A SCANNING ELECTRON MICROSCOPY STUDY OF NATURAL ENGINEERING SOIL

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TABLES

TABLE 2.1. GRANULAR PARTICLE SHAPE CLASSIFICATION

(after B.S. 812 (1975))

CLASSIFICATION	DESCRIPTION
ROUNDED	Fully water-worn or completely shaped by attrition.
IRREGULAR	Naturally irregular, or partly shaped by attrition and having rounded edges.
ANGULAR	Possessing well defined edges formed as the intersection of roughly planar faces.
FLAKY	Material of which thickness is small relative to the other two dimensions.
ELONGATED	Material, usually angular, in which the length is considerably larger than the other two dimensions.
FLAKY and ELONGATED	Material having length considerably larger than width, and width considerably larger than thickness.

TABLE 3.1.

OUTLINE OF MICROFABRIC FORM CLASSIFICATION SCHEME

PRINCIPAL FORMS	SUB-FORMS		SUB-DIVISION OF SUB-FORMS
I ELEMENTARY PARTICLE ARRANGEMENTS	CLAY PARTICLE ARRANGEMENTS		RANDOM PARALLEL PARTLY DISCERNIBLE
	GRANULAR PARTICLE ARRANGEMENTS		CLEAN GRAIN-GRAIN CLOTHED GRAIN-GRAIN
	ORGANIC ARRANGEMENTS		-
II PARTICLE ASSEMBLAGES	BASIC ORDER	CONNECTOR	BRIDGE BUTTRESS
		AGGREGATION	REGULAR IRREGULAR
		INTERWEAVING BUNCH	-
		MATRIX (OR LAYER REGION SYSTEMS)	CLAY REGION CLAY-GRANULAR REGION GRANULAR REGION
	HIGHER ORDER	MICROLENSE MICROVEIN MICROLAYER	
III PORE SPACE	BASIC ORDER	INTRA-ELEMENTAL INTRA-ASSEMBLAGE INTER-ASSEMBLAGE	
	HIGHER ORDER	TRANS-ASSEMBLAGE	

TABLE 3.2.

LEVELS OF RELATIVE ABUNDANCE

RELATIVE ABUNDANCE SCALE	DESCRIPTIVE TERMINOLOGY FOR SCALAR UNITS	
	SKELETON ARRANGEMENTS	PORE SPACES
4	DOMINANT	DOMINANT
3	FREQUENTLY OBSERVED	CONSIDERABLE CONTRIBUTION
2	OCCASIONALLY OBSERVED	APPRECIABLE CONTRIBUTION
1	RARELY OBSERVED	SMALL CONTRIBUTION
0	NOT APPARENT	NO CONTRIBUTION APPARENT

TABLE 3.3.

ANISOTROPY SCALE

DEGREE	CAUSE
VERY HIGH	COMPLETE PREFERRED ORIENTATION OF 'FEATURES'.
HIGH	STRONG PREFERRED ORIENTATION OF 'FEATURES'.
MEDIUM	MODERATE PREFERRED ORIENTATION OF 'FEATURES'.
LOW	SLIGHT PREFERRED ORIENTATION OF 'FEATURES'.
NIL	HAPHAZARD OR RANDOM ORIENTATION OF 'FEATURES'.

TABLE 5.1. GEOLOGICAL GROUPING AND BASIC ENGINEERING PROPERTIES OF SOIL STUDIED

GEOLOGICAL GROUPING.		SAMPLE LOCATION.	w_n %	w_l %	w_p %	I_p %	I_l	U.S.C.S.	% BY WEIGHT CLAY <2μ	% BY WEIGHT SILT	% BY WEIGHT SAND	DOMINANT CLAY MINERAL(S)	SOURCE OR AUTHORITATIVE REFERENCE
LAID DEPOSITS WATER	(i) MARINE.	GRANGEMOUTH	57	68	28	40	0.71	CH	21	69	10		Gabr (1975)
		DRAMMEN TOWN	51	58	29	29	0.76	CH	50	50	nil	illite	Bjerrum (1967, 1973)
		SUNDLAND	48	41	26	15	1.46	CL	20	80	nil	illite	Bjerrum (1967, 1973)
		SOLBERGELVA	41	39	22	16	1.20	CL	35	65	nil	illite	Bjerrum (1967, 1973)
		ELLINGSRUD	35	25	22	3	4.3	ML	38	62	nil	illite	Bjerrum (1967, 1973)
		JACKSON	49	111	29	82	0.25	CH	72	28	nil	kaolinite and montmorillonite	Johnson et al (1973)
		LUANDA	16	68	28	40	~0.3	CH	45	54	1	montmorillonite	Novias-Ferreira and Horta da Silva (1973)
	(ii) BRACKISH WATER.	GALLOWGATE	33	55	27	28	0.2	CH	50	46	4		Gabr (1975)
		LAURIESTON	33	47	24	23	0.39	CL	50	48	2		Gabr (1975)
		RENFREW	35	39	22	17	0.93	CL	42	55	3		Gabr (1975)
		SHANNON (A)	40	33	28	5	2.40	ML	8			illite and kaolinite	Soil Mechanics Ltd. (1973)
		SHANNON (B)	55	62	28	34	0.79	CH	42	58	nil	illite and kaolinite	Soil Mechanics Ltd. (1973)
		SAINT ALBAN	65	40	19	21	2.0	CL	39	55	6	illite	La Rochelle et al (1974)
		SAINT JEAN VIANNEY	42	30	18	12	2.0	CL	69	3		illite	La Rochelle (1974)
		BOSTON	43	51	23	28	0.74	CH	50	50	nil	illite	Martin (1971)
	(iii) FRESH-WATER.	TUCSON	13	67	28	39		CH	30	65	5	montmorillonite	Sultan (1969)
		MARICOPA	10	42	28	14		CL	20			montmorillonite	Dudley (1970)
		LYDDA	17	45	18	27		CL	41			montmorillonite	Kassif et al (1965)
		HOLON	27	70	23	47		CH	54			montmorillonite	Kassif et al (1965)
		AFULAH	40	92	25	67		CH	65	25		montmorillonite	Frydman (1972)
		HURLFORD	37	40	19	21	0.86	CL	45	50	5		Gabr (1975)
		NEW LISKEARD — CLAY LAYERS	70	73	26	47	0.94	CH	89	11	nil	illite	Lo and Stermac (1965)
		NEW LISKEARD — SILTY LAYERS	30	31	19	12	0.92	CL	28	72	nil	illite	Quigley & Ogunbadejo (1972)
WIND-BORNE DEPOSITS		FORD	10	30	20	10		CL	19	80	1	illite	Fookes and Best (1969)
		TONGRINNE						CL	15	85	nil		Mellors (1971)
		TRANSVAAL	13	27	15	12		SC	20	17	60	kaolinite	Jennings & Knight (1957)
GLACIAL DEPOSITS		HURLFORD — WEATHERED	18	39	23	16		CC	22	28	30	kaolinite	McCown et al (1974)
		HURLFORD — FRESH	11	26	17	9		CC	20	24	24	kaolinite	McCown et al (1974)
		GLEN ORCHY 6-18	17	15	2			GM	nil	22	50		McCown (1975)
		LAGLINGARTEN 13-35	27	25	2			SM	nil	10	40		McCown (1975)
		BREIDAMERKURJOKULL	9	16	13	3		SM	5	10	42	clay fraction comp.rock flour	McCown (1975)
		STOCKHOLM	6	non plastic				SM	nil	25	45		McCown (1973)
		TAYLOR VALLEY		27	11	16		SC	5	35	55	clay fraction comp.rock flour	McCown (1975)
RESIDUAL DEPOSITS		CASENGA	11	63	23	40		CH	47	5	48	montmorillonite	Horta da Silva (1971a)
		ONDERSTEPOORT	27	79	44	35		MH	65	22	9	amorphous mat. + montmorillonite	de Bruyn (1963)

TABLE 6.1. NATURAL CONSOLIDATION HISTORY OF SOILS STUDIED.

SOIL GROUPING				p'_o kN/m^2 approx.	$\frac{p'_c}{p'_o}$ approx.	COMMENTS AND REFERENCES
LIGHTLY COMPRESSED	ONE-DIMENSIONAL	MARINE	CRANGEMOUTH	110	1.0	Gabr (1975).
			DRAMMEN TOWN	107	1.6	Deposit is normally consolidated and reserve resistance is a result of delayed consolidation. Bjerrum (1967).
			SUNDLAND	84	1.0	Deposits are normally consolidated with no measurable reserve resistance. Bjerrum (1967).
			SOLBERGELVA			
			ELLINGSRUD			Deposit is normally consolidated but has measurable reserve resistance due to delayed consol. Kazi & Moum (1973).
		ESTUARINE	GALLOWGATE	120	1.0	Gabr (1975).
			LAURILSTON	110	2.0	Gabr (1975).
			RENFREW	110	1.0	Gabr (1975).
			SHANNON (A)			Deposits are of recent age and were sampled at shallow depth.
			SHANNON (B)			Deposits are of recent age and were sampled at shallow depth.
			SAINT ALBAN	77	2.0	It appears that cementation and aging may have induced the overconsolidation. LaRochelle et al (1974).
			SAINT JEAN VIANNEY	1000		Deposit appears signif. overconsol. but it is likely that signif. prop. of preconpression is attributable to cementation. La Rochelle (1974).
			BOSTON			Deposit is lightly overconsolicated. Martin (1971).
		LACUSTRINE	HURLFORD	54	1.4	Gabr (1975).
			NEW LISKEARD (CLAY)	300	2.5	It is unlikely that the effective overburden pressure has ever exceeded significantly the present value. The build up of pre-compression is believed to be related to cementation. Quigley & Ogunbadejo (1972).
			NEW LISKEARD (SILTY)	280	2.3	
	THREE-DIMENSIONAL	WIND-BLOWN	FORD			Fookes & Best (1969).
			TONGRINNE			Mellors (1971).
			TRANSVAAL			Jennings & Knight (1957).
		MELT-OUT TILL	GLEN ORCHY			The deposits have been sampled from very shallow depth. They have suffered insitu drying out and by virtue of their texture and composition may be considered to have experienced slight compression. McGown (1975).
			LAGLINGARTEN			
			BREIDAMERKURJOKULL			
			TAYLOR VALLEY			
			STOCKHOLM			McGown (1973).
HEAVILY COMPRESSED	ONE-DIMENSIONAL	MARINE	JACKSON			These deposits have been heavily compressed by the weight of overburden. Johnson et al (1973). Novias-Ferreira and Horta da Silva (1973).
			LUANDA			
		LODG. TILL	HURLFORD WEATHERED			These deposits have been heavily compressed by the weight of overlying ice. McGown et al (1974).
			HURLFORD FRESH			
	THREE-DIMENSIONAL	FLOODPLAIN	TUCSON			These deposits have been sampled from very shallow depth. They have suffered insitu drying out and by virtue of their texture and composition may be considered to have experienced considerable compression. Sultan (1969). Dudley (1970). Frydman (1972). Horta da Silva (1971a). De Bruyn (1963).
			MARICOPA			
			LYDDA			
			HOLON			
			AFULAH			
		RESIDUAL	CASENGA			
			ONDERSTEPOORT			

TABLE 7.1.

GEOTECHNICAL PROPERTIES OF SENSITIVE SOILS STUDIED

SOIL GROUP	SOIL LOCATION	DEPOSITIONAL ENVIRONMENT	(1) w_n %	(2) w_l %	(3) I_p %	(4) I_l	SALINITY g/l	(5) S_u KN/m²	(6) S_t	(7) R_u KN/m²	REFERENCE
SCOTTISH	GRANGEMOUTH	MARINE	57	68	40	0.73	27	51	2.5	~ 20	Gabr (1975)
	RENFREW	ESTUARINE	35	39	17	0.93	1.5	16	3.	~ 5	
	LAURIESTON	ESTUARINE	33	47	23	0.39	1.5	52	2-4	13 - 26	
	GALLOWGATE	ESTUARINE	33	55	28	0.2	1.9	58	2-4	14 - 27	
	HURLFORD	LACUSTRINE	37	40	21	0.86	?	9	3.	3	
NORWEGIAN	DRAMMEN TOWN	MARINE	51	58	29	0.76	27	23	8	~ 3	Bjerrum (1967) (1974) Schjetne (1972)
	SOLBERGELVA	MARINE	41	39	16	1.20	15	16	8	2	
	SUNDLAND	MARINE	48	41	15	1.46	2	20	17	1.2	
	ELLINGSGRUD	MARINE	35	25	3	4.3	1	8	70	0.1	
CANADIAN	NEW LISKEARD	LACUSTRINE	70	73	47	0.94	~ 1.4	40	→ 20	→ 2	Quigley & Ogunbadejo (1972)
			30	31	12	0.92					
	SAINT ALBAN	ESTUARINE	65	40	21	2.0	0.3	24	22	0.9	La Rochelle et al (1974)
	SAINT JEAN VI	ESTUARINE	42	30	12	2.0	~ "	400	500→∞	0.8→0	La Rochelle (1974)

1. Natural water content
2. Liquid limit
3. Plasticity index
4. Liquidity index
5. Undrained shear strength
7. Remoulded undrained strength

6. Sensitivity : Classification after Rosenqvist (1953).

insensitive	~ 1
medium sensitive	~ 2 - 4
very sensitive	~ 4 - 8
slightly quick	~ 8 -16
medium quick	~ 16 -32
very quick	~ 32 -64
extra quick	~ 64

TABLE 7.2.

SUMMARY OF THE COLLAPSE AND EXPANSION CHARACTERISTICS OF THE SOILS STUDIED

BEHAVIOUR	SOIL LOCATION	COLLAPSE AND/OR EXPANSION CHARACTERISTICS	REFERENCE(S)
COLLAPSE:	FORD	This soil has been, from oedometer tests, shown to be potentially collapsible despite some previous collapse. The mechanical properties are similar to those of the loessial soils from North America, Europe and Asia. The e-log p curves for a set of typical tests are shown in Fig. 7.14. Samples were loaded incrementally from an initial vertical stress of 10 kN/m^2 up to 100, 800 and 2800 kN/m^2. Samples were flooded at each of these stresses. The collapse behaviour is clearly seen. The low compressibility of the samples in the desiccated state and the non collapsing behaviour of pre-wetted and remoulded samples is also apparent. Comparison of the flooded and remoulded curves suggests that flooding particularly under lower stresses did not completely destroy the desiccated fabric.	Fookes and Best (1969)
	TONGRINNE	This soil is typical of the collapse prone loessial deposits from Europe.	Mellors (1971).
	TRANSVAAL	This soil is an example of the extensive collapse prone aeolian sands of south west Africa. Double oedometer tests have served to demonstrate that collapse occurs upon wetting and loading.	Jennings & Knight (1957)
	GLEN ORCHY LAGLINGARTEN BREIDAMERKURJOKULL STOCKHOLM TAYLOR VALLEY	These soils have been reported as being susceptible to collapse upon wetting and loading.	McCown (1975)
EXPANSION:	LUANDA	Double oedometer tests have confirmed that this soil is potentially expansive. Fig. 7.15. shows the results of a typical test. Swelling pressures reach values in excess of 1600 kN/m^2 for samples at the natural desiccated state. A degree of anisotropic swelling behaviour has been noted with the greatest expansion measured perpendicular to bedding.	Horta De Silva (1974) Novias-Ferreira & Horta De Silva (1973)
	JACKSON	Field and laboratory investigations have shown that this deposit is highly expansive.	Cronke (1969) Johnson et al (1973)
	LYDDA HOLON AFULAH	Swelling pressure tests have indicated that for the condition of zero volume change (1) Lydda exerts the greatest pressure (600 kN/m^2) and Holon and Afulah exert approximately 320 kN/m^2 and (2) isotropic behaviour is displayed. Free swell tests indicate that Afulah is the most expansive (100%), Holon is next (16C%) and Lydda is the least expansive (100%).	Komornik et al (1965) Frydman (1972)
	ONDERSTEPOORT	Laboratory tests have indicated that this soil has a very high specific expansion (expansion per unit mass of grains) and very large moisture affinity.	De Bruyn (1963)
DUAL BEHAVIOUR:	TUCSON	Double oedometer tests have indicated that below a stress of around 220 kN/m^2 (swelling pressure) the soil in its natural desiccated state would display expansion on wetting while above this critical pressure the soil is prone to collapse on wetting.	Sultan (1969)
	MARICOPA	This soil is typical of the collapsing deposits in the San Joaquin Valley, California. Oedometer tests have confirmed the collapse behaviour and have also indicated that expansion may occur upon wetting under very light loads.	Dudley (1970), (1973)
	CASENCA	Double oedometer tests have indicated that below a stress of around 800 kN/m^2 (swelling pressure) the soil in its natural desiccated state would display expansion on wetting while above this critical pressure the soil is likely to collapse on wetting, Fig. 7.16.	Horta De Silva (1971a)

TABLE B.1.

GENERAL BACKGROUND AND BASIC PROPERTIES OF SOILS STUDIED IN PRELIMINARY CRITICAL POINT DRYING INVESTIGATION.

SOIL DESCRIPTION	SAMPLE LOCATION		w_n	w_l	w_p
Artificially consolidated (1-dim.) pure illite.	-		36	75	33
Glacio-estuarine illitic silty clay.	Ottawa, Canada.		65	75	28
Marine mud - illitic clayey silt.	San Francisco Bay, U.S.A.		83	55	30
Glacio-lacustrine varved clay (illitic).	New Liskeard, Canada.	clay layer	68	73	25
		silt layer	44	47	22
Lacustrine clay.	Lake Portchartrain, New Orleans, U.S.A.		80	90	24

TABLE 8 - 2. Macroscopic Observations - Artificial Illite Specimens

drying method	approximate overall shrinkage or swelling (%)			General Characteristics
	vert.	hor.	vol.	
Critical Point Drying. Specimens impregnated with 100% methanol - Co_2.	-0.8	-1.5	-3	No surface flaking or distortion of specimens apparent. Cracks apparent in 2 specimens during impregnation. Cracks in 3rd specimen after drying. Slight swelling noted during impregnation in each case.
Critical Point Drying. Specimens impregnated with 25% - 100% methanol - Co_2.	-0.4	-1.1	-1.9	No distortion of specimens apparent. Slight flaking after drying evident in 2 specimens. Cracks apparent during impregnation. Slight swelling noted during impregnation.
Air-drying.	-8	-11	-26	No distortion, surface flaking or cracking apparent.

TABLE 8 - 3. Macroscopic Observations - Leda Clay Specimens

drying method	approximate overall shrinkage or swelling (%)			General Characteristics
	vert.	hor.	vol.	
Critical Point Drying. Specimens impregnated with 100% methanol - Co_2.	-1.8	-0.6	-1.9	No distortion, surface flaking or swelling (during impregnation) of specimens apparent. Cracking during impregnation observable in one specimen.
Critical Point Drying. Specimens impregnated with 25%-100% methanol - Co_2.	-1.9	-2.4	-6.1	No distortion, surface flaking or noticeable swelling (during impregnation) of specimens apparent. Cracks appeared during impregnation in 2 specimens.
Air-drying.	-12.5	-13.3	-3 6	No surface flaking or cracking of specimens apparent. A slight longitudinal curvature observed in one specimen.

TABLE 8 - 4. Macroscopic Observations on San Francisco Bay Mud.

Drying Method	approximate overall shrinkage or swelling (%)			General Characteristics
	vert.	hor.	vol.	
Critical Point Drying. Specimens impregnated with 100% methanol - Co_2.	~ 0	-2.2	-2.2	No distortion, cracking or swelling (during impregnation) of specimens apparent. Some flaking after drying on surfaces observed in each case.
Critical Point Drying. Specimens impregnated with 25% - 100%methanol - Co_2.	-2.5	-2.8	-7.5	No distortion or swelling (during impregnation) of specimens apparent. Cracking (during impregnation) observable in 1 specimen. Surface flaking after drying observable on another specimen.
Air-drying.	-17.1	-14.4	-41.3	No distortion, surface flaking or cracking apparent.

TABLE 8 - 5. Macroscopic Observations on Varved Clay.

Drying Method	approximate overall shrinkage or swelling (%)			General Characteristics
	vert.	hor.	vol.	
Critical Point Drying. Specimens impregnated with 100% methanol - Co_2.	-2.5	-1.6	-6.4	No distortion, surface flaking or noticeable swelling (during impregnation) of specimens observable. Cracking observed during impregnation in each case.
Critical Point Drying. Specimens impregnated with 25%-100% methanol - Co_2.	-0.4	~0	-0.7	No distortion, surface flak- cracking or swelling (during impregnation) of specimens observed.
Air-drying.	-12.9	-8.4	-30.6	No surface flaking apparent. Cracking observable in one specimen while in another some longitudinal curvature was observed.

TABLE 8.6.

MACROSCOPIC OBSERVATIONS - LAKE PORTCHARTRAIN.

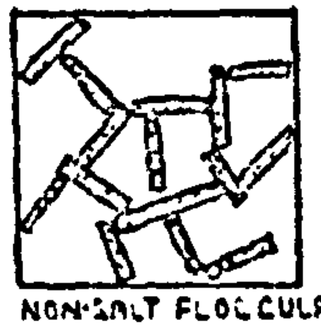
DRYING METHOD	APPROXIMATE OVERALL SHRINKAGE OR SWELLING	GENERAL CHARACTERISTICS
Critical Point Drying. Specimens impregnated with 100% methanol - Co_2.	None apparent.	No distortion apparent. Two specimens displayed cracking and swelling during impregnation and surface flaking after drying.
Air-dried.	Significant shrinkage.	No distortion, surface flaking or cracking.
Oven-dried.	Considerable shrinkage.	No distortion, surface flaking or cracking.

F I G U R E S

HONEYCOMB

FIG. 2.1.

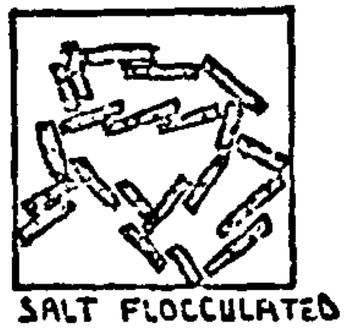
TERZAGHI (1948)



NON-SALT FLOCCULATED

FIG. 2.2.

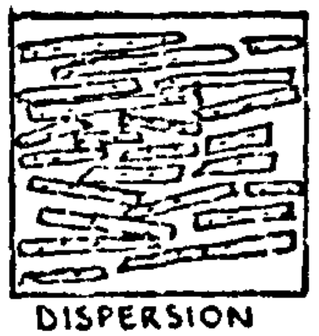
LAMBE (1958)



SALT FLOCCULATED

FIG. 2.3.

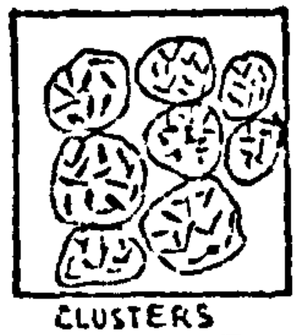
LAMBE (1958)



DISPERSION

FIG. 2.4.

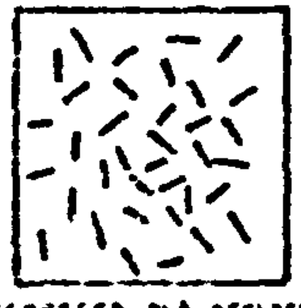
LAMBE (1958)



CLUSTERS

FIG. 2.5

OLSEN (1962)

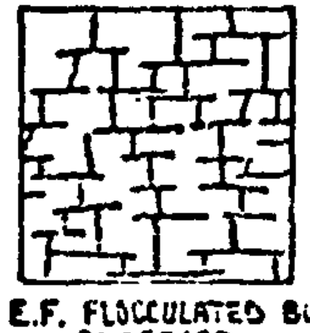


DISPERSED AND DEFLOCCULATED

(a)

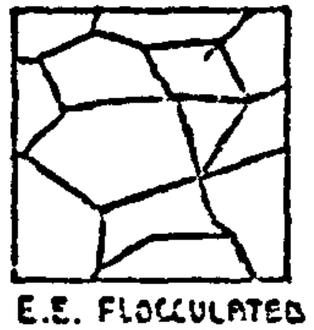
AGGREGATED BUT DEFLOCCULATED

(b)



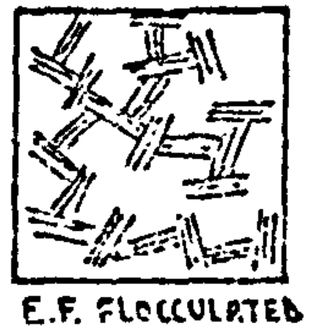
E.F. FLOCCULATED BUT DISPERSED.

(c)



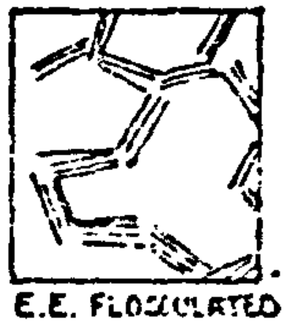
E.E. FLOCCULATED BUT DISPERSED

(d)



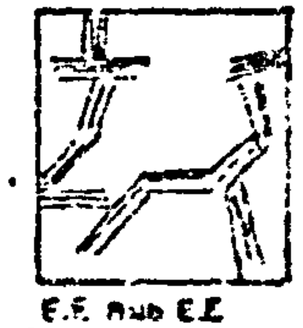
E.F. FLOCCULATED AND AGGREGATED

(e)



E.E. FLOCCULATED AND AGGREGATED

(f)



E.E AND E.E FLOCCULATED, AGGREGATED

(g)

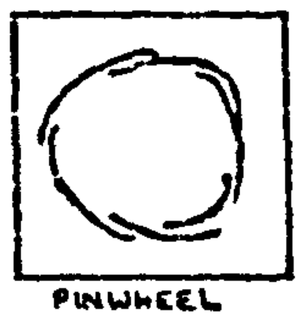
FIG. 2.6

MODES OF PARTICLE ASSOCIATION IN CLAY SUSPENSIONS

VAN OLPHEN (1963)

STEP-STEPPED CROSSHORSE.

(a)



PINWHEEL

(b)

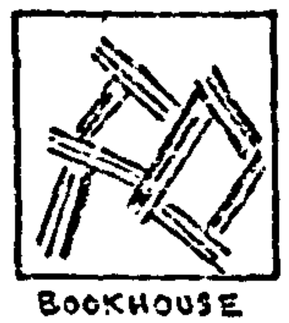
FIG. 2.7

O'BRIEN (1971)

TURBOSTRATIC DOMAINS

FIG. 2.8.

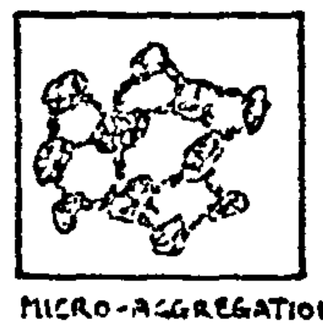
BARDEN AND SIDES (1971)



BOOKHOUSE

FIG. 2.9

BARDEN AND SIDES (1971)



MICRO-AGGREGATION - FRESHWATER

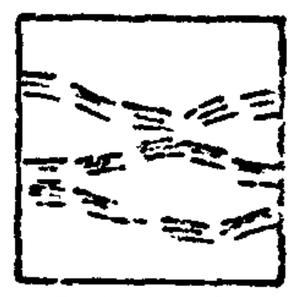
(a)

MICRO-AGGREGATION - MARINE

(b)

FIG. 2.10

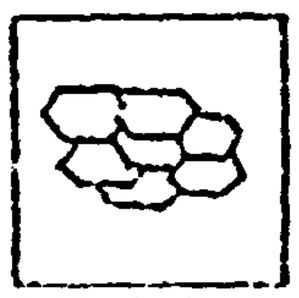
POSCH (1973)



TACTOIDAL

FIG. 2.11.

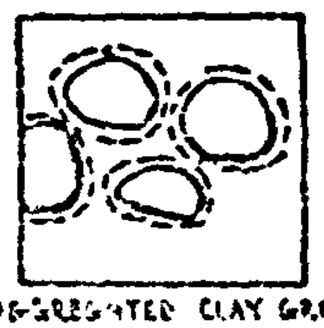
EMERSON (1962)



PARTICLE INTERGROWTH

FIG. 2.12.

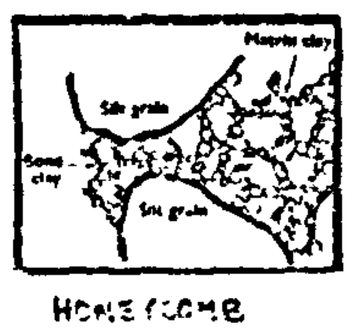
SMART (1969)



AGGREGATED CLAY GRAIN ARRANGEMENTS.

FIG. 2.13.

DUDLEY (1970)



HONEYCOMB

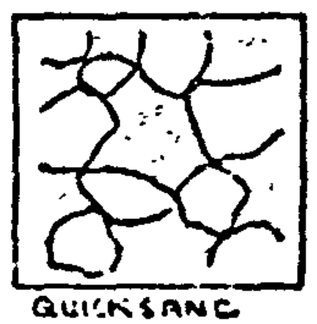
FIG. 2.14

CASAGRANDE (1932)

BRAIDED

FIG. 2.15

SMART (1969)

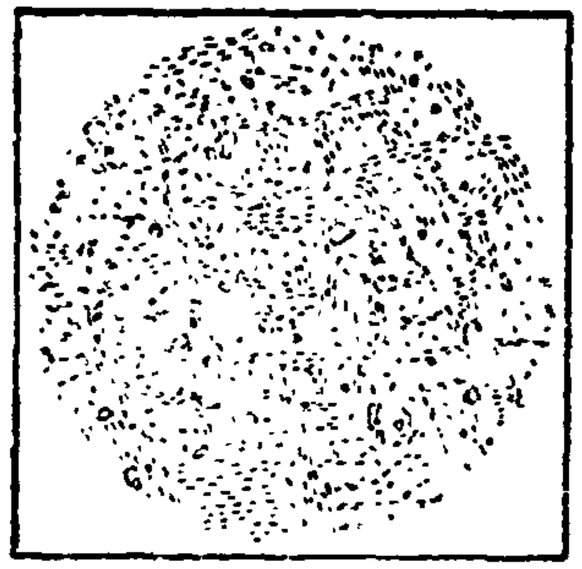


QUICKSAND

FIG. 2.16

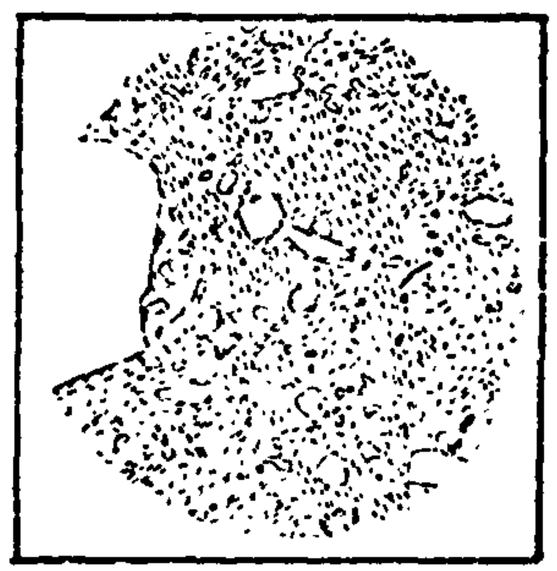
TERZAGHI AND PECK (1948)

150μ



PERPENDICULAR FIBROUS

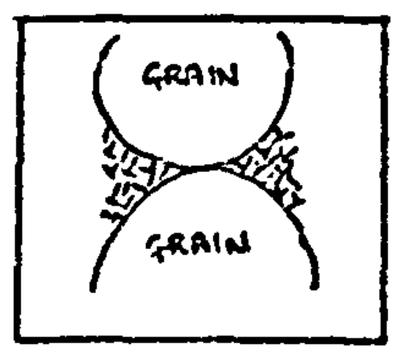
FIG. 2.17.



CRISS-CROSS FIBROUS

FIG. 2.18.

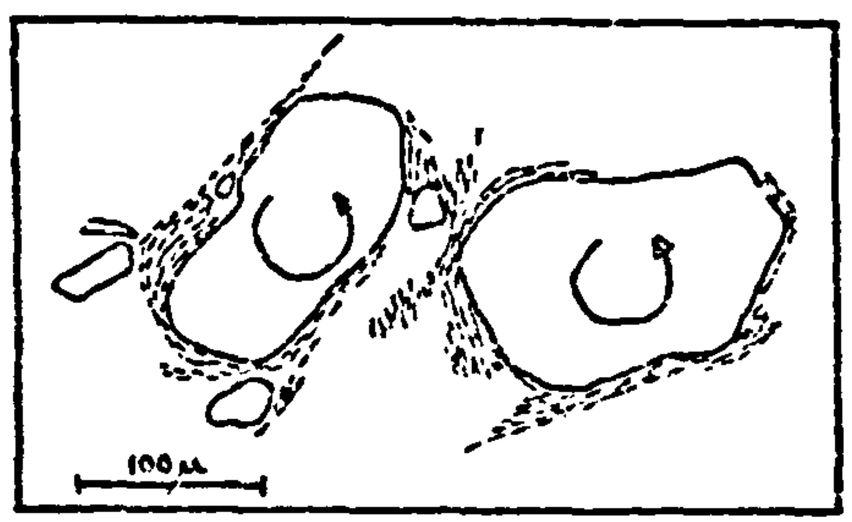
KORINA AND FAUSTOVA (1964)



RING BUTTRESS

FIG. 2.20.

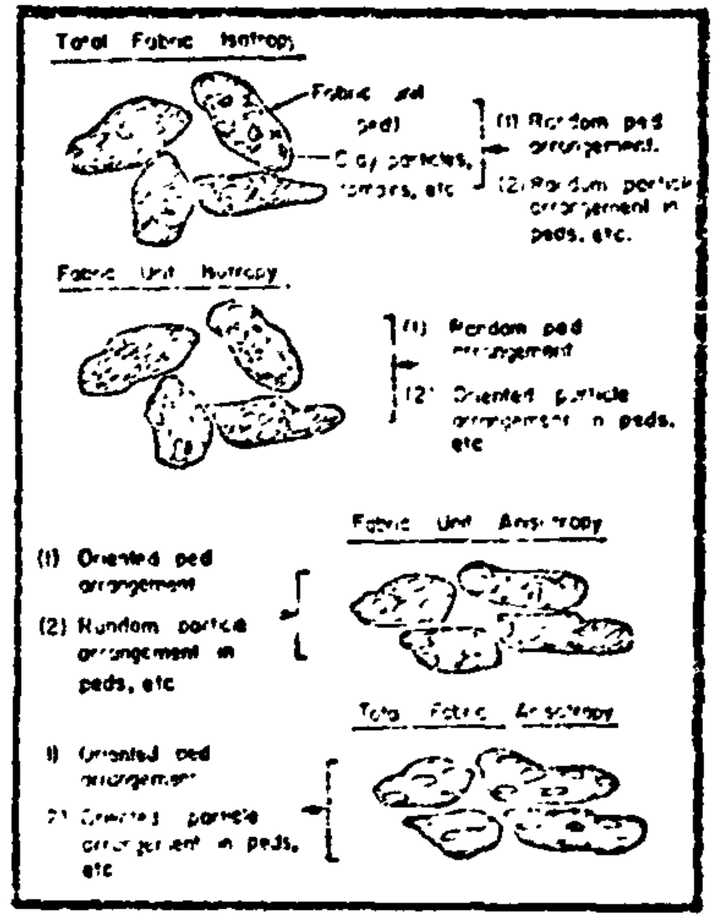
DUDLEY (1970)



PARTIAL STRIPPING OF CUTAN

FIG. 2.19

LAFESER (1964)



FIRST- AND SECOND-ORDER FABRIC CHARACTERISATION.

FIG. 2.21.

YONG AND WARKENTIN (1975)

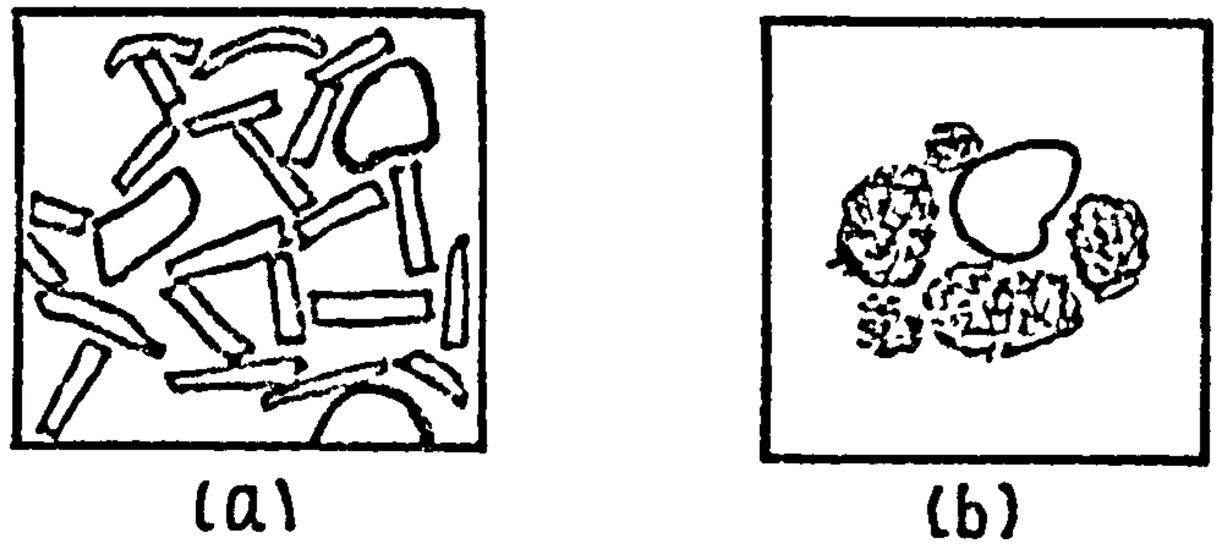


FIG. 3.1. RANDOM CLAY ARRANGEMENTS

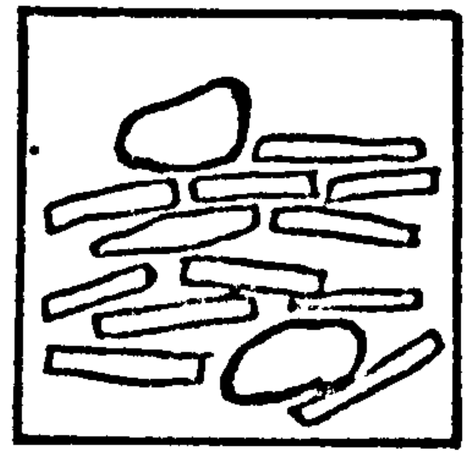


FIG. 3.2. PARALLEL CLAY

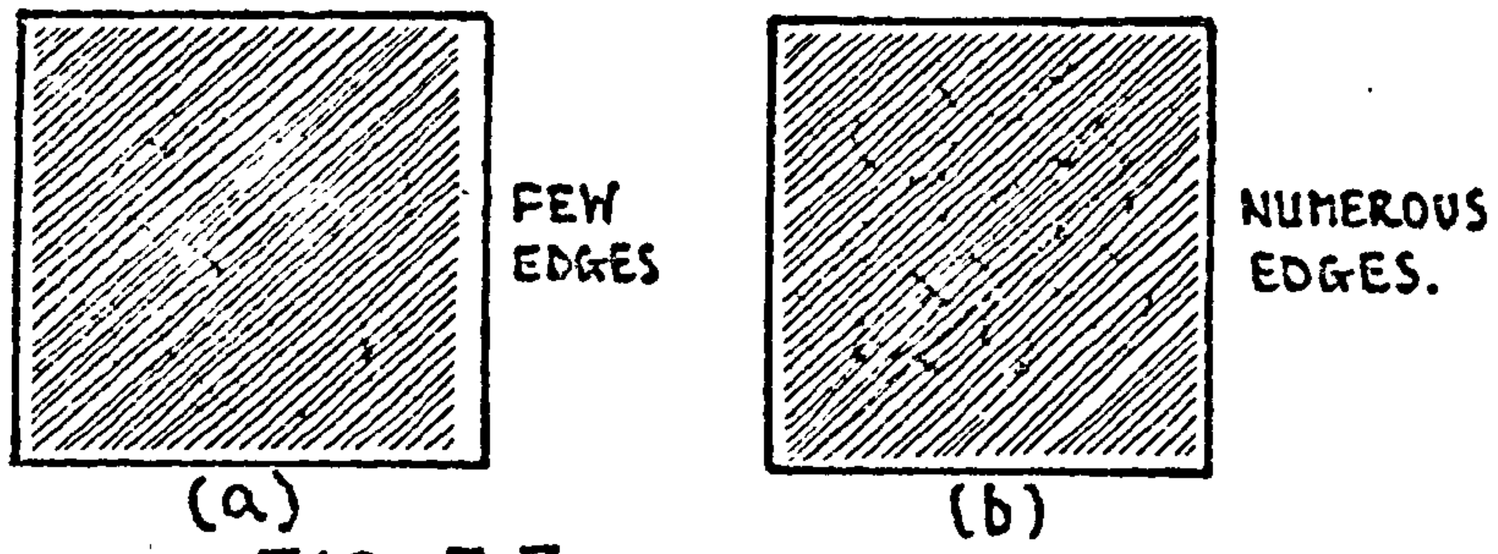


FIG. 3.3. PARTLY DISCERNIBLE CLAY ARRANGEMENTS.

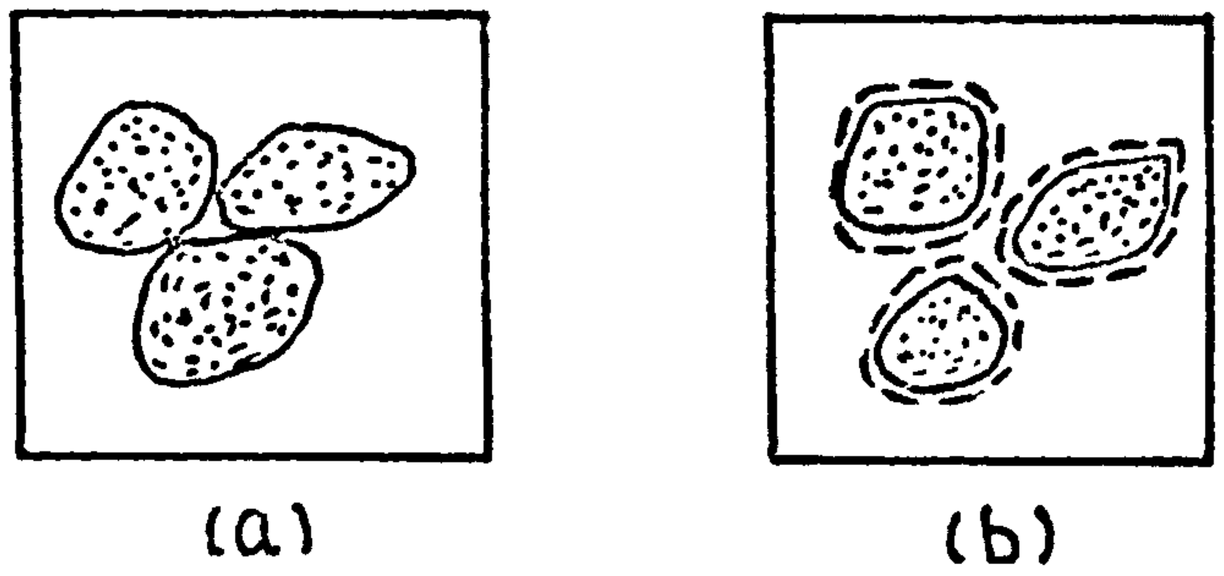
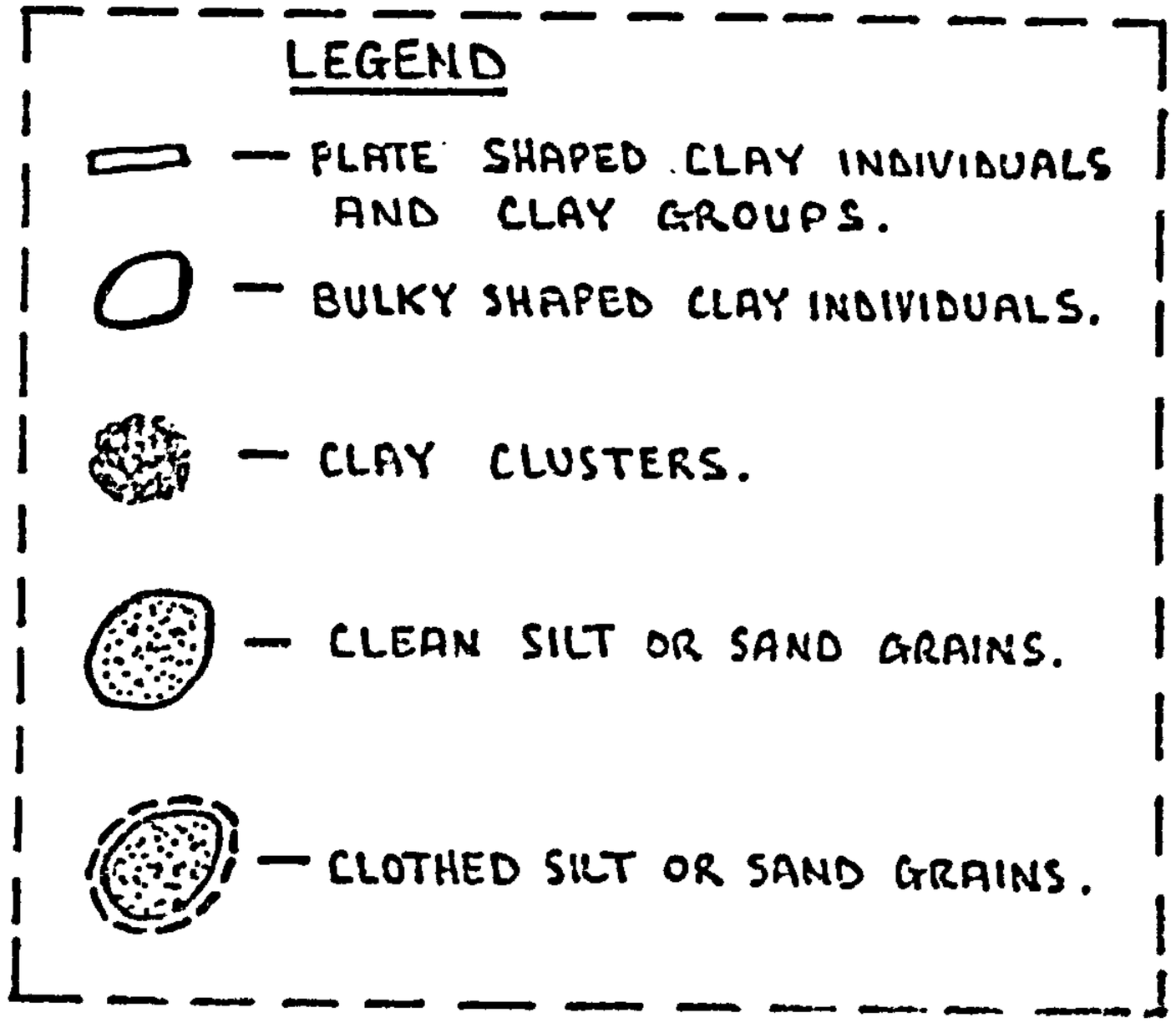


FIG. 3.4. GRANULAR ARRANGEMENTS



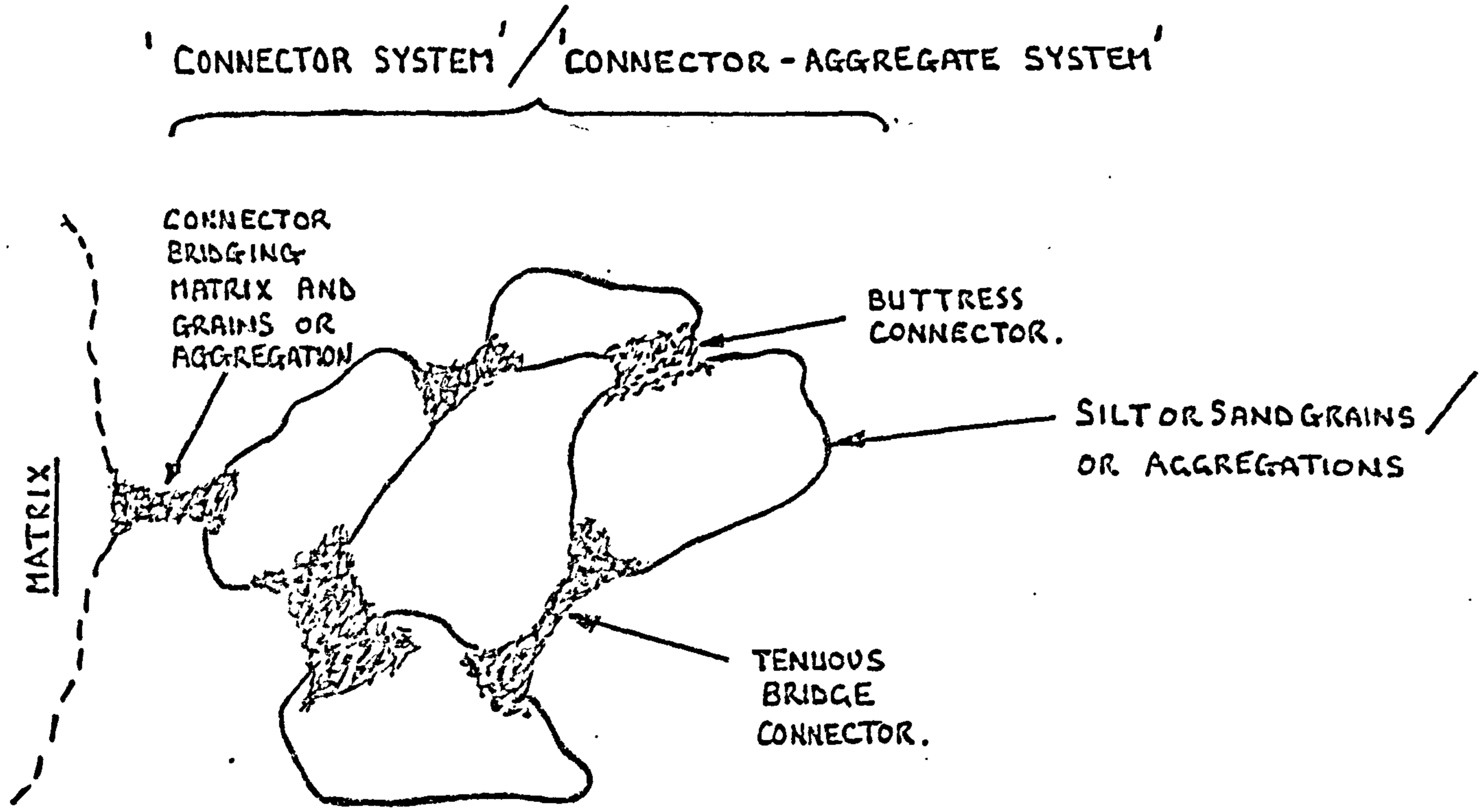
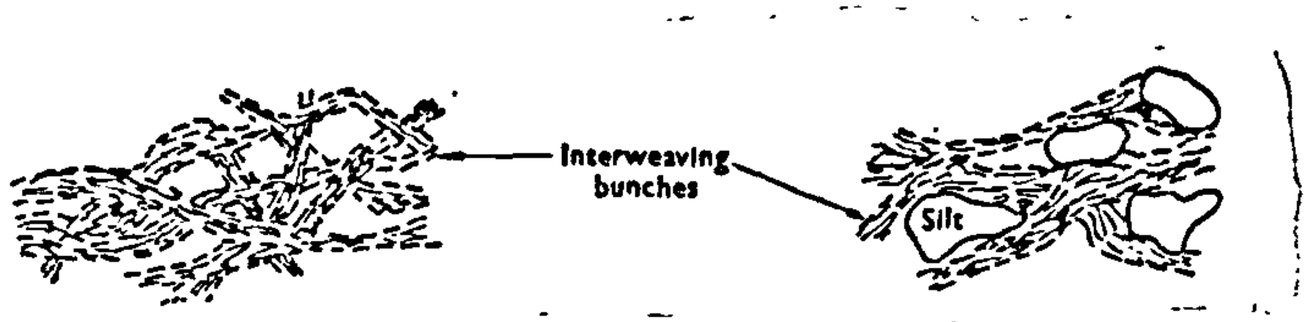


FIG. 3.5. NATURE AND OCCURRENCE OF CONNECTOR ASSEMBLAGES.



(a) INTERWOVEN SYSTEM.

(b) INTERWOVEN SYSTEM WITH SILT INCLUSIONS.

FIG. 3.7. NATURE AND OCCURRENCE OF INTERWEAVING BUNCHES.

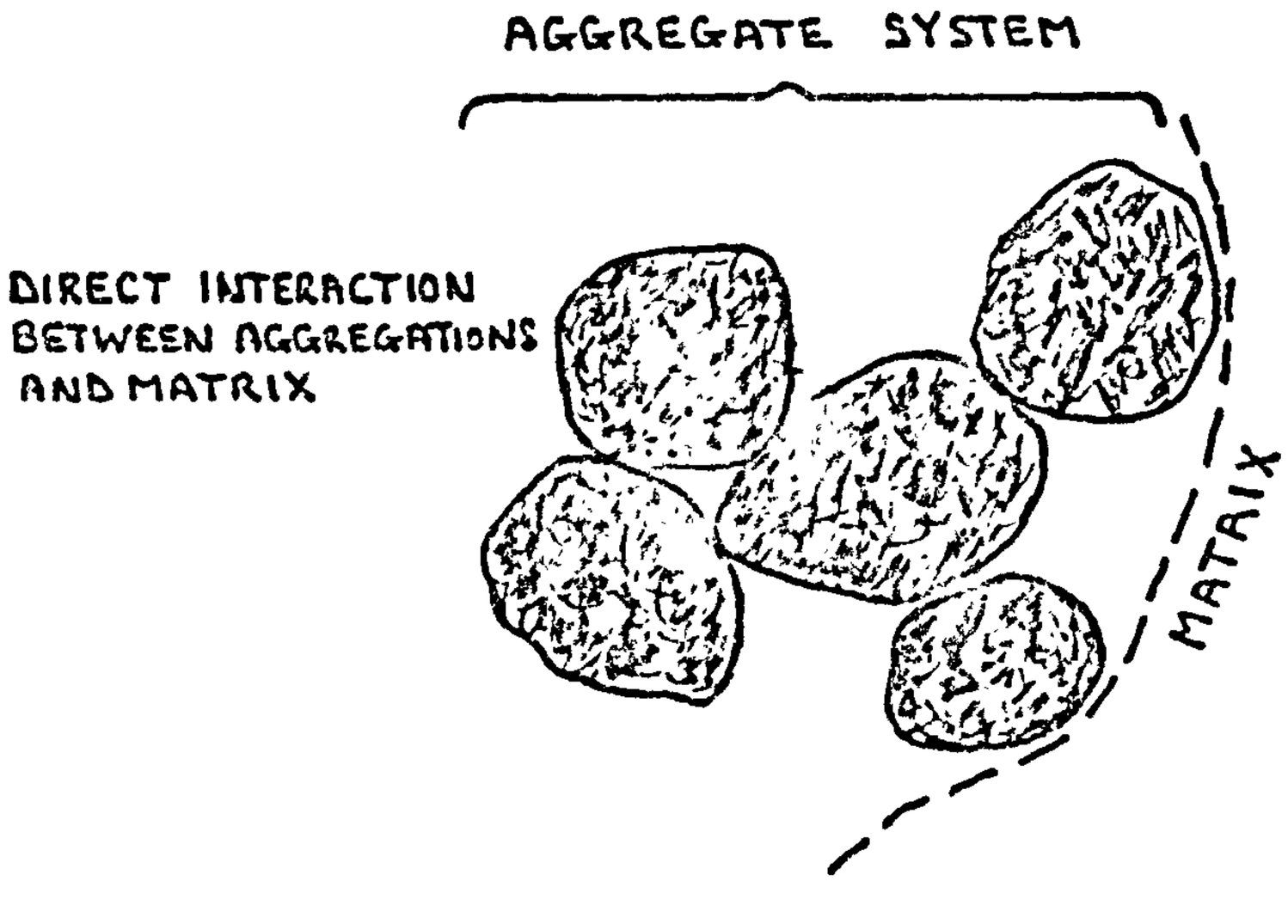


FIG. 3.6 NATURE AND OCCURRENCE OF REGULAR AGGREGATIONS.

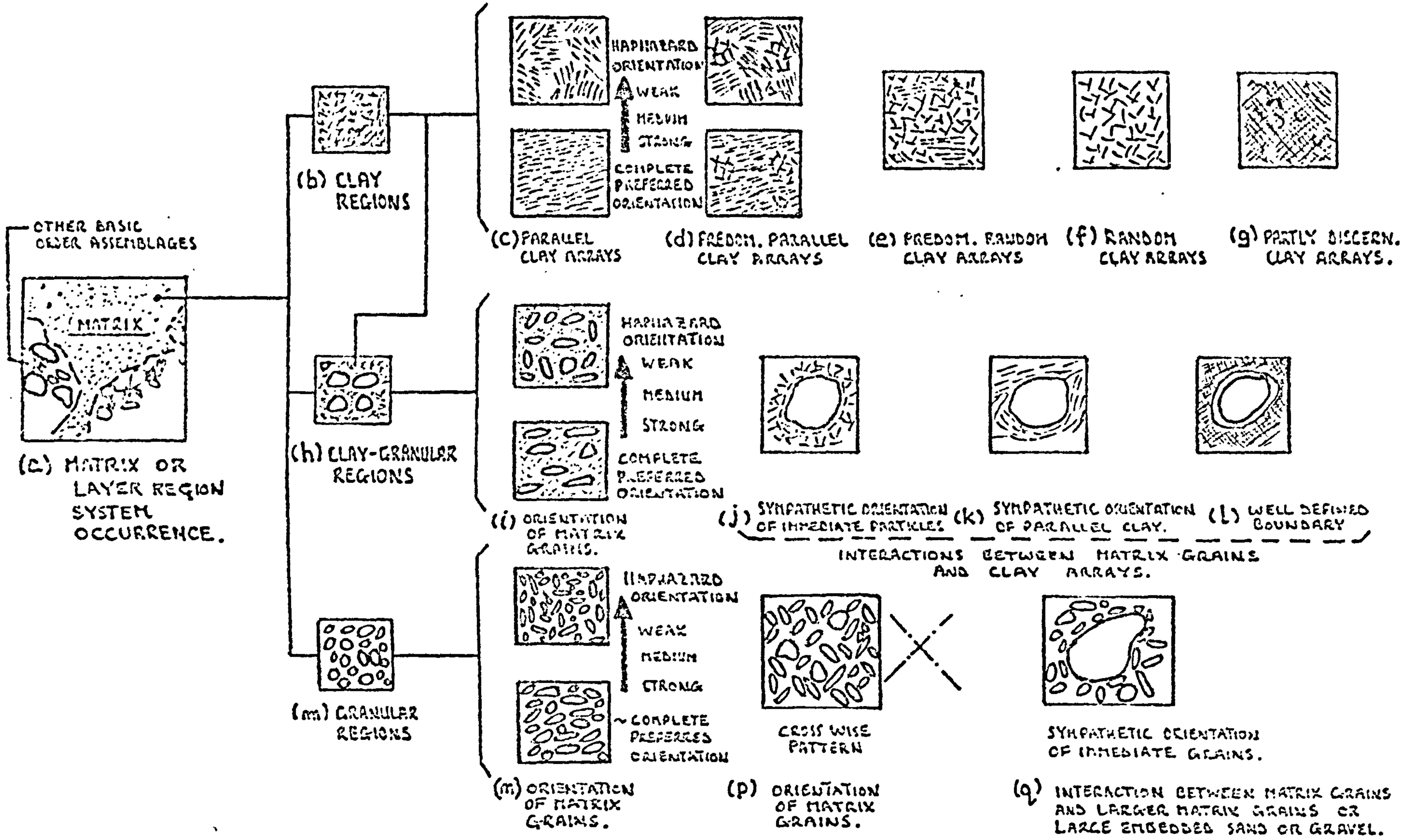


FIG. 3.8 THE NATURE OF PARTICLE MATRICES AND LAYER REGION SYSTEMS

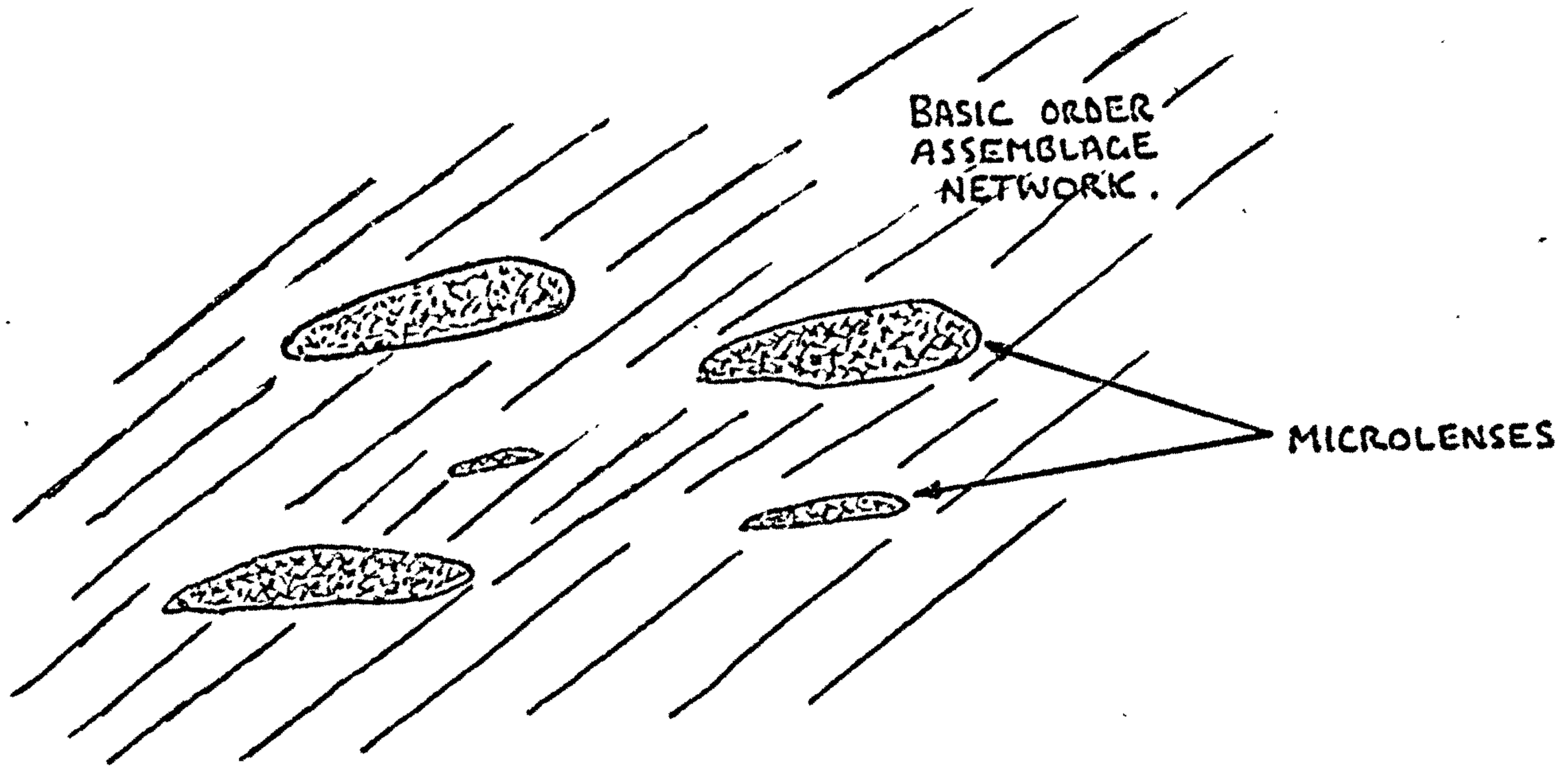


FIG. 3.9. NATURE AND OCCURRENCE OF MICROLENSES.

(a) INDIVIDUAL VEINS.

(b) CLAY VEIN SYSTEMS.

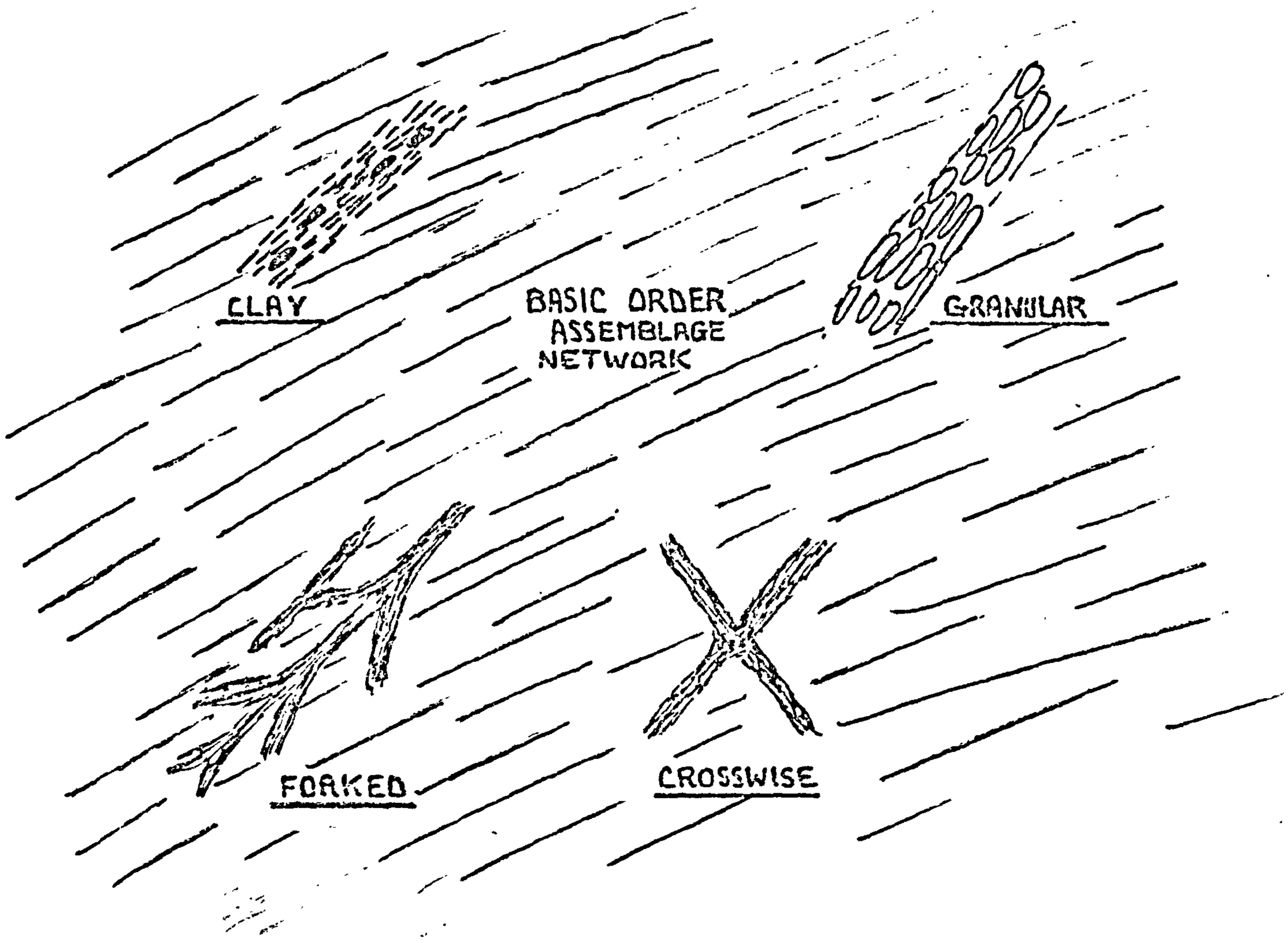
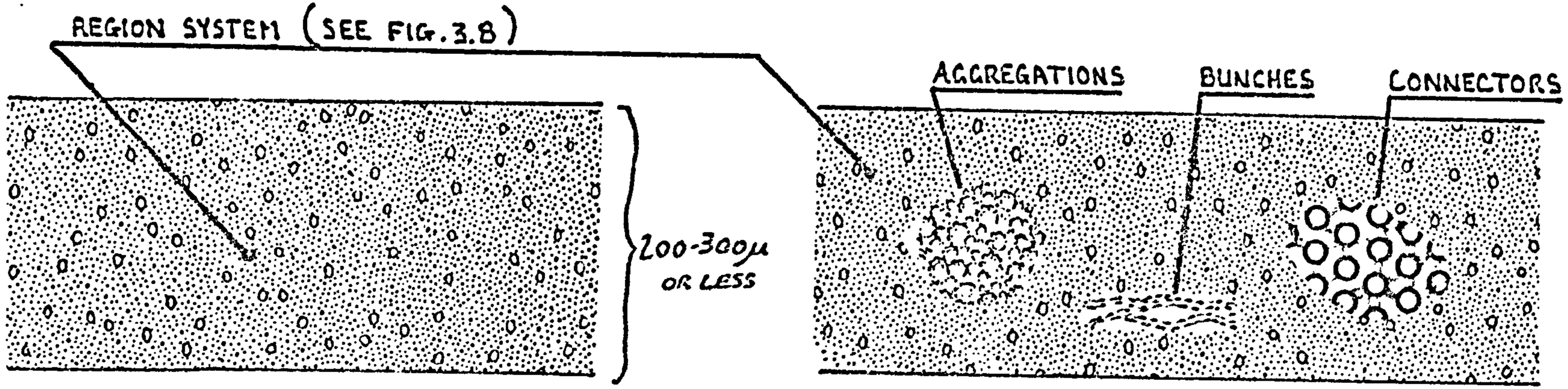


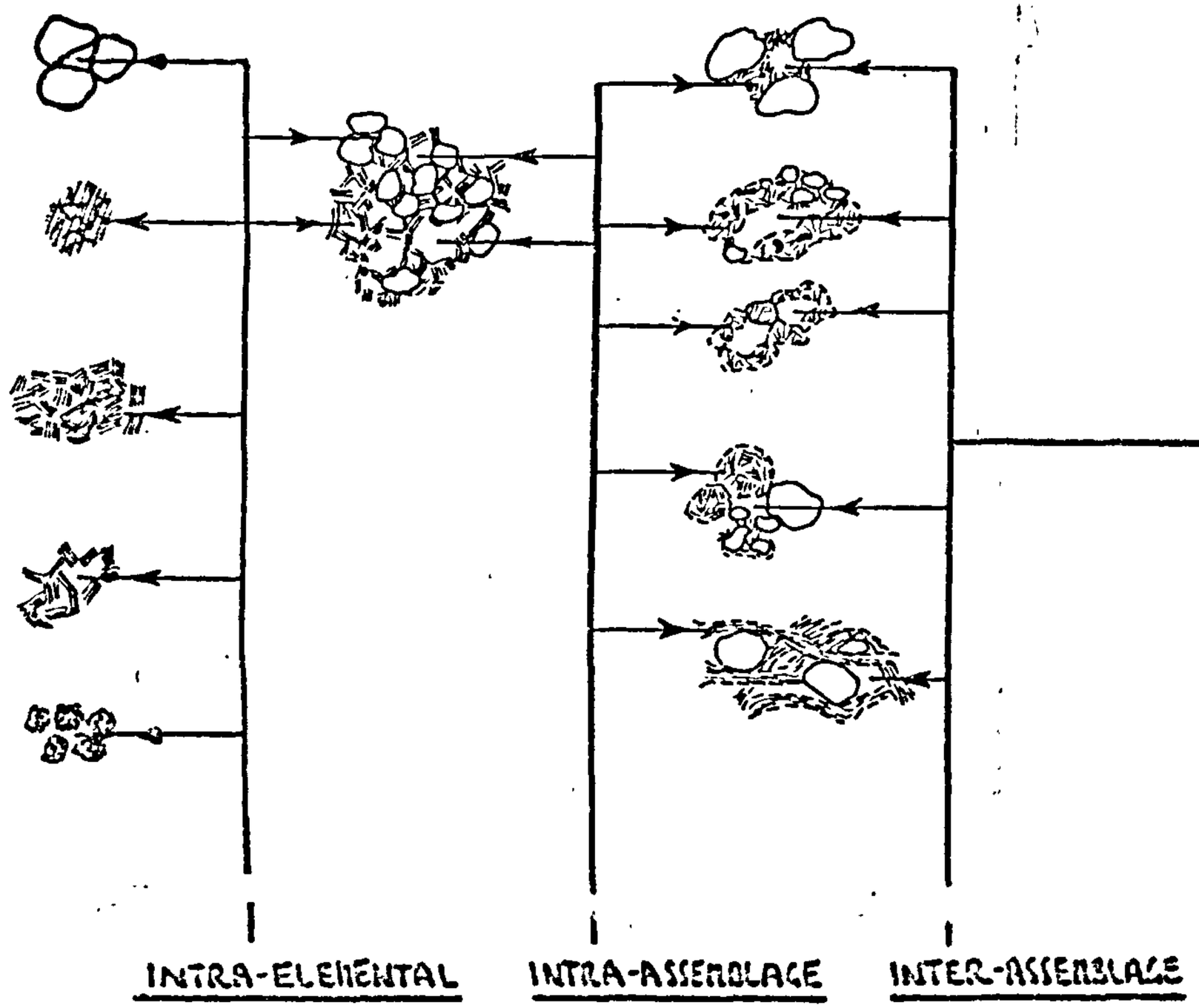
FIG. 3.10 NATURE AND OCCURRENCE OF MICROVEINS



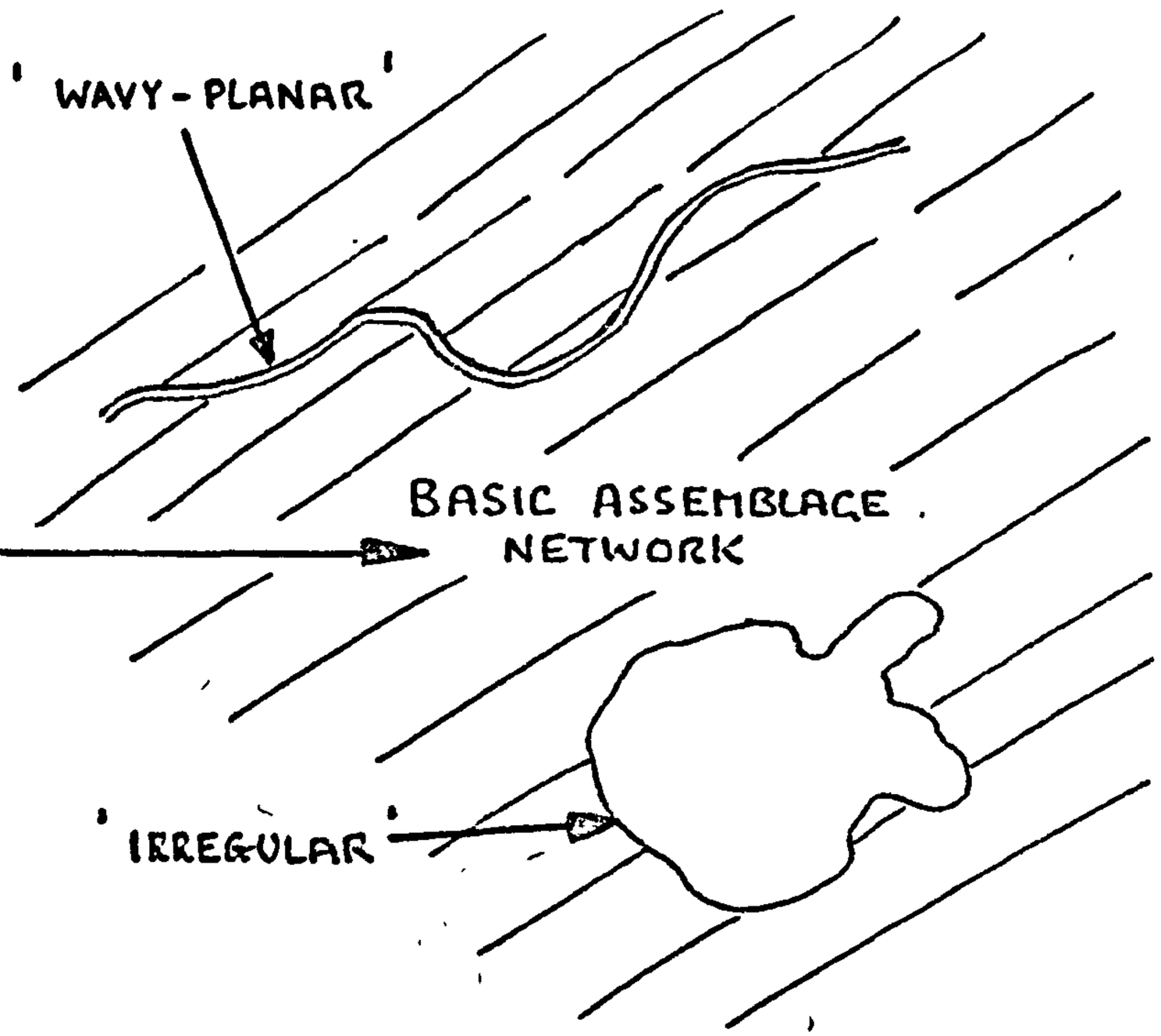
(a) LAYER COMPRISED ENTIRELY OF ELEMENTARY PARTICLE ARRAYS

(b) LAYER COMPRISED OF REGION SYSTEM, AGGREGATIONS, BUNCHES, CONNECTORS.

FIG. 3.11. INTERNAL ORGANISATION OF MICROLAYERS.

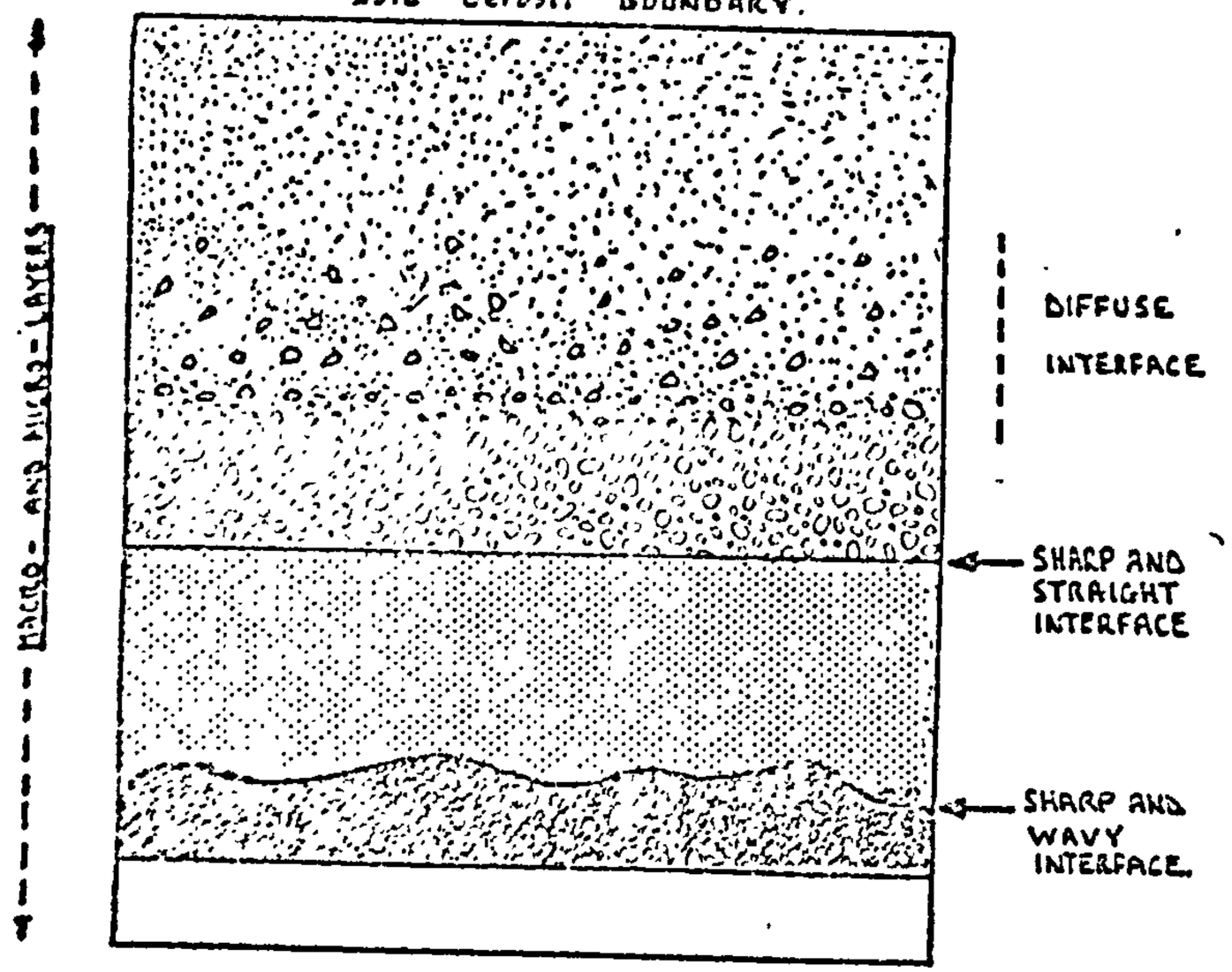


(a) BASIC PORES

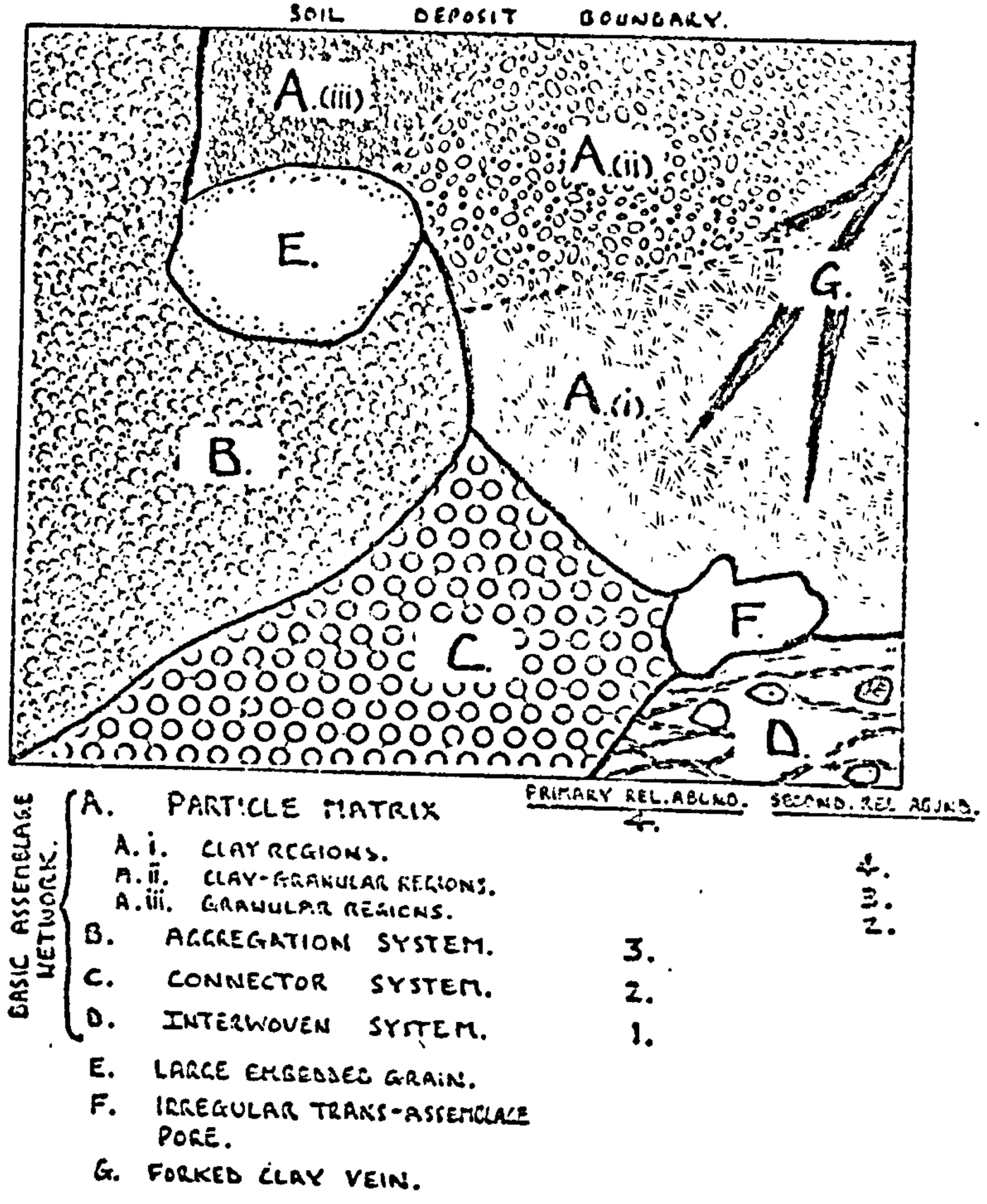


(b) TRANS ASSEMBLAGE PORES.

FIG. 3.12. NATURE AND OCCURRENCE OF PORE SPACES.



(a) Layered Soil



(b) Non Layered Soil

FIG. 3.13 COMPOSITE MICROFABRIC

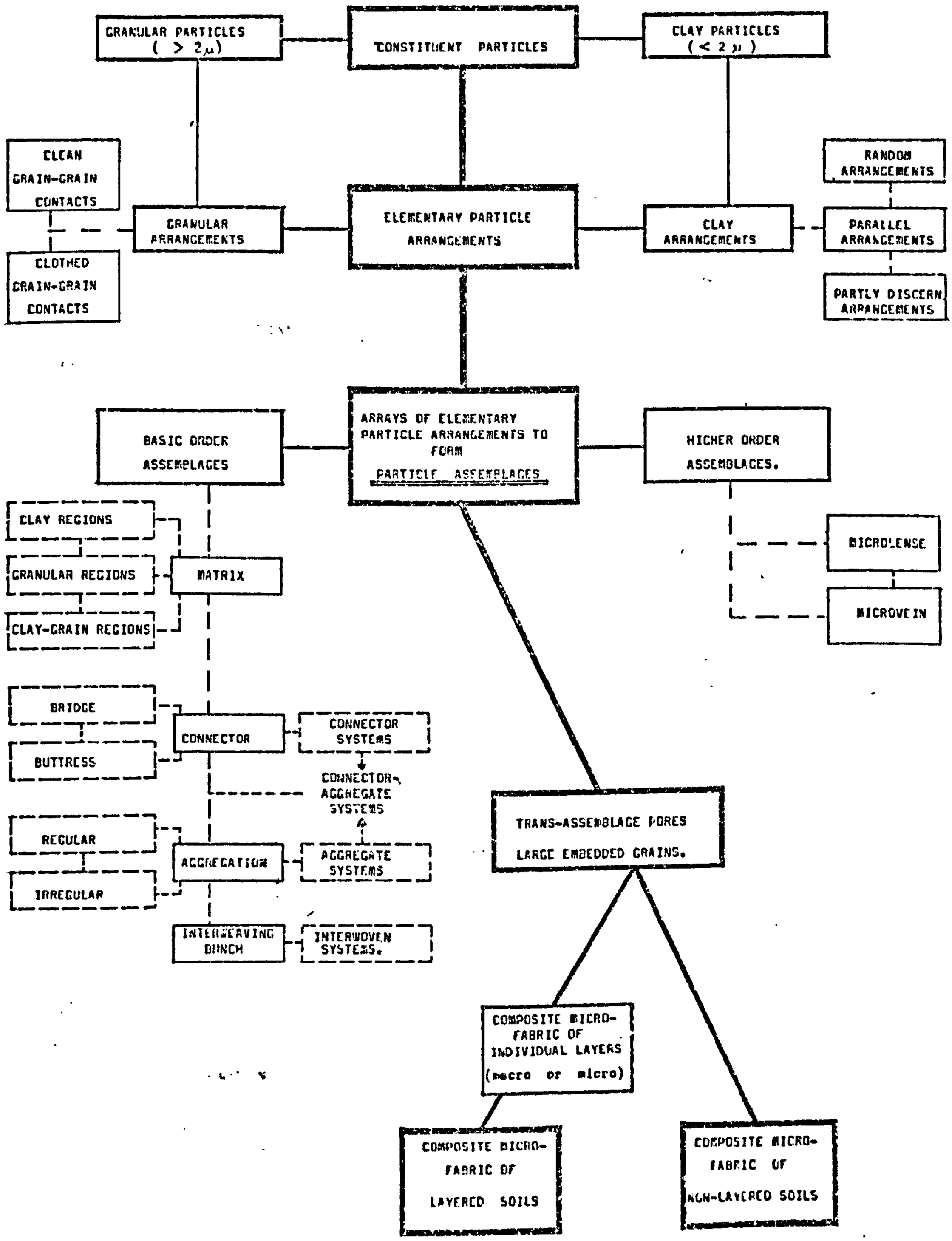


FIG. 3.14. SUMMARY OF MICROFABRIC CHARACTERISATION SCHEME

FIGURES - CHAPTER 5

LEGEND

MICROFABRIC FORMS

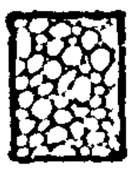
R - Random clay arrangements

P - Parallel clay arrangements

PD - Partly discernible clay arrangements

CLE - Clean grain-grain contacts

CLO - Clothed grain-grain contacts

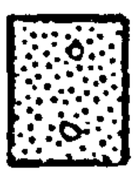


C - Clay regions

G - Granular regions

C-G - Clay-granular regions

Within either Matrix or region system



BR - Bridge connector

BU - Buttress connector

Reg - Regular aggregation

Irr - Irregular aggregation

Interweaving bunch

Intra-elemental

Intra-assemblage

Inter-assemblage

COMPOSITE MICROFABRIC ANISOTROPY

PRED. - Predominantly

S.P.O. - Strong preferred orientation

M.P.O. - Medium preferred orientation

W.P.O. - Weak preferred orientation

FIG. 5.1. MICROFABRIC OF MARINE CLAYEY SILT - CHANGEMOUTH, SCOTLAND

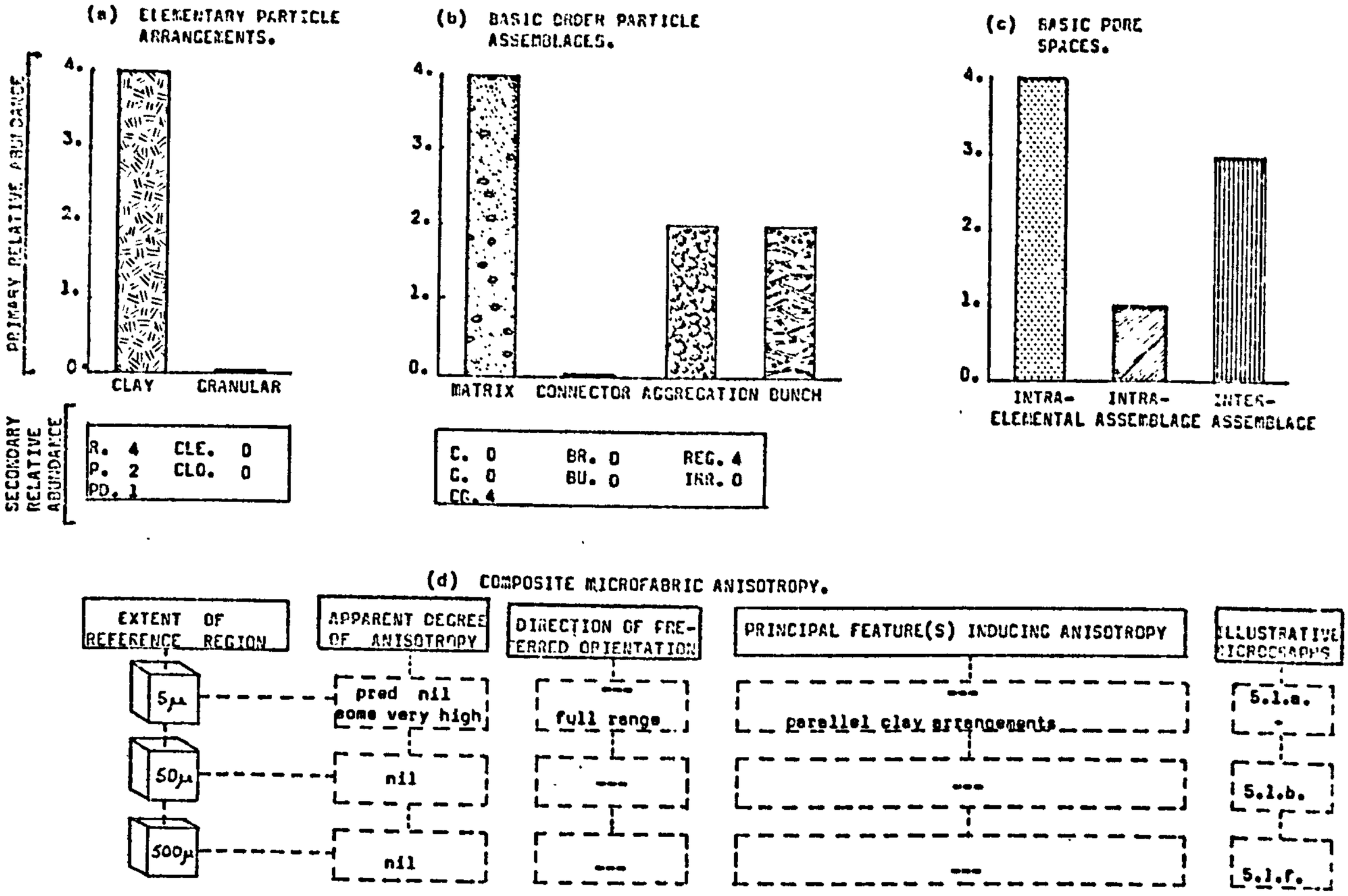


FIG. 5.2. MICROFABRIC OF MARINE PLASTIC CLAY - DRAMMEN TOWN, NORWAY

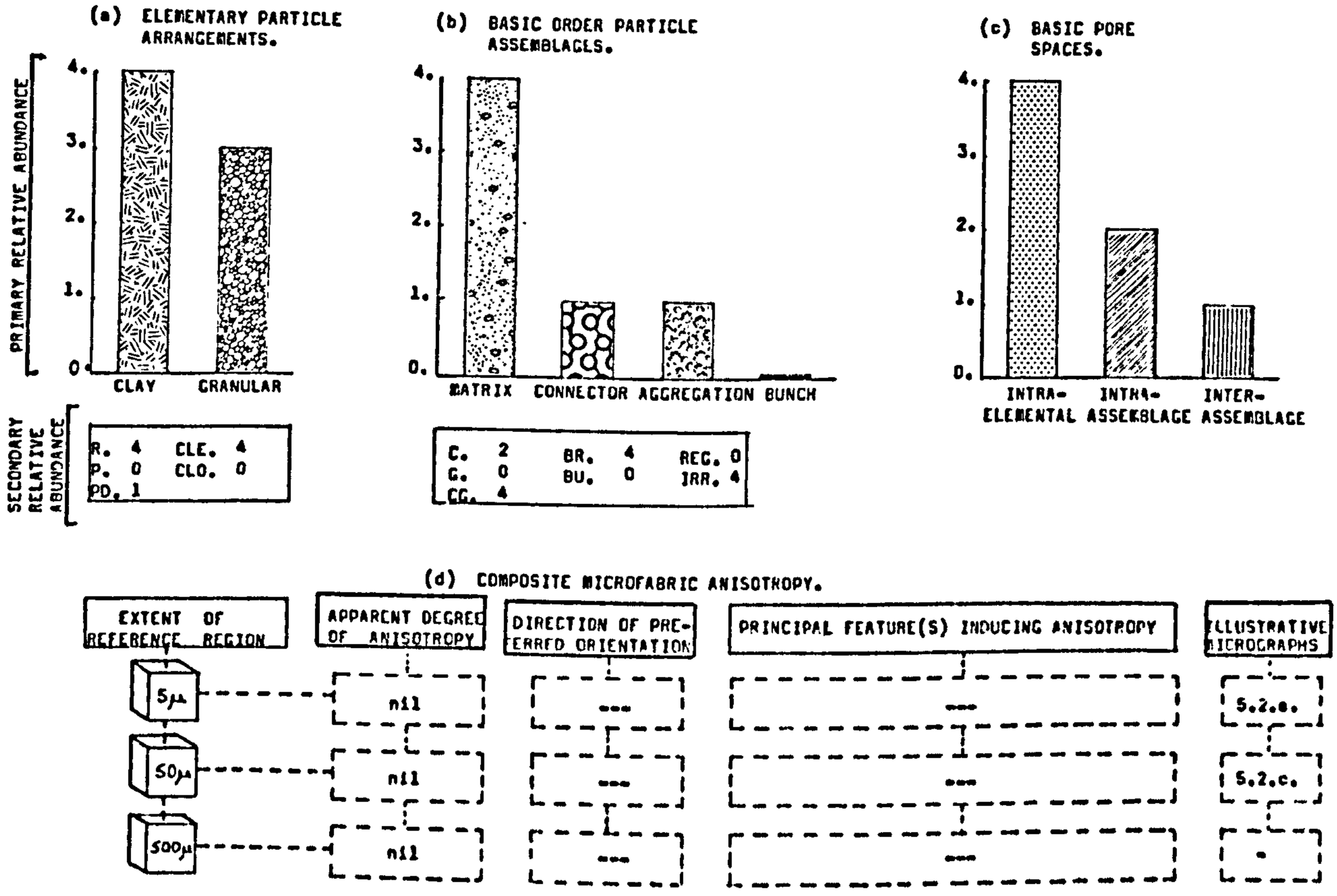


FIG. 5.3. MICROFABRIC OF MARINE CLAYEY SILT - SUNDLAND, NORWAY

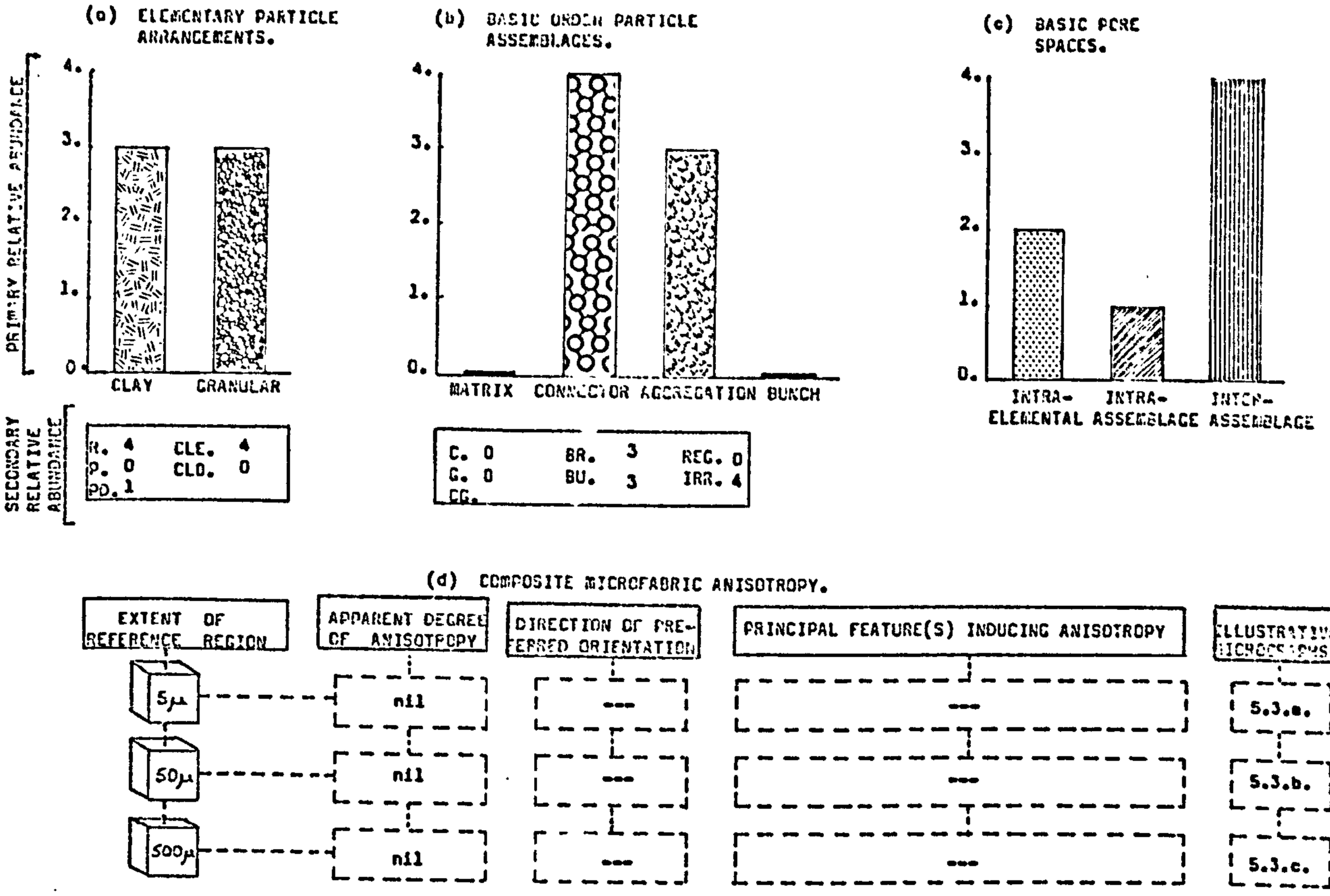


FIG. 5.4. MICROFABRIC OF MARINE SILTY CLAY - SOLBERGELVA, NORWAY

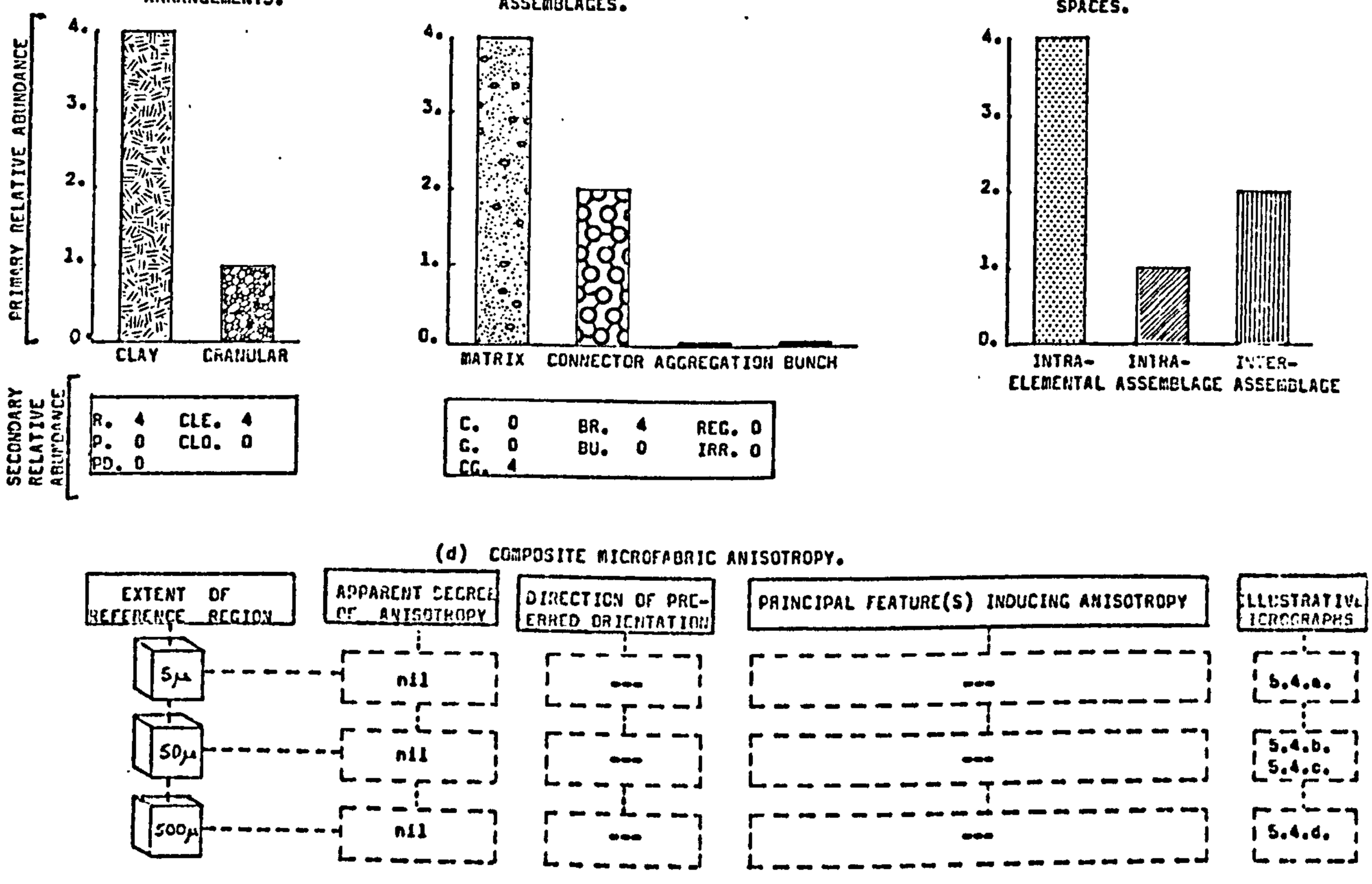
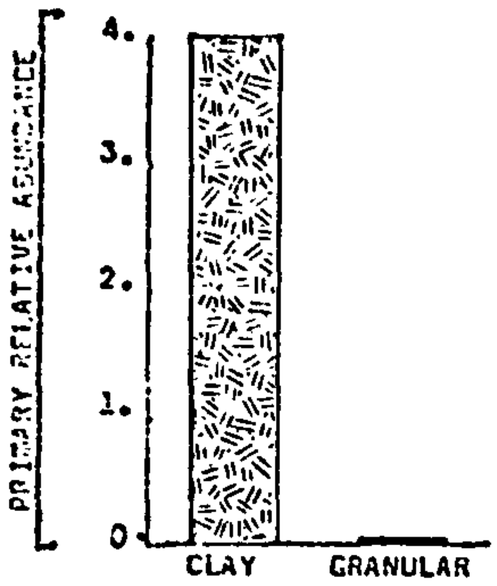


FIG. 5.5. MICROFABRIC OF MARINE SILTY CLAY - ELLINGSRUD, NORWAY

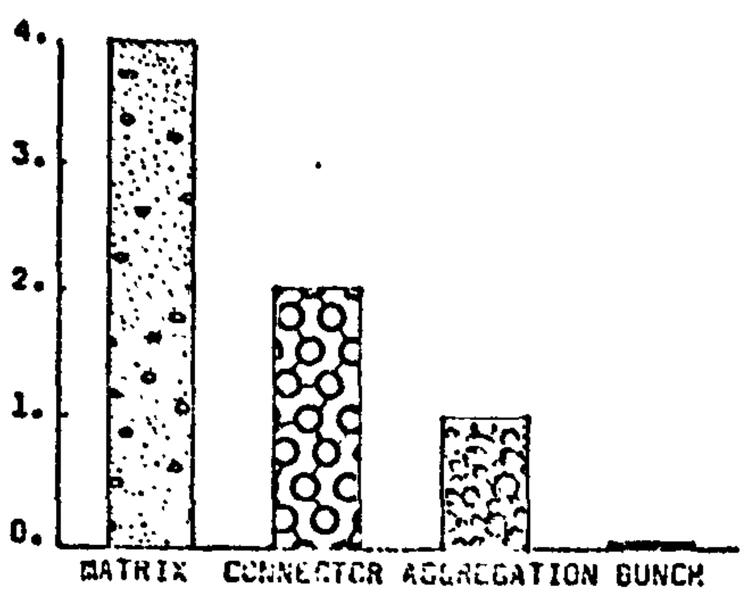
(a) ELEMENTARY PARTICLE ARRANGEMENTS.



SECONDARY RELATIVE ABUNDANCE

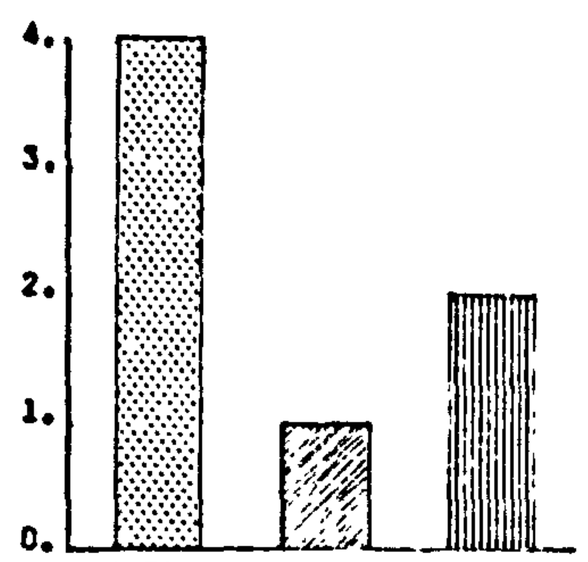
R.	4	CLE.	
P.	0	CLO.	
PD.	0		

(b) BASIC ORDER PARTICLE ASSEMBLAGES.



C.	0	BR.	3	REG.	0
G.	0	BU.	3	IRR.	4
CG.	4				

(c) BASIC PORE SPACES.

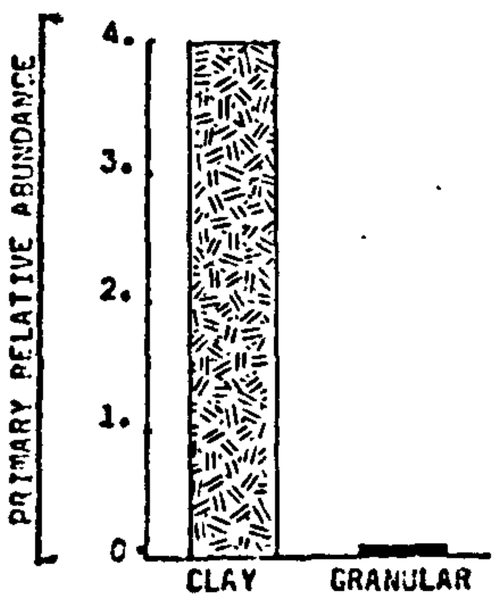


(d) COMPOSITE MICROFABRIC ANISOTROPY.

EXTENT OF REFERENCE REGION	APPARENT DEGREE OF ANISOTROPY	DIRECTION OF PREFERRED ORIENTATION	PRINCIPAL FEATURE(S) INDUCING ANISOTROPY	ILLUSTRATIVE MICROGRAPHS
5μ	nil	---	---	5.5.a.
50μ	low	horizontal	medium degree preferred orientation of silt grains.	5.5.b.
500μ	low	horizontal	medium degree preferred orientation of silt grains.	-

FIG. 5.6. MICROFABRIC OF MARINE CLAY - JACKSON, U.S.A.

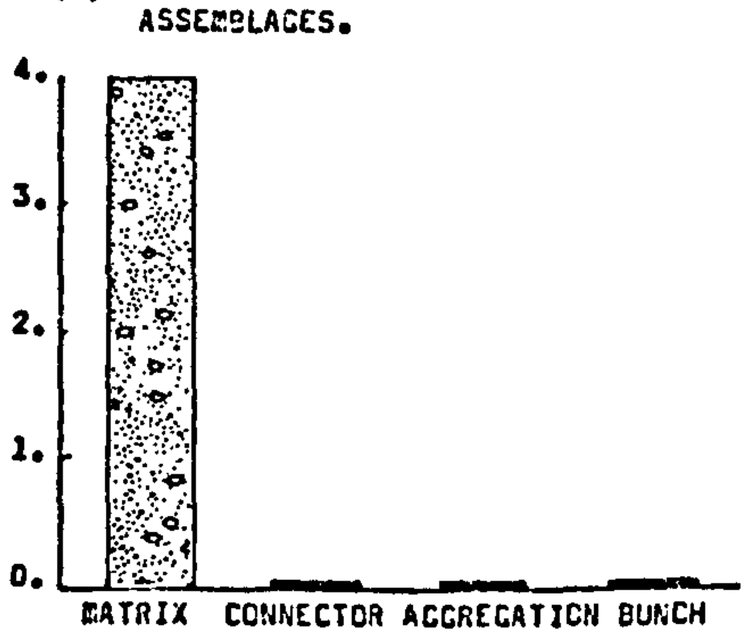
(a) ELEMENTARY PARTICLE ARRANGEMENTS.



SECONDARY RELATIVE ABUNDANCE

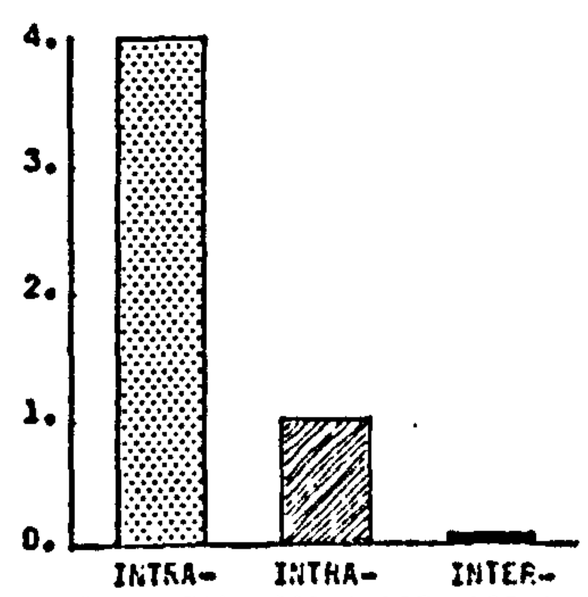
R.	2	CLE.	0
P.	4	CLO.	0
PD.	0		

(b) BASIC ORDER PARTICLE ASSEMBLAGES.



C.	4	BR.	0	REG.	0
G.	0	BU.	0	IRR.	0
CG.	0				

(c) BASIC PORE SPACES.



(d) COMPOSITE MICROFABRIC ANISOTROPY.

EXTENT OF REFERENCE REGION	APPARENT DEGREE OF ANISOTROPY	DIRECTION OF PREFERRED ORIENTATION	PRINCIPAL FEATURE(S) INDUCING ANISOTROPY	ILLUSTRATIVE MICROGRAPHS
5μ	pred very high some nil	horizontal ---	parallel clay arrangements	5.6.a. 5.6.b.
50μ	pred. very high some low	horizontal horizontal	parallel clay array with e.p.o. partly parallel clay array with e.p.o.	5.6.c. 5.6.d.
500μ	high	horizontal	predominently parallel clay array with e.p.o. plus e.p.o. of silt grains.	5.6.e.

FIG. 5.7. MICROFABRIC OF MARINE SILTY CLAY - LUANDA, ANGOLA

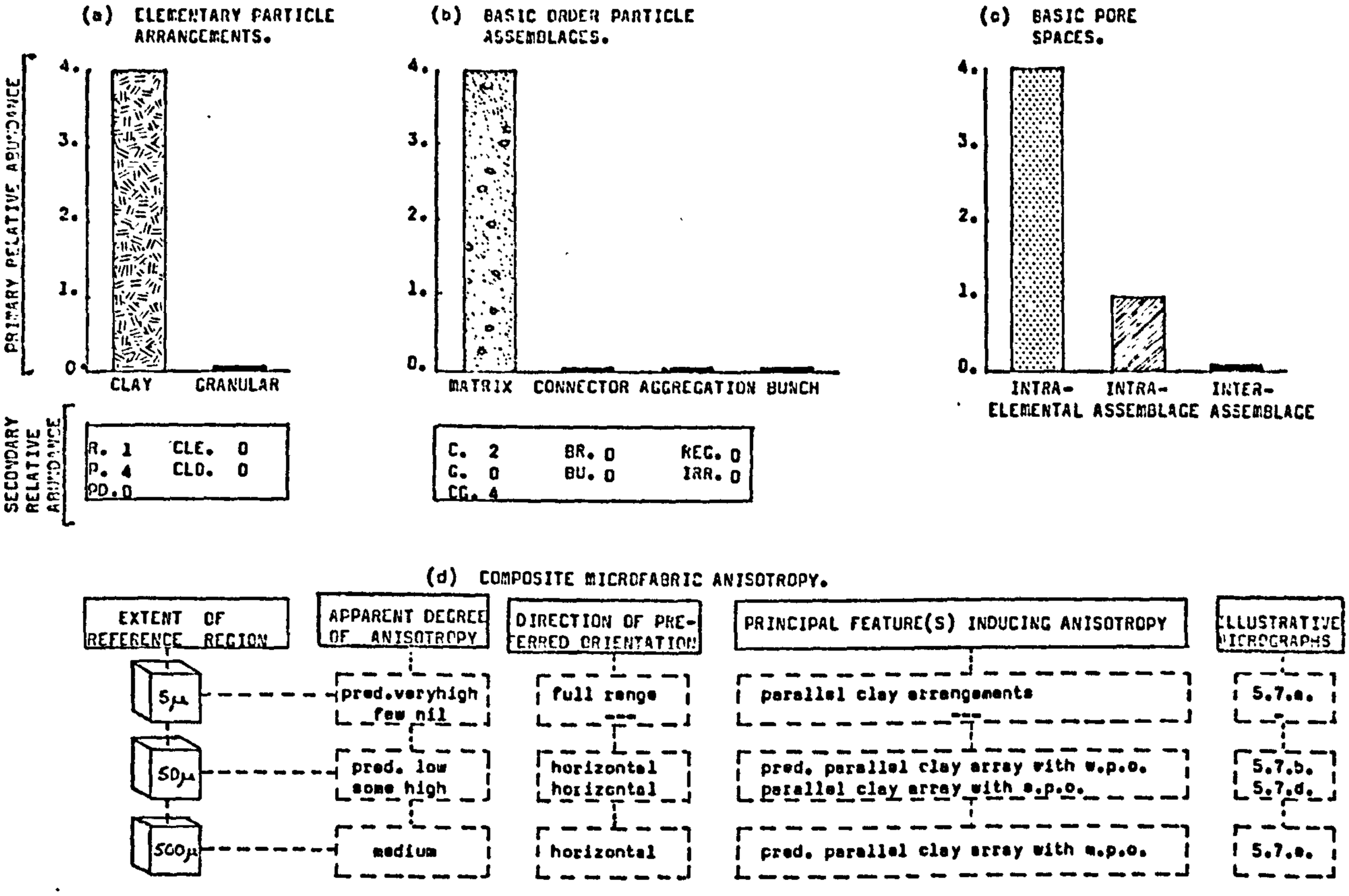


FIG. 5.8. MICROFABRIC OF ESTUARINE SILTY CLAY - GALLOWGATE, SCOTLAND

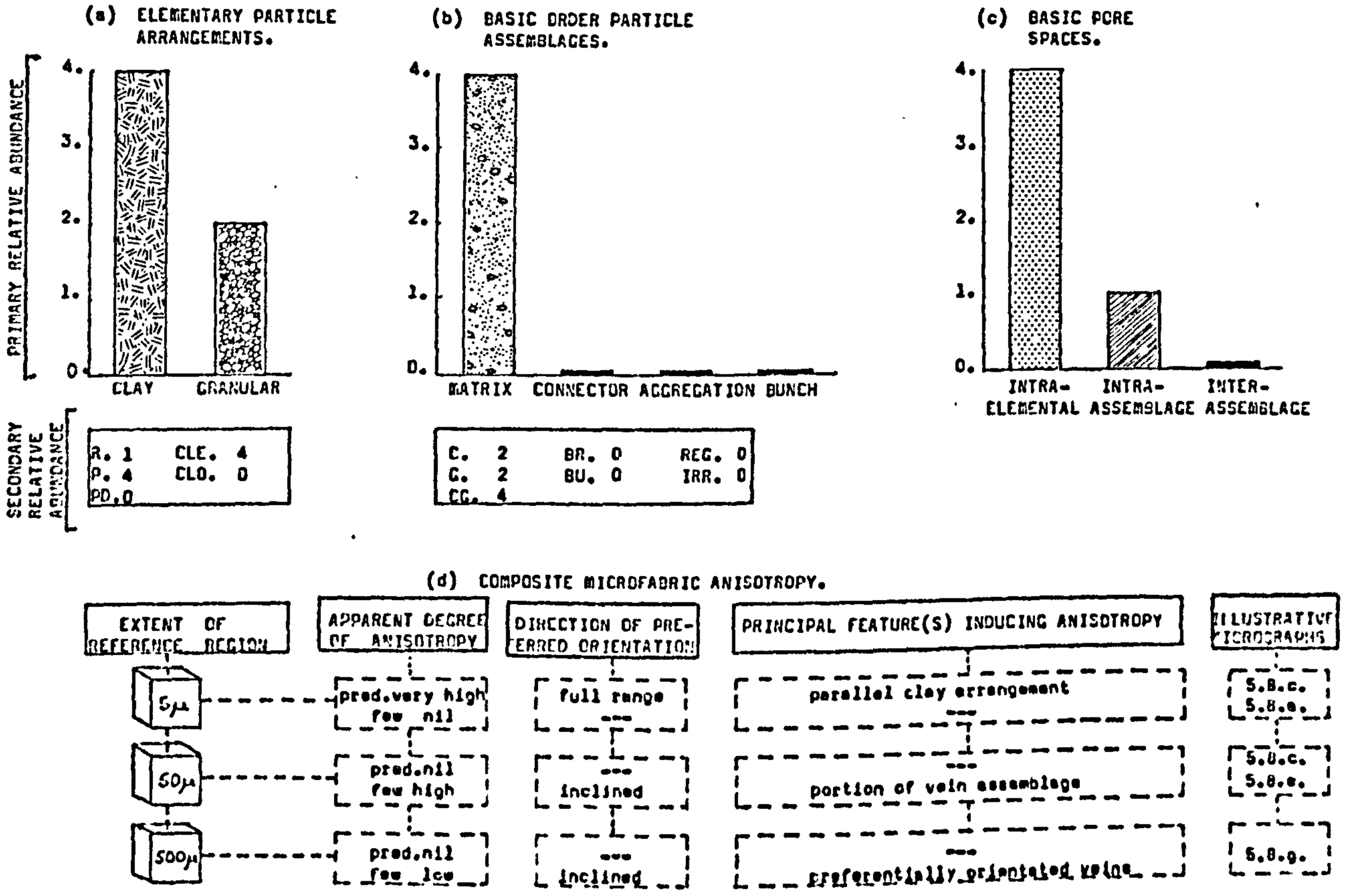
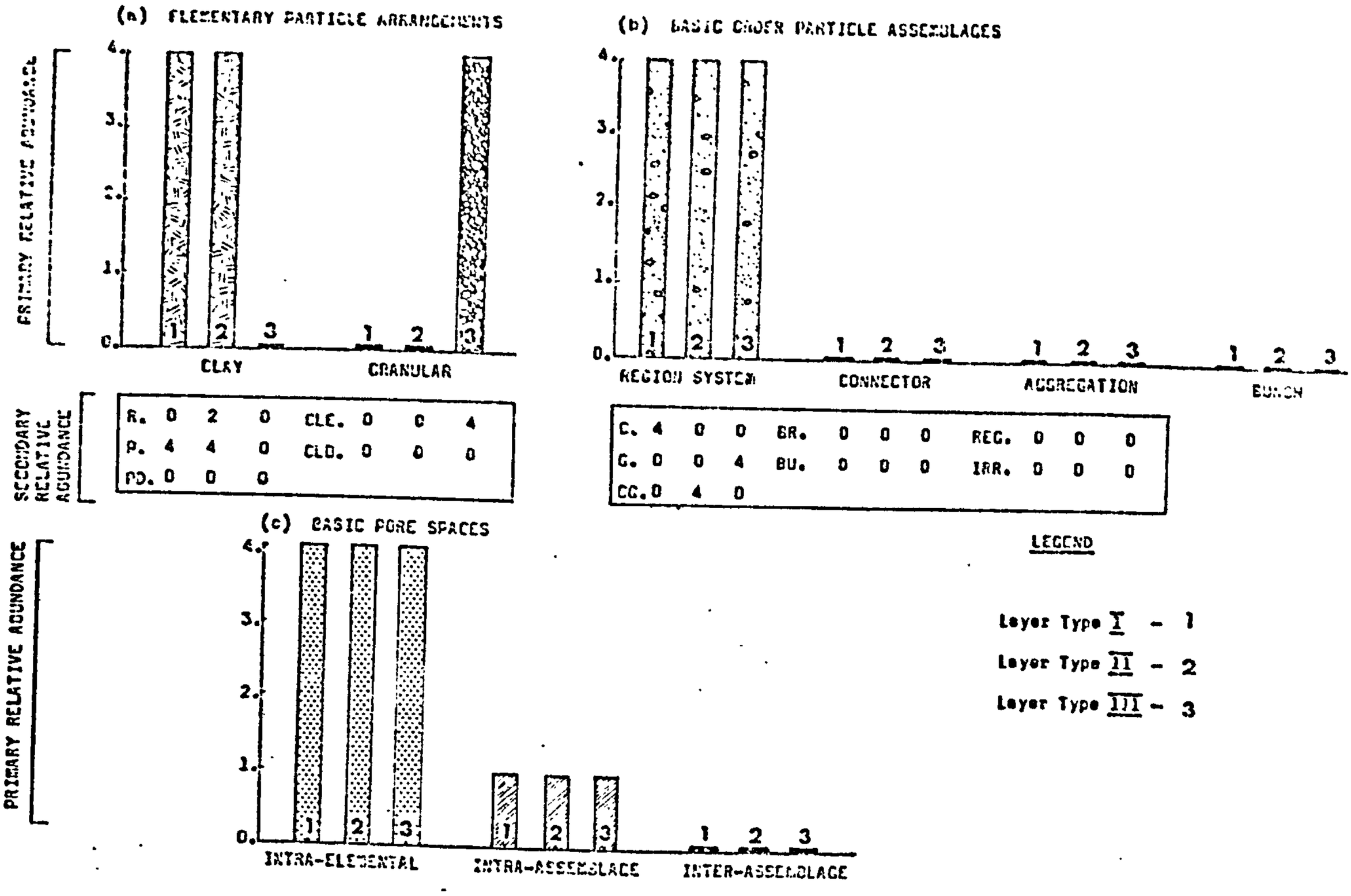


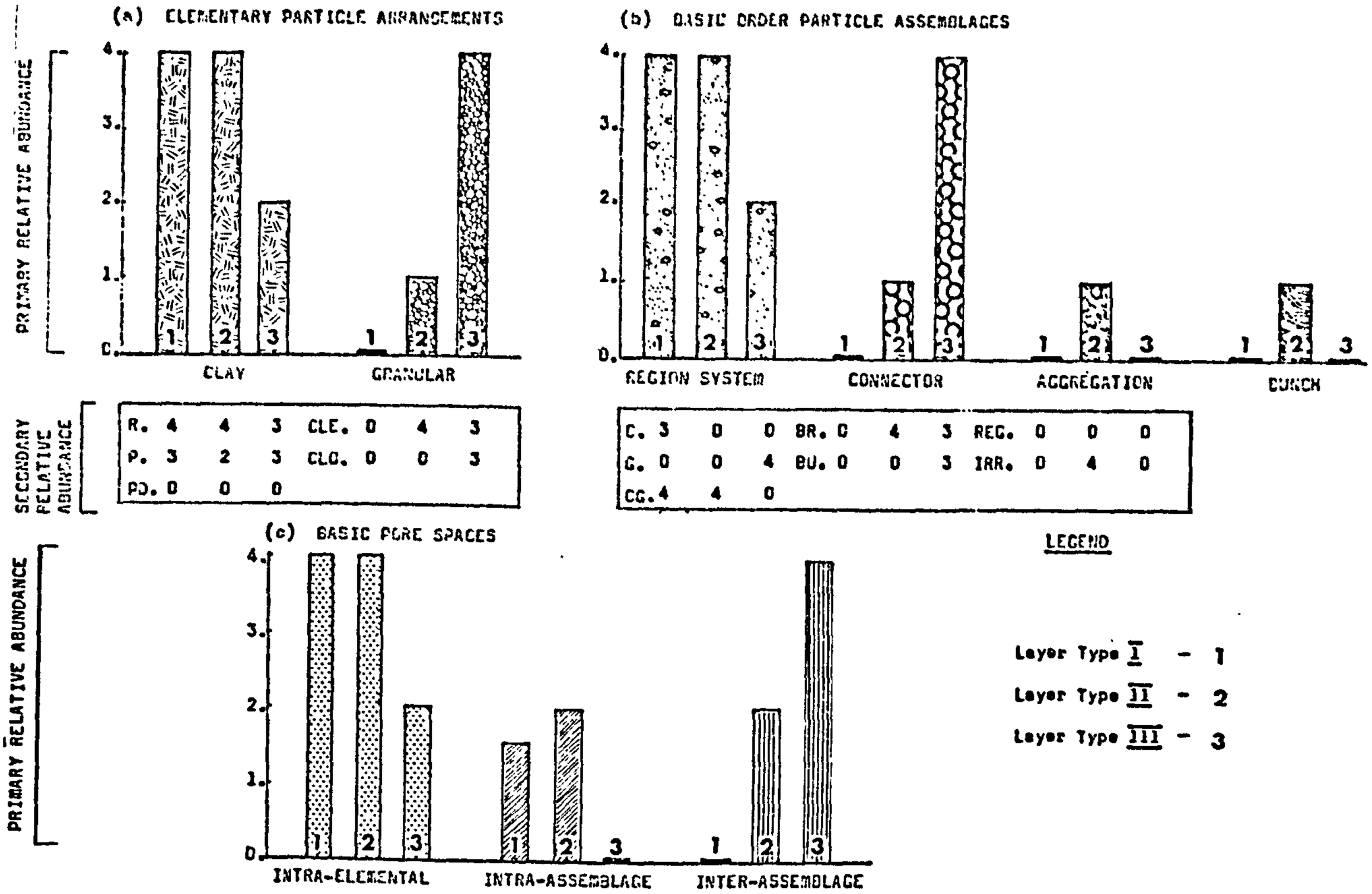
FIG. 5.9. MICROFABRIC OF ESTUARINE SILTY CLAY - LAURIESTON, SCOTLAND



(d) COMPOSITE MICROFABRIC ANISOTROPY

Extent of Reference Region.	Layer Type.	Apparent Degree of Anisotropy	Direction of Preferred Orientation	Principal Feature(s) Inducing Anisotropy	Illustrative Micrographs.
5μ	1	very high	horizontal	parallel clay arrangements	5.9.a.
	2	pred.very high some nil	horizontal	parallel clay arrangements	5.9.e.
	3	--	---	---	-
50μ	1	very high	horizontal	parallel clay array displaying c.p.o.	5.9.b.
	2	high	horizontal	pred. parallel clay array with c.p.o. plus c.p.o. of silt grains.	5.9.c.
	3	medium	horizontal	c.p.o. silt grains	5.9.d.
500μ	1	very high	horizontal	parallel clay array with c.p.o.	5.9.a.
	2	high	horizontal	pred. parallel clay array with c.p.o. plus c.p.o. of silt grains	5.9.f.
	3	medium	horizontal	c.p.o. of silt grains	5.9.g.

