Technical Memorandum

GBRMPA - TM - 6

Great Barrier Reef Marine Park Authority
Townsville, Queensland

Technical Memorandum — GBRMPA — TM — 6

Age Structure of the Fantome Island Fringing Reef

D. P. Johnson

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GREAT BARRIER REEF MARINE PARK AUTHORITY

TECHNICAL MEMORANDUM GBRMPA-TM-6

AGE STRUCTURE OF THE FANTOME ISLAND FRINGING REEF

D.P. JOHNSON

SUMMARY

Radiocarbon age dating of three high recovery cores from the leeward fringing reef of Fantome Island (Palm Isles, Central Great Barrier Reef), indicate the reef began forming about 6,000 years BP. The reef has formed by progradation of a hard bottom, reef top unit over soft reef slope deposits. Progradation has averaged 1m/10 years over the past 5,000 years.

Management of such fringing reefs will need to focus on preserving the soft reef slope deposits (to prevent erosion and undercutting) as well as maintaining a favourable environment for coral growth.

Keywords: Great Barrier reef Marine Park Authority, Fantome Island reef, age structure, radiocarbon dating, fringing reefs, management.

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1. INTRODUCTION

This report details radiocarbon analyses of coral samples recovered during a drilling programme on the fringing reef, Fantome Island during May, 1981. The programme was funded by the Australian Institute of Marine Science (AIMS), and involved scientific personnel from AIMS, and the Department of Geology, James Cook University of North Queensland.

Fantome Island is situated 75km north of Townsville (Fig. 1) and is composed of Permo-Carboniferous granite (de Keyser, Fardon & Cuttler, 1965). The island is one of several continental islands which lie offshore between Townsville and Lucinda, and each island has fringing reefs developed. These islands and their fringing reefs are sufficiently close to the coast to be influenced by terrigenous outfalls from the mainland. As such they represent a different reef environment to the main shelf reefs which lie further offshore (Fig. 1), and are beyond the influence of river outfalls.

The Fantome Island fringing reef (Fig. 2) was cored to provide a comparison with previously studied, offshore shelf reefs, e.g. Britomart Reef (Johnson, Cuff and Rhodes, 1984). A more detailed,general paper is in preparation (Johnson and Risk, in prep.).

Methods

The cores were recovered using equipment described by Rhodes (1981). The cores are 85mm diameter. Apart from intervals of no recovery (see Fig. 3), recovery was 50% and generally 75%. Sixteen coral samples were selected for radiocarbon dating. However, two were rejected after x-ray diffraction analyses indicated they contained less than 95% aragonite. The weight and mineralogic composition of each dated sample are given in Table 1.

The samples were analysed by BetaAnalytic Inc., whose report is attached (Appendix I). The report states the measuring standards and assumptions used. Three duplicate samples were sent to the Radiocarbon Laboratory, University of Waterloo (Canada) and results are in close agreement. Age dating results and aragonite composition of each sample are given in Table 2, listing the C14 age, the conventional age incorporating correction for isotopic fractionation (Stuiver and Polach, 1977), and corrected ages using the Gillespie and Polach (1979) connection for C14 depletion in seawater relative to the atmosphere.

Individual samples were prepared by sawing and drilling under tap water to remove impure sections (contaminated by matrix introduced by boring organisms). Samples were treated with Chlorox, etched in 10% HCl for 2 minutes to remove loosely adhering material, then rinsed twice in distilled water for 1 hour, and dried at room temperature.

TABLE 1

Fantome Core Samples for Radiocarbon Dating

Sample	Location	Approx. Wt.	Aragonite	Calcite	Quartz
1	Fantome 1/1.08m	110 gm	100	0	Tr
2	Fantome 1/2.05	98	100	0	0
3	Fantome 1/3.20	95	100	0	0
4	Fantome 1/4.40	115	100	0	Tr
5	Fantome 1/5.20	93	100	0	Tr
6	Fantome 1/8.60	40	100	0	Tr
7	Fantome 1/10.90	94	96	2	2
8	Fantome 2/1.50	53	100	0	Tr
9	Fantome 2/3.92	69	56	44	0
10	Fantome 3.1.15	76	98.5	1.5	Tr
11	Fantome 3/2.40	109	100	0	Tr
12	Fantome 3/4.84	53	100	0	0
13	Fantome 3/6.30	68	99	0	1
14	Fantome 3/7.20	123	100	0	0

