BORDER CAVE

VOLUME II

Appendix 1. A survey of the extant flora in the vicinity of Border Cave *

John Anderson

An investigation of three ~ 5 x 6 km 'map units' (see Fig. 1) near Nsoko was carried out on occasions between 1970 and 1976. These areas encompass all of the major plant habitats which would have been reasonably accessible to a group of hunter-gatherers based in the cave. The project was confined to the indigenous woody plants in view of the fact that these constitute a very major fraction of the identifiable floral debris in the deposit.

My research programme was aimed at obtaining the following data:

a) Full check list of species in the defined areas.

b) Relative abundance of each species per 'map unit'.

c) Habitat preferences of every species in the surveyed region.

d) Particularly accurate information as to species presently growing in the immediate vicinity of the cave.

e) Possible agents which could have transported the fossil species into the sediments.

Details of the classifications employed are given in Figures 1 and 2 and in the Codes. The detailed analytical results of this undertaking are set forth fully in Table 1.

Acknowledgements

I wish to thank P. Beaumont, R. Crawford, F. Venter and P. Venter for field assistance at various times during the duration of this now completed official project of the Botanical Research Institute, Pretoria.

References

* Based on a communication from J. Anderson, dated 1976.

CODES FOR TABLE 1

Plant abundance rating code

✓ = Present (frequency not established)

½ = Very rare

1 = Fairly rare

1½ = Occasional

2 = Common

2½ = Dominant (with 4-7 other species)

3 = Dominant (with 2-3 other species)

3½ = Dominant (with a scatter of other species)

4 = Exclusive

Map unit code

See Figure 1.

Plant size and form code

D = Dwarf

L = Low

M = Medium

H = High

S = Shrub

T = Tree

Cl = Climber

Plant habitat code

See Figure 2

Dash = Species absent in this habitat

Blank = Data still to be established

FIG. 1 DETAILS OF BORDER CAVE SURROUNDINGS SHOWING 'MAP UNITS' AS USED IN TABLE I

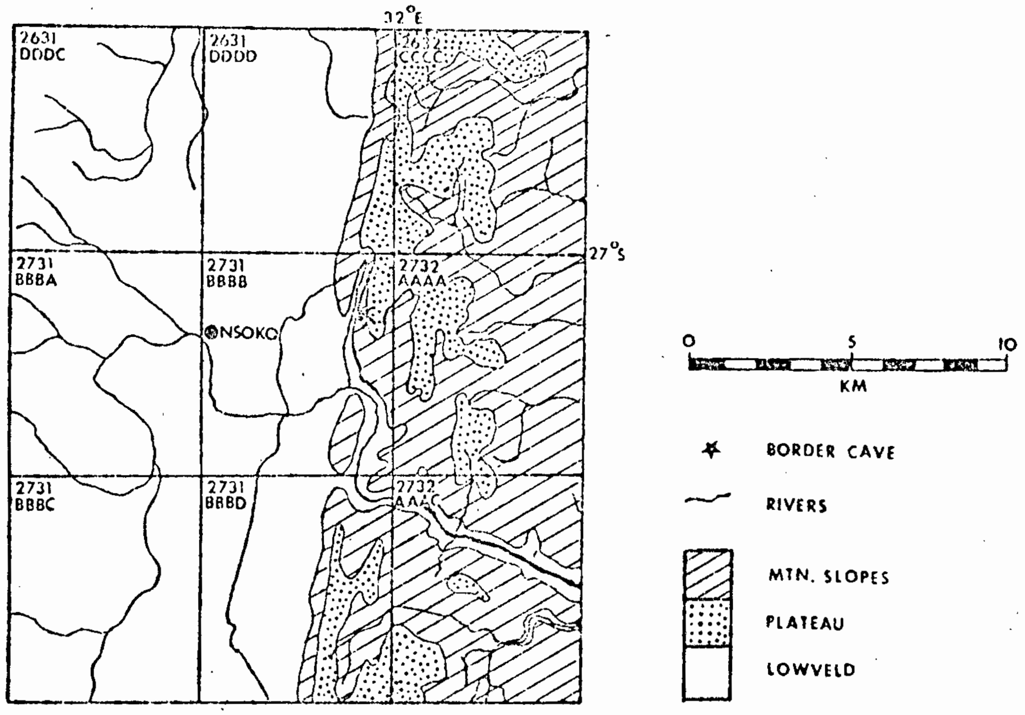
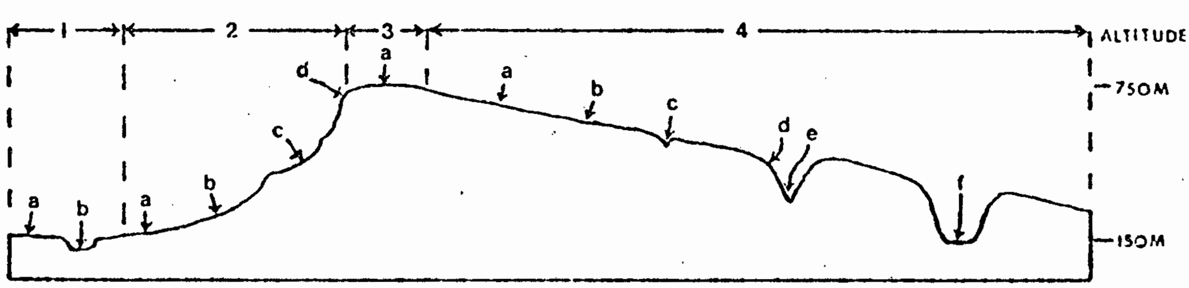


FIG. 2 SCHEMATIC CROSS-SECTION THROUGH LEBOMBO MOUNTAINS SHOWING MAJOR PLANT HABITATS AS USED IN TABLE I



I : LOWVELD
a-plain, woodland
b-riverine

2: SCREE SLOPE
a-junction scree and plain
b-slopes; forest
c-slopes, woodland
d-scarp

3: PLATEAU

4: DIP SLOPE
a-moderate slope, forest
b-moderate slope, woodland
c-riverine, gently incised
d-steep slope, forest
e-riverine, gorge
f-riverine, flat bottom valley

Table I Provisional checklist of trees, shrubs and climbers in the vicinity of Border Cave

John Anderson

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	1 b	2 a	2 b	2 c	2 d	3 a	4 a	4 b	4 c	4 d	4 e	4 f
ZAMIACEAE																	
Encephalartos lebomboensis	½	½	✓	LS	–	–	–			½				½		–	–
Encephalartos sp.		½		DS	–	–	–							½		–	–
LILIACEAE																	
Aloe arborescens	1½			HS	–	–	–			1½						–	–
Aloe bainesii	1½			MT	–	–	–			1½						–	–
Aloe marlothii	2½	2	2½	LT					2½				2				
Dracaena hookeriana	½			LS	–	–	–	½	–	–	–	–	–	–	–	–	–
VELLOZIACEAE																	
Xerophyta clavata		½		DS	–	–	–	–	–	–	–	–	–	½	–	–	–
SALICACEAE																	
Salix woodii	2			LT	–	–	–	–	–	–	–	–	–	–	–	–	2
ULMACEAE																	
Celtis africana	2	2	½	MT		½									2		
Trema orientalis	2½	½		MT	–	–	–								2½		
Chaetachme aristata	½			LT	–	–	–								½		
MORACEAE																	
Ficus burkei	1½	½	✓	HT	–	–	–						1½	½			
Ficus capensis	2	1½		HT	–	–	–	–	–	–	–	–	–			1½	2
Ficus capreifolia			2	HS	–	2	–	–	–	–	–	–	–	–	–	–	–

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	1 b	2 a	2 b	2 c	2 d	3 a	4 a	4 b	4 c	4 d	4 e	4 f
Ficus ingens	½	1½	✓	MT	–	–	–							1½			
Ficus salicifolia	½			MT	–	–	–							½			
Ficus soldanella	1½	1	✓	MT	–	–	–							1½			
Ficus sonderi		1	✓	MT	–	–	–	–	–	–	–		1				
Ficus sycomorus	2		2½	HT	–	2½	–	–	–	–	–	–	–	–	–	–	2½
URTICACEAE																	
Urera tenax	½	½	✓	LT	–	–	–								½		
Pouzolzia hypoleuca	1½		✓	HS	–	–	–								1½		
OLACACEAE																	
Olax dissitiflora	1	½		LT	–	–	–				1				½		
Ximenia americana	2	½	1½	LT			2								½		
Ximenia caffra	½	1	✓		–	–	–						1				
PORTULACACEAE																	
Portulacaria afra	2		✓	LS	–	–	–			2							
RUNUNCULACEAE																	
Clematis brachiata	1	½		CL	–	–	–						1				
MENISPERMACEAE																	
Cocculus hirsutus	½		1½	CL		1½	½	–	–	–	–	–	–	–	–	–	–
Tinospora fragosa	½	1½		CL	–	–	–								1½		
ANNONACEAE																	
Uvaria caffra	1	2		MT	–	–	–	1							2		

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	1 b	2 a	2 b	2 c	2 d	3 a	4 a	4 b	4 c	4 d	4 e	4 f
?Artabotrys monteiroae	½			LT	–	–	–	½									
CAPPARACEAE																	
Cladostemon kirkii	1	½		MT	–	–	–	1				–	–	–	½	–	–
Capparis tomentosa			1½	CL			1½										
Boscia albitrunca			1½	LT	1½			–	–	–	–	–	–	–	–	–	–
Cadaba natalensis	1		1½	CL			1½	–	–	–	–	–	–	–	–	–	–
Maerua angolensis	1½		1	MT			1½	–	–	–	–	–	–	–	–	–	–
Maerua brevipetiolata			½	CL	–	–	½	–	–	–	–	–	–	–	–	–	–
MIMOSACEAE																	
Albizia anthelmintica			1	MT	1			–	–	–	–	–	–	–	–	–	–
Albizia versicolor			✓	HT													
Acacia ataxacantha	3	3	1	MT			2								3		
" caffra		1	½	MT			½	–	–	–	–				1	–	–
" gerrardii	2	2½	1½	MT	1½								2½				
" grandicornuta			✓	MT													
" karroo	2		3	MT			3	–	–	–	–	–	–	–	–	–	–
" luederitzii	2			MT	2			–	–	–	–	–	–	–	–	–	–
" nigrescens	2½		2½	HT			2½										

Table I continued

Identification	Location 2731 BBBD	2732 AAAC	2731 BBBB	Height Class	Habitat 1 a	b	2 a	b	c	d	3 a	4 a	b	c	d	e	f
Acacia nilotica kraussiana	2½	2	2½	MT	2½								2½				
Acacia robusta clavigera	2	2	2	HT	2												2
Acacia tortilus heteracantha	3½		3	MT	3½			–	–	–	–	–	–	–	–	–	–
Acacia xanthophloea	2½		3	HT	–	3	–	–	–	–	–	–	–	–	–	–	2½
Dichrostachys cinerea	3	2½	3	LT	3								2½				
CAESALPINIACEAE																	
Schotia brachypetala		1	½	HT			½	–	–	–	–			½		1	
Bauhinia galpinii		2½		LT	–	–	–	–	–	–	–		2½			–	–
Caesalpinia decapetala	2½			HS	–	–	–								2½		
Peltophorum africanum	½		1	MT	1								½				
PAPILIONACEAE																	
Bolusanthus speciosus			1½	MT	1½			–	–	–	–	–	–	–	–	–	–
Crotalaria sp.			2½	HS			2½	–	–	–	–	–	–	–	–	–	–
Indigofera arrecta	1½			LS	–	–	–	–	–	–	–	–	–	–	–	–	1½
Mundulea sericea	½	½	✓	LT	–	–	–						½				

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	1 b	2 a	2 b	2 c	2 d	3 a	4 a	4 b	4 c	4 d	4 e	4 f
Sesbania sesban sesban nubica		½	2	HS	2		–	–	–	–	–	–	–	–	–	½	–
Ormocarpum trichocarpum	1½		1½	LT	1½			–	–	–	–	–	–	–	–	–	–
Dalbergia armata	1½	1½		CL	–	–	–				–				1½		
Dalbergia melanoxylon			✓	LT													
Pterocarpus angolensis			✓	HT													
Pterocarpus rotundifolius			✓	HT													
Lonchocarpus capassa			✓	HT													
Erythrina latissima			✓	LT													
Erythrina lysistemon	2			MT	–	–	–								2		
ERYTHROXYLACEAE																	
Erythroxylum delagoense	2	½		LT	–	–	–				2		½			–	–
Erythroxylum emarginatum			✓	LT													
ZYGOPHYLLACEAE																	
Balanites maughamii	1	½	1	LT			1								½		

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	Habitat 1 b	Habitat 2 a	Habitat 2 b	Habitat 2 c	Habitat 2 d	Habitat 3 a	Habitat 4 a	Habitat 4 b	Habitat 4 c	Habitat 4 d	Habitat 4 e	Habitat 4 f
RUTACEAE																	
Fagara capensis	2	1½		LT	–	–	–								2		
Calodendrum capense	½			MT	–	–	–	½	–	–	–	–	–	–	–	–	–
Vepris reflexa	½	1½		LT	–	–	½				½				1½		
Vepris undulata	1	½		LT	–	–	–				1				½		
Teclea natalensis			✓	LT													
Clausena anisata			2	LT	–		2	–	–	–	–	–	–	–	–	–	–
BURSERACEAE																	
Commiphora harveyi	½	1	✓	LT	–	–	–				½		1				
Commiphora neglecta	1			LT	–	–	–								1		
Commiphora schimperi	1½			LT			½								1½		
Commiphora woodii			✓	LT													
PTAEROXYLACEAE																	
Ptaeroxylon obliquum	2	½	½	MT	–	–	1½			2					½		
MELIACEAE																	
Turraea obtusifolia		½	✓	LS	–	–	–	–	–	–	–	–	½	–	–	–	–
Ekebergia capensis	1	1		HT	–	–	–				–			1			
Trichilia emetica			✓	HT													

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	1 b	2 a	2 b	2 c	2 d	3 a	4 a	4 b	4 c	4 d	4 e	4 f
EUPHORBIACEAE																	
Securinega virosa	1½		1½	HS	–		1½	–	–	–	–	–	–	–	–	–	–
Phyllanthus reticulatus	2½	1	2	CL	–	2	–								1		2½
Antidesma venosum		½		MT	–	–	–	–	–	–	–	–		½			
Croton gratissimus	½	1		MT	–	–	1	–	–	–	–				1	–	–
Croton sylvaticus	½	1		MT	–	–	–								1		
Acalypha glabrata		1	✓	HS	–	–	–				–				1		
Clutia pulchella		1		LS	–	–	–	–	–	–	–				1		
Suregada africana	1½			LT	–	–	–	1½	–	–	–	–	–	–	–	–	–
Spirostachys africana	2½	1½	2	HT			2				–				2½		
Euphorbia cooperi	½			LT	–	–	–								½	–	–
Euphorbia ?grandidens		2		MT	–	–	–	–	–	–	–	–	–	–	2	–	–
Euphorbia tirucalli	2½	2½	✓	MT	–	–	½								2½	–	–
ANACARDIACEAE																	
Sclerocarya caffra	2	2	2	HT	1½		2						2				
Harpephyllum caffrum	2	½		MT	–	–	–	2					½			–	–
Ozoroa engleri (large leaf)	1½	1	1	LT	1	–	–	–	–	–	–		1½			–	–

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	Habitat 1 b	Habitat 2 a	Habitat 2 b	Habitat 2 c	Habitat 2 d	Habitat 3 a	Habitat 4 a	Habitat 4 b	Habitat 4 c	Habitat 4 d	Habitat 4 e	Habitat 4 f
Rhus chirindensis legatii	1½		✓	MT	–	–	–				1½						
Rhus gueinzii	1½		2	LT		2	1½	–	–	–	–	–	–	–	–	–	–
Rhus leptodictya	½			MT											½		
Rhus pentheri	2	1½	½	LT			½								2		
Rhus pyroides			1	LT		1		–	–	–	–	–	–	–	–	–	–
Rhus rehmannii	1½			LT	–	–	–				1½						
CELASTRACEAE																	
Maytenus heterophylla	2	1½	2½	LT	2		2½								2		
Maytenus mossambicensis			✓	LT													
Maytenus nemorosa	1½			LT	–	–	–				1½						
Maytenus penduncularis	1			LT	–	–	–	1									
Maytenus senegalensis	2		2½	LT	1½	2½	1½	–	–	–	–					–	2
Maytenus undata	1½	1½		LT	–	–	–				1½						
Maytenus sp.	1	1		LT	–	–	–	1			1						
Putterlickia pyracantha	1			HS	–	–	–	–	–	–	1	–	–	–	–	–	–
Cassine aethiopica	1½		½	LT			1				1½			–		–	–

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	1 b	2 a	2 b	2 c	2 d	3 a	4 a	4 b	4 c	4 d	4 e	4 f
Cassine transvaalensis			½	LT	–	–	½	–	–	–	–	–	–	–	–	–	–
Allocassine laurifolia	½			CL	–	–	–	–	–	–	½	–	–	–	–	–	–
ICACINACEAE																	
Apodytes dimidiata	1	½	✓	LT	–	–	–				1						
SAPINDACEAE																	
Atalaya alata	2	1	✓	MT	–	–	–				2						
Pappea capensis	1½	½	1½	MT			1½								1½		
Hippobromus pauciflorus	1	1½	½	LT			½				1½						
RHAMNACEAE																	
Ziziphus mucronata	1½	1½	2	MT			2								1½		
Ziziphus rivularis		½		LT			–	–	–	–	–	–	–	–	–	½	–
Berchemia discolor	1½	1½	1½	MT			1½				1½					–	–
VITACEAE																	
Rhoicissus rhomboidea	½			CL	–	–	–	½									
Rhoicissus tomentosa		1		CL	–	–	–									1	
Rhoicissus tridentata	2	1½	½	CL			½								2		

Table I continued

Identification	Location			Height Class	Habitat												
	2731	2732	2731		1		2				3	4					
	BBBD	AAAC	BBBB		a	b	a	b	c	d	a	a	b	c	d	e	f
Cissus quadrangularis	2		1½	CL			2								½		
Cissus rotundifolia	2		2				2	–	–	–	–	–	–	–	–	–	–
TILIACEAE																	
Grewia bicolor	1½		½	HS	1½			–	–	–	–	–	–	–	–	–	–
Grewia flavescens	1	1½	1½	HS			1½								1½		
Grewia hexamita	1½		1½	LT	1½			–	–	–	–	–	–	–	–	–	–
Grewia monticola		½		LT	–	–	–						½				
Grewia occidentalis	1½	½	1	LT			1								1½		
Grewia subspathulata	1	1	1	HS	1								1				
Grewia villosa	1½		½	LS	½								1½				
MALVACEAE																	
Hibiscus praeteritus	1	1½	½	LS			½								1½		
STERCULIACEAE																	
Dombeya burgessiae	2	1½	✓	HS	–	–	–				2		1½				
Dombeya cymosa	½	1	½	LT			½								1		
Dombeya rotundifolia	1	½	½	MT			½								1		
Sterculia rogersii		½		MT	–	–	–	–	–	–	–	–	–	–	½	–	–

Table I continued

Identification	Location			Height Class	Habitat												
	2731	2732	2731		1		2				3	4					
	BBBD	AAAC	BBBB		a	b	a	b	c	d	a	a	b	c	d	e	f
OCHNACEAE																	
Ochna arborea arborea	1½	½		MT	–	–	–	1½							½		
Ochna arborea oconnorii	1½			MT	–	–	–	1½									
Ochna natalitia	1	1		LT	–	–	–								1		
Ochna serrulata	½			HS	–	–	–	–	–	–	½	–	–	–	–	–	–
FLACOURTIACEAE																	
Scolopia zeyheri	½	½	½	LT			½								½		
Flacourtia indica	½			LT	–	–	–								½		
Dovyalis caffra	½	½	½	LT	½		½								½		
Dovyalis zeyheri	½			LT			½	–	–	–	–						
PASSIFLORACEAE																	
Adenia gummifera		½		CL	–	–	–	–	–	–	–	–	–	½	–	–	–
LYTHRACEAE																	
Galpinia transvaalica	2	2½	✓	MT	–	–	–	2							2½		
COMBRETACEAE																	
Combretum hereroense	2		2	LT	–	–	2	–	–	–	–	–	–	–	–	–	–
Combretum kraussii	2½	2½	✓	LT	–	–	–								2½		
Combretum molle	1½	1½	✓	MT	–	–	–								1½		

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	1 b	2 a	2 b	2 c	2 d	3 a	4 a	4 b	4 c	4 d	4 e	4 f
Combretum zeyheri			✓	MT													
Terminalia phanerophlebia	2	1		LT	–	–	–						2				
MYRTACEAE																	
Syzygium cordatum	✓	½		MT	–	–	–							½			
Syzygium guineense			✓	MT													
Heteropyxis natalensis	1½	2½		MT	–	–	–								2½		
ARALIACEAE																	
Cussonia natalensis		1		MT	–	–	–	–	–	–	–	–	–	1	–	–	–
Cussonia spicata	1½		✓	MT	–	–	–						1½				
UMBELLIFEREAE																	
Heteromorpha arborescens	½		✓	LT	–	–	–				½						
MYRSINACEAE																	
Rapanea melanophloeos			✓	MT													
SAPOTACEAE																	
Sideroxylon inerme	1		1½	MT	–	–	1½	1									
Mimusops obovata	1½	1		MT	–	–	–	1½									
Vitellariopsis marginata	2½	1	✓	MT	–	–	–	2½									

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1a	1b	2a	2b	2c	2d	3a	4a	4b	4c	4d	4e	4f
EBENACEAE																	
Euclea divinorum	2		2½	LT			2½								1½		
Euclea natalensis	1		½	LT	–	–	½								1		
Euclea schimperi schimperi	1½	1½	2	LT			1½								1½		
Euclea undulata myrtina	½		½	LT			½	–	–	–	–	–	–	–	–	–	–
Diospyros dichrophylla	3	2½	✓	LT	–	–	–				3		2½				
Diospyros lycioides guerkii			½	LT	–	½	–	–	–	–	–	–	–	–	–	–	–
Diospyros natalensis nummularia	1½	1	✓	LT	–	–	–	1½							1		
OLEACEAE																	
Schrebera alata	½	2		LT	–	–	–	–	–	–	½			2		–	–
Olea africana	1½	½		LT	–	–	–				1½				½	–	–
Olea capensis	1½		1½	LT	–	–	–				1½					–	–
Jasminum breviflorum	1		1½	CL			1½	–	–	–	–	–	–	–	–	–	–
SALVADORACEAE																	
Azima tetracantha			2	CL	–	2	1	–	–	–	–	–	–	–	–	–	–
Salvadora angustifolia	½			LT	½	–	–	–	–	–	–	–	–	–	–	–	–

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	1 b	2 a	2 b	2 c	2 d	3 a	4 a	4 b	4 c	4 d	4 e	4 f
Secamone parvifolia			1	CL			1	-	-	-	-						
BORAGINACEAE																	
Cordia caffra			½	MT	-	½	-	-	-	-	-	-	-	-	-	-	-
Cordia ovalis (small leaf)	2		½	LT	2			-	-	-	-	-	-	-	-	-	-
Ehretia rigida	3	½	3	HS			3								1½		
VERBENACEAE																	
Lantana rugosa	½	½		LS	-	-	-				½				½		
Lippia javanica	3	2	1½	LS			1½				3				2		
Premna mooiensis	1½	1	✓	LT			½	1½							1		
Vitex wilmsii	2½	2½	✓	LT	-	-	-				2½		2½				
Clerodendrum glabrum	1½		1½	LT			1½								1½		
Holmskioldia tettensis	2	1½		LT			½								2		
LABIATAE																	
Iboza riparia	2	2	✓	LS	-	-	-								2		
Orthosiphon labiatus	3			LS	-	-	-		3			-	-	-	-	-	-
SOLANACEAE																	
Lycium shawsii			½	HS	-	½	-	-	-	-	-	-	-	-	-	-	-
BIGNONIACEAE																	
Tecomaria capensis	2½	1		LT	-	-	-	2½							1		

Table I continued

Identification	Location 2731 BBBD	Location 2732 AAAC	Location 2731 BBBB	Height Class	Habitat 1 a	Habitat 1 b	Habitat 2 a	Habitat 2 b	Habitat 2 c	Habitat 2 d	Habitat 3 a	Habitat 4 a	Habitat 4 b	Habitat 4 c	Habitat 4 d	Habitat 4 e	Habitat 4 f
Kigelia africanum			½	HT	–	½	–	–	–	–	–	–	–	–	–	–	–
ACANTHACEAE																	
Barleria gueinzii	1	1		LS	–	–	–	1							1		
Duvernoia aconitiflora		1½		HS	–	–	–	–	–	–	–	–	–	–	–	1½	–
RUBIACEAE																	
Adina microcephala galpinii	2	1½		HT	–	–	–	–	–	–	–	–	–	1½	–		2
Tarenna barbertonensis	1	1½	✓	LT	–	–	–				1		1½			–	–
Xeromphis rudis	2½	2	1	LS			1				2½		2				
Gardenia spatulifolia			1	LT	1	–	–	–	–	–	–	–	–	–	–	–	–
Kraussia floribunda		1½		LT	–	–	–	–	–	–	–				1½		
Vangueria cyanescens	½	½	½	LT			½						½		½		
Vangueria infausta	2	2		LT	–	–	–				2		2				
Canthium inerme	2½			LT	–	–	–	–	–	–	2½	–	–	–	–	–	–
Canthium mundtianum	2½	2		LT	–	–	–				2½		2				
Plectroniella armata	½	1	1½	LT			1½				½				1		
Dinocanthium hystrix	½		½	LT			½								½		

Table I continued

Identification	Location			Height Class	Habitat												
	2731	2732	2731		1		2				3	4					
	BBBD	AAAC	BBBB		a	b	a	b	c	d	a	a	b	c	d	e	f
Pavetta breyeri breyeri		½		LT	–	–	–	–	–	–	–				½		
Pavetta galpinii		1½		LT	–	–	–	–	–	–	–	–	1½	–	–	–	–
Pavetta lanceolata	1	½	½	LT	–	½	–								1		
COMPOSITAE																	
Vernonia sp.			1	HS	–	1	–	–	–	–	–	–	–	–	–	–	–
Brachylaena ilicifolia	1		1	LT	–	–	1	1								–	–
Tarchonanthus trilobus galpinii	1		✓	LT	–	–	–	–	–	–	1	–	–	–	–	–	–
Senecio barbertonicus	1	½		HS			½				1		½				
Senecio pleistocephalus	1	½		CL	–	–	–				1				½		

Appendix 2. Some remarks relating to the larger animals in the Hlane Game Sanctuary *

T.E. Reilly

The Hlane (Swazi : wild and desolate place) lowveld region is bordered to the north by the perennial Mbuluzi River and to the east by the Lebombo Mountains and lies about 90 km north of Border Cave. The natural vegetation there is _Acacia_ - _Sclerocarya_ open savanna parkland, interspersed with patches of dense bush (_Dichrostachys_ and _Euclea_) as also close-growing stands of _Spirostachys_. Dominant grasses are _Themeda triandra_ and _Panicum maximum_, while others occurring in local abundance are _Eragrostis superba_, _Eurochloa_ sp., _Bothriochloa_ sp. and _Brachiaria_ spp.

The species list (Table 1) is based on personal observations over the past decade or more and may be regarded as reasonably accurate. _Lepus capensis_ and _Lepus crawshayi_ do not occur in the area now, while _Procavia capensis_ and _Dendrohyrax arborens_ are unrecorded from either the eastern or the western flanks of the central and southern sectors of the Lebombo Mountains (but see Klein, 1977).

When considering the present relative abundance ratings it should be borne in mind that :

a) The cited frequencies are artificial in the sense that continued and selective pressures by man on some of the species would by now have rendered them as extinct here as elsewhere in Swaziland, if protection had not come about in 1967.

b) There are very substantial short-term fluctuations in the frequencies of many species as a result of a complex interaction of variables within limits ultimately imposed by environmental controls, as is evidenced, for example, by a drastic decline in the local _Connochaetes taurinus_ population from 4500 to 2000 during 1976.

References

* Based on communication from Reilly dated 1977

KLEIN, R.G. 1977. The mammalian fauna from the Middle and Late Stone Age (Later Pleistocene) levels at Border Cave, Natal Province, South Africa. _S. Afr. archaeol. Bull._, **32** : 14-27.

Table I (continued)

Genus and species Common name	Present habitat Lowveld	 Lebombo	Occupation record Unbroken	 Extinct	 Visitor	 Re-intro	Relative abundance Very rare	 Fairly rare	 Fairly common	 Very common
Canis adustus	x	x	x				x			
Side-striped jackal										
Canis mesomelas	x	x	x						x	
Black-backed jackal										
Lycaon pictus	-	-	-	1952	-	-	-	-	-	-
Wild dog										
Mellivora capensis	x	x	x				x			
Ratel										
Vivera civetta	x	x	x				x			
African civet										
Genetta spp.	x	x	x							x
Genet spp.										
Herpestes sanguineus	x	x	x						x	
Slender mongoose										
Helogale parvula	x	x	x					x		
Dwarf mongoose										
Mungos mungo	x	x	x				x			
Banded mongoose										
Ichneumia albicauda	-	x	x				x			
White-tailed mongoose										
Crocuta crocuta	x	x	x				x			
Spotted hyaena										

Table I (continued)

Genus and species Common name	Present habitat Lowveld	 Lebombo	Occupation record Unbroken	 Extinct	 Visitor	 Re-intro.	Relative abundance Very rare	 Fairly rare	 Fairly common	 Very Common
Proteles cristatus	x	x	x				x			
Aardwolf										
Felis libyca	x	x	?							
African wild cat										
Felis serval	x	x	x				x			
Serval										
Felis caracal	x	x	x				x			
Caracal										
Panthera leo	-	-	-	$\pm$1890	1952	-	-	-	-	-
Lion										
Panthera pardus	x	x	x				x			
Leopard										
Acinonyx jubatus	-	-	-	$\pm$1955	-	-	-	-	-	-
Cheetah										
Dendrohyrax arboreus	-	?	?							
Tree dassie										
Loxodonta africana	-	-	-	$\pm$1890	1952	-	-	-	-	-
African elephant										
Equus burchelli	x	x	x						x	
Burchell's zebra										

Table I (continued)

Genus and species Common name	Present habitat Lowveld	 Lebombo	Occupation record Unbroken	 Extinct	 Visitor	 Re-intro.	Relative abundance Very rare	 Fairly rare	 Fairly common	 Very common
Diceros bicornis Black rhinoceros	-	-	-	±1890	-	-	-	-	-	-
Ceratotherium simum White rhinoceros	x	-	-	±1870	-	1965	x			
Hippopotamus amphibius Hippopotamus	x	-	x				x			
Phacochoerus aethiopicus Warthog	x	-	-	±1890	-	1973		x		
Potamochoerus porcus Bushpig	x	x	x					x		
Giraffa camelopardalis Giraffe	x	-	-	±1890	-	1975	x	-	-	-
Taurotragus oryx Cape eland	-	-	-	±1890	-	-	-	-	-	-
Tragelaphus strepsiceros Greater kudu	x	x	x					x		
Tragelaphus angasi Nyala	x	-	-	±1950	-	1969	x	-	-	-
Tragelaphus scriptus Bushbuck	x	x	x				x			
Hippotragus equinus Roan antelope	-	-	-	±1961	-	-	-	-	-	-

Table I (continued)

Genus and Species Common name	Present habitat Lowveld	 Lebombo	Occupation record Unbroken	 Extinct	 Visitor	 Re-intro.	Relative abundance Very rare	 Fairly rare	 Fairly common	 Very common
Hippotragus niger Sable antelope	-	-	-	±1890	-	-	-	-	-	-
Kobus ellipsiprymnus Waterbuck	x	-	x				x			
Redunca arundinum Southern reedbuck	x	x	x				x			
Redunca fulvorufula Mountain reedbuck	-	x	x				x			
Alcelaphus lichtensteini Lichtenstein's hartebeest	-	-	-	±1890	-	-	-	-	-	-
Damaliscus lunatus Tsessebe	-	-	-	±1935	-	-	-	-	-	-
Connochaetes taurinus Blue wildebeest	x	-	x						x	
Aepyceros melampus Impala	x	x	x							x
Cephalophus natalensis Red duiker	x	x	x					x		
Cephalophus monticola Blue duiker	-	?	?	?			x			
Sylvicapra grimmia Grimm's/Grey duiker	x	x	x							x

Table I (continued)

Genus and species Common name	Present habitat Lowveld	 Lebombo	Occupation record Unbroken	 Extinct	 Visitor	 Re-intro.	Relative abundance Very rare	 Fairly rare	 Fairly common	 Very common
Ourebia ourebi Oribi	-	-	-	1975?	-	-	-			
Oreotragus oreotragus Klipspringer	x	x	x				x			
Raphicerus campestris Steenbok	x	x	x				x			
Raphicerus sharpei Sharpe's grysbok	x	?	?	1967?	-	-	-	-	-	-
Syncerus caffer African buffalo	-	-	-	±1890	1954	-	-	-	-	-
Crocodylus niloticus Crocodile	x	-	x				x			
Varanus nilotica Water leguan	x	x	x						x	
Varanus exanthematicus Rock leguan	x	x	x						x	
Python sebae Python	x	x	x					x		

Table I (continued)

Genus and species Common name	Present habitat Lowveld	 Lebombo	 Unbroken	Occupation record Extinct	 Visitor	 Re-intro.	Relative abundance Very rare	 Fairly rare	 Fairly common	 Very common
Kinixys belliana Hingeback tortoise	x	x	x					x		
Geochelone pardalis Leopard tortoise	x	x	x						x	

Abbreviations

Extinct = locally extinct; Re-intro. = re-introduced

Appendix 3 A note on the present avian inhabitants of Border Cave

Roger Savile-Davis

Observations in December 1973 suggest that only four bird species actually occupy the cave. A brief description of their respective habits is given below.

Onychognathus morio morio (Red winged starling)
The primary plumes of this species are distinctive in being a darker orange than those of the pale winged starlings with which it could be confused. The flock of six flew off together from the cave at sunrise, but remained nearby all day, returning however only when people were not in the vicinity of their nesting sites. On some mornings a few feathers were found below and presumably derived from roosts which were located in inaccessible crevices and mainly constructed of twigs, fine grasses and intertwined feathers.

Columba guinea phaenota (Rock pigeon)
This race differs in a number of respects from Bradfieldi, particularly with respect to colour and distribution. Roosting sites were all in the cave bar one on the cliff-face above the cave-mouth. The three living in the cave left singly at sunrise and stayed away all day, only returning in the evenings to roost. The pair on the ledge above the cave however remained in one area there for long periods. It is possible that they were nesting but this species is reputed to breed during the colder seasons and neither bird was seen carrying nesting material.

Cecropis abisinica unitatus (Lesser striped swallow)
The markings on this species are quite unmistakeable. Two pairs were noted to have nests in well-hidden crevices on the cave roof. They continually flew to and from these and did not appear to be greatly perturbed by nearby human activities. Both male and female entered the nest at the same time and sometimes remained inside together for ten minutes or more before one left. It seems as if these swallows had some difficulty in locating their nests when lighting was poor.

Tyto alba affinis (Barn owl)
A single individual was sighted once, perched at the back of the cave, during a brief visit to the site in 1975. Owl feathers and faeces had previously been found in the deposit and it seems probable that these belong to affinis.

Thamnolaea cinnamomeventris cinnamomeventris (Mocking chat)
A single individual entered the cave area for a few metres and for no more than five minutes on one occasion. This was probably by chance rather than intention and there is thus no reason to include this species amongst the avian cave residents.

References

CLANCEY, P.A. 1964. The birds of Natal and Zululand. Edinburgh : Oliver and Boyd.

GILL, E.L. 1968. A first guide to South African birds. 8th Edition. Cape Town : Maskew Miller.

ROBERTS, A. 1970. Roberts' birds of South Africa. 3rd Edition (Rev. by McLachlan, G.R. and Liversidge, R.) Johannesburg : Trustees of the John Voelcker Bird Book Fund.

SKEAD, C.J. 1967. The sunbirds of Southern Africa. Cape Town : Balkema.

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Iron Age

	Q	R	S	T
24	0 53 53	0 53 53	0 53 53	0 53 53
23	0 46 46	0 46 46	0 46 46	0 46 46
22	5 46 41	3 46 43	0 46 46	0 46 46
21	25 38 13	20 46 26	5 46 41	3 46 43
20	- - -	30 38 8	23 38 15	10 38 28
19	- - -	38 46 8	33 38 5	23 38 15
18	- - -	- - -	- - -	30 38 8
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Sterile

	Q	R	S	T
24	53 76 23	53 76 23	53 84 31	53 84 31
23	46 64 18	46 69 23	46 76 30	46 76 30
22	46 66 20	46 71 25	46 76 30	46 71 25
21	38 61 23	46 61 15	46 69 23	46 65 19
20	38 58 20	38 64 26	38 61 23	38 61 23
19	46 53 7	46 53 7	38 53 15	38 46 8
18	- - -	- - -	- - -	38 46 8
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 1BS. LR

	Q	R	S	T
24	76 84 8	76 85 9	84 93 9	84 94 10
23	64 77 13	69 90 21	76 86 10	76 89 13
22	66 77 11	71 89 18	76 88 12	71 84 13
21	61 75 14	61 81 20	69 81 12	65 85 20
20	58 66 8	64 74 10	61 77 16	61 77 16
19	53 64 11	53 64 11	53 66 13	46 69 23
18	53 65 12	47 53 14	43 58 15	46 57 11
17	64 71 13	53 60 7	- - -	- - -
16	65 70 5	62 65 3	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 1WA.

	Q	R	S	T
24	84 86 2	85 91 6	93 98 5	94 99 5
23	77 85 8	90 99 9	86 91 5	89 98 9
22	77 89 12	89 102 13	88 98 10	84 98 14
21	75 84 9	81 93 12	81 97 16	85 104 19
20	66 80 14	74 86 12	77 91 14	77 95 18
19	64 81 17	64 81 17	66 84 18	69 91 22
18	65 79 14	53 76 23	58 76 18	57 74 17
17	71 79 8	60 77 17	- - -	- - -
16	70 78 8	65 74 9	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 2BS. UP

	Q	R	S	T
24	86 106 20	91 107 16	98 109 11	99 112 13
23	85 110 25	99 111 12	91 109 18	98 112 14
22	89 114 25	102 114 12	98 112 14	98 109 11
21	84 110 26	93 109 16	97 107 10	104 112 8
20	80 112 22	86 109 23	91 107 16	95 105 10
19	81 102 21	81 108 27	84 102 18	91 102 11
18	79 99 20	76 102 26	76 100 24	74 97 23
17	79 95 16	77 97 20	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated.
B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. A+B

	Q	R	S	T
24	106 135 29	107 135 28	109 131 22	112 135 23
23	110 138 28	111 136 25	109 132 23	112 136 24
22	114 136 22	114 132 18	112 130 18	109 130 21
21	110 131 21	109 130 21	107 127 20	112 127 15
20	112 128 16	109 127 18	107 123 16	105 122 17
19	- - -	- - -	102 117 15	102 118 16
18	- - -	- - -	100 114 14	97 114 17
17	- - -	97 110 13	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. C

	Q	R	S	T
24	135 140 5	135 140 5	131 136 5	135 140 5
23	138 144 6	136 141 5	132 140 8	136 142 6
22	136 145 9	132 138 6	130 135 5	130 135 5
21	131 140 9	130 137 7	127 133 6	127 132 5
20	128 137 9	127 137 10	123 130 7	122 128 6
19	- - -	- - -	117 127 10	118 127 9
18	- - -	- - -	114 122 8	114 121 7
17	- - -	110 118 8	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 2WA

	Q	R	S	T
24	- - -	140 152 12	136 147 11	- - -
23	- - -	141 156 15	140 152 12	- - -
22	- - -	138 156 18	135 149 14	- - -
21	- - -	137 163 26	133 151 18	- - -
20	- - -	137 160 23	130 147 17	128 140 12
19	- - -	124 150 26	127 147 20	127 142 15
18	- - -	121 145 24	122 145 23	121 137 16
17	- - -	118 142 24	- - -	- - -
16	- - -	117 142 25	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 3BS

	Q	R	S	T
24	- - -	152 185 33	147 180 33	- - -
23	- - -	156 185 29	152 183 31	- - -
22	- - -	156 180 24	149 173 24	- - -
21	- - -	163 180 17	151 173 22	- - -
20	- - -	160 173 13	147 168 21	140 163 23
19	- - -	150 163 13	147 168 21	142 160 18
18	- - -	145 160 15	145 157 12	137 147 10
17	- - -	142 147 5	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 3WA

	Q	R	S	T
24	- - -	185 187 2	180 184 4	- - -
23	- - -	185 188 3	183 187 4	- - -
22	- - -	180 188 8	173 184 11	- - -
21	- - -	180 185 5	173 185 12	- - -
20	- - -	173 178 5	168 183 15	163 188 25
19	- - -	163 168 5	168 179 11	160 178 18
18	- - -	160 168 8	157 169 12	147 163 16
17	- - -	147 161 14	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 1GBS. UP

	Q	R	S	T
24	- - -	187 221 34	184 229 45	- - -
23	- - -	188 218 30	187 222 35	- - -
22	- - -	188 218 30	184 216 32	- - -
21	- - -	185 211 26	185 206 21	- - -
20	- - -	178 202 24	183 204 21	- - -
19	- - -	168 201 33	179 197 18	178 196 18
18	- - -	168 198 30	169 196 27	163 185 22
17	- - -	161 186 25	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum 1GBS. LR

	Q	R	S	T
24	- - -	221 224B 3	229 230B 1	- - -
23	- - -	218 230B 12	222 231B 9	- - -
22	- - -	218 229B 11	216 227B 11	- - -
21	- - -	211 227 16	206 224 18	- - -
20	- - -	202 230 28	204 229 25	- - -
19	- - -	201 229 28	197 226 29	196 213 17
18	- - -	198 226 28	196 221 25	185 213 28
17	- - -	186 216 30	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 4 Spatial distribution: Level thickness

Border Cave. Excavation 3A Rear. Stratum BACO. A

	Q	R	S	T
24	- - -	- - -	- - -	- - -
23	- - -	- - -	- - -	- - -
22	- - -	- - -	- - -	- - -
21	- - -	227 229B 2	224 226B 2	- - -
20	- - -	230 240B 10	229 231B 2	- - -
19	- - -	229 244B 15	226 230B 4	213 218B 5
18	- - -	226 254B 28	221 241B 20	213 224B 11
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Mean depth. Upper surface

Centre: Mean depth. Lower surface

Base: Estimated stratum thickness

First two readings are in cm. below datum

-: No data/Unexcavated

B: Bedrock over entire square

Appendix 5 Stratum volumes

Border Cave. Excavation 3A Rear

Stratum	Data squares Number	Estimated volume Cu. m.
1BS.UP.I.A.	23	6,55
1BS.UP.S.	25	4,40
1BS.LR.	32	3,36
1WA	32	3,35
2BS.UP.	30	4,42
2BS.LR.A + B	25	4,19
2BS.LR.C	25	1,43
2WA	19	2,94
3BS.	18	3,05
3WA	18	1,49
1GBS.UP.	17	3,94
1GBS.LR.	17	2,67
BACO.A	10	0,83

Appendix 6 Typological analysis: non-flaking processes

Border Cave. Exc. 3A Rear and 3B

Technological Process	Material Group	Typological Class	Typological Subclass	Stratum: 1BS.UP Iron Age	1BS.UP Sterile	1BS.LR	1WA	2BS.UP 2BS.LR A+B	2BS.LR.C 2WA	1RGBS. A	Totals
Cutting	Bone	Notched item		-	-	1	-	-	1	-	2
	Wood	Notched item		-	-	4	-	-	-	-	4
	Subtotals			-	-	5	-	-	1	-	6
Cutting and Perforating	Stone	Bored stone		-	-	1	1	-	-	-	2
	Seashell	Pendant		1	1	2	1	-	-	-	5
	Subtotals			1	1	3	2	-	-	-	7
Grinding	Bone	Tusk item		-	-	1	3	-	6	1	11
		Point		-	-	2	1	-	-	-	3
		Awl		-	-	-	1	-	-	-	1
		Spatula		1	-	-	-	-	-	-	1
	Subtotals			1	-	3	5	-	6	1	16
Grinding and Perforating	Eggshell	Bead	Unfinished	-	-	1	1	-	-	-	2
			Complete	-	-	6	8	-	-	-	14
	Subtotals			-	-	7	9	-	-	-	16
Weaving and Braiding	Fibre	String		12	-	-	-	-	-	-	12
		Rope		3	-	-	-	-	-	-	3
		Basketry		4	-	-	-	-	-	-	4
	Subtotals			19	-	-	-	-	-	-	19
Fusion and Smelting and Moulding	Clay	Sherds	Matt rim	13	-	2	-	-	-	-	15
			Matt body	110	12	7	9	-	-	-	138
			Burn. rim	10	1	-	-	-	-	-	11
			Burn. body	17	3	2	1	-	-	-	23
	Glass	Beads		216	2	3	-	-	-	-	221
	Copper	Beads		1	-	1	-	-	-	-	2
	Aluminium	Modern		-	-	1	-	-	-	-	1
	Subtotals			367	18	16	10	-	-	-	411

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Rear Stratum IBS.UP. Iron Age

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	-	-	-	-	-	-	-
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	-	-	-	-	-	-	-
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	-	-	-
	Tool 2	Burin		-	-	-	-	1	-	1
		Scaled piece	Single-edged	-	-	-	1	1	-	2
			Double-edged	-	-	-	-	-	-	-
	Sub-totals			-	-	-	1	2	-	3

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	1	-	-	-	-	-	1
			I1(b)	1	-	-	2	5	-	8
			I2	3	1	-	-	9	-	13
		Blade	B1(a)	-	-	-	-	-	-	-
			B1(b)	-	-	-	-	-	-	-
			B2(a)	-	-	-	-	-	-	-
			B2 (b)	-	-	-	-	-	-	-
		Point	P1(a)	-	-	-	-	-	-	-
			P1(b)	-	-	-	-	-	-	-
			P2(a)	-	-	-	-	-	-	-
			P2(b)	-	-	-	-	-	-	-
		Blade-Point	BP2 (a) and (b)	-	-	-	-	-	-	-
	Sub-totals			5	1	-	2	14	-	22
	Core	Irregular		-	-	-	1	1	-	2
		Bipolar		-	-	-	5	16	-	21
		Adjacent platform		-	-	-	-	-	-	-
		Radial prepared	Discoidal	-	-	-	-	-	-	-
			Triangular	-	-	-	-	-	-	-
			Blade	-	-	-	-	-	-	-
		Plain platform		-	-	-	-	-	-	-
	Sub-totals			-	-	-	6	17	-	23

Technological Process	Analytical Group	Typological Class	Typological Subclass	Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
				Material						
Flaking	Waste 1	Broken tool	Scraper	-	-	-	-	-	-	-
			Trimmed point 1	-	-	-	-	-	-	-
			Trimmed point 2	-	-	-	-	-	-	-
			Backed piece 1	-	-	-	-	-	-	-
			Backed piece 2	-	-	-	-	-	-	-
			Modified butt	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	-	-	-
	Waste 2	Atypical flake	Rejuvenation	-	-	-	-	-	-	-
			Malformed	1	-	-	-	3	-	4
		Broken flake	Proximal	8	1	2	1	26	2	40
			Distal	2	1	1	-	7	-	11
		Unclassifiable		3	-	2	73	183	1	262
	Sub-totals			14	2	5	74	219	3	317
Incidental	Utilized	Hammerstone		-	-	-	-	-	-	-
		Grindstone		-	-	-	-	-	1	1
		Pigment	Haematite Ground							-
			Haematite Plain							8
			Miscellaneous Plain							1
		Thorn								-
	Sub-totals			-	-	-	-	-	1	10
	Admixture	Intrusive		-	-	-	-	1	1	2
		Re-used		-	-	-	-	1	-	1
	Sub-totals			-	-	-	-	2	1	3

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Stratum IBS.UP Sterile
Rear

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	-	-	-	-	-	-	-
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	-	-	-	-	-	-	-
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	-	-	-
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	3	1	1	5
			Double-edged	-	-	-	-	-	-	-
	Sub-totals			-	-	-	3	1	1	5

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	–	–	–	–	–	–	–
			I1(b)	1	–	–	–	–	1	2
			I2	1	–	–	1	4	–	6
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	–	–	–	–	–	–	–
			B2(a)	–	–	–	–	–	–	–
			B2 (b)	–	–	–	–	–	–	–
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	–	–	–	–	–
			P2(a)	–	–	–	–	–	–	–
			P2(b)	–	–	–	–	–	–	–
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			2	–	–	1	4	1	8
	Core	Irregular		–	–	–	1	1	–	2
		Bipolar		–	–	–	3	4	–	7
		Adjacent platform		–	–	–	–	–	–	–
		Radial prepared	Discoidal	–	–	–	–	–	–	–
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			–	–	–	4	5	–	9

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	–	–	–
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–
	Waste 2	Atypical flake	Rejuvenation	–	–	–	–	–	–	–
			Malformed	–	1	–	–	–	–	1
		Broken flake	Proximal	8	3	–	–	7	4	22
			Distal	1	–	2	–	2	1	6
		Unclassifiable		4	1	1	31	50	4	91
	Sub-totals			13	5	3	31	59	9	120
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							–
			Haematite Plain							2
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	–	2
	Admixture	Intrusive		–	–	–	–	–	–	–
		Re-used		–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Stratum 1BS. LR. Rear

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	1	-	-	-	-	-	1
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	1	-	-	-	-	-	1
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	-	-	-	-	-	-	-
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			2	-	-	-	-	-	2
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	5	23	-	28
			Double-edged	-	-	-	5	3	-	8
	Sub-totals			-	-	-	10	26	-	36

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	2	–	–	–	–	2	4
			I1(b)	41	19	10	4	24	5	103
			I2	32	14	11	4	28	8	97
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	–	–	–	–	–	–	–
			B2(a)	–	–	–	–	–	–	–
			B2 (b)	–	–	–	–	–	–	–
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	–	–	–	–	–
			P2(a)	–	–	–	–	–	–	–
			P2(b)	–	–	–	–	–	–	–
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			75	33	21	8	52	15	204
	Core	Irregular		3	–	–	2	20	–	25
		Bipolar		–	–	1	48	102	1	152
		Adjacent platform		–	–	–	–	–	–	–
		Radial prepared	Discoidal	1	–	–	–	1	–	2
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		1	–	–	–	–	–	1
	Sub-totals			5	–	1	50	123	1	180

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	-	-	-	-	-	-	-
			Trimmed point 1	-	-	-	-	-	-	-
			Trimmed point 2	-	-	-	-	-	-	-
			Backed piece 1	-	-	-	-	-	-	-
			Backed piece 2	-	-	-	-	-	-	-
			Modified butt	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	-	-	-
	Waste 2	Atypical flake	Rejuvenation	3	1	1	-	-	-	5
			Malformed	9	4	1	1	9	1	25
		Broken flake	Proximal	148	68	17	18	95	12	358
			Distal	36	20	7	13	55	3	134
		Unclassifiable		102	22	11	613	1248	28	2024
	Sub-totals			298	115	37	645	1407	44	2546
Incidental	Utilized	Hammerstone		-	-	-	-	-	-	-
		Grindstone		-	-	-	-	-	-	-
		Pigment	Haematite Ground							10
			Haematite Plain							57
			Miscellaneous Plain							5
		Thorn								3
	Sub-totals			-	-	-	-	-	-	75
	Admixture	Intrusive		4	1	-	2	9	-	16
		Re-used		-	-	-	-	-	-	-
	Sub-totals			4	1	-	2	9	-	16

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Stratum 1WA. Rear

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	–	–	–	–	1	–	1
			Convex-edged	–	–	–	–	1	–	1
			Concave-edged	–	–	–	–	–	–	–
			Irregular-edged	–	–	–	–	1	–	1
			Compound	–	–	–	–	–	–	–
		Trimmed point 1	Defined	–	–	–	–	–	–	–
			Convergent	–	–	–	–	–	–	–
			Oblique	–	–	–	–	–	–	–
		Trimmed point 2	Unifacial	–	–	–	–	–	–	–
			Bifacial	–	–	–	–	–	–	–
		Backed piece 1	Curve-backed	–	–	–	–	–	–	–
			Irregular-backed	–	–	–	–	–	–	–
		Backed piece 2	Segment	–	–	–	–	–	–	–
			Trapeze	–	–	–	–	–	–	–
		Modified butt	Point	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
		Denticulate		–	–	–	–	–	–	–
		Other		–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	3	–	3
	Tool 2	Burin		–	–	–	–	–	–	–
		Scaled piece	Single-edged	1	–	–	34	133	–	168
			Double-edged	–	–	–	11	32	–	43
	Sub-totals			1	–	–	45	165	–	211

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	1	–	1	2	3	1	8
			I1(b)	81	39	21	3	60	14	218
			I2	93	24	30	11	88	8	254
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	–	1	–	1	3	–	5
			B2(a)	–	–	–	–	2	–	2
			B2 (b)	–	–	1	–	1	–	2
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	–	–	–	–	–
			P2(a)	–	–	–	–	–	–	–
			P2(b)	–	–	–	–	–	–	–
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			175	64	53	17	157	23	489
	Core	Irregular		4	–	–	8	63	–	75
		Bipolar		–	–	2	140	358	1	501
		Adjacent platform		–	–	–	–	–	–	–
		Radial prepared	Discoidal	–	–	–	–	–	–	–
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		–	–	–	–	1	–	1
	Sub-totals			4	–	2	148	422	1	577

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	–	–	–
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–
	Waste 2	Atypical flake	Rejuvenation	–	–	1	–	–	–	1
			Malformed	30	8	7	–	11	4	60
		Broken flake	Proximal	357	92	68	25	243	34	819
			Distal	96	16	21	26	153	7	319
		Unclassifiable		222	29	44	1901	5652	19	7867
	Sub-totals			705	145	141	1952	6059	64	9066
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							11
			Haematite Plain							48
			Miscellaneous Plain							1
		Thorn								3
	Sub-totals			–	–	–	–	–	–	63
	Admixture	Intrusive		6	1	1	1	8	1	18
		Re-used		–	–	–	–	–	–	–
	Sub-totals			6	1	1	1	8	1	18

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Front Stratum 1BES.

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Tool 1	Scraper	Straight-edged	-	-	-	-	-	-	-
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	-	-	-	-	-	-	-
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	-	-	-
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	3	22	-	25
			Double-edged	-	-	-	2	1	-	3
	Sub-totals			-	-	-	5	23	-	28

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	–	–	–	–	–	–	–
			I1(b)	21	1	3	3	16	4	48
			I2	17	3	8	–	31	–	59
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	–	–	–	–	–	–	–
			B2(a)	–	–	–	–	–	–	–
			B2 (b)	–	–	2	–	–	–	2
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	–	–	–	–	–
			P2(a)	–	–	–	–	–	–	–
			P2(b)	–	–	–	–	–	–	–
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			38	4	13	3	47	4	109
	Core	Irregular		2	–	–	3	21	–	26
		Bipolar		–	–	–	29	23	–	52
		Adjacent platform		–	–	–	–	–	–	–
		Radial prepared	Discoidal	1	–	–	–	–	–	1
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			3	–	–	32	44	–	79

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	–	–	–
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–
	Waste 2	Atypical flake	Rejuvenation	–	–	–	–	1	–	1
			Malformed	5	3	1	–	–	–	9
		Broken flake	Proximal	77	10	12	6	50	8	163
			Distal	8	1	5	7	37	2	60
		Unclassifiable		66	2	7	438	937	7	1457
	Sub-totals			156	16	25	451	1025	17	1690
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							1
			Haematite Plain							3
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	–	4
	Admixture	Intrusive		2	–	1	–	3	–	6
		Re-used		–	–	–	–	–	–	–
	Sub-totals			2	–	1	–	3	–	6

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Stratum 2BS.UP.
Rear

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Tool 1	Scraper	Straight-edged	-	-	-	-	-	-	-
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	-	-	-	-	-	-	-
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	1	-	1
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	1	-	1
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	6	12	-	18
			Double-edged	-	-	-	-	4	-	4
	Sub-totals			-	-	-	6	16	-	22

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Flake	Irregular	I1(a)	-	-	-	-	-	-	-
			I1(b)	16	5	-	-	2	1	24
			I2	31	3	6	-	3	2	45
		Blade	B1(a)	-	-	-	-	-	-	-
			B1(b)	1	-	-	-	1	-	2
			B2(a)	3	-	-	-	1	-	4
			B2 (b)	11	-	4	-	-	-	15
		Point	P1(a)	-	-	-	-	-	-	-
			P1(b)	-	-	-	-	-	-	-
			P2(a)	-	-	-	-	-	-	-
			P2(b)	-	-	-	-	-	-	-
		Blade-Point	BP2 (a) and (b)	-	-	-	-	-	-	-
	Sub-totals			62	8	10	-	7	3	90
	Core	Irregular		2	-	-	1	12	-	15
		Bipolar		-	-	-	1	4	-	5
		Adjacent platform		-	-	-	-	1	-	1
		Radial prepared	Discoidal	2	-	1	-	-	-	3
			Triangular	-	-	-	-	-	-	-
			Blade	-	-	-	-	-	-	-
		Plain platform		-	-	-	-	-	-	-
	Sub-totals			4	-	1	2	17	-	24

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	–	–	–
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–
	Waste 2	Atypical flake	Rejuvenation	3	–	1	–	–	–	4
			Malformed	2	1	–	–	–	–	3
		Broken flake	Proximal	71	6	9	7	30	5	128
			Distal	22	–	4	5	19	1	51
		Unclassi-fiable		28	2	3	32	140	–	205
	Sub-totals			126	9	17	44	189	6	391
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							–
			Haematite Plain							10
			Miscellaneous Plain							–
		Thorn								2
	Sub-totals			–	–	–	–	–	–	12
	Admixture	Intrusive		–	–	–	–	–	–	–
		Re-used		1	–	–	–	–	–	1
	Sub-totals			1	–	–	–	–	–	1

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Stratum 2BS. LR. A+B Rear

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Tool 1	Scraper	Straight-edged	–	–	–	–	–	–	–
			Convex-edged	–	–	–	–	–	–	–
			Concave-edged	–	–	–	–	–	–	–
			Irregular-edged	1	–	–	–	1	–	2
			Compound	–	–	–	–	–	–	–
		Trimmed point 1	Defined	–	–	1	–	–	1	2
			Convergent	–	–	–	–	–	–	–
			Oblique	–	–	–	–	–	3	3
		Trimmed point 2	Unifacial	–	–	–	–	–	–	–
			Bifacial	–	–	–	–	–	–	–
		Backed piece 1	Curve-backed	–	–	–	–	–	–	–
			Irregular-backed	1	–	–	–	–	–	1
		Backed piece 2	Segment	–	–	–	–	–	–	–
			Trapeze	–	–	–	–	1	–	1
		Modified butt	Point	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
		Denticulate		1	–	–	–	–	–	1
		Other		–	–	–	–	–	–	–
	Sub-totals			3	–	1	–	2	4	10
	Tool 2	Burin		–	–	–	–	–	–	–
		Scaled piece	Single-edged	–	–	–	8	10	–	18
			Double-edged	–	–	–	1	2	–	3
	Sub-totals			–	–	–	9	12	–	21

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Flake	Irregular	I1(a)	2	-	-	-	-	-	2
			I1(b)	59	5	15	-	15	2	96
			I2	129	10	46	5	14	11	215
		Blade	B1(a)	-	-	-	-	-	-	-
			B1(b)	7	-	2	-	2	-	11
			B2(a)	6	-	6	-	-	-	12
			B2 (b)	22	-	8	-	2	3	35
		Point	P1(a)	-	-	-	-	-	-	-
			P1(b)	1	-	-	-	-	-	1
			P2(a)	-	-	-	-	-	-	-
			P2(b)	1	-	2	-	-	-	3
		Blade-Point	BP2 (a) and (b)	-	-	-	-	-	1	1
	Sub-totals			227	15	79	5	33	17	376
	Core	Irregular		7	-	1	1	4	-	13
		Bipolar		-	-	-	1	6	-	7
		Adjacent platform		1	-	-	-	-	-	1
		Radial prepared	Discoidal	3	-	1	-	3	-	7
			Triangular	-	-	-	-	-	-	-
			Blade	-	-	-	-	-	-	-
		Plain platform		1	-	1	-	1	1	4
	Sub-totals			12	-	3	2	14	1	32

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	–	–	–	1	–	–	1
			Trimmed point 1	2	–	–	–	–	1	3
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	2	–	–	2
	Sub-totals			2	–	–	3	–	1	6
	Waste 2	Atypical flake	Rejuvenation	2	–	3	–	–	–	5
			Malformed	3	–	1	–	1	–	5
		Broken flake	Proximal	296	19	92	16	70	25	518
			Distal	145	7	48	8	43	9	260
		Unclassifiable		86	5	18	42	223	5	379
	Sub-totals			532	31	162	66	337	39	1167
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							2
			Haematite Plain							12
			Miscellaneous Plain							1
		Thorn								3
	Sub-totals			–	–	–	–	–	–	18
	Admixture	Intrusive		–	–	1	–	–	–	1
		Re-used		–	–	–	–	1	–	1
	Sub-totals			–	–	1	–	1	–	2

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Stratum 2BS.LR.C

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	8	-	3	-	-	1	12
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	1	-	-	-	-	-	1
			Irregular-edged	1	-	-	-	-	-	1
			Compound	1	-	-	-	-	1	2
		Trimmed point 1	Defined	5	-	3	-	-	-	8
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	1	-	-	-	-	-	1
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	4	-	1	-	-	1	6
			Miscellaneous	7	-	1	-	-	1	9
		Denticulate		-	-	-	-	-	1	1
		Other		-	-	-	-	-	1	1
	Sub-totals			28	-	8	-	-	6	42
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	-	-	-	-
			Double-edged	-	-	-	-	1	-	1
	Sub-totals			-	-	-	-	1	-	1

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Flake	Irregular	I1(a)	-	1	-	-	-	-	1
			I1(b)	129	12	50	-	15	20	226
			I2	316	10	155	-	15	91	587
		Blade	B1(a)	1	-	-	-	-	-	1
			B1(b)	17	1	4	-	-	1	23
			B2(a)	24	1	10	-	2	7	44
			B2 (b)	54	-	13	-	-	17	84
		Point	P1(a)	-	-	-	-	-	-	-
			P1(b)	1	-	-	-	-	-	1
			P2(a)	3	-	2	-	-	-	5
			P2(b)	8	-	2	-	-	3	13
		Blade-Point	BP2 (a) and (b)	2	-	1	-	-	-	3
	Sub-totals			555	25	237	-	32	139	988
	Core	Irregular		15	-	2	-	5	-	22
		Bipolar		-	-	-	-	-	-	-
		Adjacent platform		1	-	-	-	-	-	1
		Radial prepared	Discoidal	7	-	-	-	2	-	9
			Triangular	1	-	-	-	-	-	1
			Blade	2	-	-	-	-	-	2
		Plain platform		1	-	1	-	1	-	3
	Sub-totals			27	-	3	-	8	-	38

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	2	–	1	–	–	2	5
			Trimmed point 1	3	–	–	–	–	–	3
			Trimmed point 2	1	–	–	–	–	–	1
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	2	–	1	–	–	–	3
			Miscellaneous	1	–	1	–	–	–	2
	Sub-totals			9	–	3	–	–	2	14
	Waste 2	Atypical flake	Rejuvenation	18	1	5	–	1	1	26
			Malformed	11	–	6	–	–	1	18
		Broken flake	Proximal	875	37	266	6	29	184	1397
			Distal	431	14	113	2	7	80	647
		Unclassifiable		180	2	52	12	57	24	327
	Sub-totals			1515	54	442	20	94	290	2415
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							16
			Haematite Plain							49
			Miscellaneous Plain							7
		Thorn								3
	Sub-totals			–	–	–	–	–	–	75
	Admixture	Intrusive		1	–	1	–	1	1	4
		Re-used		–	–	–	–	–	–	–
	Sub-totals			1	–	1	–	1	1	4

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. Stratum 2 WA

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	1	-	1	-	1	2	5
			Convex-edged	-	-	1	-	-	-	1
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	1	-	-	-	-	1
		Trimmed point 1	Defined	2	-	1	-	-	1	4
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	1	-	-	-	-	-	1
		Modified butt	Point	3	-	-	-	-	-	3
			Miscellaneous	1	-	-	-	-	-	1
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			8	1	3	-	1	3	16
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	2	2	-	4
			Double-edged	-	-	-	2	1	-	3
	Sub-totals			-	-	-	4	3	-	7

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Flake	Irregular	I1(a)	–	1	–	–	–	–	1
			I1(b)	86	21	21	2	35	9	174
			I2	195	20	76	3	38	18	350
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	9	–	1	–	–	–	10
			B2(a)	6	–	1	–	2	1	10
			B2 (b)	21	–	2	–	1	2	26
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	2	–	–	–	–	–	2
			P2(a)	4	–	–	–	1	–	5
			P2(b)	3	–	–	–	–	–	3
		Blade-Point	BP2 (a) and (b)	–	–	1	–	–	1	2
	Sub-totals			326	42	102	5	77	31	583
	Core	Irregular		6	1	3	3	9	1	23
		Bipolar		–	–	–	1	–	–	1
		Adjacent platform		–	–	–	–	–	–	–
		Radial prepared	Discoidal	5	1	1	–	–	–	7
			Triangular	–	–	–	–	–	–	–
			Blade	2	–	1	–	–	–	3
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			13	2	5	4	9	1	34

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	1	–	–	–	2	–	3
			Trimmed point 1	1	–	–	–	1	–	2
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	–	–	1	–	1
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	1	–	–	–	–	–	1
			Miscellaneous	–	–	–	–	–	1	1
	Sub-totals			3	–	–	–	4	1	8
	Waste 2	Atypical flake	Rejuvenation	1	–	3	–	–	–	4
			Malformed	18	3	5	–	2	–	28
		Broken flake	Proximal	751	65	164	5	135	41	1161
			Distal	413	23	91	6	82	21	636
		Unclassifiable		230	25	31	37	359	6	688
	Sub-totals			1413	116	294	48	578	68	2517
Incidental	Utilized	Hammerstone		–	–	–	–	–	1	1
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							23
			Haematite Plain							54
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	1	78
	Admixture	Intrusive		–	–	–	–	–	–	–
		Re-used		–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3B Stratum 1RBS

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	–	–	–	–	–	–	–
			Convex-edged	–	–	–	–	–	–	–
			Concave-edged	–	–	–	–	–	–	–
			Irregular-edged	–	–	–	–	–	–	–
			Compound	–	–	–	–	–	–	–
		Trimmed point 1	Defined	–	–	–	–	–	–	–
			Convergent	–	–	–	–	–	–	–
			Oblique	–	–	–	–	1	–	1
		Trimmed point 2	Unifacial	–	–	–	–	–	–	–
			Bifacial	–	–	–	–	–	–	–
		Backed piece 1	Curve-backed	–	–	–	–	1	–	1
			Irregular-backed	–	–	–	–	–	–	–
		Backed piece 2	Segment	1	–	–	–	–	–	1
			Trapeze	–	–	–	–	1	–	1
		Modified butt	Point	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
		Denticulate		–	–	–	–	–	–	–
		Other		–	–	–	–	–	–	–
	Sub-totals			1	–	–	–	3	–	4
	Tool 2	Burin		–	–	–	–	–	–	–
		Scaled piece	Single-edged	–	–	–	–	2	–	2
			Double-edged	–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	2	–	2

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Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	1	-	-	-	-	-	1
			I1(b)	15	-	7	1	17	1	41
			I2	19	1	10	1	24	1	56
		Blade	B1(a)	-	-	-	-	-	-	-
			B1(b)	-	-	-	-	-	-	-
			B2(a)	1	-	1	-	3	-	5
			B2 (b)	3	-	1	-	-	-	4
		Point	P1(a)	-	-	-	-	-	-	-
			P1(b)	-	-	-	-	-	-	-
			P2(a)	-	-	1	-	-	-	1
			P2(b)	-	-	-	-	-	-	-
		Blade-Point	BP2 (a) and (b)	-	-	-	-	-	-	--
	Sub-totals			39	1	20	2	44	2	108
	Core	Irregular		3	-	1	1	10	1	16
		Bipolar		-	-	-	2	-	-	2
		Adjacent platform		1	-	-	-	-	-	1
		Radial prepared	Discoidal	1	-	-	-	3	-	4
			Triangular	-	-	-	-	-	-	-
			Blade	1	-	-	-	2	-	3
		Plain platform		2	-	1	-	2	-	5
	Sub-totals			8	-	2	3	17	1	31

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	-	-	-	-	1	-	1
			Trimmed point 1	-	-	-	-	-	-	-
			Trimmed point 2	-	-	-	-	-	-	-
			Backed piece 1	-	-	-	-	-	-	-
			Backed piece 2	-	-	-	-	-	-	-
			Modified butt	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	1	-	1
	Waste 2	Atypical flake	Rejuvenation	-	-	-	-	2	-	2
			Malformed	3	1	-	-	4	-	8
		Broken flake	Proximal	184	12	30	2	64	2	294
			Distal	121	5	18	1	41	1	187
		Unclassifiable		87	1	11	13	170	1	283
	Sub-totals			395	19	59	16	281	4	774
Incidental	Utilized	Hammerstone		-	-	-	-	-	-	-
		Grindstone		-	-	-	-	-	-	-
		Pigment	Haematite Ground							-
			Haematite Plain							-
			Miscellaneous Plain							-
		Thorn								-
	Sub-totals			-	-	-	-	-	-	-
	Admixture	Intrusive		-	-	-	-	-	-	-
		Re-used		-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	-	-	-

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Rear Stratum 3BS

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	-	-	-	-	-	-	-
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	1	-	-	-	1	-	2
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	2	-	-	-	1	-	3
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	2	-	-	-	2	-	4
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	3	-	-	-	2	-	5
			Trapeze	2	-	-	-	1	-	3
		Modified butt	Point	-	-	1	-	-	-	1
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			10	-	1	-	7	-	18
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	-	-	-	-
			Double-edged	-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	-	-	-

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	–	–	–	–	–	–	–
			I1(b)	32	5	3	–	32	3	75
			I2	44	3	19	–	52	2	120
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	3	–	3	–	10	1	17
			B2(a)	3	–	3	–	5	1	12
			B2 (b)	7	–	4	–	6	–	17
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	–	–	–	–	–
			P2(a)	–	–	–	–	–	–	–
			P2(b)	–	–	–	–	–	–	–
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			89	8	32	–	105	7	241
	Core	Irregular		3	–	2	–	35	1	41
		Bipolar		–	–	–	–	1	–	1
		Adjacent platform		1	–	–	–	–	–	1
		Radial prepared	Discoidal	1	–	–	–	2	1	4
			Triangular	–	–	–	–	–	–	–
			Blade	1	–	1	–	–	–	2
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			6	–	3	–	38	2	49

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	1	–	1
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	2	–	–	–	4	–	6
			Backed piece 2	–	–	1	–	1	–	2
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			2	–	1	–	6	–	9
	Waste 2	Atypical flake	Rejuvenation	1	–	–	–	2	–	3
			Malformed	5	–	1	–	4	–	10
		Broken flake	Proximal	276	10	65	2	176	4	533
			Distal	210	1	49	–	152	5	417
		Unclassi-fiable		155	–	18	16	412	–	601
	Sub-totals			647	11	133	18	746	9	1564
Incidental	Utilized	Hammerstone		–	–	–	–	–	1	1
		Grindstone		–	–	–	–	–	1	1
		Pigment	Haematite Ground							4
			Haematite Plain							25
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	2	31
	Admixture	Intrusive		–	–	–	–	1	–	1
		Re-used		–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	1	–	1

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Rear Stratum 3WA

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	-	-	-	-	-	-	-
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	-	-	-	-	-	-	-
			Convergent	1	-	-	-	-	-	1
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	1	-	-	-	2	-	3
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			2	-	-	-	2	-	4
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	1	-	-	1
			Double-edged	-	-	-	-	-	-	-
	Sub-totals			-	-	-	1	-	-	1

				Material						Totals
Technological Process	Analytical Group	Typological Class	Typological Subclass	Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	–	–	–	–	–	–	–
			I1(b)	4	2	1	–	1	–	8
			I2	5	1	4	–	13	–	23
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	–	–	2	–	1	–	3
			B2(a)	–	–	2	–	2	–	4
			B2 (b)	–	–	3	2	1	–	6
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	–	–	–	–	–
			P2(a)	–	–	–	–	–	–	–
			P2(b)	–	–	–	–	–	–	–
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			9	3	12	2	18	–	44
	Core	Irregular		1	–	–	1	7	–	9
		Bipolar		–	–	–	2	–	–	2
		Adjacent platform		1	–	1	–	1	–	3
		Radial prepared	Discoidal	–	–	–	–	–	–	–
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			2	–	1	3	8	–	14

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	–	–	–
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	1	–	1
			Backed piece 1	1	–	–	–	–	–	1
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			1	–	–	–	1	–	2
	Waste 2	Atypical flake	Rejuvenation	–	–	–	–	–	–	–
			Malformed	3	–	–	–	4	1	8
		Broken flake	Proximal	71	9	12	2	39	2	135
			Distal	57	3	18	1	26	1	106
		Unclassi-fiable		67	5	12	14	192	–	290
	Sub-totals			198	17	42	17	261	4	539
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							1
			Haematite Plain							1
			Miscellaneous Plain							2
		Thorn								–
	Sub-totals			–	–	–	–	–	–	4
	Admixture	Intrusive		–	–	–	–	–	–	–
		Re-used		–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3B Stratum 1RGBS. A

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	–	–	–	–	1	–	1
			Convex-edged	–	–	–	–	–	–	–
			Concave-edged	–	–	–	–	–	–	–
			Irregular-edged	–	–	1	–	–	–	1
			Compound	–	–	–	–	–	–	–
		Trimmed point 1	Defined	2	–	–	–	–	–	2
			Convergent	–	–	–	–	–	–	–
			Oblique	–	–	–	–	–	–	–
		Trimmed point 2	Unifacial	–	–	–	–	–	–	–
			Bifacial	–	–	–	–	–	–	–
		Backed piece 1	Curve-backed	4	1	–	1	2	2	10
			Irregular-backed	–	–	1	–	1	–	2
		Backed piece 2	Segment	1	–	3	–	2	2	8
			Trapeze	–	–	1	–	–	1	2
		Modified butt	Point	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
		Denticulate		–	–	–	–	–	–	–
		Other		–	–	–	–	–	–	–
	Sub-totals			7	1	6	1	6	5	26
	Tool 2	Burin		–	–	–	–	–	–	–
		Scaled piece	Single-edged	–	–	–	1	1	–	2
			Double-edged	–	–	–	–	1	–	1
	Sub-totals			–	–	–	1	2	–	3

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	–	–	–	–	–	–	–
			I1(b)	75	4	19	6	37	2	143
			I2	204	3	54	2	73	5	341
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	12	–	6	3	8	1	30
			B2(a)	24	–	6	1	7	–	38
			B2 (b)	31	1	12	–	8	2	54
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	–	–	–	–	–
			P2(a)	–	–	–	–	–	–	–
			P2(b)	1	–	–	–	–	–	1
		Blade-Point	BP2 (a) and (b)	–	–	1	–	–	–	1
	Sub-totals			347	8	98	12	133	10	608
	Core	Irregular		8	–	1	3	12	–	24
		Bipolar		1	–	–	9	–	–	10
		Adjacent platform		–	–	–	–	–	–	–
		Radial prepared	Discoidal	8	–	2	–	5	–	15
			Triangular	–	–	–	–	–	–	–
			Blade	8	–	2	–	3	–	13
		Plain platform		1	–	–	–	4	–	5
	Sub-totals			26	–	5	12	24	–	67

