ANTHROPOGENIC DISTURBANCE

OF

ENVIRONMENTAL SIGNALS

RETAINED IN MASSIVE CORALS

VOLUME II

Thesis submitted by

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METHODOLOGY

The methodology will be divided into sections -

1. Selection of study sites, and general introduction to the study area.
2. Nutrient monitoring programme
3. Sediment desorption techniques
4. Removal and sample preparation of the coral cores.
5. Analytical techniques
6. Statistical techniques

1. SELECTION OF STUDY SITES, AND GENERAL INTRODUCTION TO THE STUDY AREA:

1.a Terrestrial:

The terrestrial section of the study area included agricultural lands of the upper Barron River catchment on the Atherton Tablelands, sugarcane fields on the coast in the lower Barron and South Mossman river catchments, and the estuarine reaches of the North Mossman River and Newell Creek (also draining sugarcane land). Because of its relevance to the Thesis, complete site description and selection of study sites has been included within the main text.

1.b. MARINE:

1.b(i) Selection of sampling sites:

Seventeen reefs in the Cairns section of the Great Barrier Reef Marine Park were selected for sampling. Two additional samples were taken, one from the north of the study area in a location presumed to be relatively pristine (No Name Reef), and another to the south of the study area (Brook Islands Reef) to provide geographical contrast. It was originally planned to analyse one cored sample from Green Island Reef on an annual basis and to use this information as the basis for future interpretative assessment of all other reefs. Each additional sample was to be examined at a one in ten year interval, using the information retrieved from the Green Island sample as the framework for the remaining sclerochronological interpretation.

Green Island Reef was chosen for a number of reasons -

(a) the Island had previously been subjected to a number of Crown-of-Thorn infestations during the last 20 years,

(b) the presumption that the Green Island area was a primary source of Crown-of-Thorn outbreaks (Kenchington 1977),

(c) an academic belief that Crown-of-Thorn infestations may be linked to anthropogenically enhanced levels of nutrients in the marine environment (Endean 1973),

(d) the depauperate state of the Green Island Reef, and

(e) a possible link between the rapid rise of Green Island Reef as a tourist destination, and the parameters outlined above.

As the study progressed it became apparent that each coral sample maintained an individual identity and needed to be analysed on an annual basis. Within the time constraints imposed by the research programme, a decision was made to sacrifice wider geographical interpretation for temporal understanding and examination was restricted to seven reefs.

In addition to the control site at No Name Reef, and the geographically diverse location of the Brook Islands, choice of study site was based on varying distances from the Barron River, visitor impact, and location across the continental shelf. The seven samples eventually chosen for geochemical and geomechanical analysis were No Name, Batt, Hastings, Thetford, Upolu, Green Island and the Brook Islands (Figure A1).

Table A1. Geographic Location of reefs studied.

Reef	*Latitude and Longitude*	*Distance from Mainland*	*Distance major River System*	*Nearest major River System*
No Name	*14:39S 145:39E*	*70 km*	*200 km*	*Daintree*
Batt	*16:25S 145:46E*	*30 km*	*25 km*	*Daintree*
Hastings	*16:31S 146:01E*	*60 km*	*45 km*	*Barron*
Upolu	*16:41S 145.56E*	*25 km*	*28 km*	*Barron*
Green Is	*16:46S 145:58E*	*20 km*	*20 km*	*Barron*
Thetford	*16:48S 146:11E*	*30 km*	*45 km*	*Barron*
Brook Is	*18:09S 146:18E*	*25 km*	*45 km*	*Herbert*

1.b(ii) Geomorphological description of the reefs studied (Figure A1):

No Name Reef - an off-shore ribbon reef, approximately 2 sq.km in area. The reef flat is only exposed during periods of extreme low water spring-tides.

Hastings Reef - an off-shore crescentic reef, approximately 10 km^2 in area. The reef flat is exposed only during periods of extreme low water. In recent years Hastings Reef has attracted extensive tourist activity. Floating pontoons at a number of intermittent sites have been established on the leeward side of the reef.

Thetford Reef - a mid-shelf crescentic reef, approximately 8 sq.km in area. The reef flat at this site is also only exposed during periods of extreme low water.

Upolu Cay Reef - a mid-shelf planar reef of approximately 12 sq. km. With the exception of neap tides, the reef flat is exposed during all low tides. An unvegetated sand cay has formed on the north-west leeward end of the reef flat.

Batt Reef - a mid/nearhore planar reef of approximately 120 sq.km in area. To some extent the reef flat is exposed during all low tides below approximately 0.8m.

Green Island Reef - a mid/nearshore planar reef of approximately 7 sq km. The reef flat is generally exposed during all low tides below approximate 0.8 m. The reef supports an extensive tourist operation on a vegetated sand cay. The cay and adjacent reef flat have been heavily modified during recent years by the addition of resort buildings, toilet blocks, groynes, jetties and an underwater observatory (Baxter 1990). During the past the reef has provided material for lime on the nearby mainland (Pulsford 1991).

Brook Island Reef - a mid/nearshore fringing reef of approximately 1.2 sq km. Parts of the reef flat are exposed during low tides.

Porites colonies selected for core sampling and subsequent sclerochronological interpretation were located on the leeward side of the respective reefs in no more than 5m of water (Figure A2).

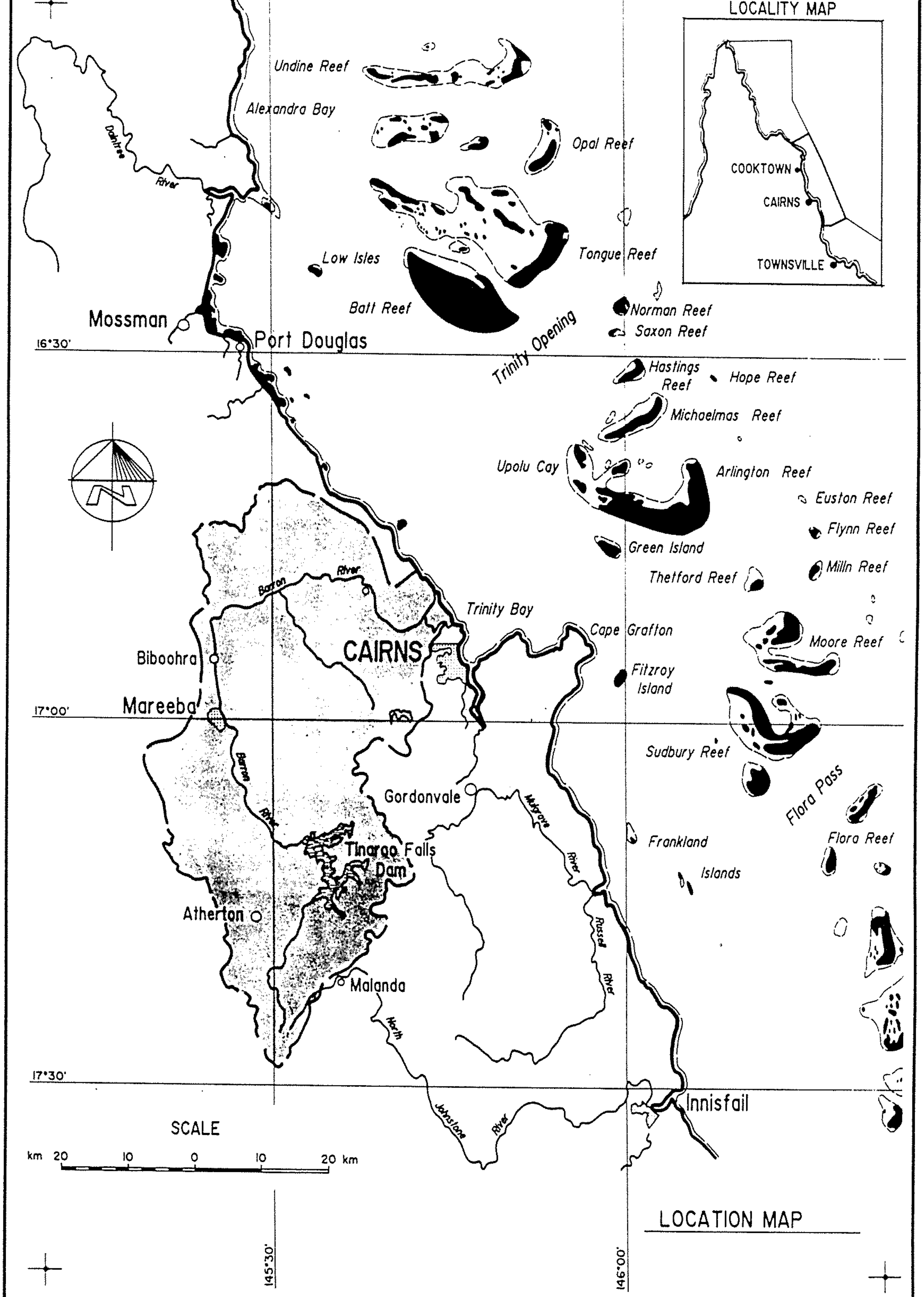


Figure A1: *Geographical location of reefs cored.*

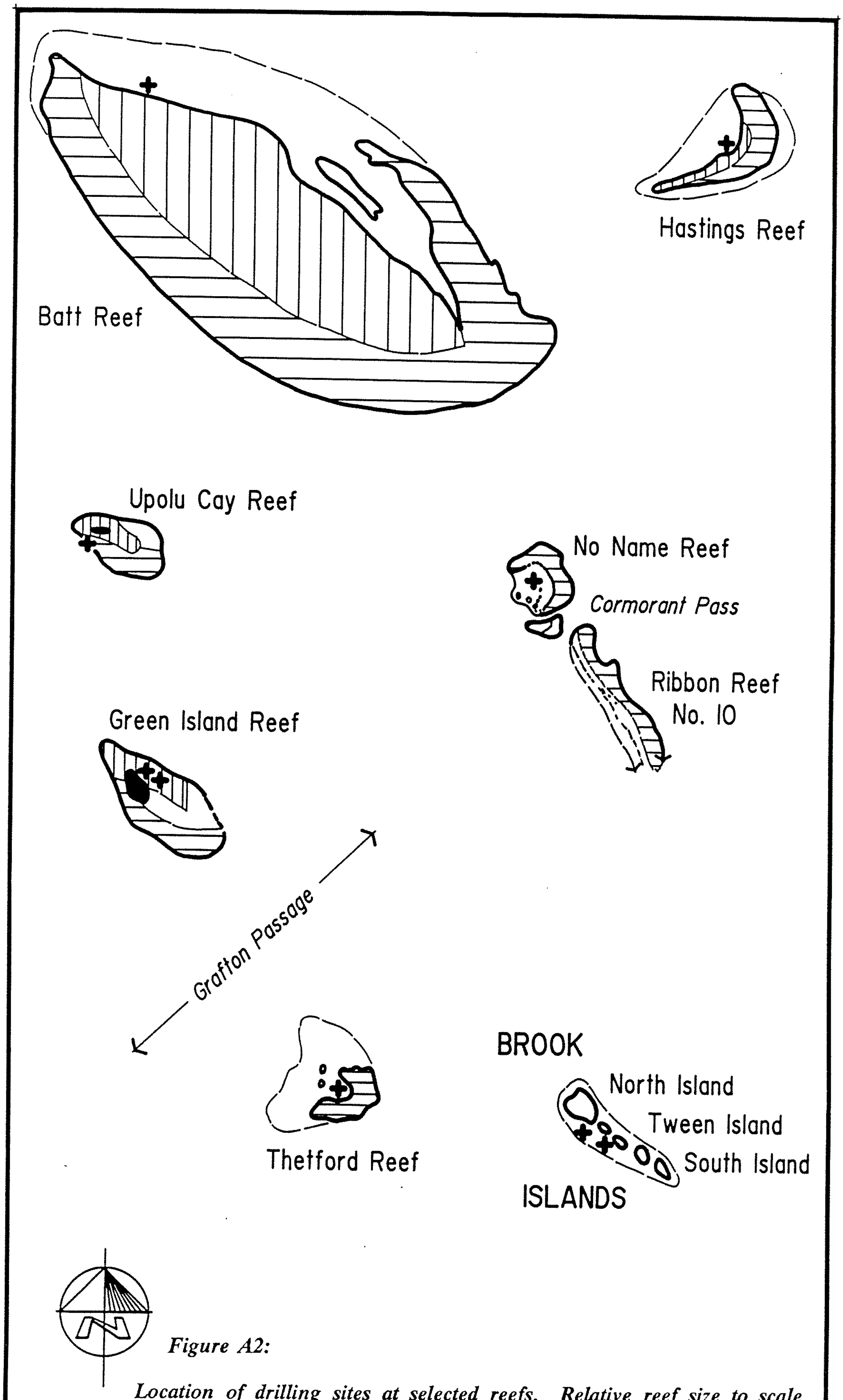


Figure A2:

Location of drilling sites at selected reefs. Relative reef size to scale. Individual placement in diagram not according to geographical location.

Table A2. Estimated Visitor Impact on Reefs Studied

Reef	Estimated Degree of Impact
No Name Reef	Negligible
Batt Reef	Limited
Hastings Reef	Considerable recently
Upolu Reef	Limited
Green Island	Extreme
Thetford Reef	Limited
Brook Island	Considerable

Table A3. Estimated distance from possible source of nutrient

Reef	Nutrient Source	Distance
No Name Reef	Upwelling	Immediate
Hastings Reef	Upwelling Visitors Barron River	Immediate Immediate 45 km
Green Island	Local sewage Barron River	Immediate 25 km
Batt Reef	Daintree River Barron River Short coastal streams	25 km 45 km 25 km
Thetford Reef	Upwelling Barron River Johnstone River	15 km 45 km 80 km
Upolu Cay Reef	Upwelling Barron River	25 km 28 km
Brook Islands	Herbert River Visitors	45 km Immediate (limited)

2. NUTRIENT MONITORING PROGRAMME

2.a. TERRESTRIAL:

Site Selection:

Sampling locations were chosen to provide the most intensive monitoring programme possible within the time and monitory constraints of the budget. The requirements for site selection were -

1. accessibility during all seasons
2. water flow during all seasons

Additional sites were added as access through property was granted. Where these data are presented, periodicity will be stated.

Sampling time-frame:

Long-term Monitoring Programme - A two year monitoring programme was planned to extend from February 1987 to January 1989. 1987 and 1988 wet seasons were comparatively 'dry' periods (Appendix C). Following the onset of a reasonably heavy wet season at the beginning of 1989, the programme was extended to April 1989. Terrestrial sampling was conducted at the beginning of each month between February 1987 and April 1989.

Short-term Monitoring Programme - To assess the short-term dynamics of one section of the Upper Barron River Catchment the river was sampled at Yungaburra on a daily basis between the 3rd and 19th November 1988 inclusive. Rainfall data and stream discharge figures were obtained from the Bureau of Meteorology in Brisbane. Daily rainfall totals were verified through the Atherton newspaper. Barron River Discharge data (Queensland Water Resources Commission) for the short-term dynamic study refers to Picnic Crossing (Yungaburra).

Sampling procedure:

Water samples for future analysis were collected as near as possible to the centre of each stream using a hand held syringe. Samples were drawn directly into the syringe and delivered into acid rinsed, named and dated, polyethylene nutrient sampling bottles through disposable 0.45 micron Minisart filters. 50 ml of sample was collected from each site. Collection bottles and sampling syringe were each rinsed several times in the water being sampled. Samples were placed on ice in an air conditioned vehicle and frozen as quickly as possible.

2.b. MARINE:

Water samples for future nutrient analysis were collected from a number of reefs (Figure 12, Volume 1, p.46), by the Marine Parks section of the Queensland National Parks and Wildlife Service (QNPWS), Cairns, and by the Low Isles Light House Keeper.

Sampling procedure:

All collections of water samples were subject to weather conditions. Instructions were issued, and demonstrations given, on sampling techniques. All samples were to be taken in approximately 10 metres, and not less than 5 metres of water, away from the obvious presence of boats or tourists. 50ml samples were collected from each site, drawn into disposable syringes and discharged through 0.45 micron Minisart disposable filters into the labelled and dated sample bottle. Samples were to be iced down and frozen as soon as possible. According to the samplers, freezing normally took place well within six hours. To eliminate possible sampler error, however, five pipette drops of 32% UNIVAR Hydrochloric Acid were added to, and left in, each 100 ml sample bottle in accordance with the directions of the analysing technicians at the Australian Institute of Marine Science.

3. SEDIMENT DESORPTION TECHNIQUES:

3a Sample collection

Sampling locations were chosen to represent different morphological areas of the reef flat (Figure 14, Volume 1, p.54). Sediment samples were collected between the 13th and 14th October 1989 from a number of sites across the Low Isles reef flat. Where possible, samples were collected by pressing collection jars into the top sediments and removing the undisturbed sample. Clear plastic jars were used for collection. No pressure blocks occurred during collection of these samples. Samples taken at depth (80 cm) in the mangrove park were retrieved from the bottom of an augured hole at low tide. In areas where the overlying sediment was less than 10 mm deep (e.g. in the Southern Gap; Figure 14, Volume 1, p.54), sample material was scooped from the surface using a small trowel. Sample size ranged from 200 gm to 1 kg depending on the amount of sediment available. Samples were then presumed to be representative of the sediments of the sampled area. Samples were placed into zip-topped plastic bags, labelled and immediately frozen and returned to the laboratory for future analysis.

Water and sediment samples were collected each hour, over one full tidal cycle, on the 14th October 1989, from a single location on the reef flat (see Figure 14, Volume 1, p.54). Sampling took place in the approximate centre of a natural drainage channel on the northwestern side of the island. This site was chosen because -

(a) the area is the main drainage channel for waters flowing on to and off the reef flat,

(b) the area does not dry out at low tide,

(c) the area is easily accessible during all stages of the tidal cycle, and under all weather conditions.

Water samples were collected, stored and analysed in accordance with the methods stated below. Sediments were collected from the underlying substrate immediately after collection of the water sample. Sediment samples were removed and stored as outlined above. Sediments were analysed for dissolved phosphate in accordance with the techniques outlined below.

The mineralogy of the sampled sediments was determined using X-ray Diffractometry (see below). After XRD analysis, the collected sediments were subjected to the the treatments outlined below, and the solution produced was analysed for soluble PO_4^3 using the methods described under "Nutrient Analysis" below.

3b Sample preparation:

Desorption techniques designed to mimic the reef environment as closely as possible, were conducted under laboratory conditions. To provide empirical status, agitation from tidal and wave action was simulated using a magnetic stir bar. Average oceanic temperature around Low Isles is approximately 26°C. Ponded water often reaches 40°C. Shallow surface waters over the dark mangrove muds can reach 60°C and above. Inundation by freshwater alters the pH and promotes the mobilisation of phosphates from the sediments.

Prior to analysis, samples were dried at 40°C, weighed, divided into four sections of equal weight and subjected to four separate desorption treatments. Desorption procedure was carried out in accordance with the methods of Entsch *et.al* (1983). However, in many areas of the reef flat sediment cover was less than 10mm. Therefore, samples were occasionally considerably smaller than the samples collected by Entsch *et.al.*

3c Sample treatment:

Treatment 1:

Sediments were mechanically dried at temperatures of <35°C. Samples were sieved and 20 g of sample from the <65 micron portion weighed into a 150 ml beaker. Most of the phosphate was presumed to be held by the <65 micron portion of the sample. 100 ml of seawater from the James Cook University Aquarium (pH 8.3, PO_4 0.13 μM) was added to the weighed material. The solution was stirred using a magnetic stir bar (spin rate = 1100 rpm) for 30 seconds. During stirring the sample was heated to average oceanic temperature around Low Isles of 26°C. After 90 seconds settling time 75 ml of supernatant solution was removed and analysed for PO_4 content using the molybdate colorimetric techniques of Murphy & Riley (1962). A Varian 634 UV-Vis Spectrophotometer fitted with 10 cm cells was used for adsorption readings. The procedure was repeated another five times on the same sample.

Treatment 2:

As for Treatment 1, but heated during stirring to 40°C.

Treatment 3:

As for Treatment 1, but heated during stirring to 60°c.

Treatment 4:

As for Treatment 1, but washed with rainwater (pH 5.3; PO_4 0.0 μM) and heated during stirring to 26°C.

