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THE REMARKABLE CAVE, SOUTHEASTERN TASMANIA : ITS GEOMORPHOLOGICAL DEVELOPMENT AND ENVIRONMENTAL HISTORY

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(with one table, two text-figures and three plates)

ABSTRACT

The paper describes a sequence of slope and valley-fill deposits that occur in a fossil geo at Remarkable Cave on the Tasman Peninsula of southeastern Tasmania. These deposits overlie a cobble beach deposit on the floor of the geo which is believed to be of Last Interglacial age. The slope and valley-fill deposits predate 37,000 BP and an early Last Glacial age is suggested. Pollen from organic and charcoal-rich horizons suggest that the vegetation of the area was mainly a *Leptospermum* scrub or heath with local areas of *Eucalyptus* forest/woodland. *Pomaderris apetala* and *Dicksonia antarctica* occurred in damp valleys. Fire was an important environmental factor during this time and probably contributed to the maintenance of sub-climax vegetation associations and permitted severe episodic erosion of soil and regolith materials from the steep valley sides after burning. The sea cave known as Remarkable Cave was mainly formed during the last 6,000 years and is much younger than the geo which it intersects.

INTRODUCTION

The Remarkable Cave is a large, elongated, vertical-sided sea cave of the blowhole type situated 5 km south of Port Arthur on the Tasman Peninsula (fig. 1). The cave attracts tourists because it is possible to descend to a small cobble beach, where the cave intersects a fossil geo that is plugged by a fill of Late Quaternary sediments, and to look seaward through the cave. The distant light outlines the cave entrance which has a shape similar to the map of Tasmania (plate 1.)

On first visiting the Remarkable Cave I was impressed by three things. First, the exploitation by wave erosion of a fault structure which has produced the Remarkable Cave at a time much later than the wave erosion that created the geo which it intersects. Second, the presence of a buried beach deposit in the bottom of the geo. This beach is seen on the left at the base of the steps that descend to the modern cobble beach (plate 2). Third, the presence in the geo of a thick plug of slope and valley-fill deposits that overlies the boulder beach and has not been completely re-excavated by waves moving directly up the geo from the open sea (plate 3). Inspection of these deposits revealed that they contained wood, plant remains, charcoal and pollen in numerous horizons. The possibility of dating slope and water laid deposits in association with marine deposits and erosional forms prompted further investigation of these deposits in the hope that the results would throw some light on the Late Quaternary environmental development of this locality. This paper will present a description of the landforms and deposits and will discuss some aspects of the Late Quaternary development of the Remarkable Cave area.

LANDFORMS AND GEOLOGY

The Remarkable Cave is developed along a nearly vertical fault plane which dips at 80°NE, trends towards 165° and is downthrown to the southwest by about 2 m. The fault occurs in the contact zone between Triassic sandstones and a sill-like intrusion of Jurassic dolerite (Powell 1967). Much of the zone consists of deformed hornfels