FIG. 5.10. MICROFABRIC OF ESTUARINE SILTY CLAY - RENFREW, SCOTLAND



(d) COMPOSITE MICROFABRIC ANISOTROPY

Extent of Reference Region.	Layer Type.	Apparent Degree of Anisotropy	Direction of Preferred Orientation	Principal Feature(s) Inducing Anisotropy	Illustrative Micrographs.
5μ	1	pred. nil some very high	--- horizontal	--- parallel clay arrangements.	5.10.a.
	2	pred, nil some very high	--- horizontal	--- parallel clay arrangements	-
	3	some nil some very high	--- full range	--- parallel clay arrangements	-
50μ	1	pred. low some high	horizontal horizontal	partly parallel clay array with s.p.o. plus s.p.o. of silt pred. parallel clay array with s.p.o. plus s.p.o. of silt	5.10.c. 5.10.c.
	2	pred. nil ---	--- ---	--- ---	5.10.d.
	3	some medium some nil	horizontal ---	s.p.o. of silt grains ---	5.10.g. 5.10.g.
500μ	1	medium	horizontal	partly parallel clay array with s.p.o. plus s.p.o. of silt	5.10.c.
	2	nil	horizontal	partly parallel clay array within matrix with s.p.o. plus s.p.o. of bunches	-
	3	medium	horizontal	s.p.o. of silt grains	5.10.g.

FIG. 5.11. MICROFABRIC OF ESTUARINE SANDY SILT - SHANNON (A), EIRE.

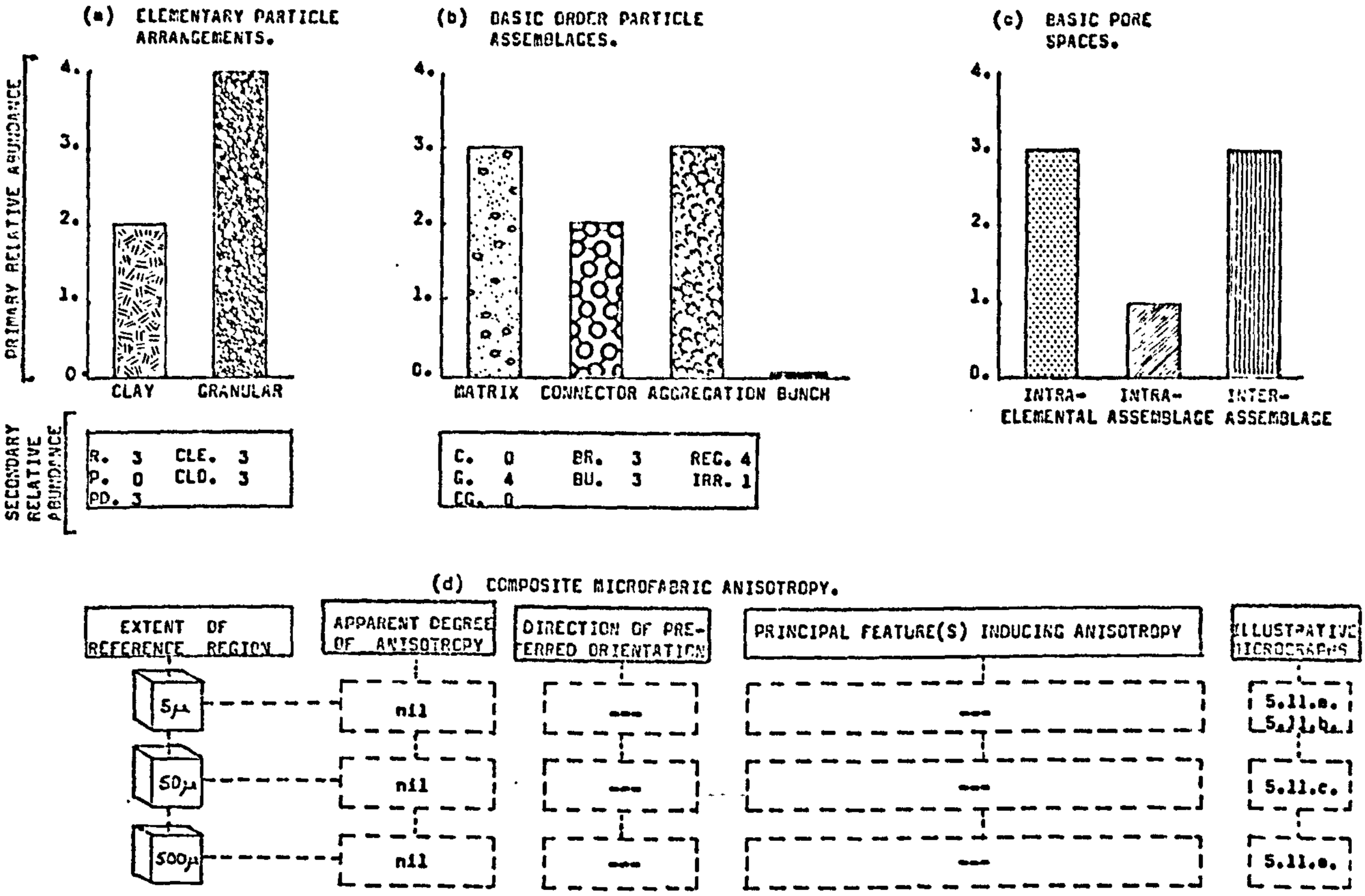


FIG. 5.12. MICROFABRIC OF ESTUARINE SILTY CLAY - SHANNON (B), EIRE.

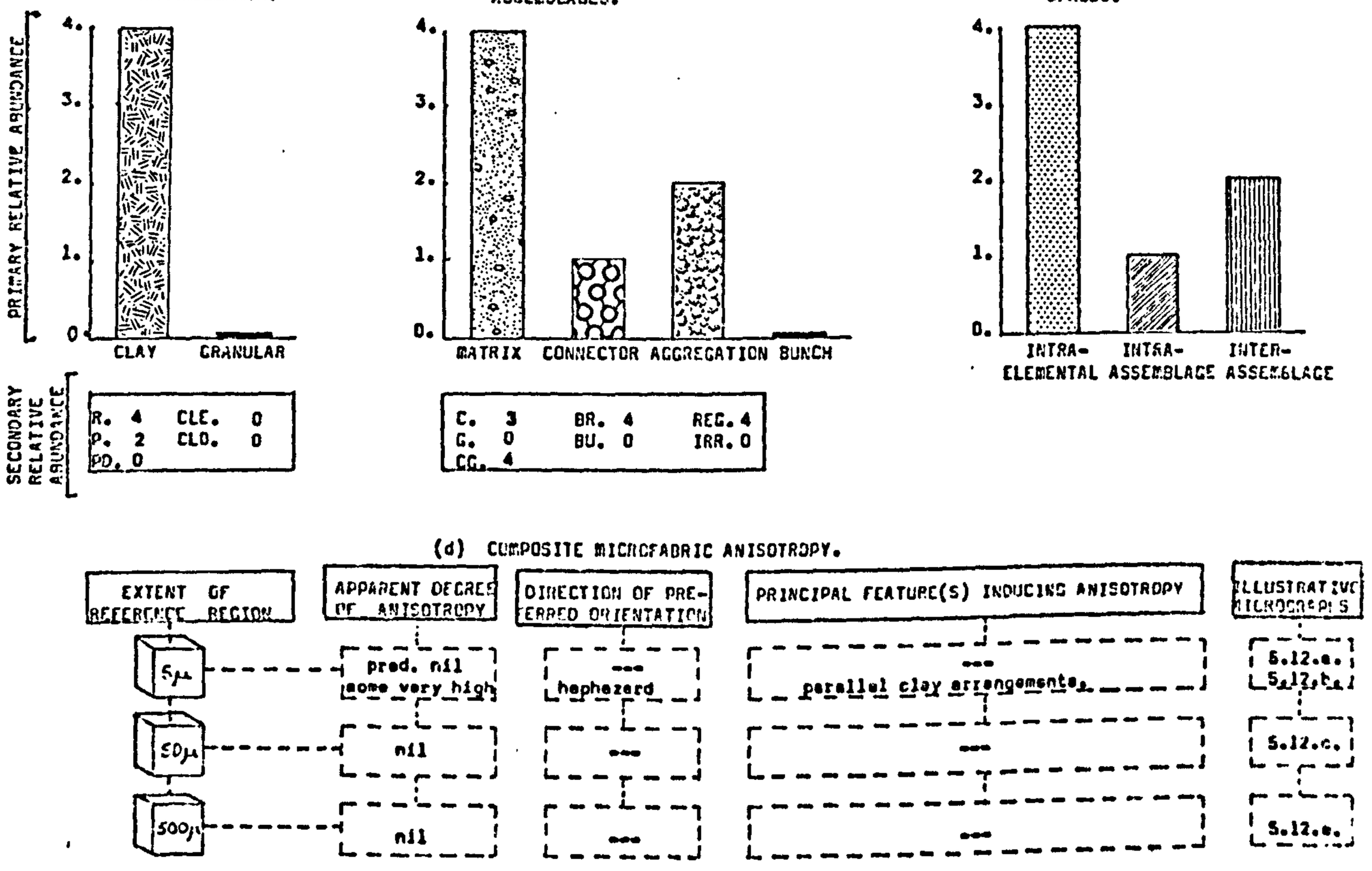


FIG. 5.13. MICROFABRIC OF ESTUARINE SILTY CLAY - SAINT ALBAN, CANADA

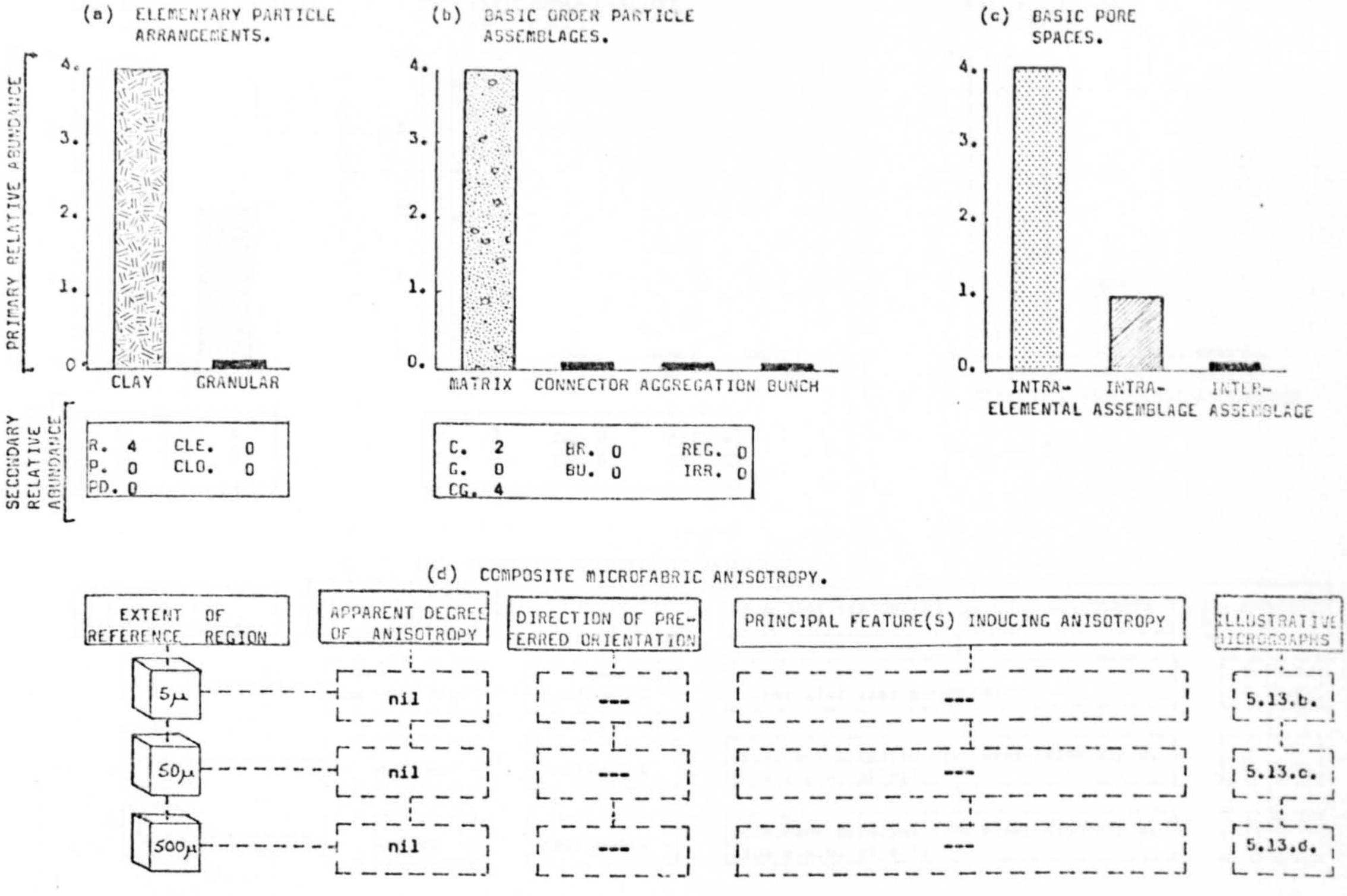


FIG. 5.14. MICROFABRIC OF ESTUARINE CLAY - SAINT JEAN VIANNEY, CANADA

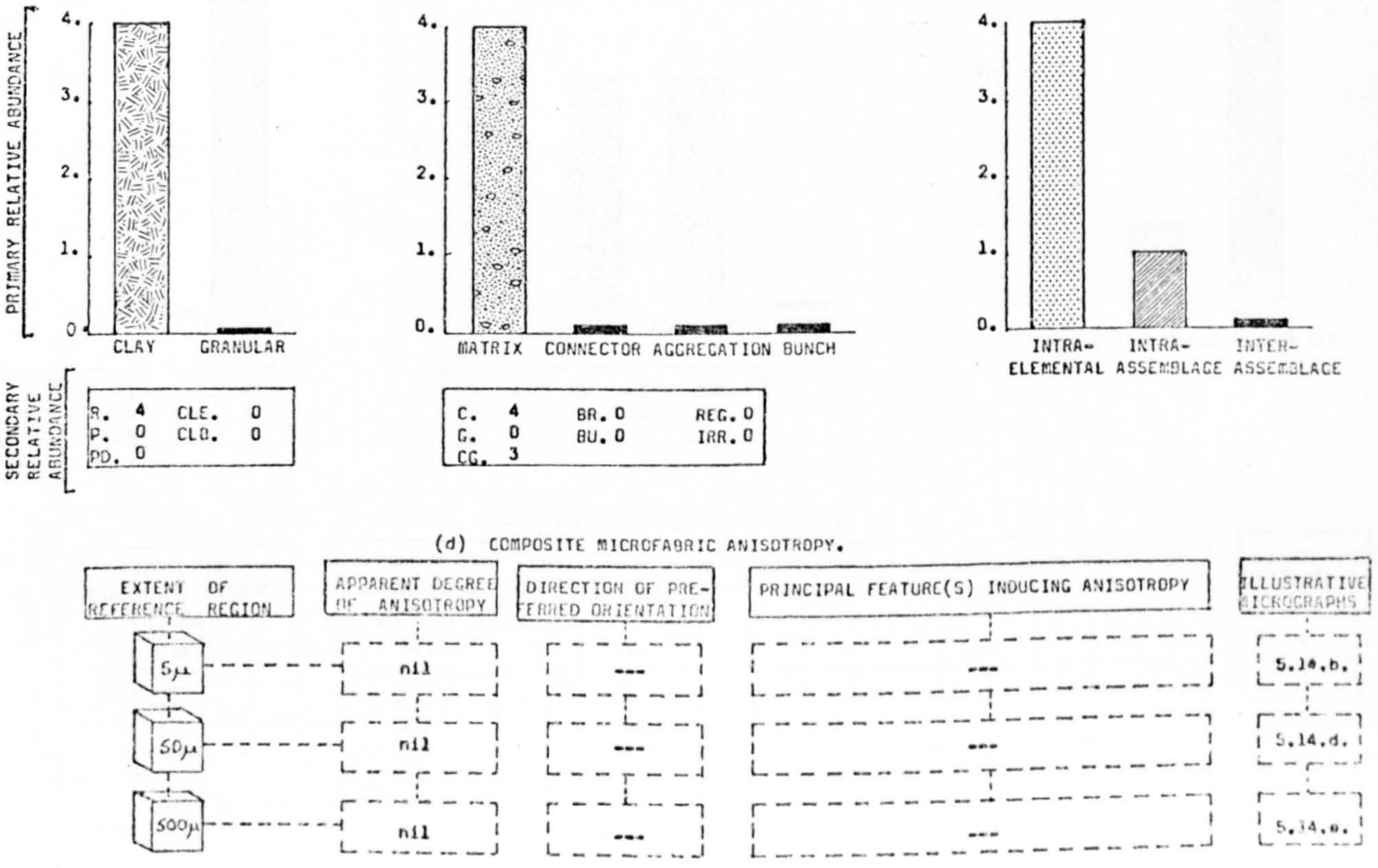


FIG. 5.15. MICROFABRIC OF ESTUARINE BLUE CLAY - BOSTON, U.S.A.

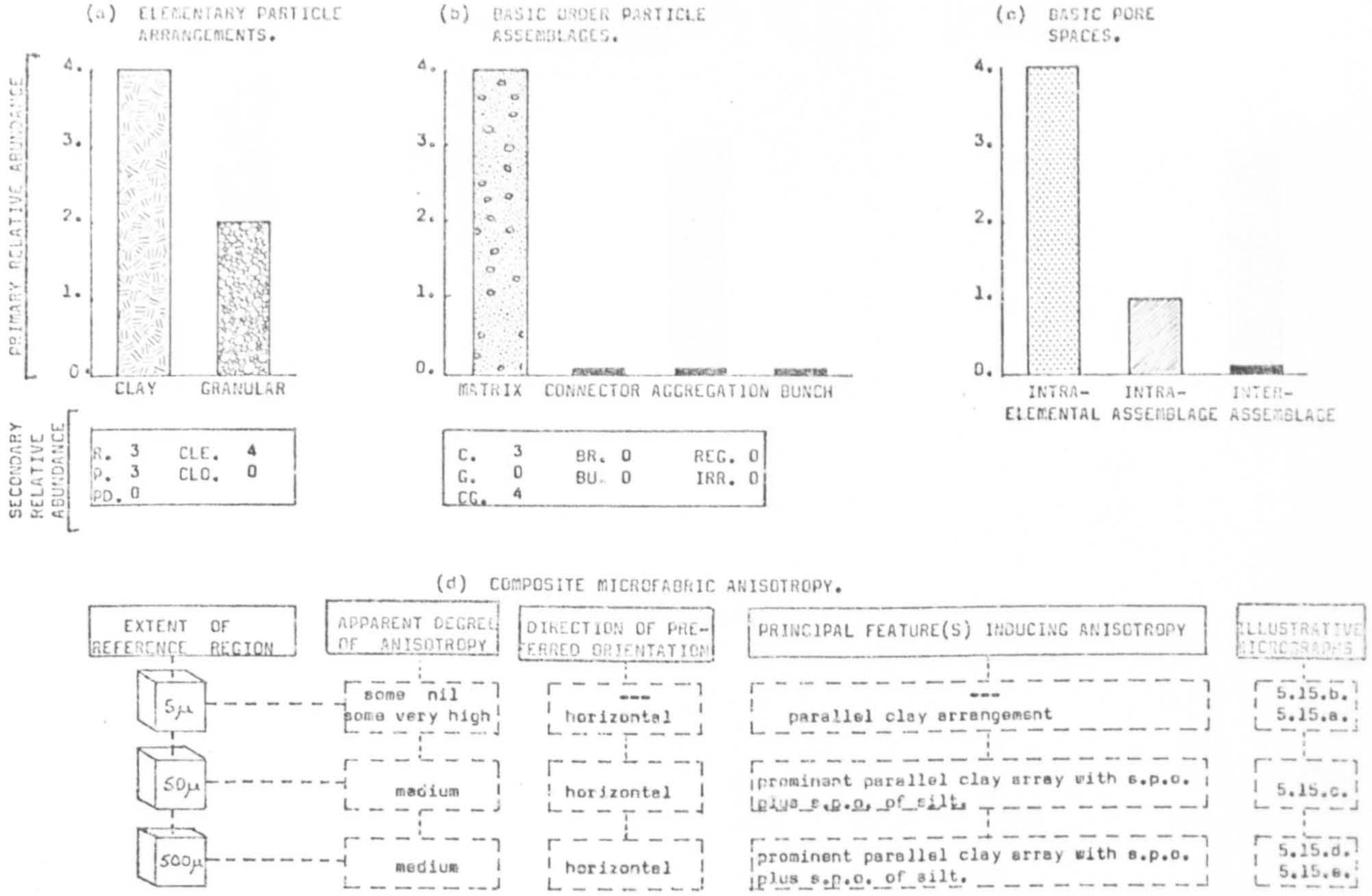


FIG. 5.16. MICROFABRIC OF FRESH WATER CLAYEY SILT - TUCSON, U.S.A.

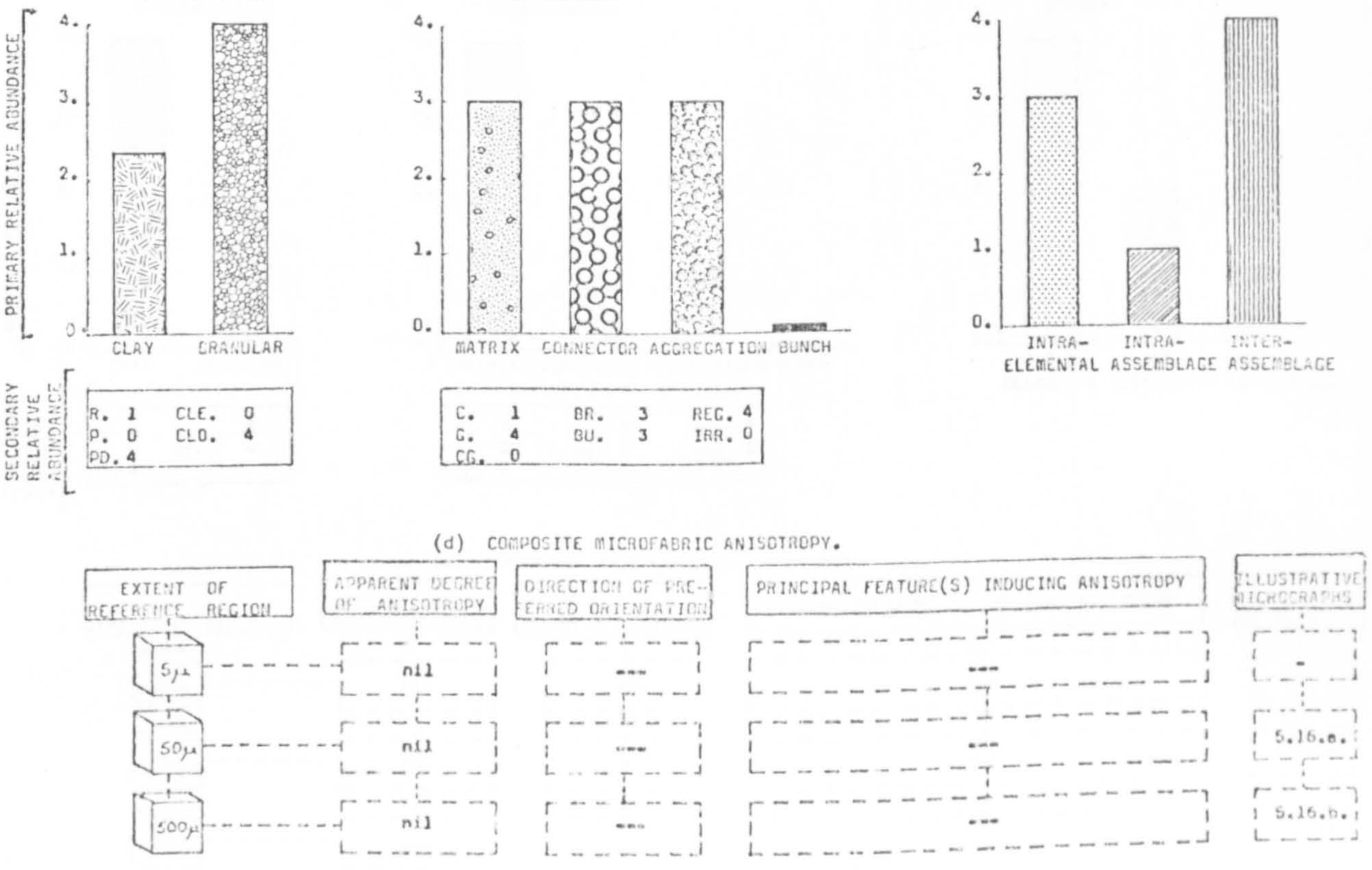


FIG. 5.17. MICROFABRIC OF MUD FLOW CLAYEY SILT - MARICOPA, U.S.A.

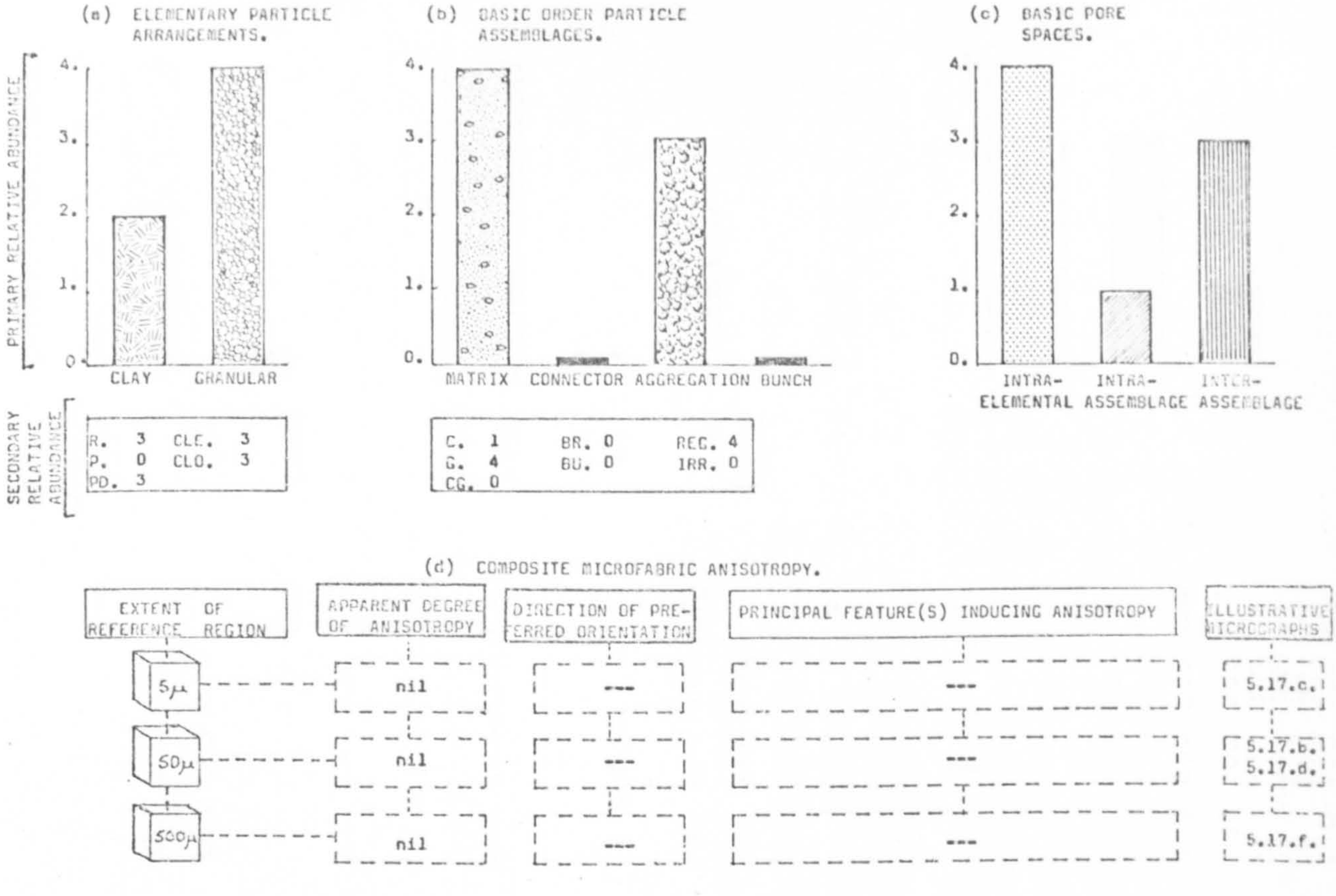


FIG. 5.18. MICROFABRIC OF FRESH WATER SILTY CLAY - LYDDA, ISRAEL

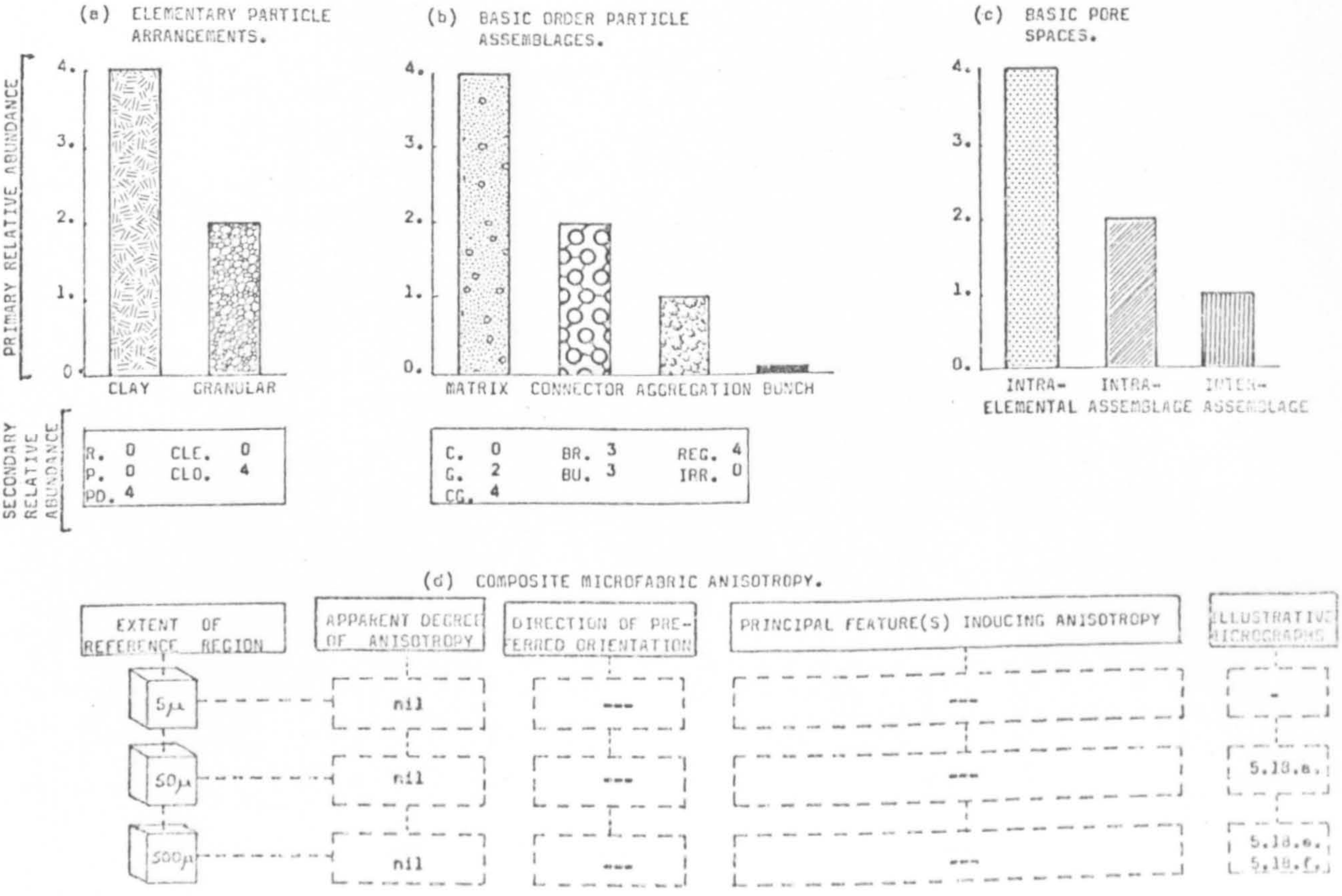


FIG. 5.19. MICROFABRIC OF FRESH WATER CLAY - HOLON, ISRAEL

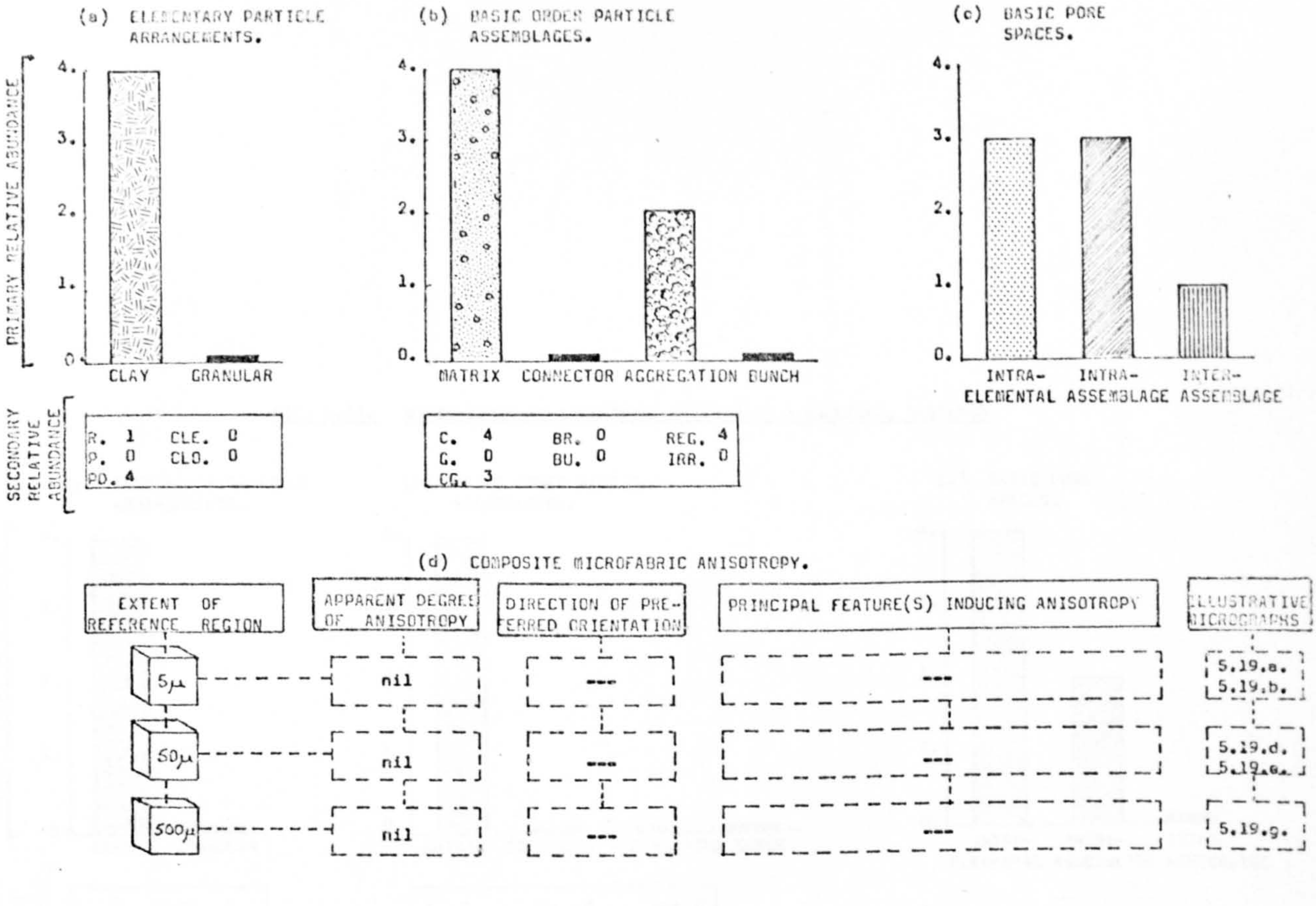


FIG. 5.20. MICROFABRIC OF FRESH WATER CLAY - AFULAH, ISRAEL

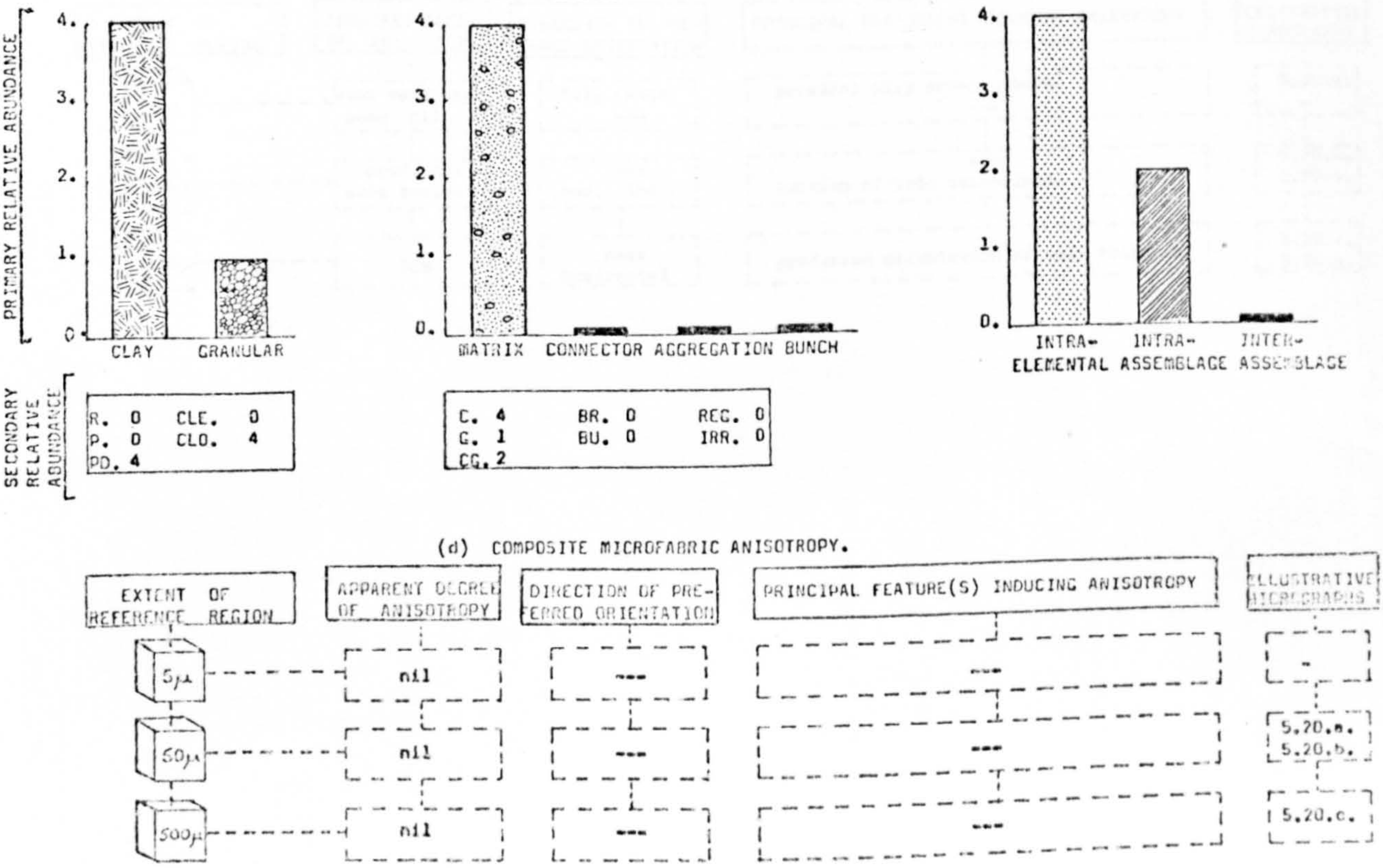


FIG. 5.21. MICROFABRIC OF LACUSTRINE SILTY CLAY - HURLFORD, SCOTLAND

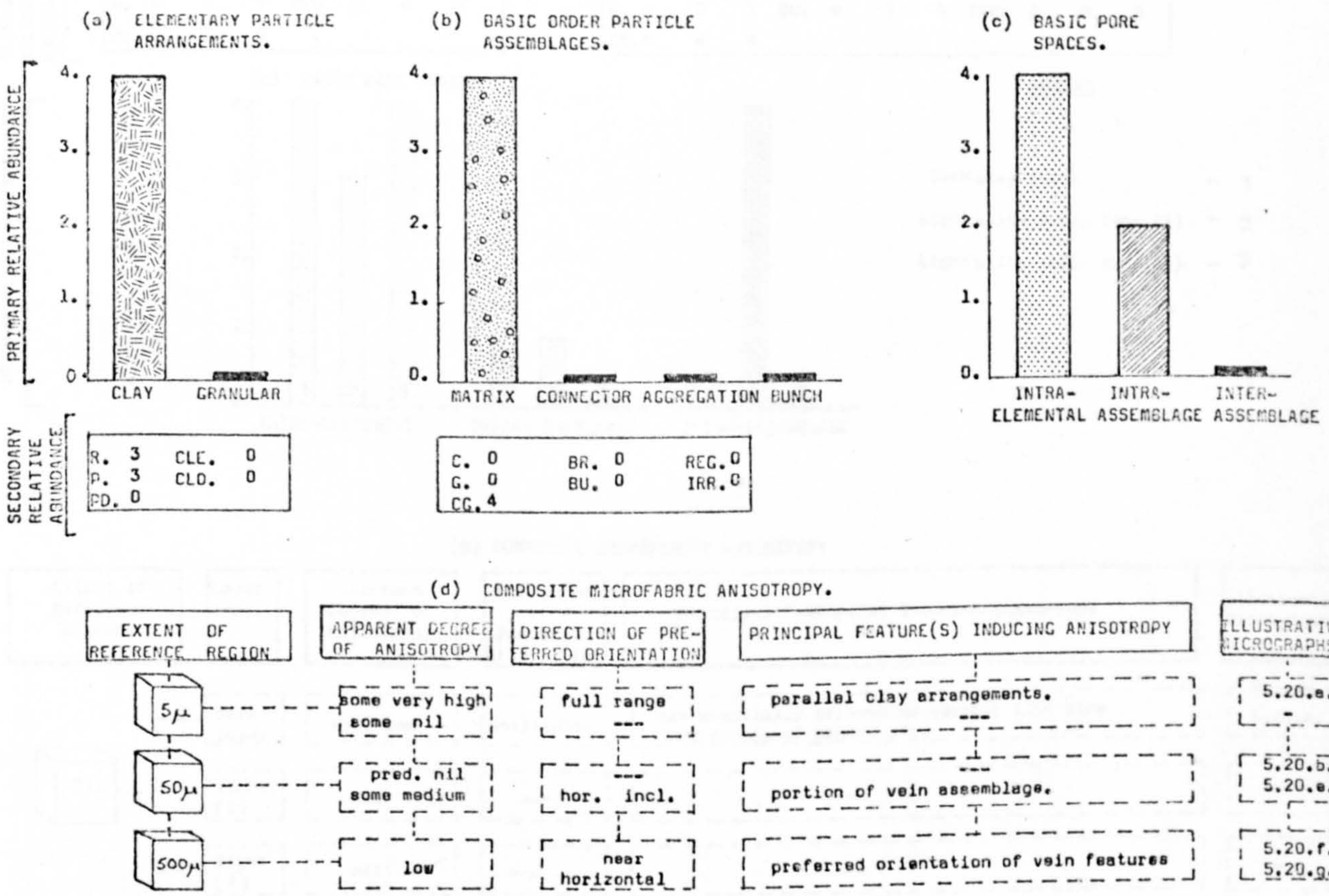
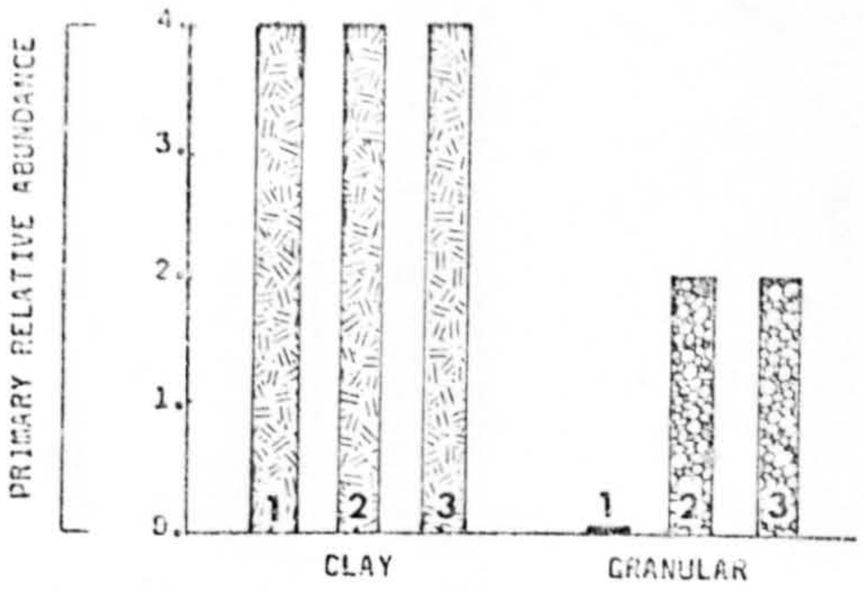


FIG. 5.22. MICROFABRIC OF LACUSTRINE VARVED CLAY - NEW LISKEARD, CANADA

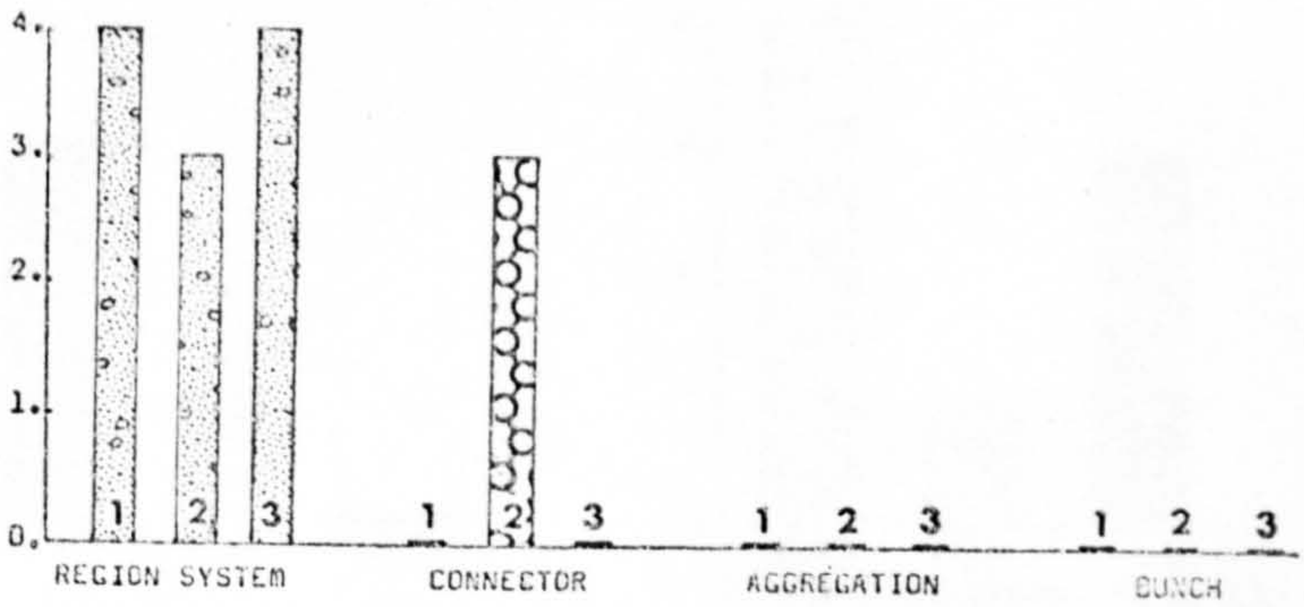
(a) ELEMENTARY PARTICLE ARRANGEMENTS



SECONDARY RELATIVE ABUNDANCE

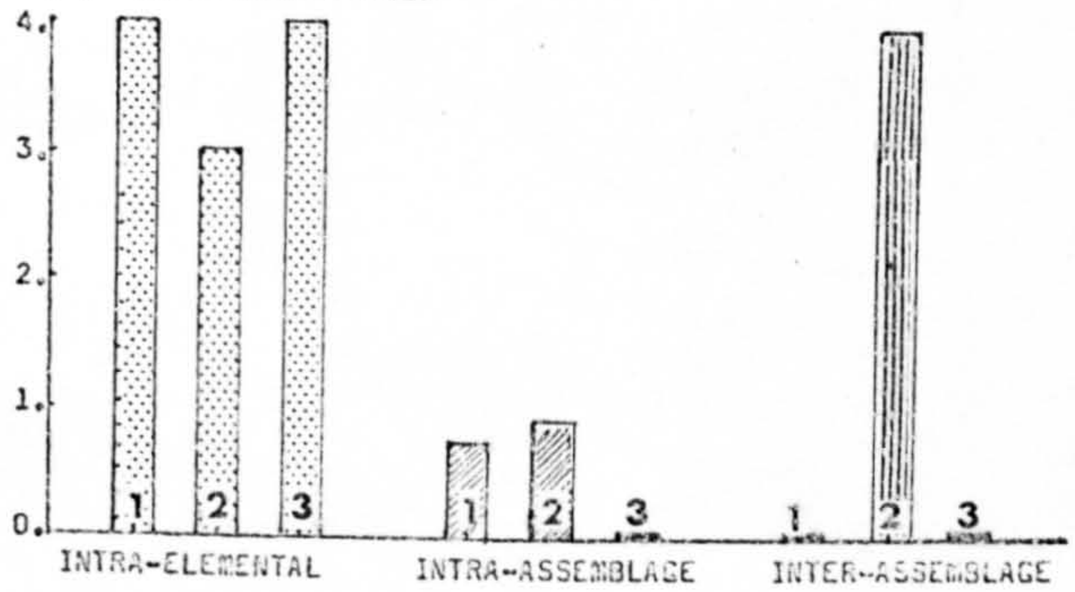
R.	4	4	4	CLE.	0	4	4
P.	0	0	0	CLO.	0	0	0
PD.	0	0	0				

(b) BASIC ORDER PARTICLE ASSEMBLAGES



C.	4	0	2	BR.	0	3	0	REG.	0	0	0
G.	0	3	2	BU.	0	3	0	IRR.	0	0	0
CG.	0	4	4								

(c) BASIC PORE SPACES



LEGEND

Dark clay layer – 1

Light silty layer type (1) – 2

Light silty layer type (2) – 3

(d) COMPOSITE MICROFABRIC ANISOTROPY

Extent of Reference Region.	Layer Type.	Apparent Degree of Anisotropy	Direction of Preferred Orientation	Principal Feature(s) Inducing Anisotropy	Illustrative Micrographs.
5μ	dark layer	very low	horizontal	preferentially orientated coarser clay size individuals of random clay	5.22.a.
	light (1)	nil	---	---	-
	light (2)	nil	---	---	-
50μ	dark layer	very low	horizontal	preferentially orientated coarser clay size individuals of random clay	5.22.c.
	light (1)	nil	---	---	5.22.d.
	light (2)	nil	---	---	5.22.e.
500μ	dark layer	very low	horizontal	preferentially orientated coarser clay size individuals of random clay	-
	light (1)	pred. nil some sed.	--- toward hor.	--- pref. orientated microlenses of clay with basic orde[illegible] network.	- 5.22.e.
	light (2)	nil	---	---	5.22.f.

FIG. 5.23. MICROFABRIC OF LOESS - FORD, ENGLAND

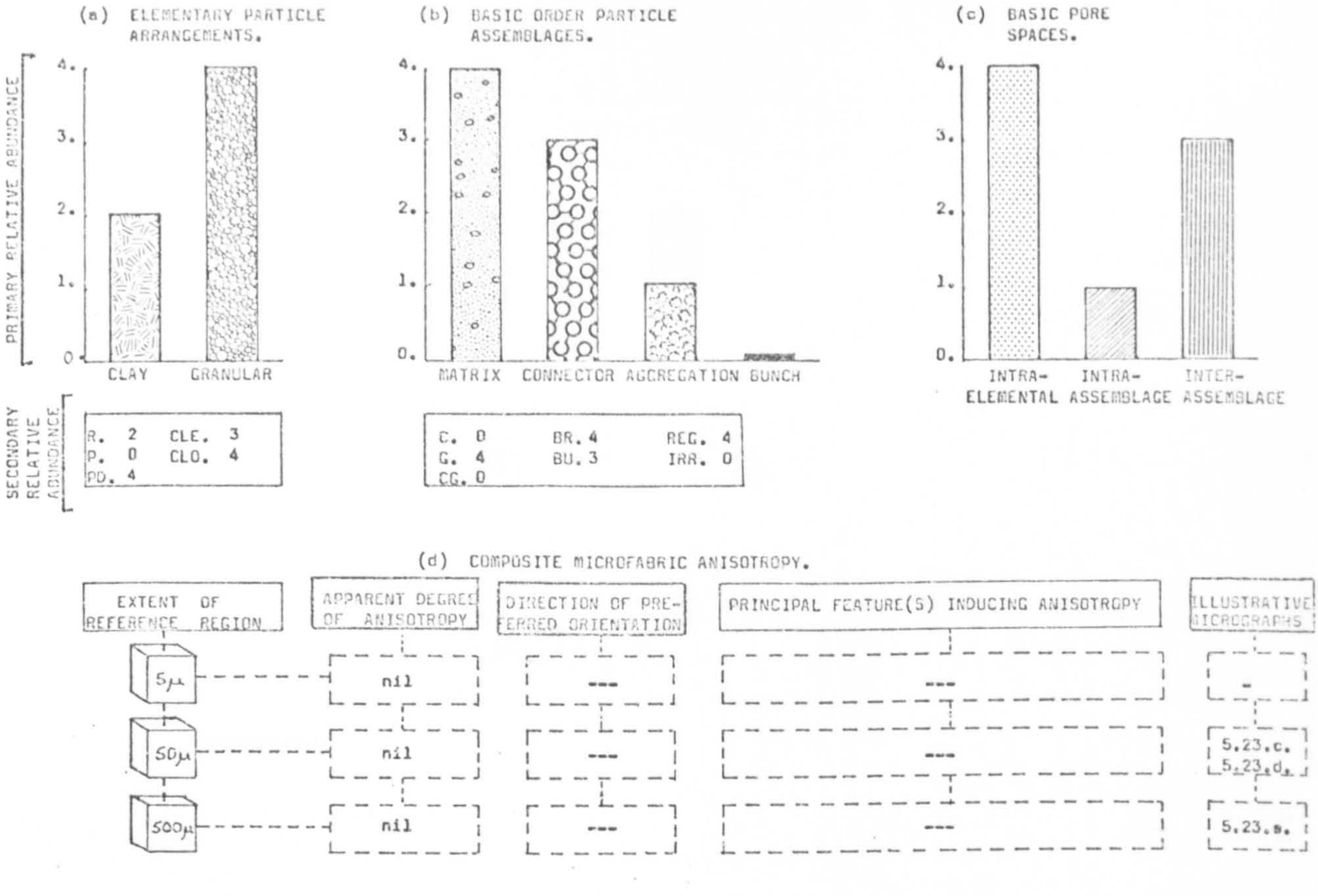


FIG. 5.24. MICROFABRIC OF LOESS - TONGRINNE, BELGIUM

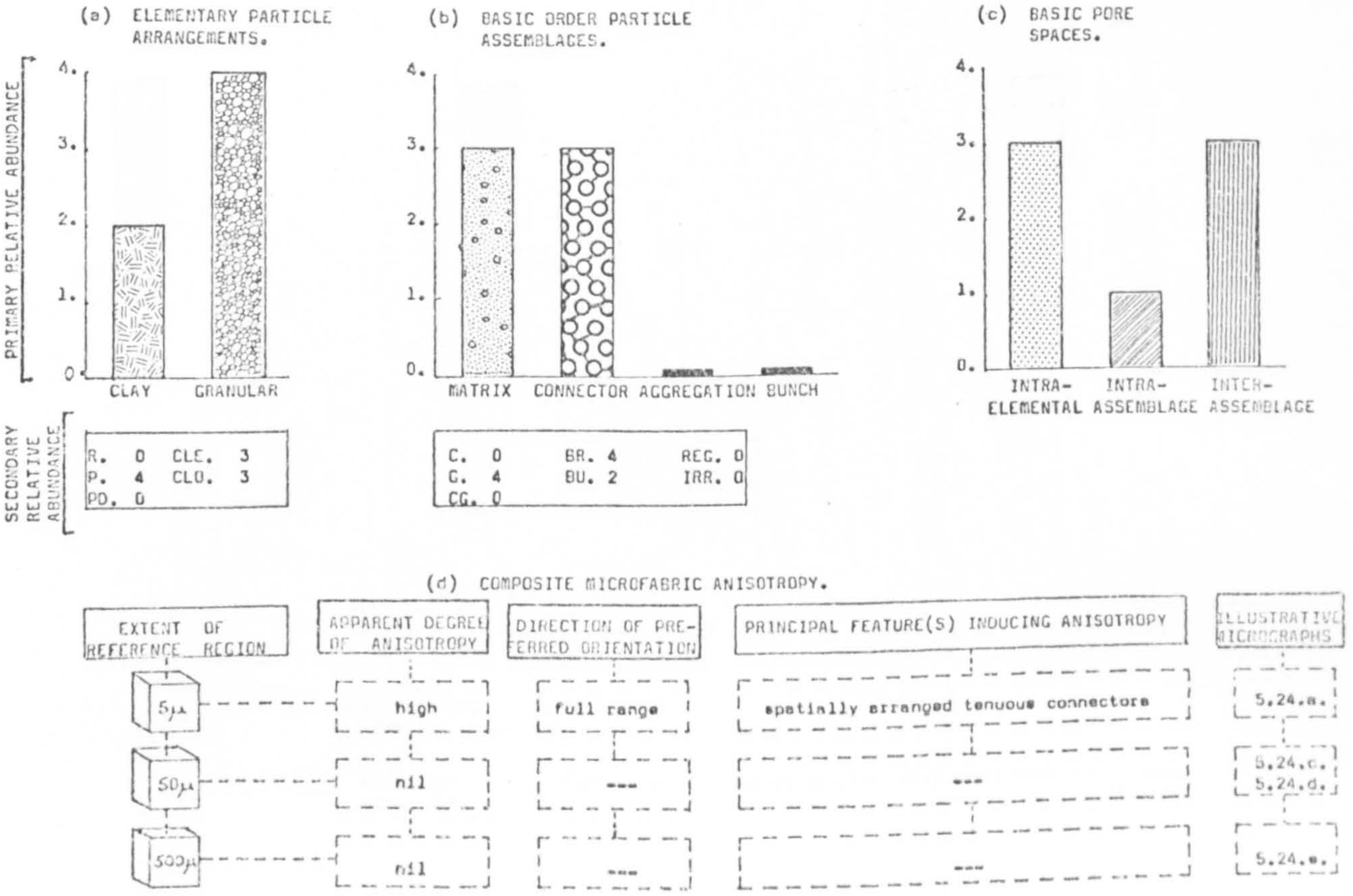


FIG. 5.25. MICROFABRIC OF AEOLIAN SAND - TRANSVAAL, S.A.

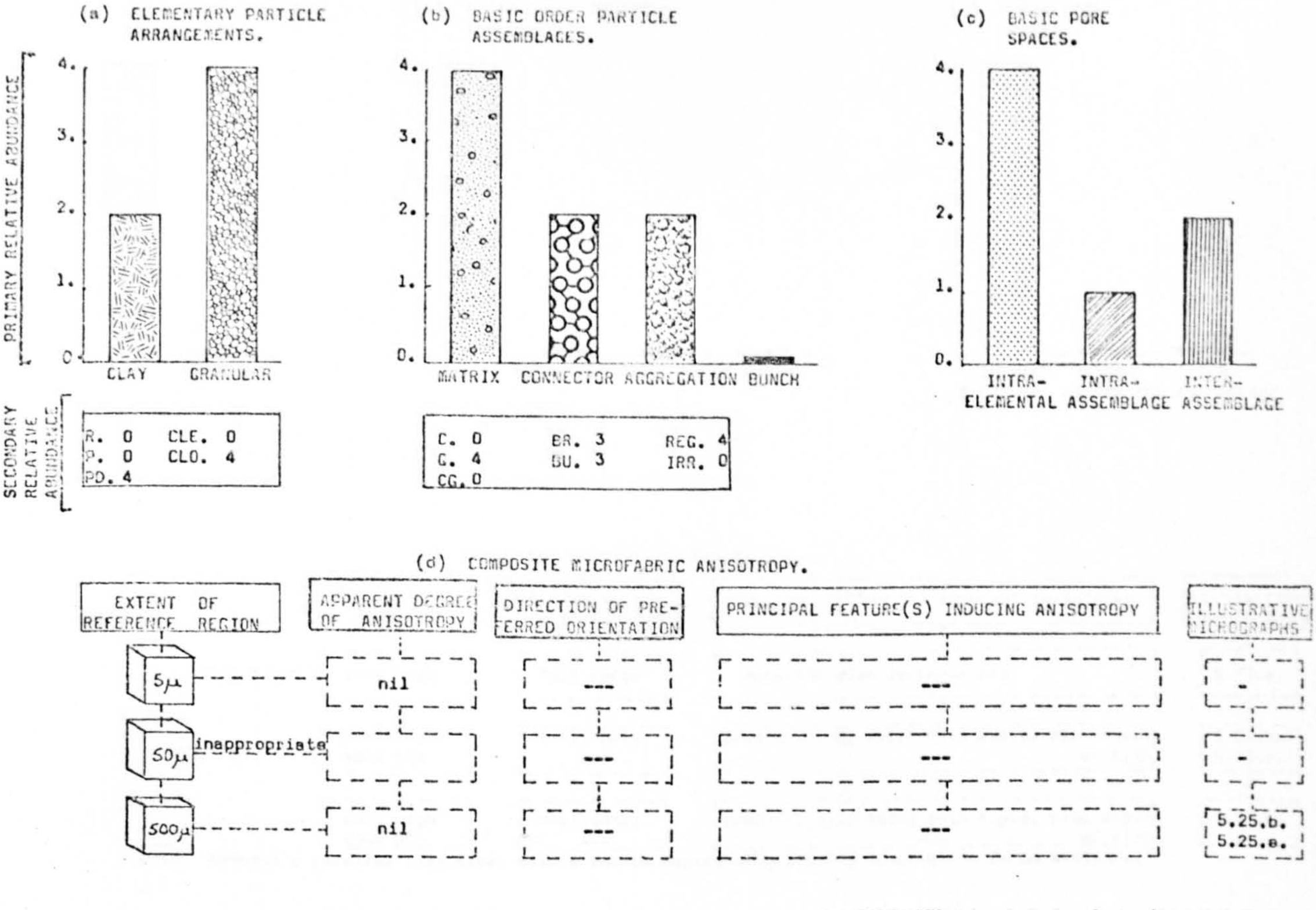


FIG. 5.26. MICROFABRIC OF WEATHERED LODGEMENT TILL - HURLFORD, SCOTLAND

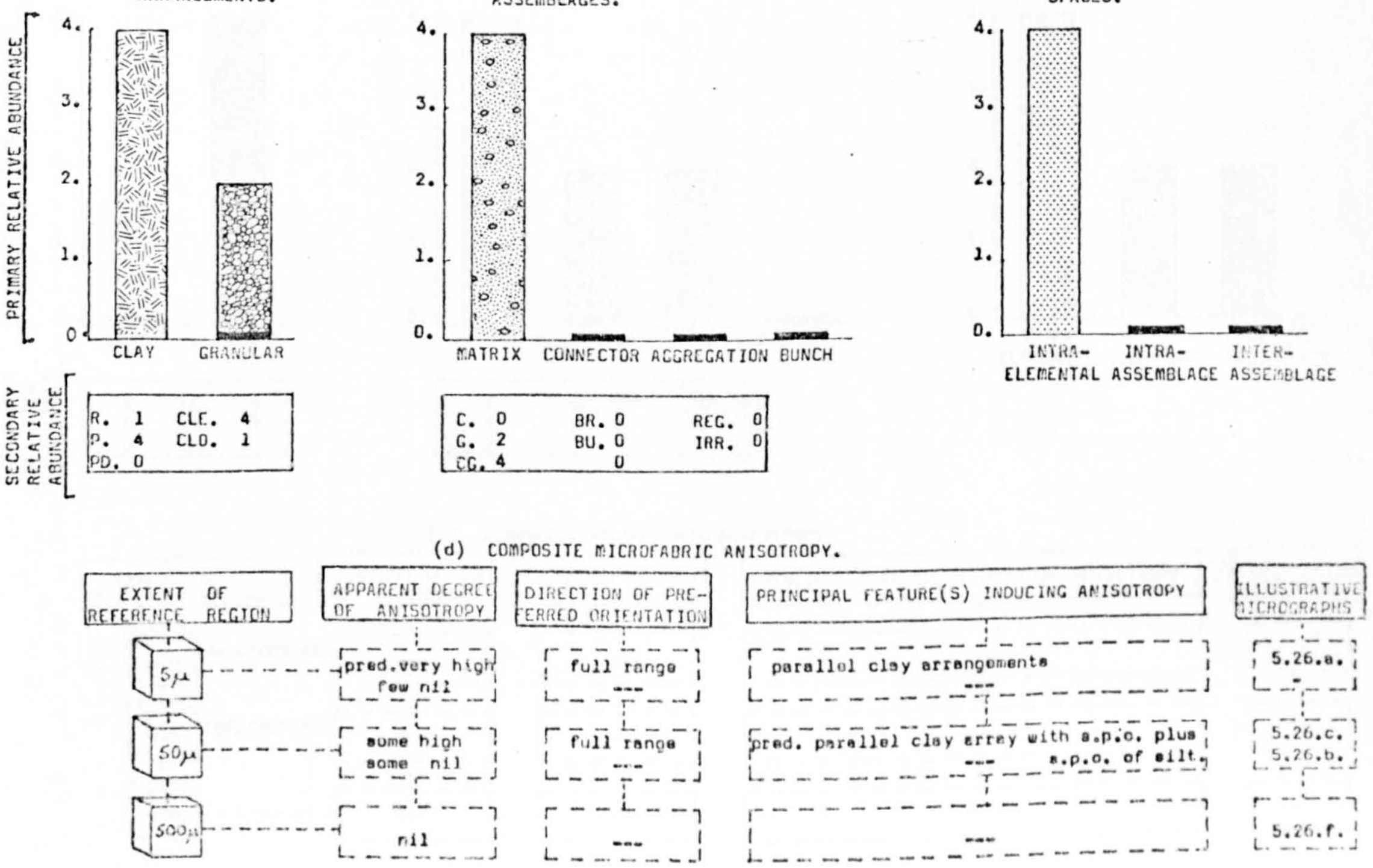


FIG. 5.27. MICROFABRIC OF FRESH LODGEMENT TILL - HURLFORD, SCOTLAND

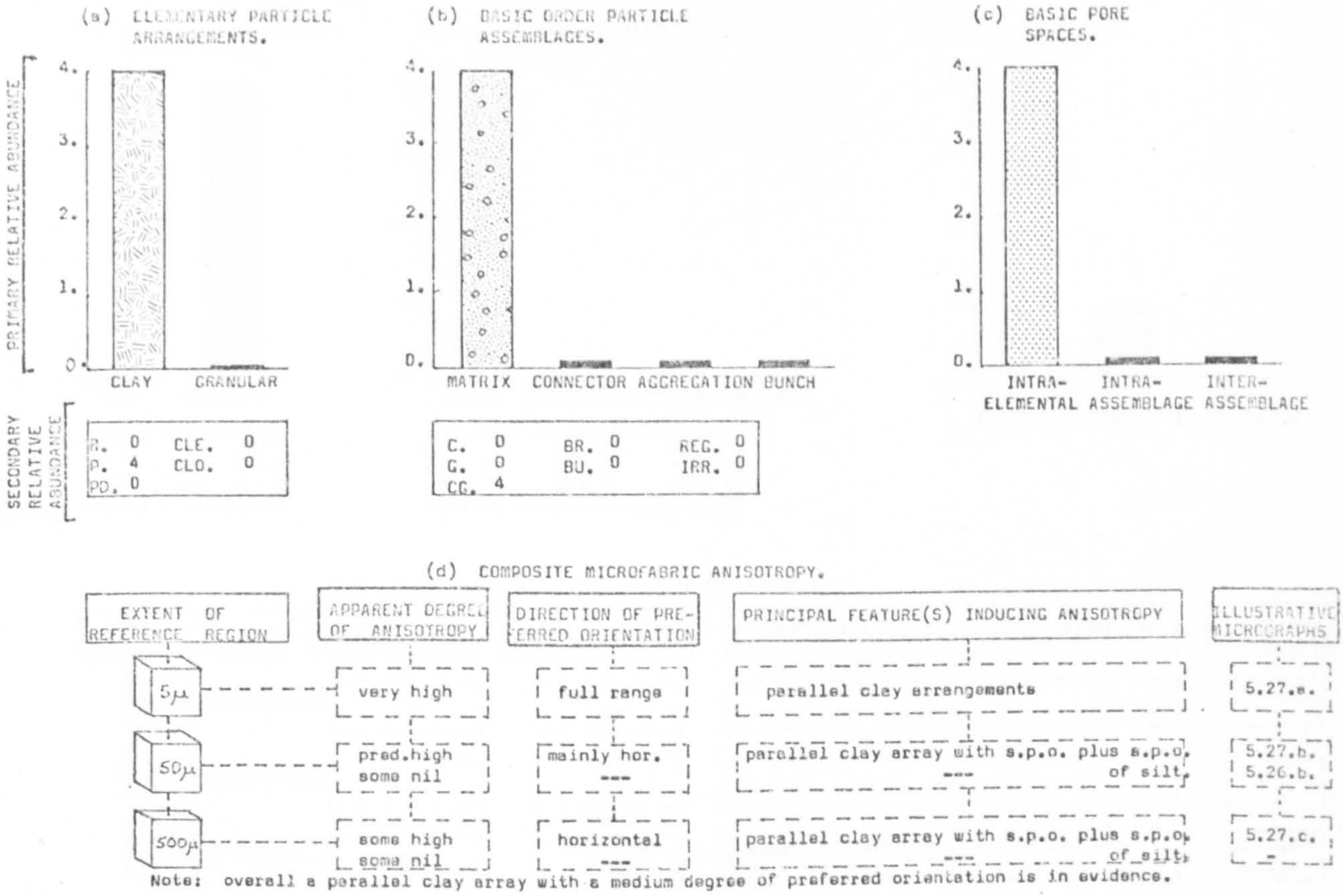


FIG. 5.28. MICROFABRIC OF MELT-OUT TILL - GLEN ORCHY, SCOTLAND

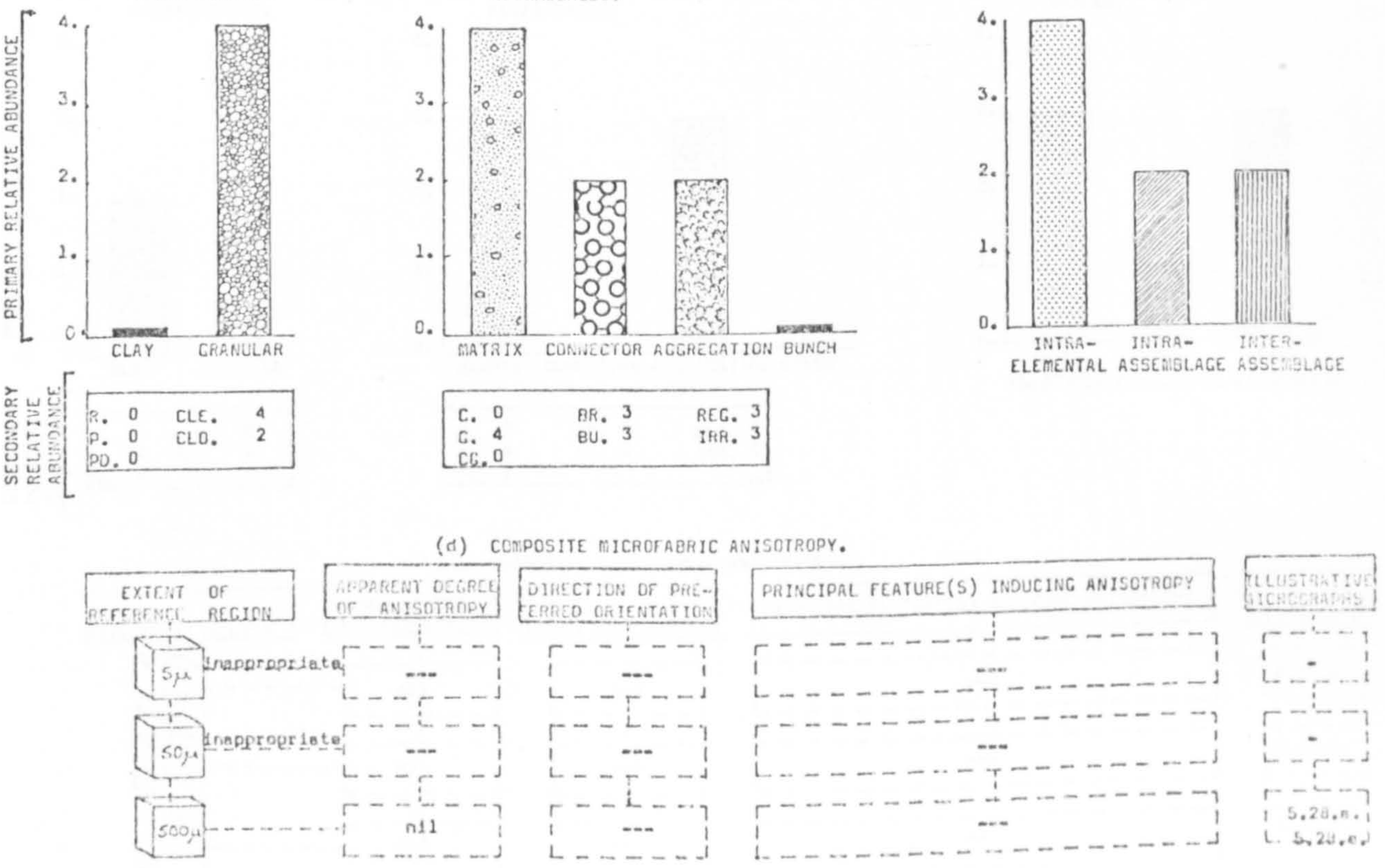


FIG. 5.29. MICROFABRIC OF MELT-OUT TILL - LAGLINGARTEN, SCOTLAND

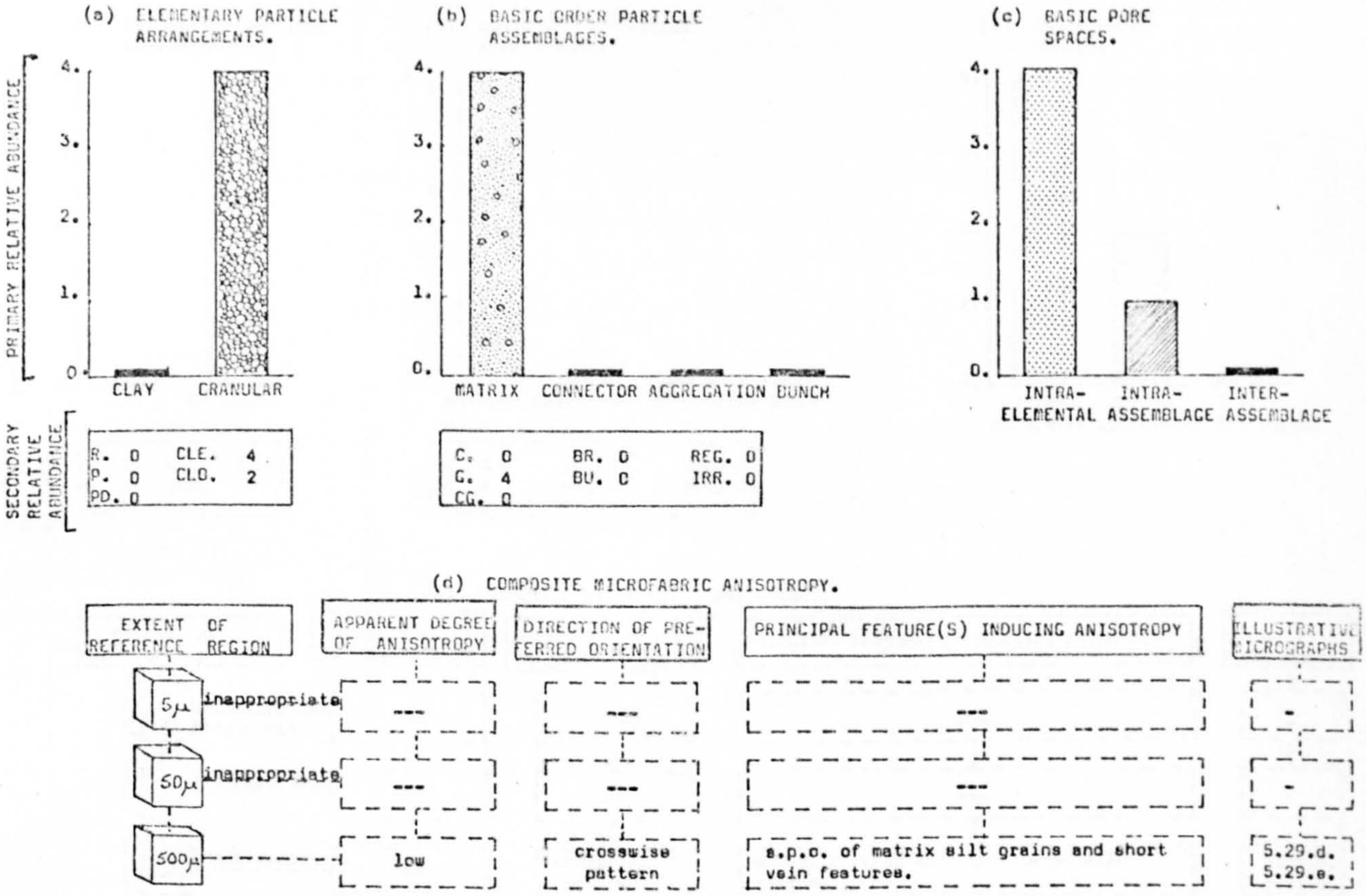


FIG. 5.30. MICROFABRIC OF MELT-OUT TILL - BREIDAMERKURJOKULL, ICELAND

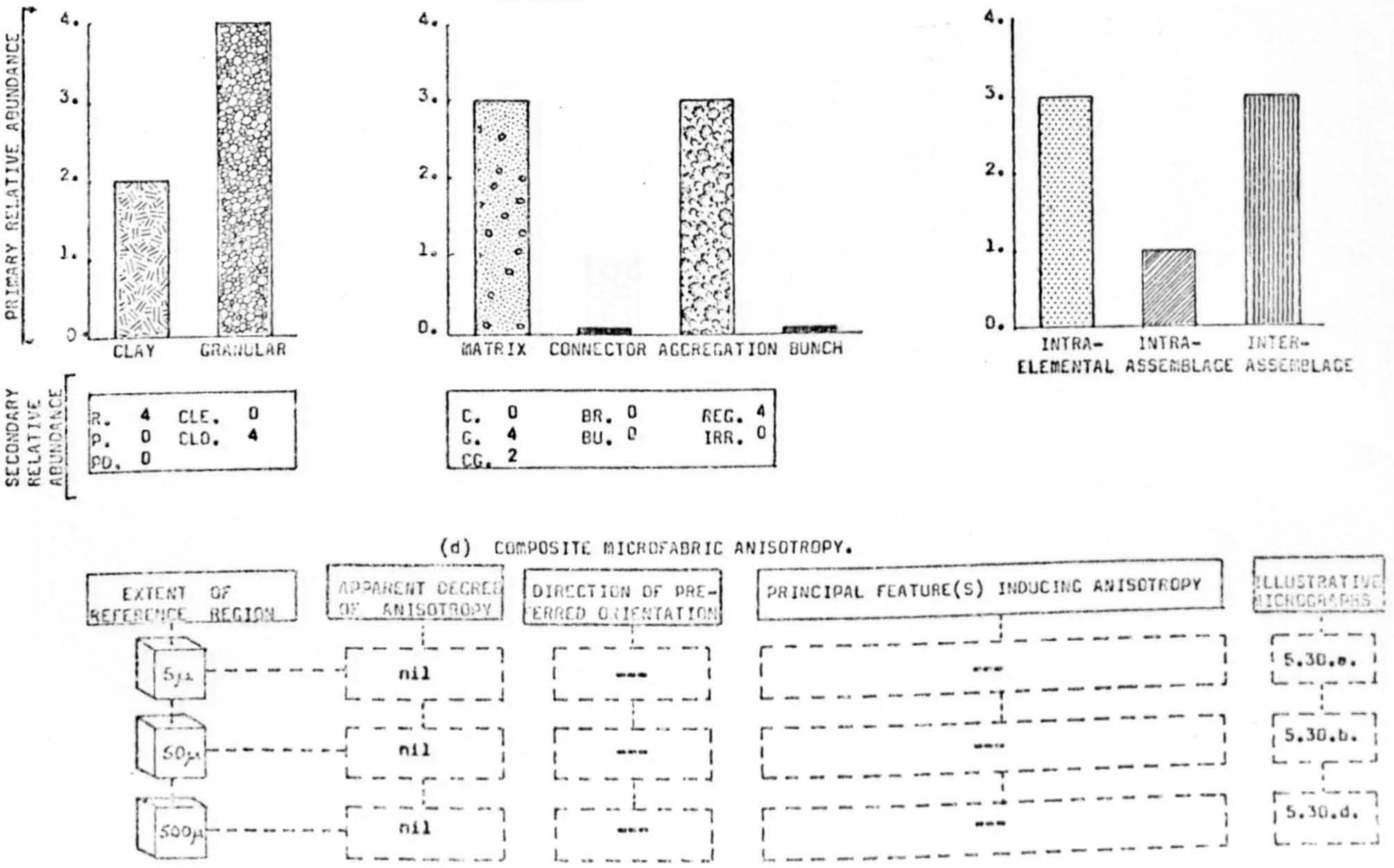


FIG. 5.31. MICROFABRIC OF MELT-OUT TILL - STOCKHOLM, SWEDEN

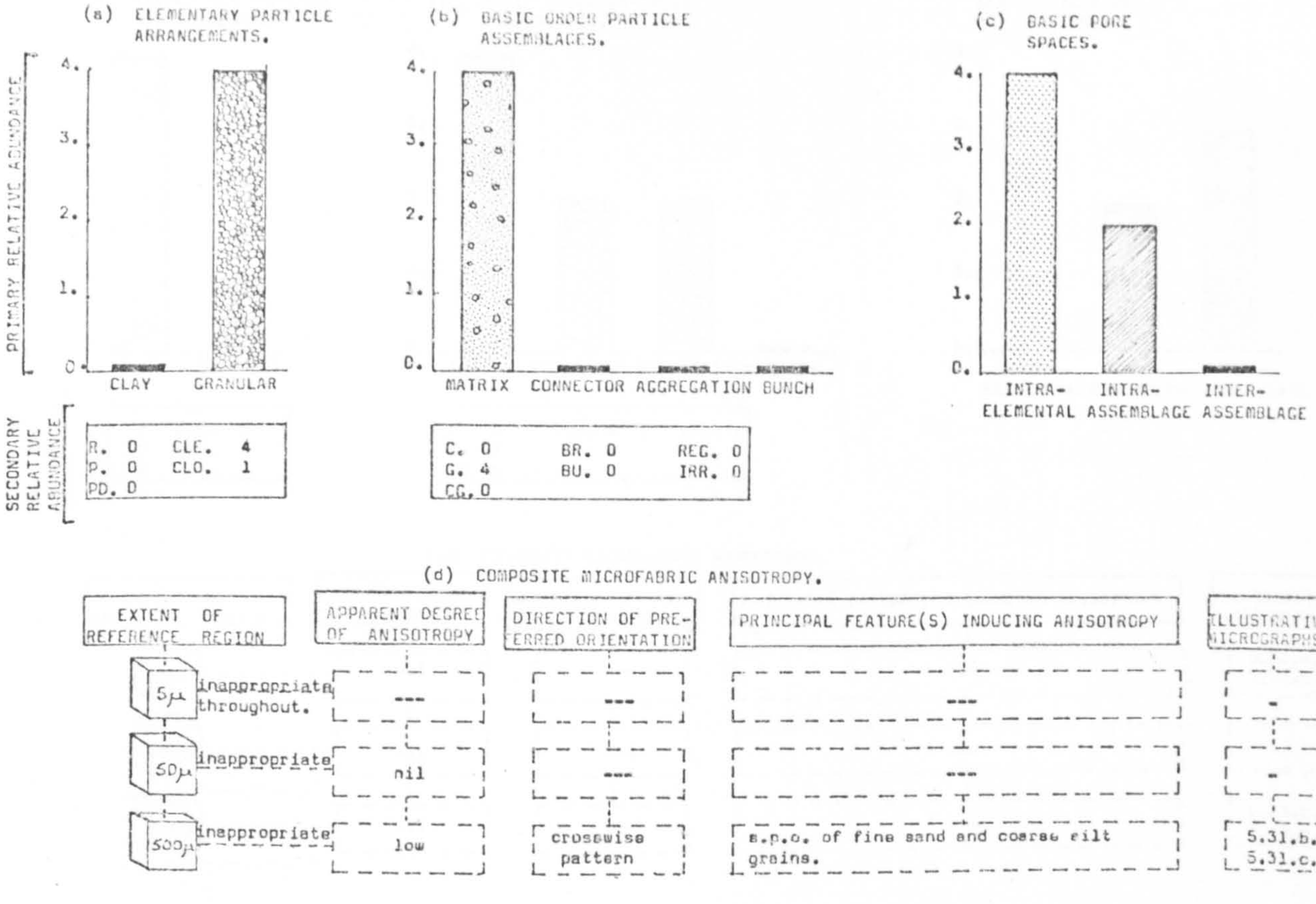


FIG. 5.32. MICROFABRIC OF MELT-OUT TILL - TAYLOR VALLEY, ANTARCTICA

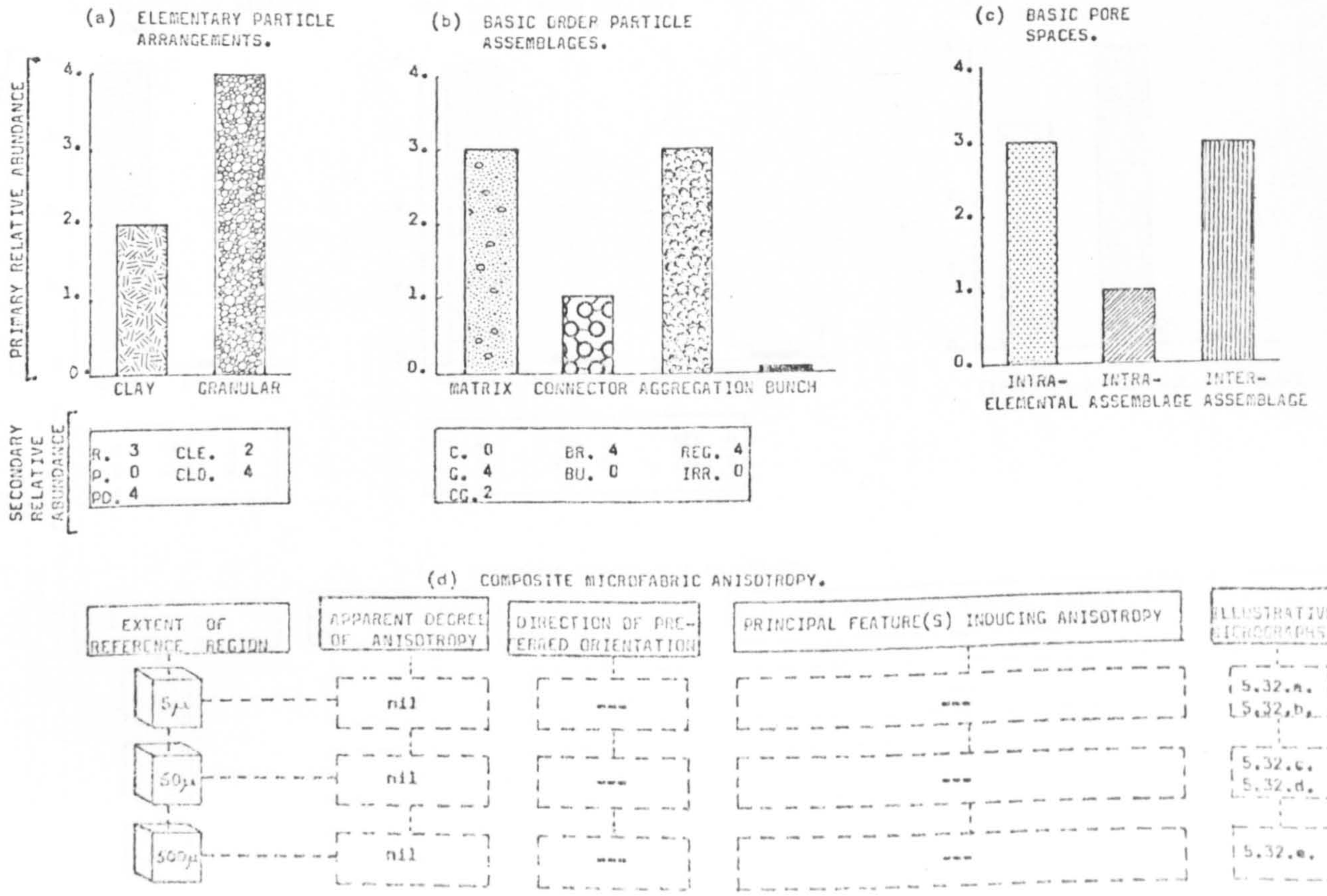


FIG. 5.33. MICROFABRIC OF RESIDUAL CLAY - CASENGA, ANGOLA

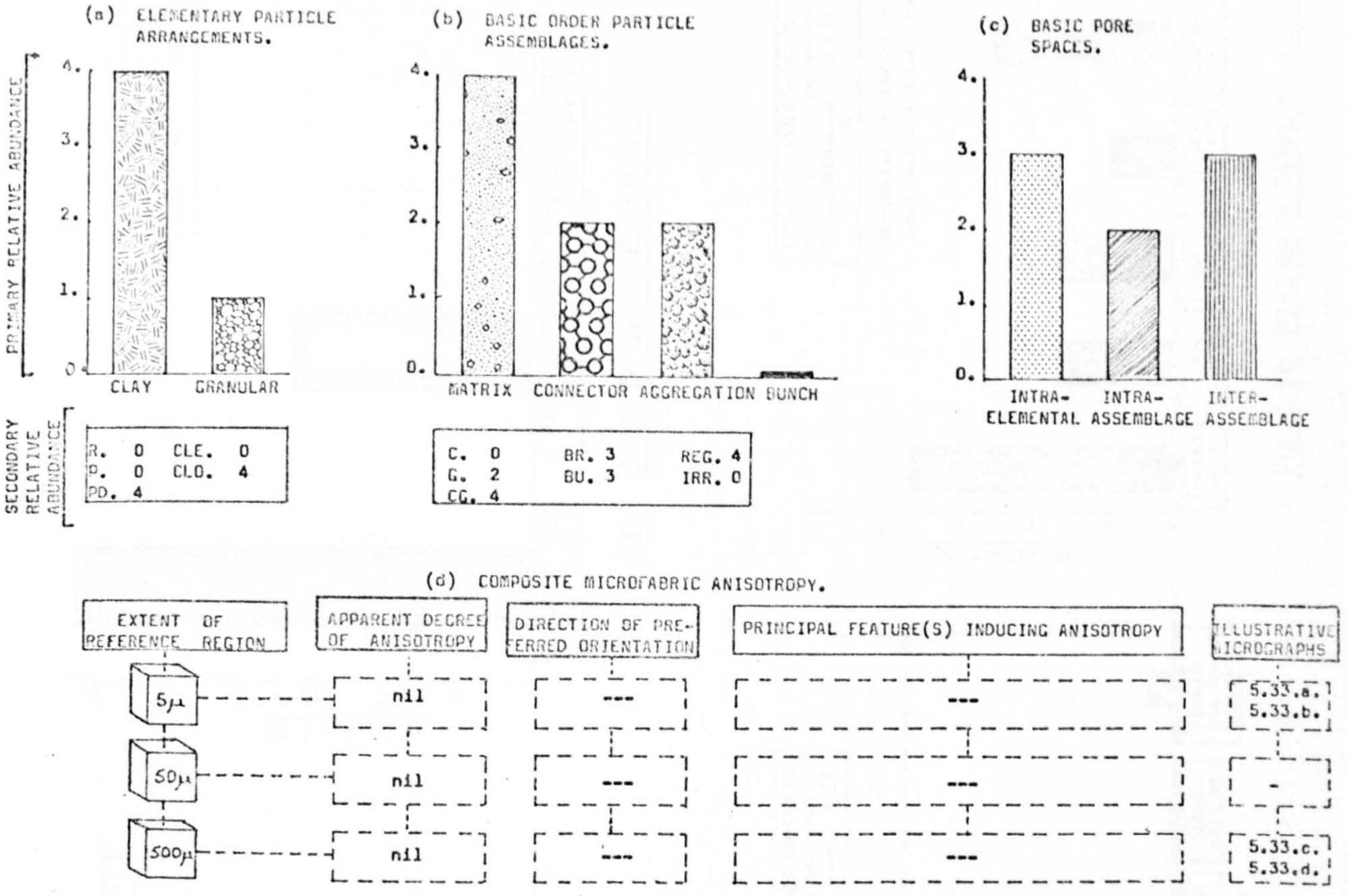
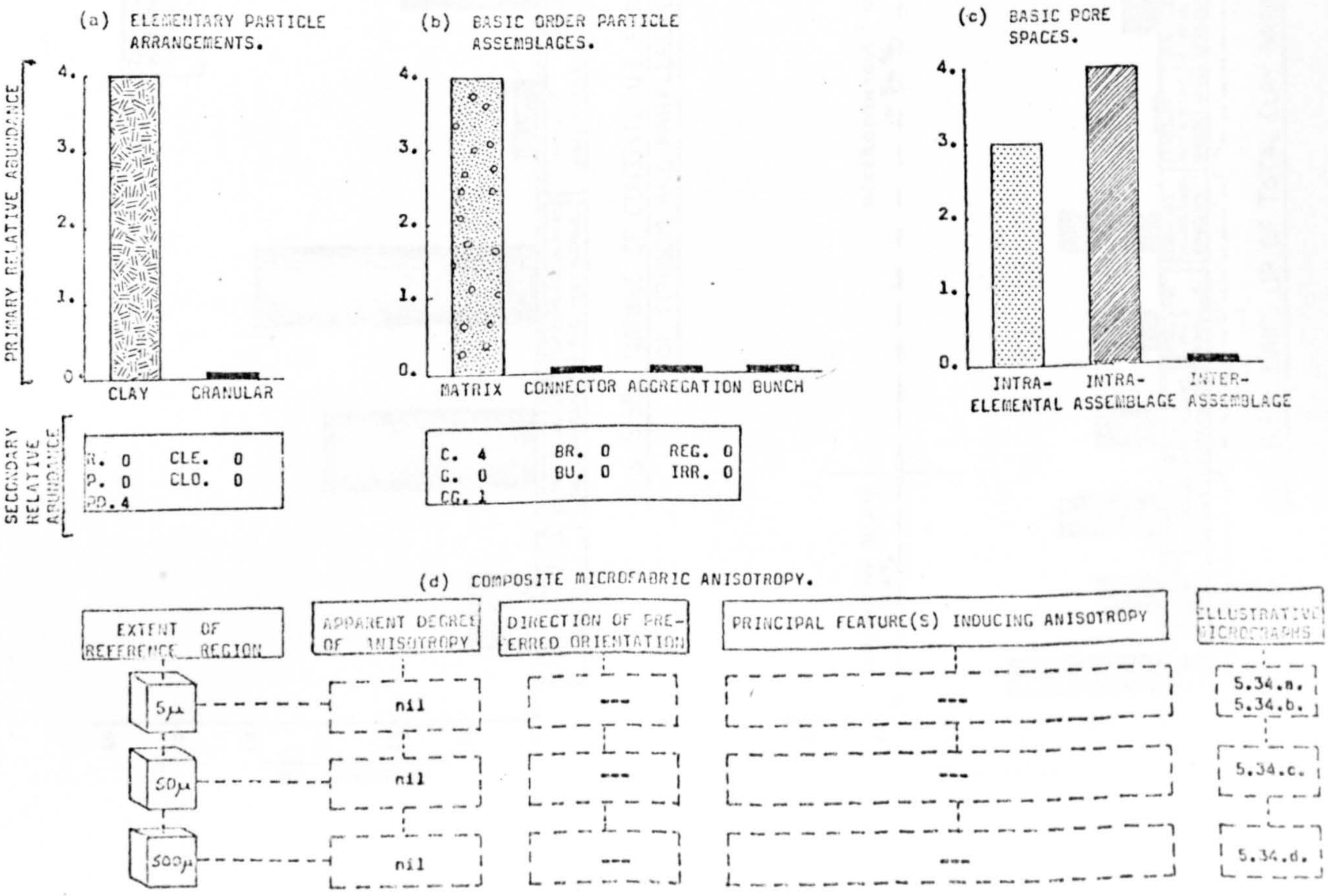


FIG. 5.34. MICROFABRIC OF RESIDUAL CLAY - ONDERSTEPOORT, S.A.



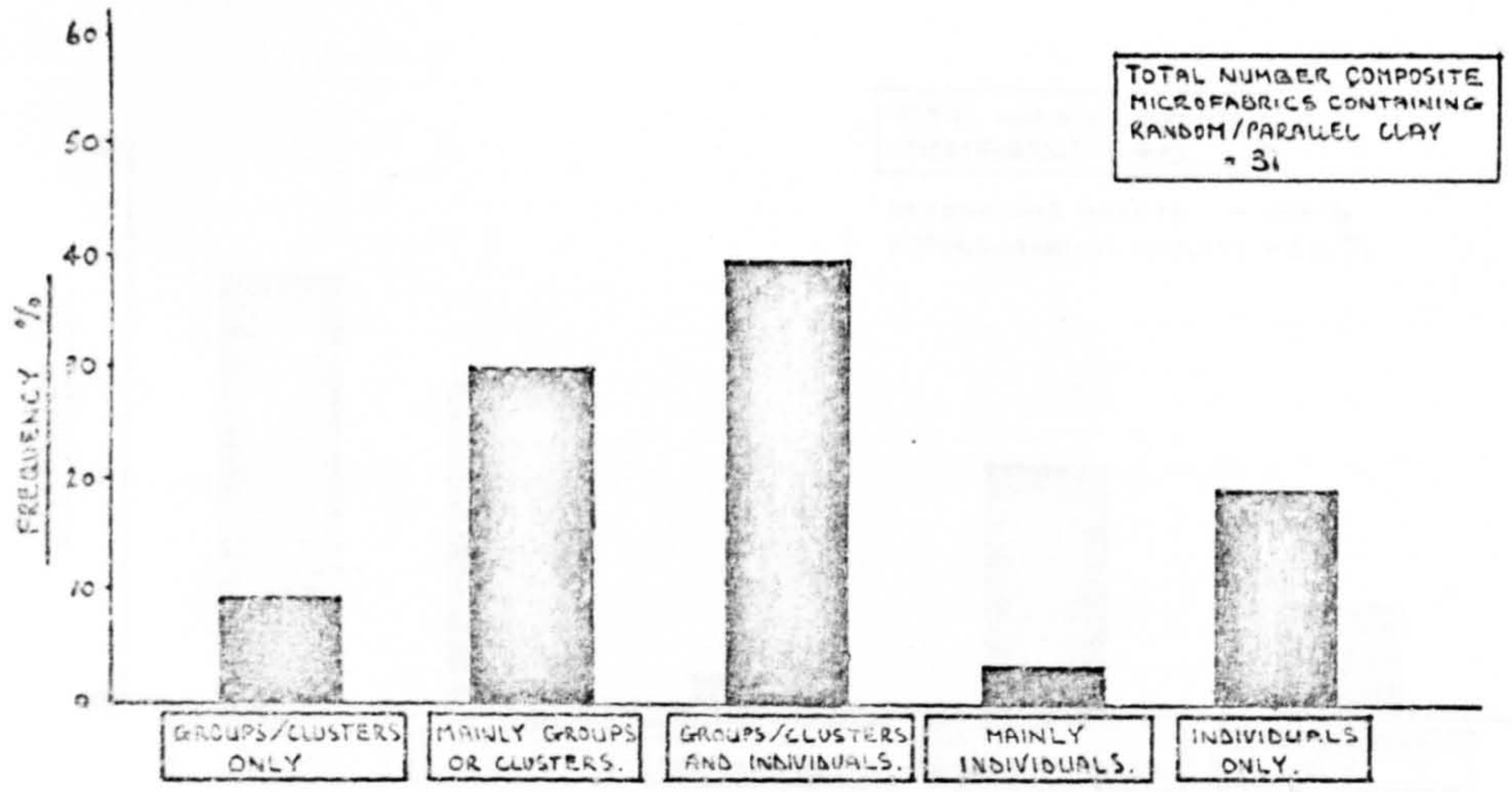


FIG. 5.35. NATURE OF CONSTITUENT PARTICLES OF RANDOM AND PARALLEL CLAY.

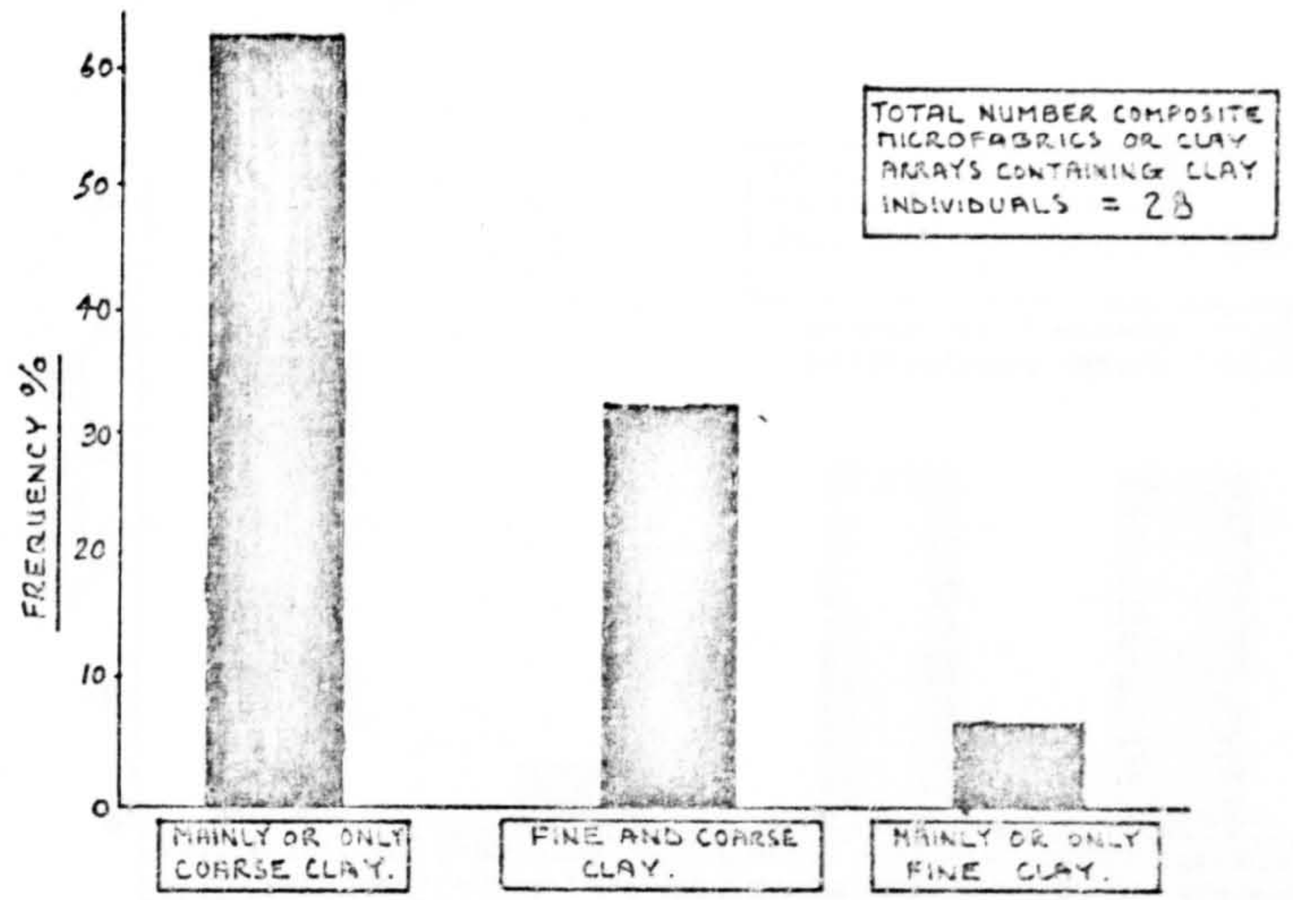


FIG. 5.36. SIZE OF CLAY INDIVIDUALS.

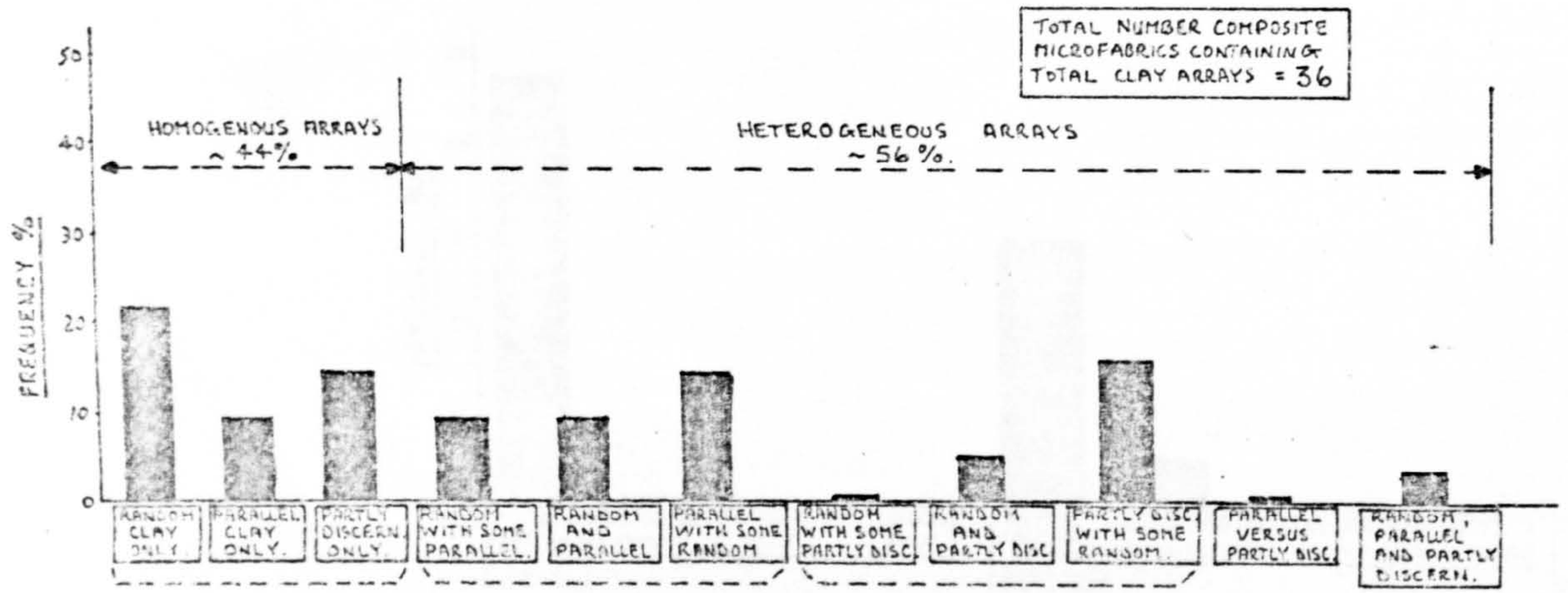


FIG. 5.37. MAKE UP OF TOTAL CLAY ARRAYS

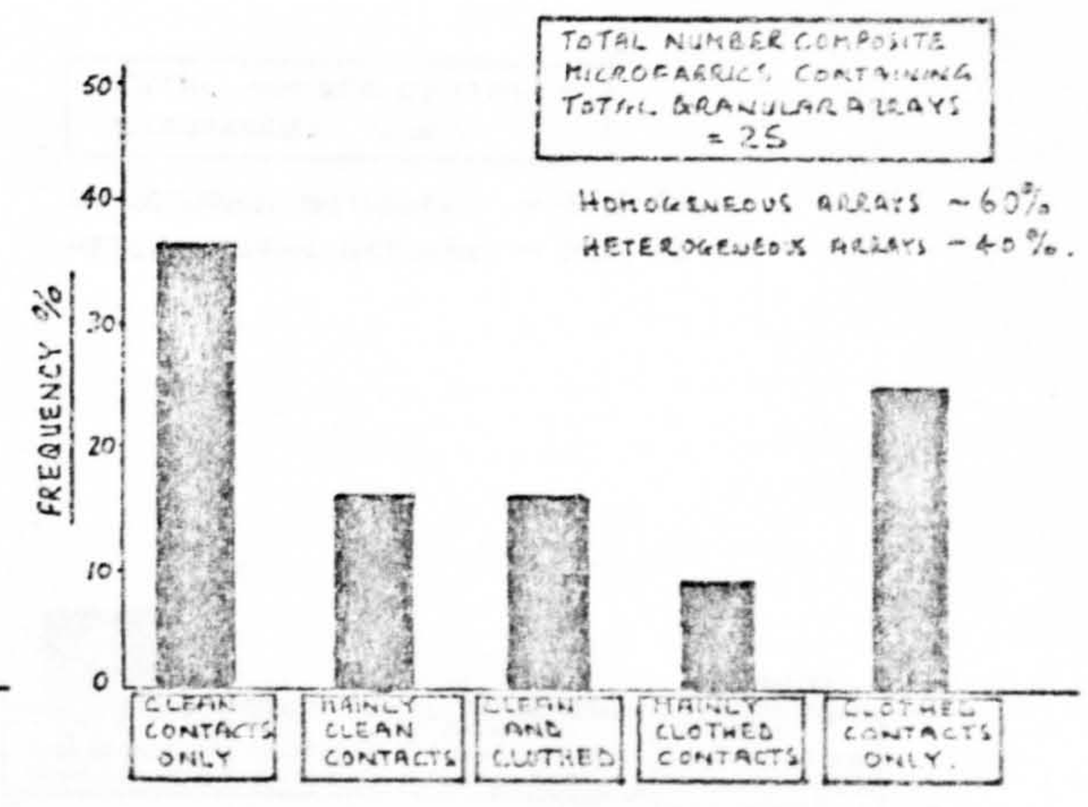


FIG. 5.38. MAKE UP OF TOTAL GRANULAR ARRAYS.

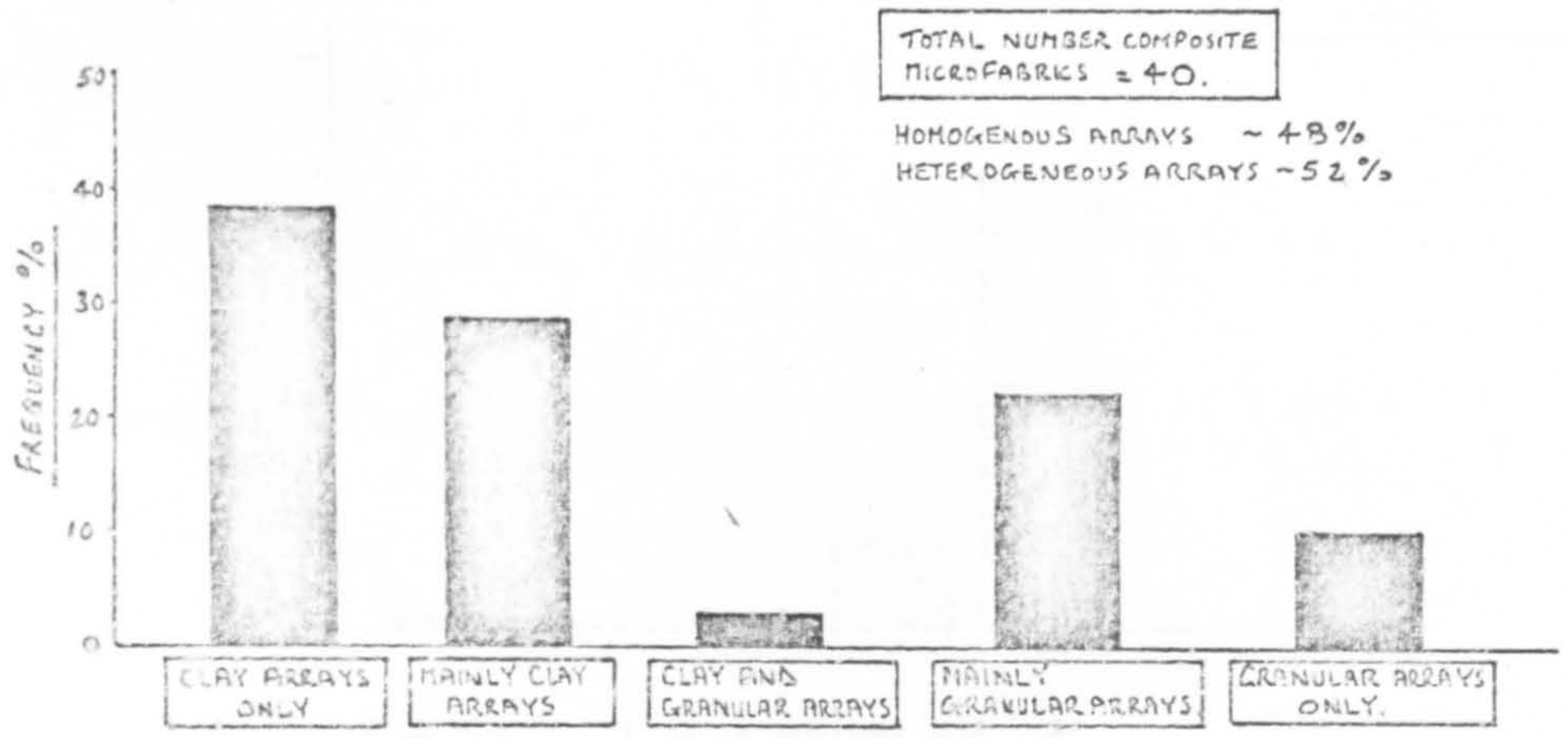


FIG. 5.39. MAKE UP OF TOTAL ELEMENTARY ARRAY(1)

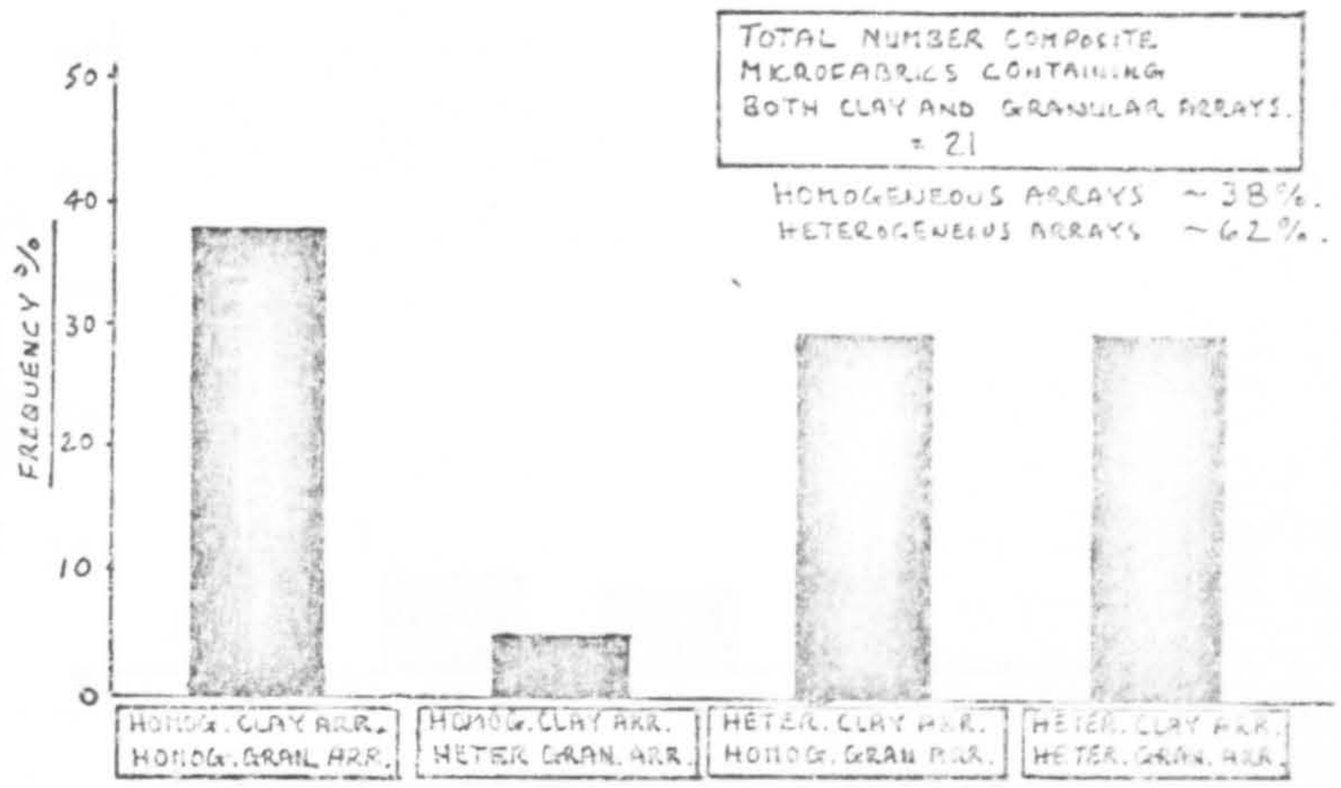


FIG. 5.40. MAKE UP OF TOTAL ELEMENTARY ARRAY (2)

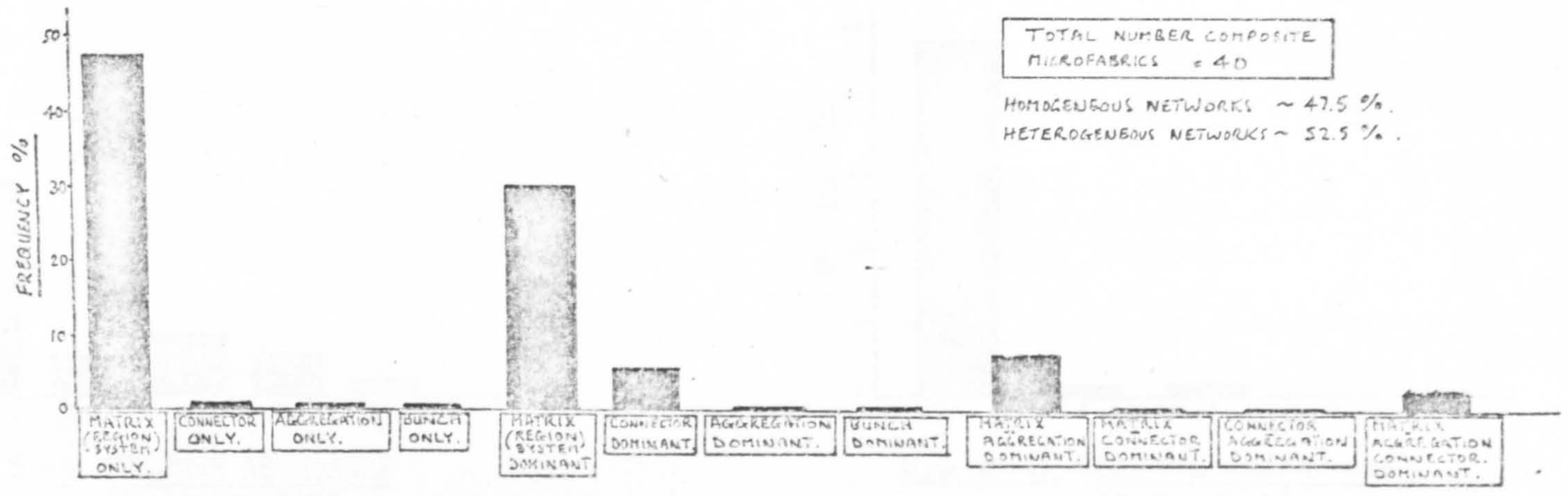


FIG. 5.41. DOMINANT PARTICLE ASSEMBLAGE(S) WITHIN BASIC ASSEMBLAGE NETWORK.

