GENETIC INFLUENCES ON THE

NATURE AND PROPERTIES OF BASAL

MELT OUT TILLS

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TABLE 3.1. THE RELATIONS BETWEEN AVERAGE SIZES OF NON-UNIFORM PARTICULATE SUBSTANCES, PROVIDED A LOG-NORMAL DISTRIBUTION IS OBEYED.

Average Size	Symbol	Mathematical Definition (Summation between i=1 and i=n)	Equivalent Natural Logarithms in Terms of Statistical Parameters of Distribution Curve by Number, $\bar{M}_n$ and σ_n
Geometric mean on weight basis	$\bar{M}_g$	$\frac{\sum n_i M_i^4}{\sum n_i M_i^3}$	$\ln \bar{M}n + 3.0 \ln^2 \sigma n$
Arithmetic mean on number basis	$\bar{M}_{an}$	$\frac{\sum n_i M_i}{\sum n_i}$	$\ln \bar{M}n + 0.5 \ln^2 \sigma n$
Surface area	$\bar{M}_{sa}$	$\left\{\frac{\sum n_i M_i^2}{\sum n_i}\right\}^{\frac{1}{2}}$	$\ln \bar{M}n + 1.0 \ln^2 \sigma n$
Volume	$\bar{M}$	$\left\{\frac{\sum n_i M_i^3}{\sum n_i}\right\}^{\frac{1}{3}}$	$\ln \bar{M}n + 1.5 \ln^2 \sigma n$
Specific surface area	$\bar{M}_s$	$\frac{\sum n_i M_i^3}{\sum n_i M_i^2}$	$\ln \bar{M}n + 2.5 \ln^2 \sigma n$

TABLE 4.1 CONSTRUCTION DETAILS OF NORWEGIAN DAMS (After KJAERNSLI, 1968).

			CREST		CORE							
No. Name	Year of Construction Owner	Height m Volume, 1000 m^3	Length m width m	Form	Material	Compaction	k m/sec	ρ_d opt. t/m^3	w opt. %	Transition	Supporting fill	Bedrock
2 Bordal 1	1958-9 NVE	42 300	300 7	Curved upstream R=350m	Moraine	8 t vibrating roller, 0.6m layers	2.10^{-1}	2.05	7.5	Sandy gravel compacted as supporting fill	Gravel placed in 0.6 m layers, sluiced and compacted with 8 t vibr. roller	Gniess Granite
7 Arsteddalen	1961-63 Norsk Hydro	59 450	300 7	Curved upstream R=400 m	Moraine	15 t tracter 0.25m layers	7.10^{-4}	2.10	9.0	Sandy gravel and tunnel spoil	Quarried rock, 5 m layers. Sluiced.	Crystalline limestone
12 Tunhovd	1964-65 NVE	37 261	320 7	Curved upstream	Moraine	[illegible] t vibrating roller, 0.6 m layers	9.10^{-5}	2.15	7.5	Sandy gravel	Downstream; Tunnel spoil placed in [illegible] -.5 m 1 yers and sluiced. Upstream; Quarried rock, partly dumped in water	Calcitic Diabase
13 Hyttejuvet	1963-65 Norsk Hydro	93 1,435	350 7	Curved upstream	Moraine	15 t tracter 0.25m layers	7.10^{-6}	2.17	7.8	Sandy gravel and tunnel spoil	Quarried rock, 5m layers, sluiced	Mica Schist
17 Akersvatn	1964-67 NVE	53.5 1,085	485 7	Curved upstream	Moraine	8 t vibrating roller, 0.?m layers	1.10^{-3}	2.15	8.5	Gravelly sand and tunnel spoil	Quarried rock, 5m layers, sluiced	Schist
18 Kalvatn	1965-67 NVE	48.5 400	390 6	Curved upstream	Moraine	8 t vibrating roller, 0.?m layers	1.10^{-3}	2.14	9.5	Gravelly sand and tunnel spoil	Quarried rock, 5m layers, sluiced	Mica Schist
22 Vasslivatn	1967 Sørtrøndelag Elektrisitetsverk	25 70	150 5	Curved upstream R=155m	Moraine	15 t tracter 0.25 m layers	3.10^{-3}	2.17	7.5	Gravelly sand	Tunnel spoil, 1.5 m layers, sluiced	-
27 Follsjø	1965-69 NVE	74 940	565 6	Curved upstream, R=155m	Moraine	10 t vibrating roller, 0.6m layers	2.10^{-3}	2.14	7.5	Gravelly sand and tunnel spoil	Quarried rock, 5m layers sluiced	Amphibolite and Gniess Mica Schist
28 Manndøla	1968-69 Sundsbarm Kraftverk	26.5 114	110 5	Curved upstream, R=210m	Moraine	4.4 t vibrating roller, 0.6m layers	5.10^{-7}	2.14	7.3	Sandy gravel	Tunnel spoil, 1.5m layers, sluiced	Quartzite
51 Dravladalsvatn	1971-72 NVE	29 192	340 5	Partly curved upstream, R=100m	Moraine	15 t tractor, 0.25m layers	4.10^{-2}	2.16	7.6	Sandy gravel and tunnel spoil	Tunnel spoil 1.5m layers. sluiced. Quarried rock, 5 m layers. sluiced.	Gniess with Amphibolite and mica layers.
52 Vatna	1971-72 Finndøla Kraftverk	28 173	310 5	Curvilinear, R=150m	Moraine	5 t vibrating roller, 0.6 m layers	$3.1?^{-3}$	2.14	7.3	Sandy gravel and tunnel spoil	Quarried rock, 3 m layers, sluiced.	Gniess Granite
55 Juklevatn	1971-73 NVE	58 610	350 5	Straight	Moraine	10 t vibrating roller, 0.8m layers	$5.1?^{-2}$	2.15	[illegible]	Gravel and tunnel spoil	Quarried rock, 5m layers, sluiced	-
56 Nyasvatn 1	1971-73 NVE	58 210	250 5	Partly curved downstream R=35m	Moraine	Tractor, 0.25m layers	3.10^{-2}	2.12	8.0	Gravel and tunnel spoil	Tunnel spoil, 1.5m layers, Quarried rock, 5m layers.	Gniess Granite.

Table 4.2 - GEOTECHNICAL PROPERTIES OF TILL MATERIALS IN CANADIAN DAMS (After McDonald et al, 1961)

DAM OR DYKE				IMPERVIOUS FILL MATERIAL						
							SHEAR STRENGTH		PLACING CONDITIONS	
							At Wopt	At 125% of Wopt		
No.	Name year of completion	Type (A) Max. height (m)	k(µm/sec) Max. Hydr Gradient	L_L (%) P_L (%)	Wopt. (%) (B) ρ_d Max.(t/m^3)	G_S	ϕ_d (°) C_d (kN/m^2)	ϕ_d (°) C_d (kN/m^2)	Compaction Method	Av. Field Comp' Water Content ((% of Proctor)
	GLACIAL TILLS-PLASTIC									
6	Niagara Storage 1957	RS 20.6	0.025 2.8×10^{-4}	41 21	20 1.66	2.70	- -	23-26 4.8	Sheepsfoot Roller	92 105
7	Conestogo 1957	EH 30.9	0.05 0.7×10^{-4}	20-32 11-17	10-17 2.03- 1.81	2.67	- -	- -	Pneumatic Tired Roller	95-100 100
8	Fanshawe 1952	EC 30.9	0.005 1.3×10^{-4}	15-25 13-18	- -	2.65	- -	- -	Construct- ion Equip- ment	95-100 100
9	St. Mary 1950	EH 60.6	- 0.8×10^{-4}	35 14	15 1.81	2.71	28 20.3	- -	Sheepsfoot Roller	94 95
	GLACIAL TILLS-NON PLASTIC									
11	Menihek 1953	EH 12.1	0.3 1.2×10^{-4}	16 14	10 2.11	2.63 2.74	28 19.1	- -	Sheepsfoot Roller	80-100 95
14	Sisson 1952	EH 25.7	2.5 0.4×10^{-4}	- -	12-18 1.97-1.75	- -	- -	- -	Sheepsfoot Roller	80-120 90-105
15	Lake St. Anne 1958	RS 36.3	15.0 4.5×10^{-4}	Non- Plastic Silty Till	8 2.05	2.73	39 22.7	39 16.7	Construct- ion Equip- ment	101 96
16	Bersimis No. 1 1955	RS 68.2	2.0 6.0×10^{-4}	Non- Plastic Silty Till	9 2.16	2.72	35.5 65.5	38.0 51.6	Construct- ion Equip- ment	101 98
17	Cornwall 1958	EH 25.7	0.25 0.5×10^{-4}	14 10	10 2.11	2.71	- -	39 0	Sheepsfoot Roller	96 101
18	Shand 1942	EH 22.7	0.06 0.6×10^{-4}	- -	9 2.14	2.74	32 46.4	- -	Sheepsfoot Roller	129 92

Notes -(A) EH - Earthfill, Homogeneous Section EC - Earthfill, Central Core RS - Rockfill, Sloping Core

(B) Measured in Standard Proctor Test.

TABLE 5.1 CLASSIFICATION OF SOME SCOTTISH TILLS

LOCATION	COWAL ROAD SITES	CORROUR FOREST FERSIT ROAD	CORROUR FOREST GHUILBINN ROAD	CORROUR FOREST STRATH-OSSIAN WAY	GLENGARRY FOREST GLEN KINGIE	STRATHYRE FOREST	GLEN ORCHY FOREST
LITHOLOGY	MICA SCHIST	GRANITE	GRANITE	GRANITE	GRANULITE	QUARTOZE MICA SCHIST	QUARTZITE AND MICA SCHIST
PARTICLE SIZE GRADING	FIGS. 5.16 to 5.20	FIG. 27	FIG. 28	FIG. 29	FIGS. 5.37 to 5.39	FIGS. 5.46	FIGS. 5.51 to 5.54
SPLIT SIZE mm	0.6	2.0	0.8	0.8	0.4	0.4	0.2
SPLIT SIZE ø	0.8	-1.0	0.3	0.3	1.3	1.3	2.3
RANGE % FINES FOR 100 mm DIAMETER	23-95%	45-73%	43-63%	28-52	10-66	25-58	5-25
	53% Average	58% Average	52% Average	48% Average	30% Average	53% Average	14% Average
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)							
ACCORDING TO B.S. 1377	SILTY SAND	SILTY SAND	SILTY SAND	SILTY SAND	SILTY SAND	SILTY SAND	SILTY SAND
MODIFIED WENT-WORTH SCALE	COARSE SILT FINE TO V. FINE SAND	SILT SAND	COARSE SILTY V. FINE TO MEDIUM SAND	COARSE SILTY V. FINE TO MEDIUM SAND	MEDIUM TO COARSE SILT - FINE SAND	COARSE SILTY v. fine SAND	COARSE SILT v. fine SAND
DOEGLAS'S INDICES (ø Scale)	Q_1 M_D Q_3	Q_1 M_D Q_3	Q_1 M_D Q_3	Q_1 M_D Q_3	Q_1 M_D Q_3	Q_1 M_D Q_3	Q_1 M_D Q_3
Max.	5.7 4.8 3.1	4.6 2.3 0.7	4.5 3.1 1.8	4.4 2.9 1.5	6.2 4.1 2.2	5.5 4.0 2.9	5.8 4.1 3.1
Aver.	5.5 3.7 2.5	3.9 1.8 0.4	4.0 3.5 1.75	3.8 2.5 1.3	4.7 3.1 1.9	5.0 3.8 2.8	4.8 3.5 2.8
Min.	4.1 2.6 1.7	3.2 1.3 0.0	3.8 2.9 1.7	3.2 2.1 1.1	3.3 2.3 1.6	4.7 3.5 2.7	4.0 2.8 2.4

TABLE 5.2 CLASSIFICATION OF SOME SCOTTISH AND MODERN GLACIAL TILLS

LOCATION	GLEN TROOL CAIRN EDWARD FOREST (BENNEN)	GLEN TROOL GARCROGO FOREST	GLEN TROOL GARRARIES FOREST	BACKWATER DAM, UPPER SILTY TILL	BACKWATER DAM - NORTH BORROW PIT	BLAISEN HARDANGER - JOKULEN	LACROIX GLACIER ANTARCTICA
LITHOLOGY	GRANITE GREYWACKE	GRANITE GREYWACKE	GRANITE GREYWACKE	SCHISTOZE GRIT/MICA SCHIST	SCHISTOZE GRIT/MICA SCHIST	GRANITE - GNIESS PHYLLITE	GRANITE - GNIESS
PARTICLE SIZE GRADING	Fig. 5.61	Fig. 5.62	Fig. 5.63	Fig. 5.71	Fig. 5.75	Fig. 5.85	Fig. 5.90
AVERAGE SPLIT SIZE mm	0.6	0.3	0.9	0.2	0.2	0.11	0.095
AVERAGE SPLIT SIZE Ø	0.8	1.3	0.1	2.3	2.3	3.2	3.4
RANGE OF % FINES FOR 100 mm DIAMETER	20-50% 34% Average	9-35% 25% Average	35-54% 47% Average	30-66% 48% Average	50-65% 57% Average	26-45% 38% Average	50%
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)							
ACCORDING TO B.S. 1377	Silty Sand	Silty Sand	Silty Sand	Clayey Silt with Sand	Clayey Silt with Sand	Clayey Silt	Clayey Silt
MODIFIED WENTWORTH SCALE	Coarse Silty Fine to very Fine Sand	Medium Coarse Silt - Fine to V. Fine sand	Medium Coarse Silt - Fine to V. Fine Sand	Clayey Silt with V. Fine Sand	Clayey Silt with V. Fine Sand	Clayey V. Fine to Coarse Silt	Clayey V. Fine to Coarse Silt
DOEGLAS'S INDICES (Ø SCALE)	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3
MAX.	6.2 3.8 2.1	5.8 4.1 3.0	5.2 3.3 2.0	10.0 5.7 4.1	10.3 5.8 4.1	8.3 6.7 5.6	
AVER.	4.9 2.9 1.8	5.3 3.5 2.5	5.0 3.1 1.9	7.8 5.1 3.8	8.4 5.1 3.8	7.8 6.3 5.4	7.4 5.8 4.6
MIN.	3.8 2.1 1.4	4.8 2.8 2.0	4.8 2.9 1.7	6.1 4.7 3.3	7.0 4.6 3.4	7.3 5.9 5.1	

TABLE 5.3 CLASSIFICATION OF NORWEGIAN DAM TILLS (2 - 22)

LOCATION	BORDAL	ARSTADDALEN	TUNHOVD	HYTTEJUVET	AKERSVATN (UMSKARAT)	KALVATN (SPRUTFUSS-MYRA)	VASSLIVATN
DAM NO.	2	7	12	13	17	18	22
LITHOLOGY	Gniess - Granite	Crystalline Limestone	Calcitic Diebase	Mica Schist	Schist	Mica Schist	?
PARTICLE SIZE GRADING	Fig. 5.93	Fig. 5.94	Fig. 5.95	Fig. 5.96	Fig. 5.97	Fig. 5.98	Fig. 5.99
AVERAGE SPLIT SIZE mm	0.2	0.1	0.15	0.1	0.13	0.22	0.4
AVERAGE SPLIT SIZE Ø	2.3	3.3	2.8	3.3	3.0	2.1	1.3
RANGE OF % FINES FOR 20 mm DIAMETER	28 - 50% 35% Average	47 - 70% 59% Average	38 - 67% 48% Average	35 - 54% 50% Average	38 - 60% 53% Average	47 - 83% 62% Average	32 - 57% 40% Average
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)							
ACCORDING to B.S. 1377	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt	Sandy Silt
MODIFIED WENTWORTH SCALE	V. Fine Sand V. Fine to Coarse silt.	Clayey - V. Fine to Coarse silt	Clayey - V. Fine to Coarse silt	Clayey - V. Fine to Coarse silt	Clayey - V. Fine to Coarse silt	V. Fine to Fine sand - V. Fine to Coarse silt.	Clayey - V. Fine to Coarse silt
TYPICAL DOEGLAS'S GRAIN SIZE INDICES (Ø)	Q_1 M_d Q_3 6.7 4.3 3.2	Q_1 M_d Q_3 9.1 6.0 4.3	Q_1 M_d Q_3 7.8 5.9 4.5	Q_1 M_d Q_3 9.5 7.0 5.1	Q_1 M_d Q_3 7.2 5.6 4.4	Q_1 M_d Q_3 6.2 4.7 3.0	Q_1 M_d Q_3 7.1 4.9 2.9

TABLE 5.4 CLASSIFICATIONS OF NORWEGIAN DAM TILLS (27 - Ex 1)

LOCATION	,FOLLSJO	MANDØLA	DRAVLA-DALSVATN	VOTNA	JUKLAVATN	MYSEVATN	STOLSVATN
DAM NO.	27	28	51	52	55	56	Ex 1
LITHOLOGY	Amphilolite and Gniess Mica Schist	Quartzite	Gneiss with Amphilolite And Mica Layers	Gniess Granite	?	Gniess Granite	Gniess
PARTICLE SIZE GRADING	Fig. 5.100	Fig. 5.101	Fig. 5.102	Fig. 5.102	Fig. 5.102	Fig. 5.102	Fig. 5.103
AVERAGE SPLIT SIZE mm	0.28	0.19	0.15	0.38	0.7	0.3	0.15
AVERAGE SPLIT SIZE Ø	1.9	2.4	2.8	1.4	0.6	1.7	2.8
RANGE OF % FINES FOR 20mm DIAMETER	14 - 70% 48% Average	34 - 68% 54% Average	51%	52%	48%	49%	22 - 49% 40% Average
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)							
ACCORDING TO B.S. 1377	Sandy Silt	Sandy Silt	Sandy Silt	Silty Sand	Silty Sand	Silty Sand	Sandy Silt
MODIFIED WENTWORTH SCALE	Clayey V. Fine to Coarse Silt	V. Fine to Fine Sand - V. Fine to Coarse Silt	Fine to Coarse Silt V. Fine to Fine Sand	Fine to Coarse Silt V. Fine to Fine Sand	Fine to Coarse Silt V. Fine to Medium Sand	Fine to Coarse Silt V. Fine to Fine Sand	Fine to Coarse Silt V. Fine to Fine Sand
TYPICAL DOEGLAS'S GRAIN SIZE INDICES (Ø) Q_1 M_d Q_3	6.6 4.8 3.0	5.9 4.2 3.4	5.7 4.3 3.6	4.8 3.3 2.3	5.2 3.4 2.0	5.1 3.8 2.7	5.2 4.1 3.5

TABLE 5.5 CLASSIFICATION OF CANADIAN DAM TILLS (After McDonald et al 1961)

LOCATION	NIAGARA STORAGE (6)	CONESTOGO (7)	FANSHAWE (8)	ST. MARY (9)	MENIHEK (11)	SISSON (14)	LAKE ST.ANNE (15)	BERSIMIS NO. 1 (16)	CORNWALL (17)	SHAND (18)
LITHOLOGY	NOT GIVEN									
PARTICLE SIZE DISTRIBUTION	Fig.5.112	Fig.5.112	Fig.5.112	Fig.5.112	Fig.5.113	Fig.5.113	Fig.5.113	Fig.5.113	Fig.5.113	Fig.5.113
SPLIT SIZE mm	0.052	0.06	0.026	0.04	0.4	0.68	0.6	0.56	0.18	0.35
SPLIT SIZE Ø	4.3	4.1	5.3	4.8	1.3	0.6	0.8	0.9	2.4	1.5
% FINES FOR A MAXIMUM DIAMETER (mm)	85% (max 2mm)	73% (max 4mm)	48% (max 8mm)	73% (max 0.4mm)	72% (max 20mm)	44% (max 15mm)	70% (max 20mm)	72% (max 20mm)	48% (max 20mm)	71% (max 20mm)
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)										
ACCORDING TO B.S. 1377	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Silty Sand	Sandy Clayey Silt	Silty Sand	Silty Sand	Sandy Silt	Sandy Clayey Silt
MODIFIED WENTWORTH SCALE	Clayey very fine to Coarse Silt	Clayey very Fine to Coarse Silt	Clayey very fine to Medium Silt	Clayey very Fine to Coarse Silt	Medium to coarse silty very Fine to Coarse Sand	Silty Clayey Sand	Silty very fine to Coarse Sand With Clay	Silty very fine to Coarse Sand	Fine to very Fine Sandy Silt with Clay	Medium to very Fine Sandy Silt With Clay
DOEGLAS'S INDICES (Ø SCALE) Q_1 M_d Q_3	9.6 7.8 6.2	9.6 7.6 5.8	9.9 8.1 6.9	.10 8.7 6.6	3.9 2.6 2.0	9.3 6.1 2.8	4.9 2.5 1.9	5.1 3.7 2.0	7.4 5.4 3.9	8.6 5.9 3.7

TABLE 5.6 CLASSIFICATION OF VARIOUS CANADIAN TILLS

LOCATION	SHAND DAM	52% DOLOMITIC TILL ONTARIO	67% DOLOMITIC TILL ONTARIO	77% DOLOMITIC TILL ONTARIO	VILLE LA SALLE MONTREAL	ILE HERON MONTREAL
LITHOLOGY	Dolomite	As Above	As Above	As Above	Not Known	Not Known
PARTICLE SIZE DISTRIBUTION	Fig. 5.119	Fig. 5.124	Fig. 5.124	Fig. 5.124	Fig. 5.129	Fig. 5.130
SPLIT SIZE mm	0.35	0.14	0.19	0.055	0.03	0.04
SPLIT SIZE Ø	1.5	2.9	2.4	4.2	5.1	4.7
% FINES FOR MAXIMUM DIAMETER	50-87% 74% Average (max. 100mm)	69% (Max. 30 mm)	56% (Max. 50 mm)	21% (Max. 60mm)	3-78% 30% Average (Max. 100 mm)	20-60% 50% Average (Max. 100 mm)
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)						
ACCORDING TO B.S. 1377	Sandy Clayey Silt	Sandy Clayey Silt	Sandy Silt	Sandy Silt	Clayey Silt	Clayey Silt
MODIFIED WENTWORTH SCALE	Medium to Very Fine Sandy Silt with Clay	Very Fine Sandy Silt with Clay	Fine to Very Fine Sandy Silt with Clay	Very Fine Sandy Silt	Clayey Very Fine to Medium Silt	Clayey Very Fine to Coarse Silt
DOEGLAS'S INDICES (Ø SCALE)	Q_1 M_d Q_3 8.6 5.9 3.8	Q_1 M_d Q_3 7.9 6.1 4.6	Q_1 M_d Q_3 6.8 5.1 3.7	Q_1 M_d Q_3 6.0 4.8 4.0	Q_1 M_d Q_3 8.5 6.9 6.0	Q_1 M_d Q_3 8.3 6.8 5.5

TABLE 5.7 CLASSIFICATION OF KRUMBEIN'S VALPARAISO TILLS (1 - 8)

LOCATION		1	2	3	4	5	6	7	8
LITHOLOGY		AS SHOWN IN FIG. 5.148							
PARTICLE SIZE DISTRIBUTION		Fig. 5.136	Fig. 5.136	Fig. 5.136	Fig. 5.136	Fig. 5.136	Fig. 5.136	Fig. 5.137	Fig. 5.137
SPLIT SIZE	mm	0.05	0.048	0.030	0.055	0.042	0.040	0.050	0.049
	Ø	4.4	4.5	5.1	4.25	4.6	4.7	4.4	4.35
% FINES (MAX. SIZE OF COARSE 1 mm)		70	76	73	68	88	84	83	77
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)									
ACCORDING TO B.S. 1377		CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT
MODIFIED WENTWORTH SCALE		COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY	CLAYEY V. FINE TO COARSE SILT
DOEGLAS INDICES		Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_1	Q_1 M_d Q_3	Q_1 M_d Q_3
(Ø SCALE)		9.9 7.6 5.9	10.0 7.85 6.3	10.2 8.3 6.7	10.5 8.0 6.0	9.8 7.9 6.4	9.85 7.7 6.35	10.3 8.0 6.5	8.95 7.1 5.95

TABLE 5.8 CLASSIFICATION OF KRUMBEIN'S VALPARAISO TILLS (9 - 16)

LOCATION	9	10	11	12	13	14	15	16
LITHOLOGY	AS SHOWN IN FIG. 5.148							
PARTICLE SIZE DISTRIBUTION	FIG. 5.137	FIG. 5.137	FIG. 5.137	FIG. 5.137	FIG. 5.138	FIG. 5.138	FIG. 5.138	FIG. 5.138
SPLIT SIZE mm	0.069	0.07	0.026	0.052	0.045	0.05	0.04	0.04
SPLIT SIZE Ø	3.95	3.9	5.3	4.3	4.6	4.4	4.7	4.7
% FINES (MAX SIZE OF COARSE 1 mm)	86	88	80	83	80	78	56	62
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)								
ACCORDING TO B.S. 1377	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT	CLAYEY SILT
MODIFIED WENTWORTH SCALE	CLAYEY COARSE TO V. FINE SILT	COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY	CLAYEY COARSE TO V. FINE SILT	CLAYEY COARSE TO V. FINE SILT	COARSE TO V. FINE SILTY CLAY	COARSE TO V. FINE SILTY CLAY
DOEGLAS INDICES (Ø SCALE) Q_1 M_d Q_3	9.9 7.7 5.95	10.4 8.0 6.2	10.3 8.8 7.1	10.3 8.1 6.3	9.4 7.3 6.0	10.0 7.4 5.9	10.2 7.7 6.0	10.3 7.8 6.3

TABLE 5.9 CLASSIFICATION OF KRUMBEIN'S VALPARAISO TILLS (17 - 24)

LOCATION	17	18	19	20	21	22	23	24
LITHOLOGY	AS SHOWN IN FIG. 5.148							
PARTICLE SIZE DISTRIBUTION	FIG. 5.138	Fig. 5.138	Fig. 5.139	Fig. 5.139	Fig. 5.139	Fig. 5.139	Fig. 5.139	Fig. 5.139
SPLIT SIZE mm	0.046	0.034	0.020	0.021	0.018	-	0.021	0.019
SPLIT SIZE Ø	4.5	5.0	5.7	5.6	5.9	-	5.6	5.8
% FINES (MAX. SIZE OF COARSE 1 mm)	80	78	74	69	57	-	55	52
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)								
ACCORDING TO B.S. 1377	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	- -	Clayey Silt	Silty Clay
MODIFIED WENTWORTH SCALE	Coarse to V Fine Silty Clay	Coarse to V Fine Silty Clay	Coarse to V Fine Silty Clay	Coarse to V Fine Silty Clay	Coarse to V. Fine Silty Clay	-	Coarse to V. Fine Silty Clay	Medium to Fine Silty Clay
DOEGLAS INDICES (Ø SCALE)	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3
	10.2 7.9 6.3	10.3 8.4 6.9	10.5 8.6 7.1	10.1 8.0 6.7	10.5 8.7 7.2	- - -	10.5 8.9 7.3	10.5 9.3 7.8

TABLE 5.10 CLASSIFICATION OF KRUMBEIN'S ILLINOIS TILLS (A - H)

LOCATION	A	B	C	D	E	F	G	H
LITHOLOGY	AS SHOWN IN FIG. 5.164							
PARTICLE SIZE DISTRIBUTION	Fig. 5.150	Fig. 5.150	Fig. 5.150	Fig. 5.150	Fig. 5.151	Fig. 5.151	Fig. 5.151	Fig. 5.151
SPLIT SIZE mm	0.072	0.07	0.065	0.060	0.031	0.028	0.033	0.029
SPLIT SIZE Ø	3.8	3.9	4.0	4.1	5.1	5.2	4.95	5.15
% FINES (MAX. SIZE 1 mm)	40	45	50	50	45	52	40	46
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)								
ACCORDING TO B.S. 1377	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt
MODIFIED WENTWORTH SCALE	Clayey V. Fine to Coarse Silt	Clayey V. Fine to Coarse Silt	Clayey V. Fine to Coarse Silt	Clayey V. Fine to Coarse Silt	Clayey V. Fine to Coarse Silt	Clayey V. Fine to Coarse Silt	Clayey V. Fine to Coarse Silt	Clayey V. Fine to Coarse Silt
DOEGLAS'S INDICES (Ø SCALE)	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3	Q_1 M_d Q_3
	8.4 6.4 5.1	8.8 6.7 5.3	8.5 6.5 5.2	9.0 6.9 5.5	9.8 7.6 5.9	9.9 7.7 6.2	9.0 7.1 6.0	9.0 7.5 6.2

TABLE 5.11 CLASSIFICATION OF KRUMBEIN'S ILLINOIS TILLS (J - P_I)

LOCATION	J	K	L	M	N	O	P	P_I
LITHOLOGY	AS SHOWN IN FIG. 5.164							
PARTICLE SIZE DISTRIBUTION	Fig. 5.152	Fig. 5.152	Fig. 5.152	Fig. 5.153	Fig. 5.153	Fig. 5.153	Fig. 5.153	Fig. 5.153
SPLIT mm	0.023	0.021	0.025	0.028	0.020	0.020	0.025	0.030
SIZE Ø	5.5	5.7	5.4	5.3	5.75	5.75	5.4	5.15
% FINES (MAX. SIZE 1 mm)	68	66	65	77	60	77	88	88
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)								
ACCORDING TO B.S. 1377	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt
MODIFIED WENTWORTH SCALE	Medium to Very Fine Silty Clay	Medium to Very Fine Silty Clay	Medium to Very Fine Silty Clay	Medium to Very Fine Silty Clay	Medium to Very Fine Silty Clay	Medium to Very Fine Silty Clay	Medium to Very Fine Silty Clay	Medium to Very Fine Silty Clay
DOEGLAS'S INDICES (Ø SCALE) Q_1 M_d Q_3	10.0 8.1 6.8	9.6 7.6 6.6	9.6 7.9 6.6	9.6 7.7 6.6	9.5 7.6 6.7	9.9 7.9 6.9	10.5 8.4 7.1	10.5 9.0 7.4

TABLE 5.12 CLASSIFICATION OF KRUMBEIN'S ILLINOIS TILLS (Q - W)

LOCATION		Q	R	S	T	U	V	W
LITHOLOGY		AS SHOWN IN FIG. 5.164						
PARTICLE SIZE DISTRIBUTION		Fig. 5.154	Fig. 5.154	Fig. 5.154	Fig. 5.154	Fig. 5.154	Fig. 5.154	Fig. 5.154
SPLIT	mm	0.039	0.032	0.031	0.030	0.030	0.030	0.032
SIZE	Ø	4.8	5.0	5.1	5.15	5.15	5.15	5.00
% FINES (MAX. SIZE 1 mm)		83	92	86	82	84	82	88
CLASSIFICATION OF FINE SOIL FRACTION (MATRIX)								
ACCORDING TO B.S. 1377		Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt	Clayey Silt
MODIFIED WENTWORTH SCALE		Fine to very Fine Silty Clay	Fine to very Fine Silty Clay	Fine to very Fine Silty Clay	Fine to very Fine Silty Clay	Fine to very Fine Silty Clay	Fine to very Fine Silty Clay	Fine to very Fine Silty Clay
DOEGLAS'S INDICES (Ø SCALE)	Q_1	10.2	10.5	10.5	10.3	10.3	10.3	10.2
	M_d	8.1	8.6	8.8	8.2	8.4	8.4	8.7
	Q_3	6.7	7.1	7.2	6.7	7.0	7.0	7.0

TABLE 6.1. MEAN PARTICLE SIZE DIFFERENCE IN TILLS.

SITE	MEAN PARTICLE SIZE * DIFFERENCE
Scottish Tills	
Cowal	0.02 to 0.014
Courrour	0.0014 to 0.021
Strathyre	0.005 to 0.007
Glen Orchy	0.008 to 0.011
Glen Trool	0.008 to 0.02
Backwater Dam	0.0085 to 0.01
Blaisen	0.0014 to 0.003
Norwegian Dams	
2	0.03
7	0.029
12	0.013
13	0.028
17	0.023
18	0.036
22	0.012
27	0.018
28	0.048
51	0.054
52	0.034
55	0.027
56	0.039
EX1	0.042

TABLE 6.1. (contd.)

SITE	MEAN PARTICLE SIZE * DIFFERENCE
Canadian Dams	
6	0.023
7	0.022
8	0.015
9	0.032
11	0.009
14	0.002
15	0.006
16	0.042
17	0.015
18	0.008
Montreal Ville la Salle	0.009
Ile Heron	0.066
Valparaiso	0.042
Illinois	0.087

* Mean Particle Size Difference is taken as the ratio of the fine soil fraction D 50 size to the coarse soil fraction D 50 size when the maximum particle size is 100 mm diameter.

TABLE 6.2. PARTICLE ORGANISATION IN COWAL TILL WHEN COMPACTED AT OPTIMUM BRITISH STANDARD CONDITIONS.

Percentage Fines Content	State of Particle Organisation
0 - 10	Clast Controlled
10 - 15	Clast dominated
15 - 37	Well graded
37 - 80	Matrix dominated
80 - 100	Matrix controlled

TABLE 6.3. RELATIVE APPARENT ABUNDANCE CLASSIFICATION.

RELATIVE ABUNDANCE OF A FORM.	REPRESENTATIVE SYMBOL.	DESCRIPTION
Not apparent	N.A.	No examples of this form are observable.
Rare	1.	Few examples of this form to be found.
Occasional	2.	Examples of this form are observable but not common.
Frequent	3.	A large number of forms of this type are to be found.
Dominant	4.	This form is very common and is dominant.

SOIL PROPERTIES	CENTRAL BREIDAMERKURJOKULL ICELAND	WEST BREIDAMERKURJOKULL ICELAND	BLAISEN NORWAY
LIQUID LIMIT (%)	16	20	18
PLASTIC LIMIT (%)	13	15	15
WATER CONTENT (%)	9	7.4	10
DRY DENSITY (t/m^3)	2.37	1.95	1.81
SPECIFIC GRAVITY	2.85	2.85	2.74
ROCK CONSTITUENTS	Basalt suite	Basalt suite	Granite-gneiss, phyllite

TABLE 6.4. AVERAGE PHYSICAL PROPERTIES OF NORWEGIAN AND ICELANDIC TILLS

SOIL PROPERTY	BREIDAMERKURJOKULL ICELAND	BLAISEN NORWAY
LIQUID LIMIT (%)	26	20
PLASTIC LIMIT (%)	19	14
WATER CONTENT (%)	60	44

TABLE 6. 5 PROPERTIES OF FROZEN TILLS FROM NORWEGIAN AND ICELANDIC GLACIERS

TABLE 6.6. PERCENTAGE OF CLASTS IN EACH OF SEVEN DESCRIPTIVE SHAPE CLASSES AND INDEXES OF FLATNESS FOR THE TILLS SAMPLED.

Descriptive shape classes	ICELAND			NORWAY	
	BR/C 17	BR/C 10	BR/W 3B	B/65/A	B/72/D
OVOID	8	16	24	20	8
RHOMBOHEDROID	20	16	8	12	12
TABULAR	14	20	8	20	20
DISCOID	2	-	-	12	16
WEDGE	40	28	44	24	28
ROD	14	14	12	8	16
VARIHEDROID	2	4	4	4	4
Number of clasts	100	75	50	50	50
Number of levels sampled	3	3	2	2	2
Index of flatness (I_f)*	173	197	185	217	225
Standard Deviation	46	144	48	65	81

$*I_f = \frac{a+b}{2c} \cdot 100$ (Cailleux 1947)

SOIL		CLAY SIZE ARRANGEMENTS						GRANULAR ARRANGEMENTS		
		OVERALL PRESENCE	SINGLE PARTICLE		GROUPS		PARTLY DIS-CERNIBLE ARRANGEMENTS	OVERALL PRESENCE	CLEAN	CLOTHED
			RANDOM	PARALLEL	RANDOM	PARALLEL			GRAIN/GRAIN	GRAIN/GRAIN
BLAISEN NORWAY	1972	1	3	3	2	2	N.A.	4	3	3
	1965	1	3	3	2	2	1	4	2	4
BREIDAMERKUR-JOKULL, ICELAND		1-2	3	3	2	2	N.A.	3-4	2	4
LACROIX GLACIER ANTARCTIC		2	1	N.A.	3	2	3	3	2	4
COWAL SCOTLAND		1	N.A.	3	N.A.	3	N.A.	4	4	2
GLEN ORCHY SCOTLAND		1	1	2	2	4	1	5	4	2

TABLE 6.7 APPARENT RELATIVE ABUNDANCES OF ELEMENTARY PARTICLE ARRANGEMENTS.

SOIL		CONNECTORS	INTERWEAVING BUNCHES	AGGREGATIONS		MATRICES	
				REGULAR	IRREGULAR	CLAY/GRANULAR	GRANULAR
BLAISON, NORWEGIAN	1972	2	N.A.	2	N.A.	N.A.	4
	1965	N.A.	N.A.	1	N.A.	2	4
BREIDAMERKURJOKULL ICELAND		1	N.A.	3	1	2	3
LACROIX GLACIER ANTARCTICA		1	N.A.	3	N.A.	2	4
COWAL, SCOTLAND		N.A.	N.A.	N.A.	N.A.	N.A.	4
GLEN ORCHY, SCOTLAND		2	N.A.	3	3	N.A.	4

TABLE 6.8 APPARENT RELATIVE ABUNDANCES OF THE BASIC LEVEL OF PARTICLE ASSEMBLAGES.

TABLE 6.10. SOIL PROPERTIES OF TILL VIEWED IN ELECTRON MICROSCOPE.

SITE	ANTARCTICA	LAGLINGARTEN	GLEN ORCHY
LIQUID LIMIT (%)	27	27	17
PLASTIC LIMIT (%)	11	25	15
WATER CONTENT (%)	-	13-60	6-18
DRY DENSITY (t/m^3)	2.26	1.0-2.01	-
SPECIFIC GRAVITY	2.71	2.68	2.70
Rock Constituents	Granite Gneiss Sandstone Dolerite	Mica Schists Quartzite Limestone	Quartzite Granite Schist

TABLE 7.1. SPECIFIC GRAVITIES OF MATERIALS TESTED.

Origin of Material	Specific Gravity of Fines	Specific Gravity of Coarse
Laglingarten	2.65	2.71
Strathyre	2.66	2.71
Corrour	2.58	2.64

TABLE 7.2. PROPOSED LIMITS OF PARTICLE-SIZE DISTRIBUTION FOR BASES AND SURFACINGS, WITH TOLERANCES.

Percentage passing						
	Base			Surfacing	Base or Surfacing	
	Nominal maximum size			Nom.max. size	Nominal maximum size	
B.S. Sieve Size	3-in.	$1\frac{1}{2}$-in.	$\frac{3}{4}$-in.	$\frac{3}{4}$-in.	$\frac{3}{8}$in.	$\frac{3}{16}$in.
3 in.	100	-	-	-	-	-
$1\frac{1}{2}$ in.	80 - 100	100	-	-	-	-
$\frac{3}{4}$ in.	60 - 80	80 - 100	100	100	-	-
$\frac{3}{8}$ in.	45 - 65	55 - 80	80 - 100	80 - 100	100	-
$\frac{3}{16}$ in.	30 - 50	40 - 60	50 - 75	60 - 85	80 - 100	100
No. 7	-	30 - 50	35 - 60	45 - 70	50 - 80	80 - 100
No. 14	-	-	-	35 - 60	40 - 65	50 - 80
No. 25	10 - 30	15 - 30	15 - 35	-	-	30 - 60
No. 52.	-	-	-	20 - 40	20 - 40	20 - 45
No. 200	5 - 15	5 - 15	5 - 15	10 - 25	10 - 25	10 - 25

Notes

1. Not less than 10 per cent should be retained between each pair of successive sieves specified for use, excepting the largest pair.

2. The two smaller sized materials ($\frac{3}{8}$ and $\frac{3}{16}$in.) may have up to 35 per cent of stones not larger than $1\frac{1}{2}$-in., provided that the material passing the $\frac{3}{16}$in. sieve is within the limits specified.

3. The material passing the No. 36 sieve shall have the following characteristics (B.S. 1377: 1967);-

TABLE 7.2. (contd.)

for basis	Liquid limit not exceeding 25 per cent.
	Plasticity index not exceeding 6 per cent.
For surfacings	Liquid limit not exceeding 35 per cent.
	Plasticity index between 4 and 8 per cent.

Extract from soil mechanics for Road Engineers

H.M.S.O.

TABLE 7.3. RANGE OF NATURAL WATER CONTENTS IN TILLS TESTED

Site	Water Content of < 20 mm ($\frac{3}{4}$") Material		
	Minimum	Average	Maximum
Laglingarten	13.4	37.0	59.7
Corrour Forest	3.40	8.40	15.0
Strathyre	7.6	25.9	54.0

TABLE 7.4 RELATIONSHIP BETWEEN PROCTOR OPTIMUM WATER CONTENT AND WATER CONTENT AT MINIMUM PERMEABILITY FOR NORWEGIAN DAMS.

DAM*	PROCTOR OPTIMUM WATER CONTENT (%)	WATER CONTENT AT MINIMUM PERMEABILITY (%)	DIFFERENCE IN WATER CONTENT (%)
AKERSVATN	8.5	10.0	+1.5
KALVATN	9.3	11.0	+1.7
VASSLIVATN	7.2	9.4	+2.2
FOLLSJØ	7.1	9.2	+2.1
MANNDOLA	7.0	8.0	+1.0
DRAVALADALSVATN	9.2	11.2	+2.0
VATNA	8.5	8.5	0
MYSEVATN	7.5	8.7	+1.2
JUKLAVATN	7.5	7.8	+0.3
STØLSVATN	7.2	8.5	+1.3

* TYPICAL GRADINGS DETAILED IN CHAPTER 5 WERE USED IN THESE TESTS WITH A MAXIMUM PARTICLE SIZE LIMIT OF 20 mm DIAMETER.

TABLE 7.5. PERMEABILITY VALUES IN MONTREAL TILLS.

Soils Tested	Number of Tests	Coefficient of Permeability (um/sec) Average	Range
Undisturbed Laboratory Specimen	30	2.8×10^{-2}	3×10^{-1} to 1×10^{-3}
Remoulded Laboratory Specimen	25	-	10 to 10^{-3}
In-situ Undisturbed Permeability Test	7	3×10^{-1}	6×10^{-1} to 9×10^{-3}
Recompacted Till In-situ Test	32	1.5×10^{-6}	3×10^{-4} to 1×10^{-7}

TABLE 7.6. SOURCE AND PROPERTIES OF KOERNER'S (1970a) SOIL.

Source	d_{10} (mm)	Hazen's Uniformity Coefficient	Min. Density (t/m^3)	Max. Density (t/m^3)	Angularity	Sphericty
Crushed massive milky quartz	0.25	1.25	1.18	1.57	Angular	0.45
Crushed Ottawa Sand	0.25	1.25	1.38	1.66	Sub-Angular	0.58
Fines of Ottawa Sand	0.25	1.25	1.47	1.73	Sub-Rounded	0.67

FIGURES

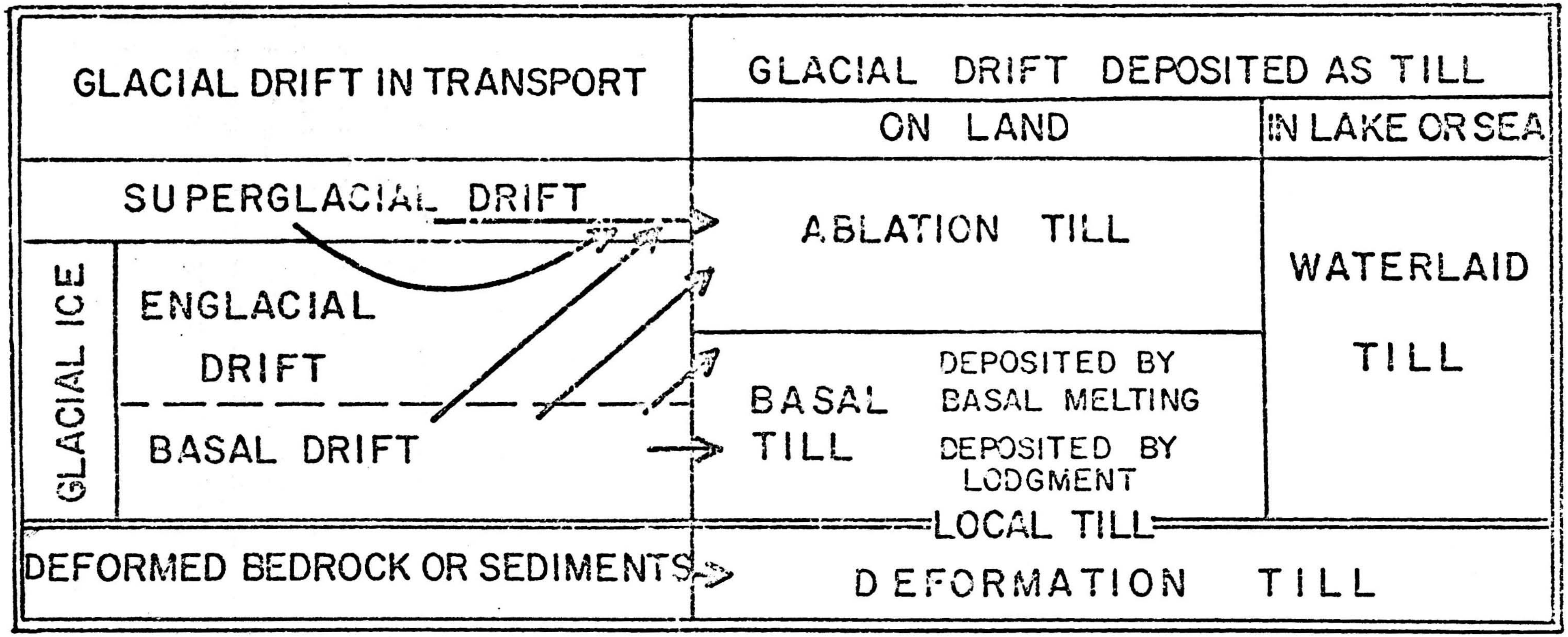


FIG. 2.1. CLASSIFICATION OF TILLS AND GLACIAL DRIFT IN TRANSPORT (DREIMANIS AND VAGNER 1971).

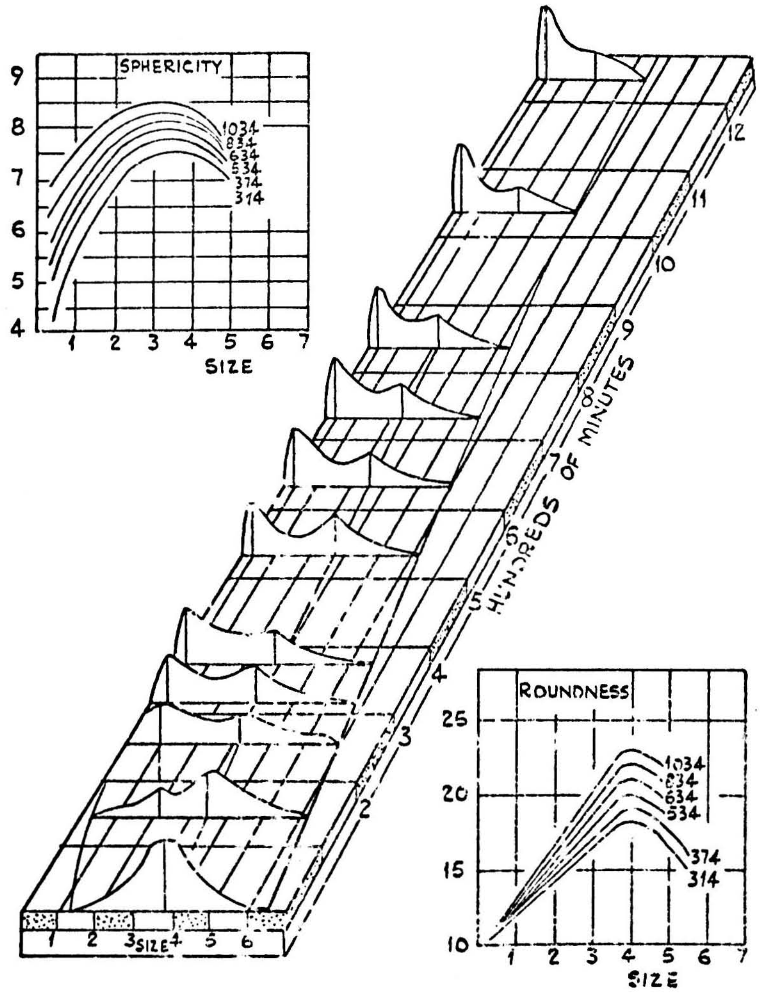


FIG. 3·1. GRAIN ANALYSES OF MINERALS IN BALL MILLS, MICROCLINE

CENTRAL FIGURE: FREQUENCY-DISTRIBUTION CURVES, PER CENT BY NUMBER OF GRAINS PLOTTED AGAINST SIZE, mm, AS NOMINAL SECTIONAL DIAMETER, FOR NUMBER OF MIN ROTATED DRY IN BALL MILL.

UPPER LEFT: SPHERICITY, BASED UPON PATTERNS OF RITTENHOUSE, AND PLOTTED FROM SCATTER DIAGRAMS. NUMBERS REFER TO LENGTH OF TIME ROTATED.

LOWER RIGHT: ROUNDNESS, BASED UPON PATTERNS OF KRUMBEIN. NUMBERS REFER TO LENGTH OF TIME ROTATED.

(AFTER ALLING. 1944)

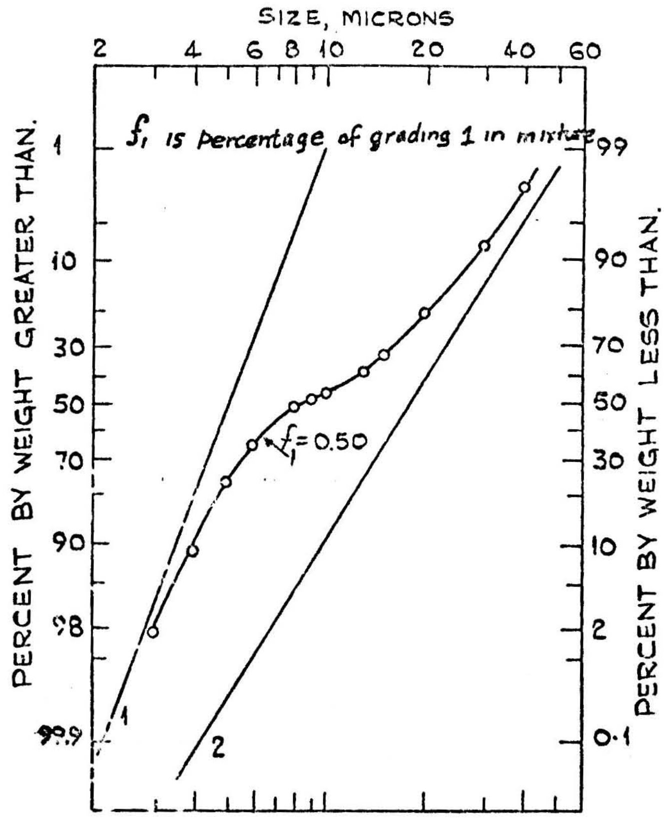


FIG. 3.2. HETEROGENEOUS DISTRIBUTION. (IRANI AND CALLIS 1963)

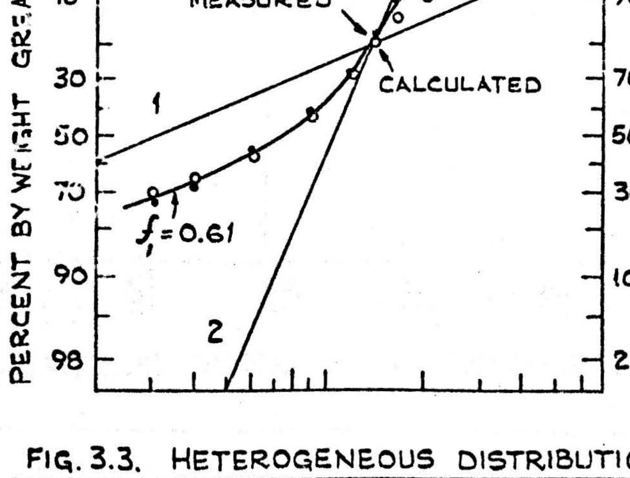
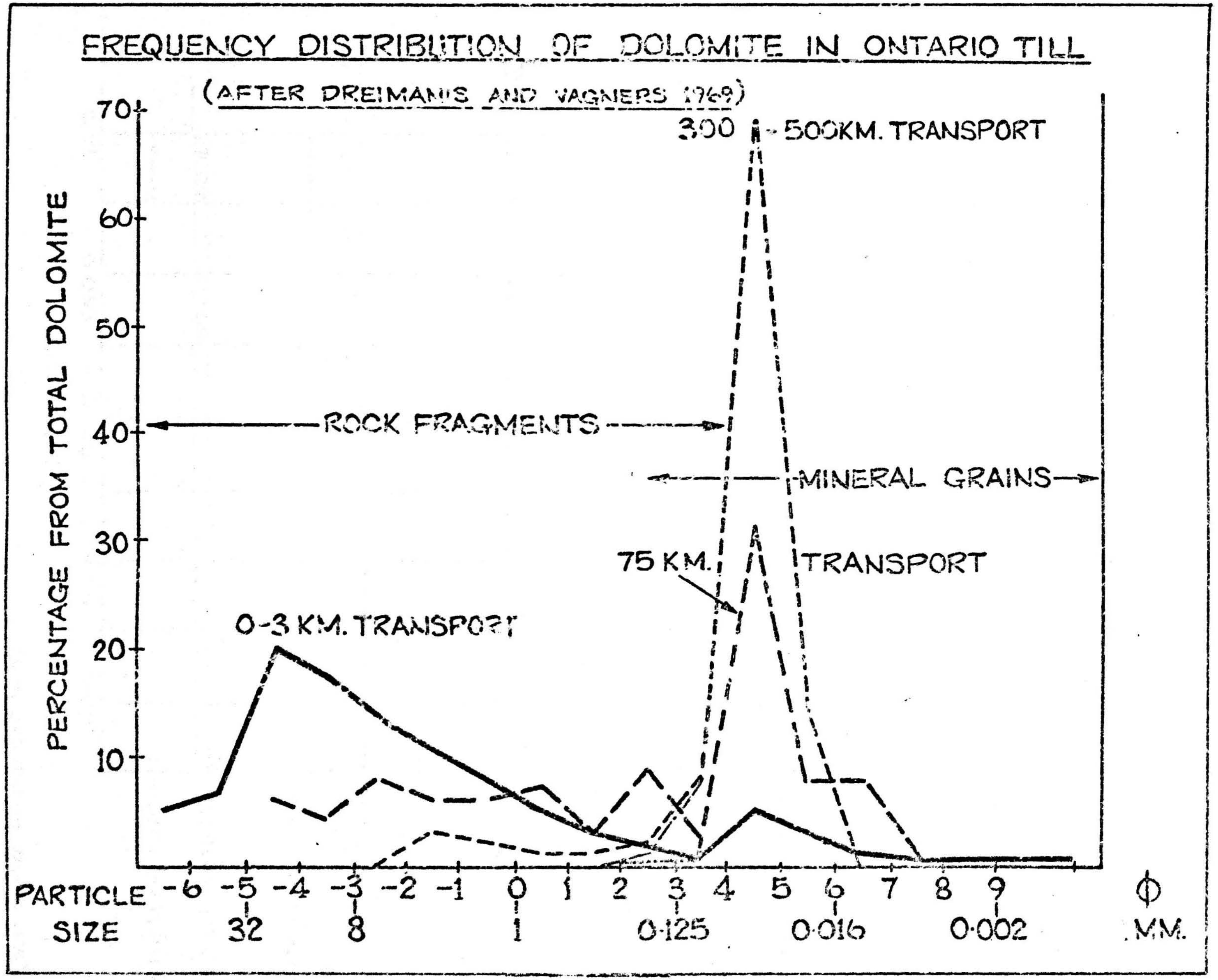


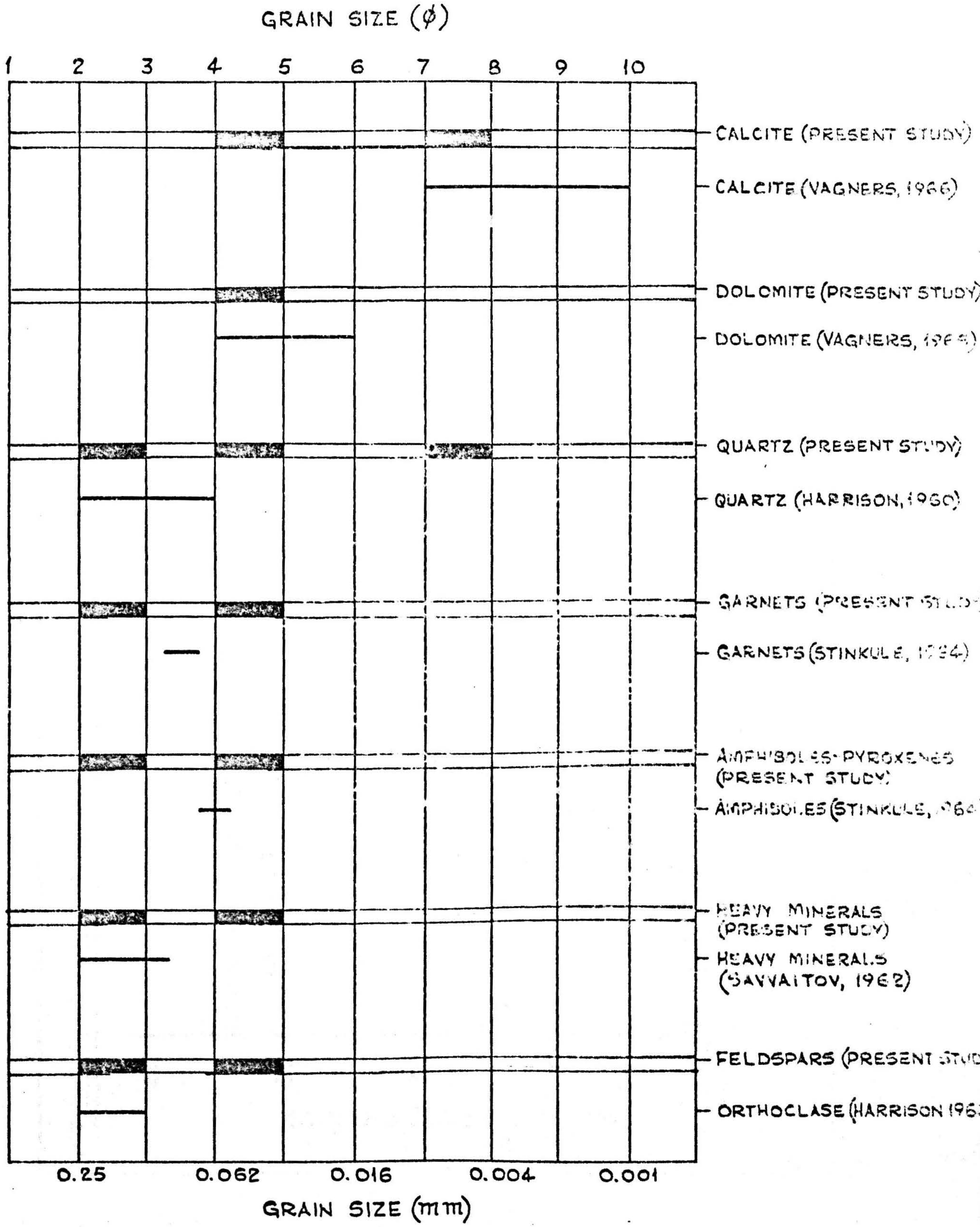
FIG. 3.3. HETEROGENEOUS DISTRIBUTIONS (IRANI AND CALLIS 1963).



Note: ϕ is $-\mathrm{Log}_2$ of the diameter in mm.

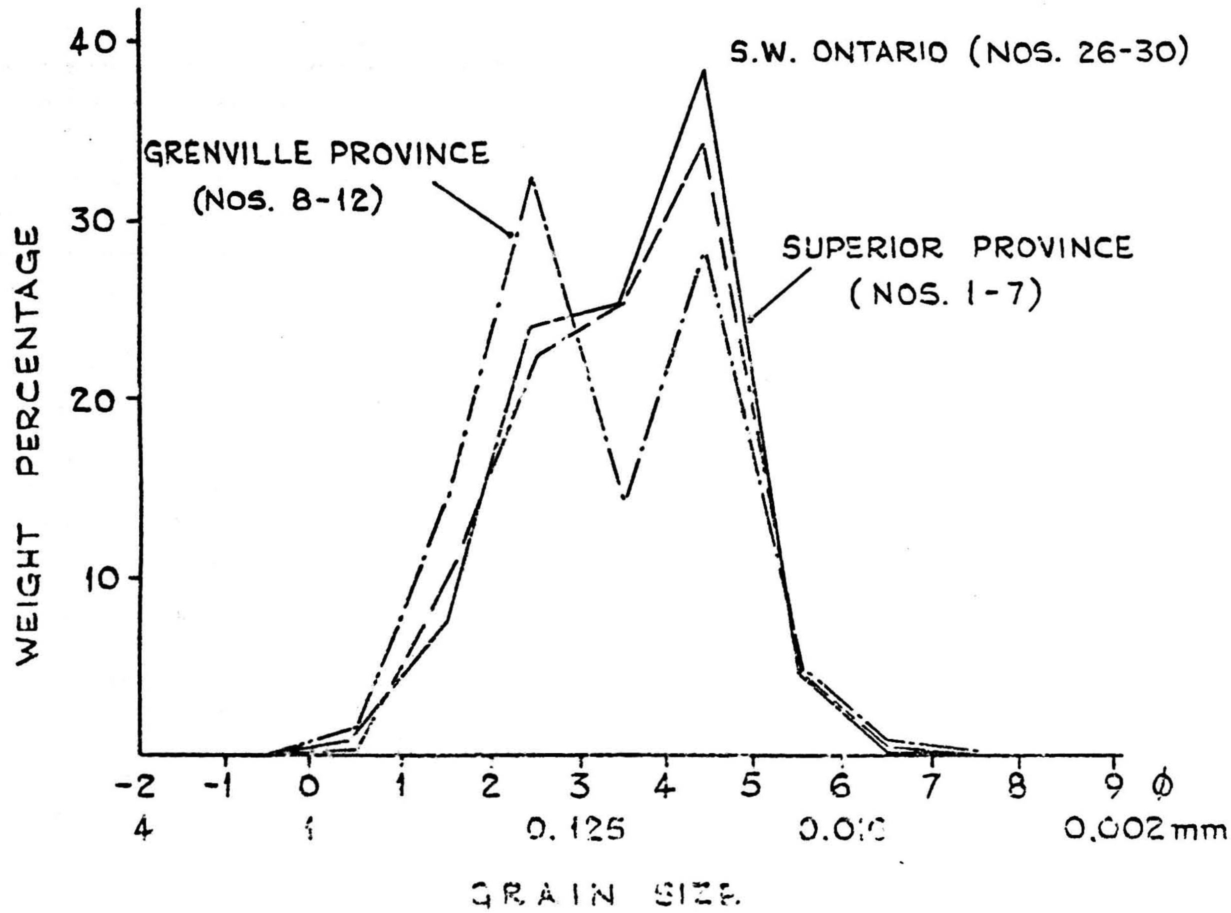
FIG. 3.4.

FIG. 3.5. TERMINAL MODES IN BASAL TILL



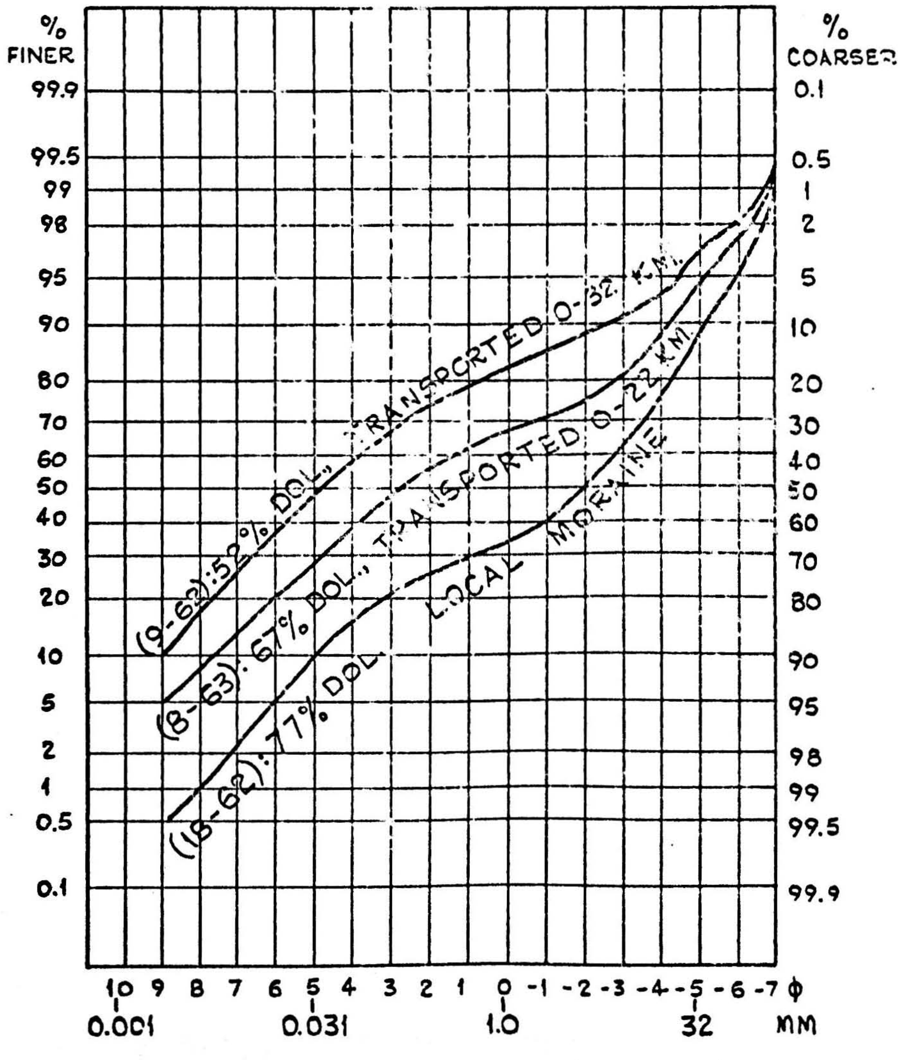
(AFTER DREIMANIS AND VAGNERS 1969.)

FIG.3.6. GARNET DISTRIBUTION IN TILLS OF ONTARIO

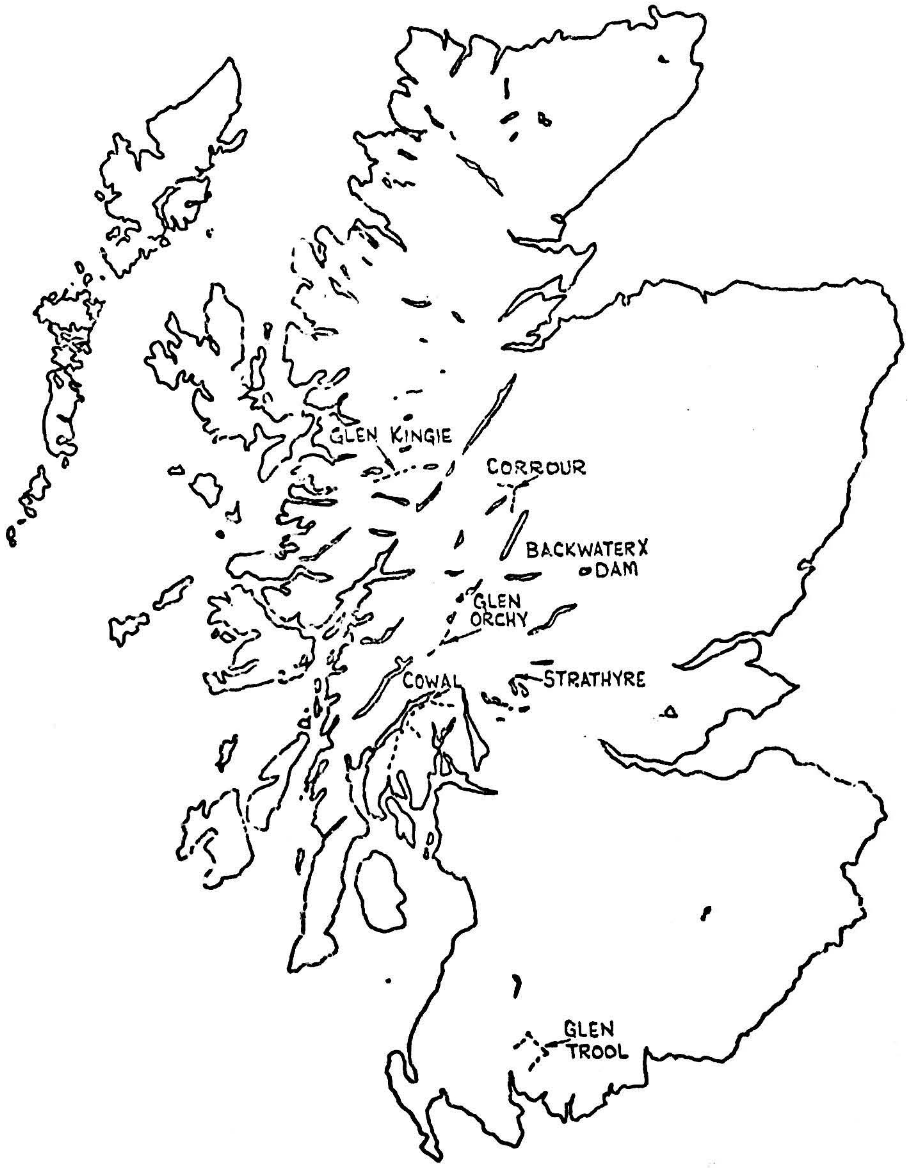


(After Dreimanis and Vagners 1971)

FIG. 3.7. DOLOMITIC TILLS OF S.W. ONTARIO CANADA.



(AFTER DREIMANIS, 1969).



SCOTTISH SITES STUDIED.

FIG. 4.1.

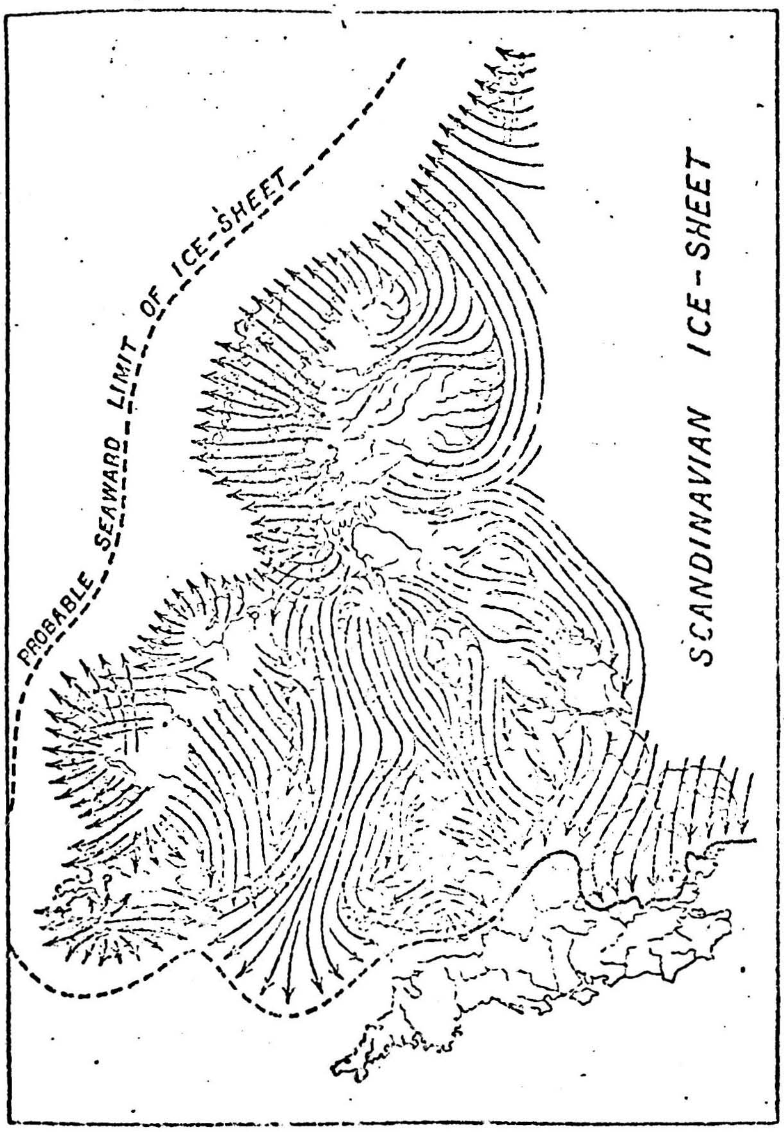


FIG. 4.2. MAP SHOWING LINES OF ICE FLOW AND THE LIMITS OF GLACIATION IN THE BRITISH ISLES (WRIGHT 1937).

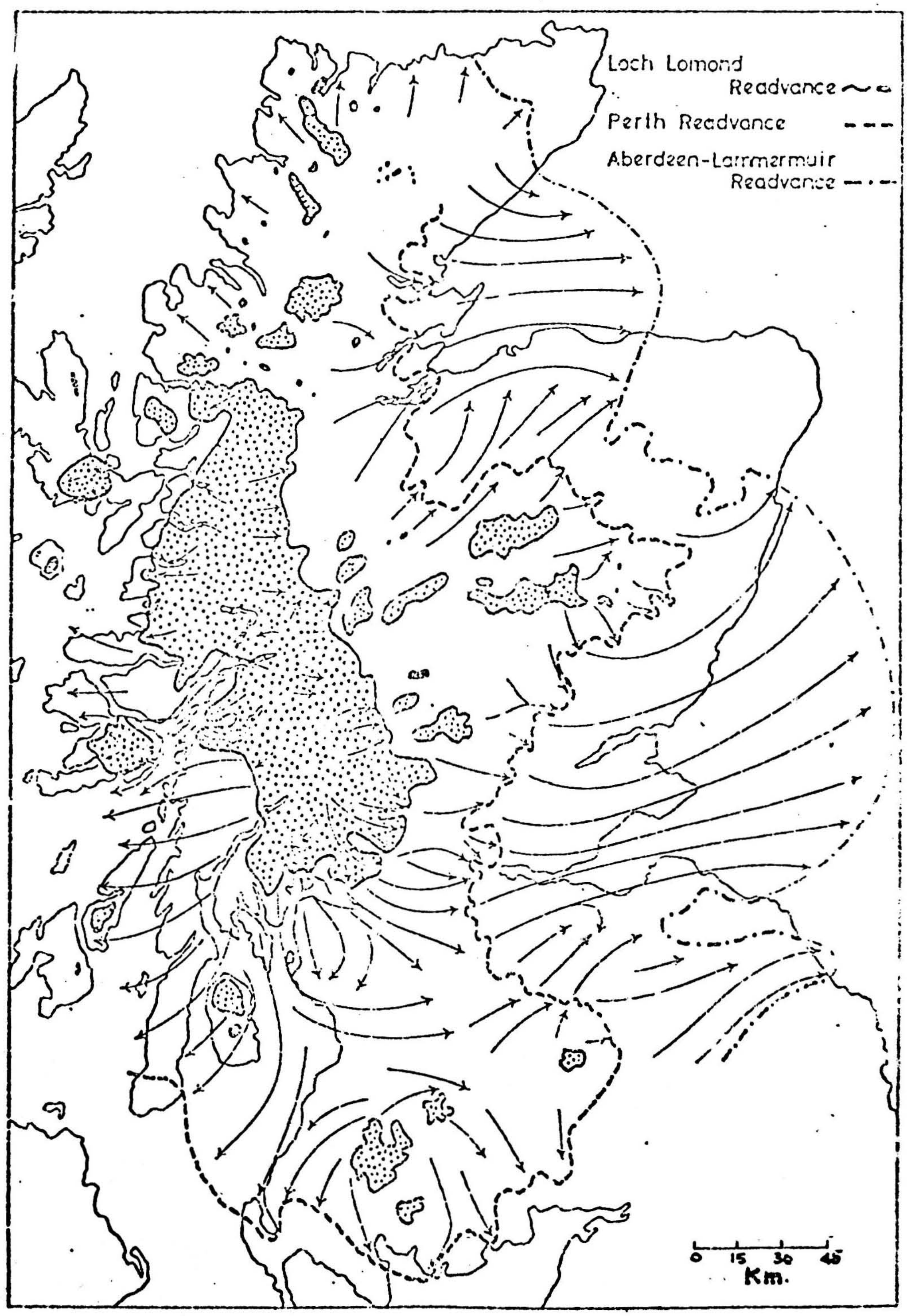


FIG. 4.3

Map showing Limits of Glacial Readvance

(Sissons, 1967)

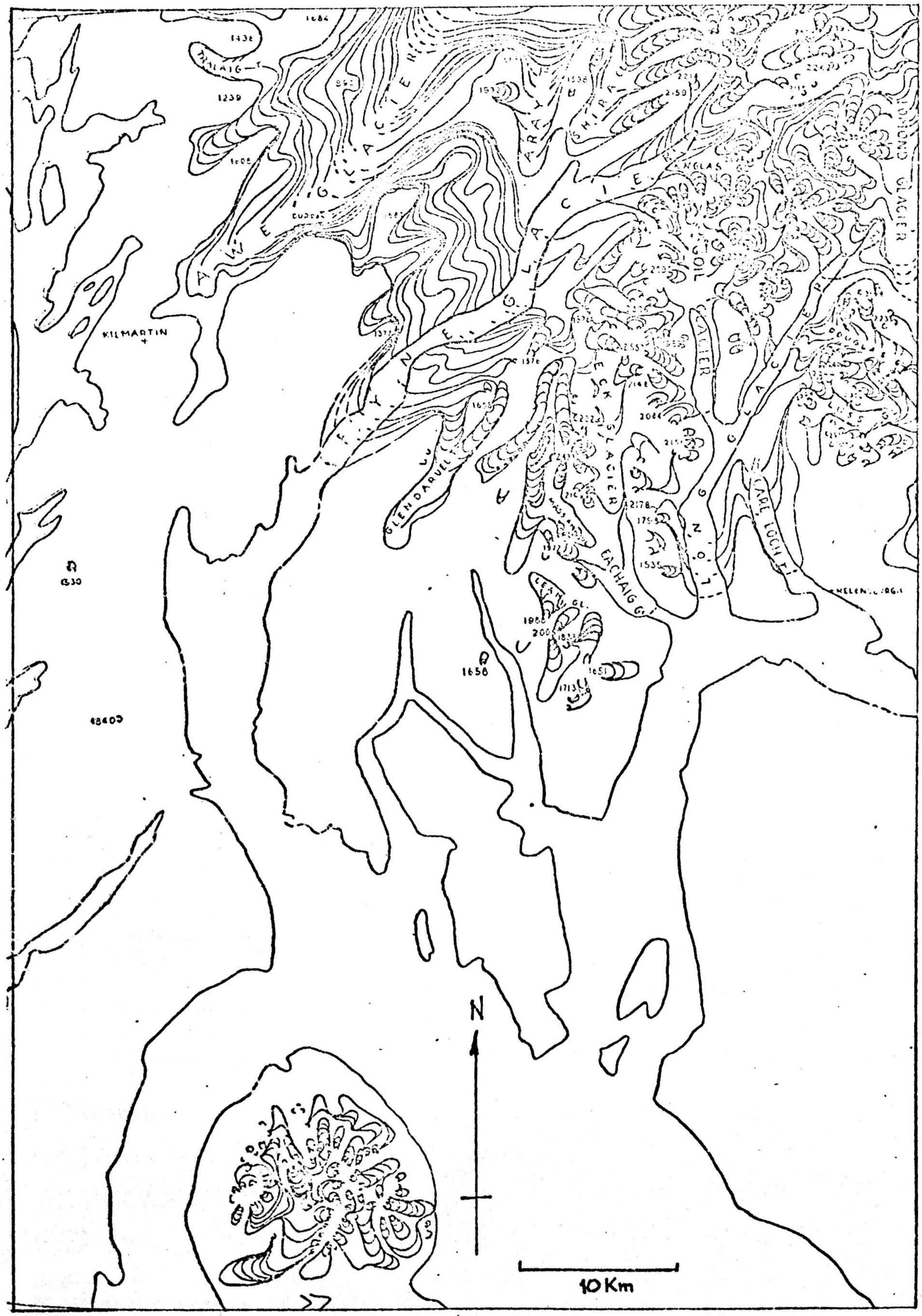
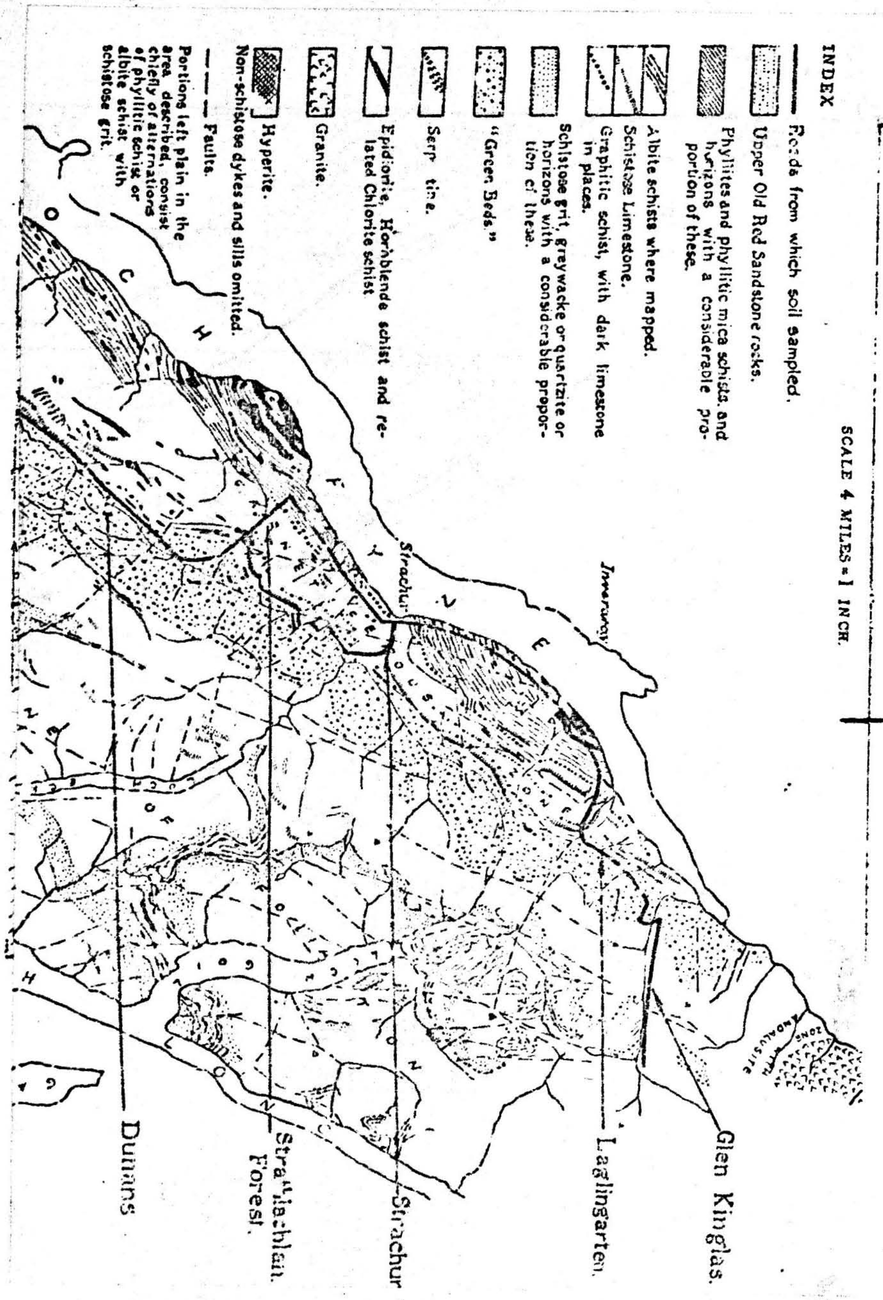


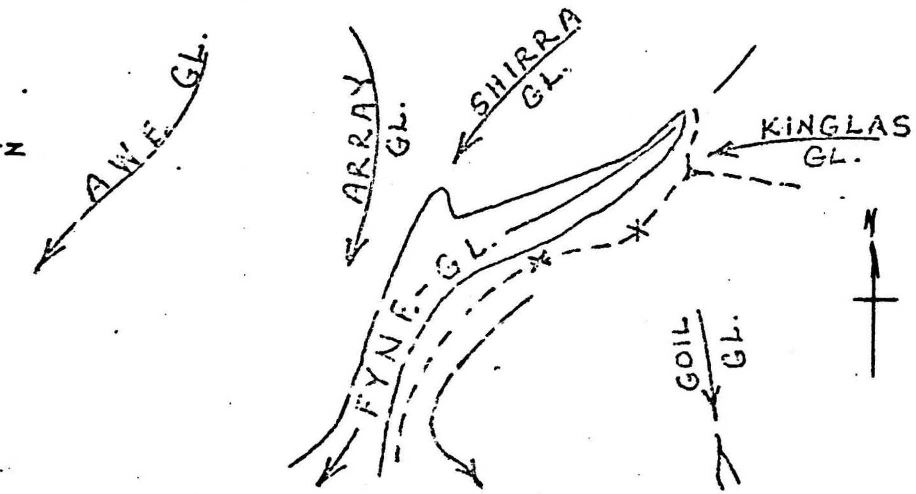
FIG. 4.4. GLACIAL MARGINS OF AWE, FYNE AND LONG GLACIERS.

(CHARLESWORTH 1956)



LAGLINGARTEN

Note:- Samples have been taken from the location indicated on the plan opposite and have been compared with other samples taken from various sections of roadwork along the A815.



Sketch Map showing direction of Glaciers

(not to scale)

FIG. 4.5. SAMPLE LOCATIONS AND GLACIAL DIRECTIONS AT LAGLINGARTEN.

FIG. 4.6. MARGINS OF SPEY AND TAY GLACIERS.

(CHARLESWORTH 1956)

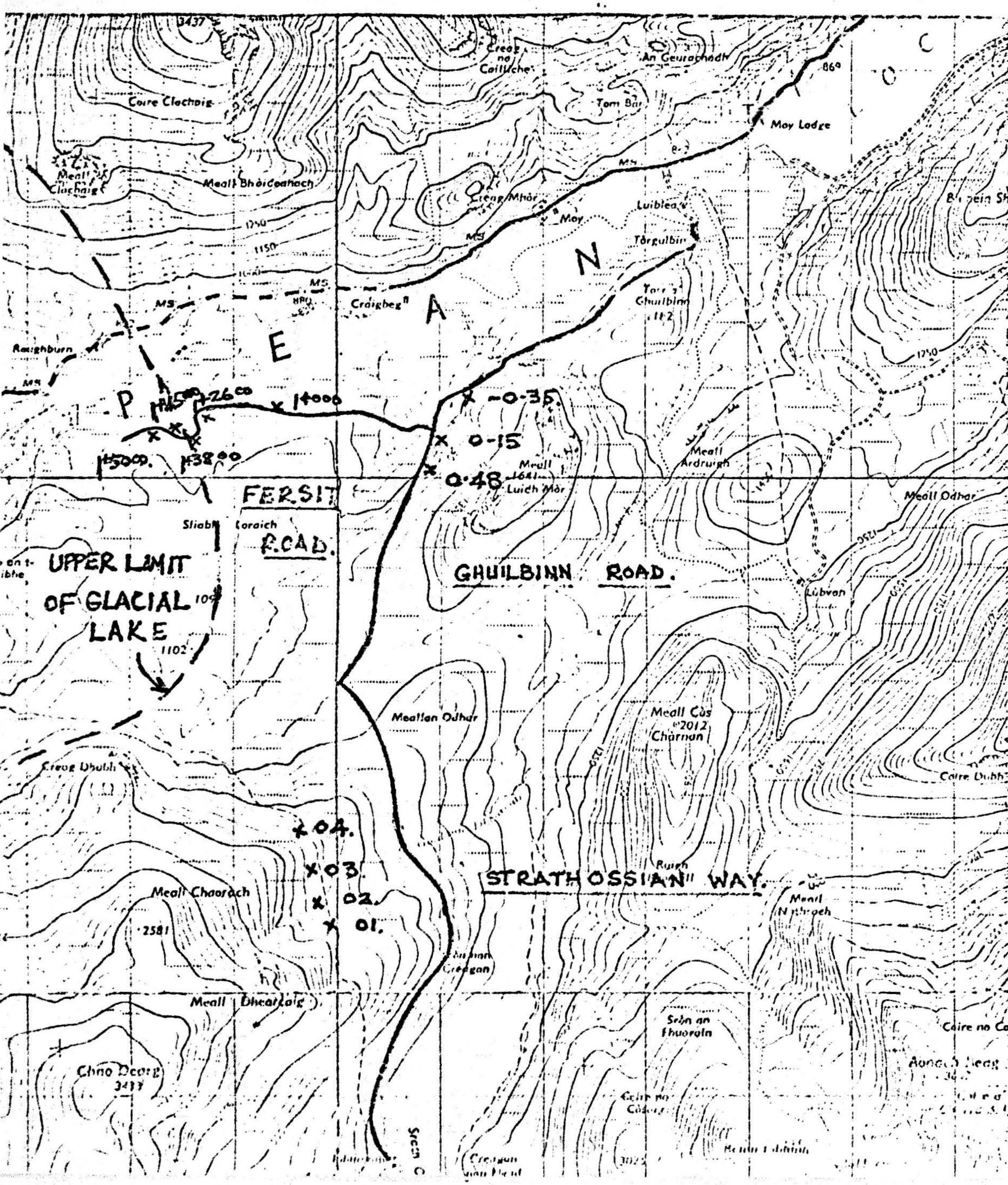


FIG. 4.7. SAMPLE LOCATIONS AND GLACIATION DIRECTION AT CORROUR FOREST.

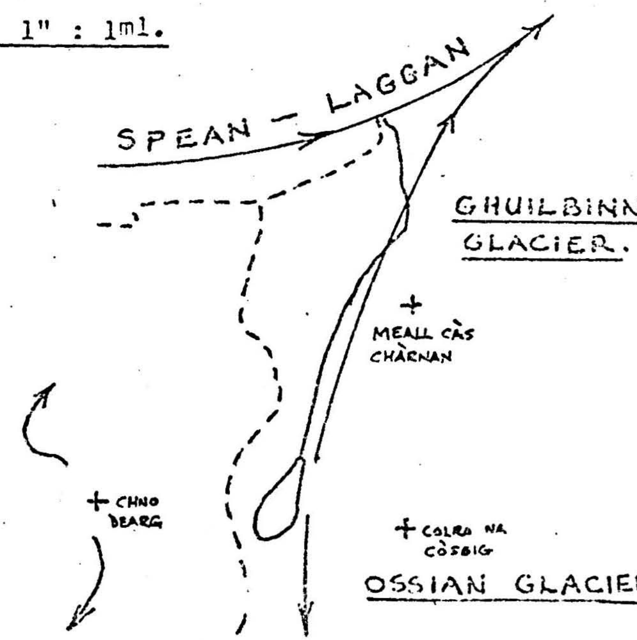
NOTES ON SAMPLING NOMENCLATURE

I) For purpose of identification of samples the roads in Corrour Forest area have been split into Fersit Road, Strathossian Way, and Ghuilbinn Road, all as indicated on the map opposite.

II) Due to the inaccessibility of the roadline for Strathossian Way samples relating to this section were taken from the existing drovers track some 200 ft. in altitude above the level of the proposed road.

A study of the glaciology of this section indicates that the samples should be of similar nature to the soil on the proposed roadline.

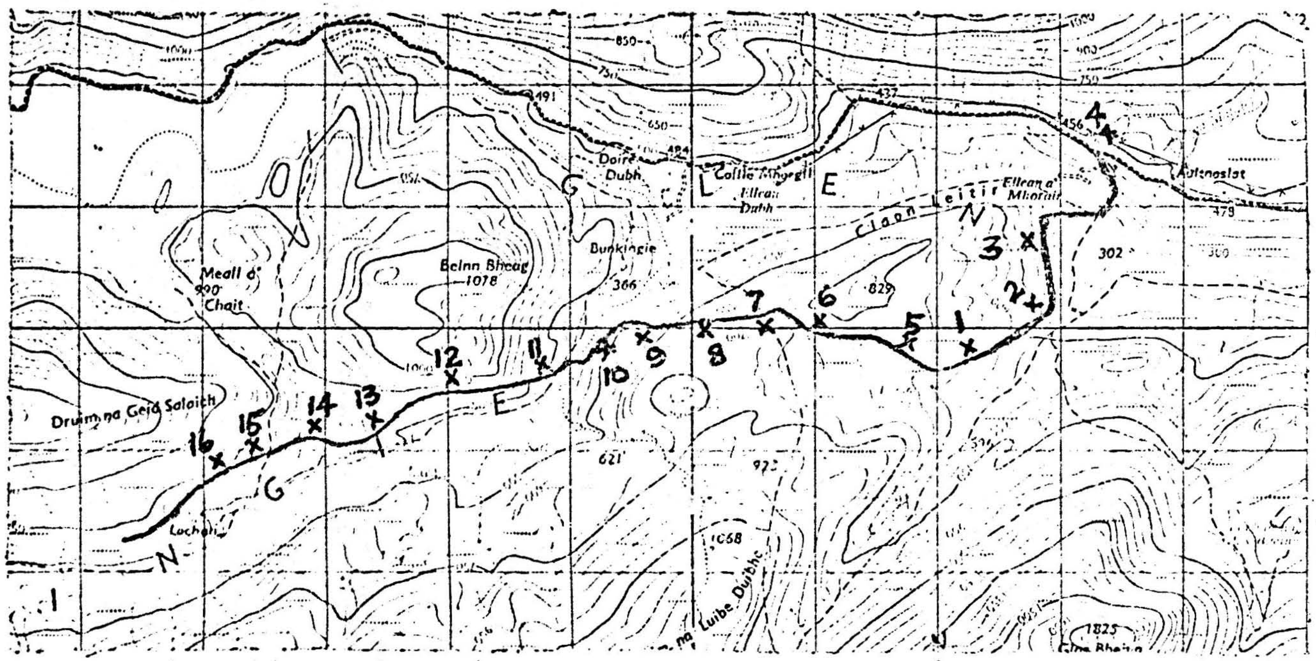
LOCATION PLAN 1" : 1ml.



SKETCH MAP SHOWING DIRECTION OF GLACIERS

FIG 4.8 MARGINS OF ICE IN SOUTH WEST HIGHLANDS

(CHARLESWORTH 1956).



GLENGARRY FOREST

KINGIE, POULARY, AND GREENFIELD FARM

Note:- Samples have been taken at half mile intervals along the line of the proposed road.

The locations of the sampling points are shown on the map opposite.

LOCATION PLAN 1" : 1 ml.

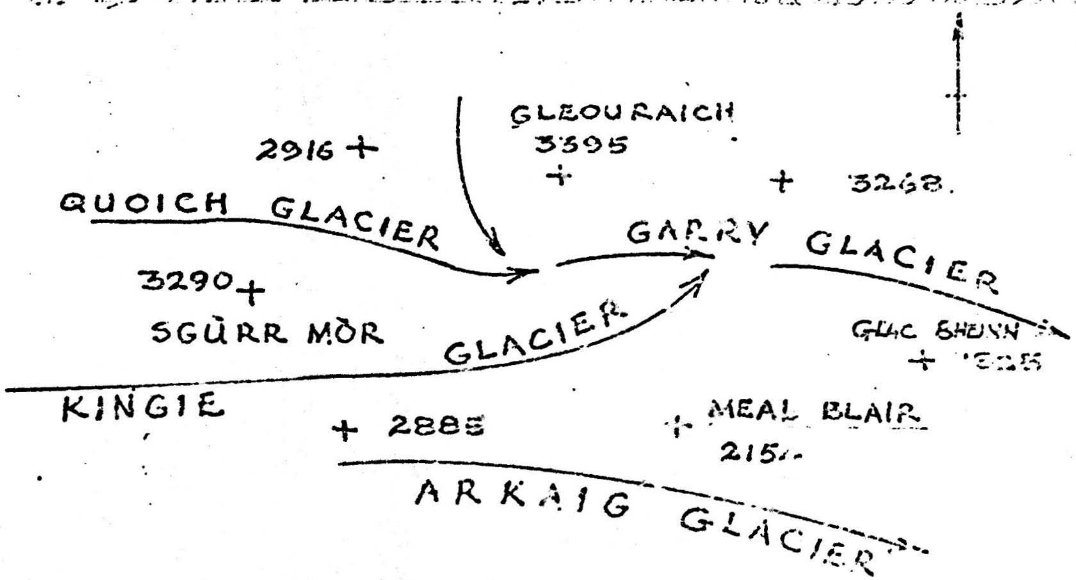


FIG. 4.9.

SAMPLE LOCATIONS AND GLACIATION DIRECTI[ON]

AT GLEN KINGIE.

SKETCH MAP SHOWING THE DIRECTION
OF THE GLACIERS

(not to scale)

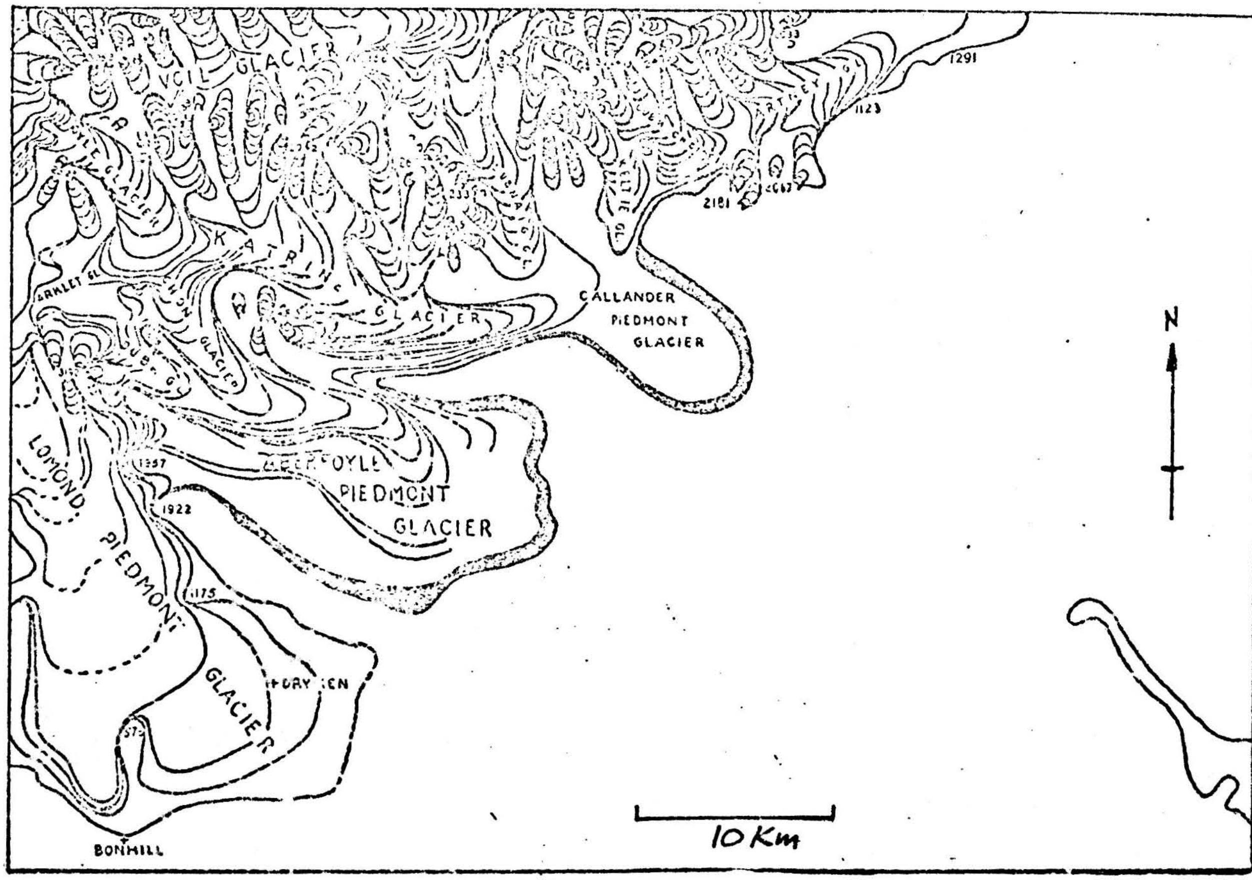
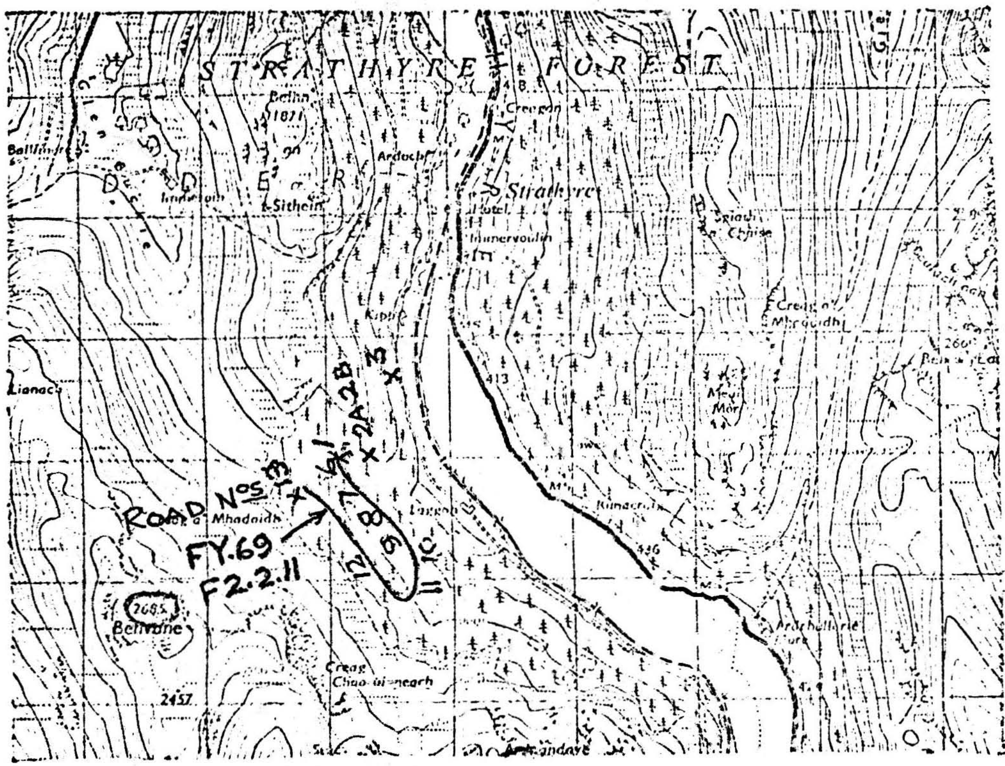


FIG. 4.10 Margins of Lomond Aberfoyle and Callander Glaciers.

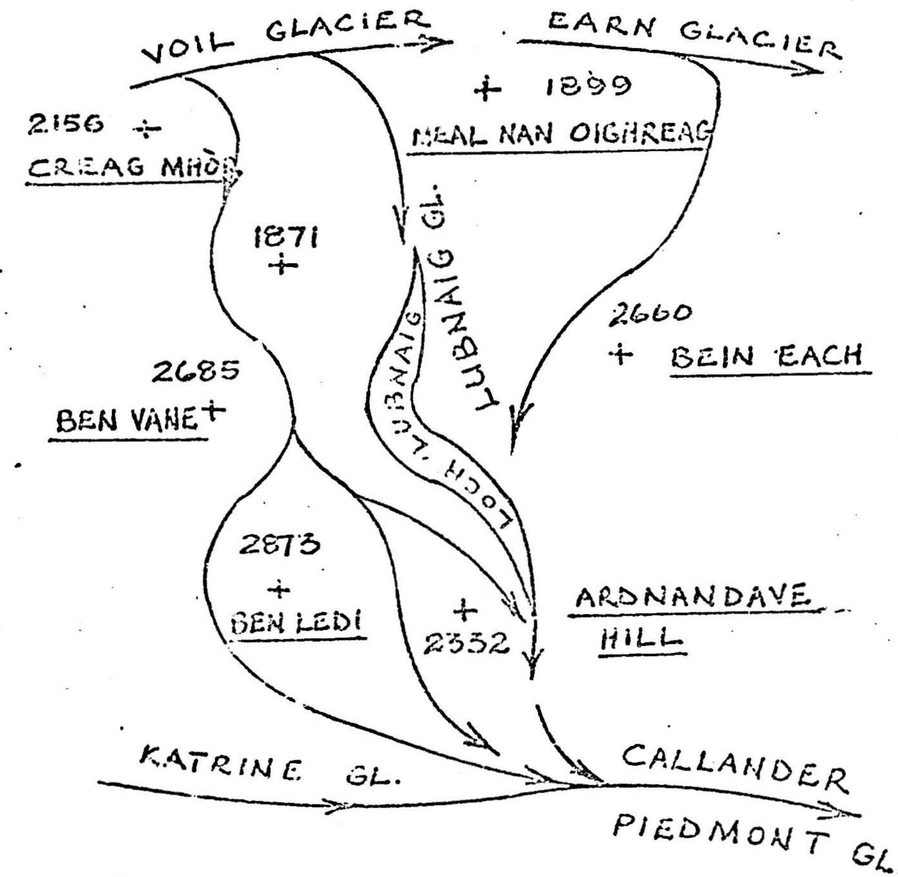
(Charlesworth 1956).



STRATHYRE FOREST

Note:- Samples have been taken at **300m** intervals and have been related to Forestry Commission chainage pegs.

LOCATION PLAN 1" : 1ml.

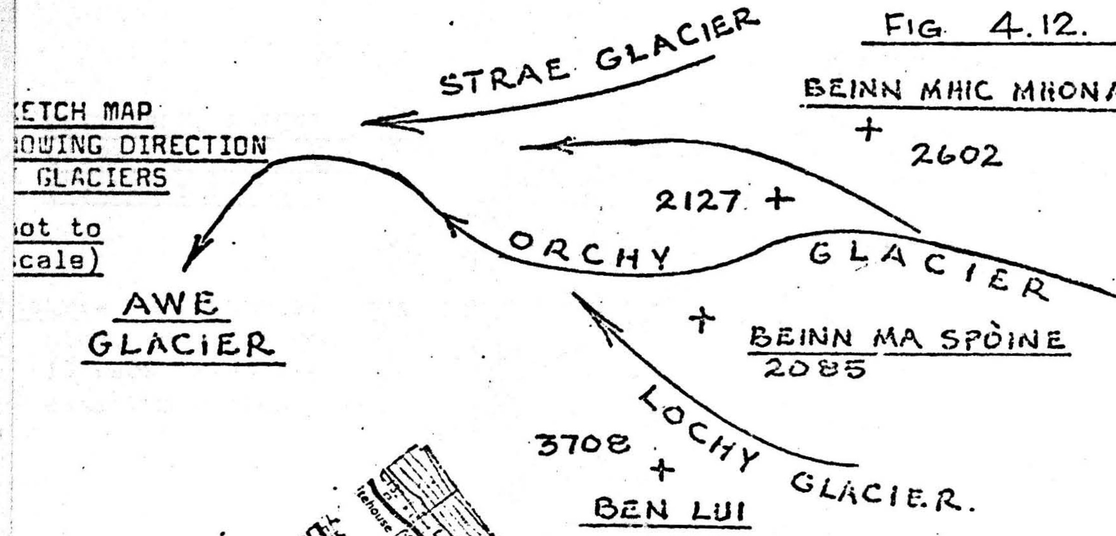


SKETCH MAP SHOWING DIRECTION OF GLACIERS

(not to scale)

FIG. 4.11. SAMPLE LOCATIONS AND GLACIATION DIRECTIONS AT STRATHYRE FOREST.

FIG. 4.12. SAMPLE LOCATIONS AND GLACIATION DIRECTIONS AT GLEN ORCHY FOREST.

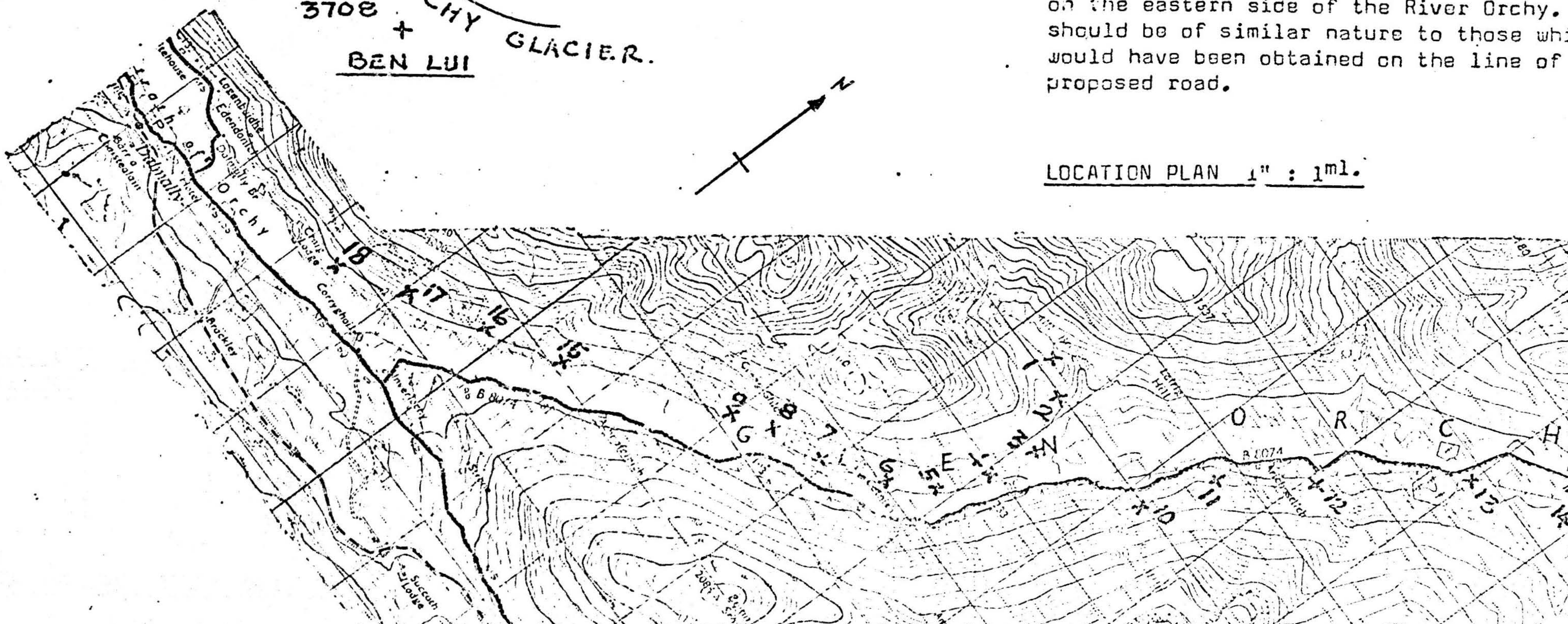


GLEN ORCHY FOREST

Plan showing location of samples taken in Glen Orchy along the line of a proposed road

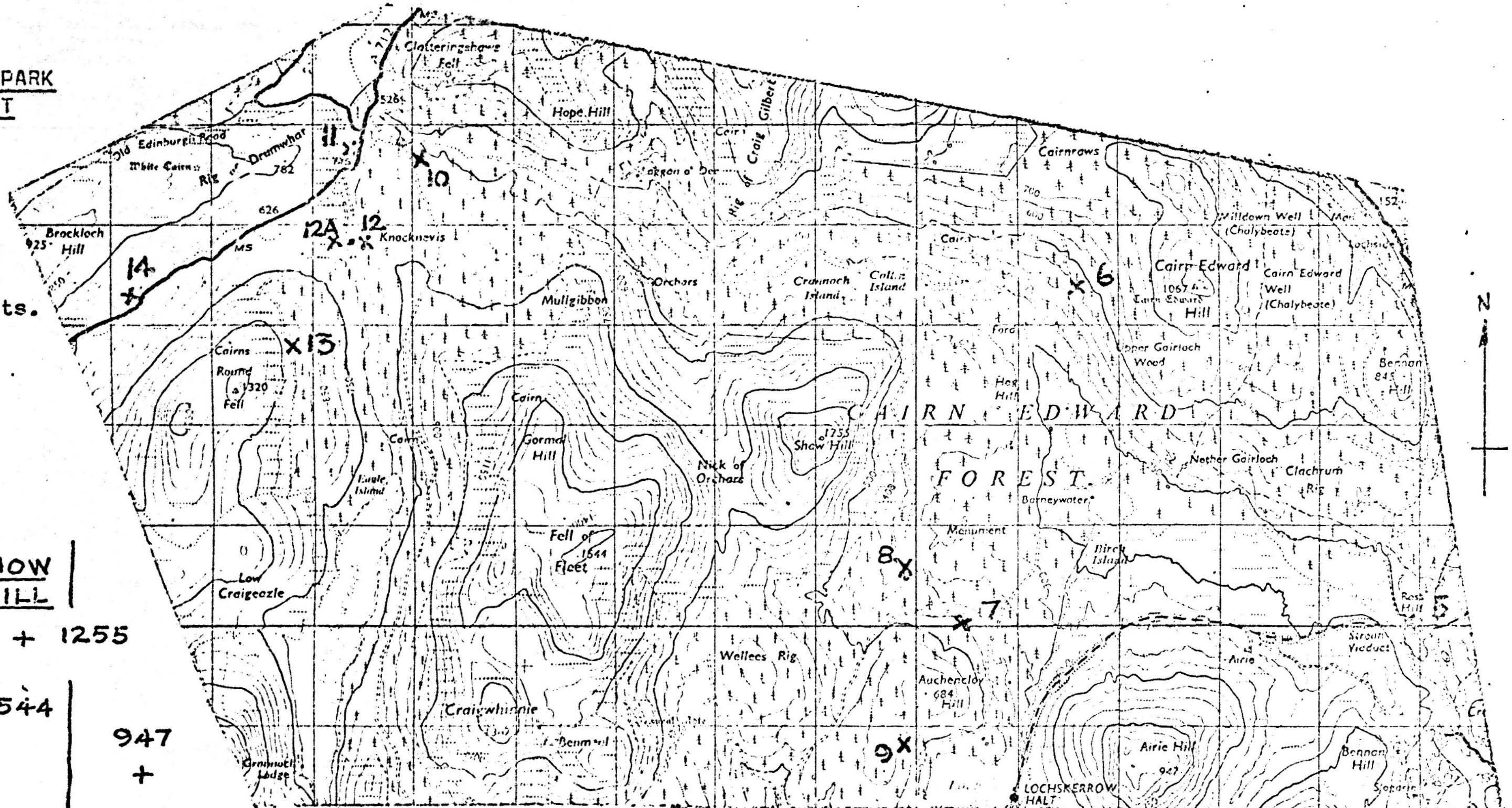
Due to the inaccessibility of the upper part of the Glen with regard to the extraction of samples 10, 11, 12, 13 and 14 have been taken on the eastern side of the River Orchy. These should be of similar nature to those which would have been obtained on the line of the proposed road.

LOCATION PLAN 1" : 1ml.

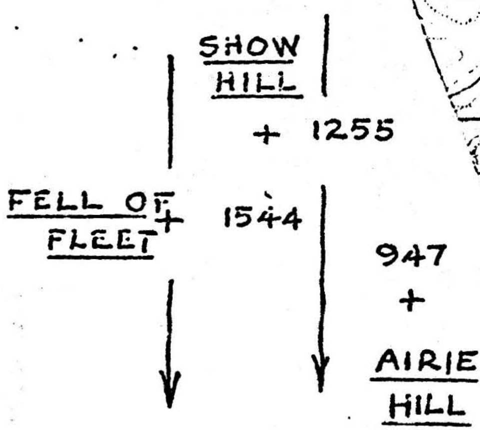


GLEN TROOL FOREST PARK
CAIRN EDWARD FOREST
(BENNAN SECTION)

Note:- All samples other than 12A and 13 were taken from existing borrow pits.

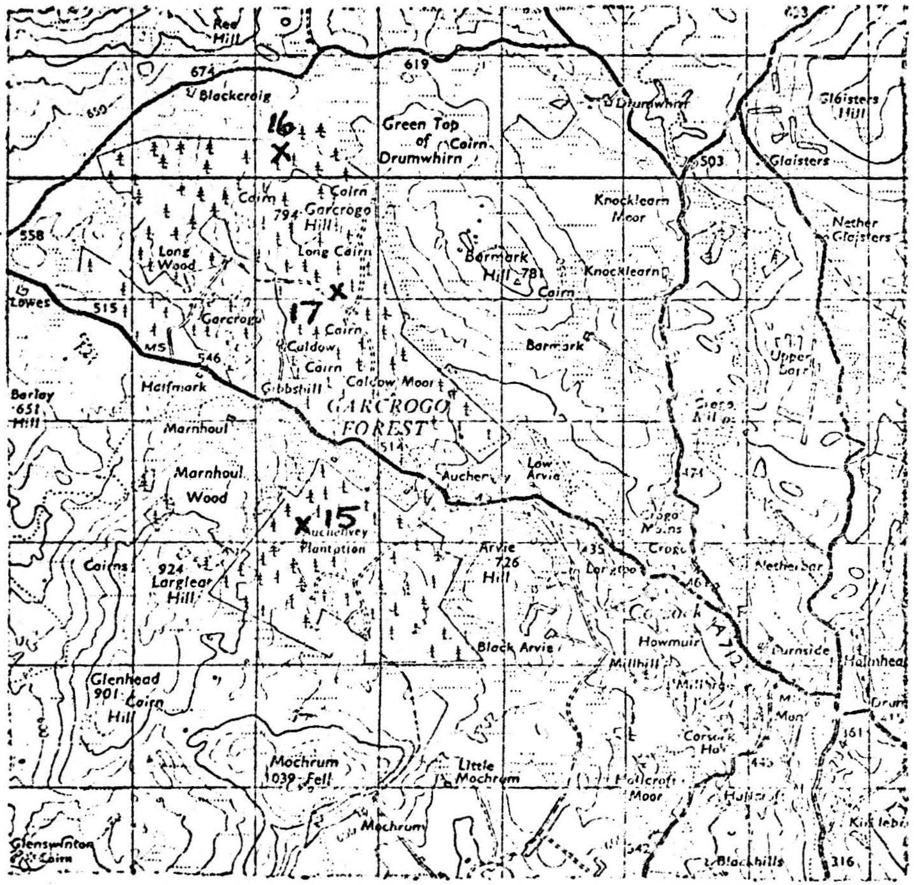


LOCATION PLAN 1" : 1$^{ml.}$



SKETCH MAP SHOWING DIRECTION OF GLACIERS
(not to scale)

FIG. 4.13. SAMPLE LOCATIONS AND GLACIATION DIRECTIONS AT CAIRN EDWARD FOREST (BENNAN SECTION).



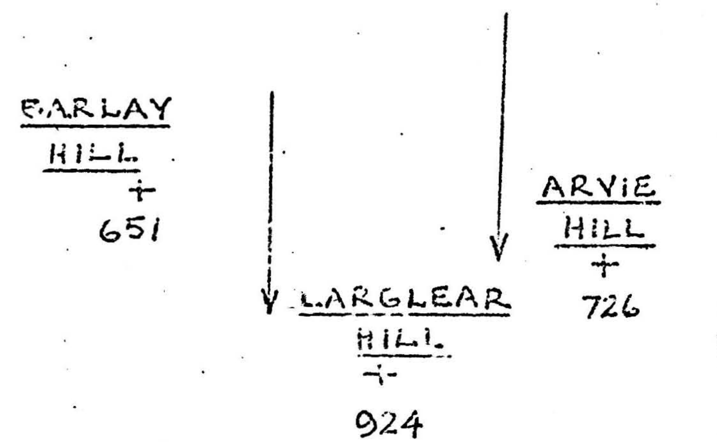
LOCATION PLAN 1" : 1^ml.

GLEN TROOL FOREST PARK

GARCROGO FOREST

Note:- Samples No. 15 and 17 taken from existing borrow pits.

Sample No. 16 taken from trial pit in forest.



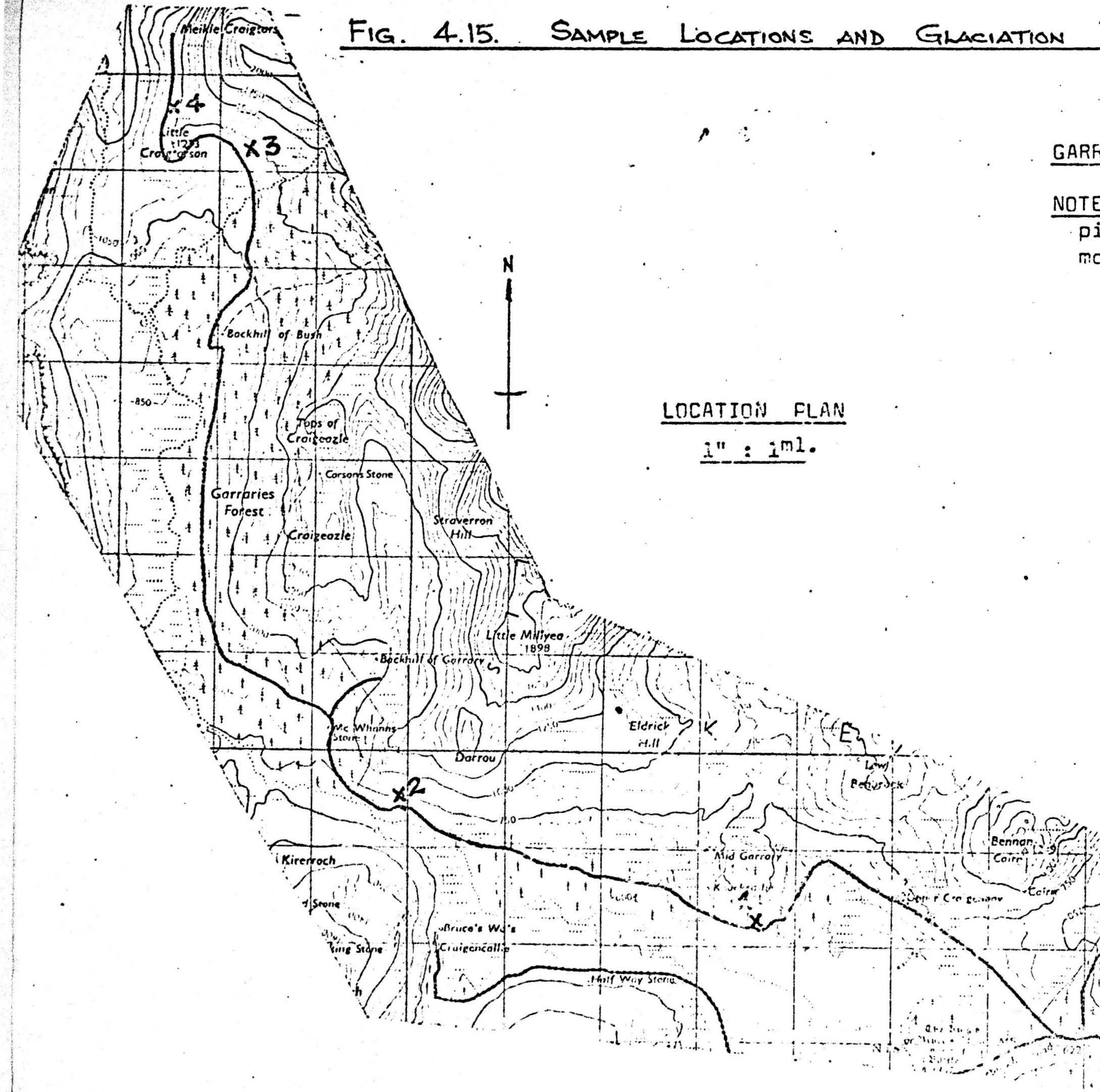
SKETCH MAP SHOWING THE DIRECTION OF THE GLACIER

(not to scale)

FIG. 4.14. SAMPLE LOCATIONS AND GLACIATION DIRECTIONS AT GARCROGGO FOREST.

Fig. 4.15. Sample Locations and Glaciation Directions at Garraries Forest

GLEN TROOL FOREST PARK

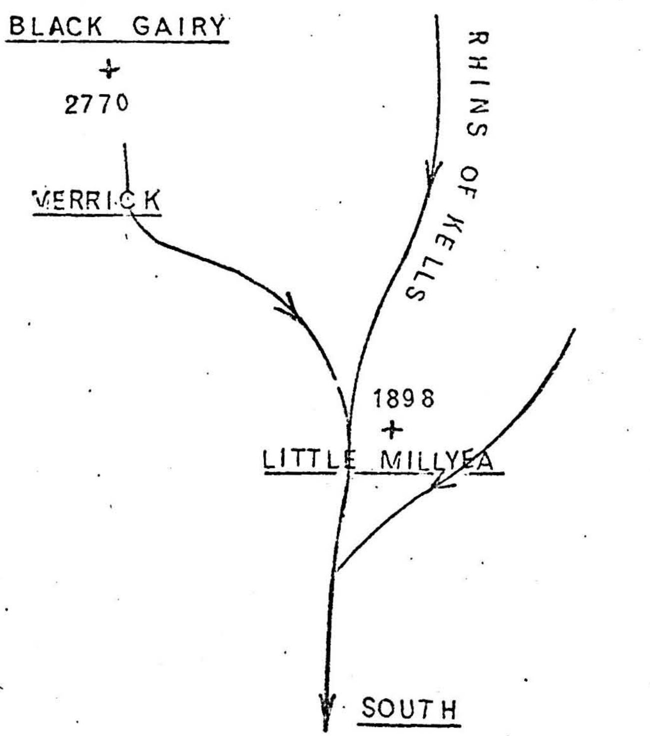


LOCATION PLAN

1" : 1ml.

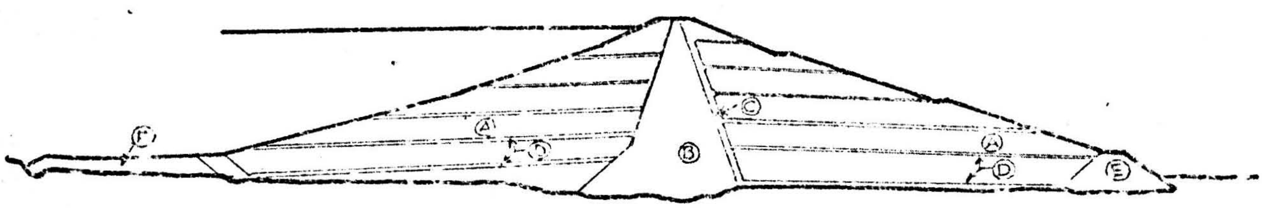
GARRARIES FOREST

NOTE:- Samples 1, 2 and 3 taken from borrow pits, sample No. 4 from cutting in sheet moraine.



SKETCH MAP SHOWING THE DIRECTION OF THE GLACIERS

(not to scale)



A. GLACIAL TILL SHOULDERS.
B. GLACIAL TILL CORE
C. CHIMNEY DRAIN – GRAVEL
D. LATERAL DRAINS – GRAVEL
E. RUBBLE TOE WALL.
F. SPOIL MATERIAL.

0 30 60
SCALE IN METRES.

FIG. 4.16 MATERIALS IN BACKWATER DAM.

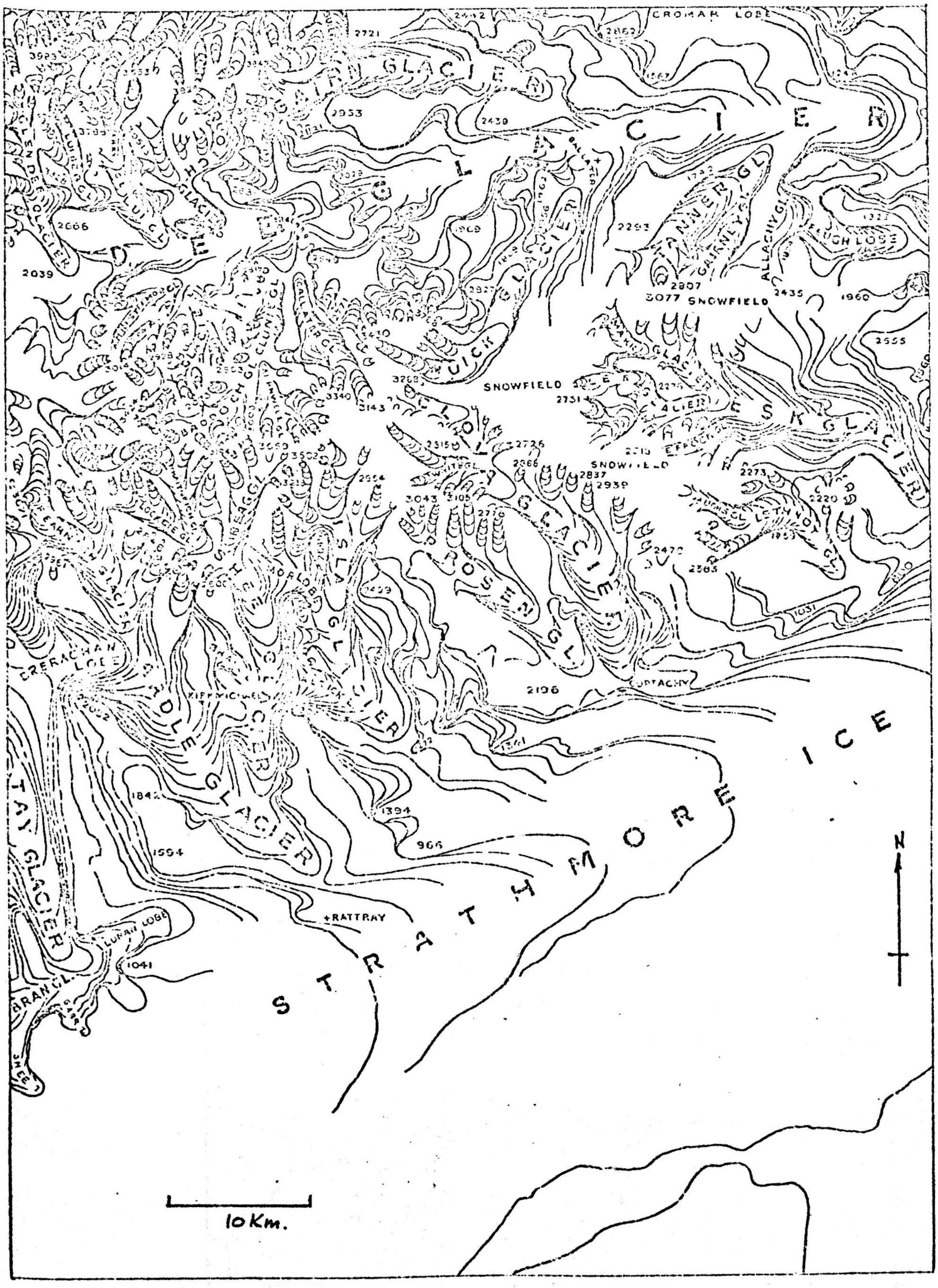


FIG 4.17 MARGINS OF DEE, ESK-ARDLE AND OUTER TAY GLACIERS

(CHARLESWORTH 1956)

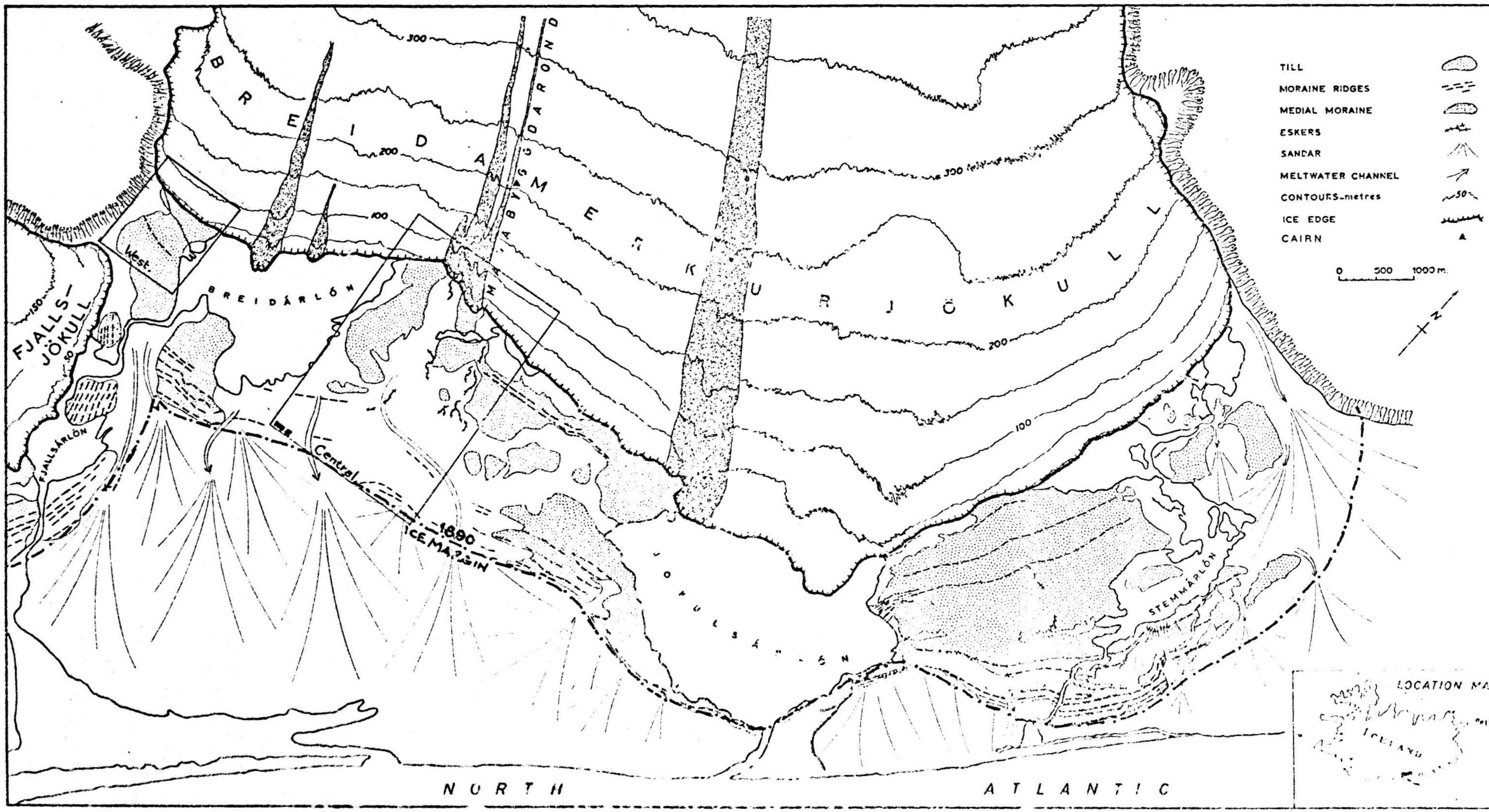
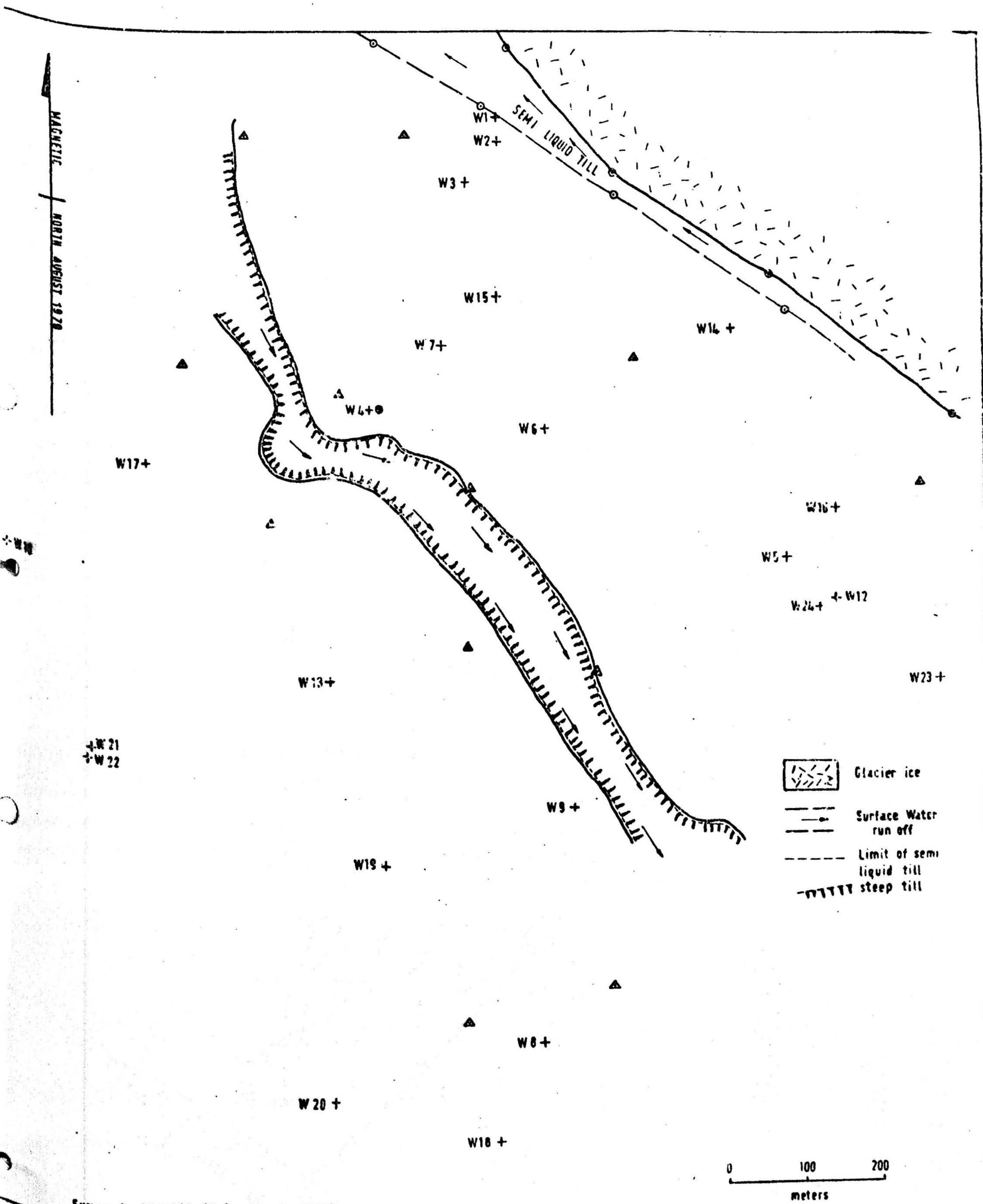
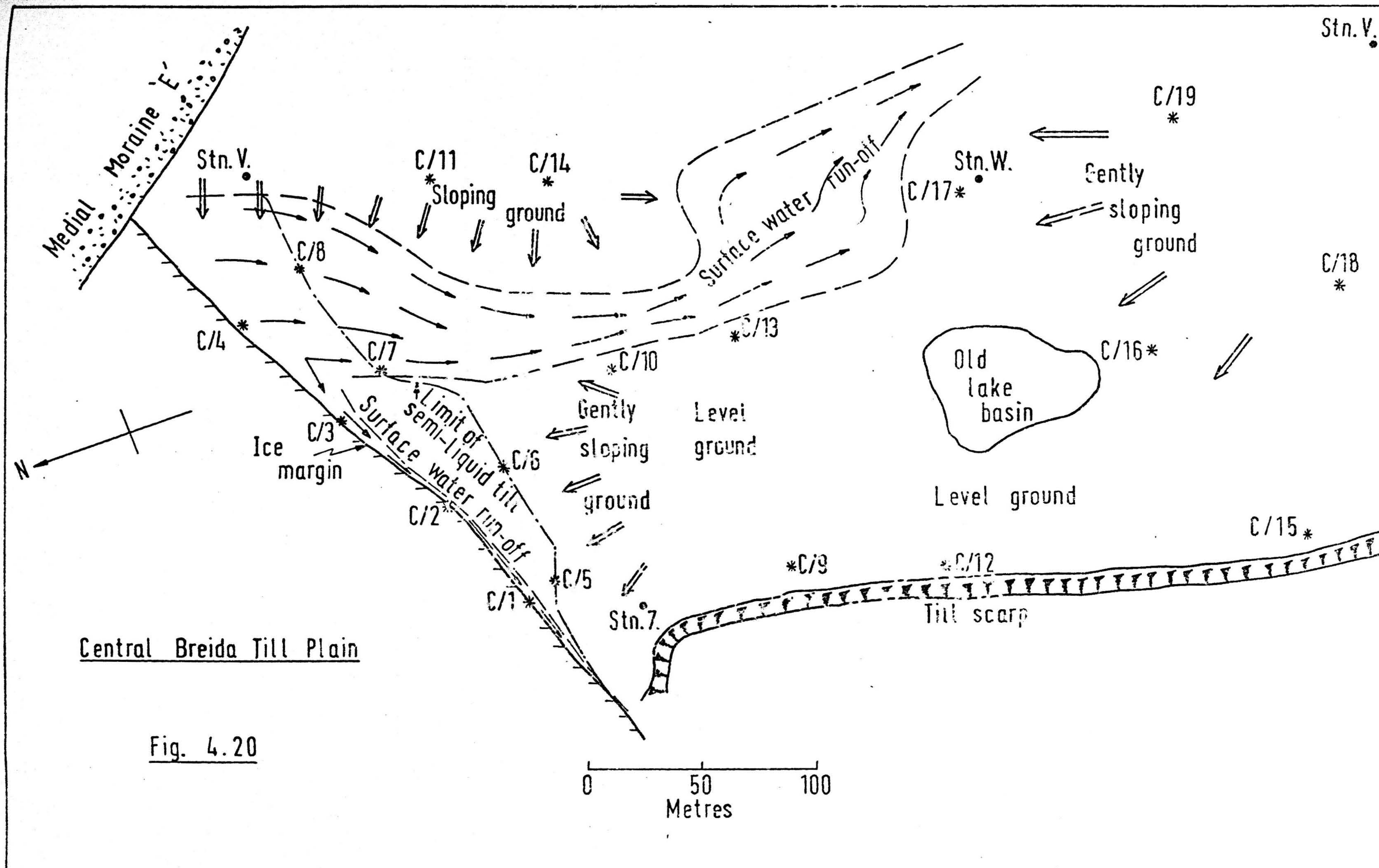


FIG. 4.18. Breiðamerkurjökull and its proglacial area (AFTER PRICE, 1969).



Survey by R.G. WARD. (Univ of Keele 1970)

FIG. 4·19 MAP OF WEST BREIDA SAMPLING AREA



Central Breida Till Plain

Fig. 4.20

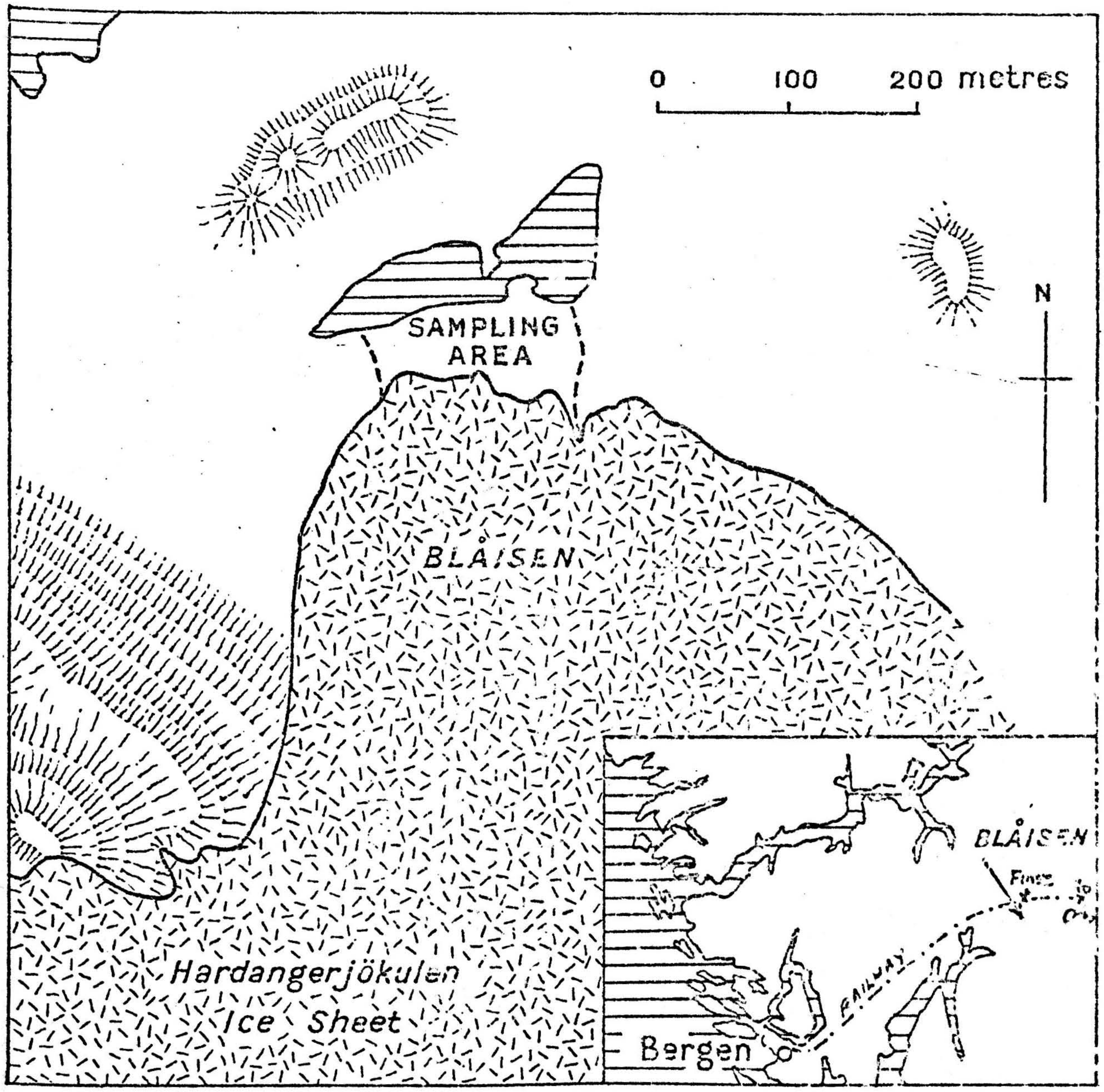


FIG 4.21. SAMPLING AREA AT BLÅISEN, SOUTHERN NORWAY.

