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APPENDICES

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APPENDIX 1

Petrographic Procedures

Modal analyses were undertaken on thin sections of sandstones collected from throughout the study area. Two samples were analysed for the Katberg, twenty for the Burgersdorp Formation and thirty one for the Molteno Formation.

For the modal analyses 300 points per thin section were counted. Graphs represented by Galehouse (1971) showing probable error at 95.4% confidence level, plotted against points counted for various mineral percentages, indicate that this number represent an optimum investment of time. A brief description of each category and the criteria used to distinguish it from other categories is given below.

Quartz: Monocrystalline quartz.
Feldspar: Total feldspar; no distinction was drawn between plagioclase and K-feldspar.
R.F. : Total lithic fragments, including polycrystalline quartz#, chert, sedimentary, metasedimentary, and undifferentiated rock fragments.

The modal percentages of feldspar and lithic fragments may be slightly underestimated due to the difficulty in recognising decomposed feldspars and granitic grains.

Because of the difficulty in assigning provenance to polycrystalline quartz grains, certain authors (eg Lewis & McConchie, 1994) include it with Qm. They are however here considered as non-disaggregated rock fragments.

Sandstone compositional categories

Katberg and Burgersdorp Formations

Sample	Stratigraphic horizon	Modal % Quartz	Feldspar	Rock Fragments
Katberg Formation				
94/3/A1	Katberg (North)	36	23	41
92/1/M1	Katberg (South)	51	11	38
Burgersdorp Formation				
92/5/Y8	Upper Burgersdorp	65	9	26
92/5/E3	Upper Burgersdorp	61	10	29
92/3/R1	Upper Burgersdorp	63	7	30
92/3/T5	Upper Burgersdorp	62	9	29
92/3/T2	Upper Burgersdorp	67	7	26
92/3/A1	Upper Burgersdorp	61	8	31
92/5/S7	Upper Burgersdorp	75	8	17
92/5/S10	Upper Burgersdorp	72	9	19
92/5/S12	Upper Burgersdorp	70	12	18
92/3/T3	Upper Burgersdorp	65	8	27
92/5/P1	Upper Burgersdorp	60	6	34
92/5/V7	Middle Burgersdorp	56	6	38
92/5/V11	Middle Burgersdorp	55	11	34
92/5/I2	Middle Burgersdorp	49	12	39
94/3/C1	Middle Burgersdorp	52	14	34
94/3/A5	Middle Burgersdorp	51	11	38
92/5/V6	Middle Burgersdorp	55	13	32
94/3/D6	Middle Burgersdorp	51	7	42
94/3/A3	Lower Burgersdorp	46	16	38
92/4/B6	Lower Burgersdorp	41	21	38

Moltono Formation

Sample	Stratigraphic horizon	Locality	Modal % Quartz	Feldspar	Rock Fragments
02/5/F3	Indwe	Norwood	86	7	7
04/4/E1	Indwe	R394	83	8	9
02/5/D14	Indwe	R394	90	4	6
04/3/D3	Indwe	Olywyn	86	5	9
04/3/C3	Indwe	Olywyn	83	5	12
04/4/F1	BB5	B'hoek Pass	84	10	6
04/4/F2	BB5	B'hoek Pass	85	3	12
04/4/F3	BB5	B'hoek Pass	85	6	9
02/5/L10	BB5	B'hoek Pass	84	9	7
02/5/Z11	BB4	B'hoek Pass	81	10	9
03/2/N10	BB4	B'hoek Pass	70	11	10
03/2/N9	BB4	B'hoek Pass	81	12	7
04/4/H4	BB4	Eilandsfontein	82	15	3
04/3/D2	BB4	Olywyn	80	16	4
03/2/J*	BB3	B'hoek Pass	80	16	4
03/2/N8	BB3	B'hoek Pass	75	18	7
03/2/N7	BB3	B'hoek Pass	74	15	11
03/2/N6	BB3	B'hoek Pass	76	16	8
03/2/N5	BB3	B'hoek Pass	79	14	6
02/3/O3	BB3	Hillside	79	8	13
02/5/V2	BB2	B'hoek Pass	76	21	3
02/5/V4	BB2	B'hoek Pass	80	15	5
04/4/F4	BB2	B'hoek Pass	76	15	9
02/3/M1	BB2	Avilion	84	6	10
02/3/M2	BB2	Avilion	82	8	10
02/3/O1	BB2	Avilion	84	5	11
02/5/Z10	BB1	B'hoek Pass	80	15	5
02/3/A3	BB1	Norwood	77	17	6
02/5/F4	BB1	Norwood	69	20	11
02/3/U1	BB1	Avilion	73	17	10
02/3/W3	BB1	Avilion	79	16	5

APPENDIX 2

Fossil material collected from Subzone C

Catalogue Number	Identification	Locality	Grid Reference	Formation
BP/1/5530	*Angonisaurus* skull	Avilion	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5531	*Angonisaurus* skull	Wilgerkloof	S31°30'39" E26°23'10"	Burgersdorp
BP/1/5532	Medium sized dicynodont skull	Norwood	S31°30'31" E26°22'56"	Burgersdorp
BP/1/5533	Anterior portion dicynodont skull and lower jaw	Wilgerkloof	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5534	Dicynodont left caniniform	Norwood	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5535	Dicynodont intertemporal bar	Avilion	S31°34'33" E26°24'00"	Burgersdorp
BP/1/5536	Dicynodont humerus	Lytham	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5537	*Thrinchodon* snout and partial lower jaw	Avilion	S31°34'34" E26°24'07"	Burgersdorp
BP/1/5538	*Thrinchodon* snout	Avilion	S31°34'32" E26°24'01"	Burgersdorp
BP/1/5539	Small cynodont in nodule	Norwood	S31°34'37" E26°23'53"	Burgersdorp
BP/1/5540	*Diademodon* skull	Avilion	S31°30'37" E26°23'07"	Burgersdorp
BP/1/5541	*Diademodon* lower jaw	Norwood	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5542	*Cynognathus* anterior tip of lower jaw	Avilion	S31°34 34" E26°24'01"	Burgersdorp
BP/1/5543	*Cynognathus* anterior tip f lower jaw	Avilion	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5544	*Cynognathus* anterior tip of lower jaw	Avilion	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5545	*Cynognathus* postcrania	Avilion	S31°34'48" E26°25'04"	Burgersdorp
BP/1/5546	Cynodont postcrania	Norwood	S31°30'37" E26°23'07"	Burgersdorp
BP/1/5547	Cynodont humerus	Avilion	S31°34'33" E26°24'06"	Burgersdorp
BP/1/5548	Cynodont poste ania	Avilion	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5549	Cynodont scapula	Norwood	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5550	Amphibian lower jaw	Norwood	S31°30'22" E26°22'37"	Burgersdorp
BP/1/5551	*Parotosaurus mareani* skull	Wilgerkloof	S31°30'38" E26°23'12"	Burgersdorp
BP/1/5552	Fragmentary amphibian skull	Norwood	S31°30'40" E26°22'40"	Burgersdorp
BP/1/5553	Fragmentary amphibian skull	Wilgerkloof	S31°30'30" E26°23'10"	Burgersdorp
BP/1/5554	Partial amphibian skull	Eilandshoek	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5555	Archosaur tooth	Norwood	S31°34'34" E26°24'01"	Burgersdorp
BP/1/5556	?Archosaur jugal	Norwood	S31°34'34" E26°24'01"	Burgersdorp

APPENDIX 3

Fossils collected from subzones A & B and Wood Fossils

Catalogue Number	Identification	Locality	Map/Grid Reference	Formation
Subzone A				
BP/1/5400	*Thrinaxodon* sp.	Bosrand 12	S28°18'25" E27°47'25" Paul Roux district	Burgersdorp
BP/1/5401	*Thrinaxodon* sp.	Bosrand 12	S28°18'25" E27°47'25"	Burgersdorp
BP/1/5402	*Thrinaxodon* sp.	Bosrand 12	S28°18'25" E27°47'25"	Burgersdorp
BP/1/5403	*Thrinaxodon* sp.	Bosrand 12	S28°18'25" E27°47'25"	Burgersdorp
BP/1/5404	*Thrinaxodon* sp.	Bosrand 12	S28°18'25" E27°47'25"	Burgersdorp
BP/1/5405a	*Thelegnathus contritus*	Bosrand 12	S28°18'25" E27°47'25"	Burgersdorp
BP/1/5405b	*Thelegnathus oppressus*	Bosrand 12	S28°18'25" E27°47'25"	Burgersdorp
BP/1/5525	Archosaur lower jaw	Gwhamiekop	S28°17'27" E27°42'41" Senekal district	Burgersdorp
BP/1/NA	*Kestroseurus* skull and lower jaw	Gwhamiekop	S28°17'27" E27°42'41"	Burgersdorp
Subzone B				
BP/1/5559(a-c)	"*Parotosuchus*" *africanus* fragmentary skull	Nooitgedacht	S30°52'23" E26°15'00"	Burgersdorp
BP/1/5562	"*Parotosuchus*" *africanus* lower jaw	Nooitgedacht	S30°52'23" E26°15'06"	Burgersdorp
BP/1/5563	Brachyopid atlas	Nooitgedacht	S30°52'23" E26°15'06"	Burgersdorp
BP/1/NA	*Ceratodus* tooth plates	Nooitgedacht	S30°52'23" E26°15'06"	Burgersdorp
BP/1/5624	*Kannemeyeria simocephala* complete skeleton	Bethal	S30°20'10" E26°23'40"	Burgersdorp
BP/1/NA	*Kannemeyeria simocephala* Numerous skull fragments	Bethal	S30°20'10" E26°23'40"	Burgersdorp
Wood				
BP/10/302	*Araucarioxylon*	Orangefontein	S30°42'25" E26°33'15"	Molteno
BP/10/303	*Araucarioxylon*	Norwood	S31°34'34" E26°23'06"	Molteno
BP/10/305	Podocarp wood	Norwood	S31°36'40" E26°22'40"	Burgersdorp
BP/10/306	*Araucarioxylon*	Avilion	S31°30'37" E26°23'07"	Molteno
BP/10/307	*Araucarioxylon*	Avilion	S31°34'35" E26°24'01"	Molteno
BP/10/455b	*Araucarioxylon*	Bushmanshoek Pass	S31°30'05" E26°25'06"	Molteno
BP/10/456	*Araucarioxylon*	Bushmanshoek Pass	S31°30'05" E26°27'32"	Molteno

BP/1/NA = Not yet catalogued

APPENDIX 4

Avilion Stratotype

Kind and Rank	:	Unit reference stratotype
Nature of section	:	Cliff face section exposing the upper 200m of the formation. This section preserves the best exposures of the upper Burgersdorp Formation in the south of the basin.
Location	:	On the farm Avilion, Bamboeshoek Valley, Storkstroom district (Map Ref. 3126CB Moordenaarshoek; S31°34'34" E26°24'00")
Accessibility	:	Good; short walk from farmhouse.
Lithology	:	See section Fig.2.81.
Structure	:	Strata dip between 2-4° to the NW. No major faulting occurs, with only minor displacement by dolerite evident.
Palaeontology	:	Preserves a faunal assemblage assignable to Subzone C of the *Cynognathus* Assemblage Zone.
Boundaries and contact relationships	:	Lower boundary not exposed at this section. Upper boundary disconformable with the overlying Bamboesberg Member of the Molteno Formation.

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APPENDIX 6

Geochemical Analyses

Major element

(all data in wt%)

Sample No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	TOTAL
92/5/Ba1	2.42	0.26	0.98	0.13	0.04	1.08	0.39	0.20	0.00	0.14	2.19	7.85
92/5/E5	10.66	0.28	7.34	1.63	39.48	1.15	11.32	0.17	0.93	0.11	21.10	94.17
92/5/K11	33.42	0.55	9.03	30.49	11.14	1.01	0.40	0.17	1.79	0.37	10.73	99.10
92/5/W11	32.27	0.55	9.51	19.77	8.92	0.96	7.80	0.16	1.66	5.90	10.31	97.81

Total Fe as Fe_2O_3
LOI: Loss On Ignition

Trace element

(all data in ppm)

Sample No.	Rb	Sr	Y	Zr	Nb	Co	Ni	Cu	Zn	V	Cr	Ba
92/5/Ba1	114	825	<3	633	27	9	<9	121	11	<15	[illegible]	HIGH*1
92/5/E5	66	3338	27	71	4	73	15	107	108	20	[illegible]	2212
92/5/K11	113	863	33	140	11	<9	16	67	67	74	80	1690
92/5/W11	120	582	66	113	11	<9	21	9	70	61	31	2432

HIGH*1 : Off the standard (>35%)

APPENDIX 7

Pebble axes and orientations

Bamboesberg and Indwe Sandstone Members

Stratigraphic position	L	I	S	I/L	S/L	Palaeo current
Bamboesberg	16.1	7.5	5.2	0.466	0.693	350
Bamboesberg	10.0	7.6	5.3	0.475	0.697	312
Bamboesberg	7.2	6.8	1.5	0.944	0.221	350
Bamboesberg	27.2	12.6	9.8	0.463	0.778	318
Bamboesberg	12.0	9.1	5.6	0.758	0.615	322
Bamboesberg	65.0	52.7	31.5	0.811	0.485	335
Indwe	16.6	7.5	4.9	0.452	0.653	314
Indwe	5.0	2.6	1.7	0.520	0.654	350
Indwe	11.5	6.9	3.8	0.600	0.551	302
Indwe	7.3	5.6	2.1	0.767	0.375	322
Indwe	12.5	9.0	4.8	0.720	0.533	324
Indwe	10.1	7.3	4.5	0.723	0.616	012
Indwe	7.8	5.5	2.3	0.705	0.295	358
Indwe	6.5	4.9	2.0	0.754	0.408	012
Indwe	7.2	5.5	2.4	0.764	0.436	322
Indwe	6.1	4.5	1.9	0.738	0.422	011
Indwe	11.1	8.0	2.1	0.721	0.263	318
Indwe	16.01	6.8	1.5	0.944	0.221	296
Indwe	30.2	27.9	15.8	0.924	0.566	343
Indwe	16.0	14.0	7.0	0.875	0.500	356
Indwe	12.0	10 5	5.5	0.875	0.524	349
Indwe	22.0	15.0	9.2	0.682	0.613	004
Indwe	17.0	10.1	5.7	0.594	0.564	356
Indwe	25.6	17.6	9.7	0.687	0.551	347

L = Long axis
I = Intermediate axis
S = Short axis

All measurements in centimetres (cm)

A Stratigraphic, Sedimentological and Palaeoenvironmental synthesis of the Beaufort-Molteno contact in the Karoo Basin.

Volume II

By

Philip John Hancox

Thesis submitted for the degree of Philosophiae Doctor in the Faculty of Science
(Departments of Geology/Palaeontology)
University of the Witswatersrand, Johannesburg, 1998.

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CHAPTER 3

CHAPTER 4

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LEGEND FOR STRATIGRAPHIC SECTIONS

Lithologies

Sandstone

Siltstone

Mudstone

Coal

Dolerite d^d

Facies

Se_h

Se_l

Sh

Sm

St

Sp

Sr

Fh

Fr

Fm

C

Other Sedimentary Structures

Erosion surface — er

irregular

incised

Extraformational clasts

Paleocurrent vector mean

Rhizoconcretions

Bioturbation

Manganeese rich nodular layer

LEGEND FOR LATERAL PROFILES

□	=	Sandstone
▪	=	Fines
⟷	=	Orientation of Profile
(3)	=	Bounding Surface Order
CH	=	Channel fill element
ACH	=	Abandoned channel fill
DA	=	Downstream accreted macroform
LA	=	Laterally accreted macroform

NOTES ON FIGURES AND DIAGRAMS

Palaeontological specimen figures:

////	=	Matrix covered or abraded
#	=	Foramen or opening

Geological hammer in all Figures = ± 30cm

Compass = 10cm

qj.	=	quadratojugal
q.r.p.	=	quadrate ramus of the pterygoid
r.t.	=	root of canine tooth
sio.	=	sulcus infraorbitalis
sj.	=	sulcus jugularis
smx.	=	septomaxilla
so.	=	supraoccipital
spl.	=	splenial
sq.	=	squamosal
sso.	=	sulcus supraoccipitalis
s.ste.	=	sulcus temporalis
st.	=	stapes
ste.	=	supratemporal
sur.	=	surangular
tab.	=	tabular
v.	=	vomer

ABBREVIATIONS USED IN THE FIGURES

MORPHOLOGICAL ABBREVIATIONS

ang.	=	angular
art.	=	articular
b.	=	basioccipital
bs.	=	basisphenoid
cm.	=	crista muscularis
co.	=	crista obliqua
ct.	=	crista terminalis
cte.	=	crista tabularis externa
den.	=	dentary
ect.	=	ectopterygoid
eo.	=	exoccipital
ex.nar.	=	external narial opening
for.mag.	=	foramen magnum
fr.	=	frontal
i.c.	=	opening for internal carotid artery
ip.	=	interparietal
ipv.	=	inter-pterygoid vacuity
ju.	=	jugal
k.ps.	=	keel on parasphenoid
la.	=	lamina ascendens
lac.	=	lachrymal
la.f.	=	lachrymal foramen
l.f.	=	labial fossa
l.p.f.	=	lateral palatal fenestra
ma.f.	=	mandibular fenestra
mb.	=	maxillary buttress
mx.	=	maxilla
nas.	=	nasal
p.par.	=	post parietal
p.pr.	=	paroccipital process
p.pt.	=	palatine ramus of the pterygoid
p.t.f.	=	post-temporal fenestra
pal.	=	palatine
par.	=	parietal
pf.	=	prefrontal
pin.	=	pineal opening
pmx.	=	premaxilla
po.	=	postorbital
pof.	=	postfrontal
prep.	=	preparietal
pro.	=	prootic
ps.	=	parasphenoid
pter.	=	pterygoid
pv.	=	processus ventralis
q.	=	quadrate

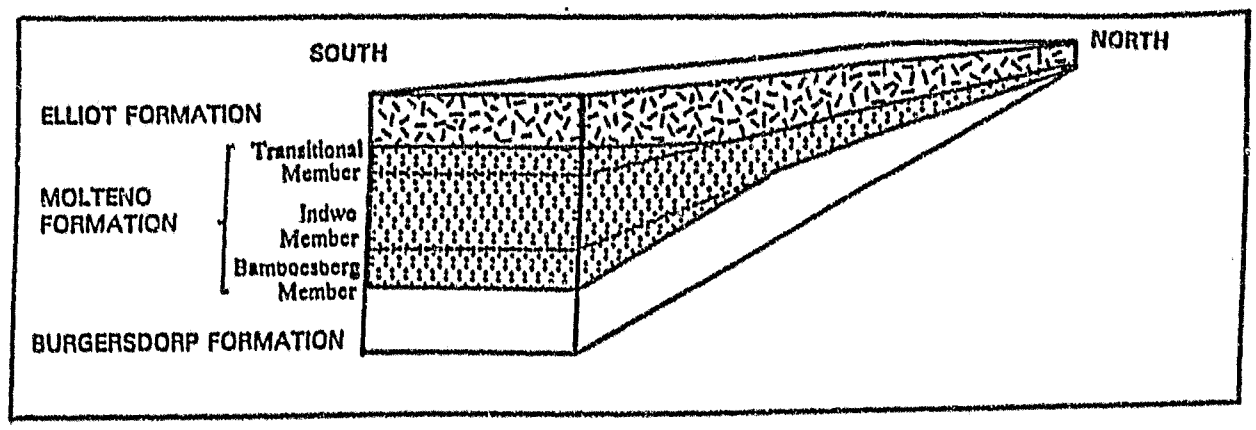


Figure 1.1: Block diagram showing the regional relationships beween the Burgersdorp, Molteno and Elliot Formations (After Turner, 1975a).

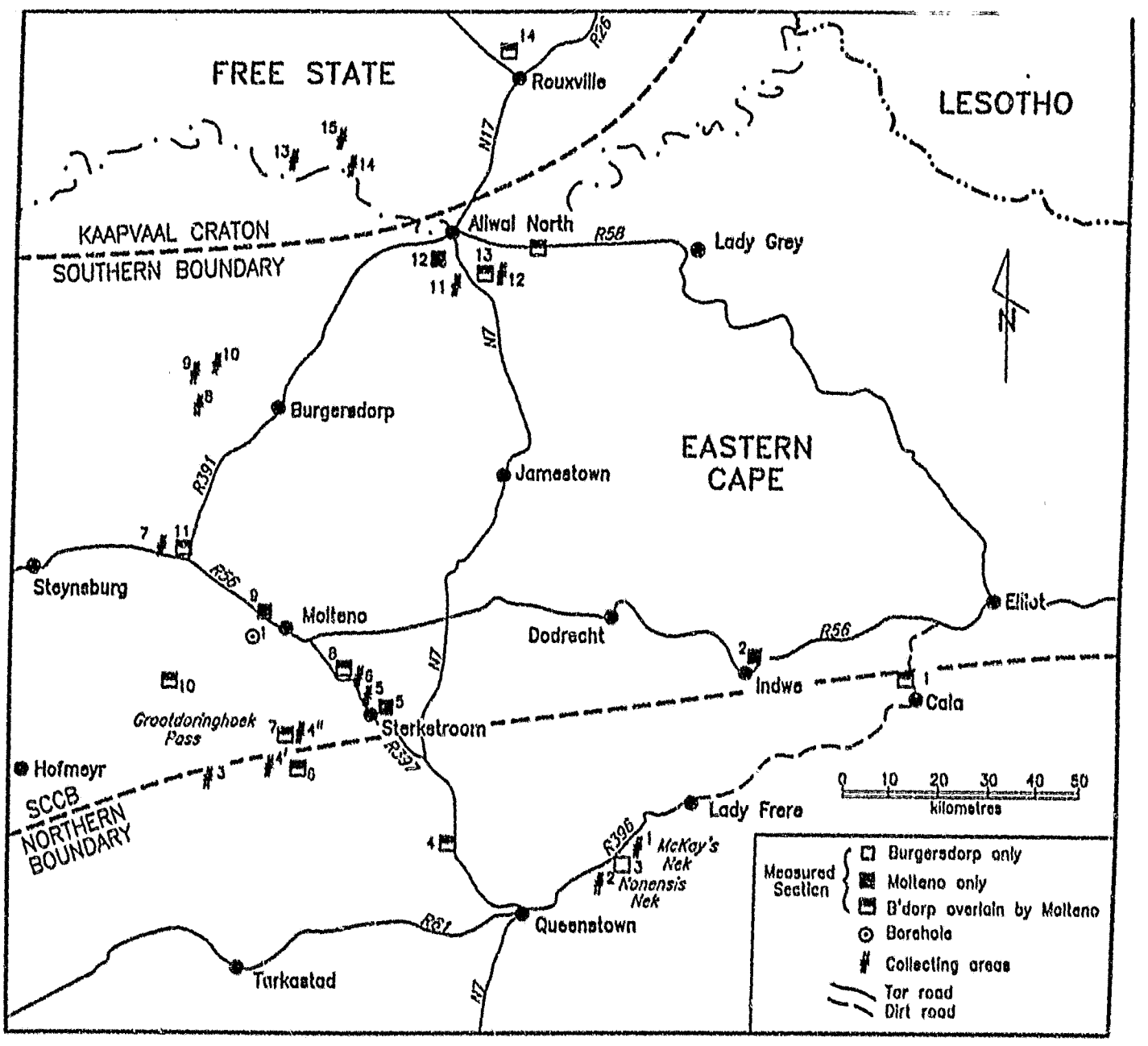


Figure 1.2: Locality map of the study area.

Extended Legend: Figure 1.2

Collecting Areas

#1 McKay's Nek: Sandbody geometries and architectural elements of the Middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

#2 Nonensi's Nek: Type exposures of the Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B)

#3 Farm Wilgerskoof: Exposures of the upper Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone C); overlain by the Bamboesberg and Indwe Members of the Molteno Formation.

#4 Farm Norwood: Exposures of the upper Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone C); overlain by the Bamboesberg and Indwe Members of the Molteno Formation.

#4' Farm Avillon: Exposures of the upper Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone C); overlain by the Bamboesberg and Indwe Members of the Molteno Formation.

#5 Bushmanshoek Pass: Exposures of the upper Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone C).

#6 Bushmanshoek Pass: Exposures of the Bamboesberg and Indwe Members.

#7 Farm Hillside: Exposures of the middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

#8 Farm Winaarsbaken: Exposures of the middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

#9 Farms Grootdam and Nooitgedacht: Exposures of the middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

#10 Farm Beseba: Exposures of the middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

#11 Farm Elandshoek: Exposures of the middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

#12 Farm Braamspruit: Exposures of the middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

#13 Farm Kaalmansgat: Exposures of the lower Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone A)

#14 Farm Gladdegrond: Exposures of the middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

#15 Farms Bethal/Slootkraal: Exposures of the middle Burgersdorp Formation; *Cynognathus* Assemblage Zone (Subzone B).

Measured sections

□1 Cala Pass: Burgersdorp Formation to basal Indwe Sandstone Member.

□2 Indwe Town: Upper Bamboesberg and Indwe Members of the Molteno Formation.

□3 Nonensi's Nek: Middle Burgersdorp Formation.

□4 Roadcut on R397: Indwe Sandstone Member.

□5 Kous Ras Nature Reserve: uppermost Bamboesberg and Indwe Sandstone Members of the Molteno Formation.

□6 Farm Norwood: Burgersdorp Formation to basal Indwe Sandstone Member.

□7 Farm Avillon: Burgersdorp Formation to basal Indwe Sandstone Member.

□8 Bushmanshoek Pass: Uppermost Burgersdorp Formation and Bamboesberg and Indwe Sandstone Members of the Molteno Formation.

□9 Roadcut on the R56: Uppermost Bamboesberg and basal Indwe Sandstone Members of the Molteno Formation.

□10 Grootforinghoek Pass: Type section of the Bamboesberg Member of the Molteno Formation.