Tr = less than 0.5%

FIGURE 1

Location Map

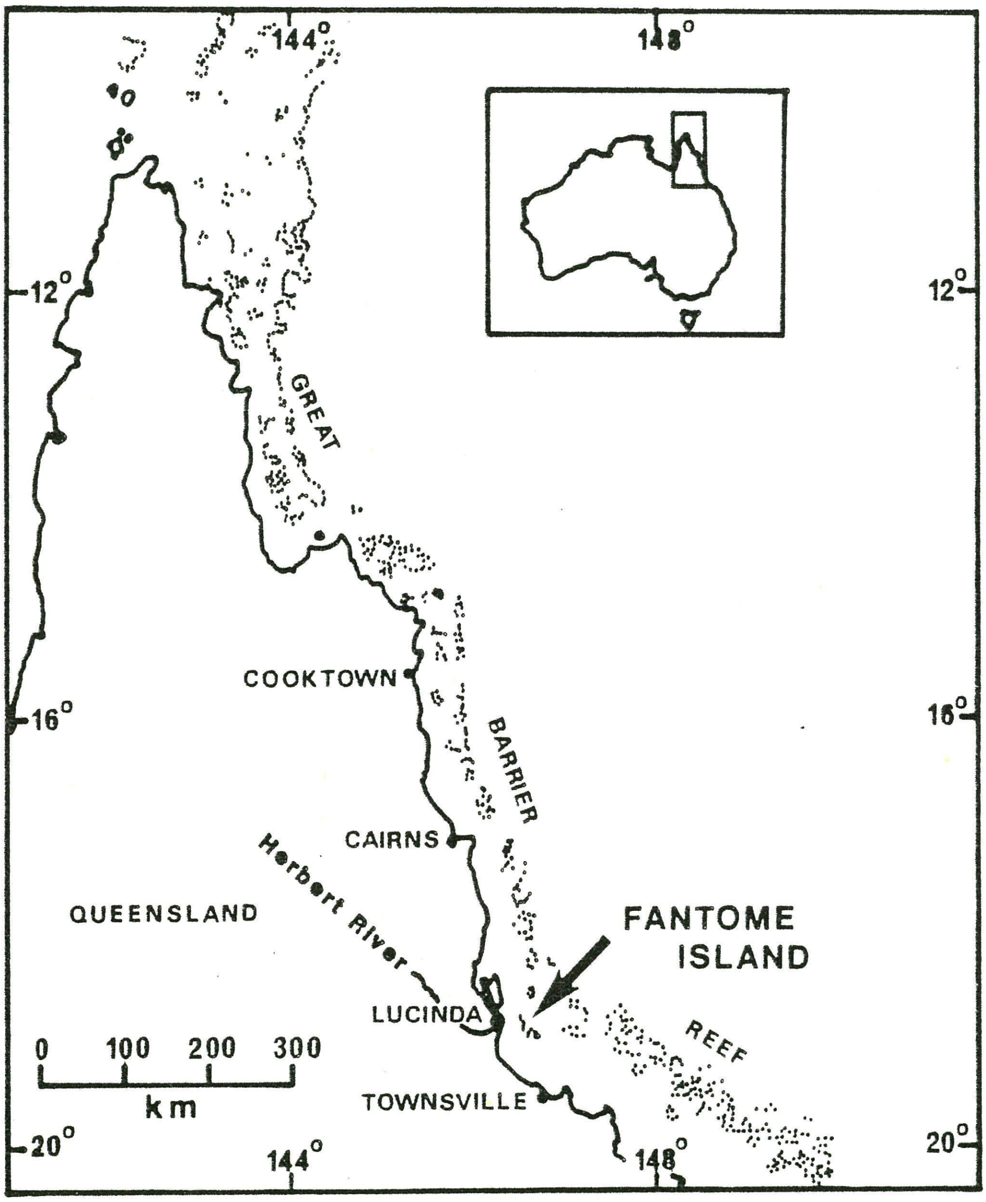


TABLE 2

Radiocarbon Dating Results

Sample No.[1]	Core depth[2]	Composition Aragonite %	$C^{13/12}$ 0/00	C^{14} age B.P.±1sd[3]	Conventional age[4]	Corrected age[5]
Beta 5702	1/11.08m	100	+0.93	1000 ± 70	1420 ± 70	970 ± 80
Beta 4703	1/2.05m	100	+0.61	1820 ± 90	2250 ± 90	1810 ± 100
Beta 5704	1/3.20m	100	-0.92	2150 ± 70	2550 ± 80	2100 ± 90
Beta 5705	1/4.40m	100	-0.73	2520 ± 80	2920 ± 90	2470 ± 100
Beta 5706	1/5.20m	100	-1.10	1950 ± 100	2340 ± 100	1890 ± 105
Beta 5707	1/8.60m	100	-0.75	2180 ± 100	2580 ± 110	2130 ± 115
Beta 5708	1/10.90m	96	-0.91	2490 ± 90	2880 ± 100	2430 ± 105
Beta 5709	2/1.50m	100	-1.43	5520 ± 100	5910 ± 110	5460 ± 115
Beta 5711	3/1.15	99	-0.24	4070 ± 110	4470 ± 120	4020 ± 125
Beta 5712	3/2.40m	100	+1.19	3480 ± 80	3910 ± 80	3460 ± 90
Beta 5713	3/4.84m	100	+0.14	4190 ± 70	4600 ± 70	4150 ± 80
Beta 5714	3/6.30m	99	+0.44	4920 ± 100	5340 ± 100	4890 ± 105
Beta 5715	3/7.20m	100	+0.18	3880 ± 110	4290 ± 120	3840 ± 125
Wat 1107	3/1.15m	99	0.0	4160 ± 100	4575 ± 100	4125 ± 105
Wat 1109	3/2.40m	100	+0.1	3960 ± 80	4380 ± 80	3930 ± 90
Wat 1108	3/6.30m	99	+0.7	4900 ± 120	5330 ± 120	4880 ± 125