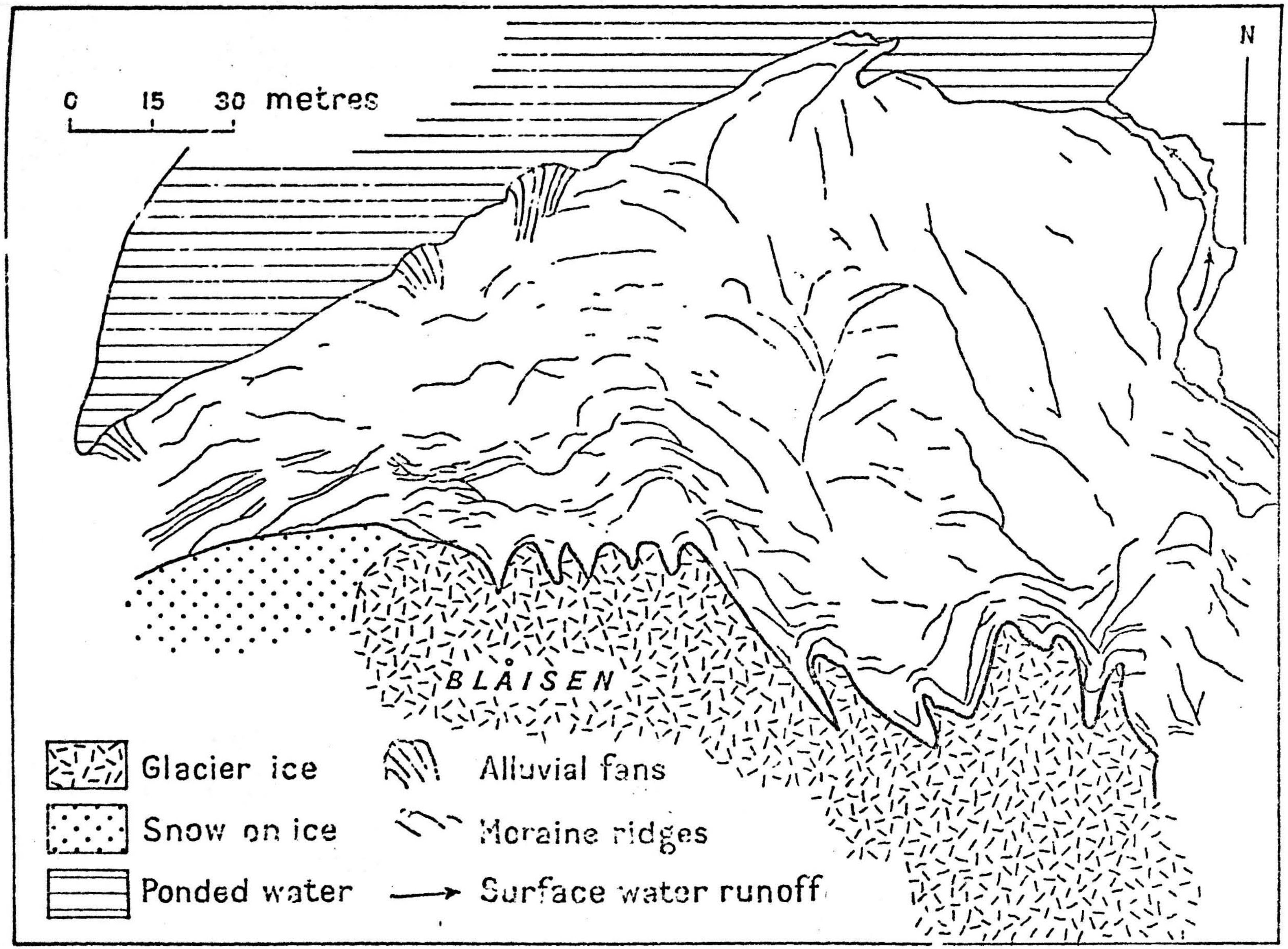


FIG 4.22 PROGLACIAL FEATURES AT BLÅISEN SOUTHERN NORWAY

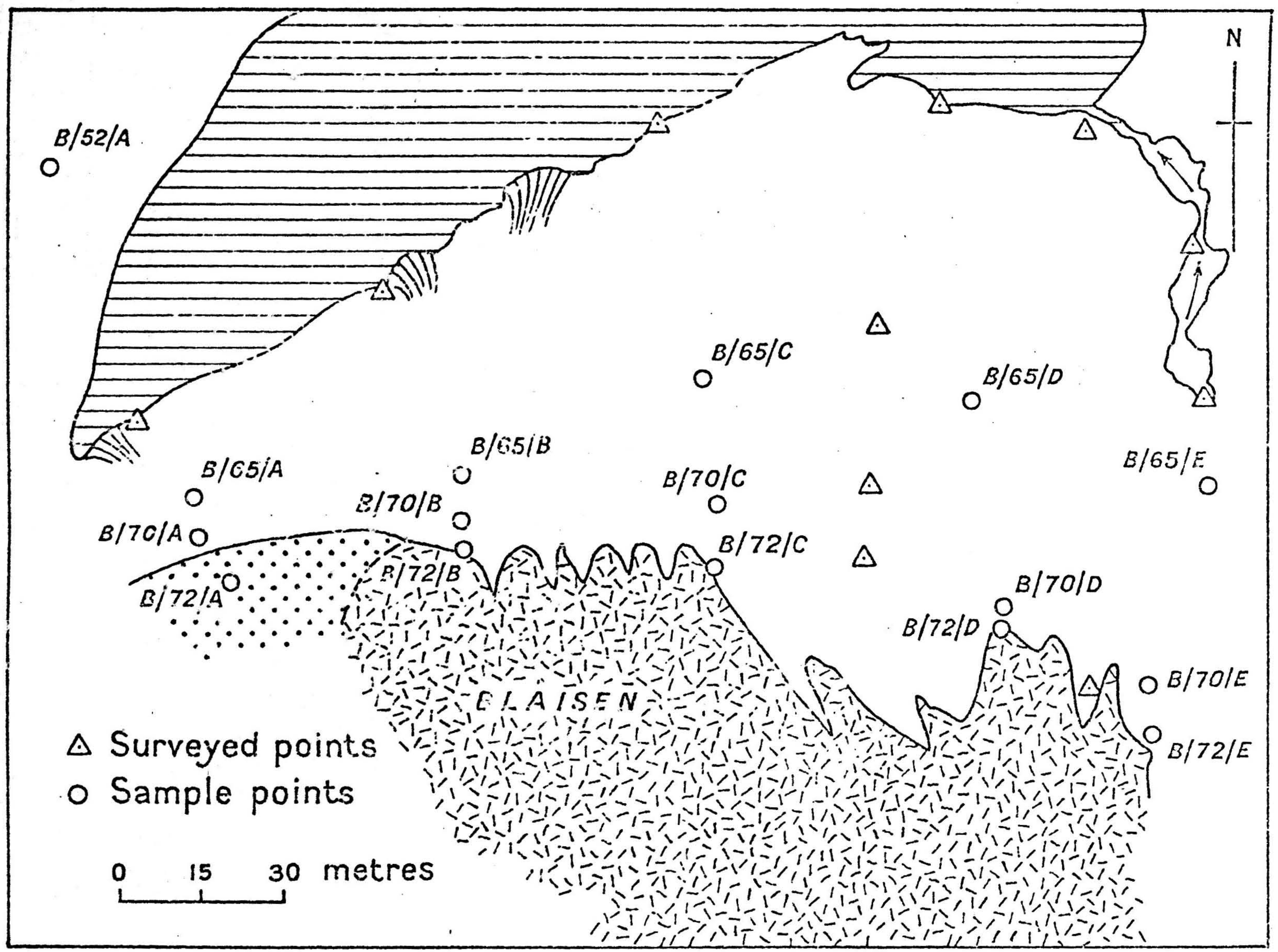


FIG. 4.23. SAMPLE POINTS AT BLÅISEN SOUTHERN NORWAY.

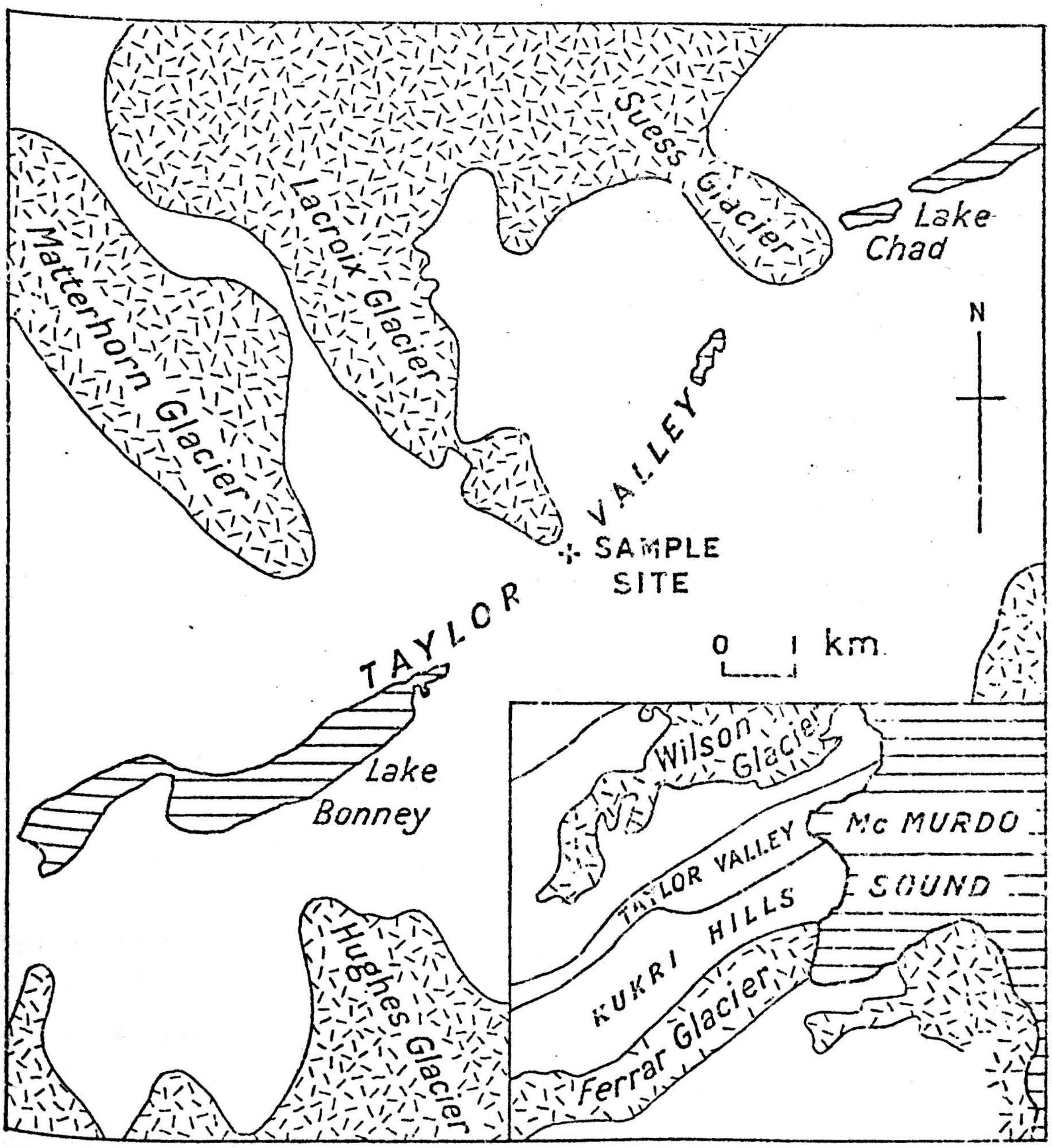


FIG. 4.24. LOCATION OF LACROIX GLACIER SAMPLE SITE.

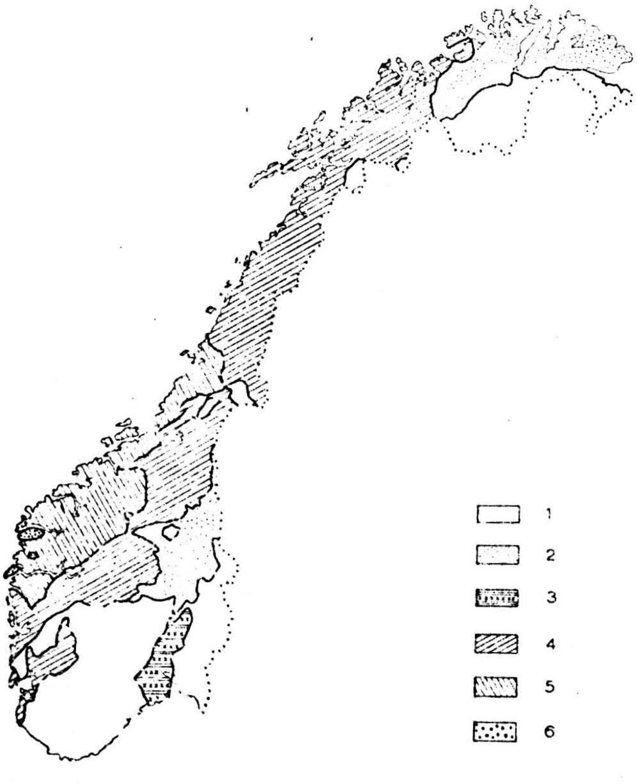
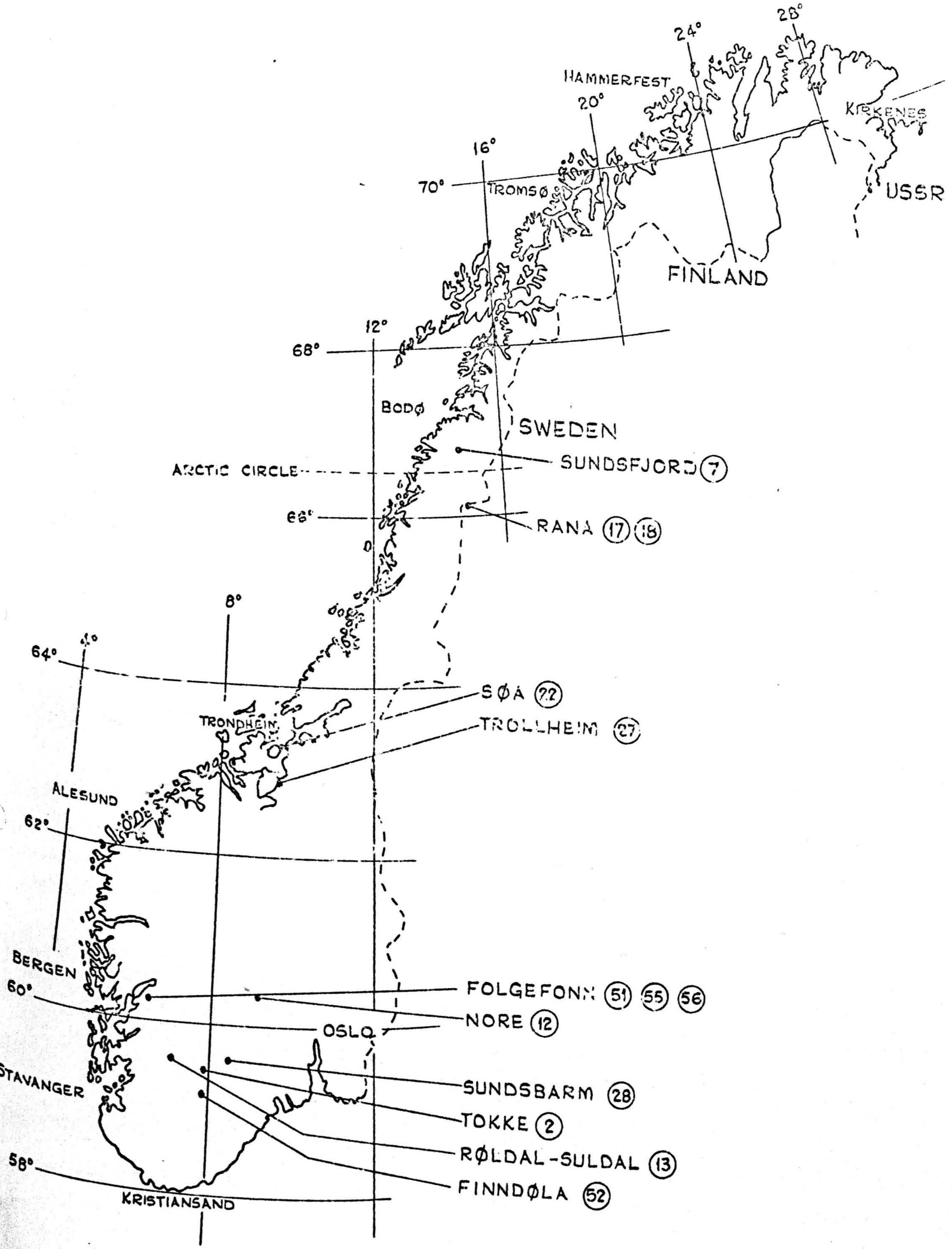


FIG. 4.25 Bedrock map of Norway. (1) Pre-Eocambrian rocks (mainly gneiss, granite, sandstone, quartzite). (2) Rocks of Eocambrian age (Sedimentary and gneissic rocks) (3) Cambro-Silurian sedimentary rocks and Permian effusive and plutonic rocks (4) Caledonian thrust masses and strongly altered Cambro-Silurian sedimentary rocks (5) Mainly gneissic rocks with Caledonian structure (6) Mainly Devonian sedimentary rocks.

(Kjaernsli, 1968)

FIG. 4.26. LOCATIONS OF NORWEGIAN DAMS STUDIED



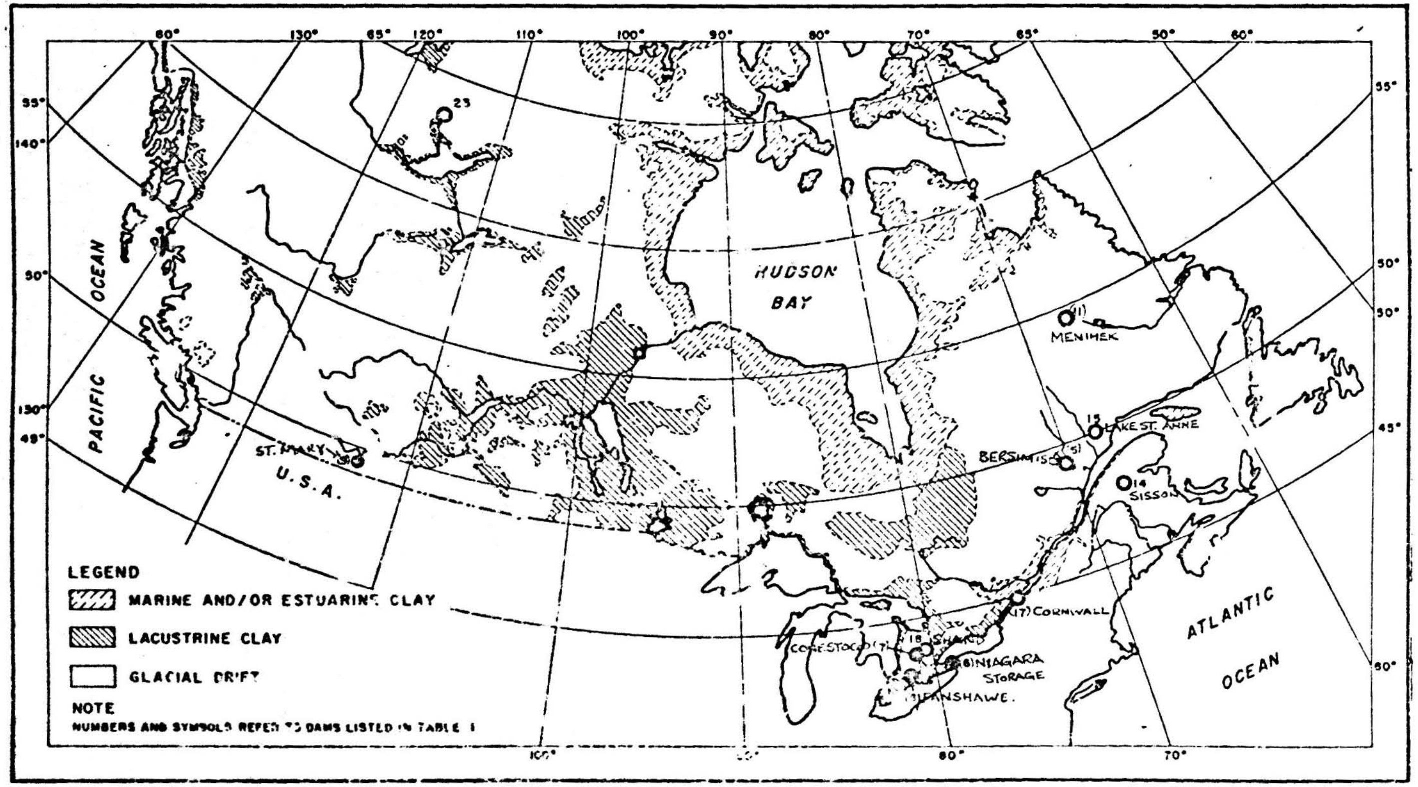
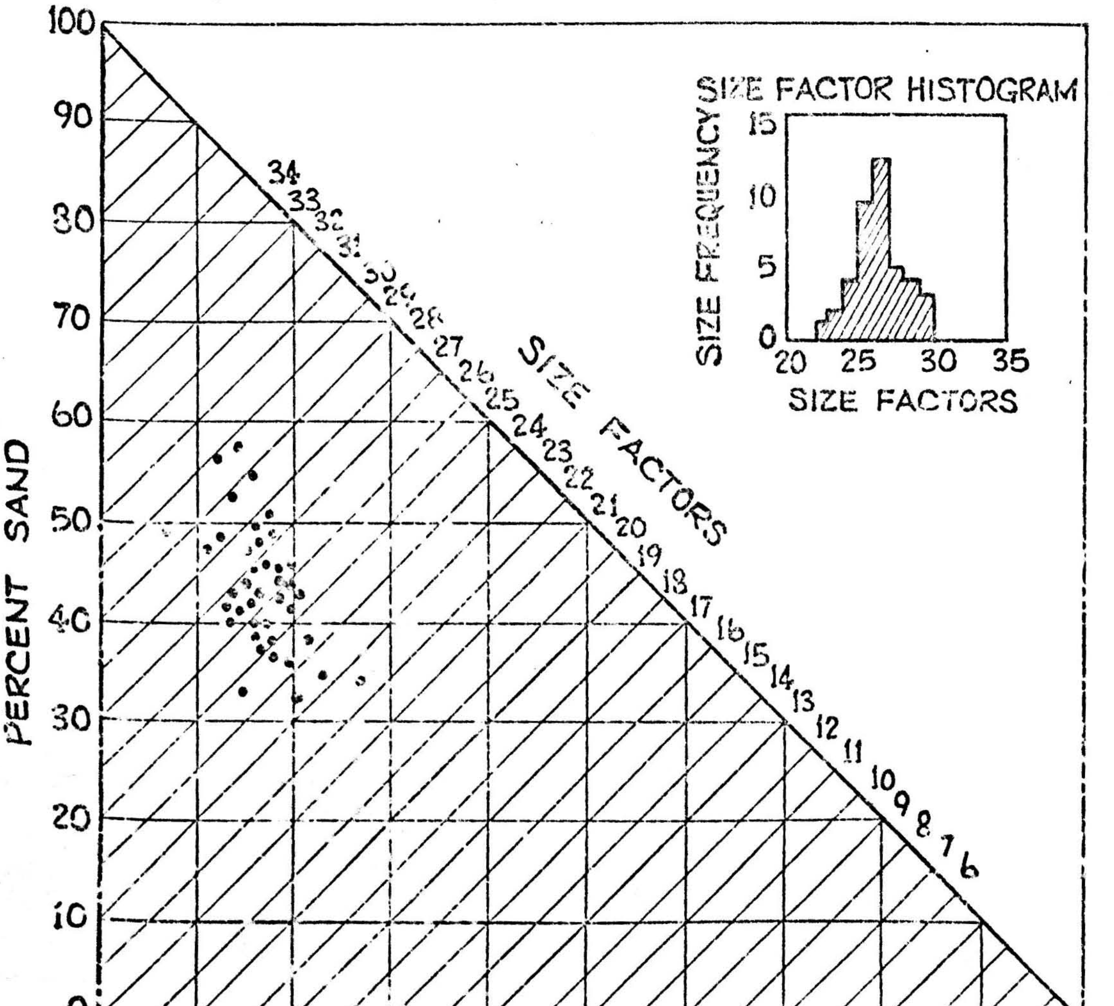


FIG. 4.27. Locations of Dams in Canada With Respect to the Distribution of Dominant Surface Soil Groups.

(McDONALD et al. 1961)



SIZE FACTORS GRAPH

(AFTER SHEPPS 1958)

FIG. 5.1

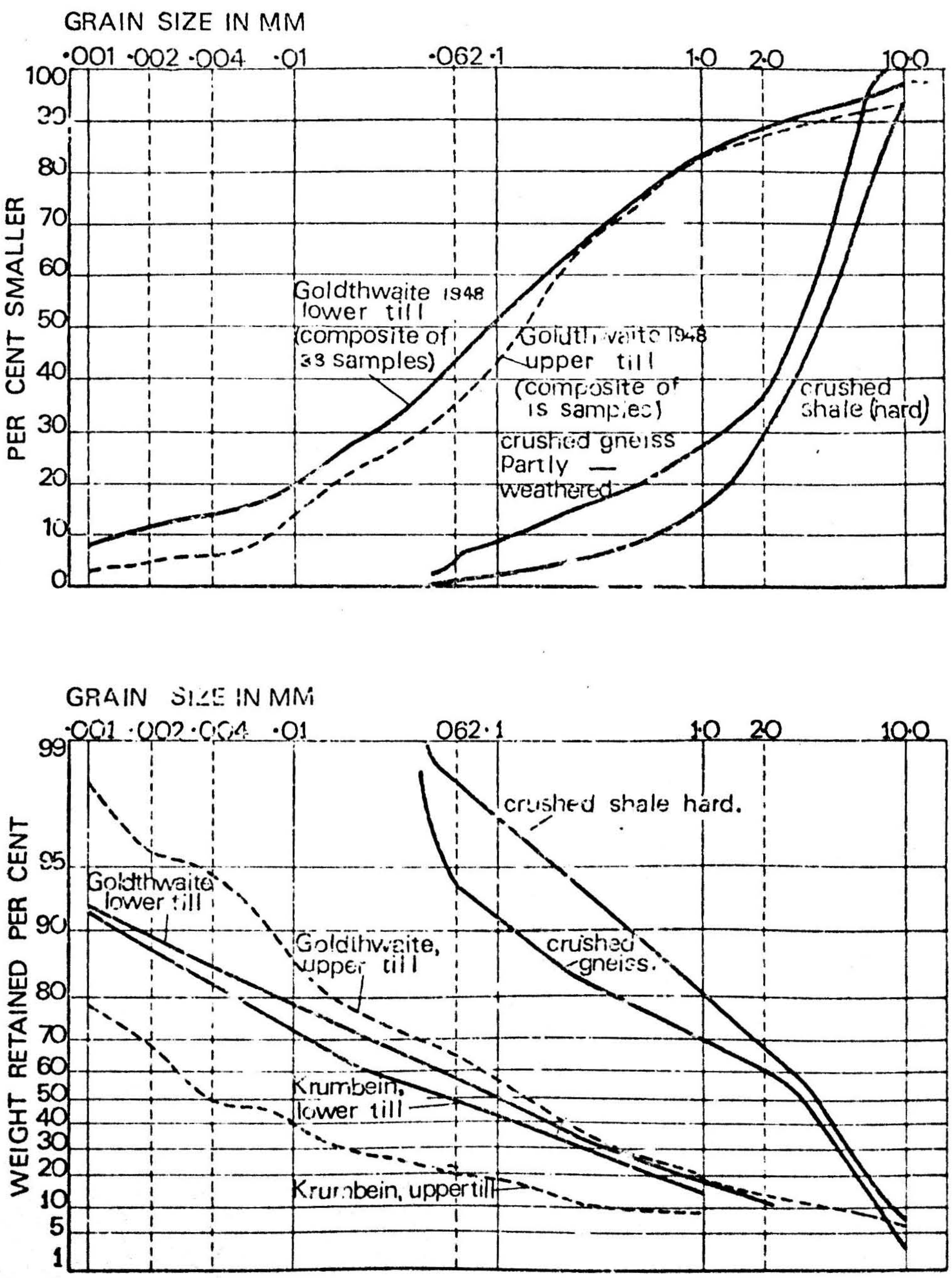
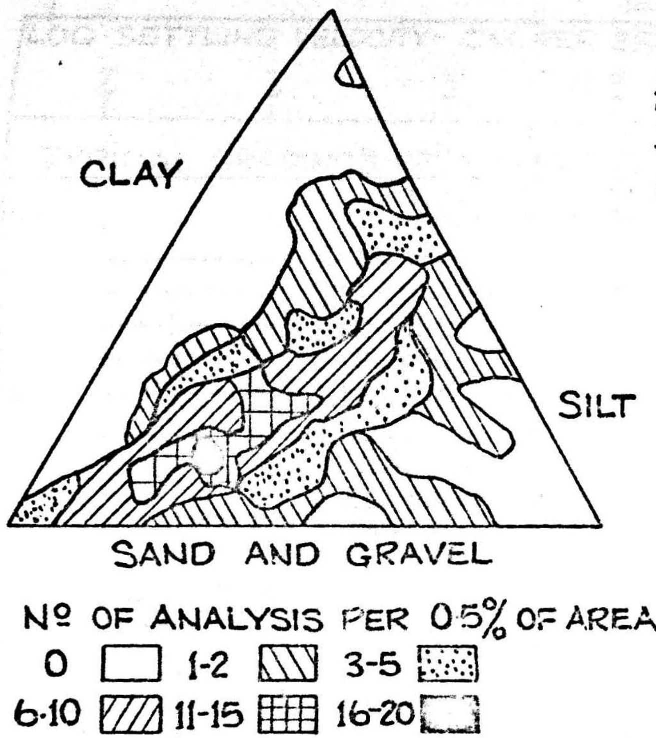
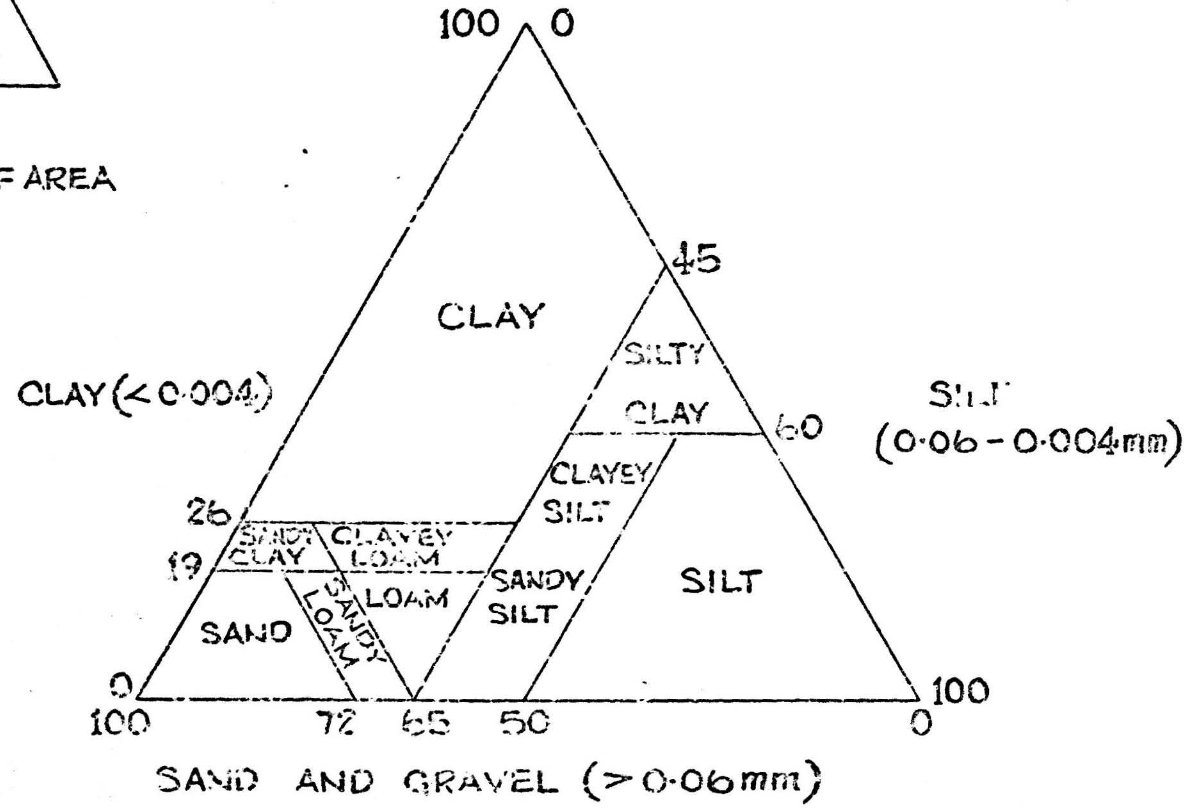


FIG. 5.2. GRAIN SIZE DISTRIBUTION OF TILLS FROM ELSON (1961).

FIG. 5.3.
TRIANGULAR
GRAIN SIZE DISTRIBUTION FOR
ABOUT 500 TILLS - BY ELSON (1961)





PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT

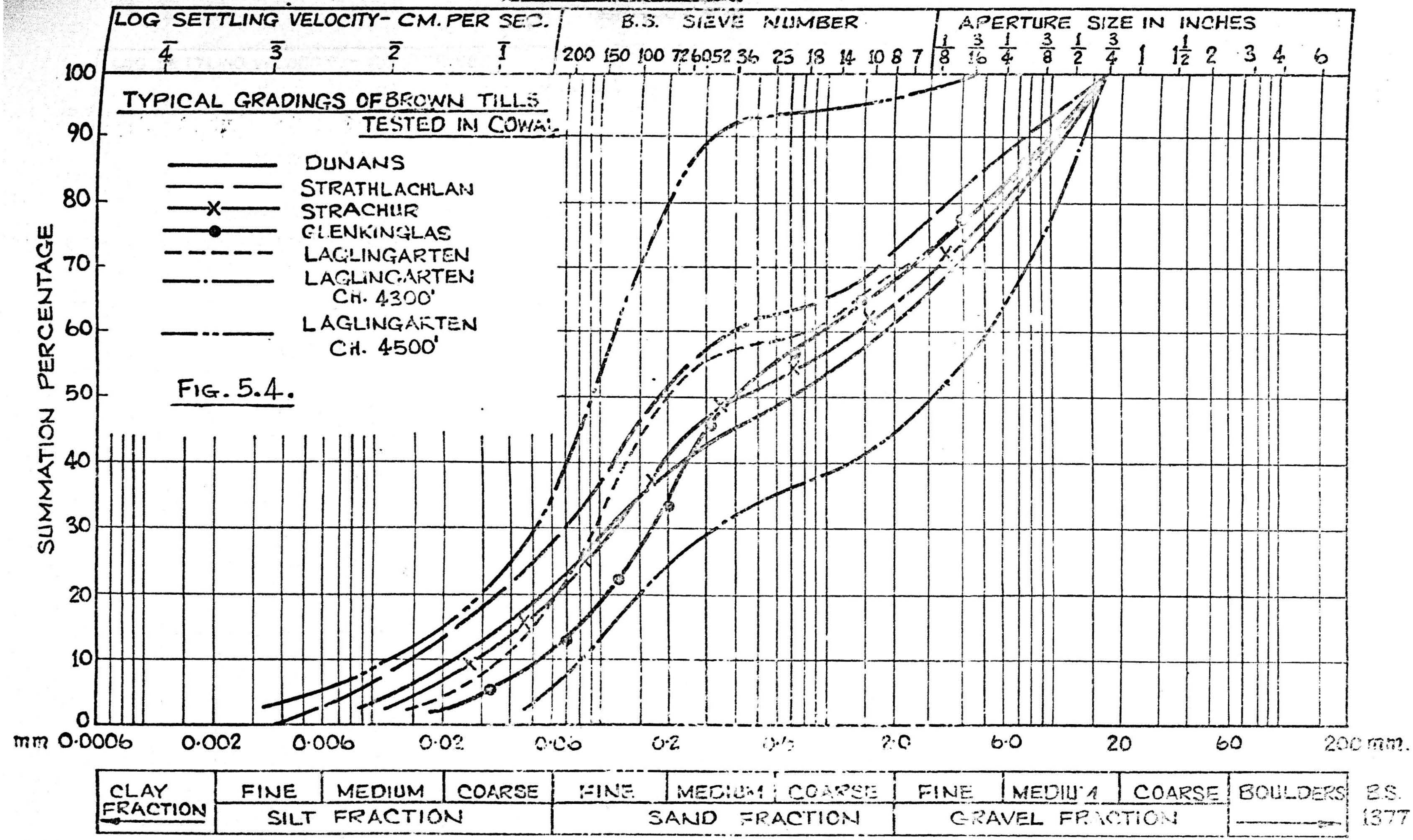


FIG. 5.4.

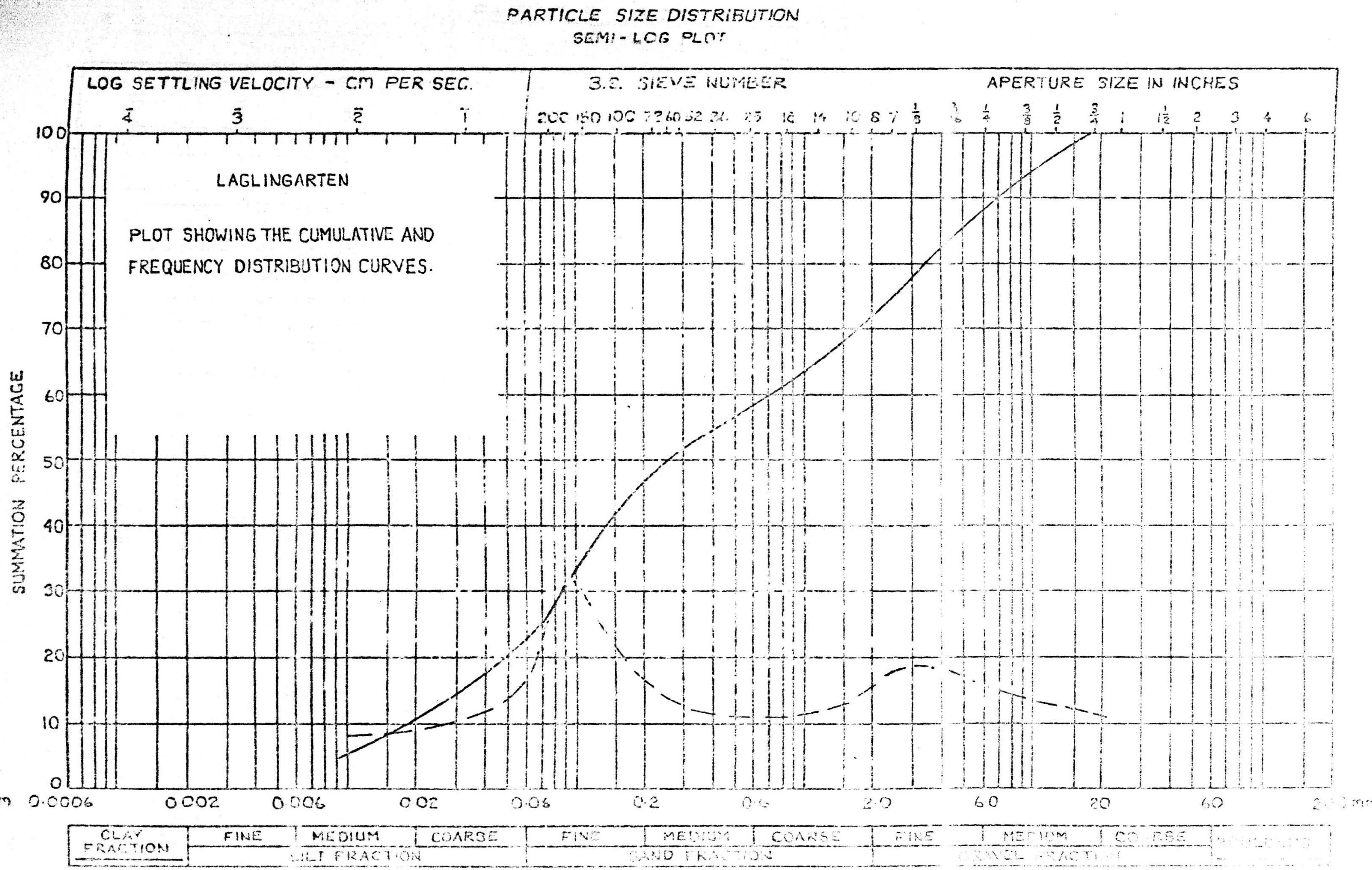


FIG. 5.5 CUMULATIVE AND FREQUENCY DISTRIBUTION CURVES FOR LAGLINGARTEN TI...

PARTICLE SIZE DISTRIBUTION

LOG PROBABILITY PLOT

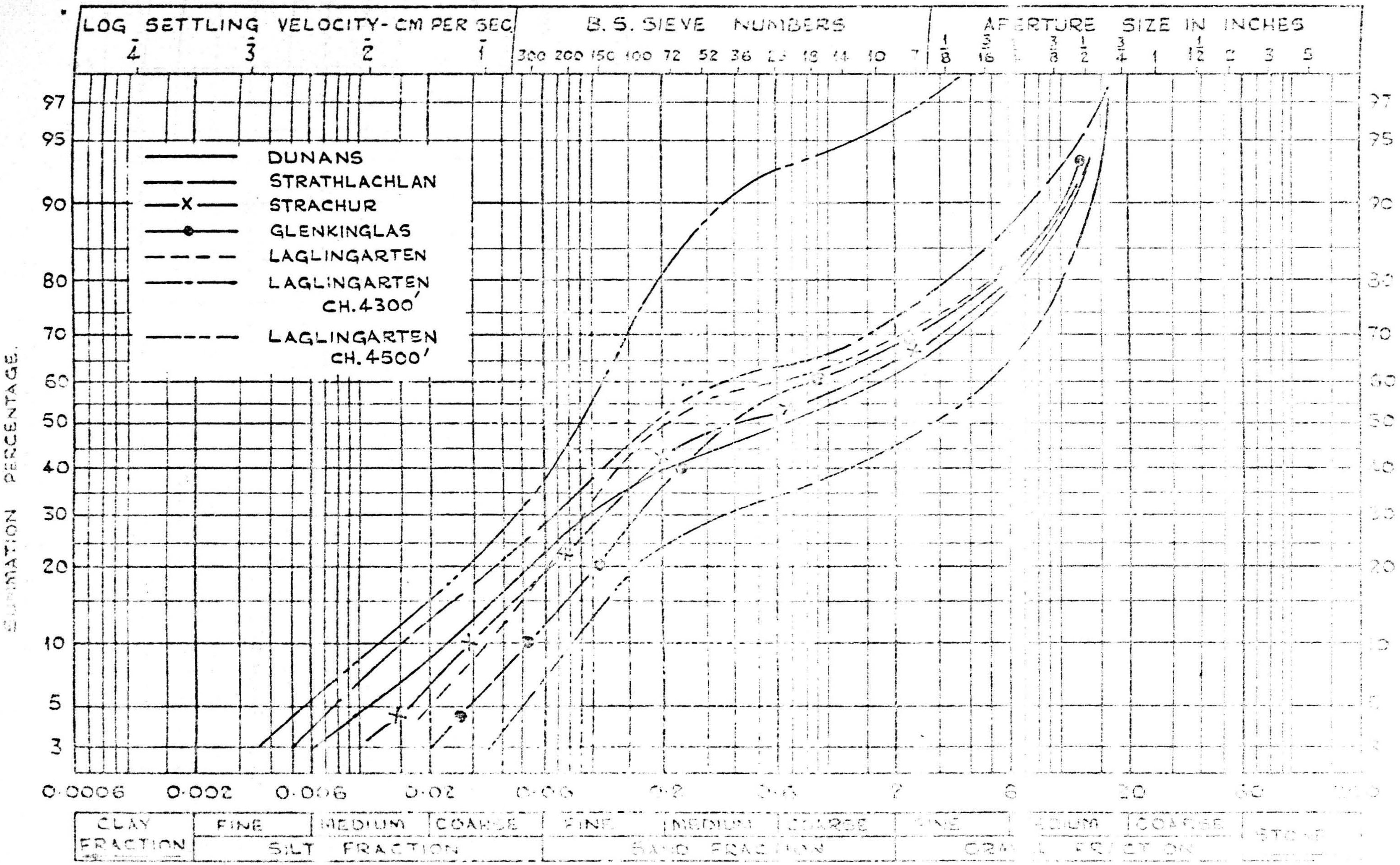


FIG. 5.6. LOG [illegible]

PARTICLE SIZE DISTRIBUTION.

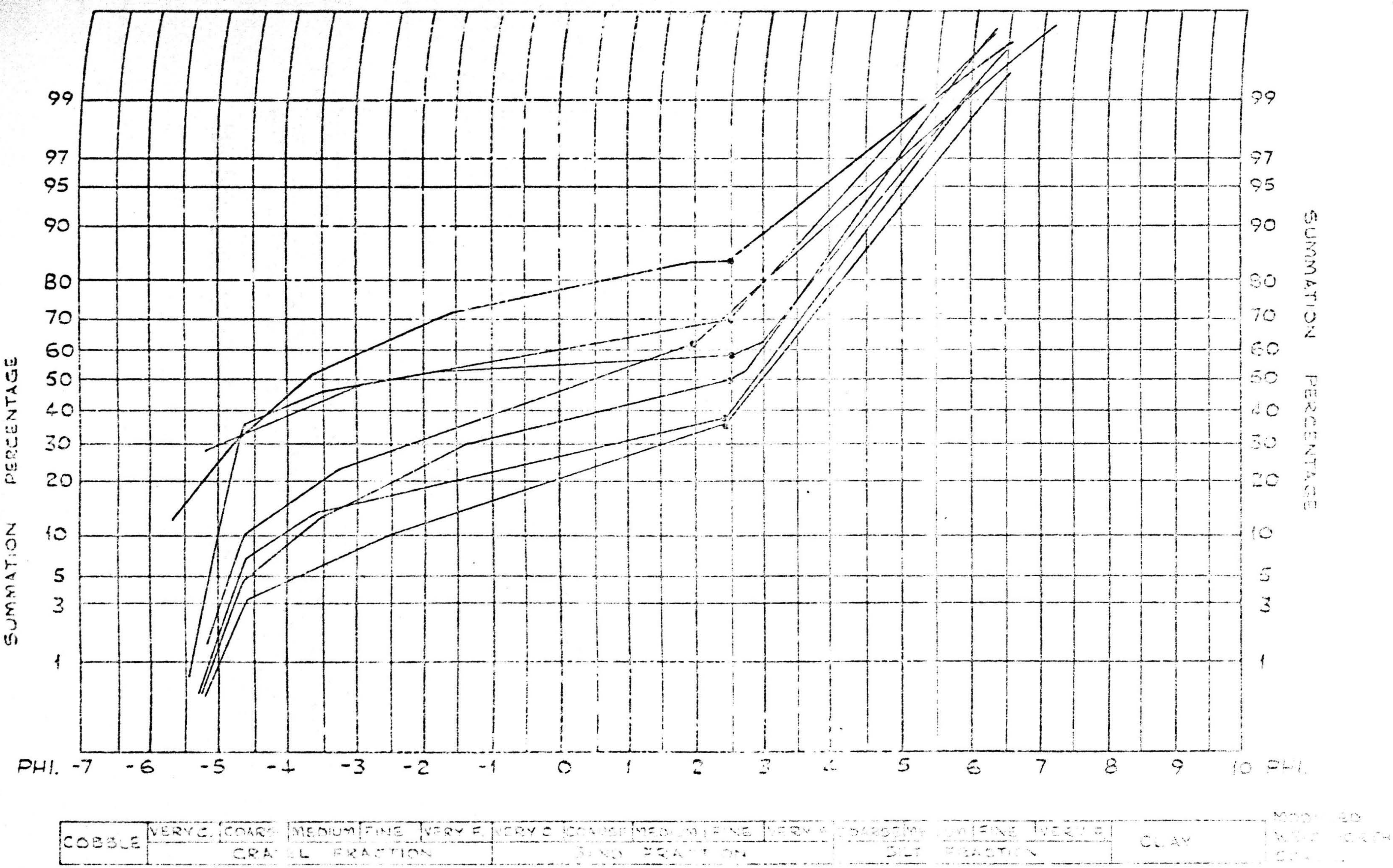


FIG. 5·7. PHI - P[illegible]BABILITY PLOT FOR [illegible]

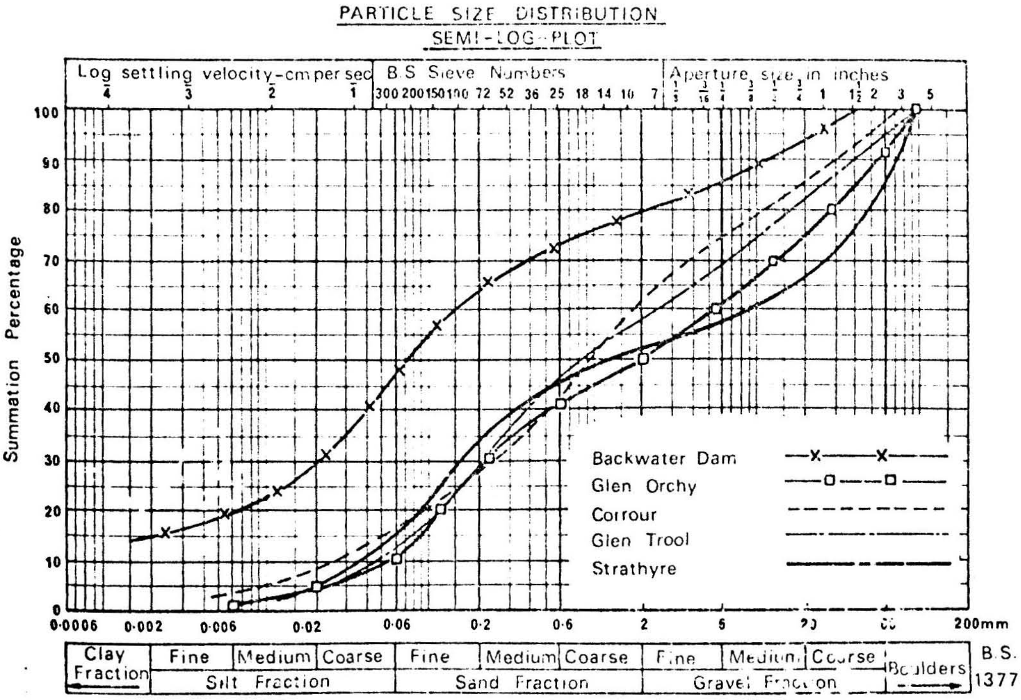


FIG. 5.8. SEMI-LOG PLOT OF OTHER SCOTTISH TILLS.

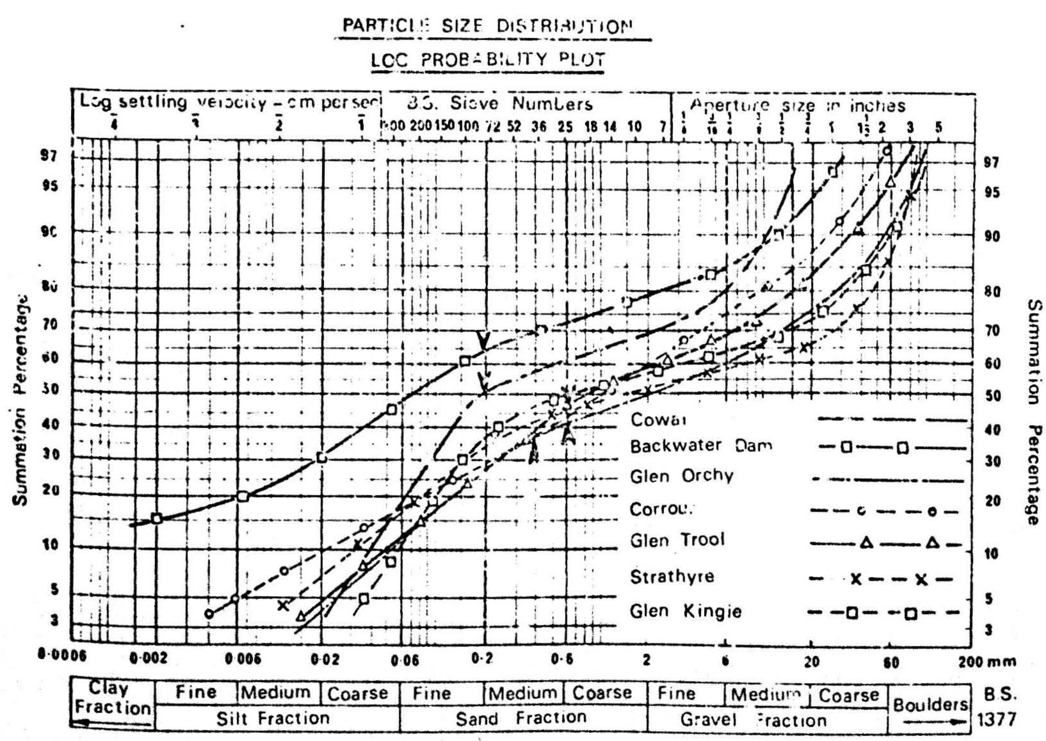


FIG 5.9. LOG-PROBABILITY PLOT OF SCOTTISH TILLS.

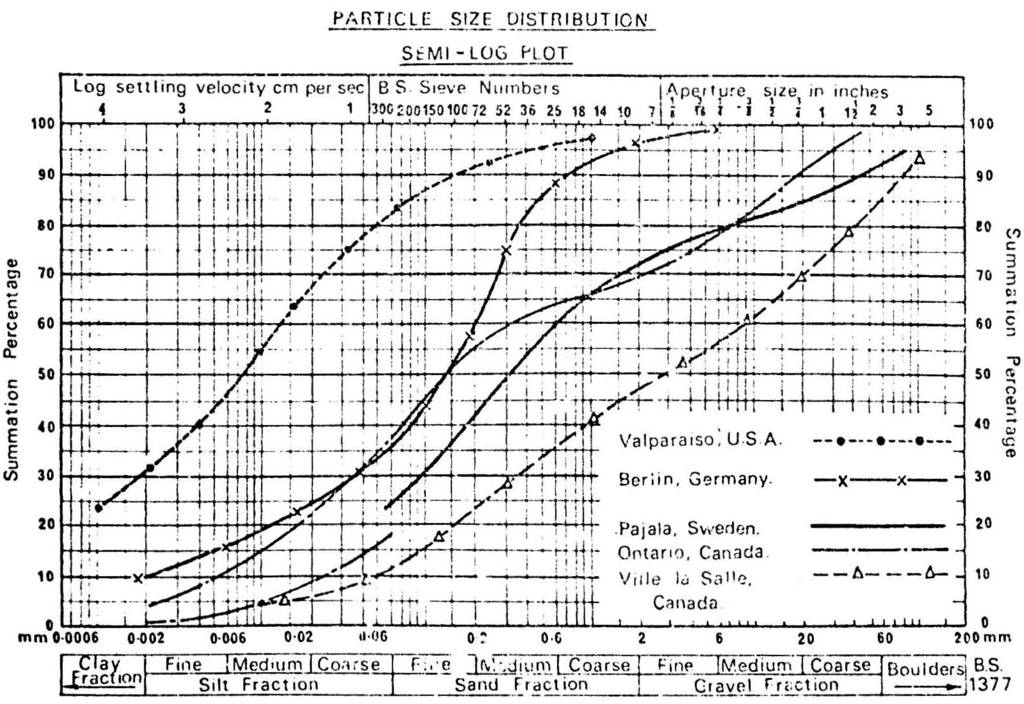


FIG. 5.10. SEMI-LOG PLOT FOR FOREIGN TILLS.

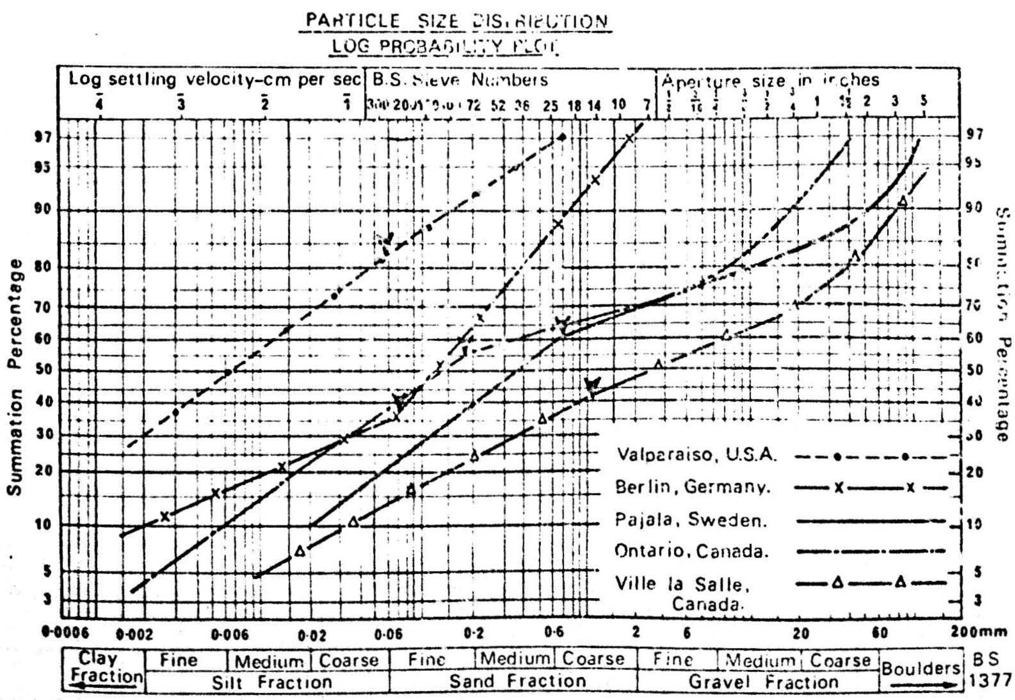


FIG. 5.11. LOG-PROBABILITY FOR FOREIGN TILLS.

Ø-PROBABILITY PLOT

PARTICLE SIZE DISTRIBUTION.

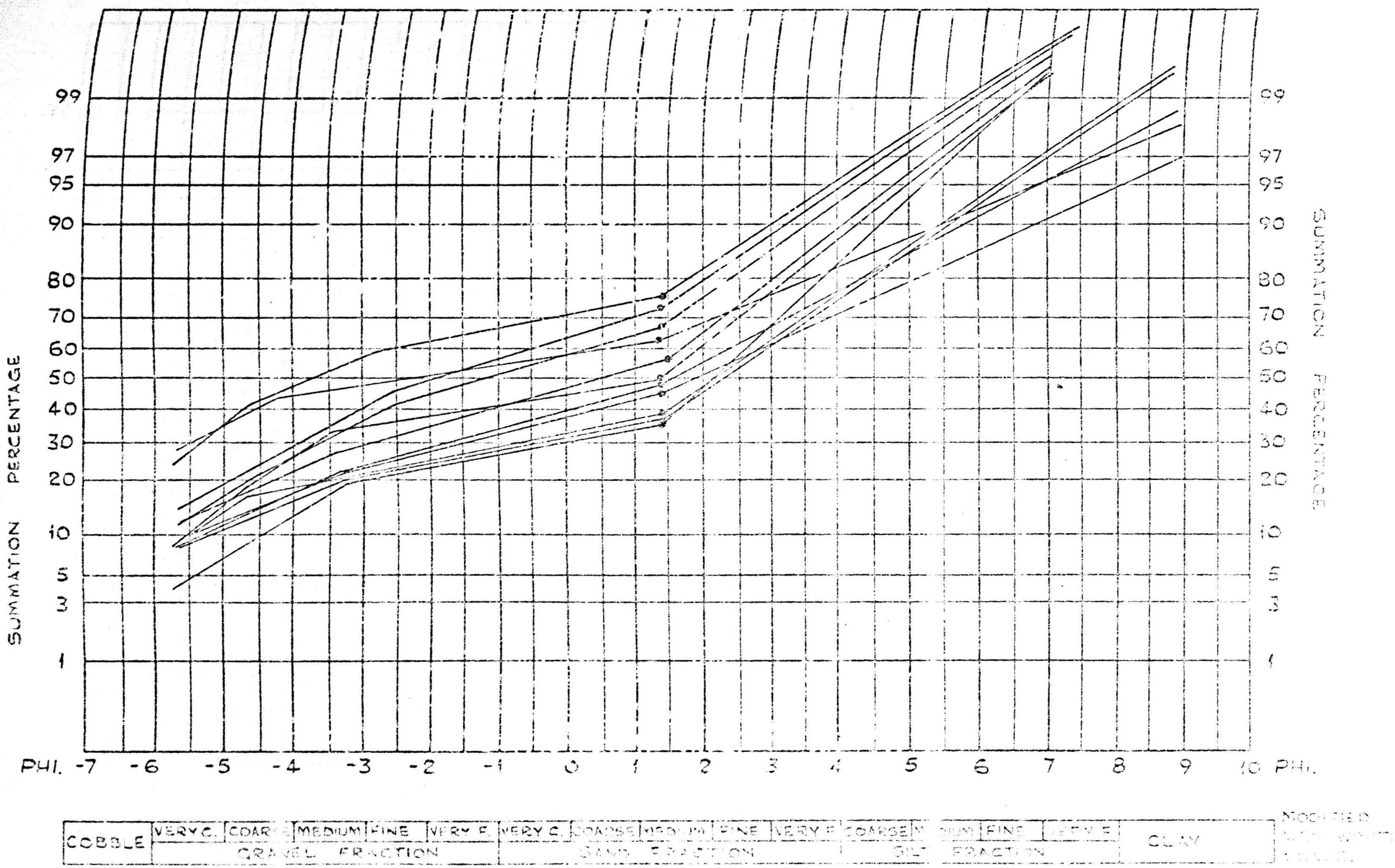


FIG. 5.12. PHI-PROBABILITY PLOT FOR

Ø - PROBABILITY PLOT.

PARTICLE SIZE DISTRIBUTION.

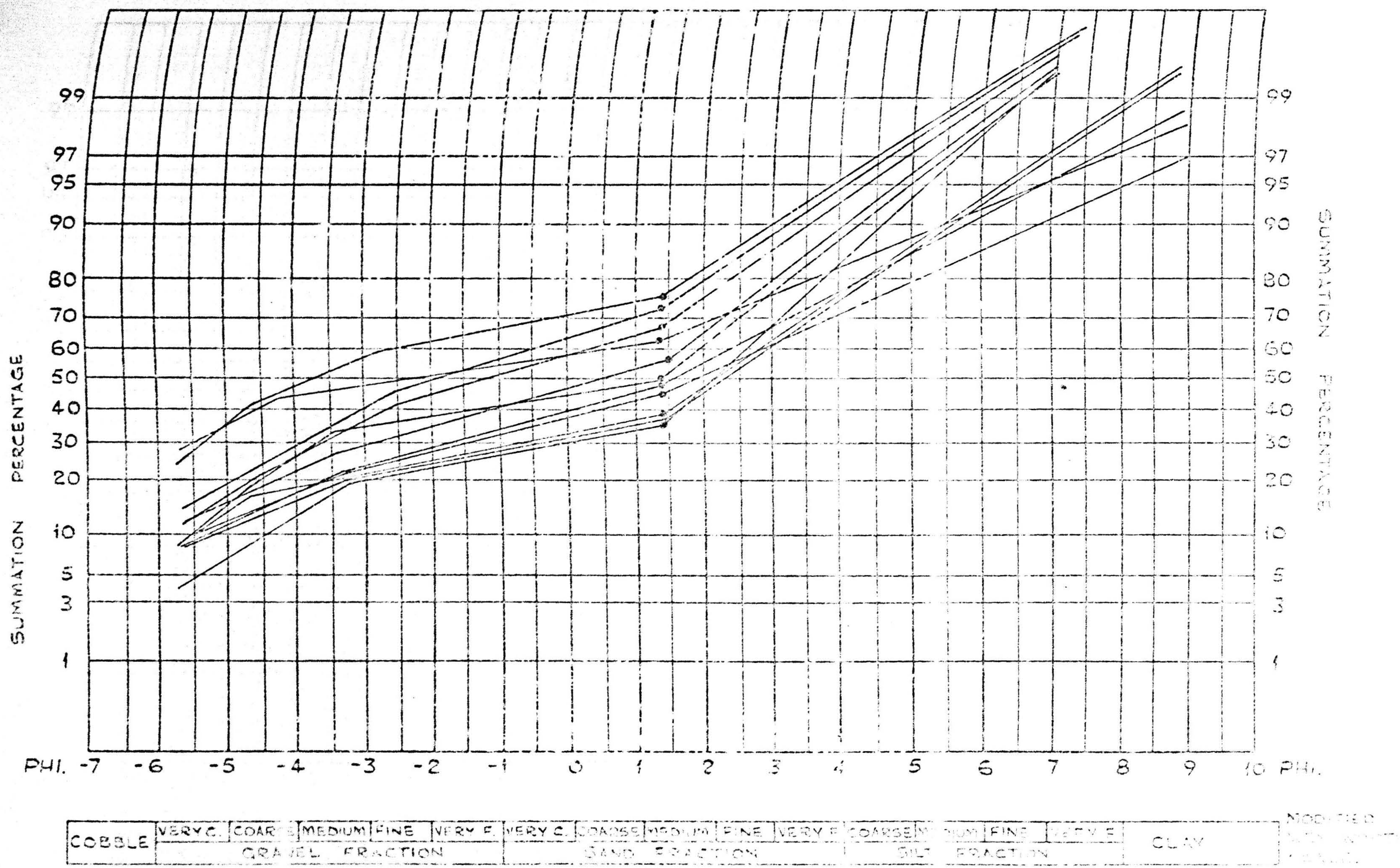


FIG. 5·12. PHI-PROBABILITY PLOT FOR

∅ - PROBABILITY PLOT.

PARTICLE SIZE DISTRIBUTION.

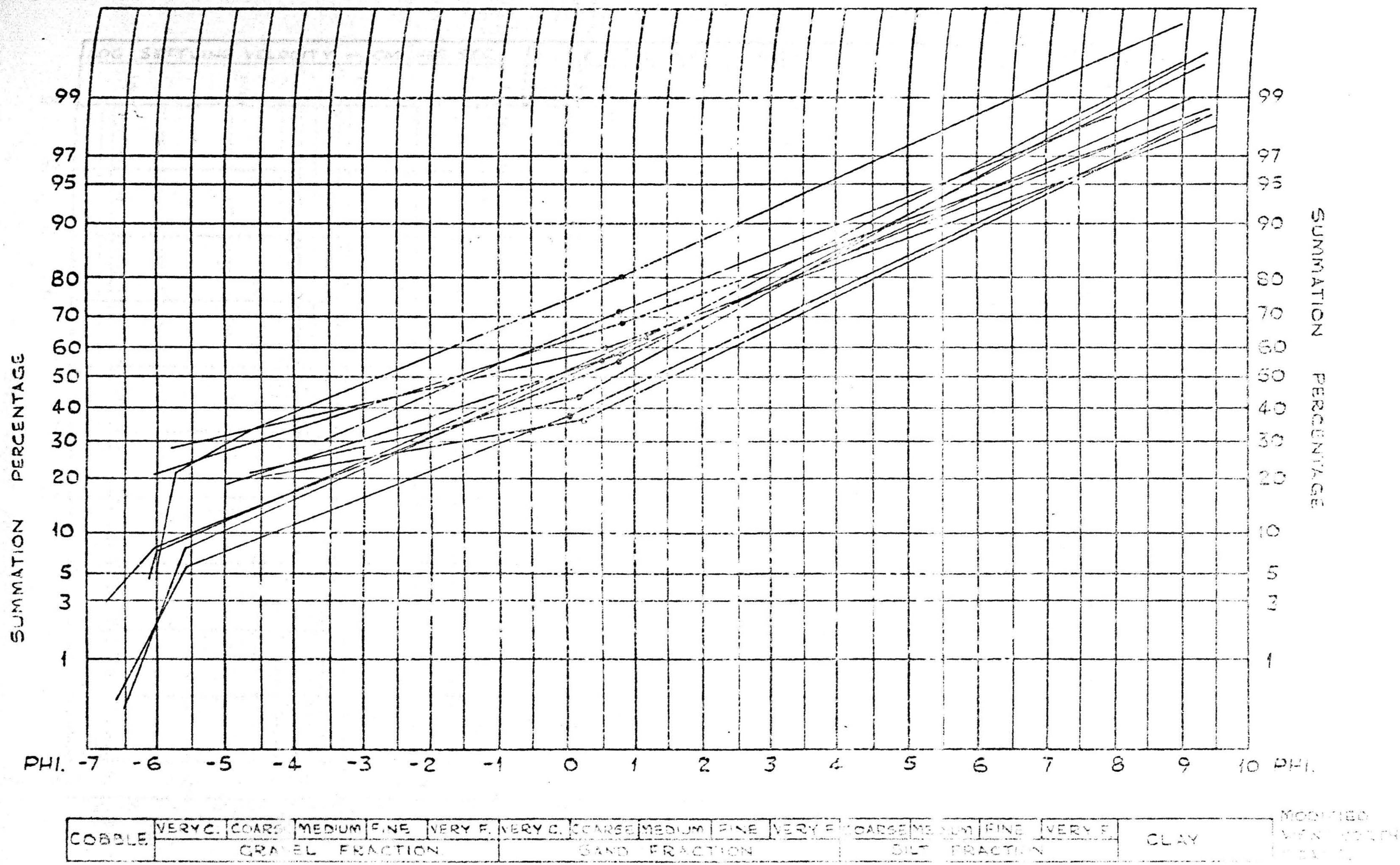


FIG. 5.13. PHI - PROBABILITY PLOT FO[illegible] CORR[illegible] TILL.

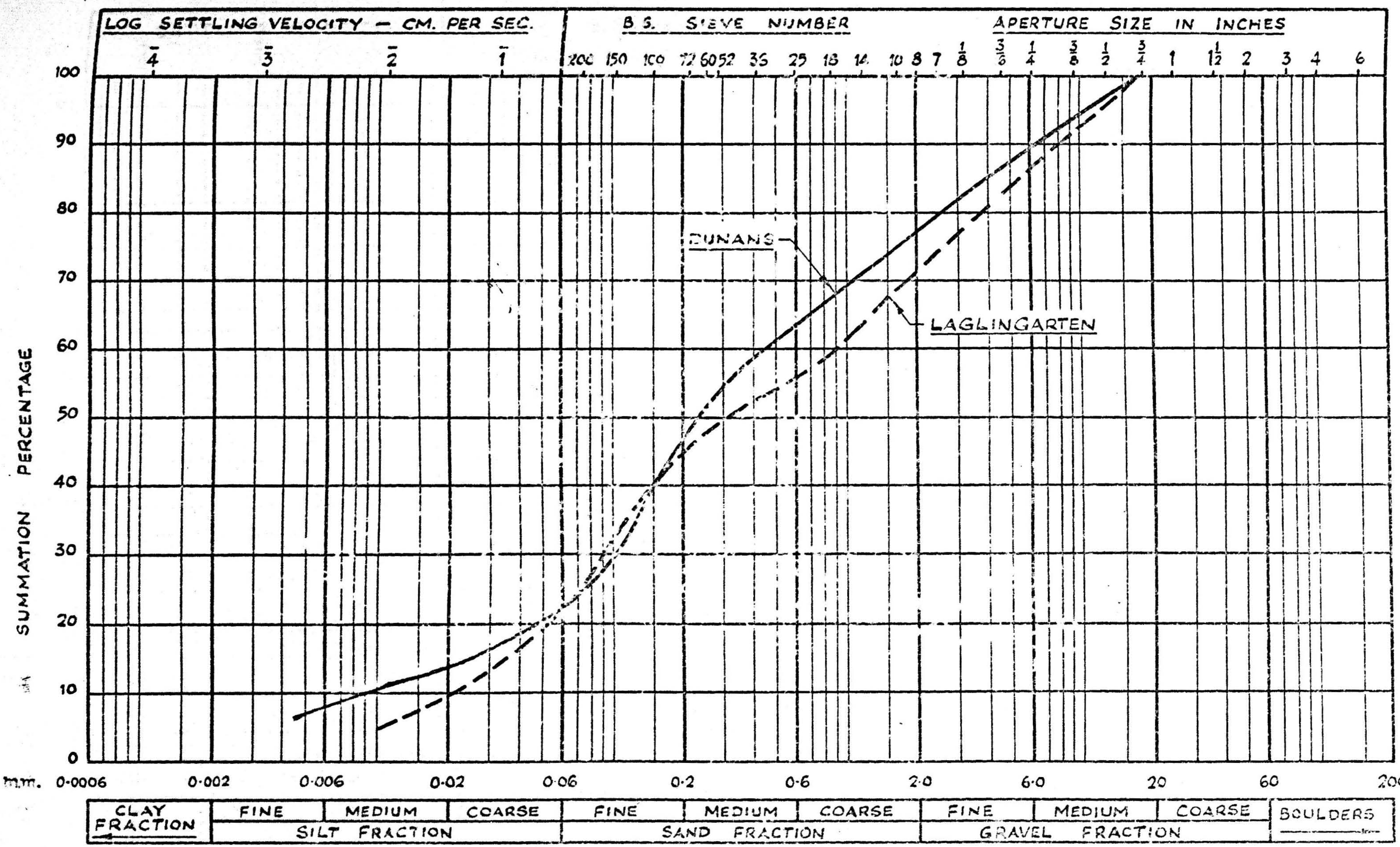


FIG. 5.14. TYPICAL GRADING OF GREY COWAL TILL.

PARTICLE SIZE DISTRIBUTION

LOG PROBABILITY PLOT

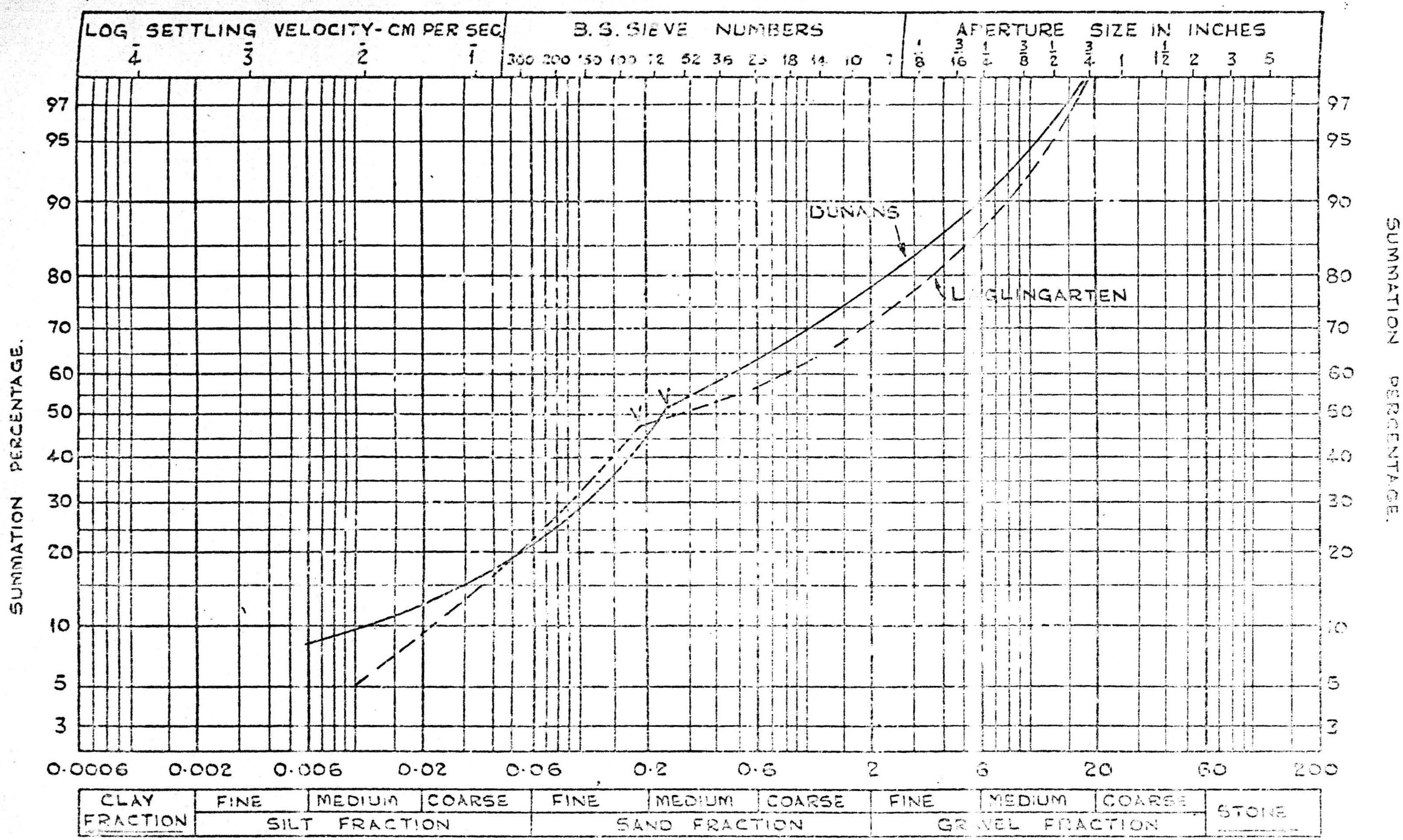


FIG. 5.15. LOG PROBABILITY PLOT OF GREY COWAL TILL

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

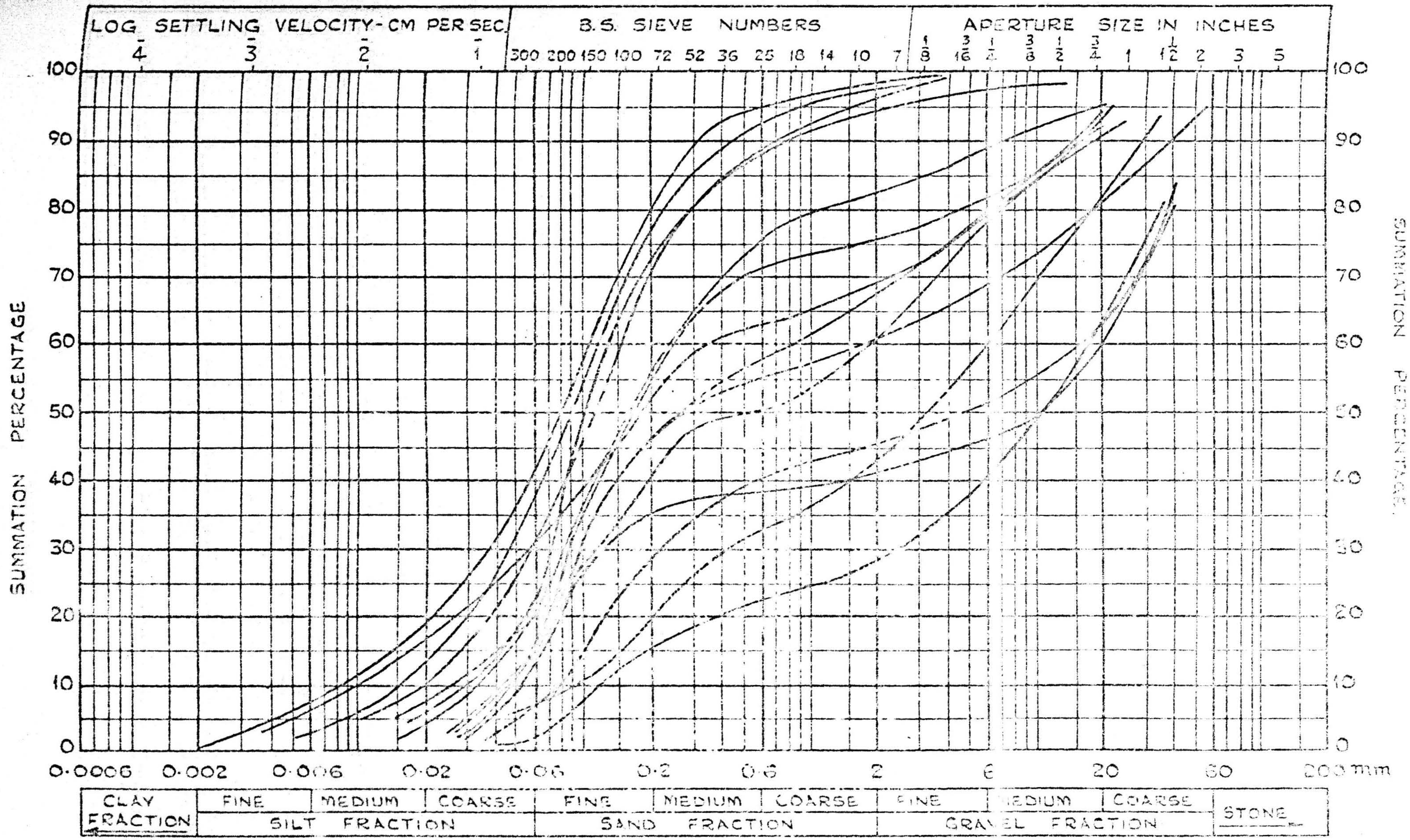


FIG. 5.16 RANGE OF GRADINGS FOR [illegible] [illegible].

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

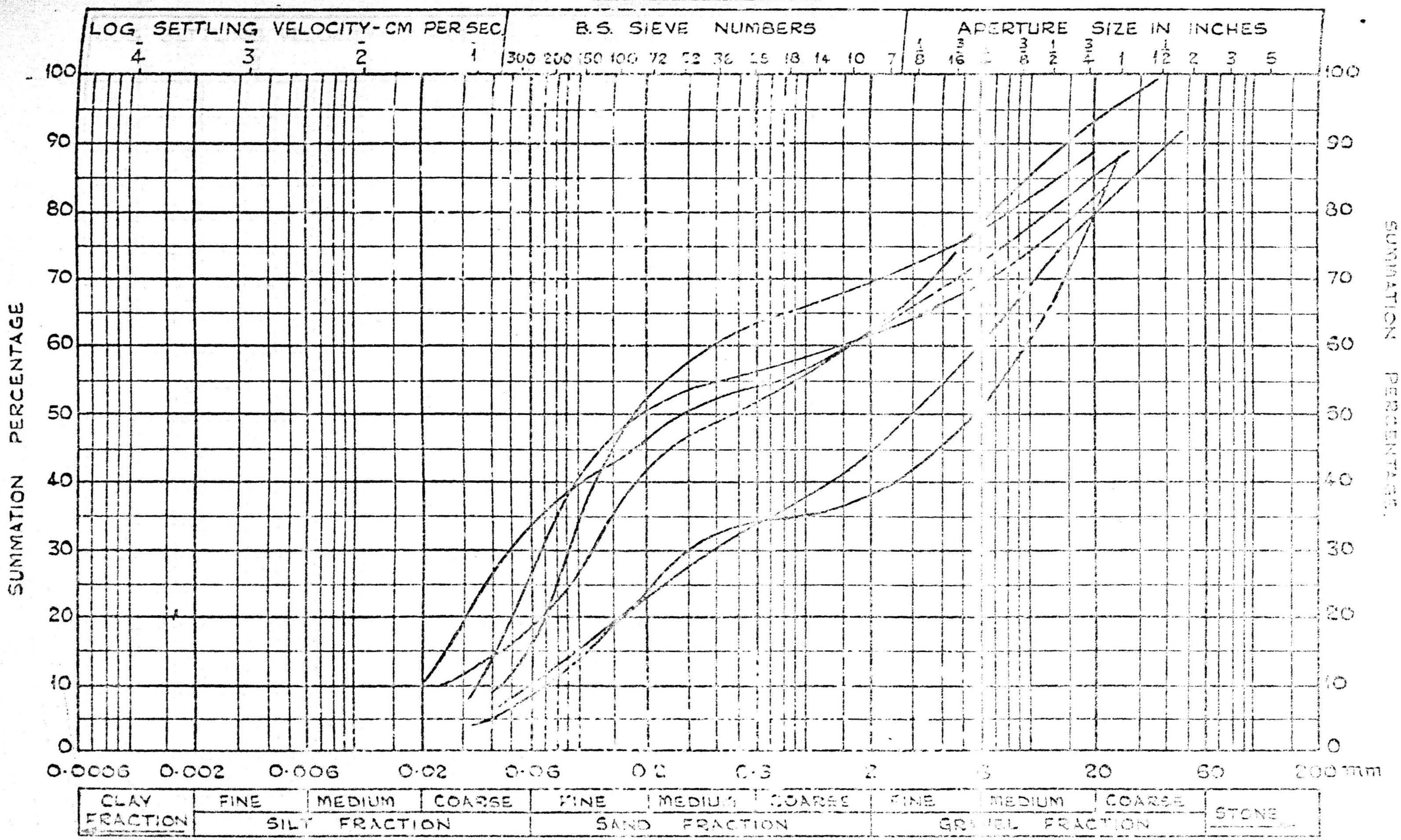


FIG. 5.17. STRACHUR TILL GRADING

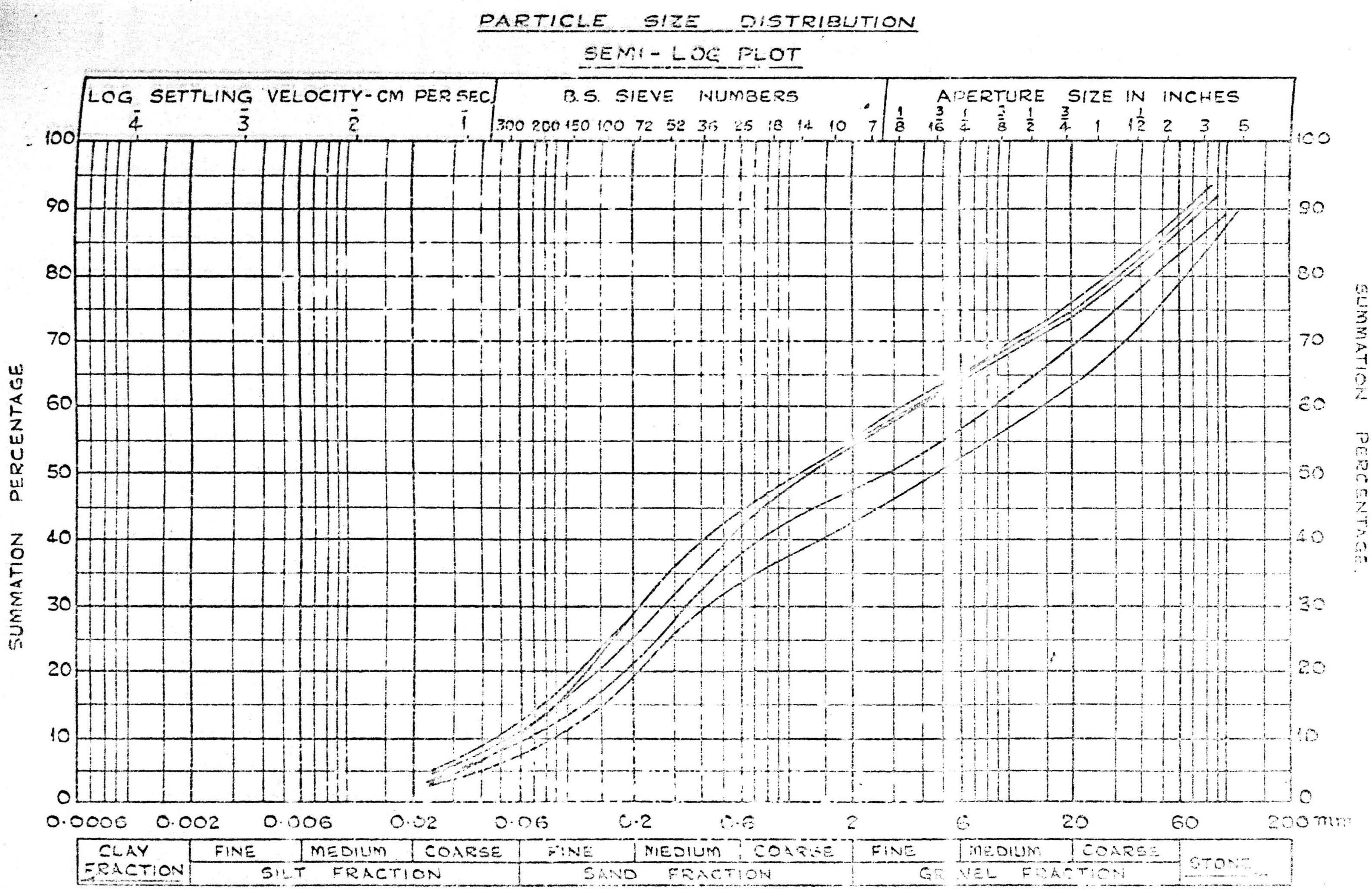


FIG 5·18. GLEN KINGLAS TILL GRADINGS.

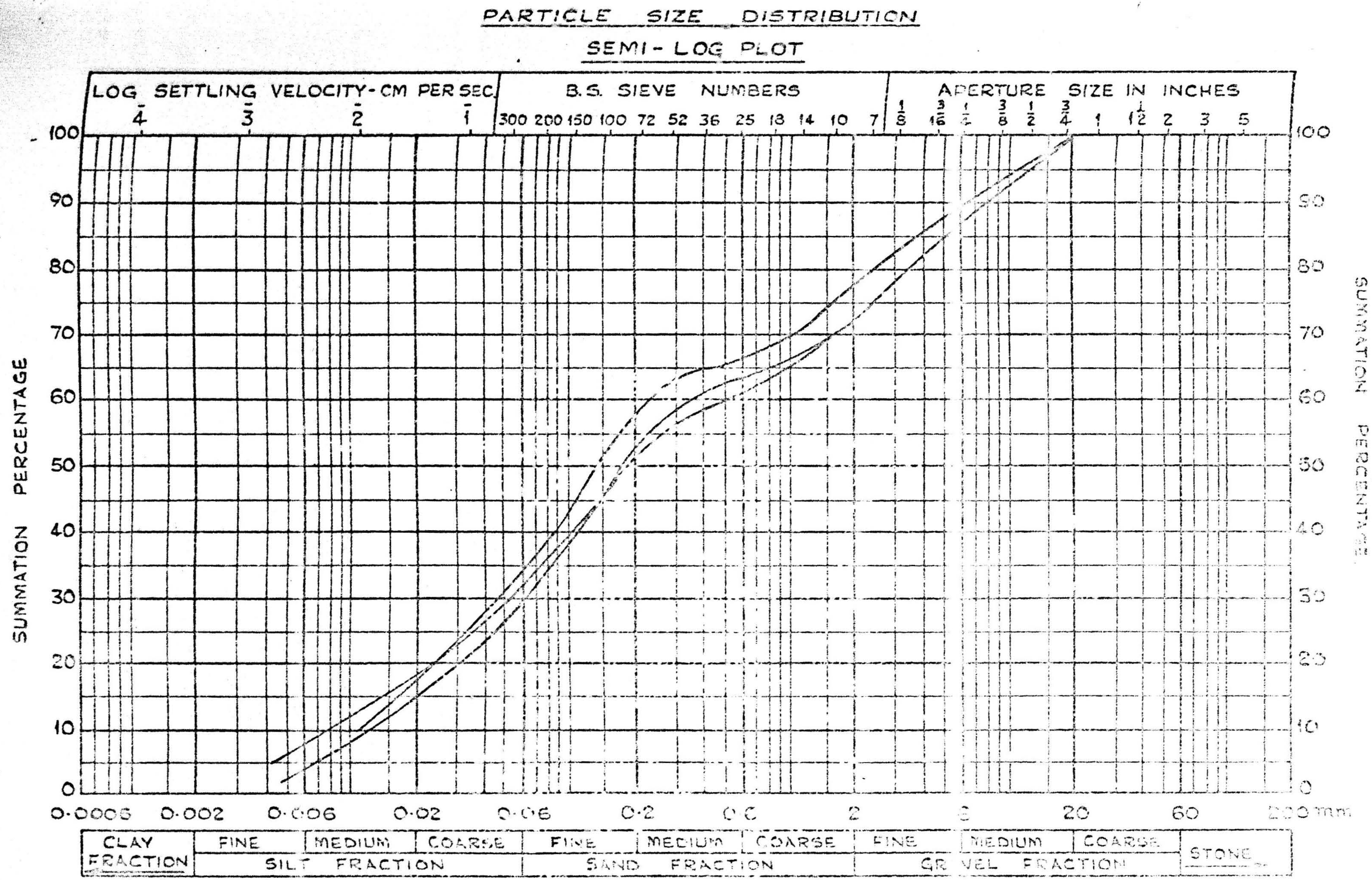


FIG 5.49. STRATHLACHLAN TILL GRADINGS.

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

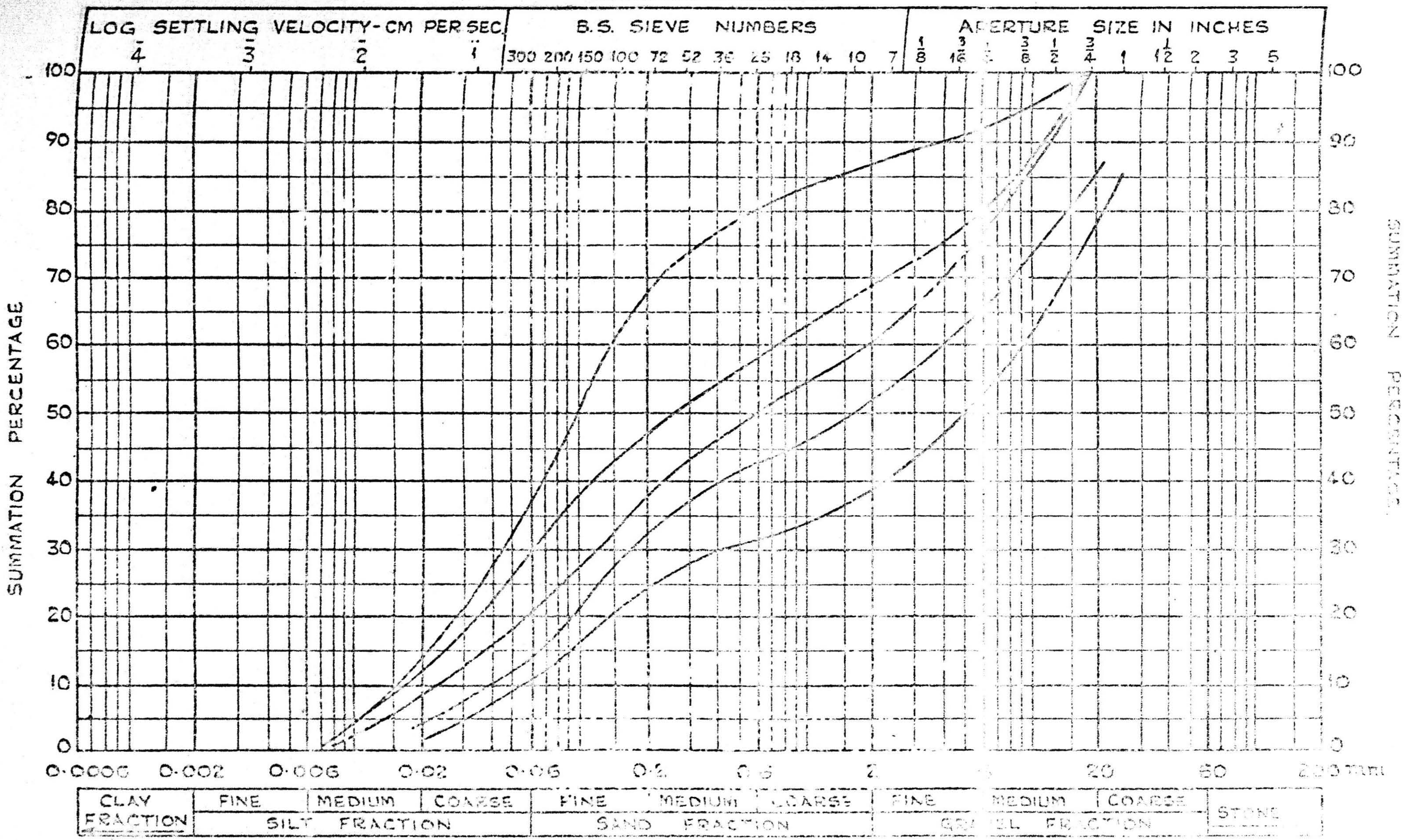
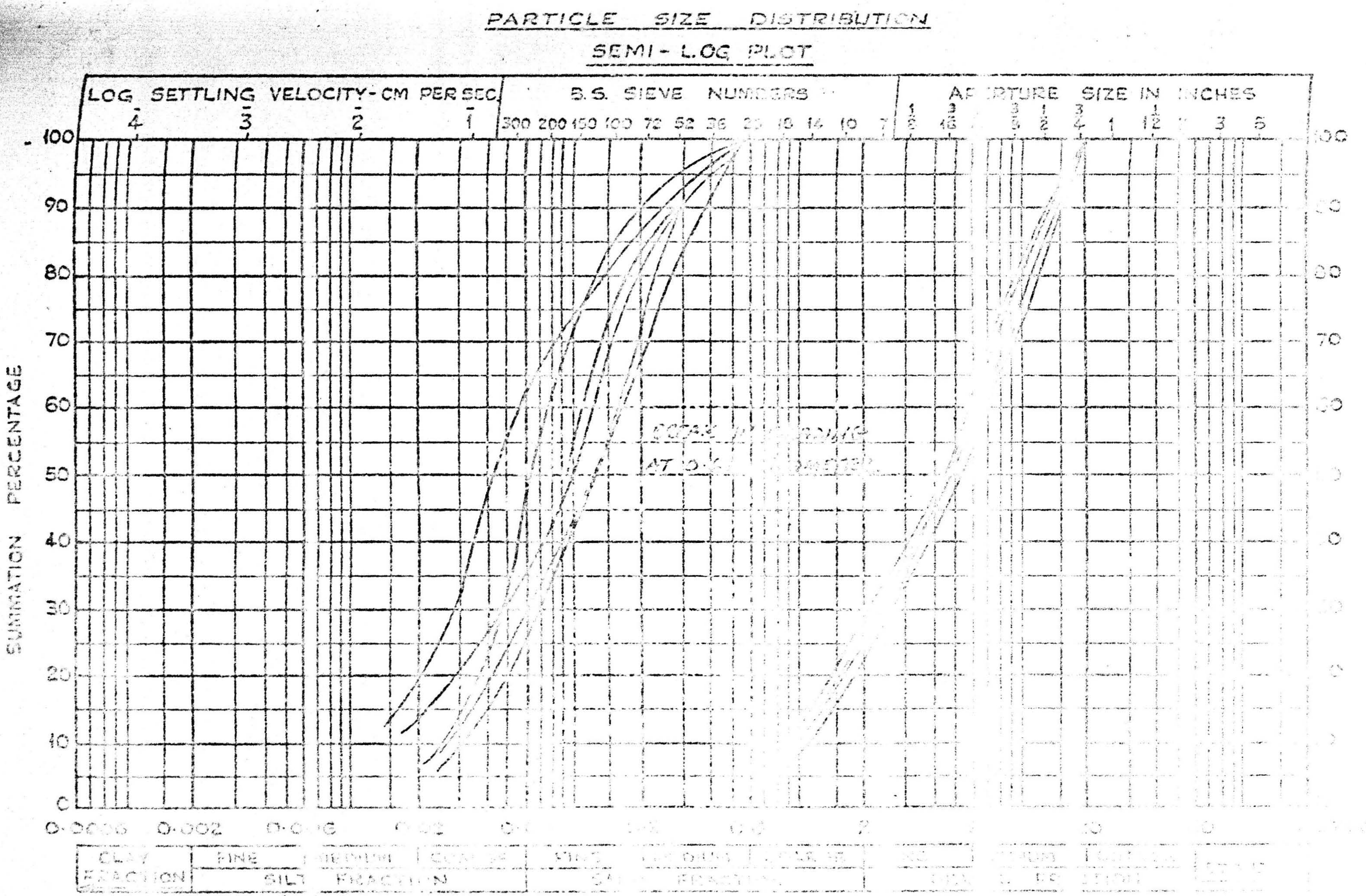


FIG 5.20. DUNANS HILL G[illegible]INGS

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

FIG. ... SIZE FRACTIONS ... TILL.


PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT
LOG SETTLING VELOCITY - CM PER SEC
B.S. SIEVE NUMBERS
APERTURE SIZE IN INCHES
SUMMATION PERCENTAGE
100
90
80
70
60
50
40
30
20
10
0
300 200 150 100 72 52 36 14 10 7
0·0006 0·002
CLAY FRACTION
FINE SILT FRACTION
SAND FRACTION

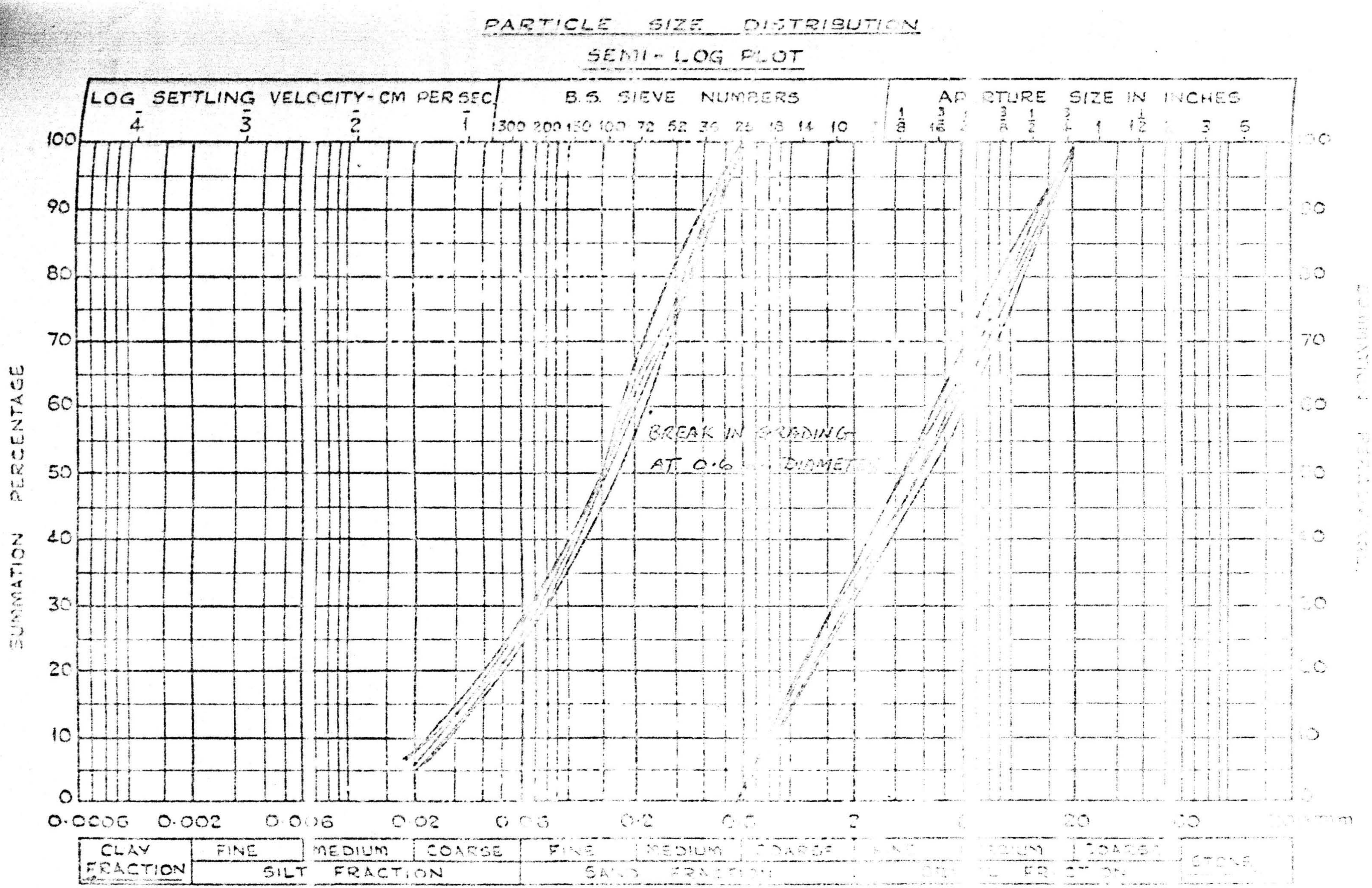


FIG. 5.23. SIZE FRACTIONS FOR GLEN KINGLAS TILL

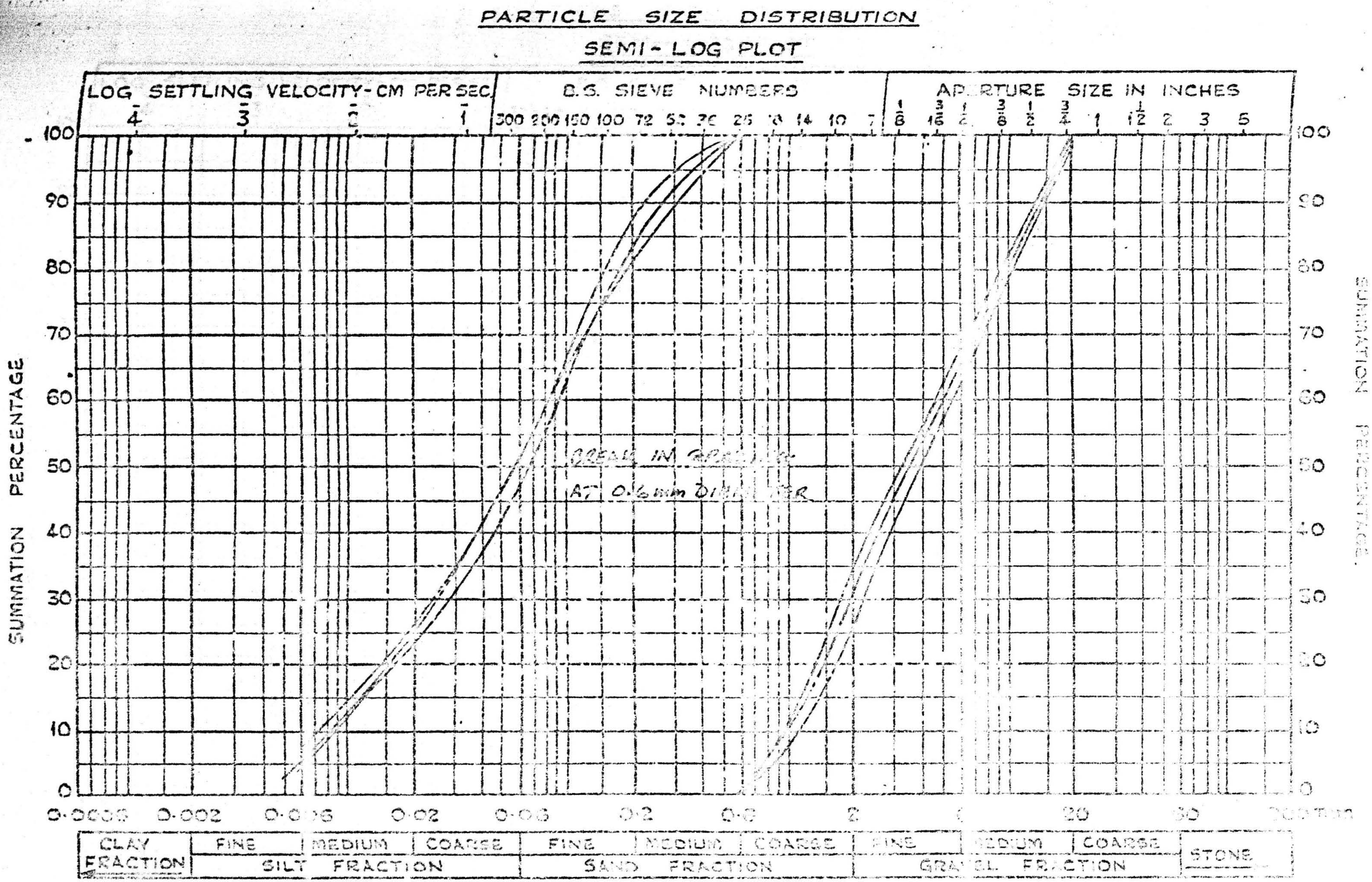


FIG. 5.24 SIZE FRACTION FOR STRATHLACHLAN TILL

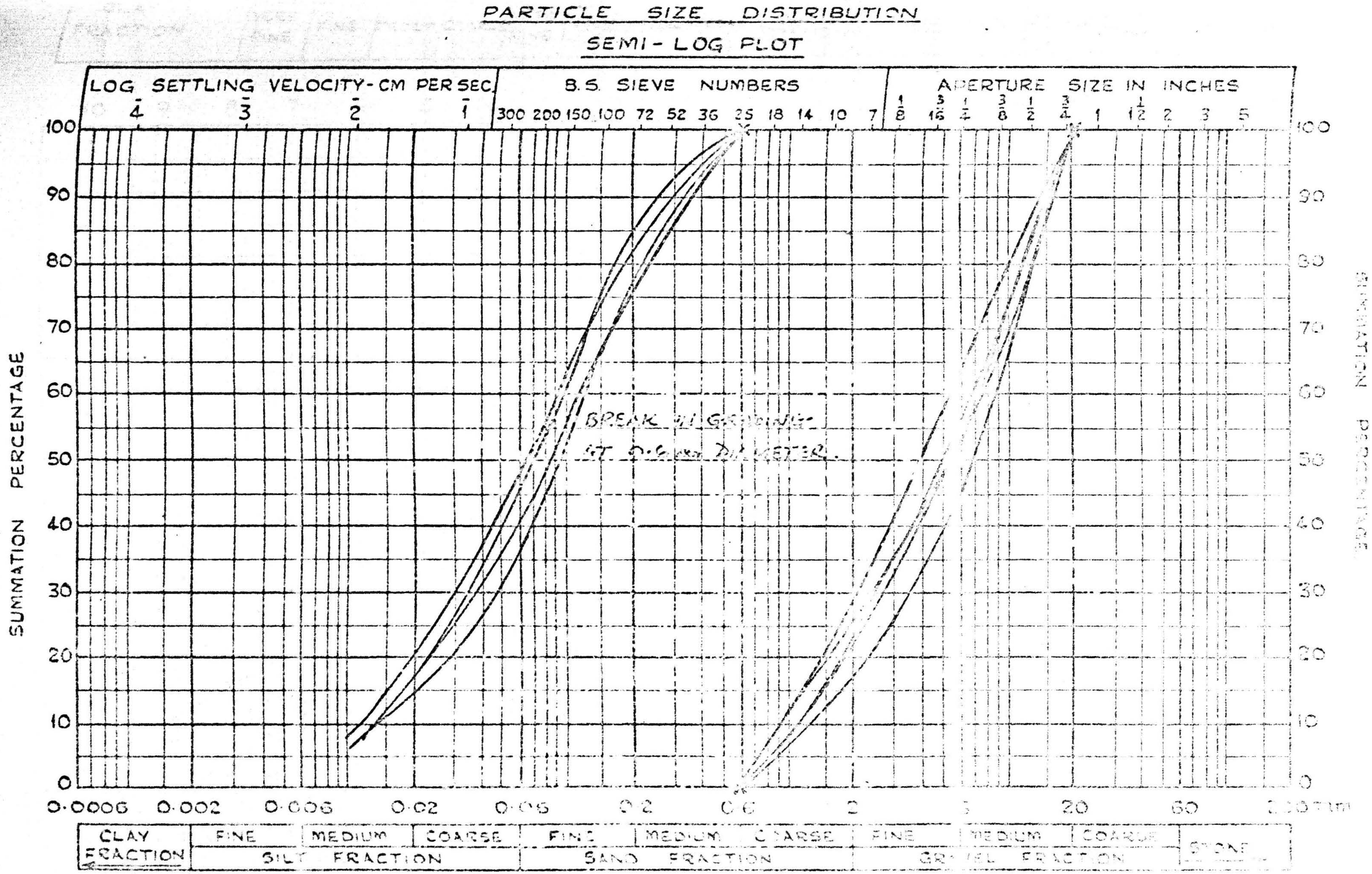


FIG. 5·25. SIZE FRACTIONS FOR DUNNING TILL.

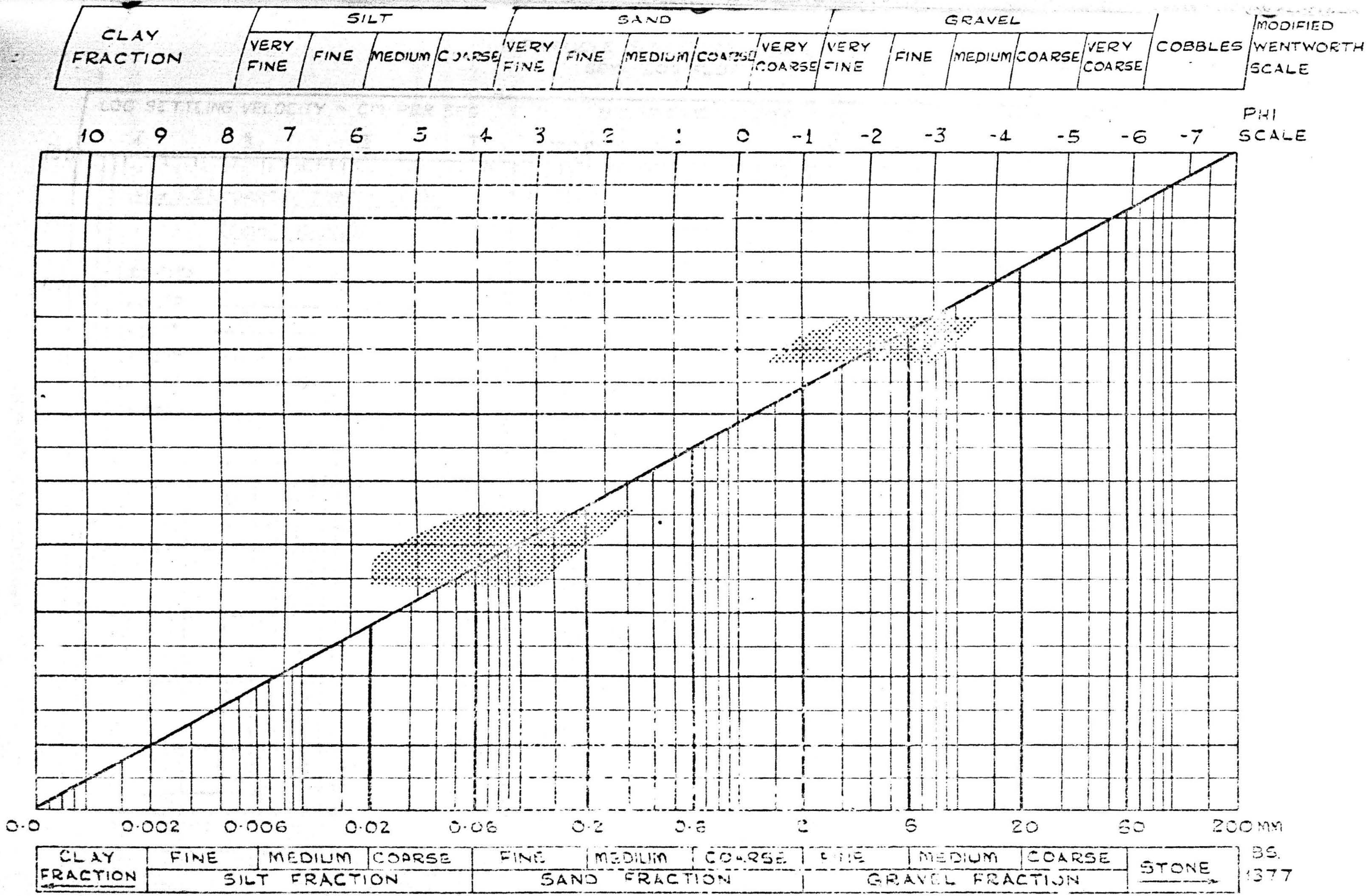
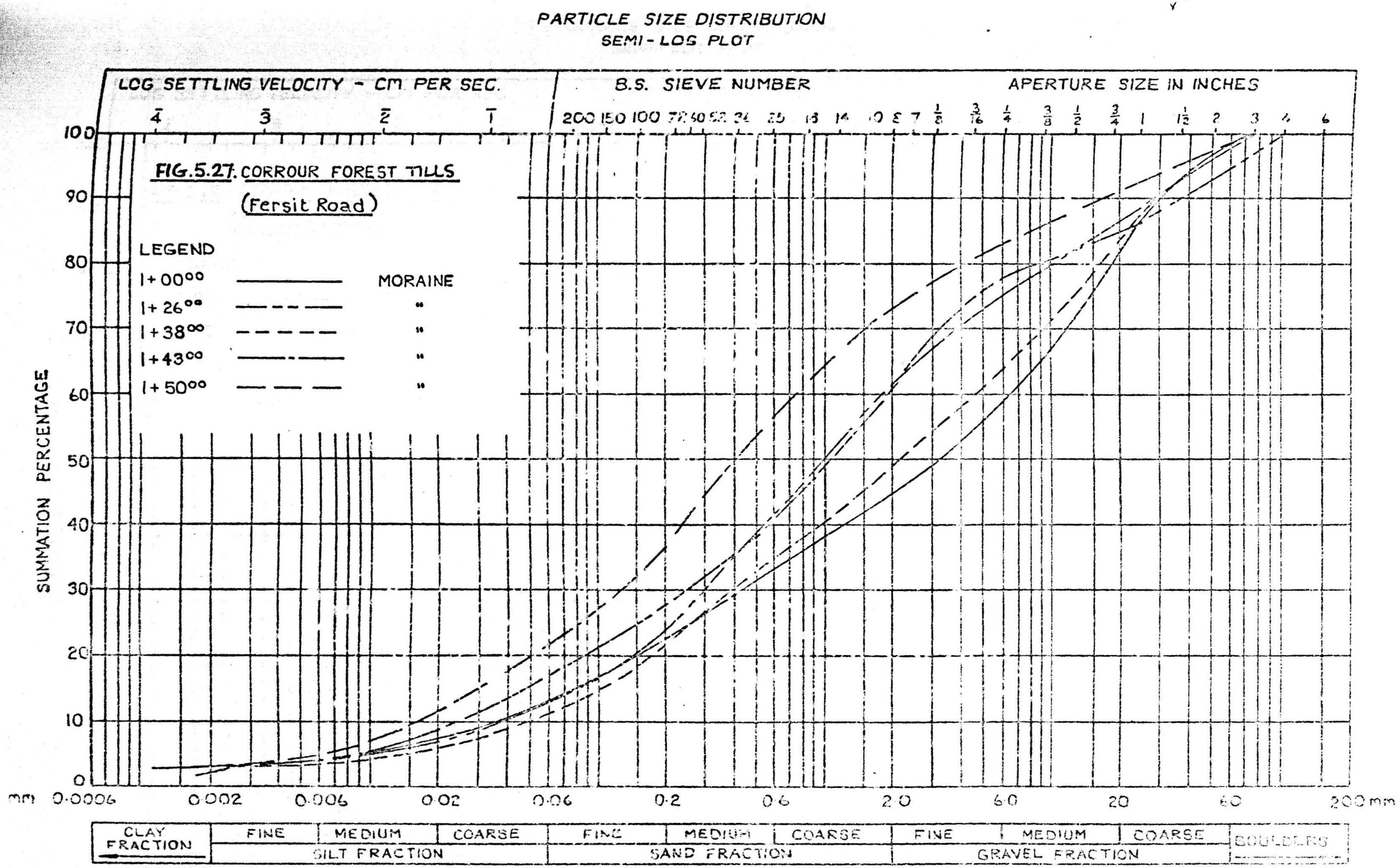
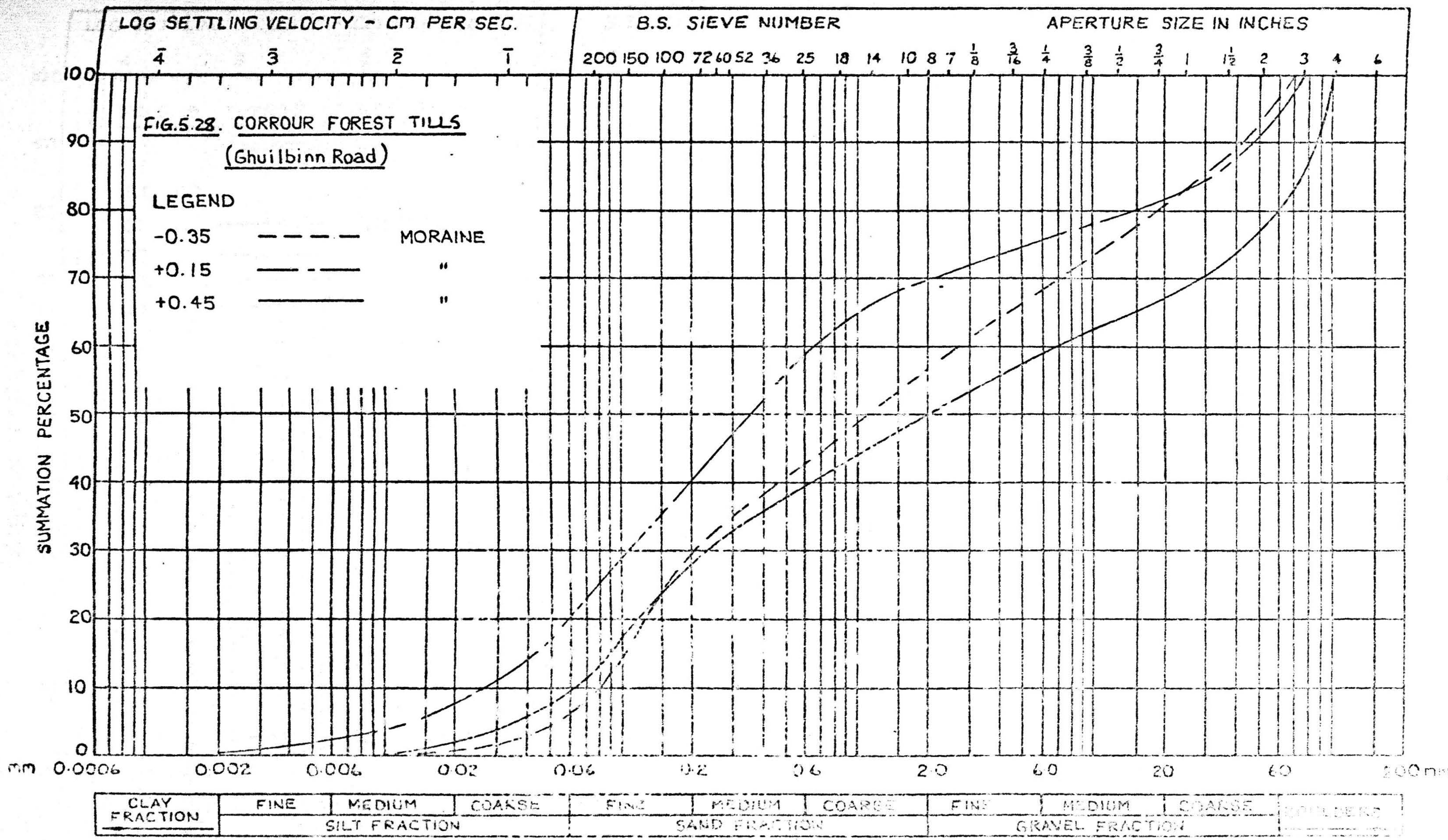


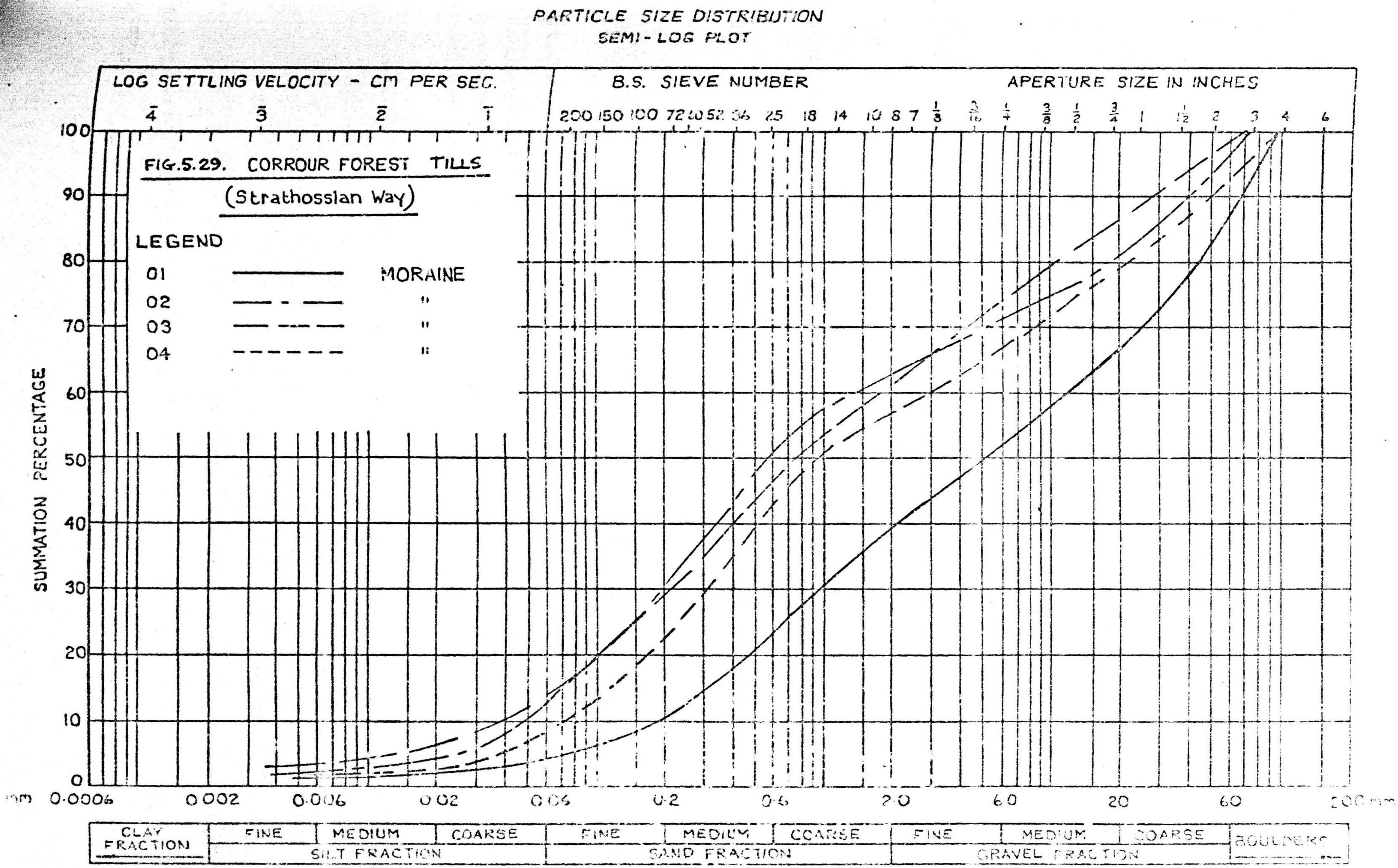
FIG. 5.26. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR COWAL SOILS.



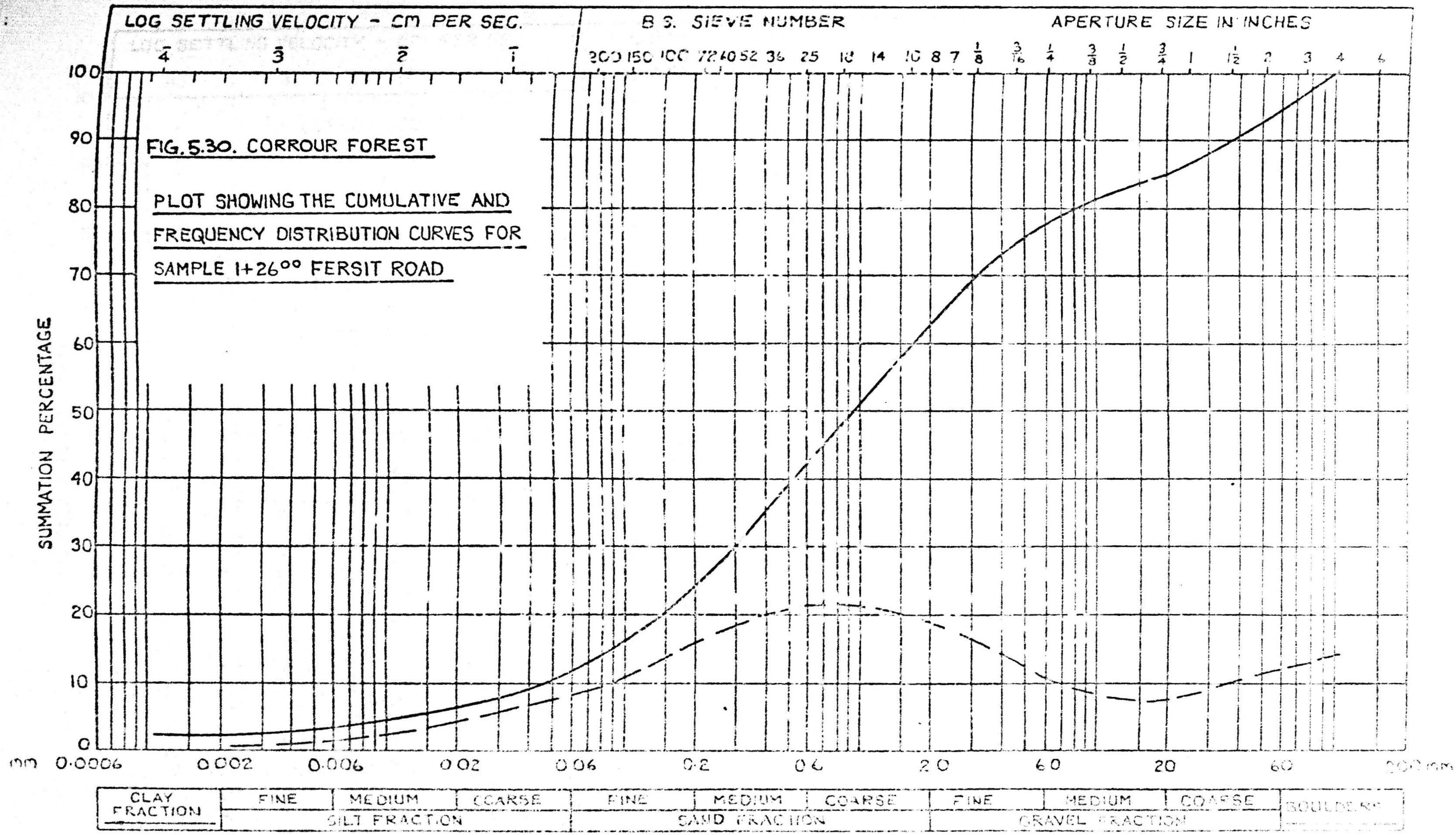
PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT
LOG SETTLING VELOCITY - CM PER SEC.
B.S. SIEVE NUMBER
APERTURE SIZE IN INCHES
FIG. 5.27. CORROUR FOREST TILLS
(Fersit Road)
LEGEND
1+00⁰⁰ MORAINE
1+26⁰⁰ "
1+38⁰⁰ "
1+43⁰⁰ "
1+50⁰⁰ "
SUMMATION PERCENTAGE
CLAY FRACTION
FINE
MEDIUM
COARSE
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION
BOULDERS

PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT




PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT
LOG SETTLING VELOCITY - CM PER SEC.
B.S. SIEVE NUMBER
APERTURE SIZE IN INCHES
FIG. 5.29. CORROUR FOREST TILLS
(Strathossian Way)
LEGEND
01 MORAINE
02 "
03 "
04 "
SUMMATION PERCENTAGE
CLAY FRACTION
FINE
MEDIUM
COARSE
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION
BOULDERS

PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT



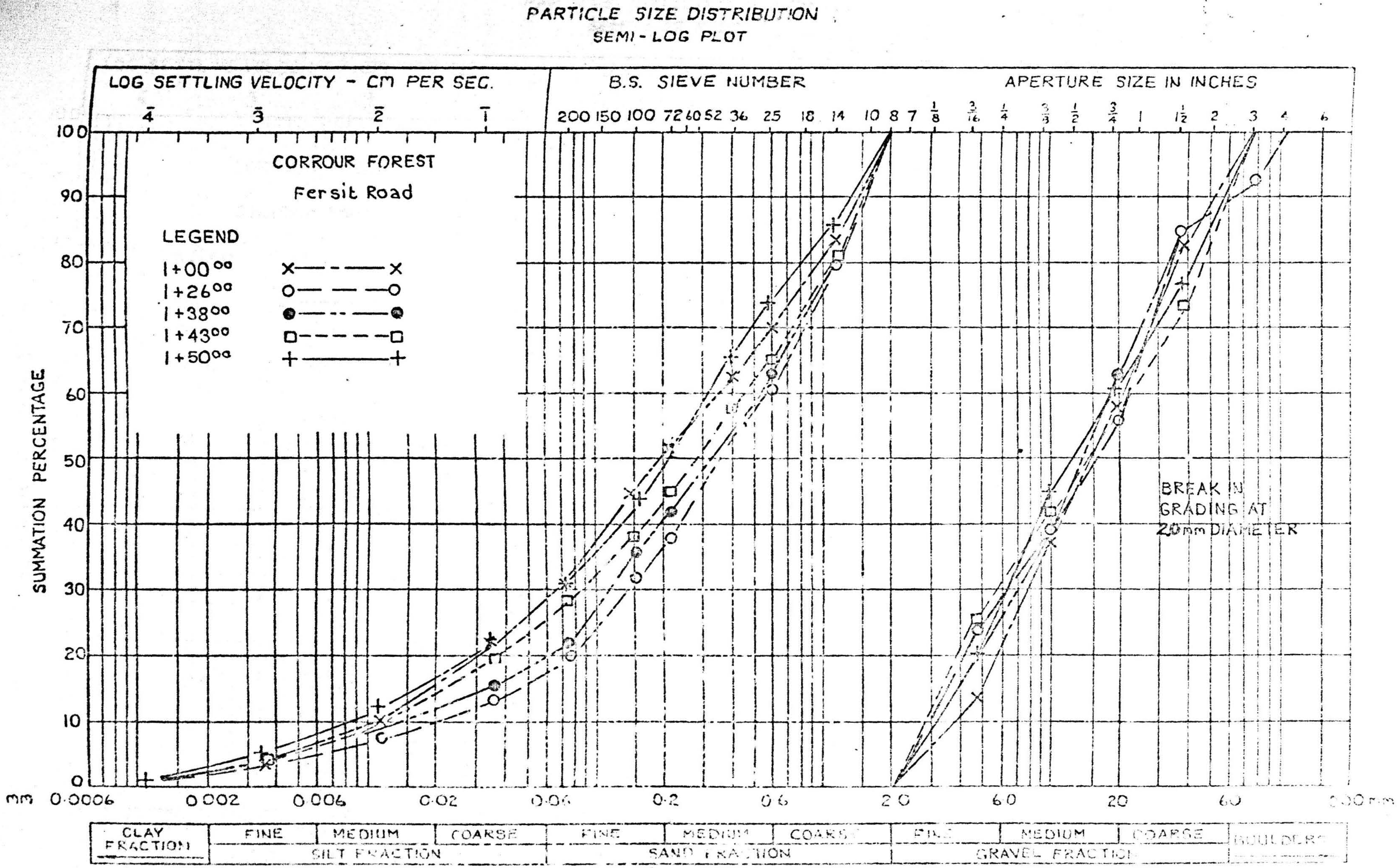


FIG. 5.31 SIZE FRACTIONS FOR CORROUR TILLS (FERSIT ROAD)

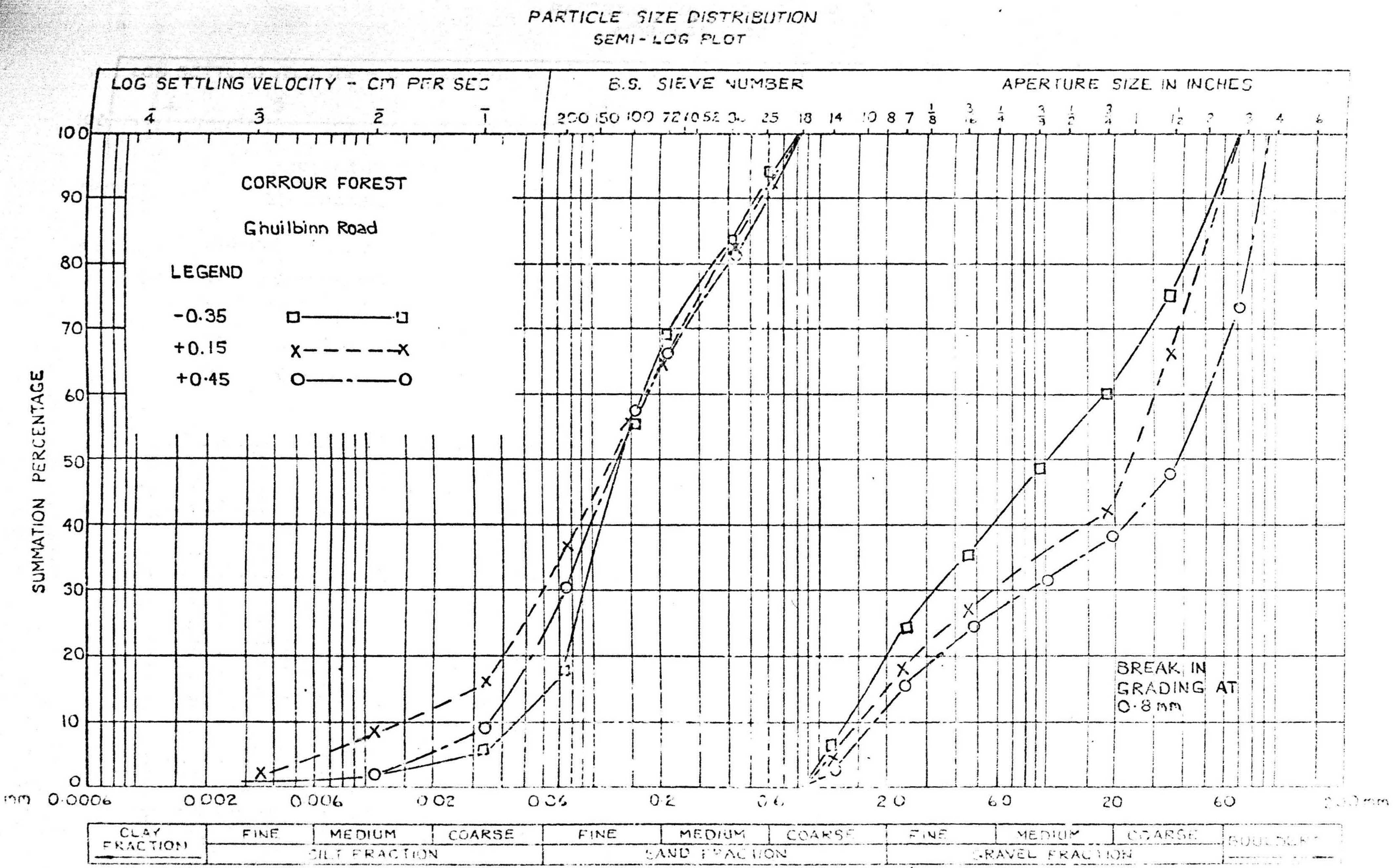


FIG. 5.32 SIZE FRACTIONS FOR CORROUR TILL (Ghuilbinn ROAD)

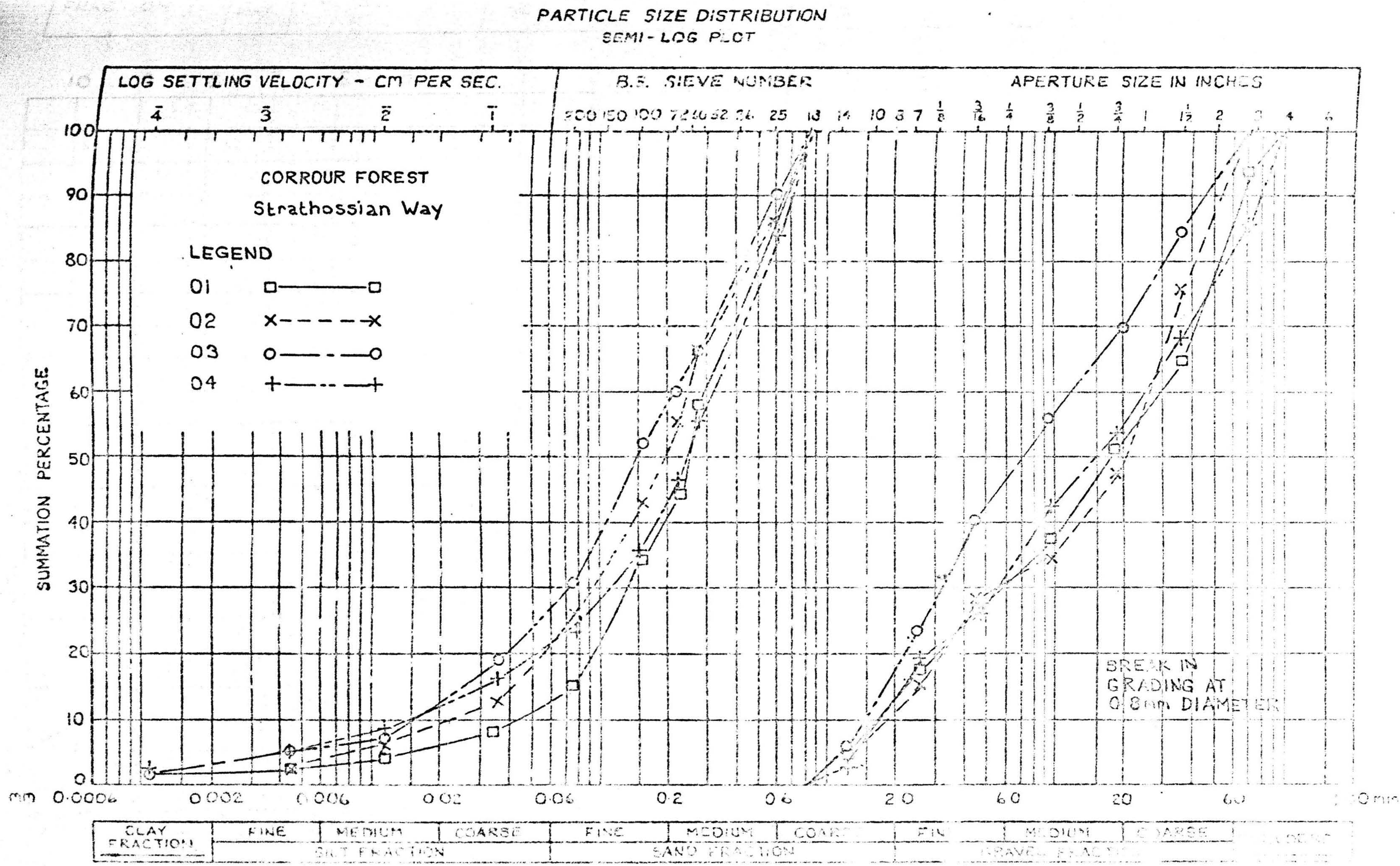


FIG 5.33. SIZE FRACTIONS FOR CORROUR TILL (STRATHOSSIAN WAY).

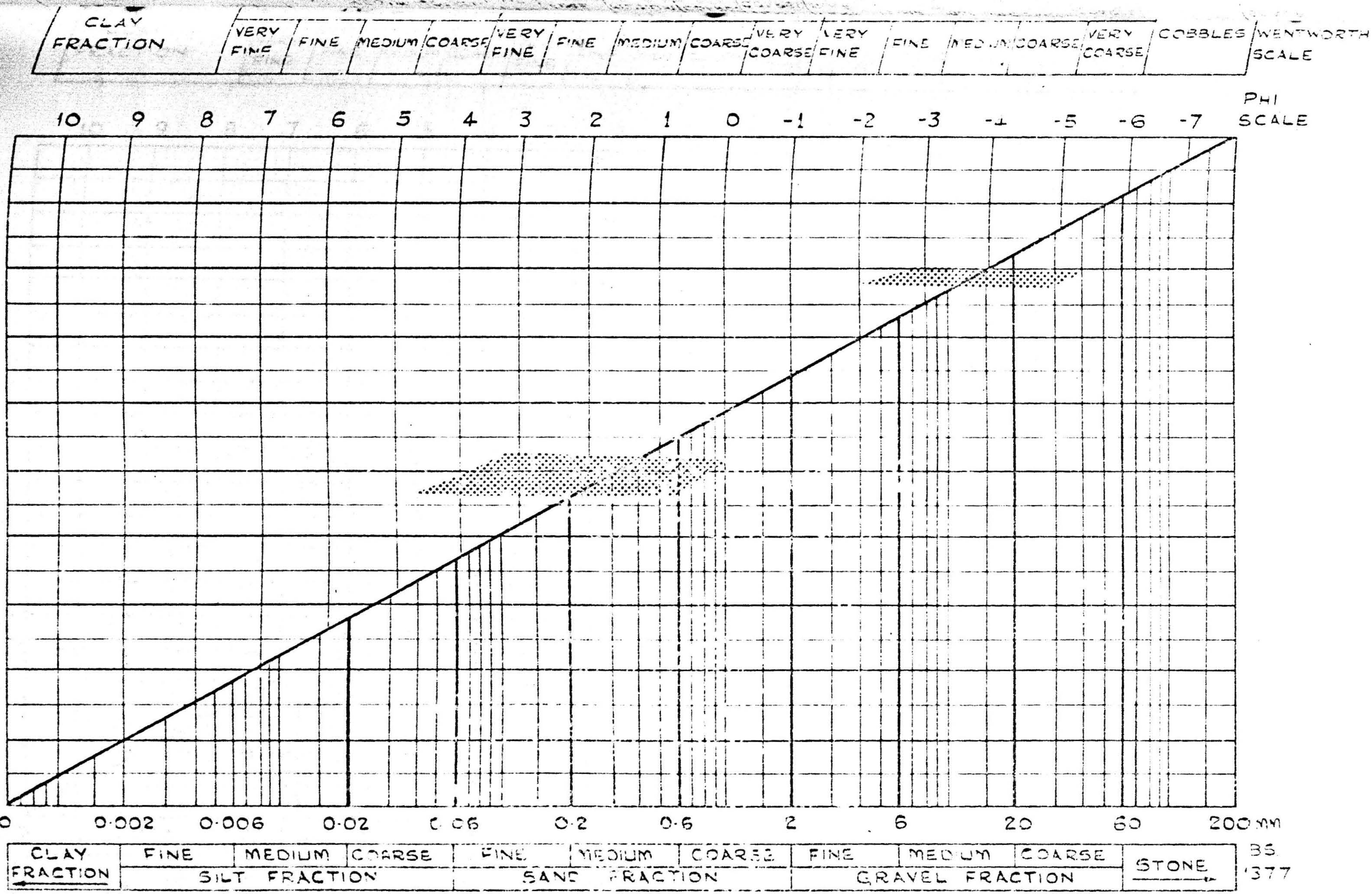


FIG.5.34. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR CORROUR TILLS (FERSIT ROAD)

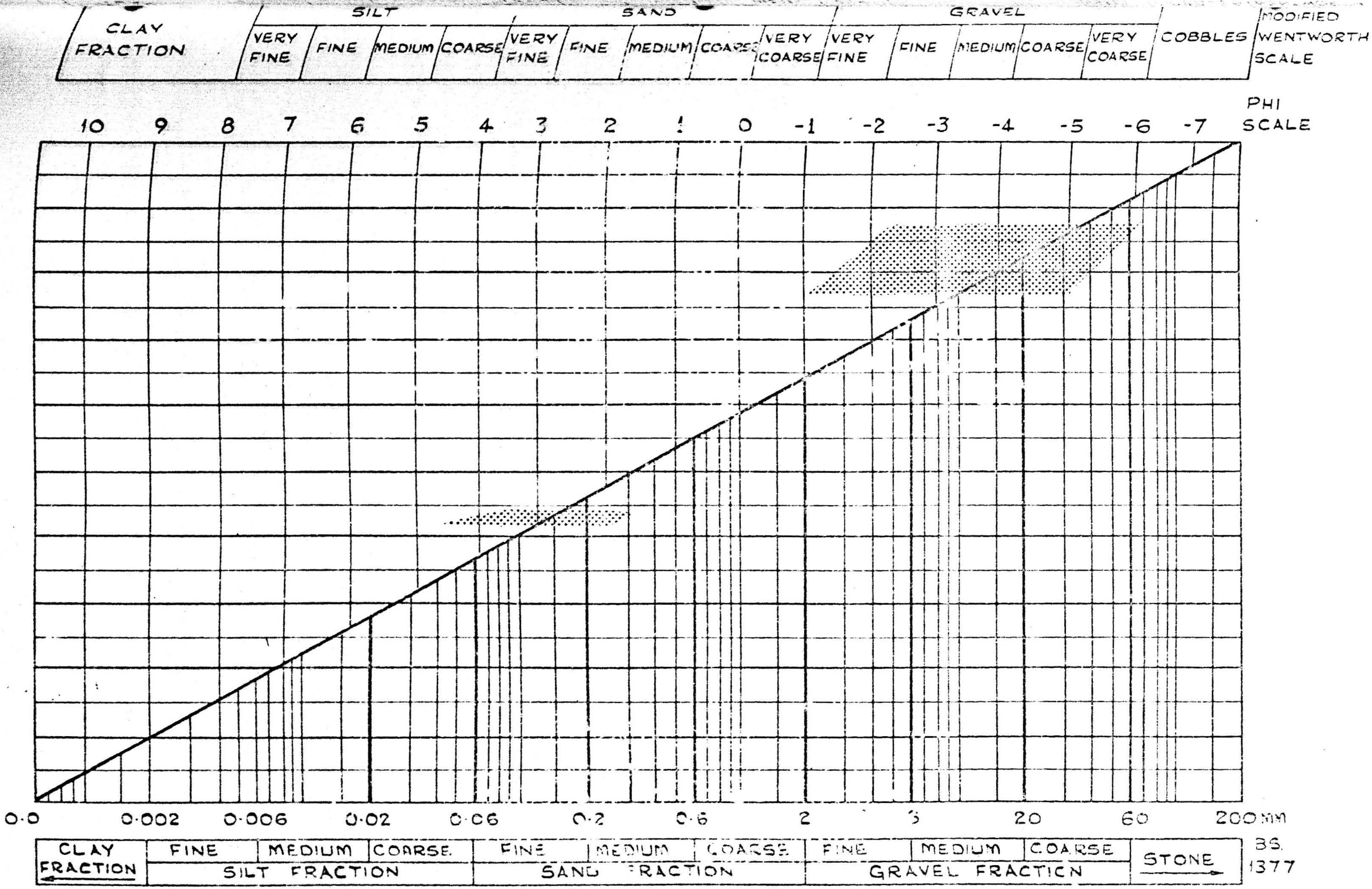


FIG. 5.35. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR GHUILBINN ROAD, CORROUR.

