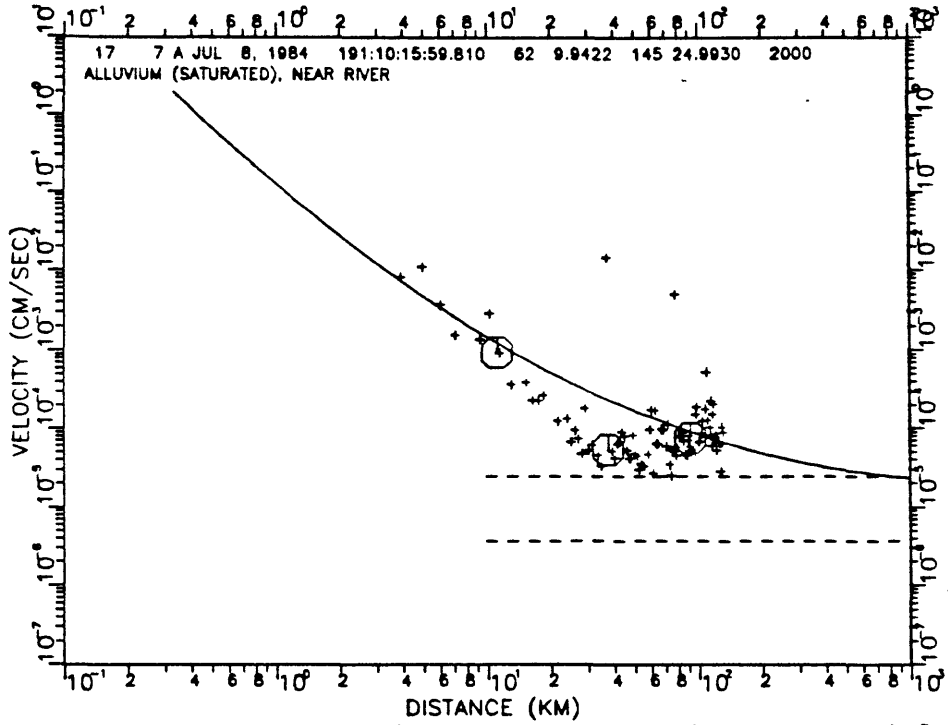

Figure A17. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 17, shot point 7. See page A1 for complete description.

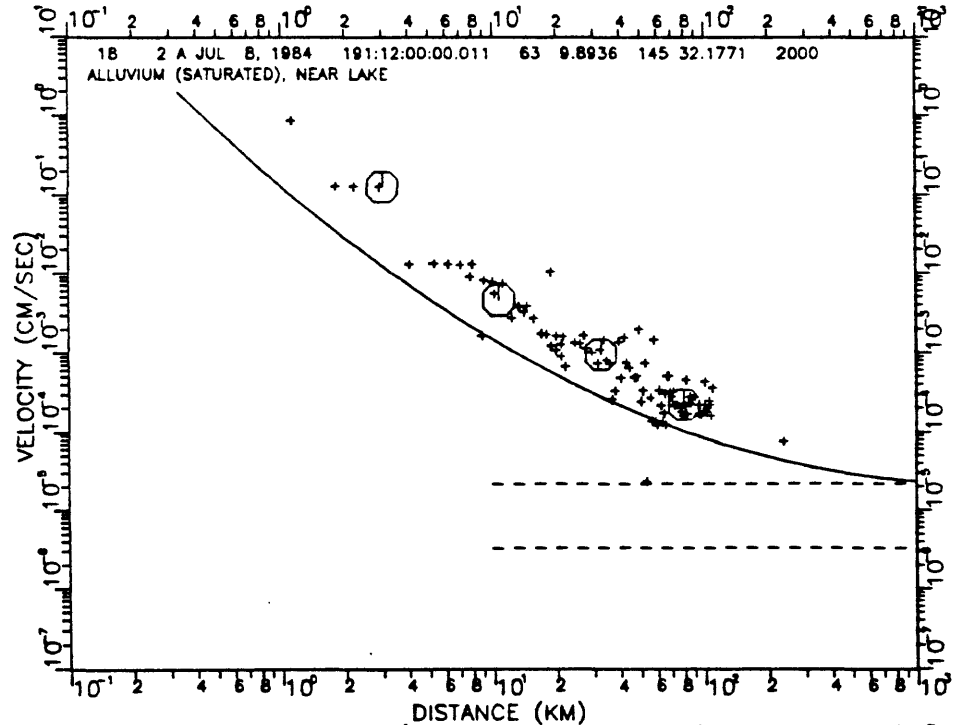

Figure A18. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 18, shot point 2. See page A1 for complete description.

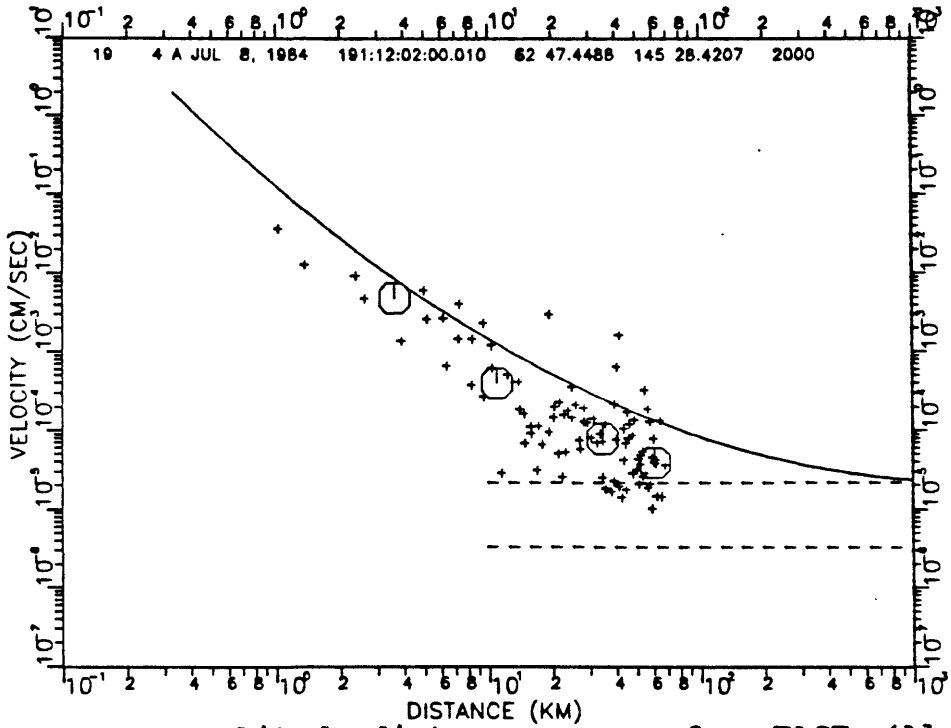

Figure A19. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 19, shot point 4. See page A1 for complete description.

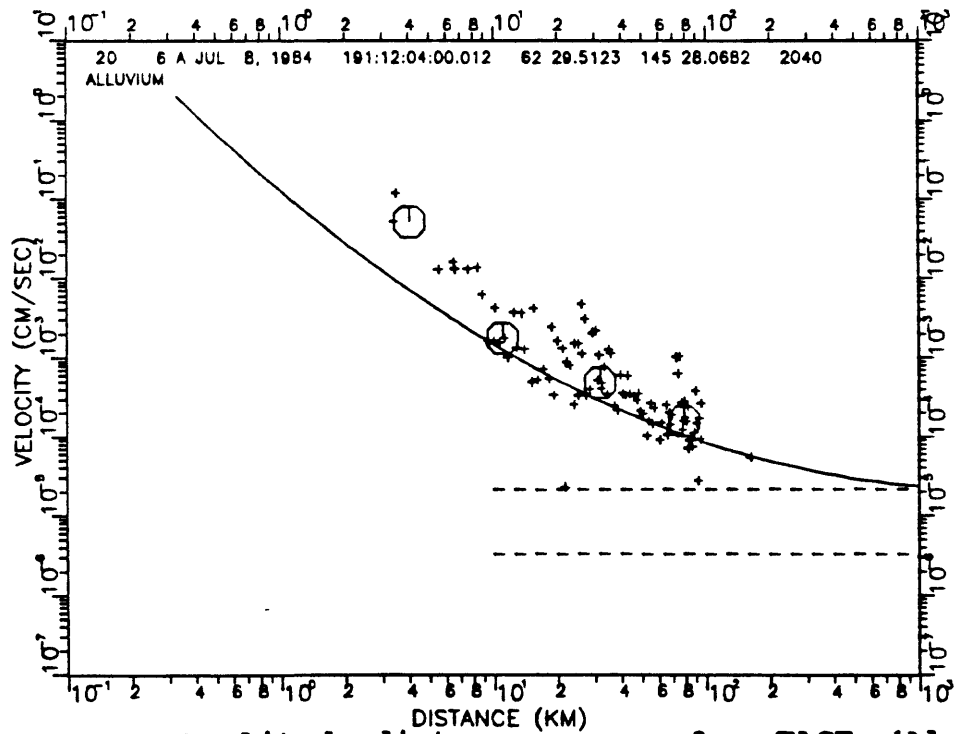

Figure A20. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 20, shot point 6. See page A1 for complete description.

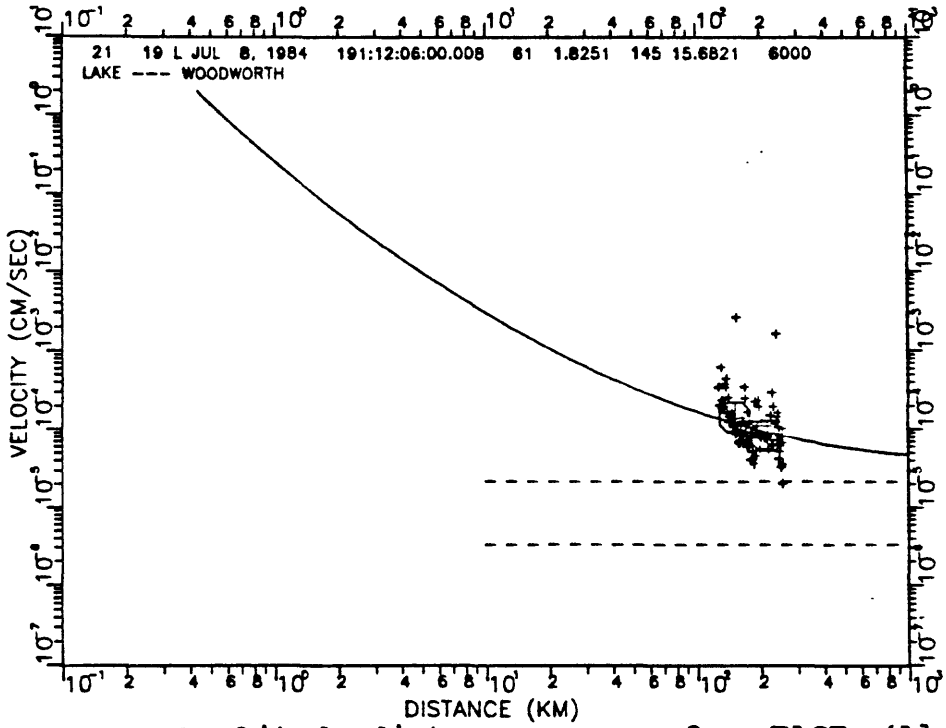

Figure A21. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 21, shot point 19. See page A1 for complete description.

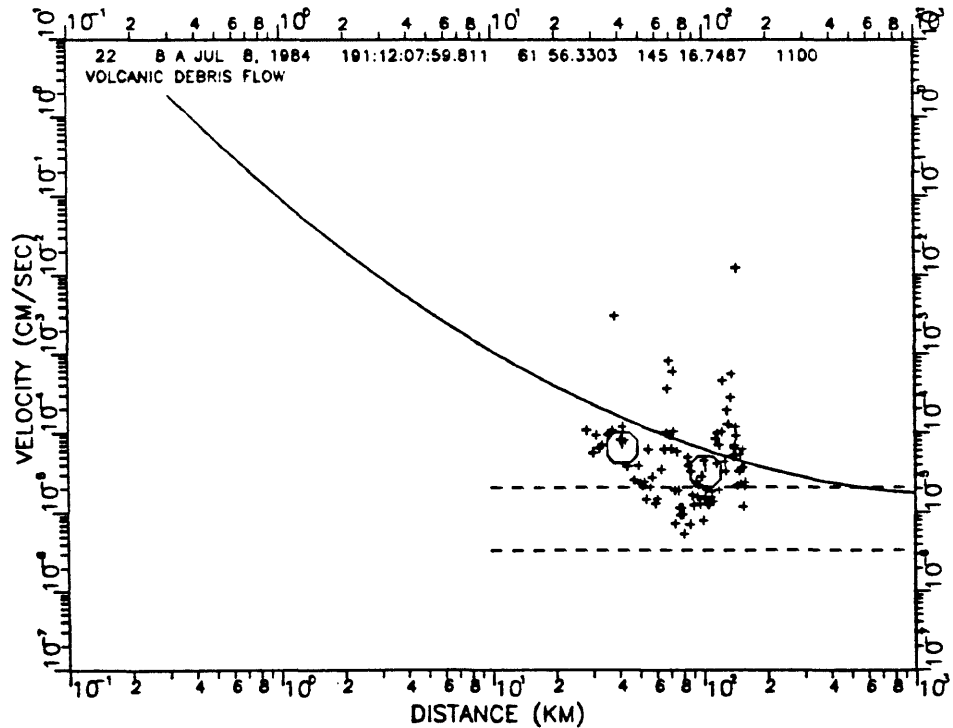

Figure A22. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 22, shot point 8. See page A1 for complete description.

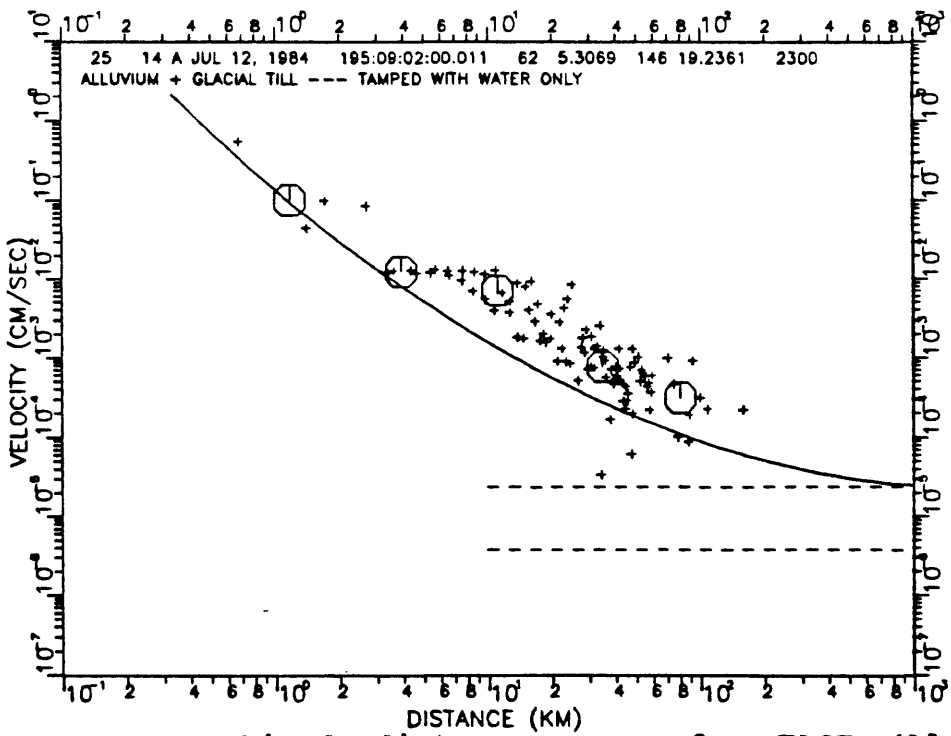

Figure A23. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 25, shot point 14. See page A1 for complete description.

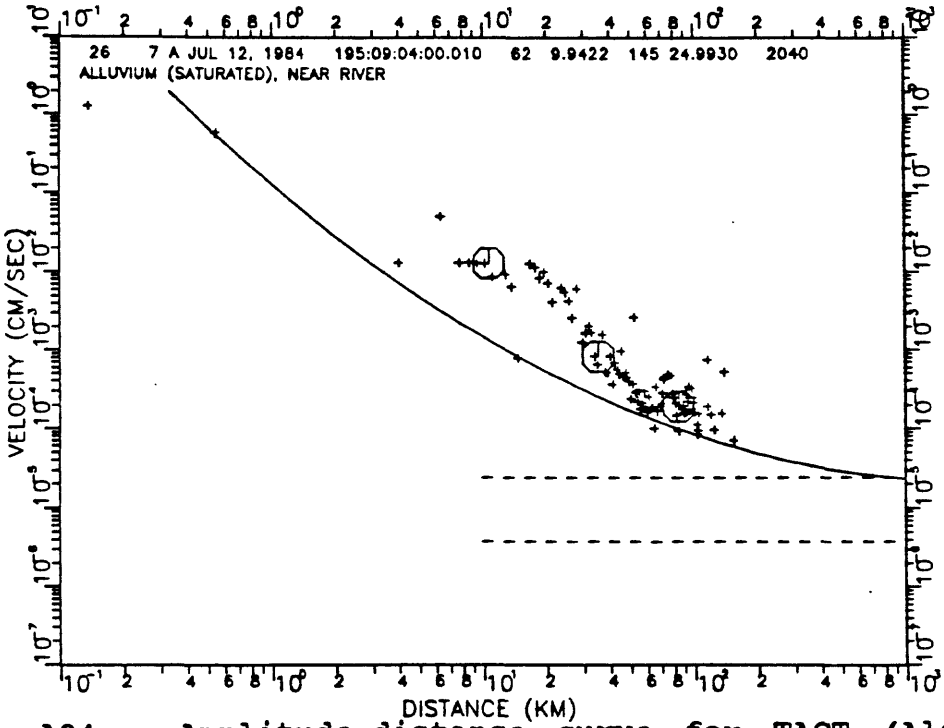

Figure A24. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 26, shot point 7. See page A1 for complete description.

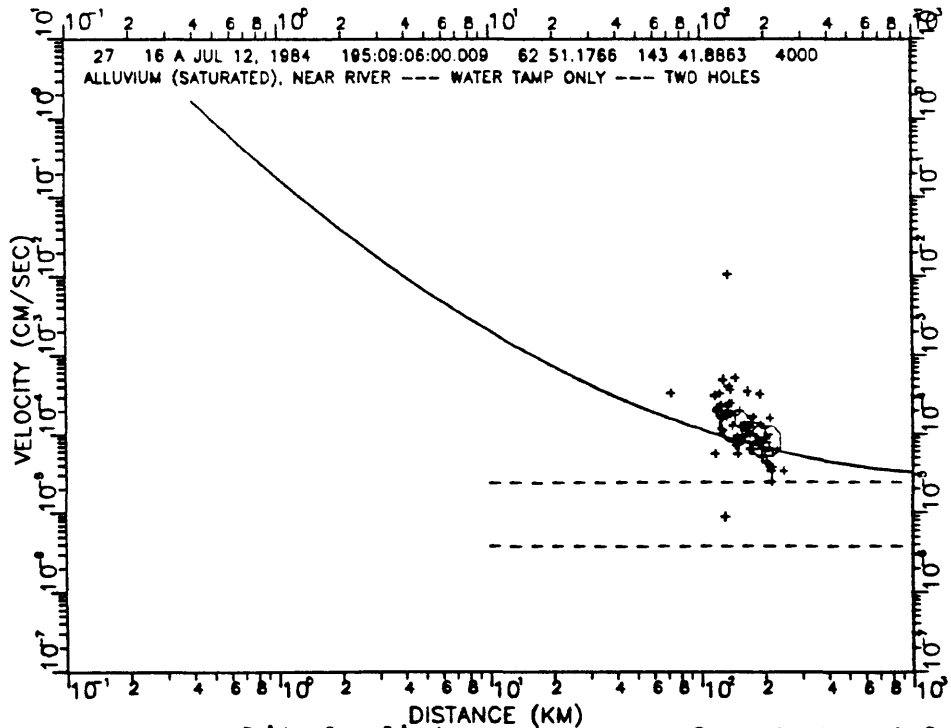

Figure A25. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 27, shot point 16. See page A1 for complete description.

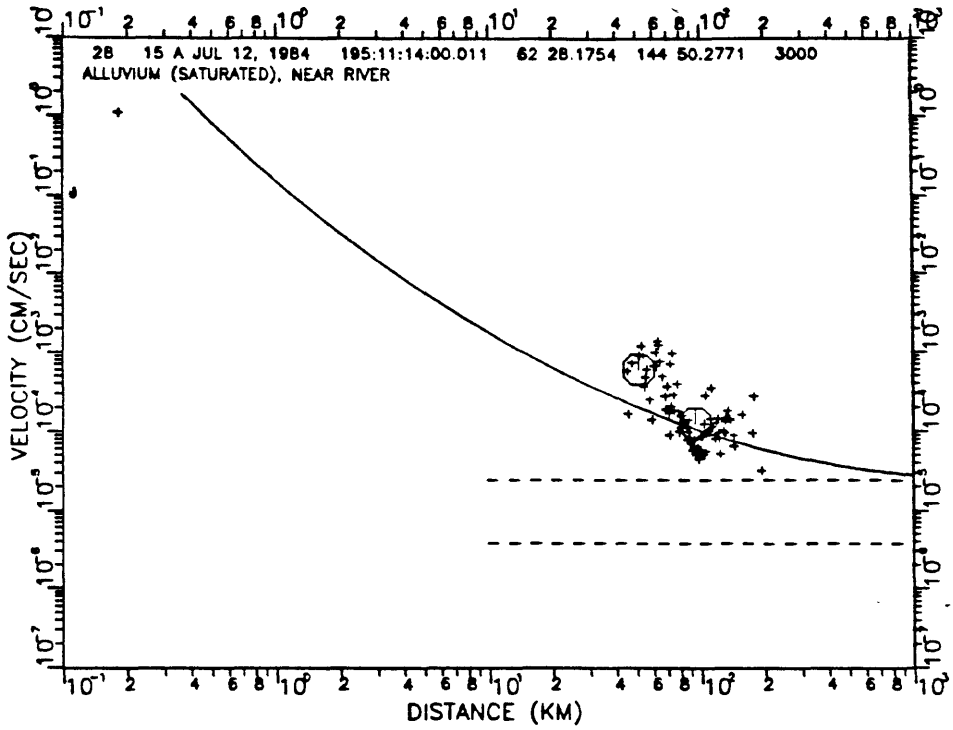

Figure A26. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 28, shot point 15. See page A1 for complete description.

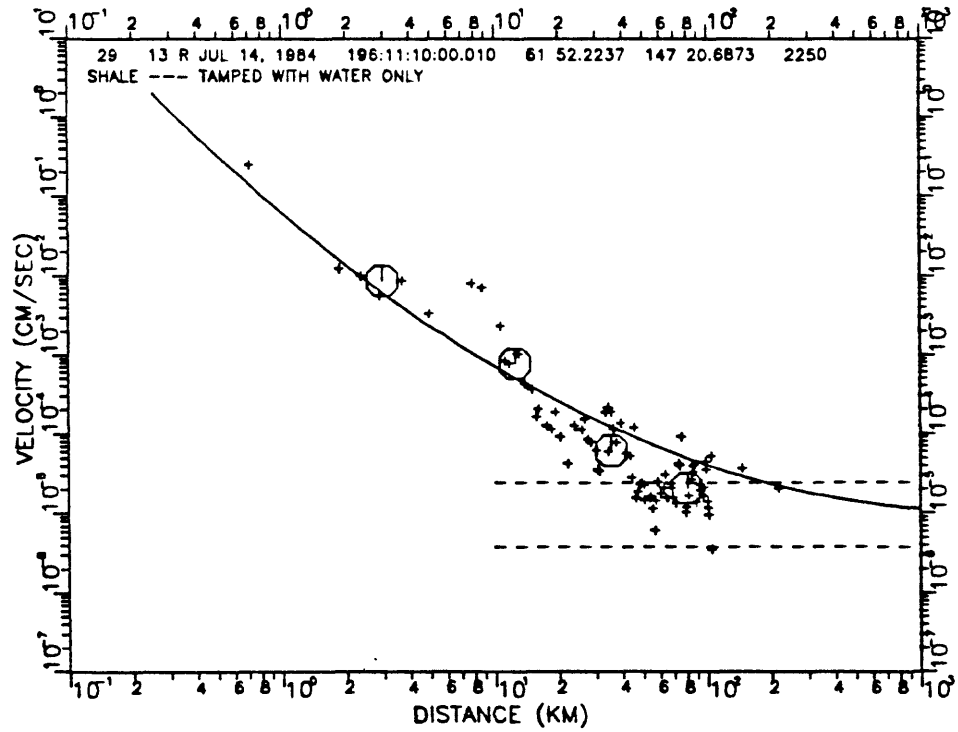

Figure A27. Amplitude-distance curve for TACT (Alaska) 1984 experiment, shot 29, shot point 13. See page A1 for complete description.

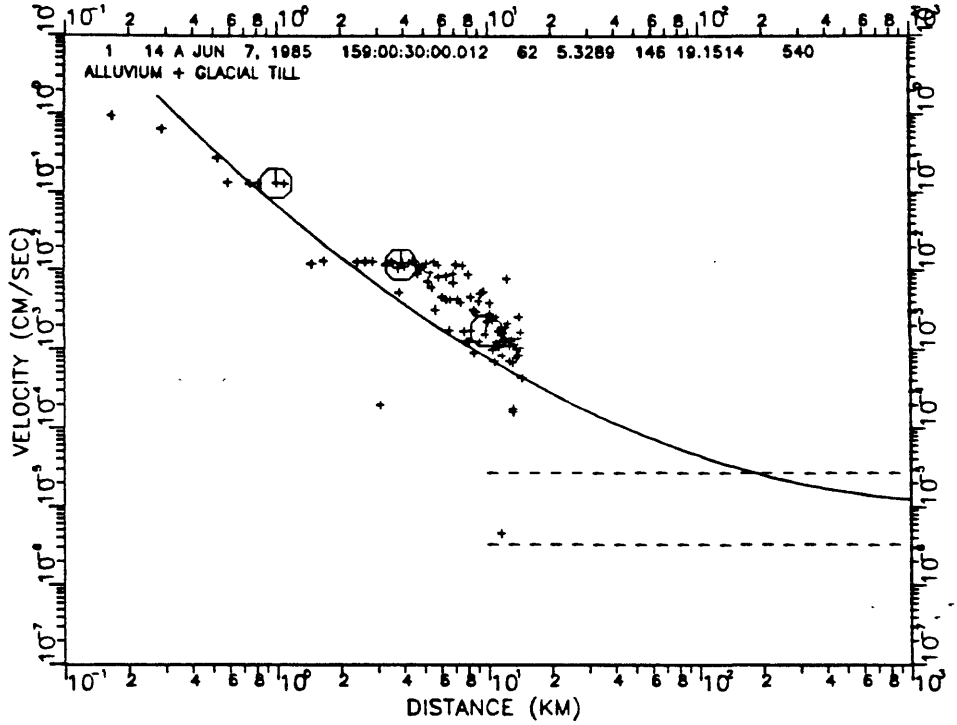

Figure A28. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 1, shot point 14. See page A1 for complete description.

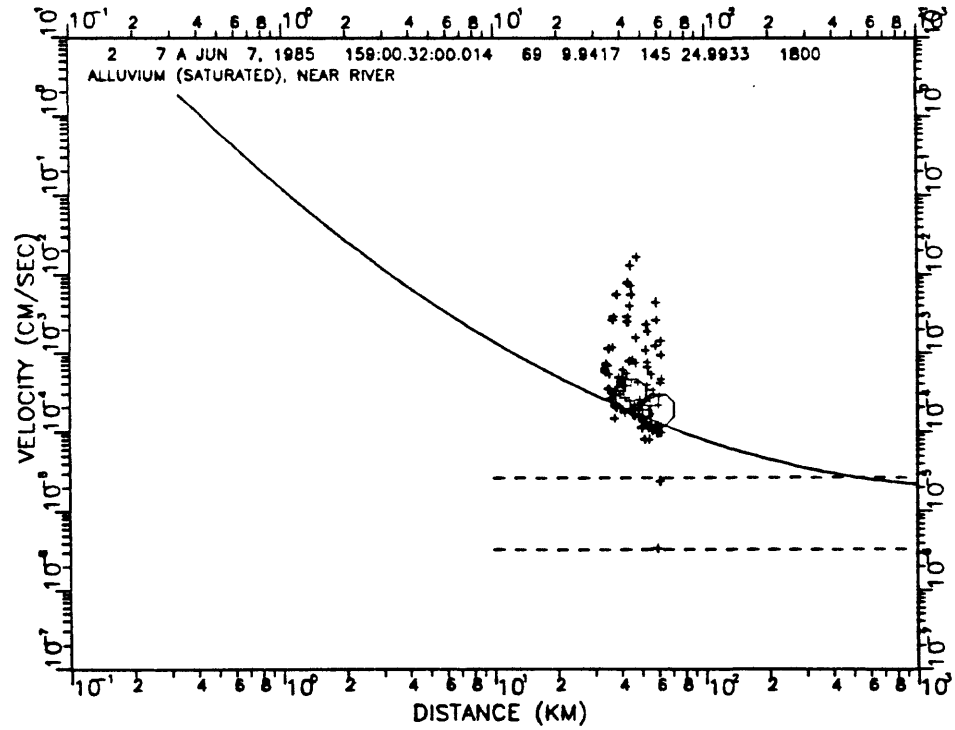

Figure A29. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 2, shot point 7. See page A1 for complete description.

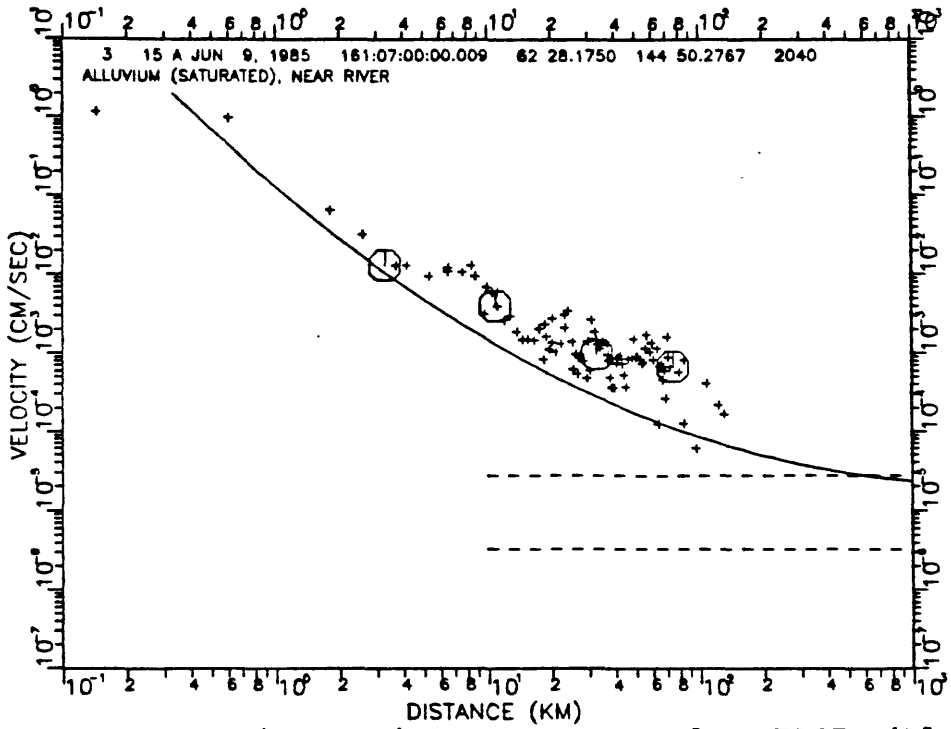

Figure A30. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 3, shot point 15. See page A1 for complete description.

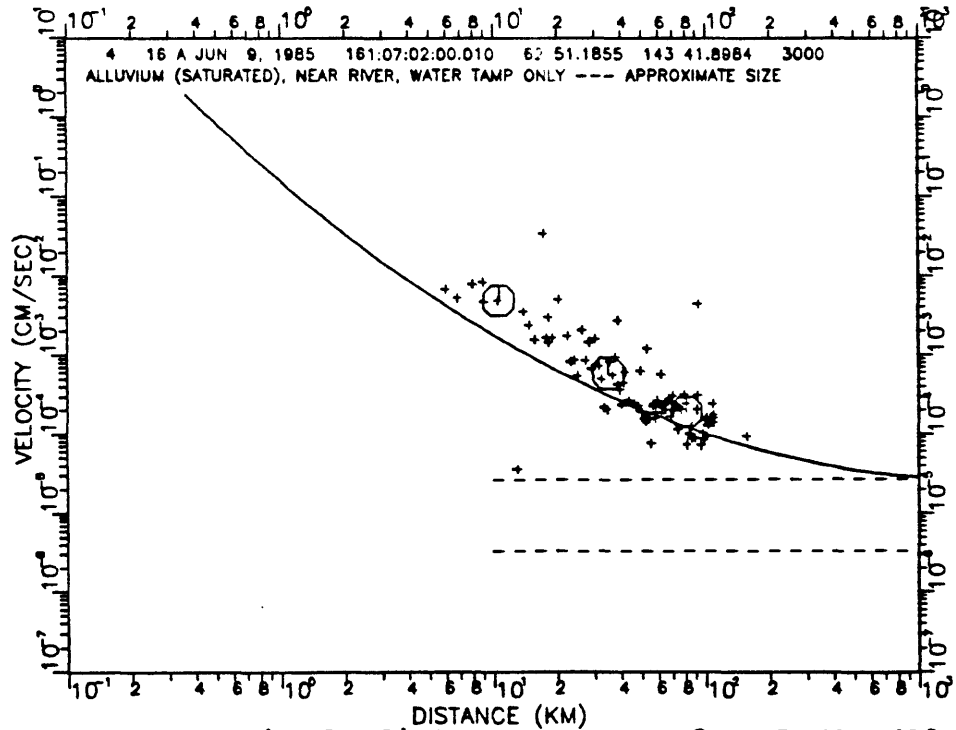

Figure A31. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 4, shot point 16. See page A1 for complete description.

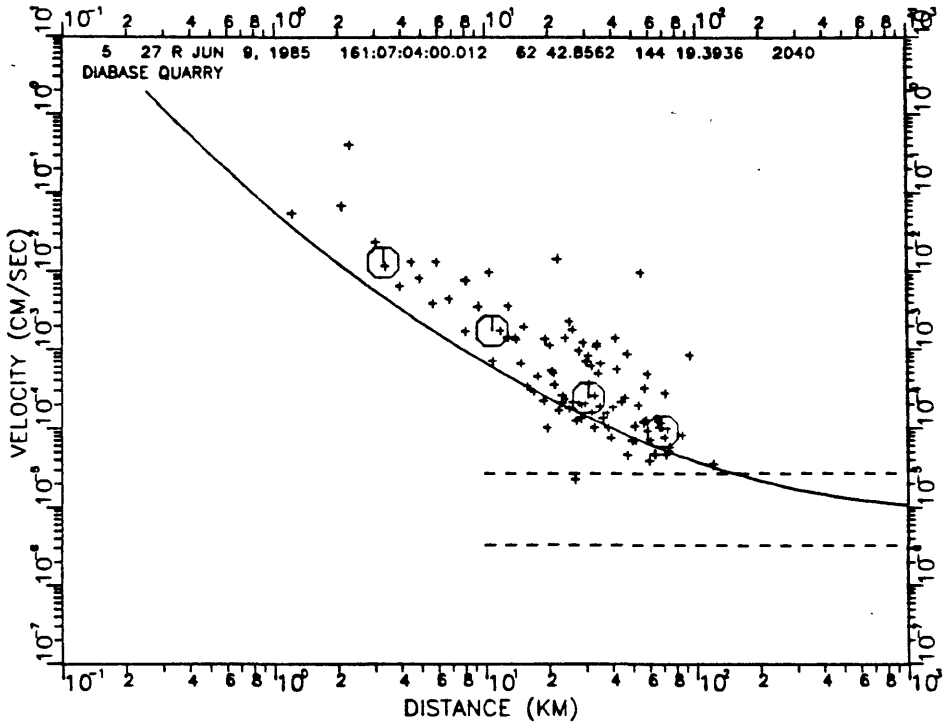

Figure A32. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 5, shot point 27. See page A1 for complete description.

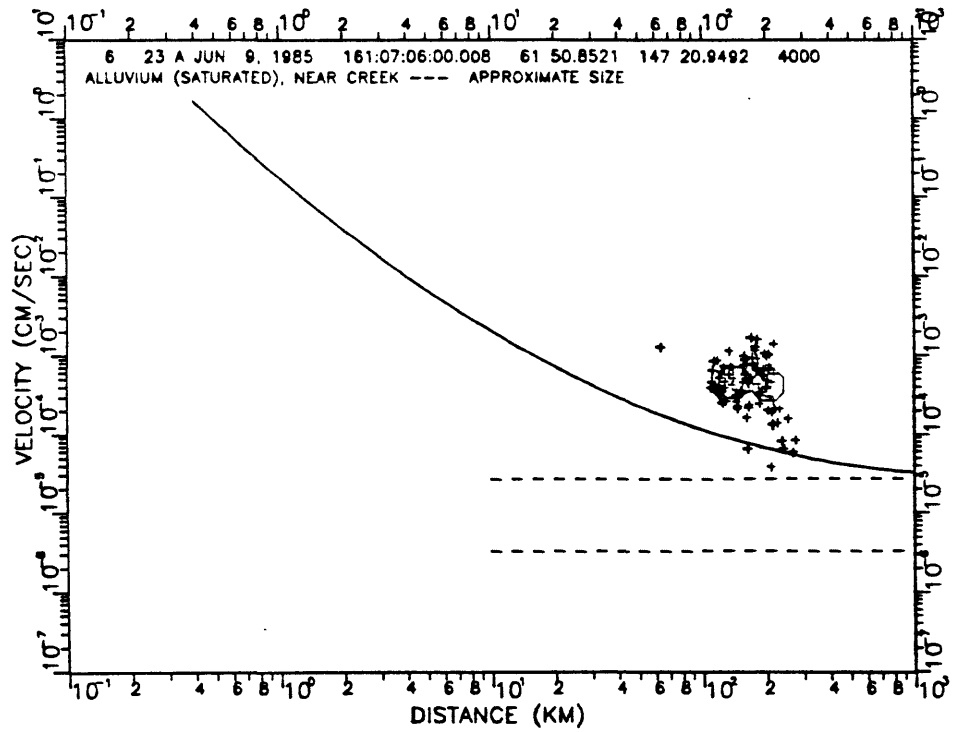

Figure A33. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 6, shot point 23. See page A1 for complete description.

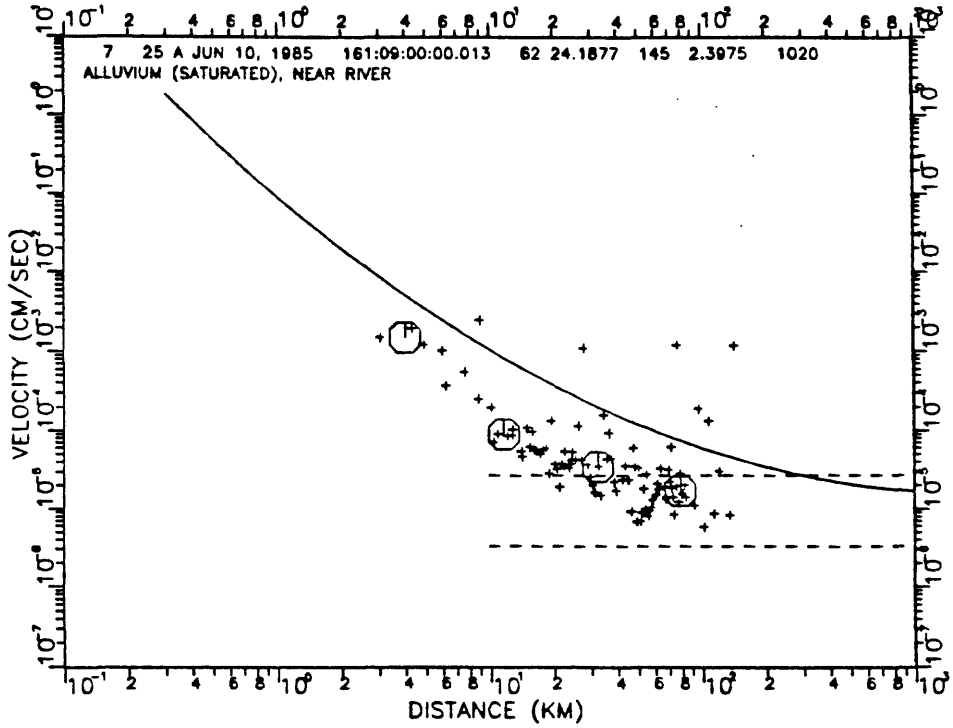

Figure A34. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 7, shot point 25. See page A1 for complete description.