□11 Farm Hillside: Middle Burgersdorp Formation and Bamboesberg and Indwe Sandstone Members of the Molteno Formation.

□12 Farm Olivefontein: Upper Bamboesberg and Indwe Sandstone Members of the Molteno Formation.

□13 Farm Braamspruit: Middle Burgersdorp and Upper Bamboesberg and Indwe Sandstone Members of the Molteno Formation.

□14 Roadcut on the R30 between Rouxville and Smithfield: Middle Burgersdorp and Upper Bamboesberg and Indwe Sandstone Members of the Molteno Formation.

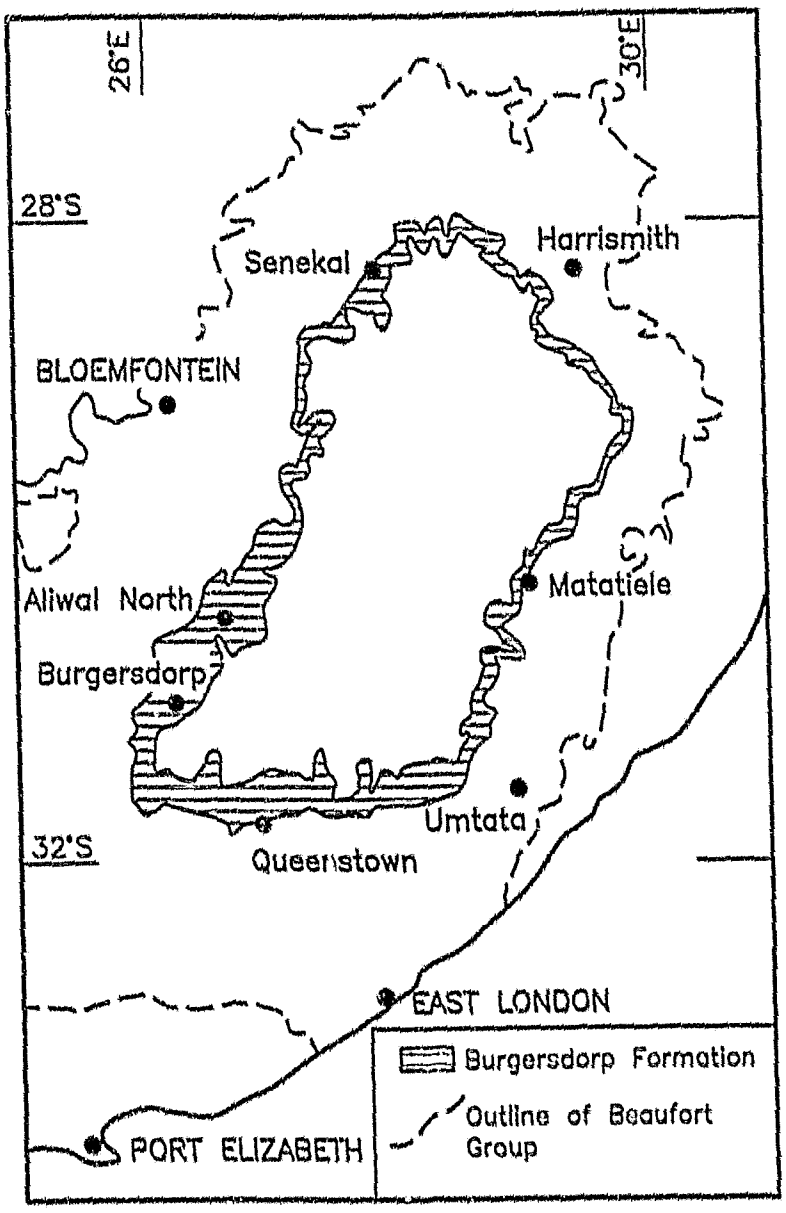


Figure 2.1a: Geographical distribution of the Burgersdorp Formation.

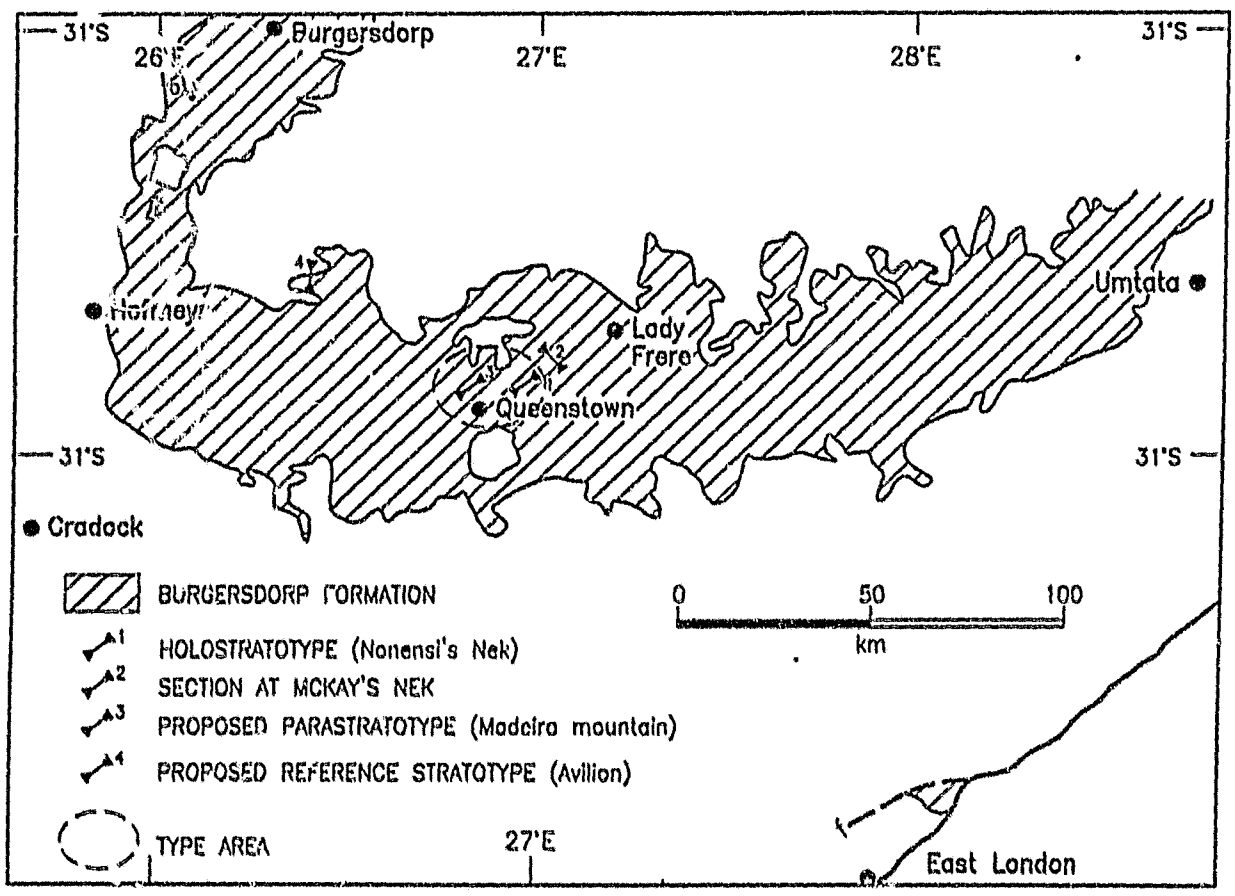


Figure 2.1b: Distribution of the Burgersdorp Formation in the south of the basin, including the location of the type area and holostratotype (After Johnson & Hiller, 1990).

Figure 2.2: Intraclast conglomerate facies (Se_i) with bone (b). Lower Burgersdorp Formation. Scale bar = 1cm.

Figure 2.3: Intraclast conglomerate facies (Se_i) with bone (b). Upper Burgersdorp Formation.

Figure 2.4: Plan view of trough cross-stratified sandstone facies (St).

Figure 2.5: Planar cross-stratified sandstone facies (Sp).

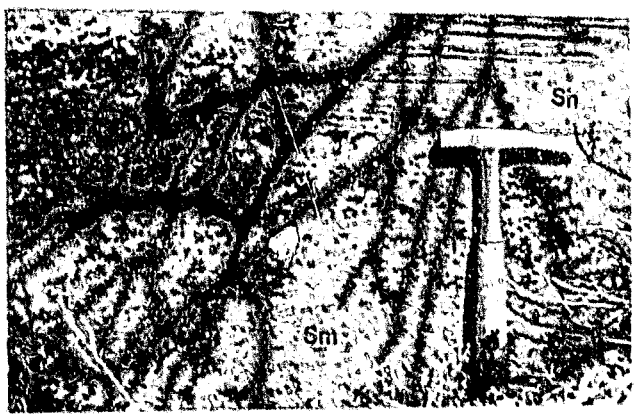


Figure 2.6: Massive sandstone facies (Sm grading upwards into facies Sh

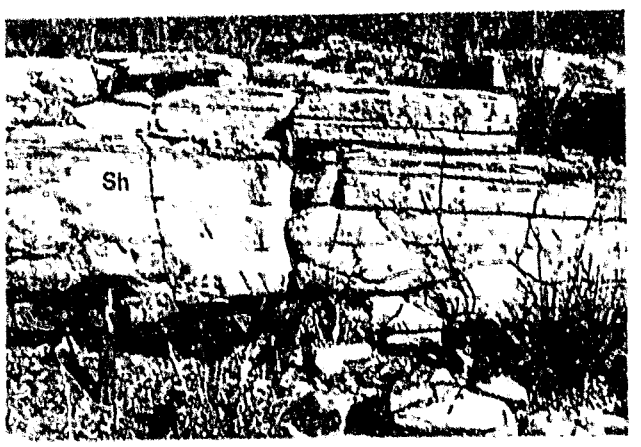


Figure 2.7: Horizontally stratified sandstone facies (Sh).

Figure 2.8: Parting lineation on bed-top surface of facies Sh.

Figure 2.9: Ripple cross-laminated sandstone facies (Sr).

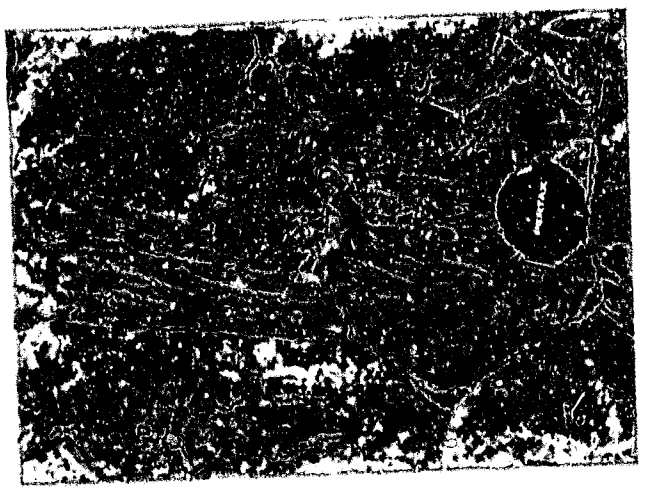


Figure 2.10: Assymetric ripples preserved on upper surface of facies Sr. Note the bioturbation of the *Planolites* type (P).

Figure 2.11: Massive mudstone facies (Fm).

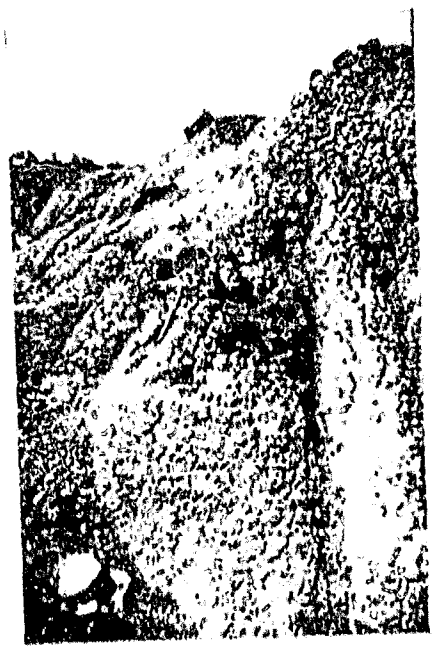


Figure 2.12: Horizontally-laminated siltstone facies (Fh) grading upwards into facies Fm.

Figure 2.13a: Individual rhizoretions of Type I palaeosol. Scale bar = 1cm.

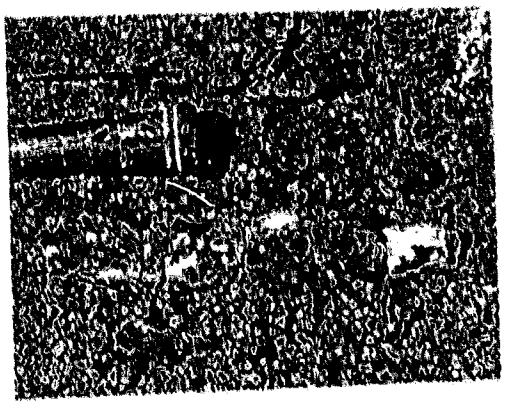


Figure 2.13b: Horizontally orientated matted rhizoliths in Type I palaeosol. Scale bar = 10cm.

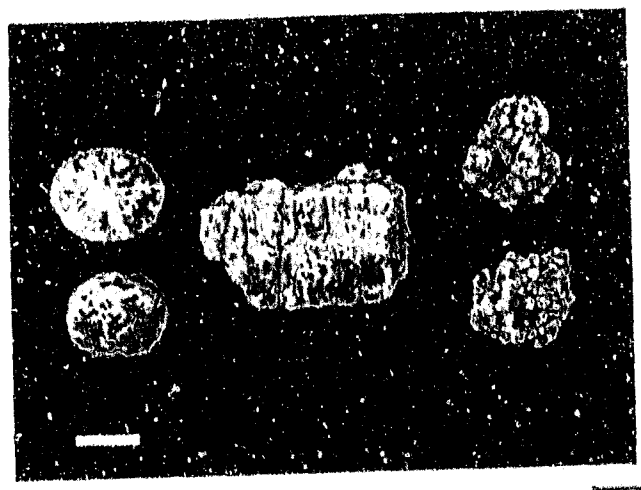


Figure 2.14a: Three typical morphs of barytes nodules compared. Scale bar = 1cm.

Figure 2.14b: Photomicrograph of barytes crystals radiating from a central groundmass. Crossed polars with gypsum plate, 10X magnification.

Figure 2.14c: Photomicrograph of radial crystals of barytes. Note the interdigitation with the fines facies. Crossed polars, 10X magnification.

Figure 2.15: Calcite encrusted amphibian (A) remains from Type II palaeosol.

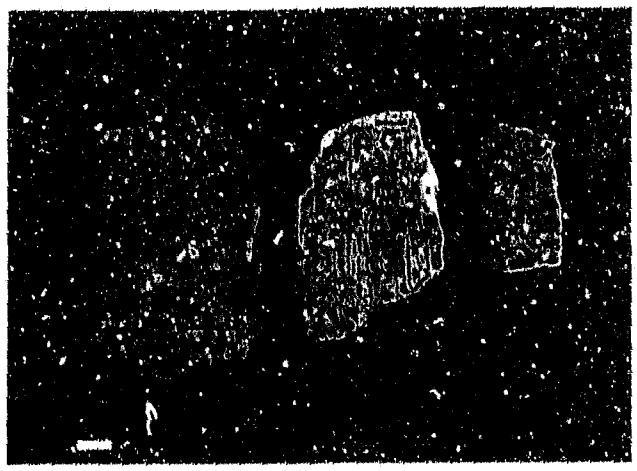


Figure 2.16a: Root impressions and casts in Type II palaeosol.
Scale bar = 1cm.

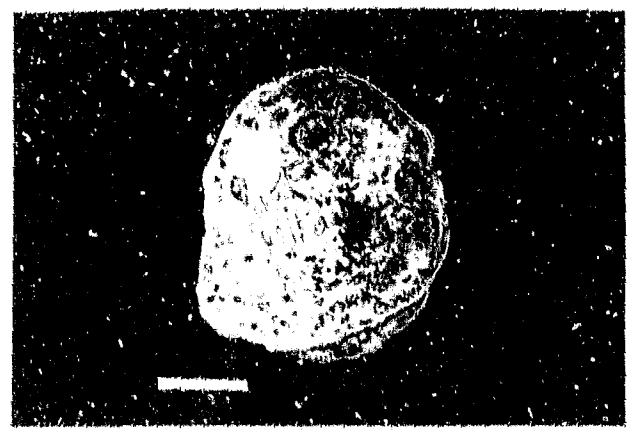


Figure 2.16b: Polished surface of a silicified rhizolith from a Type II palaeosol. Note the presence of radiating root hair tubules in the outer micritic encrustations.
Scale bar = 1cm.

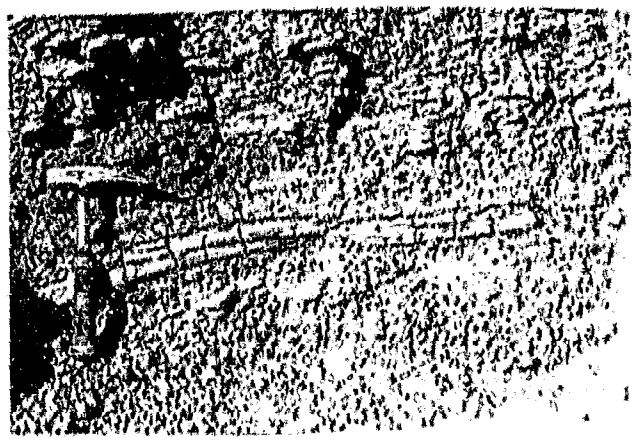


Figure 2.16c: Silicified podocarp root from a Type II palaeosol.

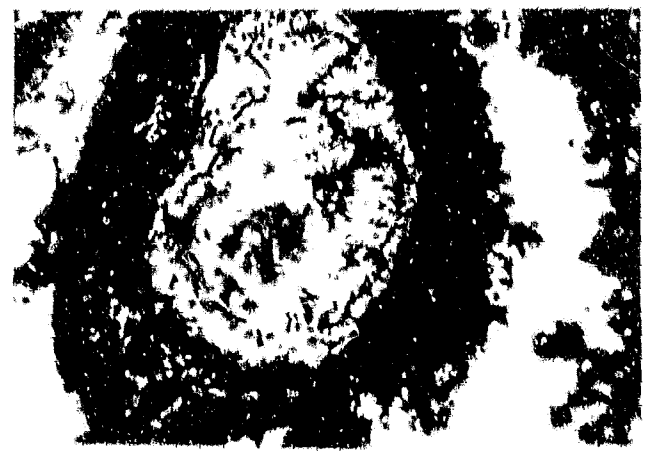


Figure 2.16d: Photomicrograph of coprolite from Type II palaeosol.
Crossed polars.
4X magnification.

Figure 2.17: Vertical and blotchy style colour mottling in Type III palaeosol. Scale bar = 1cm.

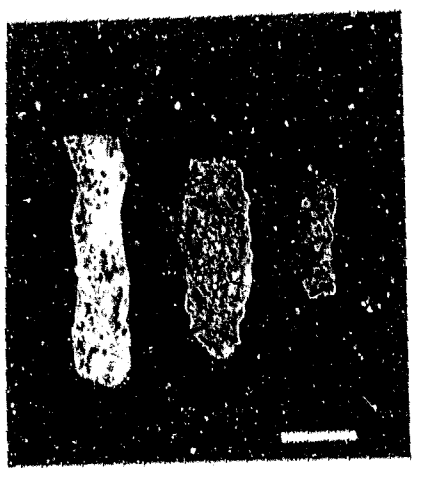


Figure 2.18: Rhizocretions from Type III palaeosol.

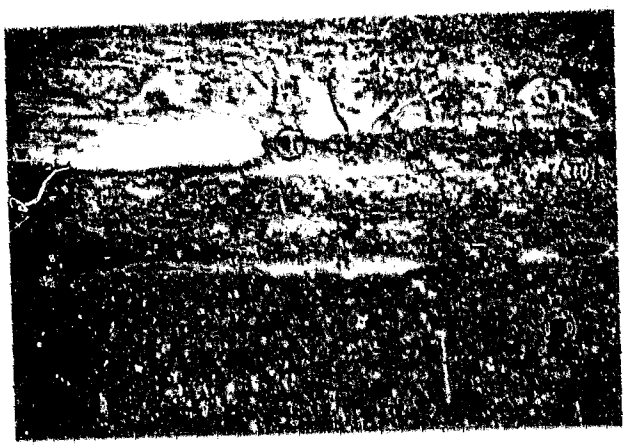


Figure 2.19: Stacked Type II and III palaeosols Nonensi's Nek, Eastern Cape. Scale bar = 1.5m.

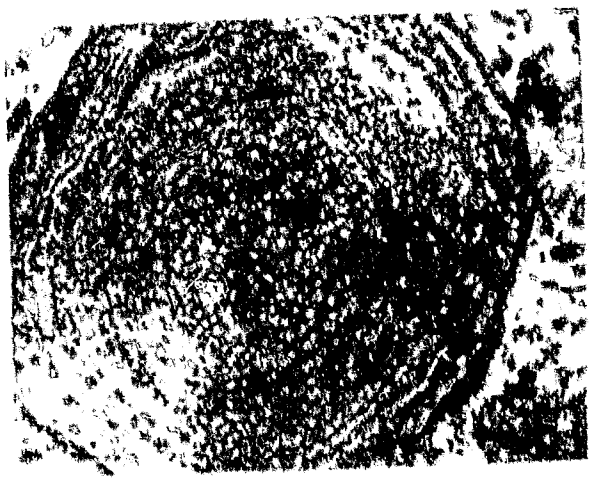


Figure 2.20: Photomicrograph of a cross section through a spheroidal inorganic carbonate grain. Note the irregular concentric growth layers, indestinct nucleus and sparite matrix. Crossed polars with gypsum plate, 4X Magnification.

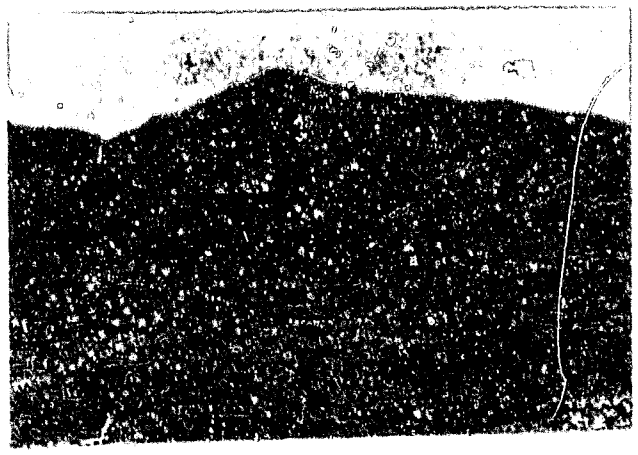
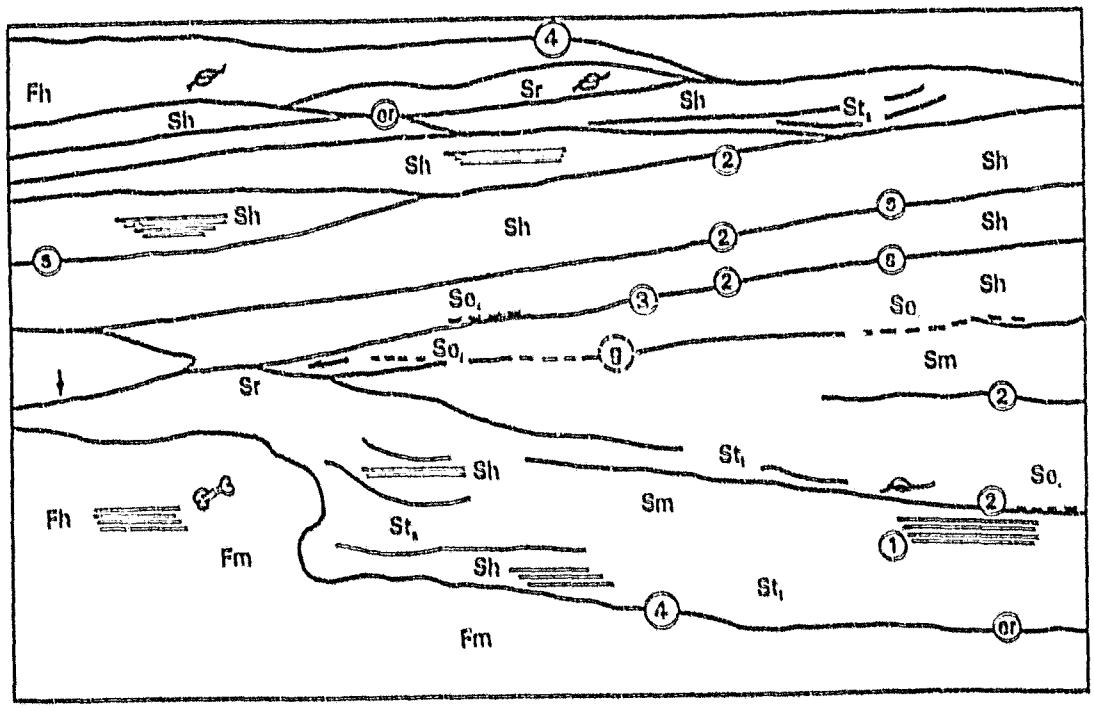


Figure 2.21: Type section of the Burgersdorp Formation, Nonensi's Nek. Note the fining upward packages of sandstones (S) and fines (F). Exposed sequence is ± 500m thick.

Figure 2.22a: Thick, lenticular channel deposit, Bushmanshoek Pass, Eastern Cape. Scale bar = 1m.



② Bounding surface order
Therapsid fossil
Plant material
Downlap

Figure 2.22b: Interpretation and architectural geometry of the lenticular channel fill in Figure 2.22a.