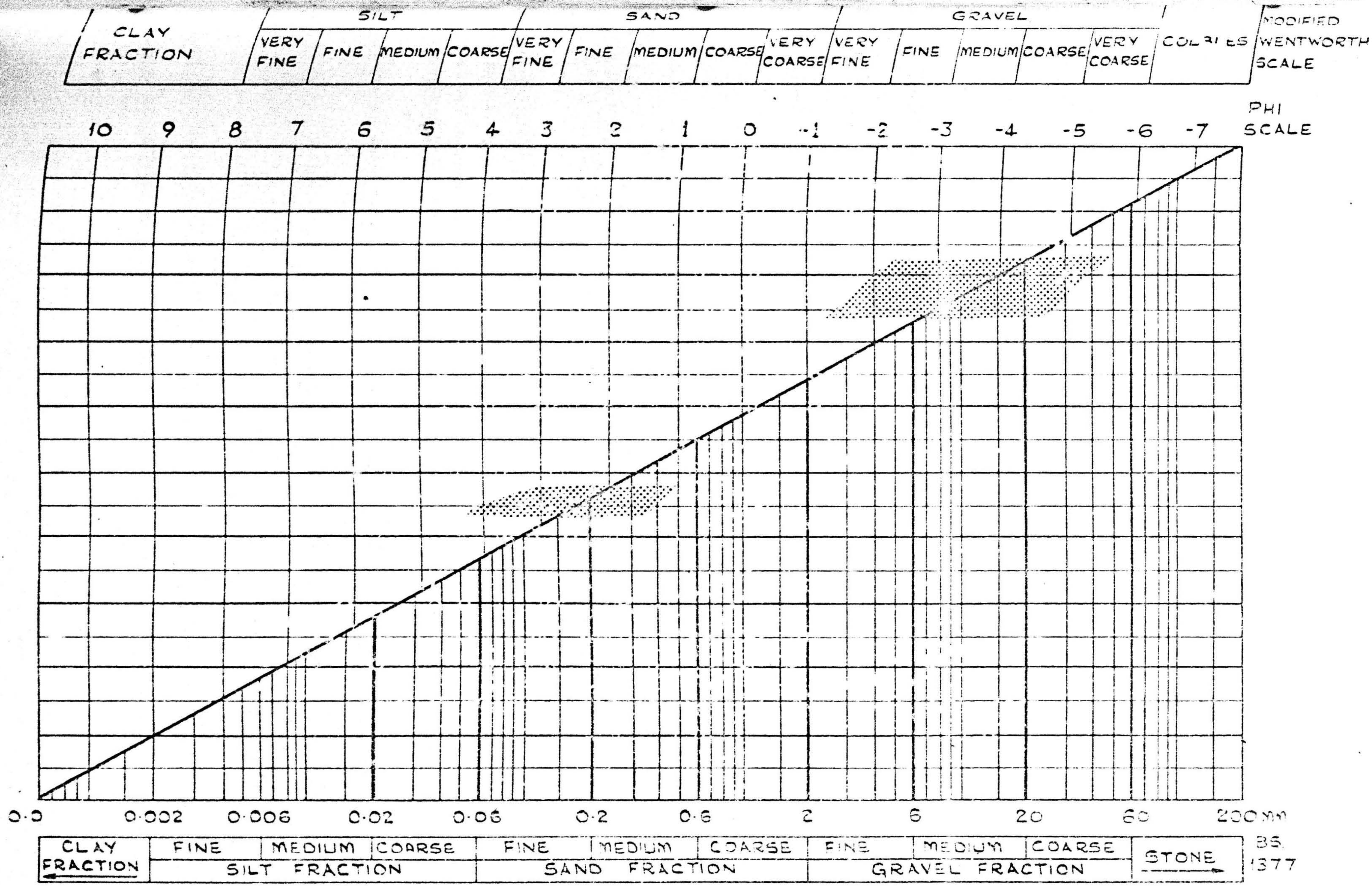
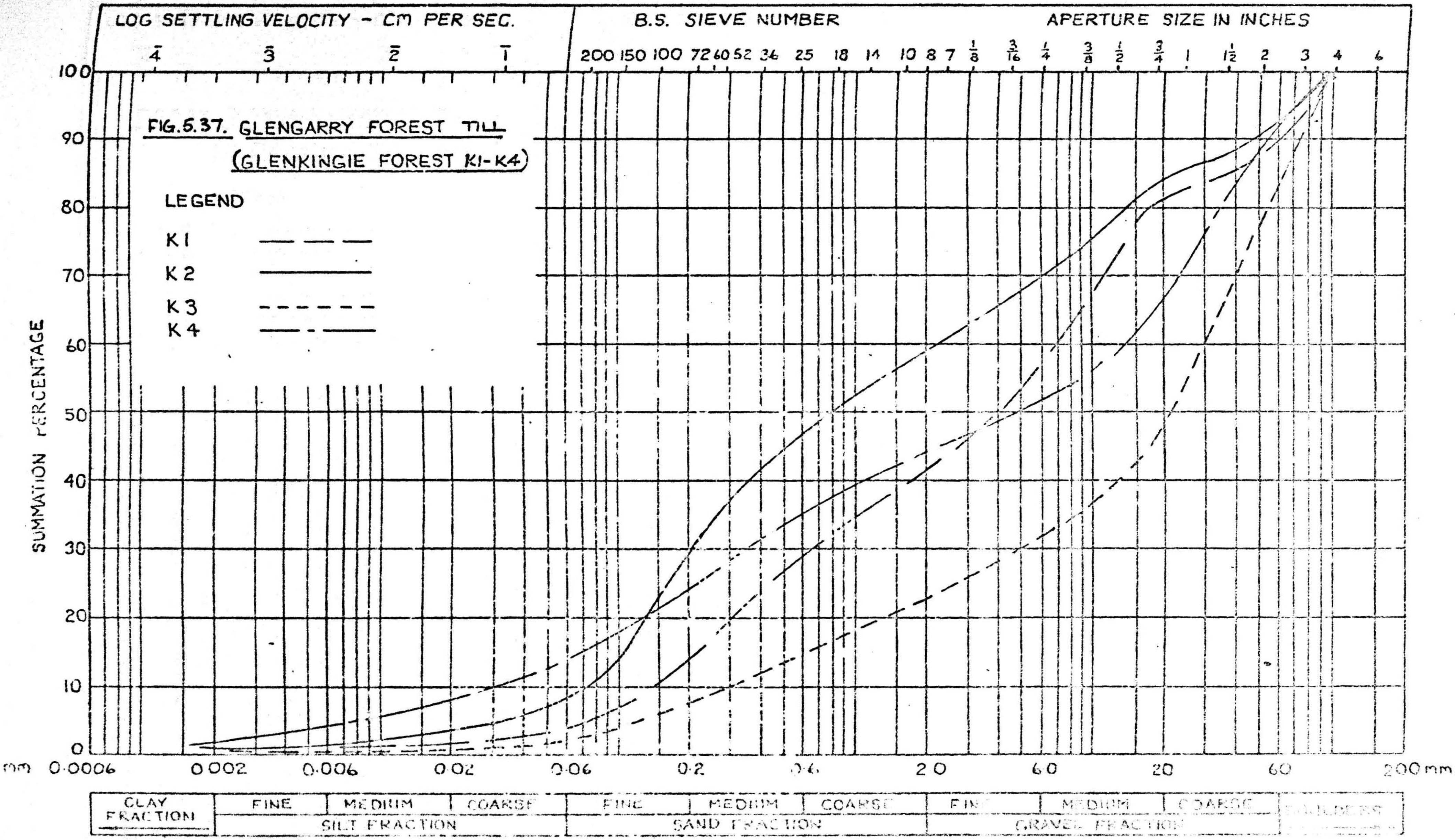
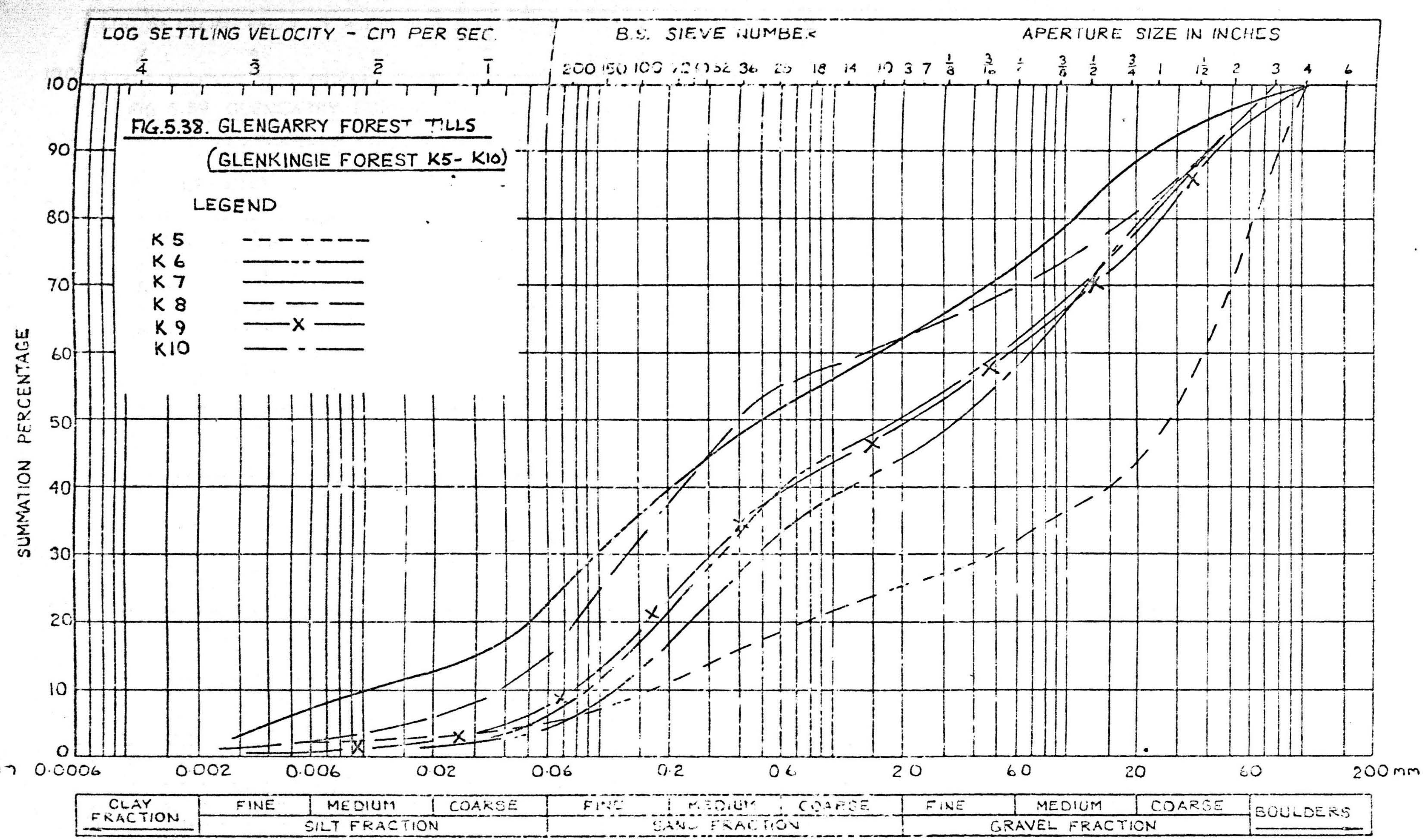


FIG. 5.36. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR CORROUR FOREST (STRATHOSSIAN WAY)

PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT



PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT



PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT

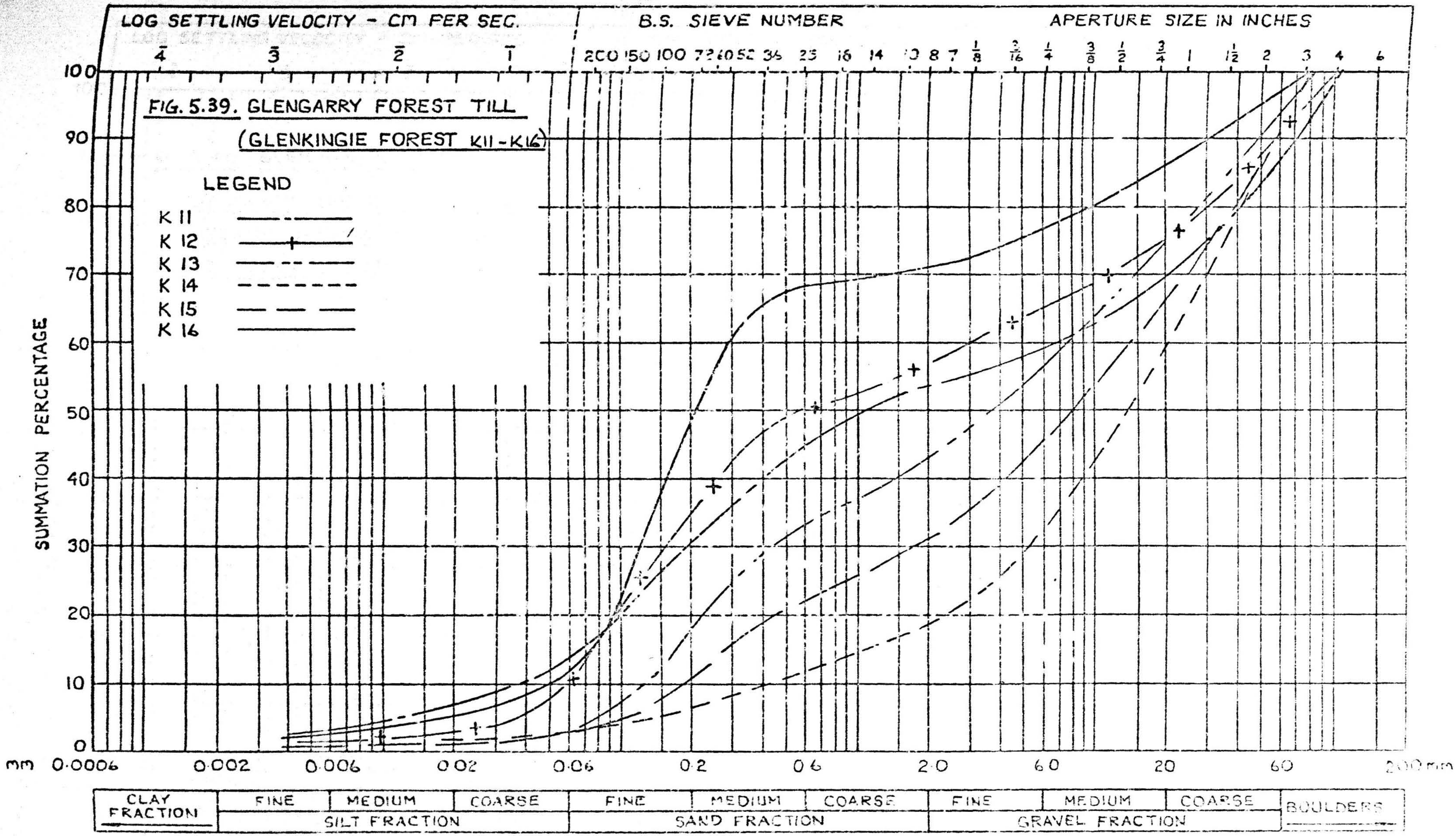
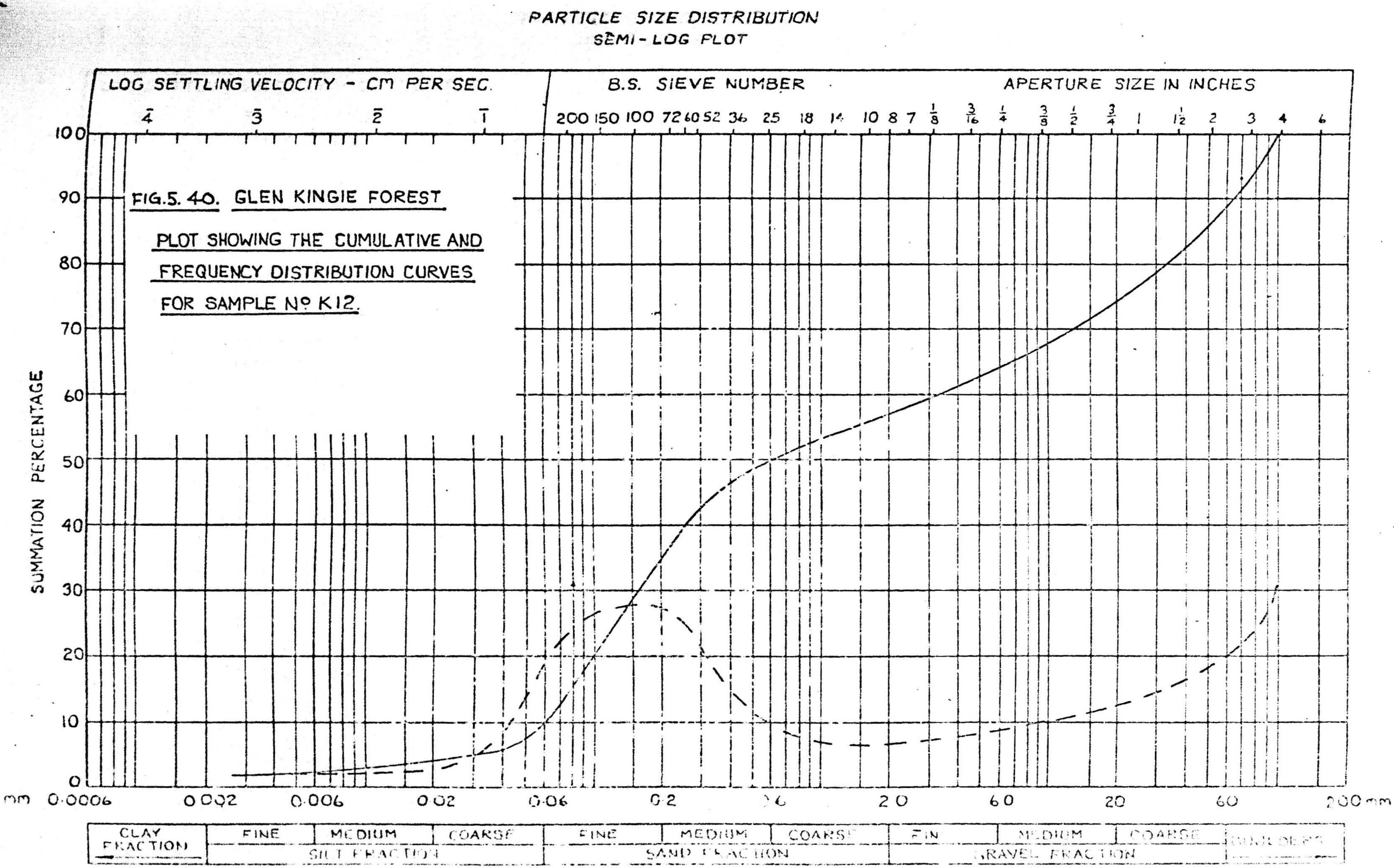


FIG. 5.39. GLENGARRY FOREST TILL
(GLENKINGIE FOREST K11-K16)



PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT
LOG SETTLING VELOCITY - cm PER SEC.
B.S. SIEVE NUMBER
APERTURE SIZE IN INCHES
SUMMATION PERCENTAGE
FIG.5. 40. GLEN KINGIE FOREST
PLOT SHOWING THE CUMULATIVE AND
FREQUENCY DISTRIBUTION CURVES
FOR SAMPLE Nº K12.
mm 0.0006
0.002
0.006
0.02
0.06
0.2
2.0
6.0
20
60
200 mm
CLAY FRACTION
FINE
MEDIUM
COARSE
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION

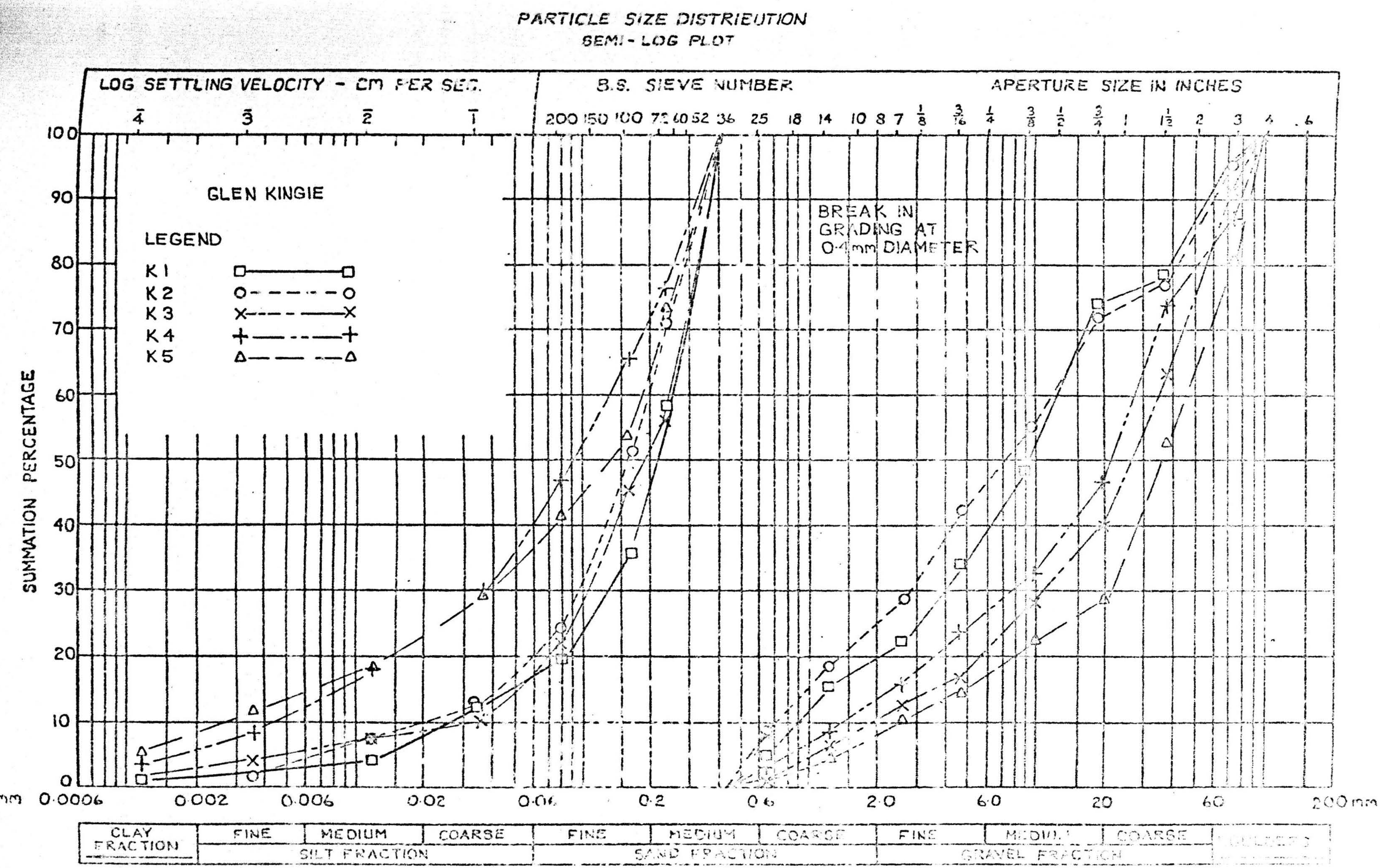


FIG 5.41 SIZE FRACTIONS FOR GLEN KINGIE TILLS K1 - K5.

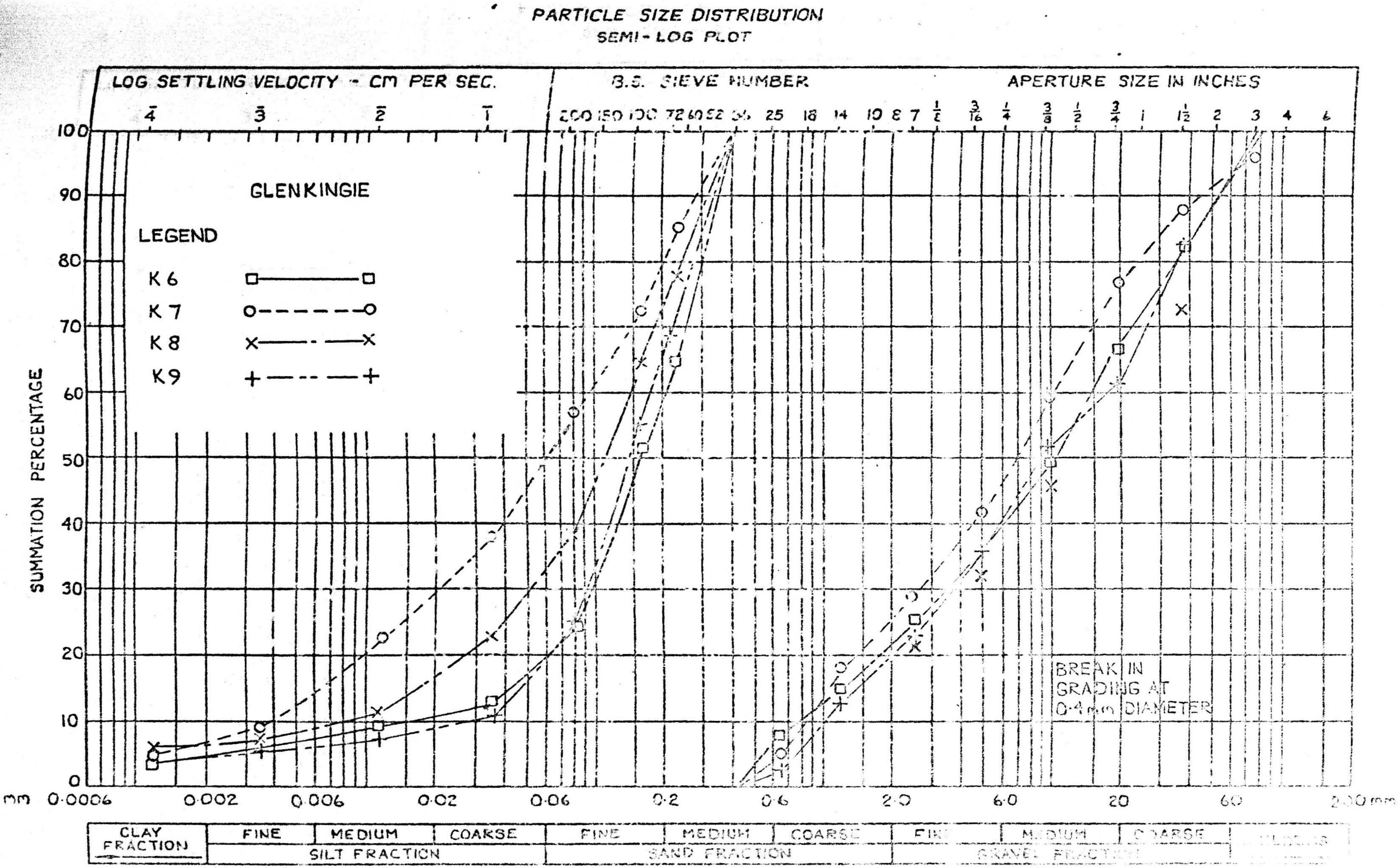


FIG. 5.42 SIZE FRACTIONS FOR GLEN KINGIE TILLS K6 - K9.

PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT

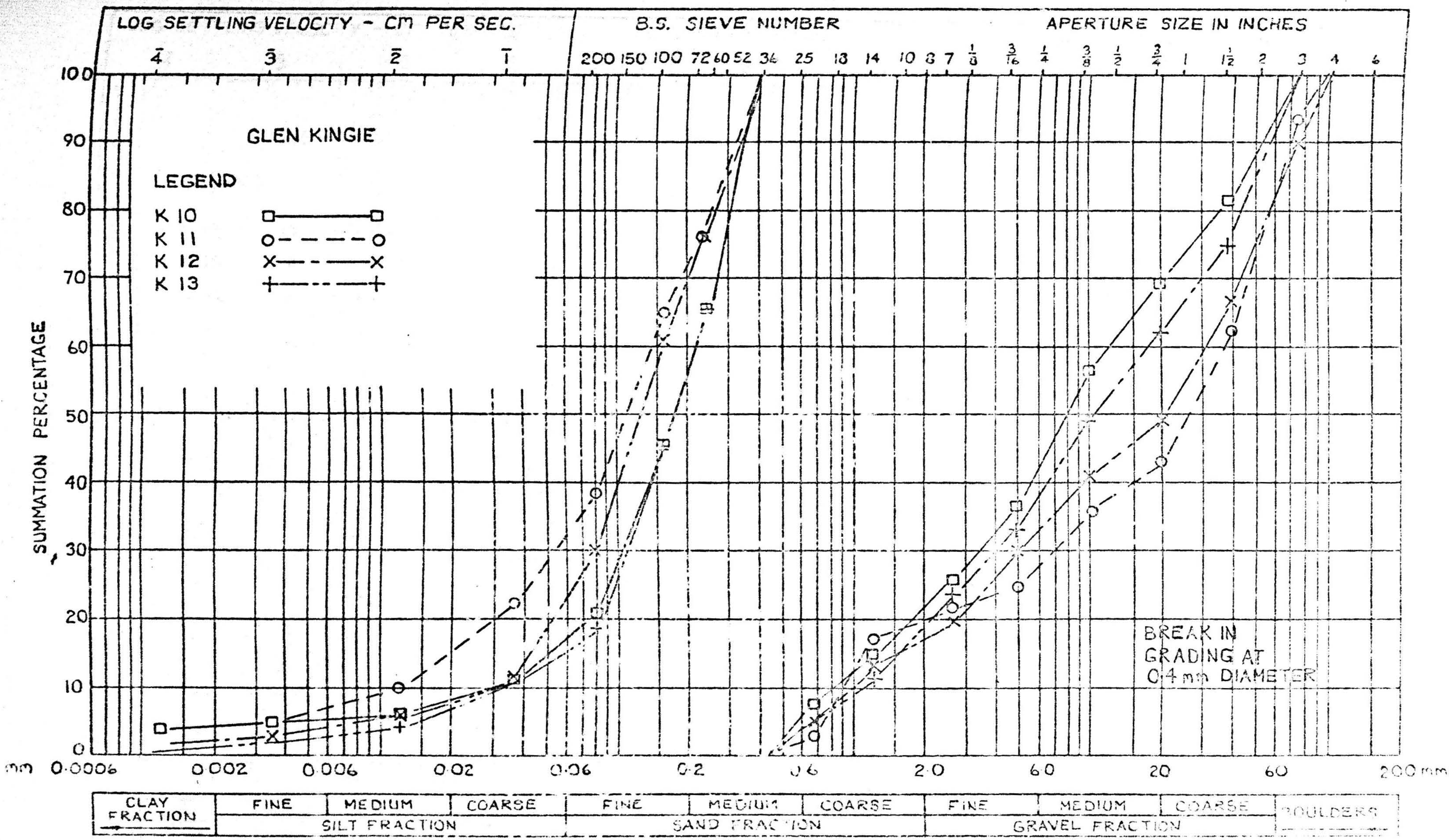


FIG 5.43 SIZE FRACTIONS FOR GLEN KINGIE TILLS K10–K13.

PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT

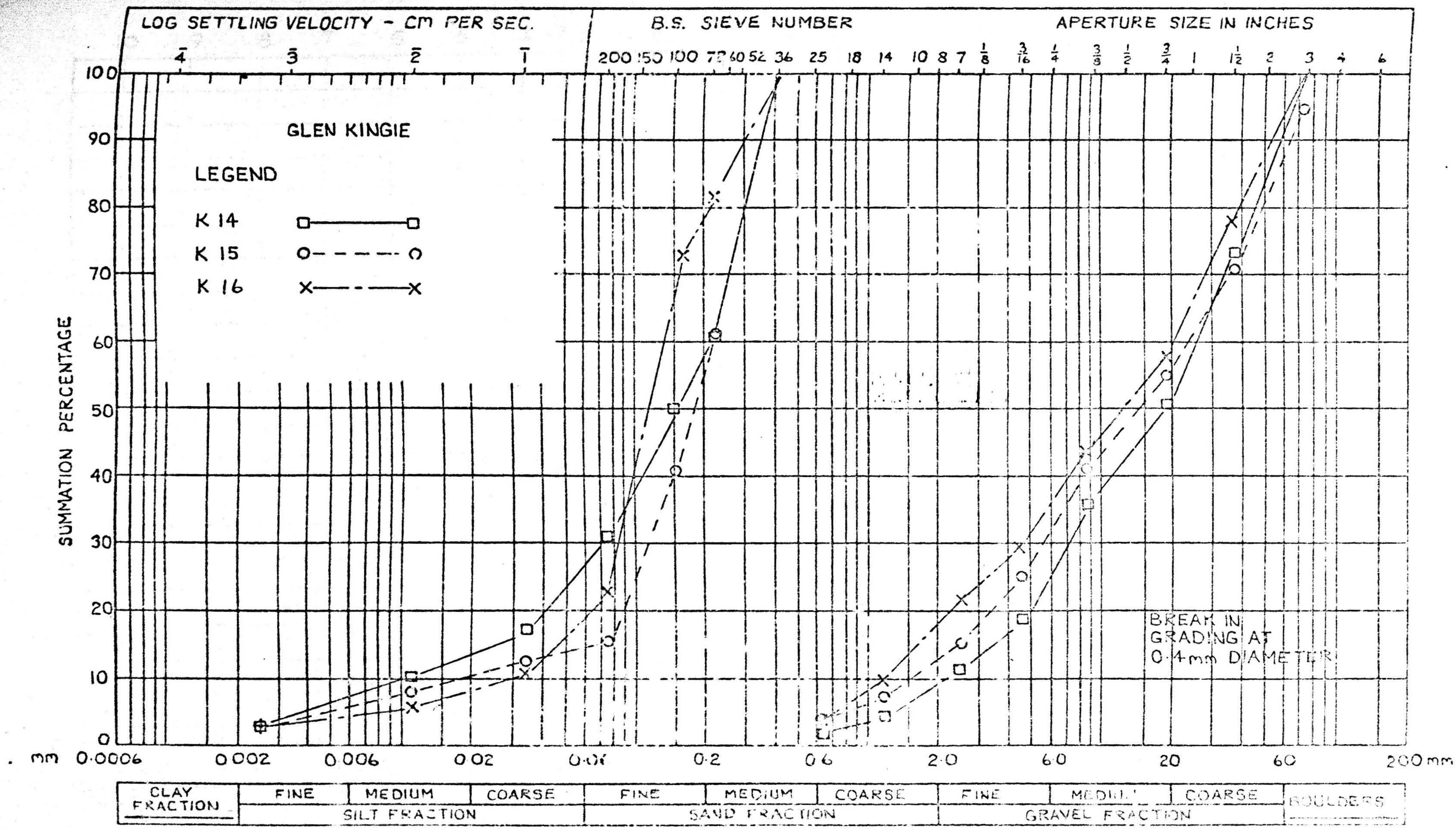


FIG. 5.44 SIZE FRACTION FOR GLEN KINGIE TILLS K14 - K16.

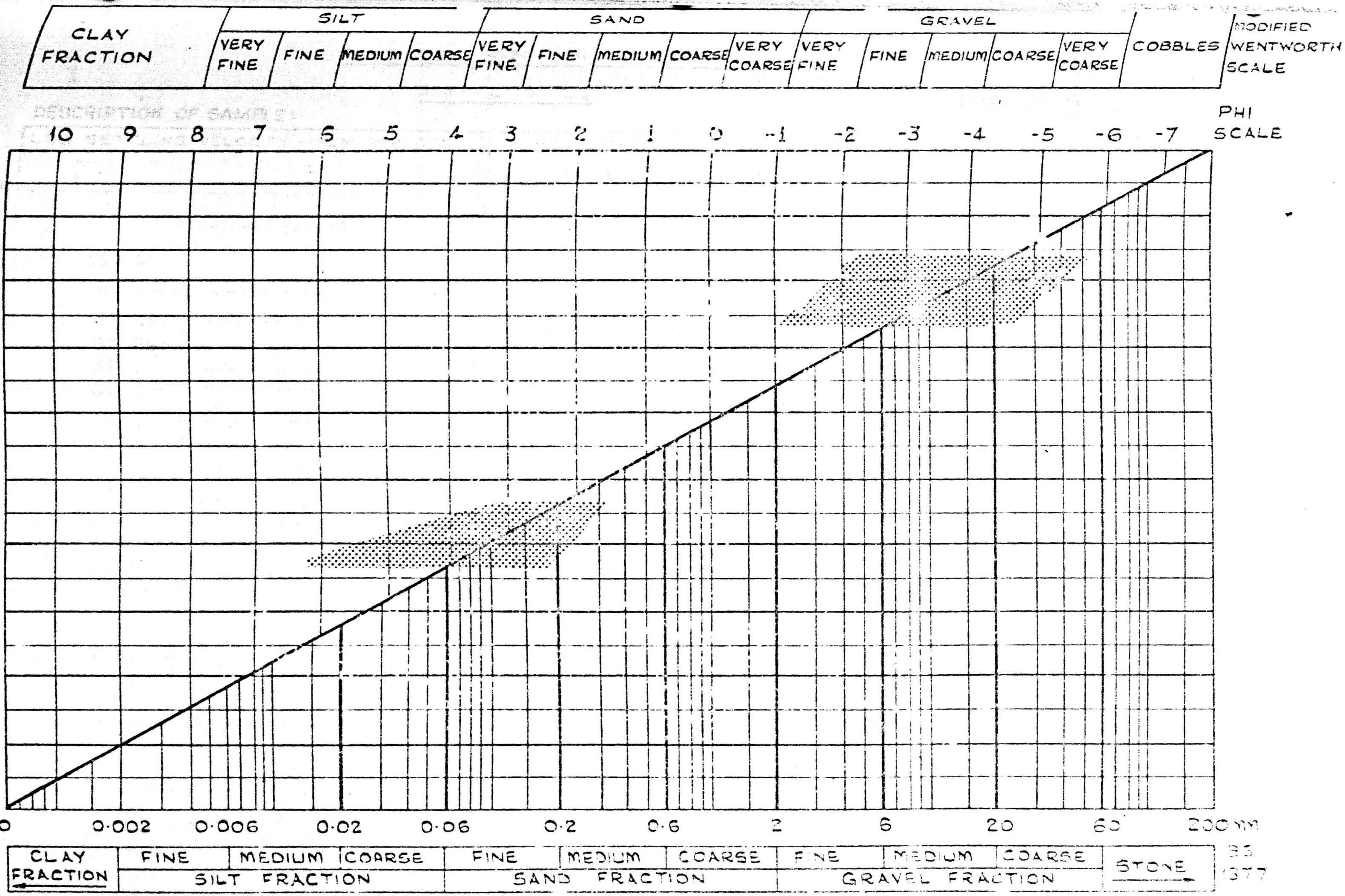


FIG.5.45. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR GLEN KINGIE TILLS.

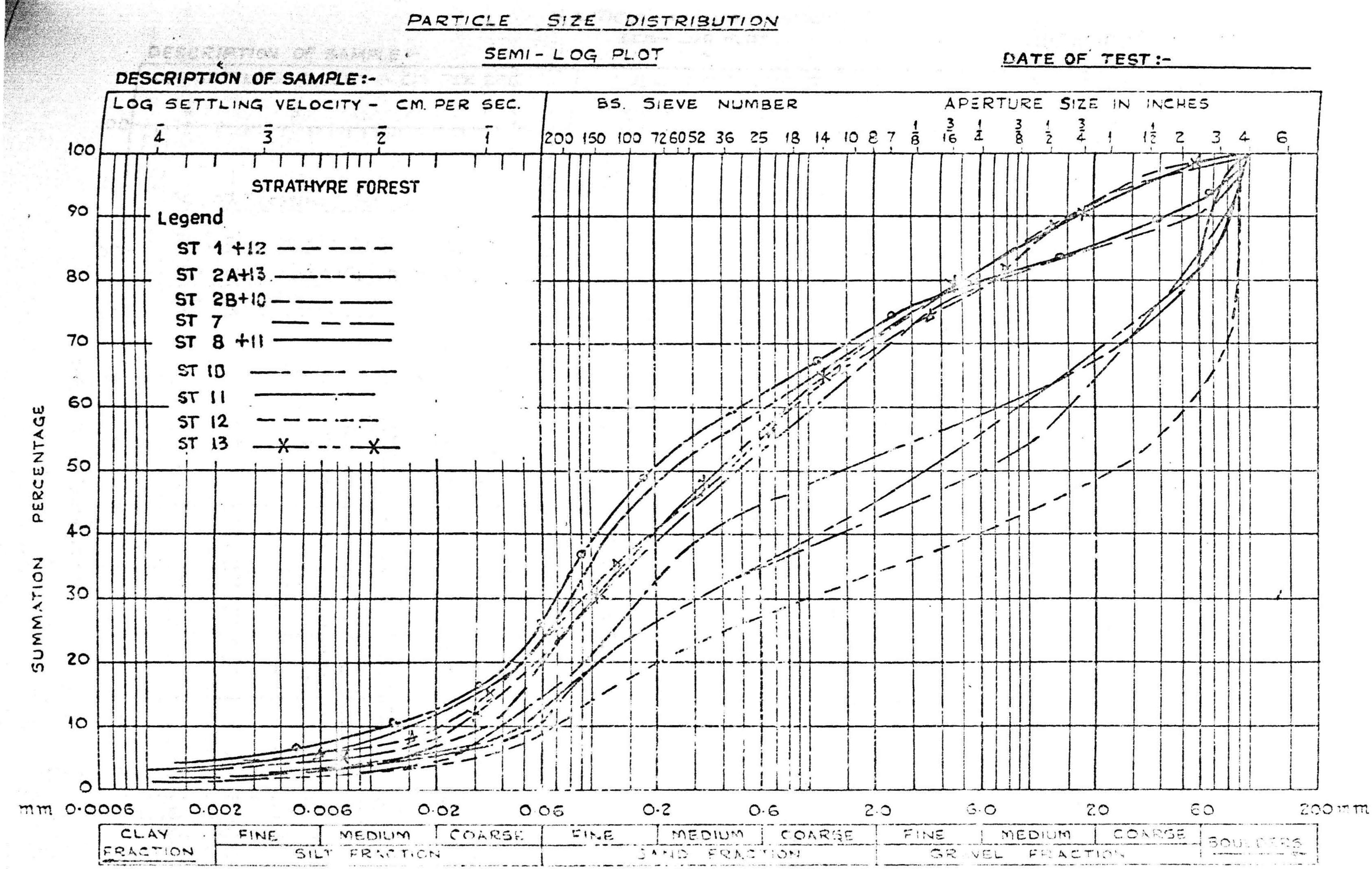
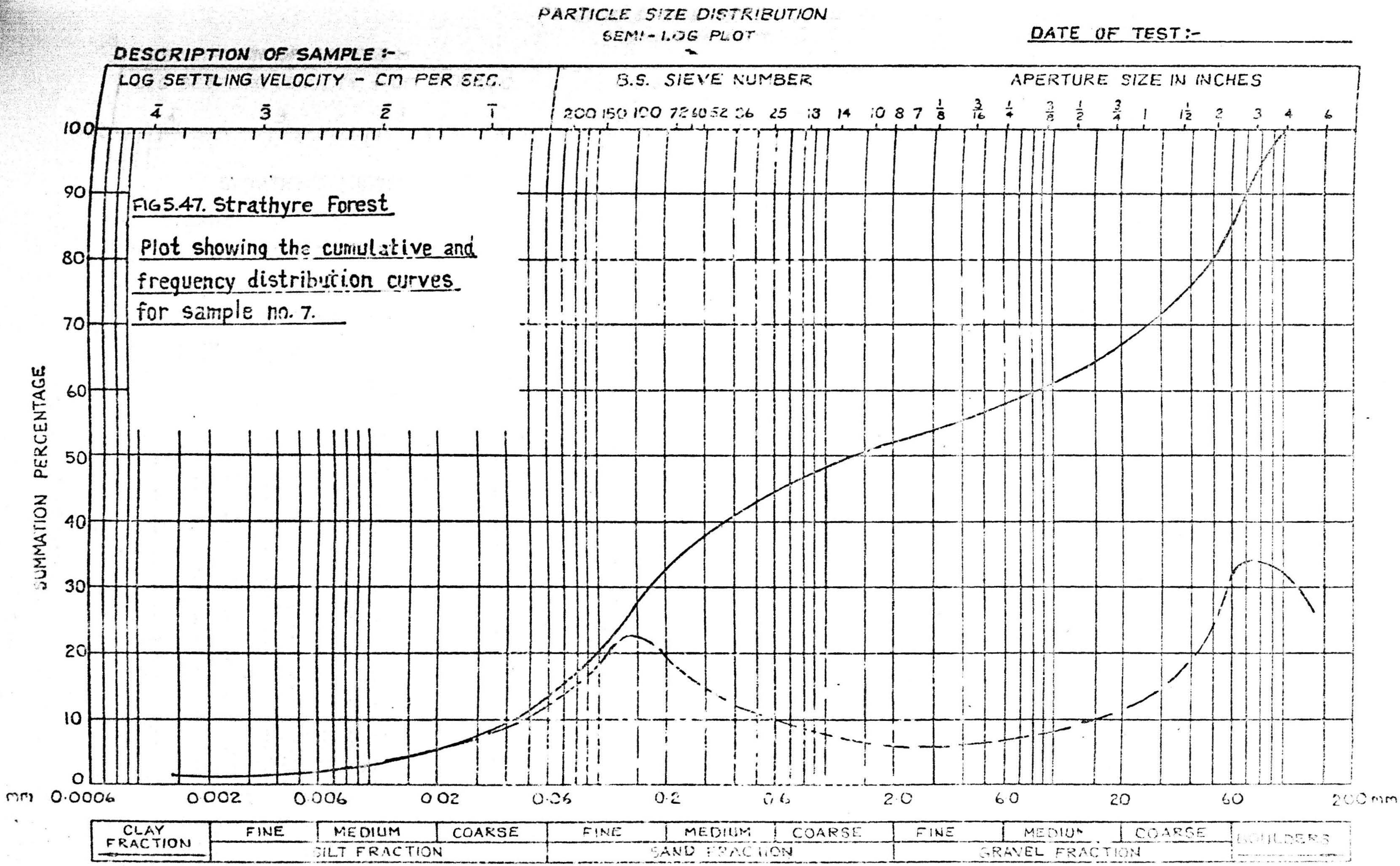


FIG. 5.46. GRADINGS for STRATHYRE TILLS


PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT
DATE OF TEST:-
DESCRIPTION OF SAMPLE:-
LOG SETTLING VELOCITY - cm PER SEC.
B.S. SIEVE NUMBER
APERTURE SIZE IN INCHES
FIG 5.47. Strathyre Forest
Plot showing the cumulative and frequency distribution curves for sample no. 7.
SUMMATION PERCENTAGE
mm 0.0006
0.002
0.006
0.02
0.06
0.2
0.6
2.0
6.0
20
60
200 mm
CLAY FRACTION
FINE
MEDIUM
COARSE
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION
BOULDERS

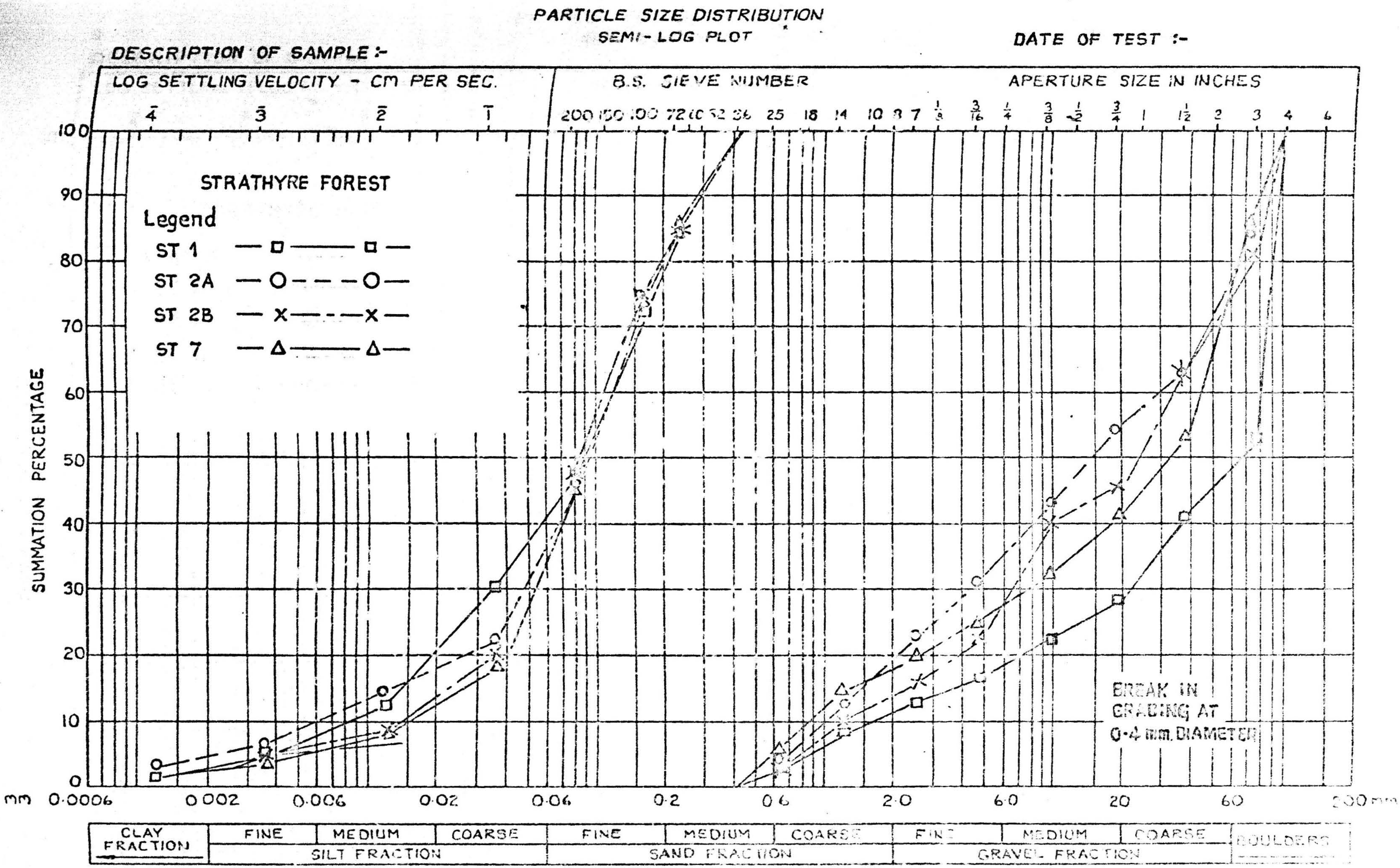


FIG. 5·48 SIZE FRACTIONS FOR STRATHYRE TILLS (ST1 – ST7)

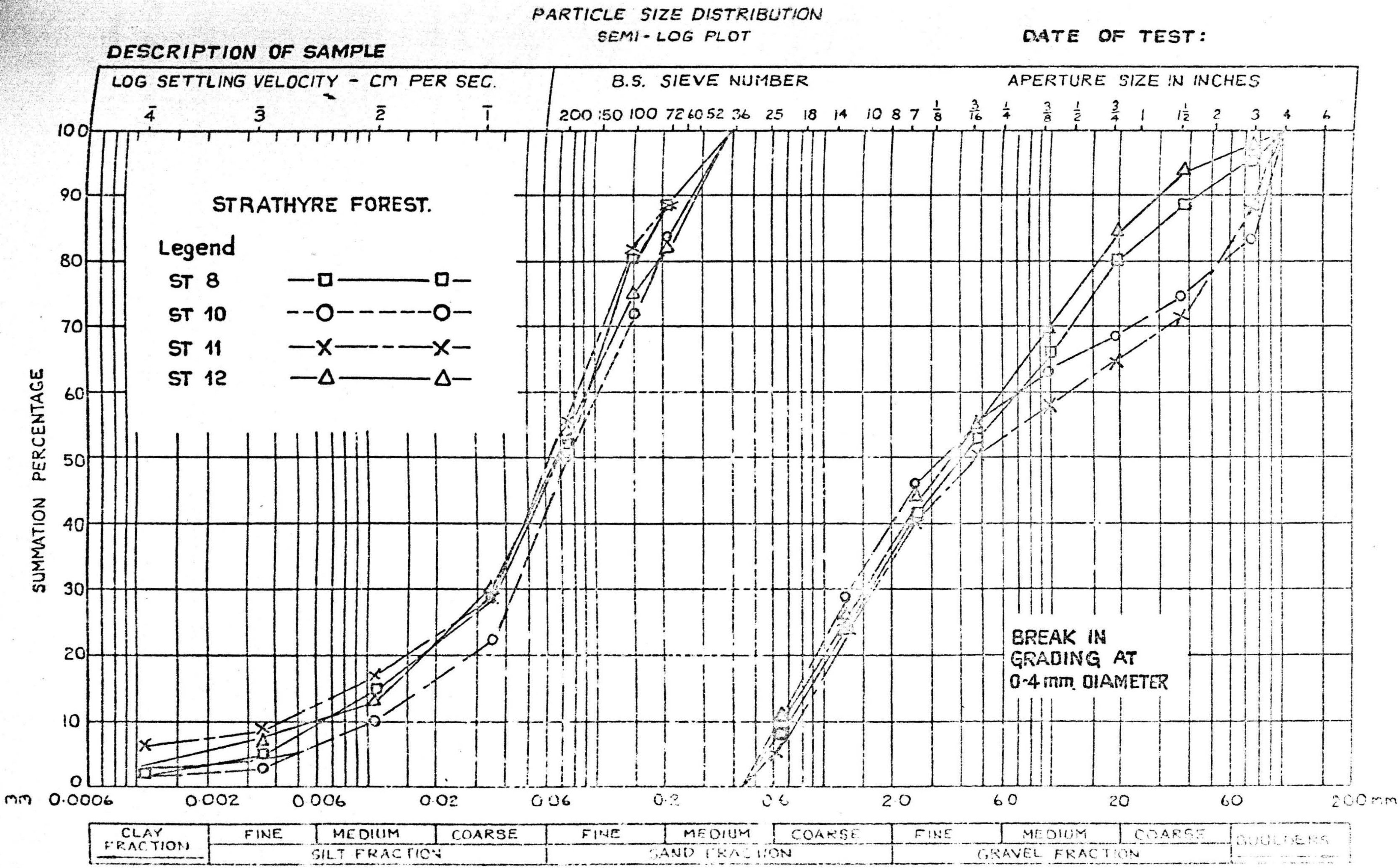


FIG. 5·49. SIZE FRACTIONS FOR STRATHYRE TILLS ST8 - ST12.

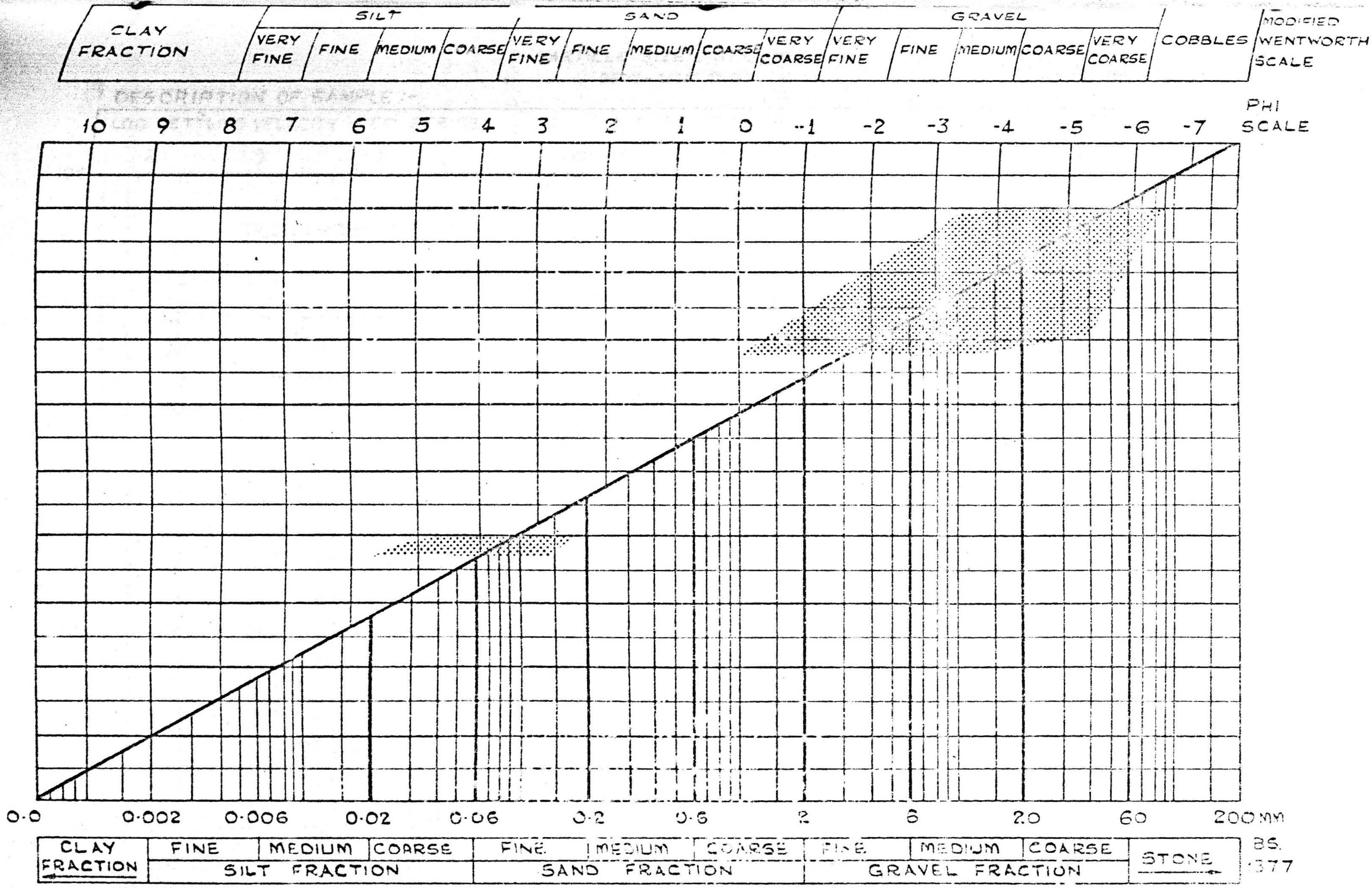


FIG. 5.50. TEXTURAL CLASSIFICATION BASED ON Q_1 M_d, Q_3 FOR STRATHYRE TILLS

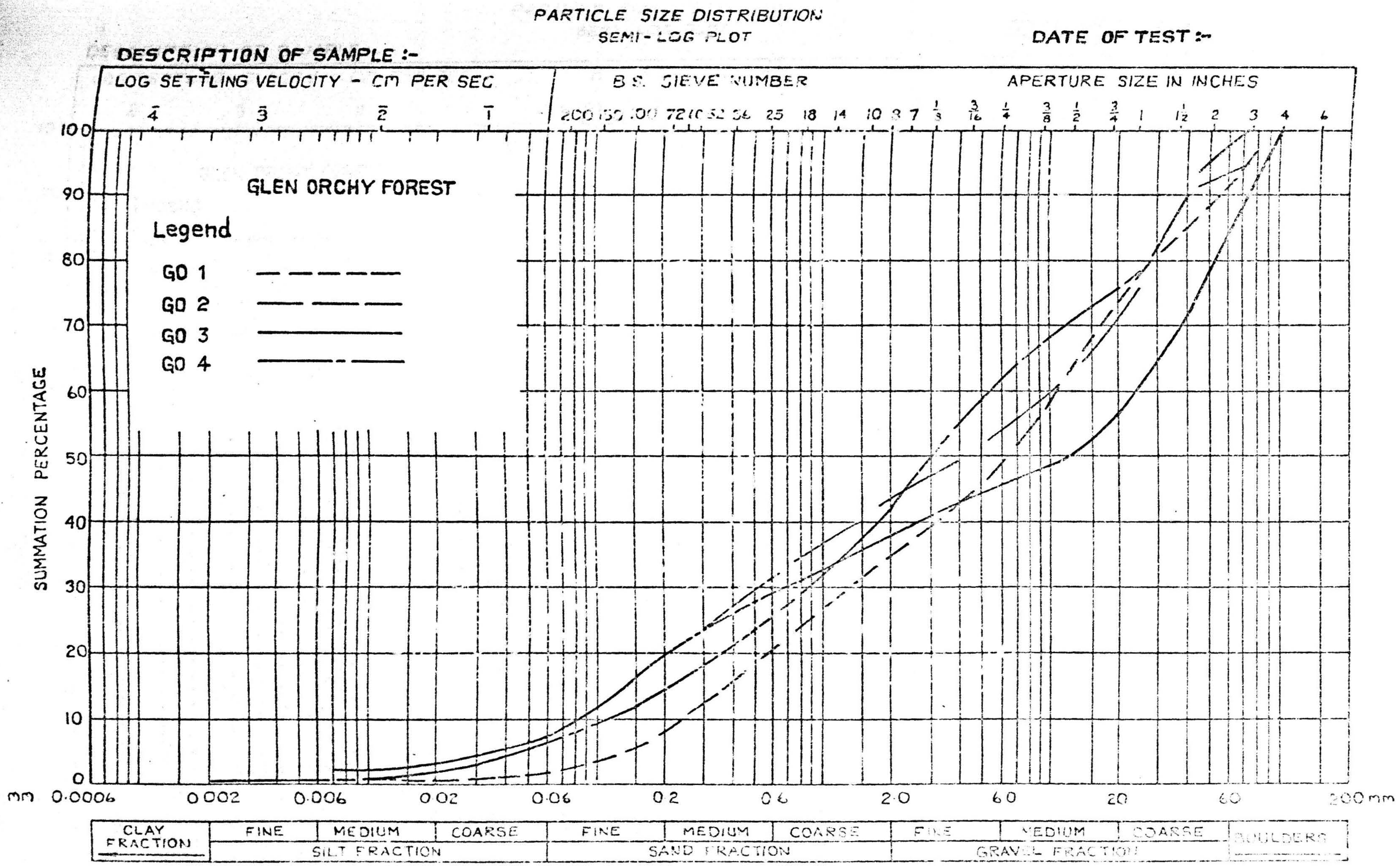


FIG. 5.51 GRADINGS FOR GLEN ORCHY TILLS GO1 – GO4.

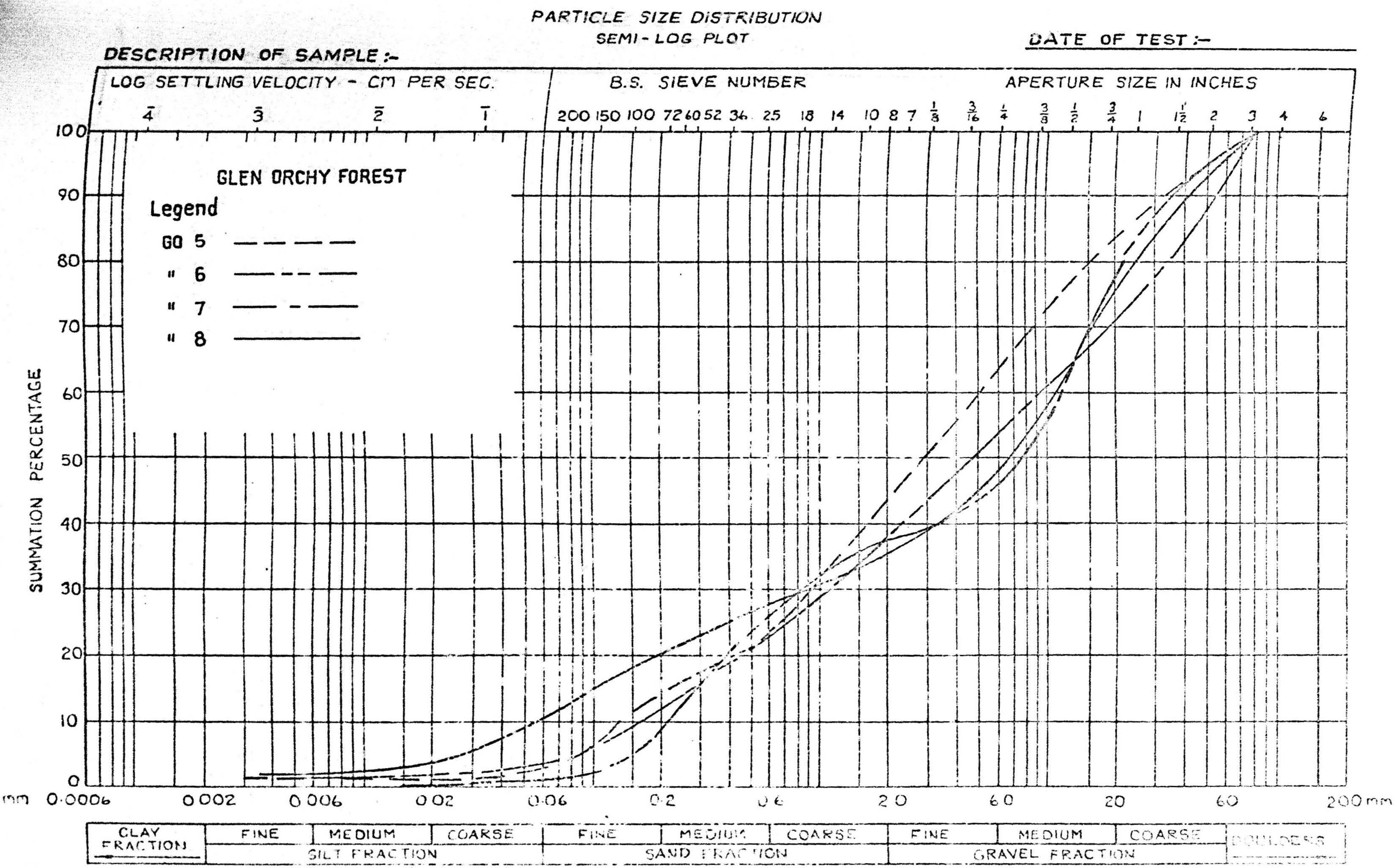


FIG 5.52 GRADINGS FOR GLEN ORCHY TILLS GO5 - GO8

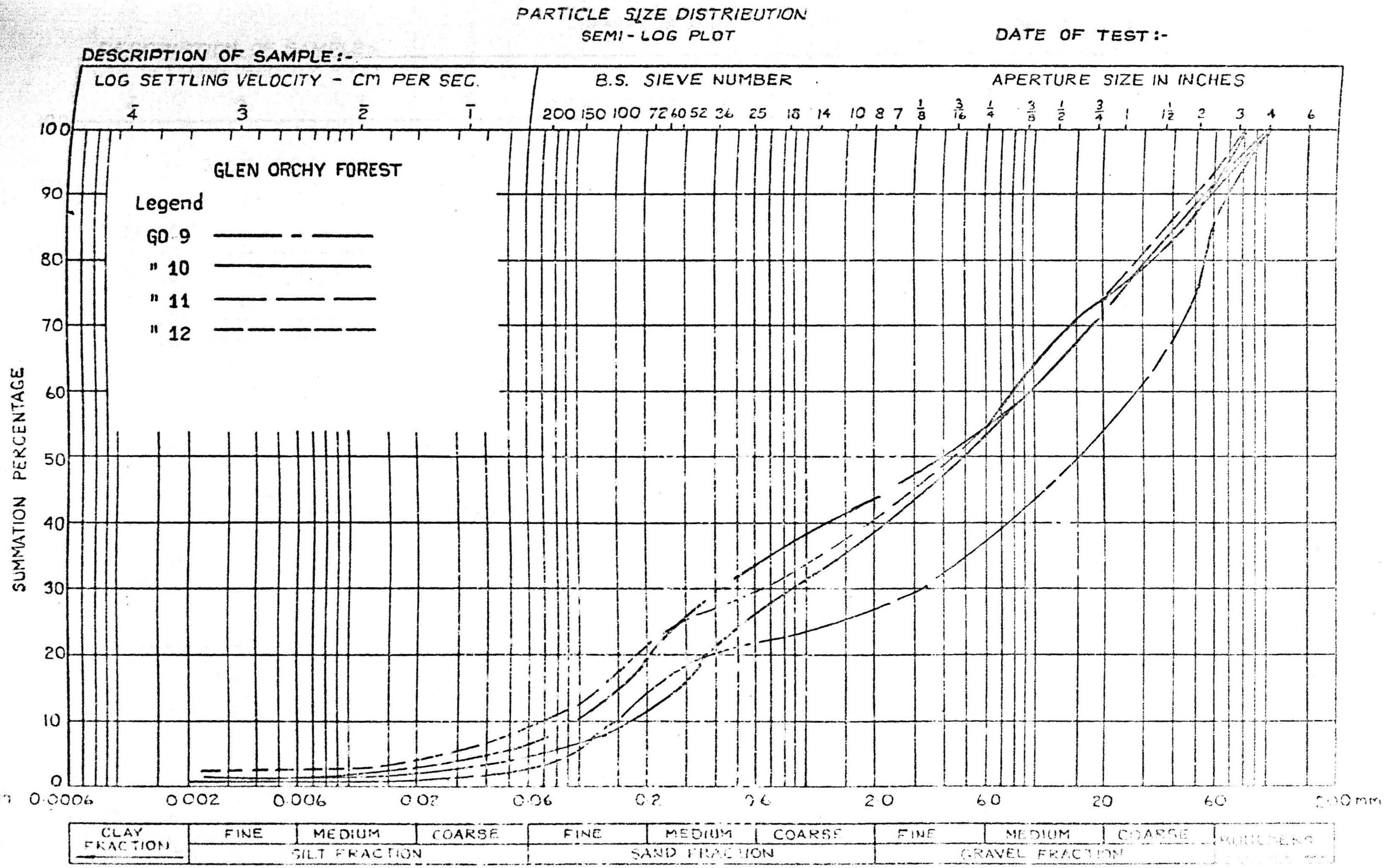


FIG. 5·53 GRADINGS FOR GLEN ORCHY TILLS GO9 - G12.

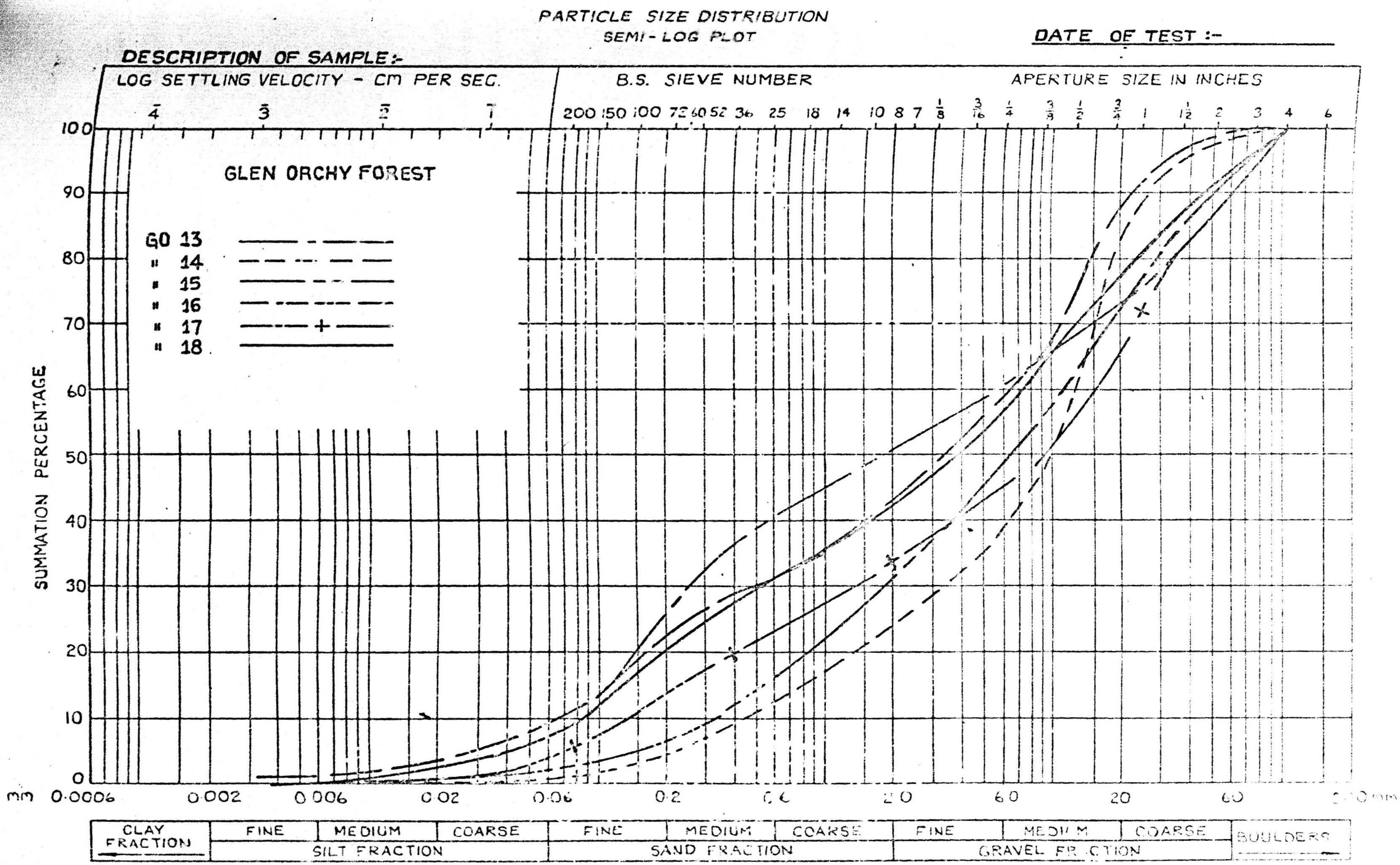


FIG. 5·54 GRADINGS FOR GLEN ORCHY TILLS GO 13 – GO 18.

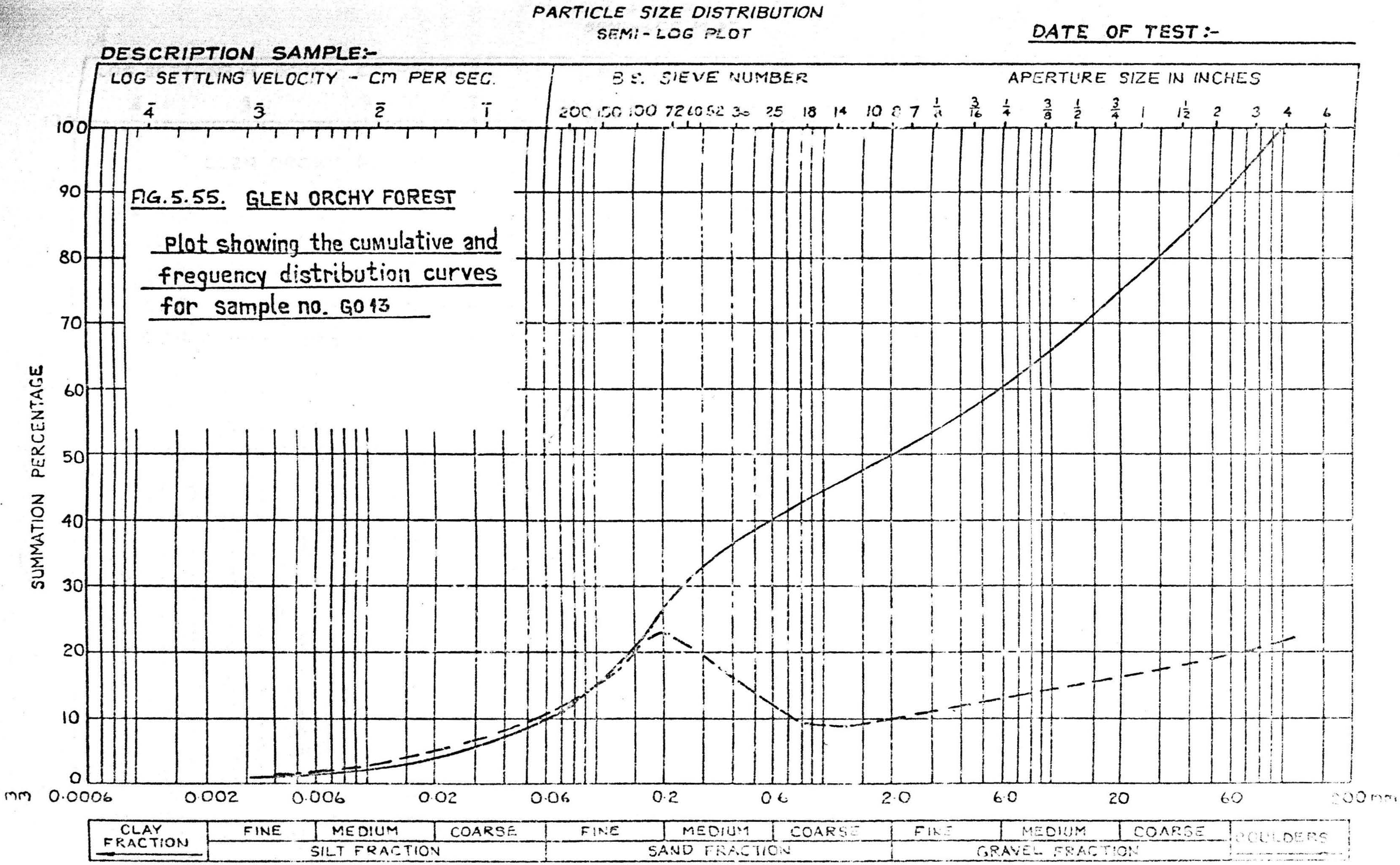


FIG. 5.55. GLEN ORCHY FOREST

Plot showing the cumulative and frequency distribution curves for sample no. GO 13

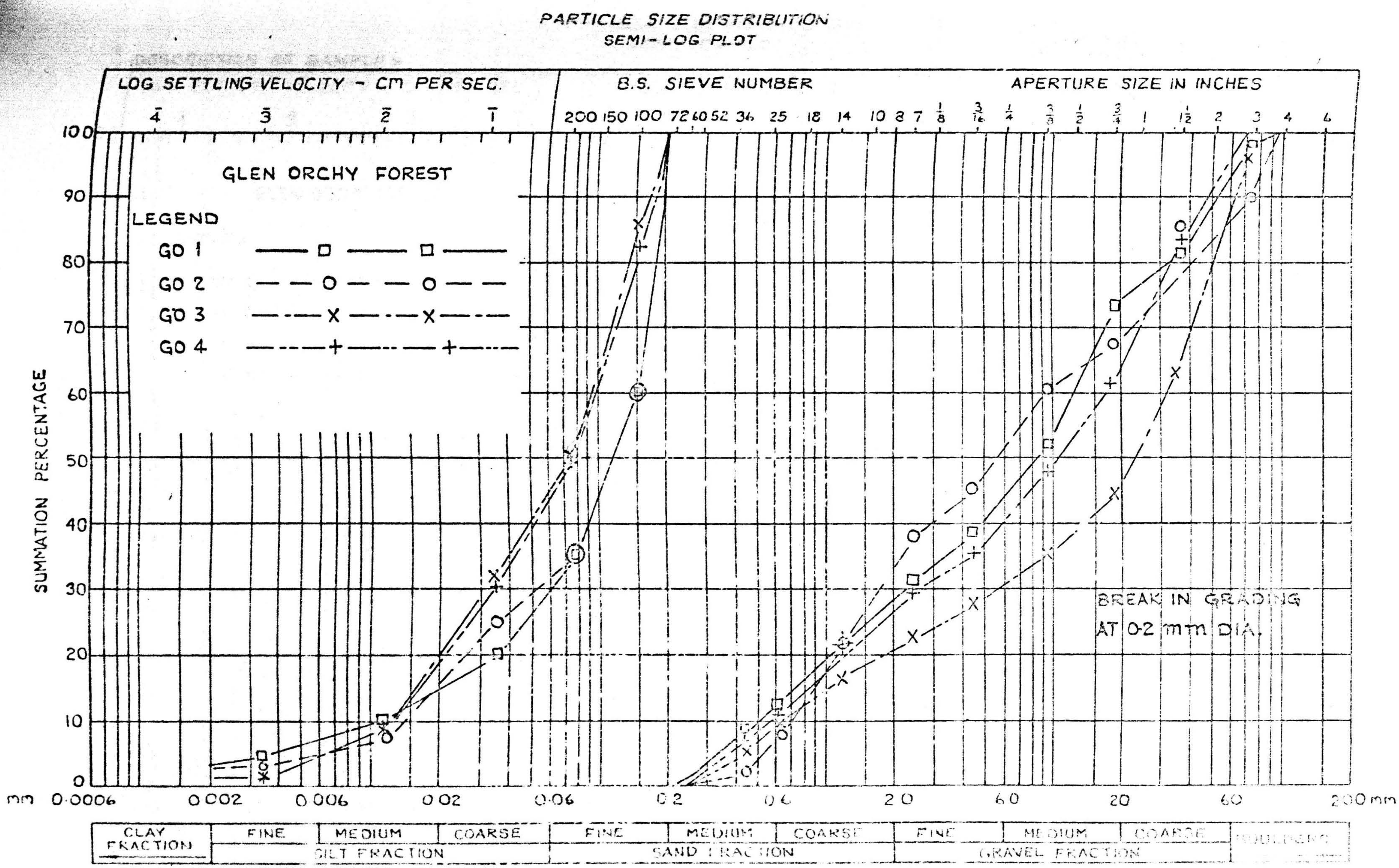


FIG. 5.56. SIZE FRACTIONS FOR GLEN ORCHY TILLS GO1 - GO4.

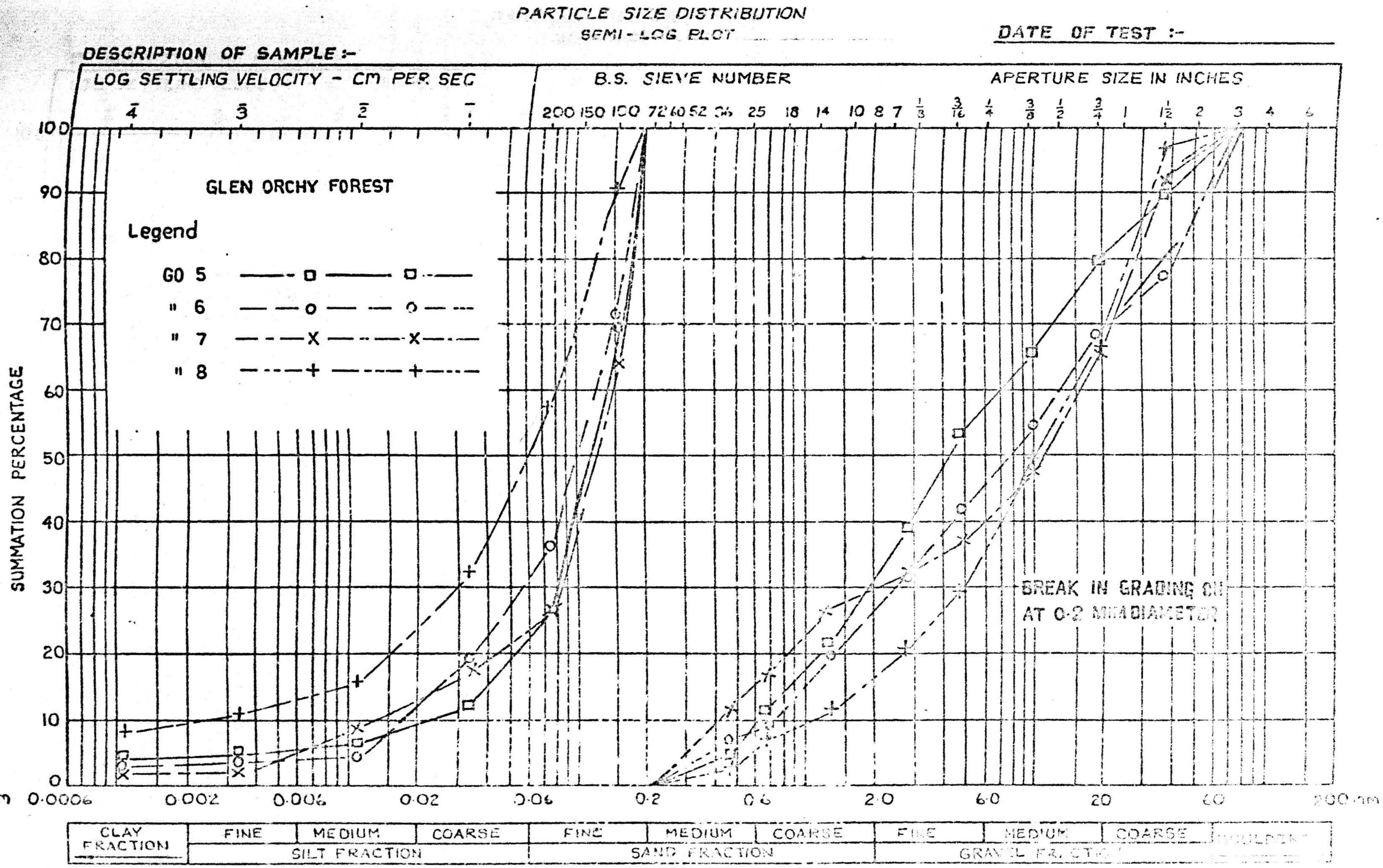


FIG 5·57 SIZE FRACTIONS FOR GLEN ORCHY TILLS GO5 – GO8.

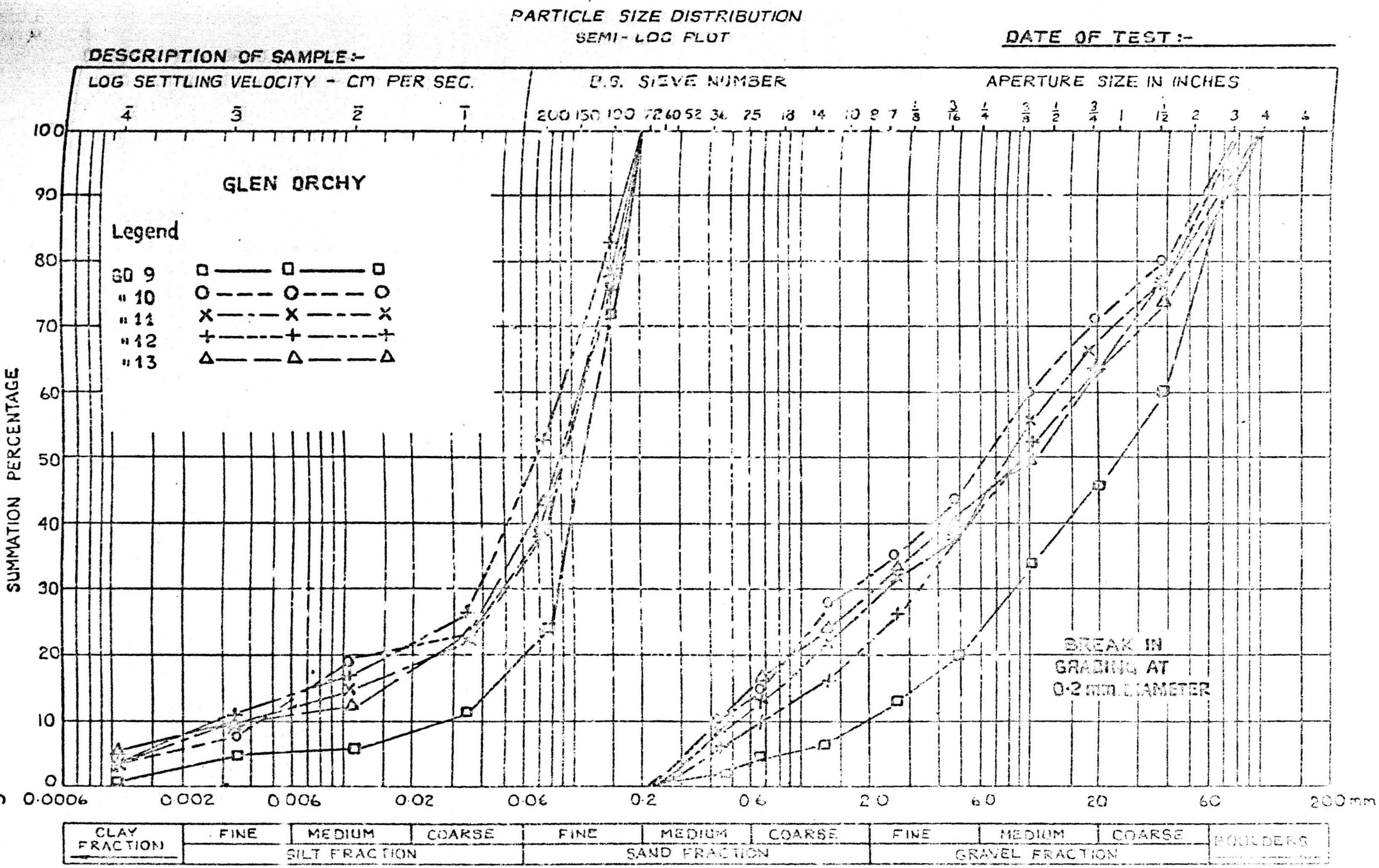


FIG 5·58 SIZE FRACTIONS FOR GLEN ORCHY TILLS GO9 - GO13.

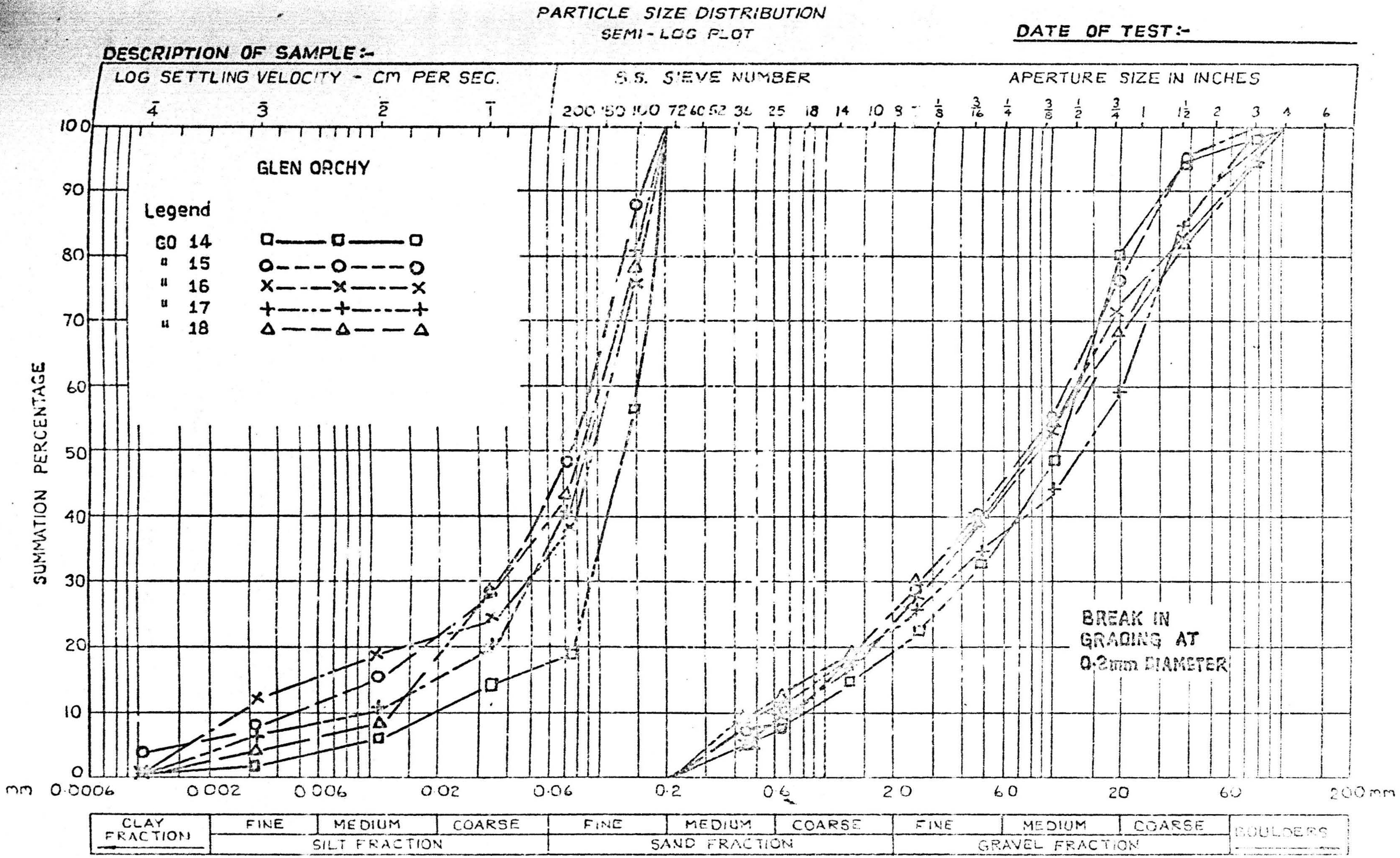


FIG 5.59 SIZE FRACTIONS FOR GLEN ORCHY TILLS GO14 - GO18.

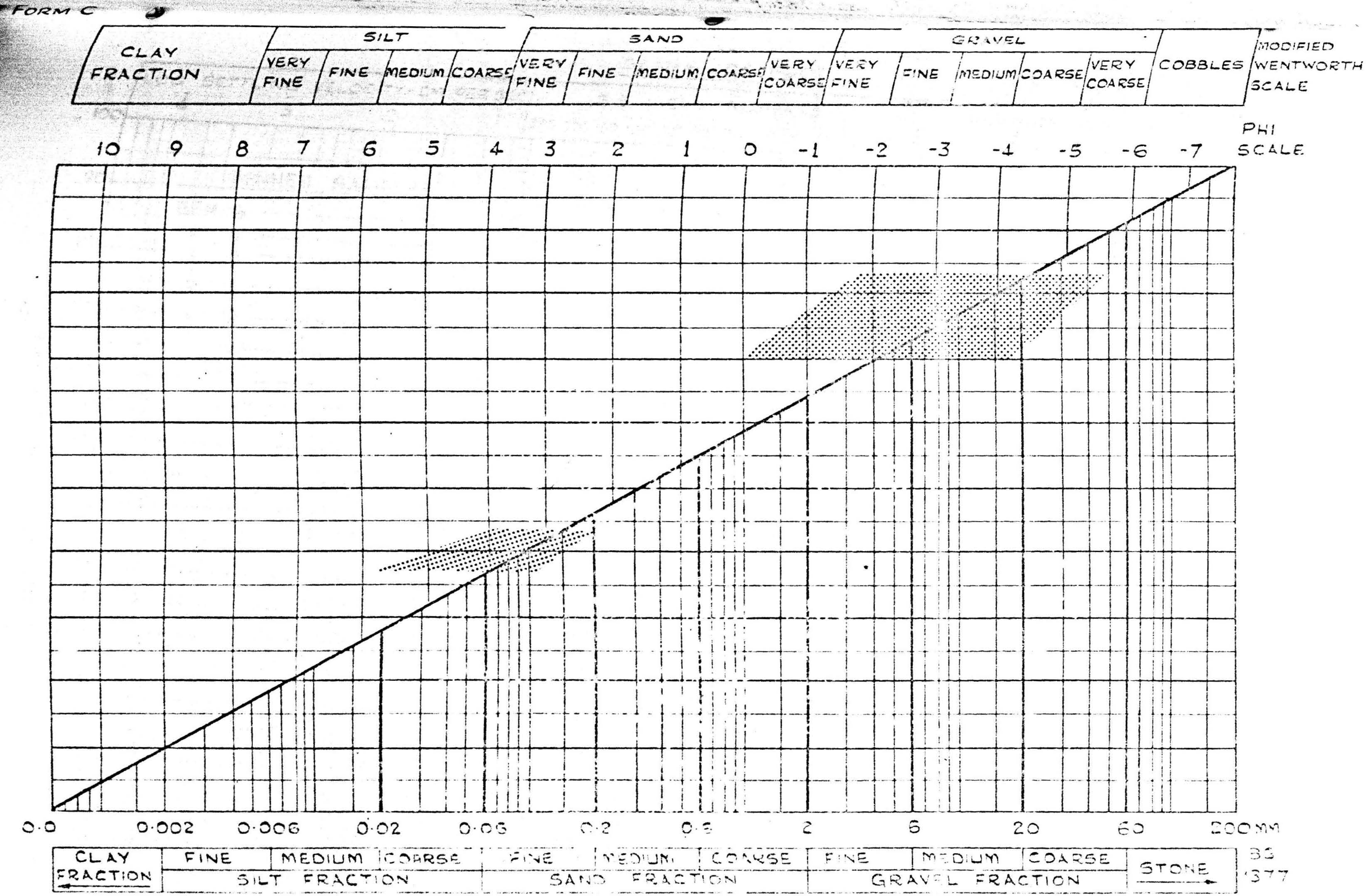


Fig. 5.60. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 for GLEN ORCHY TILLS.

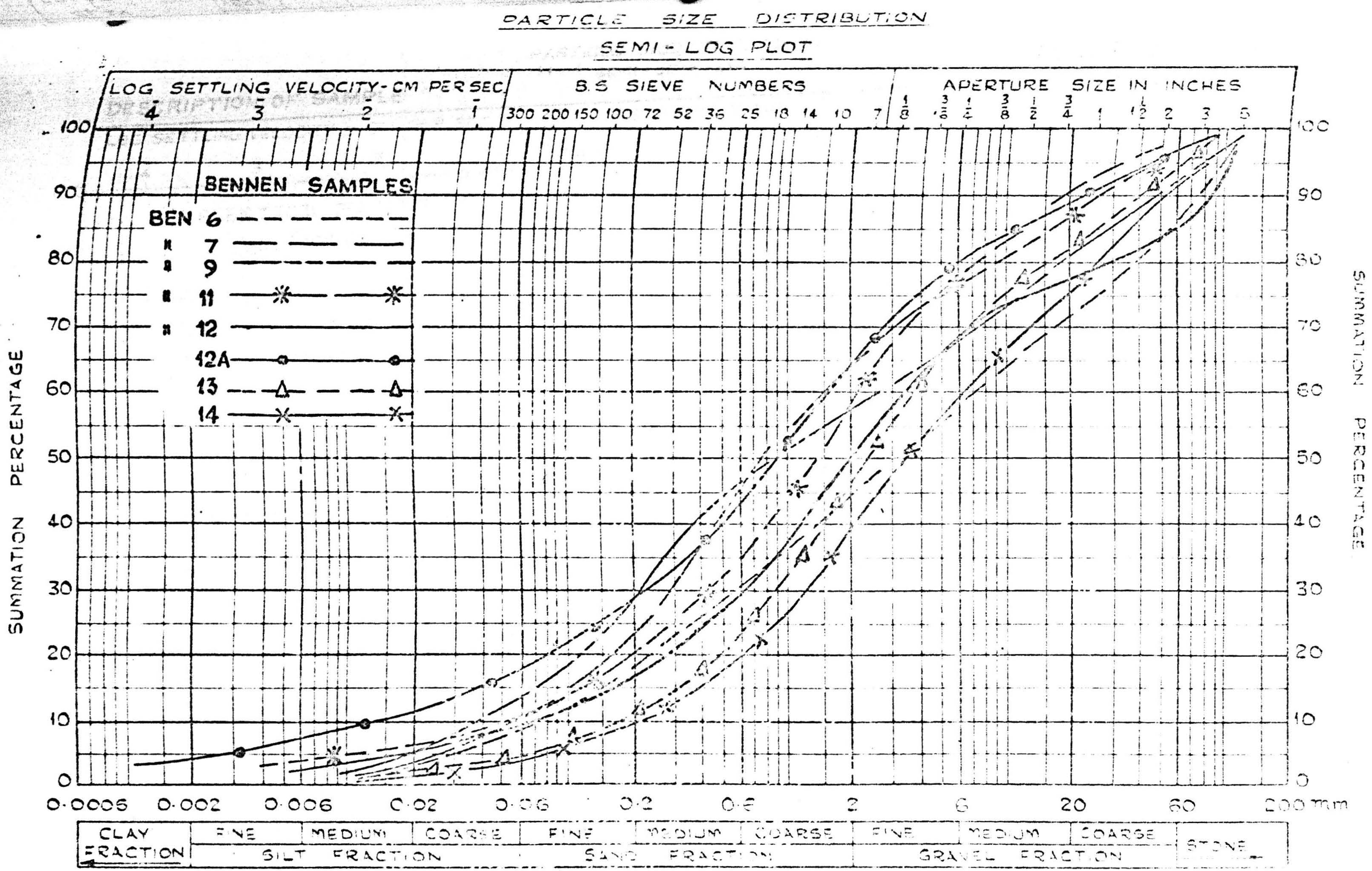


FIG. 5.61 GRADINGS FOR BENNEN TILLS.

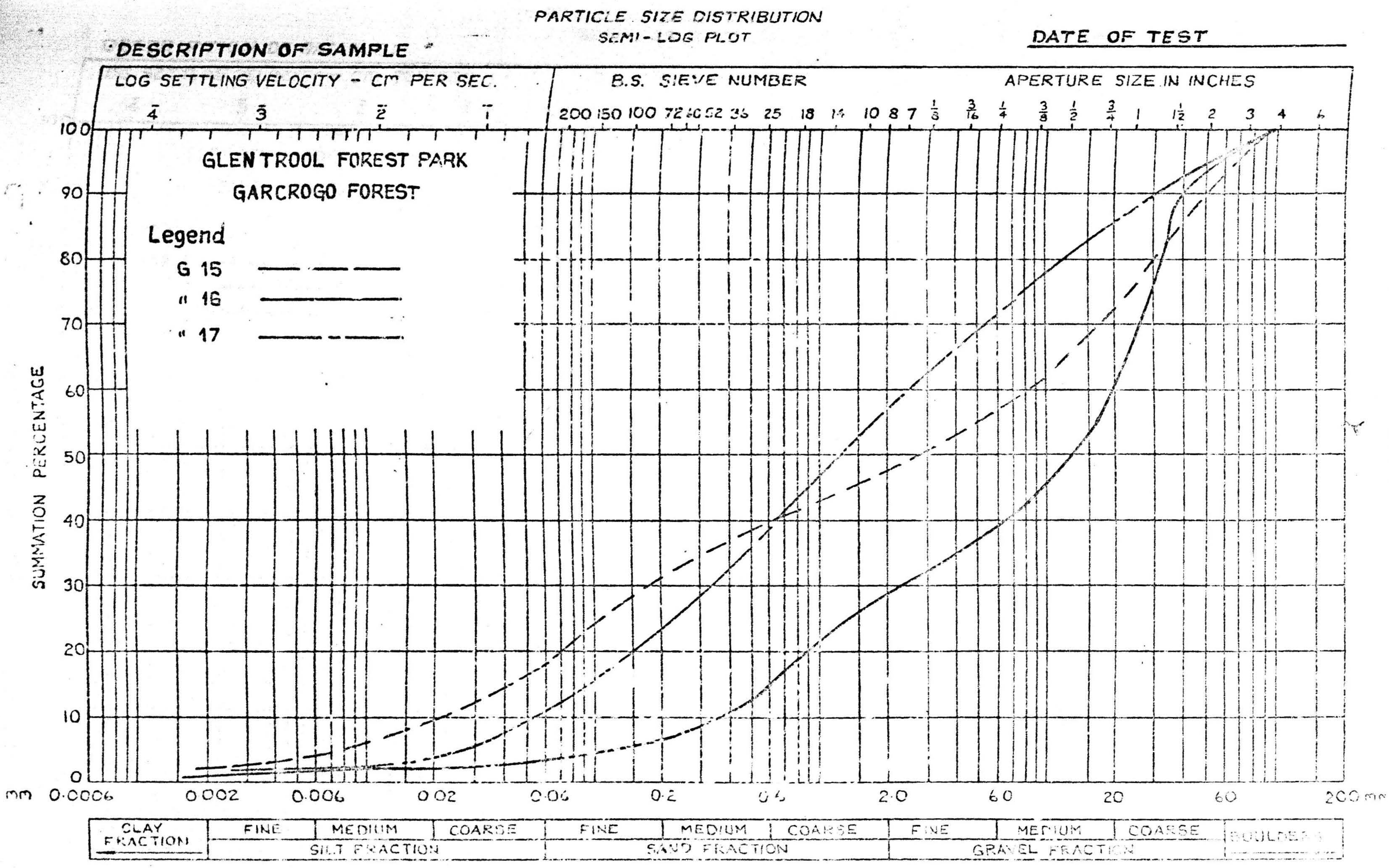


FIG. 5·62 GRADINGS FOR GARCROGO TILLS

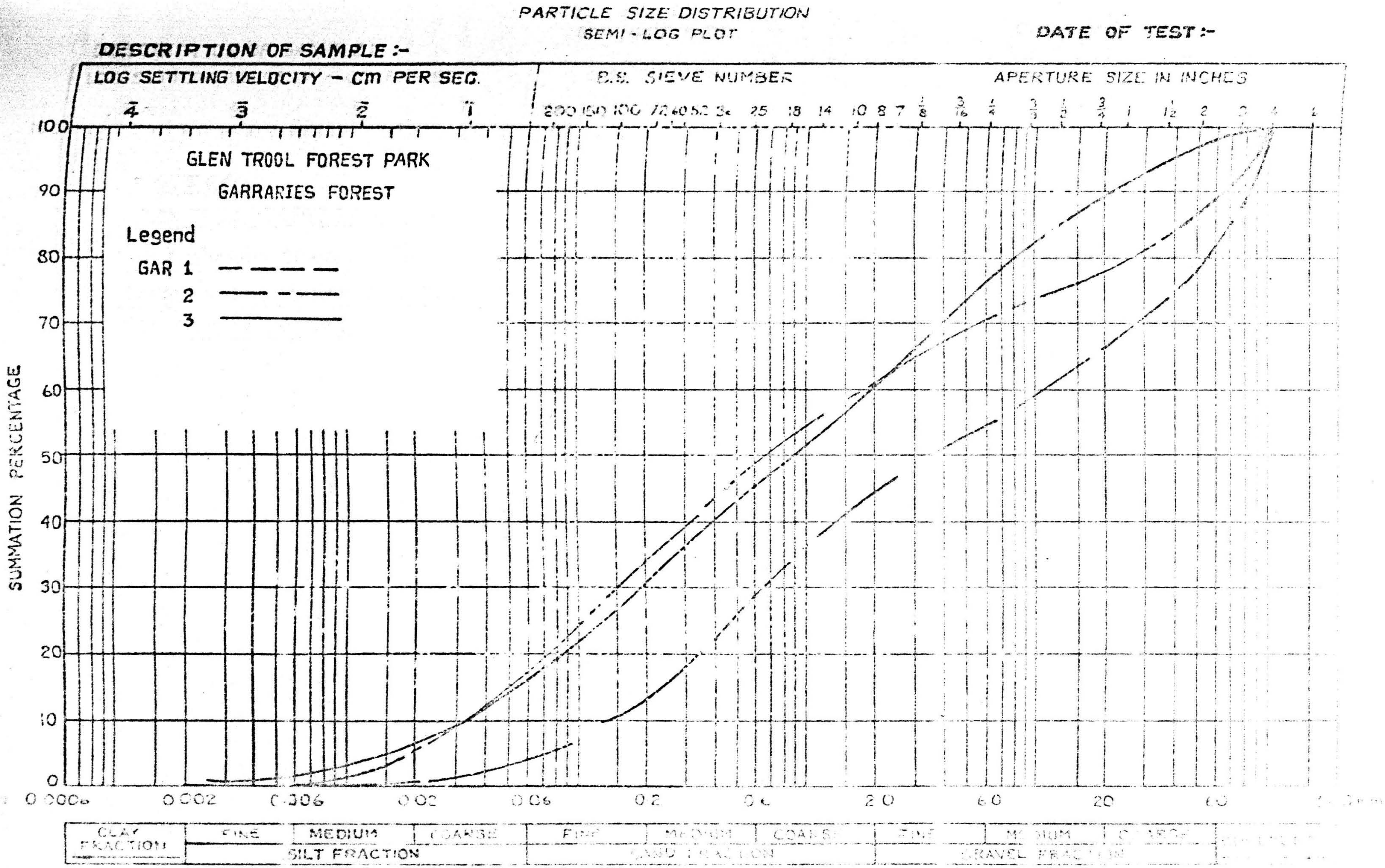
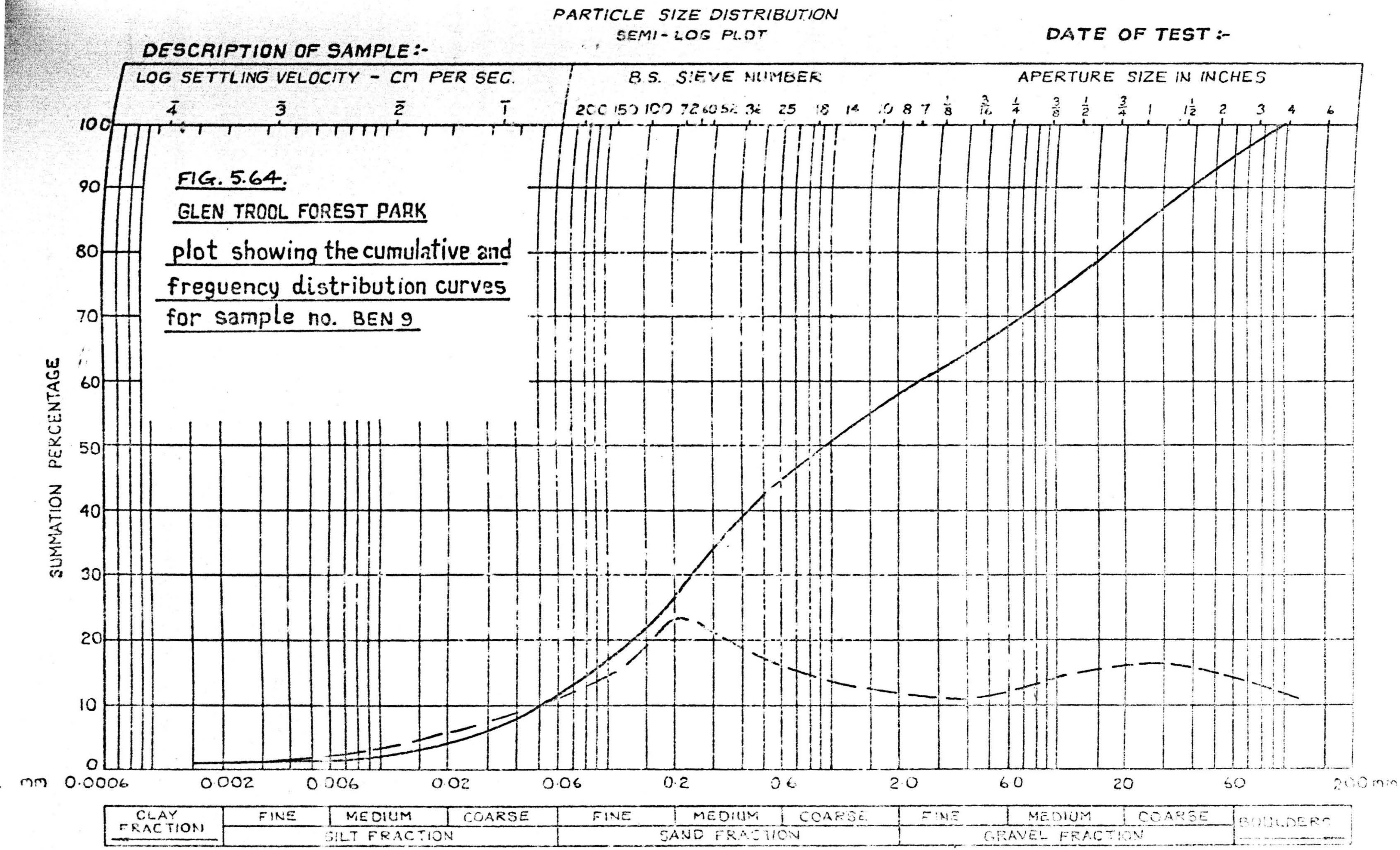


FIG. 5·63 GRADINGS FOR GARRARIES TILLS.



PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT
DATE OF TEST :-
DESCRIPTION OF SAMPLE :-
LOG SETTLING VELOCITY - CM PER SEC.
B.S. SIEVE NUMBER
APERTURE SIZE IN INCHES
FIG. 5.64.
GLEN TROOL FOREST PARK
plot showing the cumulative and frequency distribution curves for sample no. BEN 9
SUMMATION PERCENTAGE
CLAY FRACTION
FINE
MEDIUM
COARSE
SILT FRACTION
SAND FRACTION
GRAVEL FRACTION
BOULDERS

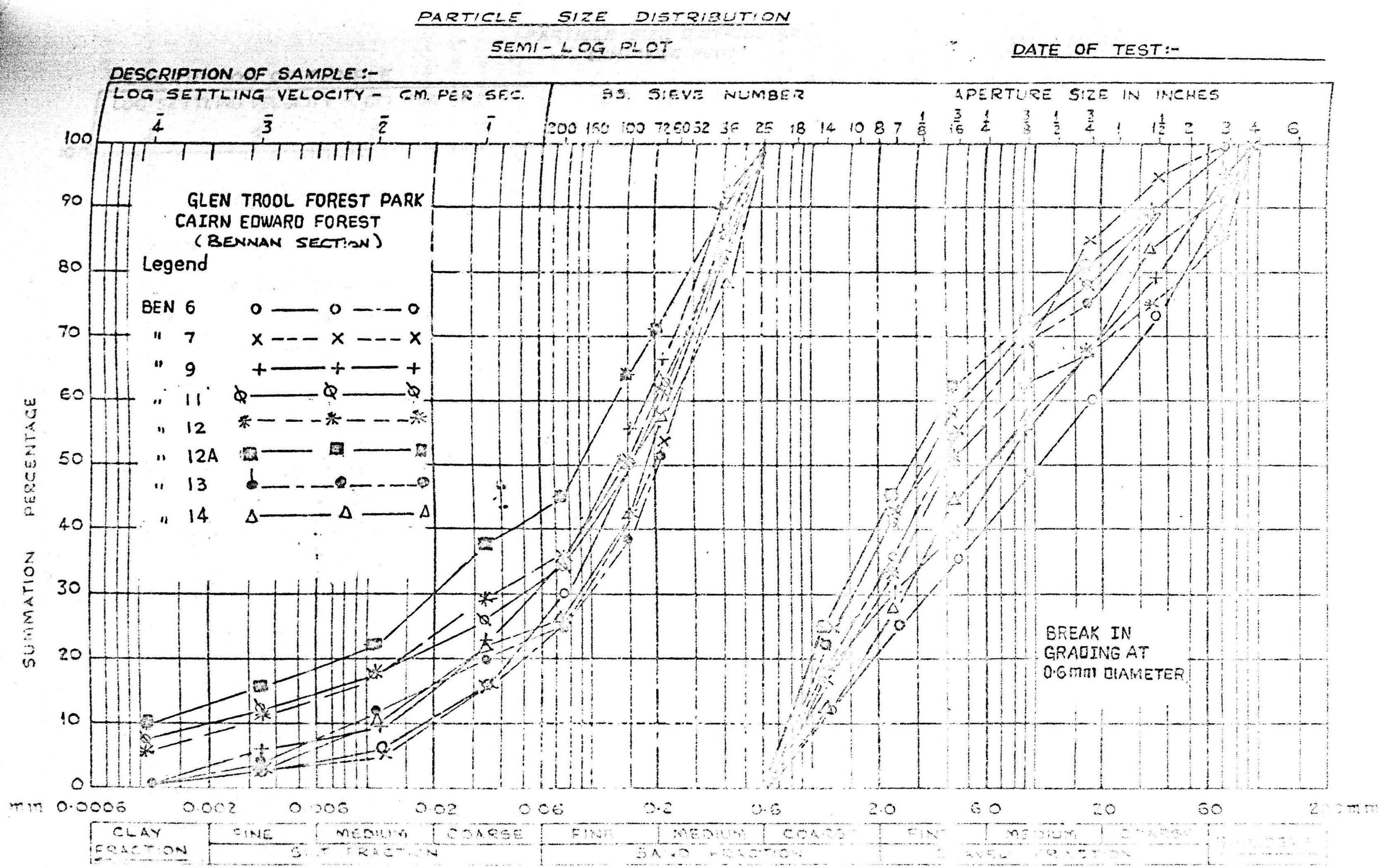


FIG No. 5·65 SIZE FRACTIONS FOR BENNAN TILLS

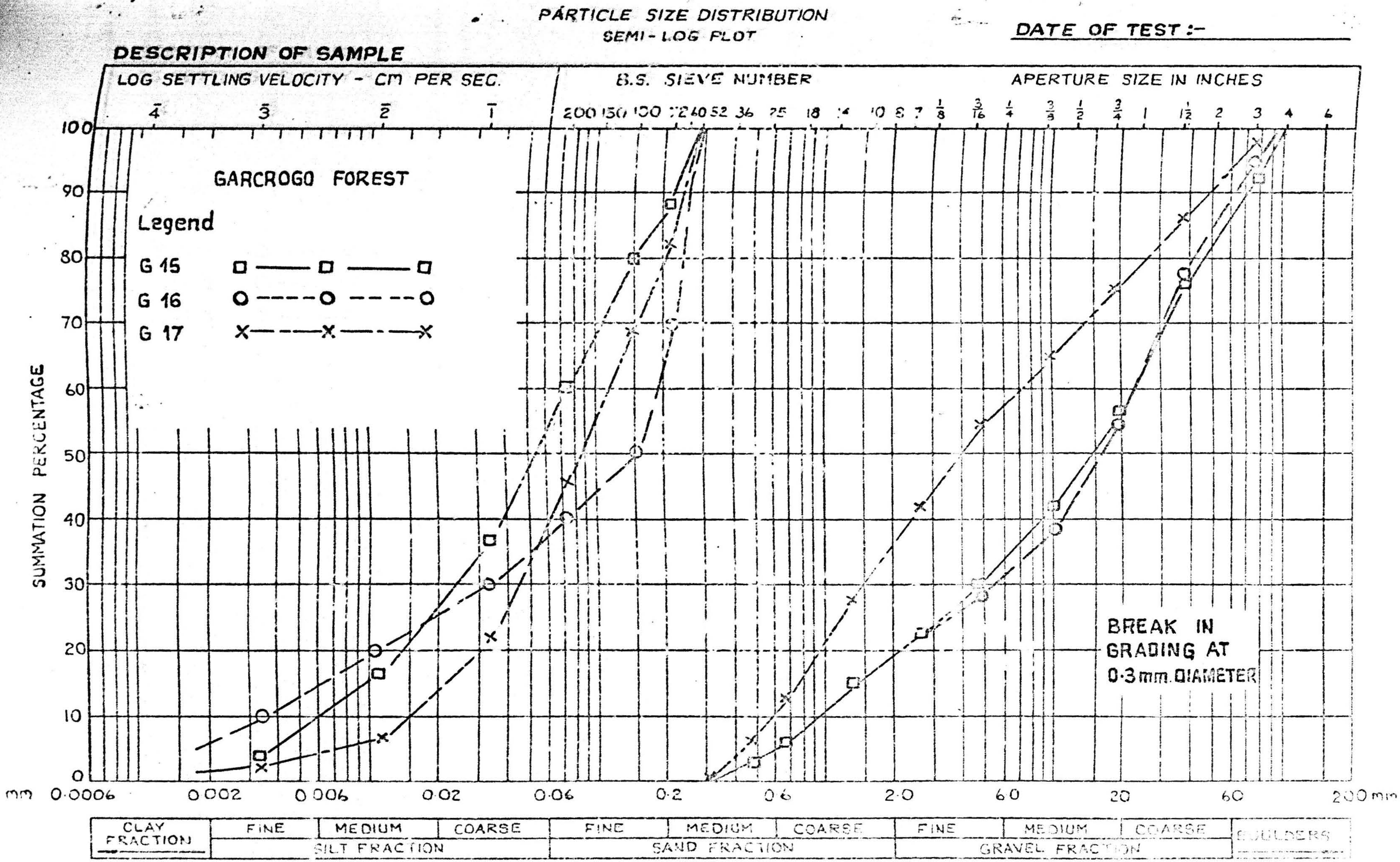


FIG. 5·66. SIZE FRACTIONS FOR GARCROGO TILLS.

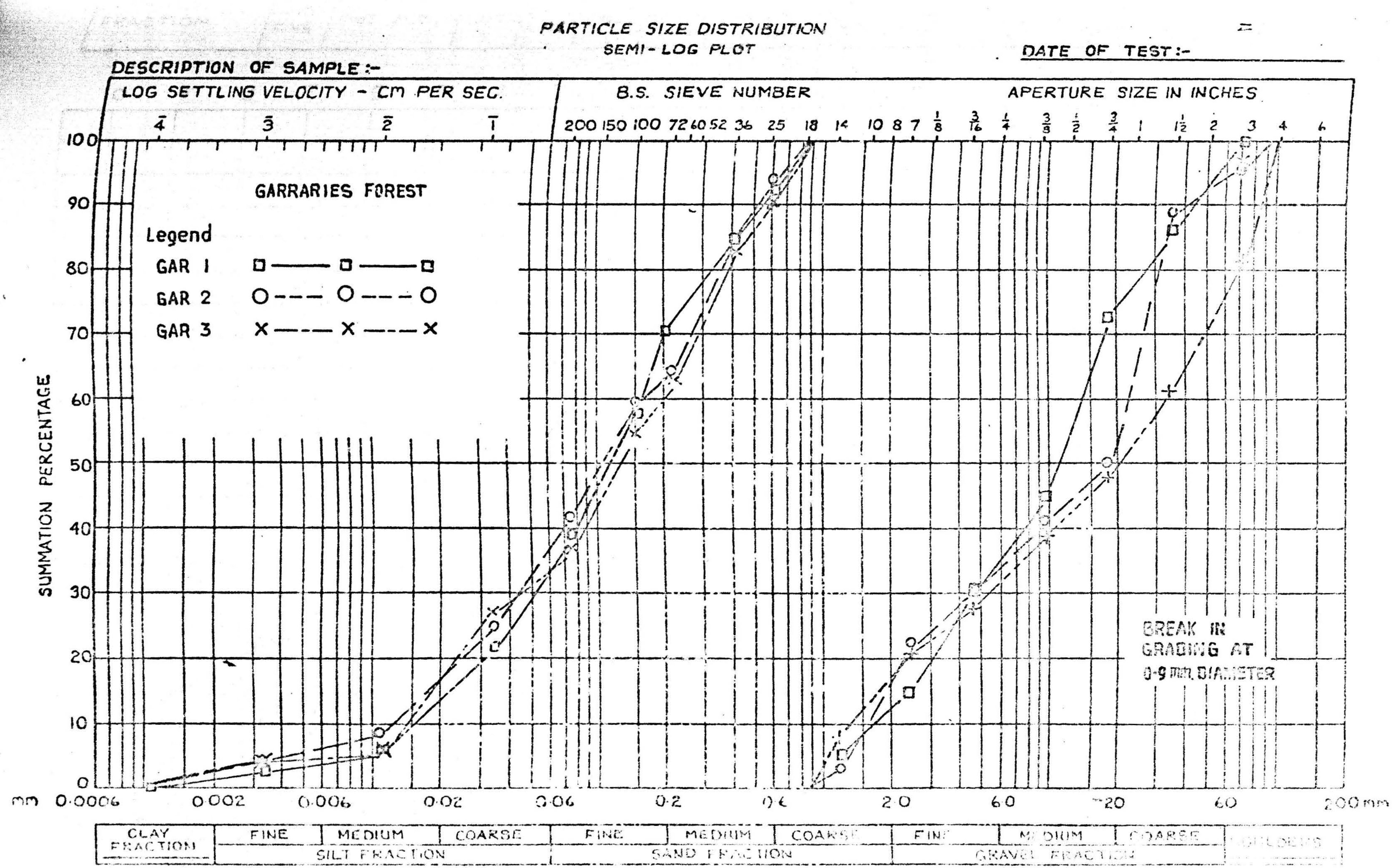


FIG 5·67 SIZE FRACTIONS FOR GARRARIES TILLS

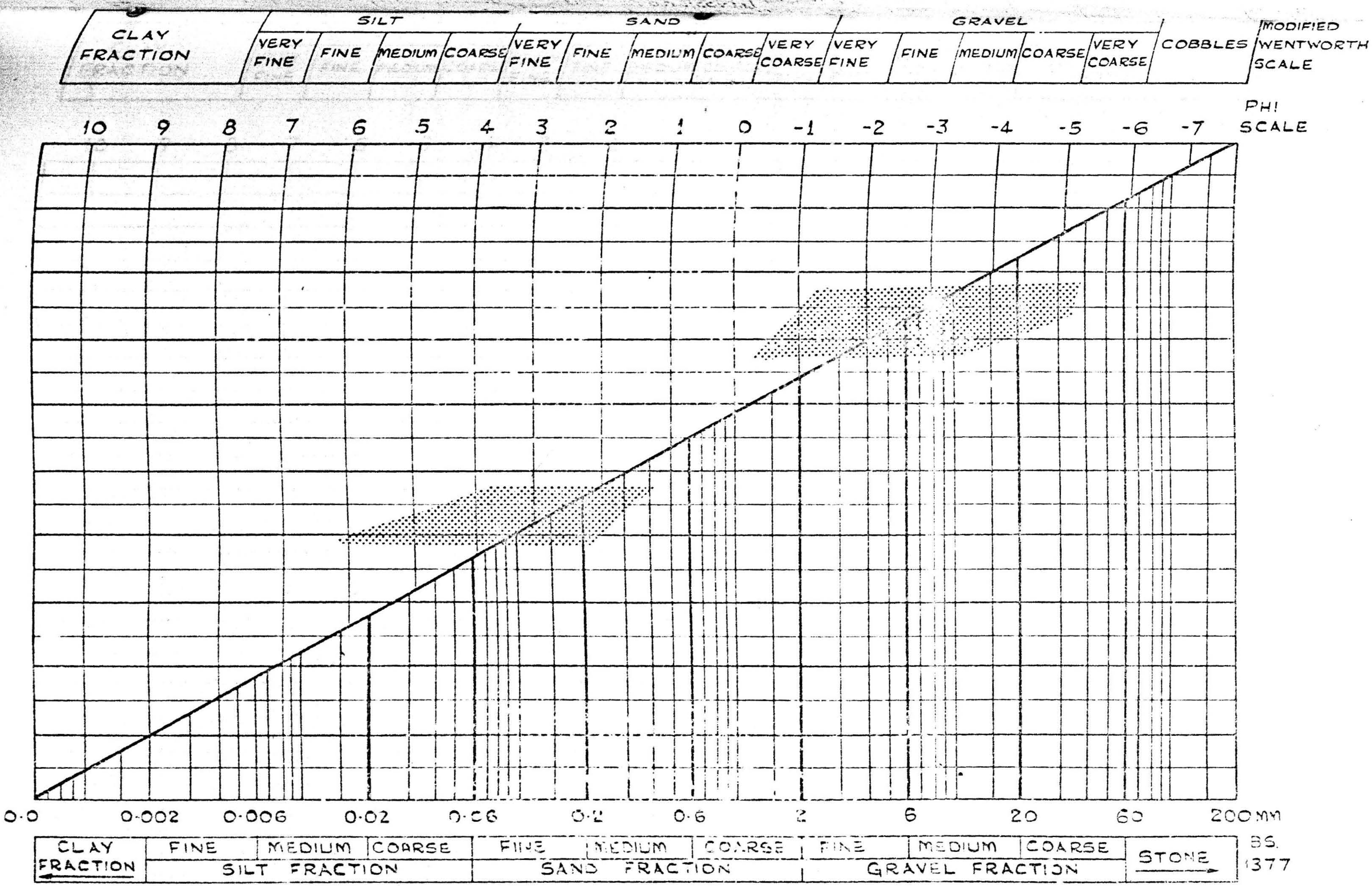


FIG. 5.68. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR BONNAN TILLS

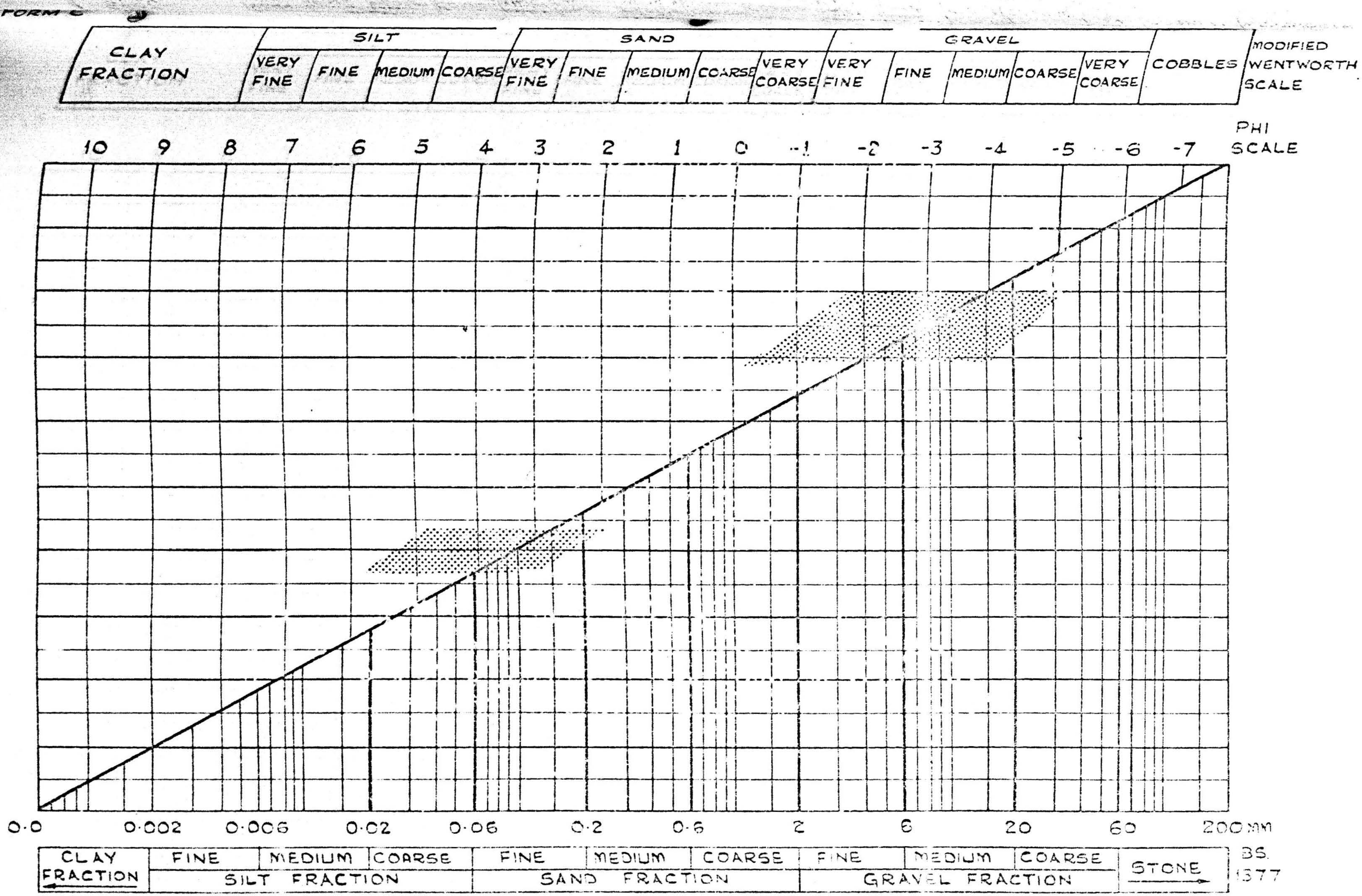


FIG. 5.69. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR G[illegible]RROGO TILLS

FORM C

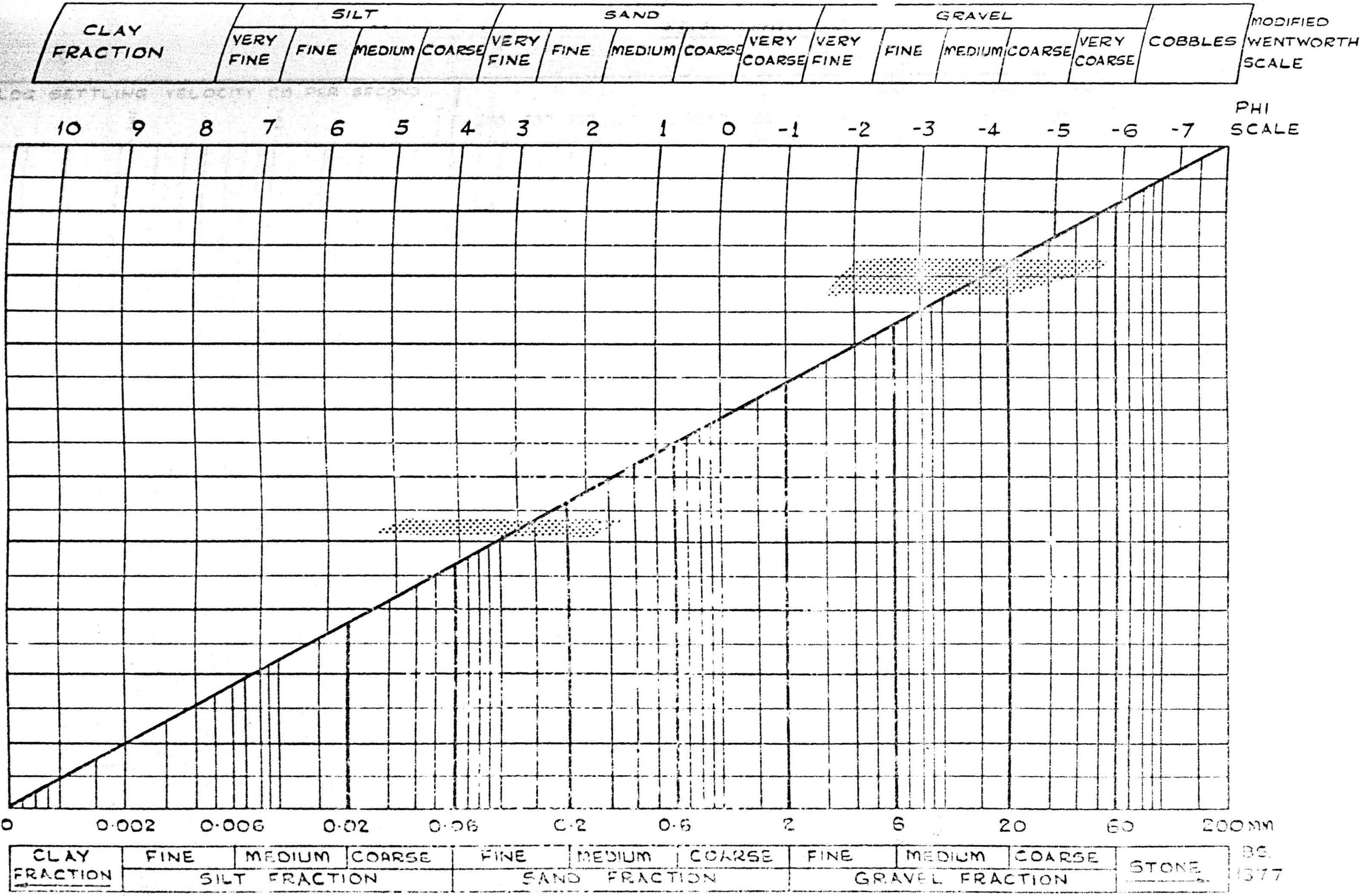


FIG. 5.70. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR [illegible] TILLS.

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

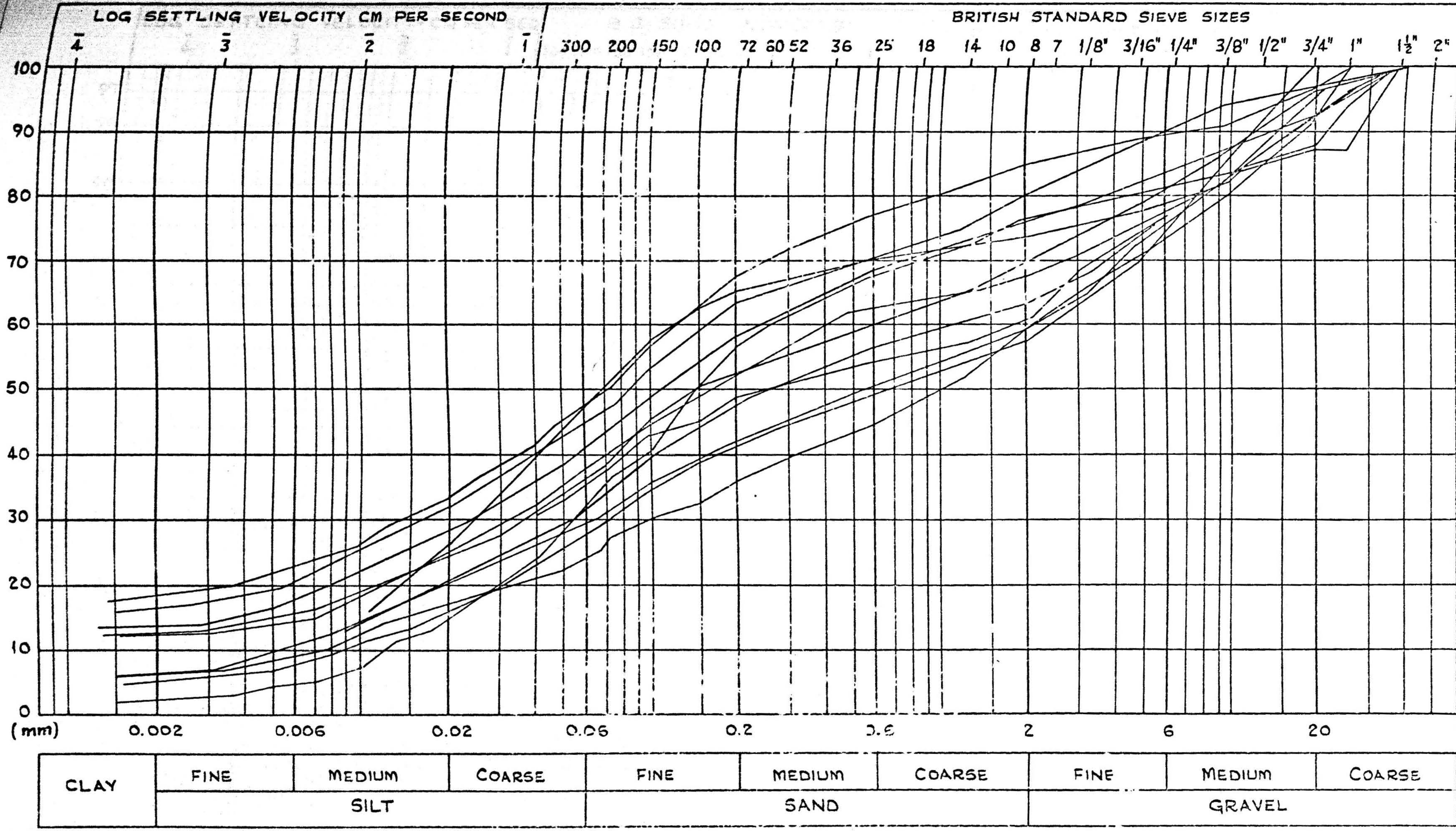


FIG. 5.71. GRADINGS FOR BACKWATER DAM UPPER SILTY TILL.

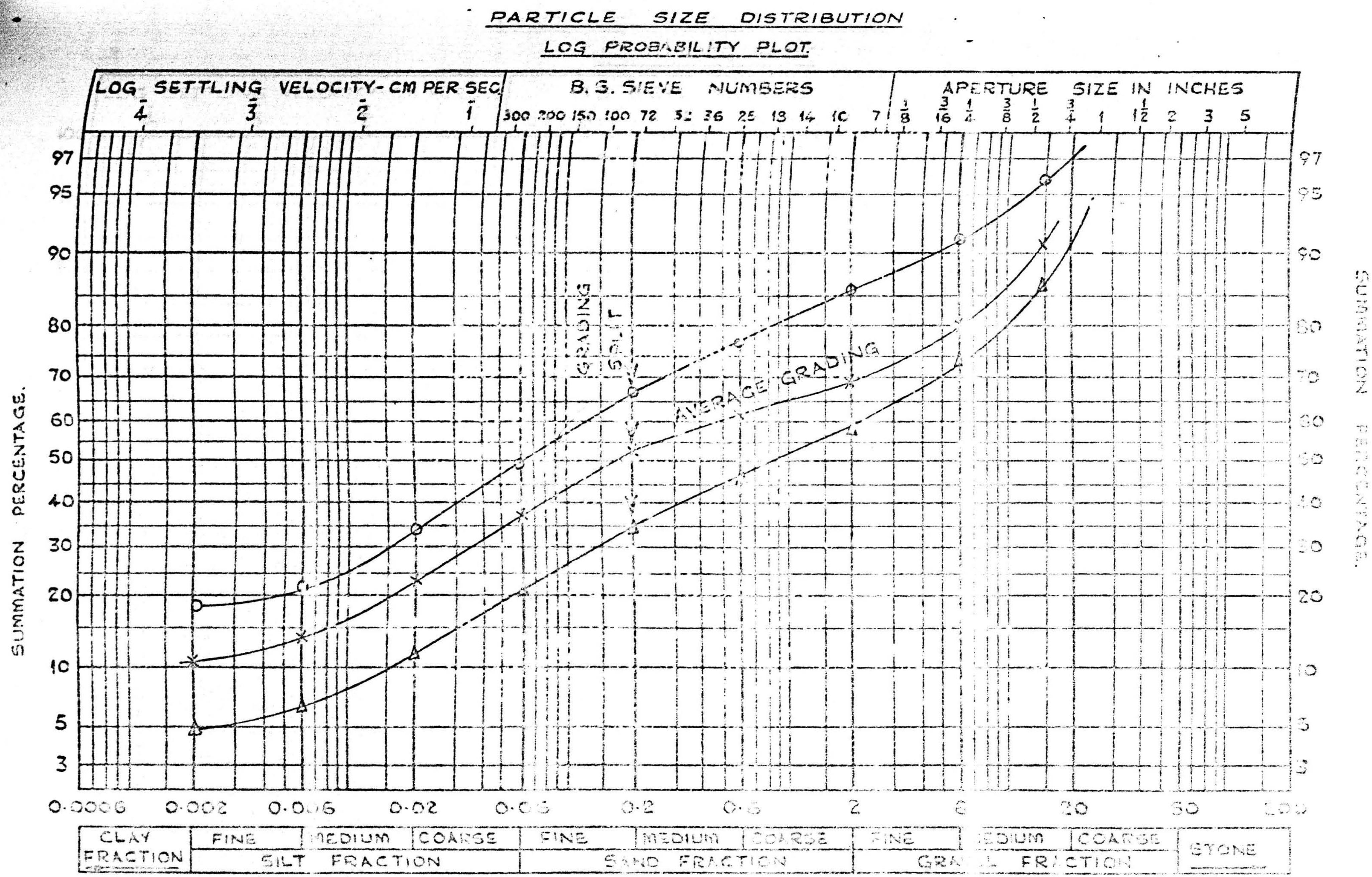


FIG. 5·72 LOG PROBABILITY PLOT OF BACKWATER UPPER SILTY FILL.

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

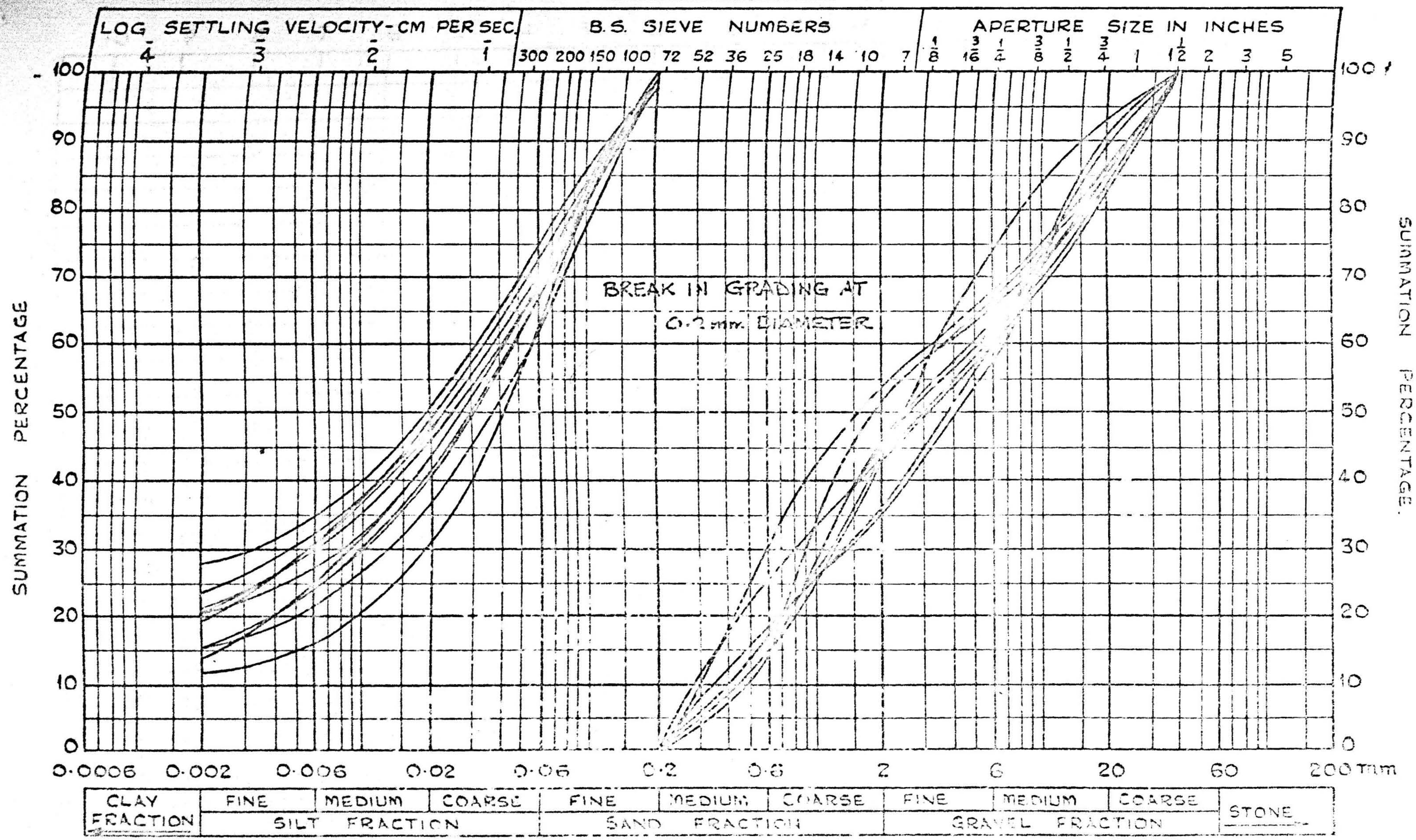


FIG 5.73 SIZE FRACTIONS FOR BACKWATER UPPER SILTY TILL.