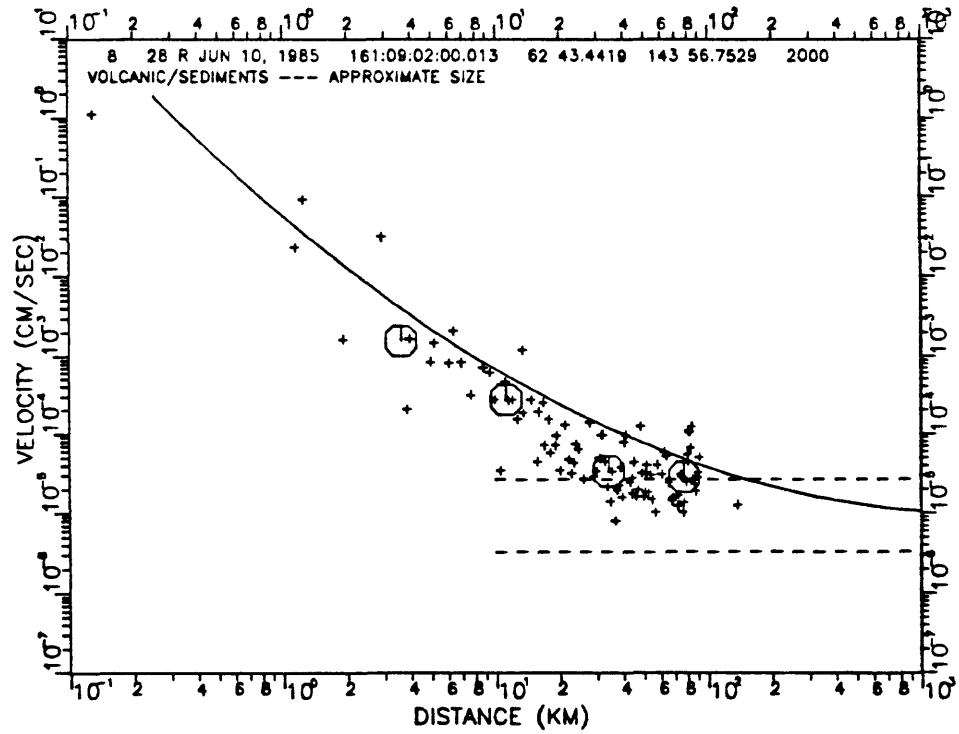

Figure A35. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 8, shot point 28. See page A1 for complete description.

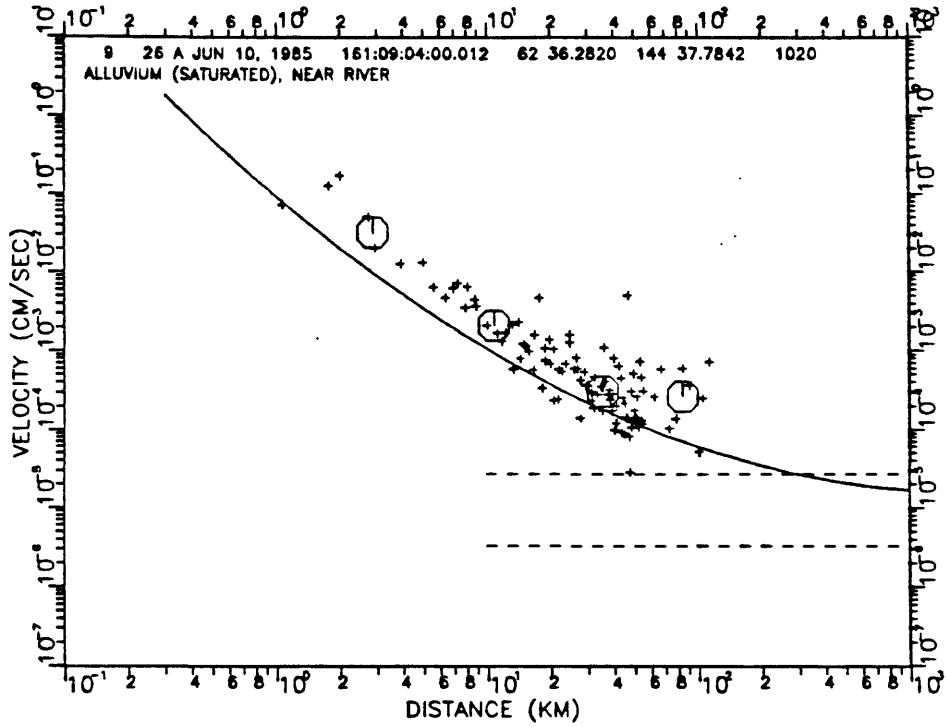

Figure A36. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 9, shot point 26. See page A1 for complete description.

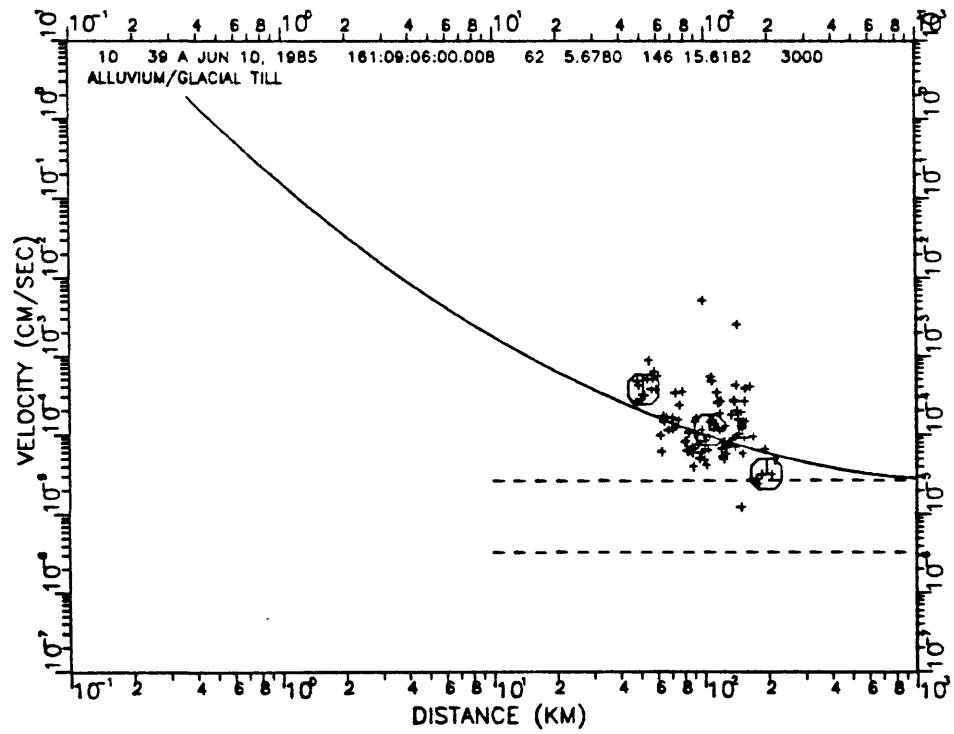

Figure A37. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 10, shot point 39. See page A1 for complete description.

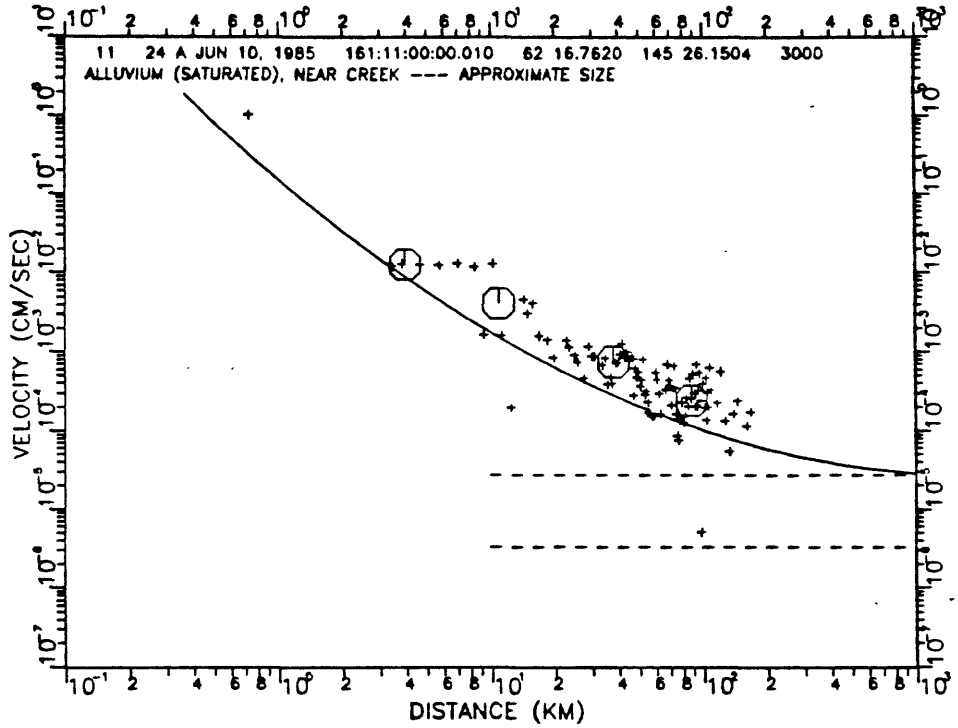

Figure A38. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 11, shot point 24. See page A1 for complete description.

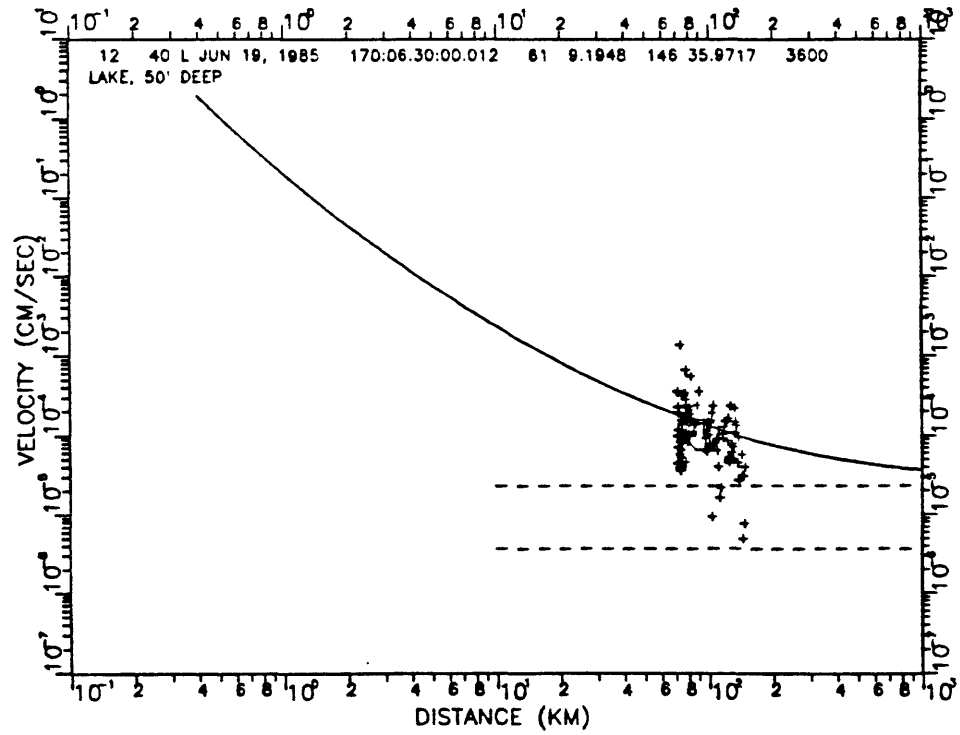

Figure A39. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 12, shot point 40. See page A1 for complete description.

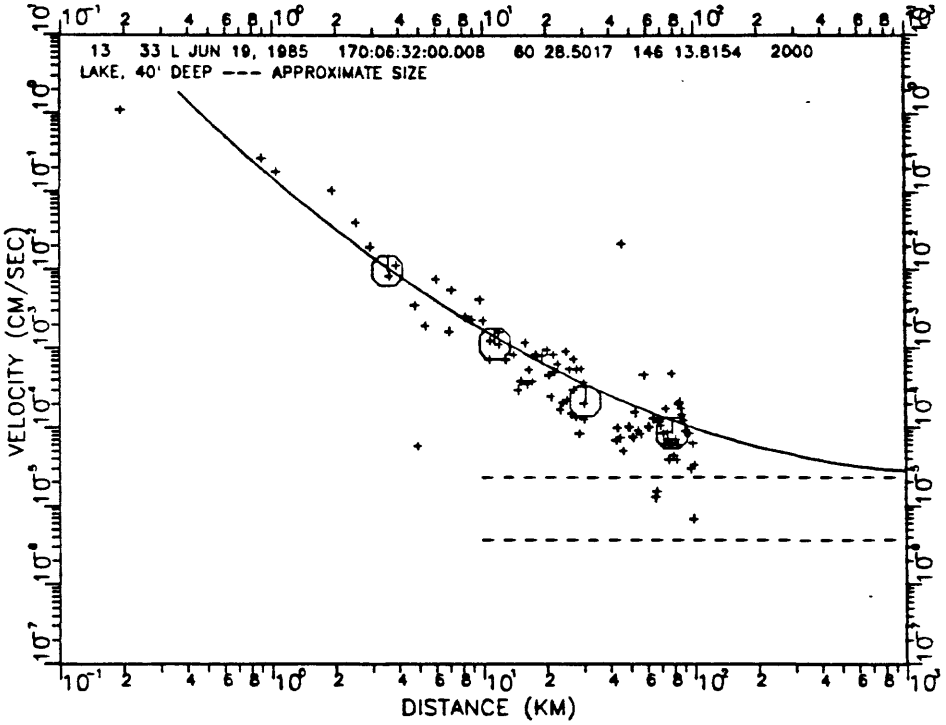

Figure A40. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 13, shot point 33. See page A1 for complete description.

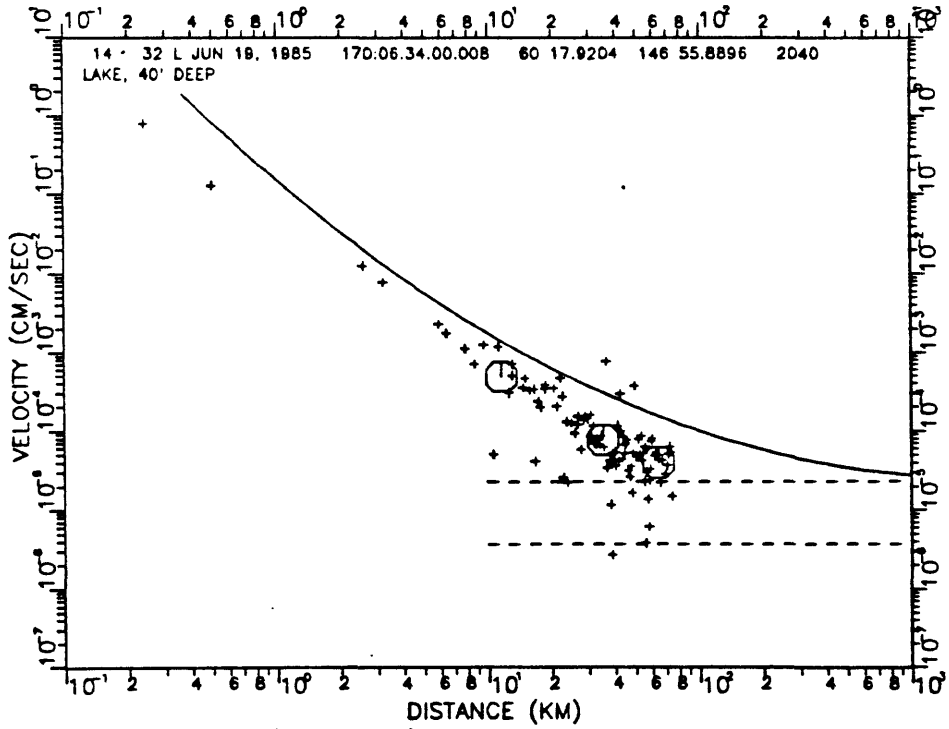

Figure A41. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 14, shot point 32. See page A1 for complete description.

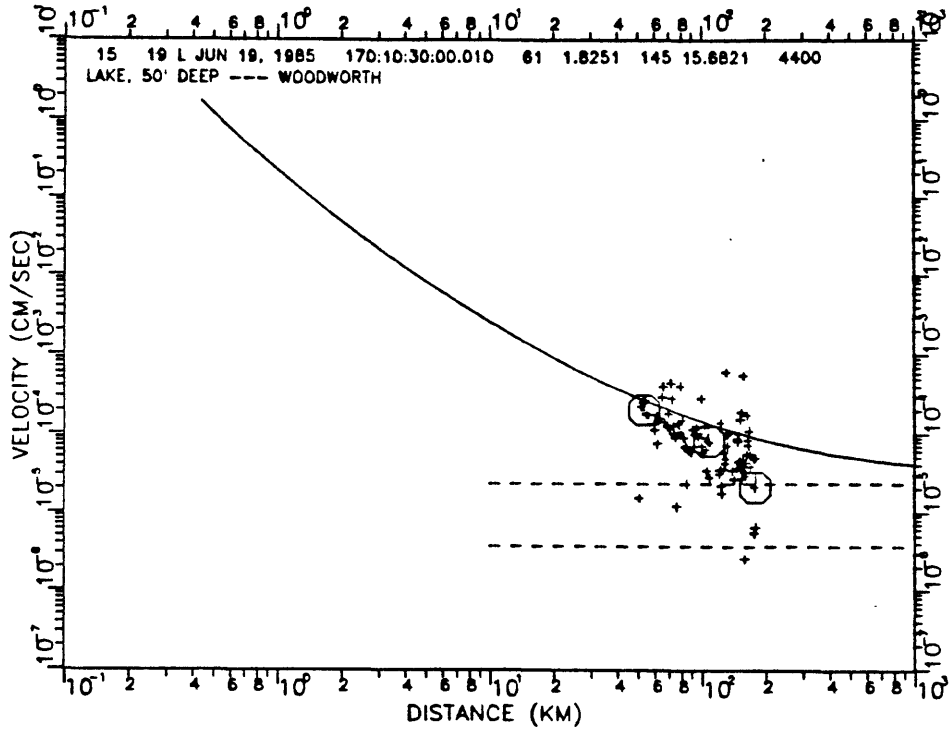

Figure A42. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 15, shot point 19. See page A1 for complete description.

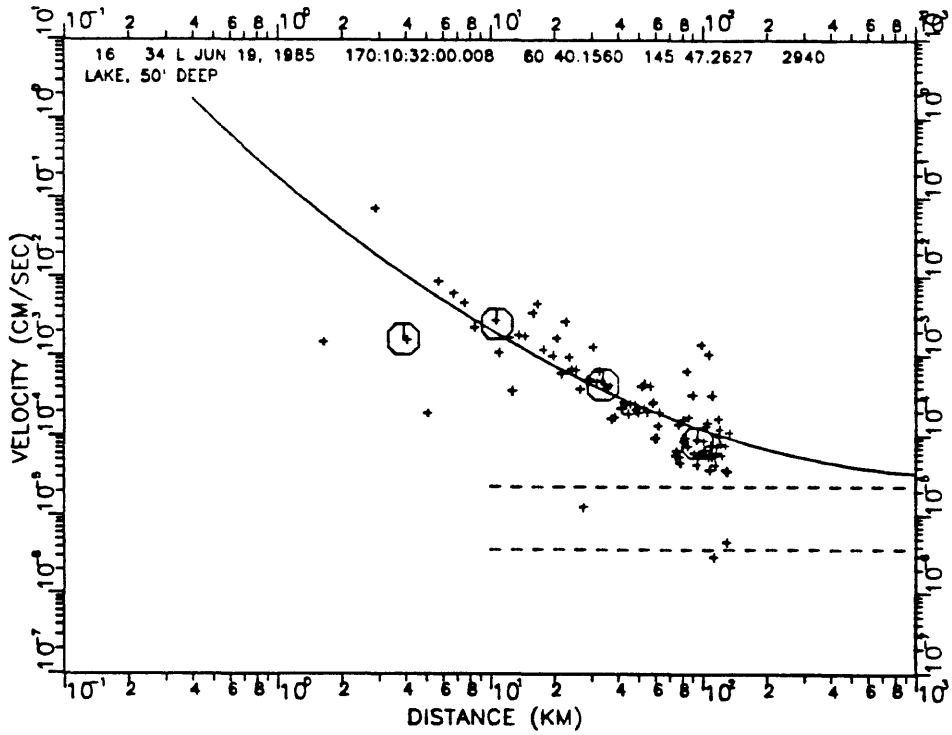

Figure A43. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 16, shot point 34. See page A1 for complete description.

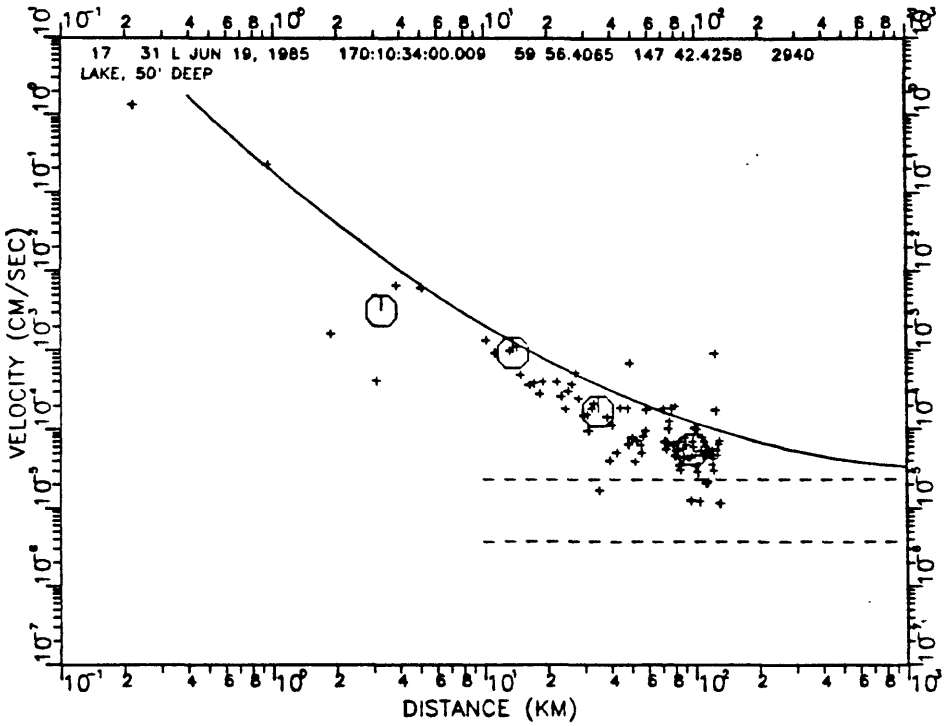

Figure A44. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 17, shot point 31. See page A1 for complete description.

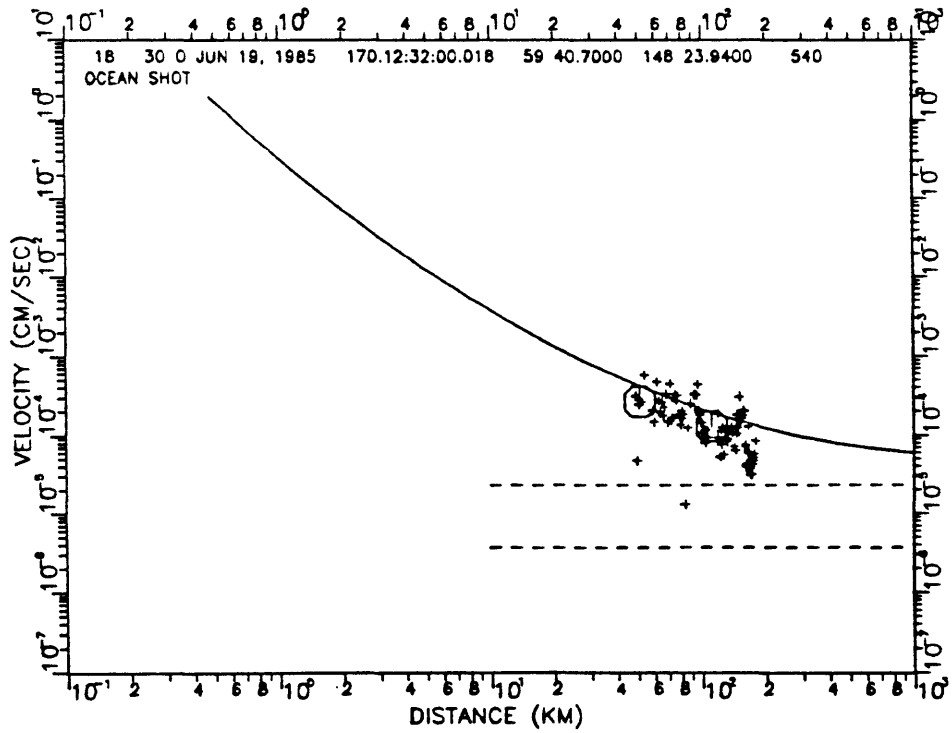

Figure A45. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 18, shot point 30. See page A1 for complete description.

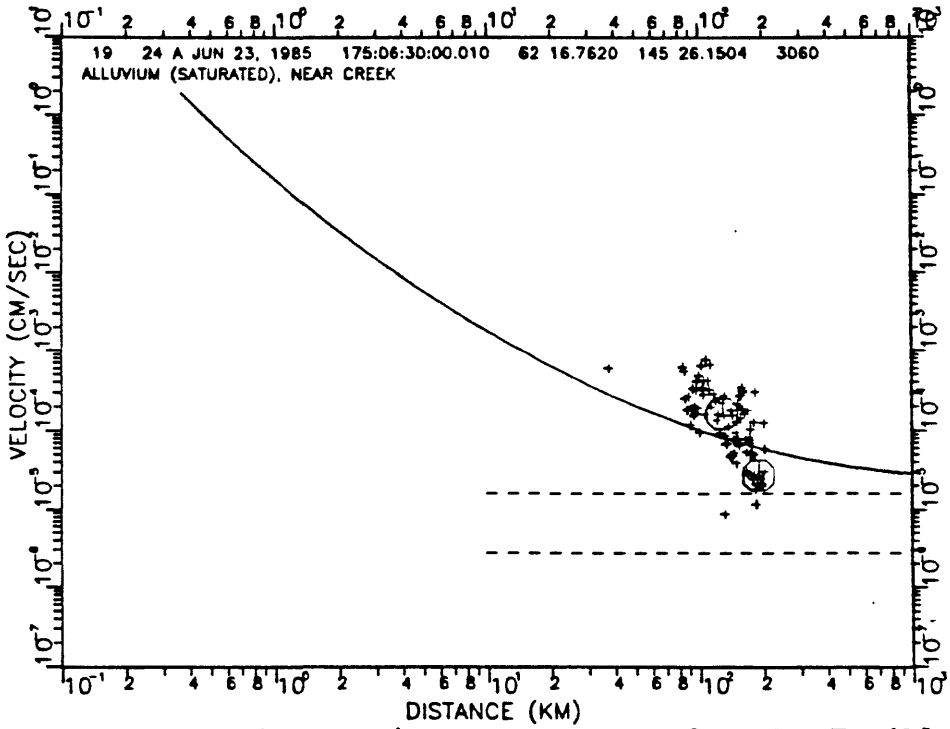

Figure A46. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 19, shot point 24. See page A1 for complete description.

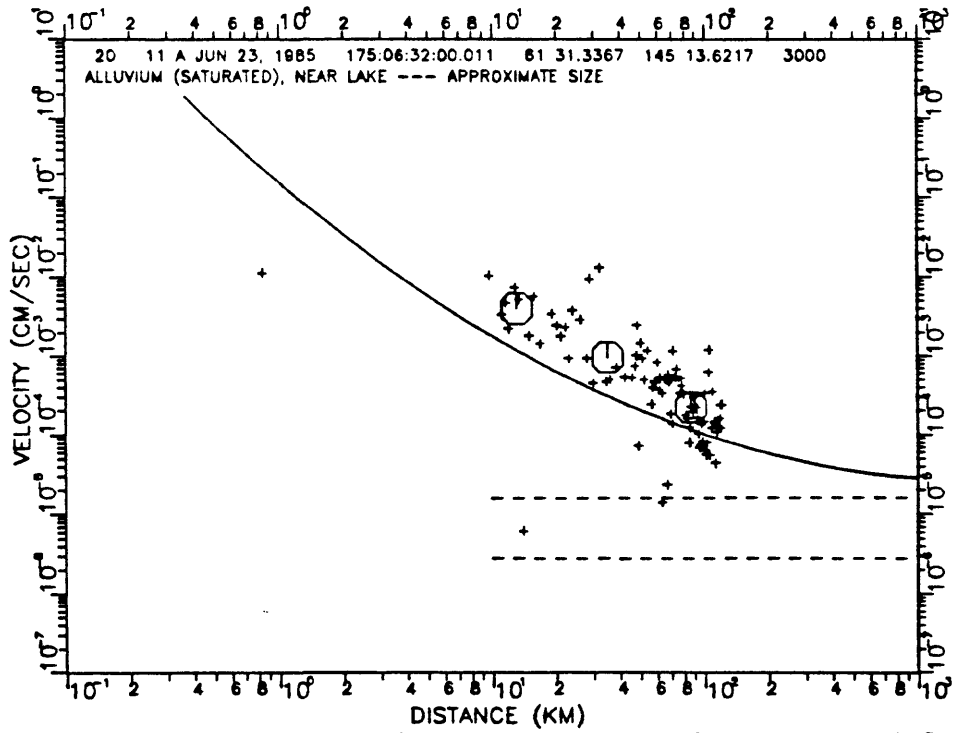

Figure A47. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 20, shot point 11. See page A1 for complete description.

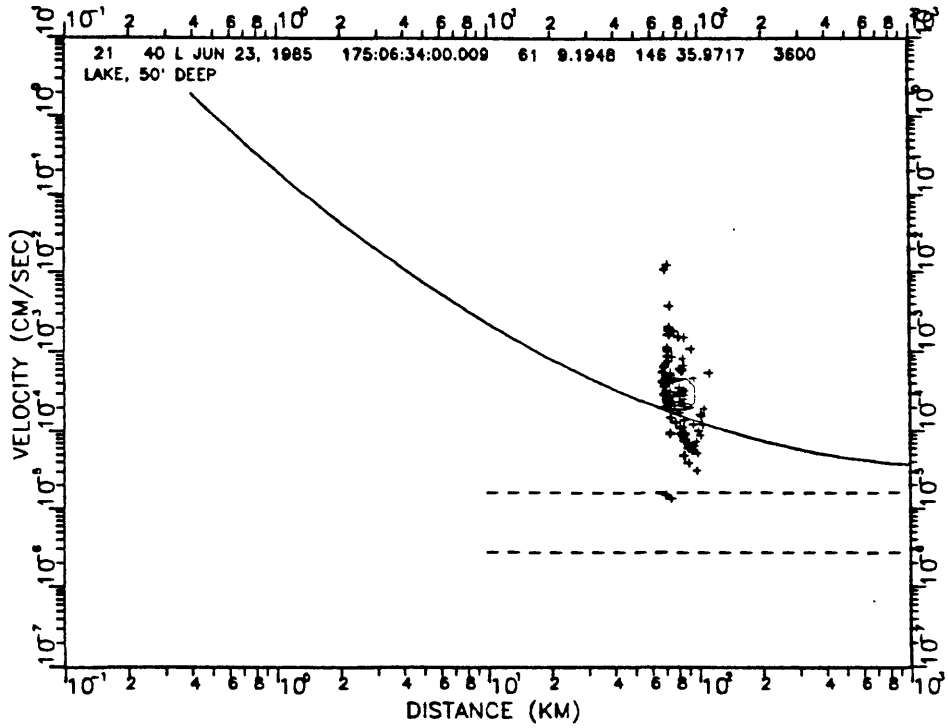

Figure A48. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 21, shot point 40. See page A1 for complete description.

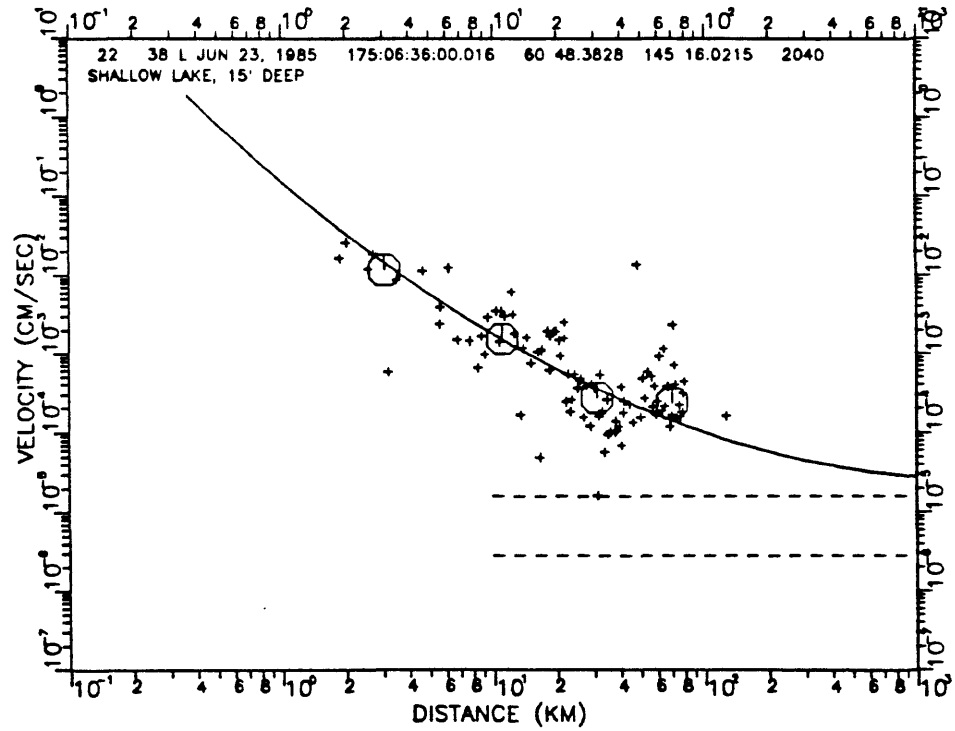

Figure A49. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 22, shot point 38. See page A1 for complete description.

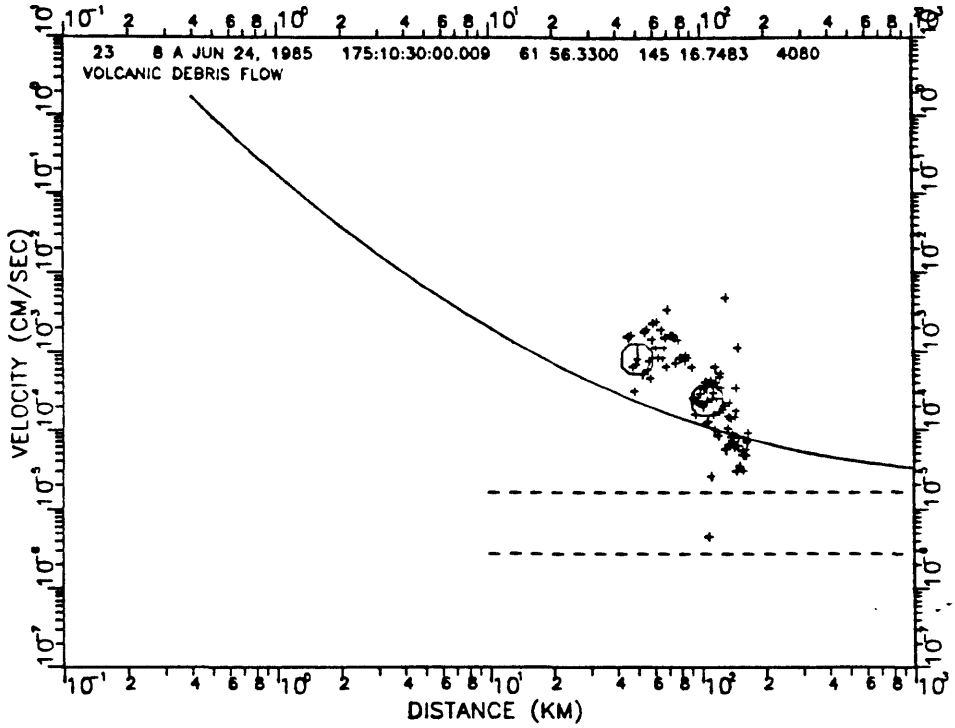

Figure A50. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 23, shot point 8. See page A1 for complete description.

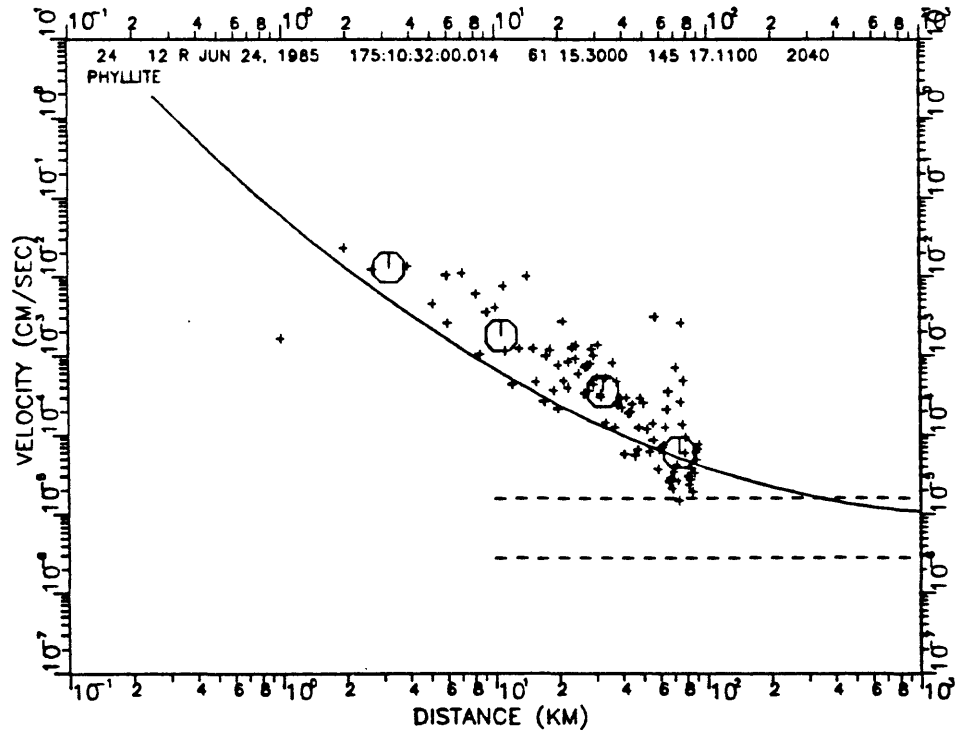

Figure A51. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 24, shot point 12. See page A1 for complete description.

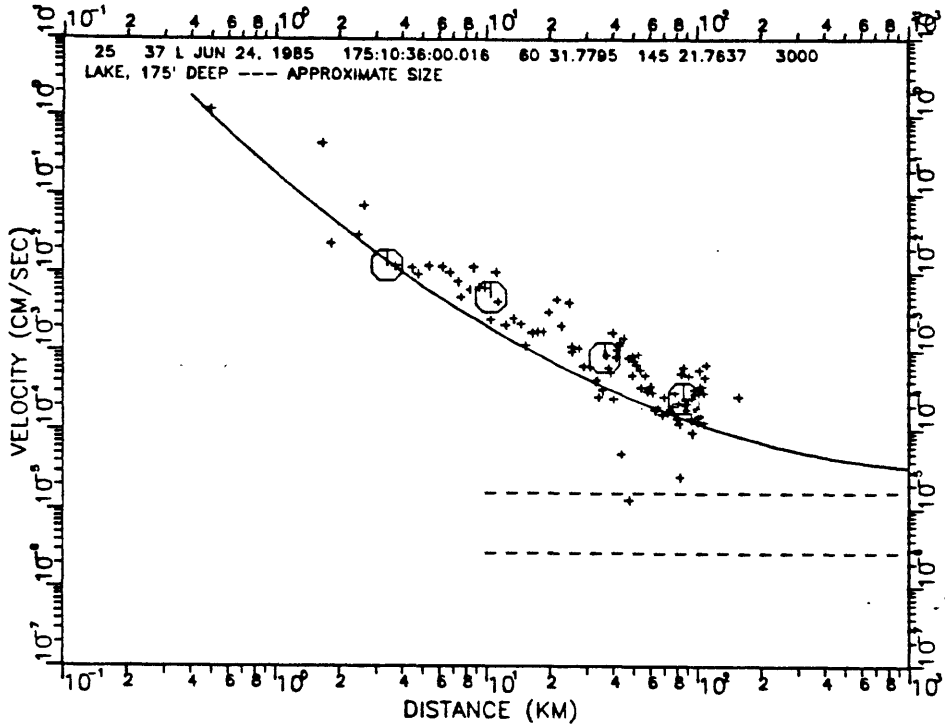

Figure A52. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 25, shot point 37. See page A1 for complete description.