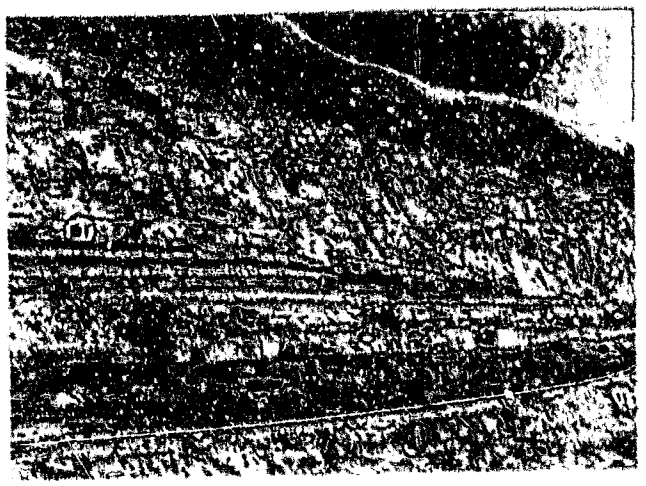


Figure 2.23: Tabular channel sandstone geometries showing erosional downcutting of the profile by the channel. Scale bar = 1m.

Figure 2.24a: Sole marks on the basal surface of a channel fill sandstone.

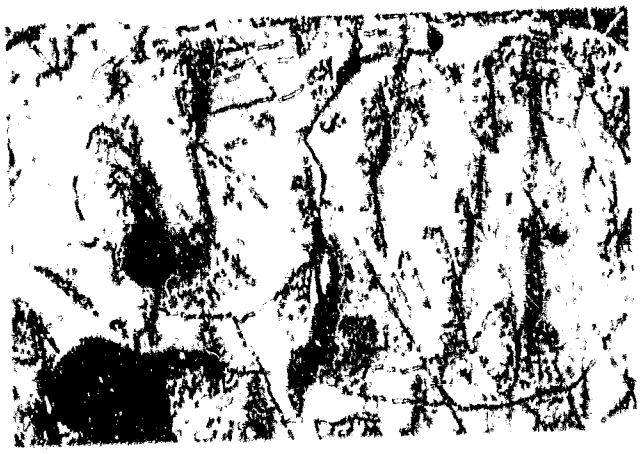


Figure 2.24b: Flute casts on the basal surface of a channel fill sandstone.

Figure 2.25: Basal erosional contact of typical channel fill, overlain by facies Sh.

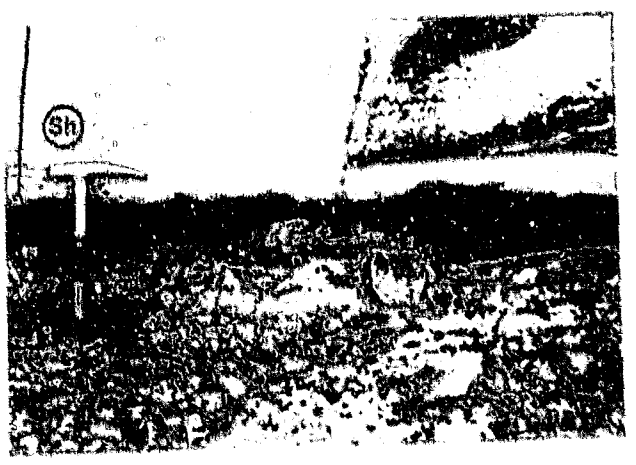


Figure 2.26: Lower channel fill sequence showing an irregular, erosional base overlain by stacked sets of facies St, and Sh.

Figure 2.27: Upper channel fill sequence showing large sets of facies Sh and St$_l$. The top of the St$_l$ set is sharp (S) and preserves dune forms.

Figure 2.28: Lateral profile of a small channel fill. Roadcut on the farm Hillside, Burgersdorp district.

Figure 2.29: Lateral profile of a mixed load channel fill. Note the sandstone/mudstone couplets developed in the point bar element, and the nature of the two channel fills.

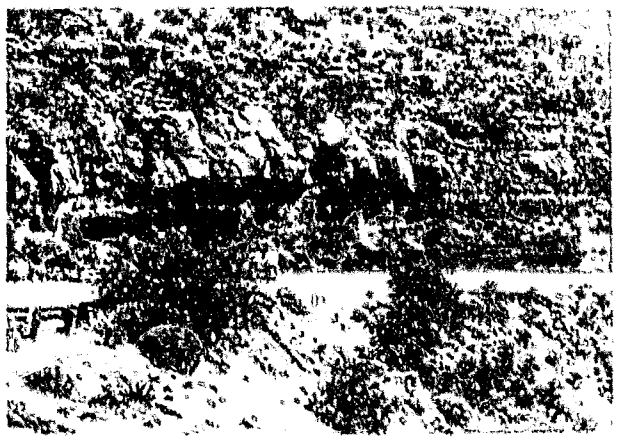


Figure 2.30: Laterally extensive tabular sheet sandstone; Middle Burgersdorp Formation. Nonensi's Nek, Eastern Cape.

Figure 2.31a: Low angle epsilon cross stratification and scroll bar morphology, Aliwal North, Eastern Cape. Scale bar = 2m.

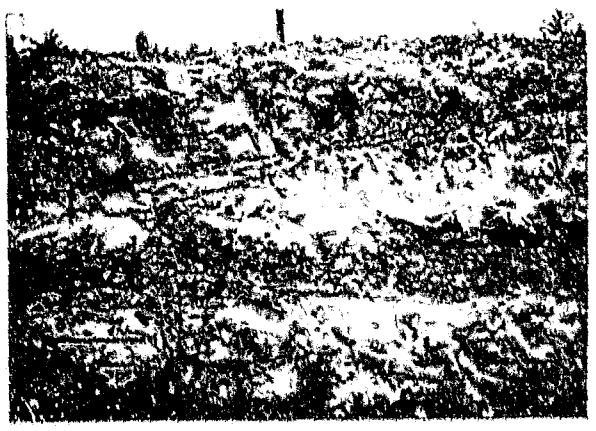


Figure 2.31b: Stacked point bar elements without interspersed veneers of mudstone, Bushmanshoek Pass, Eastern Cape. Scale bar = 1m.

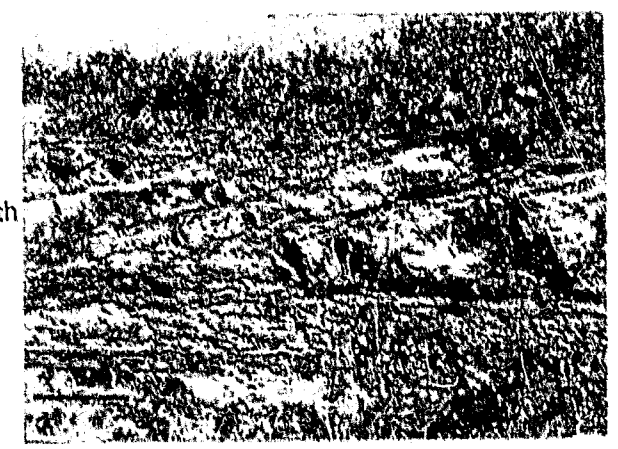


Figure 2.31c: Laterally accreted point bar elements with interspersed veneers of mudstone, Aliwal North district, Eastern Cape. Scale bar = 1m.

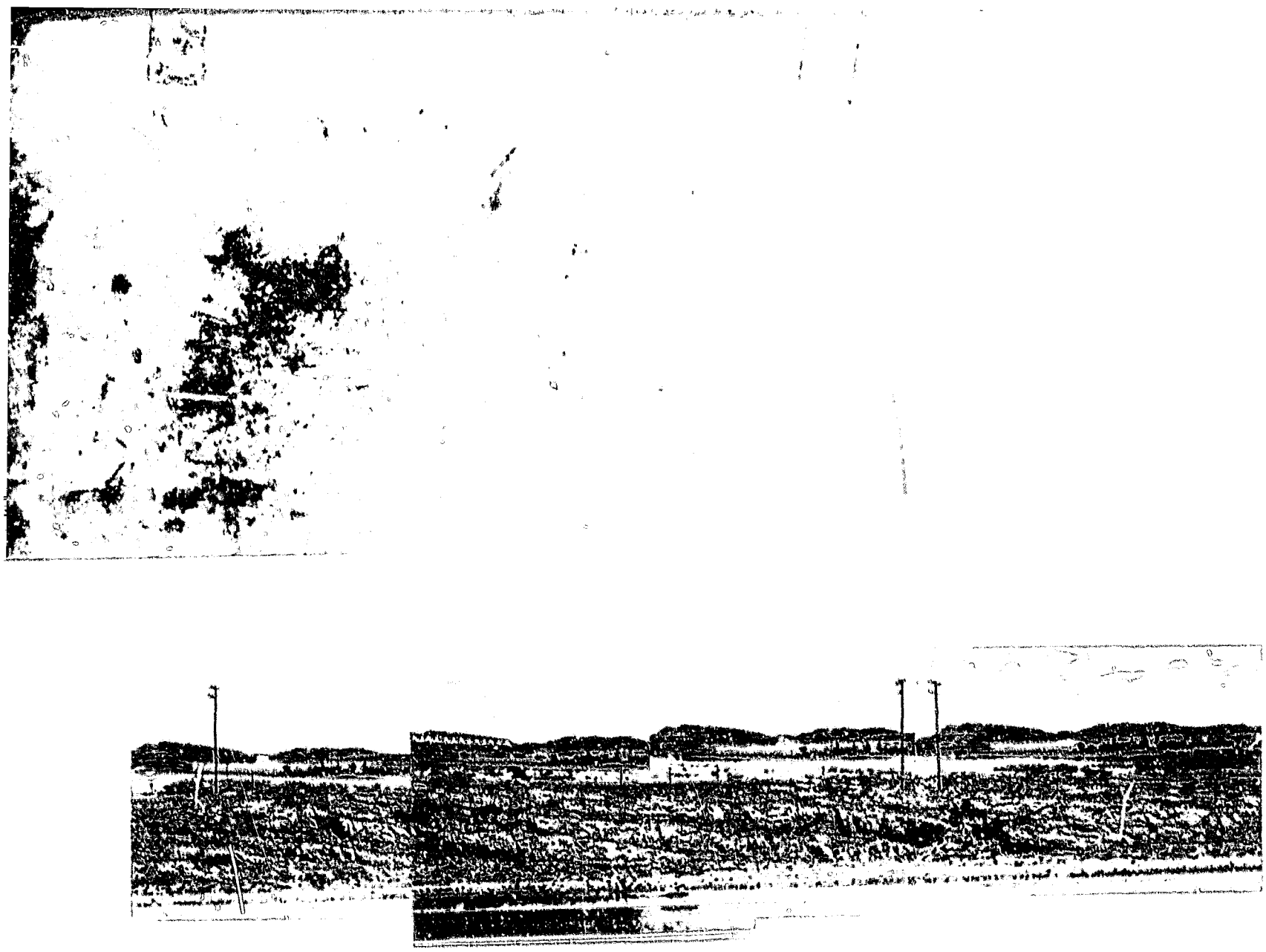


Figure 2.32: Lateral profile of laterally accreted sandstone and mudstone couplets. Roadcut near Rouxville, Free State.

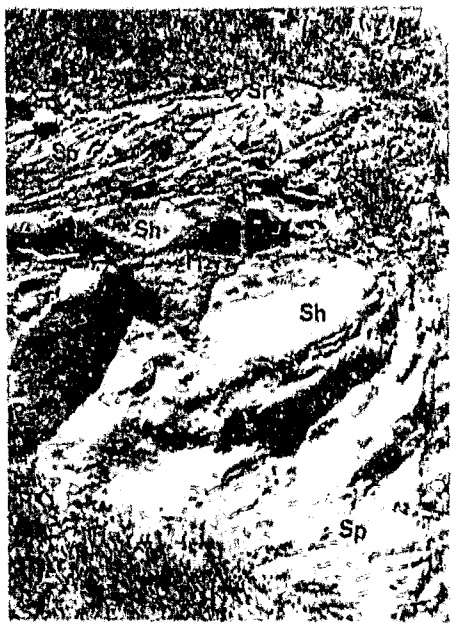


Figure 2.33: Close up of laterally accreted macroform in Figure 2.32. Note the abundance of facies Sp and Sh and the sequence terminations in either Sr or Fr.

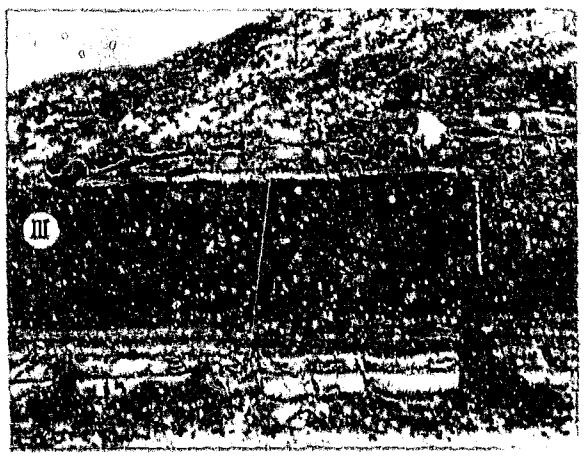


Figure 2.34: Flat bottomed lenticular floodplain channel, overlying incipiently developed Type III palaeosol. Nonensi's Nek, Eastern Cape. Scale bar = 1.5m.

Figure 2.35: Thick, tabular multi-episode sandstone splay element, interspersed in floodplain fines. Roadcut on the R396, Eastern Cape.

Figure 2.36: Close up of thick, multi-episode sandstone splay in Figure 2.35. Note the sharp flat nature of the base, and the upward decrease in thickness of the overlying thin splay sandstones.

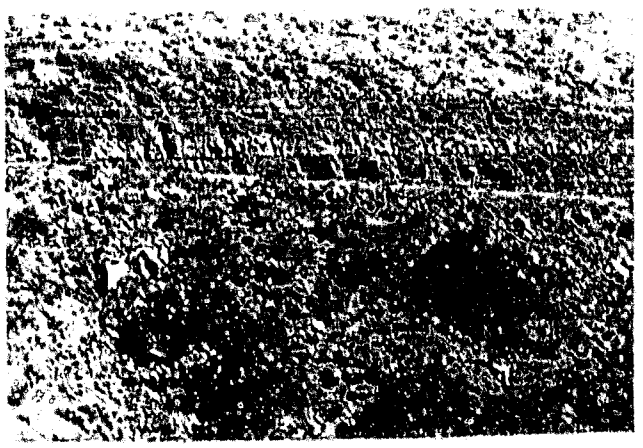


Figure 2.37: Laterally continuous thick sandstone splay in floodbasin fines. Nonensi's nek, Eastern Cape.

Figure 2.38: Cross-section of sandstone splay showing the typical sharp, flat lower contact and plano-convex top. Note the presence of a channel on the splay fan apex. Scale bar = 2m.

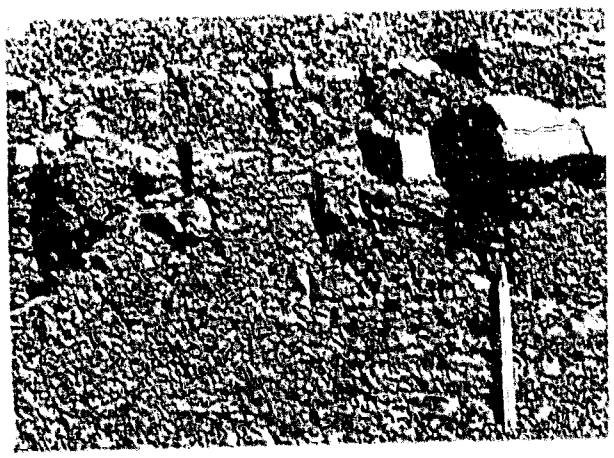


Figure 2.39: Thin, distal floodplain sandstone splay. Note the irregular nature and sharp lower and upper contact.

Figure 2.40: Plant rootlets in thin, non-calcareous very fine grained sandstone splay. Scale bar = 1cm.

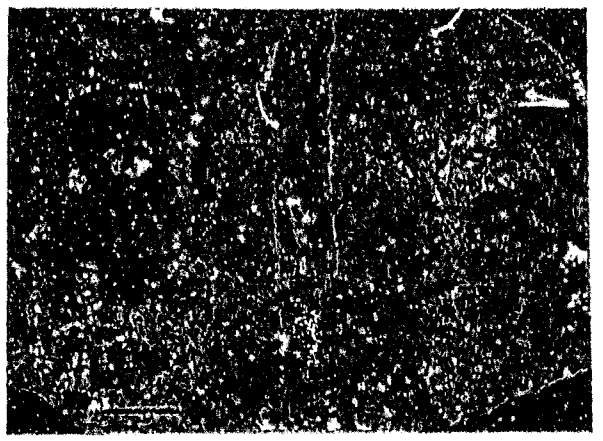


Figure 2.41a: Cross section of a thin distal floodbasin siltstone splay showing vertically orientated invertebrate trace. Scale bar = 1cm.

Figure 2.41b: Plan view of bioturbated thin splay sandstone surface.

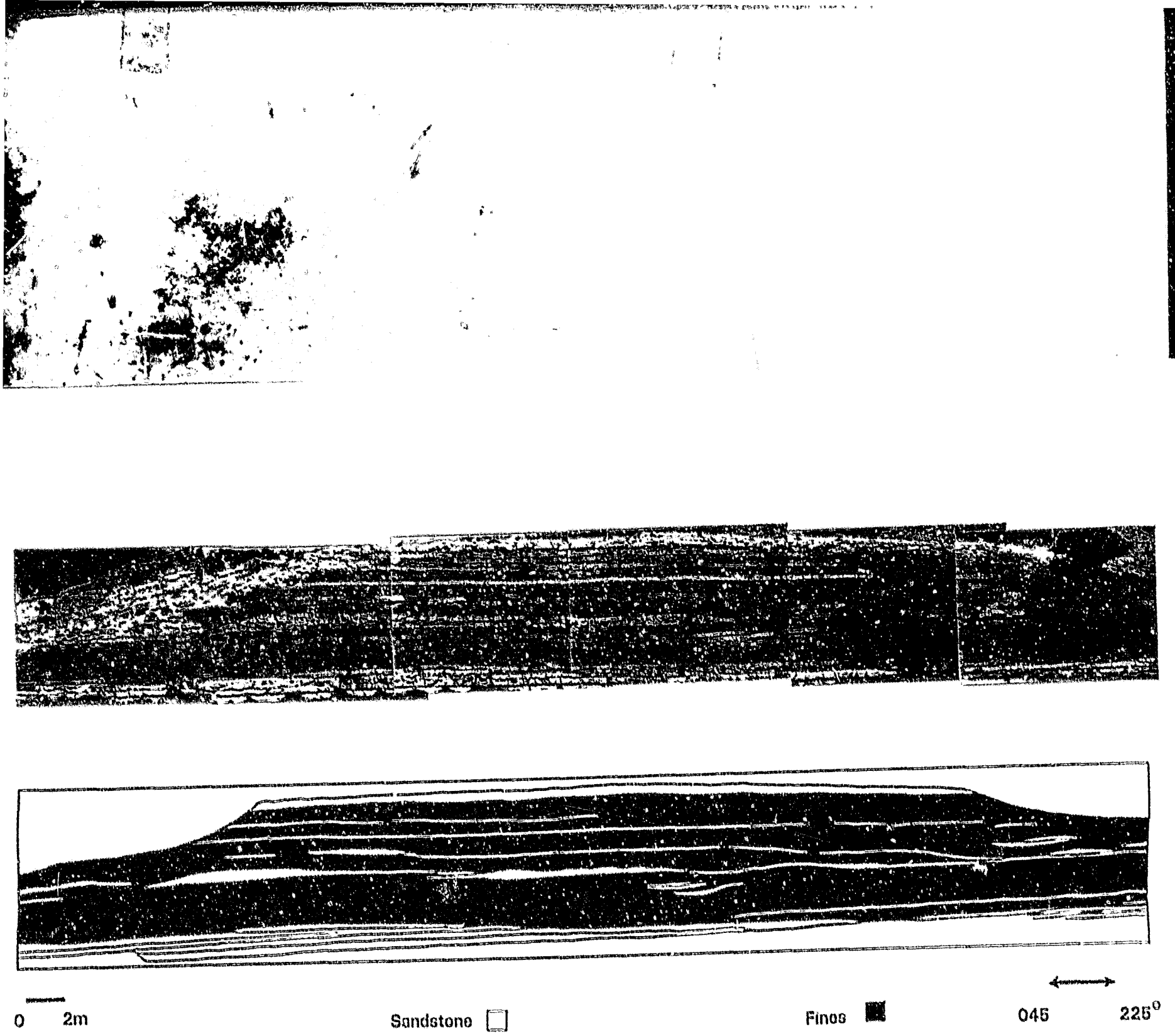


Figure 2.42: Lateral profile of typical floodplain architecture. Nononsi's Nek, Eastern Cape.

Figure 2.43a: Photomicrograph of a typical texturally and mineralogically sub-mature sandstone (facies St_t) from the Burgersdorp Formation. Note the framework grains of quartz (Q), sodium plagioclase feldspar (F), rock fragments (R) and intergranular material (M). Crossed polars, 10X magnification.

Figure 2.43b: Photomicrograph of facies St_t showing typical sub-rounded quartz grains (Q), well rounded plagioclase feldspar (F) and clay matrix (M). Crossed polars, 10X magnification.

Figure 2.44: Photomicrograph of euhedral sodium plagioclase feldspar (F), showing albitic twinning. Crossed polars, 10X magnification.

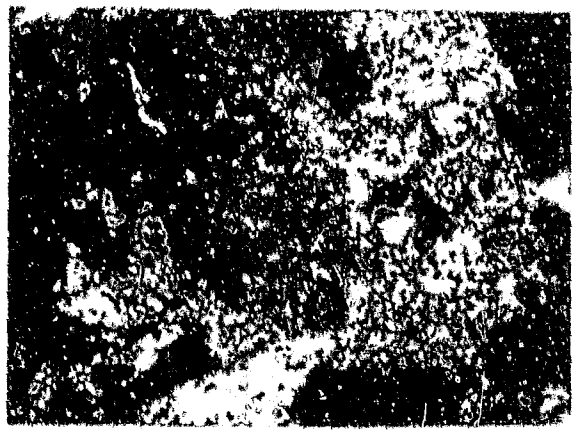


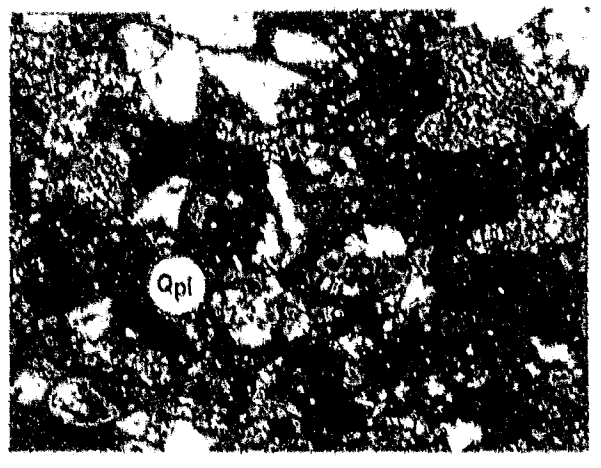
Figure 2.45: Photomicrograph of facies Sh from the Katberg Formation. Note the abundance of plagioclase feldspars. Crossed polars, 10X magnification.

Figure 2.46a: Photomicrograph showing kaolinitic alteration of orthoclase. Plane polarised light, 10X magnification.

Figure 2.46b: Photomicrograph showing kaolinitic alteration of orthoclase (O). Note also the undulose extinction of the quartz grain (Q). Crossed polars, 10X magnification.

Figure 2.47a: Photomicrograph of sedimentary rock fragment (Rs) Crossed polars, 10X magnification.

Figure 2.47b: Photomicrograph of polycrystaline quartz grain of plutonic (Qpl) origin. Crossed polars, 10X magnification.



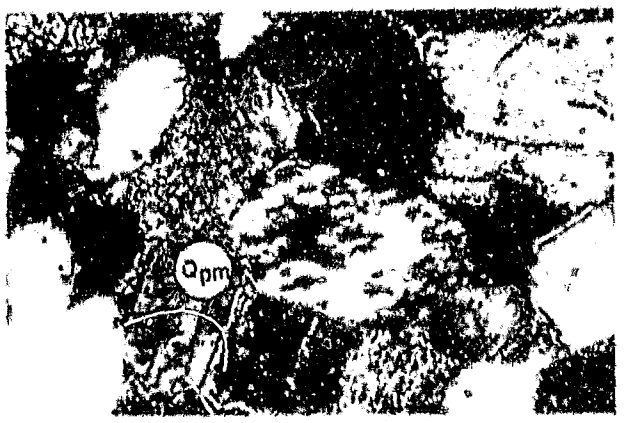


Figure 2.47c: Photomicrograph of polycrystaline quartz grain of metamorphic origin (Qpm). Crossed polars, 10X magnification.

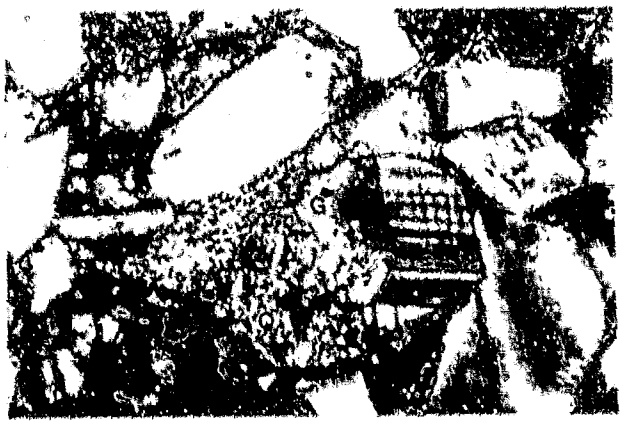


Figure 2.47d: Photomicrograph of granitic rock fragment (G). Note the slight alteration of the orthoclase feldspar (O). Crossed polars, 10X magnification.