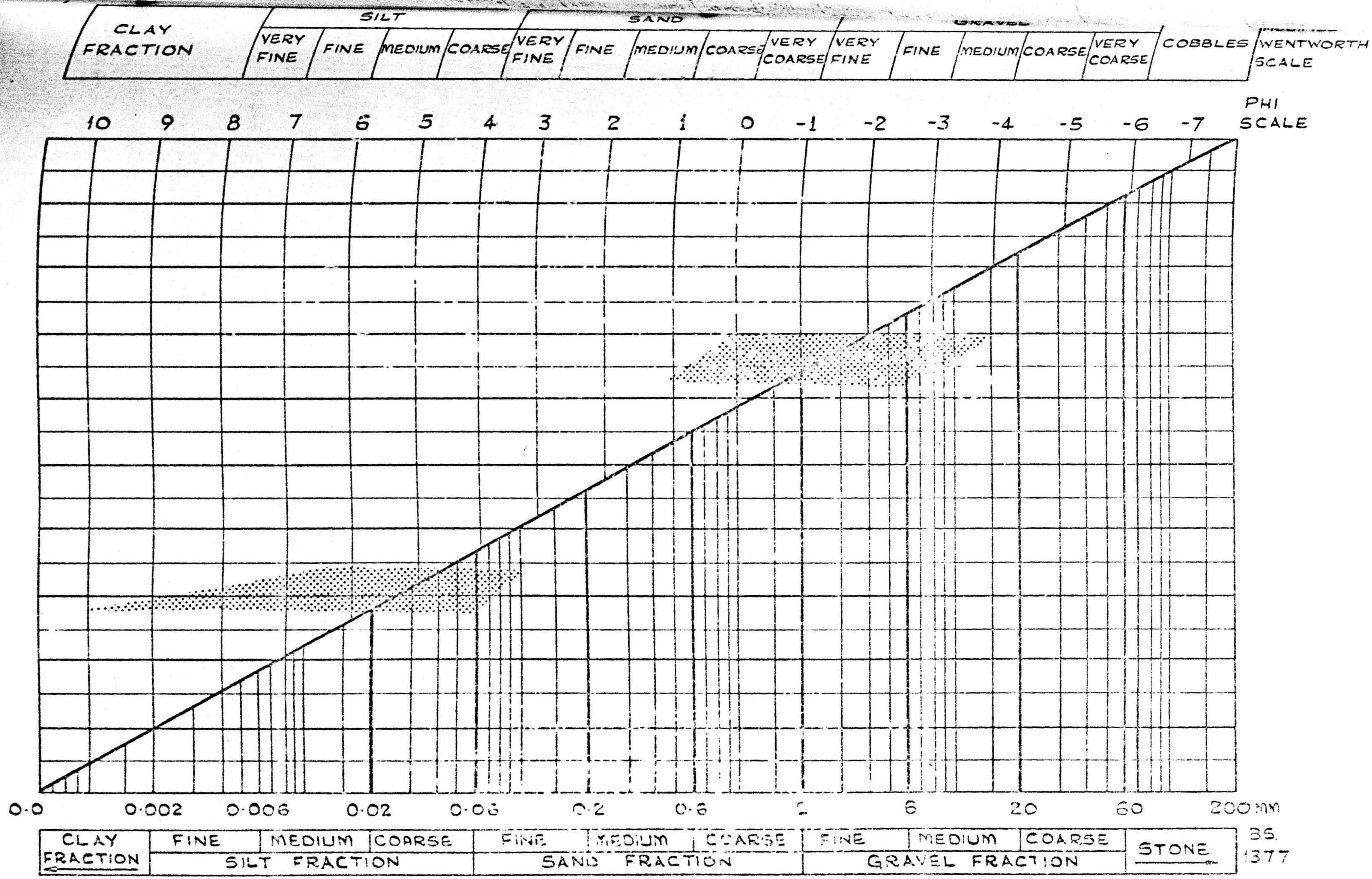


FIG.5.74. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR BACKWATER UPPER SILTY TILL

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

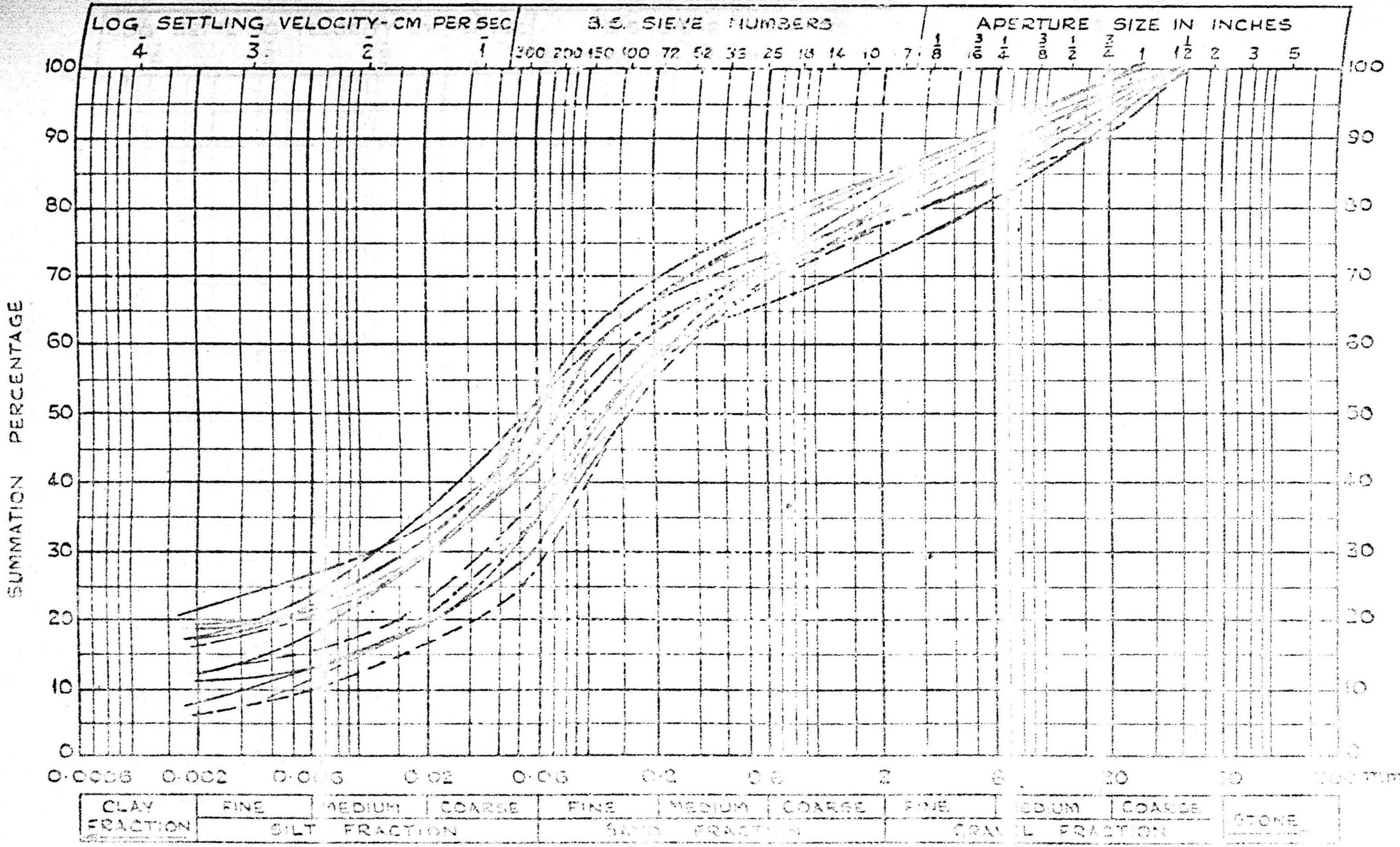


FIG 5.75 GRADINGS FOR BACKWATER DAM NORTH DEPOSIT TILLS

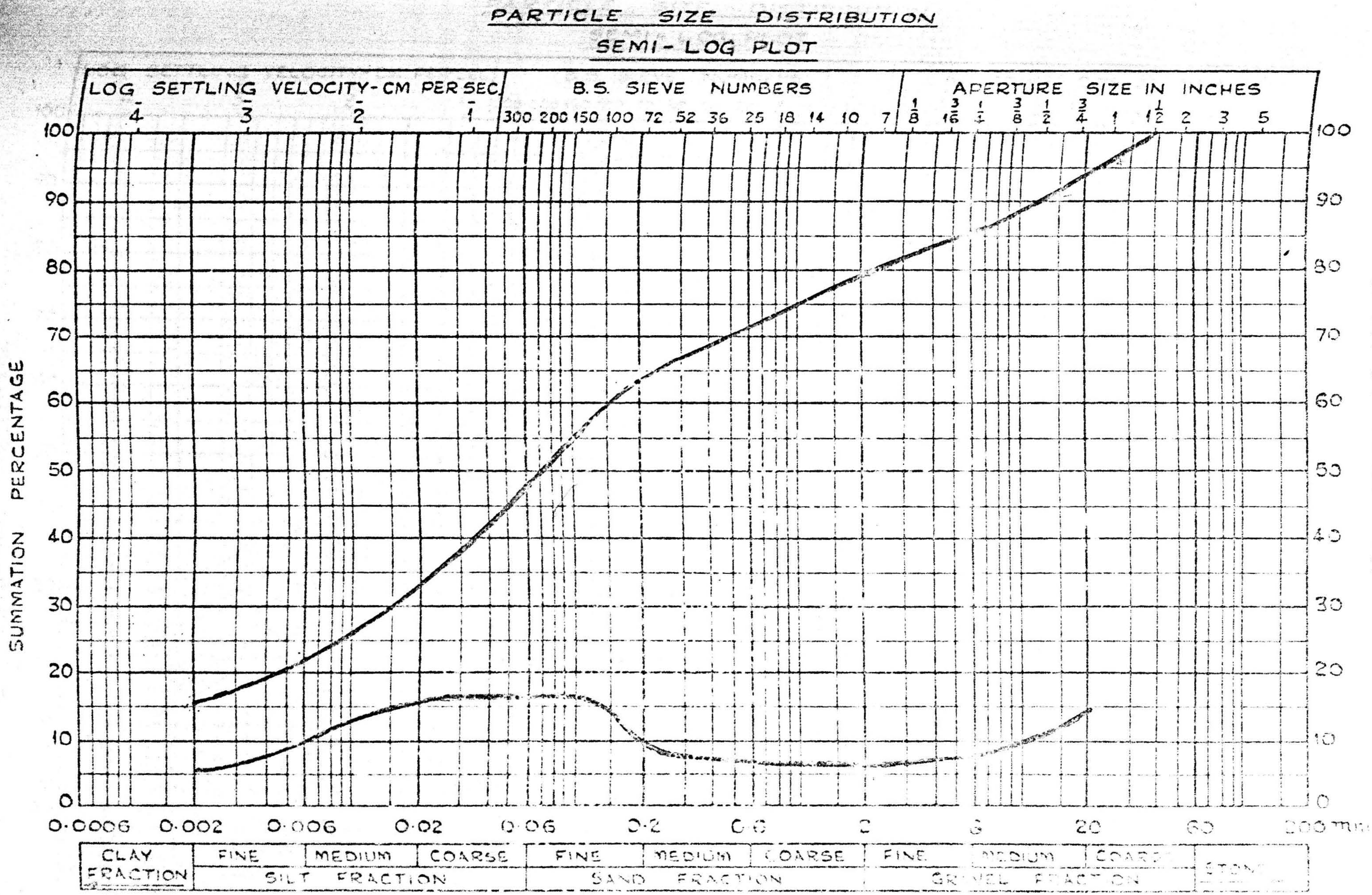


FIG. 5·76 BACKWATER DAM NORTH DEPOSIT TILL – PLOT SHOWING CUMULATIVE AND FREQUENCY CURVES.

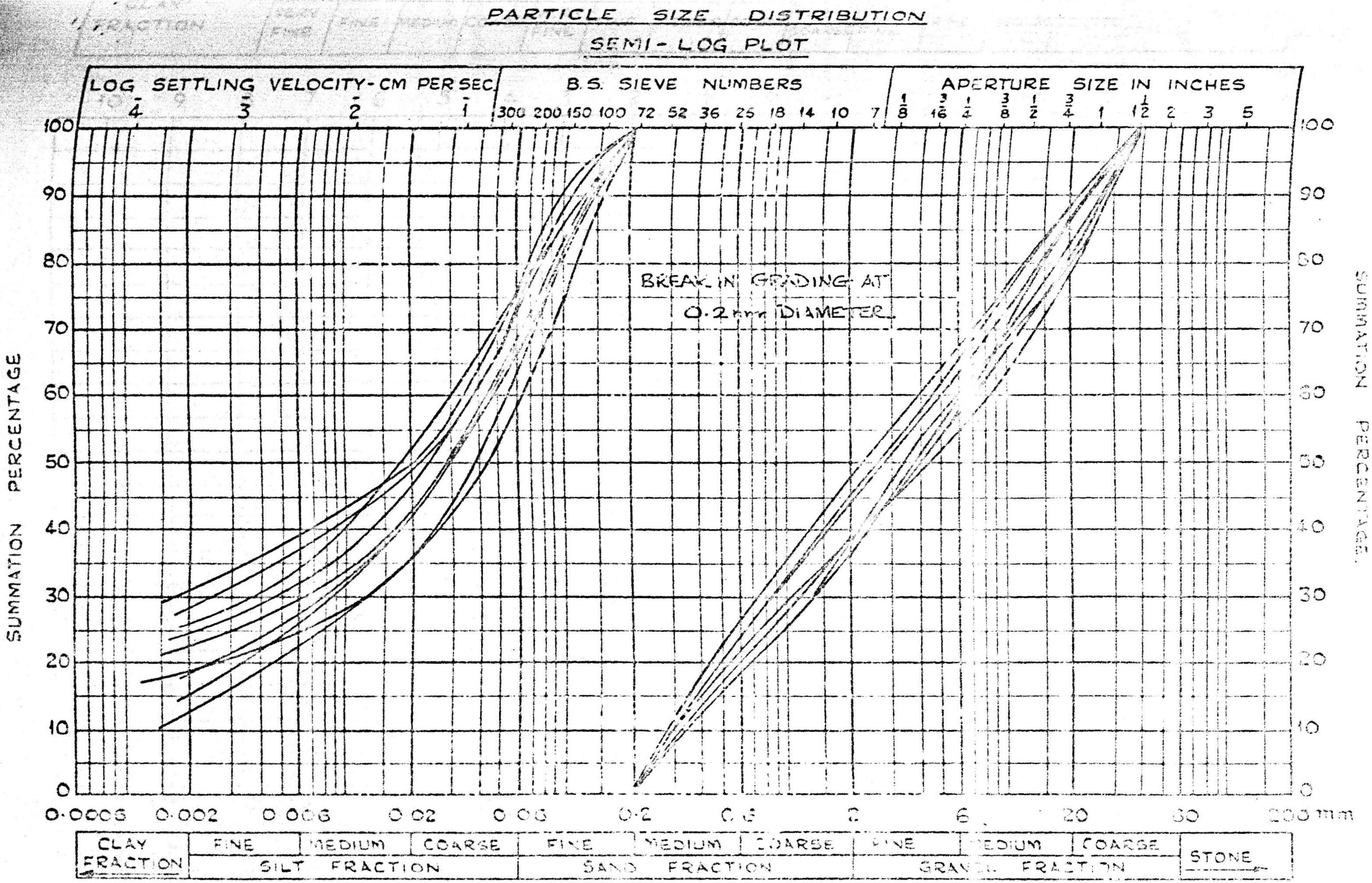


FIG 5·77 SIZE FRACTIONS FOR BACKWATER DAM NORTH DEPOSIT TILLS

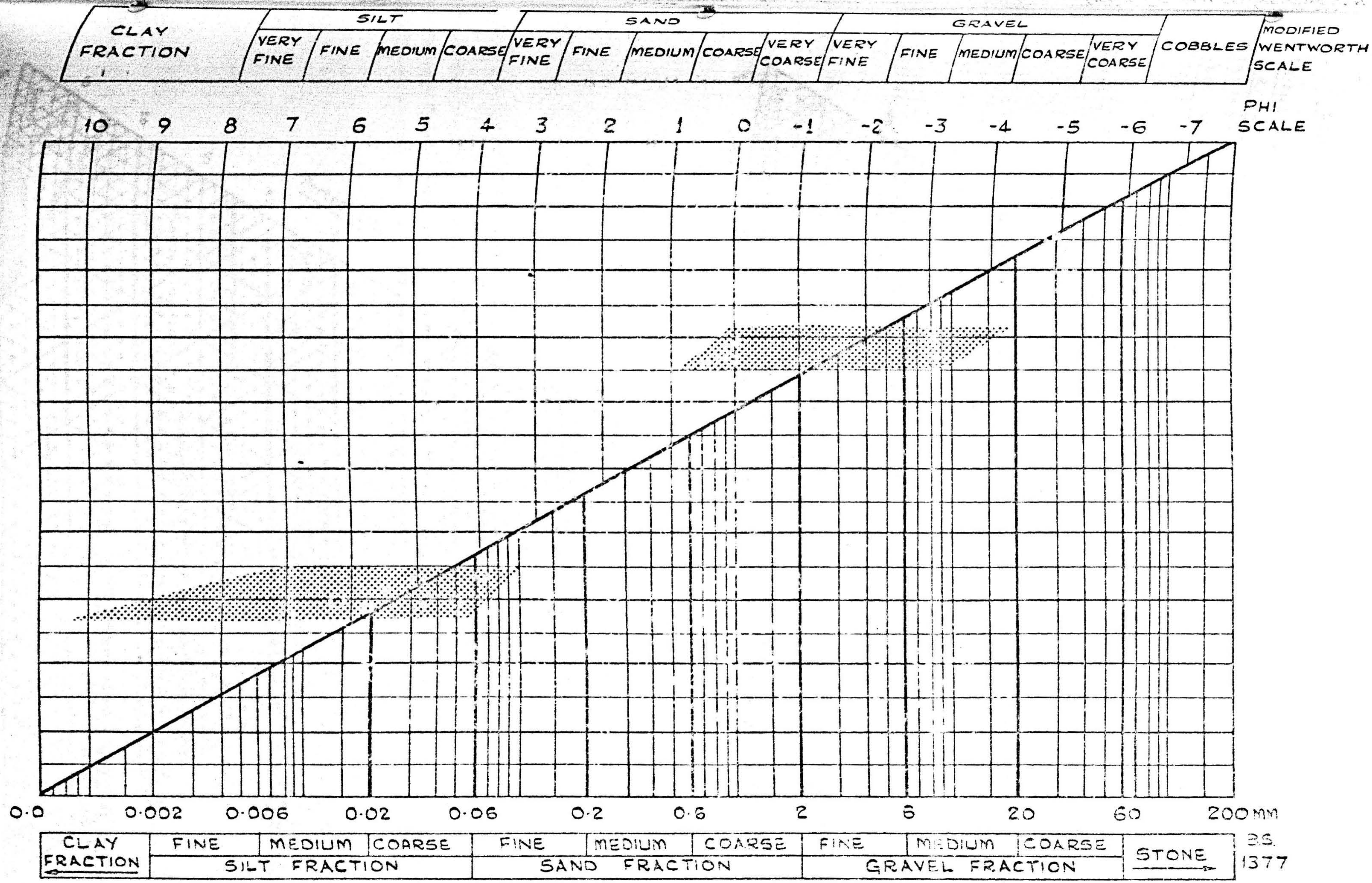
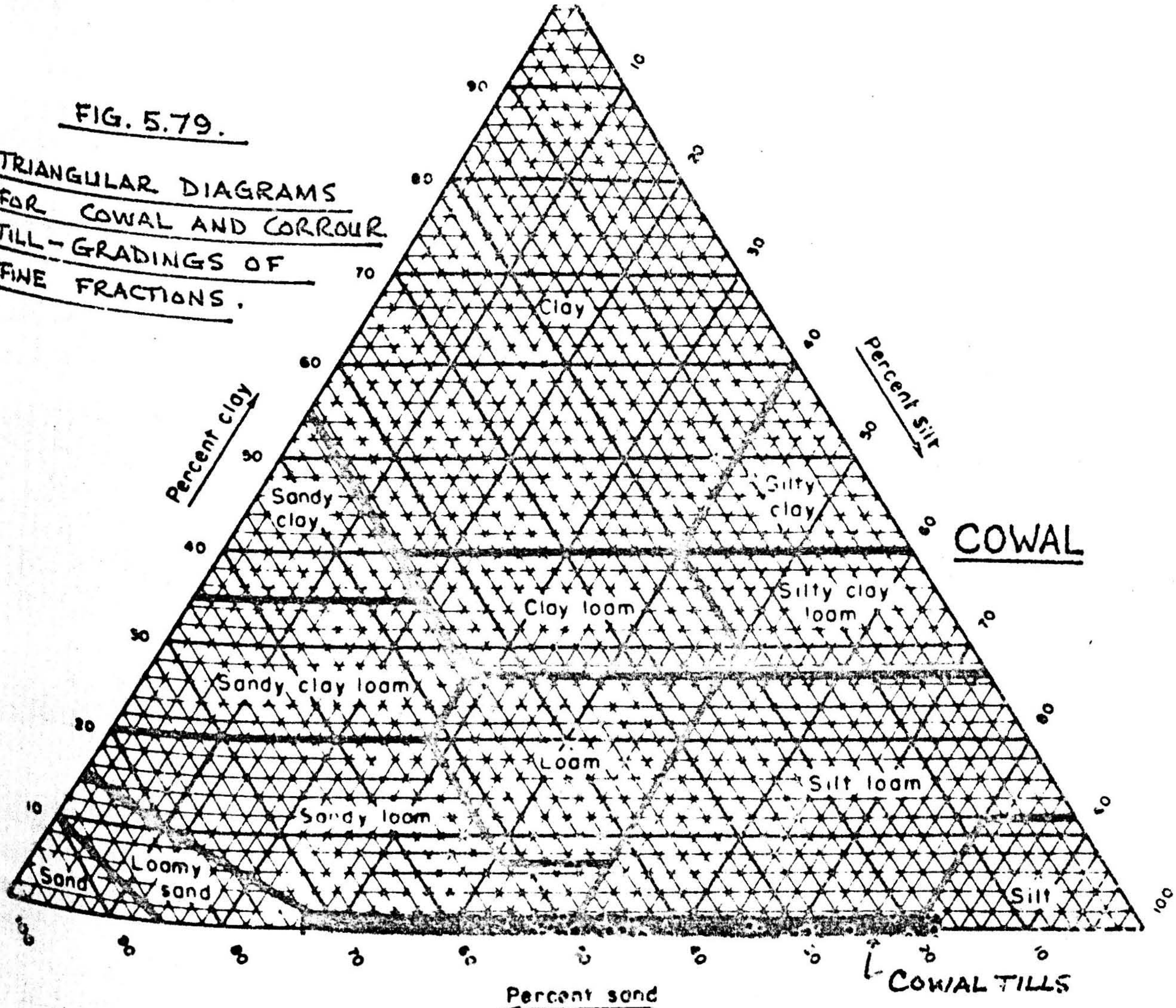


FIG. 5.7B. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR BACKWATER DAM NORTH DEPOSIT TILLS

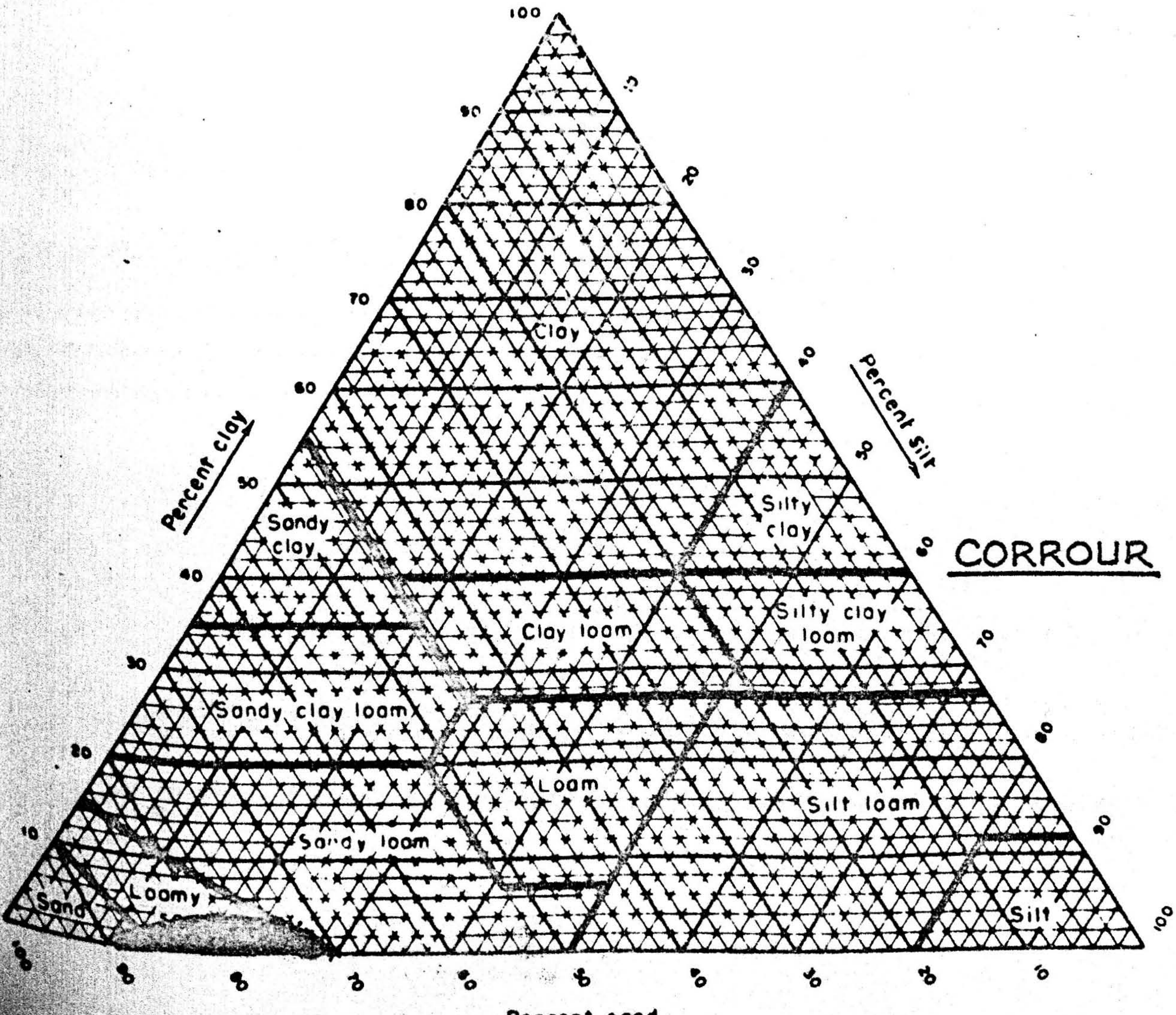
FIG. 5.79.

TRIANGULAR DIAGRAMS FOR COWAL AND CORROUR TILL-GRADINGS OF FINE FRACTIONS.



COWAL

COWAL TILLS

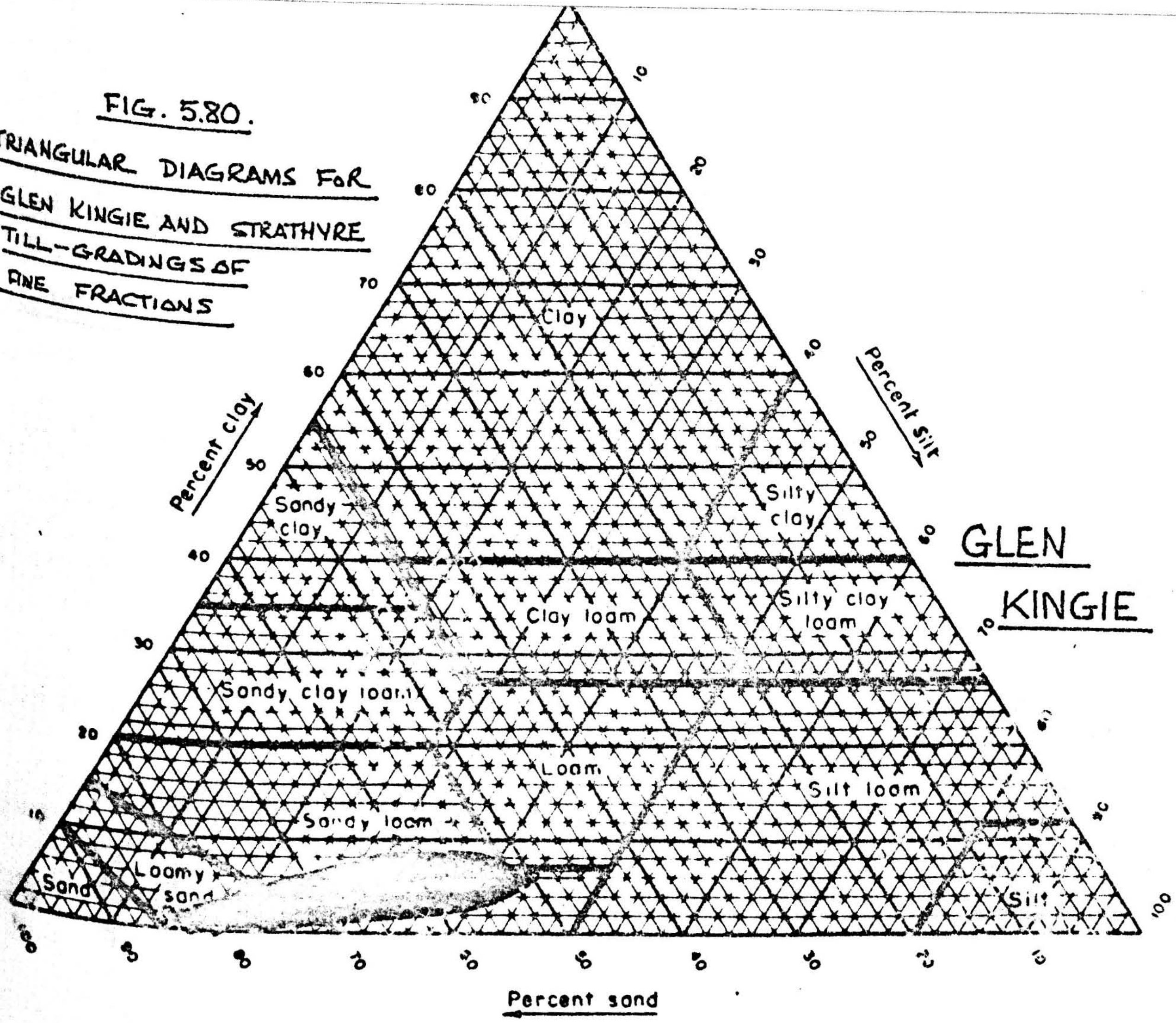


CORROUR

FIG. 5.80.

TRIANGULAR DIAGRAMS FOR GLEN KINGIE AND STRATHYRE TILL-GRADINGS OF FINE FRACTIONS

GLEN KINGIE



STRATHYRE

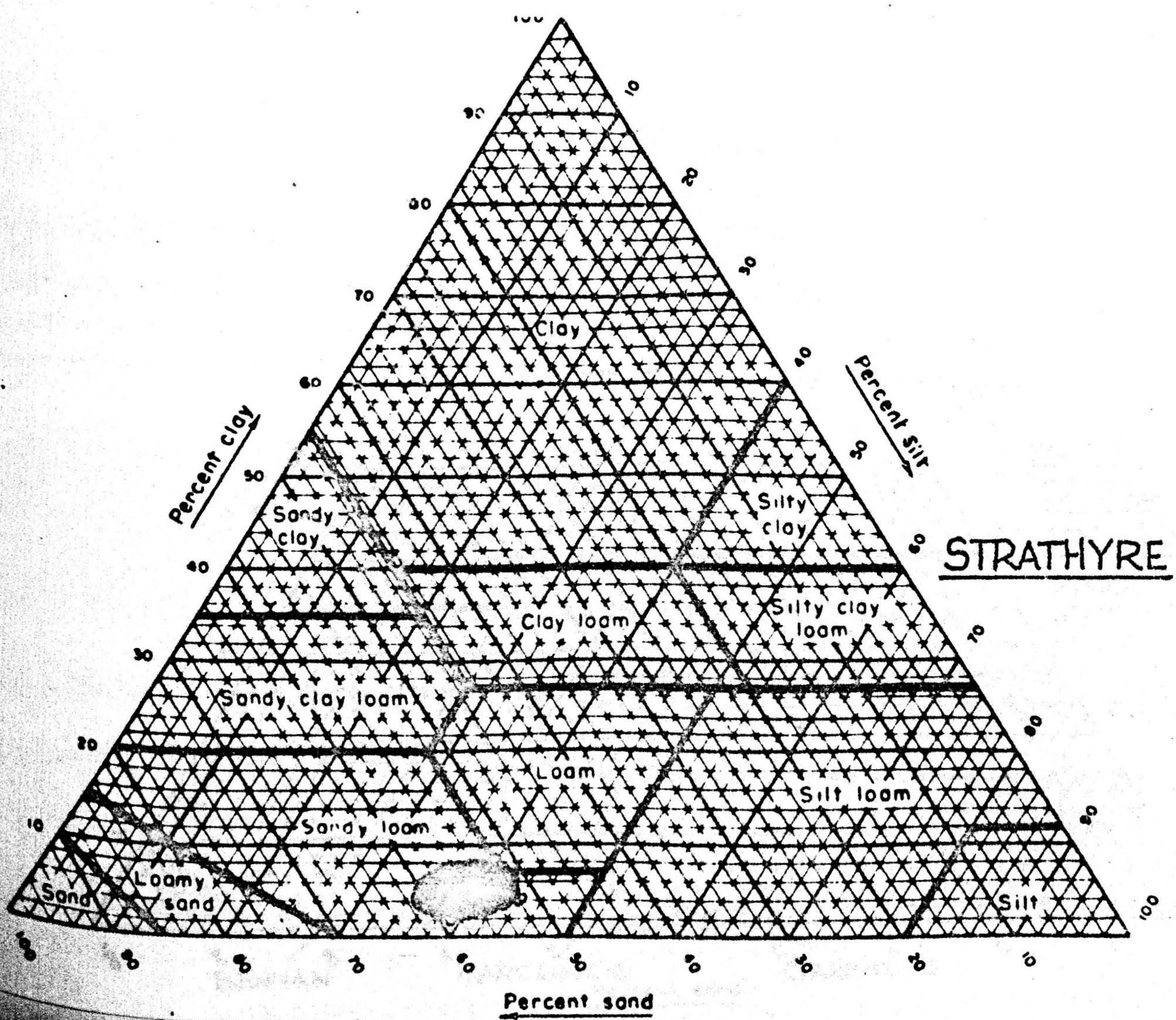
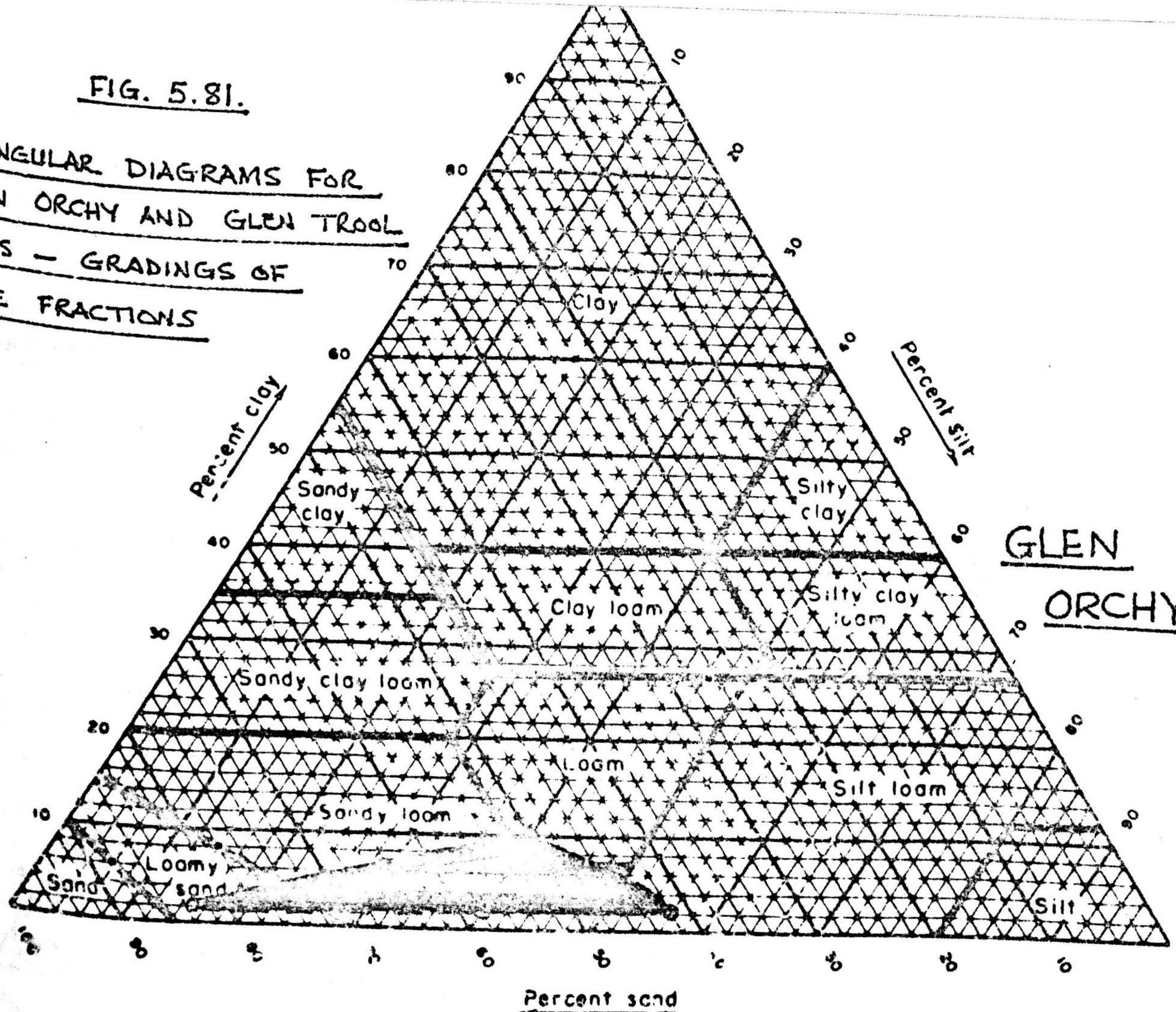
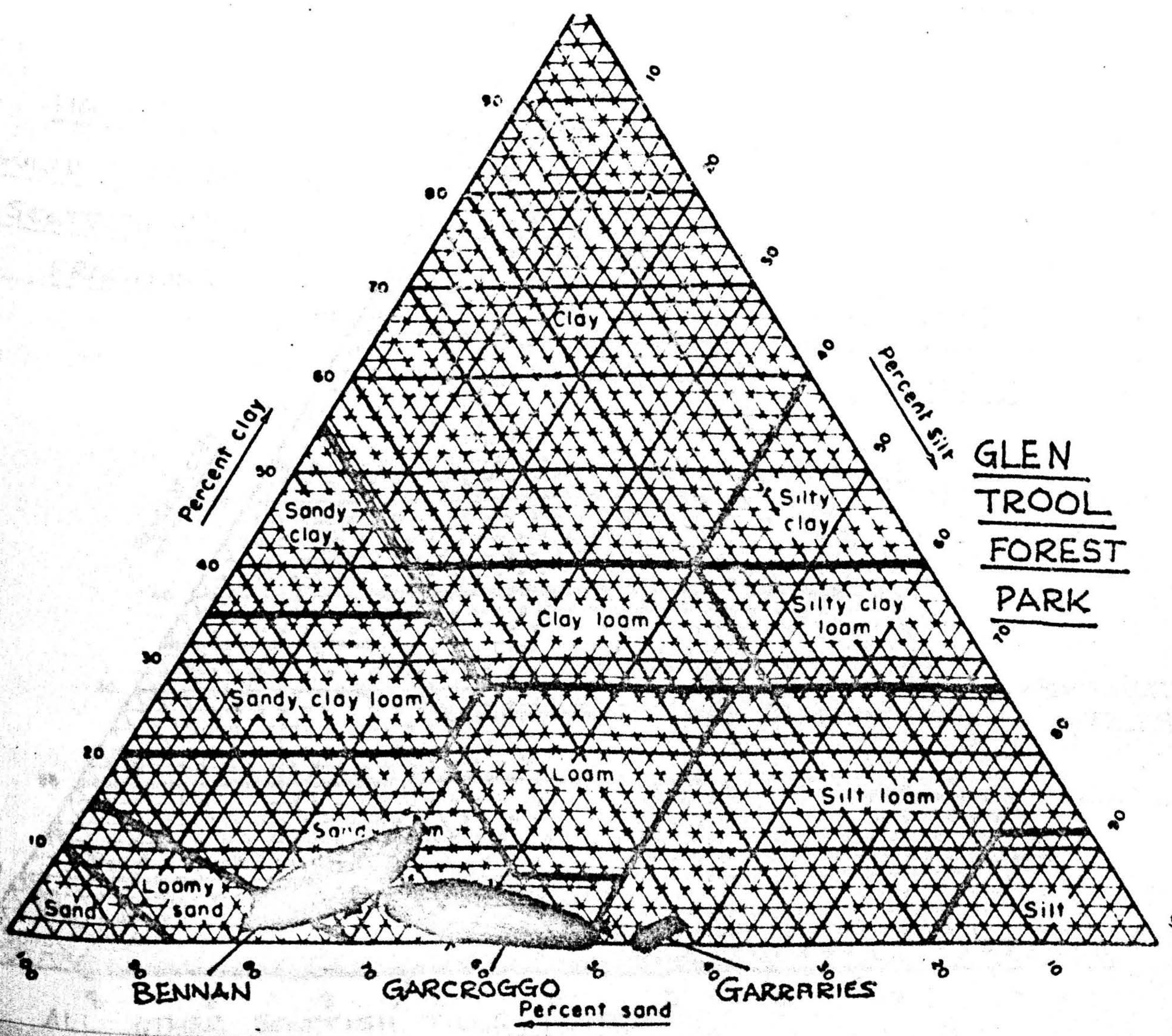


FIG. 5.81.

TRIANGULAR DIAGRAMS FOR GLEN ORCHY AND GLEN TROOL TILLS — GRADINGS OF FINE FRACTIONS



GLEN ORCHY



GLEN TROOL FOREST PARK

FIG. 5.82.

TRIANGULAR DIAGRAM FOR BACKWATER TILLS FINE FRACTIONS

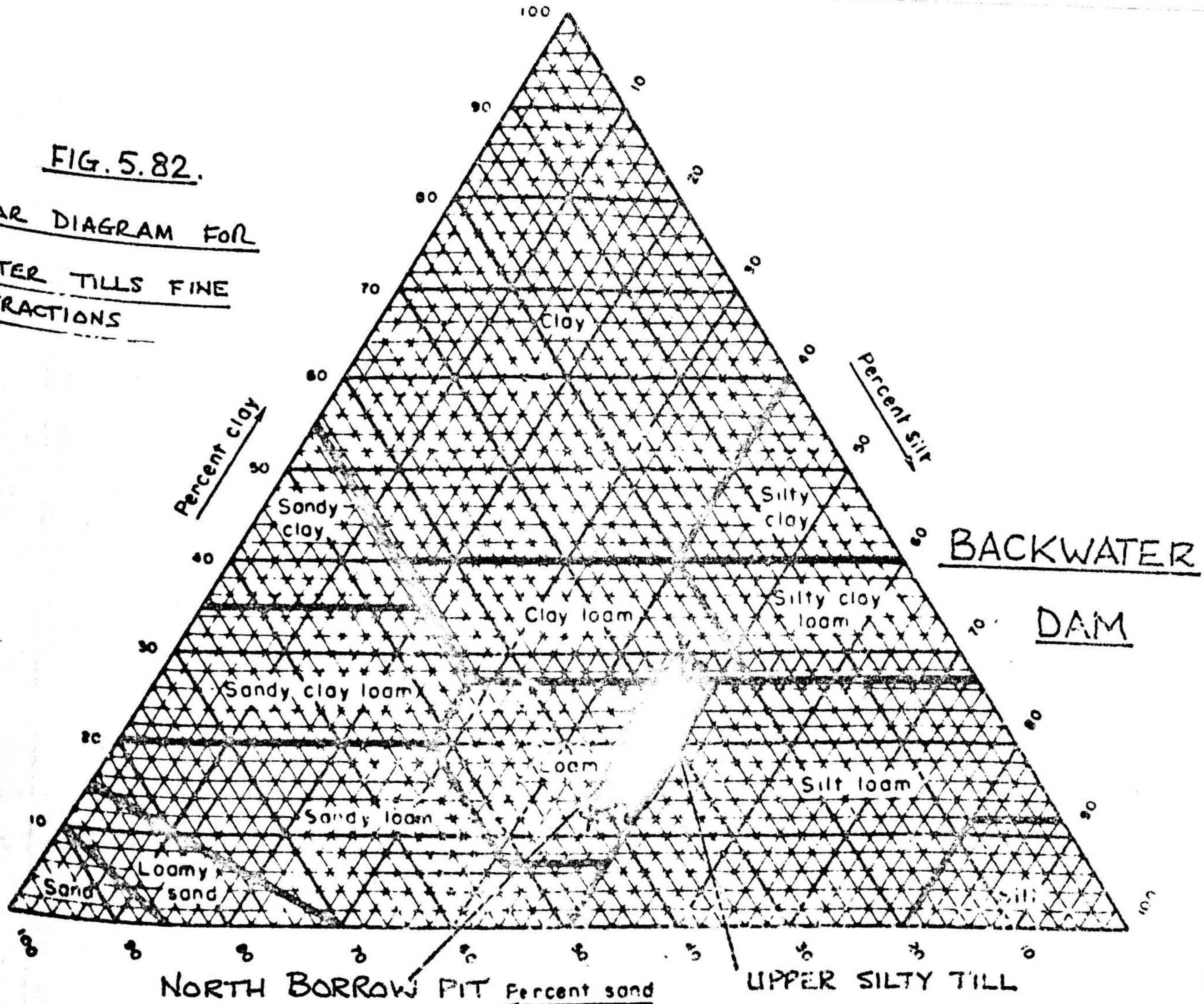
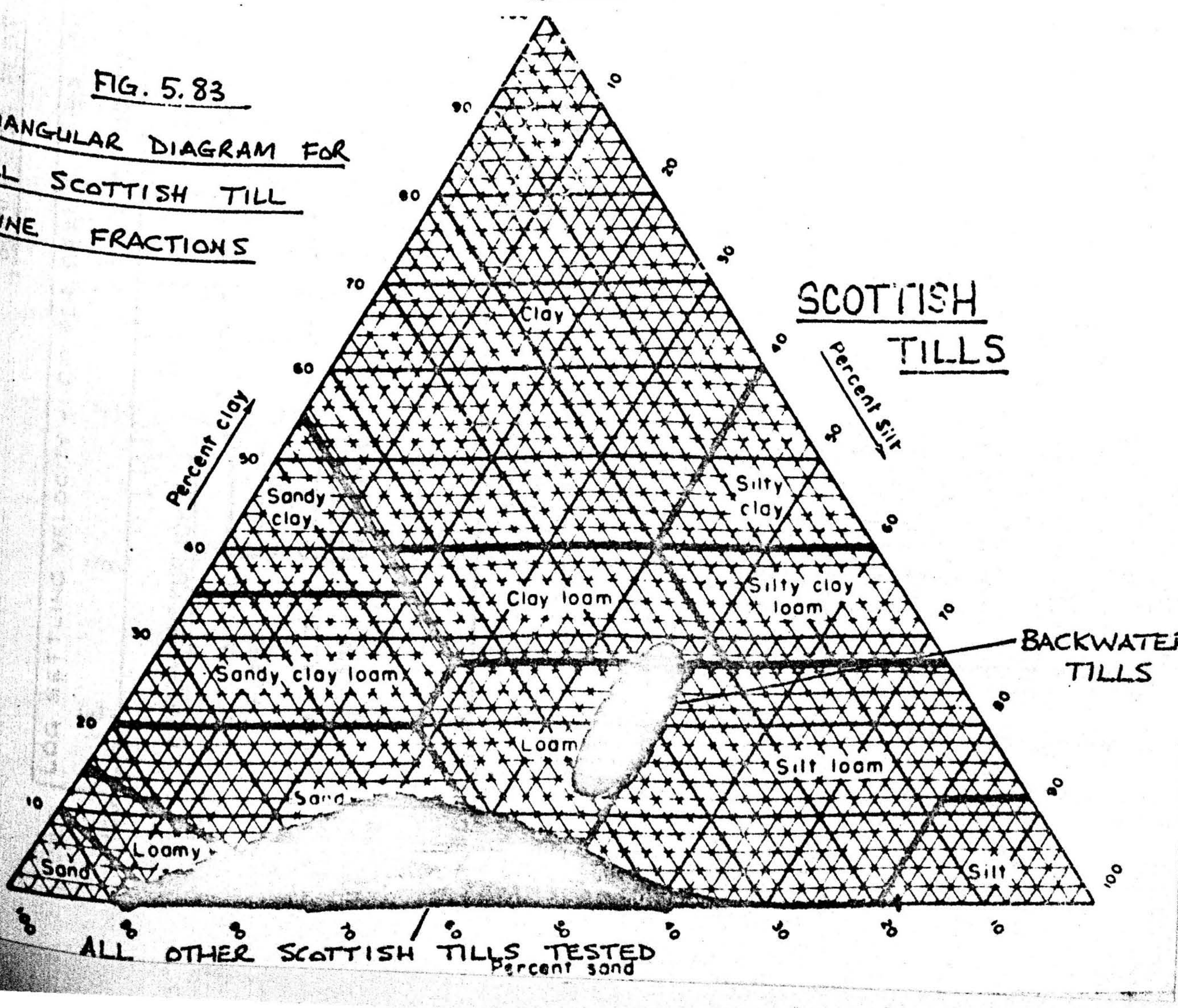


FIG. 5.83

TRIANGULAR DIAGRAM FOR ALL SCOTTISH TILL FINE FRACTIONS



PARTICLE SIZE DISTRIBUTION

SEMI - LOG PLOT

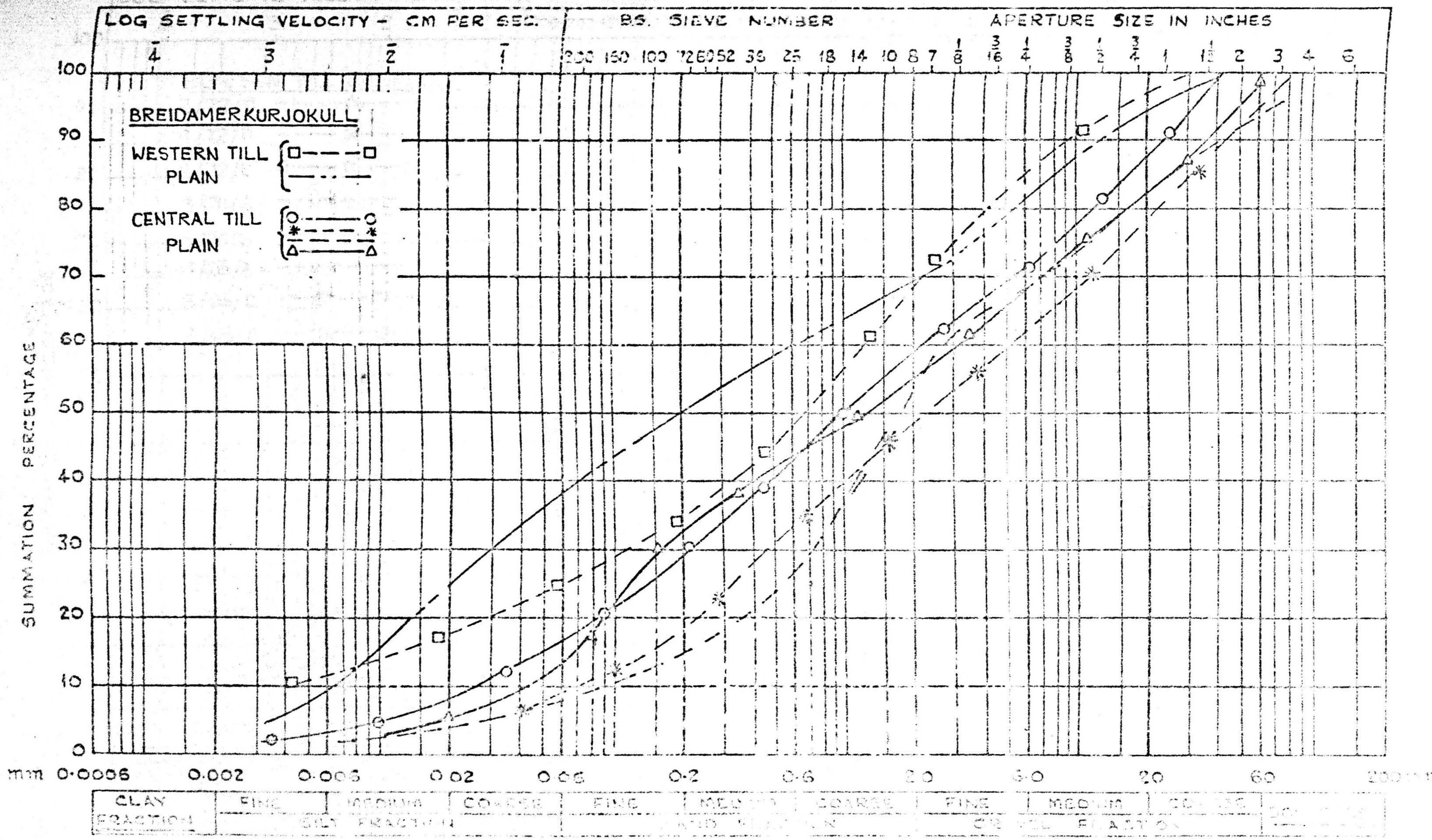


FIG. 5.84 GRADINGS FOR BREIDAMERKURJOKULL TILLS

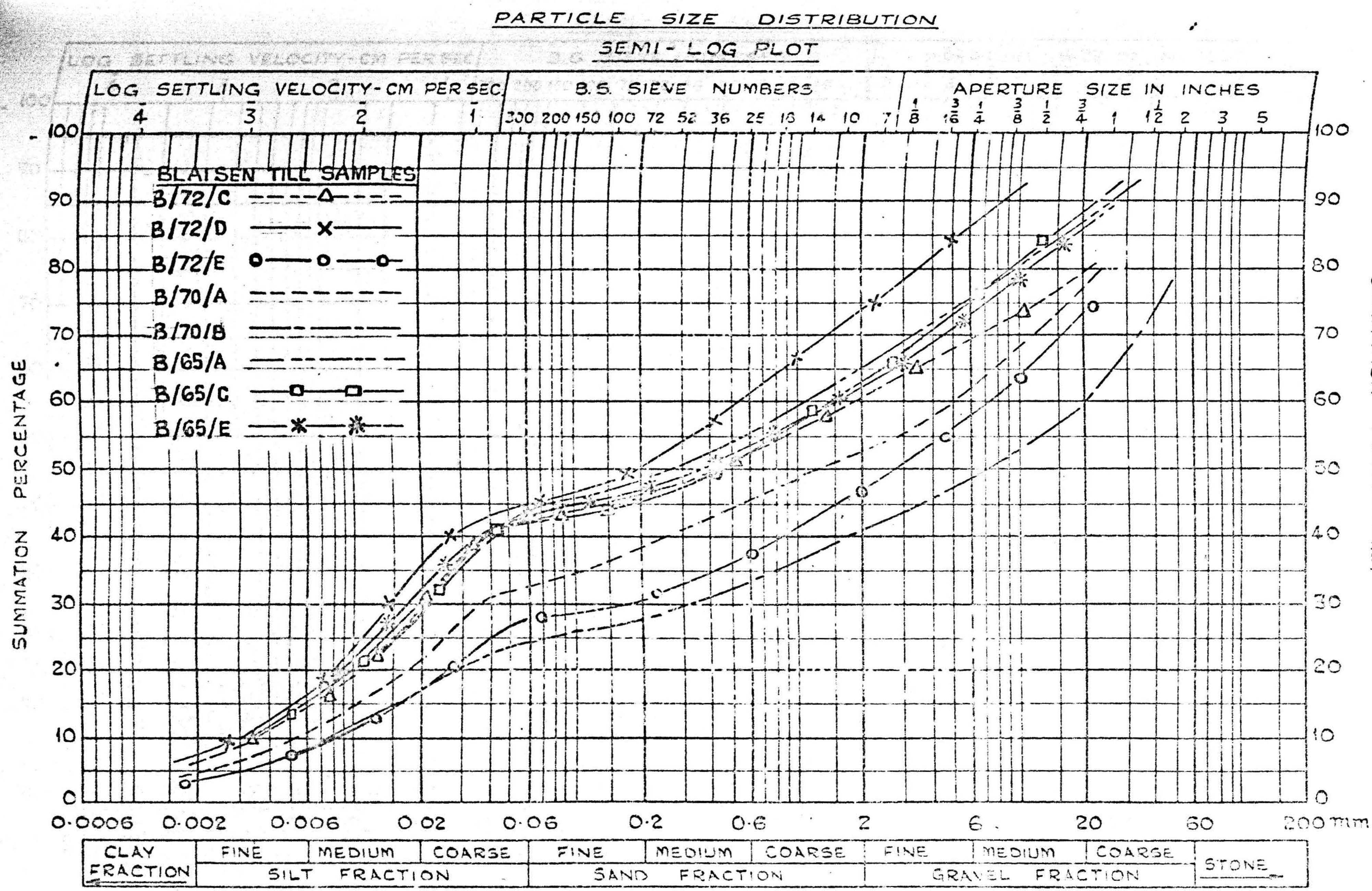


FIG. 5.85 GRADINGS FOR BLAISEN TILLS.

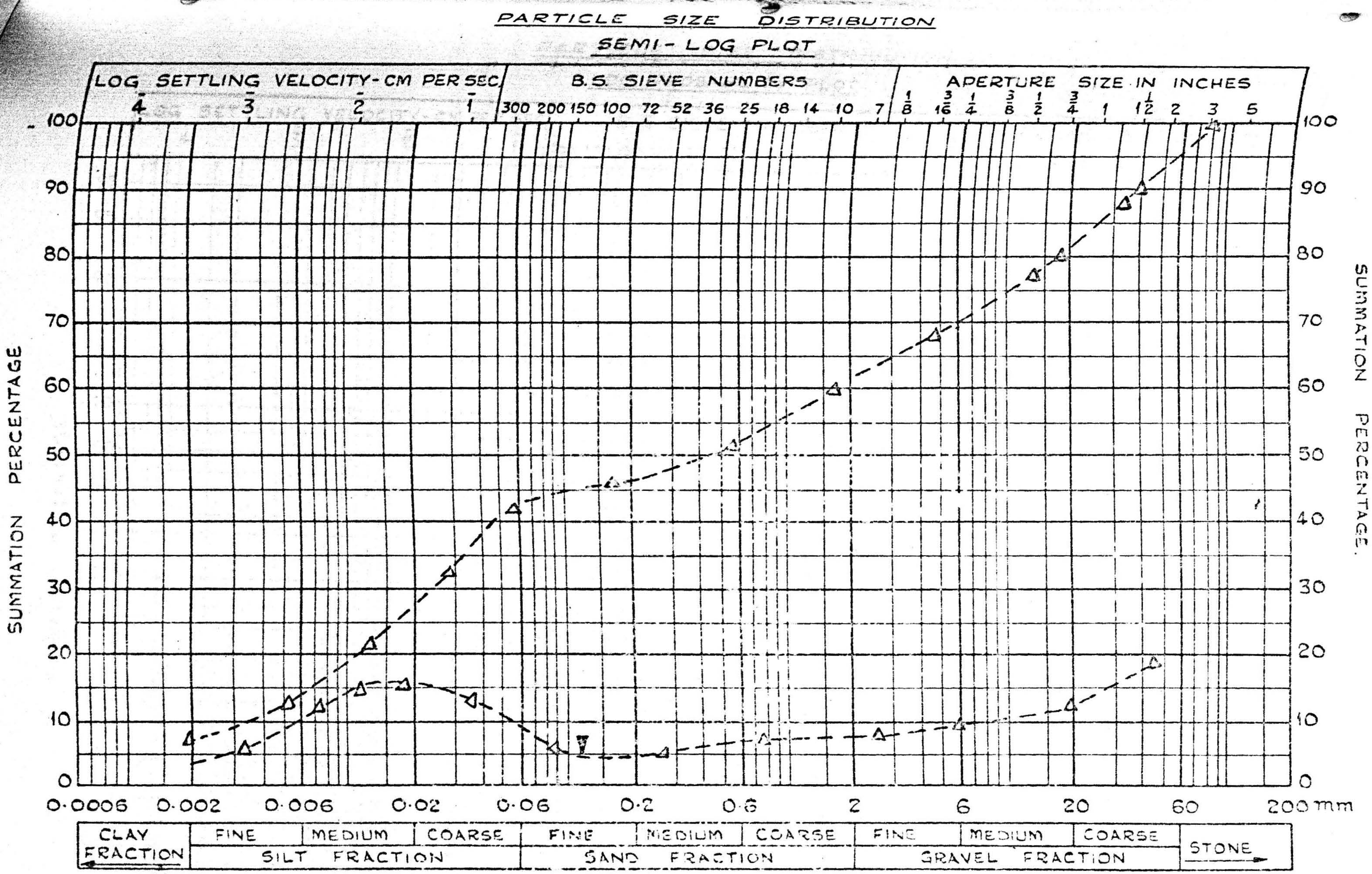


FIG. 5.86 BLAISEN TILL - PLOT SHOWING THE CUMULATIVE AND FREQUENCY DISTRIBUTION CURVES FOR B/72/C

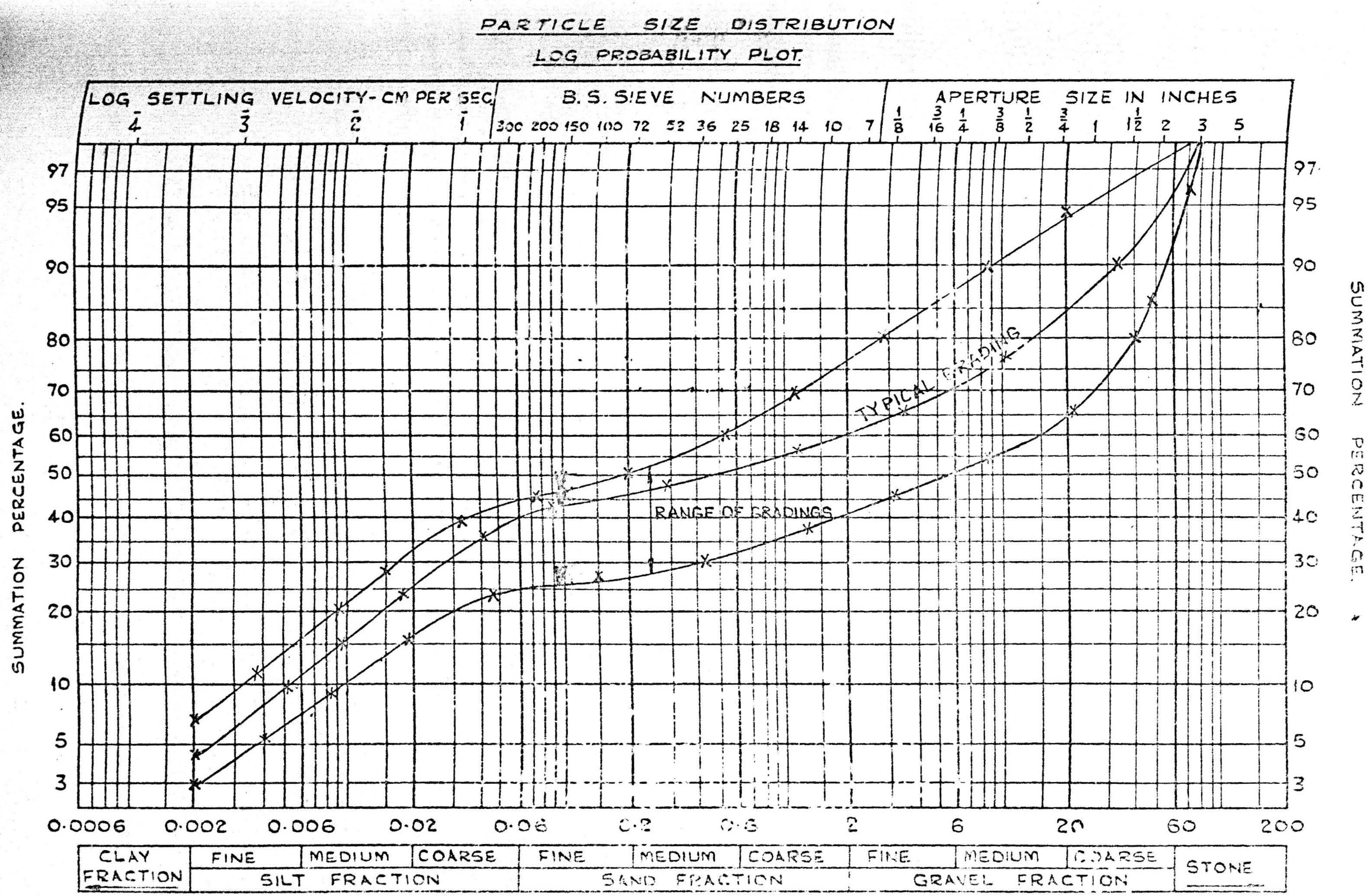


FIG. 5.87 LOG PROBABILITY PLOT OF BLAKEEN TILL GRADINGS.

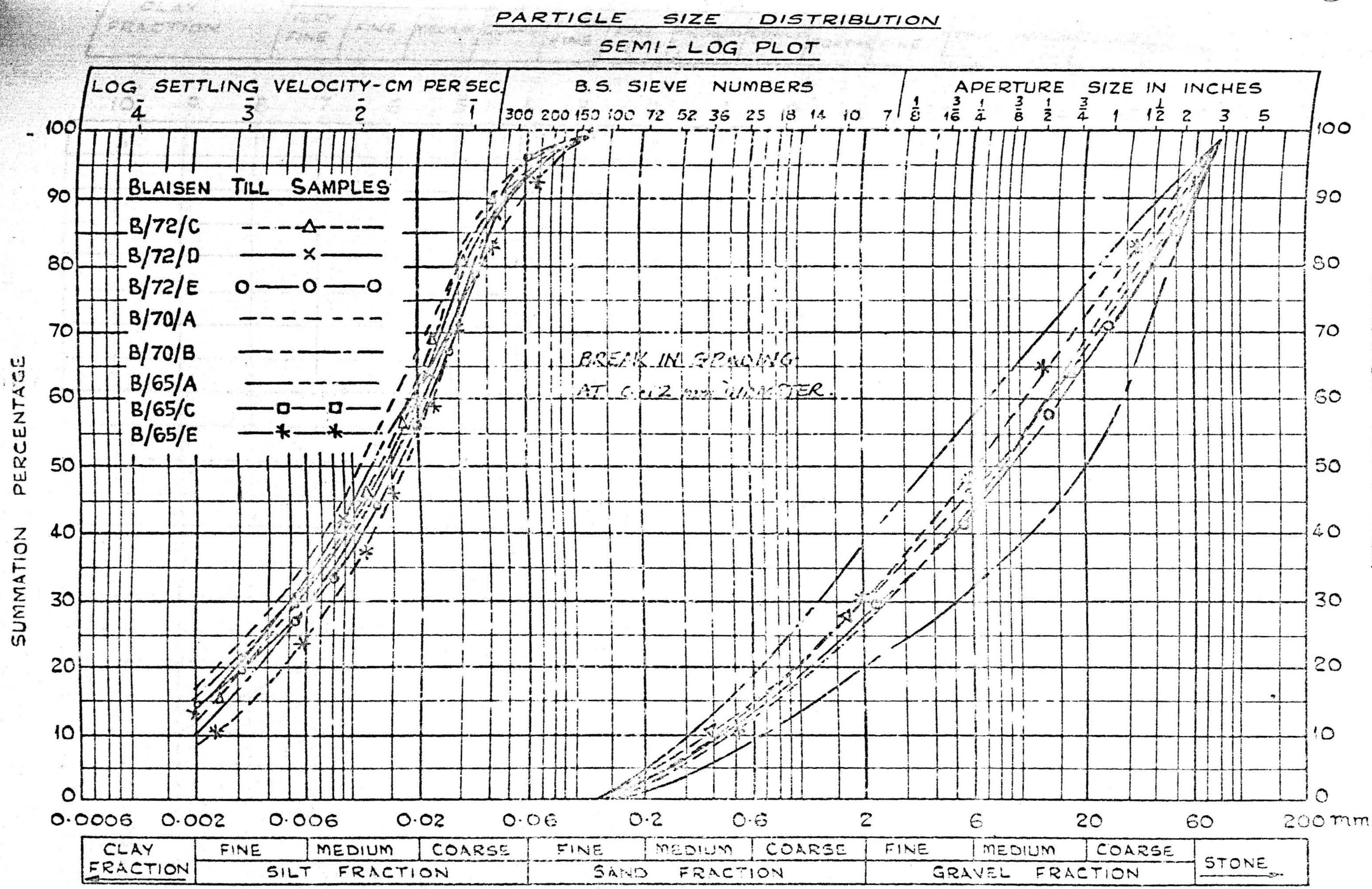


FIG. 5.88. SIZE FRACTIONS FOR BLAISEN TILLS.

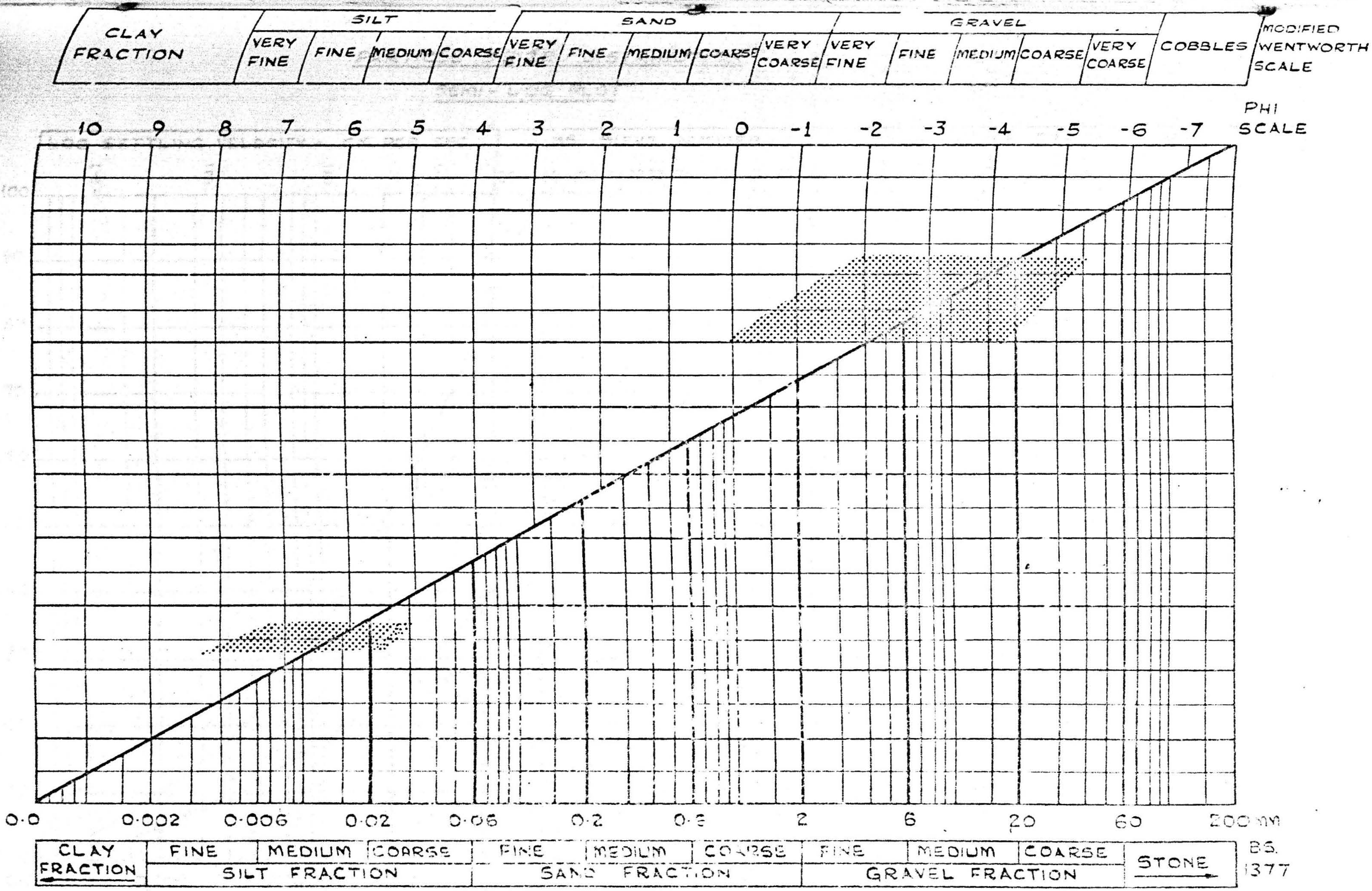


FIG. 5.89. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR [illegible] TILL

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

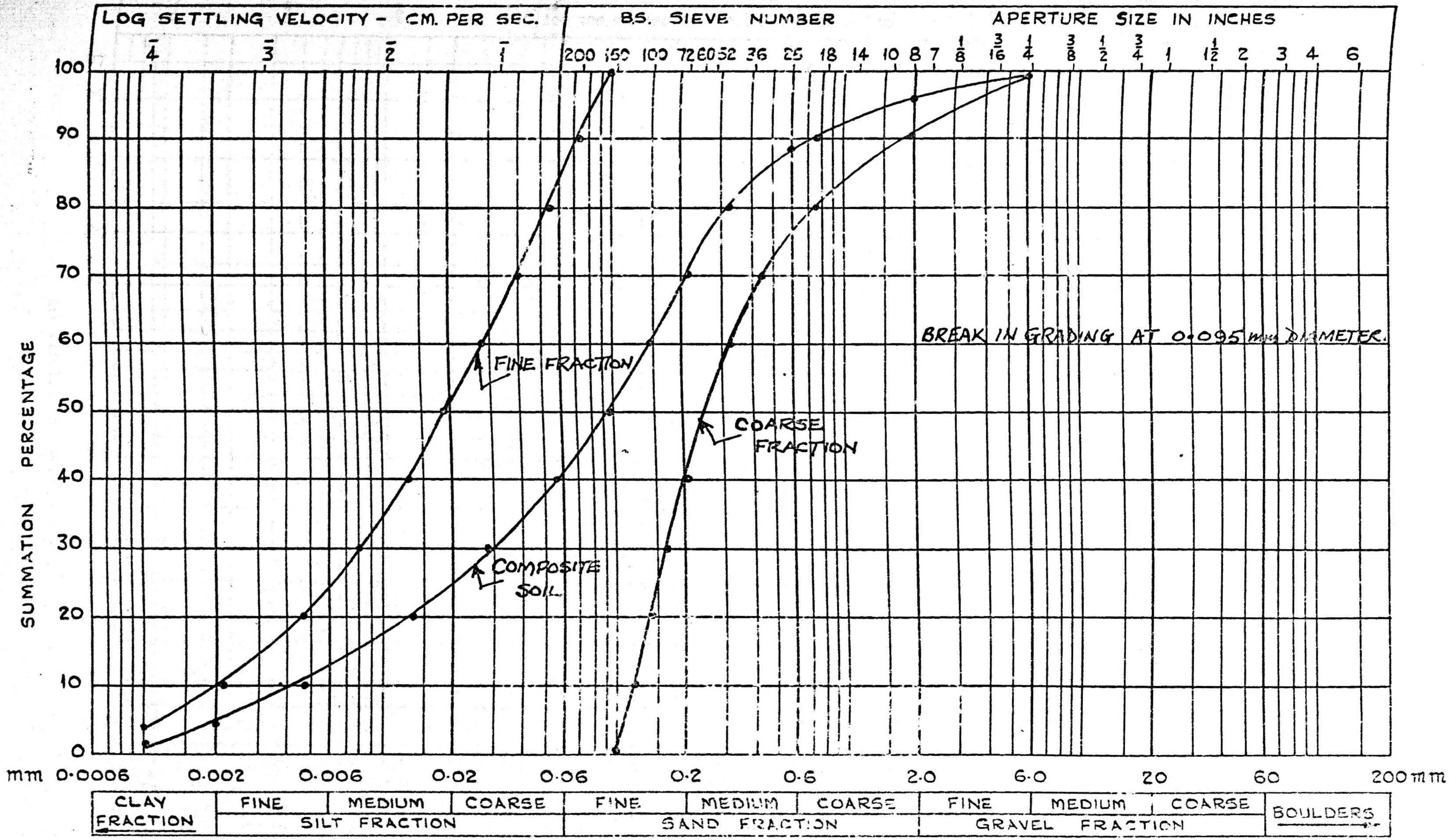


FIG 5.90. SIZE FRACTIONS FOR ANTARCTICA TILL.

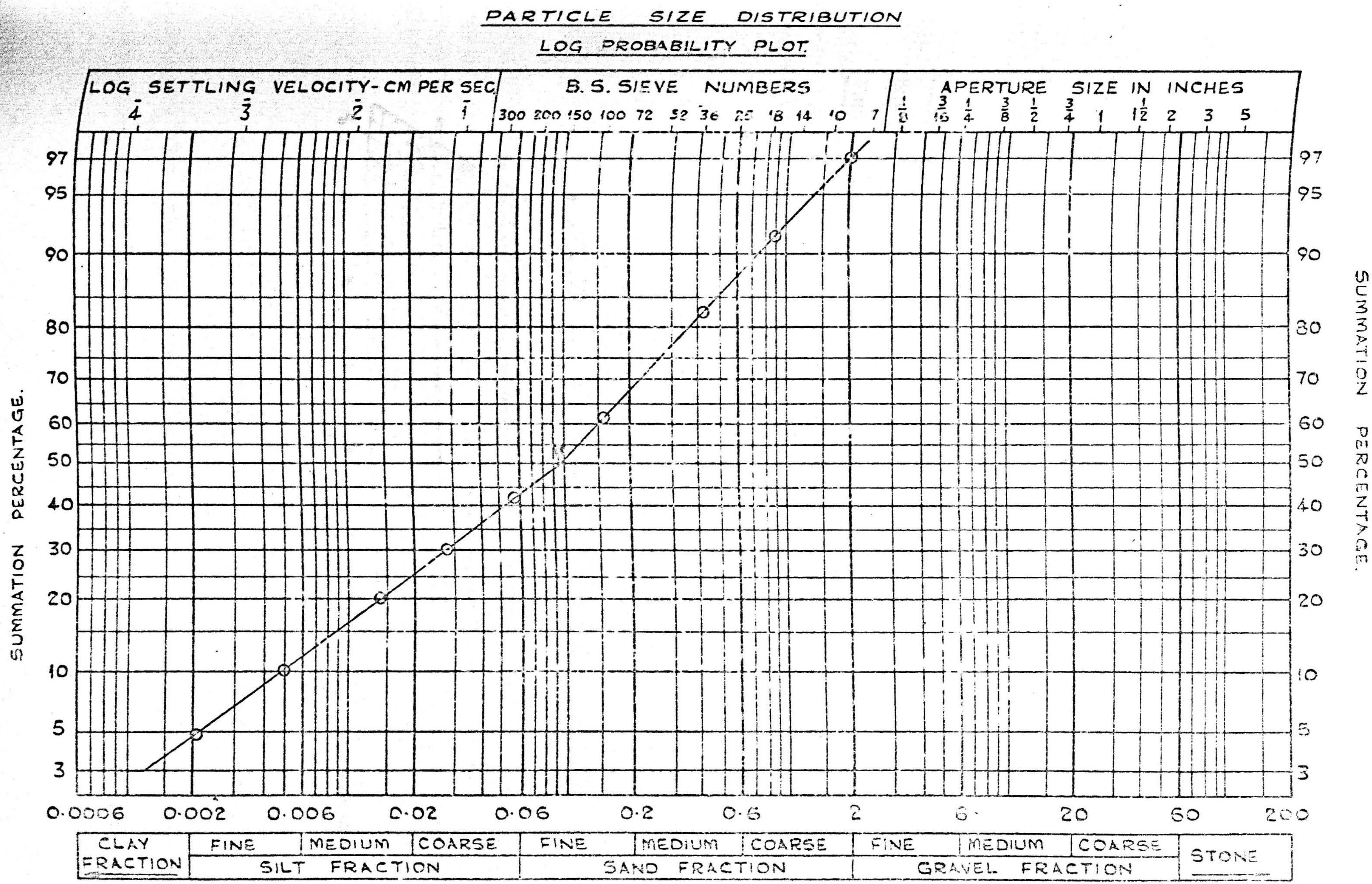
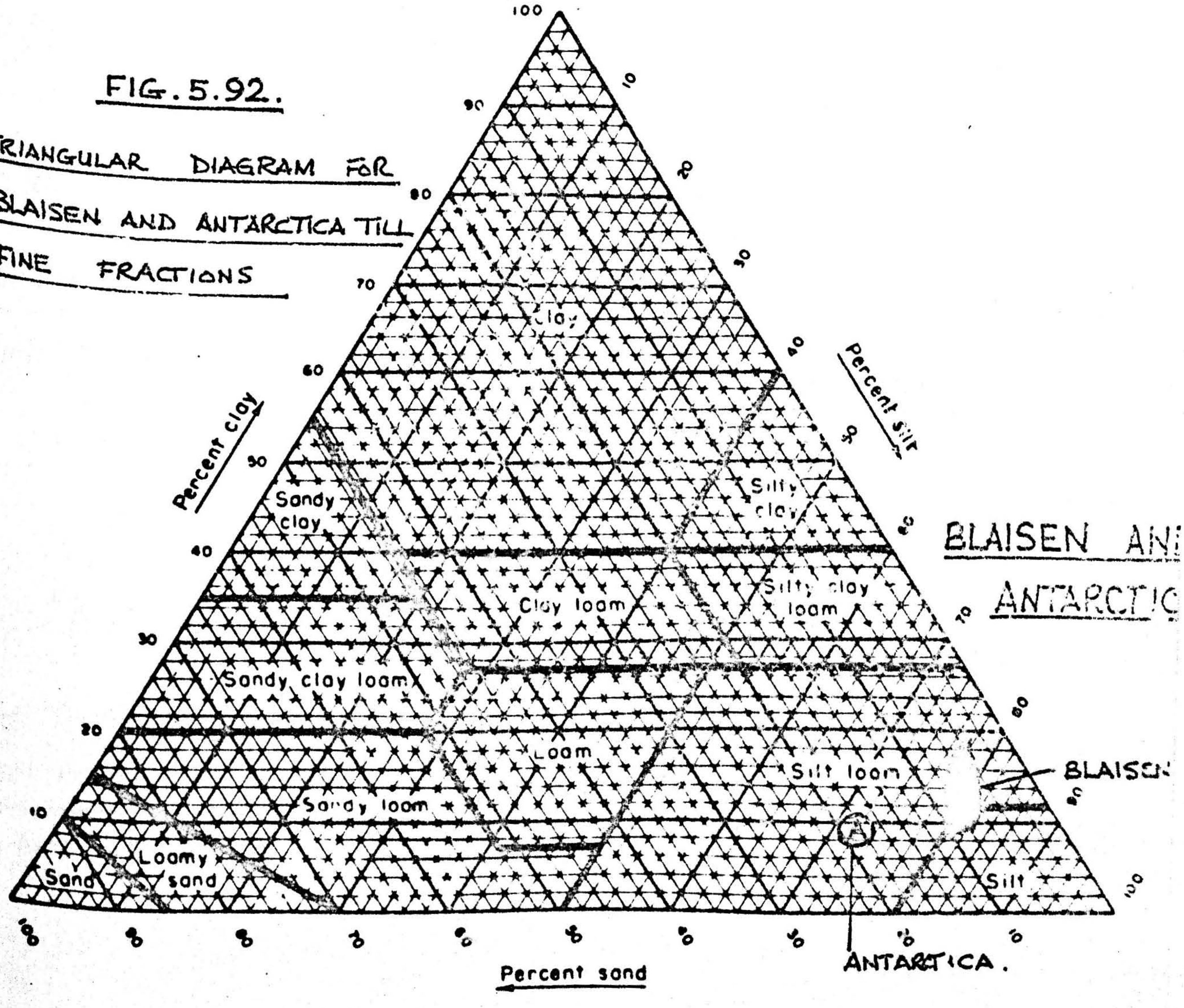


FIG. 5.91 LOG PROBABILITY PLOT FOR ANTARCTICA TILL

FIG. 5.92.

TRIANGULAR DIAGRAM FOR BLAISEN AND ANTARCTICA TILL FINE FRACTIONS



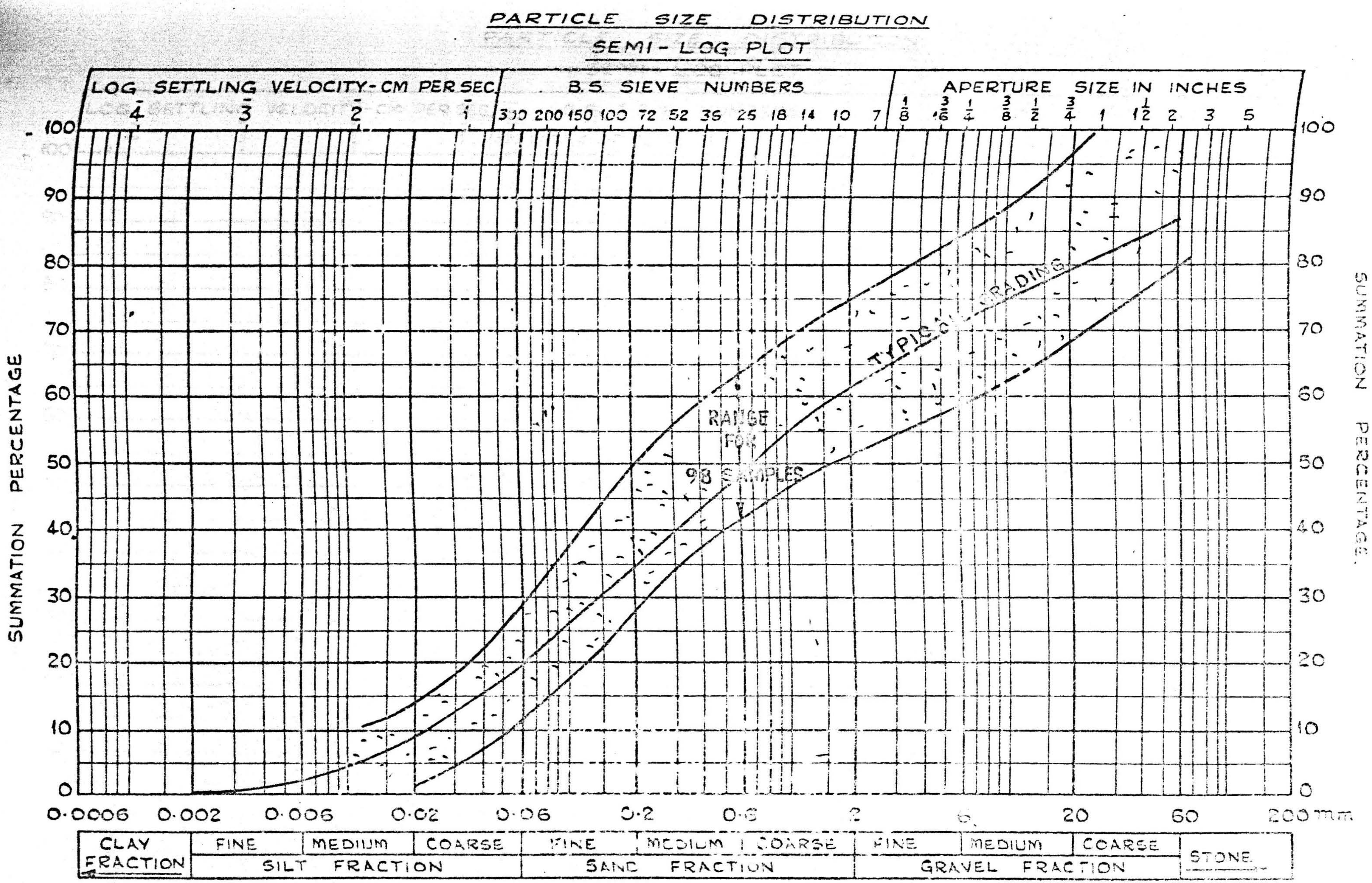


FIG 5.93 GRADINGS FOR BORDAL DAM TILL (2)

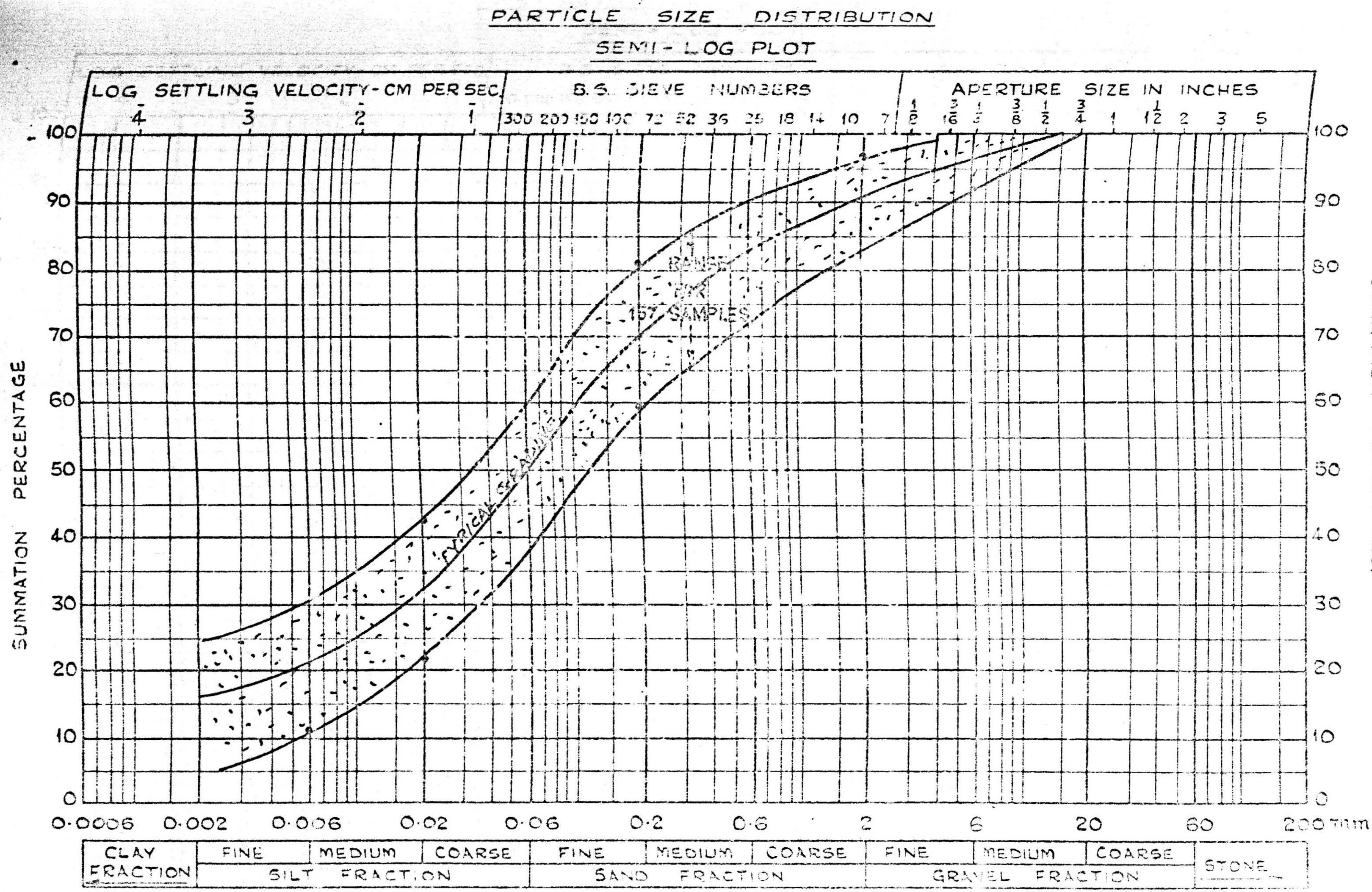


FIG. 5.94. GRADINGS FOR ARSTADDALEN DAM TILL (7)

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

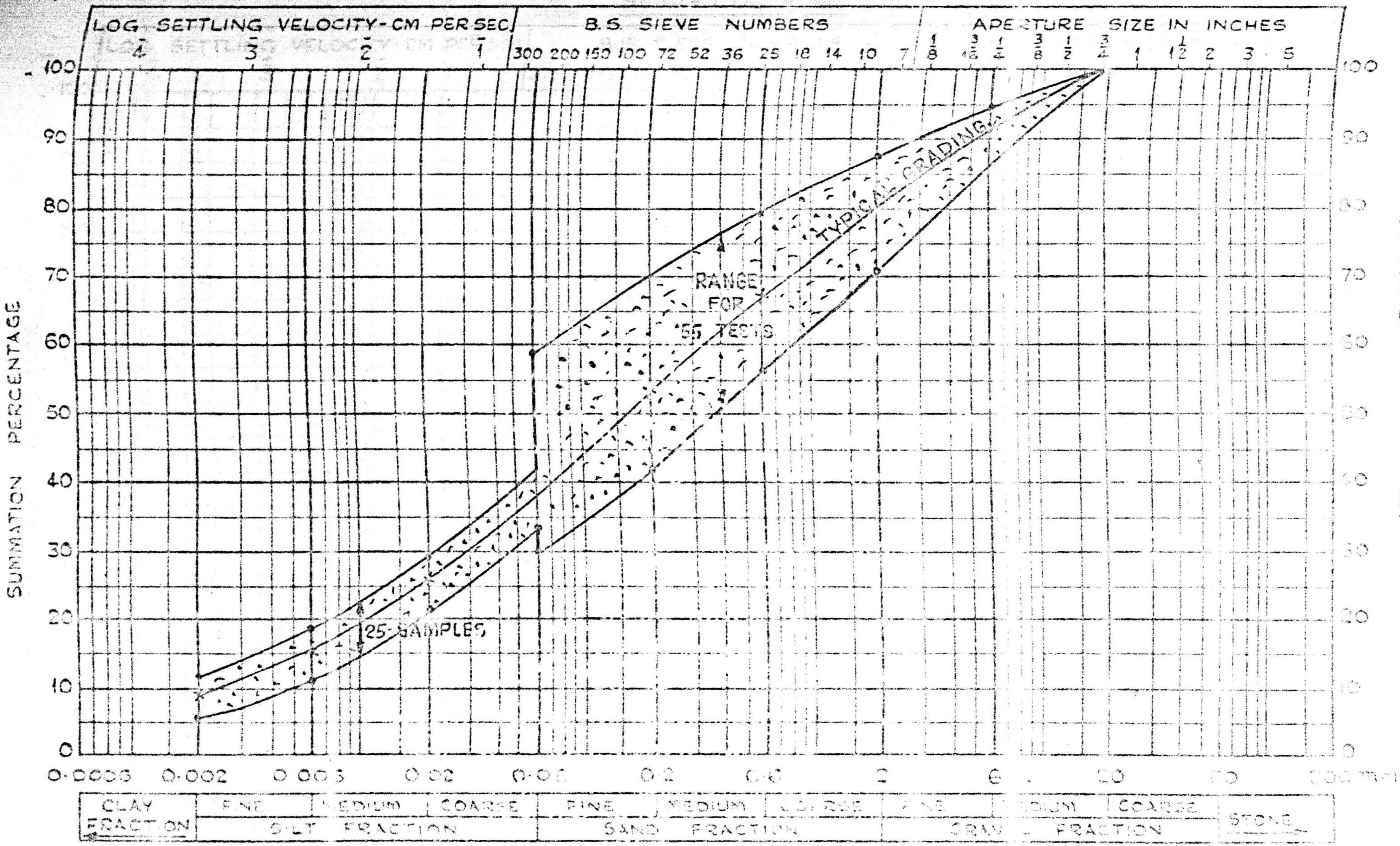
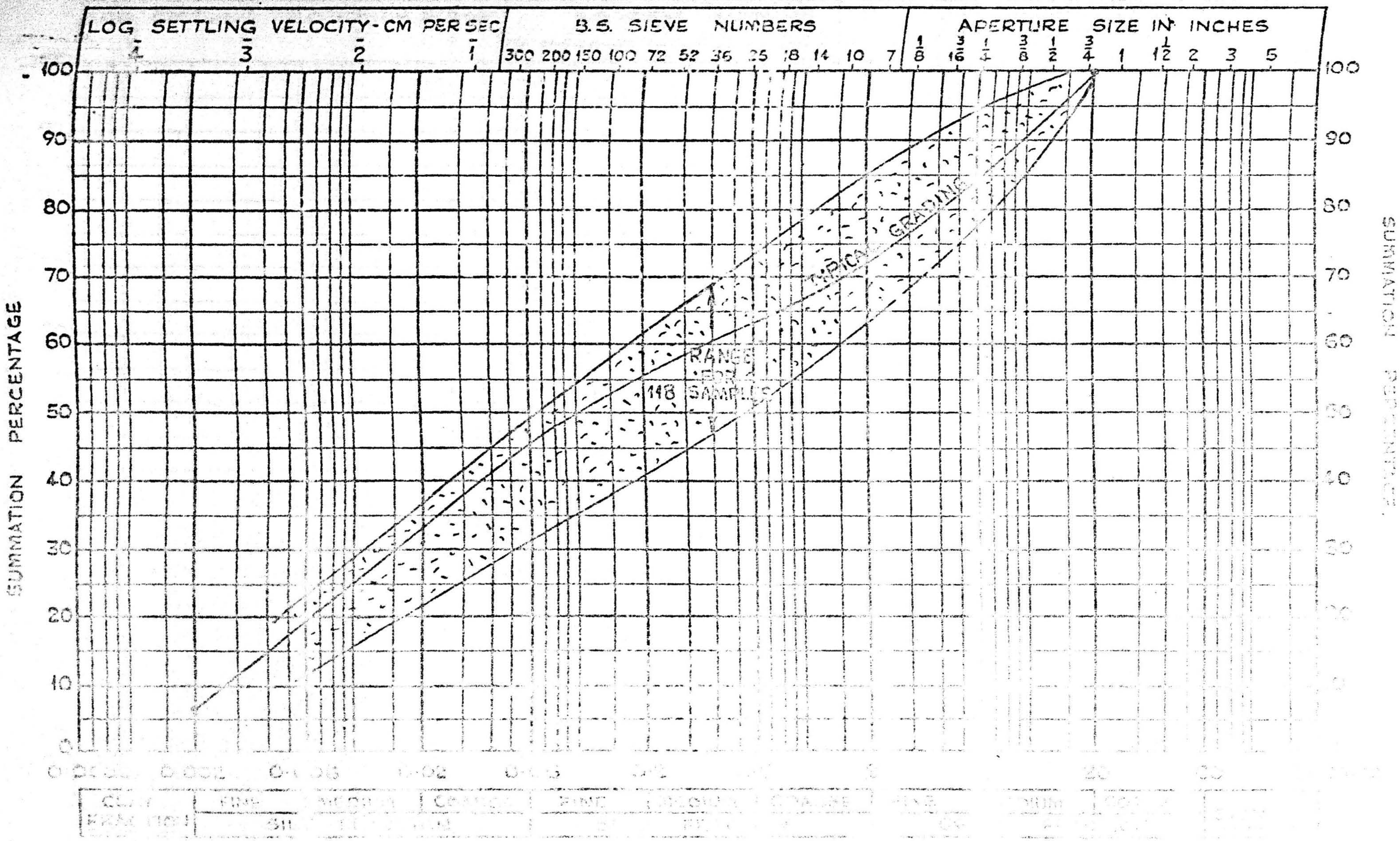


FIG 5.95. GRADINGS FOR TUNHOVD DAM TILL (12)

FORM A

PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT



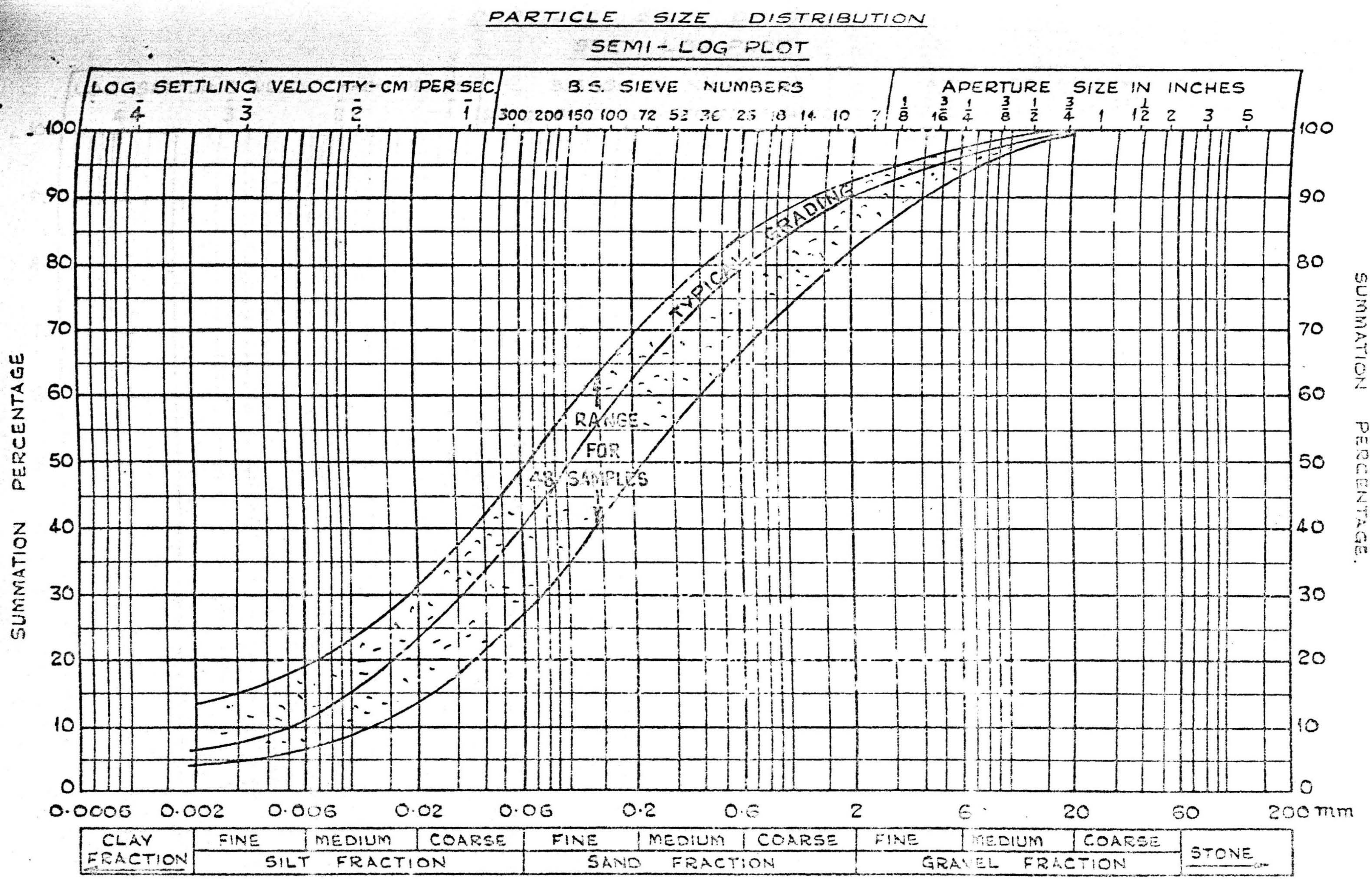


FIG. 5·97 GRADINGS FOR AKERSVATN DAM TILL (17)

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

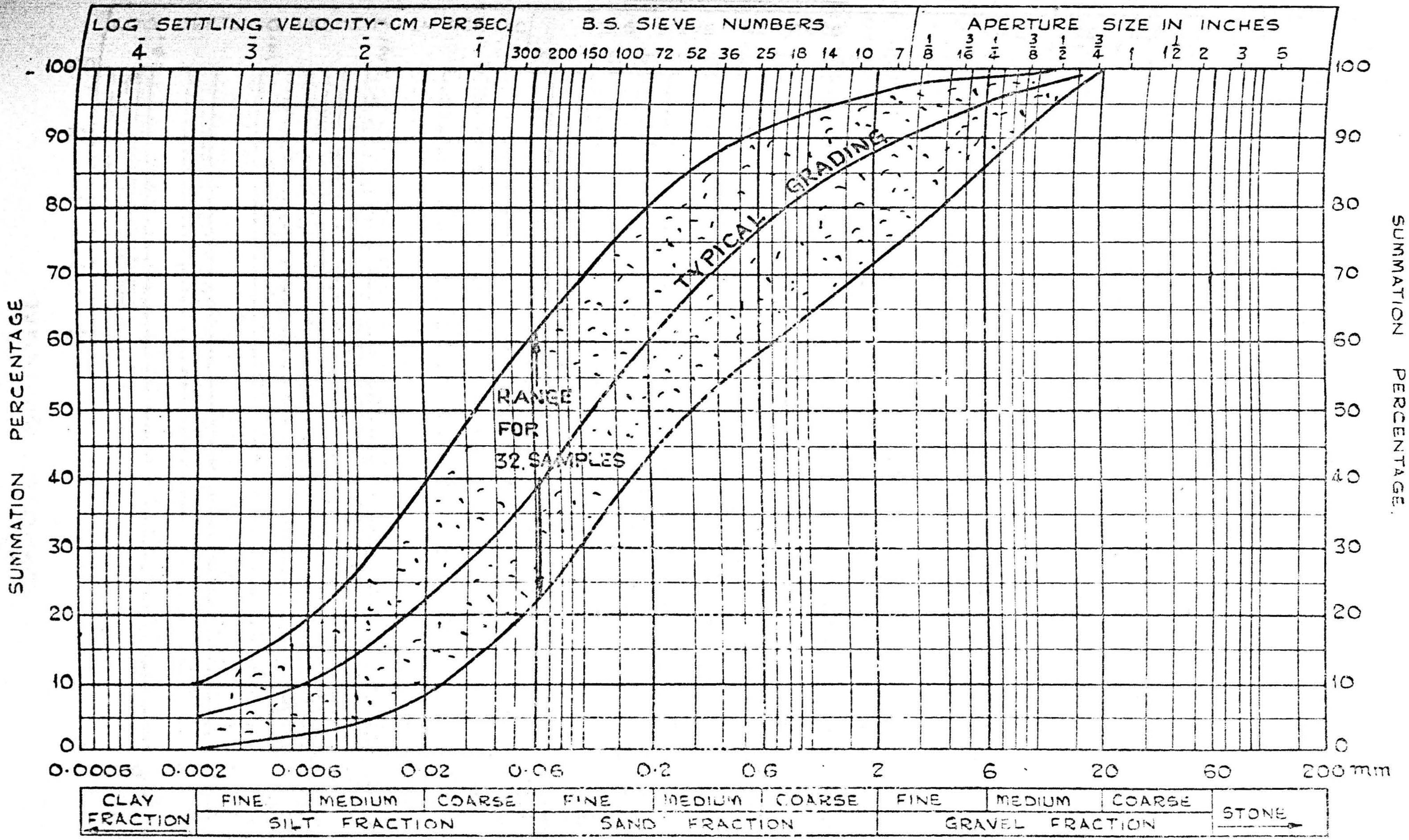


FIG. 5.98 GRADINGS FOR KALVATN (SPRUTFUSSMYRA) DAM TILL (18)

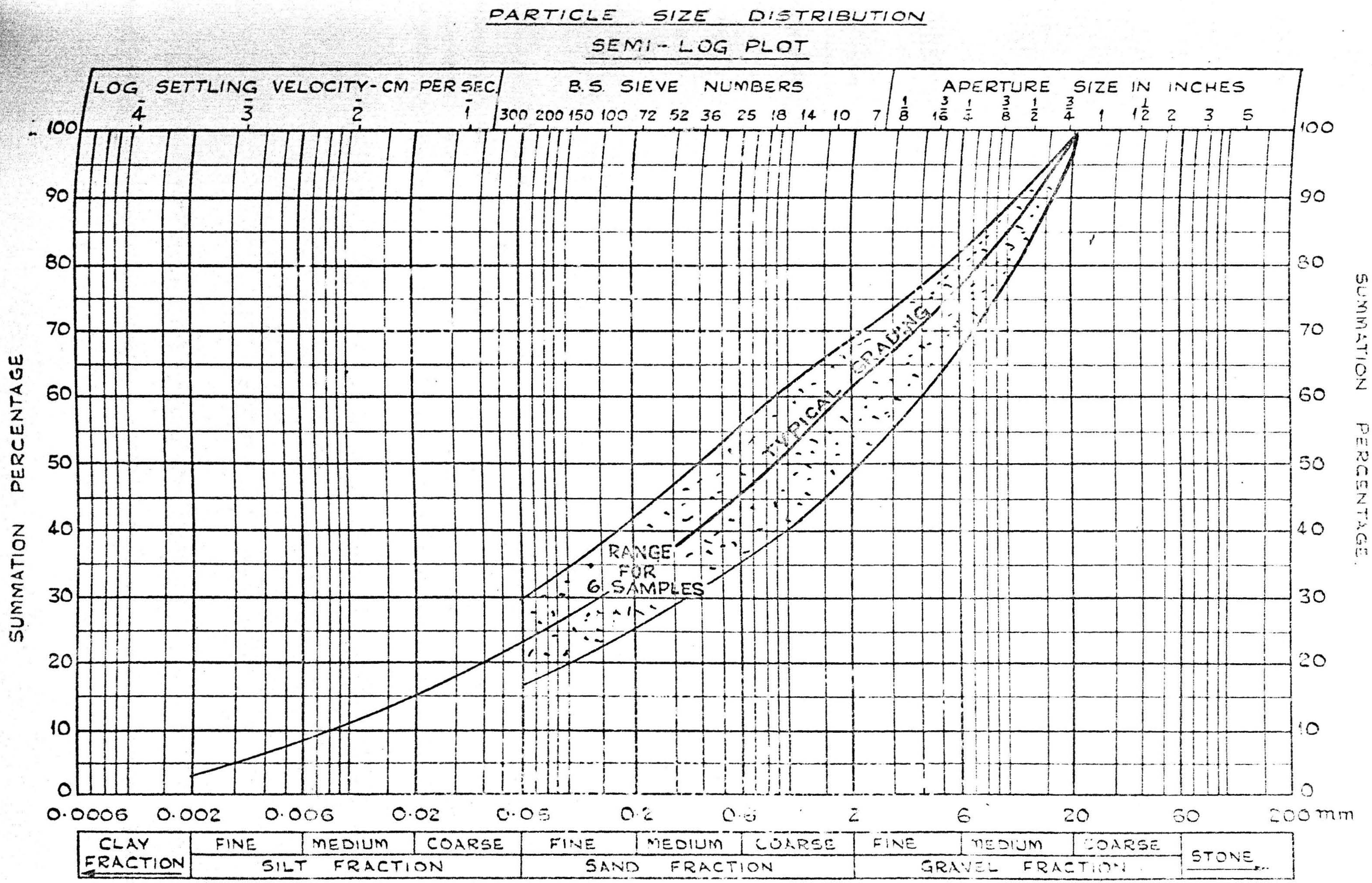


FIG 5.99 GRADINGS FOR VASSLIVATN DAM TILL (22)

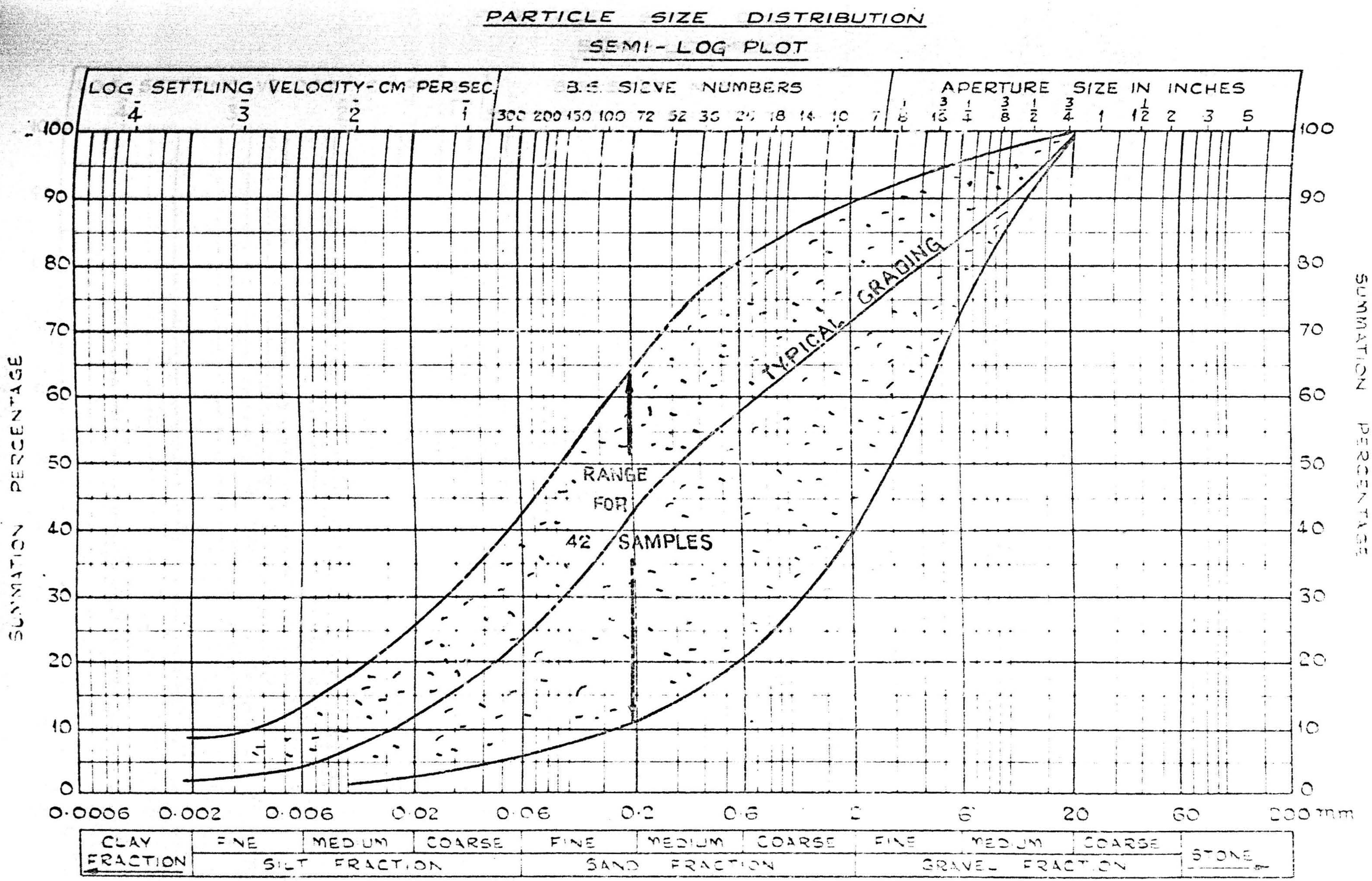


FIG 5.100 GRADINGS FOR FOLLSJØ DAM TILL (27)

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

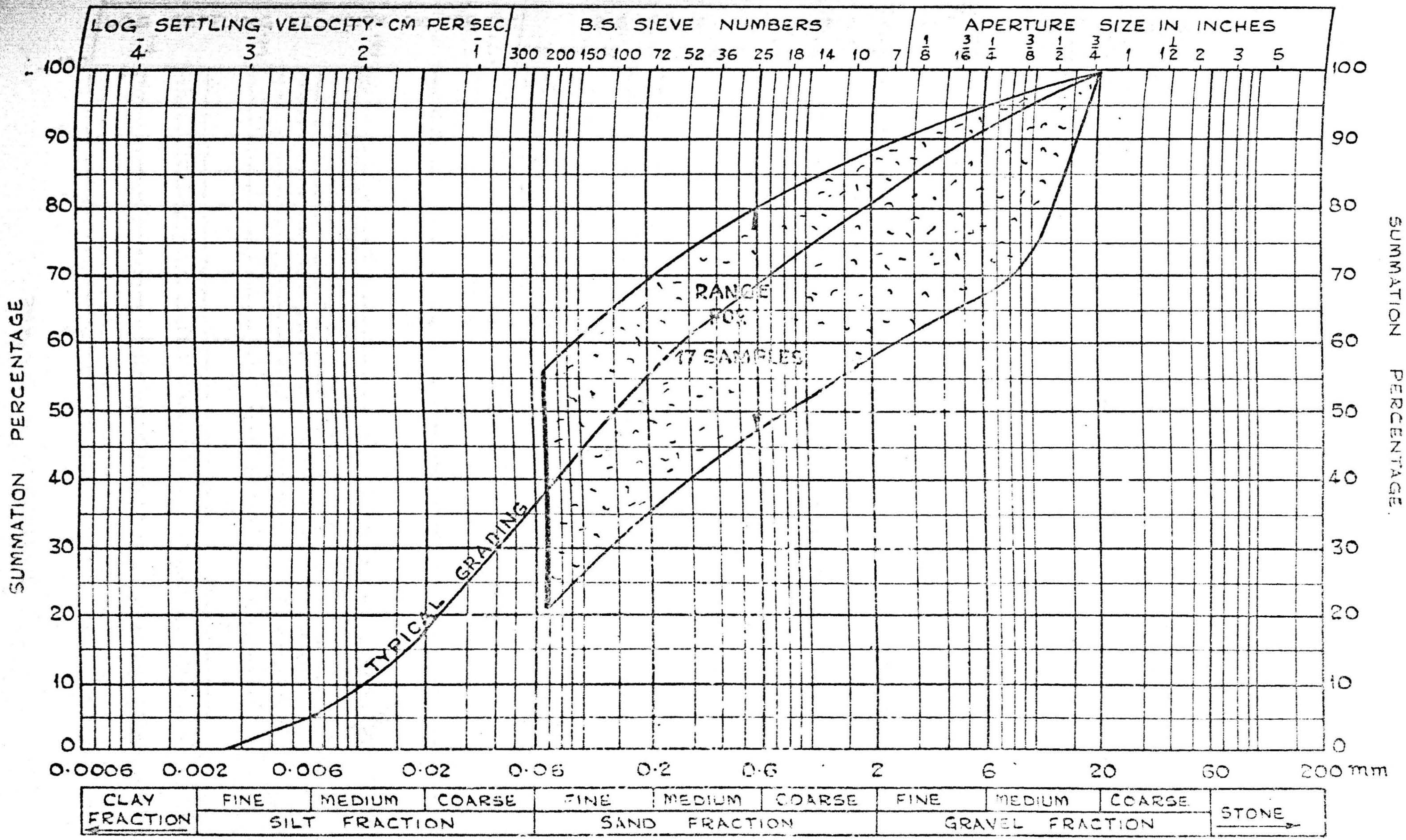


FIG. 5.101. GRADINGS FOR MANNDULA DAM TILL (28)

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

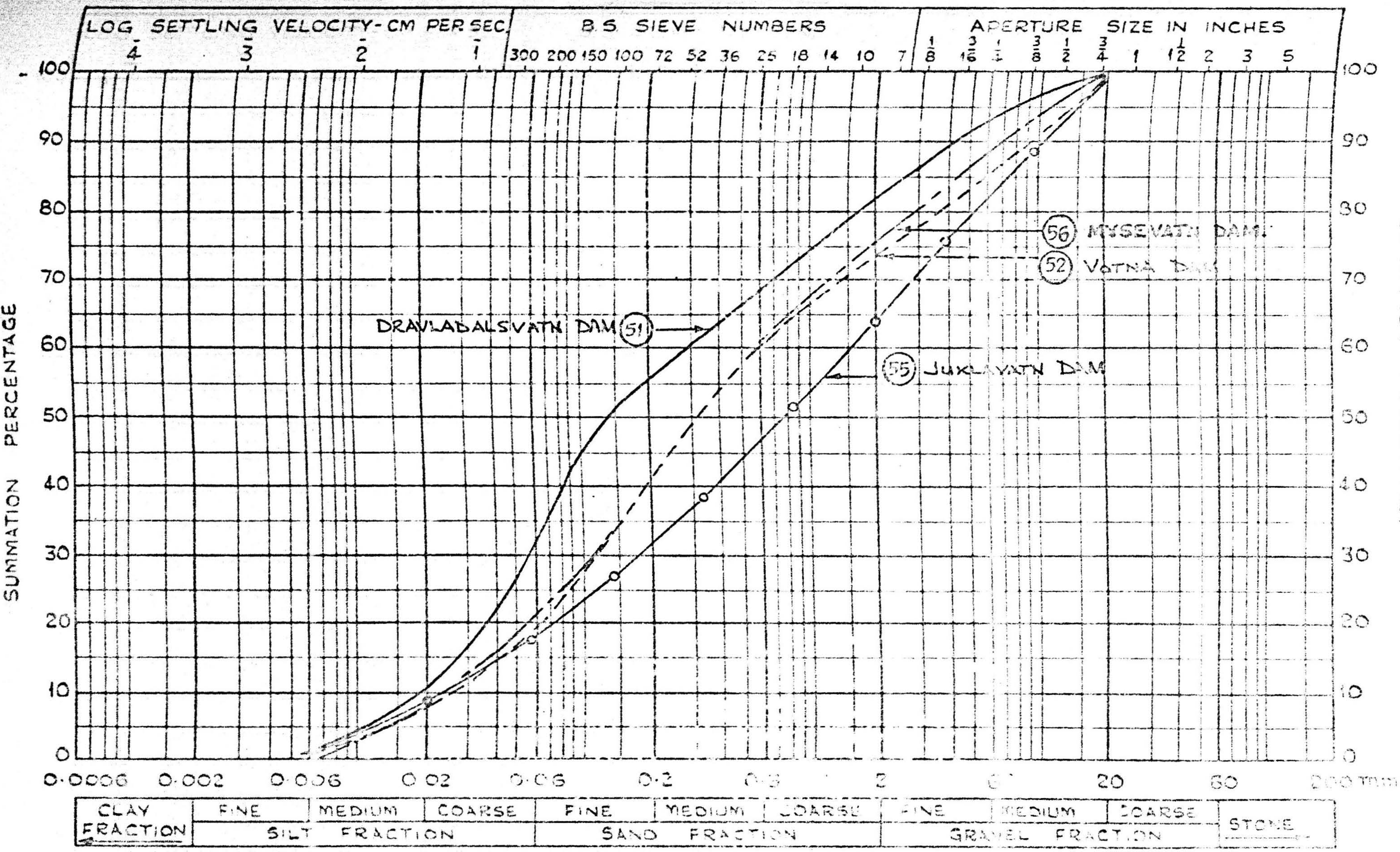


FIG. 5·102 GRADINGS FOR VARIOUS NORWEGIAN DAMS.

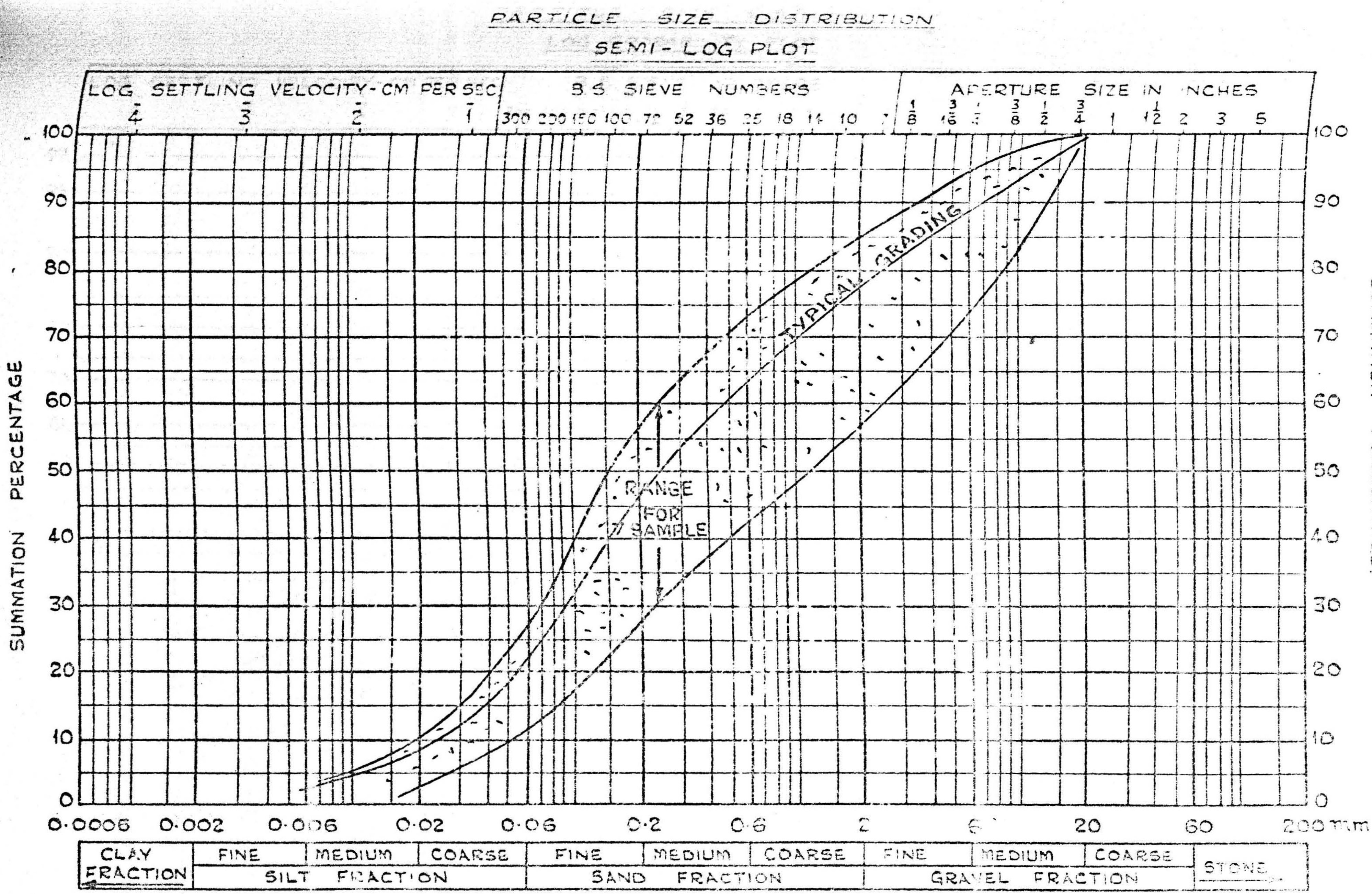


FIG. 5.103 GRADING FOR STØLSVATN DAM. (EXI). TILL

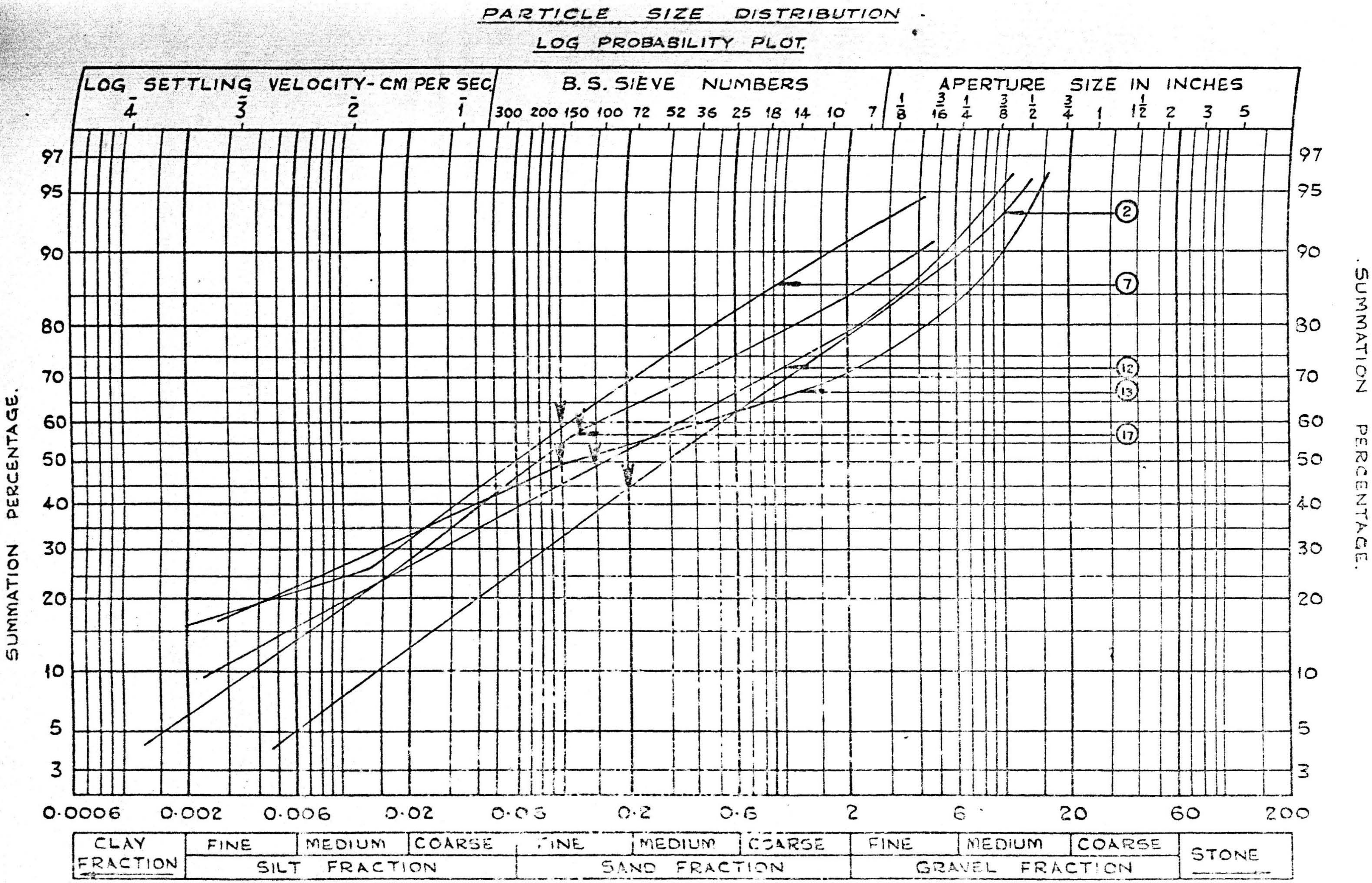


FIG. 5.104 LOG PROBABILITY PLOT OF NORWEGIAN DAM TILLS (2 - 17)

PARTICLE SIZE DISTRIBUTION

LOG PROBABILITY PLOT

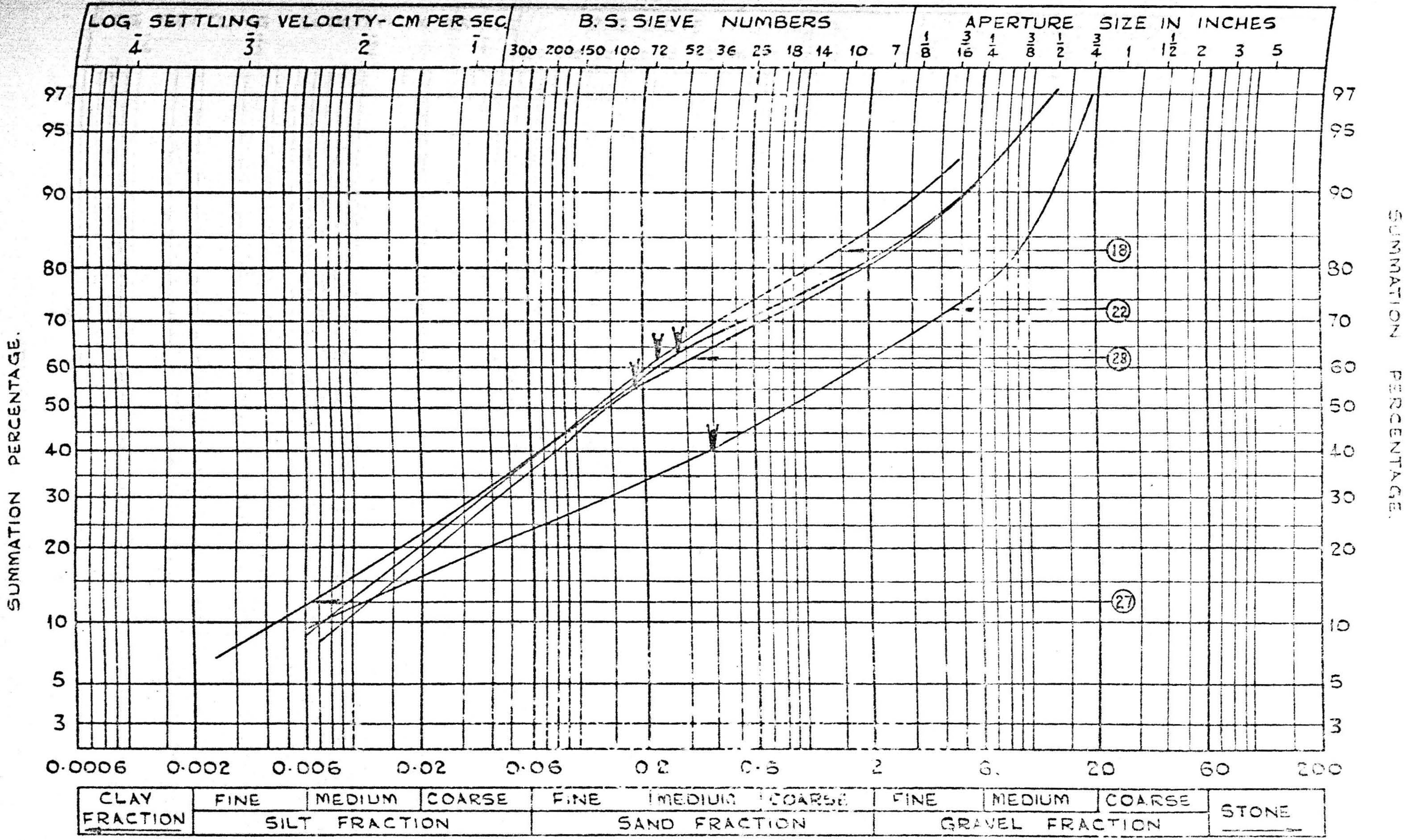


FIG. 5.105 LOG PROBABILITY PLOT FOR NORWEGIAN DAM TILLS (18 – 27)

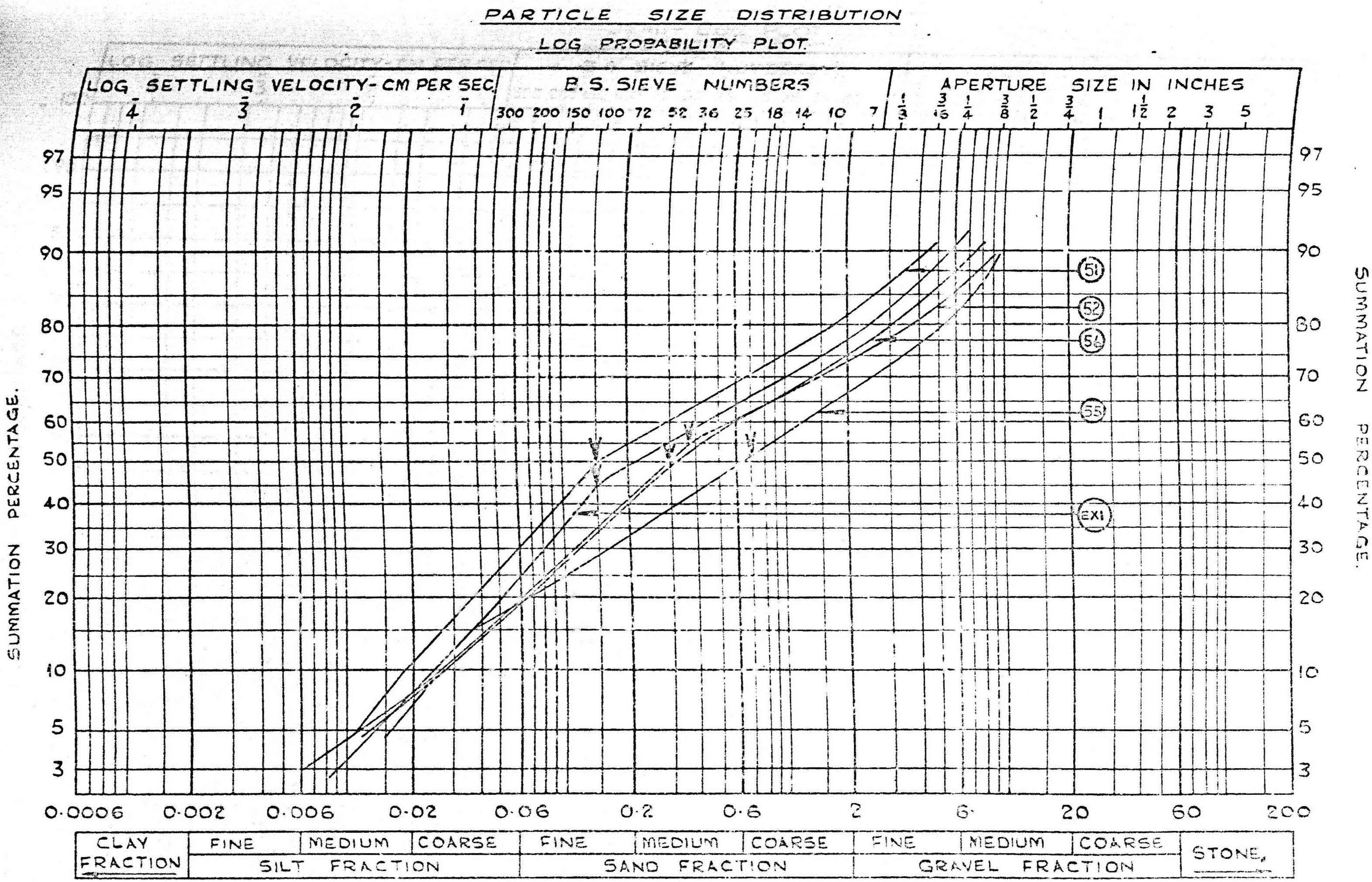


FIG. 5.106 LOG PROBABILITY PLOTS FOR NORWEGIAN DAM TILLS (51 – EX1).

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

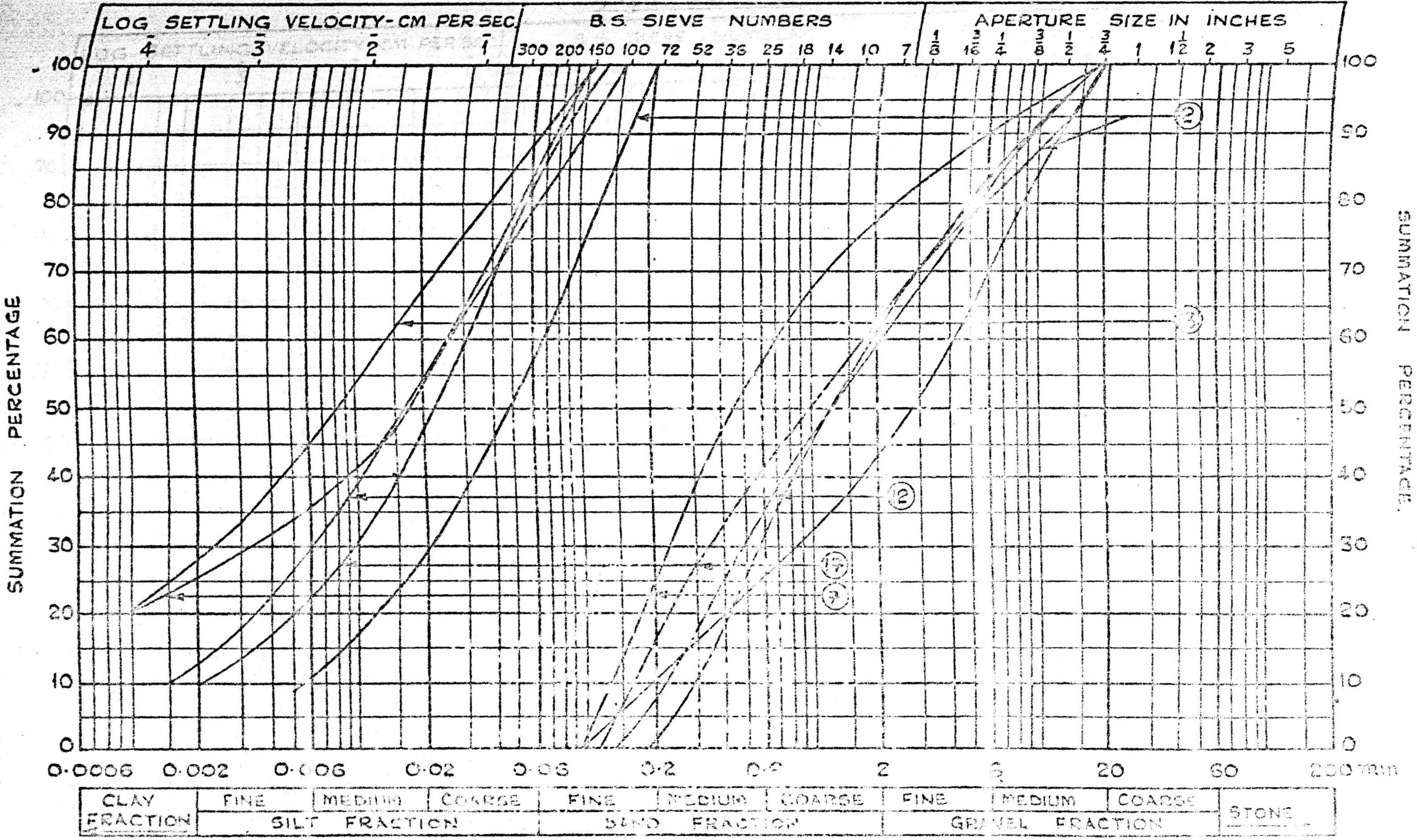


FIG. 5.407 SIZE FRACTIONS FOR NORWEGIAN DAM TILLS (1-17)

PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT

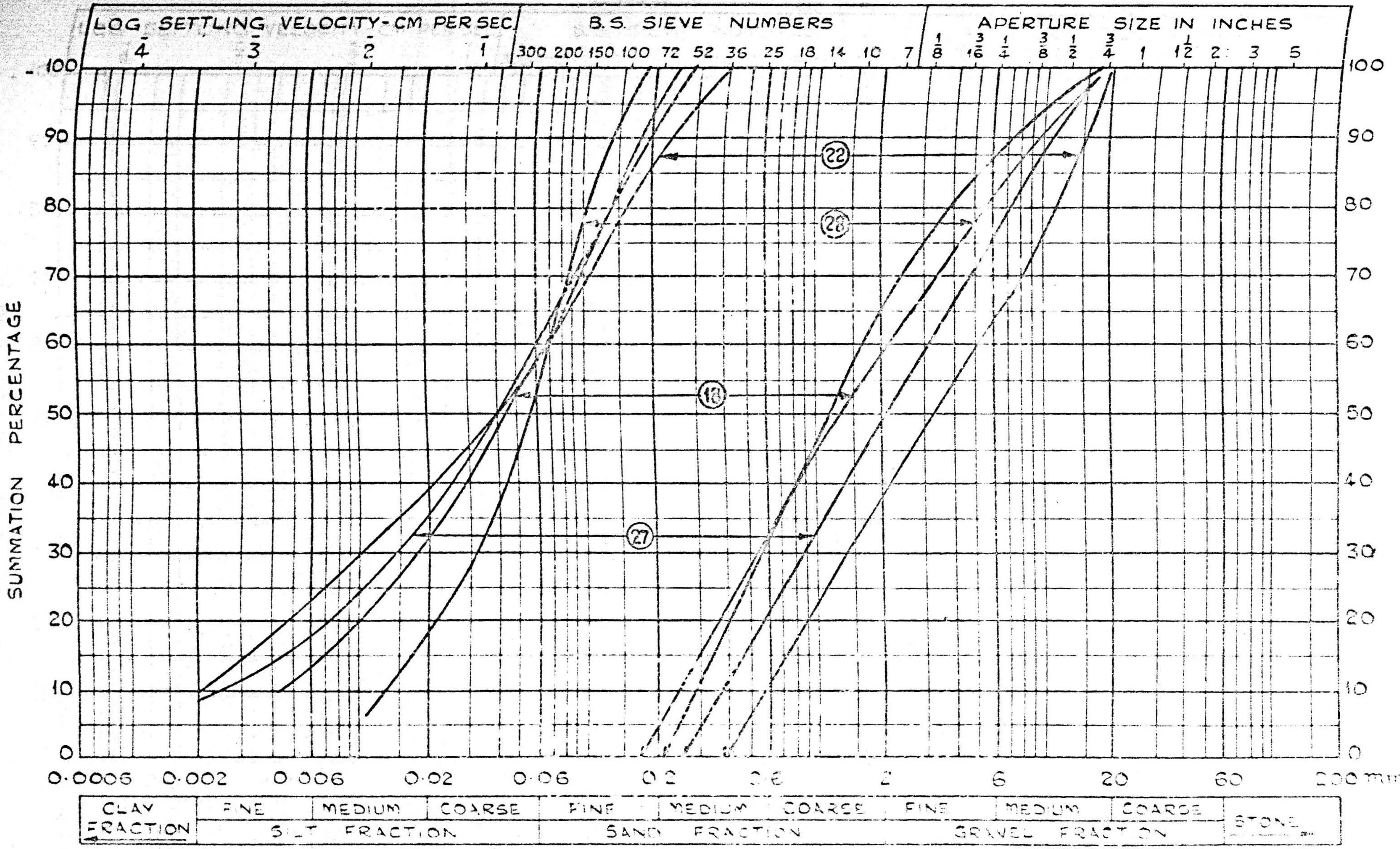


FIG. 5·108 SIZE FRACTIONS FOR NORWEGIAN DAM TILLS (18 – 27).