3d Mineralogical determination of the sediments:

After drying and prior to the application of desorptive manipulations, 20-40 g of the finer sediments (<65 microns) were ground and the mineralogy determined using X-Ray Diffractometry (XRD) following the methodology outlined below. Semi-quantitative classification values were apportioned to the assessed mineralogy by assigning the values outlined in Table A4.

Table A4.: Semi-quantitative values assigned to sediment mineralogy from the Low Isles reef flat. Mineralogy determined using X-ray Diffractometry.

Proportions were estimated, and values assigned, as -	
0-5 divisions above base line	*= (1) Trace only present*
0-25 divisions above base line	*= (2) Minor quantity present*
25-70 divisions above base line	*= (3) Medium quantity present*
70-80 divisions above base line	*= (4) Medium to Major quantity present*
>80 divisions above base line	*= (5) Major quantity present*

DESIGNATED VALUES -					
MINERAL	*VALUE 1*	*VALUE 2*	*VALUE 3*	*VALUE 4*	*VALUE 5*
APPROXIMATE PROPORTION OF SAMPLE ASSIGNED TO EACH CODE:					
Quartz & Felspar	*0-2*	*2-5*	*5-18*	*18-22*	*22->*
Calcite & High Mg calcite	*0-2*	*2-10*	*10-38*	*38-42*	*42->*
Aragonite	*0-2*	*2-7*	*7-28*	*28-32*	*32->*
Gypsum	*0-2*	*2-10*	*10-38*	*38-42*	*42->*
Kaolinite, Illite/Smectite, Mixed Layer Clays			*SEE BELOW*		

Due to their small particle size and relative surface area, the importance of the Kaolinite, Illite/Smectites and Mixed Layer Clays to the total available surface area suitable for ionic exchange was recognised during the apportionment of the sediment miners. Finer clays were estimated as -

Presence but not easily distinguishable in the XRD analysis	*= 2 (Minor)*
Easily distinguishable in the XRD analysis	*= 3 (Medium)*
Obvious presence in the XRD analysis	*= 4 (Medium/Major)*
Distinct occurrence in the XRD analysis	*= 5 (Major)*

This classification scheme takes account of the relatively poor diffracting ability of the small, disordered clay particles.

4. REMOVAL AND TREATMENT OF CORAL CORES

4.a. Drilling Programme

A commercial Jacro 100 Drilling Rig was specially modified for use under marine conditions. Modifications to the drilling rig were primarily for safety, ease of handling and manipulation onto a *Porites* colony, and maintenance. The modifications were not designed to allow deep underwater drilling. Drilling was consequently restricted to *Porites* colonies in no more than one metre of water at mid-tide. For interpretation of anthropogenic influences it was necessary to remove enough material to establish a time period prior to European settlement in North Queensland (approximately 100 years). In the Great Barrier Reef lagoon, extension rates of *Porites* colonies are usually between 5 and 20 mm yr^{-1} (Isdale 1981). Where possible, the drilling platform was established on a colony capable of providing at least two metres of coral core. In areas where a suitably sized colony could not be located, and the reef was considered of sufficient importance to warrant a compromise, a colony large enough to establish the drilling platform was selected as an alternative.

The core barrel was fitted with a tungsten carbide 50 mm bit with carbide inserts below a cemented carbide reaming shell. Bit and reaming shell were designed to maximise penetration and minimise sideward drift within the colony. The coral colony was drilled along the growth axis and as near as possible to the estimated centre of the living colony. Where this was not possible, the drilling rig was angled to direct the core barrel along the estimated growth axis. Core material was drawn into a split casing insert, removed and placed into labelled core holding trays, sealed, and transported back to the laboratory for subsequent analysis.

At the completion of each drilling session, the manufactured cavity was sealed with a prepared concrete plug. Follow-up studies at James Cook University of North Queensland (J.Goudie, pers.com) have shown that the plugged cavity is quickly covered by new material.

4.b. Core Preparation

Cores were thoroughly washed with fresh water prior to bedding in Rockhard Plaster in boxed aluminium holding trays. To ensure precision cutting, restrictors were attached to the tracking bench of a thoroughly cleaned tungsten tipped circular rock saw. With the assistance of Mr. B. Parker at the Australian Institute of Marine Science, one 7 mm and one 2 mm slab were removed from the approximate centre of each bedded core using established cutting procedures. The prepared slabs were then presumed to contain every recorded year from the time of collection to the depth of barrel penetration.

4.c. X-Radiography

To determine the chronology of the coral core according to the methods of Knutson *et.al* (1972), X-radiographs were made of each sectioned length of material using a Circlex condenser discharge unit. Exposure was 47 kV at 20 milliamp-seconds (MAS) with a tube to film distance of 90 cm. The photo-sensitive material was Kodak medical orthochromatic/green sensitive film, combined with a Kodak Min-R intensifying screen. Radiography was carried out commercially by Waterhouse Radiology of Townsville, North Queensland. Initially both the 2 mm and the 7 mm slabs were X-rayed but it was found that resolution of the paired density bands was enhanced using the 2 mm slab. In addition, the 2mm slab was easier to manipulate and dissect, and consequently all X-rays were conducted on the 2 mm thick sample. Where chronological diagnosis was difficult, interpretation was enhanced by examining the fluorescent bands.

4.d. Spectrofluorescence

Isdale (1984) demonstrated the ability of yellow-green fluorescent bands in nearshore corals to provide individual signatures of summer monsoonal rainfall and river runoff. Boto and Isdale (1985) further noted that all corals emitted a blue background fluorescence. Prior to preparation for examination using Atomic Absorption Spectrometry (AAS), Scanning Electron Microscopy (SEM) or X-ray Diffraction (XRD), the cores were illuminated with long-wave UV light and photographed by Mr. M. Cuthill in the Australian Institute of Marine Science Photographic Unit.

Density variation within the *Porites* skeleton consists of a pair of high and low density bands constituting one calendar year (Knutson *et.al* 1972; Buddemeier & Kinzie 1976). However, the paired bands are often made up of a number of visible small bands of varying intensity. Under these circumstances differentiation between the bands, and allocation of a seasonal starting point, to either of the bands, becomes difficult. In the Great Barrier Reef lagoon, location of the fluorescent bands is superimposed on the high density portion of the paired density bands according to the onset of the summer wet season. Where chronological order could not be established on the X-ray image of the density bands alone, dating continued by referring to the location of the fluorescent bands.

4.e. Sample preparation

Combined use of the above methods allowed the strength and periodicity of rainfall and runoff to be attributed to identifiable time periods. Thus, wet and dry years could be identified and dated with a reasonable degree of accuracy using the techniques devised by Isdale (1984) Knutson *et.al* (1972) and Buddemeier and Kinzie (1976).

The 2 mm thick coral section was then transected on an annual basis according to the location of the beginning of the heavy density band (or the beginning of the green-yellow fluorescent band if necessary) using a dissecting scalpel. Use of the 2 mm thick section had three advantages -

(1) clearer X-radiographic determination of the density bands,

(2) elimination of a degree of annual overlap introduced by the spherical growth habits of massive corals, and

(3) use of a scalpel increased the accuracy of chronological dissection of the annual bands.

The removed portion of the section was then assigned a date where the summer high density period represented the January that would be incorporated into that period. Each removed sample of coral core was then presumed to contain a matching pair of high and low density bands, a wet and a dry season, and to be representative of a predetermined calendar year. It is acknowledged that this may, or may not, co-incide exactly with the coral year.

The removed sample of coral core was divided vertically into two portions. One portion of sample was retained in an identified, sealed sample bottle for possible examination using SEM. The remaining portion of sample material was powdered using agate mortar and pestle and analysed using XRD prior to preparation for analysis by AAS. Weights were standardised to 2.5 mg ± 2% to minimise differences in ionic strength in the resulting acidified solutions.

The year of collection (usually 1988) was dropped from all comparative studies. Core material removed from the stem of the coral was also not included in the analysis.. This was done because exploratory examination using Atomic Absorption Spectrometry (AAS) and Scanning Electron Microprobe Analysis showed erratic behaviour in the chemical composition of both the newly precipitated material (i.e. the outermost section of the colony, extending into the skeleton equivalent to approximately 1yr prior to the time of collection) and the base material of the *Porites* skeleton. All coral colonies examined displayed similar erratic behaviour at these two locations. Similar behaviour has been noted by previous researchers (e.g. Weber, 1973 p2177) and was considered beyond the scope of this thesis. Therefore, to avoid unnecessary ambiguity, the year of collection and the base material was eliminated from the data set.

5. *ANALYTICAL TECHNIQUES*

5.a. NUTRIENT ANALYSIS

Unless otherwise stated, all results used were analysed by the Australian Institute of Marine Science Analytical Laboratory using Flow-through Injection Analysis (Ryle 1981). Replicate samples were collected at intermittent intervals and forwarded to The Australian Centre for Tropical Freshwater Research Laboratory for determination of analytical accuracy. Distilled water was periodically passed through the disposable 0.45 micron Minisart filters and forwarded to the Australian Institute of Marine Science Analytical Laboratory to assess filter purity and analytical accuracy. Where applicable, salinity was indicated on the sampling bottles and salinity concentrations determined by the Australian Institute of Marine Science prior to nutrient analysis.

Although only phosphate will be discussed in this Thesis, early analysis at the Australian Institute of Marine Science automatically included all nutrients. The inter-Laboratory analytical variability will be included for NO_3 and NH_4 as an indication of the consistency of the phosphate values. Variability of phosphate values between analyses at the Australian Institute of Marine Science and The Australian Centre for Tropical Freshwater Research was usually less than 3% for river waters and between 10 and 15% for marine waters. NO_3 values were consistently an order of magnitude higher when analysed by

The Australian Centre for Tropical Freshwater Research. From the consistency of these values and subsequent discussions with the Laboratory Technicians it was determined that the higher values were due to analytical insensitivity. NH_4 values were erratic, both within and between the different Laboratories.

Collection methods, storage and sampling techniques were discussed fully with Laboratory staff prior to the onset of the programme. Tests conducted by the Australian Institute of Marine Science (J. Wellington, pers.com) suggest only minor decreases in phosphate and nitrate values take place under acid preservation. According to J. Wellington and A. Nott, Australian Institute of Marine Science (pers.com.), this method stabilised the phosphate and nitrate in solution, but had an unknown effect on ammonia stability.

5.b ATOMIC ABSORPTION SPECTROMETRY (AAS)

Lack of a suitable commercial atomic absorption coral aragonite standard made the generation of reliable, repetitive, standard curves difficult. To overcome this problem, an internal standard was created. Approximately one kilogram of coral skeleton from an outer shelf *Porites* colony was crushed using an agate mortar and pestle. The powdered material was thoroughly mixed, fractionated and forwarded to Classic Comlabs Ltd, Adelaide, South Australia, for chemical determination using Inductively Coupled Plasma calibrated to calcium carbonate standards (Table A5). Samples were run in duplicate and an averaged representation presented. This material subsequently became the internal standard against which all analysis became relative.

Determination of the comparative calcium, strontium, potassium, sodium, iron and magnesium content of each representative annual sample was conducted in the Geology Department, James Cook University, using standard Atomic Absorption techniques. Solutions of the dissolved samples containing 5% HCl were analysed using a Varian Techtron AA5 Atomic Absorption Spectrophotometer. Air-acetylene reducing flames were used for all determinations.

During analysis, every eighth sample was duplicated. Samples were analysed in batches of 40 and calibration checked at the beginning and mid-way through the running of each batch.

Table A5: Aragonite Internal Standard - CompositionTable A5: Aragonite Internal Standard - Composition

Sample:	*Porites genus Coral*	
Mineralogy:	*Aragonite*	
Location:	*No Name Reef, GBR, Australia*	
Assay:	*Classic Comlabs, Job No.9AD3076*	
Element	*Determination*	*Accuracy*
C	*11.24 wt%*	*± 0.5 wt%*
Ca	*39.05 wt%*	*± 0.01 wt%*
Sr	*7250 ppm*	*± 5 ppm*
Na	*4400 ppm*	*± 10 ppm*
Mg	*1260 ppm*	*± 100 ppm*
Fe	*630 ppm*	*± 4 ppm*
K	*45 ppm*	*± 10 ppm*

5.c. SCANNING ELECTRON MICROSCOPY:

Each annual band was divided into 2 sections, both including a paired density band. One section was ground using an agate mortar and pestle. The ground section was then further divided. One portion was analysed using conventional Atomic Absorption Spectrometry for elemental determination. The remaining portion was smeared on to a glass slide for crystallographic assessment (see X-ray Diffractometry, this Appendix). The unground portion of each annual band was then used to determine skeletal porosity by spatially mapping the coral skeleton using Scanning Electron Microscopy.

The unground sections of each annual band were impregnated with resin (3 parts Ferro Epoxy Resin LC261:1 part Ferro Hardener LC249), attached to glass microscope slides taken down to an even 775 microns, cut to 200 micron sample thickness using a diamond tipped saw, and polished mechanically using a polishing pad and one micron diamond impregnated polishing cream. Care was taken to avoid uneven and/or over-polishing. Any damage to the prepared sample immediately became apparent under the SEM and the sample was discarded and replaced.

Prepared samples were carbon coated to a thickness of 15 nm using high purity Carbon Graphite 1.5 mm diameter rods. The method was verified using a polished brass plate which assumes an indigo red colouration after coating to the appropriate thickness. This method of carbon coating follows the standard geological methodology for qualitative electron microprobe analysis.

Analyses were made using a Tracor Northern Image Processing Package on a TN3500 system fitted to a JEOL JXA840A Electron Microprobe. Probe current was adjusted to 10 nA using a Picoamp Metre and the SEM's condenser control. Analyses were conducted in compositional mode in back scatter at approximately 30 uA emission current and 15 kV accelerating voltage.

Differentiation between skeletal walls and voids was made by processing the image into varying shades and assigning the shades to bins within the Image Processing Package. All shades below Bin 144 were allocated to voids, and everything above Bin 144 allocated to skeletal material. Contrast and gain were constantly monitored by calibrating the resolution against a pre-determined standard. Only occasional minor adjustments were necessary provided the height of the sample material and the holding slide remained consistent.

To verify both sampling accuracy and sample homogeneity, additional samples were removed from three different annual bands and analysed at varying times using the same principles established for all other samples (Table A6).

High and low density bands were usually quite distinct when imaged on the SEM. Care was taken to sample evenly the high and low density bands where these were visible. To ensure as much bias as possible was eliminated from the analysis, framed images were processed at six different sites moving in a clockwise direction around the sample. A seventh site overlapping the high and low density bands was then included. Particularly large samples required a total of nine sampling sites. This ensured that all of the sample was included in the analysis. In portions of the skeleton, paired density bands were often indistinct. Random sampling around the perimeter of the specimen followed by sampling in the centre of the specimen then had to be considered sufficient. Relative percentages from the combined sampling sites were averaged.

Table A6: Verification of Scanning Electron Microscopy techniques developed for examination of skeletal porosity in Porites samples. Replicate examination was conducted on samples removed from three different annual bands and analysed at varying intervals to determine sampling accuracy and sample homogeneity. Analysis followed the same methods outlined above. Natural variation will occur throughout the sample because of the high and low density bands characteristic of the Porites coral.

PERCENT VOIDS ASSESSED AT EACH SITE							
SITE NUMBER	1891			1981		1982	
	A	B	C	A	B	A	B
#1	59.6	59.3	58.1	61.1	63.4	56.6	63.3
#2	57.3	57.5	57.5	59.7	61.5	55.8	61.6
#3	56.6	56.6	56.6	59.4	60.8	55.5	68.9
#4	54.7	56.1	54.1	59.2	58.4	55.5	52.5
#5	53.4	55.7	53.5	58.8	58.1	55.2	51.4
#6	53.4	54.7	53.5	58.6	57.8	52.6	50.7
#7	51.7	54.5	52.6	58.1		51.3	
#8	50.9						
AVG	55.24	56.34	54.1	59.27	60	54.6	56.4
STD.DEV.	2.53	1.55	2.15	0.89	2.06	1.78	5.06

STANDARD DEVIATION BETWEEN MEANS - REPLICATES AND ALL ANALYSED SITES:

SAMPLE No.1 (1891)	0.90
SAMPLE No.2 (1981)	0.36
SAMPLE No.3 (1982)	0.88
TOTAL ANALYSIS (1867-1987)	4.48

The framed image always included only sample material. The section of material within the processing frame was never allowed to include the external edge of the sample where thinning during polishing may have occurred. Image analysis was always made at 20X magnification. Unbiased sampling and random selection of sampling sites could not be guaranteed at higher magnification. Sample size was determined by the width of the annual band. Under lower magnification, it was sometimes impossible to completely fill the frame with the amount of sample material available. In instances where the high and low density bands were uneven, misrepresentation of the true annual average density occurred under lower magnifications.

5.d. X-RAY DIFFRACTOMETRY (XRD)

The XRD pattern of aragonite is well documented (Joint Committee of Powder Diffraction Standards, Pattern No.5-0453) and examination of this pattern shows that the major reflections occur between 20-51° 2θ for CuKa. Traces for each annual band were, therefore, run through this region.

Angular precision for this region was routinely assessed using elemental Si (National Bureau of Standards, No.640a) as an external standard and corrections applied if necessary. Precision of repeated measurements was +/- 0.02°2θ.

Sample homogeneity was assessed by running seven slides from a single annual sample seven times forward and seven times backwards through the region 20-51° 2θ (the number seven was an arbitrary figure). This was done routinely throughout the analysis, but the repetition was performed more often if the deviation from the anticipated location was particularly anomalous (>±0.06°2θ). Sample homogeneity was consistently high (Table A7).

Table A7: ***Verification of XRD Methodology. To verify the reliability of the procedure, seven smear mounts were prepared from each of several specimens. Values represent the degree of deviation from the anticipated location of the XRD (111) aragonite peak. All replicates are from Green Island.***

	1878	1884	1890	1897	1909	1916	1958	1972	1981	1985
#1	-.01	.05	-.03	-.06	-.10	0	-.15	-.10	-.22	-.05
#2	0	.04	-.02	-.08	-.10	0	-.15	-.10	-.22	-.05
#3	0	.04	-.03	-.06	-.10	0	-.15	-.10	-.22	-.05
#4	0	.06	-.02	-.08	-.10	0	-.15	-.10	-.22	-.04
#5	0	.05	-.03	-.08	-.10	0	-.15	-.10	-.22	-.05
#6	0	.04	-.02	-.08	-.11	0	-.15	-.10	-.22	-.06
#7	0	.05	-.02	-.06	-.10	0	-.15	-.10	-.22	-.05
AV	0	.047	-.024	-.07	-.10	0	-.15	-.10	-.22	-.05

Sample preparation was routinely checked by preparing, analysing, scraping off, re-doing, and re-analysing the same sample, seven times. This was done in conjunction with the verification of sample homogeneity. Sample preparation techniques were consistently high.

Analysis of the major (111), (021) and (012) reflections of aragonite indicated shifts up to 0.2° 2θ when referenced to the Joint Committee of Powder Diffraction Standards, Pattern No.5-0453. As there was a consistency in the direction of shift in these major reflections, the (111) reflection was chosen as an indicator of crystallographic perturbation.

6. DATA HANDLING AND STATISTICAL ANALYSIS

Unless specifically outlined in the text, the data were analysed for statistically significant correlations using Pearson's Product Moment Correlations within the *STATISTIX II* programme for microcomputers. This is an interactive statistical package in which missing values in a sub-set automatically exclude the entire set of data entries for that particular sub-set (in this case, the entire sampling period). While this method of analysis produces a number of "missing cases" it ensures all site data have equal temporal rating, thus eliminating ambiguous assessment of data which may have been collected under varying climatic conditions. Site 4 (Henry Hannum Bridge) contained a number of missing observations. Incorporation would have resulted in an unreasonably reduced set of useable cases. Unless otherwise stated, data from the Henry Hannum Bridge site have been removed from the data set. Given the vastly different temporal conditions (see Chapter 2) operating in the study area, it was considered essential that as many confounding variables as possible were removed from the statistical interpretation of the data set. Therefore, statistical evaluation was conducted only on the time period when all sites were sampled (December 1987 to April 1989). If data outside this time period was included in the analysis, this was stated in the text.