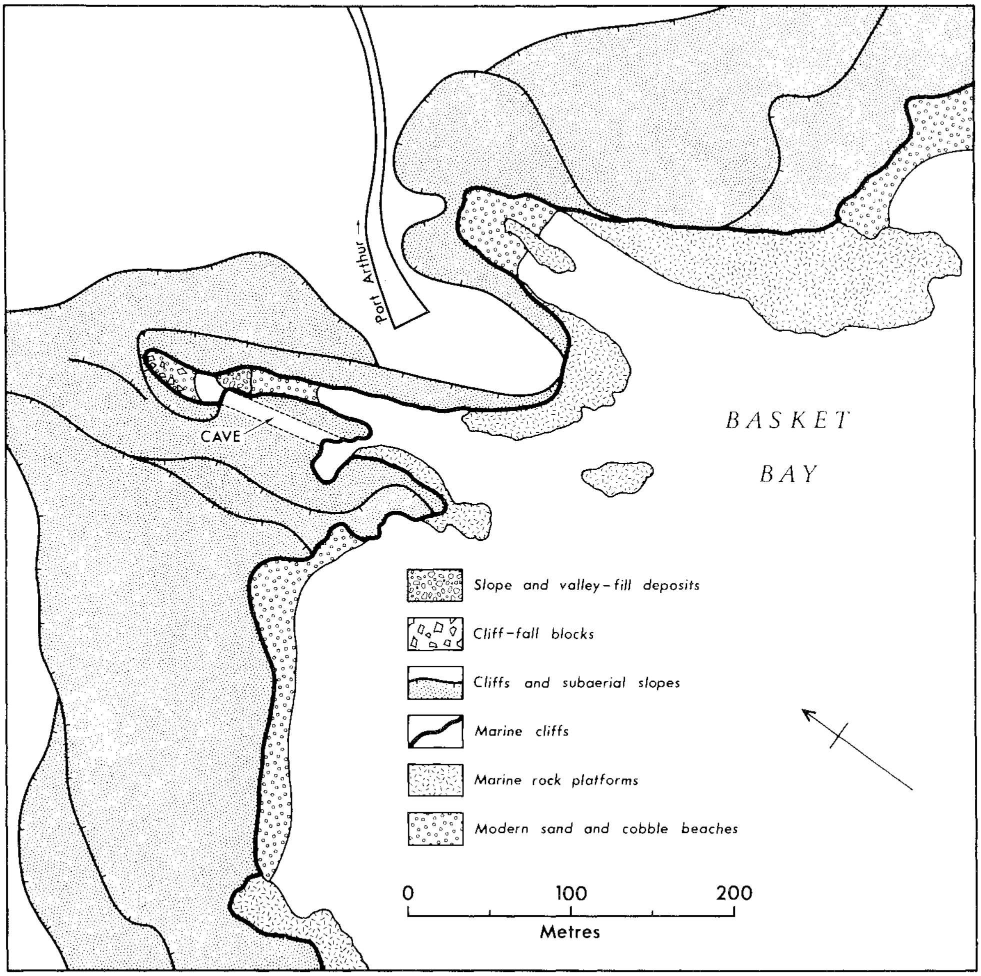

FIG. 1 - Location of the Remarkable Cave

developed between the sandstones that occur southwest of the fault and the dolerite which occurs below the floor of the cave and in the lower walls of the geo to the east.

The geo trends at about 165°, exceeds 25 m in depth and was developed along a line of structural weakness that intersects the Remarkable Cave fault at the back of the cave. The southwestern wall of the geo is inclined at 82° and the northeastern wall at 67°.

PLATE 1 - The Remarkable Cave: a sea cave developed along a fault plane during the Holocene

PLATE 3 - The slope deposits that fill the fossil geo at Remarkable Cave

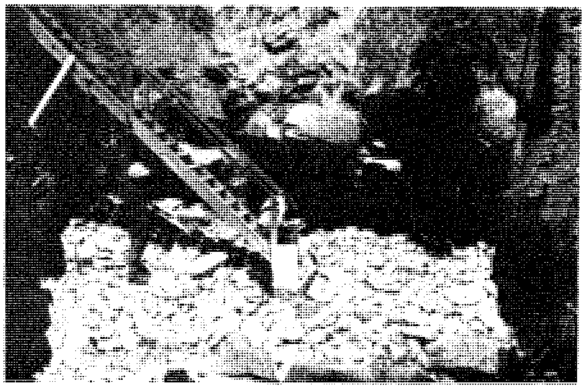

PLATE 2 - Cobble and boulder beach of Last Interglacial age sealed in the fossil geo at Remarkable Cave

At and south of the mouth of the geo and the entrance to Remarkable Cave the 100-150 m high cliffs of Basket Bay exhibit a two-storied profile. The upper and areally more extensive part of the profile consists of a slope of 20-30° inclination which has been sub-aerially sculptured. Several small, shallow, first order valleys have been eroded into this slope and are truncated by the lower near vertical cliffs of marine erosion. Some of the cliffs have marine eroded platforms at their base.