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	1	–	1
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	1	–	–	–	–	–	1
			Backed piece 2	1	–	–	–	–	1	2
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			2	–	–	–	1	1	4
	Waste 2	Atypical flake	Rejuvenation	2	–	1	–	–	1	4
			Malformed	4	1	–	1	4	–	10
		Broken flake	Proximal	1423	19	217	15	228	34	1936
			Distal	1109	2	167	18	225	31	1552
		Unclassifiable		616	7	36	82	529	5	1275
	Sub-totals			3154	29	421	116	986	71	4777
Incidental	Utilized	Hammerstone		–	–	–	–	–	1	1
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							2
			Haematite Plain							3
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	1	6
	Admixture	Intrusive		–	–	–	–	–	–	–
		Re-used		–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3B Stratum 1RGBS. B

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Tool 1	Scraper	Straight-edged	–	–	–	–	1	–	1
			Convex-edged	–	–	–	–	2	–	2
			Concave-edged	–	–	–	–	–	–	–
			Irregular-edged	–	–	–	–	–	–	–
			Compound	–	–	–	–	–	–	–
		Trimmed point 1	Defined	2	–	–	–	–	1	3
			Convergent	–	–	–	–	–	–	–
			Oblique	1	–	–	–	–	–	1
		Trimmed point 2	Unifacial	–	–	–	–	–	–	–
			Bifacial	–	–	–	–	–	–	–
		Backed piece 1	Curve-backed	–	–	–	–	1	–	1
			Irregular-backed	–	–	–	–	–	–	–
		Backed piece 2	Segment	3	–	2	–	1	2	8
			Trapeze	–	–	–	–	–	–	–
		Modified butt	Point	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
		Denticulate		–	–	–	–	–	–	–
		Other		–	–	–	–	–	–	–
	Sub-totals			6	–	2	–	5	3	16
	Tool 2	Burin		–	–	–	–	–	–	–
		Scaled piece	Single-edged	–	–	–	1	–	–	1
			Double-edged	–	–	–	–	–	–	–
	Sub-totals			–	–	–	1	–	–	1

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Flake	Irregular	I1(a)	–	–	–	–	–	–	–
			I1(b)	37	10	17	1	18	1	84
			I2	106	7	39	2	33	10	197
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	2	–	6	–	1	1	10
			B2(a)	8	–	2	–	1	–	11
			B2 (b)	10	1	7	–	6	1	25
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	1	–	–	–	1
			P2(a)	–	–	1	–	–	–	1
			P2(b)	1	–	–	–	–	–	1
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			164	18	73	3	59	13	330
	Core	Irregular		3	–	–	3	12	–	18
		Bipolar		–	–	–	3	–	–	3
		Adjacent platform		1	–	–	–	–	–	1
		Radial prepared	Discoidal	2	–	–	–	1	–	3
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		–	–	1	–	–	–	1
	Sub-totals			6	–	1	6	13	–	26

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	1	–	–	–	1	–	2
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	1	–	–	–	1
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			1	–	1	–	1	–	3
	Waste 2	Atypical flake	Rejuvenation	–	–	–	–	1	–	1
			Malformed	9	–	–	–	6	–	15
		Broken flake	Proximal	633	28	135	19	116	18	949
			Distal	484	10	116	13	107	19	749
		Unclassi-fiable		320	3	31	46	299	1	700
	Sub-totals			1446	41	282	78	529	38	2414
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							2
			Haematite Plain							2
			Miscellaneous Plain							1
		Thorn								–
	Sub-totals			–	–	–	–	–	–	5
	Admixture	Intrusive		2	1	–	–	1	1	5
		Re-used		–	–	–	–	–	–	–
	Sub-totals			2	1	–	–	1	1	5

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Rear + Stratum 1GBS.UP

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	-	-	-	-	-	1	1
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	1	-	-	-	-	-	1
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	-	-	-	-	-	-	-
			Convergent	1	-	1	-	-	-	2
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	-	-	-	-	-	-	-
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			2	-	1	-	-	1	4
	Tool 2	Burin		1	-	-	-	-	-	1
		Scaled piece	Single-edged	-	-	-	-	1	-	1
			Double-edged	-	-	-	-	-	-	-
	Sub-totals			1	-	-	-	1	-	2

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Flake	Irregular	I1(a)	–	–	–	–	–	–	–
			I1(b)	52	12	18	–	34	8	124
			I2	51	19	59	–	31	2	162
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	3	–	2	–	–	–	5
			B2(a)	2	–	4	–	1	–	7
			B2 (b)	–	–	3	–	–	–	3
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	–	–	–	–	–
			P2(a)	–	1	–	–	–	–	1
			P2(b)	1	–	2	–	–	–	3
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			109	32	88	–	66	10	305
	Core	Irregular		9	3	4	2	10	2	30
		Bipolar		–	–	–	1	–	–	1
		Adjacent platform		2	–	1	–	–	–	3
		Radial prepared	Discoidal	3	–	1	–	1	–	5
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	1	–	–	–	1
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			14	3	7	3	11	2	40

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	–	–	–
			Trimmed point 1	1	–	–	–	–	–	1
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			1	–	–	–	–	–	1
	Waste 2	Atypical flake	Rejuvenation	2	–	–	–	–	–	2
			Malformed	15	4	4	–	5	–	28
		Broken flake	Proximal	488	94	210	2	142	30	966
			Distal	214	21	85	2	68	15	405
		Unclassifiable		294	16	96	40	536	5	987
	Sub-totals			1013	135	395	44	751	50	2388
Incidental	Utilized	Hammerstone		–	–	–	–	–	3	3
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							1
			Haematite Plain							6
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	3	10
	Admixture	Intrusive		5	–	–	–	–	–	5
		Re-used		–	–	2	–	–	–	2
	Sub-totals			5	–	2	–	–	–	7

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Stratum 1GBS. LR Rear

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	-	-	1	-	-	-	1
			Convex-edged	1	-	-	-	-	-	1
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	-	-	1	-	-	-	1
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	1	-	2	-	-	-	3
			Convergent	-	-	-	-	-	-	-
			Oblique	2	-	1	-	-	-	3
		Trimmed point 2	Unifacial	1	-	-	-	-	-	1
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			5	-	5	-	-	-	10
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	-	2	-	2
			Double-edged	-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	2	-	2

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	1	-	-	-	-	-	1
			I1(b)	92	12	73	-	38	6	221
			I2	132	8	142	-	48	11	341
		Blade	B1(a)	1	-	-	-	-	-	1
			B1(b)	7	2	8	-	3	-	20
			B2(a)	3	-	19	-	2	-	24
			B2 (b)	20	1	17	-	2	1	41
		Point	P1(a)	-	-	-	-	-	-	-
			P1(b)	1	-	1	-	-	1	3
			P2(a)	3	-	3	-	-	-	6
			P2(b)	19	-	15	-	-	2	36
		Blade-Point	BP2 (a) and (b)	-	-	-	-	-	-	-
	Sub-totals			279	23	278	-	93	21	694
	Core	Irregular		12	-	3	-	20	-	35
		Bipolar		-	-	-	-	1	-	1
		Adjacent platform		-	-	-	1	-	1	2
		Radial prepared	Discoidal	4	-	6	-	1	-	11
			Triangular	-	-	-	-	-	-	-
			Blade	-	-	-	-	-	-	-
		Plain platform		1	-	-	-	2	-	3
	Sub-totals			17	-	9	1	24	1	52

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	-	-	-	-	-	-	-
			Trimmed point 1	-	-	2	-	-	-	2
			Trimmed point 2	2	-	-	-	2	-	4
			Backed piece 1	-	-	-	-	-	-	-
			Backed piece 2	-	-	-	-	-	-	-
			Modified butt	-	-	-	-	-	-	-
			Miscellaneous	1	-	-	-	-	-	1
	Sub-totals			3	-	2	-	2	-	7
	Waste 2	Atypical flake	Rejuvenation	-	-	1	-	-	-	1
			Malformed	13	2	4	-	7	1	27
		Broken flake	Proximal	825	46	389	2	153	45	1460
			Distal	504	18	251	1	89	19	882
		Unclassifiable		385	7	142	11	543	9	1097
	Sub-totals			1727	73	787	14	792	74	3467
Incidental	Utilized	Hammerstone		-	-	-	-	-	-	-
		Grindstone		-	-	-	-	-	-	-
		Pigment	Haematite Ground							7
			Haematite Plain							10
			Miscellaneous Plain							-
		Thorn								-
	Sub-totals			-	-	-	-	-	-	17
	Admixture	Intrusive		3	-	-	-	2	-	5
		Re-used		-	-	-	-	3	-	3
	Sub-totals			3	-	-	-	5	-	8

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3A Rear Stratum BACO. A

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Tool 1	Scraper	Straight-edged	-	-	1	-	-	-	1
			Convex-edged	-	-	-	-	-	-	-
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	1	-	-	-	-	-	1
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	1	-	-	-	-	-	1
			Convergent	-	-	-	-	-	-	-
			Oblique	-	-	-	-	-	-	-
		Trimmed point 2	Unifacial	1	-	-	-	-	-	1
			Bifacial	-	-	-	-	-	-	-
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			3	-	1	-	-	-	4
	Tool 2	Burin		1	-	-	-	-	-	1
		Scaled piece	Single-edged	-	-	-	-	-	-	-
			Double-edged	-	-	-	-	-	-	-
	Sub-totals			1	-	-	-	-	-	1

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	2	1	1	–	–	–	4
			I1(b)	134	17	19	–	14	1	185
			I2	346	30	61	–	12	6	455
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	12	2	3	–	1	2	20
			B2(a)	10	–	4	–	–	–	14
			B2 (b)	16	2	3	–	–	–	21
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	3	–	–	–	–	–	3
			P2(a)	9	1	2	–	–	–	12
			P2(b)	23	–	2	–	–	–	25
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			555	53	95	–	27	9	739
	Core	Irregular		11	–	2	–	1	–	14
		Bipolar		–	–	–	–	–	–	–
		Adjacent platform		6	–	–	–	–	–	6
		Radial prepared	Discoidal	4	–	–	–	1	–	5
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		1	–	1	–	–	–	2
	Sub-totals			22	–	3	–	2	–	27

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	1	–	1	–	–	–	2
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
	Sub-totals			1	–	1	–	–	–	2
	Waste 2	Atypical flake	Rejuvenation	–	–	–	–	–	–	–
			Malformed	14	3	3	–	1	–	21
		Broken flake	Proximal	1652	101	171	1	61	16	2002
			Distal	1022	22	114	–	47	4	1209
		Unclassifiable		880	14	56	5	132	6	1093
	Sub-totals			3568	140	344	6	241	26	4325
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							–
			Haematite Plain							1
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	–	1
	Admixture	Intrusive		13	1	4	–	–	–	18
		Re-used		–	–	–	–	–	–	–
	Sub-totals			13	1	4	–	–	–	18

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3B Stratum BACO. B

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	-	-	1	-	-	-	1
			Convex-edged	1	-	1	-	1	-	3
			Concave-edged	-	-	-	-	-	-	-
			Irregular-edged	-	-	-	-	-	-	-
			Compound	-	-	-	-	-	-	-
		Trimmed point 1	Defined	1	-	1	-	-	-	2
			Convergent	-	-	1	-	-	-	1
			Oblique	1	-	-	-	-	-	1
		Trimmed point 2	Unifacial	-	-	-	-	1	-	1
			Bifacial	1	-	1	-	-	1	3
		Backed piece 1	Curve-backed	-	-	-	-	-	-	-
			Irregular-backed	-	-	-	-	-	-	-
		Backed piece 2	Segment	-	-	-	-	-	-	-
			Trapeze	-	-	-	-	-	-	-
		Modified butt	Point	-	-	-	-	-	-	-
			Miscellaneous	-	-	-	-	-	-	-
		Denticulate		-	-	-	-	-	-	-
		Other		-	-	-	-	-	-	-
	Sub-totals			4	-	5	-	2	1	12
	Tool 2	Burin		-	-	-	-	-	-	-
		Scaled piece	Single-edged	-	-	-	-	1	-	1
			Double-edged	-	-	-	-	-	-	-
	Sub-totals			-	-	-	-	1	-	1

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	1	–	–	–	–	–	1
			I1(b)	110	13	38	–	15	6	182
			I2	222	14	86	–	14	13	349
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	3	–	3	–	–	–	6
			B2(a)	7	–	3	–	–	–	10
			B2 (b)	15	–	5	–	–	1	21
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	–	–	1	–	–	–	1
			P2(a)	5	–	1	–	–	–	6
			P2(b)	8	–	4	–	–	1	13
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			371	27	141	–	29	21	589
	Core	Irregular		15	–	2	–	2	–	19
		Bipolar		–	–	–	–	–	–	–
		Adjacent platform		5	–	1	1	1	2	10
		Radial prepared	Discoidal	11	–	3	–	–	–	14
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			31	–	6	1	3	2	43

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	–	–	–
			Trimmed point 1	3	–	1	–	–	2	6
			Trimmed point 2	3	–	2	–	–	–	5
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	1	–	2	–	–	1	4
	Sub-totals			7	–	5	–	–	3	15
	Waste 2	Atypical flake	Rejuvenation	–	–	–	–	–	–	–
			Malformed	11	1	5	–	–	3	20
		Broken flake	Proximal	1473	84	439	1	65	54	2116
			Distal	900	31	294	–	43	21	1289
		Unclassifiable		928	6	228	3	180	15	1360
	Sub-totals			3312	122	966	4	288	93	4785
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							3
			Haematite Plain							2
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	–	5
	Admixture	Intrusive		2	–	–	–	–	1	3
		Re-used		–	–	–	–	–	–	–
	Sub-totals			2	–	–	–	–	1	3

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3B Stratum BACO. C

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	1	–	–	–	–	–	1
			Convex-edged	–	–	–	–	2	–	2
			Concave-edged	–	–	–	–	–	–	–
			Irregular-edged	–	–	1	–	1	–	2
			Compound	–	–	–	–	–	–	–
		Trimmed point 1	Defined	1	–	1	–	–	–	2
			Convergent	–	–	–	–	–	–	–
			Oblique	–	–	–	–	–	–	–
		Trimmed point 2	Unifacial	–	–	–	–	–	–	–
			Bifacial	1	–	–	–	–	–	1
		Backed piece 1	Curve-backed	2	–	2	–	3	–	7
			Irregular-backed	–	–	–	–	–	–	–
		Backed piece 2	Segment	–	–	–	–	–	–	–
			Trapeze	–	–	–	–	–	–	–
		Modified butt	Point	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
		Denticulate		–	–	1	–	–	–	1
		Other		–	–	–	–	–	–	–
	Sub-totals			5	–	5	–	6	–	16
	Tool 2	Burin		–	–	–	–	1	–	1
		Scaled piece	Single-edged	–	–	–	–	–	–	–
			Double-edged	–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	1	–	1

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	1	–	–	–	–	2	3
			I1(b)	196	20	64	–	30	36	346
			I2	498	23	192	2	48	32	795
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	6	1	4	–	1	2	14
			B2(a)	18	2	2	–	1	–	23
			B2 (b)	33	2	17	–	3	1	56
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	1	–	–	–	–	–	1
			P2(a)	16	–	1	–	–	2	19
			P2(b)	26	–	11	–	–	3	40
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			795	48	291	2	83	78	1297
	Core	Irregular		15	4	3	1	25	–	48
		Bipolar		–	–	–	–	–	–	–
		Adjacent platform		7	1	–	–	3	–	11
		Radial prepared	Discoidal	5	–	2	–	1	–	8
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			27	5	5	–	29	–	67

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Waste 1	Broken tool	Scraper	1	–	–	–	–	–	1
			Trimmed point 1	1	–	–	–	2	–	3
			Trimmed point 2	2	–	2	–	1	–	5
			Backed piece 1	–	–	–	–	–	–	–
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	1	1
	Sub-totals			4	–	2	–	3	1	10
	Waste 2	Atypical flake	Rejuvenation	1	–	–	–	1	–	2
			Malformed	28	1	12	–	5	3	49
		Broken flake	Proximal	2316	98	501	5	182	141	3243
			Distal	1164	31	304	3	112	50	1664
		Unclassifiable		891	11	155	14	486	28	1585
	Sub-totals			4400	141	972	22	786	222	6543
Incidental	Utilized	Hammerstone		–	–	–	–	–	2	2
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							1
			Haematite Plain							–
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	2	3
	Admixture	Intrusive		3	1	1	–	1	1	7
		Re-used		1	–	–	–	–	–	1
	Sub-totals			4	1	1	–	1	1	8

APPENDIX 7 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Border Cave Exc. 3B Stratum BACO.D

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	Totals
Flaking	Tool 1	Scraper	Straight-edged	1	–	–	–	–	–	1
			Convex-edged	–	–	–	–	–	–	–
			Concave-edged	–	–	–	–	–	–	–
			Irregular-edged	1	–	–	–	–	–	1
			Compound	–	–	–	–	–	–	–
		Trimmed point 1	Defined	1	–	1	–	–	–	2
			Convergent	–	–	–	–	–	–	–
			Oblique	–	–	–	–	–	–	–
		Trimmed point 2	Unifacial	–	–	–	–	–	–	–
			Bifacial	–	–	–	–	–	–	–
		Backed piece 1	Curve-backed	–	–	–	–	–	–	–
			Irregular-backed	–	–	–	–	–	–	–
		Backed piece 2	Segment	–	–	–	–	–	–	–
			Trapeze	–	–	–	–	–	–	–
		Modified butt	Point	–	–	–	–	–	–	–
			Miscellaneous	–	–	–	–	–	–	–
		Denticulate		–	–	–	–	–	–	–
		Other		–	–	–	–	–	–	–
	Sub-totals			3	–	1	–	–	–	4
	Tool 2	Burin		–	–	–	–	–	–	–
		Scaled piece	Single-edged	–	–	–	–	–	–	–
			Double-edged	–	–	–	–	–	–	–
	Sub-totals			–	–	–	–	–	–	–

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Flake	Irregular	I1(a)	–	–	–	–	–	–	–
			I1(b)	95	19	10	–	4	4	132
			I2	189	21	63	–	6	5	284
		Blade	B1(a)	–	–	–	–	–	–	–
			B1(b)	4	–	1	–	–	–	5
			B2(a)	6	–	4	–	–	–	10
			B2 (b)	14	2	5	–	–	1	22
		Point	P1(a)	–	–	–	–	–	–	–
			P1(b)	3	1	–	–	–	–	4
			P2(a)	12	–	4	–	–	4	20
			P2(b)	16	–	6	–	–	–	22
		Blade-Point	BP2 (a) and (b)	–	–	–	–	–	–	–
	Sub-totals			339	43	93	–	10	14	499
	Core	Irregular		2	–	–	–	3	–	5
		Bipolar		–	–	–	–	–	–	–
		Adjacent platform		1	–	1	–	–	–	2
		Radial prepared	Discoidal	–	–	–	–	–	–	–
			Triangular	–	–	–	–	–	–	–
			Blade	–	–	–	–	–	–	–
		Plain platform		–	–	–	–	–	–	–
	Sub-totals			3	–	1	–	3	–	7

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material						Totals
				Rhyolite 1	Rhyolite 2	Quartzite 1	Quartz 1 & 2	Chalcedony	Additional	
Flaking	Waste 1	Broken tool	Scraper	–	–	–	–	–	–	–
			Trimmed point 1	–	–	–	–	–	–	–
			Trimmed point 2	–	–	–	–	–	–	–
			Backed piece 1	–	–	1	–	–	–	1
			Backed piece 2	–	–	–	–	–	–	–
			Modified butt	–	–	–	–	–	–	–
			Miscellaneous	1	–	–	–	–	–	1
	Sub-totals			1	–	1	–	–	–	2
	Waste 2	Atypical flake	Rejuvenation	–	–	–	–	–	–	–
			Malformed	9	2	3	–	2	–	16
		Broken flake	Proximal	883	61	206	–	32	23	1205
			Distal	429	18	109	–	19	11	586
		Unclassi-fiable		371	4	51	–	46	3	475
	Sub-totals			1692	85	369	–	99	37	2282
Incidental	Utilized	Hammerstone		–	–	–	–	–	–	–
		Grindstone		–	–	–	–	–	–	–
		Pigment	Haematite Ground							–
			Haematite Plain							1
			Miscellaneous Plain							–
		Thorn								–
	Sub-totals			–	–	–	–	–	–	1
	Admixture	Intrusive		–	–	2	–	1	–	3
		Re-used		–	–	–	–	–	–	–
	Sub-totals			–	–	2	–	1	–	3

Appendix 8 A provisional evaluation of the engraved objects from Border Cave*

Alexander Marshack

The items listed in Table 1 were sent to me for study at the Peabody Museum of Archaeology and Ethnology. They were first photographed (Figs. 1-8). The wooden artefacts tended to come out dead black. I therefore printed them lighter than normal in order to bring out the faint and shallow markings.

All of the specimens appear to be incomplete as a result of breakage. Microscopic examination was restricted to the various items from J-O 15-17 slumped, Q21 61cm - 1WA and T18 46cm - 1WA. Only on these were the markings extensive enough to permit any detailed interpretation.

Least ambiguous are the engravings on the rib fragment from J-O 15-17 slumped. The 32 tiny incisions on this item were clearly made in a regular manner and with the same tool, grip, and pressure, indicating a single marking and a decorational intent. The microscope also revealed that these notches were all heavily and equally worn along their upper surfaces, as though the artefact had been in use, or had been handled for a long time.

In sharp contrast are the incisions found on the wooden specimens from Q21 61cm - 1WA. These are certainly marked in sets, but irregularly placed and accumulated. It is as a result difficult to impute or validate a decorational or notational intent. The surfaces of all four items are slightly humified, thereby precluding an analysis of wear patterns.

Different again are the notches on the baboon fibula from T18 46cm - 1WA. These appear to have been marked irregularly by strokes of varying pressure and angle, as also seemingly by a number of differing tools. This suggests that there was no one rhythm in the marking and no one grip upon the tool or the bone. Furthermore, microscopic examination shows that the rounding and smoothing of use, evidenced on most of the incisions, is definitely absent from those at one end of the specimen.

The 1BS.LR specimens therefore provide an analytical and interpretive problem in that:

a) If the markings are decorative, then they are oddly and clumsily made and accumulated in comparison with the object from J-O 15-17 slumped.

b) If they are notational, then they are not, as they should be according to the definition, sequential accretions of visually discrete sets capable of being differentiated and read back as such by the maker.

The engravings on these specimens would seem in fact to have their closest affinities with what may be termed ritual markings. Ethnographic examples of these are the known shamanistic artefacts of bone, stone and stick, which are or were occasionally marked during ritual or ceremonial as part of the act of participation or invocation. Such essentially non-decorational and non-notational objects are widely known, though they have not been much discussed in the published literature. I have found them to be ubiquitous amongst the engraved prehistoric stones of the American Indians and Australian Aborigines, as also in cultures subsequent to the Mousterian of Eurasia.

In sum, it is at present impossible to be certain as to the symbolic intent of the bone and wood fragments from the IBS.LR. Nevertheless, what these items do demonstrate is of very considerable importance. For if the dating of the stratum from which they derive is correct, then these are both the earliest and the southernmost evidence yet found for the intentional accumulation of engraved marks - whether for decorational or notational or ritual purposes.

Any of these three possibilities would indicate a capacity for symbolism and thus be suggestive of an evolved sapiens culture with the probability of developed linguistic correlates. This is positive and startling enough for the region and time-level from which they derive without striving for indications of arithmetical notation.

The variable markings from this Early L.S.A. level have therefore their own significance for southern Africa, since they indicate the presence of a complex cultural tradition in which remarkably varied types of material and classes of object were symbolically marked for possibly differing purposes. Posing the problem in this way makes it possible for future research to conduct comparative studies which will either enlarge or narrow down the specific traditions involved.

The artefacts are therefore of particular interest despite the inadequacy of my analysis. They, like other recent finds such as the specimens from Ksar 'Aqil in Libya (Tixier 1974) and from Devil's Lair in Australia (Dortch, 1976) are vital in providing an ever widening and deepening insight into the evolving and pandemic symbolizing capacity of early Homo sapiens.

References

* Based on letter dated 5 June, 1977.

DORTCH, C.E. 1976. Two engraved stone plaques of late Pleistocene age from Devil's Lair, Western Australia. Archaeol. and Phys. Anthrop. in Oceania, 11, 32-44.

TIXIER, J. 1974. Poinçon décoré du Paléolithique Supérieur à Ksar 'Aqil (Liban). Paléorient, 21, 187-192.

TABLE 1. Inventory of engraved objects from Border Cave

Unprovenanced

Items recovered during the clearance of disturbed deposit from Horton's Pit. Associated with cultural debris ranging from I.A. to M.S.A.

a) Squares J-O. 15-17. Slumped. One uncharred and indeterminate rib fragment with notches along an edge (Figs. 1 and 2).

b) Squares Q-R. 13-15. Slumped. One charred warthog tusk fragment with notches along an edge.

c) Square T9. Slumped. One uncharred and indeterminate rib fragment with notches along an edge (Fig. 3).

Stratum 1BS.LR.

In situ items from Exc. 3A Rear. Associated with Early L.S.A. Level radiocarbon dated to ~37000 B.P.

a) Square T18 46cm - 1WA. One uncharred baboon fibula fragment with notches along an edge (Figs. 4 and 5).

b) Square Q21 61cm - 1WA. Four uncharred wood fragments with shallow engraved lines over much of their surfaces (Fig. 6).

Stratum 2WA

In situ item from Exc. 3A Rear. Associated with M.S.A. Level radiocarbon dated to > 49000 B.P.

a) Square T19. 2WA. One charred and indeterminate rib fragment with notches along an edge. (Figs. 7 and 8).

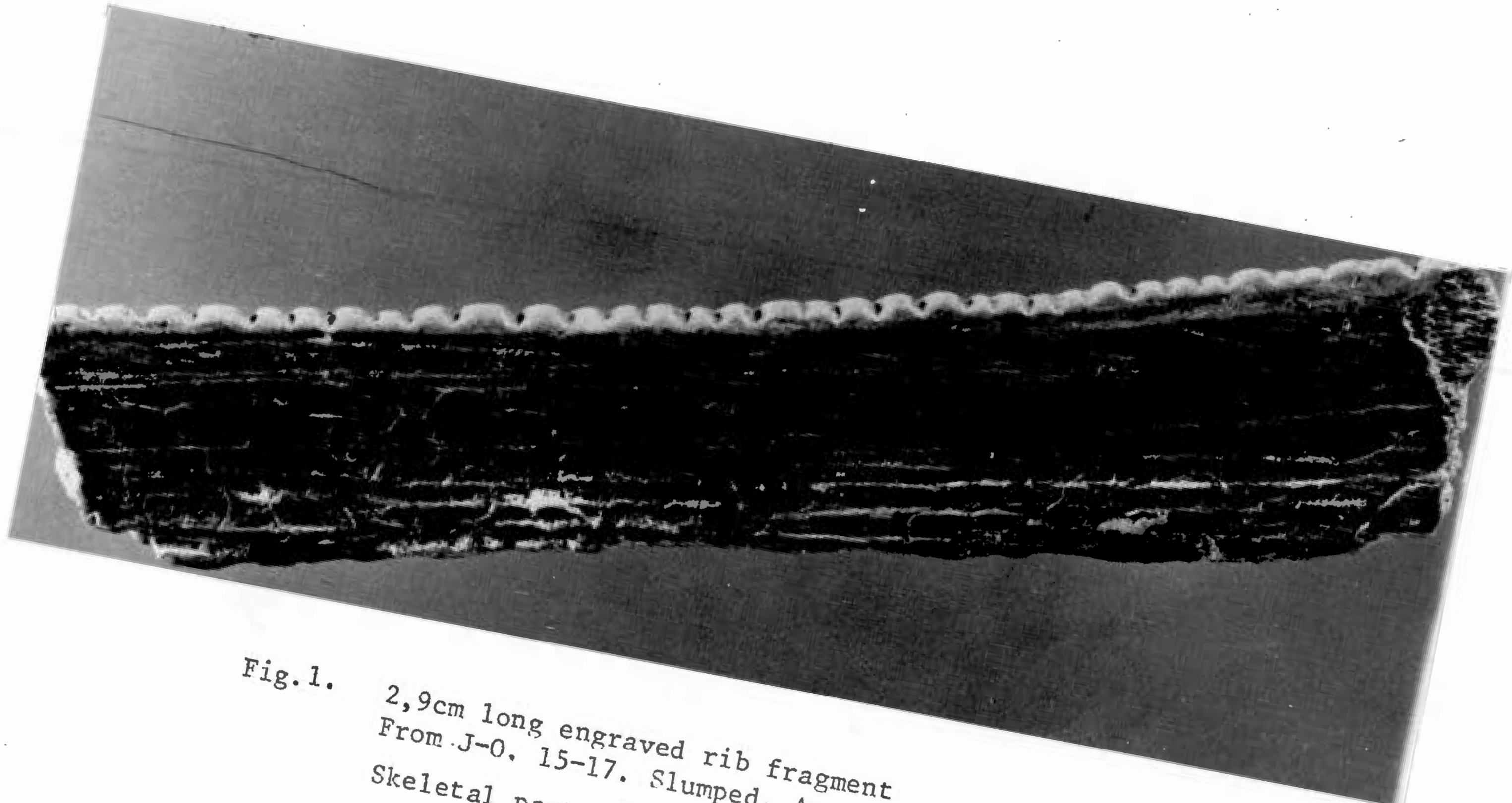


Fig.1. 2,9cm long engraved rib fragment
From J-O. 15-17. Slumped. Associations uncertain
Skeletal part identification by J. Kitching
Photograph by courtesy of A. Marshack

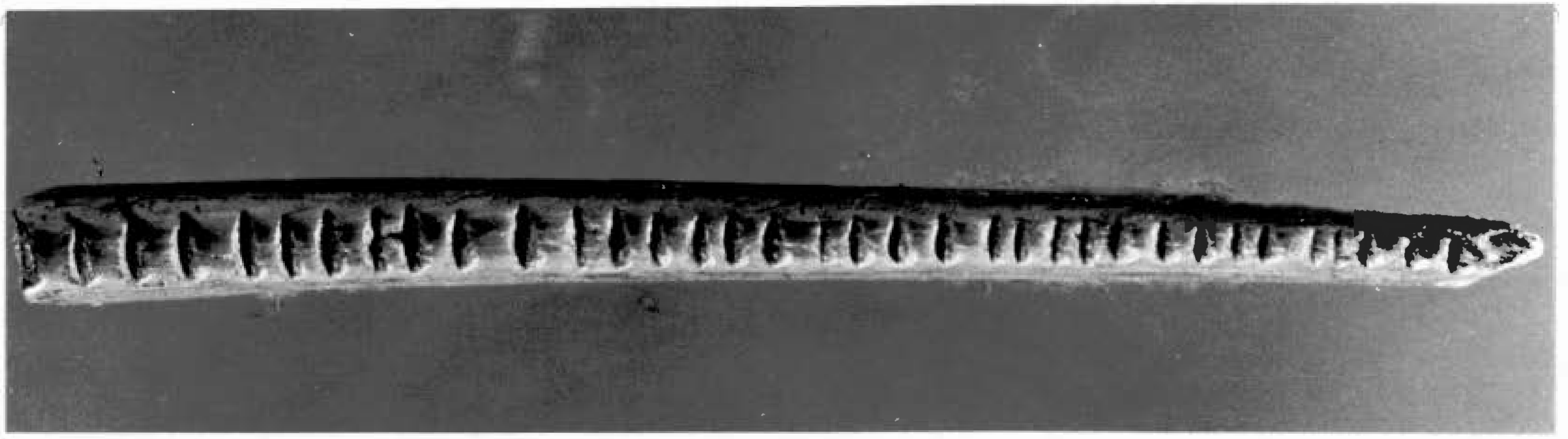


Fig. 2. 2,9cm long engraved rib fragment
From J-O 15-17. Slumped. Associations uncertain
Skeletal part identification by J. Kitching
Photograph by courtesy of A. Marshack

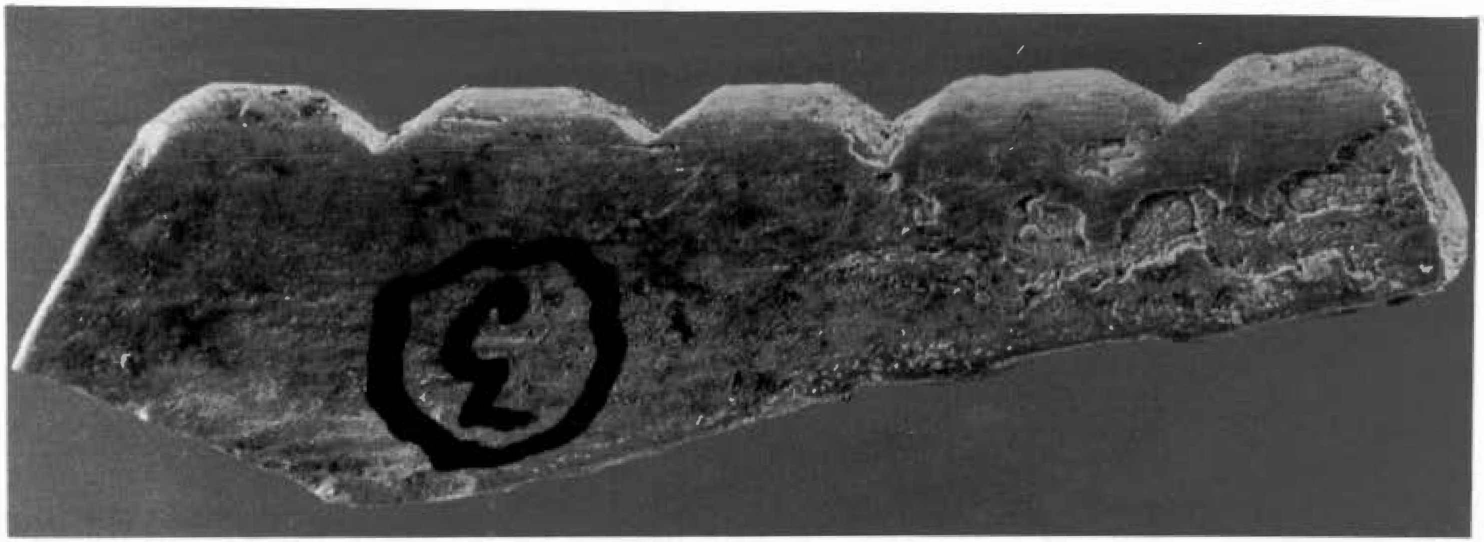


Fig. 3 2,1cm long engraved rib fragment
From T9. Slumped. Associations uncertain
Skeletal part identification by J. Kitching
Photograph by courtesy of A. Marshack

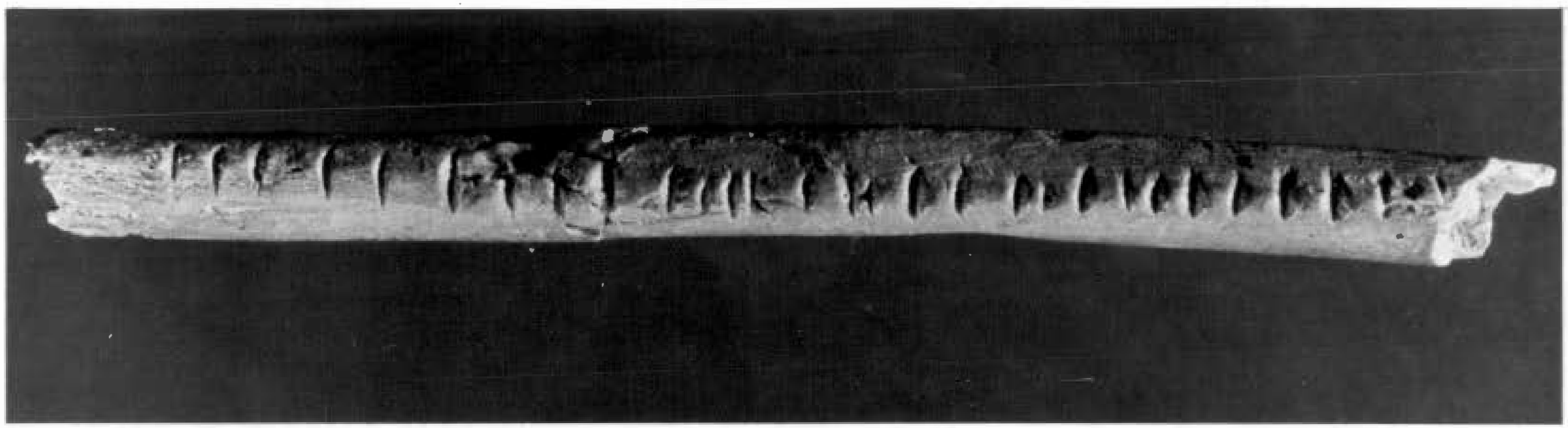


Fig. 4 7,7cm long engraved baboon fibula
From T18 46cm.-1WA.1BS.LR.

Skeletal part identification by J. Kitching

Photograph by courtesy of A. Marshack

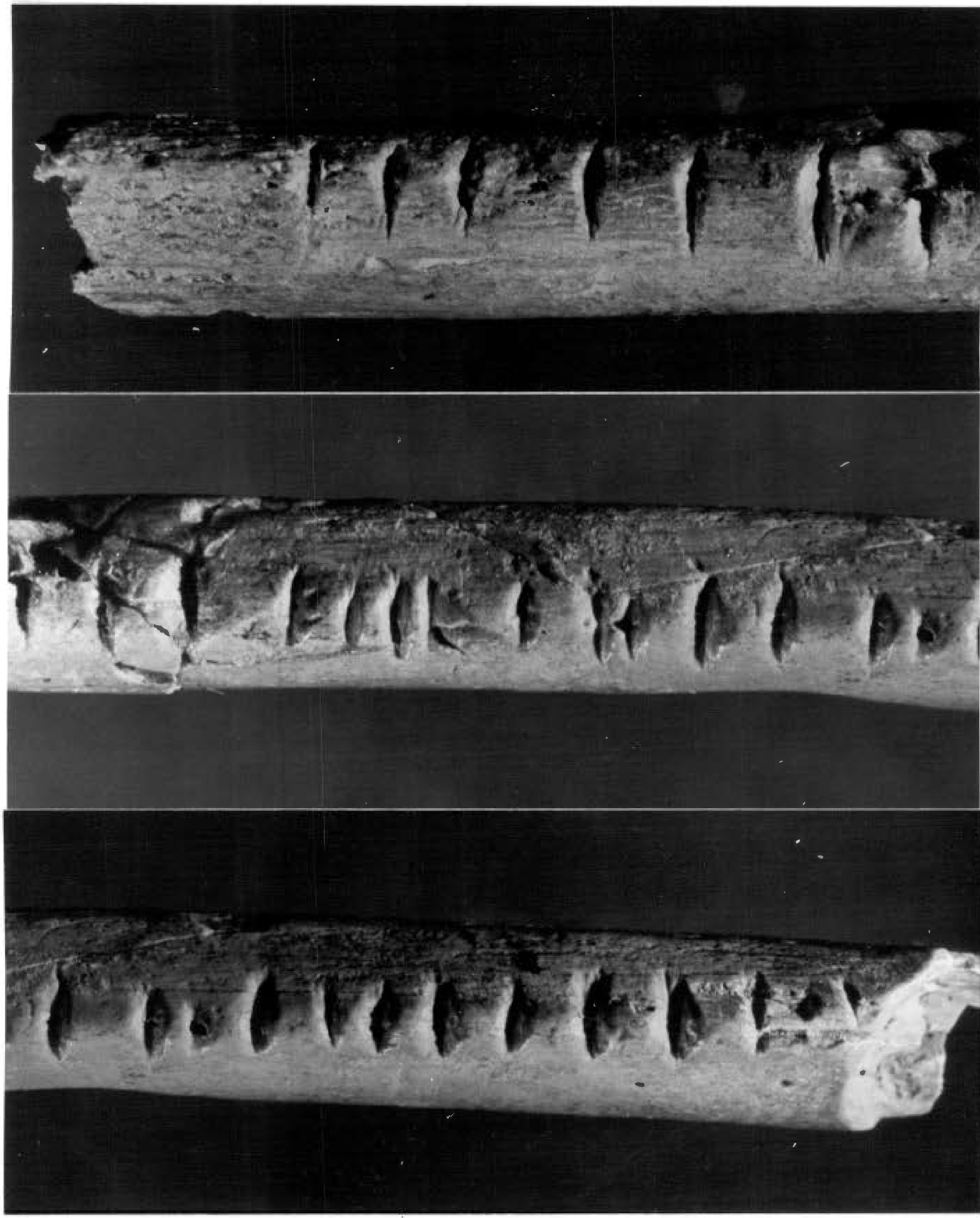


Fig. 5 The engraved baboon fibula enlarged still further.
Photographs by courtesy of A. Marshack

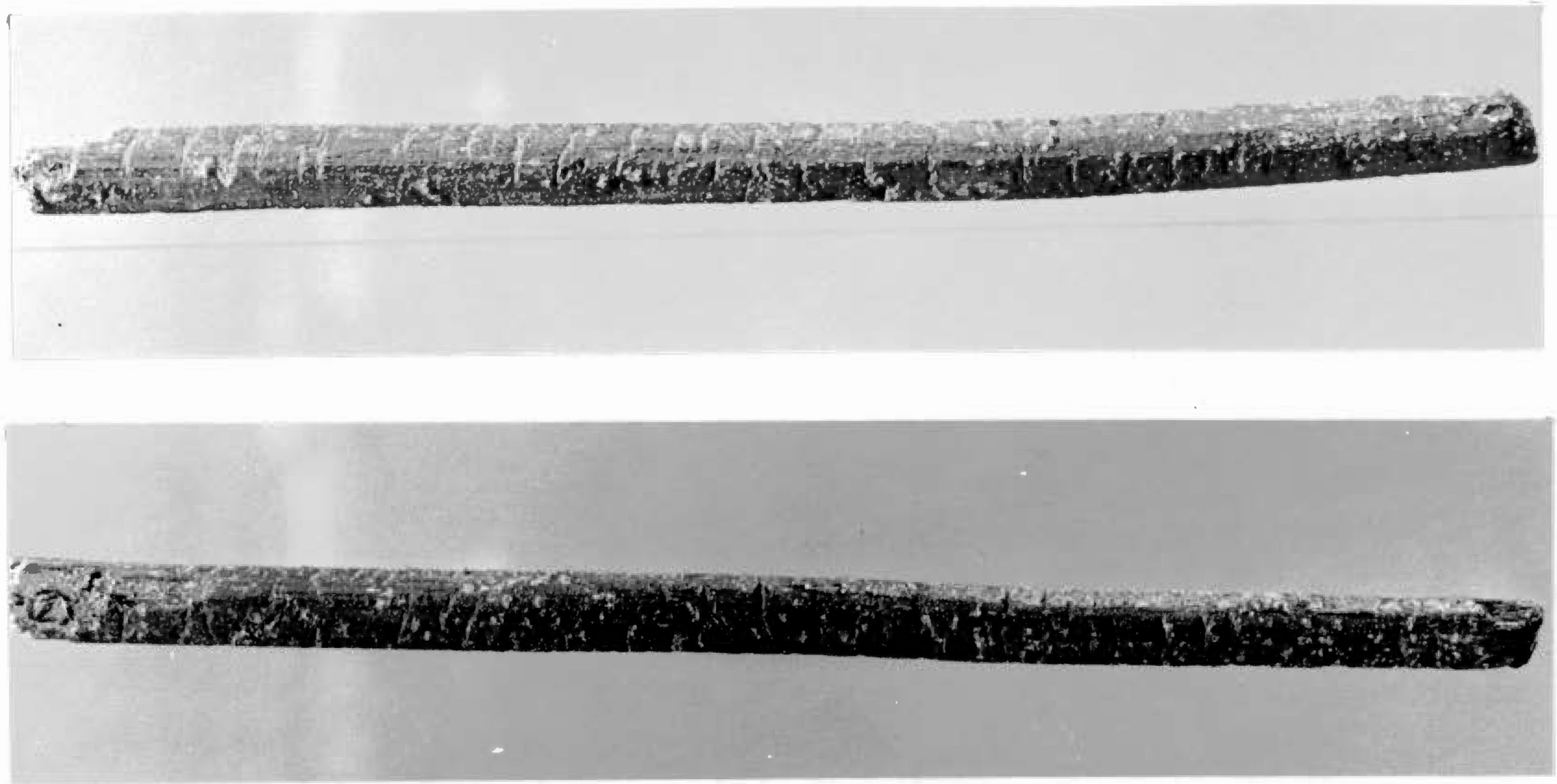


Fig. 6 10,8cm long engraved wood fragment : two views. From Q21. 61cm - 1WA.1BS.LR.
Photograph by courtesy of A. Marshack

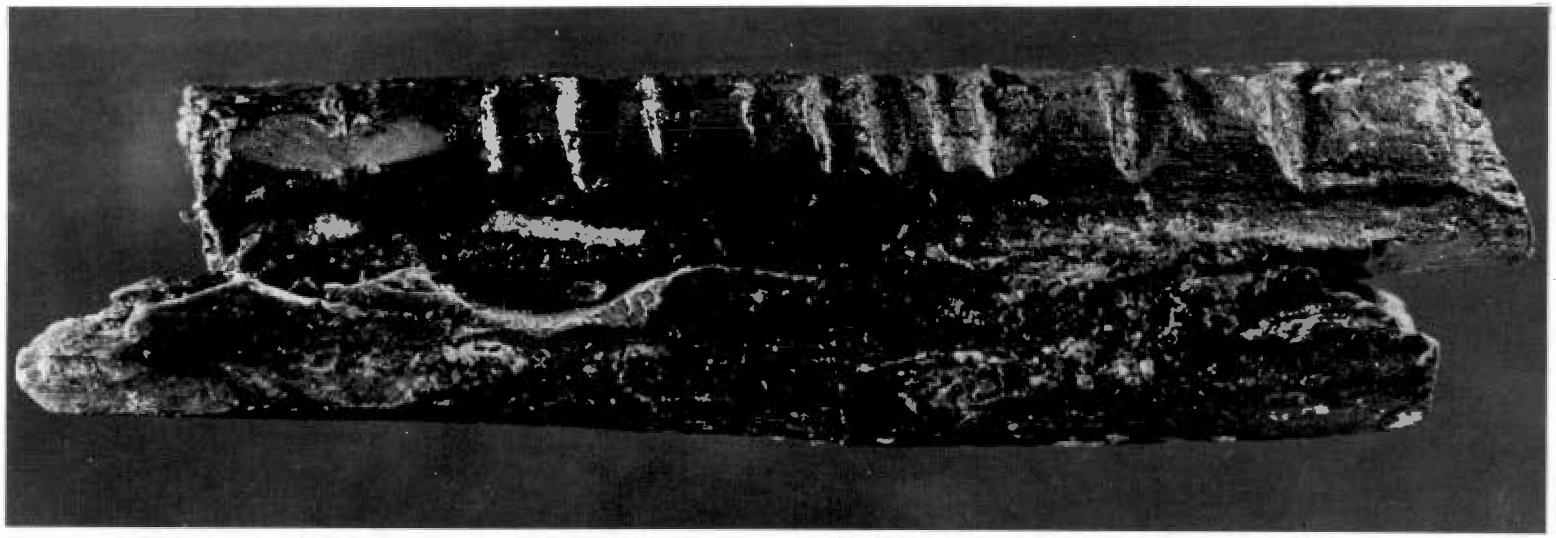


Fig. 7. 3,8cm long engraved rib fragment
From T19. 2WA

Skeletal part identification by J. Kitching

Photograph by courtesy of A. Marshack

Fig. 8. 3,8cm long engraved rib fragment. From T19. 2WA
Skeletal part identification by J. Kitching
Photograph by courtesy of A. Marshack

Appendix 9 Formal tool class proportions

Border Cave. Exc. 3A + 3B

Material	Analysis	Stratum 1BS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS.+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO. A+B	BACO. C+D
Rhy.1+	Scraper n	2	1	21	1	2	4	7	5
Qtzite.1	Scraper %	-	-	35,0	-	8,0	-	29,2	25,0
	Trim.pt.n	-	3	16	3	6	14	17	10
	Trim.pt.%	-	-	26,7	-	24,0	-	70,8	50,0
	Back.pc.1 n	-	1	1	5	6	-	-	5
	Back.pc.1 %	-	-	1,7	-	24,0	-	-	25,0
	Back.pc.2 n	-	-	1	7	11	-	-	-
	Back.pc.2 %	-	-	1,7	-	44,0	-	-	-
	Mod.butt n	-	-	21	1	-	-	-	-
	Mod.butt %	-	-	35,0	-	-	-	-	-
	Scaled pc. n	1	-	-	-	-	-	-	-
	Scaled pc.%	-	-	-	-	-	-	-	-
	Total n	3	5	60	17	25	18	24	20
	Total %	-	-	100,1	-	100,0	-	100,0	100,0

Appendix 9 (continued)

Material	Analysis	Stratum 1BS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS.+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO. A+B	BACO. C+D
Qtz.1+2	Scraper n	-	1	-	-	-	-	-	-
	Scraper %	-	-	-	-	-	-	-	-
	Trim.pt. n	-	-	-	-	-	-	-	-
	Trim.pt.%	-	-	-	-	-	-	-	-
	Back.pc.1 n	-	-	-	-	1	-	-	-
	Back.pc.1 %	-	-	-	-	-	-	-	-
	Back.pc.2 n	-	-	-	-	-	-	-	-
	Back.pc.2 %	-	-	-	-	-	-	-	-
	Mod.butt n	-	-	-	-	-	-	-	-
	Mod.butt %	-	-	-	-	-	-	-	-
	Scaled pc.n	60	15	4	1	2	-	-	-
	Scaled pc.%	100,0	-	-	-	-	-	-	-
	Total n	60	16	4	1	3	-	-	-
	Total %	100,0	-	-	-	-	-	-	-

Appendix 9 (continued)

Material	Analysis	1BS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	Stratum 3BS.+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO. A+B	BACO. C+D
Chalc.	Scraper n	3	1	3	2	6	-	1	3
	Scraper %	1,4	3,2	-	-	-	-	-	-
	Trim.pt. n	-	-	1	2	-	2	1	3
	Trim.pt. %	-	-	-	-	-	-	-	-
	Back.pc.1 n	-	1	1	6	4	-	-	3
	Back.pc.1 %	-	3,2	-	-	-	-	-	-
	Back.pc.2 n	-	1	-	6	3	-	-	-
	Back.pc.2 %	-	3,2	-	-	-	-	-	-
	Mod.butt. n	-	-	-	-	-	-	-	-
	Mod.butt. %	-	-	-	-	-	-	-	-
	Scaled pc. n	214	28	4	-	2	3	1	-
	Scaled pc. %	98,6	90,3	-	-	-	-	-	-
	Total n	217	31	9	16	15	5	3	9
	Total %	100,0	99,9	-	-	-	-	-	-

Appendix 9 (continued)

Material	Analysis	Stratum							
		1BS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS.+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO. A+B	BACO. C+D
All	Scraper η	5	3	31	3	8	5	8	8
	Scraper %	1,8	5,3	37,3	8,8	15,1	20,8	26,7	27,6
	Trim.pt. η	-	8	18	5	7	16	21	13
	Trim.pt. %	-	14,0	21,7	14,7	13,2	66,7	70,0	44,8
	Back.pc.1 η	-	2	2	11	14	-	-	8
	Back.pc.1 %	-	3,5	2,4	32,4	26,4	-	-	27,6
	Back.pc.2 η	-	1	1	13	20	-	-	-
	Back.pc.2 %	-	1,8	1,2	38,2	37,7	-	-	-
	Mod.butt η	-	-	23	1	-	-	-	-
	Mod.butt %	-	-	27,7	2,9	-	-	-	-
	Scaled pc. η	275	43	8	1	4	3	1	-
	Scaled pc. %	98,2	75,4	9,6	2,9	7,5	12,5	3,3	-
	Total η	280	57	83	34	53	24	30	29
	Total %	100,0	100,0	99,9	99,9	99,9	100,0	100,0	100,0

Appendix 10 Formal tool/Flake minimum number proportions
Border Cave. Exc. 3A + 3B

Material	Analysis	Stratum 1BS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO A+B	BACO C+D
Rhy.1	Tool n	3	5	48	15	16	12	16	13
	Flake n	919	671	2603	469	2598	1742	4091	4384
	Tool/Fl.%	0,3	0,7	1,8	3,2	0,6	0,7	0,4	0,3
Rhy.2	Tool n	-	-	1	-	1	-	-	-
	Flake n	287	49	174	30	75	201	269	253
	Tool/Fl.%	-	-	0,6	-	1,3	-	-	-
Qtzite.1	Tool n	-	1	14	2	9	8	12	9
	Flake n	195	196	802	124	533	982	866	1115
	Tool/Fl.%	-	0,5	1,7	1,6	1,7	0,8	1,4	0,8
Qtz.1+2	Tool n	60	18	4	1	3	-	-	-
	Flake n	78	31	16	6	51	4	2	7
	Tool/Fl.%	76,9	58,1	-	-	5,9	-	-	-
Chalc.	Tool n	217	31	9	16	15	5	3	10
	Flake n	668	144	281	364	560	468	185	324
	Tool/Fl.%	32,5	21,5	3,2	4,4	2,7	1,1	1,6	3,1
Addit.	Tool n	-	5	12	-	9	1	4	1
	Flake n	101	55	409	14	85	108	107	260
	Tool/Fl.%	-	9,1	2,9	-	10,6	0,9	3,7	0,4
All	Tool n	280	60	88	34	53	26	35	33
	Flake n	2248	1146	4285	1007	3902	3505	5520	6343
	Tool/Fl.%	12,5	5,2	2,1	3,4	1,4	0,7	0,6	0,5

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Qtz. = quartz; Chalc. = chalcedony; Addit. = additional; Fl. = flake

APPENDIX 11 UNBROKEN FLAKE CLASS PROPORTIONS : RHYOLITE 1

Border Cave. Exc. 3A +3B

Subclasss	Analysis	Stratum														
		1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS LR.C	2WA	1RBS	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
I1	n	43	102	77	129	86	16	36	75	37	52	93	136	111	197	95
	%	57,3	48,1	26,6	23,2	26,4	–	36,7	21,6	22,6	47,7	33,3	24,5	29,9	24,8	28,0
I2	n	32	110	160	316	195	19	49	204	106	51	132	346	222	498	189
	%	42,7	51,9	55,4	56,9	59,8	–	50,0	58,8	64,6	46,8	47,3	62,3	59,8	62,7	55,8
Sub.T	n	75	212	237	445	281	35	85	279	143	103	225	482	333	695	284
	%	100,0	100,0	82,0	80,2	86,2	–	86,7	80,4	87,2	94,5	80,6	86,8	89,7	87,5	83,8
B1	n	–	–	8	18	9	–	3	12	2	3	8	12	3	6	4
	%	–	–	2,8	3,2	2,8	–	3,1	3,5	1,2	2,8	2,9	2,2	0,8	0,8	1,2
B2	n	–	–	42	78	27	4	10	55	18	2	23	26	22	51	20
	%	–	–	14,5	14,1	8,3	–	10,2	15,9	11,0	1,8	8,2	4,7	5,9	6,4	5,9
Sub.T	n	–	–	50	96	36	4	13	67	20	5	31	38	25	57	24
	%	–	–	17,3	17,3	11,0	–	13,3	19,3	12,2	4,6	11,1	6,8	6,7	7,2	7,1
P1	n	–	–	1	1	2	–	–	–	–	–	1	3	–	1	3
	%	–	–	0,3	0,2	0,6	–	–	–	–	–	0,4	0,5	–	0,1	0,9
P2	n	–	–	1	11	7	–	–	1	1	1	22	32	13	42	28
	%	–	–	0,3	2,0	2,1	–	–	0,3	0,6	0,9	7,9	5,8	3,5	5,3	8,3
Sub.T	n	–	–	2	12	9	–	–	1	1	1	23	35	13	43	31
	%	–	–	0,7	2,2	2,8	–	–	0,3	0,6	0,9	8,3	6,3	3,5	5,4	9,1
BP	n	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–
	%	–	–	–	0,4	–	–	–	–	–	–	–	–	–	–	–
Grand T.	n	75	212	289	555	326	39	98	347	164	109	279	555	371	794	339

Abbreviations

T. = total

APPENDIX 11 UNBROKEN FLAKE CLASS PROPORTIONS : RHYOLITE 2

Border Cave. Exc. 3A +3B

Subclasss	Analysis	Stratum														
		1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS LR.C	2WA	1RBS	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
I1	n	20	40	10	13	22	–	7	4	10	12	12	18	13	20	19
	%	–	58,8	–	–	52,4	–	–	–	–	–	–	34,0	–	41,7	44,2
I2	n	11	27	13	10	20	1	4	3	7	19	8	30	14	23	21
	%	–	40,3	–	–	47,6	–	–	–	–	–	–	56,6	–	47,9	48,8
Sub.T	n	31	67	23	23	42	1	11	7	17	31	20	48	27	43	40
	%	–	98,5	–	–	100,0	–	–	–	–	–	–	90,6	–	89,6	93,0
B1	n	–	1	–	1	–	–	–	–	–	–	2	2	–	1	–
	%	–	1,5	–	–	–	–	–	–	–	–	–	3,8	–	2,1	–
B2	n	–	–	–	1	–	–	–	1	1	–	1	2	–	4	2
	%	–	–	–	–	–	–	–	–	–	–	–	3,8	–	8,3	4,7
Sub.T	n	–	1	–	2	–	–	–	1	1	–	3	4	–	5	2
	%	–	1,5	–	–	–	–	–	–	–	–	–	7,5	–	10,5	4,7
P1	n	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
	%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,3
P2	n	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–
	%	–	–	–	–	–	–	–	–	–	–	–	1,9	–	–	–
Sub.T	n	–	–	–	–	–	–	–	–	–	1	–	1	–	–	1
	%	–	–	–	–	–	–	–	–	–	–	–	1,9	–	–	2,3
BP	n	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand T.	n	31	68	23	25	42	1	11	8	18	32	23	53	27	48	43

Abbreviations

T. = total

APPENDIX 11 UNBROKEN FLAKE CLASS PROPORTIONS : QUARTZITE 1

Border Cave. Exc. 3A +3B

Subclasss	Analysis	Stratum 1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS LR.C	2WA	1RBS	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
I1	n	10	25	15	50	21	7	4	19	17	18	73	20	38	64	10
	%	–	37,9	16,9	21,1	20,6	–	9,1	19,4	23,3	20,5	26,3	21,1	27,0	22,0	10,8
I2	n	13	38	52	155	76	10	23	54	39	59	142	61	86	192	63
	%	–	57,6	58,4	65,4	74,5	–	52,3	55,1	53,4	67,0	51,1	64,2	61,0	66,0	67,7
Sub.T	n	23	63	67	205	97	17	27	73	56	77	215	81	124	256	73
	%	–	95,5	75,3	86,5	95,1	–	61,4	74,5	76,7	87,5	77,4	85,3	88,0	88,0	78,5
B1	n	–	–	2	4	1	–	5	6	6	2	8	3	3	4	1
	%	–	–	2,2	1,7	1,0	–	11,4	6,1	8,2	2,3	2,9	3,2	2,1	1,4	1,1
B2	n	–	3	18	23	3	2	12	18	9	7	36	7	8	19	9
	%	–	4,5	20,2	9,7	2,9	–	27,3	18,3	12,3	8,0	12,9	7,4	5,7	6,5	9,7
Sub.T	n	–	3	20	27	4	2	17	24	15	9	44	10	11	23	10
	%	–	4,5	22,5	11,4	3,9	–	38,6	24,4	20,5	10,2	15,8	10,5	7,7	7,9	10,8
P1	n	–	–	–	–	–	–	–	–	1	–	1	–	1	–	–
	%	–	–	–	–	–	–	–	–	1,4	–	0,4	–	0,7	–	–
P2	n	–	–	2	4	–	–	–	–	1	2	18	4	5	12	10
	%	–	–	2,4	1,7	–	–	–	–	1,4	2,3	6,5	4,2	3,5	4,1	10,8
Sub.T	n	–	–	2	4	–	–	–	–	2	2	19	4	6	12	10
	%	–	–	2,4	1,7	–	–	–	–	2,8	2,3	6,9	4,2	4,2	4,1	10,8
BP	n	–	–	–	1	1	–	–	1	–	–	–	–	–	–	–
	%	–	–	–	0,4	1,0	–	–	1,0	–	–	–	–	–	–	–
Grand T.	n	23	66	89	237	102	19	44	98	73	88	278	95	141	291	93

Abbreviations

T. = total

APPENDIX 11 UNBROKEN FLAKE CLASS PROPORTIONS : CHALCEDONY

Border Cave. Exc. 3A +3B

Subclasss	Analysis	Stratum														
		1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS LR.C	2WA	1RBS	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
I1	n	24	79	17	15	35	17	33	37	18	34	38	14	15	30	4
	%	46,2	38,9	42,5	-	45,5	38,6	26,8	27,8	30,5	51,5	40,9	-	-	36,1	-
I2	n	28	118	17	15	38	24	65	73	33	31	48	12	14	48	6
	%	53,8	58,1	42,5	-	49,4	54,5	52,8	54,9	55,9	47,0	51,9	-	-	57,8	-
Sub.T	n	52	197	34	30	73	41	98	110	51	65	86	26	29	78	10
	%	100,0	97,0	85,0	-	94,8	93,2	79,7	82,7	86,4	98,5	92,5	-	-	93,9	-
B1	n	-	3	3	-	-	-	11	8	1	-	3	1	-	1	-
	%	-	1,5	7,5	-	-	-	8,9	6,0	1,7	-	3,2	-	-	1,2	-
B2	n	-	3	3	2	3	3	14	15	7	1	4	-	-	4	-
	%	-	1,5	7,5	-	3,9	6,8	11,4	11,3	11,9	1,5	4,3	-	-	4,8	-
Sub.T	n	-	6	6	2	3	3	25	23	8	1	7	1	-	5	-
	%	-	3,0	15,0	-	3,9	6,8	20,3	17,3	13,6	1,5	7,6	-	-	6,0	-
P1	n	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P2	n	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	1,3	-	-	-	-	-	-	-	-	-	-
Sub.T	n	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	1,3	-	-	-	-	-	-	-	-	-	-
BP	n	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand T.	n	52	203	40	32	77	44	123	133	59	66	93	27	29	83	10

Abbreviations

T. = total

APPENDIX 11 UNBROKEN FLAKE CLASS PROPORTIONS : ADDITIONAL

Border Cave. Exc. 3A +3B

Subclasss	Analysis	Stratum														
		1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS LR.C	2WA	1RBS	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
I1	n	7	20	3	20	9	1	3	2	1	8	6	1	6	38	4
	%	–	–	–	14,4	–	–	–	–	–	–	–	–	–	48,8	–
I2	n	8	7	13	91	18	1	2	5	10	2	11	6	13	32	5
	%	–	–	–	65,5	–	–	–	–	–	–	–	–	–	41,0	–
Sub.T	n	15	27	16	111	27	2	5	7	11	10	17	7	19	70	9
	%	–	–	–	79,9	–	–	–	–	–	–	–	–	–	89,8	–
B1	n	–	–	–	1	–	–	1	1	1	–	–	2	–	2	–
	%	–	–	–	0,7	–	–	–	–	–	–	–	–	–	2,6	–
B2	n	–	–	3	24	3	–	1	2	1	–	1	–	1	1	1
	%	–	–	–	17,3	–	–	–	–	–	–	–	–	–	1,3	–
Sub.T	n	–	–	3	25	3	–	2	3	2	–	1	2	1	3	1
	%	–	–	–	18,0	–	–	–	–	–	–	–	–	–	3,9	–
P1	n	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
	%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P2	n	–	–	–	3	–	–	–	–	–	–	2	–	1	5	4
	%	–	–	–	2,2	–	–	–	–	–	–	–	–	–	6,4	–
Sub.T	n	–	–	–	3	–	–	–	–	–	–	3	–	1	5	4
	%	–	–	–	2,2	–	–	–	–	–	–	–	–	–	6,4	–
BP	n	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–
	%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Grand T.	n	15	27	20	139	31	2	7	10	13	10	21	9	21	78	14

Abbreviations

T. = total

APPENDIX 12 : FACETING PROPORTIONS. I2 SUBCLASS

Border Cave. Exc. 3A + 3B

Material	Category	Analysis	Stratum 1BS.LR	1WA+ 1BES	2BS.UP +LPA+B	2BS.LR C	2WA	1RBS	3BS.+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D.
Rhy.1	1.	n	26	92	90	177	117	11	19	146	68	32	83	204	120	254	102
		%	-	90,3	60,8	60,4	70,1	-	-	76,0	73,9	65,3	68,0	62,8	57,4	54,6	56,7
	2/2	n	2	8	30	77	38	3	11	35	20	10	31	86	61	158	69
		%	-	7,8	20,3	26,3	22,8	-	-	18,2	21,7	20,4	25,4	26,5	29,2	34,0	38,3
	2/3+	n	1	2	28	39	12		6	11	4	7	8	35	28	53	9
		%	-	1,9	18,9	13,3	7,2	-	-	5,7	4,3	14,3	6,6	10,8	13,4	11,4	5,0
	3	n	3	7	12	23	28	4	13	12	14	2	10	21	13	33	9
	Total	1+2	29	103	148	293	167	14	36	192	92	49	122	325	209	465	180
	Total	1-3	32	110	160	316	195	18	49	204	106	51	132	346	222	498	189
Qtzite.1	1	n	11	34	30	83	27	6	9	38	21	39	76	35	49	86	31
		%	-	-	58,8	57,6	39,1	-	-	77,6	-	73,6	60,3	62,5	67,1	49,4	50,8
	2/2	n	-	1	8	40	33	4	9	11	8	12	39	14	21	62	21
		%	-	-	15,7	27,8	47,8	-	-	22,4	-	22,6	31,0	25,0	28,8	35,6	34,4
	2/3+	n	-	-	13	21	9		1	-	3	2	11	7	3	26	9
		%	-	-	25,5	14,6	13,0	-	-	-	-	3,8	8,7	12,5	4,1	14,9	14,8
		n	2	3	1	11	7	-	4	5	7	6	16	5	13	18	2
	Total	1+2	11	35	51	144	69	10	19	49	32	53	126	56	73	174	61
	Total	1-3	13	38	52	155	76	10	23	54	39	59	142	61	86	192	63
Chalc.	1	n	14	53	11	8	22	14	27	48	14	14	31	7	5	21	4
		%	-	94,6	-	-			-	80,0	-	-	79,5	-	-	47,7	-
	2/2	n	-	2	1	2	6	4	9	12	4	5	6	4	6	16	2
		%	-	3,6	-	-			-	20,0	-	-	15,4	-	-	36,4	-
	2/3+	n	-	1	2	-	1		1	-	1	1	2	-	2	7	-
		%	-	1,8	-	-			-	-		-	5,1	-	-	15,9	-
		n	14	62	3	5	9	6	28	14	14	11	9	1	1	4	-
	Total	1+2	14	56	14	10	29	18	37	60	29	20	39	11	13	44	6
	Total	1-3	28	118	17	15	38	24	65	74	33	31	48	12	14	48	6

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; 1= plain; 2 = prepared; 3 = indeterminate

APPENDIX 13 UNBROKEN/TOTAL FLAKE PROPORTIONS

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum 1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS LR.C	2WA	1RBS	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
Rhy.1	Unbr.	87	248	299	584	345	42	107	353	173	126	292	569	382	824	348
	Dam.	148	434	367	875	751	184	347	1423	633	488	825	1652	1473	2316	883
	Total	235	682	666	1459	1096	226	454	1776	806	614	1117	2221	1855	3140	1231
	%	37,0	36,4	44,9	40,0	31,5	18,6	23,6	19,9	21,5	20,5	26,1	25,6	20,6	26,2	28,3
Rhy.2	Unbr.	38	79	24	26	45	2	11	9	18	36	25	56	28	49	45
	Dam.	68	102	25	37	65	12	19	19	28	94	46	101	84	98	61
	Total	106	181	49	63	110	14	30	28	46	130	71	157	112	147	106
	%	35,8	43,6	49,0	41,3	40,9	-	-	-	39,1	27,7	35,2	35,7	25,0	33,3	42,5
Qtzite.1	Unbr.	23	75	94	248	110	20	45	99	73	92	283	98	146	303	96
	Dam.	17	80	101	266	164	30	77	217	135	210	389	171	439	501	206
	Total	40	155	195	514	274	50	122	316	208	302	672	269	585	804	302
	%	57,5	48,4	48,2	48,2	40,1	40,0	36,9	31,3	35,1	30,5	42,1	36,4	25,0	37,7	31,8
Chalc.	Unbr.	61	216	41	33	79	50	133	137	66	71	100	28	29	89	12
	Dam.	95	293	100	29	135	64	215	228	116	142	153	61	65	182	32
	Total	156	509	141	62	214	114	348	365	182	213	253	89	94	271	44
	%	39,1	42,4	29,1	53,2	36,9	43,9	38,2	37,5	36,3	33,8	39,5	31,5	30,9	32,8	27,3
Addit.	Unbr.	16	31	20	141	31	2	8	11	13	10	22	9	24	81	14
	Dam.	12	42	30	184	41	2	6	34	18	30	45	16	54	141	23
	Total	28	73	50	325	72	4	14	45	31	40	67	25	78	222	37
	%	-	42,5	40,0	43,4	43,1	-	-	24,4	-	25,0	32,8	-	30,8	36,5	-

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional; Unbr. = unbroken; Dam. = damaged

Appendix 14 Core subclass proportions

Border Cave. Exc. 3A + 3B

		Stratum							
Material	Analysis	IBS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1 +	Irregular n	9	10	26	6	12	28	30	20
Qtzite.1	Irregular %	-	50,0	54,2	-	31,6	59,6	48,4	55,6
	Bipolar n	3	-	-	-	1	-	-	-
	Bipolar %	-	-	-	-	2,6	-	-	-
	Adj.plat.n	-	1	1	3	1	3	12	9
	Adj.plat.%	-	5,0	2,1	-	2,6	6,4	19,4	25,0
	Rad.prep.n	2	7	19	3	22	15	18	7
	Rad.prep.%	-	35,0	39,6	-	57,9	31,9	29,0	19,4
	Pln.plat.n	1	2	2	-	2	1	2	-
	Pln.plat.%	-	10,0	4,2	-	5,3	2,1	3,2	-
	Total n	15	20	48	12	38	47	62	36
	Total %	-	100,0	100,1	-	100,0	100,0	100,0	100,0

Appendix 14 (continued)

Material	Analysis	Stratum 1BS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO. A+B	BACO. C+D
Qtz.1+2	Irregular n	13	2	3	1	6	2	-	1
	Irregular %	5,7	-	-	-	-	-	-	-
	Bipolar n	217	2	1	2	12	1	-	-
	Bipolar %	94,3	-	-	-	-	-	-	-
	Adj.plat.n	-	-	-	-	-	1	1	-
	Adj.plat.%	-	-	-	-	-	-	-	-
	Rad.prep.n	-	-	-	-	-	-	-	-
	Rad.prep.%	-	-	-	-	-	-	-	-
	Pln.plat.n	-	-	-	-	-	-	-	-
	Pln.plat.%	-	-	-	-	-	-	-	-
	Total n	230	4	4	3	18	4	1	1
	Total %	100,0	-	-	-	-	-	-	-

Appendix 14 (continued)

Material	Analysis	Stratum IBS.LR.+ 1WA+IBES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO. A+B	BACO. C+D
Chalc.	Irregular n	104	16	14	42	24	30	3	28
	Irregular %	17,7	51,6	-	91,3	64,9	85,7	-	87,5
	Bipolar n	483	10	-	1	-	1	-	-
	Bipolar %	82,0	32,3	-	2,2	-	2,9	-	-
	Adj.plat. n	-	1	-	1	-	-	1	3
	Adj.plat.%	-	3,2	-	2,2	-	-	-	9,4
	Rad.prep. n	1	3	2	2	9	2	1	1
	Rad.prep.%	0,2	9,7	-	4,3	24,3	5,7	-	3,1
	Pln.plat. n	1	1	1	-	4	2	-	-
	Pln.plat.%	0,2	3,2	-	-	10,8	5,7	-	-
	Total n	589	31	17	46	37	35	5	32
	Total %	100,1	100,0	-	100,0	100,0	100,0	-	100,0

Appendix 14 (continued)

Material	Analysis	Stratum 1BS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO. A+B	BACO. C+D
All	Irregular n	126	28	45	50	42	65	33	53
	Irregular %	15,1	50,0	62,5	79,4	45,2	70,7	47,1	71,6
	Bipolar n	705	12	1	3	13	2	-	-
	Bipolar %	84,3	21,4	1,4	4,8	14,0	2,2	-	-
	Adj.plat. n	-	2	1	4	1	5	16	13
	Adj.plat. %	-	3,6	1,4	6,3	1,1	5,4	22,9	17,6
	Rad.prep. n	3	10	22	6	31	17	19	8
	Rad.prep. %	0,4	17,9	30,6	9,5	33,3	18,5	27,1	10,8
	Pln.plat. n	2	4	3	-	6	3	2	-
	Pln.plat. %	0,2	7,1	4,2	-	6,5	3,3	2,9	-
	Total n	836	56	72	63	93	92	70	74
	Total %	100,0	100,0	100,1	100,0	100,1	100,1	100,0	100,0

Abbreviations

Chalc. = chalcedony; Adj.plat. = adjacent platform; Rad.prep. = radial prepared; Pln.plat = plain platform.