Exceptionally high phosphate values were recorded on some occasions (15.0 μM at the South Mossman River in August 1988; 18.2 at Freshwater Creek and 39.6 at Henry Hannum Bridge in April 1989). These may be sampling or analytical artefacts. However, the value at South Mossman followed a single rainfall event immediately prior to sampling. The Freshwater Creek and Henry Hannum Bridge samples were collected during extreme flood conditions. It is impossible to know if the values were analytically incorrect or whether the floodwaters carried excessive phosphate values from sources unknown. While these values may or may not be real, in the absence of proof of their analytical unreliability, with the exclusion of Henry Hannum Bridge as stated above, their levels were read into the data set as an indication of the nutrient status of the rivers under all sampled conditions. Henry Hannum Bridge results were included in all graphic displays.

APPENDIX B

SHORT–TERM DYNAMIC STUDY BARRON RIVER, YUNGABURRA

SOLUBLE PHOSPHORUS CONCENTRATIONS RAINFALL DATA AND BARRON RIVER DISCHARGE AT PICNIC CROSSING (YUNGABURRA)

BARRON RIVER AT YUNGABURRA - NOVEMBER DAILY SAMPLING -

DATE	PO4 (µm)	RIVER DISCHARGE AT PICNIC CROSSING (Ml)	RAINFALL (mm)
NOV.1		77.60	
NOV.2		87.60	
NOV.3	1.07	107.60	2.60
NOV.4	1.06	93.00	4.20
NOV.5		79.40	0.00
NOV.6	0.61	70.50	0.00
NOV.7	0.35	63.60	0.80
NOV.8	0.35	58.40	0.00
NOV.9	0.33	56.50	0.00
NOV.10	1.30	51.00	0.00
NOV.11	2.29	46.90	8.10
NOV.12	0.29	42.30	0.00
NOV.13	0.47	40.20	0.00
NOV.14		39.70	0.00
NOV.15	10.30	47.50	29.20
NOV.16	0.37	63.70	0.00
NOV.17	0.37	64.50	0.00
NOV.18	0.45	58.90	0.00
NOV.19	0.29	53.10	23.60

APPENDIX C

CLIMATIC DATA FOR THE STUDY AREA

RAINFALL AND DISCHARGE DATA FOR THE BARRON RIVER

MTH	YEAR	RAINFALL (MILLIMETRES)					RIVER DISCHARGE (MEGALITRES)			
		KAIRI mm	MALANDA mm	ATHERTON mm	KURANDA mm	CAIRNS A'PORT mm	PICNIC X-NG Ml	TINAROO FALLS Ml	MAREEBA Ml	MYOLA Ml
		91	78	104	126		526	5677	9464	74813
F	1987	155	189	186	661	428	2703	2243	7777	76852
M	1987	109	167	309	121	227	4383	820	4608	24833
A	1987	121	270	148	313	307	7644	862	2526	15374
M	1987	52	81	56	97	103	9244	586	2846	15200
J	1987	66	105	71	160	144	8422	90	3646	15796
J	1987	31	42	33	101	41	5754	166	2926	15103
A	1987	6	14	9	38	16	2781	3048	3895	8667
S	1987	25	34	20	61	63	1709	3680	4729	7780
O	1987	14	23	15	32	13	967	6474	7956	8419
N	1987	122	162	121	64	63	1617	5206	8374	9876
D	1987	215	203	345	161	291	3459	4357	10196	17862
J	1988	30	47	15	65	133	3184	4771	6272	8836
F	1988	220	270	263	149	160	10534	3275	14456	34354
M	1988	145	197	115	320	338	5835	1994	5213	16076
A	1988	51	61	48	72	104	4138	3142	4118	8241
M	1988	45	62	39	117	102	3411	3448	5634	8301
J	1988	21	38	13	18	34	2155	2913	6064	8024
J	1988	40	75	40	85	39	3074	3684	4491	8561
A	1988	78	98	56	59	32	3098	5057	6683	9053
S	1988	21	21	16	62	88	2145	1188	7578	8008
O	1988	18	78	27	30	35	901	1	9787	8395
N	1988	277	159	232	181	276	2913	2	6051	13019
D	1988	249	319	220	305	262	11243	10	10569	25474
J	1989	215	157	248	273	327	14236	16	17536	56135
F	1989	183	141	182	176	246	13136	22	14240	49564
M	1989	486	569	368	675	520	42855	193	44086	268368
A	1989	263	348	222	583	551	32277		51200	171636

BARRON RIVER DISCHARGE
APRIL 1989

DATE	DISCHARGE (MEGALITRES)
1	1369.6
2	1453.9
3	1437.2
4	1249.0
5	1195.4
6	2199.6
7	4568.7
8	4813.2
9	2058.4
10	1602.7
11	1382.4
12	1234.6
13	1131.7
14	1047.6
15	1624.8
16	1762.2
17	1828.5
18	1610.8
19	1397.3
20	14657.5
21	31901.6
22	11482.0
23	8375.8
24	20725.5
25	16380.1
26	8767.4
27	6910.6
28	6344.1
29	5830.4
30	5271.3

APPENDIX D

PHOSPHATE RESULTS TERRESTRIAL

LEGEND

SITE	*ABBREVIATION*	*SITE No*
MALANDA	*MAL*	*1*
YUNGABURRA	*YGB*	*2*
TINAROO	*TIN*	*3*
HENRY HANNUM BRIDGE	*HHB*	*4*
EDMUND KENNEDY BRIDGE	*EDK*	*5*
GRANITE CREEK	*GRAN*	*6*
EMERALD CREEK	*EMLD*	*7*
BIBOOHRA	*BIB*	*8*
BILWON	*BIL*	*9*
DAVIES CREEK	*DAV*	*10*
CLOHESY RIVER	*CLOH*	*11*
KOAH	*KOAH*	*12*
MYOLA (KURANDA)	*MYO*	*13*
FRESHWATER CREEK	*FRSH*	*14*
LAKE PLACID	*PLAC*	*15*
THOMATIS CREEK	*THOM*	*16*
SOUTH MOSSMAN RIVER	*SMOSS*	*17*
COOYAH BEACH	*COO*	*18*
NEWELL POINT	*NEW*	*19*

PHOSPHATE RESULTS
- TERRESTRIAL -

MONTH	YEAR	MAL (1)	YGB (2)	TIN (3)	HHB (4)	EDK (5)	GRAN (6)	EMLD (7)
F	1987		0.20			0.94		0.58
M	1987	0.36	0.48	2.00		1.09		0.62
A	1987	0.33	0.55	0.92		0.35	0.31	0.36
M	1987	0.36	0.35	0.42		0.53	0.42	0.32
J	1987	0.48	0.32	0.57		0.83	0.28	0.30
J	1987	1.27	1.26	1.26		1.22	1.10	0.26
A	1987							
S	1987							
O	1987	8.40	0.87	0.79		0.12	0.12	0.31
N	1987	0.45	0.38	0.40		2.36	2.01	0.18
D	1987	9.00	11.40	9.20		11.40	13.40	2.36
J	1988	0.33	1.21	0.68		0.44	0.21	0.18
F	1988	1.85	1.56	3.67		1.76	2.77	1.51
M	1988	2.35	1.75	2.00		2.15	4.27	4.00
A	1988		2.33	3.03		3.35	1.58	1.54
M	1988	0.31	0.25	2.75	1.73	0.54	0.71	0.19
J	1988	0.16	0.30	0.15	0.12	0.14	0.09	
J	1988	0.79	1.73	0.28	0.97	0.68	0.60	0.73
A	1988	1.33	7.60	2.04	0.33	0.33	3.00	0.33
S	1988	0.43	0.37	0.22	0.37	0.30	0.30	0.31
O	1988	0.28	0.31	0.39	0.42	0.54	0.20	0.22
N	1988	0.95	0.68	0.97	0.26	0.40	0.31	1.55
D	1988	1.61	3.92	0.26	2.1	1.34	4.12	1.43
J	1989	0.76	1.01	0.35	1.88	1.06	2.13	0.45
F	1989	1.37	1.08	0.5	0.51	0.93	0.42	0.37
M	1989	0.29	0.15	0.63		0.34	0.9	0.37
A	1989	0.6	2.3	0.4	39.2	1.1	0.4	0.3

PHOSPHATE RESULTS - TERRESTRIAL -

MONTH	YEAR	BIB (8)	BIL (9)	DAV (10)	CLOH (11)	KOAH (12)	MYO (13)	PLAC (14)
F	1987			0.25	0.14		0.36	0.48
M	1987				0.07		0.17	0.13
A	1987			0.27	0.20		0.30	0.22
M	1987			0.37	0.12		0.48	0.20
J	1987			0.25	0.22		0.22	0.21
J	1987			0.13	0.18		0.13	0.38
A	1987							
S	1987							
O	1987			0.28	0.28			0.14
N	1987	0.29	0.30	2.34	1.58	0.23	0.23	0.24
D	1987	1.84		1.68	1.10	2.95	7.70	11.30
J	1988		0.46	0.18	0.21	0.18	0.15	0.33
F	1988	2.89	2.82	3.72	0.93	3.14	1.31	1.66
M	1988	4.31	1.67	0.59	1.89	0.71	0.43	0.43
A	1988	2.36	2.20	2.13	3.38	1.89	2.90	1.90
M	1988	0.17	0.38	0.09	0.10	0.15	0.50	0.28
J	1988	0.80	0.14	0.17	0.14	0.14	0.14	0.14
J	1988	0.62	0.71	0.55	0.81	0.55	0.57	0.33
A	1988	0.39	0.24	0.30	0.30	0.63	0.25	1.34
S	1988	0.62	0.30	0.30	0.24	0.32	1.72	0.37
O	1988	1.78	0.23	0.12	0.14	0.24	0.24	0.25
N	1988	0.52	0.35	0.54	0.13	0.3	0.52	2.43
D	1988	2.98	1.3	1.07	0.81	1.24	1.19	1.40
J	1989	0.91	1.67	0.45	0.2	0.76	0.81	1.06
F	1989	1.23	1.09	0.21	0.68	0.24	1.8	0.63
M	1989	0.01	1.08	0.6	0.15	2.77	1.36	0.79
A	1989	0.4	0.8	0.2	0.4	10.6		3.50

PHOSPHATE RESULTS - TERRESTRIAL -

MONTH	YEAR	FRSH (15)	THOM (16)	SMOSS (17)	COO (18)	NEW (19)		
F	1987							
M	1987							
A	1987	1.11	1.51					
M	1987	0.43	0.26					
J	1987	0.22	0.68					
J	1987	0.18	1.25					
A	1987							
S	1987							
O	1987	1.13	1.42					
N	1987	0.21	0.79	0.21	20.50	1.24		
D	1987	0.36	2.18					
J	1988	1.23	0.86		1.24	1.05		
F	1988	2.55	2.89	2.87	2.48	3.04		
M	1988	1.05	0.69	1.40				
A	1988	2.52	4.36	1.76	4.33	1.74		
M	1988	0.11	1.46	0.13	1.45	1.48		
J	1988	0.17	1.29	0.27	0.72	0.82		
J	1988	0.33	0.94	0.46	0.40	0.45		
A	1988	2.65	5.30	15.00	1.22	0.94		
S	1988	0.37	3.31	0.69	1.55	0.93		
O	1988	0.34	3.66	0.25	3.17	2.05		
N	1988	2.64	1.84	0.76	0.44	1.91		
D	1988	2.80	1.66	1.30	4.98	1.67		
J	1989	0.40	1.62	0.30	0.50	0.96		
F	1989	0.48		0.24	0.33	0.20		
M	1989	1.12	0.10	1.89		7.16		
A	1989	18.20	1.80	0.50	1.30	3.20		

APPENDIX E

PHOSPHATE RESULTS MARINE

LEGEND

SAMPLING SITE	*ABBREVIATION*
END OF CAIRNS LEADS	*CNS LDS*
HALF-WAY TO GREEN ISLAND	*1/2WAY*
EARLY MONTHLY SAMPLING (FIRST FORTNIGHT) - LOW ISLES	*LOW(A)*
LATE MONTHLY SAMPLING (SECOND FORTNIGHT) - LOW ISLES	*LOW(B)*
GREEN ISLAND	*GRN*
UPOLU CAY	*UPO*
MICHAELMAS CAY	*MCHLMS*
HASTINGS REEF	*HSTG*
SAXON REEF	*SXN*
TONGUE REEF	*TNG*
ARLINGTON REEF	*ARL*
NORMAN REEF	*NRMN*
THETFORD REEF	*THET*
MILLN REEF	*MLLN*
FLYNN REEF	*FLNN*
EUSTON REEF	*ESTN*
SUDBURY REEF	*SDBY*
MOORE REEF	*MRE*

PHOSPHATE RESULTS
- MARINE -

MONTH	YEAR	CNS LDS	1/2WAY	LOW(A)	LOW(B)	GRN	UPL
F	87						
M	87						
A	87						
M	87	0.85	0.73			0.48	0.22
J	87	0.31	0.16			0.32	
J	87	0.31	0.45	1.12	0.41	0.48	0.38
A	87			0.49	1.33		
S	87				0.28		
O	87	0.27	0.35	0.81	0.42	0.26	0.38
N	87	0.25	0.37	0.17	0.55	0.29	
D	87	0.27	0.25	0.33	0.32	0.15	
J	88	0.21	0.13	0.58	0.39		0.49
F	88			0.75	0.25		
M	88	0.21	0.24	0.33	0.35	0.30	
A	88	5.00		0.23	0.25	1.85	1.99
M	88	0.42					
J	88						
J	88						
A	88	1.55					
S	88			4.35			
O	88			0.31			
N	88			0.33	0.80		
D	88			0.61	0.25	0.18	
J	89			0.11	0.32		
F	89			0.18	0.35		
M	89	0.20	0.18	0.80	0.41	0.04	0.18
A	89	0.03	0.3			1.90	

PHOSPHATE RESULTS
- MARINE -

MONTH	YEAR	MCHLMS	HSTG	SXN	TNG	ARL	NRMN
F	87						
M	87						
A	87						
M	87	0.24	0.35			0.19	
J	87	0.21	0.23			0.27	
J	87	0.38	0.40			0.36	
A	87						
S	87						
O	87	0.56					0.35
N	87						
D	87	0.17					
J	88						
F	88						
M	88	3.93					
A	88					0.78	
M	88		0.56				0.75
J	88						0.12
J	88	0.36	0.54			0.35	
A	88	1.65					0.18
S	88						
O	88						
N	88				0.37	2.97	
D	88					0.16	0.72
J	89						
F	89						
M	89	0.29	0.15	0.25			0.3
A	89						

PHOSPHATE RESULTS
- MARINE -

MONTH	YEAR	THET	MLLN	FLNN	ESTN	SDBY	MRE
F	87						
M	87						
A	87						
M	87	0.34					0.77
J	87						
J	87						
A	87						
S	87						
O	87						
N	87	0.23				0.20	0.21
D	87						
J	88						
F	88						
M	88						
A	88						6.00
M	88	0.23		0.40	0.39	0.44	0.38
J	88				0.50		
J	88			0.36			
A	88			0.49		0.43	0.56
S	88						
O	88						
N	88					0.23	0.38
D	88						
J	89						
F	89						
M	89	1.30	0.29		0.10		0.80
A	89	0.10		0.70			0.10

APPENDIX F

COMPARISONS OF NUTRIENT MONITORING DATA DEMONSTRATING THE VALUE OF SHORT INTERVAL SAMPLING

COMPARISONS OF NUTRIENT MONITORING DATA DEMONSTRATING THE VALUE OF SHORT INTERVAL SAMPLING

PROGRAMME	*04/03/89*	*18/03/89*	*10/04/89*
	µm PO_4	*µm PO_4*	*µm PO_4*
Brady et.al	*0.21*	-	-
This programme	*0.04*	*1.9*	*0.03*

APPENDIX G

STATISTICS
PEARSONS PRODUCT MOMENT CORRELATIONS

PHOSPHATE RESULTS

LEGEND
(FROM TABLE 3.1)

Division of the Barron\Mossman River catchments into areas of similar agricultural practices.

AREA	SAMPLING SITE	LAND USE	CLIMATE	SOURCE OF WATER SUPPLY
AREA A SOUTHERN TABLELANDS	(1) MALANDA (2) YUNGABURRA	MAIZE PEANUTS POTATOES DAIRYING CATTLE	SOME FROSTS, WET, MAINLY SUMMER RAINFALL.	RAINFALL. SOME IRRIGATION DURING WINTER
AREA B LAKE TINAROO	(3) LAKE TINAROO	BASE OF LAKE TINAROO OVERFLOW SOME CATTLE STATE FOREST	SOME FROSTS WET, MAINLY SUMMER RAINFALL.	RAINFALL
AREA C MID TABLELANDS	(5) EMERALD C., (6) EDMUND KENNEDY BRIDGE, (7) GRANITE C.	ORCHARDS SMALL CROPS CATTLE SOME PEANUTS	COOL WINTER HOT SUMMER DRY SUMMER RAINFALL.	RAINFALL. IRRIGATION
AREA D NORTHERN TABLELANDS	(8) BIBOOHRA (9) BILWON	ORCHARDS CATTLE	HOT DRY SOME SUMMER RAINFALL.	IRRIGATION
AREA E EASTERN TABLELANDS	(10) DAVIES C. (11) CLOHESY R. (12) KOAH	SMALL CROPS SOME ORCHARDS CATTLE	COOL WINTER HOT SUMMER WET IN RANGES. DRY ON TABLELAND S. SUMMER RAINFALL.	RAINFALL. IRRIGATION.
AREA F RANGES	(13) MYOLA (KURANDA)	SOME SMALL CROPS URBAN	COOL HEAVY SUMMER RAINFALL	RAINFALL

LEGEND
(FROM TABLE 3.1)

Division of the Barron\Mossman River catchments into areas of similar agricultural practices.