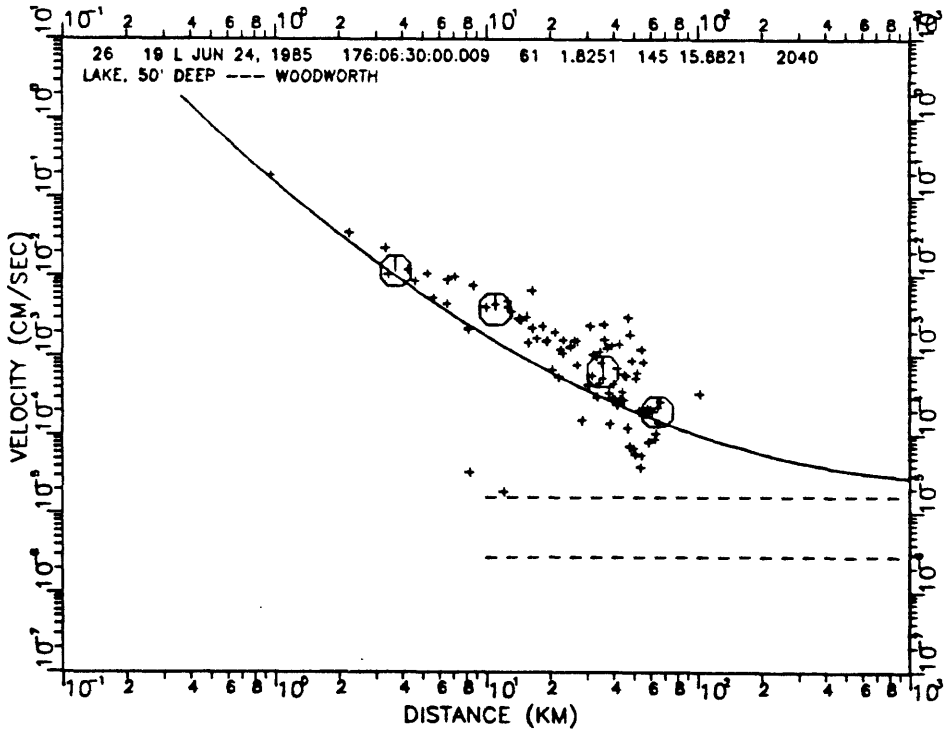

Figure A53. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 26, shot point 19. See page A1 for complete description.

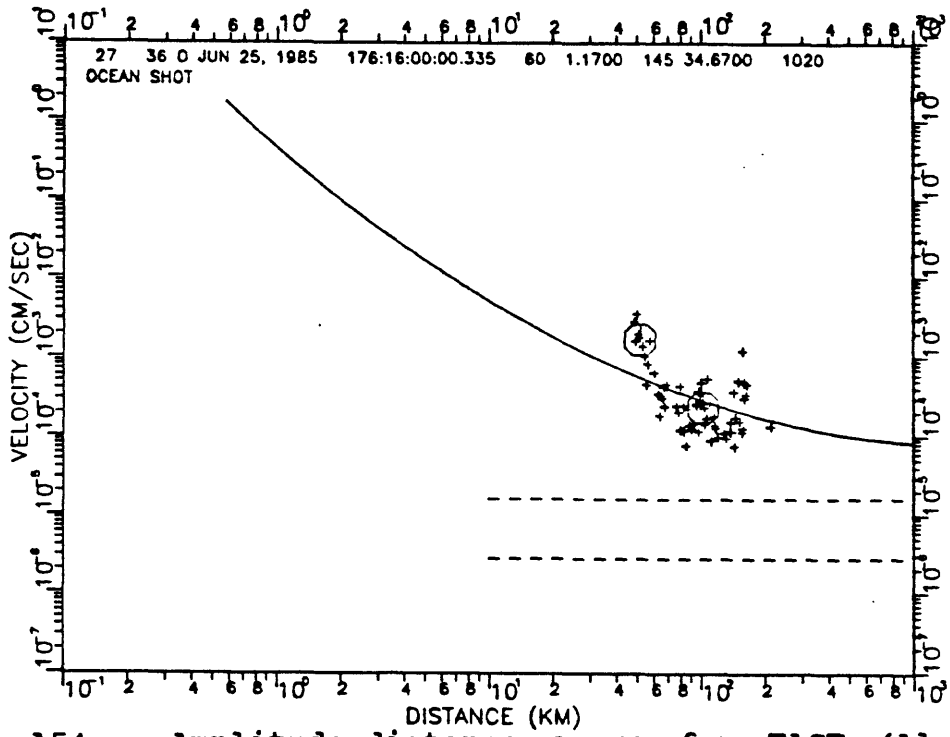

Figure A54. Amplitude-distance curve for TACT (Alaska) 1985 experiment, shot 27, shot point 36. See page A1 for complete description.

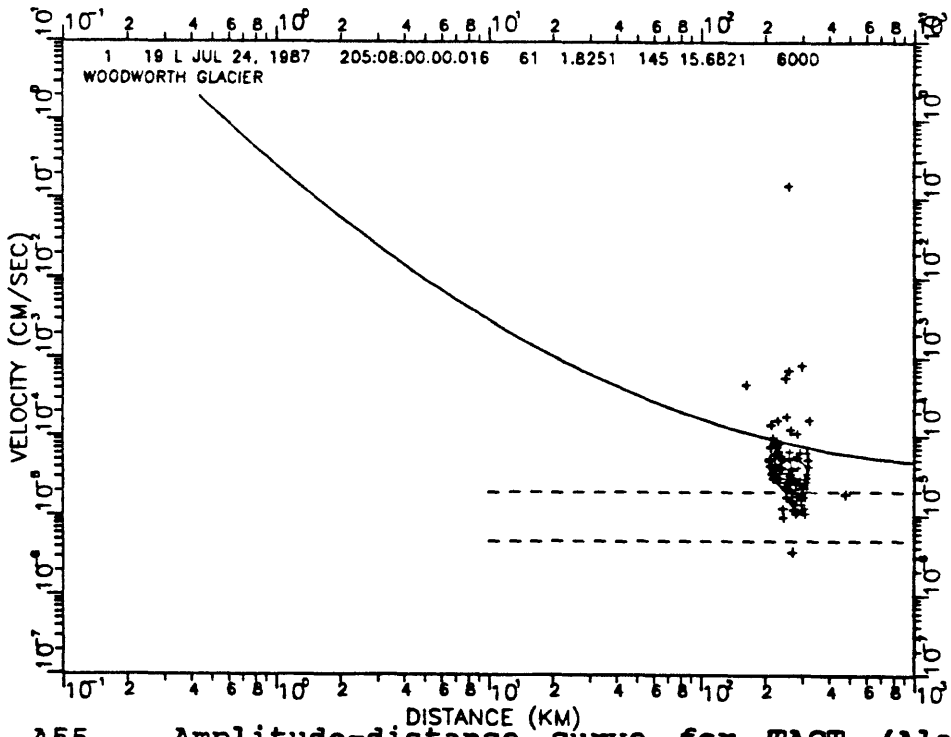

Figure A55. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 1, shot point 19. See page A1 for complete description.

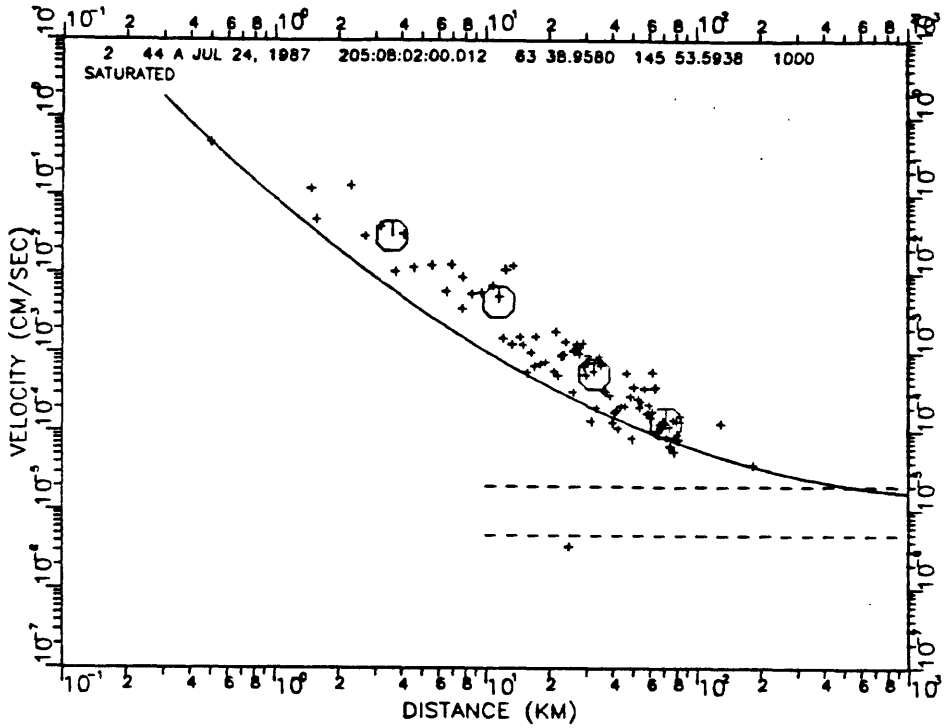

Figure A56. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 2, shot point 44. See page A1 for complete description.

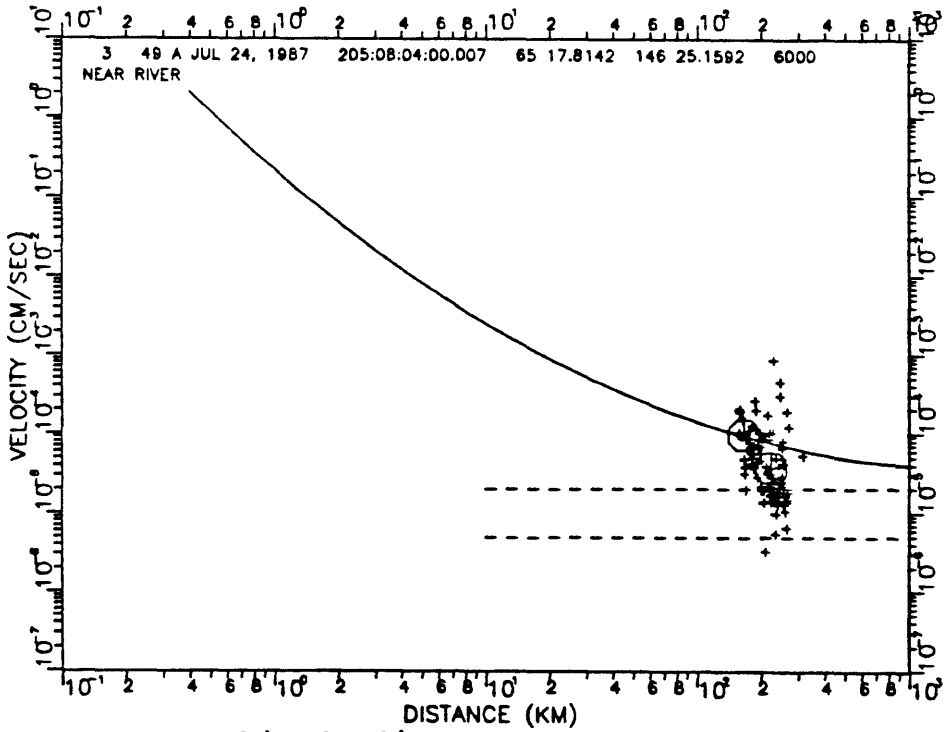

Figure A57. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 3, shot point 49. See page A1 for complete description.

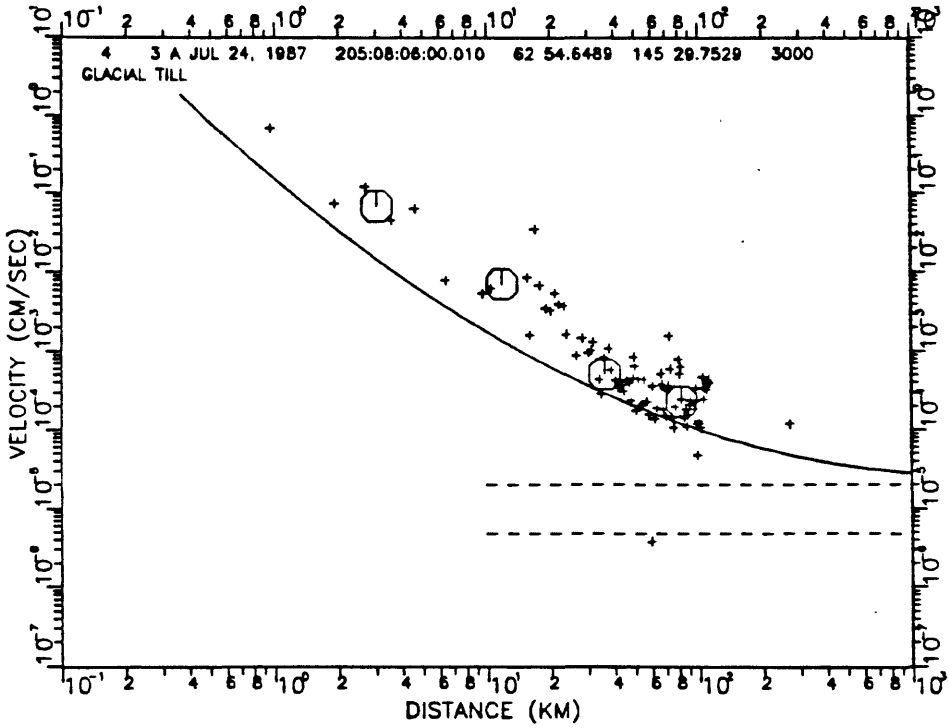

Figure A58. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 4, shot point 3. See page A1 for complete description.

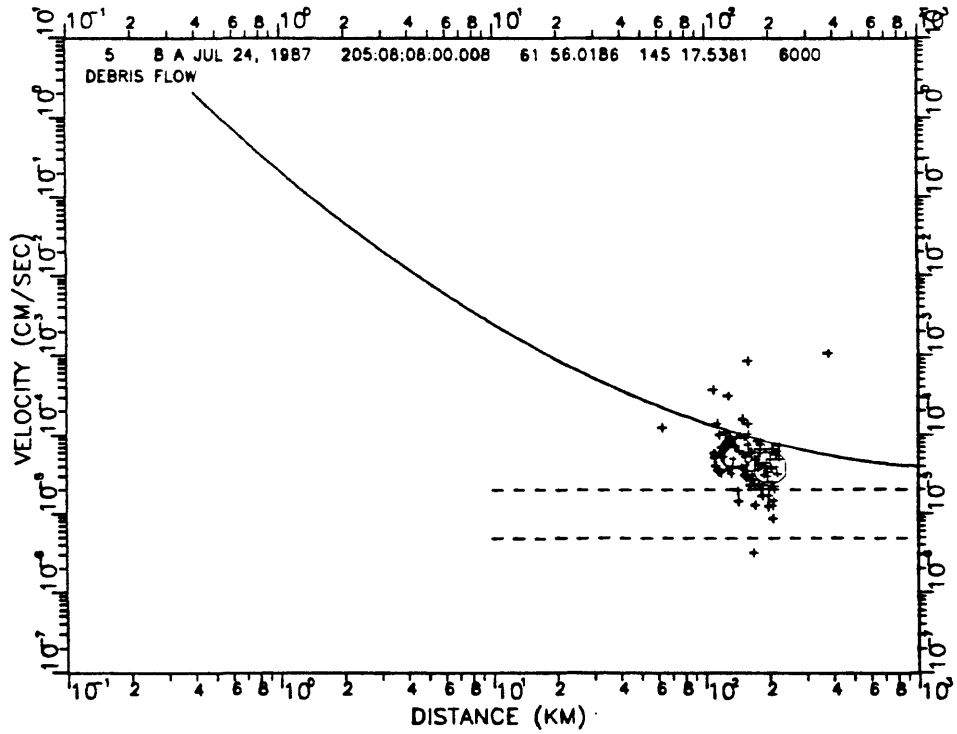

Figure A59. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 5, shot point 8. See page A1 for complete description.

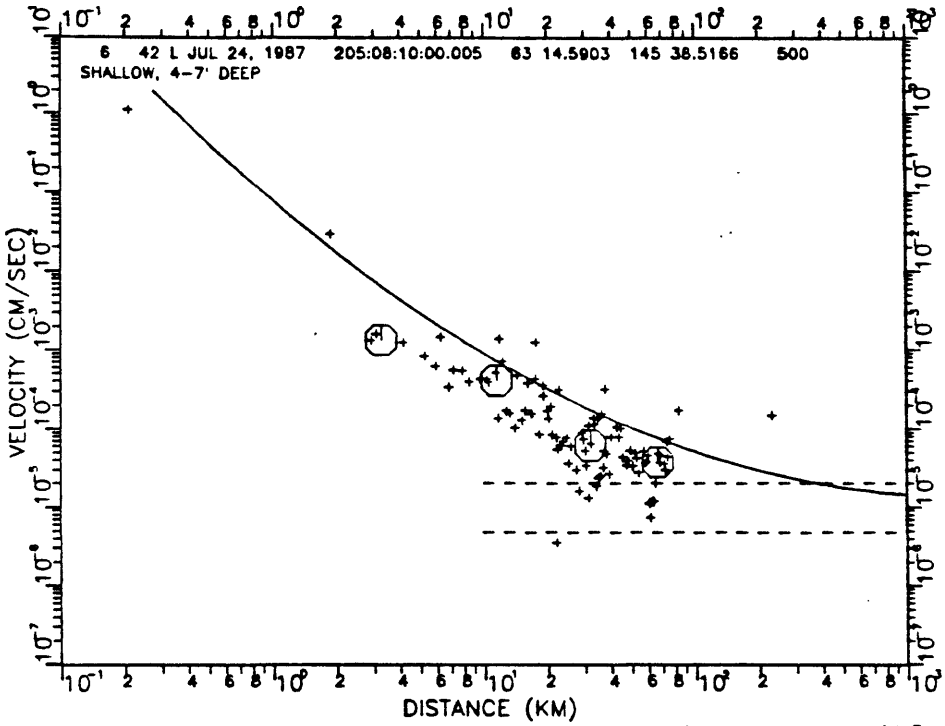

Figure A60. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 6, shot point 42. See page A1 for complete description.

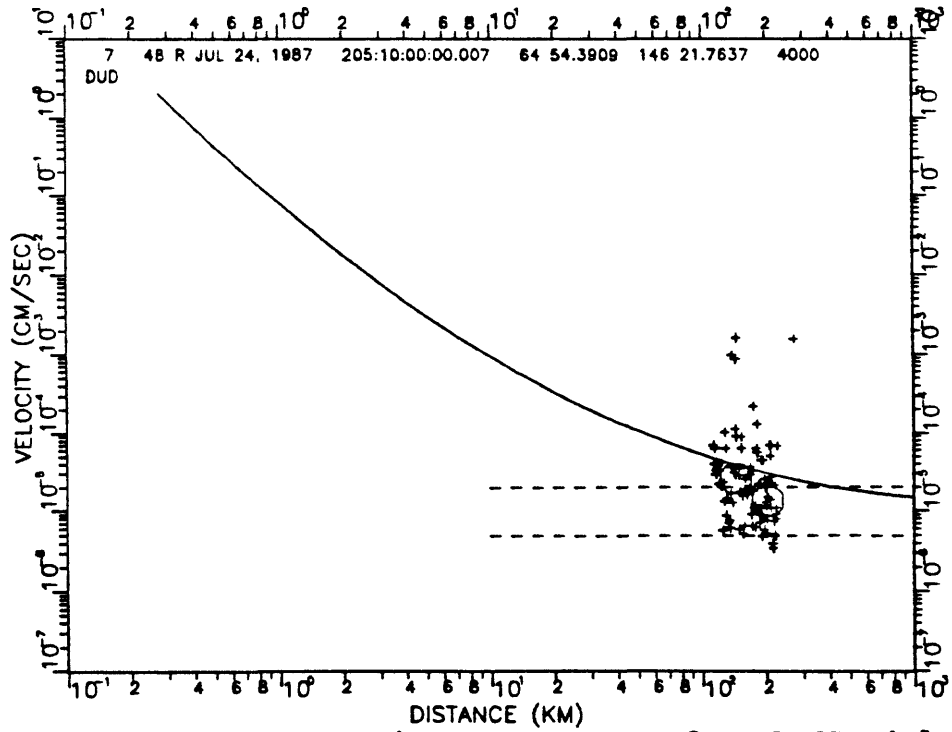

Figure A61. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 7, shot point 48. See page A1 for complete description.

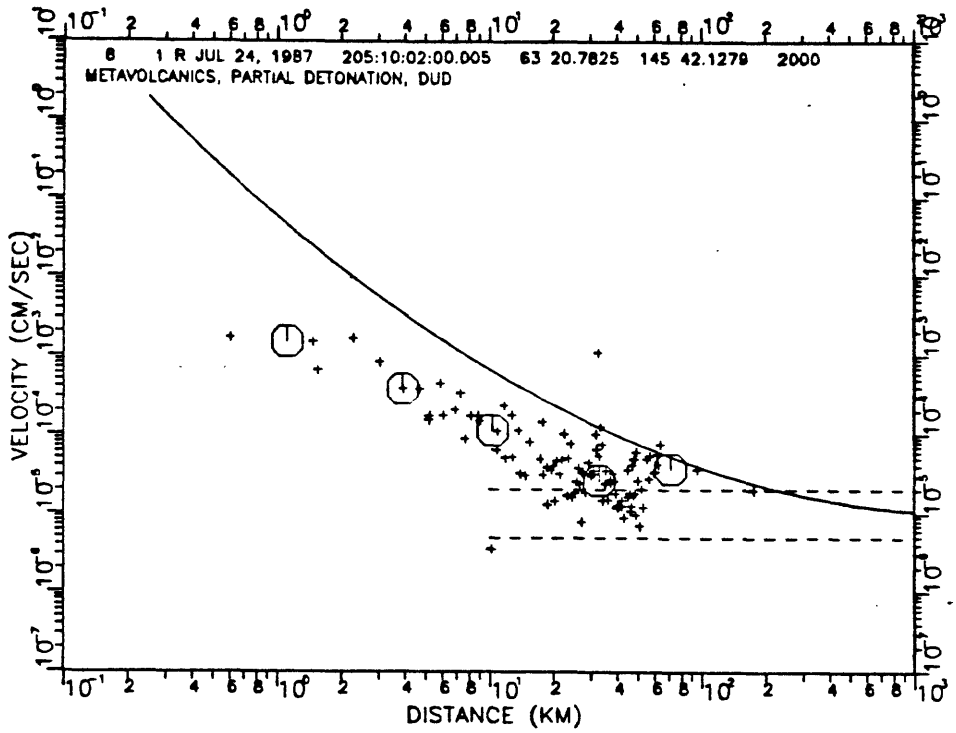

Figure A62. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 8, shot point 1. See page A1 for complete description.

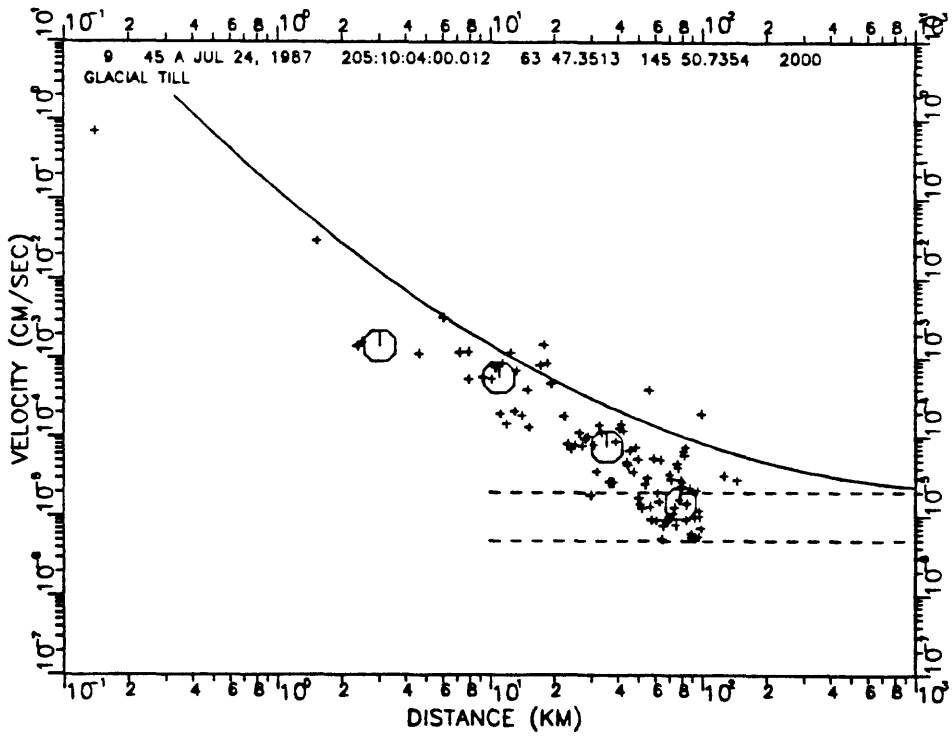

Figure A63. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 9, shot point 45. See page A1 for complete description.

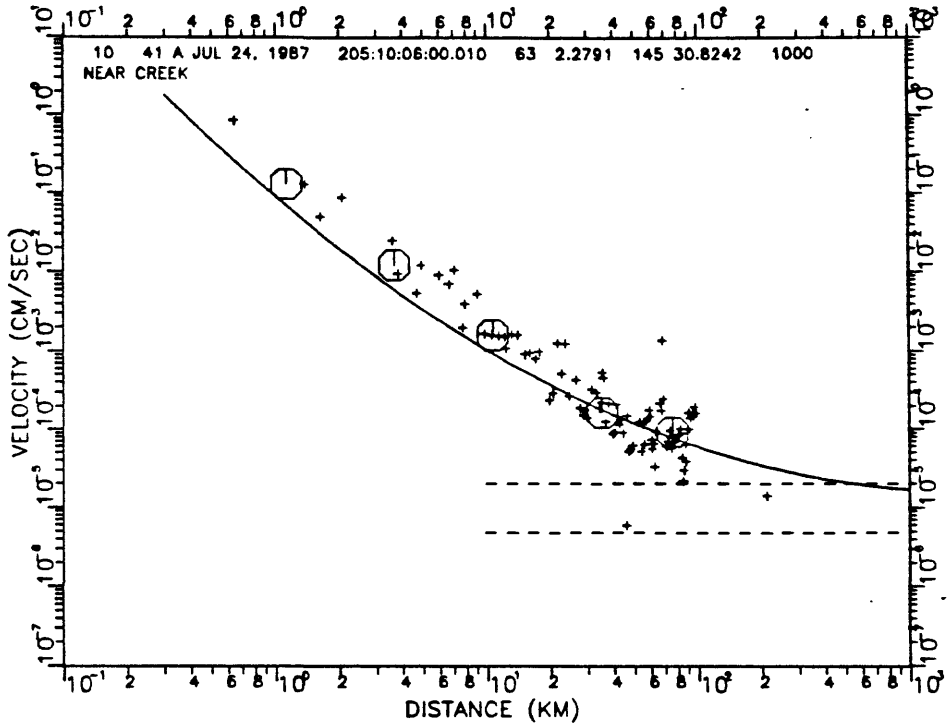

Figure A64. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 10, shot point 41. See page A1 for complete description.

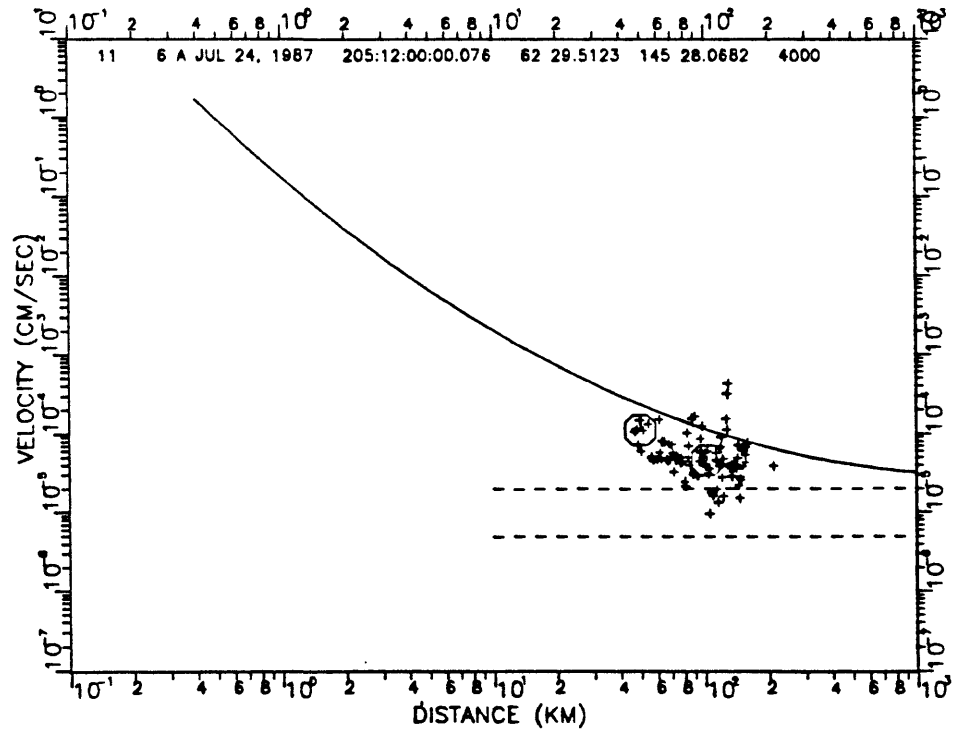

Figure A65. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 11, shot point 6. See page A1 for complete description.

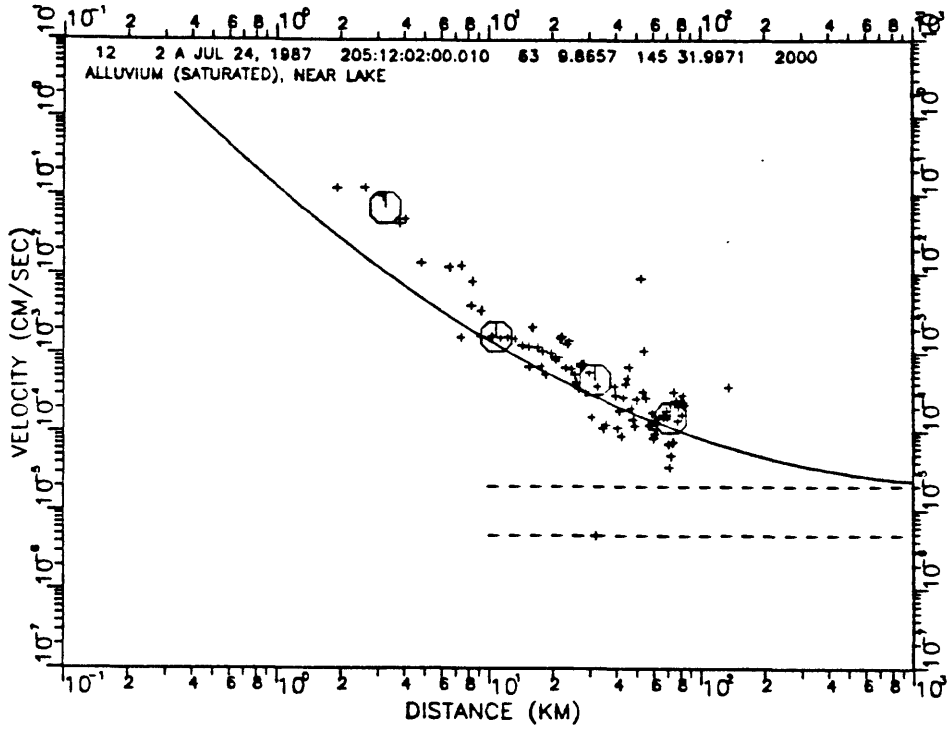

Figure A66. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 12, shot point 2. See page A1 for complete description.

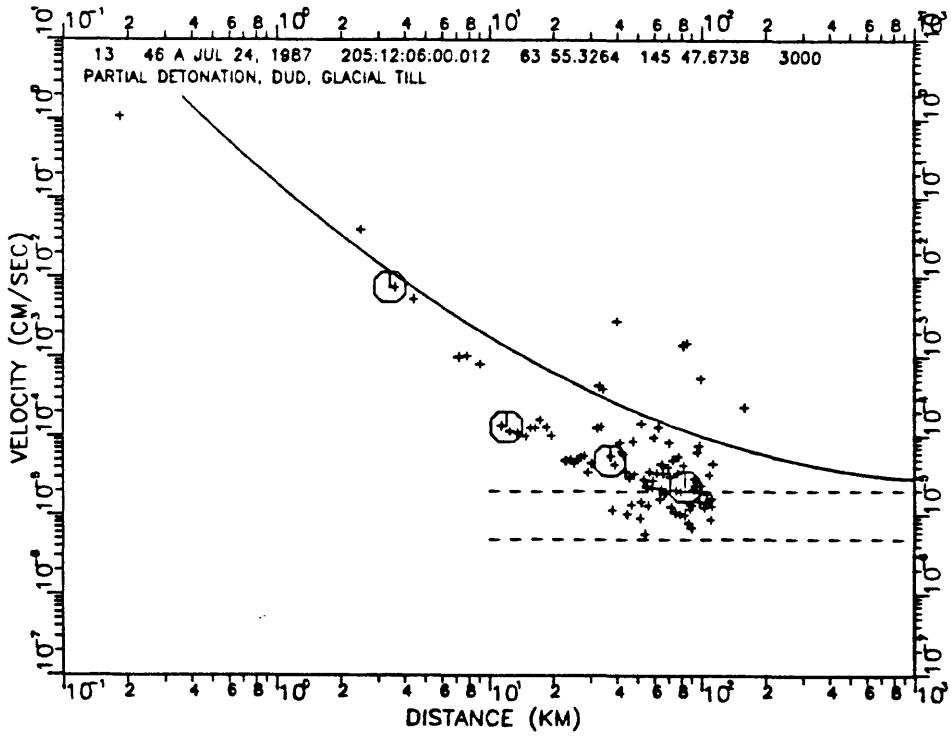

Figure A67. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 13, shot point 46. See page A1 for complete description.

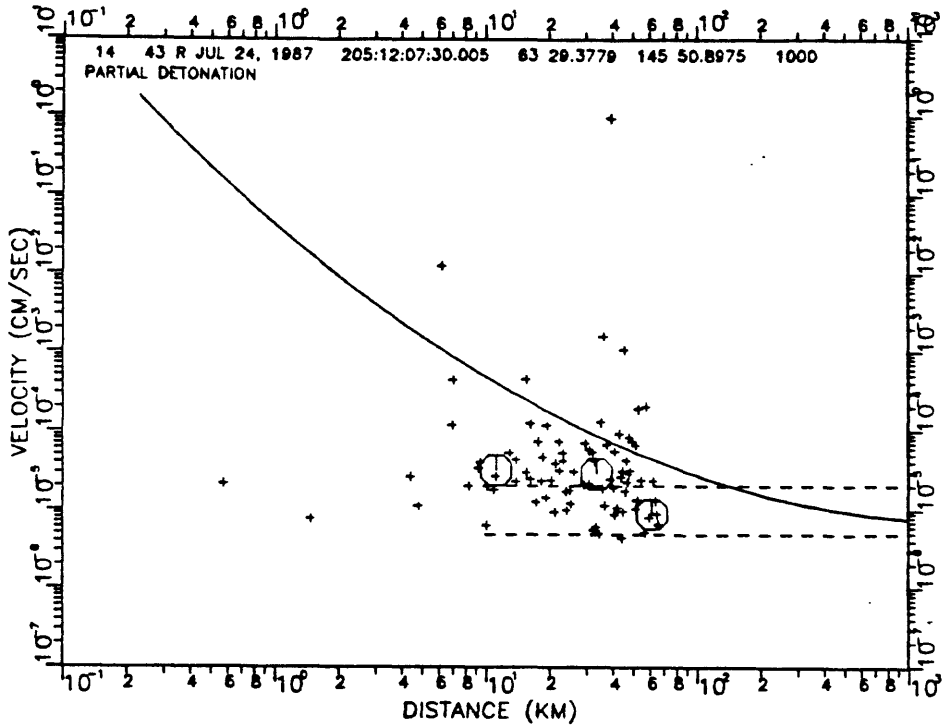

Figure A68. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 14, shot point 43. See page A1 for complete description.

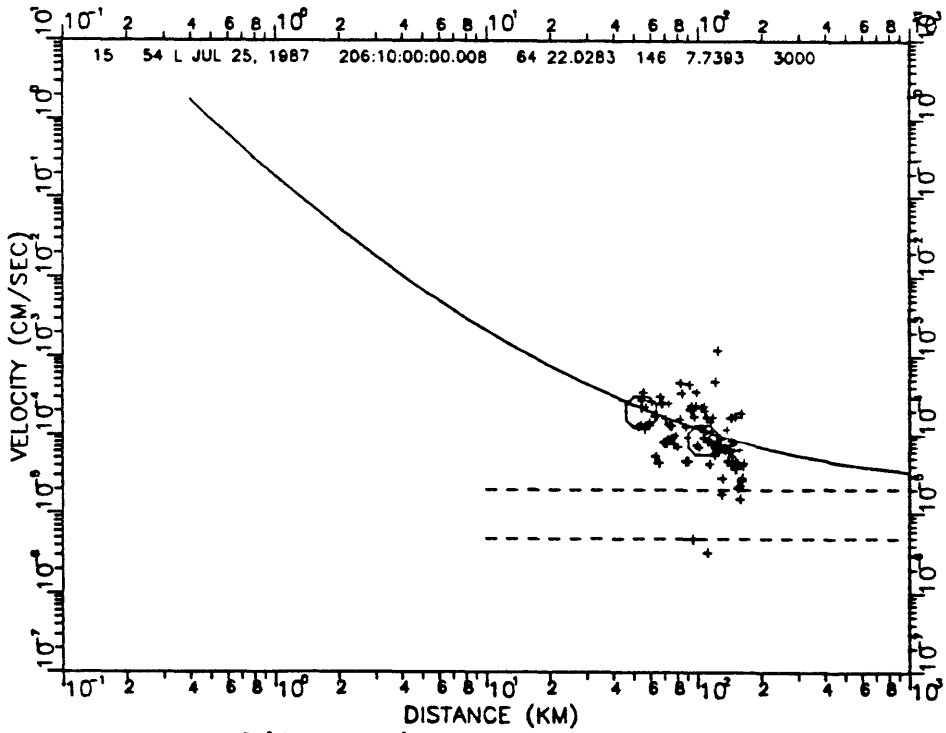

Figure A69. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 15, shot point 54. See page A1 for complete description.

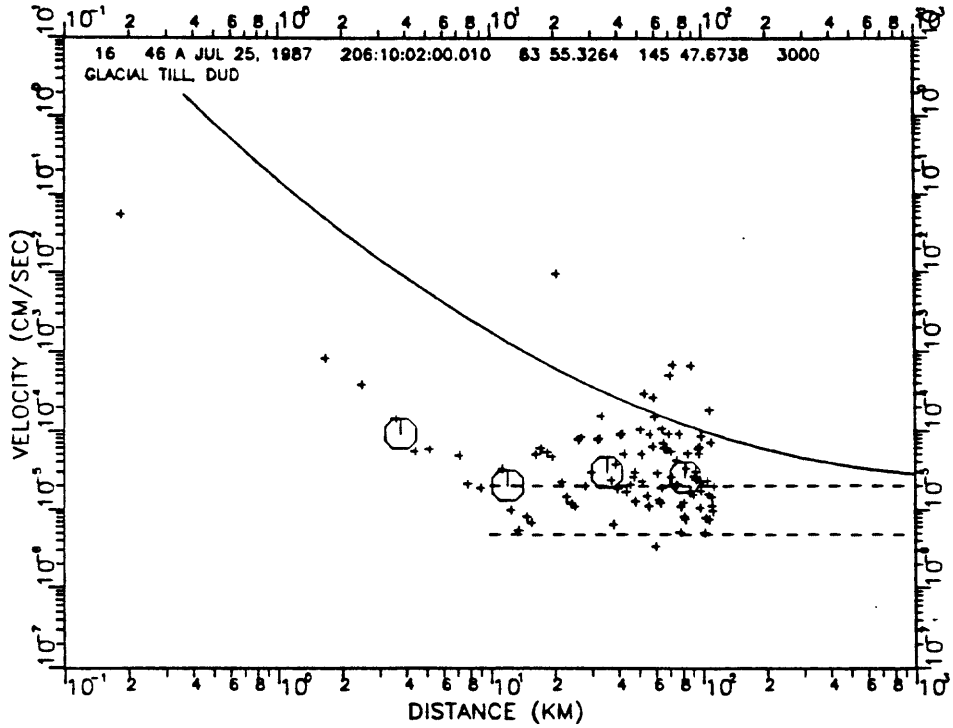

Figure A70. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 16, shot point 46. See page A1 for complete description.