1 Beta = Beta-Analytical Inc., Miami laboratory number
Wat = Radiocarbon Lab., University of Waterloo, Ontario laboratory number.

2 1/1.08m = Fantome 1, 1.08m depth below surface.

3 Radiocarbon age, Libby half-life.

4 Conventional age = corrected for C^{13} content to -25% P.D.B.

5 Corrected age = conventional age minus reservoir effect (450 ± 35 years for eastern Australia).

2. DESCRIPTION OF THE AREA

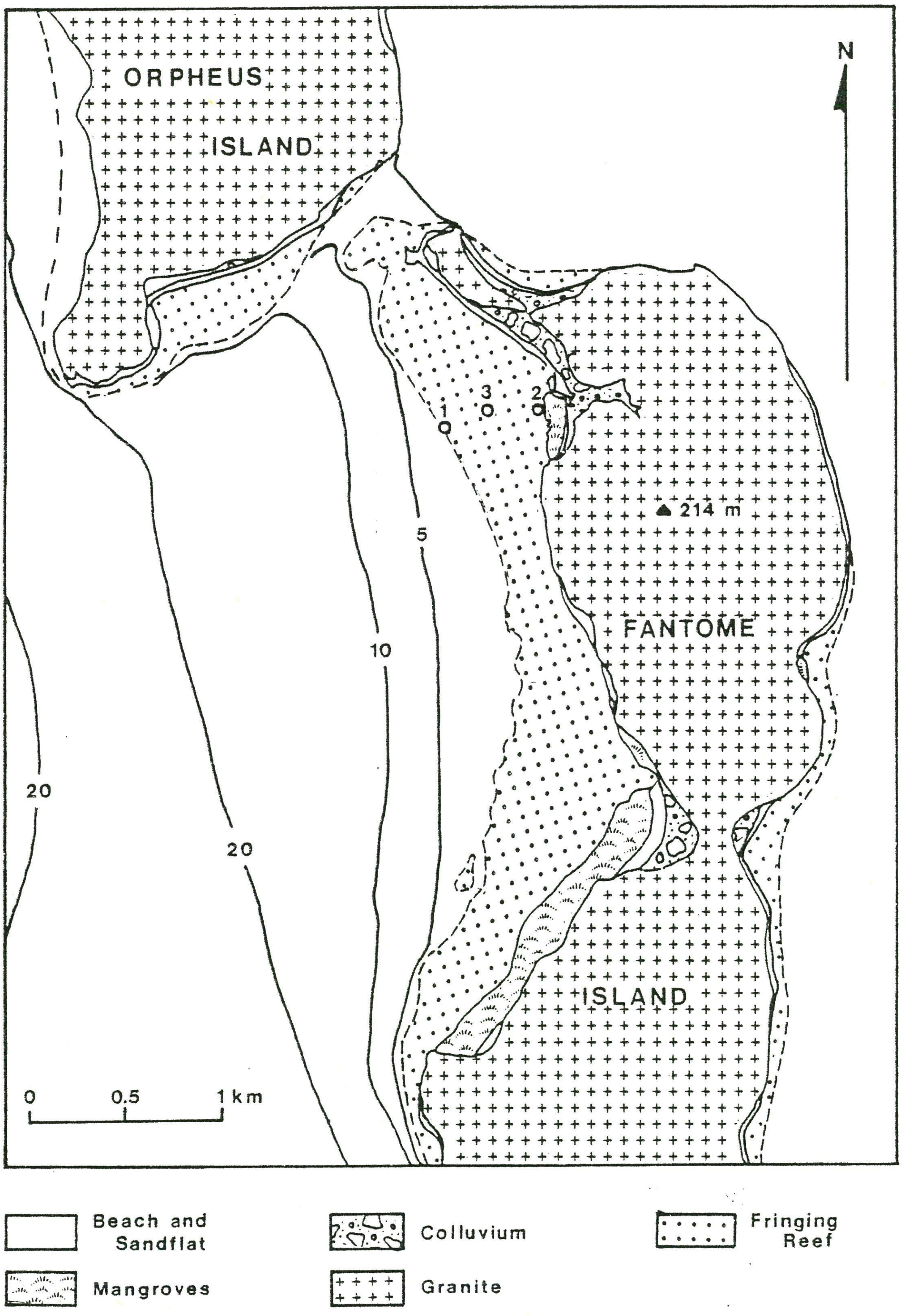
Small fringing reefs occur on the windward side of Fantome Island, and an extensive reef along the leeward side (Fig 2). The leeward reef is 600m wide and 5km long, with a relatively flat, intertidal, upper surface, and a steep seaward slope. Landward the reef passes onto beaches, mangroves (*Rhizophora* sp.) or abuts rocky headlands. Seaward the slope passes into Halifax Bay. Three zones are recognised across the modern reef: 1) inner (sandflat) zone, 2) outer (rubble) zone, 3) reef slope. The first two zones constitute the reef flat which occupies the lower half of the tidal range; the reef slope is subtidal.