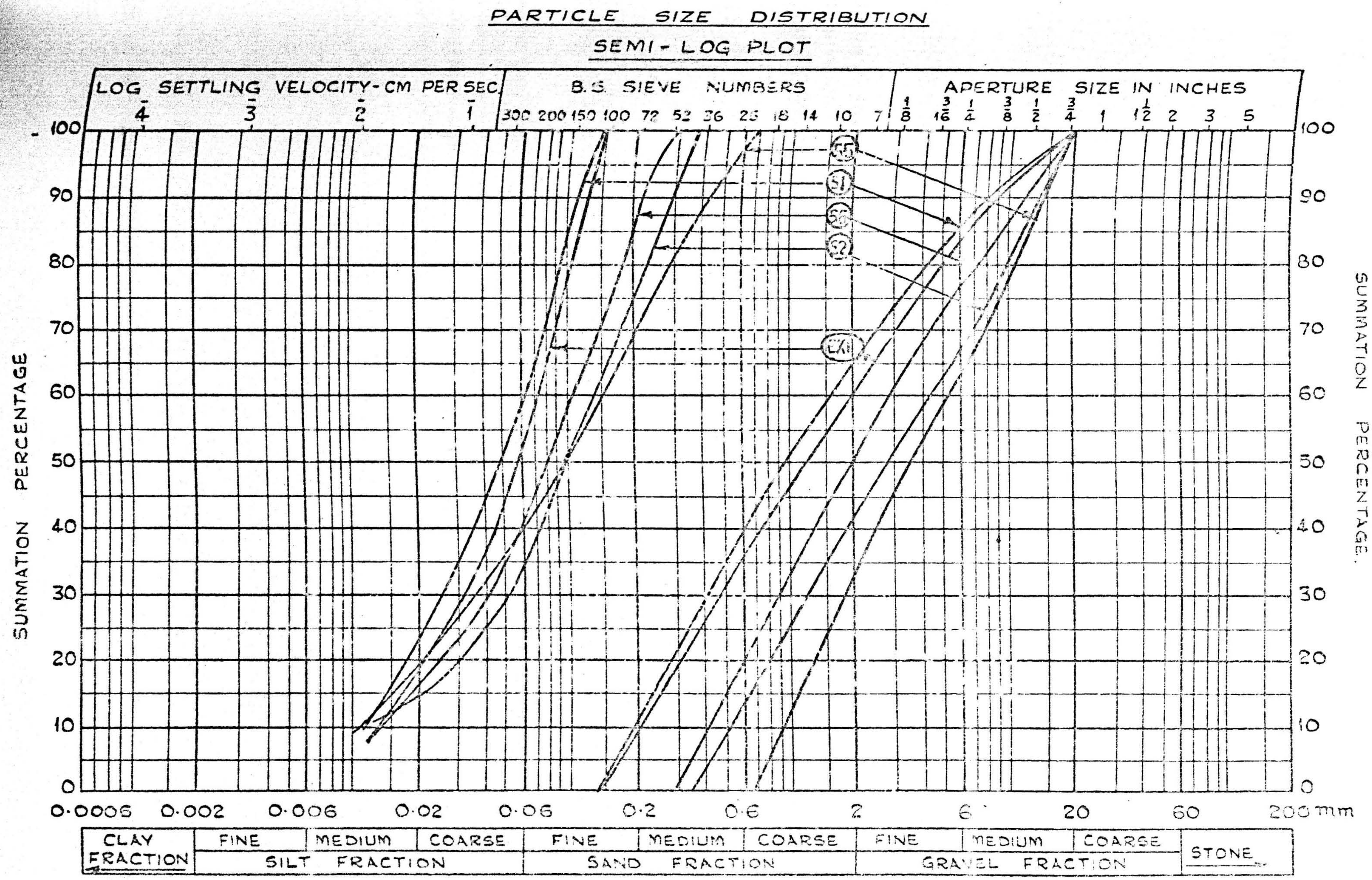


FIG. 5.109 SIZE FRACTIONS FOR NORWEGIAN DAM TILLS (S1 – EX1)

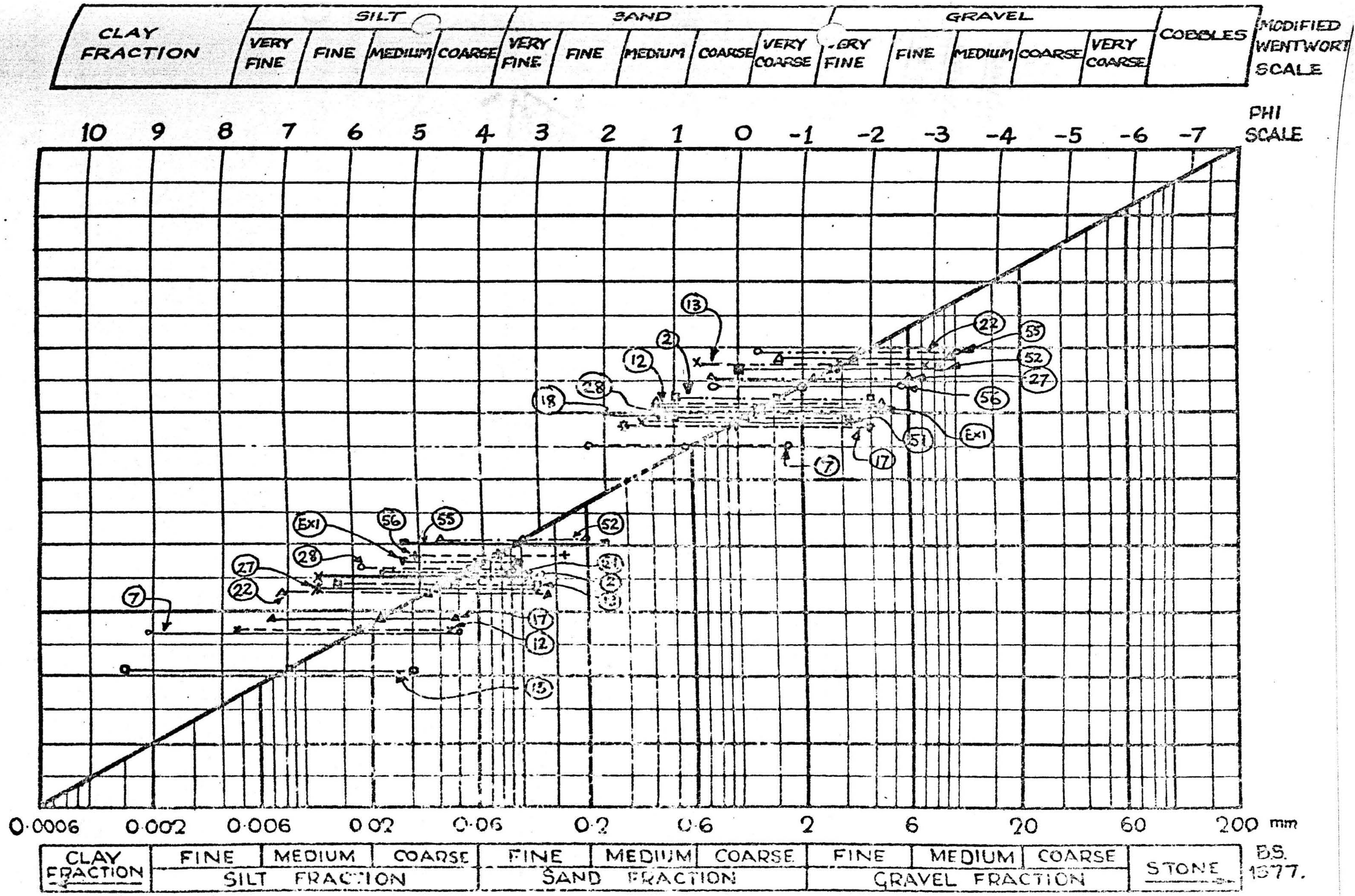
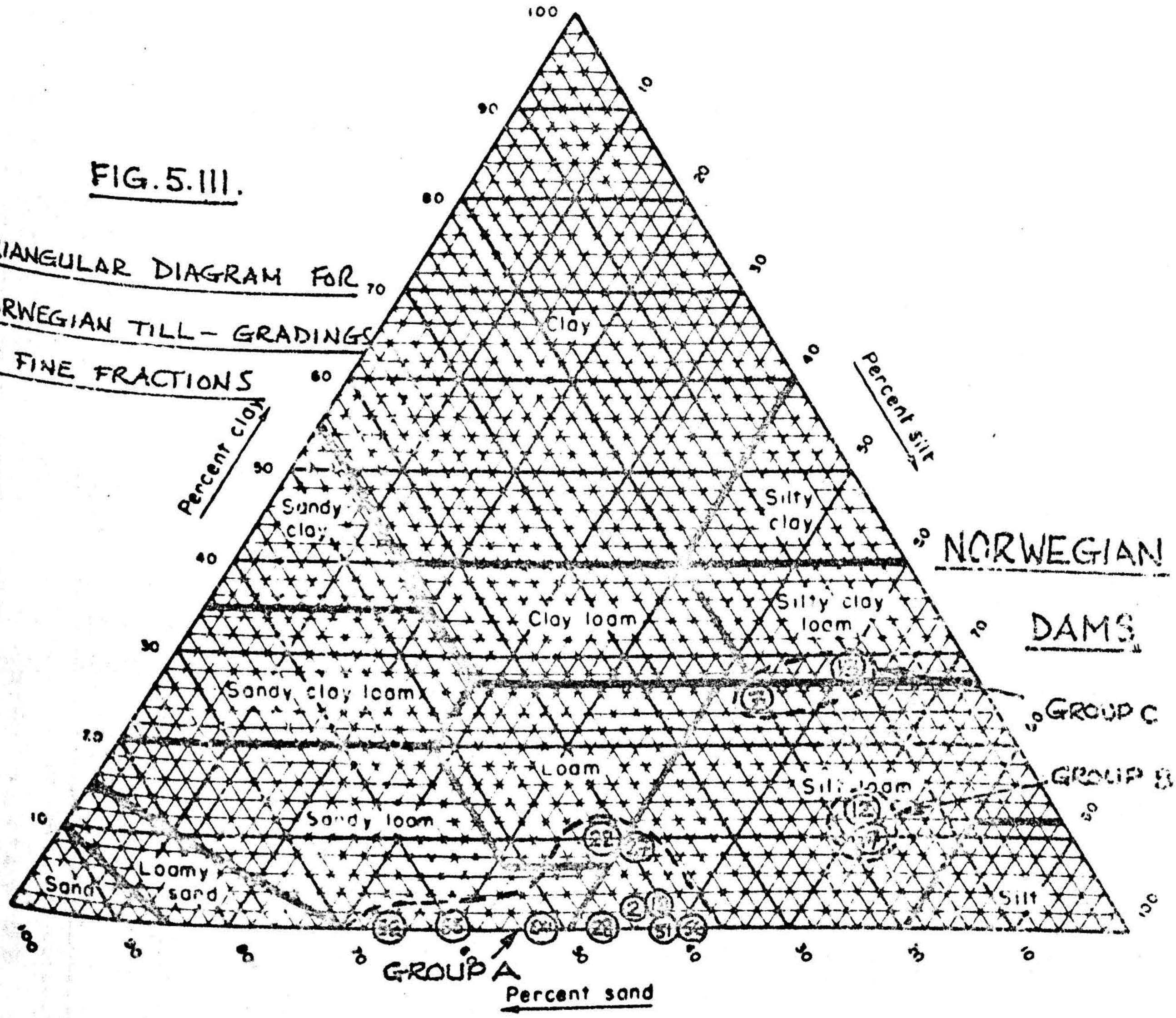


FIG. 5.110. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR NORWEGIAN DAMS.

FIG. 5.III.

TRIANGULAR DIAGRAM FOR NORWEGIAN TILL - GRADINGS OF FINE FRACTIONS



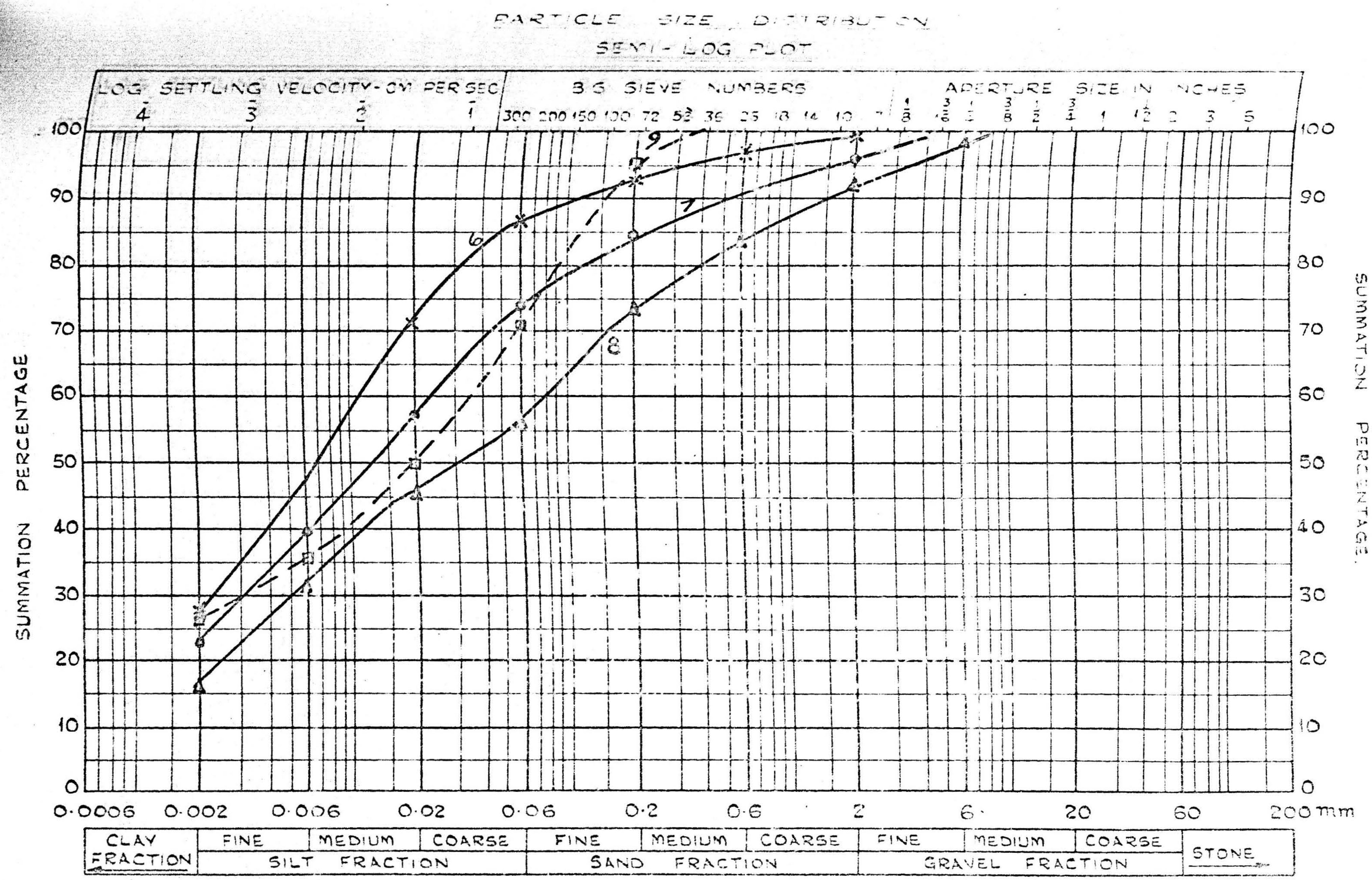


FIG 5.112. GRADINGS FOR CANADIAN DAM TILLS (6-9)

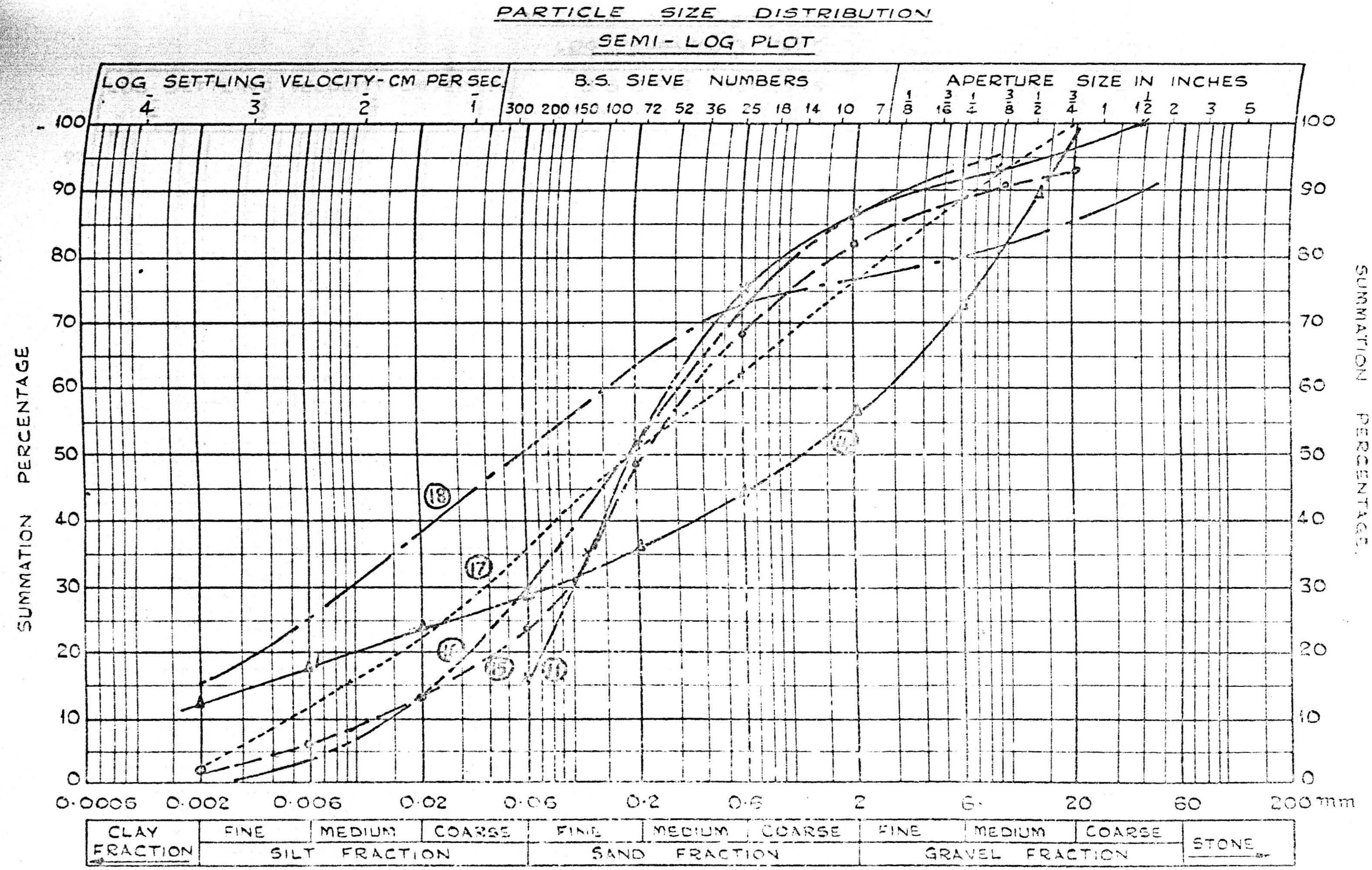


FIG. 5.113. GRADINGS FOR CANADIAN DAM TILLS (11–18).

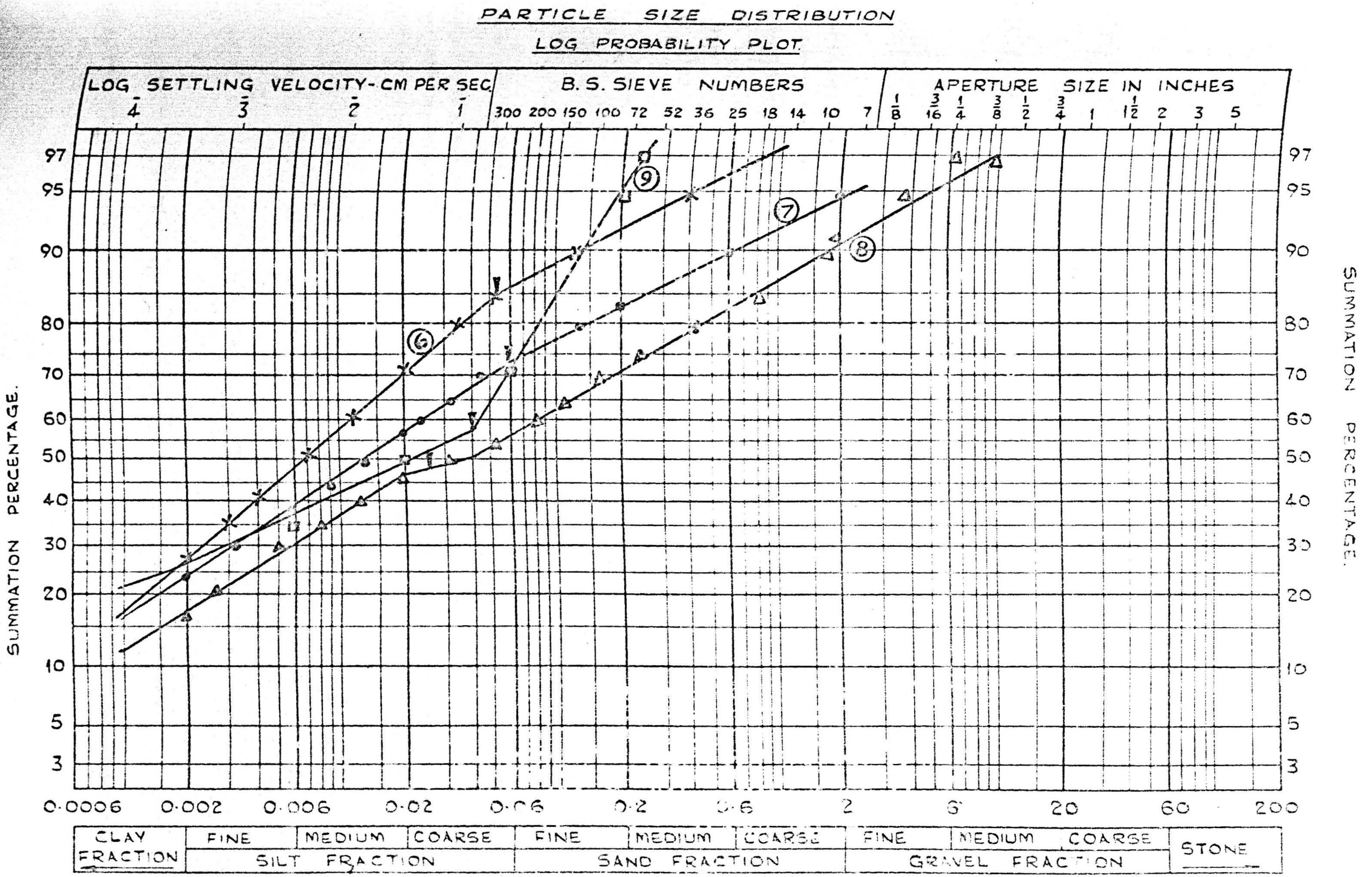


FIG. 5 114. LOG PROBABILITY PLOT FOR CANADIAN DAM TILLS (6-9).

PARTICLE SIZE DISTRIBUTION

LOG PROBABILITY PLOT

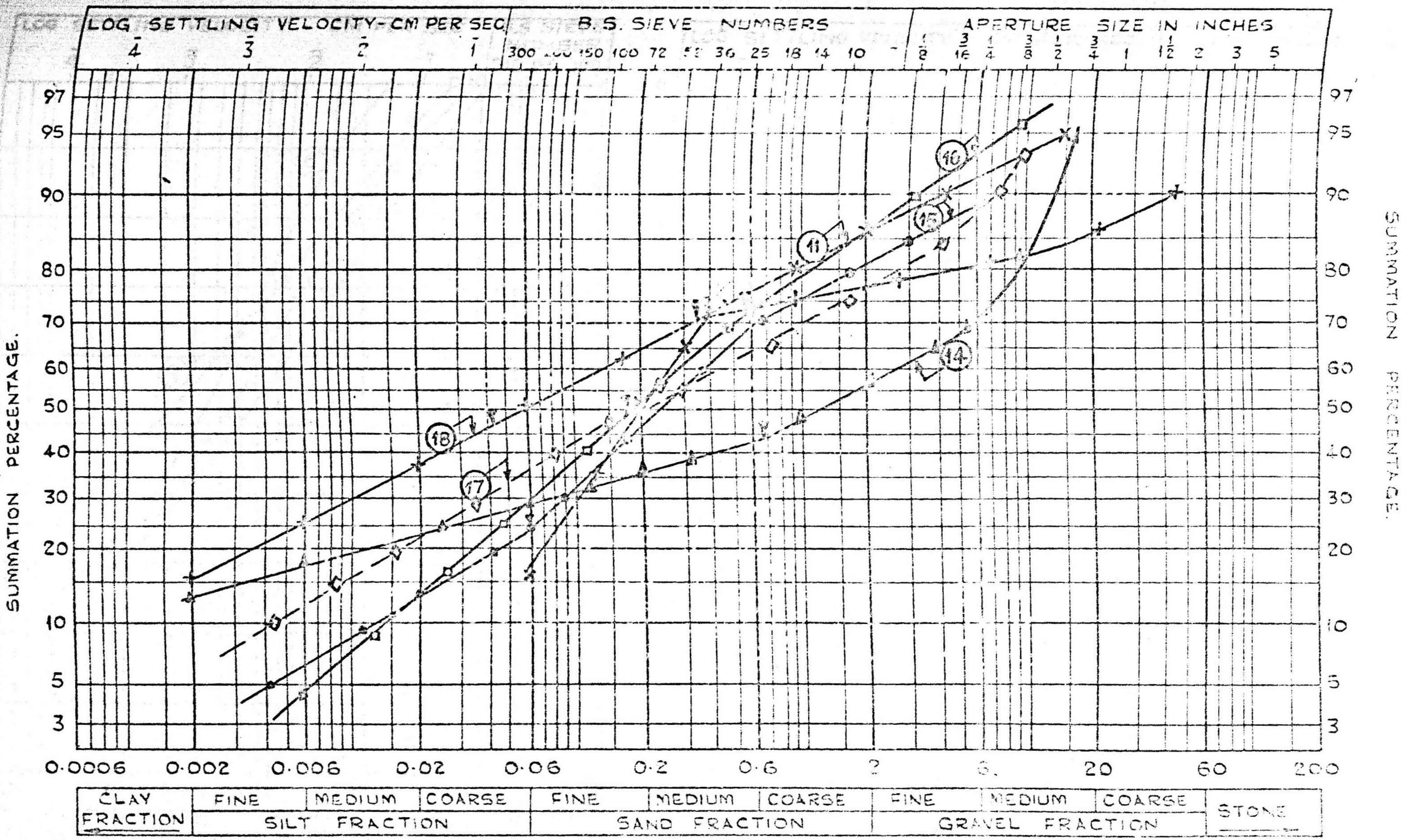


FIG. 5.115 LOG PROBABILITY PLOT FOR CANADIAN DAM TILLS (11-18).

PARTICLE SIZE DISTRIBUTION
SEMI - LOG PLOT

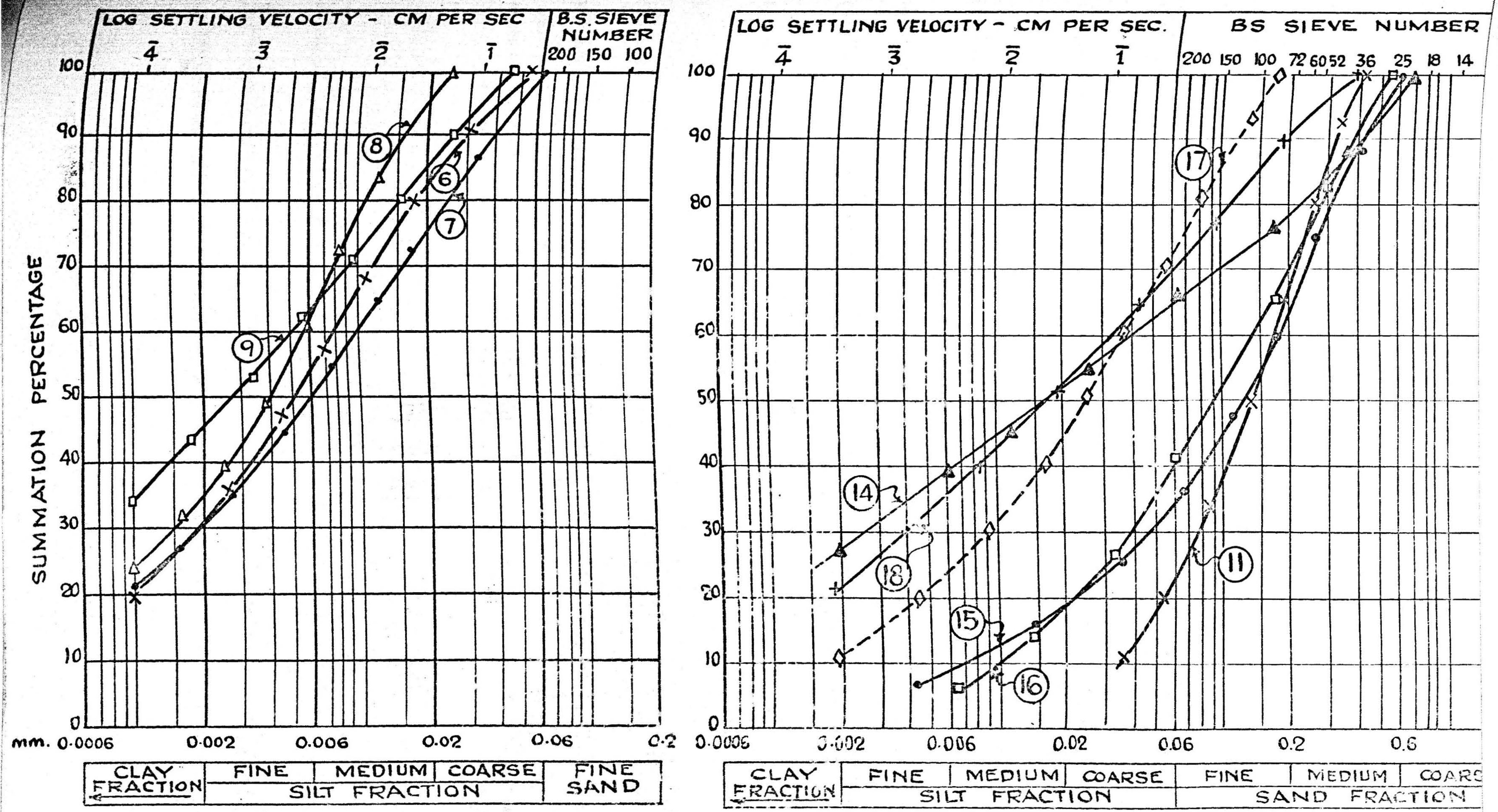
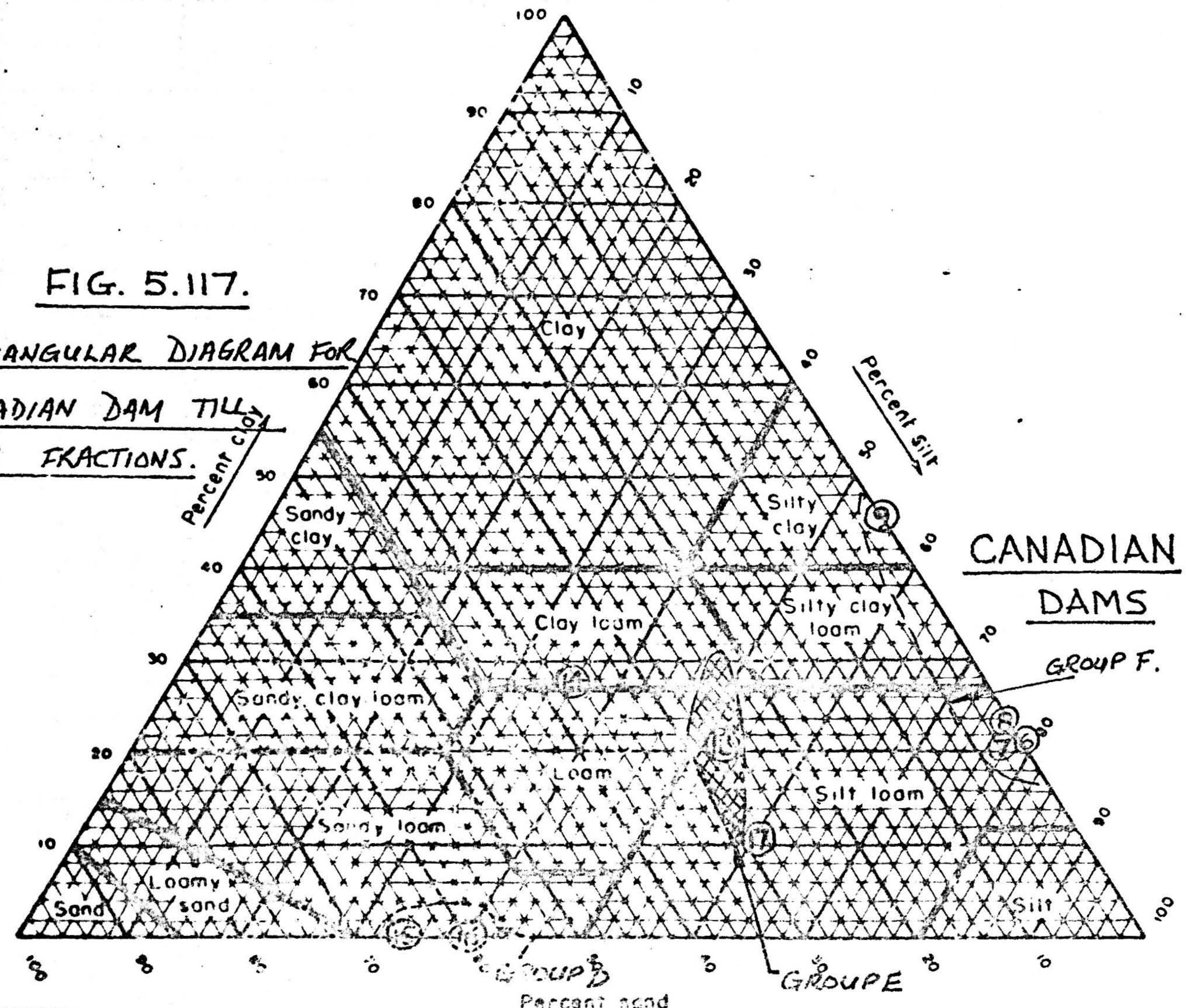


FIG. 5.116. FINE FRACTIONS OF CANADIAN DAM TILLS.

FIG. 5.117.

TRIANGULAR DIAGRAM FOR CANADIAN DAM TILL FINE FRACTIONS.



CANADIAN DAMS

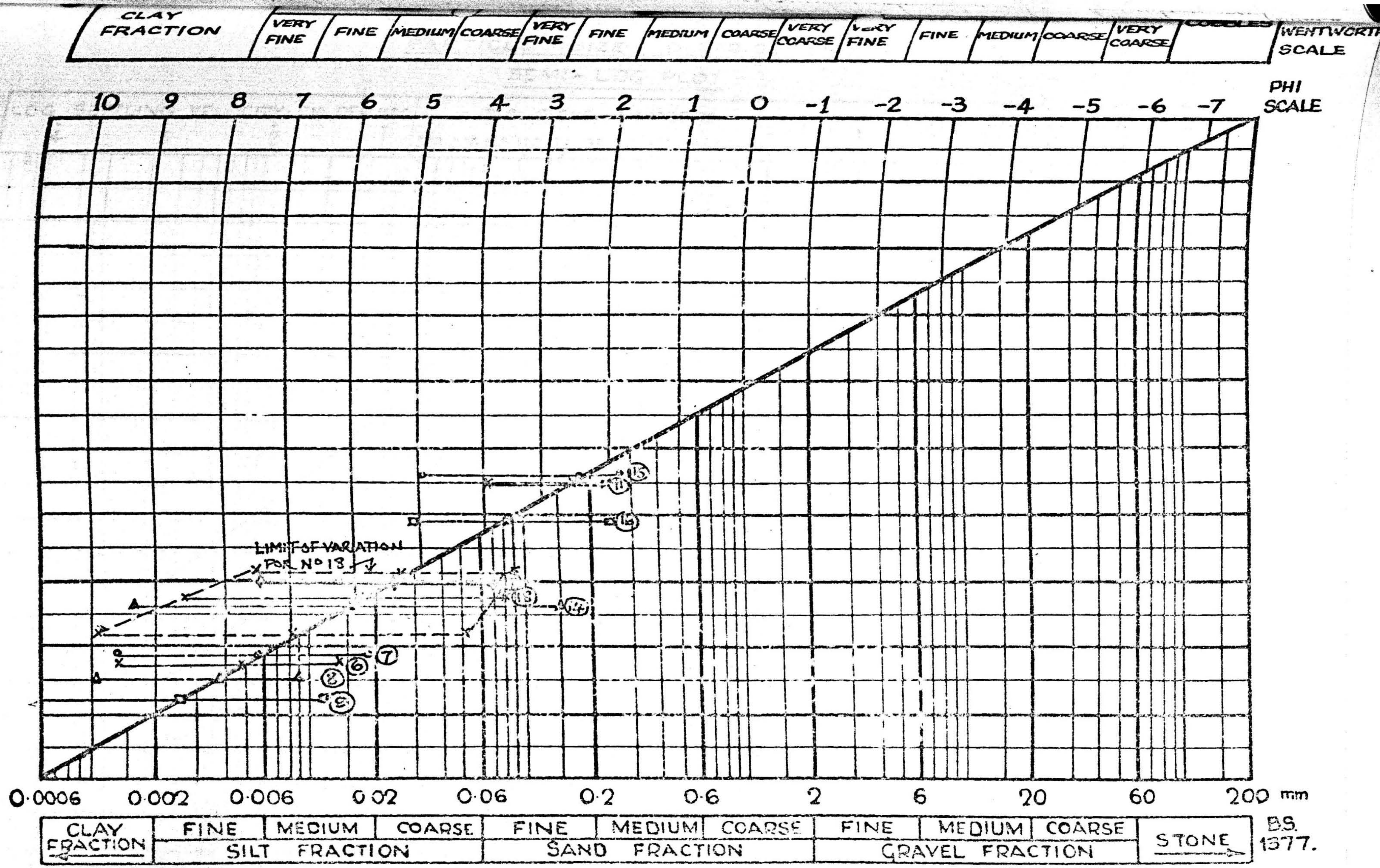


FIG.5.118 TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR CANADIAN DAM TILLS.

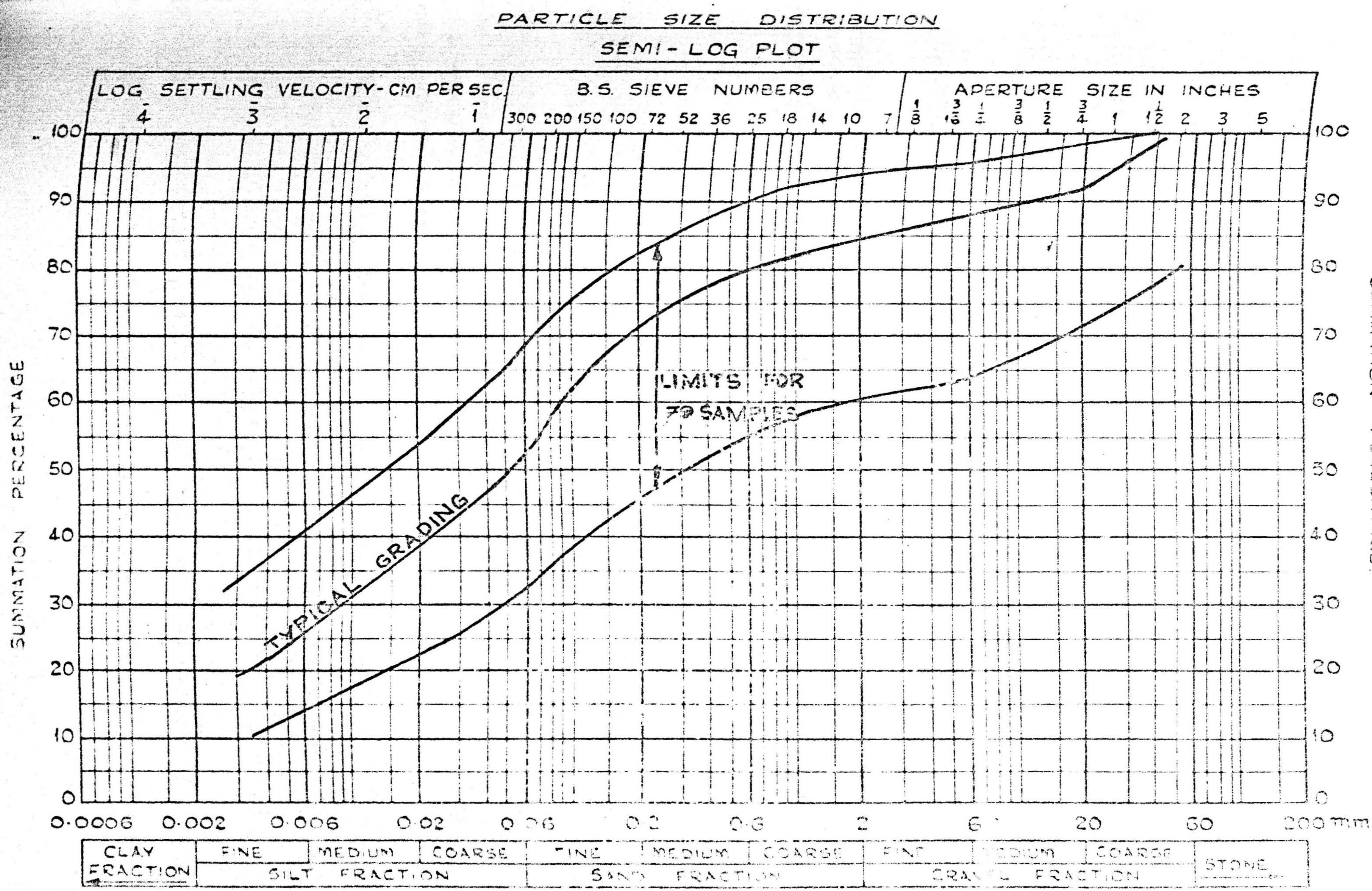


FIG 5.119. GRADINGS FOR SHAND DAM CANADA. (18).

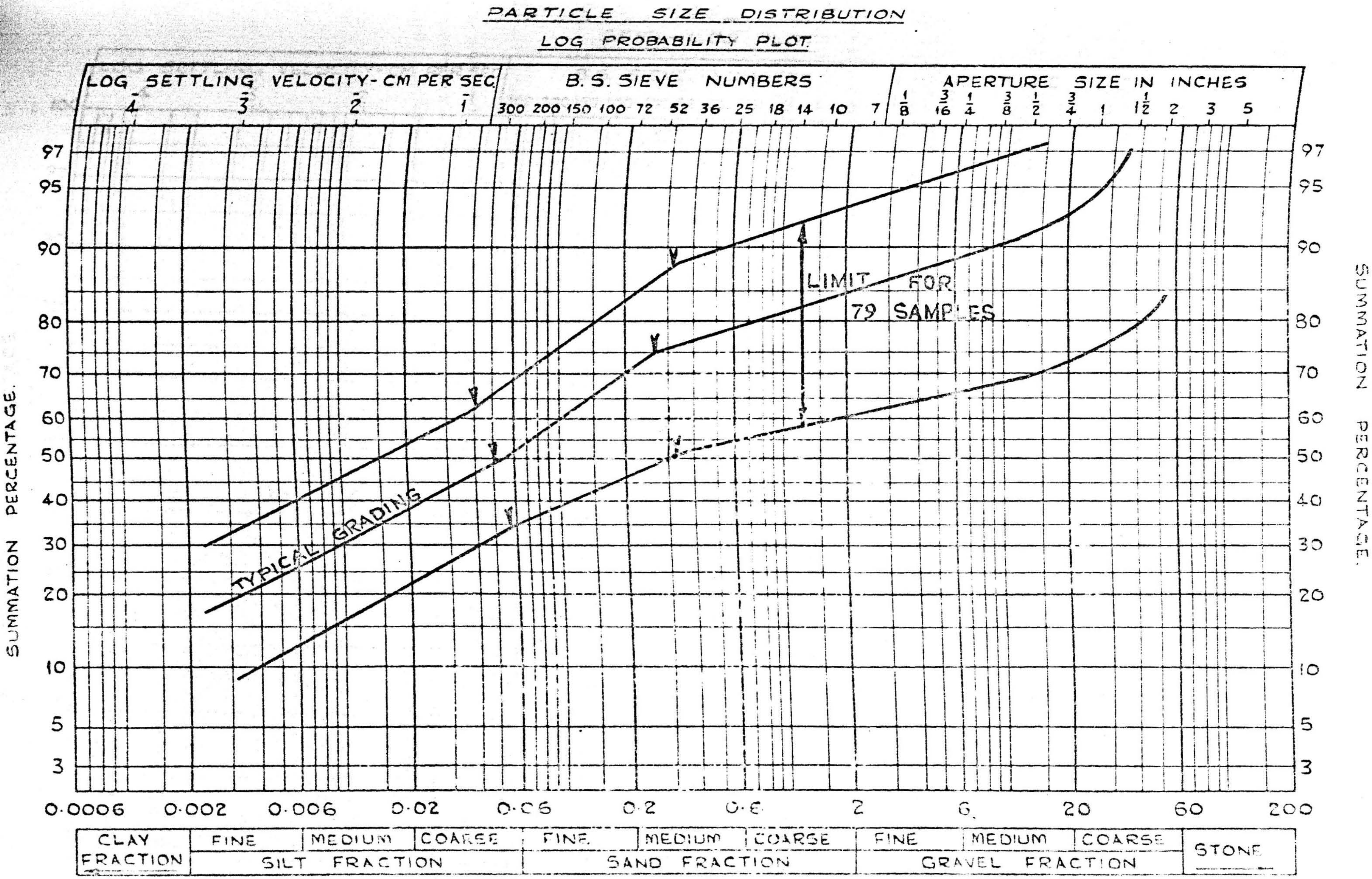


FIG 5.120. LOG PROBABILITY FOR SHAND DAM, CANADA (18)

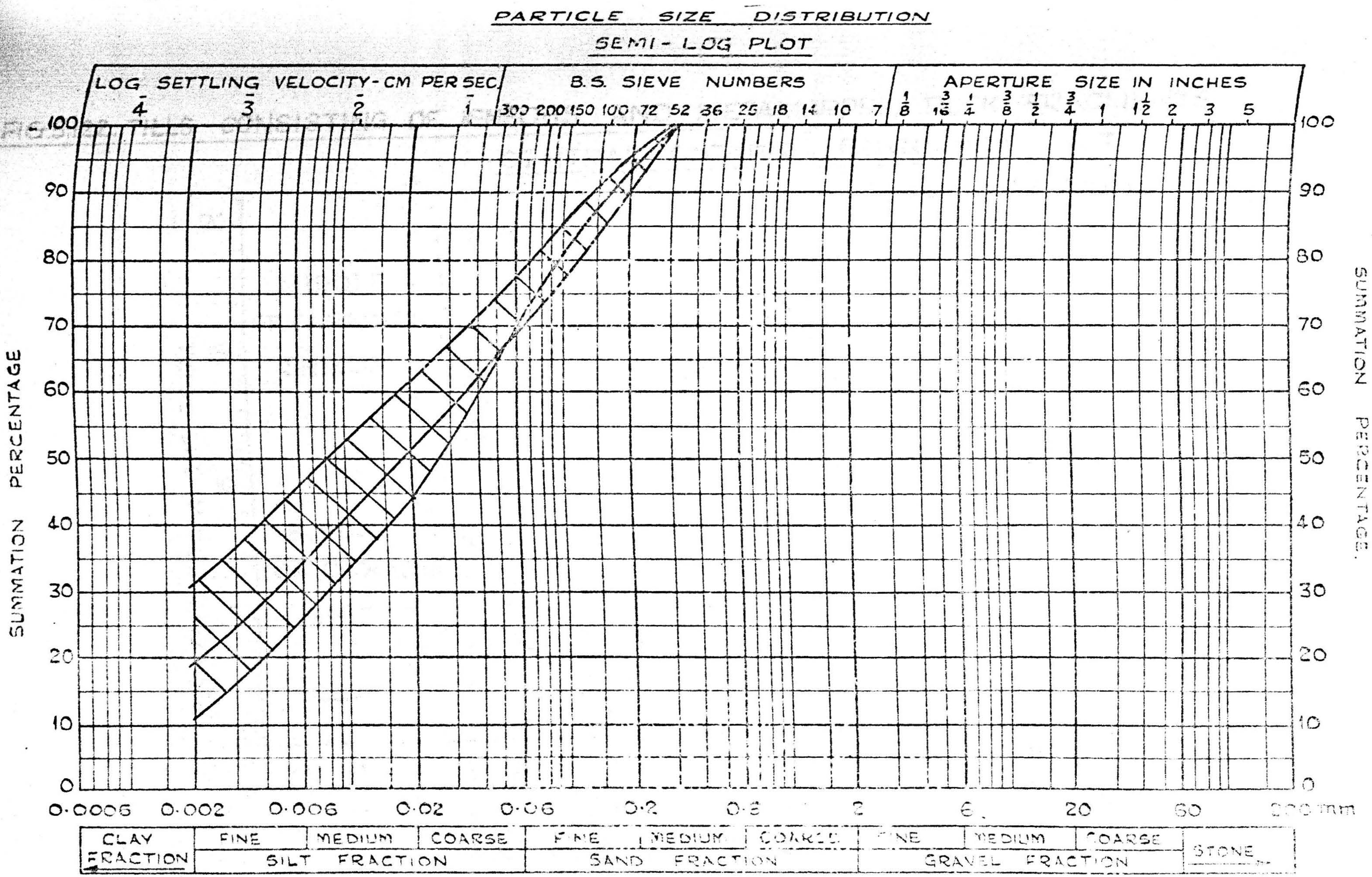
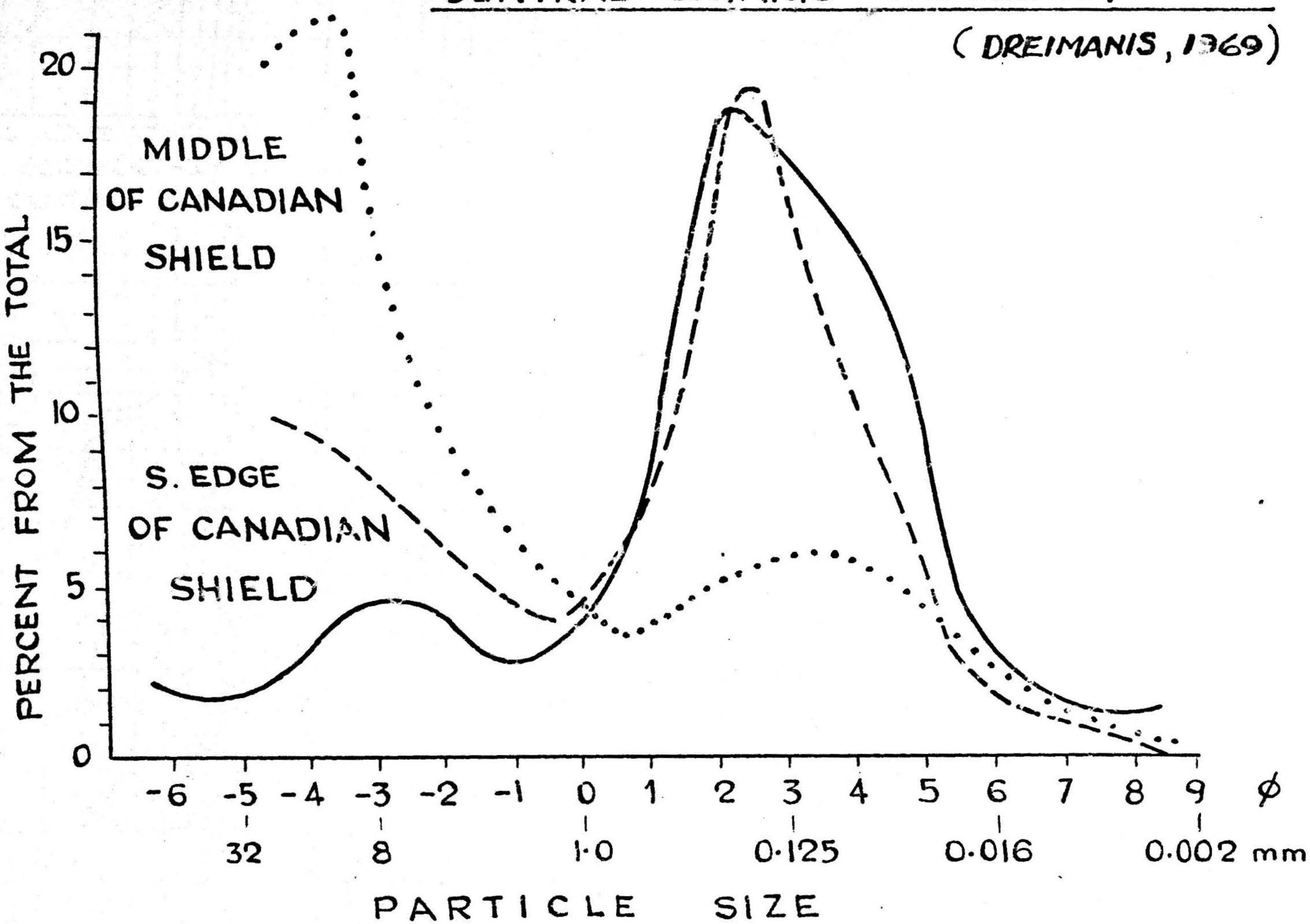


FIG 5.121. FINE FRACTIONS OF SHAND DAM TILL CANADA.

FIG.5.122. TILLS CONSISTING OF IGNEOUS AND METAMORPHIC ROCK FRAGMENTS CENTRAL ONTARIO – FREQUENCY PLOT.

(DREIMANIS, 1969)



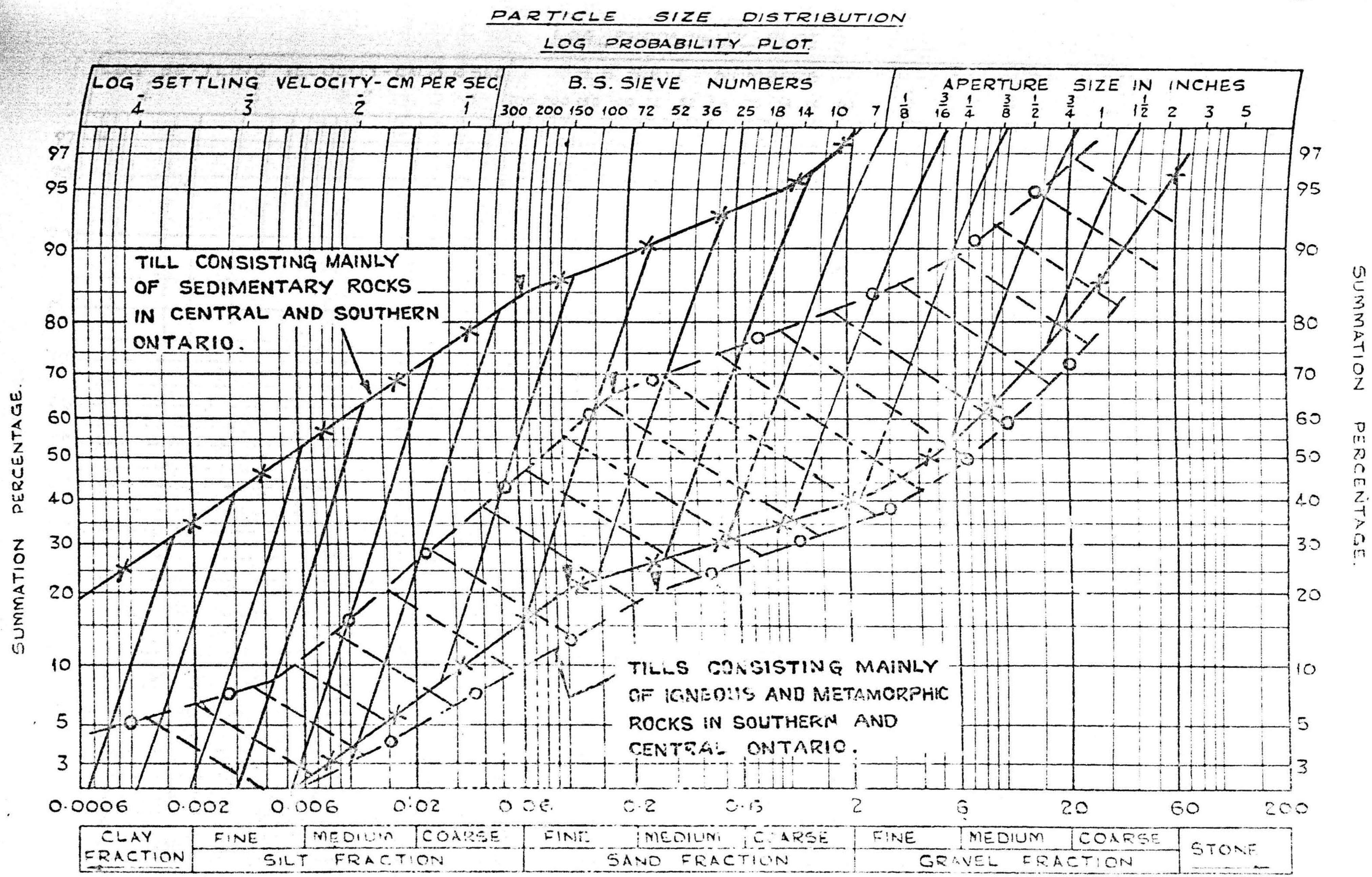


FIG. 5.123. LOG PROBABILITY PLOT OF SEDIMENTARY, IGNEOUS AND METAMORPHIC ONTARIO ROCK TILLS.

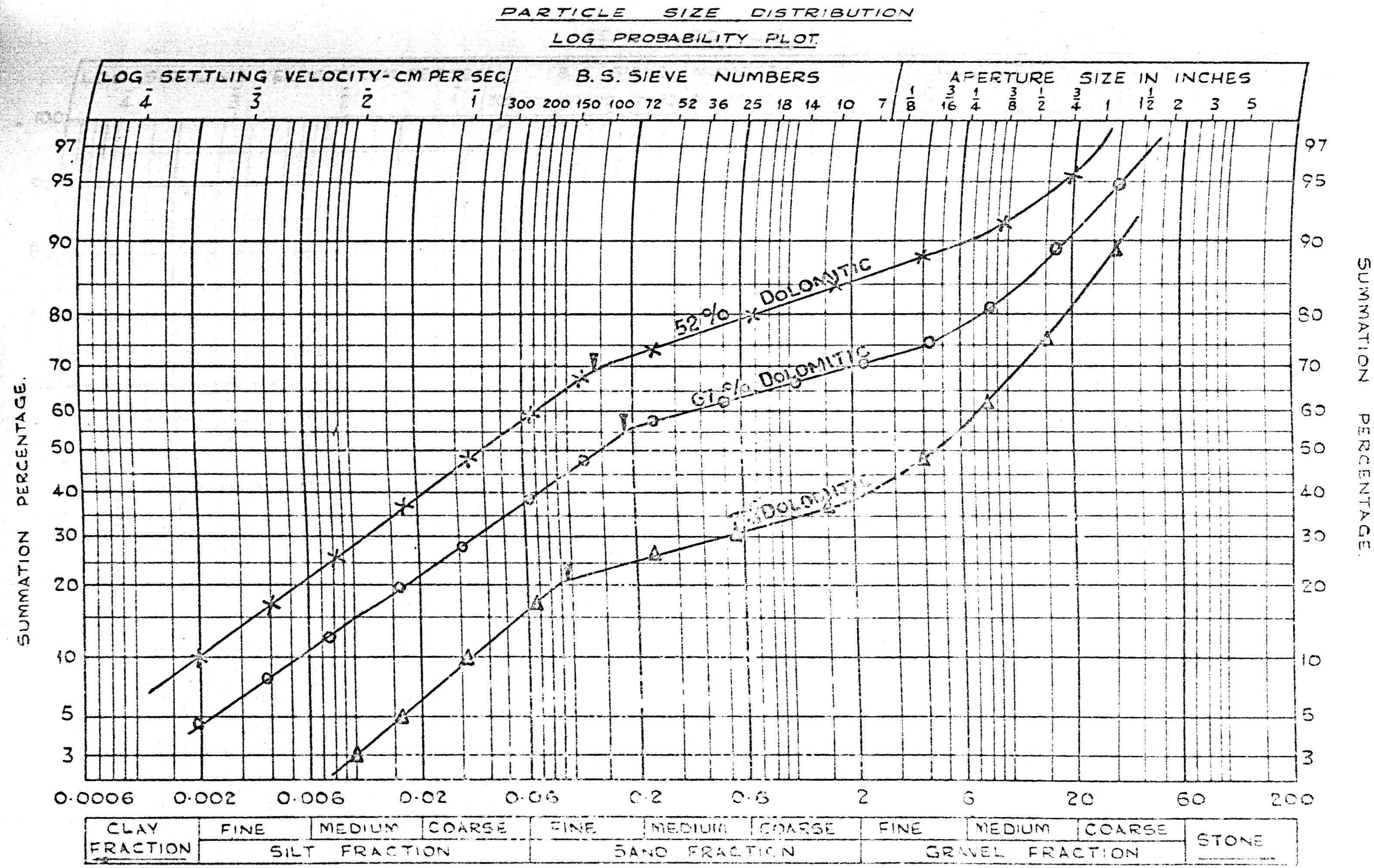


FIG. 5. 124. LOG PROBABILITY PLOTS OF DOLOMITIC TILLS IN ONTARIO (AFTER DREIMANIS, 19[illegible]).

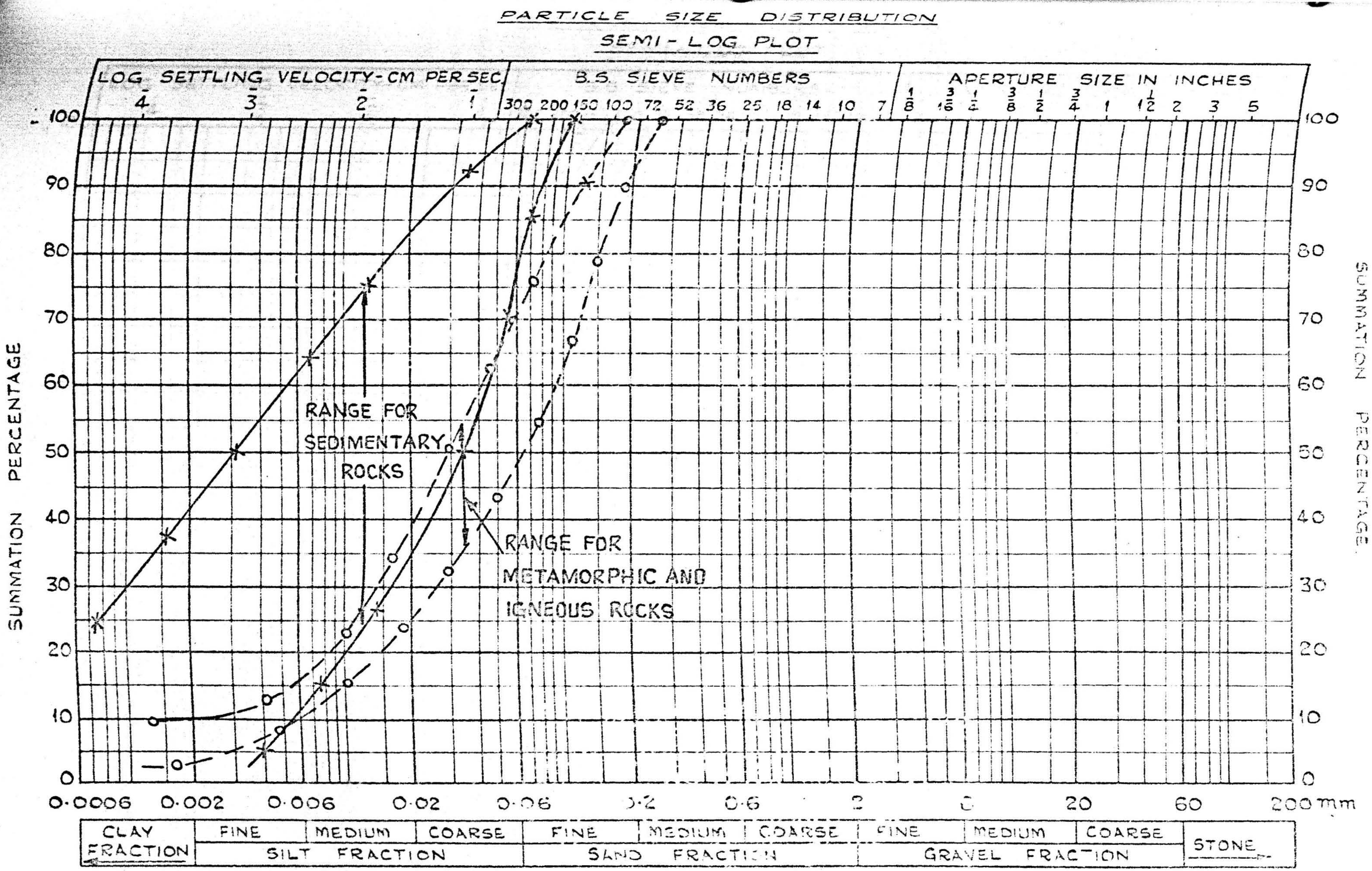


FIG. 5.125. GRADINGS FOR SEDIMENTARY, METAMORPHIC AND IGNEOUS ROCK TILLS FROM ONTARIO

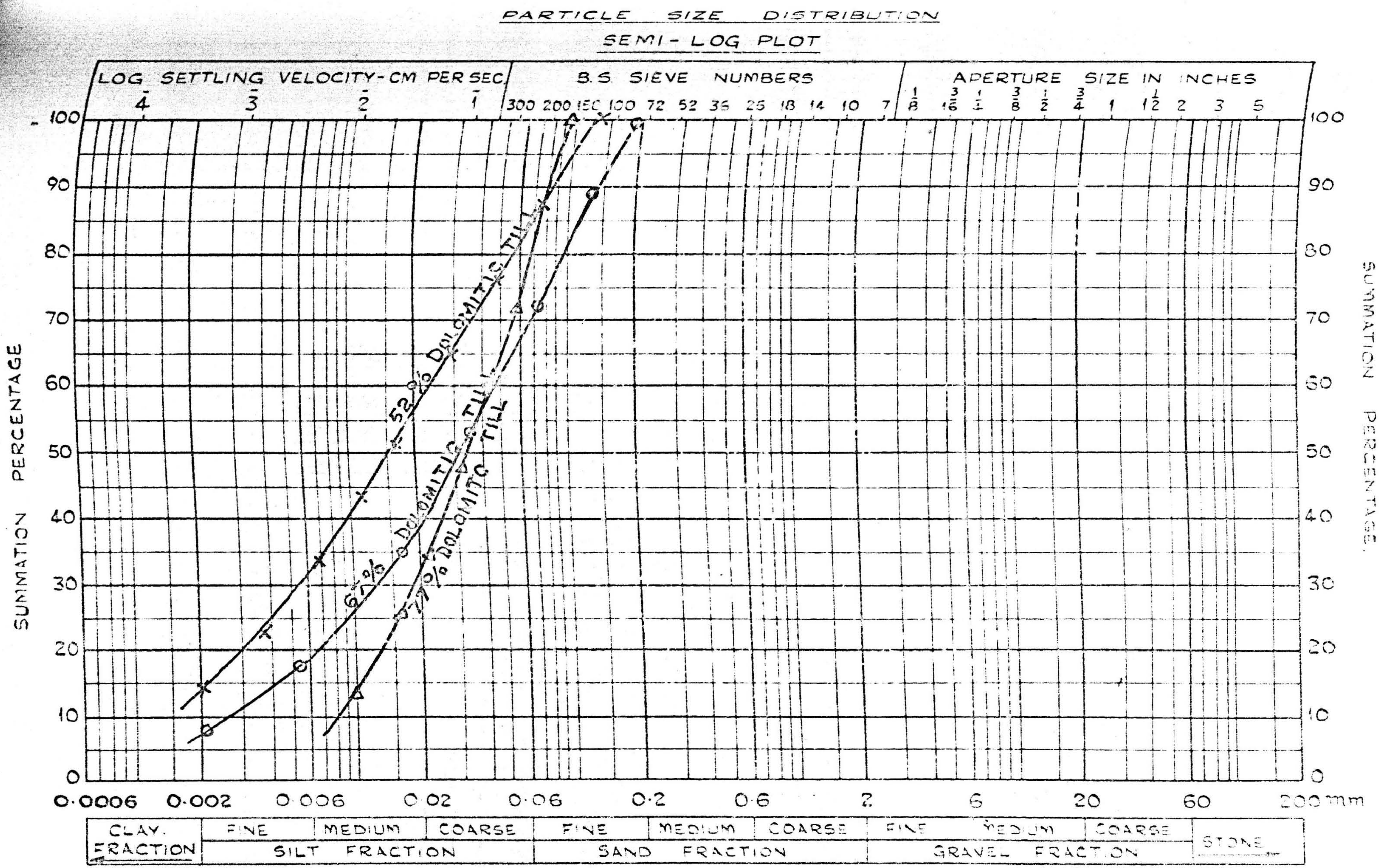
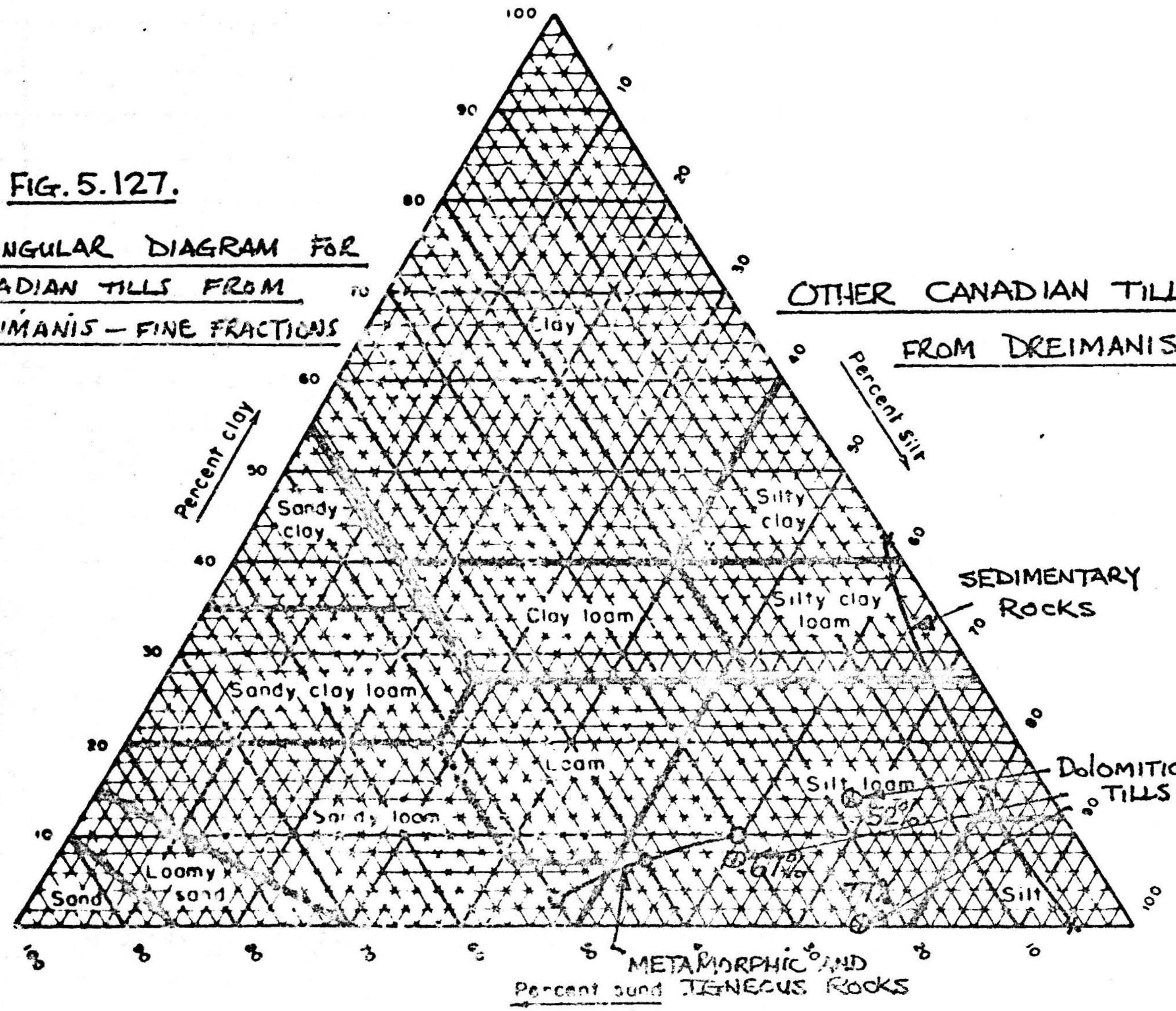


FIG. 5.126. GRADINGS FOR DOLOMITIC TILLS IN ONTARIO (after Dreimanis, 1969).

FIG. 5.127.

TRIANGULAR DIAGRAM FOR CANADIAN TILLS FROM DREIMANIS – FINE FRACTIONS

OTHER CANADIAN TILLS FROM DREIMANIS



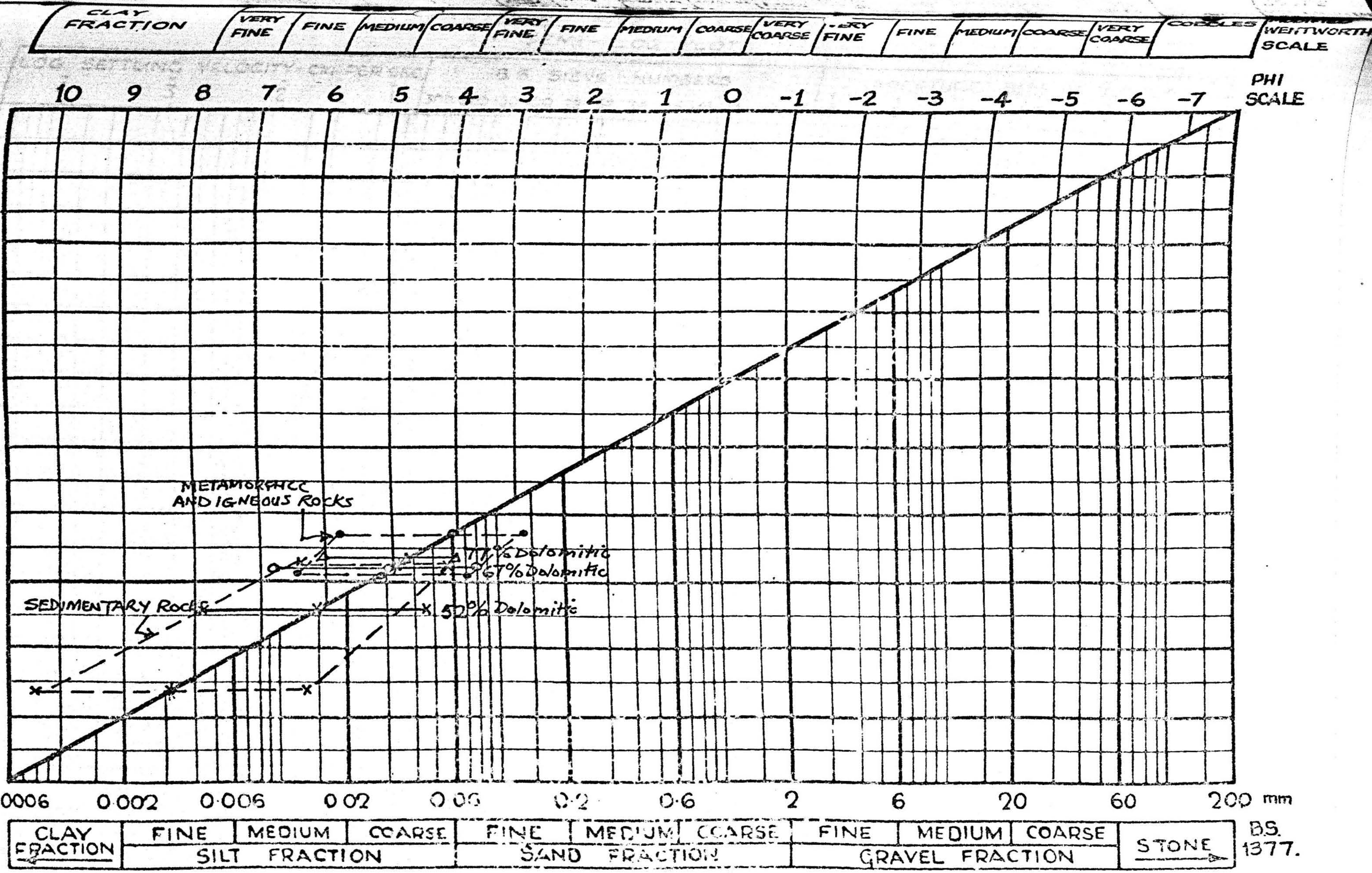


FIG 5.128. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 E? CANADIAN TILLS (after DREIMAN

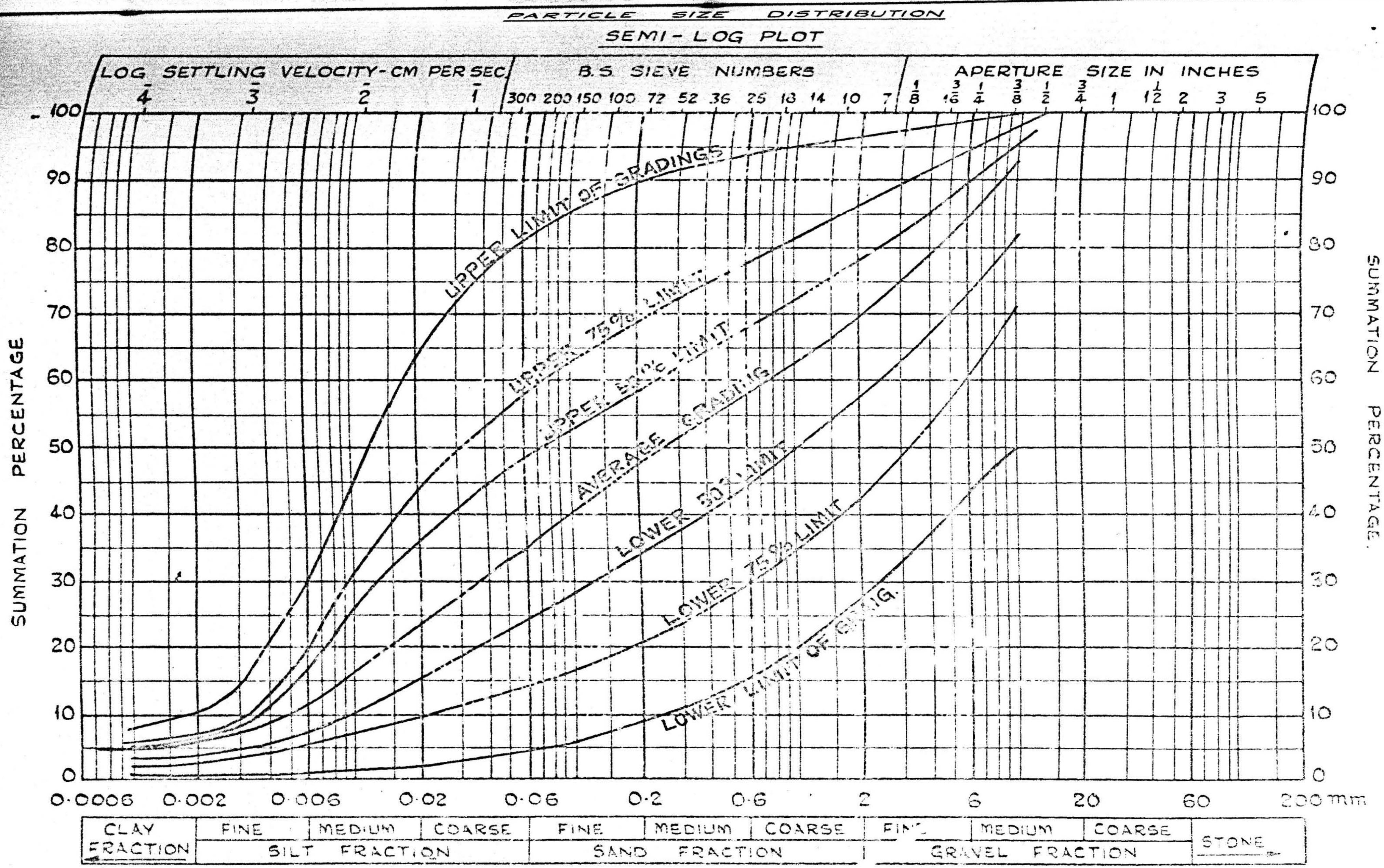


FIG. 5.129. GRADINGS FROM VILLE LA SALLE, LACHINE MONTREAL TILLS.

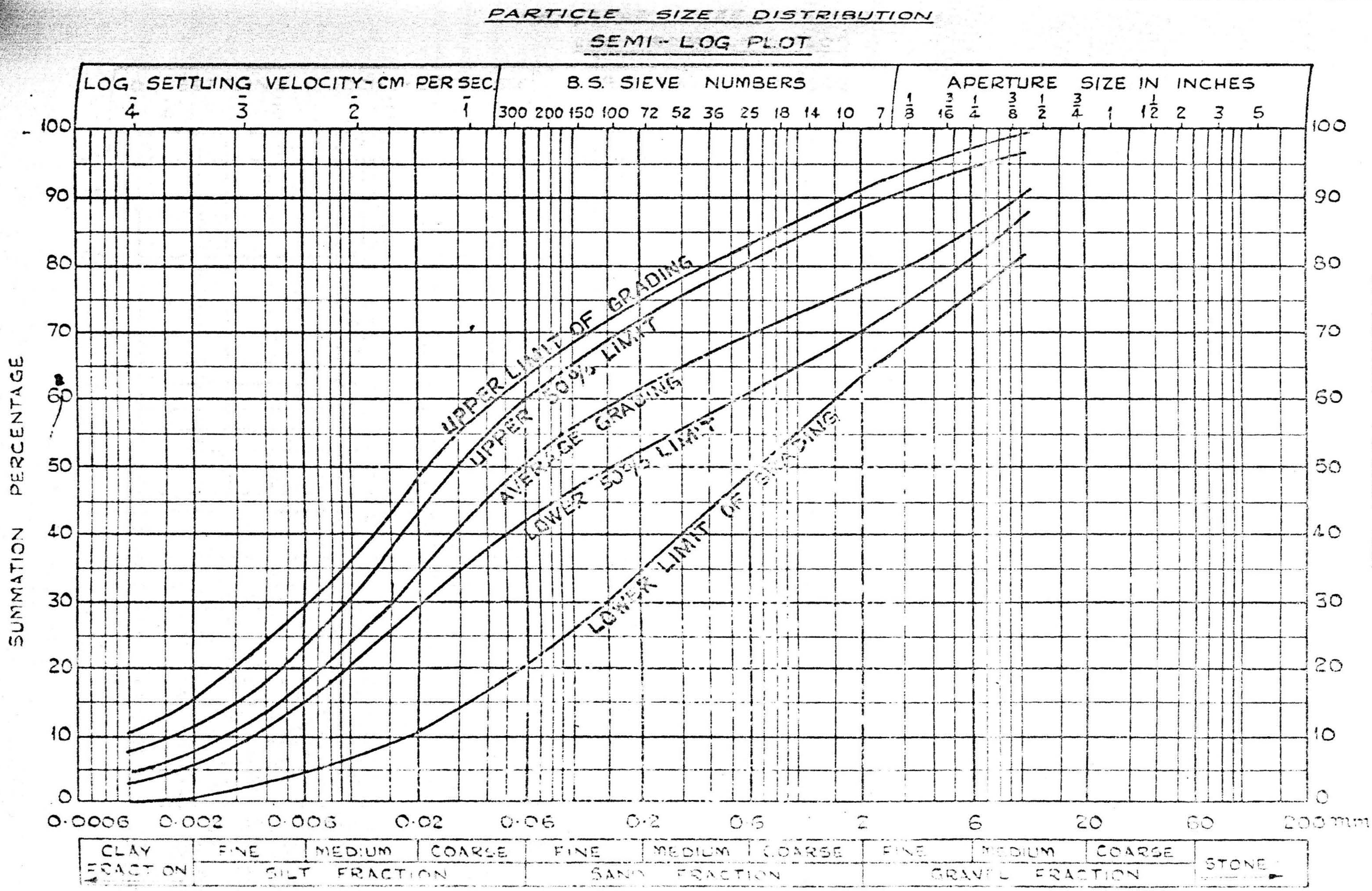


FIG. 5.130. GRADINGS FROM ÎLE HERON, RIVER NORD MONTREAL TILL.

PARTICLE SIZE DISTRIBUTION

LOG PROBABILITY PLOT

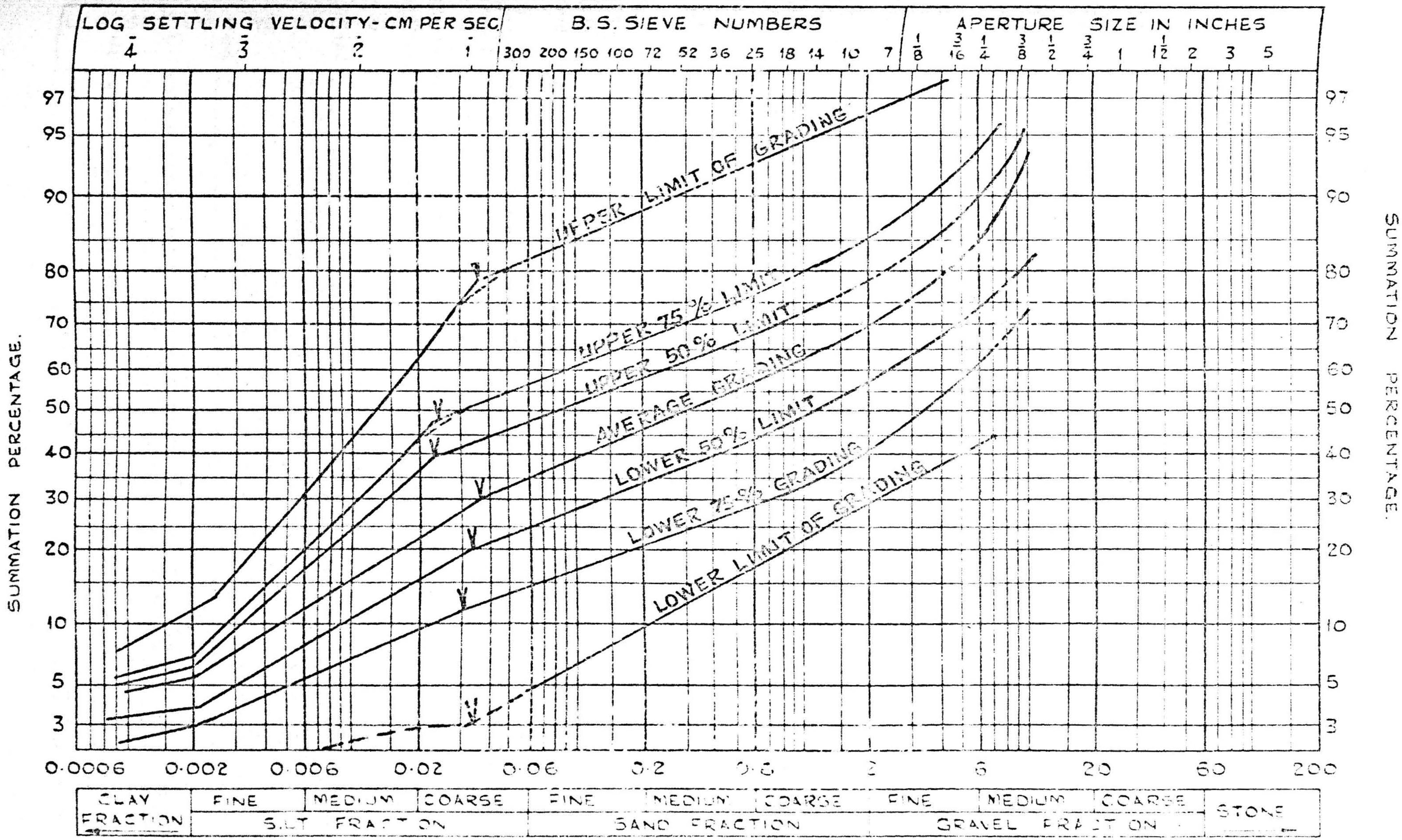


FIG.131. LOG PROBABILITY PLOT OF VILLE LA SALLE, LACHINE, MONTREAL TILL

PARTICLE SIZE DISTRIBUTION

LOG PROBABILITY PLOT

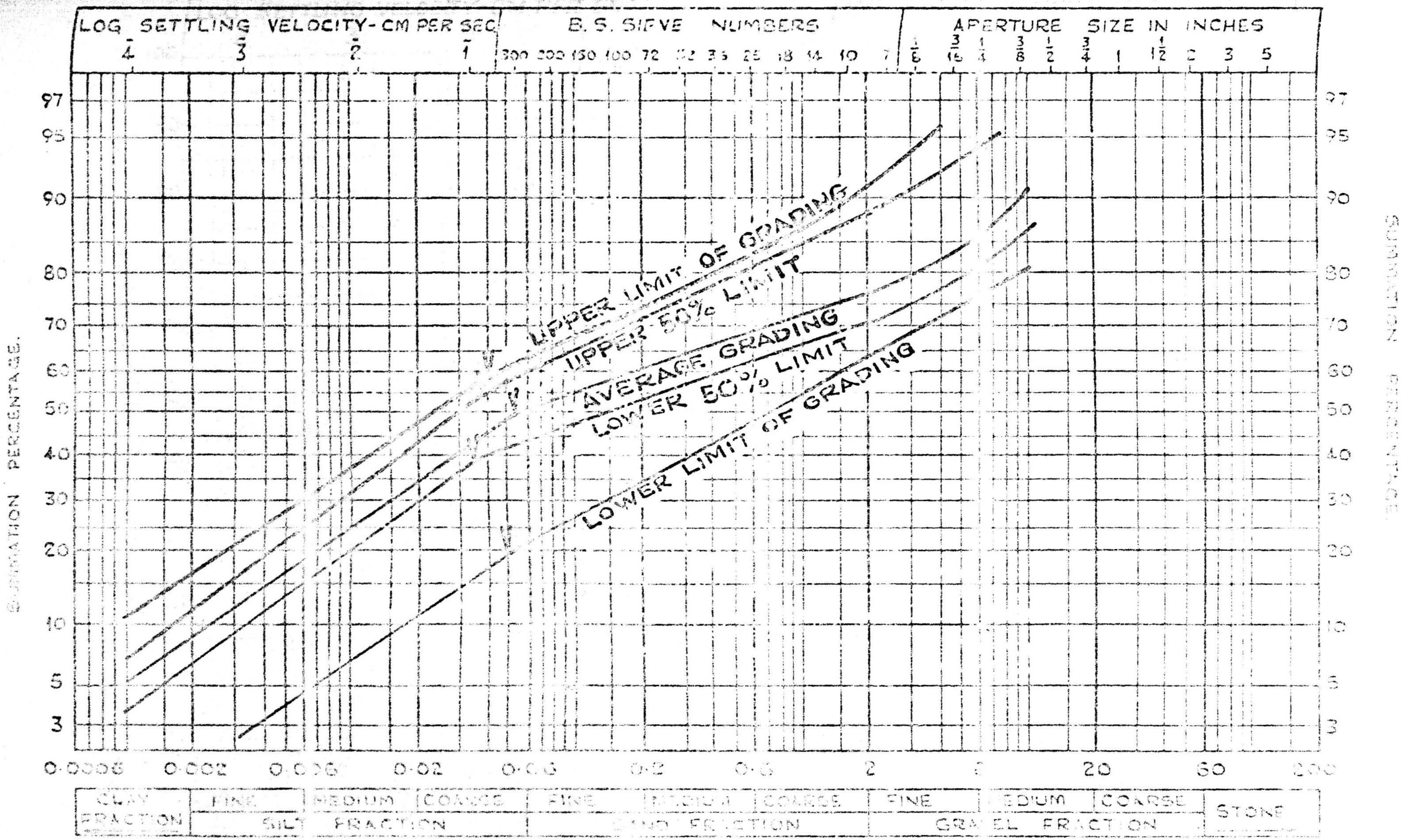
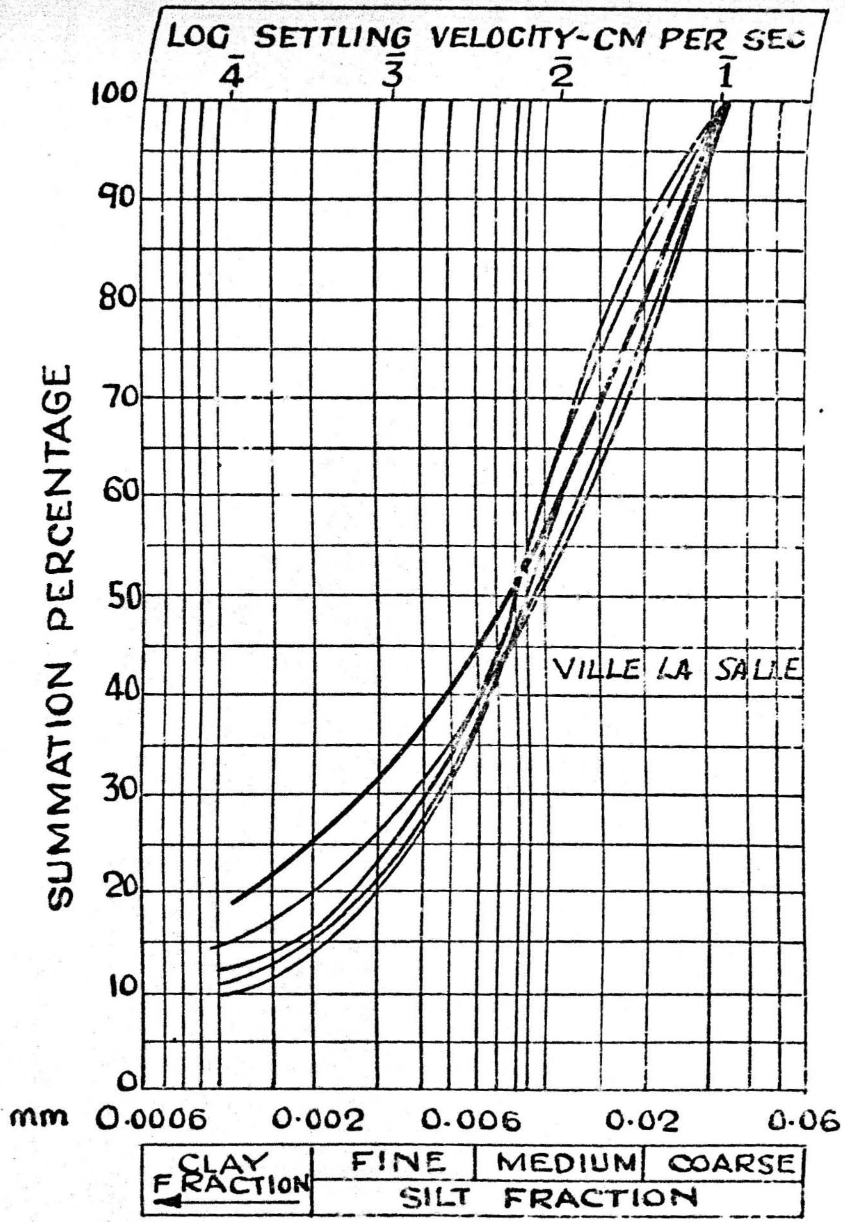


FIG 3.132 LOG PROBABILITY OF ÎLE [illegible], MONTREAL TILL

PARTICLE SIZE DISTRIBUTION
SEMI-LOG PLOT



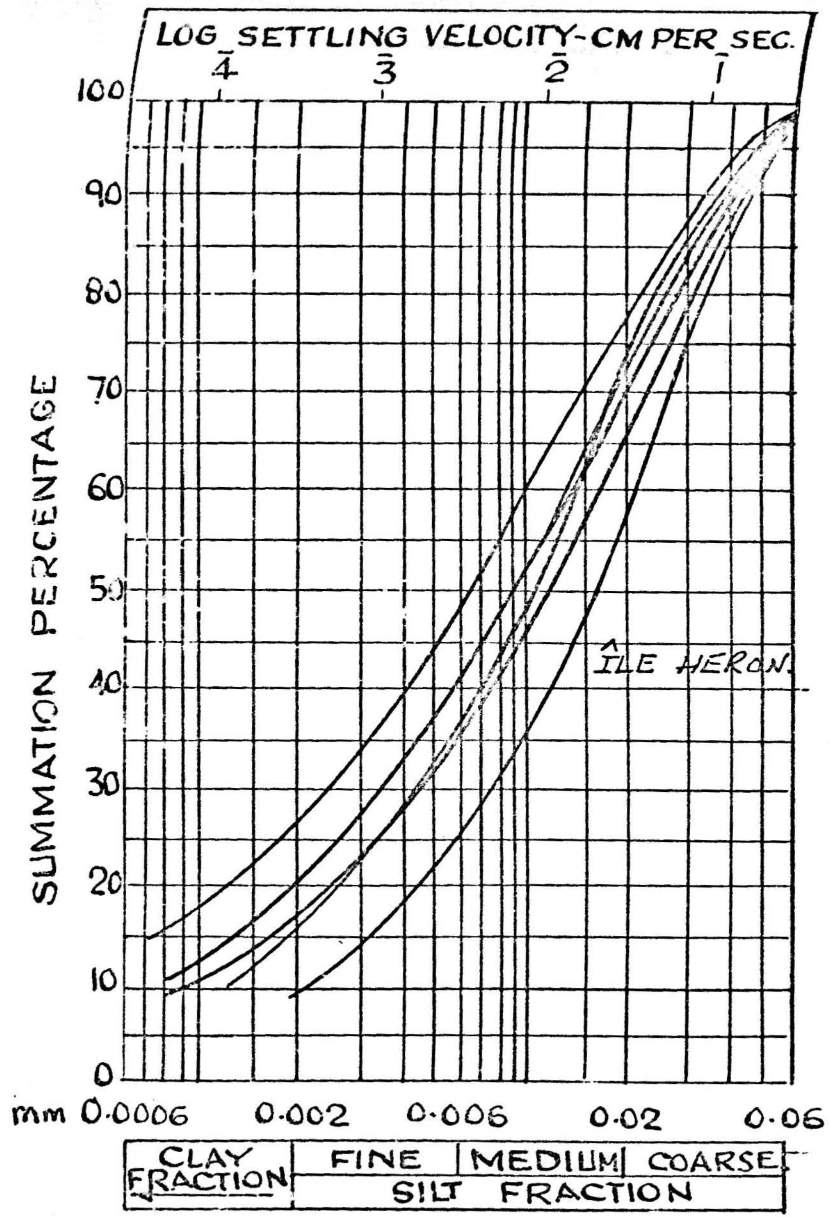
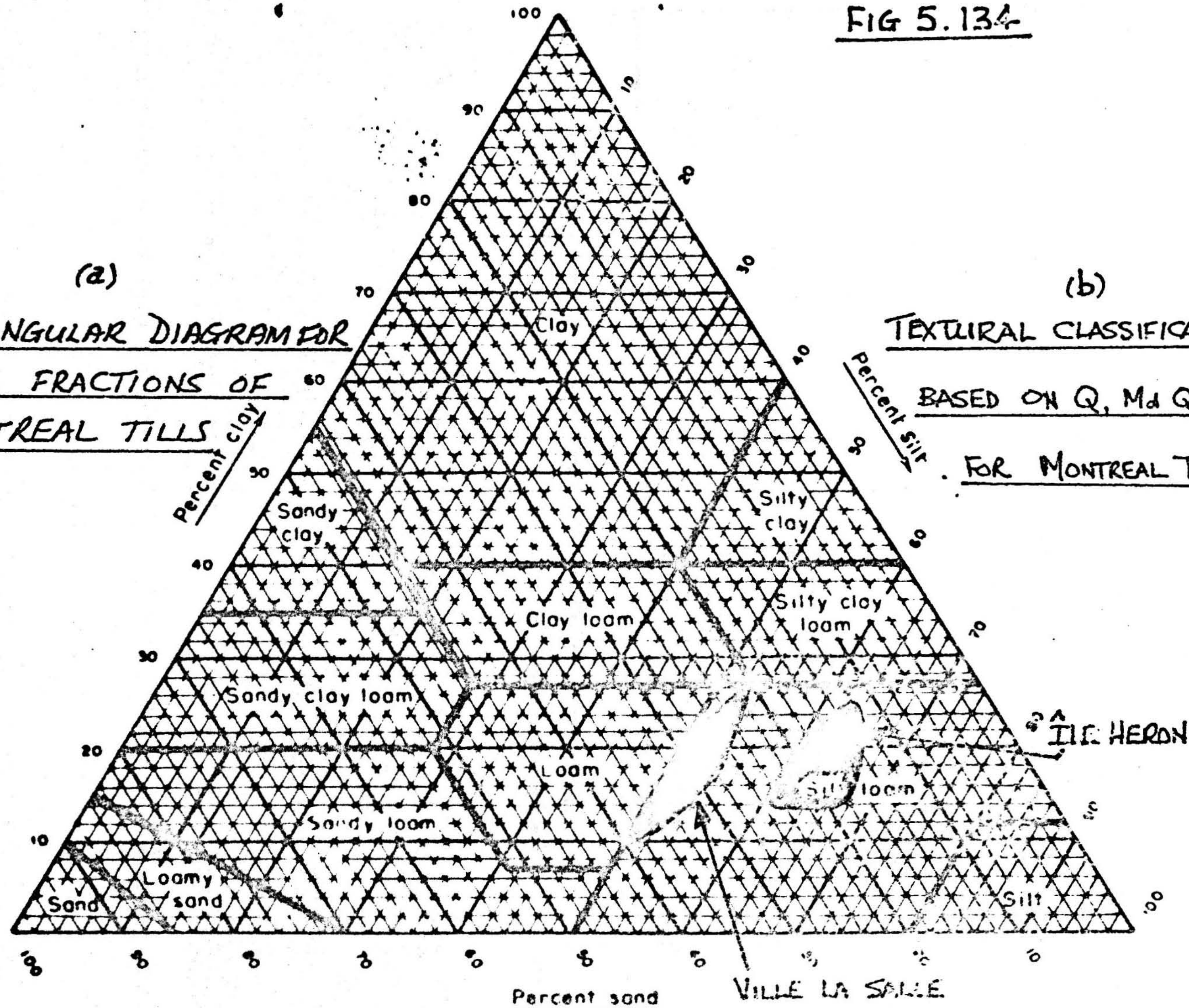


FIG. 5.133 FINE SOIL FRACTIONS OF MONTREAL TILLS.

FIG 5.134

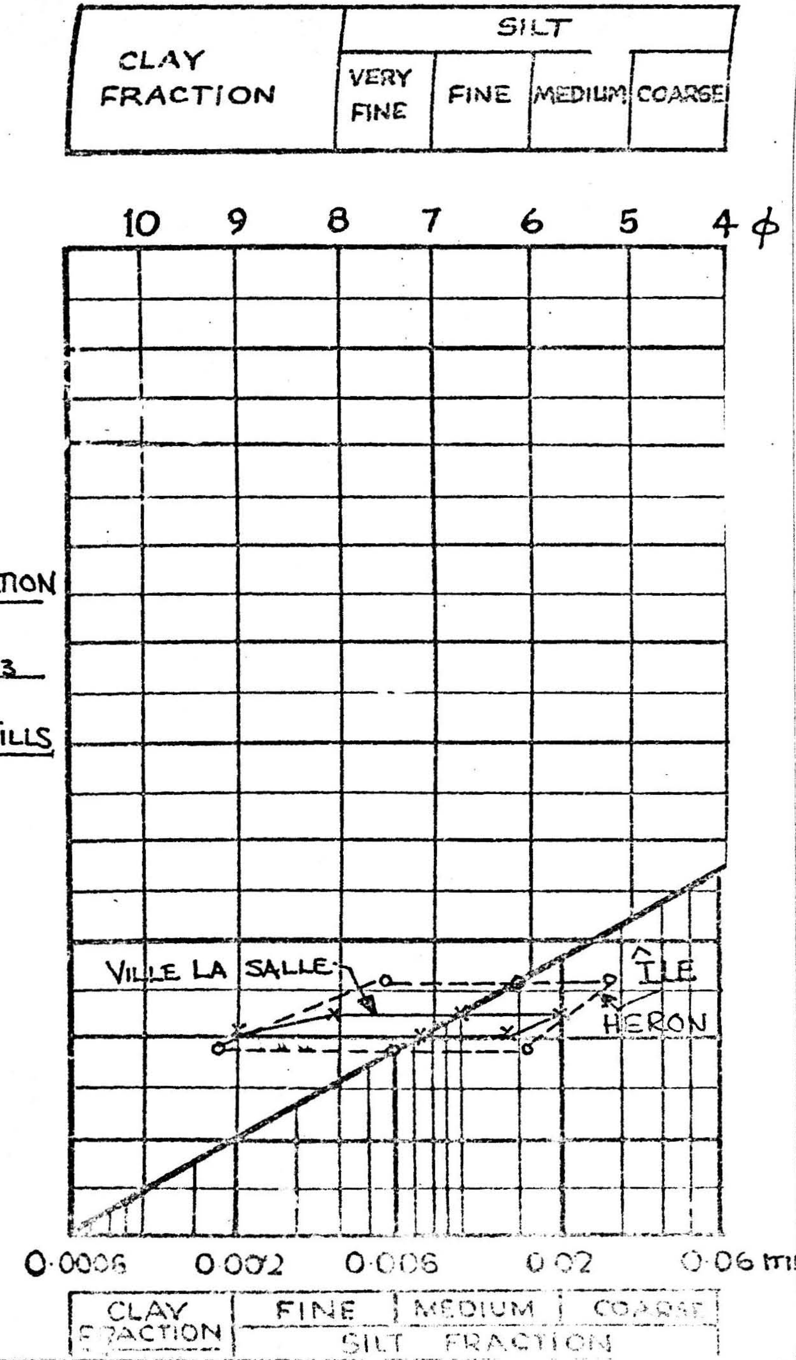
(a)

TRIANGULAR DIAGRAM FOR FINE FRACTIONS OF MONTREAL TILLS



(b)

TEXTURAL CLASSIFICATION BASED ON Q, Md Q3 FOR MONTREAL TILLS



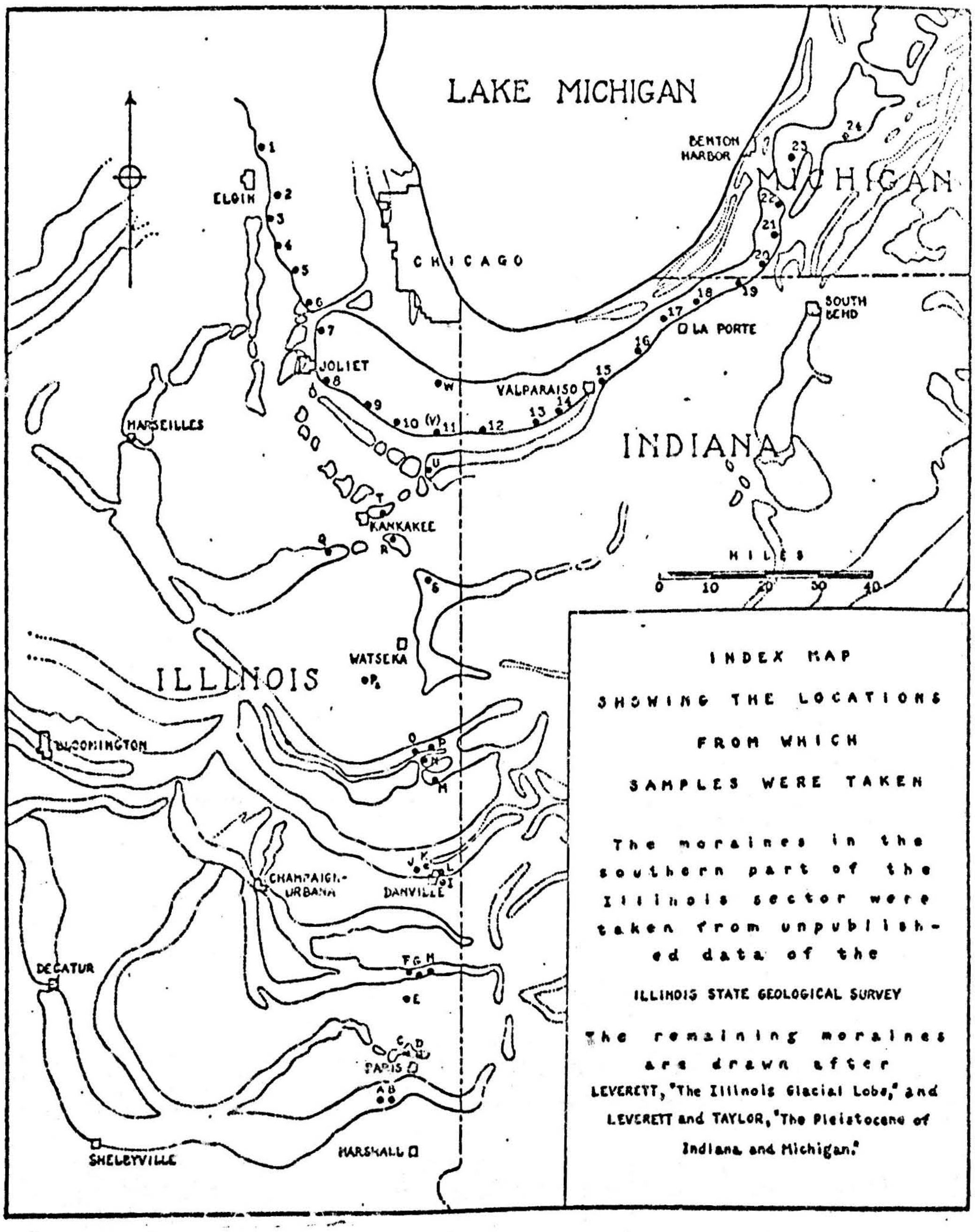


FIG. 5.135. LOCATION MAP FOR KRUMBEIN'S SAMPLES.
(KRUMBEIN, 1953)

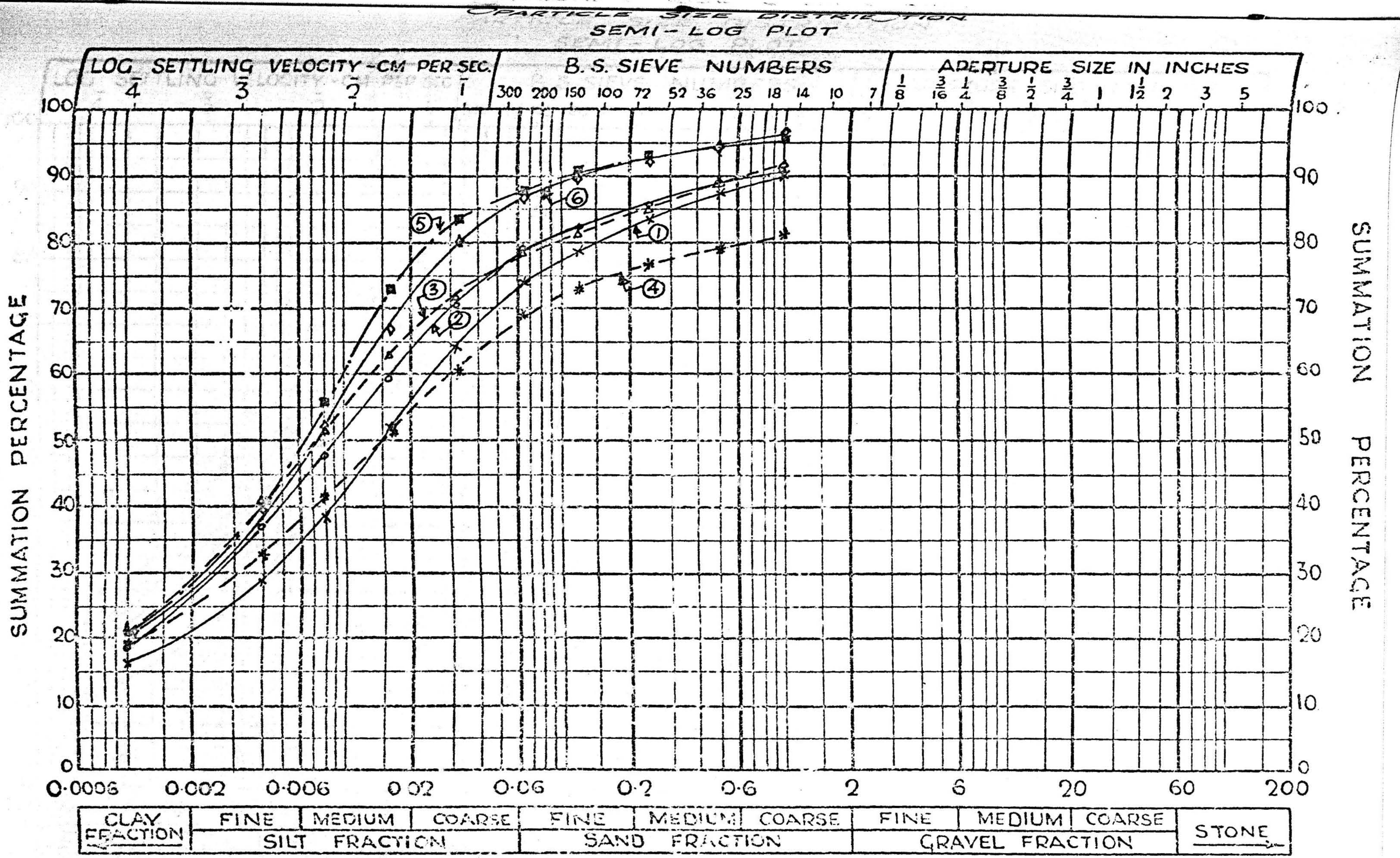


FIG 5.136. GRADINGS FOR KRUMBEIN'S VALPARAISO TILLS (1-5)

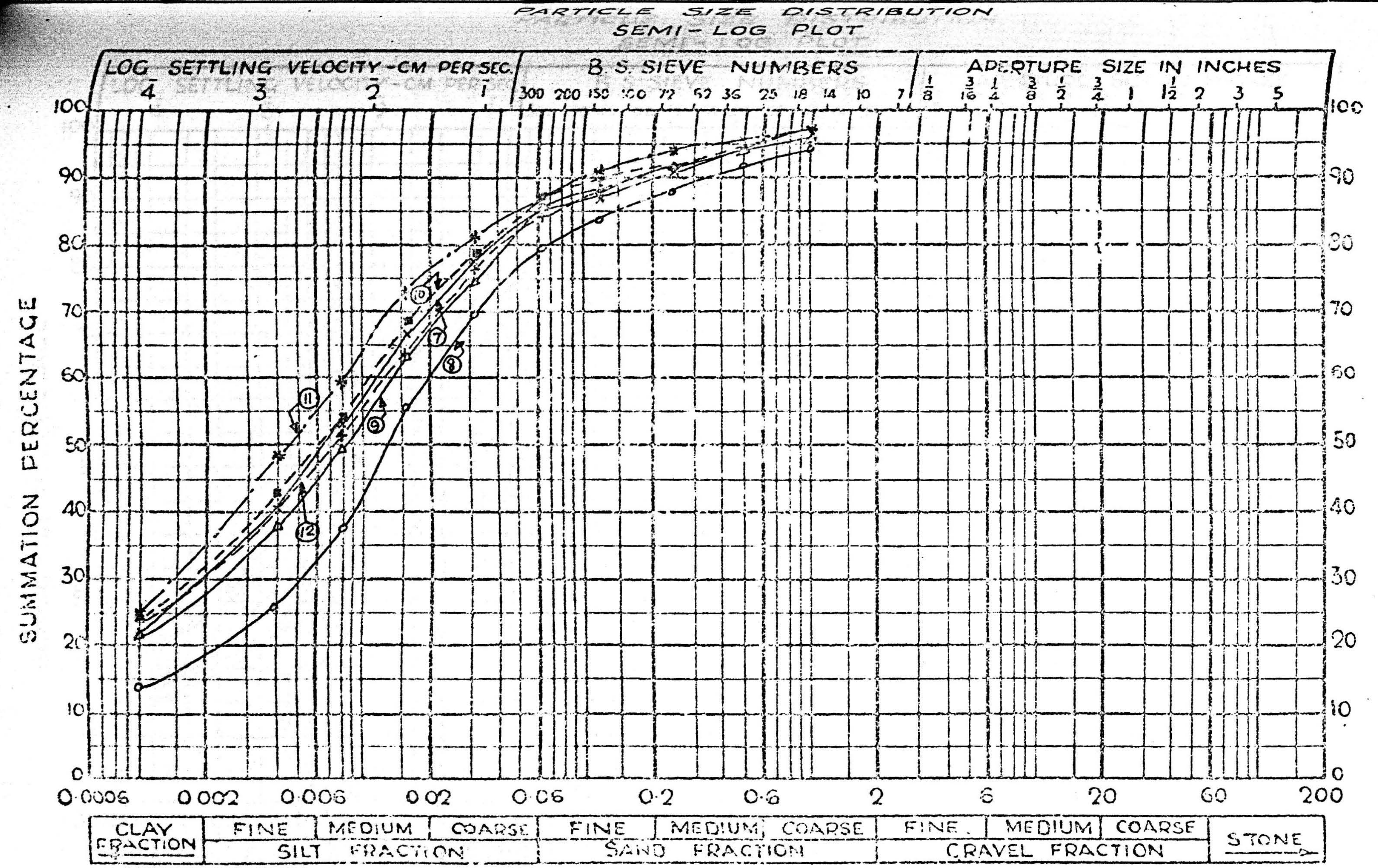


FIG. 5.137. GRADINGS FOR KRUMBEIN'S VALPARAISO TILLS (7 -- 12)

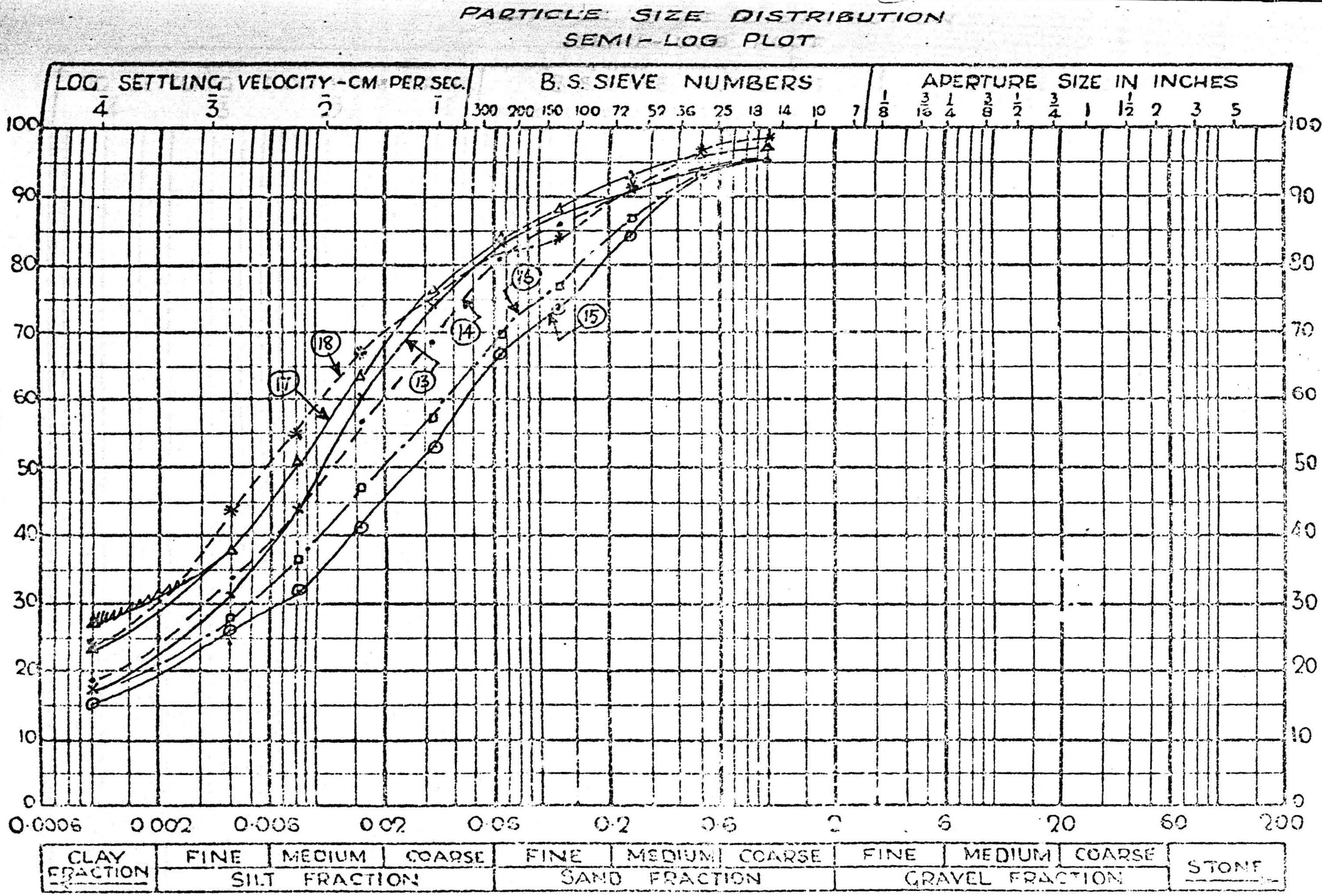


FIG. 5. 138. GRADINGS FOR KRUMBEIN'S VALPARAISO TILLS (13-18).

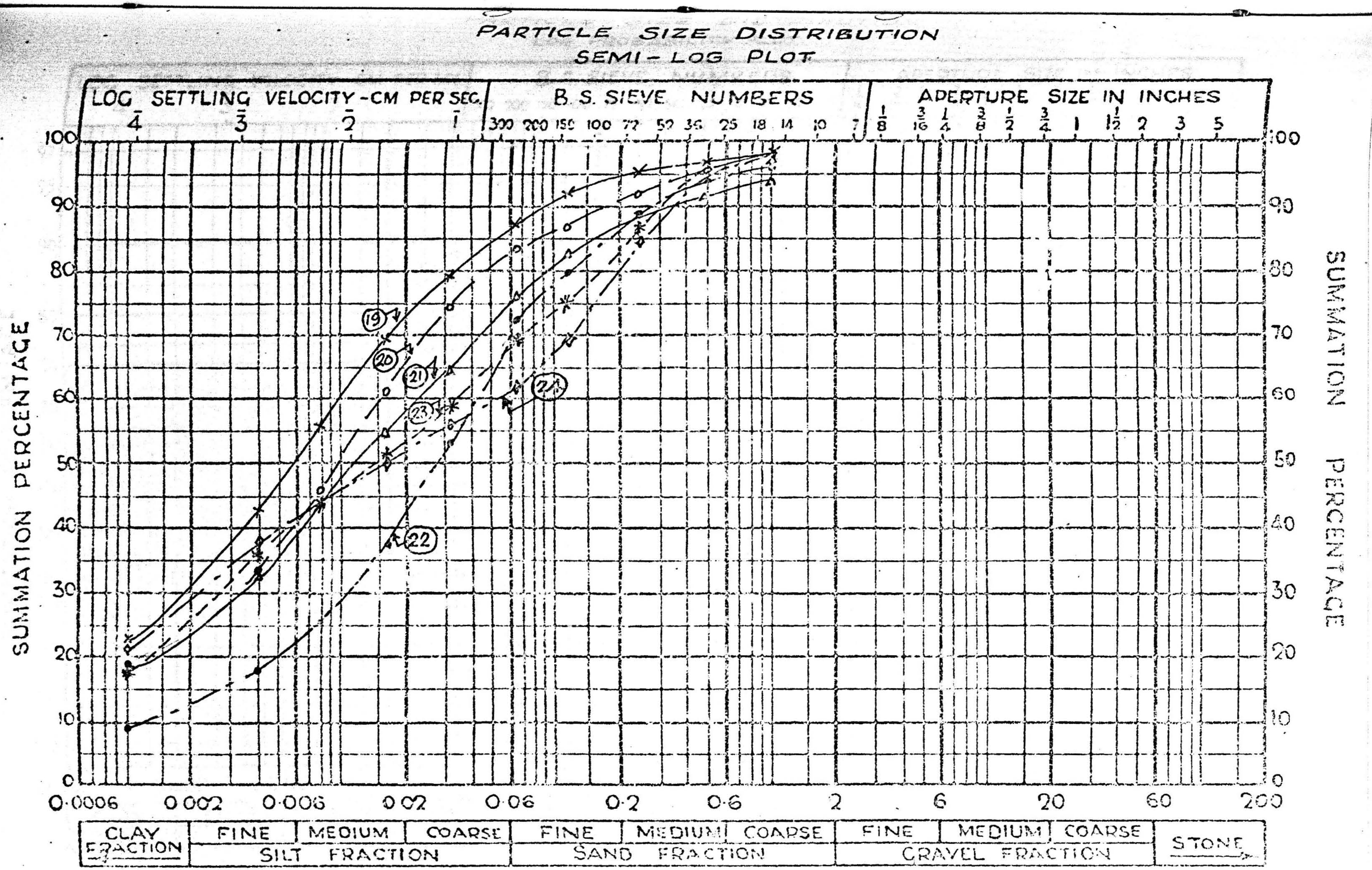


FIG. 5.139 GRADINGS FOR KRUMBEIN'S VALPARAISO TILLS (19-24).

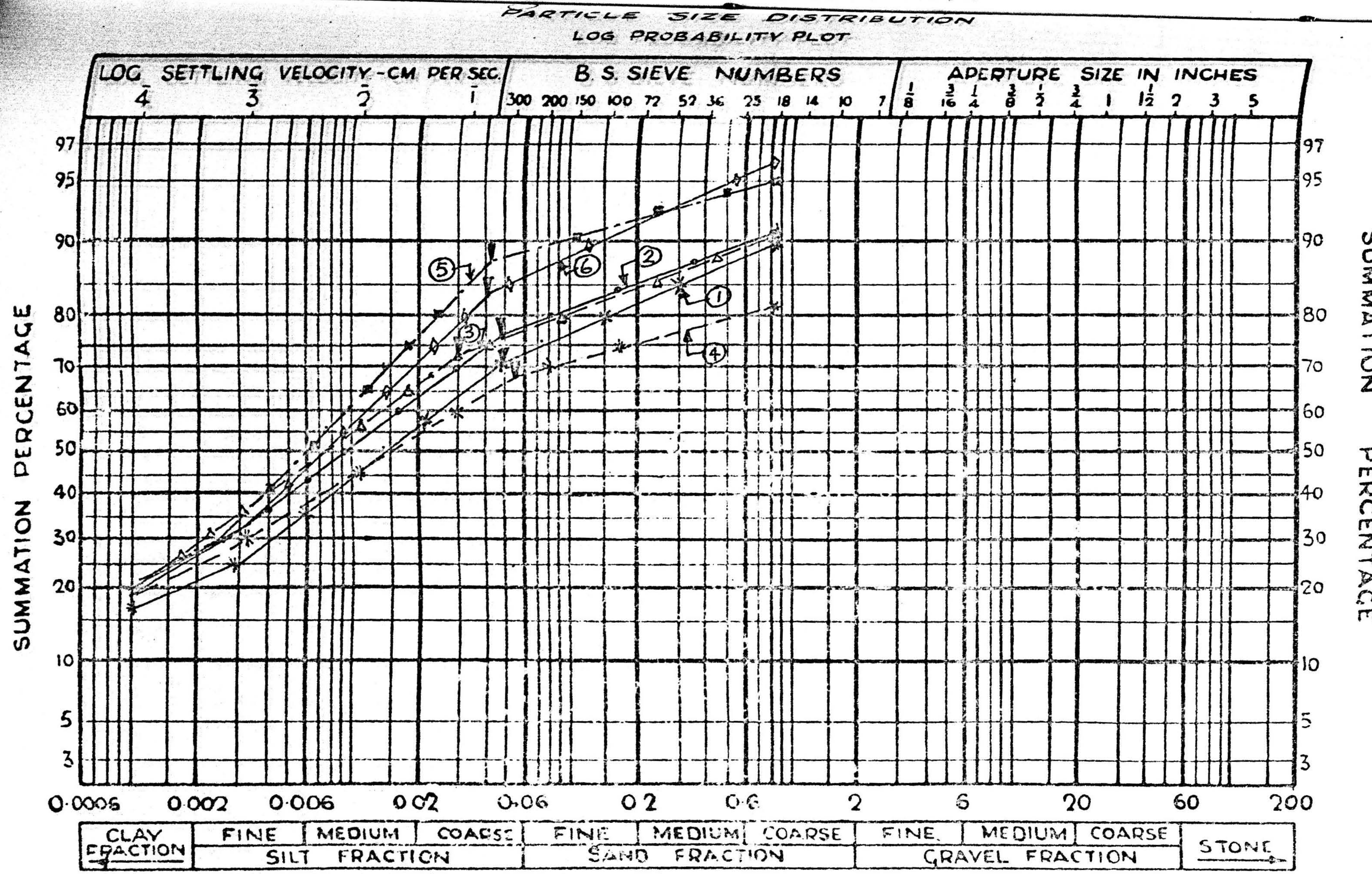


FIG. 5.140. LOG PROBABILITY PLOT OF KRUMBEIN VALPARAISO TILLS (1-5).

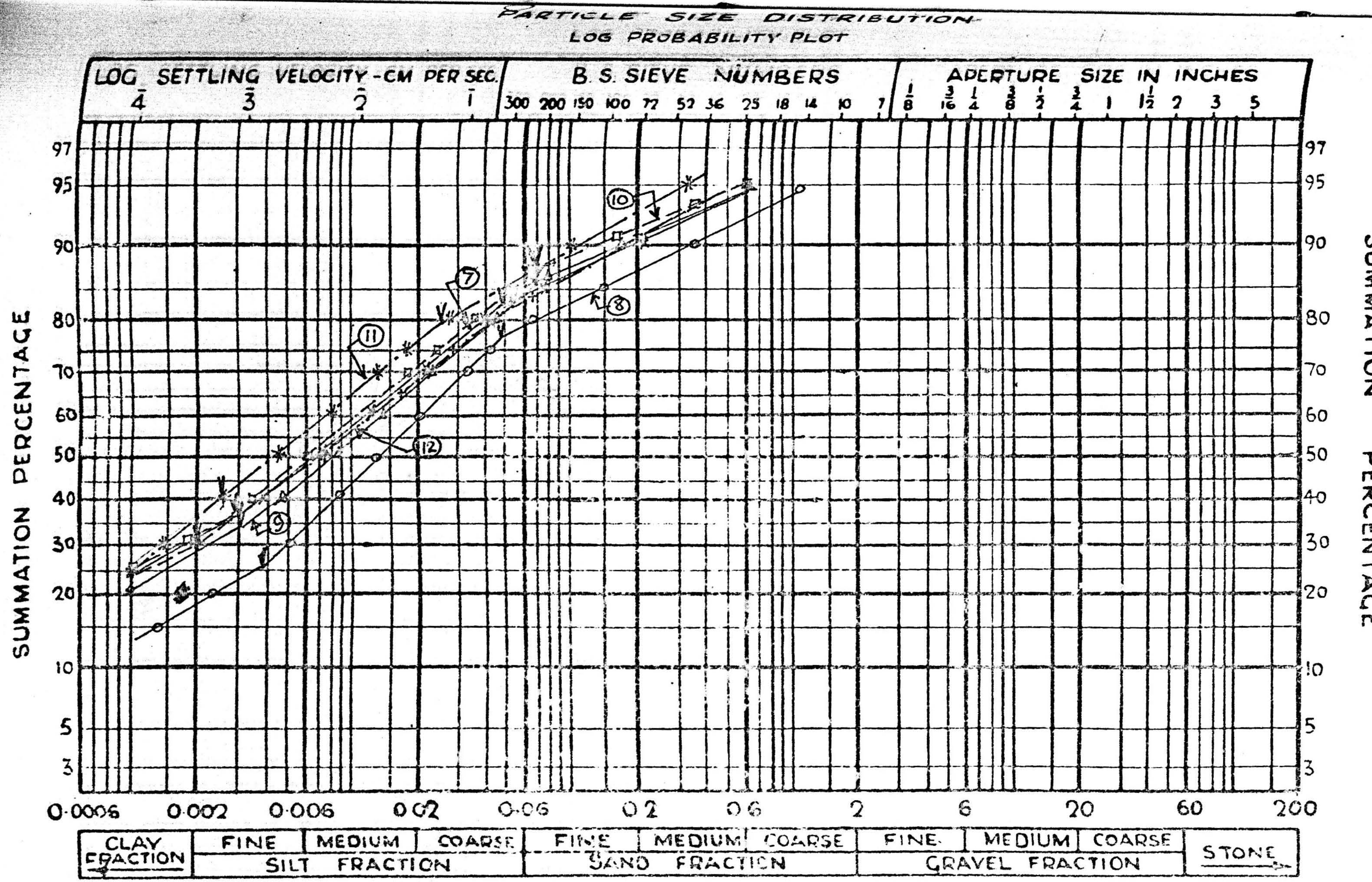


FIG. 5.141. LOG PROBABILITY PLOT OF KRUMBEIN'S VALPARAISO TILLS (7–12).

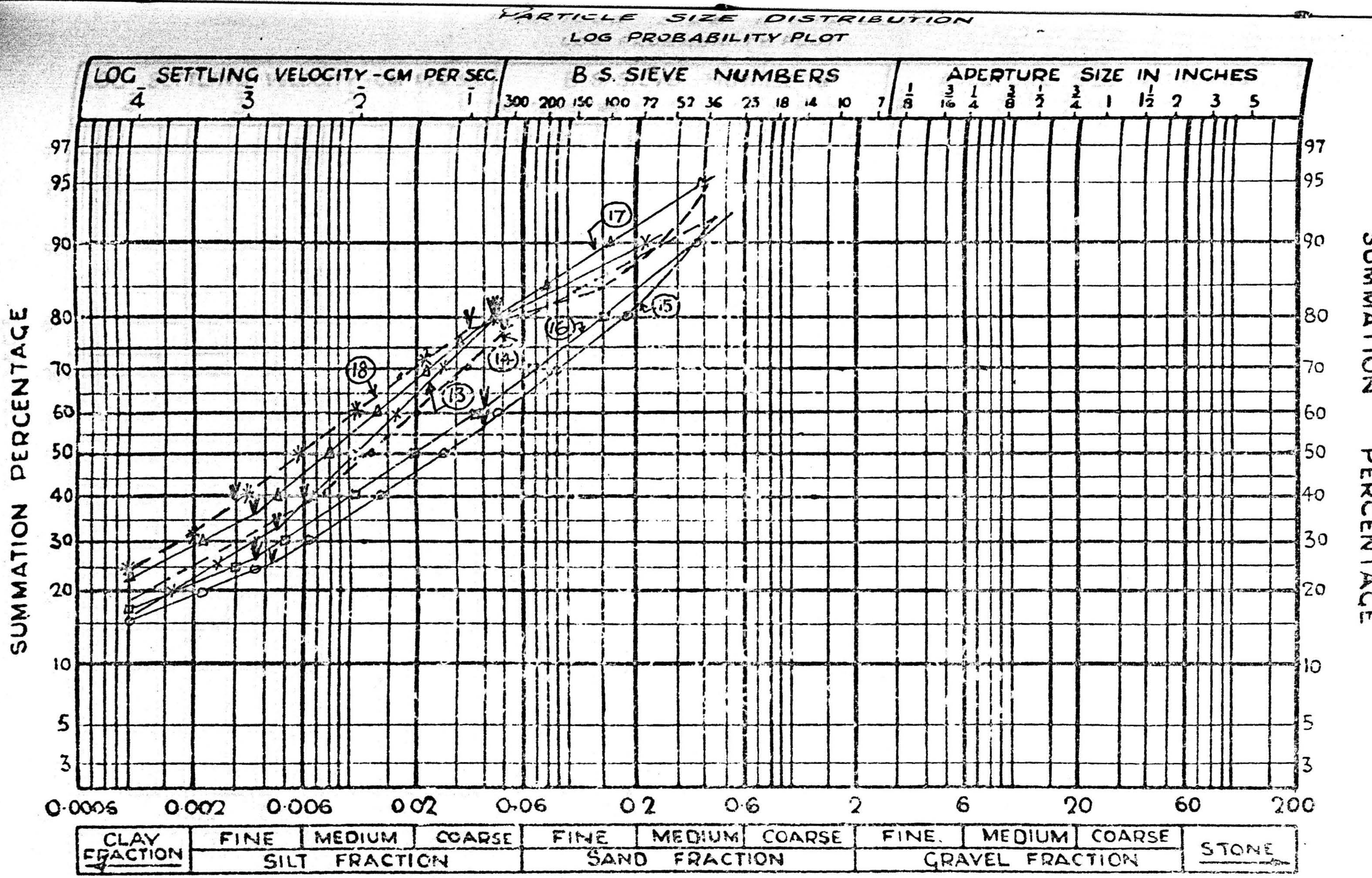


FIG. 5.142. LOG PROBABILITY PLOT OF KRUMBEIN'S VALPARAISO TILLS (13-18).

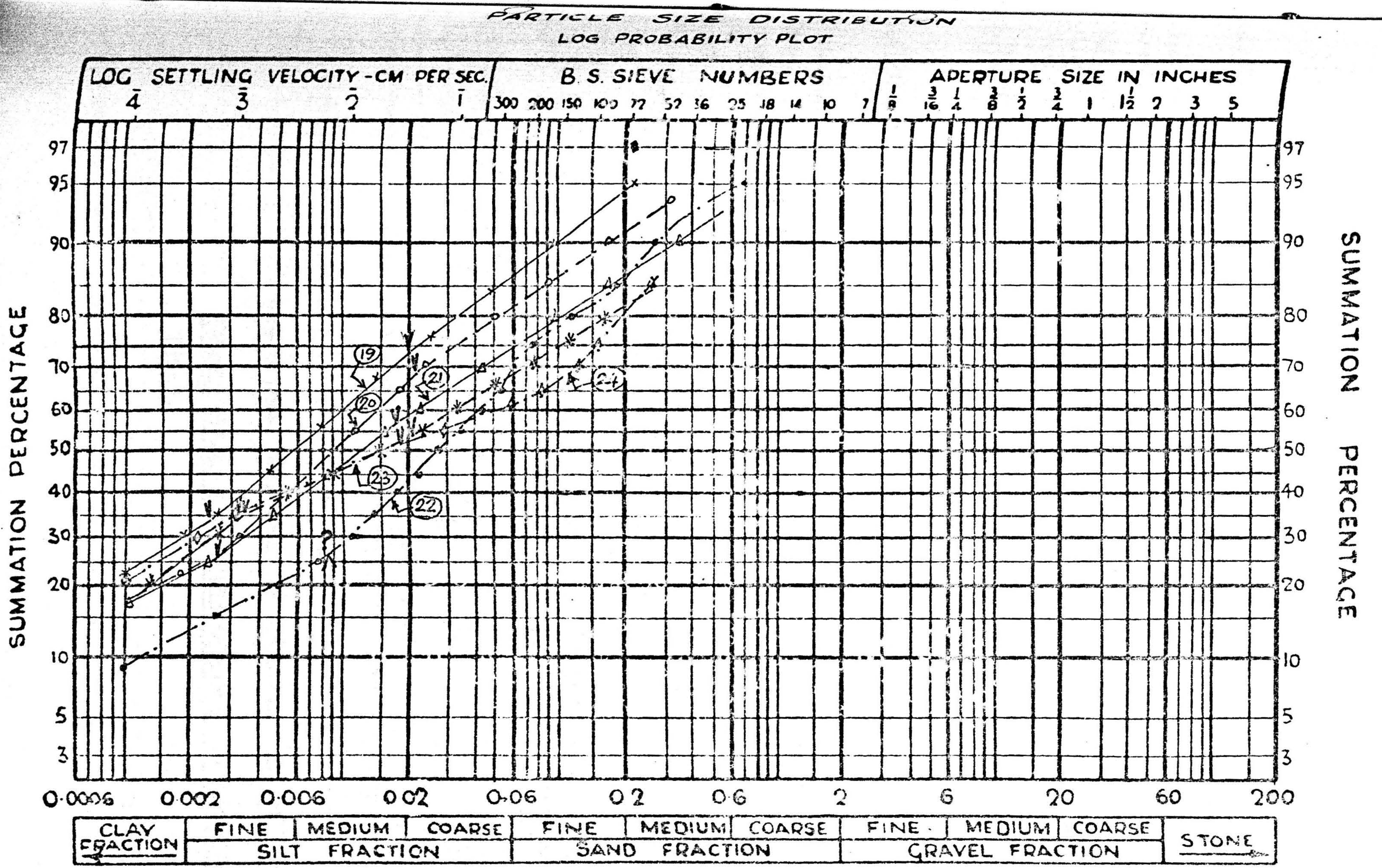


FIG. 5.143. LOG PROBABILITY PLOT OF KRUMBEIN'S VALPARAISO TILLS (19-24).

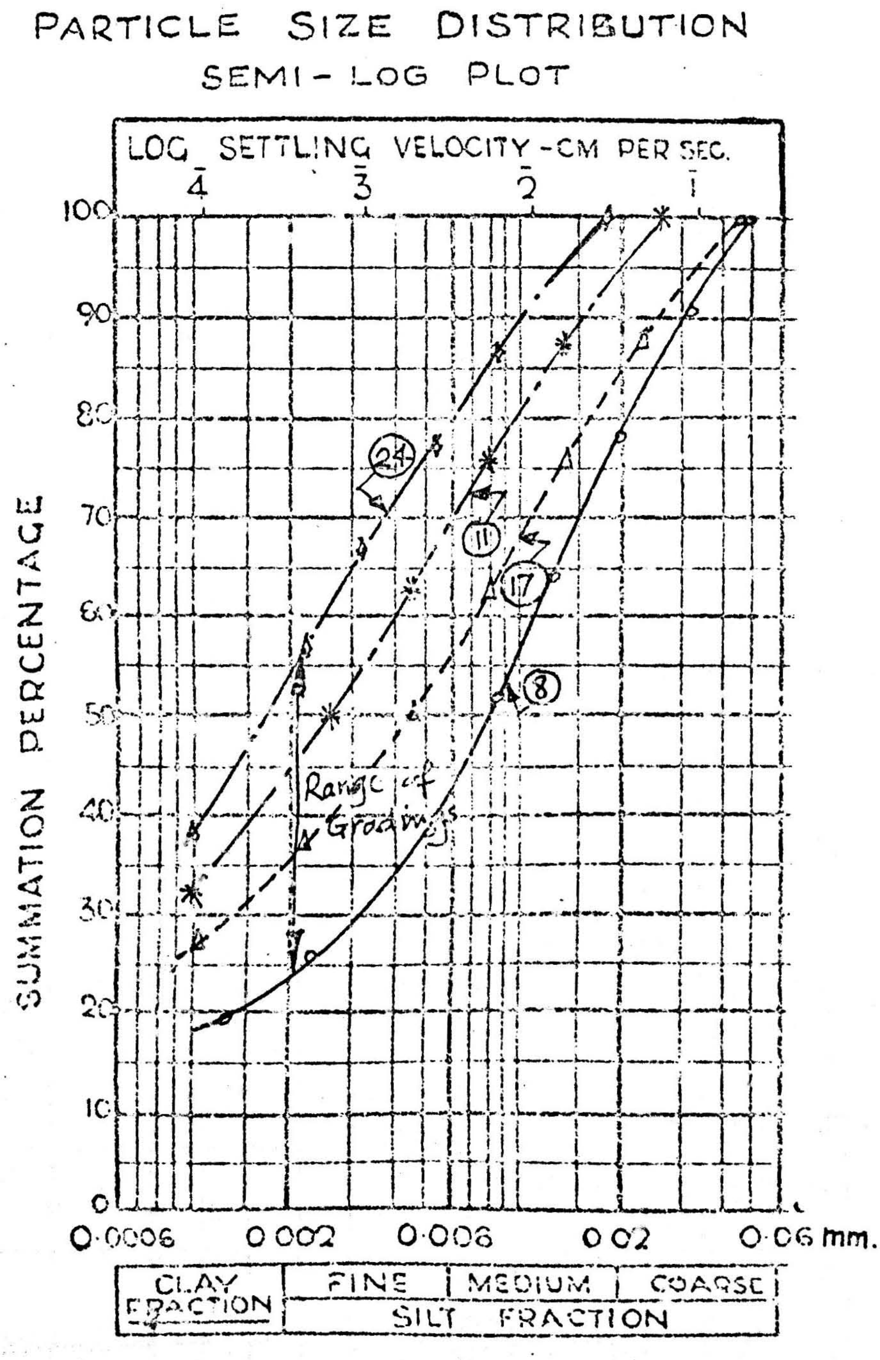


FIG. 5.144. RANGE OF GRADINGS OF FINE FRACTIONS OF KRUMBEIN'S VALPARAISO TILLS

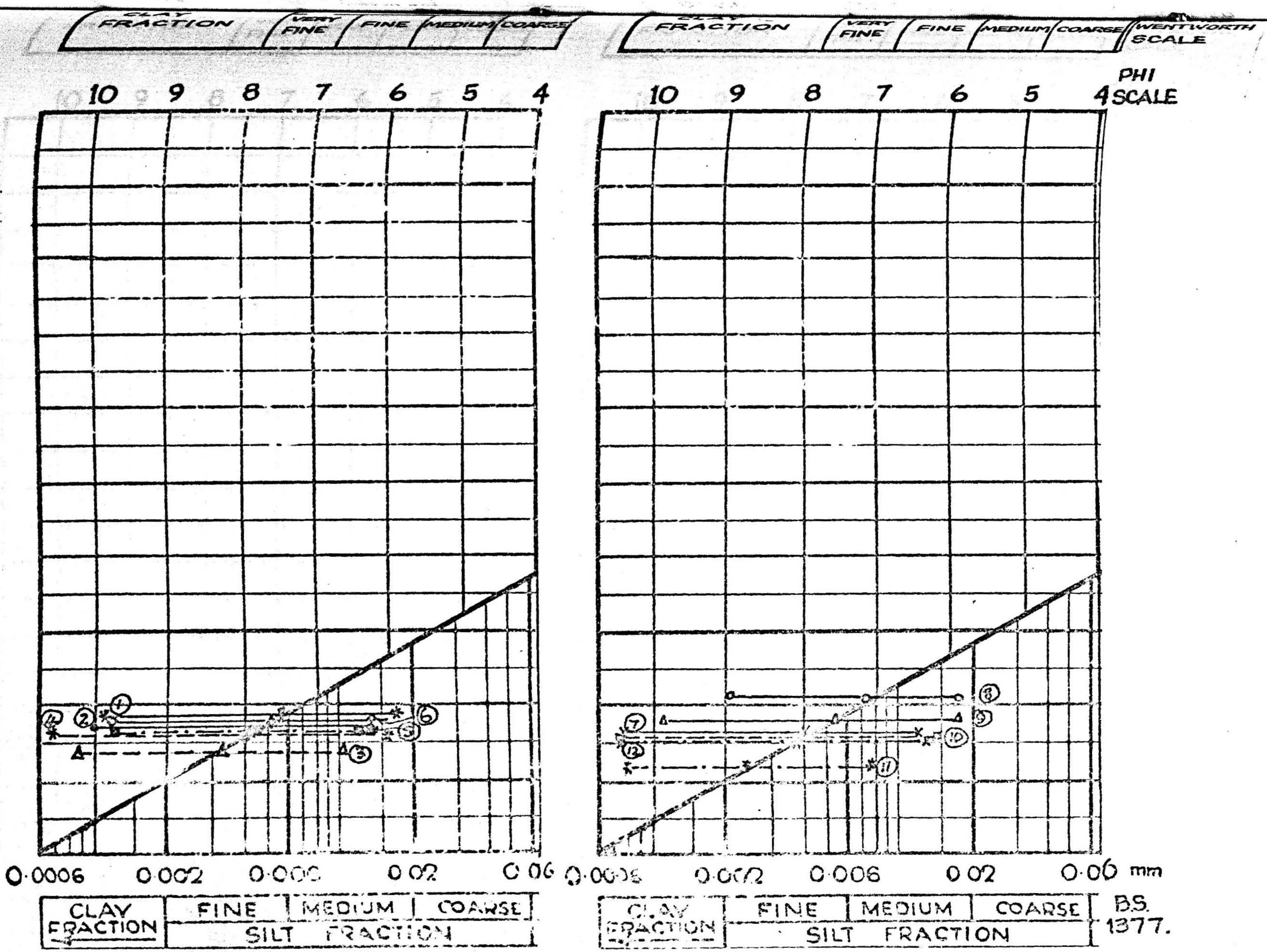


FIG. 5.145. TEXTURAL CLASSIFICATION BASED ON Q_1 MD Q_3 FOR KRUMEIN'S VALPARAISO TILLS (1 - 12) FINE FRACTIONS

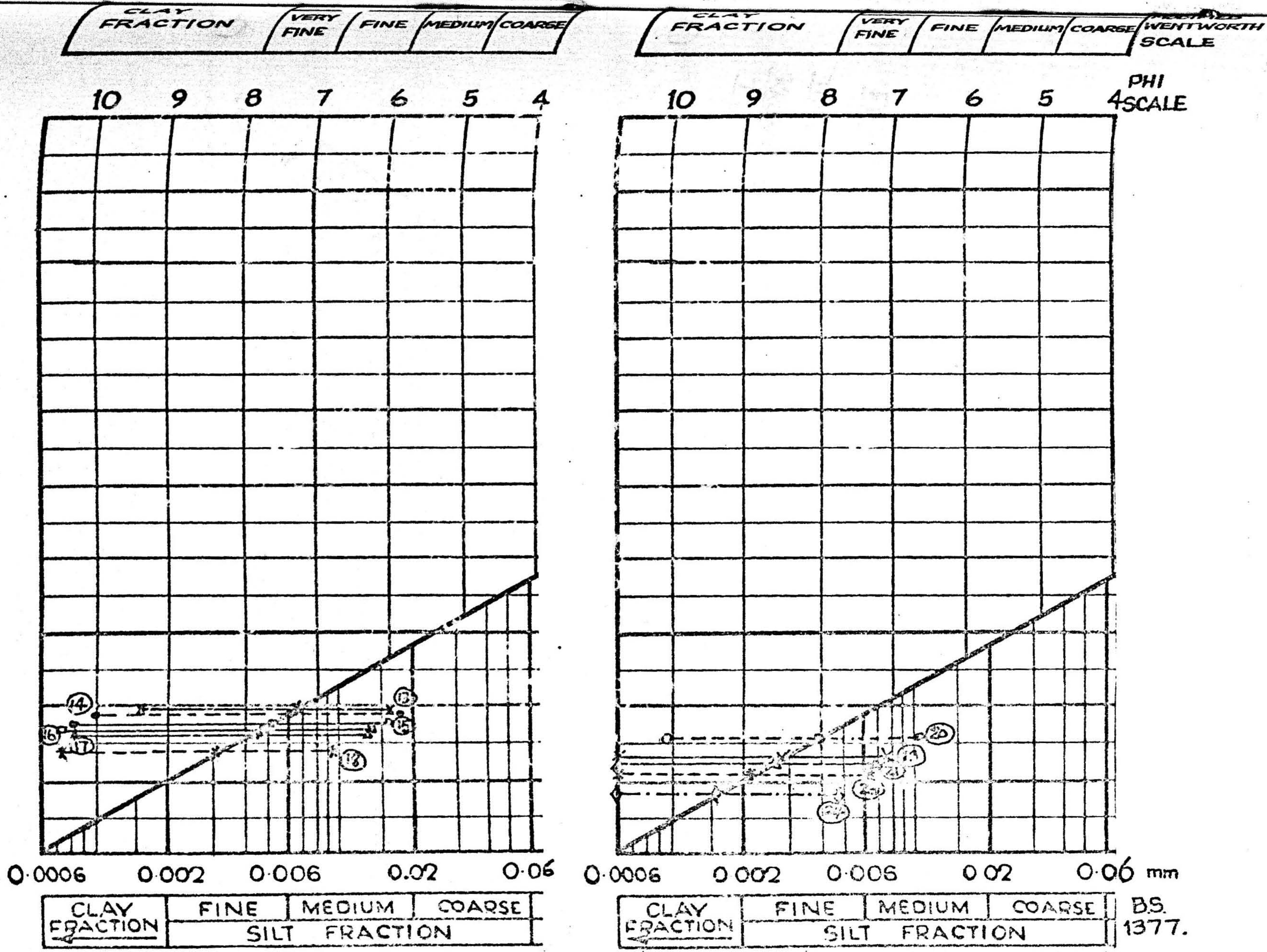


FIG. 5. 146 TEXTURAL CLASSIFICATION BASED ON Q_1, Md, Q_3 FOR KRUMBEIN'S VALPARAISO TILLS (13-24) FINE FRACTIONS.

FIG. 5.147.

TRIANGULAR DIAGRAM FOR KRUMBEIN'S VALPARAISO/ILLINOIS TILLS – FINE FRACTIONS.