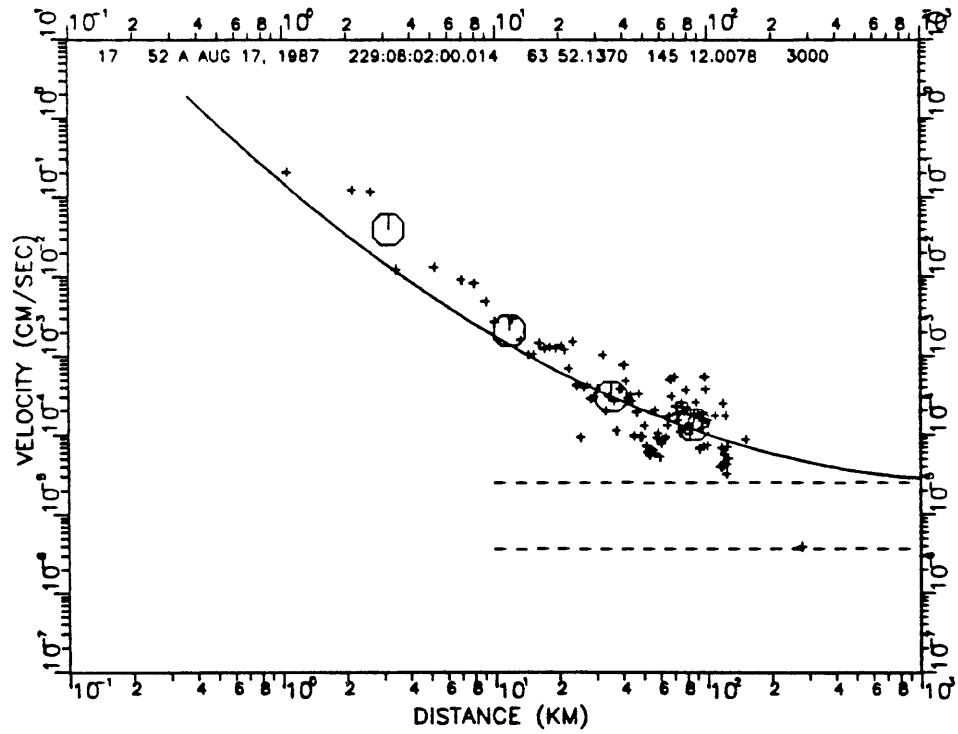

Figure A71. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 17, shot point 52. See page A1 for complete description.

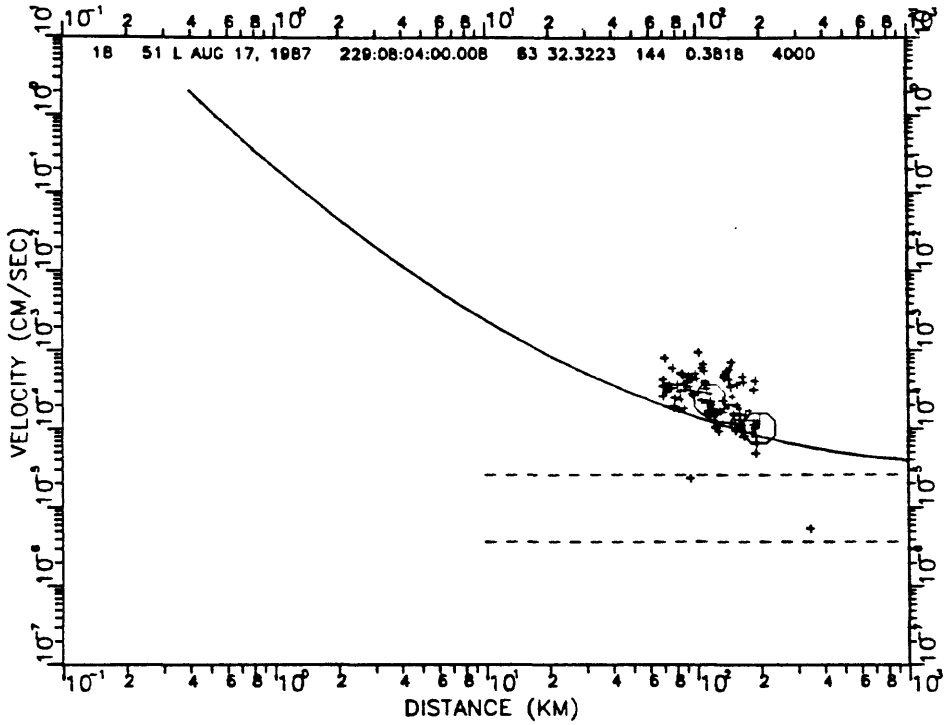

Figure A72. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 18, shot point 51. See page A1 for complete description.

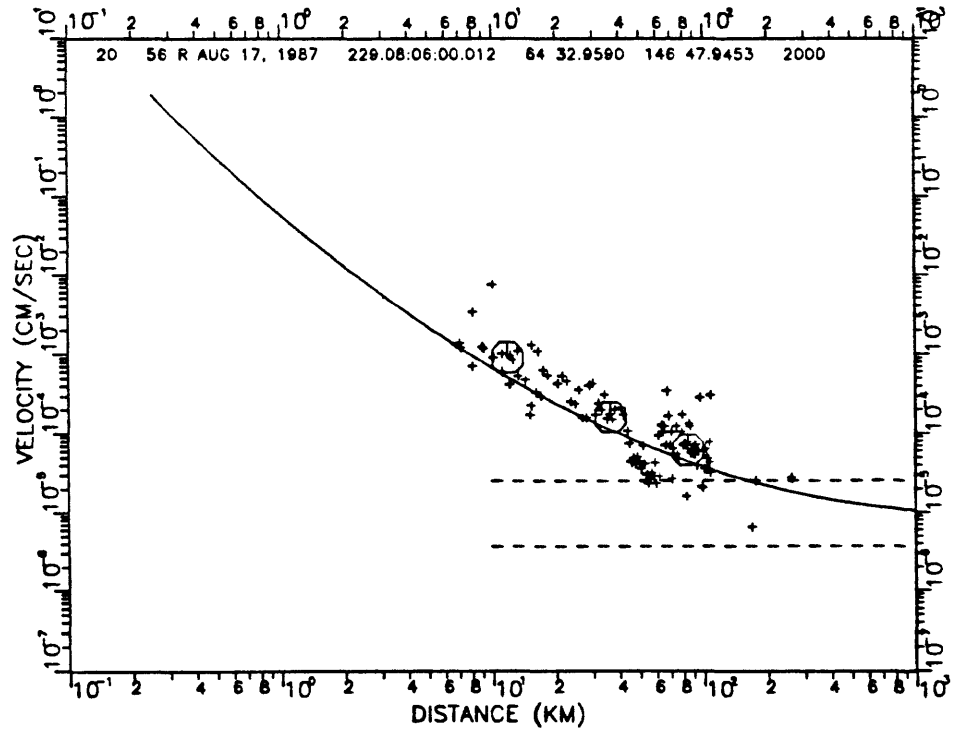

Figure A73. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 20, shot point 56. See page A1 for complete description.

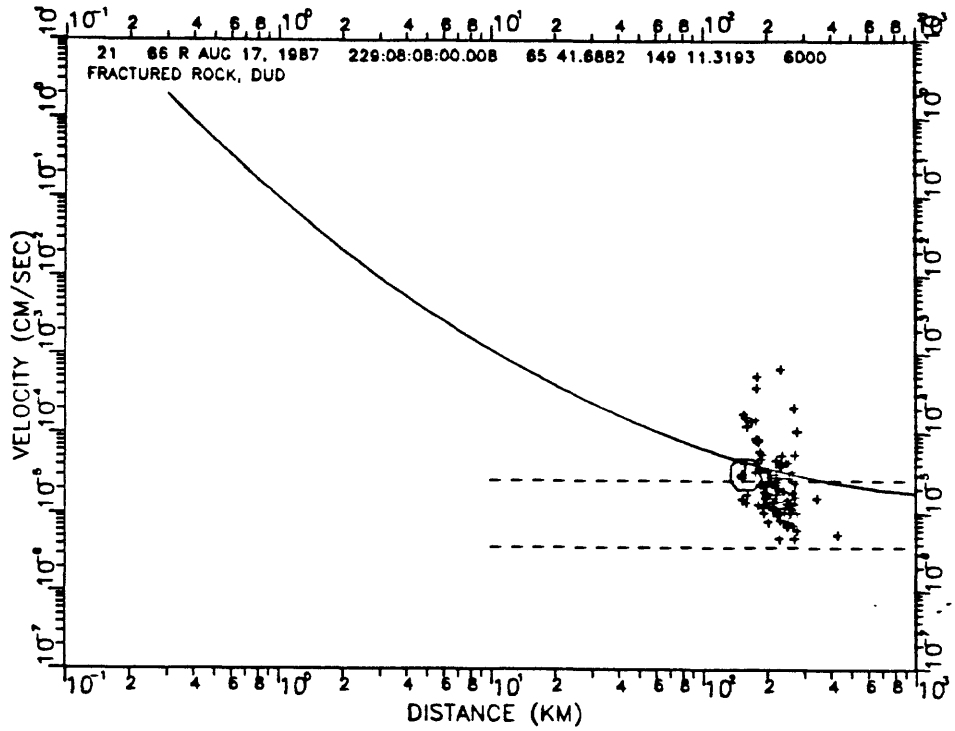

Figure A74. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 21, shot point 66. See page A1 for complete description.

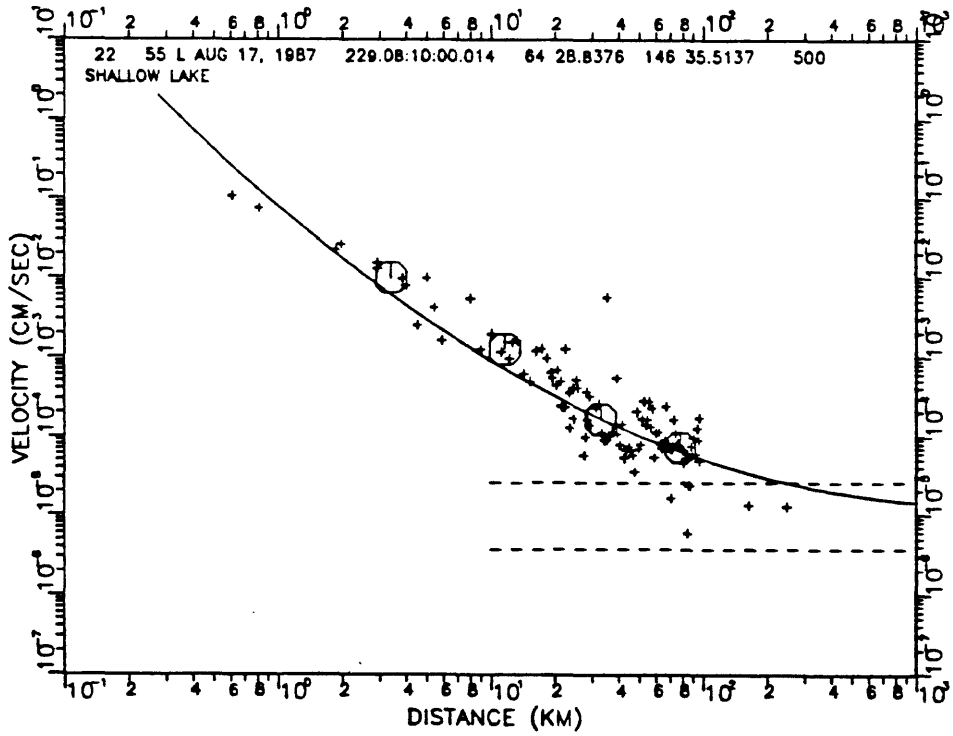

Figure A75. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 22, shot point 55. See page A1 for complete description.

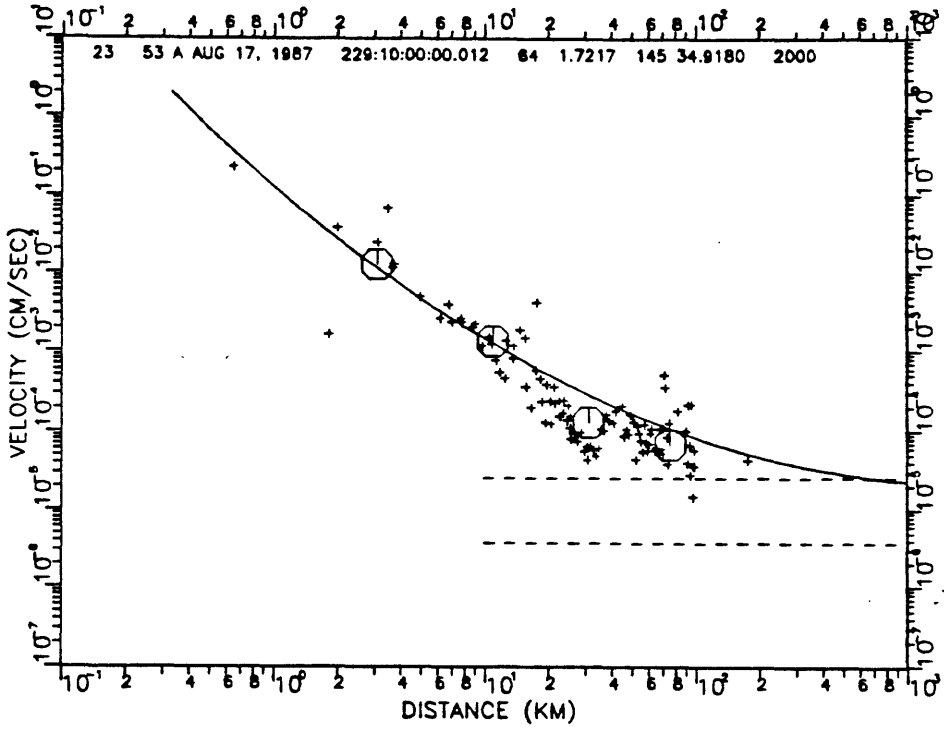

Figure A76. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 23, shot point 53. See page A1 for complete description.

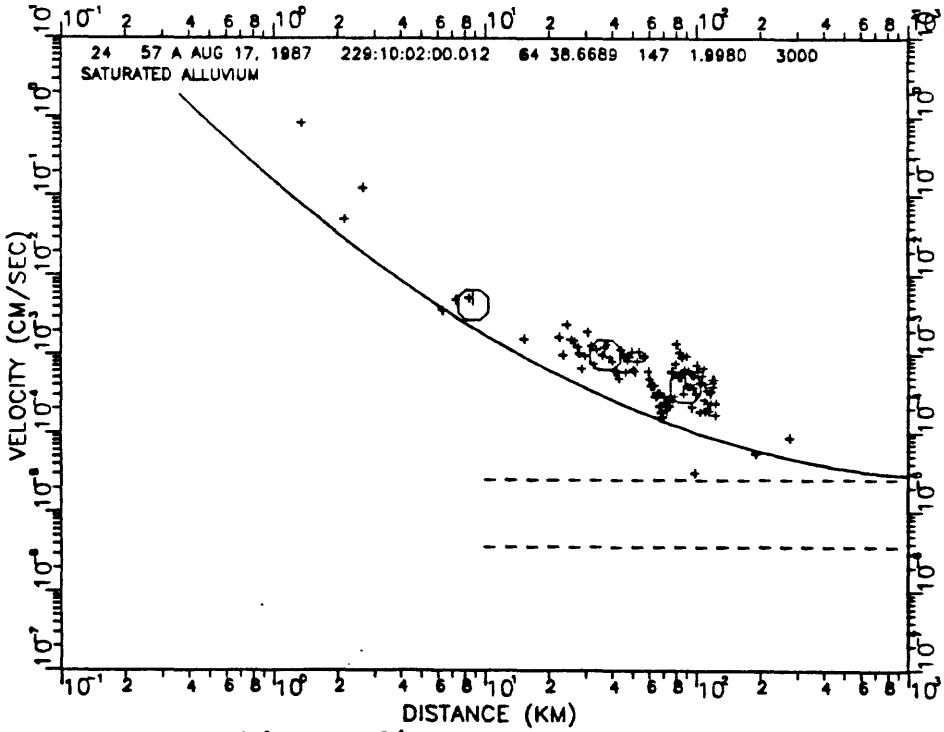

Figure A77. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 24, shot point 57. See page A1 for complete description.

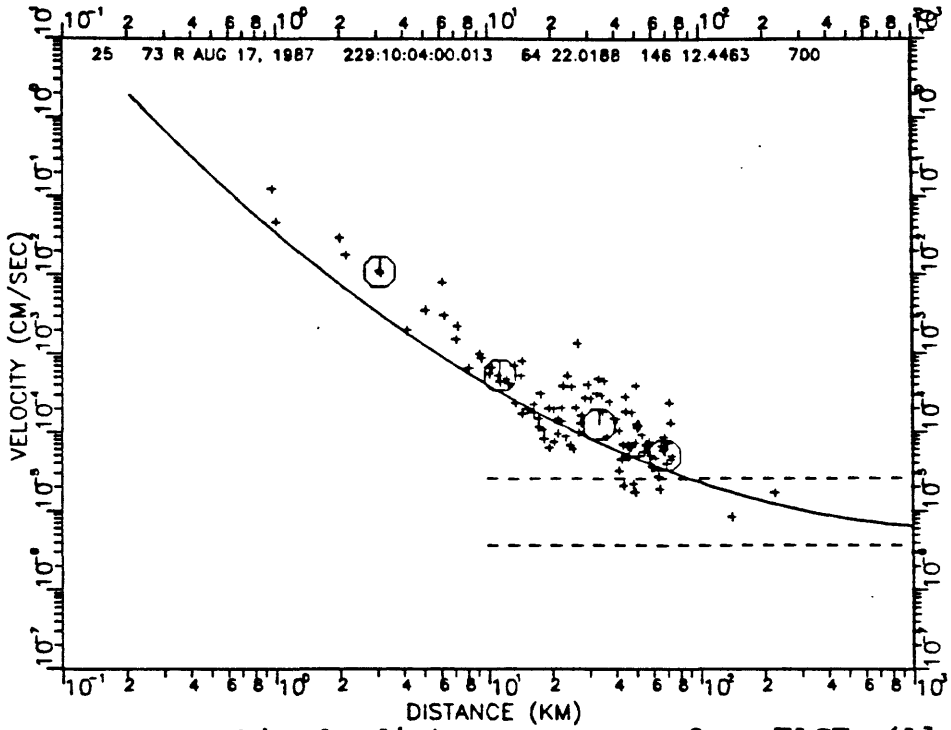

Figure A78. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 25, shot point 73. See page A1 for complete description.

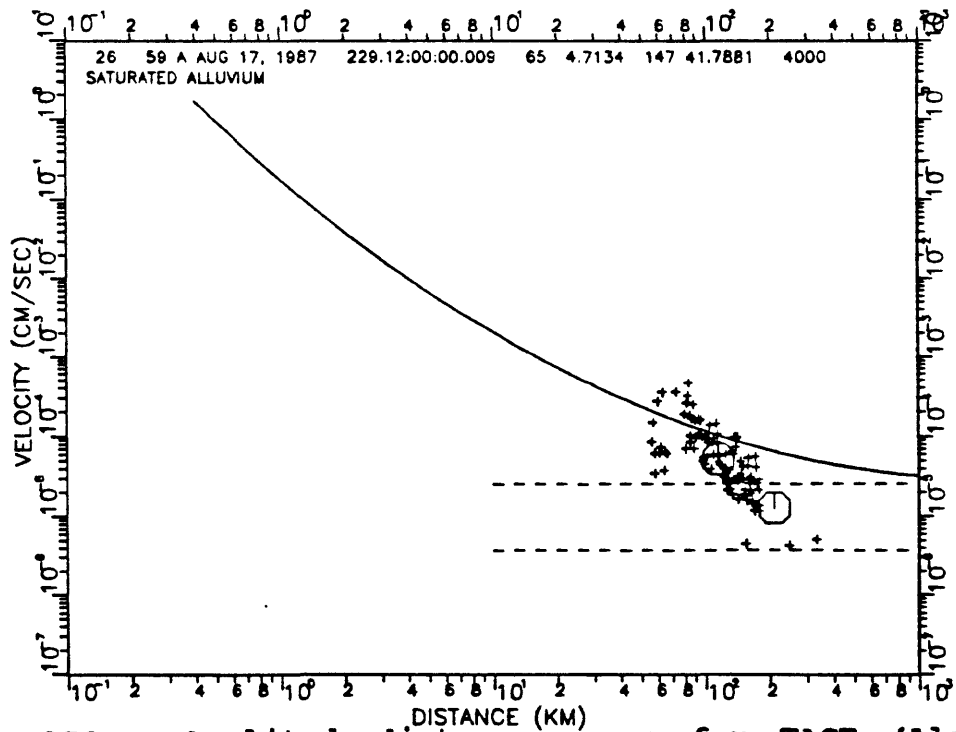

Figure A79. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 26, shot point 59. See page A1 for complete description.

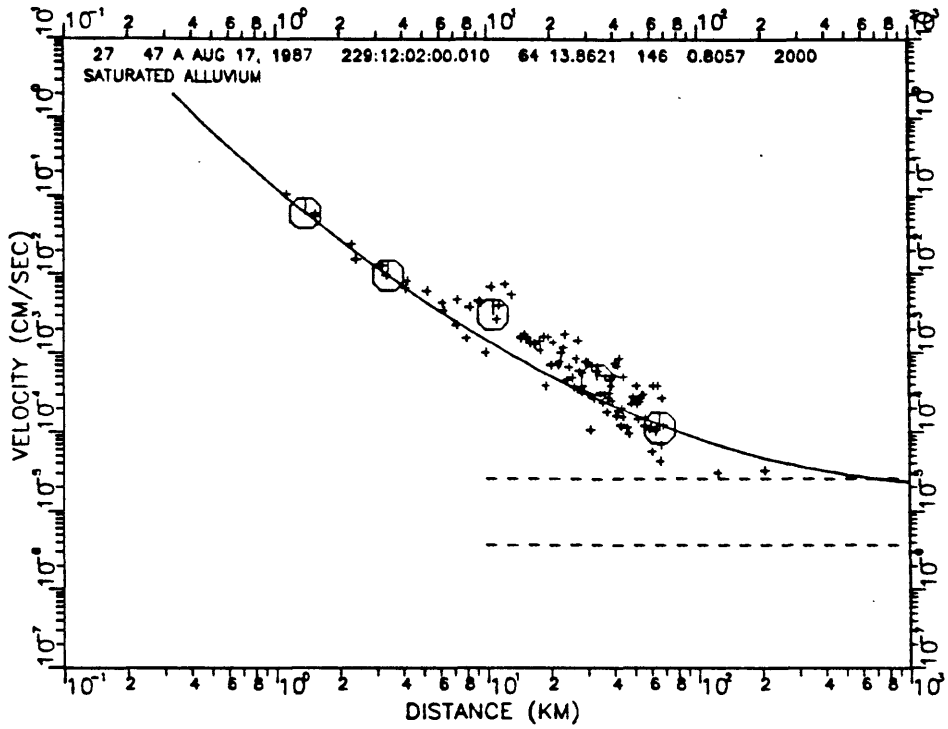

Figure A80. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 27, shot point 47. See page A1 for complete description.

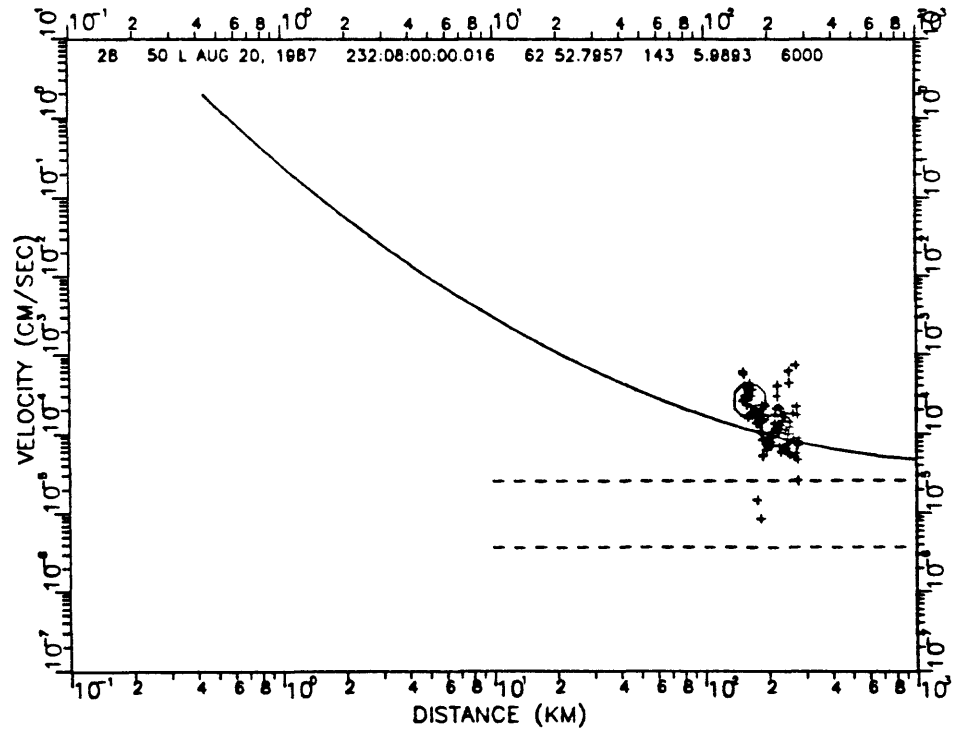

Figure A81. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part A, shot 28, shot point 50. See page A1 for complete description.

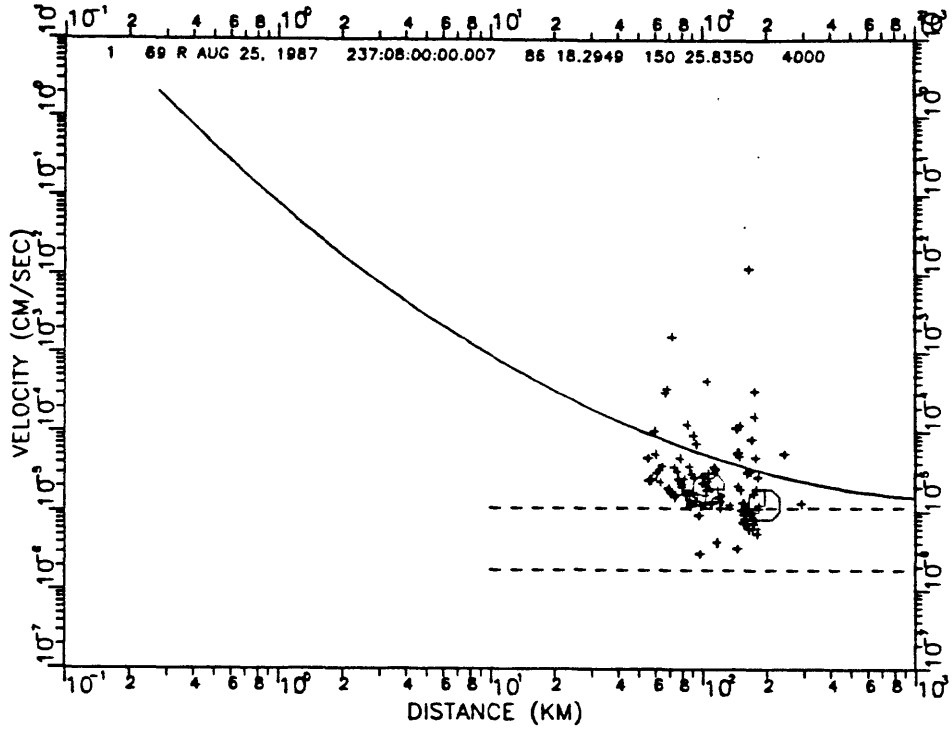

Figure A82. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 1, shot point 69. See page A1 for complete description.

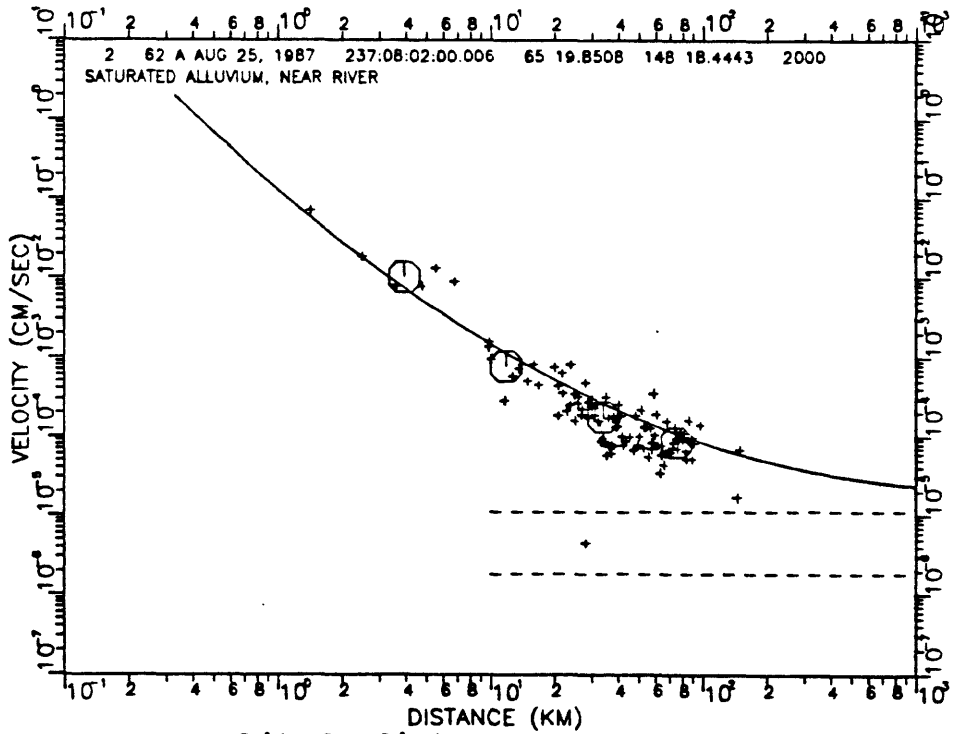

Figure A83. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 2, shot point 62. See page A1 for complete description.

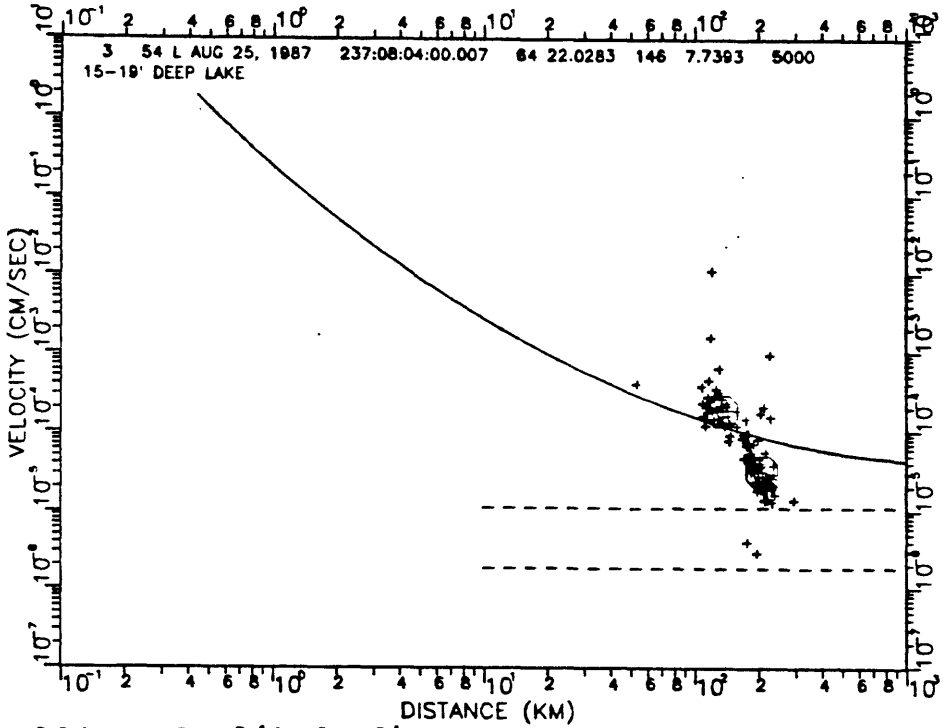

Figure A84. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 3, shot point 54. See page A1 for complete description.

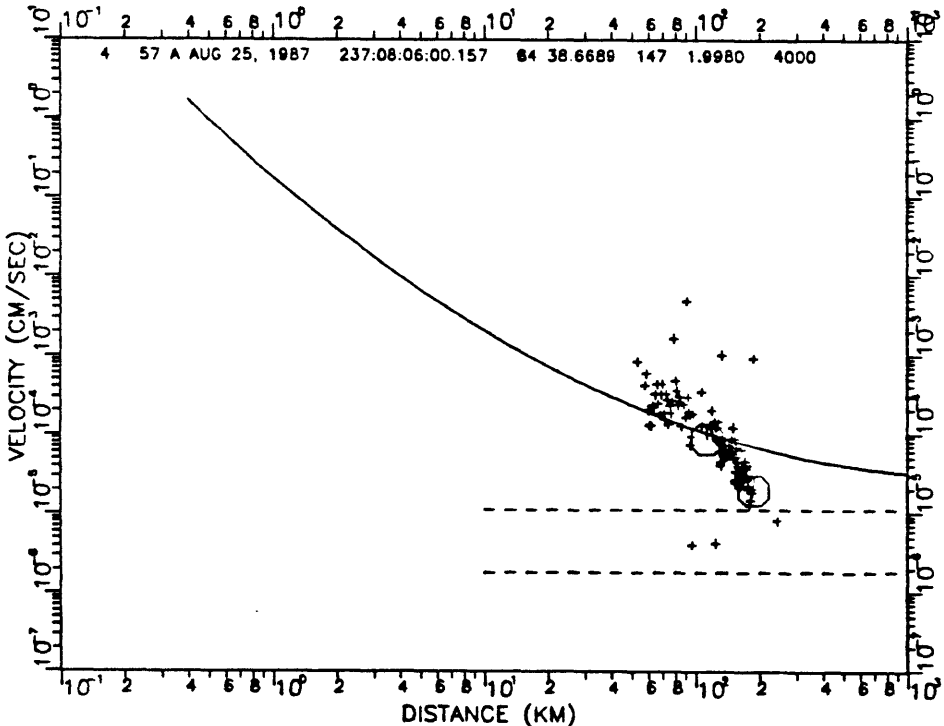

Figure A85. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 4, shot point 57. See page A1 for complete description.

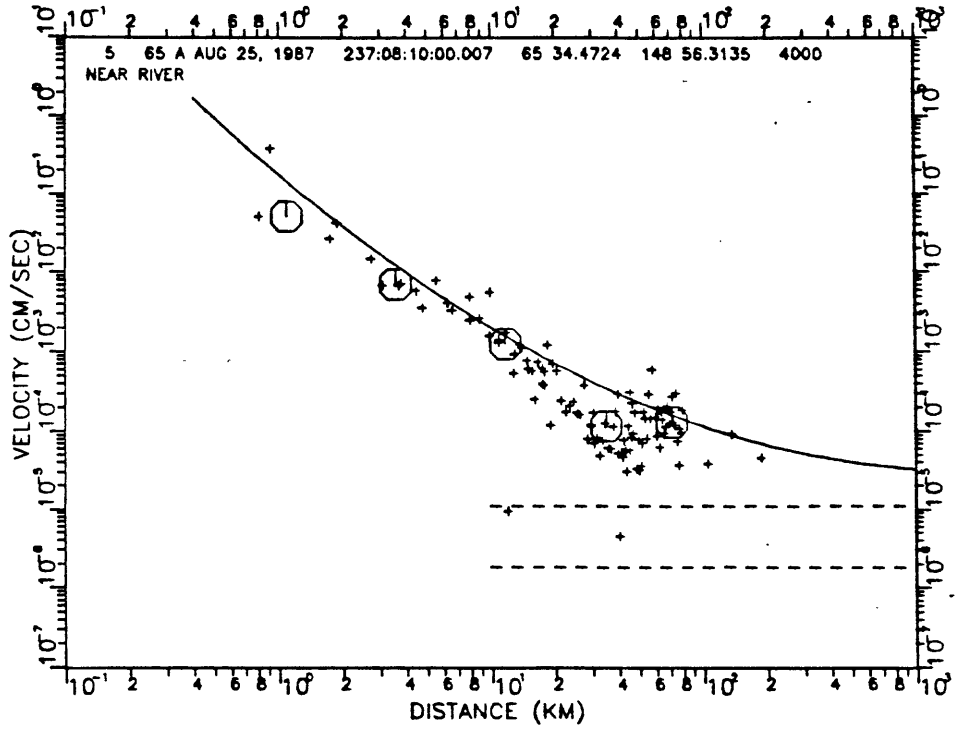

Figure A86. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 5, shot point 65. See page A1 for complete description.

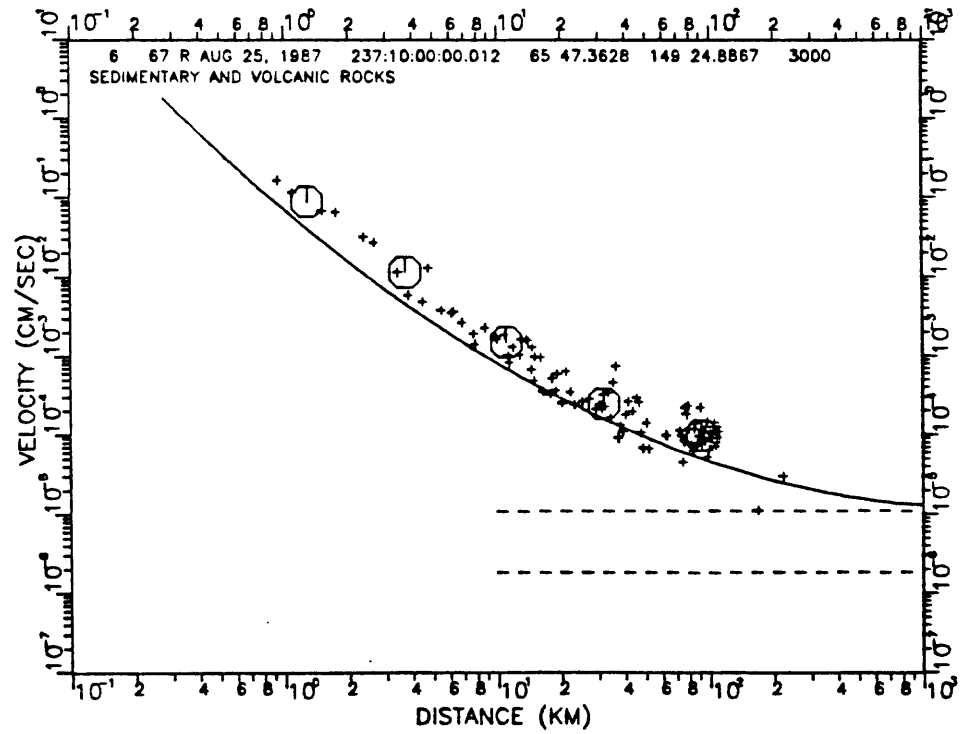

Figure A87. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 6, shot point 66. See page A1 for complete description.

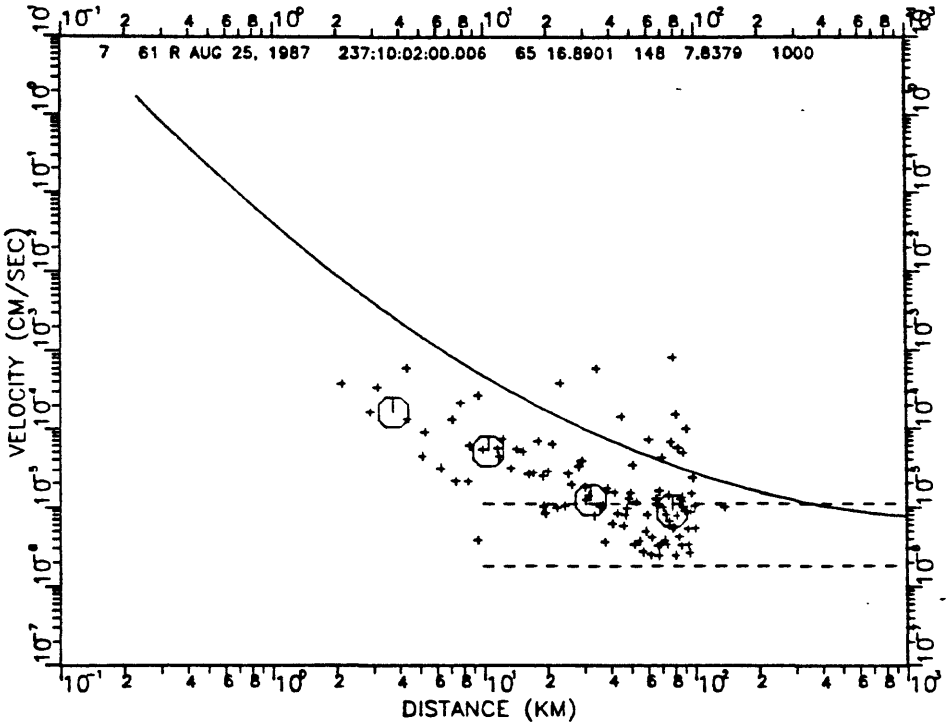

Figure A88. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 7, shot point 61. See page A1 for complete description.