The inner zone is up to 250m wide, and is 90% mobile sand, the surface of which may be flat, rippled or covered with conical mounds at the mouths of crustacean burrows. Patches of brownish algal mat occur along the inner edge. Sediment is medium to coarse skeletal sand with scattered skeletal and litoclastic gravel. Shallow pools contain rare knobs of *Goniastrea*, sponges, and commonly algae and seagrasses (*Halimeda, Padina, Hydroclathrus, Halophila*).

The outer zone comprises *in situ* coral heads and abundant rubble with scattered sandy pools. The seaward rim (approximately LWOST) has approximately 80% hard substrate, mainly dead, massive corals extensively bored by *Tridacna*. Many corals occur as microatolls with dead centres and living edges. Individual colonies may be up to 0.5m across, the most common genera are *Goniastrea* and *Symphyllia*, with less common *Acropora millepora*, *Montipora ramosa* and *Leptastrea* sp. Small colonies of *Sinularia* with spiculite bases occur. Apart from the rim, the rest of the outer zone contains only 50 to 80% hard substrate, with no large, massive corals, although small live *Goniastrea favulus*, *Montipora ramosa* and *Porites* sp. are present. Algae are abundant in shallow pools and rock crevices (*Padina, Hydroclathrus*, *Halimeda*). Dead coral colonies are extensively bored by *Tridacna*, mytilids, sponges and sipunculids, and encrusted with *Chama* and *Spondylus*.

FIGURE 2

Map of Study Area



The reef slope descends gradually seawards, flattening at approximately 8m water depth. The upper part of the slope has abundant Porites colonies 2 to 2.5m high with intervening rippled and burrowed sand. Porites extend to 5m water depth, where intervening sediment is muddy. Below this, Porites is absent and Goniopora mounds occur. Goniopora is replaced by Anacropora below 8m.

Environment

The climate is tropical with marked dry (winter) and wet (summer) seasons. Prevailing wind and weather systems are from the southeast, though during summer a NE component is introduced (Pickard, 1977). During summer (January-March) the area is prone to cyclones with gale-force winds, heavy rains and storm surges. Over 80% of the 2034mm annual rainfall occurs in summer.

Average seawater temperatures range from 19°C (June-July) to 31°C (December-March) (Pickard, 1977). Water remaining on the reef flat during low tide was hot to the touch. Elsewhere in the region cyclonic rain may lower normal surface seawater salinities (35°/oo) to less than a 20°/oo (Archibald & Kenny, 1980).

3. STRATIGRAPHY

All three cores penetrated through the reef to mottled brown clays and weathered granite which are interpreted as late Pleistocene colluvial units and bedrock respectively.

Four units are recognised in the cores (Fig 3) from top to bottom; reef top unit (4.0-7.2m thick), reef slope unit (3.0-4.1m), basal unit (0.9-1.5m), alluvial unit (greater than 2.0m). The reef top unit is composed of coral rudstone with massive colonies of Porites, Symphyllia and Sinularia spiculite. Gravel-sized coral and bivalve fragments are invariably abraded, bored by mytilids, sponges and sipunculids, and encrusted by coralline algae, milleporids, serpulids, bryozoans and rock oysters. Matrix is grey, muddy skeletal sand.

The reef slope unit is grey, carbonate/terrigenous mud with scattered coral gravel. Horizons of floatstone and rudstone occur. Coral and bivalve debris is less bored and encrusted, and matrix more muddy than in the reef top unit. The basal unit is coarse, often gravelly, quartz sand with minor skeletal and granitic lithoclast debris. It is generally finer and muddy towards the top, probably due to mixing of the overlying reef slope sediments by burrowers. The alluvial unit is brown/frey mottled sandy clay and weathered granite, with irregular nodules and veins of white (low Mg calcite) carbonate.