Appendix 15 Flake minimum number /core proportions

Border Cave. Exc. 3A + 3B

Material	Analysis	Stratum 1BS.LR.+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP.+LR	BACO A+B	BACO C+D
Rhy.1	Core η	12	16	40	8	32	31	53	30
	Flake η	919	671	2603	469	2598	1742	4091	4384
	Fl/Core	76,6	41,9	65,1	58,6	81,2	56,2	77,2	146,1
Rhy.2	Core η	-	-	2	-	-	3	-	5
	Flake η	287	49	174	30	75	201	269	253
	Fl/Core	-	-	-	-	-	-	-	50,6
Qtzite.1	Core η	3	4	8	4	6	16	9	6
	Flake η	195	196	802	124	533	982	866	1115
	Fl/Core	-	-	100,3	-	88,8	61,4	96,2	185,8
Qtz.1+2	Core η	230	4	4	3	18	4	1	1
	Flake η	78	31	16	6	51	4	2	7
	Fl/Core	0,3	-	-	-	2,8	-	-	-
Chalc.	Core η	589	31	17	46	37	35	5	32
	Flake η	668	144	281	364	560	468	185	324
	Fl/Core	1,1	4,6	16,5	7,9	15,1	13,4	37,0	10,1
Addit.	Core η	2	1	1	2	-	3	2	-
	Flake η	101	55	409	14	85	108	107	260
	Fl/Core	-	-	-	-	-	-	-	-

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Qtz. = quartz; Chalc. = chalcedony; Addit. = additional; Fl. = flake

Appendix 16 Proximal/Broken Flake proportions

Border Cave. Exc. 3A + 3B

Material	Analysis	Stratum														
		1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS.LR. C	2WA	1RBS.	3BS+ 3WA	1RGBS. A	1RGBS. B	1GBS. UP	1GBS. LR	BACO. A	BACO. B	BACO C	BACO D
Rhy.1	Prox.	148	434	367	875	751	184	347	1423	633	488	825	1652	1473	2316	883
	Dist.	36	104	167	431	413	121	267	1109	484	214	504	1022	900	1164	429
	Total	184	538	534	1306	1164	305	614	2532	1117	702	1329	2674	2373	3480	1312
	%	80,4	80,7	68,7	67,0	64,5	60,3	56,5	56,2	56,7	69,5	62,1	61,8	62,1	66,6	67,3
Rhy.2	Prox.	68	102	25	37	65	12	19	19	28	94	46	101	84	98	61
	Dist.	20	17	7	14	23	5	4	2	10	21	18	22	31	31	18
	Total	88	119	32	51	88	17	23	21	38	115	64	123	115	129	79
	%	73,3	93,6	-	72,5	73,9	-	-	-	-	81,7	71,9	82,1	73,0	76,0	77,2
Qtzite. 1	Prox.	17	80	101	266	164	30	77	217	135	210	389	171	439	501	206
	Dist.	7	26	52	113	91	18	67	167	116	85	251	114	294	304	109
	Total	24	106	153	379	255	48	144	384	251	295	640	285	733	805	315
	%	-	75,5	66,0	70,2	64,3	62,5	53,5	56,5	53,8	71,2	60,8	60,0	59,9	62,2	65,4
Chalc.	Prox.	95	293	100	29	135	64	215	228	116	142	153	61	65	182	32
	Dist.	55	190	62	7	82	41	178	225	107	68	89	47	43	112	19
	Total	150	483	162	36	217	105	393	453	223	210	242	108	108	294	51
	%	63,3	60,7	61,7	-	62,2	61,0	54,7	50,3	52,0	67,6	63,2	56,5	60,2	61,9	62,7
Addit.	Prox.	12	42	30	184	41	2	6	34	18	30	19	16	54	141	23
	Dist.	3	9	10	80	21	1	6	31	19	15	9	4	21	50	11
	Total	15	51	40	264	62	3	12	65	37	45	28	20	75	191	34
	%	-	82,4	75,0	69,7	66,1	-	-	52,3	-	66,7	-	-	72,0	73,8	-

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional; Prox. = proximal; Dist. = distal

Appendix 17 Unclassifiable wast/flake minimum number proportions

Border Cave. Exc. 3A + 3B

Material	Analysis	Stratum 1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS LR.C	2WA	1RBS	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO A	BACO B	BACO C	BACO D
Rhy.1	Waste n	102	288	114	180	230	87	222	616	320	294	385	880	928	891	371
	Flake n	237	682	671	1496	1107	227	469	1785	813	617	1125	2225	1866	3149	1235
	Waste %	43	42	17	12	21	38	47	35	39	48	34	40	50	28	30
Rhy.2	Waste n	22	31	7	2	25	1	5	7	3	16	7	14	6	11	4
	Flake n	106	181	49	63	111	14	30	29	46	130	71	157	112	147	106
	Waste %	21	17	14	3	23	-	-	-	7	12	10	9	5	7	4
Qtzite.1	Waste n	11	51	21	52	31	11	30	36	31	96	142	56	228	155	51
	Flake n	40	155	196	525	277	50	124	322	211	303	679	271	595	811	304
	Waste %	28	33	11	10	11	22	24	11	15	32	21	21	38	19	17
Qtz.1+2	Waste n	613	2339	74	12	37	13	30	82	46	40	11	5	3	14	-
	Flake n	27	51	31	6	10	4	6	29	22	2	2	1	1	7	-
	Waste %	2270	4586	-	-	-	-	-	-	-	-	-	-	-	-	--
Chalc.	Waste n	1248	6589	363	57	359	170	604	529	299	536	543	132	180	486	46
	Flake n	156	512	144	62	219	118	364	372	188	213	255	89	96	280	44
	Waste %	800	1287	252	92	164	144	166	142	159	252	213	148	188	174	105
Addit.	Waste n	28	26	5	24	6	1	-	5	1	5	9	6	15	28	3
	Flake n	28	73	55	333	76	4	14	51	34	41	67	25	82	223	37
	Waste %	-	36	9	7	8	-	-	10	-	12	13	-	18	13	-

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Qtz. = quartz; Chalc. = chalcedony; Addit. = additional; Waste n = unclassifiable waste number; Flake n = flake minimum number; % = rounded off to nearest whole number

APPENDIX 18 RAW MATERIAL CLASS PROPORTIONS

Border Cave. Exc. 3A + 3B

Material	Analysis	Stratum 1BS.LR	1WA+ 1BES	2BS.UP +LR.A+B	2BS. LR.C	2WA	1RBS	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
Rhy.1	n	237	683	671	1496	1107	227	469	1785	813	618	1125	2226	1866	3149	1235
	%	37,6	36,1	56,4	60,2	61,3	54,2	46,5	69,2	61,9	47,2	51,1	80,4	67,8	68,2	71,6
Rhy.2	n	106	181	49	63	111	14	30	29	46	130	71	155	112	147	106
	%	16,8	9,6	4,1	2,5	6,1	3,3	3,0	1,1	3,5	9,9	3,2	5,6	4,1	3,2	6,1
Qtzite.1	n	40	155	196	525	277	50	124	310	211	303	680	271	595	811	304
	%	6,3	8,2	16,5	21,1	15,3	11,9	12,3	12,0	16,1	23,2	30,9	9,8	21,6	17,6	17,6
Qtz.1+2	n	37	101	46	6	14	4	7	30	23	2	2	1	1	7	-
	%	5,9	5,3	3,9	0,2	0,8	1,0	0,7	1,2	1,8	0,2	0,1	0,0	0,0	0,2	0,0
Chalc.	n	182	700	172	63	222	120	364	374	188	214	257	89	97	281	44
	%	28,9	37,0	14,5	2,5	12,3	28,6	36,1	14,5	14,3	16,4	11,7	3,2	3,5	6,1	2,5
Addit.	n	28	73	55	333	76	4	14	51	32	41	67	25	82	223	37
	%	4,4	3,9	4,6	13,4	4,2	1,0	1,4	2,0	2,4	3,1	3,0	0,9	3,0	4,8	2,1
Total	n	630	1893	1189	2486	1807	419	1008	2579	1313	1308	2202	2767	2753	4618	1726
	%	99,9	100,1	100,0	99,9	100,0	100,0	100,0	100,0	100,0	100,0	100,0	99,9	100,0	100,1	99,9

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Qtz. = quartz; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3A Stratum 1BS.LR

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	43	$\bar{X}$	41,3	39,0	12,6	97,5	30,7	32,3	31,5	-	93,0	7,0	11,6	88,4
	I2	32	$\bar{X}$	31,4	32,8	8,7	114,8	29,5	27,4	-	9,4	81,3	9,4	6,2	93,8
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Rhy. 2	I1	20	$\bar{X}$	44,6	41,3	14,2	104,1	33,1	34,2	-	-	85,0	15,0	5,0	95,0
	I2	11	$\bar{X}$	33,2	29,8	7,4	97,5	22,5	25,0	-	-	90,9	9,1	9,1	90,9
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	10	$\bar{X}$	31,9	35,0	10,4	116,7	31,8	31,4	-	-	100,0	-	30,0	70,0
	I2	13	$\bar{X}$	31,4	29,9	8,0	103,9	25,7	26,4	-	-	84,6	15,4	15,4	84,6
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Chalc.	I1	24	$\bar{X}$	14,2	14,3	3,4	111,5	25,1	26,2	-	4,2	62,5	33,3	4,2	95,8
	I2	28	$\bar{X}$	12,5	12,0	2,7	103,5	21,6	23,4	-	-	50,0	50,0	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	I1	7	$\bar{X}$	30,2	37,4	9,1	143,9	30,4	22,4	-	14,3	71,4	14,3	-	100,0
	I2	8	$\bar{X}$	26,6	29,2	5,6	107,8	20,8	19,6	-	-	87,5	12,5	12,5	87,5
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres . = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3A Stratum 1WA and 1BES

Raw Material	Flake subclass	Sample n	Analy-sis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	102	$\bar{X}$	34,1	35,7	9,1	112,0	27,4	26,5	27,0	5,9	85,3	8,8	4,9	95,1
	I2	110	$\bar{X}$	30,3	27,2	6,7	99,5	23,3	24,5	23,9	9,1	84,5	6,4	10,0	90,0
			SX	14,50	10,15	3,45	33,30	8,35	7,95						
			S$\bar{X}$	1,40	0,95	0,35	3,20	0,80	0,75						
Rhy. 2	I1	40	$\bar{X}$	40,9	36,6	10,8	98,1	27,9	31,7	29,8	5,0	95,0	–	5,0	95,0
	I2	27	$\bar{X}$	34,7	34,2	7,9	103,6	23,3	23,8	–	3,7	81,5	14,8	3,7	96,3
			SX	–	–	–	–	–	–						
			S$\bar{X}$	–	–	–	–	–	–						
Qtzite 1	I1	25	$\bar{X}$	32,6	31,8	9,2	111,0	30,3	29,4	–	–	92,0	8,0	12,0	88,0
	I2	38	$\bar{X}$	28,4	24,5	6,5	93,2	23,1	27,1	25,1	2,6	89,5	7,9	10,5	89,5
			SX	13,70	10,85	3,80	37,75	8,95	12,20						
			S$\bar{X}$	2,20	1,75	0,60	6,15	1,45	2,00						
Chalc.	I1	79	$\bar{X}$	15,7	13,3	3,5	88,8	22,1	26,2	24,2	–	58,2	41,8	2,5	97,5
	I2	118	$\bar{X}$	12,2	11,3	2,3	94,8	18,0	19,9	19,0	2,5	44,9	52,6	4,2	95,8
			SX	4,80	5,75	1,40	30,00	6,85	6,95						
			S$\bar{X}$	0,45	0,55	0,15	2,80	0,65	0,65						
Addit.	I1	20	$\bar{X}$	35,7	42,4	10,2	119,4	27,8	24,7	–	–	100,0	–	10,0	90,0
	I2	7	$\bar{X}$	24,6	32,4	6,6	137,3	26,9	20,0	–	–	85,7	14,3	14,3	85,7
			SX	–	–	–	–	–	–						
			S$\bar{X}$	–	–	–	–	–	–						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate; Pres . = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3A Stratum 2BS.UP and 2BS.LR.A+B

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	77	$\bar{X}$	36,6	32,0	9,1	94,2	25,5	28,9	27,2	24,7	68,8	6,5	15,6	84,4
	I2	160	$\bar{X}$	33,3	28,6	6,9	92,2	20,6	23,7	22,2	36,3	56,3	7,4	22,5	77,5
			SX	14,60	11,90	3,85	31,40	6,45	8,05						
			$S\bar{X}$	1,15	0,95	0,30	2,50	0,50	0,65						
Rhy. 2	I1	10	$\bar{X}$	46,6	43,6	13,7	99,6	32,2	34,0	–	10,0	80,0	10,0	30,0	70,0
	I2	13	$\bar{X}$	34,0	33,5	7,9	103,1	22,9	24,4	–	23,1	46,2	30,7	–	100,0
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						
Qtzite 1	I1	15	$\bar{X}$	44,0	36,6	9,5	85,9	22,2	26,5	–	13,3	86,7	–	40,0	60,0
	I2	52	$\bar{X}$	30,1	28,4	6,1	103,1	21,1	21,3	21,2	40,4	57,7	1,9	34,6	65,4
			SX	14,90	11,90	3,20	34,55	8,20	7,00						
			$S\bar{X}$	2,05	1,65	0,45	4,80	1,15	0,95						
Chalc.	I1	17	$\bar{X}$	27,6	21,4	5,3	83,2	21,1	25,9	–	47,1	52,9	–	5,9	94,1
	I2	17	$\bar{X}$	12,7	12,5	2,4	102,3	19,9	19,6	–	17,6	64,8	17,6	–	100,0
			SX	–	–	–	–	–							
			$S\bar{X}$	–	–	–	–	–							
Addit.	I1	3	$\bar{X}$	35,5	46,3	8,8	137,5	24,5	18,5	–	–	100,0	–	–	100,0
	I2	13	$\bar{X}$	21,2	20,0	4,5	98,7	19,7	21,5	–	23,1	61,5	15,4	–	100,0
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19. Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3A Stratum 2BS.LR.C

Raw Material	Flake subclass	Sample n	Analy-sis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. % Fac.	Pln.	Ind.	Util. % Pres.	Abs.
Rhy. 1	I1	129	X̄	43,7	38,3	11,6	93,9	27,2	30,9	29,2	17,1	74,4	8,5	21,7	78,3
	I2	316	X̄	38,5	31,7	7,9	90,2	21,2	24,8	23,0	36,7	56,0	7,3	24,4	75,6
			SX	16,40	12,25	3,75	34,00	7,80	8,00						
			SX̄	0,90	0,70	0,20	2,00	0,45	0,45						
Rhy. 2	I1	13	X̄	53,4	43,6	12,5	87,4	24,7	29,4	-	23,1	76,9	-	7,7	92,3
	I2	10	X̄	36,4	32,0	9,4	93,5	27,1	27,1	-	-	90,0	10,0	-	100,0
			SX	-	-	-	-	-	-						
			SX̄	-	-	-	-	-	-						
Qtzite 1	I1	50	X̄	45,1	32,9	9,2	83,2	21,4	27,3	24,4	24,0	68,0	8,0	36,0	64,0
	I2	155	X̄	37,6	30,7	7,5	90,8	20,9	24,9	22,9	39,4	53,5	7,1	33,5	66,5
			SX	17,30	10,65	3,65	32,80	6,80	9,35						
			SX̄	1,40	0,85	0,30	2,65	0,55	0,75						
Chalc.	I1	15	X̄	24,6	22,9	6,6	98,9	27,2	29,5	-	6,7	80,0	13,3	-	100,0
	I2	15	X̄	16,0	19,3	3,7	129,6	24,5	19,2	-	13,3	53,4	33,3	-	100,0
			SX	-	-	-	-	-	-						
			SX̄	-	-	-	-	-	-						
Addit.	I1	20	X̄	45,8	37,6	8,5	94,0	20,3	22,9	-	30,0	60,0	10,0	25,0	75,0
	I2	91	X̄	33,8	28,9	7,3	94,5	22,2	25,0	23,6	34,1	56,0	9,9	18,7	81,3
			SX	14,95	10,85	3,65	33,20	8,00	8,90						
			SX̄	1,55	1,15	0,40	3,50	0,85	0,95						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3A Stratum 2WA

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	86	$\bar{X}$	42,6	34,8	10,8	90,3	27,0	31,3	29,2	22,1	67,4	10,5	3,5	96,5
	I2	195	$\bar{X}$	30,5	27,3	6,1	96,8	20,8	22,6	21,7	25,6	60,0	14,4	13,8	86,2
			SX	13,80	10,60	3,00	31,30	6,25	7,25						
			$S\bar{X}$	1,00	0,75	0,20	2,25	0,45	0,50						
Rhy. 2	I1	22	$\bar{X}$	53,4	45,5	14,3	86,8	27,0	32,2	–	9,1	81,8	9,1	4,5	95,5
	I2	20	$\bar{X}$	37,1	36,1	9,8	104,0	26,7	27,1	–	30,0	65,0	5,0	–	100,0
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						
Qtzite 1	I1	21	$\bar{X}$	37,1	27,4	9,0	75,4	25,0	32,9	–	19,0	76,2	4,8	4,8	95,2
	I2	76	$\bar{X}$	33,8	29,9	6,3	95,9	19,2	20,9	20,1	55,3	35,5	9,2	14,5	85,5
			SX	17,15	12,05	3,50	29,50	6,15	6,40						
			$S\bar{X}$	1,95	1,40	0,40	3,40	0,70	0,75						
Chalc.	I1	35	$\bar{X}$	24,0	22,6	6,6	95,0	28,0	30,2	–	5,7	68,6	25,7	5,7	94,3
	I2	38	$\bar{X}$	17,3	16,0	3,7	97,0	22,3	23,4	–	18,4	57,9	23,7	5,3	94,7
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						
Addit.	I1	9	$\bar{X}$	28,9	26,2	6,2	101,6	22,3	24,6	–	44,4	44,4	11,2	11,1	88,9
	I2	18	$\bar{X}$	35,6	33,0	7,5	105,1	23,2	23,0	–	50,0	33,3	16,7	16,7	83,3
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres . = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3B Stratum 1RBS

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	16	$\bar{X}$	33,9	25,5	7,1	83,4	21,3	27,9	-	12,5	68,8	18,7	6,2	93,8
	I2	18	$\bar{X}$	26,9	23,3	5,6	97,0	21,0	23,4	-	16,7	61,1	22,2	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Rhy. 2	I1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	I2		$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	7	$\bar{X}$	41,9	32,9	8,9	79,2	21,0	26,6	-	28,6	57,1	14,3	28,6	71,4
	I2	10	$\bar{X}$	46,2	23,7	6,0	62,4	15,3	25,5	-	40,0	60,0	-	20,0	80,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Chalc.	I1	18	$\bar{X}$	21,3	14,4	4,6	81,1	22,8	31,3	-	11,1	50,0	38,9	16,7	83,3
	I2	24	$\bar{X}$	21,1	15,7	3,9	88,9	21,1	25,5	-	16,7	58,3	25,0	16,7	83,3
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	I1	1	$\bar{X}$	31,0	16,0	4,5	51,6	14,5	28,1	-	-	100,0	-	-	100,0
	I2	1	$\bar{X}$	22,5	22,5	3,5	100,0	15,6	15,6	-	-	100,0	-	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3A Stratum 3BS. and 3WA.

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	36	$\bar{X}$	39,9	33,1	9,3	92,8	24,6	28,4	-	13,9	77,8	8,3	13,9	86,1
	I2	49	$\bar{X}$	27,5	22,9	4,9	97,9	18,8	20,4	19,6	34,7	38,8	26,5	26,5	73,5
			SX	17,65	11,05	3,35	37,95	8,20	7,15						
			S$\bar{X}$	2,50	1,60	0,45	5,40	1,15	1,00						
Rhy. 2	I1	7	$\bar{X}$	47,0	34,1	12,9	76,6	30,2	37,4	-	-	100,0	-	14,3	85,7
	I2	4	$\bar{X}$	50,3	42,5	12,4	85,4	23,8	28,0	-	50,0	50,0	-	25,0	75,0
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	4	$\bar{X}$	35,9	38,5	8,5	115,0	22,2	19,8	-	25,0	75,0	-	50,0	50,0
	I2	23	$\bar{X}$	29,2	23,5	5,5	92,6	19,8	23,1	-	43,5	39,1	17,4	17,4	82,6
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Chalc.	I1	33	$\bar{X}$	26,2	20,4	5,4	79,4	20,7	27,1	-	12,1	63,6	24,2	12,1	87,9
	I2	65	$\bar{X}$	19,2	15,4	3,1	93,7	17,2	18,9	18,1	15,4	41,5	43,1	12,3	87,7
			SX	14,30	7,90	2,50	31,15	7,30	6,80						
			S$\bar{X}$	1,75	1,00	0,30	3,85	0,90	0,85						
Addit.	I1	3	$\bar{X}$	32,3	32,8	7,3	123,8	25,4	24,4	-	-	100,0	-	-	100,0
	I2	2	$\bar{X}$	36,5	30,3	6,3	92,4	17,8	19,6	-	-	100,0	-	50,0	50,0
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres . = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3B Stratum 1RGBS.A.

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform Prep. % Fac.	Platform Prep. % Pln.	Platform Prep. % Ind.	Util. % Pres.	Util. % Abs.
Rhy. 1	I1	75	$\bar{X}$	33,2	28,8	7,9	93,2	24,6	27,6	26,1	21,3	72,0	6,7	10,7	89,3
	I2	204	$\bar{X}$	25,0	20,7	4,4	91,8	18,2	20,8	19,5	22,5	71,6	5,9	11,3	88,7
			SX	13,85	8,65	2,55	29,05	6,20	6,95						
			$S\bar{X}$	0,95	0,60	0,20	2,05	0,40	0,50						
Rhy. 2	I1	4	$\bar{X}$	36,0	33,8	10,9	97,0	27,5	29,5	-	-	100,0	-	-	100,0
	I2	3	$\bar{X}$	32,8	32,2	8,2	96,5	24,3	25,3	-	-	100,0	-	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	19	$\bar{X}$	26,6	22,5	5,9	86,1	21,2	25,8	-	15,8	63,2	21,0	10,5	89,5
	I2	54	$\bar{X}$	24,6	20,2	4,1	91,4	17,9	20,9	19,4	20,4	70,4	9,2	20,4	79,6
			SX	12,25	8,10	1,95	31,90	5,85	6,95						
			$S\bar{X}$	1,65	1,10	0,25	4,35	0,80	0,95						
Chalc.	I1	37	$\bar{X}$	21,4	16,2	4,6	81,9	22,0	28,8	-	10,8	67,6	21,6	5,4	94,6
	I2	74	$\bar{X}$	17,8	13,7	2,8	87,3	17,9	20,6	19,3	16,2	64,9	18,9	13,5	86,5
			SX	9,80	6,05	1,65	36,35	8,40	6,85						
			$S\bar{X}$	1,15	0,70	0,20	4,25	0,95	0,80						
Addit.	I1	2	$\bar{X}$	25,0	23,8	5,0	95,1	19,6	20,7	-	-	50,0	50,0	-	100,0
	I2	5	$\bar{X}$	22,7	19,7	5,2	87,8	23,2	25,8	-	-	100,0	-	20,0	80,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3B Stratum 1RGBS.B

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	37	$\bar{X}$	38,7	28,3	8,8	78,5	23,6	33,6	-	27,0	73,0	-	21,6	78,4
	I2	106	$\bar{X}$	25,8	22,5	4,8	96,4	19,5	21,3	20,4	22,6	64,2	13,2	10,4	89,6
			SX	14,70	9,00	2,70	33,0	7,25	6,95						
			$S\bar{X}$	1,45	0,85	0,25	3,20	0,70	0,70						
Rhy. 2	I1	10	$\bar{X}$	50,6	51,4	16,6	110,5	33,3	31,2	-	-	100,0	-	-	100,0
	I2	7	$\bar{X}$	41,1	35,9	7,6	93,9	20,4	21,5	-	14,3	71,4	-	42,9	57,1
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	17	$\bar{X}$	39,9	29,3	8,1	81,6	21,2	28,4	-	5,9	70,6	23,5	29,4	70,6
	I2	39	$\bar{X}$	29,0	22,1	4,8	86,1	17,6	21,9	19,8	28,2	53,8	18,0	30,8	69,2
			SX	14,05	6,80	2,15	30,10	6,00	8,00						
			$S\bar{X}$	2,00	1,10	0,35	4,80	0,95	1,30						
Chalc.	I1	18	$\bar{X}$	21,9	17,2	4,4	88,1	20,1	24,7	-	16,6	55,6	27,8	11,1	88,9
	I2	33	$\bar{X}$	17,8	16,0	3,0	94,4	17,4	18,7	-	15,2	42,4	42,4	18,2	81,8
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	I1	1	$\bar{X}$	43,0	34,0	11,0	79,1	25,6	32,4	-	-	100,0	-	100,0	-
	I2	10	$\bar{X}$	25,1	20,5	3,8	88,0	15,0	18,0	-	10,0	50,0	40,0	20,0	80,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3A Stratum IGBS.UP.

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	52	$\bar{X}$	39,4	34,1	11,1	91,6	29,0	32,9	31,0	17,3	75,0	7,7	5,8	94,2
	I2	51	$\bar{X}$	31,6	26,7	7,6	88,0	24,3	28,5	26,4	33,3	62,7	4,0	19,6	80,4
			SX	13,65	10,00	3,65	22,05	7,90	8,90						
			S$\bar{X}$	1,90	1,40	0,50	3,10	1,10	1,25						
Rhy. 2	I1	12	$\bar{X}$	68,9	52,2	16,3	79,2	23,9	32,2	-	-	100,0	-	8,3	91,7
	I2	19	$\bar{X}$	39,4	36,7	9,7	95,1	24,9	26,7	-	26,3	68,4	5,3	-	100,0
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	18	$\bar{X}$	33,9	24,3	6,8	80,0	20,5	28,9	-	11,1	77,8	11,1	16,7	83,3
	I2	59	$\bar{X}$	27,4	23,1	5,8	96,4	22,7	25,2	24,0	23,7	66,1	10,2	15,3	84,7
			SX	13,20	8,95	3,05	43,30	8,75	7,65						
			S$\bar{X}$	1,70	1,15	0,40	5,65	1,15	1,00						
Chalc.	I1	34	$\bar{X}$	19,8	16,6	4,8	94,4	25,5	29,2	-	5,9	73,5	20,6	-	100,0
	I2	31	$\bar{X}$	17,6	16,9	3,9	102,5	22,8	23,1	-	19,4	45,2	35,5	12,9	87,1
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Addit.	I1	8	$\bar{X}$	37,9	27,6	9,9	78,2	25,6	38,5	-	25,0	75,0	-	12,5	87,5
	I2	2	$\bar{X}$	20,3	24,0	5,3	119,2	24,9	20,9	-	-	50,0	50,0	-	100,0
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation. 3A Stratum 1GBS.LR.

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	93	$\bar{X}$	34,8	29,2	8,5	90,8	25,5	29,0	27,3	15,1	82,8	2,1	11,8	88,2
	I2	132	$\bar{X}$	31,8	25,3	6,5	84,8	21,1	25,8	23,5	29,5	62,9	7,6	18,9	81,1
			SX	13,00	10,40	3,25	28,10	8,25	8,10						
			S$\bar{X}$	1,15	0,90	0,30	2,45	0,70	0,70						
Rhy. 2	I1	12	$\bar{X}$	40,7	35,5	11,1	98,4	29,6	32,2	-	8,3	91,7	-	16,7	83,3
	I2	8	$\bar{X}$	36,7	30,8	8,2	98,0	23,1	24,4	-	25,0	50,0	25,0	12,5	87,5
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	73	$\bar{X}$	37,6	28,8	7,8	82,7	21,5	27,4	24,5	19,2	74,0	6,8	12,3	87,7
	I2	142	$\bar{X}$	32,7	25,5	6,4	84,0	20,3	25,3	22,8	35,2	53,5	11,3	21,1	78,9
			SX	13,35	9,75	3,00	29,80	7,60	7,95						
			S$\bar{X}$	1,10	0,80	0,25	2,50	0,65	0,65						
Chalc.	I1	38	$\bar{X}$	24,5	18,9	5,6	83,2	24,2	30,5	-	7,9	76,3	15,8	5,3	94,7
	I2	48	$\bar{X}$	21,1	17,5	4,0	90,4	19,6	22,9	21,3	16,7	64,6	18,7	6,2	93,8
			SX	9,45	7,60	1,95	34,05	6,50	6,85						
			S$\bar{X}$	1,35	1,10	0,30	4,90	0,95	1,00						
Addit.	I1	6	$\bar{X}$	40,0	30,8	8,3	79,3	22,2	28,6	-	50,0	50,0	-	33,3	66,7
	I2	11	$\bar{X}$	29,3	23,5	6,1	96,4	21,4	25,0	-	45,5	45,5	9,0	18,2	81,8
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3A Stratum BACO.A

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	136	$\bar{X}$	36,8	31,6	8,6	94,3	25,0	28,5	26,8	25,0	71,3	3,7	6,6	93,4
	I2	346	$\bar{X}$	33,6	27,3	7,0	88,5	21,4	25,2	23,3	35,0	59,0	6,0	13,3	86,7
			SX	16,75	11,90	3,85	28,70	7,60	7,65						
			$S\bar{X}$	0,90	0,65	0,20	1,55	0,40	0,40						
Rhy. 2	I1	18	$\bar{X}$	45,6	39,1	10,1	96,8	24,1	26,2	-	22,2	72,2	5,6	-	100,0
	I2	30	$\bar{X}$	41,6	35,1	10,5	84,3	24,6	30,0		23,3	73,3	3,4	10,0	90,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	20	$\bar{X}$	38,2	28,6	8,1	78,9	20,8	30,5	-	20,0	70,0	10,0	5,0	95,0
	I2	61	$\bar{X}$	30,6	24,4	6,1	86,2	20,8	24,6	22,7	34,4	57,4	8,2	26,2	73,8
			SX	13,50	8,80	3,30	26,00	9,35	8,35						
			$S\bar{X}$	1,75	1,15	0,45	3,35	1,20	1,05						
Chalc.	I1	14	$\bar{X}$	19,6	16,5	4,3	86,1	22,5	26,3	-	28,6	35,7	35,7	14,3	85,7
	I2	12	$\bar{X}$	25,1	21,2	6,1	81,8	22,0	26,7	-	33,3	58,3	8,4	16,7	83,3
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	I1	1	$\bar{X}$	25,5	24,5	6,5	96,1	25,5	26,5	-	-	100,0	-	-	100,0
	I2	6	$\bar{X}$	30,8	28,8	7,3	95,7	23,6	24,8	-	16,7	83,3		50,0	50,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3B Stratum BACO.B

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	111	$\bar{X}$	40,5	32,0	9,7	87,2	25,6	30,7	28,2	23,4	67,6	9,0	17,1	82,9
	I2	222	$\bar{X}$	35,2	29,5	7,8	90,0	23,2	26,6	24,9	40,1	54,1	5,8	21,6	78,4
			SX	14,20	10,15	3,40	29,95	9,00	8,05						
			$S\bar{X}$	0,95	0,70	0,25	2,00	0,60	0,55						
Rhy. 2	I1	13	$\bar{X}$	42,5	39,0	12,1	101,7	30,0	31,3	-	23,1	76,9		7,7	92,3
	I2	14	$\bar{X}$	37,8	34,0	8,3	97,0	22,4	23,8	-	42,9	57,1		7,1	92,9
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	38	$\bar{X}$	43,2	33,4	9,5	83,7	22,6	28,1	-	23,7	60,5	15,8	18,4	81,6
	I2	86	$\bar{X}$	31,5	25,1	6,1	89,2	20,0	24,0	22,0	27,9	57,0	15,1	18,6	81,4
			SX	16,10	10,0	3,35	33,20	7,80	10,05						
			$S\bar{X}$	1,75	1,10	0,35	3,60	0,85	1,10						
Chalc.	I1	15	$\bar{X}$	27,6	26,2	7,4	102,3	29,2	29,2	-	46,7	33,3	20,0	13,3	86,7
	I2	14	$\bar{X}$	28,7	21,6	4,7	80,0	17,4	22,5	-	57,1	35,7	7,2	21,4	78,6
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	I1	6	$\bar{X}$	49,9	42,3	11,9	93,6	24,8	28,2	-	-	83,3	16,7	-	100,0
	I2	13	$\bar{X}$	44,3	33,7	8,5	78,2	19,5	25,4	-	38,5	61,5	-	15,4	84,6
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3B Stratum BACO.C

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	197	$\bar{X}$	40,6	33,5	9,4	88,1	24,2	28,8	25,0	25,4	65,0	9,6	7,1	92,9
	I2	498	$\bar{X}$	37,4	30,0	7,5	86,7	21,0	25,0	23,0	42,4	51,0	6,6	14,1	85,9
			SX	14,90	9,75	3,20	26,70	8,00	7,45						
			$S\bar{X}$	0,65	0,45	0,15	1,20	0,35	0,35						
Rhy. 2	I1	20	$\bar{X}$	46,2	41,8	11,9	94,8	27,2	29,3	-	20,0	70,0	10,0	-	100,0
	I2	23	$\bar{X}$	36,7	34,3	9,8	95,3	26,7	28,2	-	30,4	60,9	8,7	4,3	95,7
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	I1	64	$\bar{X}$	41,4	31,4	8,8	82,8	21,9	29,7	25,8	10,9	16,6	12,5	7,8	92,2
	I2	192	$\bar{X}$	38,1	28,5	6,8	81,2	18,8	24,3	21,6	45,8	44,8	9,4	16,1	83,9
			SX	15,60	10,20	3,10	29,80	7,05	7,90						
			$S\bar{X}$	1,10	0,75	0,20	2,15	0,50	0,55						
Chalc.	I1	30	$\bar{X}$	32,9	24,8	7,5	83,1	24,8	31,2	-	23,3	63,3	13,4	20,0	80,0
	I2	48	$\bar{X}$	30,8	23,8	5,9	80,7	19,6	25,0	22,3	47,9	43,8	8,3	20,8	79,2
			SX	10,80	7,60	2,60	22,15	6,35	7,25						
			$S\bar{X}$	1,55	1,10	0,40	3,20	0,90	1,05						
Addit.	I1	38	$\bar{X}$	44,2	35,1	10,1	88,1	23,6	28,8	-	10,5	81,6	7,9	-	100,0
	I2	32	$\bar{X}$	33,7	32,1	7,1	100,1	21,9	22,6	-	25,0	65,6	9,4	9,4	90,6
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres . = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 19 Metrical analysis: I1 and I2 subclasses

Border Cave. Excavation 3B Stratum BACO.D

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	I1	95	$\bar{X}$	41,1	33,8	9,5	85,2	24,0	28,9	26,5	26,3	69,5	4,2	7,4	92,6
	I2	189	$\bar{X}$	37,9	29,9	8,0	84,5	22,0	27,0	24,5	41,3	54,0	4,7	16,4	83,6
			SX	13,45	8,65	3,20	25,80	7,00	8,20						
			S$\bar{X}$	1,00	0,65	0,25	1,90	0,50	0,60						
Rhy. 2	I1	19	$\bar{X}$	44,1	37,0	11,5	88,9	26,7	31,0	–	–	84,2	15,8	–	100,0
	I2	21	$\bar{X}$	44,1	34,1	10,0	80,6	23,2	30,6	–	23.8	76,2	–	9,5	90,5
			SX	–	–	–	–	–	–						
			S$\bar{X}$	–	–	–	–	–	–						
Qtzite 1	I1	10	$\bar{X}$	35,5	24,6	8,1	79,0	23,3	33,0	–	20,0	60,0	20,0	10,0	90,0
	I2	63	$\bar{X}$	40,5	30,4	7,9	80,8	20,5	25,8	23,2	47,6	49,2	3,2	25,4	74,6
			SX	14,70	7,95	3,15	23,40	8,10	7,80						
			S$\bar{X}$	1,85	1,00	0,40	2,95	1,00	1,00						
Chalc.	I1	4	$\bar{X}$	37,1	28,6	9,8	80,2	27,5	34,6	–	50,0	25,0	25,0	–	100,0
	I2	6	$\bar{X}$	28,0	19,5	4,9	74,7	18,5	24,6		16,7	66,6	16,7	33,3	66,7
			SX	–	–	–	–	–	–						
			S$\bar{X}$	–	–	–	–	–	–						
Addit.	I1	4	$\bar{X}$	36,6	43,3	8,9	124,6	24,6	20,8	–	25,0	75,0	–	–	100,0
	I2	5	$\bar{X}$	34,1	28,3	5,3	83,2	16,0	20,3	–	20,0	40,0	40,0	–	100,0
			SX	–	–	–	–	–	–						
			S$\bar{X}$	–	–	–	–	–	–						

Abbreviations:

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 20 Metrical analysis: B1 and B2 subclasses

Border Cave. Excavation 3A Stratum 1BS.LR and 1WA and 1BES

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Pel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	B1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	B2	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	B1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	B2	3	$\bar{X}$	48,2	21,2	8,3	47,0	17,4	37,7	-	-	66,7	33,3	66,7	33,3
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Chalc.	B1	3	$\bar{X}$	14,7	9,8	2,3	65,0	15,9	25,4	-	-	33,3	66,7	-	100,0
	B2	3	$\bar{X}$	14,2	5,0	1,5	35,8	10,4	30,9	-	-	-	100,0	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	B1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	B2	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = Utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 20 Metrical analysis: B1 and B2 subclasses

Border Cave. Excavation 3A Stratum 2BS.UP. and 2BS.LR.A+B

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	B1	8	$\bar{X}$	53,9	26,3	8,3	51,9	15,9	31,0	-	12,5	87,5	-	-	100,0
	B2	42	$\bar{X}$	42,4	23,7	6,9	58,6	16,4	28,7	22,6	31,0	61,9	7,1	23,8	76,2
			SX	16,25	7,45	3,00	15,75	4,75	7,15						
			$S\bar{X}$	2,50	1,15	0,45	2,45	0,75	1,10						
Qtzite 1	B1	2	$\bar{X}$	22,8	14,3	3,3	62,1	14,0	22,0	-	-	100,0	-	-	100,0
	B2	18	$\bar{X}$	35,8	19,0	5,4	56,6	15,2	28,1	-	38,9	55,6	5,5	33,3	66,7
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Chalc.	B1	3	$\bar{X}$	52,3	30,7	9,2	59,4	17,5	31,6	-	33,3	66,7	-	33,3	66,7
	B2	3	$\bar{X}$	24,7	18,7	4,2	67,3	16,6	21,9	-	33,3	33,3	33,4	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	B1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	B2	3	$\bar{X}$	49,8	24,7	8,8	64,2	19,1	33,3	-	66,7	33,3	-	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = Utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 20 Metrical analysis: B1 and B2 subclasses

Border Cave. Excavation 3A Stratum 2BS.LR.C and 2WA

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	B1	27	$\bar{X}$	53,5	24,6	8,1	48,1	15,3	32,6	-	11,1	81,5	7,4	29,6	70,4
	B2	105	$\bar{X}$	52,4	25,1	7,8	50,3	15,1	30,8	23,0	47,6	48,6	3,8	30,5	69,5
			SX	19,30	8,05	3,15	13,40	4,20	7,80						
			S$\bar{X}$	1,90	0,80	0,30	1,30	0,40	0,75						
Qtzite 1	B1	5	$\bar{X}$	63,7	37,8	9,0	62,0	13,9	28,0	-	-	100,0	-	40,0	60,0
	B2	26	$\bar{X}$	57,6	28,4	8,3	50,8	14,8	29,5	-	61,5	30,8	7,7	42,3	57,7
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Chalc.	B1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	B2	5	$\bar{X}$	26,4	12,1	3,6	46,9	13,9	30,7	-	20,0	80,0	-	-	100,0
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Addit.	B1	1	$\bar{X}$	50,0	29,5	7,5	59,0	15,0	25,4	-	100,0	-	-	100,0	-
	B2	27	$\bar{X}$	52,6	25,4	8,0	48,9	15,4	32,0	-	33,3	63,0	3,7	22,2	77,8
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = Utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate; Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 20 Metrical analysis: B1 and B2 subclasses

Border Cave. Excavation 3A Stratum 3BS amd 3WA

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	B1	3	$\bar{X}$	58,3	24,3	7,5	42,3	12,6	32,0	-	33,3	33,4	33,3	66,7	33,3
	B2	10	$\bar{X}$	46,3	19,8	5,3	46,1	12,4	27,7	-	40,0	40,0	20,0	70,0	30,0
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Qtzite 1	B1	5	$\bar{X}$	59,9	22,9	6,1	38,2	10,1	26,8	-	40,0	-	60,0	60,0	40,0
	B2	12	$\bar{X}$	52,9	18,8	5,0	37,0	9,9	26,7	-	16,7	58,3	25,0	58,3	41,7
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Chalc.	B1	11	$\bar{X}$	39,6	16,5	4,7	43,9	13,2	29,7	-	18,1	45,5	36,4	18,2	81,8
	B2	14	$\bar{X}$	28,4	12,3	3,5	45,9	11,3	25,7	-	7,1	28,6	64,3	35,7	64,3
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						
Addit.	B1	1	$\bar{X}$	49,0	20,5	7,0	41,8	14,3	34,1	-	-	-	100,0	-	100,0
	B2	1	$\bar{X}$	55,0	22,0	3,5	40,0	6,4	15,9	-	100,0	-	-	100,0	-
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = Utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 20 Metrical analysis: B1 and B2 subclasses

Border Cave. Excavation 3B Stratum IRGBS.A+B

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep.% Fac.	Pln.	Ind.	Util.% Pres.	Abs.
Rhy. 1	B1	14	$\bar{X}$	41,8	22,2	6,1	54,4	14,7	28,3	-	14,3	85,7	-	7,1	92,9
	B2	73	$\bar{X}$	45,1	20,3	5,5	47,8	12,4	26,8	19,6	19,2	63,0	17,8	39,7	60,3
			SX	17,40	6,95	2,75	14,90	3,80	7,50						
			$S\bar{X}$	2,05	0,80	0,30	1,75	0,45	0,90						
Qtzite 1	B1	12	$\bar{X}$	45,2	17,8	5,0	41,5	11,4	28,6	-	8,3	66,7	25,0	25,0	75,0
	B2	27	$\bar{X}$	41,7	21,8	4,7	53,4	12,0	24,1	-	22,2	59,3	18,5	48,1	51,9
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Chalc.	B1	9	$\bar{X}$	36,6	17,2	5,3	49,9	14,3	31,0	-	11,1	77,8	11,1	33,3	66,7
	B2	22	$\bar{X}$	30,3	13,3	3,5	44,8	11,7	26,6	-	18,2	54,5	27,3	27,3	72,7
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	B1	2	$\bar{X}$	60,0	23,8	7,8	41,5	14,3	33,4	-	50,0	50,0	-	100,0	-
	B2	3	$\bar{X}$	22,8	15,7	3,2	75,3	14,7	20,1	-	-	100,0	-	33,3	66,7
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = Utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 20 Metrical analysis: B1 and B2 subclasses

Border Cave. Excavation 3A Stratum 1GBS.UP. and 1GBS.LR.

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep.% Fac.	Platform Prep.% Pln.	Platform Prep.% Ind.	Util.% Pres.	Util.% Abs.
Rhy. 1	B1	12	$\bar{X}$	47,4	23,8	7,3	52,8	15,6	30,5	-	25,0	75,0	-	33,3	66,7
	B2	25	$\bar{X}$	41,7	22,2	7,2	54,9	17,7	32,1	-	48,0	48,0	4,0	44,0	56,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite 1	B1	10	$\bar{X}$	45,3	18,8	6,7	41,6	14,4	34,9	-	30,0	70,0	-	20,0	80,0
	B2	43	$\bar{X}$	43,7	19,7	6,0	45,7	14,2	32,0	23,1	18,6	79,1	2,3	27,9	72,1
			SX	15,95	7,85	2,35	12,25	4,55	9,00						
			$S\bar{X}$	2,45	1,20	0,35	1,85	0,70	1,40						
Chalc.	B1	3	$\bar{X}$	34,7	21,3	6,7	61,3	19,2	31,4	-	-	100,0	-	-	100,0
	B2	5	$\bar{X}$	26,5	13,6	3,7	53,5	14,2	27,3	-	20,0	60,0	20,0	20,0	80,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	B1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	B2	1	$\bar{X}$	41,5	21,0	10,0	50,6	24,1	47,6	-	100,0	-	-	100,0	-
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = Utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 20 Metrical analysis: B1 and B2 subclasses

Border Cave. Excavation 3A and 3B Stratum BACO.A and BACO.B

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	B1	15	$\bar{X}$	51,9	26,2	7,9	51,7	15,4	30,8	-	26,7	66,7	6,6	20,0	80,0
	B2	48	$\bar{X}$	49,1	25,4	7,8	53,0	16,0	30,5	23,3	47,9	50,0	2,1	27,1	72,9
			SX	15,95	8,45	3,45	12,80	5,25	8,00						
			$S\bar{X}$	2,30	1,20	0,50	1,85	0,75	1,15						
Qtzite 1	B1	6	$\bar{X}$	52,6	20,2	6,8	44,8	13,4	33,6	-	50,0	50,0	-	16,7	83,3
	B2	15	$\bar{X}$	48,0	21,2	6,7	46,3	14,5	31,3	-	60,0	40,0	-	40,0	60,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Chalc.	B1	1	$\bar{X}$	29,5	12,5	3,5	42,4	11,9	28,0	-	-	-	100,0	-	100,0
	B2	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	B1	2	$\bar{X}$	39,3	23,5	4,5	59,7	11,6	19,9	-	-	100,0	-	-	100,0
	B2	1	$\bar{X}$	65,5	36,0	10,0	55,0	15,3	27,8	-	100,0	-	-	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = Utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 20 Metrical analysis: B1 and B2 subclasses

Border Cave. Excavation 3B Stratum BACO.C and BACO.D

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. %			Util. %	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	B1	10	$\bar{X}$	61,9	25,0	8,9	48,0	16,9	36,2	-	30,0	70,0	-	40,0	60,0
	B2	71	$\bar{X}$	56,4	27,9	8,5	50,9	15,2	30,2	22,7	43,7	52,1	4,2	21,1	78,9
			SX	15,05	7,05	3,10	11,20	4,40	7,65						
			$S\bar{X}$	1,80	0,85	0,35	1,35	0,55	0,90						
Qtzite 1	B1	5	$\bar{X}$	67,5	29,3	10,0	43,7	15,2	34,8	-	-	100,0	-	20,0	80,0
	B2	28	$\bar{X}$	54,6	27,3	7,2	49,2	13,3	27,7	-	64,3	35,7	-	39,3	60,7
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Chalc.	B1	1	$\bar{X}$	55,5	18,0	8,0	32,4	14,4	44,4	-	-	-	100,0	-	100,0
	B2	4	$\bar{X}$	37,3	19,1	5,0	52,1	13,2	24,7	-	50,0	25,0	25,0	25,0	75,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Addit.	B1	2	$\bar{X}$	54,3	18,5	7,3	34,7	13,9	39,9	-	-	100,0	-	-	100,0
	B2	2	$\bar{X}$	42,5	26,3	8,8	62,3	20,7	33,5	-	100,0	-	-	50,0	50,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = Utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony; Addit. = additional

Appendix 21 Metrical analysis: P1 and P2 subclasses

Border Cave. Excavation 3A Stratum 1BS.LR and 1WA and 1BES

Raw Material	Flake subclass	Sample n	Analy-sis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	P1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	P2	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite.1	P1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	P2	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite.

Appendix 21 Metrical analysis: P1 and P2 subclasses

Border Cave, Excavation 3A Stratum 2BS.UP and 2BS.LR.A+B

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	P1	1	$\bar{X}$	64,0	32,0	11,5	50,0	18,0	35,9	-	-	100,0	-	-	100,0
	P2	1	$\bar{X}$	44,0	18,0	4,5	40,9	10,2	25,0	-	100,0	-	-	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite.1	P1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	P2	2	$\bar{X}$	39,5	27,8	6,5	69,8	17,0	24,5	-	50,0	50,0	-	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite.

Appendix 21 Metrical analysis: P1 and P2 subclasses

Border Cave, Excavation 3A Stratum 2BS.LR.C and 2WA

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	P1	3	$\bar{X}$	59,7	32,5	12,2	55,5	20,7	37,8	–	66,7	33,3	–	33,3	66,7
	P2	18	$\bar{X}$	56,1	28,1	8,6	53,3	16,9	31,6	–	66,7	33,3	–	33,3	66,7
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						
Qtzite.1	P1	0	$\bar{X}$	–	–	–	–	–	–	–	–	–	–	–	–
	P2	4	$\bar{X}$	62,5	32,3	9,9	51,5	15,8	30,7	–	75,0	25,0	–	50,0	50,0
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite.

Appendix 21 Metrical analysis: P1 and P2 subclasses

Border Cave. Excavation 3A Stratum 3BS and 3WA

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	P1	0	$\bar{X}$	–	–	–	–	–	–	–	–	–	–	–	–
	P2	0	$\bar{X}$	–	–	–	–	–	–	–	–	–	–	–	–
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						
Qtzite.1	P1	0	$\bar{X}$	–	–	–	–	–	–	–	–	–	–	–	–
	P2	0	$\bar{X}$	–	–	–	–	–	–	–	–	–	–	–	–
			SX	–	–	–	–	–	–						
			$S\bar{X}$	–	–	–	–	–	–						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate; Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite.

Appendix 21 Metrical analysis: P1 and P2 subclasses

Border Cave, Excavation 3B Stratum 1RGBS.A+B

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	P1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	P2	2	$\bar{X}$	43,5	20,0	5,3	46,7	12,5	26,3	-	100,0	-	-	50,0	50,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite.1	P1	1	$\bar{X}$	41,0	15,5	5,0	37,8	12,3	32,3	-	-	-	100,0	-	100,0
	P2	1	$\bar{X}$	51,0	27,5	13,0	53,9	25,5	47,3	-	-	100,0	-	-	100,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite.

Appendix 21 Metrical analysis: P1 and P2 subclasses

Border Cave, Excavation 3A Stratum 1GBS.UP and 1GBS.LR.

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	P1	1	$\bar{X}$	38,5	21,0	8,0	54,5	20,8	38,1	-	-	100,0	-	-	100,0
	P2	23	$\bar{X}$	38,2	24,7	7,8	64,6	20,6	31,9	-	73,9	26,1	-	56,5	43,5
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						
Qtzite.1	P1	1	$\bar{X}$	45,5	19,0	6,0	41,8	13,2	31,6	-	100,0	-	-	-	100,0
	P2	20	$\bar{X}$	41,1	23,6	7,9	60,8	20,1	33,3	-	40,0	55,0	5,0	50,0	50,0
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite.

Appendix 21 Metrical analysis: P1 and P2 subclasses

Border Cave. Excavation 3A and 3B Stratum BACO.A and BACO.B

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	P1	3	$\bar{X}$	66,7	40,7	13,2	61,4	20,3	32,6	-	66,7	33,3	-	33,3	66,7
	P2	45	$\bar{X}$	53,4	35,4	11,7	68,2	22,2	33,1	27,7	66,7	28,9	4,4	37,8	62,2
			SX	16,50	10,40	3,95	13,95	5,90	6,90						
			S$\bar{X}$	2,45	1,55	0,60	2,10	0,90	1,05						
Qtzite.1	P1	1	$\bar{X}$	95,0	48,0	13,0	50,5	13,7	27,1	-	100,0	-	-	100,0	-
	P2	9	$\bar{X}$	46,6	28,4	9,6	62,0	21,0	33,2	-	66,7	33,3	-	55,6	44,4
			SX	-	-	-	-	-	-						
			S$\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite.

Appendix 21 Metrical analysis: P1 and P2 subclasses

Border Cave. Excavation 3A Stratum BACO.C and BACO.D

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform Prep.%			Util.%	
											Fac.	Pln.	Ind.	Pres.	Abs.
Rhy. 1	P1	4	$\bar{X}$	51,0	28,2	8,3	59,7	16,6	27,9	-	75,0	25,0	-	25,0	75,0
	P2	70	$\bar{X}$	50,7	31,6	9,9	63,2	19,9	31,6	25,8	68,6	31,4	-	25,7	74,3
			SX	11,55	8,65	3,20	13,95	6,00	6,75						
			$S\bar{X}$	1,40	1,05	0,40	1,65	0,70	0,80						
Qtzite.1	P1	0	$\bar{X}$	-	-	-	-	-	-	-	-	-	-	-	-
	P2	22	$\bar{X}$	48,4	31,3	10,0	64,4	20,9	32,2	-	18,2	81,8	-	59,1	40,9
			SX	-	-	-	-	-	-						
			$S\bar{X}$	-	-	-	-	-	-						

Abbreviations

Rel. = relative; Prep. = preparation; Util. = utilization; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
Pres. = present; Abs. = absent; Rhy. = rhyolite; Qtzite. = quartzite.

APPENDIX 22 METRICAL ANALYSIS : I2 L Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum												
		1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR C	2WA	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
Rhy.1 + Qtzite .1	$\bar{X}$	30,2	32,5	38,2	31,4	28,1	24,9	26,7	29,3	32,3	33,2	34,2	37,6	38,5
	SX	14,50	14,65	16,70	14,75	16,90	13,50	14,55	13,40	13,20	16,25	14,75	15,10	13,75
	$S\bar{X}$	1,40	1,15	0,90	1,00	2,00	0,95	1,45	1,70	1,10	0,90	0,95	0,65	1,00
	n	193	212	471	271	72	258	145	110	274	407	308	690	252
Chalc.	$\bar{X}$	12,2	12,7	16,9		19,2	17,8		19,7		27,0		30,5	
	SX	5,00	-	6,90		14,30	9,10		9,60		-		10,80	
	$S\bar{X}$	0,40	-	-		1,75	1,15		1,35		-		1,55	
	n	146	17	53		65	107		79		26		54	

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony

APPENDIX 22 METRICAL ANALYSIS : I2 B/L% Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum 1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR C	2WA	3BS+ 3WA	1RGBS A	1PGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
Rhy.1 + Qtzite .1	$\overline{X}$	101,1	94,9	90,4	96,5	96,2	91,7	93,6	92,5	84,4	88,2	89,8	85,2	83,6
	SX	35,50	32,15	33,60	30,80	37,35	29,65	32,20	33,45	29,00	28,30	30,85	27,55	25,20
	S$\overline{X}$	3,20	2,50	2,00	2,25	4,40	2,05	3,20	3,10	2,45	1,55	2,00	1,20	1,90
	n	193	212	471	271	72	258	145	110	274	407	308	690	252
Chalc.	$\overline{X}$	96,5	102,3	106,2		93,7	89,5		95,1		80,8		80,1	
	SX	33,50	-	35,60		31,15	33,40		33,50		-		21,85	
	S$\overline{X}$	2,75	-	-		3,85	4,25		4,90		-		3,20	
	n	146	17	53		65	107		79		26		54	

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony

APPENDIX 22 METRICAL ANALYSIS : I2 Rel.T. Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum												
		1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR C	2WA	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
Rhy.1 + Qtzite .1	$\bar{X}$	25,0	22,0	23,0	21,3	20,2	19,5	20,2	25,1	23,1	23,2	24,1	22,6	24,2
	SX	9,80	7,35	7,95	6,60	7,95	6,55	7,05	8,30	8,00	7,85	8,65	7,70	7,70
	$S\bar{X}$	0,80	0,60	0,45	0,50	0,95	0,45	0,70	1,10	0,65	0,40	0,60	0,35	0,55
	n	193	212	471	271	72	258	145	110	274	407	308	690	252
Chalc.	$\bar{X}$	19,7	19,8	22,6		18,1	18,9		22,0		22,0		22,2	
	SX	7,45	-	8,10		7,05	7,00		7,10		-		6,80	
	$S\bar{X}$	0,65	-	-		0,90	0,90		1,00		-		1,00	
	n	146	17	53		65	107		79		26		54	

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite; Chalc. = chalcedony

APPENDIX 22 METRICAL ANALYSIS : I2 V. GROUPINGS

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum												
		1BS.LR+ 1WA+1BES	2BS.UP+ LRA+B	2BS.LR C	2WA	3BS+ 3WA	1RGBS A	1RGBS B	1GBS UP	1GBS LR	BACO. A	BACO. B	BACO. C	BACO. D
Rhy.1 + Qtzite.1	L	48,0	45,2	43,7	46,7	60,1	54,2	54,7	45,9	40,8	49,0	43,3	40,1	35,8
	B	40,5	41,7	37,3	39,2	43,9	41,4	37,5	38,1	39,6	42,5	35,9	33,4	28,2
	T	53,5	55,0	47,9	51,0	63,7	55,8	53,2	50,5	48,4	54,9	46,8	43,5	40,0
	$\bar{X}$	47,3	47,3	43,0	45,6	55,9	50,5	48,5	44,8	42,9	48,8	42,0	39,0	34,7
	$\frac{B}{L}$	35,1	34,0	37,2	31,9	38,8	32,3	34,4	35,7	34,3	32,1	34,4	32,4	30,1
	$\frac{T}{L}$	39,5	33,2	35,4	30,6	41,4	33,8	36,4	35,7	38,2	36,9	38,9	37,9	33,7
	$\frac{T}{B}$	38,7	33,7	34,0	31,7	37,7	33,4	33,6	30,8	31,4	30,9	33,5	30,6	30,4
	$\bar{X}$	37,8	33,6	35,5	31,4	39,3	33,2	34,8	34,1	34,6	33,3	35,6	33,6	31,4
	n	193	212	471	271	72	258	145	110	274	407	308	690	252

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

APPENDIX 22 METRICAL ANALYSIS : I2 V. GROUPINGS

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum							
		1BS.LR+ 1WA+1BES	2BS.UP+ LRA+B	2BS.LR C 2WA	3BS+ 3WA	1RGBS A 1RGBS B	1GBS UP 1GBS LR	BACO. A BACO. B	BACO. C BACO. D
Chalc.	L	41,0	-	40,8	74,5	51,1	50,0	-	35,4
	B	49,6	-	37,9	51,3	43,8	46,5	-	32,0
	T	63,0	-	44,6	80,6	51,7	52,5	-	44,0
	$\bar{X}$	51,2	-	41,1	68,8	48,9	49,7	-	37,1
	$\frac{B}{L}$	34,6	-	33,5	33,2	37,3	35,2	-	27,3
	$\frac{T}{L}$	37,4	-	39,6	42,4	42,4	34,7	-	32,6
	$\frac{T}{B}$	38,1	-	31,8	36,0	32,6	30,2	-	28,1
	$\bar{X}$	36,7	-	35,0	37,2	37,4	33,4	-	29,3
	n	146	17	53	65	107	79	26	54

Abbreviations

Chalc. = chalcedony

Appendix 23 Metrical analysis : B2.L. Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum							
		1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1 +	$\overline{X}$	48,2	40,4	53,5	49,9	44,2	43,0	48,9	55,9
Qtzite.1	SX	0	17,15	19,05	-	16,90	14,15	15,00	15,40
	S$\overline{X}$	-	2,50	1,90	-	2,05	2,45	2,30	1,80
	n	3	60	131	22	100	68	63	99

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

Appendix 23 Metrical analysis : B2. B/L% Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum							
		1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1 +	$\bar{X}$	47,0	58,0	50,4	41,1	49,3	49,1	51,4	50,4
Qtzite.1	SX	-	15,50	13,30	-	17,40	13,80	12,95	10,70
	S$\bar{X}$	-	2,45	1,30	-	1,75	1,85	1,85	1,35
	n	3	60	131	22	100	68	63	99

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

Appendix 23 Metrical analysis : B2. Rel.T. Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum 1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1 +	$\bar{X}$	27,6	22,3	22,8	19,1	19,2	23,9	23,1	22,1
Qtzite.1	SX	-	6,50	6,00	-	5,75	6,80	6,15	5,85
	$S\bar{X}$	-	0,95	0,60	-	0,70	1,05	0,95	0,75
	n	3	60	131	22	100	68	63	99

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

APPENDIX 23 Metrical analysis : B2.V

Border Cave. Exc. 3A.+3B

Material	Analysis	Stratum 1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS. A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1+	L	-	42,5	35,6	-	38,2	32,9	30,7	27,5
Qtzite.1	B	-	35,4	32,5	-	45,2	35,7	32,2	26,5
	T	-	49,2	39,2	-	49,1	36,7	43,3	36,4
	$\bar{X}$	-	42,4	35,8	-	44,2	35,1	35,4	30,1
	$\frac{B}{L}$	-	26,7	26,4	-	35,3	28,1	25,2	21,2
	$\frac{T}{L}$	-	30,1	29,0	-	32,9	32,6	31,0	28,8
	$\frac{T}{B}$	-	28,6	25,0	-	28,4	26,3	24,3	25,4
	$\bar{X}$	-	28,5	26,8	-	32,2	29,0	26,8	25,1
	n	3	60	131	22	100	68	63	99

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

Appendix 24 Metrical analysis : P2.L. Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum							
		1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1 +	$\bar{X}$	-	41,0	57,3	-	46,0	39,5	52,2	50,6
Qtzite.1	SX	-	-	-	-	-	10,45	15,50	11,30
	$S\bar{X}$	-	-	-	-	-	-	2,45	1,40
	n	0	3	22	0	3	43	54	92

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

Appendix 24 Metrical analysis : P2.B/LZ Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum 1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	IRGBS A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1 +	$\bar{X}$	-	60,2	52,9	-	49,1	62,8	67,1	63,5
Qtzite.1	SX	-	-	-	-	-	12,75	14,05	14,40
	$S\bar{X}$	-	-	-	-	-	-	2,10	1,65
	n	0	3	22	0	3	43	54	92

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

Appendix 24 Metrical analysis : P2. Pel.T. Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum 1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1 +	$\bar{X}$	-	19,7	24,1	-	25,1	26,5	27,6	25,9
Qtzite.1	SX	-	-	-	-	-	6,35	6,85	6,60
	$S\bar{X}$	-	-	-	-	-	-	1,00	0,75
	n	0	3	22	0	3	43	54	92

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

APPENDIX 24 Metrical analysis : P2. V. Groupings

Border Cave. Exc. 3A +3B

Material	Analysis	Stratum 1BS.LR+ 1WA+1BES	2BS.UP+ LR.A+B	2BS.LR.C +2WA	3BS+ 3WA	1RGBS A+B	1GBS UP+LR	BACO. A+B	BACO. C+D
Rhy.1 +	L	-	-	-	-	--	26,5	29,7	22,3
Qtzite.1	B	-	-	-	-	-	25,0	29,2	25,2
	T	-	-	-	-	-	29,5	34,6	30,3
	$\overline{X}$	-	-	-	-	-	27,0	31,2	25,9
	$\frac{B}{L}$	-	-	-	-	-	20,3	20,9	22,7
	$\frac{T}{L}$	-	-	-	-	-	28,7	28,9	31,8
	$\frac{T}{B}$	-	-	-	-	-	21,1	22,1	21,3
	$\overline{X}$	-	-	-	-	-	23,4	24,0	25,3
	n	0	3	22	0	3	43	54	92

Abbreviations

Rhy. = rhyolite; Qtzite. = quartzite

APPENDIX 25 METRICAL ANALYSIS : I1/I2%

Border Cave. Exc. 3A + 3B. I2 = 100%

		Stratum														
Material	Analysis	1BS.LR	1WA+ 1BES	2BS.UP+ LR.A+B	2BS. LR.C	2WA	1RBS.	3BS+ 3WA	1RGBS. A	1RGBS. B	1GBS. UP	1GBS. LR	BACO. A	BACO. B	BACO. C	BACO. D
Rhy.1	I1n	43	102	77	129	86	16	36	75	37	52	93	136	111	197	95
	I2n	32	110	160	316	195	18	49	204	106	51	132	346	222	498	189
	L	131,5	112,5	109,9	113,5	139,7	-	145,1	132,8	150,0	124,7	109,4	109,5	115,1	108,6	108,4
	B	118,9	131,3	111,9	120,8	127,5	-	144,5	139,1	125,8	127,7	115,4	115,8	108,5	111,7	113,0
	T	144,8	135,8	131,9	146,8	177,0	-	189,8	179,5	183,3	146,1	130,8	122,9	124,4	125,3	118,8
	$\frac{B}{L}$	84,9	112,6	102,2	104,1	93,3	-	94,8	101,5	81,4	104,1	107,1	106,6	96,9	101,6	100,8
	$\frac{T}{L}$	104,1	117,6	123,8	128,3	129,8	-	130,9	135,2	121,0	119,3	120,9	116,8	110,3	115,2	109,1
	$\frac{T}{B}$	117,9	108,2	121,9	124,6	138,5	-	139,2	132,7	157,7	115,4	112,4	113,1	115,4	115,2	107,0
	Rel.T	110,5	113,0	122,5	127,0	134,6	-	135,2	133,8	110,8	117,4	116,2	115,0	113,3	108,7	108,2
	Pln.P	114,4	100,9	122,2	132,9	112,3	-	200,5	100,6	113,7	119,6	131,6	120,8	125,0	127,5	128,7
	Util.A.	94,2	105,7	108,9	103,6	111,9	-	117,1	100,7	87,5	117,2	108,8	107,7	105,7	108,1	110,8

Abbreviations

Rhy. = rhyolite; Rel. = relative; Pln.P. = plain platform; Util.A. = utilization absent

Appendix 26 Spatial distribution: fused or smelted items

Border Cave. Excavation 3A Rear. Stratum IBS. UP. Iron Age

24	0	0	2	0	1	1	0	0
	0		0		0		0	
	0	0	0	0	0	0	0	0
23	14	4	16	1	7	1	0	0
	0		0		0		0	
	0	0	0	0	0	0	0	0
22	3	0	16X	2	12	0	11	3
	0		2		5		5	
	0	0	0	0	0	0	1	0
21	1	0	8X	2	8	0	33	5
	0		4		1		195	
	0	0	0	0	0	0	0	0
20	-	-	6	1	4	2	1	1
	-		0		0		0	
	-	-	0	0	0	0	0	0
19	-	-	2	0	1	0	1	0
	-		1		3		0	
	-	-	0	0	0	0	0	0
18	-	-	-	-	-	-	3	0
	-		-		-		0	
	-	-	-	-	-	-	0	0
17	-	-	-	-	-	-	-	-
	-		-		-		-	
	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
	-		-		-		-	
	-	-	-	-	-	-	-	-
	Q		R		S		T	

Legend:

Top left: Sherd totals

Top right: Sherd rims

Centre: Glass or porcelain beads

Base left: Copper beads

Base right: Modern objects

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 26 Spatial distribution: fused or smelted items

Border Cave. Excavation 3A Rear. Stratum IBS. UP. Sterile

	Q	R	S	T
24	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
23	1 0 0 0 0	1 0 0 0 0	0 0 0 0 0	0 0 0 0 0
22	0 0 0 0 0	1 0 0 0 0	1 0 0 0 0	0 0 0 0 0
21	1 0 0 0 0	1 0 0 0 0	0 0 0 0 0	0 0 0 0 0
20	0X 0 0 0 0	1 0 0 0 0	0 0 0 0 0	2X 0 0 0 0
19	0X 0 0 0 0	4X 1 1 0 0	3 0 1 0 0	0 0 0 0 0
18	- - - - -	- - - - -	- - - - -	0 0 0 0 0
17	- - - - -	- - - - -	- - - - -	- - - - -
16	- - - - -	- - - - -	- - - - -	- - - - -

Legend:

Top left: Sherd totals

Top right: Sherd rims

Centre: Glass or porcelain beads

Base left: Copper beads

Base right: Modern objects

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 26 Spatial distribution: fused or smelted items

Border Cave. Excavation 3A Rear. Stratum . 1BS. LR.

	Q	R	S	T
24	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
23	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
22	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
21	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
20	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
19	0X 0 0 0 0	2X 2 0 0 0	0 0 0 0 0	0x 0 1 0 0
18	1X 0 0 0 0	2X 0 0 1 0	1X 0 0 0 0	0X 0 1 0 0
17	2X 0 0 0 0	1X 0 1 0 1	- - - - -	- - - - -
16	2X 0 0 0 0	0X 0 0 0 0	- - - - -	- - - - -

Legend:

Top left: Sherd totals

Top right: Sherd rims

Centre: Glass or porcelain beads

Base left: Copper beads

Base right: Modern objects

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 26 Spatial distribution: fused or smelted items

Border Cave. Excavation 3A Rear. Stratum 1WA

	Q		R		S		T	
	0	0	0	0	0	0	0	0
24	0		0		0		0	
	0	0	0	0	0	0	0	0
	-	-	0	0	0	0	0	0
23	-		0		0		0	
	-	-	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
22	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
21	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
20	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	1X	0
19	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	2X	0	0	0	0	0
18	0		0		0		0	
	0	0	0	0	0	0	0	0
	2X	0	1X	0	-	-	-	-
17	0		0		-		-	
	0	0	0	0	-	-	-	-
	2X	0	2X	0	-	-	-	-
16	0		1		-		-	
	0	0	0	0	-	-	-	-

Legend:

Top left: Sherd totals

Top right: Sherd rims

Centre: Glass or porcelain beads

Base left: Copper beads

Base right: Modern objects

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 1BS. UP Iron Age

	Q	R	S	T
24	22 100,0 0 1	7 85,7 0 1	2 100,0 0 0	3 100,0 0 0
23	8 75,0 0 0	36 91,7 0 0	4 100,0 0 0	1 100,0 0 0
22	9 88,9 0 0	227X 92,1 0 2	1 0,0 0 4	4 100,0 0 0
21	0 0,0 0 0	19X 84,2 0 1	5 100,0 0 0	2 100,0 0 0
20	- - - -	3 66,7 0 0	1 0,0 0 0	1 100,0 0 0
19	- - - -	3 100,0 0 0	0 0 0 0	0 0 0 0
18	- - - -	- - - -	- - - -	13 100,0 0 0
17	- - - -	- - - -	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 1BS. UP Sterile

	Q	R	S	T
24	0 0 0 0	5 60,0 0 0	4 100,0 0 0	1 0,0 0 1
23	4 50,0 0 0	3 0,0 0 0	0 0 0 0	1 100,0 0 0
22	4 75,0 0 0	16 93,8 0 0	7 85,7 0 0	1 100,0 0 0
21	0 0 0 0	2 100,0 0 0	1 0,0 0 0	5 100,0 0 0
20	2X 100,0 0 0	1 100,0 0 0	4 100,0 0 0	33X 69,7 0 1
19	18X 88,9 0 0	15X 80,0 0 0	10 70,0 0 0	2 50,0 0 0
18	- - - -	- - - -	- - - -	0 0 0 0
17	- - - -	- - - -	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 1BS. LR.

	Q	R	S	T
24	22 86,4 0 1	31 77,4 0 2	28 67,9 0 0	13 69,2 0 0
23	185 84,9 1 8	203 91,1 0 1	19 78,9 0 0	14 100,0 0 0
22	70 78,6 0 0	165 97,6 0 0	93 82,8 0 5	73 90,4 0 0
21	67 68,7 1 0	129 89,9 0 3	69 52,2 0 0	163 83,4 0 2
20	17 94,1 0 0	253 66,4 0 18	75 45,3 0 0	290 74,1 0 7
19	59X 83,1 0 0	41X 82,9 0 1	74 63,5 0 0	160X 65,0 0 10
18	49X 85,7 0 1	163X 84,7 0 1	123X 50,4 0 3	80X 75,0 0 1
17	52X 88,5 0 0	51X 84,3 0 0	- - - -	- - - -
16	96X 93,8 0 6	58X 86,2 0 0	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 1WA.

	Q	R	S	T
24	314 88,2 0 11	131 93,1 0 2	59 71,2 0 0	62 56,5 1 1
23	- - - -	31 64,5 0 0	48 89,6 0 1	204 74,5 0 0
22	136 97,8 0 0	187 89,3 0 0	175 87,4 0 3	576 92,9 0 3
21	205 86,8 0 0	230 86,1 0 1	485 92,0 0 3	483 92,5 0 1
20	510 90,0 0 0	400 83,3 0 2	678 91,7 0 3	524 88,7 0 6
19	522 68,2 0 7	813 82,4 0 3	822 91,5 0 4	411X 92,5 0 1
18	283 94,7 0 0	460X 90,4 1 0	599 84,1 0 0	385 81,6 1 3
17	161X 95,0 0 2	216X 86,6 0 0	- - - -	- - - -
16	75X 61,3 0 0	193X 60,6 0 0	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 2BS. UP

	Q	R	S	T
24	- - - -	1 0,0 0 0	7 100,0 0 0	21 52,4 0 3
23	22 9,1 0 0	2 0,0 0 0	18 72,2 0 7	16 12,5 0 0
22	12 41,7 0 0	25 44,0 0 0	46 65,2 0 0	23 82,6 0 0
21	20 20,0 0 0	45 55,6 0 0	33 87,9 0 0	2 100,0 0 0
20	18 27,8 0 0	28 46,4 0 0	7 42,9 0 0	16 62,5 0 0
19	6 66,7 0 0	60 78,3 0 0	16 75,0 0 0	12 75,0 0 0
18	19 21,1 1 0	23 21,7 0 0	5 40,0 0 0	16 37,5 0 0
17	7 57,1 0 0	2 0,0 0 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. A+B

	Q	R	S	T
24	20 25,0 1 0	7 0,0 0 0	58 5,2 1 0	38 2,6 2 0
23	68 17,6 1 0	17 5,9 0 0	22 9,1 1 1	36 2,8 1 0
22	77 23,4 0 2	26 30,8 0 0	22 40,9 0 0	33 6,1 1 1
21	70 15,7 0 0	22 40,9 0 0	132 21,2 0 0	74 18,9 0 2
20	72 75,0 2 0	109 34,9 0 0	245 60,8 1 1	52 34,6 0 0
19	- - - -	- - - -	130 32,3 0 5	38 36,8 1 0
18	- - -	- - -	93 24,7 0 2	115 9,6 2 2
17	- - - -	43 25,6 0 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. C

	Q	R	S	T
24	152 6,6 0 3	70 11,4 1 2	318 2,8 3 1	137 8,8 7 10
23	111 38,7 1 2	84 7,1 2 8	160 1,9 4 4	72 13,9 2 0
22	175 8,6 0 6	152 0,0 0 0	92 6,5 3 8	38 7,9 0 2
21	177 1,1 5 1	204 2,0 2 2	155 1,3 4 3	91 2,2 1 1
20	149 4,0 1 0	175 0,0 1 0	128 0,0 3 3	153 1,3 4 1
19	- - - -	- - - -	163 2,5 2 3	157 3,2 3 4
18	- - - -	- - - -	170 1,2 2 2	131 0,0 3 3
17	- - - -	78 0,0 1 3	- - - -	- - - -
16	- - - -	9X 22,2 0 3	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 2WA

24	- - - -	46 47,8 0 1	58 67,2 0 7	- - - -
23	- - - -	141 51,1 0 0	83 30,1 0 4	- - - -
22	- - - -	129 53,5 0 3	76 34,2 0 4	- - - -
21	- - - -	91 29,7 0 9	230 56,1 2 12	- - - -
20	- - - -	131 20,6 2 5	108 33,3 0 9	22 27,3 0 0
19	- - - -	183 18,6 0 1	78 25,6 0 5	87 33,3 1 9
18	- - - -	399 8,3 9 3	119 22,7 0 0	78 29,5 1 4
17	- - - -	271 13,3 3 0	- - - -	- - - -
16	- - - -	849 7,4 6 1	- - - -	- - - -
	Q	R	S	T

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 3BS

	Q	R	S	T
24	- - - -	186 44,6 2 4	118 55,1 2 2	- - - -
23	- - - -	509 44,6 6 5	110 55,5 2 4	- - - -
22	- - - -	187 71,1 0 1	59 52,5 0 1	- - - -
21	- - - -	44 47,7 2 0	64 35,9 0 7	- - - -
20	- - - -	81 49,4 0 3	63 34,9 1 0	21 66,7 3 0
19	- - - -	86 50,0 2 0	125 50,4 2 2	46 43,5 1 0
18	- - - -	46 23,9 0 0	78 46,2 4 0	45 42,2 0 0
17	- - - -	31 64,5 0 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 3WA

	Q	R	S	T
24	- - - -	0 0 0 0	1 0,0 0 0	- - - -
23	- - - -	0 0 0 0	25 68,0 0 0	- - - -
22	- - - -	7 71,4 0 0	58 43,1 0 0	- - - -
21	- - - -	11 27,3 0 0	64 46,9 3 0	- - - -
20	- - - -	8 37,5 0 0	127 60,6 1 0	29 65,5 0 0
19	- - - -	5 0,0 0 0	86 34,9 1 0	35 48,6 0 0
18	- - - -	5 80,0 0 0	118 69,5 0 1	43 44,2 0 2
17	- - - -	- - - -	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 1GBS. UP.

	Q	R	S	T
24	- - - -	52 30,8 0 0	80 41,3 0 2	- - - -
23	- - - -	51 19,6 0 0	124 58,9 0 0	- - - -
22	- - - -	72 29,2 0 1	108 59,3 0 0	- - - -
21	- - - -	113 17,7 0 0	67 31,3 1 0	- - - -
20	- - - -	125 21,6 0 0	81 37,0 1 0	- - - -
19	- - - -	119 32,8 1 1	104 25,0 0 1	20 15,0 0 0
18	- - - -	162 27,2 0 0	125 48,0 1 2	35 65,7 0 0
17	- - - -	131 28,2 0 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum 1GBS. LR.

	Q	R	S	T
24	- - - -	3 0,0 0 0	12 16,7 0 1	- - - -
23	- - - -	34 2,9 1 2	40 15,0 0 0	- - - -
22	- - - -	44 22,7 0 0	81 13,6 1 0	- - - -
21	- - - -	112 17,9 1 0	99 17,2 1 2	- - - -
20	- - - -	251 11,6 0 0	335 17,6 0 1	- - - -
19	- - - -	481 29,1 0 0	368 23,9 0 0	191 27,2 2 3
18	- - - -	492 20,5 2 4	605 21,0 5 1	178 33,7 1 2
17	- - - -	909 23,1 3 2	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 27 Spatial distribution: stone artefacts

Border Cave. Excavation 3A Rear. Stratum BACO. A.

24	- - - -	- - - -	- - - -	- - - -
23	- - - -	- - - -	- - - -	- - - -
22	- - - -	- - - -	- - - -	- - - -
21	- - - -	48 2,1 0 0	0 0 0 0	- - - -
20	- - - -	- - - -	81 18,5 0 0	- - - -
19	- - - -	295 3,7 2 0	187 9,1 0 0	85 11,8 0 0
18	- - - -	560 7,0 2 0	415 2,7 1 0	157 8,3 0 0
17	- - - -	- - - -	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -
	Q	R	S	T

Legend:

Top: Number of stone artefacts

Centre: Percentage of silicates

Base left: Number of retouched tools

Base right: Number of pigment fragments

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 28 : <u>Border Cave hominid 1</u>.
Hertha de Villiers.