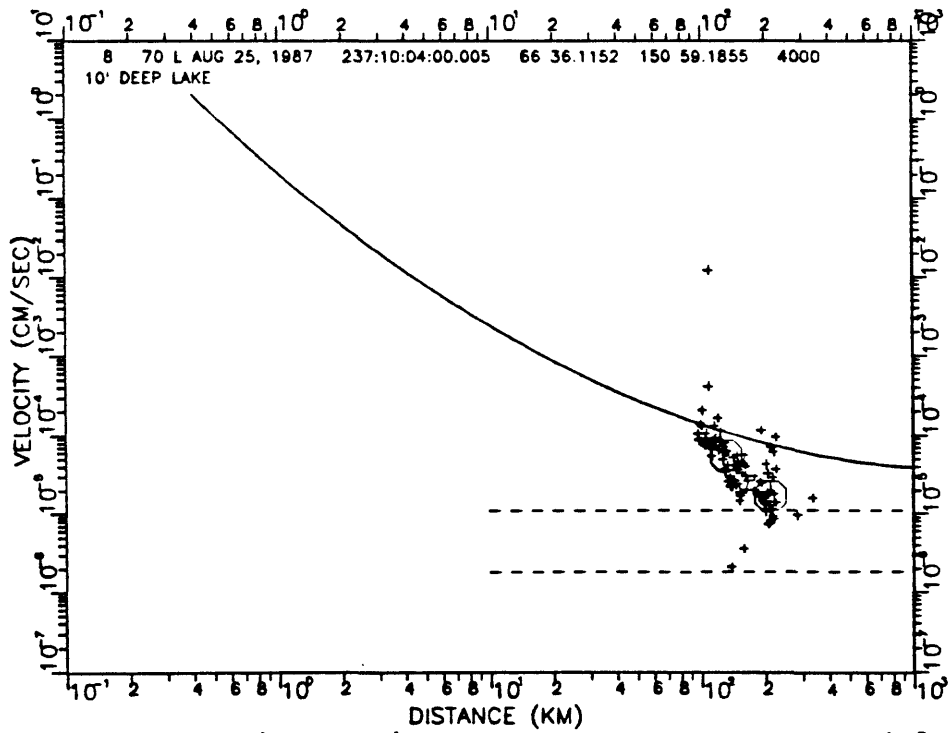

Figure A89. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 8, shot point 70. See page A1 for complete description.

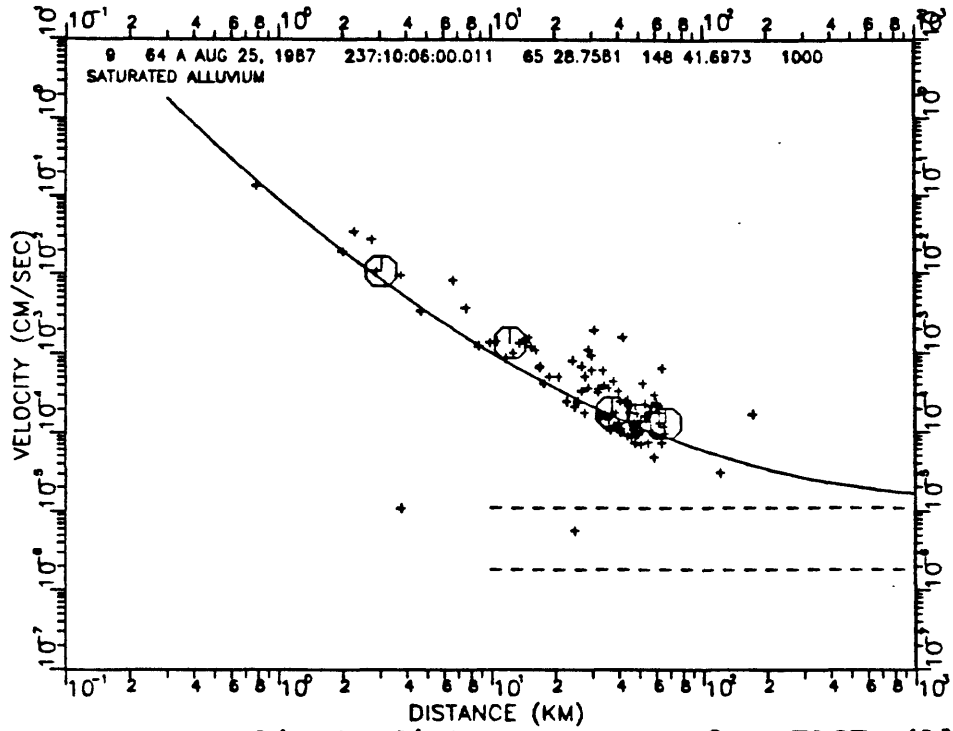

Figure A90. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 9, shot point 64. See page A1 for complete description.

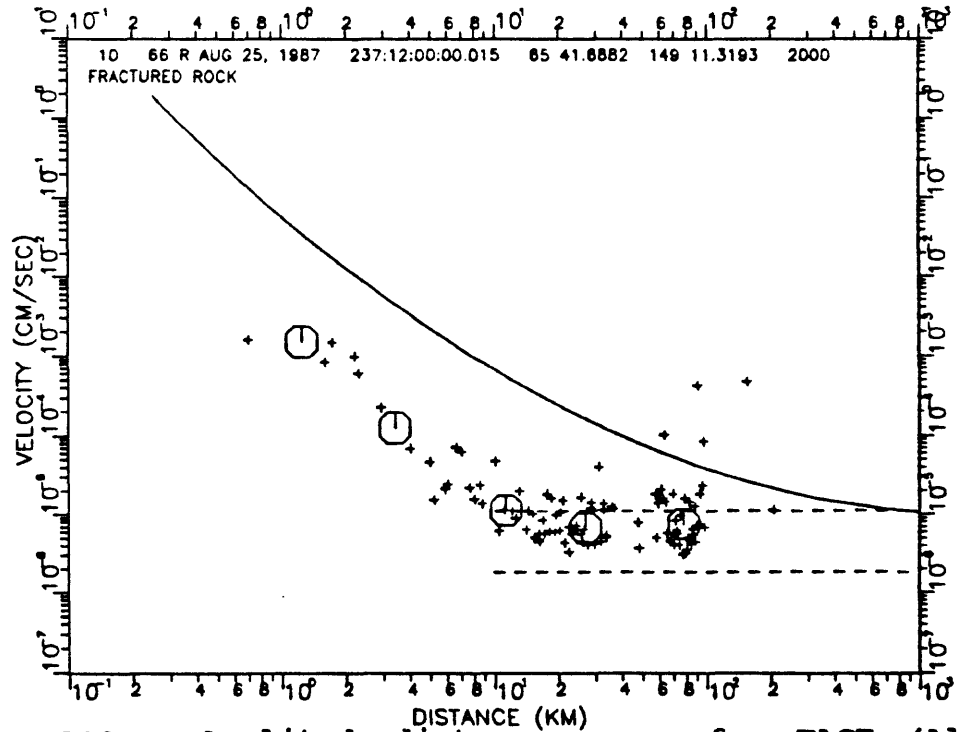

Figure A91. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 10, shot point 66. See page A1 for complete description.

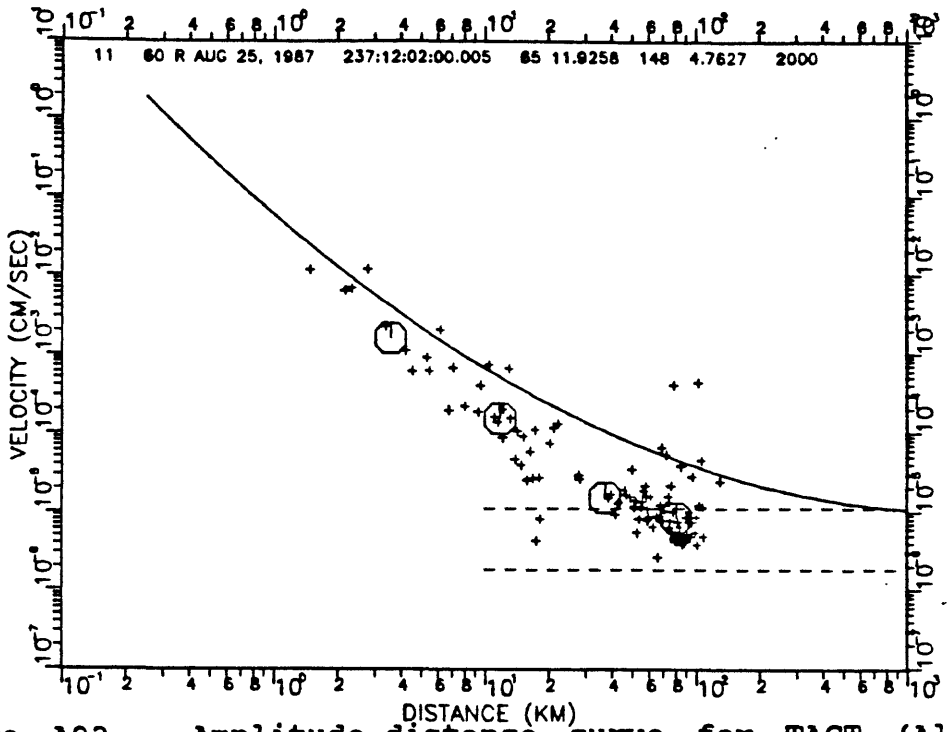

Figure A92. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 11, shot point 60. See page A1 for complete description.

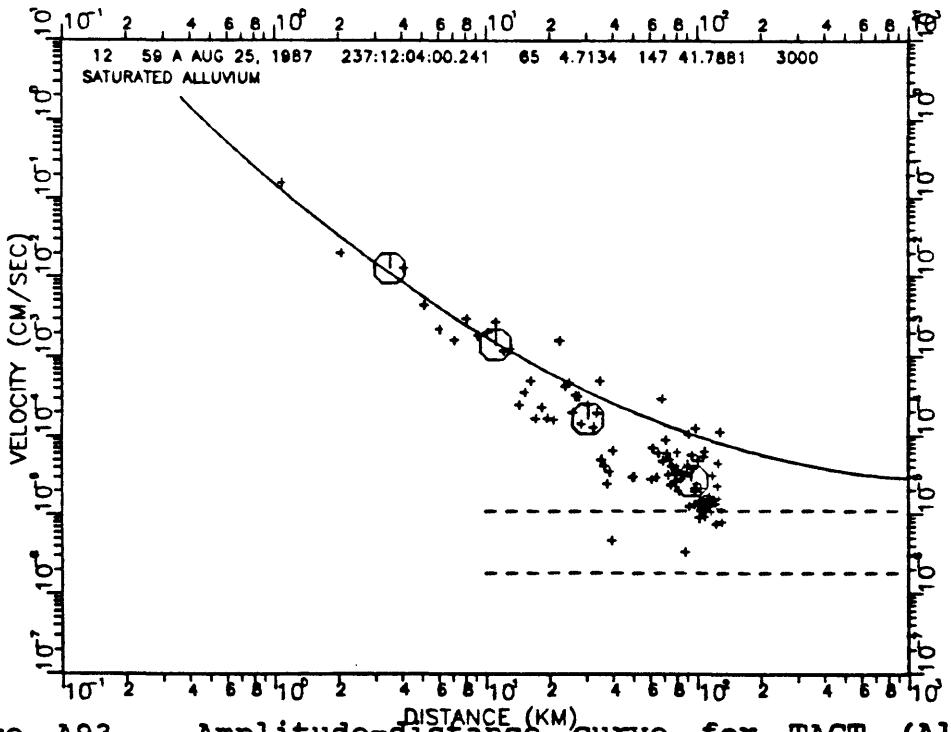

Figure A93. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 12, shot point 59. See page A1 for complete description.

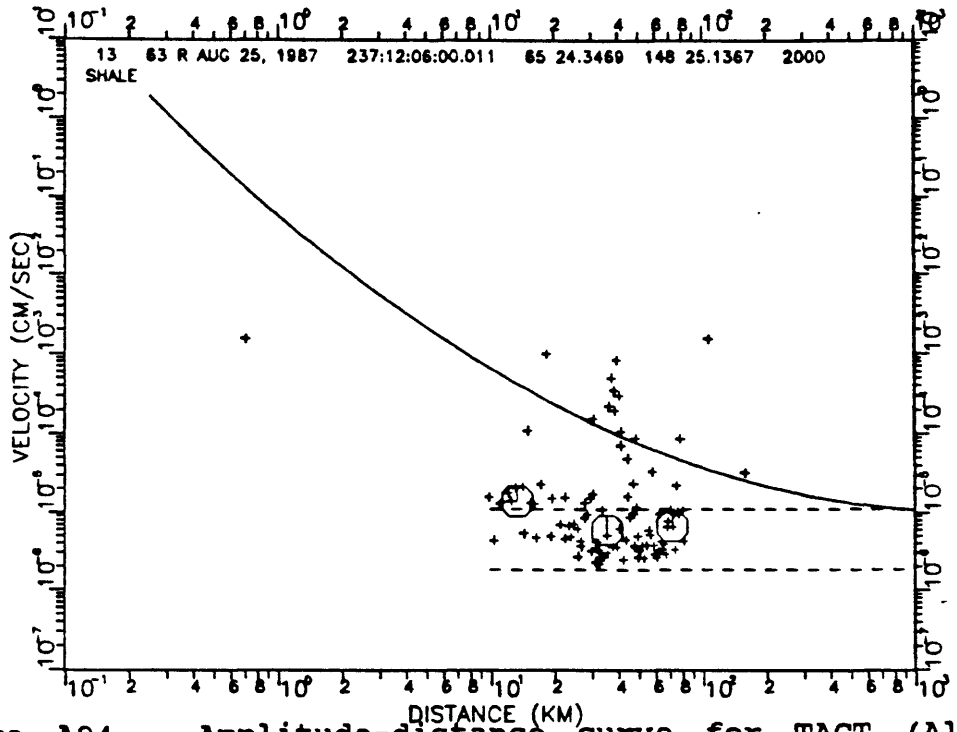

Figure A94. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 13, shot point 63. See page A1 for complete description.

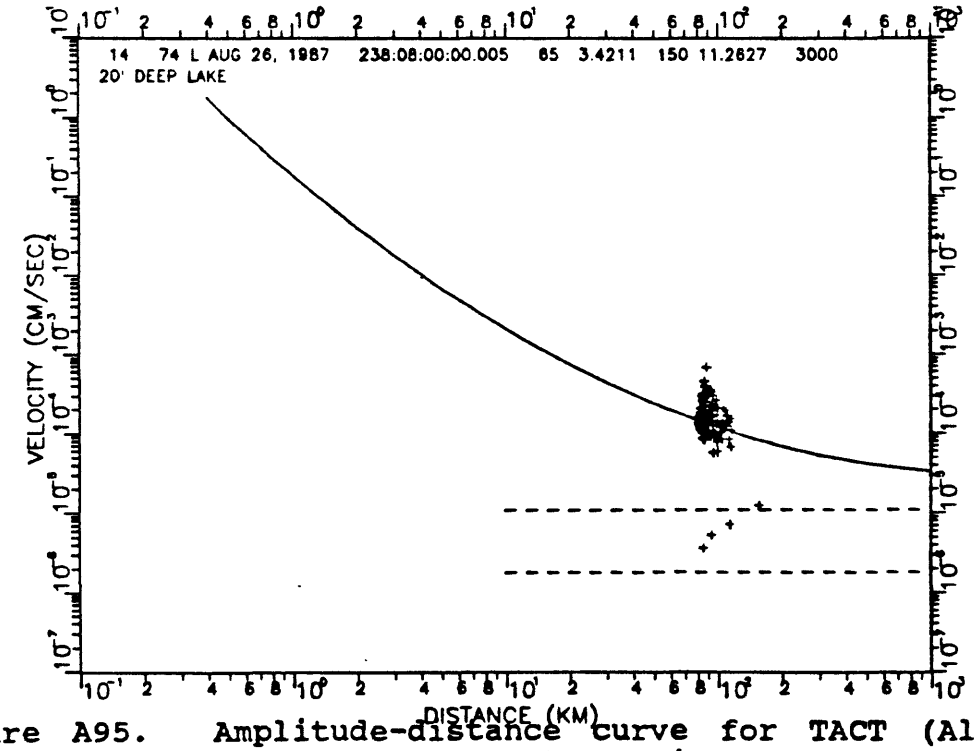

Figure A95. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 14, shot point 74. See page A1 for complete description.

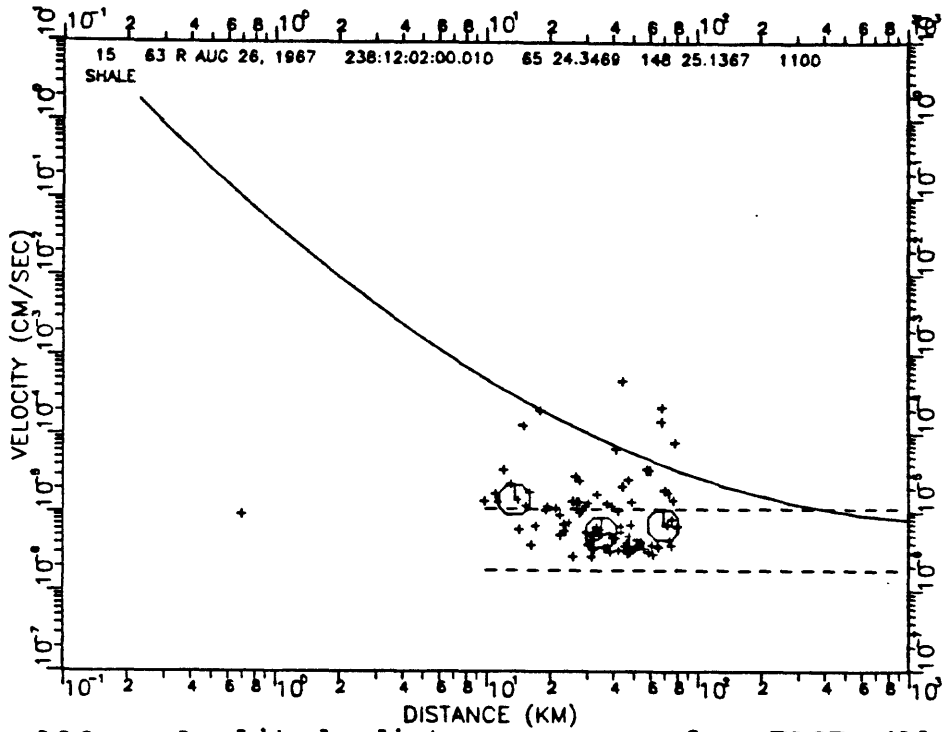

Figure A96. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 15, shot point 63. See page A1 for complete description.

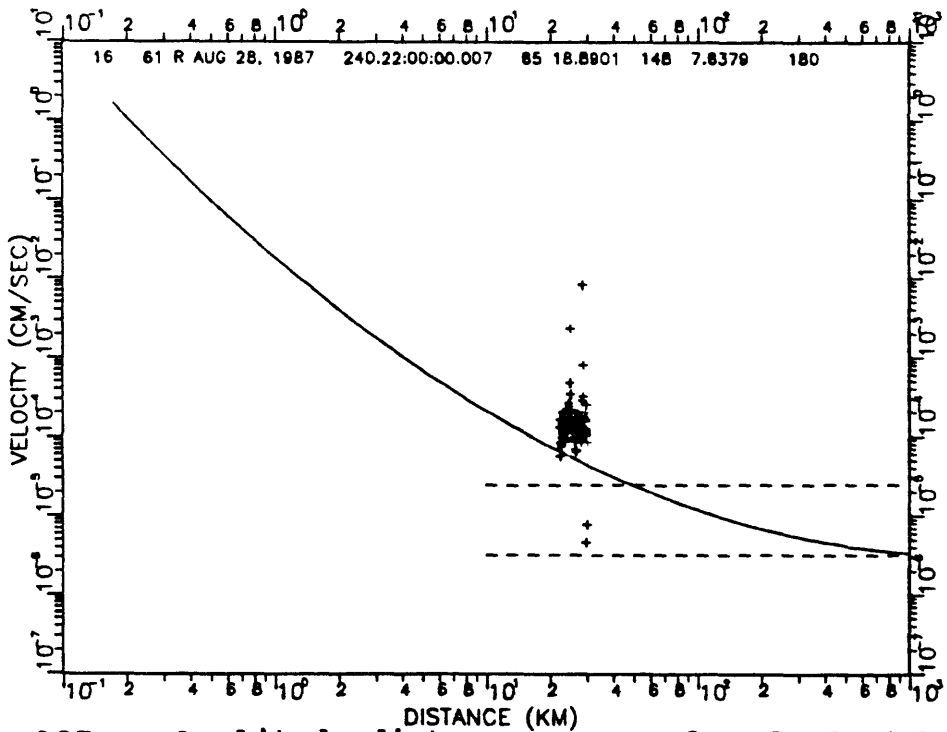

Figure A97. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 16, shot point 61. See page A1 for complete description.

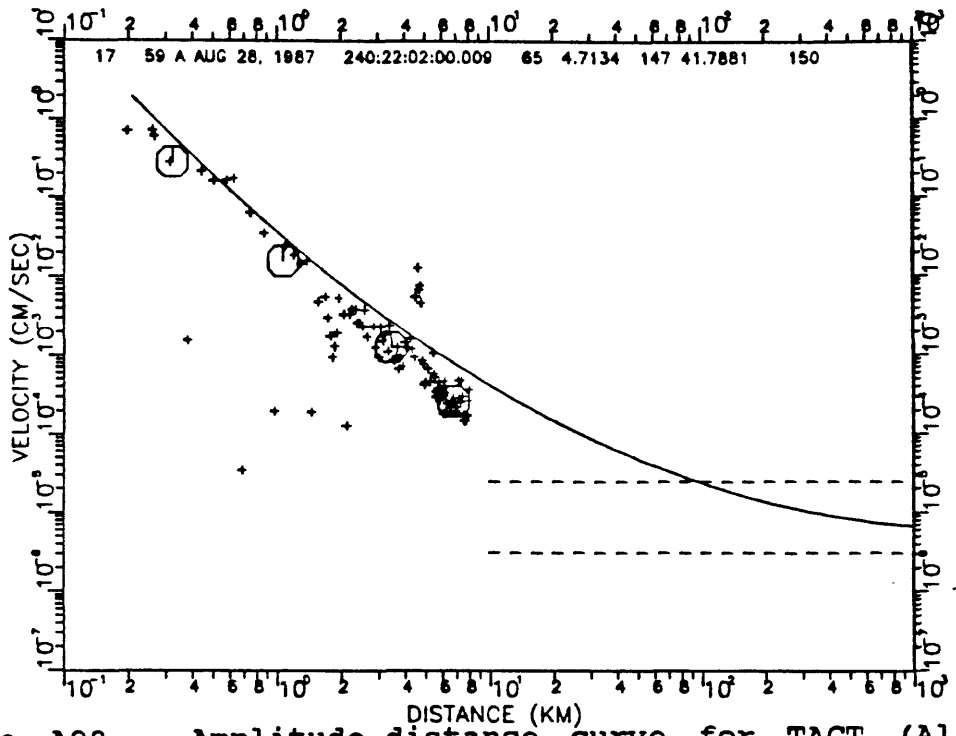

Figure A98. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 17, shot point 59. See page A1 for complete description.

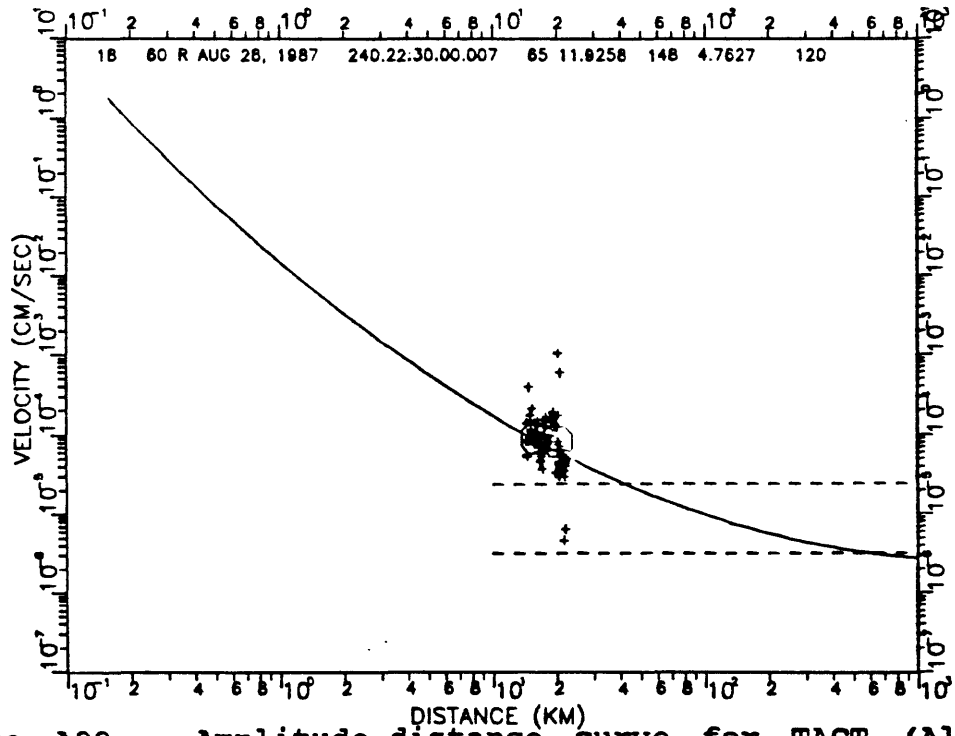

Figure A99. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 18, shot point 60. See page A1 for complete description.

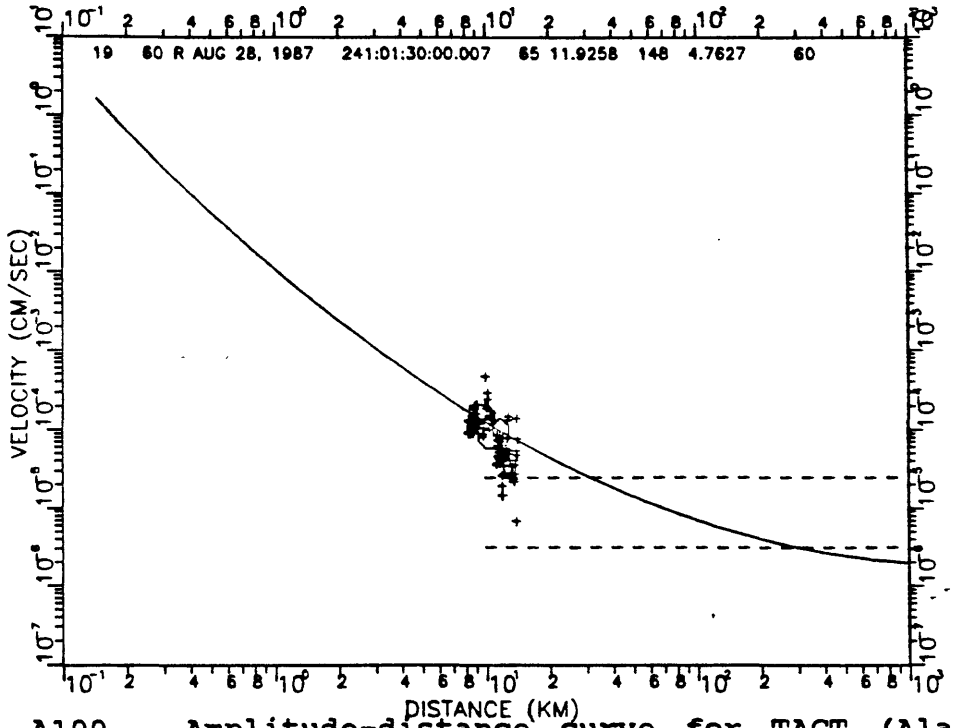

Figure A100. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 19, shot point 60. See page A1 for complete description.

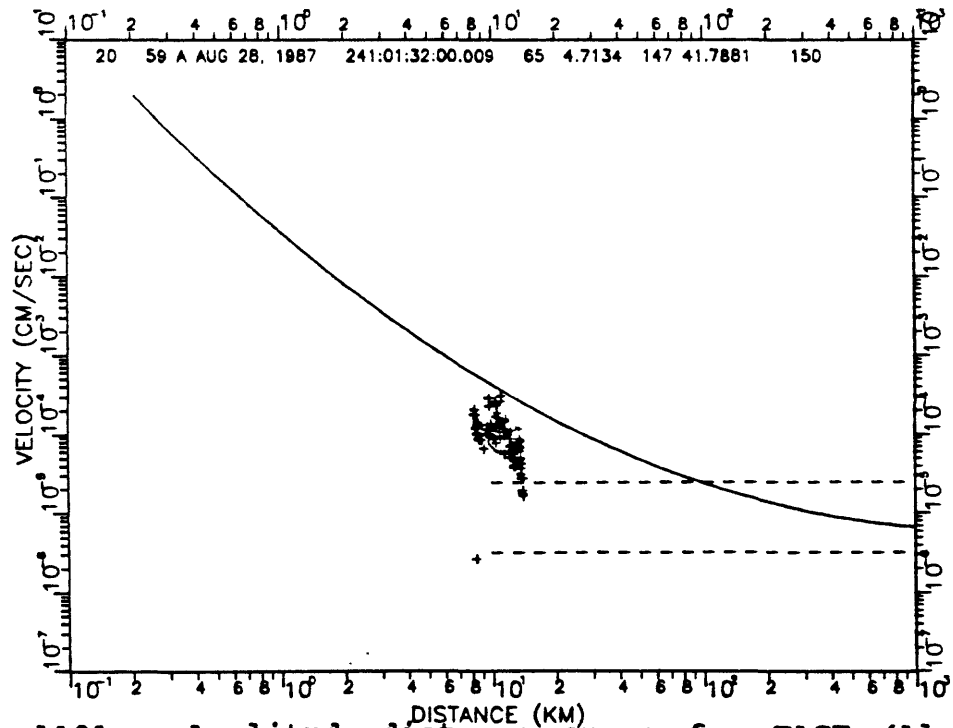

Figure A101. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 20, shot point 59. See page A1 for complete description.

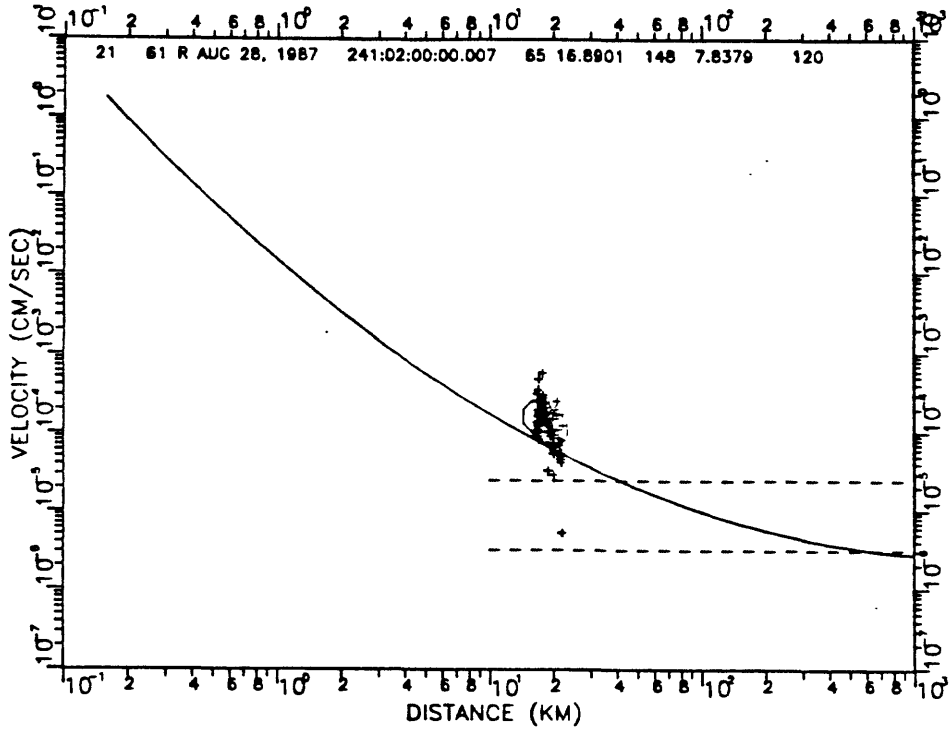

Figure A102. Amplitude-distance curve for TACT (Alaska) 1987 experiment, Part B, shot 21, shot point 61. See page A1 for complete description.

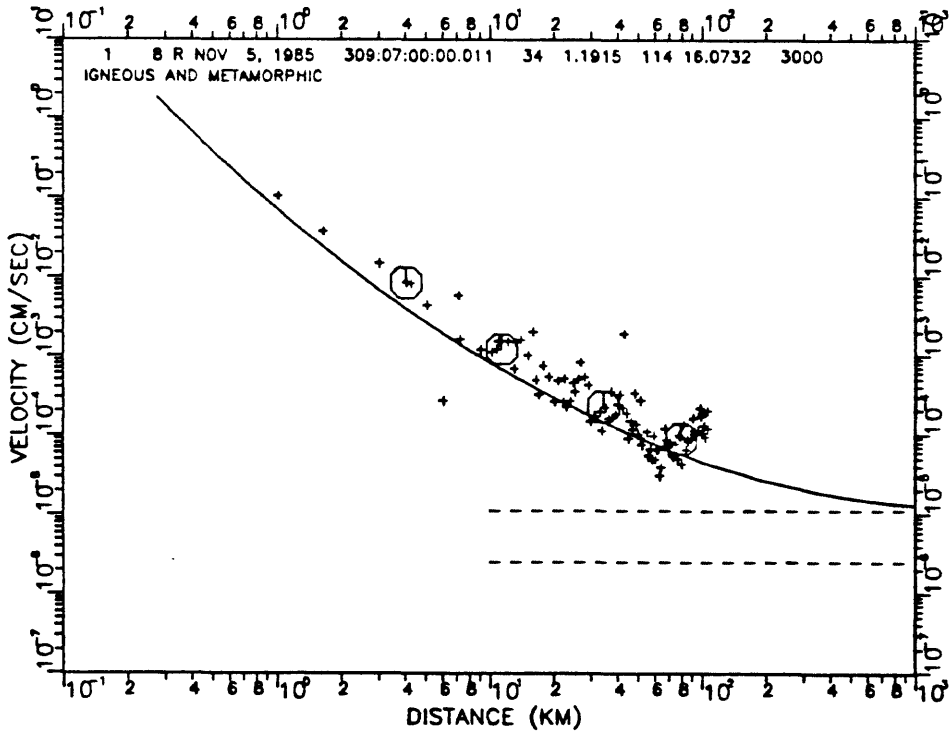

Figure A103. Amplitude-distance curve for PACE 1985 experiment, shot 1, shot point 8. See page A1 for complete description.

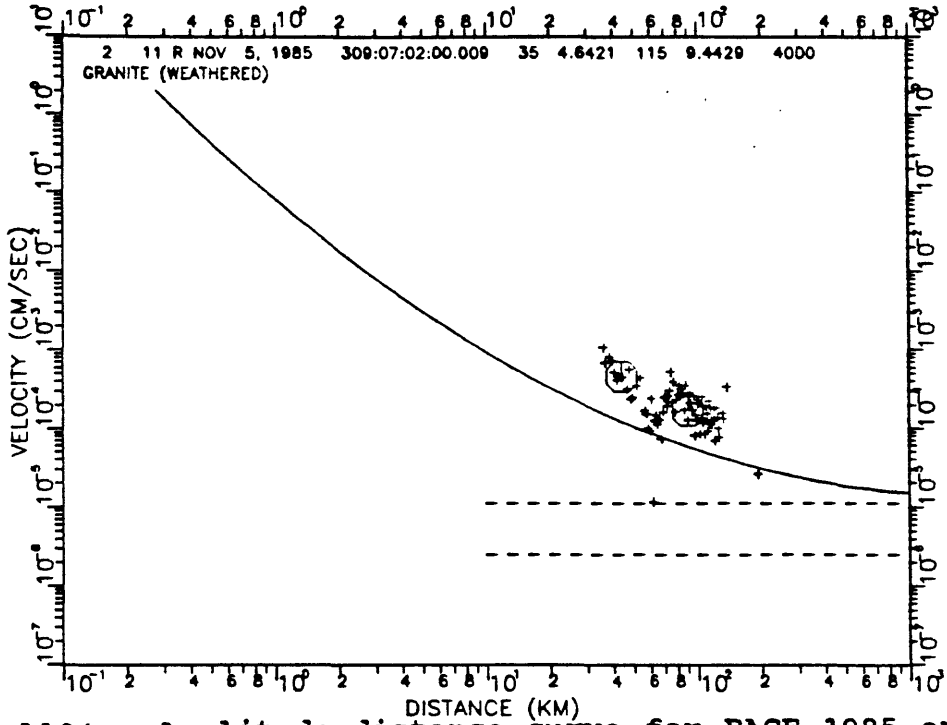

Figure A104. Amplitude-distance curve for PACE 1985 experiment, shot 2, shot point 11. See page A1 for complete description.

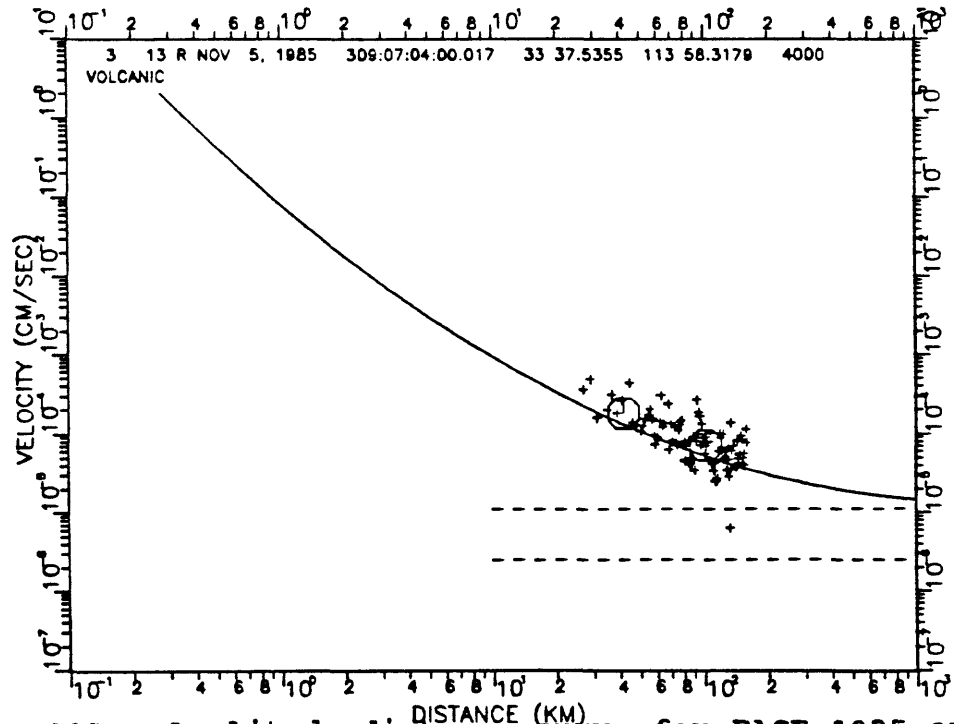

Figure A105. Amplitude-distance curve for PACE 1985 experiment, shot 3, shot point 13. See page A1 for complete description.

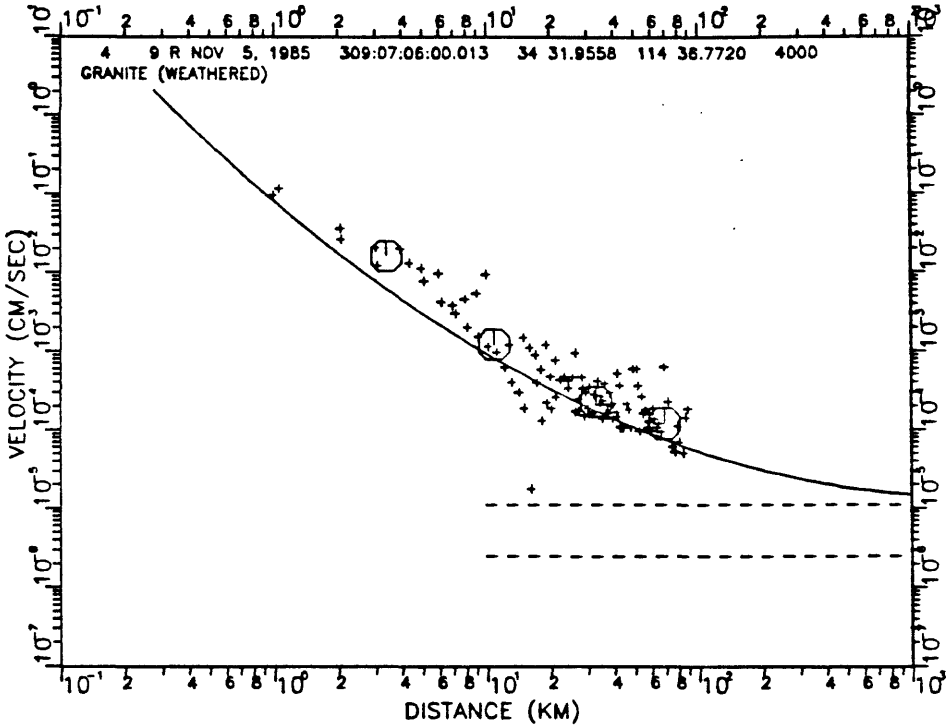

Figure A106. Amplitude-distance curve for PACE 1985 experiment, shot 4, shot point 9. See page A1 for complete description.