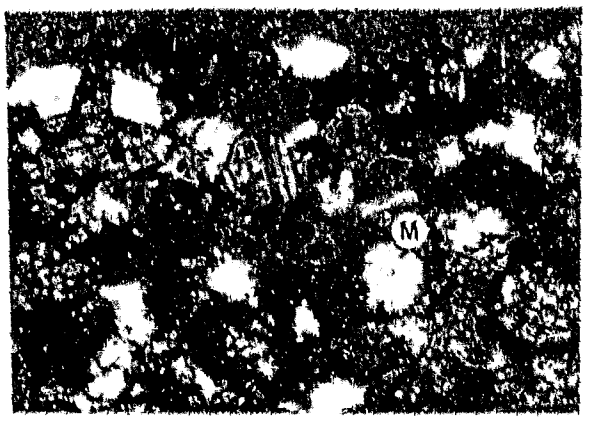


Figure 2.48a: Photomicrograph of detrital grain of muscovite (M). Crossed polars, 10X magnification.

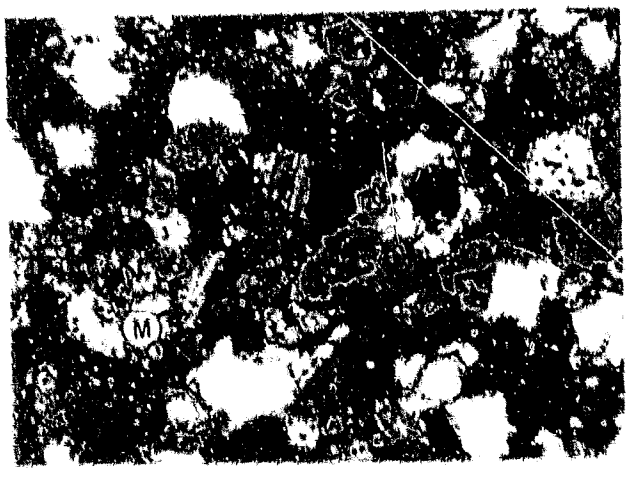


Figure 2.48b: Photomicrograph of detrital grain of muscovite (M). Crossed polars, 10X magnification.

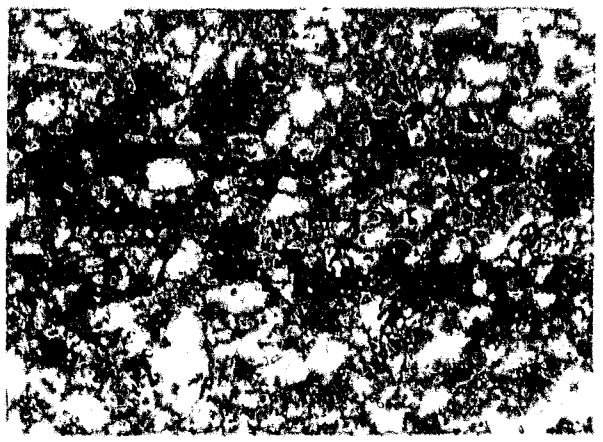


Figure 2.49: Photomicrograph of detrital opaque oxides from facies Sh. Plane polarised light, 10X magnification.

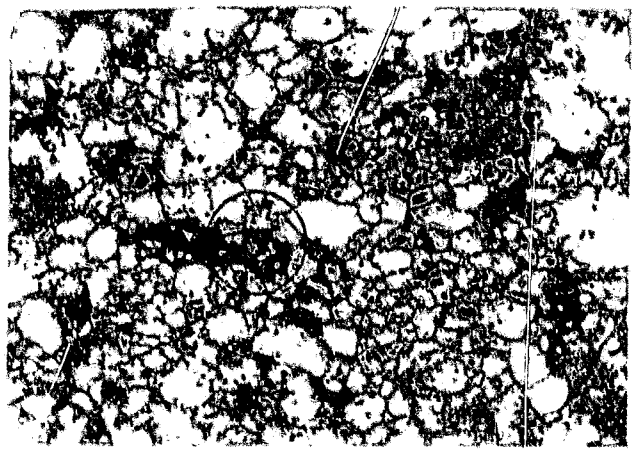


Figure 2.50a: Photomicrograph of detrital zircon from facies Sh. Plane polarised light, 10X magnification.

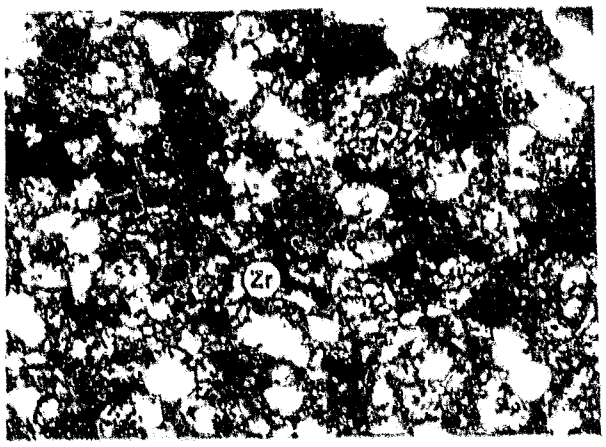
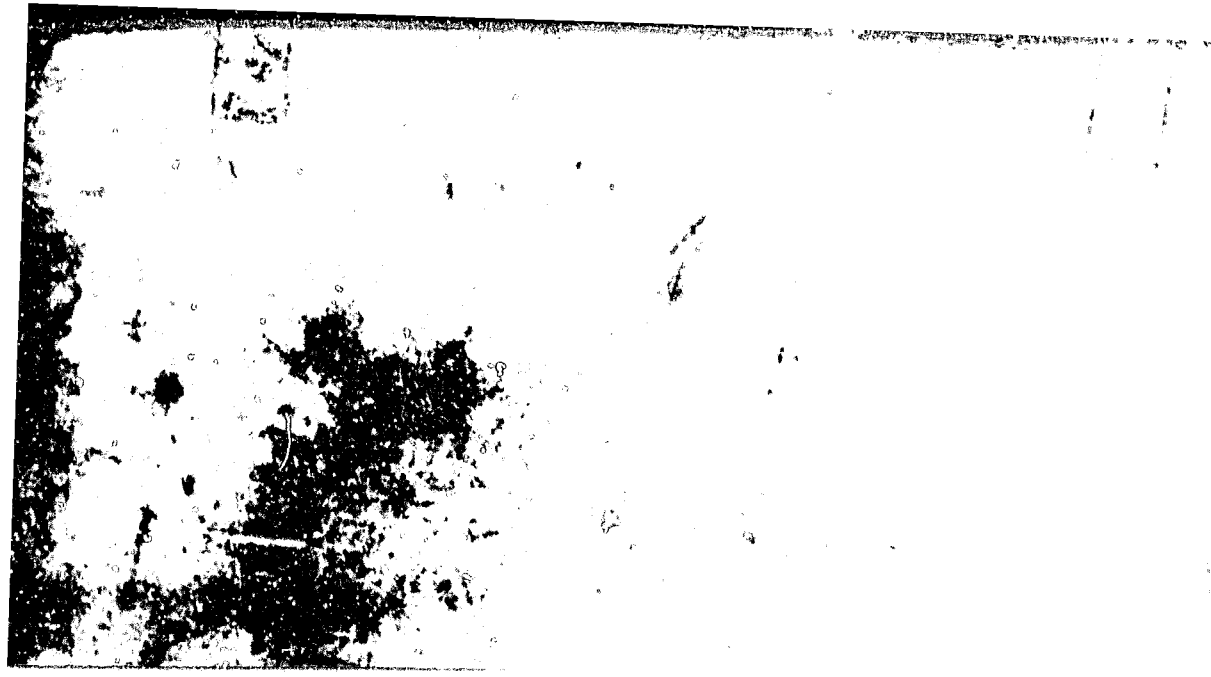


Figure 2.50b: Photomicrograph of detrital zircon (Zr) from facies Sh. Crossed polars, 10X magnification.



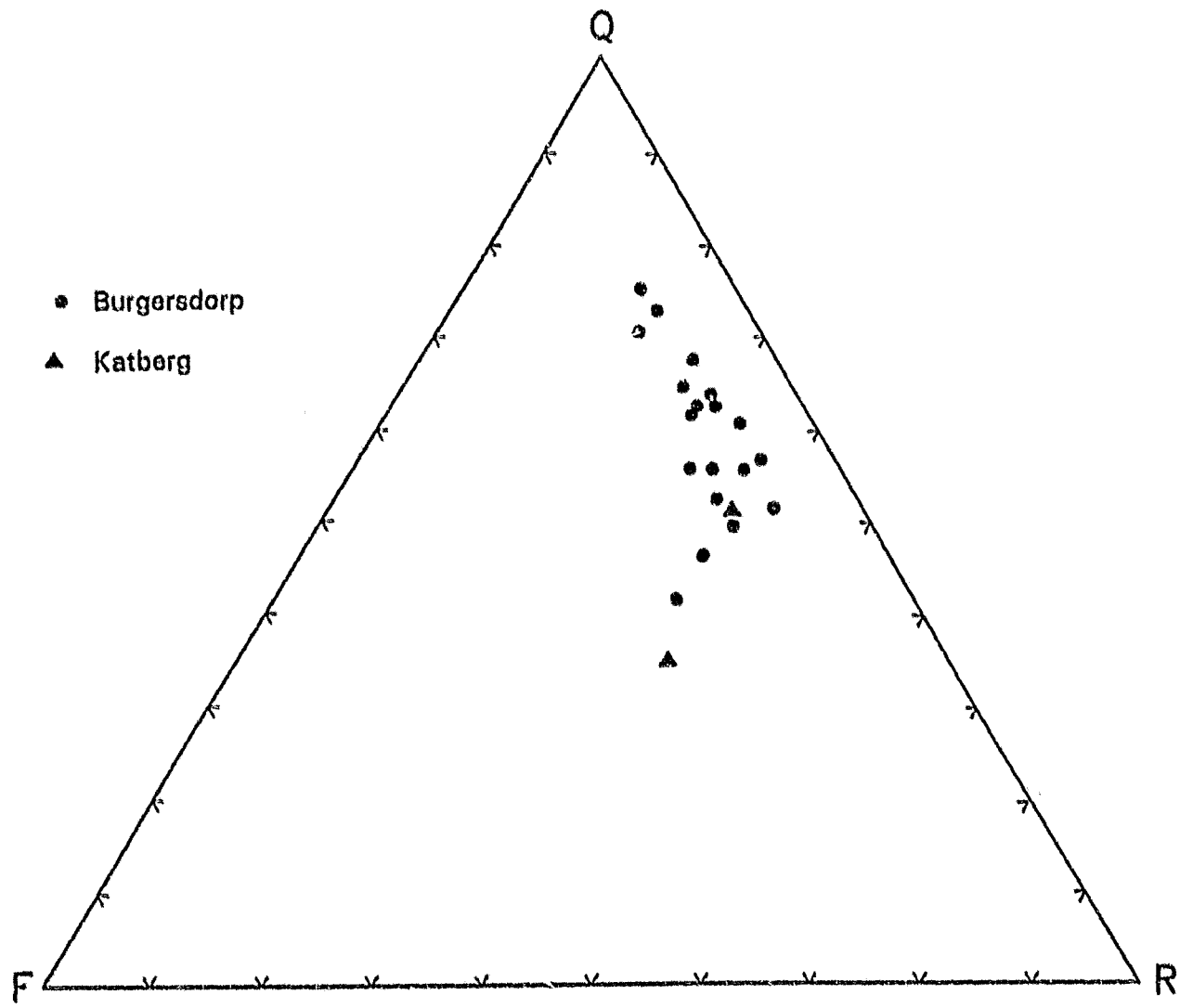


Figure 2.51: Framework grain plot for the sandstones of the Burgersdorp and Katberg Formations.

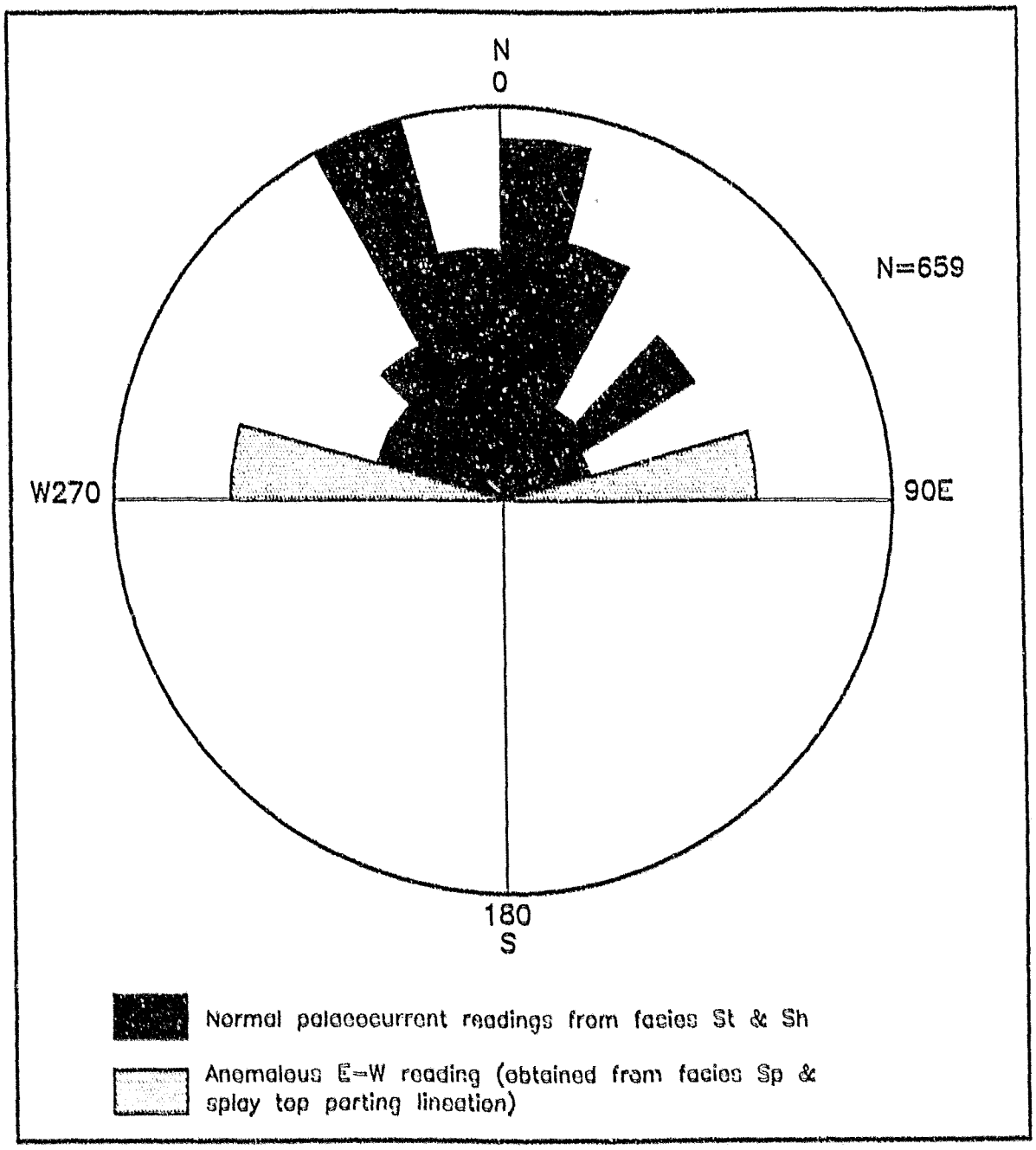


Figure 2.52: Rose net showing palaeocurrent directions for the upper Burgersdorp Formation.

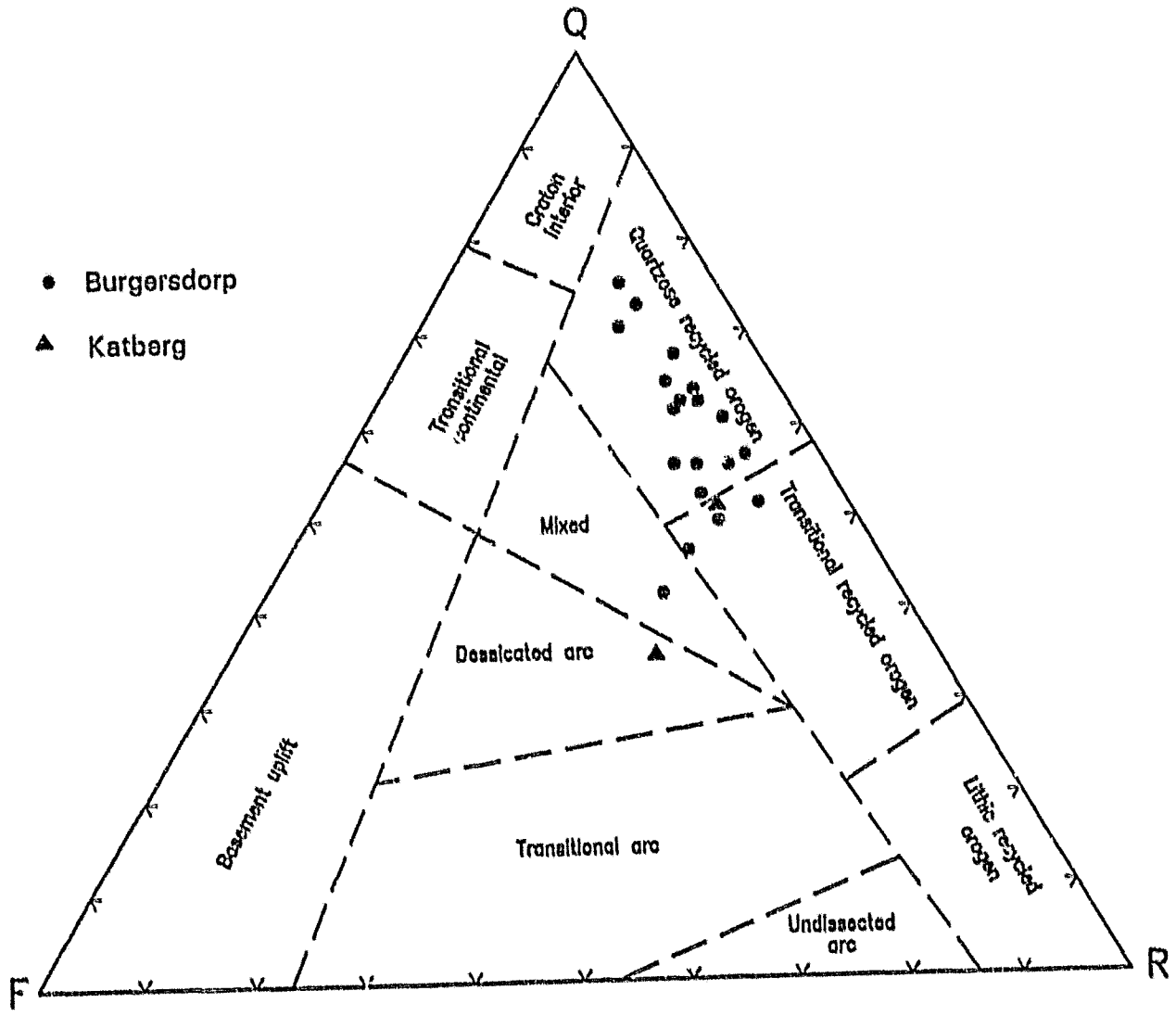


Figure 2.53: Framework grain plot for the sandstones of the Burgersdorp and Katberg Formations, with tectonic setting fields from Dickinson *et al* (1983).

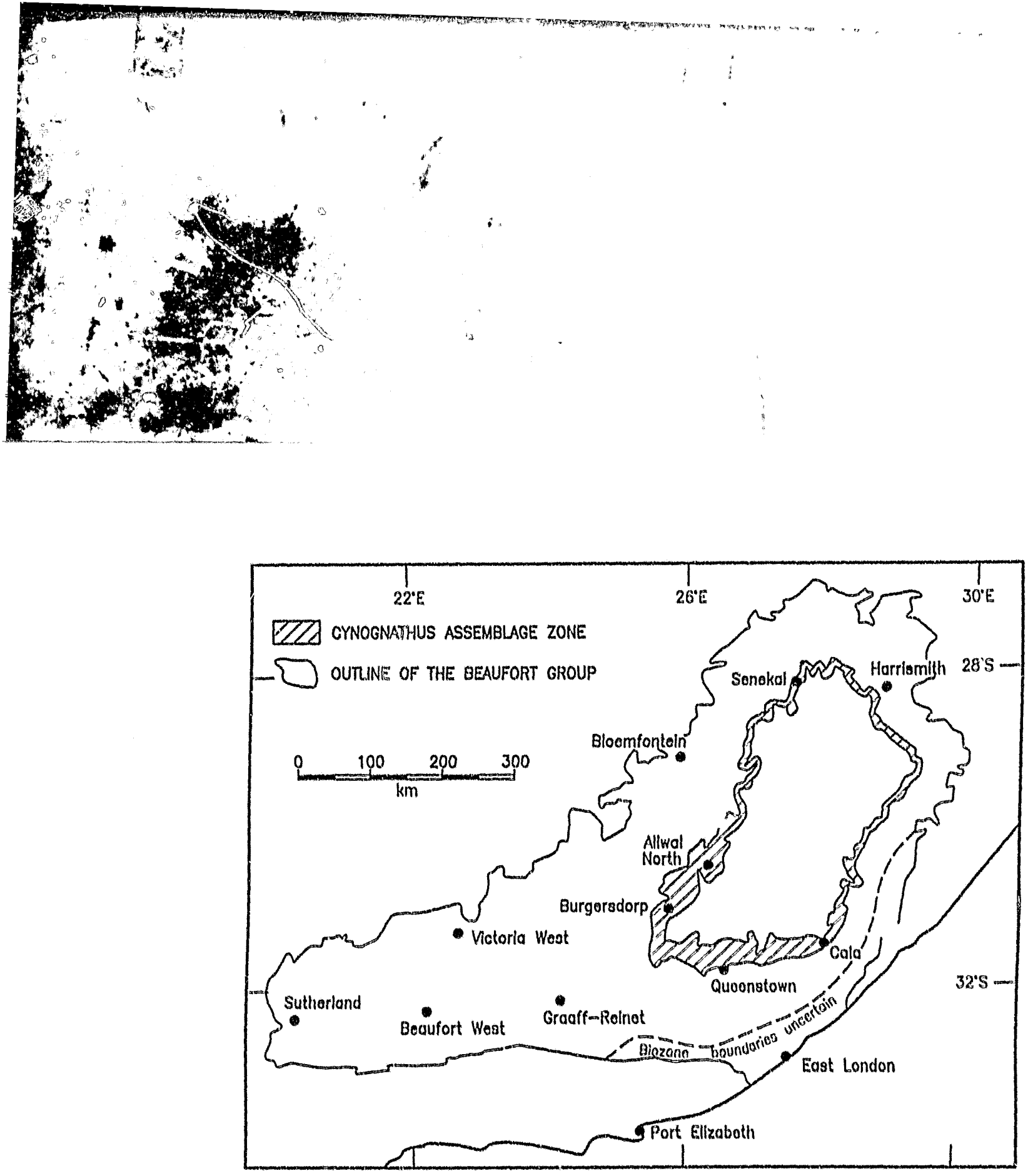


Figure 2.54: Geographical distribution of the *Cynognathus* Assemblage Zone (After Kitching, 1996).