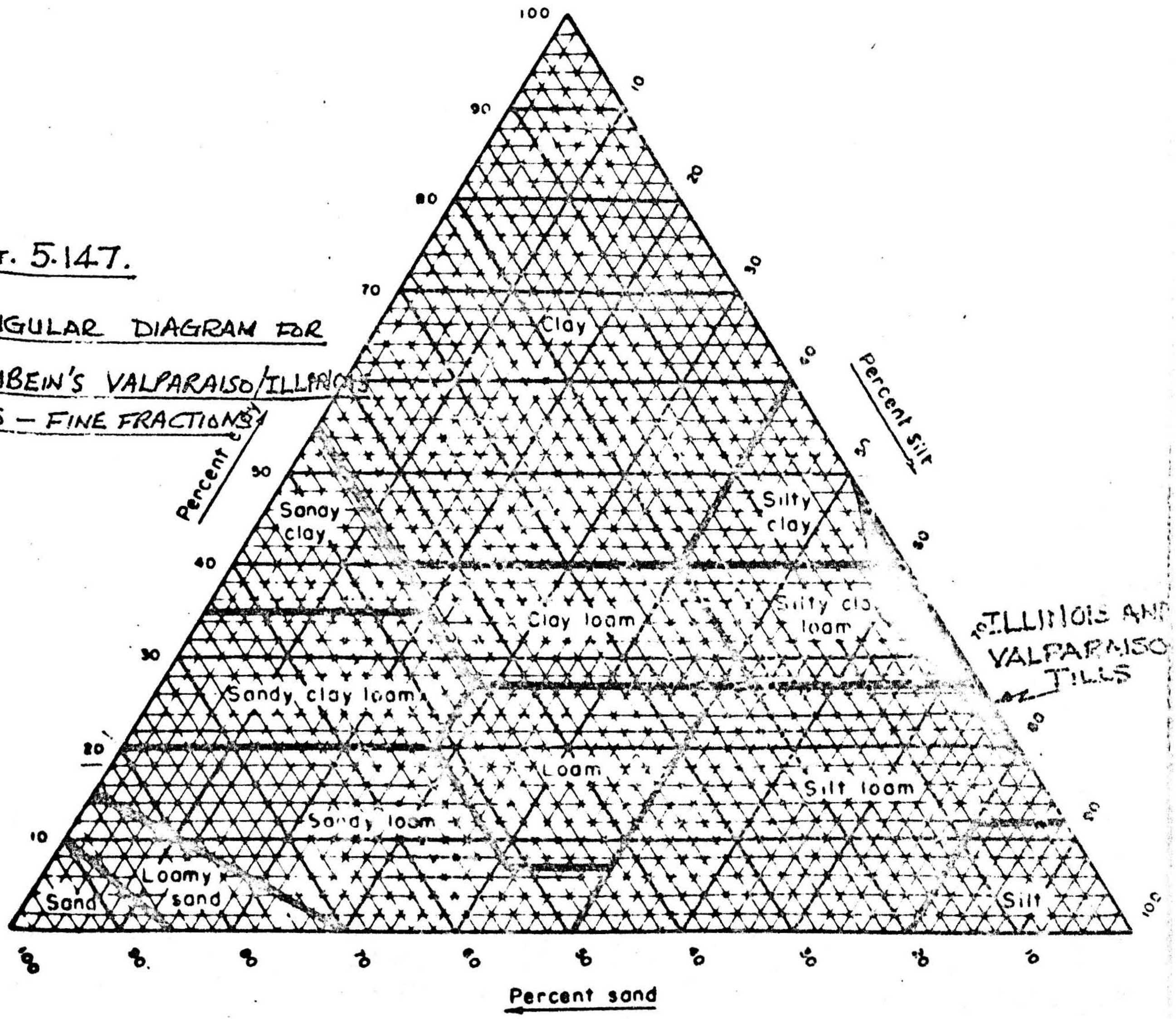


FIG. 5.148. LITHOLOGIC VARIATION IN VALPARAISO TILL (AFTER KRUMBEIN, 1953).

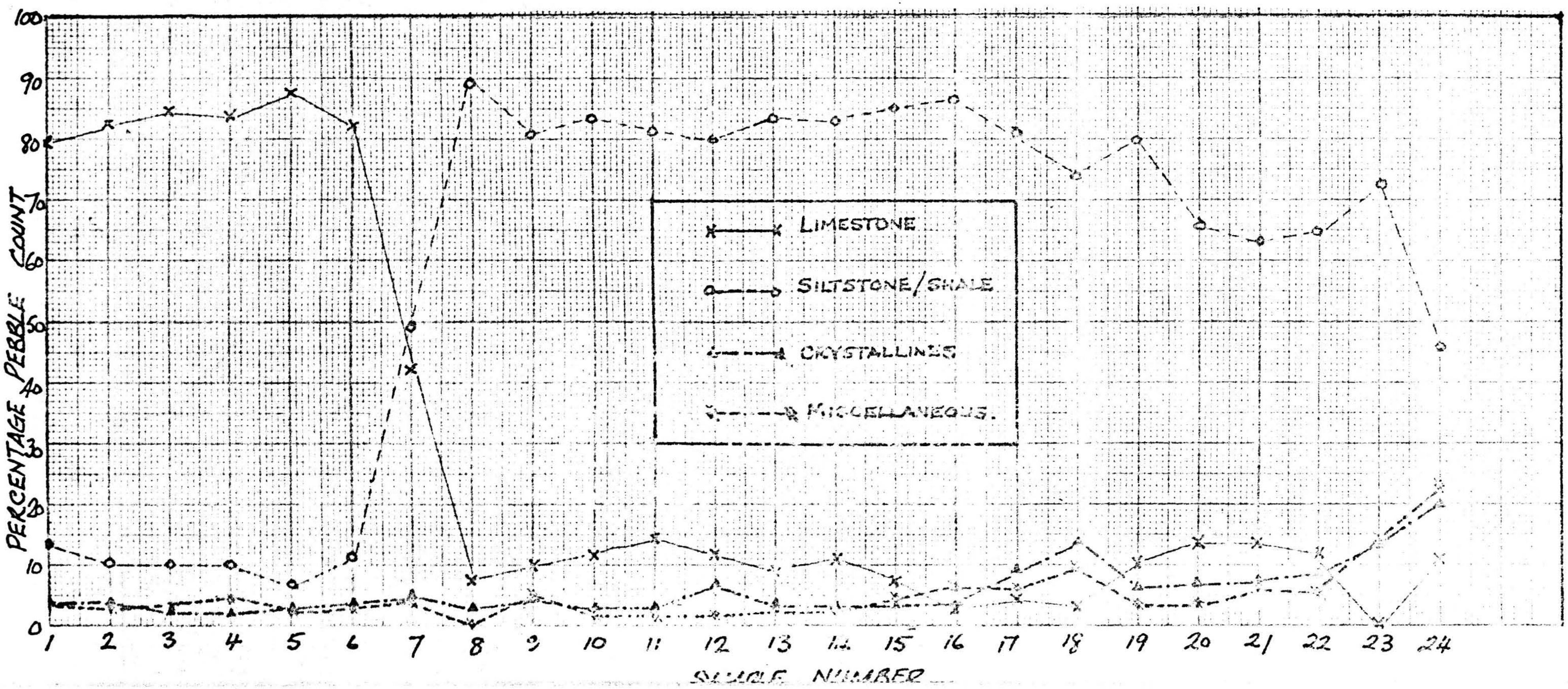
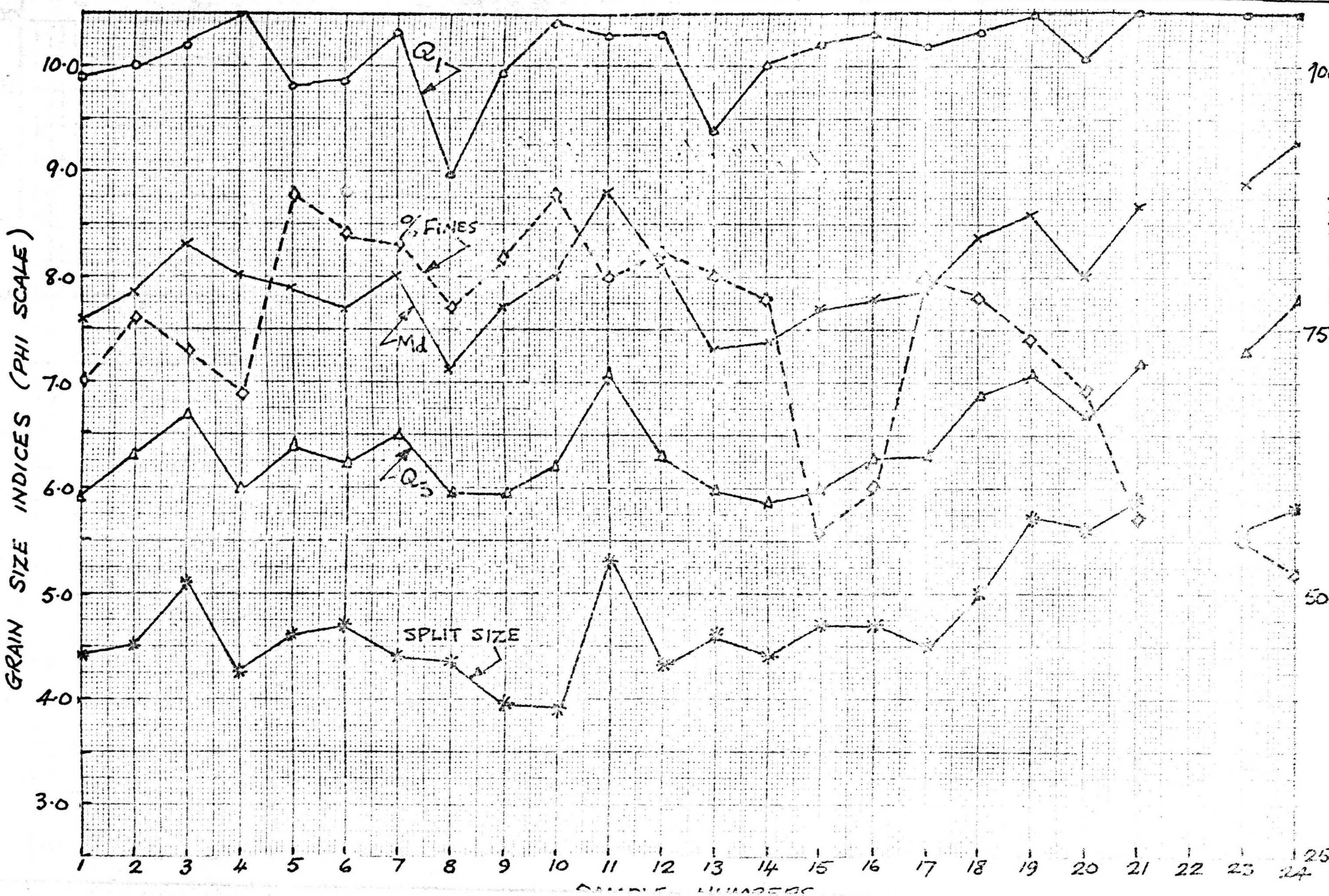


FIG. 5.149. VARIATION OF THE GRAIN SIZE INDICES AND FINES CONTENT IN VALPARAISO TILL



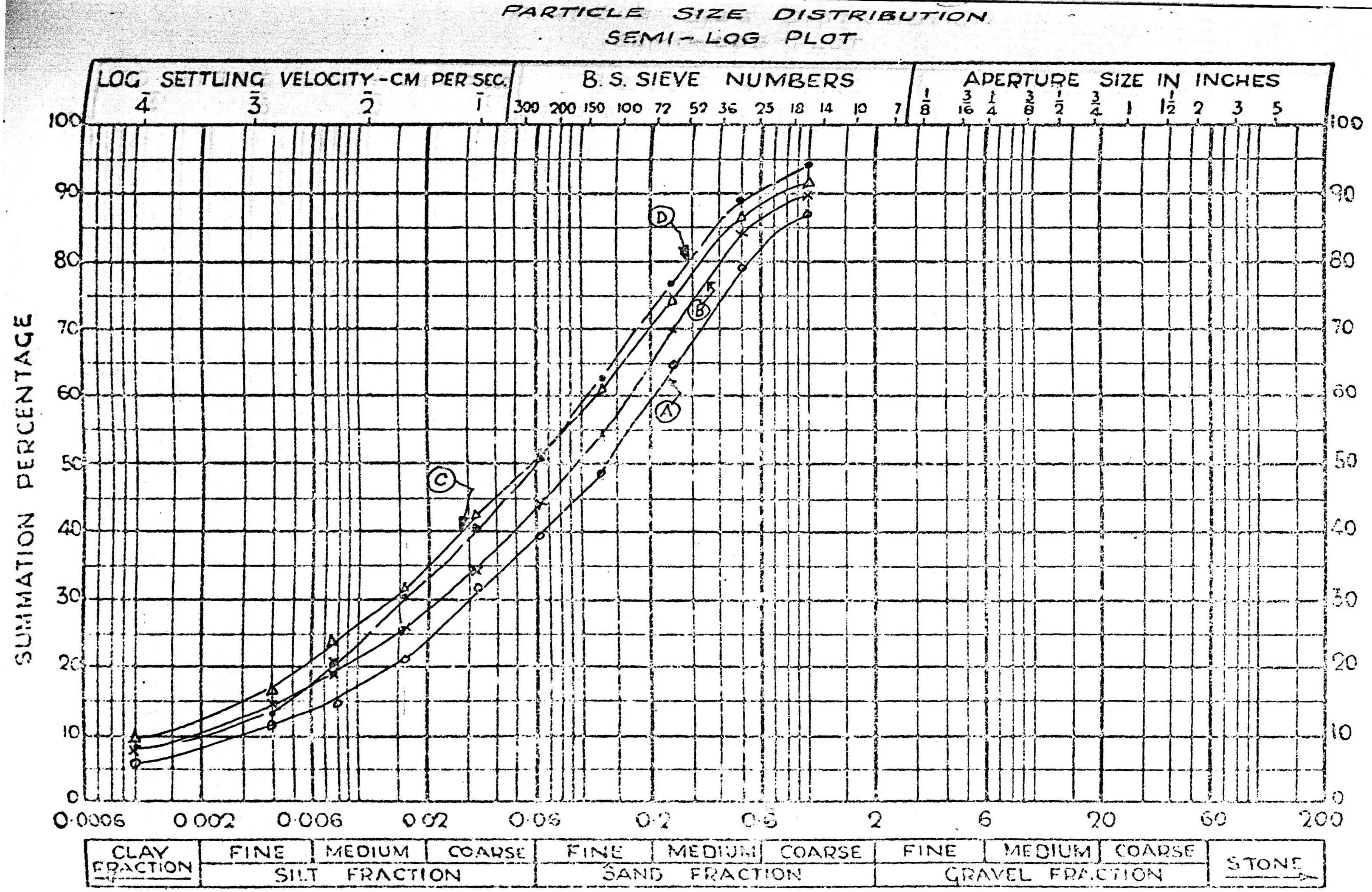


FIG. 5.150. GRADINGS FOR KRUMBEIN'S ILLINOIS TILLS (A-D).

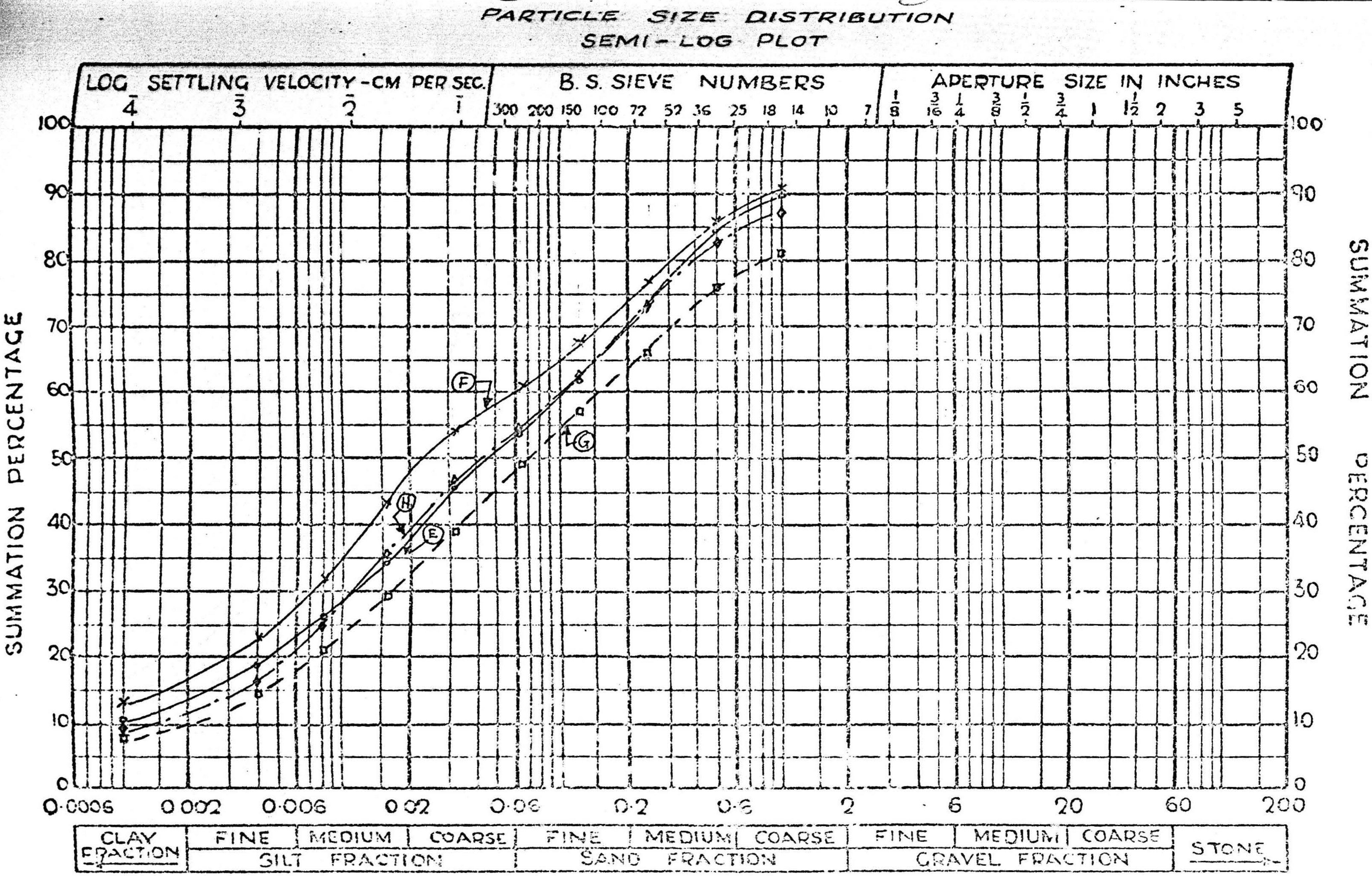


FIG. 5.151. GRADINGS FOR KRUMBEIN'S ILLINOIS TILLS (E-H).

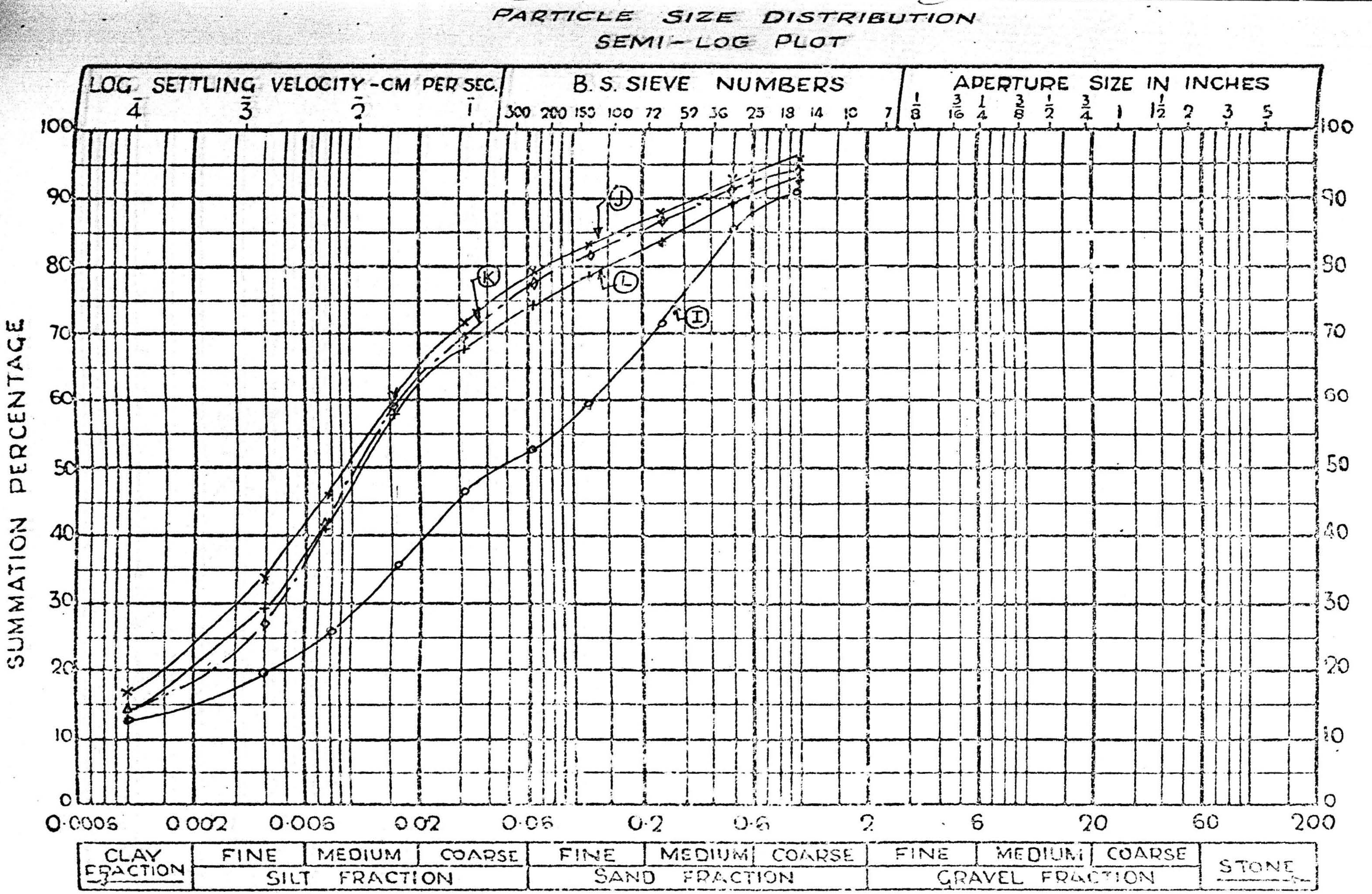


FIG. 5.152. GRADINGS FOR KRUMBEIN'S ILLINOIS TILLS (I-L).

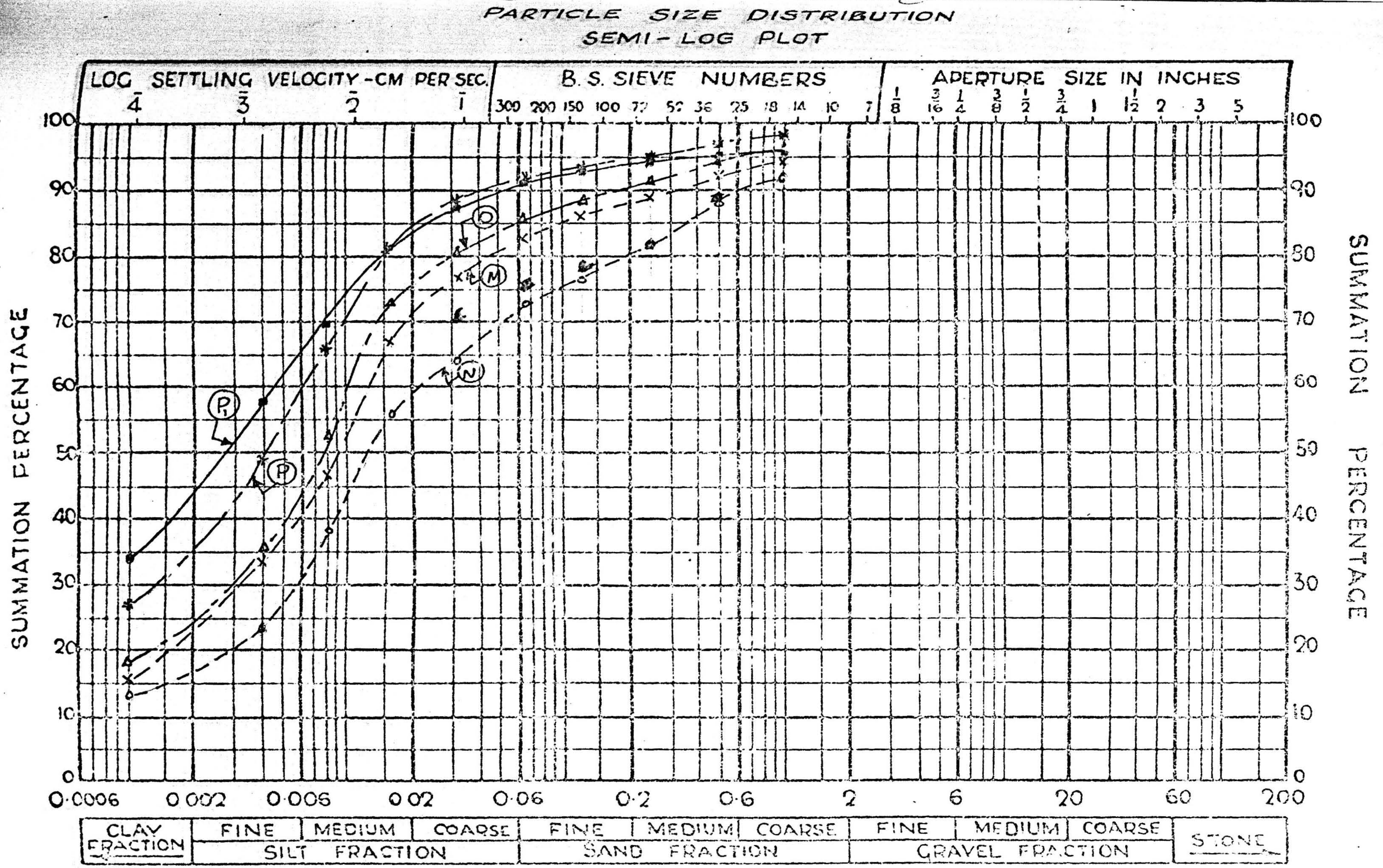


FIG. 5.153. GRADINGS FOR KRUMBEIN'S ILLINOIS TILLS (M – P_1)

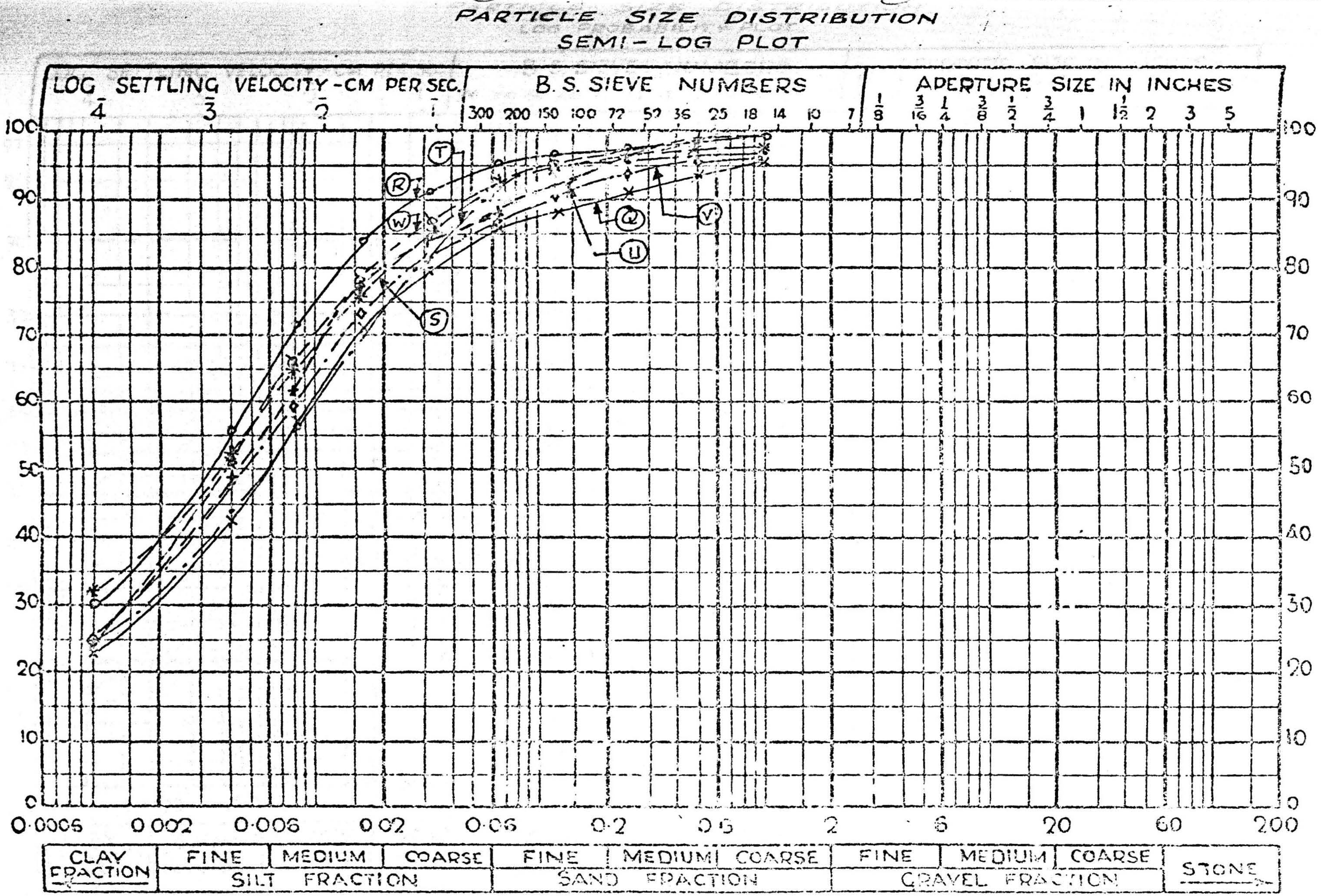


FIG. 5.154. GRADINGS FOR KRUMBEIN'S ILLINOIS TILLS (Q–V).

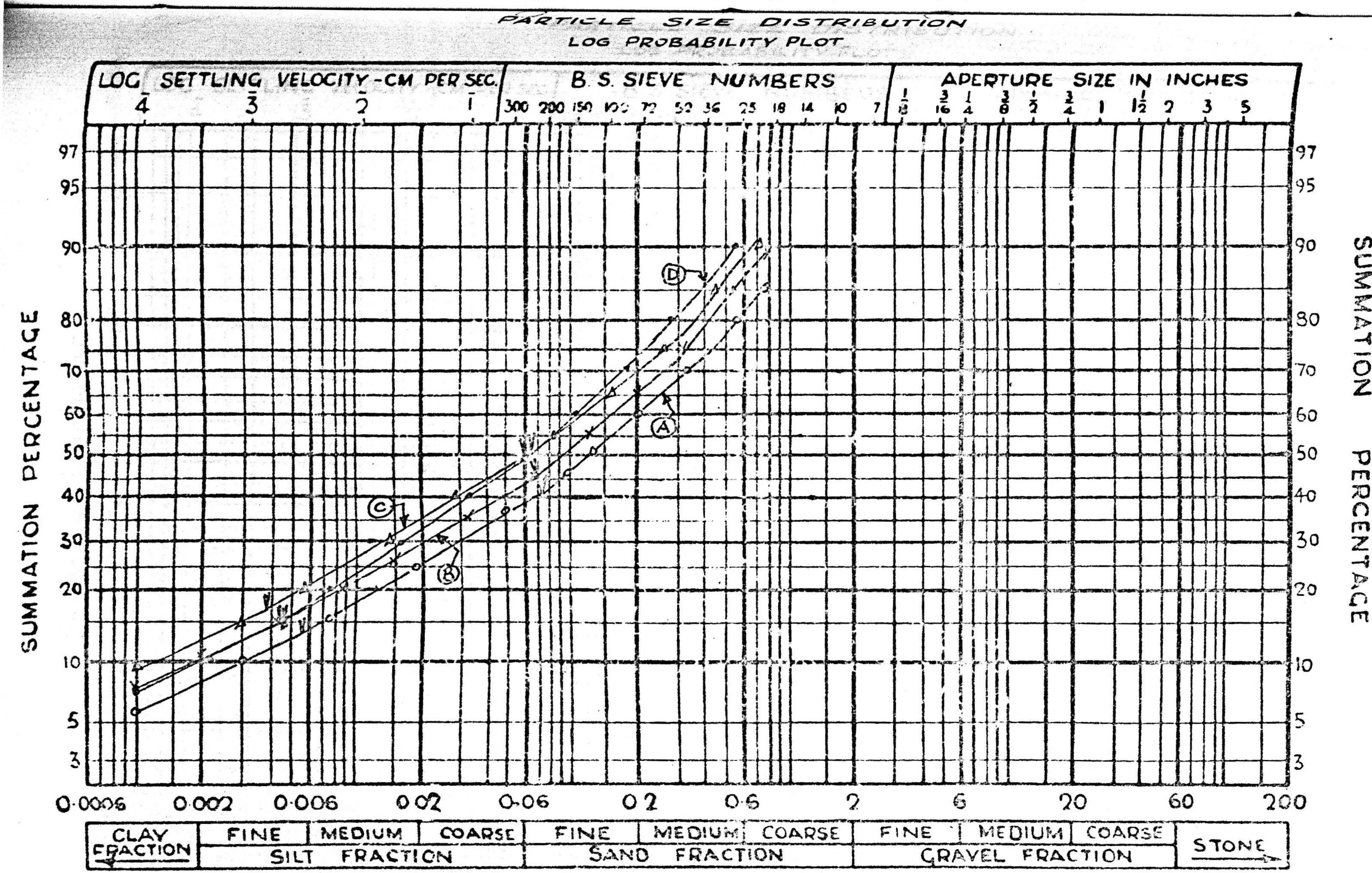


FIG. 5.155. LOG PROBABILITY PLOT OF KRUMBEIN'S ILLINOIS TILLS (A-D).

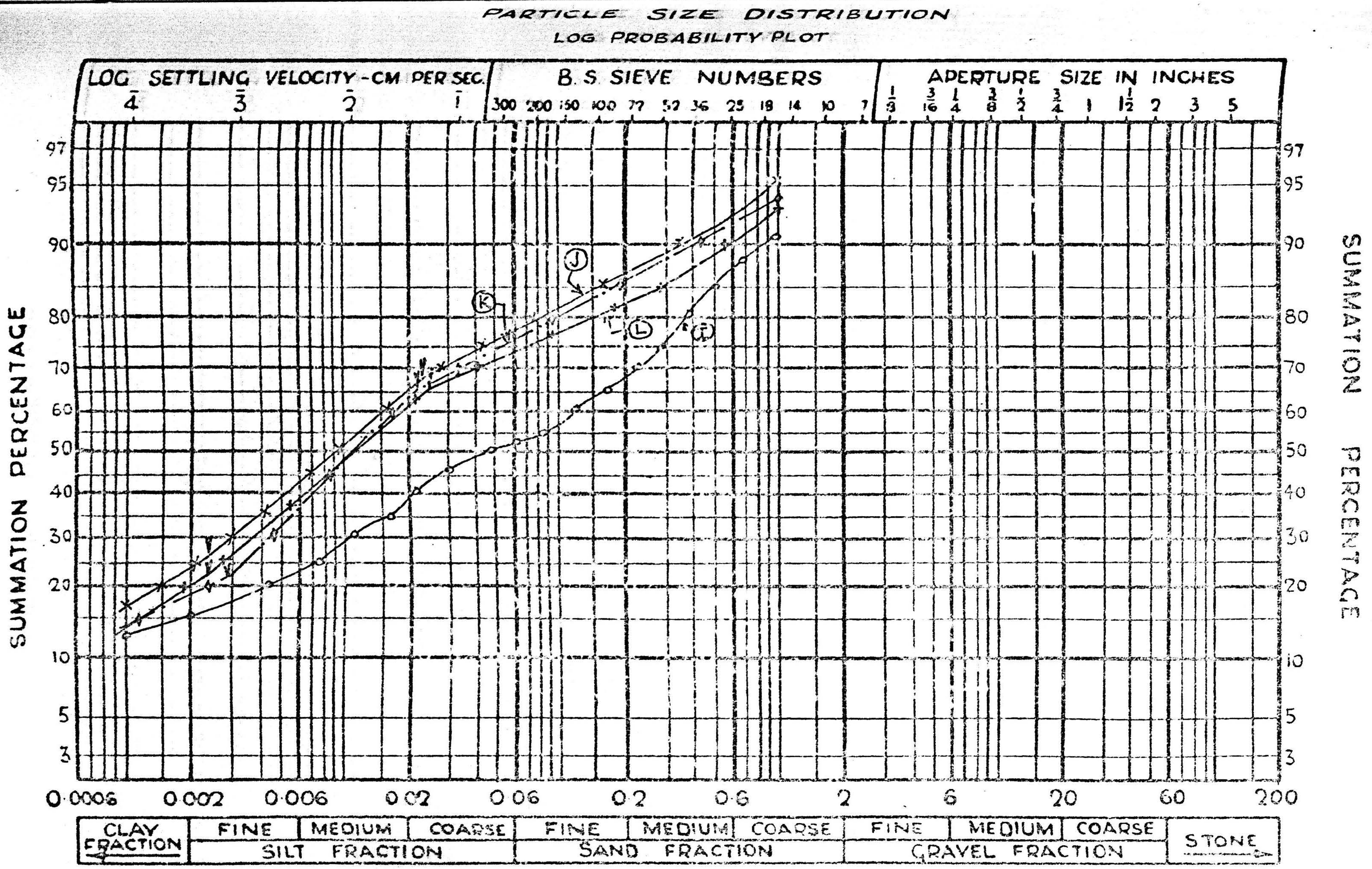


FIG. 5.157. LOG PROBABILITY PLOT OF KRUMBEIN'S ILLINOIS TILL (I-L).

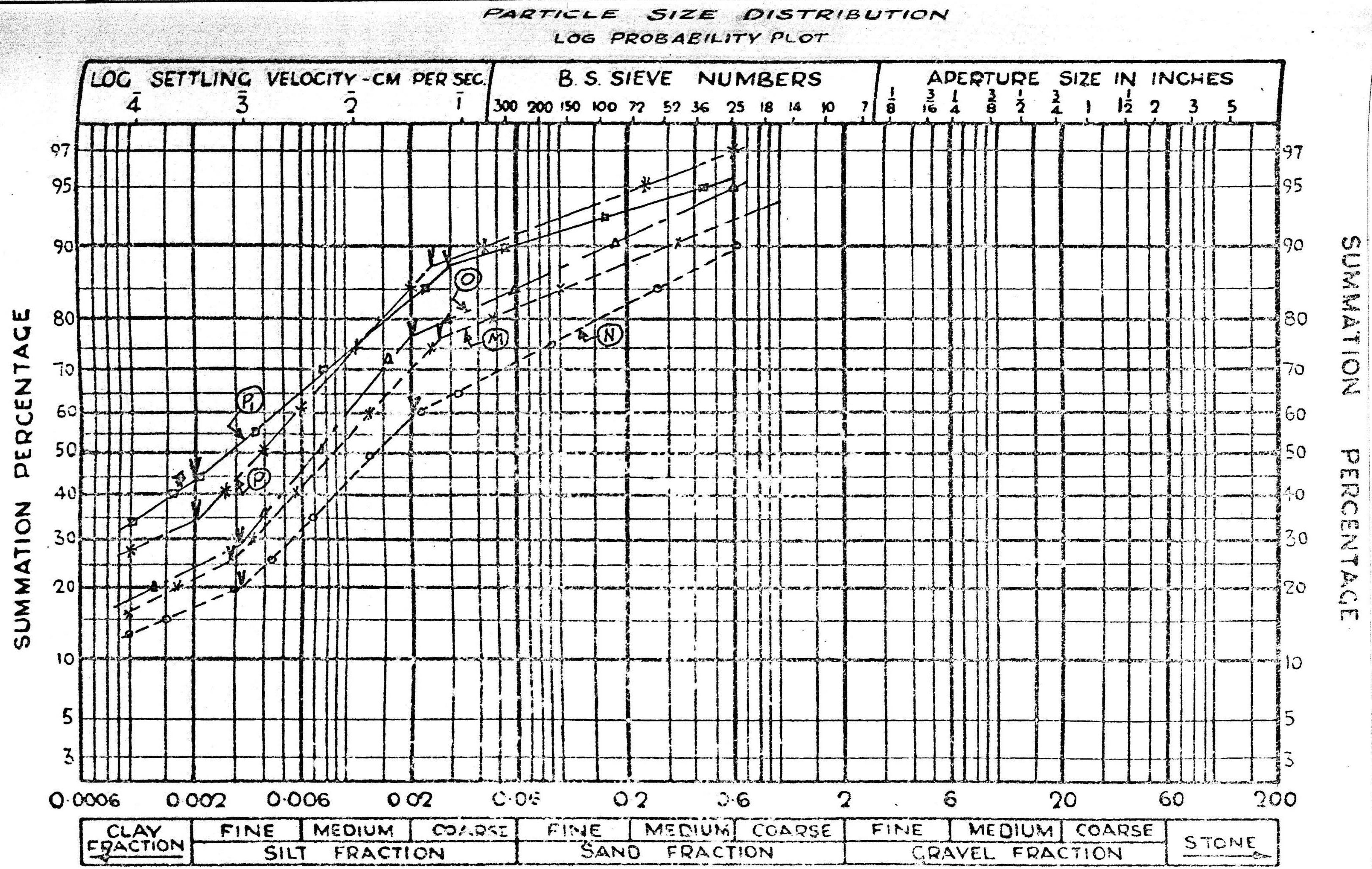


FIG. 5.158. LOG PROBABILITY PLOT OF KRUMBEIN'S ILLINOIS TILLS (M-P).

PARTICLE SIZE DISTRIBUTION
LOG PROBABILITY PLOT

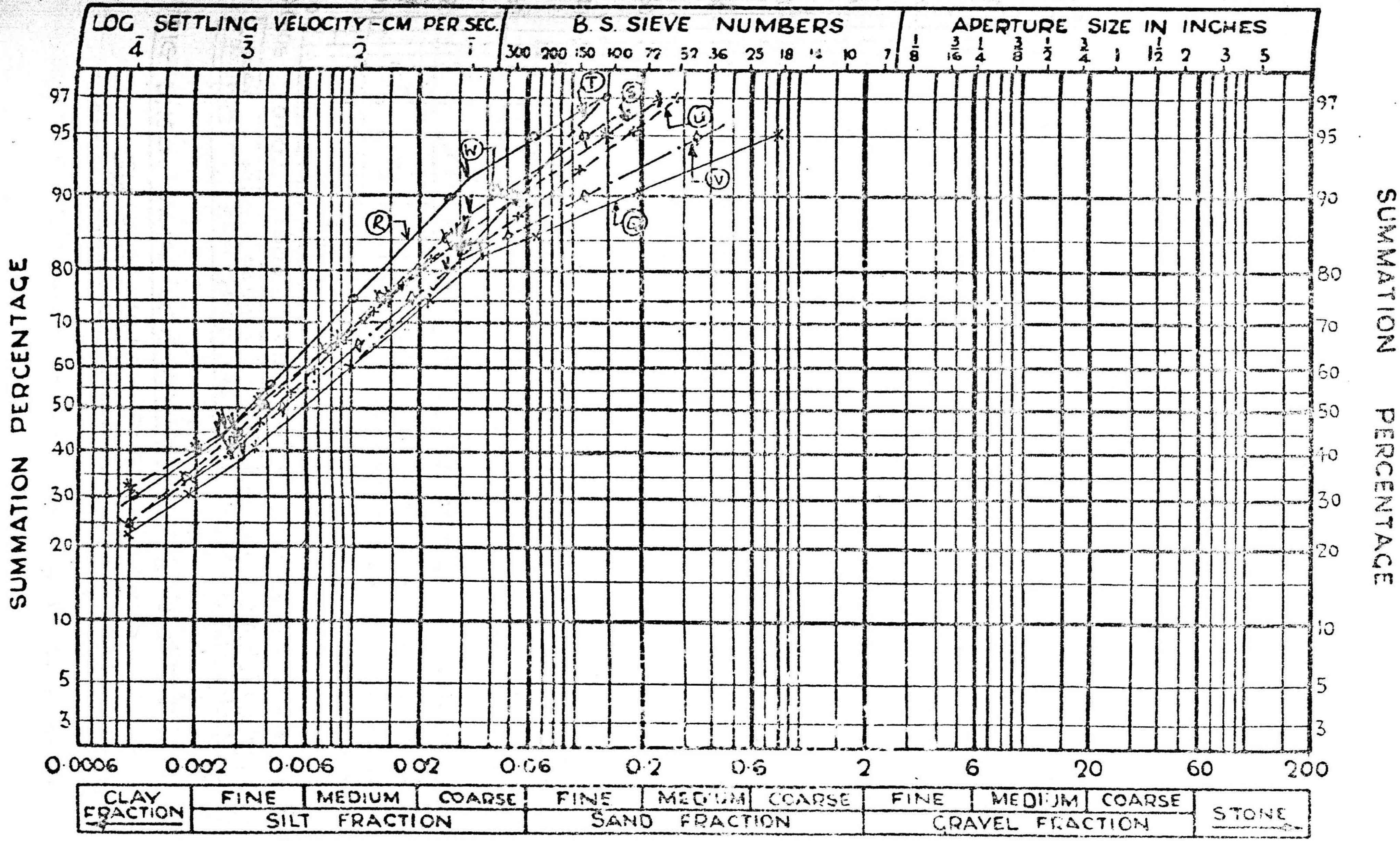


FIG. 5.159. LOG PROBABILITY PLOT OF KRUMBEIN'S ILLINOIS TILLS (Q - W).

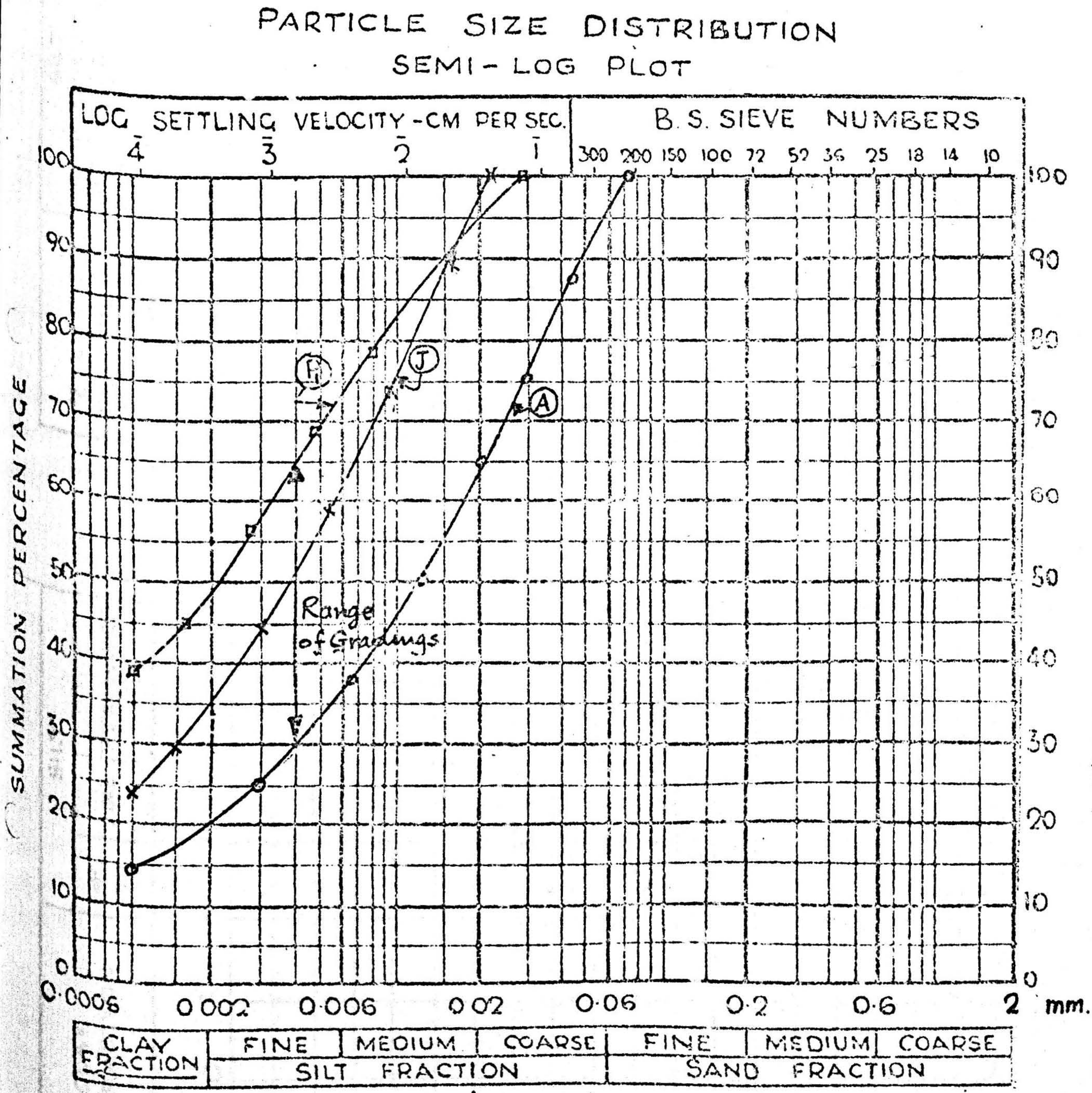


FIG. 5.160. RANGE OF GRADINGS FOR KRUMBEIN'S ILLINOIS TILLS - FINE FRACTIONS.

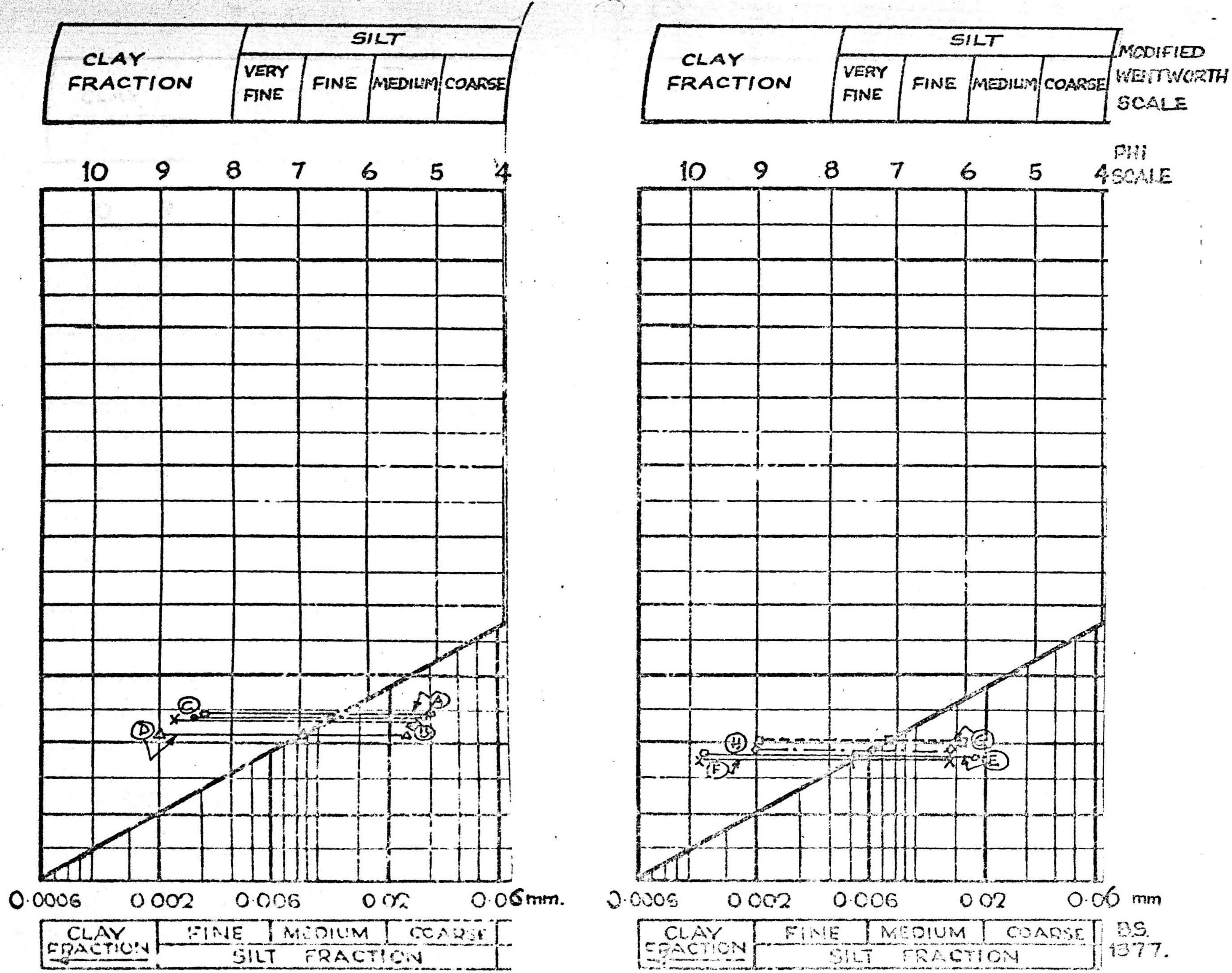
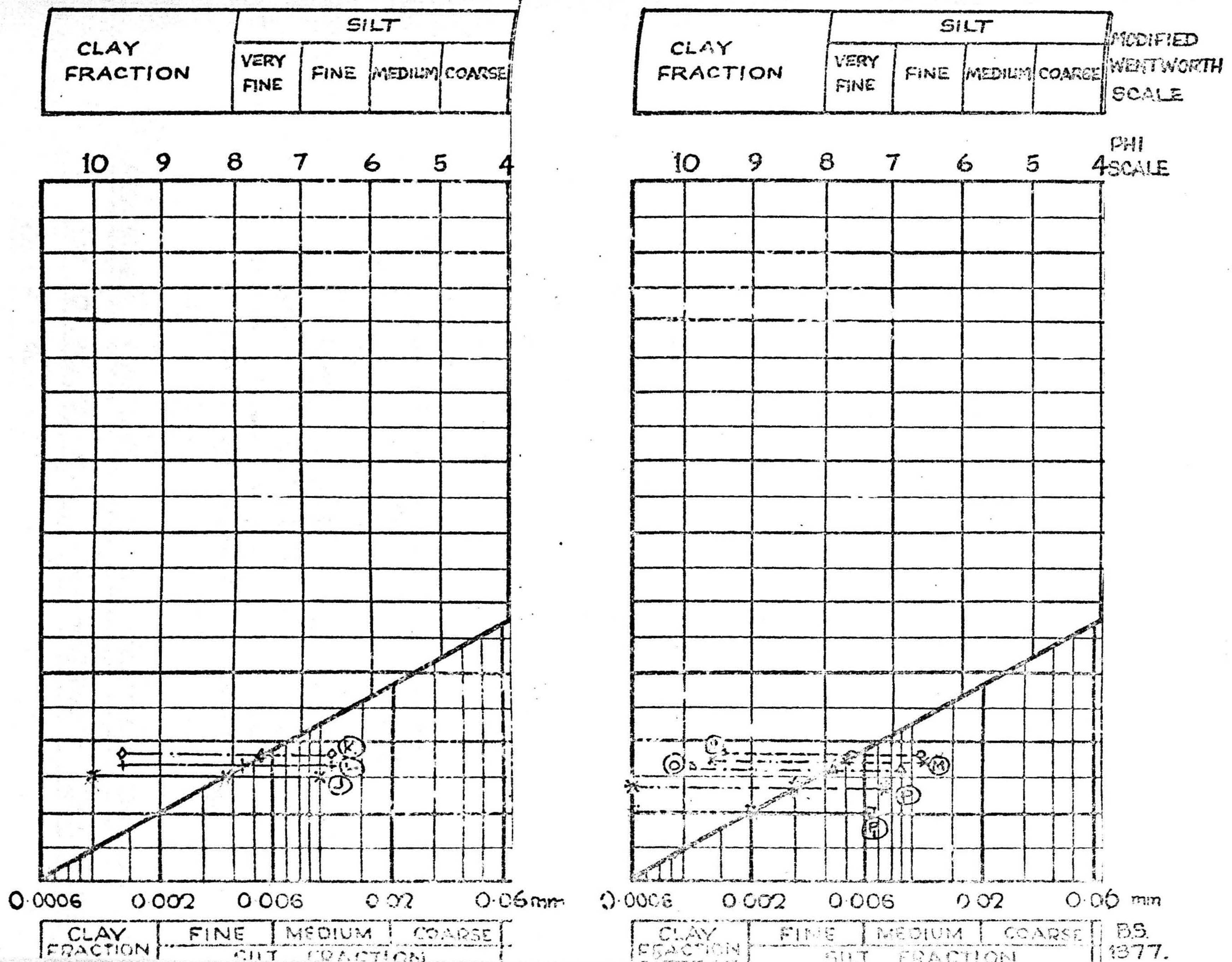


FIG. 5.161. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3:
FOR KRUMBEIN'S ILLINOIS TILLS. (A–H).

FIG. 5.162. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3, FOR KRUMBEIN'S ILLINOIS TILLS (J–P).



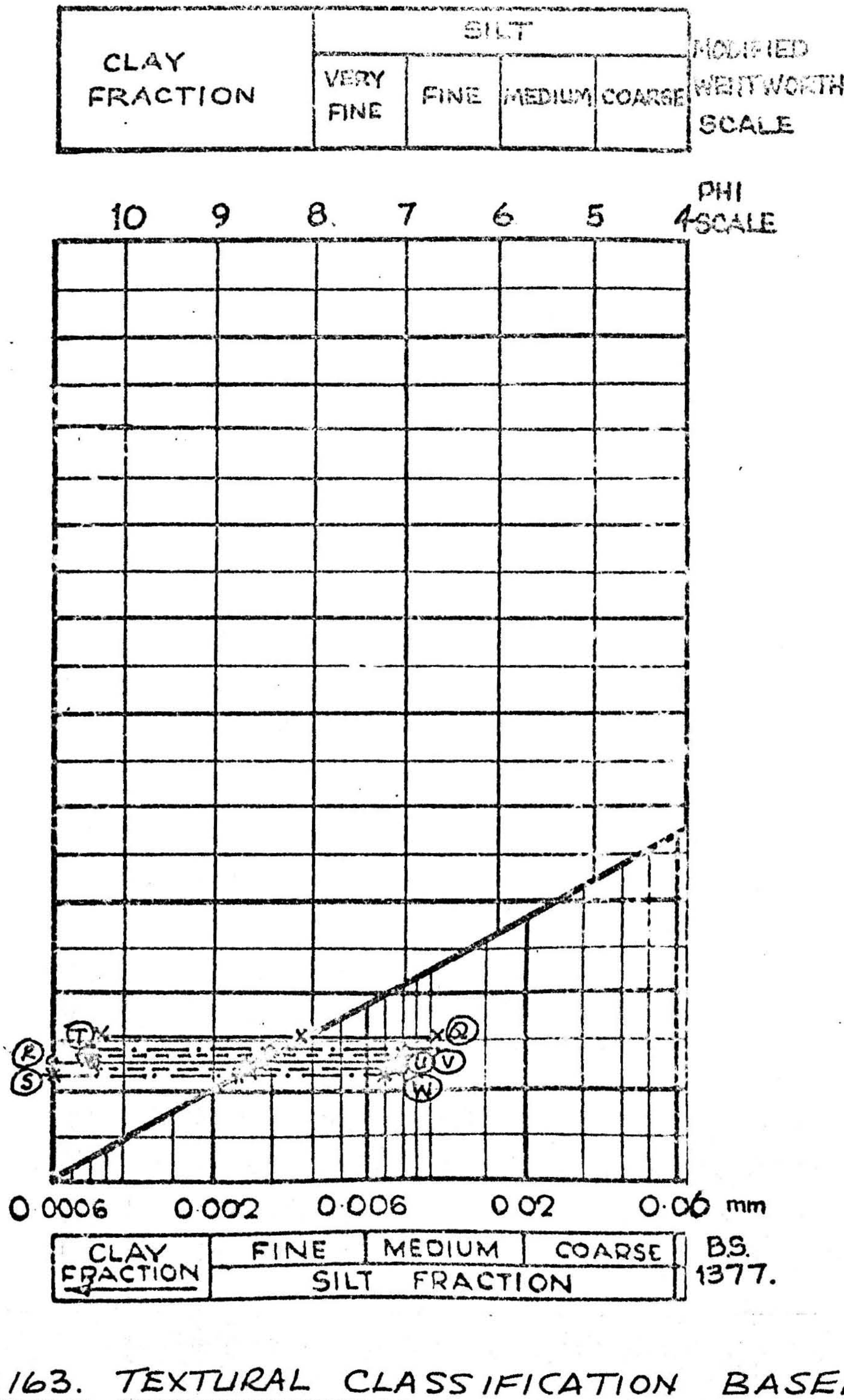


FIG. 5.163. TEXTURAL CLASSIFICATION BASED ON Q_1, M_d, Q_3 FOR KRUMBEIN'S ILLINOIS TILLS (Q–W).

FIG. 5.164. LITHOLOGIC VARIATIONS IN ILLINOIS TILL (AFTER KRUMBEIN, 1953).

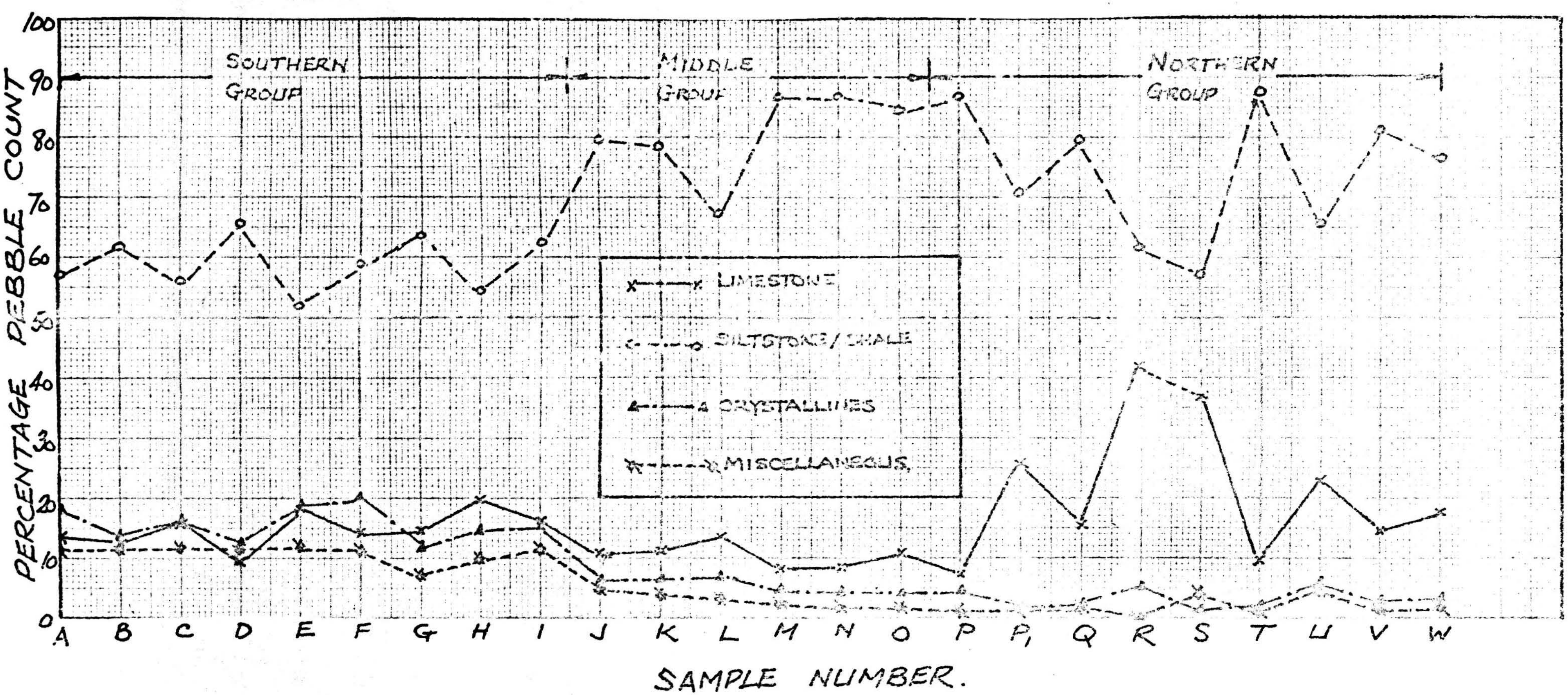


FIG. 5.165. VARIATION IN GRAIN SIZE INDICES AND FINES CONTENT IN KRUMBEIN'S ILLINOIS TILLS.

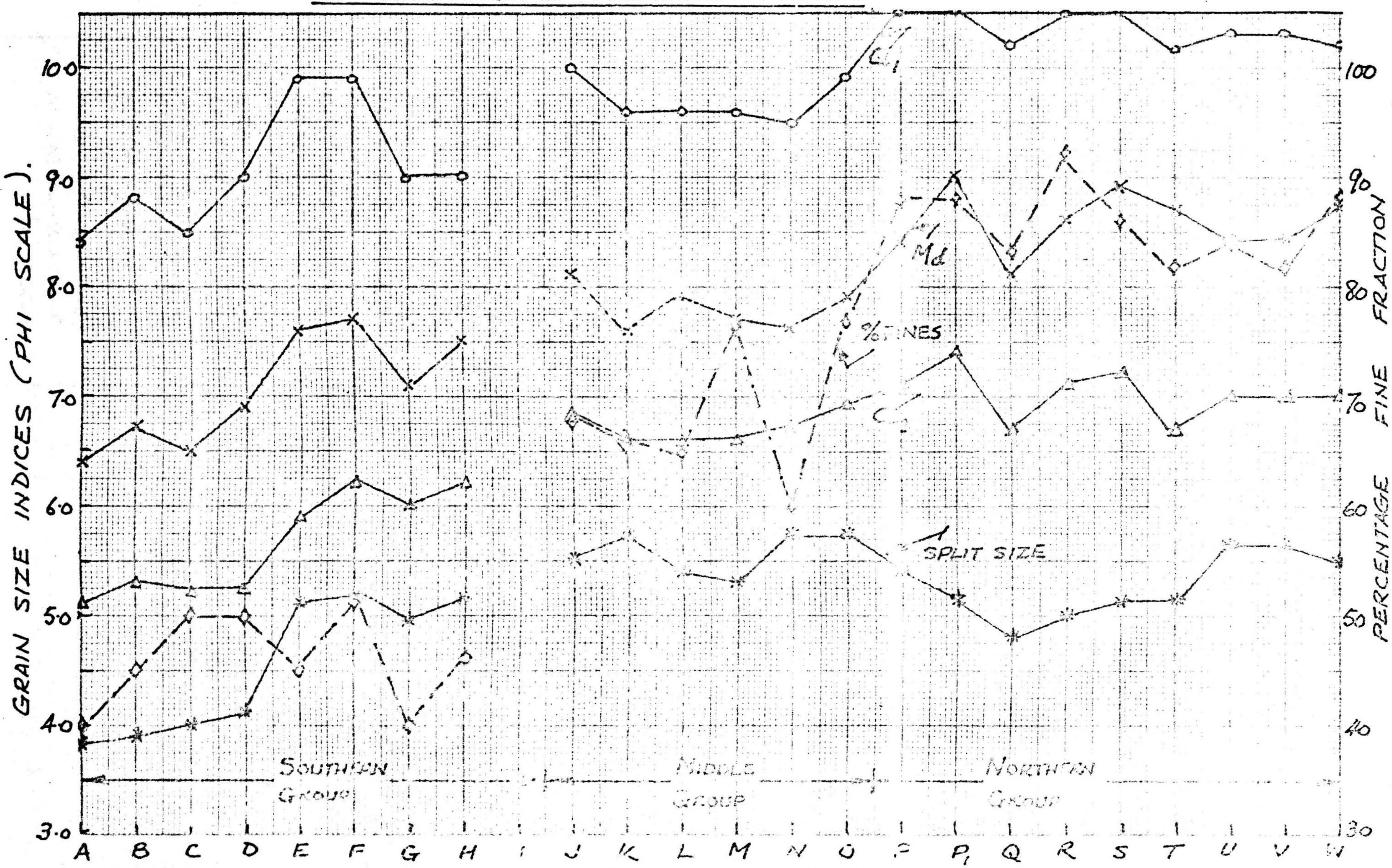


FIG. 5.166. VARIATION IN UPPER SPLIT SIZES IN ALL TILLS.

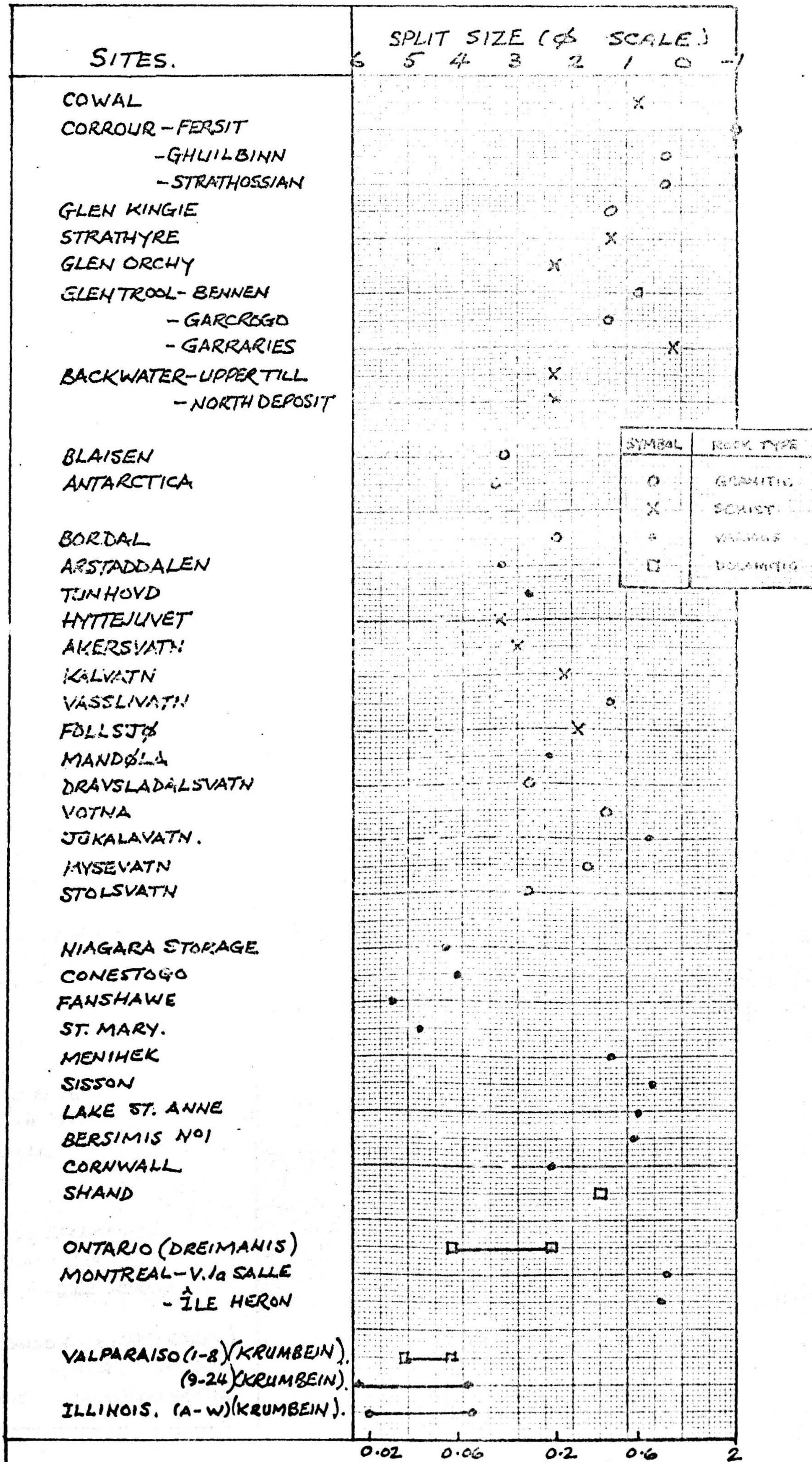


FIG. 5.167. VARIATION IN PERCENTAGE FINES IN ALL TILLS.

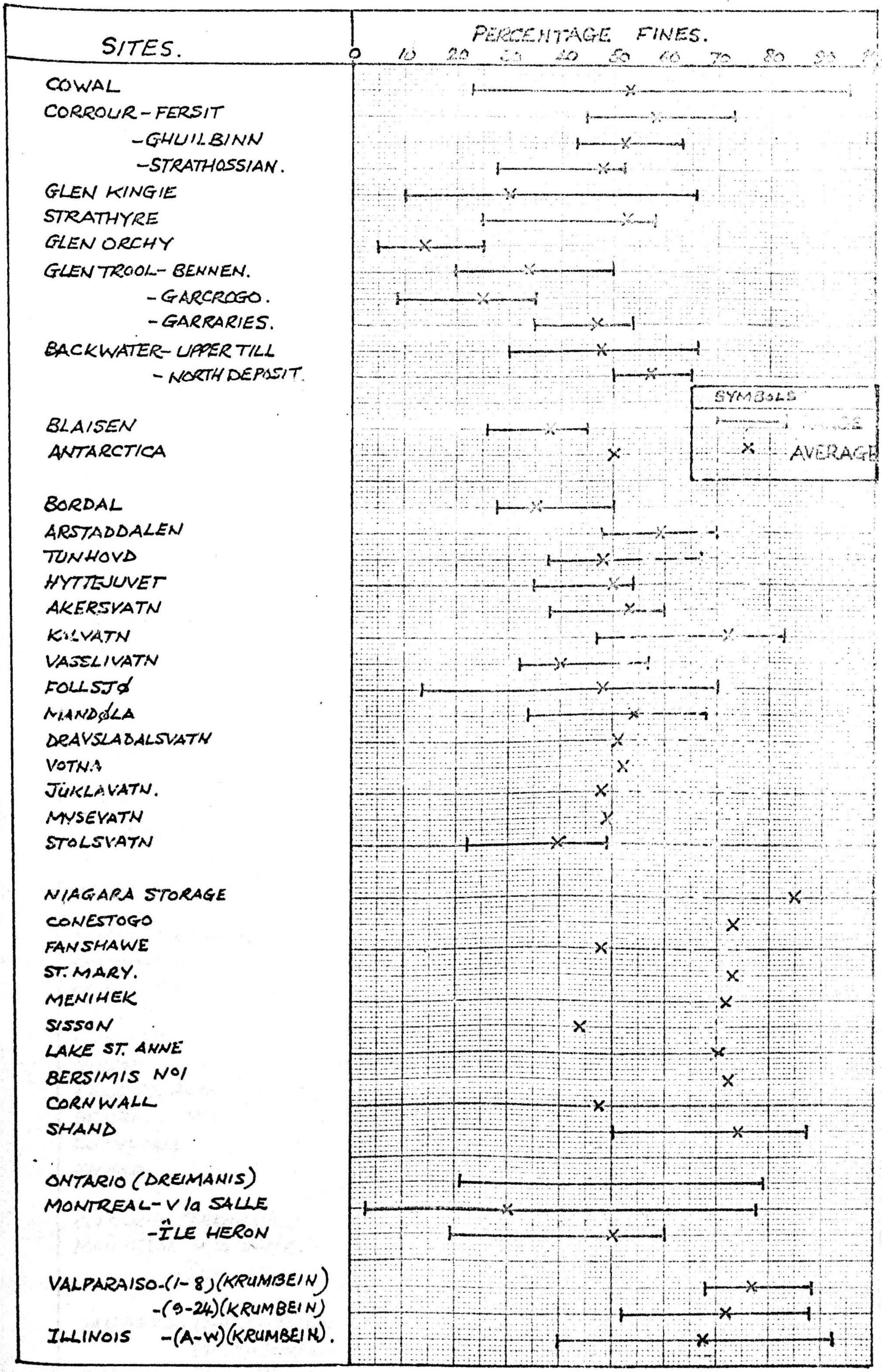
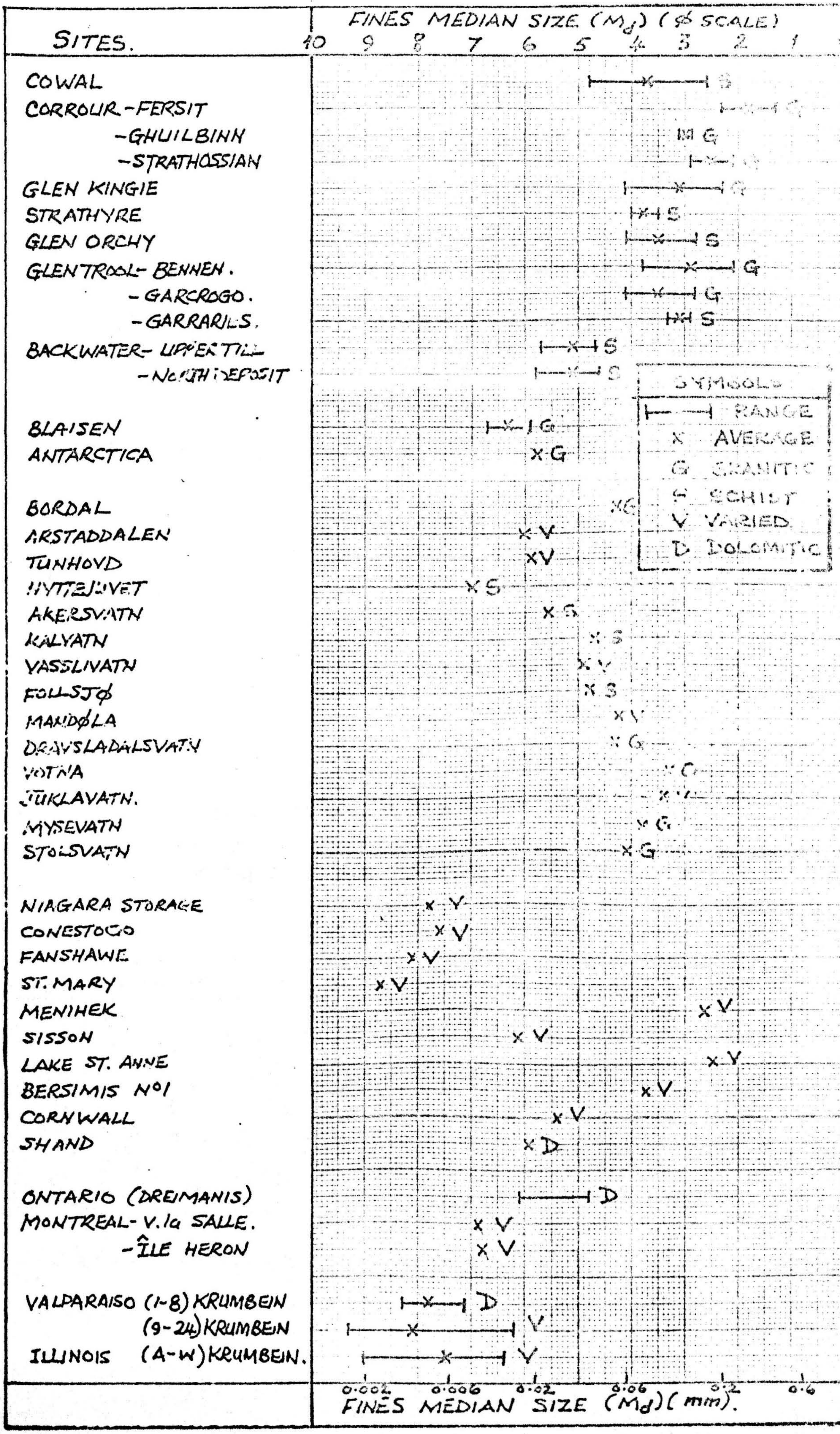
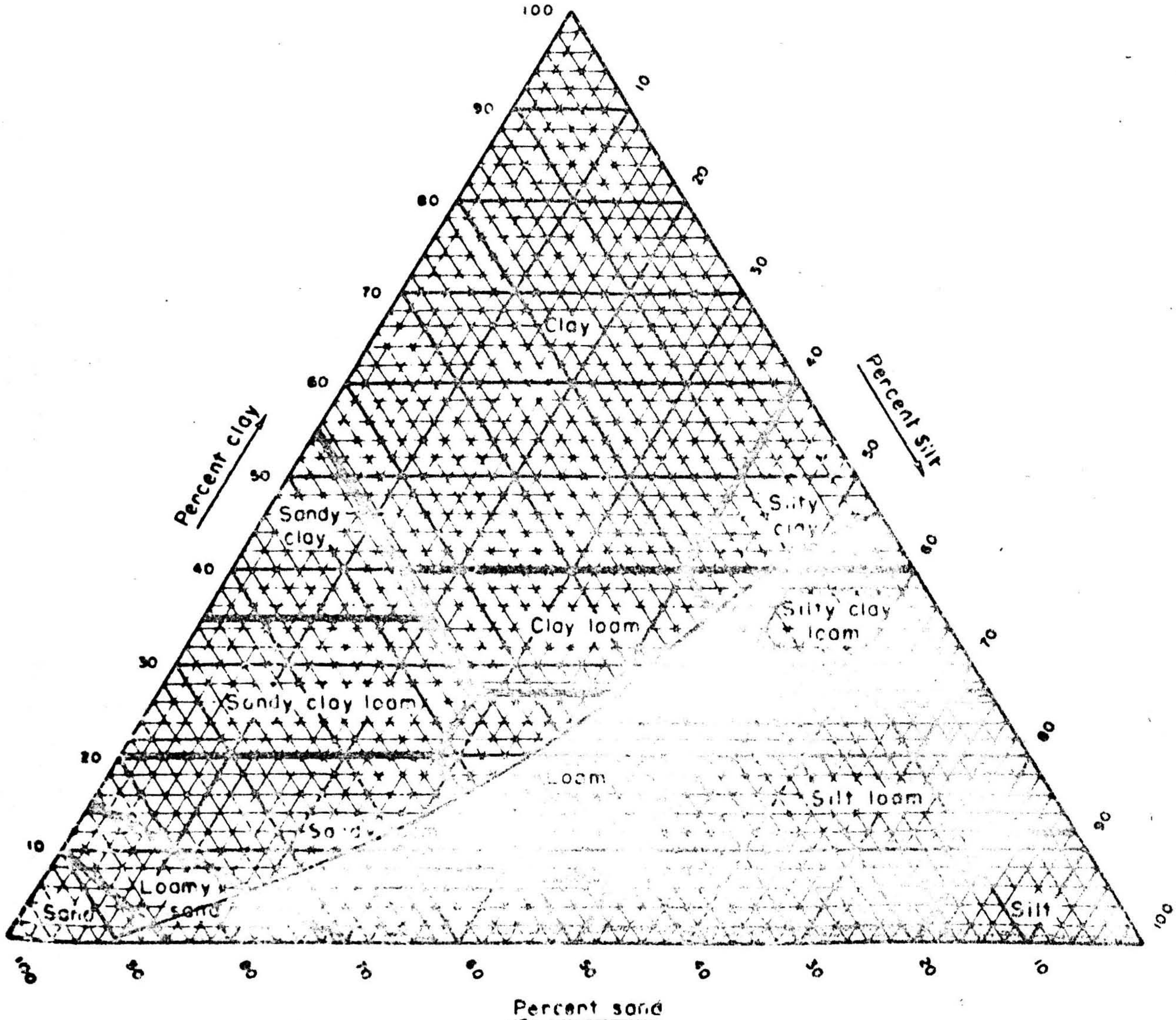


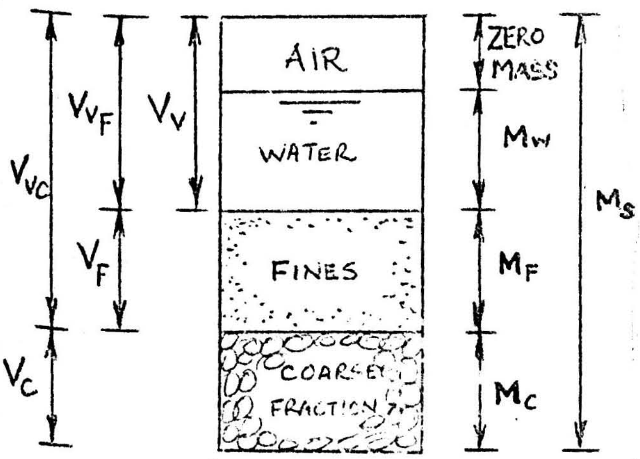
FIG. 5.168. MEDIAN GRAIN SIZE INDICES IN ALL TILLS.





PERCENTAGES OF CLAY (BELOW 0.002 mm.),
SILT (0.002 TO 0.05 mm.), AND SAND (0.05 TO 2.0 mm.)
IN THE BASIC SOIL TEXTURAL CLASSES

FIG. 5.169. TRIANGULAR DIAGRAM FOR ALL TILLS.



V_s = Total volume of composite soil

V_c = Absolute volume of coarse fraction

V_F = Absolute volume of fine fraction

V_v = Absolute volume of voids in composite soil

V_{vc} = Volume of voids within coarse fraction $= (V_F + V_v)$

V_{vF} = Volume of voids within fine fraction $= (V_{vc} - V_F) = V_v$

G_s = Specific Gravity of composite soil

G_c = Specific Gravity of coarse grains

G_f = Specific Gravity of fine grains

Ms = Mass of composite soil

Mc = Mass of coarse fraction

MF = Mass of fine fraction

Mw = Mass of water

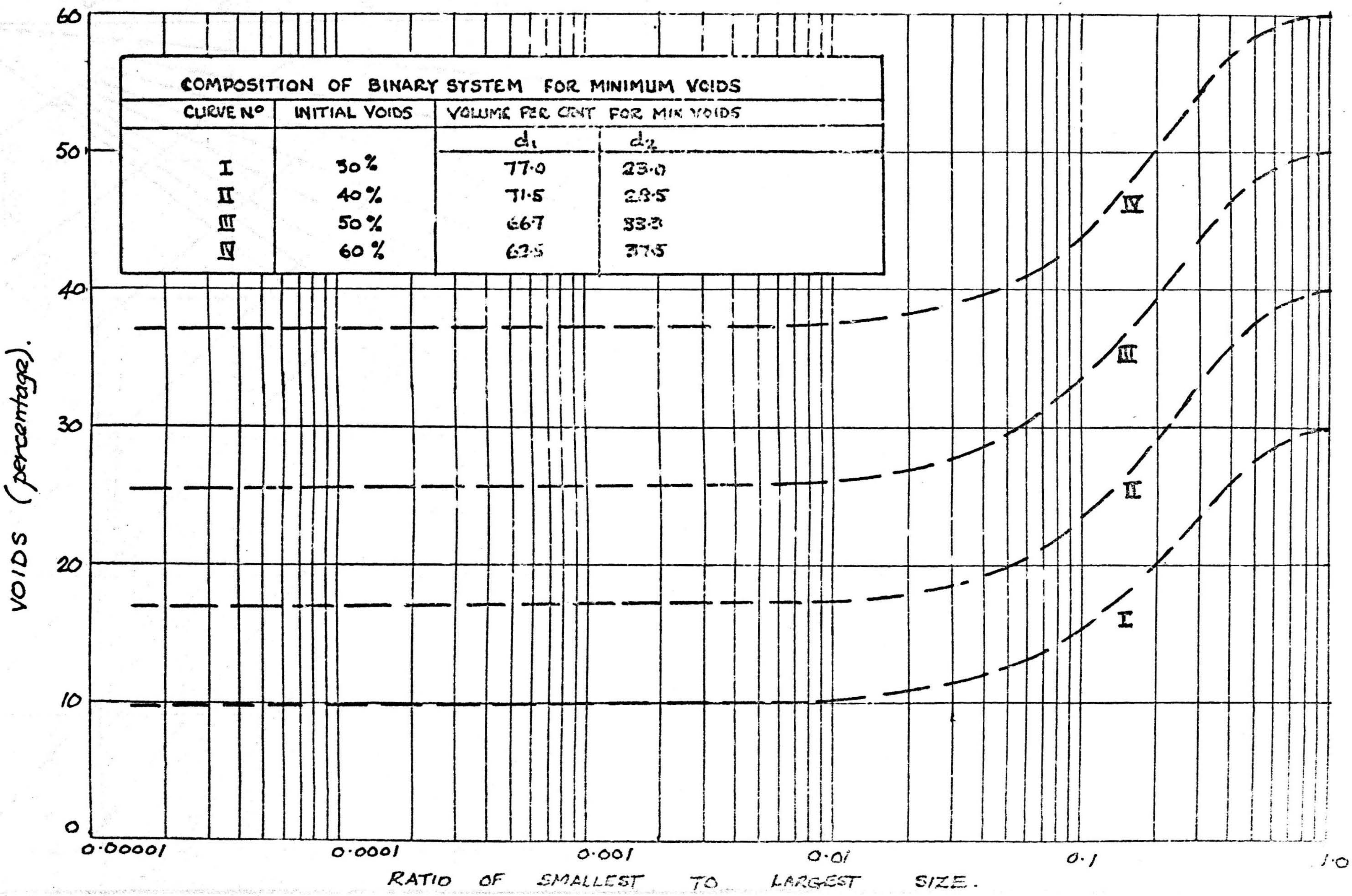
<u>Note</u> Suffixes:- S denotes the composite soil

C " " coarse fraction

F " " fine fraction.

FIG. 6.1. MODEL OF COMPOSITE SOIL.

FIG. 6.2. MINIMUM POSSIBLE VOIDS IN BEDS OF TWO COMPOSITE SIZES (AFTER FURNAS, 1931).

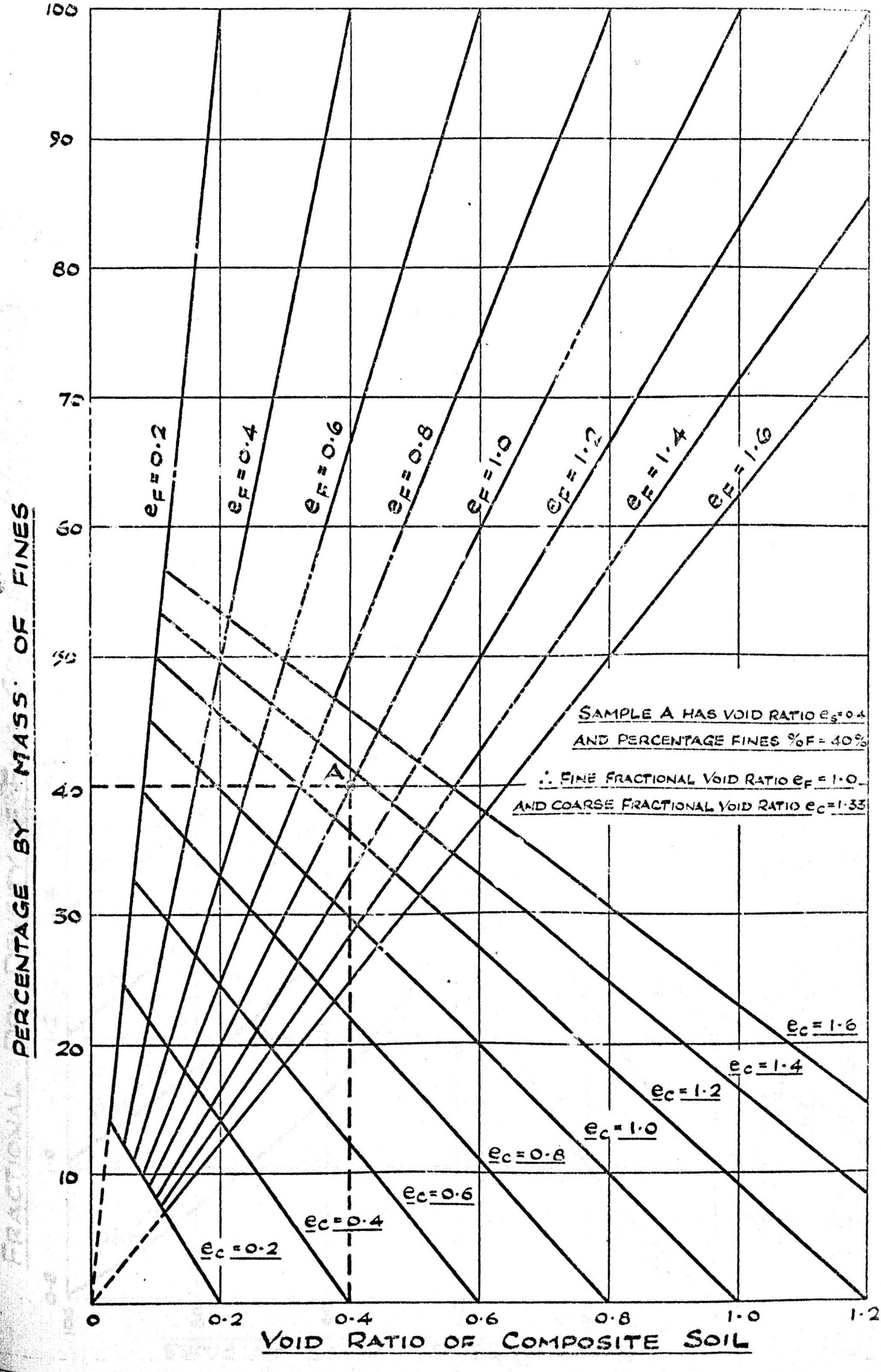


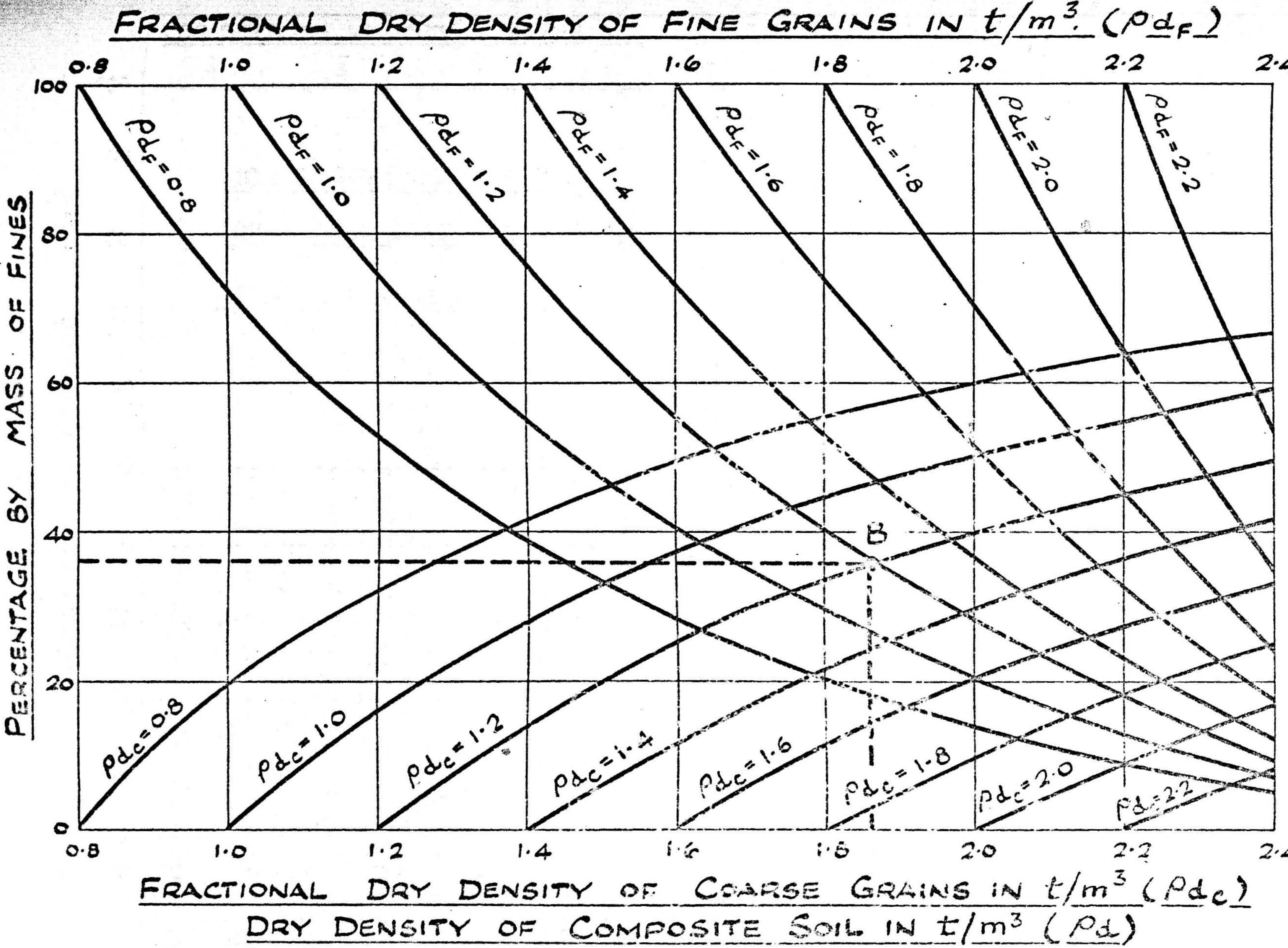
COMPOSITION OF BINARY SYSTEM FOR MINIMUM VOIDS

CURVE Nº	INITIAL VOIDS	VOLUME PER CENT FOR MIN VOIDS	
		d_1	d_2
I	30 %	77·0	23·0
II	40 %	71·5	28·5
III	50 %	66·7	33·3
IV	60 %	62·5	37·5

FIG. 6.3. FRACTIONAL VOID RATIO – PERCENTAGE FINES

(FOR UNIFORM SPECIFIC GRAVITY)





SAMPLE B HAS DRY DENSITY
$= 1·86\ t/m^3$
AND PERCENTAGE FINES
$= 36\ \%$

$\therefore$ FINE FRACTIONAL DRY DENSITY
$\gamma d_F = 1·20\ t/m^3$
AND COARSE FRACTIONAL DRY DENSITY
$\gamma d_c = 1·20\ t/m^3$

FIG. 6.4 DRY DENSITY PERCENTAGE FINES – MASTER CURVES FOR UNIFORM S.G = 2·68.

PARTICLE SIZE DISTRIBUTION

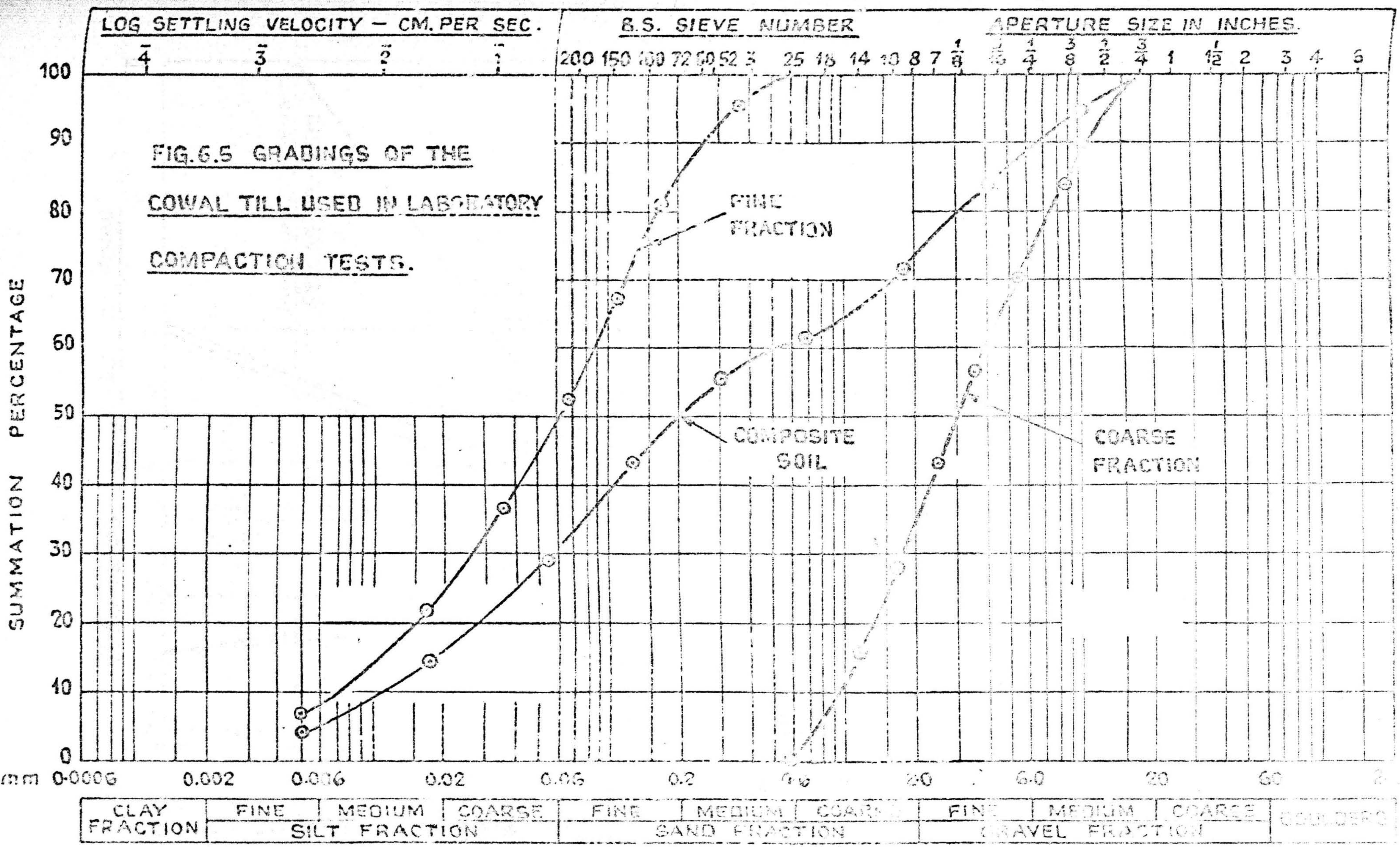


FIG. 6.5 GRADINGS OF THE COWAL TILL USED IN LABORATORY COMPACTION TESTS.

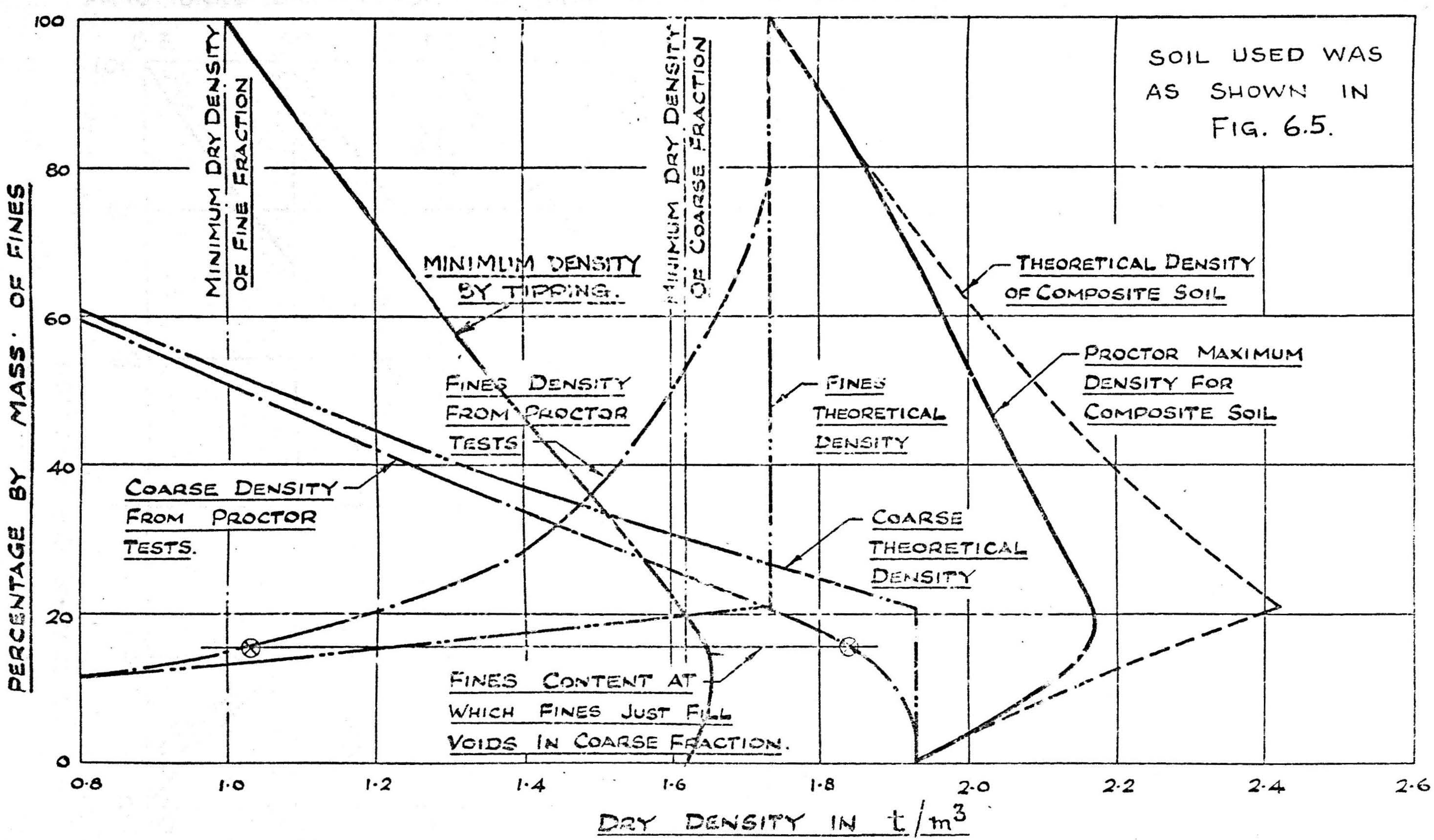


FIG.6.6. VARIATION IN MAXIMUM DRY DENSITY OF A COMPOSITE SOIL FROM STANDARD PROCTOR TESTS AND TIPPING.

(NOTE : SOIL USED WAS AS SHOWN IN FIG.6.5)

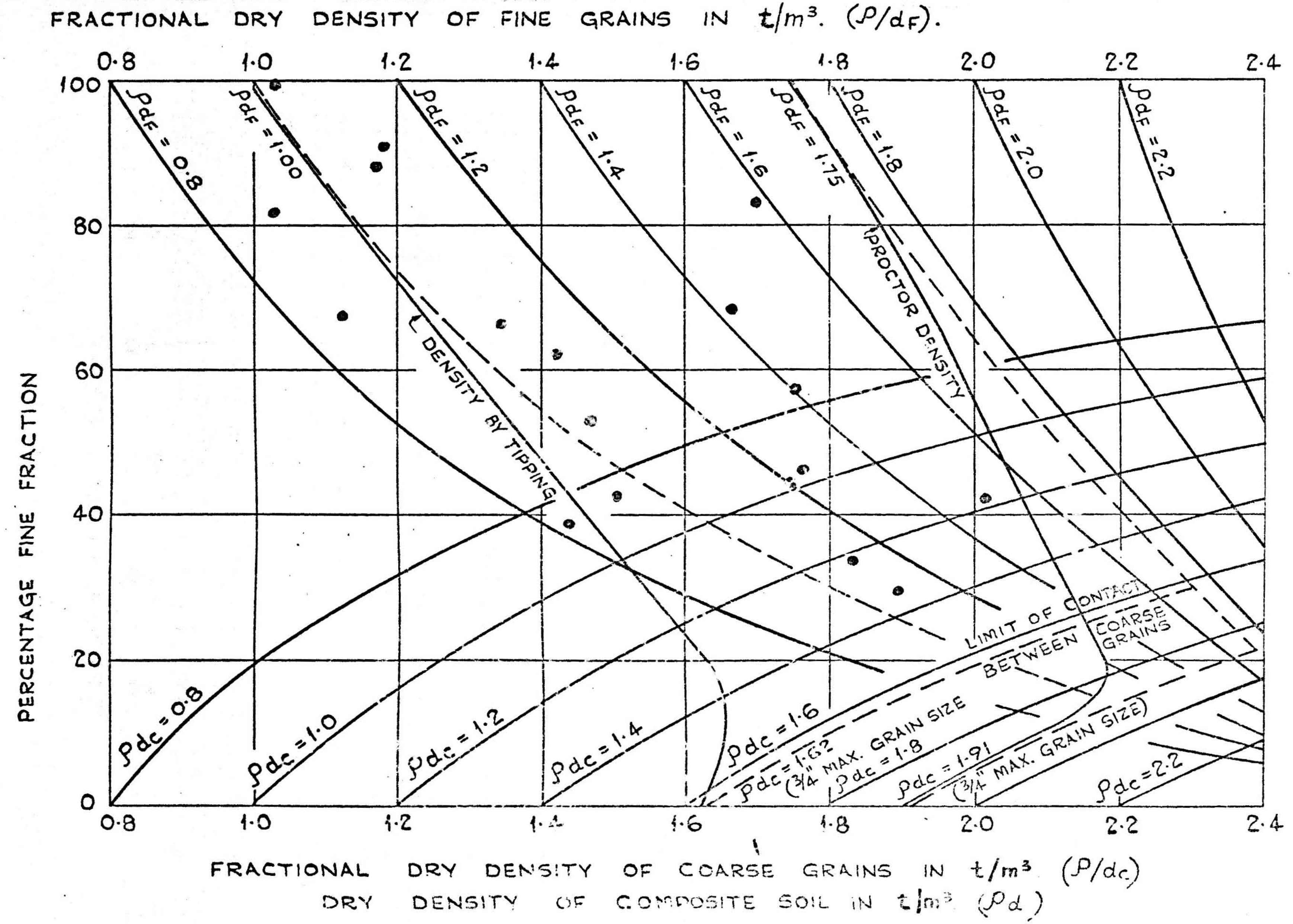


FIG. 6·7. PLOT OF FIELD DENSITY MEASUREMENTS FOR BROWN COWAL TILLS

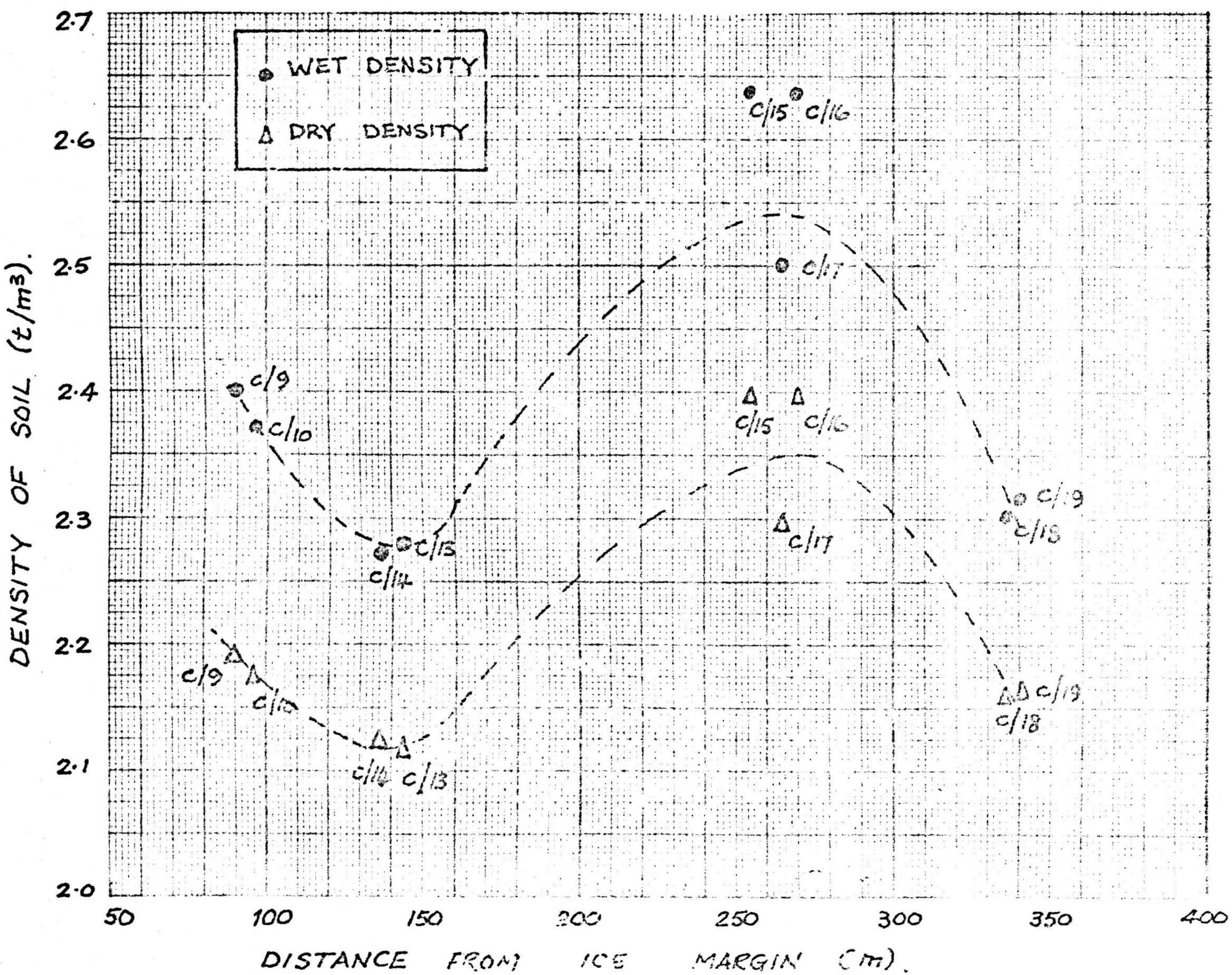
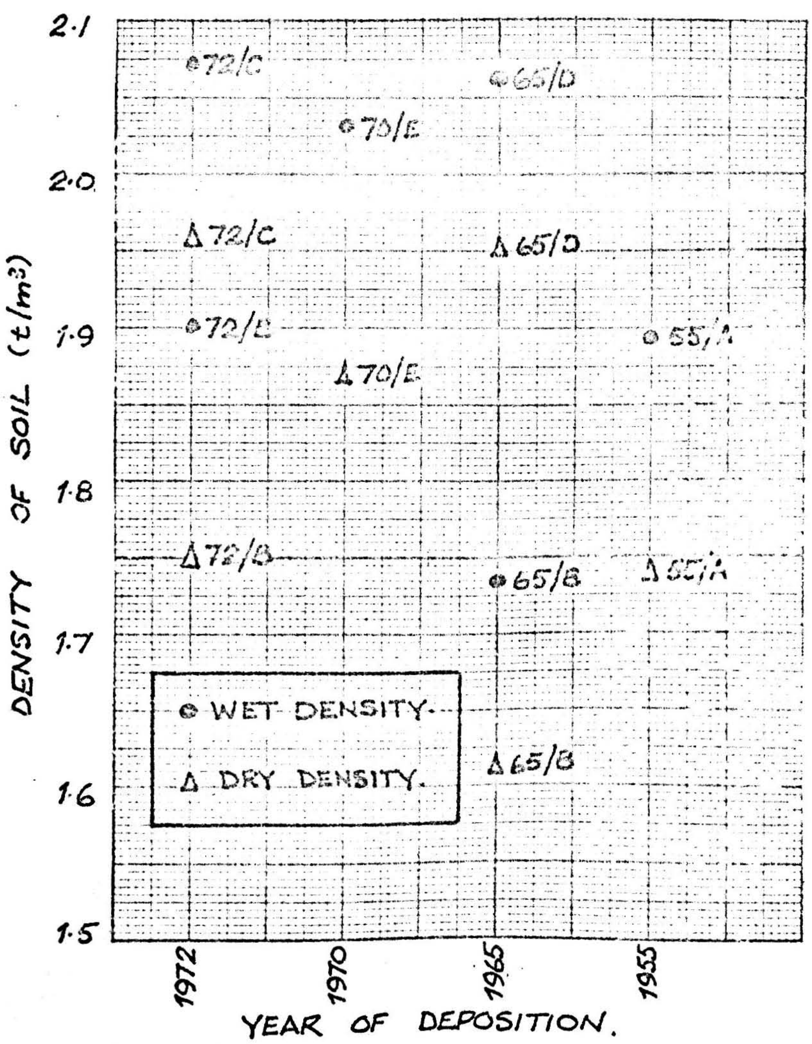
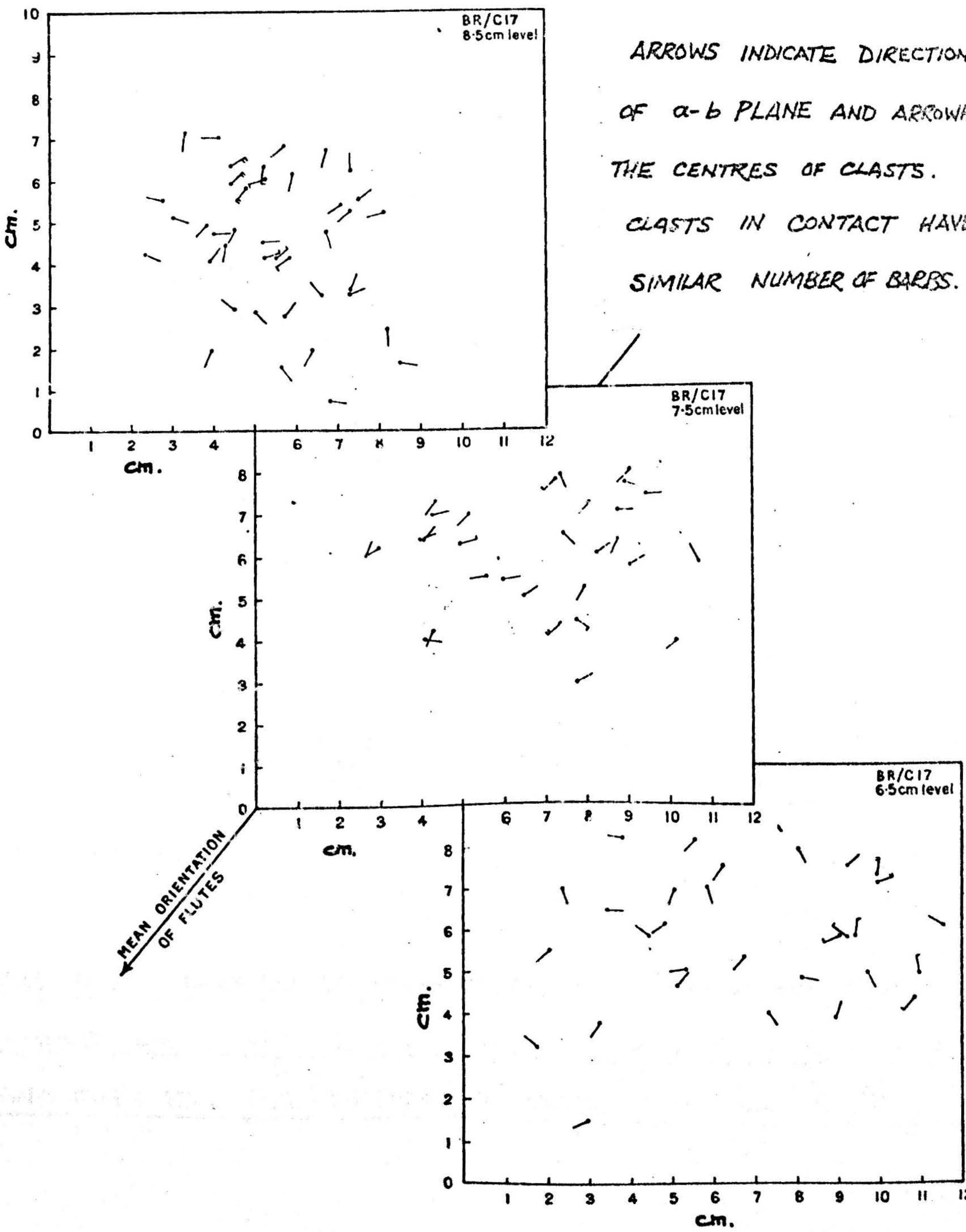


FIG. 6.8. IN-SITU DENSITY OF CENTRAL BREIDAMERKURJOKULL TILLS.

FIG. 6.9. IN-SITU DENSITY OF BLAISEN TILLS.





ARROWS INDICATE DIRECTION OF a-b PLANE AND ARROWHEADS THE CENTRES OF CLASTS. CLASTS IN CONTACT HAVE SIMILAR NUMBER OF BARBS.

FIG. 6.10 . TIERED DIAGRAM EXPRESSING THE LOCATION AND DIP OF a- b PLANES OF CLASTS AT THREE LEVELS WITHIN BREIDAMERKURJOKULL SAMPLE BR/C17.

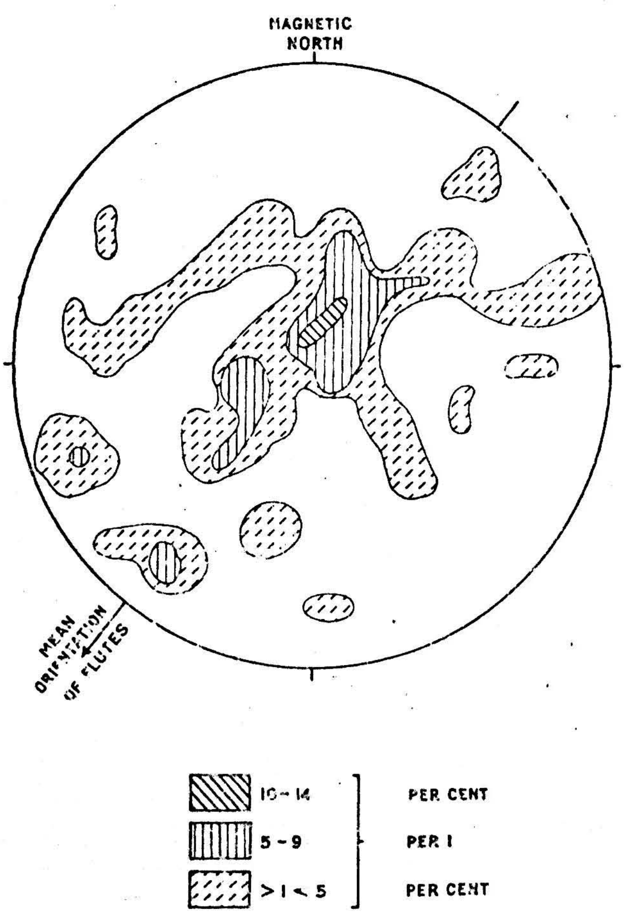


FIG. 6.11. CONTOURED SCHMIDT NET EXPRESSING CLAST FABRIC DATA FOR 8.5 cm. LEVEL SHOWN IN PLATE 6.3 AND FIG. 6.10, FOR BREIDAMERKURJOKULL TILL BR/C 17.

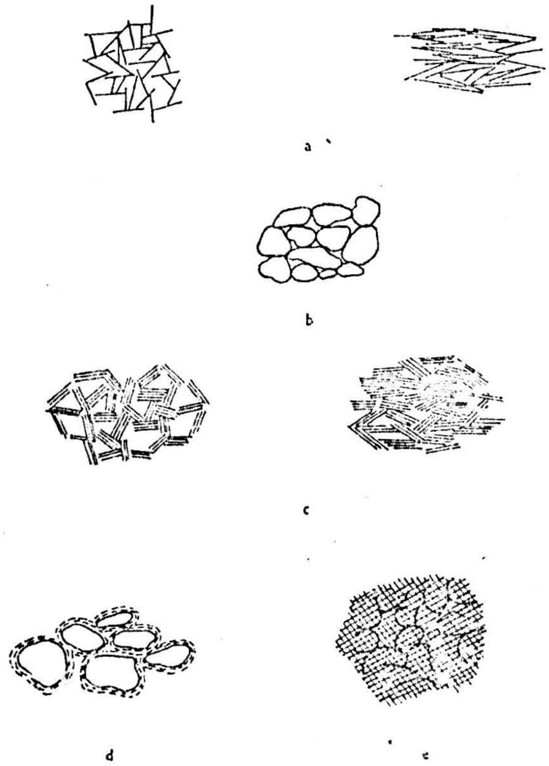


FIG. 6.12. SCHEMATIC REPRESENTATION OF ELEMENTARY PARTICLE ARRANGEMENTS.

(a) INDIVIDUAL CLAY PLATELET INTERACTION;

(b) INDIVIDUAL SILT OR SAND PARTICLE INTERACTION;

(c) CLAY PLATELET GROUP INTERACTION;

(d) CLOTHED SILT OR SAND PARTICLE INTERACTION;

e) PARTLY DISCERNIBLE PARTICLE INTERACTION.

(COLLINS AND McGOWN, 1974.)

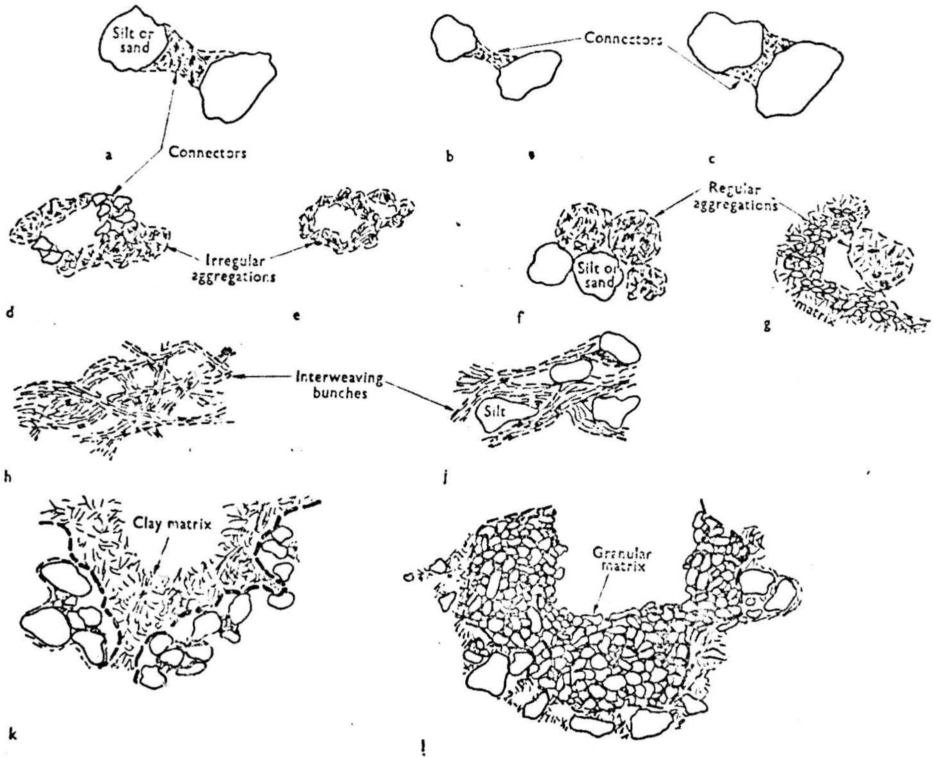


FIG. 6.13. SCHEMATIC REPRESENTATION OF PARTICLE ASSEMBLAGES.

(a),(b),(c) CONNECTORS; (d) IRREGULAR AGGREGATIONS. LINKED BY CONNECTORS; (e) IRREGULAR AGGREGATION FORMING A HONEYCOMB ARRANGEMENT; (f) REGULAR AGGREGATIONS INTERACTING WITH SILT OR SAND GRAINS; (g) REGULAR AGGREGATIONS INTERACTING WITH PARTICLE MATRIX; h) INTERWEAVING BUNCHES OF CLAY; (j) INTERWEAVING BUNCHES OF CLAY WITH SILT INCLUSIONS; (k) CLAY PARTICLE MATRIX; (l) GRANULAR PARTICLE MATRIX. (COLLINS AND McGOWN 1974.

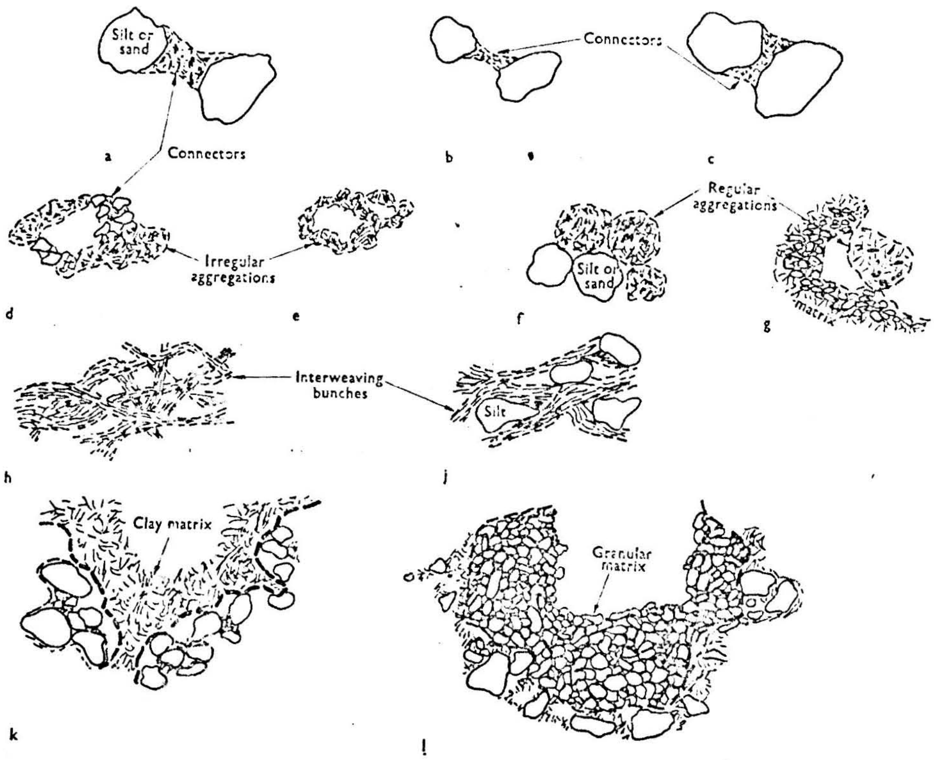


FIG. 6.13. SCHEMATIC REPRESENTATION OF PARTICLE ASSEMBLAGES.

(a),(b),(c) CONNECTORS; (d) IRREGULAR AGGREGATIONS. LINKED BY CONNECTORS; (e) IRREGULAR AGGREGATION FORMING A HONEYCOMB ARRANGEMENT; (f) REGULAR AGGREGATIONS INTERACTING WITH SILT OR SAND GRAINS; (g) REGULAR AGGREGATIONS INTERACTING WITH PARTICLE MATRIX; h) INTERWEAVING BUNCHES OF CLAY; (j) INTERWEAVING BUNCHES OF CLAY WITH SILT INCLUSIONS; (k) CLAY PARTICLE MATRIX; (l) GRANULAR PARTICLE MATRIX. (COLLINS AND McGOWN 1974.

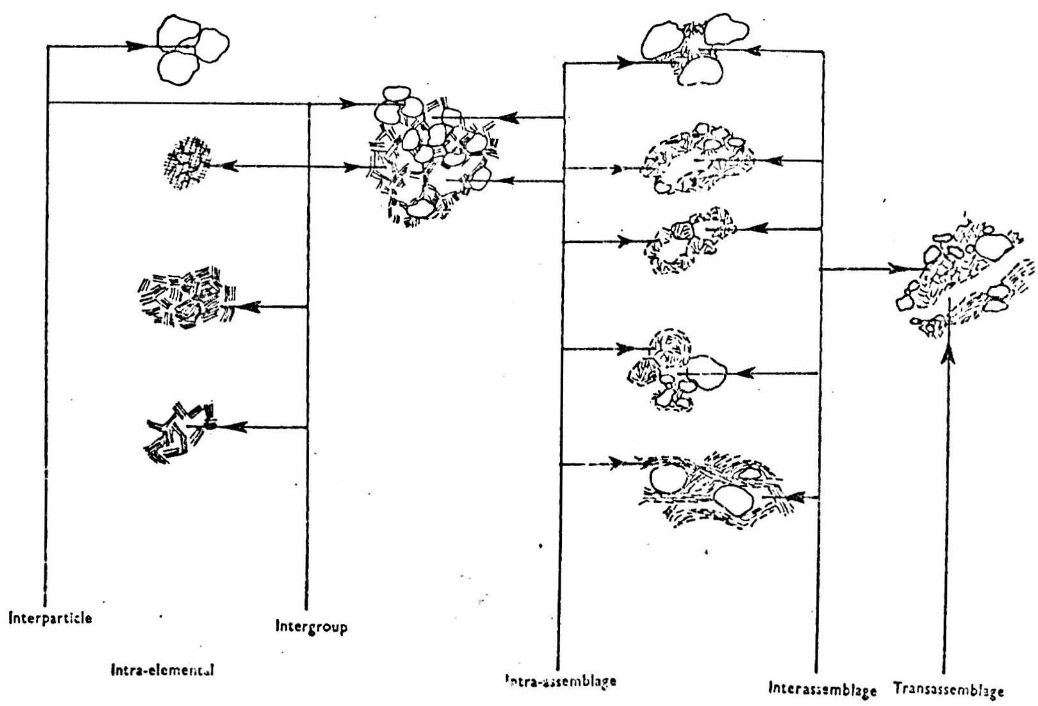


FIG. 6.14. SCHEMATIC REPRESENTATION OF PORE SPACE TYPES. (COLLINS and McGOWN 1974

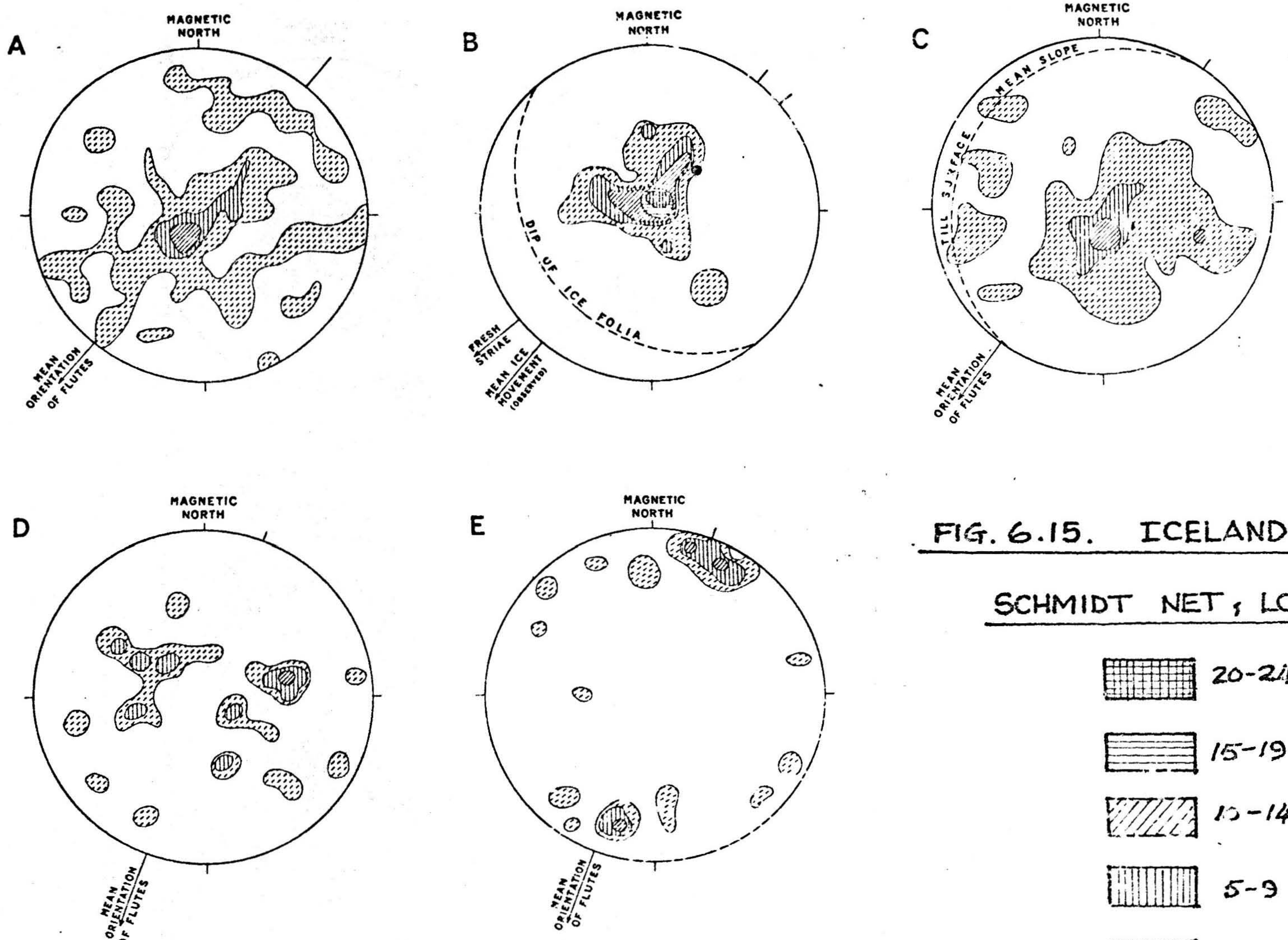
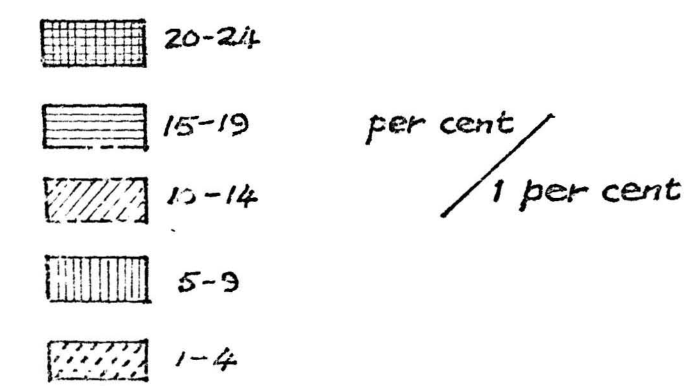


FIG. 6.15. ICELANDIC CLAST FABRIC DATA.

SCHMIDT NET, LOWER HEMISPHERE.



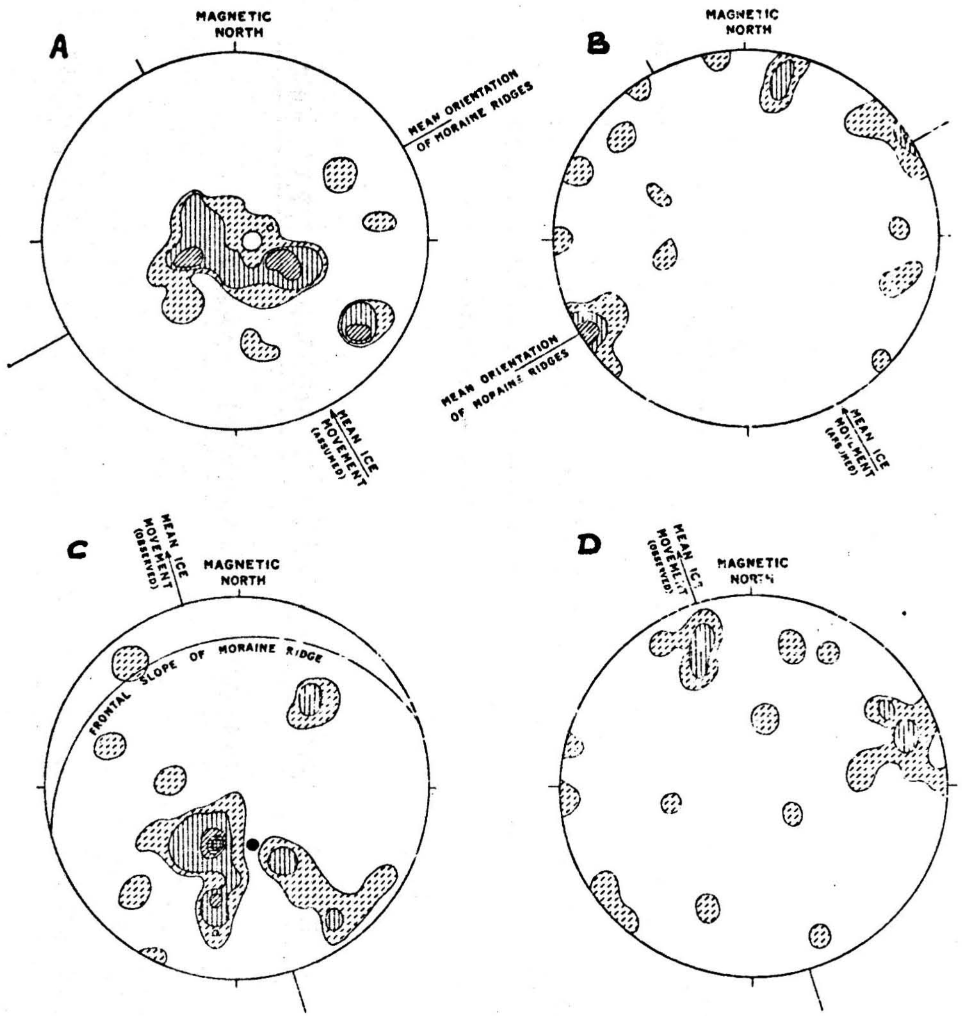
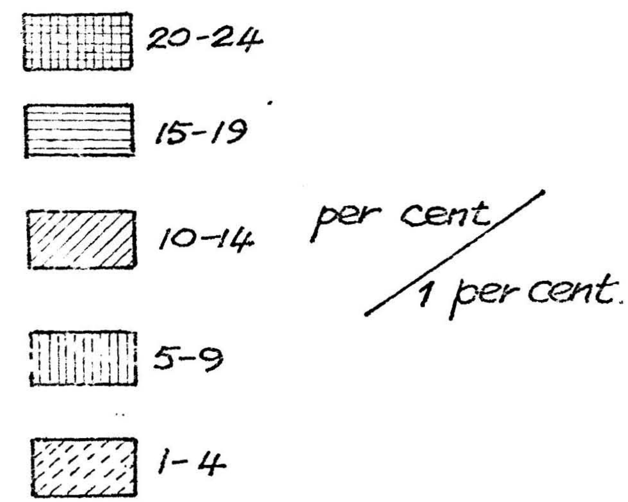


FIG. 6.16 NORWEGIAN CLAST FABRIC DATA

SCHMIDT NET, LOWER HEMISPHERE



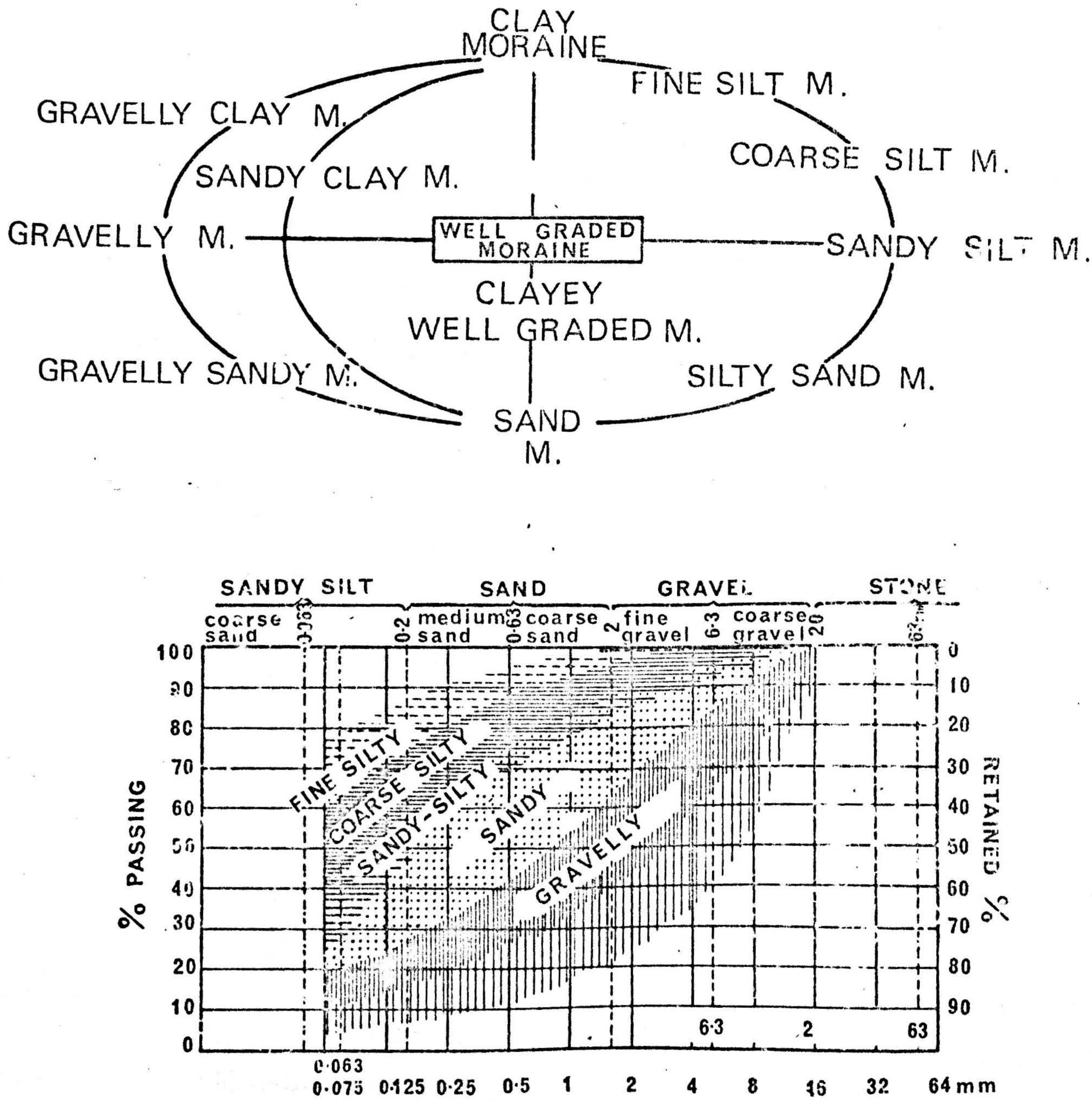
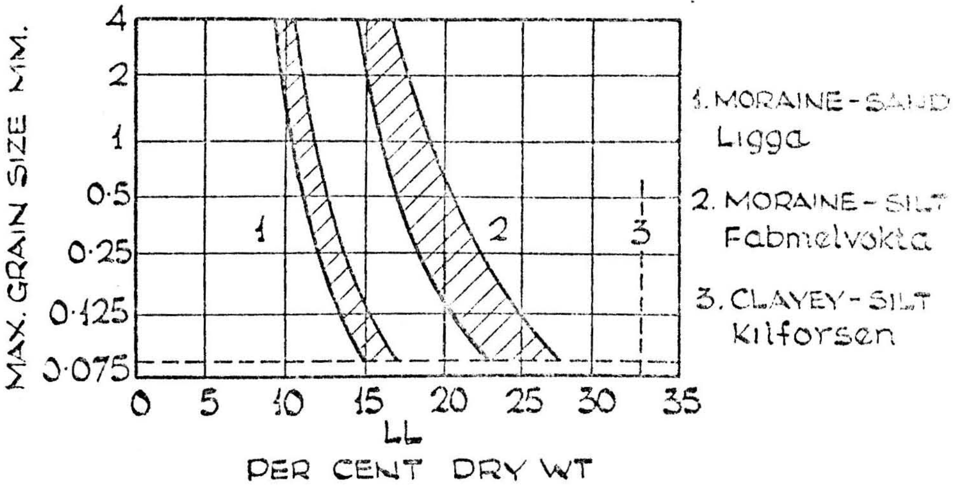
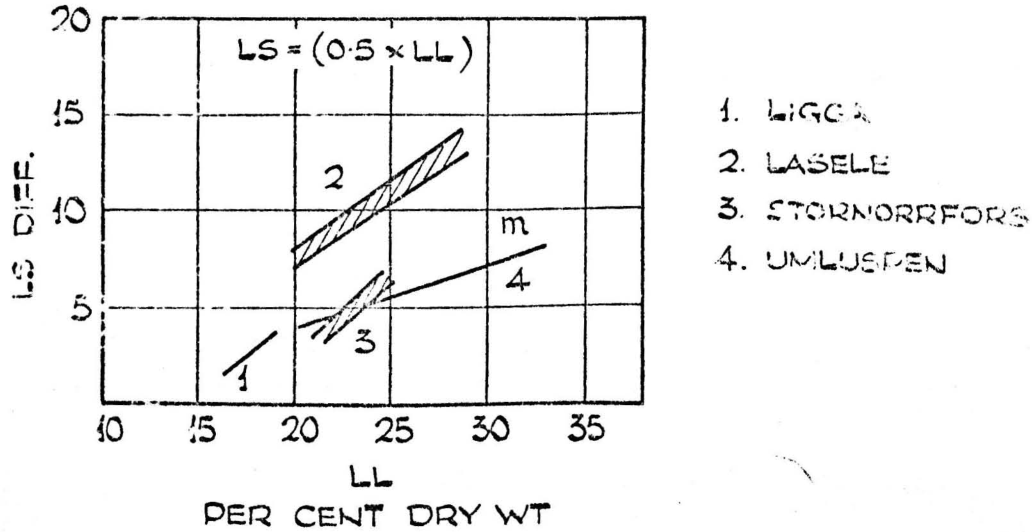


FIG. 7.1. SWEDISH CLASSIFICATION OF SOILS FROM MORAINES. (BESKOW, 1951).