The cranium (Tables 1-6; Figs. 1-7) consists of eight fragments of the frontal bone, including the complete left and medial half of the right superior orbital margins; four fragments of the left and five fragments of the right parietal bones, including the anterior portion of the sagittal suture at bregma; the mastoid, tympanic and petrous parts, the styloid process and two fragments of the squamous part of the left temporal bone; the mastoid, tympanic and posterior aquamous part of the right temporal bone, and a small postero-lateral portion of the occipital squame.

The facial skeleton is represented by the damaged right zygomatic bone, the temporal process being defective. Although the zygomatic bone does not articulate directly with the frontal bone it corresponds in size with the cranial fragments and can be ascribed to the same individual.

The cranium was reconstructed by A.R. Hughes of the Department of Anatomy, University of the Witwatersrand, Johannesburg. Articulation of the fragments was facilitated by the presence of an almost complete frontal bone and the anterior portion of the sagittal suture at bregma. On the right and left sides the fragments of frontal, parietal and temporal bone proved to be contiguous. By symmetry with the left superior orbital margin, the lateral half of the right was reconstructed and the right zygomatic bone articulated.

The remains are those of a fully adult individual as judged by the size and thickness of the vault bones. The cranial sutures are patent and Cooke <u>et</u> <u>al</u>. (1945) record an estimated age of about thirty years. However, the method of ageing by the degree of external and internal suture obliteration has come under considerable criticism, particularly by Singer (1953), Cobb (1955), McKern and Stewart (1957) and Genoves (1960), who consider that, even if there is a general trend in suture closure, it is of little use as a guide for age determination in any individual instance. Owing to the absence of the pelvic bones, it is not possible to assess the sex with any degree of accuracy. However, the robust cranial vault bones, the presence of superciliary eminences, marked supramastoid crests and muscular markings on the occipital squame suggest that these remains are those of a male rather than of a female.

The bones of the cranial vault are of only moderate thickness and vary between 5mm and 9mm.

Although the cranial vault (Table 1) is not sufficiently complete for accurate measurement, it appears to have been long (estimated cranial length 194mm; horizontal perimeter 541mm), of moderate height (estimated auricular height 115 mm) and broad (estimated maximum cranial breadth 141mm; minimum frontal breadth 108mm; bi-auricular breadth 125 mm). By the interracial formula (Martin & Saller, 1966) an estimate of 1507cc for cranial capacity was obtained.

In norma verticalis the parietal contours show a moderate or juvenile degree of bossing. The dolicho-cranial brain case is thus ovoid. The preserved portion of the nuchal surface is convex, with well defined muscular markings.

In norma lateralis the cranial contour shows a forehead of moderate height, with a frontal chord-arc index of 84,6%. The forehead recedes slightly and curves gently into the vault (frontal angle 27°), reaching its highest point vertically above the biporionic axis. The glabella projects to a moderate degree (estimated glabellar protrusion 5mm). The superior limb of the parietotemporal suture appears to have been convex, the posterior limb continuing the convexity. The region above asterion is slightly flattened. The mastoid process is broad and of medium length (mastoid length 27mm). The digastric fossa is shallow and not exposed in norma lateralis. The mastoid crest is well developed. The supramastoid groove is shallow but definite and the supramastoid crest is marked. The tympanic plate of the temporal bone is moderately thickened. Unfortunately, the glenoid fossa is almost completely destroyed.

Norma frontalis shows a broad frontal region (estimated outer bi-orbital breadth 120mm) with moderately developed frontal bosses and a faint metopic ridge. The superciliary eminences show marked development (superciliary projection 9mm) but do not encroach upon the glabella. Laterally the eminces show a very sligh diminution in depth and are faintly demarcated from the thickened, rounded lateral part of the superior orbital margin. There is no supra-orbital torus. X-ray photographs show that the frontal sinus is small. The orbits appear to have been of moderate height (mesoconch) and on the left side the superior orbital margin is notched. The interorbital region is wide (estimated interorbital breadth 28,8mm) and the nasion appears to have been depressed. The zygomatic bone, from medial to lateral, presents, an even convex contour and the frontal process faces anteriorly and laterally.

The Border Cave 1 cranium (Table 1) is thus dolicho-orthocranial (cranial index 72,6%; auricular height index 59,2%) and ovoid in norma verticalis. The frontoparietal index of 76,5% falls in the eurymetopic category and indicates that there is no frontal narrowing. The individual measurements fall within the respective ranges recorded for South African Negro crania (de Villiers, 1968).

Cooke _et al_. (1945) stated that, on the basis of "both its increased breadth and massive well-developed supra-orbital torus" the Border Cave cranium may be considered as "occupying an intermediate position between the Florisbad fossil and those of Fish Hoek and Springbok Flats". This and later statements (Wells, 1950, 1952), particularly the reference to the supposed presence of a supra-orbital torus, would appear to have influenced subsequent authors writing in the field of fossil man in Southern Africa. The presence of a supra-orbital torus has not been confirmed by the present study. The superciliary eminences, although well developed (superciliary projection 9mm), do not encroach on the glabella; nasion, on the other hand, is depressed. Similar configurations of superciliary eminences, glabella and nasion were noted in two randomly selected South African Negro crania

(A694 - superciliary projection 11mm; A1511 - superciliary projection 9mm) and in a cranium attributed to a recent San (Bushman) from the Eastern Cape (A1175 - superciliary projection 6mm). Although these crania are both shorter and narrower than the Border Cave specimen and the superior orbital margins are not as thickened, the general supra-orbital and glabellar morphology displayed by the Border Cave cranium would appear to occur in both recent South African Negro and San (Bushman) crania.

A metrical comparison of the Border Cave cranium with those from Tuinplaas - Springbok Flats (Hughes, in press), Skildergat - Fish Hoek (Keith, 1931), Cape Flats (Drennan, 1929), Boskop (Dreyer et al., 1938) and Otjiseva (de Villiers, 1972) shows that except for external bi-orbital breadth, the Border Cave cranial dimensions fall well within the range recorded for the listed fossil crania (Table 1). On the other hand, comparison of the Border Cave dimensions (Table 2) with the mean values obtained for recent San (Bushman), Khoikhoin (Hottentot) and South African Negro cranial series (Rightmire, 1970) emphasises the length and more especially the breadth differences between pre-historic and recent South African crania, namely, the cranial length recorded for the Border Cave cranium is 194mm, the breadth 141mm, the minimum frontal breadth 108mm, and the bi-auricular breadth 125mm, whereas the corresponding highest male mean values are 188,01mm (Xhosa), 135,81mm (Hottentot or Khoikhoin), 98,45 (Xhosa) and 114,73mm (Sotho) respectively.

To measure the apparent divergences, Mahalanobis's (1936) D^2 distance statistic was applied to the data. As an expression of separation, indices based on Rao's (1952) technique for discriminant analysis were devised by Professor D. Hawkins, Department of Applied Mathematics, University of the Witwatersrand, Johannesburg. The basic comparative data were those of Rightmire (1960) and eight common measurements were available (Table 2).

MAHALANOBIS D^2: The D^2 value between Border Cave 1 specimen and each of the eight recent South African populations is large, ranging from 30,42 in the Border Cave/Bushman (San) male comparison to 44,09 in the Border Cave/Bushman (San) female comparison (Table 3). All distances between the Border Cave cranium and the recent populations are highly significant ($X^2{}_{,99}$ = 20,1), providing strong evidence that the Border Cave cranium is not representative of any of these populations.

Of the fossil crania listed in Table 1, only the Tuinplaas (Springbok Flats) cranium has sufficient measurements available for comparison with Border Cave 1 and Rightmire's eight groups (Table 2). The values of were computed using six measurements (Table 4). Both Border Cave 1 and Tuinplaas crania show large values of D^2 with the eight recent groups. Like Border Cave 1, the Tuinplaas cranium differs significantly from all recent groups ($X^2{}_{,95}$ = 11,1), but the D^2 between Border Cave and Tuinplaas is small (2,66) and well below the significance level, this suggests that the two crania are not markedly dissimilar and could represent variants of the same population.

<u>Discriminant Analysis</u> : Two indices were calculated which together accounted for 93,1% of the total discrimination between Border Cave 1, Tuinplaas, and the recent South African cranial series. The loadings of these indices are given in Table 5, the values in Table 6, and Fig. 7.

The first index accounts for 78,8% of the discrimination and identifies strongly with glabellar protrusion, bi-auricular breadth and mastoid length. The second index accounts for a further 14,3% of the discrimination and is identifiable with glabellar protrusion and mastoid length.

Fig. 7 indicates that the first index is primarily responsible for separating the Border Cave and Tuinplaas crania from the recent South African cranial series, while the second index separates the males and females.

Discriminant analysis suggests that greater size, more particularly greater breadth, separates the Border Cave and Tuinplaas crania from recent South African populations. In a study of Upper Palaeolithic, Mesolithic and Neolithic crania from Europe, Frayer (1972) demonstrated a reduction in general size and more particularly a reduction in the breadth of the cranial base in the Neolithic crania.

Conclusions. The D^2 between the Border Cave cranium and each of the recent Khoisan and South African Negro cranial series is large and all distances are highly significant in both the eight and six character comparisons. If the six-character D^2 values (Table 4) are taken to reflect the distances satisfactorily, it would appear that the Border Cave and Tuinplaas crania are morphologically similar, but that neither is closely related to recent Khoisan or South African Negro populations. Discriminant analysis shows both Border Cave 1 and Tuinplaas crania to have marginal positions in relation to the scatter of positions for recent South African populations (Fig. 7). Yet both crania show recognizable Negro features, notably dolicho-orthocrany, the absence of frontal narrowing and ovoidy (Table 1).

A whole range of evidence appears to justify regarding the Negro and Khoisan populations as divergent specializations of a single stock, variously named: Proto-Negro-Khoisan (Brothwell, 1963), basic *Homo sapiens afer* Linn. (Wells, 1969) and Protonegriform (Tobias, 1972). Wells (1969) included both the Border Cave 1 and Tuinplaas crania in his undifferentiated basic *Homo sapiens afer* group. If the association of the Border Cave 1 remains with the M.S.A., is accepted as valid, this would extend the range of basic *Homo sapiens afer* back to at least 50,000 B.P.

Acknowledgements.

I wish to thank Professor P.V. Tobias, Head of the Department of Anatomy, University of the Witwatersrand, Johannesburg for providing the facilities for this study as well as for his helpful suggestions.

I am also indebted to Professor Douglas Hawkins of the Department of Applied Mathematics, University of the Witwatersrand, Johannesburg for his ever-ready assistance with the statistical aspects of this study and to Mr. A.R. Hughes for the photographs.

References.

BROTHWELL, D. 1963. Evidence of early population change incentral and southern Africa : doubts and problems. Man, 63 ; 101-104.

COBB, W.M. 1955. The age incidence of suture closure. Am. J. phys. Anthrop., 13 : 394-395.

COOKE, H.B.S., MALAN, B.D. & WELLS, L.H. 1945. Fossil man in the Lebombo Mountains, South Africa : the 'Border Cave', Ingwavuma district, Zululand. Man, 45 : 6-13.

DE VILLIERS, H. 1968. The skull of the South African Negro. Johannesburg : Witwatersrand Univ. Press.

DE VILLIERS, H. 1972. The first fossil human skeleton from South West Africa. Trans. R. Soc. S. Afr., 40 : 187-196.

DRENNAN, M.R. 1929. An Australoid skull from the Cape Flats. J.R. Anthrop. Inst., 59 : 417-427.

DREYER, T.F., MEIRING, A.J.D., & HOFFMAN, A.C. 1938. A comparison of the Boskop with other abnormal forms from South Africa. Z. Rassenk., 7 : 289-296.

FRAYER, D.W. 1972. Changes in the shape and form of the skull from the Upper Palaeolithic to the Neolithic. Seminar on human evolution. Ann Arbor, Univ. of Michigan.

GENOVÉS, S. 1960. Revaluation of age, stature, and sex of the Tepexpan remains, Mexico. Am. J. phys. Anthrop., 18 : 205-217.

HUGHES, A.R. n.d. The Tuinplaas human skeleton from Springbok Flats, Transvaal. In press.

KEITH, A. 1931. New discoveries relating to the antiquity of man. London : Williams and Norgate.

MAHALANOBIS, P.C. 1936. On the generalised distance statistic. Proc. Nat. Inst. Sci. India, 2 : 49-55.

MARTIN, R. & SALLER, K. 1966. Lehrbuch der Anthropologie. 3rd Ed. Stuttgard : Fisher Verlag.

MCKERN, T.W. & STEWART, T.D. 1957. Skeletal age changes in young American males. Headquarters Quartermasters' Research and Development Comman. Natick, Mass.

RAO, C.R. 1952. Advanced statistical methods in biometric research. New York : Wiley.

RIGHTMIRE, G.P. 1970. Iron Age skulls from Southern Africa re-assessed by multiple discriminant analysis. Am. J. phys. Anthrop., 33 : 147-167.

SINGER, R. 1953. Estimation of age from cranial suture closure. J. forens. Med., 1 : 52-59.

TOBIAS, P.V. 1972. Recent human biological studies in Southern Africa, with special reference to Negroes and Khoisans. Trans. R. Soc. S. Afr., 40 : 109-133.

WELLS, L.H. 1950. The Border Cave skull, Ingwavuma district, Natal. Am. J. phys. Anthrop., 8 : 241-243.

WELLS, L.H. 1952. Human crania of the Middle Stone Age in South Africa. In : Proc. 1st Pan-Afr. Congr. Prehist., Nairobi, 1947 : 125-133. Oxford : Basil Blackwell.

WELLS, L.H. 1969. Homo sapiens afer Linn. Content and earliest representatives. S. Afr. Archaeol. Bull., 24 : 172-173.

TABLE 1. Comparison of the Border Cave Cranium with other Southern African crania.

Character	Border Cave (Ingwavuma) Present Study	Tuinplaas (Springbok Flats) Hughes (in press)	Fish Hoek (Skildergat) Keith (1931)	Cape Flats Drennan (1929)	Boskop Dreyer *et al.* (1938)	Otjiseva de Villiers (1972)	S.A. Negro – de Villiers (1968)	
							Range Males	Range Females
Max. Cranial L.	194 ?	200	200	191	205	174	168-200	168-201
Max. Cranial B.	141 ?	143	151	132	150	151	117-150	122-145
Auricular H.	115 ?	117	114	107	115		96-124	93-122
Glabellar protrusion	5	6			102	108	85-114	85-111
Min. Frontal B.	108 ?	106	105				94-126	94-121
Biauricular B.	125 ?	130					16-32	15-30
Ext. Bi-orbital B.	120 ?	114	111				107-153	118-141
Interorbital B.	28,8 ?	26					96-133	102-124
Frontal sagittal arc	137							
Frontal sagittal chord	116							
Frontal Angle	27°							
Mastoid L.	27	29,5						
Horizontal Circumference	541 ?	561					466-557	469-553
Cranial Capacity	1 507 ?	1 581	1 600	1 344	1 800			
Cranial Index	72,6	71,5	75,5	67,6	73,1		60,7-82,7	66,8-82,4
Auricular Height Index	59,2	58,5	57,0	56,0	56,0		54,1-70,7	49,7-67,4
Frontal sag. chord/arc Index	84,6						76,1-99,2	79,7-91,6
Frontoparietal Index	76,5	74,1	69,5		68,0		62,0-84,6	63,9-81,5

TABLE 2: Eight cranial measurements of Border Cave, compared with Tuinplaas, Bushman, Hottentot and South African Negro samples.

	Border Cave Present Study	Tuinplaas* (Springbok Flats)	Bushman** Male	Hottentot Male	Zulu Male	Sotho Male	Xhosa Male	Bushman Female	Zulu Female	Sotho Female
Cranial L.	194	200	180.60	182,94	186,33	187,17	188,08	170,68	180,44	179,56
Glabellar protrusion	5	6	4.80	5,37	5,10	5,11	5,08	3,50	4,50	4,13
Cranial B.	141	143	134,80	135,81	135,20	133,82	135,70	130,25	133,34	130,03
Min. Frontal B.	108	106	94,40	92,43	98,13	98,14	98,45	90,00	95,31	92,80
Biauricular B.	125	130	111,80	112,00	113,13	114,73	113,70	105,00	109,97	114,73
Frontal Sag. chord	116	–	111,00	112,12	112,63	113,25	113,04	105,00	110,56	109,30
Frontal Angle	27	–	29,50	28,31	27,77	28,63	27,79	29,25	29,34	28,23
Mastoid L.	27	29,5	24,55	24,50	28,53	28,28	28,66	20,12	24,54	23,73

*Hughes (in press)
**Rightmire (1970)

TABLE 3. Values of D^2 based on eight characters: Border Cave, recent S.A. populations.

	Border Cave	Bushman Male	Hottentot Male	Zulu Male	Sotho Male	Xhosa Male	Bushman Female	Zulu Female	Sotho Female
Border Cave	–	30,42	33,90	39,19	32,25	34,06	44,09	37,88	41,39
Bushman male		–	0,70	2,47	1,49	2,36	3,06	0,95	1,53
Hottentot male			–	2,49	1,69	2,25	4,39	1,40	1,54
Zulu male				–	0,48	0,33	6,95	1,44	2,15
Sotho male					–	0,30	7,02	1,67	2,45
Xhosa male						–	7,69	1,76	2,43
Bushman female							–	2,60	1,96
Zulu female								–	0,50
Sotho female									–

TABLE 4. Values of D^2 based on six characters: Border Cave, Tuinplaas, recent S.A. populations.

	Border Cave	Tuinplaas	Bushman Male	Hottentot Male	Zulu Male	Sotho Male	Xhosa Male	Bushman Female	Zulu Female	Sotho Female
Border Cave	–	2,66	10,65	12,08	11,16	9,11	10,52	19,91	11,94	14,82
Tuinplaas		–	14,88	14,55	14,63	11,78	13,51	27,98	17,53	20,03
Bushman male			–	0,56	1,47	1,24	1,72	2,76	0,31	0,72
Hottentot male				–	2,03	1,62	2,03	4,22	1,20	1,21
Zulu male					–	0,19	0,09	6,64	1,30	2,13
Sotho male						–	0,15	6,97	1,45	2,28
Xhosa male							–	7,38	1,59	2,31
Bushman female								–	2,27	1,74
Zulu female									–	0,38
Sotho female										–

TABLE 5. Index loadings for five cranial measurements.

Index	1.	2.
Percentage of trace	78,8	14,3
Variance within groups	23,4	10,5
Loadings		
Maximum cranial L.	0,022	0,024
Glabellar protrusion	0,139	0,194
Minimum frontal B.	0,043	0,035
Biauricular B.	0,163	0,059
Mastoid L.	0,165	0,307

TABLE 6. Index values for Border Cave, Tuinplaas and recent South African cranial series.

Index	1.	2.
Border Cave	146,05	2,11
Tuinplaas	149,60	4,54
Bushman male	131,11	3,98
Hottentot male	131,31	4,82
Zulu male	132,16	7,48
Sotho male	133,71	6,94
Xhosa male	132,91	7,66
Bushman female	124,81	0,82
Zulu female	129,76	4,22
Sotho female	128,14	4,16

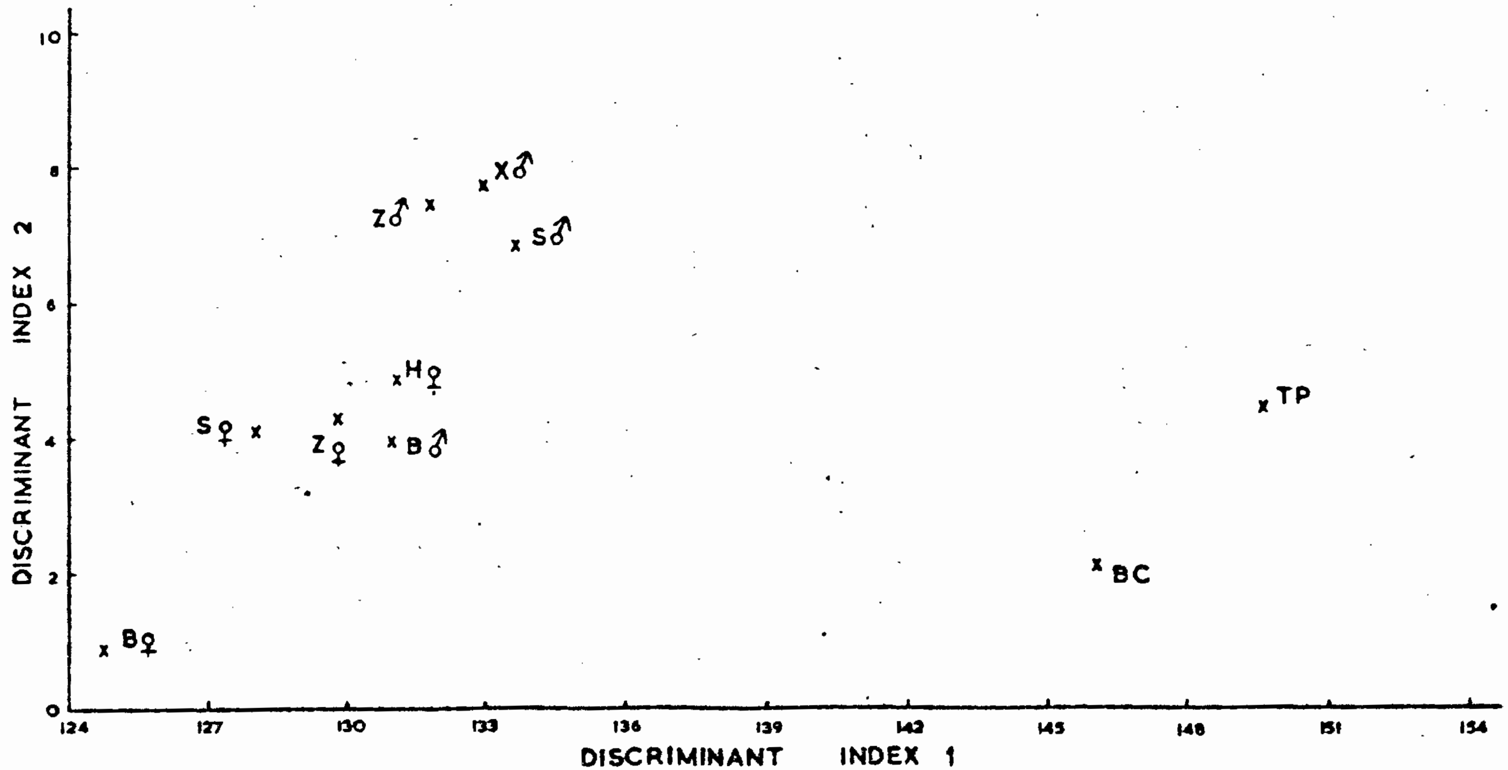


Figure 1. Values of discriminant indices 1 and 2. Key: BC – Border Cave 1 cranium. TP – Tuinplaas (Springbok Flats) cranium. B – San (Bushman) cranial series. H – Khoikhoin (Hottentot) cranial series. S – Sotho cranial series. X – Xhosa cranial series. Z – Zulu cranial series.

Fig. 2 Border Cave 1 : norma frontalis
Photograph by courtesy of A. Hughes

Fig. 3 Border Cave 1 : norma lateralis (right)
Photograph by courtesy of A. Hughes

Fig. 4 Border Cave 1 : norma lateralis (left)
Photograph by courtesy of A. Hughes

Fig. 5 Border Cave 1 : norma verticalis
Photograph by courtesy of A. Hughes

Fig. 6 Border Cave 1 : norma occipitalis
Photograph by courtesy of A. Hughes

Fig. 7 Border Cave 1 : norma basalis
Photograph by courtesy of A. Hughes

Appendix 29 : <u>Border Cave hominid 2</u>.

Hertha de Villiers.

The specimen (Table 1; Fig. 1) comprises most of the corpus mandibulae, that is, to the area below the third molars. Anteriorly, the corpus is fractured on the left side in the region of the lateral incisor and posteriorly, in the region of the third molar. On the right there is a fracture passing through the socket of the first molar. Both right and left rami are represented by little more than the anterior borders. The condyloid and coronoid processes as well as the angles are missing. The teeth, except for the mesial root of the second right molar, are missing, although from their sockets there is evidence that all permanent teeth, except the left second and third molars were present at the time of death. The loss of these teeth appears to have occurred some time before death, as indicated by resorption of the alveolar bone. The mandible is that of a fully adult individual.

The corpus mandibulae is of moderate height and robusticity. The height of the corpus at M_1 is 26mm and the thickness 11,4mm. The robusticity index is thus 43,8%. Corresponding measurements at M_2 are 24mm and 12,8mm, giving a robusticity index at M_2 of 58,1%. The alveolar margin in the region of the symphysis menti is damaged but an estimated symphyseal height of 30mm was obtained by reference to the relatively undamaged alveolar margin at P_3 . The symphyseal thickness is 14,8mm and the symphyseal robusticity index 48,3%. The chord between the mental foramina is 44,1mm.

The lateral surface of the corpus mandibulae tapers anteroposteriorly and is marked by a single superiorly directed mental foramen, which lies below the apex of the second premolar, nearer the lower margin of the corpus than the upper. The prominentia lateralis (Weidenreich, 1936) is slight and extends downwards towards the inferior border, terminating in a distinct tubercle - the tuberculum marginale posterius (of Weidenreich). Anteriorly, the prominence divides into a slight upper torus lateralis superior which extends to the mental foramen and a lower definite marginal torus which terminates in a distinct protuberance, the tuberculum marginale anterius. The torus lateralis superior and the marginal torus are separated by a shallow sulcus intertoralis which disappears posteriorly as the inferior part of the prominentia lateralis becomes continuous with the tuberculum marginale posterius. The body of the mandible is thickest in this region.

The anterior surface of the symphyseal region presents a well developed mental protuberance; the mental tubercles are, however, not apparent. The alveolar bone in this region is broken but a subalveolar depression, the incisura mandibulae anterior (Virchow, 1920), can be identified, and is divided by an upward median prolongation of the mental protuberance into two fossae mentales on either side of the midline. The overall effect is of a moderately pointed chin.

On the medial surface of the corpus mandibulae a well marked prominentia alveolaris (of Weidenreich) is apparent. A definite mylohyoid line runs forward and downwards and part of the prominence is still apparent inferior to the mylohyoid line in the region of M_2 . Anteriorly is the submandibular fossa.

The posterior surface of the symphyseal region is approximately vertical and is marked by a faint superior transverse torus and four irregular elevations, the two superior and the two inferior genial tubercles. The genial tubercles are flanked by the shallow triangular sublingual fossae.

The inferior surface of the symphyseal region shows two shallow digastric fossae separated in the midline by an interdigastric ridge.

In Table 1 the measurements and robusticity indices of this adult mandible are compared with those of other fossil hominid and modern South African Negro mandibles.

In absolute height the Border Cave mandible (symphyseal 30mm, M_1 26mm, and M_2 24mm) is smaller than those of Tuinplaas (40mm, 35,2mm, 32,5mm respectively), Skildergat (symphyseal height 38mm, M_1 32,1mm), Cape Flats (32mm, 32,4mm respectively) and Otjiseva 37mm, 24,3mm respectively). At the symphyis menti the Border Cave mandible exceeds in thickness (14,5mm) only the Boskop (13,2mm) and Otjiseva (12,5mm) mandibles. At M_1 (11,4mm) and M_2 (12,8mm) the thickness is less in the Border Cave mandible than in the other fossil specimens listed in Table 1. The Border Cave mandible is thus smaller than the Tuinplaas, Skildergat, Cape Flats and Otjiseva mandibles and is less robust than the Boskop mandible. On the other hand, the height (symphyseal and M_2), length (chord $M_2 P_3$) and breadth (chord between mental foramina)dimensions recorded for the Border mandible fall well within the corresponding ranges for South African Negro mandibles. A further factor is the sex of the individual represented by the mandible. Topinard (Weidenreich, 1936) originally pointed out that males develop higher mandibular bodies and thus have lower robusticity indices. Shima (Weidenreich, 1936) corroborated this sex difference. The Border Cave mandibular height and breadth dimensions lie closer to the female South African Negro mean values than to the corresponding male means. Although there are no reliable means available for determining the sex of the Border Cave mandible, the dimensions suggest that this specimen may represent a female.

The mandible would appear to be too narrow and low to be ascribed, with any degree of confidence, to the same individual as is represented by the broad and apparently male cranium. The cranium and mandible previously registered as A1102 have now been registered as A1102a and A1102b respectively and designated Border Cave 1 and 2 respectively.

Conclusions. The height, length and breadth dimensions of the Border Cave 2 mandible fall well within the ranges recorded for South African Negro mandibles, and lie close to the corresponding mean values for female mandibles (de Villiers, 1968).

References

DE VILLIERS, H. 1968. The skull of the South African Negro. Johannesburg : Witwatersrand Univ. Press.

VIRCHOW, H. 1920. Die Menschlichen Skeletreste aus dem Kampfeschen Bruch in Travertin von Ehringsdorf bei Weimar. Jena : Fischer Verlag.

WEIDENREICH, F. 1936. The mandible of Sinanthropus pekinensis : A comparative study. Palaeont. Sin. (D), 7 : 1-162.

TABLE 1. Comparison of Border Cave Mandible with other Southern African Mandibles.

	Border Cave Present Study	Tuinplaas (Springbok Flats) Tobias (1971)	Boskop Tobias (1971)	Skildergat (Fish Hoek) Tobias (1971)	Cape Flats Tobias (1971)	Otjiseva de Villiers (1972)	S.A. Negro – de Villiers (1968) Range Males	Range Females	Mean Males	Mean Females
Symphyseal height	30	40	27	38	32	37	23,0-41,0	26,0-41,0	34,0	32,7
Symphyseal thickness	14,5	18	13,2	15	16	12,5				
Symphyseal Index	48,3	45,0	49,0	39,5	50.0	33,7				
Height at M_1	26	35,2	24,3	32,1	32,4	32,7				
Thickness at M_1	11,4	18	14,9	15,7	14,4	13,7				
Robusticity Index at M_1	43,8	51,1	61,3	48,9	44,4	40,9				
Height at M_2	24	32,5					19,0-35,0	20,0-33,0	26,5	25,0
Thickness at M_2	12,8	17,9								
Robusticity Index at M_2	58,1	55,0								
Chord M_2 P_3	30	33,3?					26,0-35,0	27,0-33,0	30,0	29,1
Chord between mental foramina	44,1	51,5?					38,0-57,0	38,0-53,0	46,0	44,8

Fig. 1 Border Cave 2 mandible : lateral view
Photograph by courtesy of A. Hughes

Appendix 30 : Border Cave hominid 3

Hertha de Villiers.

This infant skeleton consists of the following cranial and postcranial bones:

i) Cranium : right petromastoid part of the temporal bone; right and left condylar parts of the occipital bone; two small fragments of parietal bone.

ii) Mandible.

iii) Postcranial:

Right side: nine ribs, including the first rib and rib fragments; scapula, with portion of the medial border, blade and inferior angle missing; clavicle, with the lateral extremity missing; humerus, radius and proximal two-thirds of ulna; metacarpal bones (three); femur, tibia (fractured in the lower third of the shaft), and fibula (fractured in the mid-shaft region); ilium; talus and calcaneus.

Left side: eight ribs and rib fragments; radius (fractured in the upper third of the shaft) and ulna; metacarpal bones (three); femur (fractured in the upper third of the shaft) and tibia; ilium and ischium.

Vertebrae: Cervical-right and left lateral masses of the atlas; three bodies and four right vertebral arch elements.

Thoracic - five vertebral bodies, five right and four left vertebral arch elements.

Lumbar - one vertebral body and three right vertebral arch elements.

Sacral - four vertebral bodies, right and two left vertebral arch elements.

The remains are those of an infant between four and six months of age. This estimate is based on the average time of appearance of the ossification centres (Caffey, 1961), the mean lengths of long bones (Maresh, 1955) and the development of the dentition (Watson & Lowrey, 1969) in Caucasoid populations. Since variation in bone maturation and tooth development may be great, it is not possible to determine the age more accurately. Moreover, assessment is based on standards derived from Caucasoid populations, since to my knowledge, none is available for African infant populations. An age of "about 3 months" is recorded for the Border Cave infant in the Catalogue of Fossil Hominids (Oakley & Campbell, 1967).

Infant Cranium. The cranium, consisting as it does of only two small vault bone fragments, condylar parts of the occipital bone, and the right petromastoid part of the temporal bone, is too fragmentary to provide any useful information.

Infant Mandible. (Table 1; Fig. 1). The mandible consists of the body fractured on the left side in the region of the socket for the second decidous molar. The right ramus is complete, save that the condyloid process and the tip of the coronoid process are missing. The anterior border of the left ramus is defective in its lower third, as is the condyle on its medial and lateral aspects. The pars basalis is complete, but the pars alveolaris is in part defective. On the right side the alveolar bone is missing on the lingual aspect of the sockets for the second decidous and first permanent molar teeth, and on the buccal aspect of the sockets for the canine and first decidous molar teeth. On the left side both lingual and buccal walls of the distal two sockets are defective, as is the bone on the labial aspect of the sockets for the anterior teeth.

The contour of the body seen from above is shaped like a divergent U, the intercanine region joining the rest of the body at a somewhat obtuse angle. The mandible is broad in relation to its length (bigonial breadth (go/go) 45,6mm and projective length of the corpus (cpl) 44,0mm. The ramus is low and broad (projective height of ramus (rl) 17,5mm and minium breadth of ramus (rb) 17,0mm), with a shallow sigmoid notch. The angle of the mandible is slightly everted. The inferior border of the body is concave: it shows two projections, one formed posteriorly by the angle and one anteriorly by the inferior end of the symphysis menti. The symphysis is low (symphyseal height (h_1) 15,1mm) and relatively thick (8,0mm), the resultant index being 52,9%. The symphysis is somewhat convex in lateral profile, the mental portion receding slightly behind the alveolar portion. The mandible shows on its anterior surface near the symphysis the depressions described by Hrdlička (1930) as mental fossae. In the inferior part of the symphysis menti are two triangular depressions, reflecting possibly the presence of mental ossicles. The single mental foramen is situated below the socket for the first deciduous molar and is directed superiorly. The upper part of the inner surface of the symphyseal region, the planum alveolare, is slightly inclined downwards and backwards and terminates in a slightly transverse ridge, the superior transverse torus. Below the torus is a well defined genial fossa. The genial tubercles are not apparent. The mandibular foramen has the typical infantile character of a circular aperture directed posteriorly. No lingula is apparent. The mylohyoid line is faint and the mylohyoid groove is situated immediately below the margin of the mandibular foramen.

In Table 1, the measurements and indices of the Border Cave infant mandible are compared with those of other available infant mandibles of approximately the same age namely, four South African Negro, three from Bambandyanalo, Northern Transvaal (Galloway, 1959) and three from the Oakhurst Shelter, near George, Cape Province (Drennan, 1937).

Discriminant analysis (Rightmire, 1970) has indicated that the Bambandyanalo people fall within the range expected of the modern Southern African Negro and the Oakhurst Shelter remains have been characterised as Khoisan (Drennan, 1937).

On a metrical basis alone, it would be difficult to distinguish the Border Cave infant mandible from South African Negro mandibles, in particular A662, A1842 and A614. In the South African Negro mandible A657 the ramus is appreciably higher (25mm) than in the Border Cave 3 specimen (17,5mm) and in the Negro mandibles A662 (19,5mm) and A1842 (18,5mm). The Bambandyanalo mandibles are larger in all their dimensions and may well represent somewhat older individuals, whereas the Khoisan mandibles from Oakhurst Shelter are smaller in all their dimensions.

The symphyseal height is low in the Border Cave 3 mandible; however, the 15,1mm recorded is an estimate based on a fragmented alveolar margin. The height of the body shows little variation amongst the Border Cave 3 and South African Negro mandibles (10,7mm to 11,2mm). The Negro mandibles A662 and A657 are, however, slightly thicker in the molar region and this is reflected in their higher robusticity indices, indicative perhaps of smaller molars in the Border Cave 3 and A1842 mandibles.

The contour of the body as seen from above is angulated in the South African Negro mandibles and in the Bambandyanalo K32 mandible (Galloway, 1959); that is, the intercanine region joins the rest of the body at a definite angle, so that the contour is U-shaped rather than divergent U-shaped as in Border Cave 3, Bambandyanalo K20 and K23 infants.

The rameal indices show all these African infant rami to be relatively broad and, as in the Border Cave 3 mandible, the angle is slightly everted in the South African Negroes A662, A1842 and A614. In this respect, the Border Cave 3 and South African Negro infant mandibles differ from the San (Bushman) mandibles described by Wells (1931) in which the angle is "distinctly" everted. In the Bambandyanalo mandibles (K20, K32, K23) the angles are likewise everted (Galloway, 1959).

The inferior border of the body is concave in all four South African Negro mandibles (as in the Border Cave 3 specimen), showing two projections formed by the inferior end of the snymphysis menti and the angles respectively. The inferior border thus does not exhibit the sinuosity of the San and Bambandyanalo infant mandibles (Wells, 1931; Galloway, 1959).

The mental protuberance is prominent and pointed in the South African Negro infant mandibles, the mental fossae are well defined and the inferior border of the mandible is rounded. The general development of these features is similar to that seen in Border Cave 3 specimen, whereas from Wells's (1931) account it appears that the mental protuberance is less well developed and less salient in the San (Bushman) infant mandibles.

In the Border Cave 3 specimen, the symphysis menti recedes inferiorly (an effect possibly produced by the apparently missing mental ossicles). The anterior surface is thus slightly convex, a feature of the San (Bushman) infant mandible. In the South African Negro infants and in the Bambandyanalo K32 infant, on the other hand, the symphysis is approximately straight, in Bambandyanalo K20 and K23 it is somewhat concave.

The planum alveolare is not clearly demarcated and inclined in the South African Negro infant mandibles, as it is in the Border Cave 3 specimen, and the superior transverse torus is barely discernible. As in the Border Cave specimen, the South African Negro mandible A1842 shows a genial fossa and no apparent genial tubercles, whereas in the infant A662 the genial area is slightly elevated and shows two faintly demarcated superior tubercles and a single median inferior tubercle. Negro infant mandibles A614 and A657 exhibit a single median ridge in the genial region.

<u>Summary on the Mandible</u>: i) Metrically the Border Cave 3 infant mandible cannot be clearly distinguished from the South African Negro infant mandibles of comparable age, but

it is larger than the Khoisan jaws and smaller than the Bambandyanalo specimens.

ii) The principal differences between Border Cave 3 mandible and those of recent South African Negro infants lie in the contour of the mandible as seen from above, in the inclination of the planum alveolare and in the profile of the symphysis menti.

iii) The morphology of the symphysis menti relates the Border Cave 3 mandible to the San (Bushman) mandible, whereas the contour of the mandible as seen from above aligns it with the Bambandyanalo K 20 and K23 specimens.

iv) The morphology of the planum alveolare is not mentioned by Wells (1931), Drennan (1937) and Galloway (1959).

Infant Postcranial Skeleton. (Table 2; Fig. 2). The post-cranial skeleton, axial as well as appendicular, shows no unusual or distinctive features.

All measurements have been made on the diaphyses and in each case the maximum length is recorded.

The humerus is 81mm in length, the radius 67mm and the ulna 74mm. The radio-humeral index and ulnar-humeral index are 82,7% and 91,3% respectively. The tibiofemoral index of 90,4% shows the leg to be long relative to the thigh (tibial length 85mm, femoral length 94mm), while the humero-femoral index of 86,1% shows a relatively long upper limb.

There is no flattening of the femur, the platymeric index being 89,8%. The mid-shaft of the femur is cylindrical in cross section with a pilasteric index of 100,0%. The shaft of the tibia is convex forward and there is no flattening, the platycnenic index being 97,5%.

Comparative long bone measurements and indices are given in Table 2 for Border Cave 3, South African Negro, Bambandyanalo and Oakhurst Shelter infants, as well as the mean values for Caucasoid males and females of approximately comparable age (Maresh, 1955).

The Border Cave 3 infant limb bones are but slightly longer than those of the four South African Negroes, appreciably longer than those of the Khoisan infants from Oakhurst Shelter and somewhat shorter than those of the Bambandyanalo K20 and K23 infants. The femur is eurymeric and the tibia eurycnemic in all these African infants.

The ulnar-humeral index in all the populations represented shows the ulna to be relatively long, particularly in the younger infants. The radio-humeral index ranges from 90,1% in a three months old Negro infant (A662) to 77,0% in Caucasoid females of six months. There is a tendency in the younger infants, African and Caucasoid, to exhibit the simian feature of a relatively long radius.

The tibio-femoral index shows a tendency for the tibiae to be relatively longer in African than in Caucasoid infants.

The humero-femoral index shows that infant populations represented had, to a degree, relatively long upper limbs and this feature is more pronounced in the younger infants.

Summary on the Postcranial Skeleton. i) Both radius (67mm) and ulna (74mm) are long relative to the humerus (81mm) in the Border Cave 3 specimen. The radio-humeral index is 82,7% and the ulnar-humeral index is 91,3%.

ii) The tibia (85mm) is long relative to the femur (94mm) and the tibiofemoral index is 90,4%.

iii) The limb bones of the Border Cave 3 infant are slightly longer than those of South African Negro infants but appreciably longer than those of the Khoisan infants of approximately comparable age. The limb proportions are, however, similar, as are the pilasteric, platymeric and platycnemic indices.

Affinities

The Border Cave infant shows a cluster of metrical and morphological features which align it with the South African Negro infant, as well as morphological features which relate it to the Khoisan infant.

The Border Cave infant may thus represent the infant stage of the undifferentiated basic *Homo sapiens afer* form, exhibiting as it does both Negro and Khoisan affinities.

References.

CAFFEY, J. 1961. Pediatric X-ray diagnosis. 4th Ed. Chicago : Year Book Medical Publishers Inc.

DRENNAN, M.R. 1937. Archaeology of the Oakhurst Shelter, George. IV. The children of the cave-dwellers. Trans. R. Soc. S. Afr., 25 : 281-293.

GALLOWAY, A. 1959. The skeletal remains of Bambandyanalo. Johannesburg : Witwatersrand Univ. Press.

HRDLIČKA, A. 1930. Mental fossae. Am. J. phys. Anthrop., 14 : 317-318.

MARESH, M.M. 1955. Linear growth of long bones of extremities from infancy through adolescence. A.M.A.J. Dis. Child, 89 : 725-730.

OAKLEY, K.P. & CAMPBELL, B.G. 1967. Catalogue of fossil hominids. Part 2. Africa. London : British Mus. (Nat. Hist.).

RIGHTMIRE, G.P. 1970. Iron Age skuls from Southern Africa re-assessed by multiple discrimination analysis. Am. J. phys. Anthrop., 33 : 147-167.

WATSON, E.H. & LOWREY, G.H. 1969. Growth and development of children. 5th Ed. Chicago : Year Book Medical Publishers Inc.

WELLS, L.H. 1931. Growth changes in the Bushman mandible. J. Anat., 66 : 50-63.

TABLE 1. Comparison of Border Cave infant mandible with other Southern African infant mandibles. (Measurements are given in mm).

Character	Border Cave Present Study	South African Negro Present Study				Bambandyanalo Galloway (1959)			Oakhurst Shelter Drennan (1937)		
		A 662 3/12yr.	A 1842 3/12yr.	A 657 4/12yr.	A 614 5/12yr	K20 4/12yr.	K32 4/12yr.	K23 6/12yr.	M 6/12yr.	N 6/12yr	O 6/12yr.
h_1	15,1?	16,2	15,7	16,9	16,3	18	17	18	13,0	12,5	10,0
Symphyseal thickness	8,0	8,3	8,3	8,8	8,3	10	11	9			
Symphyseal Index	52,9	51,2	52,8	52,0	50,9	55,6	64,7	50,0			
Height at m_2	11,1	10,9	11,2	10,7	11,1						
Thickness at m_2	8,8	9,5	8,9	9,4	8,7						
Robusticity Index	79,2	87,1	79,4	87,8	78,3						
*zz	29,8	31,6	30,5	28,8	28,2						
*gogo	45,6	44,7	45,7	48,2		46	60	54			
*ml	51 ?	54	50	52		58	57	60	43	40,5	42
*cpl	44	43	40	41							
*rl	17,5	17,5	18,5	25		22	21	22	15,0	13,0	14,5
*rb	17,0	19,4	17,0	18,2		22	19	26	14,5	16,0	16,0
Rameal Index	97,1	110,8	91,8	70,2		100,0	90,4	118,1	96,6	123,0	110,3

*Where available abbreviated biometrical symbols are used.

TABLE 2. Comparison of Border Cave infant long bones with other Southern African and Caucasoid long bones. (Measurements are given in mm).

Character \ Age in months	Border Cave	South African Negro			Bambandyanalo		Oakhurst Shelter				Caucasoid			
	4 – 6	A 662 3	A 657 3	A 614 5	K20 4	K32 4	M 6	N 6	O 6	P 6	Male Mean 2	Female Mean - 2	Male Mean 6	Female Mean 6
Humerus L.	81	71	78	79	84	86	64	64	62	68	73	71	88	87
Radius L.	67	64	64	62			50	53	53		59	57	70	67
Ulna L.	74	65	70	70	76		59	60	60	62	67	65	77	76
Ul-Hum Index	91,3	91,5	89,7	88,6	90,5		92,1	93,7	96,7	91,1	*91,7	*91,5	*87,5	*87,3
Rad-Hum Index	82,7	90,1	82,0	78,4			78,1	82,3	85,4		*80,8	*80,2	*79,5	*77,0
Femur L.	94	87	94	93	101		79	75	78	77	86	87	112	112
A-P Diam.	8,7	8,8	9,4	8,2	9,0	9,0								
Trans. Diam.	9,7	9,7	9,6	8,6	10,0	10,0								
Platymeric Index	89,6	90,7	97,9	95,3	90,0	90,0								
A-P Diam. shaft	6,5	7,0	7,1	6,0	8,0	9,0								
Trans. Diam. shaft	6,5	6,4	7,1	6,0	9,0	9,0								
Pilastric Index	100,0	109,3	100,0	100,0	88,9	100,0								
Tibia L.	85	77	80	83		88	66	66	67	69	69	70	89	89
A-P Diam.	8,0	9,0	8,4	7,9		11,0								
Trans. Diam.	7,8	7,7	7,4	7,7		9,0								
Platycnemic Index	97,5	85,5	88,0	97,4		81,8								
Tibio-femoral Index	90,4	88,5	85,1	89,2			83,5	88,0	85,8	89,6	*80,2	*80,4	*79,4	*79,4
Humero-femoral Index	86,1	81,6	82,9	84,9	83,1		81,0	85,3	79,4	88,3	*84,8	*81,6	*78,5	*77,7

*Calculated from the mean values.

Fig. 1 Border Cave 3 mandible : dorsal view
Photograph by courtesy of A. Hughes

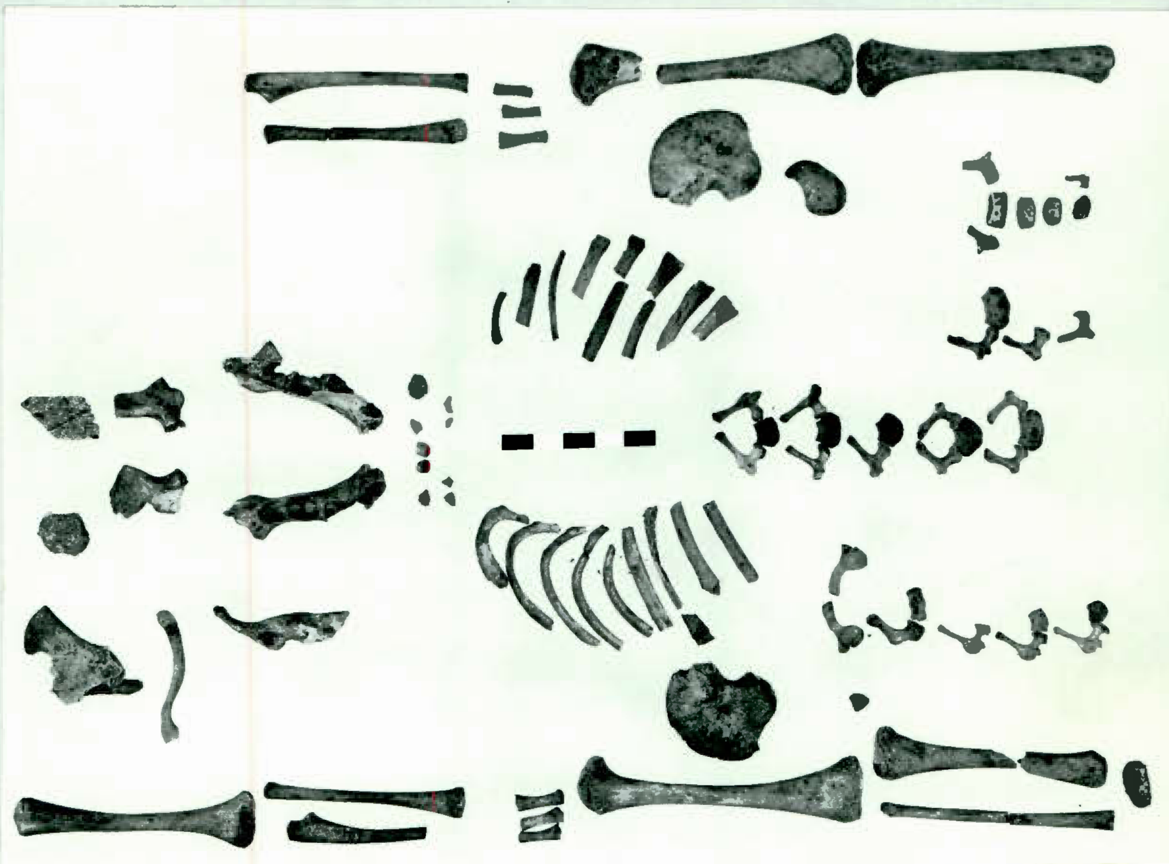


Fig. 2 The entire skeleton of Border Cave 3.
Photograph by courtesy of A. Hughes

Appendix 31 Border Cave hominid 4

Hertha de Villiers

The skeletal remains comprise:

Mandible	
Hyoid bone	- right greater cornu missing
Vertebrae	- 7 cervical
	- 11 thoracic
	- 5 lumbar
	- 1 sacrum
Manubrium and sternum	
Rib	- 22 ribs and rib fragments
Clavicle	- right and left
Scapula	- right and left
Humerus	- right and left
Ulna	- right and left
Radius	- right and left
Carpal bones	- 13
Metacarpal bones	- 8
Phalanges	- 31
Os coxae	- right and left
Femur	- right and left
Tibia	- right
Fibula	- right and left
Patella	- right
Tarsal bones	- 13
Metatarsal bones	- 10
Phalages	- 11
Sesamoid bone	- 1

The missing tibia and patella, as also some vertebrae and limb extremities, were previously removed for C-14, F.U.N. and A.A. determinations.

The remains are those of a slightly built individual of between 38 and 45 years of age. This assessment is based firstly on McKern and Stewart's 1957 evaluation of pubic symphyseal age variation (38 + years) and secondly on Brothwell's 1963 tentative classification of age and molar wear in pre-Medieval British skulls (35-45 years).

The ischiopubic index (95%), subpubic angle (90^{o}), and femoral head diameter (39,6mm) fall within the female range of variation.

The estimated living stature, based on Trotter and Gleser's 1958 regression formulae for American Negro females is 160,7cm.

The femur is platymeric, with a well developed linea aspera (Platymeric index = 74,6%; Pilasteric index = 124,3%).

The tibia, however, is eurycnemic, that is, not flattened with a cnemic index of 71,0%.

In the past platymeria and pilastering have been considered as racial or population criteria. But Lisowski (1968) demonstrated, in a study of different Ethiopian socio-economic groups, that these features of the femur result from nutritional deficiencies, which affect the structure of the bone, and influence the osseous resistance to the stress of locomotion, thereby giving the characteristic appearances.

The lumbar and sacral vertebrae (L34 and S1) show the marked lipping of ankylosing spondylitis, the phalanges of both the fingers and toes the osteitic changes of Heberdens arthritis.

Osteo-arthritic lipping of the glenoid cavity and pitting of the greater tubercle of the humerus indicates that the individual may well have suffered from a 'frozen' right shoulder. The anterior and medial surfaces of the upper region of the shaft of the right humerus show a number of small irregular depressions with rounded edges (Fig. 1). This undoubtedly artificial damage would seem most possibly to represent a witchdoctor's surgical attempt at curing the condition (J. Chabalala, pers. comm.).

The mandible is complete, but has been fractured in the region of the left coronoid process and the right first molar and canine. The left lateral incisor is ectopic and had erupted on the lingual surface of the alveolar process. The left third molar is missing; it either failed to erupt or was lost antemortem, since the socket is no longer apparent. All teeth show marked attrition with dentine exposure.

The measurements and indices (Table 1), as also the non-metrical characters, fall well within the corresponding ranges of the male South African Negro. It is therefore unlikely, but not impossible, that the mandible belongs to the postcranial skeleton.

REFERENCES

BROTHWELL, D.R. 1963. Digging up bones. London : British Mus. (Nat. Hist.)

LISOWSKI, E. 1968. Osseous characteristics of the femur and tibia indicating malnutrition or racial differences. Proc. VIIIth Internat. Cong. Anthrop. and Ethnol. Sci. Vol.1 Tokyo & Kyoto : Sci. Council of Japan.

McKERN, T.W. and STEWART, T.D. 1957. Skeletal age changes in young American males. Natick, Mass.: Headquarters Quartermasters Res. and Dev. Command.

TROTTER, M. and GLESER, G.C. 1958. A re-evaluation of estimation of stature based on measurements of stature taken during life and long bones after death. Am. J. phys. Anthrop., **16** : 79-123.

TABLE 1

Measurements and indices of the Border Cave BC 4 mandible compared with those for the South African Negro mandible. (Measurements in millimetres. Biometrical symbols)

Character	Present study BC 4	S.A. Negro male mean	S.A. Negro male range	S.A. Negro female mean	S.A. Negro female range
cyl	23,1	19,9	16,0-25,0	18,3	14,0-24,0
crh	65,0	59,0	44,0-74,0	53,0	44,0-68,0
rl	63,0	57,0	45,0-69,0	51,9	42,0-62,0
rb	41,4	35,2	26,0-44,0	33,1	27,0-39,0
100 rb/rl	65,7	61,4	42,6-84,4	63,9	50,9-80,9
cpl	87,0	80,9	67,0-96,0	76,8	66,0-89,0
w_1	126,9?	114,7	98,0-134,0	109,4	94,0-124,0
crcr	92,7?	92,9	77,0-106,0	88,5	80,0-99,0
gogo	96,0	91,3	74,0-110,0	84,2	70,0-98,0
zz	50,3?	46,0	38,0-57,0	44,8	38,0-53,0
Mandibular angle	121	120	103 -135	125	115 -138
Symphyseal Height	33,9	34,7	26,0-41,0	33,1	28,0-48,0
Symphyseal Thick.	14,9	13,5	10,0-17,0	13,5	5,0-16,0
Robusticity Index	43,9	39,1	25,3-53,7	42,2	13,1-49,8
M_1 Height	27,6	28,8	23,0-36,0	27,7	20,0-32,0
M_1 Thick.	15,9	13,5	10,0-17,0	13,1	5,0-15,0
Robusticity index	57,6	47,2	36,8-65,6	47,7	40,3-61,7
M_2 Height	27,0	25,7	22,0-30,0	24,5	20,0-30,0
M_2 Thick.	17,5	15,1	11,0-19,0	14,9	12,0-18,0
Robusticity Index	64,8	59,0	39,3-80,1	61,3	46,2-76,7

Fig. 1 Border Cave 4 : upper shaft of right humerus showing irregular pitting of artificial origin.

Identification by H. de Villiers

Photograph by D. Rokos

Appendix 32 : Border Cave hominid 5.

Hertha de Villiers.

The specimen comprises most of the right half of the corpus mandibulae and ramus as well as the base of the left half (Tables 1-4; Figs. 1-4). Surface damage mars the anterior border of the right ramus and the edge of the mandibular incisure. The condylar and coronoid processes are missing. The base of the right half of the corpus mandibulae and the symphysis menti are intact but the alveolar part is defective on the buccal aspect of the premolar - first molar region. For the most part, however, the full depth of the corpus is preserved. Anteriorly, the alveolar bone is damaged and the specimen is broken, obliquely, just to the left of the lateral incisor socket so that only the base of the left half of the corpus mandibulae, from the region of the canine to the area of the second left molar, is included.

Of the teeth the right I_2, $\dot{C}$, M_2 and M_3 are preserved as well as the broken root stump of P_3 . Surface dentine is evident on the wear surfaces of all the intact teeth. Attrition is uneven in M_2 , while pulp cavities are exposed in I_2 and C. From the sockets there is evidence that I_1 , P_4 and M_1 (right) and I_2 (left) were present at the time of death. The age of the individual then is estimated at between 25 and 35 years on the basis of the tentative classification of Brothwell (1963).

The mandible is of moderate height, length and robusticity (Table 1). Thus the height of M_1 (measured on the lingual aspect of the corpus) is 29.5mm and the thickness is 13.6mm. The robusticity index at M_1 is, therefore, 46.1%. Corresponding measurements at M_2 are 26.2mm and 15.7mm giving a robusticity index at M_2 of 59.9%. The alveolar margin in the region of the symphysis menti is damaged but an estimated symphyseal height of 34mm was obtained by reference to the relatively undamaged alveolar margin at I_2 . The symphyseal thickness is 13.4mm giving a symphyseal robusticity index of 39.4%.

The lateral surface of the corpus mandibulae tapers anteroposteriorly and is marked by two mental foramina. A small, superiorly directed, accessory mental foramen is situated anterosuperiorly to the major foramen and below the sockets of P_3 and P_4, whereas the large, oval, laterally directed major foramen lies below the socket of P_4 , nearer the lower border of the corpus than the upper. The surface is characterized by a torus lateralis superior, (Weidenreich, 1936). This torus extends anteriorly beyond the mental foramen. Posteriorly, it is more prominent between M_2 and M_3 as it builds up to become the prominentia lateralis. The body of the mandible is thickest along the summit of this prominence. Below the torus lateralis superior is a faint sulcus interoralis separating it from a slight marginal torus. The interoral sulcus disappears posteriorly as the lower part of the prominentia lateralis becomes continuous with the posterior part of the marginal torus. Anteriorly the torus lateralis superior and the marginal torus terminate in a small protuberance, the tuberculum marginale anterior. None of these features is exceptional for recent man.

The anterior surface of the symphyseal region presents a moderately well developed protuberance; the mental tubercles are, however, not apparent. A shallow sub-alveolar depression, the incisura mandibulae anterior (Virchow, 192), can be identified and is divided by a broad upward, median prolongation of the mental protuberance into two shallow fossae mentales on either side of the midline. The overall effect is of a pointed chin. There is no prognathism.

On the medial surface of the corpus mandibulae a well marked prominentia alveolaris (Weidenreich, 1936) is apparent. A definite mylohyoid line runs forwards and downwards and part of the prominence is still apparent inferior to the mylohyoid line in the region of M_2 Further forwards the submandibular fossa is apparent.

The posterior of the symphyseal region is approximately vertical and is marked by a faint superior transverse torus, a median genial pit and three irregular elevations - the two superior genial tubercles and a single median inferior tubercle. Immediately above the superior genial tubercles is the median supraspinous foramen and below the inferior genial tubercle are two infraspinous foramina.

The inferior surface of the symphyseal region shows two shallow digastric fossae separated in the midline by an interdigastric ridge.

The shape of the ramus is roughly rhomboidal and the mandibular notch appears to have been relatively deep with a fair degree of bony buttressing between the condyloid and coronoid processes. There is a slight eversion of the angle region and the posterior border is blunt. The mandibular foramen is large leading off from a deep vestibule. The lingula is broken but appears to have rested on a broad base. The mylohyoid groove is deep and the area for the attachment of the medial pterygoid muscle is broadly ridged.

In Table 1 the measurements and robusticity indices of Border Cave 5 are compared with those of other fossil and modern Southern African mandibles. It is regrettable that the San (Bushman) samples are small and that no Khoikhoin (Hottentot) series of sufficiently complete adult mandibles were available for comparison.

In absolute height the Border Cave 5 adult mandible (symphyseal height 34mm, M_1 29.5mm, M_2 26.2mm) is smaller than Tuinplaas (40mm, 35.0mm and 32.5mm respectively), Skildergat (symphyseal height 38.0mm, M_1 32.1mm), Cape Flats (M_1 32.4mm) and Otjiseva (symphyseal height 37.0 mm, M_1 32.7mm). At the symphysis menti the Border Cave 5 specimen (13.4mm) exceeds in thickness only the Boskop (13.2mm) and Otjiseva (12.5mm) mandibles. At M_1 (13.6mm) the thickness is less than in the other fossil mandibles listed in Table 1, except that of the Border Cave 2 mandible (11.4mm). The second Border Cave mandible is thus, in general, small than the Tuinplaas, Skildergat, Cape Flats and Otjiseva mandibles.

A further factor is the sex of the individual represented by the mandible. Topinard (Weidenreich, 1936) originally pointed out that males develop higher mandibular bodies and thus have lower robusticity indices. The Border Cave 5 mandibular dimensions lie closer to the South African Negro male means than to the corresponding female means. Although there are no reliabel means available for determining the sex of the Border Cave 5 mandible, the morphology and dimensions suggest that this specimen may well represent a male.

To measure the relationships between the Border Cave and other ancient and modern Southern African mandibles listed in Table 1, Mahalanobis' D^2 distance statistic was applied to the data in Table 1. The results are represented in Tables 2 and 3.

The D^2 values between the Border Cave 5 specimen and each of the modern Southern African populations are small and range from 0.75 Border Cave/South African Negro male comparison to 7.49 Border Cave/San (Bushman) female comparison. The P values given in Table 3 indicate that the Border Cave 5 mandible is not significantly different from the modern South African mandibles at the 5% confidence limit and that it is nearer to the Negro than the San (Bushman), in particular the Negro male.

For the fossil mandibles listed in Table 1 the values of D^2 were computed using the six common measurements. The D^2 distance between the second Border Cave, Skildergat (3.27) and Otjiseva (4.15) specimens are small and not significant at the 5% confidence limit (Table 3), suggesting that these three mandibles are not markedly dissimilar. However, the D^2 distances between the Border Cave 5 mandible, Tuinplaas (11.71) and Boskop (12.59) are larger and indicate that, in general, there is less similarity between these mandibles. Further, the Border Cave 2 and Border Cave 5 mandibles are separated by $D^2 = 8.69$. The first Border Cave mandible, apparently female, resembles rather the San (Bushman) female mandible than the South African Negro male mandible.

Canonical variates were calculated and the value for the two most effective variates are given in Table 4. Although the small number of possible measurements on the fossil mandibles makes for poor discrimination, the figures suggest that the second Border Cave adult mandible lies closer to the modern South African Negro mandibles that to either the first Border Cave specimen or the San (Bushman) mandibles. At least some of this separation may depend on the greater height dimensions of the second Border Cave mandible.

It is concluded that the metrical and non-metrical characteristics of the mandible fall well within the range of variation recorded for modern Homo sapiens. The statistical and comparative anatomical results favour a link with the South African Negro male.

I thank Professor Douglas Hawkins and Mr. I. Abramson of the Department of Applied Mathematics, University of the Witwatersrand, for their assistance with the statistical aspects of this study. Professor T.R. Trevor Jones provided the facilities for this study.

References.

BROTHWELL, D.R. 1963. Digging up bones. London : British Museum (Nat. Hist.).

DE VILLIERS, H. 1972. The first fossil human skeleton from South West Africa. Trans. R. Soc. S. Afr., 40 : 187-196.

DE VILLIERS, H. 1973. Human skeletal remains from Border Cave, Ingwavuma district, KwaZulu, South Africa. Ann. Tvl. Mus., 28 : 229-256.

TOBIAS, P.V. 1971. Human skeletal remains from the Cave of Hearths, Makapansgat, Northern Transvaal. Am. J. phys. Anthrop., 8 : 244-243.

VIRCHOW, H. 1920. Die Menschlichen Skeletreste aus dem Kampfeschen Bruch in Travertin von Ehringsdof bei Weimar. Jena : Fisher Verlag.

WEIDENREICH, F. 1936. The mandible of Sinanthropus pekinensis : A Comparative study. Palaeont. Sin. (D), 7 : 1-162.

Table 1. Comparison of second adult mandible from Border Cave with other Southern African mandibles (measurements in mm)

Character	Border Cave (present study)	Border Cave 2 DeVilliers 1973	Tuinplaas Tobias 1971	Boskop Tobias 1971	Skildergat Tobias 1971	Cape Flats Tobias 1971	Otjiseva DeVilliers 1973	Mean S.A. Negro male (n=50, present study)	Mean S.A. Negro female (n=50, present study)	Mean San Bushman male (n=14, present study)	Mean San Bushman female (n=8, present study)
Symphyseal height	34.0?	30.0	40.0	27.0	38.0	32.0	37.0	34.70	33.10	30.51	28.67
Symphyseal thickness	13.4	14.5	18.0	13.2	15.0	16.0	12.5	13.57	13.55	12.62	13.31
Symphyseal index	39.4	48.3	45.0	49.0	39.4	50.0	33.7	39.45	42.25	41.63	46.94
Height at M_1	29.5	26.0	35.0	24.3	32.1	32.4	32.7	28.83	27.70	24.49	24.58
Thickness at M_1	13.6	11.4	18.0	14.9	15.7	14.0	13.7	13.57	13.12	12.91	13.10
Robusticity index M_1	46.1	43.8	51.4	61.3	48.9	44.4	41.8	47.25	47.71	53.34	53.54
Height at M_2	26.2	24.0	32.5	–	–	–	–	25.75	24.50		
Thickness at M_2	15.7	12.8	17.9	–	–	–	–	15.15	14.95		
Robusticity index M_2	59.9	58.1	55.0	–	–	–	–	59.07	61.38		
Min. Antero post breadth ramus	34.6	–	–	–	–	–	–	35.75	34.05		
Molar-premolar chord	28.3?	30.0	–	–	–	–	–	30.11	29.19		
Projective length corpus	83.0?	–	–	–	–	–	–	81.41	77.47		

Table 2. Values of D^2 based on 6 characters: Border Cave, ancient and modern South African mandibles

	Border Cave (present study)	Border Cave 2	Tuinplaas	Boskop	Skildergat	Cape Flats	Otjiseva	S.A. Negro male	S.A. Negro female	Bushman (San) male	Bushman (San) female
Border Cave (present study)	–	8.69	11.71	12.59	3.27	8.02	4.15	0.75	1.09	4.59	7.49
Border Cave 2	–	–	26.73	15.40	15.09	14.71	19.53	6.72	4.70	7.81	4.98
Tuinplaas	–	–	–	33.70	4.18	15.37	14.54	12.25	15.49	26.08	28.42
Boskop	–	–	–	–	17.94	17.33	17.19	11.78	10.47	8.88	3.18
Skildergat	–	–	–	–	–	10.77	5.47	2.88	5.07	12.03	13.38
Cape Flats	–	–	–	–	–	–	7.60	10.52	10.45	17.58	14.83
Otjiseva	–	–	–	–	–	–	–	5.72	7.29	12.57	15.10
S.A. Negro male	–	–	–	–	–	–	–	–	0.37	3.80	5.70
S.A. Negro female	–	–	–	–	–	–	–	–	–	2.28	4.09
San male	–	–	–	–	–	–	–	–	–	–	4.04
San female	–	–	–	–	–	–	–	–	–	–	–

Table 3. Significance of D^2 Border Cave, ancient and modern South African mandibles (%)

	Border Cave (present study)	Border Cave 2	Tuinplaas	Boskop	Skildergat	Cape Flats	Otjiseva	S.A. Negro male	S.A. Negro female	Bushman (San) male	Bushman (San) female
Border Cave (present study)	–	.65	.4743	.4265	.9526	.7000	.9190	.9909	.9827	.6652	.3896
Border Cave 2	–	–	.0544	.2964	.3089	.3249	.1647	.3961	.6237	.3308	.6474
Tuinplaas	–	–	–	.0177	.9175	.2976	.3322	.0834	.0303	.0015	.0011
Boskop	–	–	–	–	.2067	.2267	.2312	.0960	.1421	.2517	.8437
Skildergat	–	–	–	–	–	.5284	.8541	.8442	.5788	.1060	.0864
Cape Flats	–	–	–	–	–	–	.7268	.1399	.1429	.0204	.0577
Otjiseva	–	–	–	–	–	–	–	.1866	.0892	.0090	.1390

Table 4. Canonical variates I and II: Border Cave, ancient and modern South African mandibles

	Canonical variates	
	I	II
Border Cave (present study)	−0.6708	−0.1843
Border Cave 2	0.6715	1.0019
Tuinplaas	−3.2300	0.4025
Boskop	2.0783	1.5402
Skildergat	−1.8823	0.4305
Cape Flats	−0.9018	1.2609
Otjiseva	−1.4110	0.0494
S.A. Negro male	−0.5451	0.0505
S.A. Negro female	−0.0429	−0.0193
San male	1.2132	−0.7909
San female	1.5524	1.1893

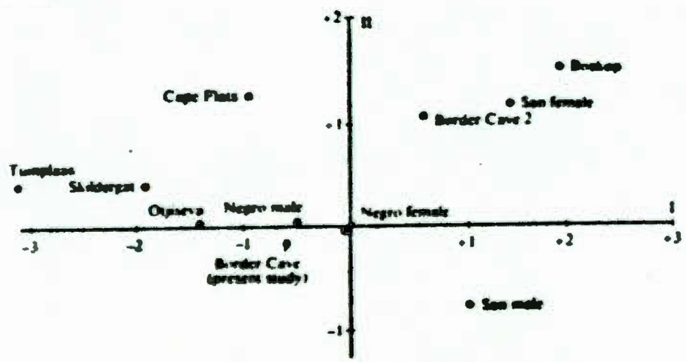


Fig. 4. Canonical variates.

Fig. 1 Border Cave 5 : lateral view

Photograph by courtesy of A. Hughes

Fig. 2 Border Cave 5 : frontal view
Photograph by courtesy of A. Hughes

Fig. 3 Border Cave 5 : dorsal view
Photograph by courtesy of A. Hughes

Appendix 33 The mammalian macrofauna from Border Cave

Richard G. Klein

Counts and Identifications

Before the Border Cave bones were sent to me for study (at the South African Museum), the microfaunal remains, believed to have been introduced in owl pellets, were removed for separate specialist attention, so that my task consisted of analyzing only those bones thought to have been introduced directly through human activity. I found most of these to be small, non-diagnostic fragments which I could identify to neither body part nor taxon. Among the remainder, a very small fraction belonged to reptiles, birds and fish. I separated these out, but a lack of appropriate comparative material and experience prevented me from identifying most of them to species. They will not be discussed further here.

The overwhelming majority of the "identifiable" bones belonged to various kinds of mammals and I undertook a detailed analysis of these. I especially recorded information which would permit calculation of the minimum number of individuals by which each mammal species was represented in each level. Wherever feasible, I sorted body parts into lefts and rights and took the larger sum (left or right) as the minimum number of individuals represented by that body part. I also assumed that fused and unfused epiphyses of the same body part (e.g. the distal tibia) of a taxon must come from different individuals, even if one epiphysis were left and the other right. I sorted phalanges, vertebrae (excepting atlases and axes which I counted separately), and for some taxa also metapodials, into gross categories (e.g. thoracic vertebrae or left second phalanges) and calculated the minimum number of individuals represented by numerical division (for example, I divided by four to obtain the minimum number of individuals of a bovid represented by left second phalanges). For teeth, almost all of which occurred as isolated specimens (rather than set in jaws with one or more additional teeth), I also recorded information on eruption and wear to allow calculation not only of the minimum numbers of "mouths" from which the teeth probably came, but also an idea of the ages of animals at time of death.

I was able to assign most reasonably complete Border Cave teeth and most non-bovid and non-suid post-cranial elements to species or at least to genus. But I had less confidence in my ability to assign suid post-cranial elements consistently to one or the other of the two species

Raphicerus (grysboks and steenbok) are impossible to assign to species, but the inferior margin of the mandible of one more or less complete jaw was relatively straight as in the steenbok (R. campestris) (see Klein 1976: Fig. 1). Since steenbok would be most likely on geographic grounds as well, I have tentatively assigned all the Raphicerus teeth to R. campestris. There are at least two different hares present, a larger one which is almost certainly Lepus capensis and a smaller one which is possibly Lepus crawshayi. Since I was unable to separate the hare specimens consistently between the two species, I have conservatively lumped them for inclusion in the table. Finally, it is likely that there are two species of hyrax present - both the rock hyrax (Procavia capensis) and the tree hyrax (Dendrohyrax arboreus) but again my inability to separate all parts consistently caused me to combine them for presentation in Table 1.

Paleoenvironmental implications of the Border Cave Fauna

With the prominent exception of the extinct species (Bond's springbok, the "giant Cape horse", and possibly the small bastard hartebeest), the species listed in Table 1 were historic inhabitants of the eastern lowveld in which Border Cave is located. In a general sense, then, the fauna suggests that throughout the time span represented in Beaumont's principal excavation, the environment was broadly similar to the present one, with a persistent mosaic of dense, low, thickets particularly along water courses, and large expanses of grassland and savanna (see the relevant sections of Acocks 1953 descriptions of lowveld vegetation).

A close examination of Table 1 will show that there is a tendency for creatures that prefer bushier environments (especially bushpig, Cape buffalo, tragelaphine antelopes, and impala) to be relatively more common in the Pietersburg and Epi-Pietersburg (≑ BACO.A - 3BS.UP) and in the 'Early L.S.A.' (= 1WA and 1BS. LR) levels. In the intervening 'Post-Howieson's Poort' layers (2WA - 2BS.UP) species preferring more open vegetation (Burchell's zebra, warthog and alcelaphine antelopes) tend to be relatively more abundant. Unfortunately, as Table 2 shows, the numbers in Table 1 are not large enough to provide complete statistical support for the observed contrasts. In particular, the relative frequency of animals preferring more open settings is not significantly different (in the statistical sense) in the 'Post-Howieson's Poort' from that in the underlying Pietersburg/Epi-Pietersburg.

Because the Border Cave bones are so highly fragmented, it is unlikely that even a considerable enlargement of the sample through further excavavations could substantially increase the numbers in Tables 1 and 2. This is especially true for the suids and equids, the teeth of which tend to break up into small fragments which are identifiable to species, but not to position in the mouth, a vital datum if the minimum number of individuals is to be computed. It is therefore probable that the hypothesis that there were significant changes in the proportion of species preferring bushier vegetation versus those preferring grassier settings can only be tested further if another index of species frequency is adopted. There are two obvious possibilities. The first is the number of teeth or tooth fragments assigned to a species in a given level. The second is the number of grid squares in which teeth of a species occur in any level. (Beaumont recorded all finds with regard to a grid of squares 0,91m on a side).

Each of the two indices of species frequency suggested in the last paragraph has clearcut drawbacks. The major difficulty with an index based on teeth or tooth fragments is that it will clearly overemphasize the importance of suids and equids whose teeth are more prone to fragmentation than those of bovids. Theoretically, an index based on the number of squares in which teeth occur could also favour species whose teeth tend to fragment more easily. In fact, at Border Cave, dental fragments belonging especially to zebra and suids (particularly warthog) generally occur in clusters within a square, suggesting that most fragmentation occurred after the teeth reached their final positions within the site. At least at Border Cave, then, the major problem with a frequency index based on number of squares in which teeth of a species occur is that it assumes that the teeth of all species are about equally susceptible to dispersion across the surface of the site. This is a difficult, if not impossible assumption to test, but I believe it is reasonable, at least with regard to the teeth of animals bushpig/warthog size or larger. Overall in fact, in a fauna like that from Border Cave, in which so many teeth are fragmented and not readily assigned to a place in the mouth, the number of squares in which teeth of a species occur might be a more accurate estimate of both its absolute and relative frequency within the excavated area than the more conventional minimum numbers presented in Table 1.