TOTAL NUMBER
COMPOSITE MICROFABRICS
= 40

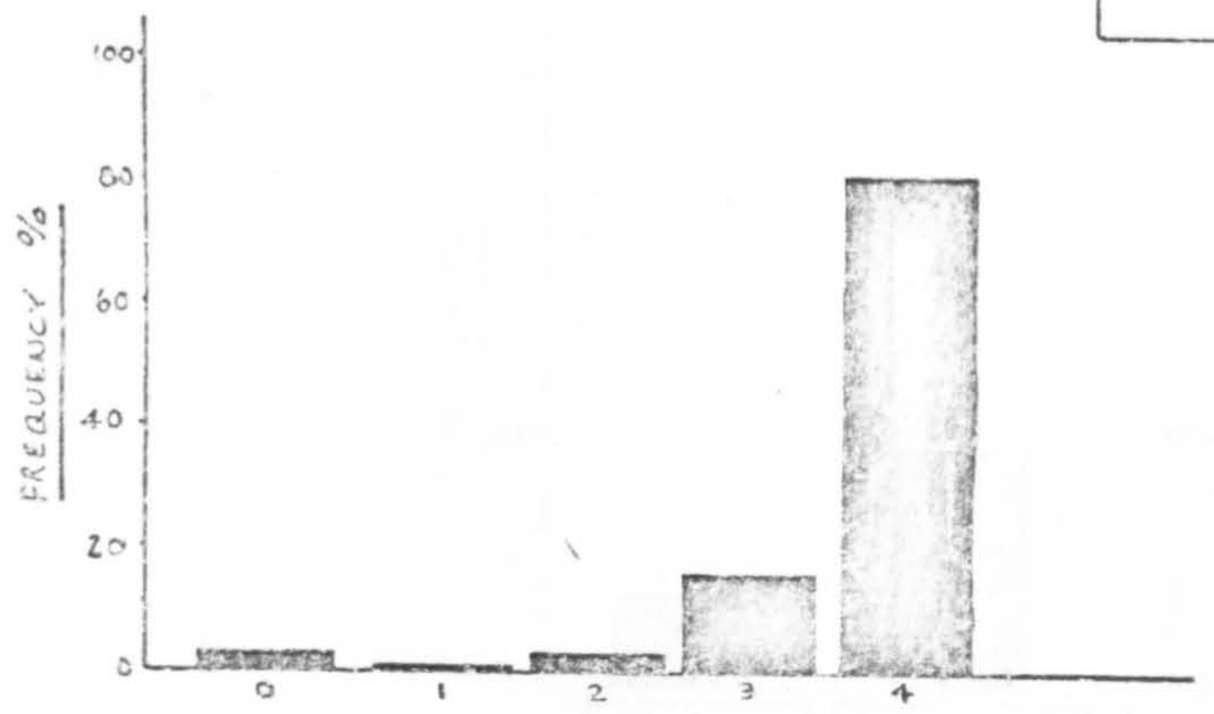


FIG. 5.42. RELATIVE ABUNDANCE OF MATRIX OR REGION SYSTEMS

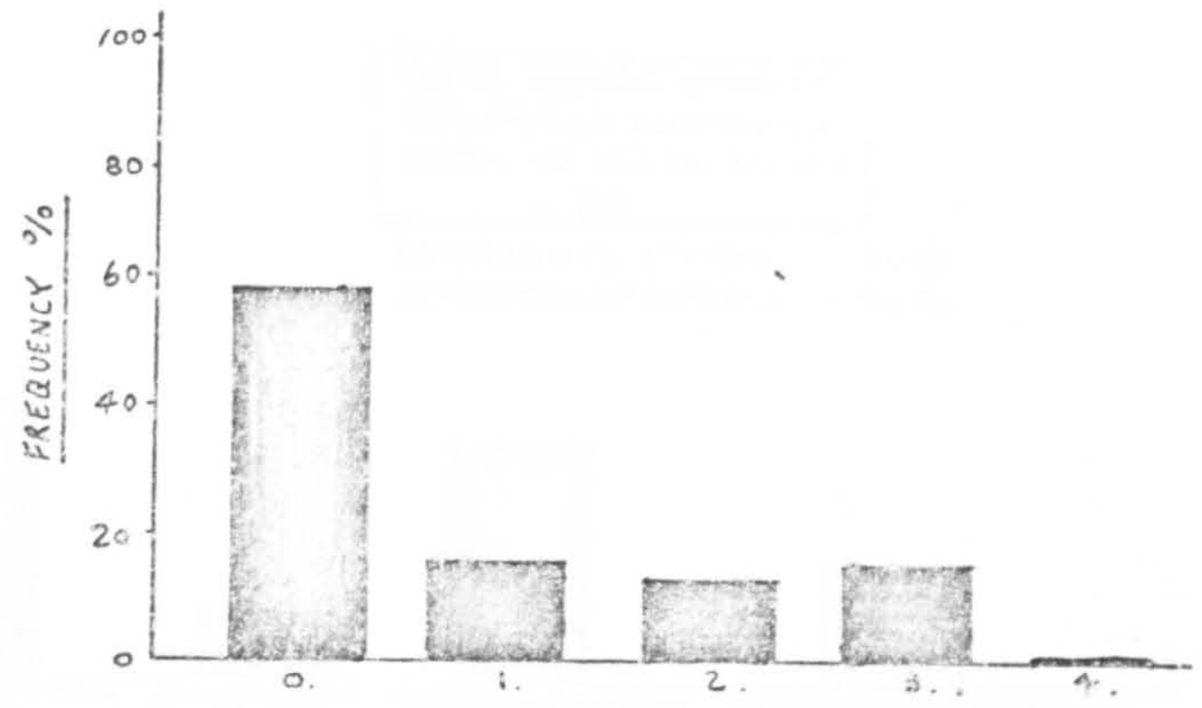


FIG. 5.43. RELATIVE ABUNDANCE OF AGGREGATIONS.

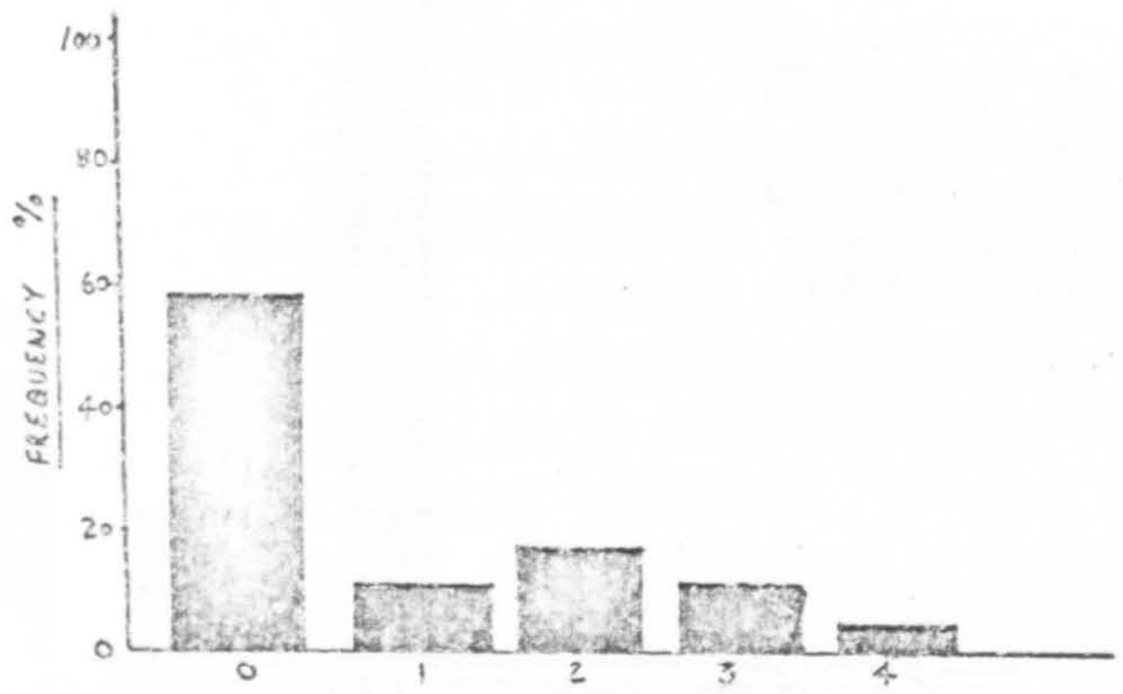


FIG. 5.44. RELATIVE ABUNDANCE OF CONNECTORS

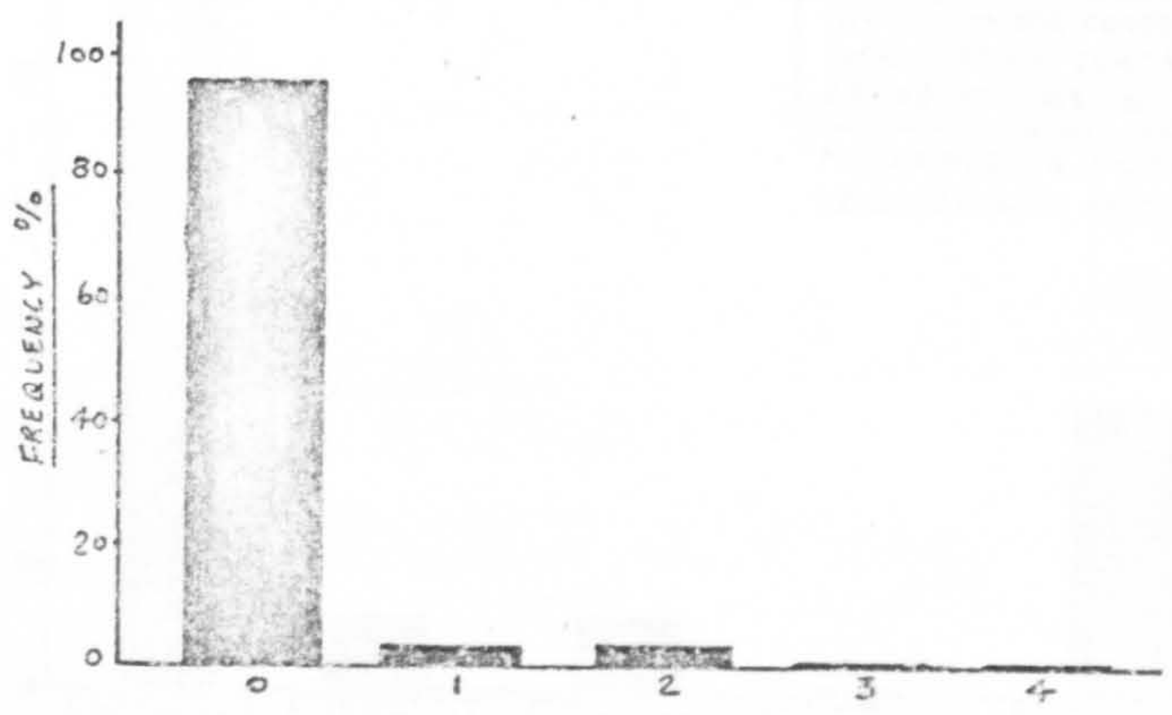


FIG. 5.45. RELATIVE ABUNDANCE OF BUNCHES

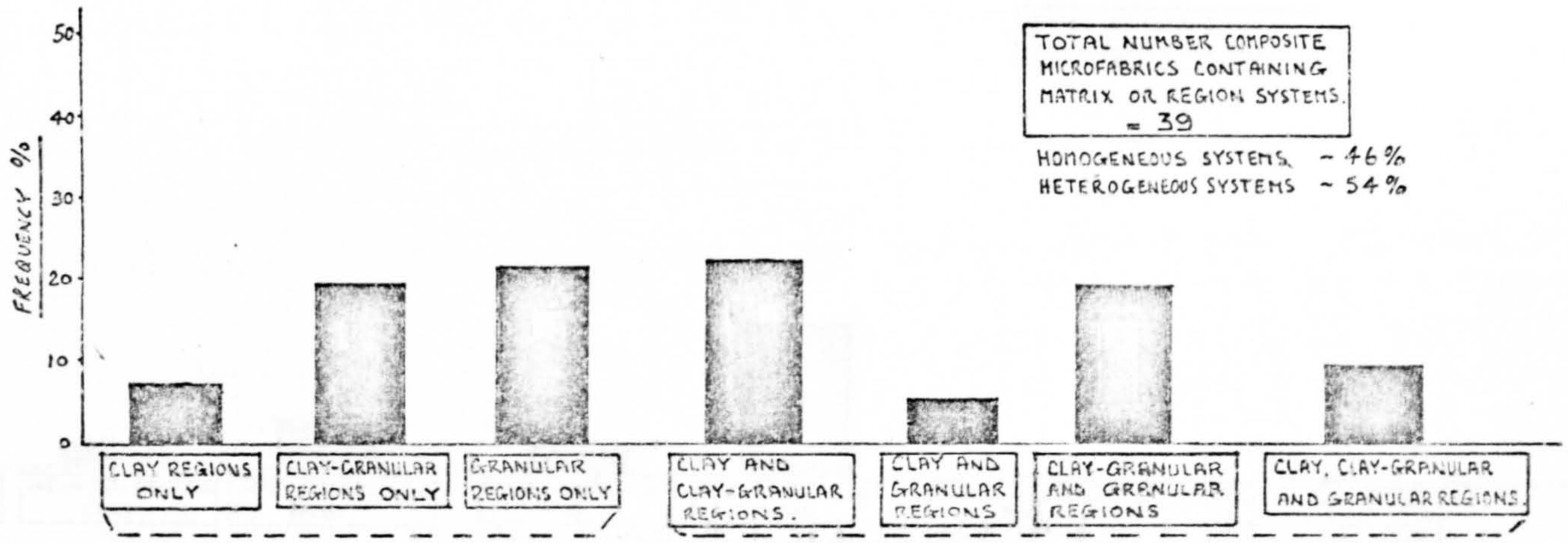


FIG. 5.46. MAKE UP OF MATRIX AND REGION SYSTEMS

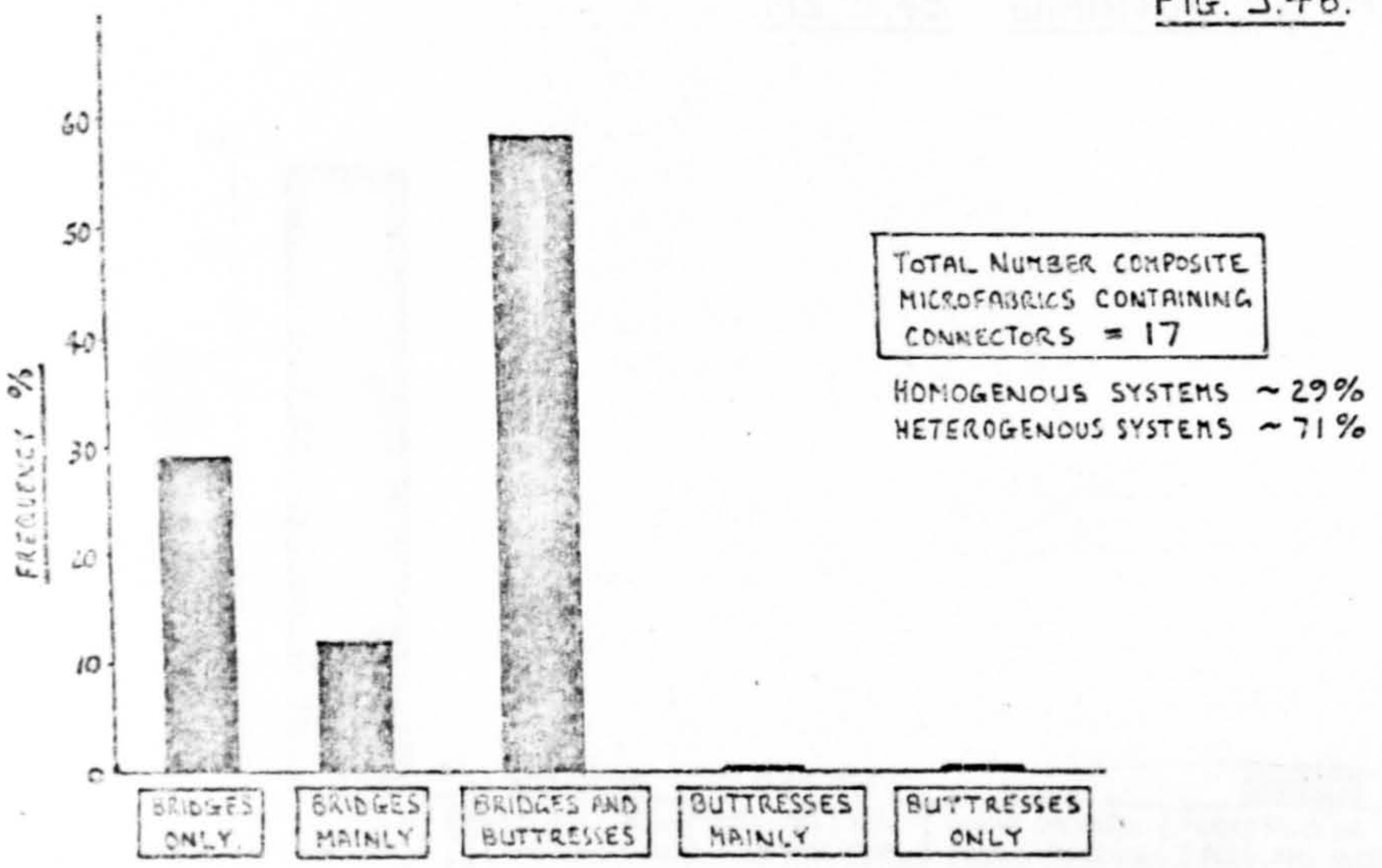


FIG. 5.47. MAKE UP OF CONNECTOR SYSTEMS

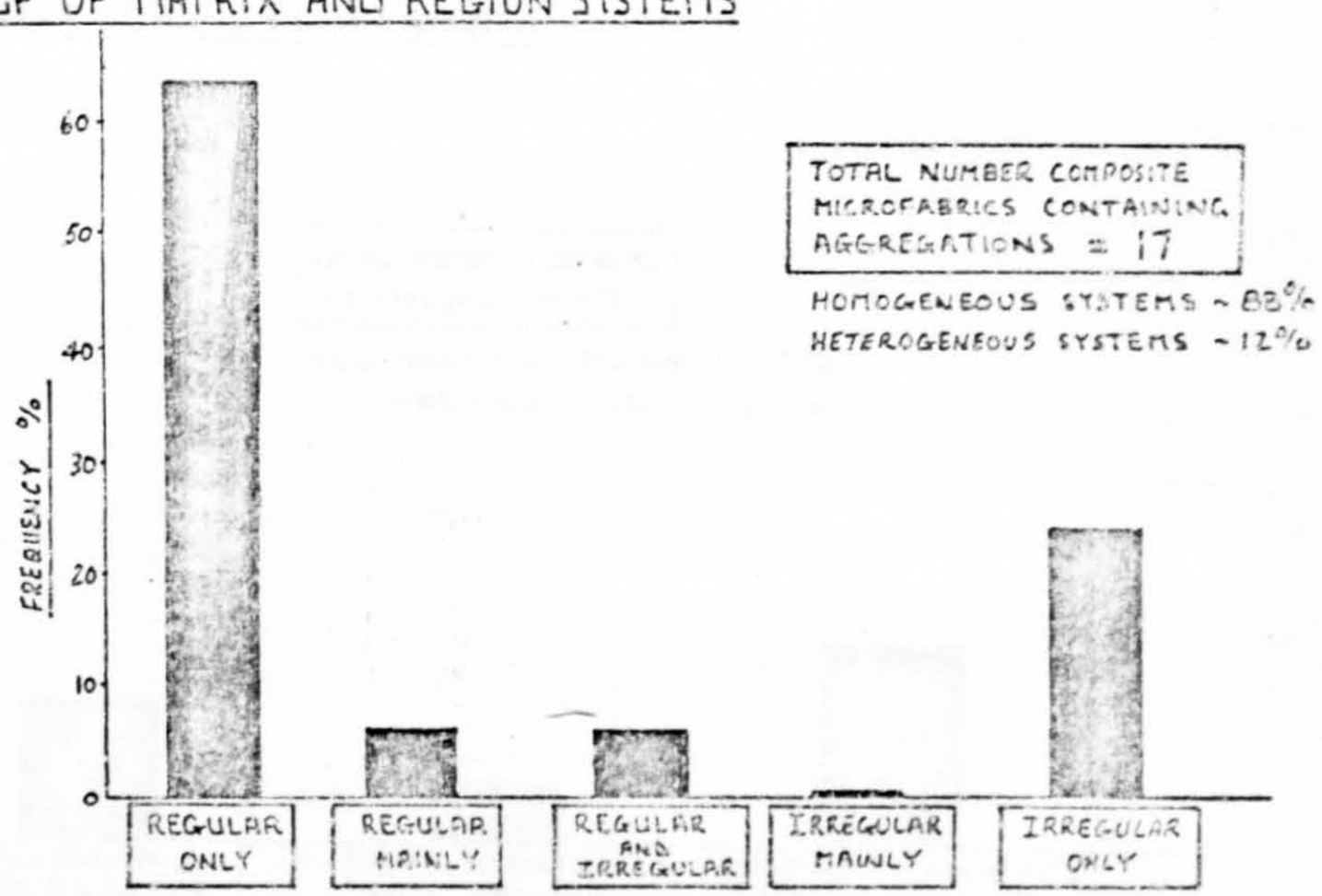


FIG. 5.48. MAKE UP OF AGGREGATION SYSTEMS

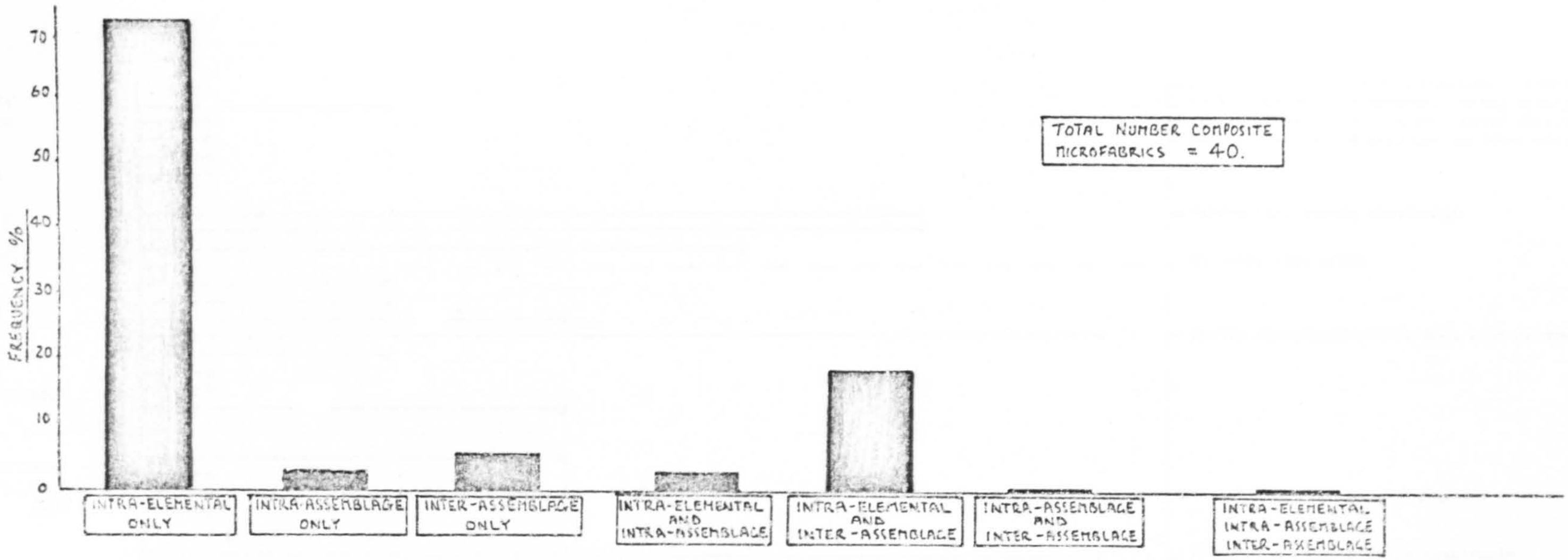


FIG. 5.49 DOMINANT PORE TYPE(S) WITHIN BASIC PORE SPACE

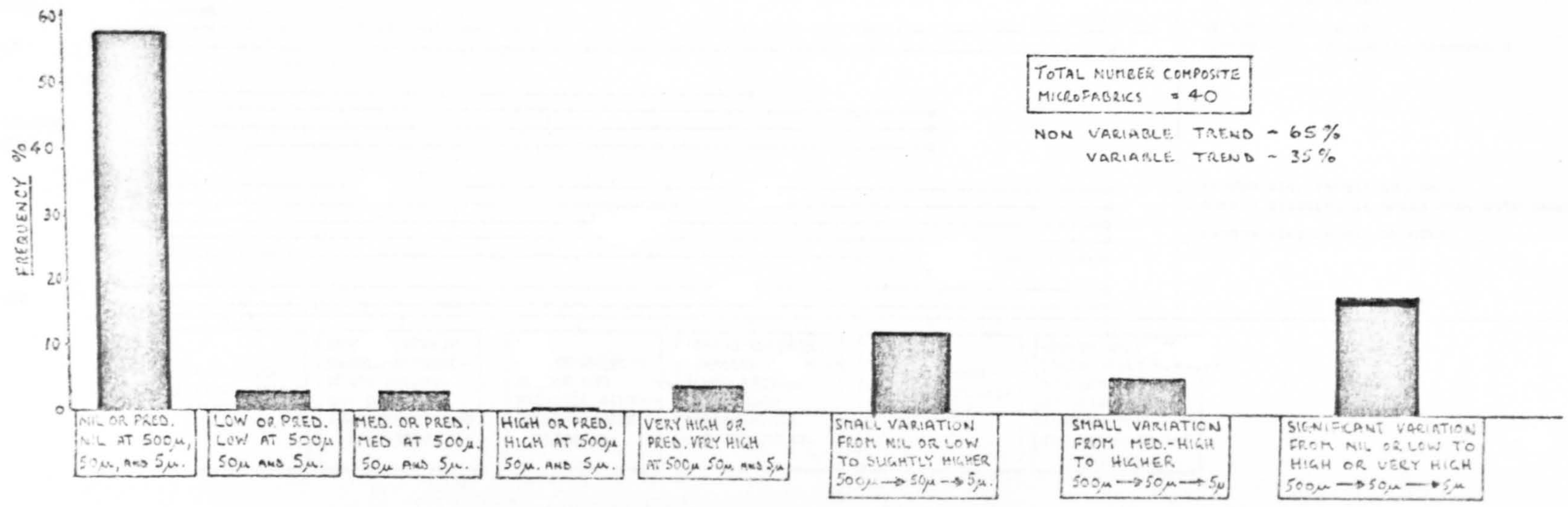


FIG. 5.50 COMPOSITE MICROFABRIC ANISOTROPY

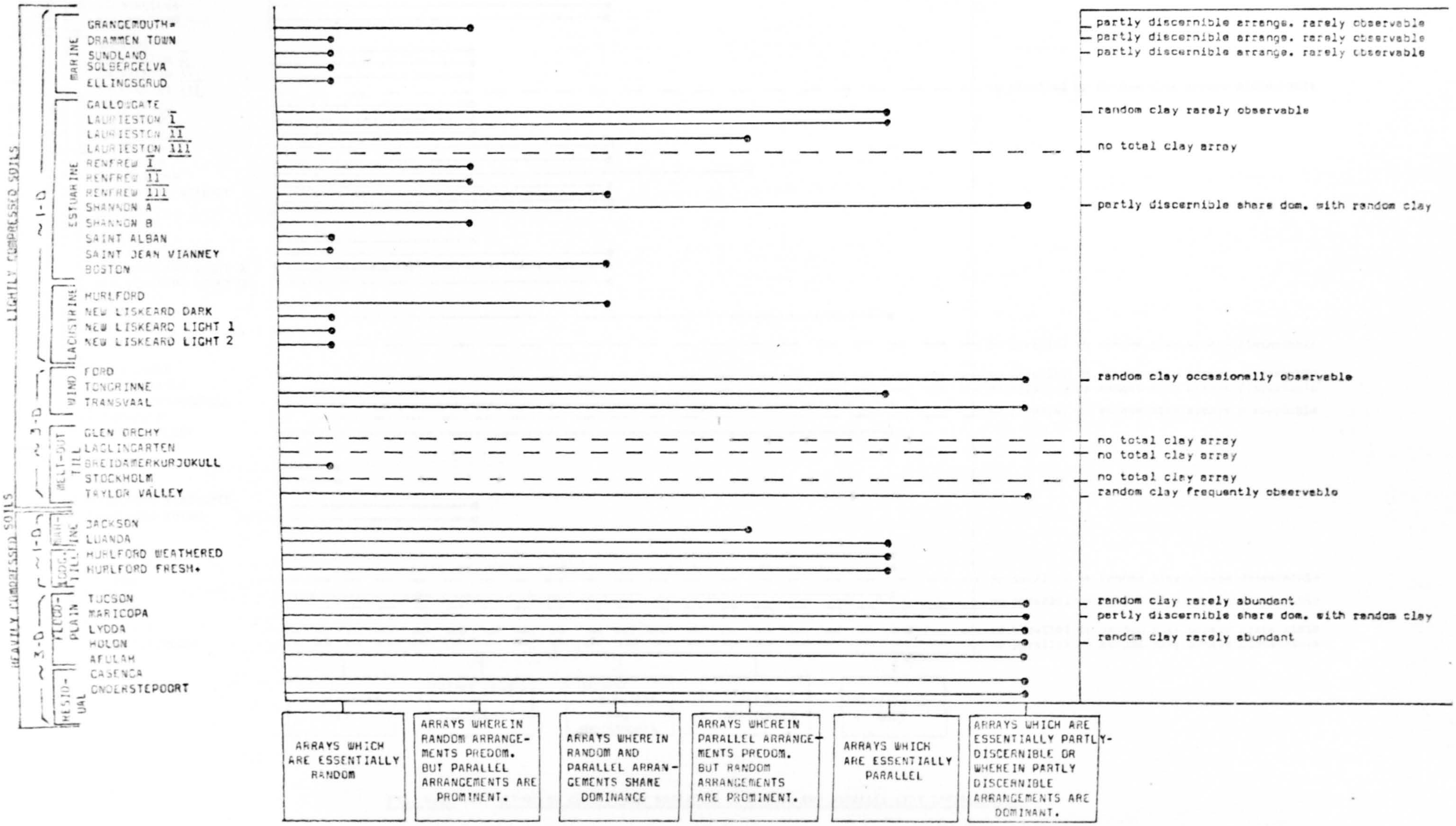


FIG. 6.1. MAKE UP OF TOTAL CLAY ARRAY.

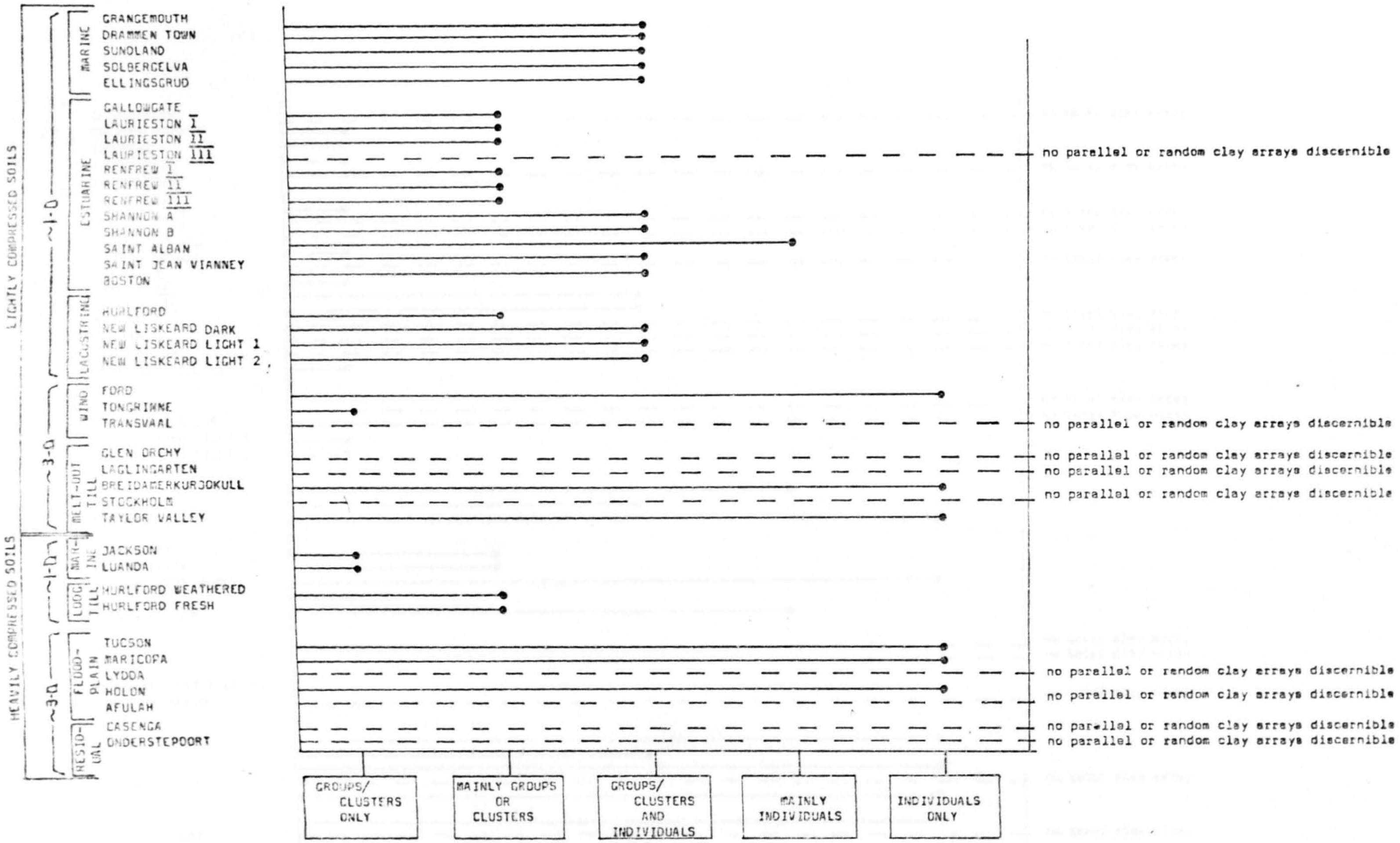


FIG. 6.2. NATURE OF CONSTITUENT PARTICLES OF RANDOM AND PARALLEL CLAY ARRANGEMENTS.

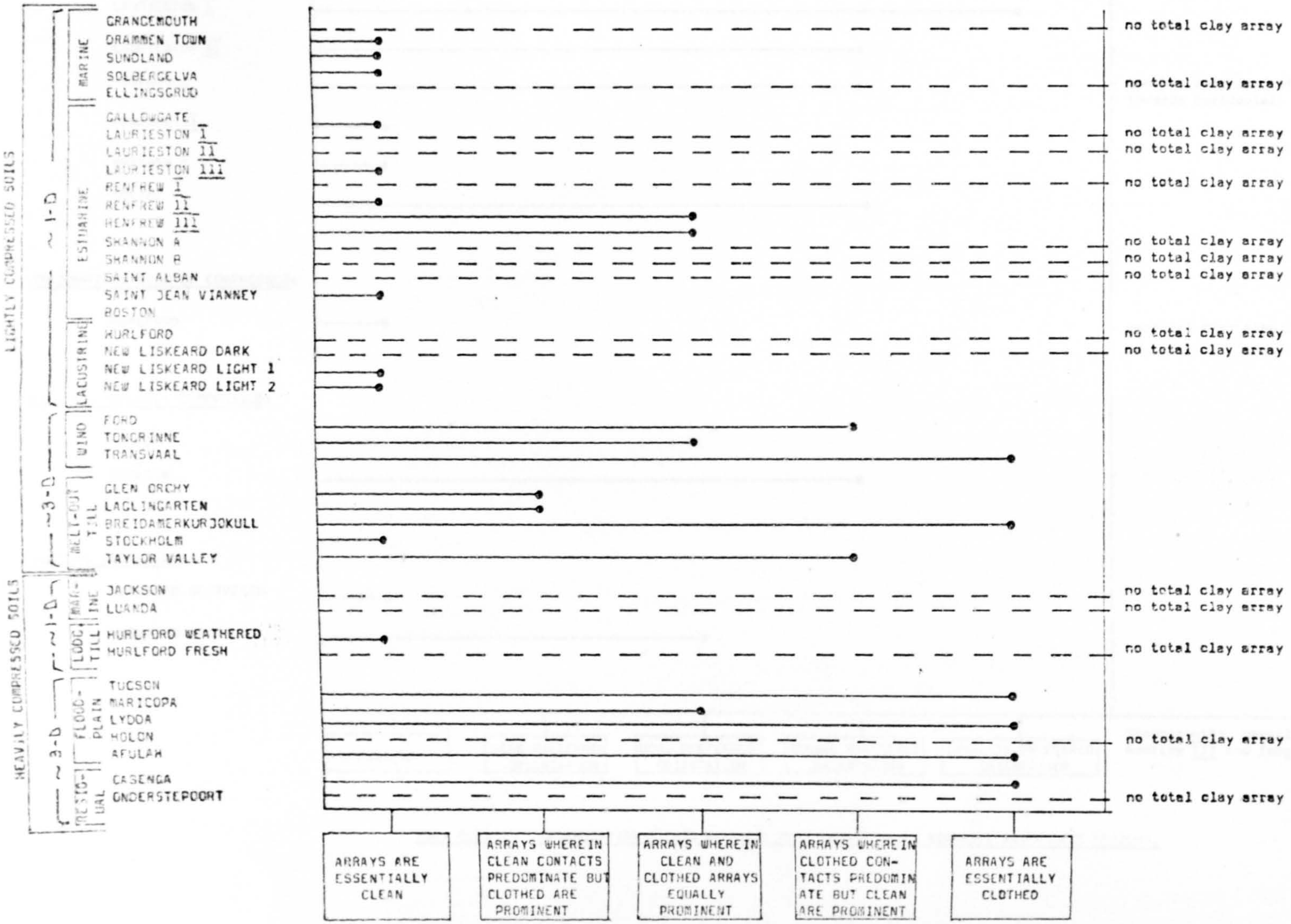


FIG. 6.3. MAKE UP OF TOTAL GRANULAR ARRAY.

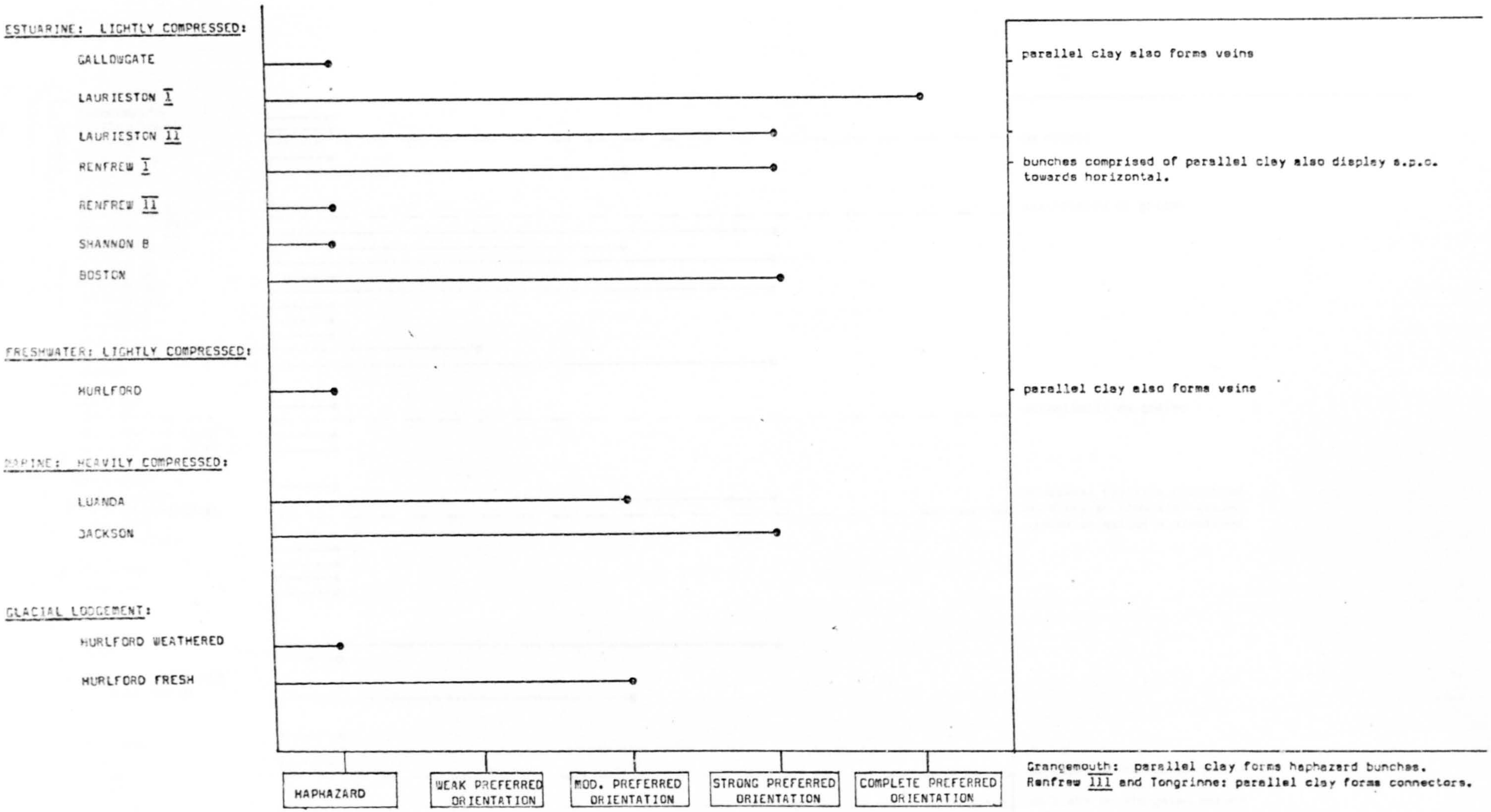


FIG. 6.4. ORGANISATION WITHIN PARALLEL CLAY ARRAYS WHICH COMPRISE ASSEMBLAGE REGIONS.

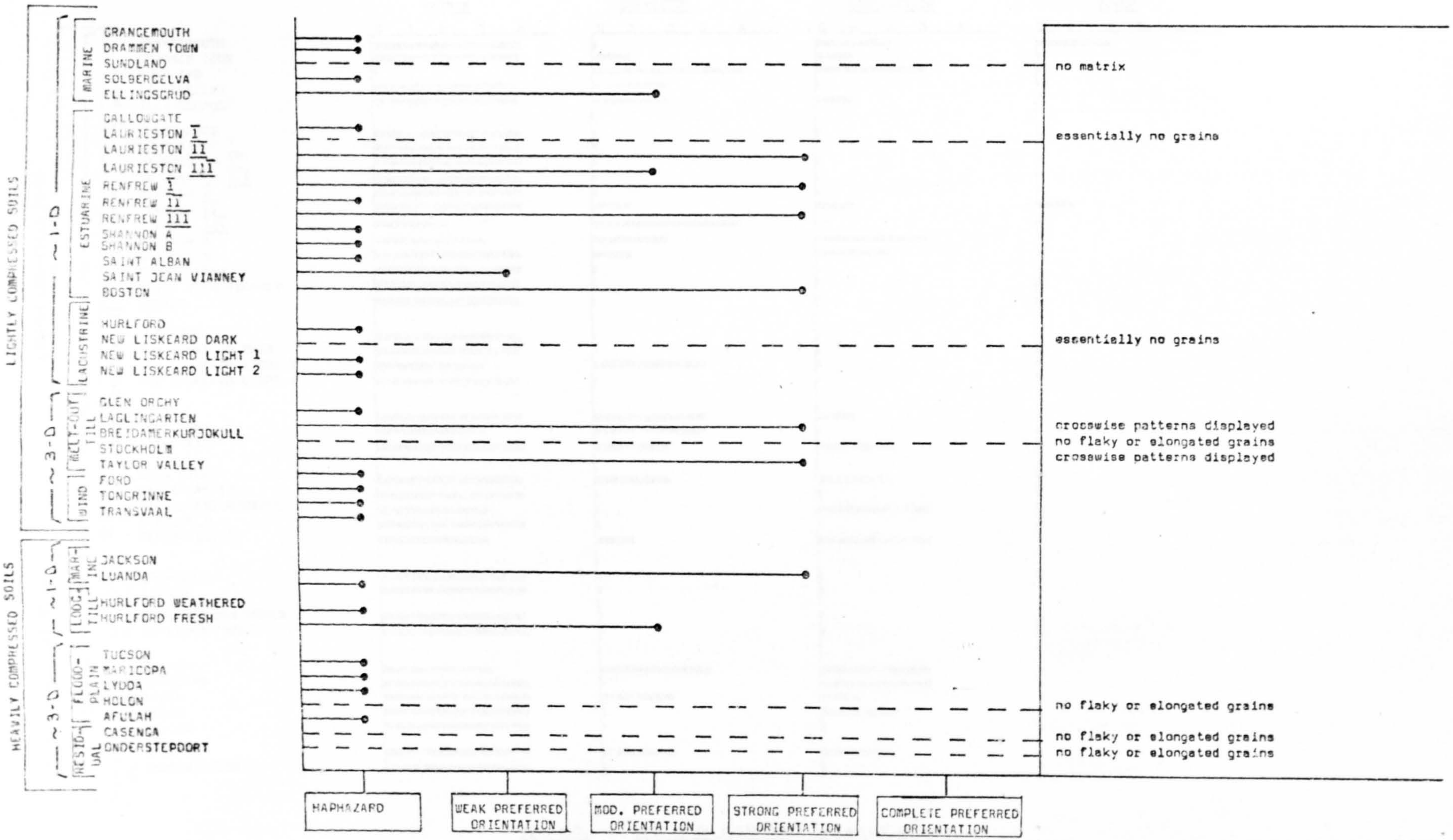


FIG. 6.5. OVERALL DEGREE OF PREFERRED ORIENTATION OF GRAINS WITHIN GRANULAR AND CLAY-GRANULAR MATRIX OR LAYER REGIONS.

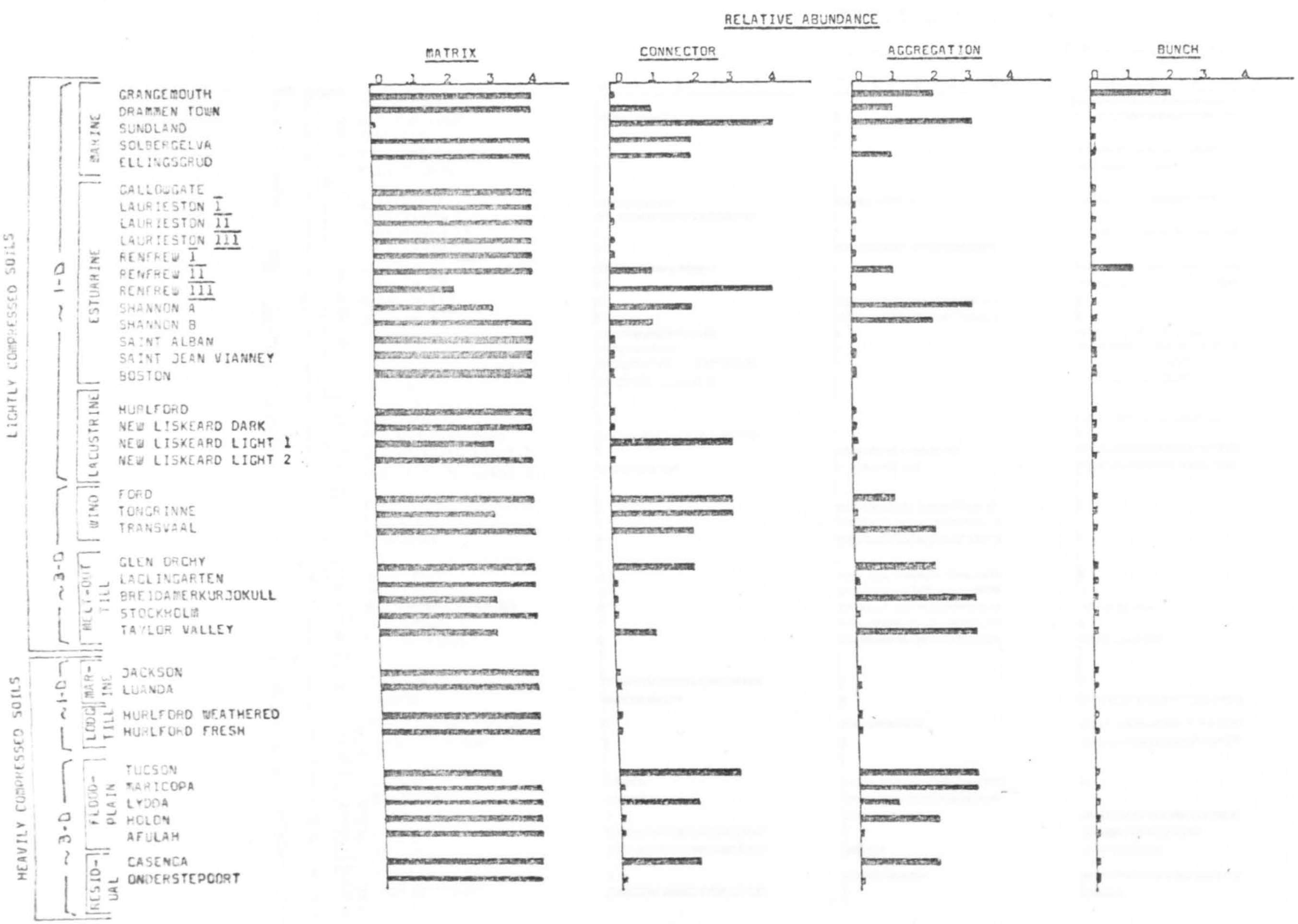


FIG. 6.6. MAKE UP OF BASIC ORDER ASSEMBLAGE NETWORK.

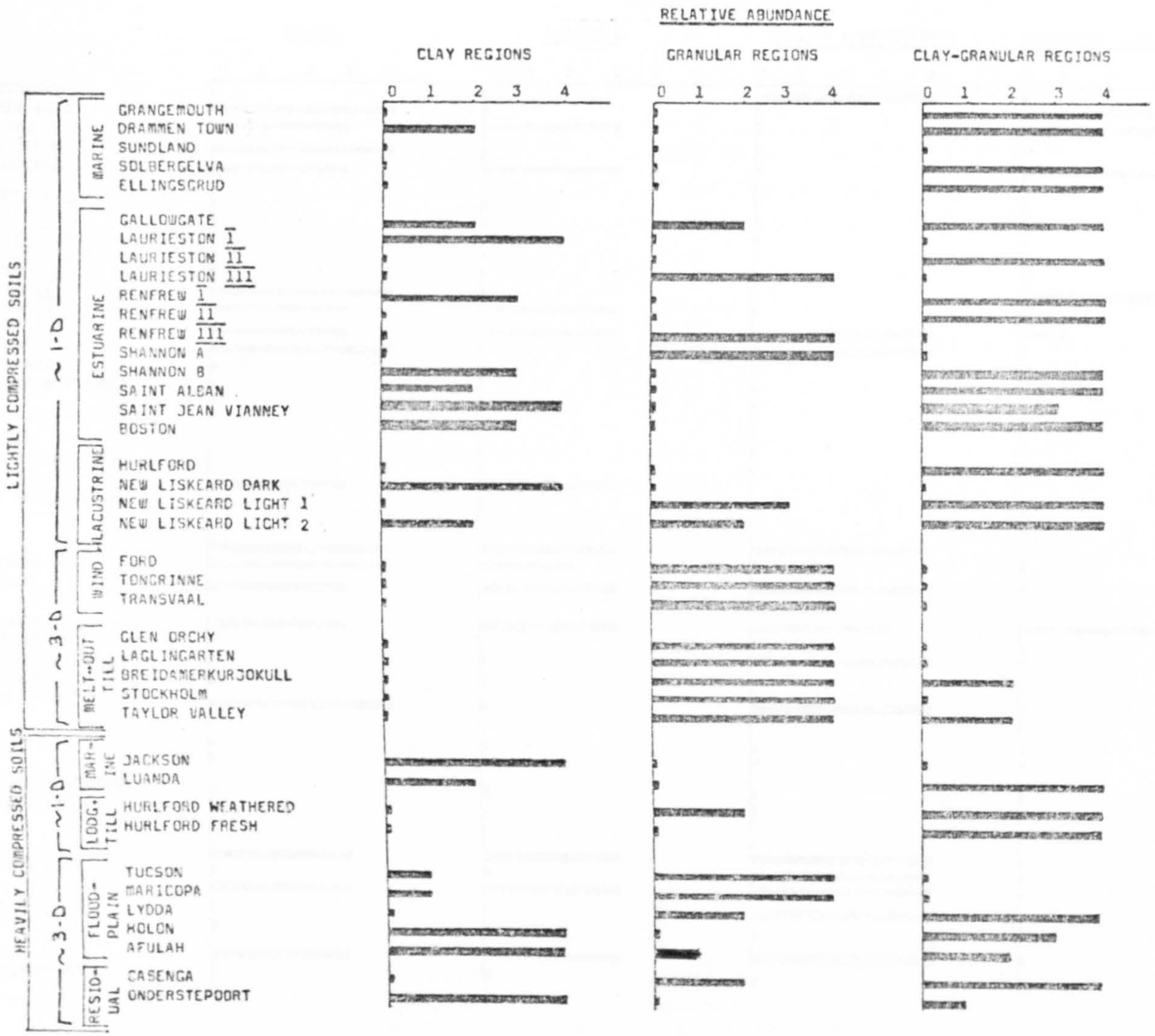


FIG. 6.7. MAKE UP OF MATRIX OR REGION SYSTEMS

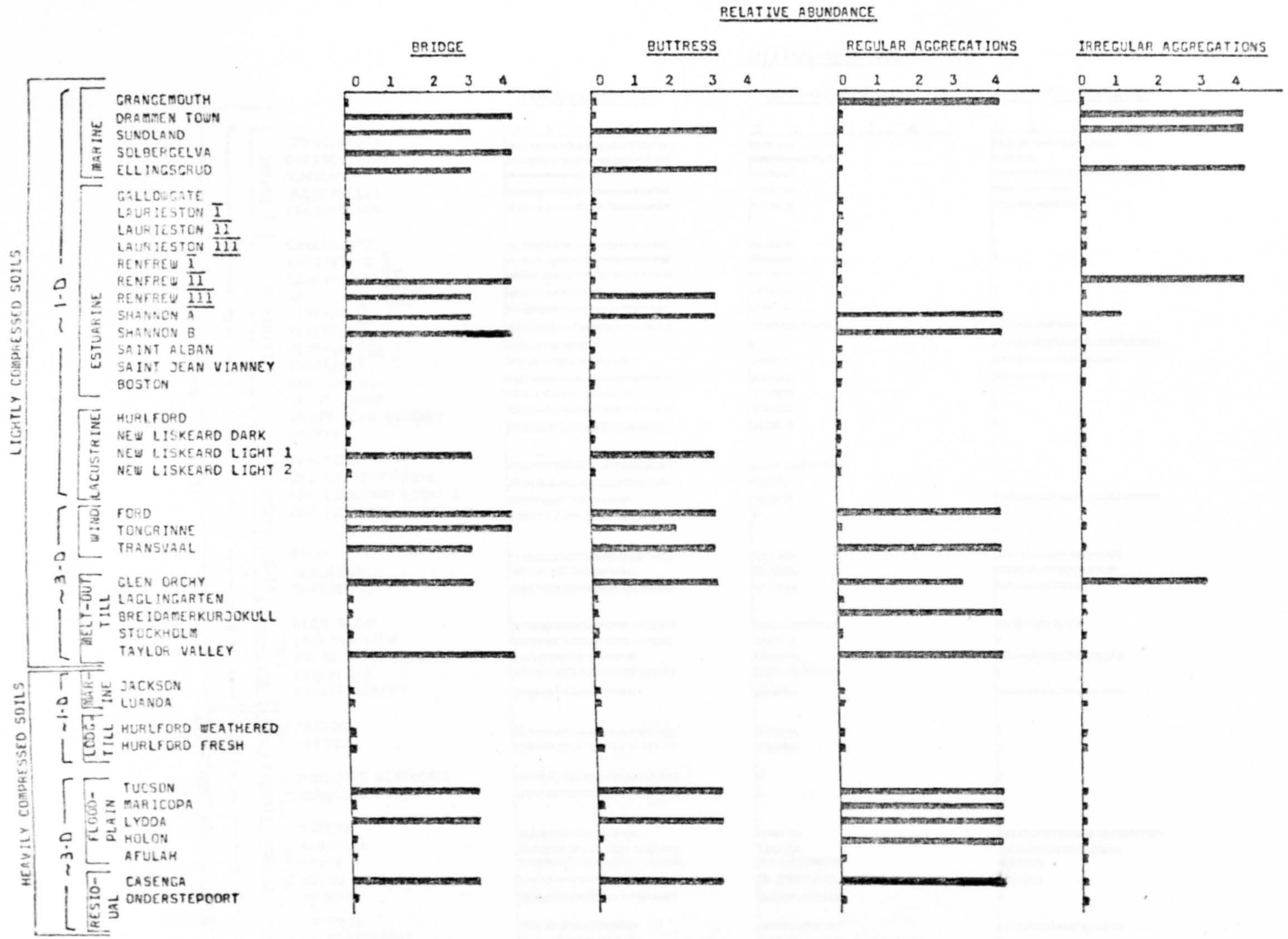


FIG. 6.8. MAKE UP OF CONNECTOR AND AGGREGATION SYSTEMS.

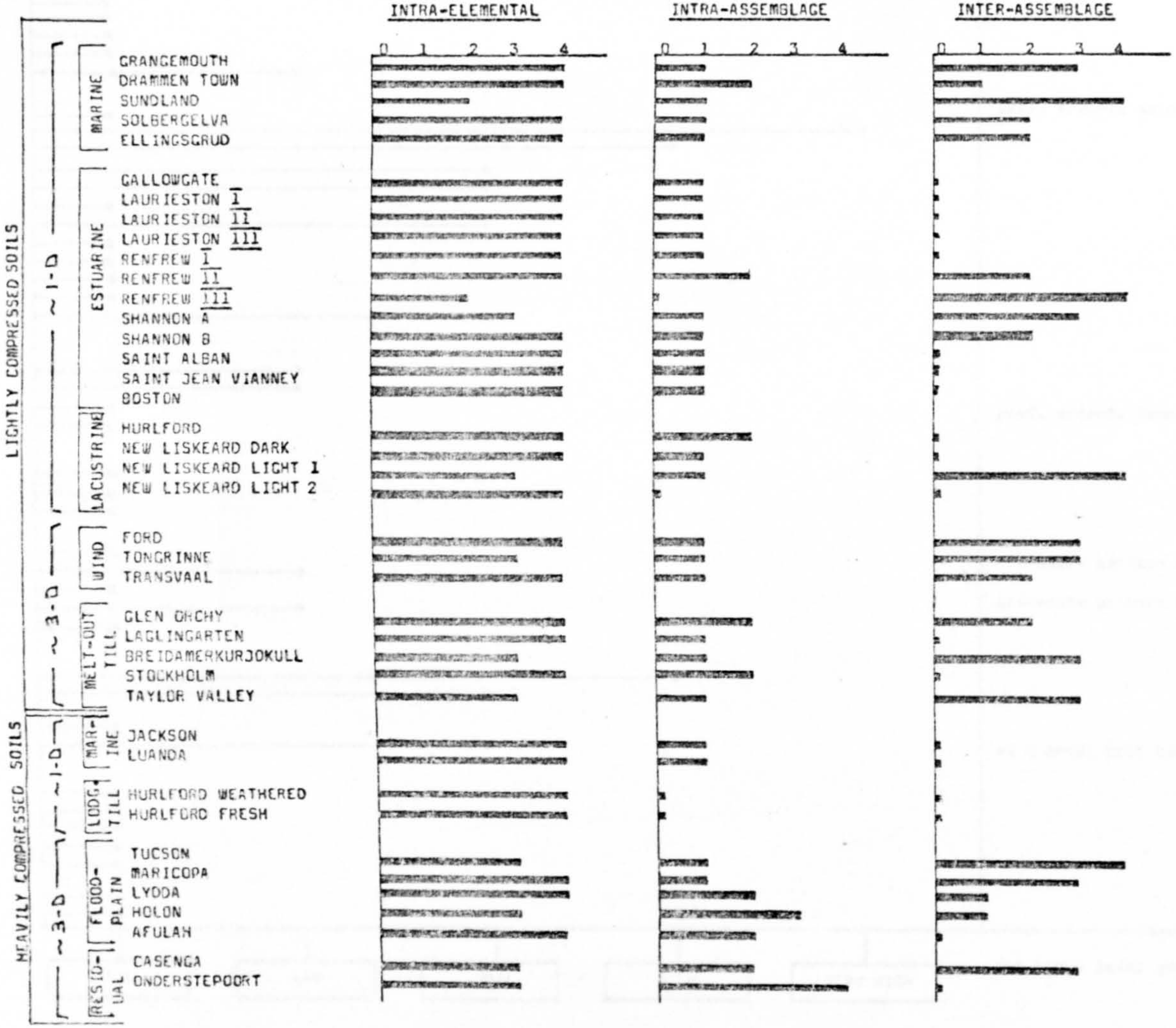


FIG. 6.9. MAKE UP OF BASIC PORE SPACE.

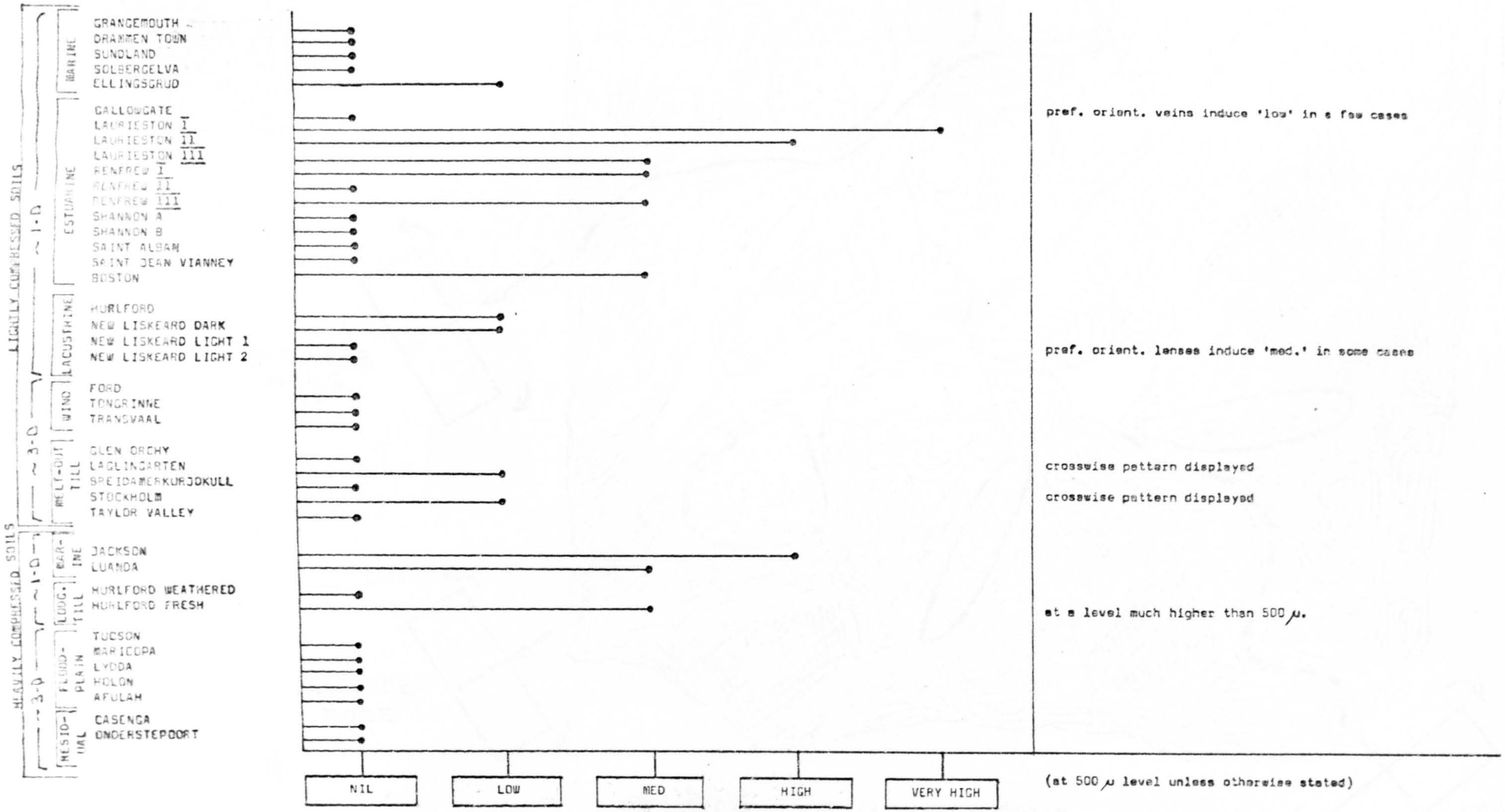


FIG. 6.10. DEGREE OF ANISOTROPY DISPLAYED BY COMPOSITE MICROFABRIC.

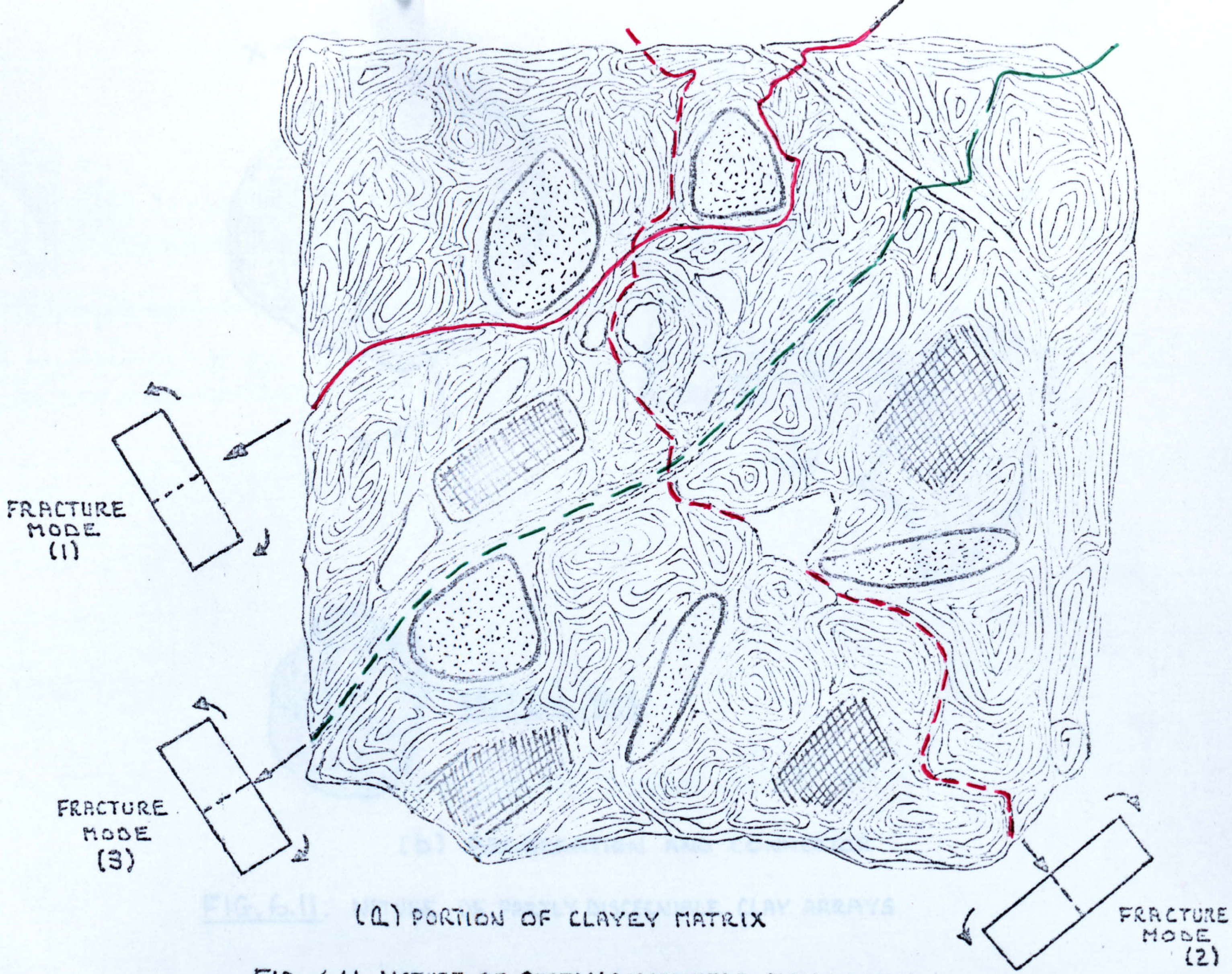
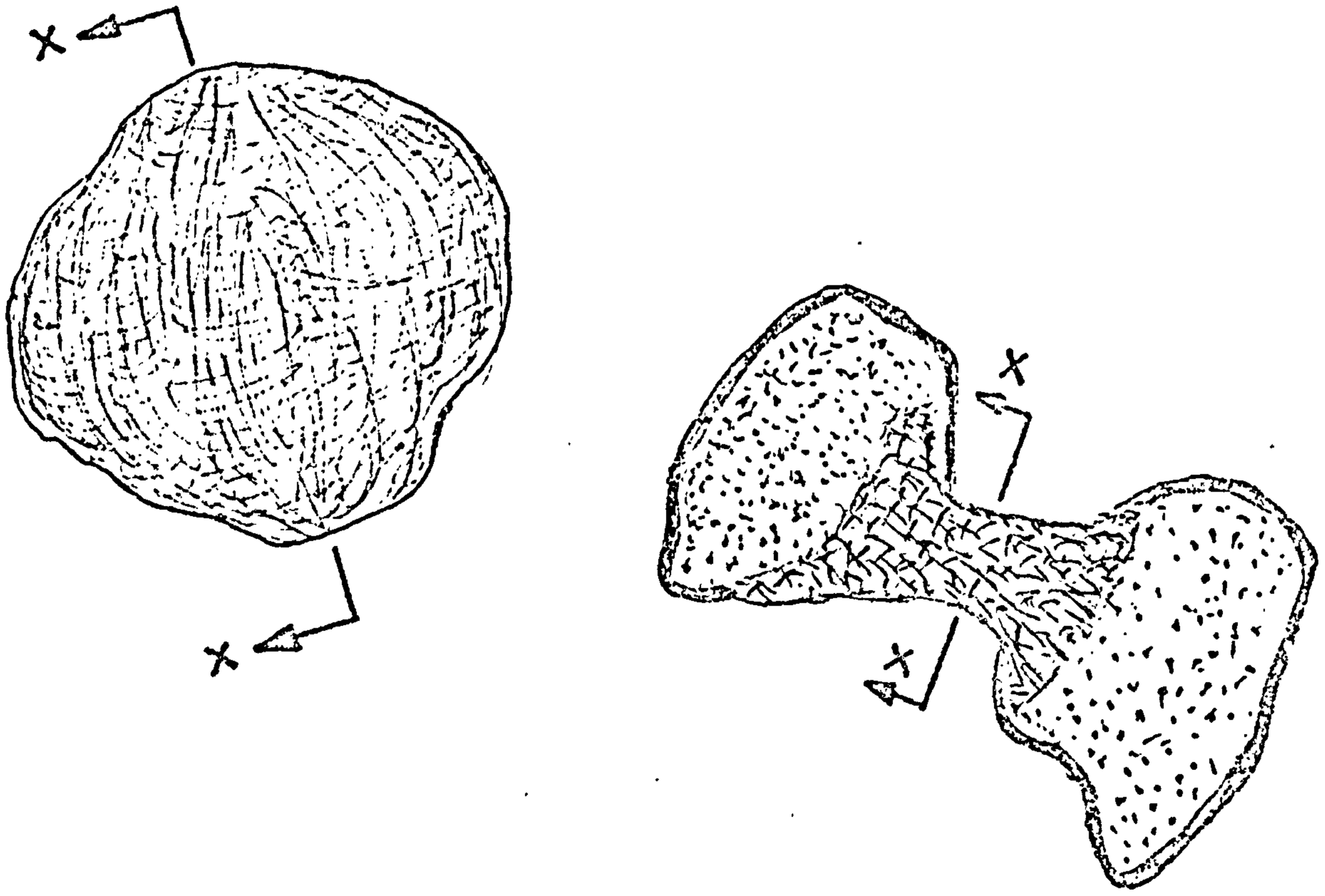


FIG. 6.11. NATURE OF PARTLY DISCERNIBLE CLAY ARRAYS



SECTION X-X

(b) AGGREGATION AND CONNECTOR

FIG. 6.11. NATURE OF PARTLY DISCERNIBLE CLAY ARRAYS

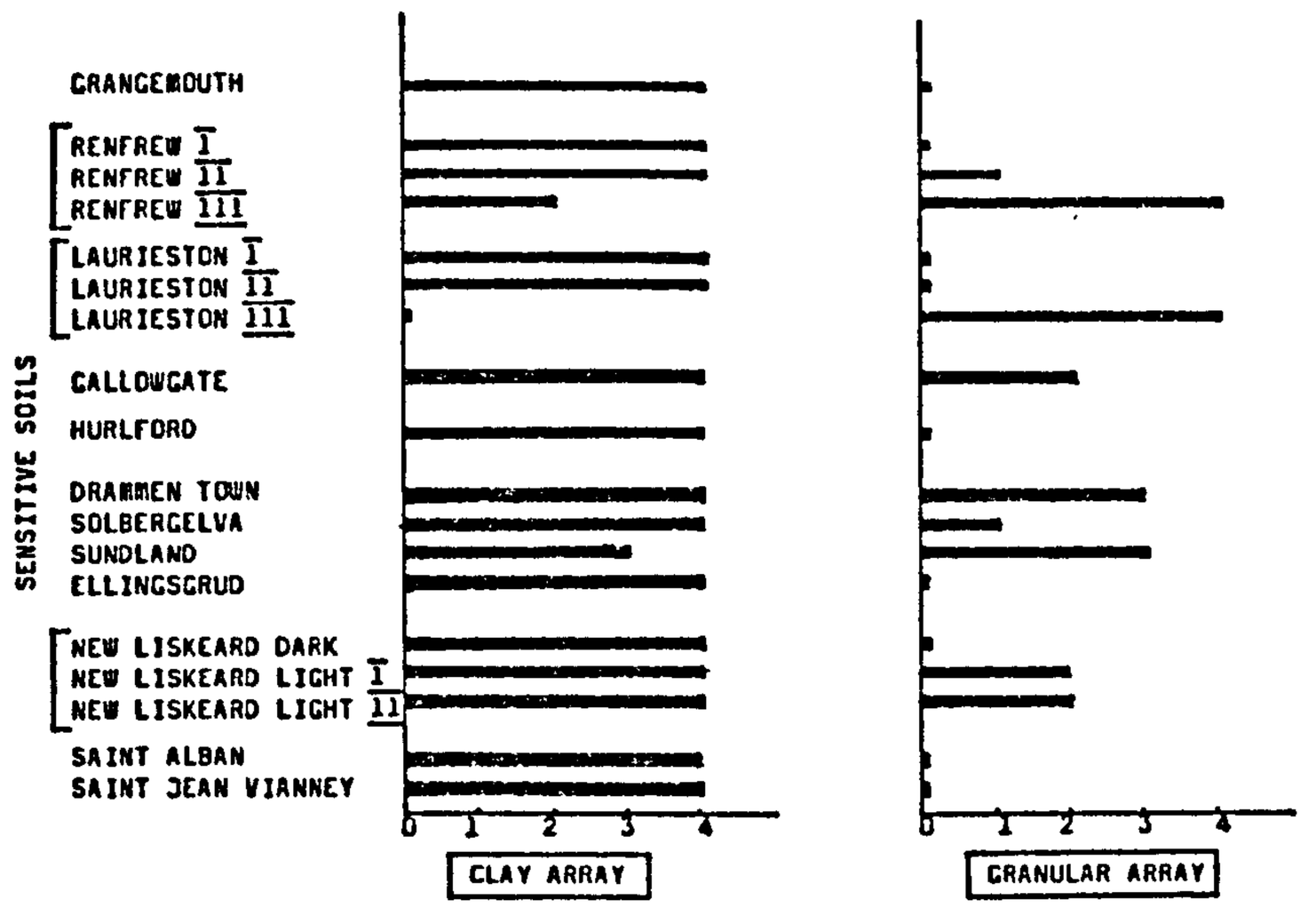


FIG. 7.1. MAKE UP OF TOTAL ELEMENTARY PARTICLE ARRAY

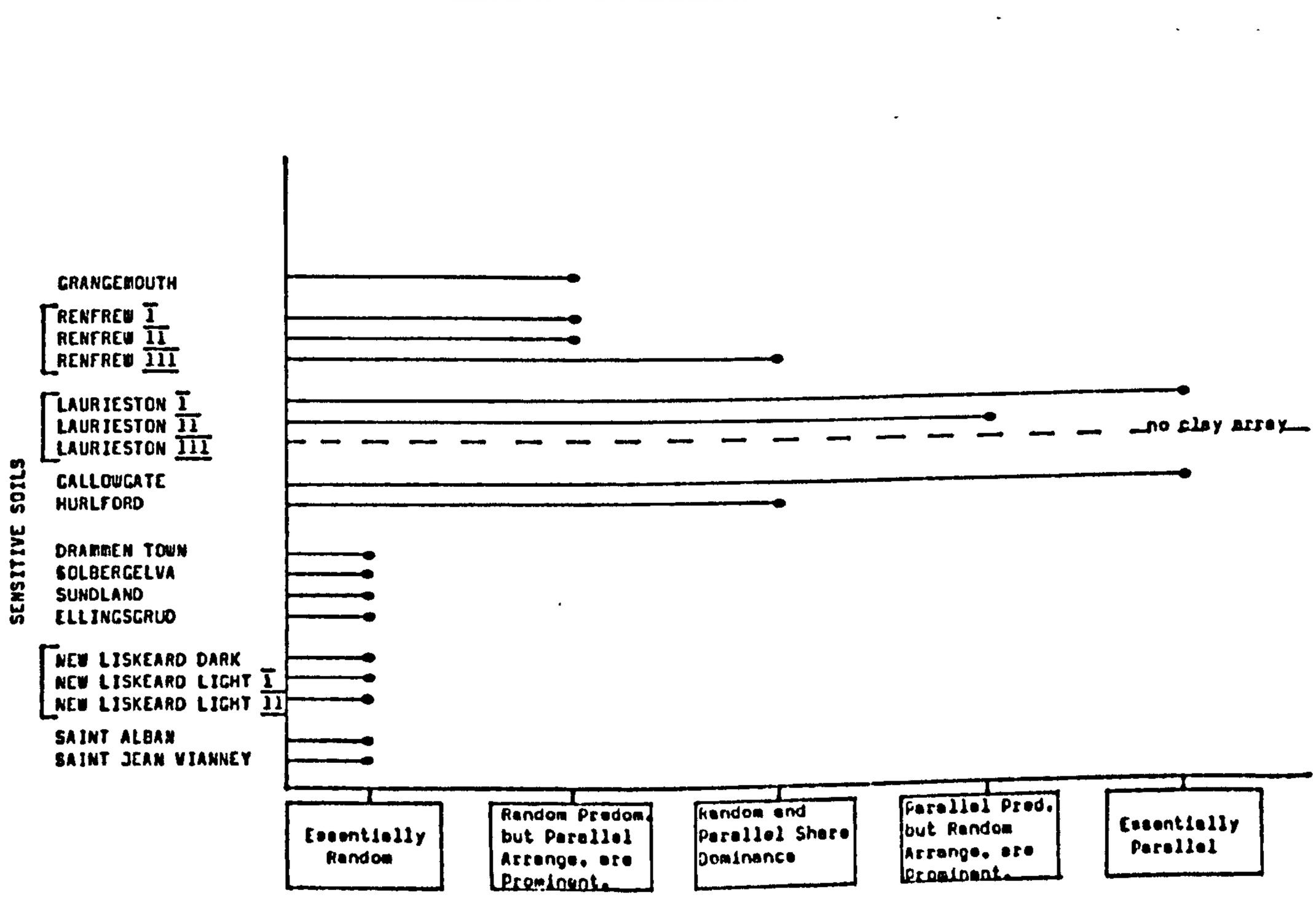


FIG. 7.2. MAKE UP OF TOTAL CLAY ARRAY

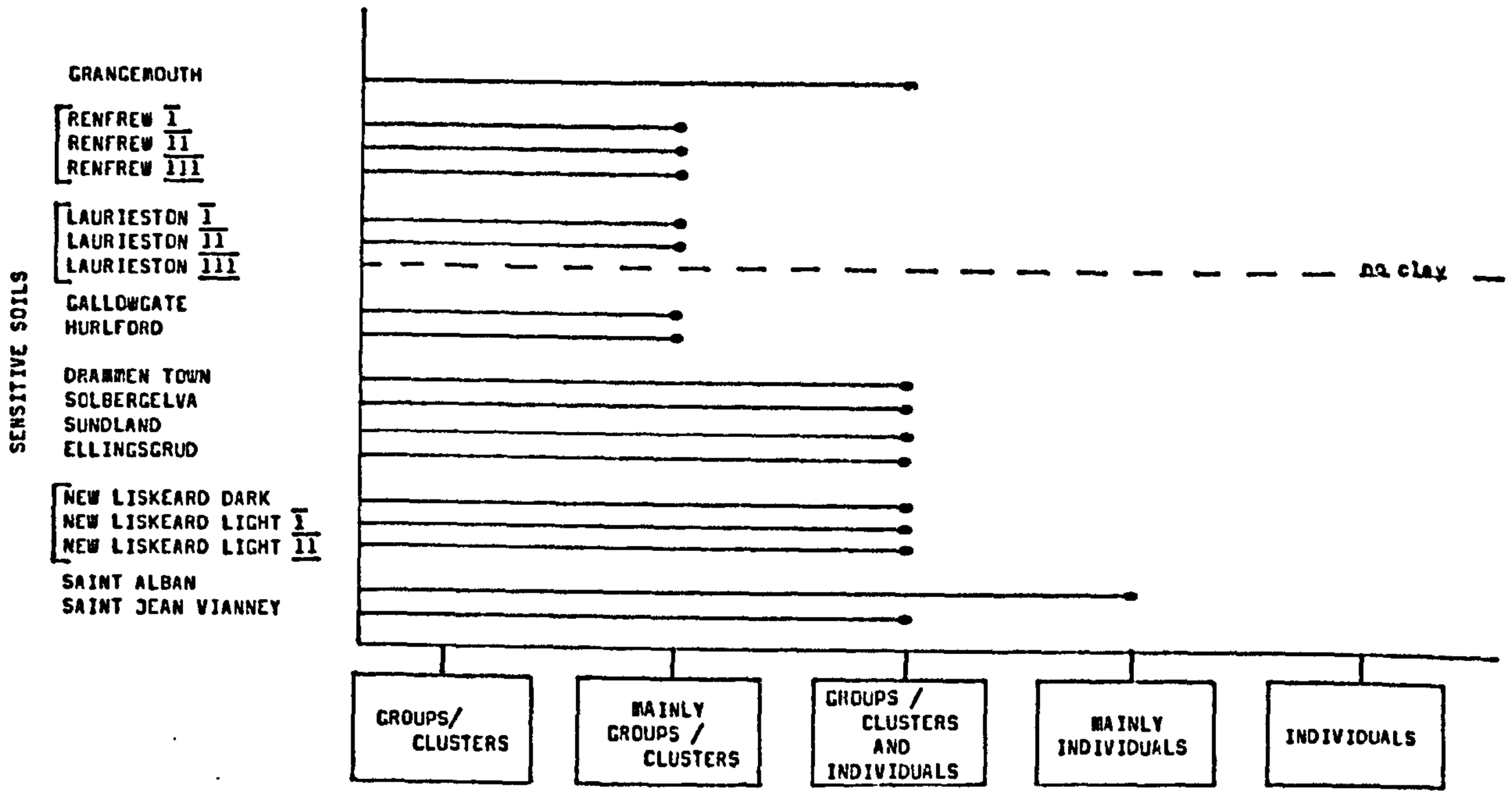


FIG. 7.3. NATURE OF CONSTITUENT PARTICLES OF RANDOM AND PARALLEL CLAY ARRANGEMENTS

SOIL	MAKE UP OF GRANULAR ARRAYS
RENFREW I	CLEAN CONTACTS: SILT SIZES: FLAKY AND ANGULAR SHAPES.
RENFREW II	CLEAN AND CLOTHED CONTACTS: MEDIUM-FINE SILT SIZES: FLAKY, ELONGATED AND ANGULAR: CLOSELY PACKED.
LAURIESTON I	CLEAN CONTACTS: MEDIUM-FINE SILT SIZES: ELONGATED AND ANGULAR SHAPES: CLOSELY PACKED.
CALLOWGATE	CLEAN CONTACTS: MEDIUM-FINE SILT SIZES: FLAKY AND ELONGATED SHAPES: CLOSELY PACKED.
DRAMMEN TOWN	CLEAN CONTACTS: FINER SILT SIZES: FLAKY AND ELONGATED AND LOOSELY PACKED.
SOLBERGELVA	CLEAN CONTACTS: FINER SILT SIZES: FLAKY AND ANGULAR AND LOOSELY PACKED.
SUNDLAND	CLEAN CONTACTS: FINER SILT SIZES: FLAKY, ELONGATED AND ANGULAR SHAPES: LOOSE AND CLOSE PACKING.
NEW LISKEARD LIGHT I	CLEAN CONTACTS: FINER SILT SIZES: ANGULAR AND ELONGATED: VERY LOOSELY PACKED HONEYCOMBED IN PLACES.
NEW LISKEARD LIGHT II	CLEAN CONTACTS: MEDIUM-FINE SILT SIZES: ANGULAR AND ELONGATED: LOOSELY PACKED.

SENSITIVE SOILS

FIG. 7.4. MAKE UP OF GRANULAR ARRAYS

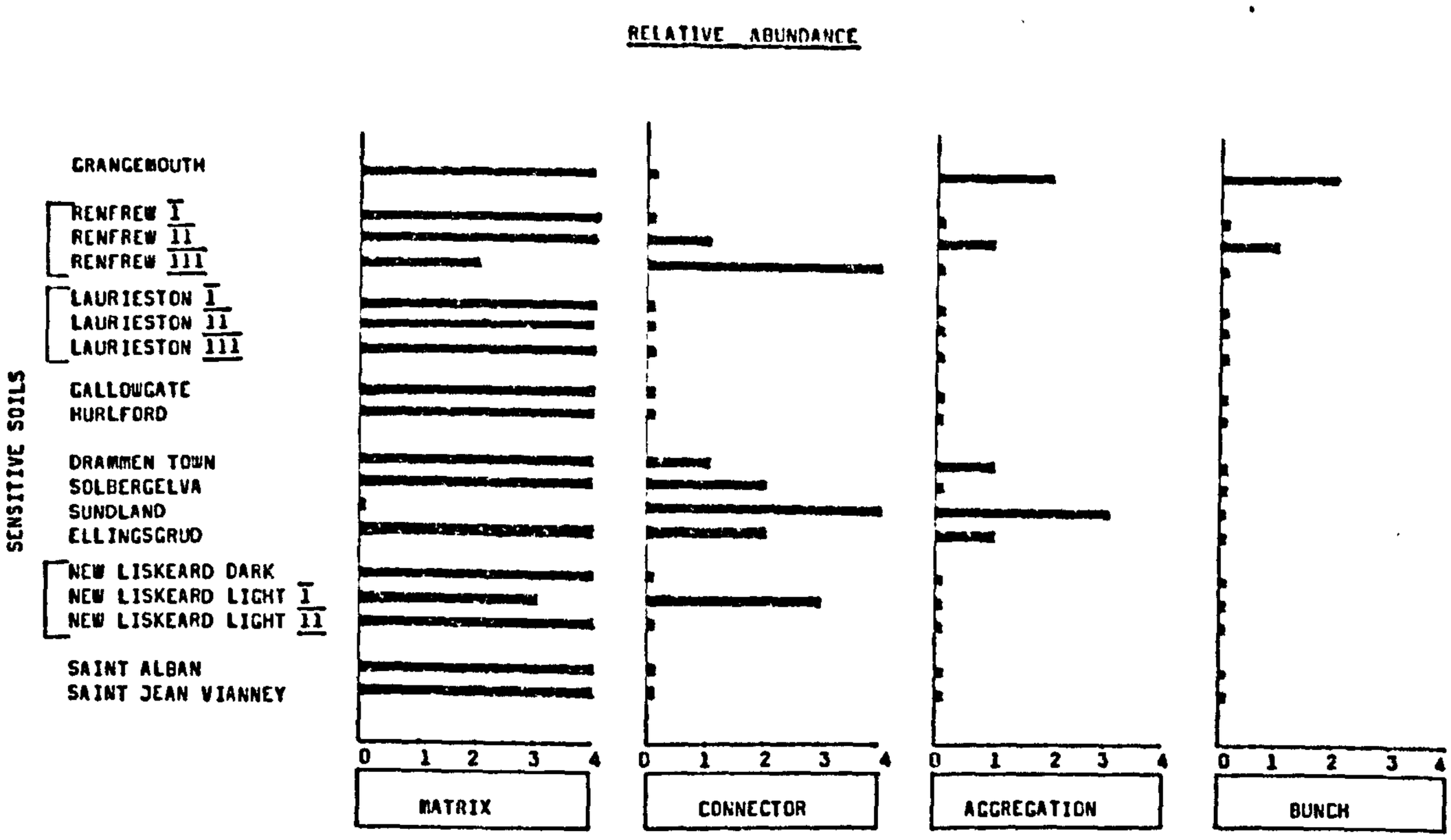


FIG. 7.5. MAKE UP OF BASIC ASSEMBLAGE NETWORK

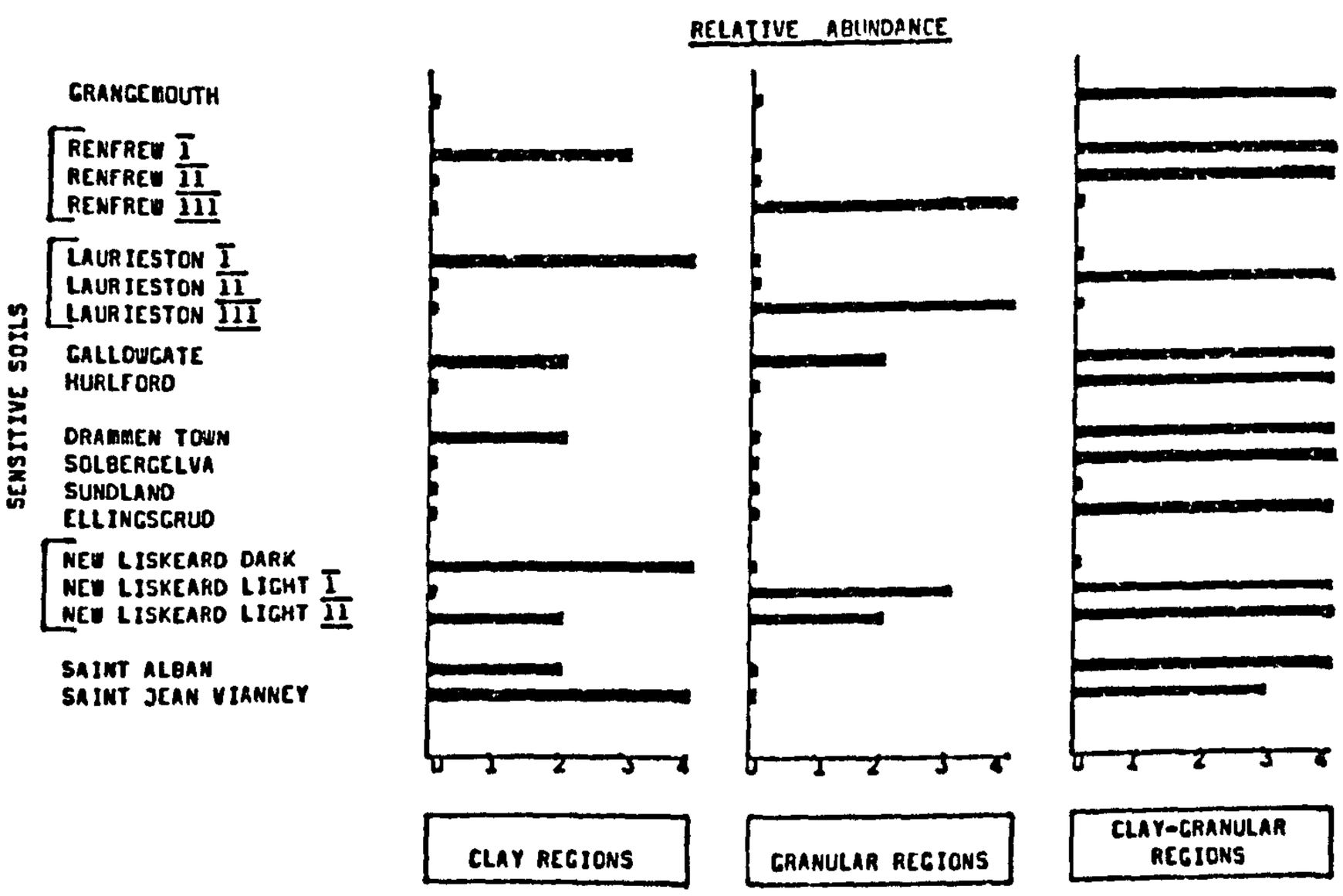


FIG. 7.6. MAKE UP OF MATRIX OR LAYER REGION SYSTEMS

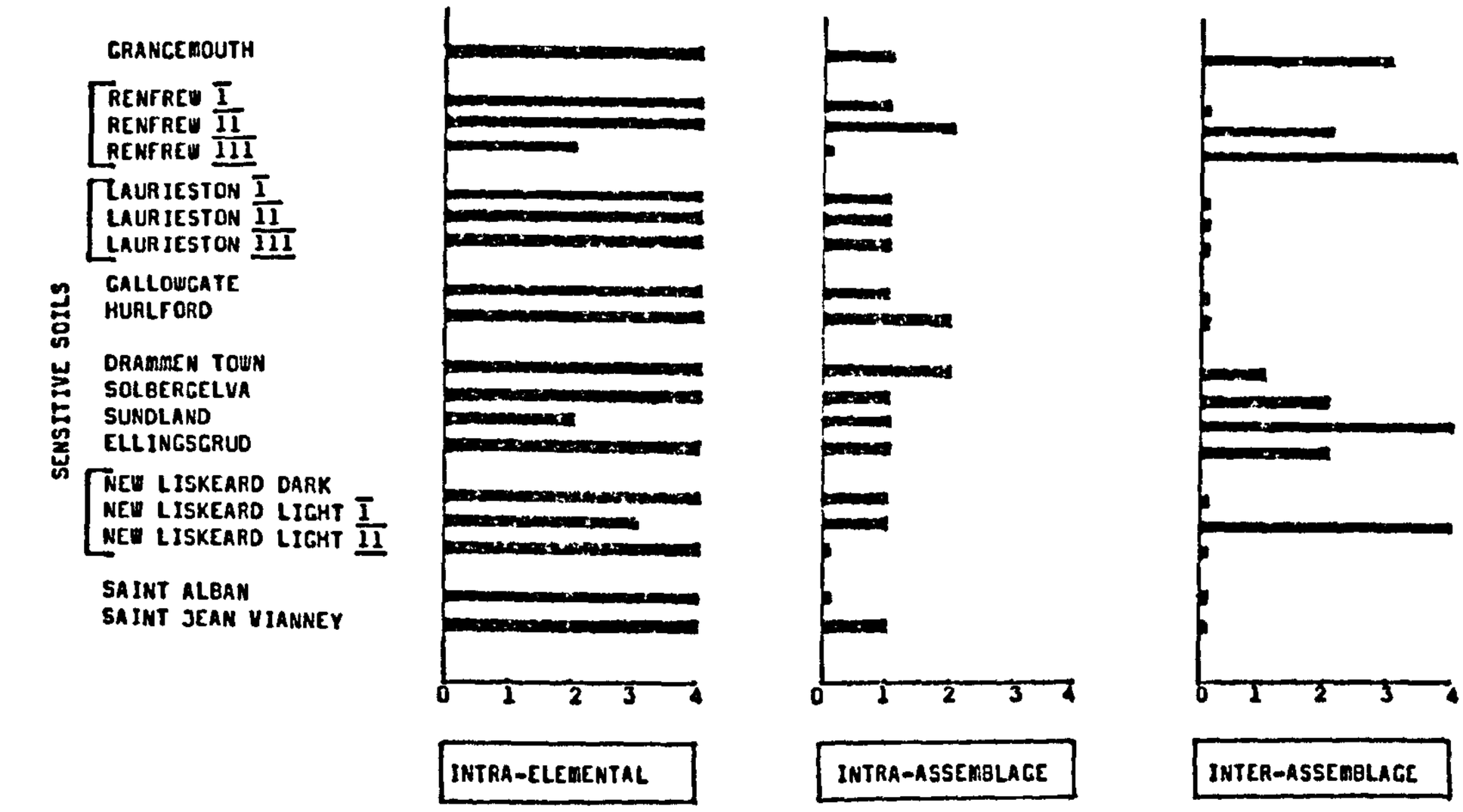


FIG 7.7. MAKE UP OF BASIC PORE SPACE

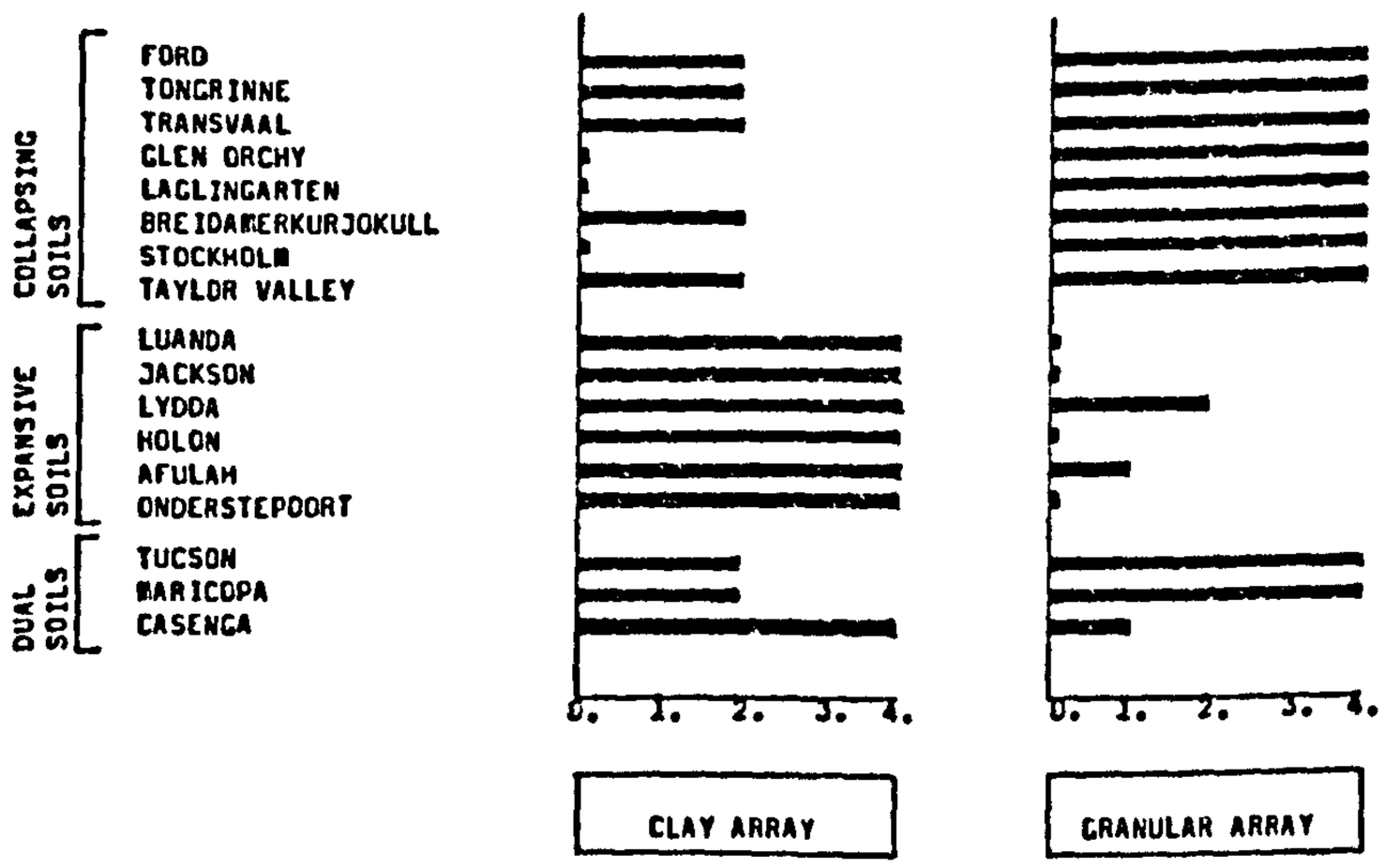


FIG. 7.8. MAKE UP OF TOTAL ELEMENTARY PARTICLE ARRAY

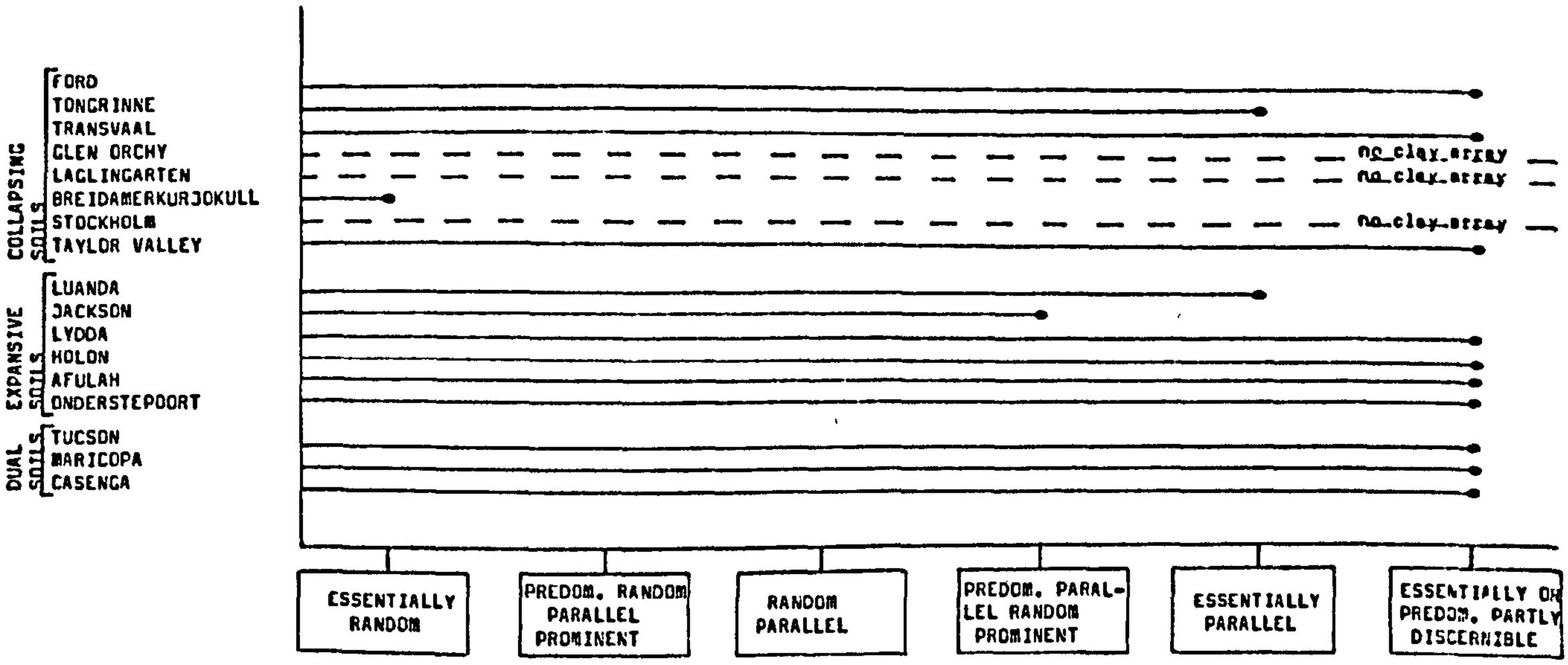
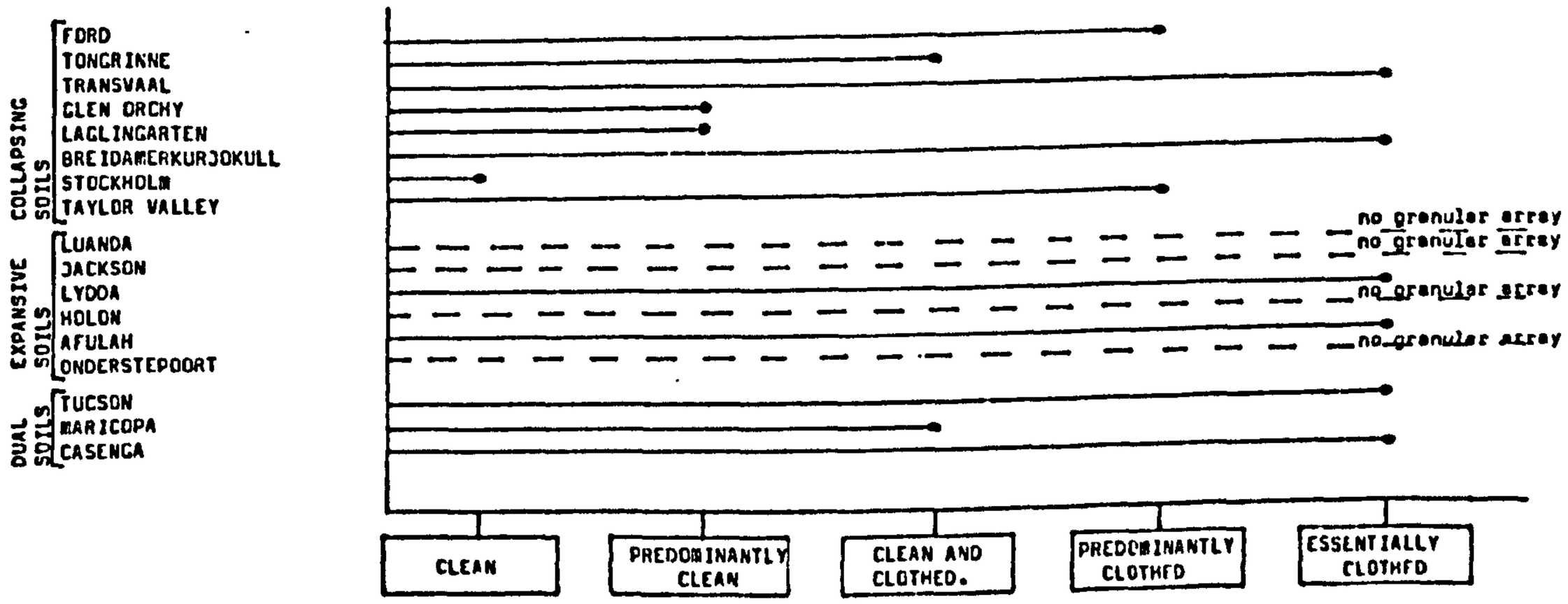


FIG. 7.9. MAKE UP OF TOTAL CLAY ARRAY



7.10. MAKE UP OF TOTAL GRANULAR ARRAY

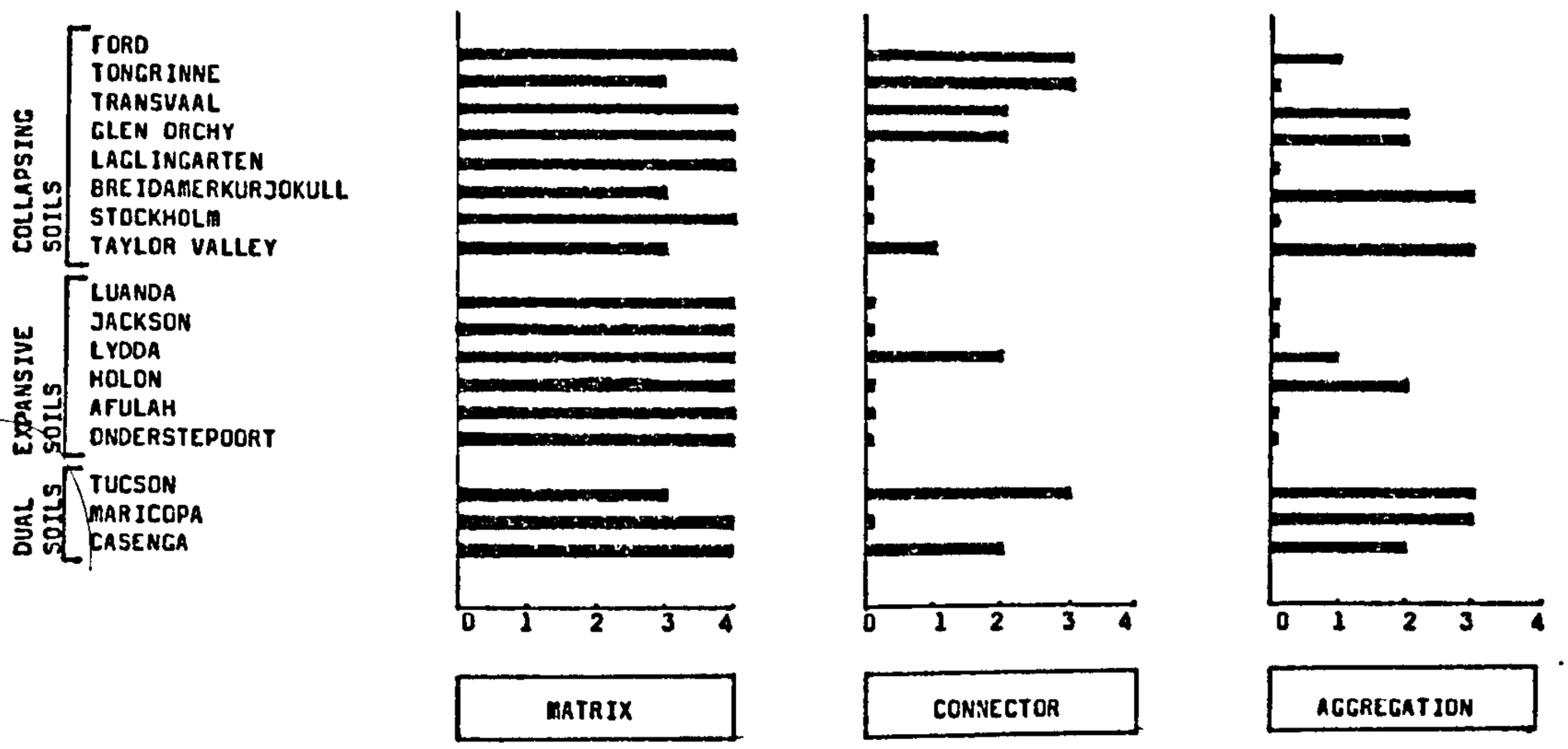


FIG. 7.11. MAKE UP OF BASIC ASSEMBLAGE NETWORK

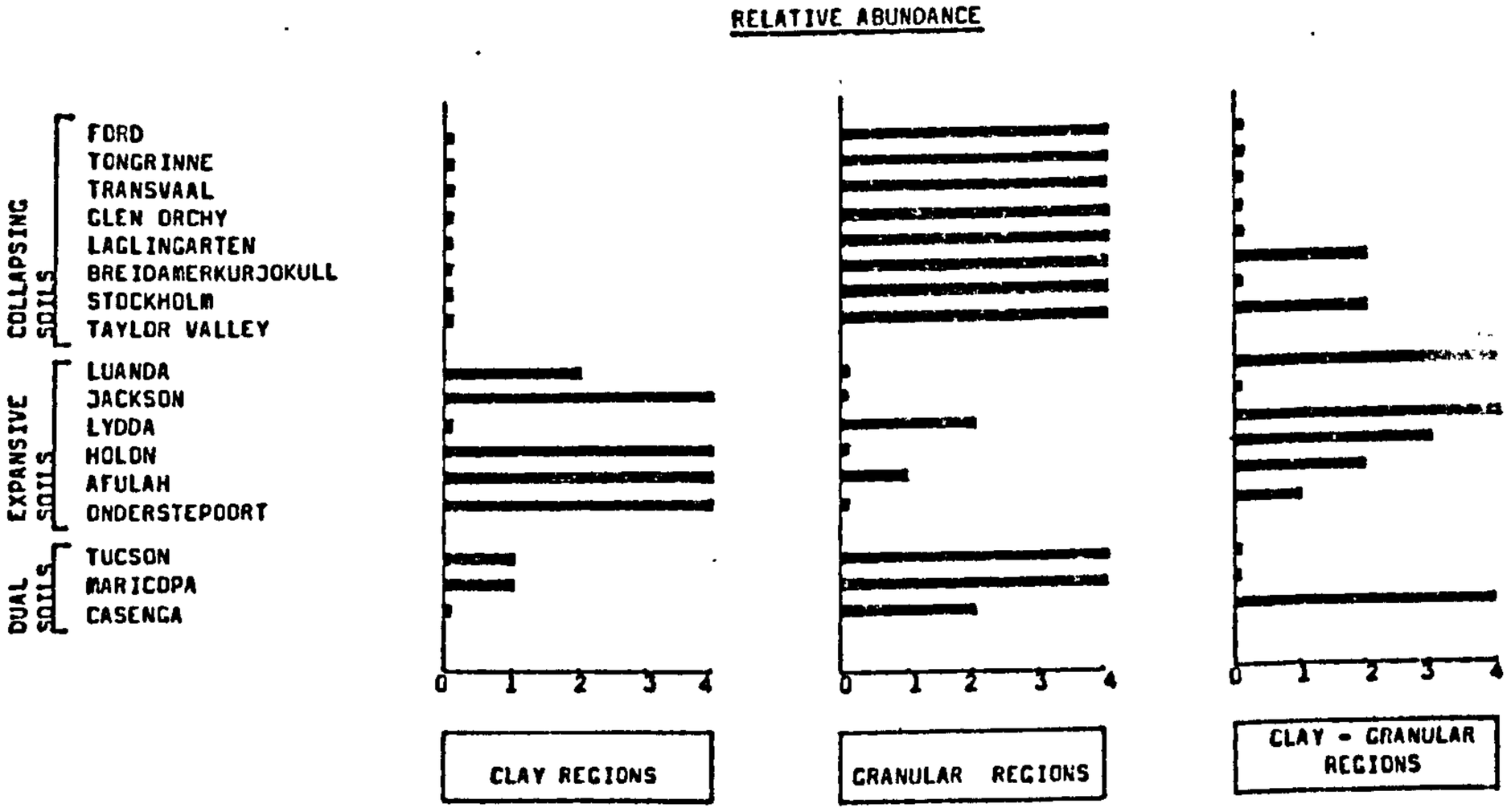


FIG. 7.12. MAKE UP OF MATRIX OR LAYER REGION SYSTEMS

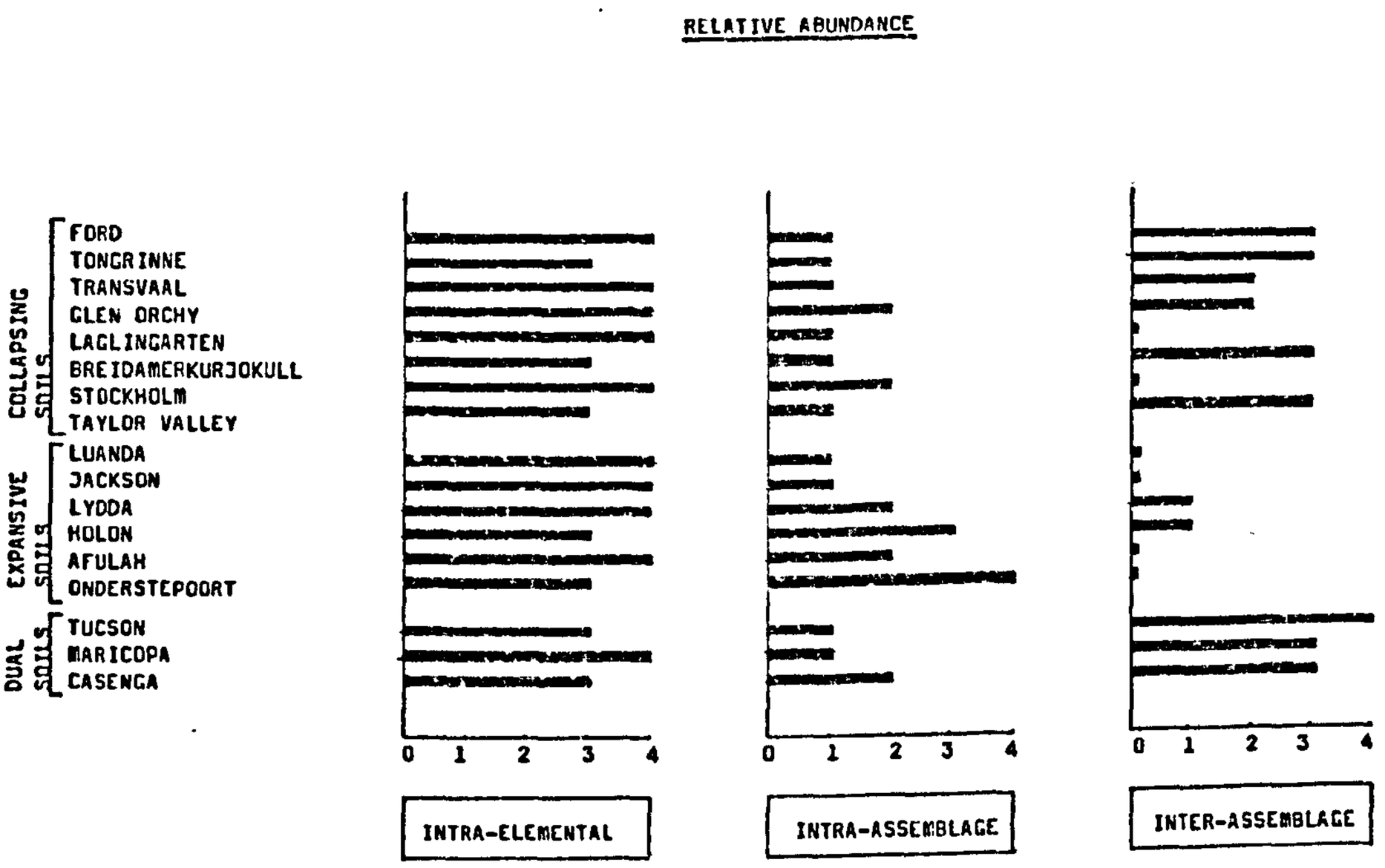


FIG. 7.13. MAKE UP OF BASIC PORE SPACE

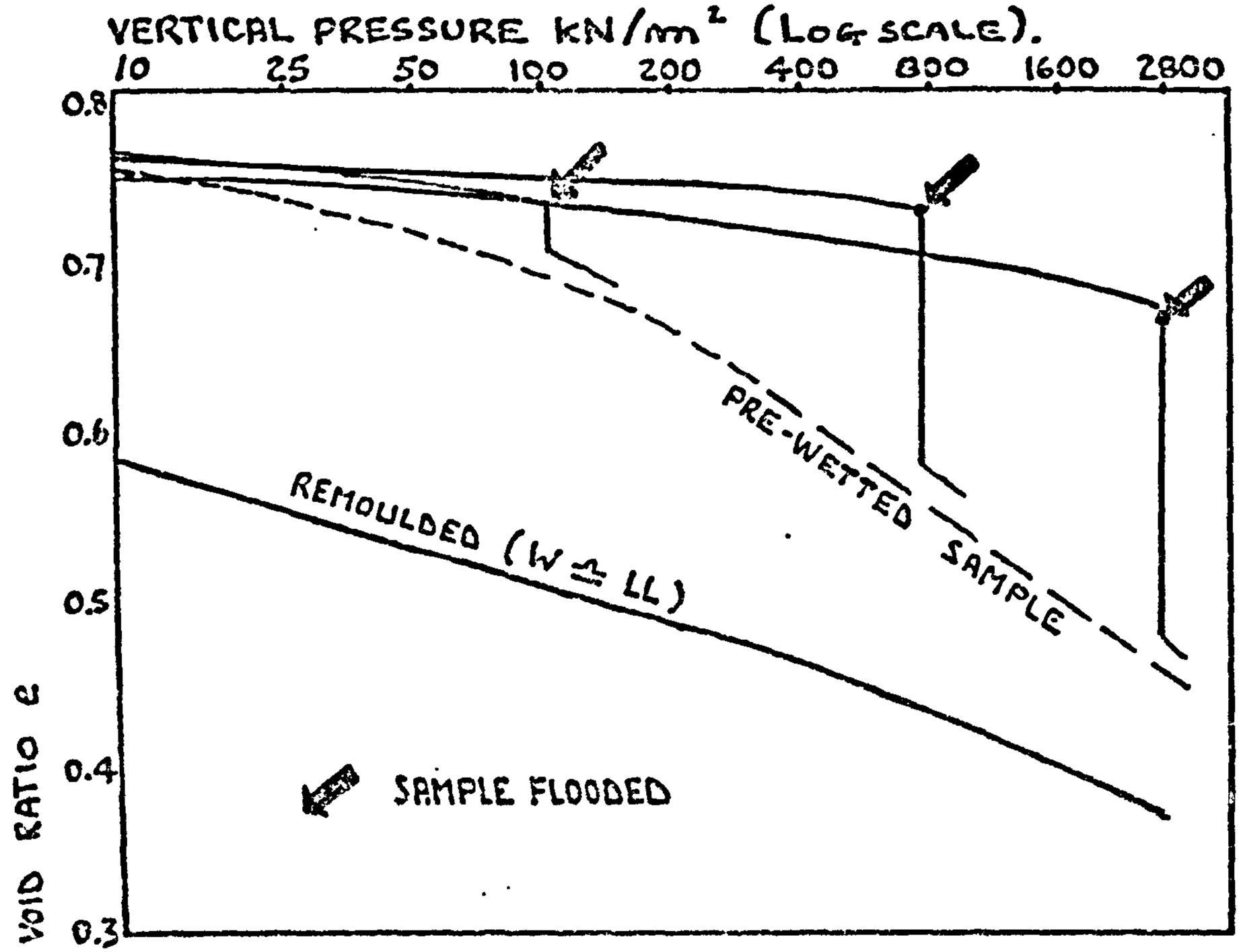
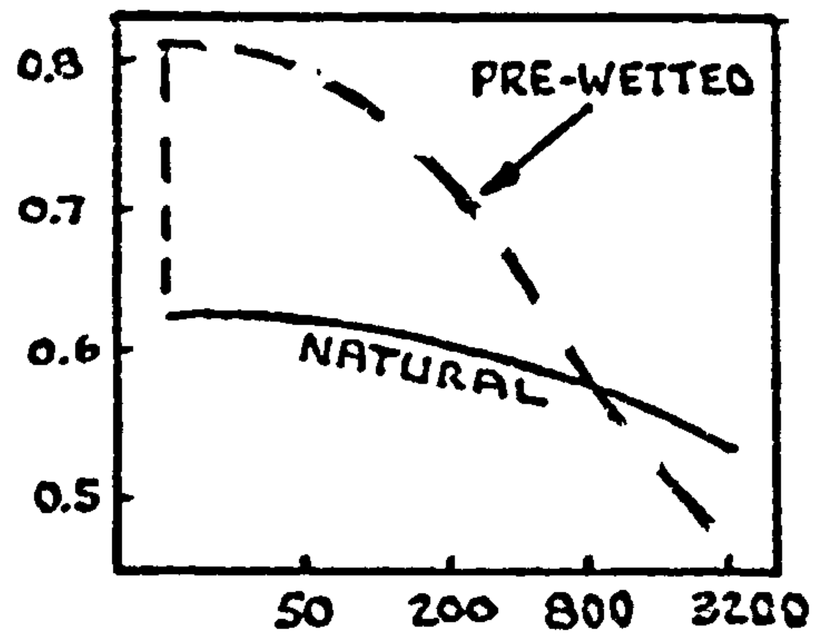


FIG. 7.14. e-LOG P CURVES - FORD LOESS

(FOOKES AND BEST (1969))

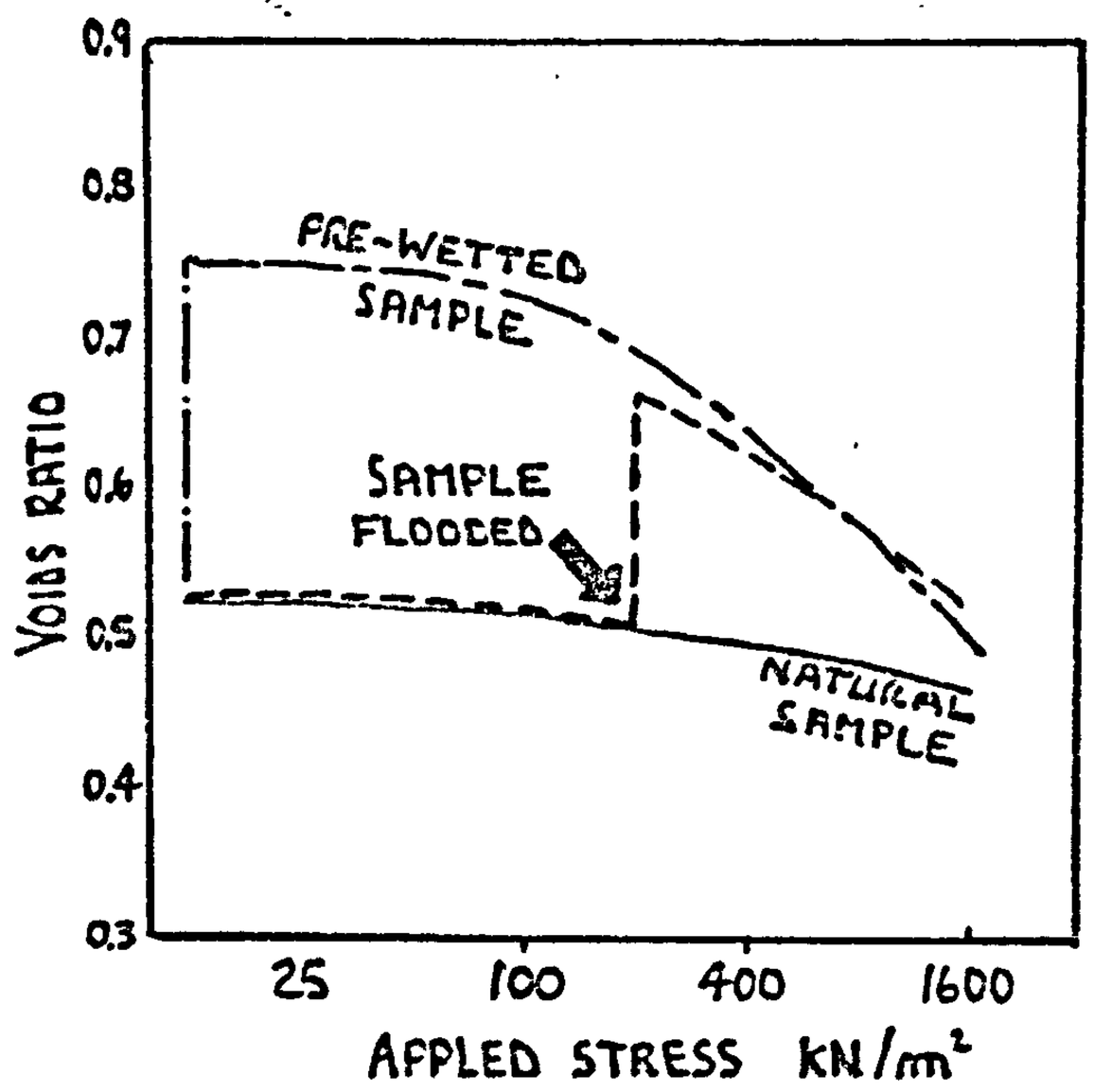
HORTA DA SILVA (1971 a)



CASENGA EXPANSIVE CLAY

FIG. 7.16. OEDOMETER TEST CURVES ADJUSTED TO EQUAL INITIAL VOIDS RATIO.