AREA	*SAMPLING SITE*	*LAND USE*	*CLIMATE*	*SOURCE OF WATER SUPPLY*
AREA G *COASTAL STRIP - CAIRNS AREA*	*(14) FRESHWATER* *(15) L.PLACID* *(16) THOMATIS C*	*SUGARCANE* *URBAN*	*HOT* *HEAVY* *SUMMER* *RAINFALL*	*RAINFALL*
AREA H *COASTAL STRIP - MOSSMAN AREA*	*(17) S.MOSSMAN RIVER* *(18) COOYAH BCH* *(19) NEWELL PT*	*SUGARCANE* *URBAN*	*HOT* *HEAVY* *SUMMER* *RAINFALL*	*RAINFALL*

PEARSON'S PRODUCT MOMENT CORRELATIONS
PHOSPHATE CONCENTRATION
WITH CLIMATIC DATA

TERRESTRIAL

	AREA A	AREA B	AREA C	AREA D	AREA E	AREA F	AREA G
AREA A	1.0000						
AREA B	0.3991	1.0000					
AREA C	0.5690	0.4709	1.0000				
AREA D	0.3942	0.4961	0.8329	1.0000			
AREA E	0.2963	0.6056	0.6464	0.6816	1.0000		
AREA F	0.1500	0.2875	0.2157	0.4154	0.5661	1.0000	
AREA G	0.6939	0.5206	0.3158	0.3041	0.4104	0.3494	1.0000
AREA H	0.3688	0.1733	0.2934	-0.0841	0.3924	-0.1132	0.2943
*KAIRI	-0.0157	-0.0373	0.1910	0.1696	0.2757	0.2005	0.0266
*MALANDA	0.0265	0.0041	0.2717	0.2524	0.3780	0.1666	-0.0267
*ATHERTON	-0.0045	0.0238	0.2441	0.2757	0.3550	0.2293	0.0611
*KURANDA	-0.0478	-0.0703	0.2375	0.2148	0.1803	0.1950	-0.1651
*CAIRNS AIRPORT	-0.0812	-0.0687	0.2706	0.2843	0.1374	0.2252	-0.1411
#PICNIC CROSSING	-0.1206	-0.0829	-0.0078	0.0752	0.2127	0.3009	-0.1643
#TINAROO FALLS	0.2396	0.3636	0.0563	-0.1863	0.1829	-0.2932	0.0379
#MAREEBA	-0.2376	-0.1537	-0.1391	-0.0420	0.1548	0.2096	-0.1894
#MYOLA	-0.2172	-0.1276	-0.1191	-0.0658	0.1489	0.2234	-0.2053

	AREA H	*KAIRI	*MALANDA	*ATHERTON	*KURANDA	*CAIRNS AIRPORT	#PICNIC CROSSING
AREA H	1.0000						
*KAIRI	0.1153	1.0000					
*MALANDA	0.2432	0.9287	1.0000				
*ATHERTON	0.0948	0.9662	0.8752	1.0000			
*KURANDA	-0.0178	0.8942	0.9110	0.8107	1.0000		
*CAIRNS AIRPORT	-0.1626	0.8837	0.8008	0.8344	0.9391	1.0000	
#PICNIC CROSSING	0.0170	0.8540	0.8853	0.7880	0.9152	0.8169	1.0000
#TINAROO FALLS	0.4847	-0.5111	-0.3813	-0.5165	-0.5058	-0.6051	-0.4312
#MAREEBA	0.0894	0.8130	0.8504	0.7585	0.8392	0.7302	0.9677
#MYOLA	0.0641	0.8073	0.8480	0.7098	0.8765	0.7543	0.9764

	#TINAROO FALLS	#MAREEBA	#MYOLA
#TINAROO FALLS	1.0000		
#MAREEBA	-0.4266	1.0000	
#MYOLA	-0.3761	0.9757	1.0000

CASES INCLUDED =16
MISSING CASES =11
RAINFALL =*
RIVER DISCHARGE =#

PEARSON'S PRODUCT MOMENT CORRELATIONS
PHOSPHATE LOAD
WITH CLIMATIC DATA

TERRESTRIAL

	AREA A	AREA B	AREA C	AREA D	AREA E	AREA F	AREA G
AREA A	1.0000						
AREA B	0.1413	1.0000					
AREA C	0.7372	0.1428	1.0000				
AREA D	0.6896	0.1410	0.8891	1.0000			
AREA E	0.1903	-0.0655	0.5640	0.5261	1.0000		
AREA F	0.1873	-0.2009	0.4630	0.4468	0.9643	1.0000	
AREA G	0.3846	-0.0372	0.6945	0.6709	0.9508	0.9152	1.0000
AREA H	0.1131	-0.1347	0.4653	0.3754	0.9802	0.9615	0.9069
*KAIRI	0.4636	-0.2125	0.7202	0.6136	0.7947	0.7898	0.8755
*MALANDA	0.5022	-0.1288	0.7890	0.6666	0.8807	0.8327	0.9065
*ATHERTON	0.5328	-0.1553	0.8044	0.7391	0.7075	0.6898	0.8353
*KURANDA	0.4164	-0.2446	0.6710	0.5473	0.8400	0.8517	0.8526
*CAIRNS AIRPORT	0.4162	-0.2973	0.6378	0.5552	0.6907	0.7298	0.7478
#PICNIC CROSSING	0.3542	-0.1926	0.6120	0.5806	0.9425	0.9715	0.9461
#TINAROO FALLS	-0.2828	0.6032	-0.2512	-0.3853	-0.2652	-0.3791	-0.3848
#MAREEBA	0.2215	-0.2380	0.5612	0.5507	0.9441	0.9628	0.9402
#MYOLA	0.1689	-0.2228	0.4890	0.4473	0.9682	0.9915	0.9263

	AREA H	*KAIRI	*MALANDA	*ATHERTON	*KURANDA	*CAIRNS AIRPRT	PICNIC CROSSING
AREA H	1.0000						
*KAIRI	0.7619	1.0000					
*MALANDA	0.8537	0.9287	1.0000				
*ATHERTON	0.6385	0.9662	0.8752	1.0000			
*KURANDA	0.8282	0.8942	0.9110	0.8107	1.0000		
*CAIRNS AIRPORT	0.6573	0.8837	0.8008	0.8344	0.9391	1.0000	
#PICNIC CROSSING	0.9198	0.8540	0.8853	0.7880	0.9152	0.8169	1.0000
#TINAROO FALLS	-0.2373	-0.5111	-0.3813	-0.5165	-0.5058	-0.6051	-0.4312
#MAREEBA	0.9311	0.8130	0.8504	0.7585	0.8392	0.7302	0.9677
#MYOLA	0.9705	0.8073	0.8480	0.7098	0.8765	0.7543	0.9764

	#TINAROO FALLS	#MAREEBA	#MYOLA
#TINAROO FALLS	1.0000		
#MAREEBA	-0.4266	1.0000	
#MYOLA	-0.3761	0.9757	1.0000

CASES INCLUDED = 16
MISSING CASES = 11
RAINFALL = *
RIVER DISCHARGE = #

APPENDIX H

COMPARATIVE ANALYSIS
GREEN ISLAND
CORES #1 AND #2
WITH DATA FROM
NO NAME REEF, UPOLU CAY, BATT REEF
AND BROOK ISLANDS

CHEMICAL ANALYSIS

COMPARATIVE ANALYSIS GREEN ISLAND CORES #1 AND #2 WITH DATA FROM NO NAME REEF, UPOLU CAY, BATT REEF AND BROOK ISLANDS

CHEMICAL ANALYSIS

CALCIUM

YEAR	GREEN IS #1	GREEN IS #2	NO NAME REEF	UPOLU CAY	BATT REEF	BROOK ISLANDS
1883	37.97	38.52		38.37	38.93	38.29
1884	37.97	38.42		38.24	39.87	38.80
1885	38.54	38.35		38.18	39.72	38.57
1886	37.83	38.05		38.05	38.56	38.22
1887	38.19	38.72		38.18	38.71	38.31
1888	38.33	37.84		38.12	38.66	38.10
1889	38.04	38.13		38.31	38.87	38.12
1890	37.46	38.46		38.56	39.12	38.04
1891	38.97	38.49		38.18	39.04	37.92
1892	38.23	37.91	37.74	38.44	38.35	38.79
1893	38.60	37.87	38.41	38.37	39.27	38.51
1894	38.45	38.49	39.05	38.44	38.75	38.19
1895	38.23	38.37	38.39	38.18	38.79	38.21
1896	37.97	37.74	38.72	38.42	38.84	38.42
1897	38.04	38.42	38.53	38.31	39.07	38.46
1898	38.60	38.68	38.06	38.07	39.02	38.25
1899	38.45	38.40	38.89	38.18	39.09	38.15
1900	38.60	38.56	38.39	38.37	38.74	38.34
1901	38.23	38.22	39.05	38.37	39.36	38.37
1902	38.38	37.45	38.26	38.37	38.85	38.34
AVG	38.25432	38.25432	38.50183	38.28626	38.98044	38.32257
S.D.	0.330714	0.333585	0.388475	0.135227	0.357227	0.222026

COMPARATIVE ANALYSIS
GREEN ISLAND CORES #1 AND #2
WITH DATA FROM
NO NAME REEF, UPOLU CAY, BATT REEF
AND BROOK ISLANDS

CHEMICAL ANALYSIS

STRONTIUM

YEAR	GREEN IS # 1	GREEN IS # 2	NO NAME REEF	UPOLU CAY	BATT REEF	BROOK ISLAND
1883	0.78	0.78		0.76	0.74	0.75
1884	0.78	0.80		0.77	0.73	0.72
1885	0.79	0.78		0.77	0.73	0.73
1886	0.78	0.78		0.76	0.72	0.75
1887	0.78	0.77		0.77	0.74	0.69
1888	0.81	0.79		0.77	0.73	0.71
1889	0.78	0.78		0.77	0.73	0.75
1890	0.78	0.79		0.76	0.73	0.72
1891	0.78	0.78		0.77	0.72	0.74
1892	0.77	0.78	0.76	0.77	0.73	0.72
1893	0.78	0.79	0.77	0.77	0.74	0.73
1894	0.79	0.78	0.75	0.77	0.72	0.71
1895	0.79	0.79	0.76	0.77	0.73	0.75
1896	0.77	0.78	0.75	0.76	0.74	0.77
1897	0.79	0.79	0.76	0.77	0.73	0.76
1898	0.77	0.78	0.76	0.77	0.72	0.76
1899	0.79	0.78	0.76	0.77	0.73	0.73
1900	0.79	0.78	0.76	0.77	0.75	0.73
1901	0.79	0.79	0.76	0.76	0.71	0.76
1902	0.79	0.78	0.76	0.76	0.73	0.74
AVG	0.783901	0.783901	0.760777	0.768366	0.729778	0.736033
S.D.	0.007279	0.005993	0.00407	0.003911	0.007162	0.02012

COMPARATIVE ANALYSIS
GREEN ISLAND CORES #1 AND #2
WITH DATA FROM
NO NAME REEF, UPOLU CAY, BATT REEF
AND BROOK ISLANDS

CHEMICAL ANALYSIS

MAGNESIUM

YEAR	GREEN IS # 1	GREEN IS # 2	NO NAME REEF	UPOLU CAY REEF	BATT REEF	BROOK ISLANDS
1883	0.090	0.107		0.103	0.127	0.103
1884	0.096	0.096		0.103	0.127	0.103
1885	0.096	0.096		0.109	0.127	0.103
1886	0.096	0.096		0.109	0.127	0.103
1887	0.096	0.090		0.103	0.127	0.103
1888	0.090	0.096		0.109	0.121	0.103
1889	0.090	0.090		0.109	0.121	0.103
1890	0.096	0.090		0.103	0.121	0.103
1891	0.096	0.090		0.109	0.127	0.103
1892	0.090	0.090	0.103	0.109	0.127	0.109
1893	0.090	0.084	0.109	0.109	0.133	0.109
1894	0.090	0.090	0.103	0.103	0.145	0.109
1895	0.090	0.096	0.115	0.109	0.151	0.103
1896	0.090	0.090	0.115	0.103	0.151	0.103
1897	0.090	0.084	0.109	0.109	0.163	0.103
1898	0.090	0.090	0.109	0.109	0.163	0.103
1899	0.090	0.096	0.109	0.103	0.151	0.103
1900	0.090	0.090	0.103	0.109	0.133	0.103
1901	0.090	0.090	0.096	0.109	0.139	0.103
1902	0.090	0.096	0.096	0.109	0.139	0.103
AVG	0.092274	0.092274	0.105816	0.106446	0.135697	0.103431
S.D	0.002764	0.00484	0.005956	0.002877	0.013282	0.002153

APPENDIX I

INTRA- AND INTER-REEF COMPARISONS

MULTIVARIATE AND UNIVARIATE ANALYSIS

Identity

M Matrix

M-transformed Parameter Estimates

Whole Model

Test	Value	Approx. F	DF Num	DF Den	Prob>F
Wilks' Lambda	0.0436566	40.0363	15	284.74	0.0000
Pillai's Trace	1.5078136	21.2199	15	315	0.0000
Hotelling-Lawley	9.9296383	67.3009	15	305	0.0000
Roy's Max Root	8.6260496	181.1470	5	105	0.0000

EigenValue	Canonical Corr
8.62604957	0.94663363
1.24241663	0.74434706
0.06117213	0.24009543

Eigvec			
Ca	0.07813869	0.10585176	0.2888071
Sr	-5.5584949	7.62762822	-0.5847018
Mg	9.98839608	8.9438438	-5.6287985

CentroidVal			
Grand	-1.6945386	110.832173	103.052333
Ca	-1.1160578	111.615821	105.190446
Sr	-3.8372997	113.772571	102.826934
Mg	1.21184973	113.434621	101.414485
Batt	3.53417068	111.757812	103.158483
Brook	-0.6542575	108.573395	103.036823
Green #1	-4.5722422	111.221047	103.189202
Green #2	-4.5778675	111.216012	103.192389
No Name	-1.6730668	110.922724	103.279942
Upolu	-2.2143057	111.342796	102.559582

Canonical Centroid Plot

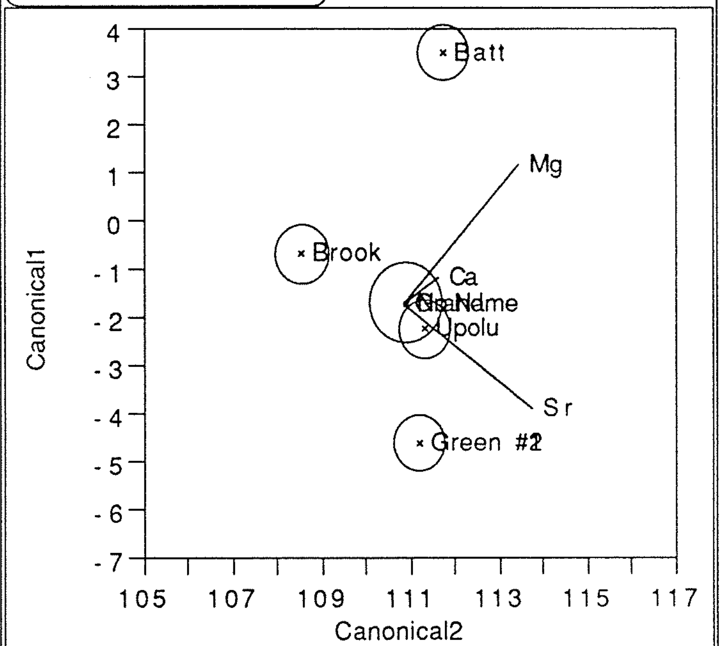


Figure 15: Biplot of multivariate centroid means with associated 95% confidence ellipsoids on the first two canonical axes exploring variation in chemical composition among locations, for the time period 1883–1902.

Means

Summary of Fit

Rsquare	0.444848
Root Mean Square Error	0.308247
Mean of Response	38.42773
Observations (or Sum Wgts)	111

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	7.994457	1.59889	16.8275
Error	105	9.976734	0.09502	Prob>F
C Total	110	17.971191		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	Batt	No Name	Brook	Upolu	Green #2	Green #1
Batt	0.000000	0.478613	0.657870	0.694175	0.726120	0.726125
No Name	-0.47861	0.000000	0.179257	0.215562	0.247507	0.247512
Brook	-0.65787	-0.17926	0.000000	0.036305	0.068250	0.068255
Upolu	-0.69417	-0.21556	-0.03631	0.000000	0.031945	0.031950
Green #2	-0.72612	-0.24751	-0.06825	-0.03194	0.000000	0.000005
Green #1	-0.72612	-0.24751	-0.06825	-0.03195	-5e-6	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.90303

Abs(Dif)-LSD	Batt	No Name	Brook	Upolu	Green #2	Green #1
Batt	-0.28298	0.142705	0.374893	0.411198	0.443143	0.443148
No Name	0.142705	-0.38157	-0.15665	-0.12035	-0.0884	-0.0884
Brook	0.374893	-0.15665	-0.28298	-0.24667	-0.21473	-0.21472
Upolu	0.411198	-0.12035	-0.24667	-0.28298	-0.25103	-0.25103
Green #2	0.443143	-0.0884	-0.21473	-0.25103	-0.28298	-0.28297
Green #1	0.443148	-0.0884	-0.21472	-0.25103	-0.28297	-0.28298

Positive values show pairs of means that are significantly different.

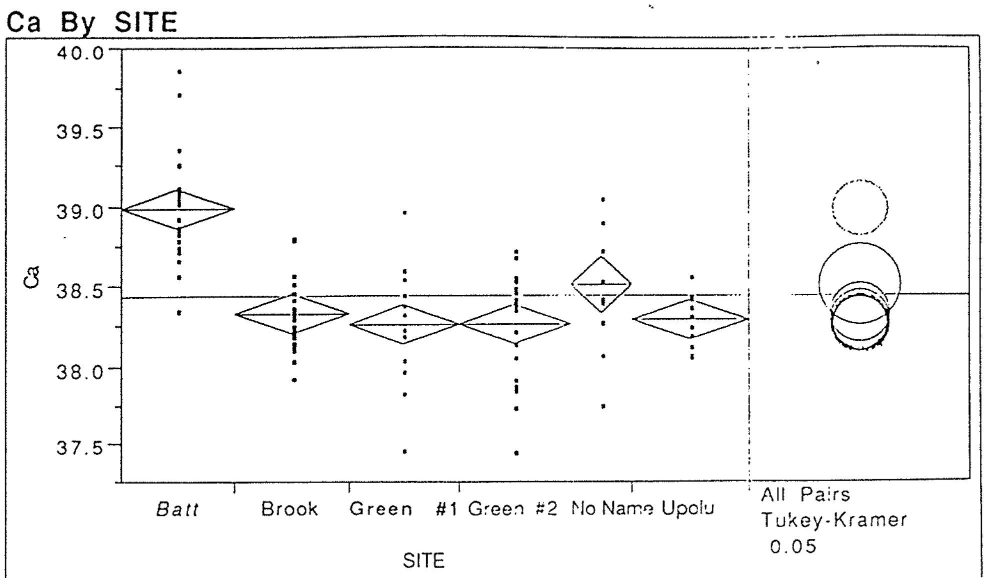


Figure 16: Graph showing mean calcium levels over time (1883–1902) for each location ± 95% confidence intervals. Means comparisons presented were assessed using Tukey–Kramer HSD Test (α=0.05).

Means

Summary of Fit

Rsquare	0.825799
Root Mean Square Error	0.010413
Mean of Response	0.760441
Observations (or Sum Wgts)	111

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	0.05397578	0.010795	99.5505
Error	105	0.01138609	0.000108	Prob>F
C Total	110	0.06536187		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	Green #2	Green #1	Upolu	No Name	Brook	Batt
Green #2	0.000000	0.000000	0.015495	0.023113	0.047855	0.054110
Green #1	-0.00000	0.000000	0.015495	0.023113	0.047855	0.054110
Upolu	-0.01549	-0.01549	0.000000	0.007618	0.032360	0.038615
No Name	-0.02311	-0.02311	-0.00762	0.000000	0.024742	0.030997
Brook	-0.04786	-0.04785	-0.03236	-0.02474	0.000000	0.006255
Batt	-0.05411	-0.05411	-0.03862	-0.031	-0.00626	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.90303

Abs(Dif)-LSD	Green #2	Green #1	Upolu	No Name	Brook	Batt
Green #2	-0.00956	-0.00956	0.005935	0.011765	0.038295	0.044550
Green #1	-0.00956	-0.00956	0.005935	0.011765	0.038295	0.044550
Upolu	0.005935	0.005935	-0.00956	-0.00373	0.022800	0.029055
No Name	0.011765	0.011765	-0.00373	-0.01289	0.013394	0.019649
Brook	0.038295	0.038295	0.022800	0.013394	-0.00956	-0.0033
Batt	0.044550	0.044550	0.029055	0.019649	-0.0033	-0.00956

Positive values show pairs of means that are significantly different.

Sr By SITE

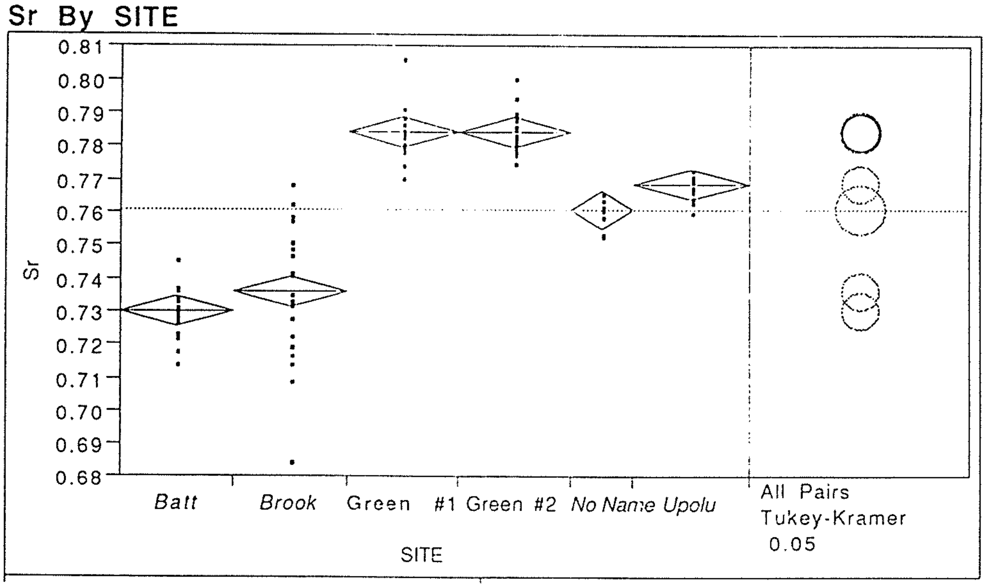


Figure 17: Graph showing mean strontium levels over time (1883–1902) for each location ± 95% confidence intervals. Means comparisons presented were assessed using Tukey–Kramer HSD Test (α=0.05).