Table 3 presents the number of squares in which teeth of zebra, suids and bovids are represented in the various layers of Beaumont's principal excavation. Table 4, based on data extracted from Table 3, shows that the "number of squares" estimates of species frequency strongly substantially different from modern ones (bushier), while the "Post-Howieson's Poort" levels were laid down in an interval in which the vegetational setting approximated the historic one (relatively grassy).

Subsistence implications of the Border Cave fauna

In the absence of independent evidence for climatic or vegetational change as the cause of the faunal fluctuations discussed in the last section, it is possible to argue that the fluctuations reflect only the changing hunting practices of the ancient inhabitants of Border Cave. However, in my opinion, it is difficult to understand why people would shift their focus in hunting from a set of species preferring more closed vegetational conditions to a set preferring more open ones and then back to the first set, unless the species themselves were fluctuating in frequency. Especially given the time spans over which the faunal fluctuations seem to have been taking place, I think that general environmental change must remain the fundamental explanation.

My analysis of several large Middle Stone Age and Later Stone Age faunas from sites in the southern Cape Province has suggested that in that area at least, Middle Stone Age peoples took significantly more eland and significantly fewer suids than Later Stone Age peoples living under essentially similar environmental conditions (Klein 1975). I have hypothesized that this reflects Middle Stone Age avoidance of especially dangerous prey (suids and eland would be on virtually opposite ends of a continuum from very fierce to relatively docile when attacked). From Tables 1 and 3, it is obvious that there are no significant differences between the Border Cave MSA and LSA levels in the abundance of eland. It is generally uncommon at the site, perhaps because it has always been an uncommon species in lowveld faunas. Table 6 shows that there is also no evidence for an increase in suids (vs. bovids) in the Border Cave LSA. Perhaps documentation for such an increase would only appear in much larger samples, given that suids have probably always been much more common in the vicinity of Border Cave than in the southern Cape. Alternatively, it is possible that an increase in the suid/bovid ratio really only characterizes LSA cultures that are substantially later than the "Early LSA" of Border Cave. In the southern Cape, the LSA faunas I have compared to MSA ones are at least 20,000 years younger than the youngest local MSA fauna and 15,000 years younger than the Border Cave "Early LSA." The first southern Cape archeological fauna known to fall in the time range of the Border Cave "Early LSA" is only now being excavated by H.J. Deacon at Boomplaas Cave near Oudtshoorn.

The Border Cave fauna is similar to virtually all other archeological faunas in the low frequency of carnivores (Table 1). This presumably reflects a mutual avoidance relationship between stone age man and at least the larger carnivores. The largest and most dangerous ungulates available - elephant and rhinoceroses - are also poorly (and only questionably) represented at the site. They too were perhaps infrequently hunted, though at least in part, the near absence of their remains at the site may reflect the difficulty of bringing home their heavy bones, even if a kill were made.

Some additional information on the way in which the inhabitants of Border Cave interacted with various prey species may be obtained from an examination of the ages of animals at time of death. Table 7 presents dental age distributions for the bovids, the only Border Cave species for which there are large enough samples of ageable teeth to establish such distributions. In evaluating Table 7, it is important to keep in mind that there may be preservational biases against teeth of very young animals, especially of the smaller species. However, contrasts within the table, at least between the age distributions of species with teeth of roughly comparable size, probably have paleoecological significance. Particularly interesting in this regard is the relatively high frequency of very young animals (in dental states I and II) in buffalo and their absence or near absence among other species like Roan/sable, hartebeest/tsessebe, wildebeest and kudu, whose deciduous teeth would probably survive destructive agencies about as well as those of buffalo. A similarly high proportion of very young individuals characterizes buffalo age distributions in southern Cape stone age faunas I have examined. In fact, as Table 8 shows, the dental age distribution of buffalo at time of death is remarkably similar between Border Cave and the two southern Cape sites (Klasies River Mouth and Nelson Bay Cave) which have provided comparable quantities of buffalo remains. Further, the age distributions in Table 8 are probably very similar to those in large predator kills in Kruger National Park (Pienaar 1969), although direct numerical comparisons are not possible because the Kruger buffalo have been aged by somewhat different criteria and most very young buffalos killed in Kruger are totally eaten, so that precise estimates of their numbers are impossible. The apparent similarity among the age distributions from three stone age sites widely separated in time and space (see Table 8) and between them and the distribution in Kruger Park lion and hyena kills suggests that in stone age times at least, characteristics of buffalo behavior, herd structure, etc. were probably more important in determining predation patterns than the particular characteristics of the predator.

The absence or near absence of very young wildebeest, hartebeest/tsessebe, etc. at Border Cave may mean that the stone age inhabitants were generally not in the vicinity when these species calved or that the species were migratory and the calves were born somewhere else. Unfortunately, the Border Cave dental samples are too small to test the hypothesis of seasonally restricted parturition and human occupation by determining, for example, if the crown height measurements of any species form equidistant clusters, like those used by Kurten (1953) to demonstrate seasonal births and deaths in fossil Chinese bovids. Unfortunately, also, with the exception of the buffalo, those species which occur at both Border Cave and in the southern Cape faunas I have analyzed are represented in one place or the other by numbers that are too small to allow meaningful comparisons between age distributions.

The implications of Border Cave body part frequencies

Table 9 presents the minimum numbers of non-bovid individuals represented by different body parts at Border Cave. Figure 1 provides comparable data for the bovids, presented not by species, but by size class for reasons discussed previously. The order in which body parts are listed in the figure was determined primarily by their frequency of occurrence in small bovids. Where ties occurred, more proximal elements were listed first.

The data in Figure 1 may be used to illustrate what are probably the main determinants of body part frequency discrepancies at Border Cave. Supported by the results of significance tests in the caption, the figure implies that the patterns of body part representation are different as between the smaller bovids and the larger ones. In particular, the number and magnitude of frequency discrepancies among body parts are greater for the larger bovids than for the smaller ones. This suggests that the larger the bovid, the less likely it was to reach the site intact, that is, the more likely it was that only selected parts of it would be returned. Perkins and Daly (1968) have labelled this relationship the "schlepp effect" from the German verb ' to drag'. With regard to the large bovids, a rapid examination of Figure 1 will show that they are represented almost entirely by parts of the skull and feet; their limbbones and vertebrae are very rare. The implication is that the inhabitants of Border Cave preferentially brought back large bovid skulls and feet, a pattern which also seems to have characterized the occupants of other stone age cave sites, for example those of Klasies River Mouth Cave 1, as discussed by Klein (1976).

Examination of Table 9 will show that suids and zebra are also characterized by pattern of body part representation in which foot and skull bones predominate heavily. It is possible that the emphasis on feet and skull has been exaggerated by the accidental assignment of some zebra and especially suid limbbones and vertebral fragments to the large medium bovid category. Very frequently zebra and suid limbbones and vertebrae can be very difficult to distinguish from homologous pieces of similarly sized bovids. Still, the number of mistakes cannot be so large as to alter the general conclusion that only selected portions of suid and zebra carcasses tended to reach the site.

The Border Cave bones are very highly fragmented, partly as a result of food preparation, but probably mainly as a result of repeated trampling, burning, etc. from which they were poorly protected by relatively slow sedimentation combined with relatively intensive occupation. Most of the frequency discrepancies in the smaller bovids (and also some of those in the larger ones) almost certainly reflect the differential durability of different bones when subjected to intense pre- and especially post-depositional destructive agencies. As expected, if differential durability were playing an important role, the data in Figure 1 show that distal humeri tend to outnumber proximal ones, proximal radii distal ones, proximal femora distal ones, and distal tibiae proximal ones. (For a discussion of the durability characteristics that make these the expected results, see Brain 1969).

Although the pattern of differences in body part representation among bovid size classes is roughly the same for the Border Cave sample as for other faunas I have analyzed in a similar way (e.g. The Klasies River Mouth 1 fauna reported in Klein 1976), comparisons I have not reported here generally reveal some significant differences between the frequencies in any Border Cave size category and those in its counterpart at other sites. The differences may be partly due to differences between Border Cave and other sites in the species and frequencies of species comprising each size category, but I think the principal reason for the differences is the relatively great post-depositional destructive pressure to which the Border Cave fauna has been subjected, leading to a much higher degree of fragmentation than in most of the faunas I have examined.

It is probable that differential bone durability is largely responsible for body part frequency discrepancies in the hares and other small mammals included in Table 9. I plan to pursue this point further in the analysis of body part frequencies from sites in the southern Cape (Die Kelders and Byneskranskop) in which small mammals are especially well represented.

Extinct species in the Border Cave Fauna

Besides the "giant Cape horse" and possibly the small bastard hartebeest mentioned previously, there is another extinct species in the Border Cave fauna - the hyperhypsodont, Bond's springbok, *Antidorcas bondi* (Figure 2). (*A. bondi* was formerly referred to as "*Gazella*" *bondi*, but Vrba (1973) has presented compelling evidence that the species is best assigned to *Antidorcas*). With a history extending back to at least the early Pleistocene (Vrba 1973), Bond's springbok was still widespread in the southern African interior in the Upper Pleistocene, occurring at various sites, for example, Florisbad and Vlakkraal in the Orange Free State, the Cave of Hearths in the Transvaal, and Chelmer in Rhodesia (Cooke 1963, Table 7), where it was often accompanied by other extinct taxa, notably the "giant horse," the giant buffalo (*Pelorovis antiquus*), and the "giant hartebeest" (*Megalotraugs priscus*).

Evidence from the southern Cape suggests that the giant buffalo, "giant hartebeest", and giant equid made their last appearance there in the terminal Pleistocene (Klein 1974 and unpublished). It is unclear whether they disappeared at the same time, earlier, or perhaps even somewhat later in the southern African interior. Similarly, the time of extinction of Bond's springbok remains completely unknown. Border Cave is so far the only site where the species has been recorded in a radiocarbon-dated context (in unit 1WA with an apparent 14-C age in the vicinity of 38,000 years B.P.) and in association with a post-Middle Stone Age industry. Table 1 and 3 show that the species is most prominent in those Border Cave horizons in which zebra, warthog and alcelaphines predominate, suggesting that it preferred relatively open vegetational settings. This could have been predicted from its extraordinarily hypsodont teeth and knowledge of its closest surviving relative, the extant springbok, Antidorcas marsupialis.

Conclusions

Study of the bones of larger mammals from P.B. Beaumont's excavations at Border Cave suggests the following conclusions:

(1) A vegetational mosaic broadly similar to the present one persisted in the area over apparently protracted periods of the Upper Pleistocene. At the same time, changes in species frequencies through time indicate that there were significant long-term fluctuations in the relative amount of grass versus bush in the mosaic. I have hypothesized that times with more bush (e.g. "Early LSA") reflect colder phases locally, while an interval with more grass ("Post-Howieson's Poort") represents a time when conditions more nearly approached modern ones (an "interstadial").

(2) There is no evidence for differences in hunting practices between the Middle Stone Age and Later Stone Age inhabitants of Border Cave, although it is possible such differences, if they exist, would only emerge in larger samples.

(3) Similar to comparable data from other sites, the Border Cave body part frequency data indicate that smaller animals tended to be brought back to the site intact, while only selected parts of larger ones were generally returned. Many, if not most differences in body part frequencies between taxa represented at Border Cave and comparable taxa in other faunas I have analyzed are probably due to the extreme fragmentation of the Border Cave bones, reflecting the severe pre- and especially post-depositional destructive pressures to which they were subjected.

(4) The Border Cave fauna contains at least two and possibly three extinct species, of which the most interesting is perhaps Bond's springbok Antidorcas bondi. The species with which it is associated at Border Cave underline its preference for open vegetational settings, also inferrable from its dentition. The evidence from Border Cave suggests that Bond's springbok survived until at least 38,000 B.P., after the first Later Stone Age peoples had made their appearance at the cave.

Acknowledgements

I thank Peter Beaumont for making the Border Cave fauna available to me and Q.B. Hendey for providing study facilities in his department (Palaeomammalogy) at the South African Museum. My presence at the Museum was made possible by a grant from the National Science Foundation.

REFERENCES

ACOCKS, J.P.H. 1953. Veld types of South Africa. Bot. Surv. S. Afr. Mem. No. 28.

BEAUMONT, P.B. 1973. Border Cave - a progress report. S. Afr. J. Sci., 69 : 41-46.

BEAUMONT, P.B. and BOSHIER, A.K. 1972. Some comments on recent findings at Border Cave, northern Natal. S. Afr. J. Sci., 68: 22-24.

BRAIN, C.K. 1969. The contribution of Namib Desert Hottentots to an understanding of australopithecine bone accumulations. Scient. Pap. Namib Desert. Res. Stn. 39 : 13-22.

Cooke, H.B.S. 1963. Pleistocene mammal faunas of Africa, with particular reference to Southern Africa. In Howell, F.C. & Bourliere, F., eds. African Ecology and Human Evolution: 65-116. Chicago, Aldine Publishing Co.

COOKE, H.B.S., MALAN, B.D. and WELLS, L.H. 1945. Fossil man in the Lebombo Mountains, South Africa: the "Border Cave", Ingwavuma District, Zululand. Man , 45 (3) : 6-13

KLEIN, R.G. 1972. The late Quaternary mammalian fauna of Nelson Bay Cave (Cape Province, South Africa): its implications for megafaunal extinctions and environmental and cultural change. Quat. Res. 2 : 135-142

KLEIN, R.G. 1975. Middle Stone Age man-animal relationships in southern Africa: evidence from Klasies River Mouth and Die Kelders. Science, 190 : 265-267.

KLEIN, R.G. 1976. The fossil history of Raphicerus H. Smith 1827 (Bovidae, Mammalia) in the Cape Biotic Zone. Ann. S. Afr. Mus. (in press).

KLEIN, R.G. 1976. The mammalian fauna of the Klasies River Mouth Sites, southern Cape Province, South Africa. S. Afr. archaeol. Bull., 31 : 75-98.

KURTEN, B. 1953. On the variations and population dynamics of fossil and recent mammal populations. Acta zool. fenn. 76 : 1-122.

MENTIS, M.T. 1970. Estimates of natural biomasses of large herbivores in the Umfolozi Game Reserve Area. Mammalia 34 : 363-393.

NIE, N.H., HULL, C.H., JENKINS, J.G., STEINBRENNER, K. & BENT, D.H. 1975. Statistical Package for the Social Sciences. New York, McGraw-Hill.

PERKINS, D. and DALY, P. 1968. A hunter's village in Neolithic Turkey. Sci. Am., 219 (11) : 97-106.

PIENAAR, U. de V. 1969. Observations on developmental biology, growth and some aspects of the population ecology of African Buffalo (Syncerus caffer caffer Sparrman) in the Kruger National Park. Koedoe, 12 : 29-52.

VRBA, E.S. 1973. Two species of Antidorcas Sundevall at Swartkrans (Bovidae, Mammalia). Ann. Transv. Mus. 28 : 287-352.

TABLE 1. The minimum numbers of individuals by which different mammalian taxa are represented in the various levels of Border Cave excavation 3A. The acronyms for the levels are based on fuller designations presented in Beaumont (1973). The cultural designations are based on Beaumont (op. cit. and pers. comm.). In terms of the species list, small bovids include grysbok, oribi and klipspringer; small medium ones mountain reedbuck, impala, bushbuck, springbok and sheep/goat; large medium ones waterbuck, roan/sable, bastard hartebeest, wildebeest, kudu and nyala; large ones eland and buffalo. There is some post-cranial material which is perhaps derived from the blue duiker (Cephalophus monticola). This has been included with the small bovids.

	1BS. UP.	1BS. LR.	1WA	2BS. UP.	2BS. LR.A	2BS. LR.B	2BS LR.C	2WA	3BS. UP.	3BS. LR.	3WA	1GBS. UP	1GBS. LR	BACO A
	I. Age Sterile	Early LSA		Post-Howieson's Poort					Epi-Pietersburg			Pietersburg		
Papio ursinus, Chacma baboon	1	1	1	-	1	-	-	-	-	-	-	1	-	-
Cercopithecus aethiops, Vervet monkey	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Mellivora capensis, Honey badger	-	1	-	-	-	-	-	-	1	-	-	-	-	-
Panthera pardus, Leopard	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Lycaon pictus, Hunting dog	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Carnivora gen. et sp. indet.														
Small (Herpestes pulverulentus-size)	1	1	1	-	1	1	-	1	-	-	-	1	-	-
Small medium (Felis libyca-size)	-	1	1	-	-	-	-	-	-	-	-	-	1	-
Hyracoidea (Procavia capensis and Dendrohyrax arboreus), Hyraxes	1	2	2	-	1	-	-	-	-	-	1	-	1	1
Loxodonta africana, Elephant	-	?1	-	-	-	-	-	-	-	-	-	-	-	-
Rhinocerotidae gen. et sp. indet., Rhino	-	-	-	-	-	-	?1	-	-	-	-	-	-	-
Equus cf. burchelli, Burchell's zebra	1	-	1	-	2	-	2	1	-	-	-	1	2	1
Equus cf. capensis, "Giant Cape horse"	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Potamochoerus porcus, Bushpig	1	1	1	1	-	-	-	-	-	-	-	1	1	-
Phacocherus aethiopicus, Warthog	-	-	1	-	1	-	1	1	-	-	-	-	-	-
Suidae - general, pigs	1	1	2	1	1	1	1	1	1	1	1	1	1	-
Hippopotamus amphibius, Hippopotamus	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Raphicerus cf. campestris, Steenbok	-	1	1	-	1	1	1	-	1	-	1	-	-	-
Ourebia ourebi, Oribi	-	1	2	1	-	-	1	-	-	-	1	1	1	-
Oreotragus oreotragus, Klipspringer	3	1	-	1	1	-	-	-	-	-	1	-	-	-
Redunca fulvorufula, Mountain Reedbuck	-	3	2	-	-	-	-	2	1	-	2	-	1	-
Kobus ellipsiprymnus, Waterbuck	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Hippotragus spp., Roan/Sable	-	-	-	-	?1	-	-	2	-	-	-	2	-	-
Aepyceros melampus, Impala	-	1	1	1	-	-	1	-	-	-	-	-	-	-
Damaliscus cf. dorcas, Blesbok	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Alcelaphus buselaphus/Damaliscus lunatus, Hartebeest/Tsessebe	1	-	1	-	1	-	4	2	-	-	-	-	-	-
Connochaetes taurinus, Blue wildebeest	-	-	1	1	1	-	1	-	-	-	1	-	1	-
Antidorcas bondi, Bond's springbok	-	-	3	-	2	1	3	-	-	-	-	-	-	-
Tragelaphus strepsiceros, Greater Kudu	-	-	1	-	?1	-	1	-	1	-	-	-	-	1
T. angasi, Nyala	-	-	-	-	-	-	1	-	-	-	-	1	?1	-
T. scriptus, Bushbuck	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Taurotragus oryx, Eland	-	-	-	-	-	-	1	?1	-	-	-	-	?1	-
Syncerus caffer, Cape buffalo	?1	4	3	-	1	-	1	3	-	-	3	2	-	-
Ovis aries/Capra hircus, Sheep/goat	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Bovidae - general														
Small	2	3	3	2	2	1	2	1	1	-	2	1	2	1
Small medium	2	3	5	1	3	1	4	3	1	1	2	1	2	1
Large medium	1	2	2	1	2	1	5	3	1	1	1	3	2	1
Large	1	3	4	1	1	1	2	2	1	2	3	2	1	1
Lagomorpha (cf. Lepus capensis and ?Lepus crawshayi), Hares	7	4	8	2	2	2	2	1	2	2	1	3	3	1
Hystrix africae-australis, Porcupine	1	-	-	-	-	-	-	1	-	-	-	-	-	-

TABLE 2. The minimum numbers of individuals represented by bushpig, Cape buffalo, tragelaphine antelopes, and impala as opposed to warthog, zebra, and alcelaphine antelopes in the major culture-stratigraphic units of Border Cave. Based on frequency data in Table 1.

The minimum numbers of individuals represented by:	1BS.LR.+ 1WA	2BS.UP- 2WA	3BS.UP- BACO.A
Bushpig, Cape buffalo, tragelaphine antelopes and impala	12 (80%)[a]	12 (39%)[b]	12 (63%)[c]
Warthog, zebra and alcelaphine antelopes	3[d]	18[e]	7[f]
	15	31	19

Chi-square values (Yates corrected)

$\frac{ab}{de} = 4.92$, p = .05-.02

$\frac{bc}{ef} = 1.66$, p = .2-.1

$\frac{ac}{df} = 0.48$, p = .9-.8

TABLE 3. The numbers of squares in which teeth of zebra, suids and bovids occur in the various levels of Border Cave (Beaumont excavations)

	IBS.UP	IBS.LR	1WA.	2BS UP	2BS LR.A	2BS LR.B	2BS LR.C	2WA	3BS UP	3BS. LR	3WA	1GBS UP	1GBS LR	BACO A
	I.Age + Sterile	Early L.S.A.		Post-Howieson's Poort					Epi-Pietersburg			Pietersburg		
Burchell's zebra	1	–	1	–	4	–	11	9	–	–	–	1	2	2
Bushpig	1	3	3	2	–	–	–	–	–	–	–	8	1	–
Warthog	–	–	6	–	1	–	6	3	–	–	–	–	–	–
Steenbok	–	2	2	–	1	1	3	–	1	–	1	–	–	–
Oribi	–	3	5	1	–	–	1	–	–	–	2	1	1	–
Klipspringer	3	1	–	1	2	–	–	–	–	–	1	–	–	–
Mountain reedbuck	–	6	3	–	–	–	–	3	1	–	2	–	2	–
Waterbuck	–	–	–	–	–	–	–	–	–	–	–	2	–	–
Roan/Sable	–	–	–	–	–	–	–	3	–	–	–	2	–	–
Impala	–	1	1	1	–	–	1	–	–	–	–	–	–	–
Blesbok	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Hartebeest/Tsessebe	1	–	2	–	1	–	7	3	–	–	–	–	–	–
Wildebeest	–	–	1	1	3	–	1	–	–	–	1	–	1	–
Bond's springbok	–	–	3	–	4	1	7	–	–	–	–	–	–	–
Kudu	–	–	2	–	–	–	1	–	–	–	–	–	–	2
Nyala	–	–	–	–	–	–	1	–	–	–	–	1	–	–
Bushbuck	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Eland	–	–	–	–	–	–	3	–	–	–	–	–	–	–
Buffalo	–	11	6	–	1	–	1	3	–	–	2	5	–	–

TABLE 4. "Number of squares" estimates of the frequency of bushpig, Cape buffalo, tragelaphine antelopes, and impala, as opposed to warthog, zebra, and alcelaphine antelopes in the major culture-stratigraphic units of Border Cave. Based on frequency data in Table 3.

Composite number of squares in which occur:	1BS.LR + 1WA	2BS.UP-2WA	3BS.UP-BACO.A
Bushpig, Cape buffalo, tragelaphine antelopes, and impala	27 (73%)[a]	14 (22%)[b]	20 (71%)[c]
Warthog, zebra and alcelaphine antelopes	10[d]	50[e]	8[f]
	37	64	28

Chi-square values (Yates-corrected)

$\frac{ab}{de} = 23.31$, $p < .001$

$\frac{bc}{ef} = 18.46$, $p < .001$

$\frac{ac}{df} = 0.02$, $p = .9-.8$

TABLE 5. Varimax rotated principal components solution of the frequency variation in zebra, bushpig, warthog, hartebeest/tsessebe, wildebeest, kudu and buffalo through the deposits of Border Cave. Only components with eigenvalues greater than 1 are included (the eigenvalue of the fourth initial component was 0.56). A species that has a loading of > .71 on a component has more than 50% (> .71 x .71) of its variation explained by that component. This means that species that have loadings of > .71 on the same component are probably varying together in a systematic way. (a high negative loading, as in the case of wildebeest on component 2 below, implies a strong inverse frequency relationship with species that have high positive loadings on the same component). The matrix submitted for analysis (an appropriately reduced version of Table 3) in fact exhibits too little frequency variation among too few provenience units to be totally appropriate for principal components analysis, but the results are still highly supportive of an inverse frequency relationship between species preferring bushier environments and those preferring grassier ones. For additional discussion, see the text. The analysis was performed on the University of Chicago's IBM 370/168 Computer using the method"PA1" and appropriate options of the subprogram FACTOR from the Statistical Package for the Social Sciences (Nie et al. 1975)

	Components		
	1	2	3
Zebra	0.91	-0.23	-0.04
Bushpig	-0.40	0.72	0.08
Warthog	0.77	0.05	0.52
Hartebeest/Tsessebe	0.96	-0.08	0.14
Wildebeest	-0.12	-0.84	0.15
Kudu	0.12	-0.07	0.94
Cape buffalo	-0.13	0.82	0.01
Eigenvalue of initial component	3.07	1.71	1.01
Percentage of variance explained	43.9	24.4	14.4

TABLE 6. The frequencies of suids and bovid in the Middle Stone Age and Later Stone Age deposits of Border Cave. Compiled from data in Tables 1 and 3.

	Frequency estimates based on the minimum number of individuals in different units.		Frequency estimates based on the numbers of squares in which teeth of different taxa occur in different units.	
	LSA (1BS.LR + 1WA)	MSA (2BS.UP-BACO.A)	LSA (1BS.LR + 1WA)	MSA (2BS.UP-BACO.A)
Suids	3 (11%)	10 (12%)	12 (20%)	21 (20%)
Bovids	25	73	49	86

TABLE 7. The frequencies of bovids in different dental age-states in the stone age deposits of Border Cave. I = dp4 erupting to erupted, but essentially unworn; II = M1 erupting to erupted, but essentially unworn; III = M2 erupting to erupted, but essentially unworn; IV = M3 erupting to erupted, but essentially unworn; V = P4 erupting to erupted, but essentially unworn; VI = P4 in early to mid-wear; VII = P4 in late wear.

	DENTAL AGE-STATES						
	Younger					Older	
	I	II	III	IV	V	VI	VII
Steenbok	-	-	-	1	-	4	1
Oribi	-	-	3	1	1	3	-
Klipspringer	-	-	-	3	-	5	-
Mountain reedbuck	1	-	-	1	2	7	-
Waterbuck	-	-	-	-	-	1	-
Roan/Sable	1	-	-	1	1	-	1
Impala	-	-	1	3	2	-	-
Small bastard hartebeest	-	-	-	-	1	-	-
Hartebeest/tsessebe	-	-	1	3	1	3	-
Wildebeest	-	-	1	2	-	3	-
Bond's springbok	-	-	3	1	2	3	-
Kudu	-	-	-	2	-	1	-
Nyala	-	-	-	1	-	-	?1
Bushbuck*	-	-	-	-	-	-	-
Eland	-	-	?1	-	-	1	-
Buffalo	5	1	1	2	3	4	1

* no ageable teeth

TABLE 8. The percentage of buffalo in different dental age states in the Middle and Later Stone Age levels of Border Cave, the Middle Stone Age levels of Klasies River Mouth, and the Later Stone Age levels of Nelson Bay Cave. The Klasies MSA probably dates from between 125,000 and 60-50,000 B.P. (Klein 1975 and in press). The Nelson Bay LSA is bracketed between 18,500 and 5000 B.P. by radiocarbon (Klein 1972). The dental states are defined in the caption to Table 7.

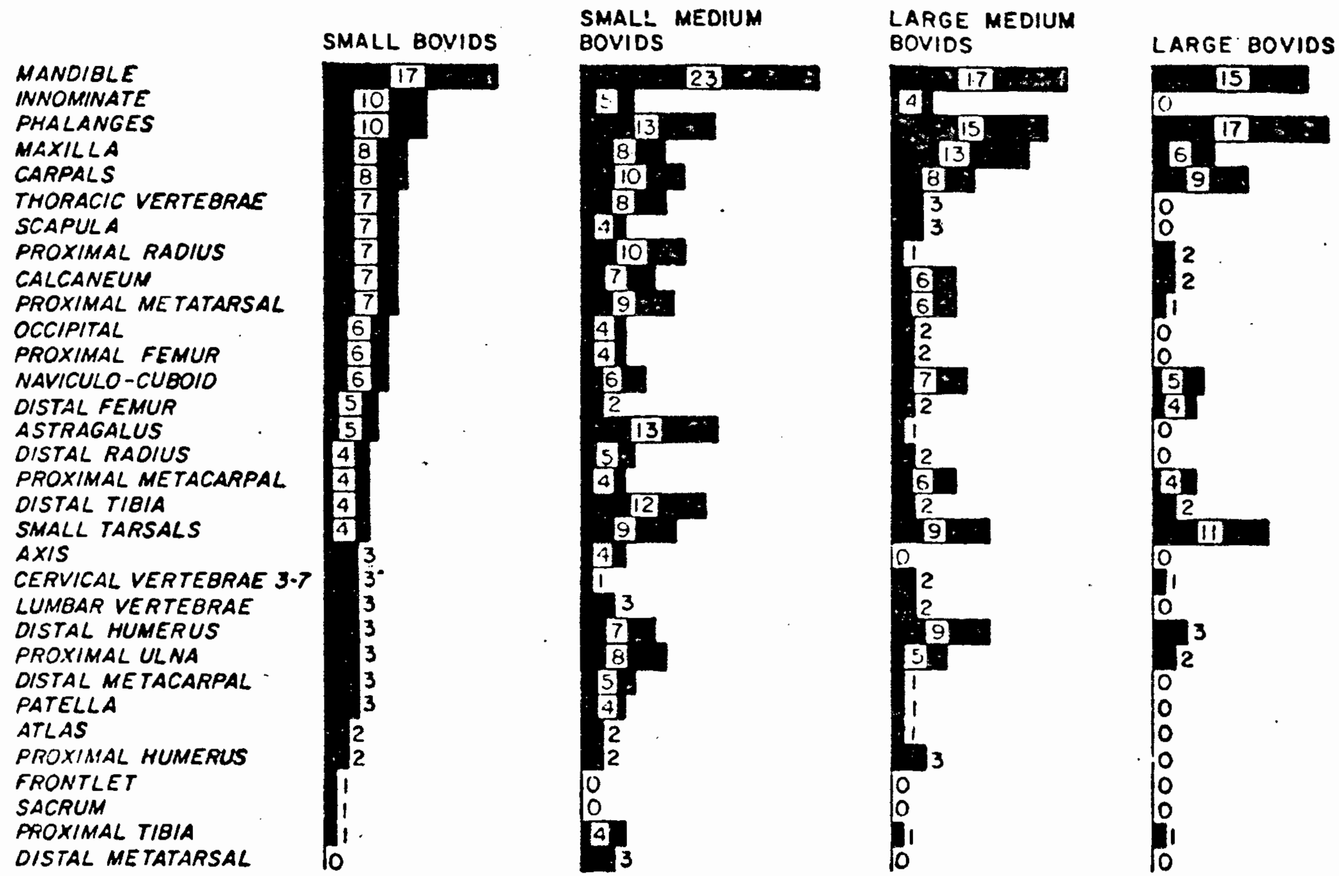
	Percentages							
	Younger					Older		
	I	II	III	IV	V	VI	VII	(N)
Border Cave	29	6	6	12	18	24	6	(17)
Klasies River Mouth	30	19	6	9	7	23	7	(70)
Nelson Bay Cave	25	18	4	11	7	25	11	(56)

TABLE 9. The minimum numbers of non-bovid individuals represented by different body parts at Border Cave.

	Hares	Porcupine	Baboon	Vervet monkey	Honey badger	Leopard	Hunting dog	Indeterminate small carnivore	Indeterminate small medium carnivore	Hyraxes	Elephant	Rhinoceros	Zebra	Giant Cape Horse	Suids	Hippopotamus
Maxilla	23	)1	1	1	-	-	-	-	-	4	?1*)	)?1	3	-	)10	)1
Mandible	26	)	2	-	-	-	1	5	1	4	-	)	10	1	)	)
Atlas	2	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Axis	2	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-
Cervicals 3-7	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thoracic vertebrae	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lumbar vertebrae	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sacrum	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapula	13	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
Proximal humerus	5	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Distal humerus	14	-	-	-	-	-	-	1	-	4	-	-	-	-	-	-
Proximal radius	4	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Distal radius	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Proximal ulna	9	-	-	-	-	-	-	-	1	2	-	-	1	-	2	-
Distal ulna	8	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Carpals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1
Innominate	22	-	-	1	-	-	-	2	-	2	-	-	-	-	-	-
Proximal femur	11	-	-	-	-	-	-	-	1	2	-	-	1	-	-	-
Distal femur	10	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Patella	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proximal tibia	6	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Distal tibia	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Astragalus	9	-	-	-	-	-	-	-	-	1	-	-	1	-	3	-
Calcaneum	20	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
Other tarsals	2	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
Metapodials	10	-	1	-	1	1	-	-	1	-	-	-	2	-	8	-
Phalanges	2	-	3	-	1	-	-	-	1	-	-	-	5	-	12	-

* Ivory fragments

FIG. 1



BORDER CAVE. The minimum numbers of different sized bovids represented by various body parts.

FIGURE 1. The minimum numbers of different-sized bovids represented by different body parts at Border Cave. (Small bovids include steenbok, oribi and klipspringer; small medium ones mountain reedbuck, impala, bushbuck and springbok; large medium ones waterbuck, roan/sable, bastard hartebeest, hartebeest, wildebeest, kudu and nyala; and large ones eland and buffalo).

Results of chi-square and Kolmogorov-Smirnov tests for the significance of frequency differences between different-sized bovids are presented directly below. Values that are underlined indicate a difference significant at the .05 level or below.

Chi-square				
Small	-----			
Small medium	24.99	----		
Large medium	33.68	37.57	----	
Large	63.65	62.47	31.17	----
	Small	Small Medium	Large Medium	Large

Kolmogorov-Smirnov				
Small	----			
Small medium	1.19	----		
Large medium	0.80	1.01	----	
Large	1.65	1.92	0.78	----
	Small	Small Medium	Large Medium	Large

Appendix 34 Macrofaunal fragmentation

Border cave. Excavation 3A Rear

Stratum	Total number	Total mass	Fragmentation Number per kg.
1BS.UP.IA	1737	1605	1082
1BS.UP.S	1271	909	1398
1BS.LR.	18377	17447	1053
1WA	30530	30084	1015
2BS.UP.	3138	2656	1181
2BS.LR.A + B	9516	7432	1280
2BS.LR.C	20414	19843	1029
2WA	26898	34332	783
3BS	5022	4125	1217
3WA	870	616	1412
1GBS.UP.	12169	10944	1112
1GBS.LR.	9329	7692	1213
BACO.A	2376	1820	1305

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Iron Age

	Q	R	S	T
24	38 28 0	42 97 0	16 5 0	27 44 0
23	55 65 0	44 90 0	36 75 0	50 28 0
22	598 511 0	364X 321 0	81 41 0	20 14 0
21	94 61 0	66X 55 0	77 38 0	29 16 0
20	- - -	6 22 0	29 27 1	11 20 0
19	- - -	16 15 0	5 3 0	3 10 0
18	- - -	- - -	- - -	30 19 0
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Sterile

	Q	R	S	T
24	7 2 0	43 9 0	11 9 0	0 0 0
23	79 31 0	44 12 0	3 2 0	1 1 0
22	35 66 0	120 91 0	43 38 0	11 7 0
21	1 4 0	40 24 0	25 17 0	58 27 0
20	20X 20 0	5 6 0	22 133 0	87x 85 0
19	176X 128 0	354X 109 0	46 21 0	11 10 0
18	- - -	- - -	- - -	29 57 0
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

O: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. LR.

	Q	R	S	T
24	168 163 0	113 134 0	250 174 0	46 29 0
23	1391 1273 1	1061 687 0	89 83 0	52 61 0
22	234 238 0	679 623 0	670 549 0	491 418 0
21	364 294 1	453 467 0	1069 996 0	1575 1770 0
20	119 109 0	1471 1779 0	1483 1955 0	1027X 1135 0
19	487X 322 0	410X 181 0	562 568 0	765x 666 1
18	435X 216 0	678X 497 0	583X 545 0	526X 592 0
17	270X 196 0	283X 251 0	- - -	- - -
16	396X 302 1	177X 174 0	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1WA

24	1770 1281 0	804 603 0	426 401 0	280 222 0
23	- - -	175 95 0	436 311 0	780 643 0
22	422 443 0	458 345 0	589 457 0	1473 1112 2
21	734 715 0	303 473 0	900 1110 0	1434 1052 0
20	1615 1499 0	1870 2355 0	1515 1596 0	858 958 0
19	2159 2494 0	2168 2175 0	2421 1934 2	595X 602 0
18	672 724 0	1109X 1194 0	1554 1872 0	861 970 0
17	1040X 1164 1	822X 840 0	- - -	- - -
16	287X 444 0	832x - -	- - -	- - -
	Q	R	S	T

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 2BS. UP

	Q	R	S	T
24	- - -	32 16 0	55 26 0	138 76 0
23	68 38 0	18 8 0	44 33 0	47 35 0
22	227 121 0	102 52 0	141 100 0	81 54 0
21	118 85 0	516 463 0	72 96 0	29 29 0
20	129 116 0	164 161 0	40 29 0	32 19 0
19	68 56 0	376 310 0	86 82 0	123 154 0
18	74 56 0	207 166 0	49 76 0	21 41 0
17	53 59 0	28 99 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

O: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. A+B

	Q	R	S	T
24	60 35 0	120 190 0	48 49 0	115 83 0
23	222 142 0	99 110 0	53 36 0	217 191 0
22	359 219 0	377 234 0	54 33 0	200 140 0
21	545 310 0	362 262 0	466 305 0	544 395 0
20	482 430 0	1147 1060 0	811 508 0	408 325 0
19	- - -	- - -	863 633 0	234 195 0
18	- - -	- - -	897 960 0	642 511 0
17	- - -	191 76 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. C

	Q	R	S	T
24	910 714 0	674 823 0	1017 951 0	1066 1055 0
23	1028 827 0	669 601 0	920 1389 1	821 888 0
22	1037 805 0	1001 1309 0	531 435 0	584 438 0
21	712 575 0	1195 1150 0	689 648 2	448 509 0
20	791 894 0	1340 1086 2	764 687 0	780 650 0
19	- - -	- - -	1070 1059 0	530 466 0
18	- - -	- - -	923 975 0	518 516 0
17	- - -	396 393 0	- - -	- - -
16	- - -	46X 77 0	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 2WA

	Q	R	S	T
24	- - -	630 779 0	729 741 0	- - -
23	- - -	1655 1288 0	1952 2511 0	- - -
22	- - -	1605 1835 0	922 1623 0	- - -
21	- - -	1162 1474 0	1770 2469 0	- - -
20	- - -	2140 1881 0	1621 2447 0	369 525 0
19	- - -	1750 2026 0	1745 1845 0	989 1684 0
18	- - -	1331 2499 1	1966 1723 0	892 1994 0
17	- - -	2072 3114 0	- - -	- - -
16	- - -	1598 1874 0	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 3BS

	Q	R	S	T
24	- - -	610 599 0	441 466 0	- - -
23	- - -	1448 1099 0	309 246 0	- - -
22	- - -	552 389 0	138 81 0	- - -
21	- - -	93 59 0	91 91 0	- - -
20	- - -	191 212 0	137 76 0	107 79 0
19	- - -	54 98 0	139 71 0	132 65 0
18	- - -	90 54 0	160 113 0	80 89 0
17	- - -	250 238 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 3WA

	Q	R	S	T
24	- - -	0 0 0	3 3 0	- - -
23	- - -	0 0 0	33 20 0	- - -
22	- - -	36 19 0	27 15 0	- - -
21	- - -	12 10 0	90 44 0	- - -
20	- - -	46 24 0	101 37 0	96 103 0
19	- - -	53 32 0	82 43 0	131 66 0
18	- - -	17 10 0	124 165 0	19 25 0
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1GBS. UP.

	Q	R	S	T
24	- - -	467 514 0	362 291 0	- - -
23	- - -	376 625 0	415 368 0	- - -
22	- - -	404 463 0	569 545 0	- - -
21	- - -	487 610 0	387 339 0	- - -
20	- - -	1133 895 0	804 592 0	- - -
19	- - -	1288 1160 0	1260 1054 0	546 278 0
18	- - -	1328 1322 0	1326 1050 0	488 250 0
17	- - -	529 588 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1GBS. LR.

	Q	R	S	T
24	- - -	85 66 0	44 53 0	- - -
23	- - -	189 138 0	120 93 0	- - -
22	- - -	190 223 0	324 382 0	- - -
21	- - -	338 428 0	250 285 0	- - -
20	- - -	593 713 0	652 505 0	- - -
19	- - -	763 870 0	963 659 0	691 514 0
18	- - -	829 749 0	1339 669 0	790 570 0
17	- - -	1169 775 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 35 Spatial distribution: macrofaunal fragments

Border Cave. Excavation 3A Rear. Stratum BACO. A

	Q	R	S	T
24	- - -	- - -	- - -	- - -
23	- - -	- - -	- - -	- - -
22	- - -	- - -	- - -	- - -
21	- - -	42 34 0	0 0 0	- - -
20	- - -	- - -	94 52 0	- - -
19	- - -	370 251 0	311 226 0	144 146 0
18	- - -	343 244 0	561 480 0	511 387 0
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Number of fragments

Centre: Mass of fragments (g)

Base: Number of bone tools

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 36 The microfaunal remains from Border Cave*

G. de Graaff

Table 1 lists the results of a brief study in 1976 of the identifiable small mammal vestiges from Border Cave. Time unfortunately precluded my placing the data on a more quantitative basis.

The overall evidence appears to point to a relatively warm subtropical outside environment throughout much of the sedimentary sequence. Within this there seems to be fairly minor fluctuations if we assume that the studied remains represent true random samples reflecting climatic changes in the site vicinity. If so, then I would tentatively interpret *Crocidura*, *Leggada*, *Rhabdomys*, *Praomys*, and *Tatera* as being generally 'dry' area forms, and *Otomys* as more typical of 'wet' conditions. On the basis of this assessment it is suggested that:

(a) BACO.A was drier than at present;

(b) 1GBS.UP - 3BS. was wetter than at present;

(c) 2BS.UP+LR was similar to the present.

References

* Based on letter from de Graaff dated 1976.

Table 1. Microfaunal checklist for Exc. 3A Rear at Border Cave

G. de Graaff

Family	Genera and Species	Stratum IBS.UP	IBS.LR +1WA	2BS+ 2WA	3BS+ 3WA	1GBS UP+LR	BACO A
Macrosieledidae	cf. *Elephantulas*						
Soricidae	cf. *Crocidura* sp.			XX			X
Chiroptera	gen. et sp. indet.						
Bathyergidae	cf. *Crytomys hottentotus*						
Muridae	cf. *Mus* sp.						O
	Aethomys namaquaensis						
	Leggaoa cf. *minutoides*			X			
	Pelomys cf. *fallax*						
	Rhabdomys cf. *pnmilio*			X			
	Praomys natalensis			X			
	cf. *Acomys* sp.						
Cricetidae	*Otomys* cf. *irroratus*			XX	XX	XX	X
	Mystromys cf. *albicantatus*		X				
	cf. *Tatera* sp.			X			

Code

X Genus and/or species present

XX Genus and/or species abundant

O Family present. No other details

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. UP Iron Age

	Q	R	S	T
24	108 6 1	196 13 0	56 3 0	86 3 0
23	88 7 2	168 20 0	208 18 0	80 6 0
22	276 27 185	601X 123 19	239 24 0	332 32 0
21	190 51 5	185X 40 2	113 20 0	354 28 0
20	- - -	95 21 0	53 10 0	142 10 0
19	- - -	18 5 0	22 6 0	51 6 0
18	- - -	- - -	- - -	52 7 0
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Sterile

24	63 0 1	140 8 0	51 1 0	26 0 0
23	40 2 0	205 6 0	33 3 0	97 3 0
22	710 69 157	614 63 91	217 4 0	364 24 0
21	445 98 0	737 46 0	117 11 0	302 32 0
20	816X 138 0	712 83 1	30 6 3	70X 6 0
19	201X 28 0	37X 3 0	58 7 2	10 2 0
18	- - -	- - -	- - -	34 5 0
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -
	Q	R	S	T

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. LR

	Q	R	S	T
24	20 3 0	23 0 1	6 0 0	11 0 0
23	112 0 2	123 1 0	22 0 0	30 2 0
22	64 1 0	37 1 2	74 9 0	196 4 0
21	239 31 0	380 14 3	23 2 0	238 19 1
20	108 11 0	249 20 2	40 3 0	24X 4 1
19	115X 13 0	42X 6 1	24 3 0	42x 5 0
18	29X 7 0	22X 2 1	24X 3 0	29X 3 0
17	29X 2 0	6X 1 1	- - -	- - -
16	22X 8 0	5X 0 0	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces.

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1WA.

	Q	R	S	T
24	34 0 1	32 0 0	271 22 77	1 0 0
23	- - -	15 0 2	9 1 1	15 0 1
22	147 3 1	9 1 1	42 6 1	41 3 10
21	171 9 15	278 28 4	30 2 8	34 1 5
20	8 0 2	130 12 11	17 1 2	16 1 5
19	29 1 10	38 1 13	20 1 8	20X 1 5
18	9 0 2	27X 2 6	20 1 1	3 0 0
17	14X 0 1	4X 1 0	- - -	- - -
16	6X 1 1	16x 1 0	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 2BS. UP

	Q	R	S	T
24	- - -	18 2 2	68 7 0	50 2 3
23	82 7 0	15 0 0	53 2 0	30 4 0
22	176 14 0	5 0 0	50 4 0	51 7 0
21	535 29 6	616 83 0	58 1 1	43 3 1
20	28 1 1	215 21 18	0 0 0	40 0 1
19	20 0 6	20 3 3	5 0 0	52 4 0
18	0 0 0	5 0 0	0 0 0	29 4 0
17	3 0 0	0 0 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. A + B

	Q	R	S	T
24	22 3 1	48 3 0	23 3 2	25 2 0
23	80 6 0	220 - 0	98 4 18	4 0 0
22	204 19 0	58 4 0	20 1 0	70 3 0
21	132 10 2	98 11 3	72 6 1	330 18 0
20	34 1 1	42 3 0	60 6 1	100 14 0
19	- - -	- - -	60 2 5	97 4 1
18	- - -	- - -	10 0 2	168 16 0
17	- - -	2 0 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 2BS. LR.C

	Q	R	S	T
24	17 1 2	44 5 2	2 0 0	3 0 0
23	5 0 0	15 2 0	34 2 1	0 0 0
22	0 0 0	11 0 0	31 4 1	21 3 0
21	33 0 1	14 0 0	8 1 0	58 6 0
20	30 3 0	13 0 0	12 1 0	18 0 0
19	- - -	- - -	6 0 0	23 1 2
18	- - -	- - -	7 0 2	9 2 0
17	- - -	10 0 0	- - -	- - -
16	- - -	6 0 0	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 2WA

	Q	R	S	T
24	- - -	16 0 2	30 0 0	- - -
23	- - -	25 1 3	6 0 0	- - -
22	- - -	18 0 11	9 0 1	- - -
21	- - -	65 3 2	60 3 11	- - -
20	- - -	2 0 0	128 2 25	8 0 1
19	- - -	6 0 2	33 1 20	0 0 0
18	- - -	5 0 4	16 0 10	25 1 10
17	- - -	3 0 3	- - -	- - -
16	- - -	16 0 0	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 3BS

	Q	R	S	T
24	- - -	347 27 2	123 5 2	- - -
23	- - -	616 - 5	249 9 5	- - -
22	- - -	58 4 6	54 2 0	- - -
21	- - -	47 2 1	18 0 0	- - -
20	- - -	196 12 3	22 0 1	207 21 8
19	- - -	5 0 0	8 0 0	26 0 3
18	- - -	2 0 0	7 0 0	3 0 0
17	- - -	0 0 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 3WA

	Q	R	S	T
24	- - -	0 0 0	3 1 0	- - -
23	- - -	0 0 0	30 1 6	- - -
22	- - -	7 0 3	4 0 1	- - -
21	- - -	0 0 0	2 0 0	- - -
20	- - -	0 0 0	8 0 0	111 - 17
19	- - -	0 0 0	0 0 0	21 0 4
18	- - -	0 0 0	0 0 0	2 0 0
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1GBS. UP

	Q	R	S	T
24	-	77	217	-
	-	0	7	-
	-	1	0	-
23	-	88	122	-
	-	7	0	-
	-	3	0	-
22	-	64	13	-
	-	-	0	-
	-	2	2	-
21	-	24	15	-
	-	1	0	-
	-	1	1	-
20	-	24	25	-
	-	0	1	-
	-	3	23	-
19	-	6	7	43
	-	0	0	0
	-	0	0	35
18	-	2	51	23
	-	0	3	0
	-	0	3	5
17	-	0	-	-
	-	0	-	-
	-	0	-	-
16	-	-	-	-
	-	-	-	-
	-	-	-	-

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum 1GBS. LR

	Q	R	S	T
24	- - -	28 1 0	40 5 0	- - -
23	- - -	32 1 0	48 2 3	- - -
22	- - -	33 1 5	9 0 0	- - -
21	- - -	83 1 2	24 0 16	- - -
20	- - -	24 1 2	70 0 60	- - -
19	- - -	15 0 1	8 0 0	208 6 175
18	- - -	11 0 4	0 0 0	130 0 90
17	- - -	0 0 0	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 37 Spatial distribution: microfaunal fragments

Border Cave. Excavation 3A Rear. Stratum BACO. A.

	Q	R	S	T
24	- - -	- - -	- - -	- - -
23	- - -	- - -	- - -	- - -
22	- - -	- - -	- - -	- - -
21	- - -	0 0 0	0 0 0	- - -
20	- - -	- - -	0 0 0	- - -
19	- - -	0 0 0	0 0 0	440 76 14
18	- - -	5 0 1	18 0 12	146 5 14
17	- - -	- - -	- - -	- - -
16	- - -	- - -	- - -	- - -

Legend:

Top: Total fragment count

Centre: Number of jaws with teeth

Base: Number of charred pieces

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 38 Report on the molluscan remains from Border Cave

Ina Plug

Method of analysis

The total sample recovered from the 1970-71 excavations was sent to me for study at the Transvaal Museum. Initial sorting was according to the various trenches and levels as indicated by the excavator (Beaumont, 1973). Minimum numbers of individuals were determined either on columellae/apexes or on undiagnostic fragments alone, assuming one individual only per spit or stratum, in cases where the former two portions were not present.

Counts and comments

The remains were on the whole very fragmented and no complete shells were found. As a result identifications to species level were only possible in a few instances.

Large fresh-water bivalve

Fragments represent a minimum number of three individuals but were too small for species identification. The presence of these forms suggests the possibility of permanent surface water within home range of the cave during 1BS, 1RBS and 1GBS.UP times.

Metachatina kraussi

The portions of a minimum number of two individuals were found. This species is one of the large African land snails and is found in Natal and KwaZulu (Barnard, 1951: 149). It is thus not out of place at Border Cave.

Achatina sp.

This group accounted for all bar seven of the total sample of 3529 fragments. Species identification was again not possible due to severe fragmentation. A minimum number of 84 individuals are present. It would thus seem that *Achatina* formed a small but consistent fraction of prehistoric man's diet in this area at certain time-levels. This is not surprising as they are easy to collect, especially in summer.

Conclusions

My identifications and minimum number counts are fully detailed in Tables 1-3. This data reveals that fragments are mainly confined to relatively few of the strata recognised in Exc. 3A.Rear. The sample from 1GBS.UP is particularly large with 1076 fragments. This is followed by 1WA with 634 fragments and 1GBS.LR with 352 fragments. No certain explanation can as yet be offered for these marked temporal fluctuations in molluscan frequencies.

References

BARNARD, K.H. 1951. A beginner's guide to South African shells. Cape Town, Maskew Miller

BEAUMONT, P.B. 1973. Border Cave - a progress report. S. Afr. J. Sci., 69, 41-46

Table 1. Molluscan remains : counts and identifications.

Border Cave. Excavation 3A Rear

Class: Lamellibranchiata

Large freshwater bivalve

Stratum	Frag. no.	Min. ind.	Based on
1BS	1	1	fragment
1GBS.UP	1	1	hinge
Totals	2	2	

Class: Gasteropoda

Family: Achatinidae

Metachatina kraussi

Stratum	Frag. no.	Min. ind.	Based on
1GBS.UP	3	2	columellae
Totals	3	2	

Class: Gasteropoda

Family: Achatinidae

Achatina sp.

Stratum	Frag. no.	Min. ind.	Based on
1BS.UP.S.	17	1	fragments
1BS.LR	108	2	apex,columella
1WA	634	5	columellae
2BS.UP	10	1	fragments
2BS.LR	17	1	fragments
2WA	8	1	apex
3BS.LR	26	1	fragments
1GBS.UP	1076	19	columellae
1GBS.LR.+BACO.A	352	5	columellae
Totals	2248	36	

Table 2. Molluscan remains : counts and identifications

Border Cave. Excavation 3A Front (S + T 5-17)

Class : Gasteropoda

Family: Achatinidae

Achatina sp.

Stratum	Frag. no.	Min. ind.	Based on
1BS.UP	56	3	columellae
1BS.LR	114	3	apex, columella fragments
1BS.UP+LR	97	6	apexes, fragments
1BES	11	2	apexes
1GBS.UP	655	13	columellae
1GBS.LR+BACO.A	94	9	fragments
Undifferentiated	87	6	fragments
Totals	1114	43	

Table 3. Molluscan remains : counts and identifications

Border Cave. Excavation 3B

Class: Lamellibranchiata

Large freshwater bivalve

Stratum	Frag. no.	Min. ind.	Based on
1RBS	2	1	hinge, fragment
Totals	2	1	

Class : Gasteropoda

Family : Achatinidae

Achatina sp.

Stratum	Frag. no.	Min. ind.	Based on
1RBS	17	1	columella
1RGBS.A	67	2	apex, fragments
1RGBS.B	69	1	columella
BACO.C	7	1	fragments
Totals	160	5	

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Iron Age

	0	0	0	0	0	0	0	0
24	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
23	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	6X	0	0	0	0	0
22	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	5X	0	0	0	0	0
21	0		0		0		0	
	0	0	0	0	0	0	0	0
	-	-	0	0	2	0	2	0
20	-		0		0		0	
	-	-	0	0	0	0	0	0
	-	-	0	0	0	0	0	0
19	-		1N		0		0	
	-	-	0	0	0	0	0	0
	-	-	-	-	-	-	0	0
18	-		-		-		0	
	-	-	-	-	-	-	0	0
	-	-	-	-	-	-	-	-
17	-		-		-		-	
	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
16	-		-		-		-	
	-	-	-	-	-	-	-	-
	Q		R		S		T	

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc - total count

Base right: Mollusc - charred count

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Sterile

	Q	R	S	T
24	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
23	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	3 0 0 0 0
22	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
21	0 0 0 1 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
20	0X 0 0 0 0	0 0 1N 0 0	0 0 0 0 0	0X 0 0 0 0
19	1X 1 0 1 1	3X 2 0 14 3	0 0 0 0 0	0 0 0 0 0
18	- - - - -	- - - - -	- - - - -	0 0 0 1 0
17	- - - - -	- - - - -	- - - - -	- - - - -
16	- - - - -	- - - - -	- - - - -	- - - - -

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc - total count

Base right: Mollusc - charred count

O: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 1BS. LR.

	Q		R		S		T	
	4	0	3	1	5	0	4	0
24	0		1OE		0		0	
	0	0	0	0	0	0	0	0
	7	0	105	2	0	0	1	0
23	0		1OE		1OE		0	
	0	0	0	0	0	0	0	0
	26	0	32	0	22	0	14	3
22	0		1OE		1OE		0	
	0	0	0	0	7	7	0	0
	18	6	19	4	1	0	16	0
21	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	20	8	2	1	3X	0
20	0		1OE		0		0	
	0	0	0	0	0	0	0	0
	0X	0	6X	4	5	0	6x	2
19	0		0		1N		1OE	
	11	3	10	4	0	0	0	0
	6X	2	6X	2	8X	3	9X	1
18	0		0		0		1OE	
	25	14	15	10	8	7	4	4
	1X	1	2X	1	-	-	-	-
17	1N		0		-		-	
	15	8	3	2	-	-	-	-
	4X	2	4X	3	-	-	-	-
16	0		0		-		-	
	8	0	3	2	-	-	-	-

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc - total count

Base right: Mollusc - charred count

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 1WA

24	63	0	51	6	2	1	0	0
	3		0		0		0	
	35	4	0	0	3	3	0	0
23	-	-	2	1	0	0	9	3
	-		0		0		0	
	-	-	0	0	0	0	9	1
22	65	0	0	0	34	0	10	3
	0		0		0		0	
	0	0	0	0	0	0	11	1
21	13	3	36	-	10	0	4	0
	0		0		0		0	
	0	0	1	0	9	6	7	7
20	38	18	118	86	3	2	0	0
	0		0		0		0	
	69	55	8	6	6	6	0	0
19	5	3	14	7	28	12	6X	6
	10E		10E		10E		20E	
	6	3	45	32	58	35	5	4
18	2	2	13X	10	149	-	5	5
	0		1N		0		10E	
	27	16	40	32	150	139	23	19
17	7X	5	3X	1	-	-	-	-
	0		0		-		-	
	48	35	23	11	-	-	-	-
16	2X	1	8X	-	-	-	-	-
	0		0		-		-	
	7	4	0	0	-	-	-	-
	Q		R		S		T	

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc - total count

Base right: Mollusc - charred count

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 2BS. UP

	Q	R	S	T
24	- - - - -	0 0 0 0 0	0 0 0 0 0	0 0 0 2 0
23	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
22	0 0 0 0 0	0 0 0 0 0	0 0 0 4 0	0 0 0 0 0
21	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
20	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
19	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
18	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
17	0 0 0 10 0	0 0 0 0 0	- - - - -	- - - - -
16	- - - - -	- - - - -	- - - - -	- - - - -

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = *Nassa*

Base left: Mollusc - total count

Base right: Mollusc - charred count

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. A+B

	Q	R	S	T
24	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
23	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
22	1 0 0 0 0	3 0 0 0 0	2 0 0 0 0	0 0 0 0 0
21	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
20	0 0 0 0 0	0 0 0 0 0	1 0 0 0 0	0 0 0 0 0
19	- - - - -	- - - - -	0 0 0 0 0	0 0 0 0 0
18	- - - - -	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
17	- - - - -	0 0 0 0 0	- - - - -	- - - - -
16	- - - - -	- - - - -	- - - - -	- - - - -

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc - total count

Base right: Mollusc - charred count

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum . 2BS. LR. C

	73	0	0	0	0	0	0	0
24	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	0	0	1	0	0	0
23	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
22	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
21	0		0		0		0	
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
20	0		0		0		0	
	0	0	0	0	0	0	0	0
	-	-	-	-	0	0	0	0
19	-		-		0		0	
	-	-	-	-	0	0	0	0
	-	-	-	-	0	0	0	0
18	-		-		0		0	
	-	-	-	-	0	0	0	0
	-	-	0	0	-	-	-	-
17	-		0		-		-	
	-	-	0	0	-	-	-	-
	-	-	0	0	-	-	-	-
16	-		0		-		-	
	-	-	0	0	-	-	-	-
	Q		R		S		T	

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc - total count

Base right: Mollusc - charred count

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 2WA

	Q		R		S		T	
24	–	–	0	0	6	–	–	–
	–		0		0		–	
	–	–	0	0	0	0	–	–
23	–	–	0	0	0	0	–	–
	–		0		0		–	
	–	–	0	0	0	0	–	–
22	–	–	0	0	0	0	–	–
	–		0		0		–	
	–	–	0	0	0	0	–	–
21	–	–	0	0	0	0	–	–
	–		0		0		–	
	–	–	0	0	0	0	–	–
20	–	–	0	0	0	0	0	0
	–		0		0		0	
	–	–	0	0	0	0	0	0
19	–	–	0	0	0	0	0	0
	–		0		0		0	
	–	–	0	0	0	0	0	0
18	–	–	6	–	0	0	0	0
	–		0		0		0	
	–	–	0	0	0	0	0	0
17	–	–	0	0	–	–	–	–
	–		0		–		–	
	–	–	4	0	–	–	–	–
16	–	–	2	1	–	–	–	–
	–		0		–		–	
	–	–	4	1	–	–	–	–

Legend:

Top left: Ostrich – total count

Top right: Ostrich – charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc – total count

Base right: Mollusc – charred count

0: Absent

X: Disturbed/Admixture

–: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 3BS

	Q		R		S		T	
	-	-	0	0	6	0	-	-
24	-		0		0		-	
	-	-	0	0	27	-	-	-
	-	-	0	0	0	0	-	-
23	-		0		0		-	
	-	-	0	0	0	0	-	-
	-	-	0	0	0	0	-	-
22	-		0		0		-	
	-	-	0	0	0	0	-	-
	-	-	2	0	0	0	-	-
21	-		0		0		-	
	-	-	0	0	0	0	-	-
	-	-	0	0	0	0	0	0
20	-		0		0		0	
	-	-	1	0	0	0	0	0
	-	-	0	0	0	0	0	0
19	-		0		0		0	
	-	-	0	0	0	0	0	0
	-	-	0	0	0	0	0	0
18	-		0		0		0	
	-	-	0	0	20	0	0	0
	-	-	0	0	-	-	-	-
17	-		0		-		-	
	-	-	0	0	-	-	-	-
	-	-	-	-	-	-	-	-
16	-		-		-		-	
	-	-	-	-	-	-	-	-

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc - total count

Base right: Mollusc - charred count

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum 1GBS. LR

	-	-	0	0	0	0	-	-
24	-		0		0		-	
	-	-	1	0	0	0	-	-
	-	-	0	0	0	0	-	-
23	-		0		0		-	
	-	-	3	0	0	0	-	-
	-	-	0	0	0	0	-	-
22	-		0		0		-	
	-	-	5	-	0	0	-	-
	-	-	0	0	0	0	-	-
21	-		0		0		-	
	-	-	6	0	1	0	-	-
	-	-	0	0	0	0	-	-
20	-		0		0		-	
	-	-	3	0	13	12	-	-
	-	-	0	0	1	0	0	0
19	-		0		0		0	
	-	-	46	14	68	38	23	9
	-	-	0	0	0	0	0	0
18	-		0		0		0	
	-	-	44	22	20	3	16	9
	-	-	0	0	-	-	-	-
17	-		0		-		-	
	-	-	110	50	-	-	-	-
	-	-	-	-	-	-	-	-
16	-		-		-		-	
	-	-	-	-	-	-	-	-
	Q		R		S		T	

Legend:

Top left: Ostrich - total count

Top right: Ostrich - charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc - total count

Base right: Mollusc - charred count

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 39 Spatial distribution: Shell fragments

Border Cave. Excavation 3A Rear. Stratum BACO. A

	Q	R	S	T
24	– – – – –	– – – – –	– – – – –	– – – – –
23	– – – – –	– – – – –	– – – – –	– – – – –
22	– – – – –	– – – – –	– – – – –	– – – – –
21	– – – – –	0 0 0 0 0	0 0 0 0 0	– – – – –
20	– – – – –	– – – – –	0 0 0 0 0	– – – – –
19	– – – – –	1 0 0 0 0	1 0 0 0 0	0 0 0 11 0
18	– – – – –	2 0 0 0 0	1 0 0 2 0	1 0 0 1 0
17	– – – – –	– – – – –	– – – – –	– – – – –
16	– – – – –	– – – – –	– – – – –	– – – – –

Legend:

Top left: Ostrich – total count

Top right: Ostrich – charred count

Centre: Number of beads or pendants

OE = Ostrich; N = Nassa

Base left: Mollusc – total count

Base right: Mollusc – charred count

0: Absent

X: Disturbed/Admixture

–: No data/Unexcavated

Appendix 40 Insect remains from Exc. 3A Rear

Identification	Stratum 1BS.UP 1.A	1BS.UP S	1BS.LR	2BS
Carabidae				
Anthiinae	1	1		
Scaritinae		1		1
Cerambycidae				
Lamiinae				
Tragocephala variegata	1			
Curculionidae	5		1	
Melolonthidae				
Dynastinae?	1			
Melolonthinae				
Schizonycha sp.	1	1		
Ptinidae				
Meziosoma sp.				1
Scarabaeidae	1	2	1	
Scarabaeinae		1		
Scarabaeini		1		
Kheper sp.	1			
Ornitinii				
Ornitis sp.	2			
Coprinae				
Catharsius sp.			1	
Copris sp.				1
Heliocopris sp.	3		1	
Tenebrionidae	2	1		
Adesmisni	1			
Tettiganidae				
Eurycorypha preserpinea				1

Appendix 41 Spatial distribution : other organic vestiges

Border Cave. Excavation 3A Rear. Stratum 1BS.UP Iron Age

	Q	R	S	T
24	Mi 1In 0 0 2G,1C	0 0 0 0 2G,1C	0 0 0 1Fe 0	0 1In 0 0 2G
23	Mi 0 0 0 0	0 2In 0 1Fe 2G,1C	Mi 3In 0 0 1G,1C	0 3In 0 0 0
22	0 0 Ha 0 2G,1B	Mi,X 23In Ha 0 0	0 0 0 0 1G	Mi 1In 0 0 4G,1C
21	0 0 Ha 3Fe 4G	OX 1In Ha 11Fe 144G,1B	0 1In 0 1Fe 6G	0 6In 0 0 22G
20	- - - - -	0 0 Ha 11Fe 0	0 2In 0 6Fe 11G	0 0 0 0 0
19	- - - - -	Mi 0 0 7Fe 11G	0 0 0 4Fe 11G	Mi 0 0 13Fe 4G
18	- - - - -	- - - - -	- - - - -	0 0 0 11Fe 4G
17	- - - - - -	- - - - - -	- - - - - -	- - - - - -
16	- - - - -	- - - - -	- - - - -	- - - - -

Legend

Top left: Millipede segments (Mi)

Top right: Insect remains (In)

Centre left: Hair fragments (Ha)

Centre right: Number of feathers (Fe)

Base left: Number of coprolites:

G = Goat
C = Cattle
F = Felid
B = Bird
R = Rodent

0: Absent

X: Disturbed/Admixture

-: No data/ Unexcavated

Appendix 41 Spatial distribution : other organic vestiges

Border Cave. Excavation 3A Rear. Stratum 1BS.UP. Sterile

	Q	R	S	T
24	0 0 0 0 0	0 0 0 0 1C	0 2In 0 0 1C	0 0 0 0 0
23	0 0 0 0 0	0 0 0 0 1C	0 0 0 0 4C	0 0 0 0 0
22	0 0 0 0 1G	0 1In 0 0 1C	0 1In 0 0 0	0 0 0 0 0
21	0 0 0 1Fe 1G,1B	0 1In 0 0 1G	0 1In 0 0 1G	0 1In 0 0 0
20	0X 1In 0 6Fe 8G,1R	0 0 0 1Fe 6G,2B	0 0 0 0 1G	0X 1In 0 38Fe 0
19	0X 0 Ha 6Fe 4G	0X 0 0 0 3G	0 0 0 1Fe 12G,1F	Mi 2In 0 0 7G,1F
18	- - - - -	- - - - -	- - - - -	Mi 0 0 9Fe 6G
17	- - - - -	- - - - -	- - - - -	- - - - -
16	- - - - -	- - - - -	- - - - -	- - - - -

Legend

Top left: Millipede segments (Mi)

Top right: Insect remains (In)

Centre left: Hair fragments (Ha)

Centre right: Number of feathers (Fe)

Base left: Number of coprolites:

- G = Goat
- C = Cattle
- F = Felid
- B = Bird
- R = Rodent

0: Absent

X: Disturbed/Admixture

-: No data/ Unexcavated

Appendix 41 Spatial distribution : other organic vestiges

Border Cave. Excavation 3A Rear. Stratum 1BS.LR.

	Q	R	S	T
24	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
23	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
22	0 0 0 0 0	0 1In 0 0 1C	0 0 0 0 0	0 0 0 0 0
21	0 2In 0 0 0	0 0 0 0 3G	0 0 0 0 0	0 0 0 0 0
20	0 0 0 0 0	0 0 0 0 1G	0 0 0 0 0	0 0 0 1Fe 0
19	OX 1In 0 14Fe 2G	OX 1In 0 10Fe 2G,1C	0 0 0 0 7G	OX 0 0 24Fe 1F
18	OX 0 0 17Fe 0	Mi,X 1In 0 20Fe 45G	OX 0 0 9Fe 12G,1C	Mi,X 0 0 6Fe 0
17	OX 0 0 15Fe 4G	Mi,X 0 0 4Fe 0	- - - - -	- - - - -
16	OX 1In 0 51Fe 4G,1C	OX 0 0 13Fe 1G	- - - - -	- - - - -

Legend

Top left: Millipede segments (Mi)

Top right: Insect remains (In)

Centre left: Hair fragments (Ha)

Centre right: Number of feathers (Fe)

Base left: Number of coprolites:

G = Goat
C = Cattle
F = Felid
B = Bird
R = Rodent

0: Absent

X: Disturbed/Admixture

-: No data/ Unexcavated

Appendix 41 Spatial distribution : other organic vestiges

Border Cave. Excavation 3A Rear. Stratum 1WA

	Q		R		S		T	
24	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0		0		0		0	
23	-	-	0	0	0	0	0	0
	-	-	0	0	0	0	0	0
	-		0		0		0	
22	0	0	Mi	0	0	0	0	0
	0	0	0	0	Ha	0	0	0
	0		0		0		0	
21	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0		0		0		0	
20	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0		0		0		0	
19	0	0	0	0	0	0	OX	0
	0	0	0	0	0	0	0	0
	0		0		0		3G	
18	Mi	0	Mi,X	0	0	0	0	0
	0	0	Ha	3Fe	0	0	0	0
	0		4G		0		0	
17	Mi,X	0	Mi,X	0	-	-	-	-
	0	0	Ha	5Fe	-	-	-	-
	0		4G,1C		-		-	
16	OX	0	OX	0	-	-	-	-
	0	8Fe	0	0	-	-	-	-
	0		0		-		-	

Legend

Top left: Millipede segments (Mi)

Top right: Insect remains (In)

Centre left: Hair fragments (Ha)

Centre right: Number of feathers (Fe)

Base left: Number of coprolites:

- G = Goat
- C = Cattle
- F = Felid
- B = Bird
- R = Rodent

0: Absent

X: Disturbed/Admixture

-: No data/ Unexcavated

Appendix 41 Spatial distribution : other organic vestiges

Border Cave. Excavation 3A Rear. Stratum 2BS.UP

	Q	R	S	T
24	Mi - - - -	Mi 0 0 0 0	0 0 0 0 0	0 0 0 0 0
23	Mi 0 0 0 0	0 0 0 0 0	Mi 0 0 0 0	Mi 0 0 0 0
22	0 11In 0 0 0	0 0 0 0 0	Mi 0 0 0 0	Mi 0 0 0 0
21	0 0 0 0 0	Mi 0 0 0 0	0 0 0 0 0	0 0 0 0 0
20	0 0 0 0 0	0 0 0 0 0	Mi 0 Ha 0 0	0 0 0 0 0
19	0 0 0 0 0	Mi 0 0 0 0	Mi 0 0 0 0	0 0 0 0 0
18	Mi 0 0 0 1C?	Mi 0 0 0 1G	0 1In 0 0 0	0 0 0 0 0
17	Mi 0 0 0 0	Mi 0 0 0 0	- - - - -	- - - - -
16	- - - - -	- - - - -	- - - - -	- - - - -

Legend

Top left: Millipede segments (Mi)

Top right: Insect remains (In)

Centre left: Hair fragments (Ha)

Centre right: Number of feathers (Fe)

Base left: Number of coprolites:

G = Goat
C = Cattle
F = Felid
B = Bird
R = Rodent

0: Absent

X: Disturbed/Admixture

-: No data/ Unexcavated

Appendix 41 Spatial distribution : other organic vestiges

Border Cave. Excavation 3A Rear. Stratum 2BS.LR.A-C

	Q	R	S	T
24	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
23	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
22	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
21	Mi 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
20	0 1In 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0
19	- - - - -	- - - - -	0 0 0 0 0	0 0 0 0 0
18	- - - - -	- - - - -	0 0 0 0 0	0 0 0 0 0
17	- - - - -	Mi 0 0 0 1G?	- - - - -	- - - - -
16	- - - - -	MiX 0 0 0 1G	- - - - -	- - - - -

Legend

Top left: Millipede segments (Mi)

Top right: Insect remains (In)

Centre left: Hair fragments (Ha)

Centre right: Number of feathers (Fe)

Base left: Number of coprolites:

G = Goat
C = Cattle
F = Felid
B = Bird
R = Rodent

0: Absent

X: Disturbed/Admixture

-: No data/ Unexcavated

Appendix 42 Some comments on the excavated feathers from Border Cave

Roger Savile-Davis

Most of the plumes recovered from the 1970-71 excavations show remarkable preservation in terms of structure and colour (Fig. 70). The often perfect retention of these features made it relatively easy to ascribe the major fraction of the specimens to a specific species and body position (Table 1).

A consideration of the total data in this connection indicates that:

1. A high proportion of the excavated feathers belong to the same three main species which occupy the cave at present (red winged starling, rock pigeon, lesser striped swallow).
2. Feathers found in the deposit coincide, as far as can be presently established, with the overlapping areas used for roosting today by the above-mentioned species, which would suggest, in view of the C-14 readings, that occupation patterns have remained fairly constant over the last thousand years and more.
3. *Cecropis* was only represented by tail-feathers.
4. *Struthio* feathers were presumably brought in by man.