4. REEF HISTORY

Radiocarbon results are plotted on a stratigraphic cross section (Fig. 3), together with relevant data from Chappel et al. (1983, Table 2). Chappel et al.'s dates were from microatolls collected along a levelled transect close to our drilling sites. Microatoll ages range from 5340 ± 80 years at the inner edge of the reef flat (0.8-1.2m above MLWS) to 2540 ± 90 years at the outer edge (0.35-0.55m above MLWS).

Fantome 1 is the most completely dated core, with seven dates, ranging from 970 ± 105 to 2430 ± 105 years B.P. There is reasonably consistent younging upwards, with a minor reversal in mid section. The second and third dates show that the colony is upright, with an indicated growth rate of 3.8 mm yr^{-1}. Dates in Fantome 1 are less than 2500 yrs B.P., and are all younger than in the other two cores.

Fantome 3 contains materials dated between 3460 ± 90 and 4890 ± 105 yrs B.P. The central three dates form an upward-younging sequence, but the top and bottom dates indicate age reversals. The top date and two of the three central dates have replicate age determinations which agree reasonably well, and further substantiate the upward-younging trend. The top date was determined on a discoloured *Porites* colony which contained approximately 1.5% calcite. The addition of younger matrix

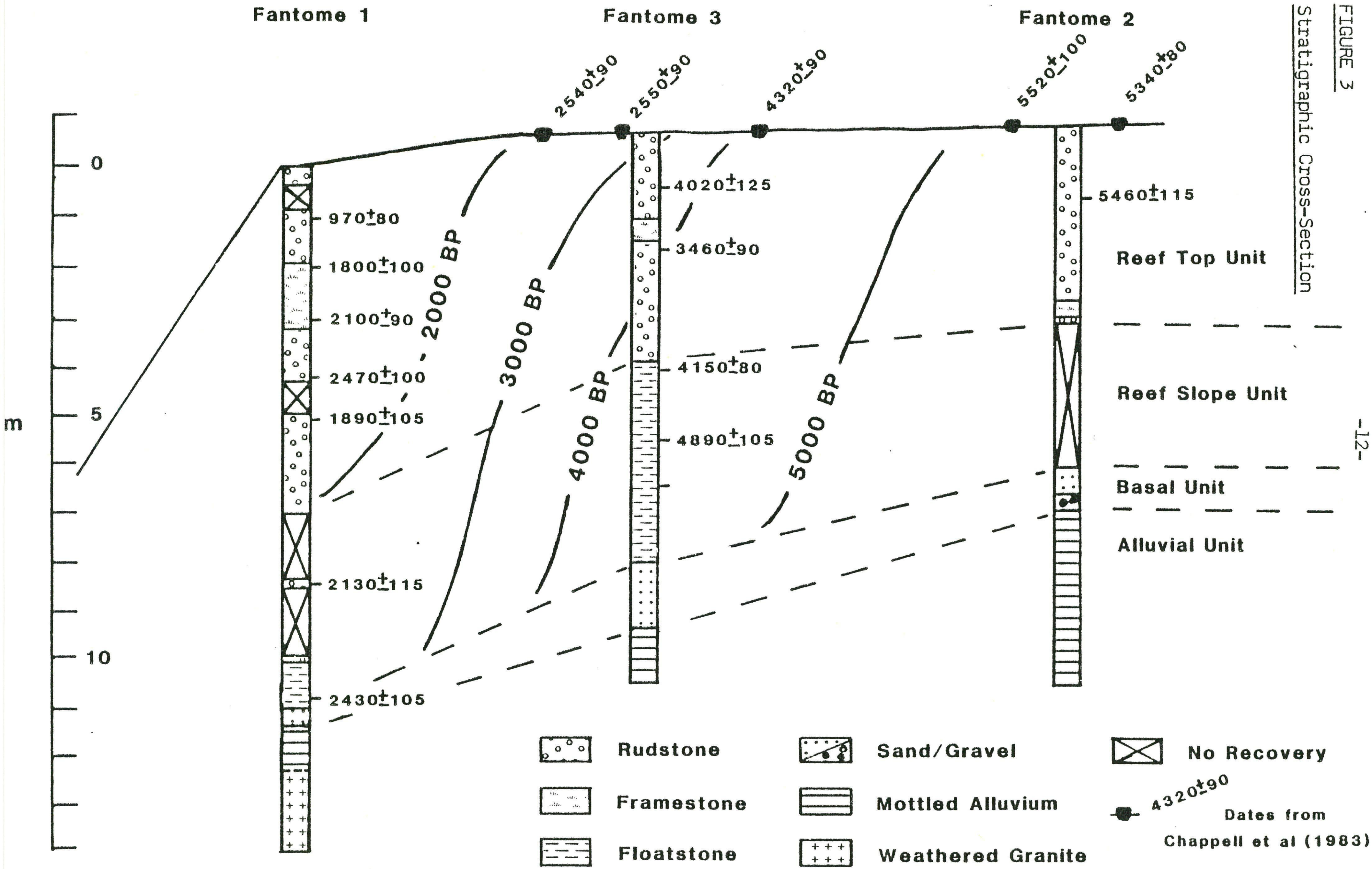


FIGURE 3

Stratigraphic Cross-Section

carbonate would have produced a younger radiocarbon date, not an older one. Since the replicate dates are in agreement, we are confident the date, and hence the age reversal, are valid. The basal date was determined on a very muddy, heavily-bored coral, which had to be cut into small pieces to obtain relatively clean material. There was insufficient material for a replicate date. Although the coral analyzed as 100% aragonite, the discolouration indicated it may have contained younger matrix carbonate. We regard this as a bad date, and have omitted it from the cross-section.