NOVIAS-FERREIRA AND HORTA DA SILVA (1973)



LUANDA EXPANSIVE CLAY

FIG. 7.15. OEDOMETER TEST CURVES ADJUSTED TO EQUAL INITIAL VOIDS RATIO.

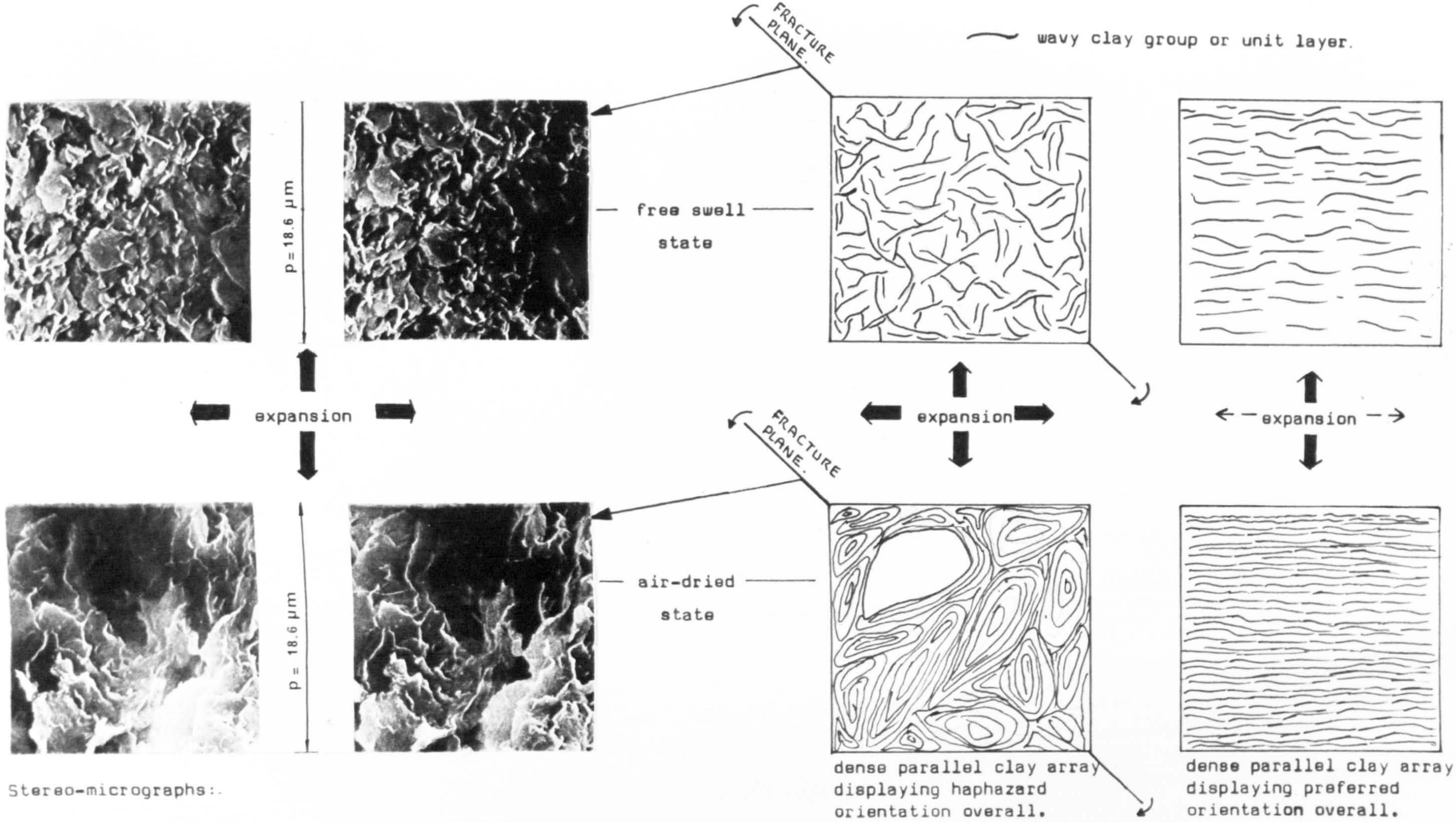


FIG. 7.17. THE EXPANSION MECHANISM FROM THE MICROFABRIC VIEWPOINT

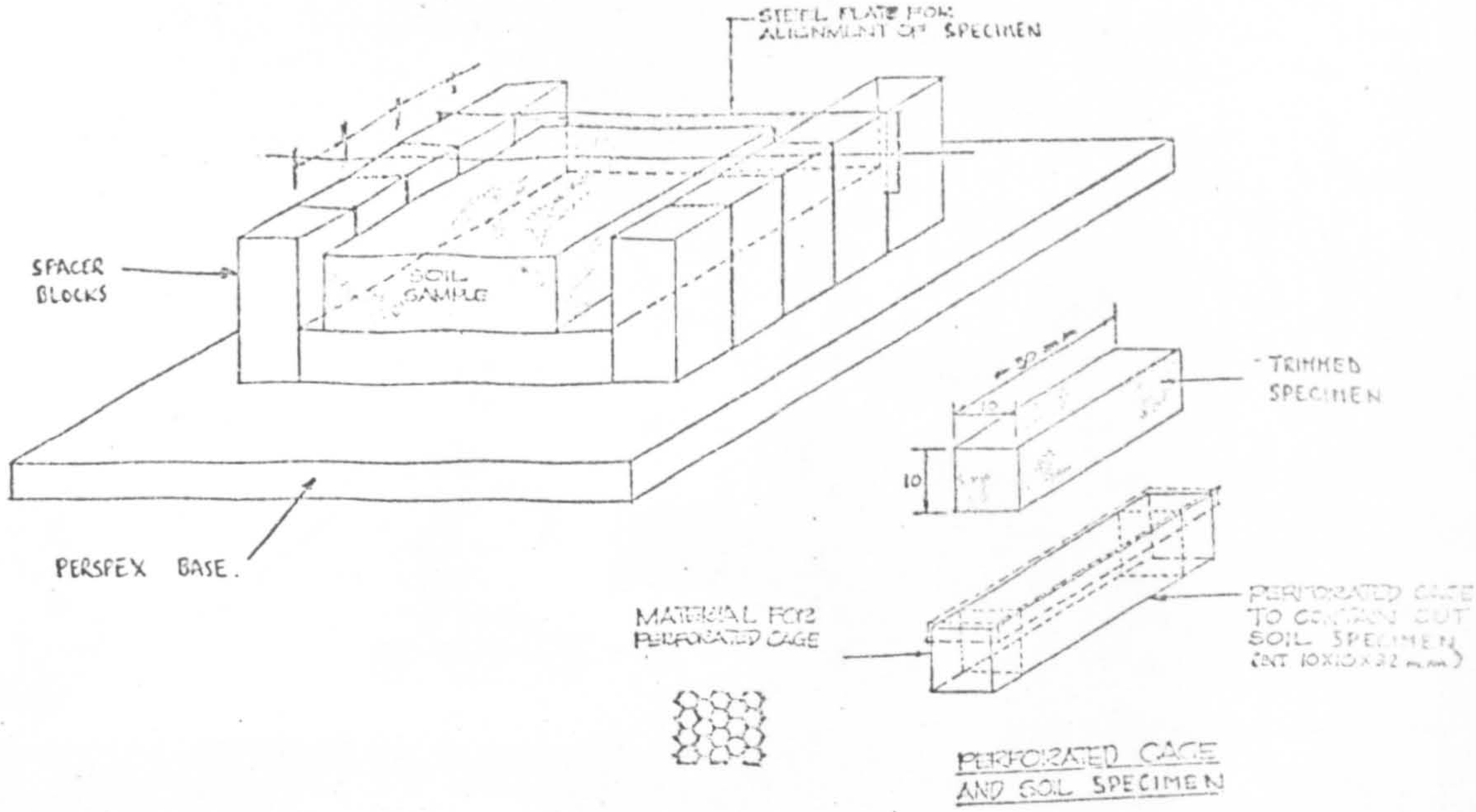
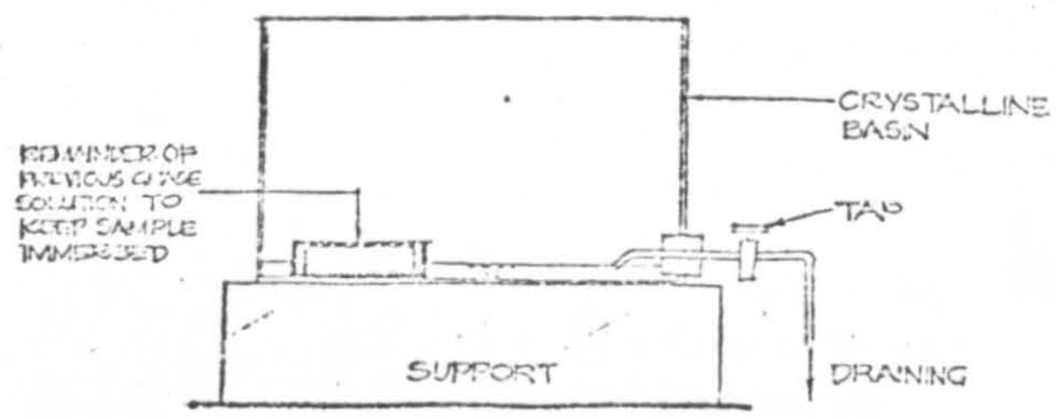
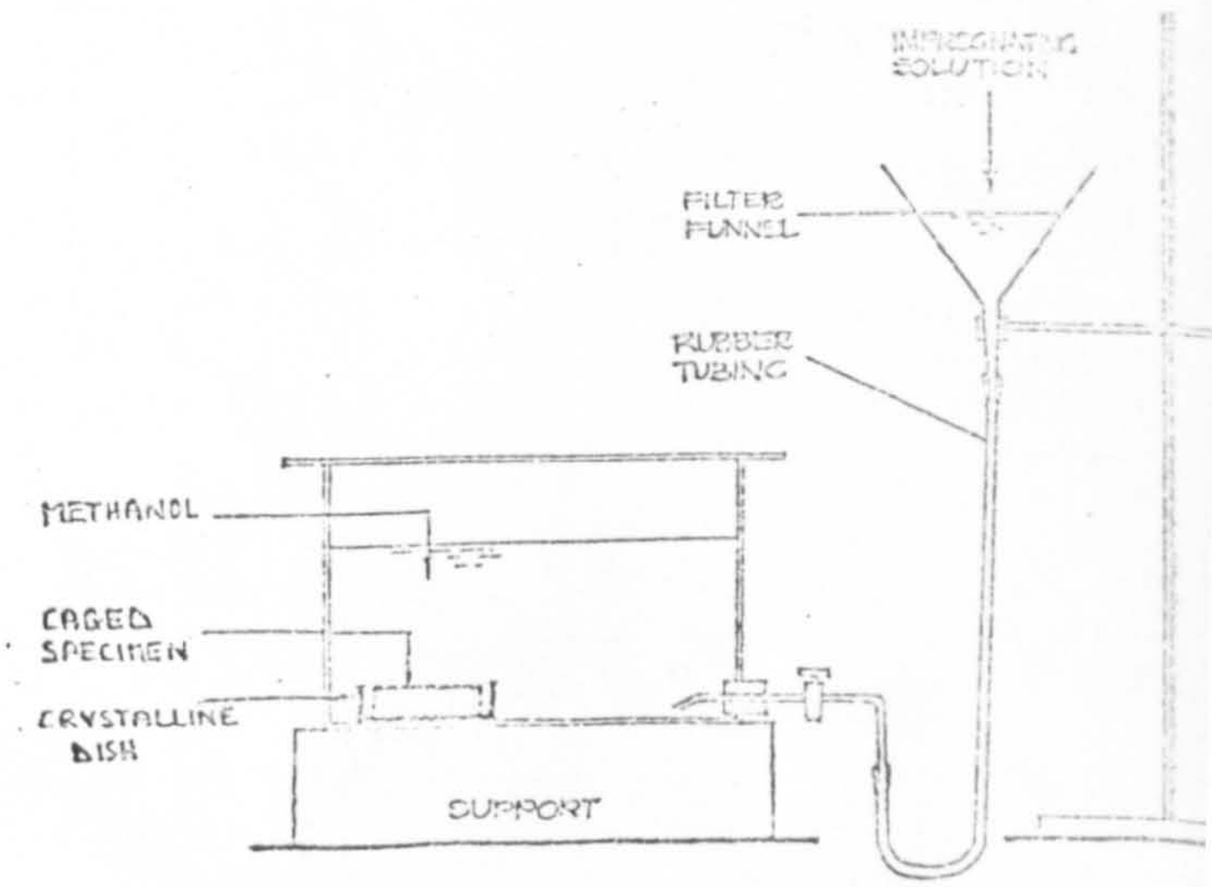


FIG. B.1 APPARATUS FOR TRIMMING AND CONTAINING SPECIMENS

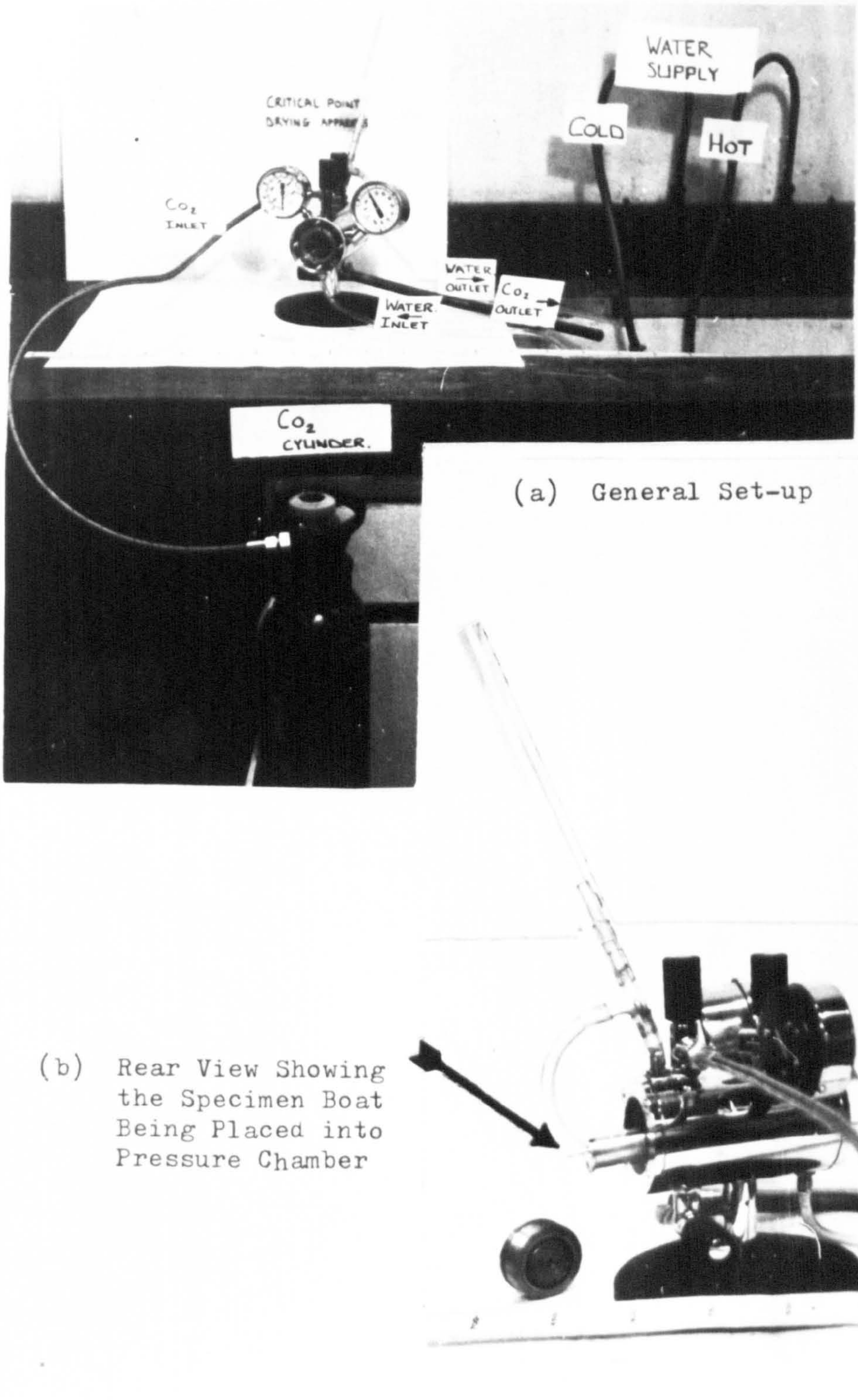


DRAINING.



FILLING

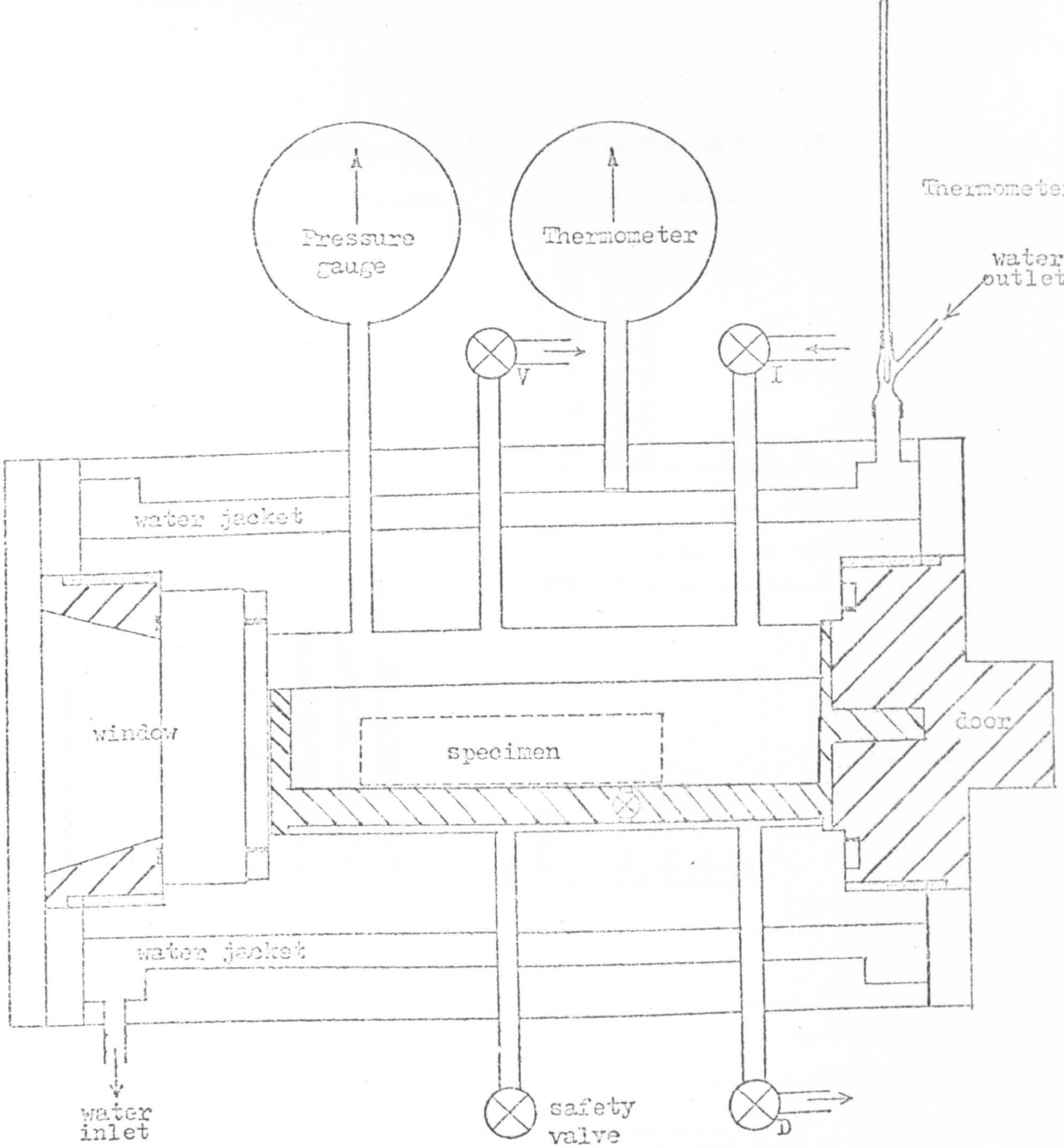
FIG. B.2. APPARATUS FOR METHANOL SUBSTITUTION.



(a) General Set-up

(b) Rear View Showing the Specimen Boat Being Placed into Pressure Chamber

FIG. B.3. CRITICAL POINT DRYING APPARATUS



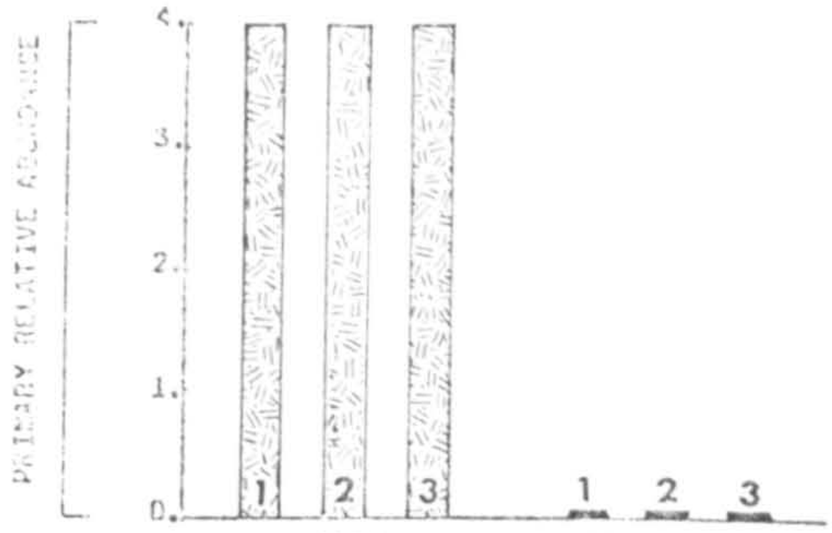
gas handling valves:

V - vent valve
I - inlet valve
D - drain valve

Fig. B.4. Semi-scale schematic diagram of the Critical Point Drying apparatus (E3000). (The pressure vessel body is to scale; valves and gauges are shown schematically)

FIG. 8.5. MICROFABRIC OF LAKE PORTCHARTRAIN CLAY, NEW ORLEANS

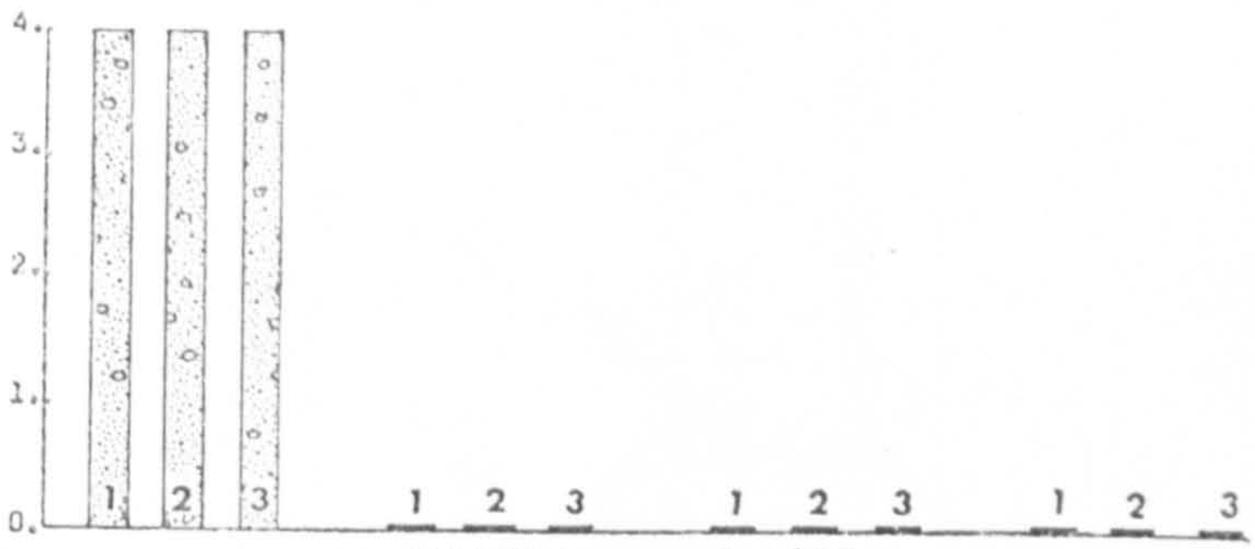
(a) ELEMENTARY PARTICLE ARRANGEMENTS



SECONDARY RELATIVE ABUNDANCE

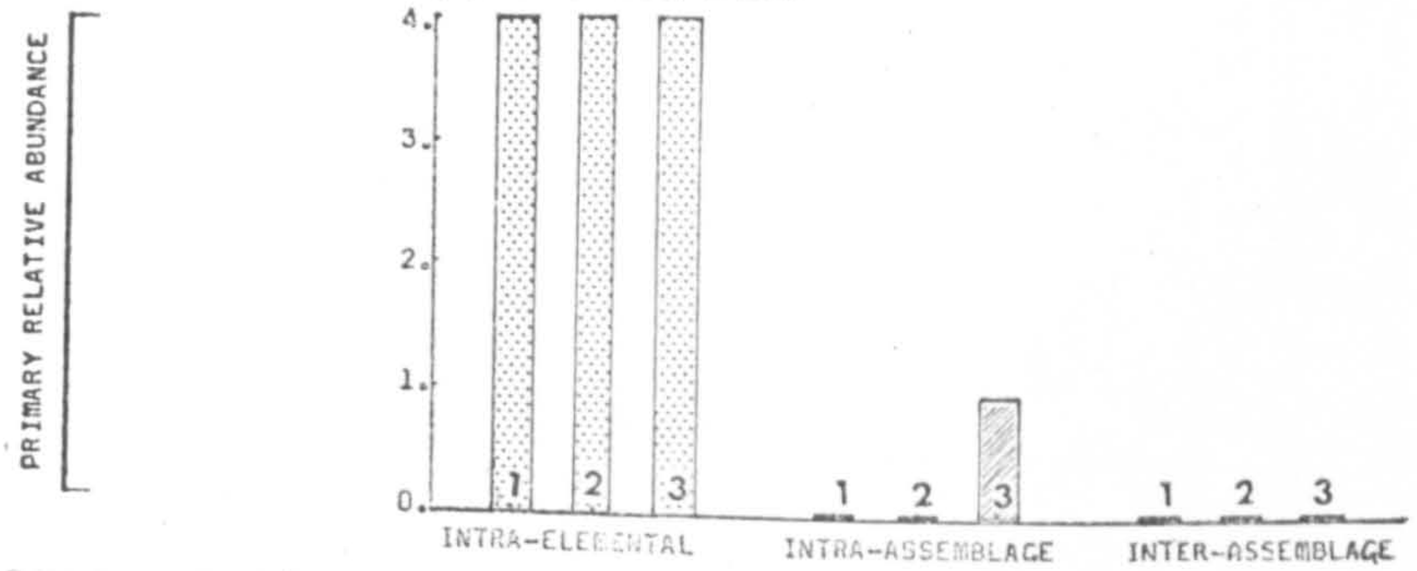
R.	2	4	4	CLE.	0	0	0			
P.	4	0	0	CLO.	0	0	0			
PD.	0	0	0							

(b) BASIC ORDER PARTICLE ASSEMBLAGES



C.	1	0	2	BR.	0	0	0	REG.	0	0	0
G.	0	0	0	BU.	0	0	0	IRR.	0	0	0
CC.	4	4	4							

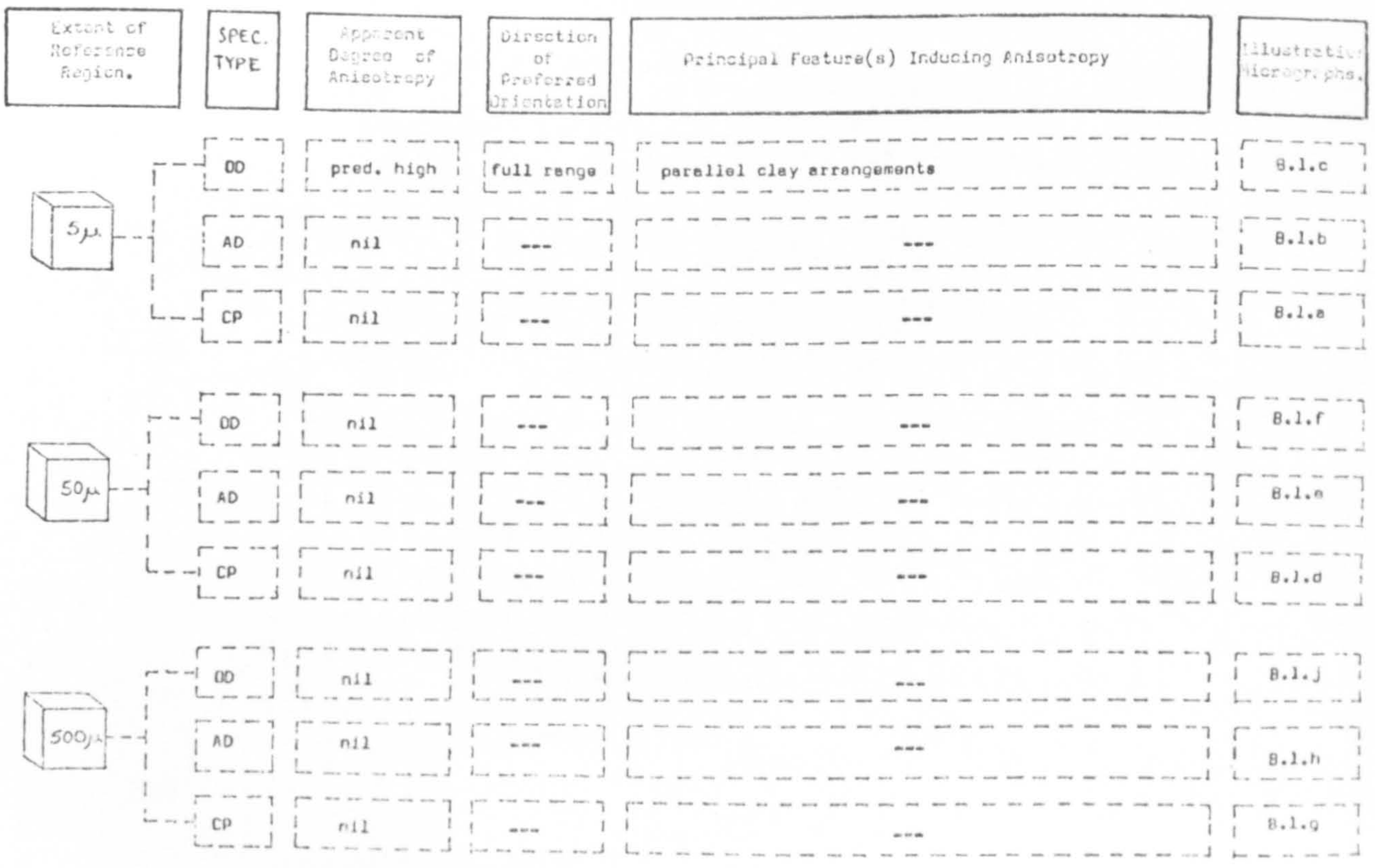
(c) BASIC PORE SPACES



LEGEND

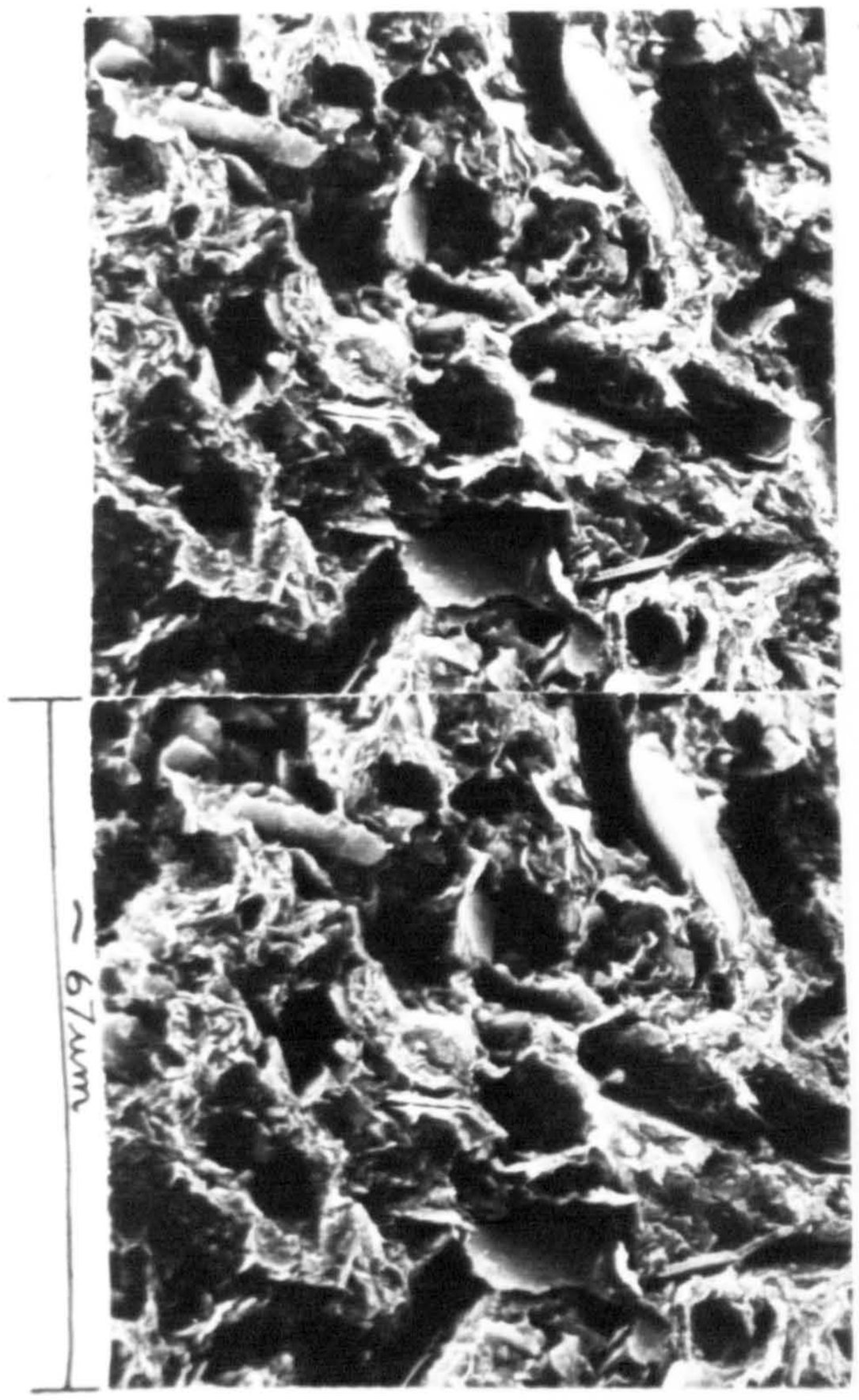
Oven dried (OD)	1
Air dried (AD)	2
Critical Point dried (CP)	3

(d) COMPOSITE MICROFABRIC ANISOTROPY



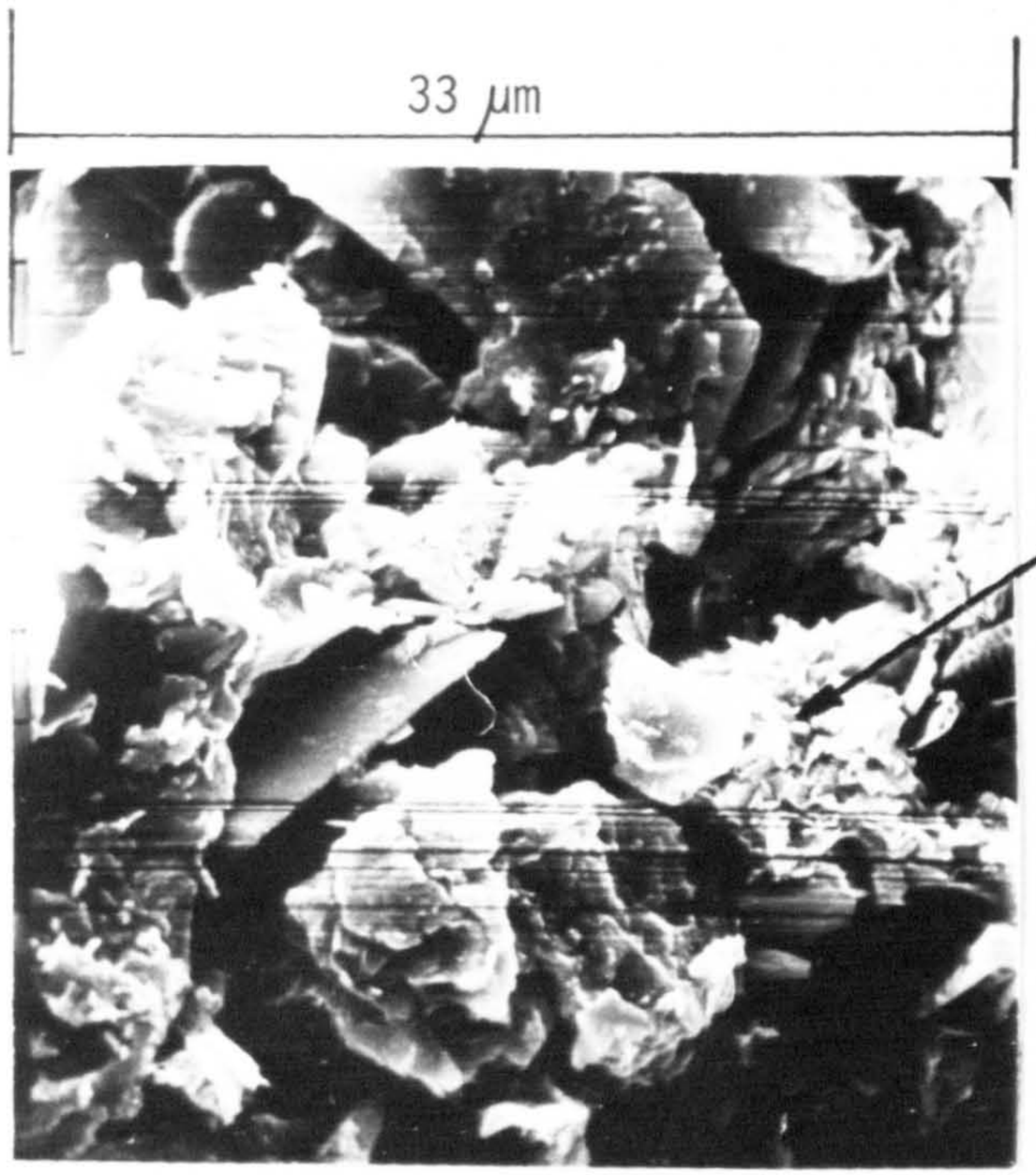
MICROGRAPHS

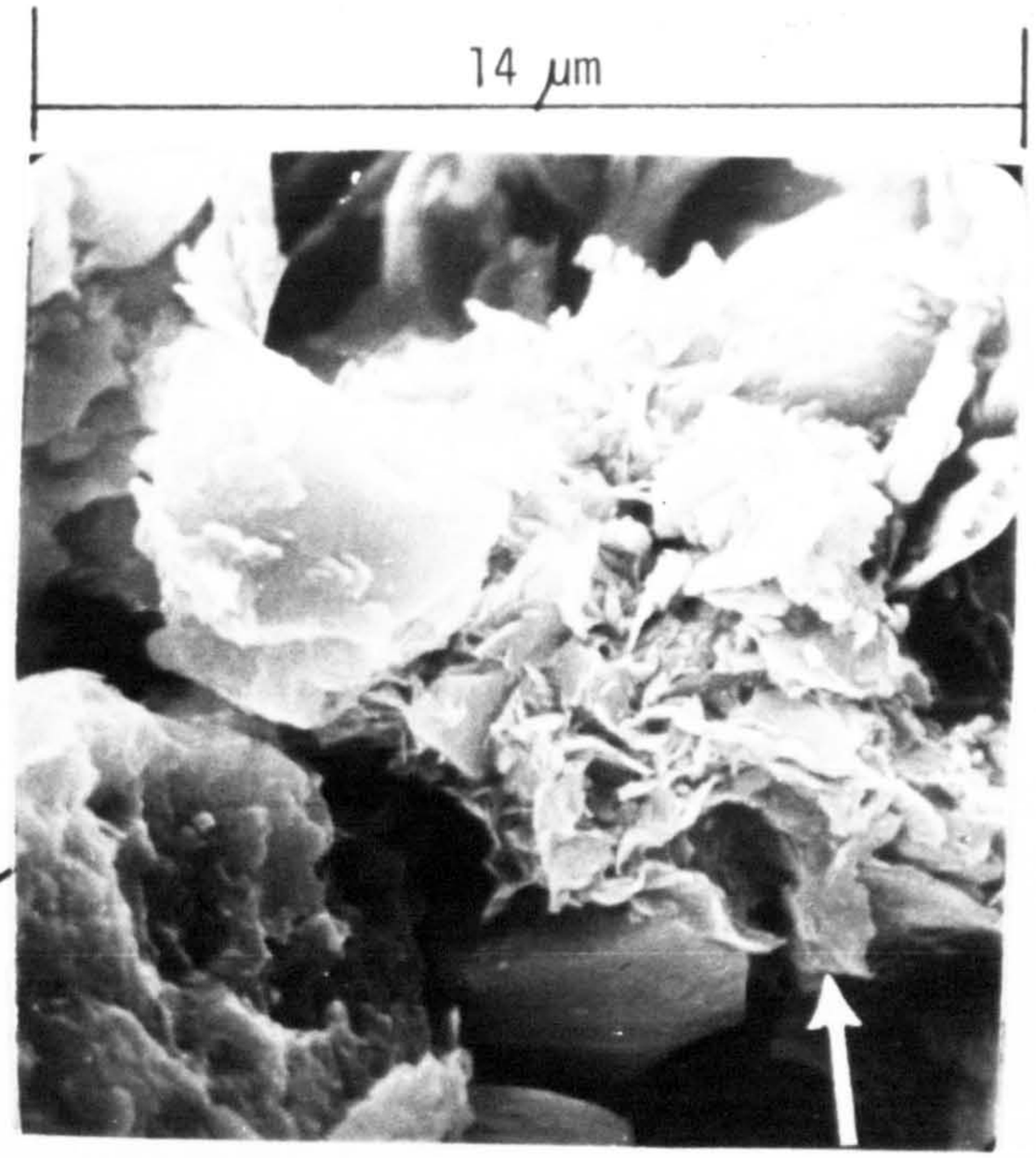
(a) Random Clay Arrangements



(b) Clay-Granular Matrix Region

MIC. 5.1. MARINE CLAYEY SILT - GRANGEMOUTH, SCOTLAND

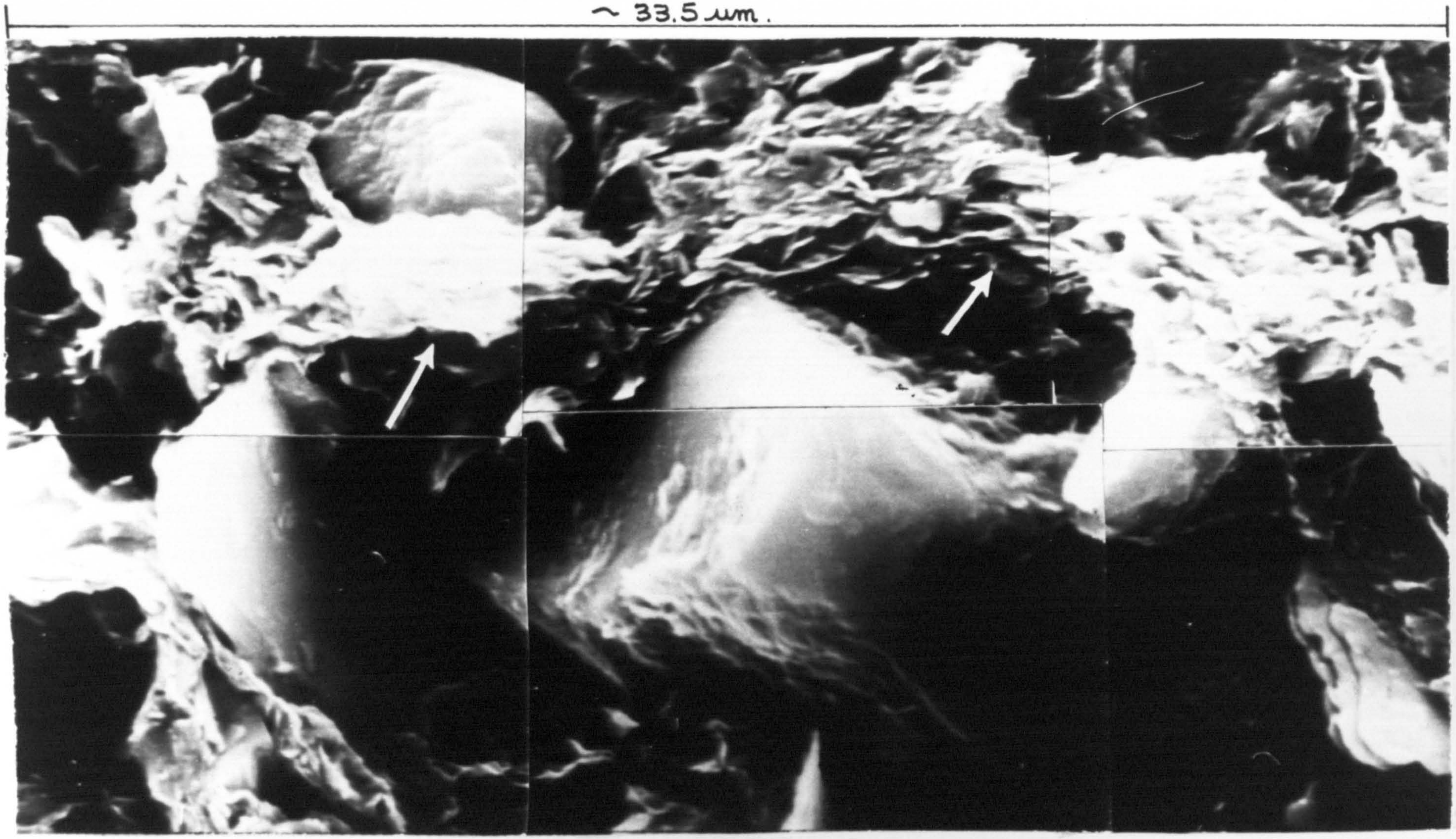




x 5500

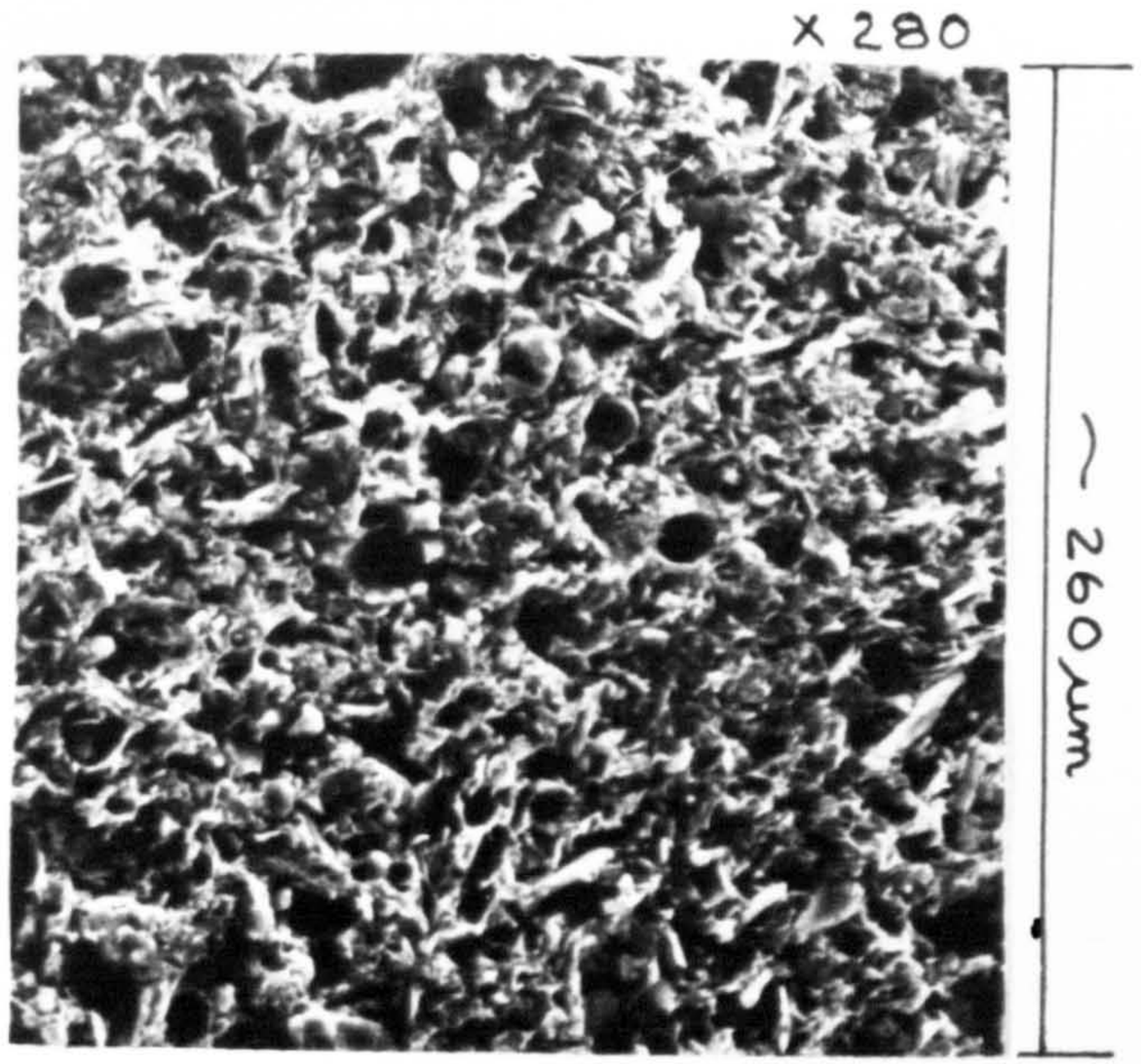
(c) Nature and interaction of regular aggregations

MIC. 5.1. MARINE CLAYEY SILT - GRANGEMOUTH, SCOTLAND

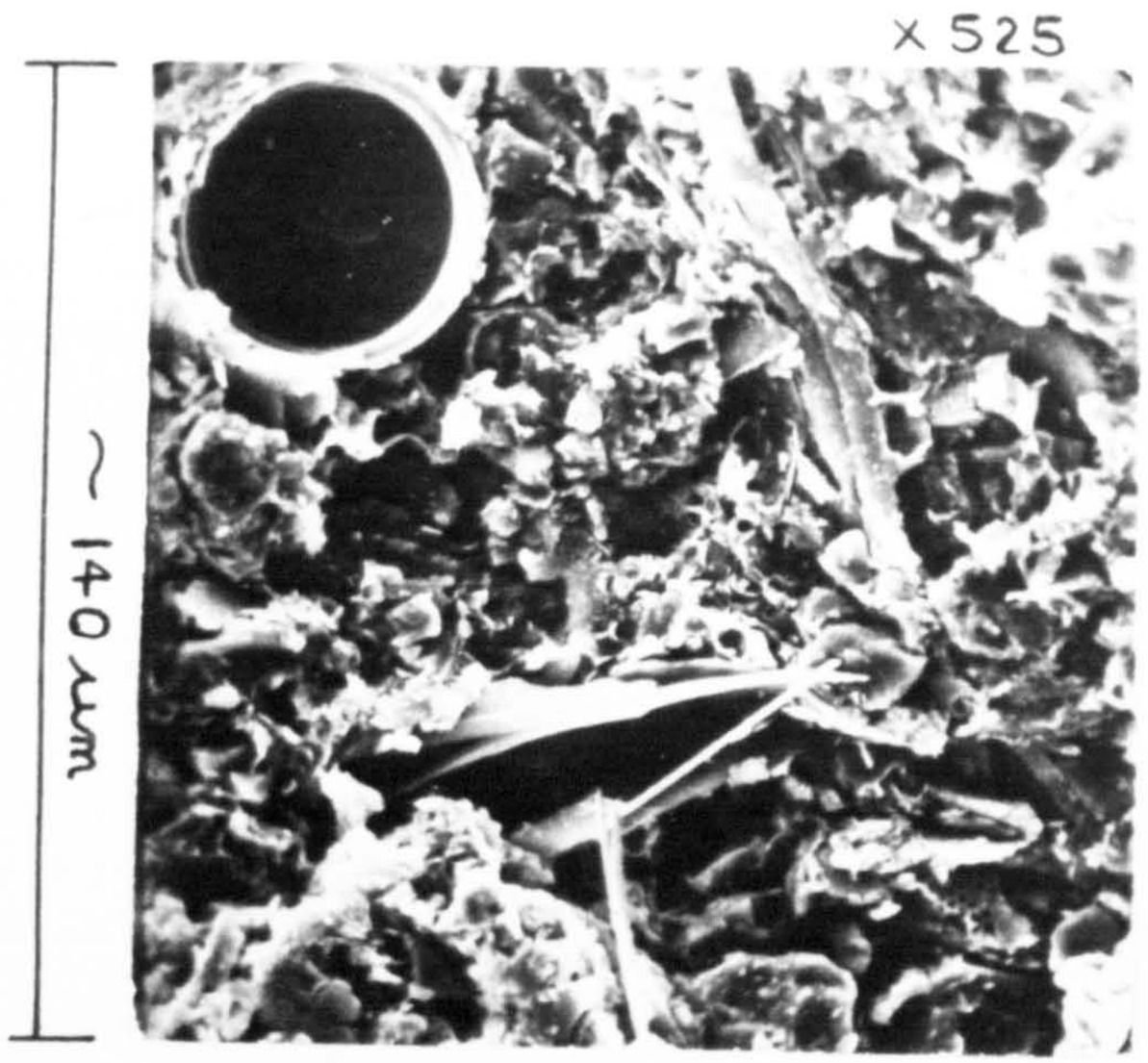


(d) Interweaving Bunches

MIC. 5.1. MARINE CLAYEY SILT - GRANGEMOUTH, SCOTLAND

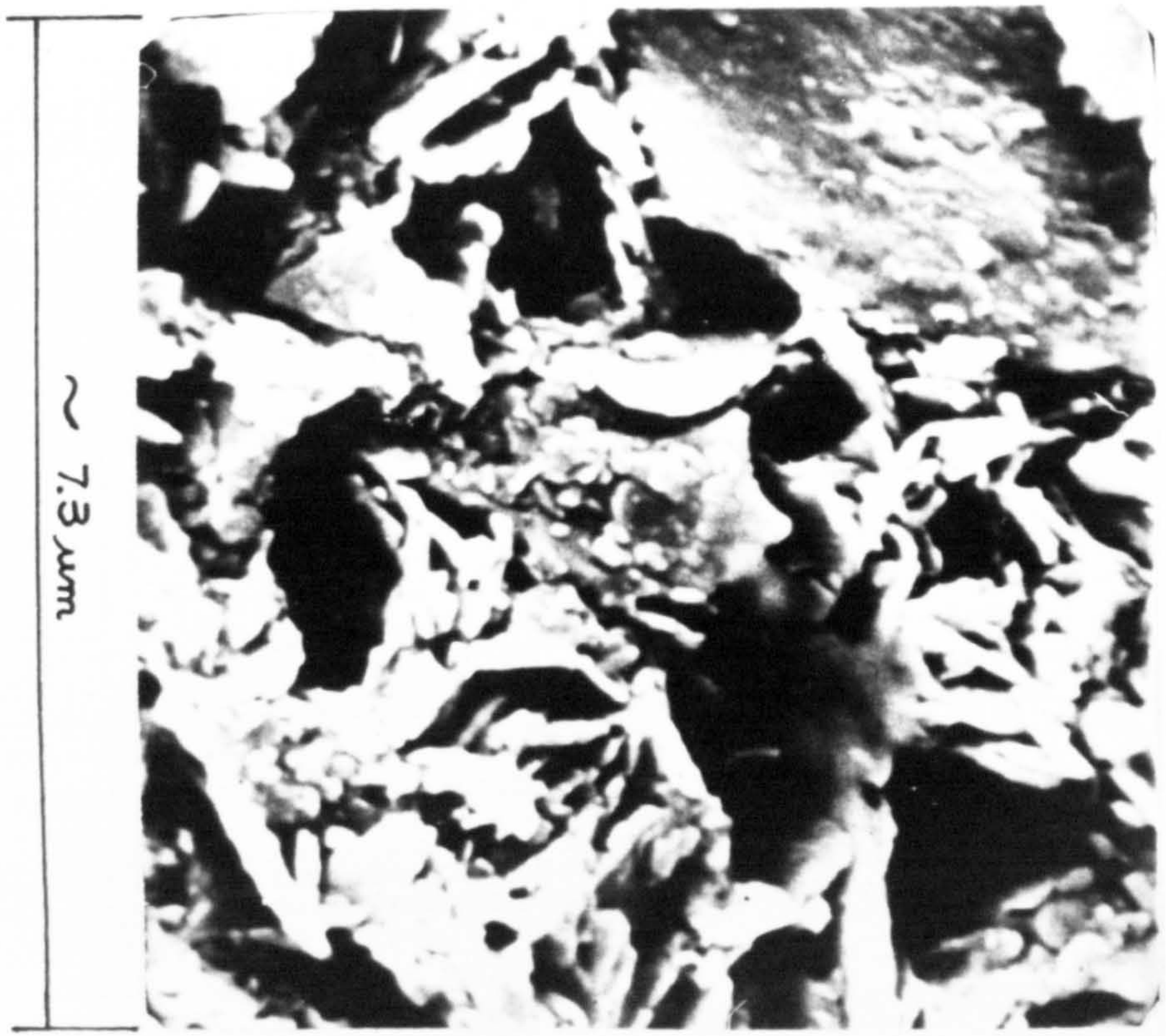


(f) Composite Microfabric



(e) Fossil Particles

MIC. 5.1. MARINE CLAYEY SILT - GRANGEMOUTH, SCOTLAND



(a) Random Clay Arrangements

MIC. 5.2. MARINE PLASTIC CLAY - DRAMMEN TOWN, NORWAY

~ 85 μm

Clay Region

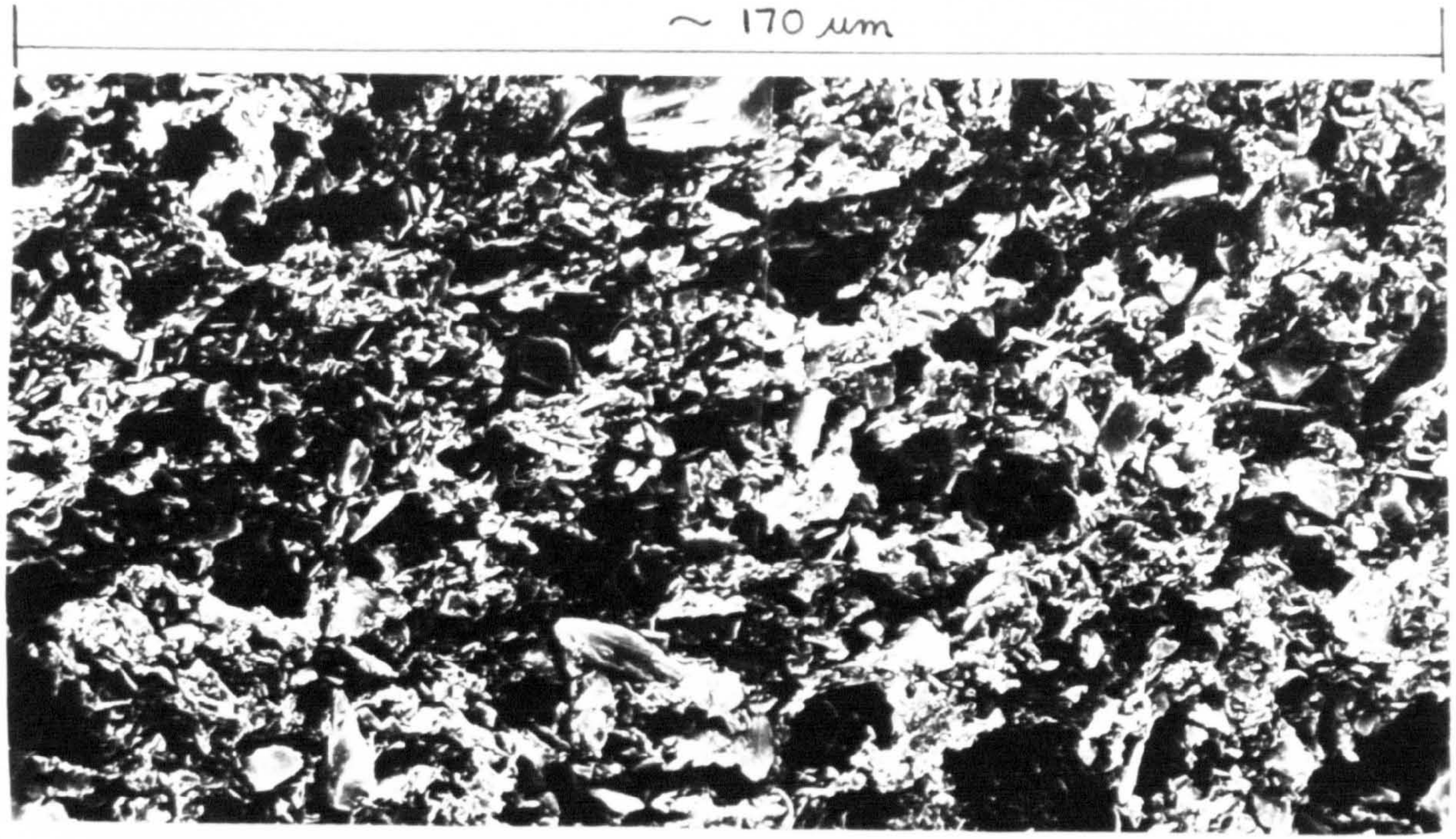
Clay Rich Clay-Granular Region

Open Clay-Granular Region with Prominence of Grain-Grain Contacts

(b) Matrix Regions

× 2800

MIC. 5.2. MARINE PLASTIC CLAY - DRAMMEN TOWN, NORWAY



(c) Composite Microfabric × 900

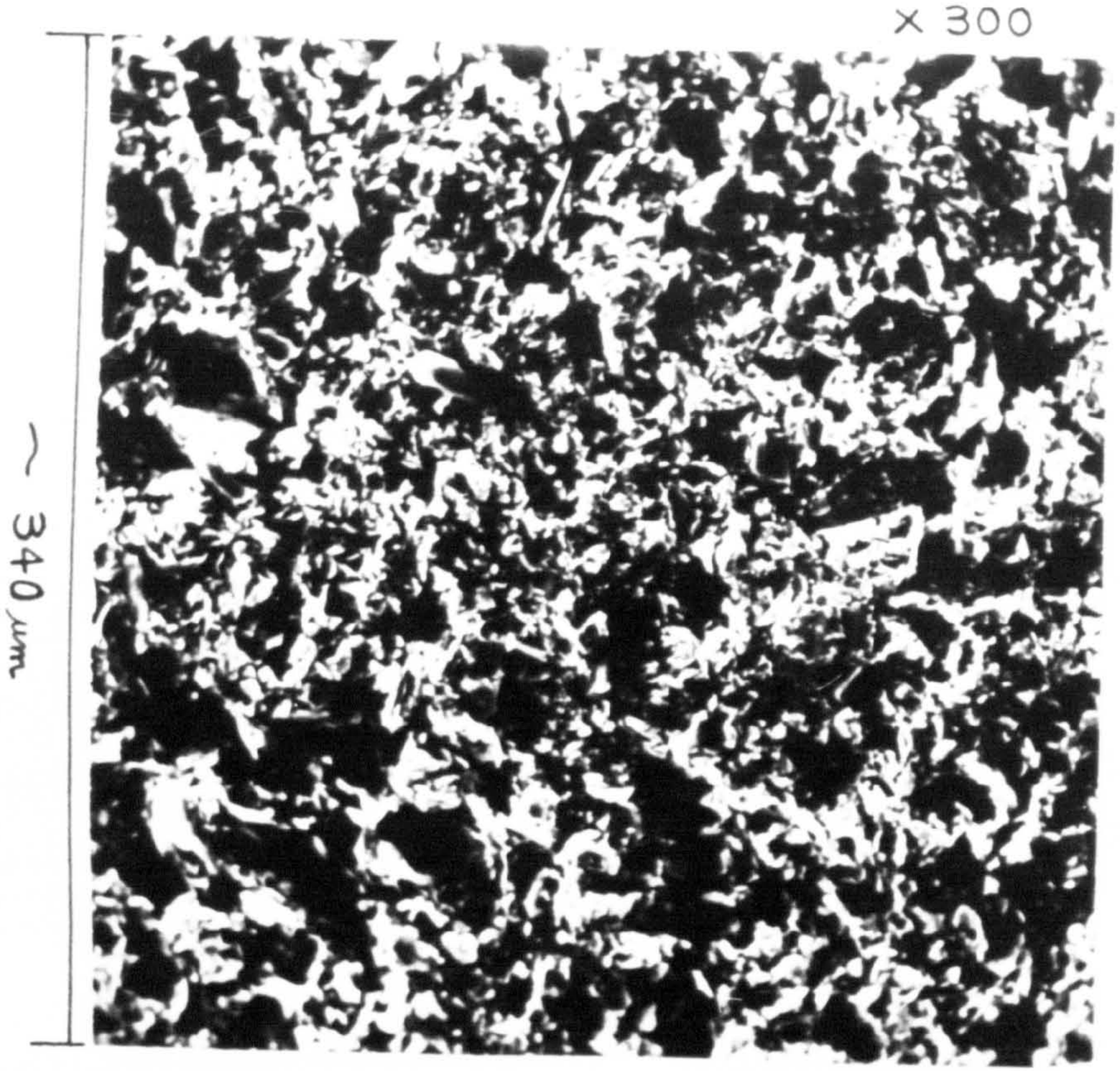
MIC. 5.2. MARINE PLASTIC CLAY - DRAMMEN TOWN, NORWAY

(a) Connector System x 7000

MIC. 5.3. MARINE CLAYEY SILT - SUNDLAND, NORWAY

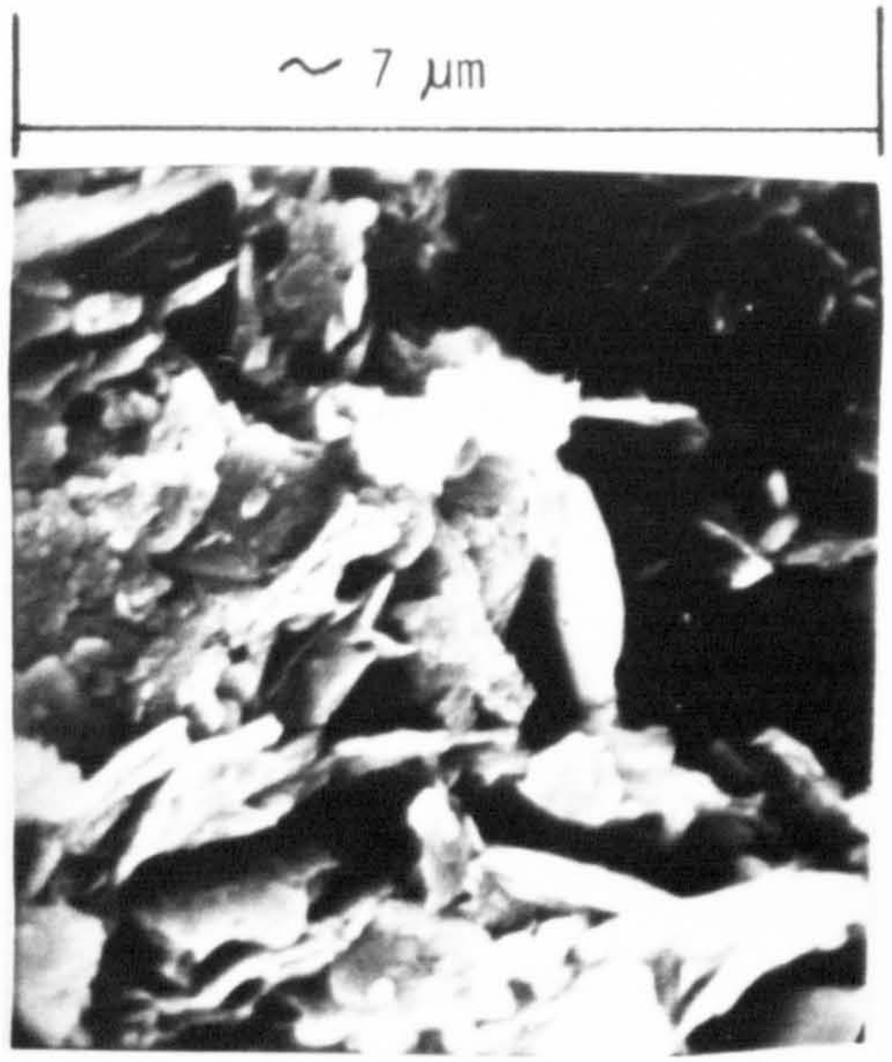
(b) Irregular aggregation with connector linkages × 1500

MIC. 5.3 MARINE CLAYEY SILT - SUNDLAND, NORWAY

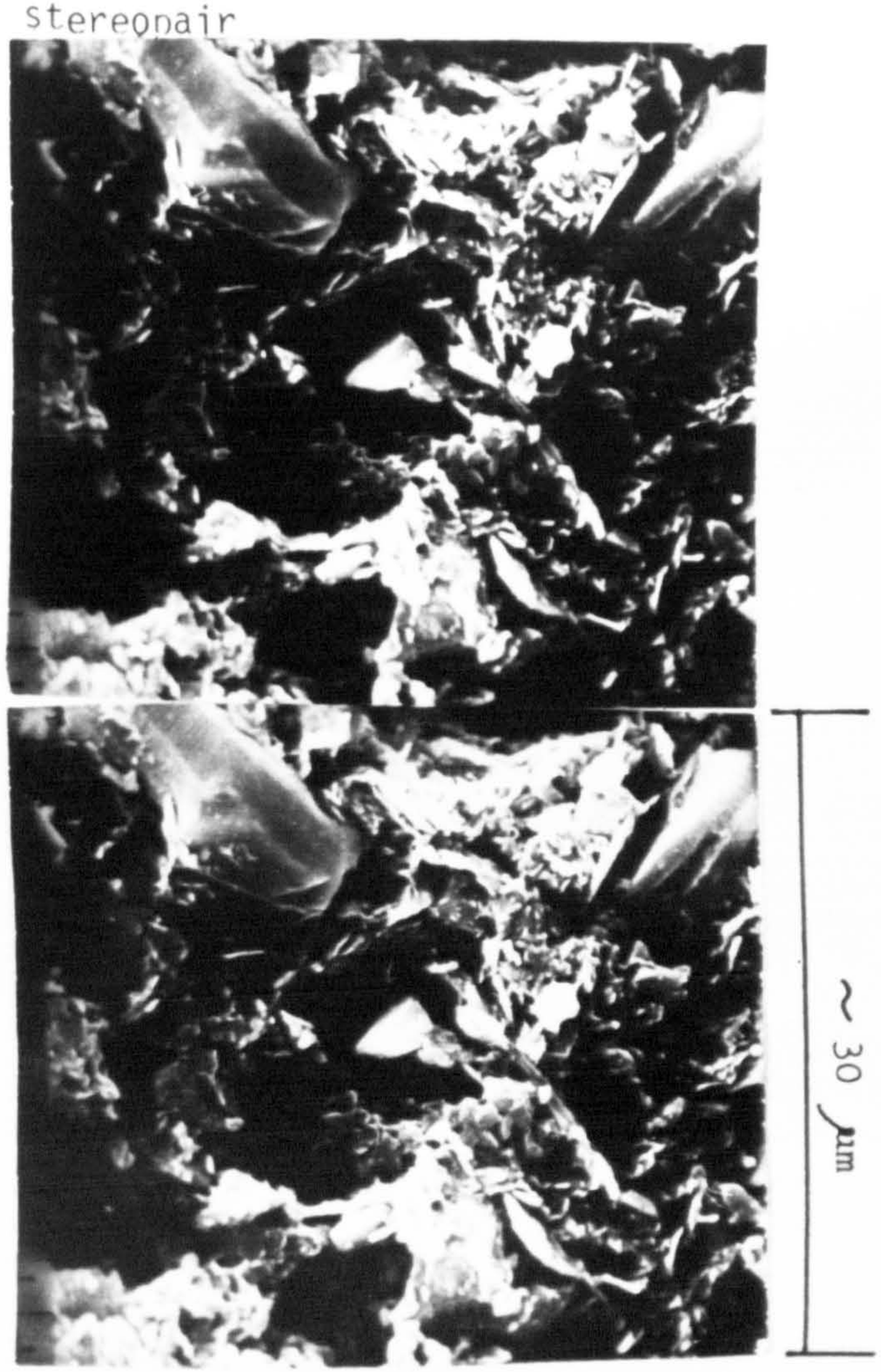


(c) Composite Microfabric

MIC. 5.3. MARINE CLAYEY SILT - SUNDLAND, NORWAY

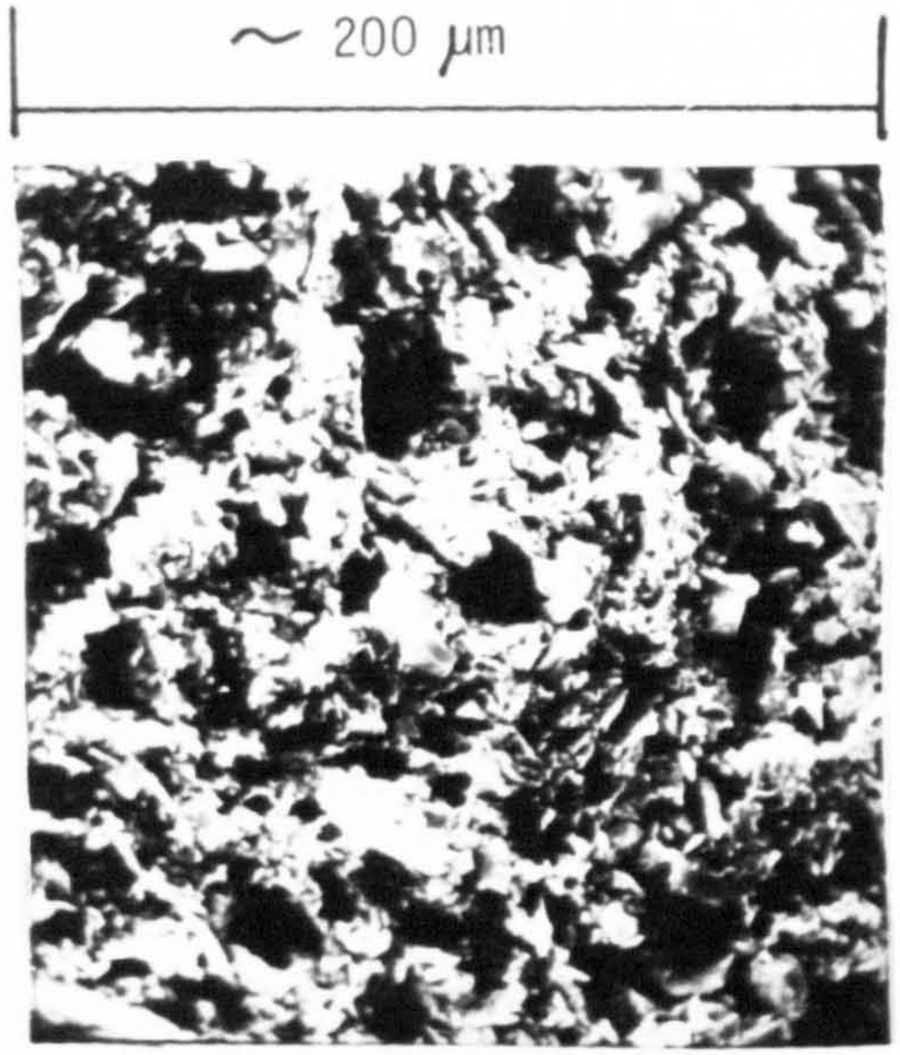


(a) Random clay arrangements x 8900

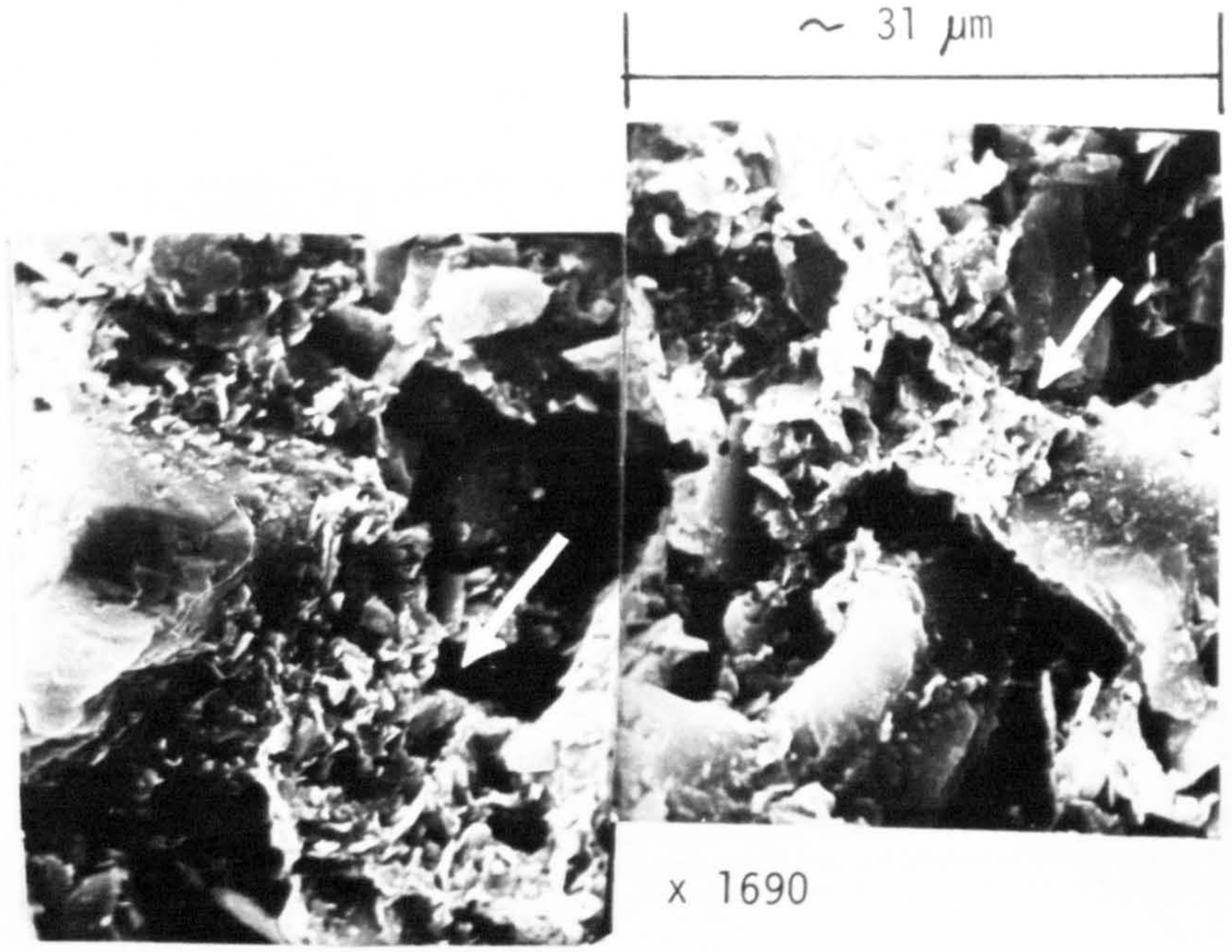


(b) Clay-granular matrix region. x 2100

MIC. 5.4. MARINE SILTY CLAY - SOLBERGELVA, NORWAY

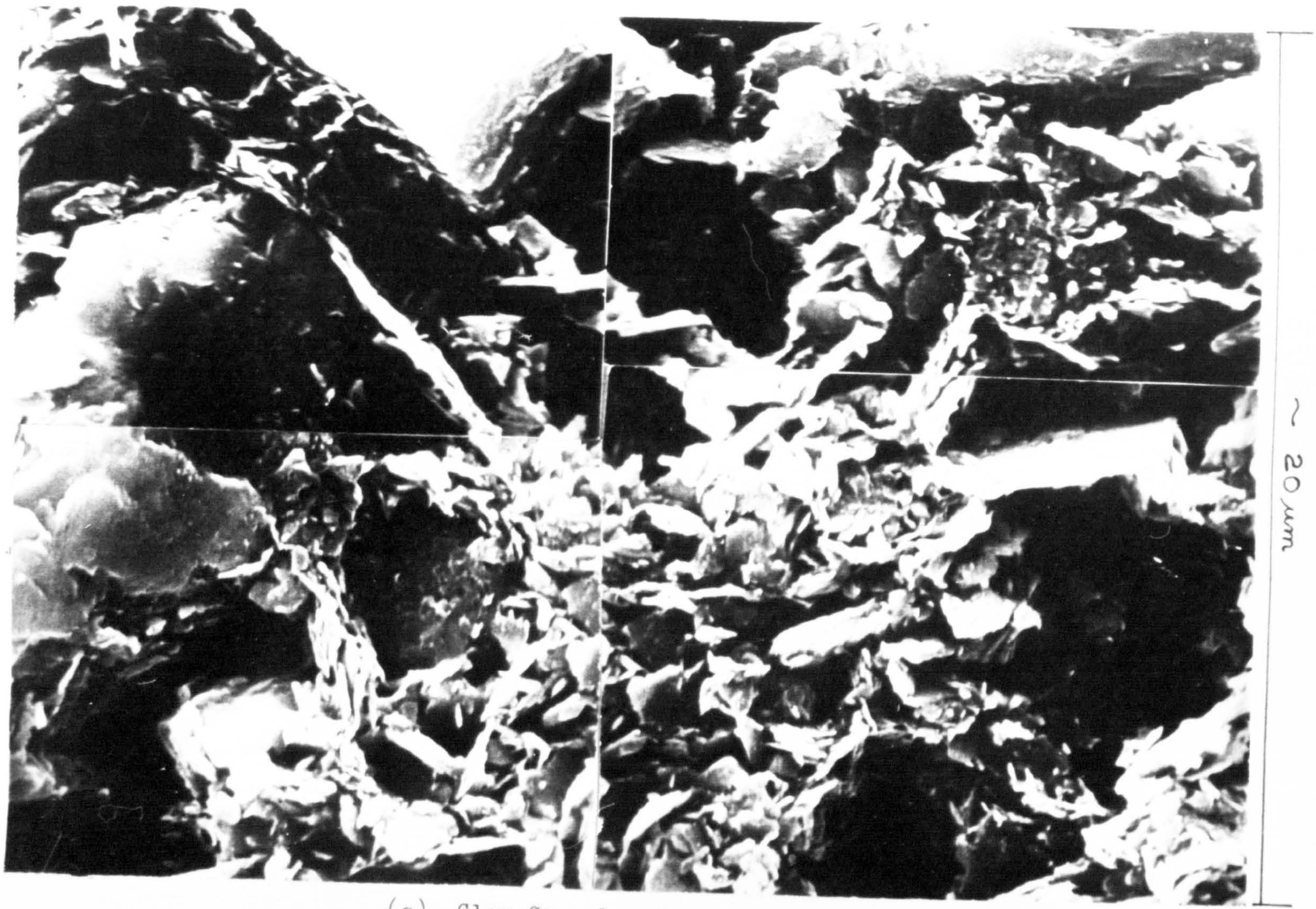


(d) Composite microfabric x 310



(c) Connectors x 1690

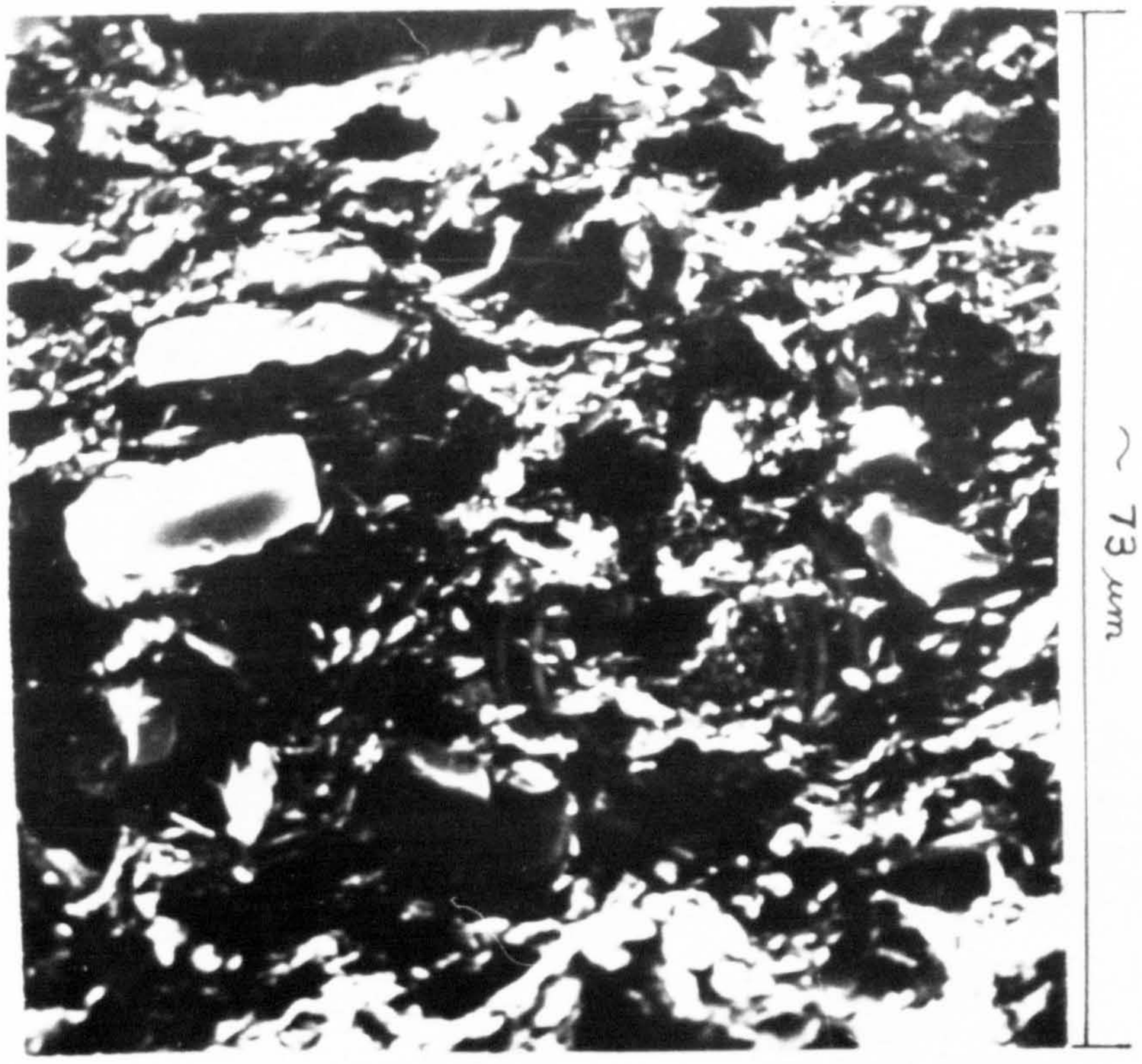
MIC. 5.4. MARINE SILTY CLAY - SOLBERGELVA, NORWAY



(a) Clay-Granular Matrix Region

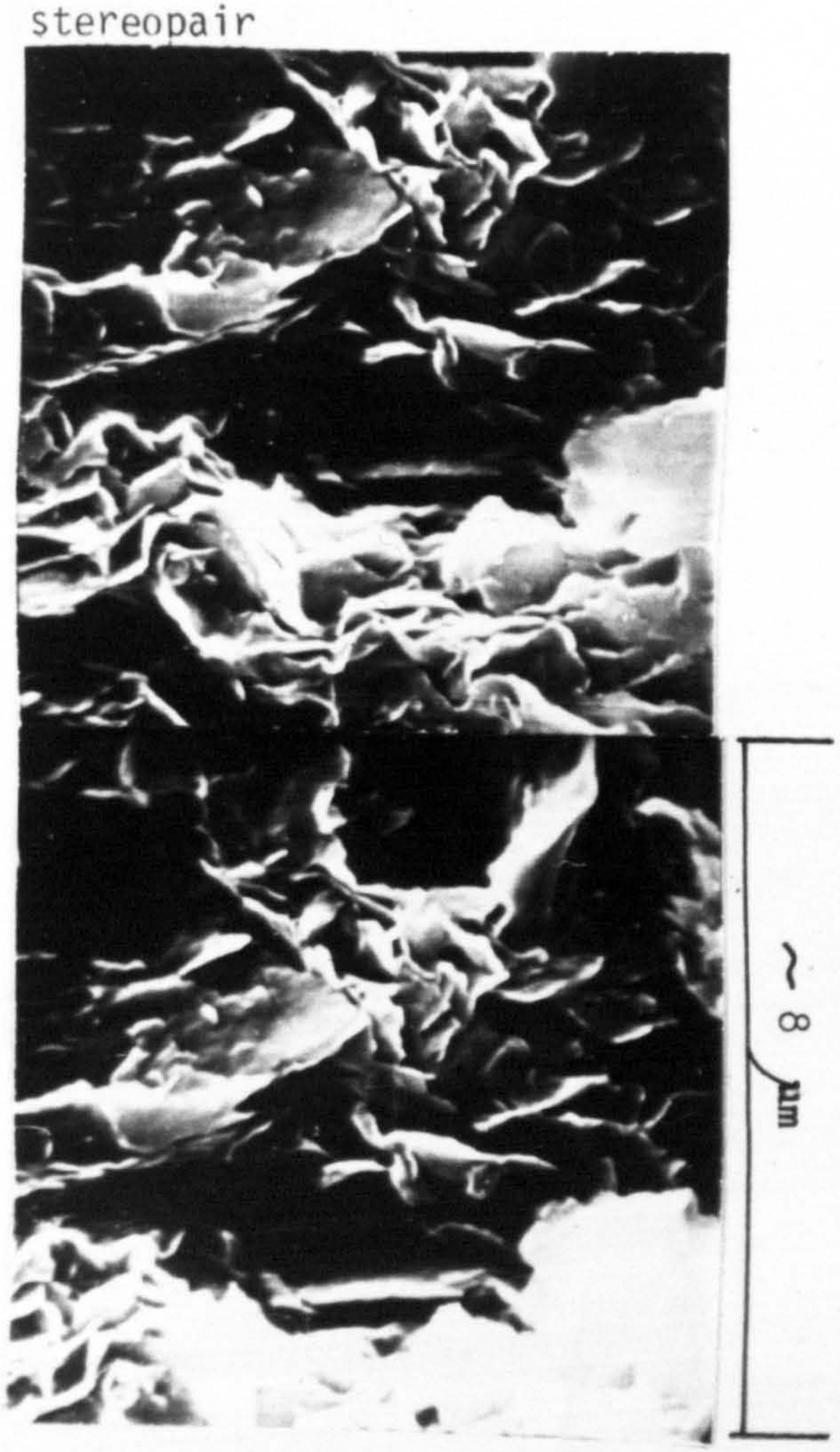
X 7000

MIC. 5.5. MARINE SILTY CLAY - ELLINGSGRUND, NORWAY

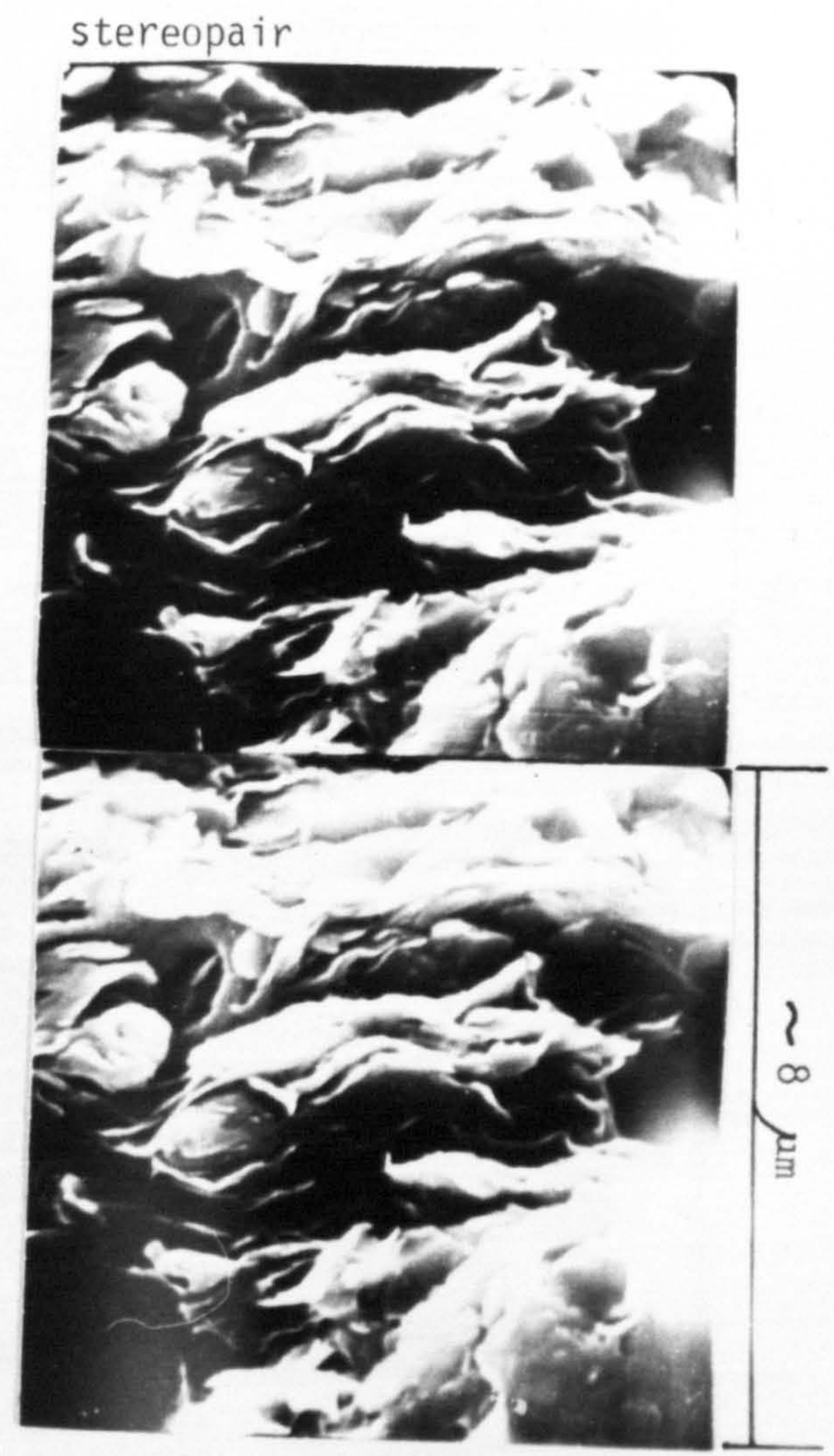


(b) Composite Microfabric

MIC. 5.5. MARINE SILTY CLAY - ELLINGSGRUND, NORWAY

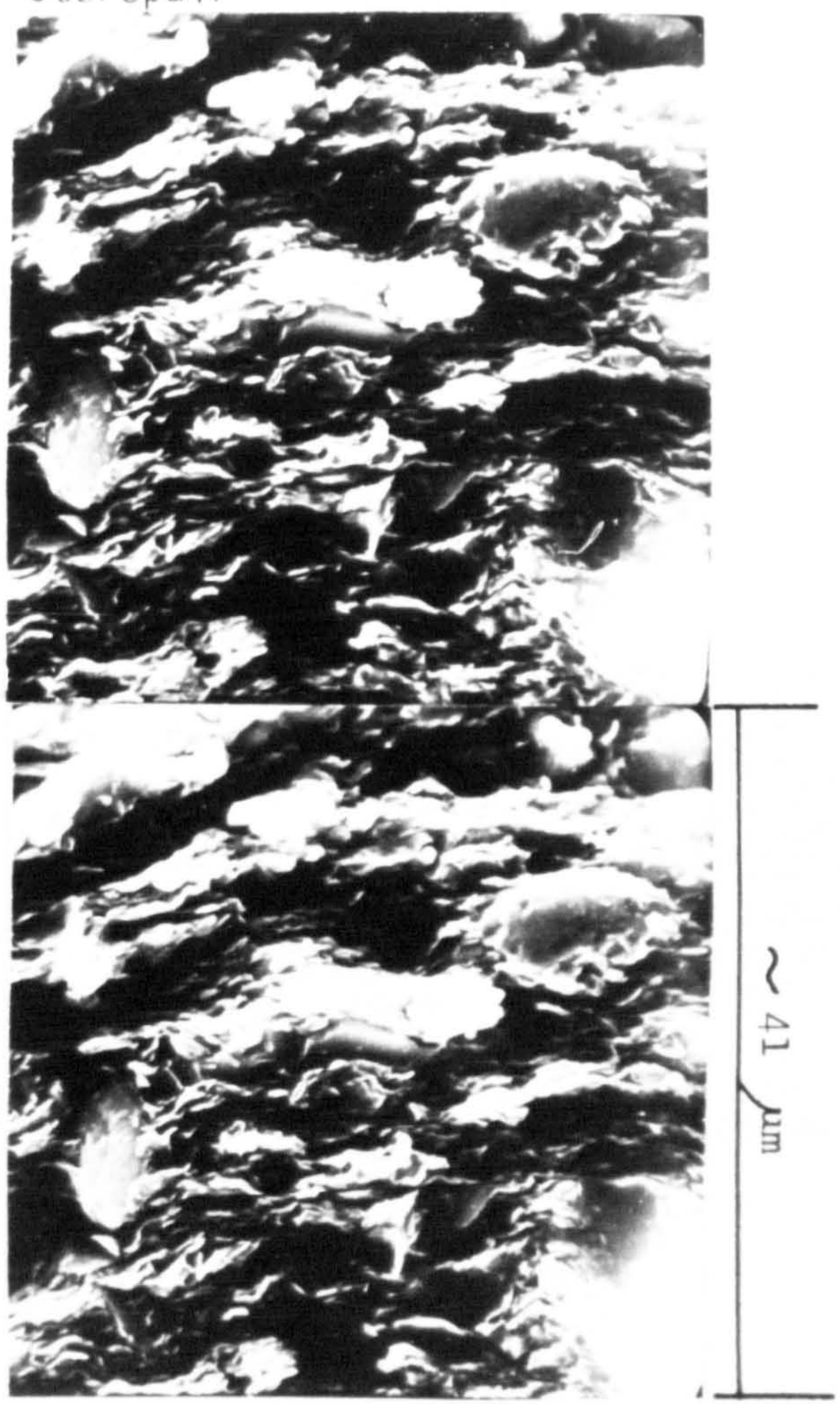


(b) Random clay arrangements. x 7900

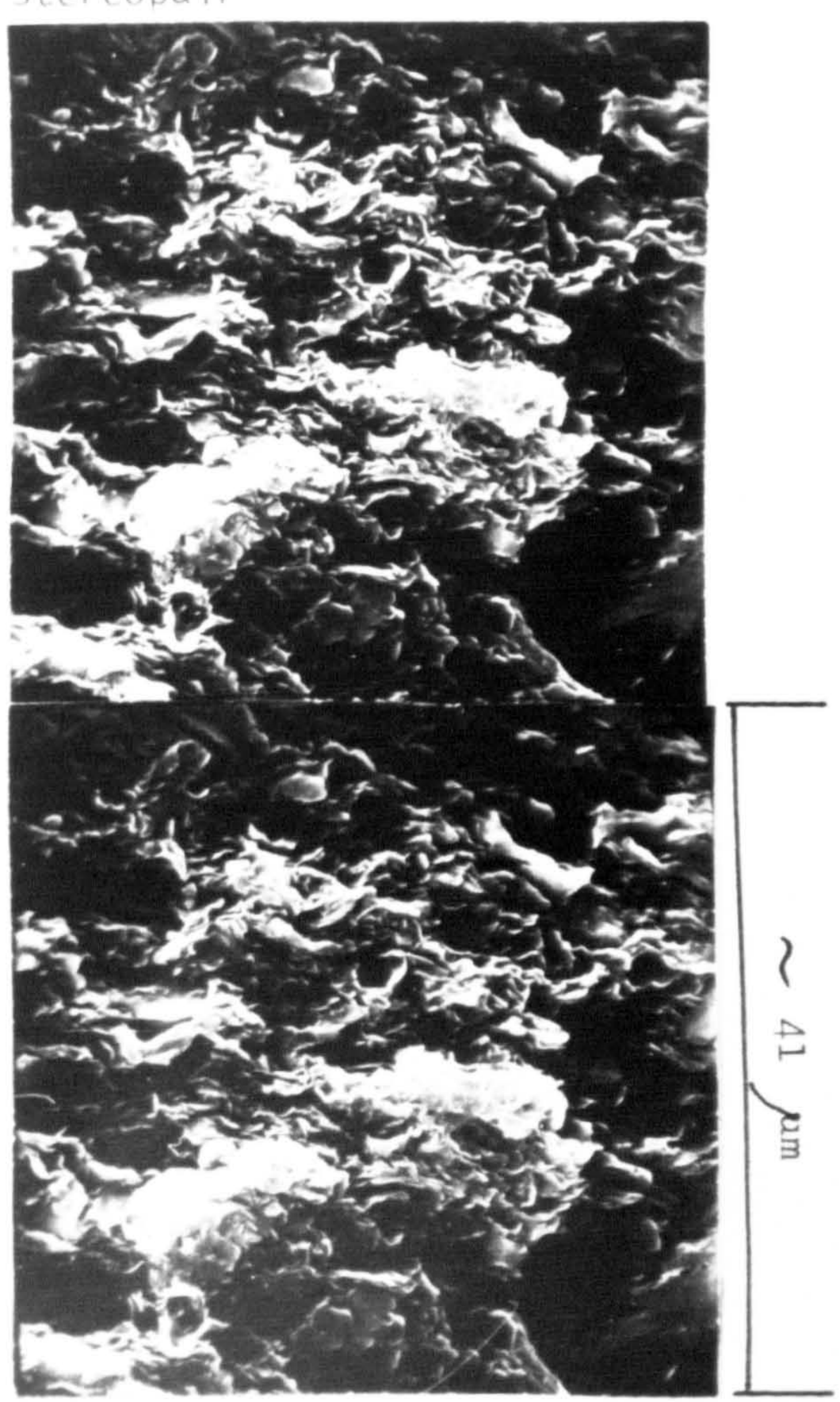


(a) Parallel clay arrangements. x 7900

MIC. 5.6. MARINE CLAY - JACKSON, U.S.A.

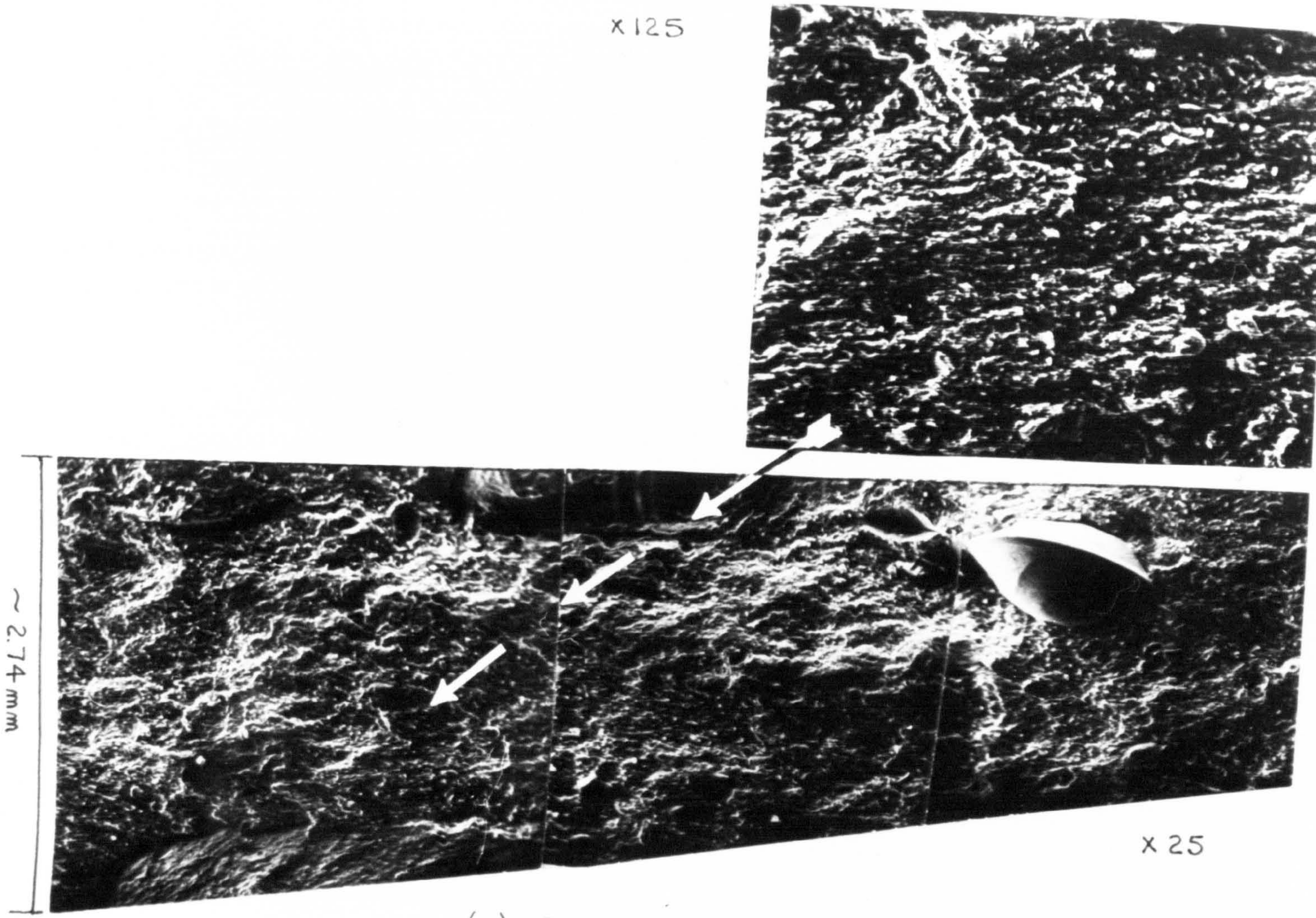


(c) Clay-granular matrix region.



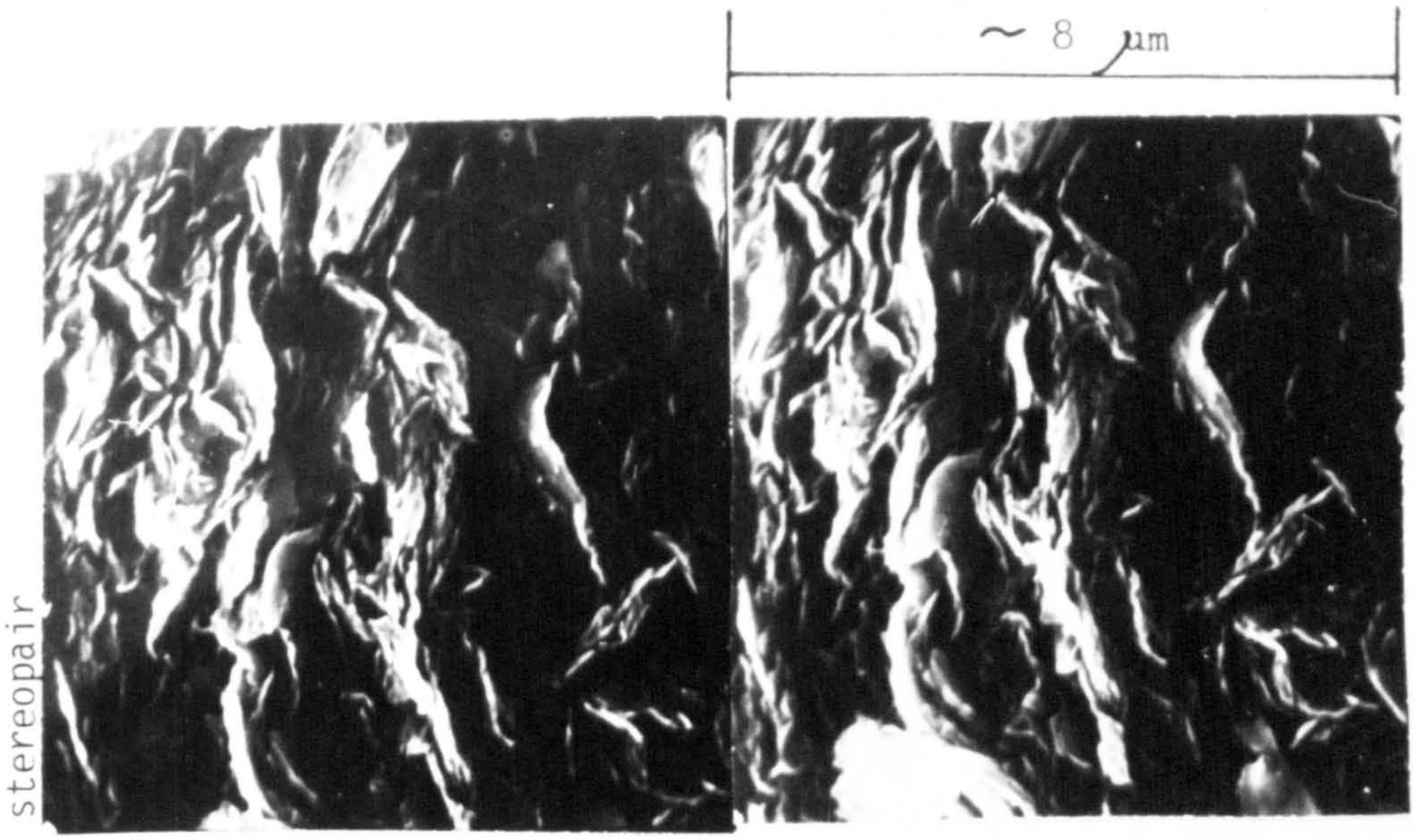
(d) Clay matrix region.

MIC. 5.6. MARINE CLAY - JACKSON, U.S.A.

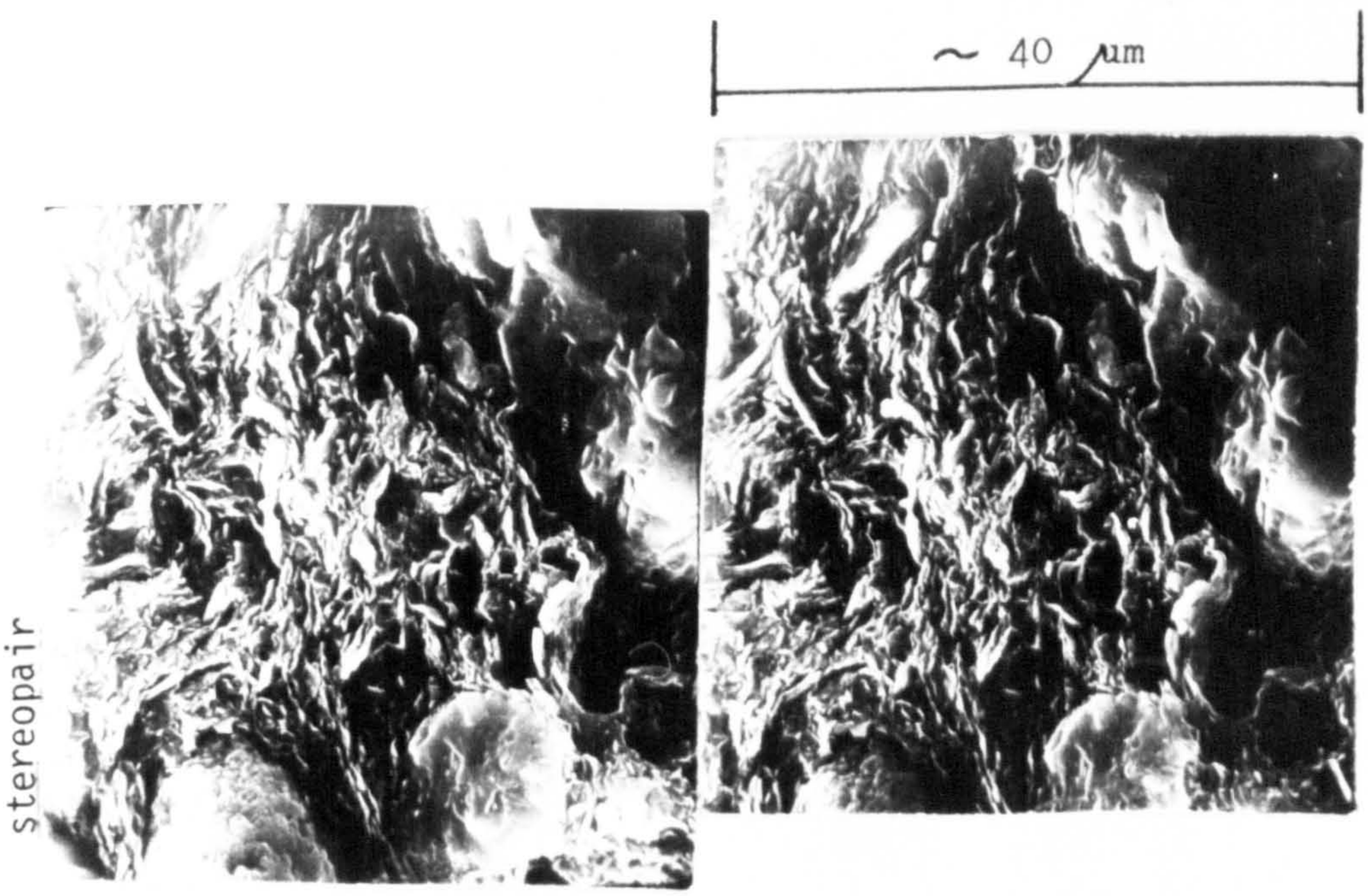


(e) Composite Microfabric

MIC. 5.6. MARINE CLAY - JACKSON, U.S.A.