TABLE 1. Feather distribution and identification

Border Cave. Exc. 3A Rear and Front

Exc	Stratum	Square and Depth cm	Disturbed	Recovered	Identified	Bird species				
						Onychog.	Columba	Cecropis	Tyto	Struthio
3A Rear	1BS.UP	Q21 18-38		3	3	1	2	-	-	-
	Iron Age	R19 30-46	D	7	6	6	-	-	-	-
		R20 23-38		11	11	3	7	1?	-	-
		R21 15-30	D	11	7	3	4	-	-	-
		R23 0-8		1	-	-	-	-	-	-
		S19 30-38		4	1	1	-	-	-	-
		S20 15-30		2	2	-	2	-	-	-
		S20 30-38		4	3	1	2	-	-	-
		S21 23-30		1	1	1	-	-	-	-
		S24 8-15		1	1	-	1	-	-	-
		T18 18-38		11	11	2	8	1	-	-
		T19 15-30		13	1	1	-	-	-	-
Totals				69	47	19	26	2	-	-
3A Rear	1BS.UP	Q19 38-53	D	6	-	-	-	-	-	-
	Sterile	Q20 28-46	D	5	3	2	1	-	-	-
		Q20 53-61		1	1	1?	-	-	-	-
		Q21 38-46		1	1	-	1	-	-	-
		R20 38-46		1	1	-	1	-	-	-
		S19 38-46		1	1	1	-	-	-	-
		T18 38-46		9	8	4	4	-	-	-
		T20 46-53	D	25	19	12	7	-	-	-
		T20 53-61	D	13	12	7	4	-	-	1
Totals				62	46	27	18	-	-	1
3A Rear	1BS.LR	Q16 61-1WA	D	51	38	26	11	-	1	-
		Q17 56-1WA	D	15	11	9	1	1	-	-
		Q18 48-61	D	8	6	2	4	-	-	-
		Q18 61-1WA	D	9	9	6	3	-	-	-
		Q19 53-61	D	10	6	-	6	-	-	-
		Q19 61-1WA	D?	4	2	2	-	-	-	-
		R16 58-1WA	D	13	5	3	2	-	-	-
		R17 46-1WA	D	4	-	-	-	-	-	-
		R18 45-1WA	D	20	17	7	9	1	-	-
		R19 53-61	D	7	5	3	2	-	-	-
		R19 61-1WA	D	3	3	1?	2	-	-	-
		S18 36-46	D	1	-	-	-	-	-	-
		S18 46-1WA	D	8	1	-	1	-	-	-
		T18 46-1WA	D	6	5	3	2	-	-	-
		T19 46-53	D	8	-	-	-	-	-	-
		T19 53-1WA		16	14	9	5	-	-	-
		T20 61-69	D	1	1	-	-	-	1	-
Totals				184	123	71	48	2	2	-

TABLE 1. (continued)

Exc.	Stratum	Square and Depth cm	Disturbed	Recovered	Identified	Bird species: Onychog.	Columba	Cecropis	Tyto	Struthio
3A Rear	1WA	Q16	D	8	-	-	-	-	-	-
		R17	D	5	4	2	2	-	-	-
		R18	D	2	1	1	-	-	-	-
		R18		1	1	1	-	-	-	-
Totals				16	6	4	2	-	-	-
3A Front	1BS	S13-15	D	70	60	28	29	3	-	-
		T7	D	6	5	1	4	-	-	-
		T8	D	36	21	12	9	-	-	-
		T9	D	22	16	12	2	1	1	-
		T10	D	32	22	7	15	-	-	-
		T11	D	63	30	11	18	-	-	1
		T12	D	29	24	13	11	-	-	-
		T13-15	D	26	18	7	11	-	-	-
		T16 28-38	D	3	3	-	3	-	-	-
		T17 25-46	D	6	2	1	-	1	-	-
Totals				293	201	92	102	5	1	1
3A Front	2BS	S17 91-99	D	2	2	-	2	-	-	-
		S17 99-107	D	6	6	3	3	-	-	-
		T16 84-91	D	1	1	-	-	-	-	1
		T16 91-99	D	1	-	-	-	-	-	-
		T17 69-76	D	1	-	-	-	-	-	-
		T17 91-99	D	13	11	7	4	-	-	-
Totals				23	20	10	9	-	-	1

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Iron Age

	Q	R	S	T
24	49 127 – 0	95 23 TLSM 2Ro	47 11 TLSM 0	27 0 TLSM 0
23	16 4 – 0	200 65 TLSM 1Ba	105 0 TLSM 0	16 3 TLS 0
22	26 201 – 0	582X 12 TLSFM 2Ba,2St	12 7 S 0	117 + 0 LSM 1Sw,1Ro,1St
21	30 16 – 0	285X 14 TLSM 0	52 0 TLSM 0	217 0 TLSM 3St
20	– – – –	80 17 TLSM 6St	50 4 TLSM 0	60 21 TLSM 0
19	– – – –	230 15 TLSM 1Ba	105 12 TLSM 1Sw	30 0 TLS 0
18	– – – –	– – – –	– – – –	50 12 TLS 0
17	– – – –	– – – –	– – – –	– – – –
16	– – – –	– – – –	– – – –	– – – –

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

–: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 1BS. UP. Sterile

	Q	R	S	T
24	0,5 0 — 0	15 0 TLM 0	29 0 TM 0	0 0 0 0
23	1 0 — 0	12 0 TSM 0	193 0 TLM 0	3 0 FM 0
22	65 50 — 0	68 0 TLSM 0	3,5 0 TLS 0	23 3 TSM 0
21	12 0 — 0	20 0 TLSM 0	50 21 TLSM 0	4 11 TL 0
20	35X 10 — 0	35 0 TLSM 0	17 5 TLSM 0	25X 23 TLS 0
19	75X 21 TLSM 0	105X 19 TLSM 0	40 0 TLSM 0	35 1 TSM 0
18	– – – –	– – – –	– – – –	60 0 TLS 0
17	– – – –	– – – –	– – – –	– – – –
16	– – – –	– – – –	– – – –	– – – –

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

–: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 1BS. LR.

	Q	R	S	T
24	0 50 0 0	0 101 0 0	1 85 TM 0	0 32 0 0
23	17 195 – 0	35 157 TF 0	5 26 TM 0	0 119 0 0
22	35 150 TSFM 0	55+ 67 TFM 0	15 73 TFM 0	10,5 159 TF 0
21	110 22 – 1Sw,2Ut	80 83 TLSFM 0	45 189 TM 0	60 269 TLM 0
20	5 14 – 0	173 262 TSFM 0	220 190 TSM 0	93 291 TLSM 0
19	95X 111 TLSM 0	60X 48 TLSM 0	155 135 TLSM 0	85x 160 TM 1Ut
18	130X 57 TLSM 0	455x 64 TLSM 0	195+X 226 TLSFM 0	130x 225 TL 0
17	110X 15 TLSM 0	80X 21 – 0	– – – –	– – – –
16	280X 39 TLSM 0	40X 21 – 0	– – – –	– – – –

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

–: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 1WA

	Q	R	S	T
24	7 330 – 0	8 166 TF 0	0 146 0 0	0 121 0 0
23	– – – –	15 29+ FM 0	0 151 0 0	4 187 F 0
22	24 190 – 0	35 290 F 0	2 – – 0	8 245 T 0
21	275 223 TFM 0	60 159 TFM 0	30 353 TM 0	10 30+ TM 0
20	50 190 TFM 0	117 260 TFM 0	50 438 TM 0	35 216 TM 2Sw
19	110 495 TSM 0	90 485 TSM 1Ut	73 595 TM 4Sw	20X 222 TLSM 0
18	65 192 TM 0	180X 276 TSFM 1Sw,1Ut	24 290 TFM 0	45 353 TM 0
17	90X 161 TLSM 1Ut	80X 186 TLSM 0	– – – –	– – – –
16	10X – TS 1Sw	–X – 0 0	– – – –	– – – –

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

–: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 2BS. UP

24	- - - -	0 4 0 0	0 10 0 0	0 35 0 0
23	0 20 0 0	0 2 0 0	0 18 0 0	0 45 0 0
22	0 45 0 0	0 35 0 0	0,5 17 TS 0	20 0 TM 0
21	0 35 0 0	1 130 FM 0	0 0 0 0	0 7 0 0
20	10 35 TLF 0	0 45 0 0	0 20 0 0	0 0 0 0
19	2 35 TS 1Ut	5 134 TM 0	0 45 0 0	0 63 0 0
18	5 45 TFM 0	10 57 TSM 0	4 14 L 0	1,5 64 L 1Ut
17	5 0 TLM 0	3 25 TLM 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -
	Q	R	S	T

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. A+B

	Q	R	S	T
24	0 23 0 0	5 8 M 0	0 30 0 0	0 7 0 0
23	0 96 0 0	0 13 0 0	0,5 24 T 0	0 14 0 0
22	0 88 0 0	12 55 TSFM 0	0 30 0 0	0 0 0 0
21	0 232 0 0	10 60 FM 0	11 195 TLM 1Ut	2 95 T 0
20	3 264 T 0	10 79 F 0	2 318 T 1Ut	4 86 M 0
19	- - - -	- - - -	10 225 T 0	8 58 T 0
18	- - - -	- - - -	7 250 TM 1Ut	2 80 T 0
17	- - - -	12 178 TSM 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 2BS. LR. C

24	1 99 TM 0	0,5 107 M 0	6 130 TM 0	0,1 10 L 0
23	0 – 0 0	10 70 TM 0	15 170 T 0	0 60 0 0
22	7 – – 0	4 124 TM 0	21 95 TM 0	0,3 0 T 0
21	90 214 TFM 0	20 130 TM 0	5 50 TFM 0	5 15 TM 0
20	25 174 TM 0	15 174 TM 0	40 53 TM 0	10 64 TM 0
19	– – – –	– – – –	30 77 TM 1Ut	5 67 TM 0
18	– – – –	– – – –	15 105 T 2Ut	5 63 T 0
17	– – – –	25 104 TM 0	– – – –	– – – –
16	– – – –	3 18 TSM 0	– – – –	– – – –
	Q	R	S	T

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

–: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 2WA

	Q	R	S	T
24	– – – –	0 160 0 0	0 240 0 0	– – – –
23	– – – –	0,2 219 T 0	1 260 TF 0	– – – –
22	– – – –	5 264 T 0	0 145 0 0	– – – –
21	– – – –	7 268 TM 0	20 220 TM 0	– – – –
20	– – – –	17 306 LF 0	3 187 TM 0	0 68 0 0
19	– – – –	15 222 TM 1Sw?	5 228 TF 0	4 396 TS 0
18	– – – –	30 460 TLSM 0	– 290 – –	15 544 F 0
17	– – – –	0 680 0 0	– – – –	– – – –
16	– – – –	5 358 TM 0	– – – –	– – – –

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

–: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 3BS.

	Q	R	S	T
24	- - - -	5 173 - 0	3 215 T 0	- - - -
23	- - - -	2,3 245 TFM 0	0 320 0 0	- - - -
22	- - - -	0 273 0 0	0 310 0 0	- - - -
21	- - - -	12 138 - 0	0 102 0 0	- - - -
20	- - - -	1 105 L 0	0 100 0 0	28 51 TM 0
19	- - - -	0 25 0 0	0 41 0 0	17 52 T 0
18	- - - -	0 45 0 0	0 - 0 0	3 215 T 0
17	- - - -	0 45 0 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 3WA

	Q	R	S	T
24	- - - -	0 0 0 0	0 0 0 0	- - - -
23	- - - -	0 0 0 0	0 19 0 0	- - - -
22	- - - -	0 20 0 0	0 4 0 0	- - - -
21	- - - -	0 22 0 0	0,1 0 - 0	- - - -
20	- - - -	0 0 0 0	0 24 0 0	0 27 0 0
19	- - - -	0 0 0 0	0 0 0 0	0 5 0 0
18	- - - -	0 13 0 0	0 5 0 0	0 8 0 0
17	- - - -	- - - -	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 1GBS. UP.

	Q	R	S	T
24	- - - -	1 254 - 0	0 198 0 0	- - - -
23	- - - -	0 142 0 0	0 182 0 0	- - - -
22	- - - -	0 152 0 0	0 154 0 0	- - - -
21	- - - -	2 162 - 0	0 108 0 0	- - - -
20	- - - -	0 262 0 0	0 80 0 0	- - - -
19	- - - -	10 253 - 0	0 161 0 0	0 55 0 0
18	- - - -	4 160 - 0	0 88 0 0	0 98 0 0
17	- - - -	0 31 0 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum 1GBS. LR

24	- - - -	0 33 0 0	0 0 0 0	- - - -
23	- - - -	0 200 0 0	0 261 0 0	- - - -
22	- - - -	2 328 T 0	0 418 0 0	- - - -
21	- - - -	0 407 0 0	0 718 0 0	- - - -
20	- - - -	3 548 - 0	0 415 0 0	- - - -
19	- - - -	0 255 0 0	0 462 0 0	0 641 0 0
18	- - - -	0 217 0 0	- 281 0 0	- 581 0 0
17	- - - -	0 415 0 0	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -
	Q	R	S	T

Legend:

Top left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 43 Spatial distribution: floral remains

Border Cave. Excavation 3A Rear. Stratum BACO. A

24	- - - -	- - - -	- - - -	- - - -
23	- - - -	- - - -	- - - -	- - - -
22	- - - -	- - - -	- - - -	- - - -
21	- - - -	0 59 0 0	0 34 0 0	- - - -
20	- - - -	- - - -	0 27 0 0	- - - -
19	- - - -	0 79 0 0	0 43 0 0	0 107 0 0
18	- - - -	0 21 0 0	0 60 0 0	0,2X 349 S 0
17	- - - -	- - - -	- - - -	- - - -
16	- - - -	- - - -	- - - -	- - - -
	Q	R	S	T

Legend:

Top, left: Unburnt plant mass

Top right: Charcoal nodule mass

Centre: Major categories present

T = Twigs; L = Leaves;

S = Seeds; F = Fibre;

M = Other

Base: Number of related artefacts

Sw = Shaped wood;

Ut. = Utilized thorn

Ba = Basketry; Ro = Rope

St = String

0: Absent

X: Disturbed/Admixture

-: No data/Unexcavated

Appendix 44 Provisional comments on the fossil leaves and seeds from Border Cave☆

John Anderson

A study of the floral debris from Exc. 3A Rear was undertaken at the Botanical Research Institute in Pretoria during 1976. The analytical results of this investigation are summarized in Tables 1-4. Some preliminary remarks relative to these are as follows:

1. A minimum number of 1140 leaves and 1400 seeds were recovered from vegetation preponderantly confined to levels down to and including the 2WA.
2. About 64 leaf and 75 seed species occur. Of these 32 of the former and 31 of the latter were identified to species level in most cases. Some 95% of the leaves and 90% of the seeds fall within the identified fractions.
3. Only 5 (~ 8%) of the identified species are common to both the leaves and the seeds. The number of identified species, which are very largely indigenous, is therefore approximately 58.
4. A total of about 120 species would be represented by the archaeological remains if the above proportion also holds true for the unidentified fraction. This is just over half of the total number of woody plant species which occur in this area presently (see Appendix 1).
5. Comparisons with the extant indigenous flora indicates that about 70% of the leaves and > 95% of the seeds are from species which occur in the area today and that about 40% of the leaves and 40% of the seeds come from species now growing in the vicinity of the cave itself.
6. Diospyros dichrophylla, Pappea capensis and Ricinus communis are the most abundant seed species and far exceed in frequency the combined totals of all the rest. None of these three species grows near the site at present and all are of known food or medicinal value to man, thus suggesting that they were probably introduced by way of that agency.
7. The general state of preservation of the fossil flora varies perceptibly with depth, being in near-herbarium condition in the IBS.UP, noticeably humified between and including the IBS.LR and the 2WA, and extremely friable below the latter level. The marked difference in this connection between the 1BS.UP and the 1BS.LR is seen as being in good accord with the hiatus indicated by the C-14 readings for these horizons

Beaumont, 1973).

8. Temporal variations in preservation do not however seem sufficient to explain the paucity of well-documented leaves and seeds in the 2BS and the 2WA. This view is based on the presence within those strata of 'fine fibre' and 'tobacco-like vegetation' categories which appear, in terms of susceptibility of decay, to be comparable to the leaves, and certainly far more so than the seeds.

9. Broadly speaking, both leaves and seeds occur most commonly in the 1BS.UP.I.A and then tail off fairly rapidly in preceding levels down to the 3BS. A major cause of this effect would seem to be downward drift as a result of human and animal agencies. This is patently so in the case of seeds of the introduced exotic Ricinus communis, which is strongly associated with the 1BS.UP.I.A (~ 90%), but which also occurs in the 1BS.UP.S (~ 5%) as also in the 1BS.LR (~ 5%).

10. Although mixing has undoubtedly occurred, the numerical evidence would suggest that some of the vertical distributional patterns are meaningful. For example:

    (a) Linociera foveolata and Dovyalis lucida leaves are most frequent in the 1BS.UP.S and/or the 1BS.LR. These species are, in addition, not present in the region today. There is also no record that either of them was or is utilized by man.

    (b) Encephalartos lebomboensis leaves show an extremely 'anomalous' distribution in which the major fraction derives from the 2BS. In this case the evidence is corroborated by the preservational status of the leaves and by concordant shifts with time in the probably related seeds.

    (c) Ochna arborea arborea leaves, Dombeya tiliaceae leaves, the 'unidentified' leaves and the 'small oval' seeds also appear to show 'aberrant' distributions, but the small samples and/or lack of more precise identification makes this information more suspect and/or less meaningful.

Acknowledgements

I wish to thank P. Beaumont for assistance with the analysis and Mrs. C. Liegme for compiling Tables 3 and 4, based on data on file at the Botanical Research Institute.

References

* Partly based on a communication from J. Anderson dated 1976.

BEAUMONT, P.B. 1973. Border Cave - a progress report. S. Afr. J. Sci., 69 : 41-46

Table 1 Temporal distribution of leaves in Exc. 3A at Border Cave

John Anderson

Identification	Now Pres.	Sum	Stratum IBS.UP.IA I.S.	P.I.	IBS.UP.S I.S.	P.I.	1BS.LR. I.S.	P.I.	1WA I.S.	P.I.	2BS.UP	2BS.LR	2WA
Strychnos spinosa	X	216	76	69	13	30	9	18	-	1	-	-	-
Vitellariopsis marginata	X	191	109	18	5	17	-	28	1	9	1	3	-
Erythroxylum emarginatum	X	157	145	2	1	3	2	4	-	-	-	-	-
Linociera foveolata		140	26	1	20	7	42	31	3	1	4	1	4
Strychnos henningsii	X	75	25	9	-	8	3	29	-	1	-	-	-
Dovyalis lucida		44	7	2	5	9	6	14	-	1	-	-	-
Ochna arborea oconnorii	X	31	13	1	1	3	1	9	1	2	-	-	-
Tarenna barbertonensis	X	23	16	-	2	-	5	-	-	-	-	-	-
Artabotrys monteiroae	?	21	15	-	-	-	-	6	-	-	-	-	-
Encephalartos lebomboensis	X	21	2	-	-	-	-	-	2	1	13	2	1
(green/olive cutin)		20	16	-	1	-	2	1	-	-	-	-	-
Euclea divinorum	X	19	4	12	3	-	-	-	-	-	-	-	-
Ochna arborea arborea	X	17	3	2	1	-	8	3	-	-	-	-	-

Table 1 - (continued)

Identification	Now Pres.	Sum	Stratum 1BS.UP.IA I.S.	P.I.	1BS.UP.S I.S.	P.I.	1BS.LR. I.S.	P.I.	1WA I.S.	P.I.	2BS.UP	2BS.LR	2WA
Dombeya tiliaceae		16	1	1	5	-	2	4	-	3	-	-	-
Adina microcephala	X	15	11	-	-	1	1	2	-	-	-	-	-
Euclea schimperi	X	15	2	1	2	8	-	2	-	-	-	-	-
Bridelia micrantha		13	3	-	1	-	1	7	-	-	-	1	-
Rawsonia lucida		10	9	-	-	-	-	1	-	-	-	-	-
Mundulea sericea	X	9	6	1	-	1	-	1	-	-	-	-	-
Cassine eucleaeformis		9	1	-	-	-	-	8	-	-	-	-	-
Encephalartos villosus		8	2	-	1	1	-	3	1	-	-	-	-
Teclea natalensis	X	6	3	-	-	-	-	3	-	-	-	-	-
Tarchonanthus trilobus	X	5	2	-	1	-	-	2	-	-	-	-	-
cf. Erythrox.emarg. (robust)	?	5	1	1	-	1	-	2	-	-	-	-	-
Cassine aethiopica	X	3	2	-	1	-	-	-	-	-	-	-	-
Vepris reflexa	X	3	1	-	-	-	-	2	-	-	-	-	-
Todaliopsis bremekampii		2	-	-	-	-	-	2	-	-	-	-	-
Drypetes gerrardii		1	1	-	-	-	-	-	-	-	-	-	-
Gerrardina foliosa		1	1	-	-	-	-	-	-	-	-	-	-

Table 1 - (continued)

Identification	Now Pres.	Sum	Stratum 1BS.UP.IA I.S.	P.I.	1BS.UP.S I.S.	P.I.	1BS.LR. I.S.	P.I.	1WA I.S.	P.I.	2BS.UP	2BS.LR	2WA
Maytenus heterophylla	X	1	-	-	-	-	-	1	-	-	-	-	-
Rhus rehmannii	X	1	-	-	-	-	-	1	-	-	-	-	-
Aloe marlothii	X	1	-	-	-	-	-	-	-	1	-	-	-
Grewia occidentalis	X	1	-	-	-	1	-	-	-	-	-	-	-
Putterlickia pyracantha	X	1	1	-	-	-	-	-	-	-	-	-	-
± 30 unidentified species		40	10	-	4	4	2	8	3	-	8	1	
Totals		1140	514	120	67	94	84	192	11	20	25	8	5

Abbreviations:

Pres. = present; I.S. = in situ; P.I. = possibly intrusive/disturbed context

Table 2 Temporal distribution of seeds in Exc. 3A at Border Cave

John Anderson

Identification	Now Pres.	Sum	Stratum 1BS.UP.IA I.S.	1BS.UP.IA P.I.	1BS.UP.S I.S.	1BS.UP.S P.I.	1BS.LR. I.S.	1BS.LR. P.I.	1WA I.S.	1WA P.I.	2BS.UP	2BS.LR	2WA
Diospyros dichrophylla	X	345	145	6	7	50	-	119	12	4	1	1	-
Pappea capensis	X	275	194	-	2	26	1	42	8	1	1	-	-
Ricinus communis (seed)	?	267	253	-	5	4	2	3	-	-	-	-	-
Ricinus communis (shell)	?	25	1	3	2	8	1	10	-	-	-	-	-
Ekebergia capensis	X	85	46	2	2	10	3	19	2	1	-	-	-
Commiphora harveyi	X	66	54	-	3	2	-	3	1	2	-	1	-
Harpephyllum caffrum	X	52	49	1	1	-	1	-	-	-	-	-	-
(small oval seed)	?	37	6	-	19	7	2	1	2	-	-	-	-
Teclea natalensis	X	32	12	-	8	2	-	7	1	2	-	-	-
Commiphora woodii	X	19	17	-	-	-	-	1	1	-	-	-	-
(pumpkin sp. 1)	?	15	14	-	1	-	-	-	-	-	-	-	-
Erythroxylum emarginatum	X	15	2	-	3	5	1	2	1	1	-	-	-
Ziziphus mucronata	X	12	5	-	5	-	-	-	1	-	-	1	-

Table 2 - (continued)

Identification	Now Pres.	Sum	1BS.UP.IA I.S.	1BS.UP.IA P.I.	1BS.UP.S I.S.	1BS.UP.S P.I.	1BS.LR. I.S.	1BS.LR. P.I.	1WA I.S.	1WA P.I.	2BS.UP	2BS.LR	2WA
							Stratum						
Encephalartos spp.	?	10	2	-	1	1	2	-	1	-	-	2	1
cf. Tephrosia sp.	?	9	8	-	-	1	-	-	-	-	-	-	-
(cucurbit sp.)	?	8	3	-	1	1	1	-	1	-	-	1	-
Sideroxylon inerme	X	6	-	-	-	1	-	3	-	-	-	-	2
(pumpkin sp. 2)	?	5	4	-	-	-	-	1	-	-	-	-	-
(woody 4-angled seed)	?	5	5	-	-	-	-	-	-	-	-	-	-
Strychnos henningsii	X	4	2	-	1	-	-	1	-	-	-	-	-
Boschia albitrunca	X	4	3	-	-	-	-	1	-	-	-	-	-
Crotalaria natalensis	?	3	3	-	-	-	-	-	-	-	-	-	-
Sclerocarya caffra	X	3	3	-	-	-	-	-	-	-	-	-	-
Combretum sp.	?	2	1	-	-	-	-	1	-	-	-	-	-
Cladostemon kirkii	X	2	-	-	2	-	-	-	-	-	-	-	-
Phyllogeiton discolor	X	2	1	-	1	-	-	-	-	-	-	-	-
Canthium inerme	X	2	2	-	-	-	-	-	-	-	-	-	-
Capparaceae: gen. et sp.	?	2	-	-	2	-	-	-	-	-	-	-	-
Apodytes dimidiata	X	1	1	-	-	-	-	-	-	-	-	-	-

Table 2 - (continued)

Identification	Now Pres	Sum	1BS.UP.IA I.S.	1BS.UP.IA P.I.	1BS.UP.S I.S.	1BS.UP.S P.I.	1BS.LR. I.S.	1BS.LR. P.I.	1WA I.S.	1WA P.I.	2BS.UP	2BS.LR	2WA
			Stratum										
Acacia nigrescens	X	1	-	-	-	-	-	1	-	-	-	-	-
Vangueria infausta	X	1	-	-	-	-	1	-	-	-	-	-	-
Celtis africana	X	1	1	-	-	-	-	-	-	-	-	-	-
Euclea sp.	?	1	1	-	-	-	-	-	-	-	-	-	-
(Woody seed - 3 holes at end)	?	4	-	-	-	-	-	-	3	1	-	-	-
(maize cob frags.)	X	3	3	-	-	-	-	1	-	-	-	-	-
(split white kernel)	?	9	-	-	-	9	-	-	-	-	-	-	-
(seed inflores-cence spp.)	?	13	9	-	1	1	-	2	-	-	-	-	-
± 40 unidenti-fied species		67	30	3	10	6	1	5	5	3	-	-	4
Totals		1413	879	15	77	134	16	223	39	15	2	6	7

Abbreviations:

Pres. = present; I.S. = in situ; P.I. = possibly intrusive/disturbed context

Table 3 - Possible transporting agents for the identified leaves in Excavation 3A at Border Cave

Species	Present	Local	Man: Food	Man: Med. and Mag.	Man: Other	Animal: Baboon	Animal: Bird and Bat
Strychnos spinosa	x		x	x		x	
Vitellariopsis marginata	x		x				x
Erythroxylum emarginatum	x	x					
Linociera foveolata						x	x
Strychnos henningsii	x			x	x		
Dovyalis lucida							?
Ochna arborea oconnorii	x			x			
Tarenna barbertonensis	x	x					
Artabotrys monteiroae	?		x	x			
Encephalartos lebomboensis	x	x	x	x	x		
Euclea divinorum	x		x	x			x
Ochna arborea arborea	x				x		
Dombeya tiliaceae							
Adina microcephala	x				x		
Euclea schimperi	x		x	x	x		
Bridelia micrantha			x	x	x		x
Rawsonia lucida					x		
Mundulea sericea	x			x	x		
Cassine eucleaeformis					x		x
Encephalartos villosus			x	x	x		
Teclea natalensis	x	x					x
Tarchonanthus trilobus	x	x					

Table 3 - (continued)

Species	Present	Local	Man: Food	Man: Med. and Mag.	Man: Other	Animal: Baboon	Animal: Bird and Bat
Cassine aethiopica	x	x	x	x	x		
Vipris reflexa	x	x			x		x
Todaliopsis bremekampii			x		x		
Drypetes gerrardii			x		x		
Gerrardina foliosa							
Maytenus heterophylla	x			x	x		x
Rhus rehmannii	x	x	?				
Aloe marlothii	x			x			
Grewia occidentalis	x		x	x	x		
Putterlickia pyracantha	x	x	x				

Abbreviations

Present = in general area; Local = in vicinity of cave (habitats 2d and 3a); Med. and Mag. = medicine and magic; Other = firewood, etc.

Table 4 - Possible transporting agents for the identified seeds in Excavation 3A at Border Cave

Species	Present	Local	Man			Animal	
			Food	Med. and Mag.	Other	Baboon	Bird and Bat
Diospyros dichrophylla	x	x	x		x	x	x
Pappea capensis	x		x		x		
Ricinus communis. Seed	?			x			
Ricinus communis. Shell	?						
Ekebergia capensis	x			x	x		x
Commiphora harveyi	x	x			x		
Harpephyllum caffrum	x		x		x		
Teclea natalensis	x	x					x
Commiphora woodii	x	x					x
Erythroxylum emarginatum	x	x					
Ziziphus mucronata	x		x	x	x		
Encephalartos spp.	?	?	x	x	x		
Sideroxylon inerme	x		?	x	x		x
Strychnos henningsii	x			x	x		
Boschia albitrunca	x		x	x	x		
Crotalaria natalensis	?	?					
Sclerocarya caffra	x		x	x	x	x	x
Combretum sp.	?	?					
Cladostemon kirkii	x			x			
Phyllogeiton discolor	?		x		x		x
Canthium inerme	x	x	x	x			x

Table 4 - (continued)

Species	Present	Local	Man: Food	Man: Med. and Mag.	Man: Other	Animal: Baboon	Animal: Bird and Bat
Apodytes dimidiata	x	x		x	x	x	x
Acacia nigrescens	x				x		
Vangueria infausta	x	x	x	x	x		x
Celtis africana	x		x	x	x	x	x
Euclea sp.	?	?	x	x			

Abbreviations

Present = in general area; Local = in vicinity of cave (habitats 2d and 3a); Med. and Mag. = medicine and magic; Other = firewood, etc.

Appendix 45 Report on a microscopic examination of floral vestiges from the 1WA and 2BS at Border Cave

John T. Brown

Two samples of a distinctive but unidentified fraction of the 'bedding material' at Border Cave were examined in April 1976. These were cleared in 5% KOH and a 10% solution of commercial bleach in H_2O. Items so treated were then mounted on microscopic slides in water subsequent to staining with Saffranin O.

All fragments showed signs of extensive damage of an apparently physical nature. There were no coherent cuticle or epidermal layers, and thus no remaining silica inclusions of epidermal cells. Also observed was the near complete destruction of the underlying mesophyll by filamentous fungi, presumably indicating a postmortem invasion of the fresh tissue by decay organisms.

Superficially, the stem sections with their attached leaf bases resemble grasses, in having a broad based parallel veined leaf with a sheathing base surrounding the stem. Other characteristic grass structures such as flowering culms or seeds were not noted in the inspected debris.

It is concluded that further identification of this material is impossible by conventional techniques due to extensive physical and biological tissue destruction.

Appendix 46 Micro-analytical readings on bone from Border Cave

Excavation	Stratum	Lab. no.	Material	U ppm.	N% Unwashed	N% Washed
3A	1BS.UP	BM-SA162	Macrofauna	-	1,15	0,95
"	1WA.A	BM-SA161	"	-	1,05	0,77
"	1WA.A	UCLA-1754C	"	13		0,80
"	1WA.B	BM-SA160	"	-	0,67	0,62
"	1WA.B	UCLA-1754D	"	17		0,83
"	2BS.LR.C	BM-SA159	"	-	0,91	0,85
"	2WA	BM-SA158	"	-	0,72	0,62
"	2WA	BM-SA157	"	-	0,69	0,57
"	2WA	UCLA-1754E	"	17,5		0,98
"	3BS.UP	BM-SA156	"	-	0,81	0,63
"	3BS.LR	BM-SA155	"	-	0,66	0,48
"	3WA	BM-SA154	"	-	0,28	0,24
"	3WA	BM-SA168	"	-		0,74
"	1GBS.UP	BM-SA153	"	-	0,59	0,55
"	1GBS.LR	BM-SA152	"	-	0,64	0,51
"	BACO.A	BM-SA163	"	-	0,73	0,84
3B	1RGBS.A	BM-SA148	"	-	0,14	0,00
"	1RGBS.B	BM-SA150	"	-	0,12	0,15
"	BACO.C	BM-SA149	"	-	0,14	0,00
Outside grid	1BS.UP	BM-SA166	Hominid B.C.4	-		0,93
3A	3WA	BM-SA167	Hominid B.C.5	-		0,48
2A	1GBS.UP	BM-SA151	Hominid B.C.3	-	0,42	0,44
"	1GBS.UP	UCLA-1754A	Hominid B.C.3	-		0,44
Horton's Pit	?	BM-SA164	Hominid B.C.1	-	0,22	0,28
"	?	UCLA-1754B	Hominid B.C.1	-		0,41
"	?	BM-SA165	Hominid B.C.2	-	0,23	0,29

Appendix 47 The aspartic acid racemization results on fossil bone from Border Cave *

J.L. Bada

A total of 31 bone samples from Border Cave was analysed at La Jolla between 1972 and 1975. The largely disappointing results of this investigation are as follows:

(a) Most or all of the 21 macrofaunal fragments appear to have been subjected to heating.

(b) It was not found possible to obtain a series of D/L ratios fully consistent with the stratigraphy on the basis of the seven microfaunal samples which were processed.

(c) All of the hominid fragments produced amino acid printout configurations which strongly suggest that they are reliable (unaffected by temperature distortion).

(d) The absence of a viable 'calibration' sample in the 20 Kyr. range effectively precluded the dating of these remains despite claims to the contrary (Protsch, 1975).

Full details of the reading obtained on the small mammal and human bone samples are given in Table 1. Work on a series of wood fragments from various levels at this site still remains to be carried out.

References

* Based on letters from Bada dated 1973-1976.

PROTSCH, R.R. 1975. The absolute dating of Upper Pleistocene sub-Saharan fossil hominids and their place in human evolution. Jl. human Evol. 4 : 297-322

Table 1. Aspartic acid D/L results

J. Bada

Stratum : 1BS.UP. Iron Age

LJ - AA 0,26

Uncharred microfauna from 30-38cm in Sq. T22, associated with the lower levels of the Iron Age.

LJ - AA 0,29

Uncharred microfauna from 38-46cm in Sq. T22, associated with the base of the Iron Age.

Stratum : 1BS.UP. Sterile

LJ - AA 0,71

Uncharred microfauna from 61-69cm in Sq. T22, associated with the base of the sterile horizon.

Stratum : 1BS.LR

LJ - AA 0,55

Uncharred microfauna from 69cm -1WA in Sq. R23, associated with 'Early L.S.A.'

LJ - AA 0,65

Uncharred microfauna from 69-76cm in Sq. T22, associated with 'Early L.S.A.'

Stratum : 2BS.LR.A+B

LJ - AA 0,65

Uncharred microfauna from Sq. R23, associated with 'Post-Howieson's Poort'.

Stratum : 3BS

LJ - AA 0,61

Uncharred microfauna from Sq. R23, associated with 'Epi-Pietersburg'.

Stratum : 1GBS.UP

LJ - AA 0,72

Uncharred fragments of hominid B.C.3 (infant) from Sqs. F12 and G12, associated with 'Pietersburg'.

Stratum : Unknown

LJ - AA 0,77

Uncharred fragments of hominid B.C.1 (adult cranium).

LJ - AA 0,72

Uncharred fragments of hominid B.C.2 (adult mandible 1).

Appendix 48 . Thermoluminescence dating of samples from Border Cave*

J.H. Fremlin

The application of the TL method to a non-ceramic material (flint) has been detailed elsewhere (Göksu et al., 1974). Some of the following introductory remarks may nevertheless be of some supplementary interest.

1. The data on which an age evaluation by this technique is based derives from two sources, namely:
   (a) some fine-grained or cryptocrystalline rock which has been heated (thermal fractures) in an undisturbed archaeological context to a temperature sufficiently high (>500°C) to completely drain it of all previously contained energy;
   (b) the matrix material in which that rock was enveloped, in order to determine the radioactive environment in which the sample has subsequently commenced storing energy again. Although clearly preferable, it may not be essential to have the exact sediment which surrounded it if the stratum is uniform in all characteristics.
2. The first essential that is measured is the total energy that the rock being investigated can contain, namely the saturation value, which gives the limit of the radiation which can be absorbed before it shows no change in output with increasing age.
3. Cherts are variable and tend to saturate early, but chalcedonies are amongst the best materials for TL, with some varieties having saturation values of > 200,000 rads. This enables very high dates to be established in terms of the usual environmental range of 0,3-1,0 rads per year, although accuracy would be very poor beyond about half of the saturation time.
4. All saturated samples are valueless since they either indicate that the material had never been heated at all or they mean that the rock was genuinely burnt, but so long ago that it has got saturated again since then.
5. Samples used in individual measurements - a few grams normally suffice - are cut or ground slices some 3-4mm in diameter and 0,3mm or less thick, with five such samples being usually used for a definitive measurement in order to reduce and estimate the random errors.
6. The radioactive levels in matrix samples are normally extremely low and precise determination of the relevant values requires large

samples (1kg or more) and is time-consuming (a few months).

7. The first ever application of TL to ostrich eggshell was based on samples from Border Cave. Initial measurements proved promising with some samples showing saturation values of about one million rads. Using this material, there is, in principle, no need for the sample to be burnt, but that condition has proved to be more useful as the organic fraction can be troublesome.

A total of 41 stones with thermal fractures and 14 ostrich eggshell pieces from Border Cave were analysed between 1972 and 1976 with the following results:

1. Two rhyolite samples were found to be unsatisfactory (Wintle, 1973). The 39 chalcedony samples were unpromising as a whole. A majority (~ 80%) showed no natural glow at all. Most of those which showed some natural glow seemed to be saturated in the high temperature region, which would suggest that prehistoric heating was not sufficient to drain them completely.
2. Two rock samples (3WA, Sq. R22; 3WA Sq. T18) were not very good, the main problems being:
   (a) severe inhomogeneity with respect to TL response;
   (b) spurious contribution to the natural glow;
   (c) colour change on heating, which affects signal transfer efficiency and may also be responsible for (b);
   (d) TL sensivity change with heating and large radiation dose;
   (e) fading of some parts of the glow;
   (f) no plateau in a plot of natural/artificial glow versus glow temperature, perhaps also as a result of (b).

   Both samples yielded a natural dose of 22,5Krads. The total dose rate for these samples is ~ 400 mrads/yr (cosmic ray - 15 mrads/yr assumed; 3WA matrix 384 mrads/yr). The calculated age of these samples is thus ~ 56,5 Kyrs ± 10% - a reading which must be regarded as somewhat suspect in view of the limitations listed above.
3. One chalcedony fragment (BACO.A, Sq S19) gave good responses to all measured parameters and a natural dose of 73 Krads. The total dose rate for this sample is ~ 415 mrads/yr (cosmic ray - 15 mrads/yr assumed; BACO.A(a) matrix - 400 mrads/yr). The calculated age for the specimen is thus 175 Kyrs ± 10%.
4. Over 90% of the ostrich eggshell samples tested gave a wide variety of 'regenerative' effects (probably a result of oxidation

processes) or failed to give a linear response to artificial radiation doses. In some cases anomalous glow curves gave almost no light output in the region between 250 and 350°C during heating, apparently as a result of re-heating during the recent past (o-1000 yrs), seemingly to 150-200°C for some days, or to a higher temperature for a shorter time. Two samples which showed this effect most markedly were 1WA, Sq T23 and one of the specimens from 1RGBS.A Sq. A7.

5. On the whole the burnt (dark grey) ostrich eggshell samples behaved best, but only specimens Sq. S16 229-236cm, S16 236-244cm and S17 236-244cm, all from BACO.A, gave useful results. These showed a satisfactory sensitivity to β irradiation, reasonable relative sensitivity to α particles 30% of that to β particles, and a mean dose of 76 Krads ± 7%. The total dose rate for these samples is ~ 415 mrads/yr, indicating an age of 173 Kyrs ± 10%, remarkably close to the chalcedony date deduced for this stratum in (3).

6. The major fraction of the radiation dose for all samples derives from the matrix material and if this has been underestimated the deduced ages would be comparably exaggerated. To test this possibility a further matrix sample from Sq S16 in BACO.A was submitted. This produced U, Th, and K values remarkably different from the previous matrix sample from this or any of the other sampled levels (laboratory or submitter error?) (see Table 1). Recalculated ages for the BACO.A ostrich eggshell and chalcedony samples based on this additional matrix sample would indicate ages of 430 and 440 Kyrs. respectively. It is tentatively concluded that the datings for this level are suspect as a result of severe environmental inhomogeneity.

References

* Based on letters from Fremlin dated 1972-1976.

GÖKSU, H.V., FREMLIN, J.H., IRWIN, H.T. and FRYXELL, R. 1974. Age determination of burnt flint by a thermoluminescent method. Science, 183 : 651-654.

WINTLE, A.G. 1973. Anomalous fading of thermoluminescence in mineral samples. Nature, 245 : 143-144.

Table 1. Sediment radioactivity : elements and concentrations

Stratum	Square/s	Sample mass g	Uranium ppm.	Thorium ppm.	Potassium %
1WA	R19,T19,T20	1280	2,3	7,3	2,1
2WA	S20,S22	1570	2,2	8,0	1,4
3WA	S21,T18	1660	2,7	9,5	2,5
1RGBS.A+B	OZ8,A9,B8	1750	3,0	9,0	2,3
BACO.A(a)	R16,R17	1540	2,4	9,1	2,4
BACO.A(b)	S16	?	1,3	4,5	0,75
BACO.D	C7 152-160cm D9 160-168cm	1580	2,8	10,0	1,3

Appendix 49

Radiocarbon dating of the Border Cave sequence : an evaluation of the Pretoria readings

J.C. Vogel

A total of 26 C-14 analyses were performed on samples excavated between December 1970 and December 1972. In the first instance our intention was to establish whether the Middle Stone Age sequence, and by implication the human remains recovered previously, lay beyond the range of radiocarbon dating or not. The results of the measurements are listed below:

Pta - 777 Border Cave skeleton BC4 — 340 ± 45 B.P.
A.D. 1610
δC^{13} =-9,5‰

Collagen from tibia of Iron Age skeleton from square 2S-13, buried from near present surface of stratum 1BS.UP.

Pta - 1318 Border Cave skeleton BC4 — 480 ± 45 B.P.
A.D. 1470
δC^{13} =-11,8‰

Collagen from ribs of Iron Age skeleton from square 2S-13, buried from near present surface of stratum 1BS.UP.

Comment: Both samples pretreated as for unburnt bone. Average for two measurements is 410 B.P. Estimated calendar date is A.D. 1460 according to calibration curve for S. Hemisphere (Vogel, 1971).

Stratum 1BS.UP. Iron Age

Pta - 1728 Border Cave 1 — 90 ± 105 B.P.
A.D. 1860
δC^{13} =-10,9‰

0,12g fragment of maize cob, at 8-15cm depth in square T21, associated with Iron Age.

Comment: Pretreated with acid and measured in small counter (Vogel and Behrens, 1976).

Pta - 870 Border Cave 2 — 170 ± 45 B.P.
A.D. 1780
δC^{13} =-17,6‰

Vegetation at 8-15cm depth in square T21, associated with Iron Age

Comment: Pretreated with acid.

Pta - 715 Border Cave 3 440 ± 55B.P.

A.D.1510

$\delta C^{13} = -21,6‰$

Vegetation at 30-38cm depth in square T19, ascribed to base of the Iron Age.

Comment: Pretreated with acid and alkali.

Pta - 703 Border Cave 4 500 ± 45 B.P.

A.D.1450

$\delta C^{13} = -20,3‰$

Vegetation at 7,5-15cm depth in square T22, associated with Iron Age.

Comment: Pretreated with acid and alkali.

Stratum 1BS.UP. Sterile

Pta - 506 Border Cave 5 2010 ± 50 B.P.

60 B.C.

$\delta C^{13} = -25,7‰$

Vegetation at 38-46cm depth in square S19, ascribed to top of stratum and associated with intrusive Iron Age and Early L.S.A.

Comment: Pretreated with acid.

Pta - 721 Border Cave 6 13300 ± 150 B.P.

11350 B.C.

$\delta C^{13} = -24,2‰$

Vegetation at 46-53cm depth in square S19, ascribed to base of stratum and associated with intrusive Early L.S.A. only.

Comment: Pretreated with acid and alkali.

Stratum 1BS.LR

Pta - 704 Border Cave 7 38600 ± 1500 B.P.

$\delta C^{13} = -24,3‰$

Charcoal nodules from 69cm to 1WA in square S21, associated with Early L.S.A.

Comment: Pretreated with acid and alkali.

Stratum 1WA

Pta - 446 Border Cave 8, acid only 37500 ± 1200 B.P.
$\delta C^{13} = -23,9‰$

Pta - 422 Border Cave 8, residue 36800 ± 1000 B.P.
$\delta C^{13} = -24,3‰$

Charcoal nodules from top of 1WA in square T21, associated with Early L.S.A.

Comment: One portion of sample pretreated with acid only (Pta-446), another pretreated with acid and alkali and insoluable residue measured.

Pta - 423 Border Cave 9 36100 ± 900 B.P.
$\delta C^{13} = -24,2‰$

Charcoal nodules from middle of 1WA in square T21, associated with Early L.S.A.

Comment: Was wrongly published as Pta-433 in S. Afr. J. Sci., 69, 45. Pretreated with acid and alkali.

Pta - 424 Border Cave 10 35700 ± 1100 B.P.
$\delta C^{13} = -24,2‰$

Charcoal nodules from base of 1WA in square T21, associated with Early L.S.A.

Comment: Pretreated with acid and alkali.

Pta - 1190 Border Cave 11 $45000 {}^{+2750}_{-2200}$ B.P.
$\delta C^{13} = -24,1‰$

Twigs from lower level of 1WA in square R19, associated with Early L.S.A.

Comment: Pretreated with acid and alkali.

Stratum 2BS.UP

Pta - 1274 Border Cave 12 $47200 {}^{+4200}_{-2750}$ B.P.
$\delta C^{13} = -25,7‰$

Charcoal nodules from square Q20, associated with latest M.S.A.

Pta - 1275 Border Cave 13 > 49100 B.P.
$\delta C^{13} = -24,4‰$

Charcoal nodules from square Q21, associated with latest M.S.A.

Pta - 877 Border Cave 14 $45400 \begin{smallmatrix} +\ 3000 \\ -\ 2000 \end{smallmatrix}$ B.P.

$\delta C^{13} = -25{,}0‰$

Charcoal nodules from square Q22, associated with latest M.S.A.

Pta - 1244 Border Cave 15 >48800 B.P.

$\delta C^{13} = -24{,}8‰$

Charcoal nodules from square R21, associated with latest M.S.A.

Pta - 872 Border Cave 16 >42300 B.P.

$\delta C^{13} = -25{,}3‰$

Charcoal nodules from square T23, associated with latest M.S.A.

Comment: All five samples pretreated with acid and alkali. Since oldest dates are more trustworthy. this stratum must be older than 49100 B.P.

Stratum 1RGBS.A

PTA - 489 Border Cave 17 >48700 B.P.

$\delta C^{13} = -24{,}8‰$

Charcoal nodules from square A7, associated with M.S.A., stratigraphically underlying stratum 2BS.

Comment: Pretreated with acid only.

Stratum 1RGBS.B

Pta - 421 Border Cave 18, acid only 36000 ± 1000 B.P.

$\delta C^{13} = -24{,}5‰$

Pta - 447 Border Cave 18, acid only >47500 B.P.

$\delta C^{13} = -25{,}0‰$

Pta - 459 Border Cave 18, residue >48350 B.P.

$\delta C^{13} = -24{,}6‰$

Pta - 463 Border Cave 18, extract >42600 B.P.

$\delta C^{13} = -24{,}5‰$

Charcoal nodules from square OZ7, associated with M.S.A.

Comment: First two portions of sample (Pta-421 and Pta-447) pretreated with acid only; remainder pretreated with acid and alkali and both insoluble residue (Pta-459) and alkali soluble fraction (Pta-463) measured.

Pta - 488 Border Cave 19 >48500 B.P.

$\delta C^{13} = -25,4‰$

Charcoal nodules from square A8, associated with M.S.A.

Comment: Pretreated with acid.

Pta - 719 Border Cave 20 $42000 {+3000 \atop -2000}$ B.P.

$\delta C^{13} = -24,6‰$

Charcoal fragments from 25-46cm depth in square OZ7 and OZ9.

Comments: Pretreated with acid only.

In order to arrive at dates for the different strata, all the results must be considered together, taking into account their interrelationship to each other and the intrinsic factors that can influence the individual measurements. On this basis we derive the following dates:

1. Stratum 1BS.UP. Iron Age

(a) Superficial deposit: The two dates of 90 $\pm$ 105 and 170 $\pm$ 45 B.P. (Pta - 1728 and Pta - 870) suggest that the Iron Age occupation ended some time between A.D. 1600 and A.D. 1850. It is not possible to pinpoint this termination more closely because of the fluctuations in the radiocarbon content of the atmosphere during the past few hundred years (cf. Vogel, 1971).
(b) The main portion of the stratum is dated by Pta - 715: 440 $\pm$ 55 B.P. and Pta - 703: 500 $\pm$ 45 B.P. which suggest a calibrated dating to the 15th century A.D. The skeleton BC4 found elsewhere in the cave similarly dates to A.D. 1460.

2. Stratum 1BS.UP. Sterile

The results suggest that this level contains a mixture of material from the strata above and below so that no date can be ascribed to it.

3. Stratum 1BS.LR

The single reading obtained for this level must be considered together with those for the underlying stratum from which it does not differ significantly. The level may thus be either of the same age or younger than Stratum 1WA.

4. Stratum 1WA

Four of the five dates for this level together with the reading for the overlying stratum are all the same within the statistical uncertainty of the measurements. The best estimate for the level as a whole is 37000 B.P. The fifth sample from the base of the stratum (45000 B.P.) may consist of a mixture of material from this and the underlying level.

5. Stratum 2BS.UP

All of the five samples from this level give dates older than 40000 B.P. Since the slightest contamination by younger organic matter in the sample would produce a "finite" date, the oldest reading must be considered the most reliable. We thus conclude that this stratum is OLDER THAN 49100 B.P.

6. Stratum 1RGBS.A+B

The dated samples from this level derive from Excavation 3B. In that area the base of the stratum is only about 50cm below the modern surface. This shallowness of the samples greatly increases the possibility of contamination by recent organic substances. Nevertheless, most of the measurements revealed no traces of radiocarbon and the stratum as a whole must be considerably older than 48000 B.P. Since it lies stratigraphically well below stratum 2BS.UP this must indeed be the case.

Conclusion

The dates for the stratum 2BS.UP prove beyond reasonable doubt that the whole Middle Stone Age sequence in the cave is older than 49100 B.P. The 1WA stratum which contains a hitherto unknown stone artefact assemblage is dated to about 37000 B.P. A considerable temporal break between these two levels is thus indicated. A second hiatus apparently exists in the rear of the cave between the stratum 1BS.LR and the 15th century Iron Age occupation in the 1BS.UP stratum.

References

VOGEL, J.C. 1971. Radiocarbon in Nature. S. Afr.J. Sci., 67, 32-42.

VOGEL, J.C. and BEHRENS, H. 1976. A mini counter for radiocarbon dating of small samples. S. Afr. J. Sci., 72 : 311.

Appendix 50 . Radiocarbon dating of the Border Cave sequence: a summary of the results obtained at La Jolla and Los Angeles

Stratum 1BS.UP. Iron Age

LJ - 2889 — 500 ± 70 B.P.
A.D. 1450

Vegetation at 30-38cm depth in square T22, associated with Iron Age.

LJ - 2890 — 590 ± 70 B.P.
A.D. 1360

Vegetation at 38-46cm depth in square T22, ascribed to base of the Iron Age.

Stratum 1BS.UP Sterile

LJ - 2891 — 650 ± 70 B.P.
A.D. 1300

Vegetation at 46-53cm depth in square T22, ascribed to top of stratum.

LJ - ? — 28500 ± 1800 B.P.

Charcoal nodules at 61-69cm depth in square T22, ascribed to base of stratum.

Stratum 1BS.LR

LJ - 2892 — 33,000 ± 2000 B.P.

Charcoal nodules at 69-76cm depth in square T22, ascribed to top of stratum and associated with 'Early L.S.A.'

Stratum 1WA

UCLA - 1754C — 32,400 ± 2500 B.P.

Uncharred bone collagen from top of 1WA in square Q19, associated with 'Early L.S.A.'

UCLA - 1754D — 34,800 ± 2500 B.P.

Uncharred bone collagen from base of 1WA in square Q19 and R19 associated with 'Early L.S.A.'

Stratum 2BS.UP

LJ - ? > 41,000 B.P.

Charcoal nodules from square Q23, associated with latest M.S.A.

Stratum 2WA

UCLA - 1754E > 45,000 B.P.

Uncharred bone collagen from squares R20 and S22, associated with latest M.S.A.

References

BADA, J.L. 1973-5. Pers. comms. re LJ readings.

PROTSCH, R.R. 1973. The dating of Upper Pleistocene Subsaharan fossil hominids and their place in human evolution: with morphological and archaeological implications. PhD dissertation. Univ. of California, Los Angeles.

PROTSCH, R.R. 1975. The absolute dating of Upper Pleistocene sub-Saharan fossil hominids and their place in human evolution. Jl. human Evol., 4 : 297-322.

Appendix 51 . The C_4 syndrome : some possible archaeological applications based on macrofaunal remains

1. It is known that certain plants have evolved an enhanced photosynthetic capacity by means of various related structural and functional modifications known as the Hatch-Slack/Kranz/C_4 syndrome. Some salient details are (Ellis, 1974; Vogel, 1976):
   (a) that the C_4 condition has been identified in about 10 families, preponderantly amongst the grasses, but also including various herbs and sub-shrubs.
   (b) That it very probably represents an evolutionary adaptation to climatic conditions typified by high temperatures and limited water during the period of active growth.
   (c) That most, if not all, C_4 species are, as a result, tropical (s.l.) in their distribution.
   (d) That the $^{13}C/^{12}C$ ratios of the 'anomalous' C_4 and 'normal' C_3 plants differ markedly and do not overlap, being about $-12\pm3‰$ and $-25\pm3‰$ respectively.
2. In terms of the above data it becomes possible to propose the following hypothesis:
   (a) that any particular tropical or temperate region may be conceived of as showing a variable (0-100%) mix of C_3 and C_4 species, depending on local variations in temperature and precipitation.
   (b) That the $^{13}C/^{12}C$ ratio derived from the bones of any reasonably long-lived adult ungulate of a given species which is largely or entirely a grazer will tend to approximate to a random sample of the C_3 or C_4 grass mix which prevailed within its lifespan and preferred habitat-range.
   (c) That mean or winter temperatures some $9^{o}C$ below present values at various times during the Pleistocene of sub-Saharan Africa (see Butzer, 1973 ; Talma *et al.*,1974) probably had a perceptible effect on the C_3/C_4 grass mix within some areas, and thus on the bone $^{13}C/^{12}C$ ratios of grazer species occupying these.
   (d) That the prehistoric archaeological manifestations of this syndrome are best investigated in marginal regions covered by savanna mosaics either at present or at times in the past when temperatures were in excess of modern values (e.g. Holocene Optimum).

3. If data confirm the feasibility of deducing the C_3/C_4 grass mix in a given area and time in terms of 2(c) then:
   (a) It may be possible to calculate the relative proportions of shrubs and trees (all C_3) to grasses then, by reference to $^{13}C/^{12}C$ readings on adult bones of a species which may be either a grazer or a browser, depending on local availability, such as the impala or springbuck.
   (b) It may be possible to make meaningful these <u>relative</u> proportions of C_4 to C_3 grasses and of shrubs and trees to grasses then, by reference to $^{13}C/^{12}C$ readings on grazers and grazer-browsers culled from a variety of present-day environmental settings for which temperature and rainfall parameters are known.
   (c) It may be possible to use 2(b) and 3(a) to broadly define the food preferences of a given extinct taxon and to assess with which other forms it had been in direct competition for some particular ecological niche, in cases where the minimum numbers of individuals counts show an inverse correlation between it and more than one other species.
   (d) It may be possible to use the $^{13}C/^{12}C$ ratio of an adult broad-spectrum scavenger and predator such a a hyaena to obtain an approximate mean value for the total ungulate fauna then extant.
   (e) It may be possible in some cases to make deductions as to early man's diet by way of a comparison of the mean $^{13}C/^{12}C$ values for contemporaneous hyaena and hominid specimens.
   (f) It may be possible to obtain a very approximate idea of the relative proportions of grazer and browser biomass then, even when the bones found are so damaged by chemical and/or physical processes as to make specific identifications very difficult.This could conceivably be done by way of $^{13}C/^{12}C$ readings on random samples of associated bovid limb-bone pieces and would depend on the assumption that hunting and bone retrieval was not too biased and that the relative mass of individual bone pieces tend, irrespective of the factors which case the fragmentation, to correlate broadly with shaft wall thickness and thus to shaft diameter and animal size. Despite the many uncertainties and approximations involved, it is noteworthy that $^{13}C/^{12}C$ readings based on possibly far from ideal random bone samples submitted

for C-14 dating, have produced not only roughly conformable results in samples from the same stratum but also readings in fair accord with known grazer-browser shifts with time in fossil faunas identified by conventional taxonomic means (Table 1; based on Beaumont and Vogel, 1972).

4. The following drawbacks pertain to this potentially important new technique for reconstructing past environmental changes and faunal interactions in the archaeological record:
   (a) It involves the destruction of possibly important taxonomic reference material.
   (b) Being only reliably based on the alkali-soluble fraction, it is dependent on the extent to which collagen is preserved which will probably largely limit its use in Africa to aggregates post-dating the Middle Pleistocene.

References

BEAUMONT, P.B. and VOGEL, J.C. 1972. On a new radiocarbon chronology for Africa south of the equator. Afr. Stud., 31 : 65-89 and 155-182.

BUTZER, K.W. 1973. Geology of Nelson Bay Cave, Robberg, South Africa. S. Afr. archaeol. Bull., 28 : 97-110.

TALMA, A.S., VOGEL, J.C. and PARTRIDGE, T.C. 1974. Isotopic contents of some Transvaal speleothems and their palaeoclimatic significance. S. Afr. J. Sci., 70 : 135-140.

ELLIS, R.P. 1974. The significance of the occurrence of both Kranz and non-Kranz leaf anatomy in the grass species *Alloteropsis semialata*. S. Afr. J. Sci., 70 : 169-173.

VOGEL, J.C. 1976. Isotopes and ungulates. Nuclear Active No. 15, 14-19.

Table 1

GrN - 5679 Redcliff Cave $41,800^{+5000}_{-3000}$ B.P.

Charred bone from Layer W in Section VI, 4,55m below datum in Profile B, near top of the Bambata (Stillbay) succession.

$\delta^{13}C$ = -12,7‰. Pretreated as for charred bone and alkali-soluble fraction dated.

GrN - 5858 Redcliff Cave $40,870^{+2300}_{-1800}$ B.P.

Charred bone from Layer W in Section VI, 4,55m below datum in Profile B, near top of the Bambata (Stillbay) succession.

$\delta^{13}C$ =-14,2‰. Pretreated as for charred bone and alkali-soluble fraction dated.

Pta-112 Heuningsneskrans Shelter 7,200 ± 70 B.P.

Charred bone from Stratum 1, at 45-68cm depth in Sq. A8, associated with 'Early L.S.A.'

$\delta^{13}C$ = -18,6‰. Pretreated as for charred bone and alkali-soluble fraction dated.

Pta - 114 Heuningsneskrans Shelter 10,430 ± 150 B.P.

Charred bone from Stratum 3, at 143-165cm depth in Sq. A9, associated with 'Early L.S.A.'

$\delta^{13}C$ = -15,9‰. Pretreated as for charred bone and alkali-soluble fraction dated.

Pta - 101 Heuningsneskrans Shelter 24,630 ± 300 B.P.

Charred bone from Stratum 3, at 435cm depth in Sq. A12, associated with 'Early L.S.A.'

$\delta^{13}C$ = -14,5‰. Pretreated as for charred bone and alkali-soluble fraction dated.

Appendix 52 . Chemical analyses of salt samples from Border Cave.*

W.S. Rapson

Two salt samples were submitted for analysis to the Research Organization of the Chamber of Mines of South Africa by A.K. Boshier in 1972. Precise descriptions and provenances are:

(a) Amorphous salt and sand from base of stratum 2WA in Square S16

(b) Crystalline salt and sand from base of stratum 2WA in Square R18.

Method

Both samples were boiled with 200ml of water for one hour and then filtered and the filtrates made up to 200ml. Residues were boiled with a further 200ml and the procedure repeated three more times. Sodium was determined by atomic absorption and magnesium and calcium by E.D.T.A. filtrations. Results are listed in Table 1.

Comments

A conclusive demonstration that the salts were of marine origin would require a much wider range of analysis covering the other kations and anions in these samples and in seawater. Interpretation even then is likely to be hindered by the contamination of any marine salts which may have found their way into the cave with water soluble salts from organic debris in the deposit or even 'pan salt' possibly brought in by the inhabitants for cooking and related purposes. An important possibility is that there could be a very significant contribution of salts by way of urine. The output of chlorides, calculated as NaCl, by this way alone is ~ 5-15g per person per day.

References

* Based on letter from Rapson dated April, 1973.

Table 1

Sample	Mass (g)	Anal.	Na	Ca	Mg	Anal.	Na	Ca	Mg
Sea water		ppm.	10561	400	1272	Ratios	26,40	1	3,18
Amorphous	104,33	% of	20,27	1,19	0,62	Ca as	17,03	1	0,52
Crystalline	10,95	mass	12,85	1,07	1,13	constant	12,01	1	1,06

Appendix 53. Calcite fragment incidence

Border Cave. Excavation 3A Rear and 3B

Stratum	Data squares Number	Calcite fragments Number	Stratum volume Cu. m.	Incidence Number per cu. m.
1BS.UP. Iron Age	23	29	6,55	4,4
1BS.UP. Sterile	25	17	4,40	3,9
1BS.LR.	32	57	3,36	17,0
1WA	31	65	3,28	19,8
2BS.UP	29	24	4,25	5,6
2BS.LR.A + B	25	10	4,19	2,4
2BS.LR.C	25	19	1,43	13,3
2WA	19	15	2,94	5,1
3BS	18	12	3,05	3,9
3WA	17	1	1,37	0,7
1GBS.UP	17	25	3,94	6,3
1GBS.LR	17	6	2,67	2,2
BACO.A	9	0	0,75	0,0
1RBS	9	102	1,18	86,4
1RGBS	9	97	2,15	45,1

Appendix 54 . <u>Lithostratigraphy of Border Cave, KwaZulu : A Middle Stone Age sequence beginning ca. 195,000 B.P.</u>

Karl W. Butzer.

During a visit to Border Cave by Butzer and Beaumont in August, 1973, the stratigraphic sequence was examined in terms of bedding properties, pedogenetic features such as calcification, gypsum or sodium salt horizons, and the prominence of cultural features such as organic hearths, ash horizons, or disconformities. A total of 22 sediment samples was collected from excavations 3A and 2, emphasizing the sedimentary matrix, rather than zones of intensive cultural or organic components. In addition, 3 lots of gravel, 2 external soil samples, and a variety of bedrock specimens were sampled. In April, 1974, Beaumont collected 12 further sediment samples from excavations 3A and 3B, and 2 lots of gravel. The gravel was morphometrically analyzed by Butzer in South Africa, while the sediment samples were processed by him in the Paleo-Ecology Laboratory of the University of Chicago.

<u>Laboratory Procedure</u>

Sediments were first examined macroscopically, including colour determination (by the <u>Munsell Soil Colour Charts</u>, natural dry state), structure, consolidation, stratification (in as far as still preserved), calcification or oxidation features, and organic structures. The detailed analytical work comprised several steps:

(1) Full hydrometer analyses, using a 5% solution of sodium pyrophosphate as peptizing agent. After determining the 2, 6, 20, and 36 micron fractions in this fashion, the same sample was subsequently passed through a set of standard sieves (37, 63, 210, 595 microns, 2 and 6.35mm), with water flushing.

(2) Textural categories--clay (under 2 microns), silt (2-63 microns), sand (63 microns - 2mm), and grit (2-6.35mm)-- were then determined. The clay-silt-sand fractions are shown as a separate cumulative curve in Fig. 1

and allow textural classification. The terminology of Link (1966) is followed here, except for soil and morphological designations, which are given according to Soil Taxonomy (Soil Survey Staff, 1975).

(3) Since the coarser fraction provides potential information as to the nature and prominence of mechanical weathering, the grades between 37 microns and 6.35mm were examined in detail, first by plotting selected values as a cumulative graph in Fig. 1. This was followed by drawing cumulative curves for each set of values to obtain the 5, 16, 25, 50, 75, 84 and 95 percentiles. These were processed by a mini-computer program to calculate the mean (Mz), sorting (So), skewness (Ski), and kurtosis (Kg) parameters of Folk and Ward (see Folk, 1966). Since these measures require representative samples to provide environmental information, 19 of the 37 samples were pretreated in sodium hydroxide to remove carbon, calcium phosphate, colloidal aggregates, or "fired" particles, and then sieved and weighed a second time. These parameters consequently apply to rhyolitic residues only.

(4) The sand and grit grades retrieved by sieving were scanned microscopically for lithology and micromorphology.

(5) Calcium carbonate equivalent (C.C.E.) was determined by the Chittick gasometric apparatus, in part also by mass loss in dilute hydrochloric acid. pH and electrical resistance (Eh, in millivolts) were determined electrometrically in distilled water.

(6) Five lots of gravel were analyzed morphometrically by the modified Lüttig technique (see Butzer, 1971: 166ff). Since all edges were angular, irregular, and uncorroded, no meaningful index of rounding could be devised. The results instead give two measures of flattening as well as size.

(7) Finally, a part of each sample was selected (matrix under 2mm) for determination of organic matter content, through the courtesy of the University of Wisconsin,

Department of Soils, Extension Division.

The most diagnostic categories of analytical data are incorporated into Fig. 1 and subsequently used to describe and interpret the various lithostratigraphic horizons. These units coincide with those of Beaumont (1973; Beaumont et al., n.d.), but a system of Arabic numbers is employed here, counted from the top down, to simplify reference to what are somewhat cumbersome field level designations.

In the subsequent description, unless otherwise stated, it is assumed that the units are powdery, unconsolidated, vesicular and weakly-structured, moderately stratified, and separated by abrupt (0-2cm), straight to slightly wavy contacts. With respect to Fig. 1, calcium carbonate equivalents are mainly in the order of 0.5-5%, and no comment is made on such low values. Similarly, pH's in the neutral to slightly alkaline range of 6,4-7.2, and Eh's of 0 to -25 warrant no further comment. Modal values of organic matter in 'background' sediments (as opposed to hearths and other lenticular concentrations) are between 2.5 and 6.5%; only lower or higher values deserve mention.

In regard to the 37 micron to 6.35mm fraction.

(a) Mean particle size (Mz) ranges from -1.65 to +2.07φ, but generally lies between +1.0 and +1.5φ; when the mean is less than +1.0, the sands will be labelled "coarse", above 1.5, "fine".

(b) Sorting is poor (So 1.0-2.0, see Folk, 1966) to very poor (So 2.0-4.0), ranging from 1.64-2.91. Values under 1.75 will be referred to as "moderately" sorted, those above 2.25 as "very poor".

(c) Skewness (asymmetry of grain-size distribution) is relatively subdued, with the occasional fine-tailed sediments beyond Ski -0.2 and coarse-tailed ones above +0.2 referred to here as "negatively" or "positively" skewed, respectively.

(d) Kurtosis (peakedness of grain-size distribution) is near normal; values above 1.2 will be referred to as "leptokurtic", i.e., with coarser and/or finer tails, those below 0.85 as "platykurtic", i.e., bimodal.

Description of the Strata

The successive units can be described from top to bottom: (1a) 30-45cm ("First Brown Sand, Upper"). Dark brown, organic silty coarse sand, with rare roof spall, some hearths and well-preserved vegetable fiber. (Iron Age; ^{14}C dates of 340, 440, 500, 590 and 650 B.P.; Beaumont and Vogel, 1972, and Beaumont et al., n.d.). Lower boundary diffuse and poorly defined, probably irregular due to cultural disturbance, e.g. storage pits; some sharp disconformities preserved locally (Beaumont, n.d.).

(1b) 20-25cm Yellowish brown, silty coarse sand, negatively skewed and leptokurtic, with considerable roof spall (larger than 6.4mm fraction comprises 15-25% of total weight at back of cave); relatively low in organic matter but with some colloidal aggregates present. (Archeologically sterile; ^{14}C dates of 2,010, 13,300 and 28,500 bp, the first possibly based on mixed charcoal fragments; Beaumont and Vogel, 1972, and Beaumont et al., n.d.).

(2) 15-20cm ("First Brown Sand, Lower"). Dark brown, silty coarse sand, very poorly sorted, negatively skewed; gritty, and with abundant roof spalls near base, grading laterally into the upper part of an angular spall horizon with limited fine matrix (Eboulis horizon I). Generally low in organic matter, except in thin but prominent hearth zones, which consist of clayey silt-sand (fine). (Early LSA; 2 ^{14}C dates of 33,000 and 38,600 bp, Beaumont and Vogel, 1972, and Beaumont et al., n.d.).

(3) 12-20cm ("First White Ash"). Dark brown, silty fine sand, grading laterally in the lower part of Eboulis Horizon I. Numerous thin black, highly organic hearths, and lenticles of light gray to brownish gray, silty calcareous ash, rich in calcium phosphate bone fragments, and fire-oxidized aggregates. (Early LSA; 3 ^{14}C dates ranging from 35,700-36,800 bp. (Beaumont and Vogel, 1972, and Beaumont et al., n.d.), indicating that units 2 and 3 are close in age.).

(4) 12-18cm ("Second Brown Sand, Upper"). Dark brown, silty sand. (Late MSA; 5 ^{14}C dates ranging from 45,400 to

"greater than" 49,100 bp. (Beaumont and Vogel, 1972, and Beaumont <u>et al</u>., n.d.), indicating a hiatus of at least 15,000 years between units 3 and 4.

(5a) <u>7-8cm</u> ("Second Brown Sand, Lower A"). Dark brown, silty sand. (Late MSA).

(5b) <u>7-10cm</u> ("Second Brown Sand, Lower B"). Dark brown to brown, silty fine sand, rich in fire-oxidized organic aggregates, grades laterally into Eboulis Horizon II. Some diffuse hearths (Late MSA).

(5c) <u>7cm</u> ("Second Brown Sand, Lower C"). Dark brown to brown silt to sand silt, highly organic, with minor spall. Some minor hearths. (Late MSA).

(6) <u>15-23cm</u> ("Second White Ash"). Dark brown, silty fine sand, slightly compact, moderately sorted and leptokurtic; interbedded with a complex of prominent black hearths, light gray, calcareous ash lenses, and reddish brown (5YR 5/4) "fired" horizons, rich in charred vegetable matter. Small lenticles of mesocrystalline sodium salts (see Beaumont, 1973, Table 1, for analyses) are present near and below the base of this horizon complex. (Late MSA).

(7a) <u>15cm</u> ("Third Brown Sand, Upper"). Yellowish brown, silty fine sand, moderately sorted, will stratified to laminated, slightly compact, and low in organic matter. ("Epi-Pietersburg" or "Howieson's Poort").

(7b) <u>10-12cm</u> ("Third Brown Sand, Lower"). Dark brown, silty sand, slightly compact; some thin, black hearths and dark ashy lenses but otherwise low in organic matter; moderate roof spall, but base grades laterally into top of Eboulis Horizon III ("Rubbly Gray Brown Sand, Upper"). ("Epi-Pietersburg" or Howieson's Poort").

(8) <u>15-20cm</u> ("Third White Ash"). Complex of reddish brown to yellow, sandy to fine sandly silt, rich in fire-oxidized aggregates, in part very poorly sorted or negatively skewed; light gray to grayish brown ash with a texture of gritty, coarse sandy silt, very poorly sorted and platykurtic; some black, organic hearths. Zones of roof spall, a local rock fall at the contact of beds 7b and 8, and grading

laterally into the base of Eboulis Horizon III ("Rubbly Gray Brown Sand, Lower"). Voids among the rock fall blocks show white (10 YR 8/2), mesocrystalline sodium salts. ("Epi-Pietersburg" or "Howieson's Poort").

(9) 17-35cm ("First Gray-Brown Sand, Upper"). Dark brown to grayish brown, silty sand, finely laminated towards top, slightly compact; dispersed spall in cave centre (Excavation 3A), grading into a spall-grit-soil horizon (Eboulis Horizon IV) with a calcareous, clayey-silt sand matrix, rich in fire-oxidized aggregates and very poorly sorted, laterally (Excavation 3B). (Early MSA).

(10a) 0-20cm ("First Gray-Brown Sand, Lower "). Dark brown, silty sand, highly organic, slightly compact. Some thin hearths. (Early MSA).

(10b) 25cm ("BACO A"). Brown to dark brown, silty sand or clayey-sand silt with some roof spall and slightly compact, in cave centre (Excavation 3A), grading into a grit-and-spall horizon (lower Eboulis Horizon IV) with a matrix of silty coarse sand, very poorly sorted and positively skewed, near the cave's north end (Excavation 3B); variable development of hearths. (Early MSA).

(11) 5-30cm ("Fourth White Ash,"). Lense of light grayish brown, highly organic silt that comprises abundant ash, forming a conspicuous marker over a feathering hearth complex (developed in Excavation 2) consisting mainly of very dark grayish brown, gritty, silty coarse sand with some roof spall. Rests on bedrock in Excavation 3A, where there are local (square S17) lenticles 3-8 mm thick of vertically precipatated, macro-crystalline gypsum within the ash or on rock. (Early MSA).

(12) 15cm ("BACO B", Upper). Brown, gritty, silty coarse sand with moderate spall concentration, very poorly sorted and positively skewed; acidic (pH 5.3) and high Eh (+25). Packed with artifacts. This and lower units restricted to Excavations 2/3B. (Early MSA).

(13) 15-18cm ("BACO B", Lower). Pink, clayey-silt sand (fine), a moderate concentration of spall, negatively skewed;

coarse angular blocky structure; compact, due to extensive impregnation with meso-to-cryptocrystalline gypsum; low in organic matter; acidic (pH 5.0) and high Eh (+55). (Early MSA).

(14) 25cm ("BACO C"). Dark brown, clayey-sand silt, negatively skewed; slightly compact; acidic (pH 4.9) and high Eh (+45). Minor hearths, extensive evidence of "firing". (Early MSA).

(15) 25cm ("BACO D"). Dark brown, clayey-sand silt to sandy-clay silt, very poorly sorted; slightly compact with crumb structure; locally calcareous due to abundant corroded, bone debris, yet acidic in general (pH 4.8) and high Eh (+35). (Early MSA).

This lower sequence rests on chemically weathered, salt-veneered, slightly cavernous, friable, light yellowish brown, rhyolitic bedrock with fine, yellowish (2.5Y) and reddish yellow (5YR) mottles. Intact bedrock is weak red ("violet)(10R) and indurated.

The brown surface soils, developed on similar bedrock above the cave roof, are qualitatively similar to the basal stratum of Border Cave (Fig. 1): a highly organic, stony, sand-silt clay (or loam) very poorly sorted and with micro-crumb structure. However, the surface soils are neutral rather than acidic. Horizonation is poorly developed, in part because organic O-horizons have been eroded to produce "black form" colluvial soils in concavities. One such black soil was sampled. It is a moderately sorted, silty-sand clay (or clay loam), negatively skewed, and with over 13% organic matter.

Analytical Interpretation of the Strata

The Border Cave depositional sequence, as described above, is highly informative in terms of sedimentology. The inclination of the cave floor and the setting within a steep cliff face precludes natural introduction of mineral sediment from the outside, either by wind or water through the entrance, or by infiltration through roof or wall fissures. Access has always been so difficult that importation of mineral sediment by man or animal has also been limited, if not minimal, with the exception of lithic artifacts and associated debitage (components that were systematically excluded from the above statistics). Nonetheless, organic agents have significantly modified the sequence by introducing plant and animal matter, and through fire, by volatilizing carbon, breaking down bone, creating aggregates (fire-oxidized grains and ash), and comminuting mineral grains from sand to silt size. Although secondary aggregates were eliminated from the analyses by sodium hydroxide application, organic-mineral colloids do contribute to the clay fraction in several levels.

Environmental interpretation of the sedimentological data consequently requires prior discussion of the several components to the cave fill.

Cultural Components. The biological factor in Border Cave is essentially cultural. Other tangible contributions are limited to variable quantities of minute, fragmentary rodent bone; since rodent burrows are nowhere in evidence in the standing sections, occasional owl roosting within the cave appears to be indicated (see Beaumont, 1973). Cultural modification is apparent in many ways:

(i) Basic fine sediment color in unit 1B is yellowish brown (10YR 5/4); that of weathered bedrock, light yellowish brown (10YR 6/4). Diffuse organic matter has discolored the strata (other than hearths or ash lenses) to an average dark brown (8.98 YR 4.35/2.78) color. This is corroborated by a mean organic matter content of 4.05% for these same strata. Organic matter ranges from diffuse humic acids to charcoal and plant-fibre, but pollen appears to be rare (Beaumont, 1973). Rodent micro-bone concentrations are greatest in those levels with yellowish brown colour and less than 3% organic matter, i.e. units 1b and 7a (see Beaumont, 1973).

(ii) Concentrated, lenticular hearths, of very dark gray or black colour, are prominent in about half of the strata. These and other discolorations serve to highlight the stratification details of the cave, showing that occupation accelerated sedimentation rates (probably through reworking of superficial sediment into lenticular cultural deposits) and created disconformities (by mobilizing or deliberately removing existing sediment). It is probable that no natural, erosional breaks exist in Border Cave.

(iii) Reddish, fired horizons, rich in oxidized aggregates ("microbrick"), are conspicuous in unit 8, and in a more subdued way, contribute to levels 3, 5b, 6, 9 and 14. Such features suggest more intensive or persistent fires, with more complete volatilization of carbon than in the black hearths.

(iv) The light gray, ashy lenses range from non-calcareous, reduced mineral ash to calcareous, phosphate-rich "bone-meal" with fragmentary, brittle and porous bone, all with some admixture of diffuse organic matter. It is probable that most of these horizons, best developed in units 3, 6, 8 and 11, are distinguished by a variable degree of bone ash. Generally, bone fragmentation is extreme, due not only to damage during initial food processing, but above all to post-depositional trampling and fire. Of some 139,000 bone fragments from Excavation 3A (Beaumont _et al_., n.d.), Klein (1977b) identified only 313 individuals of various mammals (other than rodents).