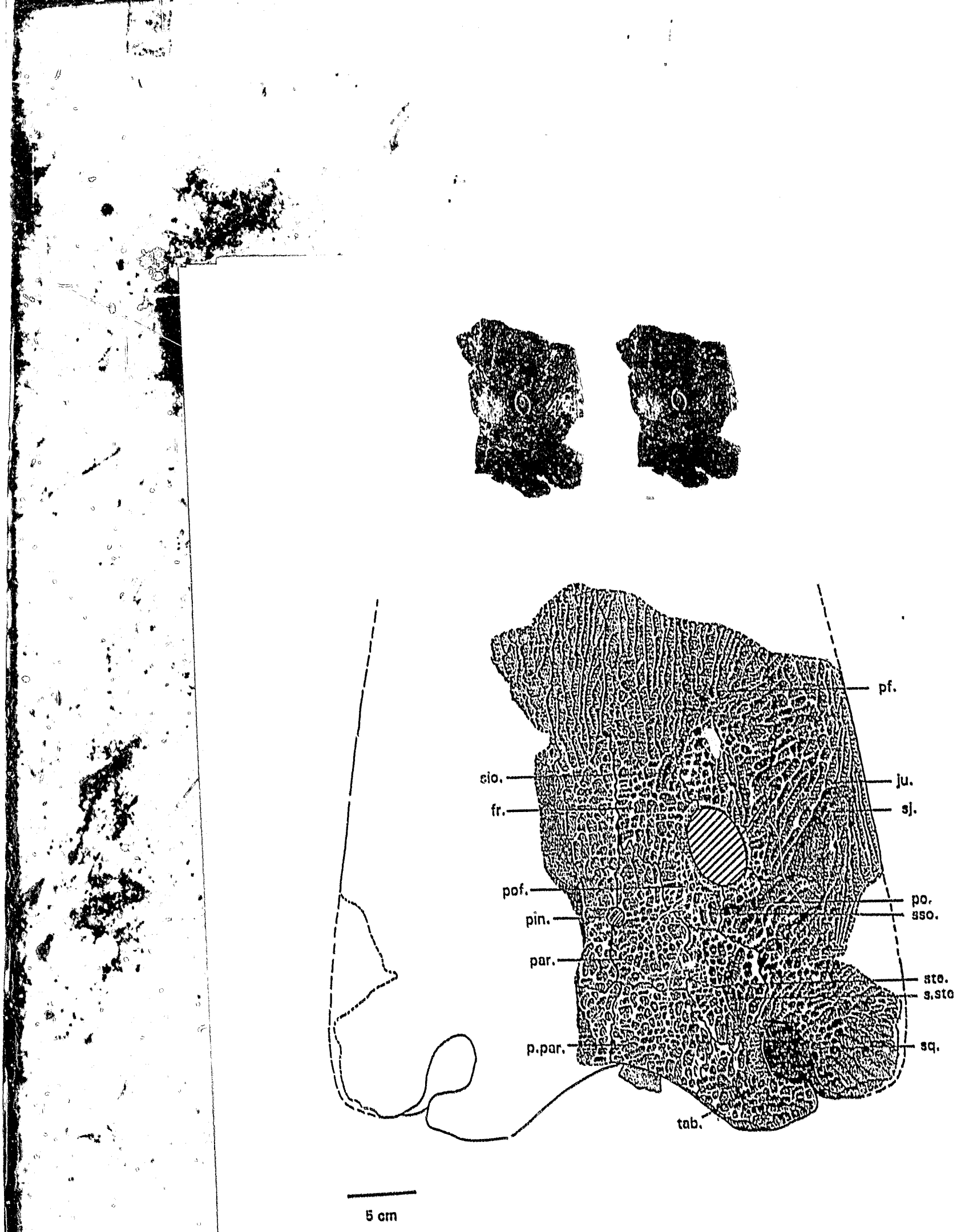
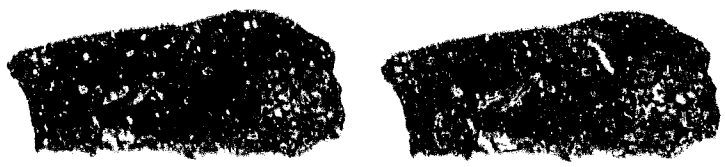
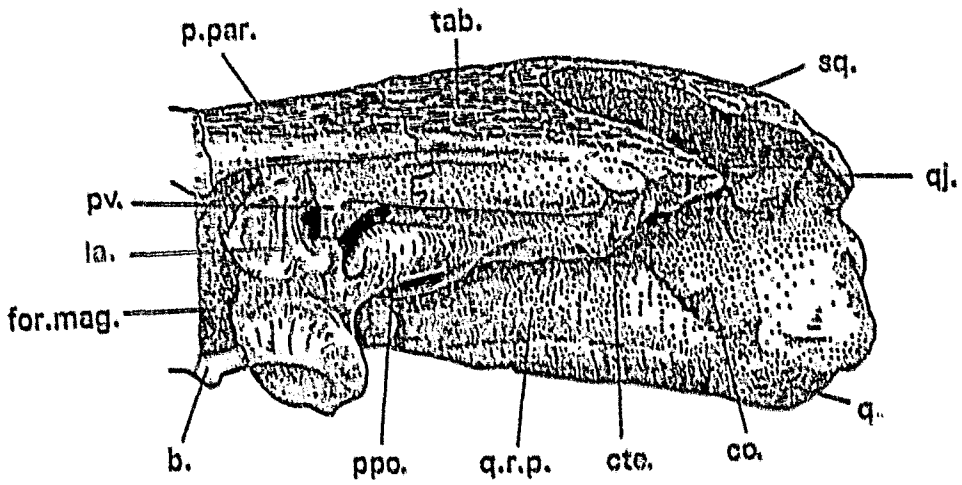


Figure 2.55: Dorsal view of the holotype skull of *Parotosuchus morgani* (RP/1/5551).





5 cm

Figure 2.56: Occipital view of the holotype skull of *Parotosuchus morgani* (BP/1/5551).

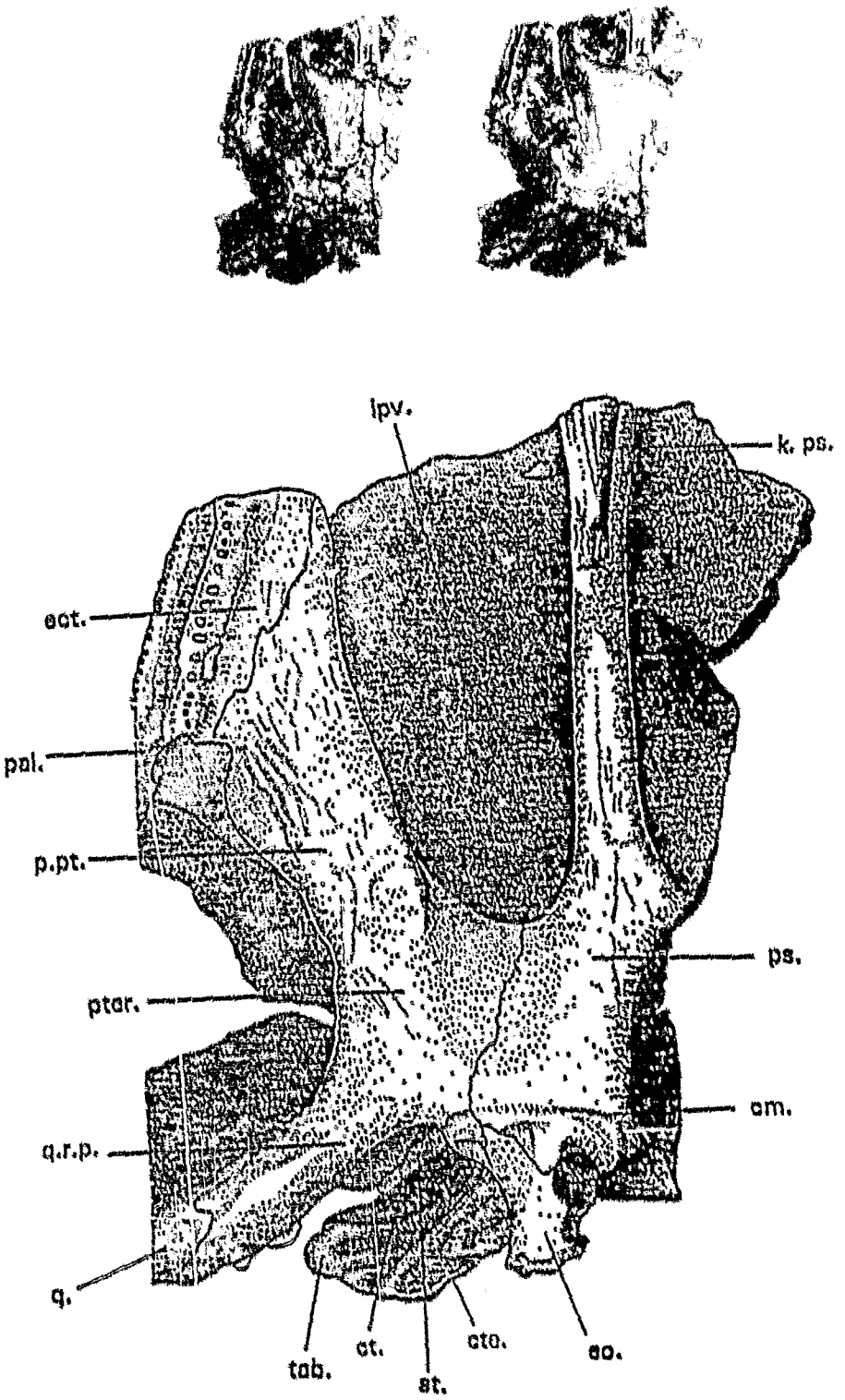
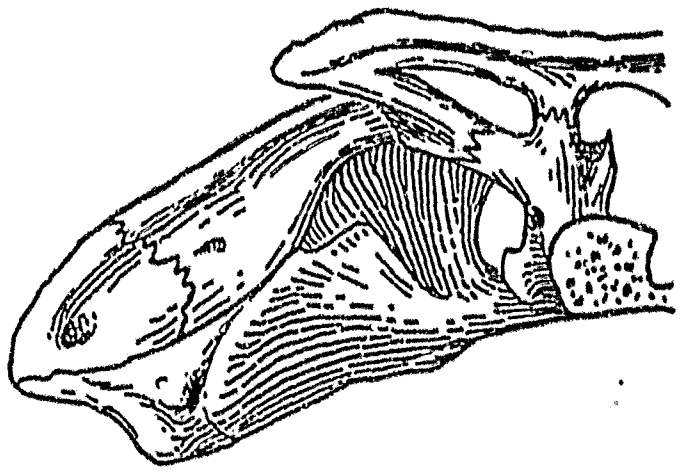
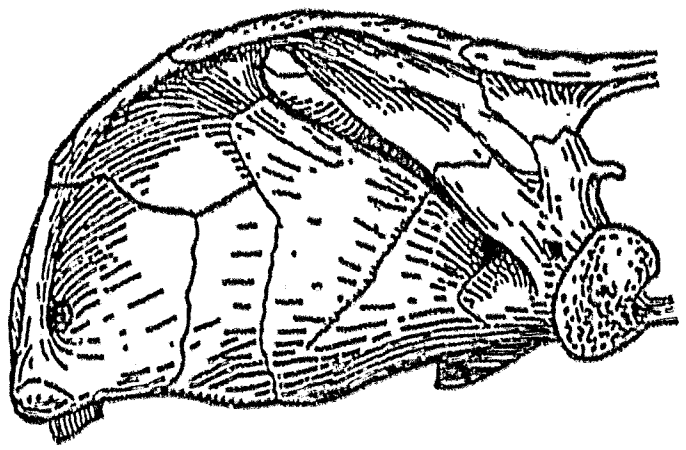


Figure 2.57: Palatal view of the holotype skull of *Parotosuchus morgani* (RP/1/5551)

A.



B.



C.

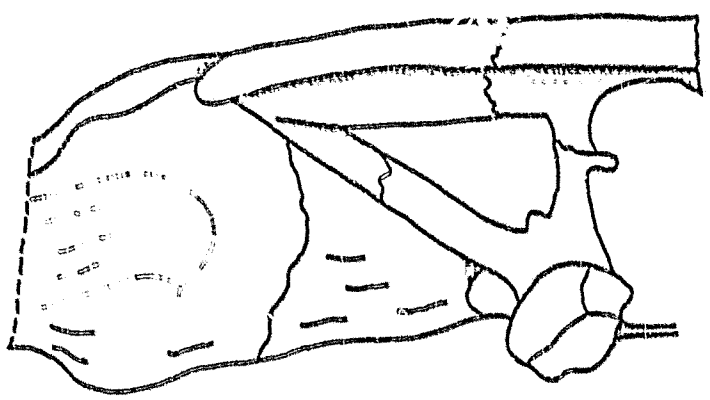


Figure 2.58: Occipital views of capitosauroid skulls showing the differences in the position of the cheek and depth of the squamosal flange (Sq): A = *Wetlugasaurus* (After Maryańska & Shishkin, 1996); B = *Cyclotosaurus* (After Ingavat & Janvier, 1981); C = *Parotosuchus morgani* (BP/1/5551).

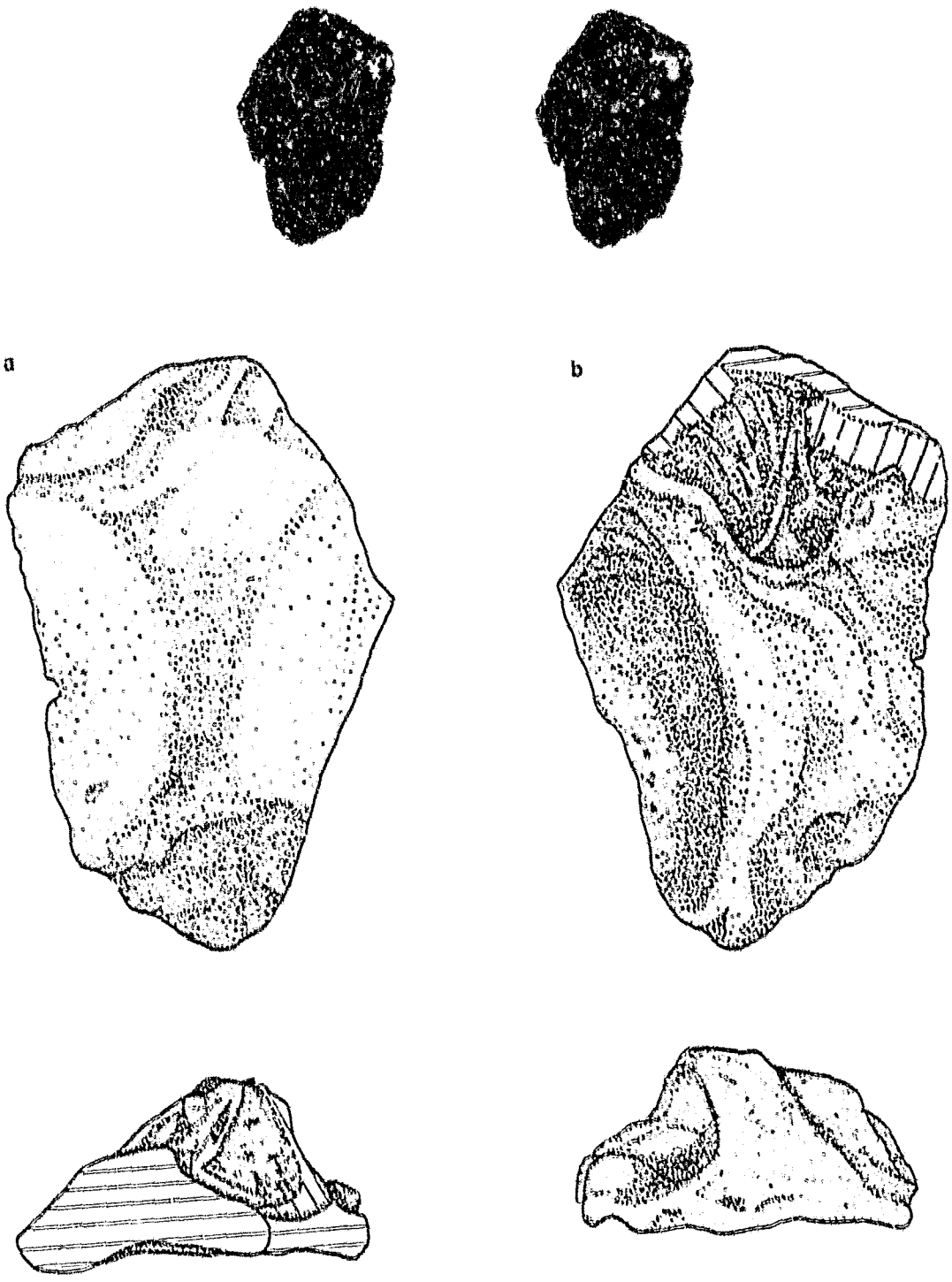


Figure 2.59: Left caniniform of *Angonisaurus coxii* (BP/1/5530): a. Lateral and dorsal views; b. Medial and ventral views.

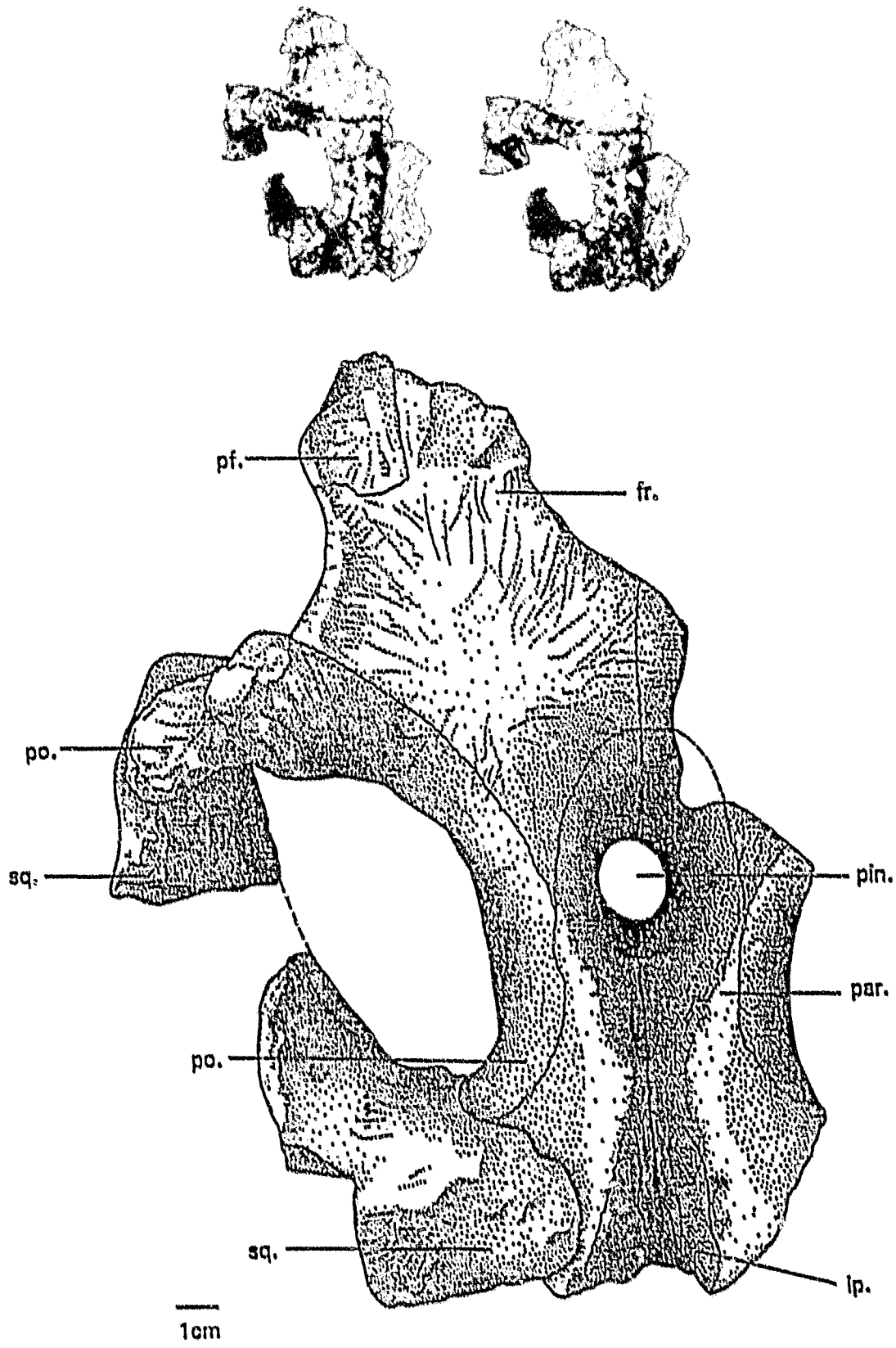
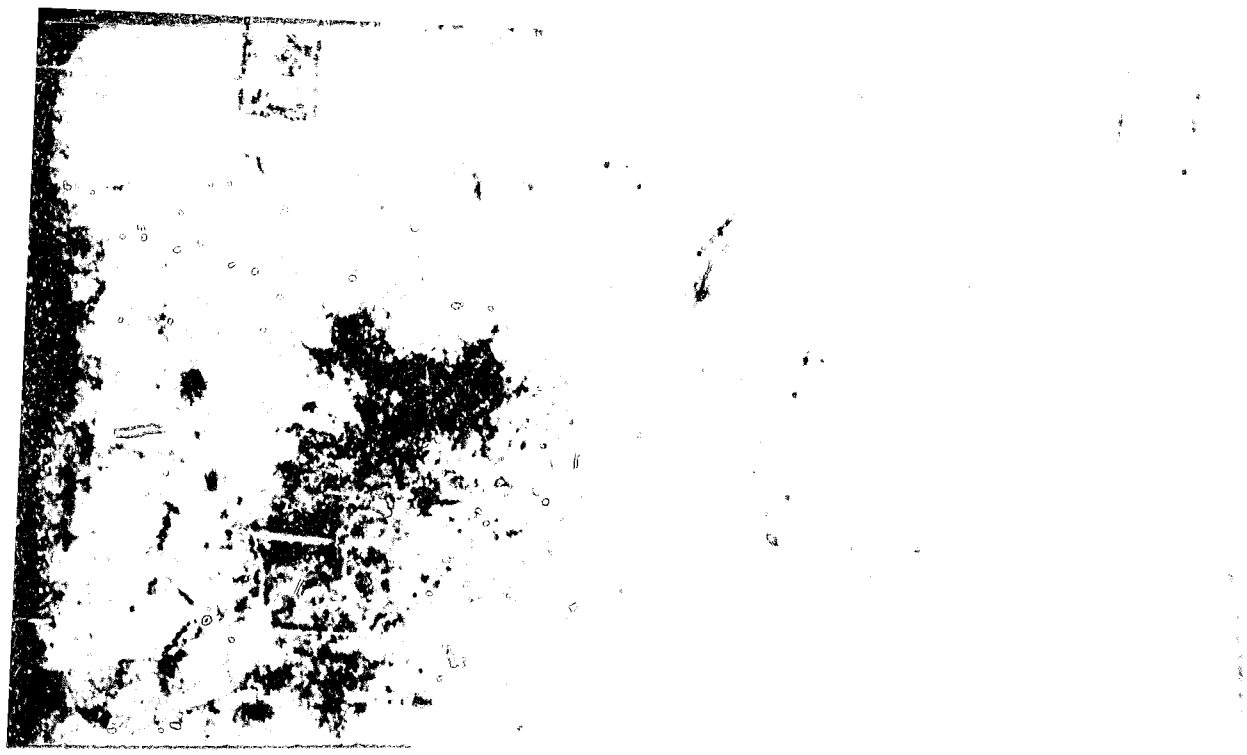


Figure 2.60: Dorsal view of the holotype of *Angonisaurus coxii* (BP/1/5530).

Figure 2.61: Lateral view of the holotype of *Angonisaurus cox*ii (BP/1/5530).



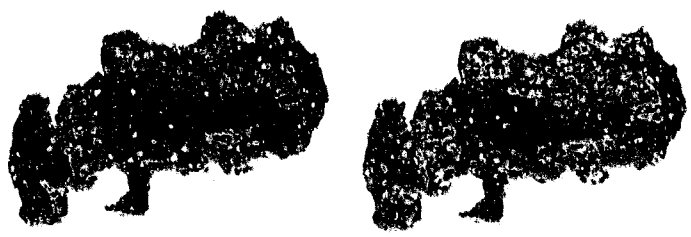


Figure 2.62: Occipital view of the holotype of *Angonisaurus coxii* (BP/1/5530).

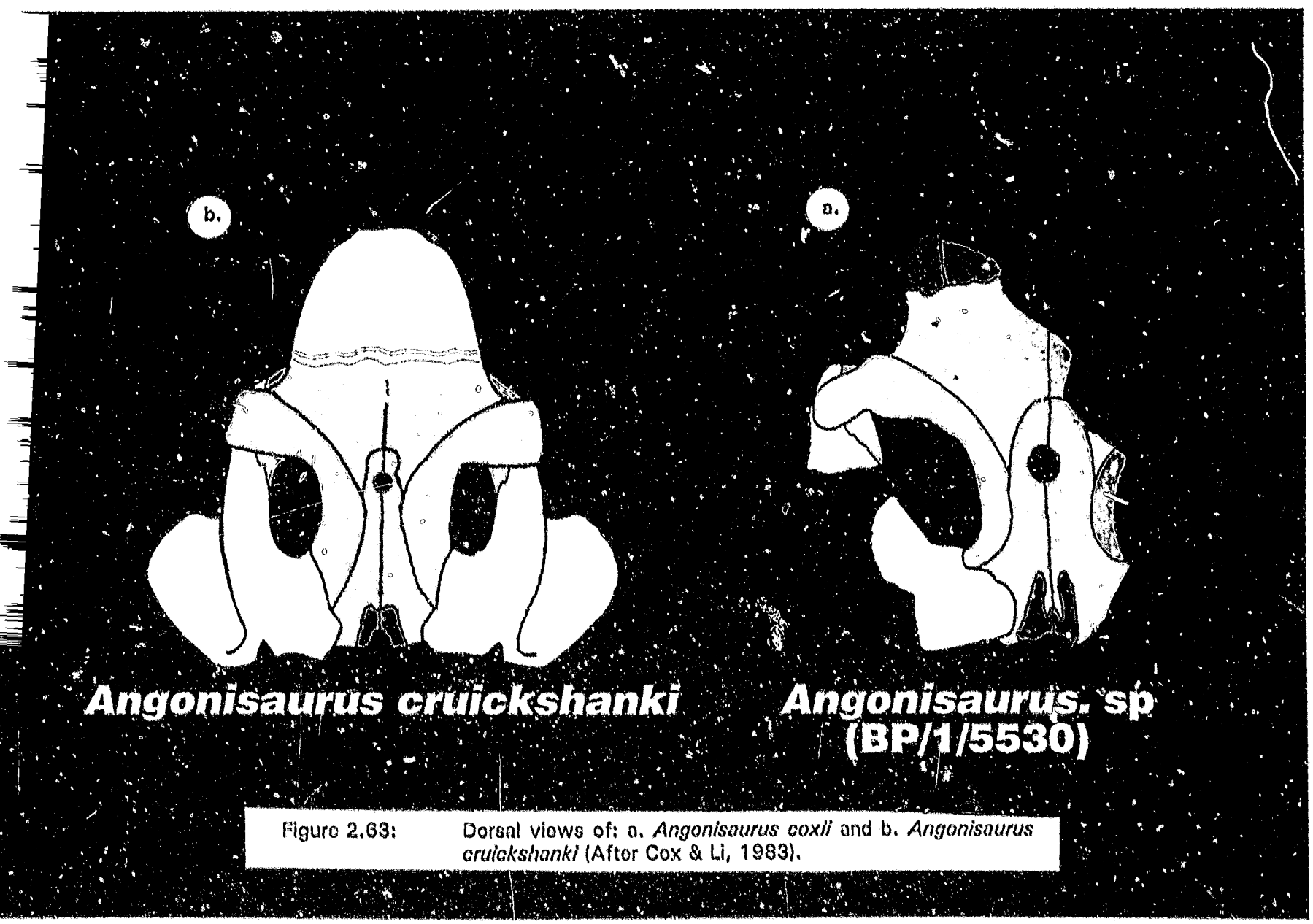
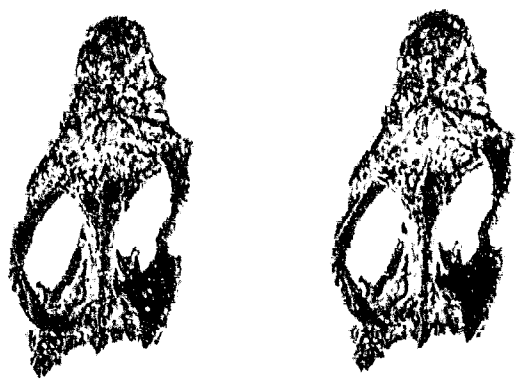


Figure 2.63: Dorsal views of: a. *Angonisaurus coxii* and b. *Angonisaurus cruickshanki* (After Cox & Li, 1983).