The upper slopes on the sides and at the head of the geo are of subaerial origin and represent the truncated remnant of an old, small first order valley. The lower sides of the geo and of the Remarkable Cave were both formed by wave erosion along lines of structural weakness at different times. In the geo, however, the erosion coincided with the axis of a small valley whereas the Remarkable Cave was formed as a direct result of erosion along a fault plane with sequential sea cave and blowhole stages prior to the present development of a small cobble beach where it intersects the geo. The floor of the geo is partly plugged with cobble beach deposits that underlie a thick succession of slope and valley-fill deposits.

STRATIGRAPHY OF DEPOSITS IN THE GEO

Over 17 m of unconsolidated beach, slope and valley-fill deposits occupy the inner part of the geo and separate it from the small cobble beach at the head of Remarkable Cave (fig. 2). The seaward section shows the relationship of these deposits with the underlying boulder and cobble beach in the bottom of the geo.

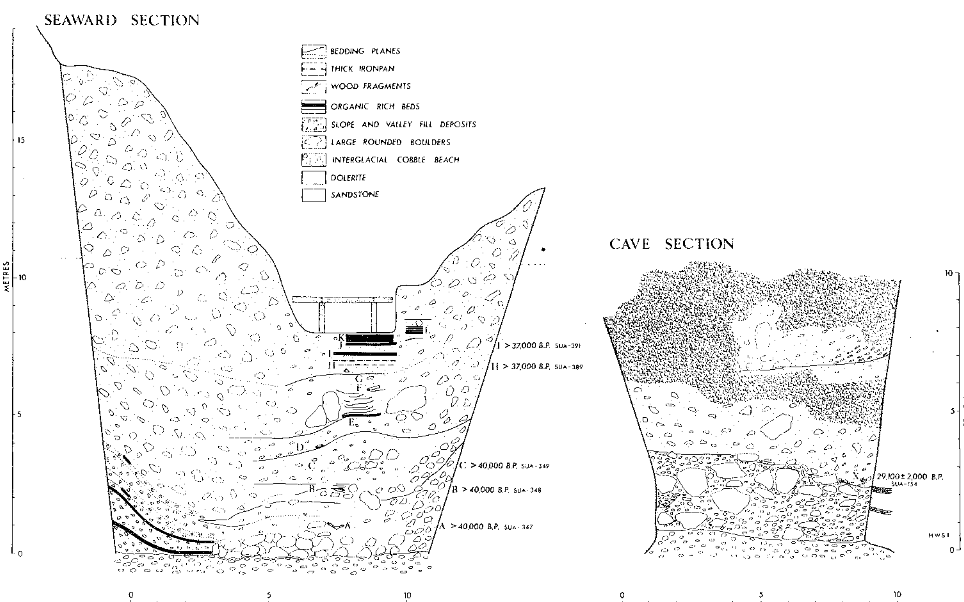

FIG. 2 - Sections of deposits exposed in the geo

Seaward Section

The lower 2-4 m of the southwestern side of the seaward section shows a sequence of stratified slope deposits composed mainly of angular fragments of sandstone from the upper wall and slope above the geo with some hornfels fragments (fig. 2). The rock fragments vary between 20 and 150 mm with some larger fragments exceeding 200 mm in diameter. The rock fragments constitute from 15-35 per cent of the deposit and are set in a matrix of medium to fine sand. The beds are inclined at 10-40° NE, the dip becoming less as the slope deposits merge with the contemporary valley-fill deposits in the axis of the geo. Near the wall of the geo the rock fragments have a strong downslope orientation of 35-40°NE. The hornfels fragments are sharp-edged and platy. From 10-40 per cent of the sandstones exhibit sharp edges and the remainder have weathered surfaces and are slightly rounded on the edges. The deposits vary from dull yellowish-brown (10YR 5/3) and dull yellow orange (10YR 6/4) to greyish-brown (7.5YR 4/2) and dark brown (7.5YR 3/3) (Standard Soil Color Charts, 1967). Locally the deposit is strongly mottled with bright brown (7.5YR 5/8) and bright reddish-brown (5YR 5/8) iron mottles, and contains thin ironpan layers and manganese nodules up to 20-30 mm size. The boundaries between the strata merge except at the base of the organic rich horizons which have sharp boundaries with the underlying beds and more gradual boundaries with the overlying beds.