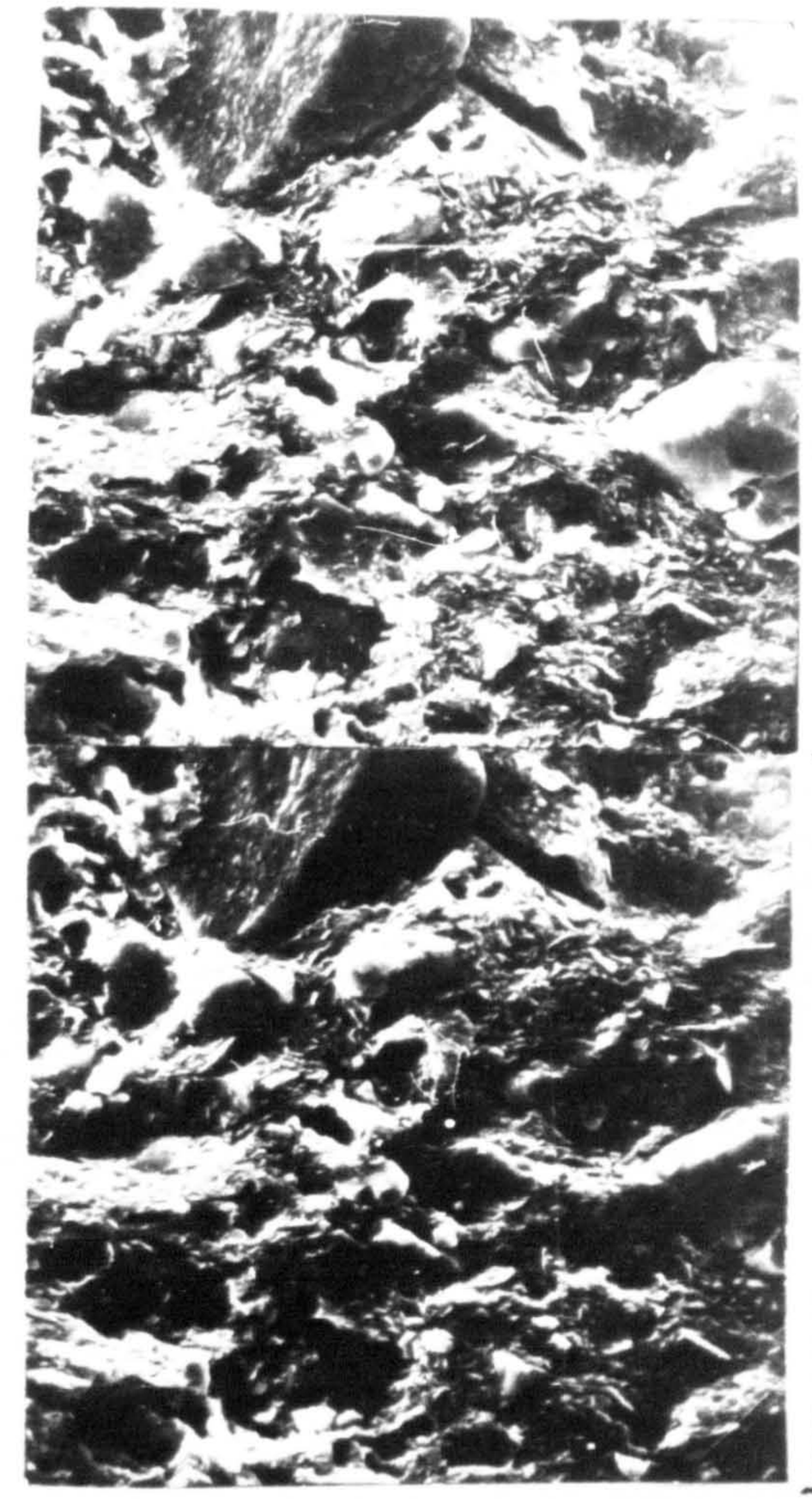
(a) Parallel clay arrangements. x 7800



(b) Predominantly parallel clay array displaying weak preferred orientation. x 1560

MIC. 5.7. MARINE SILTY CLAY- LUANDA, ANGOLA

stereopair



~ 160 µm

x 390

(c) Clay-granular matrix region.

stereopair

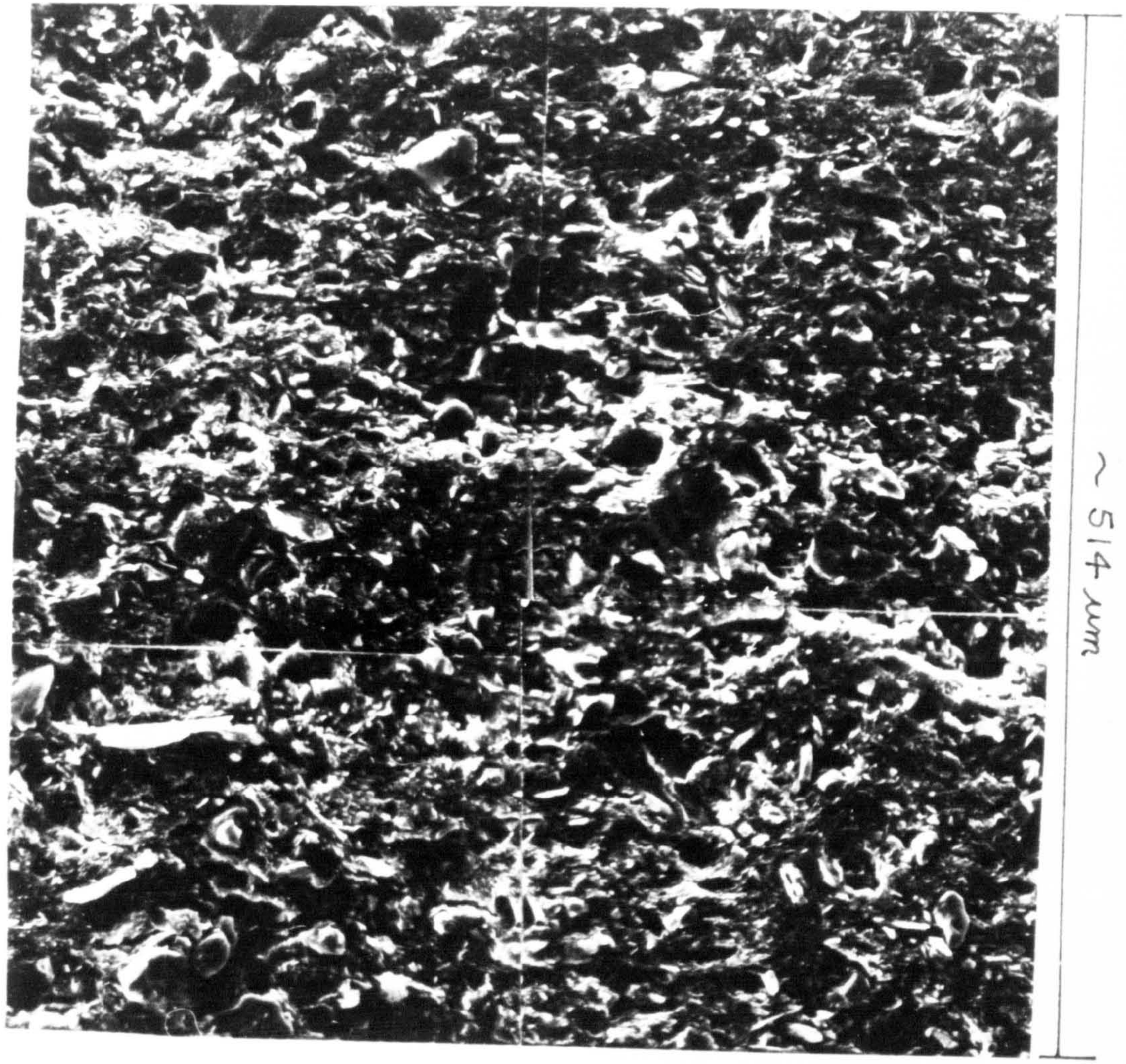
~ 81 µm

x 780

(d) Clay matrix region.

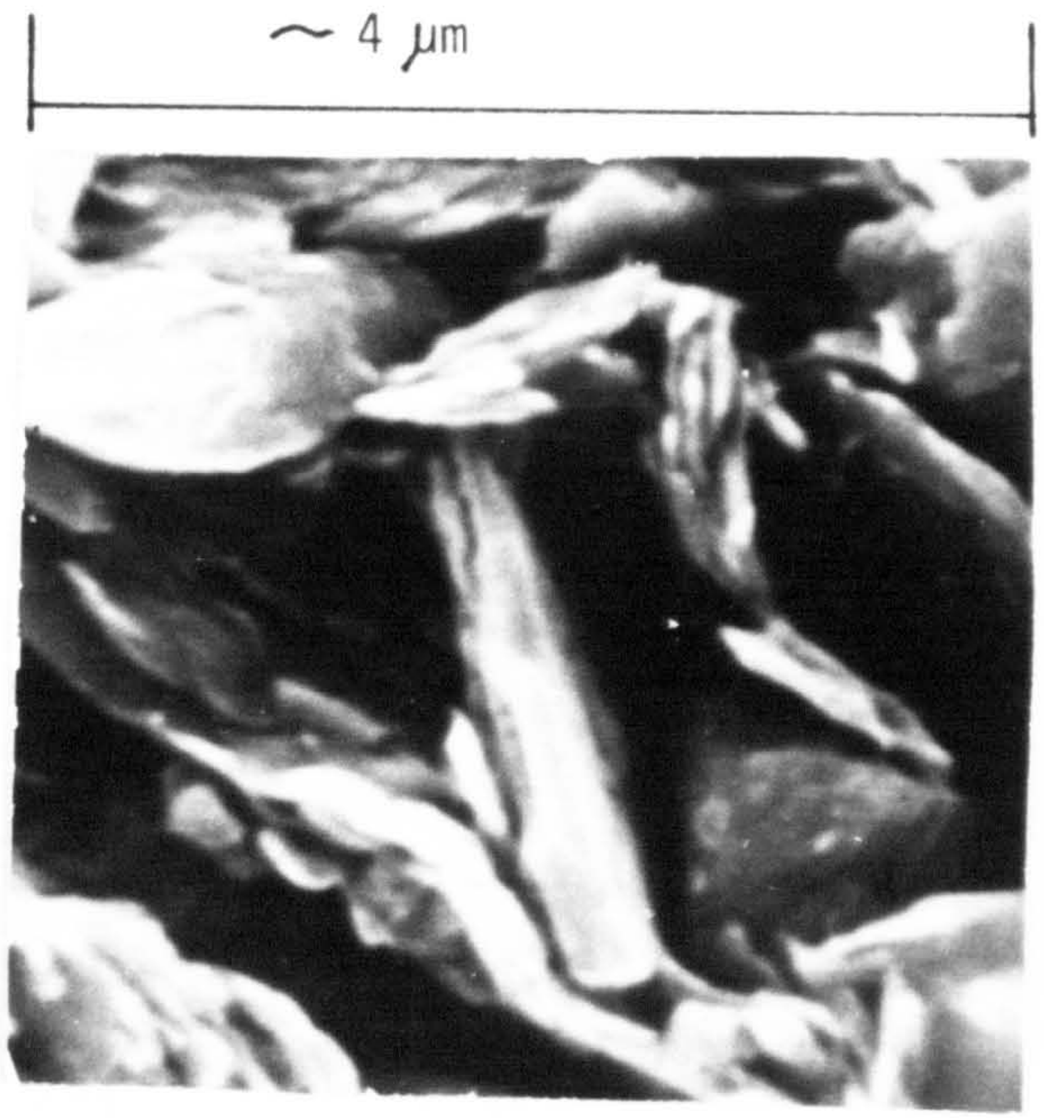
MIC. 5.7. MARINE SILTY CLAY - LUANDA, ANGOLA

X 250



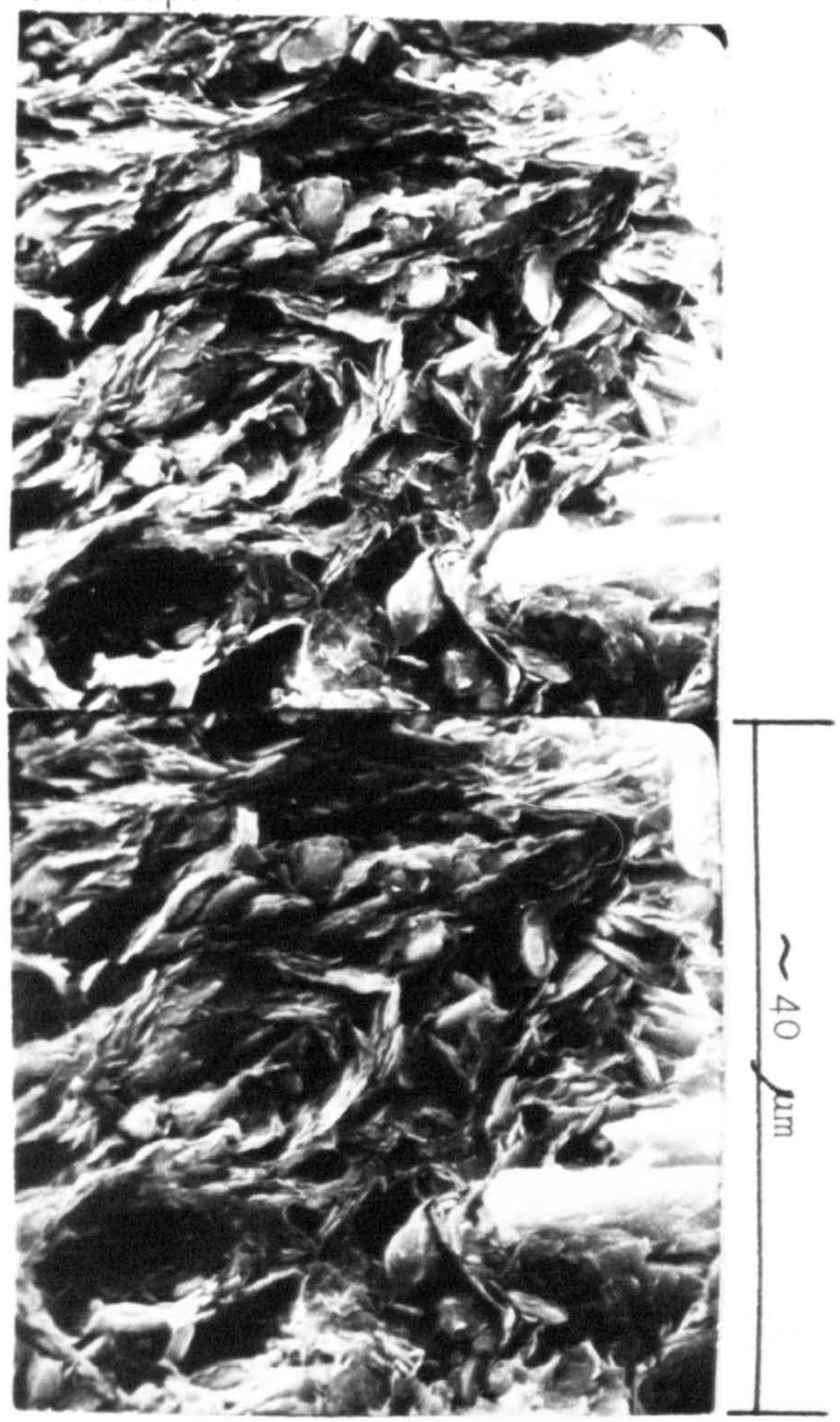
(e) Composite Microfabric

MIC. 5.7. MARINE SILTY CLAY - LUANDA, ANGOLA



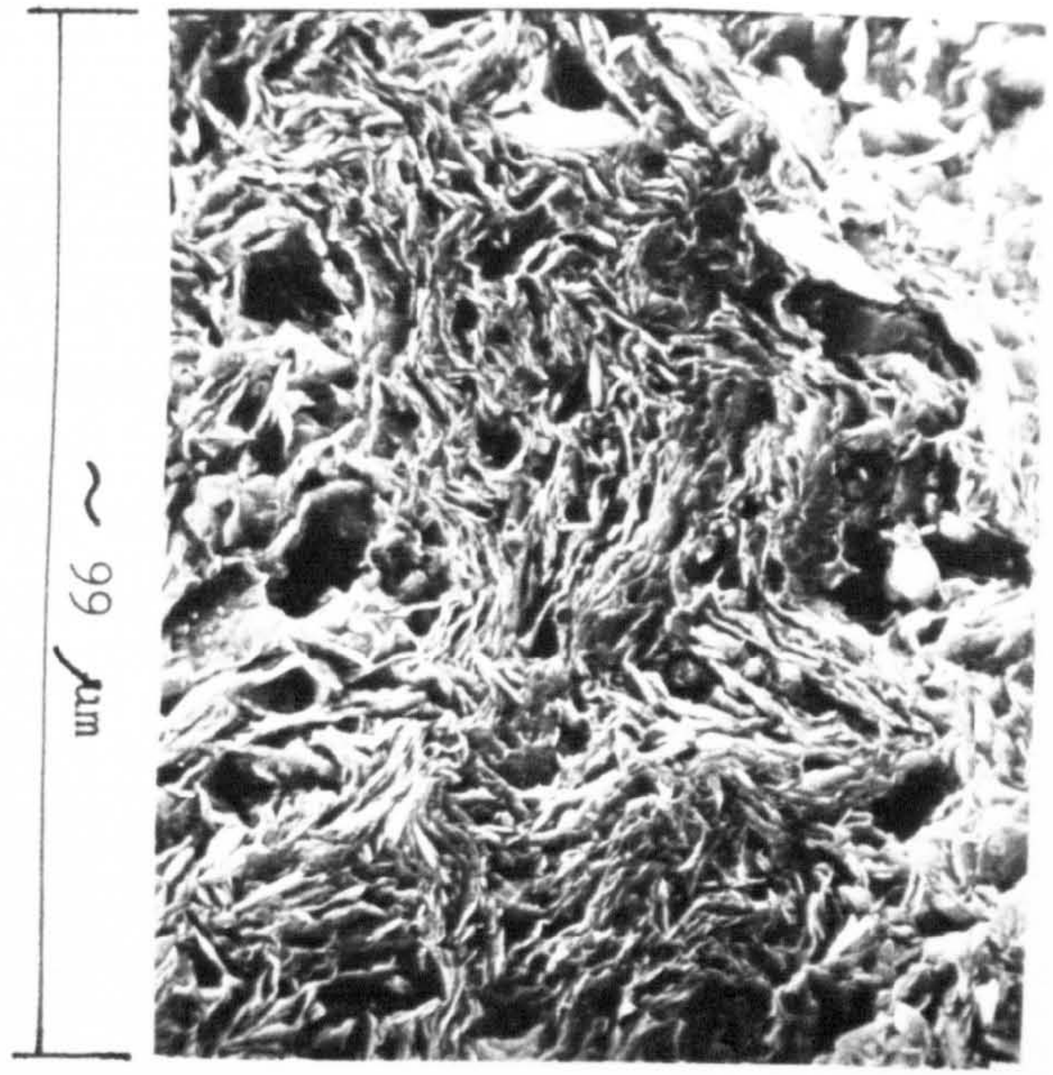
(a) Constituent clay particles x 18700

stereopair

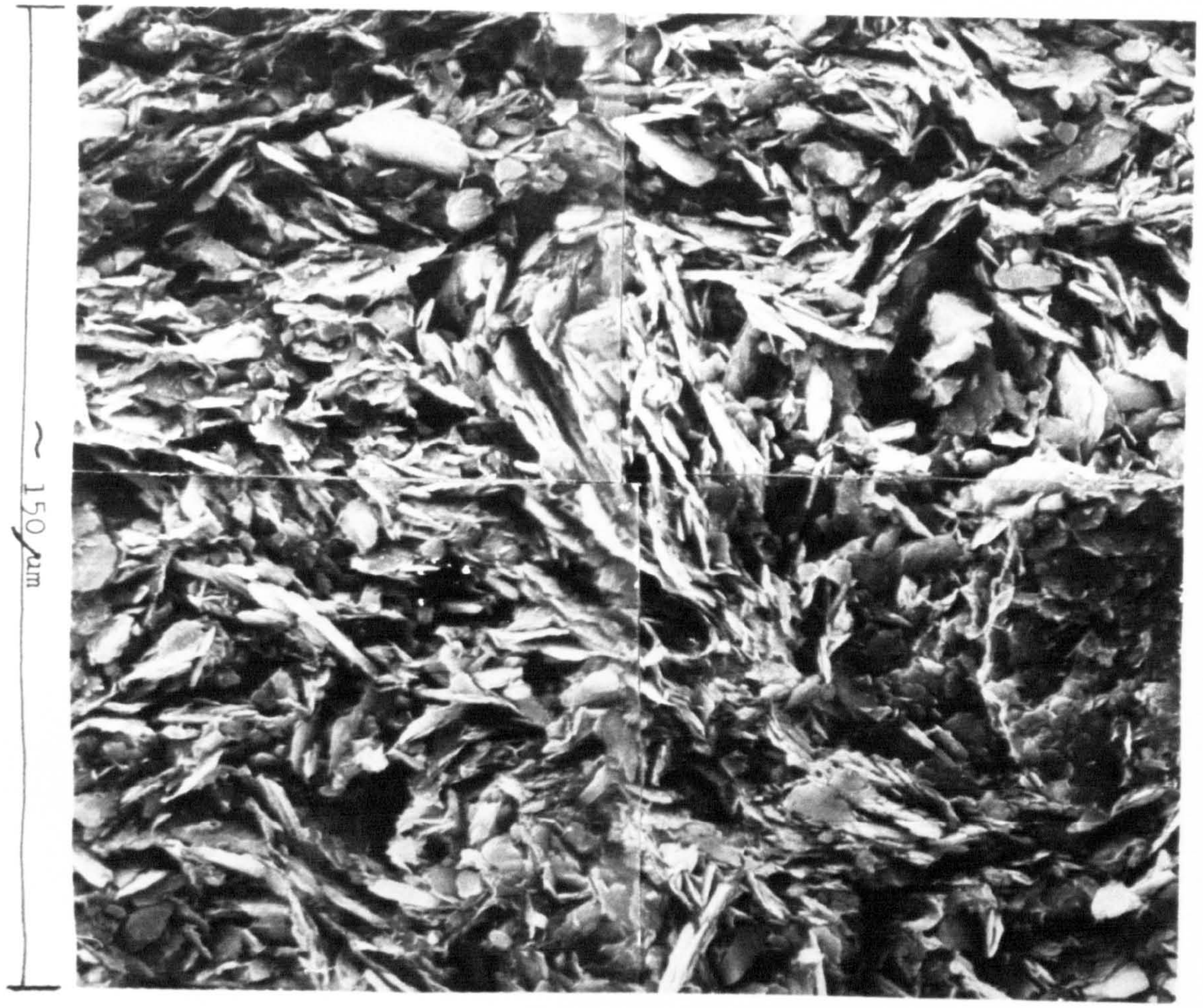


(b) Clay-granular matrix region. x 1560

MIC. 5.8. ESTUARINE SILTY CLAY - GALLOWGATE, SCOTLAND



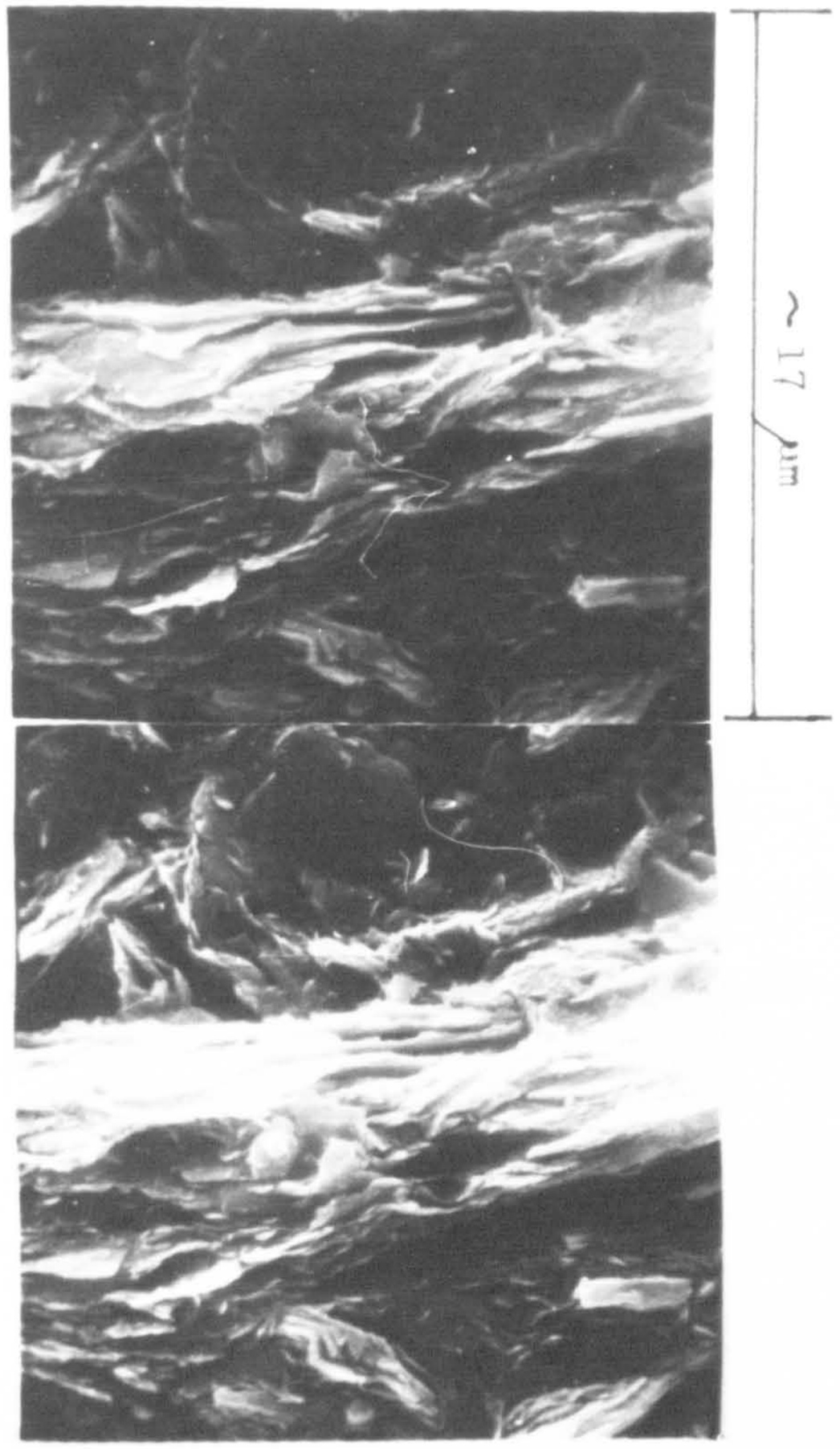
(c) Clay matrix region x 780



(d) Granular matrix region x 810

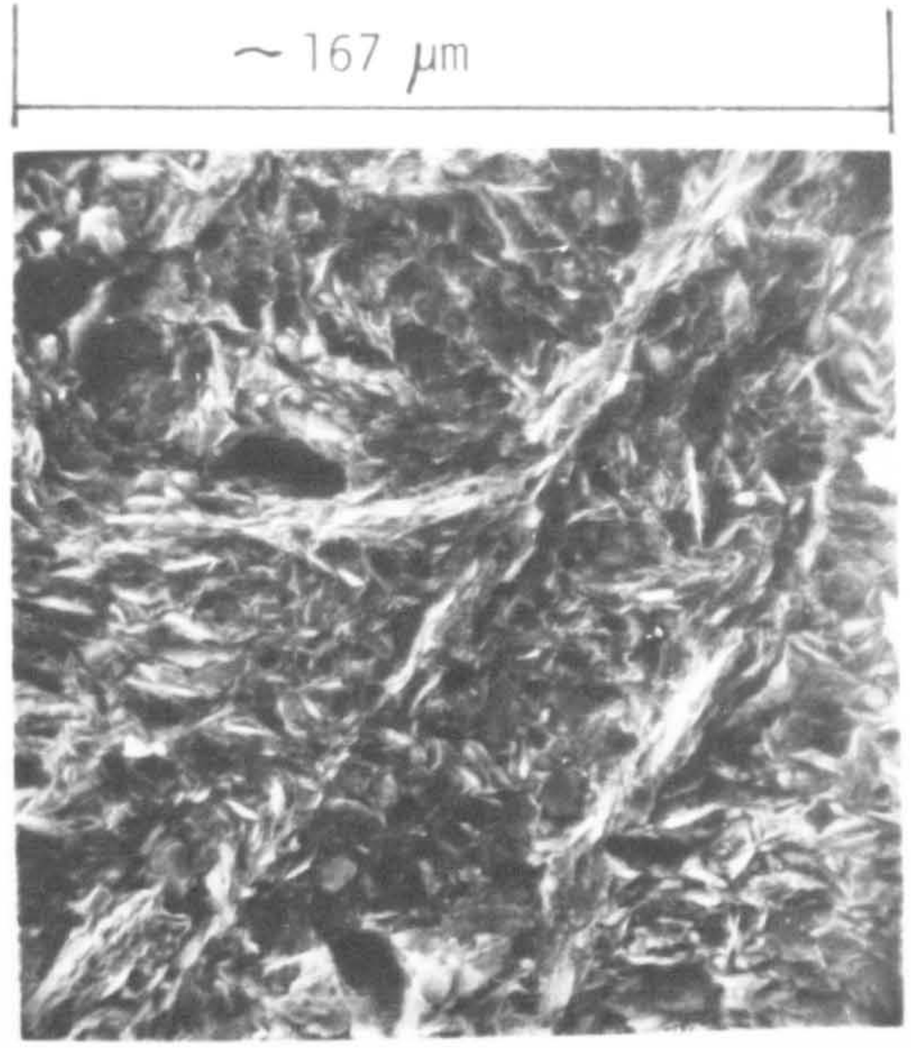
MIC. 5.8. ESTUARINE SILTY CLAY - GALLOWGATE, SCOTLAND

stereopair



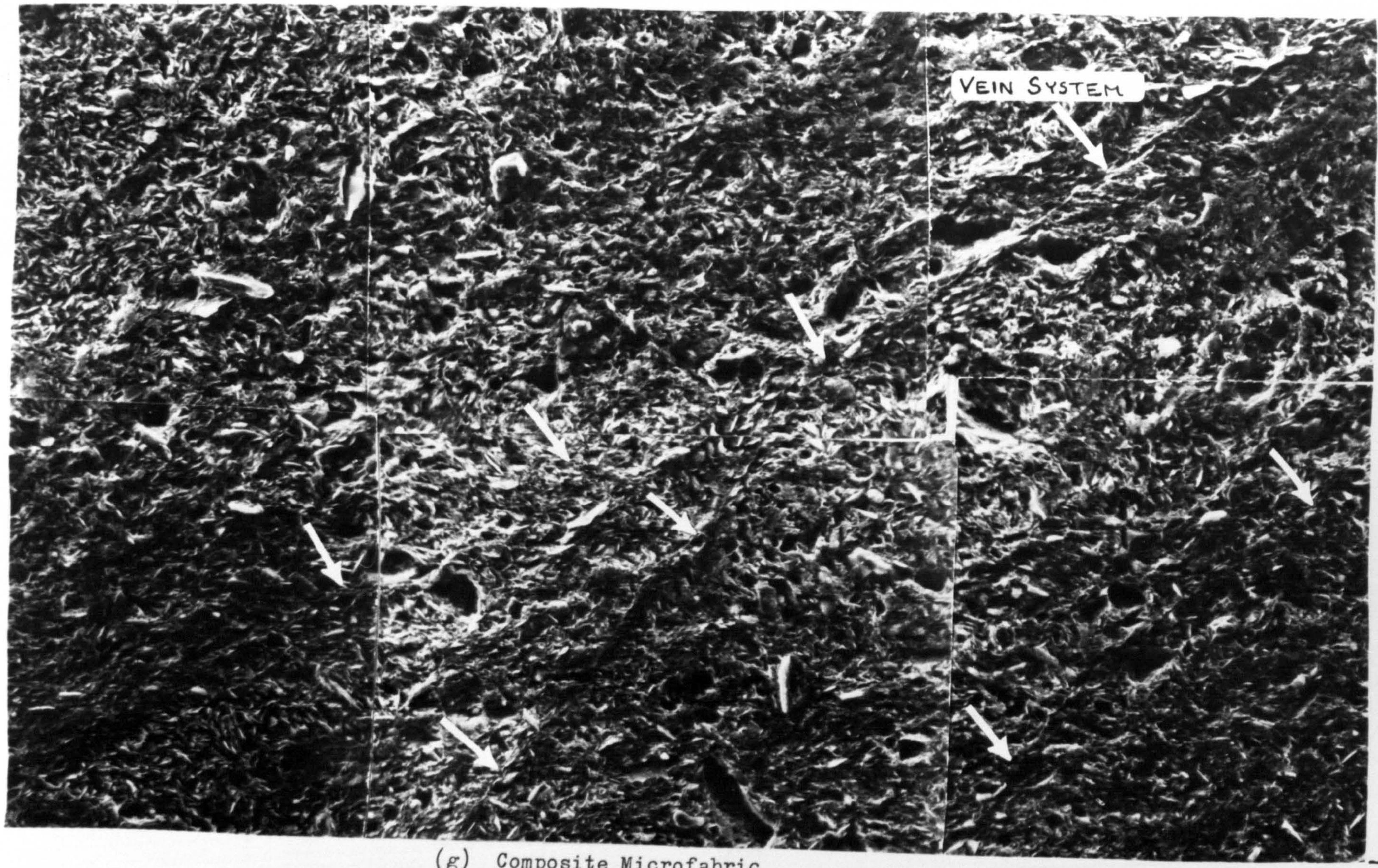
(f) Detailed character of vein.

x 3900



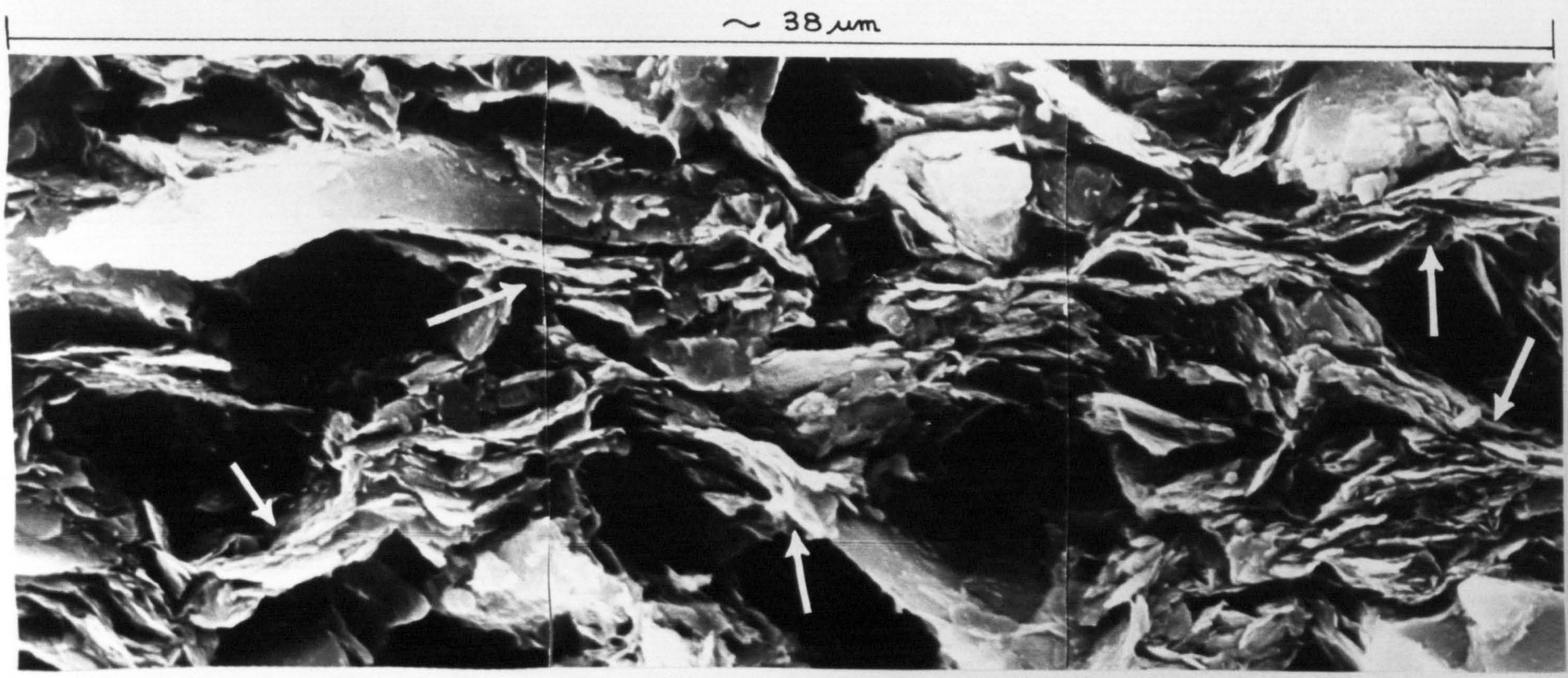
(e) Portion of vein system x 390

MIC. 5.8. ESTUARINE SILTY CLAY - GALLOWGATE, SCOTLAND



(g) Composite Microfabric

MIC. 5.8. ESTUARINE SILTY CLAY - GALLOWGATE, SCOTLAND



(a) Layer $\overline{11}$ - Parallel Clay Arrangements

× 6500

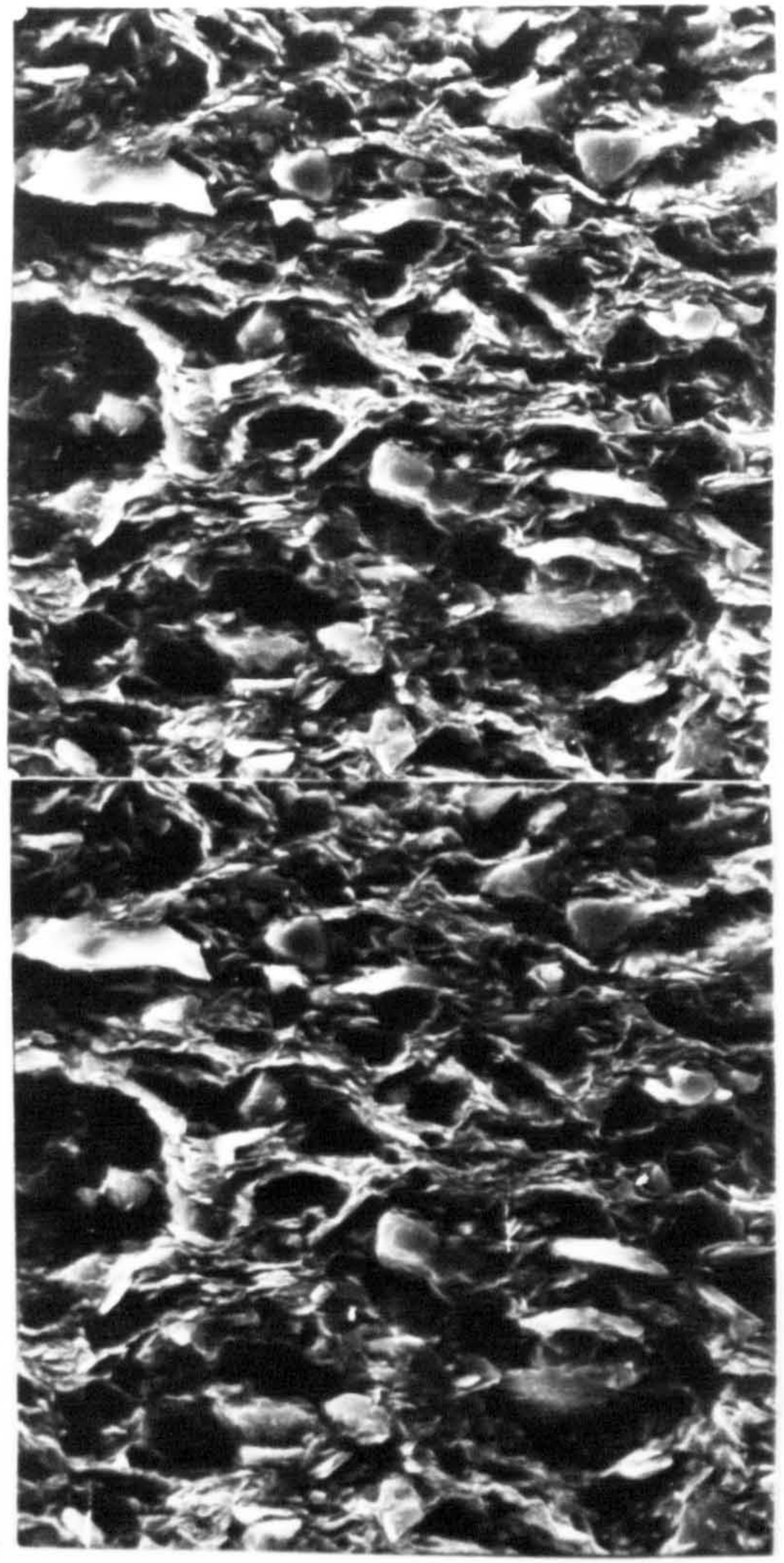
MIC. 5.9. ESTUARINE SILTY CLAY - LAURESTON, SCOTLAND

stereopair

~ 80 μm

x 825

(d) LAYER III - Granular region



~ 74 μm

(c) LAYER II - Clay-granular region

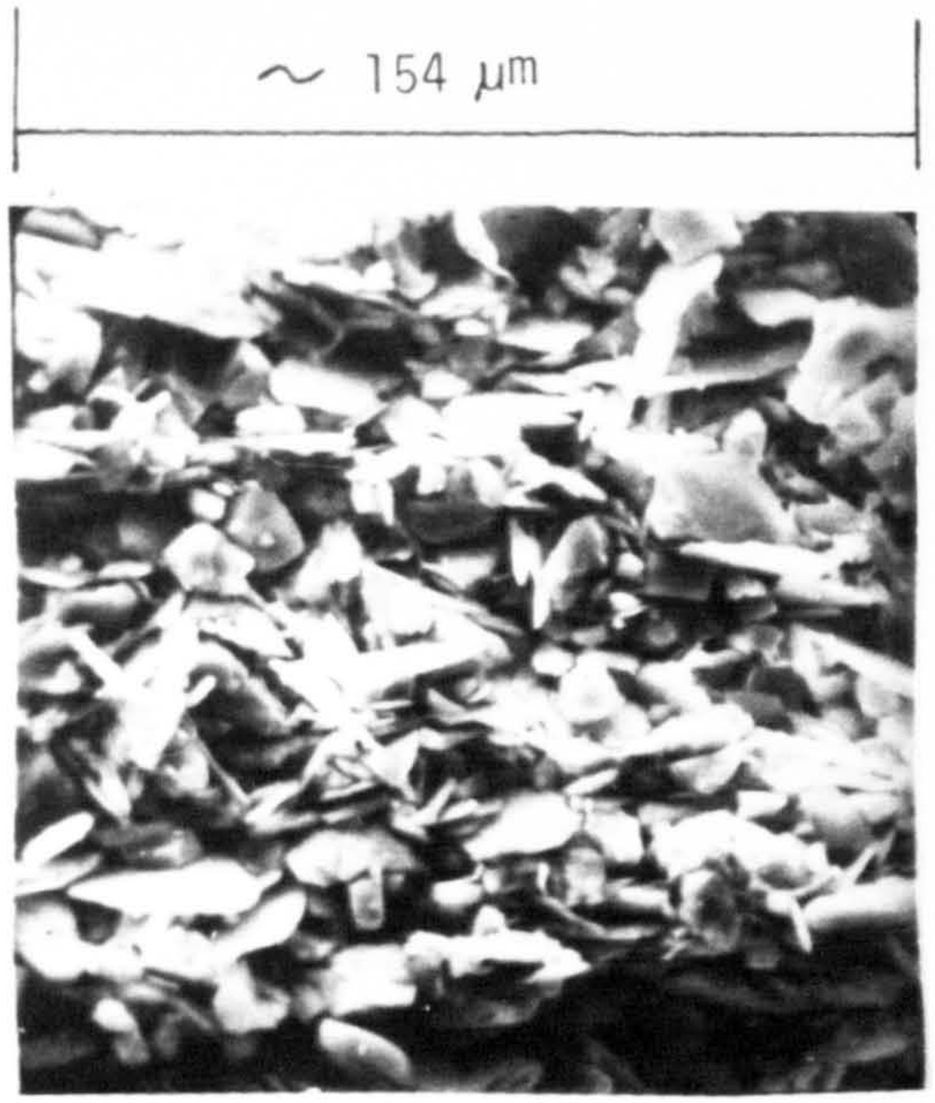
x 875

~ 27 μm

(b) LAYER I - Clay region

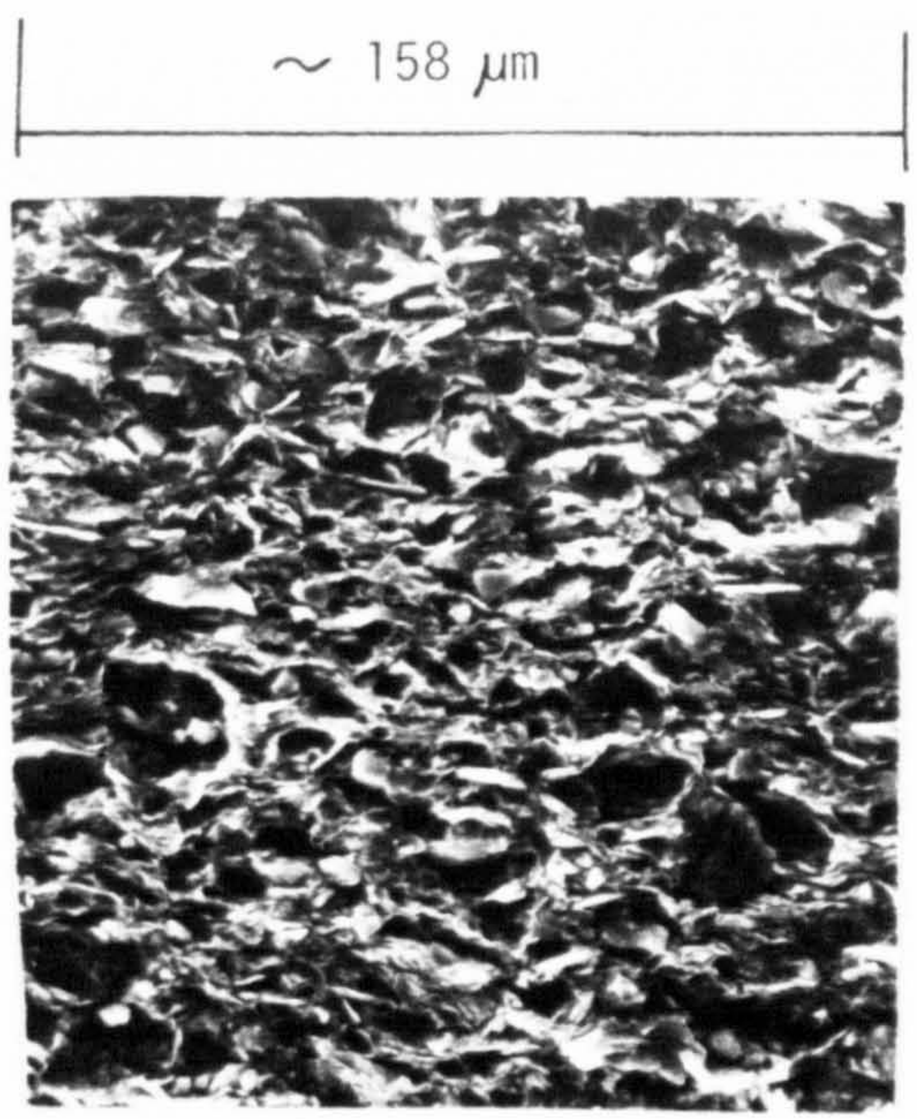
x 2800

MIC. 5.9. ESTUARINE SILTY CLAY - LAURIESTON, SCOTLAND



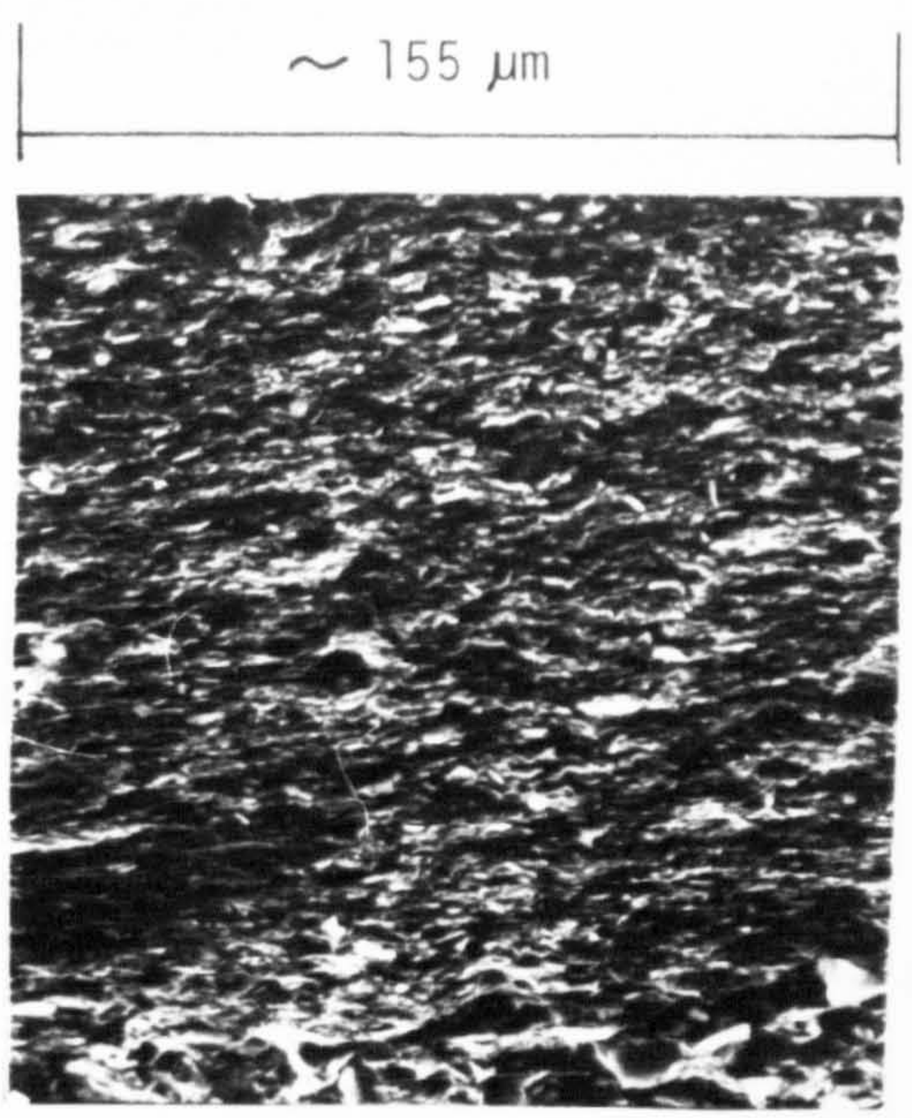
x 420

(g) LAYER III - Composite microfabric



x 400

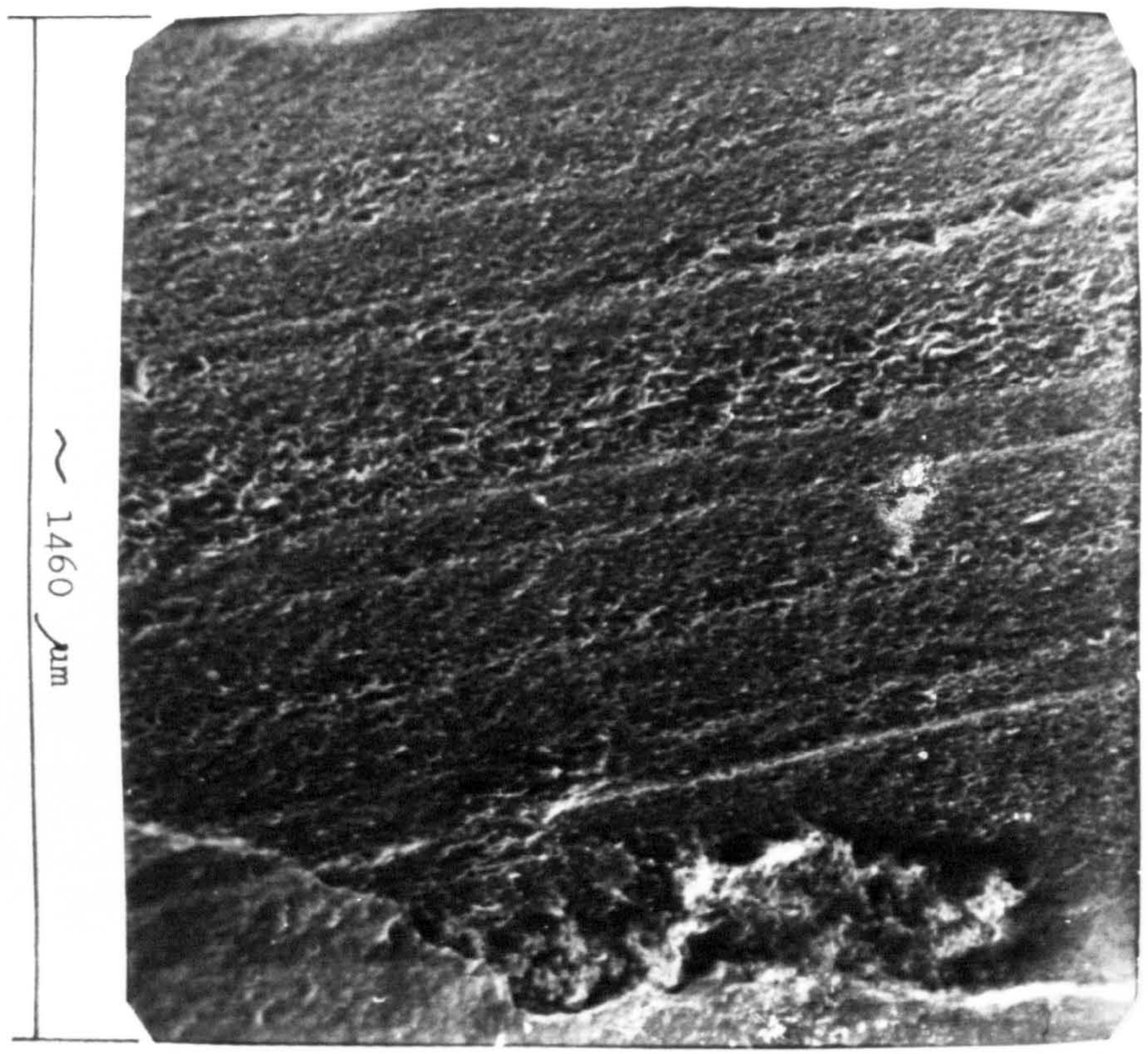
(f) LAYER II - Composite microfabric



x 410

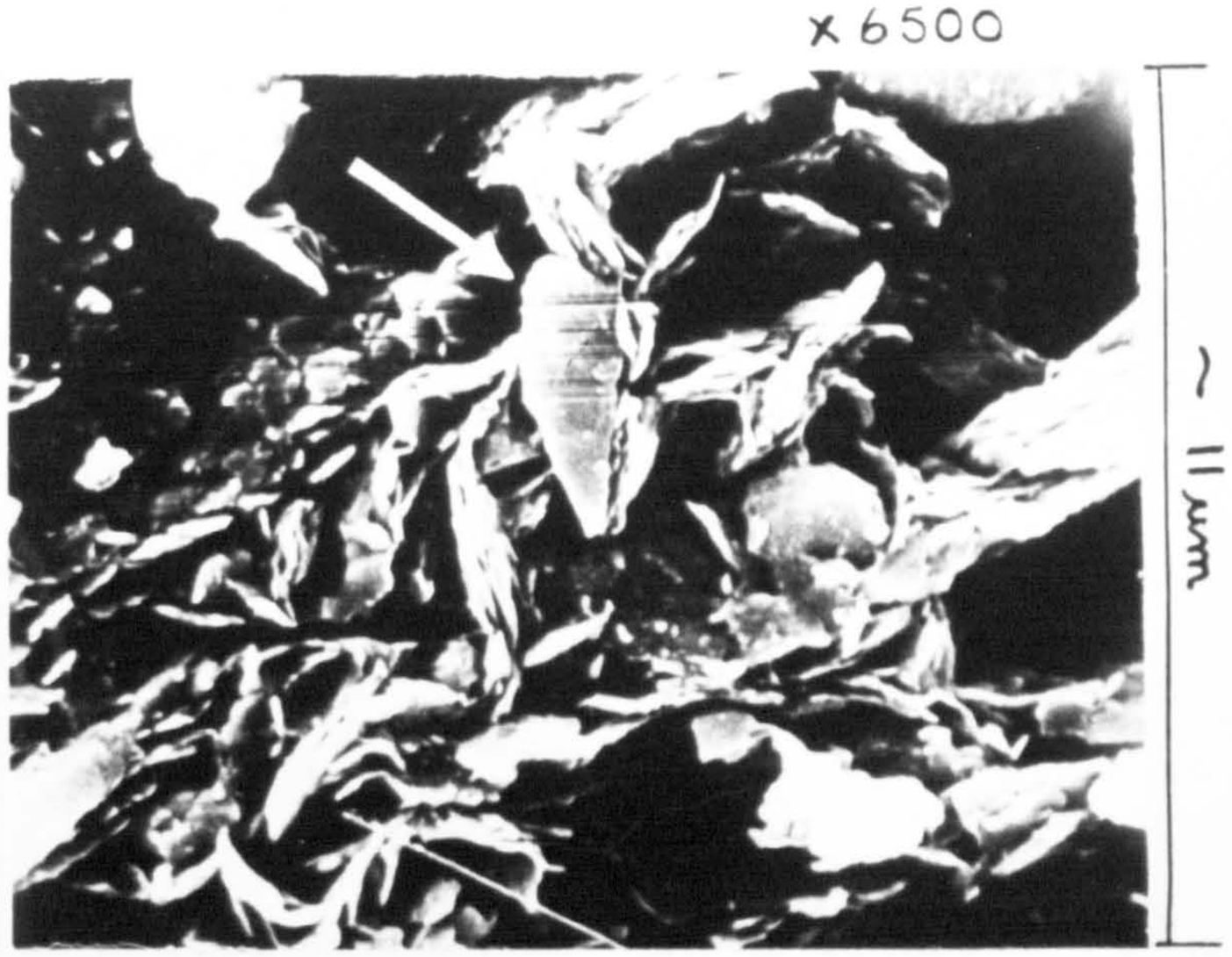
(e) LAYER I - Composite microfabric

MIC. 5.9. ESTUARINE SILTY CLAY - LAURIESTON, SCOTLAND

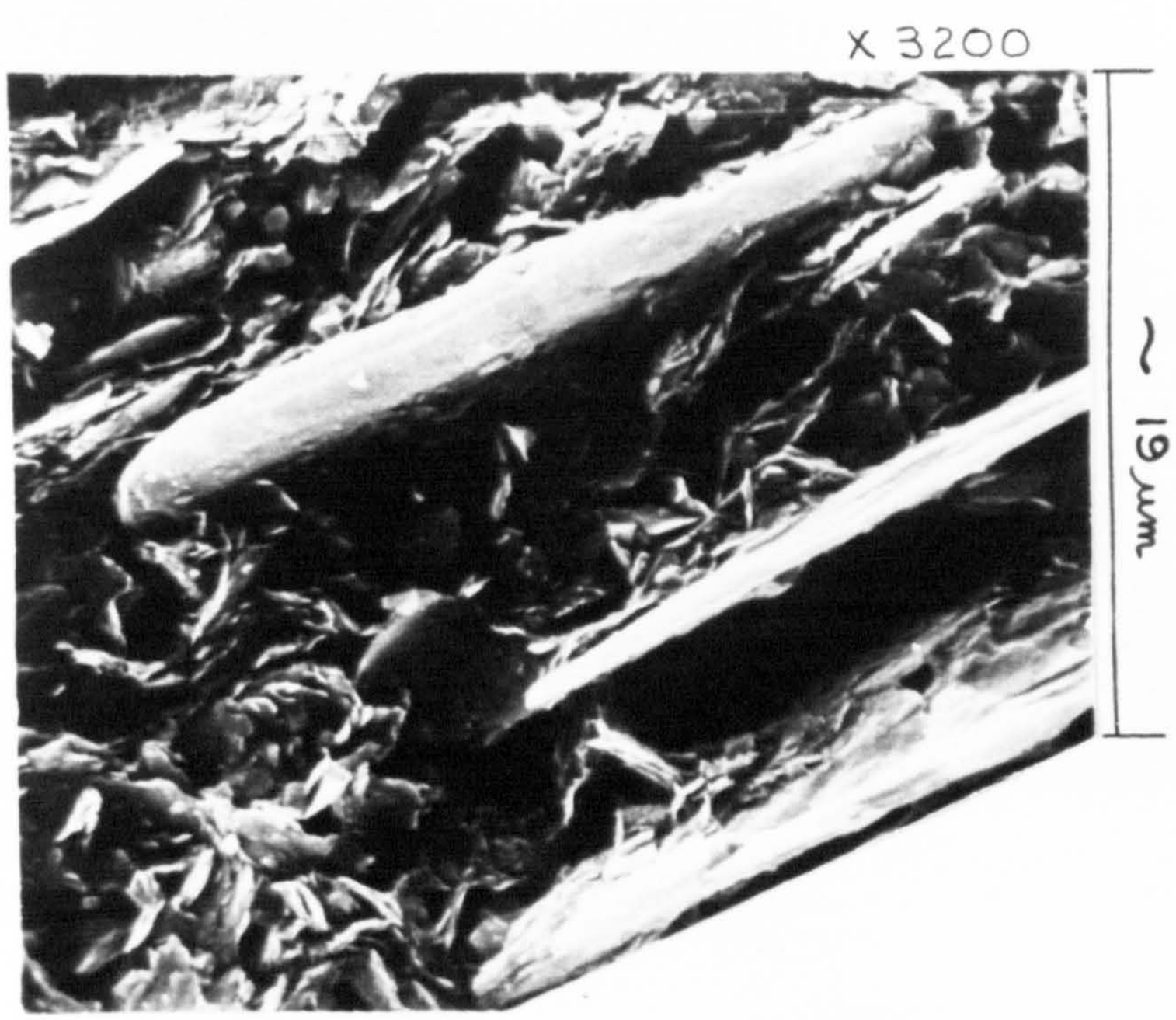


(h) Portion of the composite microfabric of the layered system x 70

MIC. 5.9. ESTUARINE SILTY CLAY - LAURESTON, SCOTLAND

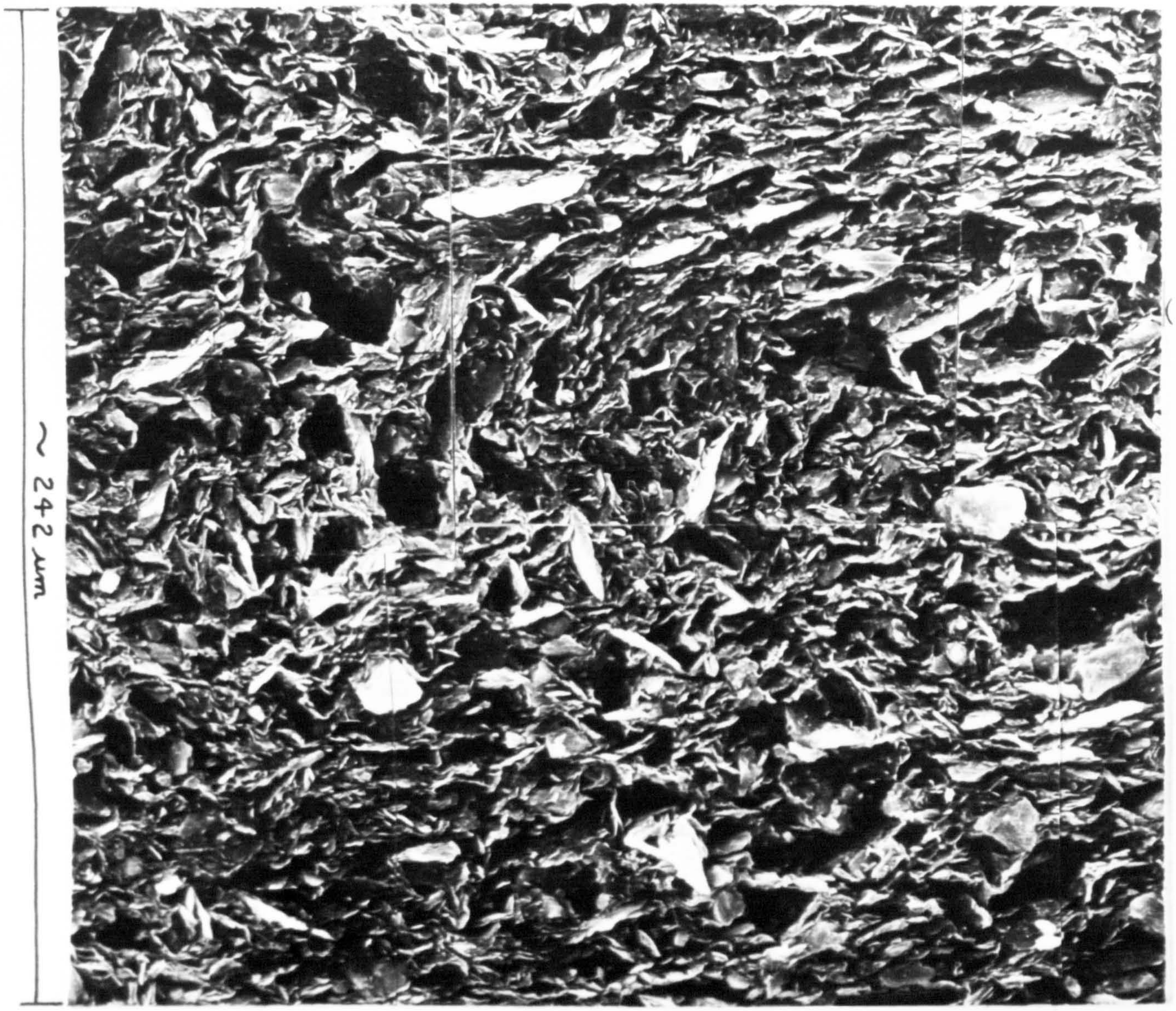


(a) Layer $\underline{\overline{1}}$ - Random Clay Arrangements



(b) Layer $\underline{\overline{1}}$ - Clay-Granular Matrix Region

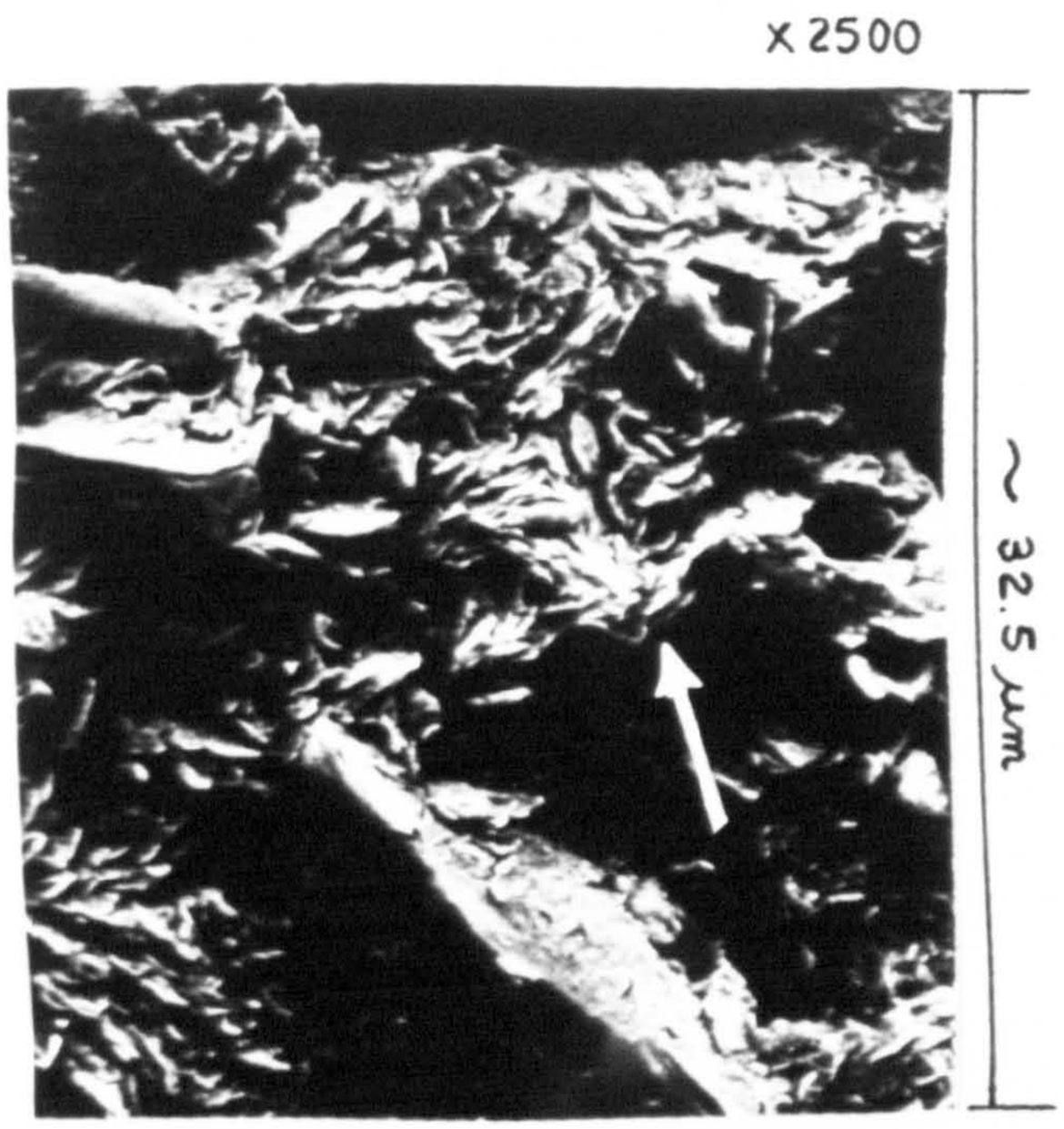
MIC. 5.10. ESTUARINE SILTY CLAY - RENFREW, SCOTLAND



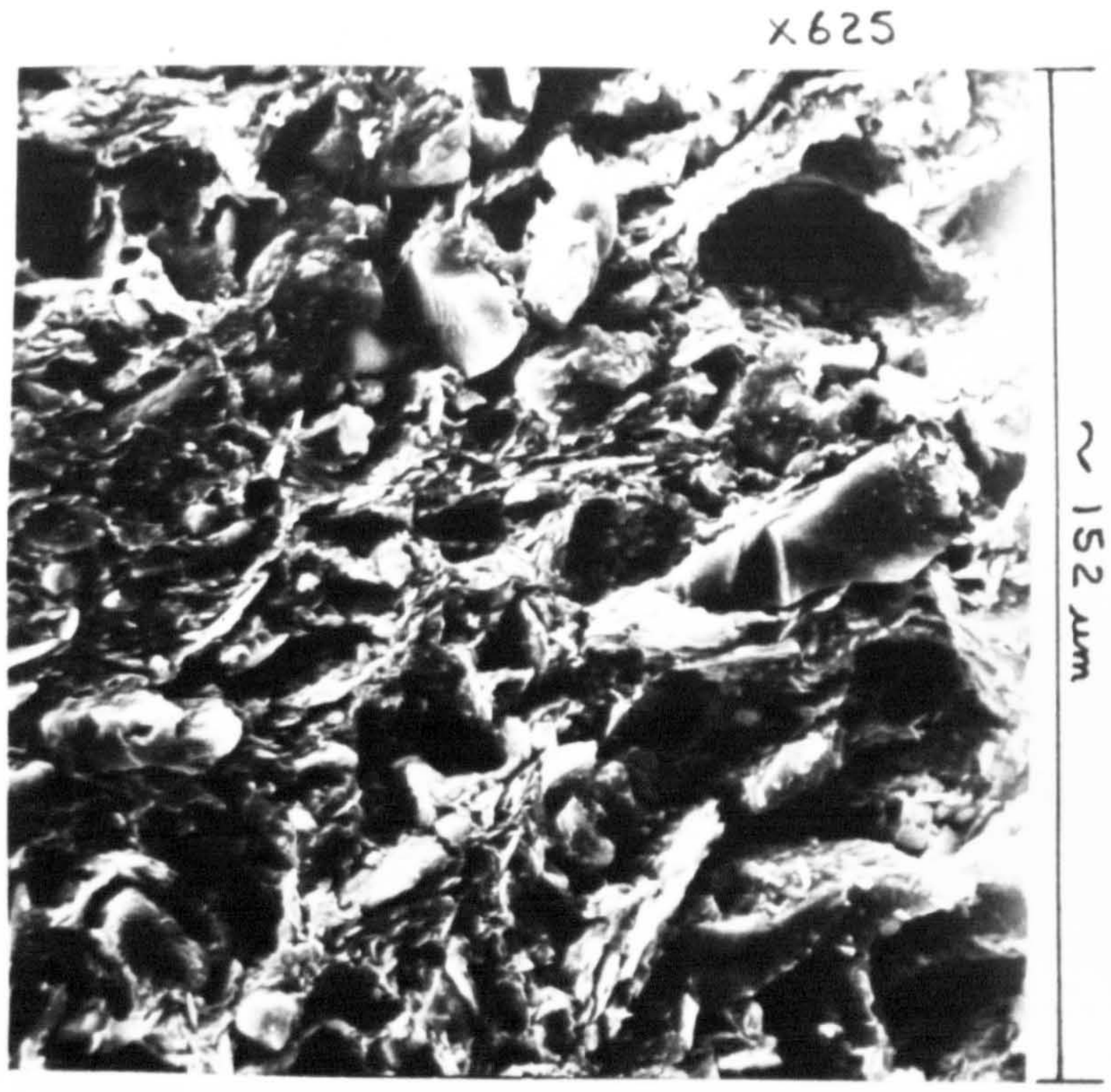
(c) Layer $\underline{1}$ - Detailed View of Region System

x 625

MIC. 5.10. ESTUARINE SILTY CLAY - RENFREW, SCOTLAND

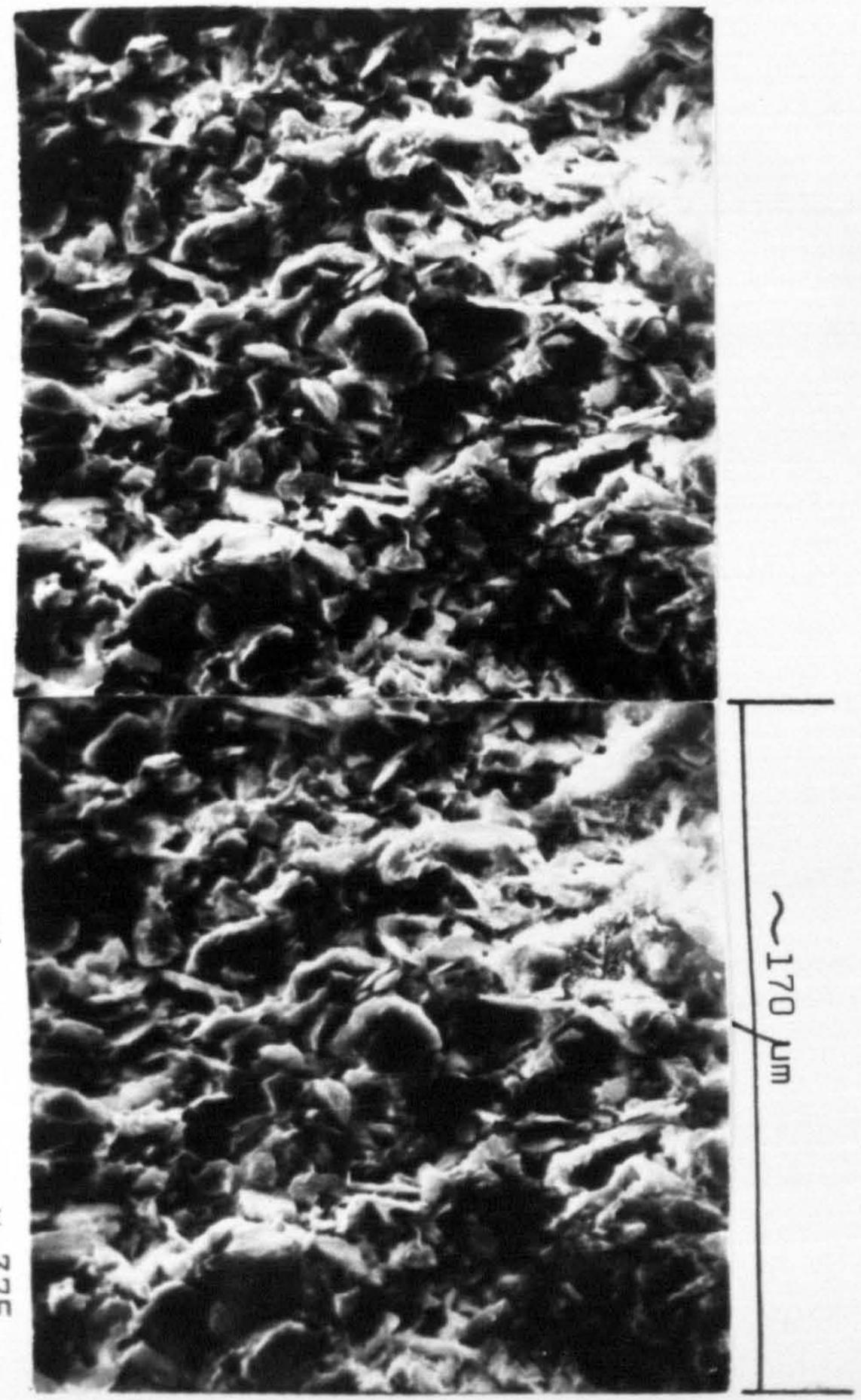


(e) Layer II - Irregular Aggregation



(d) Layer II - Clay-Granular Region

MIC. 5.10. ESTUARINE SILTY CLAY - RENFREW, SCOTLAND



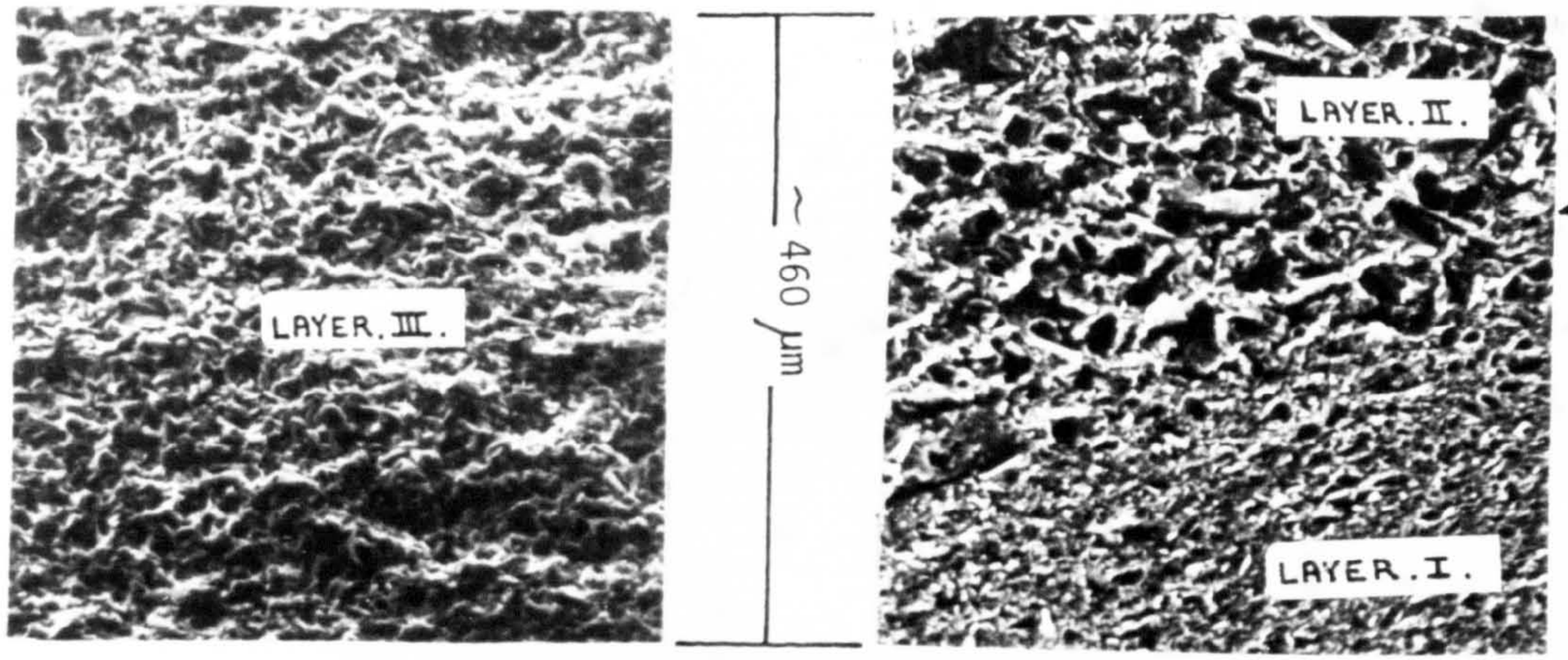
(g) LAYER III - Detailed view of composite microfabric

× 375

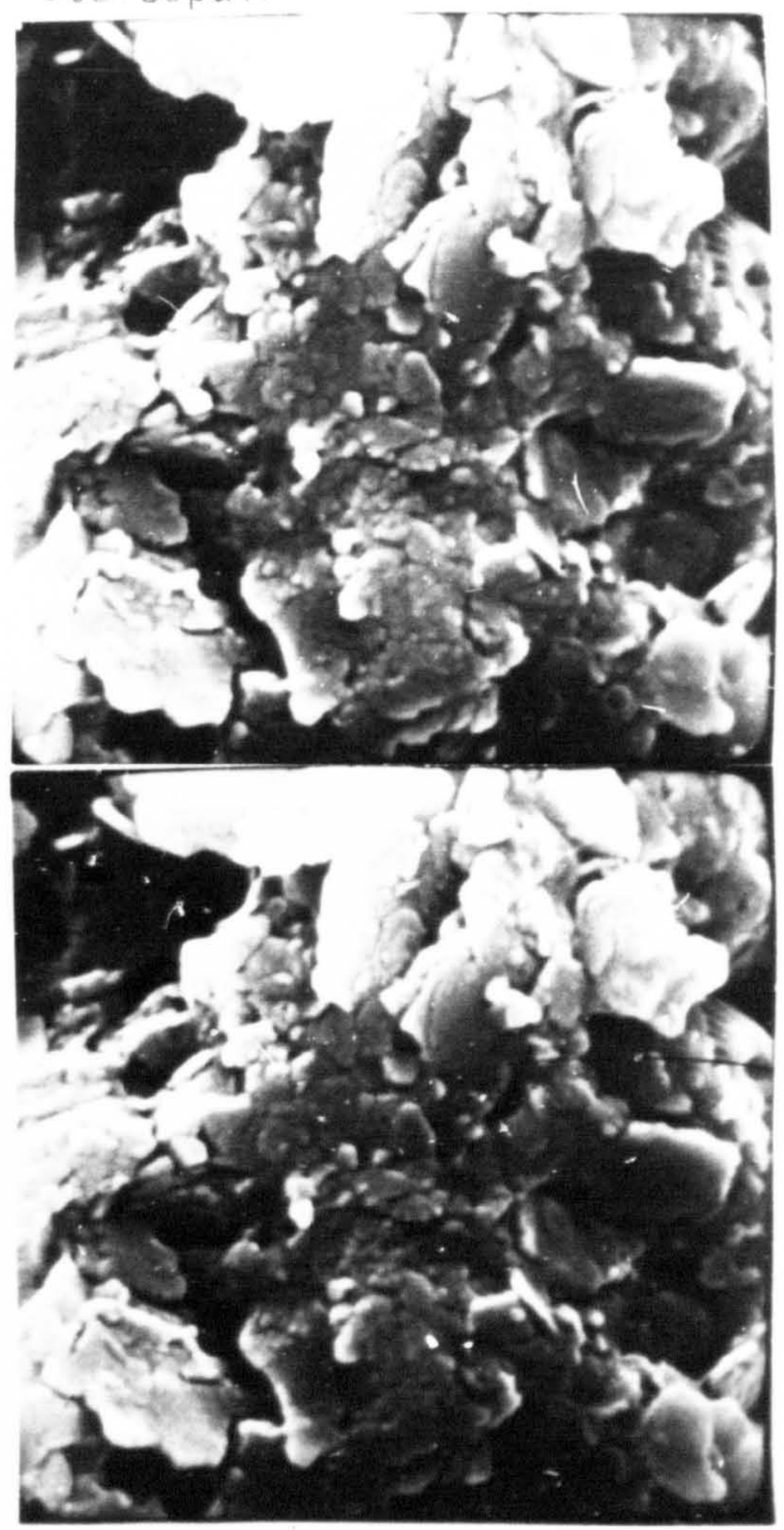
(f) LAYER III - Connector system

× 1550

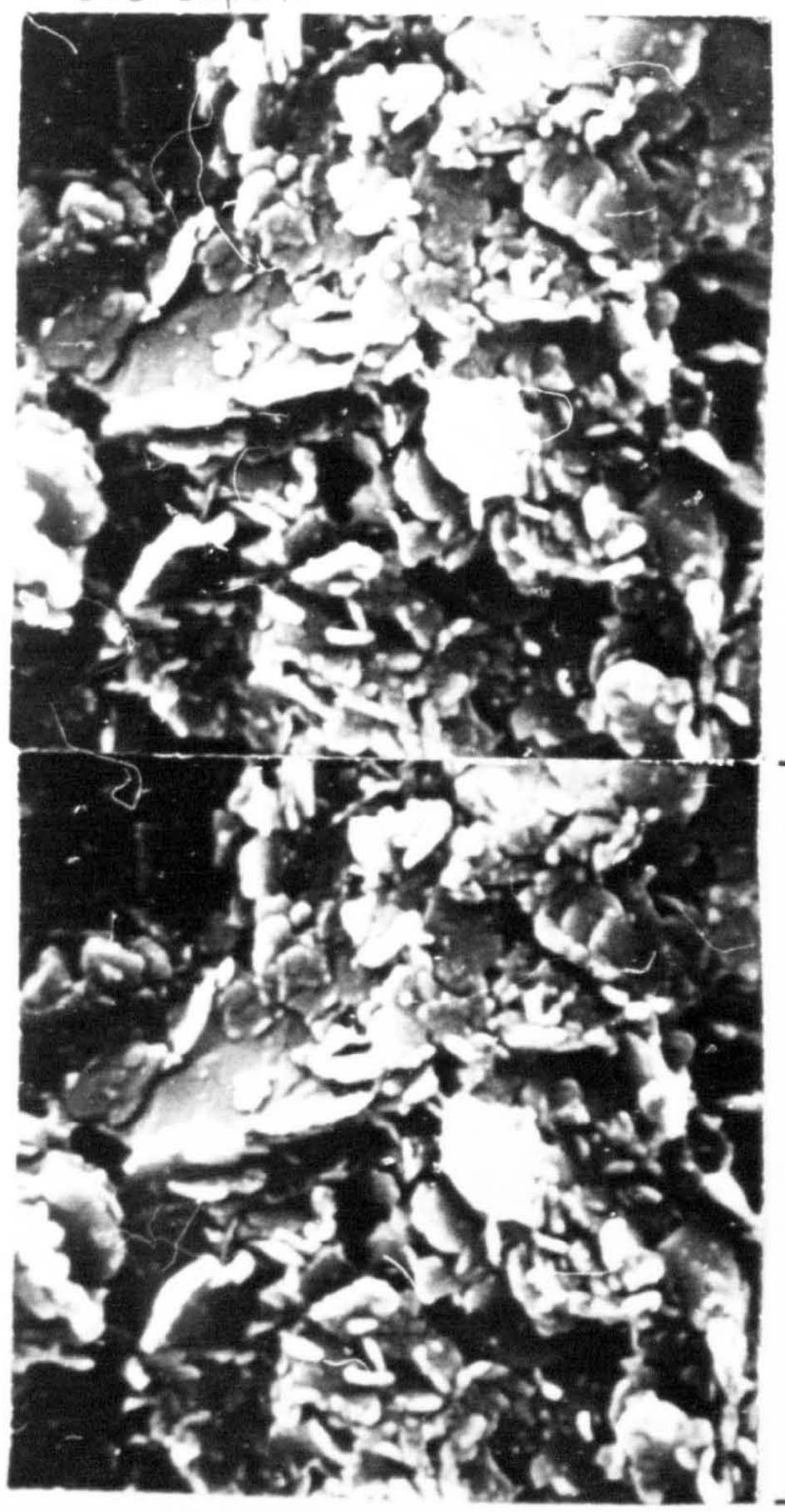
MIC. 5.10. ESTUARINE SILTY CLAY - RENFREW, SCOTLAND



MIC. 5.10. ESTUARINE SILTY CLAY - RENFREW, SCOTLAND.



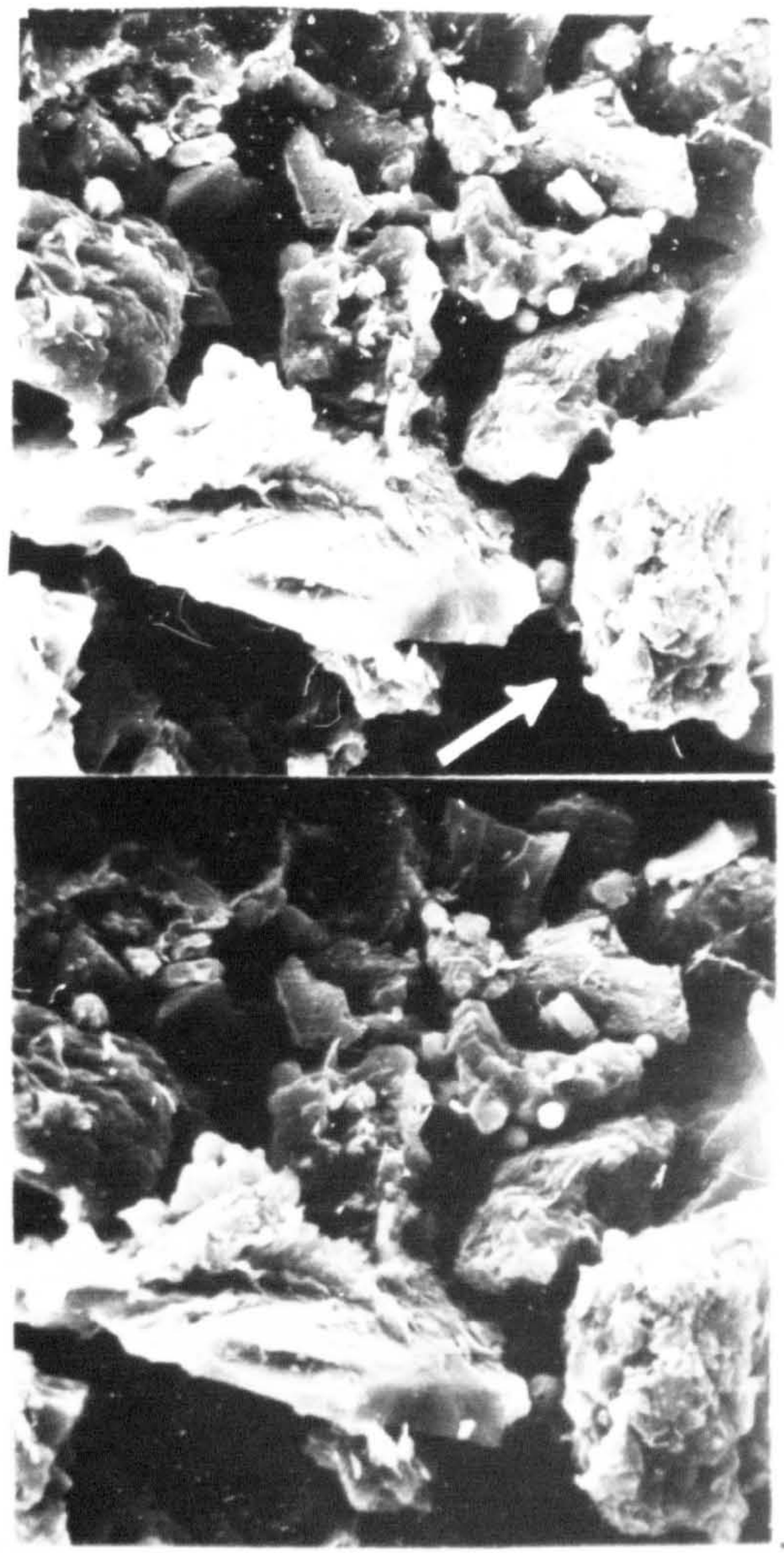
(a) Partly discernible clay arrangements.



(b) Random clay arrangements.

MIC. 5.11. ESTUARINE SANDY SILT - SHANNON (A), EIRE

stereopair

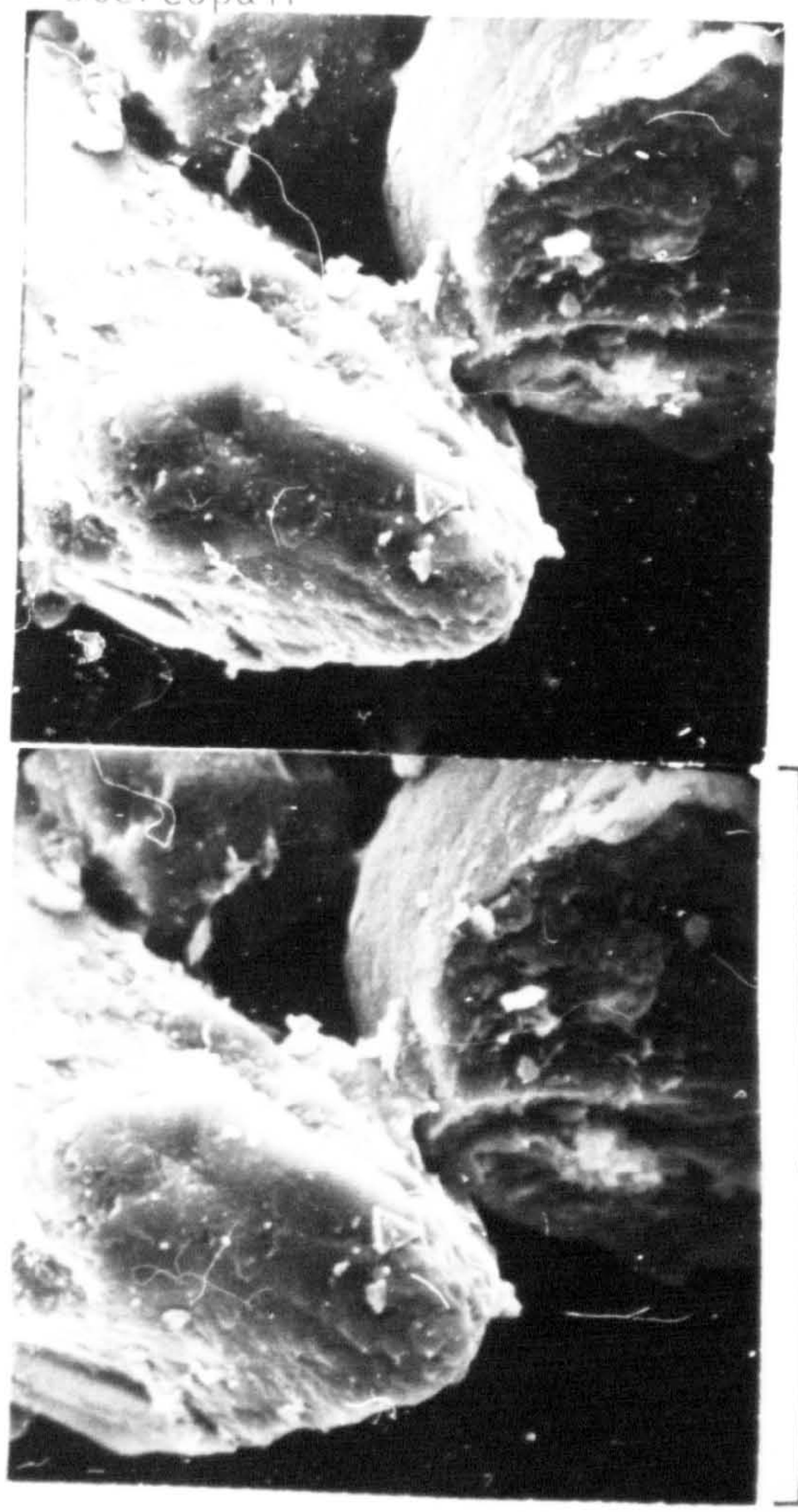


~ 84 μm

x 770

(c) Regular aggregations.

stereopair

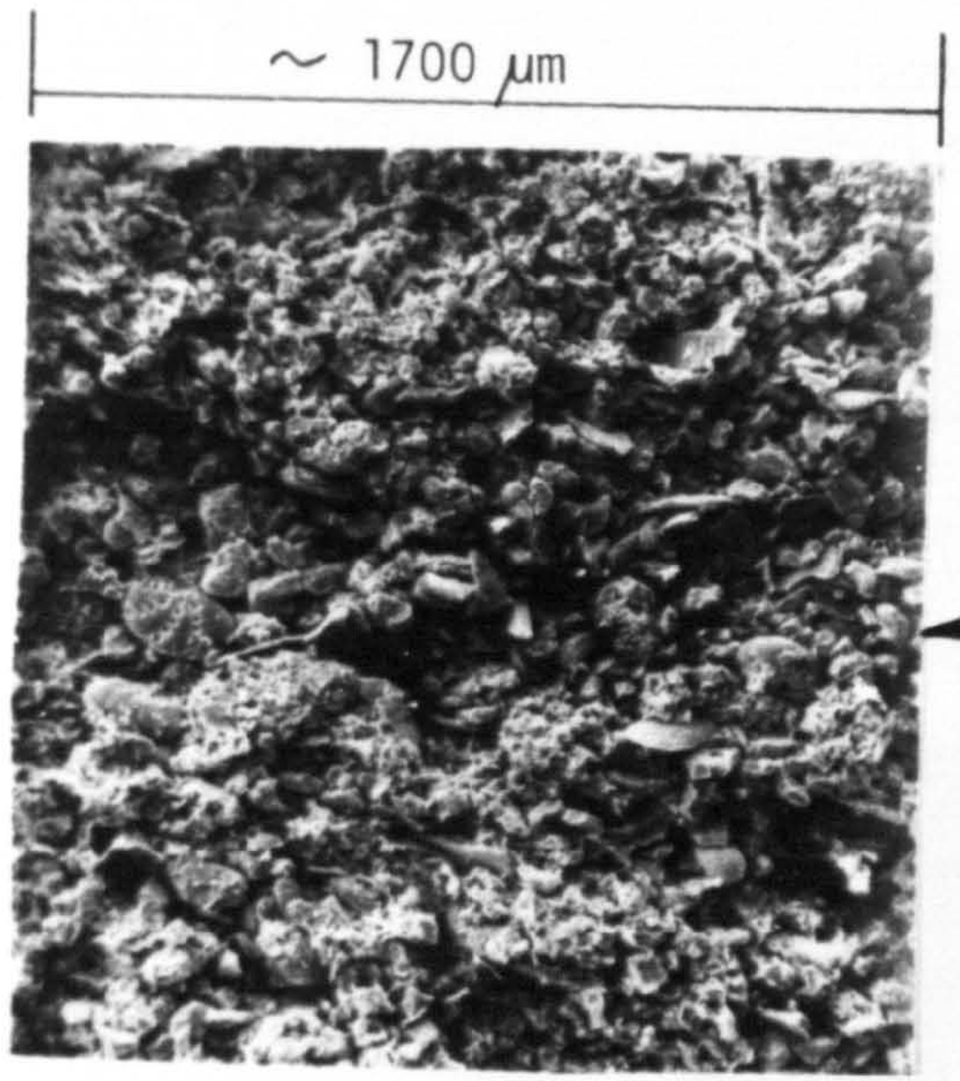


~ 81 μm

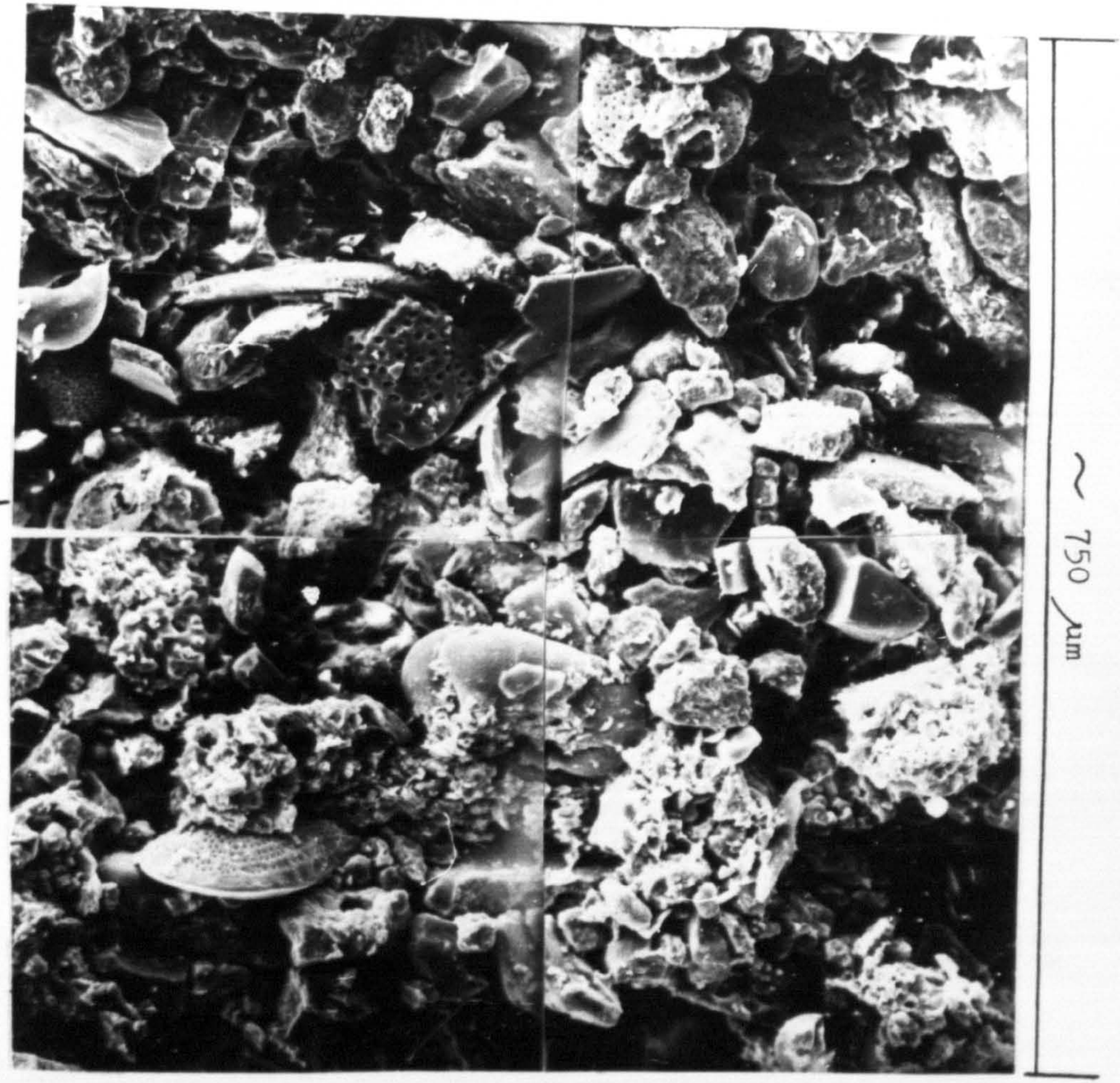
x 780

(d) Buttress connector.

MIC. 5.11. ESTUARINE SANDY SILT - SHANNON (A), EIRE

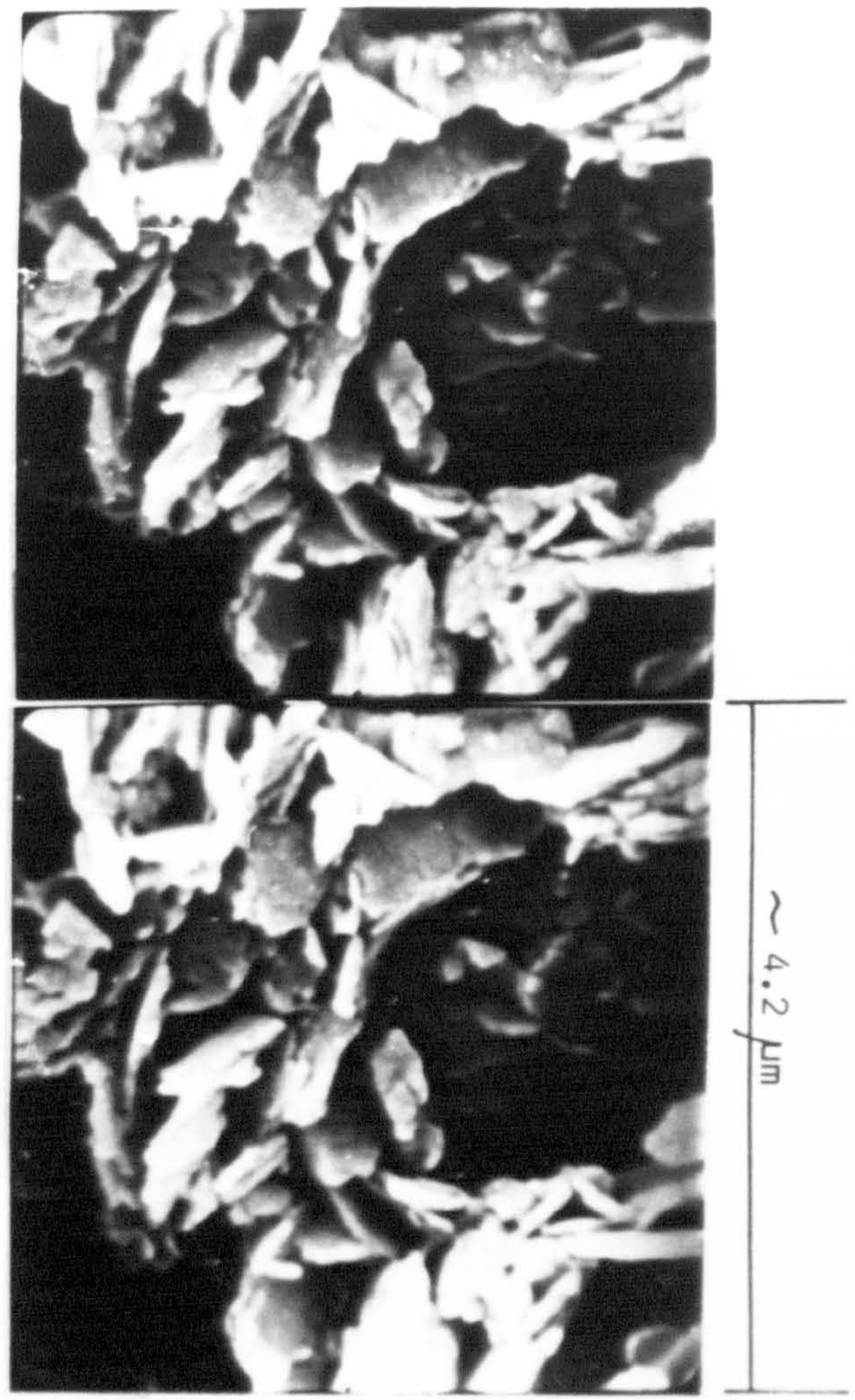


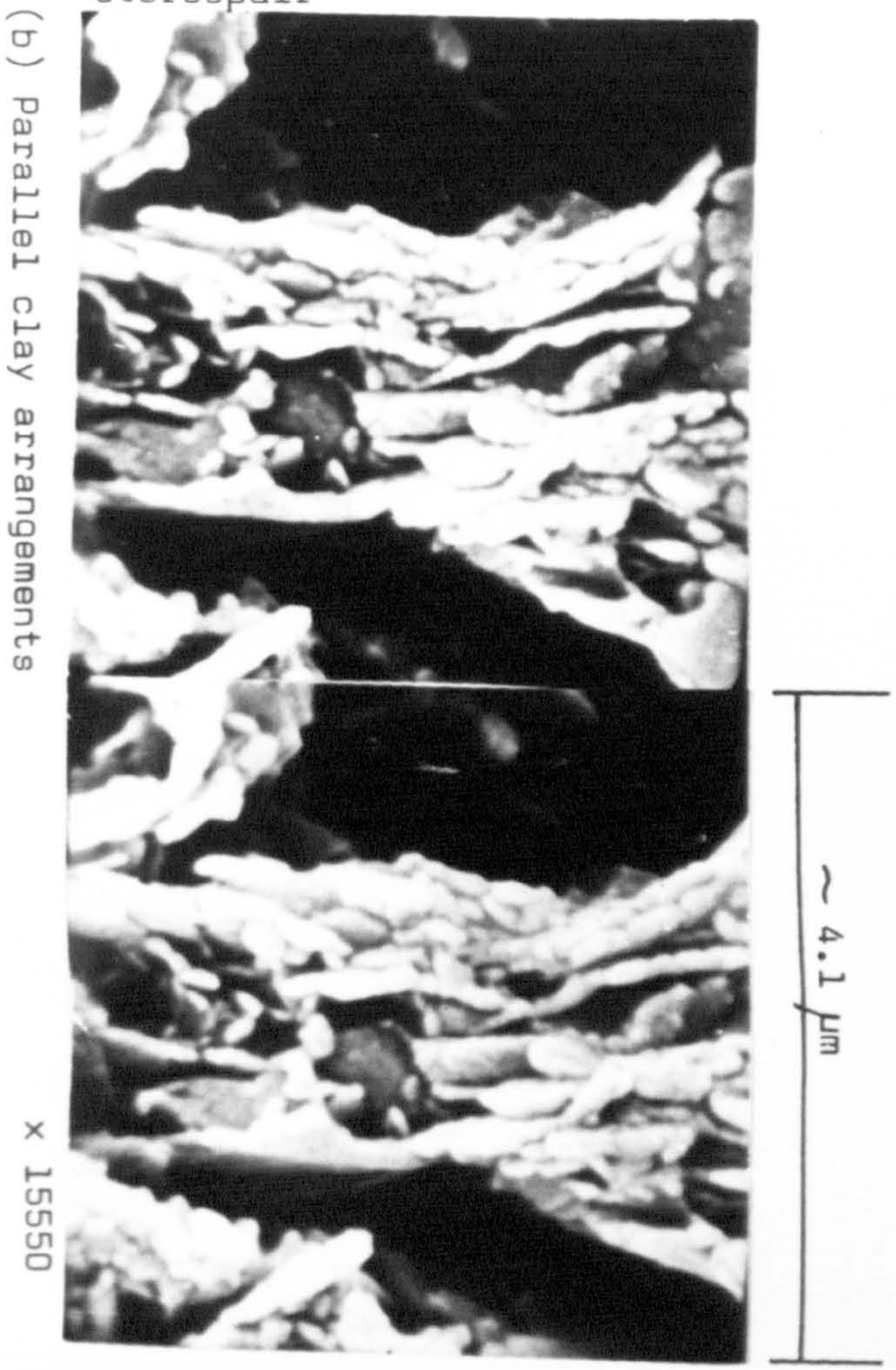
(f) General view of composite microfabric x 38



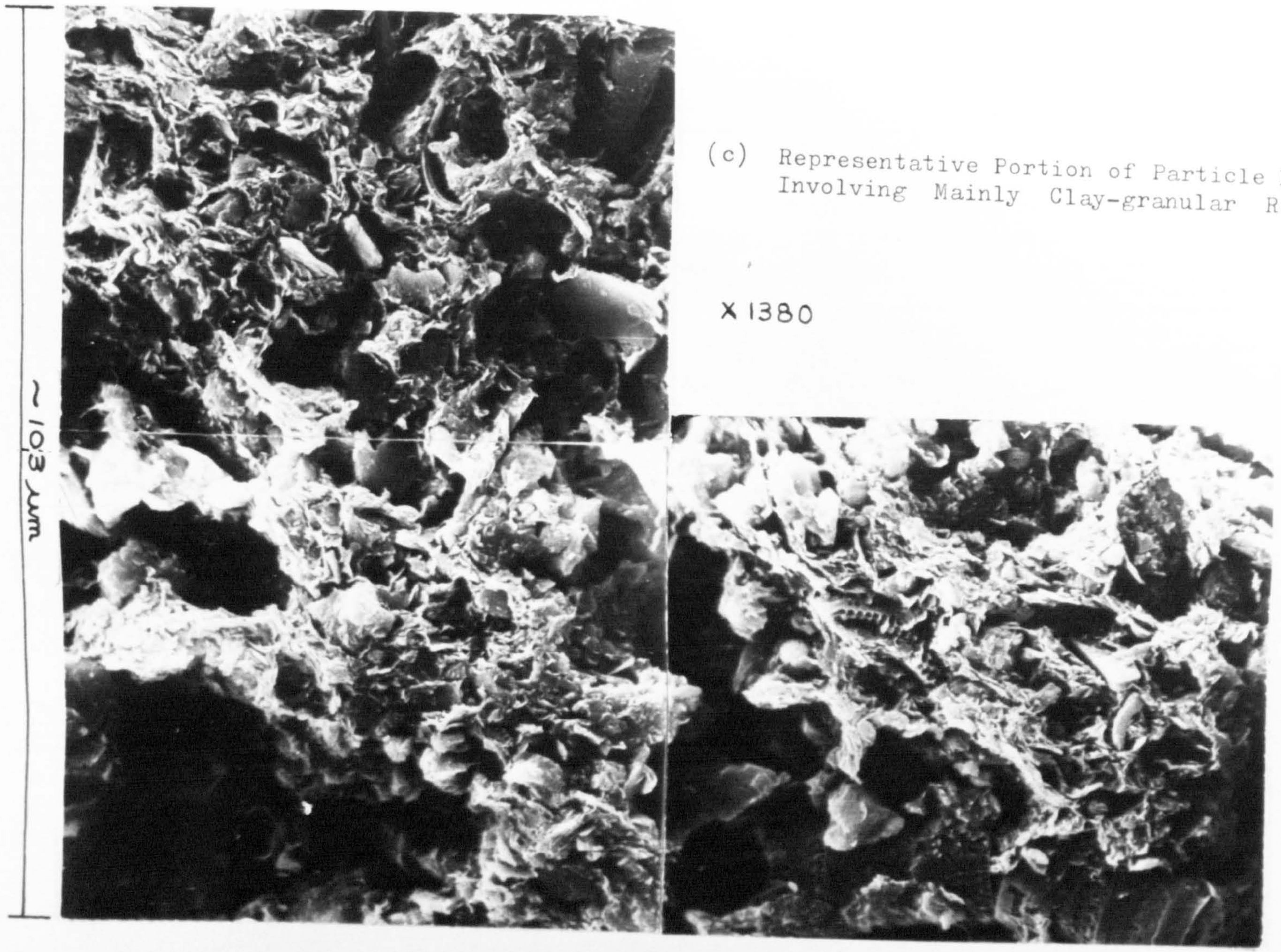
(e) Detailed view of composite microfabric x 160

MIC. 5.11. ESTUARINE SANDY SILT - SHANNON (A), EIRE





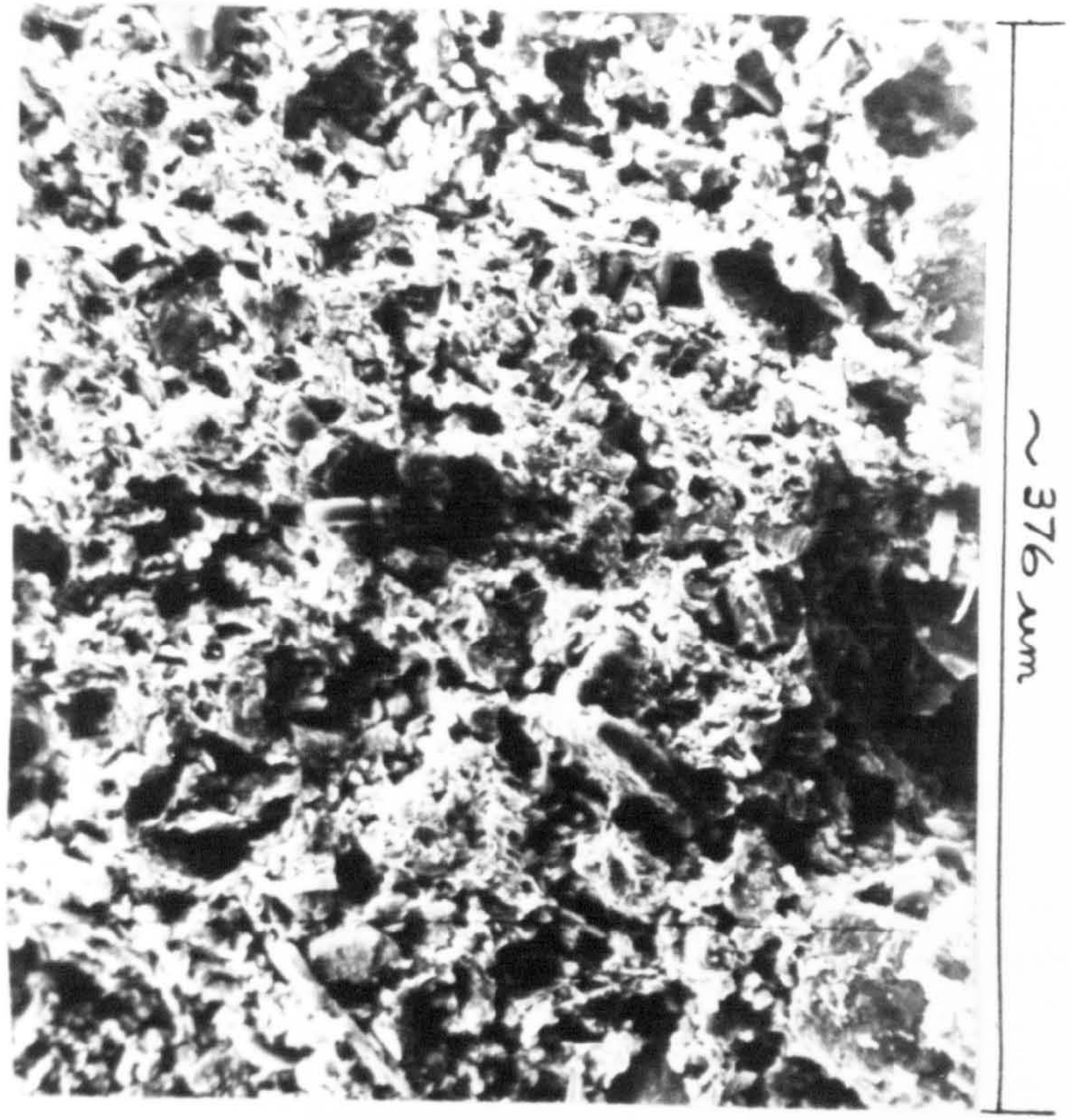
MIC. 5.12. ESTUARINE SILTY CLAY - SHANNON (B), EIRE



(c) Representative Portion of Particle Matrix Involving Mainly Clay-granular Regions

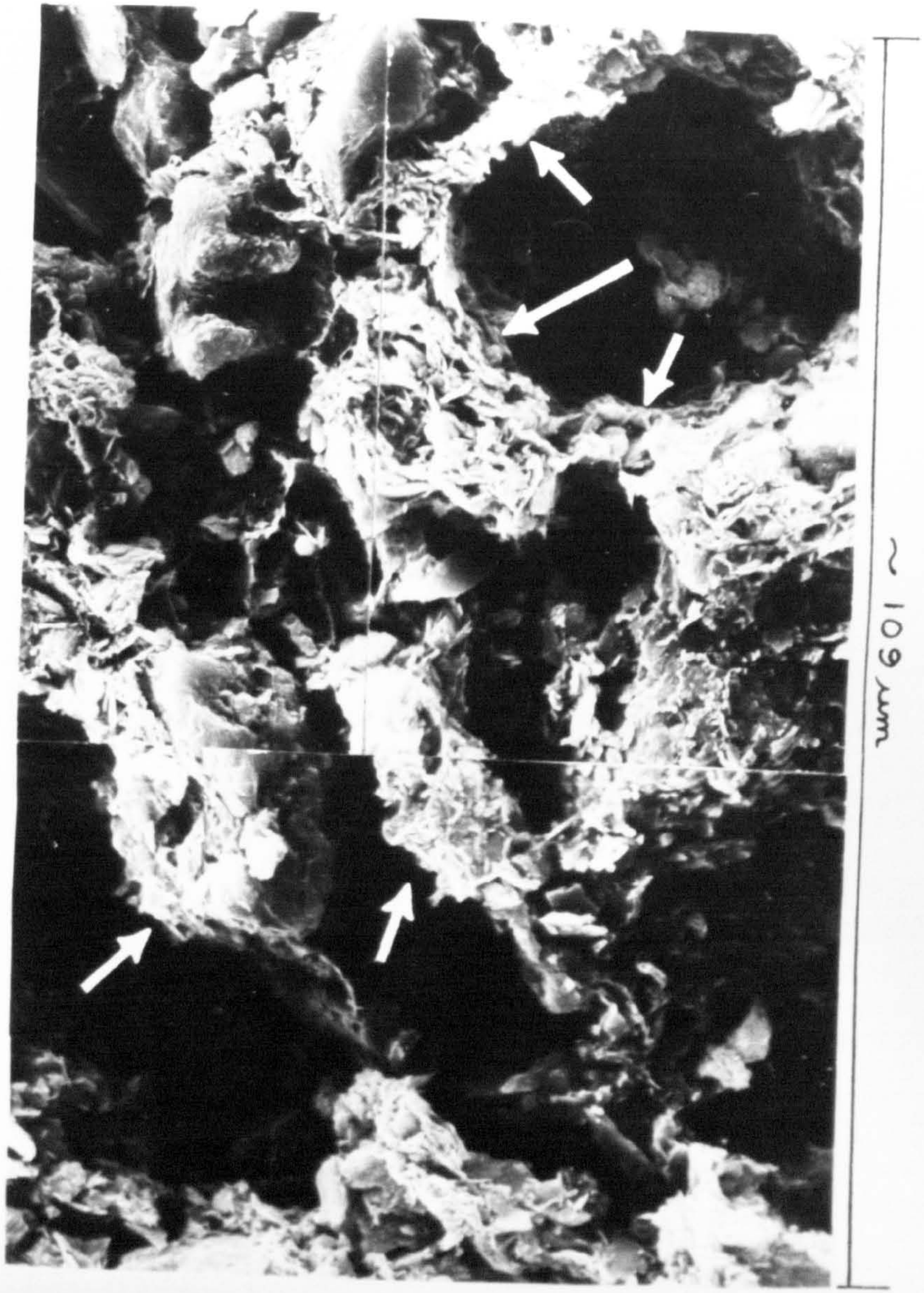
X 1380

MIC. 5.12. ESTUARINE SANDY SILT - SHANNON (B), EIRE



X 270

(e) Composite Microfabric

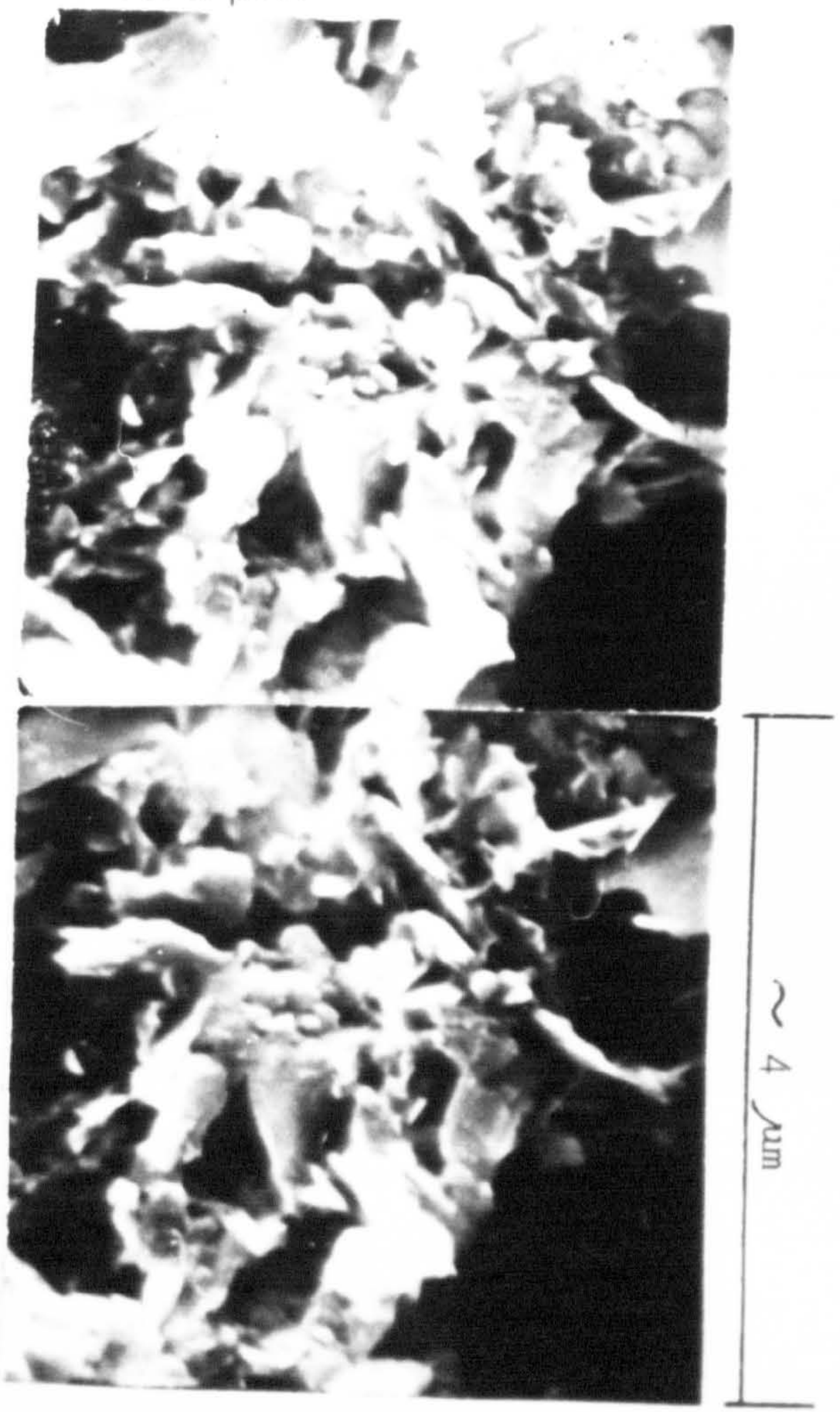


X 1380

(d) Connector-aggregate System

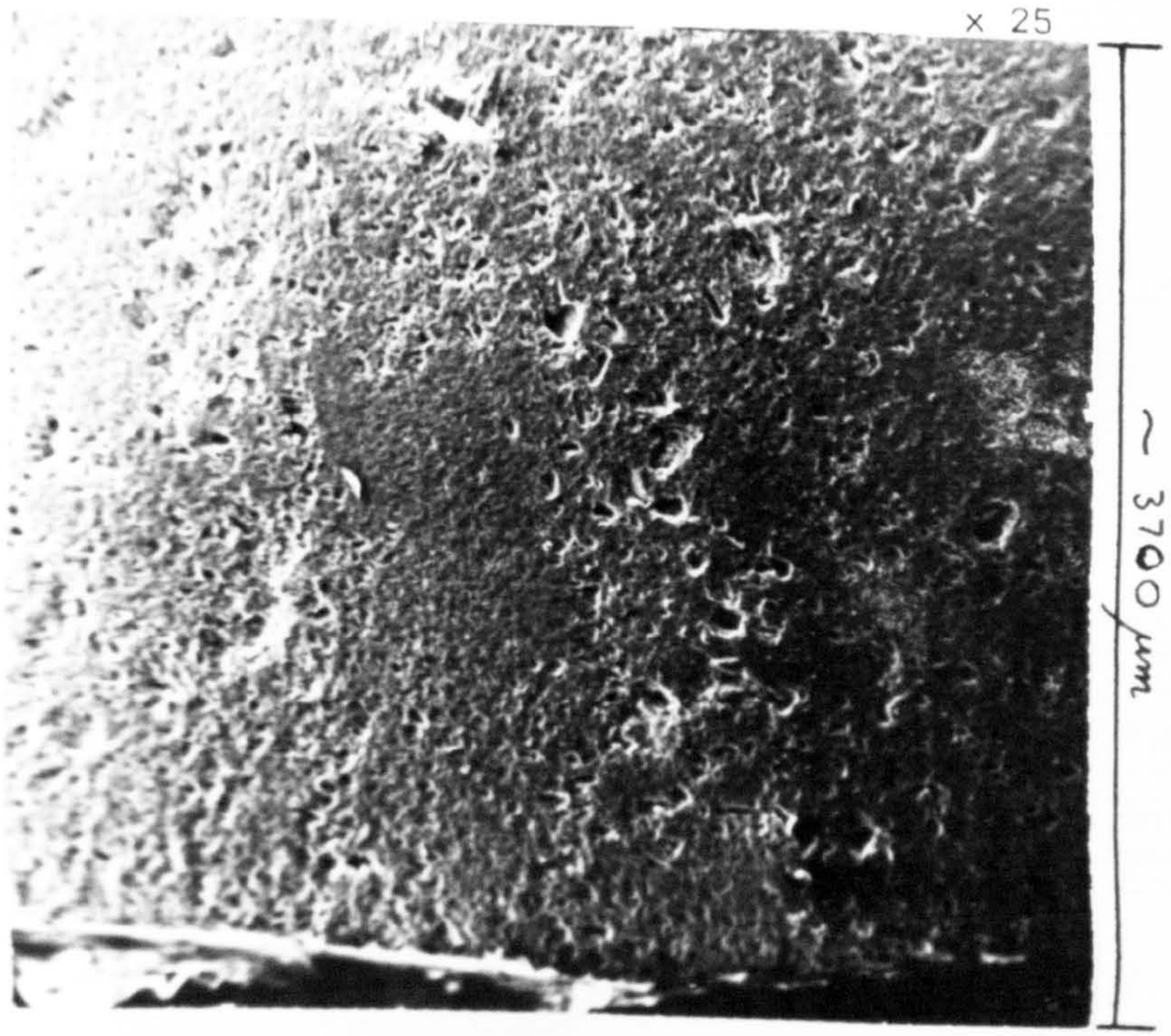
MIC. 5.12. ESTUARINE SILTY CLAY - SHANNON (B), EIRE

(b) General view of random clay arrangements

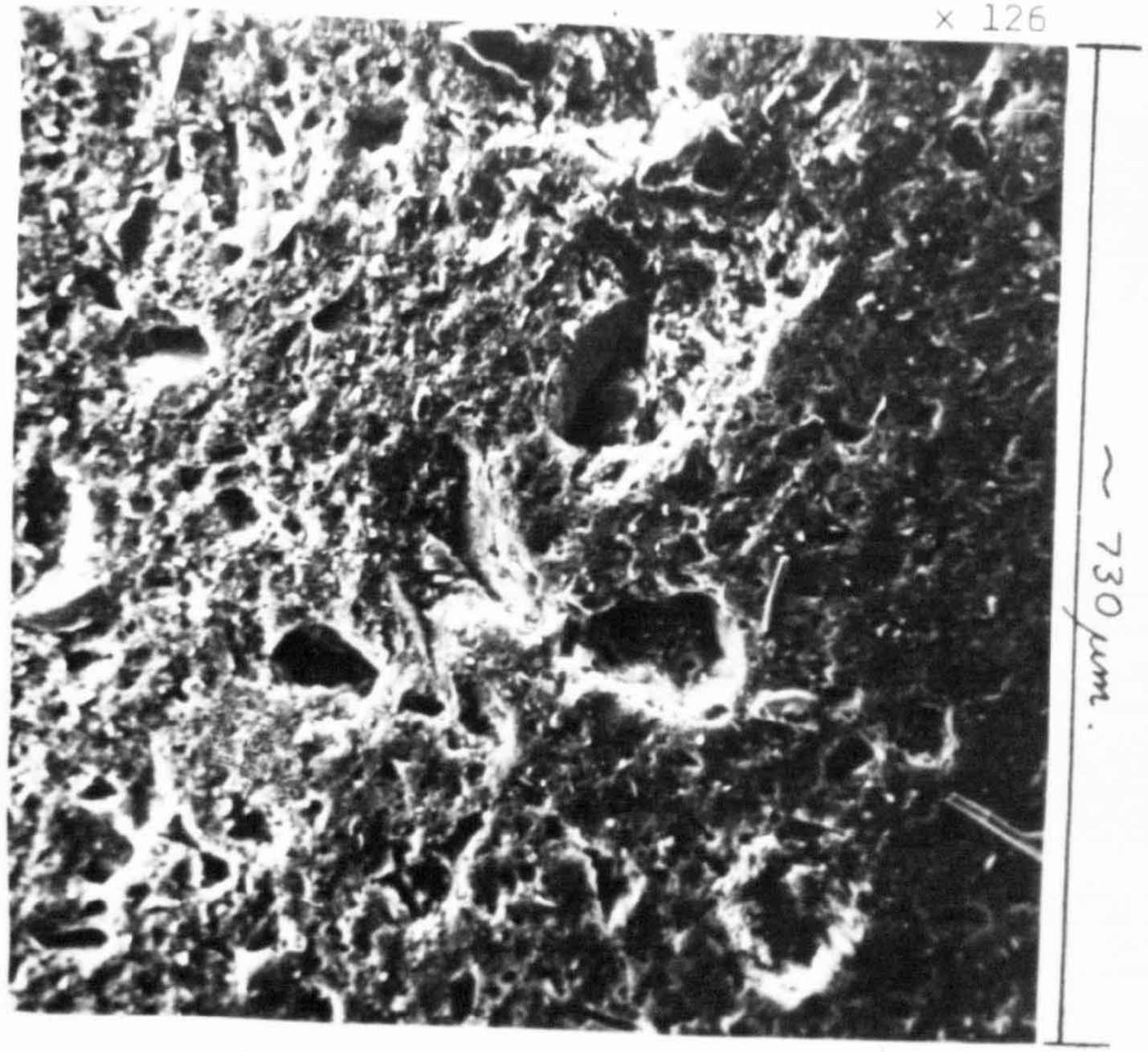


(a) Detailed view of random clay arrangements

MIC. 5.13. ESTUARINE SILTY CLAY - SAINT ALBAN, CANADA

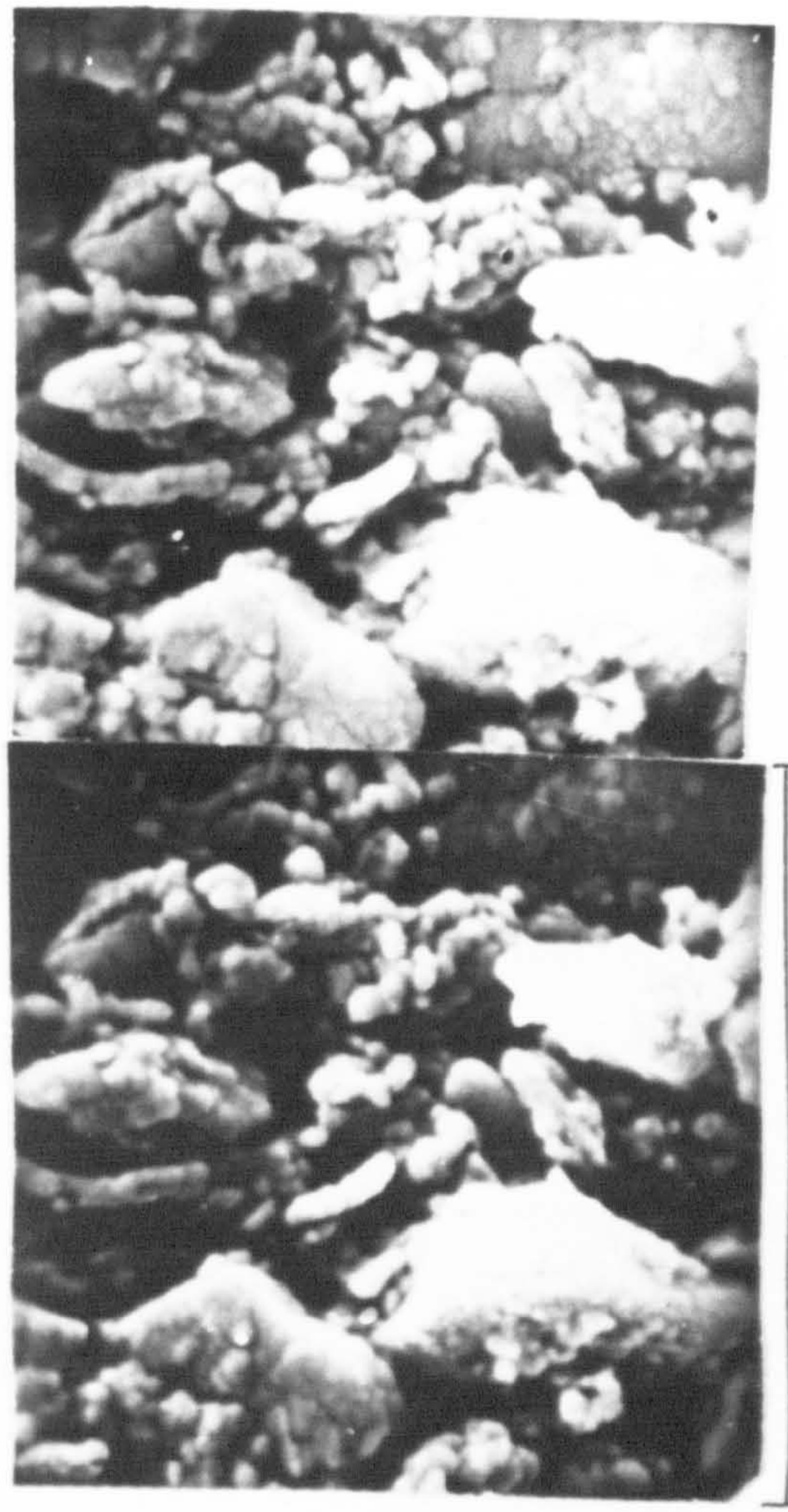


(d) Composite Microfabric



(c) Non-uniform Distribution of Grain Sizes within the clay-granular region system.