Fantome 2 recovered only one fragment which met our requirements for datable material, and this date at 5460 ± 115 yrs B.P.

Seaward parts of the reef are younger than landward parts. (Fig 3). Microatoll dates in the vicinity of Fantome 3 are all greater than 5000 yrs B.P., and from Fantome 1, younger than 2500 yrs. B.P. (Chappell et al., 1983). Surface dates near Fantome 3 are slightly younger (approx. 2500 yrs B.P) than the range of dates from Fantome 3 (3,000 - 5,000 yrs B.P.). Clearly, the time lines cut across stratigraphic boundaries, and the reef has prograded, as opposed to having accreted vertically in a layer-cake fashion. Reef accumulation began nearshore prior to 5500 years B.P.

Hopley (1982) and Chappell et al. (1982) both proposed that sea level may have reached about 1m above modern datum in this area, before falling to the present level. Falling sea level, which has left microatolls stranded above their normal tidal levels across much of the reef flat, would tend to promote erosion, or interring of older reef flat by mobile sediments.

Age Reversals

The age reversals at the top of Fantome 3 and in the central part of Fantome 1 warrant further discussion. The reversal at the top of Fantome 3 involves a date approximately 600 years younger which is 1.25m higher in the core.

This higher, younger date could be due to moating. Such effects on modern reefs normally involve a height difference less than 0.8m (Scoffin and Stoddart, 1978; McLean et al., 1978), and hence a 1.25m difference may be too large to explain this effect. A more reasonable explanation is transport, which is supported by observations of large amounts of mobile rubble on the modern reef flat. Furthermore, erosion and redistribution could have occurred during the postulated late Holocene drop in sea level.

The reversals in Fantome 1 occur in the lower part of the reef top unit and in the reef slope unit. Assuming the second top date and the basal dates in Fantome 1 are correct, the reversals involve six dates in a total time interval of some 670 years, over an accumulated thickness of 8.85 m. The average difference between successive dates is 354 years, which is not large (less than two combined standard deviations of the relevant dates). There are, therefore, several dates over a relatively short time interval, during which there was rapid reef accumulation. The age reversals are interpreted as representing transported material. Although Easton and Olsen (1976) pointed out that such reversals should be common in fringing reefs, they normally have not been reported. Part of the reason may be the generally longer average time interval sampled in published studies (e.g. 2,240 years, in Macintyre and Glynn, 1976). The tight sampling interval in Fantome 1 has demonstrated the highly dynamic nature of such reefs, where erosion and storm transport are capable of admixing debris of widely varying ages. A similarly tight sampling interval in one of the Pioneer Bay fringing reef cores (R/1 in Hopley et al., 1983, Fig (1)) showed an age reversal near the top.

Data from ancient rocks supports the transported nature of much of reef material. Middleton (1954) found that one-quarter of large (greater than 0.3 m) stromatoporoids were over-turned in Devonian reefs of south Devon, while Kobluck et al. (1977) found half the coral and stromatoporoid heads in Silurian and Devonian reefs were overturned or disoriented, in a size-independent fashion.

These results imply that most of the heads in these fossil reefs were displaced, and that those in "growth position" had simply been overturned an even number of times. The effect of storms on modern reefs has been well documented (Stoddart, 1962; Ball et al., 1967; Woodley et al., 1981; Hopley, 1982). Modern reef deposits are dominantly transported material judging from maps of surface facies distributions (Longman, 1981).

Growth Rates

Average accumulation rates for the Fantome fringing reef can only be estimated reliably from Fantome 1 data, where the average rate, between 1.08-10.90 m, is 6.7 mm yr^{-1}. Radiography showed the individual colony near the top had a growth rate of 3.8 mm yr^{-1} (vertically; location of the growth axis was not determined). All of Fantome 1 was deposited within the last 2,500 years; that is, at virtually stable sea level. Hopley et al., 1982, reported a growth rate during the last 3,000 years of 2.5 mm yr^{-1} at Pioneer Bay, Orpheus Island, based on two dates in one hole. The Fantome rate is compatible with the normal range for fringing reefs, 3.3-10.0 mm yr^{-1} (Hopley, 1982).