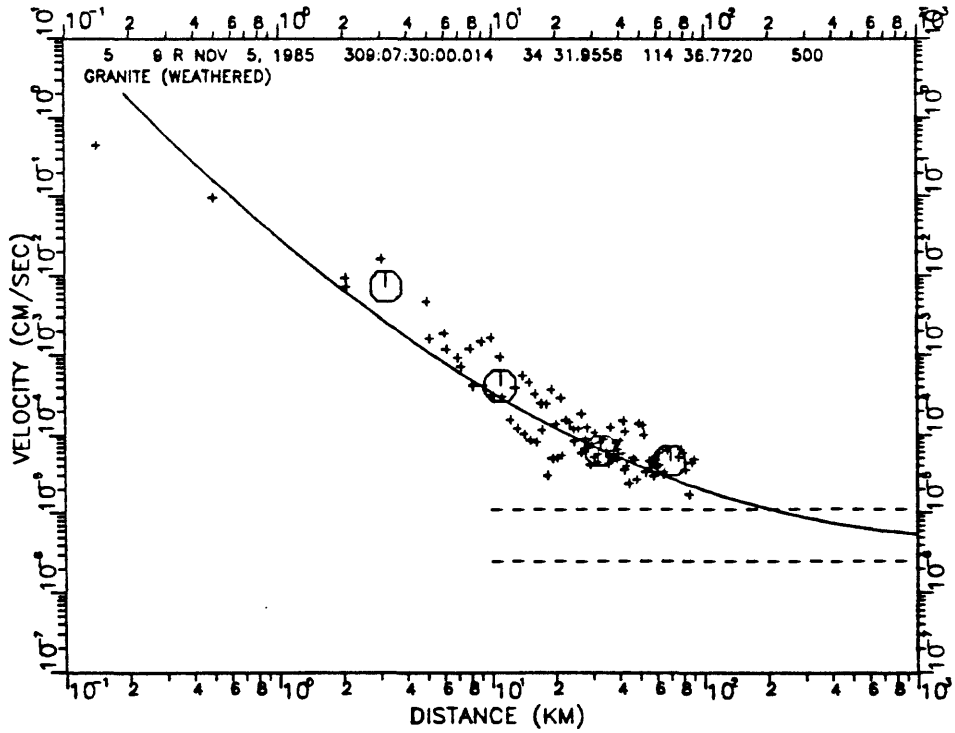

Figure A107. Amplitude-distance curve for PACE 1985 experiment, shot 5, shot point 9. See page A1 for complete description.

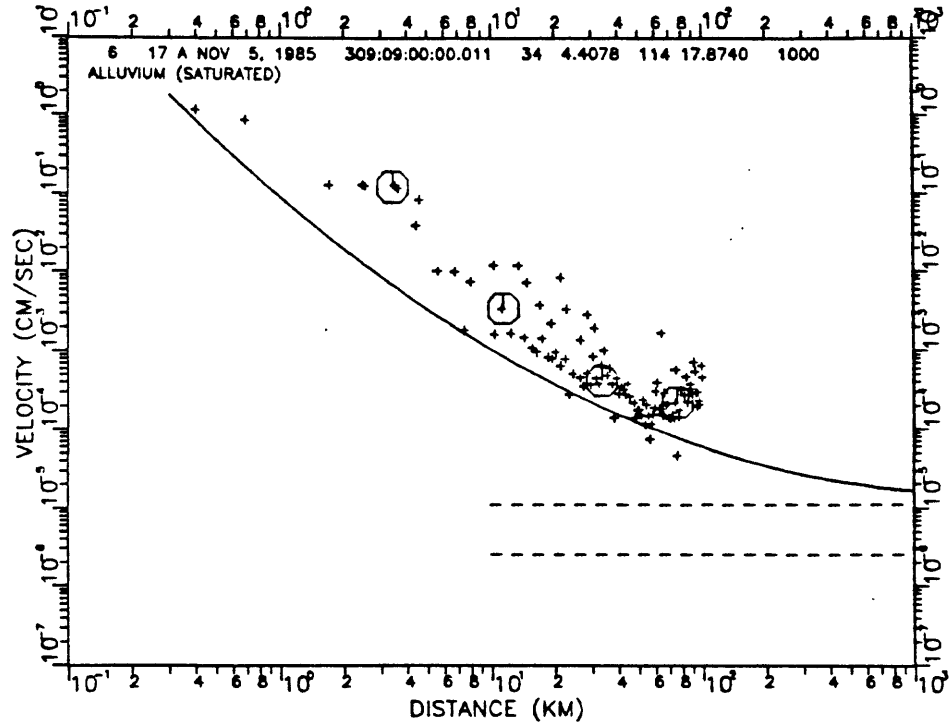

Figure A108. Amplitude-distance curve for PACE 1985 experiment, shot 6, shot point 17. See page A1 for complete description.

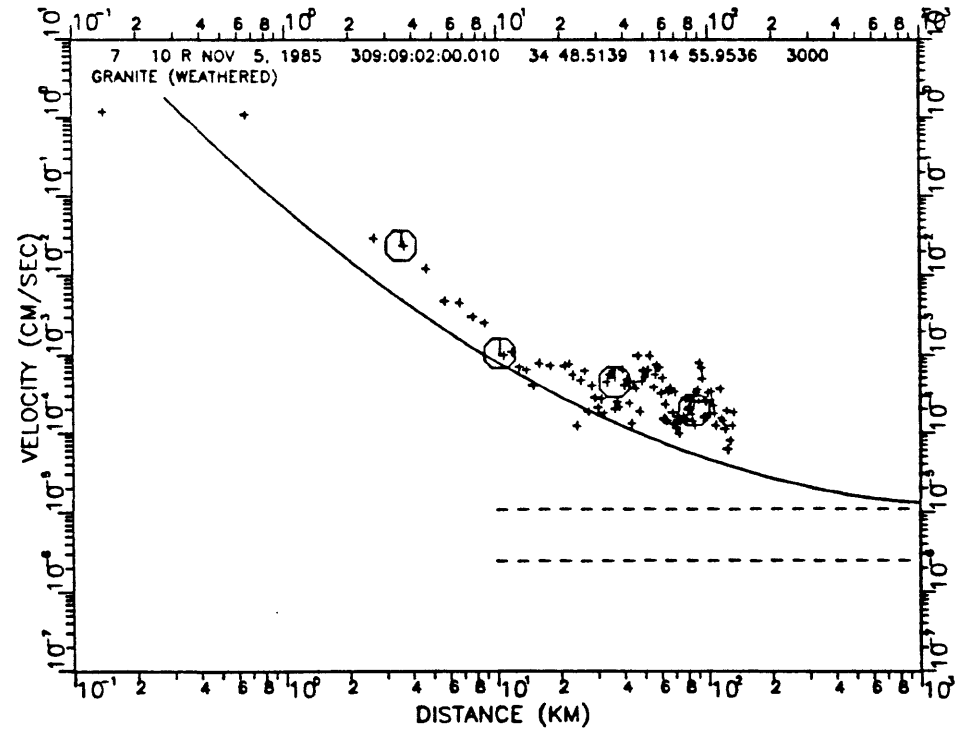

Figure A109. Amplitude-distance curve for PACE 1985 experiment, shot 7, shot point 10. See page A1 for complete description.

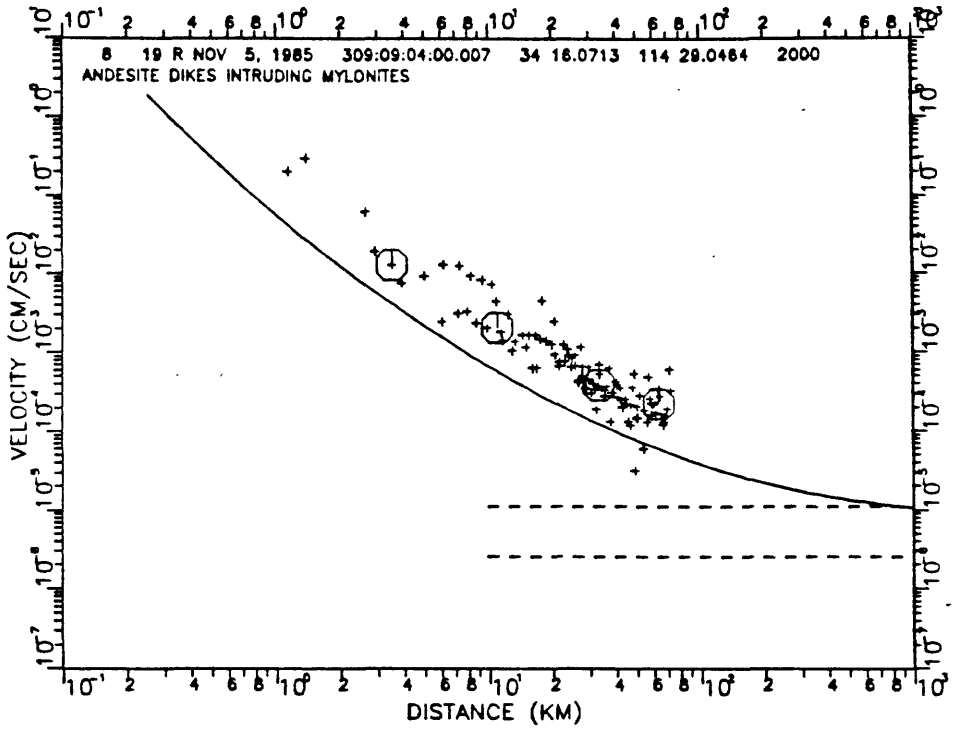

Figure A110. Amplitude-distance curve for PACE 1985 experiment, shot 8, shot point 19. See page A1 for complete description.

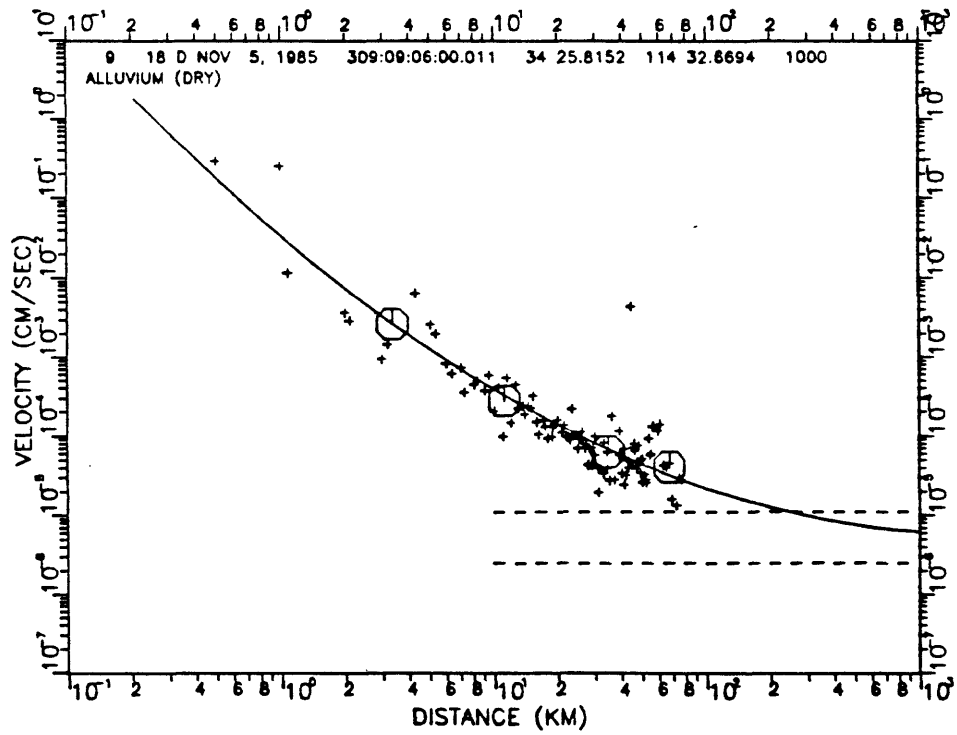

Figure A111. Amplitude-distance curve for PACE 1985 experiment, shot 9, shot point 18. See page A1 for complete description.

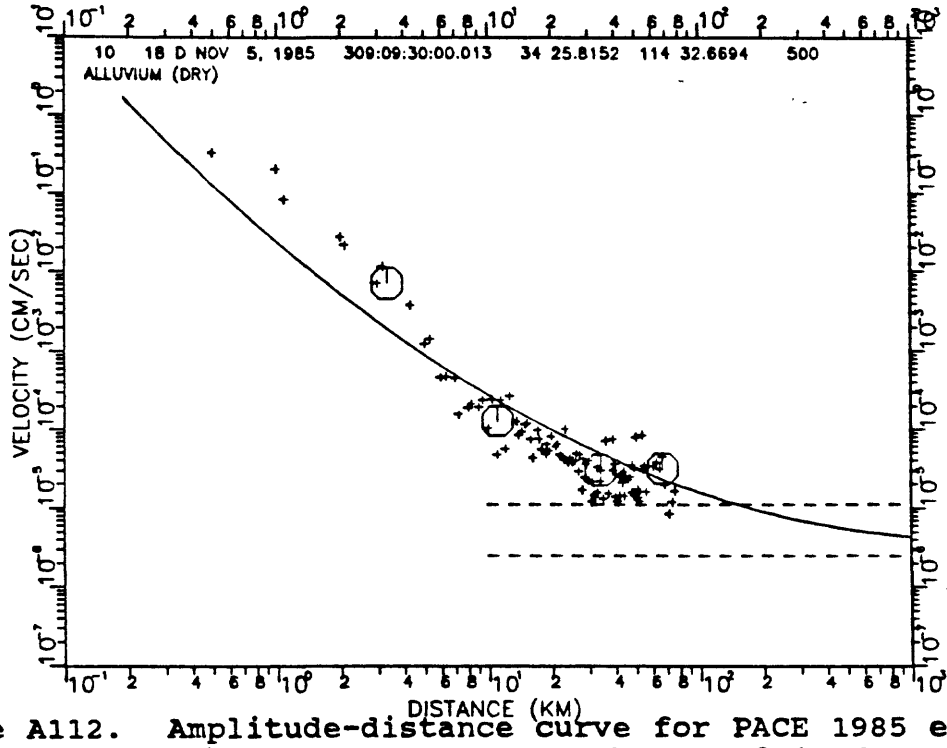

Figure A112. Amplitude-distance curve for PACE 1985 experiment, shot 10, shot point 18. See page A1 for complete description.

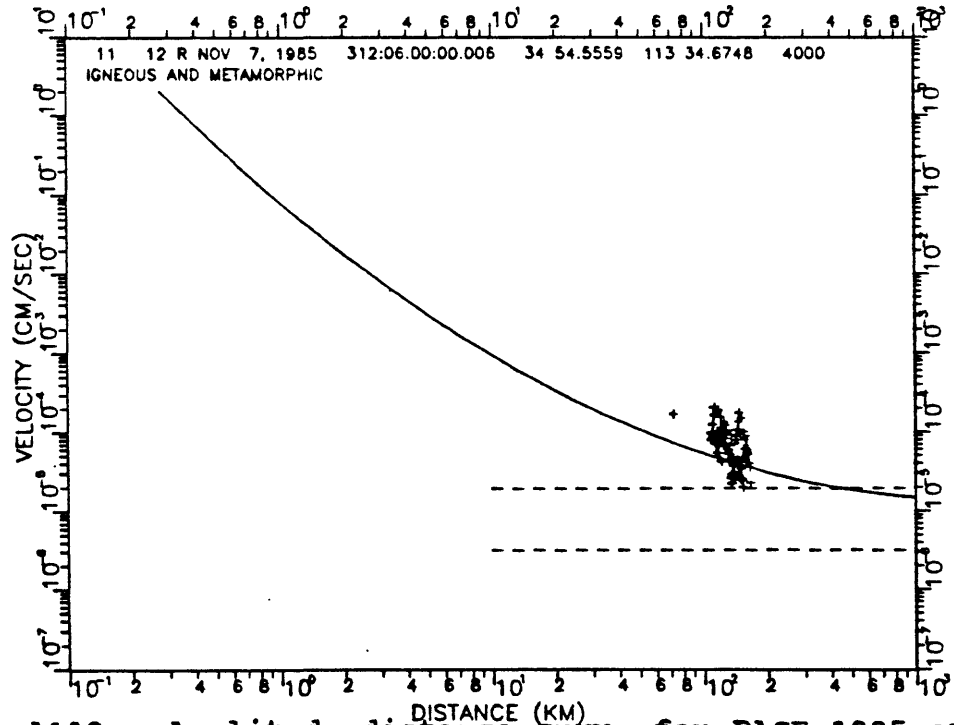

Figure A113. Amplitude-distance curve for PACE 1985 experiment, shot 11, shot point 12. See page A1 for complete description.

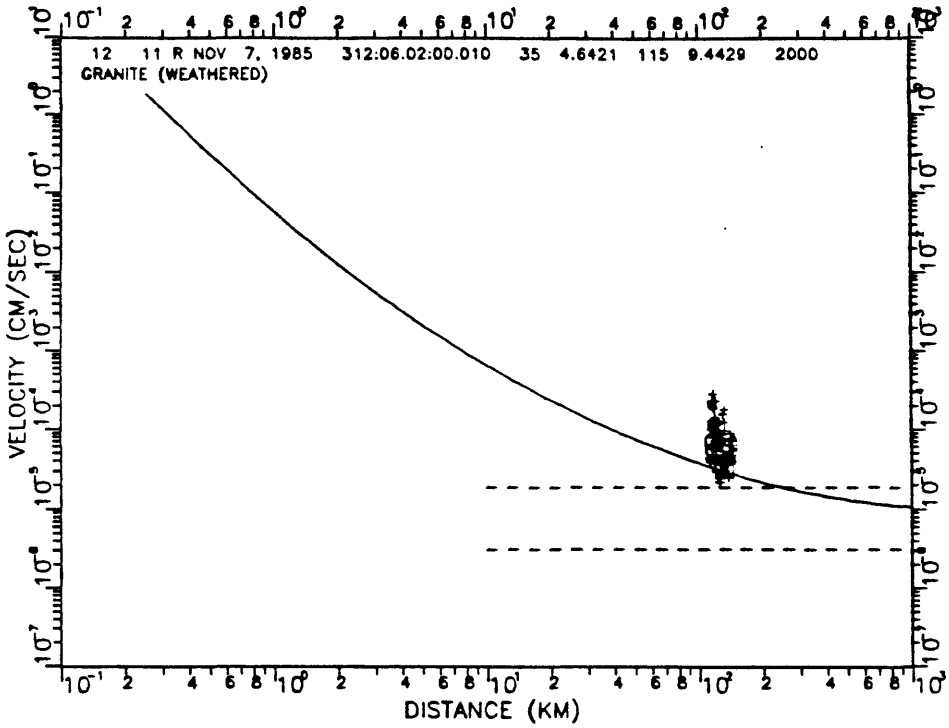

Figure A114. Amplitude-distance curve for PACE 1985 experiment, shot 12, shot point 11. See page A1 for complete description.

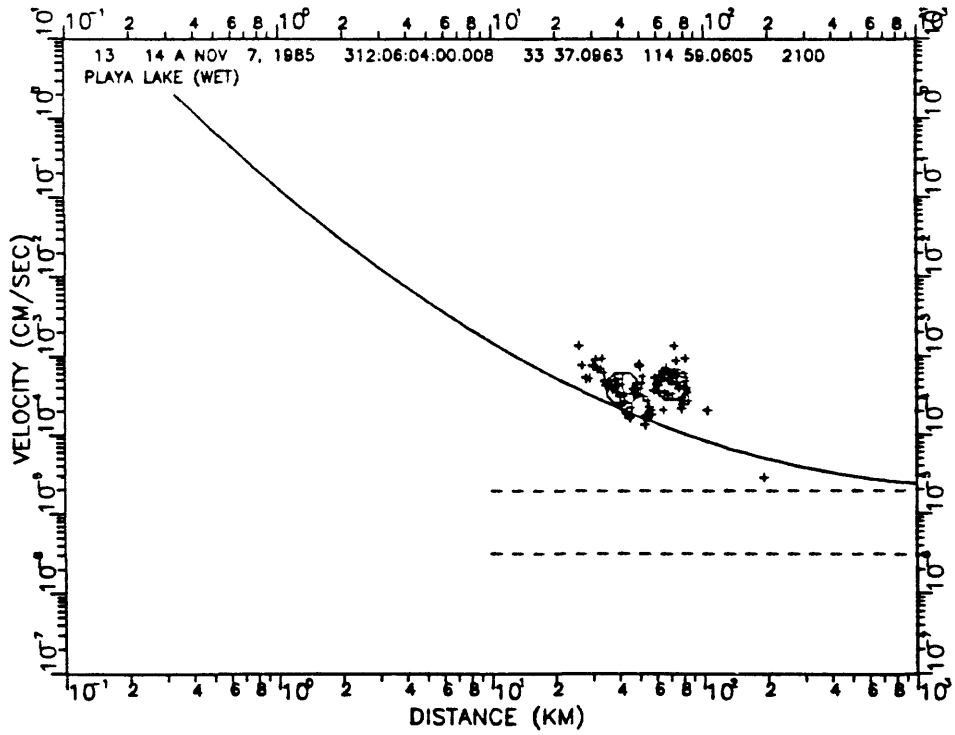

Figure A115. Amplitude-distance curve for PACE 1985 experiment, shot 13, shot point 14. See page A1 for complete description.

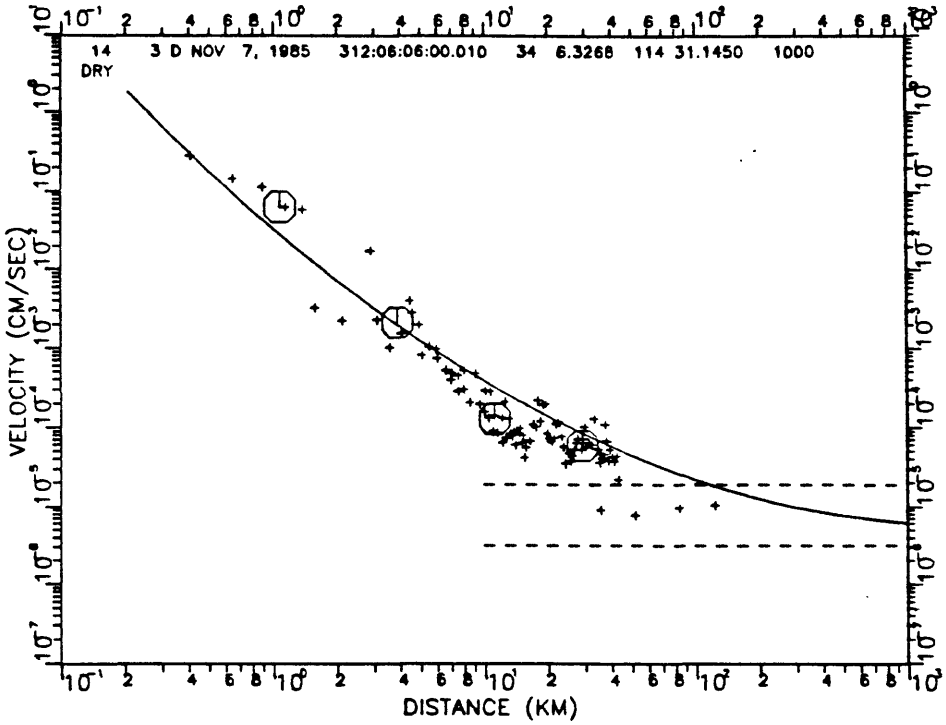

Figure A116. Amplitude-distance curve for PACE 1985 experiment, shot 14, shot point 3. See page A1 for complete description.

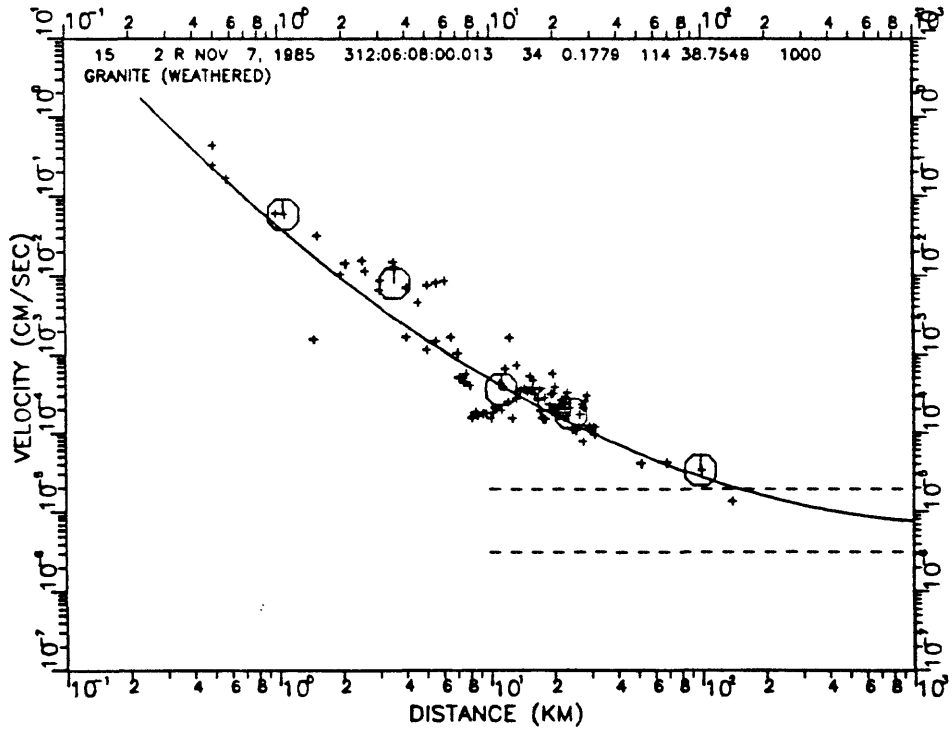

Figure A117. Amplitude-distance curve for PACE 1985 experiment, shot 15, shot point 2. See page A1 for complete description.

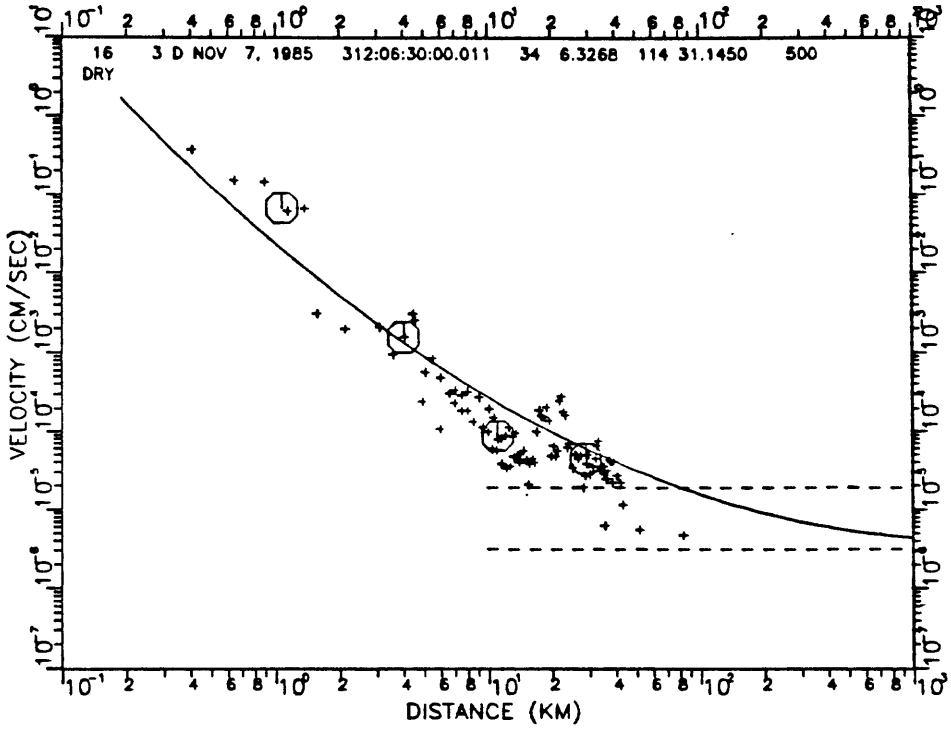

Figure A118. Amplitude-distance curve for PACE 1985 experiment, shot 16, shot point 3. See page A1 for complete description.

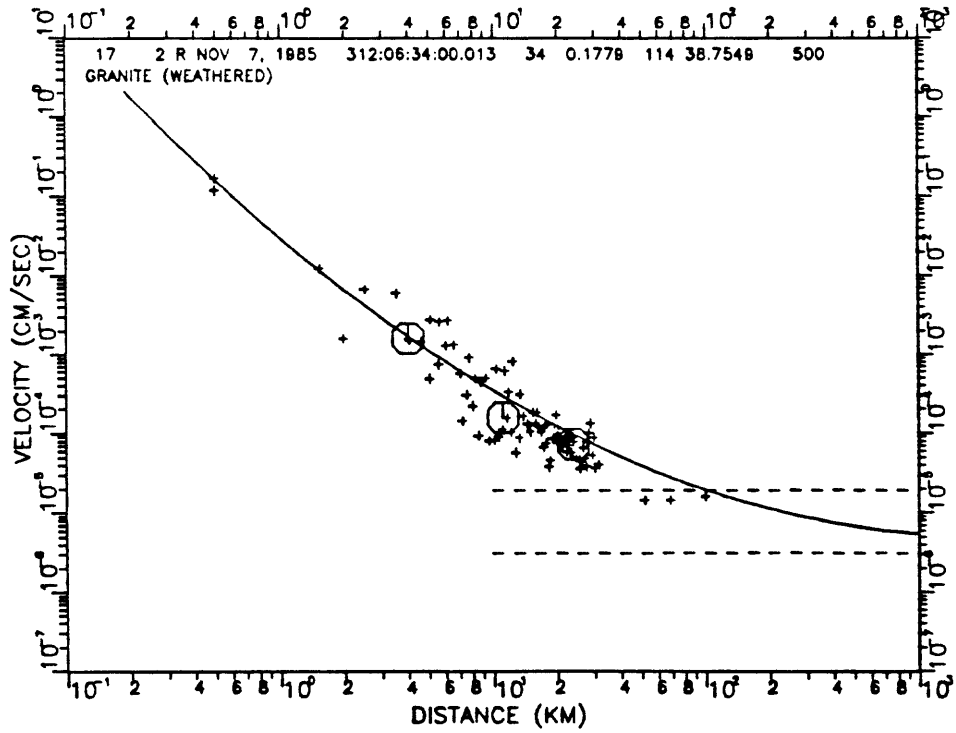

Figure A119. Amplitude-distance curve for PACE 1985 experiment, shot 17, shot point 2. See page A1 for complete description.

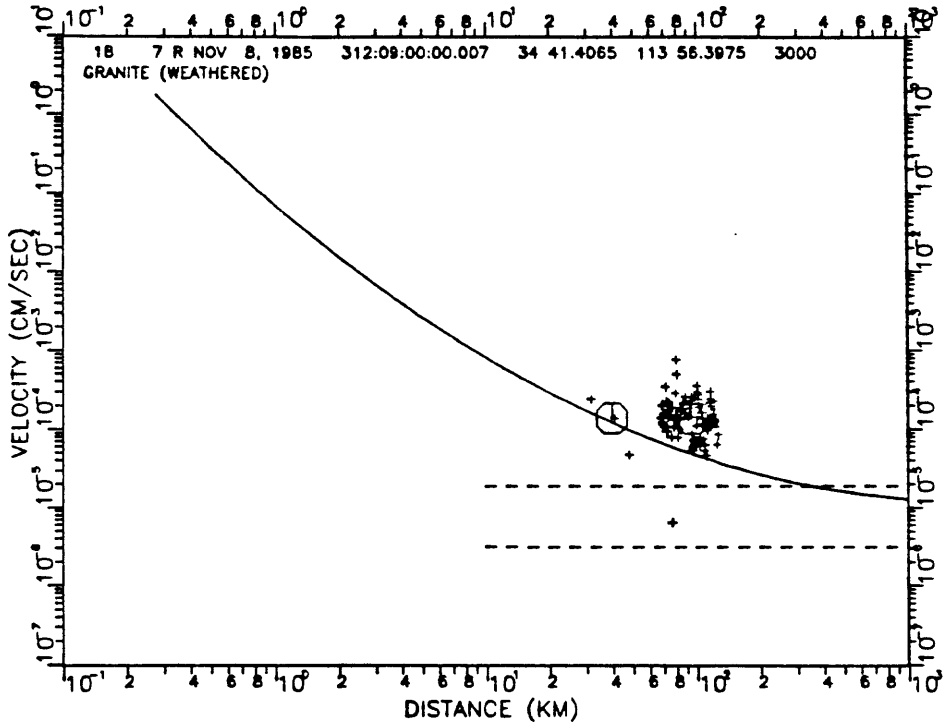

Figure A120. Amplitude-distance curve for PACE 1985 experiment, shot 18, shot point 7. See page A1 for complete description.

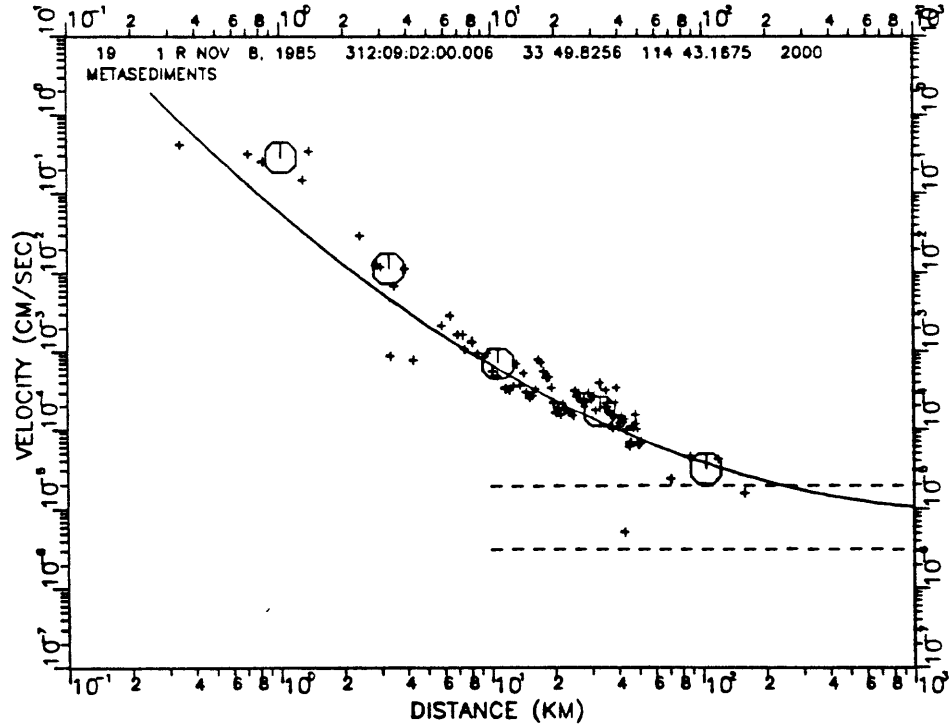

Figure A121. Amplitude-distance curve for PACE 1985 experiment, shot 19, shot point 1. See page A1 for complete description.

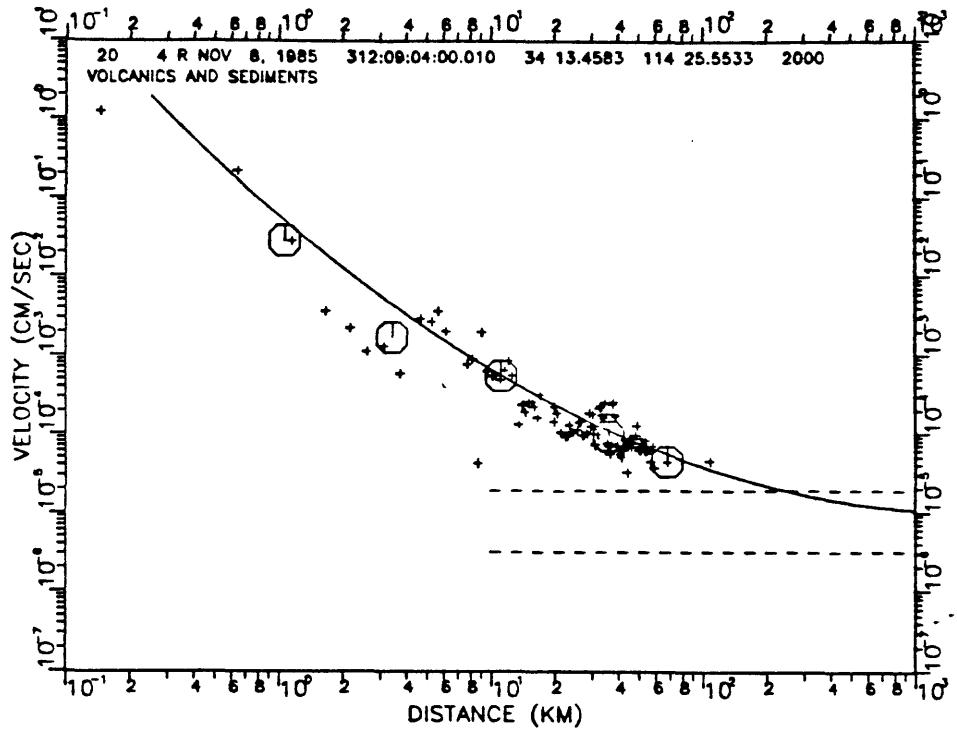

Figure A122. Amplitude-distance curve for PACE 1985 experiment, shot 20, shot point 4. See page A1 for complete description.

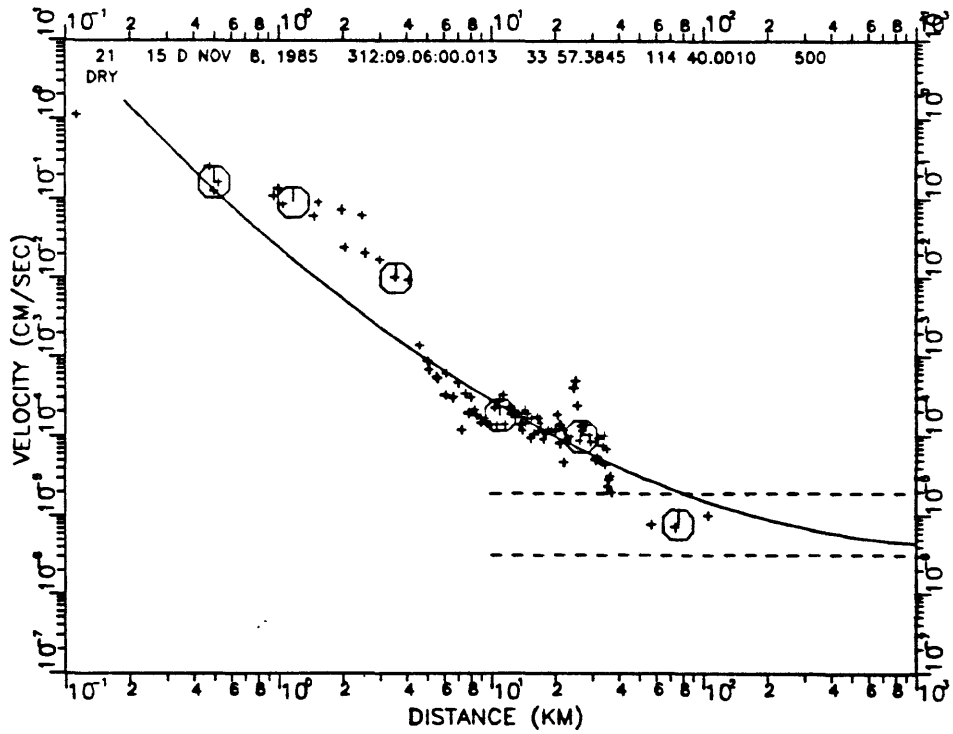

Figure A123. Amplitude-distance curve for PACE 1985 experiment, shot 21, shot point 15. See page A1 for complete description.

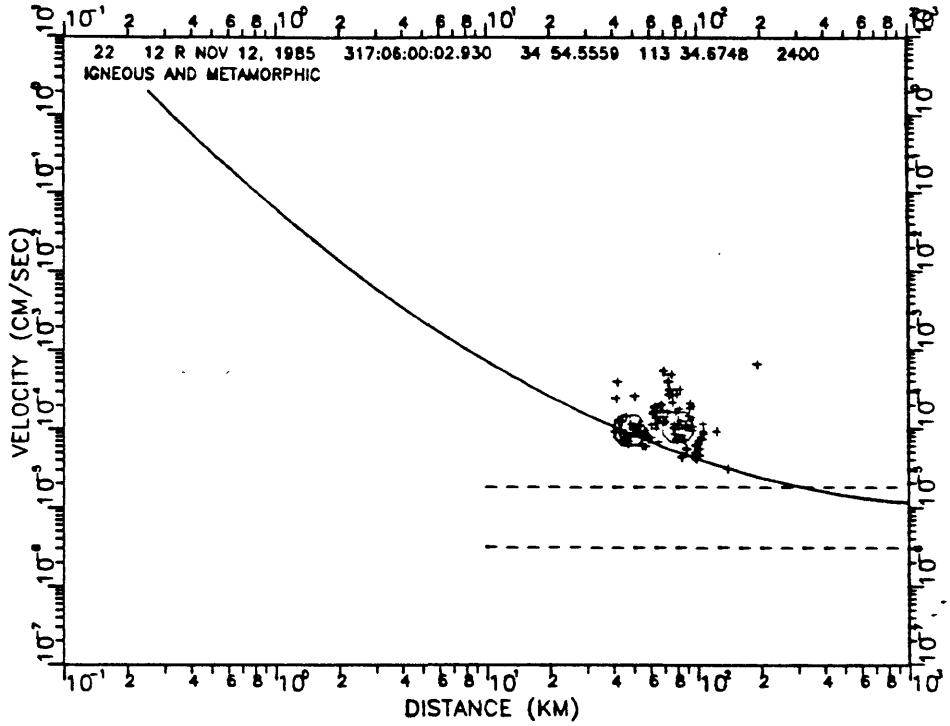

Figure A124. Amplitude-distance curve for PACE 1985 experiment, shot 22, shot point 12. See page A1 for complete description.