MIC. 5.13. ESTUARINE SILTY CLAY - SAINT ALBAN, CANADA



stereopair

(b) General view of random clay arrangements.

x 15600

~ 4 µm

stereopair

(a) Clay clusters.

x 47000

~ 1.45 µm

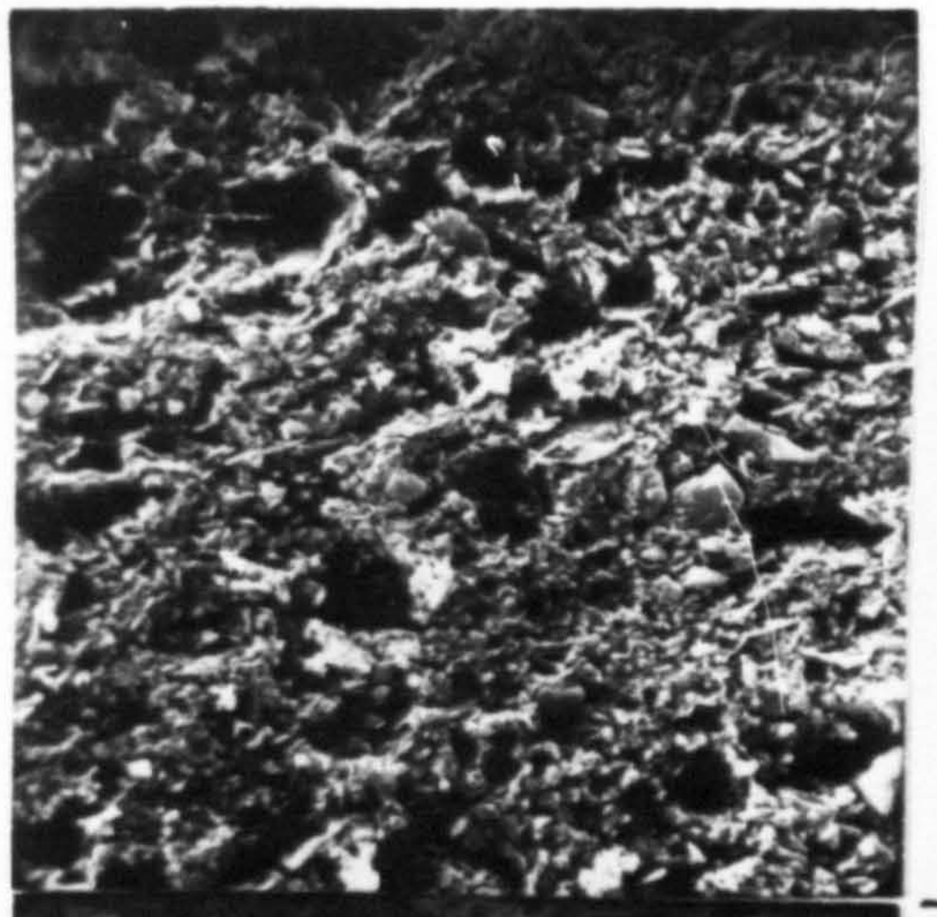
MIC. 5.14. ESTUARINE CLAY - SAINT JIAN VIANNEY, CANADA

stereopair

(c) Detailed view of particle matrix.

x 3900

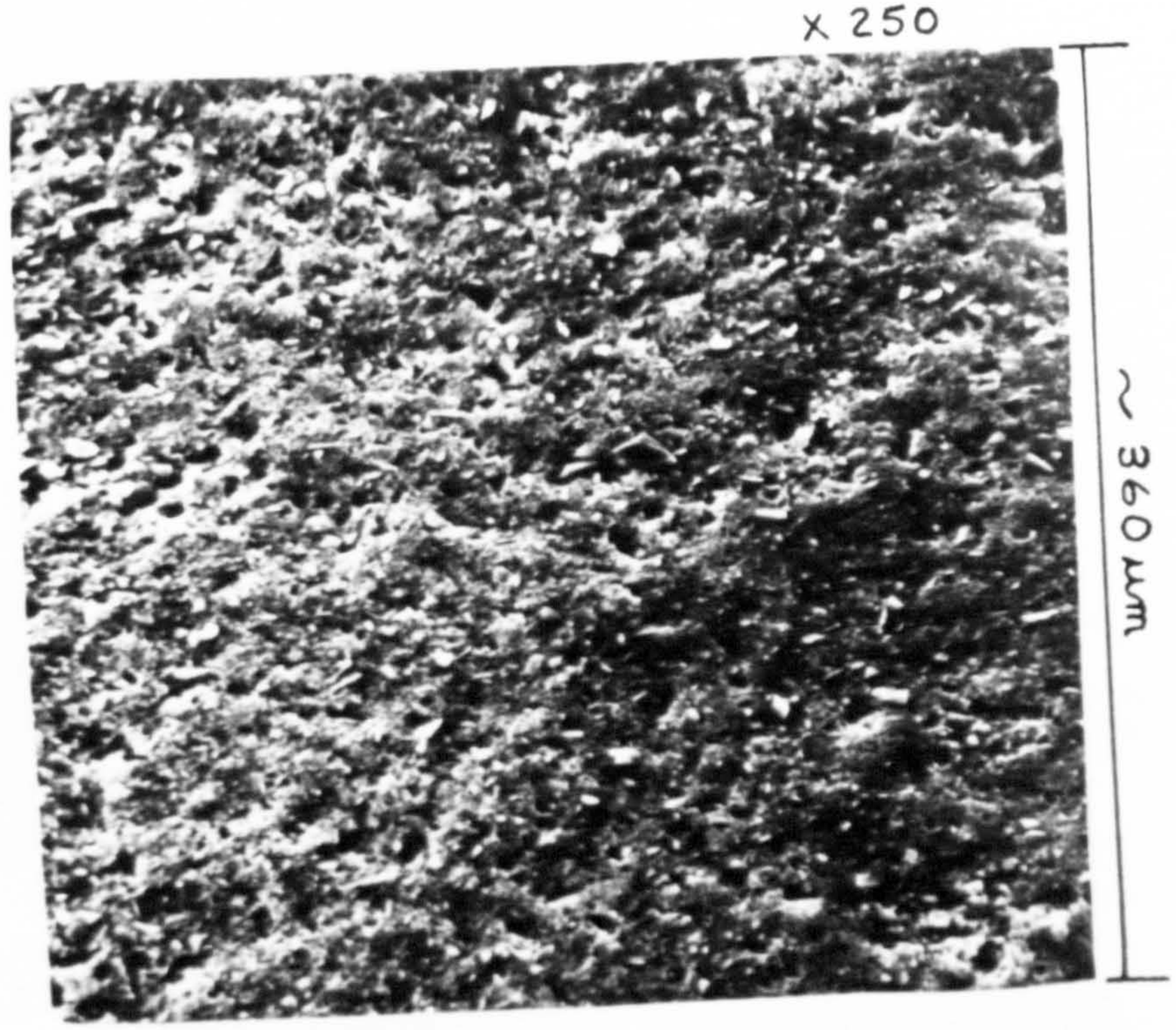
stereopair



(d) General view of particle matrix.

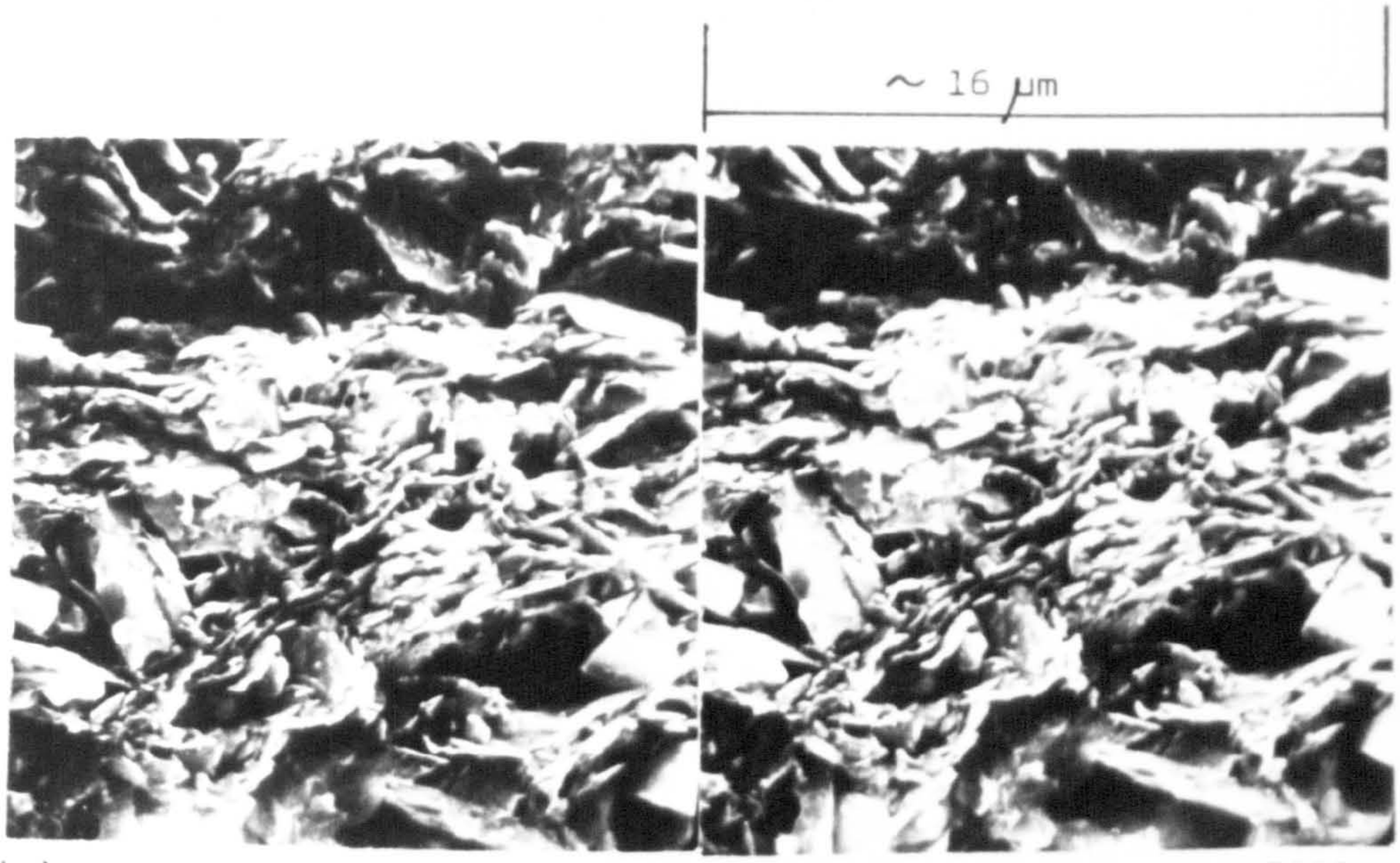
x 1600

MIC. 5.14. ESTUARINE CLAY - SAINT JIAN VIANNEY, CANADA



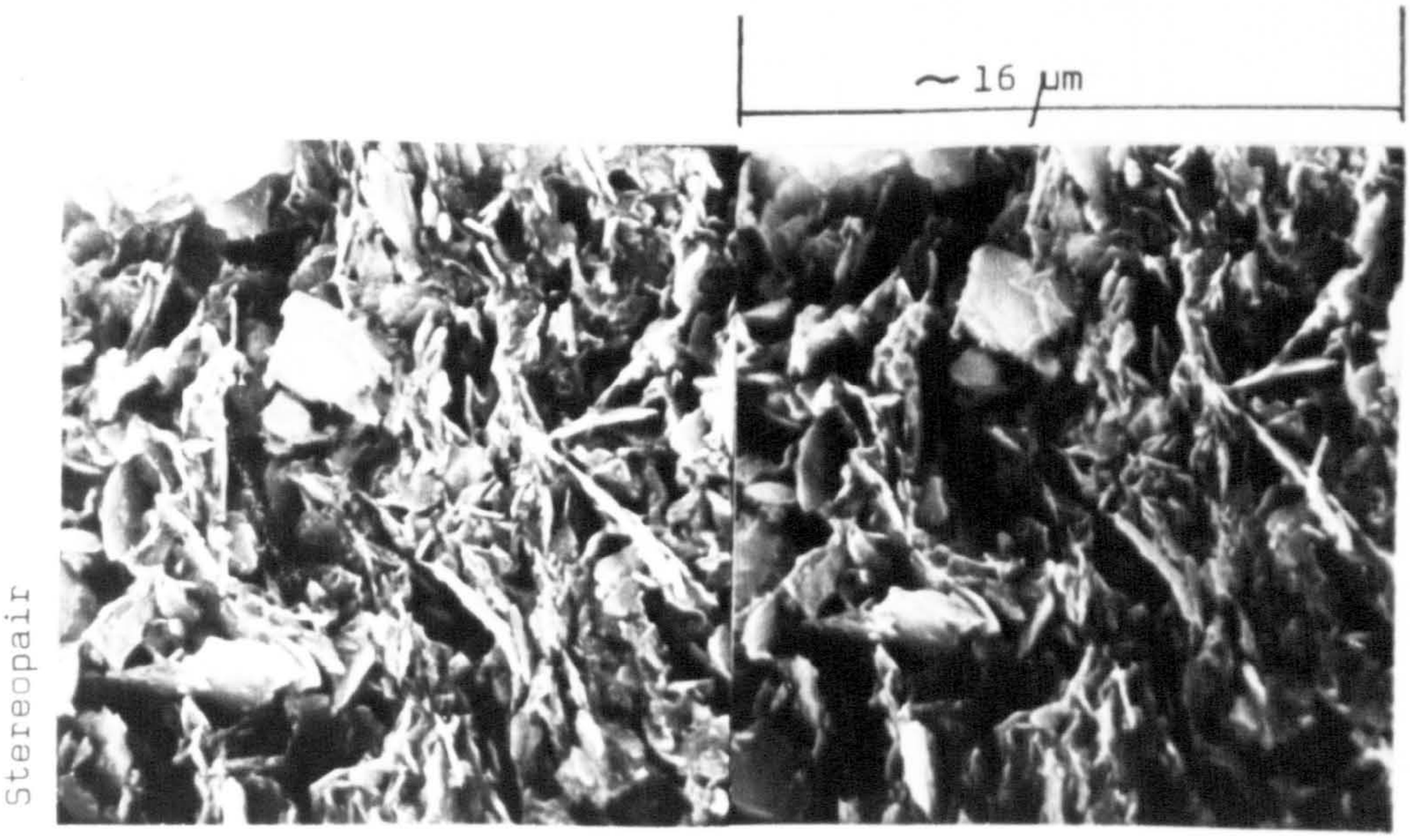
(e) Composite Microfabric

MIC. 5.14. ESTUARINE CLAY - SAINT JIAN VIANNEY, CANADA



(a) Predominantly parallel clay array within a clay-granular region

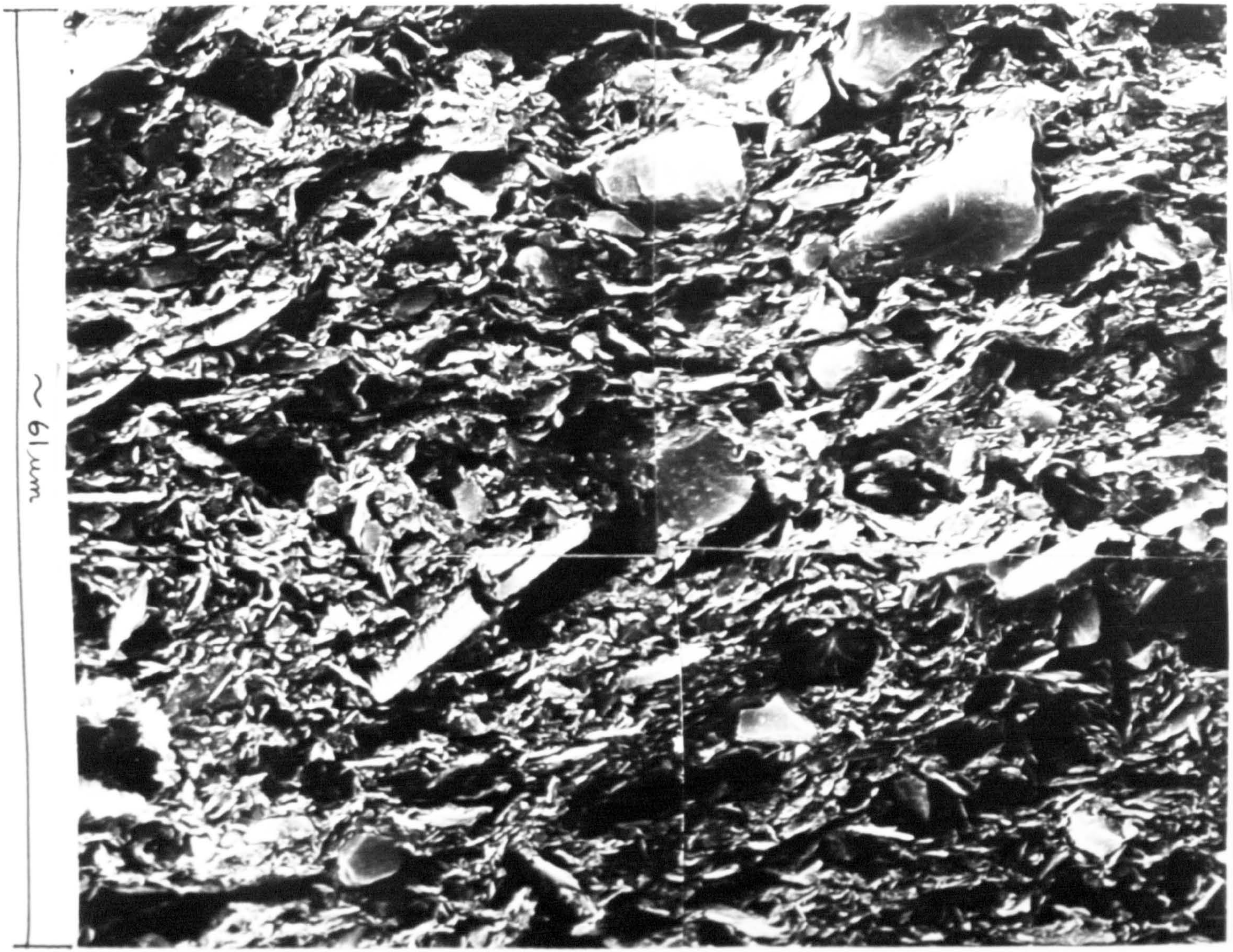
x 3900



(b) Predominantly random clay array within clay-granular region

x 3900

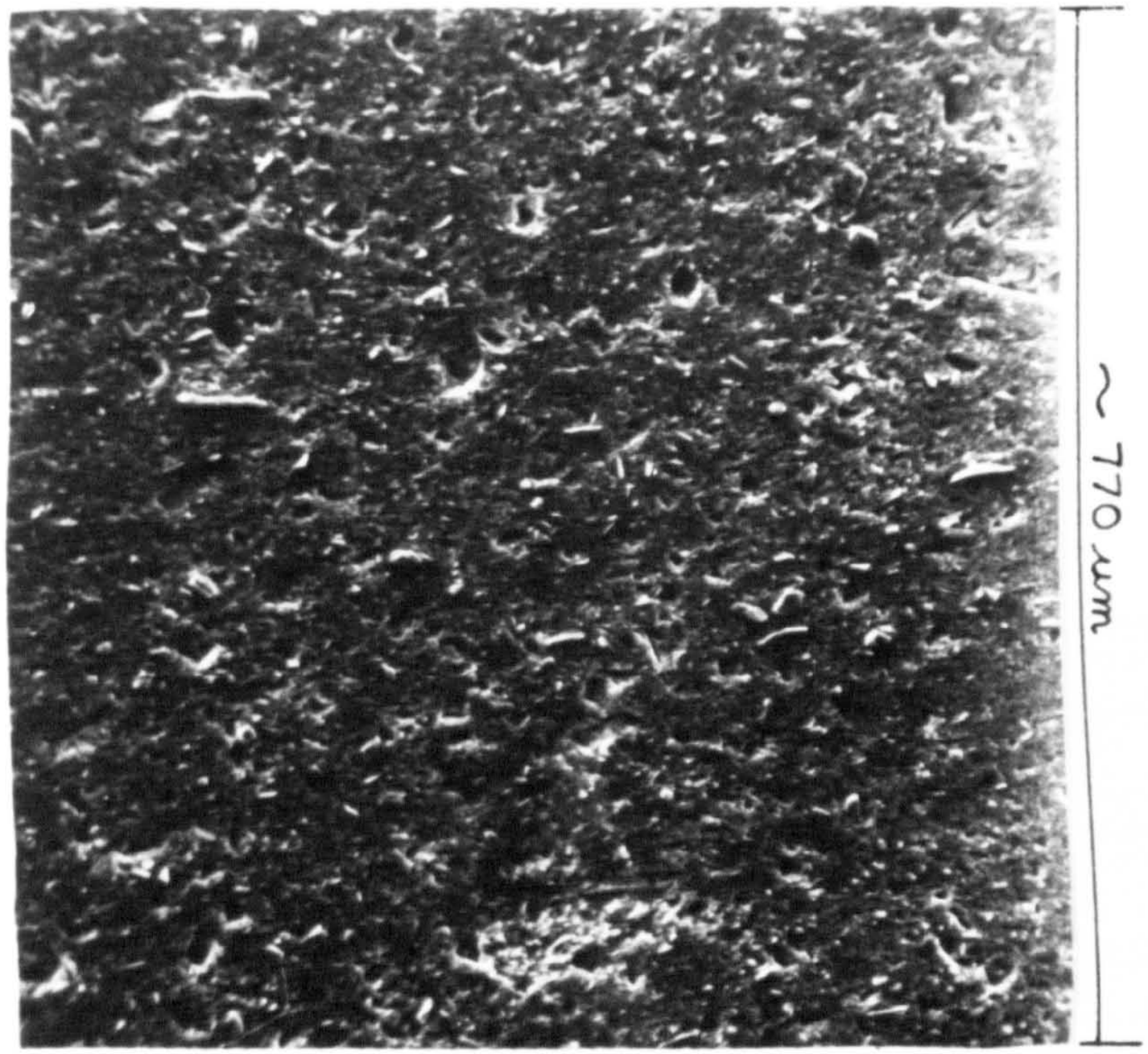
MIC. 5.15. ESTUARINE BLUE CLAY - BOSTON, U.S.A.



(c) Detailed view of Particle Matrix

X 2600

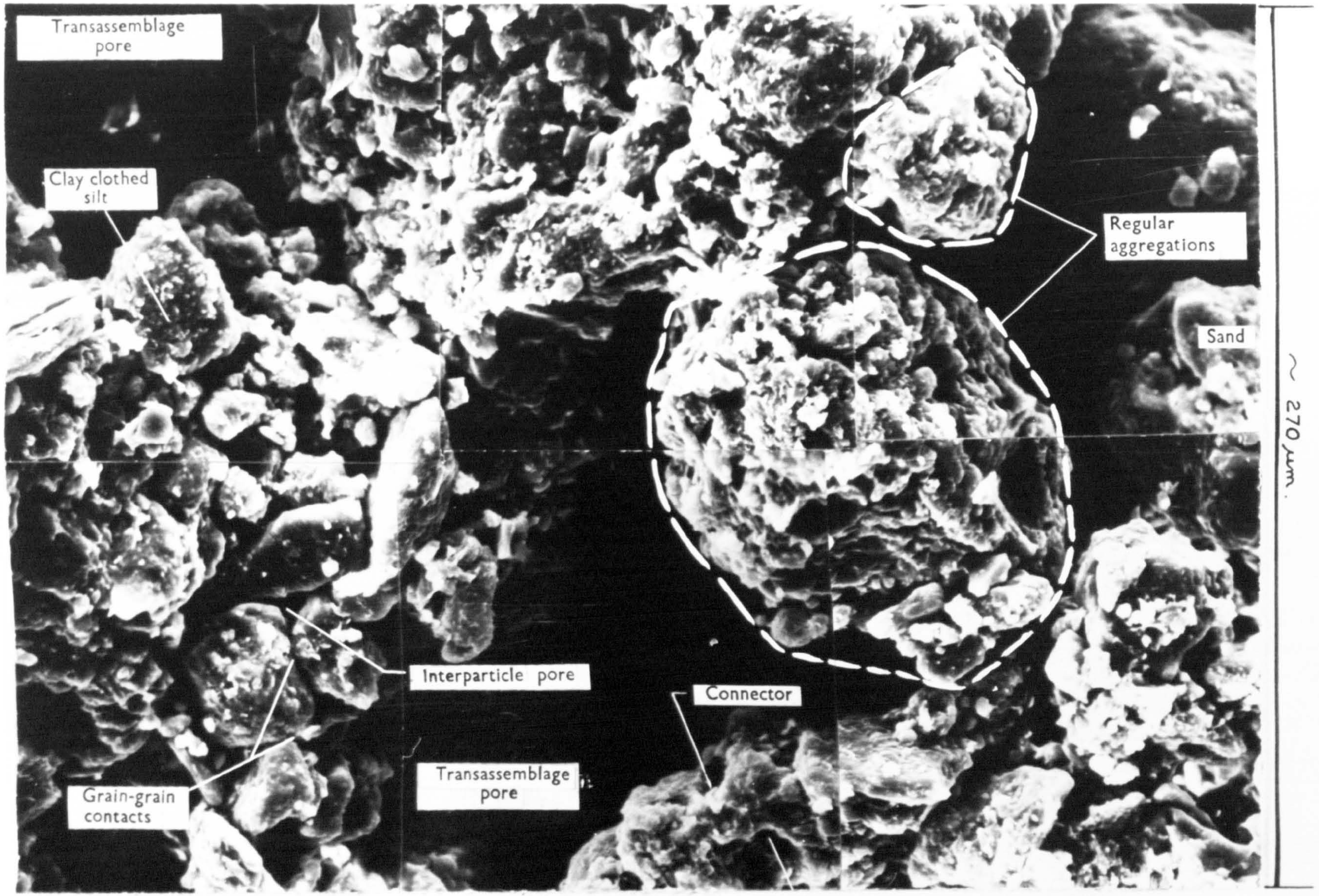
MIC. 5.15. ESTUARINE BLUE CLAY - BOSTON, U.S.A.



(e) General view of Composite Microfabric

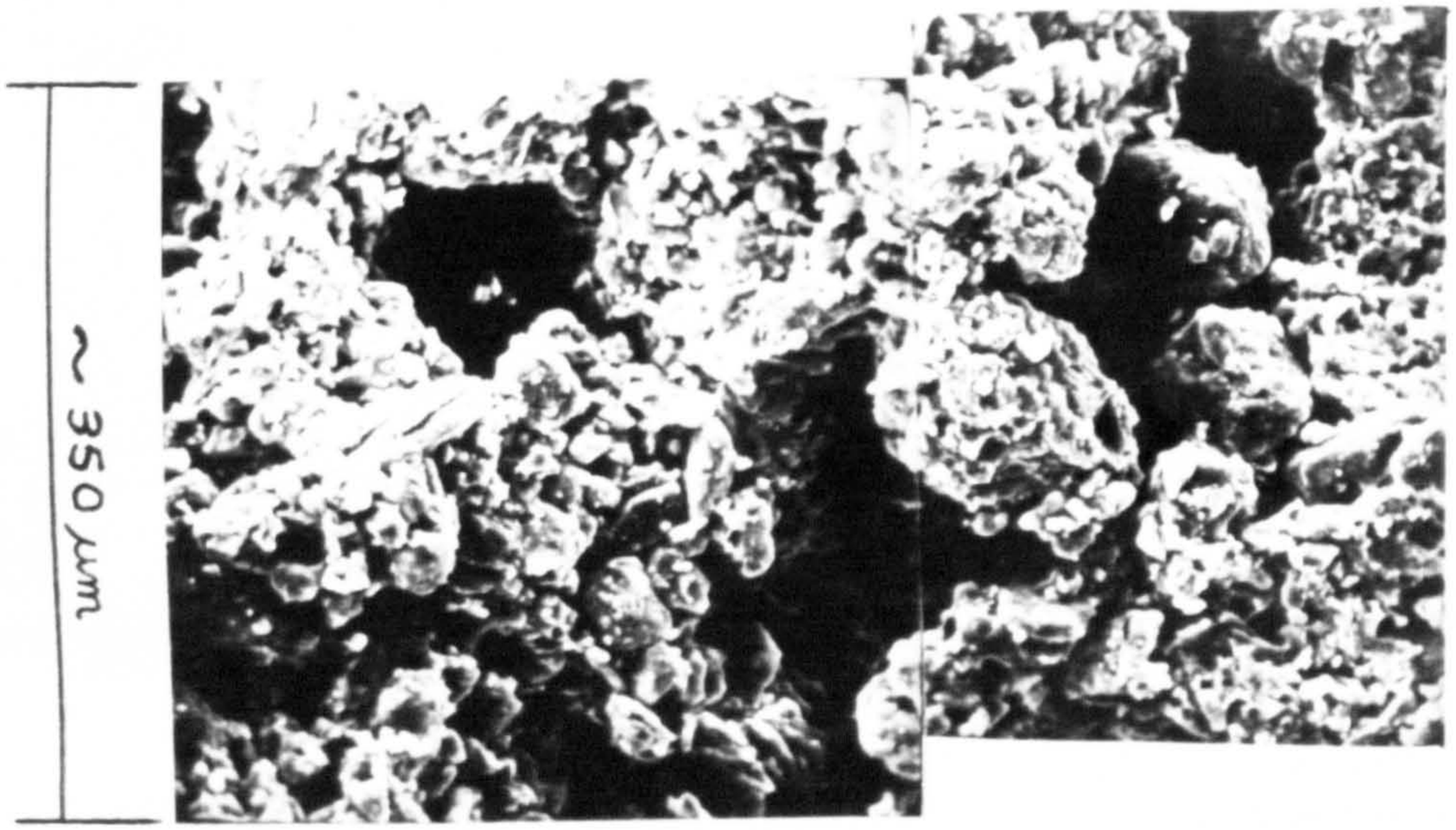
(d) Detailed view of Composite Microfabric

MIC. 5.15. ESTUARINE BLUE CLAY - BOSTON, U.S.A.



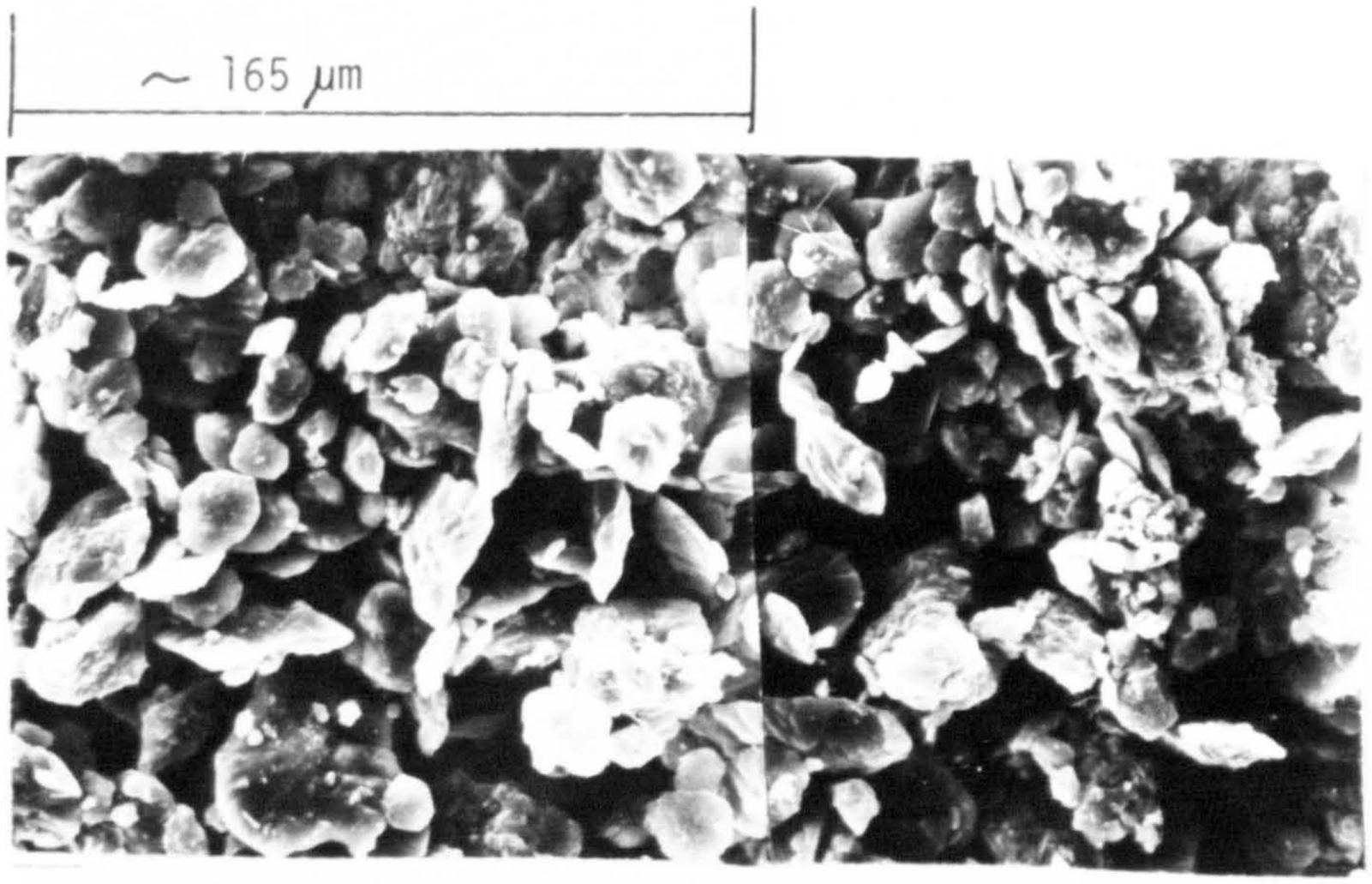
(a) Detailed View of Composite Microfabric

MIC. 5.16 FRESH WATER CLAYEY SILT - TUCSON, U.S.A.

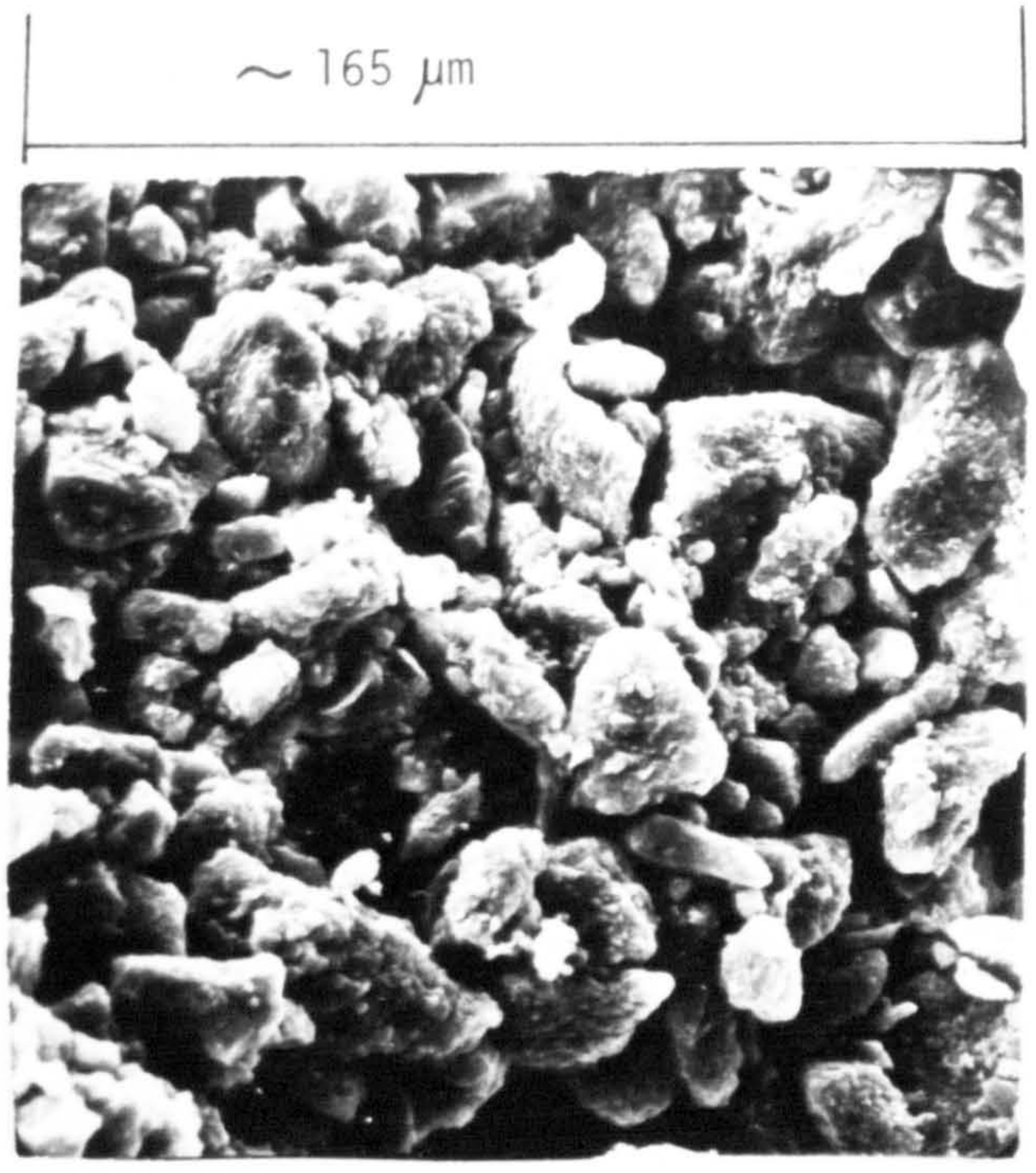


(B) General View of Composite Microfabric

MIC. 5.16. FRESH WATER CLAYEY SILT – TUCSON, U.S.A.

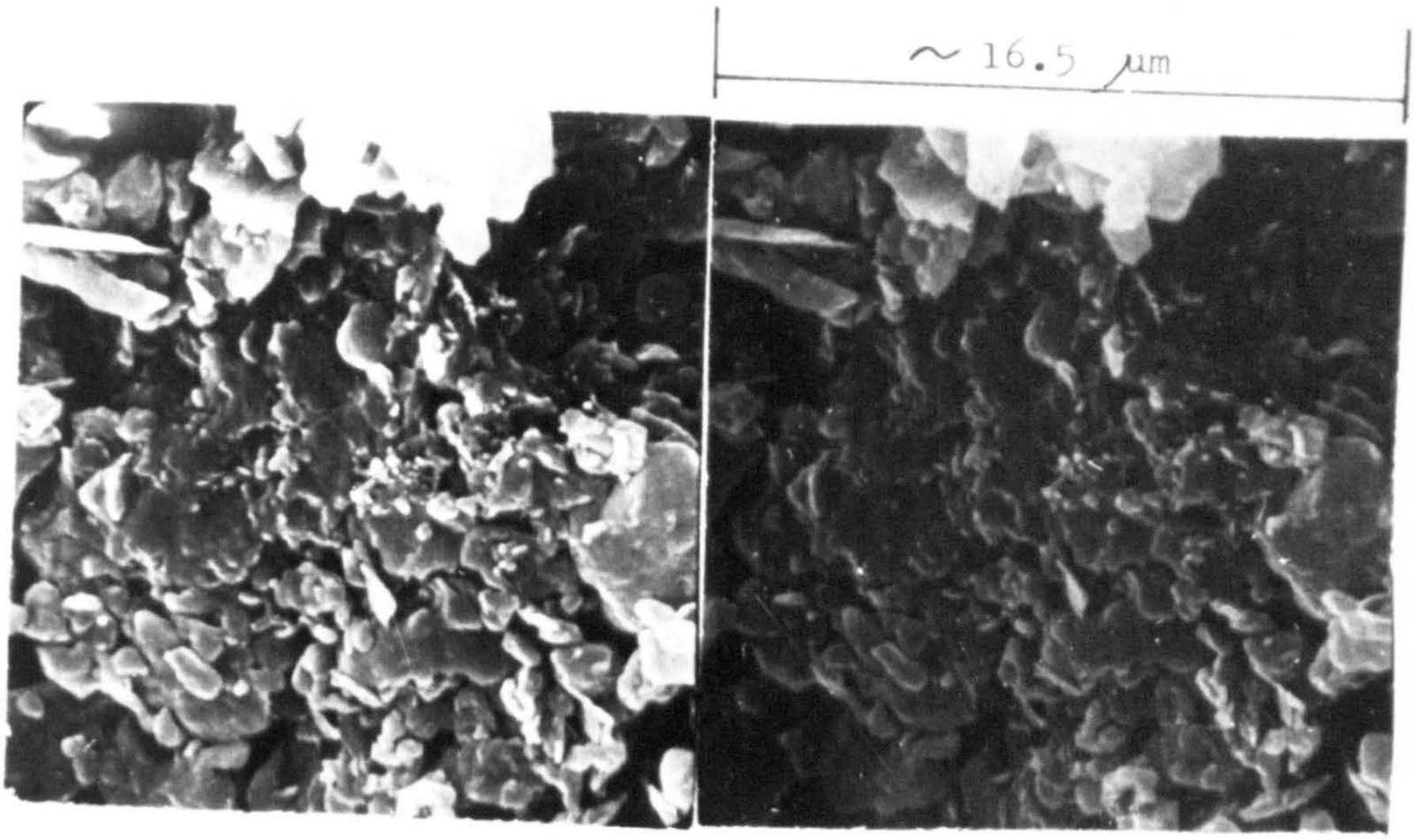


(b) Granular matrix region comprising loosely packed clean grain-grain contacts x 390

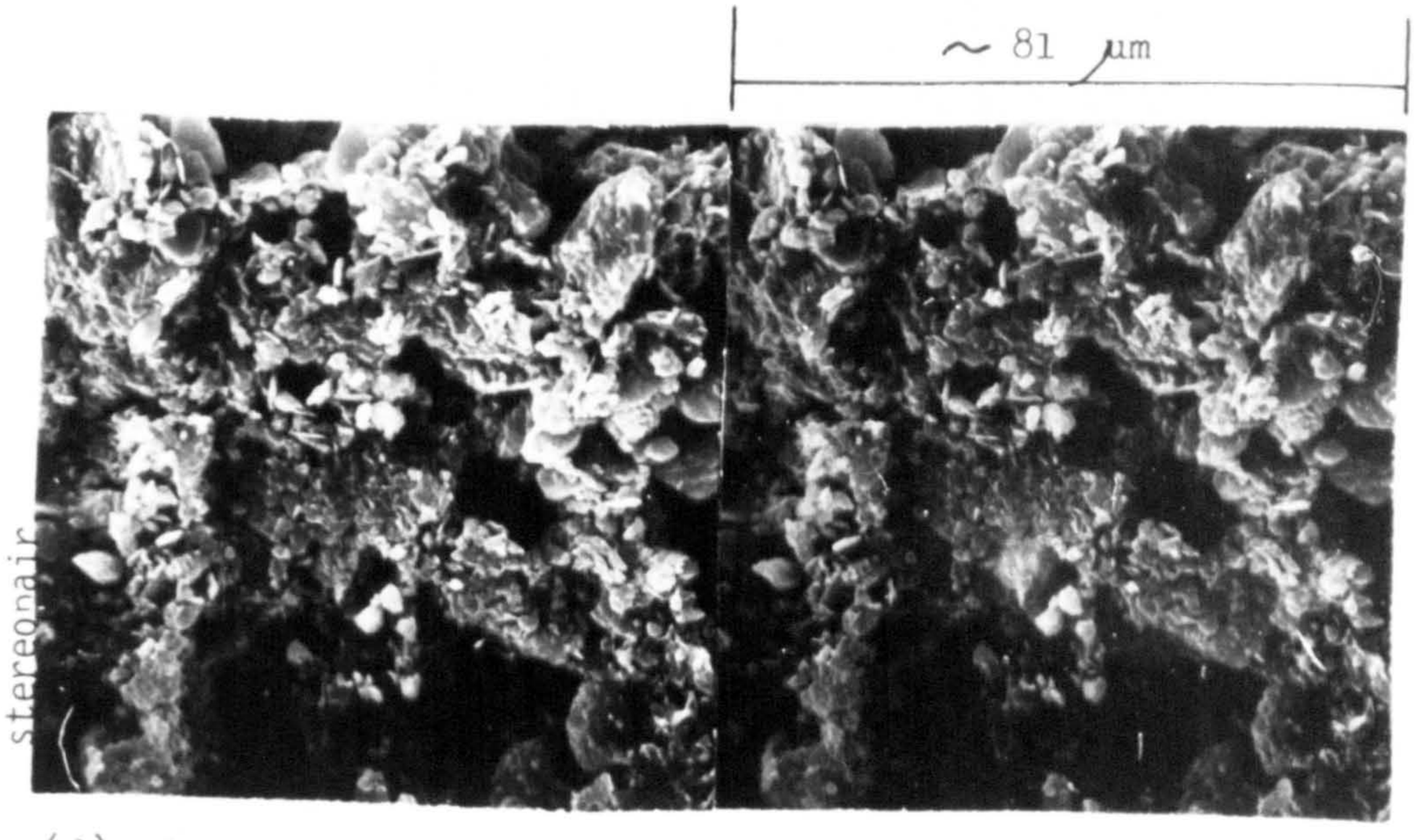


(a) Granular matrix region comprising closely packed clothed grain-grain contacts x 470

MIC. 5.17. MUD FLOW CLAYEY SILT - MARICOPA, U.S.A.



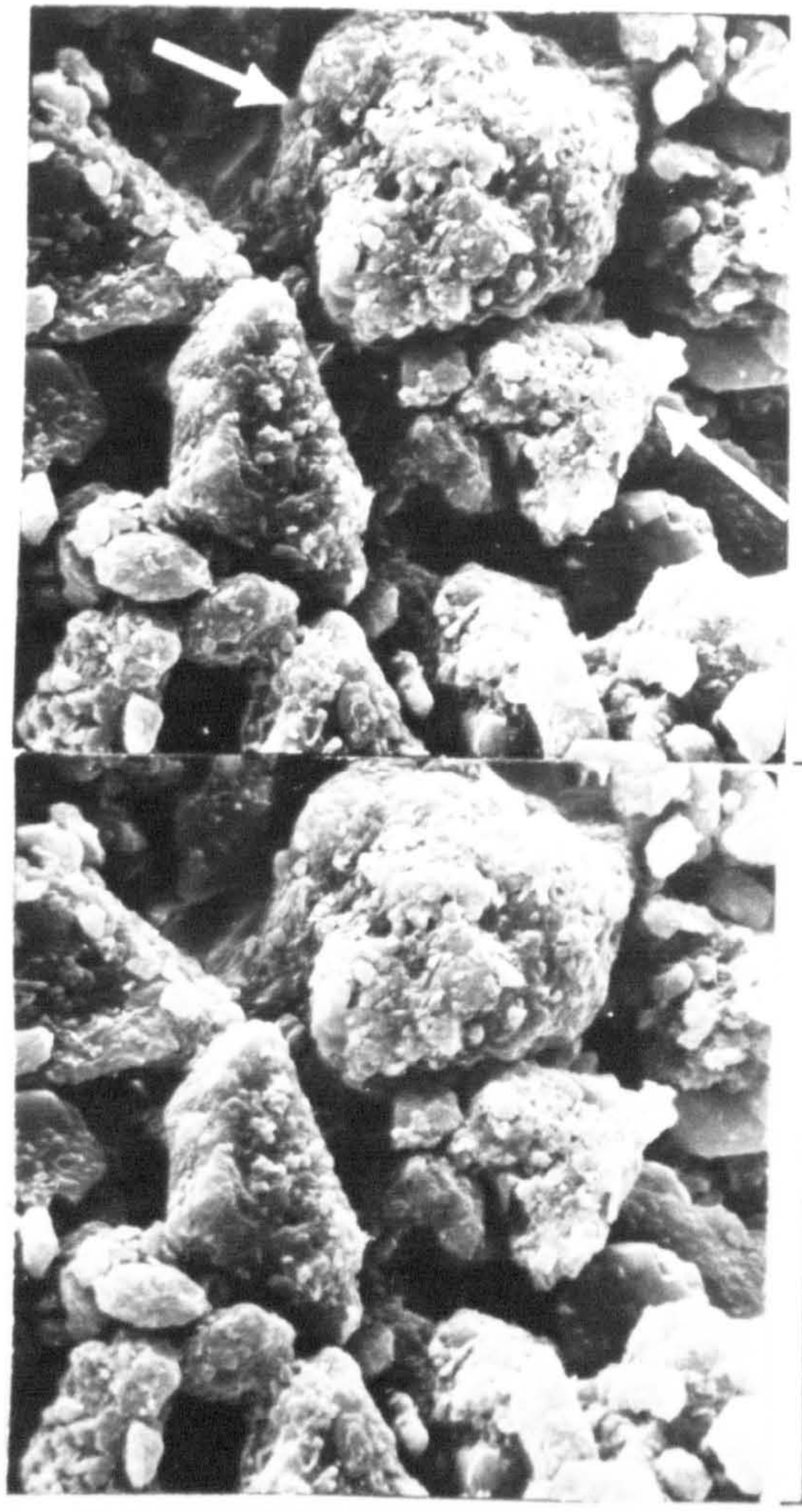
(c) Clay particle arrangements. x 3900



(d) Open clay matrix region. x 780

MIC. 5.17. MUD FLOW CLAYEY SILT - MARICOPA, U.S.A.

stereopair

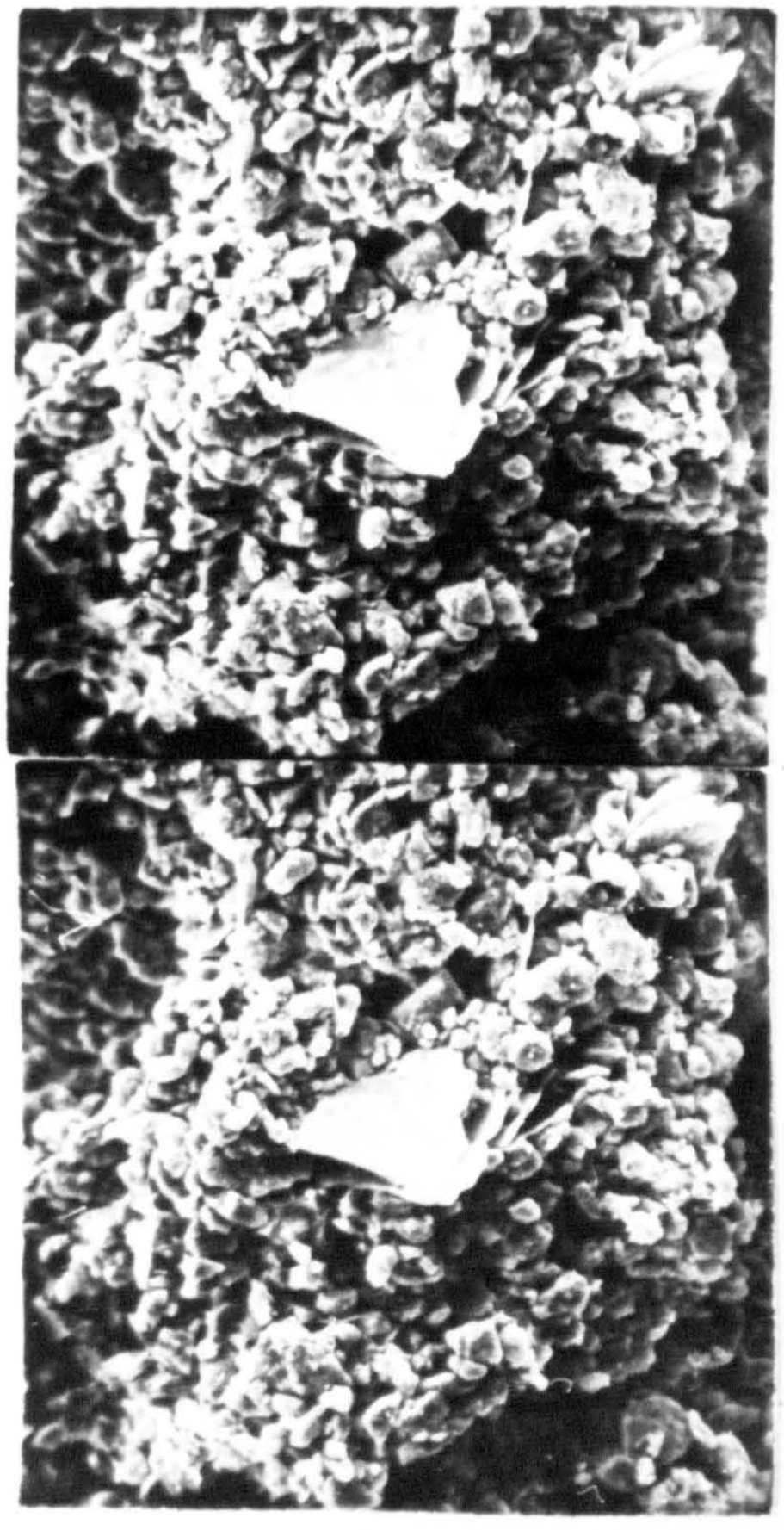


(e) Regular aggregations.

x 780

~ 81 µm

stereopair

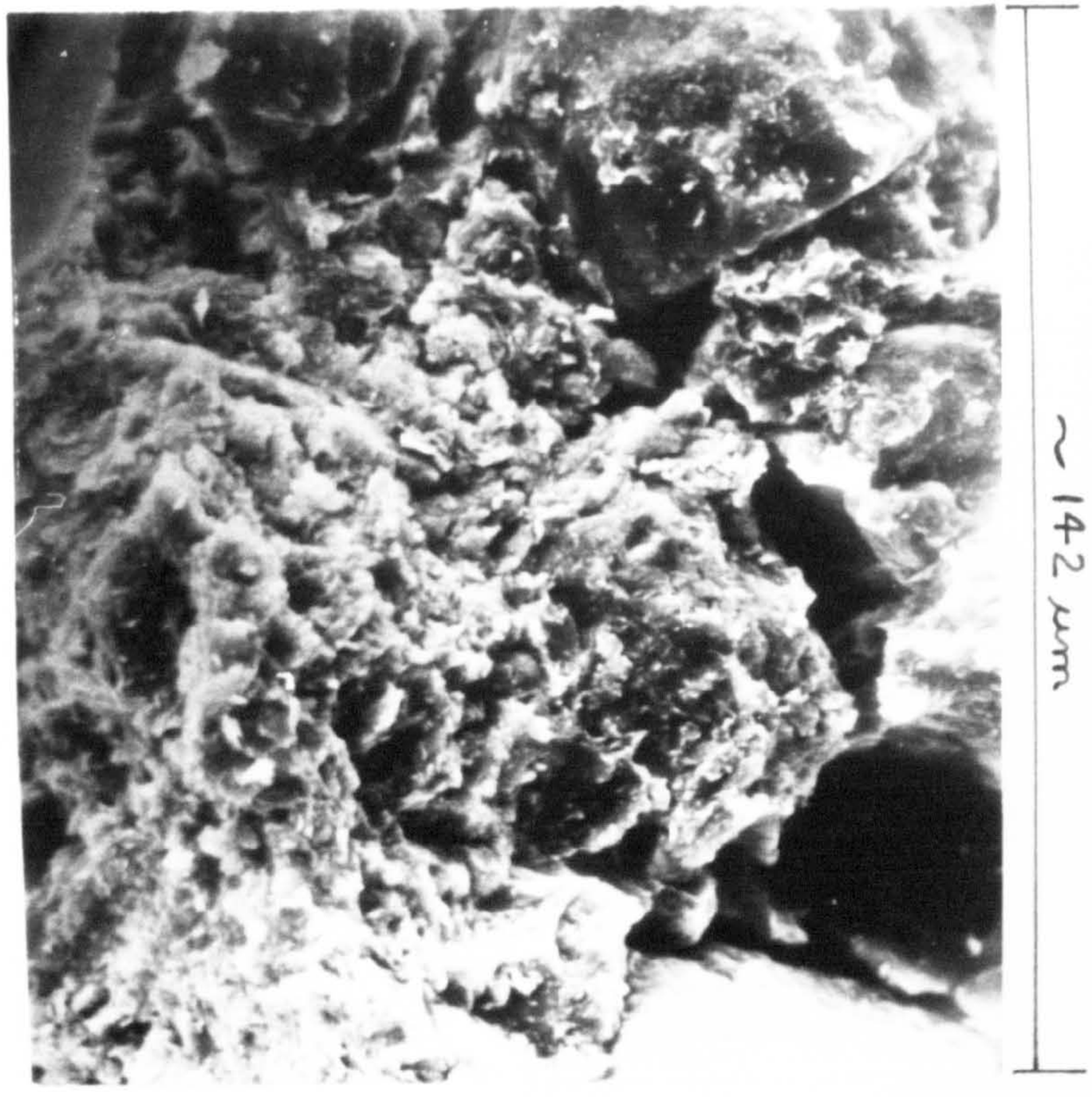


(f) Composite microfabric.

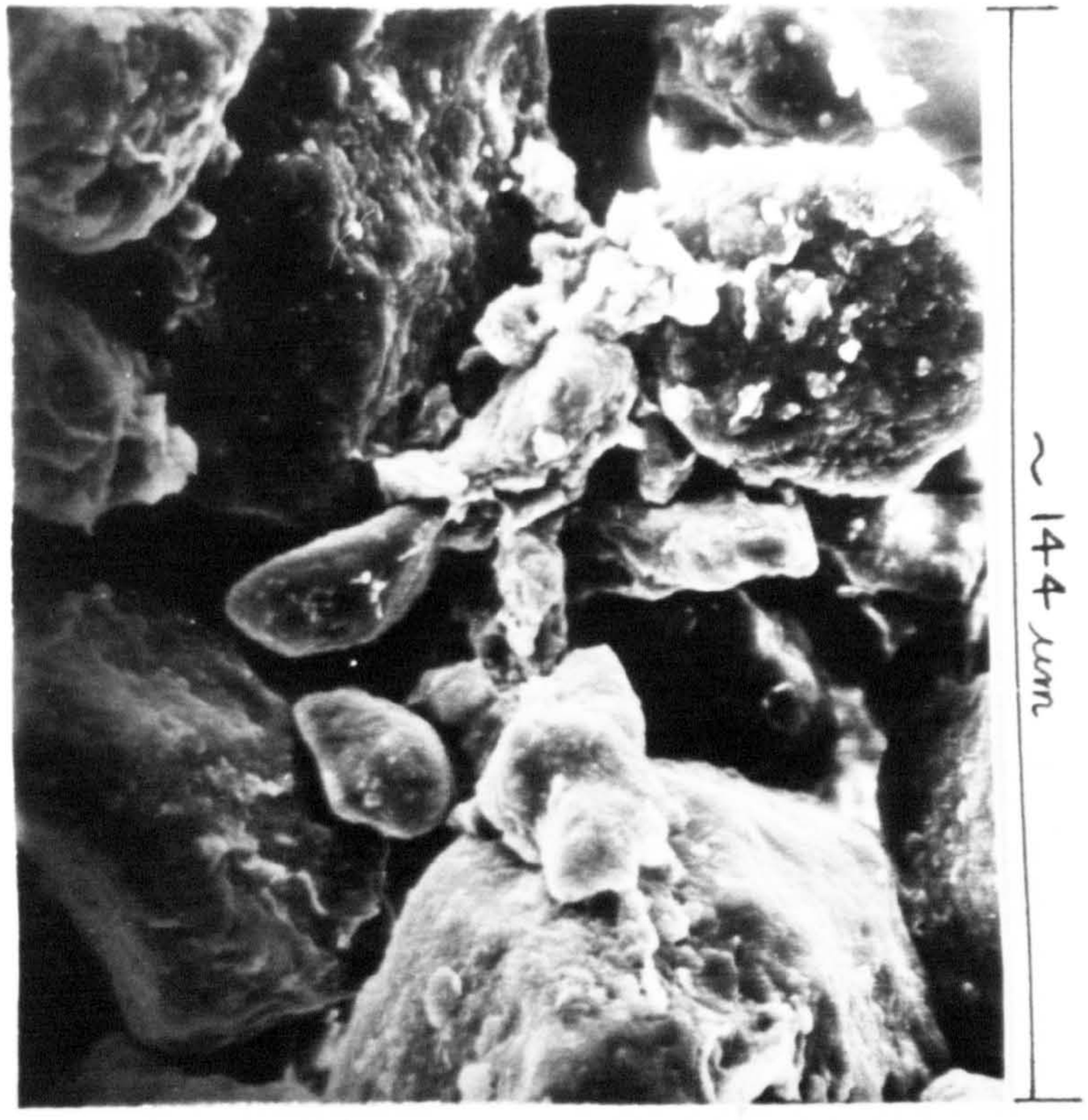
x 155

~ 41 µm

MIC. 5.17. MUD FLOW CLAYEY SILT - MARICOPA, U.S.A.

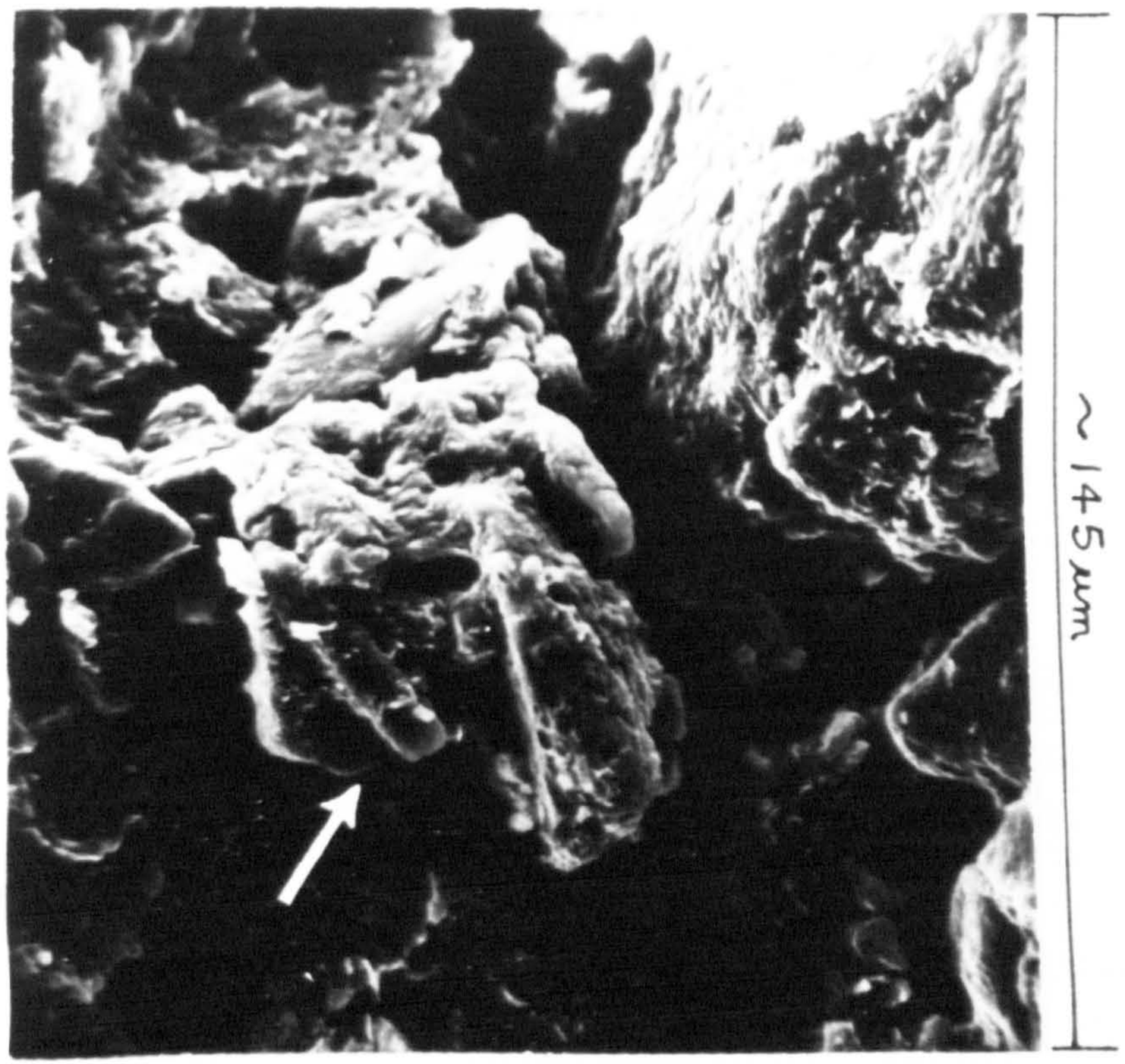


(a) Clay-Granular Matrix Region Comprising Dense Clay Array x700

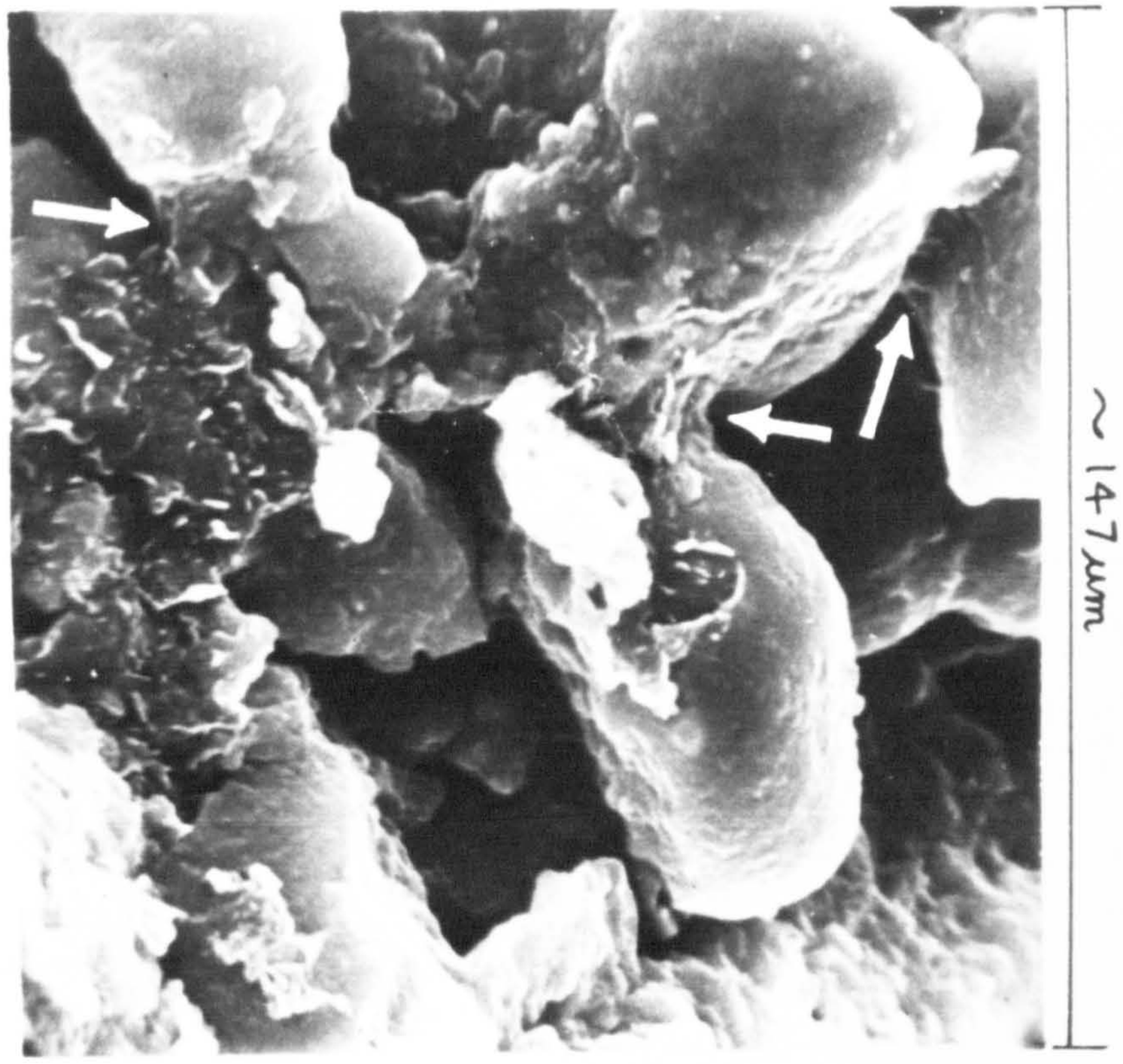


(b) Granular Matrix Region x700

MIC. 5.18. FRESH WATER SILTY CLAY - LYDDA, ISRAEL

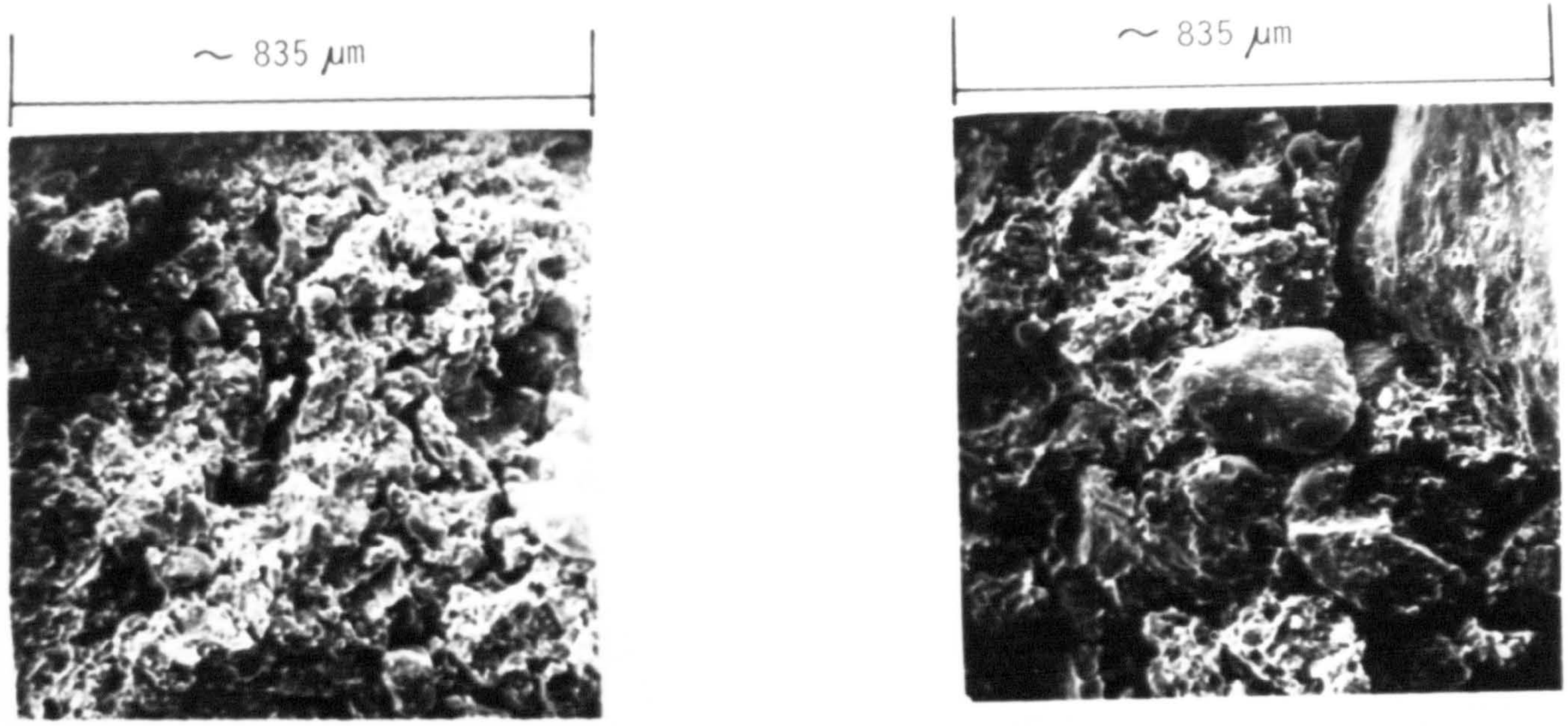


(d) Regular Aggregation ×700



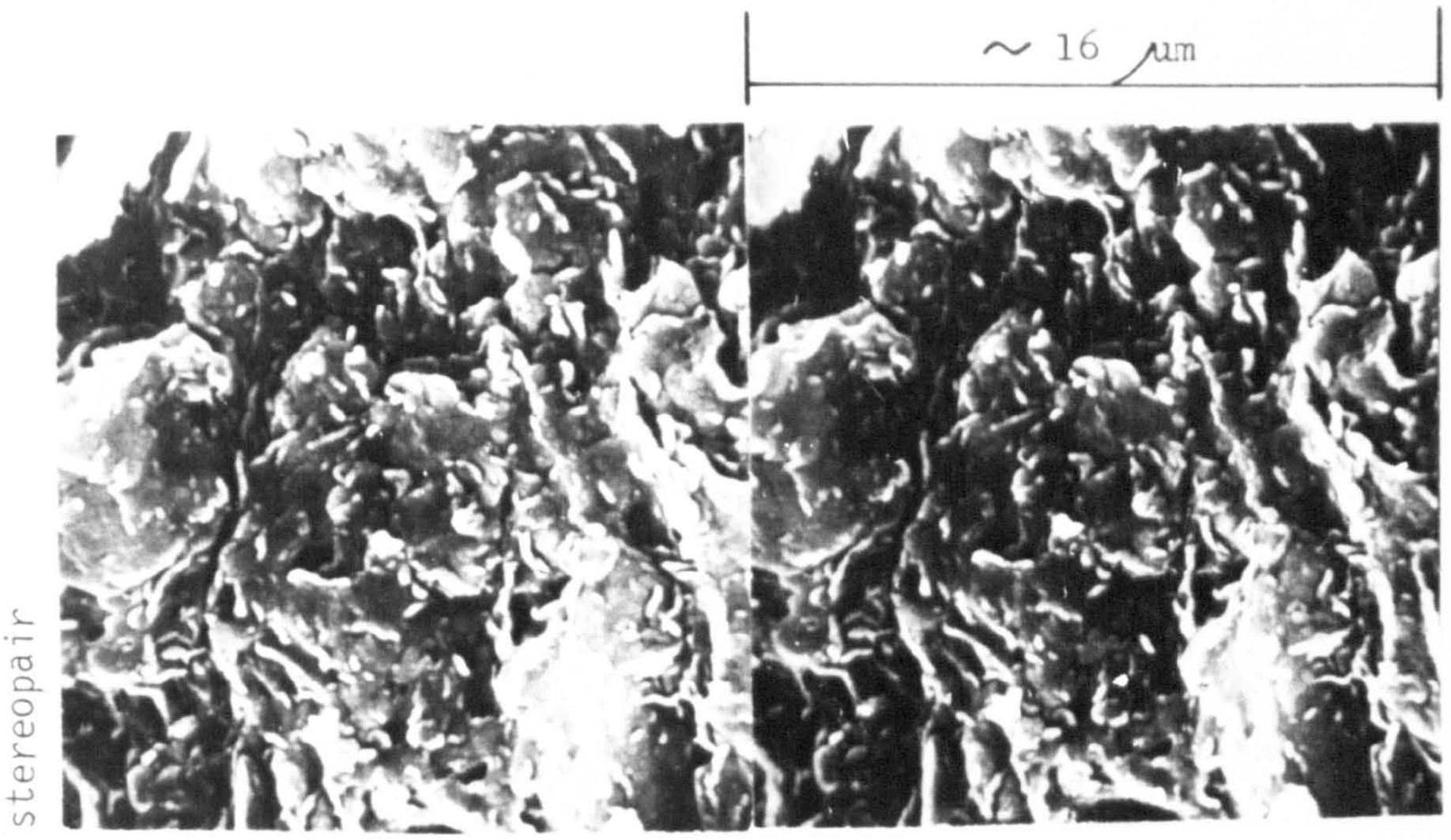
(c) Connector System ×700

MIC. 5.18. FRESH WATER SILTY CLAY - LYDDA, ISRAEL



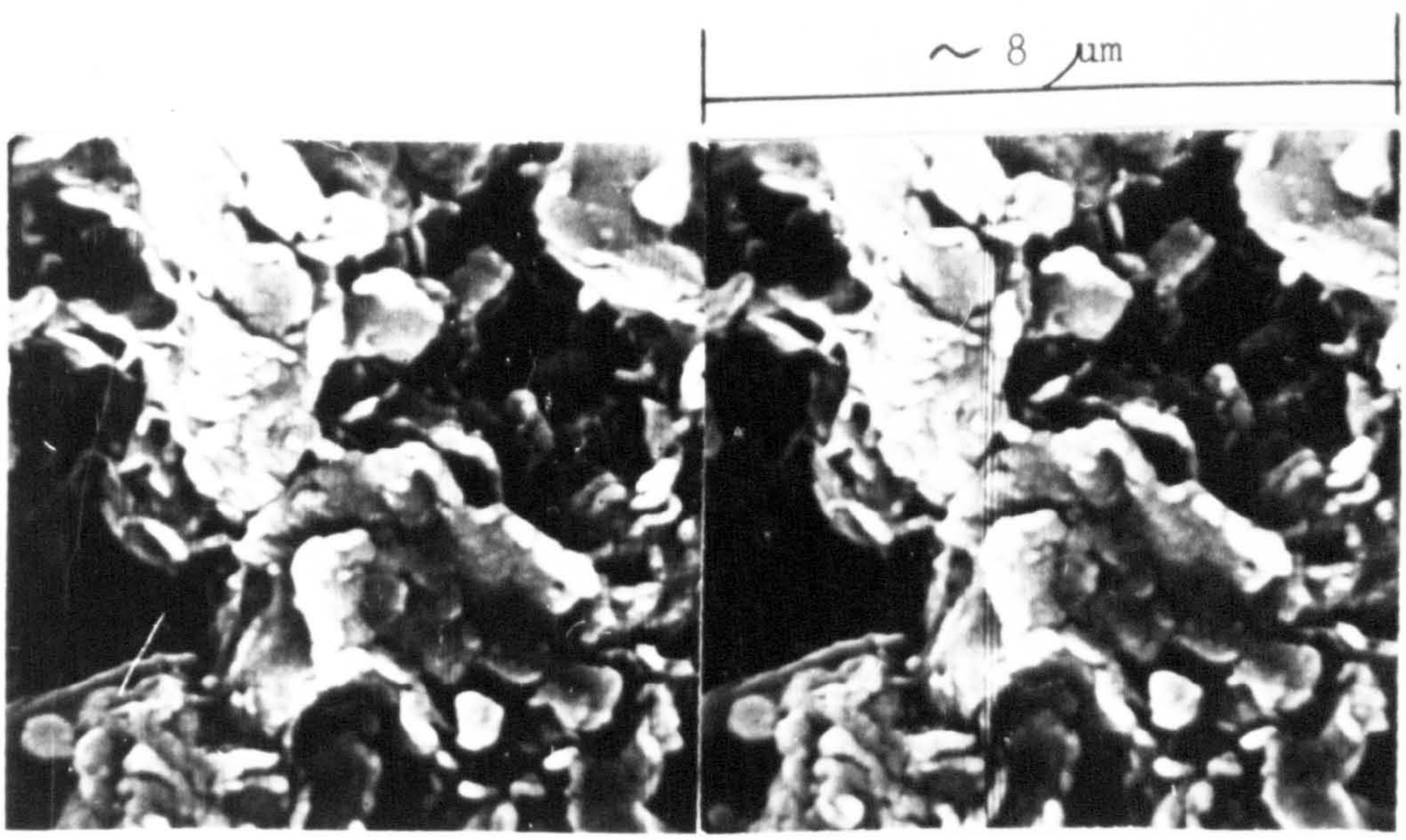
(e) Detailed views of composite microfabric
x 78

MIC. 5.18. FRESH WATER SILTY CLAY - LYDDA, ISRAEL



(a) Partly discernible clay array within a dense matrix region.

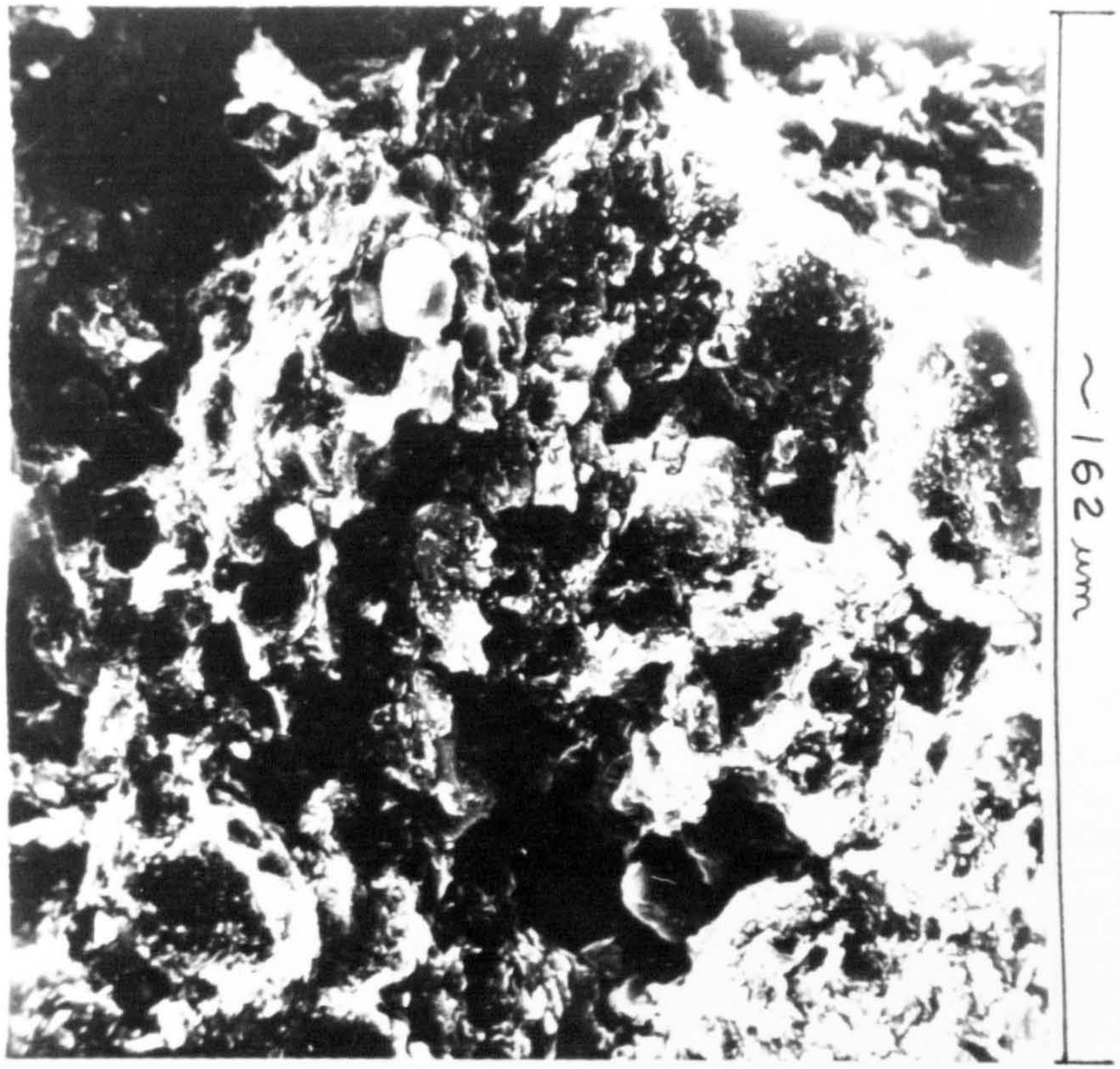
x 4100



(b) Predominantly partly discernible clay array within an open matrix region.

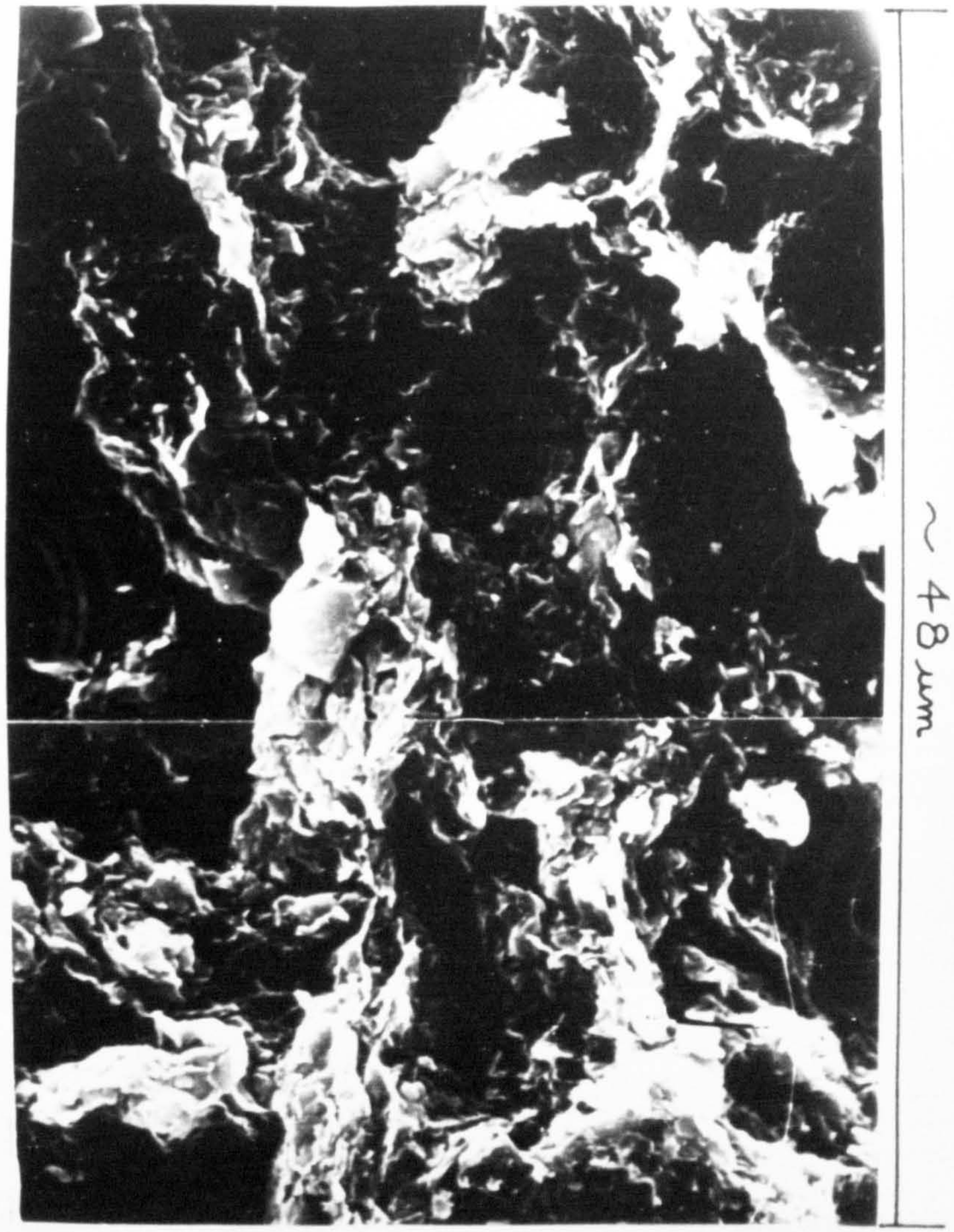
x 8100

MIC. 5.19. FRESH WATER CL[illegible] - HOLON, ISRAEL



(d) General view of Open Clay Matrix Region

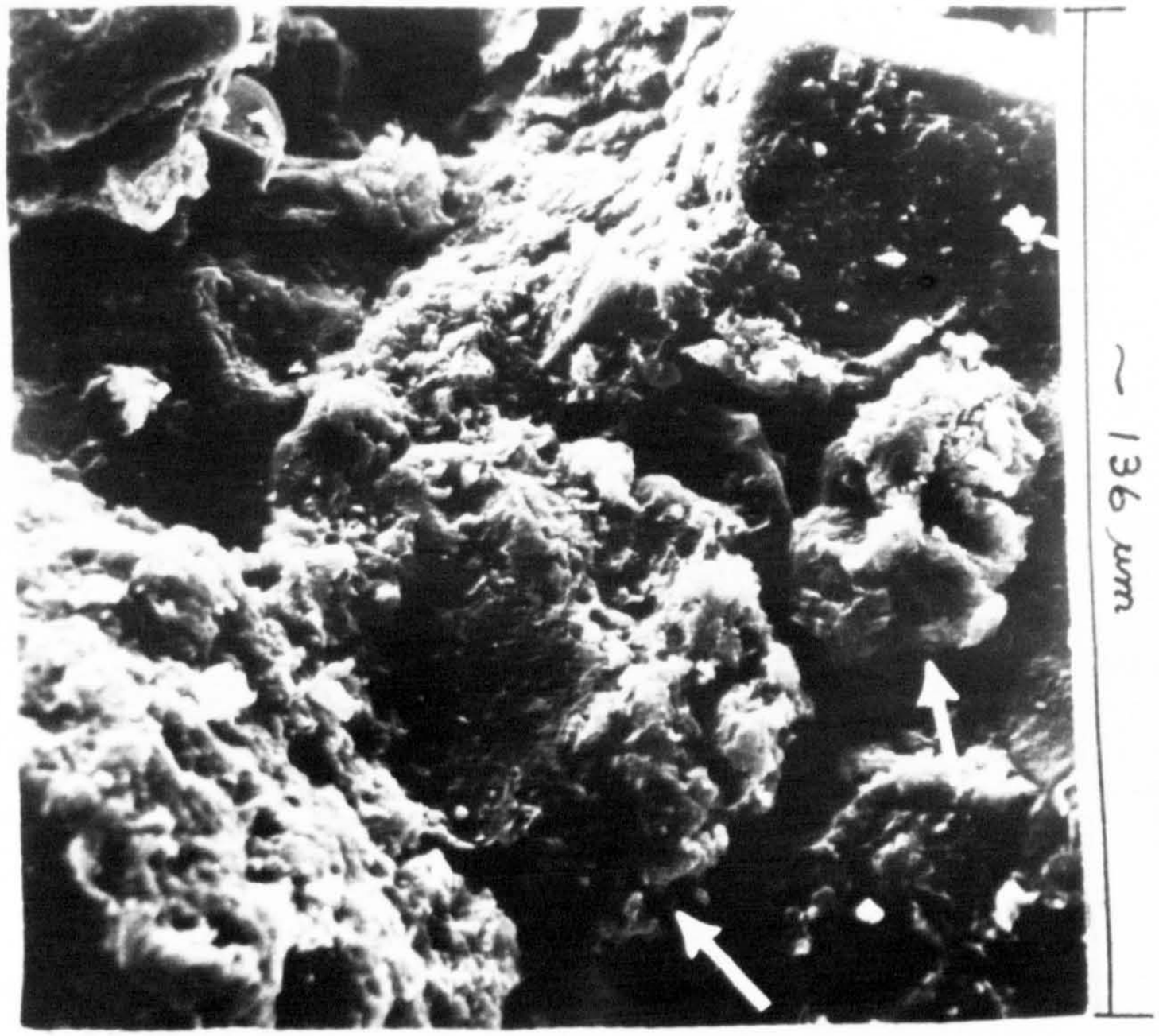
x625



(c) Detailed view of Open Clay Matrix Region

x2800

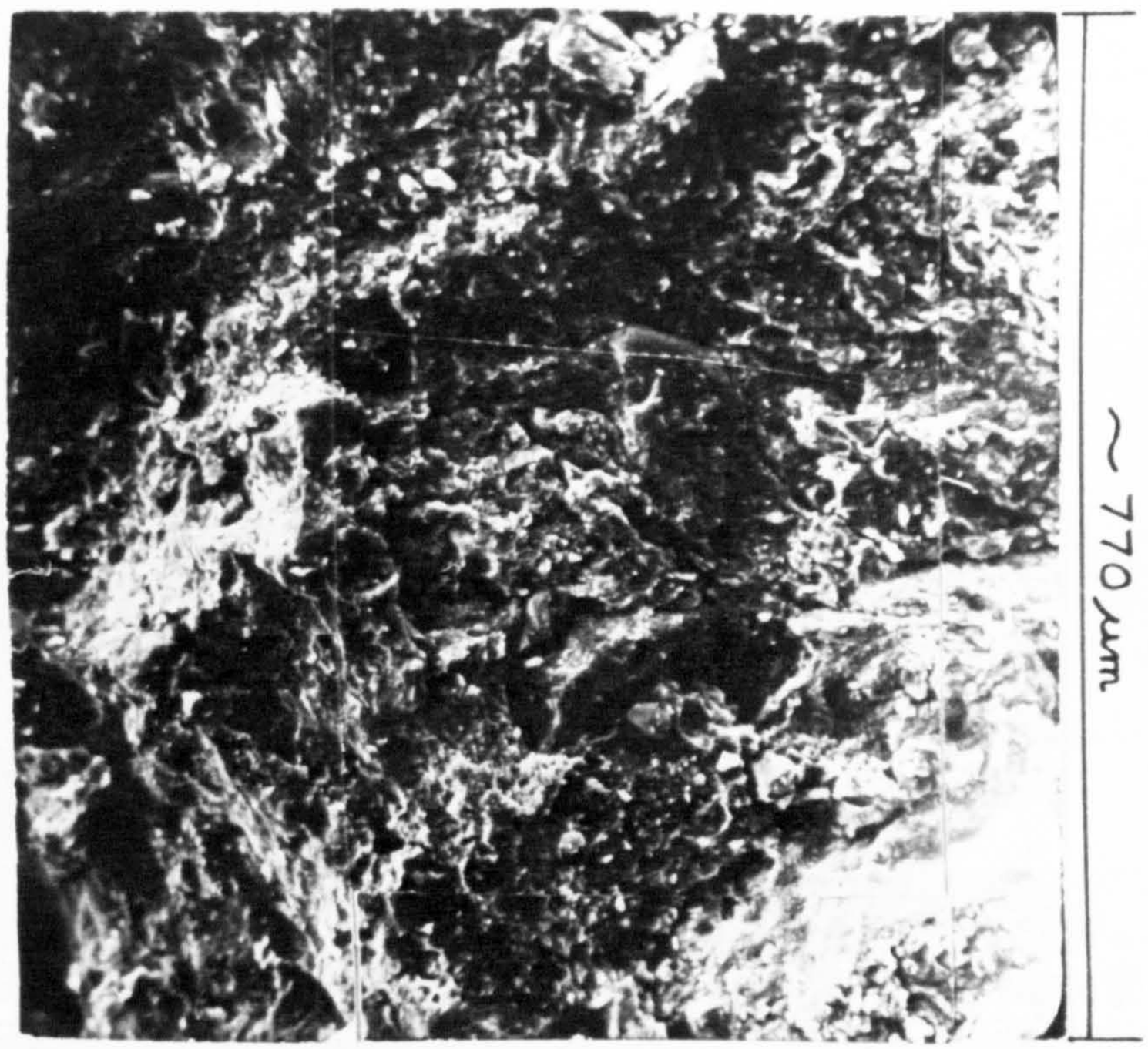
MIC. 5.19. FRESH WATER CLAY - HOLON, ISRAEL



(f) Nature and Interaction of Regular Aggregations

(e) General view of Dense Clay-Granular Matrix Region

MIC. 5.19. FRESH WATER CLAY - HOLON, ISRAEL



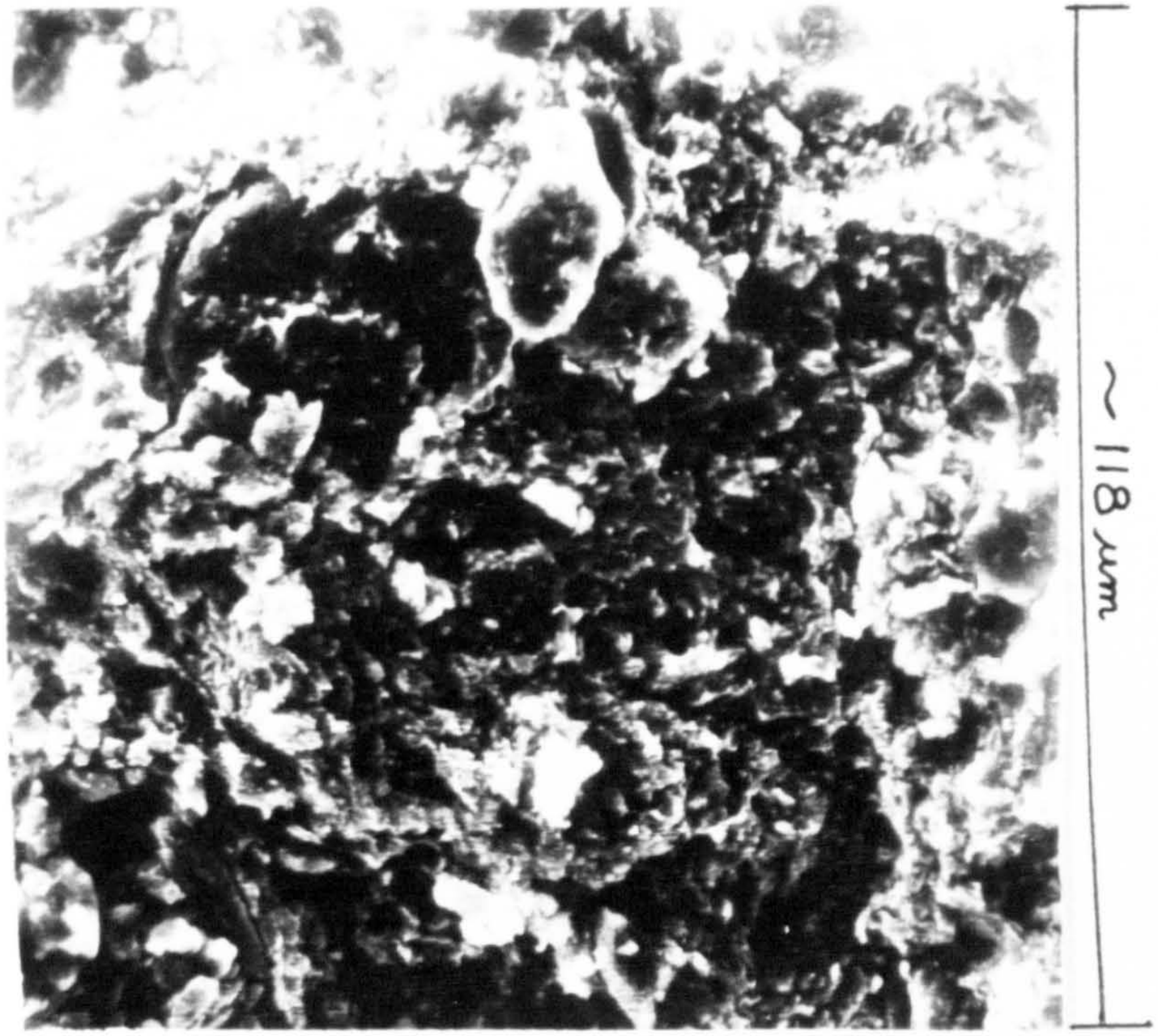
X 130

(g) General view of
Composite Microfabric

MIC. 5.19. FRESH WATER CLAY - HOLON, ISRAEL

(a) Granular Matrix Region Comprising Loosely Packed Clothed Grain-Grain Contacts

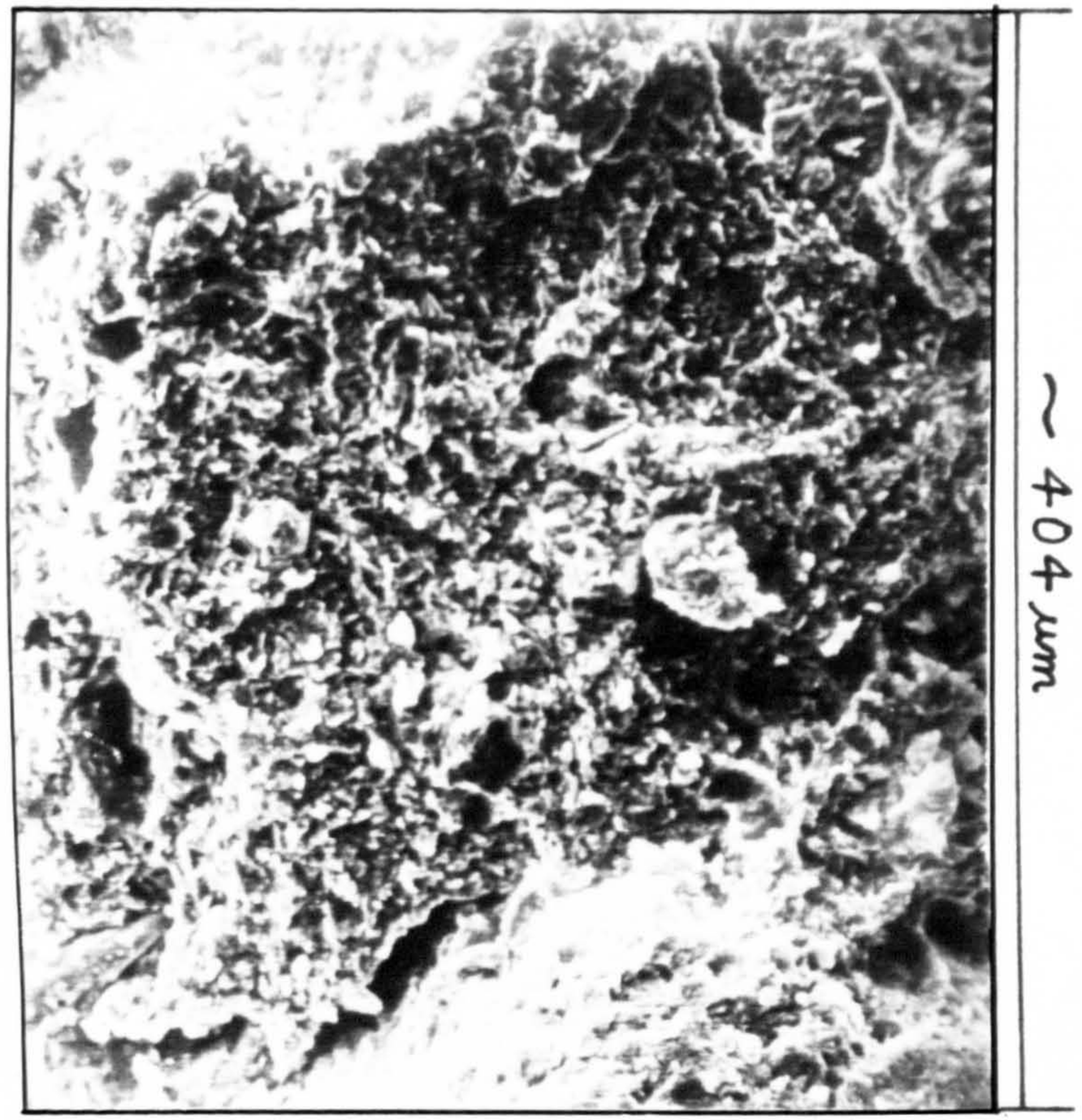
X1600



(b) General view of Clay Matrix

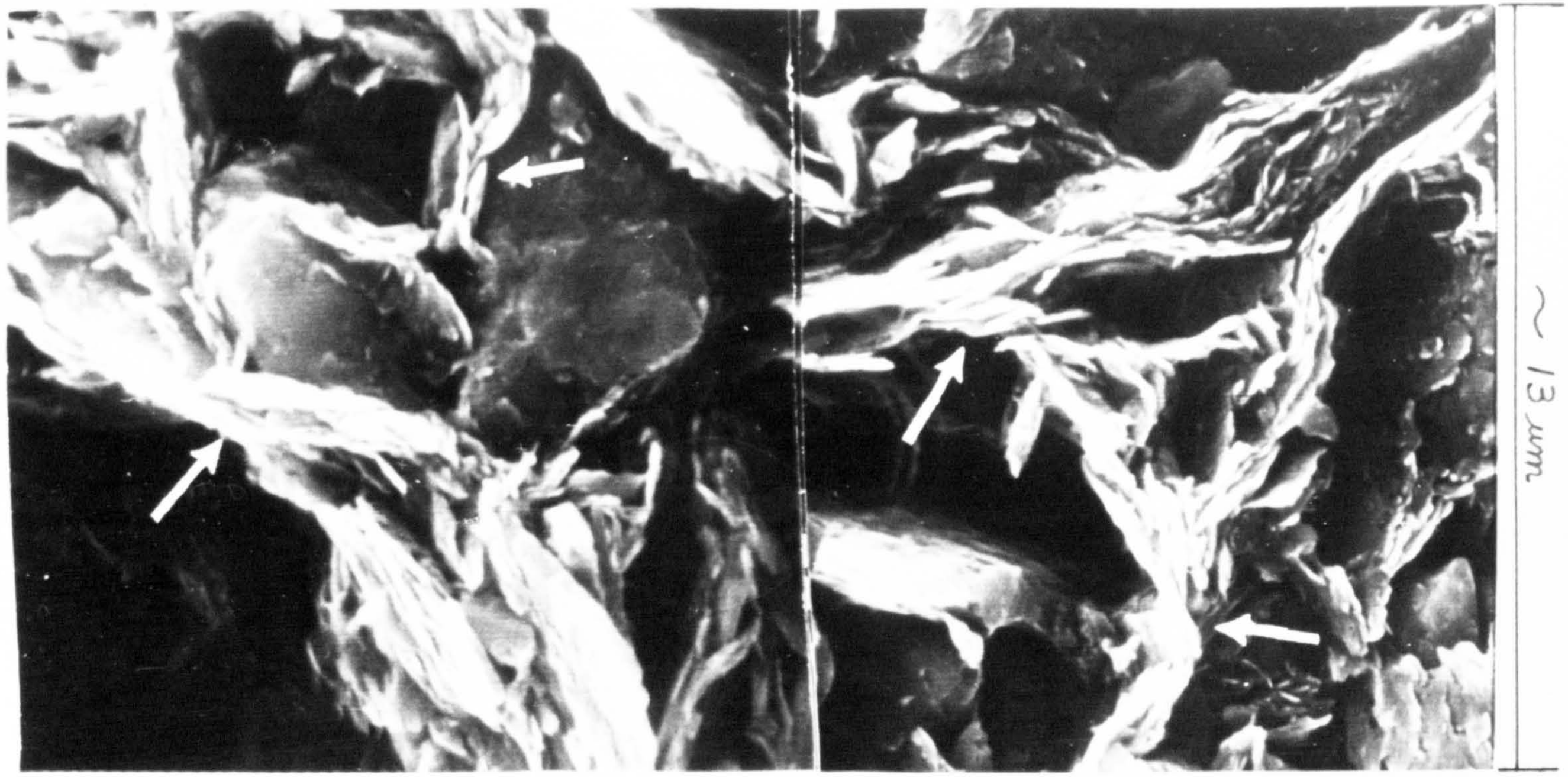
x 800

MIC. 5.20. FRESH WATER CLAY- AFULAH, ISRAEL



(c) General view of Composite Microfabric ×250

MIC. 5.20. FRESH WATER CLAY - AFULAH, ISRAEL



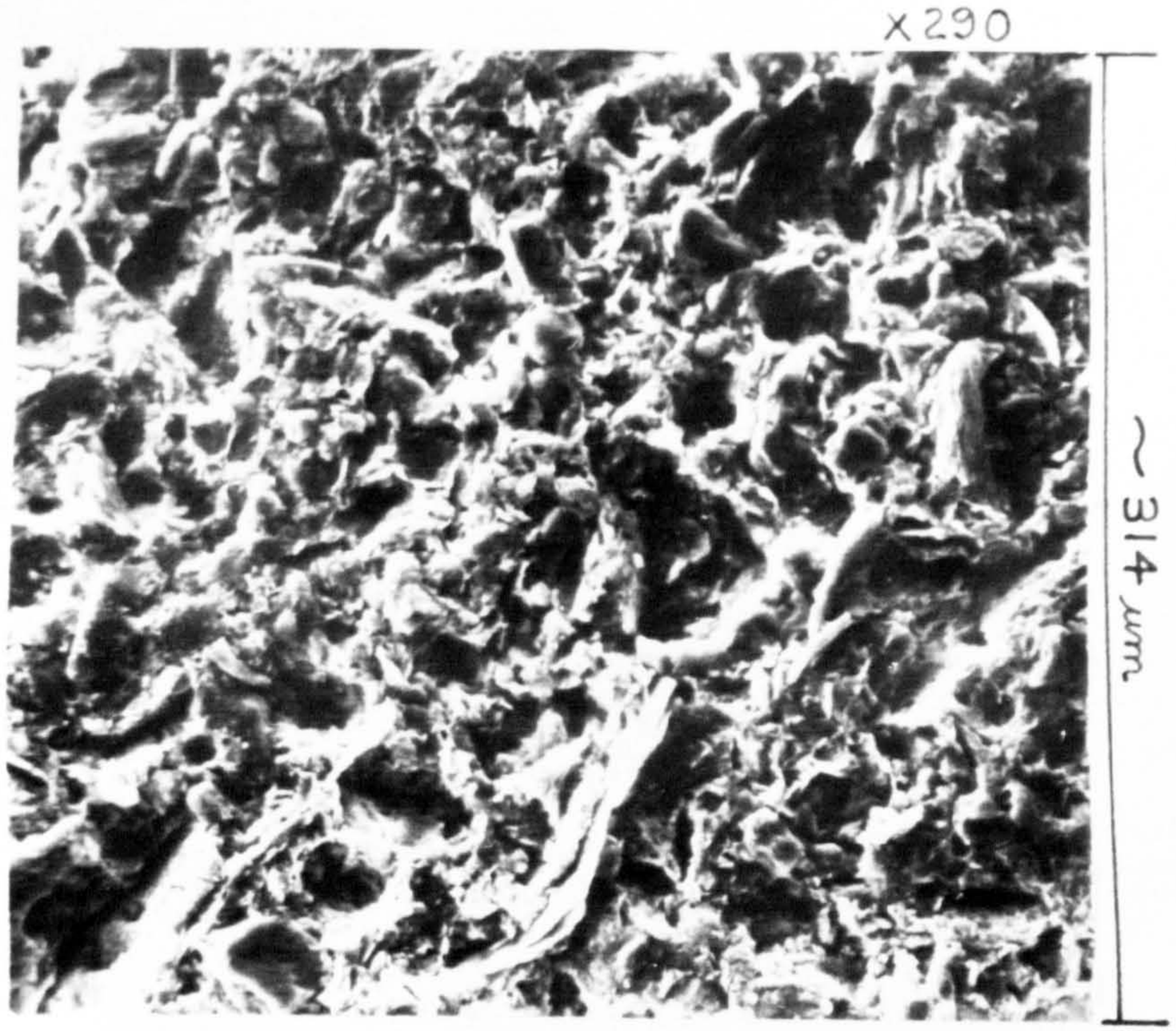
(a) Highly Detailed view Within a Clay-Granular Matrix Region of a Haphazard Parallel Clay Array x 7300