(a) RELATION BETWEEN LIQUID LIMIT AND MAX. GRAIN SIZE OF TYPICAL MORAINES AND A CLAYEY SILT

AFTER BERNELL (1957)



(b) RELATION BETWEEN LIQUID LIMIT AND VALUES OF LS DIFFERENCE FOR MORAINES

AFTER BERNELL (1957)

FIG. 7.2. RELATION BETWEEN LIQUID LIMIT, MAXIMUM GRAIN SIZE AND L.S. DIFFERENCE FOR MORAINIC SOILS.

PARTICLE SIZE DISTRIBUTION

DESCRIPTION OF SAMPLE:-

DATE OF TEST:-

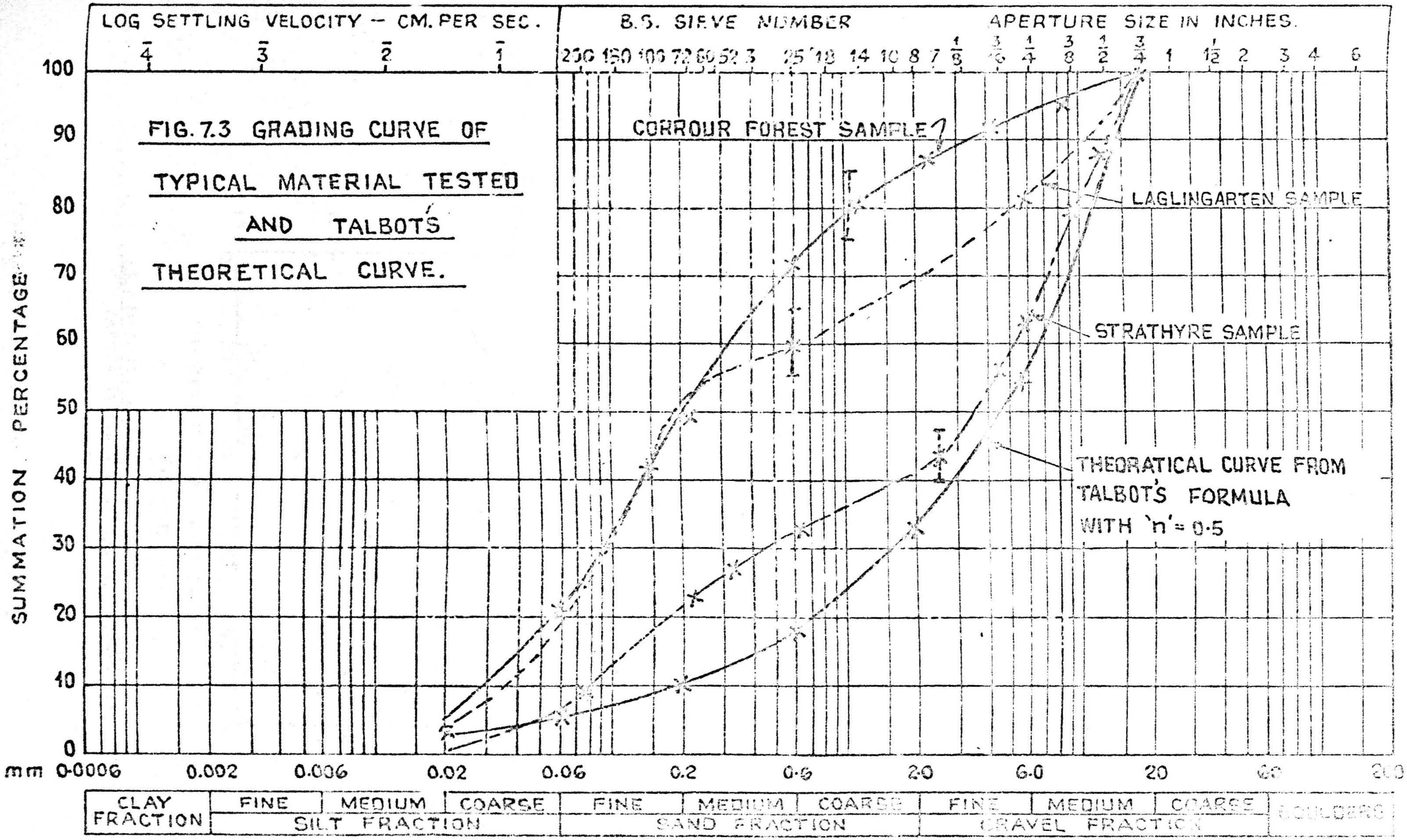


FIG. 7.3 GRADING CURVE OF TYPICAL MATERIAL TESTED AND TALBOT'S THEORETICAL CURVE.

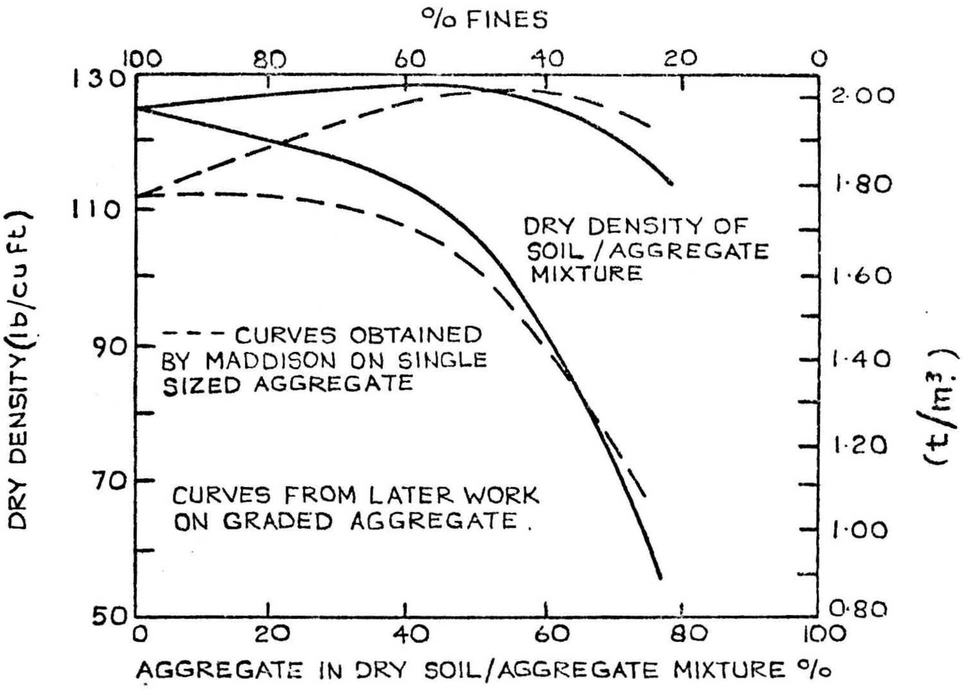


FIG. 7·4

COMPACTION OF SOIL MORTAR AT OPTIMUM MOISTURE CONTENT WITH DIFFERENT PERCENTAGE GRAVEL CONTENTS
(AFTER HIGHWAY RESEARCH BOARD 1962)

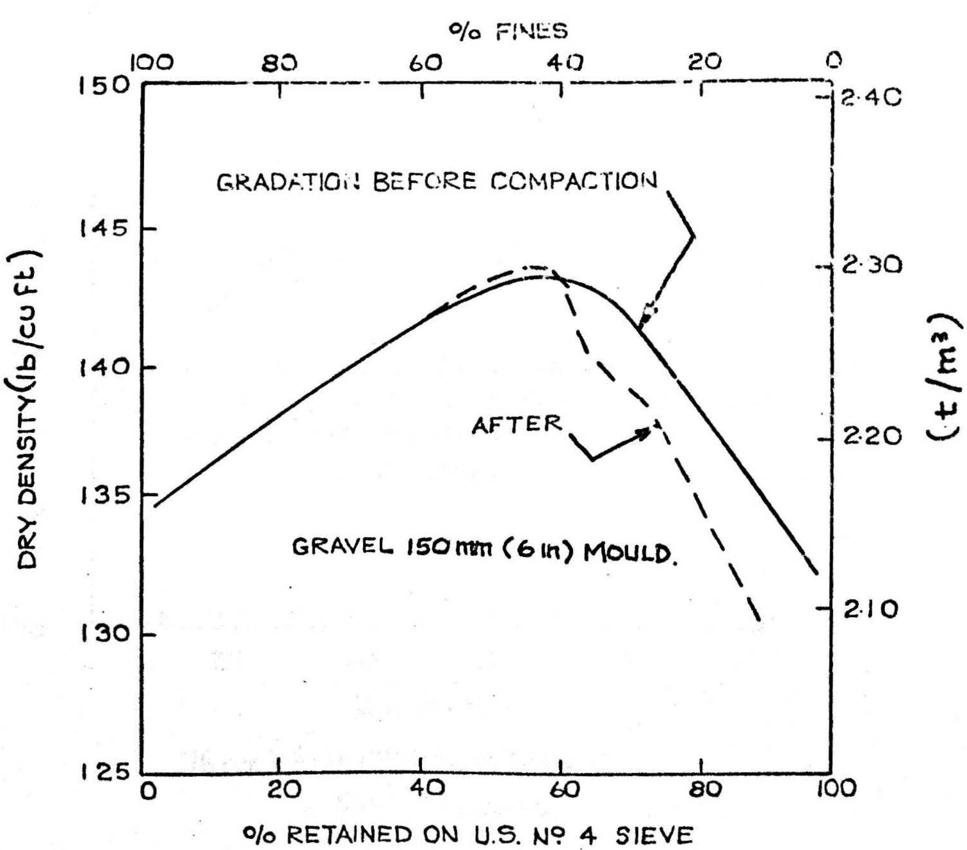
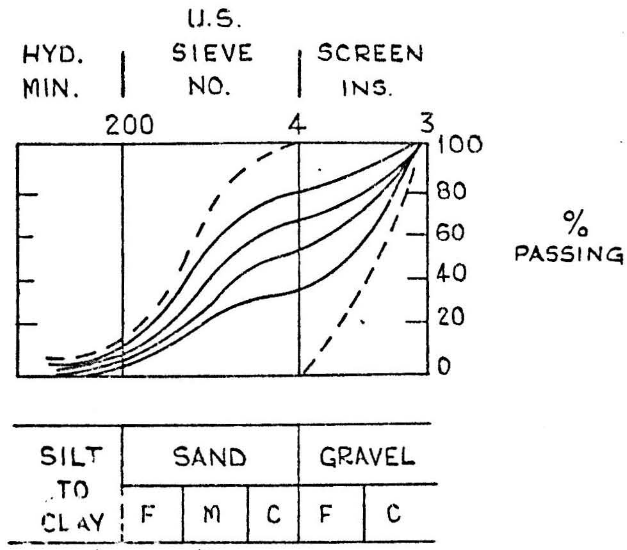
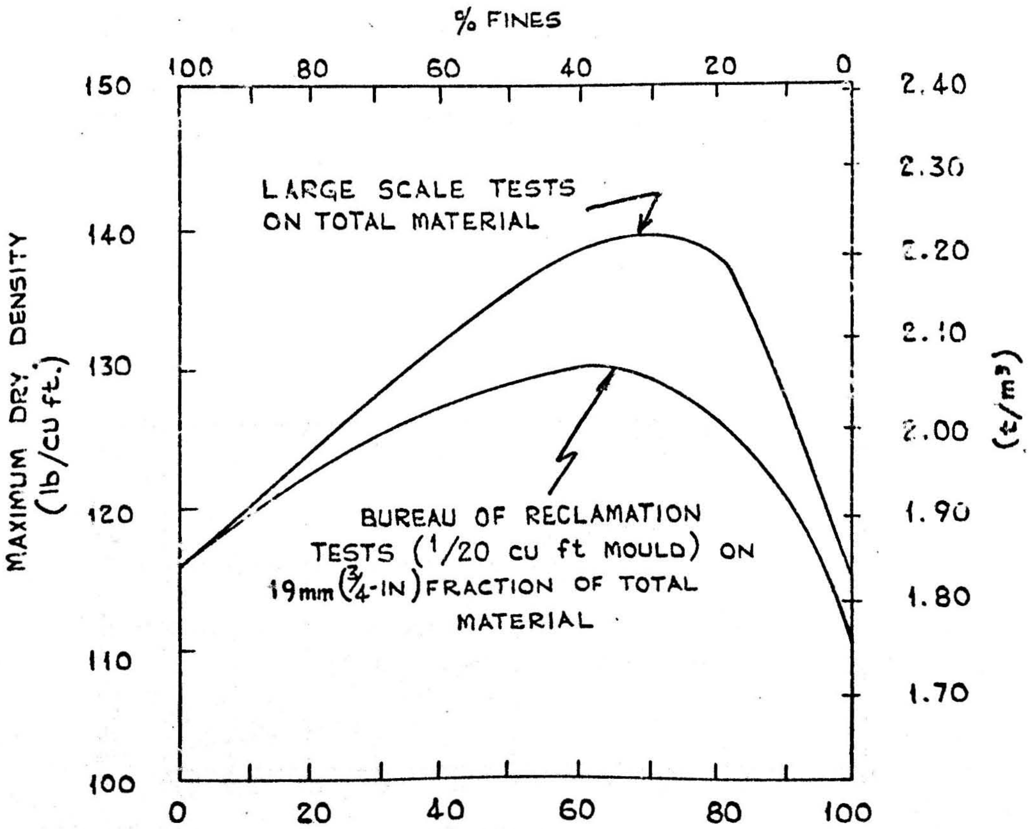


FIG. 7·5

DRY DENSITY-GRAVEL CONTENT RELATIONSHIP
(AFTER MAINFORT AND LAWTON 1952)

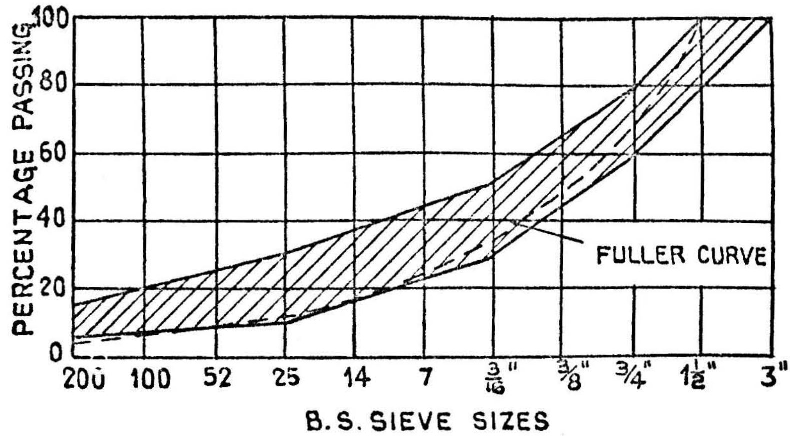


GRADATIONS USED IN INVESTIGATION OF COMPACTION CHARACTERISTICS OF GRAVELLY SANDS.

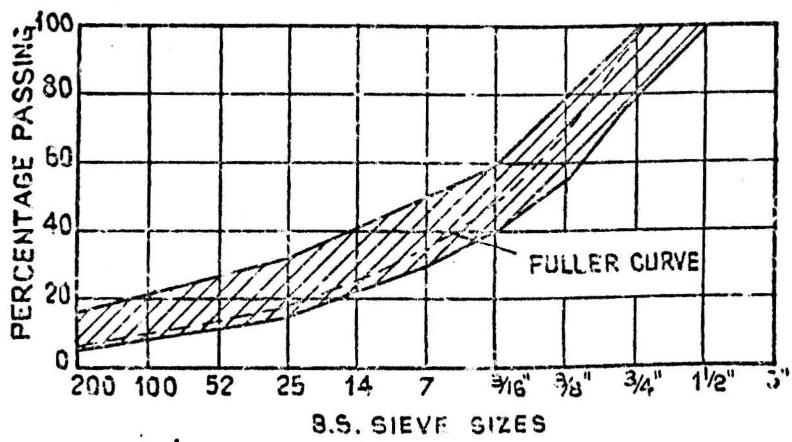


76mm (3-IN) MAXIMUM SIZE SANDY GRAVEL

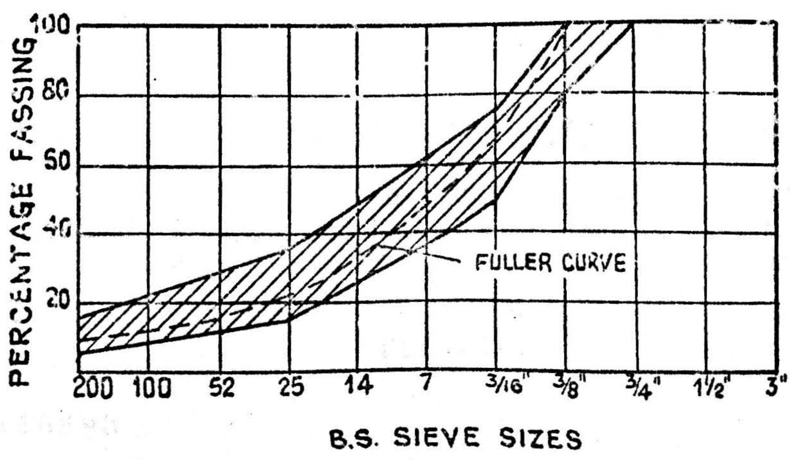
FIG. 7.6 RELATIONSHIP BETWEEN MAXIMUM DRY DENSITY AND GRAVEL CONTENT. (AFTER HOLTZ & LOWITZ, 1957)



3-IN MAXIMUM PARTICLE SIZE



½-IN MAXIMUM PARTICLE SIZE

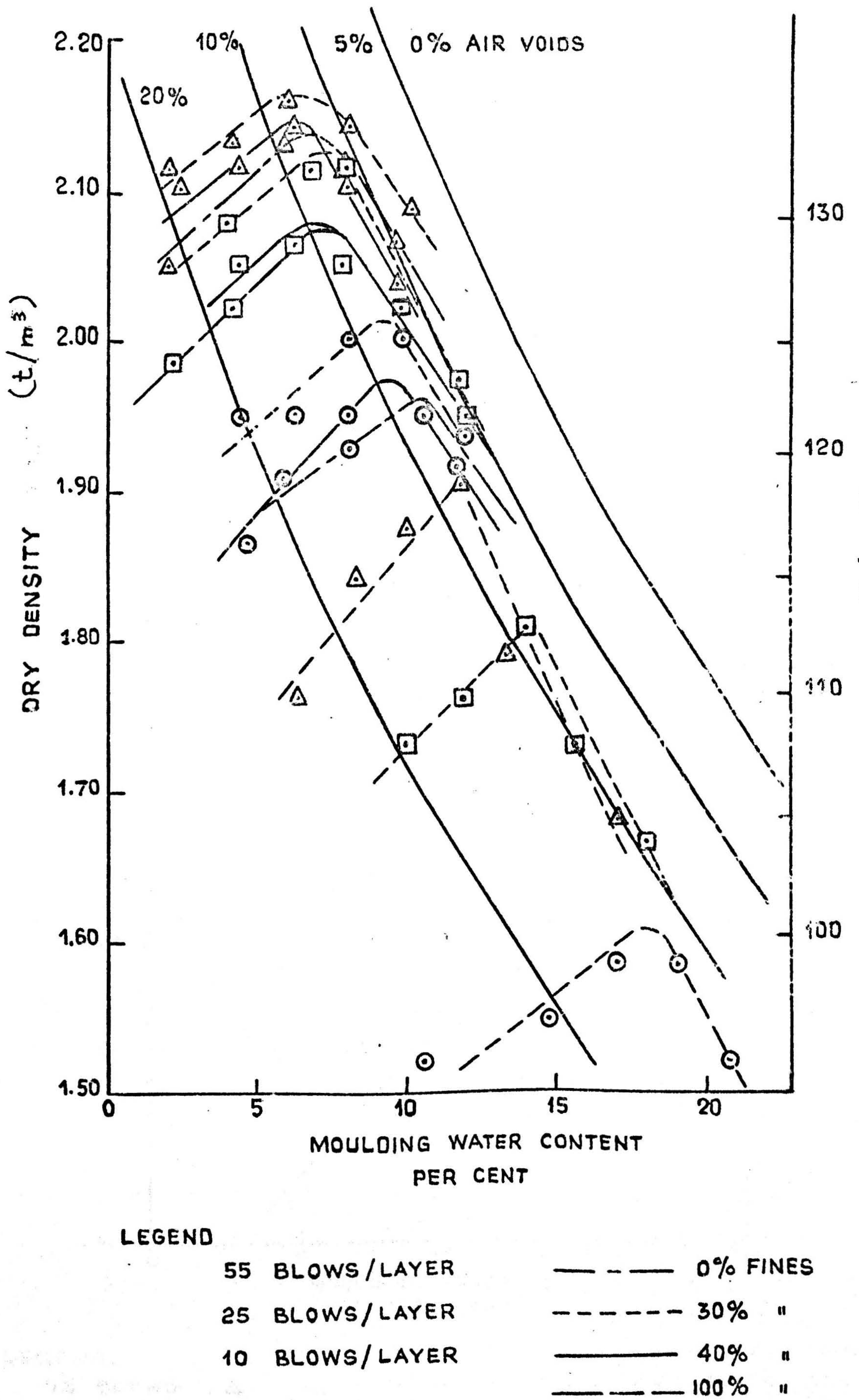


¾-IN MAXIMUM PARTICLE SIZE

FIG. 7·7

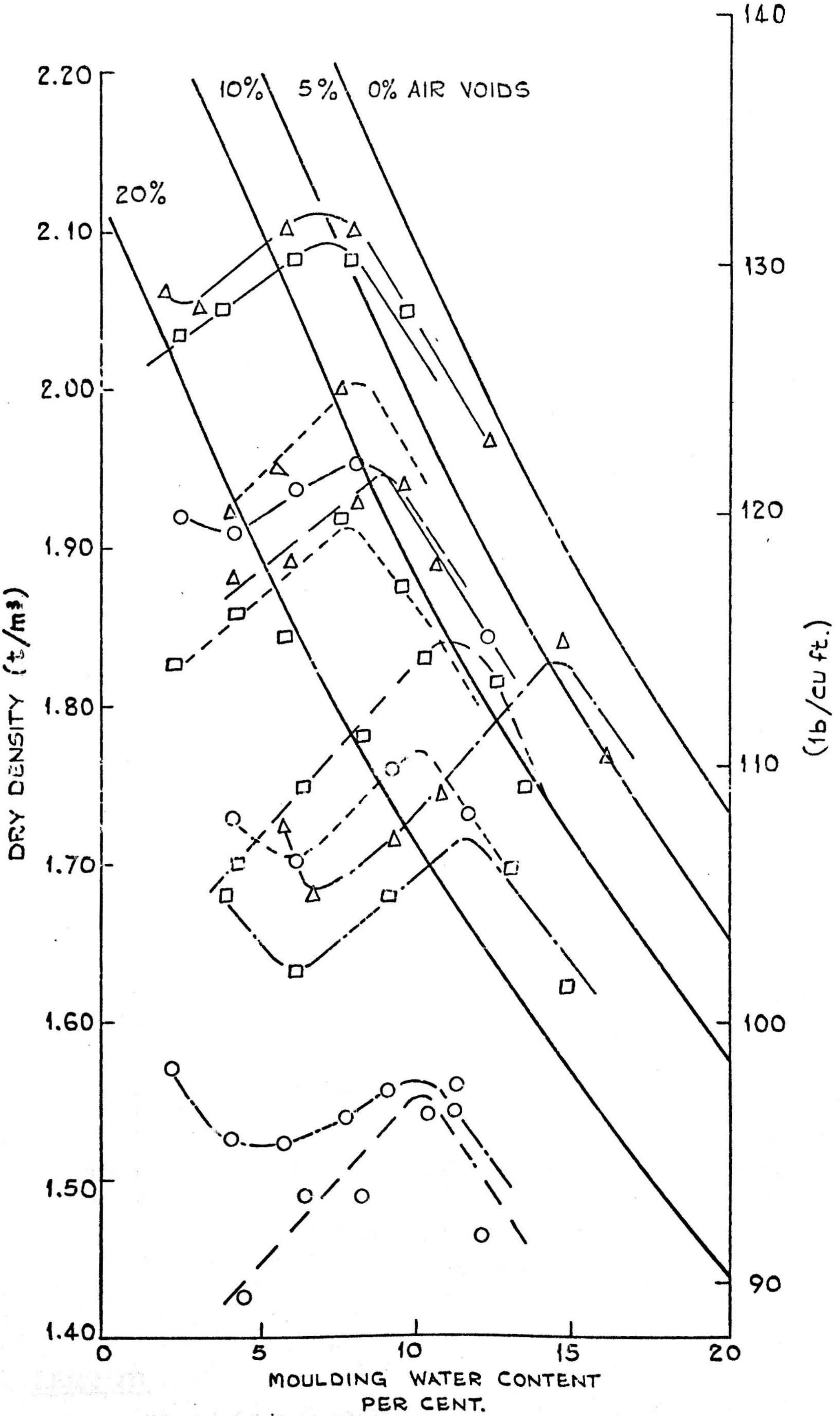
SUGGESTED PARTICLE SIZE LIMITS FOR BASE MATERIALS

EXTRACTED FROM "SOIL MECHANICS FOR ROAD ENGINEERS" H.M.S.O.



TYPICAL RELATIONSHIPS BETWEEN MOULDING CONTENT AND DRY DENSITY FOR VARYING COMPACTIVE EFFORT FOR LAGLINGARTEN TILL.

FIG. 7·8

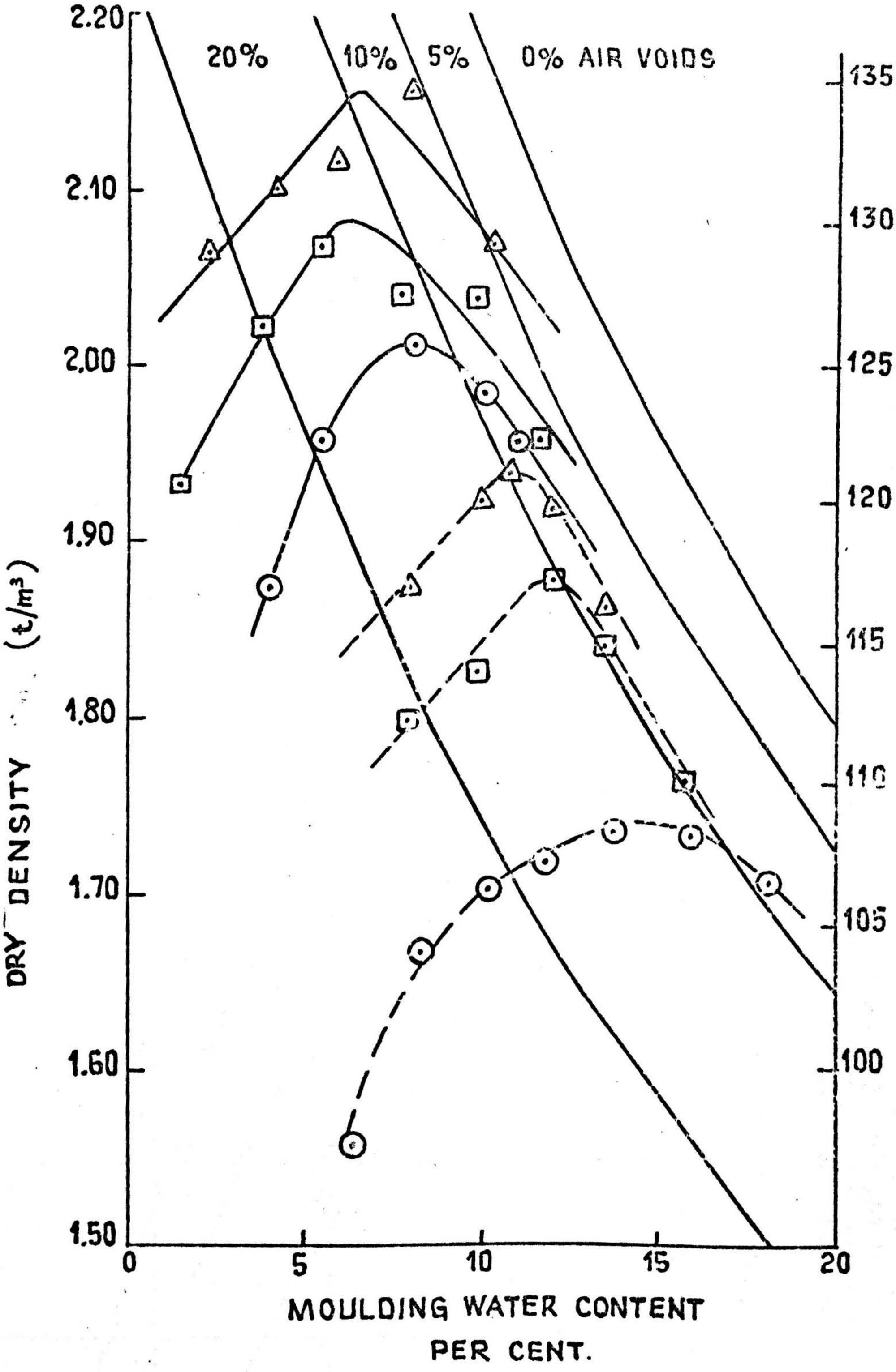


LEGEND:

55 BLOWS △
25 BLOWS □
5 BLOWS ○

—·—·— 0-PER CENT FINES
– – – – 20-PER CENT FINES
———— 40-PER CENT FINES
— — — 100-PER CENT FINES

FIG. 7.9. TYPICAL RELATIONSIPS BETWEEN MOULDING WATER CONTENT AND DRY DENSITY FOR VARYING COMPACTIVE EFFORT AND PERCENTAGE FINES FOR CORROUR TILL.



LEGEND

△	55 BLOWS / LAYER
⊡	25 BLOWS / LAYER
⊙	10 BLOWS / LAYER

——— 50 % FINES

– – – 100 % FINES

FIG. 7·10 TYPICAL RELATIONSHIPS BETWEEN MOULDING WATER CONTENT AND DRY DENSITY FOR VARYING COMPACTIVE EFFORT FOR STRATHYRE TILL.

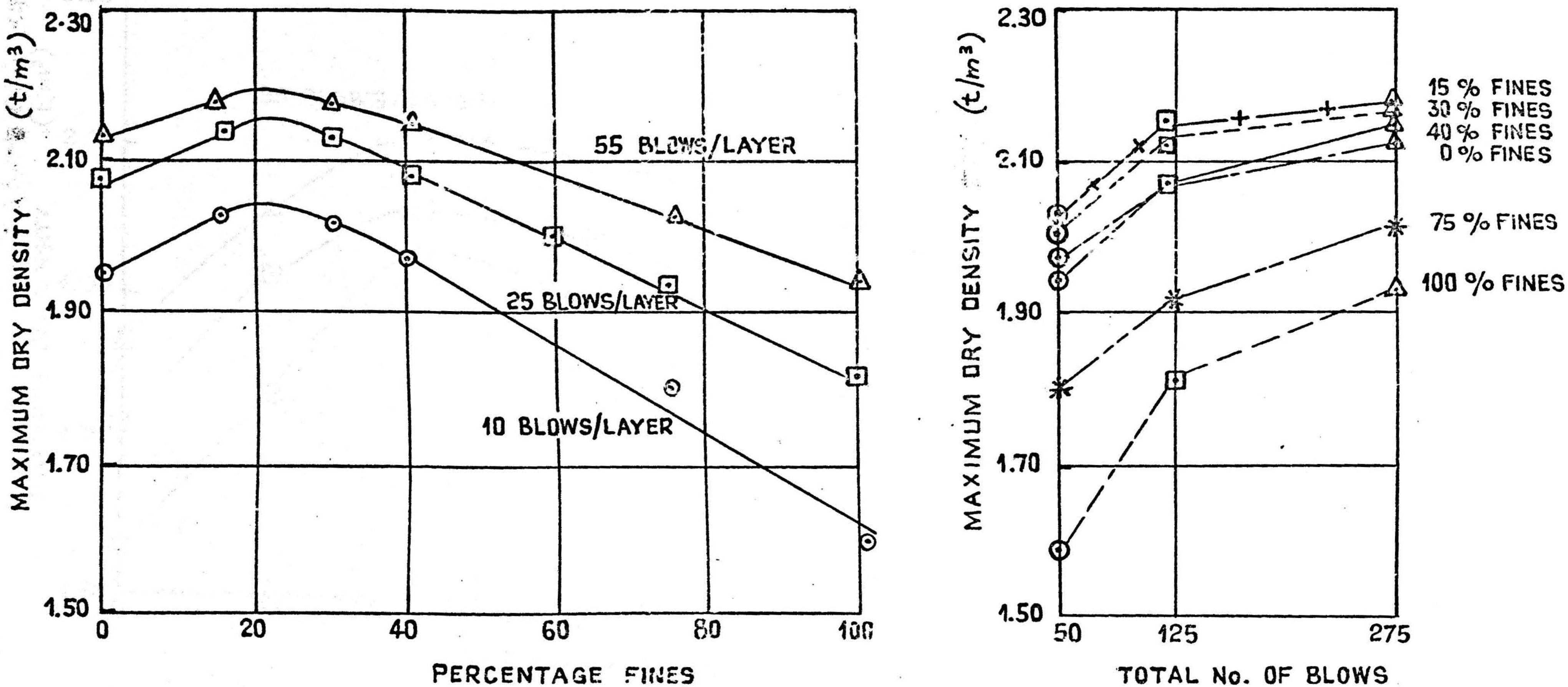


FIG.7.11 RELATIONSHIP BETWEEN PERCENTAGE FINE CONTENT AND MAXIMUM DRY DENSITY FOR VARYING COMPACTIVE EFFORT FOR LAGLINGARTEN TILLS

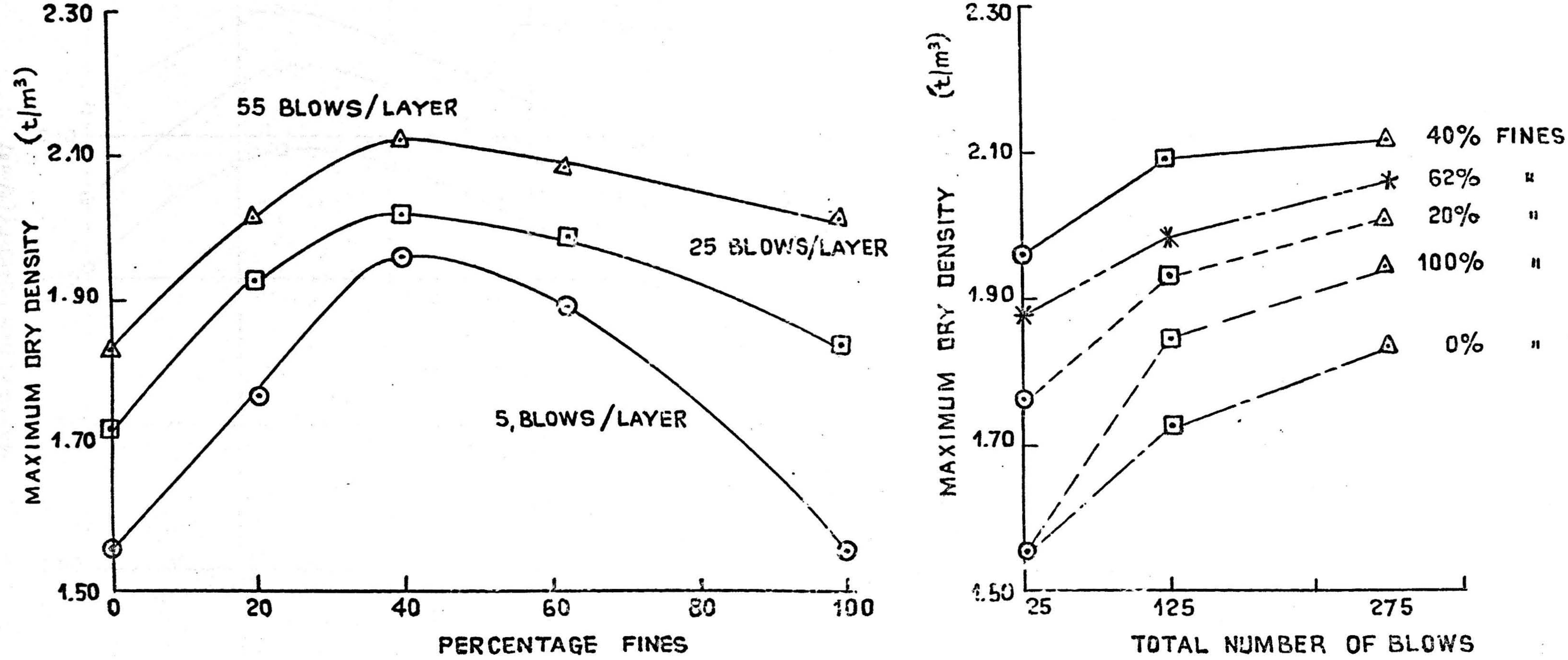


FIG. 7·12 RELATIONSHIP BETWEEN PERCENTAGE FINE CONTENT AND MAXIMUM DRY DENSITY FOR VARYING COMPACTIVE EFFORT FOR CORROUR TILLS.

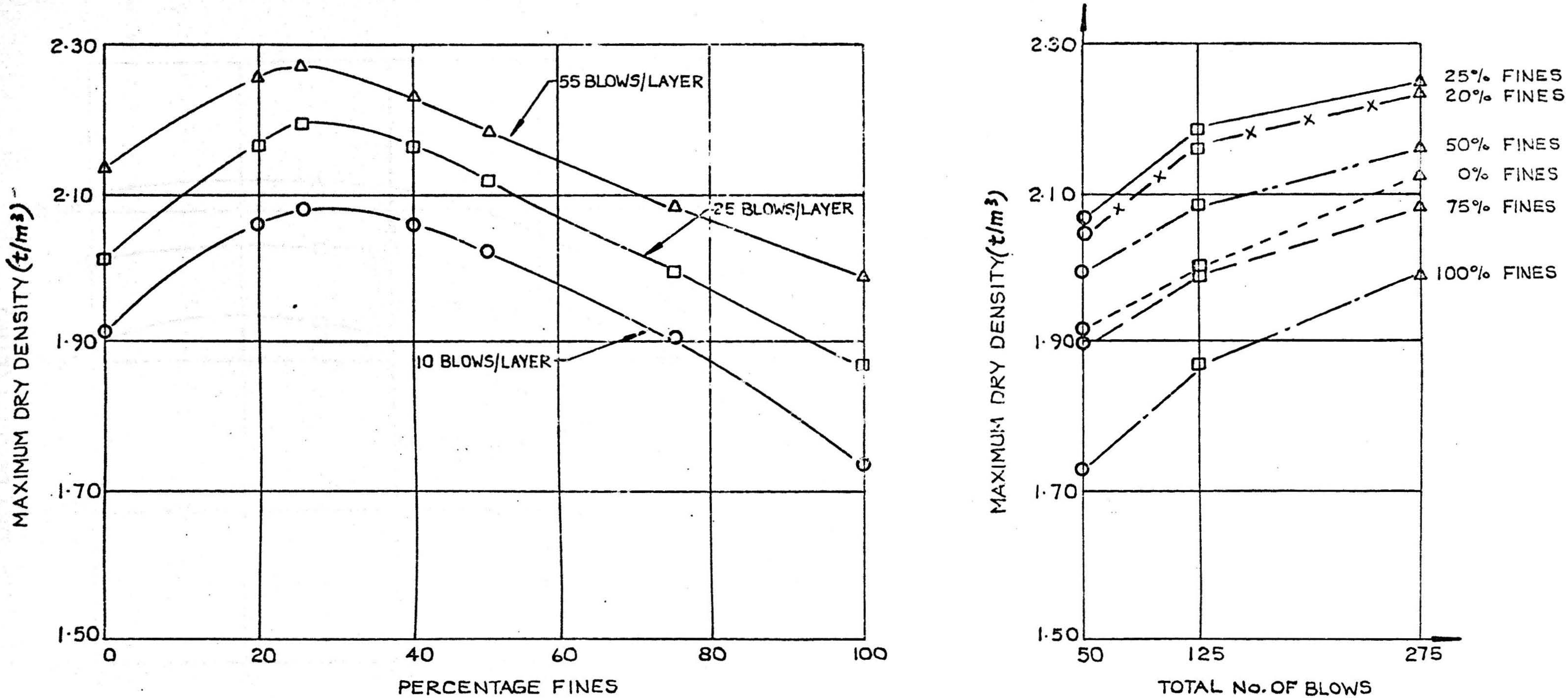


FIG 7. 13 RELATIONSHIP BETWEEN PERCENTAGE FINES CONTENT AND MAXIMUM DRY DENSITY FOR VARYING COMPACTIVE EFFORT IN STRATHYRE TILLS.

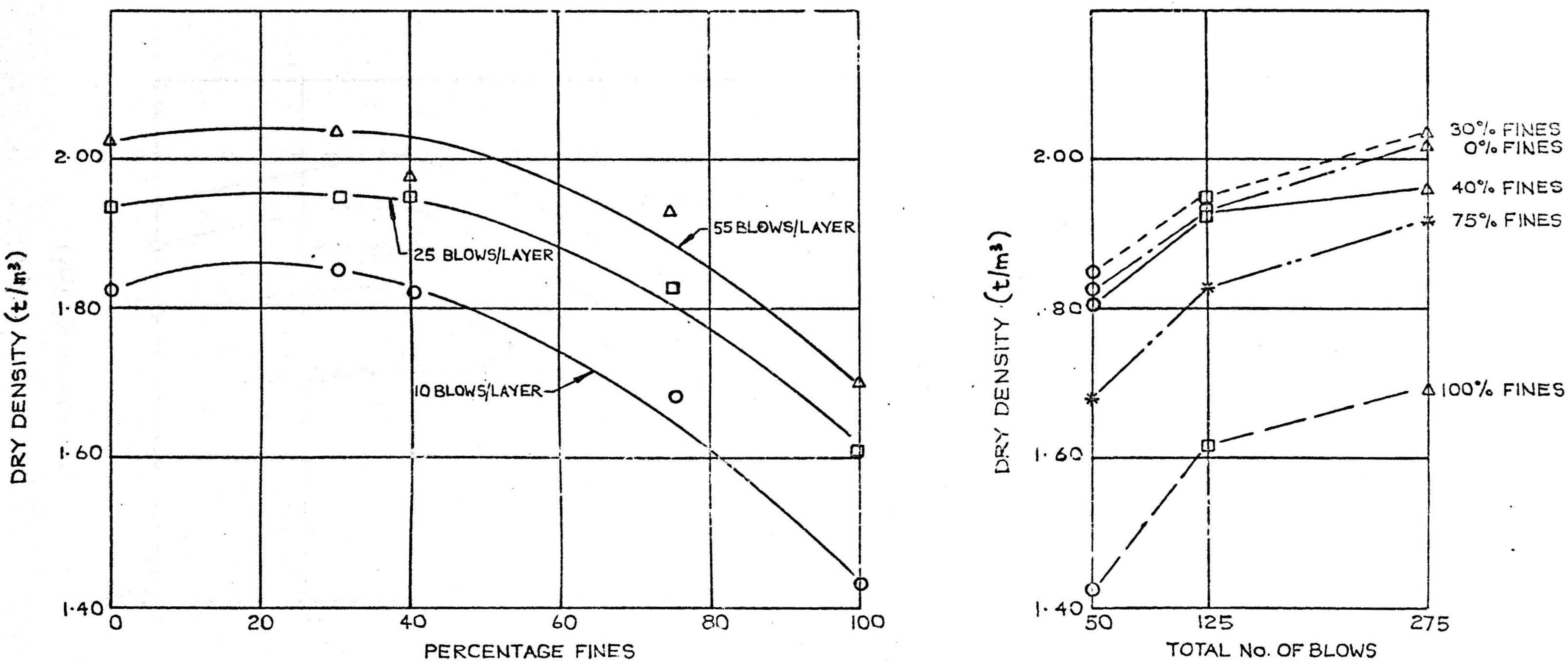


FIG. 7.14 RELATIONSHIP BETWEEN PERCENTAGE FINE CONTENT AND DRY DENSITY AT OPTIMUM WATER CONTENT PLUS 5 % FOR VARYING COMPACTIVE EFFORT FOR LAGLINGARTEN TILL.

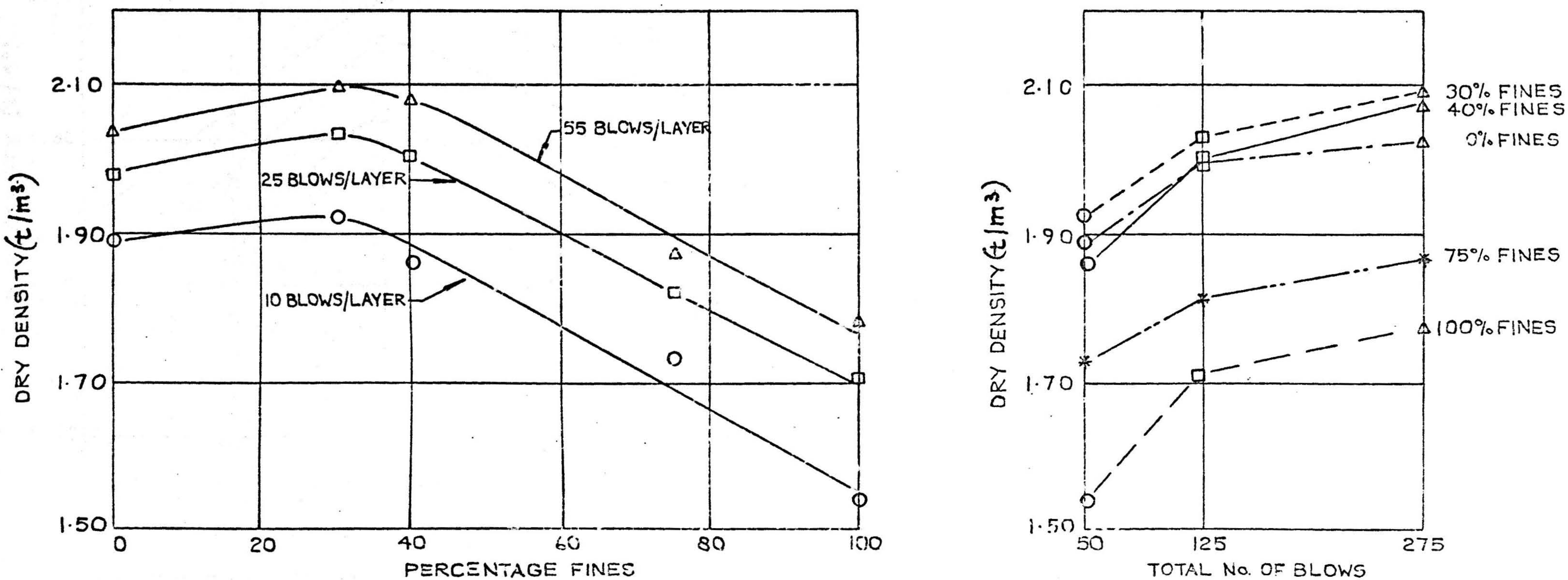


FIG. 7.15 RELATIONSHIP BETWEEN PERCENTAGE FINE CONTENT AND DRY DENSITY AT OPTIMUM WATER CONTENT MINUS 5% FOR VARYING COMPACTIVE EFFORT FOR LAGLINGARTEN TILL.

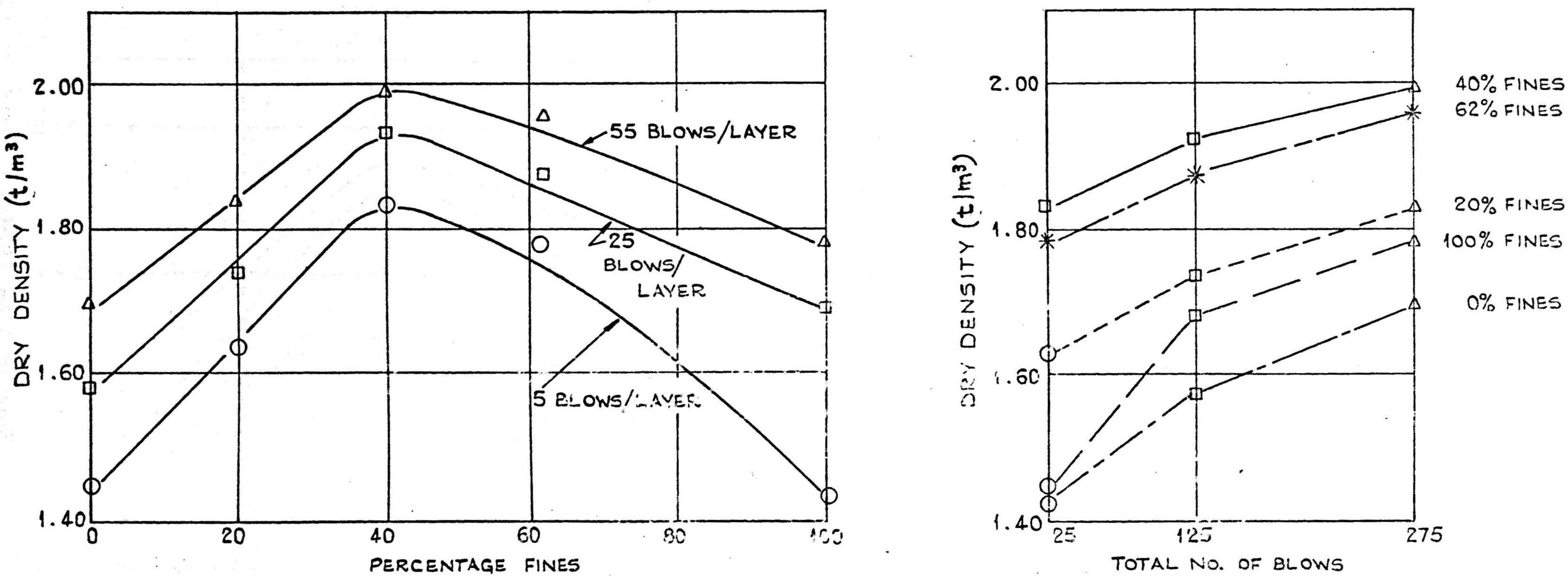


FIG. 7.16. RELATIONSHIP BETWEEN PERCENTAGE FINE CONTENT AND DRY DENSITY AT OPTIMUM WATER CONTENT PLUS 5 PER CENT FOR VARYING COMPACTIVE EFFORT FOR CORROUR TILL.

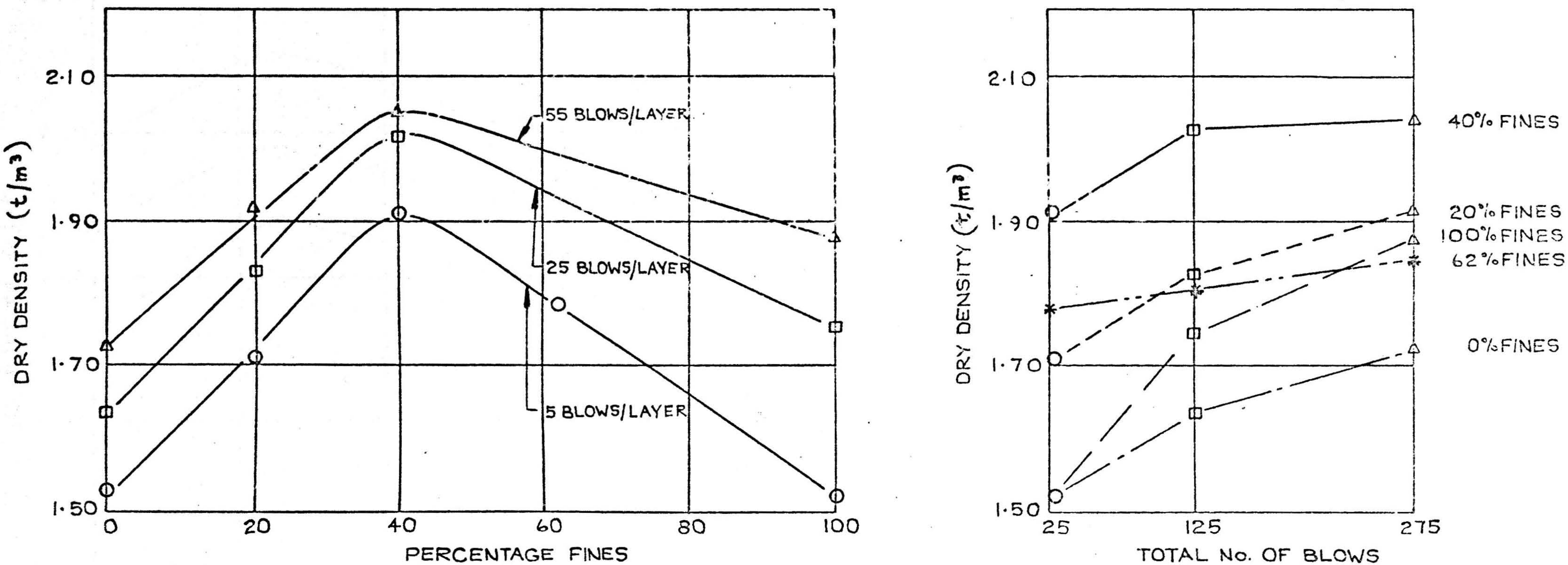


FIG. 7.17 RELATIONSHIP BETWEEN PERCENTAGE FINE CONTENT AND DRY DENSITY AT OPTIMUM WATER CONTENT MINUS 5% FOR VARYING COMPACTIVE EFFORT FOR CORROUR TILL

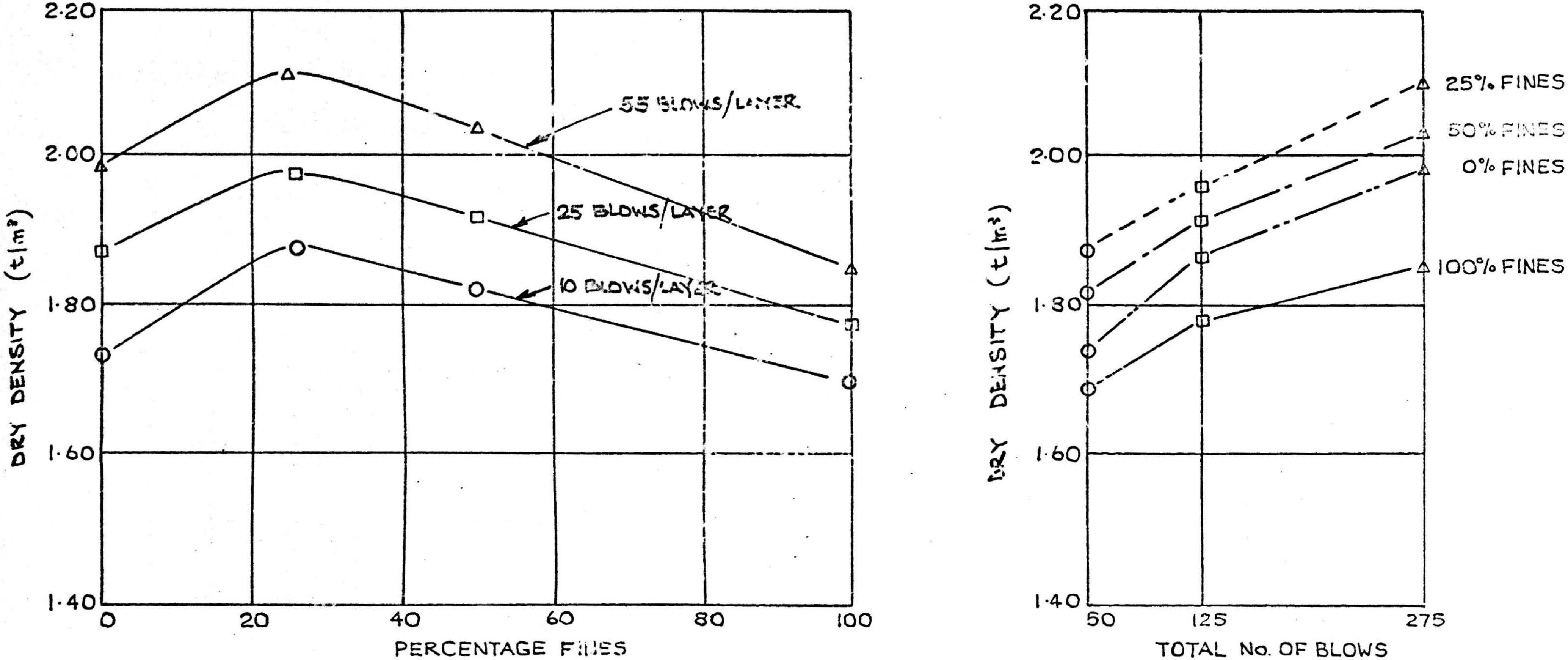


FIG. 7.18 RELATIONSHIP BETWEEN PERCENTAGE FINES CONTENT AND DRY DENSITY OF OPTIMUM WATER CONTENT MINUS 5% FOR VARYING COMPACTIVE EFFORT FOR STRATHYRE TILL

NOTE: DATA FOR OPTIMUM MOISTURE CONTENT PLUS 5 PER CENT WAS NOT OBTAINED

PARTICLE SIZE DISTRIBUTION

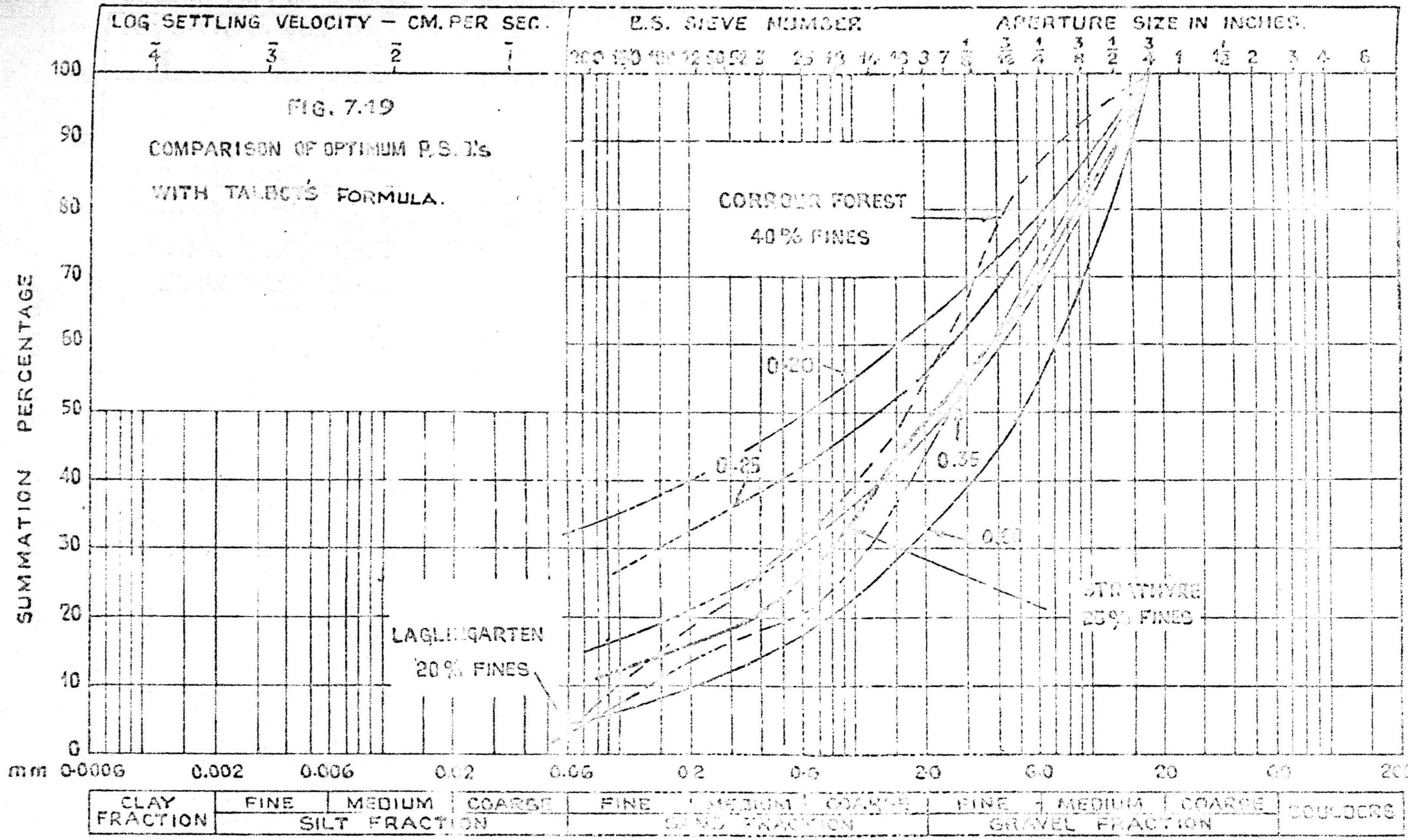


FIG. 7.19
COMPARISON OF OPTIMUM P.S.D.'s WITH TALBOT'S FORMULA.

PARTICLE SIZE DISTRIBUTION

DESCRIPTION OF SAMPLE :- COMPACTED AT 55 BLOWS/LAYER

DATE OF TEST :-

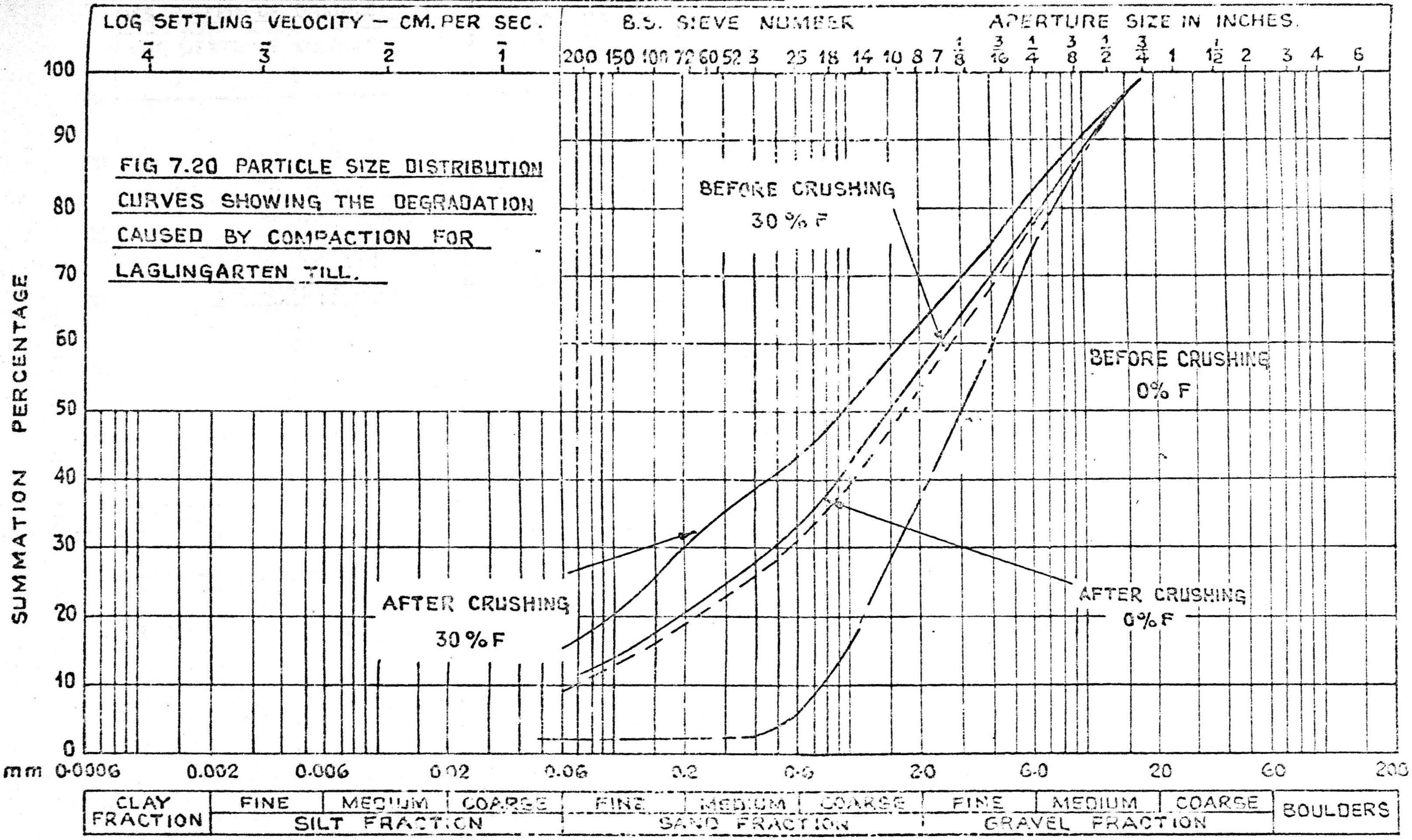


FIG 7.20 PARTICLE SIZE DISTRIBUTION CURVES SHOWING THE DEGRADATION CAUSED BY COMPACTION FOR LAGLINGARTEN TILL.

PARTICLE SIZE DISTRIBUTION

DESCRIPTION OF SAMPLE:- COMPACTED AT 55 BLOWS/LAYER

DATE OF TEST:-

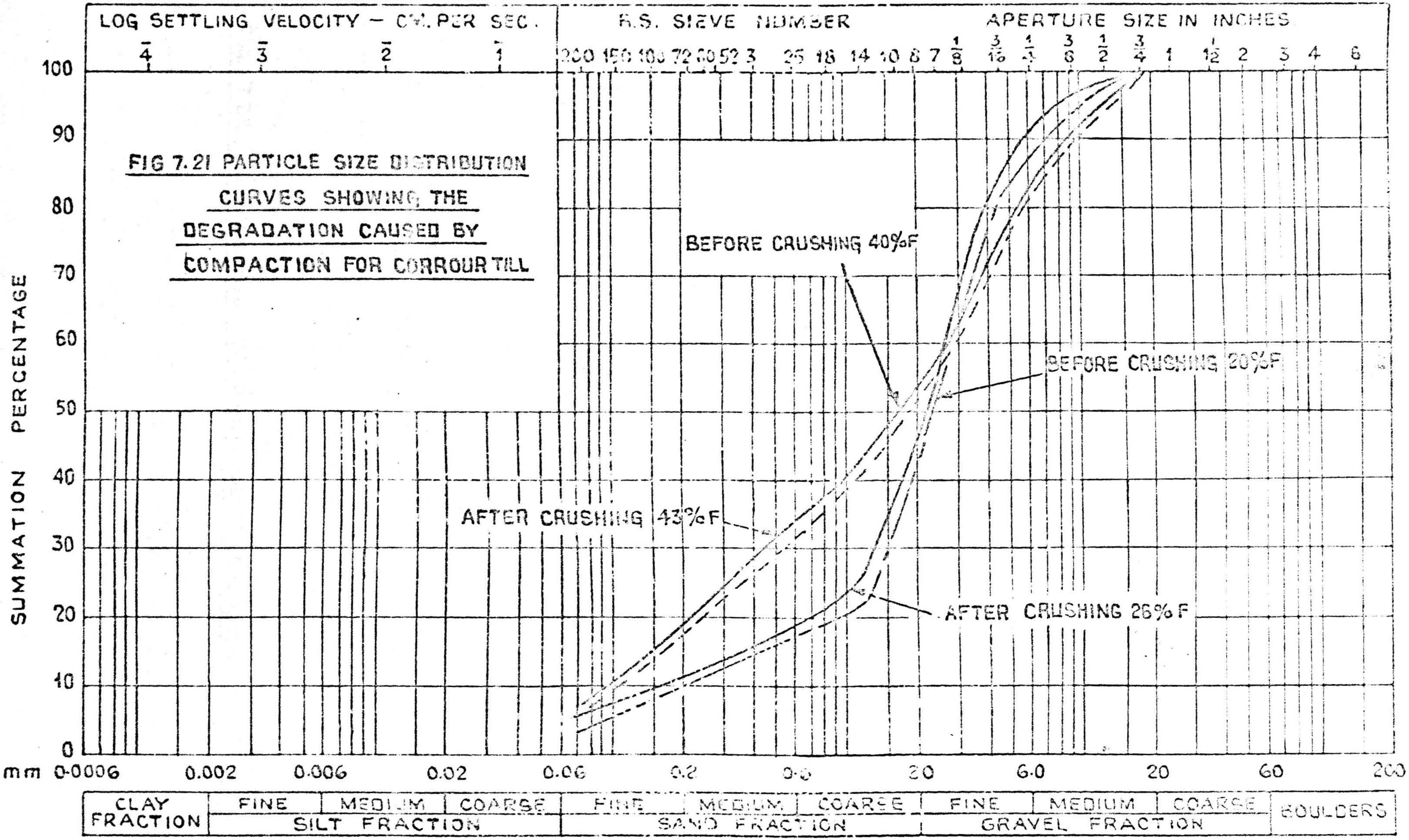


FIG 7.21 PARTICLE SIZE DISTRIBUTION CURVES SHOWING THE DEGRADATION CAUSED BY COMPACTION FOR CORROUR TILL

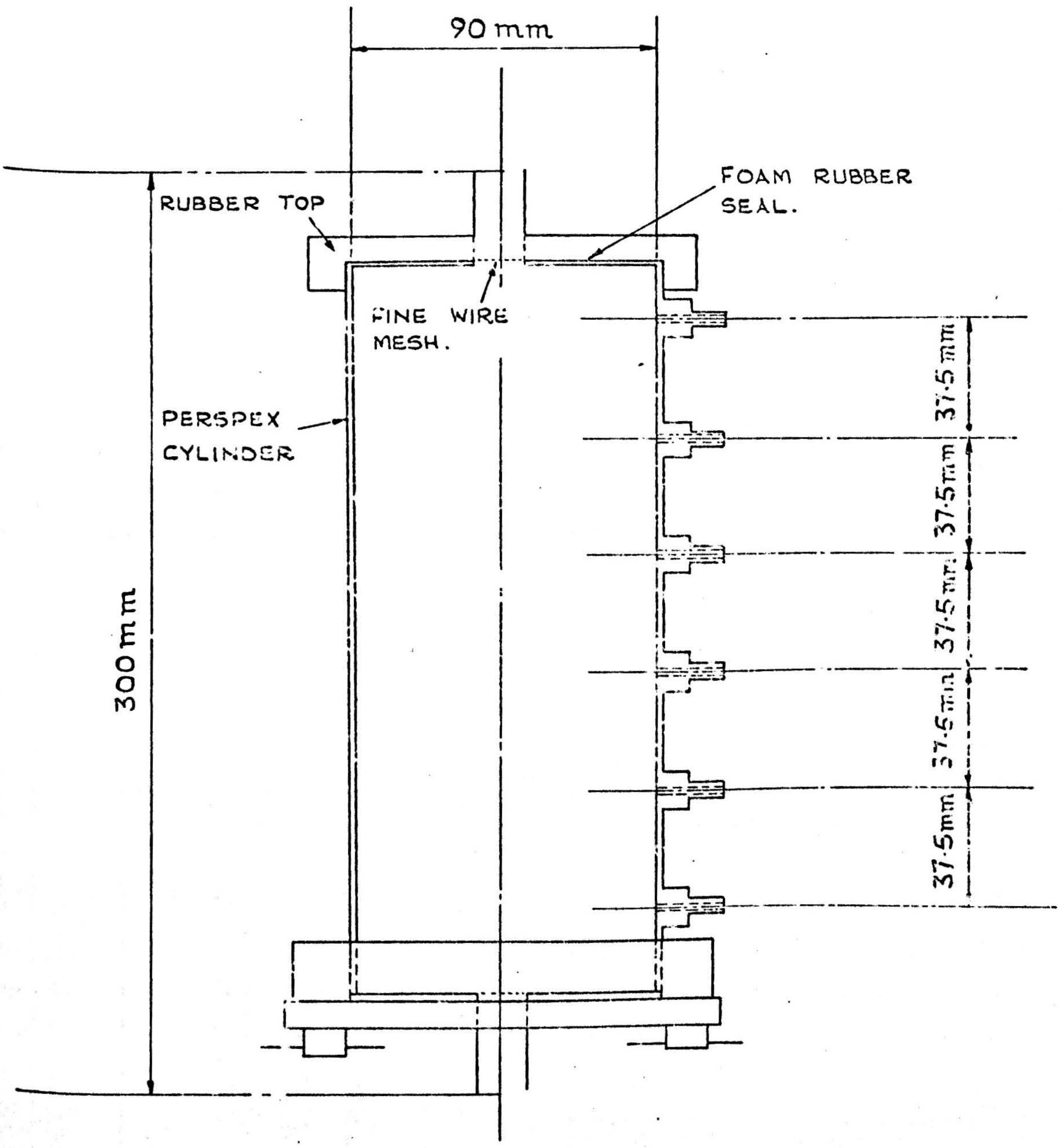


FIG. 7.22. DIMENSIONS OF PERMEABILITY CYLINDER.

PARTICLE SIZE DISTRIBUTION

SEMI-LOG PLOT

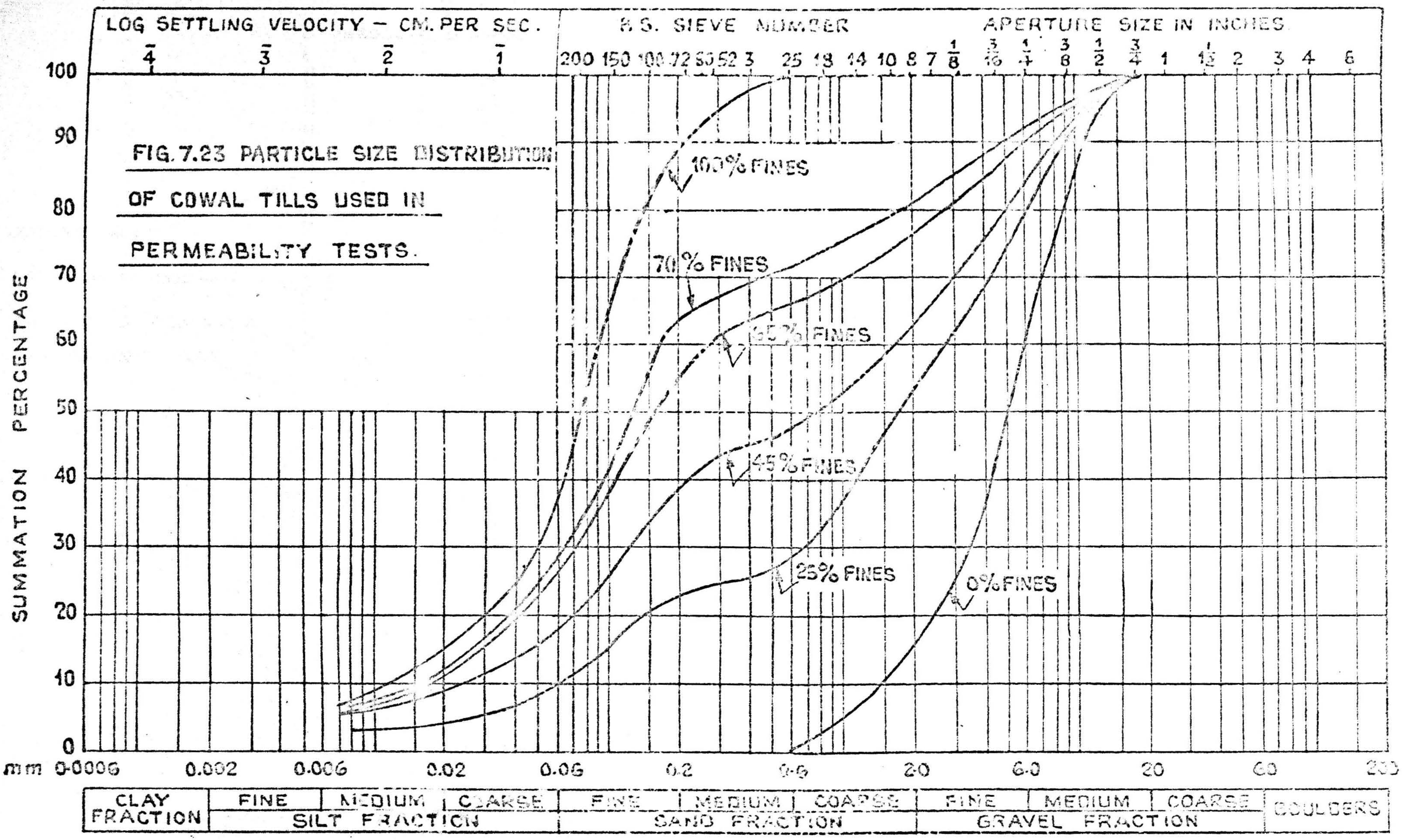


FIG. 7.23 PARTICLE SIZE DISTRIBUTION OF COWAL TILLS USED IN PERMEABILITY TESTS.

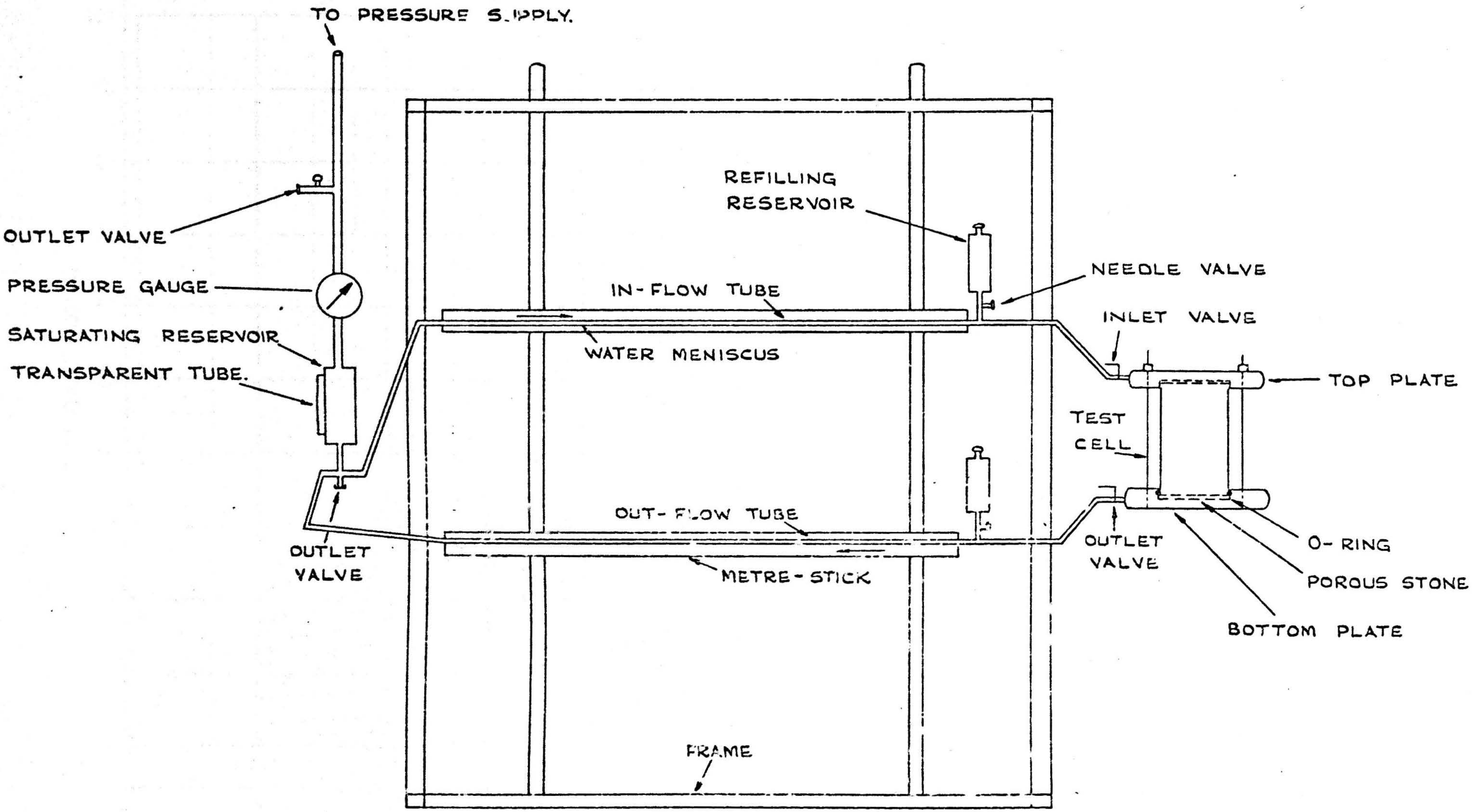


FIG. 7.24 CONSTANT HEAD PERMEABILITY APPARATUS (AFTER YOUNGER & LIM, 1969)

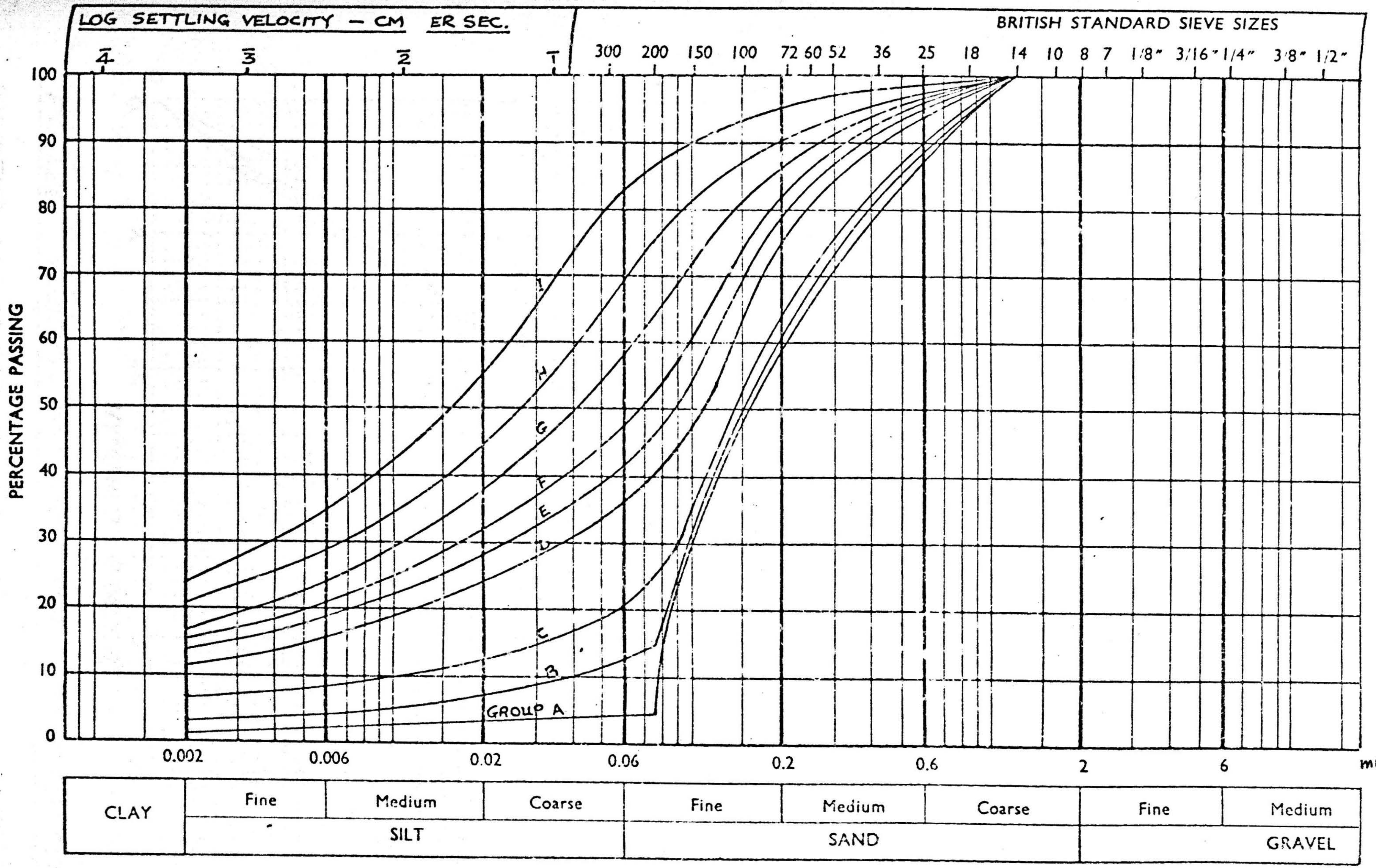


FIG. 7.25. PARTICLE SIZE DISTRIBUTIONS OF ARTIFICIALLY GRADED BACKWATER TILL.

(YOUNGER AND LIM 1969)

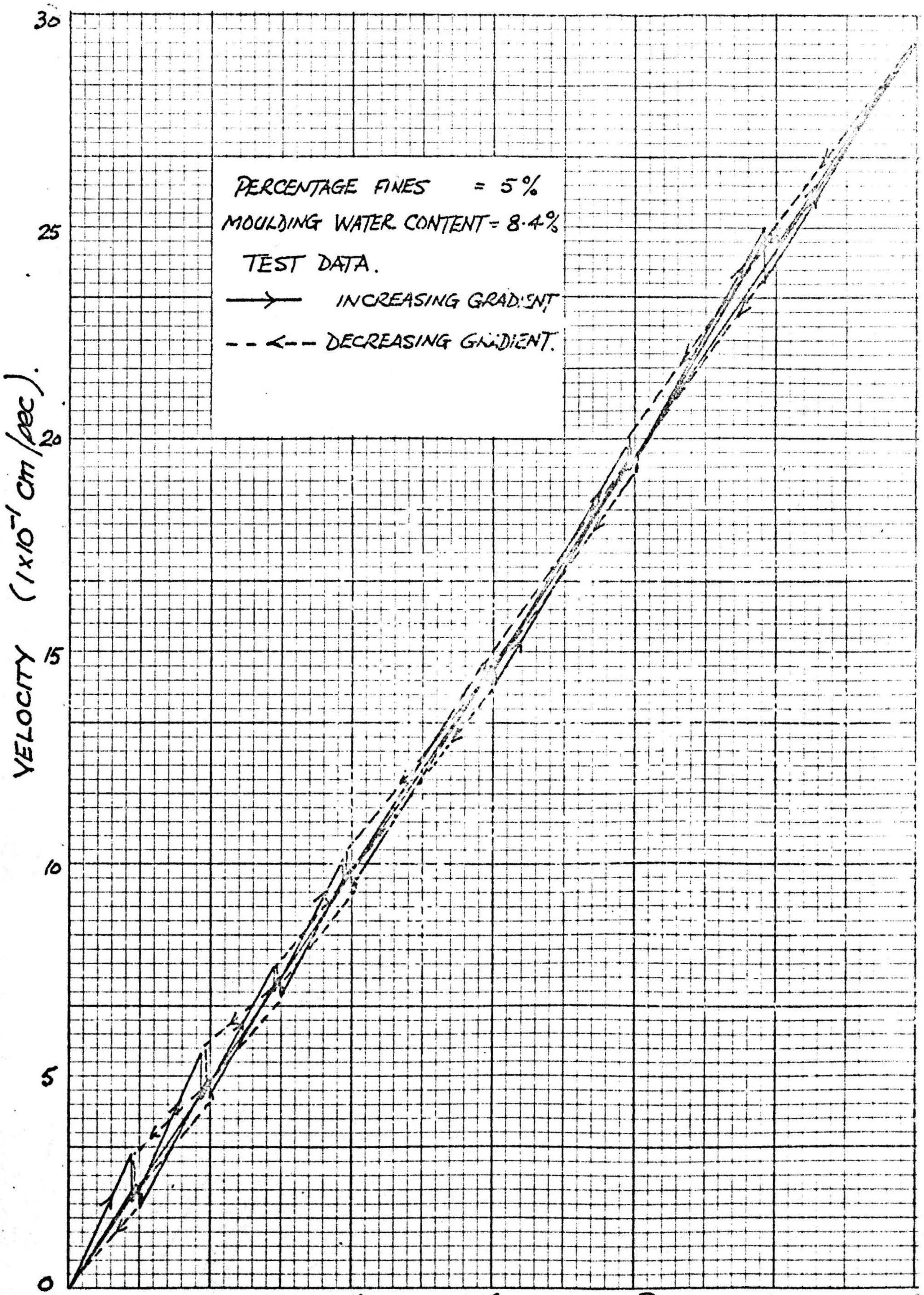


FIG 7.26. VELOCITY – GRADIENT PLOT FOR 5 PER CENT FINES COMPACTED DRY OF OPTIMUM (AFTER YOUNGER AND LIM, 1969).

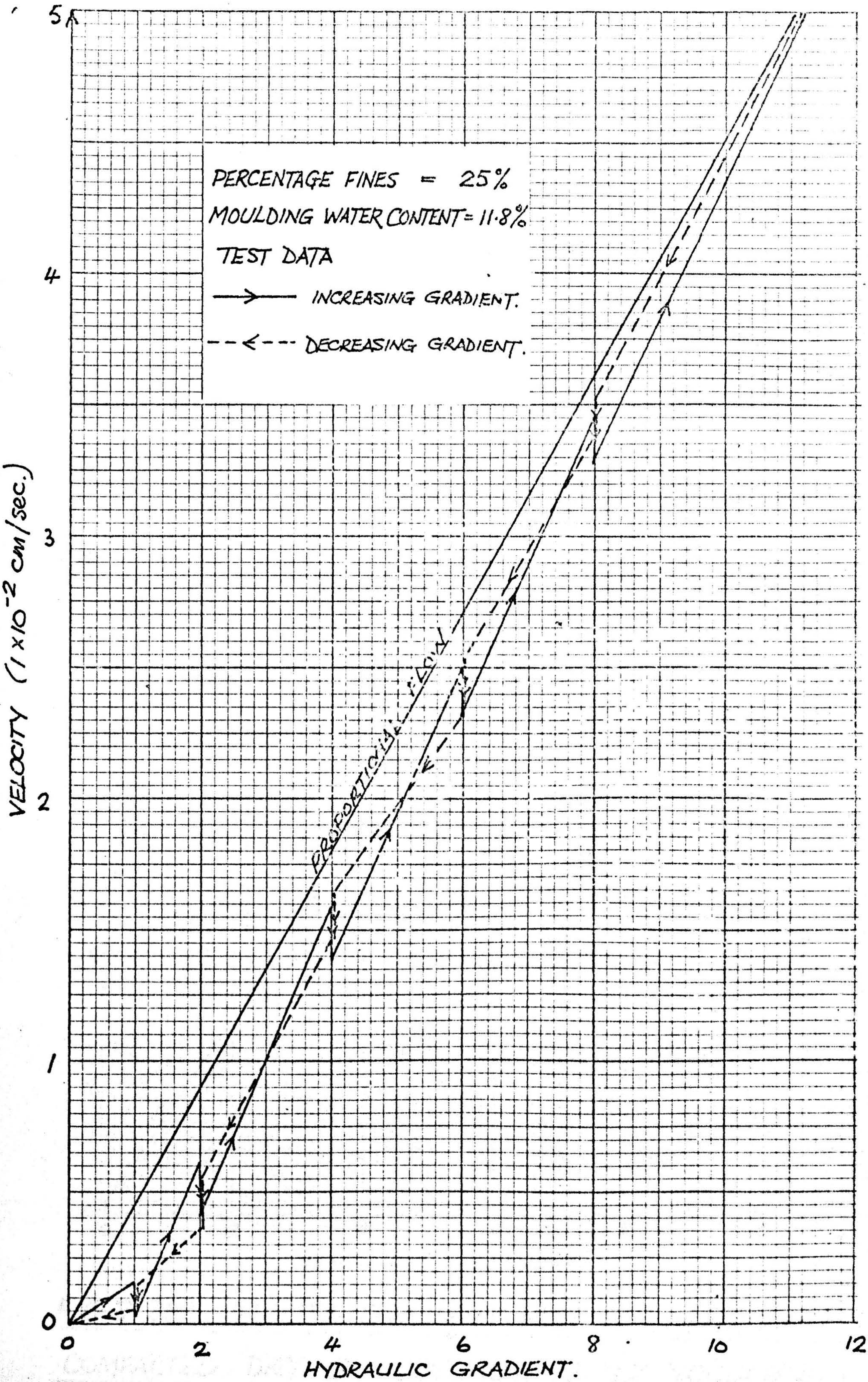


FIG.7.27. VELOCITY-GRADIENT PLOT FOR 25 PER CENT FINES COMPACTED DRY OF OPTIMUM (AFTER YOUNGER AND LIM, 1969)

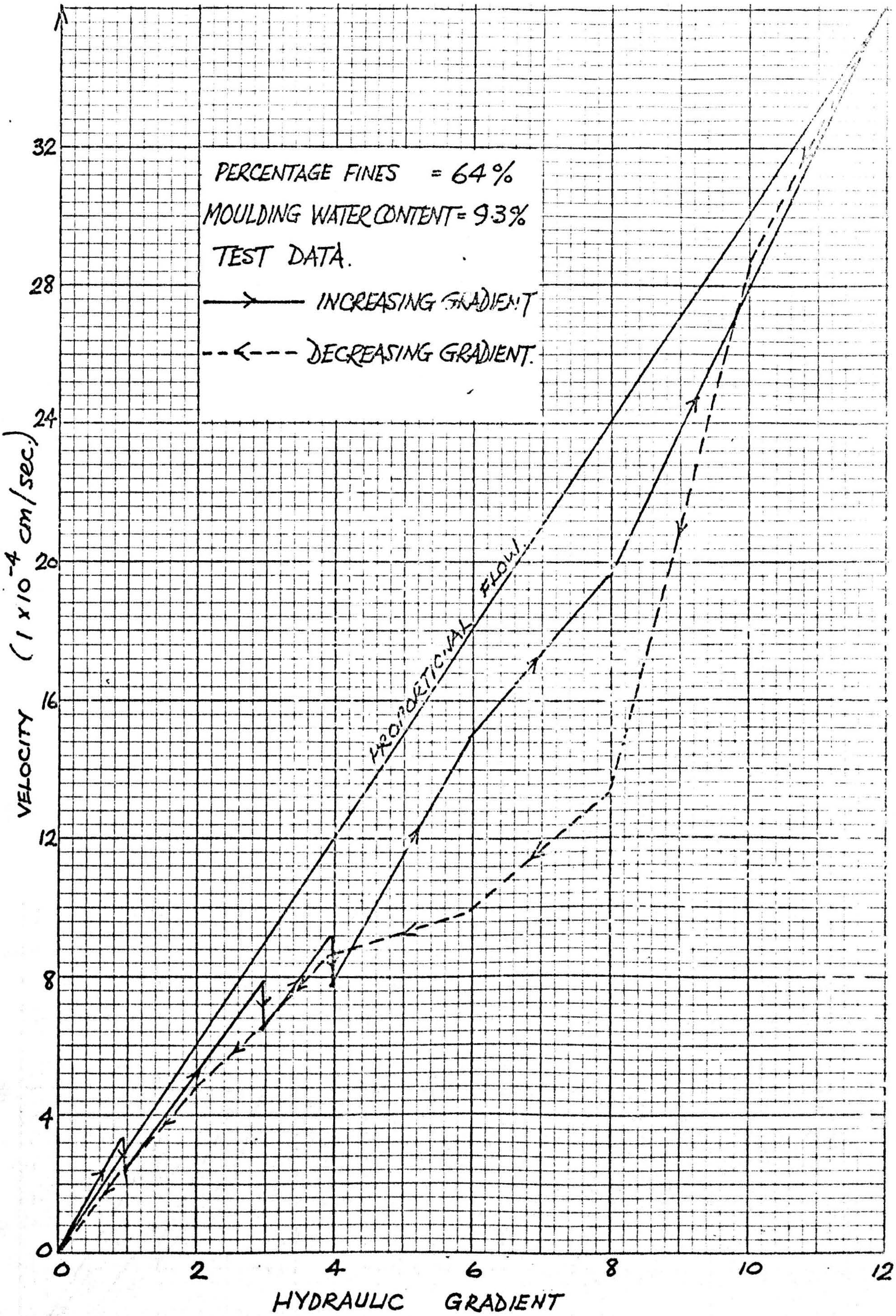


FIG. 7.28. VELOCITY-GRADIENT PLOT FOR 64 PER CENT FINES. COMPACTED DRY OF OPTIMUM (AFTER YOUNGER AND LIM, 196

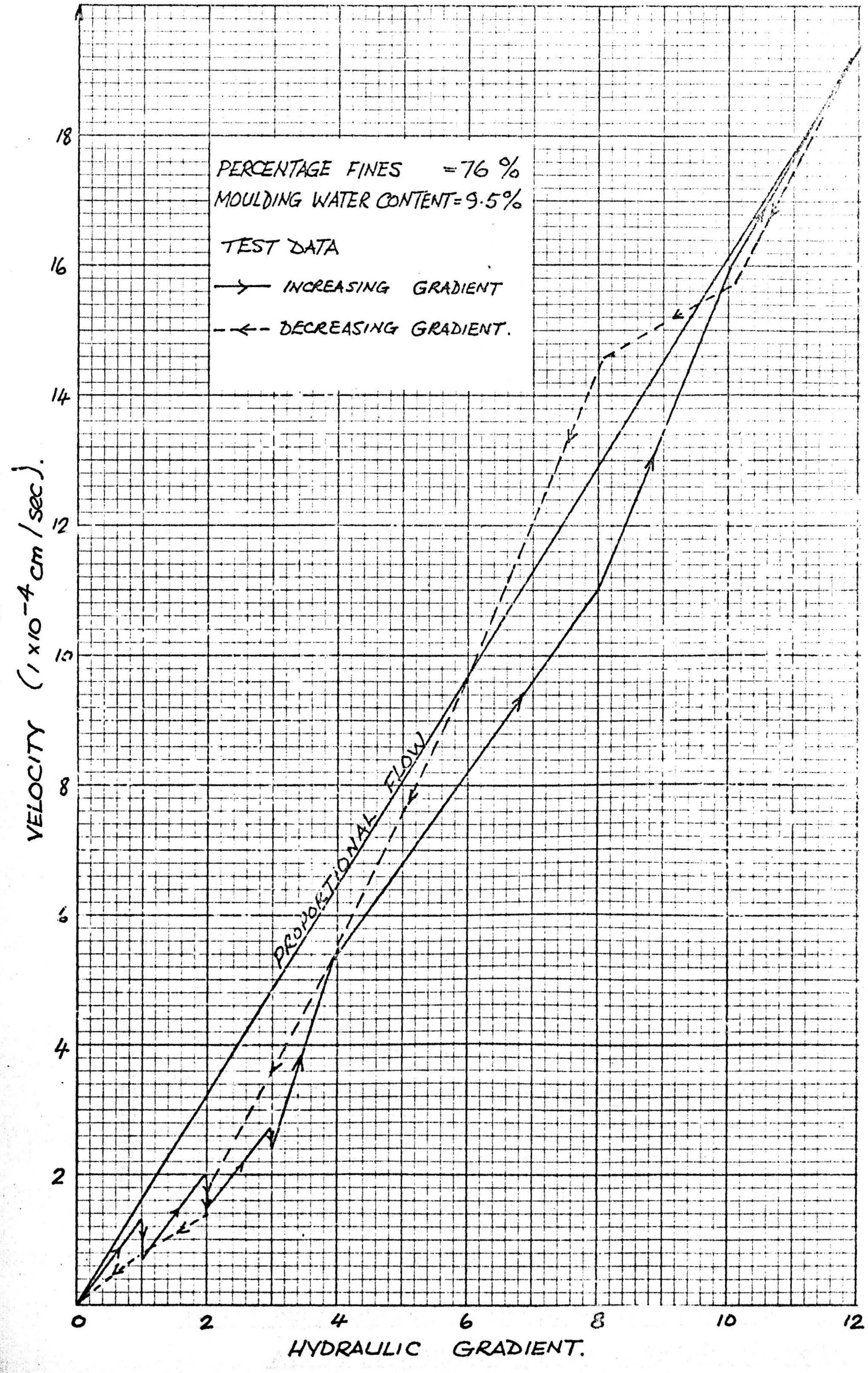


FIG. 7.29. VELOCITY GRADIENT PLOT FOR 76 PER CENT FINES COMPACTED DRY OF OPTIMUM (AFTER YOUNGER AND LIM, 1969).

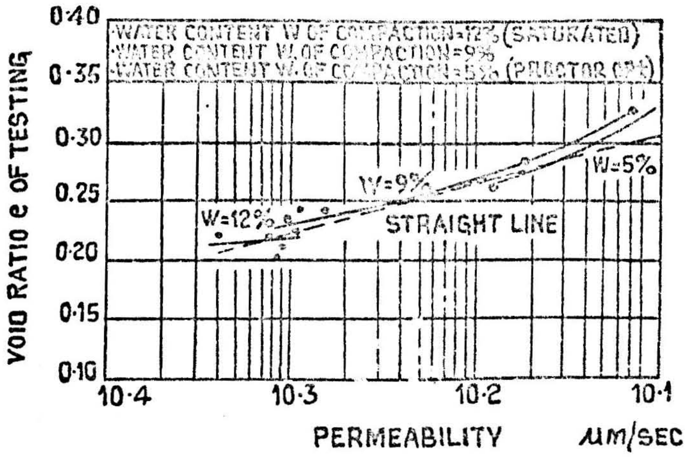


FIG 7.30 RELATION BETWEEN WATER CONTENT AT COMPACTION AND PERMEABILITY OF SANDY MORAINES (BERNELL, 1957.)

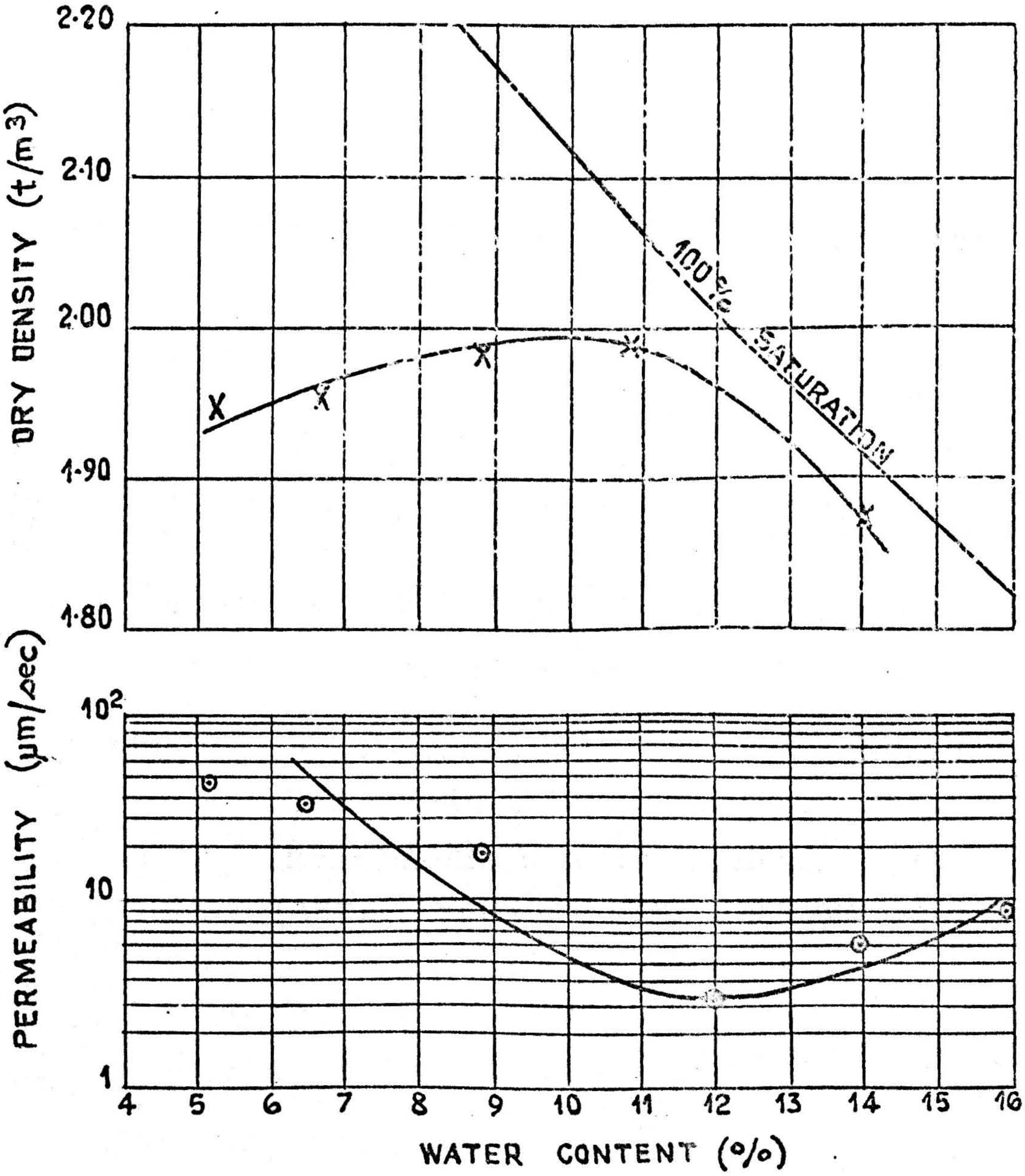


FIG.7.31. RELATIONSHIP BETWEEN WATER CONTENT DRY DENSITY AND PERMEABILITY FOR COWAL TILL (65% FINES)

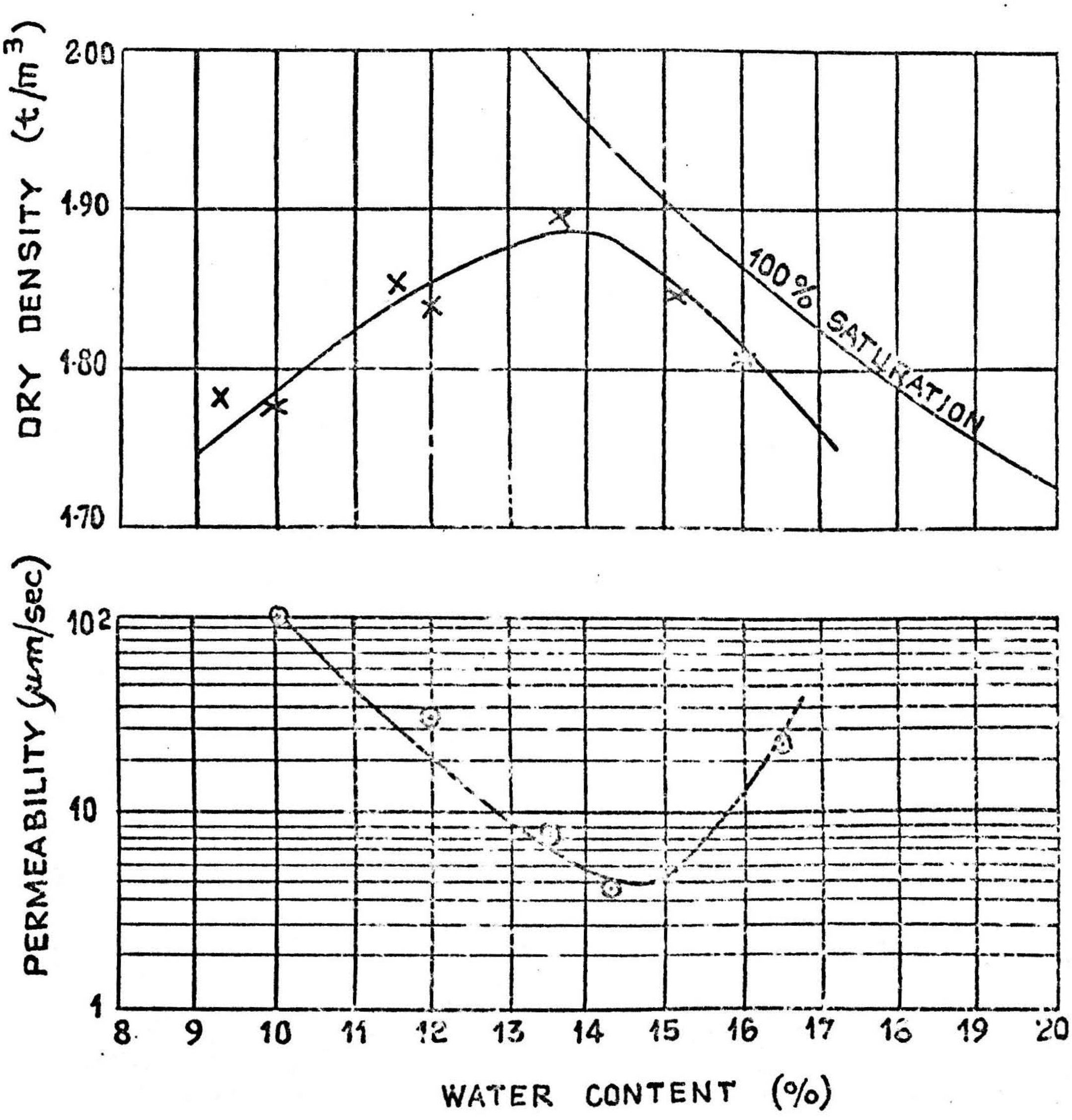


FIG 7·32 RELATIONSHIP BETWEEN WATER CONTENT, DRY DENSITY AND PERMEABILITY FOR BACKWATER TILL (46% FINES)

(AFTER YOUNGER AND LIM, 1969.

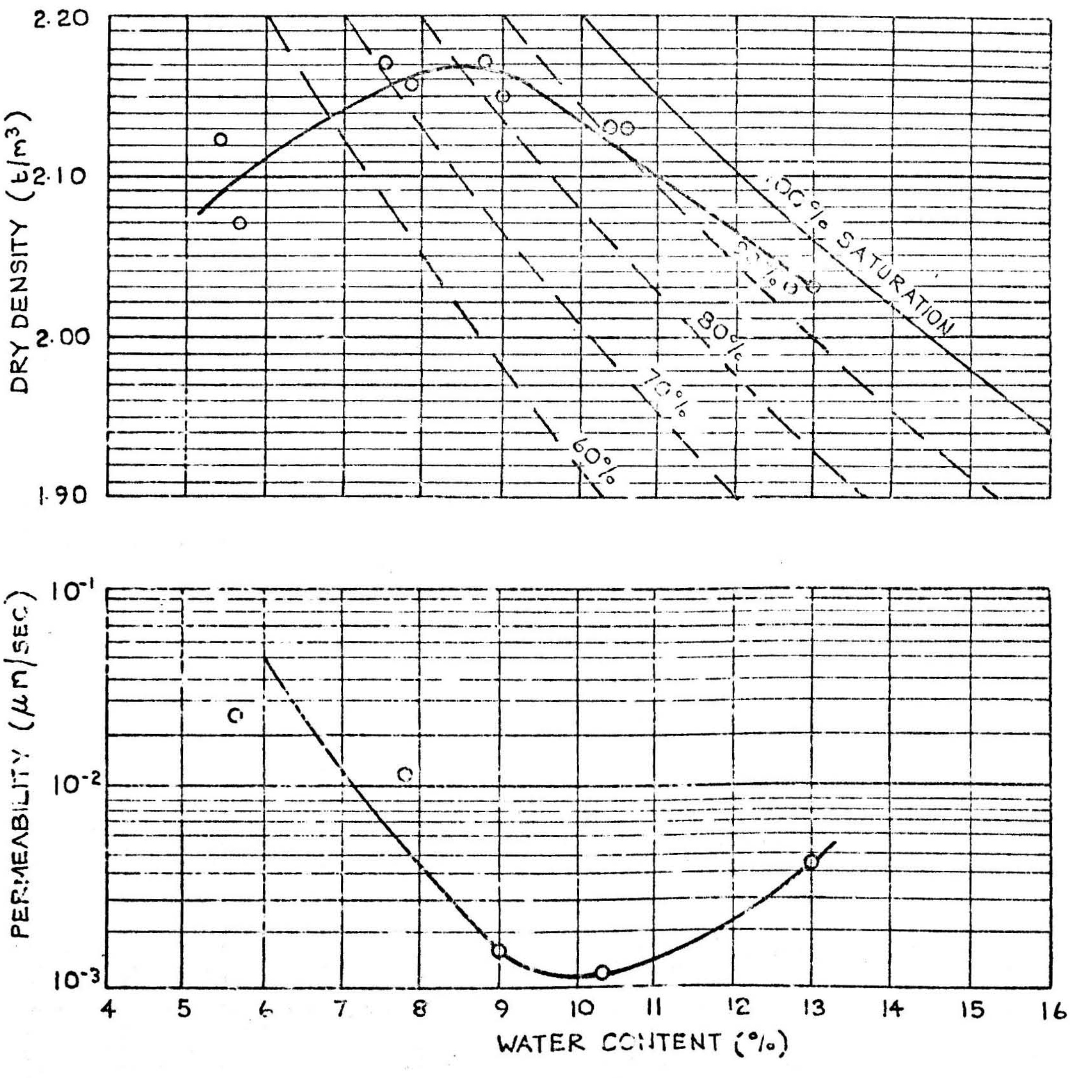


FIG. 7.33 RELATIONSHIP BETWEEN WATER CONTENT, DRY DENSITY AND PERMEABILITY FOR AKERSVATN DAM, NORWAY (SANDE, 1973)

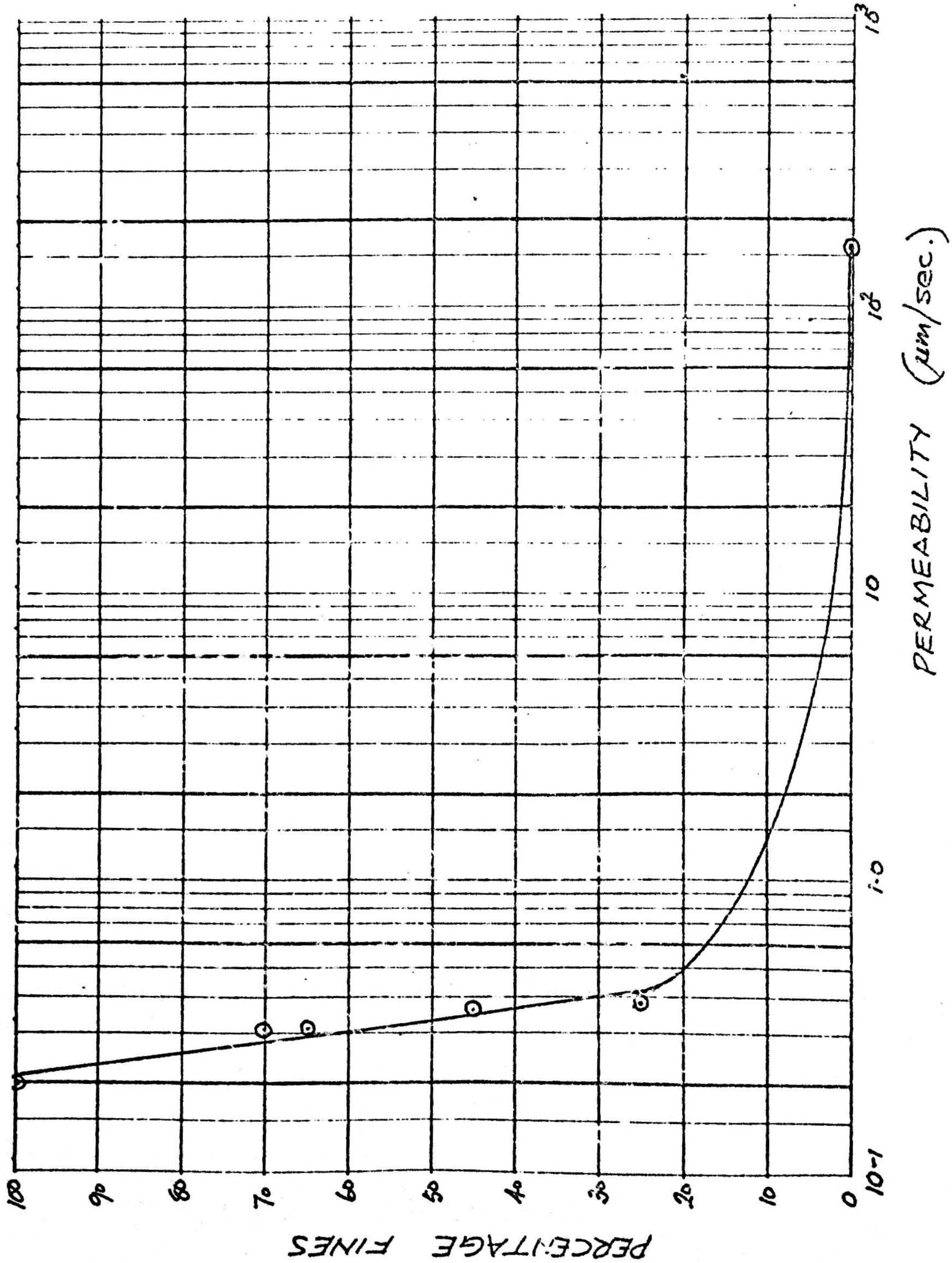


FIG. 7.34. RELATIONSHIP BETWEEN PERCENTAGE FINES AND PERMEABILITY FOR COWAL TILL.

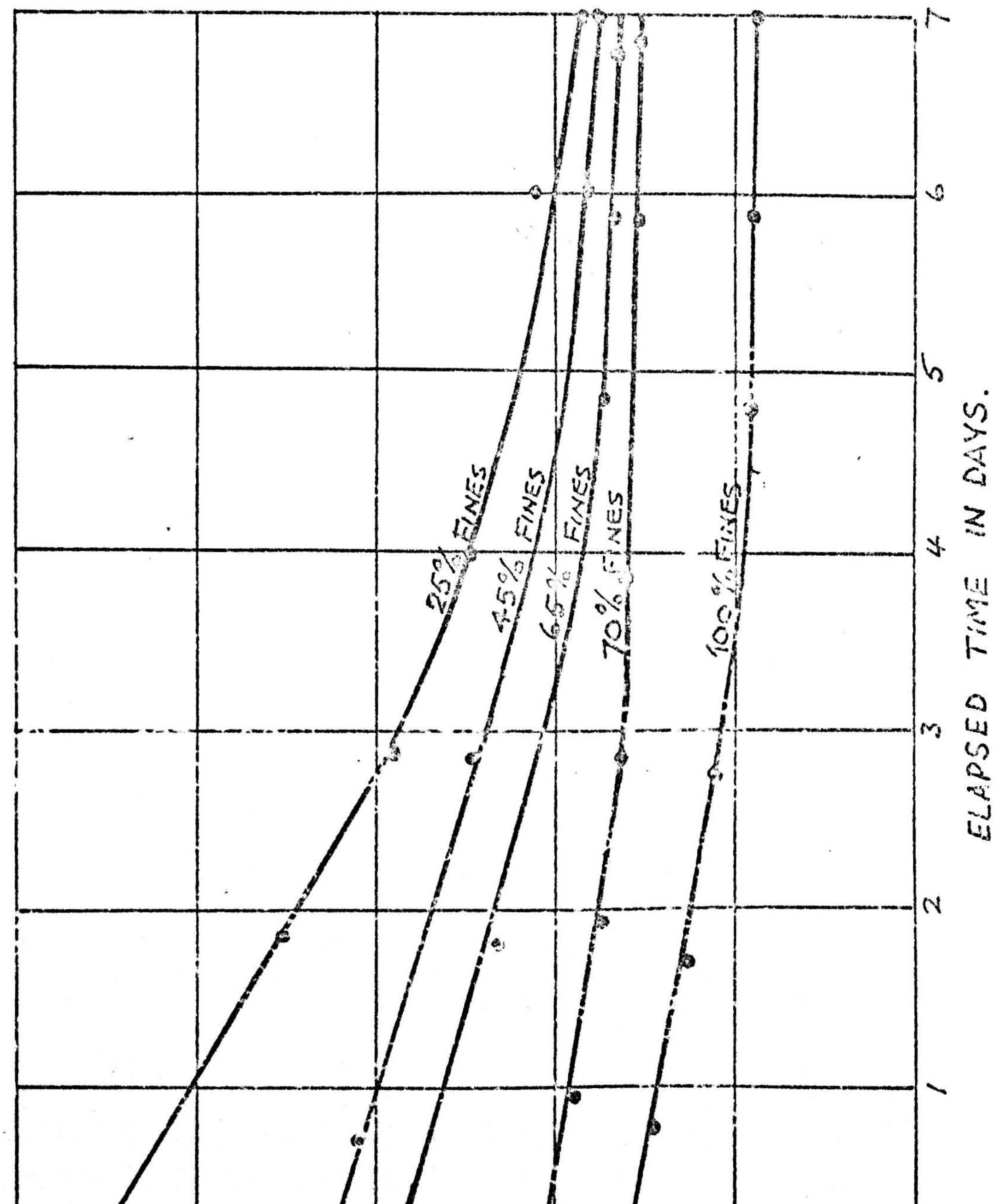


FIG 7.35. PERMEABILITY-TIME VARIATIONS IN COWAL TILL

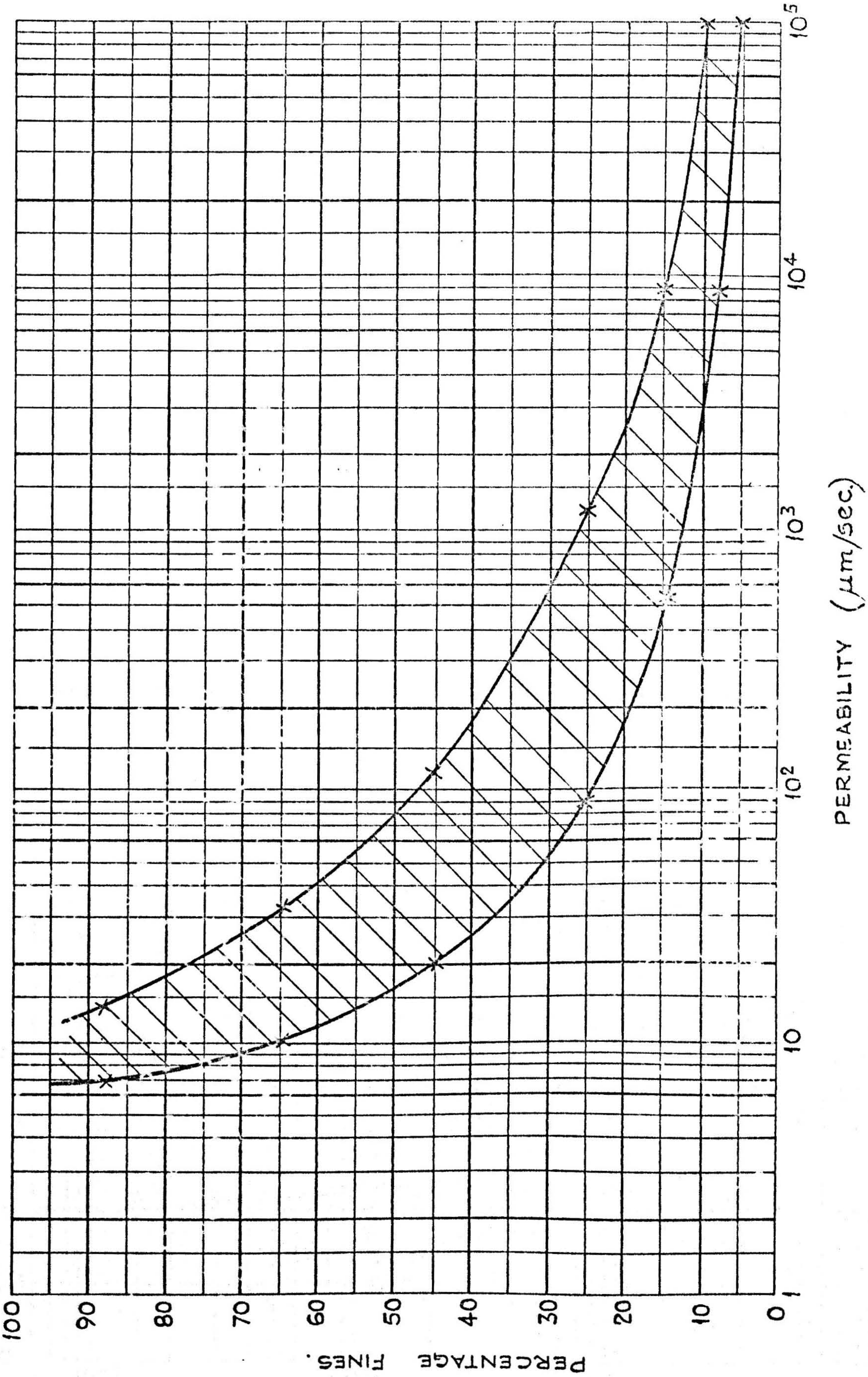


FIG. 7.36. FULL RANGE OF PERMEABILITY PERCENTAGE FINES RELATIONSHIP FOR BACKWATER TILLS TESTED BY YOUNGER AND LIM (1969).

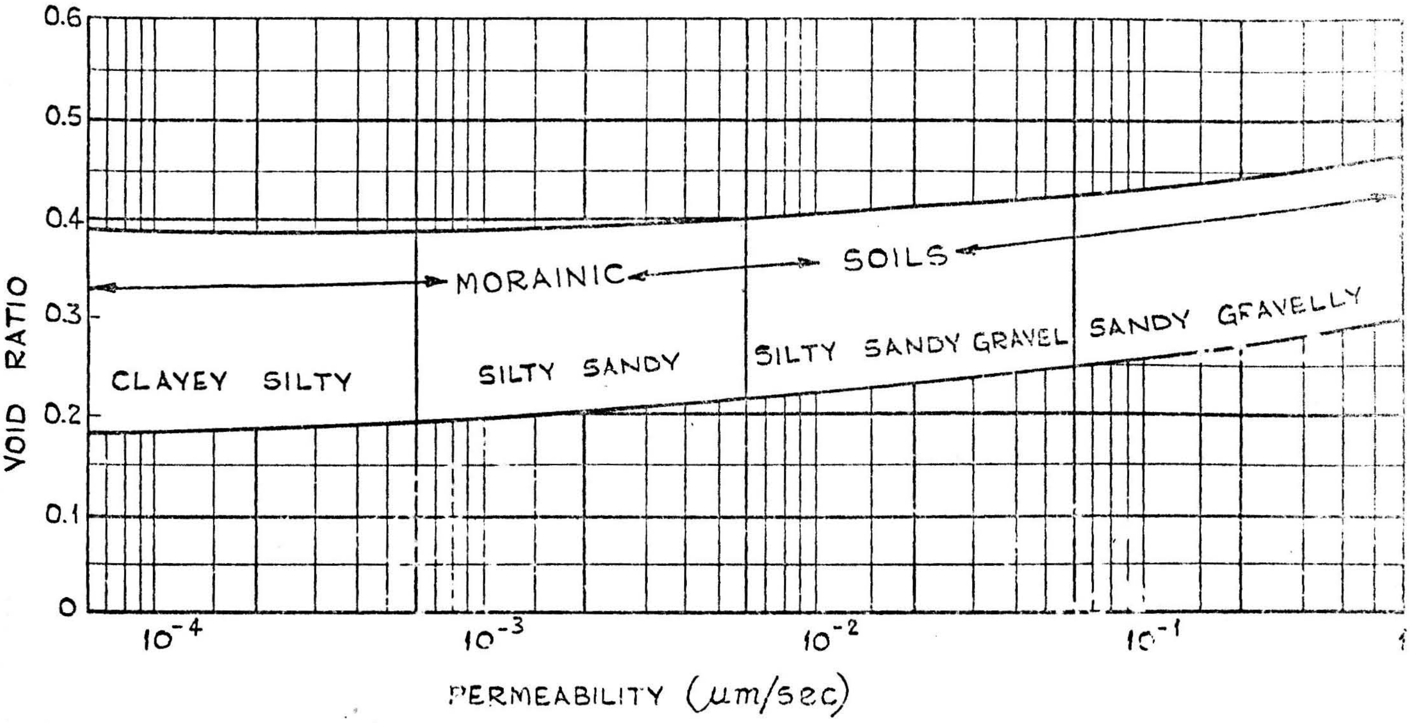


FIG. 7.37 RELATION BETWEEN VOID RATIO AND PERMEABILITY OF MORAINIC SOILS (AFTER BERNELL, 1957)

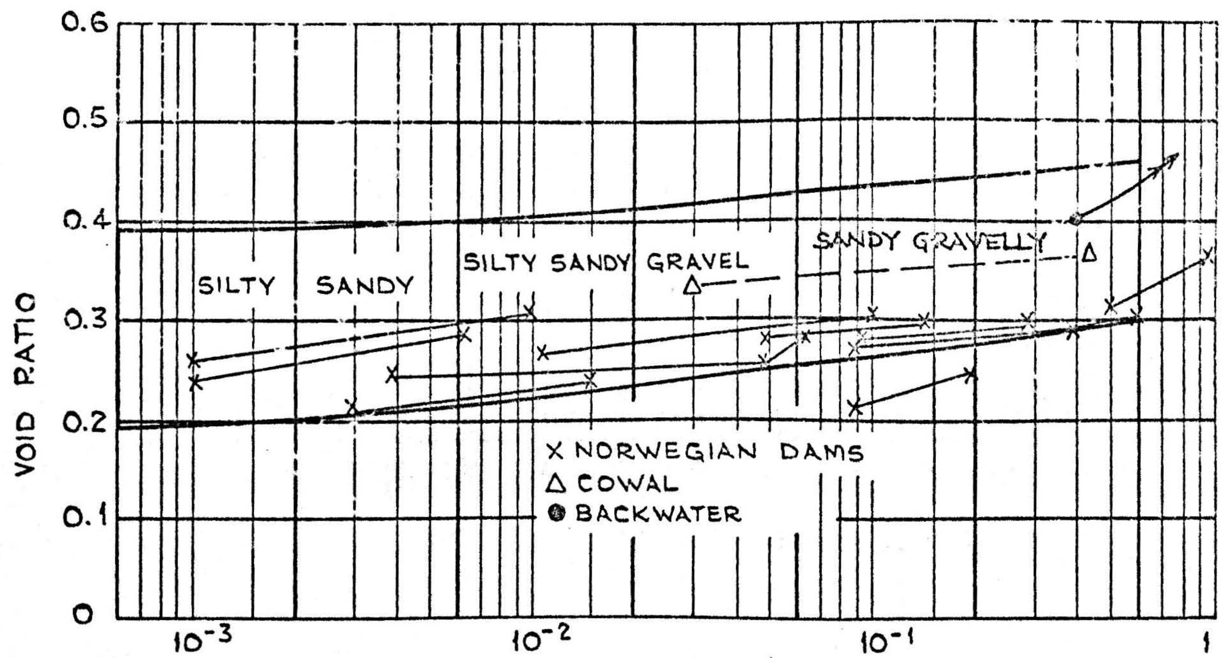


FIG. 7.38 RELATIONSHIP BETWEEN VOID RATIO AND PERMEABILITY FOR VARIOUS TILLS.

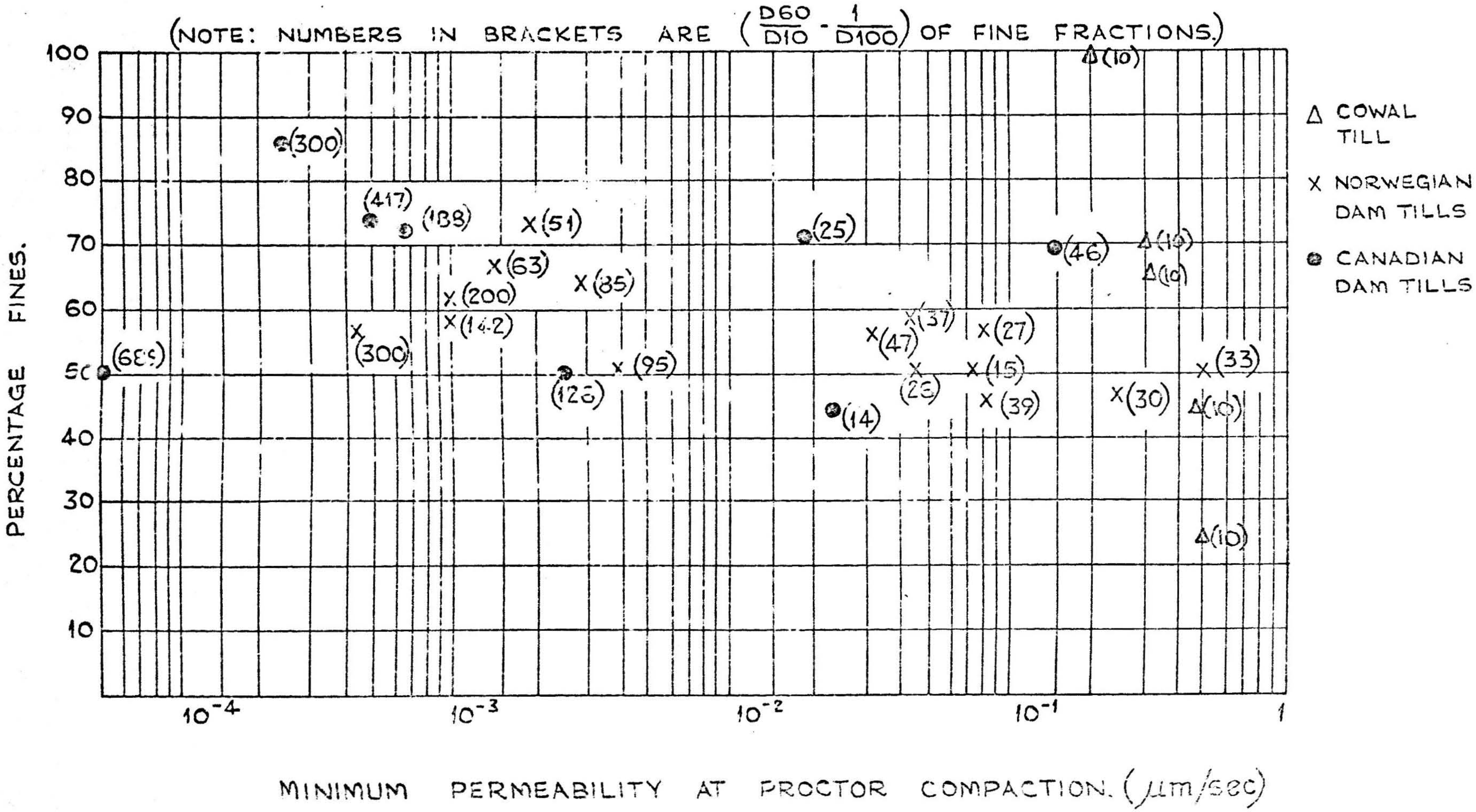


FIG. 7.39. PLOT OF PERCENTAGE FINES – MINIMUM PERMEABILITY AT PROCTOR COMPACTION FOR COWAL, NORWEGIAN AND CANADIAN TILLS.

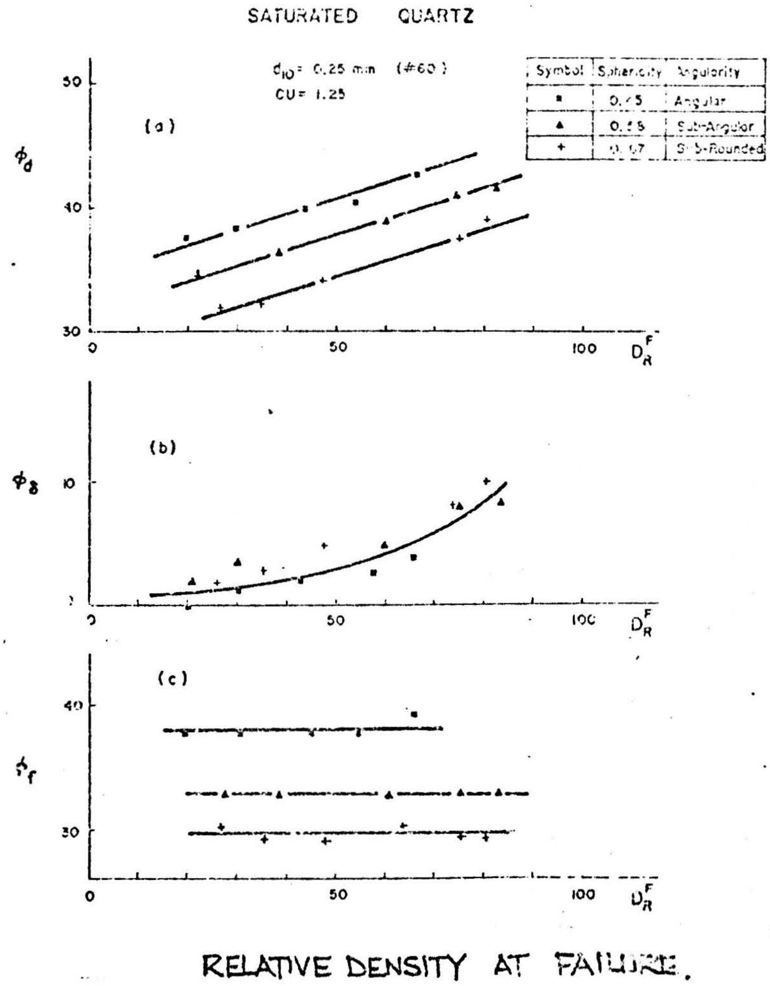


FIG. 7.40 THE EFFECT OF PARTICLE SHAPE.
(KOERNER, 1970a).

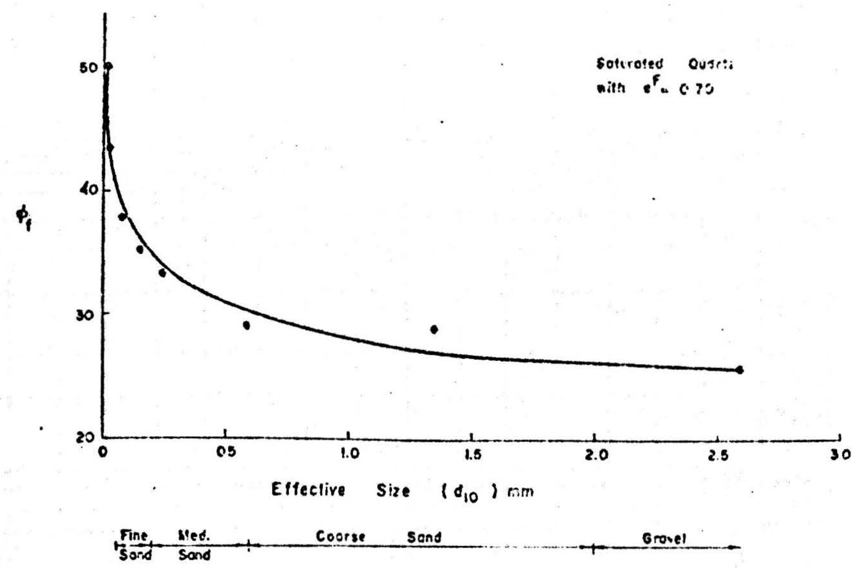


FIG. 7.41. THE EFFECT OF PARTICLE SIZE
(KOERNER 1970a)

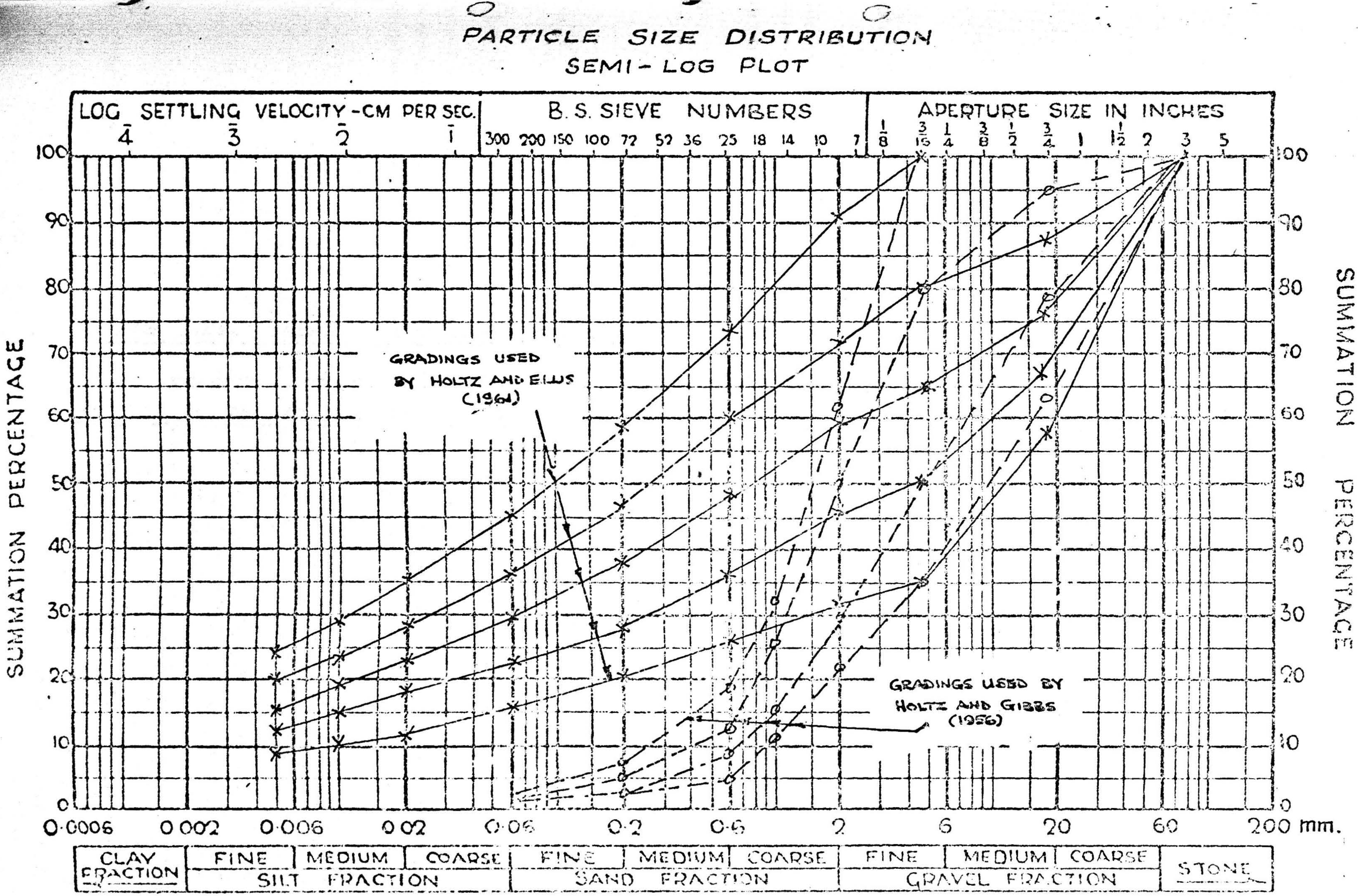
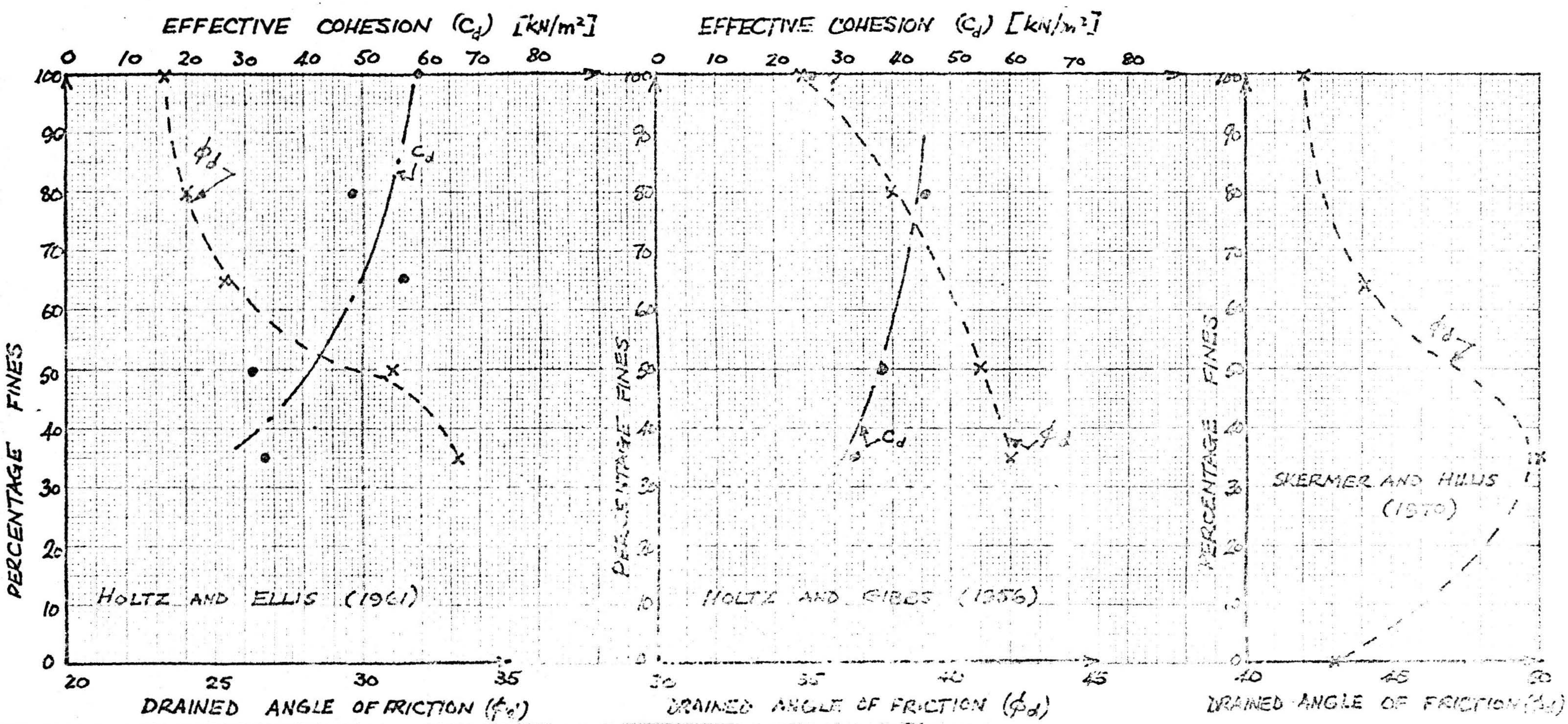


FIG. 7.42. GRADINGS USED BY HOLTZ AND GIBBS (1956) AND HOLTZ AND ELLIS (1961).

FIG. 7.43. SHEAR STRENGTH - GRADATIONAL RELATIONSHIP FOR SOME SOIL MIXTURES.



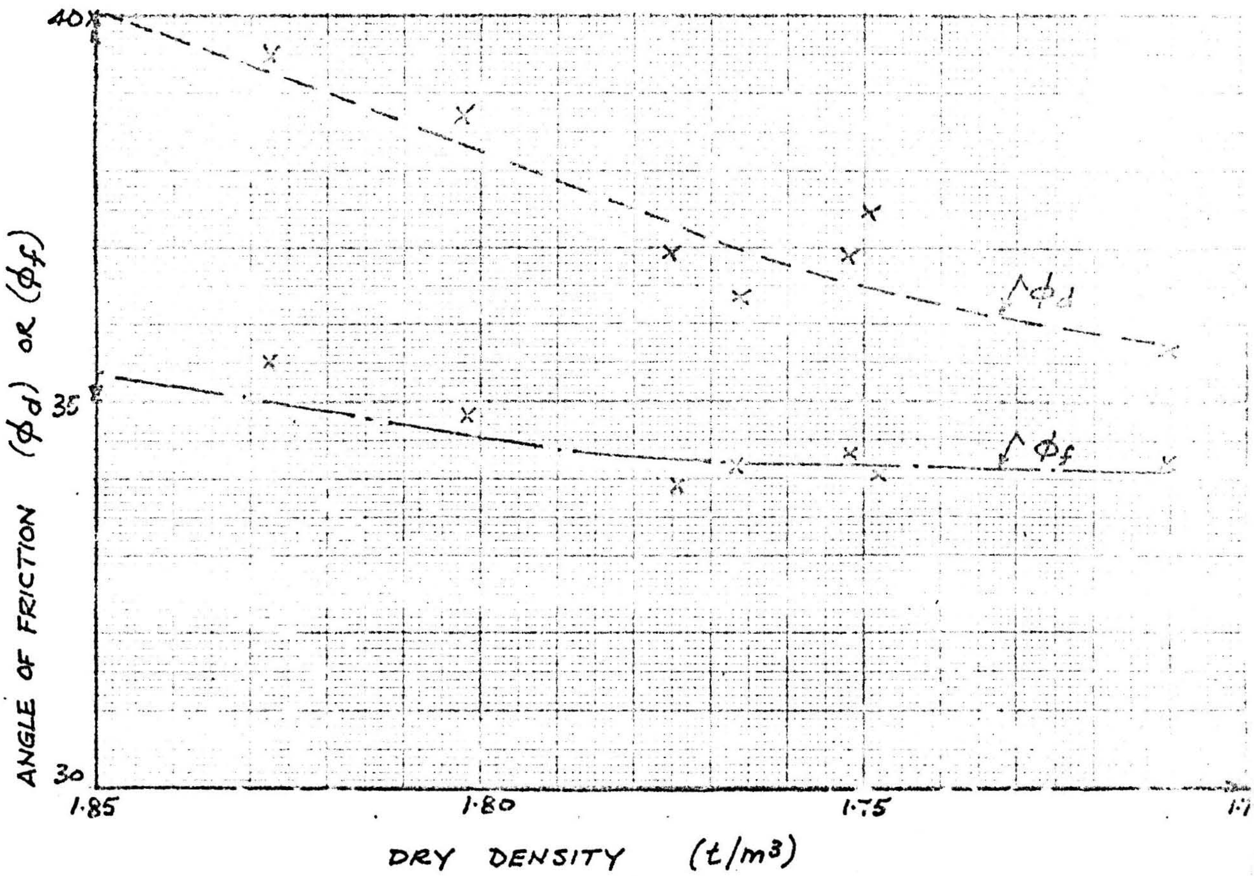


FIG. 7. 44. DRY DENSITY – SHEAR STRENGTH PLOT FOR COWAL TILL.