Means

Summary of Fit

Rsquare	0.840823
Root Mean Square Error	0.006758
Mean of Response	0.106007
Observations (or Sum Wgts)	111

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	0.02532977	0.005066	110.9287
Error	105	0.00479520	0.000046	Prob>F
C Total	110	0.03012497		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	Batt	Upolu	No Name	Brook	Green #1	Green #2
Batt	0.000000	0.029245	0.029883	0.032295	0.043410	0.043465
Upolu	-0.02924	0.000000	0.000638	0.003050	0.014165	0.014220
No Name	-0.02988	-0.00064	0.000000	0.002412	0.013527	0.013582
Brook	-0.0323	-0.00305	-0.00241	0.000000	0.011115	0.011170
Green #1	-0.04341	-0.01416	-0.01353	-0.01111	0.000000	0.000055
Green #2	-0.04346	-0.01422	-0.01358	-0.01117	-0.00006	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.90303

Abs(Dif)-LSD	Batt	Upolu	No Name	Brook	Green #1	Green #2
Batt	-0.0062	0.023041	0.022518	0.026091	0.037206	0.037261
Upolu	0.023041	-0.0062	-0.00673	-0.00315	0.007961	0.008016
No Name	0.022518	-0.00673	-0.00837	-0.00495	0.006163	0.006218
Brook	0.026091	-0.00315	-0.00495	-0.0062	0.004911	0.004966
Green #1	0.037206	0.007961	0.006163	0.004911	-0.0062	-0.00615
Green #2	0.037261	0.008016	0.006218	0.004966	-0.00615	-0.0062

Positive values show pairs of means that are significantly different.

Mg By SITE

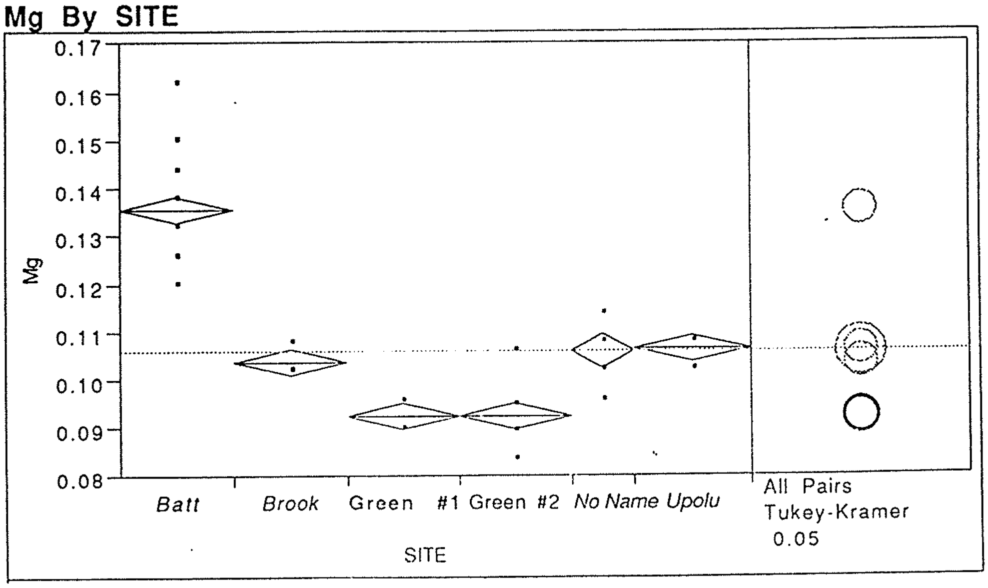


Figure 18: Graph showing mean magnesium levels over time (1883–1902) for each location ± 95% confidence intervals. Means comparisons presented were assessed using Tukey–Kramer HSD Test (α=0.05).

Identity

M Matrix

M-transformed Parameter Estimates

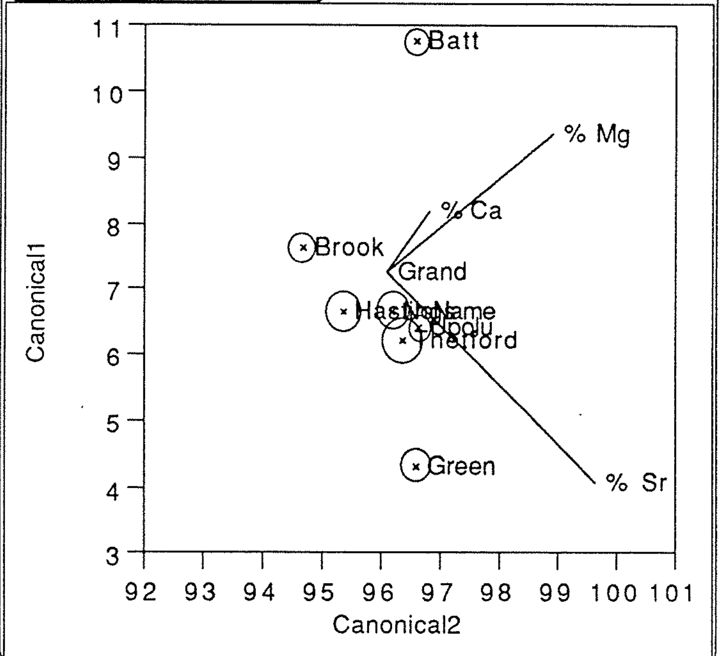
Whole Model

Test	Value	Approx. F	DF Num	DF Den	Prob>F
Wilks' Lambda	0.098385	158.9030	18	2251.9	0.0000
Pillai's Trace	1.3780317	112.9974	18	2394	0.0000
Hotelling-Lawley	4.9532621	218.6774	18	2384	0.0000
Roy's Max Root	4.1220772	548.2363	6	798	0.0000

CentroidVal

Grand	7.27659768	96.127681	88.3721637
% Ca	8.21121481	96.8487212	90.2966497
% Sr	4.06806067	99.67969	88.5398942
% Mg	9.35390178	98.9493206	86.7673529
Batt	10.7576699	96.6226135	88.5059854
Brook	7.6222495	94.6884126	88.0209012
Green	4.32442151	96.6139459	88.5405734
Hastings	6.66343225	95.3774915	89.1515119
NoName	6.67649345	96.226742	88.2661774
Thetford	6.20761674	96.3737224	89.5220507
Upolu	6.41124196	96.6791031	87.6943176

Canonical Centroid Plot



EigenValue	Canonical Corr
4.12207717	0.8970879
0.55531228	0.59753017
0.27587269	0.46499757

Eigvec

% Ca	0.04115823	0.03175283	0.08474962
% Sr	-2.1345318	2.3630322	0.11158548
% Mg	2.66878981	3.62506529	-2.0617601

Figure 20: Biplot of multivariate centroid means with associated 95% confidence ellipsoids on the first two canonical axes exploring variation in chemical composition among locations for sample sets covering the time span n–1987.

Means

Summary of Fit

Rsquare	0.424615
Root Mean Square Error	0.358064
Mean of Response	38.5359
Observations (or Sum Wgts)	805

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	75.50236	12.5837	98.1495
Error	798	102.31137	0.1282	Prob>F
C Total	804	177.81372		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	BATT	THET	HAS	NN	BRK	GRN	UPO
BATT	0.000000	0.247701	0.406235	0.610672	0.720398	0.771090	0.785054
THET	-0.2477	0.000000	0.158534	0.362970	0.472697	0.523389	0.537352
HAS	-0.40624	-0.15853	0.000000	0.204436	0.314163	0.364855	0.378818
NN	-0.61067	-0.36297	-0.20444	0.000000	0.109726	0.160418	0.174382
BRK	-0.7204	-0.4727	-0.31416	-0.10973	0.000000	0.050692	0.064655
GRN	-0.77109	-0.52339	-0.36485	-0.16042	-0.05069	0.000000	0.013964
UPO	-0.78505	-0.53735	-0.37882	-0.17438	-0.06466	-0.01396	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.95588

Abs(Dif)-LSD	BATT	THET	HAS	NN	BRK	GRN	UPO
BATT	-0.11514	0.086636	0.259387	0.474952	0.598225	0.642132	0.668494
THET	0.086636	-0.19654	-0.02653	0.186603	0.306530	0.352171	0.375267
HAS	0.259387	-0.02653	-0.17284	0.040951	0.161737	0.206938	0.230853
NN	0.474952	0.186603	0.040951	-0.15357	-0.03201	0.012792	0.037454
BRK	0.598225	0.306530	0.161737	-0.03201	-0.12882	-0.08458	-0.05886
GRN	0.642132	0.352171	0.206938	0.012792	-0.08458	-0.14143	-0.11627
UPO	0.668494	0.375267	0.230853	0.037454	-0.05886	-0.11627	-0.11796

Positive values show pairs of means that are significantly different.

Ca By Site

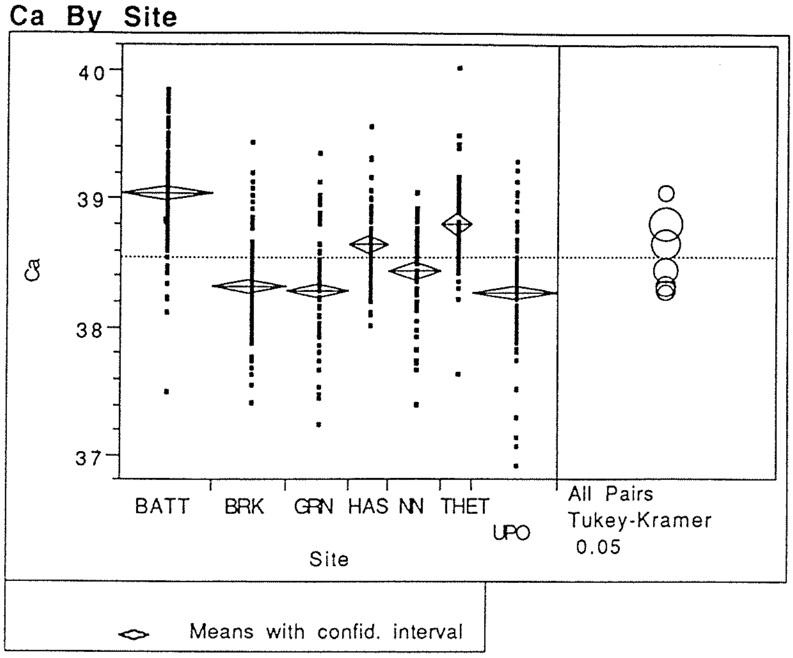


Figure 21: Graph of mean calcium concentration for each location over time (n–1987), ± 95% confidence intervals. Means comparisons presented were assessed using Tukey–Kramer HSD Test (α=0.05).

Means

Summary of Fit

Rsquare	0.723486
Root Mean Square Error	0.011273
Mean of Response	0.757022
Observations (or Sum Wgts)	805

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	0.26534524	0.044224	347.9876
Error	798	0.10141429	0.000127	Prob>F
C Total	804	0.36675953		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	GRN	THET	UPO	NN	HAS	BRK	BATT
GRN	0.000000	0.016421	0.018694	0.023360	0.028015	0.042853	0.055185
THET	-0.01642	0.000000	0.002273	0.006939	0.011594	0.026432	0.038764
UPO	-0.01869	-0.00227	0.000000	0.004666	0.009321	0.024160	0.036491
NN	-0.02336	-0.00694	-0.00467	0.000000	0.004655	0.019493	0.031825
HAS	-0.02802	-0.01159	-0.00932	-0.00466	0.000000	0.014838	0.027170
BRK	-0.04285	-0.02643	-0.02416	-0.01949	-0.01484	0.000000	0.012332
BATT	-0.05518	-0.03876	-0.03649	-0.03182	-0.02717	-0.01233	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.95588

Abs(Dif)-LSD	GRN	THET	UPO	NN	HAS	BRK	BATT
GRN	-0.00445	0.011030	0.014593	0.018712	0.023043	0.038594	0.051125
THET	0.011030	-0.00619	-0.00283	0.001386	0.005767	0.021201	0.033693
UPO	0.014593	-0.00283	-0.00371	0.000355	0.004663	0.020271	0.032821
NN	0.018712	0.001386	0.000355	-0.00483	-0.00049	0.015031	0.027552
HAS	0.023043	0.005767	0.004663	-0.00049	-0.00544	0.010039	0.022546
BRK	0.038594	0.021201	0.020271	0.015031	0.010039	-0.00406	0.008485
BATT	0.051125	0.033693	0.032821	0.027552	0.022546	0.008485	-0.00362

Positive values show pairs of means that are significantly different.

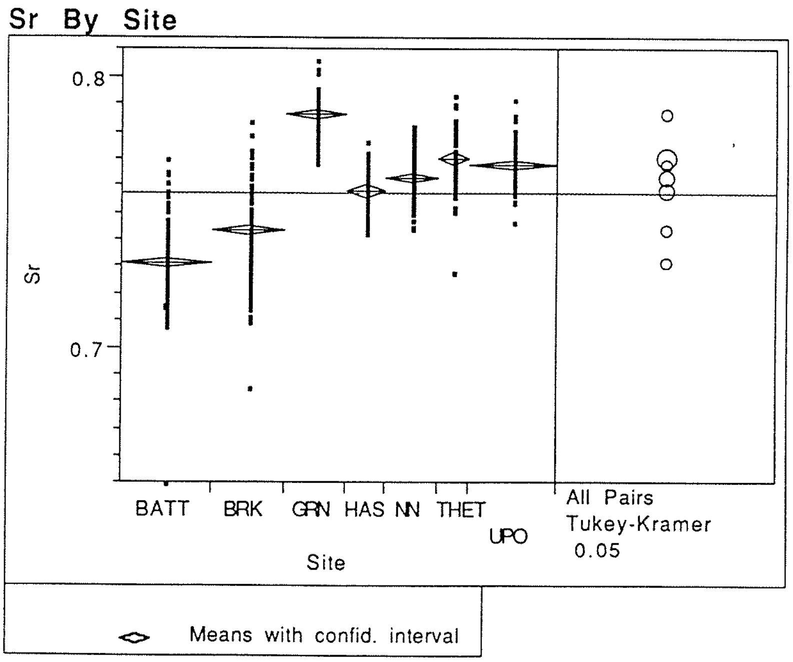


Figure 22: Graph of mean strontium concentration for each location over time (n–1987), ± 95% confidence intervals. Means comparisons presented were assessed using Tukey–Kramer HSD Test (α=0.05).

Means

Summary of Fit

Rsquare	0.649745
Root Mean Square Error	0.007292
Mean of Response	0.107692
Observations (or Sum Wgts)	805

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	0.07872398	0.013121	246.7229
Error	798	0.04243745	0.000053	Prob>F
C Total	804	0.12116143		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	BATT	UPO	NN	BRK	THET	HAS	GRN
BATT	0.000000	0.016359	0.019262	0.020616	0.025529	0.026311	0.029303
UPO	-0.01636	0.000000	0.002903	0.004257	0.009170	0.009952	0.012944
NN	-0.01926	-0.0029	0.000000	0.001354	0.006267	0.007049	0.010041
BRK	-0.02062	-0.00426	-0.00135	0.000000	0.004913	0.005695	0.008687
THET	-0.02553	-0.00917	-0.00627	-0.00491	0.000000	0.000782	0.003774
HAS	-0.02631	-0.00995	-0.00705	-0.0057	-0.00078	0.000000	0.002992
GRN	-0.0293	-0.01294	-0.01004	-0.00869	-0.00377	-0.00299	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.95588

Abs(Dif)-LSD	BATT	UPO	NN	BRK	THET	HAS	GRN
BATT	-0.00234	0.013985	0.016498	0.018128	0.022249	0.023321	0.026677
UPO	0.013985	-0.0024	0.000114	0.001742	0.005869	0.006939	0.010292
NN	0.016498	0.000114	-0.00313	-0.00153	0.002675	0.003720	0.007034
BRK	0.018128	0.001742	-0.00153	-0.00262	0.001529	0.002591	0.005932
THET	0.022249	0.005869	0.002675	0.001529	-0.004	-0.00299	0.000287
HAS	0.023321	0.006939	0.003720	0.002591	-0.00299	-0.00352	-0.00022
GRN	0.026677	0.010292	0.007034	0.005932	0.000287	-0.00022	-0.00288

Positive values show pairs of means that are significantly different.

Mg By Site

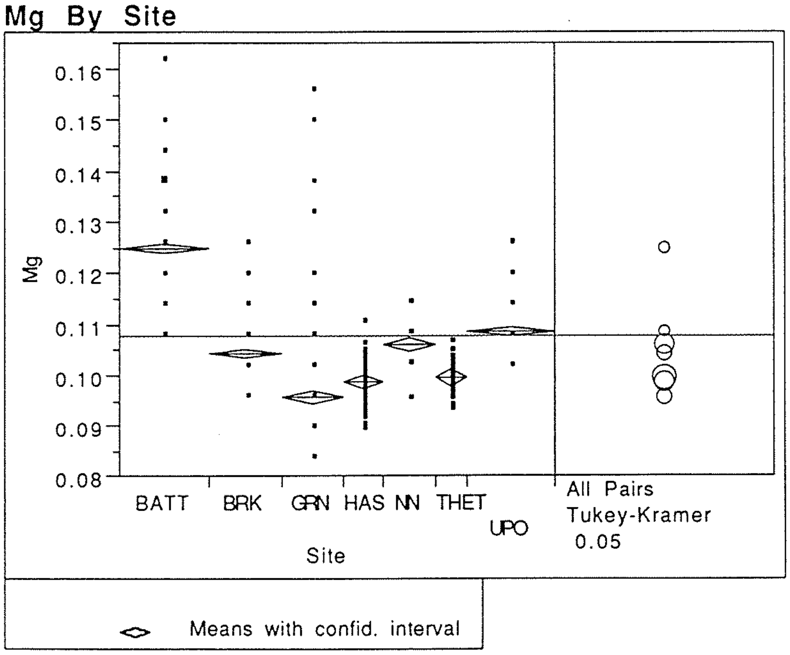


Figure 23: Graph of mean magnesium concentration for each location over time (n-1987), ± 95% confidence intervals. Means comparisons presented were assessed using Tukey-Kramer HSD Test (α=0.05).

Means

Summary of Fit

Rsquare	0.420997
Root Mean Square Error	0.026165
Mean of Response	0.474995
Observations (or Sum Wgts)	805

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	0.39724427	0.066207	96.7051
Error	798	0.54633591	0.000685	Prob>F
C Total	804	0.94358018		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	BRK	BATT	NN	UPO	HAS	GRN	THET
BRK	0.000000	0.047199	0.048093	0.051584	0.054805	0.070034	0.070710
BATT	-0.0472	0.000000	0.000895	0.004385	0.007606	0.022836	0.023511
NN	-0.04809	-0.00089	0.000000	0.003490	0.006711	0.021941	0.022616
UPO	-0.05158	-0.00438	-0.00349	0.000000	0.003221	0.018451	0.019126
HAS	-0.0548	-0.00761	-0.00671	-0.00322	0.000000	0.015230	0.015905
GRN	-0.07003	-0.02284	-0.02194	-0.01845	-0.01523	0.000000	0.000675
THET	-0.07071	-0.02351	-0.02262	-0.01913	-0.0159	-0.00068	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.95588

Abs(Dif)-LSD	BRK	BATT	NN	UPO	HAS	GRN	THET
BRK	-0.00941	0.038271	0.037736	0.042558	0.043666	0.060149	0.058567
BATT	0.038271	-0.00841	-0.00902	-0.00413	-0.00312	0.013412	0.011741
NN	0.037736	-0.00902	-0.01122	-0.00652	-0.00524	0.011153	0.009728
UPO	0.042558	-0.00413	-0.00652	-0.00862	-0.00759	0.008934	0.007282
HAS	0.043666	-0.00312	-0.00524	-0.00759	-0.01263	0.003690	0.002381
GRN	0.060149	0.013412	0.011153	0.008934	0.003690	-0.01034	-0.01184
THET	0.058567	0.011741	0.009728	0.007282	0.002381	-0.01184	-0.01436

Positive values show pairs of means that are significantly different.