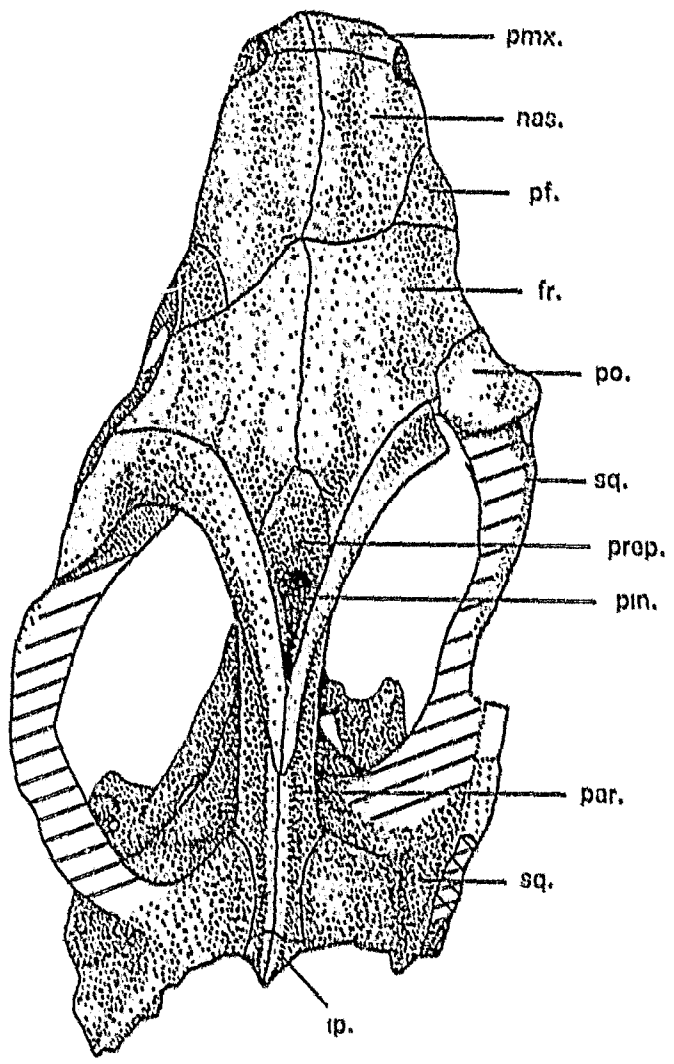
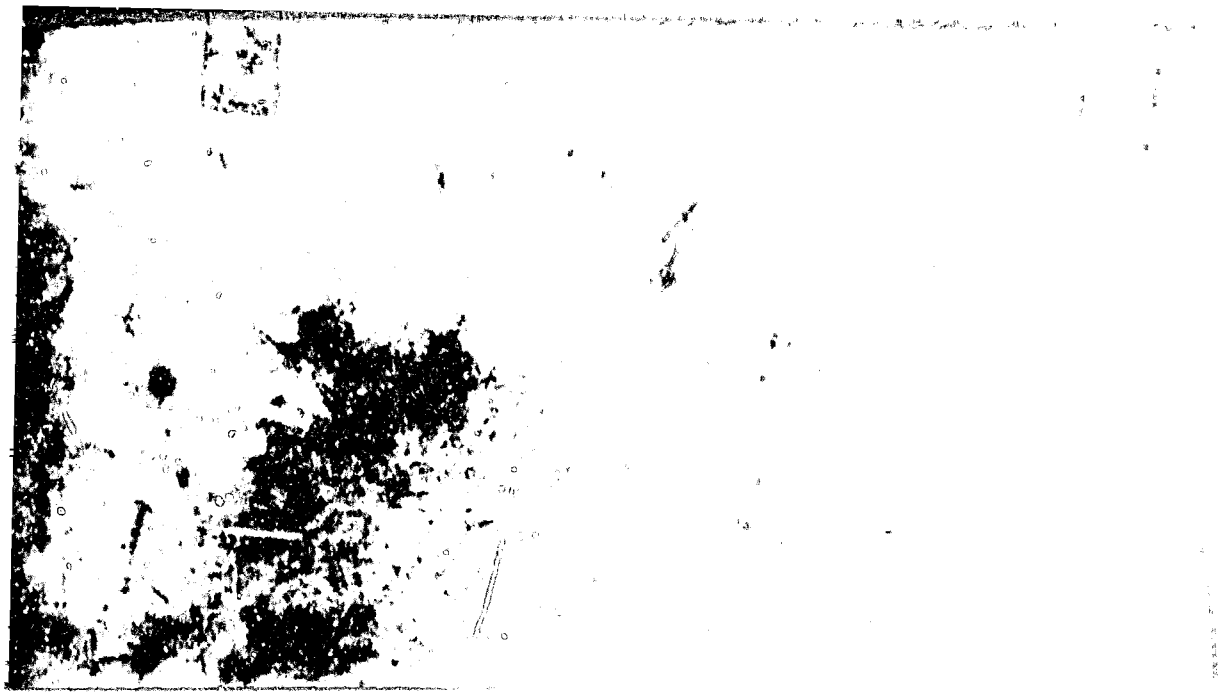
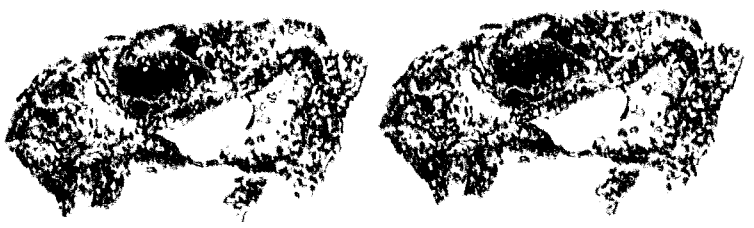


Figure 2.64: Dorsal view of the BP/1/5532.





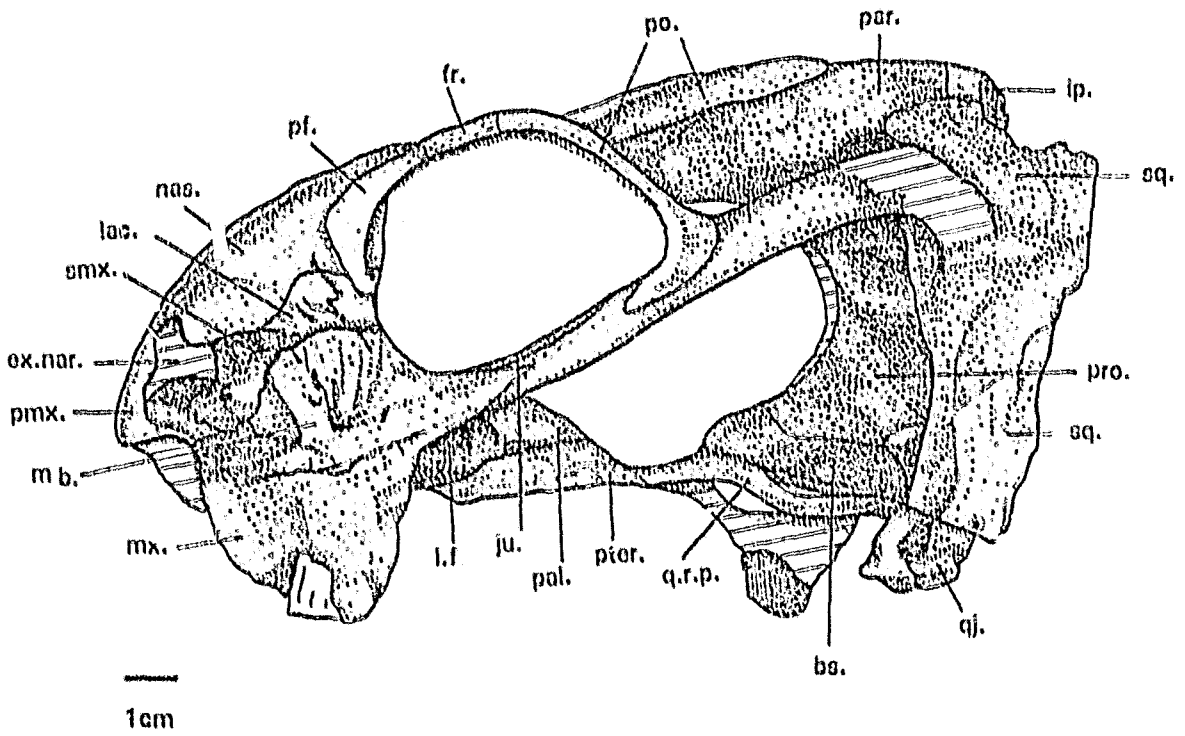
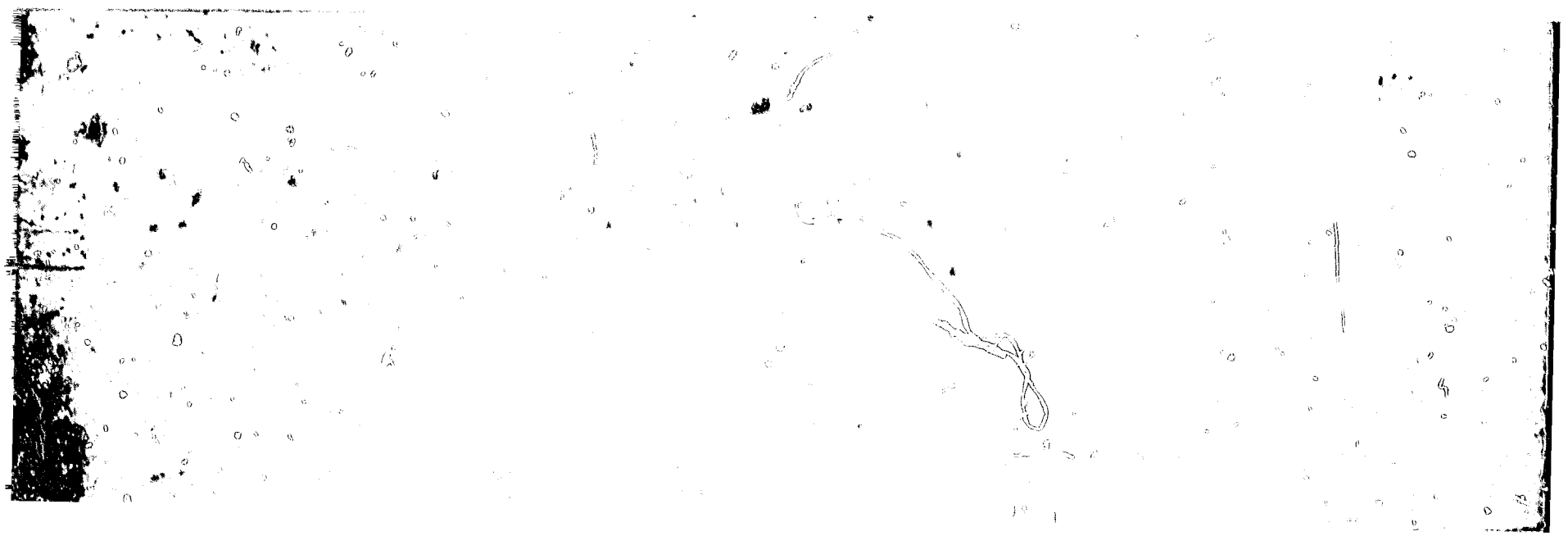


Figure 2.65: Lateral view of BP/1/5532.



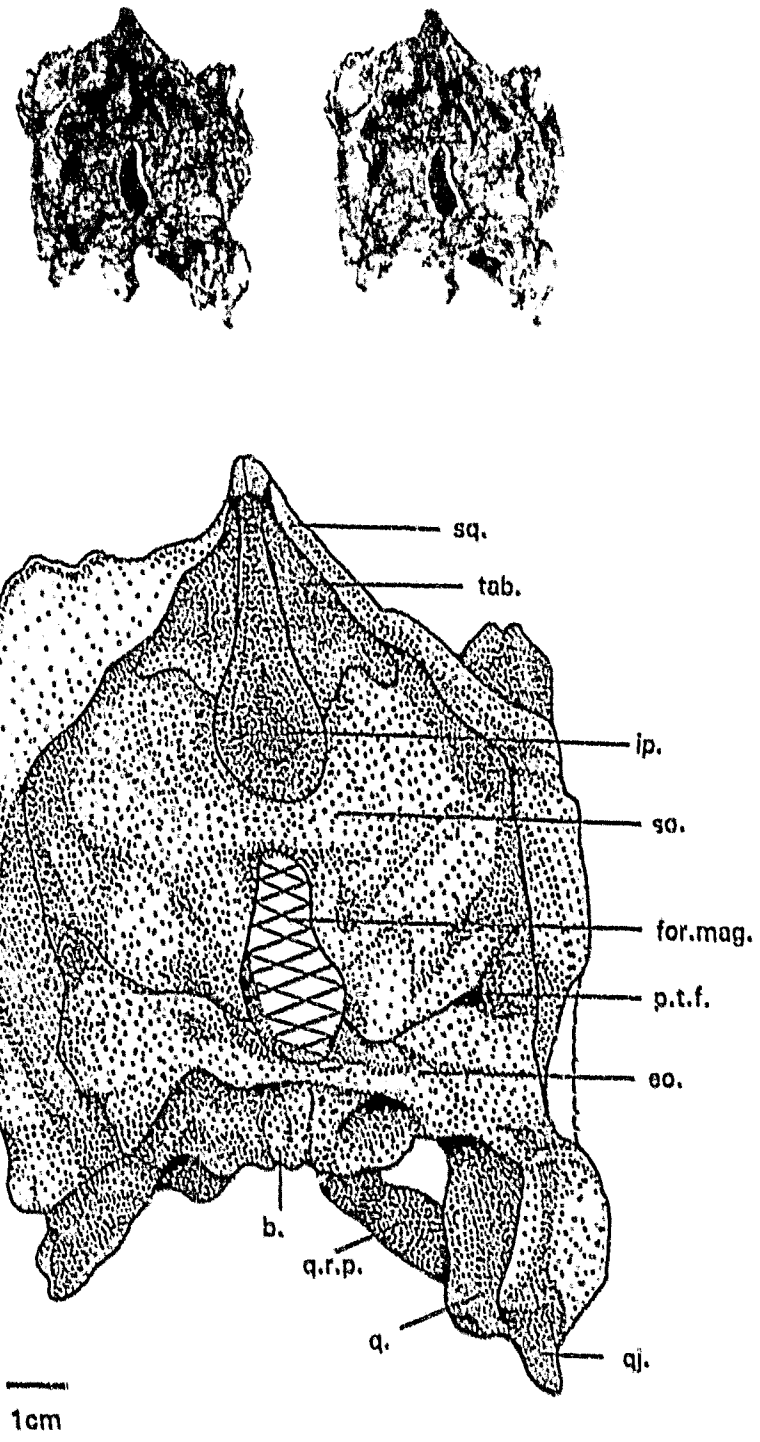


Figure 2.66: Occipital view of BP/1/5532.

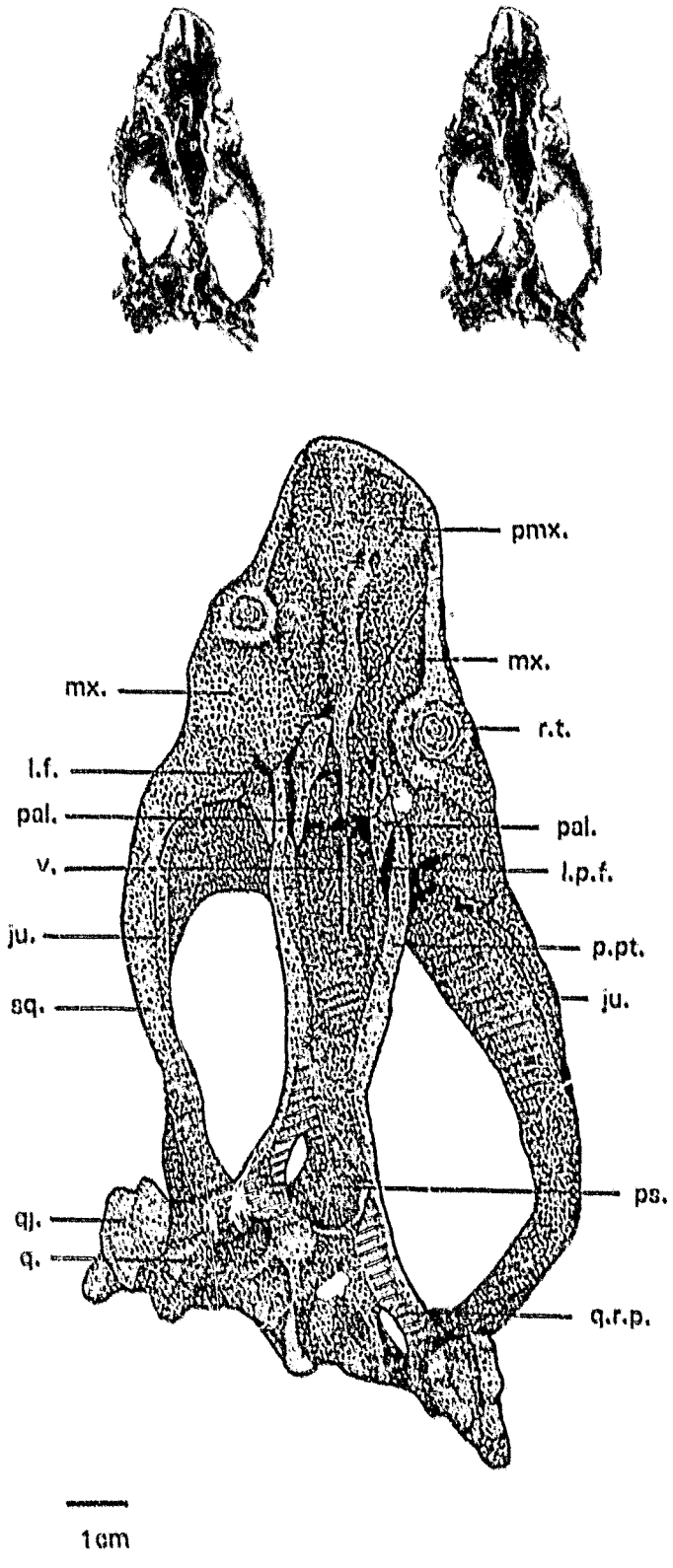
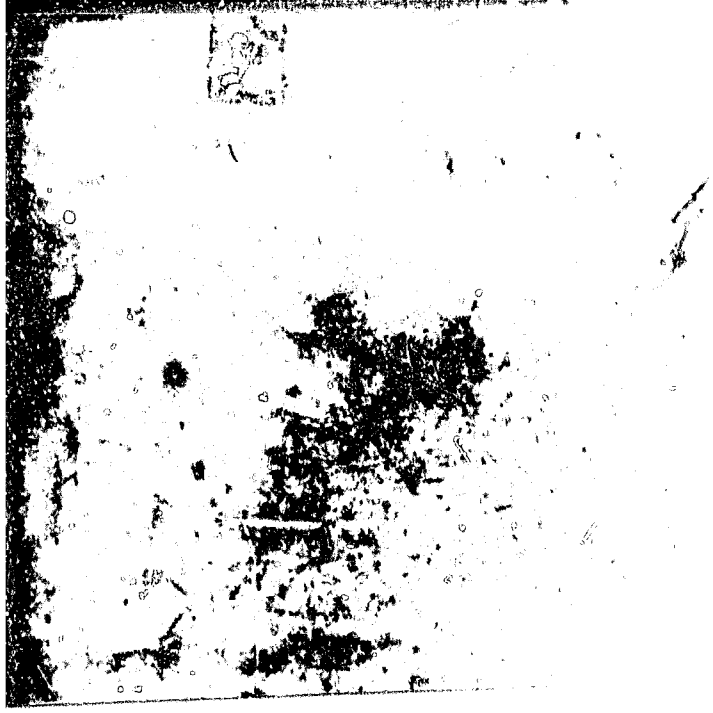
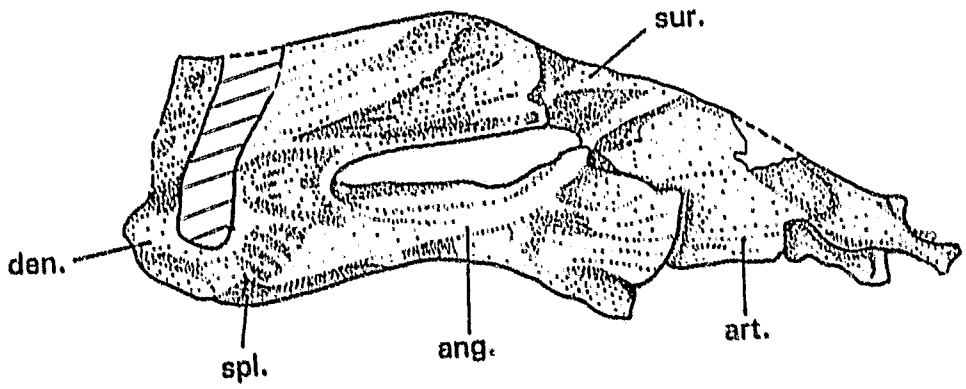


Figure 2.67: Palatal view of the BP/1/5532.





1cm

Figure 2.68: Lateral view of the lower jaw of BP/1/5532.

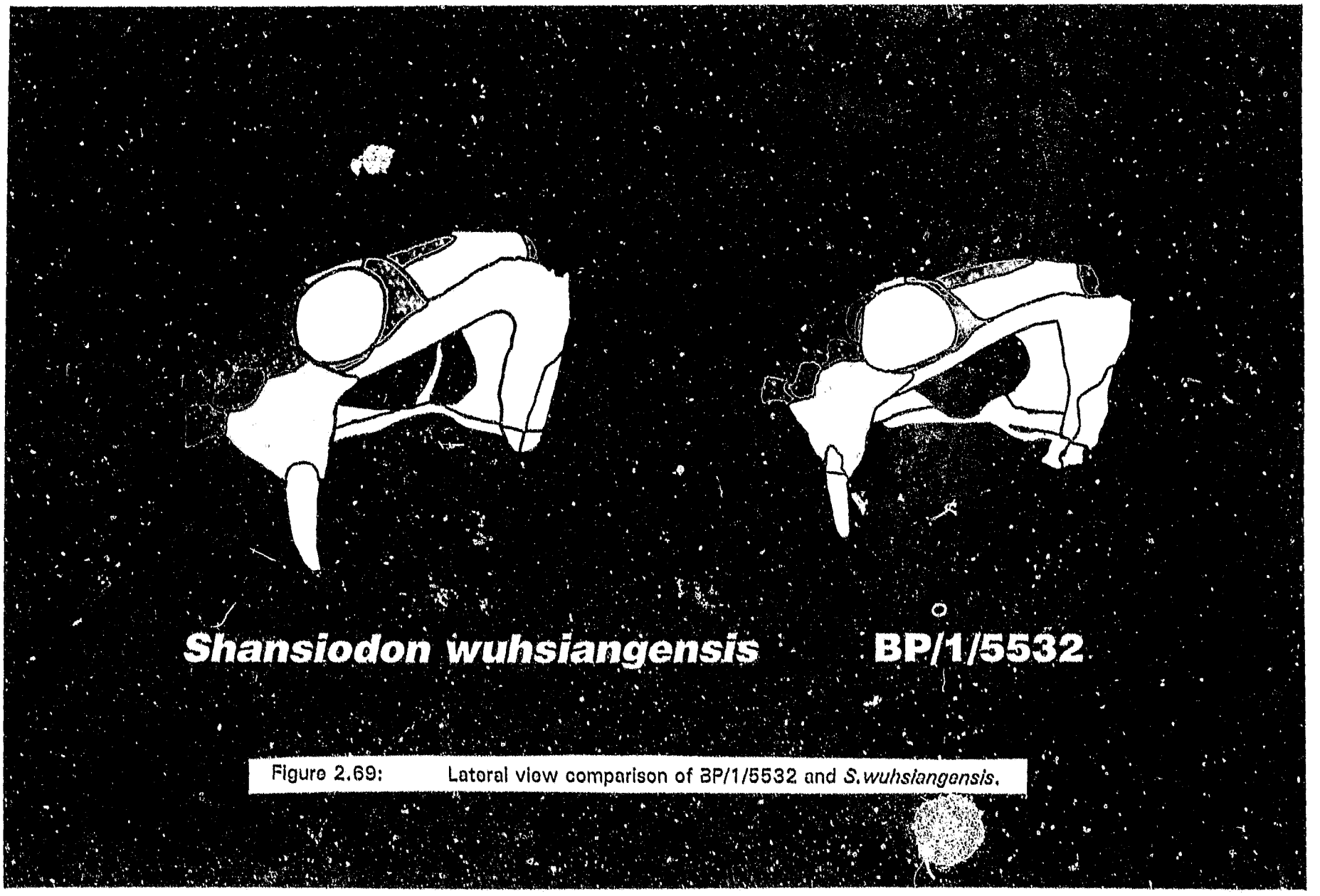


Figure 2.69: Lateral view comparison of BP/1/5532 and *S.wuhsiangensis*.