The deposits contain sparse charcoal fragments between 0-100 mm, are rich in organic detritus which includes wood and charcoal fragments between 1 and 1.1 m, and in humic materials with charcoal between 2.20 and 2.25 m. Traces of charcoal also occur in the overlying beds at 2.10-2.30 m and at 3.30-3.50 m. The organic and charcoal rich horizons in the lower part of this deposit represent several stages of transport of surface organic litter and soil materials from the slope above while the rock fragment-rich beds were formed by erosion of the valley slope and upper wall of the geo.

Between 4 and 17 m the slope deposits consist of angular, slightly weathered blocks of sandstone with occasional hornfels set in a fine sandy matrix which gives the deposit a dull yellow orange (10YR 7/2) colour. The blocks are mainly of 0.05-0.3 m size with occasional boulders up to 1 m in diameter. These deposits do not contain organic materials or detrital charcoal, are poorly bedded and sorted, and have a downslope fabric. One weakly developed but extensive bedding plane occurs between 6 and 7.5 m height.

At the foot of the northeastern wall of the geo the sandstone slope deposits are coarser than those adjacent to the southwestern wall and are slightly richer in hornfels fragments. They vary from 0.02-0.3 m in size, are angular to subangular in form, are coarsely bedded, poorly sorted, have a downslope fabric, and do not contain either organic detritals or charcoal. Above 5.5 m the amount of hornfels in the slope deposits becomes very small and at the top of the section the sandstones in the surface 0.5-1.0 m are strongly weathered. The lower part of these deposits has partly been produced by erosion of the upper part of the geo wall but most of the deposits have been produced by erosion of the sandstone slope above the geo wall.

The axis of the geo is filled with a succession of stratified minerogenic and organic-rich deposits which merge laterally on either side into the slope deposits. The basal metre consists of subrounded weathered sandstone, hornfels and dolerite boulders of 0.5-1.0 m diameter which overlie buried cobble beach deposits on the floor of the geo. The fossil cobble beach deposits are only exposed when the overlying modern beach cobbles are temporarily removed after storms but they were observed to be set in a matrix of coarse sand and are weakly cemented with iron which occassionally occurs at 5 mm thick pans. The overlying large blocks represent cliff fall boulders which have been partially rounded by former wave action. The sandstones have also been weathered during burial beneath the valley fill-deposits.

The detailed stratigraphy of the valley-fill deposits is complex. Only the main characteristics of the deposits that elucidate their origin will be described here. Between the rounded boulders and the handrail the deposits consist mainly of brownish-grey (7.5YR 4/1) to greyish-brown (7.5YR 5/2) fine sandy slope deposits which contain 10-15 per cent of sandstone and hornfels fragments of 10-300 mm and occasional large blocks of over 1 m in diameter. Many of the sandstone pebbles are strongly weathered and the deposits contain yellowish-brown (10YR 5/6) and orange (5YR 7/6) coloured iron mottles and ironpans up to 10 mm thick. Some horizons of the sandy deposits are laminated and indicate that some of the fill was occasionally transported a short distance along the axis of the valley and was deposited by water in the accumulating sedimentary fill.