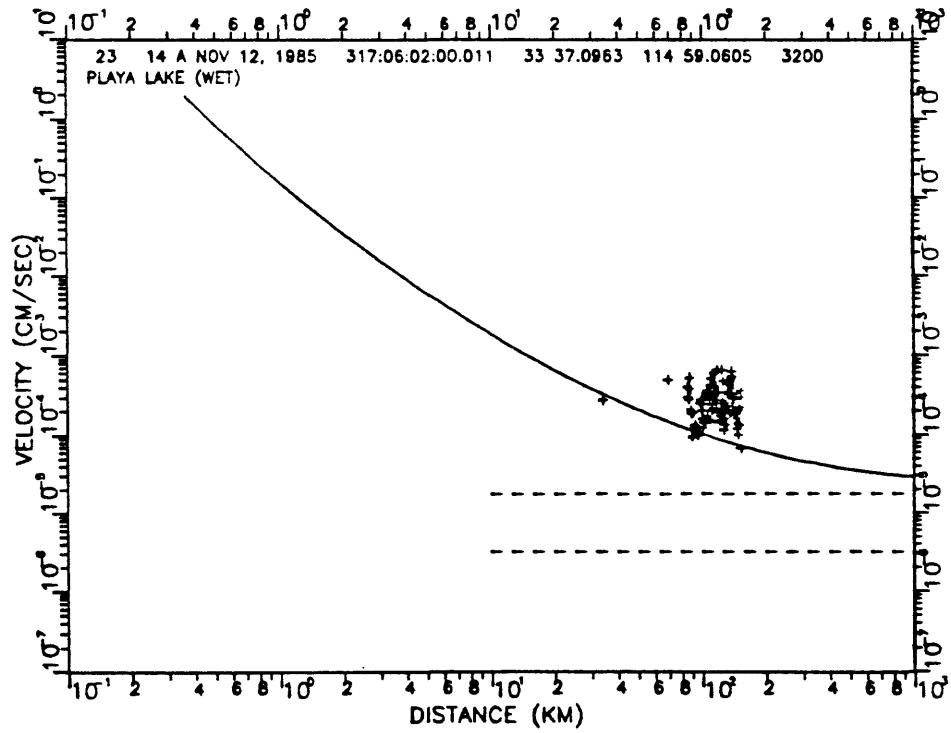

Figure A125. Amplitude-distance curve for PACE 1985 experiment, shot 23, shot point 14. See page A1 for complete description.

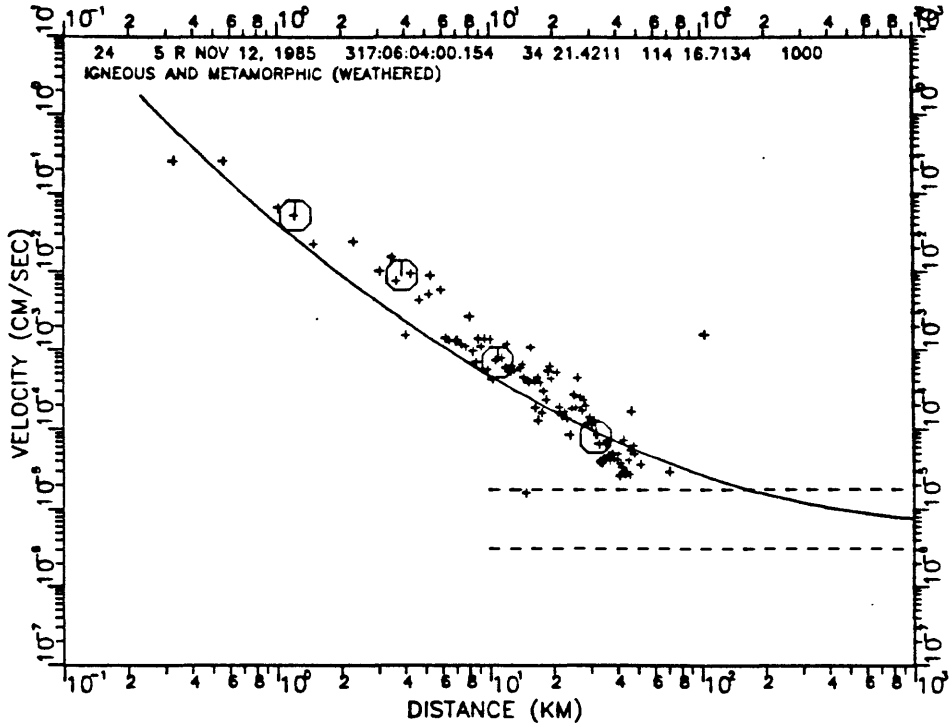

Figure A126. Amplitude-distance curve for PACE 1985 experiment, shot 24, shot point 5. See page A1 for complete description.

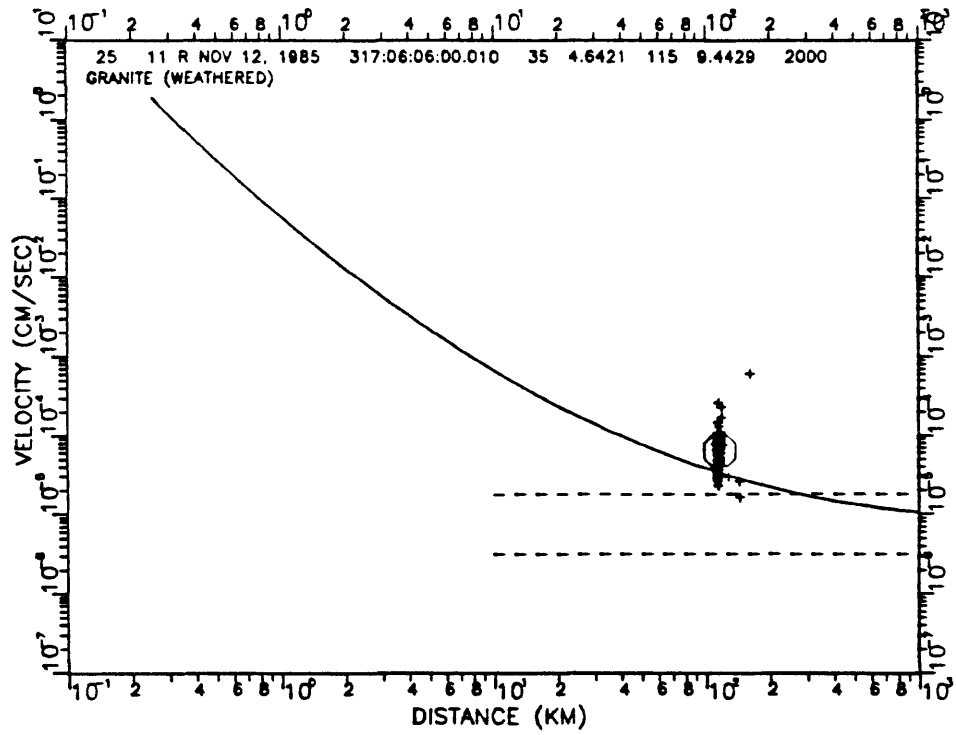

Figure A127. Amplitude-distance curve for PACE 1985 experiment, shot 25, shot point 11. See page A1 for complete description.

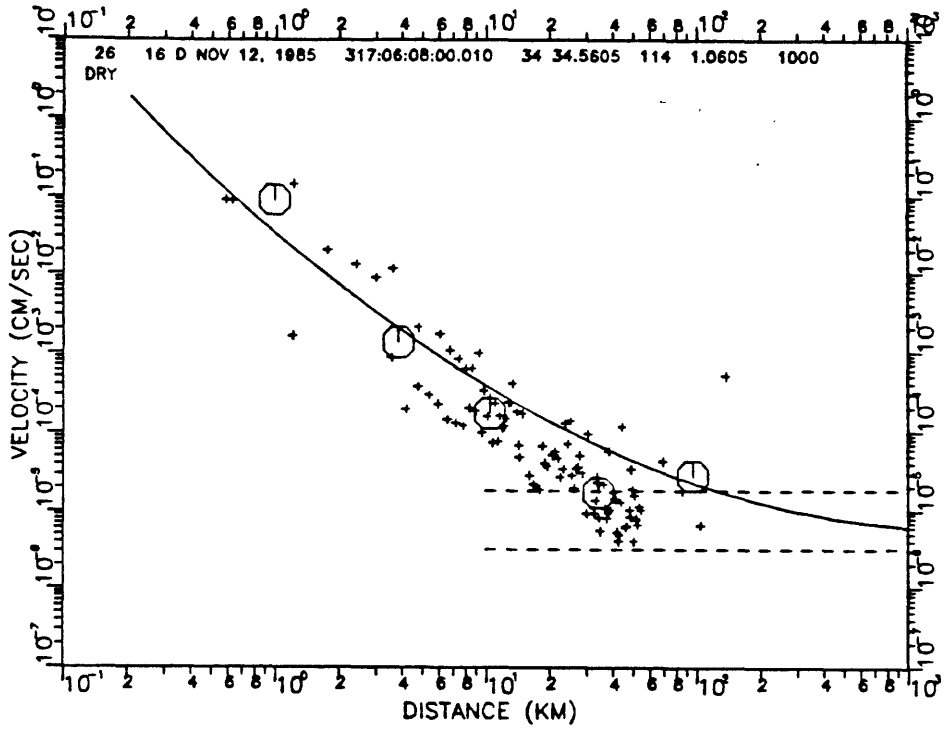

Figure A128. Amplitude-distance curve for PACE 1985 experiment, shot 26, shot point 16. See page A1 for complete description.

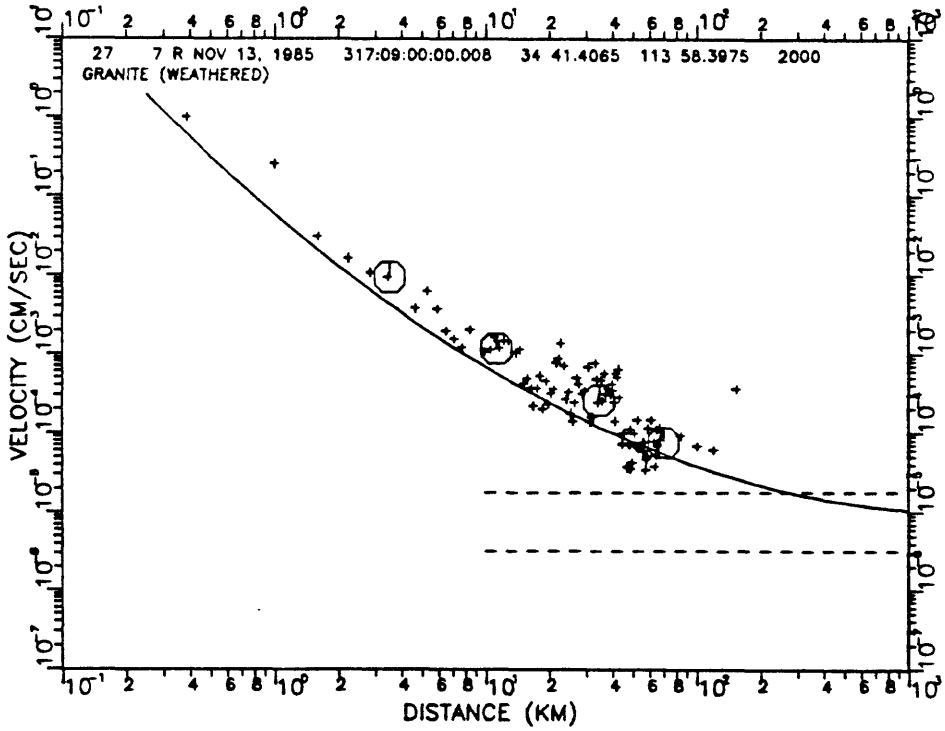

Figure A129. Amplitude-distance curve for PACE 1985 experiment, shot 27, shot point 7. See page A1 for complete description.

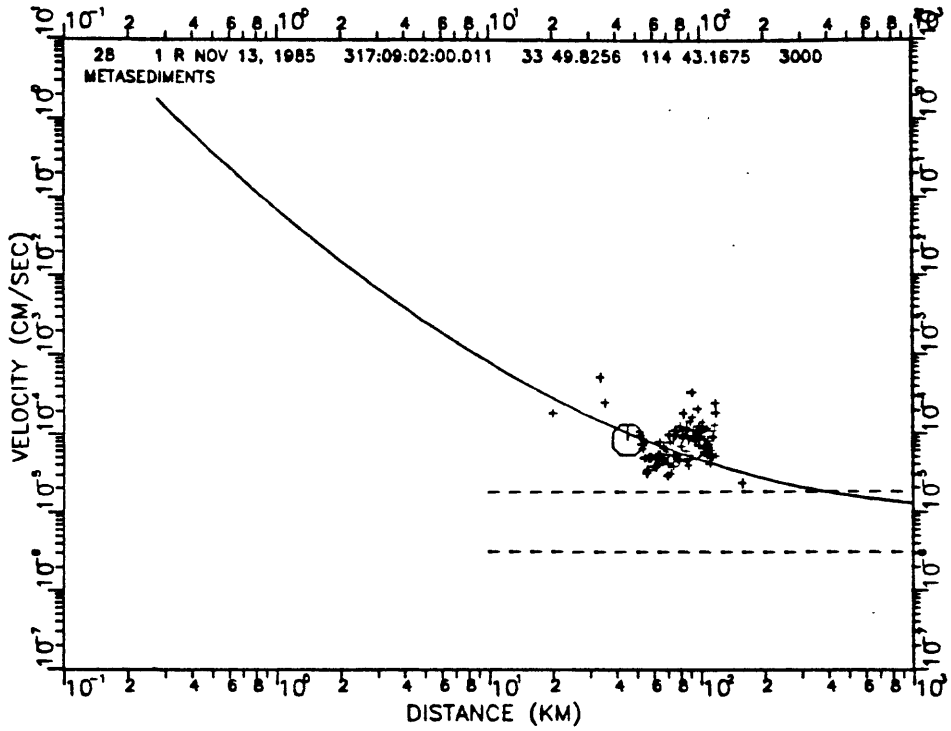

Figure A130. Amplitude-distance curve for PACE 1985 experiment, shot 28, shot point 1. See page A1 for complete description.

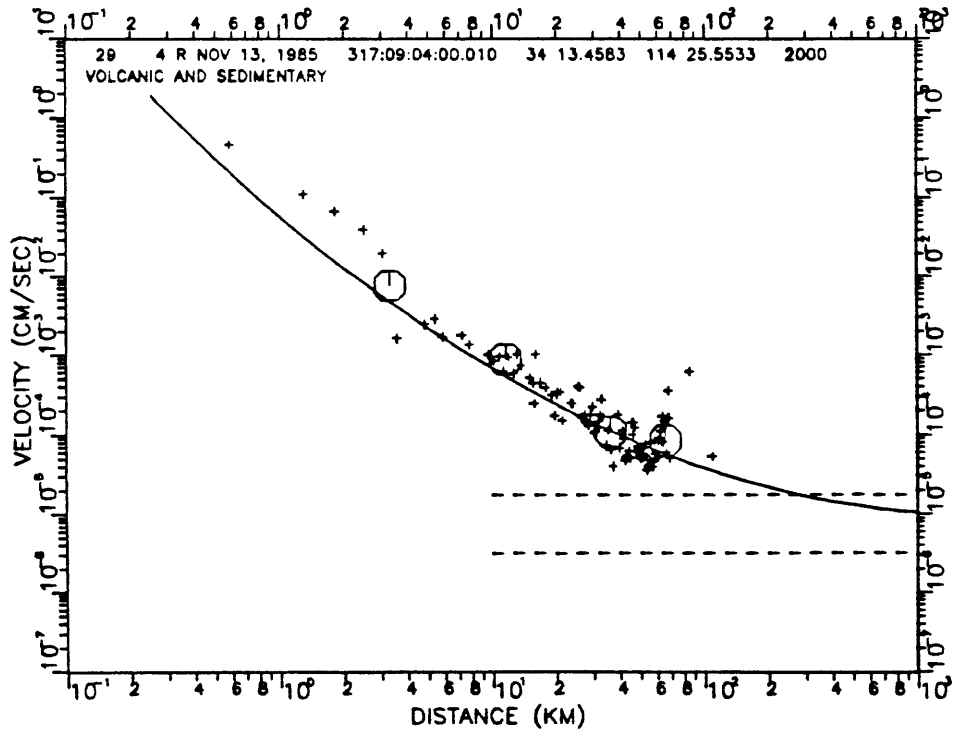

Figure A131. Amplitude-distance curve for PACE 1985 experiment, shot 29, shot point 4. See page A1 for complete description.

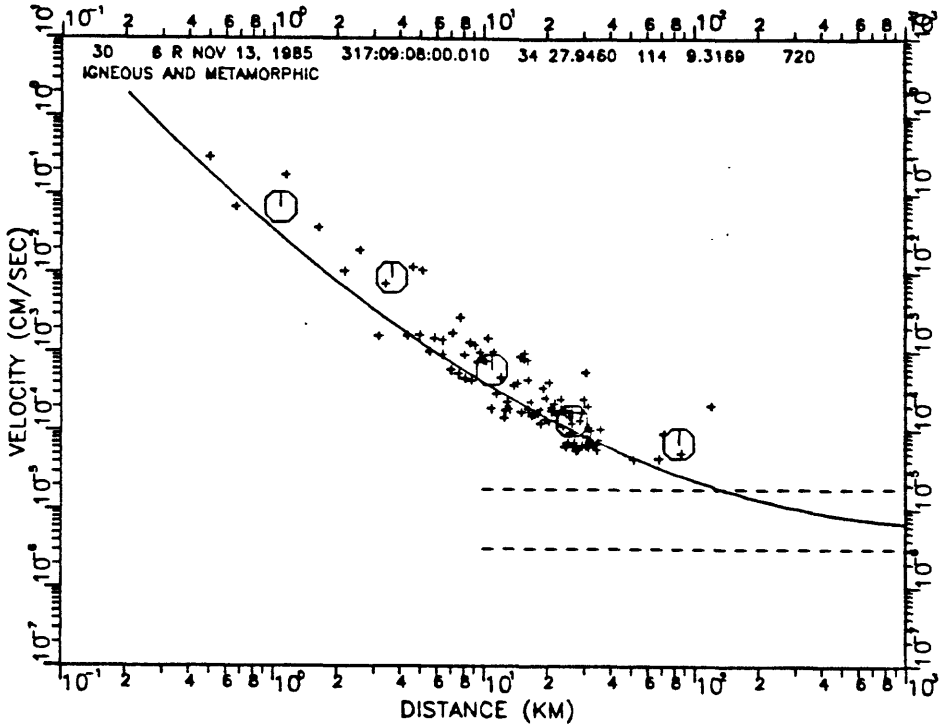

Figure A132. Amplitude-distance curve for PACE 1985 experiment, shot 30, shot point 6. See page A1 for complete description.

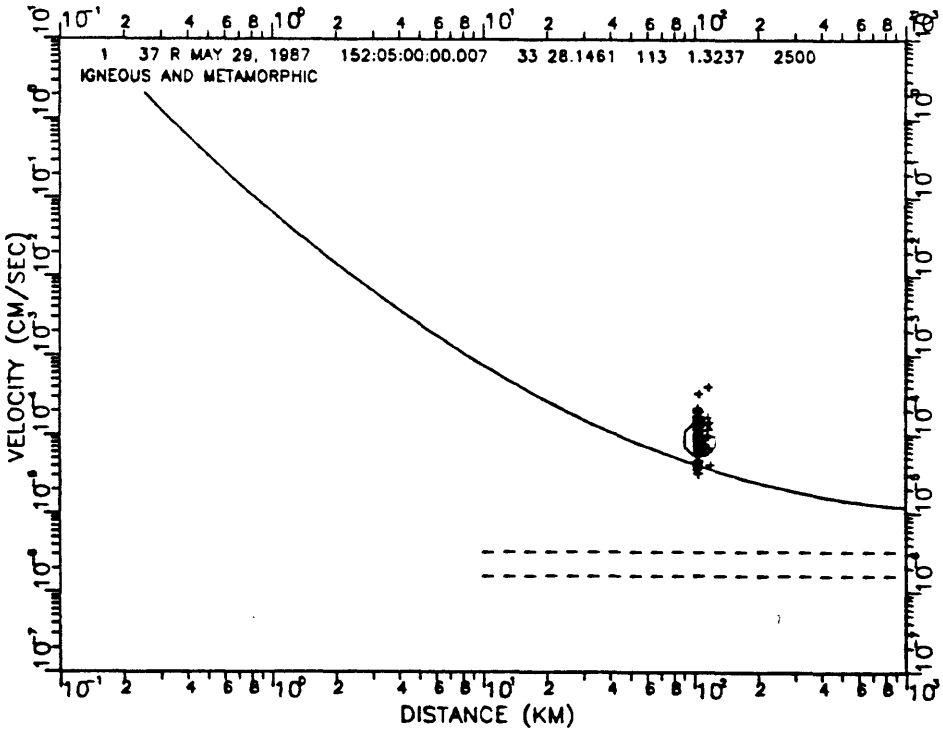

Figure A133. Amplitude-distance curve for PACE 1987 experiment, shot 1, shot point 37. See page A1 for complete description.

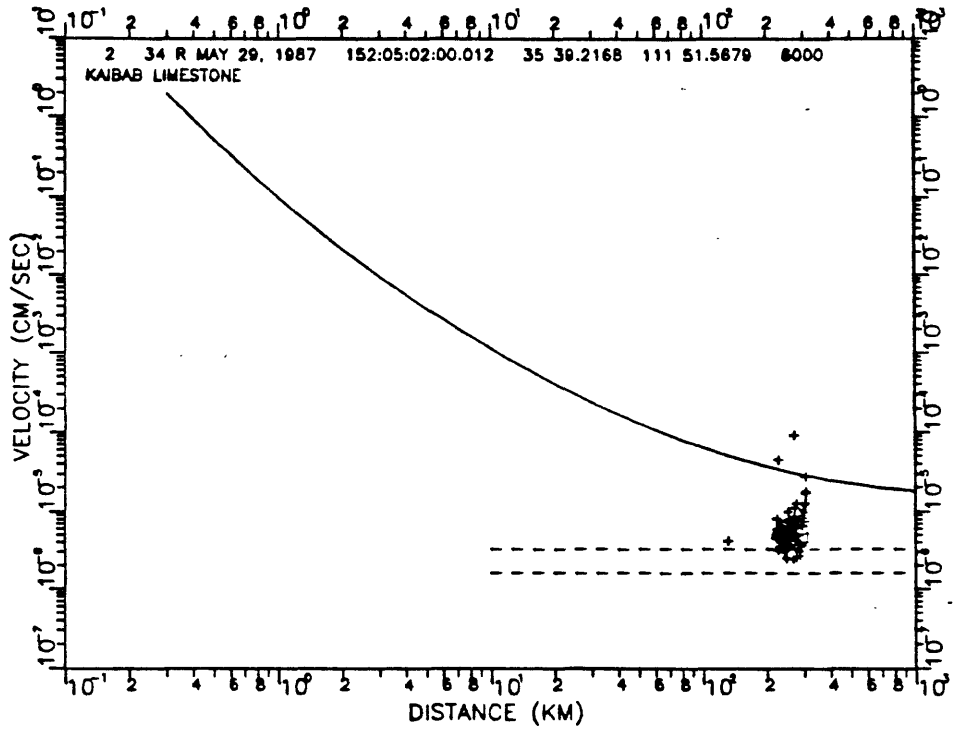

Figure A134. Amplitude-distance curve for PACE 1987 experiment, shot 2, shot point 34. See page A1 for complete description.

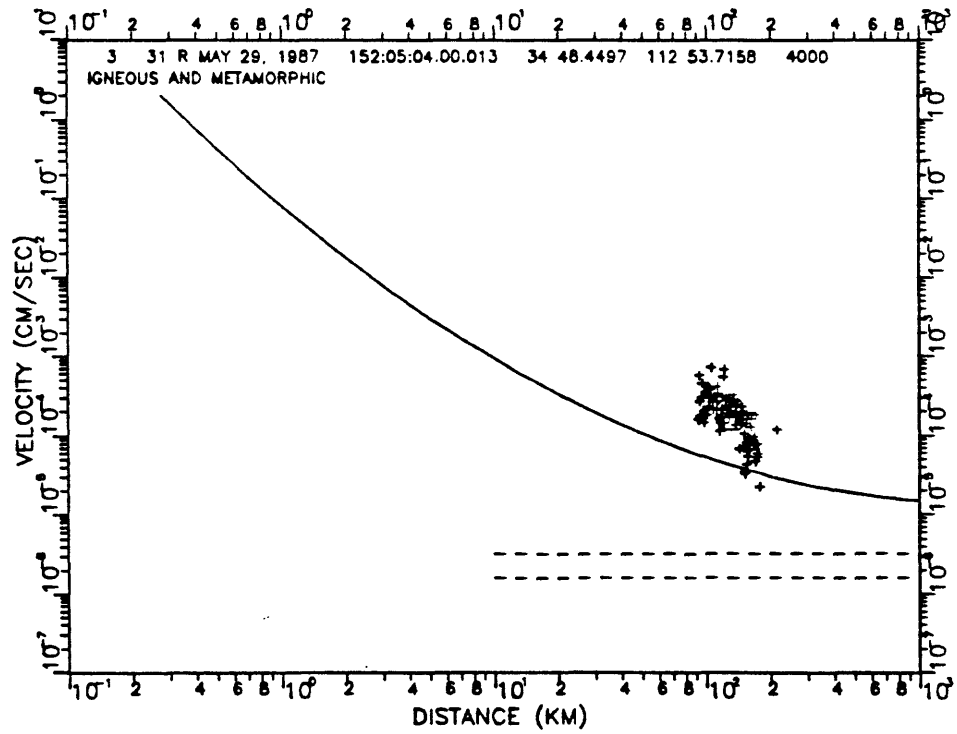

Figure A135. Amplitude-distance curve for PACE 1987 experiment, shot 3, shot point 31. See page A1 for complete description.

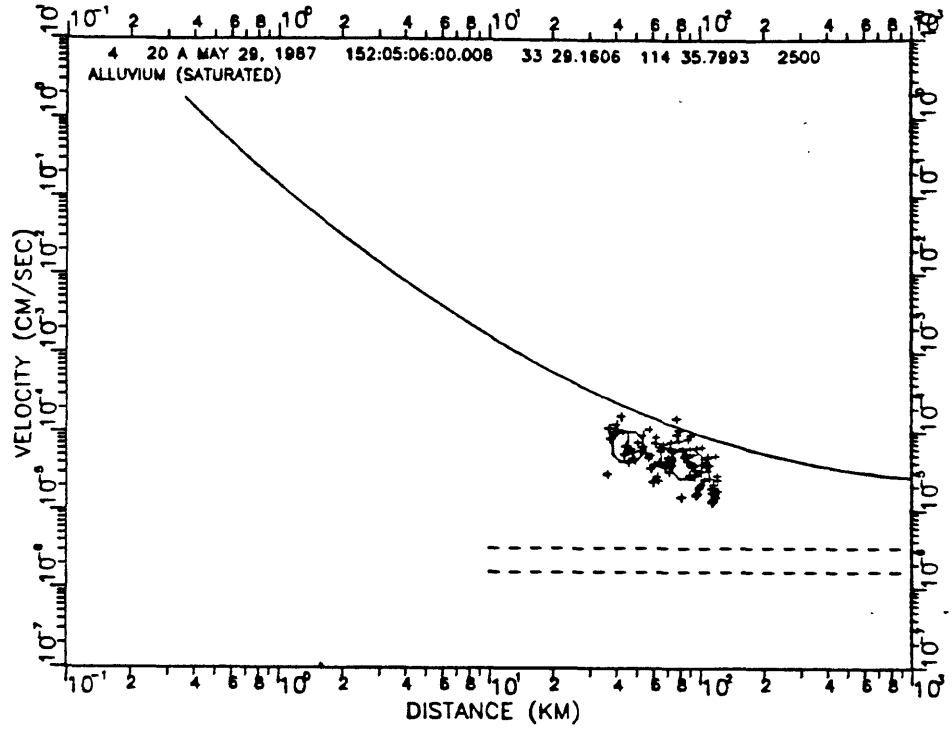

Figure A136. Amplitude-distance curve for PACE 1987 experiment, shot 4, shot point 20. See page A1 for complete description.

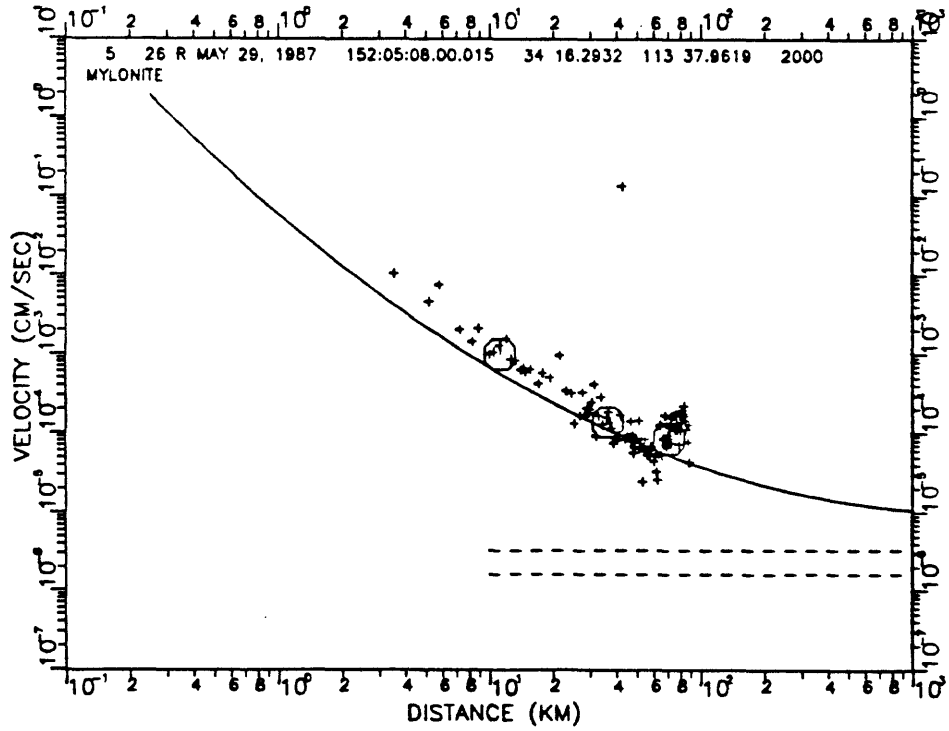

Figure A137. Amplitude-distance curve for PACE 1987 experiment, shot 5, shot point 26. See page A1 for complete description.

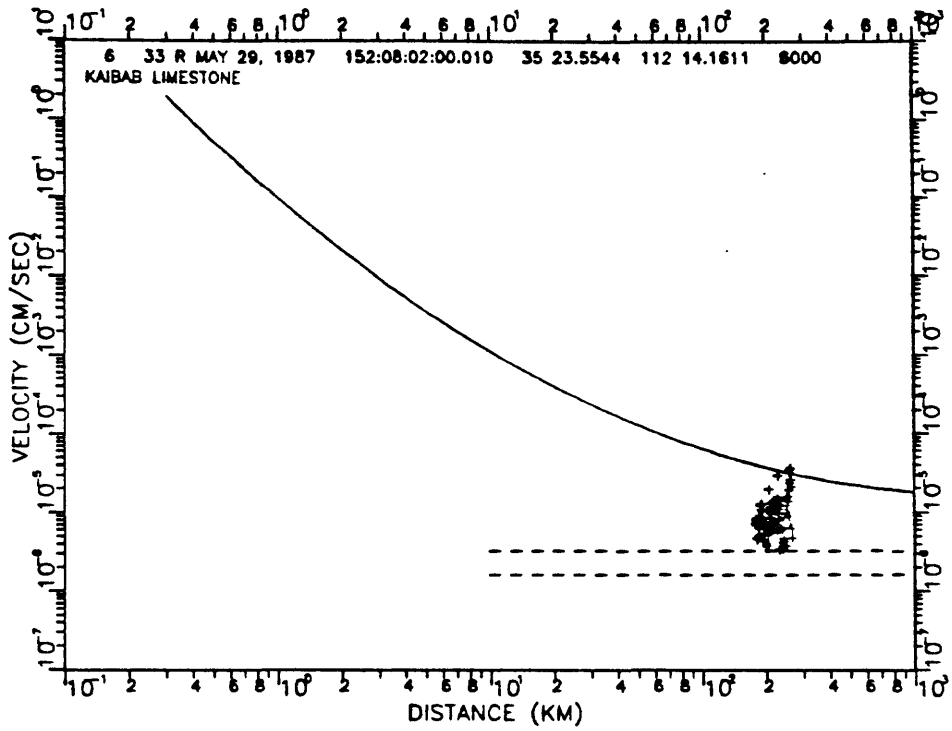

Figure A138. Amplitude-distance curve for PACE 1987 experiment, shot 6, shot point 33. See page A1 for complete description.

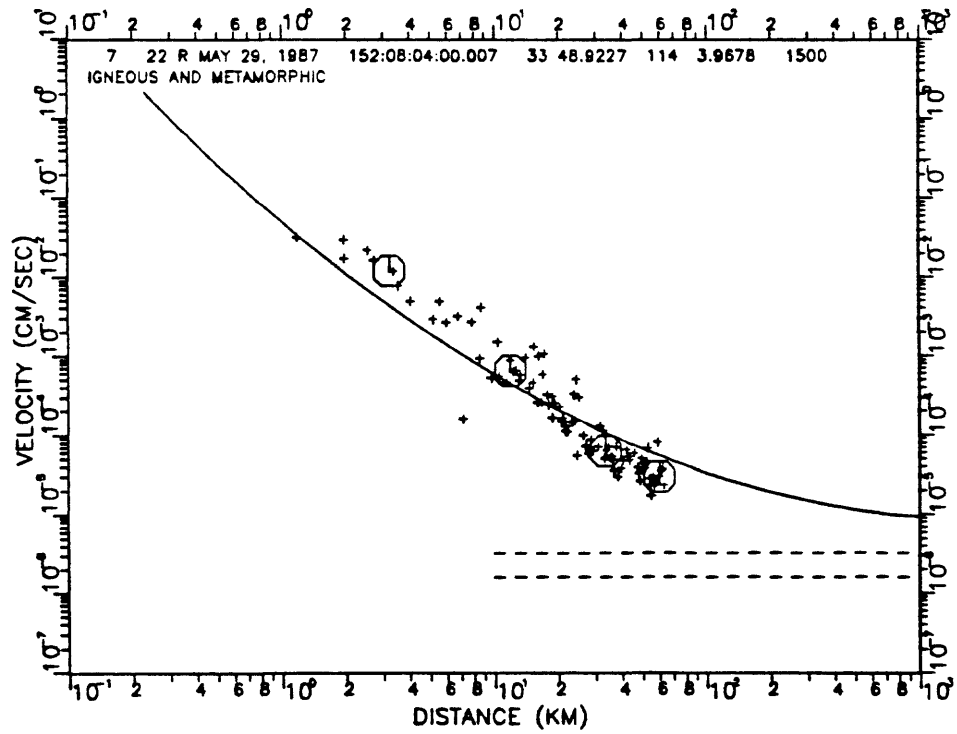

Figure A139. Amplitude-distance curve for PACE 1987 experiment, shot 7, shot point 22. See page A1 for complete description.

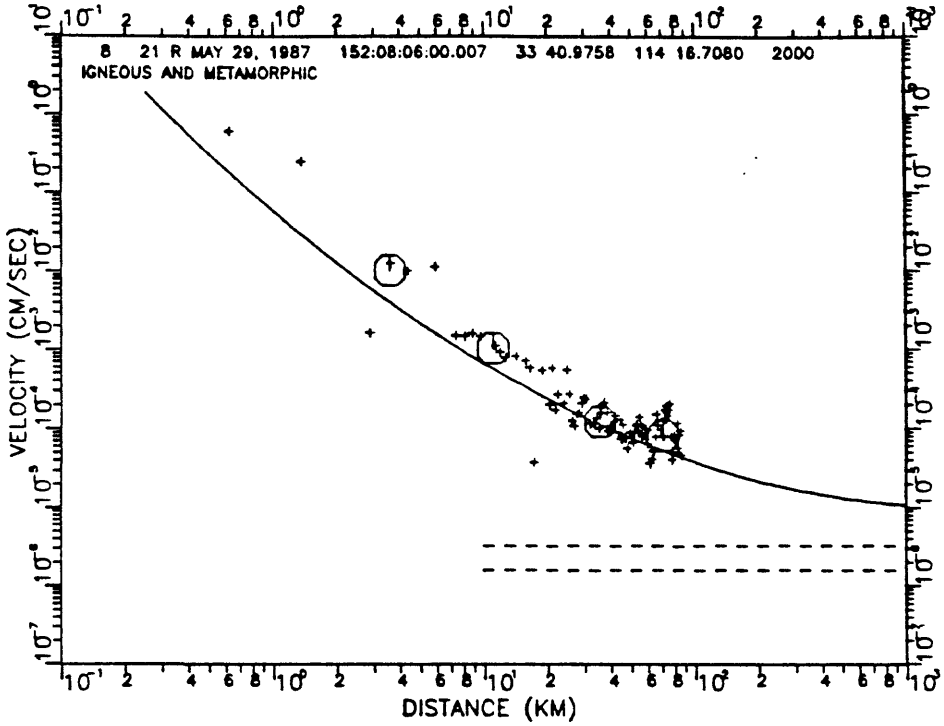

Figure A140. Amplitude-distance curve for PACE 1987 experiment, shot 8, shot point 21. See page A1 for complete description.

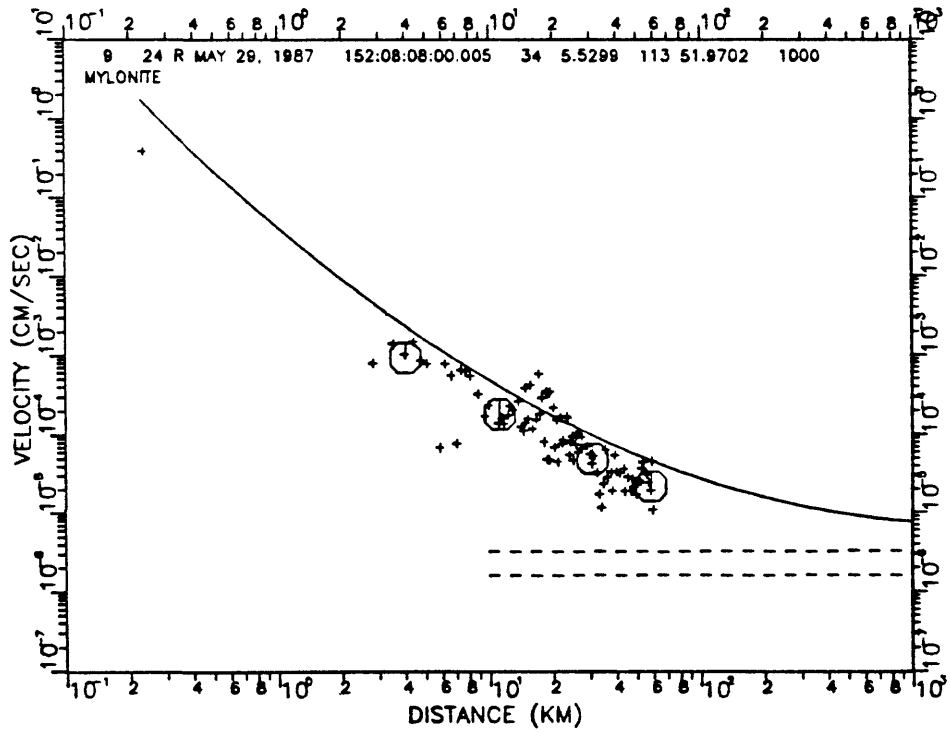

Figure A141. Amplitude-distance curve for PACE 1987 experiment, shot 9, shot point 24. See page A1 for complete description.