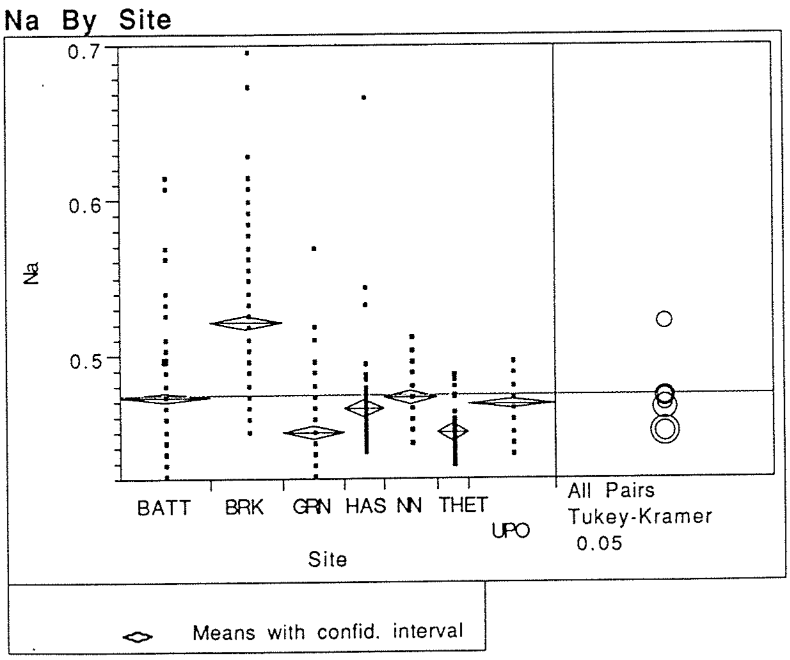


Figure 24: Graph of mean sodium concentration for each location over time (n–1987), ± 95% confidence intervals. Means comparisons presented were assessed using Tukey-Kramer HSD Test (α=0.05).

Means

Summary of Fit

Rsquare	0.408284
Root Mean Square Error	0.001316
Mean of Response	0.006177
Observations (or Sum Wgts)	805

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	0.00095353	0.000159	91.7699
Error	798	0.00138193	0.000002	Prob>F
C Total	804	0.00233546		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	GRN	NN	UPO	HAS	BATT	BRK	THET
GRN	0.000000	0.000535	0.001109	0.001765	0.001853	0.003179	0.003317
NN	-0.00053	0.000000	0.000574	0.001230	0.001318	0.002644	0.002782
UPO	-0.00111	-0.00057	0.000000	0.000656	0.000745	0.002070	0.002208
HAS	-0.00176	-0.00123	-0.00066	0.000000	0.000088	0.001414	0.001552
BATT	-0.00185	-0.00132	-0.00074	-0.00009	0.000000	0.001325	0.001464
BRK	-0.00318	-0.00264	-0.00207	-0.00141	-0.00133	0.000000	0.000138
THET	-0.00332	-0.00278	-0.00221	-0.00155	-0.00146	-0.00014	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.95588

Abs(Dif)-LSD	GRN	NN	UPO	HAS	BATT	BRK	THET
GRN	-0.00052	-8e-6	0.000630	0.001184	0.001379	0.002681	0.002688
NN	-8e-6	-0.00056	0.000071	0.000629	0.000820	0.002123	0.002134
UPO	0.000630	0.000071	-0.00043	0.000112	0.000316	0.001616	0.001612
HAS	0.001184	0.000629	0.000112	-0.00064	-0.00045	0.000854	0.000872
BATT	0.001379	0.000820	0.000316	-0.00045	-0.00042	0.000876	0.000872
BRK	0.002681	0.002123	0.001616	0.000854	0.000876	-0.00047	-0.00047
THET	0.002688	0.002134	0.001612	0.000872	0.000872	-0.00047	-0.00072

Positive values show pairs of means that are significantly different.

K By Site

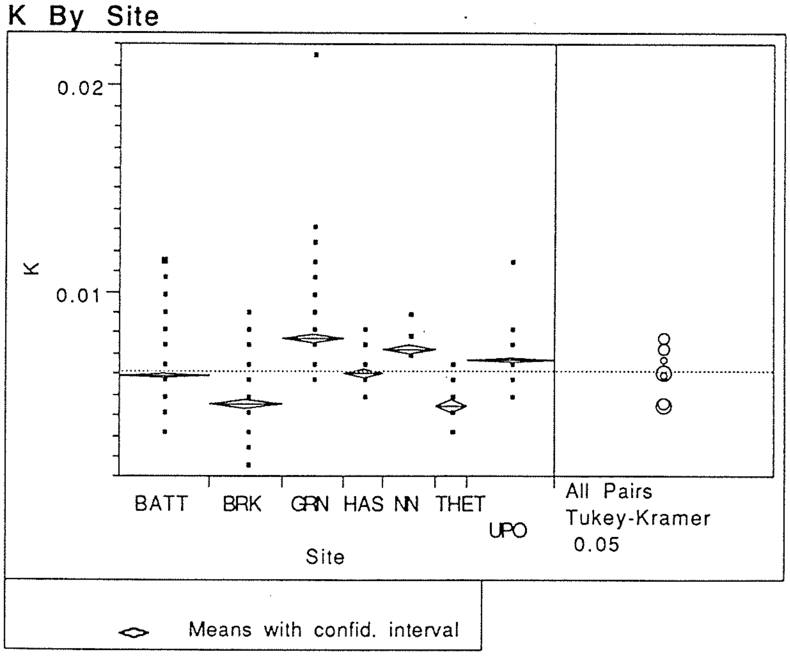


Figure 25: Graph of mean potassium concentration for each location over time (n-1987), ± 95% confidence intervals. Means comparisons presented were assessed using Tukey-Kramer HSD Test (α=0.05).

Means

Summary of Fit

Rsquare	0.262731
Root Mean Square Error	0.003178
Mean of Response	0.005676
Observations (or Sum Wgts)	805

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	0.00287161	0.000479	47.3956
Error	798	0.00805821	0.000010	Prob>F
C Total	804	0.01092981		0.0000

Mean Estimates

Means Comparisons

Dif=Mean[i]-Mean[j]	BATT	HAS	THET	GRN	NN	UPO	BRK
BATT	0.000000	0.000403	0.002285	0.002568	0.004409	0.004485	0.004509
HAS	-0.0004	0.000000	0.001883	0.002165	0.004007	0.004082	0.004107
THET	-0.00229	-0.00188	0.000000	0.000282	0.002124	0.002200	0.002224
GRN	-0.00257	-0.00216	-0.00028	0.000000	0.001842	0.001918	0.001942
NN	-0.00441	-0.00401	-0.00212	-0.00184	0.000000	0.000076	0.000100
UPO	-0.00449	-0.00408	-0.0022	-0.00192	-0.00008	0.000000	0.000024
BRK	-0.00451	-0.00411	-0.00222	-0.00194	-0.0001	-0.00002	0.000000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q *
2.95588

Abs(Dif)-LSD	BATT	HAS	THET	GRN	NN	UPO	BRK
BATT	-0.00102	-0.0009	0.000856	0.001423	0.003205	0.003451	0.003425
HAS	-0.0009	-0.00153	0.000240	0.000763	0.002556	0.002769	0.002754
THET	0.000856	0.000240	-0.00174	-0.00124	0.000559	0.000761	0.000749
GRN	0.001423	0.000763	-0.00124	-0.00126	0.000532	0.000762	0.000741
NN	0.003205	0.002556	0.000559	0.000532	-0.00136	-0.00114	-0.00116
UPO	0.003451	0.002769	0.000761	0.000762	-0.00114	-0.00105	-0.00107
BRK	0.003425	0.002754	0.000749	0.000741	-0.00116	-0.00107	-0.00114

Positive values show pairs of means that are significantly different.

Fe By Site

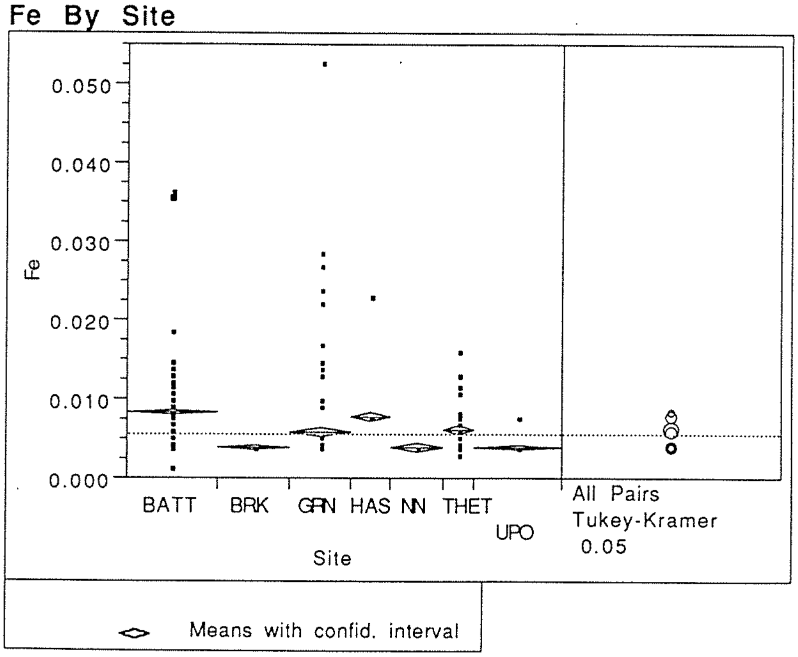


Figure 26: Graph of mean iron concentration for each location over time (n–1987), ± 95% confidence intervals. Means comparisons presented were assessed using Tukey–Kramer HSD Test (α=0.05).

Figure 27: Biplot of multivariate centroid means with associated 95% confidence ellipsoids on the first two canonical axes exploring variation in chemical composition of calcium, strontium and magnesium between locations, for sample sets covering the two time periods pre-1950 and post-1950.

Identity

M Matrix

M-transformed Parameter Estimates

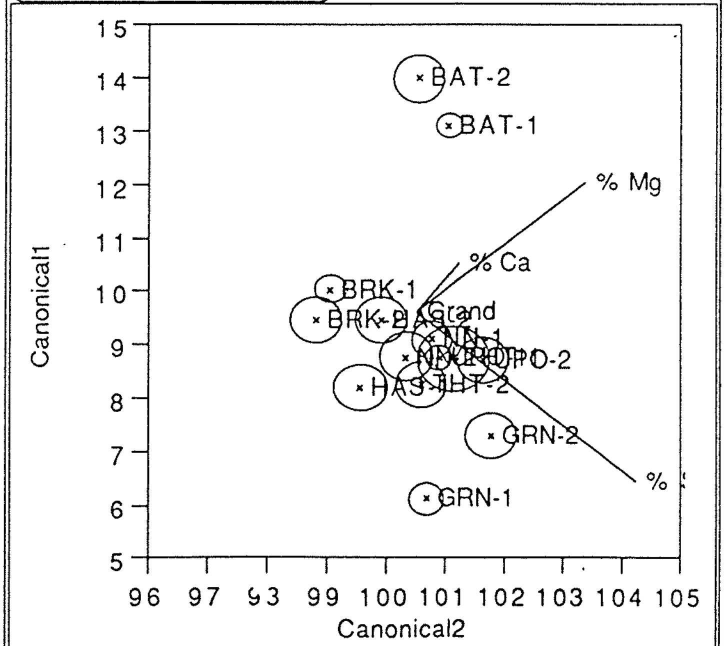
Whole Model

Test	Value	Approx. F	DF Num	DF Den	Prob>F
Wilks' Lambda	0.0780619	81.8626	39	2337.1	0.0000
Pillai's Trace	1.4760689	58.9352	39	2373	0.0000
Hotelling-Lawley	5.7587252	116.3066	39	2363	0.0000
Roy's Max Root	4.7519093	289.1354	13	791	0.0000

CentroidVal

Grand	9.59645009	100.516128	88.7156295
% Ca	10.5359411	101.268986	90.6692116
% Sr	6.4330506	104.257912	88.815674
% Mg	12.0432259	103.379532	87.0881968
BAT-1	13.0951337	101.07705	89.0320605
BAT-2	13.991535	100.563055	88.3694167
BRK-1	10.0422494	99.0908447	88.2321462
BRK-2	9.48579015	98.8197419	88.7469893
GRN-1	6.11331239	100.705631	88.9603818
GRN-2	7.27468108	101.80234	88.6277481
HAS-1	8.2233015	99.5865306	89.498536
HAS-2	9.48965974	99.9295674	89.5109943
NN-1	9.09479578	100.798272	88.7516457
NN-2	8.7877721	100.363094	88.363325
THT-1	8.74894268	101.165843	90.1045785
THT-2	8.26273177	100.615658	89.7400282
UPO-1	8.76326188	100.924545	88.0274709
UPO-2	8.71468025	101.647933	87.9700334

Canonical Centroid Plot



EigenValue	Canonical Corr
4.75190927	0.90892502
0.68531301	0.63768206
0.32150296	0.49324015

Eigvec

% Ca	0.04155553	0.0333004	0.08641077
% Sr	-2.1137948	2.50027358	0.06685003
% Mg	3.15734229	3.6949629	-2.1000543

Intercept

Test	Value	Exact F	DF Num	DF Den	Prob>F
F Test	14027.041	3689111.7	3	789	0.0000

Column 24

Test	Value	Approx. F	DF Num	DF Den	Prob>F
Wilks' Lambda	0.0780619	81.8626	39	2337.1	0.0000
Pillai's Trace	1.4760689	58.9352	39	2373	0.0000
Hotelling-Lawley	5.7587252	116.3066	39	2363	0.0000
Roy's Max Root	4.7519093	289.1354	13	791	0.0000

Figure 28: Biplot of multivariate centroid means with associated 95% confidence ellipsoids on the first two canonical axes exploring variation in chemical composition of calcium, strontium, magnesium, potassium, sodium and iron among locations, for sample sets covering the two time periods pre-1950 and post-1950.

Identity

M Matrix

M-transformed Parameter Estimates

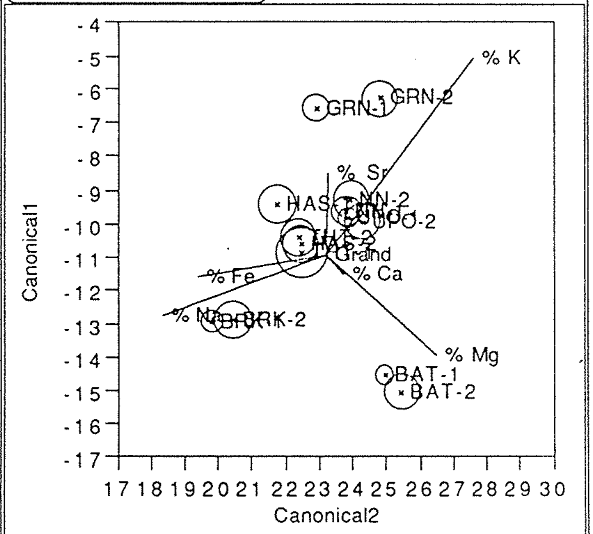
Whole Model

Test	Value	Approx. F	DF Num	DF Den	Prob>F
Wilks' Lambda	0.0091568	74.6941	78	4339.8	0.0000
Pillai's Trace	2.5958839	46.3996	78	4746	0.0000
Hotelling-Lawley	11.671687	117.3653	78	4706	0.0000
Roy's Max Root	7.0909838	431.4591	13	791	0.0000

CentroidVal

Grand	-10.924091	23.1755751	35.4943464	-30.267411	125.542523	-17.229552
% Ca	-11.550244	23.7398434	36.5505946	-30.104686	127.055066	-18.309412
% Sr	-8.5177934	23.2626545	35.1860334	-33.023738	128.299799	-15.442229
% Na	-12.762691	18.3201835	34.8856118	-29.17678	128.170802	-16.260942
% Mg	-13.952592	26.4961155	33.1881351	-32.380018	126.265693	-15.834066
% K	-5.0515114	27.6321439	34.2154345	-24.815138	125.262863	-19.403543
% Fe	-11.552926	19.3785039	43.3329591	-28.711467	125.423976	-11.99536
BAT-1	-14.542516	24.9525961	35.7882744	-30.300609	125.771671	-17.328524
BAT-2	-15.031	25.4676894	35.9367198	-29.599072	124.863458	-16.987052
BRK-1	-12.955725	19.8125502	34.6696993	-29.667172	125.792169	-17.074143
BRK-2	-12.881036	20.4530368	35.8166655	-31.283423	124.761224	-17.274728
GRN-1	-6.5672267	22.9189936	35.6234176	-30.392712	125.549612	-17.451342
GRN-2	-6.2957904	24.8214051	36.4557185	-29.229157	125.751513	-16.530675
HAS-1	-9.4045249	21.7394276	37.3408905	-29.727858	125.213809	-17.278365
HAS-2	-10.5968	22.4549268	37.1122755	-29.589995	125.472211	-17.337783
NN-1	-9.5908816	23.8259398	34.7615437	-29.71855	125.839517	-17.738276
NN-2	-9.3095075	23.9584524	34.7796022	-29.952211	125.020418	-17.632063
THT-1	-10.848414	22.4814933	36.8740994	-31.535781	126.536101	-17.324114
THT-2	-10.411912	22.3983791	37.0971989	-31.731284	125.647612	-17.151123
UPO-1	-9.8020734	23.8370598	34.3887264	-30.601665	125.369049	-17.11648
UPO-2	-9.9234118	24.2973472	34.2608032	-31.247318	125.707905	-16.810862

Canonical Centroid Plot



EigenValue	Canonical Corr
7.09098378	0.93616539
3.00282793	0.86612737
0.94117381	0.69631012
0.4376312	0.55173482
0.12539847	0.3338051
0.07367178	0.26194783

Eigvec

% Ca	-0.027696	0.02495869	0.04671993	0.00719764	0.06690272	-0.0477644
% Sr	1.60789631	0.05818677	-0.2060158	-1.8417872	1.8424213	1.19429512
% Na	-0.588139	-1.5531623	-0.1947245	0.34887561	0.84074436	0.30984273
% Mg	-3.9080069	4.28485633	-2.9759565	-2.7261277	0.9331847	1.80074817
% K	27.0773277	20.5483771	-5.8968155	25.1393767	-1.2894576	-10.023855
% Fe	-0.9469331	-5.717832	11.8038001	2.34302425	-0.178514	7.88192431

Intercept

Test	Value	Exact F	DF Num	DF Den	Prob>F
F Test	14659.137	1920347	6	786	0.0000

Column 24

Test	Value	Approx. F	DF Num	DF Den	Prob>F
Wilks' Lambda	0.0091568	74.6941	78	4339.8	0.0000
Pillai's Trace	2.5958839	46.3996	78	4746	0.0000
Hotelling-Lawley	11.671687	117.3653	78	4706	0.0000
Roy's Max Root	7.0909838	431.4591	13	791	0.0000

GREEN ISLAND
Magnesium

Means

Summary of Fit

Rsquare	0.496176
Root Mean Square Error	0.010134
Mean of Response	0.095898
Observations (or Sum Wgts)	108

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	10	0.00981049	0.000981	9.5527
Error	97	0.00996173	0.000103	Prob>F
C Total	107	0.01977222		0.0000

Mean Estimates

Level	number	Mean	Std Error
1880	10	0.093500	0.00320
1890	10	0.091700	0.00320
1900	10	0.090500	0.00320
1910	10	0.088670	0.00320
1920	10	0.097710	0.00320
1930	10	0.094100	0.00320
1940	10	0.089280	0.00320
1950	10	0.089270	0.00320
1960	10	0.098320	0.00320
1970	10	0.123640	0.00320
1980	8	0.098763	0.00358

% Mg By Decade beginning

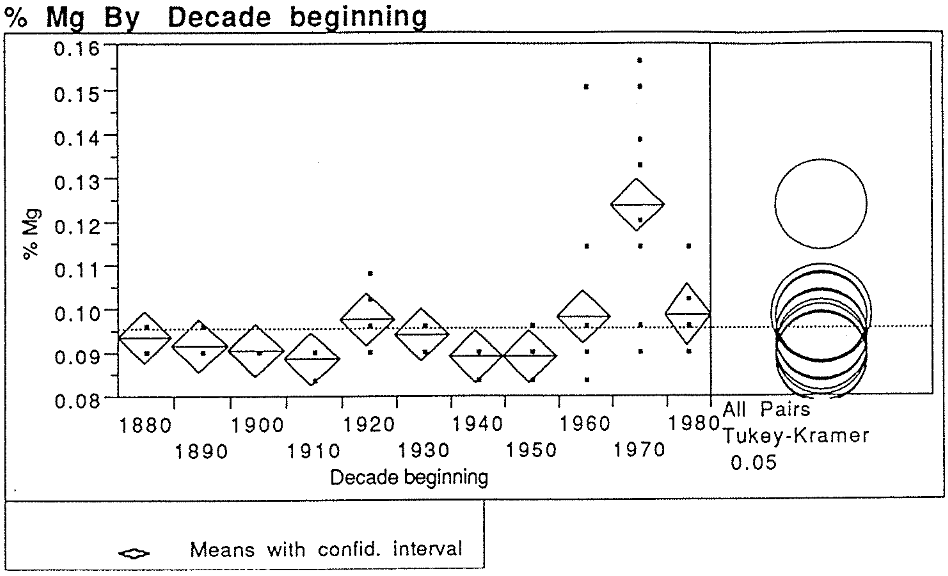


Figure 32: Graph of mean Green Island magnesium concentration for each decade ± 95% confidence intervals. Means comparisons presented were assessed using Tukey-Kramer HSD Test (α=0.05).