The deposits contain charcoal, detrital organic materials including leaf and twig fragments, and branches up to 1 m long and 0.1 m in diameter. The branches have deformed cross sections due to burial beneath the sedimentary load. Most of the organic material in the lower part of the section was derived by erosion of surface litter, soil, and the transport of wood fragments towards the axis of the valley from the slopes above the geo. Beside B (fig. 2) water deposited laminae of fine sand interfinger with five horizons of transported organic materials. Between E and F eight organic rich horizons alternate with the stratified sandy slope and washed deposits. The large 1 m sandstone boulder depresses the margins of the first and second organic horizons but the margins of the fourth to eighth horizons curve upwards over the boulder,which was deposited between the time of accumulation of the second and fourth horizon. Above 6.45 m, the bedding plane above G, the deposits are slightly less consolidated than below 6.45 m, the cross sections of wood fragments are little deformed, charcoal and humus is more abundant than wood, and the organic horizons are more fibrous and matted. Above J the organic horizons are penetrated by modern roots. The horizontality of these upper organic horizons and the fibrous nature of several suggest that they may have been developed *in situ* on the damp floor of the valley at the same time as sandstone fragments, sand, charcoal and wood fragments were transported to the valley floor from the valley sides. Similar organic horizons penetrated by modern roots at L have been buried by the sandstone slope deposits.

Cave Section

In the northeastern corner of the cave by the steps the section reveals 2-3 m of beach cobbles set in a medium to coarse sandy matrix. The cobbles are 0.2-0.25 m in diameter, are subrounded to subangular in form and elongated and flattened in shape. They are accompanied by cliff-fall boulders of sandstone, hornfels and dolerite which are 0.5-1.5 m in diameter and are of angular to subrounded form. The beach deposits consist predominantly of sandstones, siltstones and mudstones of Triassic-Permian age, with some Jurassic dolerites and occasional quartzites which may have been derived from the Triassic sediments. The deposit is moderately indurated and cemented with iron oxide which locally forms skins on the surface of the boulders. The deposit is weathered and oxidised throughout with the dolerites having a 10-20 mm deep weathering rind. The flattened cobbles and bedding of the deposit dip at 5-10° towards 165°. This indicates that deposition took place when the sea had open access along the geo. At 1.1-1.7m on the northeastern side of the section a pocket of sharp-edged angular hornfels fragments occurs within the beach deposits. These fragments have been derived directly from the adjacent wall of the geo.

The upper part of the exposed section shows two main beds of slope and valley-fill deposits. Near the base of the lower bed are numerous sharp-edged hornfels, dolerite and sandstone fragments set in a greyish-brown fine sandy matrix. The sandstones are moderately weathered. Towards the top, the greyish-brown fine sandy deposit shows orange-brown mottles and contains occasional sandstone pebbles up to 50 mm in size which are completely weathered. Between 6 and 6.5 m there is a distinct break between the highly weathered and mottled fine sandy deposits of the upper 0.5 m of the lower part of the slope and valley-fill deposits and the overlying largely unweathered light yellow-brown sandy slope and valley-fill deposits with sandstone and sharp-edged hornfels fragments of 20-50 mm size. The clear break and the weathered and mottled character of the fine sandy deposits between 6 and 6.5 m probably indicates a short break in slope deposit accumulation with the development of a gley soil on the valley floor during the interval. This horizon contained poorly preserved charcoal fragments which are probably related to an old soil or ground surface.

At the head of the Remarkable Cave there is a cone-shaped accumulation of sandstone cliff-fall blocks of 1-2 m diameter. Although a cliff-fall scar on the face above indicates that some debris has been added recently to the cone, the very large basal blocks appear to have fallen into the valley head at an earlier time. They probably constitute a remnant of the deposit that filled up the old geo floor.

Several factors need to be considered in an explanation of the origin of the slope and valley-fill deposits. The slope deposits contain numerous sharp-edged fragments yet at the same time contain many strongly weathered sandstone fragments. The sharp-edged fragments are chiefly hornfels and are explained by the alteration and fracturing that took place in the dolerite-sandstone contact zone. The unaltered sandstones are weakly to moderately cemented and would be easily eroded from the steep slopes above and on the margins of the geo to produce the slope deposits. Their weak cementation would facilitate subsequent weathering in the wet conditions of the valley floor.