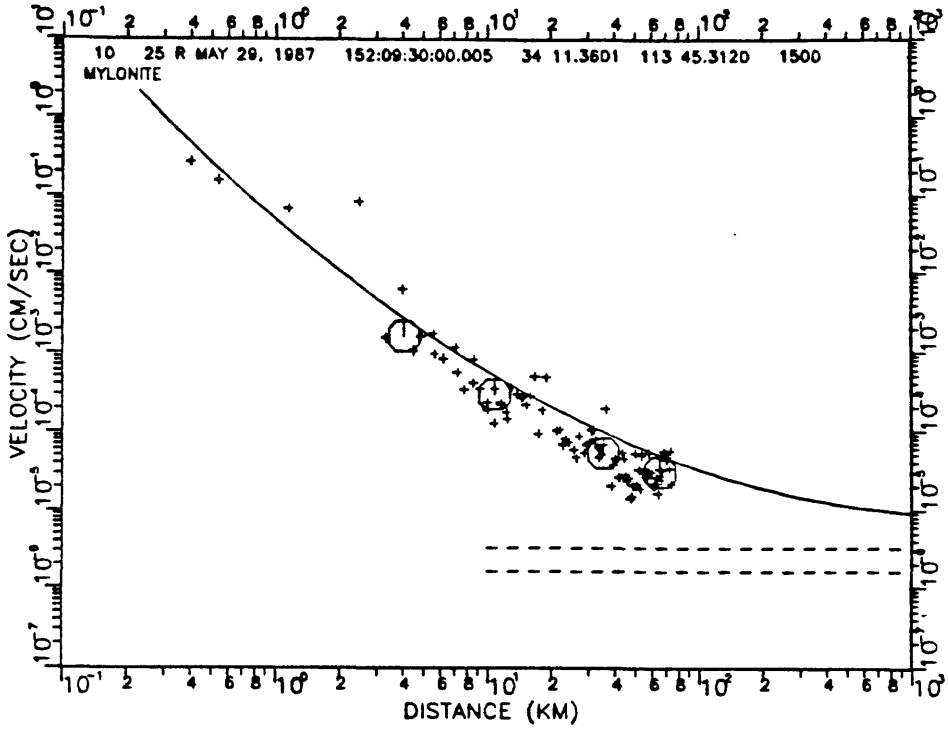

Figure A142. Amplitude-distance curve for PACE 1987 experiment, shot 10, shot point 25. See page A1 for complete description.

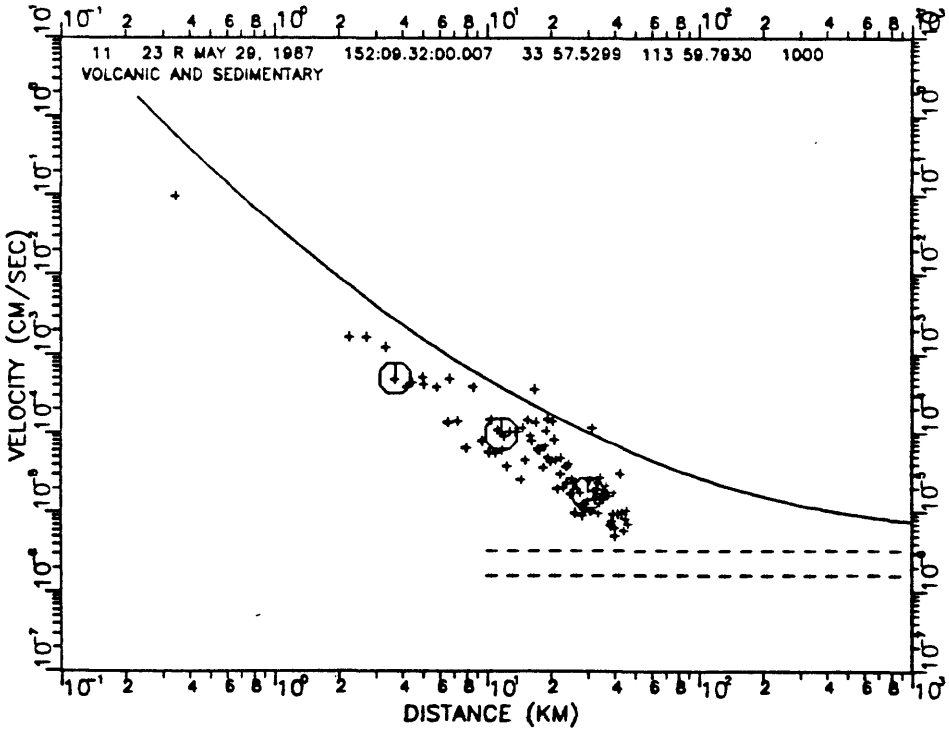

Figure A143. Amplitude-distance curve for PACE 1987 experiment, shot 11, shot point 23. See page A1 for complete description.

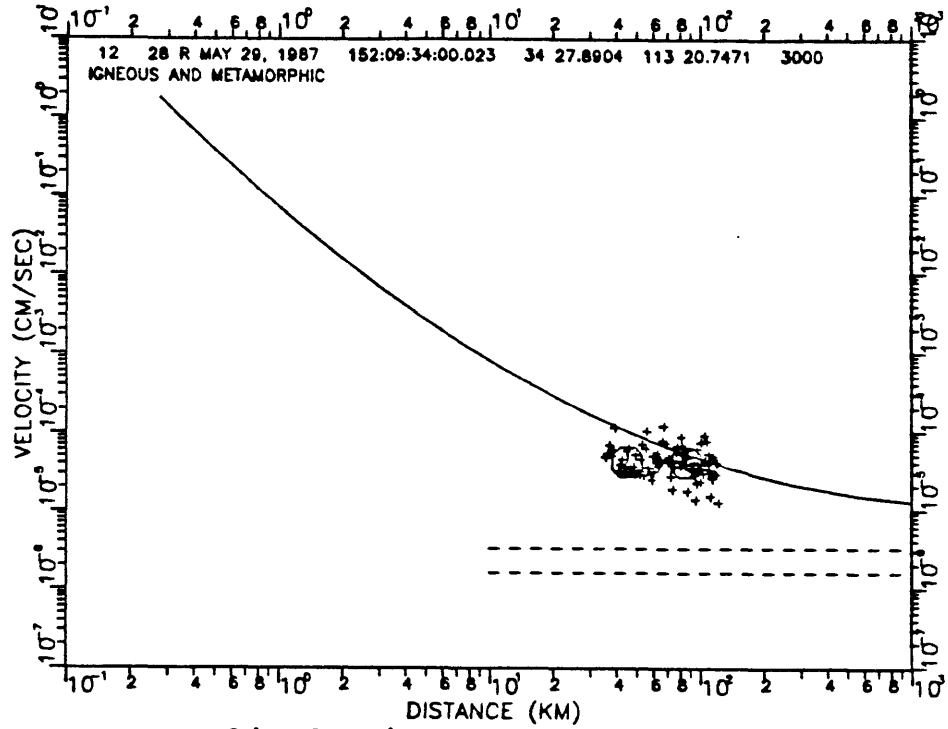

Figure A144. Amplitude-distance curve for PACE 1987 experiment, shot 12, shot point 28. See page A1 for complete description.

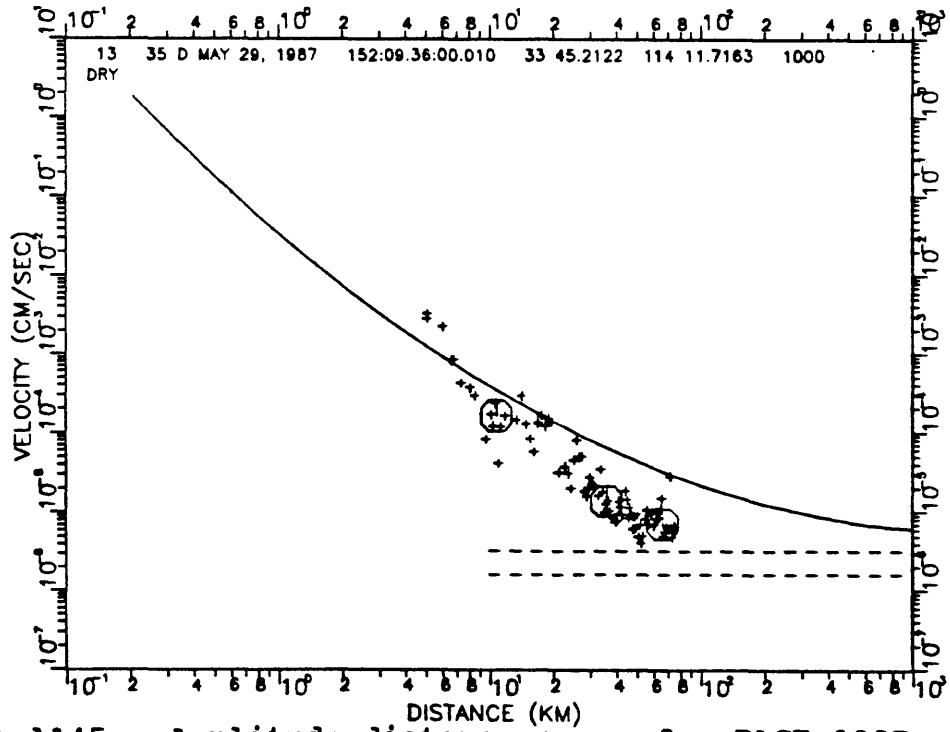

Figure A145. Amplitude-distance curve for PACE 1987 experiment, shot 13, shot point 35. See page A1 for complete description.

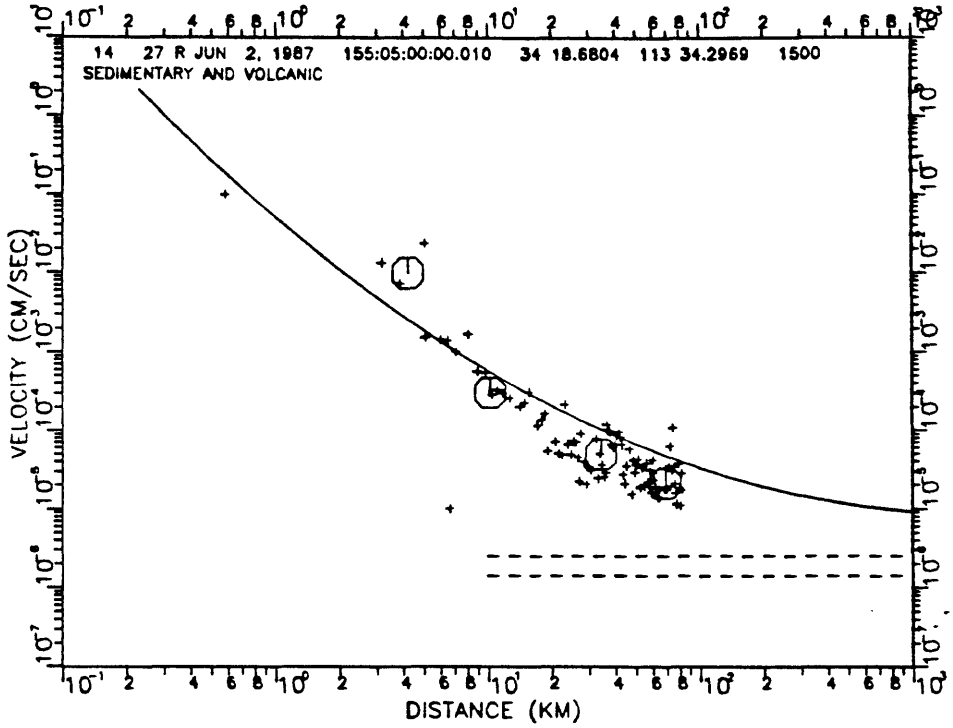

Figure A146 Amplitude-distance curve for PACE 1987 experiment, shot 14, shot point 27. See page A1 for complete description.

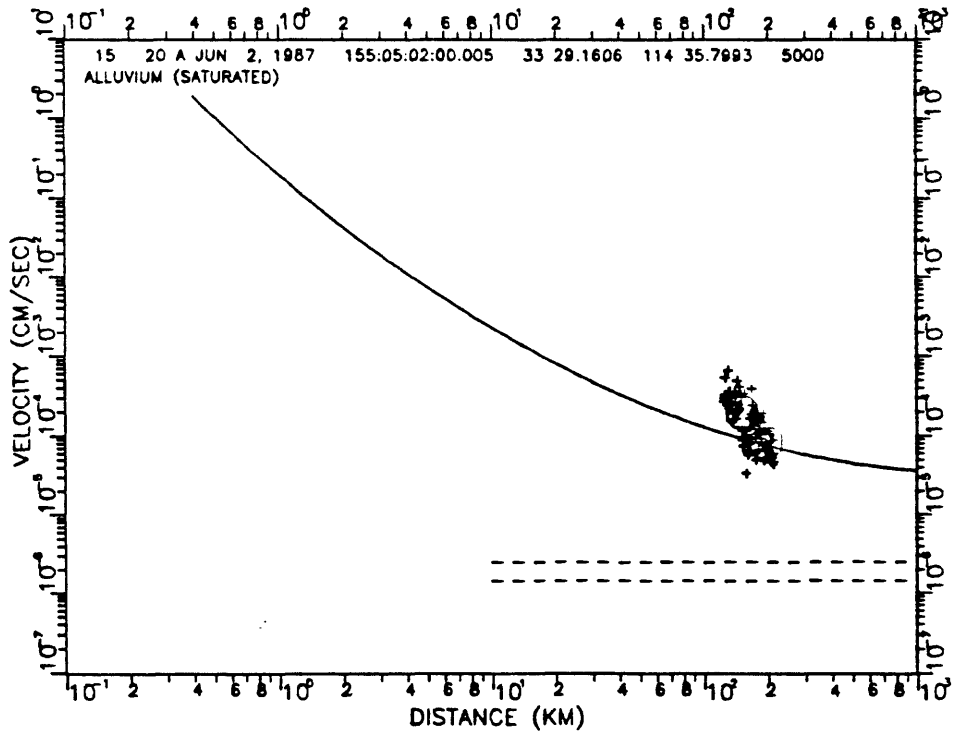

Figure A147. Amplitude-distance curve for PACE 1987 experiment, shot 15, shot point 20. See page A1 for complete description.

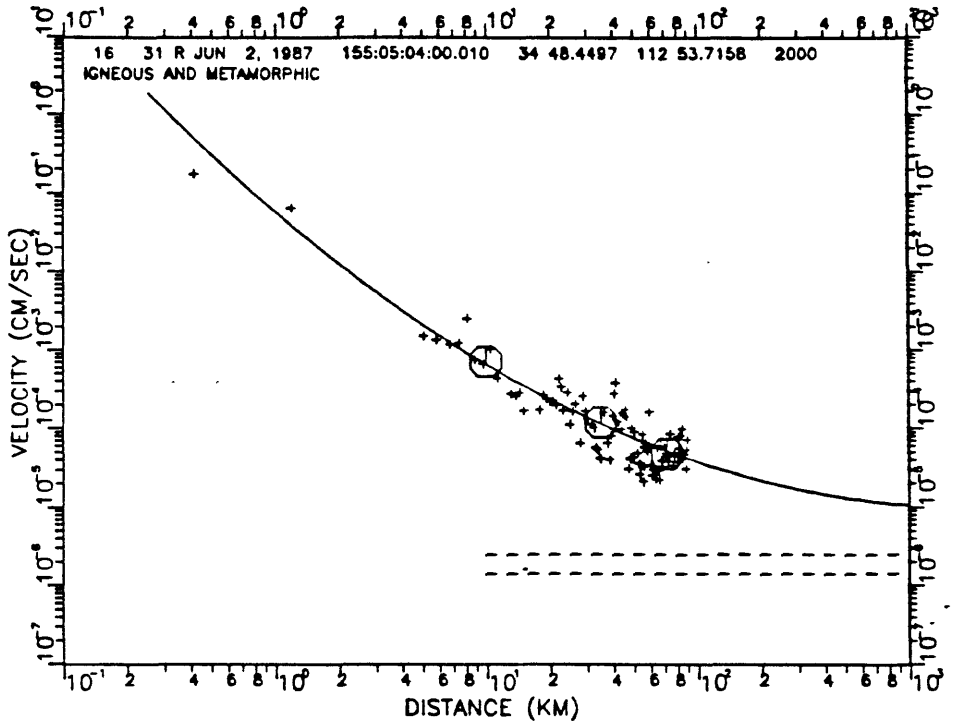

Figure A148. Amplitude-distance curve for PACE 1987 experiment, shot 16, shot point 31. See page A1 for complete description.

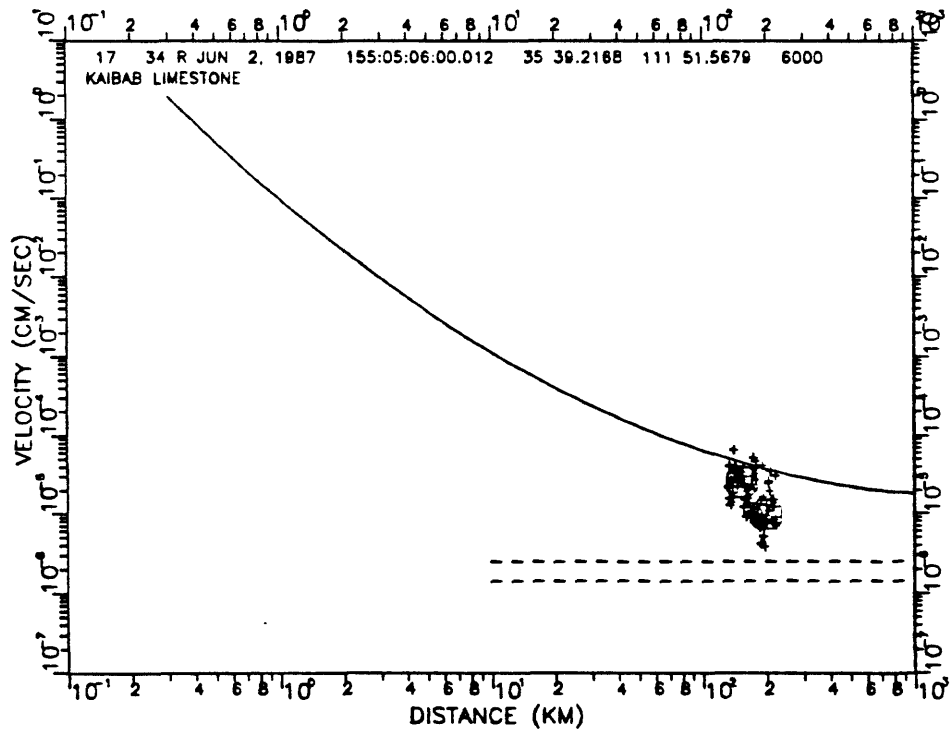

Figure A149. Amplitude-distance curve for PACE 1987 experiment, shot 17, shot point 34. See page A1 for complete description.

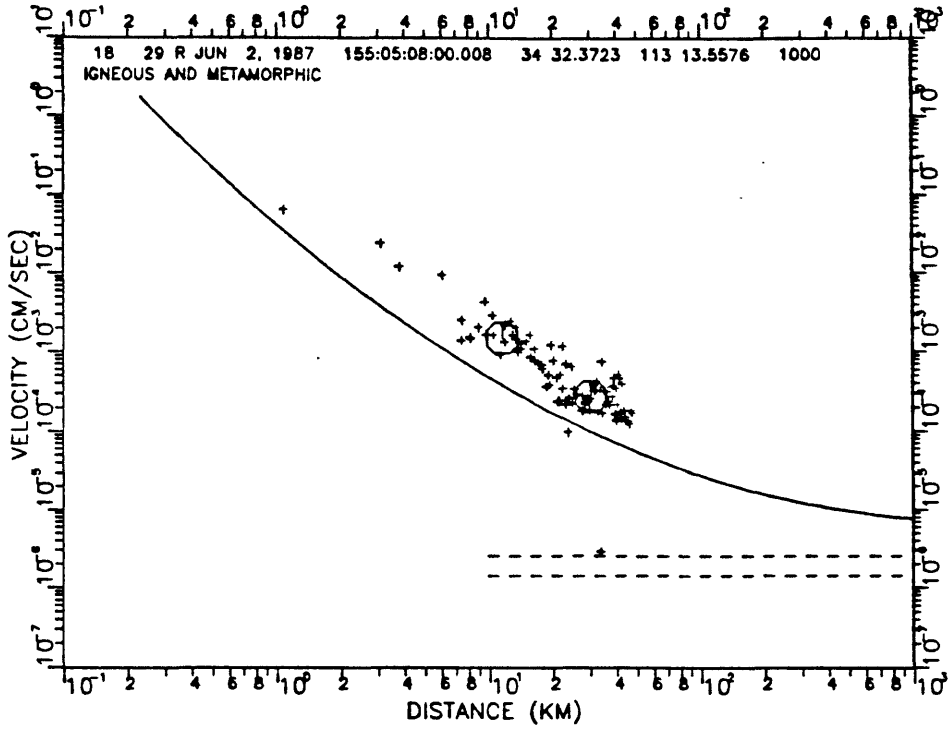

Figure A150. Amplitude-distance curve for PACE 1987 experiment, shot 18, shot point 29. See page A1 for complete description.

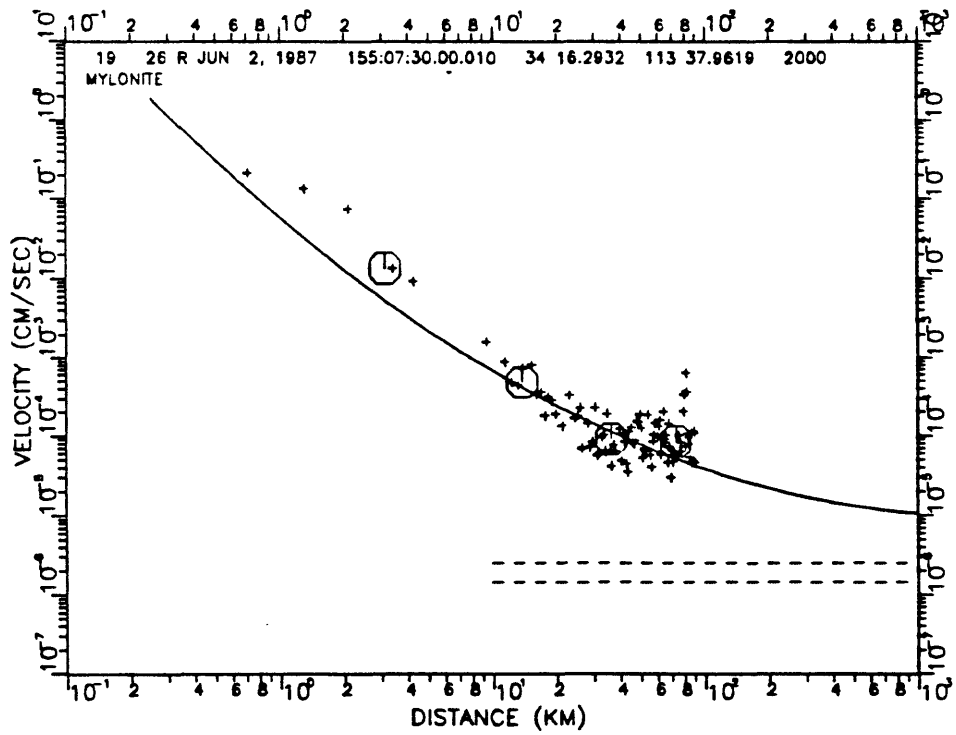

Figure A151. Amplitude-distance curve for PACE 1987 experiment, shot 19, shot point 26. See page A1 for complete description.

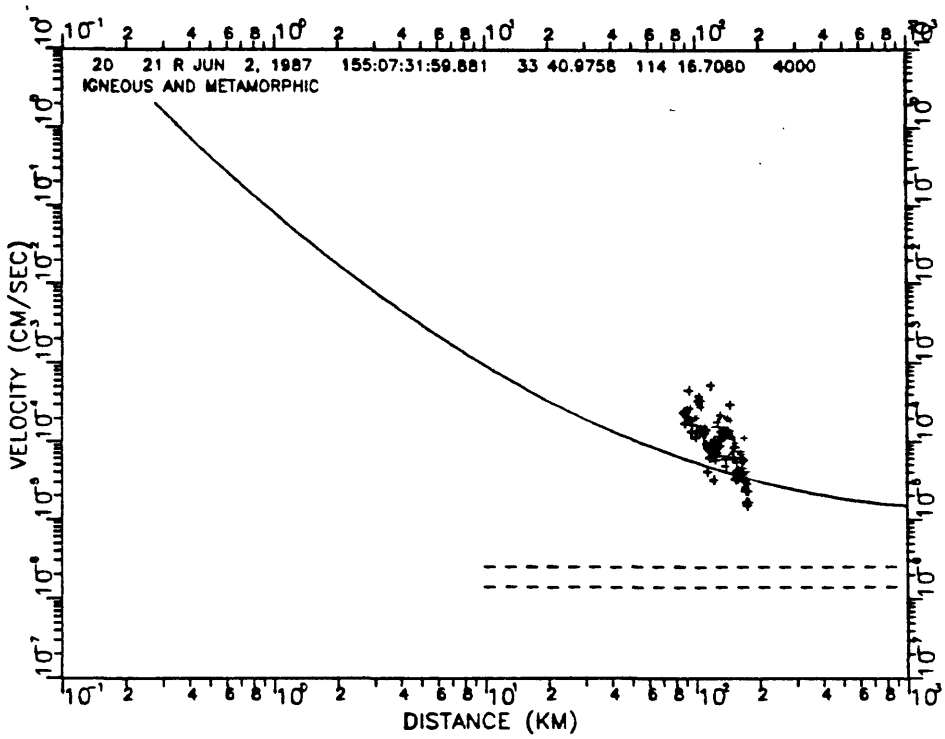

Figure A152. Amplitude-distance curve for PACE 1987 experiment, shot 20, shot point 21. See page A1 for complete description.

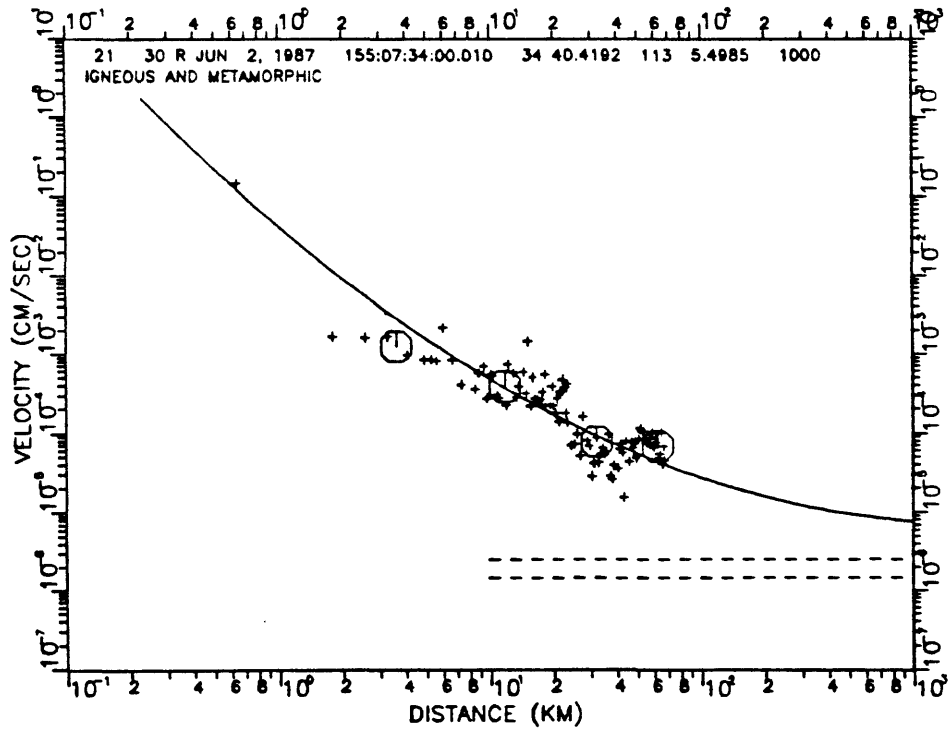

Figure A153. Amplitude-distance curve for PACE 1987 experiment, shot 21, shot point 30. See page A1 for complete description.

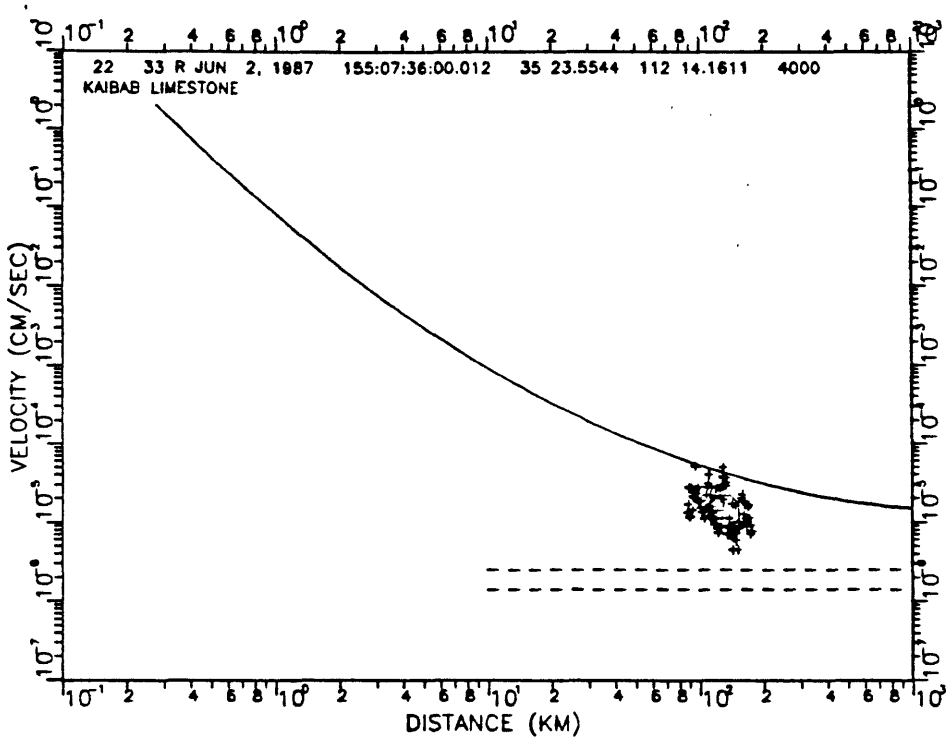

Figure A154. Amplitude-distance curve for PACE 1987 experiment, shot 22, shot point 33. See page A1 for complete description.

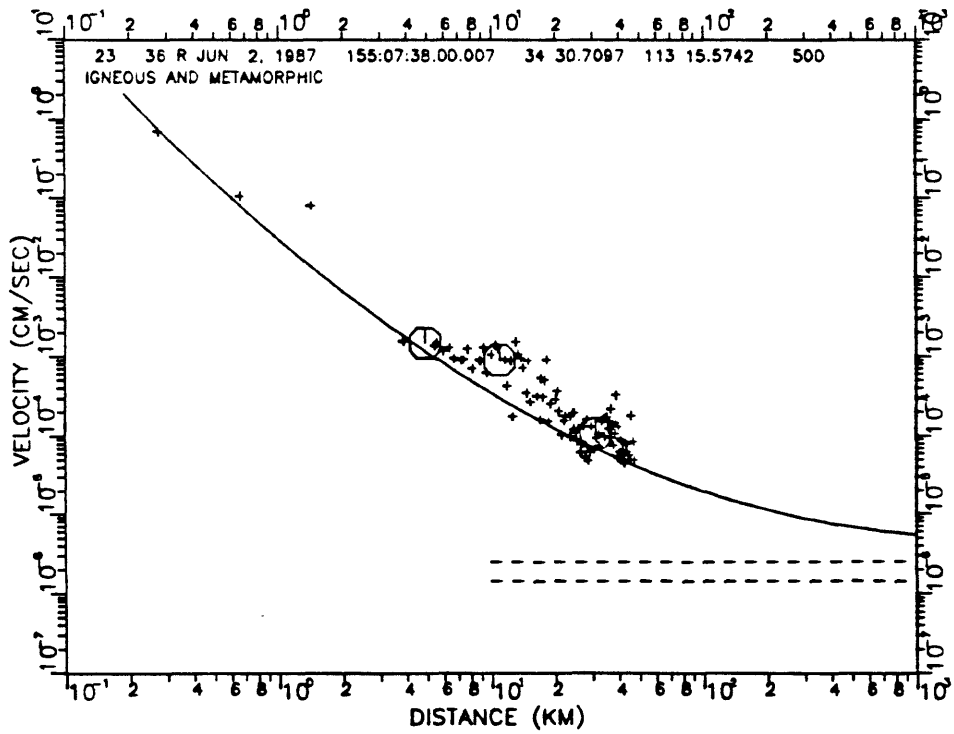

Figure A155. Amplitude-distance curve for PACE 1987 experiment, shot 23, shot point 36. See page A1 for complete description.

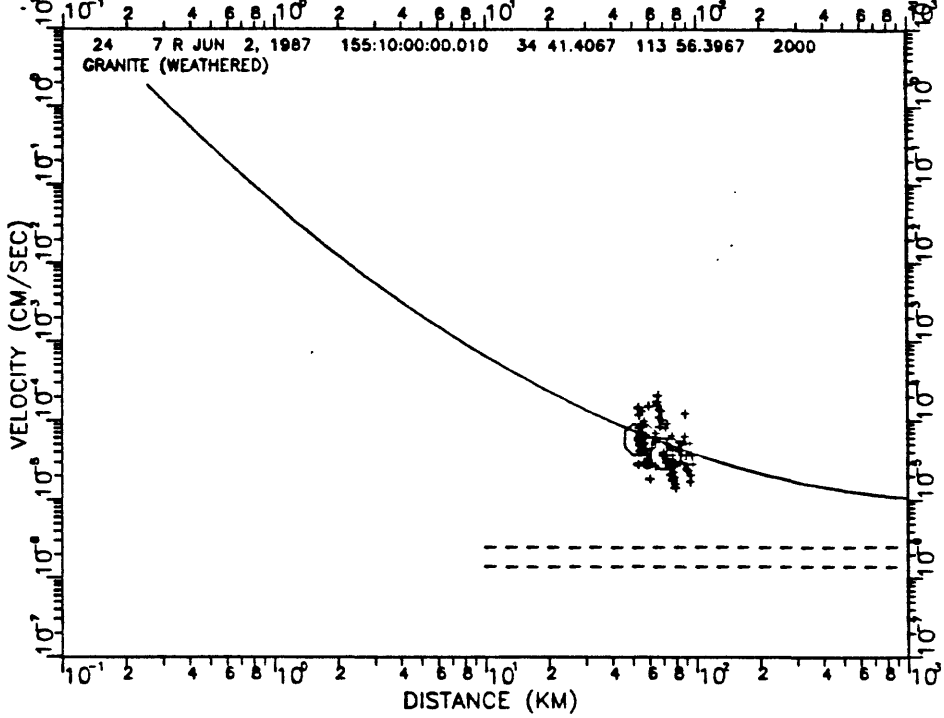

Figure A156. Amplitude-distance curve for PACE 1987 experiment, shot 24 shot point 7. See page A1 for complete description.

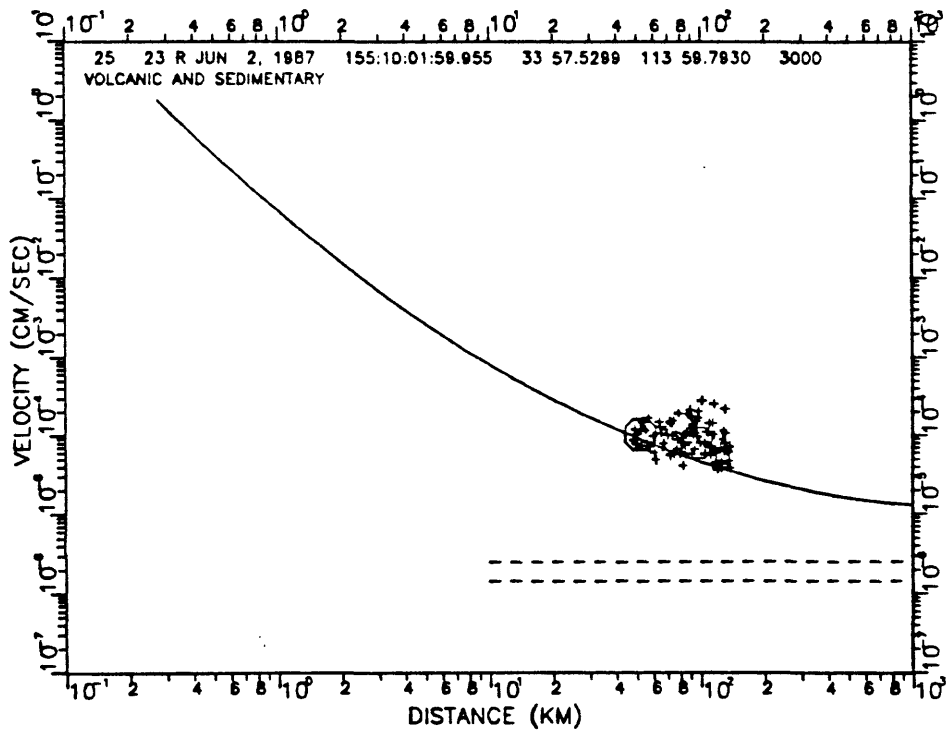

Figure A157. Amplitude-distance curve for PACE 1987 experiment, shot 25, shot point 23. See page A1 for complete description.

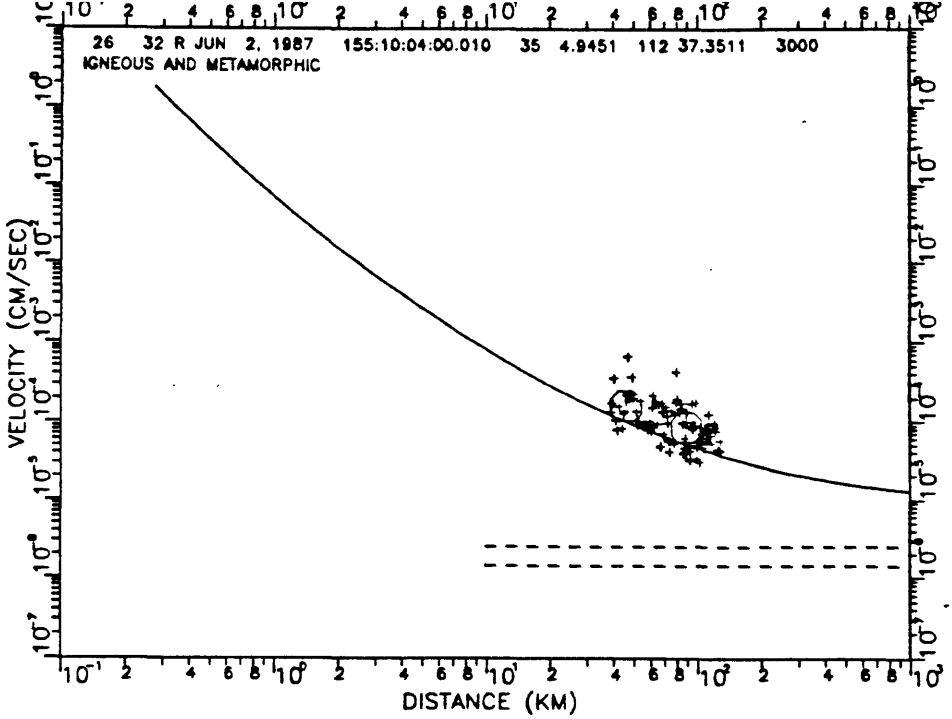

Figure A158. Amplitude-distance curve for PACE 1987 experiment, shot 26, shot point 32. See page A1 for complete description.

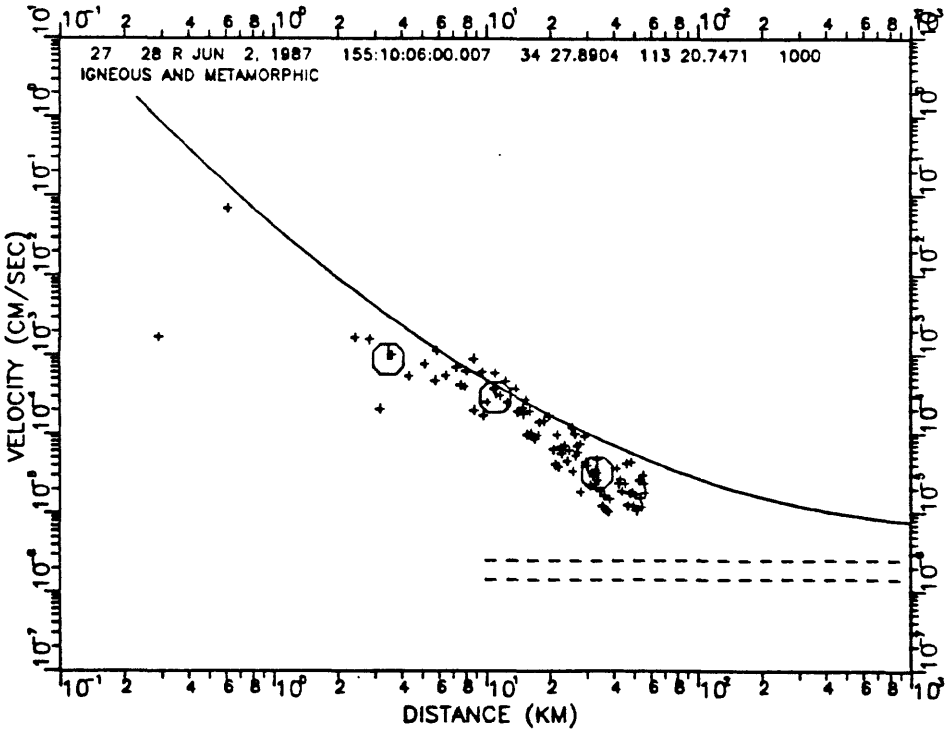

Figure A159. Amplitude-distance curve for PACE 1987 experiment, shot 27, shot point 28. See page A1 for complete description.