The age contours (Fig. 3) indicate the major pattern of reef growth has been progradation. The oldest reef is at the inner margin, and all the material in the Fantome 1 is younger than the rest of the reef. Initial growth at the innermost part is a similar pattern to that described by Hopley (1982) for the Pioneer Bay fringing reef. Initial growth probably occurred at a slightly higher sea-level, considering the 1m isobase at 5500 years B.P. proposed by Chappell et al. (1982). The stratigraphy of the Fantome Island fringing reef records development of a coarse transgressive basal unit over alluvium and weathered bedrock towards the end of the last post-glacial transgression. The reef top and slope units are interpreted as regressive deposition, such that the hard reef top unit progrades over the soft, reef slope unit. The average rate of progradation over the past 5,000 years has been 1 m/10 years.

5. IMPLICATIONS FOR REEF MANAGEMENT

Stability of the Reef Slope

Radiocarbon dating of the reef cores has shown the modern reef top unit has developed over a soft, muddy reef slope unit. Although the framework and hard bottom communities of the reef top unit have built a thicker section seawards, even the seaward part rests on muddy deposits. Furthermore extensive muddy slopes exist seaward of the reef front and pass out into Juno Bay (Johnson, unpubl. data).

These soft reef slope deposits must be preserved to ensure stability of the fringing reef mass. Alteration of local current patterns and/or sediment supply could lead to erosion of these muddy sediments, and eventually to undercutting and erosion of the fringing reef itself. The fringing reef is not protected by a resistant "wall" as are most of the shelf reefs. Brief inspections of other leeward fringing reefs in the Palm Isles suggests occurrence of this muddy slope is a typical pattern. Thus the construction of jetties, groins and other structures should only be done after careful analysis of their effects on local currents and sediment movement.

Rates of Reef Recovery

Estimates of reef growth during the past 3,000 years, that is under conditions essentially the same as the present, give a guide to expected rates of reef recovery. Hopley (1982, p. 225) has argued that in the Great Barrier Reef, "a general pattern of upward growth of 3-6mm/year to within 1m of sea level is seen, followed by a slower net rate of about 1mm/year in the accretion of the top metre." The rate in the top metre may be affected by the late Holocene sea-level drop, but the degree of the effect is impossible to estimate.

At Fantome Island reef growth was about 6.7 mm yr-1, which sits in the middle of the range 3-10 mm/yr quoted for fringing reefs by Hopley (1982). If the fringing reef is substantially eroded, it will not be re-established within the span of a human lifetime.

6. CONCLUSIONS

1) Thirteen radiocarbon dates of the Fantome Island fringing reef cores indicate the reef began forming about 6,000 years B.P. The reef has formed by progradation of a hard bottom reef top unit over a soft, reef slope unit.

2) Growth rates under present conditions are thought to be approximately 6.7 mm yr-1 based on the amount of growth over the last 3,000 years.

3) Management of such fringing reefs will need to focus on preserving the soft reef slope deposits, as well as maintaining a favourable environment for coral growth.

4) The reef growth rate is higher than for most shelf reefs, confirming previous ideas of faster rates for fringing reefs. However, the rate is till far too slow to allow re-building to present form within human lifetimes if severe erosion occurs.

7. ACKNOWLEDGEMENTS

The field programme was proposed by Dr. M.J. Risk and funded by the Australian Institute of Marine Science, and I thank the Director, Dr. John Bunt for his support. Good cores were recovered due to the dedicated efforts of Drew Thompson and cadets of RMC Duntroon under the command of Lieutenant-Colonel W.A. Williams. Gordon Bull kindly made field identifications of corals, algae and seagrasses.

I also thank Mike Risk, Bob Carter, John Hardman and Bill Ellery for help in the field, Nelleke Swager for the XRD analyses and drafting, and Ann Quadroy and Pamela Bristow for typing.

The Great Barrier Reef Marine Park Authority funded the radiocarbon and stable isotope analyses.

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APPENDIX I

REPORTS OF BETA-ANALYTICAL INC. AND UNIVERSITY OF WATERLOO

BETA ANALYTIC INC.
RADIOCARBON DATING, STABLE ISOTOPE RATIOS, THERMOLUMINESCENCE, X-RAY DIFFRACTION
P. O. BOX 248113 - CORAL GABLES, FLORIDA 33124 - (305) 667-5167

November 16, 1982

Dr. D. P. Johnson
Department of Geology
James Cook University
Townsville, QLD 4811
AUSTRALIA

Dear Dr. Johnson:

Please find enclosed the results on the fourteen coral samples recently submitted for radiocarbon dating and carbon 13 analyses. We hope these dates will be useful in your research.

The samples were pretreated by lightly etching away the outer layers with dilute acid. Your sample 9 was pretreated by first gently crushing and then attacking with acid to eliminate one half of the material; the carbon dioxide coming from the remaining half was used for the measurements. The following benzene syntheses and countings proceeded normally.