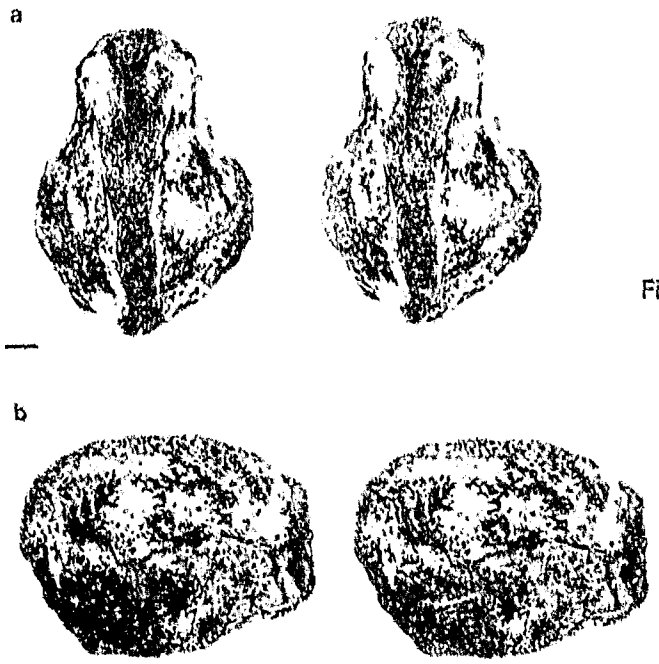


Figure 2.70: Indeterminable dicynodont intertemporal bar (BP/1/5536): a. dorsal view; b. lateral view. Scale bar = 1cm.

Figure 2.71a: Indeterminable dicynodont caniniform processes (BP/1/5526 & 5527), lateral view. Scale bar = 1cm.

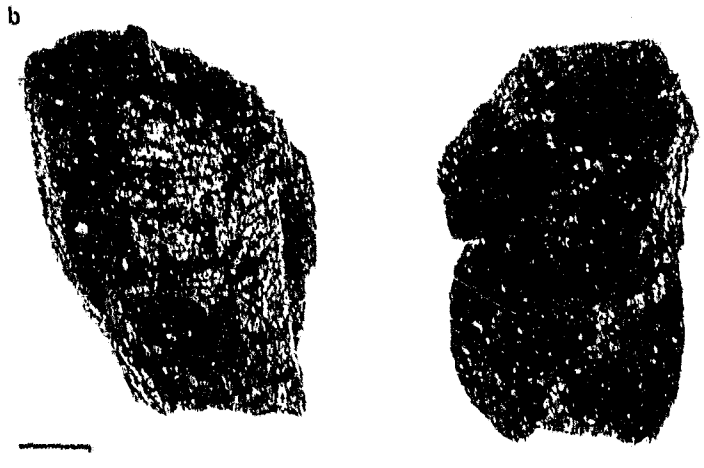


Figure 2.71b: Indeterminable dicynodont caniniform processes (BP/1/5526 & 5527), medial view. Scale bar = 1cm.

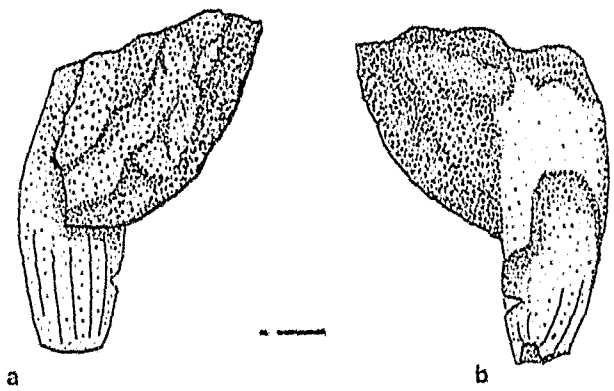


Figure 2.72: Indeterminable kannemeyeriid caniniform process (BP/1/5533): a. lateral view; b. medial view. Scale bar = 1cm.

Figure 2.73: Right Shanslodontid caniniform process (BP/1/5629). Scale bar = 1cm.

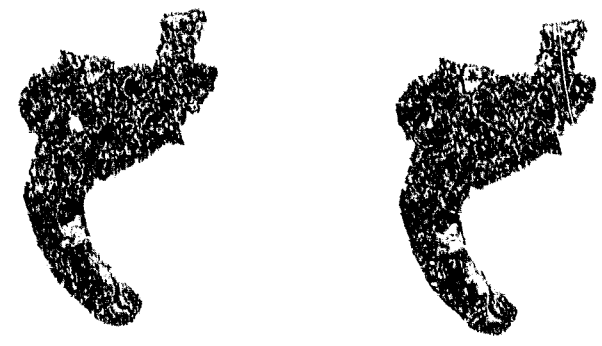


Figure 2.74: Indeterminable Archosauriform cranial element (BP/1/5556). Scale bar = 1cm.

Figure 2.75a: Miscellaneous large woody pteridiosperm axes (stems). Upper part of Subzone C of the *Cynognathus* Assemblage Zone.

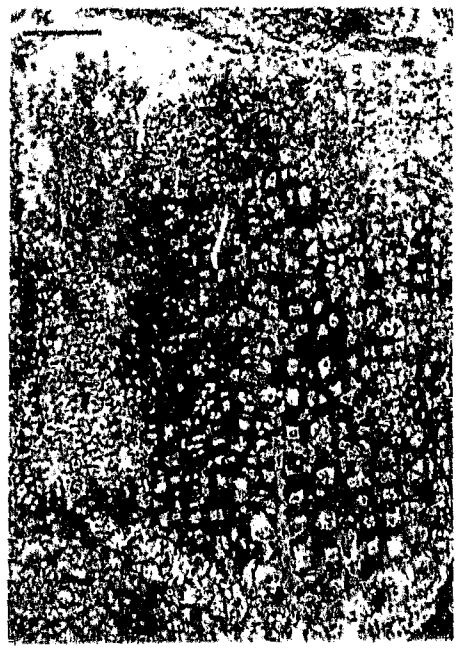


Figure 2.75b: Miscellaneous large woody pteridiosperm axes (stems). Upper part of Subzone C of the *Cynognathus* Assemblage Zone.

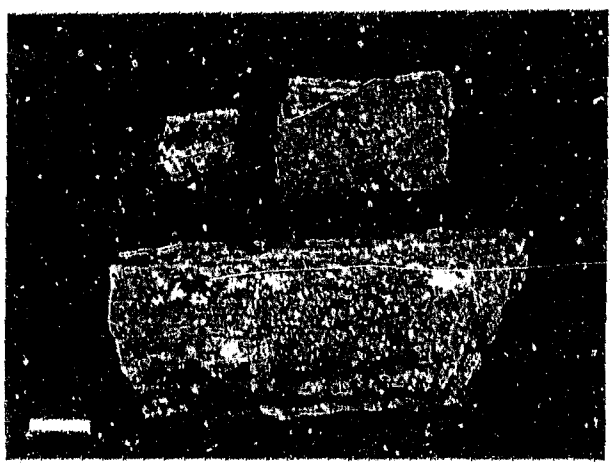


Figure 2.76: Internal casts of the sphenophyte (horsetail) *Calamites*. The small specimen is from subzone A, the intermediate from subzone B, and the large specimen from subzone C.

Figure 2.77: New seed type from the upper Burgersdorp Formation (Subzone C of the *Cynognathus* Assemblage Zone), Bushmanshoek Pass, Eastern Cape.

All scale bars on this page = 1cm

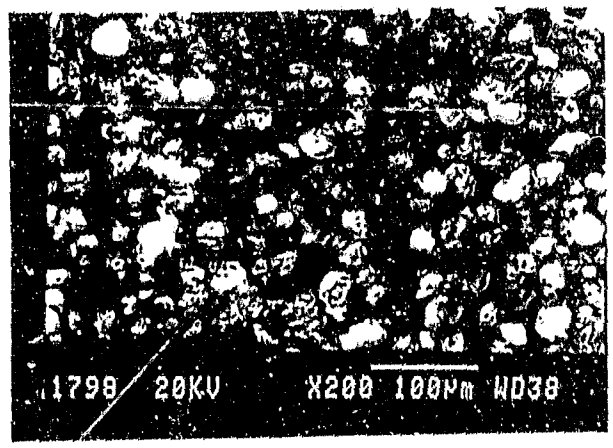


Figure 2.78a: Cross section SEM of characoal from the upper Burgersdorp Formation showing podocarp wood ray parenchyma.

Figure2.78b: Cross section SEM of characoal from the upper Burgersdorp Formation. Close up of parenchyma bundle in Fig.2.78a.

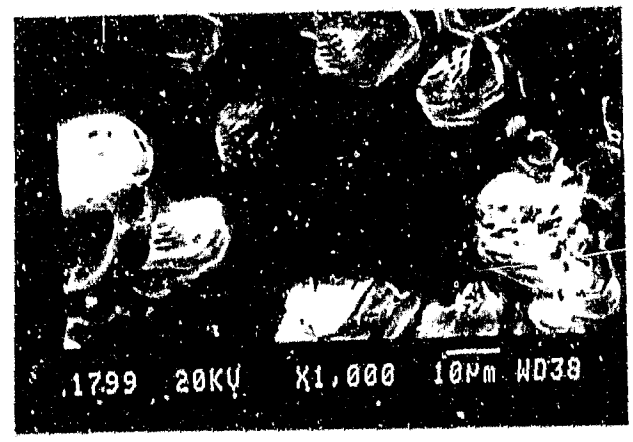
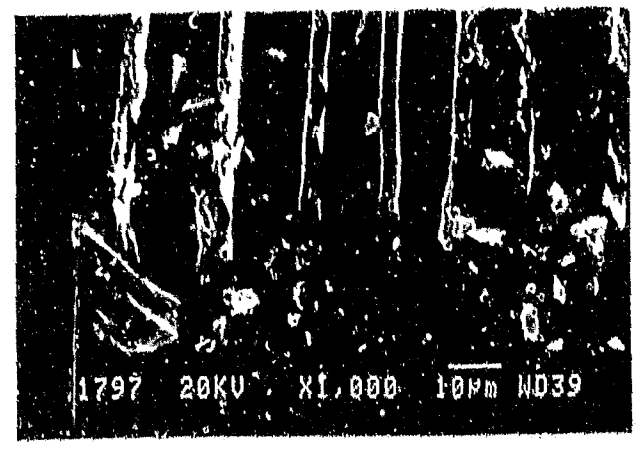


Figure 2.79a: Longitudinal section SEM of podocarp wood showing cell wall tracheids.

Figure 2.79b: Longitudinal section SEM of podocarp wood. Close up of cell wall tracheids showing regular and irregular spaced pitting.



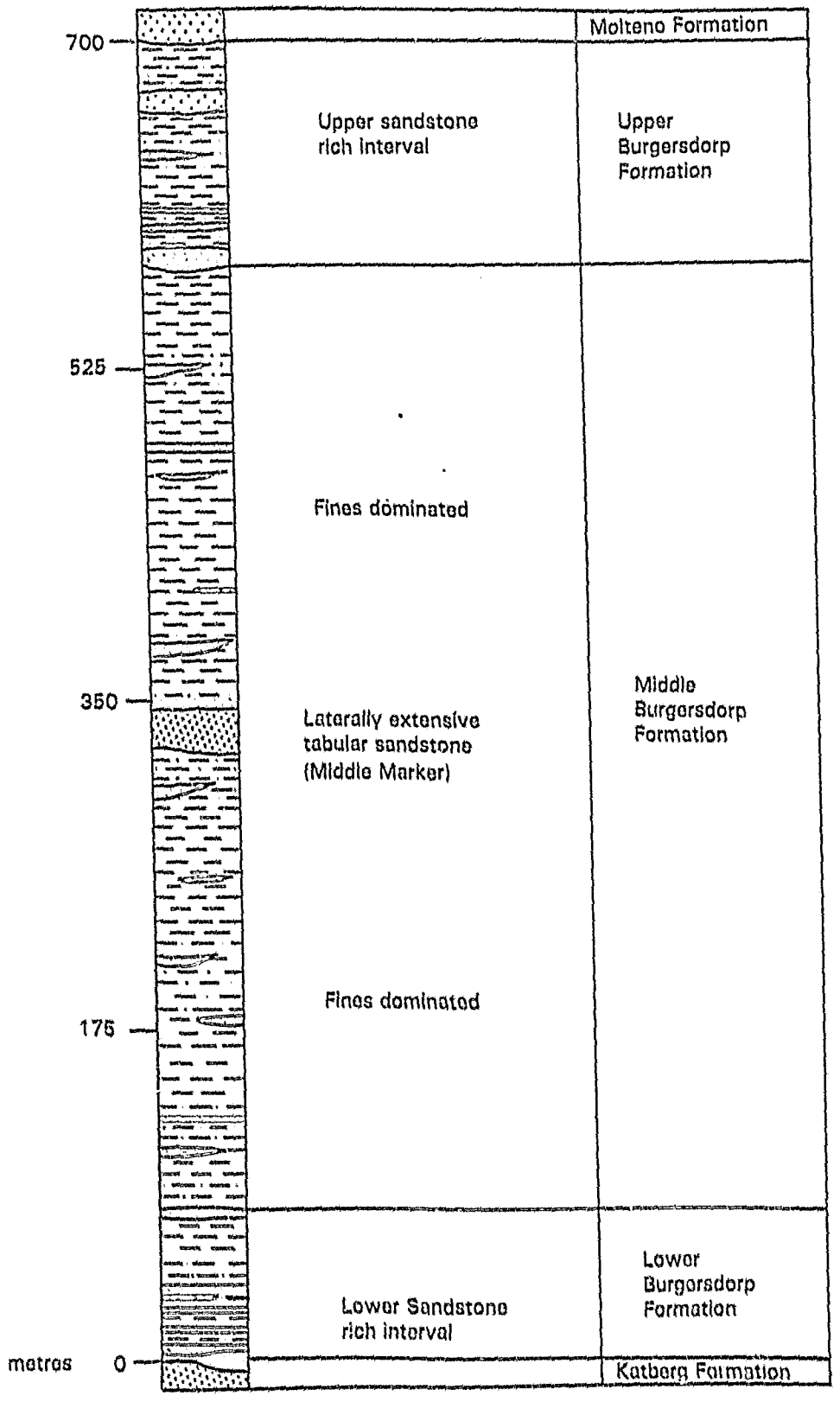


Figure 2.80: Composite lithostratigraphic section of the Burgersdorp Formation.

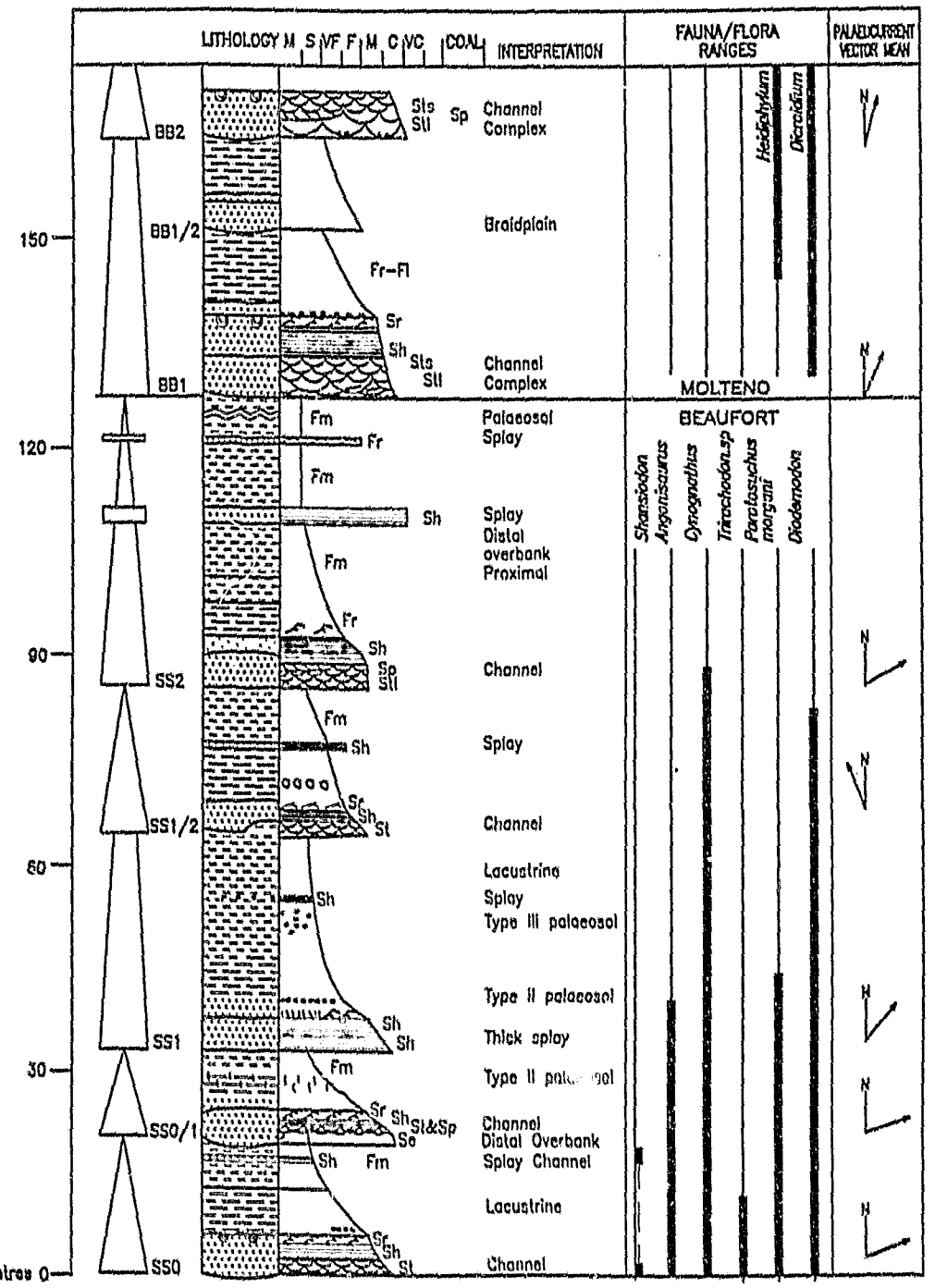


Figure 2.81: Proposed reference strat[illegible] upper Burgersdorp Formation. Farm Avillion, [illegible]alley, Eastern Cape.

Figure 2.82: Colour change to yellow grey (5Y 7/2) fines, some 10-15m from the top of the Burgersdorp Formation. Farm Avilion, Bamboeshoek Valley, Eastern Cape.

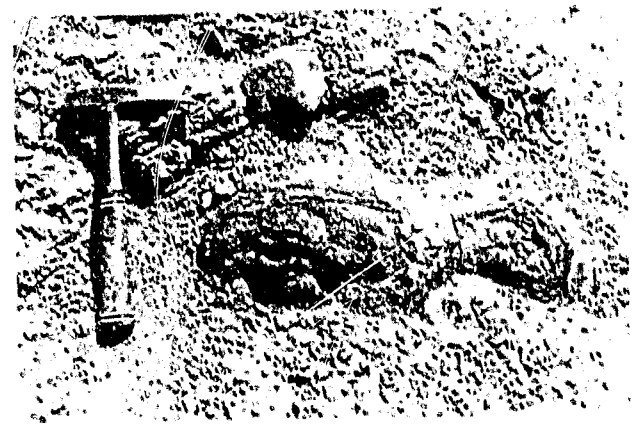


Figure 2.83: Manganeese rich nodular layer at the top of the Burgersdorp Formation. Farm Avillon, Bamboeshoek Valley, Eastern Cape.

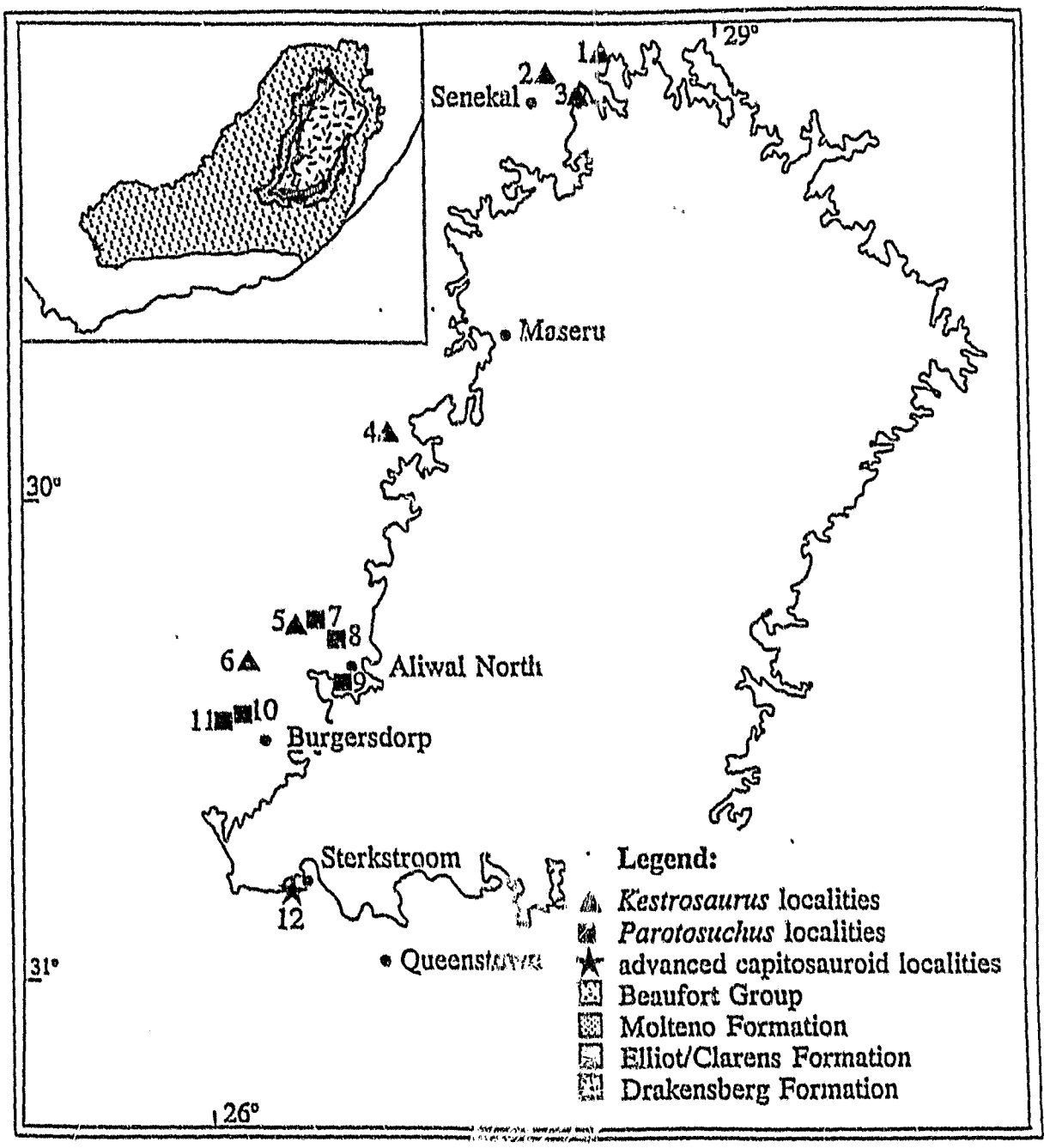


Figure 2.84: Spatial distribution of the zonal index amphibians. From Hancox *et al* (1995).

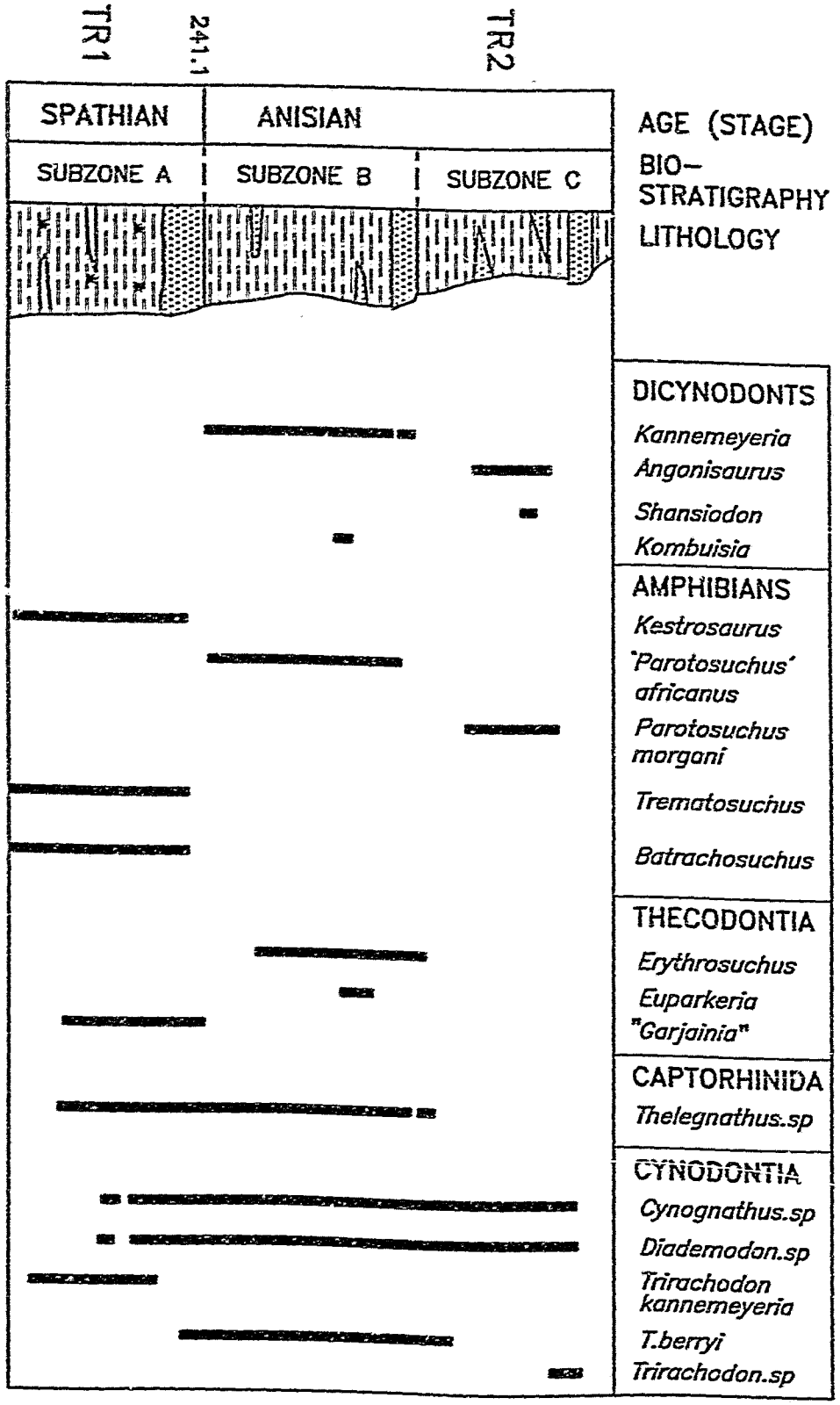


Figure 2.85: Temporal distribution of the zonal indices and their associated faunas.