(v) Fig. 1 shows a close correlation between clay-sized particles and organic matter in Excavation 3A. It is probable that, in this totally dry sector of the cave, there never has been measurable, authigenic clay mineral formation. However in Excavations 2 and 3B, clay and organic matter trends are inverse, and clays are substantially more prominent, inferring clay-mineral formation and the presence of genuine clay-humus compounds (not just organic colloids) in units 9 and 12-15.

(vi) Several silt peaks of Fig. 1 coincise noticeably with intensively disturbed cultural strata, particularly in units 3, 8 and 11. The 10-40 micron fraction is most affected. Microscopic examination of the sands of these levels reveals them to be porous, brittle, and mottled (pale brown to light gray), presumably due in part to intensive heating.

Consequently the sand-silt ratio in Excavation 3A has little non-cultural significance.

(vii) The pH and Eh fluctuations of Fig 1 show little relationship with cultural phenomena but the minor details above unit 12 can be linked to concentrations of sodium salts and calcium phosphate.

(viii) The lithic artifacts of the various level vary in terms of their relative mass with respect to sediment matrix, and in terms of the ratio of tools to debitage. Micro-debitage was common in the samples from units 3, 4, 9, 11 and 13; tools are most plentiful in units 5c, 6, 7b, and in 10 and below (Beaumont et al ., n.d.). The basic raw material is rhyolite, with some artifacts in chert, chalcedony and quartz, obtained from generally rare amygdales weathered out of the middle units of the Lebombo rhyolites, with rare quartzite from the Ngwavuma River (Cooke et al., 1945; Beaumont, 1973). A few bone and wooden tools are present in the Late MSA levels, ostrich egg shell beads in the Early LSA, and potsherds in the Iron Age deposits (Beaumont et al., n.d.).

Rubble Components. The most interesting sediment variations in Border Cave are expressed by the grit (0.6-2.0mm), fine gravel (2-6.4mm), and medium-to-coarse gravel (above 6.4mm). The first two measures are shown in Fig. 1, while the third, as determined from profile examination and semi-quantitative approximations, is recorded by the generalized profile. Selected morphometric rubble analyses (of fragments longer than 1.5cm) are presented in Table 1.

The northeastern corner of the cave has 3 distinct rubble horizons that have minimal fine matrix. They rest on bedrock and are laterally interdigitated with Excavation 3A as shown in the generalised profile of Fig. 1. In this sector, these masses of crude debris lack evidence of chemical weathering, free salts are absent, and the sedimentary strata show that fires were rarely built here. Insolational heating or selective, local pressure unloading also cannot be invoked to explain the concentration of spall production in this part of the cave. Since the spall here and in each of the excavation areas consists of the same banded to porphyritic rhyolite, lithological variation is also not involved. Equally significant is that both this section of the cave and the excavation areas have discrete horizons with spall concentration that are separated by finer beds or sedimentary breaks; additionally, the morphometric statistics show systematic vertical variation in spall size. These facts show that spall production was neither continuous nor catastrophic, and reflected long-term periodicities of an environmental nature. The only reasonable explanation is frost-weathering (for a detailed discussion of mechanical and frost-weathering relevant to spall production within a South African quartzite cave, see Butzer, 1973a). This process should be favoured by the more restricted air circulation, slower thaw rates, and increased atmospheric moisture to be expected in the most shallow, interior parts of the cave. The statistics of Table 1 confirm the visual impression that these three rubble units become increasingly and consistently finer in grade and less flattened in shape from base to top. The units can be identified as typical _éboulis secs_ (see Butzer, 1971:208-09), and are here labelled as éboulis horizons". Less typical rubble is found within the excavation areas, amid sandy to silty matrices. In the case of Eboulis Horizon II in Excavation 3B, this rubble was notably less flat and smaller in size, presumably reflecting lateral, micro-environmental differentiation. A lower rubble zone in units 9 and 10 of Excavation 3B is identified as Eboulis Horizon IV, despite its abundant matrix; flattening and size are similar to those of the true _éboulis secs_, but the rock plates are narrower here, possibly reflecting local differences of rock joint spacing; the low standard deviation of spall size (Table 1) may imply stronger jointing due to roof rock dilation near the entrance.

Crude rubble is also relatively abundant in units 1b and 12, but was not systematically collected; semi-quantitative appraisal suggests comparability with that of Eboulis II in Excavation 3A.

It is reasonable to assume that large, flat, and plentiful rubble indicates those episodes of most effective frost-weathering. On these criteria the episodes can be rated as follows: III (most effective), I, II and IV (moderately effective), and units 1b and 12 (least effective). In a very dry cave such as Border Cave, this would not reflect on cold as much as on an opportune combination of freeze-thaw intensity and abundance of interstitial rock moisture. In fact, the variation evident was probably influenced as much by available moisture as by intensity of cold.

But such significant frost-weathering does require substantially colder temperatures. A record minimum of +2°C, probable for Border Cave today, is quite inadequate to generate frost. The site is not liable to temperature inversions and has westward insolation exposure. Effective frost-weathering could not be expected without bringing the mean daily minimum temperature of the coldest month below the freezing point. This would require a mid-winter temperature depression of a least 8°C, judging by the Nsoko and other Lowveld station data (Climate of South Africa, 1954). This is a conservative estimate that is of the same order as has been suggested for Nelson Bay Cave (Plettenberg Bay) (Butzer, 1973a, 1973b). However, this does not by any means imply a mean annual temperature depression of 8°C. As a result of increased continentality, stations in the Drakensberg foothills at 800m elevation and with a similar mean temperature do experience frost. The Pleistocene glacials increased continentality (Butzer, 1976), and a greater frequency of cold winter weather patterns, possibly accompanied by a seasonal weakening of the warm (easterly) Mozambique Current, may be adequate to produce frost-weathering in Border Cave. Annual temperatures certainly were lower, but their deviation cannot be estimated from the available criteria.

The grit statistics complement the crude rubble data, although more in relative than absolute terms. Grit production is clearly accelerated in the front and very back of the cave, as represented in Fig. 1 by the parameters for units 1a/1b (from Excavation 3A, rear) and 9-15 (Excavation 2/3B). To be roughly comparable, grit percentages for those segments of the column would need to be reduced by some 50%. This infers below-average grit production in units 1a, 3-4, 6-7a, and 13-15. Combined with the crude rubble data, the implication is that units 1, 4, 5c-7a, and 14-15 accumulated under conditions similar to those in Iron Age times, i.e. warm; units 1b, 2 (lower)-3 (upper), 5b-5c and 7b-12 were related to a particularly cold climate; and the remaining beds suggest intermediate conditions.

Fine Components and Pedogenetic Phenomena. The physical residues smaller that 2mm appear, at first sight, to vary almost erratically in Fig. 1. Yet closer analysis of the detailed patterning provides critical evidence of weathering trends, occupation intensity, and sedimentological discontinuities, that may record depositional breaks. Together with the basic geochemical data, the matrix information is essential to a reconstruction of the sedimentary history of Border Cave.

The sand fraction consists of physically comminuted rhyolite, with some released feldspar and quart crystals in the finer fraction, as well as organic and other cultural admixture. All are angualr, except in lenticles of intensive occupation residues, where the sands prove to be more brittle, edge-rounded, porous, and corroded. There is no evidence of subrounded to rounded quartz grains of potential eolian origin, although exotic micro-debitage is found in some levels.

The clays of levels 9 and 12-15 are significant. They attest to chemical weathering (hydration and hydrolysis) in Excavations 2 and 3B.

The lower, clayey beds--coincident with low pH and high Eh--indicate a protracted period of hydrolytic weathering, following deposition of unit 12 and preceding that of 11.

The analytical data argue that units 12-15 represent that rare species, a true cave paleosol, i.e. older deposits significantly altered during a sedimentary break. The external climate had to be substantially moister. At distances of 8-14m inside of the dripline, and with an adverse 15° bedrock floor inclination, cave soil moisture was probably derived from rain splash, capillary seepage, and condensation.

The weathered bedrock below Excavation 2 may date to this same phase of soil formation, but with at least equal probability reflects an earlier period of chemical decomposition, prior to deposition of the earliest preserved sediments. Removal of earlier fills poses a problem, since no erosional agents are in evidence today. Yet the bulk of the original cave materials have long been removed. It is probable that chemical weathering ultimately reduced both the size of the components and the bulk of such older sediment. Early human occupants may also have been instrumental in clearing out much of the older fill.

Unit 9 suggests a lesser degree of post-depositional weathering, that may have begun during accumulation of the upper, laminated beds found near the center of the cave. Laminations in such a non-erosional setting can be attributed to repeated, possibly periodic variations in weathering intensity. The finer nature of these terminal beds suggests decelerating accumulation rates. The overlying unit 8 is sedimentologically distinct. This fact and the eboulis argue for a sudden resumption of deposition at a later time, following a hiatus. In other words, an interval of weak-pedogenesis separates units 8 and 9. The 10-15cm thick, secondary gypsum horizon that extends from Excavation 3A (in unit 11, 1 on bedrock) across to 3B (in unit 13) presumably represents a pedogenetic cs-horizon related to partial leaching and soil development. These features imply a minor period of some cave moisture in a cave that today is powdery, dusty and water-repellant, both in terms of accumulating surface sediment and samples removed from any part of the depositional column.

Unit 7a is laminated as well as sorted. However, it was not necessarily followed by a depositional break, since the overlying stratum 8 is sedimentologically identical, except for the cultural components--introduced when the first Late MSA group in Border Cave replaced roosting owls as occupants.

Two sedimentation breaks are indicated by the radiometric evidence, namely between 1b and 2, and between 3 and 4. These are reasonable in terms of the sediment data, but there is no evidence of interdepositional weathering.

Finally, the sedimentology indicates sharp discontinuities between levels 4 and 5a, 5c and 6, and 12 and 13. These almost certainly indicate depositional breaks, confirming macroscopic evaluation.

Calcium carbonate equivalents are generally under 5%, with a few local peaks in units 3, 6, 9, 11, and 15. Any calcite present is not dispersed in the sediment mass but is aggregated in the form of soft, silt or sand-sized concretions. When C.C.E. is less than 5%, bulk sediments do not disassociate in acid nor do they show visible effervescence. This confirms the microscopic impression of organic carbonates, little mobilized by soil moisture. C.C.E. need show no relationship to pH, suggesting that variation reflects on the original occupational residues rather than post-depositional geochemistry.

Beaumont (1973) notes traces of diffuse sodium salt in most levels of Excavation 3A. In addition crystalline salts are evident near and below the base of unit 6 and in the upper part of 8. These salt concentrations are subhorizontal, parallel to the occupation levels. Since sodium salts are hygrophytic and highly mobile, even in a hyperarid soil environment, they would be more readily transferred by capillary processes than gypsum or calcium carbonate. Presumably condensation moisture or urine would, at times, be adequate to this task. The relationship of these sodium horizons to two intensive occupation complexes strongly favours the urinary hypothesis. Beaumont (1973) suggests that these sodium salts are due to evaporation from sea mists and, indeed, such mists do penetrate the Lowveld, particularly during summer. This explanation finds some support in whitish evaporites locally adhering to the cave roof, near the entrance. However, sodium salts were also observed coating weathered rhyolite at the base of the sediment column, so that breakdown of the dominantly sodic plagioclase feldspars is at least equally possible.

Altogether the sedimentological information serves not only to identify grit-and-rubble horizons but suggests the presence of 8 depositional breaks within the preserved cave fill. Two of these disconformities were accompanied by soil formation. Since deposition of unit 8, the cave soil environment has remained hyperarid, even though a high degree of atmospheric humidity was prerequisite to the frost-weather discussed previously.

Climato-Stratigraphic Interpretation. Assembling the various categories of analytical and interpretative information discussed above, the sedimentary data, facies, external climates, radiocarbon dates, and prehistoric occupations inferred for the Border Cave sequence are summarized in Tables 2 and 3.

The available radiocarbon framework can be utilized to extrapolate an approximate age for the sedimentary column, assuming that the spacing and duration of depositional breaks remained broadly comparable. Utilizing the representative average unit thickness of Table 2, levels 1-3 and the first 3 breaks spanned at least 49,000 years at a theoretical mean rate of 1.84cm per 1000 years. Allowing for a negligible compaction, this suggests a time span of about 186,000 years for 342.5cm of cumulative sediment thickness plus an earlier hiatus with bedrock weathering. This should be seen as a minimum figure since compaction is evident below level 6, and particularly below 11. Using a figure of 1.84/1000 for levels 1-6, 1.66/1000 for 7-11 (10% compaction), and 1.38/1000 for 12-15 (25% compaction), the basal extrapolation increases to 208,000 years. The true age probably lies somewhere between these two estimates, the basic results of which have been applied to Table 3.

The Border Cave sequence provides a striking climato-stratigraphic sequence of cold and warm intervals, that are reasonably well dated, and that can be readily compared with the detailed succession of dramatic environmental changes documented in the loess and paleosol record of eastern Central Europe (see Kukla, 1975). There is, then, no reasonable objection to the amplitude or wave length of climatic changes inferred for Border Cave. However, direct stratigraphic correlations are best made with a global, marine record rather than with a regional, continental sequence. The deep-sea zonation of oxygen-isotopic deviations is well suited for this purpose, following the basic chronostratigraphy of Shackleton (1975; Shackleton and Opdyke. 1976), as amplified by the dated glacial-eustatic sea-level curve (Broecker et al., 1968; Bloom et al., 1974; Butzer, 1975). Another potential hemispheric reference is provided by the Greenland and Devon Island ice-core oxygen-isotopic record (see Paterson, Koerner, et al., 1977).

Allowing for minor phase shifts and dating inconsistencies, the Border Cave cold episodes of cycles G and H ca. 37,000-13,000 bp record full glacial conditions of the late Last Glacial, i.e. isotope stage 2 and terminal parts of 3; the minor episode of temperate climatic centered ca. 32,000 bp suggests an interstadial oscillation. The temperate to warm interval between mid-cycle E and the base of G coincides with the temperate, mid-Last Glacial, i.e. the central segment of isotope stage 3. The cold spasm in cycle E represents isotope stage 4 and the full-scale onset of the Last Glacial, variously dated at 65-75,000 bp by different criteria and authors. Major frost-weathering at Border Cave, in Cycle D, correlates comfortably with isotopic stage 5b, the cold Orgnac interval of the Mediterranean Basin, which saw the replacement of forest by steppe-grassland in both southern and central Europe ca. 90-95,000 bp (see Shackleton, 1975; Butzer, 1975; Kukla, 1975).

The minor paleosol of Border Cave cycle C fits comfortably in isotopic stage 5c, and the preceding cold phase in 5d. Up to this point the radiometric and extrapolated ages at Border Cave allow ready correlation with global events. Sedimentation rates in units 9-11 probably were above average (there is no evidence for a hiatus), so producing the first age discordance, that of the cycle B paleosol and its obvious correlate, isotopic stage 5e. Detailed correlations for units 12-15 are best avoided, but a general correspondence with the Penultimate Glacial, isotope stage 6, is obvious enough. A basal date of 195,000 bp for the Border Cave sediments falls within the age range suggested by radiometric extrapolation.

The Border Cave sequence is indeed remarkable in terms of its internal resolution, internal dating, and ready external correlation. The lower units 12-15 can be assigned to the late Middle Pleistocene with considerable confidence, while units 1b-11 span the entire Upper Pleistocene. The geo-archeological implications for the Middle Stone Age are momentous.

Dating the Middle Stone Age. The unusual stratigraphic and radiometric control at Border Cave shows that, despite multiple occupations, the cavern was occupied only intermittently. Yet these discrete phases of habitation substantially modified the sediment body, which is overwhelmingly cultural in its disposition.

The variable thickness of Iron Age deposits, cutting across or into late Last Glacial beds, has bracketing radiocarbon dates of 340 ± 45 bp and 650 ± 70 bp. (Table 1; Beaumont and Vogel, 1972; Beaumont, 1973; Beaumont et al., n.d.). Calibrating the maximum 1σ range, these suggest sporadic use by ancestral Swazi herders (see Beaumont, 1973) ca. 1250-1600 A.D.

The Early LSA of cycle G is also radiometrically defined, ca. 38,000-33,000 bp, placing a non-Levallois industry, with ground-bone points, small bored stones, ostrich eggshell beads, and incised (decorated) bone and wood fragments (Beaumont and Vogel, 1972; Beaumont, 1973; Beaumont *et al*., n.d.) earlier than the Upper Paleolithic of western Europe.

Of particular interest is the unexpectedly early age of the MSA which, until a decade ago, was believed to be contemporary with the Upper Paleolithic (see Klein, 1970). Vogel and Beaumont (1972), and Beaumont and Vogel (1972) have presented a detailed case that the MSA began well before 50,000 bp and largely unpublished evidence in South Africa has since been accumulating that the MSA extends back to the beginning of the Last Interglacial. In particular, at Klasie's River Mouth the MSA "I" rests directly on and in regressional deposits from the earliest, +7m Last Interglacial beach and is associated with marine shell directly linked to isotope stage 5e (Klein, 1974, 1976, 77a; Butzer, n.d.; Shackleton, n.d.). A number of other sedimentary sequences studied by Butzer, both in the interior and on the coast, confirm this pattern.

The Border Cave sequence demonstrates that the earliest MSA is even substantially older than the Last Interglacial, dating back to the beginning of the Penultimate Glacial. The following approximate ages are indicated by our results:

Late MSA ("Post-Howieson's Poort") ca. 80,000-50,000bp
"Howieson's Poort ("Epi-Pietersburg") ca. 95,000-80,000bp
Early MSA (Pietersburg") ca. 195,000-95,000bp

The artificial composition of these industries will be published shortly by Beaumont *et al*. (n.d.), while Sampson (1974) provides a general background to the various terminologies and their shifting significance.

A late Middle Pleistocene age for the earliest MSA is compatible with a tentative uranium-series date of 167,000 $\pm$ 25,000 bp for the terminal Acheulian of Fauresmith facies at Rooidam, near Kimberley (Butzer, 1974; Szabo, 1974). It is equally compatible with Butzer's unpublished study of (a) the major open-air site of Duinefontein (Melkbos) (Klein, 1976a), where a non-Acheulian industry predates Last Interglacial nearshore dunes; (b) Bushman Rock Shelter, where a long MSA sequence older than 51,000 bp (Vogel) extends through at least 4 éboulis horizons and two significant cave paleosols; and (c) Florisbad, where Peat I and the skull can be shown to be a whole landscape cycle earlier than the stratacomplex including Peat II, a horizon of classic MSA, and radiocarbon dates well in excess of 42,600 bp (Pta-1108). Furthermore, it is in line with K/Ar dating of MSA in Ethiopia at prior to 181,000 bp (Wendorf *et al.*, 1975).

Paleo-Enviromental Discussion. The present vegetation mosiac of the Lebombos and adjacent Lowveld is based on a complex topography and considerable mesoclimatic differentiation. Would the amplitude of climatic changes postulated here change only the floristic dominants or would it change the fundamental vegetation physiognomy?

A number of modern ecozones in southern Africa provide potential analogs for the climatic anomalies inferred from the Border Cave sediments.

(a) Warmer and wetter conditions are today represented in the Coast Belt Forest of northern Natal, at elevations under 450m, with 900-1500mm precipitation as well as high relative humidities (Acocks, 1975:13-15). These are semi-tropical, short to tall, evergreen forests, very dense and tangled, with shrubs, climbers, and ferns. Such closed forest may have replaced the thornveld-forest mosaic of the Lebombo but left savanna patches in the drier parts of the Lowveld. The paleosols of Border Cave cycles B and C are compatible with such an environment.

(b) Warm and drier conditions cannot be distinctly identified in the Border Cave record, but they would probably have favored expansion of sweet-grass savanna at lower elevations and a reduction of closed woodland in the Lebombos.

(c) Cooler, relatively moist anomalies find potential analogs in the eastern foothill and escarpment region of the Drakensberg (see Acocks, 1975:82-85). At 800-1500m elevation the ecozone can support temperate forest and scrub forest with *Podocarpus*, abundant shrubs and climbers, and patches of sour-grass savanna or *Protea* heath. Precipitation here is in the 700-1000mm range, with regular winter frosts. At higher elevations, up to 2150m elevation on valleysides, a similar temperate forest, with fewer species and climbers, and shifting dominants, is found in areas with severe winter frost and some snow. Such warm-to cold-temperate forests might well replace the semitropical vegetation mosaic of the Border Cave area at times of effective frost-weathering, provided that precipitation did not decrease. (d) Analogs for cold-dry conditions can be sought in the central Drakensberg, between 1850 and 3000m, in areas with from 600 to well over 1500mm precipitation, severe and sustained winter frosts, and periodic snow cover. These are grassland habitats, with Protea savannas and valleyside scrub-forests (see Acocks, 1975: 95-97). The grass constellation is "alpine", but most of the species also occur at intermediate elevations in man-made or edaphic savannas. Given a significant decrease in available moisture, greatly increased continentality, and somewhat lower temperatures, such temperate to alpine grasslands could be established in the Lebombos and even in the adjacent Lowveld.

This discussion shows that the ecological mosaic of the Lebombos and Lowveld would have responded to variations of continentality, precipitation, and temperature in a complex way. Furthermore, floristic as well as physiognomic changes must have occurred during later Pleistocene times. Forest expansion can be expected with constant thermal regime and increased rainfall, or with constant precipitation and a cooler climate. Grassland expansion can be expected with constant thermal regime and decreased rainfall, or with substantially colder climate and decreased rainfall.

Pollen in Border Cave is apparently poorly preserved, but there is much macro-botanical material, particularly in levels 1-3, that would be suitable for flotation analysis. Exploratory examination idicates abundant grass bedding (?) in levels 2-3, and utilized Acacia karroo thorns are present in level 5 (Beaumont, 1973; Beaumont et al., n.d.). This species is widespread in the savannas of Natal and the South African interior and, in isolation, implies no more than local persistence of savanna habitats.

The fauna from Excavation 3A, although poor in identifiable bone, is far mor informative. Klein (1977b) has partially resolved the problem of low numbers of individuals identified by utilizing the number of excavation squares in which various species occur to obtain usable frequency data. He shows that high concentrations of grazers (warthog, zebra and alcelaphine anyelopes) alternate with high concentrations of browsers (bushpig, Cape buffalo, tragelaphine antelopes, and impala), in a statistically significant way. His data can be reorganized by arranging the data by levels of similar facies, and grouping the animal/square counts in preferred-habitat frequencies; grazers include zebra, warthog, waterbuck, roan/sable, blesbok, hartebeest, wildebeest and Bond's springbok; browsers include bushpig, steenbok, impala, kudu and Cape buffalo (Table 4). Ignoring the small samples of levels 1a, 4 and 7b-8, the results suggest the following:

Levels 2-3	Woodland habitats dominant
Levels 5a-7a	Grassland/savanna habitats dominant
Levels 9-10	Woodland-savanna habitat mosaic.

This information allows refinement of the paleo-environmental deductions of Table 3 as based solely on sedimentological criteria:

Levels 2-3	Cool and wet
Level 5a	Cool and very dry
Levels 5b-5c?	Very cold and dry
Level 6-7a	Warm and dry
Levels 9-10	Cool and moderately wet.

If the limited faunal data are representative, level 4 times may have been wetter than today, level 7b-8 both cool and wet. Hopefully faunal information will eventually be forthcoming from Excavation 3B, levels 11-15.

Synthesizing the previous information, the Border Cave environments corresponding to the Upper Pleistocene isotope stages can be characterized as follows :

Stage:	2	? Cold-temperate grassland	(Upper Hypothermal)
	2/3	Temperate woodland	
	3	Subtropical woodland	(Interhypothermal)
	3/4	Temperate savanna	
	4	Cold-temperate grassland	(Lower Hypothermal)
	5a	Subtropical savanna	(Upper Hyperthermal)
	5b	Temperate woodland	(Interhyperthermal II)
	5c	Subtropical forest	(Middle Hyperthermal)
	5d	Temperate savanna-woodland	(Interhyperthermal I)
	5e	Semitropical forest	(Lower Hyperthermal)

These paleo-environmental trends appear to be compatible with Maud's (1968) soil stratigraphy for coastal Natal, but do not quite match those of the southern Cape Coast (latitudes 33-34°30'S) (see Butzer and Helgren, 1972; Helgren and Butzer, 1977; Butzer, 1973a, n.d.) nor those of the interior, Lower Vaal Basin (latitudes 27°30'-29°30'S) (see Butzer, Stuckenrath et al., n.d.), despite identical, superposed thermal cycles. This would indicate that KwaZulu and Swaziland constitute a distinct paleoclimatic province, probably spanning latitudes 26-29°S.

In terms of the potential catchment of Border Cave, some form of habitat mosaic would have been accessible to its hunters within less than 5km, with exception of the forest intervals of isotope stages 5c and 5e. Occupations of the cave coincided preeminently with colder phases, but not exclusively so. At some times either grassland or forest habitats were relatively scarce, but neither were ever absent within a convenient distance. Broad-spectrum hunting was practiced at all times (Klein, 1977b), and the temporal lithic trends (Beaumont et al., n.d.) show no discontinuities at times of environmental disjunction. This would seem to argue for flexible, homeostatic subsistence systems during the course of the Upper Pleistocene, if not the last 195,000 years. Only a far more detailed and multi-faceted archeological data body could hope to reveal the nature of the repeated, minor readjustments (implied by a homeostatic model) or the degree to which such adjustments coincided with tangible innovations.

Acknowledgements

The geomorphological field and laboratory work (K.W.B.) were supported by National Science Foundation grants GS-39625 (to R.G. Klein and K.W. Butzer) and BN574-12223 (to K.W. Butzer), and by the Department of Anthropology of the University of Chicago.

REFERENCES

ACOCKS, J.P.H. 1975. Veld types of South Africa. Bot. Surv. S. Afr. Mem. 40 : 1-128

BADA, J.L. 1974. Personal communication.

BEAUMONT, P.B. 1973. Border Cave - a progress report. S. Afr. J. Sci., 69 : 41-46.

BEAUMONT, P.B., VOGEL, J.C. and DE VILLIERS, H.n.d. Modern man in sub-Saharan Africa prior to 49,000 years B.P.: a review and evaluation with particular reference to Border Cave. Submitted for publication.

BEAUMONT, P.B. and VOGEL, J.C. 1972. On a new radiocarbon chronology for Africa south of the equator. Afr. Stud., 31 : 65-89 and 155-182.

BLOOM, A.L. et al. 1974. Quaternary sea level fluctuations on a tectonic coast: new $^{230}Th/^{234}U$ dates from the Huon Peninsula, New Guinea. Quat. Res., 4 : 185-205.

BROECKER, W.S. et al. 1968. Milankovich hypothesis supported by precise dating of coral reefs and deep-sea sediments. Science, 159 : 297-300.

BUTZER, K.W. 1971. Environment and Archaeology: an ecological approach to prehistory. Chicago: Aldine; London: Methuen.

BUTZER, K.W. 1973a. Geology of Nelson Bay Cave, Robberg, South Africa. S. afr. archaeol. Bull., 28 : 97-110.

BUTZER, K.W. 1973b. Pleistocene "periglacial" phenomena in Southern Africa. Boreas, 2 : 1-12.

BUTZER, K.W. 1974. Geo-archaeological interpretation of two Acheulian calc-pan sites: Doornlaagte and Rooidam (Kimberley, South Africa). Jl. archaeol. Sci., 1 : 1-25.

BUTZER, K.W. 1975. Pleistocene littoral-sedimentary cycles of the Mediterranean Basin : a Mallorquin view. In: Butzer, KW. and Isaac, G.L. Eds. After the australopithecines : stratigraphy, ecology and culture change in the Middle Pleistocene: 25-71. Chicago : Aldine; The Hague : Mouton.

BUTZER, K.W. 1976. Pleistocene climates. Geoscience and Man, 13 :27-44.

BUTZER, K.W. n.d. Geomorphology and sediment stratigraphy of archaeological sites at Klasies River Mouth, Southern Cape Province. Unpublished manuscript.

BUTZER, K.W. and HELGREN, D.M. 1972. Late Cenozoic evolution of the Cape coast between Knysna and Cape St. Francis, South Africa. Quát. Res., 2 : 143-169.

BUTZER, K.W., STUCKENRATH, R., BRUZEWICZ, A.J. and HELGREN, D.M. n.d. Late Cenozoic palaeoclimates of the Gaap Escarpment, Kalahari margin, South Africa. Submitted for publication.

CLIMATE OF SOUTH AFRICA. 1954. Part 1. Climate Statistics.Pretoria: South African Weather Bureau.

COOKE, H.B.S., MALAN, B.D. and WELLS, L.H. 1945. Fossil man in the Lebombo Mountains, South Africa: the 'Border Cave' Ingwavuma district, Zululand. Man, 45 (3) : 6-13.

FOLK, R.L. 1966. A review of grain-size parameters. Sedimentology, 6 : 73-93.

HELGREN, D.M. and BUTZER, K.W. 1977. Paleosols of the southern Cape coast, South Africa : implications for laterite definition, genesis, and age. Geog. Rev., 67 : in press.

KLEIN, R.G. 1970. Problems in the study of the Middle Stone Age of South Africa. S. Afr. archaeol. Bull., 25 : 127-35

KLEIN, R.G. 1974. Environment and subsistence of prehistoric man in the southern Cape Province, South Africa. Wld. Archaeol., 5 : 249-84.

KLEIN, R.G. 1976a. A preliminary report on the 'Middle Stone Age' open-air site of Duinefontein 2 (Melkbosstrand, S.W. Cape Province). S. Afr. archaeol. Bull., 31 : 12-20.

KLEIN, R.G. 1976b. The mammalian fauna of the Klasies River Mouth sites, southern Cape Province, South Africa. S.Afr. archaeol. Bull., 31 : 75-98.

KLEIN, R.G. 1977a. The ecology of early man in southern Africa. Science, in press.

KLEIN, R.G. 1977b. The mammalian fauna from the Middle and Late Stone Age (Upper Pleistocene) levels of Border Cave, Natal Province, South Africa. S. Afr. archaeol. Bull., 32, in press.

KUKLA, G.L. 1975. Loess stratigraphy of Central Europe. In: Butzer, K.W. and Isaac, G.L. Eds. After the Australopithecines: stratigraphy, ecology and culture change in the Middle Pleistocene : [illegible]. Chicago: Aldine; The Hague: Mouton.

LINK, A.G. 1966. Textural classification of sediments. Sedimentology, 7 : 249-54.

MAUD, R.R. 1968. Quaternary geomorphology and soil formation in coastal Natal. Zeitschrift für Geomorphologie, Suppl., 7 : 155-99.

PATERSON, W.S.B. et al. 1977. An oxygen-isotope climatic record from the Devon Island ice cap, arctic Canada. Nature, 266 : 508-11.

SHACKLETON, N.J. 1975. The stratigraphic record of deep-sea cores and its implications for the assessment of glacials, inter-glacials, stadials and interstadials in the mid-Pleistocene. In: Butzer, K.W. and Isaac, G.L. Eds. After the Australopithecines : stratigraphy, ecology and culture change in the Middle Pleistocene : 1-24. Chicago: Aldine; The Hague: Mouton.

SHACKLETON, N.J. n.d. Stratigraphy and chronology of the Klasies River Mouth deposits: oxygen isotope evidence. Unpublished manuscript.

SOIL SURVEY STAFF. 1975. Soil Taxonomy: a basic system of soil classification for making and interpreting soil surveys. U.S. Dept. Agriculture Handbook 436: 1-754.

SAMPSON, C.G. 1974. The Stone Age archaeology of Southern Africa. New York and London: Academic Press.

SZABO, B.J. 1974. Personal communication.

VOGEL, J.C. and BEAUMONT, P.B. 1972. Revised radiocarbon chronology for the Stone Age in South Africa. Nature, 237: 50-51.

WENDORF, F. et al. 1975. Dates for the Middle Stone Age of East Africa. Science, 187 : 940-42.

WYMER, J.J. 1973. Personal communication.

TABLE 1. Morphometric Rubble Analysis, Border Cave

Lithology, rhyolite; minimum size, 1.5cm major axis.

All specimens angular, with highly irregular edges.

L (major axis or length); l (minor axis or width); E (thickness)

Unit (and area)	Sample size	E/L ratio	E/l ratio	L	σ(L)
Northeast corner					
Eboulis I	100	22.5%	39.4%	3.13cm	0.69cm
Eboulis II	100	19.2	35.5	3.30	0.99
Eboulis III	100	17.2	31.7	3.67	1.22
Excavation 3A					
Eboulis II	60	27.5	50.8	2.97	0.90
Excavation 3B					
Eboulis IV	100	20.9	54.6	3.39	0.64

TABLE 2. Synthetic Interpretation of the Border Cave Sedimentary Sequence.

Unit thicknesses are averages; bracketing ages derived from radiocarbon dates; only significant prehistoric occupations mentioned.

Level 1a (30cm).	Limited grit production. Modern conditions of sedimentation and climate. 700 B.P. to present. Iron Age occupation.
Hiatus	ca. 700-13,000 B.P.
Level 1b (20cm).	Moderate éboulis and grit production. Moderate frost-weathering. Climate cold, possibly dry. Ca. 13,000-29,000 B.P.
Hiatus	ca. 29,000-33,000 B.P.
Levels 2-3 (40cm).	Important éboulis horizon. Effective frost-weathering: first accelerating, then decelerating. Climate mainly cold, possibly wet. Ca. 33,000-38,000 B.P. 'Early' Later Stone Age occupation.
Hiatus	ca. 39,000 to before 49,000 B.P.
Level 4 (15cm).	Limited grit production. Climate much like today. Late Middle Stone Age occupation.
Hiatus	
Level 5a (7.5cm).	Moderate grit production. Climate cooler.
Level 5b-5c (15cm).	Major éboulis horizon. Effective frost-weathering but decelerating with time. Climate cold; initially wetter? Late Middle Stone Age occupation.
Hiatus	
Level 6-7a (35cm).	Minimal grit production. Climate warmer or drier. At first unoccupied, then late Middle Stone Age habitation.
Level 7b-8 (30cm).	Major éboulis horizon. Maximum of effective frost-weathering, decelerating with time. Climate cold, initially wetter. "Howieson's Poort" occupation.

TABLE 2 (part 2)

Hiatus	Minor Soil Horizon. Chemical weathering, with gypsum mobilization (cs-horizon at -60 to -90cm). Greater cave moisture. Climate warm and wet.
Level 9 (25cm).	Eboulis-and-grit horizon, grading up into finer, laminated beds. Climate initially cold, then becoming temperate and/or drier. Early Middle Stone Age occupation.
Level 10 (35cm).	Major éboulis-and-grit horizon. Effective frost-weathering. Climate cold and probably wetter. Early Middle Stone Age occupation.
Level 11 (15cm).	Some éboulis production. Some frost-weathering. Climate cooler. Early Middle Stone Age occupation.
Hiatus	Major Soil Horizon. Protracted chemical weathering, with clay mineral formation in an acidic pedogenetic environment (over 80cm). Greater cave moisture. Climate warm and exceptionally wet.
Level 12 (15cm).	Moderate grit and éboulis production. Effective frost-weathering. Climate cold. Early Middle Stone Age occupation
Hiatus	
Level 13 (15cm).	Some éboulis production. Some frost-weathering. Climate cooler. Early Middle Stone Age occupation.
Level 14-15 (45cm).	Some grit production at first, but sediments comparable to 1a. Climate cool, becoming warm; no wetter than today. Early Middle Stone Age occupation.
Bedrock, weathered.	Significant chemical weathering probable prior to deposition of level 15; mechanisms of removal of previous sediment enigmatic.

TABLE 3. A tentative climato-stratigraphic framework for Border Cave

The sedimentary breaks probably coincided with an essentially modern climate. Deep-sea isotopic stages and dates after Shackleton, 1975.

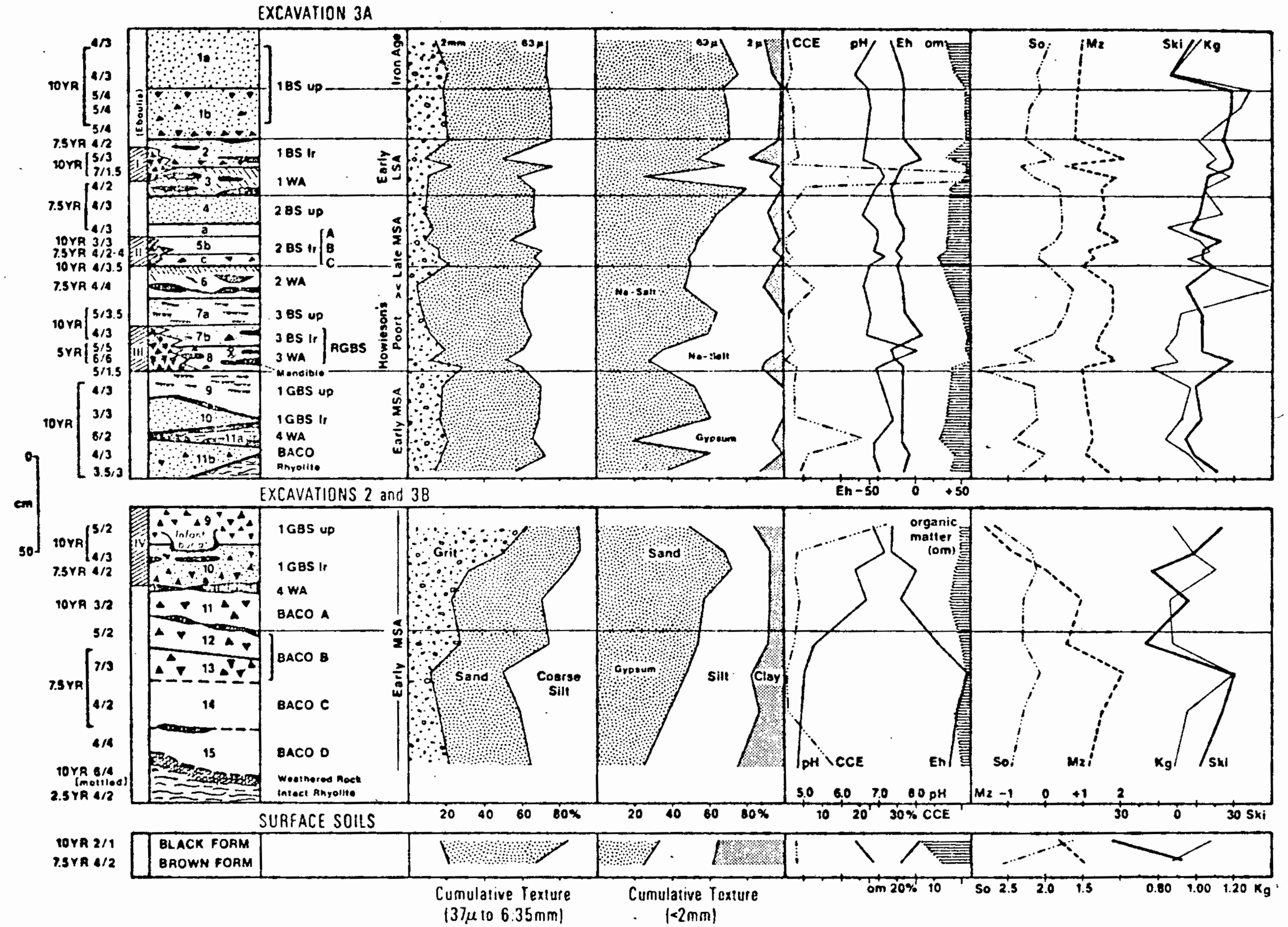
Sedimentary Cycle/Unit		Inferred Climate	(Extrapolated) C-14 Basal Ages (x 1000yr)	Deep-Sea Isotope Stage	Isotope Stage Basal Ages (x 1000yr)
I	1a	Modern	0.7	1, in part	
H	Break		13	1, in part	13
	1b	Cold; ?dry	29	2	
G	Break		33		
	2-3	Cold; ?wet	38	2/3 transition	32
F	Break		49		
	4	Warm		3, middle	
E	Break		(57)		
	5a	Temperate		3/4 transition	64
	5b-5c	Cold; ?wet		4	75
D	Break		(69)	5a, late	
	6-7a	Warm or dry		5a, early	
	7b-8	Cold, wet		5b	(95)
C	Minor Paleosol:	Warm,quite wet	(105-108)	5c	(110)
	9	Cold to temperate		5d, late	
	10	Cold, wet		5d, middle	
	11	Temperate		5d, early	
B	Major Paleosol:	Warm,very wet	(145-154)	5e	128
	12	Cold; ?dry		6, late	
A	Break		(154-165)		
	13	Temperate		6, middle	
	14	Warm		6, early	
	15	Temperate		6, early	195
? Weathering:		Warm, wet	(186-208)	7	

TABLE 4. Frequency of Excavation 3A Squares with Bones of Grazers and Browsers

Based on Klein, 1977b: Table 3.

Level	Sample Number	% Browsers	% Grazers
1a	3	33	67
2-3	44	70	30
4	4	75	25
5a	15	13	87
5b-5c	40	17	83
6-7a	22	18	82
7b-8	4	75	25
9-10	27	59	41

FIG I. BORDER CAVE SEDIMENTOLOGICAL DATA



Appendix 55 Specific gravity determinations: fossil bone

Unselected macrofaunal samples from Border Cave

Stratum	Square	Sample Mass g.	S.G. g. per ml.
1BS.UP.I.A	Q22 30-38	83	1,90
IWA	Q16	120	2,00
"	R21	200	1,74
"	R24	175	1,75
"	S18	200	2,00
"	S21	200	1,90
"	T23	160	2,00
Mean			1,90
2WA	R21	280	2,15
"	R24	200	2,16
"	S19	228	1,93
"	S22	261	2,17
"	T20	350	2,15
Mean			2,11
1GBS.UP	R20	218	2,00
	R21	323	2,00
	S19	219	2,05
	S22	280	2,02
Mean			2,02

Appendix 56 Specific gravity determinations: modern bone

All samples previously boiled in K. OH, bleached in H_2O_2 and defatted in organic solvent

Species	Age and Sex	B.P.I. Cat. No.	Sample mass g.	S.G. g. per ml.
Impala	Adult male	C101	99	1,30
Tsesseby	Adult female	C100	194	1,07
Wildebeest	Adult male	C87	169	1,01
Waterbuck	Adult female	C52	158	1,45
Waterbuck	Adult female	C52	139	1,20
Mean				1,21

Appendix 57 Antelope - skeletal/live mass %

All samples weighed minus keratin fraction

All samples previously boiled in K OH, bleached in H_2O_2 and defatted in organic solvent

Species	Age and Sex	B.P.I. Cat. No.	Skeletal Mass in g.	Live mass Range in kg	Skeletal/ Live %
Impala	Adult male	C101	3326	36-69	4,8-9,2
Tsesseby	Adult female	C100	6103	117-158	3,9-5,2
Wildebeest	Adult male	C87	9923	205-274	3,6-4,8
Waterbuck	Adult female	C52	6742	158-272	2,5-4,3
Mean					4,8

Appendix 58 Bone survival estimates

Border Cave. Exc. 3A. Stratum 1BS. LR. and 1WA

Step 1.

Correct for changes in S.G.	47500g at 1,9 S.G.
	30000g at 1,2 S.G.

Step 2

Convert to carcass weight, assuming bone 5% of total mass	600kg.

Step 3

Minimum number of antelope

Small class x 6	=	61,8kg	
Small medium x 8	=	392,0kg	
Large medium x 4	=	712,8kg	
Large class x 7	=	4454,1kg	
		5620,7kg	5621kg

Step 4

Correct for immature animals assuming 50% reduction of total mass	2810kg

Step 5

Bone survival $\frac{600}{2810} \times 100 = 21,5\%$

Appendix 58 Bone survival estimates

Border Cave. Exc. 3A. Stratum 2BS. UP and 2BS. LR. A + B

Step 1.

Correct for changes in S.G. — 10100g at 2,0 S.G.

6100g at 1,2 S.G.

Step 2.

Convert to carcass weight

assuming bone 5% of total mass — 122kg

Step 3.

Minimum number of antelope

Small class x 5	=	51,5kg	
Small medium x 5	=	245,0kg	
Large medium x 4	=	712,8kg	
Large class x 3	=	1908,9kg	
		2918,2kg	2918kg

Step 4.

Correct for immature animals

assuming 50% reduction of total mass — 1495kg

Step 5.

Bone survival — $\frac{122}{1459} \times 100 = 8,5\%$

Appendix 58 Bone survival estimates

Border Cave. Exc. 3A. Stratum 2BS. LR. C and 2WA

Step 1.

Correct for changes in S.G. 54200g at 2,1 S.G.

31000g at 1,2 S.G.

Step 2

Correct to carcass weight

assuming bone 5% of total mass 620kg

Step 3

Minimum number of antelope

Small class x 3	=	30,9kg	
Small medium x 7	=	343,0kg	
Large medium x 8	=	1425,6kg	
Large class x 4	=	2545,2kg	
		4344,7kg	4345kg

Step 4

Correct for unmature animals

assuming 50% reduction in total mass 2172kg

Step 5

Bone survival $\frac{620}{2172} \times 100 = 28,5\%$

Appendix 58 Bone survival estimates

Border Cave. Exc. 3A. Stratum 3BS. and 3WA.

Step 1.

Correct for changes in S.G. — 4700g at 2,0 S.G.

2800g at 1,2 S.G.

Step 2.

Convert to carcass weight

assuming bone 5% of total mass — 56kg

Step 3.

Minimum number of antelope

Small class x 3	=	30,9kg	
Small medium x 4	=	196,0kg	
Large medium x 3	=	534,6kg	
Large class x 6	=	3817,8kg	
		4579,3kg	4580kg

Step 4.

Correct for immature animals

assuming 50% reduction in total mass — 2290kg

Step 5.

Bone survival — $\frac{56}{2290} \times 100 = 2{,}5\%$

Appendix 58 Bone survival estimates

Border Cave Exc. 3A. Stratum 1GBS. UP. and 1GBS. LR and BACO.A

Step 1.

Correct for changes in S.G. — 20500g at 2,0 S.G.

14800g at 1,2 S.G.

Step 2.

Convert to carcass weight

assuming bone 5% of total mass — 296kg

Step 3.

Minimum number of antelope

Small class x 4	=	41,2kg	
Small medium x 4	=	196,0kg	
Large medium x 6	=	1069,2kg	
Large class x 4	=	2545,2kg	
		3851,6kg	3852kg

Step 4.

Correct for immature animals

assuming 50% reduction of total mass — 1926kg

Step 5.

Bone survival — $\frac{296}{1926} \times 100 = 15,5\%$

Appendix 59 Temporal variability : flakes +

Border Cave. Exc. 3A Rear

Stratum	Data squares number	Corrected volume cu. m.	Flakes + count number	Flakes + density number per cu. m.
1BS.UP. Iron Age	23	6,55	69	11
1BS.UP. Sterile	25	4,40	36	8
1BS.LR	32	3,36	630	188
1WA	31	3,28	1583	483
2BS.UP	29	4,25	248	58
2BS.LR.A	8	~ 2,00	-	~323
2BS.LR.B	8	~ 2,19	-	~126
2BS.LR.A+B	25	4,19	941	225
2BS.LR.C	25	1,43	2486	1739
2WA	19	2,94	1807	615
3BS.UP	4	~1,50	-	~58
3BS.LR	4	~1,55	-	~476
3BS.UP.+LR	18	3,05	814	267
3WA	17	1,37	194	142
1GBS.UP	17	3,94	760	193
1GBS.LR	17	2,67	2201	824
BACO.A	9	0,75	999	1332
BACO.B	3	0,64	2753	4302
BACO.C	3	0,64	4618	7216
BACO.D	6	0,87	1726	1984

Appendix 59 Temporal variability : charcoal

Border Cave. Exc. 3A Rear

Stratum	Data squares number	Corrected volume cu. m.	Charcoal mass grams	Charcoal density grams per cu. m.
1BS.UP. Iron Age	23	6,55	564	86
1BS.UP. Sterile	25	4,40	164	37
1BS.LR.	32	3,36	3656	1088
1WA	26	2,89	6920	2395
2BS.UP.	29	4,25	985	232
2BS.LR.A	8	~2,00	-	~934
2BS.LR.B	8	~2,19	-	~263
2BS.LR.A + B	25	4,19	2508	599
2BS.LR.C	23	1,31	2155	1645
2WA.	19	2,94	5515	1876
3BS.UP.	7	1,48	-	~379
3BS.LR.	7	1,50	-	~1269
3BS.UP.LR.	17	2,98	2455	824
3WA.	17	1,49	147	99
1GBS.UP.	17	3,94	2540	645
1GBS.LR.	17	2,67	6180	2315
BACO.A.	9	0,75	779	1039

Appendix 59 Temporal variability : macrofauna
Border Cave. Exc. 3A Rear

Stratum	Data squares number	Corrected volume cu. m.	Macrofauna mass grams.	Macrofauna density grams per cu. m.
1BS.UP. Iron Age	23	6,55	1605	245
1BS.UP. Sterile	25	4,40	909	207
1BS.LR.	32	3,36	17447	5193
1WA	30	3,21	30084	9372
2BS.UP.	29	4,25	2656	625
2BS.LR.A	8	2,00	-	~ 2768
2BS.LR.B	8	2,19	-	~ 780
2BS.LR.A + B	25	4,19	7432	1774
2BS.LR.C	25	1,43	19843	13876
2WA	19	2,94	34332	11678
3BS.UP.	4	1,50	-	~ 486
3BS.LR.	4	1,55	-	~ 2218
3BS.UP. + LR.	18	3,05	4125	1352
3WA	17	1,37	616	450
1GBS.UP.	17	3,94	10944	2778
1GBS.LR.	17	2,67	7692	2881
BACO.A	9	0,75	1820	2427

Appendix 59 Temporal variability : microfauna

Border Cave. Exc. 3A Rear

Stratum	Data squares number	Correlated volume cu. m.	Microfauna count number	Microfauna density number per cu. m.
1BS.UP. Iron Age	23	6,55	3713	567
1BS.UP. Sterile	25	4,40	6129	1407
1BS.LR.	32	3,36	2408	717
1WA	31	3,28	1506	459
2BS.UP.	29	4,25	2267	533
2BS.LR.A	8	2,00	–	~406
2BS.LR.B	8	2,19	–	~586
2BS.LR.A + B	25	4,19	2077	496
2BS.LR.C	25	1,43	424	297
2WA	19	2,94	471	160
3BS.UP.	4	1,50	–	~456
3BS.LR.	4	1,55	–	~848
3BS.UP. + LR.	18	3,05	1988	652
3WA	17	1,37	188	137
1GBS.UP.	17	3,94	801	203
1GBS.LR.	17	2,67	763	286
BACO.A.	9	0,75	609	812

Appendix 59 Temporal variability : mollusc shell

Border Cave. Exc. 3A Rear

Stratum	Data squares number	Corrected volume cu. m.	Mollusc shell number	Mollusc shell density number per cu. m.
1BS.UP. Iron Age	23	6,55	0	0
1BS.UP. Sterile	25	4,40	17	4
1BS.LR	32	3,36	109	32
1WA	31	3,28	690	210
2BS.UP	29	4,25	16	4
2BS.LR.A+B	25	4,19	0	0
2BS.LR.C	25	1,43	0	0
2WA	19	2,94	8	3
3BS	18	3,05	48	16
3WA	17	1,37	0	0
1GBS.UP	17	3,94	1152	292
1GBS.LR	17	2,67	359	135
BACO.A	9	0,75	14	19

Appendix 59 Temporal variability : ostrich eggshell

Border Cave. Excavation 3A Rear

Stratum	Data squares number	Corrected volume cu. m.	Ostrich eggshell number	Ostrich eggshell density number per cu.m.
1BS.UP Iron Age	23	6,55	15	23
1BS.UP. Sterile	25	4,40	7	2
1BS.LR	32	3,36	359	107
1WA	31	3,28	700	213
2BS.UP	29	4,25	0	0
2BS.LR.A+B	25	4,19	7	2
2BS.LR.C	25	1,43	74	52
2WA	19	2,94	14	5
3BS	18	3,05	8	3
3WA	17	1,37	0	0
1GBS.UP	17	3,94	33	8
1GBS.LR	17	2,67	1	0
BACO.A	9	0,75	6	8

Appendix 60 Spatial variability : stone artefacts

Border Cave. Excavation 3A Rear

Stratum	Data squares number	Artefacts number Σ	Artefacts No. $\bar{X}$	Artefacts No. SX	Artefacts No. V
1BS.UP. Iron Age	23	371	16,1	46,8	290,7
1BS.UP. Sterile	25	139	5,6	7,7	137,5
1BS.LR.	32	2985	93,3	71,2	76,3
1WA	31	10378	334,8	225,1	67,2
2BS.UP.	29	528	18,2	14,1	77,5
2BS.LR.A + B	25	1619	64,8	52,2	80,6
2BS.LR.C	25	3492	139,7	56,0	40,1
2WA	19	3179	167,3	187,7	112,2
3BS	18	1899	105,5	111,4	105,6
3WA	17	622	36,6	41,0	112,0
1GBS.UP.	17	1569	92,3	38,9	42,1
1GBS.LR.	17	4235	249,1	252,9	101,5
BACO.A	9	1828	203,1	186,2	91,7

Appendix 60 Spatial variability : charcoal

Border Cave. Excavation 3A Rear

Stratum	Data squares number	Charcoal Mass Σ	Charcoal Mass X	Charcoal Mass SX	Charcoal V
1BS.UP. Iron Age	23	564	24,5	47,4	193,5
1BS.UP. Sterile	25	164	6,6	12,0	181,8
1BS.LR.	32	3656	114,3	83,0	72,6
1WA	26	6920	266,2	122,7	46,1
2BS.UP	29	985	34,0	33,5	98,5
2BS.LR.A + B	25	2508	100,3	94,7	94,4
2BS.LR.C	23	2155	93,7	55,3	59,0
2WA	19	5515	290,3	145,8	50,2
3BS	17	2455	144,4	100,9	69,9
3WA	17	147	8,6	9,9	115,1
1GBS.UP	17	2540	149,4	68,1	45,6
1GBS.LR	17	6180	363,5	197,5	54,3
BACO.A	9	779	86,6	102,1	117,9

Appendix 60 Spatial variability : microfauna

Border Cave. Excavation 3A Rear

Stratum	Data squares number	Microfauna Number Σ	Microfauna No. $\overline{X}$	Microfauna No. SX	Microfauna No. V
1BS.UP. Iron age	23	3713	161,4	134,5	83,3
1BS.UP. Sterile	25	6129	245,2	266,9	108,8
1BS.LR	32	2408	75,3	90,5	120,2
1WA	31	1506	48,6	72,8	149,8
2BS.UP	29	2267	78,2	146,5	187,3
2BS.LR. A + B	25	2077	83,1	77,7	93,5
2BS.LR.C	25	424	17,0	14,5	85,3
2WA	19	471	24,8	30,8	124,2
3BS	18	1988	110,4	162,5	147,2
3WA	17	188	11,1	27,1	244,1
1GBS.UP	17	801	47,1	55,5	117,8
1GBS.LR.	17	763	44,9	53,7	119,6
BACO.A	9	609	67,7	147,5	217,9

Appendix 60 Spatial variability : macrofauna

Border Cave. Excavation 3A Rear

Stratum	Data squares number	Macrofauna Mass Σ	Macrofauna Mass $\overline{X}$	Macrofauna Mass SX	Macrofauna No. V
1BS.UP. Iron Age	23	1605	69,8	115,9	166,0
1BS.UP. Sterile	25	909	36,4	41,5	114,0
1BS.LR.	32	17447	545,2	519,7	95,3
1WA	30	30084	1002,8	653,0	65,1
2BS.UP	29	2656	91,6	94,7	103,4
2BS.LR.A + B	25	7432	297,3	270,8	91,1
2BS.LR.C	25	19843	793,7	279,6	35,2
2WA	19	34332	1806,9	662,4	36,7
3BS	18	4125	229,2	268,4	117,1
3WA	17	616	36,2	42,2	116,6
1GBS.UP	17	10944	643,8	332,8	51,7
1GBS.LR.	17	7692	452,5	270,1	59,7
BACO.A.	9	1820	202,2	162,4	80,3

Appendix 61 Heuningsneskrans Shelter.

Locality: Situated at the base of a foothill of the Drakensberg, on the farm Heuningsneskrans 476, some 18km. N.N.E. of Ohrigstad, in the eastern Transvaal, at 24^{o} 36' S, 30^{o} 39' E.

Excavation: A trial trench was suck here in late 1968 by P. Beaumont.

Stratigraphy: The deposit was excavated in arbitrary 7,5cm spits below the near-level present-day surface. Three distinct units were identified, namely:

Stratum 1: 0-69/76cm. Grey-brown sand with minor and sporadic ash lenses.

Stratum 2: 69/76-145/152cm. Interdigitating white-black ash and brown sand lenses.

Stratum 3: 145/152-635cm. Slightly calcified brown sand with occasional ash lenses.

Subsequent analysis revealed that the recovered artefacts occur in marked horizontal zones of lesser or greater abundance. These variations were used to subdivide Stratum 1 into two sublevels, Stratum 2 into two sublevels, and Stratum 3 into eight sublevels. A sharp increase in the abundance of roof spalls in the 7,5-15cm spit of Stratum 1 would appear to represent a stratigraphic break.

C-14 datings: The following readings have been obtained (Vogel and Marais, 1971; J. Bada, pers. comm.):

LJ-3199 Hnk $9{,}110 \pm 110$ B.P.
Mollusc shell from upper part of Stratum 1b, associated with 'Early L.S.A.'

Pta-112 Hnk $7{,}200 \pm 70$ B.P.
Charred bone from lower part of Stratum 1b, associated with 'Early L.S.A.'

LJ-3198 Hnk $9{,}480 \pm 120$ B.P.
Mollusc shell from Stratum 2a, associated with 'Early L.S.A.'

Pta-099 Hnk $9{,}780 \pm 85$ B.P.
Charcoal from Stratum 2a, associated with 'Early L.S.A.'

Pta-114 Hnk $10{,}430 \pm 150$ B.P.
Charred bone from Stratum 3a, associated with 'Early L.S.A.'

LJ-3150 Hnk $12{,}590 \pm 130$ B.P.
Mollusc shell from Stratum 3b, associated with 'Early L.S.A.'

Pta-100	Hnk	13,100 ± 110 B.P.

Charcoal from Stratum 3b, associated with 'Early L.S.A.'

LJ-3135	Hnk	19,840 ± 270 B.P.

Mollusc shell from Stratum 3c, associated with 'Early L.S.A.'

LJ-3136	Hnk	20,500 ± 300 B.P.

Mollusc shell from Stratum 3d, associated with 'Early L.S.A.'

LJ-3137	Hnk	21,100 ± 300 B.P.

Mollusc shell from Stratum 3e, associated with 'EArly L.S.A.'

Pta-101	Hnk	24,630 ± 300 B.P.

Charred bone from Stratum 3e, associated with 'Early L.S.A.'

LJ-3138	Hnk	23,900 ± 800 B.P.

Mollusc shell from Stratum 3f, associated with 'Early L.S.A.'

A.A. datings: The following readings have been obtained, 'calibration' being by means of LJ-3136:

LJ-AA	Hnk	12,000 B.P.

Uncharred bone from Stratum 3b, associated with 'Early L.S.A.'

LJ-AA	Hnk	14,300 B.P.

Uncharred bone from Stratum 3c, associated with 'Early L.S.A.'

LJ-AA	Hnk	22,000 B.P.

Uncharred bone from Stratum 3e, associated with 'Early L.S.A.'

LJ-AA	Hnk	24,800 B.P.

Uncharred bone from Stratum 3f, associated with 'Early L.S.A.'

LJ-AA	Hnk	31,000 B.P.

Uncharred bone from Stratum 3g, associated with 'Early L.S.A.'

Analysis: A typological and metrical analysis of the stone artefacts was carried out during the latter half of 1969 (Beaumont, in prep.).

Materials: Indurated shales vary from fine-grained to a small fraction with a coarse and hackly texture. These two facies were analysed separately but have been grouped together for present purposes. Quartzites are mainly beige-brown but a few are reddish or greyish. The 'additional' group is largely comprised of a dark shale which is often very weathered in Stratum 3.

References:

BEAUMONT, P.B. Preliminary excavations at Heuningsneskrans Shelter, Lydenburg district, eastern Transvaal. In preparation.

VOGEL, J.C. and MARAIS, M. 1971. Pretoria radiocarbon dates 1. Radiocarbon, 13, 378-394.

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 1a

Technological Process	Typological Class	Typological Subclass	Material: Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	Totals
Perforating +	Shell beads							16
	Sub-totals							16
Flaking	Scraper	Straight-edged	2	1	-	-	-	3
		Convex-edged	8	-	27	-	-	35
		Concave-edged	-	-	-	-	-	-
		Irregular-edged	2	-	-	-	-	2
		Compound	-	-	-	-	-	-
	Sub-totals		12	1	27	-	-	40
	Scaled pieces	Single-edged	2	-	18	-	-	20
		Double-edged	-	-	3	-	-	3
	Sub-totals		2	-	21	-	-	23
	Flake	Irregular	61	6	79	1	-	147
		Blade	1	-	4	-	-	5
	Sub-totals		62	6	83	1	-	152
	Core	Irregular	4	1	19	-	-	24
		Bipolar	1	-	42	-	-	43
		Plain platform	2	-	11	-	-	13
	Sub-totals		7	1	72	-	-	80
	Waste	Broken flake	83	3	144	-	1	231
		Unclassifiable	109	1	893	2	12	1017
	Sub-totals		192	4	1037	2	13	1248
Incidental	Hammerstones		2	1	-	-	-	3
	Pigment	Haematite.Ground						7
		Haematite.Plain						1
	Sub-totals		2	1	-	-	-	11

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 1b

Technological Process	Typological Class	Typological Subclass	Material: Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	Totals
Perforating +	Shell beads							29
	Sub-totals							29
Flaking	Scraper	Straight-edged	4	-	-	1	-	5
		Convex-edged	12	-	11	-	-	23
		Concave-edged	-	-	-	-	-	-
		Irregular-edged	-	-	-	-	-	-
		Compound	3	-	-	-	-	3
	Sub-totals		19	-	11	1	-	31
	Scaled pieces	Single-edged	-	-	20	-	-	20
		Double-edged	1	-	3	-	-	4
	Sub-totals		1	-	23	-	-	24
	Flake	Irregular	94	3	73	-	-	170
		Blade	2	-	5	-	-	7
	Sub-totals		96	3	78	-	-	177
	Core	Irregular	1	1	23	1	-	26
		Bipolar	2	-	37	1	-	40
		Plain platform	2	1	3	-	-	6
	Sub-totals		5	2	63	2	-	72
	Waste	Broken flake	94	3	136	1	1	235
		Unclassifiable	53	6	665	4	1	729
	Sub-totals		147	9	801	5	2	964
Incidental	Hammerstones		1	-	-	-	-	1
	Pigment	Haematite.Ground						1
		Haematite.Plain						22
	Sub-totals		1	-	-	-	-	24

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 2a

Technological Process	Typological Class	Typological Sub-class	Material: Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	Totals
Perforating +	Shell beads							36
	Sub-totals							36
Flaking	Scraper	Straight-edged	7	-	-	-	-	7
		Convex-edged	3	-	-	-	-	3
		Concave-edged	1	-	1	-	-	2
		Irregular-edged	-	-	-	-	-	-
		Compound	-	-	-	-	-	-
	Sub-totals		11	-	1	-	-	12
	Scaled pieces	Single-edged	10	-	58	-	-	68
		Double-edged	-	-	19	-	-	19
	Sub-totals		10	-	77	-	-	87
	Flake	Irregular	121	2	42	-	-	165
		Blade	1	-	2	-	-	3
	Sub-totals		122	2	44	-	-	168
	Core	Irregular	3	-	10	-	-	13
		Bipolar	3	-	76	-	-	79
		Plain platform	-	-	4	-	-	4
	Sub-totals		6	-	90	-	-	96
	Waste	Broken flake	147	5	117	-	1	270
		Unclassifiable	81	5	838	1	6	931
	Sub-totals		228	10	955	1	7	1201
Incidental	Hammerstones		-	-	-	-	-	-
	Pigment	Haematite.Ground						-
		Haematite.Plain						53
	Sub-totals		-	-	-	-	-	53

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 2b

Technological Process	Typological Class	Typological Subclass	Material					Totals
			Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	
Perforating +	Shell beads							8
	Sub-totals							8
Flaking	Scraper	Straight-edged	4	–	1	–	–	5
		Convex-edged	1	–	9	–	–	10
		Concave-edged	–	–	–	–	–	–
		Irregular-edged	–	–	2	–	–	2
		Compound	–	–	–	–	–	–
	Sub-totals		5	–	12	–	–	17
	Scaled pieces	Single-edged	2	–	36	–	–	38
		Double-edged	–	–	4	–	–	4
	Sub-totals		2	–	40	–	–	42
	Flake	Irregular	105	2	36	–	–	143
		Blade	1	–	3	–	–	4
	Sub-totals		106	2	39	–	–	147
	Core	Irregular	1	1	8	–	–	10
		Bipolar	2	–	47	–	–	49
		Plain platform	–	–	6	–	–	6
	Sub-totals		3	1	61	–	–	65
	Waste	Broken flake	106	10	91	–	–	207
		Unclassifiable	112	8	713	–	5	838
	Sub-totals		218	18	804	–	5	1045
Incidental	Hammerstones		–	–	–	–	–	–
	Pigment	Haematite. Ground						1
		Haematite. Plain						94
	Sub-totals		–	–	–	–	–	95

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 3a

Technological Process	Typological Class	Typological Subclass	Material: Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	Totals
Perforating +	Shell beads							10
	Sub-totals							10
Flaking	Scraper	Straight-edged	2	-	-	-	-	2
		Convex-edged	-	-	2	-	-	2
		Concave-edged	-	-	-	-	-	-
		Irregular-edged	-	-	1	-	-	1
		Compound	-	-	-	-	-	-
	Sub-totals		2	-	3	-	-	5
	Scaled pieces	Single-edged	2	-	44	-	-	46
		Double-edged	1	-	8	-	-	9
	Sub-totals		3	-	52	-	-	55
	Flake	Irregular	38	2	28	-	-	68
		Blade	-	-	-	-	-	-
	Sub-totals		38	2	28	-	-	68
	Core	Irregular	-	-	7	-	-	7
		Bipolar	1	-	55	-	-	56
		Plain platform	-	-	1	-	-	1
	Sub-totals		1	-	63	-	-	64
	Waste	Broken flake	59	6	64	-	-	129
		Unclassifiable	56	7	595	-	1	659
	Sub-totals		115	13	659	-	1	788
Incidental	Hammerstones		-	-	-	-	-	-
	Pigment	Haematite.Ground						-
		Haematite.Plain						26
	Sub-totals		-	-	-	-	-	26

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 3b

Technological Process	Typological Class	Typological Subclass	Material					Totals
			Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	
Perforating +	Shell beads							8
	Sub-totals							8
Flaking	Scraper	Straight-edged	-	-	-	1	-	1
		Convex-edged	-	-	1	-	-	1
		Concave-edged	-	-	-	-	-	-
		Irregular-edged	1	-	-	-	-	1
		Compound	1	-	-	-	-	1
	Sub-totals		2	-	1	1	-	4
	Scaled pieces	Single-edged	-	-	38	-	-	38
		Double-edged	-	-	3	-	-	3
	Sub-totals		-	-	41	-	-	41
	Flake	Irregular	52	3	12	3	2	72
		Blade	1	-	2	-	-	3
	Sub-totals		53	3	14	3	2	75
	Core	Irregular	6	-	7	-	1	14
		Bipolar	1	-	31	-	-	32
		Plain platform	1	-	11	1	-	13
	Sub-totals		8		49	1	1	59
	Waste	Broken flake	109	14	51	3	-	177
		Unclassifiable	126	12	401	2	41	582
	Sub-totals		235	26	452	5	41	759
Incidental	Hammerstones		1	-	-	-	-	1
	Pigment	Haematite. Ground						1
		Haematite. Plain						17
	Sub-totals		1	-	-	-	-	19

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 3c

Technological Process	Typological Class	Typological Subclass	Material: Indurated Shale	Material: Quartzite	Material: Vein Quartz	Material: Chalcedony	Material: Additional	Totals
Perforating +	Shell beads							1
	Sub-totals							1
Flaking	Scraper	Straight-edged	-	-	1	-	-	1
		Convex-edged	-	-	-	-	-	-
		Concave-edged	-	-	-	-	-	-
		Irregular-edged	-	-	-	-	-	-
		Compound	-	-	-	-	-	-
	Sub-totals		-	-	1	-	-	1
	Scaled pieces	Single-edged	-	-	46	-	-	46
		Double-edged	-	-	5	-	-	5
	Sub-totals		-	-	51	-	-	51
	Flake	Irregular	43	2	70	5	-	120
		Blade	-	-	14	2	-	16
	Sub-totals		43	2	84	7	-	136
	Core	Irregular	2	-	40	1	-	43
		Bipolar	-	-	59	-	-	59
		Plain platform	1	-	20	3	-	24
	Sub-totals		3	-	119	4	-	126
	Waste	Broken flake	87	2	123	16	-	228
		Unclassifiable	108	13	1607	16	8	1752
	Sub-totals		195	15	1730	32	8	1980
Incidental	Hammerstones		-	1	-	-	-	1
	Pigment	Haematite.Ground						1
		Haematite.Plain						32
	Sub-totals		-	1	-	-	-	34

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 3d

Technological Process	Typological Class	Typological Subclass	Material					Totals
			Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	
Perforating +	Shell beads							-
	Sub-totals							-
Flaking	Scraper	Straight-edged	-	-	-	-	-	-
		Convex-edged	-	-	-	-	-	-
		Concave-edged	-	-	-	-	-	-
		Irregular-edged	-	-	-	-	-	-
		Compound	-	-	-	-	-	-
	Sub-totals		-	-	-	-	-	-
	Scaled pieces	Single-edged	-	-	58	-	-	58
		Double-edged	-	-	9	-	-	9
	Sub-totals		-	-	67	-	-	67
	Flake	Irregular	57	3	85	-	-	145
		Blade	-	-	6	-	-	6
	Sub-totals		57	3	91	-	-	151
	Core	Irregular	-	-	23	-	-	23
		Bipolar	-	-	59	-	-	59
		Plain platform	-	-	8	-	-	8
	Sub-totals		-	-	90	-	-	90
	Waste	Broken flake	82	9	110	-	-	201
		Unclassifiable	54	1	890	-	8	953
	Sub-totals		136	10	1000	-	8	1154
Incidental	Hammerstones	-	-	-	-	-	-	-
	Pigment	Haematite.Ground						-
		Haematite.Plain						16
	Sub-totals		-	-	-	-	-	16

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 3e

Technological Process	Typological Class	Typological Subclass	Material: Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	Totals
Perforating +	Shell beads							-
	Sub-totals							-
Flaking	Scraper	Straight-edged	-	-	-	-	-	-
		Convex-edged	1	-	-	-	-	1
		Concave-edged	1	-	-	-	-	1
		Irregular-edged	-	-	-	-	-	-
		Compound	-	-	-	-	-	-
	Sub-totals		2	-	-	-	-	2
	Scaled pieces	Single-edged	3	-	59	-	-	62
		Double-edged	1	-	14	-	-	15
	Sub-totals		4	-	73	-	-	77
	Flake	Irregular	203	6	54	-	-	263
		Blade	1	-	1	-	-	2
	Sub-totals		204	6	55	-	-	265
	Core	Irregular	3	1	16	-	-	20
		Bipolar	1	-	63	-	-	64
		Plain platform	-	-	4	-	-	4
	Sub-totals		4	1	83	-	-	88
	Waste	Broken flake	169	10	64	-	-	243
		Unclassifiable	208	9	1058	-	10	1285
	Sub-totals		377	19	1122	-	10	1528
Incidental	Hammerstones		-	-	-	-	-	-
	Pigment	Haematite.Ground						2
		Haematite.Plain						13
	Sub-totals		-	-	-	-	-	15

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 3f

Technological Process	Typological Class	Typological Subclass	Material: Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	Totals
Perforating +	Shell beads							-
	Sub-totals							-
Flaking	Scraper	Straight-edged	1	-	1	-	-	2
		Convex-edged	-	-	-	-	-	-
		Concave-edged	-	-	-	-	-	-
		Irregular-edged	-	-	-	-	-	-
		Compound	-	-	-	-	-	-
	Sub-totals		1	-	1	-	-	2
	Scaled pieces	Single-edged	-	-	80	-	-	80
		Double-edged	-	-	11	-	-	11
	Sub-totals		-	-	91	-	-	91
	Flake	Irregular	58	3	37	-	-	98
		Blade	-	-	-	-	-	-
	Sub-totals		58	3	37	-	-	98
	Core	Irregular	1	-	49	-	-	50
		Bipolar	-	-	66	-	-	66
		Plain platform	-	-	10	-	-	10
	Sub-totals		1	-	125	-	-	126
	Waste	Broken flake	69	4	60	-	1	134
		Unclassifiable	77	9	1398	-	16	1500
	Sub-totals		146	13	1458	-	17	1634
Incidental	Hammerstones		-	-	-	-	-	-
	Pigment	Haematite. Ground						1
		Haematite. Plain						14
	Sub-totals		-	-	-	-	-	15

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 3g

Technological Process	Typological Class	Typological Subclass	Material: Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	Totals
Perforating +	Shell beads							-
	Sub-totals							-
Flaking	Scraper	Straight-edged	1	-	-	-	-	1
		Convex-edged	4	-	-	-	-	4
		Concave-edged	-	-	-	-	-	-
		Irregular-edged	1	-	-	-	-	1
		Compound	1	-	-	-	-	1
	Sub-totals		7	-	-	-	-	7
	Scaled pieces	Single-edged	5	-	65	-	-	70
		Double-edged	-	-	8	-	-	8
	Sub-totals		5	-	73	-	-	78
	Flake	Irregular	80	2	20	-	1	103
		Blade	-	-	-	-	-	-
	Sub-totals		80	2	20	-	1	103
	Core	Irregular	-	-	22	-	-	22
		Bipolar	-	-	40	-	-	40
		Plain platform	-	-	2	-	-	2
	Sub-totals		-	-	64	-	-	64
	Waste	Broken flake	89	2	33	-	1	125
		Unclassifiable	132	12	910	-	13	1067
	Sub-totals		221	14	943	-	14	1192
Incidental	Hammerstones		-	1	-	-	-	1
	Pigment	Haematite.Ground						-
		Haematite.Plain						14
	Sub-totals		-	1	-	-	-	15

Appendix 61 Typological analysis

Heuningsneskrans Shelter. Exc. 1968. Stratum 3h

Technological Process	Typological Class	Typological Subclass	Material					Totals
			Indurated Shale	Quartzite	Vein Quartz	Chalcedony	Additional	
Perforating +	Shell beads							4
	Sub-totals							4
Flaking	Scraper	Straight-edged	-	-	1	-	-	1
		Convex-edged	-	-	-	-	-	-
		Concave-edged	4	-	-	-	-	4
		Irregular-edged	-	-	-	-	-	-
		Compound	-	-	-	-	-	-
	Sub-totals		4	-	1	-	-	5
	Scaled pieces	Single-edged	-	-	19	-	-	19
		Double-edged	-	-	-	-	-	-
	Sub-totals		-	-	19	-	-	19
	Flake	Irregular	16	-	5	-	-	21
		Blade	2	-	-	-	-	2
	Sub-totals		18	-	5	-	-	23
	Core	Irregular	2	1	15	-	2	20
		Bipolar	-	-	18	-	-	18
		Plain platform	-	-	2	-	-	2
	Sub-totals		2	1	35	-	2	40
	Waste	Broken flake	24	3	21	-	2	50
		Unclassifiable	22	19	521	-	6	568
	Sub-totals		46	22	542	-	8	618
Incidental	Hammerstones		-	1	-	-	1	2
	Pigment	Haematite.Ground						1
		Haematite.Plain						7
	Sub-totals		-	1	-	-	1	10

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 1a

Material	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform prep.% Fac.	Pln.	Ind.
V. quartz	46	$\bar{X}$	18,4	17,2	5,0	95,5	26,8	29,3	28,2	-	69,6	30,4
		SX	5,95	6,30	2,40	26,80	7,55	9,65				
		$S\bar{X}$	0,90	0,95	0,35	3,95	1,10	1,40				
I. shale	53	$\bar{X}$	22,7	23,6	5,7	109,3	24,7	24,3	24,5	-	84,9	15,1
		SX	8,00	9,45	3,50	39,35	8,30	9,00				
		$S\bar{X}$	1,10	1,30	0,50	5,40	1,15	1,25				

Abbreviations

Rel = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate

V = vein; I = indurated

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 1b

Material	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform prep.% Fac.	Pln.	Ind.
V. quartz	127	$\bar{X}$	18,5	17,1	5,0	95,6	27,0	29,2	28,1	1,5	83,5	15,0
		SX	5,85	5,65	2,20	26,80	9,15	9,20				
		$S\bar{X}$	0,50	0,50	0,20	2,40	0,80	0,80				
I. shale	164	$\bar{X}$	21,1	23,2	5,4	118,0	25,4	23,5	24,5	1,2	89,0	9,8
		SX	7,95	8,10	2,45	41,15	7,30	8,60				
		$S\bar{X}$	0,60	0,65	0,20	3,20	0,55	0,65				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
V. = vein; I. = indurated

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 2a

Material	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform prep.% Fac.	Pln.	Ind.
V. quartz	29	$\bar{X}$	19,3	18,8	5,1	100,9	26,6	27,4	-	-	86,2	13,8
		SX	-	-	-	-	-	-				
		$S\bar{X}$	-	-	-	-	-	-				
I. shale	126	$\bar{X}$	17,7	22,1	4,4	128,3	24,6	20,3	22,5	3,2	83,3	13,5
		SX	6,25	9,05	2,20	37,75	7,45	7,35				
		$S\bar{X}$	0,55	0,80	0,20	3,35	0,65	0,65				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
V. = vein; I. = indurated

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 2b and 3a

Material	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform prep.%		
										Fac.	Pln.	Ind.
V. quartz	39	$\bar{X}$	18,7	17,5	4,8	98,9	26,2	27,9	27,1	-	69,2	30,8
		SX	7,00	5,85	2,40	29,85	8,55	8,60				
		$S\bar{X}$	-	-	-	-	-	-				
I. shale	89	$\bar{X}$	16,5	20,1	4,0	129,4	24,0	19,8	21,9	-	80,9	19,1
		SX	5,55	6,70	2,05	44,85	8,05	7,55				
		$S\bar{X}$	0,65	0,80	0,25	5,55	1,00	0,90				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;

V. = vein; I. = indurated

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 3b

Material	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform prep.% Fac.	Pln.	Ind.
V. quartz	14	$\bar{X}$	19,3	17,2	5,1	90,9	26,0	29,9	-	-	71,4	28,6
		SX	-	-	-	-	-	-				
		$S\bar{X}$	-	-	-	-	-	-				
I. shale	132	$\bar{X}$	22,5	25,9	5,7	120,2	25,6	22,6	24,1	3,1	84,8	12,1
		SX	9,05	12,20	2,70	41,25	8,30	7,50				
		$S\bar{X}$	0,80	1,05	0,25	3,60	0,70	0,65				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
V. = vein; I. = indurated

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 3c

Material	Sample	Analysis	L	B	T	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform prep.%		
	n		mm	mm	mm					Fac.	Pln.	Ind.
V. quartz	68	$\overline{X}$	16,6	13,9	4,2	86,2	25,6	30,6	28,1	1,5	76,5	22,0
		SX	4,45	3,85	1,40	21,00	6,65	8,70				
		$S\overline{X}$	0,55	0,45	0,15	2,55	0,80	1,05				
I. shale	105	$\overline{X}$	22,1	24,1	5,6	116,9	26,0	23,9	25,0	4,8	90,4	4,8
		SX	9,95	9,95	2,60	43,75	8,75	8,15				
		$S\overline{X}$	0,95	0,95	0,25	4,25	0,85	0,80				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate; V. = vein; I. = indurated.