GREEN ISLAND
Potassium

Means

Summary of Fit

Rsquare	0.452592
Root Mean Square Error	0.00165
Mean of Response	0.007823
Observations (or Sum Wgts)	108

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	10	0.00021845	0.000022	8.0199
Error	97	0.00026422	0.000003	Prob>F
C Total	107	0.00048267		0.0000

Mean Estimates

Level	number	Mean	Std Error
1880	10	0.006600	0.00052
1890	10	0.007130	0.00052
1900	10	0.006620	0.00052
1910	10	0.006210	0.00052
1920	10	0.008040	0.00052
1930	10	0.008050	0.00052
1940	10	0.006780	0.00052
1950	10	0.007230	0.00052
1960	10	0.009140	0.00052
1970	10	0.010960	0.00052
1980	8	0.009662	0.00058

Means Comparisons

% K By Decade beginning

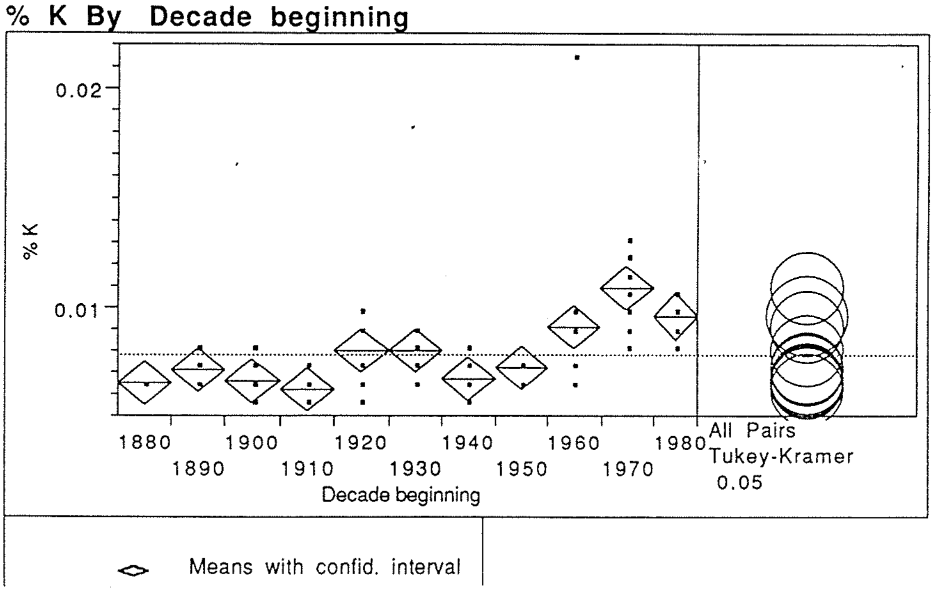


Figure 33: Graph of mean Green Island potassium concentration for each decade ± 95% confidence intervals. Means comparisons presented were assessed using Tukey-Kramer HSD Test (α=0.05).

GREEN ISLAND
Sodium

Means

Summary of Fit

Rsquare	0.423888
Root Mean Square Error	0.017877
Mean of Response	0.451155
Observations (or Sum Wgts)	108

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	10	0.02280945	0.002281	7.1370
Error	97	0.03100066	0.000320	Prob>F
C Total	107	0.05381011		0.0000

Mean Estimates

Level	number	Mean	Std Error
1880	10	0.444360	0.00565
1890	10	0.452520	0.00565
1900	10	0.444360	0.00565
1910	10	0.441400	0.00565
1920	10	0.485160	0.00565
1930	10	0.467360	0.00565
1940	10	0.436220	0.00565
1950	10	0.438440	0.00565
1960	10	0.439190	0.00565
1970	10	0.451790	0.00565
1980	8	0.464587	0.00632

Means Comparisons

% Na By Decade beginning

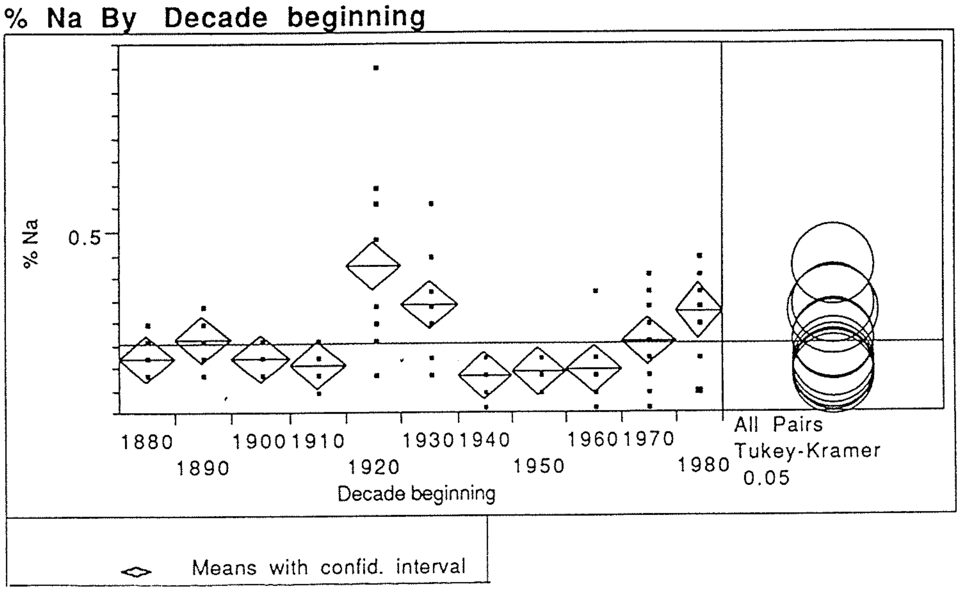


Figure 34: Graph of mean Green Island sodium concentration for each decade ± 95% confidence intervals. Means comparisons presented were assessed using Tukey–Kramer HSD Test (α=0.05).

GREEN ISLAND
Iron

Means

Summary of Fit

Rsquare	0.323355
Root Mean Square Error	0.005894
Mean of Response	0.0059
Observations (or Sum Wgts)	108

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	10	0.00161006	0.000161	4.6354
Error	97	0.00336917	0.000035	**Prob>F**
C Total	107	0.00497922		0.0000

Mean Estimates

Level	number	Mean	Std Error
1880	10	0.003900	0.00186
1890	10	0.003900	0.00186
1900	10	0.003900	0.00186
1910	10	0.003900	0.00186
1920	10	0.003900	0.00186
1930	10	0.003900	0.00186
1940	10	0.003900	0.00186
1950	10	0.004830	0.00186
1960	10	0.012300	0.00186
1970	10	0.015390	0.00186
1980	8	0.004875	0.00208

Means Comparisons

% Fe By Decade beginning

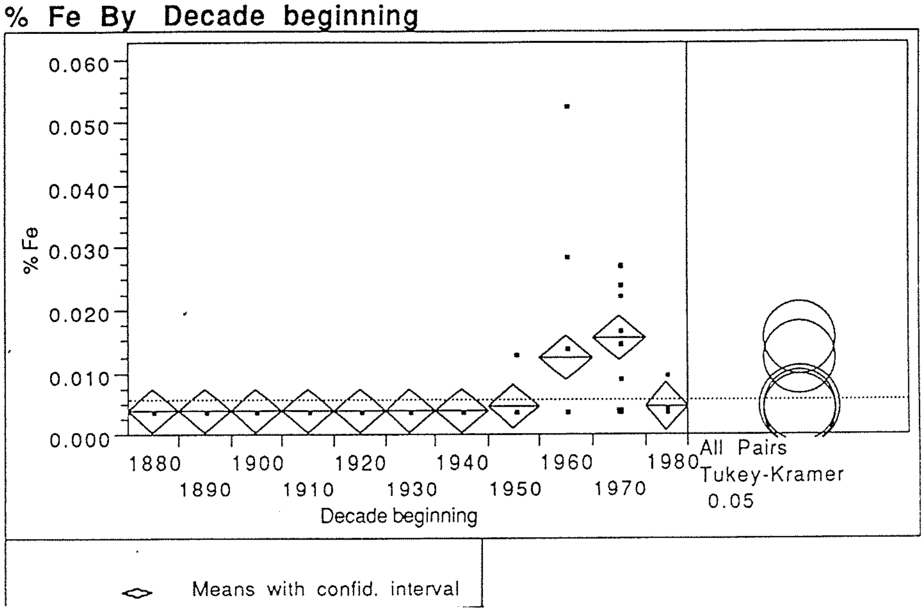


Figure 35: Graph of mean Green Island iron concentration for each decade ± 95% confidence intervals. Means comparisons presented were assessed using Tukey–Kramer HSD Test (α=0.05).

APPENDIX J

GEOCHEMISTRY RESULTS

CALCIUM

% CALCIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS.
1814					38.7149		
1815					39.4868		
1816					39.0651		
1817					38.8078		
1818					39.2867		
1819					39.1723		
1820					38.7292		
1821					39.7584		
1822					39.2867		
1823					39.1080		
1824					39.5011		
1825					38.9222		
1826					39.4940		
1827			38.4007		39.4225		
1828			38.1457		39.1938		
1829			38.4857		38.7292		
1830			38.0748		39.2224		
1831			38.3511		39.2081		
1832			37.9261		39.8013		
1833			38.4857		39.0365		
1834			38.3511		39.0151		
1835			38.4857		38.7292		
1836			38.2802		38.6792		
1837			38.3511		39.0723		
1838			38.4857		38.1360		
1839			38.4219		39.1223		
1940			38.6486		39.3296		
1841			38.3511		38.9079		
1842			38.1457		38.9865		
1843			38.4219		38.9222		

% CALCIUM							
YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS.
1844			38.4857		38.9937		
1845			38.1457		38.6149		
1846			38.6273		38.8007		
1847			38.1457		38.9579		
1848			37.9331		39.1223		
1849			38.4857		38.9722		
1850			38.6273		39.0723		
1851			38.4857		39.2367		
1852			38.6061		38.2575		
1853			38.5565		38.9079		38.0360
1854			38.3865		39.0223		39.0866
1855			38.6273		39.7727		38.5863
1856			38.3511		39.2081		38.2790
1857			38.2873		39.7227		38.3862
1858			38.1457		38.7006		38.0288
1859			37.9331		39.0080		38.0217
1860			38.0040		39.3224		38.5363
1861			38.7619		39.3510		38.0074
1862			38.1457		39.0794		38.5363
1863			39.0382		39.2009		38.1575
1864			38.3723		39.0008		38.6220
1865			38.1173		38.6149		37.9859
1866			38.3723		39.6083		38.0217
1867			38.2448		39.4797		38.4791
1868			38.2448		39.1080		38.4791
1869			38.3086		39.3367		38.3504
1870			38.3723		39.4368		38.4362
1871			38.4361		39.6869		37.9931
1872			37.9261		39.5869		38.5077
1873			38.1173		38.9579		38.5291

% CALCIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS.
1874			38.4361		39.4582		38.5220
1875			38.6911		38.7721		38.3290
1876		38.0431	38.1811		39.3510		38.3933
1877		38.8293	38.3723		39.7441		37.6500
1878		38.2575	38.1811		39.8084		38.0145
1879		38.4719	38.1811		38.8150		38.2861
1880		38.9008	38.3723		38.8436		37.7144
1881		37.8287	37.9898		39.1009		38.3290
1882		38.6006	38.4361		39.1938		38.3290
1883		37.9717	38.3723		38.9293		38.2933
1884		37.9717	38.2448		39.8727		38.8007
1885		38.5434	38.1811		39.7227		38.5720
1886		37.8287	38.0536		38.5649		38.2218
1887		38.1861	38.1811		38.7149		38.3147
1888		38.3290	38.1173		38.6649		38.1003
1889		38.0431	38.3086		38.8722		38.1217
1890		37.4642	38.5636		39.1152		38.0431
1891		38.9651	38.1811		39.0365		37.9216
1892	37.7430	38.2289	38.4361		38.3504		38.7936
1893	38.4148	38.6006	38.3723		39.2652		38.5148
1894	39.0508	38.4505	38.4361		38.7507		38.1932
1895	38.3933	38.2289	38.1811		38.7936		38.2147
1896	38.7221	37.9717	38.4219		38.8364		38.4219
1897	38.5291	38.0431	38.3086		39.0651		38.4648
1898	38.0646	38.6006	38.0677		39.0151		38.2504
1899	38.8936	38.4505	38.1811		39.0937		38.1503
1900	38.3933	38.6006	38.3723		38.7364		38.3433
1901	39.0508	38.2289	38.3723		39.3582		38.3719
1902	38.2647	38.3790	38.3723		38.8507		38.3433
1903	38.8507	38.3790	37.8216		39.1723		37.7858

% CALCIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS.
1904	38.3933	38.6721	37.9574		39.6083		38.6363
1905	38.4576	38.0145	37.9574		39.1866		38.0431
1906	38.7793	38.2289	38.1575		38.6363		38.0646
1907	38.0002	38.2289	38.0932		39.3296		38.1932
1908	38.2218	38.8221	37.7572		38.3504		38.6077
1909	38.7221	37.8287	38.1575		38.9651		38.3862
1910	38.5291	38.1861	38.2933		39.1866		38.5363
1911	39.0508	38.0431	37.8930		39.1295		38.3933
1912	37.9359	37.7572	38.4934		39.8370		38.0717
1913	38.2647	38.0431	38.2933	38.1289	39.1366		37.9717
1914	38.5863	38.8221	38.2933	38.4076	39.4725		38.4148
1915	38.5649	38.1575	37.8930	38.2218	39.3510		38.2861
1916	38.7221	38.0431	37.7572	38.3004	38.7721		38.6721
1917	38.5863	38.1575	38.2933	38.7364	39.0223		37.9931
1918	38.9365	38.6006	38.2933	38.3647	39.1152		37.9645
1919	38.4291	37.7572	38.2933	38.6935	38.7721		37.4213
1920	38.3933	38.2289	38.1575	38.5434	39.3653		38.2647
1921	38.8507	38.5434	38.2933	38.5506	39.6512		38.1289
1922	38.2647	37.9717	38.1575	38.6863	38.9222		38.4362
1923	38.3290	37.6858	38.3647	38.0217			38.5220
1924	38.9150	38.3290	37.7572	38.3433			37.9288
1925	38.2647	37.4642	38.1575	38.5077			37.5714
1926	38.5863	38.2575	38.3219	38.7292	38.7650		38.8579
1927	38.5863	39.0080	38.2933	38.3719	39.5797		38.4148
1928	38.5863	37.4714	38.0932	38.5791	38.7435		38.6149
1929	38.5220	38.0431	37.9574	38.5220	39.4368		38.5506
1930	38.5863	38.4005	38.1575	38.3147	38.9579	38.8436	38.2647
1931	38.7221	38.5148	38.1575	38.6578	38.8436	39.1438	38.5220
1932	38.5291	37.5357	38.2933	38.9436	38.4362	39.1366	38.4148
1933	38.6578	38.5148	38.1575	38.8865	38.9293	38.5863	38.1861

% CALCIUM							
YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS.
1934	38.3076	37.8287	38.4291	39.3439	39.0151	38.2361	38.1074
1935	38.5005	37.9717	37.7572	38.4862	39.0508	39.0080	38.9937
1936	38.1789	38.0860	38.2933	38.3433	39.6440	38.9794	39.4511
1937	38.1789	37.9502	38.0288	38.7650	38.8936	39.1366	38.2718
1938	38.6292	38.0860	38.3647	38.7864	39.0151	38.8436	38.2790
1939	38.5791	39.3582	38.5649	38.8364	39.0794	40.0300	38.2718
1940	38.6935	37.9502	38.1575	38.6006		39.0008	38.6292
1941	38.3719	37.4928	38.0288	38.3576	38.6649	38.7364	38.9436
1942	38.6292	39.0365	38.2933	38.7364	38.7936	39.1366	38.3719
1943	38.3076	38.3004	38.0932	38.5720	39.0723	38.9150	39.1509
1944	38.6935	38.3004	37.8216	38.2647	38.8865	38.6649	38.4005
1945	38.7578	38.3004	38.0932	38.5077	38.7435	39.4439	37.7644
1946	38.7578	38.3290	38.0932	38.4291	38.7936	38.9579	38.1789
1947	38.1789	38.3004	38.0717	38.6149	38.6649	39.4082	38.0431
1948	38.5649	37.9502	37.8430	38.8650	39.2295	38.4791	37.8930
1949	38.2147	38.5863	38.6863	38.4434	39.0866	38.2289	37.7858
1950	38.5220	38.6006	38.9150	38.9365	39.4725	38.3147	38.2289
1951	39.0580	38.0145	38.9937	38.6863	39.6512	38.6578	38.2861
1952	38.7507	38.2289	38.8364	38.5005	39.5154	37.6429	38.0860
1953	38.8293	38.6006	38.0717	38.7149	39.3010	38.5506	38.1146
1954	38.2147	38.0145	39.1438	38.7721	38.7864	39.0365	38.1360
1955	38.2933	37.8787	38.9937	38.3933	38.3576	38.4576	38.6363
1956	38.9008	37.5428	37.3070	38.7078	39.2224	39.5082	38.8650
1957	38.0646	39.1438	37.8430	39.0651	38.7936	38.7650	38.1003
1958	38.2933	38.6578	38.2289	38.1146	38.2361	38.8436	38.2790
1959	38.1432	38.8650	38.8007	38.9079		38.7864	38.1360
1960	38.0646	38.9937	38.5291	38.6077	37.5071	38.7078	38.1861
1961	38.2933	38.6578	38.7650	38.7578	39.3653	38.5649	38.4648
1962	37.4142	38.3004	39.0651	38.6863	38.6220	38.8078	38.2289
1963	38.2147	39.3582	37.9216	38.4219	38.7507	38.3790	38.8221

% CALCIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS.
1964	37.7572	39.0080	37.3070	38.3576	39.0508	38.5934	38.3004
1965	38.1432	38.6578	38.4576	39.5654	38.9794	38.7650	39.0365
1966	38.5148	38.2289	38.4576	39.0223	38.7507	38.5220	38.3219
1967	38.1432	37.9502	38.0717	38.7006	39.3439	39.1723	38.4719
1968	38.1432	38.0860	39.1438	38.9222	9.0580	38.4862	39.1366
1969	37.6858	38.6149	37.5357	38.9436	39.4511	38.6863	38.1146
1970	38.3719	37.9502	38.4576	38.9579	38.7364	38.4434	38.543
1971	38.7507	37.8287	39.2938	38.8793	39.1080	38.2361	38.5220
1972	38.4434	38.6578	38.2933	38.7435	38.4934	39.1295	39.2152
1973	38.7507	37.9502	38.3790	38.7435	38.9579	38.8078	38.3219
1974	38.3719	38.6578	38.2289	38.6721	39.1795	38.5791	38.1217
1975	37.9859	38.4434	38.4576	39.1723	39.0365	38.4434	38.2504
1976	38.1432	37.2570	38.6863	39.0008	39.1795	38.5720	38.3433
1977		38.1146	37.0783	38.8650	39.1009	39.0508	38.2218
1978	38.4434	38.1861	37.9216	38.4291	38.4719	39.0580	38.6792
1979	38.4434	38.3790	37.1569	38.4076	38.8221	38.9079	38.5434
1980	38.2933	38.6578	38.3004	38.6792	38.6149	38.4791	38.1217
1981	38.6006	37.9502	38.0717	38.8650	38.8293	38.8221	38.1575
1982	38.2933	38.6578	39.2224	38.4505	39.4296	39.0794	38.2075
1983	38.5220	38.6578	37.5357	38.6435	38.9222	39.0794	38.1932
1984	37.8359	38.2361	37.9931	38.2790	38.8150	38.6220	38.2575
1985	38.1432	37.9502	36.9282	39.3081	38.6506	39.1009	37.9502
1986	38.6006	38.3004	38.0717	38.4791	39.2009	38.8007	38.7936
1987	38.2933	38.3004	38.6863	38.3719	38.4862	39.0866	38.2647
AVG	38.4381	38.2776	38.4252	38.6426	39.0488	38.8011	38.3289
STD.DEV	0.3180	0.4112	0.4277	0.2871	0.3662	0.3728	0.3285