The valley-fill deposits contain thin beds and laminae of washed and sorted sands which demonstrate water transport along and deposition in the axis of the valley. However, there is no evidence of the presence of a significant stream in the valley and the fibrous and matted organic horizons near the top of the section suggest that it was a damp largely vegetated valley bottom without a permanent stream-course. While clearly the steep slopes above and the depth of the geo below were important factors in facilitating the accumulation of these deposits they do not account for their erosion. As it is considered (see pollen) that the area was vegetated by scrub, heath, forest/woodland and wet valley scrub associations the ground surface would have been stable for most of the time. The abundant wood fragments in the deposits indicate that this small valley had moderate sized trees probably up to 10-15 m in height at several times. The intimate associations of charcoal, organic detritus and wood in the base of the slope and valley-fill deposits suggests that strong mass movements of slope materials, slopewash and fluvial action caused the erosion of the deposits from the catchment after periods of firing which destroyed not only the vegetation cover but also the binding effects of the surface litter and ground cover. It is possible that after numerous fires and subsequent episodes of erosion that the pre-existing regolith cover had been so severely denuded that parts of the weak sandstones on the steep slopes could not be rapidly recolonised by thick vegetation. This could account for the marked reduction of charcoal and organic detritus in the slope deposits above 4 m on the western side of the seaward section.

DATING

In 1973 a sample of charcoal taken from site X between 100 and 200 mm above the junction of the fossil beach deposits and the overlying slope deposits in the cave section was assayed by the ^{14}C method as being 29,000 ± 2000 BP,(SUA-154) radiocarbon years old. This assay from the base of the slope deposits indicated that all the organic materials found in the seaward section might be within the ^{14}C age range. Samples submitted from horizons A, B and C near the base of the deposit gave infinite assays of >40,000 BP (SUA-347, 348 and 349) and samples submitted later from horizons H and J also gave infinite assays of >37,000 BP (SUA-389 and 391). The infinite assays on the samples from the seaward section indicate that all the slope and valley-fill deposits are beyond ^{14}C range and point to the sample taken from X as having been contaminated by the downward movement of modern organic acids. Mr R. Gillespie of the Sydney University Radiocarbon Laboratory who dated the samples has informed me that sample SUA-154 did not receive alkali pretreatment before assay whereas the other samples did and agrees that contamination of the sample is likely. The infinite results assist in a limited way in determining the relative and absolute ages of the main landforms and deposits developed at Remarkable Cave.

The geo and buried cobble beach deposit cannot have been formed at a date much later than the end of the Last Interglacial when on coasts primarily influenced by glacio-eustatic changes the sea retreated from its former higher levels. Therefore the formation of the geo and fossil beach probably occurred during the Last Interglacial, but the Remarkable Cave did not then exist in its present form. When sea level fell slope and fluvial processes of erosion operated on the sides of the small valley above the geo and degraded them further while the eroded materials temporarily infilled the geo. The buried beach deposits and ^{14}C dates indicate that the infilling probably occurred between the end of the Last Interglacial and before 40,000 BP, and that during the early part of the Last Glacial Stage significant quantities of organic litter, soil and fractured rock fragments were being intermittently formed and episodically removed from the slopes by erosion. It is unlikely that the formation and removal of similar deposits from these steep slopes ceased to occur after 40,000 BP. The absence of deposits of later age is probably explained by the fact that once the deep geo was filled up with sediments the later deposits would have been moved further seawards across the elevated sloping surface of the already accumulated deposits.

During the Late Last Glacial and early Holocene stages sea level rose until by 6,000 BP it had attained approximately its present level in southeastern Australia (Thom and Chappell 1975). The slope and valley-fill deposits initially excluded the sea from the geo and wave action caused strong erosion along the Remarkable Cave fault plane at the same time as it gradually removed most of the deposits from the geo. The difference in age between the re-excavated geo and the cave is also demonstrated where the cave breaches the southwestern wall of the geo near its head. The walls of the geo are smoothed and slightly weathered but the blocks of rock removed from the wall above the cave exit have left sharp angular edges on the rock surface. Thus, the geo was primarily a product of marine erosion on this steep coast during the Last Interglacial while the greater part of the Remarkable Cave appears to have been formed during the Middle and Late Holocene.