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 3d

Material	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform prep.%		
										Fac.	Pln.	Ind.
V. quartz	115	$\bar{X}$	19,9	16,1	4,7	83,3	24,1	29,4	26,8	-	90,4	9,6
		SX	4,70	4,00	1,50	20,60	7,20	7,80				
		S$\bar{X}$	0,45	0,35	0,15	1,90	0,65	0,75				
I. shale	103	$\bar{X}$	22,7	23,9	5,9	110,6	26,8	25,6	26,2	2,9	86,4	10,7
		SX	8,20	9,65	2,55	40,30	9,60	8,85				
		S$\bar{X}$	0,80	0,95	0,25	3,95	0,95	0,85				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;

V. = vein; I. = indurated.

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 3e

Material	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform prep.% Fac.	Pln.	Ind.
V. quartz	67	$\bar{X}$	20,8	18,0	5,0	91,4	24,6	28,2	26,4	3,0	86,6	10,4
		SX	7,00	4,95	2,20	25,75	8,10	9,10				
		$S\bar{X}$	0,85	0,60	0,25	3,15	1,00	1,10				
I. shale	212	$\bar{X}$	22,8	25,1	5,8	116,6	25,9	24,1	25,0	2,8	90,6	6,6
		SX	8,40	9,15	2,65	43,70	8,10	8,95				
		$S\bar{X}$	0,60	0,65	0,20	3,0	0,55	0,60				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate; V. = vein; I. = indurated.

<u>Appendix 61 Metrical analysis : I2 subclass</u>

Heuningsneskrans Shelter. Excavation 1968. Stratum 3f

Material	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform prep.% Fac.	Pln.	Ind.
V. quartz	24	$\bar{X}$	17,4	17,7	4,6	107,1	26,4	26,9	-	-	58,3	41,7
		SX	-	-	-	-	-	-				
		$S\bar{X}$	-	-	-	-	-	-				
I. shale	56	$\bar{X}$	20,3	24,8	5,5	125,4	27,2	22,6	24,9	1,8	94,6	3,6
		SX	7,30	10,80	2,45	36,60	8,60	7,05				
		$S\bar{X}$	1,00	1,45	0,35	4,90	1,15	0,95				

<u>Abbreviations</u>

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
V. = vein; I. = indurated.

Appendix 61 Metrical analysis : I2 subclass

Heuningsneskrans Shelter. Excavation 1968. Stratum 3g and 3h

Material	Sample n	Analysis	L mm	B mm	T mm	B% / L	T% / L	T% / B	Rel.T	Platform prep.% Fac.	Pln.	Ind.
V. quartz	13	$\bar{X}$	19,6	16,7	4,5	87,4	23,6	27,3	-	-	76,9	23,1
		SX	-	-	-	-	-	-				
		S$\bar{X}$	-	-	-	-	-	-				
I. shale	50	$\bar{X}$	21,2	23,6	6,1	118,1	28,8	26,3	27,6	8,0	78,0	16,0
		SX	7,65	9,25	2,95	46,40	8,85	8,20				
		S$\bar{X}$	1,10	1,30	0,40	6,55	1,25	1,15				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;
V. = vein; I. = indurated.

Appendix 61 Metrical analysis : I2. L.

Heuningsneskrans Shelter. Excavation 1968

Material	Analysis	Stratum 1a	1b	2a	2b+3a	3b	3c	3d	3e	3f	3g+3h
V.quartz	$\bar{X}$	18,4	18,5	19,3	18,7	19,3	16,6	19,9	20,8	17,4	19,6
	SX	5,95	5,85	-	7,00	-	4,45	4,70	7,00	-	-
	S$\bar{X}$	0,90	0,50	-	-	-	0,55	0,45	0,85	-	-
	n	46	127	29	39	14	68	115	67	24	13
I. shale	$\bar{X}$	22,7	21,1	17,7	16,5	22,5	22,1	22,7	22,8	20,3	21,2
	SX	8,00	7,95	6,25	5,55	9,05	9,95	8,20	8,40	7,30	7,65
	S$\bar{X}$	1,10	0,60	0,55	0,65	0,80	0,95	0,80	0,60	1,00	1,10
	n	53	164	126	89	132	105	103	212	56	50

Abbreviations

V = vein; I = indurated

Appendix 61 Metrical analysis : I2 B/L%

Heuningsneskrans Shelter. Excavation 1968

Material	Analysis	Stratum									
		1a	1b	2a	2b+3a	3b	3c	3d	3e	3f	3g+3h
V. quartz	$\bar{X}$	95,5	95,6	100,9	98,9	90,9	86,2	83,3	91,4	107,1	87,4
	SX	26,80	26,80	-	29,85	-	21,00	20,60	25,75	-	-
	$S\bar{X}$	3,95	2,40	-	-	-	2,55	1,90	3,15	-	-
	n	46	127	29	39	14	68	115	67	24	13
I. shale	$\bar{X}$	109,3	118,0	128,3	129,4	120,2	116,9	110,6	116,6	125,4	118,1
	SX	39,35	41,15	37,75	44,85	41,25	43,75	40,30	43,70	36,60	46,40
	$S\bar{X}$	5,40	3,20	3,35	5,55	3,60	4,25	3,95	3,00	4,90	6,55
	n	53	164	126	89	132	105	103	212	56	50

Abbreviations

V = vein; I = indurated

Appendix 61 Metrical analysis : I2. Rel. T.

Heuningsneskrans Shelter. Excavation 1968

Material	Analysis	Stratum 1a	1b	2a	2b+3a	3b	3c	3d	3e	3f	3g+3h
V. quartz	$\overline{X}$	28,2	28,1	27,0	27,1	28,0	28,1	26,8	26,4	26,7	25,5
	SX	8,60	9,20	-	8,60	-	7,70	7,50	8,60	-	-
	$S\overline{X}$	1,30	0,80	-	-	-	0,95	0,70	1,05	-	-
	n	46	127	29	39	14	68	115	67	24	13
I. shale	$\overline{X}$	24,5	24,5	22,5	21,9	24,1	25,0	26,2	25,0	24,9	27,6
	SX	8,65	7,95	7,40	7,80	7,90	8,45	9,25	8,55	7,85	8,55
	$S\overline{X}$	1,20	0,60	0,65	0,95	0,70	0,85	0,90	0,60	1,05	1,20
	n	53	164	126	89	132	105	103	212	56	50

Abbreviations

V = vein; I = indurated

Appendix 61 Metrical analysis : I2. V.

Heuningsneskrans Shelter. Excavation 1968

Material	Analysis	Stratum									
		1a	1b	2a	2b+3a	3b	3c	3d	3e	3f	3g+3h
V. quartz	L	32,3	31,6	-	37,4	-	26,8	23,6	33,7	-	-
	B	36,6	33,0	-	33,4	-	27,7	24,8	27,5	-	-
	T	48,0	44,0	-	50,0	-	33,3	31,9	44,0	-	-
	$\overline{X}$	39,0	36,2	-	40,3	-	29,3	26,8	35,1	-	-
	$\frac{B}{L}$	28,1	28,0	-	30,2	-	24,4	24,7	28,2	-	-
	$\frac{T}{L}$	28,2	33,9	-	32,6	-	26,0	29,9	32,9	-	-
	$\frac{T}{B}$	32,9	31,5	-	30,8	-	28,4	26,5	32,3	-	-
	$\overline{X}$	29,7	31,1	-	31,2	-	26,3	27,0	31,1	-	-
	n	46	127	29	39	14	68	115	67	24	13

Appendix 61 Metrical analysis : I2. V

Heuningsneskrans Shelter. Excavation 1968

Material	Analysis	Stratum 1a	1b	2a	2b+3a	3b	3c	3d	3e	3f	3g+3h
I. shale	L	35,2	37,7	35,3	33,6	40,2	45,0	36,1	36,8	36,0	36,1
	B	40,0	34,9	41,0	33,3	47,1	41,3	40,4	36,5	43,5	39,2
	T	61,4	45,4	50,0	51,3	47,4	46,4	43,2	45,7	44,5	48,4
	$\bar{X}$	45,5	39,3	42,1	39,4	44,9	44,2	39,9	39,7	41,3	41,2
	$\frac{B}{L}$	36,0	34,9	29,4	34,7	34,3	37,4	36,4	37,5	29,2	39,3
	$\frac{T}{L}$	33,6	28,7	30,3	33,5	32,4	33,7	35,8	31,3	31,6	30,7
	$\frac{T}{B}$	37,0	36,6	36,2	38,1	32,2	34,1	34,6	37,1	31,2	31,2
	$\bar{X}$	35,5	33,4	32,0	35,4	33,3	35,1	35,6	35,3	30,7	33,7
	n	53	164	126	89	132	105	103	212	56	50

FIG. 1 HEUNINGSNESKRANS SHELTER MOST PROBABLE SEDIMENTATION RATES

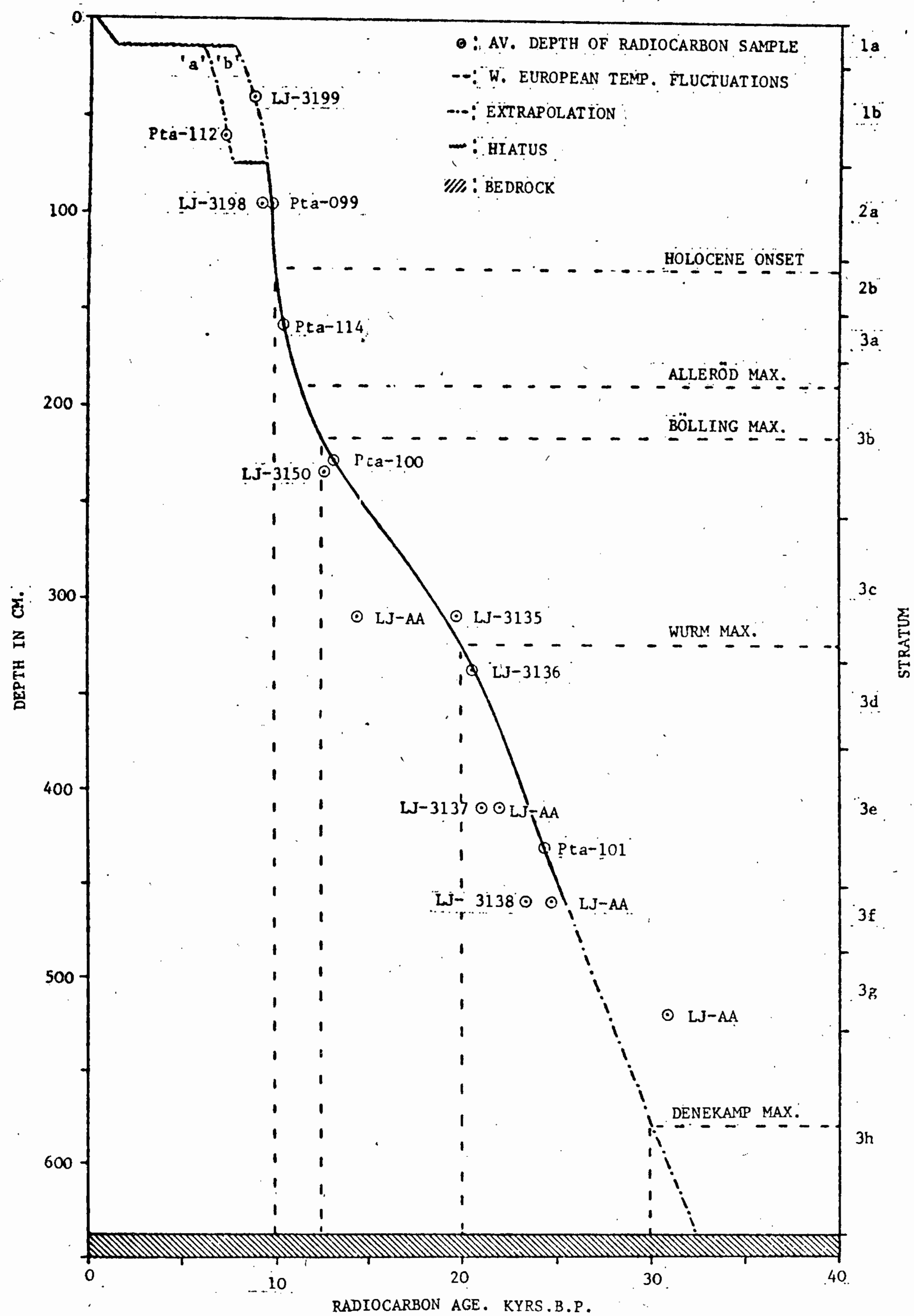


FIG.2 I2. SUBCLASS LENGTH. CHANGES WITH ABSOLUTE TIME

HEUNINGSNESKRANS SHELTER. EXC. 1968.

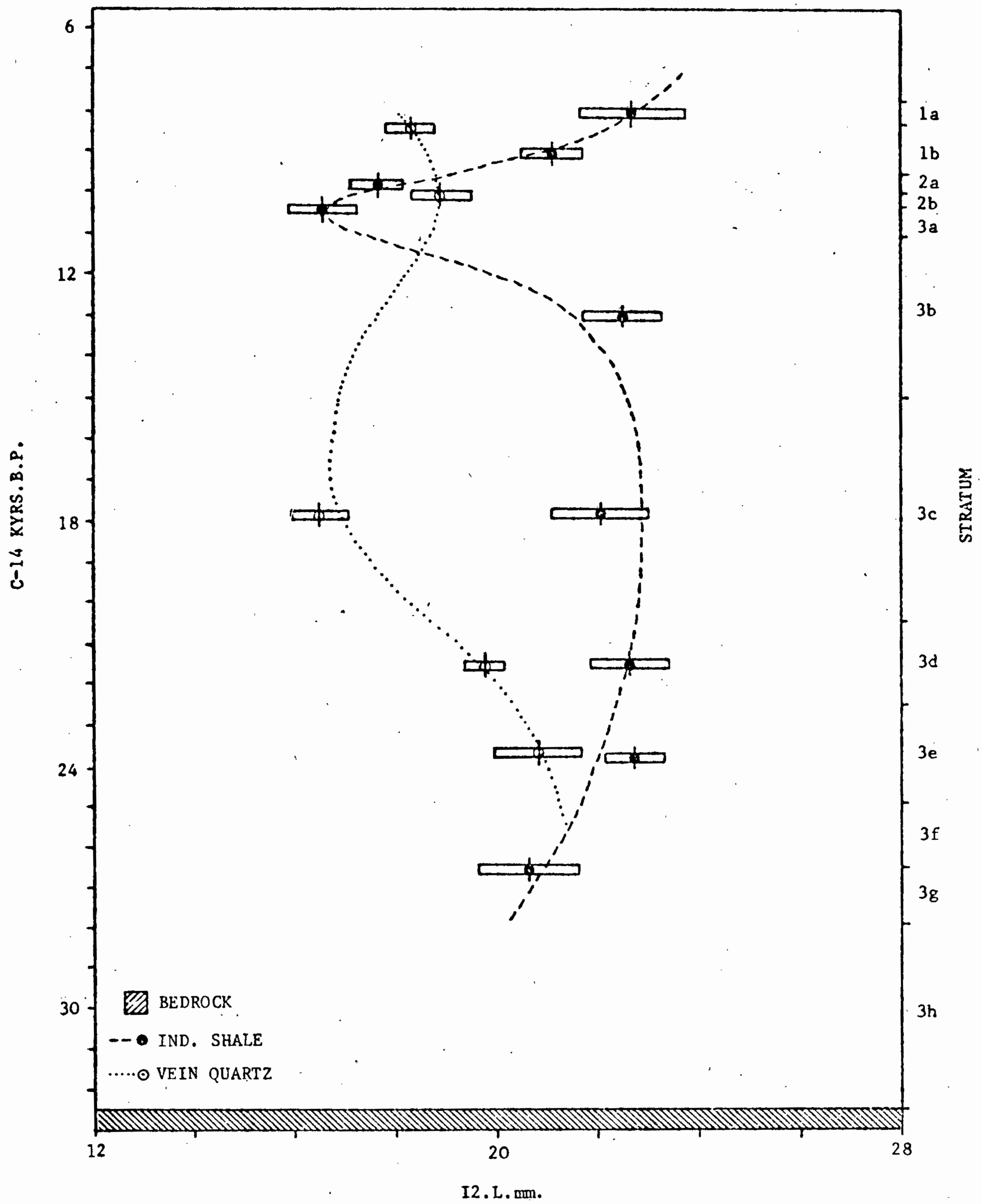


FIG. 3 I2 SUBCLASS B/L PROPORTION CHANGES WITH ABSOLUTE TIME

HEUNINGSNESKRANS SHELTER. EXC. 1968

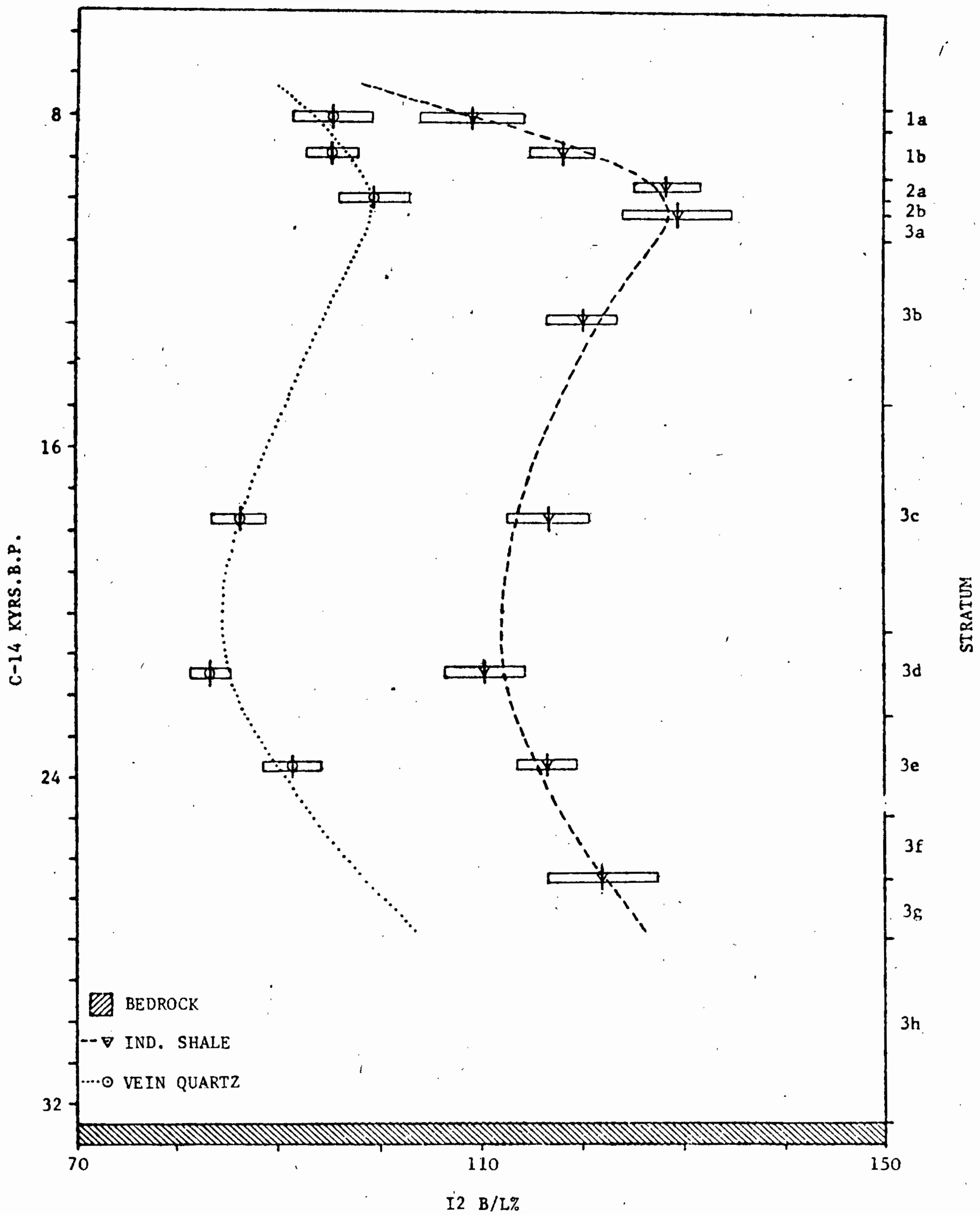


FIG. 4 I2 SUBCLASS REL.T. CHANGES WITH ABSOLUTE TIME

HEUNINGSNESKRANS SHELTER. EXC.1968

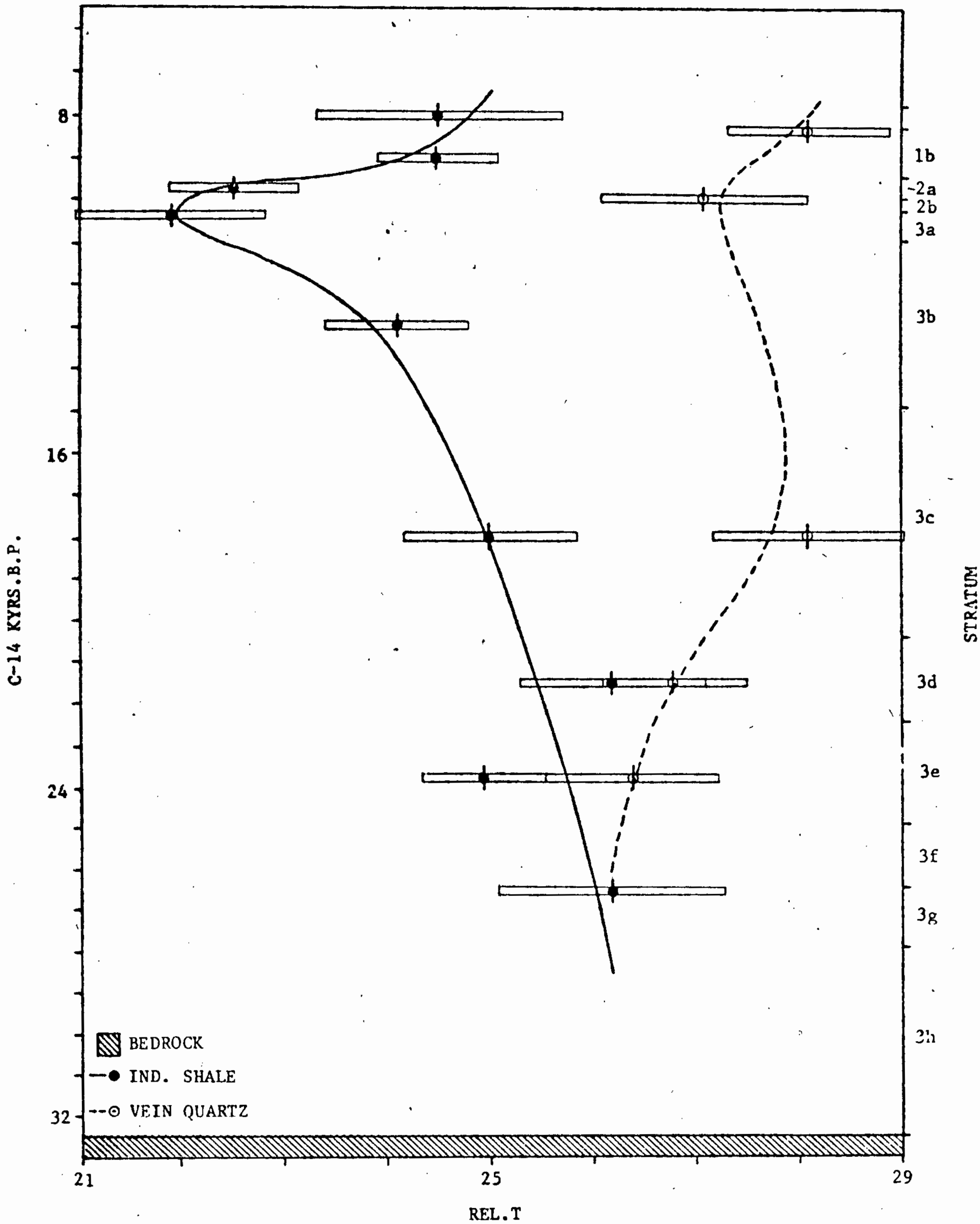


FIG. 5 I2 SUBCLASS V CHANGES WITH ABSOLUTE TIME

HEUNINGSNESKRANS SHELTER. EXC. 1968

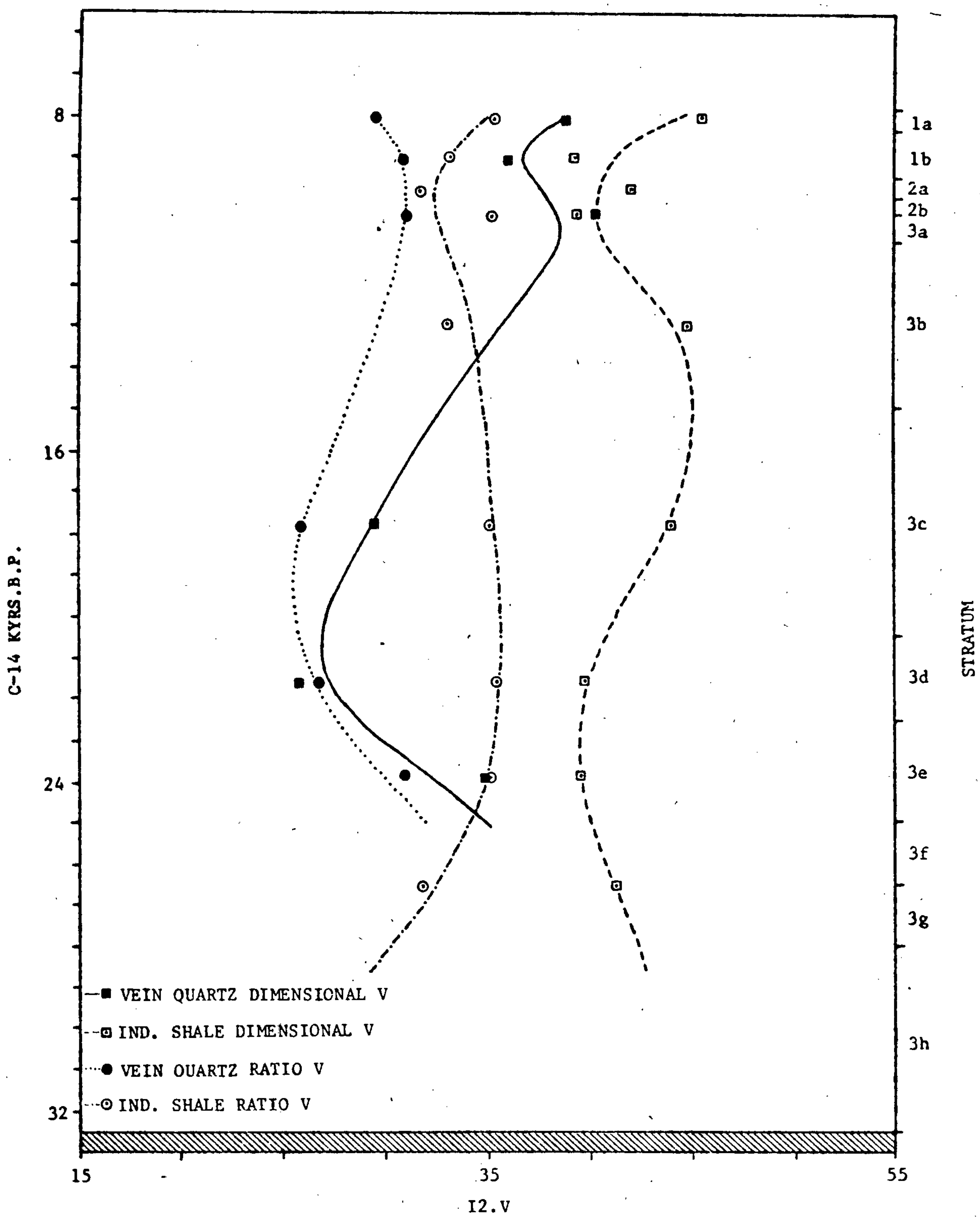


FIG. 6 HEUNINGSNESKRANS SHELTER: BONE FRAGMENTS PER KG.

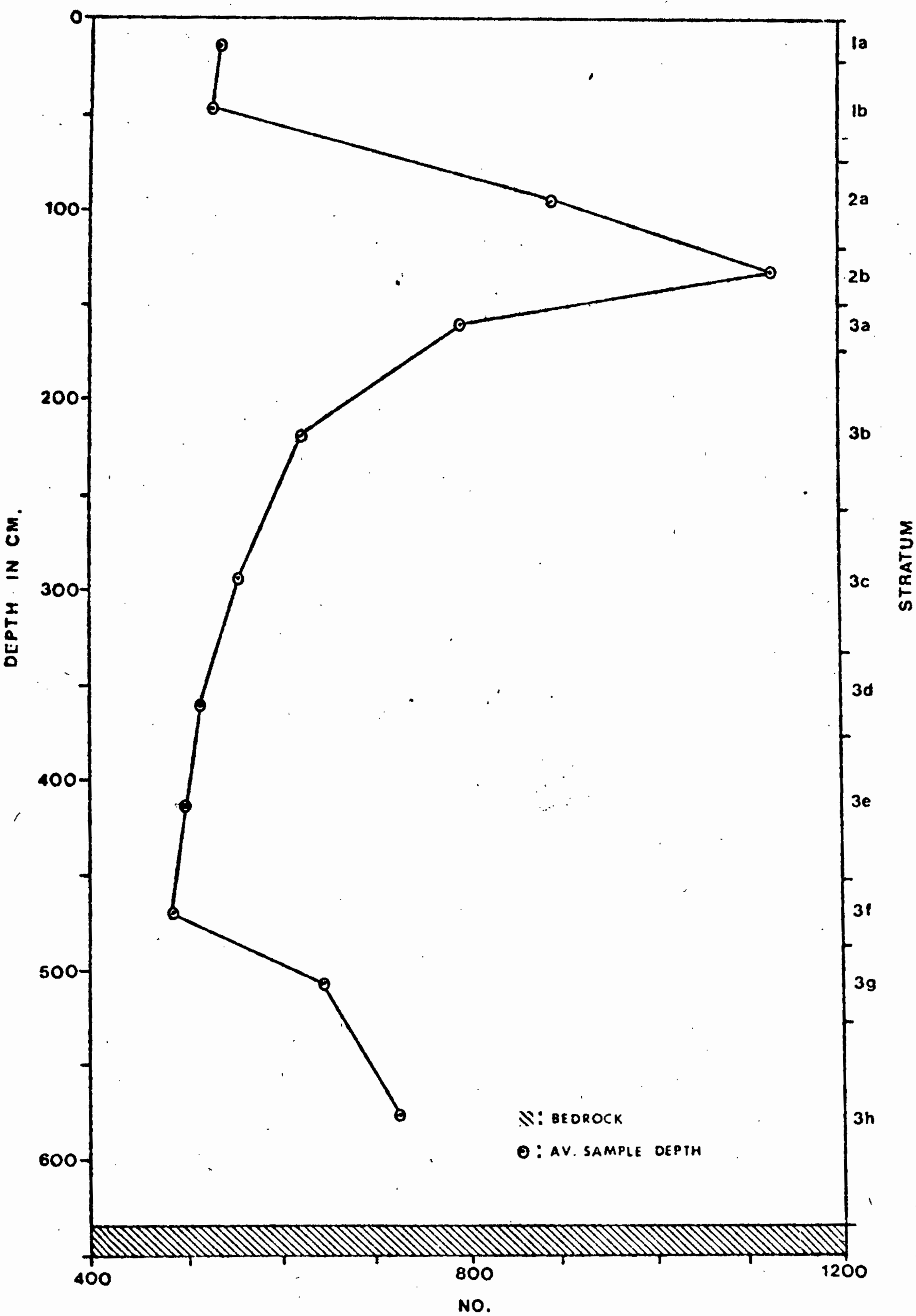
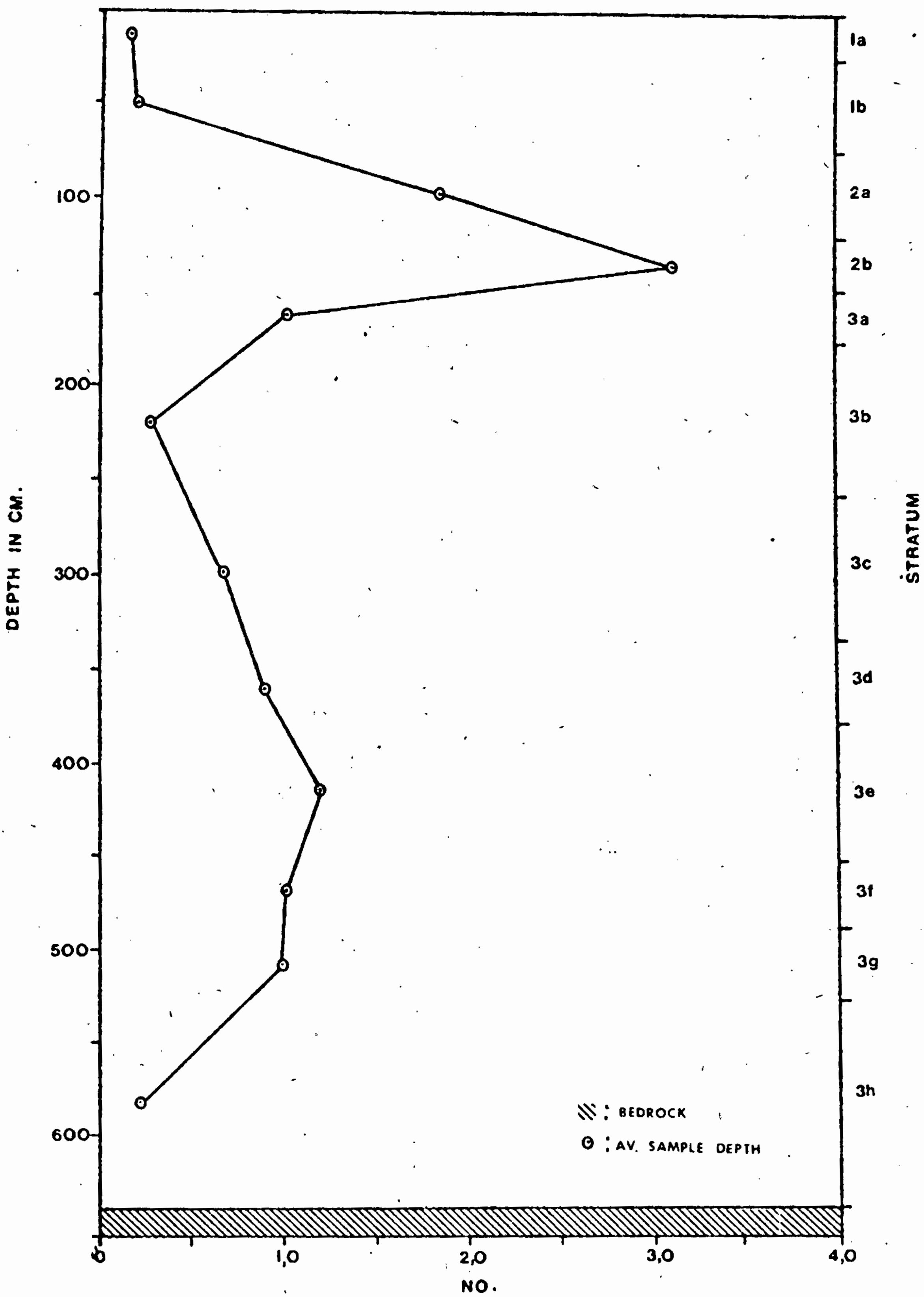


FIG. 7 HEUNINGSNESKRANS SHELTER: ARTEFACTS PER YEAR PER SQ. M.



Appendix 62 Rose Cottage Cave

Locality: Situated on the upper northern slopes of the Platberg, 5km S.E. of Ladybrand, in the eastern O.F.S., at $29^{o}15'$S, 27^{o} 30'E.
Excavations: Investigated by Malan between 1942 and 1945 and by Beaumont in early 1962 (Malan, 1947; Beaumont,1963; Schoonraad and Beaumont, 1968).
Stratigraphy: The deposit had a maximum thickness of 6,1m in the 1962 trench. Nine distinct units were identified within this. These were excavated separately by way of 5cm horizontal spits. Details are as follows :

Stratum 1: ~ 0-25cm. Horizontal brown-grey sand with some ash lenses. Wilton (Phase 3) artefacts abundant. A few sherds and modern objects. Bone abundant and unweathered.

Stratum 2: ~ 25-50cm. Horizontal grey sand with many ash lenses. Wilton (Phase 2) artefacts abundant. Bone less common.

Stratum 3: ~ 50-75cm. Horizontal beige sand with few ash lenses. Wilton (Phase 1) artefacts less common. Bone sparse and weathered.

Stratum 4: ~ 75-150cm. Horizontal grey sand with many ash lenses. 'Pre-Wilton' artefacts abundant. Bone entirely absent.

Stratum 5: ~ 150-300cm. Horizontal beige sand with sporadic and thin ash lenses. Associated with these floors are a few artefacts of 'Early LSA' type.

Stratum 6: ~ 300-350cm. A sloping grey-brown ash lense (upper hearth) unconformably underlying stratum 5 over much of the excavated area. 'Magosian' artefacts are abundant.

Stratum 7: ~ 350-375cm. A conformably sloping deep beige gritty sand. Virtually sterile.

Stratum 8: ~ 375-400cm. A sloping grey-brown ash lense (lower hearth) unconformably overlying Stratum 9 over much of the excavated area. 'Magosian' artefacts are abundant.

Stratum 9: ~ 400-610cm. A white sand with much rubble. 'Magosian' artefacts are abundant throughout.

Datings: The following C-14 readings have been obtained (Mason, 1969; Vogel, 1970; Vogel and Marais, 1971):

GrN - 5298 R.C.C. 1,100 ± 30 B.P.

Charcoal from base of Stratum 1, associated with Pottery Wilton (Phase 3).

GrN - 5299 R.C.C. 6,850 ± 45 B.P.

Charcoal from lower portion of Stratum 2, associated with Wilton (Phase 2).

Pta - 211	R.C.C.	29,430 ± 520 B.P.

Charcoal from near base of Stratum 4, associated with 'Pre-Wilton'.

GrN - 5300	R.C.C.	25,640 ± 220 B.P.

Charcoal from near base of Stratum 4, associated with 'Pre-Wilton'.

Pta - 354	R.C.C.	> 40,950 B.P.

Charcoal from base of Stratum 5, associated with 'Early L.S.A.'

Pta - 213	R.C.C.	> 50,200 B.P.

Charcoal from Stratum 6, associated with 'Upper Magosian'.

Pta - 001	R.C.C.	36,100 ± 2000 B.P.

Charcoal from Stratum 8, associated with 'Upper Magosian'.

Pta - 231	R.C.C.	> 48,400 B.P.

Charcoal from Stratum 8, associated with 'Upper Magosian'.

Pta - 214	R.C.C.	> 42,500 B.P.

Charcoal from Stratum 8, associated with 'Upper Magosian'.

SR - 116	R.C.C.	> 50,000 B.P.

Charcoal from Stratum 8, associated with 'Upper Magosian'.

Analysis: A preliminary investigation of small random artefact samples from all levels was undertaken in late 1962.

Materials: Our data suggest that the 'Magosian' horizons do not differ significantly in terms of utilized rock-types (Chalcedony: 84, 7% in Stratum 6 and 8; 81, 2% in Stratum 9). The sandstone/quartzite was noted to be very variable in terms of grain-size and induration. A fair percentage derived from river cobbles and/or nodules.

References

BEAUMONT, P.B. 1963. Two interesting artefacts from Rose Cottage Cave. S. Afr. archaeol. Bull., 18, 60-61.

MALAN, B.D. 1952. The final phase of the Middle Stone Age in South Africa. In: Proc. 1st pan-Afr. Congr. Prehist., Nairobi 1947. Oxford. Basil Blackwell.

MASON, R.J. 1969. Tentative interpretations of new radiocarbon dates for stone artefact assemblages from Rose Cottage Cave, O.F.S. and Bushman Rock Shelter, Tvl. S. Afr. archaeol. Bull., 24, 57-59.

SCHOONRAAD, M. and BEAUMONT, P.B. 1968. The North Braban Shelter, north western Transvaal. S. Afr. J. Sci., 64, 319-331.

VOGEL, J.C. 1970. Groningen radiocarbon dates 9. Radiocarbon, 12, 444-471.

VOGEL, J.C. and MARAIS, M. 1971. Pretoria radiocarbon dates I. Radiocarbon, 13, 378-394.

APPENDIX 62 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Rose Cottage Cave. Exc. 1962. Stratum 6 and 8

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material					Totals
				Quartzite	Ind. shale	Dolerite	Quartz	Chalcedony	
Flaking	Tool 1	Scraper	Straight-edged	1	–	–	–	17	18
			Convex-edged	2	–	–	–	4	6
			Concave-edged	–	–	–	–	–	–
			Irregular-edged	–	–	–	–	–	–
			Compound	–	–	–	–	1	1
		Trimmed point 1	Defined	–	–	–	–	–	–
			Convergent	–	2	–	–	6	8
			Oblique	–	–	–	–	–	–
		Trimmed point 2	Unifacial	–	–	–	–	–	–
			Bifacial	–	–	–	–	–	–
		Backed piece 1	Curve-backed	–	–	–	–	6	6
			Irregular-backed	–	–	–	–	–	–
		Backed piece 2	Segment	–	–	–	–	–	–
			Trapeze	–	–	–	–	–	–
		Borer		–	–	–	–	–	–
	Subtotals			3	2	–	–	34	39
	Tool 2	Burin		–	–	–	–	–	–
		Scaled piece	Single-edged	–	–	–	–	1	1
			Double-edged	–	–	–	–	–	–
	Subtotals			–	–	–	–	1	1

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material					Totals
				Quartzite	Ind.shale	Dolerite	Quartz	Chalcedony	
Flaking	Flake	Irregular	I1 (a)	1	-	-	-	13	14
			I1 (b)	4	2	-	-	117	123
			I2	11	1	-	-	100	112
		Blade	B1 (a)	-	-	-	-	7	7
			B1 (b)	5	-	-	-	39	44
			B2 (a)	2	1	-	-	20	23
			B2 (b)	2	-	-	-	28	30
		Point	P1 (a)	-	-	-	-	-	-
			P1 (b)	-	-	-	-	-	-
			P2 (a)	-	-	-	-	-	-
			P2 (b)	-	-	-	-	-	-
		Blade-Point	BP2 (a) and (b)	-	1	-	-	-	1
	Subtotals			25	5	-	-	324	354
	Core	Irregular		-	-	-	-	46	46
		Bipolar		-	-	-	-	1	1
		Adjacent platform		-	-	-	-	2	2
		Radial prepared	Discoidal	-	-	-	-	-	-
			Blade	-	-	-	-	-	-
		Plain platform		-	-	-	-	10	10
	Subtotals			-	-	-	-	59	59

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material					Totals
				Quartzite	Ind.shale	Dolerite	Quartz	Chalcedony	
Flaking	Waste	Broken flakes		44	28	-	-	327	399
		Unclassi-fiable		47	43	-	3	375	468
	Subtotals			91	71	-	3	710	867
Incidental	Utilized	Hammerstone?		-	-	2	-	-	2
		Pigment	Haematite Ground						2
			Haematite Plain						17
			Miscella-neous Plain						-
	Subtotals			-	-	2	-	-	21

APPENDIX 62 TYPOLOGICAL ANALYSIS : FLAKING AND INCIDENTAL PROCESSES

Rose Cottage Cave. Exc. 1962. Stratum 9

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material: Quartzite	Ind. shale	Dolerite	Quartz	Chalcedony	Totals
Flaking	Tool 1	Scraper	Straight-edged	12	–	–	–	30	42
			Convex-edged	1	1	–	–	8	10
			Concave-edged	–	–	–	–	5	5
			Irregular-edged	–	–	–	–	1	1
			Compound	–	–	–	–	1	1
		Trimmed point 1	Defined	–	–	–	–	–	–
			Convergent	2	–	–	–	2	4
			Oblique	–	–	–	–	–	–
		Trimmed point 2	Unifacial	–	1	–	–	1	2
			Bifacial	–	–	–	–	–	–
		Backed piece 1	Curve-backed	2	–	–	–	13	15
			Irregular-backed	–	–	–	–	–	–
		Backed piece 2	Segment	1	–	–	–	9	10
			Trapeze	–	–	–	–	–	–
		Borer		–	–	–	–	1	1
	Subtotals			18	2	–	–	71	91
	Tool 2	Burin		–	–	–	–	–	–
		Scaled piece	Single-edged	2	1	–	–	7	10
			Double-edged	–	–	–	–	1	1
	Subtotals			2	1	–	–	8	11

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material					Totals
				Quartzite	Ind.shale	Dolerite	Quartz	Chalcedony	
Flaking	Flake	Irregular	I1 (a)	2	-	-	-	20	22
			I1 (b)	29	1	-	-	191	221
			I2	45	5	-	-	160	210
		Blade	B1 (a)	1	-	-	-	8	9
			B1 (b)	7	1	-	-	72	80
			B2 (a)	15	-	-	-	29	44
			B2 (b)	8	3	-	-	66	77
		Point	P1 (a)	-	-	-	-	-	-
			P1 (b)	-	-	-	-	-	-
			P2 (a)	-	-	-	-	1	1
			P2 (b)	2	-	-	-	-	2
		Blade-Point	BP2 (a) and (b)	2	1	-	-	-	3
	Subtotals			111	11	-	-	547	669
	Core	Irregular		2	3	-	1	88	94
		Bipolar		-	-	-	-	2	2
		Adjacent platform		2	1	-	-	1	4
		Radial prepared	Discoidal	-	-	-	-	1	1
			Blade	-	-	-	-	-	-
		Plain platform		3	1	-	-	30	34
	Subtotals			7	5	-	1	122	135

Technological Process	Analytical Group	Typological Class	Typological Subclass	Material					Totals
				Quartzite	Ind.shale	Dolerite	Quartz	Chalcedony	
Flaking	Waste	Broken flakes		131	79	-	1	738	949
		Unclassi-fiable		88	61	-	14	896	1059
	Subtotals			219	140	-	15	1634	2008
Incidental	Utilized	Hammerstone?		-	-	21	-	-	21
		Pigment	Haematite Ground						8
			Haematite Plain						39
			Miscella-neous Plain						-
	Subtotals			-	-	21	-	-	68

Appendix 62 Metrical Analysis. Means

Rose Cottage. Exc. 1962

Stratum	Sub-class	Material	Sample	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform Prep. % Fac.	Pln.	Ind.
1-3	I2	Chalc.	165	$\bar{X}$	15,9	14,2	3,5	94,9	22,2	24,6	23,4	1,8	77,0	21,2
		Qtzite.	91	$\bar{X}$	26,5	26,2	6,8	101,2	24,9	25,4	25,2	-	91,2	8,8
		Ind.s.	44	$\bar{X}$	21,4	20,9	5,0	104,0	23,7	24,6	24,2	-	86,4	13,6
4	I2	Chalc.	51	$\bar{X}$	16,1	13,7	3,3	90,2	19,4	23,6	21,5	-	92,2	7,8
	B2	Chalc.	21	$\bar{X}$	20,0	8,7	2,3	45,7	12,0	27,6	-	-	81,0	19,0
6 + 8	I2	Chalc.	50	$\bar{X}$	22,1	15,4	3,2	77,3	14,7	22,1	18,4	24,0	52,0	24,0
	B2	Chalc.	28	$\bar{X}$	27,0	12,3	3,0	46,1	11,7	26,5	19,1	3,6	50,0	46,4
9	I2	Chalc.	50	$\bar{X}$	24,0	17,7	3,9	79,9	16,5	22,6	19,6	24,0	50,0	26,0
	I2	Qtzite.	22	$\bar{X}$	35,5	23,5	5,7	74,6	16,8	25,0	20,9	50,0	31,8	18,2
	B2	Chalc.	56	$\bar{X}$	30,3	12,5	3,6	41,3	11,8	29,8	20,8	5,3	64,3	30,4

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate

Chalc. = chalcedony; Qtzite. = quartzite; Ind.s. = indurated shale.

Appendix 63 Montagu Cave

Locality: Situated on the farm Derdeheuvel, about 10km E. of Montagu, in the south-western Cape at 33° 50'S, 20° 10'E.

Excavation: Trenched by S.H. Haughton and K.H. Barnard in 1919 and by C.M. Keller in 1964-65.

Stratigraphy: The following units were identified in the latter excavation:

Surface: Rubble from guano mining.

Layer 1: ~ 0-30cm thick; light brown sand covering a restricted area. Wilton.

Layer 2: ~ 23-152cm thick; mottled dark grey sand. Occupation 'surfaces' 1-7 in upper portion. Howieson's Poort. *s.l.*

Layer 3: ~ 36cm thick; sandy clay ranging in colour from white to reddish-brown. Acheulian.

Layer 4: ~ 0-107cm thick; red sand covering a restricted area. Sterile.

Layer 5: ~ 61-122cm thick; sandy clay bands ranging in colour from white to dark brown. Occupation 'surfaces' 8-11. Acheulian.

C-14 datings: The following readings have been obtained (Vogel and Waterbolk, 1967: 146; Vogel, 1970: 460-461; Keller, 1970a : 47; Keller 1970b: 193) :

GrN - 4725 M.C. 7,100 ± 45B.P.

Charcoal from surface levels of Layer 1, associated with Wilton.

GrN - 4726 M.C. 23,200 ± 180 B.P.

Charcoal from Surface 1 of Stratum 2, associated with Howieson's Poort *s.l.*

GrN - 5123 M.C. 19,100 ± 110 B.P.

A mixture of charcoal and black sand from between Surfaces 6 and 7 in Layer 2, associated with Howieson's Poort *s.l.*

GrN 5124 M.C. > 50,800 B.P.

Charcoal from just below Surface 7 in Layer 2, associated with Howieson's Poort *s.s.*

GrN - 4728 M.C. 45,900 ± 2100 B.P.

Charcoal from base of Layer 2, associated with Howieson's Poort *s.s.*

GX - 0947 M.C. > 38,000 B.P.

Charcoal ? from base of Layer 2, associated with Howieson's Poort *s.s.*

Analysis: Descriptions of the various aggregates have been published by Goodwin (1929) and by Keller (1970b; 1973). My metrical examination was undertaken in 1968 with the kind permission of Miss E. Shaw.

Materials: The T.M.S. quartzite varies widely in terms of grain-size but is generally coarse and felspathic. Indurated shale items were deleted from the analysis. Specimens based on a poor quality silcrete were included in the chalcedony class.

References

GOODWIN, A.J.H. 1929. The Montagu Cave: a full report of the investigation of the Montagu rock-shelter. Ann. S. Afr. Mus., 24, 1-16.

KELLER, C.M. 1970a. C14 dates - Montagu Cave. S. Afr. archaeol. Bull., 25, 47.

KELLER, C.M. 1970b. Montagu Cave: a preliminary report. Quaternaria, 13, 187-203.

KELLER, C.M. 1973. Montagu Cave in prehistory: a descriptive analysis. University of California Press. Anthropological Records. 28

VOGEL, J.C. and WATERBOLK, H.T. 1967. Groningen radiocarbon dates 7. Radiocarbon, 9, 107-155.

VOGEL, J.C. 1970. Groningen radiocarbon dates 9. Radiocarbon 12, 444-471.

Appendix 63 Unbroken flake class proportions. Quartzite

Montagu Cave. 1964-5 Excavation

Subclass	Analysis	Stratum 1	2UP.	2LR.	3UP.	3LR.	5
I1	n	51	68	58	47	62	91
	%	29,0	28,0	20,4	24,5	16,1	20,4
I2	n	107	154	196	136	312	335
	%	60,8	63,4	68,8	70,8	81,0	74,9
Sub.T	n	158	222	254	183	374	426
	%	89,8	91,4	89,1	95,3	97,1	95,3
B1	n	4	1	2	-	-	2
	%	2,3	0,4	0,7	-	-	0,4
B2	n	14	19	26	8	10	19
	%	8,0	7,8	9,1	4,2	2,6	4,3
Sub.T	n	18	20	28	8	10	21
	%	10,2	8,2	9,8	4,2	2,6	4,7
P1	n	-	-	-	-	-	-
	%	-	-	-	-	-	-
P2	n	-	1	2	-	-	-
	%	-	0,4	0,7	-	-	-
Sub.T	n	-	1	2	-	-	-
	%	-	0,4	0,7	-	-	-
BP	n	-	-	1	1	1	-
	%	-	-	0,4	0,5	0,3	-
Grand T	n	176	243	285	192	385	447

Abbreviations

T = total

Appendix 63 Unbroken flake class proportions. Chalcedony +
Montagu Cave. 1964-65 Excavation

Subclass	Analysis	Stratum 1	2UP	2LR
I1	n	22	22	63
	%	41,5	24,7	32,5
I2	n	25	47	105
	%	47,2	52,8	54,1
Sub.T	n	47	69	168
	%	88,7	77,5	86,6
B1	n	1	2	3
	%	1,9	2,2	1,5
B2	n	5	18	21
	%	9,4	20,2	10,8
Sub.T	n	6	20	24
	%	11,3	22,5	12,4
P1	n	-	-	-
	%	-	-	-
P2	n	-	-	-
	%	-	-	-
Sub.T	n	-	-	-
	%	-	-	-
BP.	n	-	-	2
	%	-	-	1,0
Grand T.	n	53	89	194

Abbreviations

T = total

Appendix 63 Metrical analysis : I1 and I2 subclasses

Montagu Cave. Excavation 1965. Stratum 2UP

Raw Material	Flake subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}$%	$\frac{T}{L}$%	$\frac{T}{B}$%	Rel.T	Platform Prep. % Fac.	Pln.	Ind.
Qtzite	I1	63	$\bar{X}$	43,5	41,2	12,8	101,6	30,3	31,1	30,7	3,2	85,7	11,1
	I2	154	$\bar{X}$	36,9	33,8	9,3	101,2	26,5	27,6	27,1	7,8	81,2	11,0
			SX	18,75	15,05	4,90	38,65	10,65	9,90				
			$S\bar{X}$	1,50	1,20	0,40	3,10	0,85	0,80				
Chalc.	I1	19	$\bar{X}$	23,0	18,3	4,9	90,4	22,8	27,6	-	10,5	73,7	15,8
	I2	47	$\bar{X}$	22,6	18,4	4,3	88,6	19,8	23,1	21,5	17,0	61,7	21,3
			SX	7,55	6,45	2,10	36,55	9,25	6,80				
			$S\bar{X}$	1,10	0,95	0,30	5,35	1,35	1,00				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;

Qtzite. = quartzite; Chalc. = chalcedony

Appendix 63 Metrical analysis : I1 and I2 subclasses

Montagu Cave. Excavation 1965. Stratum 2LR.

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform Prep.% Fac.	Pln.	Ind.
Qtzite.	I1	55	$\bar{X}$	35,8	36,2	10,3	109,1	30,8	30,3	30,6	3,6	80,0	16,4
	I2	196	$\bar{X}$	30,4	29,2	7,6	103,3	25,3	25,8	25,6	14,3	65,8	19,9
			SX	15,20	13,65	4,30	35,45	8,25	8,10				
			$S\bar{X}$	1,10	0,95	0,30	2,55	0,60	0,60				
Chalc.	I1	60	$\bar{X}$	23,0	17,8	4,7	84,4	21,3	27,4	24,4	10,0	58,3	31,7
	I2	105	$\bar{X}$	20,2	15,7	3,5	85,7	18,4	22,8	20,6	13,4	55,2	31,4
			SX	8,95	5,50	1,40	34,15	7,00	7,60				
			$S\bar{X}$	0,90	0,55	0,15	3,35	0,70	0,75				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;

Qtzite. = quartzite; Chalc. = chalcedony.

Appendix 63 Metrical analysis : I1 and I2 subclasses

Montagu Cave. Excavation 1965. Stratum 3UP.

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. % Fac.	Pln.	Ind.
Qtzite.	I1	38	$\overline{X}$	49,4	53,3	16,2	112,9	33,0	30,3	-	10,5	78,9	10,5
	I2	141	$\overline{X}$	33,6	36,5	9,3	118,4	28,9	25,6	27,3	4,2	81,6	14,2
			SX	18,10	18,00	5,95	40,20	11,80	9,70				
			$S\overline{X}$	1,55	1,50	0,50	3,40	1,00	0,80				

Appendix Metrical analysis : I1 and I2 subclasses

Montagu Cave. Excavation 1965. Stratum 3LR.

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel.T	Platform Prep. % Fac.	Pln.	Ind.
Qtzite.	I1	50	$\overline{X}$	39,9	46,7	13,4	129,4	35,0	29,8	32,4	10,0	86,0	4,0
	I2	320	$\overline{X}$	33,7	38,7	9,8	120,6	30,0	25,6	27,8	11,3	75,3	13,4
			SX	15,40	17,60	5,65	37,05	12,55	10,20				
			$S\overline{X}$	0,80	1,00	0,30	2,05	0,70	0,55				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;

Qtzite. = quartzite;

Appendix 63 Metrical analysis : I1 and I2 subclasses

Montagu Cave. Excavation 1965. Stratum 5

Raw Material	Flake Subclass	Sample n	Analysis	L mm	B mm	T mm	$\frac{B}{L}\%$	$\frac{T}{L}\%$	$\frac{T}{B}\%$	Rel.T	Platform Prep. % Fac.	Pln.	Ind.
Qtzite.	I1	79	$\bar{X}$	53,8	53,1	16,2	104,5	31,1	31,3	31,2	8,9	79,7	11,4
	I2	342	$\bar{X}$	44,8	44,9	12,9	106,4	29,9	29,3	29,6	10,5	76,9	12,6
			SX	19,80	18,55	6,15	33,25	11,15	10,20				
			$S\bar{X}$	1,05	1,00	0,35	1,80	0,60	0,55				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;

Qtzite. = quartzite;

Appendix 63 Metrical analysis : I2. L

Montagu Cave. Excavation 1965

Material	Analysis	2.UP.	2.LR.	Stratum 3.UP.	3.LR.	5
Qtzite.	$\overline{X}$	36,9	30,4	33,6	33,7	44,8
	SX	18,75	15,20	18,10	15,40	19,80
	$S\overline{X}$	1,50	1,10	1,55	0,80	1,05
	n	154	196	141	320	342
Chalc.	$\overline{X}$	22,6	20,2	-	-	-
	SX	7,55	8,95	-	-	-
	$S\overline{X}$	1,10	0,90	-	-	-
	n	47	105	-	-	-

Abbreviations

Qtzite. = quartzite; Chalc. = chalcedony

Appendix Metrical analysis : I2. B/L%

Montagu Cave. Excavation 1965

Material	Analysis	2.UP.	2.LR.	Stratum 3.UP.	3.LR.	5
Qtzite	$\overline{X}$	101,2	103,3	118,4	120,6	106,4
	SX	38,65	35,45	40,20	37,05	33,25
	$S\overline{X}$	3,10	2,55	3,40	2,05	1,80
	n	154	196	141	320	342
Chalc.	$\overline{X}$	88,6	85,7	-	-	-
	SX	36,55	34,15	-	-	-
	$S\overline{X}$	5,35	3,35	-	-	-
	n	47	105	-	-	-

Abbreviations

Qtzite. = quartzite. Chalc. = chalcedony

Appendix 63 Metrical analysis : I2. Rel. T

Montagu Cave. Excavation 1965

Material	Analysis	Stratum 2.UP.	2.LR.	3.UP.	3.LR.	5
Qtzite	$\bar{X}$	27,1	25,6	27,3	27,8	29,6
	SX	10,30	8,20	10,75	11,40	10,70
	$S\bar{X}$	0,85	0,60	0,90	0,65	0,60
	n	154	196	141	320	342
Chalc.	$\bar{X}$	21,5	20,6	-	-	-
	SX	8,05	7,30	-	-	-
	$S\bar{X}$	1,20	0,75	-	-	-
	n	47	105			

Abbreviations

Qtzite. = quartzite; Chalc. = chalcedony

Appendix 63 Metrical analysis : I2. V

Montagu Cave. Excavation 1965

Material	Analysis	Stratum 2.UP.	2.LR.	3.UP.	3.LR.	5
Qtzite	L	50,8	50,0	53,9	45,7	44,2
	B	44,5	46,7	49,3	45,5	41,3
	T	52,7	56,6	64,0	57,7	47,7
	$\bar{X}$	49,3	51,1	55,7	49,6	44,4
	$\frac{B}{L}$	38,2	34,3	34,0	30,7	31,3
	$\frac{T}{L}$	40,2	32,6	40,8	41,8	37,3
	$\frac{T}{B}$	35,9	31,4	37,9	39,8	34,8
	$\bar{X}$	38,1	32,8	37,6	37,4	34,5
	n	154	196	141	320	342

Abbreviation

Qtzite. = quartzite

Appendix 63 Metrical analysis : I2. V

Montagu Cave. Excavation 1965

Material	Analysis	2.UP.	2.LR.	Stratum 3.UP.	3.LR.	5
Chalc.	L	33,4	44,3	-	-	-
	B	35,1	35,0	-	-	-
	T	48,8	40,0	-	-	-
	$\overline{X}$	39,1	39,8	-	-	-
	$\frac{B}{L}$	41,3	39,8	-	-	-
	$\frac{T}{L}$	46,7	38,0	-	-	-
	$\frac{T}{B}$	29,4	33,3	-	-	-
	$\overline{X}$	39,1	37,0	-	-	-
	n	47	105	-	-	-

Abbreviation

Chalc. = chalcedony

Appendix 64 Indications of modern man's early religious awareness and practice in the light of recent palaeoanthropological research in Southern Africa. *

John N. Jonsson

Prior to the 19th century A.D. the existence of primordial religion was taken for granted by theologians. Subsequent to Feuerbach's 1841 psychogenetic theory however, the nature of religion has been viewed somewhat differently (cf. Feuerbach, 1957 and Freud 1962; Note 1). Generally speaking, religion is not now sought within the soil of man's origin; rather its presence is explained as being a consequence of mankind's development (Wilson, 1961). It follows from this that attention needs perforce to be given to the documented findings of human prehistory as the sole 'grundstoff' of all subsequent religious evaluations. Our common ground in this connection is in fact explicit in the statement by Hole and Heizer (1965) that "the new emphasis is on methods and theories of interpreting archaeological data in cultural terms". Considering this remark I could find no sound reason why such an approach could not or even should not include the religious idiom in its repertoire of functional interpretations.

In view of the religious factor already found embedded in ancient cultures (Ringgren and Ström, 1967) and the religious phenomena evidenced in emerging civilizations (Renfrew, 1972) it would seem not impossible that some semblance of religious awareness might have existed when man first appeared as *Homo sapiens sapiens*. However, the beginnings of religion have until recently remained enigmatic, despite the studies of prehistorians like James (1957), largely because the temporal and spatial data relating to the origins of modern man was itself ambiguous (Howells, 1967). In this context it can be seen that the discovery of remains of our own kind (de Villiers, 1973 and 1976) in levels of Border Cave dating to about 100,000 B.P. (Beaumont *et al.*, n.d.) is of real significance and no small contribution to the field of religious studies.

Of these vestiges the most illuminating from the viewpoint of this statement is the infant skeleton, regarding which the following remarks are pertinent:

1. The body was found together with a *Conus* seashell pendant or amulet (Cooke *et al.* 1945), presumably a rare and cherished item (the sea is 80km away) and unique in apparently representing the primordial beginnings of a tradition which led eventually to the often rich and varied

funerary remains of historic times.

2. The entire skeleton was found intact, which would seem to preclude either the possibility of a skull cult (e.g. Ofnet, Bavaria) or the ritual of endocannibalism, whereby relatives are devoured to ensure that the deceased remains in the closest possible union with the tribe.
3. We cannot be certain from the available evidence if the corpse was left to decompose before burial or not (Hastings, 1912). Whether colouring matter placed on flesh would eventually adhere to the underlying bone on dissolution is however a matter susceptible to the experimental approach (see below).
4. Some of the bones are recorded (Beaumont et al., n.d.) as 'having reddish-brown blotches which may represent traces of ochre, pencils of which occur throughout the deposit'. It would seem highly unlikely that this discolouration could have been due to natural factors, since no such markings were noted on the many animal bones recovered (Beaumont, pers. comm.). Some connection is thus likely with the ancient practice of using red ochre as an integral part of burial rites, quite probably as a symbolic or sacramental "surrogate for blood in all its life-giving and sustaining aspects". (Boshier and Beaumont, 1972). It would clearly be important in a case like this to establish the most probable sequence of events involved in the use of the haematite, namely whether it was sprinkled in the grave prior to burial or whether it was smeared on the body, either before or after final placement in the tomb. Unfortunately, in the past only stark recordings have been made and the presence of this phenomenon has usually not been considered to be of sufficient significance to merit the attention it deserves. Yet it is patent that more thorough attention to potential detail in this connection could well yield a rich return in interpretative data for both the archaeologist and the historian of religion. It is to the credit of Dart (cf. 1968) that he has drawn attention to the possibilities involved and also sought to evaluate what the raw data could possibly signify. That red ochre was a symbolic substance of pandemic interest to early man, with clear connotations of birth, danger and death would seem indisputable. For example (additional to Dart, op. cit.) Gesenius noted that men on Egyptian monuments were consistently represented as being red, while amongst the Hopi Indians red is the 'male' colour par excellence, linked with hunting and warfare (Bradfield, 1973). More difficult to interpret is the term 'Adam', which as a common noun, denotes a human being and

mankind collectively, but which has as its root, as it often occurs in Hebrew and Assyrian, the meaning of "to be red", as, for example, in the account of Edom (Genesis 25 : 30).

5. Finally, there is the evidence that the child came from an undoubted grave, albeit a very shallow one (Cooke, et al., 1945) This surely is a cultural trait which can be confidently interpreted by way of 'ethnographic analogy'. From that finding it would seem certain that the living inhabitants of the cave responded in a clearly recognisable way to the intersubjective, social relationships disrupted by the infant death, whether this be understood in the functionalist sense (cf. Malinowski, 1948; Note 2) or in terms of the structuralist understanding of the act (Durkheim, 1915; Note 3). More central to my theme, however, is the fact that we have here, at an early stage of the Middle Stone Age, clear signs of the presence then in Southern Africa, of that fundamental difference which separates ourselves from all other creatures. For it would seem to me undeniable that the main thrust of our activities and creative urges derives from our self-consciousness, our self-awareness, our understanding of our place in the world. This 'weltanschaung' which man (in this sense) alone has, facilitates far more than 'coolly rational thinking'; for it permits him to appreciate the mystery of life and the enigma of death, and is the mainspring of his pleasures, his sorrows and his fears, whether of the past or of the future. It is surely this previously absent dimension in man that motivated the cave occupants to the symbolism and ritual embodied in this infant burial, to that expression of compassion and concern, to that demand for ultimate values, which became or had by then become, the basis for a belief in a life beyond the grave.

Rudolf Otto (1931; Note 4) could speak of this religious awareness in terms of "mysterium tremendum et fascinans". Like Jacob in his Bethal 'how awful is this place— this is the house of God' (Genesis 28: 17ff.). Though groping as early man did, probing and afraid, he, like us, could only see through the glass darkly, and at best could only know in part. But a 'God-consciousness' there appears to have been with him, and he expressed himself, however, crudely, none the less deliberately. His human weakness, his animal love, his suffering and doubt, his ultimate concern, as also his hope for better things, are all expressed in this deliberate act of burial for a small child. And in so doing, he bore witness to some semblance of religious awareness within the arena of human experience as being present in those members of the Ingwavuma community at Border Cave towards the onset of the Upper Pleistocene some 100 millennia ago.

References and Notes

* Resume of an unpublished paper delivered by J.N. Jonsson at the 13th Congress of the International Association for the History of Religions, University of Lancaster, England, 15-22 August, 1975.

BEAUMONT, P.B., DE VILLIERS, H. and VOGEL, J.C. n.d. Modern man in sub-Saharan Africa prior to 49,000 years B.P.: a review and evaluation with particular reference to Border Cave. Submitted for publication.

BOSHIER, A.K., BEAUMONT, P.B. 1972. Mining in Southern Africa and the emergence of modern man. Optima, 22: 2-12.

BRADFIELD, R.M. 1973. A natural history of associations. Vol. 2. London : Duckworth.

COOKE, H.B.S., MALAN, B.D. and WELLS, L.H. 1945. Fossil man in the Lebombo Mountains, South Africa : the 'Border Cave' Ingwavuma district, Zululand. Man, 45(3): 6-13

DART, R.A. 1968. The birth of symbolism. Afr. Stud., 27 : 15-27.

DE VILLIERS, H. 1973. Human skeletal remains from Border Cave, Ingwavuma district, KwaZulu, South Africa. Ann. Transv. Mus., 28 : 229-256.

DE VILLIERS, H. 1976. A second adult human mandible from Border Cave, Ingwavuma district, KwaZulu, South Africa. S. Afr. J. Sci., 72 : 212-215.

DURKHEIM, E. 1915. The elementary forms of the religious life. (tr. by Swain, J.W.) London: Allen and Unwin.

FEUERBACH, L.A. 1957. The essence of Christianity (tr. by Eliot, G). New York : Harper.

FREUD, S. 1962. The future of an illusion. (tr. by Robson-Scott,W.D.). 4th imp. London : Hogarth and the Inst. of Psycho Analysis).

HASTINGS, J. 1912. Death and disposal of the dead. In: Encyclopaedia of religion and ethics. Vol. IV. Edinburgh : Clark.

HOLE, F. and HEIZER, R.F. 1965. An introduction to prehistoric archaeology. New York: Holt, Rinehart and Winston.

HOWELLS, W.W. 1967. Mankind in the making. Harmondsworth : Penguin.

JAMES. E.O. 1957. Prehistoric religion. London : Thames and Hudson.

MALINOWSKI, B. 1948. Magic, science and religion, and other essays. Boston : Beacon Press.

OTTO, R. 1931. The idea of the holy (tr. by Harvey, J.W.). London: Oxford Univ. Press.

RENFREW, C. 1972. The emergence of civilization. London: Methuen.

RINGGREN, H. and STRÖM, A.V. 1967. Religions of mankind today and yesterday. (tr. by Jensen, N.L.). Edinburgh, Oliver and Boyd.

WILSON, M. 1971. Religion and the transformation of society. Cambridge: Cambridge Univ. Press.

1. Whereas F. Hegel developed a dialectic philosophy, on the basis of the objective world being the manifestation of the 'Absolute Spirit', Feuerbach inverted the process, and reduced all to material causes. According to his theory, religion is viewed as subjective self-deception. God is the hypostazation and personification of our wishes, which he called the 'Theogonic Wish'. F. Nietsche, K. Marx, F. Engels, Russian Nihilists, Atheistic Humanists, amongst others, all work or worked within this schematic.

2. In the functionalist sense, the death customs are viewed as a social mechanism for readjustment and release of tension, of such violent emotions as fear of death and love for the deceased. The religious notions underlying the ritual thus counteract the forces of dismay and demoralization.

3. The structuralists reject the psychology of the functionalists. They feel the true role of the ritual is not to release emotion, but to create and manifest it, in order to affirm the basic values of society.

4. The central theme of his book was insistence on the part played by 'numinous' in the religious consciousness. By this he meant a certain supernatural power calling forth both cure and taboo. This he contended was the primary datum underlying all religion, characteristic of all religious experience, being the very nature of religion at all stages and behind the most divergent phenomena.

Appendix 65. Metrical analysis : I2 subclass

Elandsfontein E.S.A.

Raw material	Sample number	Analysis	L mm	B mm	T mm	B/L %	T/L %	T/B %	Rel. T	Platform Prep. %		
										Fac.	Pln.	Ind.
Qtzite	107	$\bar{X}$	50,0	46,0	14,0	95,2	29,0	31,2	30,1	23,4	76,6	-
		SX	12,1	10,2	3,45	24,7	7,85	7,25				
		V	24,1	22,2	24,6	25,9	27,1	23,2				

Abbreviations

Rel. = relative; Prep. = preparation; Fac. = faceted; Pln. = plain; Ind. = indeterminate;

Qtzite = Quartzite.