MIC. 5.21. LACUSTRINE SILTY CLAY - HURLFORD, SCOTLAND

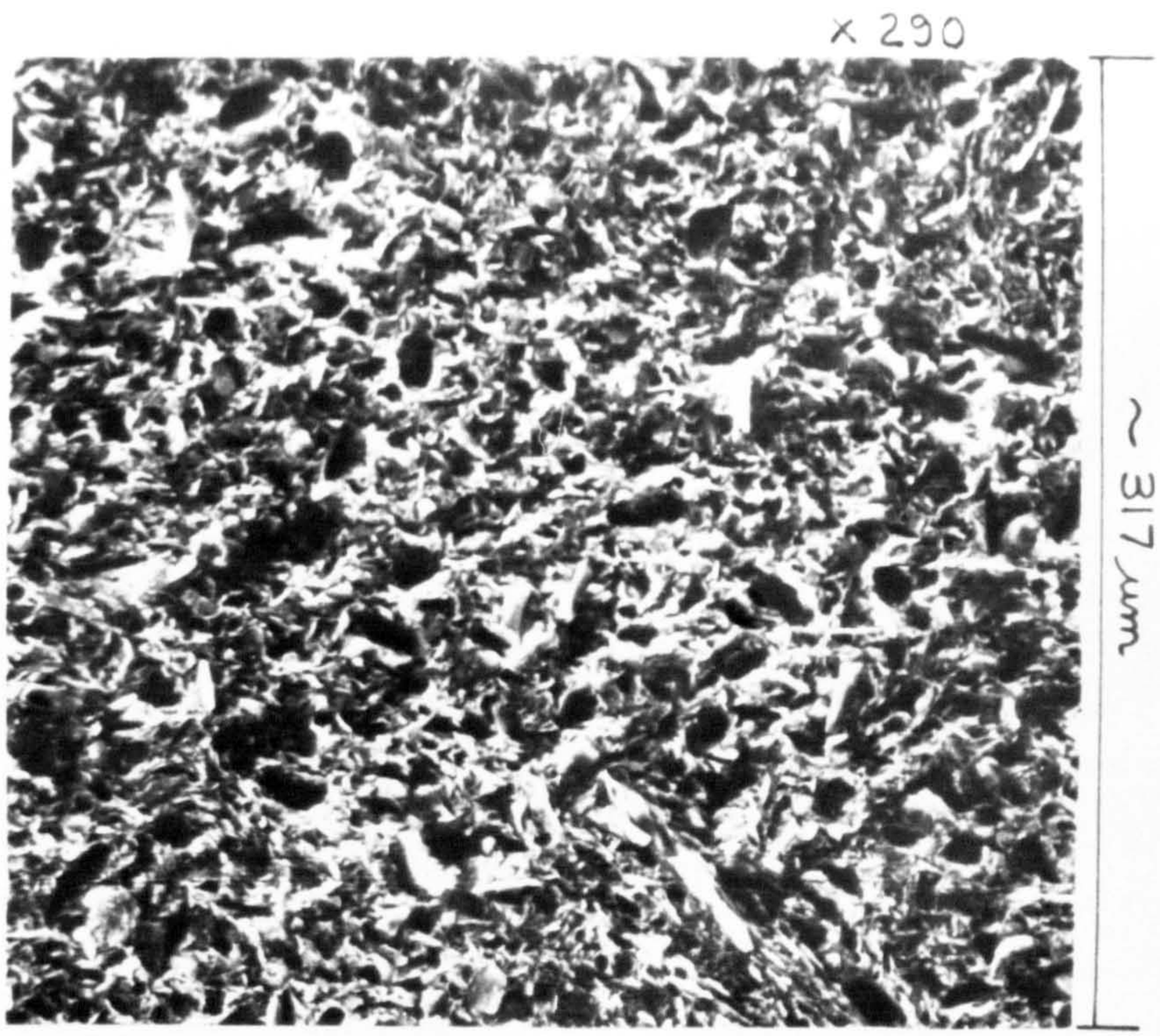
(b) Detailed view of Clay-Granular Matrix

x1450

MIC. 5.21. LACUSTRINE SILTY CLAY - HURLFORD, SCOTLAND

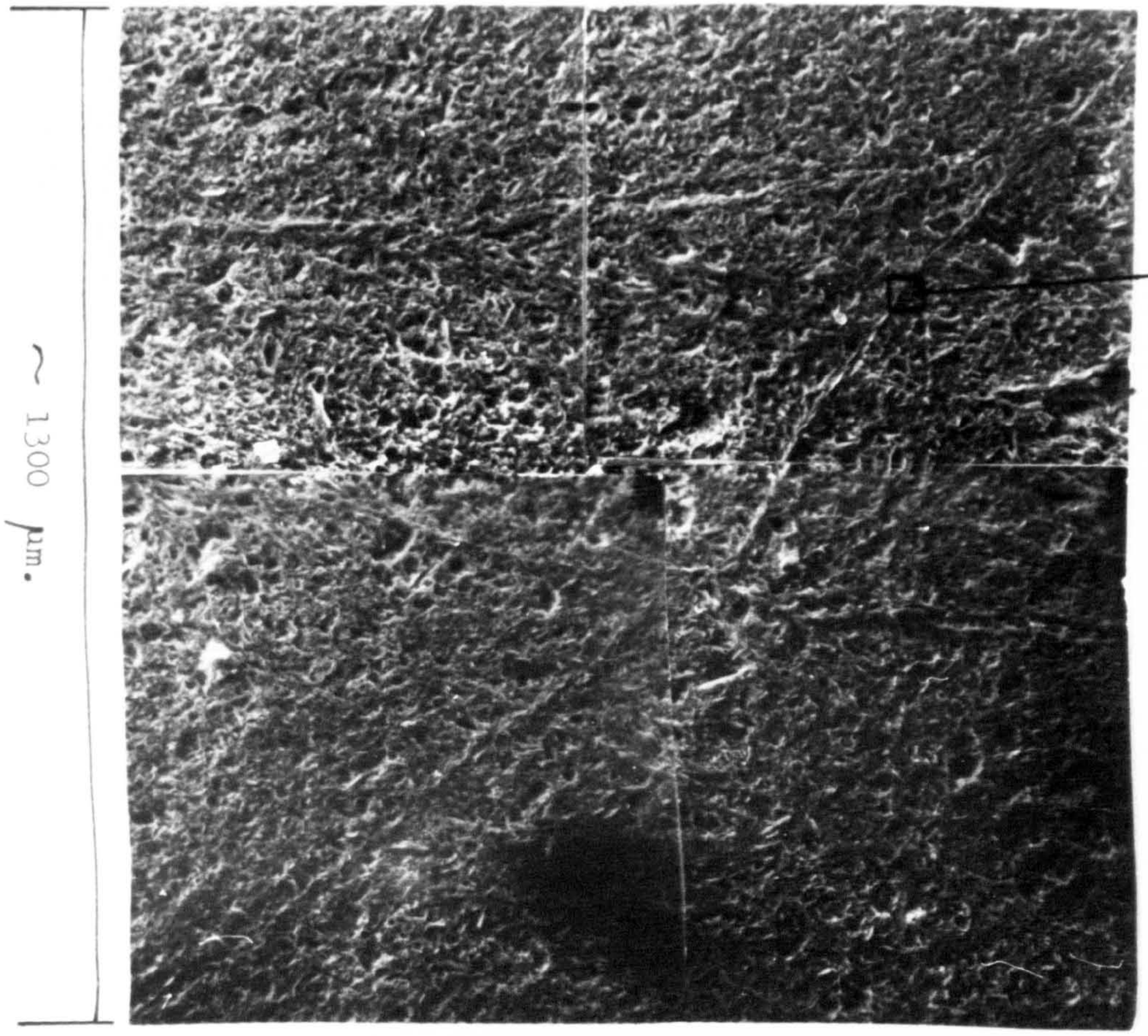


(d) General View of a Clay-Granular Matrix region Involving Coarse Matrix Silt

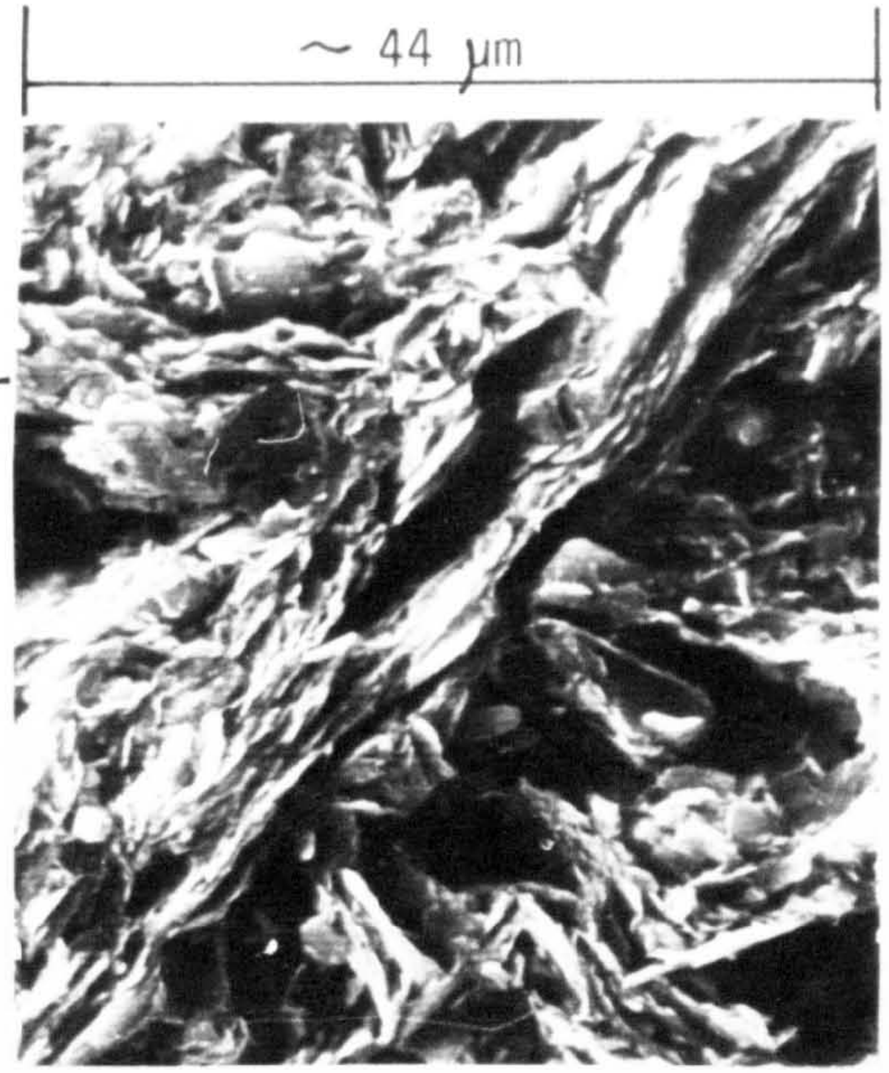


(c) General view of a Clay-Granular Matrix Region Involving Fine and Medium Matrix Silt

MIC. 5.21. LACUSTRINE SILTY CLAY - HURLFORD, SCOTLAND

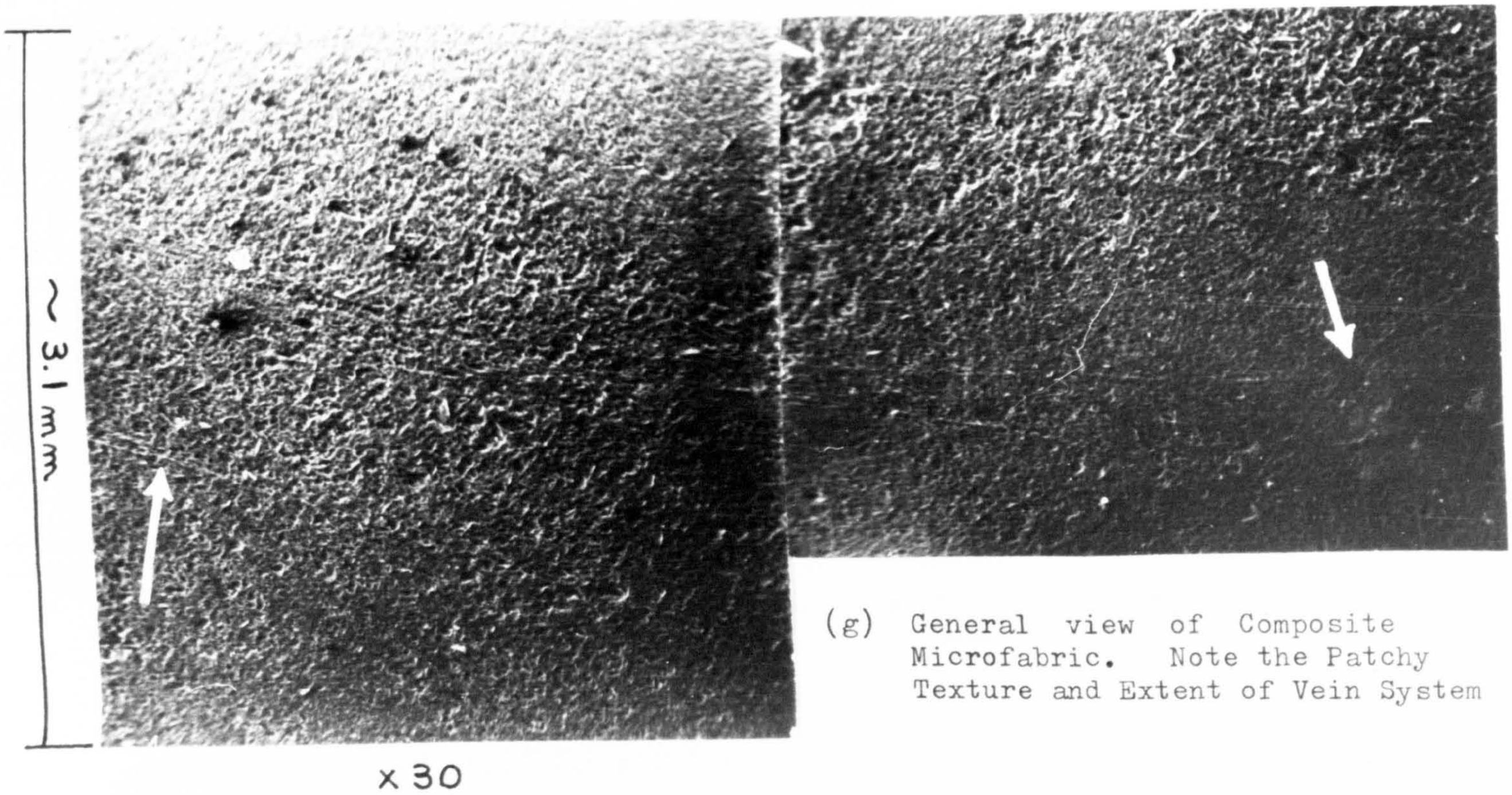


(f) Detailed view of vein system x 88



(e) Detailed view of individual vein

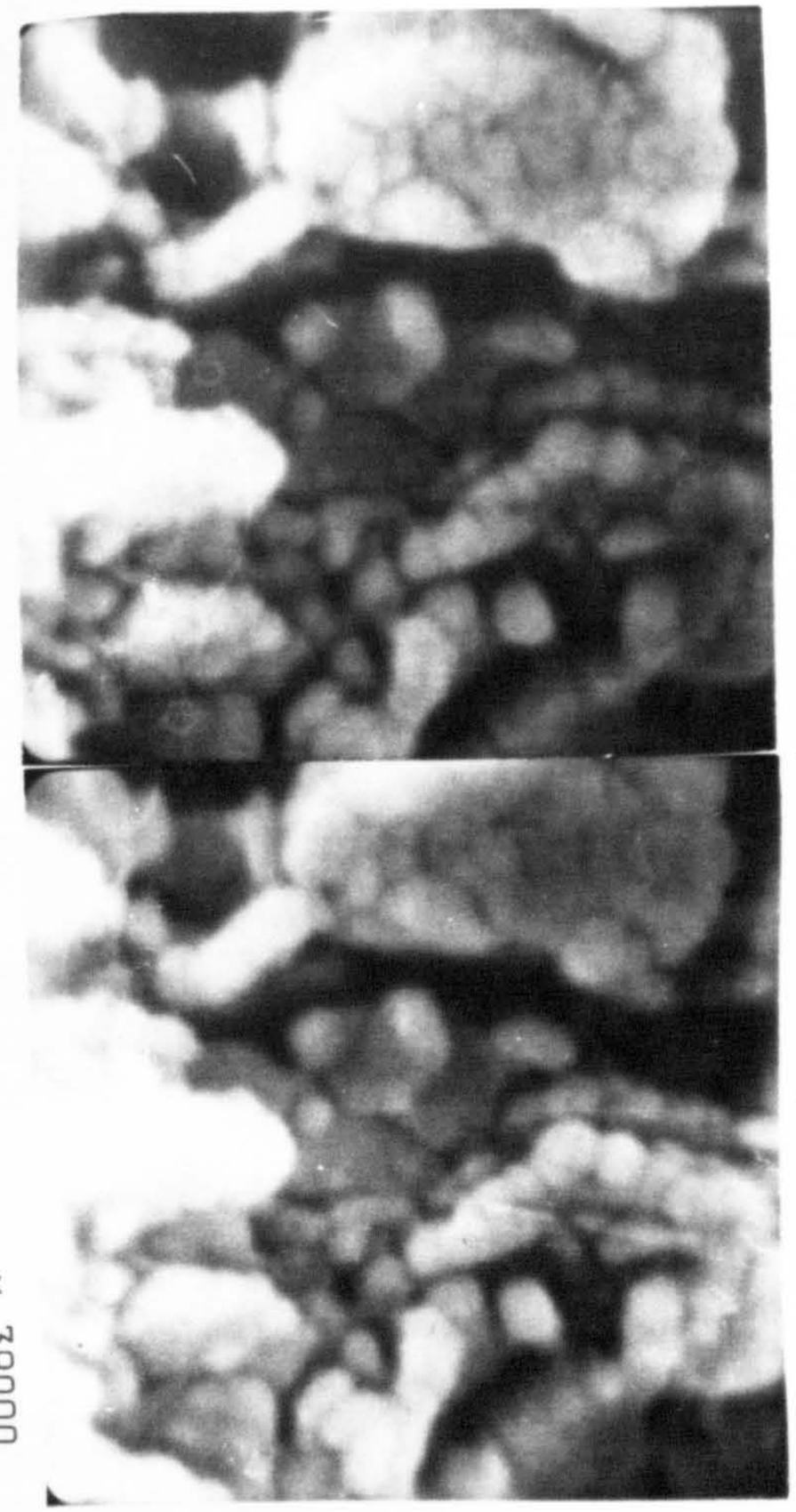
5.21. LACUSTRINE SILTY CLAY - HURLFORD, SCOTLAND



(g) General view of Composite Microfabric. Note the Patchy Texture and Extent of Vein System

5.21. LACUSTRINE SILTY CLAY - HURLFORD, SCOTLAND

Stereopair



(a) Random clay (cluster) arrangements

× 39000

~ 1.6 µm

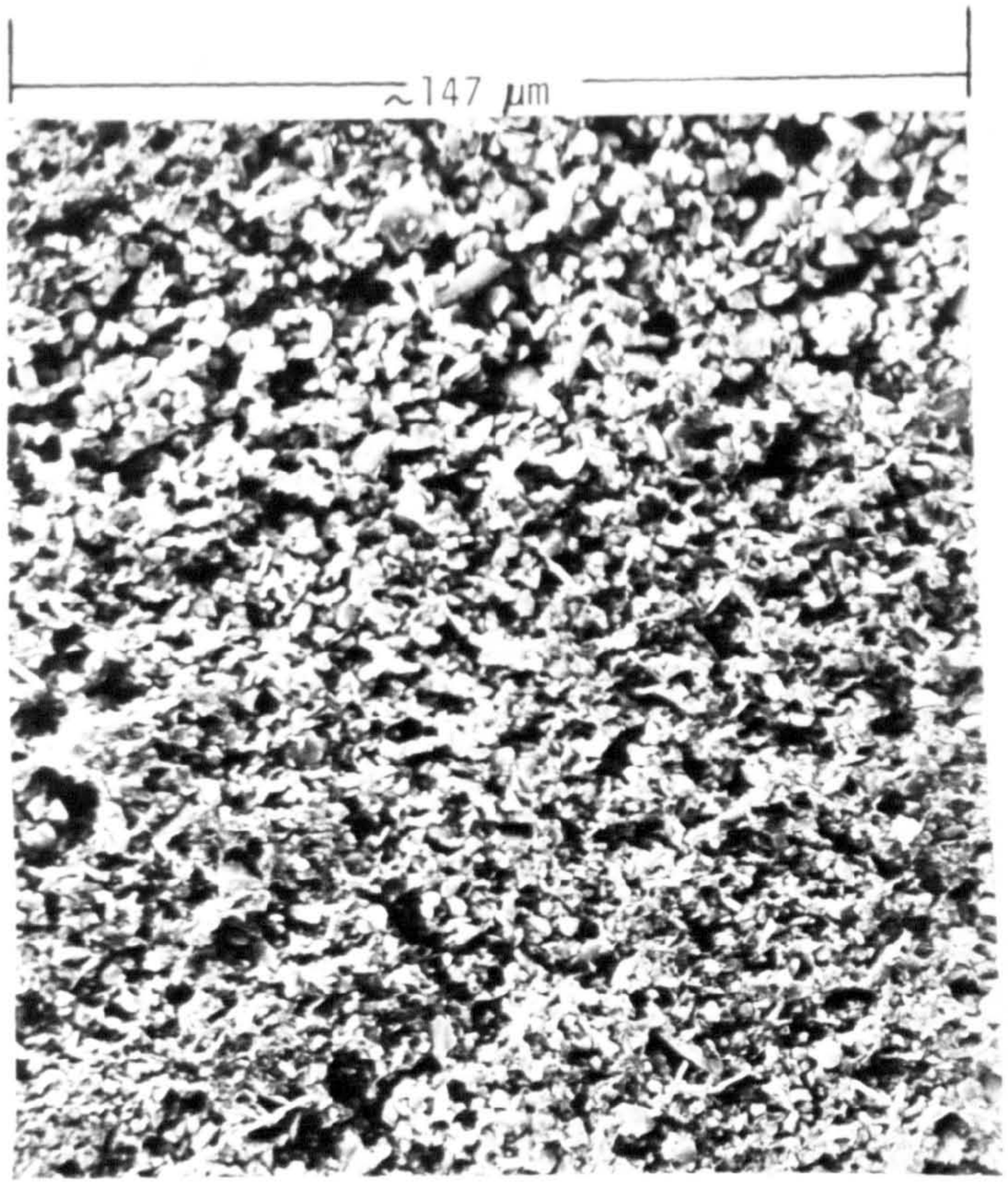
Stereopair

(b) LIGHT LAYER (l): Clean grain-grain contacts

× 1550

~ 42 µm

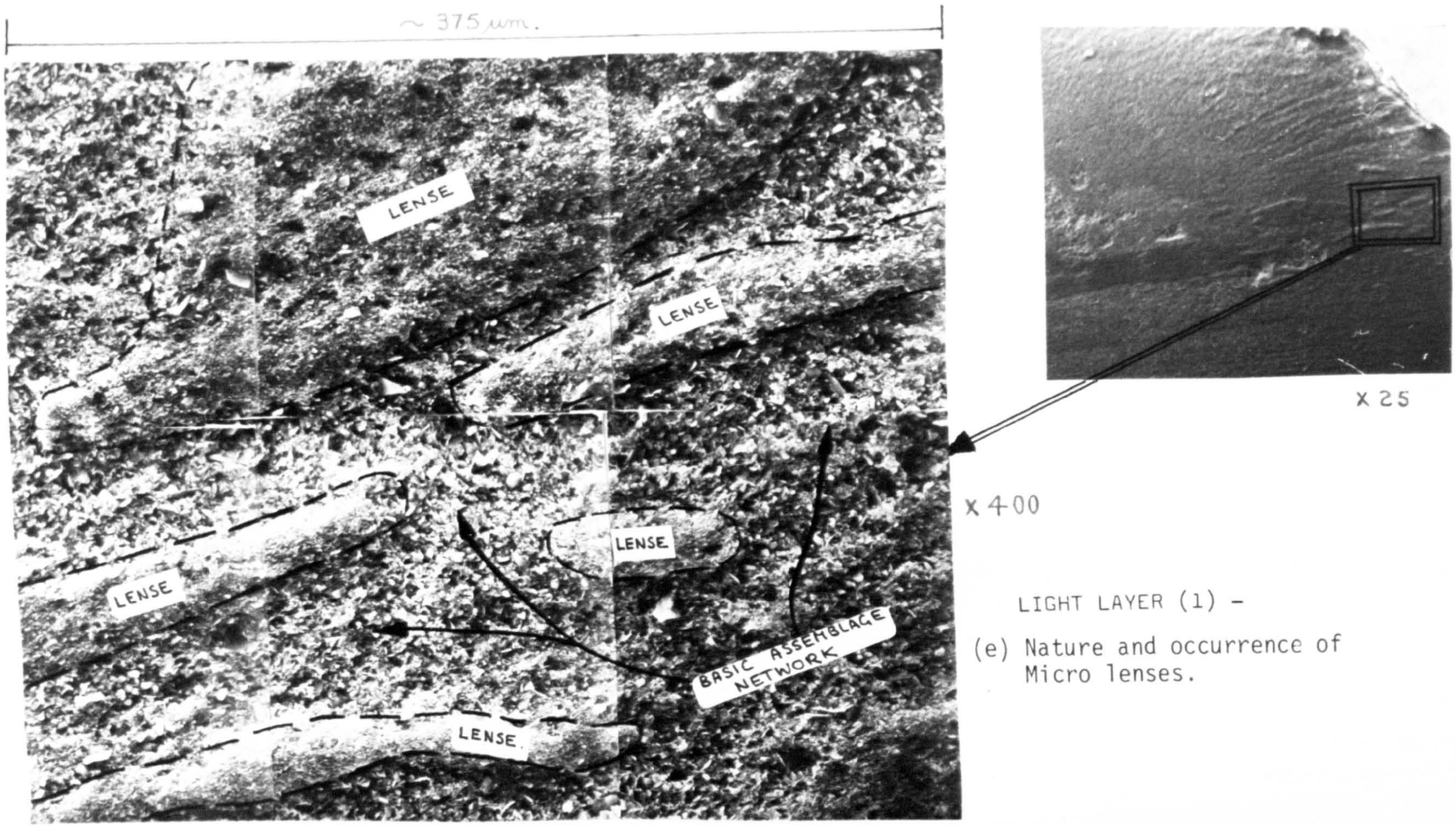
MIC. 5.22 LACUSTRINE VARVED CLAY - NEW LISKEARD, CANADA



(d) LIGHT LAYER (1) - Basic assemblage network comprising a region and connector system. x 625

(c) DARK LAYER - Clay region system x 625

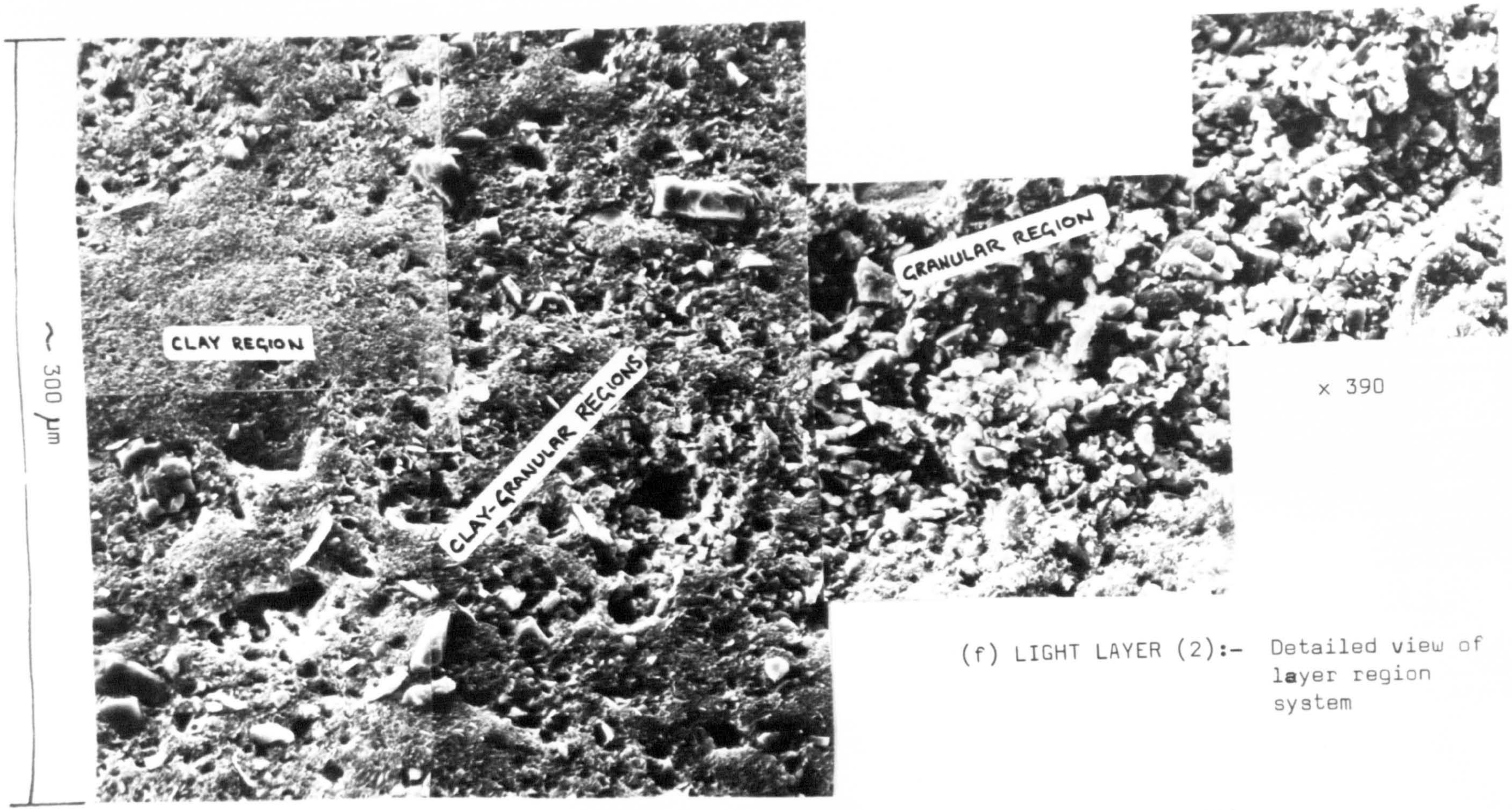
MIC. 5.22. LACUSTRINE VARVED CLAY - NEW LISKEARD, CANADA.



LIGHT LAYER (1) -

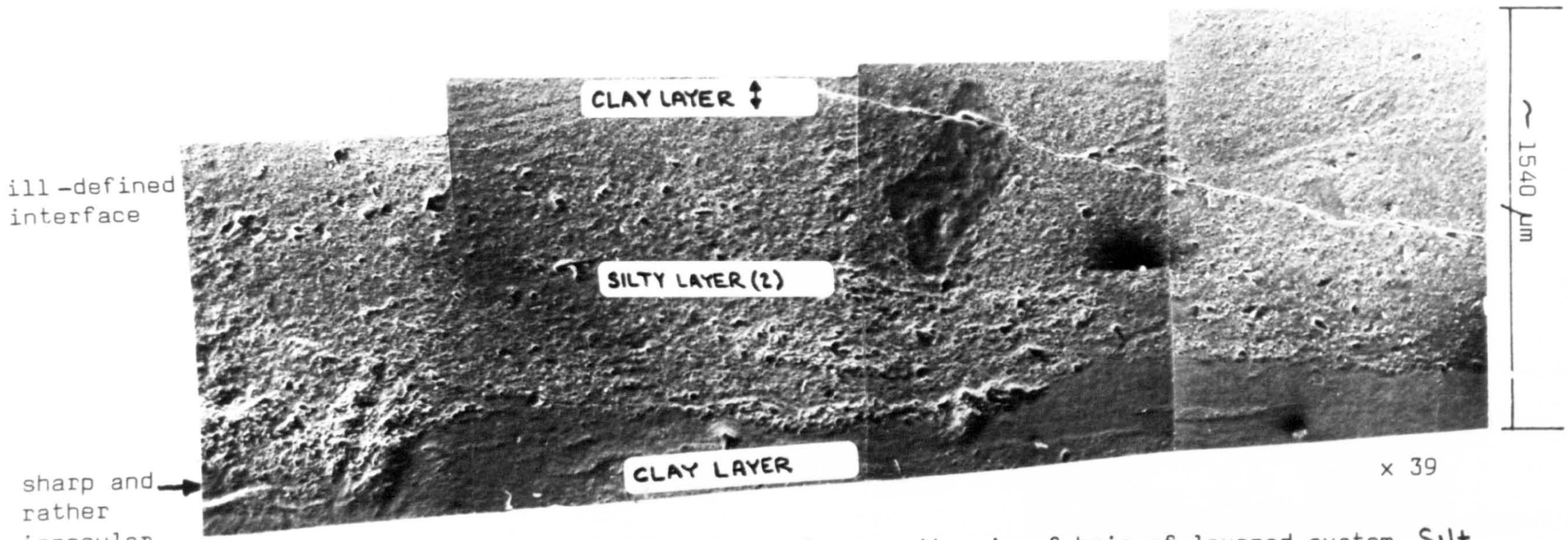
(e) Nature and occurrence of Micro lenses.

MIC. 5.22. LACUSTRINE VARVED CLAY - NEW LISKEARD, CANADA.



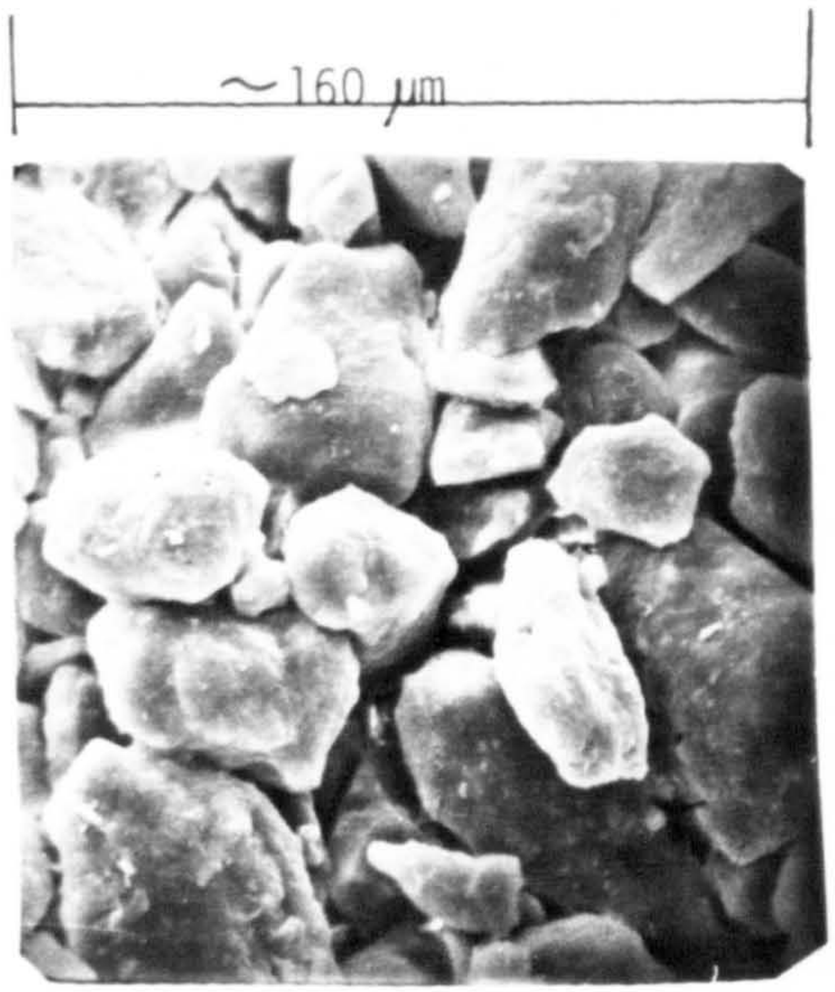
(f) LIGHT LAYER (2):- Detailed view of layer region system

MIC. 5.22 LACUSTRINE VARVED CLAY - NEW LISKEARD, CANADA



(g) Detailed view of portion of composite microfabric of layered system. Silt Layer type (2) shown sandwiched between two clay layers.

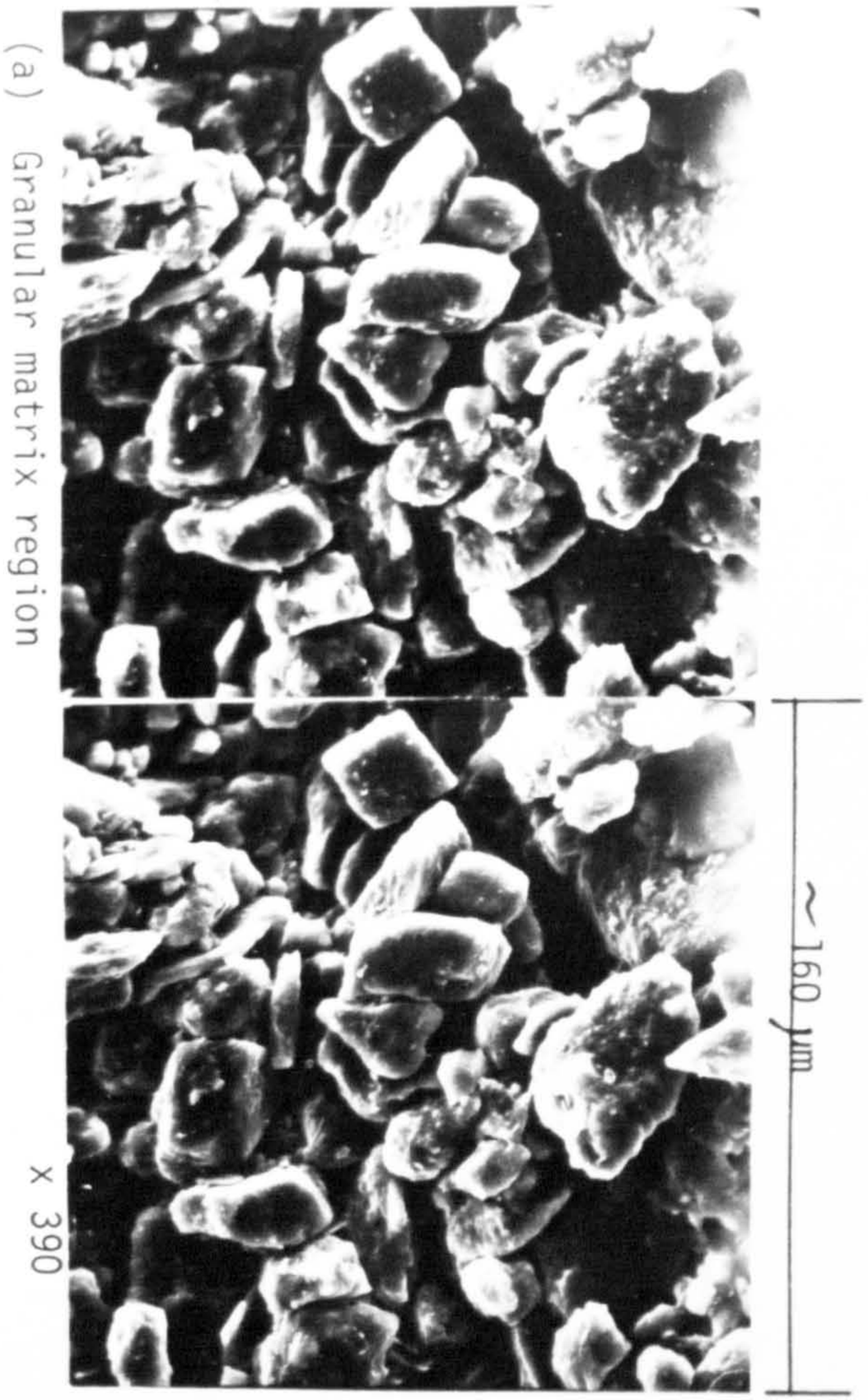
MIC. 5.22. LACUSTRINE VARVED CLAY - NEW LISKEARD, CANADA



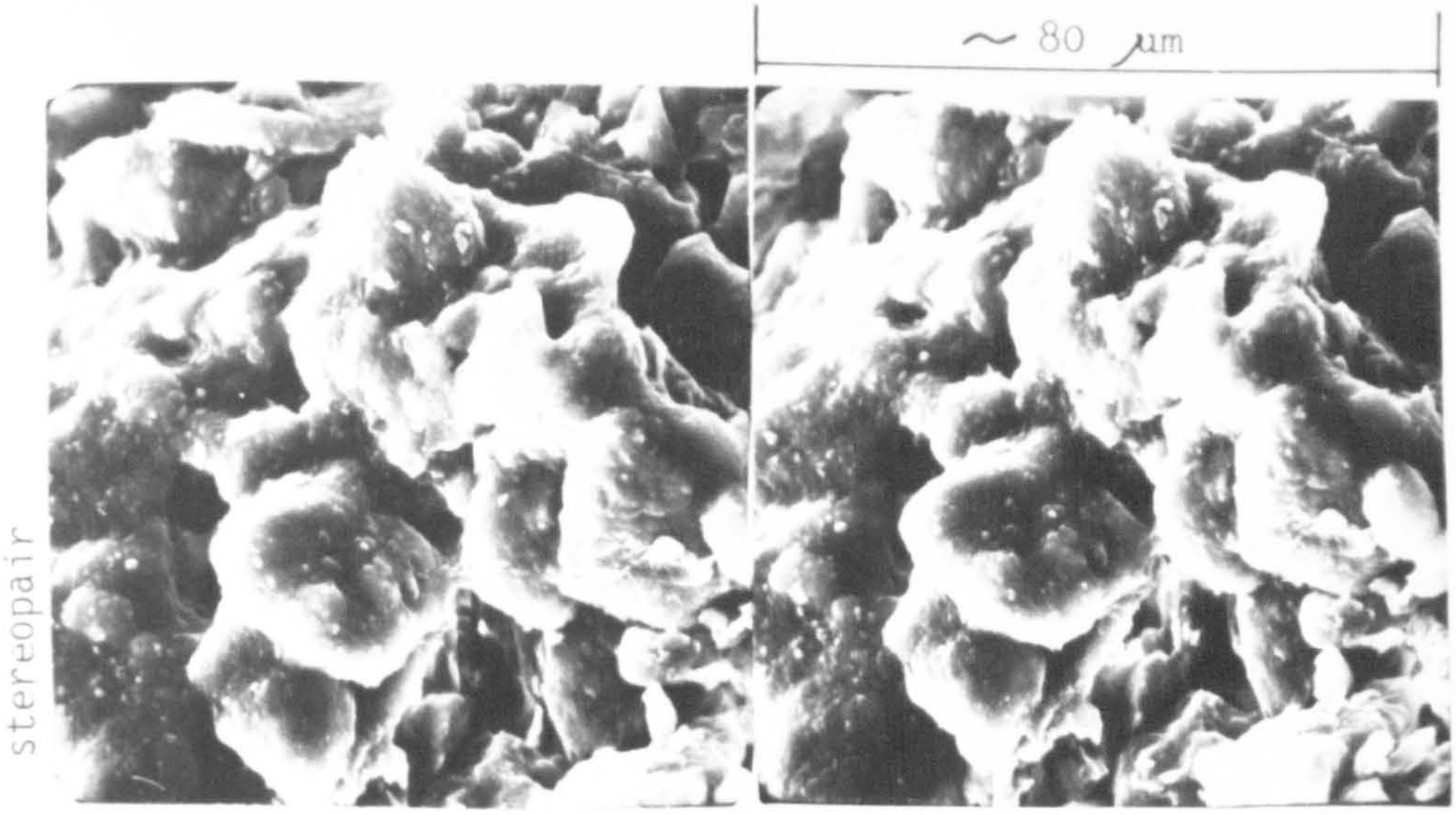
(b) Granular matrix region x390

stereopair

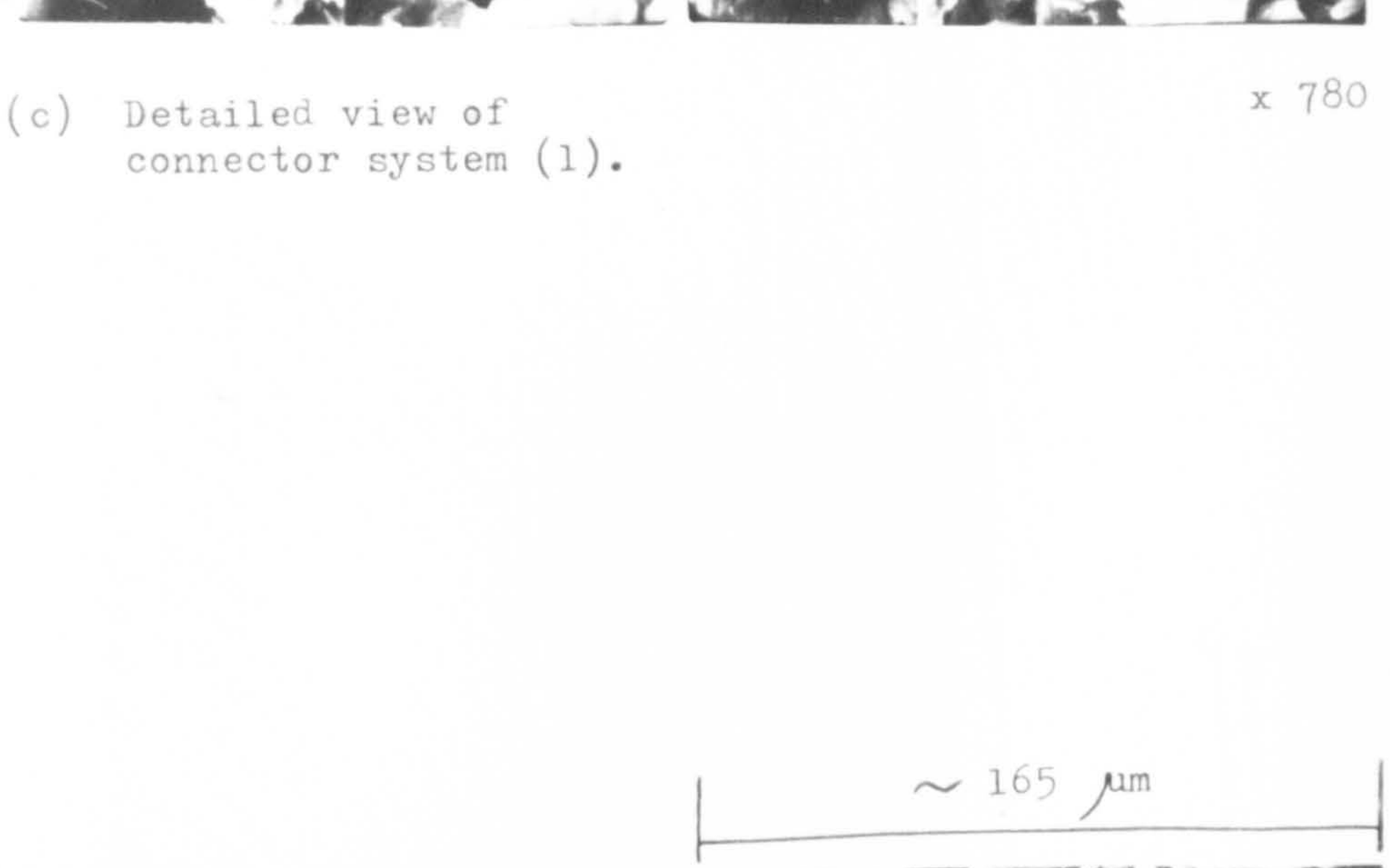
(a) Granular matrix region



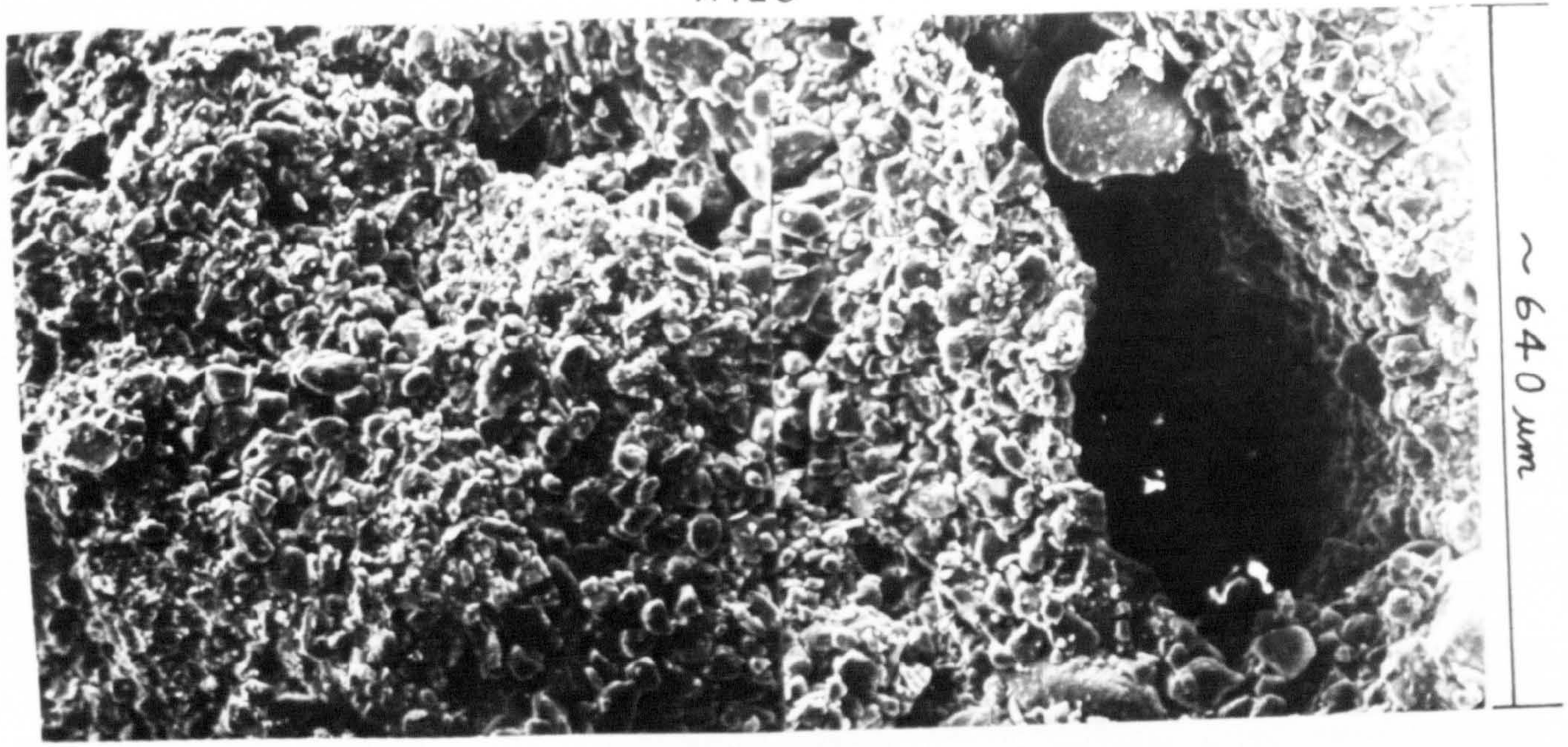
MIC. 5.23. LOESS - FORD, ENGLAND



(c) Detailed view of connector system (1). x 780

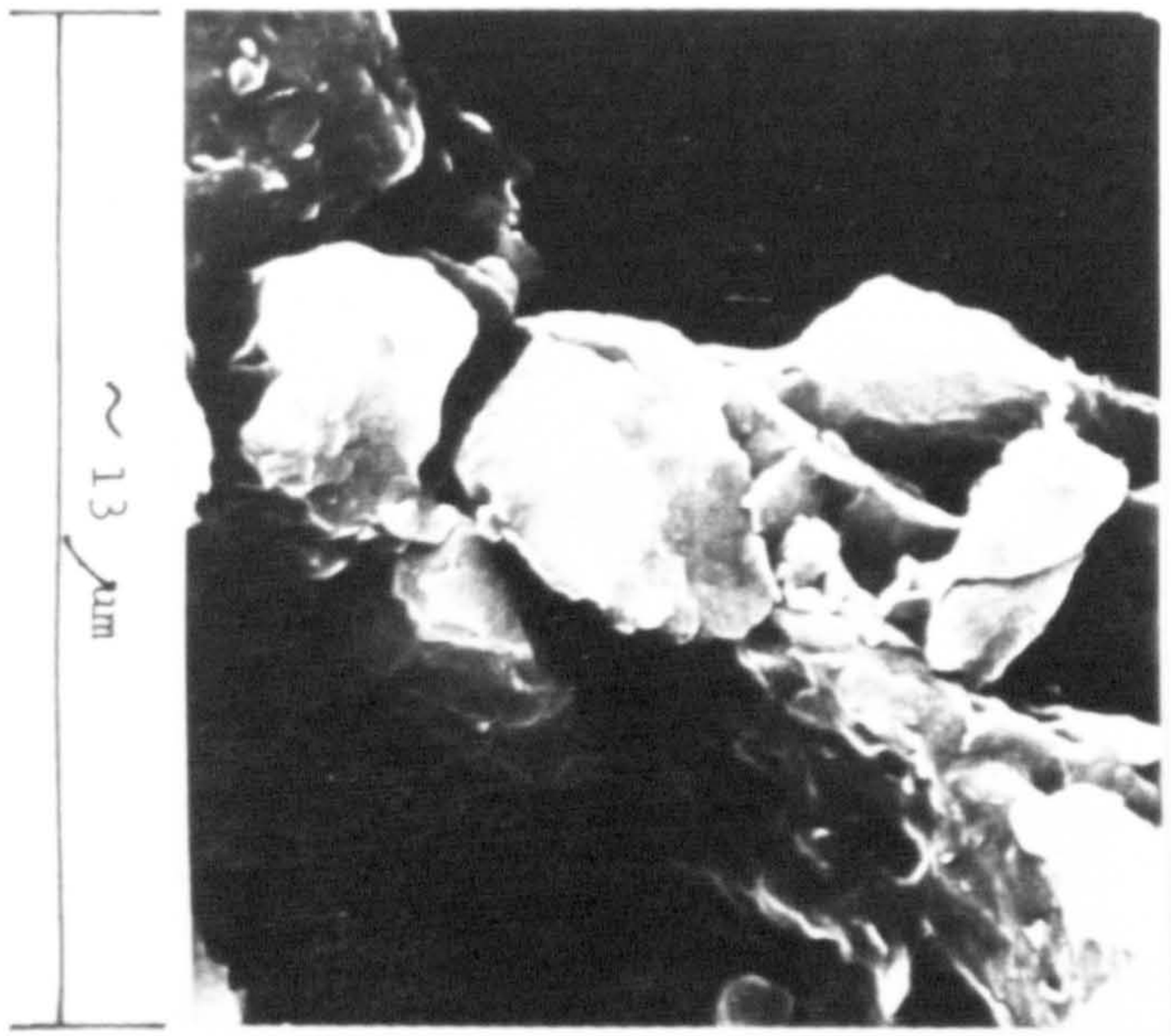


(d) Detailed view of connector system (2). x 390



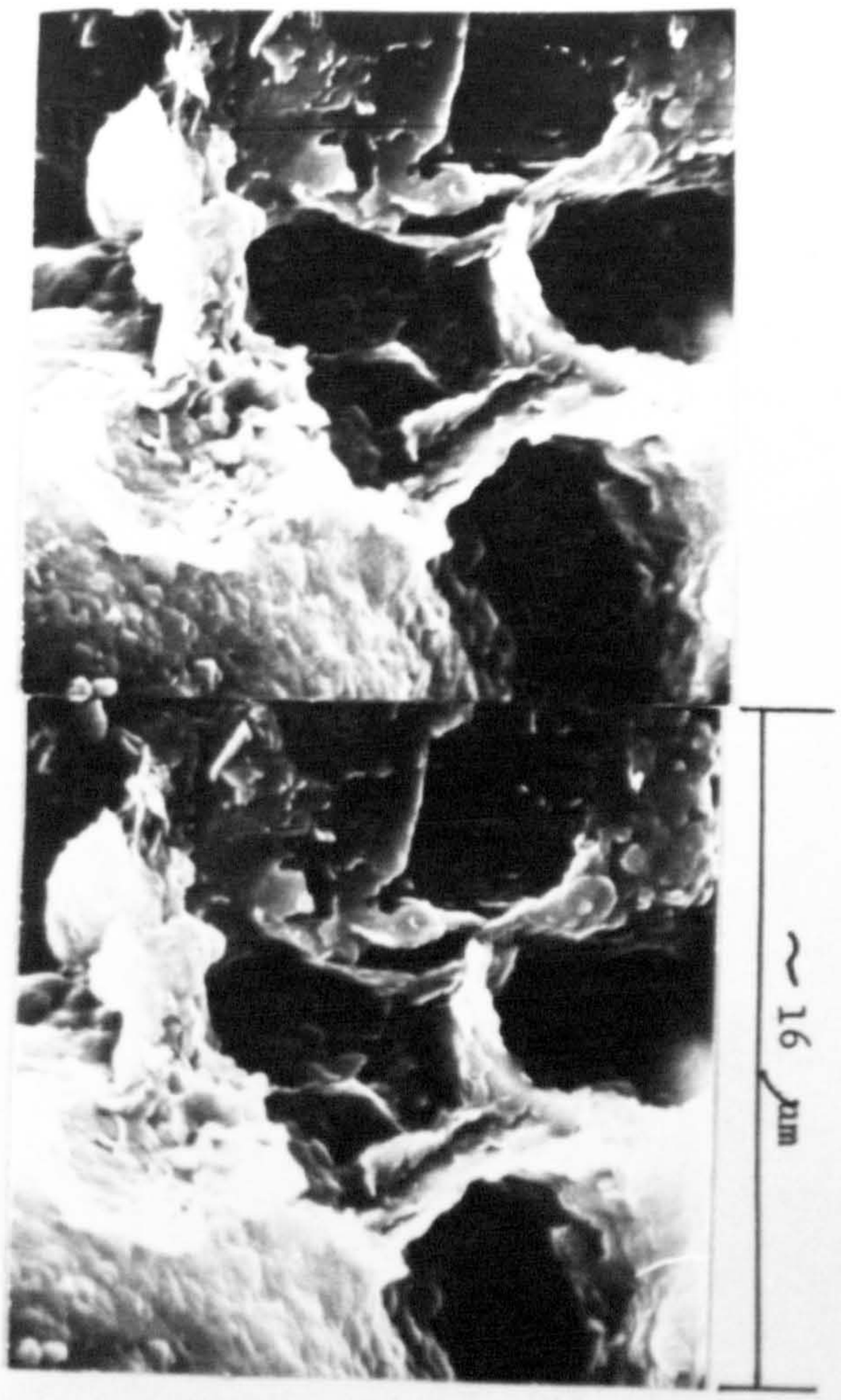
(e) Composite Microfabric

MIC. 5.23. LOESS - FORD, ENGLAND



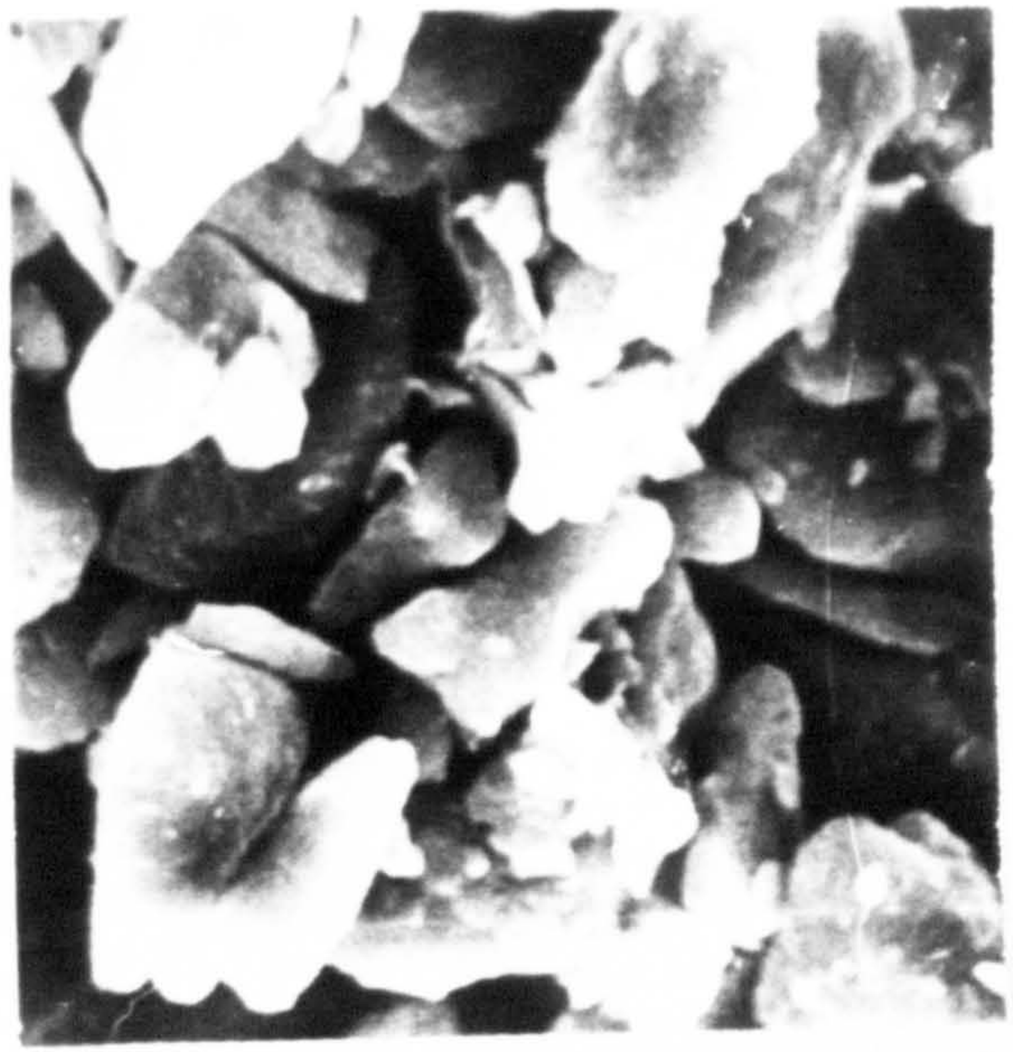
(b) Silt (bridge) connector x 5750

stereopair



(a) Clay (bridge) connectors. x 3900

MIC. 5.24. LOESS - TONGRINNE, BELGIUM

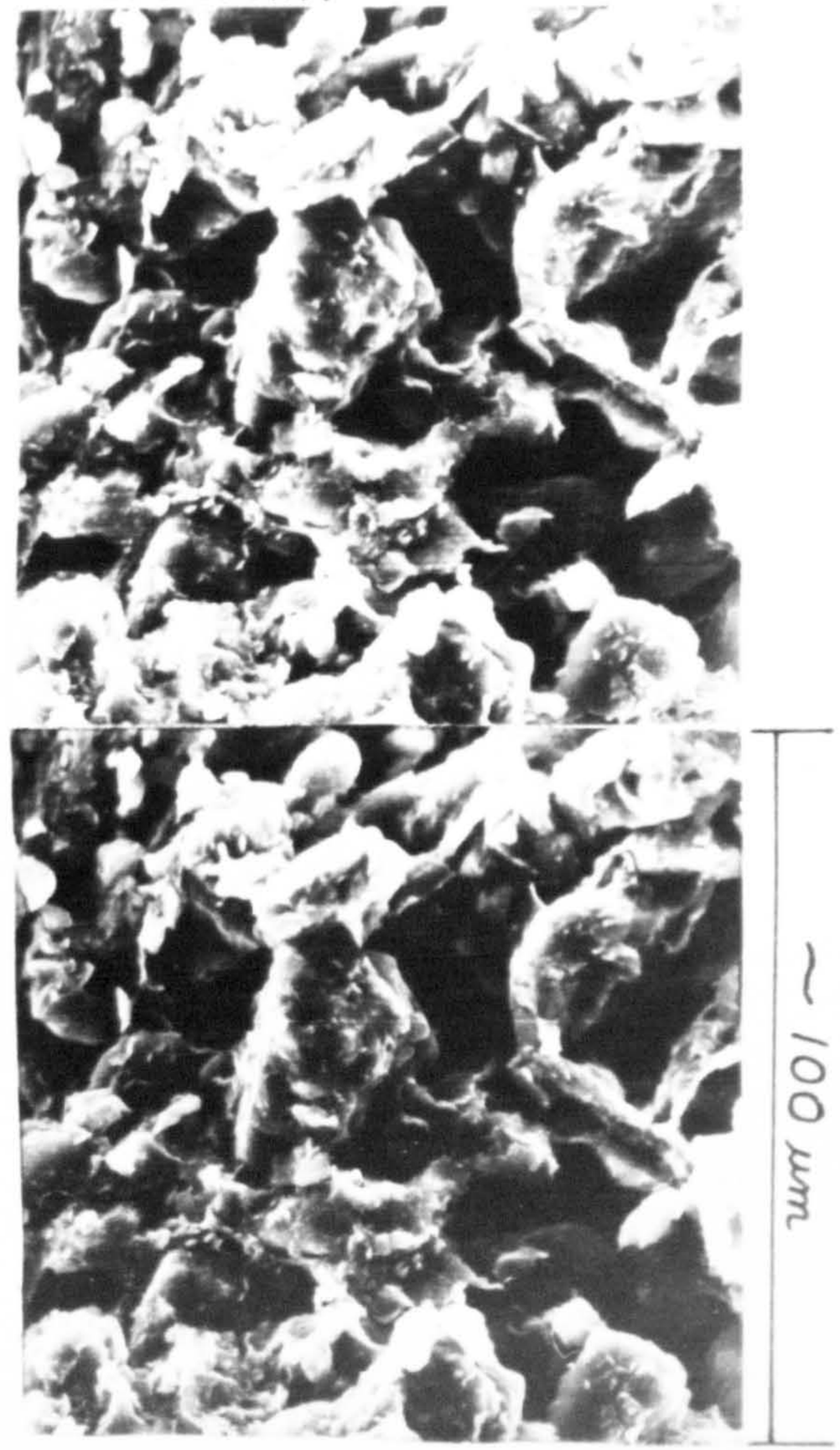


x 1400

(d) Granular Matrix Region Comprising Mainly Clean Grain-Grain Contacts

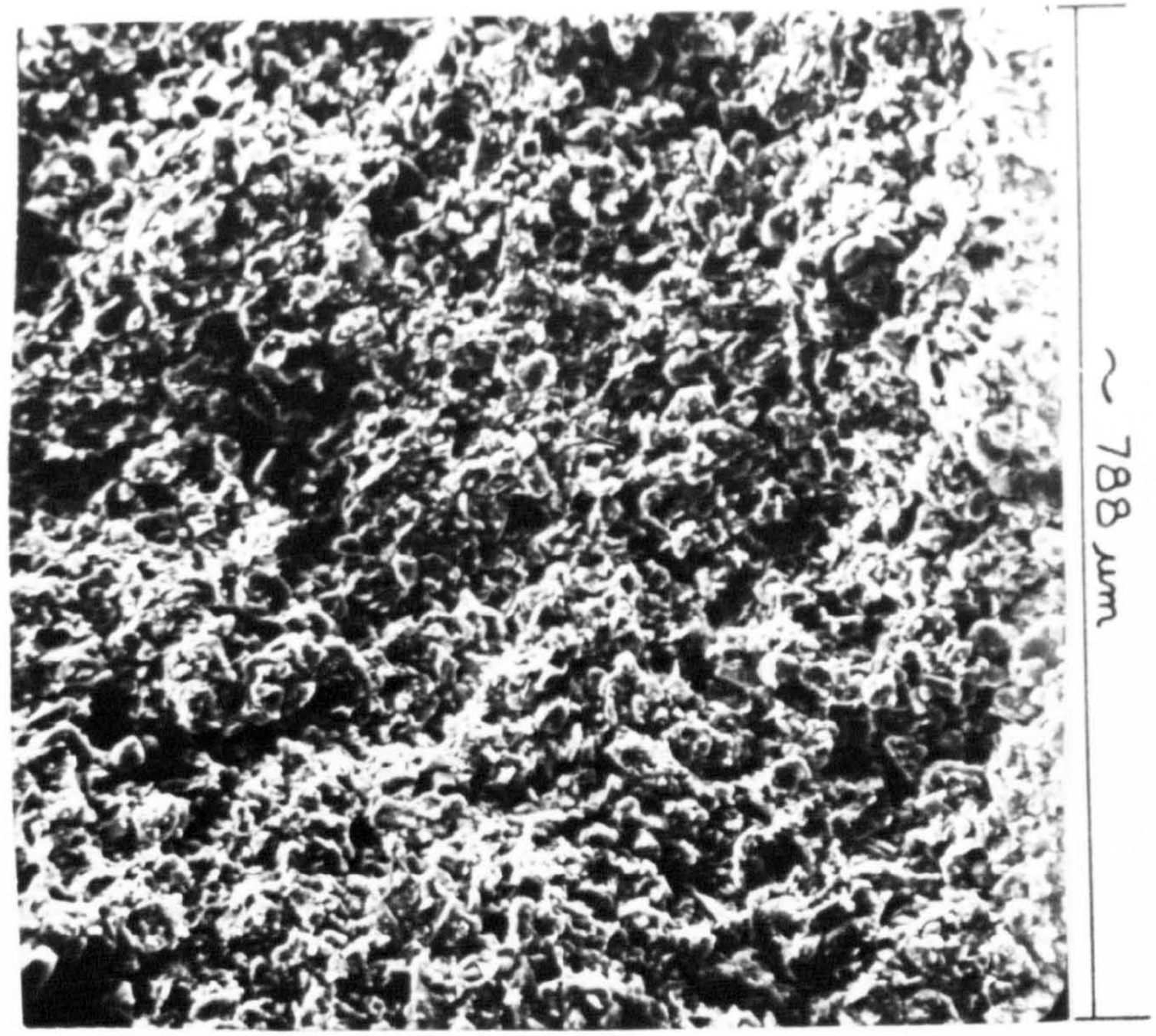
STEREOPAIR

(c) Connector System



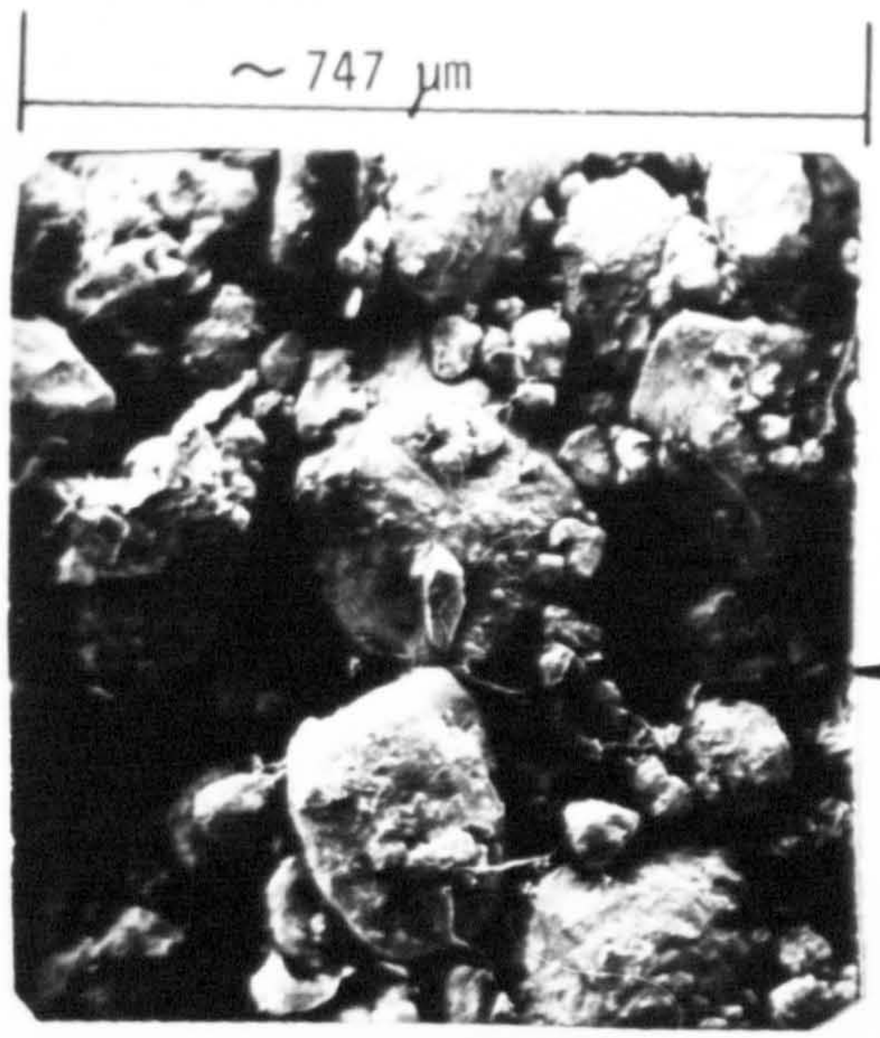
x 625

MIC. 5.24. LOESS - TONGRINNE, BELGIUM

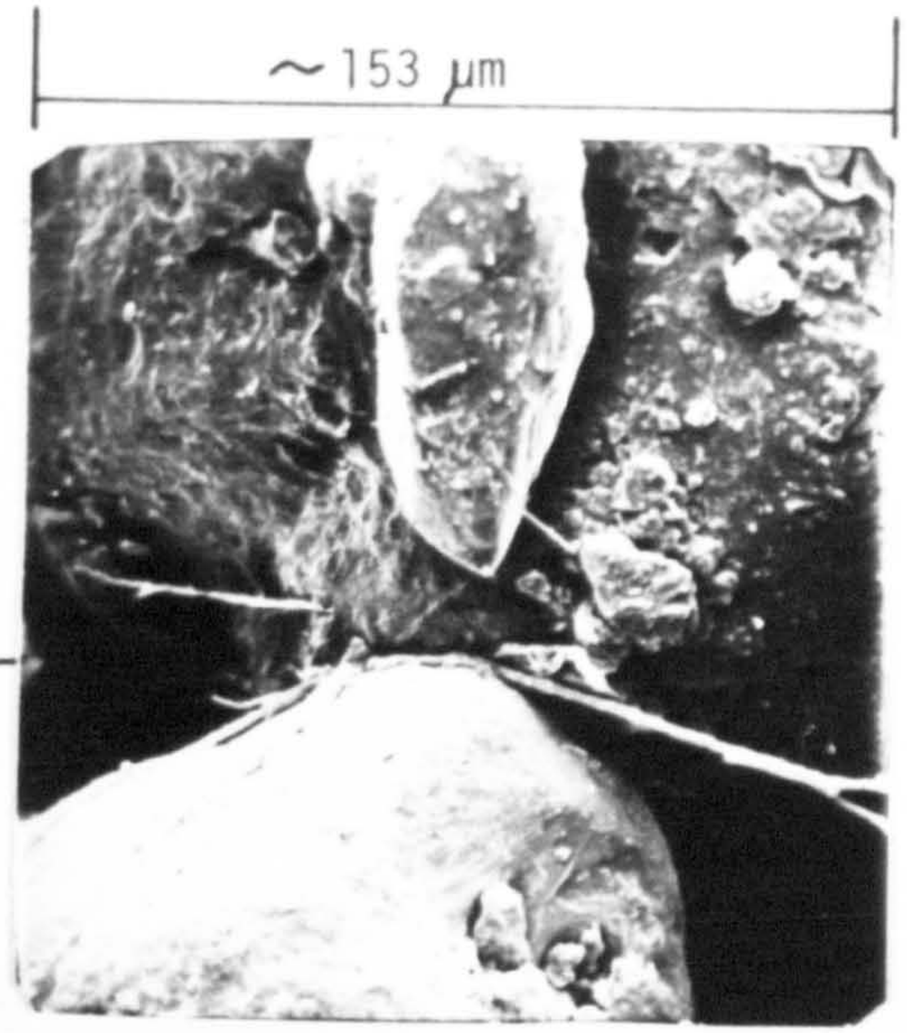


(e) Composite Microfabric

MIC. 5.24. LOESS - TONGRINNE, BELGIUM

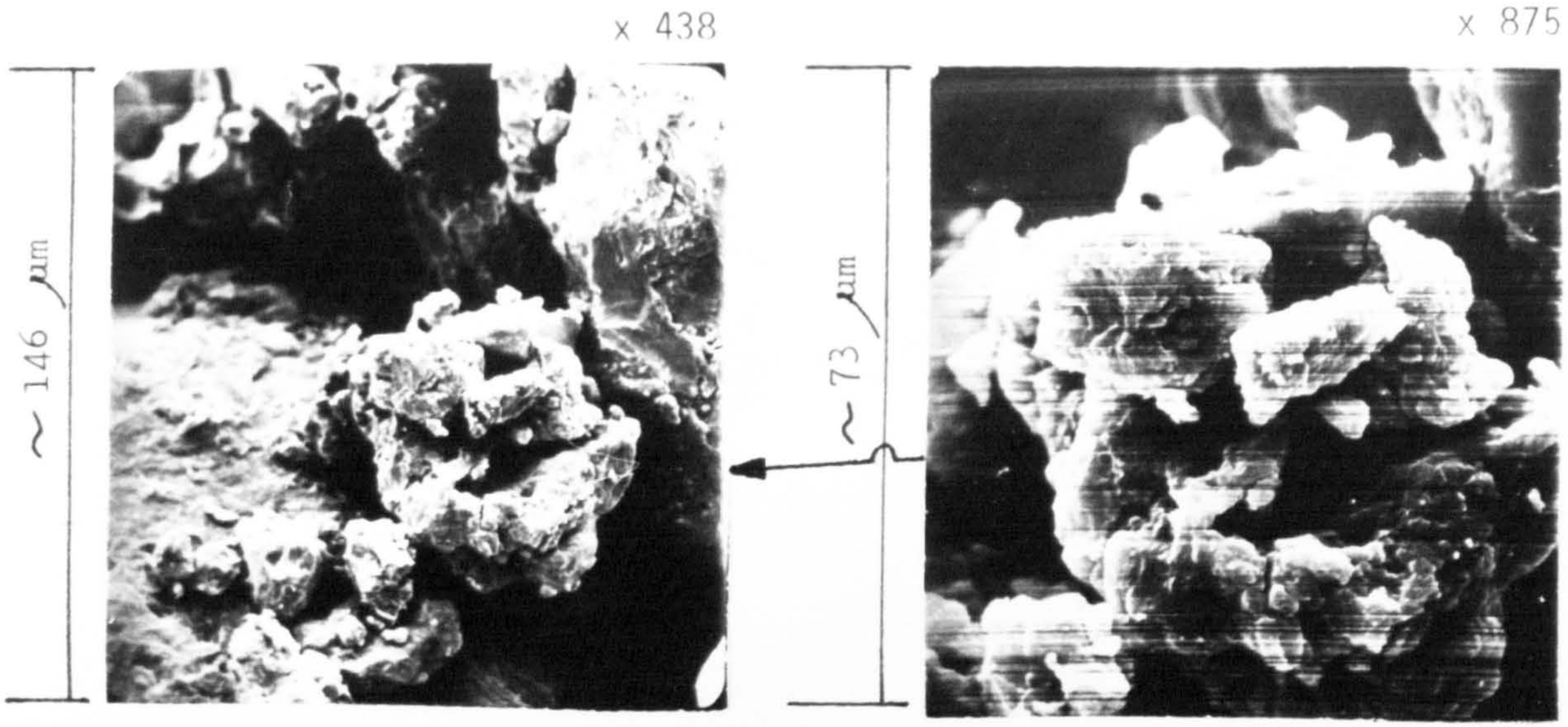


(b) Coarse granular matrix region x 85

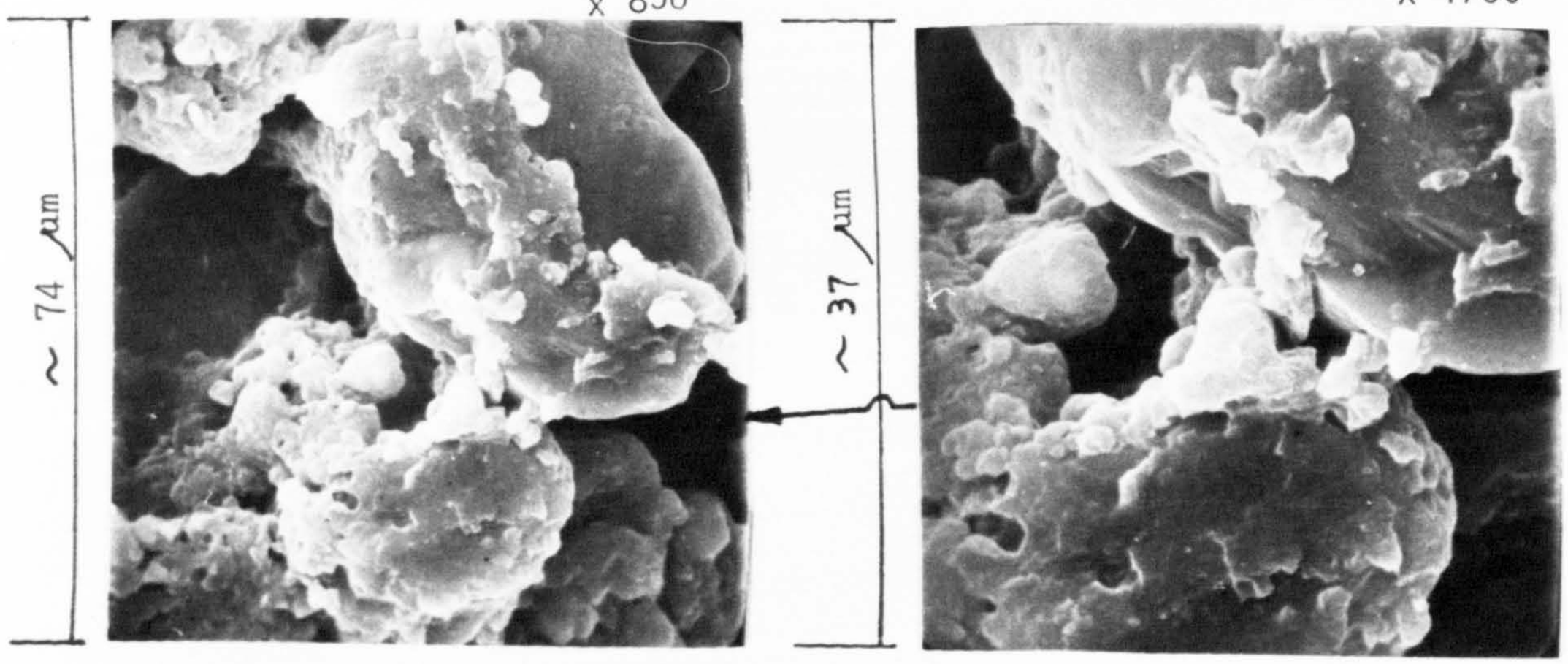


(a) Clothed grain-grain contact. Note presence of root. x425

MIC. 5.25. AEOLIAN SAND - TRANSVAAL, S.A.

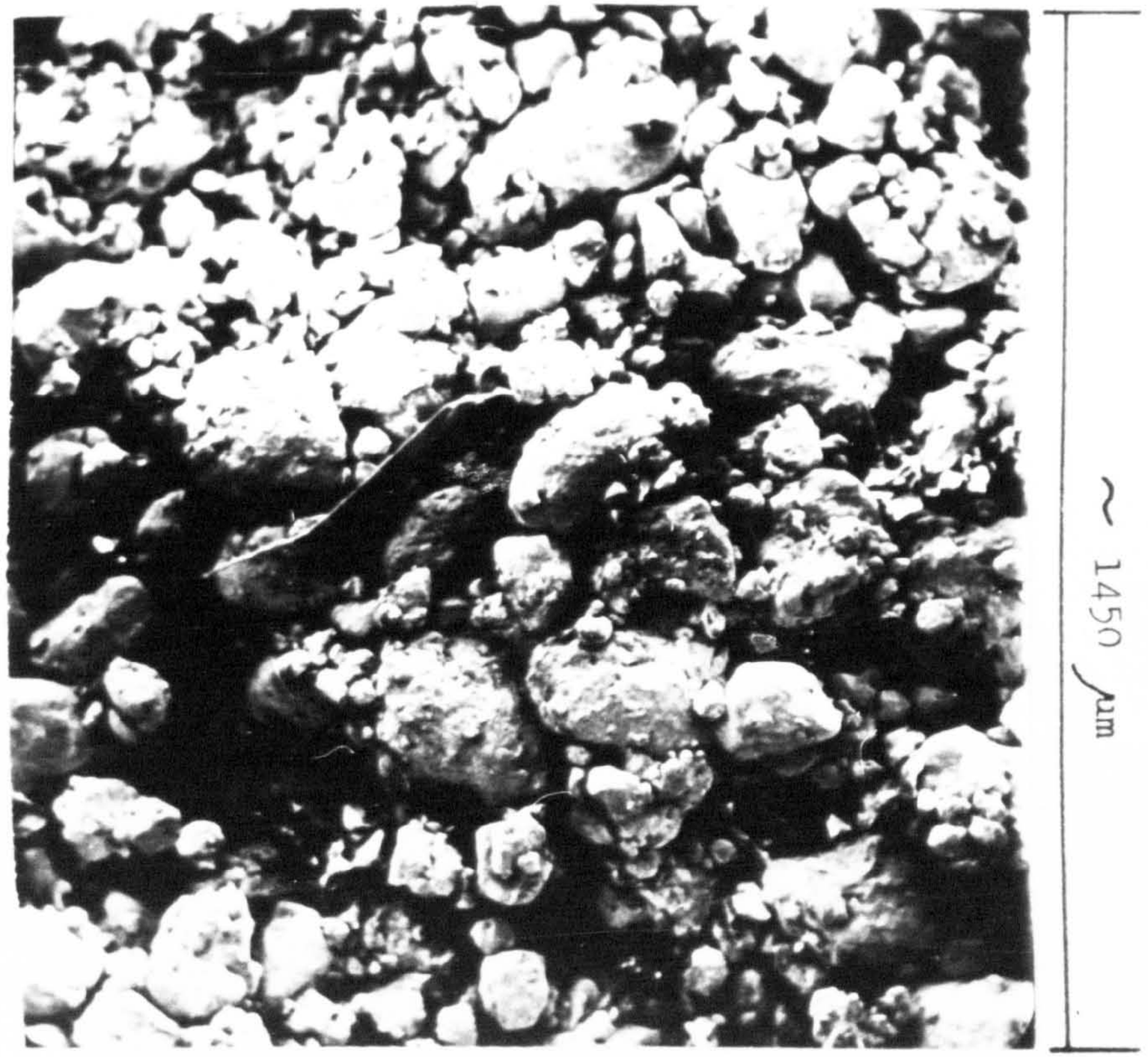


(c) Aggregation



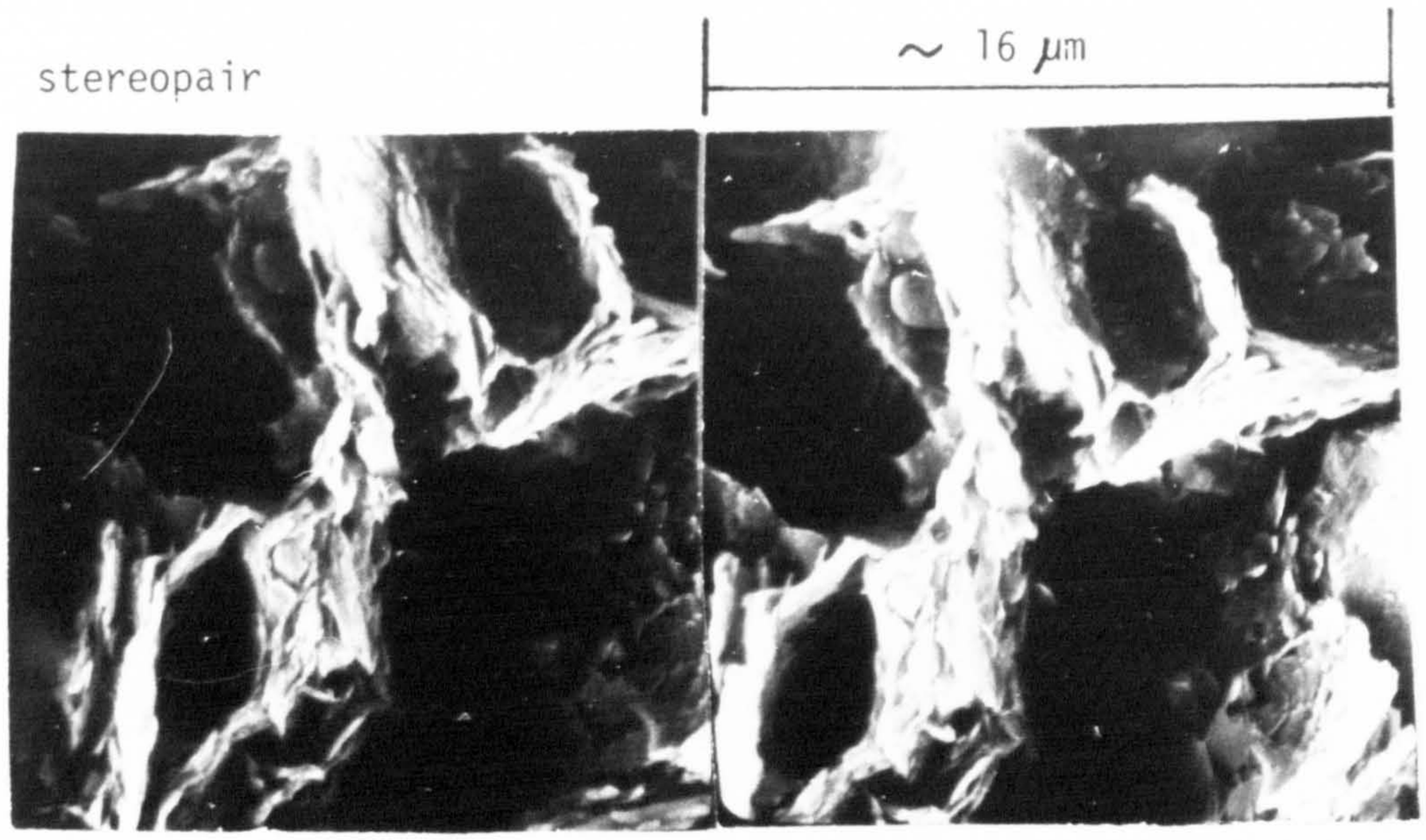
(d) Buttress connector

MIC. 5.25. AEOLIAN SAND - TRANSVAAL, S.A.



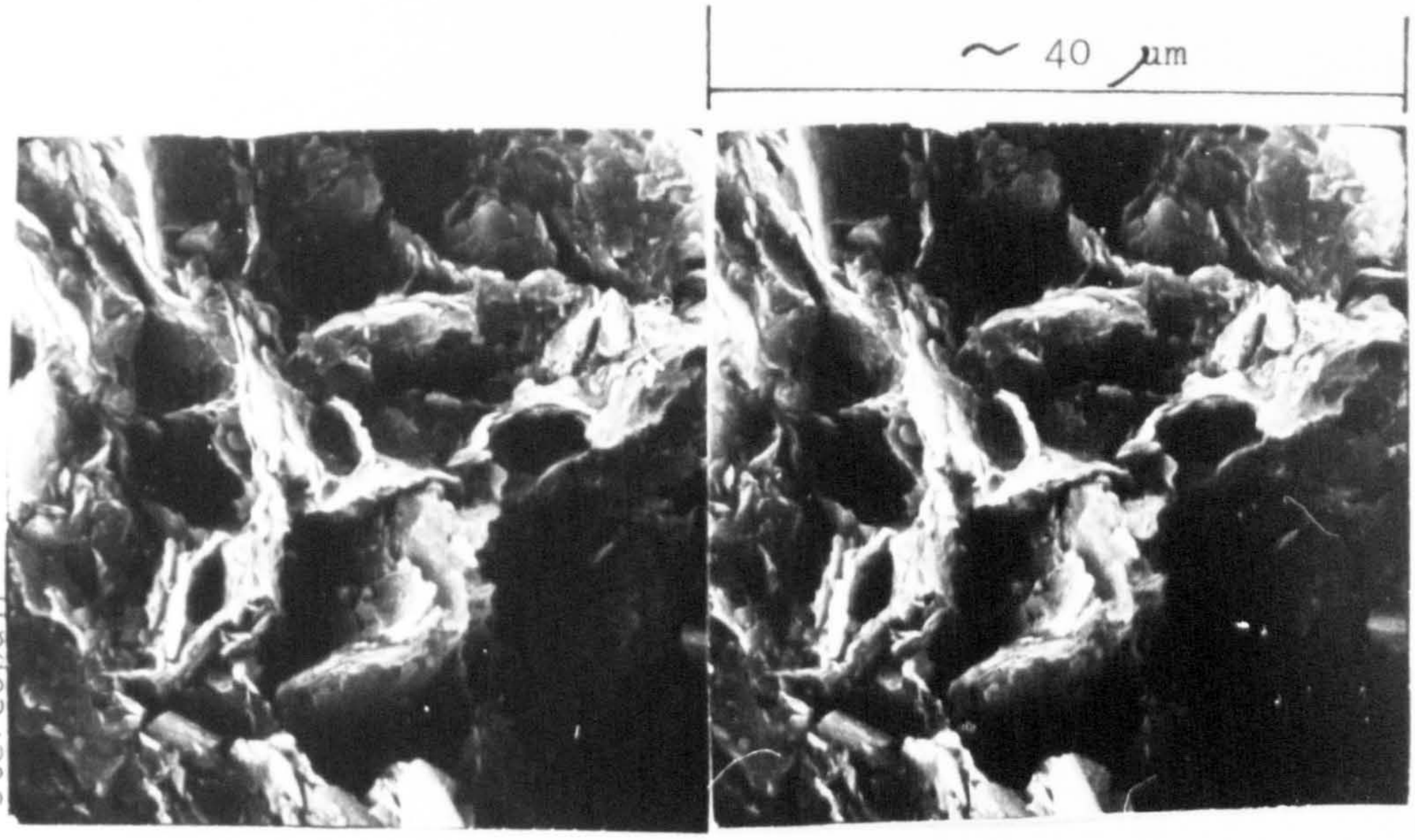
(e) Composite microfabric x 70

MIC. 5.25. AEOLIAN SAND - TRANSVAAL, S.A.

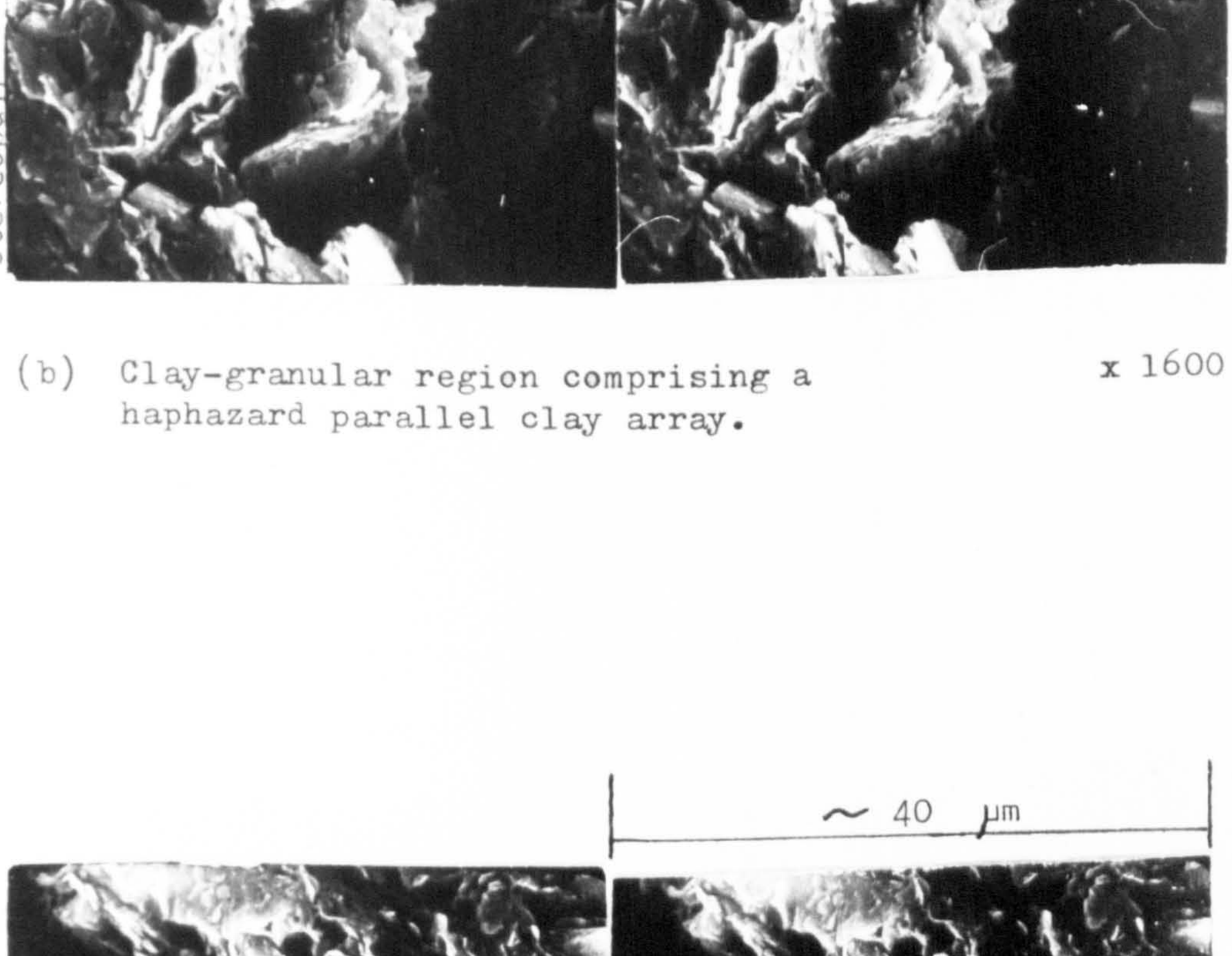


(a) Detailed view of haphazard parallel clay array x 3950

MIC. 5.26. WEATHERED LODGEMENT TILL - HURLFORD, SCOTLAND

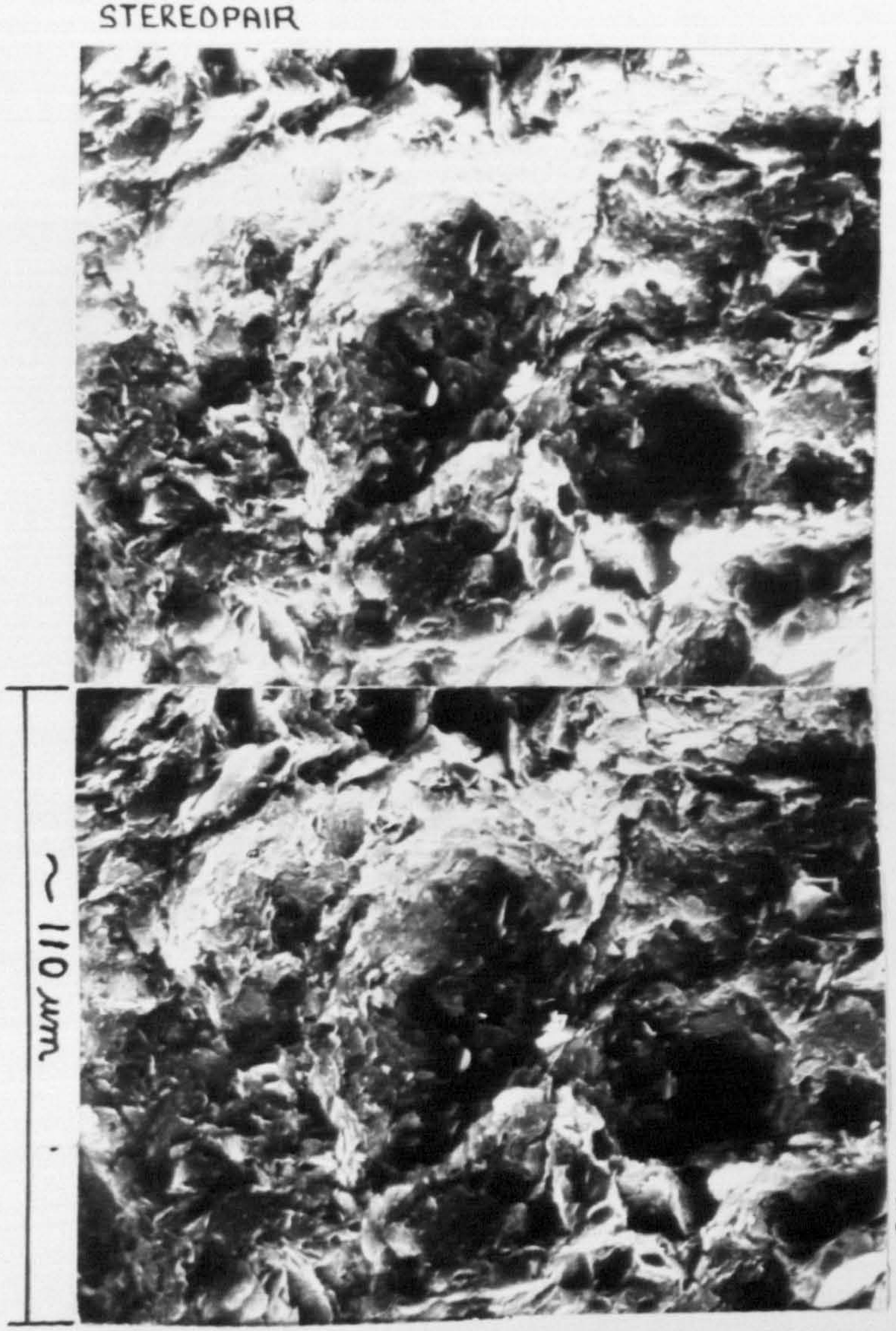


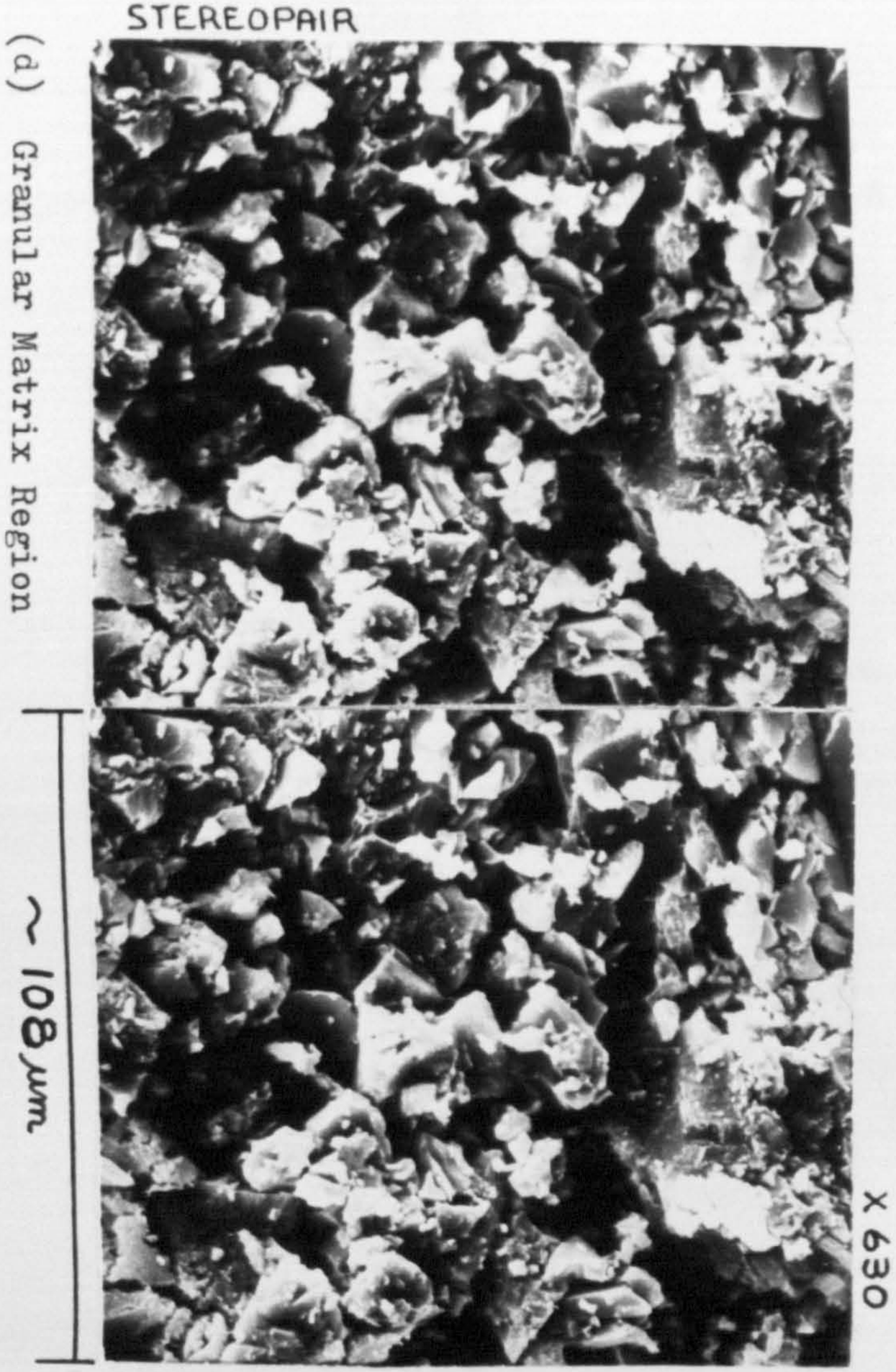
(b) Clay-granular region comprising a haphazard parallel clay array. x 1600



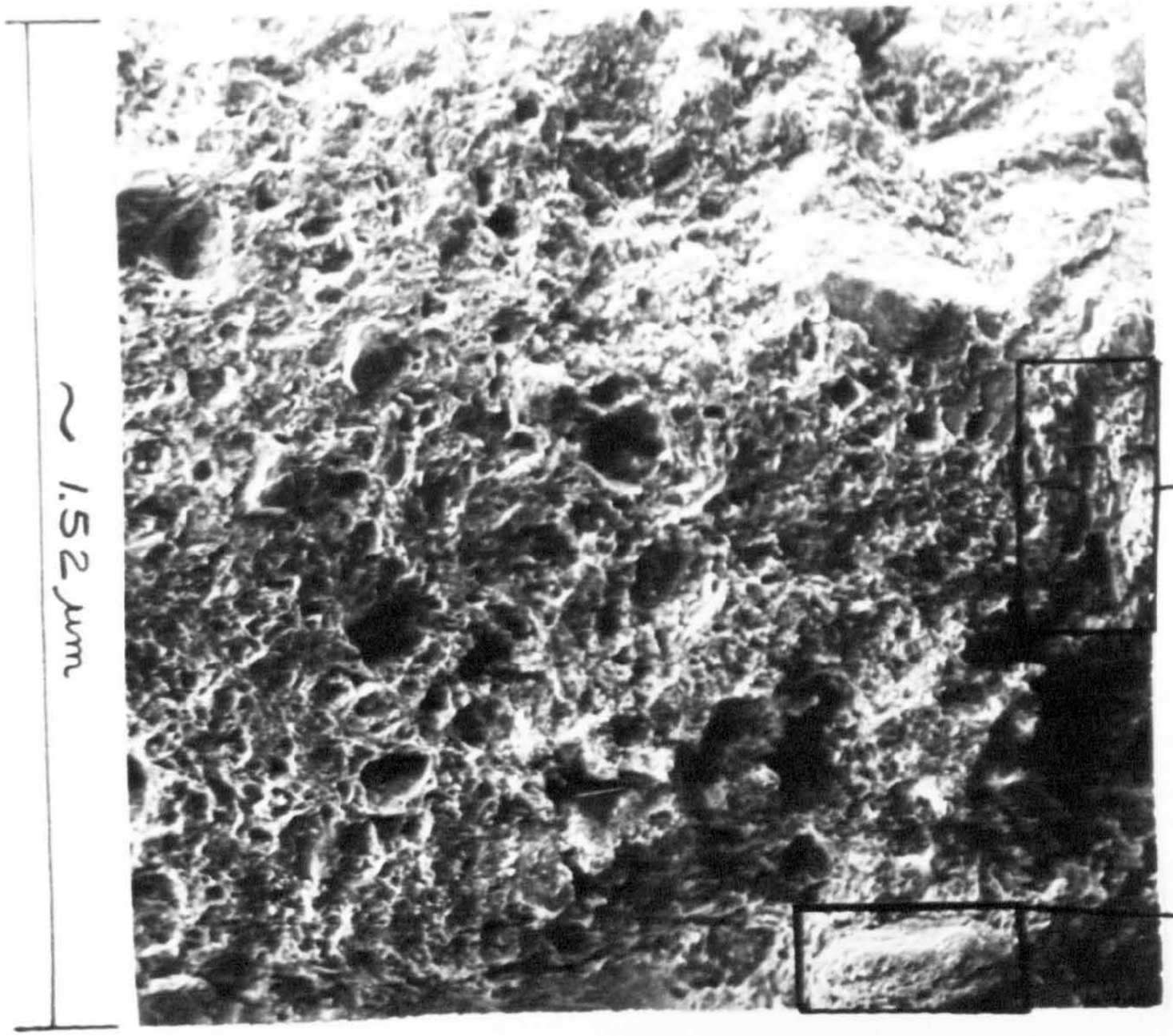
(c) Clay-granular region comprising a predominantly parallel clay array displaying strong preferred orientation. x 1600

MIC. 5.26. WEATHERED LODGEMENT TILL - HURLFORD, SCOTLAND

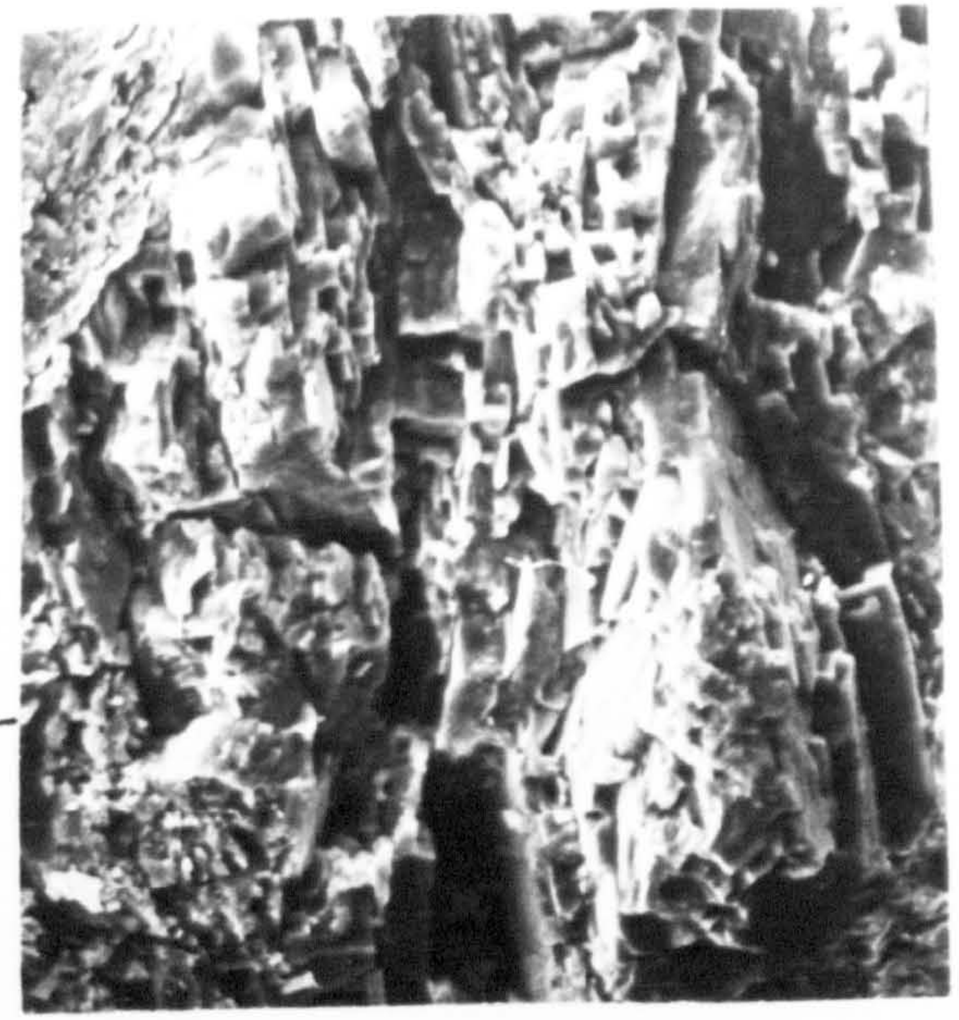




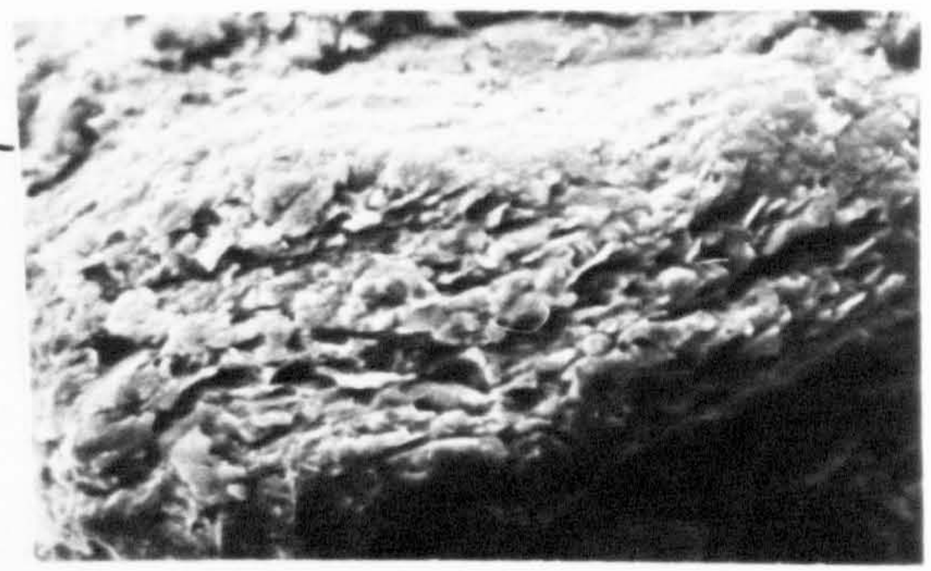
MIC. 5.26. WEATHERED LODGEMENT TILL - HURLFORD, SCOTLAND



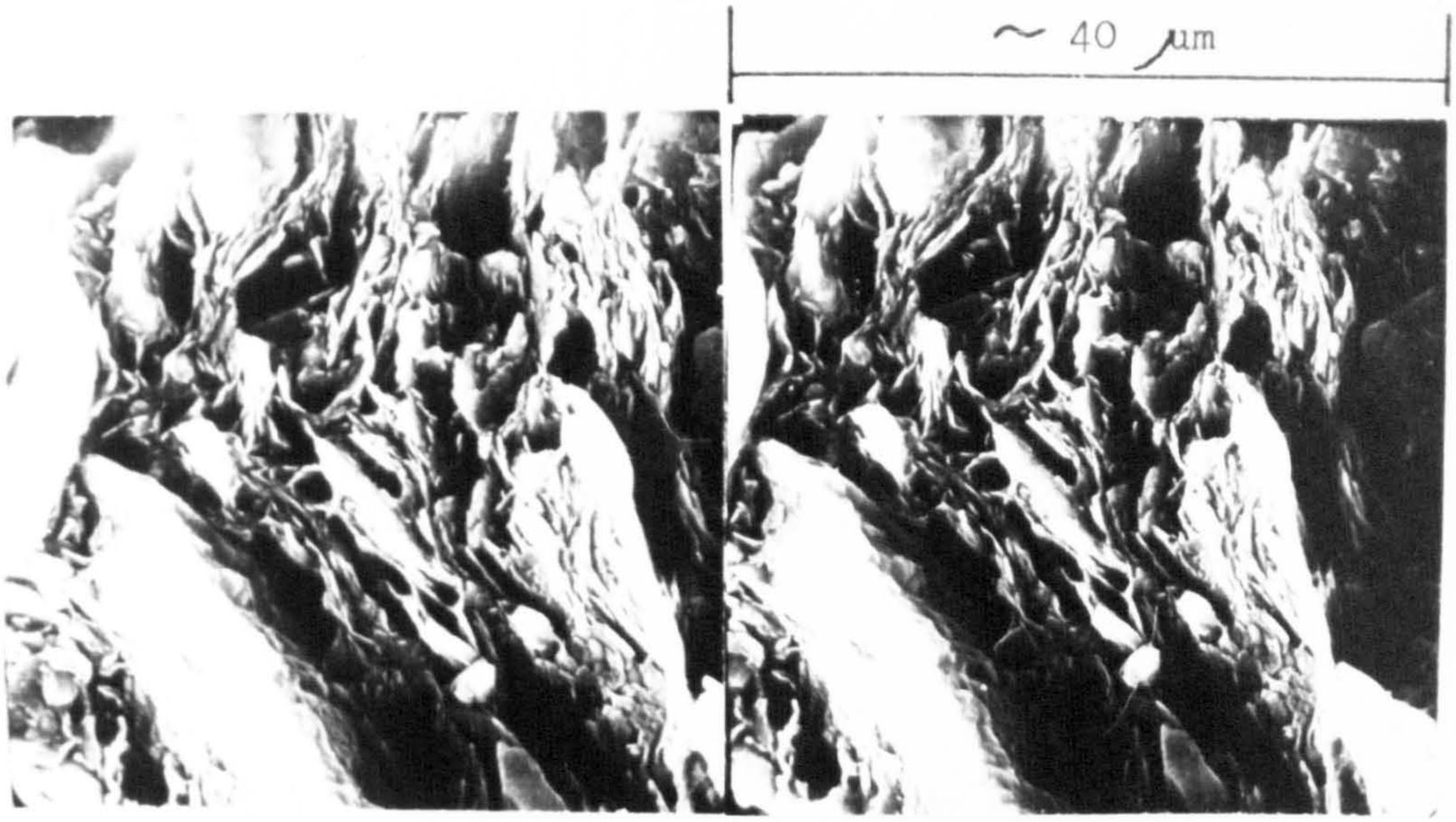
(f) Composite Microfabric x 63



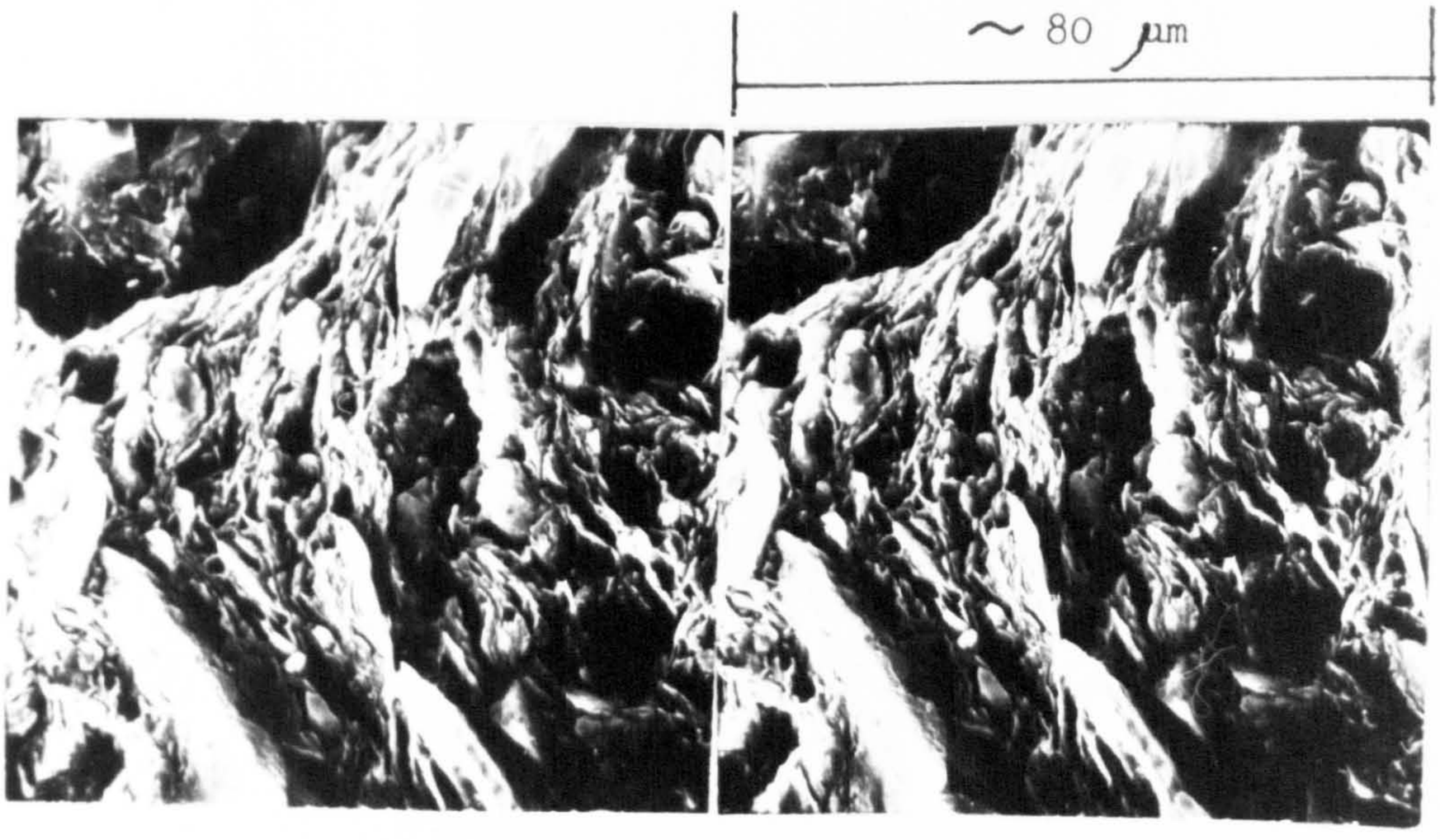
Sand Grains in State of Decomposition



MIC. 5.26. WEATHERED LODGEMENT TILL - HURLFORD, SCOTLAND

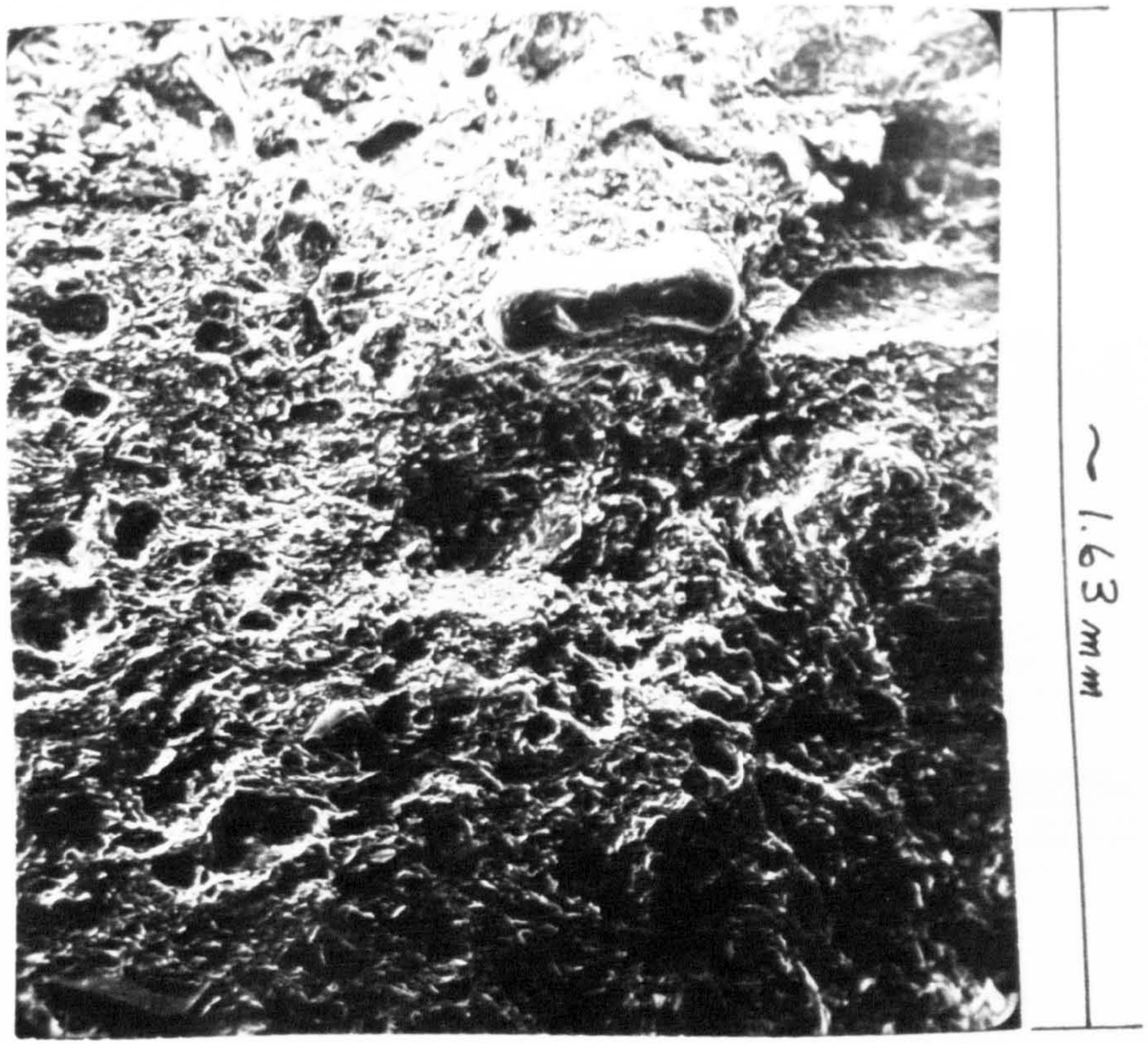


(a) Parallel clay arrangements. x 1600



(b) Clay-granular matrix region comprising a parallel clay array displaying strong preferred orientation. x 780

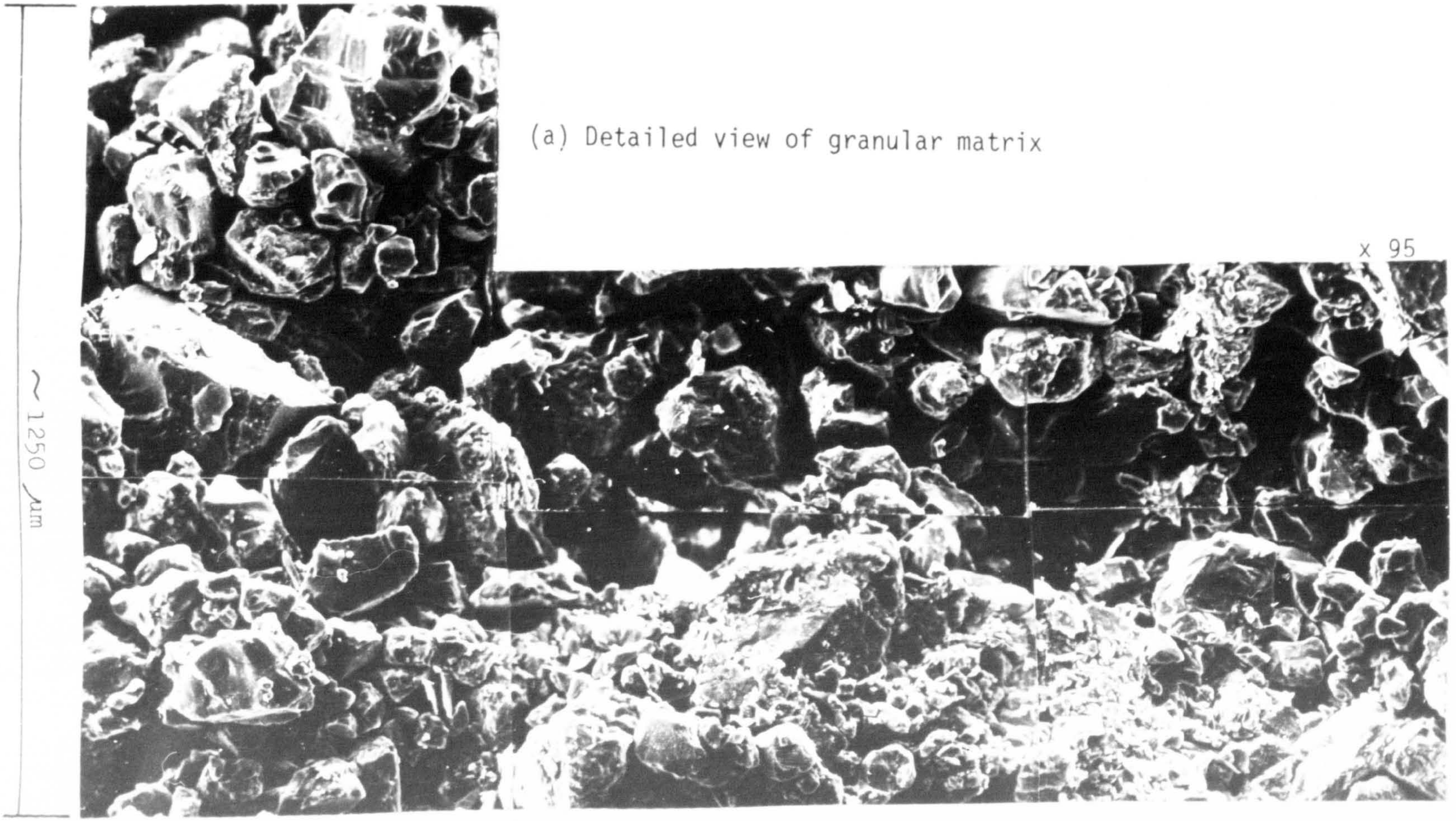
FIG. 5.27. FRESH LODGEMENT TILL - HURLFORD, SCOTLAND MICROFABRIC.