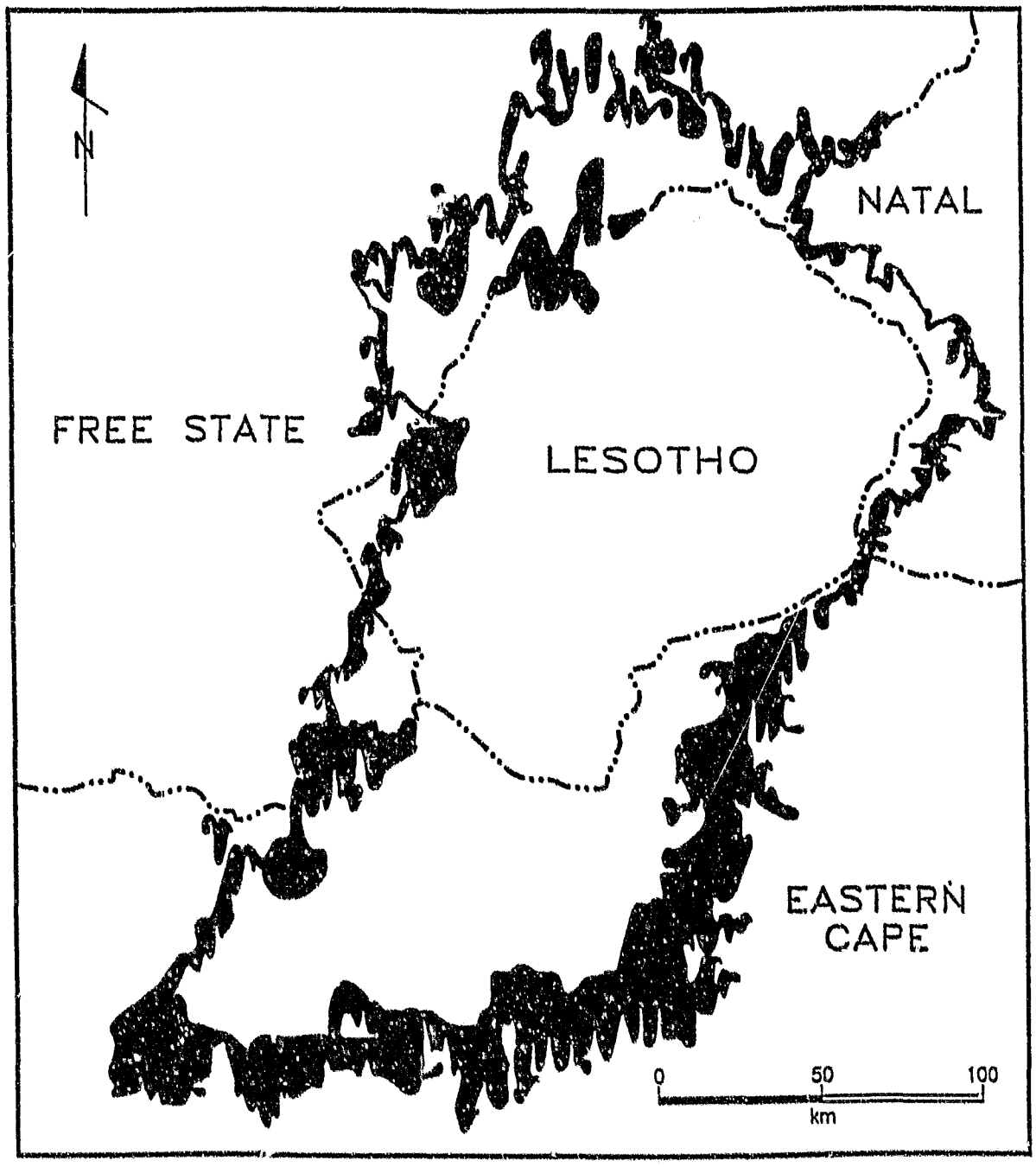


Figure 3.1: Geographical outcrop area of the Molteno Formation (After Turner, 1983).

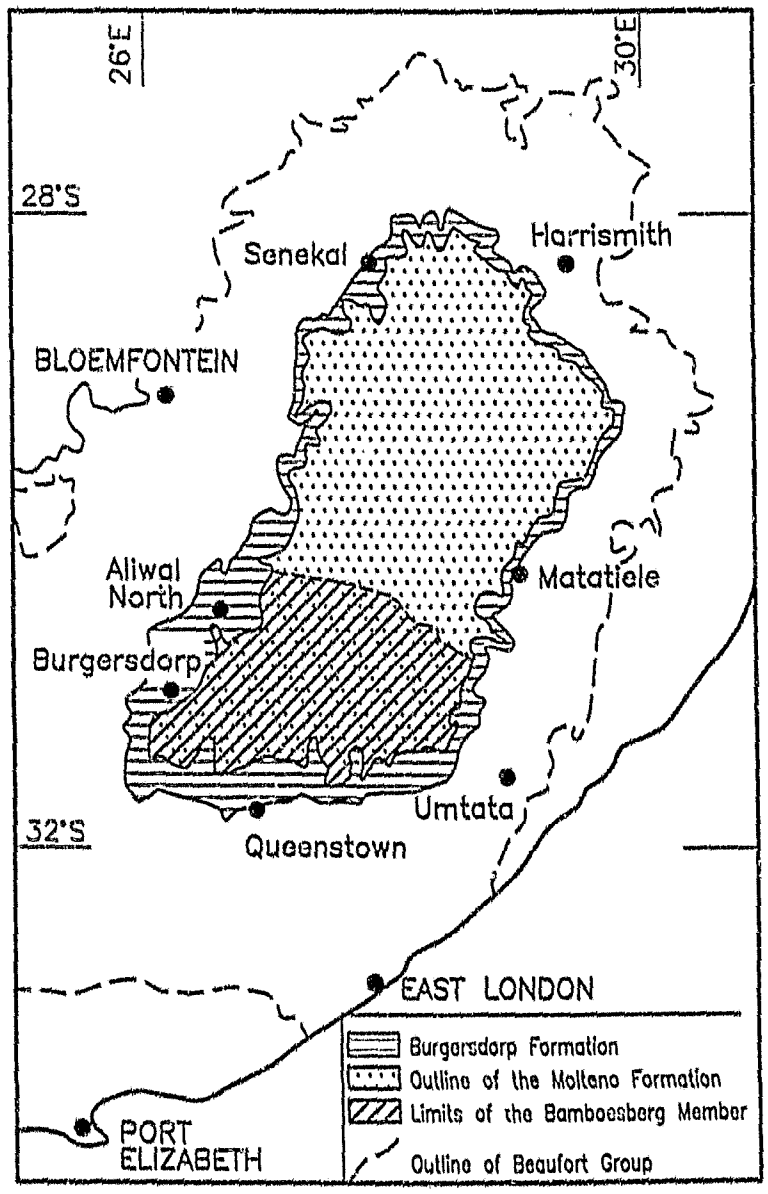


Figure 3.2: Geographical extent of the Bamboesberg Member of the Molteno Formation.

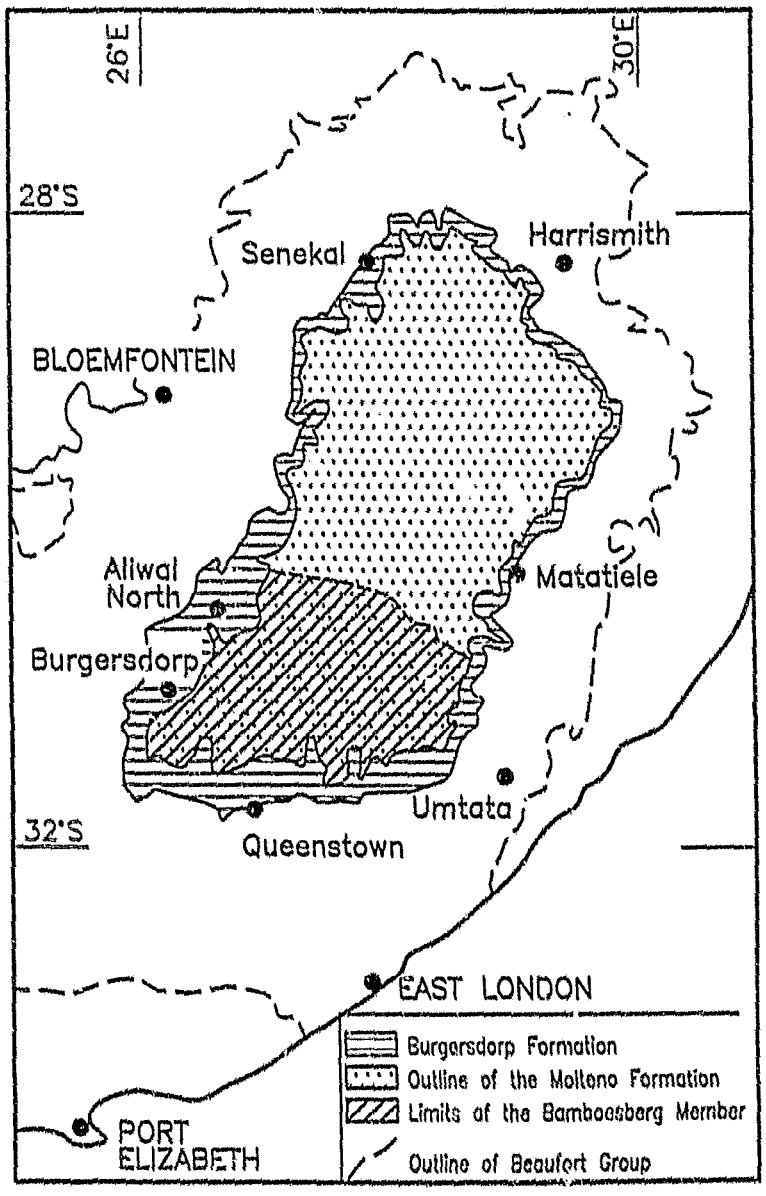


Figure 3.2: Geographical extent of the Bamboesberg Member of the Molteno Formation.

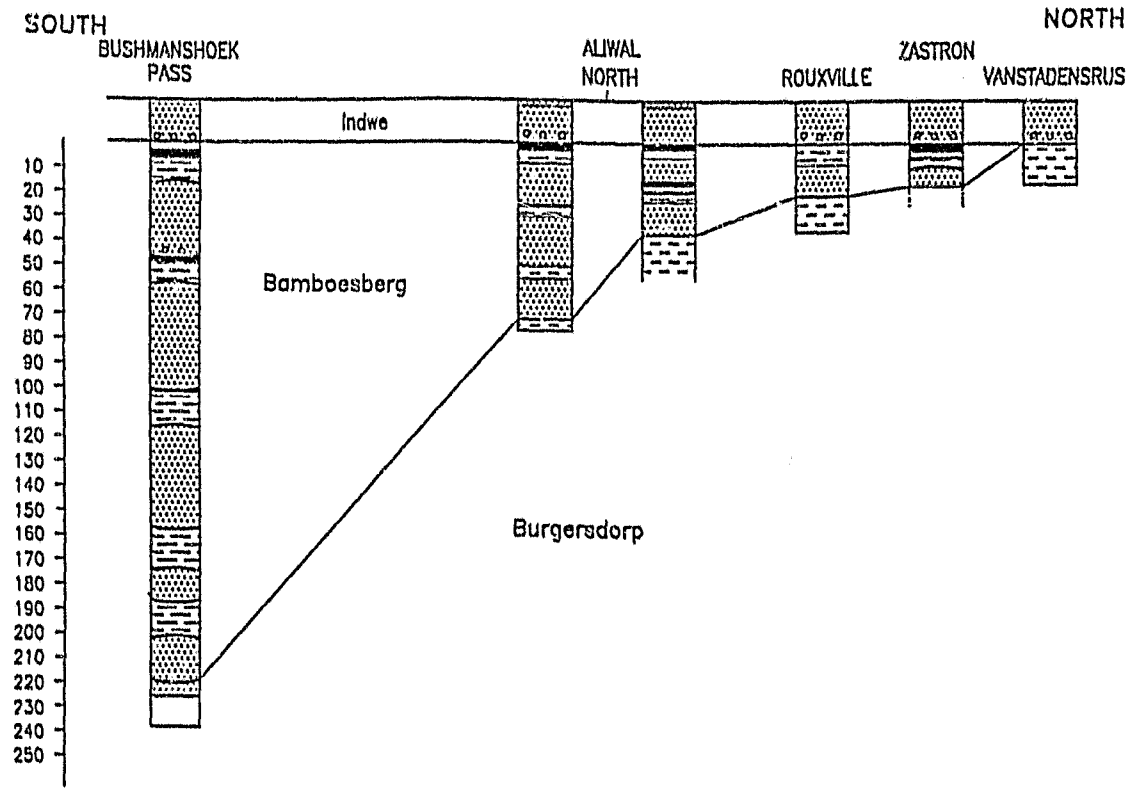


Figure 3.3a: South to north thickness variation of the Bamboesberg Member.

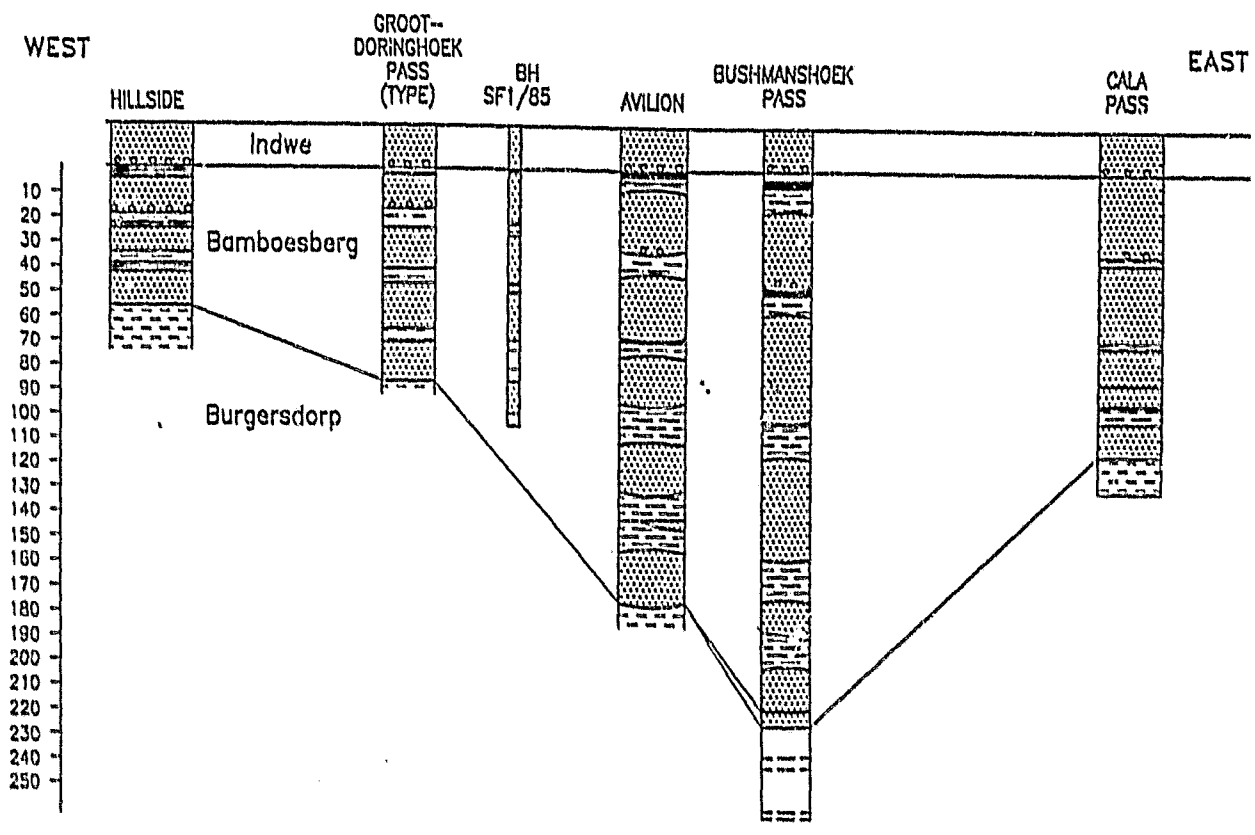


Figure 3.3b: West to east thickness variation of the Bamboesberg Member.

Figure 3.3: Regional thickness variations for the Bamboesberg Member.

Figure 3.5: Soft sediment deformation in sandstones of the Bamboesberg Member. Scale bar = 5cm.

Figure 3.4: Soft sediment deformation in sandstones of the Bamboesberg Member. Scale bar = 1cm.

Figure 3.6: Soft sediment deformation within large scale trough cross-stratified unit. Note that deformed laminae do not cross bed bounding surfaces.

Figure 3.7: Heterolithic scour fill facies (Se_h).

Figure 3.8: Intraclast scour fill facies (Se_i).

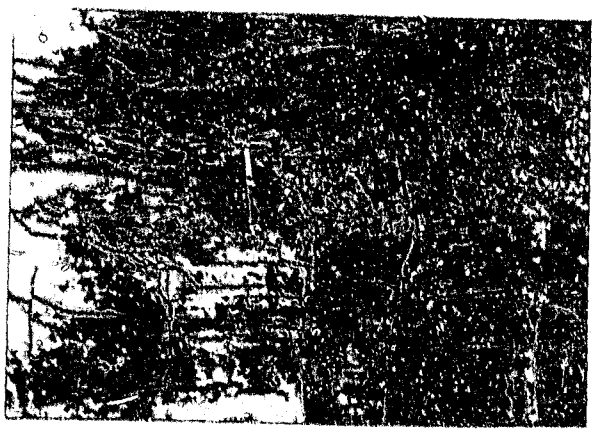


Figure 3.9: Intraclast scour fill facies (Se_i) overlain by trough cross-stratified sandstone facies (St_i).

Figure 3.10: Trough cross-stratified sandstone facies (St).

Figure 3.11: Large scale trough cross-stratified sandstone facies (St_i). Scale bar = 1m.

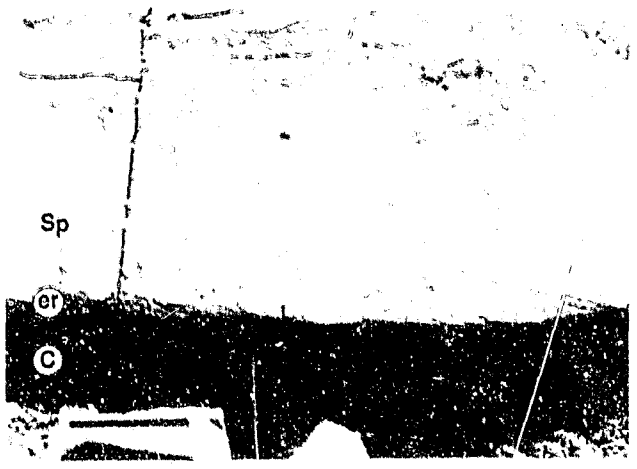
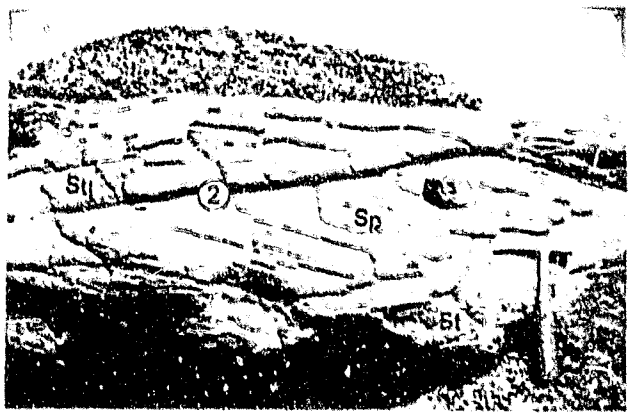


Figure 3.12: Planar cross-stratified sandstone facies (Sp). Scale bar = 15cm.

Figure 3.13: Wedge shaped set of facies Sp sandwiched between sets of facies St_l. Note the sharp nature of the second order bounding surface between the sets.



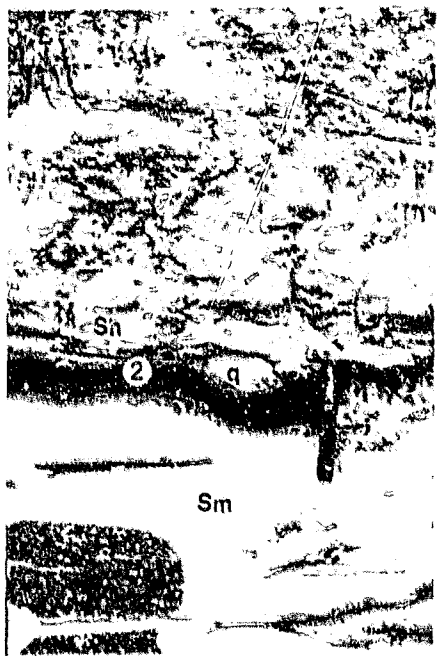


Figure 3.14: Massive sandstone facies (Sm) overlain by facies Sh.
Note the occurrence of quartzite (q) clasts on second order bounding surface between the two sets.

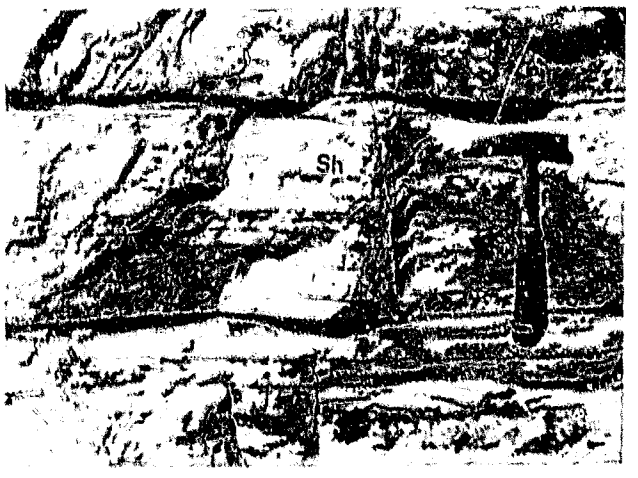


Figure 3.15: Horizontally stratified sandstone facies (Sh).

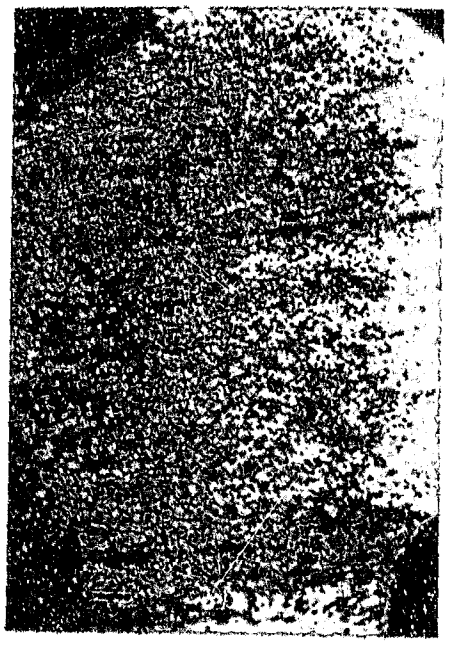


Figure 3.16: Facies Sh with concentration of heavy minerals (H) on individual laminae. Scale bar = 1cm.

Figure 3.17: Parting lineation in facies Sh_p.

Figure 3.18: Ripple cross-stratified sandstone facies (Sr). Note the erosive nature of the overlying massive sandstone (Sm). Scale bar = 10cm.

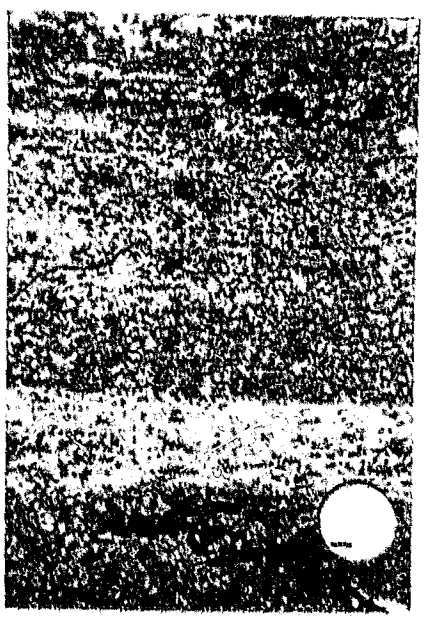


Figure 3.19: Matrix supported heterolithic clast accumulation (Fe_h). Note the small coarsening up sequences. Scale bar on R1 coin = 1cm.