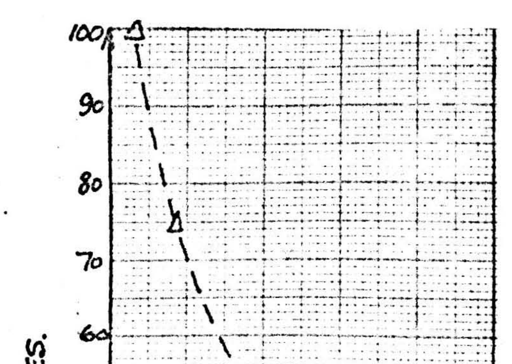
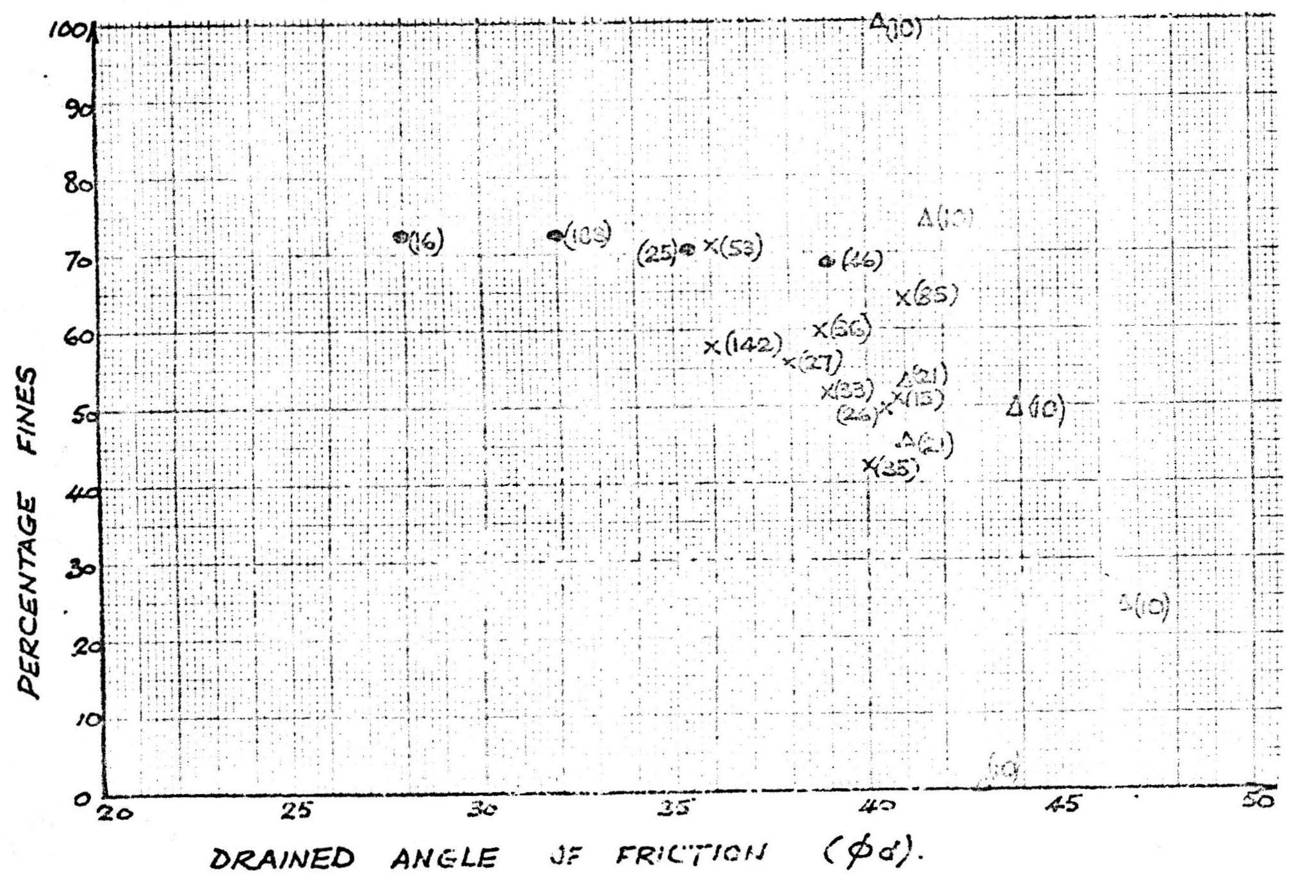


FIG. 7.45 PERCENTAGE FINES – SHEAR STRENGTH PLOT FOR COWALTILL.

FIG. 7.46. PERCENTAGE FINES – SHEAR STRENGTH RELATIONSHIP FOR SOME TILLS.



NOTE: NUMBERS IN BRACKETS ARE $\left(\frac{D_{60}}{D_{10}} \cdot \frac{1}{D_{100}}\right)$ OF FINE FRACTIONS.

PLATES

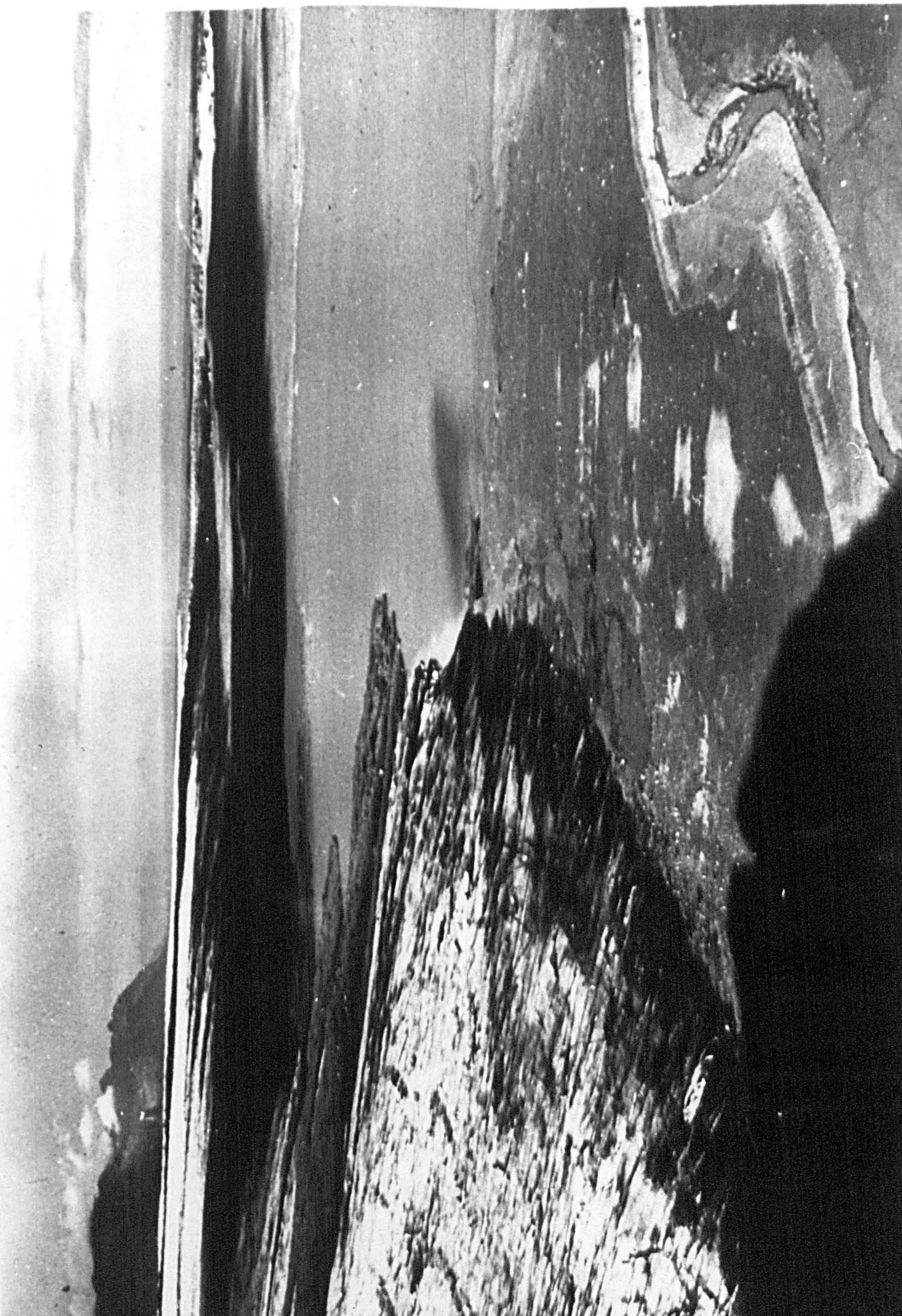


PLATE 4:1 VIEW OF BREIDA MERKURJOKULL AND BREIDA MERKUSANDUR, SOUTH EAST ICELAND.

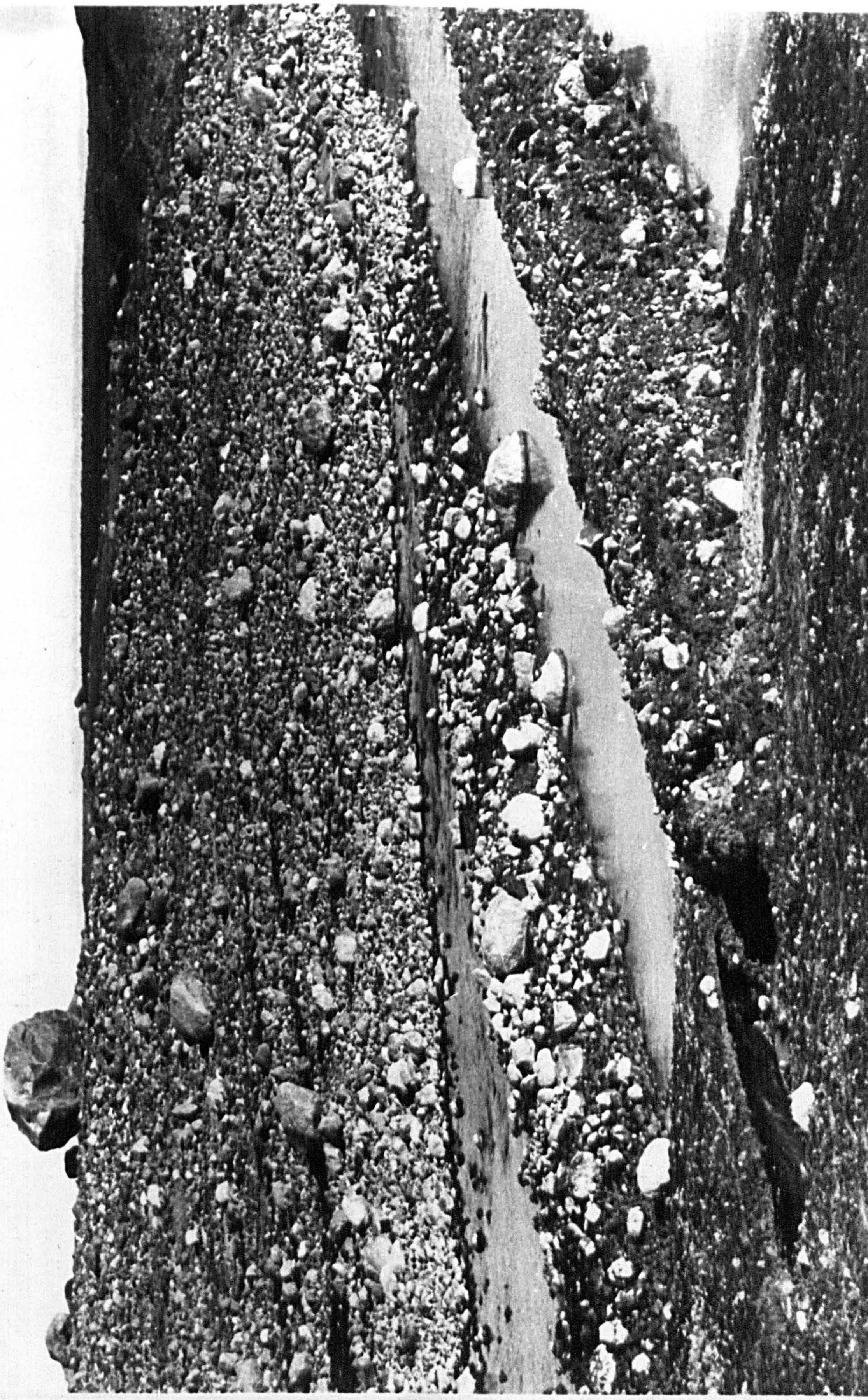


PLATE 4.2 FLUTED TILL, CENTRAL BREIDA, SHOWING FLUTE ENTERING SUBGLACIAL GROOVE (FOREGROUND).

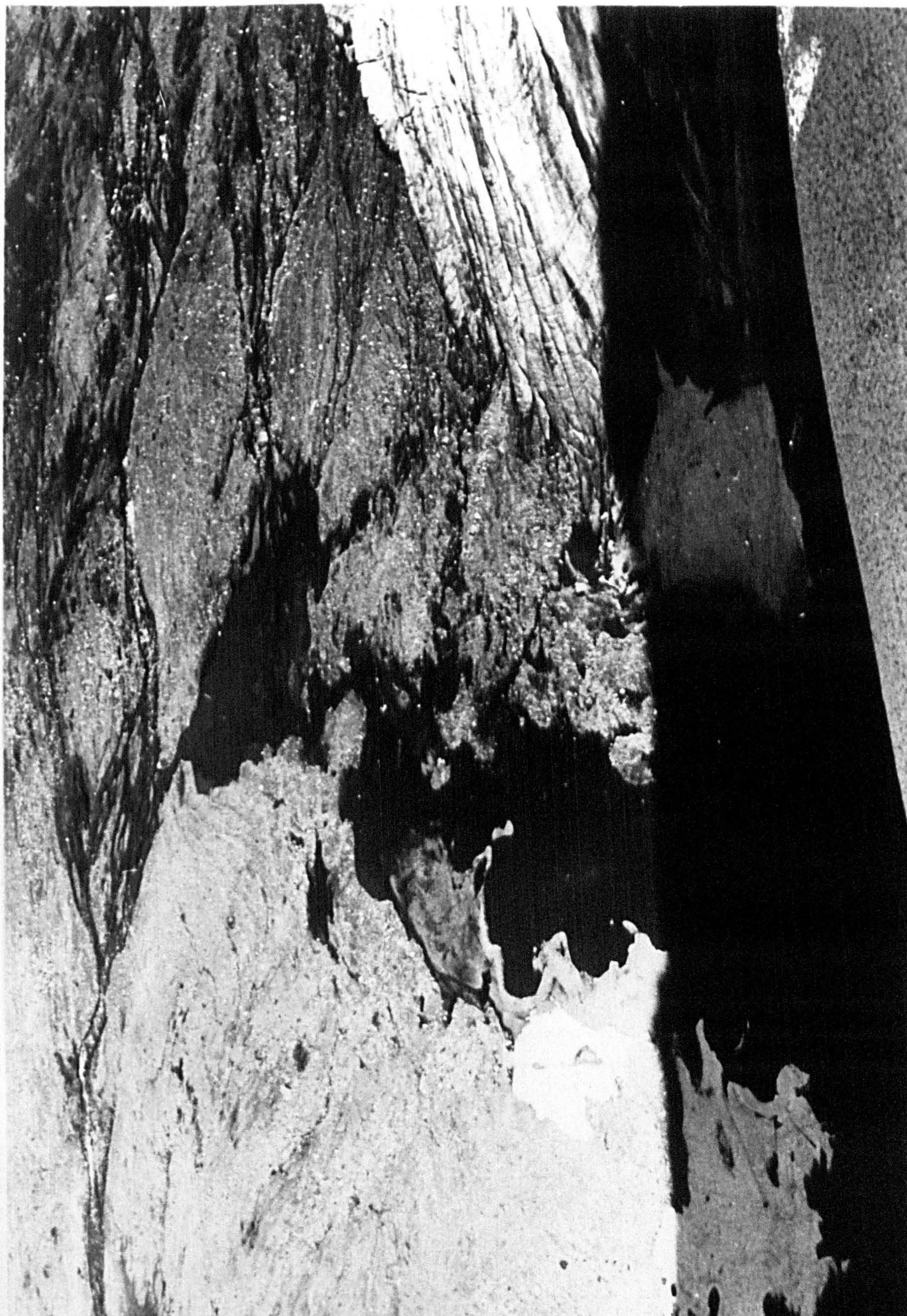


PLATE 4.3 PROGLACIAL AREA OF BLAISEN, SOUTHERN NORWAY.

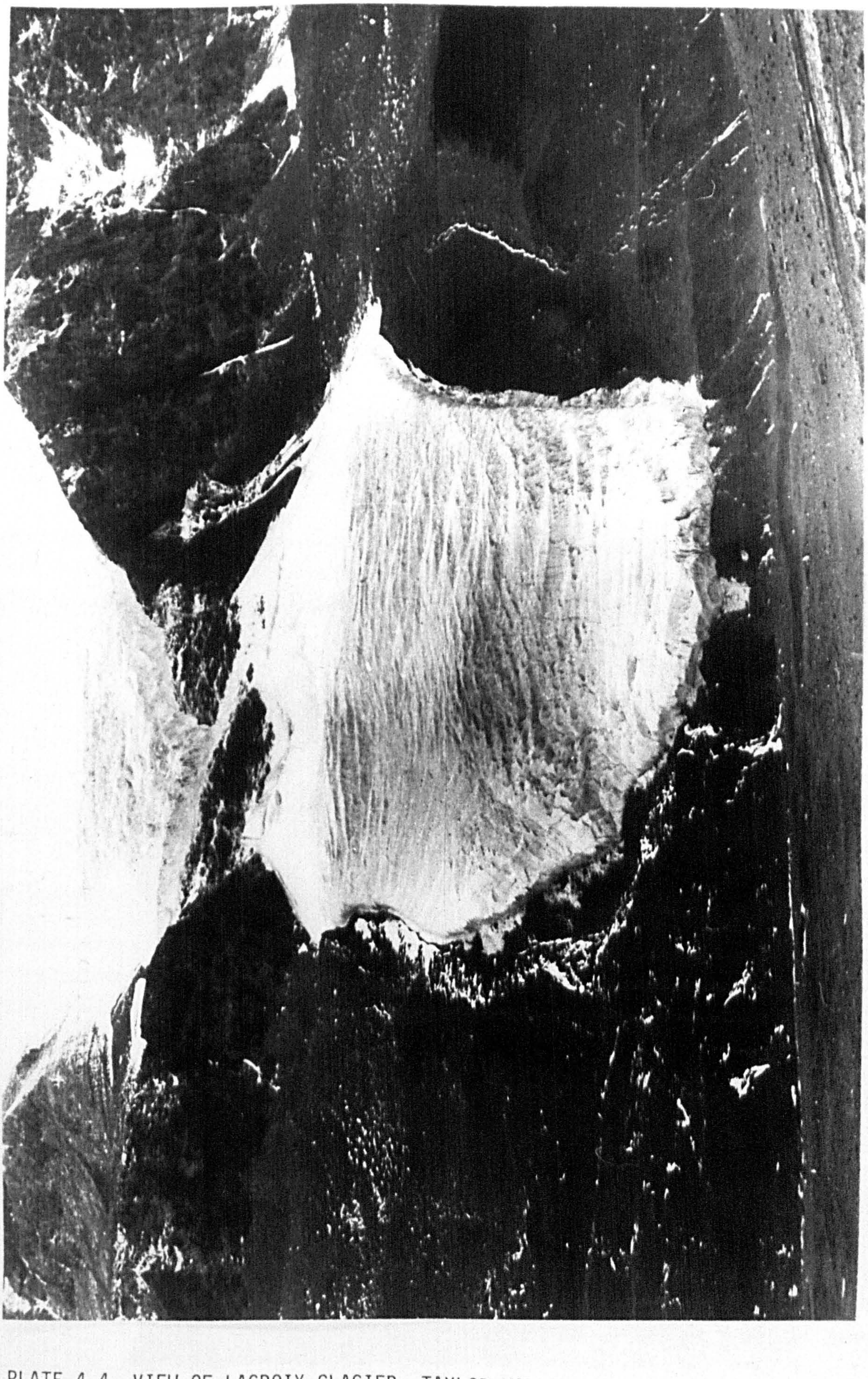


PLATE 4.4 VIEW OF LACROIX GLACIER, TAYLOR VALLEY, ANTARCTICA.

PLATE 4.5 EAST EDGE OF SNOUT OF LACROIX GLACIER, VIEW TOWARDS N.N.W.

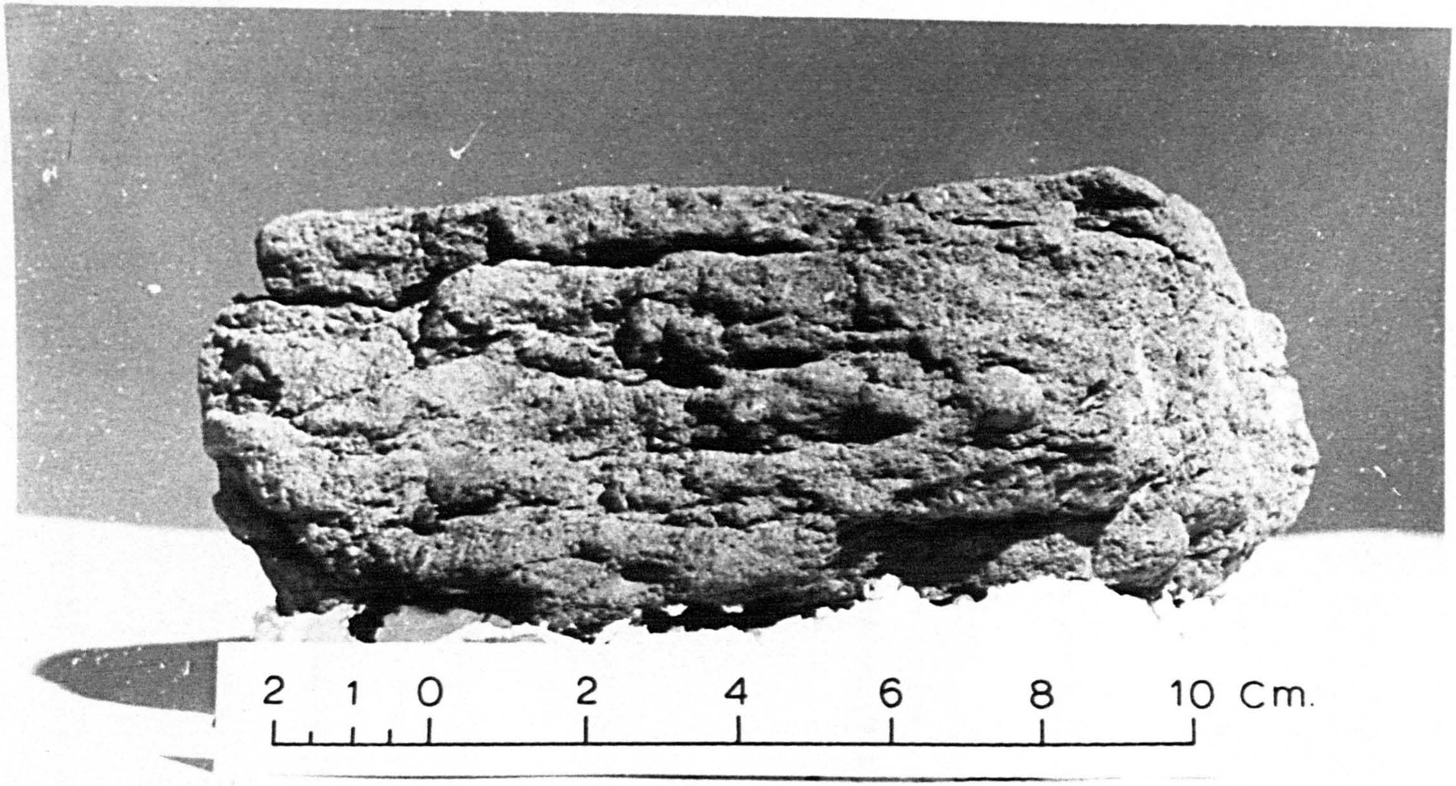


PLATE 4.6 ANTARCTIC TILL, ORIENTATED SAMPLE, VIEWING SOUTH

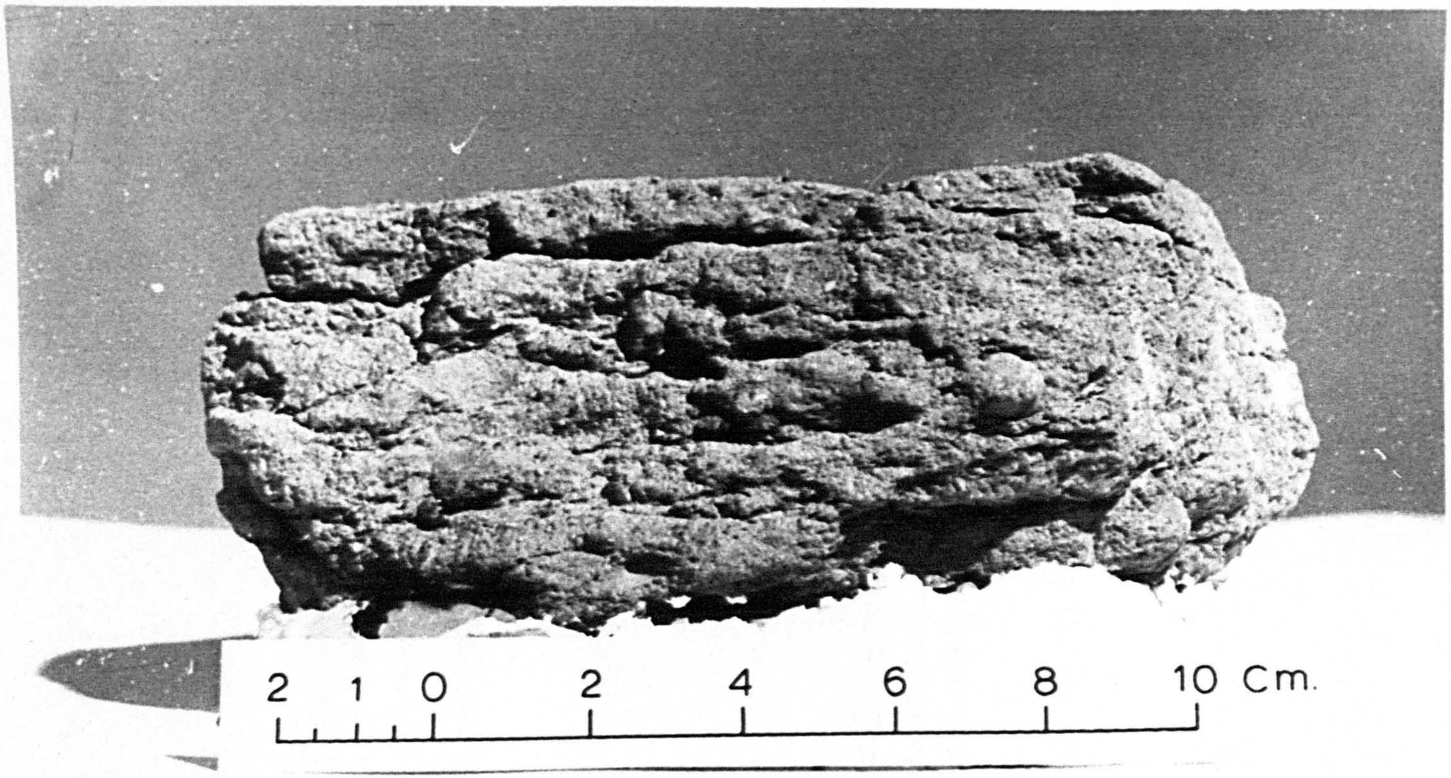


PLATE 4.6 ANTARCTIC TILL, ORIENTATED SAMPLE, VIEWING SOUTH

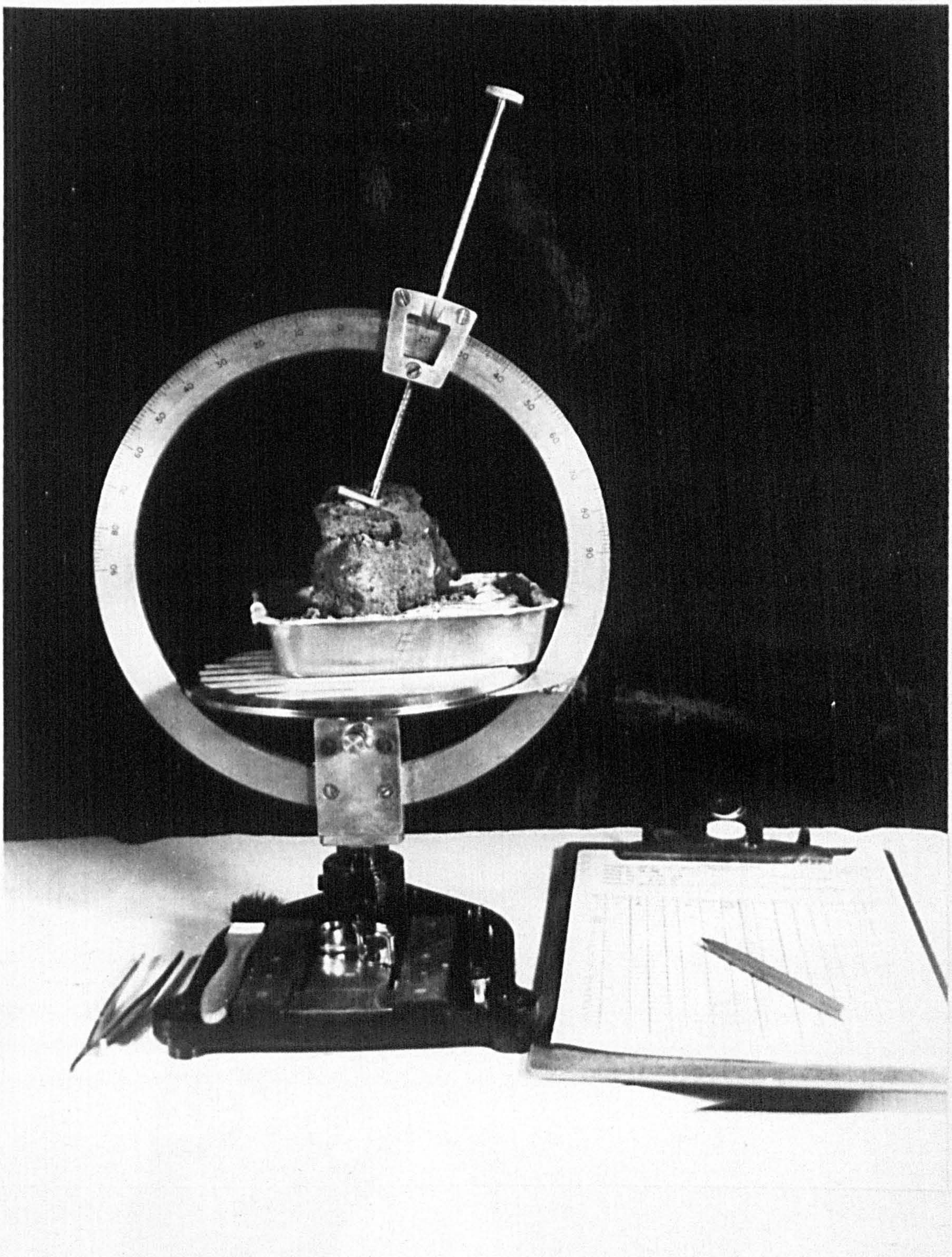


PLATE 6.1 THE LIGHTWEIGHT CONTACT GONIOMETER

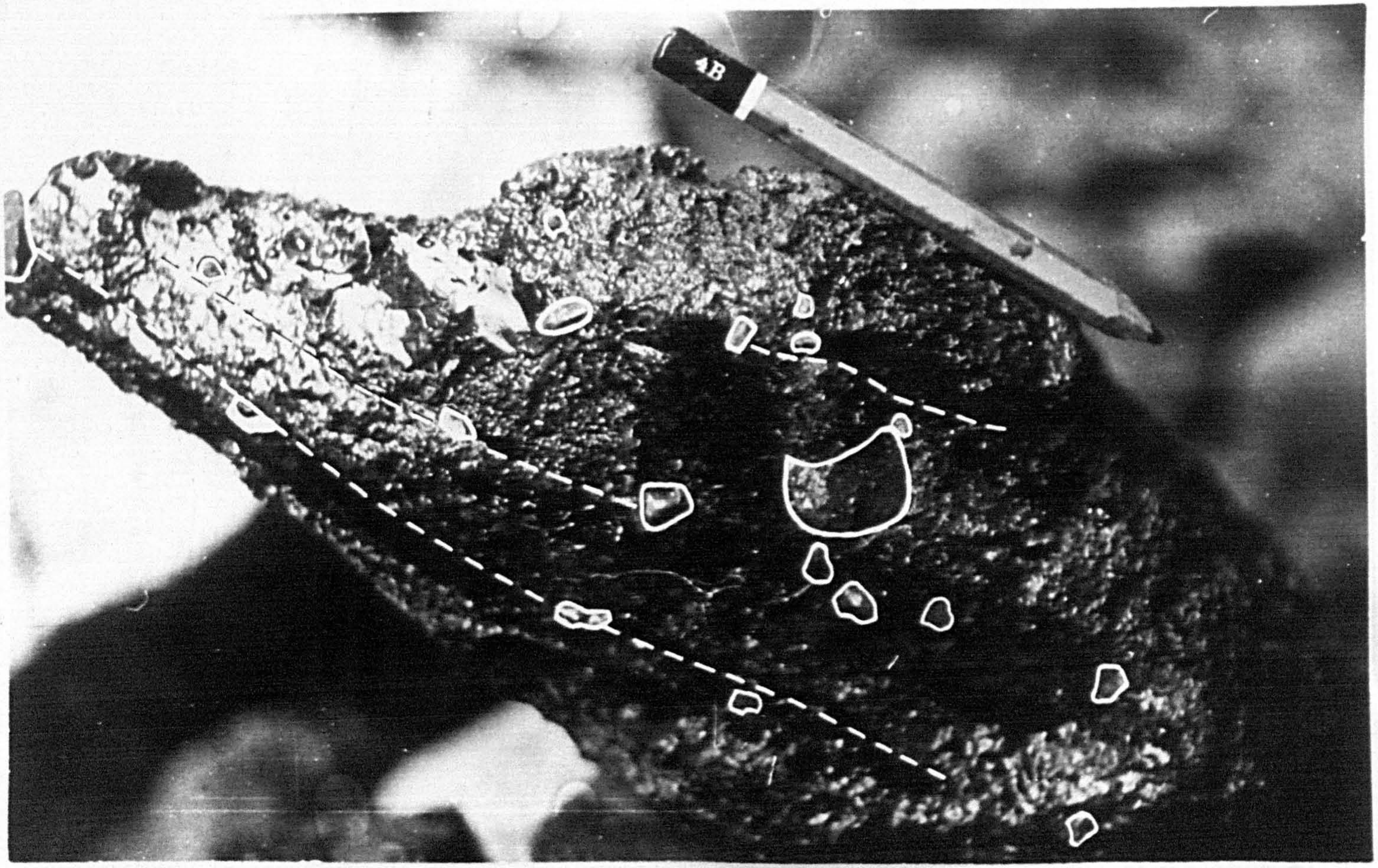


PLATE 6.2 BLOCK OF MELT DEBRIS-RICH ICE WITH CLASTS BEGINNING TO EMERGE.

(Note: Emerging clasts are circled and ice foliations are chain dotted.)

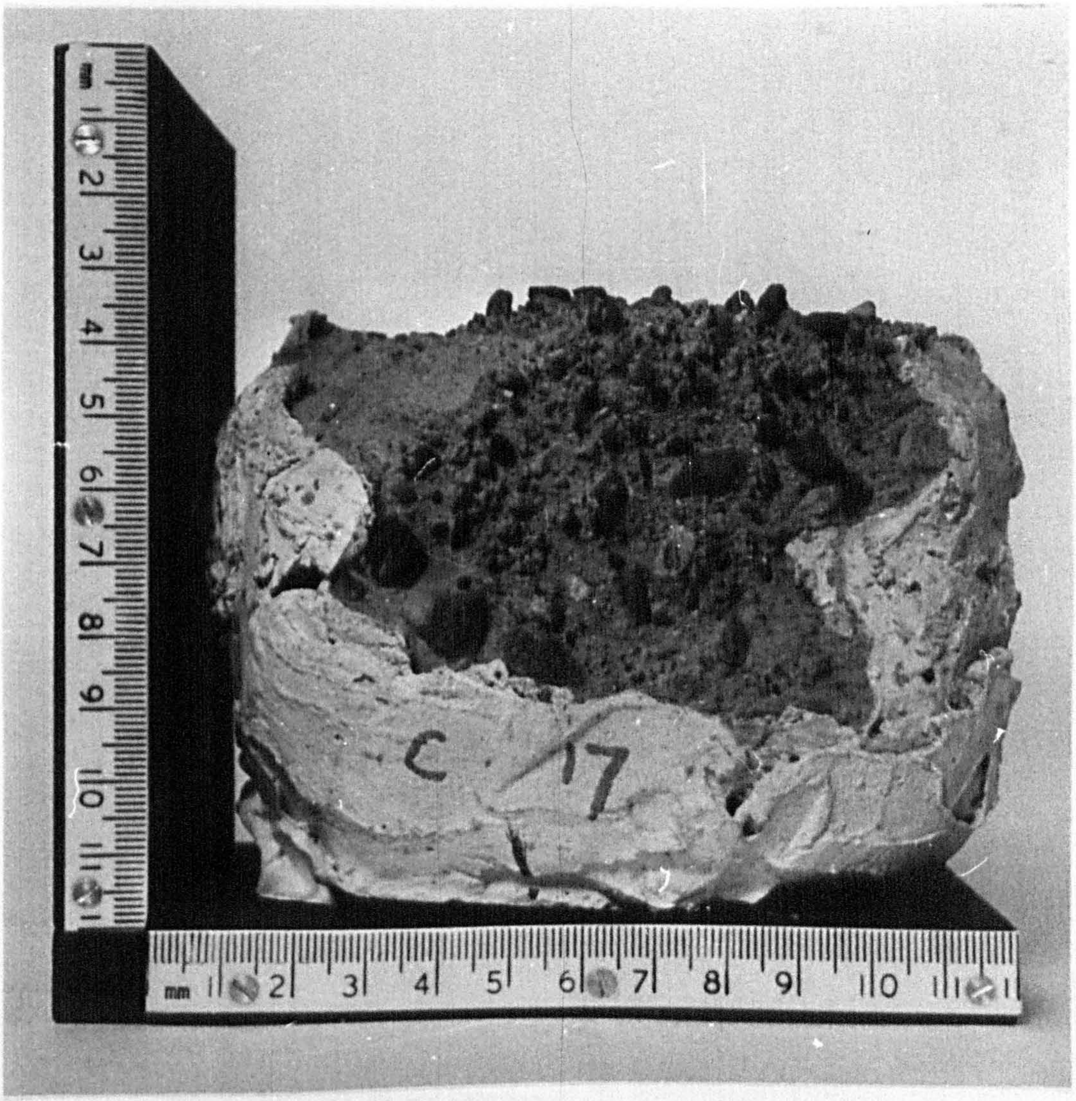


PLATE 6.3 BREIDAMERKURJOKULL SAMPLE BR/C17
LEVELLED WITH PLASTER REMOVED FROM
UPPER SURFACE AND ONE SIDE.

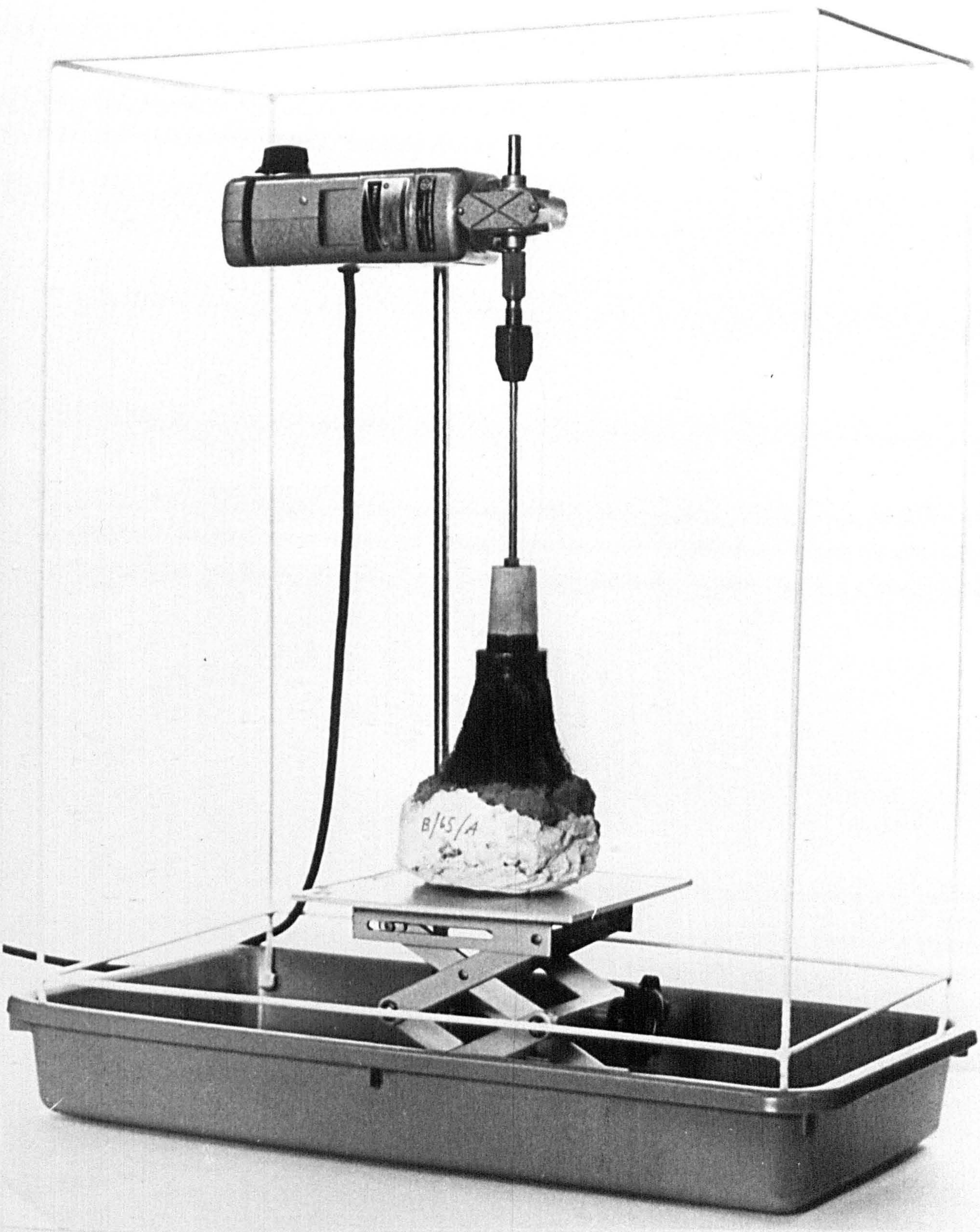


PLATE 6.4 VIEW OF BRUSHING APPARATUS.

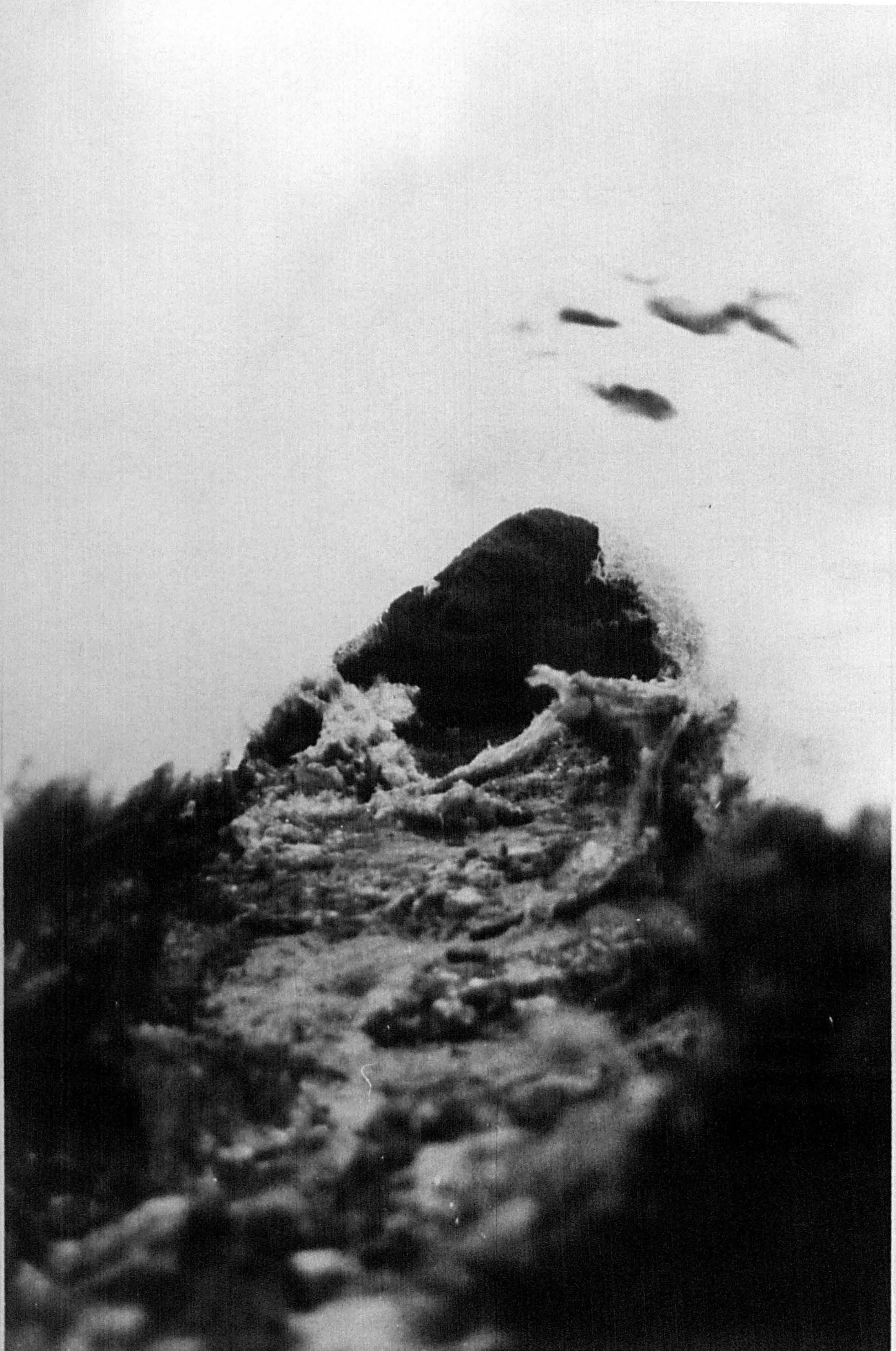


PLATE 6.5 GLACIER SOLE GROOVED BY 1.5 m DIAMETER BOULDER.

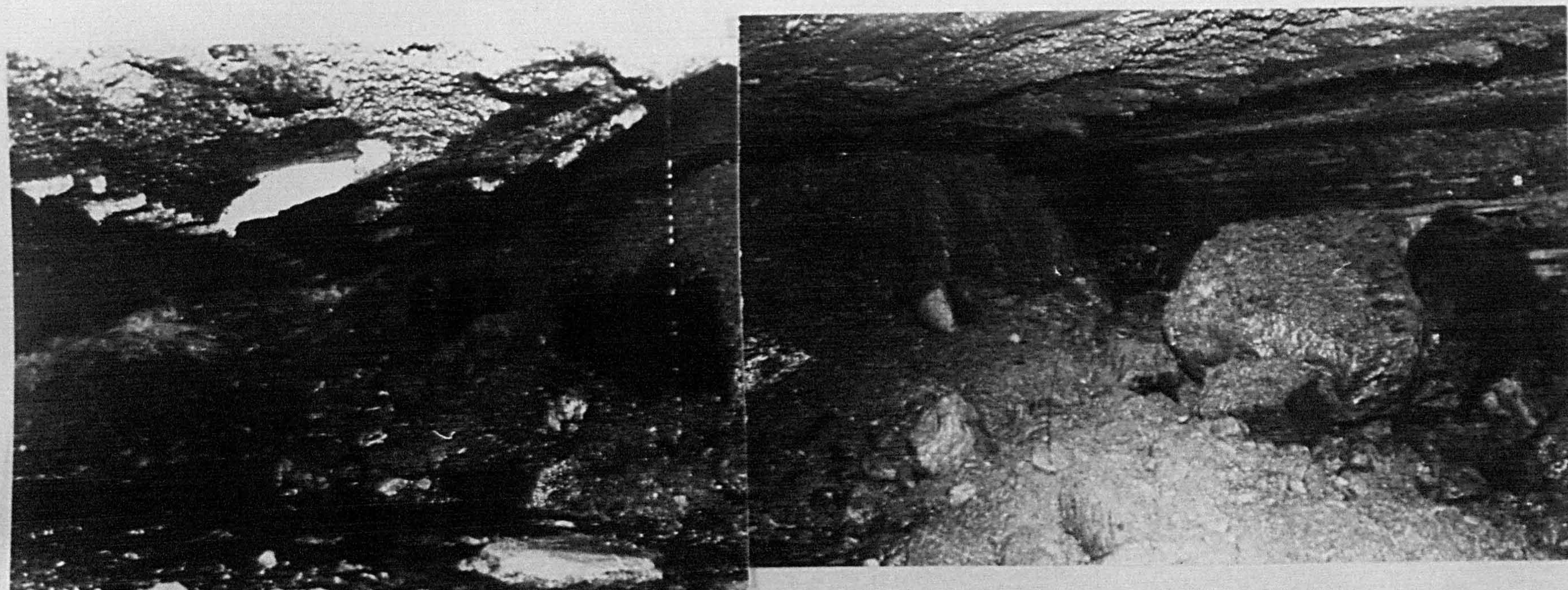


PLATE 6.6 GLACIAL SOLE GROOVED BY ROCHE MOUNTONNEE
40 m INSIDE THE MARGIN OF BLAISEN, NORWAY.

(Note: Regelation ice clusters on left side, recording seventeen sliding events in the range 0.04 to 0.08 m)

PLATE 6.7 A SMALL PUSH MORAINE IN PROCESS OF FORMATION AT THE MARGIN OF BLAISEN, SOUTHERN NORWAY.

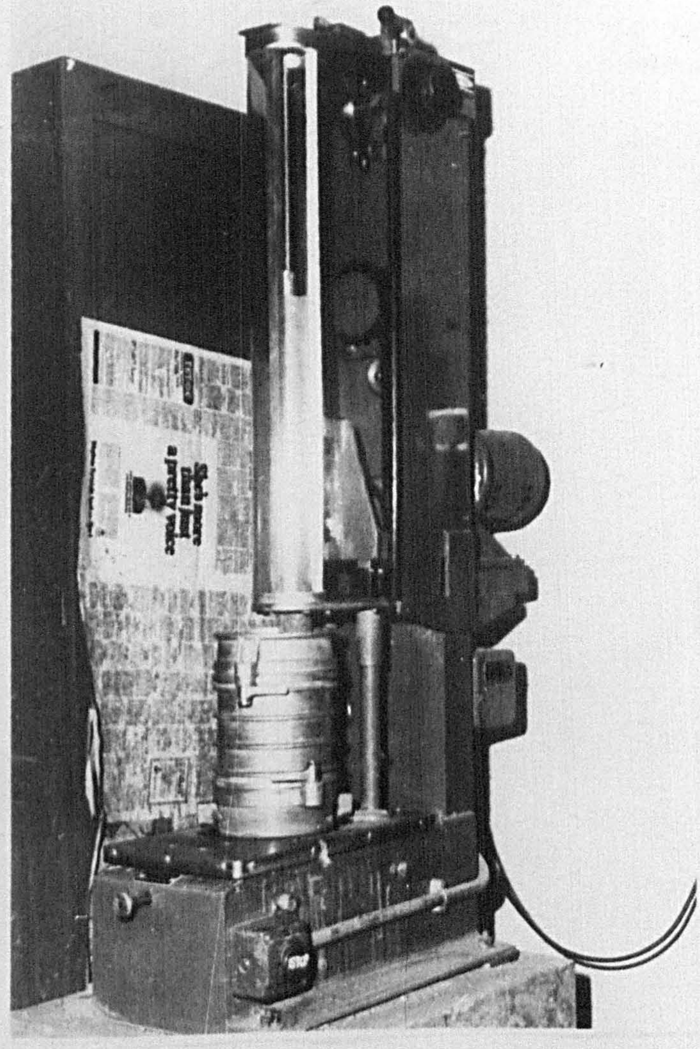


PLATE 7.1 AUTOMATIC COMPACTOR USED FOR TESTS WITH A C.B.R. MOULD FITTED TO BASE.

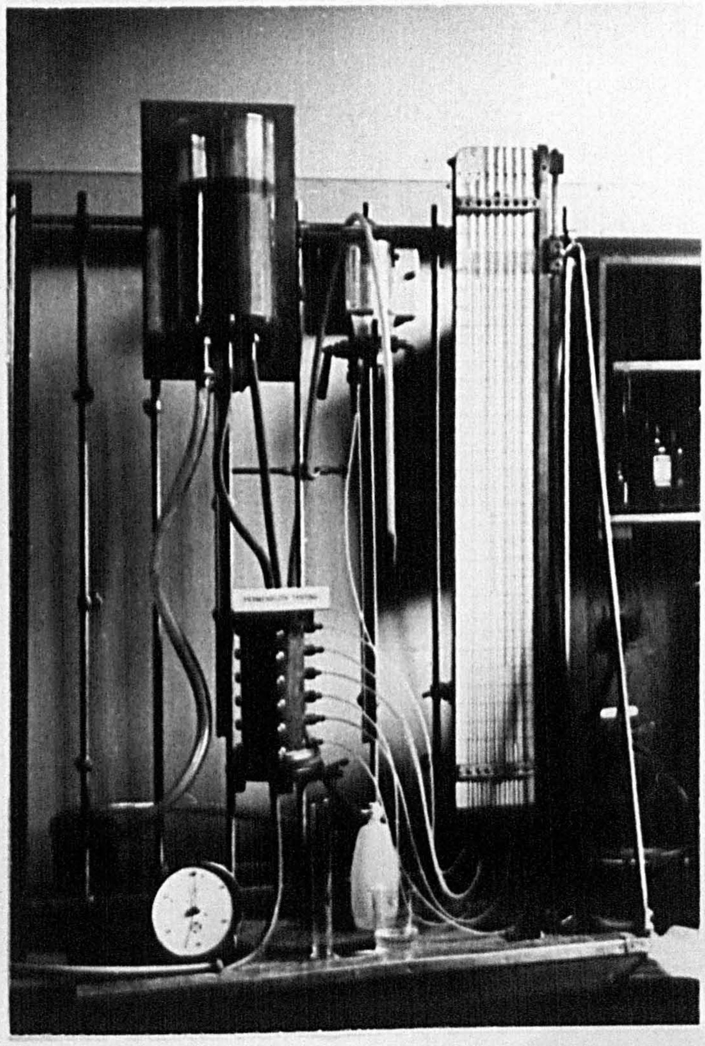


PLATE 7.2 THE PERMEABILITY APPARATUS

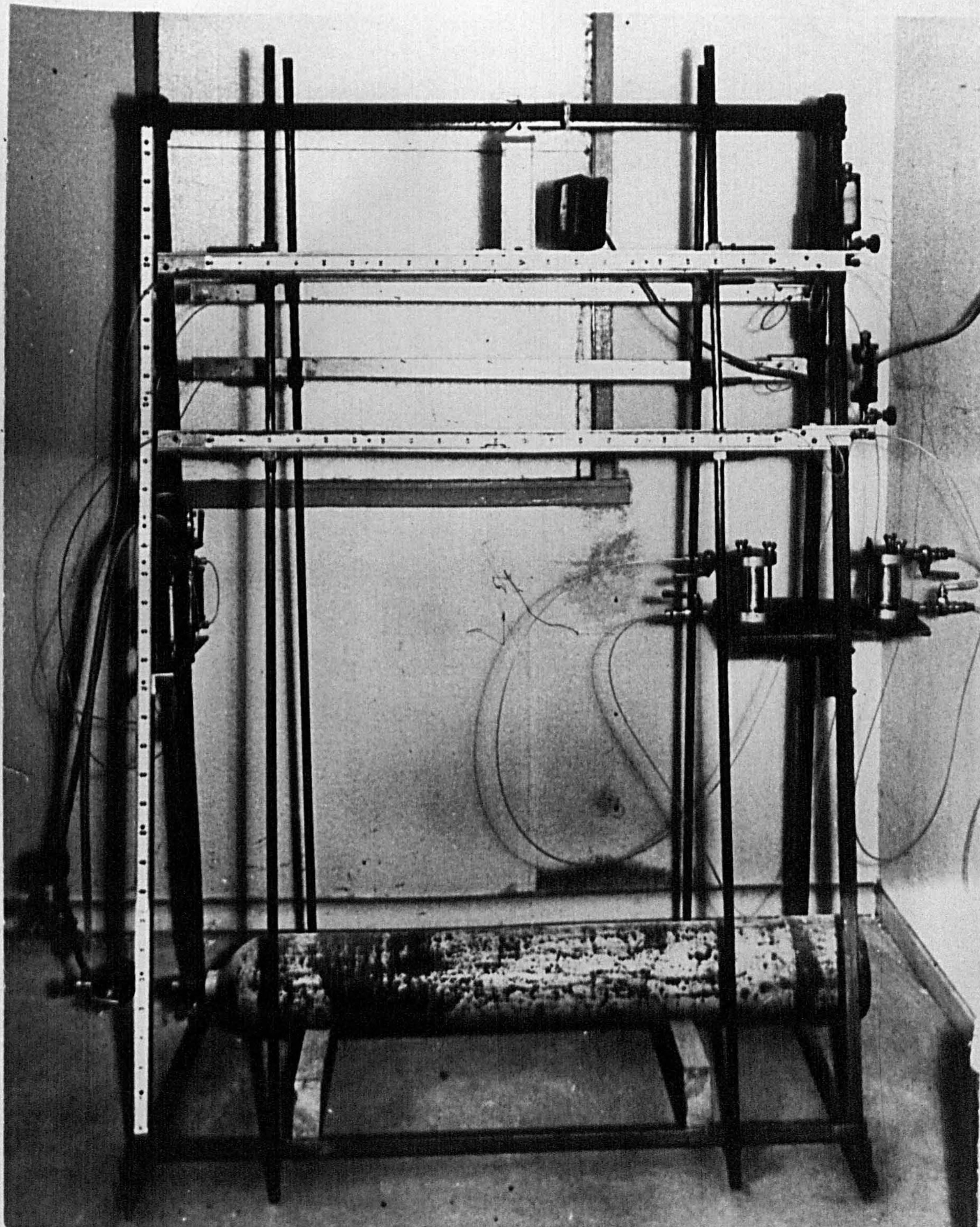
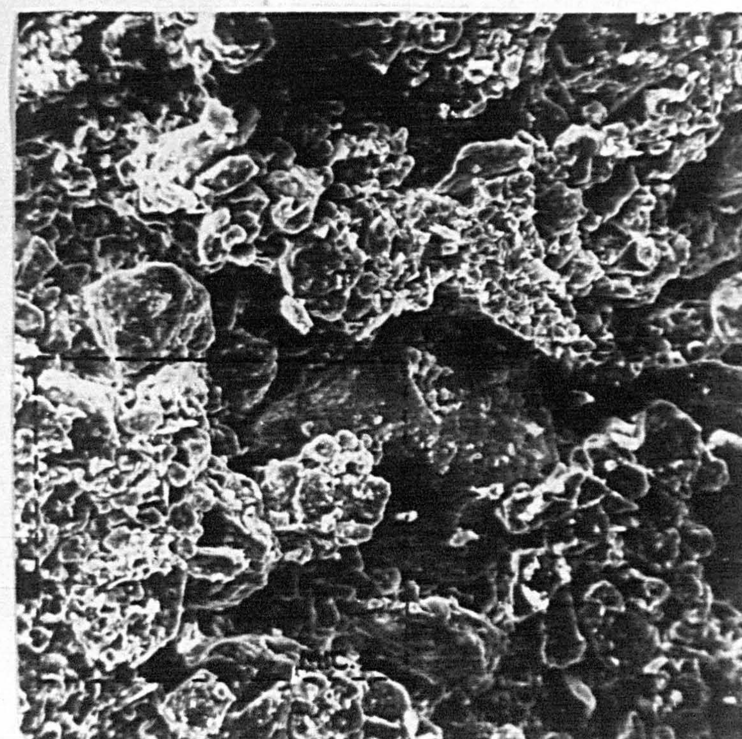


PLATE 7.3 CONSTANT HEAD PERMEABILITY APPARATUS (AFTER YOUNGER AND LIM, 1969)

MICROGRAPHS

MIC.1. BLAISEN 1972 TILL

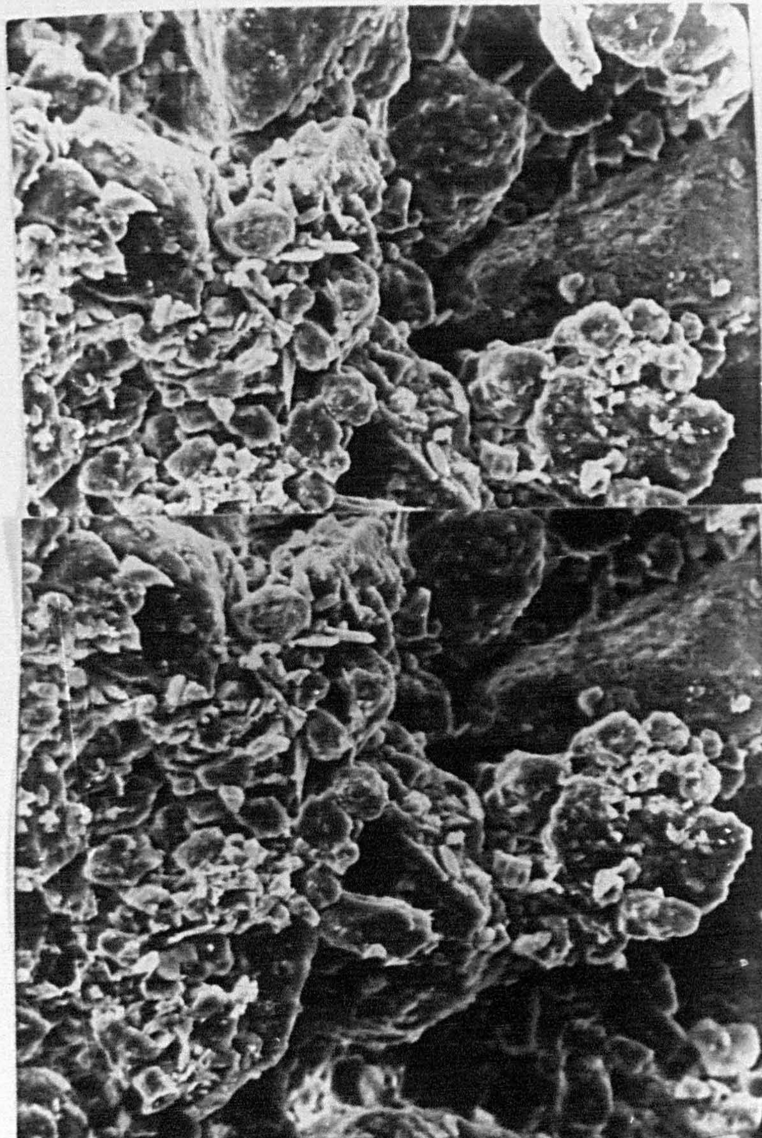
- GRANULAR MATRICES AND AGGREGATIONS.



100 μm

MIC.2. BLAISEN 1972 TILL

- DETAIL OF MIC.1.



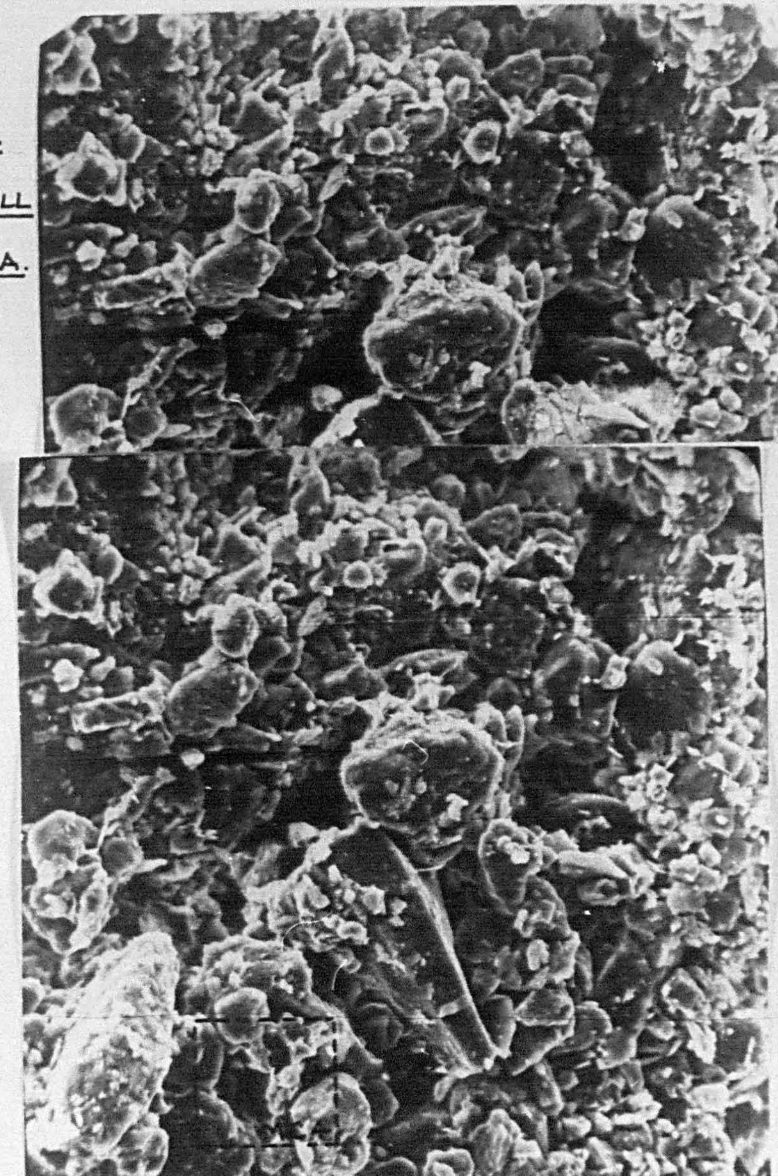
STEREO.

100 μm

MIC.3.

BLAISEN 1972 TILL

-OPEN GRANULAR AREA.



STEREO

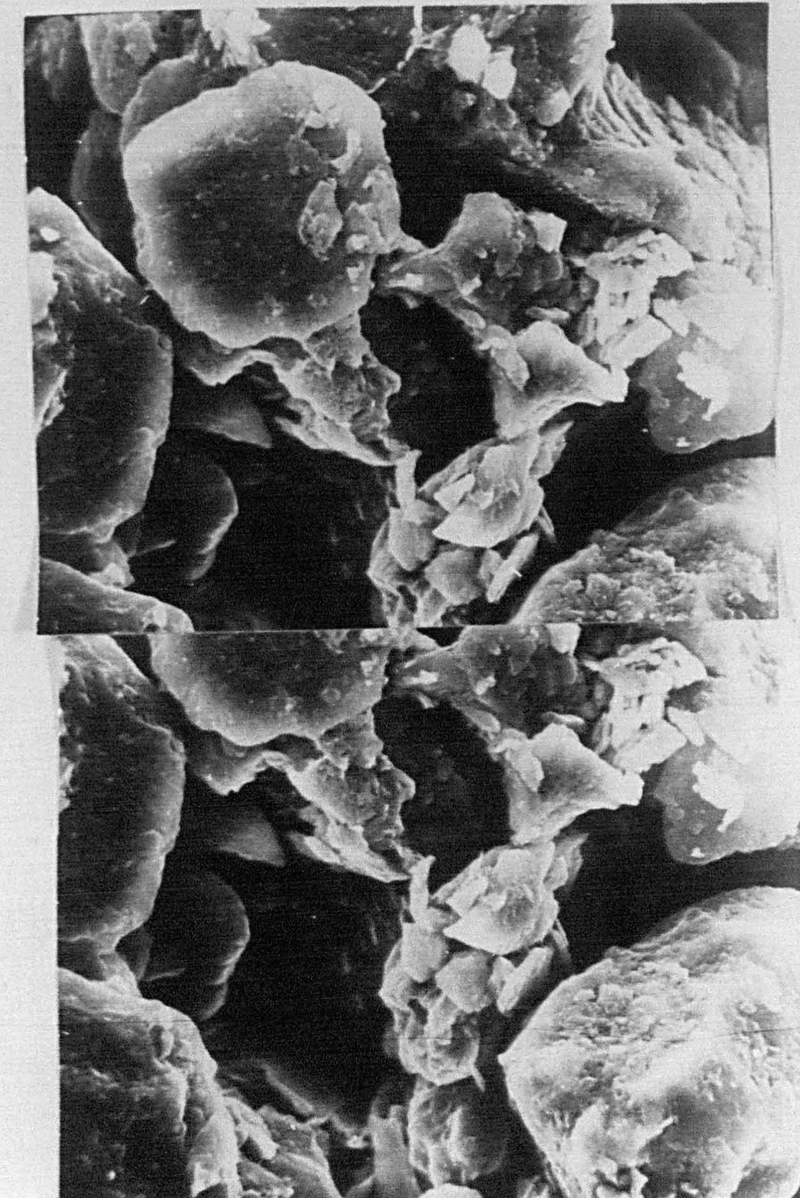
100 μm

MIC. 4.

BLAISEN 1972 TILL

-DETAIL OF MIC.3.

-OPEN CONNECTOR

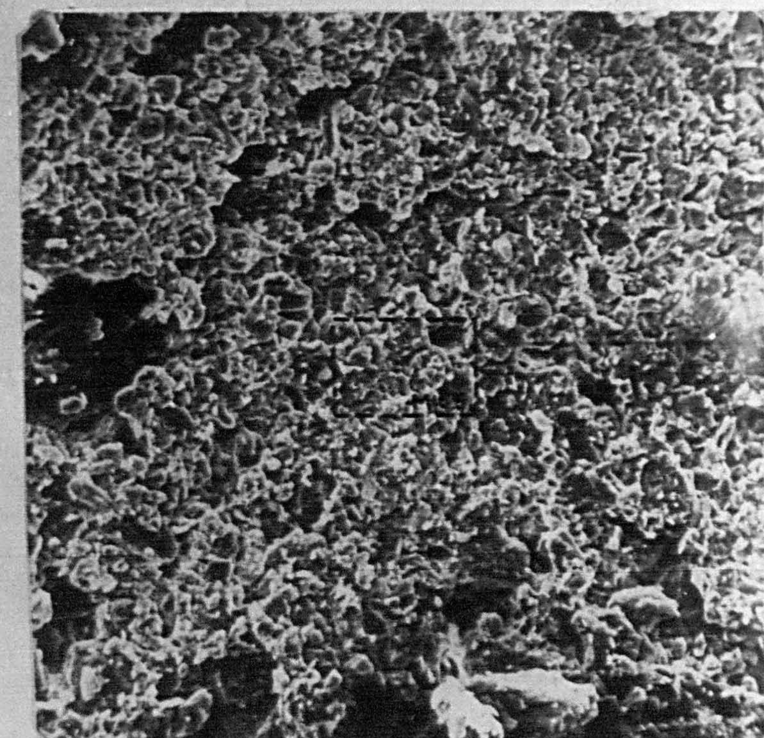


STEREO.

25 μm.

MIC. 5 BLAISEN 1972 TILL.

- COMPACT GRANULAR AREA.



100µm

STEREO.

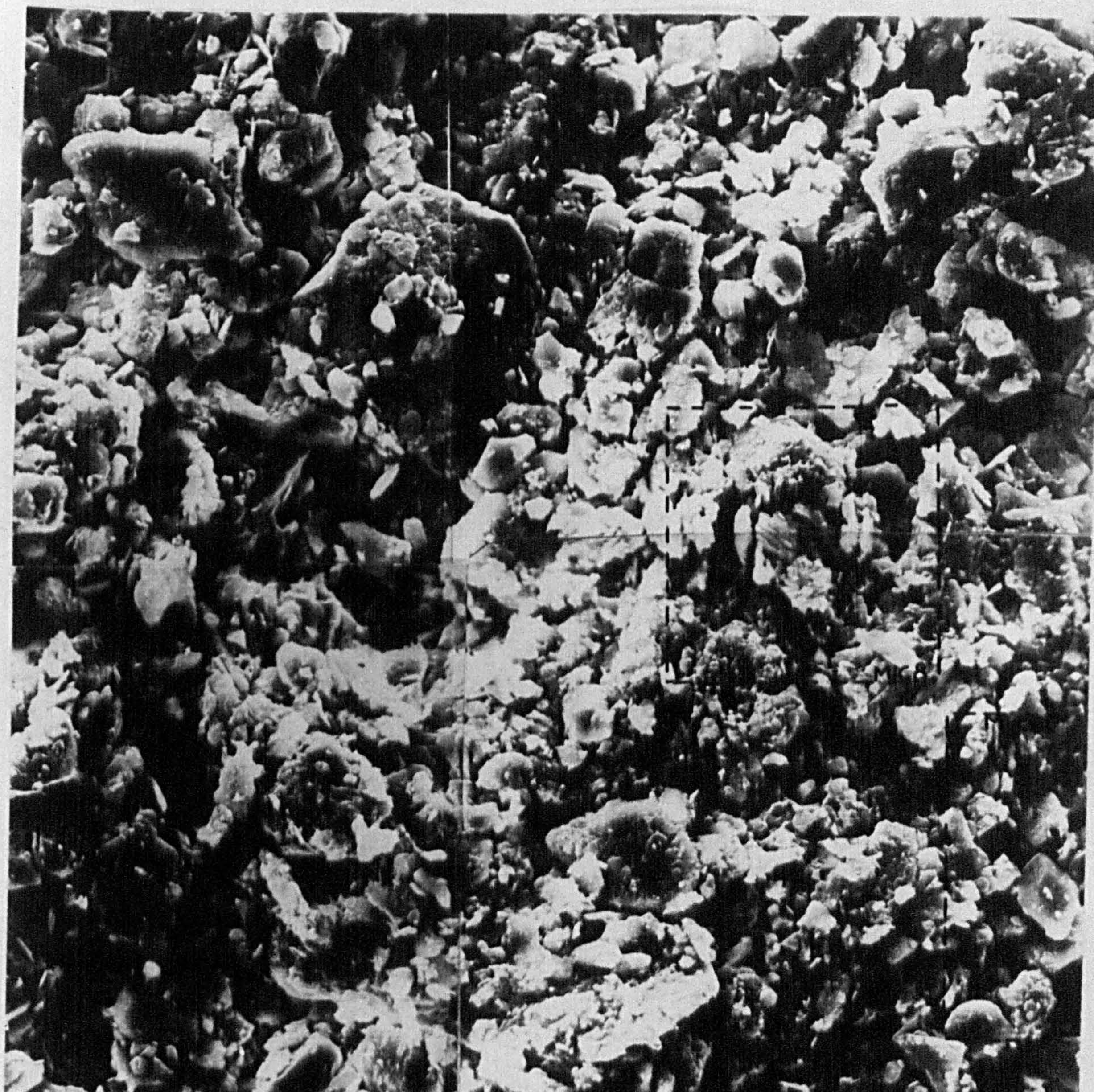
25µm.

MIC. 6.

BLAISEN 1972 TILL

DETAIL OF MIC. 5.

GRANULAR MATRIX.



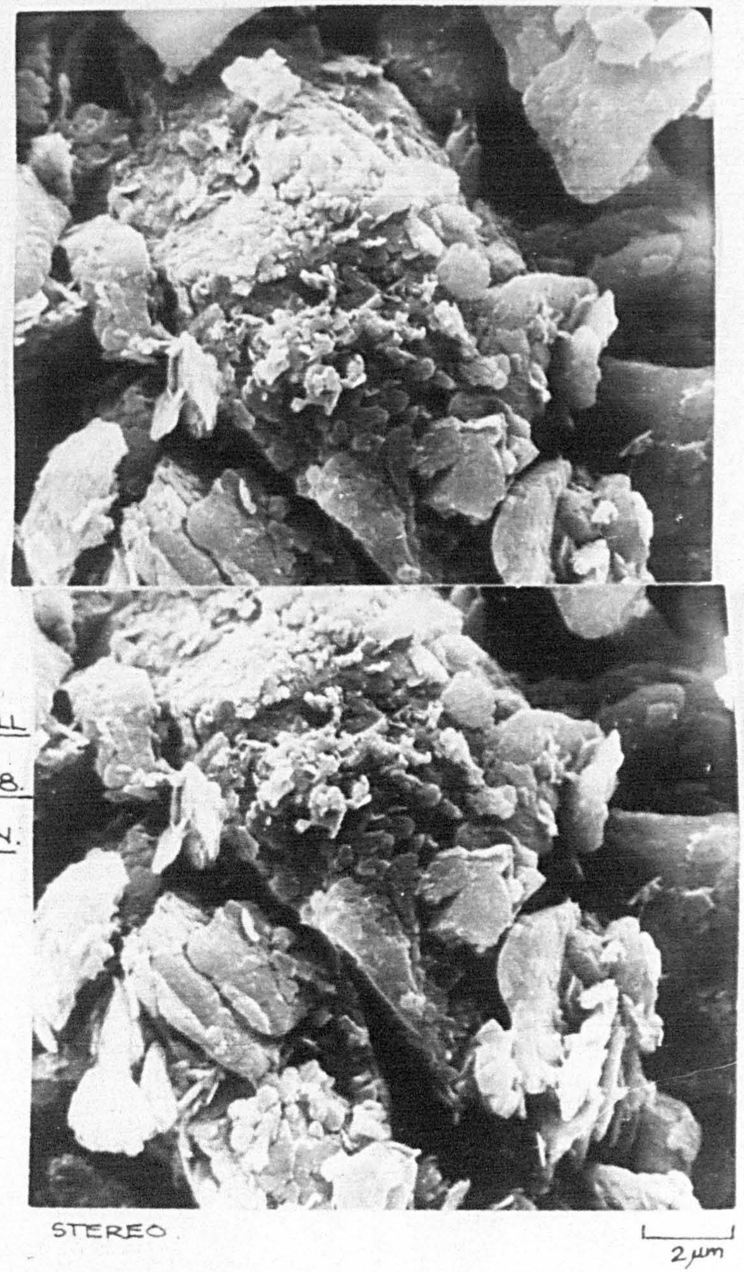
MIC. 7. BLAISEN 1972 TILL – RELATIVELY FINES RICH AREA.

MIC. 9.

BLAISEN 1972 TILL

DETAIL OF MIC. 8.

FINE AGGREGATION.

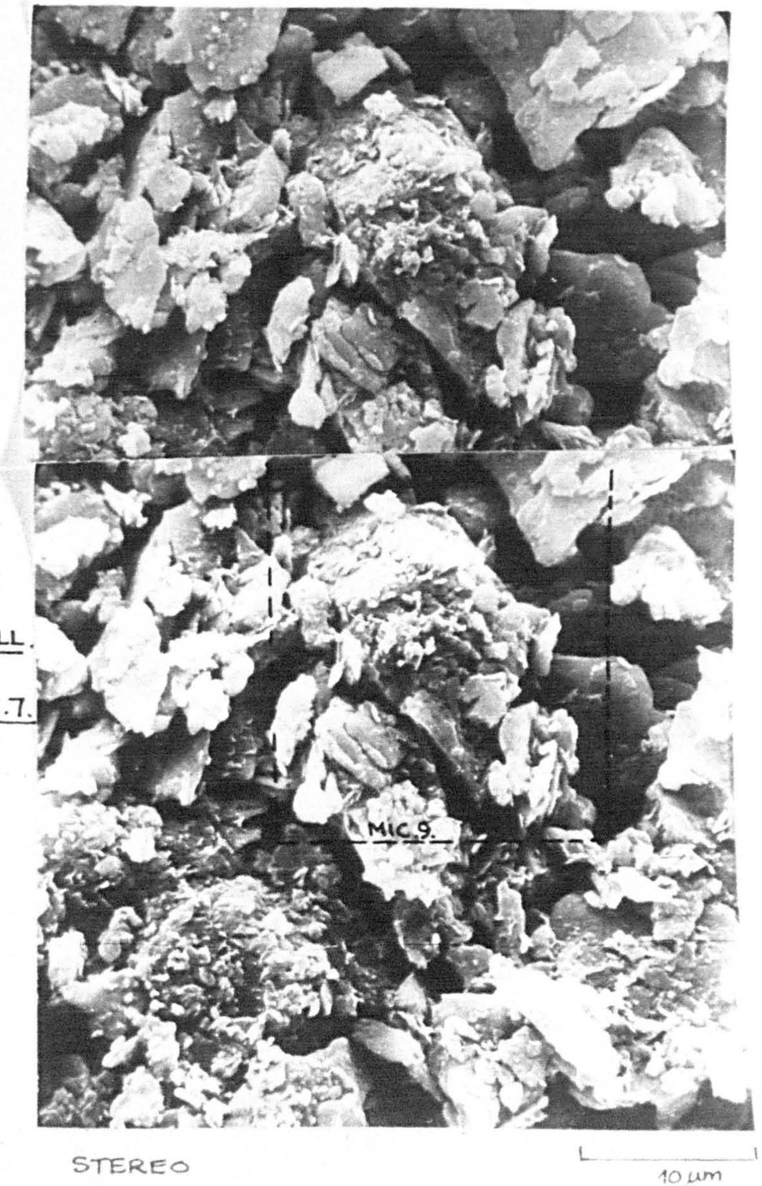


MIC. 8.

BLAISEN 1972 TILL.

- DETAIL OF MIC. 7.

- FINE AREA.

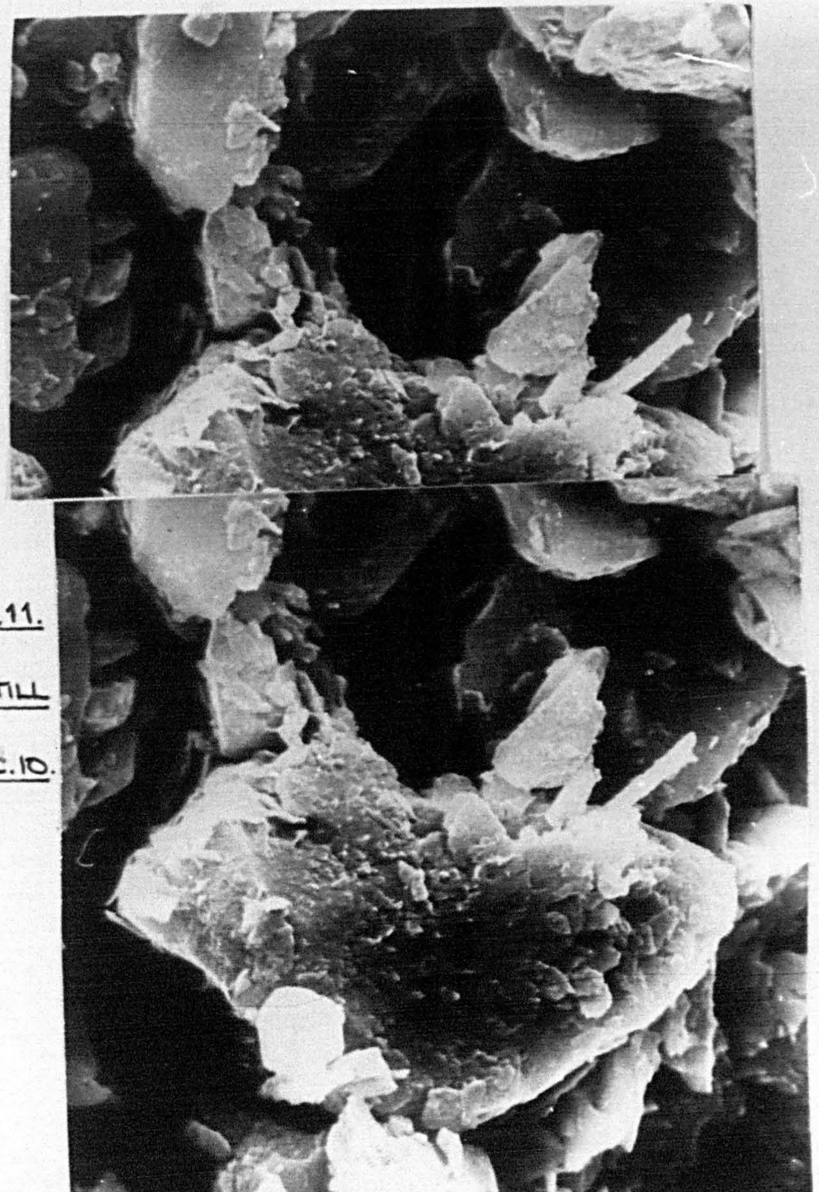


MIC.11.

BLAISEN 1972 TILL

- DETAIL OF MIC.10.

- CONNECTOR.



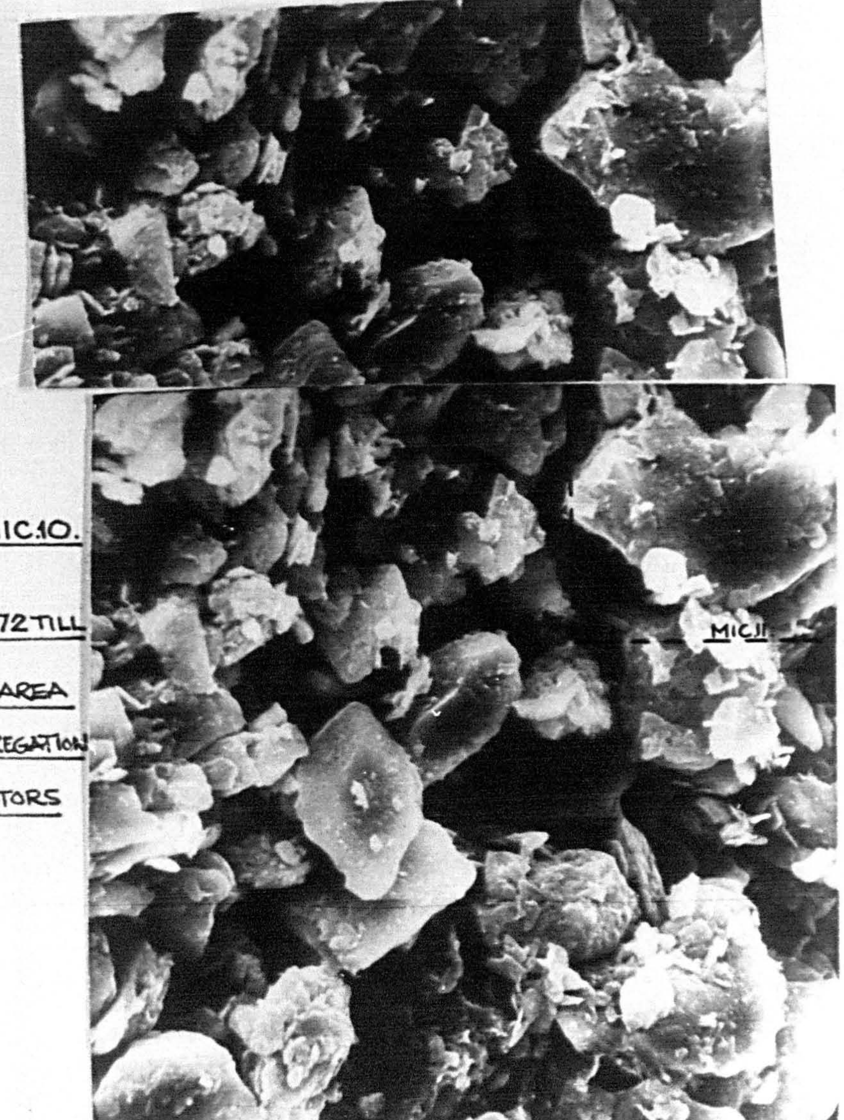
STEREO.

10 µm.

MIC.10.

BLAISEN 1972 TILL

- DETAIL OF AREA WITH AGGREGATION AND CONNECTORS



STEREO.

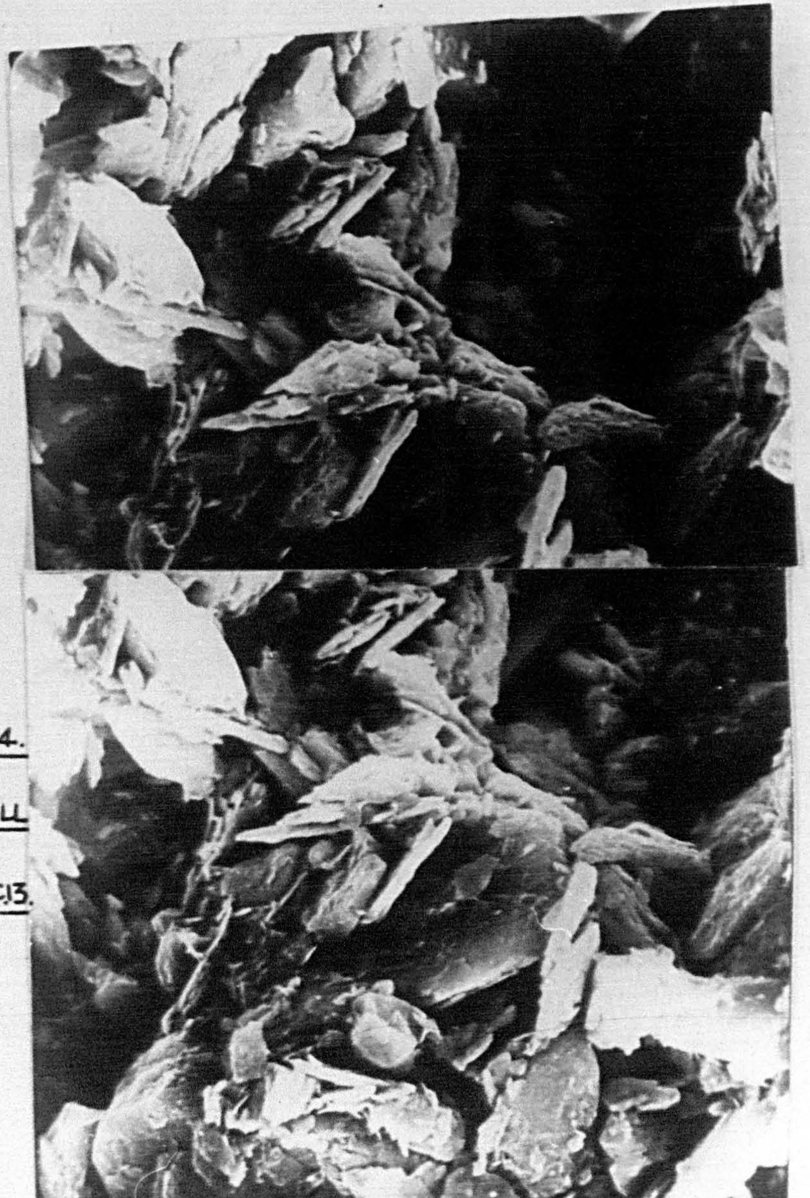
25 µm

MIC. 12. BLAISEN 1965 TILL - GRANULAR MATRIX.

MIC.14.

BLAISEN 1965 TILL

-DETAIL OF MIC.13.



STE.REO

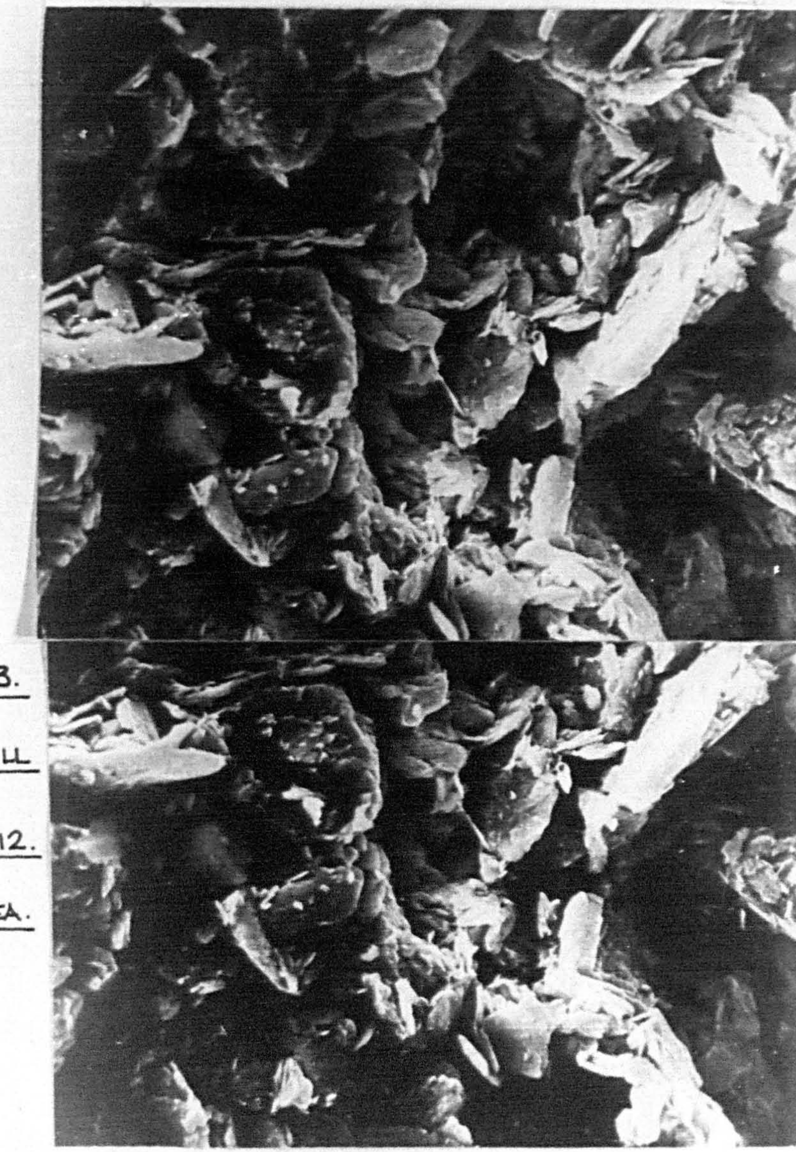
10 μm

MIC. 13.

BLAISEN 1965 TILL

-DETAIL OF MIC.12.

-GRANULAR AREA.



STEREO.

25 μm

MIC. 15.

BLAISEN 1965 TILL

- OPEN AREA WITH

CLAY SIZES.

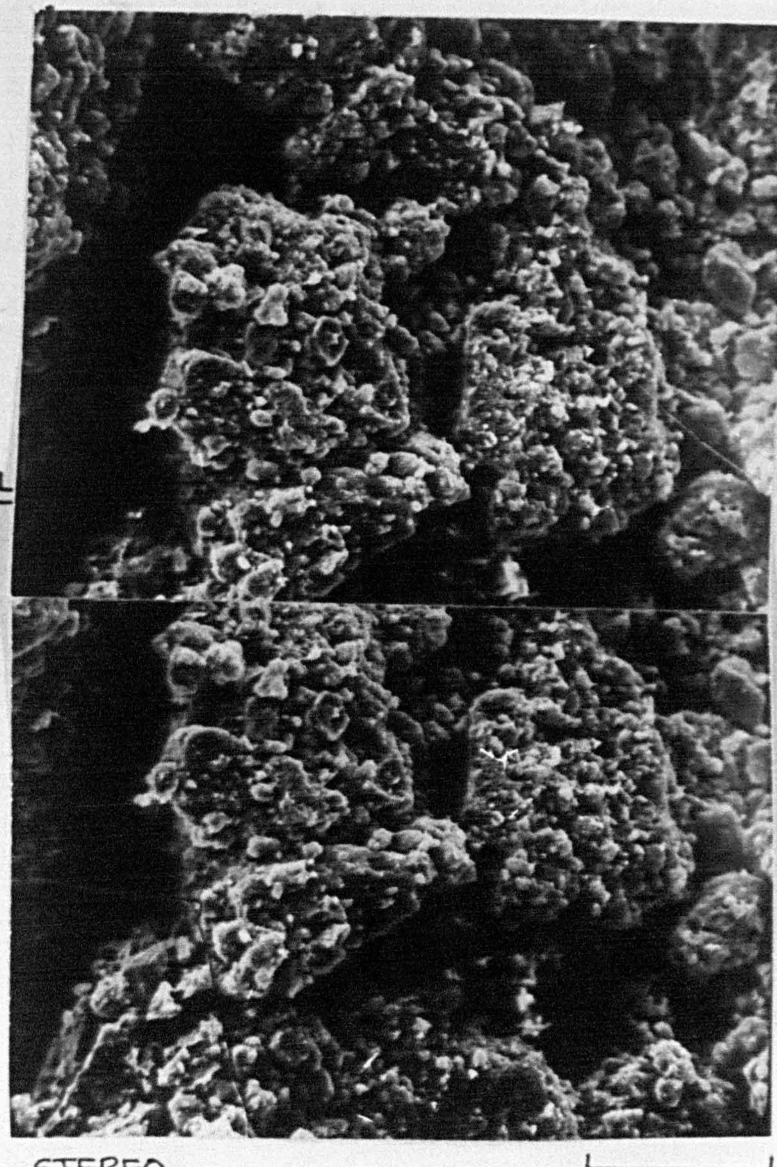
MIC. 16. BLAISEN 1965 TILL - DETAIL OF CLAY SIZE ARRANGEMENTS.

MIC. 18

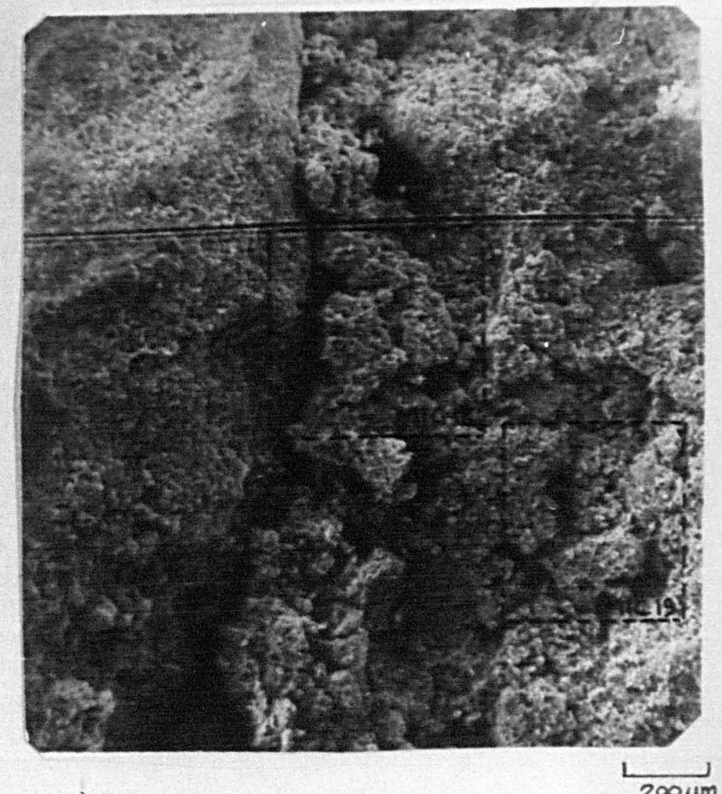
BREIDAMERKURJOKULL

TILL - DETAIL OF

MIC. 17 - PORES



STEREO.



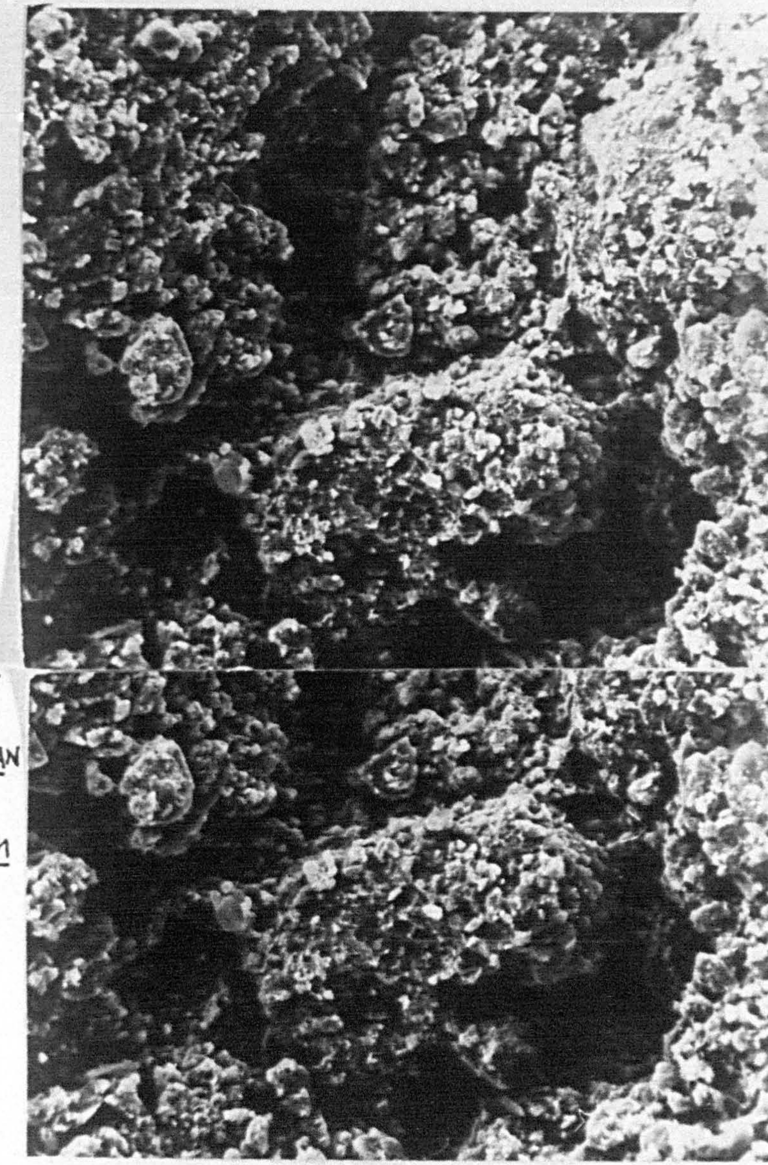
MIC. 17. BREIDAMERKURJOKULL TILL

- GENERAL FABRIC AT SIDE OF STONE.

STEREO. 25 μm

MIC.20.

BREIDAMERKUR-JOKULL TILL - DETAIL OF MIC.19.



STEREO. 100 μm.

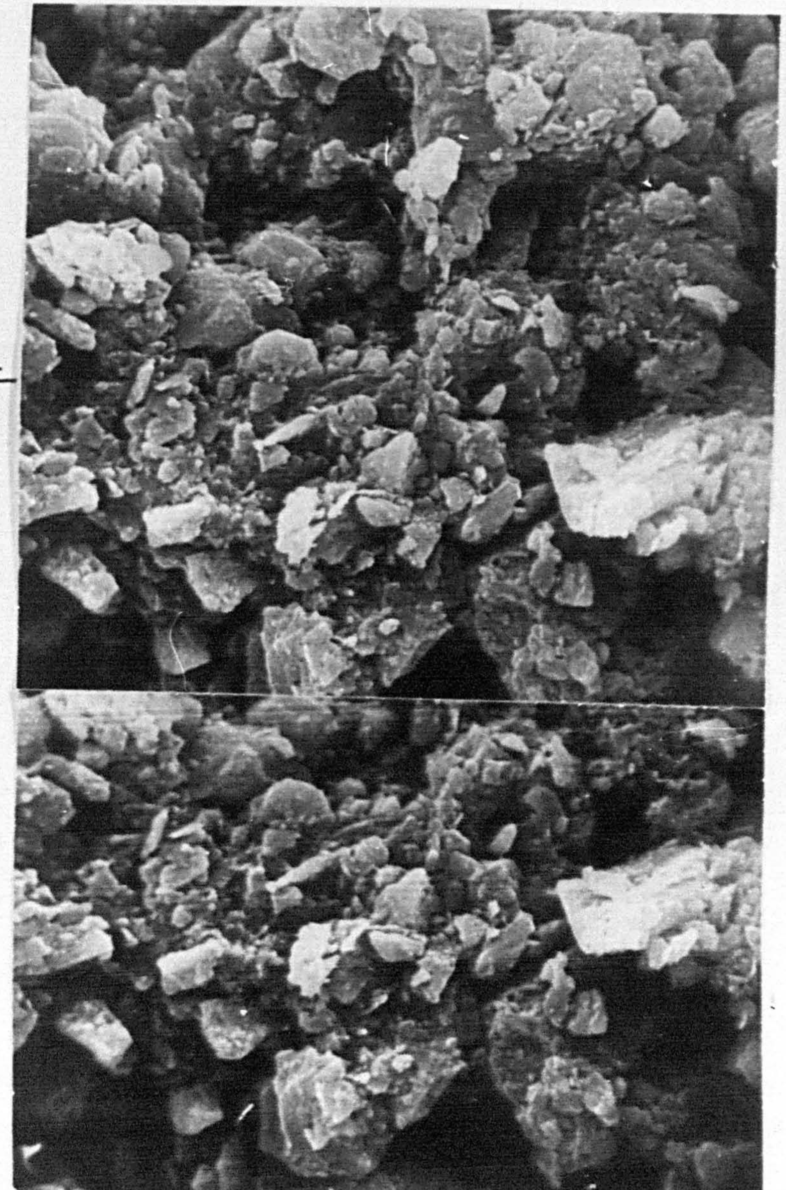
MIC.19.

BREIDAMERKUR-JOKULL TILL - AN AREA AWAY FROM STONE.

MIC. 21.

BREIDAMERKURJOKULL TILL

- AREA RICH IN FINES.

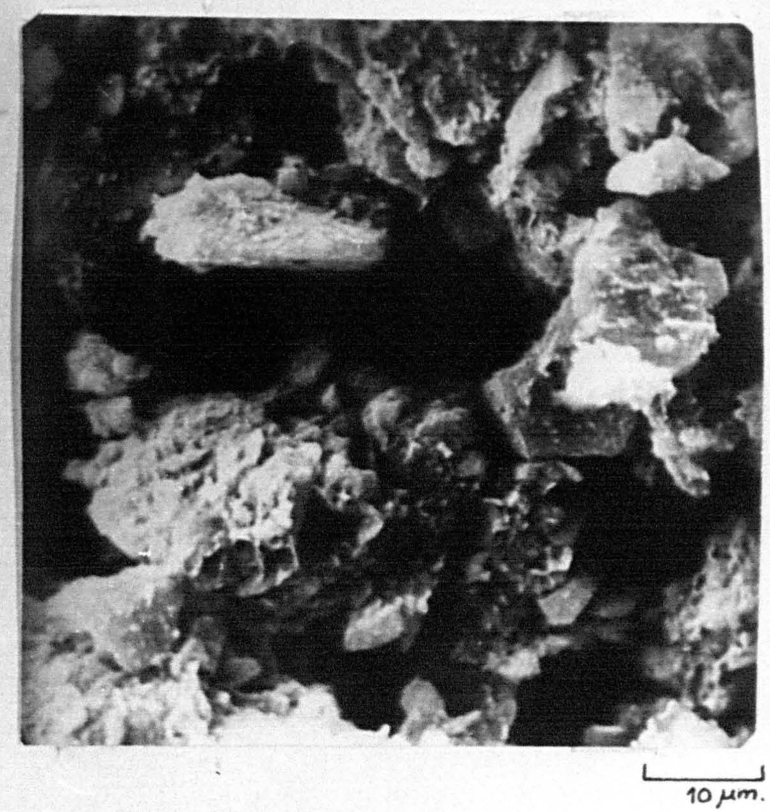


STEREO

10 μm

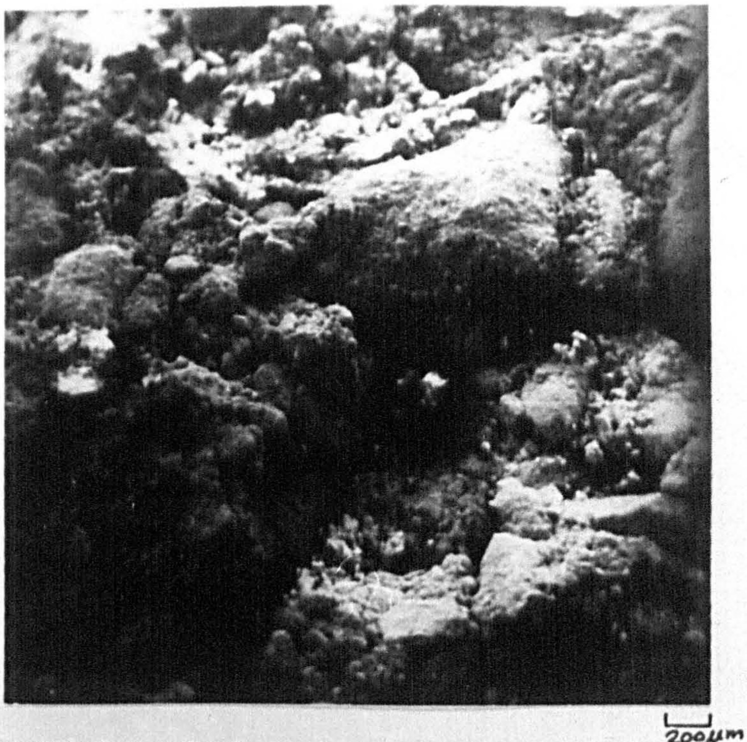
MIC. 23. BREIDAMERKURJOKULL TILL

- DETAIL OF MIC. 22. - CONNECTOR.



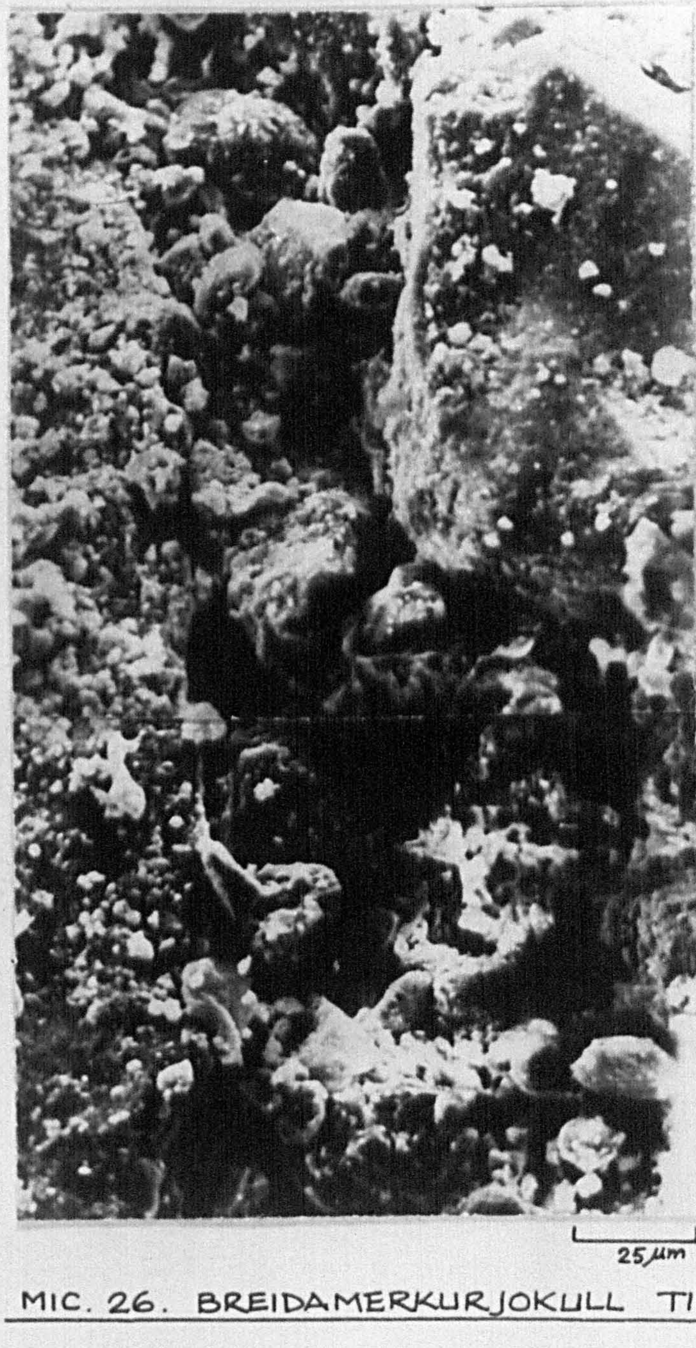
MIC. 22 BREIDAMERKURJOKULL TILL

- FINE AGGREGATIONS AND CONNECTORS.



MIC.24. BREIDAMERKURJOKULL TILL
- GENERAL VIEW OF GRANULAR AREA.

MIC. 25. BREIDAMERKURJOKULL TILL - DETAIL OF MIC. 24.



MIC. 26. BREIDAMERKURJOKULL TILL

– DETAIL OF MIC. 25.

MIC. 27. ANTARCTICA TILL - GENERAL NATURE OF FABRIC.

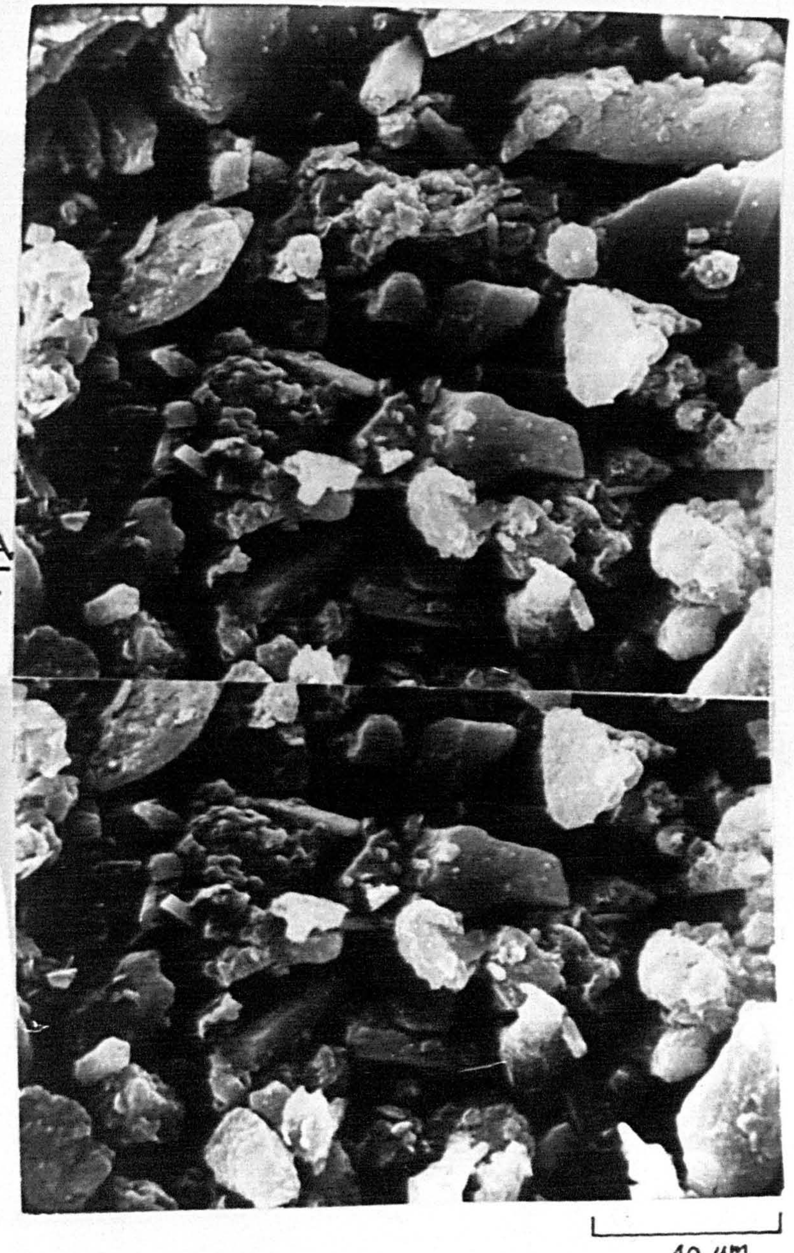
MIC. 28. ANTARCTICA TILL – SAND PARTICLE IN CLAY-GRANULAR MATRIX.

MIC. 29. ANTARCTICA TILL- DETAIL OF CLAY-GRANULAR MATRIX.

MIC. 30.

ANTARCTICA TILL

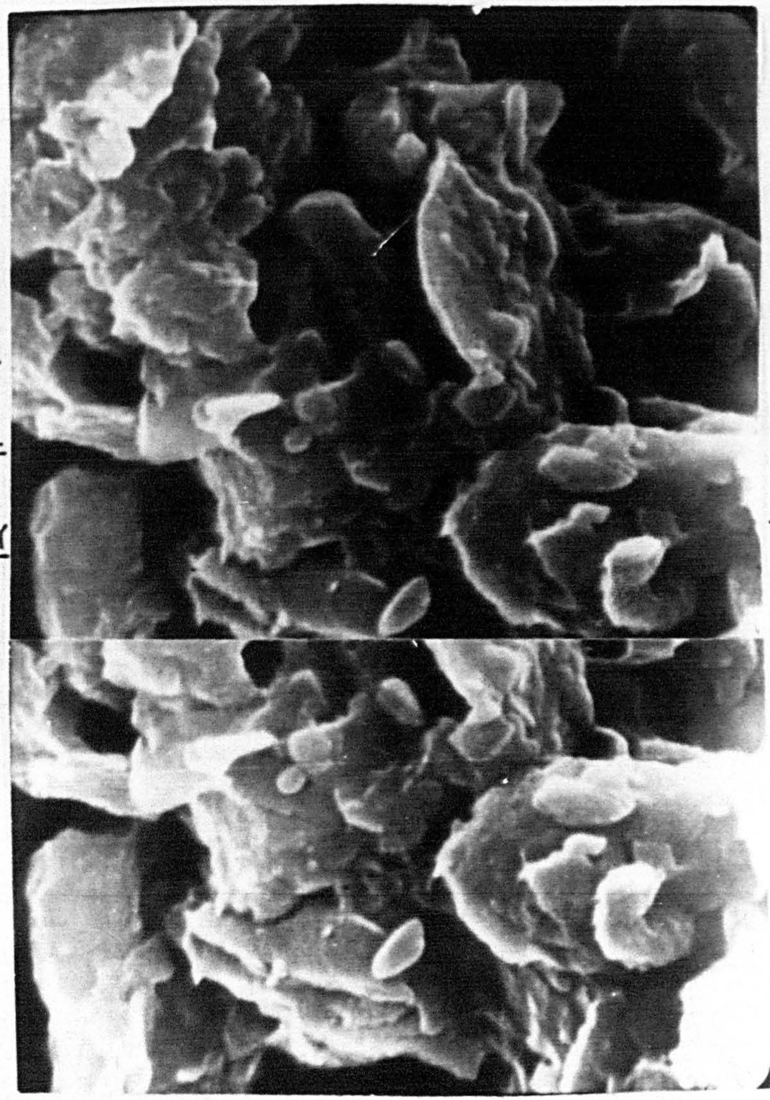
-OPEN GRANULAR AREA



MIC.32.

ANTARCTICA TILL

-DETAIL OF PARTLY DISCERNIBLE FINES IN MIC.31.



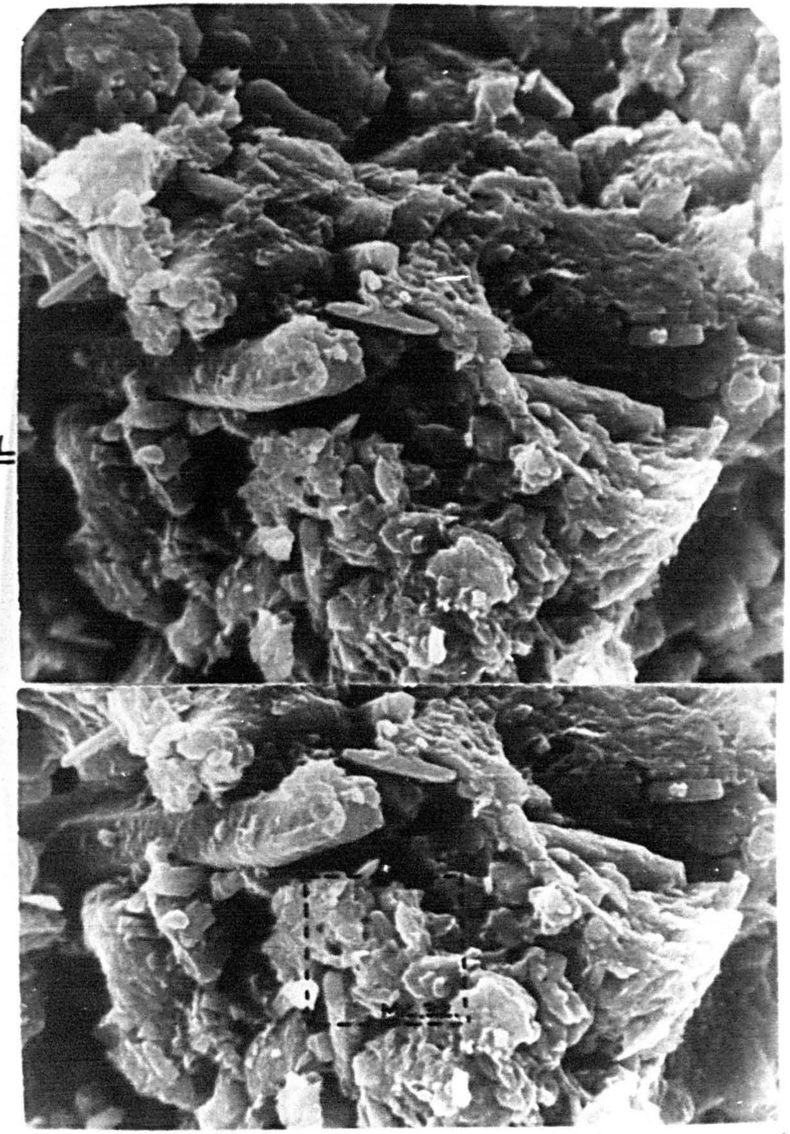
STEREO.

2 µm

MIC.31.

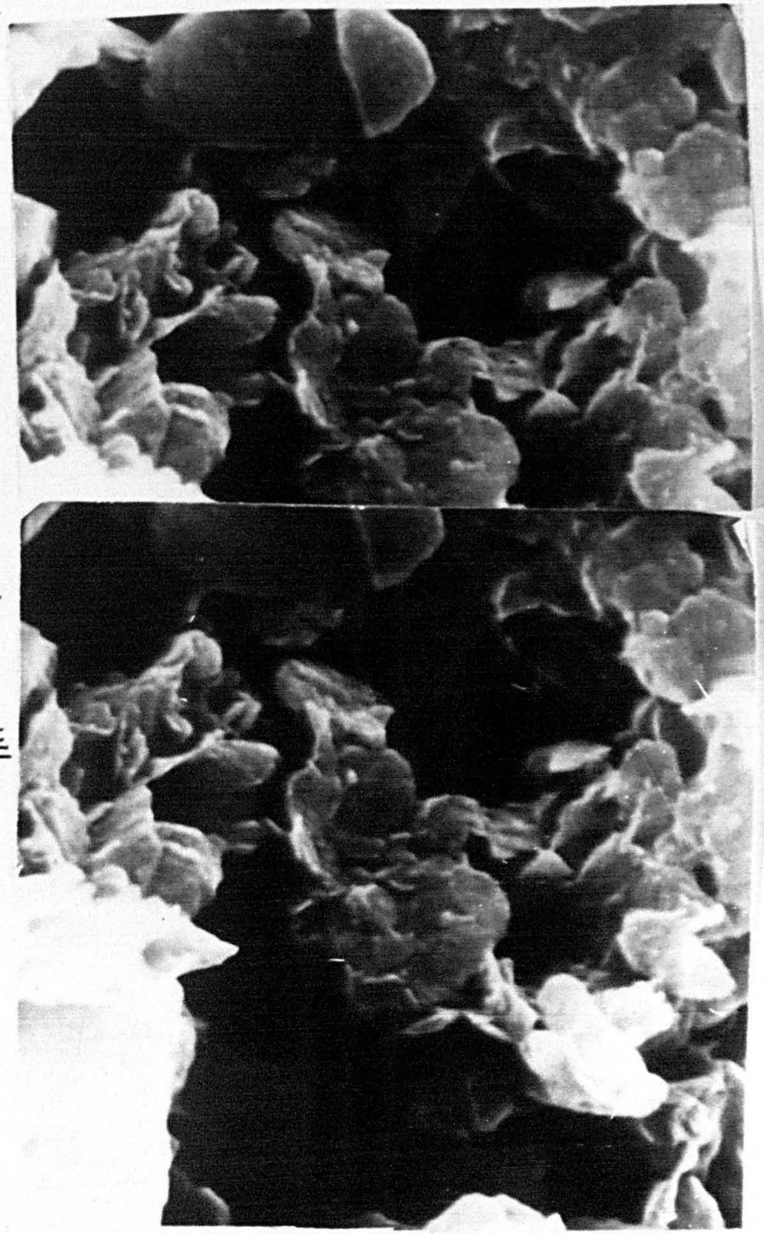
ANTARCTICA TILL

-FINES RICH AREA.



STEREO.

10 µm.



STEREO.

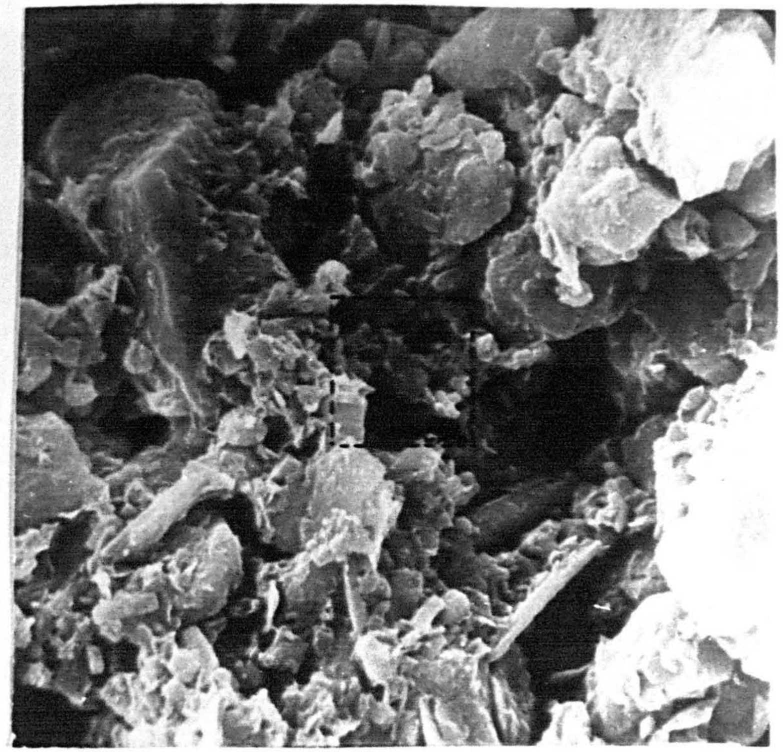
2 μm

MIC.34.

ANTARCTICA TILL

– PARTLY DISCERNIBLE

FINES IN MIC.33.

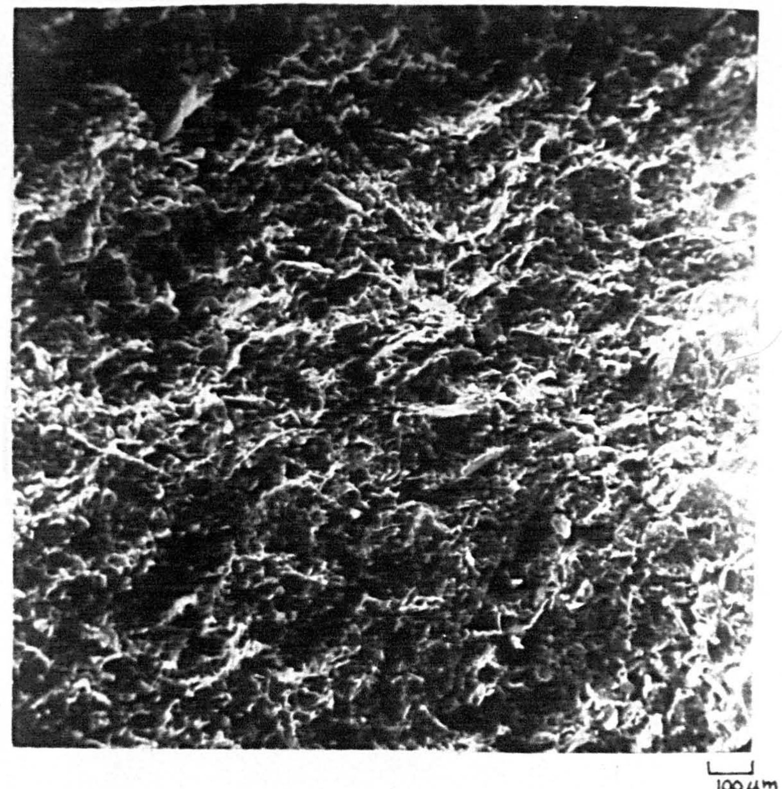


10 μm

MIC.33.. ANTARCTICA TILL

– MORE OPEN FINES RICH AREA.

MIC. 36. COWAL TILL - GENERAL MATRIX.



MIC. 35. COWAL TILL - GENERAL FABRIC.

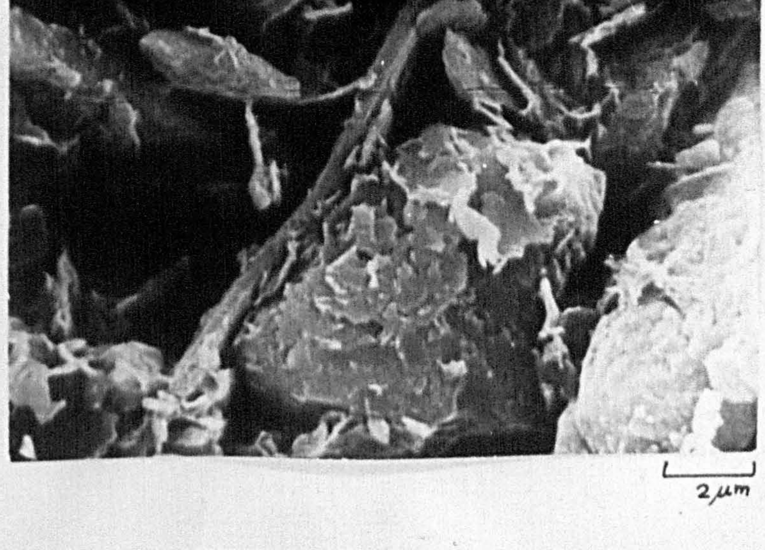
MIC. 37. COWAL TILL – MATRIX WITH CLOTHED GRAINS.

25 μm

MIC 38. COWAL TILL - THIN FLAKY FINE PARTICLES.

MIC. 39 COWAL TILL - AREA WITH CLAY SIZES.

MIC. 40. COWAL TILL - DETAIL OF CLAY SIZES.



MIC.42.

COWAL TILL

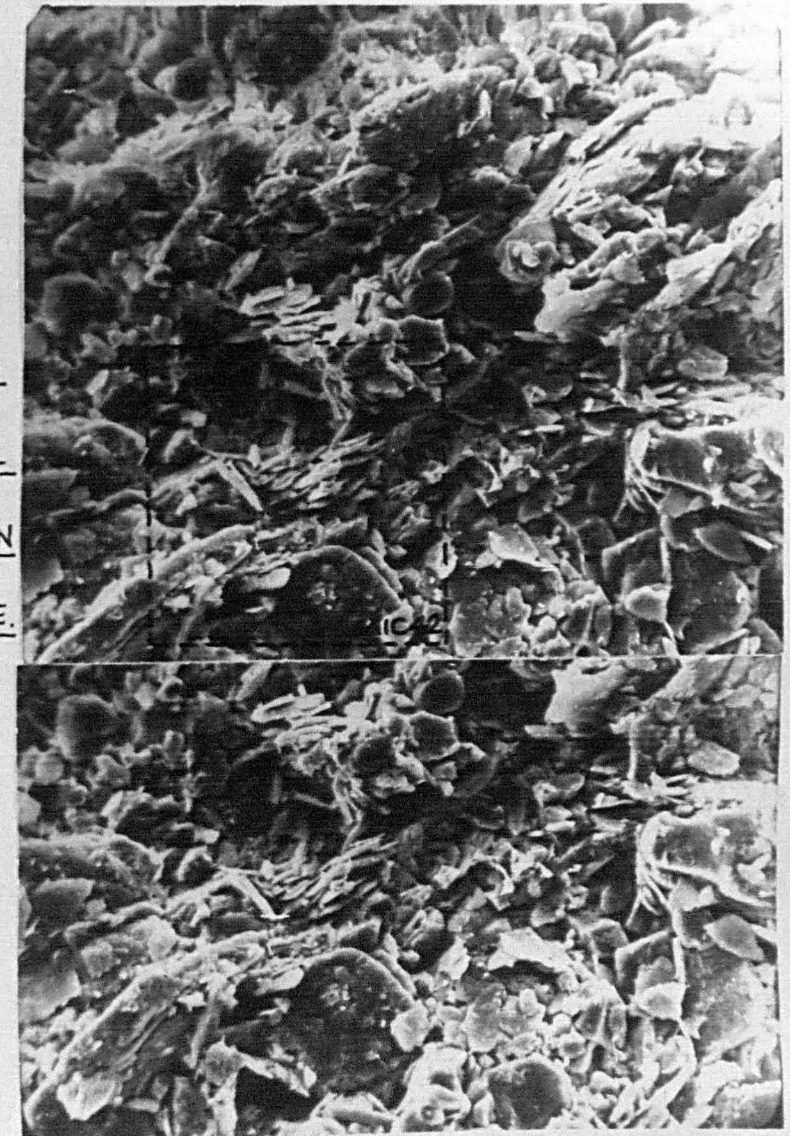
- DETAIL OF MIC.41.

MIC.41.

COWAL TILL

-PARTICLES IN

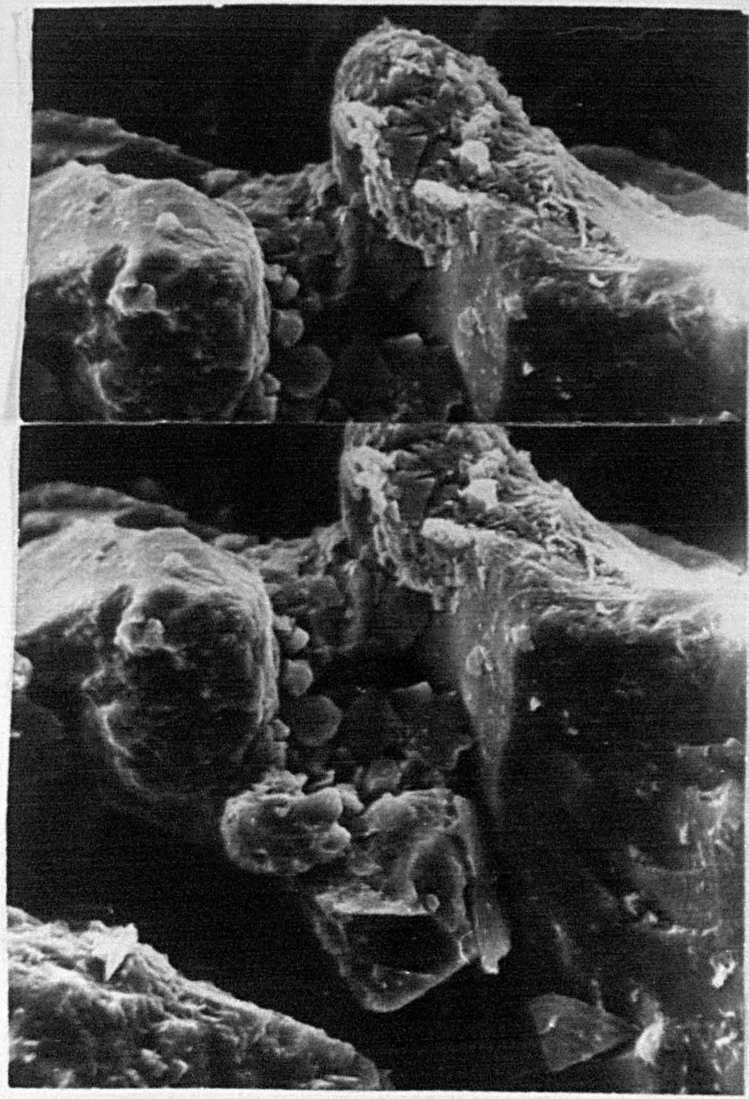
SHEAR ZONE.



MIC. 43. GLEN ORCHY TILL – DISTRIBUTION OF COARSE AND FINE PARTICLES.

MIC. 44 - GLEN ORCHY TILL - COARSE GRAIN CONNECTOR.

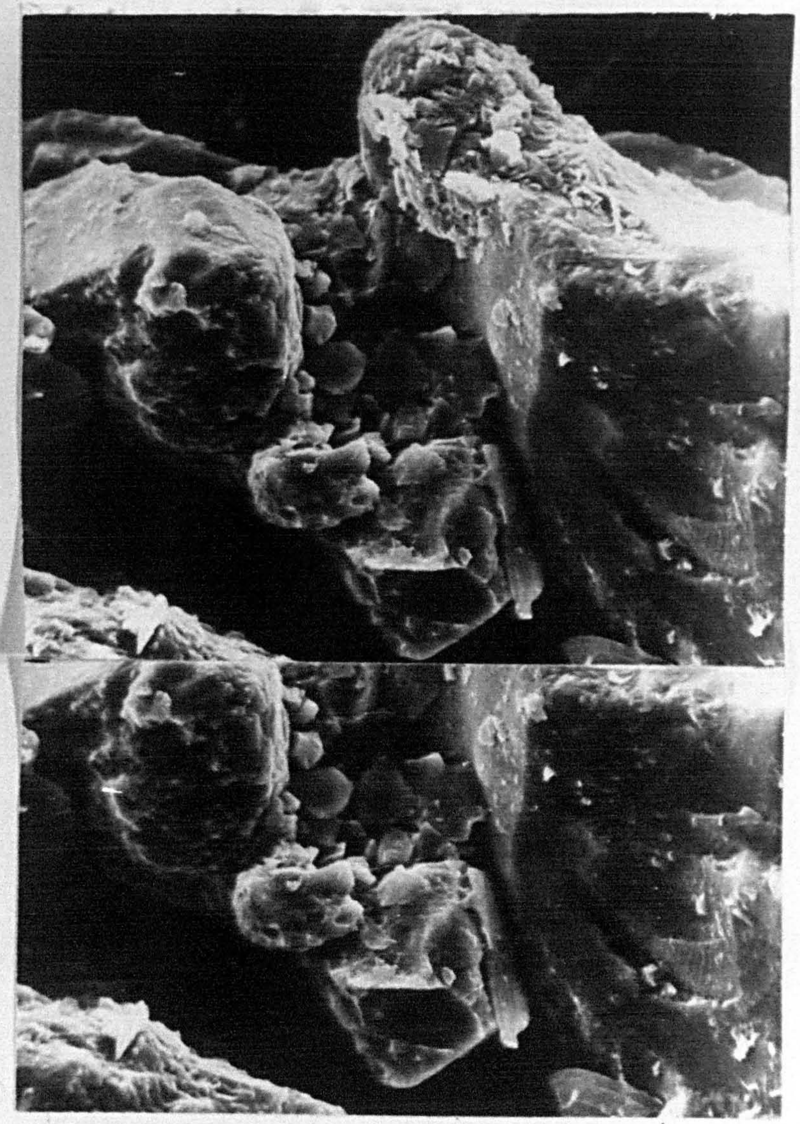
(b)



STEREO

25 µm.

(a)



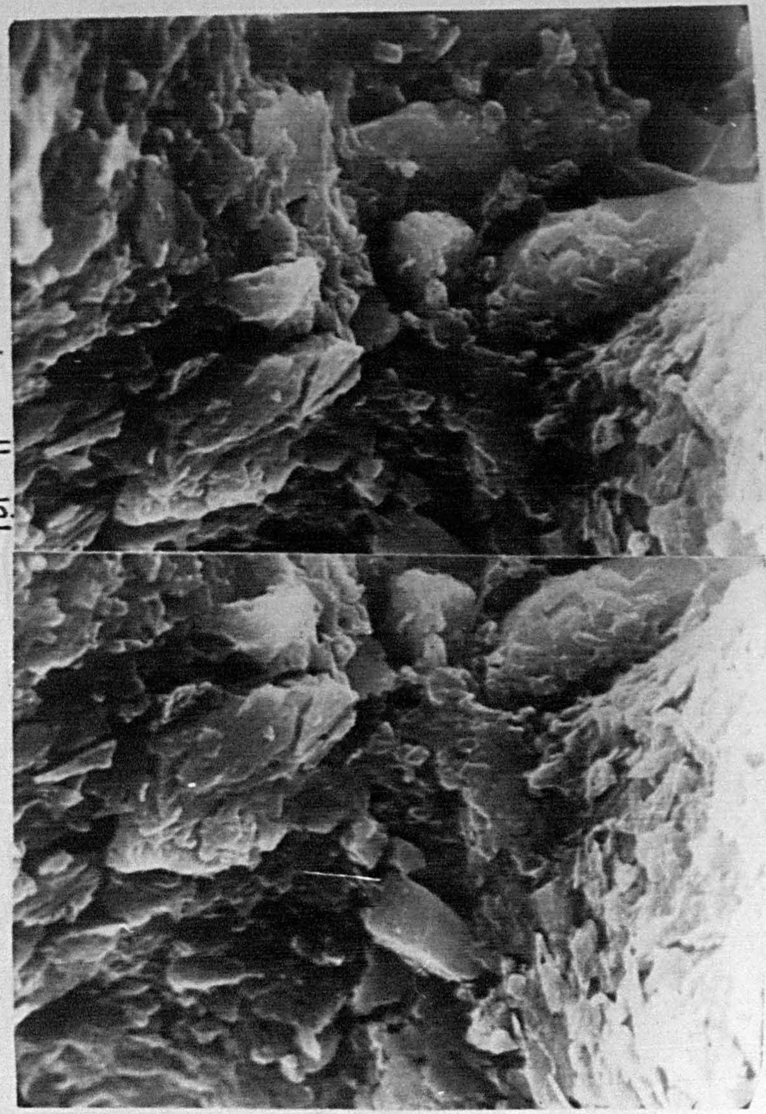
STEREO.

25 µm

MIC.46.

GLEN ORCHY TILL

DETAIL OF MIC45.



STEREO.

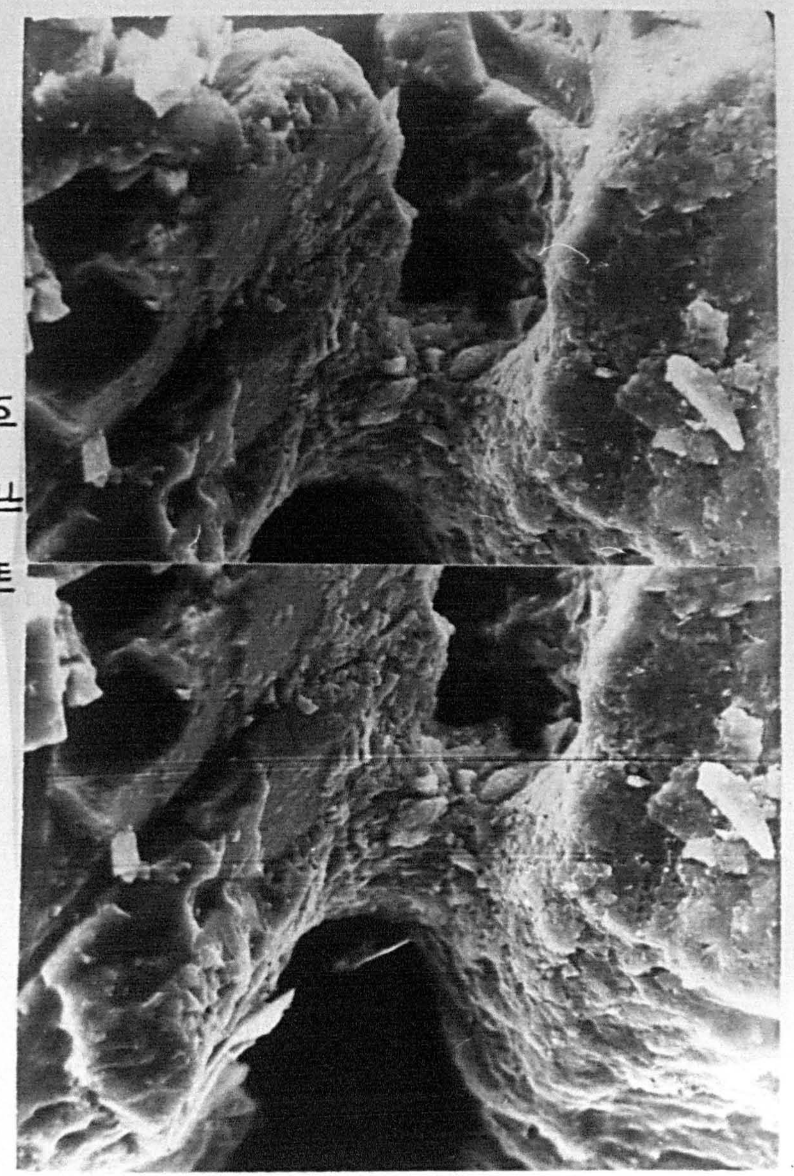
2µm

MIC.45

GLEN ORCHY TILL

FINE · PARTICLE

CONNECTOR.



STEREO.

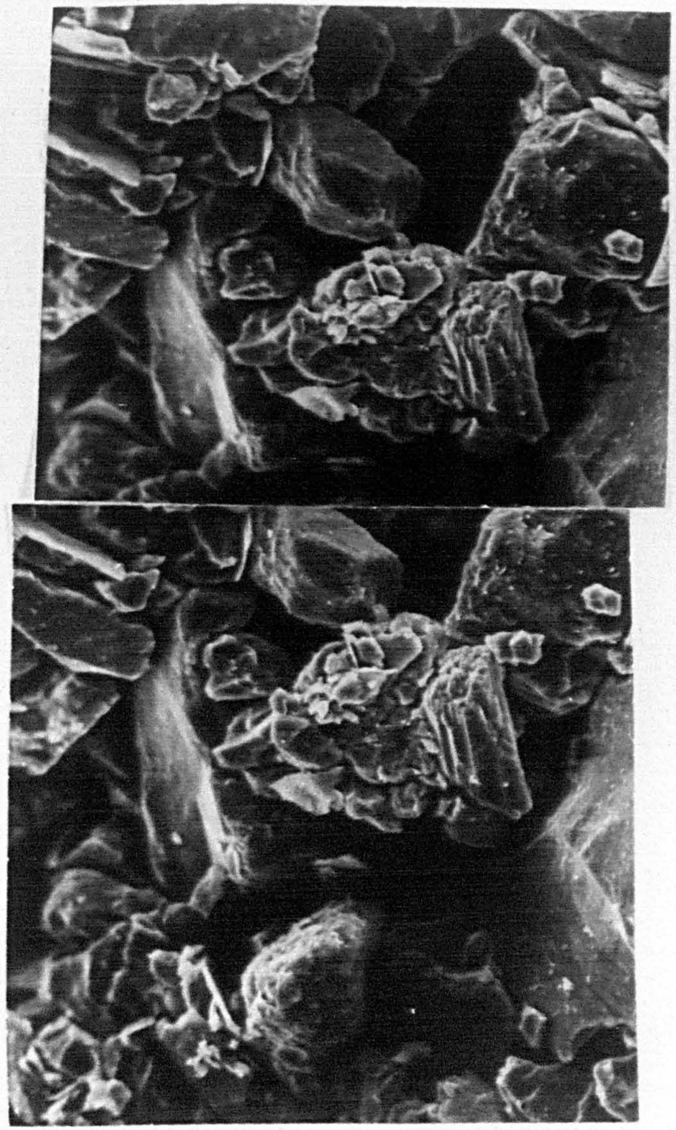
25µm

MIC. 47.

GLEN ORCHY TILL

- AGGREGATION ASSEMBLAGE

OF GRANULAR PARTICLES.



STEREO.

100 μm.

MIC. 48. GLEN ORCHY TILL — FINER AREA OF MIC. 43.

MIC. 49 GLEN ORCHY TILL — DETAIL OF CLAY SIZE PARTICLES.