POLLEN ANALYSIS

Samples A-L were collected from the organic and charcoal rich horizons in the seaward section of the slope and valley-fill deposits. The samples were processed by the Faegri and Iversen technique (1964), and relative counts based on sums of 200 grains of all pollen excluding the spores of *Dicksonia antarctica* and *Cyathea* were made. These spores are expressed as a percentage of the terretrial pollen. The pollen types were identified by comparison with reference slides of modern pollen in the collection of the Botany Department of the University of Tasmania. The taxonomic nomenclature follows Curtis (1956, 1963, 1967). The percentages are given in table 1.

Because of the problems associated with transported organic materials that contain pollen derived from older surface litters and soil materials (Havinga 1974; Riezebos and Slotboom 1974) the work was carried out only to get a general impression

TABLE 1

POLLEN PERCENTAGES FROM REMARKABLE CAVE

Vegetation	Pollen Group	A	B	C	D	E	F	G	H	I	J	K	L
ALPINE AND SUBALPINE	*Pherosphaera hookeriana*	+	+	+									
	Podocarpus								+				
TEMPERATE RAIN FOREST	*Dacrydium franklinii*		+										
	Nothofagus cunninghamii	1.8	2.2	?	+	+	1.8	4.9	3.8	+	+	1.9	2.0
	Phyllocladus asplenifolius	2.3	3.9	2.2	+		+	+	+	1.9	+	+	1.5
TREES AND SHRUBS	*Acacia*			?			1.3	+	+		+	+	
	Banksia marginata	+	1.7	2.8	+	+	1.8	1.5	1.9	1.4	1.4		6.9
	Casuarina spp.	+	+	+	2.9	3.8	2.7		+	6.0	8.6	4.7	8.3
	Compositae	22.6	25.8	12.9	10.2	2.4	12.1	12.2	7.6	10.2	6.7	6.6	8.8
	Dodonaea												+
	Drimys lanceolata	?	3.0	+	1.0		?			+			+
	Epacridaceae	1.4	1.3	+	2.0	1.4	+	3.4	1.9	3.2	2.9	2.8	13.7 excl.
	Eucalyptus spp.	20.8	12.7	27.7	14.1	21.5	8.9	9.3	16.2	7.8	22.5	23.2	23.5 *Monotoca*
	Leptospermum spp.	5.4	3.9	12.0	36.1	52.2	15.6	19.0	26.5	30.6	30.0	45.5	8.1
	Melaleuca spp.	18.1	7.4	17.0	4.9	5.7	4.0	3.9	3.3	3.7	3.8	7.6	7.4
	Monotoca	+	+	+	1.0	+	3.1	2.0	1.4	+	+	2.4	3.4
	Pomaderris apetala	11.8	10.0	10.6	5.8	1.4	9.8	13.2	7.6	11.1	5.7	1.4	4.9
	Pittosporaceae				+	+							
	Rhamnaceae	8.6	17.1	9.2	2.4	3.4	17.4	24.8	14.7	4.6	11.1	+	+ excl. *Pomaderris apetala*
	Rutaceae				6.8		+						
HERBS	Chenopodiaceae		+				+						1.5
	Cyperaceae	1.8	2.2		2.4	+	6.3	+	+	5.1	1.9	+	2.9
	Gramineae	3.2	3.9	+	2.0	1.4	2.2	5.9		7.9	1.9	+	2.0
	Haloragaceae				+					1.4			
	Onagraceae				1.0						+		
	Portulacaceae			+	+								
	Restionaceae				+	+	+						
	Umbelliferae	?	+		+	+	?				+		
	Unknowns	1.8	2.6	+	2.9	+	10.7	+	11.0	2.8	+	+	5.25
	Total	221	229	217	205	210	224	205	211	216	209	211	224
TREEFERNS	*Dicksonia antarctica* plus *Cyathea* sp.	2.3	12.2	+	49.3	31.4	49.5	9.8	42.2	18.1	30.1	10.4	54.9

+ < 1%

of the nature of the vegetation and plant groups that occupied the area while the deposits were accumulating and not for the purpose of determining systematic changes of the vegetation through time.