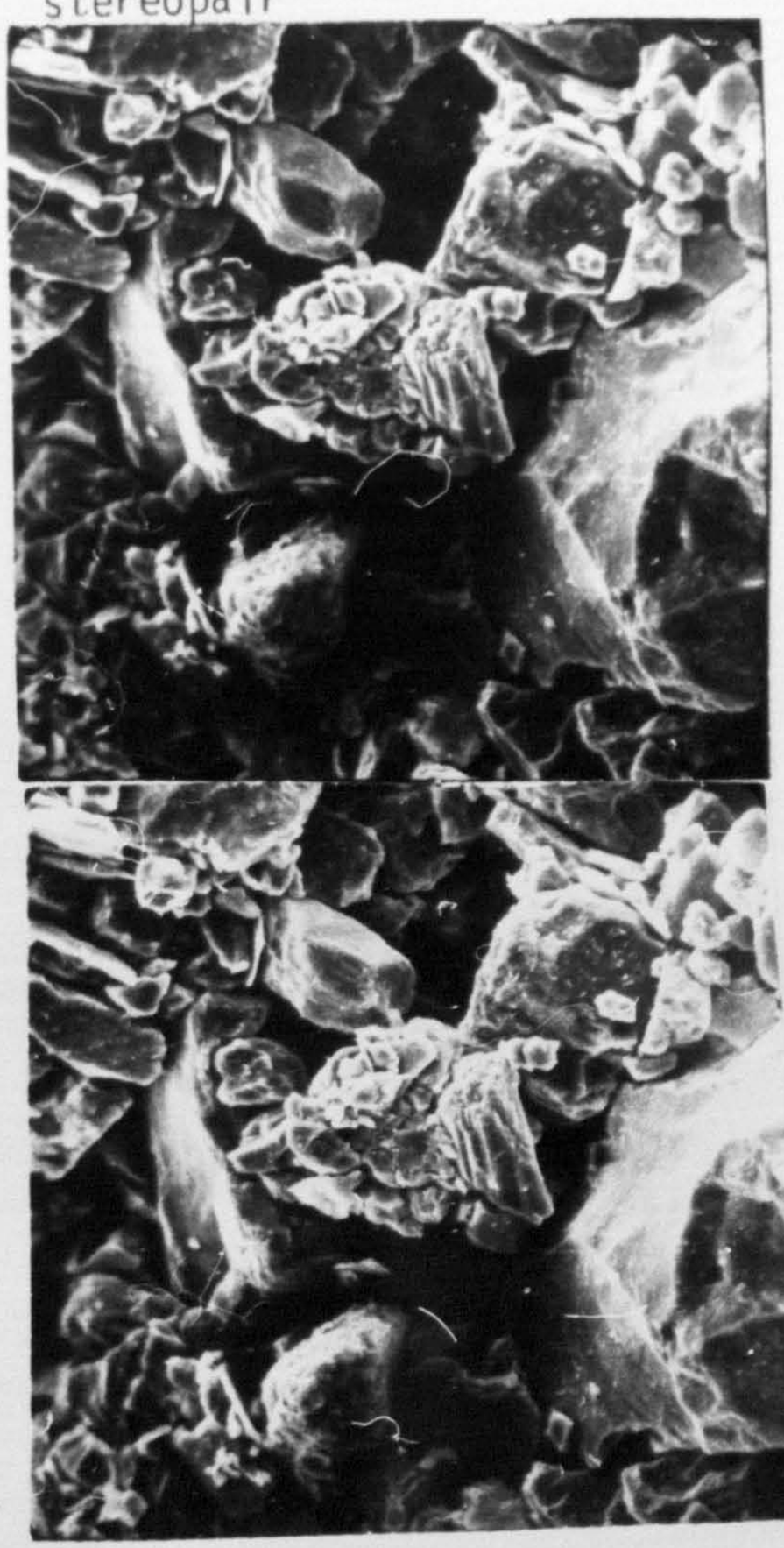
(C) Composite Microfabric

MIC. 5.27. FRESH LODGEMENT TILL - HURLFORD, SCOTLAND

(a) Detailed view of granular matrix

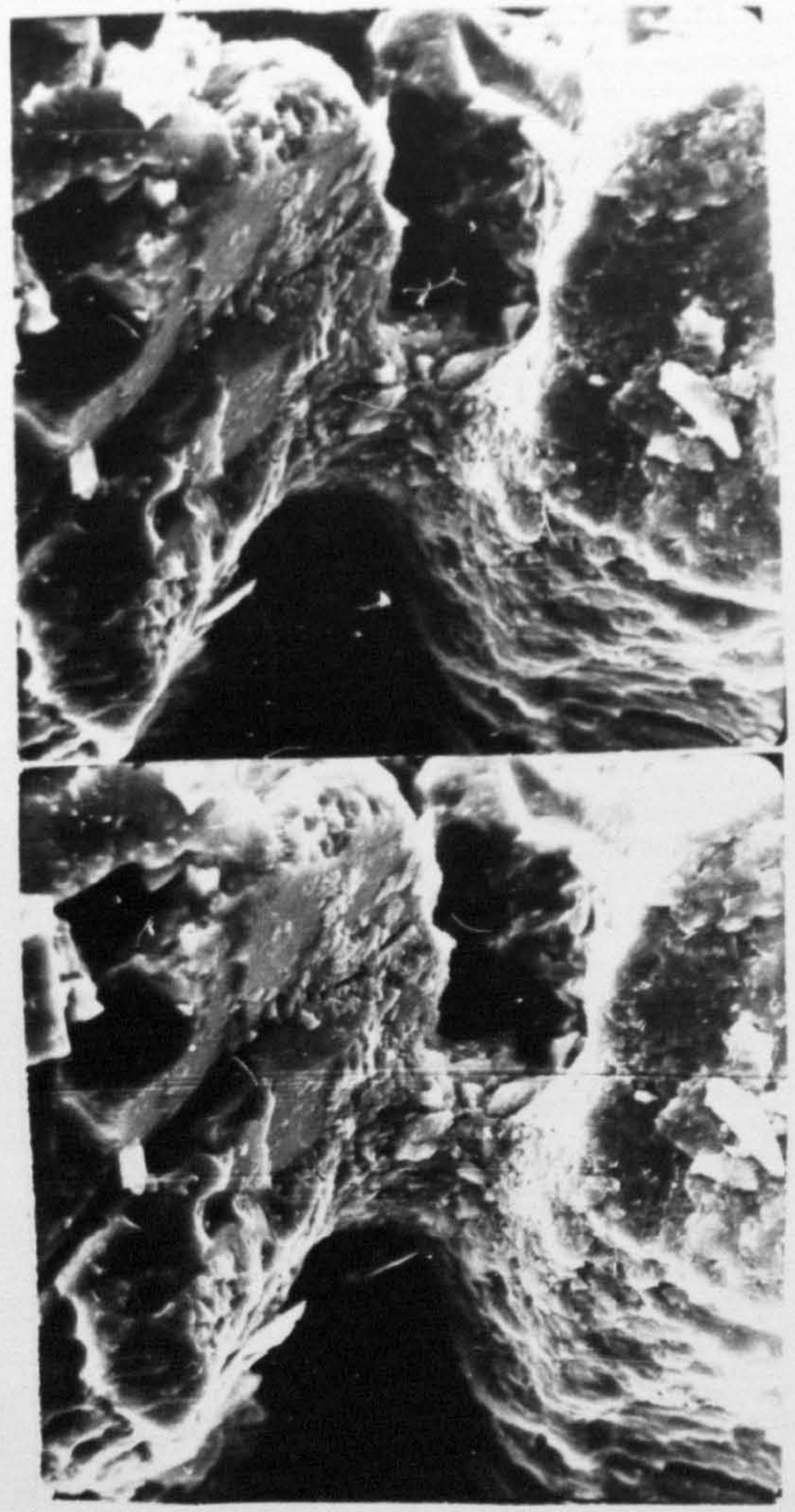


MIC. 5.28. MELT-OUT TILL - GLENORCHY, SCOTLAND



(c) Aggregation.

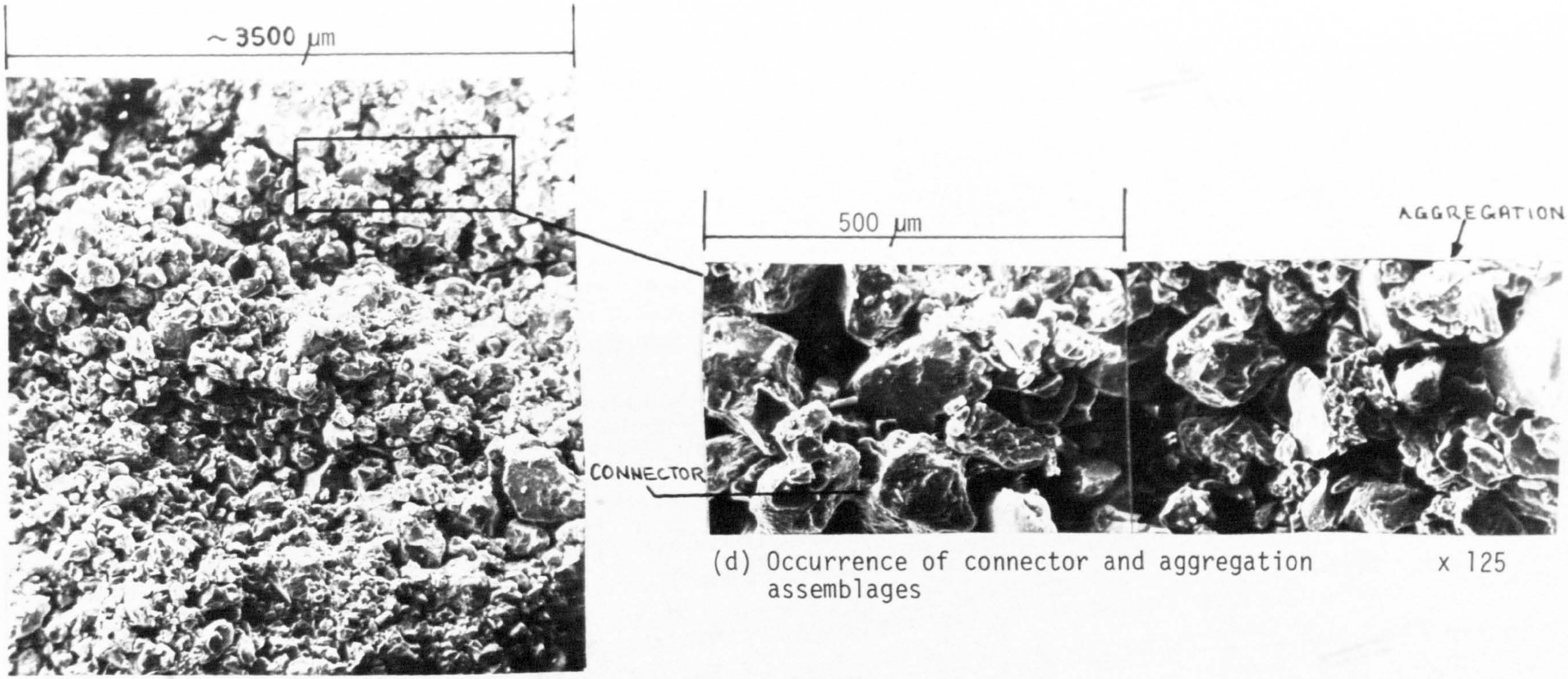
x 155



(b) Connector.

x 390

MIC. 5.28. MELT-OUT TILL - GLENORCHY, SCOTLAND



(e) Composite Microfabric x 25

(d) Occurrence of connector and aggregation assemblages x 125

MIC. 5.28. MELT-OUT TILL - GLEN ORCHY, SCOTLAND.

(b) Internal Organisation of Individual Vein

x 625

STEREOPAIR

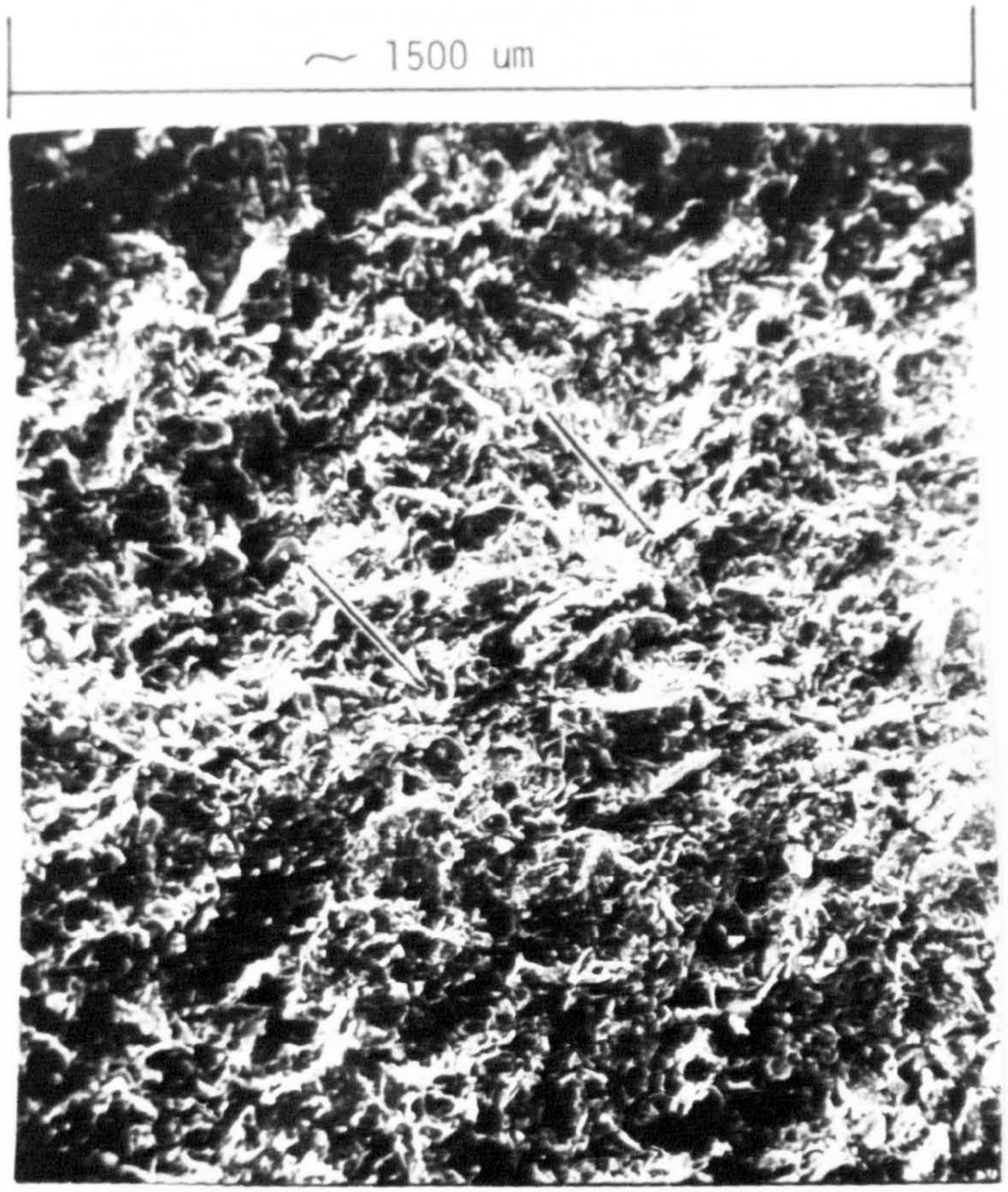
(a) Grain-Grain Contacts involving very thin flakes

x 625

MIC. 5.29. MELT-OUT TILL - LAGLINGARTEN, SCOTLAND

(c) Detailed view of granular matrix.

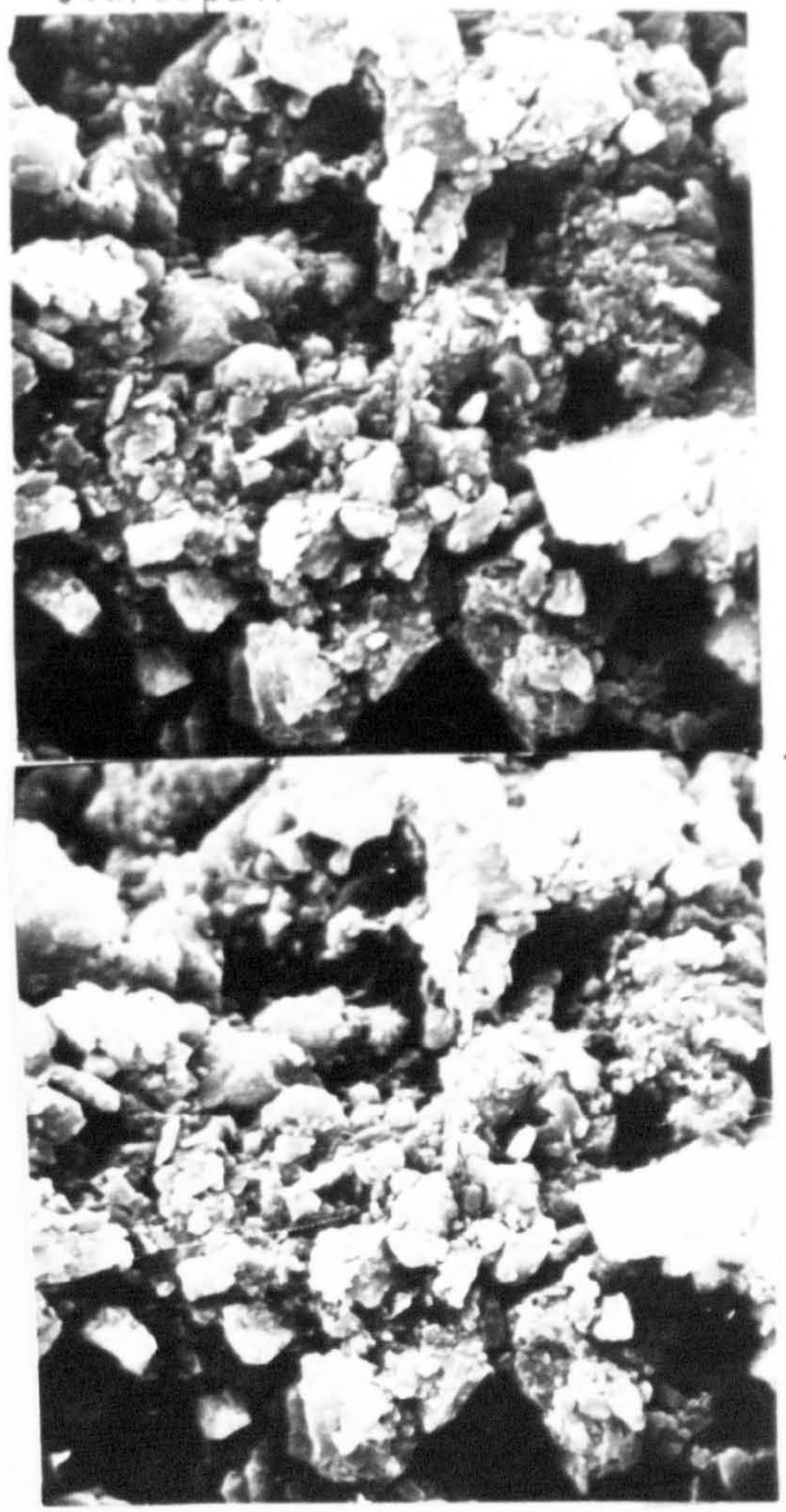
MIC. 5.29. MELT-OUT TILL - LAGLINGARTEN, SCOTLAND



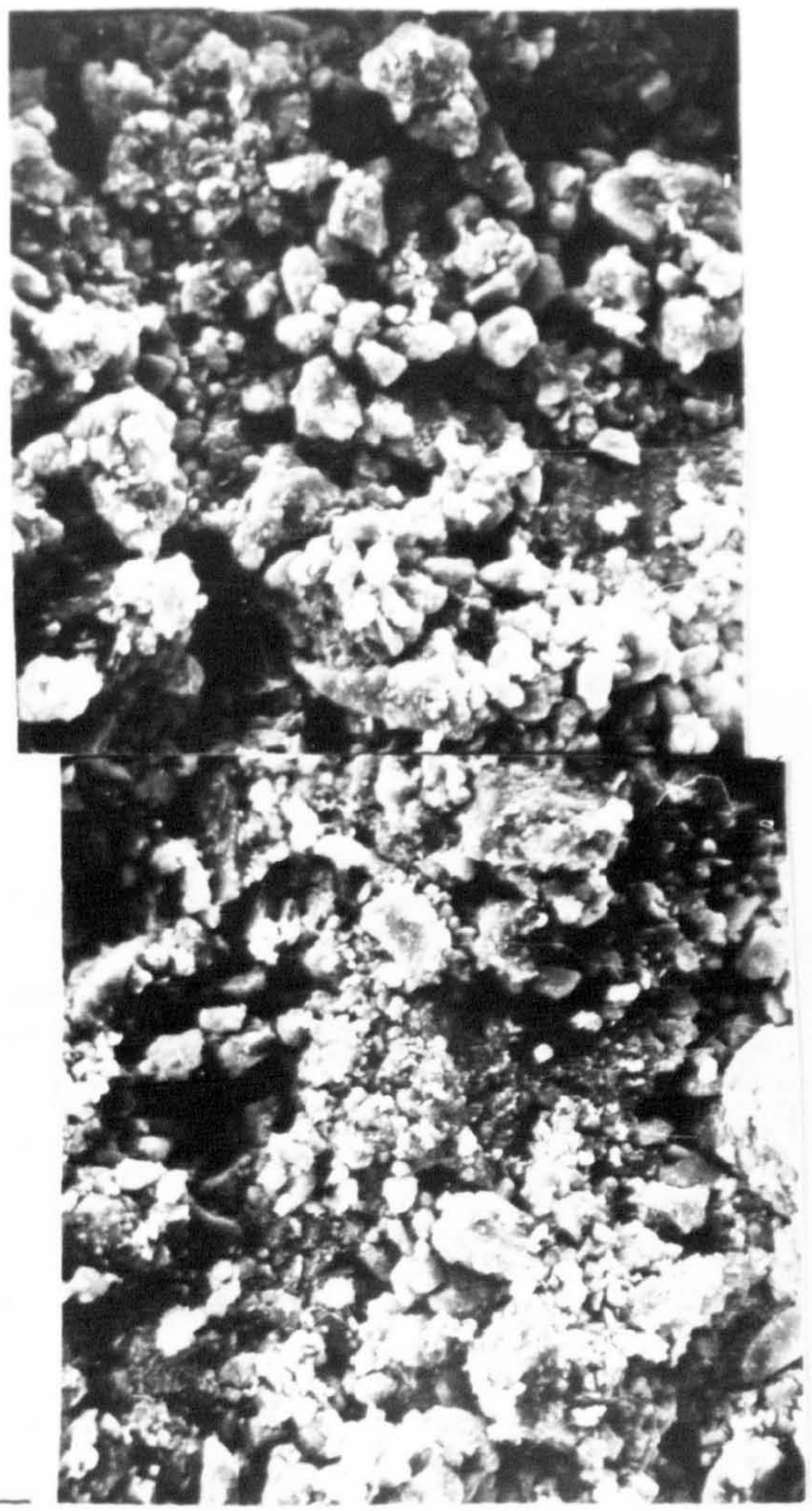
(e) Composite microfabric x 63

(d) Granular matrix x 250

MIC. 5.29. MELT-OUT TILL - LAGLINGARTEN, SCOTLAND

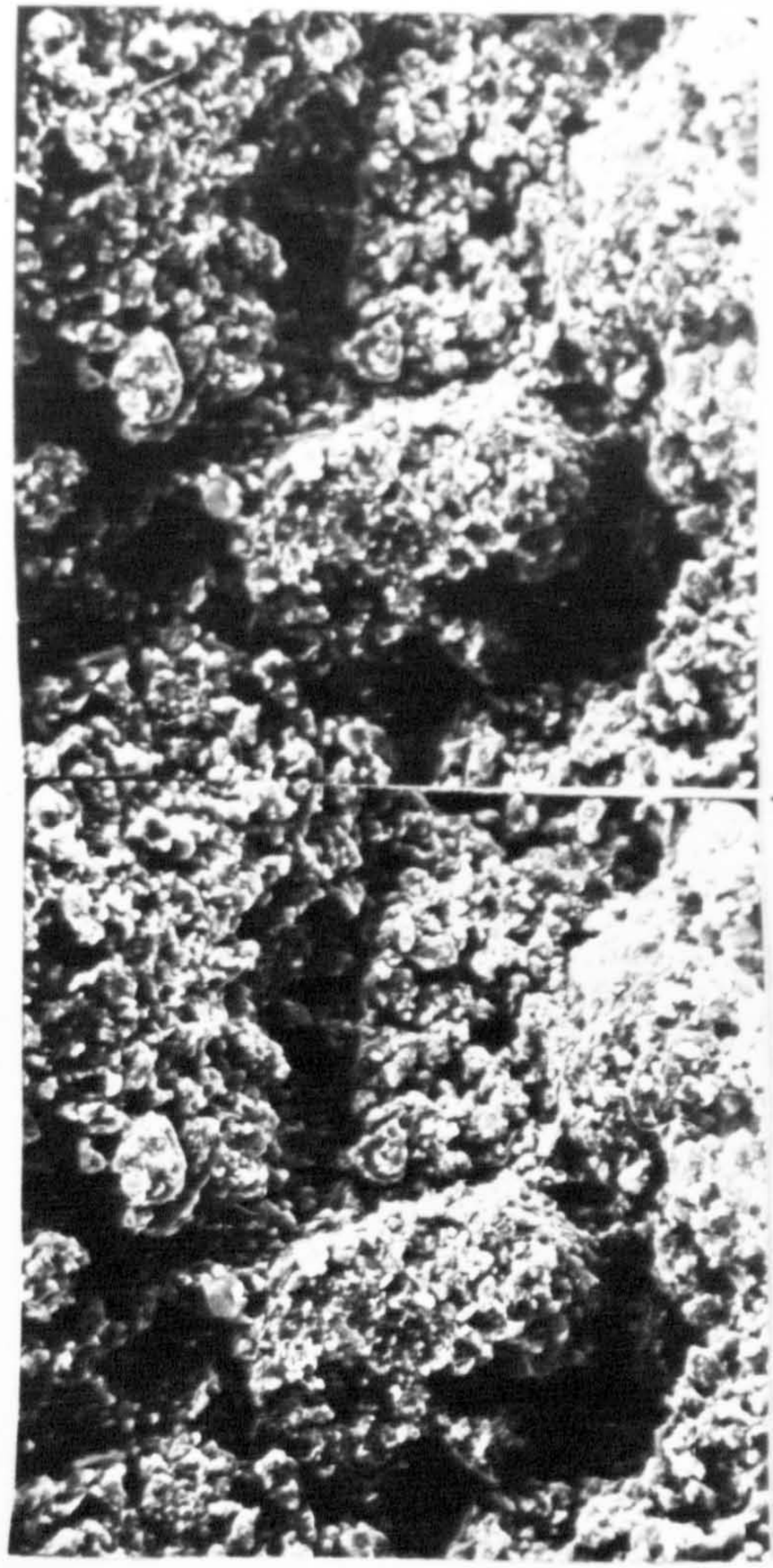


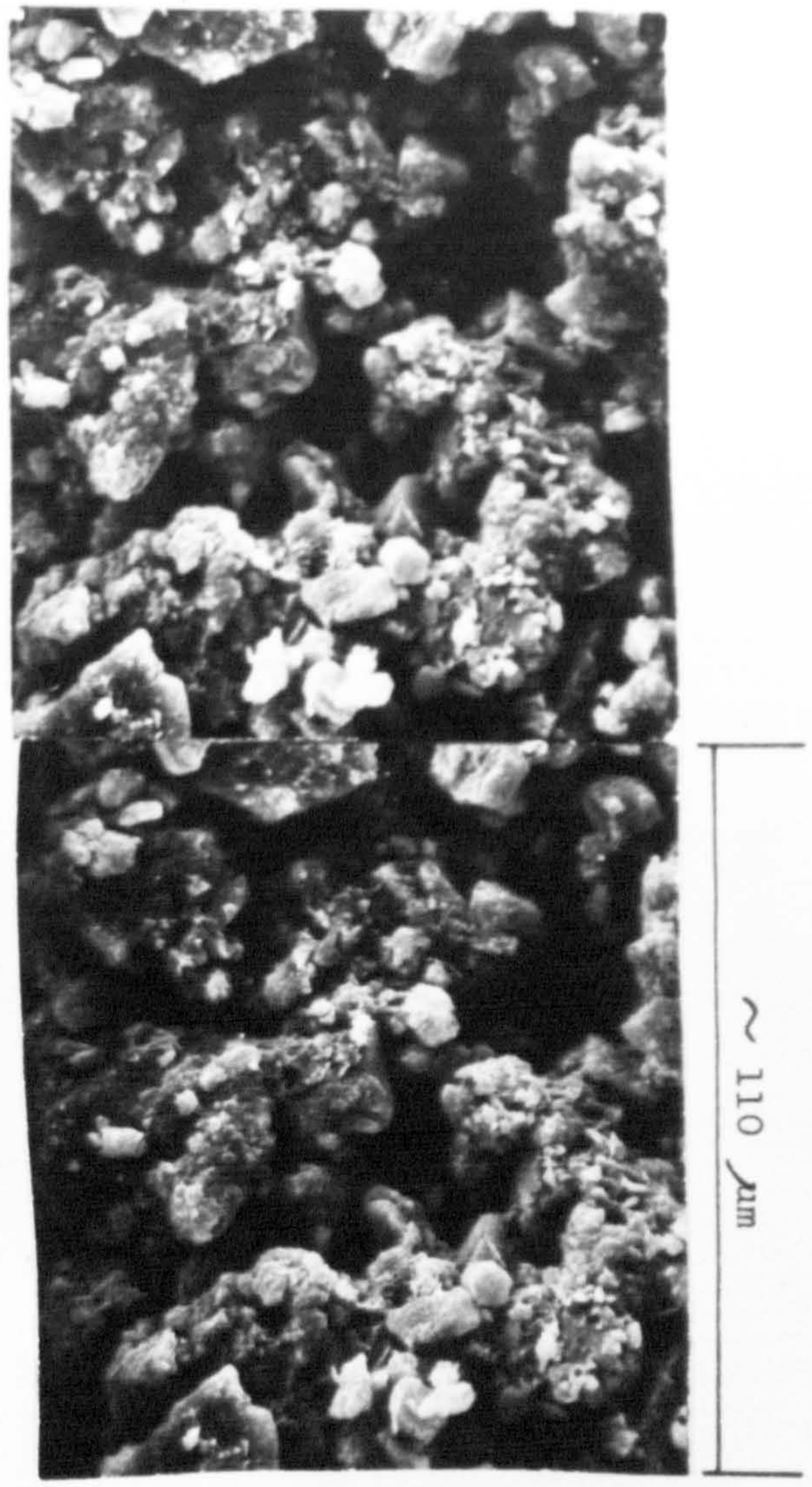
(a) Random clay arrangements. x 1600



(b) Particle matrix
x 390

MIC. 5.30. MELT-OUT TILL - BREIDA MERKURJOKULL, ICELAND





MIC. 5.30. MELT-OUT TILL - BREIDA MERKURJOKULL, ICELAND

(b) Granular matrix x 400

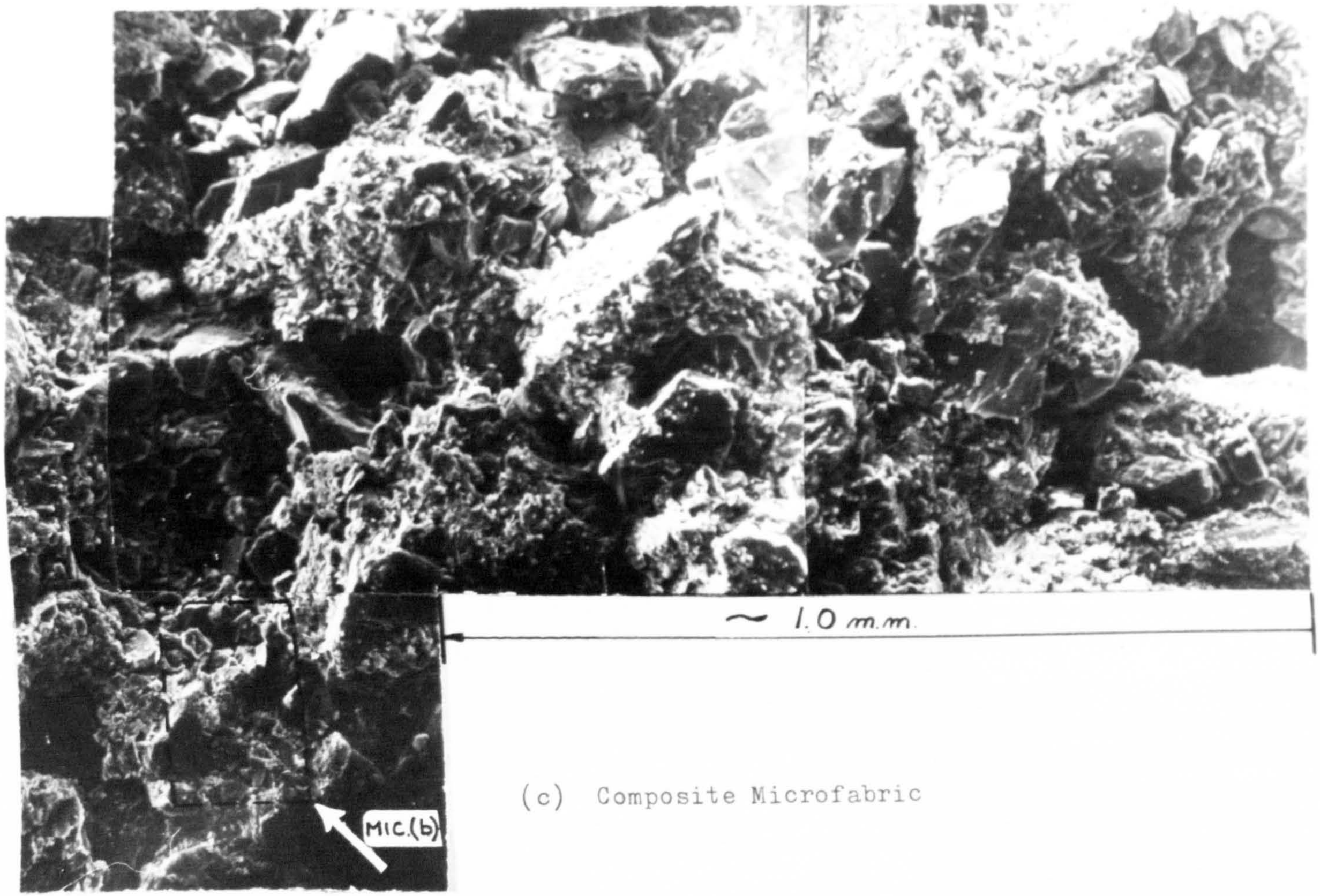
~ 325 µm

Stereopair

(a) Fine silt grain-grain contacts x 1600

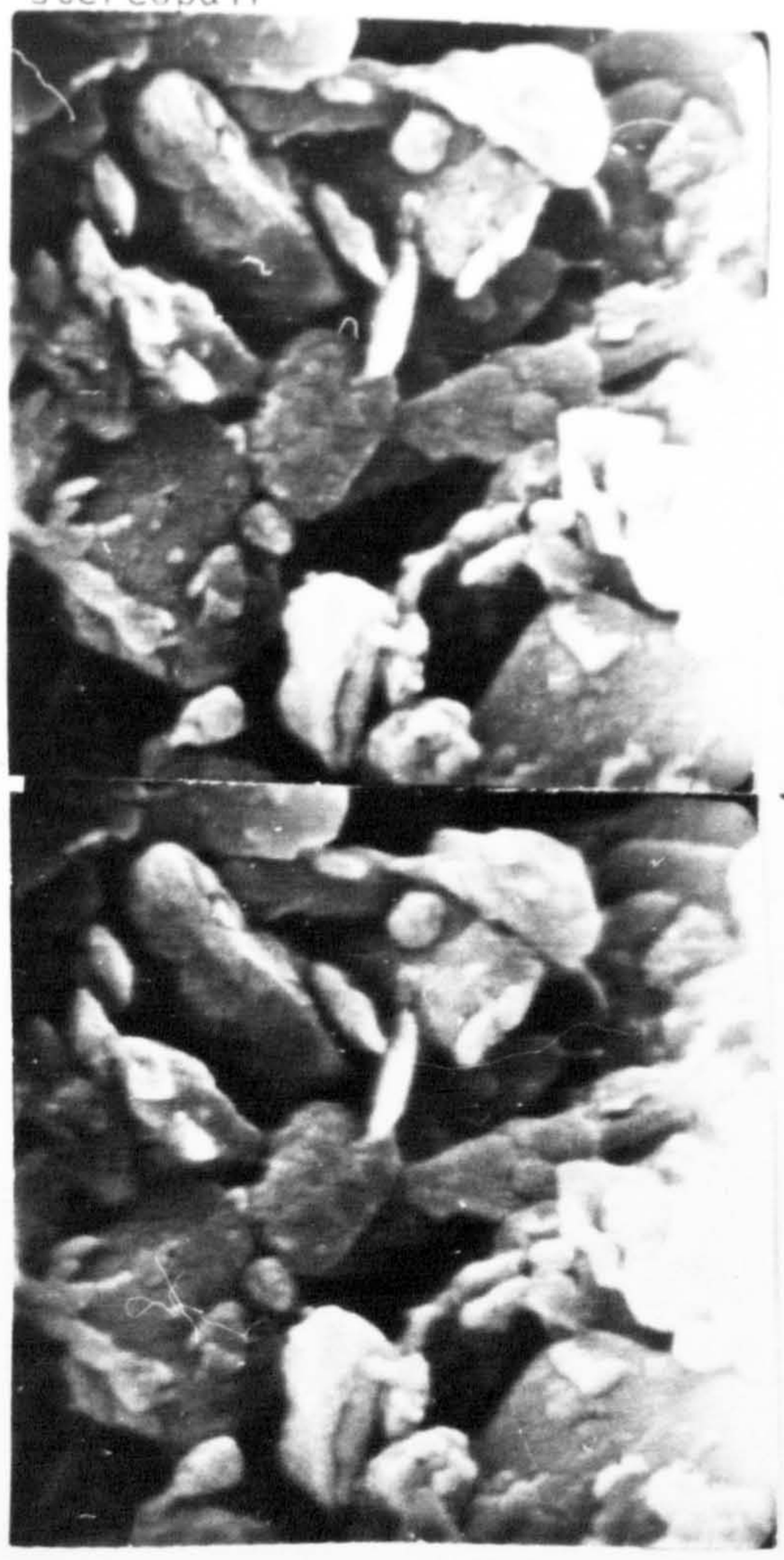
~ 40 µm

MIC. 5.31 MELT-OUT TILL - STOCKHOLM, SWEDEN

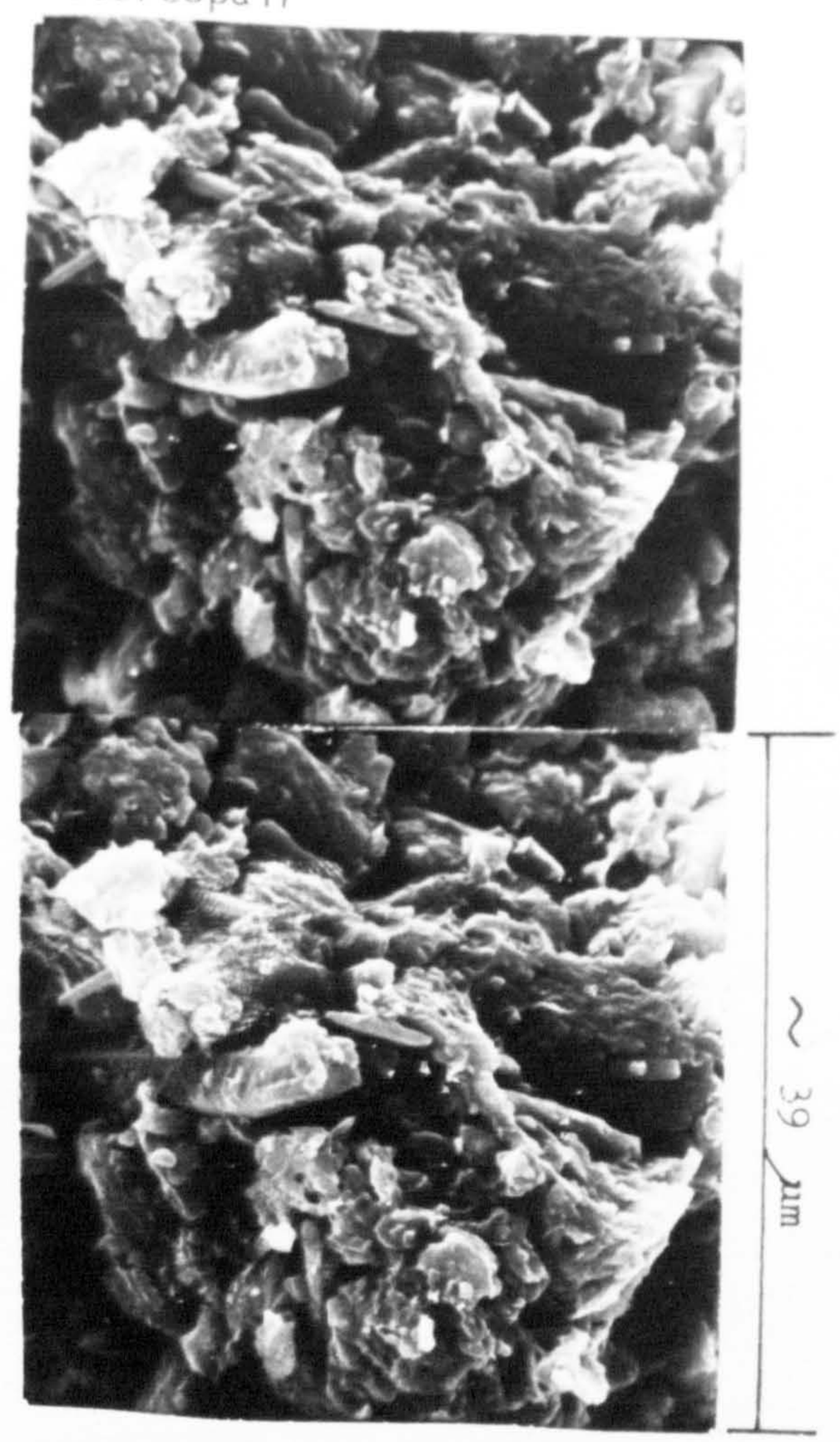


(c) Composite Microfabric

MIC. 5.31. MELT-OUT TILL - STOCKHOLM, SWEDEN



(b) Random clay (individual) arrangements.

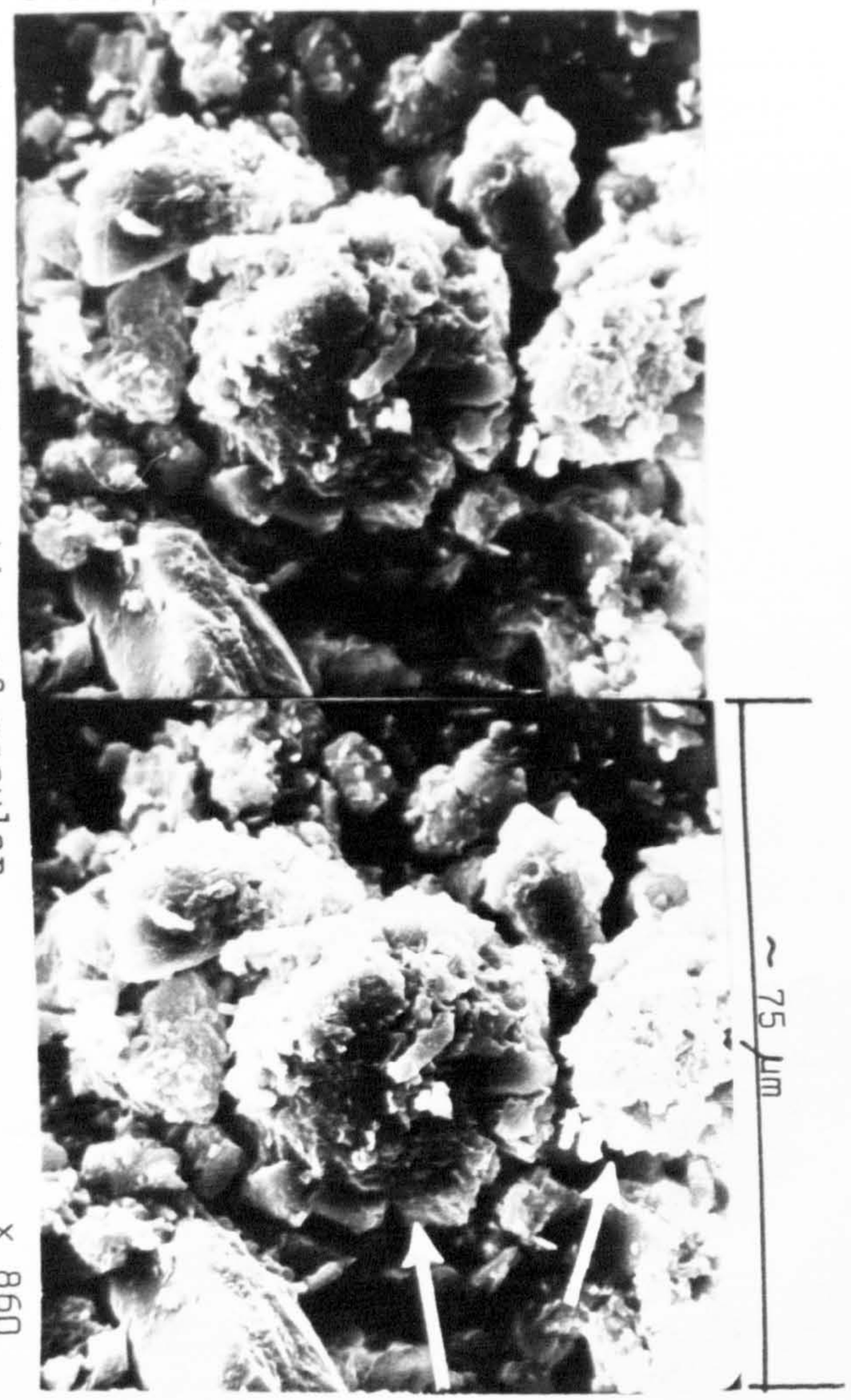


(a) Partly discernible clay arrangements.

MIC. 5.32. MELT-OUT TILL - TAYLOR VALLEY, ANTARCTICA

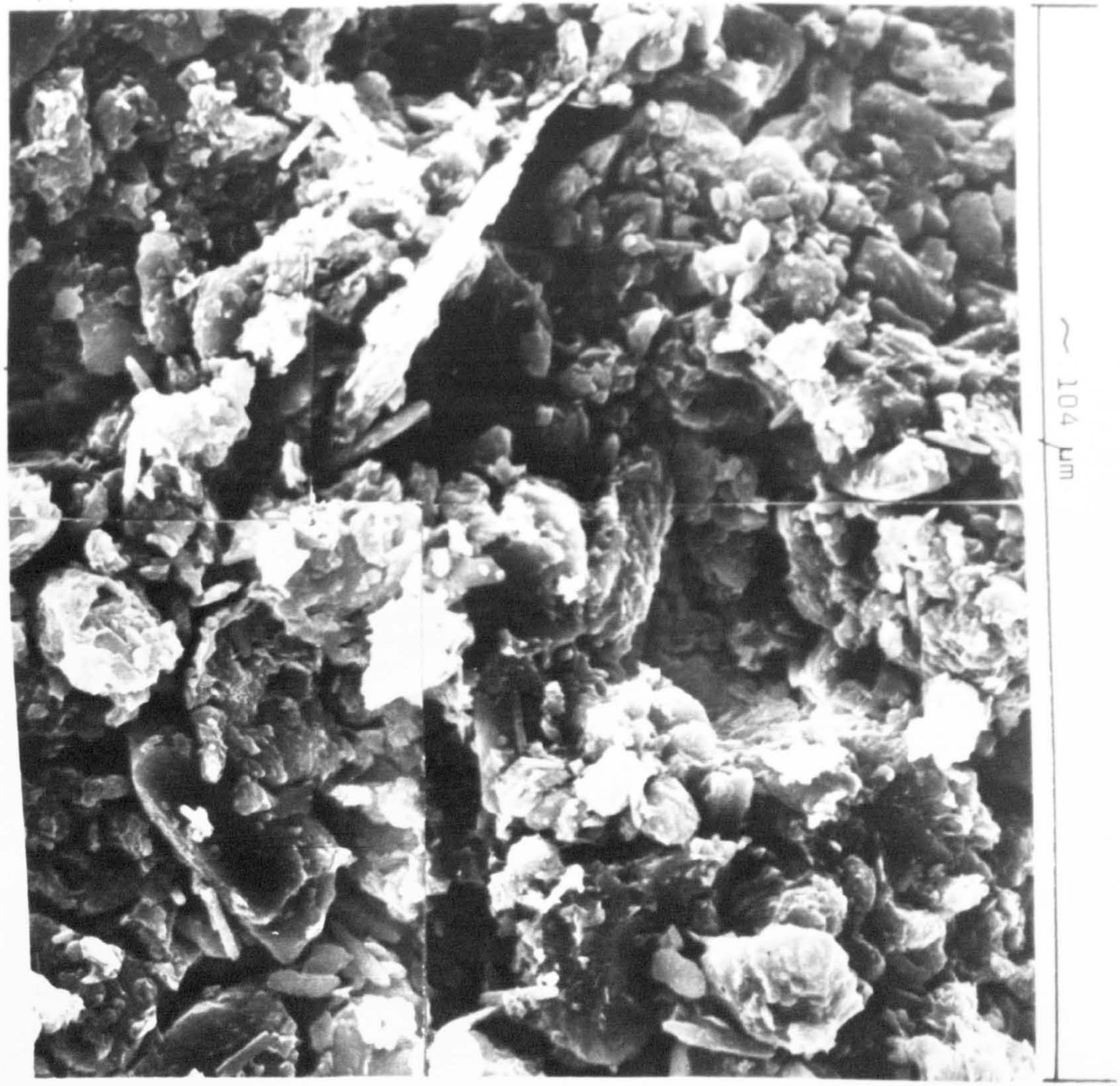
Stereopair

(d) Nature and interaction of regular aggregations

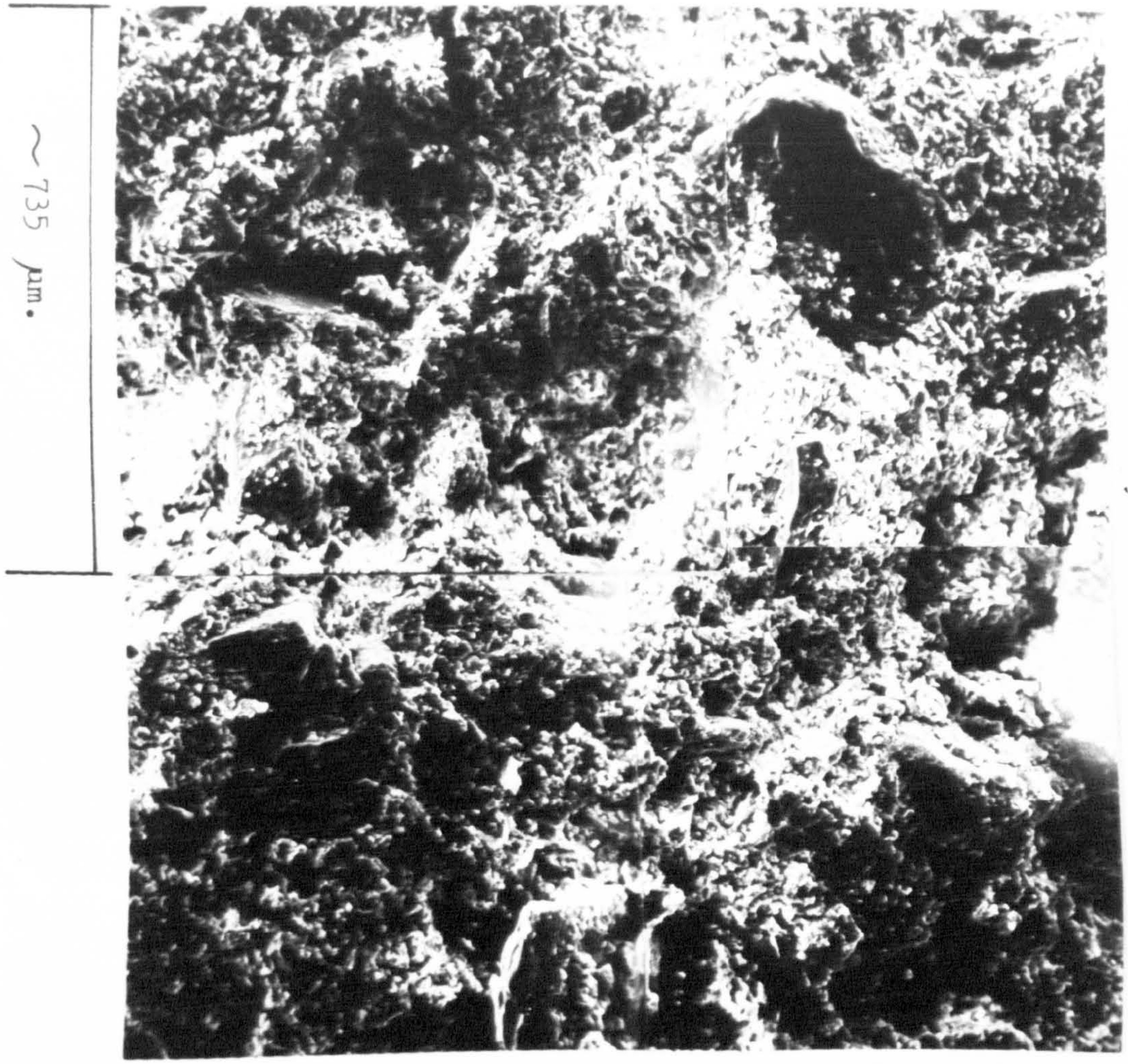


(c) Particle matrix

× 1250



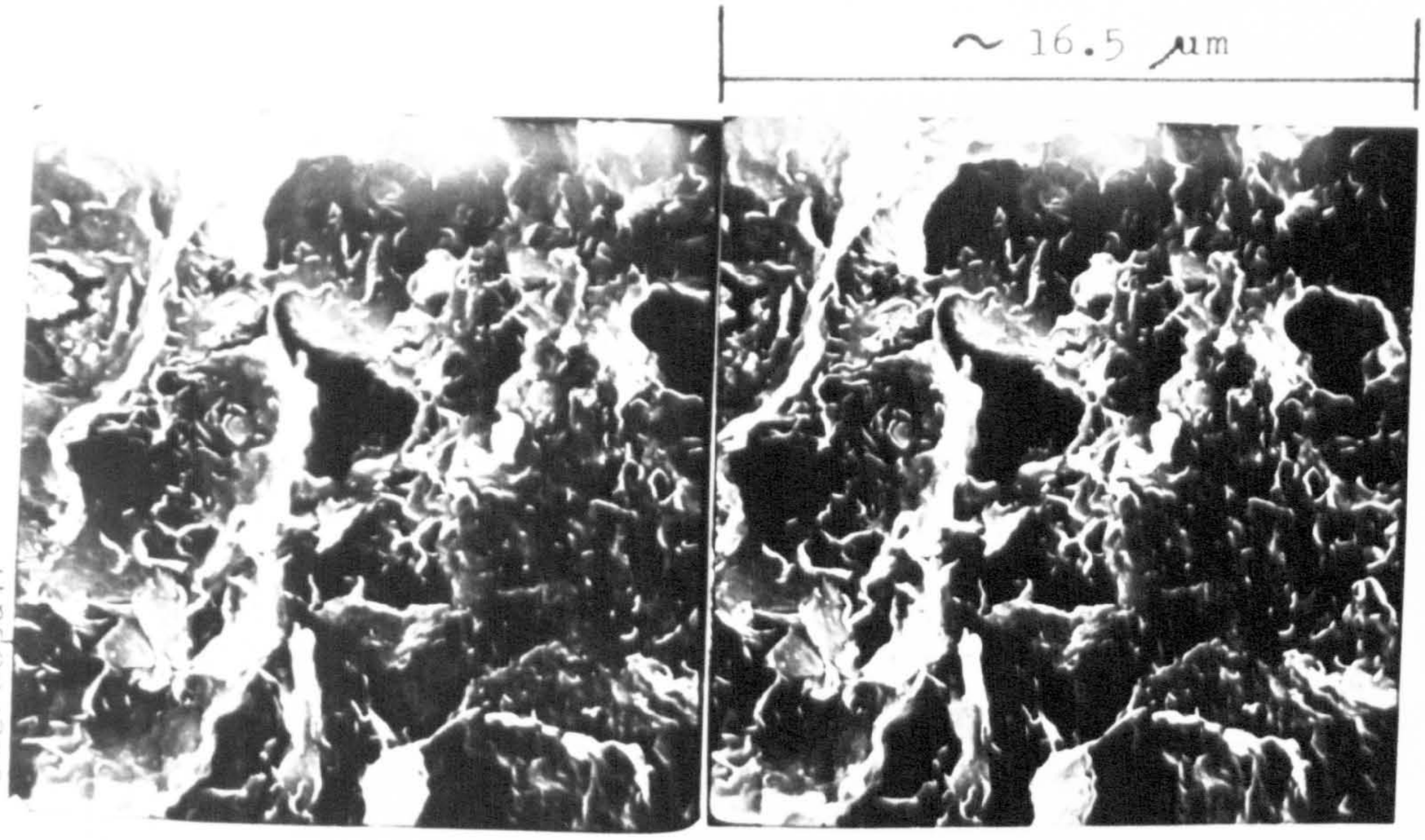
MIC. 5.32 MELT-OUT TILL - TAYLOR VALLEY, ANTARCTICA



(e) Composite microfabric

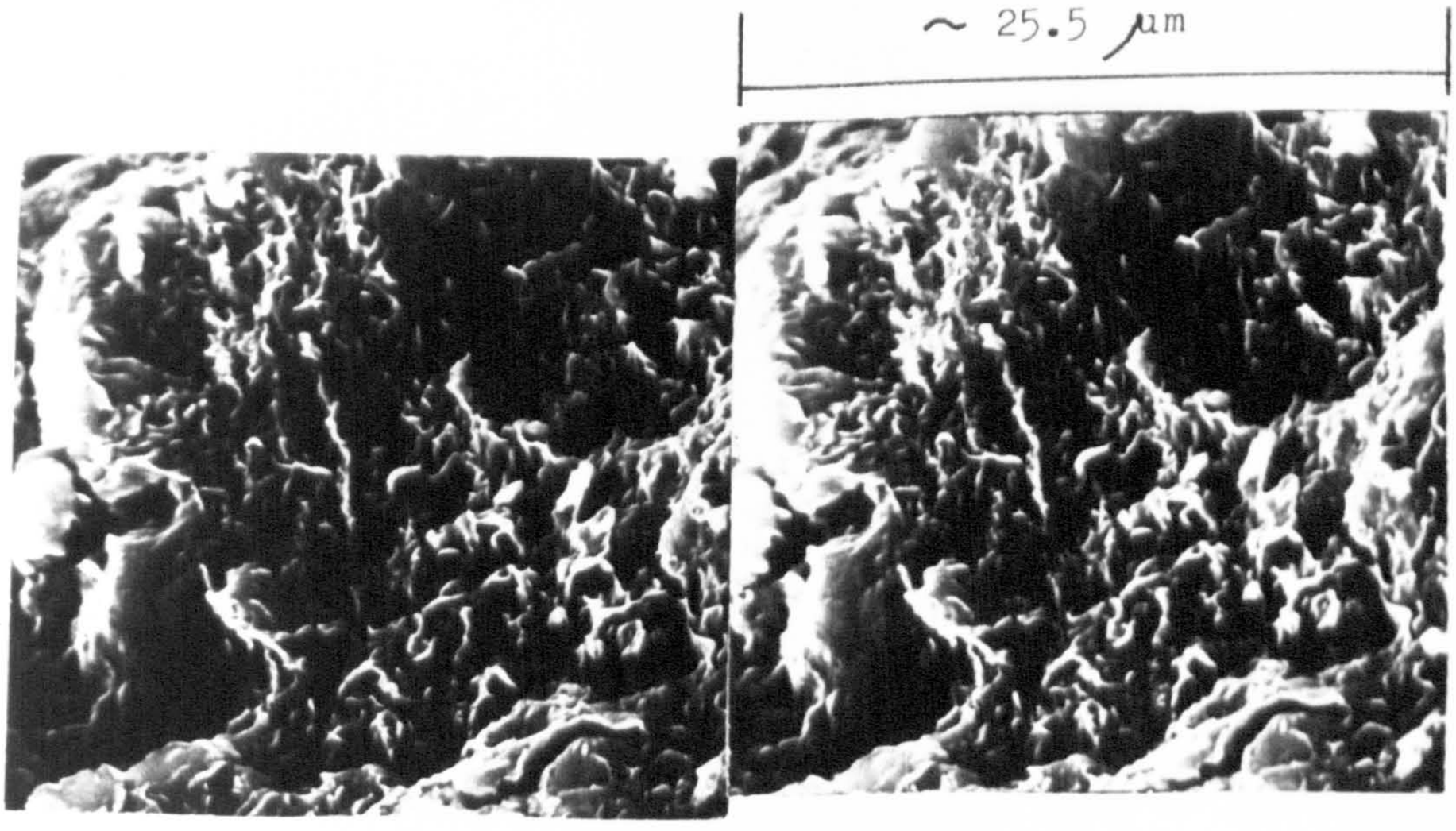
x 94

MIC. 5.32. MELT-OUT TILL - TAYLOR VALLEY, ANTARCTICA



(a) Partly discernible clay array displaying few crinkled edges.

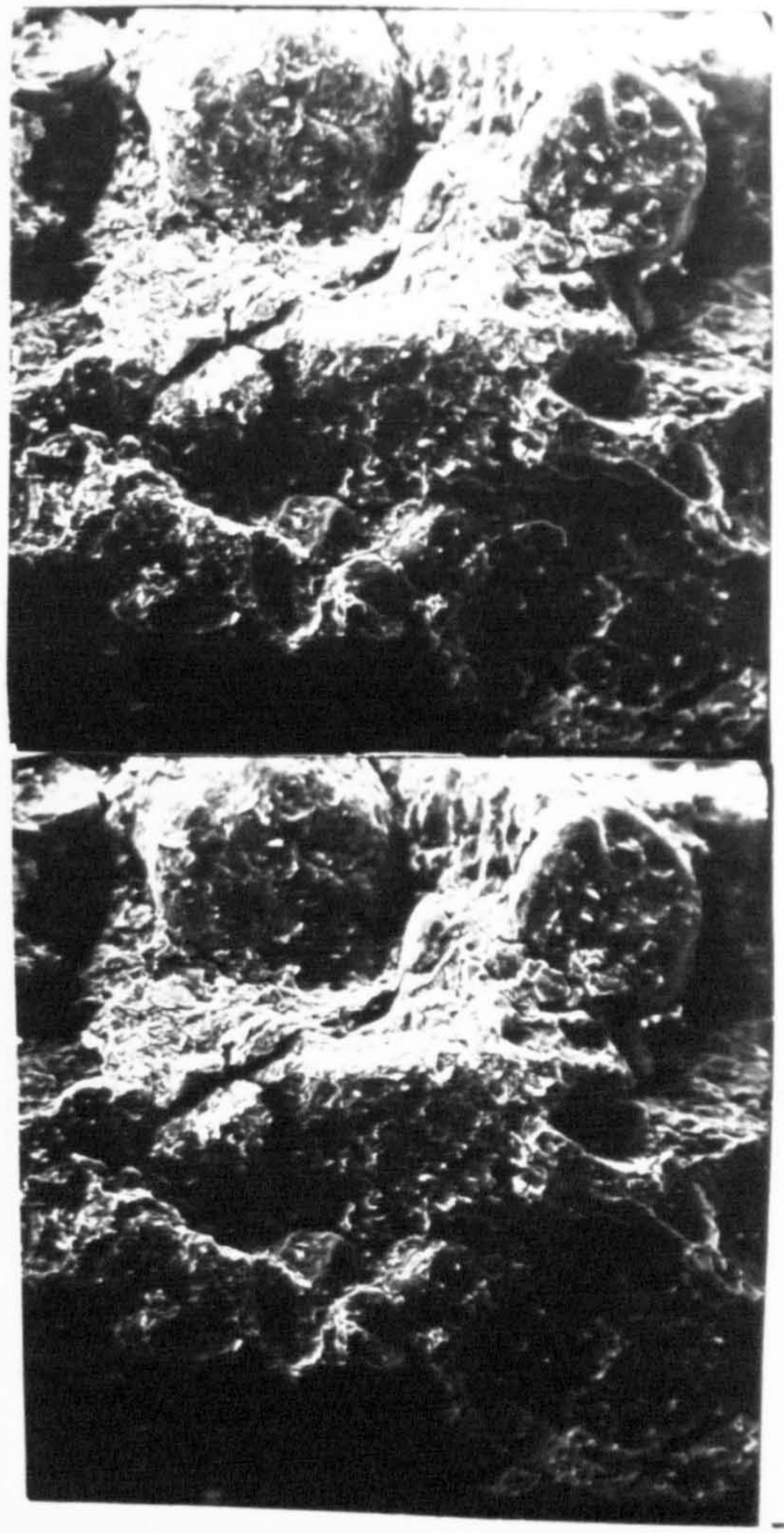
x 3750



(b) Partly discernible clay array displaying numerous crinkled edges.

x 2600

MIC. 5.33. RESIDUAL CLAY - CAS ENGA, ANGOLA

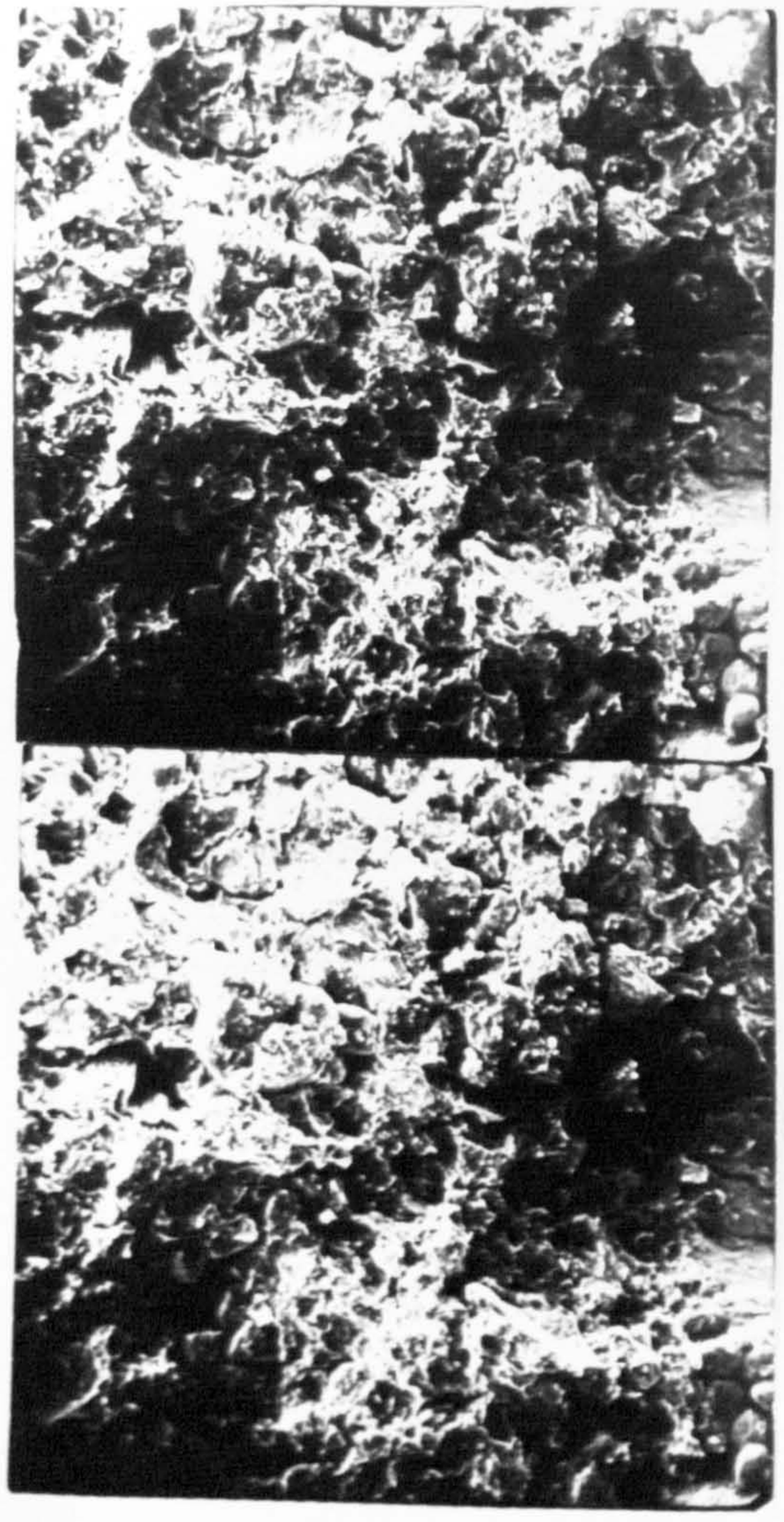


(c) Clay-granular matrix region

stereopair

~ 1600 µm.

x 40



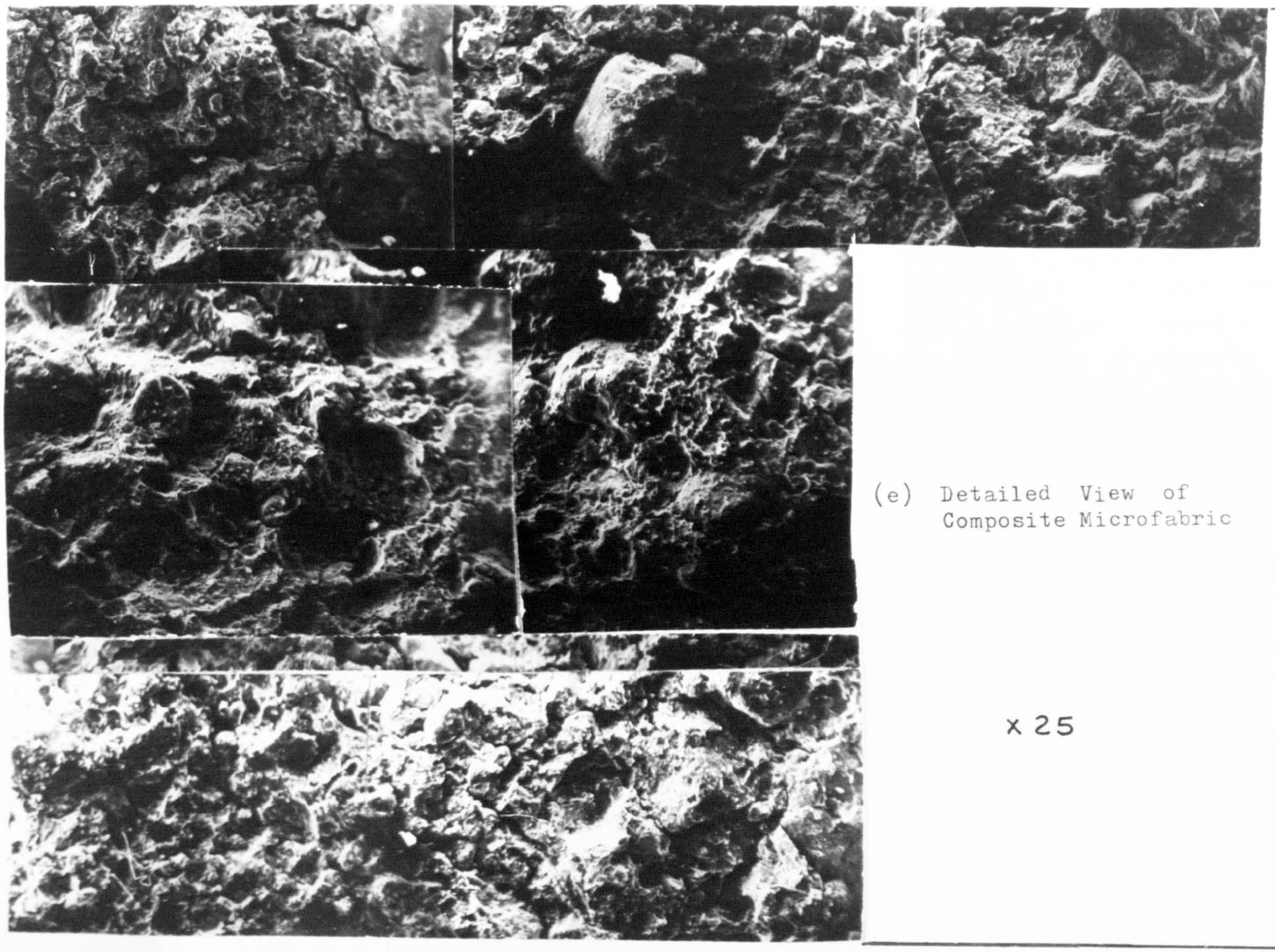
(d) Portion of composite microfabric comprising matrix, connectors and aggregations.

stereopair

~ 1600 µm.

x 40

MIC. 5.33. RESIDUAL CLAY - CASENGA, ANGOLA

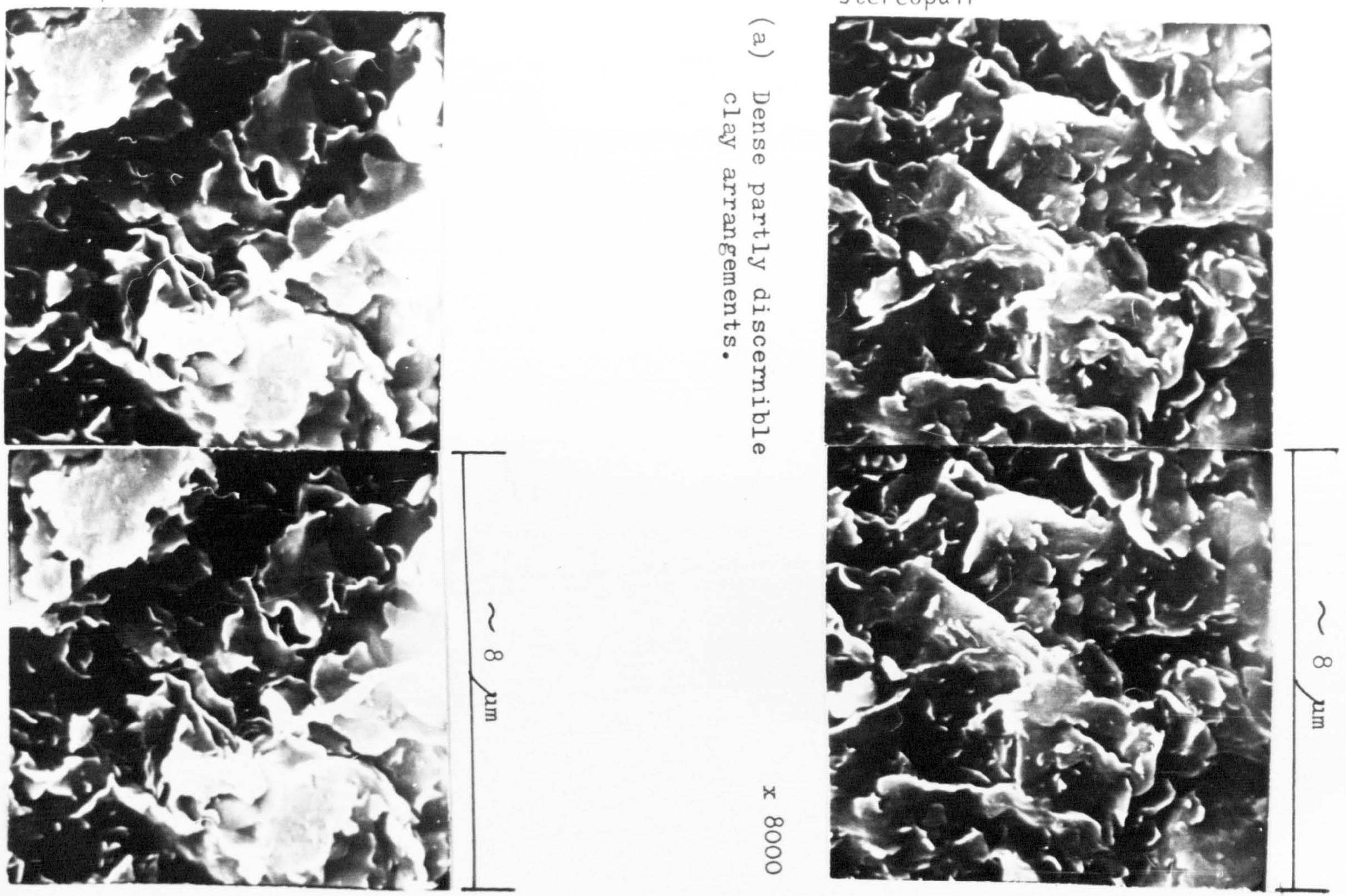


(e) Detailed View of Composite Microfabric

x 25

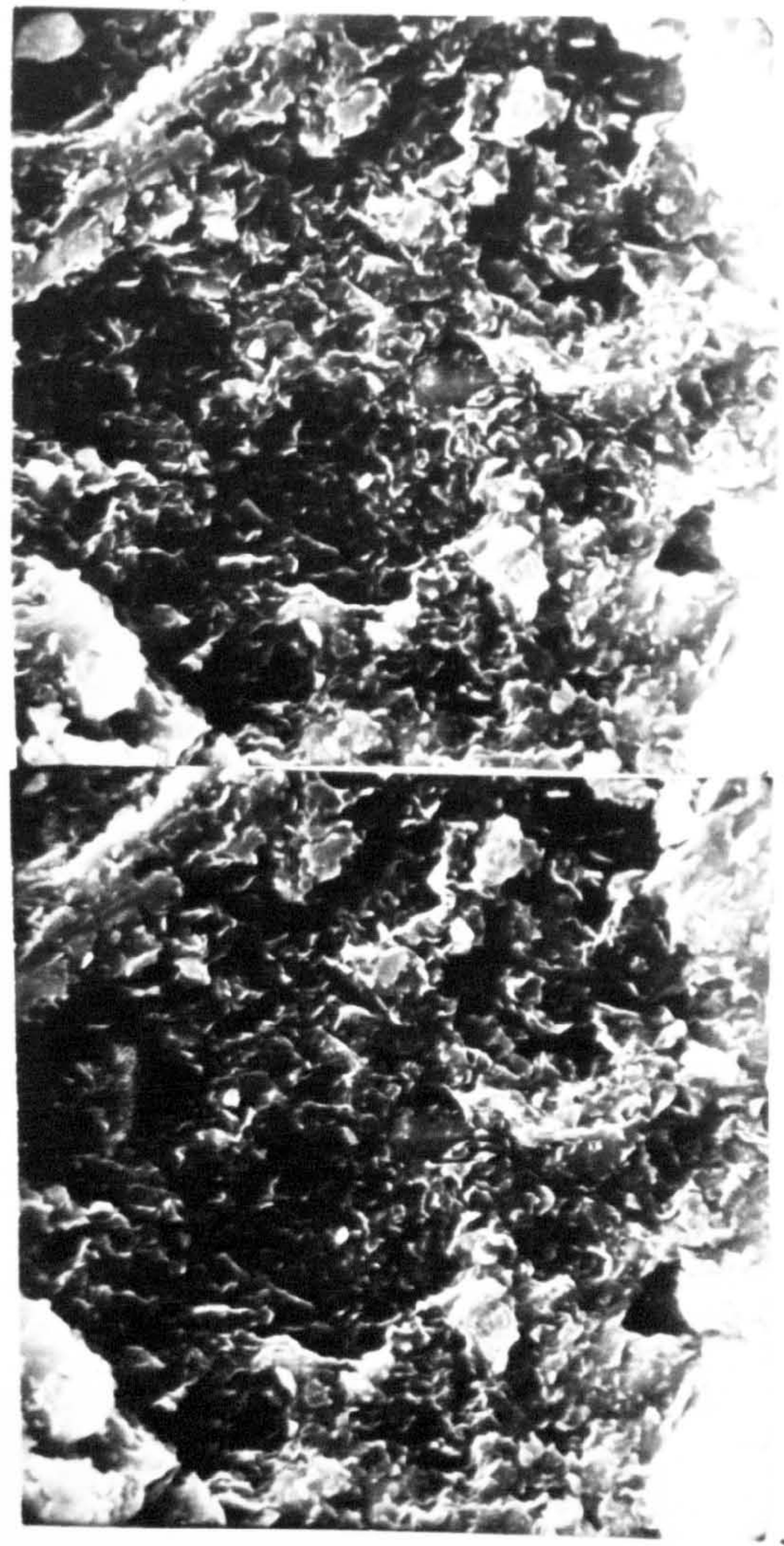
~ 6.1 mm.

MIC. 5.33. RESIDUAL CLAY - CASENGA, ANGOLA

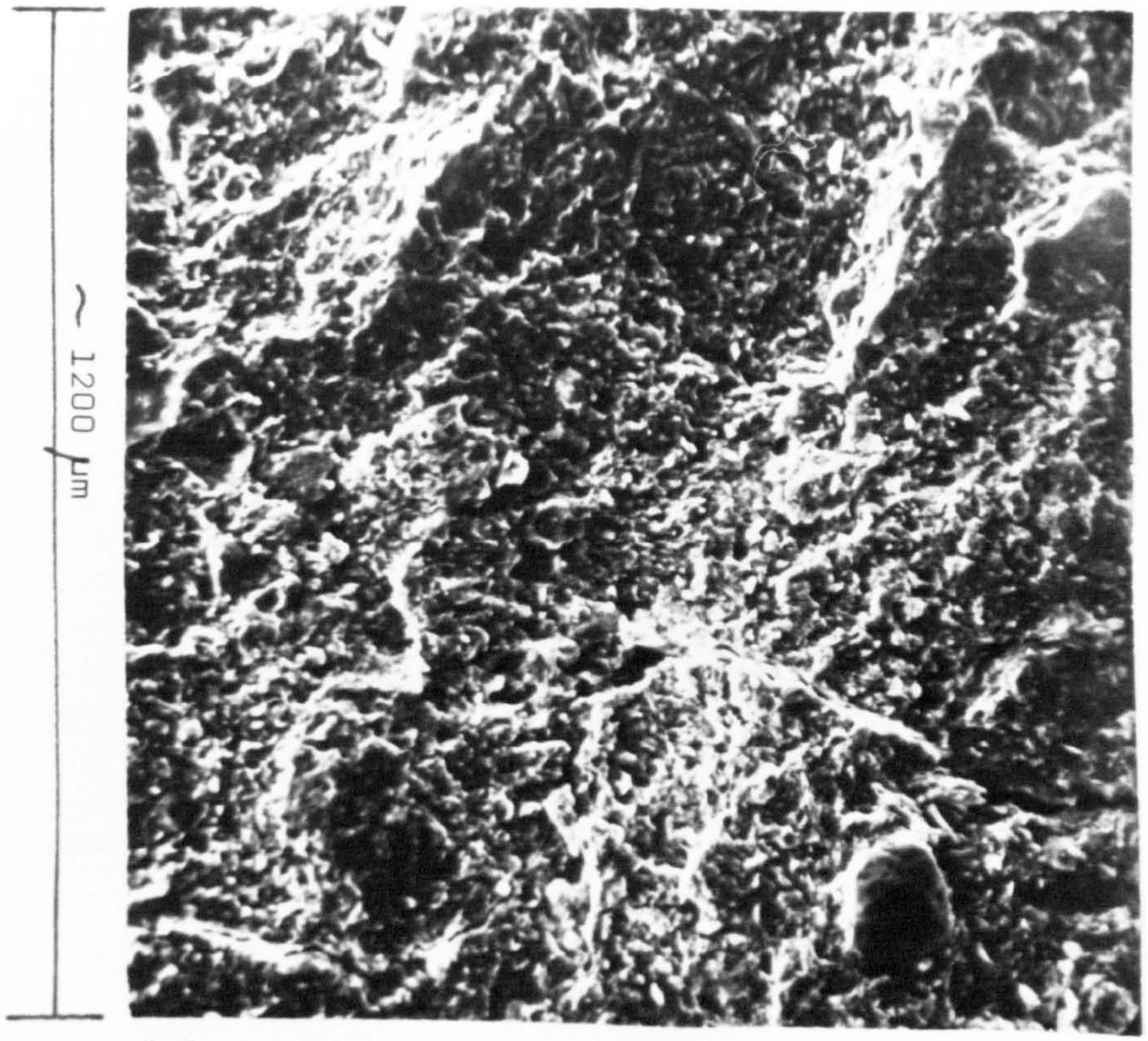


MIC. 5.34. RESIDUAL CLAY - ONDERSTEPOORT, S.A.

Stereopair

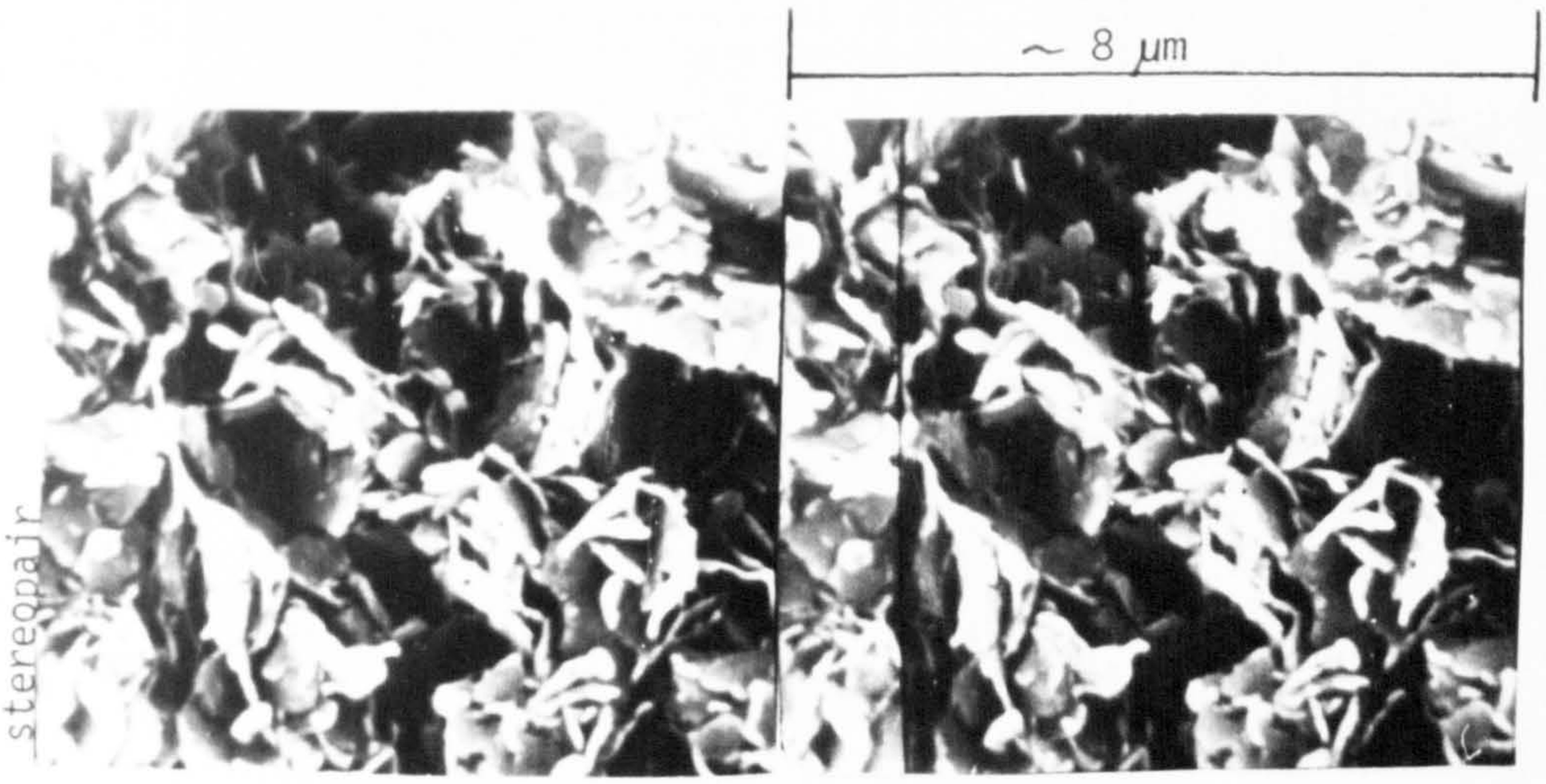


(c) Clay matrix × 1600

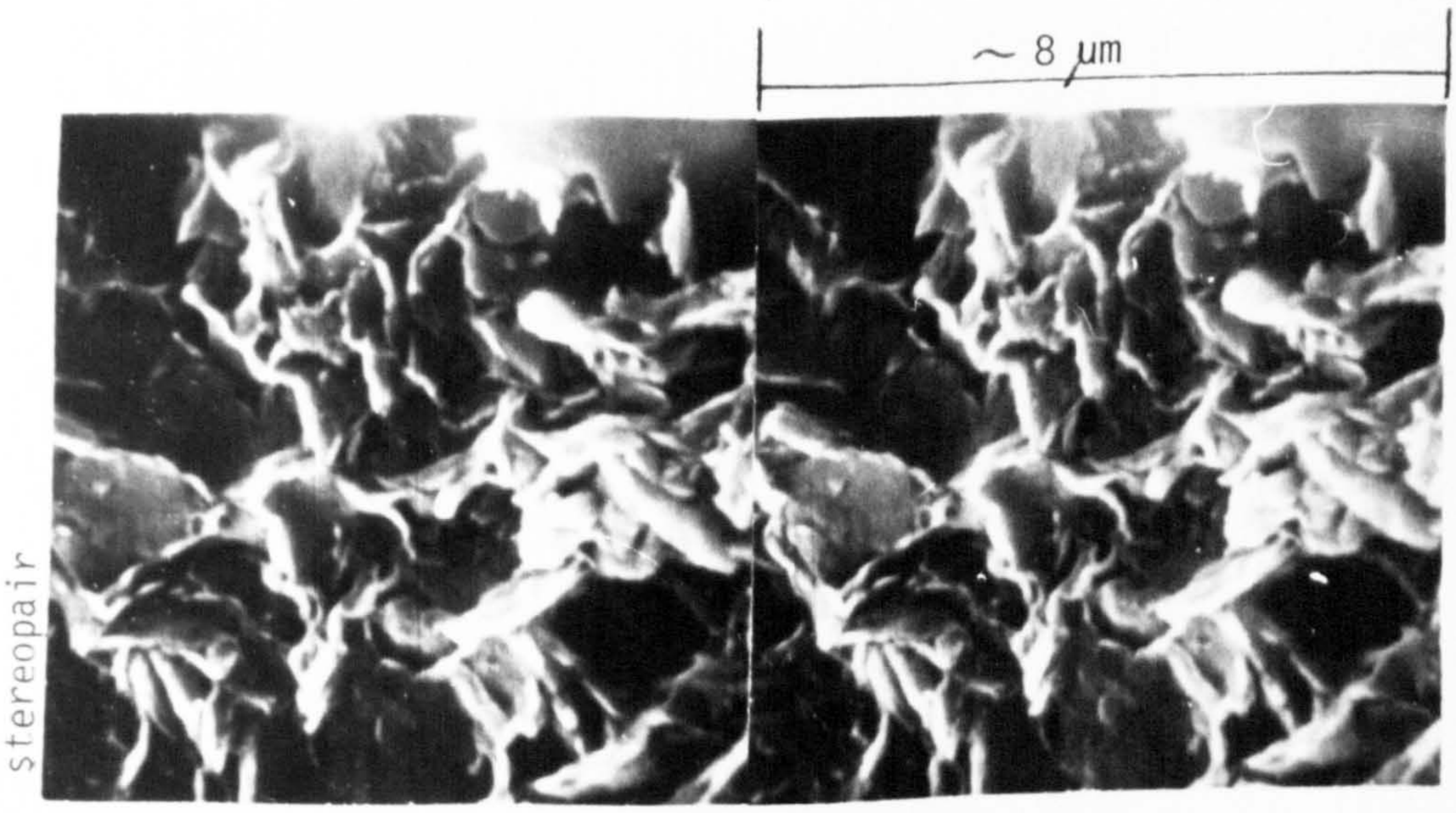


(d) Composite microfabric × 80

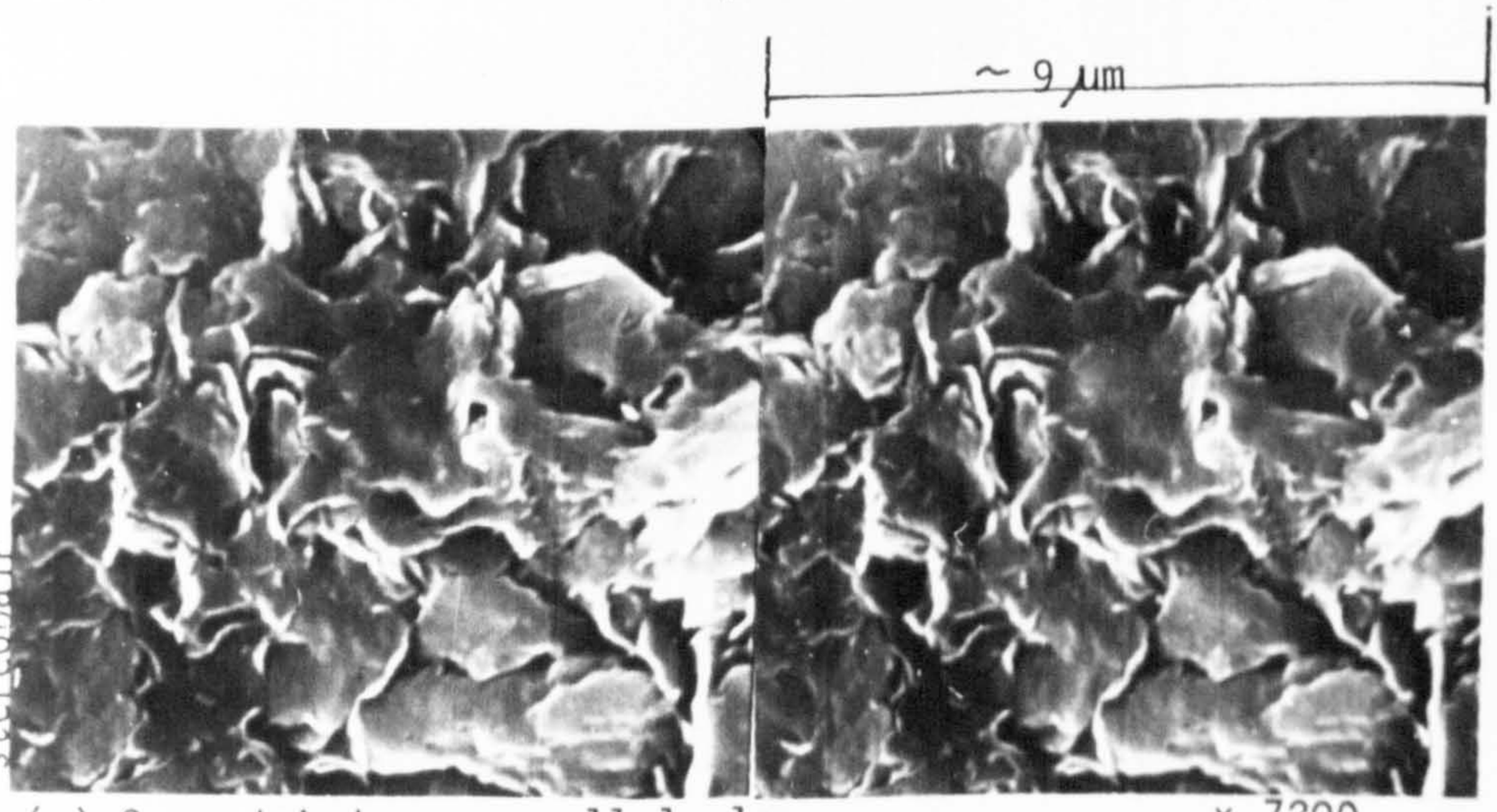
MIC. 5.34 RESIDUAL CLAY - ONDERSTEPOORT, S.A.



(a) Critical Point - random clay x 8100

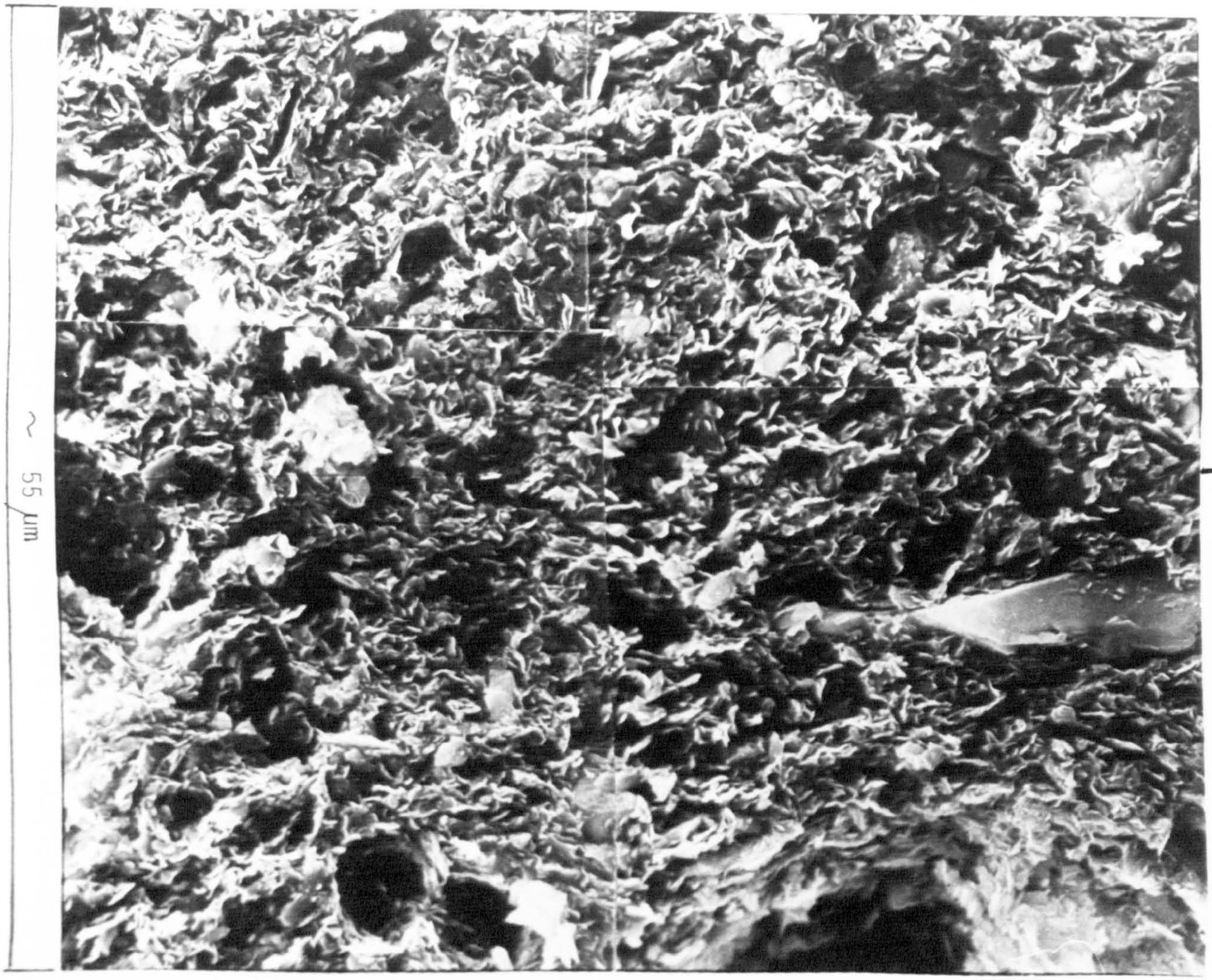


(b) Air-dried - random clay x8100

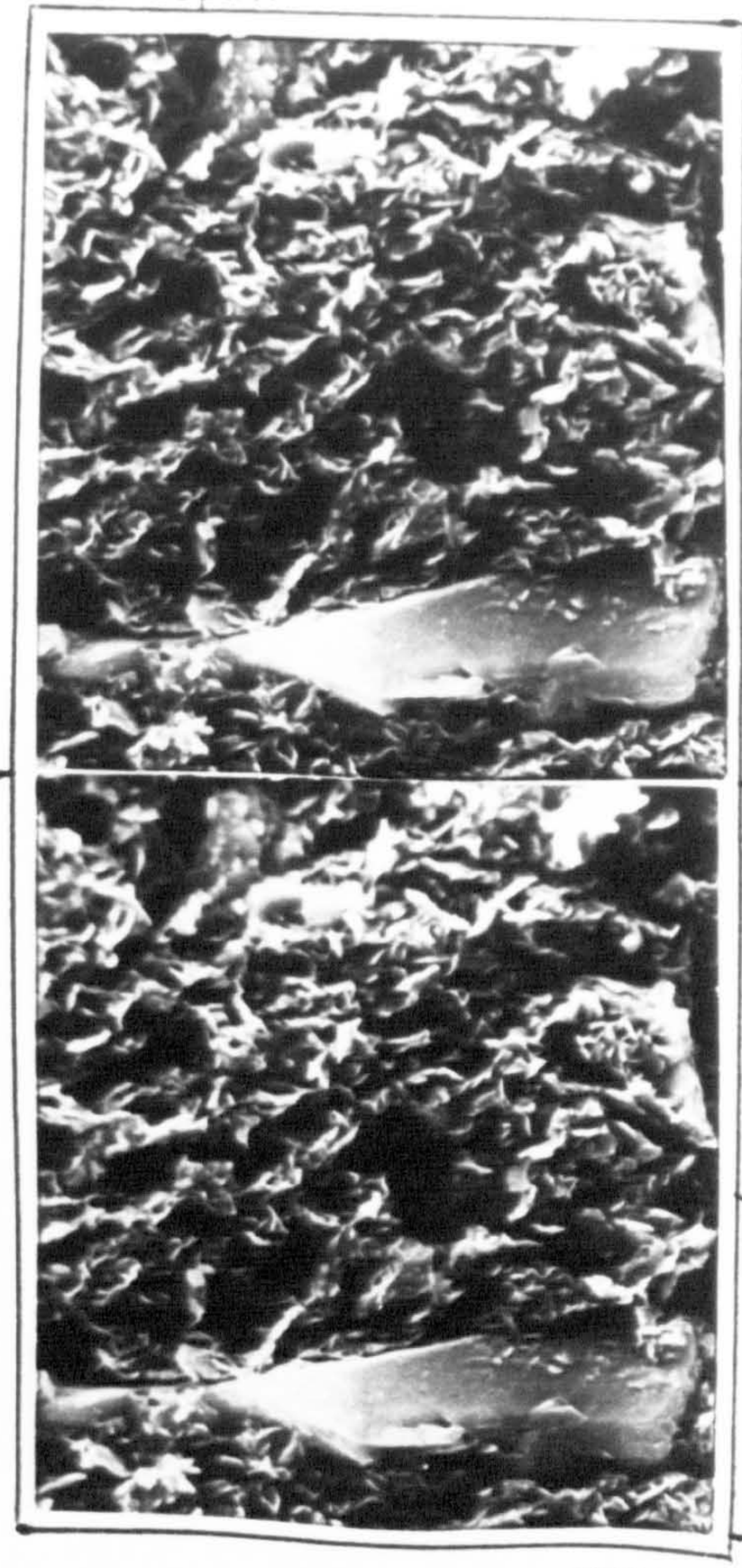


(c) Oven-dried - parallel clay x 7200

MIC.3.1 LAKE PORTCHARTRAIN CLAY.



stereopair



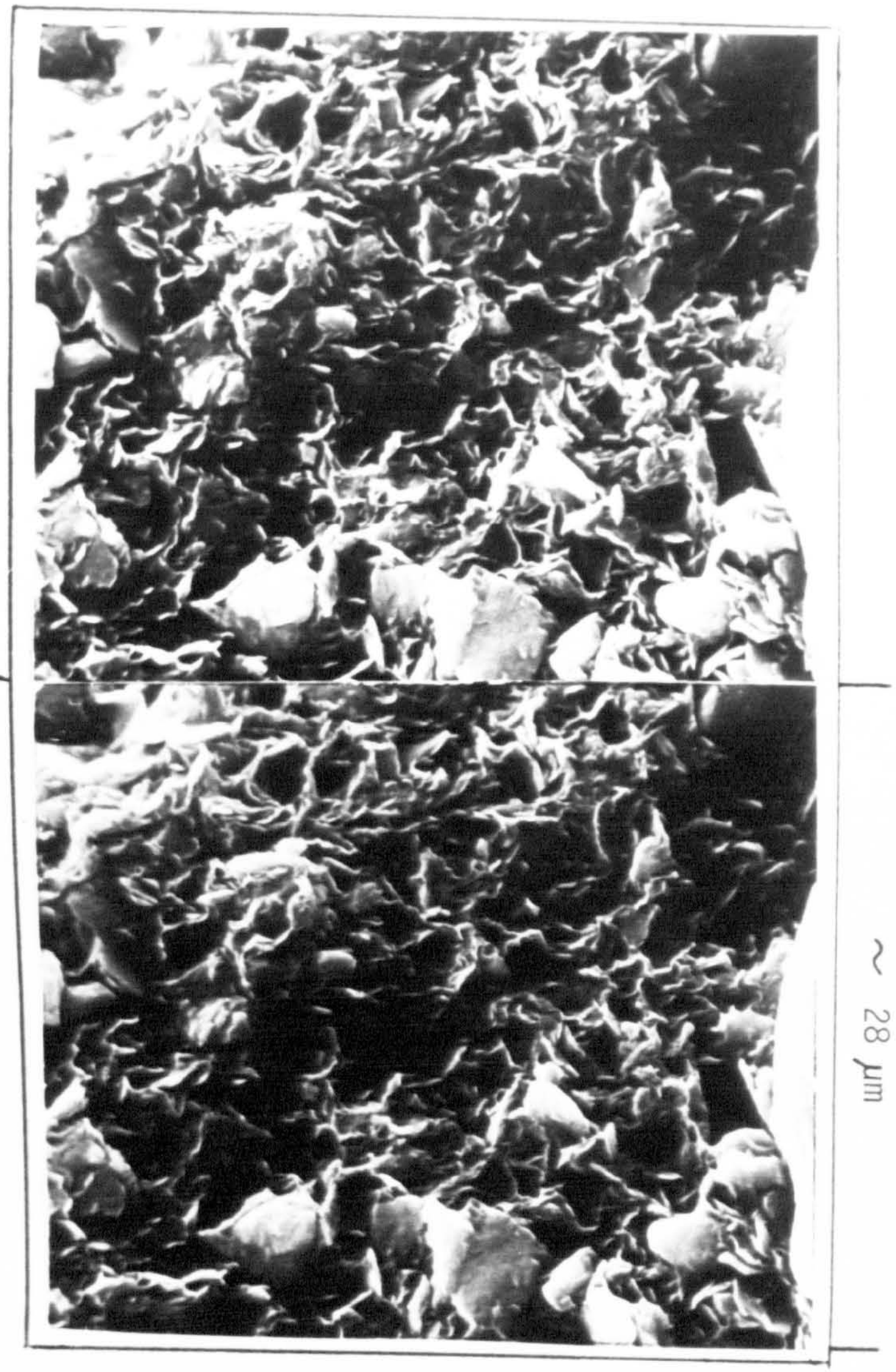
x 2000

(d) Critical point - random clay array x 2080

MIC. B .1. LAKE PORTCHARTRAIN

stereopair

~ 56 µm

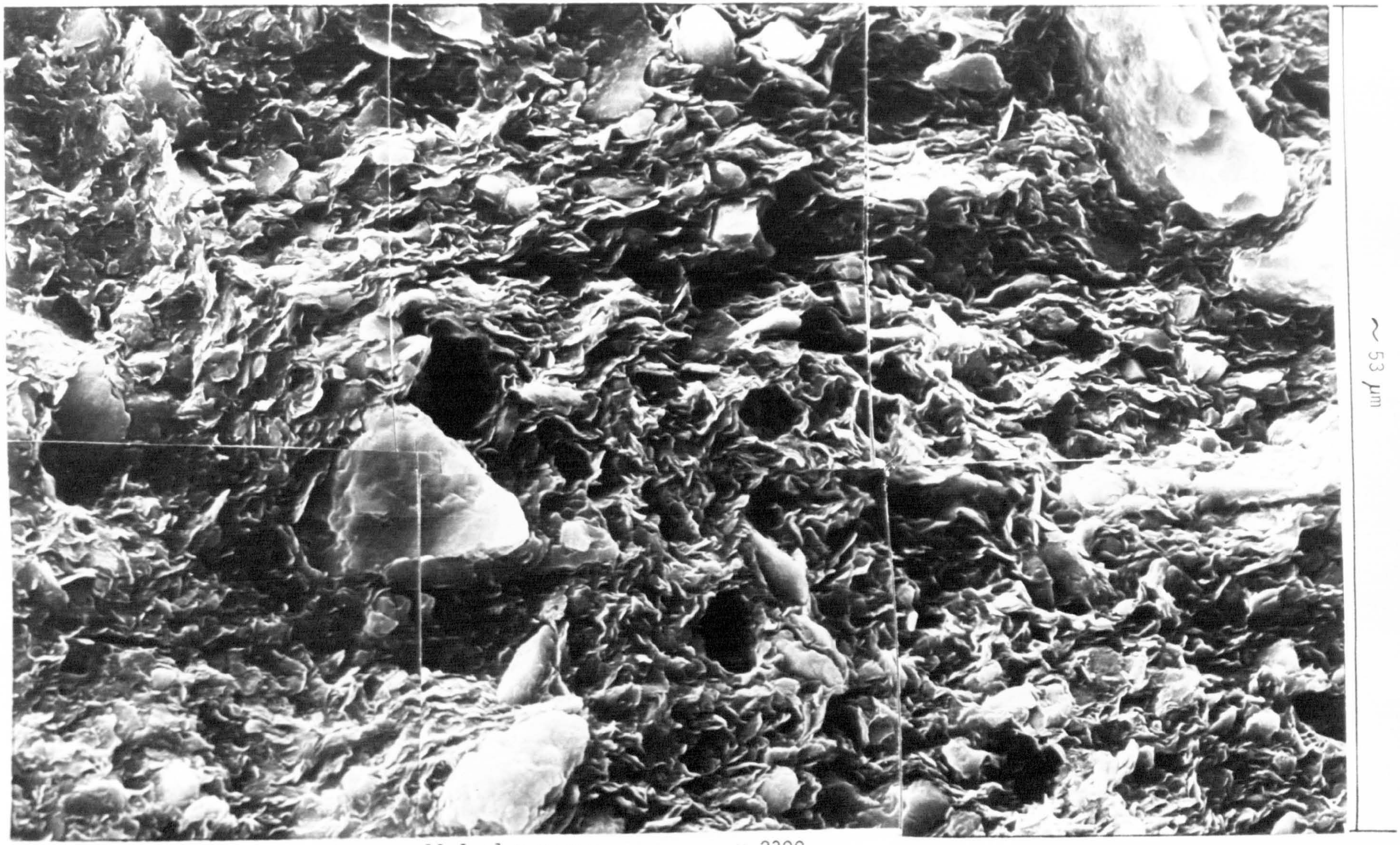


~ 28 µm

(e) Air-dried - random clay array x 2080

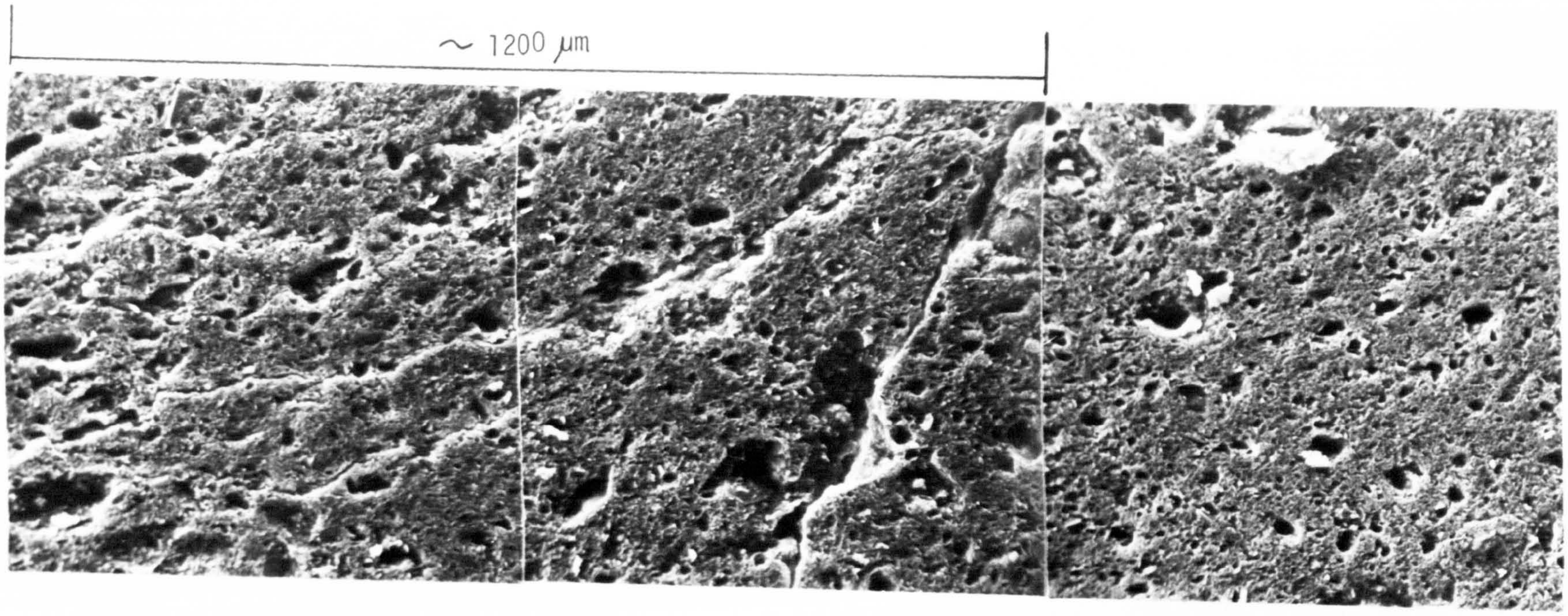
x 2080

MIC. B.I. LAKE PORTCHARTRAIN



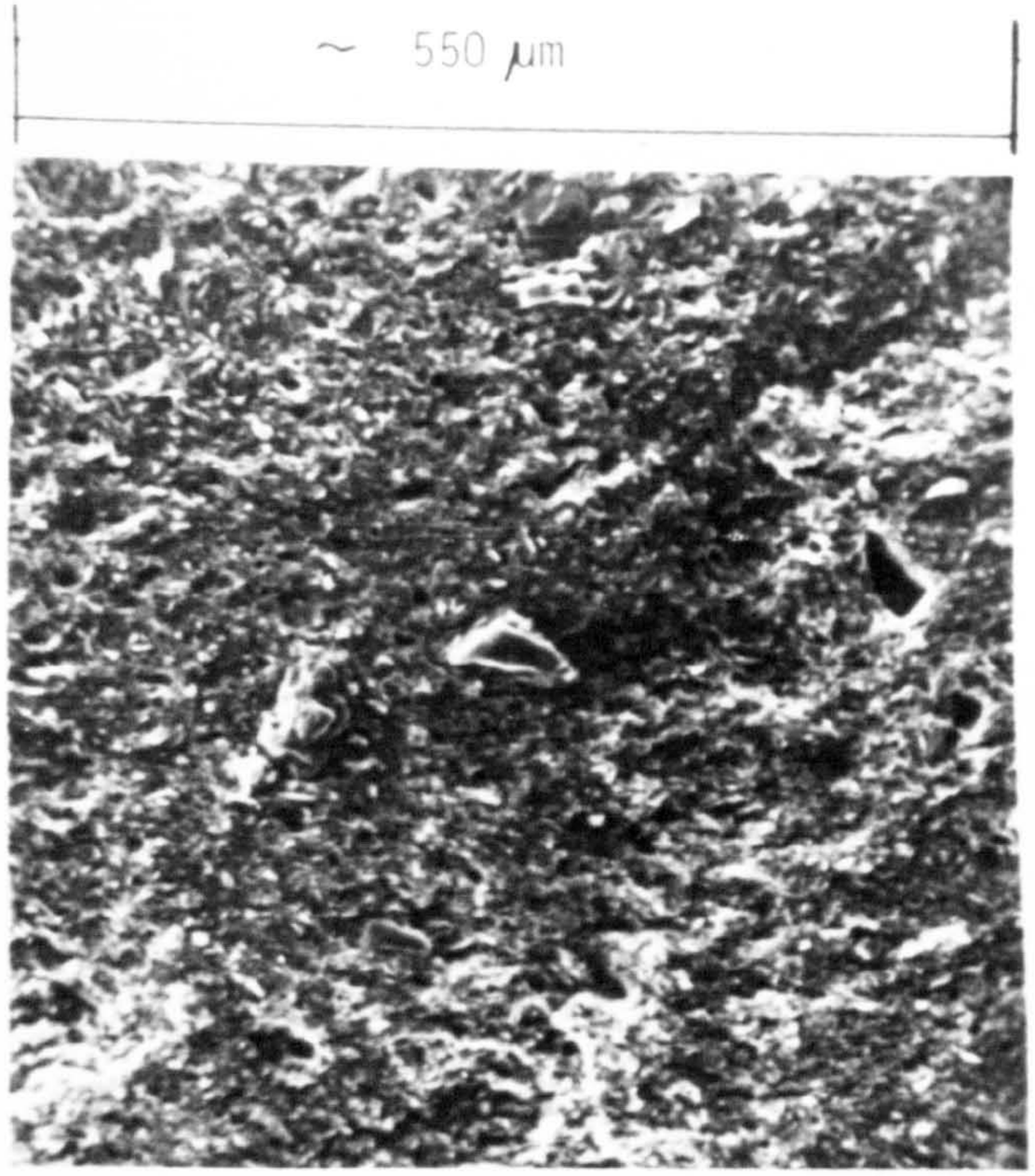
(f) Oven-dried - predominantly parallel clay array x 2300

MIC. B.I. LAKE PORTCHARTRAIN

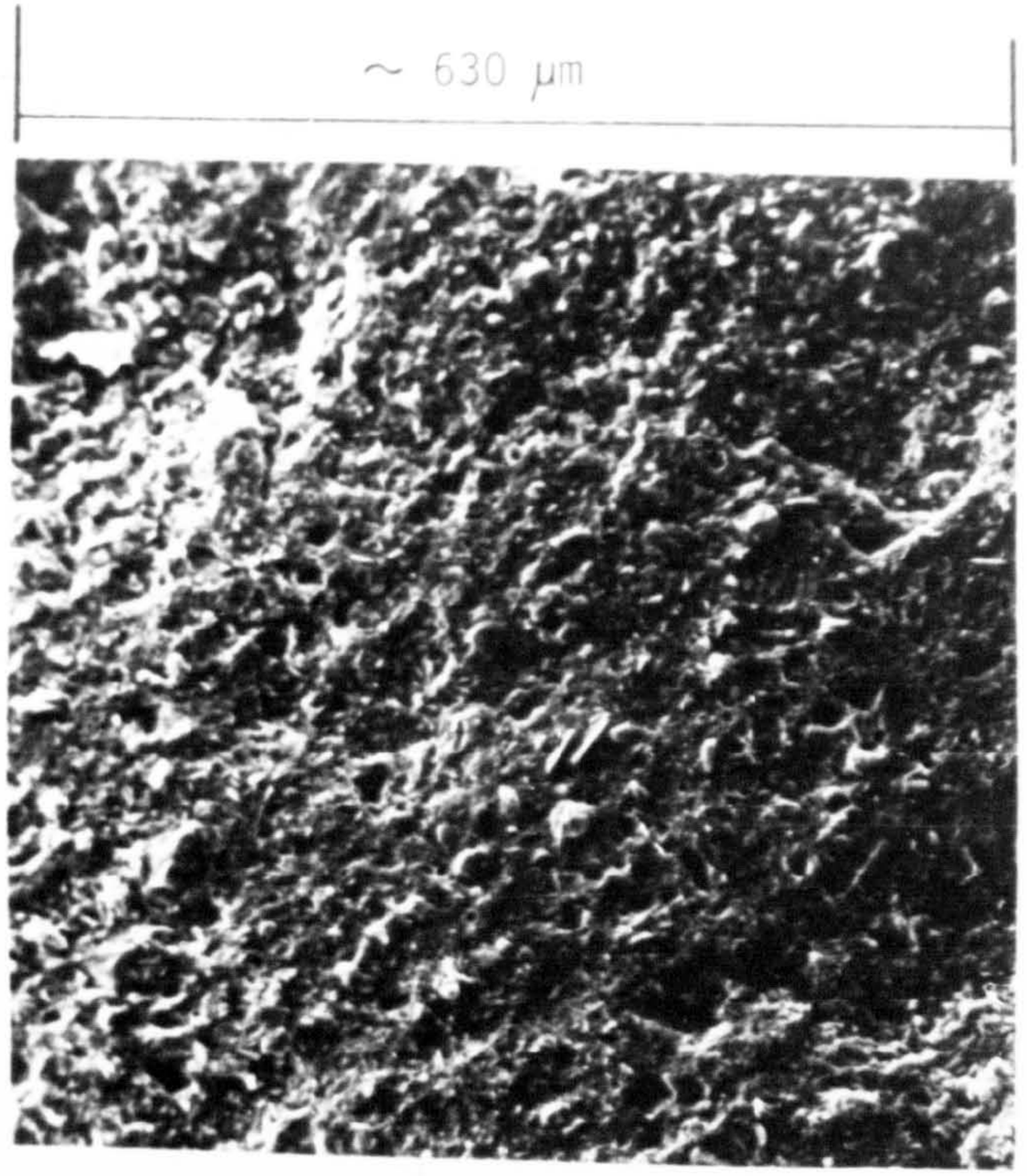


(g) Critical point - composite microfabric x 125

MIC. B.I. LAKE PORTCHARTRAIN



(j) Oven-dried - composite microfabric x 150



(h) Air-dried - composite microfabric x 130

MIC. B . I. LAKE PORTCHARTRAIN