We are sending our statement directly to your Bursar's Office. If there are any questions or if you would like to confer on the dates, my telephone number and address are listed above. Both my partner and I have over twenty years experience in radiocarbon dating. Please don't hesitate to call us if we can be of any help.

Sincerely yours,

Murry Tamers

Murry Tamers, Ph.D.
Co-director

MT/hs
encs.

BETA ANALYTIC INC.

UNIVERSITY BRANCH
P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: D. P. Johnson
James Cook University

DATE RECEIVED: October 25, 1982

DATE REPORTED: November 16, 1982

BILLED TO SUBMITTER'S INVOICE NUMBER

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	C13/C12	C-13 adjusted Radiocarbon age
Beta-5702	1	1000 ± 70 B.P.	+0.93 0/00	1420 ± 70 B.P.
Beta-5703	2	1820 ± 90 B.P.	+0.61 0/00	2250 ± 90 B.P.
Beta-5704	3	2150 ± 70 B.P.	-0.92 0/00	2550 ± 80 B.P.
Beta-5705	4	2520 ± 80 B.P.	-0.73 0/00	2920 ± 90 B.P.
Beta-5706	5	1950 ± 100 B.P.	-1.10 0/00	2340 ± 100 B.P.
Beta-5707	6	2180 ± 100 B.P.	-0.75 0/00	2580 ± 110 B.P.
Beta-5708	7	2490 ± 90 B.P.	-0.91 0/00	2880 ± 100 B.P.
Beta-5709	8	5520 ± 100 B.P.	-1.43 0/00	5910 ± 110 B.P.
Beta-5710	9	4750 ± 90 B.P.	+2.38 0/00	5200 ± 100 B.P.
Beta-5711	10	4070 ± 110 B.P.	-0.24 0/00	4470 ± 120 B.P.
Beta-5712	11	3480 ± 80 B.P.	+1.19 0/00	3910 ± 80 B.P.
Beta-5713	12	4190 ± 70 B.P.	+0.14 0/00	4600 ± 70 B.P.
Beta-5714	13	4920 ± 100 B.P.	+0.44 0/00	5340 ± 100 B.P.
Beta-5715	14	3880 ± 110 B.P.	+0.18 0/00	4290 ± 120 B.P.

In agreement with international conventions, radiocarbon dates are calculated using the Libby half-life of 5568 years and 95% of the activity of the NBS Oxalic Acid as the modern standard. The quoted errors are one standard deviation based on the random nature of the radioactive disintegration process. B.P. stands for years before 1950 A.D. Stable carbon ratios are measured relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13. No corrections were made for reservoir effect.

University of Waterloo
Earth Science Department
Waterloo, Ontario
N2L 3G1
March 8, 1984

Mike Risk
McMaster University
Geology Department
Hamilton, Ontario

Dear Mr. Risk:

I have finished the ^{14}C Australian coral samples. The results did not change significantly from the preliminary results that I gave you by phone on March 7. The results are:

	Wat#	$d^{13}C_{PDB}$	%modern	uncorrected age
F3/1.15m	1107	0.0	59.6	4160 +/- 100 years
F3/2.40m	1109	+0.1	61.1	3960 +/- 80 years
F3/6.3m	1108	+0.7	54.3	4900 +/- 120 years

You will be billed under separate cover if Diana has not already done so. If you have any questions or more samples, I look forward to hearing from you.

Sincerely,

(signed by)

Mike Jones
Isotope Lab.

[Additional Information provided by telephone]	corrected to -25pdB	1.15	4575 +/- 100
		2.4	4380 +/- 80
		6.3	5330 +/- 120

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APPENDIX II

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APPENDIX III

DOCUMENT-CONTROL DATA

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1. Document Type: Technical Memorandum

   Series Number: GBRMPA - TM - 6

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2. Document DATE: February, 1985

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3. Title: Age Structure of the Fantome Island Fringing Reef

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4. Author: Dr D.P. Johnson
Department of Geology
James Cook University of North Queensland
TOWNSVILLE QLD AUSTRALIA 4811

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5. Summary: Radiocarbon age dating of three high recovery cores from the leeward fringing reef of Fantome Island (Palm Isles, Central Great Barrier reef), indicate the reef began forming about 6,000 years BP. The reef has formed by progradation of a hard bottom, reef top unit over soft reef slope deposits. Progradation has averaged 1m/10 years over the past 5,000 years.

Management of such fringing reefs will need to focus on preserving the soft reef slope deposits (to prevent erosion and undercutting) as well as maintaining a favourable environment for coral growth.

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6. Keywords: Great Barrier Reef Marine Park Authority, Fantome Island reef, age structure, radiocarbon dating, fringing reefs, management.

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7. Descriptors:

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8. Library Numbers:

0655R