The present vegetation of the Remarkable Cave and adjacent Brown Mountain area varies from low *Eucalyptus* woodland to closed-scrub dominated by *Leptospermum* spp. with abundant *Melaleuca* spp. and open-scrub dominated by *Leptospermum* spp. There are also areas of closed-heath with *Leptospermum*, *Banksia* and *Melaleuca*, open-heath with *Leptospermum*, *Banksia* and epacridaceous species, and local areas of grassland and herbland (Jackson, in Specht *et al.* 1974). The vegetation of the area is subject to frequent firing which helps to maintain the scrub and heath communities. The present vegetation of the small catchment at Remarkable Cave is open-heath but in the bottom of adjacent valleys *D. antarctica* and *Pomaderris apetala* , typical of the understory of fire ravaged tall open (wet sclerophyll) forests, are common (Specht *et al.* 1974).

The traces of alpine and subalpine pollen (table 1.) have been transported a long distance and are unlikely to indicate the presence of these species in the area during this time. The low values for the temperate rain forest species are also consistent with long distance transport to the site from southwestern Tasmania, but it is possible that some of the *Nothofagus cunninghamii* and *Phyllocladus asplenifolius* pollen may be of local origin from the southern part of the Tasman Peninsula.

The pollen of the main tree and shrub groups is probably mainly local with the possible exceptions of *Banksia* and *Casuarina* which are easily transported, and *Drimys lanceolata* which is probably non-local.

The major components of the vegetation throughout the period consisted of species of Myrtaceae and Rhamnaceae with subsidiary Compositae, all of which must have been growing extensively in the local area. The percentage values for the Myrtaceae groups vary considerably from horizon to horizon but between D and K *Leptospermum* pollen is the chief component with 17-52 per cent. In horizons A to C and L the *Leptospermum* pollen becomes the least of the myrtaceous groups and is exceeded by *Eucalyptus* (23-28%) and *Melaleuca* (7-18%) components. Pollen of the Rhamnaceae, especially *P. apetala*, seems to have been more abundant than in the region today and on horizons B, F and G pollen of Rhamnaceae exceeds that of Myrtaceae with percentages of 27 to 38. Compositae pollen, probably chiefly of shrub species, is the main component in horizons A and B, but is an important subsidiary component of all horixons. Percentages of Epacridaceae including *Monotoca* are low except in horizon L. Gramineae, Cyperaceae, and herb values are low, only occasionally exceeding 5 per cent. The values for *D. antarctica* plus *Cyathea* fluctuate strongly from horizon to horizon from <1 to 55 per cent.

It is not possible to draw a single conclusion on the type of vegetation reflected by the pollen in the local area as the pollen rain probably represents a mixed assemblage drawn from several local vegetation associations that are similar to the associations in the area today. The spectral assemblages suggest that *Eucalyptus* forest/woodland, *Leptospermum-Eucalyptus-Melaleuca* scrub with Compositae, and *Leptospermum*-Compositae heath occupied various areas. The abundant Rhamnaceae and variable *Dicksonia* components are consistent with wet-scrub vegetation along the damp floors of small valleys. Grassland and herbland associations were unimportant and probably only occupied very restricted areas.

The charcoal in the slope and valley-fill deposits indicates that the suggested vegetation associations were strongly influenced by fire during this time and this environmental factor would have favoured the maintenance of a *Leptospermum-Melaleuca*-Compositae scrub or heath during the fire intervals. Although it is not possible to detect any successional trends from the pollen spectra, the significant *Eucalyptus P. apetala* and *D. antarctica* components suggest that in the absence of frequent firing the vegetation would have developed towards a tall open (wet sclerophyll) forest. It is also possible that the increase in *Casuarina* on horizons I to L and the higher values for *Banksia* and Epacridaceae on horizon L reflect an increase of heath low-shrubland vegetation in this small valley consequent upon firing and erosion in the catchment. The pollen evidence suggests that the vegetation of the area during most of the early part of the Last Glacial was similar in composition to that in the area today, but its density is difficult to assess.

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