STRONTIUM

% STRONTIUM

YEAR	NO NAME REEF	GREEN ISLAND	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1814					0.7615		
1815					0.7467		
1816					0.7361		
1817					0.7301		
1818					0.7236		
1819					0.7202		
1820					0.7642		
1821					0.7222		
1822					0.7351		
1823					0.7314		
1824					0.7393		
1825					0.7329		
1826					0.7286		
1827			0.7614		0.7212		
1828			0.7866		0.7315		
1829			0.7756		0.7207		
1830			0.7772		0.7344		
1831			0.7646		0.7329		
1832			0.7630		0.7650		
1833			0.7724		0.7370		
1834			0.7535		0.7511		
1835			0.7582		0.7439		
1836			0.7677		0.7522		
1837			0.7661		0.7330		
1838			0.7567		0.7286		
1839			0.7614		0.7505		
1940			0.7598		0.7412		
1841			0.7677		0.7225		
1842			0.7582		0.7477		
1843			0.7646		0.7434		

% STRONTIUM							
YEAR	NO NAME REEF	GREEN ISLAND	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1844			0.7693		0.7441		
1845			0.7598		0.7212		
1846			0.7582		0.7387		
1847			0.7614		0.7174		
1848			0.7598		0.7383		
1849			0.7567		0.7237		
1850			0.7567		0.7268		
1851			0.7582		0.7142		
1852			0.7661		0.7581		
1853			0.7614		0.7324		0.746417
1854			0.7644		0.7333		0.740204
1855			0.7614		0.7368		0.772155
1856			0.7756		0.7383		0.75973
1857			0.7463		0.7456		0.749079
1858			0.7567		0.7330		0.749079
1859			0.7567		0.7399		0.738429
1860			0.7756		0.7434		0.733991
1861			0.7646		0.7519		0.762392
1862			0.7661		0.7303		0.741979
1863			0.7567		0.7430		0.724228
1864			0.7631		0.7318		0.735766
1865			0.7713		0.7430		0.711803
1866			0.7713		0.7437		0.730441
1867			0.7696		0.7188		0.737541
1868			0.7729		0.7460		0.754405
1869			0.7647		0.7331		0.742867
1870			0.7745		0.7614		0.728666
1871			0.7664		0.7539		0.721566
1872			0.7680		0.7342		0.720678
1873			0.7582		0.7412		0.739316

% STRONTIUM							
YEAR	NO NAME REEF	GREEN ISLAND	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1874			0.7729		0.7324		0.746417
1875			0.7647		0.7414		0.710915
1876		0.7722	0.7598		0.7276		0.749079
1877		0.7886	0.7631		0.7456		0.730441
1878		0.7841	0.7615		0.7704		0.743754
1879		0.7812	0.7598		0.7565		0.729554
1880		0.7812	0.7696		0.7166		0.743754
1881		0.7931	0.7647		0.7240		0.753517
1882		0.7834	0.7762		0.7287		0.727778
1883		0.7812	0.7647		0.7374		0.749079
1884		0.7782	0.7729		0.7277		0.717128
1885		0.7916	0.7680		0.7333		0.732216
1886		0.7796	0.7647		0.7232		0.747304
1887		0.7827	0.7713		0.7368		0.685177
1888		0.8065	0.7680		0.7346		0.714465
1889		0.7812	0.7713		0.7313		0.750854
1890		0.7841	0.7598		0.7299		0.722453
1891		0.7834	0.7680		0.7224		0.741091
1892	0.7620	0.7708	0.7713		0.7285		0.719791
1893	0.7661	0.7834	0.7696		0.7375		0.734879
1894	0.7527	0.7869	0.7729		0.7237		0.70914
1895	0.7604	0.7869	0.7729		0.7281		0.747304
1896	0.7535	0.7744	0.7646		0.7367		0.768605
1897	0.7623	0.7886	0.7664		0.7314		0.762392
1898	0.7642	0.7744	0.7696		0.7185		0.757067
1899	0.7586	0.7851	0.7729		0.7280		0.733104
1900	0.7623	0.7851	0.7729		0.7456		0.727778
1901	0.7642	0.7851	0.7631		0.7144		0.758842
1902	0.7623	0.7887	0.7631		0.7267		0.741979
1903	0.7637	0.7887	0.7606		0.7258		0.753517

% STRONTIUM							
YEAR	NO NAME REEF	GREEN ISLAND	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1904	0.7661	0.7869	0.7701		0.7419		0.748192
1905	0.7471	0.7959	0.7669		0.7349		0.737541
1906	0.7577	0.7797	0.7669		0.7145		0.773043
1907	0.7451	0.7762	0.7669		0.7299		0.747304
1908	0.7623	0.7797	0.7685		0.7301		0.750854
1909	0.7547	0.7916	0.7685		0.7474		0.734879
1910	0.7637	0.7886	0.7669		0.7209		0.764167
1911	0.7565	0.7916	0.7731		0.7333		0.757067
1912	0.7496	0.8021	0.7763		0.7516		0.750854
1913	0.7680	0.7946	0.7701	0.7695	0.7169		0.740204
1914	0.7642	0.7780	0.7637	0.7609	0.7316		0.757955
1915	0.7637	0.7797	0.7685	0.7610	0.7194		0.754405
1916	0.7774	0.7916	0.7621	0.7575	0.7290		0.710028
1917	0.7680	0.7941	0.7653	0.7604	0.7390		0.740204
1918	0.7671	0.7923	0.7701	0.7670	0.7412		0.730441
1919	0.7718	0.8021	0.7653	0.7615	0.7291		0.754405
1920	0.7501	0.7834	0.7637	0.7591	0.7128		0.758842
1921	0.7671	0.7916	0.7653	0.7607	0.7377		0.721566
1922	0.7671	0.7916	0.7653	0.7640	0.7225		0.733991
1923	0.7527	0.7916	0.7637	0.7631			0.735766
1924	0.7501	0.7886	0.7621	0.7710			0.75973
1925	0.7623	0.7780	0.7669	0.7725			0.760617
1926	0.7509	0.7767	0.7697	0.7762	0.7407		0.733991
1927	0.7509	0.7786	0.7701	0.7724	0.7394		0.750854
1928	0.7441	0.7841	0.7574	0.7516	0.7331		0.746417
1929	0.7671	0.7946	0.7653	0.7615	0.7276		0.729554
1930	0.7565	0.7916	0.7669	0.7664	0.7139	0.7584	0.748192
1931	0.7706	0.7927	0.7653	0.7564	0.7220	0.7656	0.760617
1932	0.7706	0.7892	0.7701	0.7511	0.7207	0.7629	0.714465
1933	0.7671	0.7961	0.7637	0.7727	0.7260	0.7787	0.767718

% STRONTIUM

YEAR	NO NAME REEF	GREEN ISLAND	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1934	0.7671	0.7961	0.7731	0.7551	0.7309	0.7894	0.770541
1935	0.7723	0.7916	0.7653	0.7728	0.7330	0.7702	0.750738
1936	0.7723	0.7923	0.7669	0.7506	0.7247	0.7588	0.757939
1937	0.7790	0.7874	0.7653	0.7713	0.7363	0.7732	0.733635
1938	0.7825	0.7762	0.7637	0.7675	0.7262	0.7607	0.733635
1939	0.7706	0.7751	0.7637	0.7469	0.7074	0.7680	0.750738
1940	0.7654	0.7786	0.7731	0.7503		0.7814	0.76244
1941	0.7637	0.8013	0.7701	0.7641	0.7305	0.7644	0.741736
1942	0.7654	0.7916	0.7701	0.7649	0.7253	0.7822	0.733635
1943	0.7790	0.7821	0.7653	0.7560	0.7297	0.7905	0.753438
1944	0.7590	0.7857	0.7669	0.7653	0.7281	0.7798	0.727334
1945	0.7671	0.7892	0.7621	0.7678	0.7367	0.7522	0.749838
1946	0.7757	0.7916	0.7701	0.7554	0.7238	0.7717	0.735435
1947	0.7808	0.7874	0.7696	0.7500	0.7147	0.7571	0.771442
1948	0.7671	0.7839	0.7550	0.7557	0.7122	0.7792	0.747137
1949	0.7545	0.7944	0.7712	0.7607	0.7380	0.7560	0.768741
1950	0.7610	0.7887	0.7664	0.7601	0.7358	0.7681	0.76334
1951	0.7496	0.7841	0.7729	0.7512	0.7325	0.7756	0.725533
1952	0.7577	0.7906	0.7745	0.7680	0.7441	0.7277	0.766941
1953	0.7577	0.7834	0.7712	0.7557	0.7359	0.7519	0.741736
1954	0.7524	0.7797	0.7761	0.7527	0.7186	0.7686	0.733635
1955	0.7577	0.7892	0.7680	0.7595	0.7226	0.7702	0.738135
1956	0.7626	0.7841	0.7648	0.7515	0.7302	0.7767	0.736335
1957	0.7577	0.8015	0.7745	0.7682	0.7091	0.7728	0.742636
1958	0.7561	0.7874	0.7680	0.7549	0.7213	0.7650	0.751638
1959	0.7724	0.7715	0.7712	0.7621		0.7847	0.741736
1960	0.7577	0.7815	0.7680	0.7541		0.7839	0.76334
1961	0.7529	0.7786	0.7696	0.7626	0.7212	0.7647	0.733635
1962	0.7674	0.7839	0.7648	0.7450	0.7201	0.7628	0.76424
1963	0.7626	0.7839	0.7793	0.7534	0.7112	0.7654	0.724633

% STRONTIUM

YEAR	NO NAME REEF	GREEN ISLAND	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1964	0.7561	0.7962	0.7696	0.7518	0.7187	0.7658	0.739036
1965	0.7557	0.7892	0.7664	0.7548	0.7166	0.7617	0.746237
1966	0.7529	0.7834	0.7598	0.7472	0.7328	0.7760	0.724633
1967	0.7757	0.7857	0.7761	0.7573	0.7243	0.7686	0.784044
1968	0.7659	0.7744	0.7680	0.7515	0.7262	0.7810	0.76334
1969	0.7659	0.7841	0.7598	0.7560	0.7295	0.7825	0.773242
1970	0.7610	0.7692	0.7680	0.7551	0.7253	0.7598	0.729134
1971	0.7577	0.7916	0.7761	0.7433	0.7253	0.7600	0.712031
1972	0.7657	0.7733	0.7745	0.7544	0.7295	0.7837	0.768741
1973	0.7577	0.7681	0.7745	0.7612	0.7226	0.7784	0.76064
1974	0.7529	0.7857	0.7631	0.7510	0.7349	0.7671	0.748051
1975	0.7659	0.7786	0.7777	0.7429	0.7126	0.7801	0.747158
1976	0.7545	0.8065	0.7664	0.7482	0.7204	0.7933	0.756085
1977		0.7916	0.7922	0.7456	0.7115	0.7695	0.779294
1978	0.7757	0.7886	0.7858	0.7511	0.7199	0.7790	0.749836
1979	0.7740	0.7744	0.7729	0.7610	0.7358	0.7589	0.723057
1980	0.7724	0.7839	0.7648	0.7533	0.7133	0.7652	0.718593
1981	0.7659	0.7892	0.7712	0.7582	0.7150	0.7697	0.728412
1982	0.7626	0.7786	0.7842	0.7621	0.7094	0.7510	0.748944
1983	0.7659	0.8032	0.7809	0.7530	0.7286	0.7559	0.736446
1984	0.7691	0.7857	0.7696	0.7515	0.7296	0.7662	0.737339
1985	0.7675	0.7874	0.7809	0.7567	0.7146	0.7631	0.759656
1986	0.7626	0.7839	0.7696	0.7447	0.7248	0.7822	0.715915
1987	0.7659	0.7927	0.7648	0.7533	0.7319	0.7832	0.746266
AVG	0.7627	0.7861	0.7674	0.7581	0.7314	0.7697	0.7432
STD.DEVN	0.0082	0.0078	0.0066	0.0079	0.0119	0.0117	0.0169

MAGNESIUM

% MAGNESIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1814					0.1146		
1815					0.1146		
1816					0.1146		
1817					0.1146		
1818					0.1146		
1819					0.1146		
1820					0.1206		
1821					0.1146		
1822					0.1146		
1823					0.1146		
1824					0.1146		
1825					0.1206		
1826					0.1146		
1827			0.1086		0.1267		
1828			0.1026		0.1146		
1829			0.1267		0.1146		
1830			0.1026		0.1146		
1831			0.1086		0.1146		
1832			0.1086		0.1146		
1833			0.1086		0.1146		
1834			0.1147		0.1086		
1835			0.1086		0.1146		
1836			0.1086		0.1086		
1837			0.1086		0.1086		
1838			0.1086		0.1146		
1839			0.1086		0.1146		
1940			0.1086		0.1146		
1841			0.1086		0.1146		
1842			0.1086		0.1206		
1843			0.1086		0.1206		

% MAGNESIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1844			0.1086		0.1206		
1845			0.1086		0.1267		
1846			0.1086		0.1146		
1847			0.1086		0.1146		
1848			0.1026		0.1267		
1849			0.1086		0.1267		
1850			0.1086		0.1267		
1851			0.1086		0.1267		
1852			0.1086		0.1206		
1853			0.1086		0.1206		0.1025
1854			0.1086		0.1267		0.1086
1855			0.1086		0.1267		0.1086
1856			0.1086		0.1206		0.0965
1857			0.1147		0.1206		0.1025
1858			0.1086		0.1267		0.1025
1859			0.1086		0.1267		0.1025
1860			0.1086		0.1206		0.1025
1861			0.1086		0.1267		0.1086
1862			0.1086		0.1267		0.1025
1863			0.1086		0.1267		0.1086
1864			0.1086		0.1206		0.1086
1865			0.1086		0.1206		0.1086
1866			0.1086		0.1206		0.1025
1867			0.1086		0.1206		0.1025
1868			0.1025		0.1146		0.1025
1869			0.1086		0.1206		0.1086
1870			0.1086		0.1267		0.1086
1871			0.1086		0.1267		0.1025
1872			0.1086		0.1267		0.1025
1873			0.1086		0.1267		0.1086

% MAGNESIUM

YEAR	*NO NAME REEF*	*GREEN IS*	*UPOLU CAY*	*HASTINGS REEF*	*BATT REEF*	*THETFORD REEF*	*BROOK IS*
1874			*0.1086*		*0.1206*		*0.1086*
1875			*0.1086*		*0.1206*		*0.1146*
1876		*0.0965*	*0.1086*		*0.1267*		*0.1086*
1877		*0.0905*	*0.1086*		*0.1206*		*0.1146*
1878		*0.0905*	*0.1086*		*0.1206*		*0.1206*
1879		*0.0905*	*0.1086*		*0.1267*		*0.1267*
1880		*0.0965*	*0.1086*		*0.1267*		*0.1146*
1881		*0.0905*	*0.1025*		*0.1267*		*0.1086*
1882		*0.0905*	*0.1086*		*0.1267*		*0.1086*
1883		*0.0905*	*0.1025*		*0.1267*		*0.1025*
1884		*0.0965*	*0.1025*		*0.1267*		*0.1025*
1885		*0.0965*	*0.1086*		*0.1267*		*0.1025*
1886		*0.0965*	*0.1086*		*0.1267*		*0.1025*
1887		*0.0965*	*0.1025*		*0.1267*		*0.1025*
1888		*0.0905*	*0.1086*		*0.1206*		*0.1025*
1889		*0.0905*	*0.1086*		*0.1206*		*0.1025*
1890		*0.0965*	*0.1025*		*0.1206*		*0.1025*
1891		*0.0965*	*0.1086*		*0.1267*		*0.1025*
1892	*0.1025*	*0.0905*	*0.1086*		*0.1267*		*0.1086*
1893	*0.1086*	*0.0905*	*0.1086*		*0.1327*		*0.1086*
1894	*0.1025*	*0.0905*	*0.1025*		*0.1447*		*0.1086*
1895	*0.1146*	*0.0905*	*0.1086*		*0.1508*		*0.1025*
1896	*0.1146*	*0.0905*	*0.1025*		*0.1508*		*0.1025*
1897	*0.1086*	*0.0905*	*0.1086*		*0.1628*		*0.1025*
1898	*0.1086*	*0.0905*	*0.1086*		*0.1628*		*0.1025*
1899	*0.1086*	*0.0905*	*0.1025*		*0.1508*		*0.1025*
1900	*0.1025*	*0.0905*	*0.1086*		*0.1327*		*0.1025*
1901	*0.0965*	*0.0905*	*0.1086*		*0.1387*		*0.1025*
1902	*0.0965*	*0.0905*	*0.1086*		*0.1387*		*0.1025*
1903	*0.1025*	*0.0905*	*0.1086*		*0.1267*		*0.1025*

% MAGNESIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1904	0.1025	0.0905	0.1025		0.1206		0.1025
1905	0.0965	0.0905	0.1086		0.1206		0.1025
1906	0.1086	0.0905	0.1086		0.1206		0.1025
1907	0.1086	0.0905	0.1086		0.1206		0.1086
1908	0.1086	0.0905	0.1146		0.1447		0.1025
1909	0.1086	0.0905	0.1086		0.1206		0.1086
1910	0.1086	0.0844	0.1146		0.1206		0.1025
1911	0.1146	0.0844	0.1086		0.1206		0.1025
1912	0.1086	0.0905	0.1086		0.1267		0.1086
1913	0.1025	0.0844	0.1086	0.0989	0.1206		0.1025
1914	0.1086	0.0905	0.1086	0.0977	0.1267		0.1086
1915	0.1086	0.0905	0.1086	0.0947	0.1267		0.1086
1916	0.1025	0.0905	0.1086	0.0941	0.1206		0.1146
1917	0.1025	0.0905	0.1086	0.0977	0.1206		0.1206
1918	0.1025	0.0905	0.1025	0.0977	0.1267		0.1146
1919	0.0965	0.0905	0.1086	0.0983	0.1206		0.1146
1920	0.0965	0.0905	0.1025	0.0959	0.1206		0.1086
1921	0.1025	0.0965	0.1025	0.0995	0.1267		0.1086
1922	0.1025	0.1025	0.1086	0.1025	0.1267		0.1086
1923	0.1025	0.0905	0.1086	0.0959			0.1086
1924	0.1025	0.1025	0.1086	0.0953			0.1086
1925	0.1025	0.0965	0.1086	0.0935			0.1086
1926	0.1086	0.1086	0.1086	0.0929	0.1206		0.1086
1927	0.1086	0.0965	0.1086	0.0947	0.1206		0.1025
1928	0.1025	0.0905	0.1086	0.0935	0.1327		0.1025
1929	0.1025	0.1025	0.1025	0.0905	0.1267		0.1025
1930	0.1086	0.0905	0.1086	0.0923	0.1267	0.1013	0.1025
1931	0.1025	0.0965	0.1086	0.0971	0.1206	0.1019	0.1086
1932	0.1086	0.0965	0.1086	0.0899	0.1267	0.0983	0.1086
1933	0.1086	0.0965	0.1086	0.0911	0.1267	0.1007	0.1025

% MAGNESIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1934	0.1086	0.0965	0.1086	0.0947	0.1267	0.0989	0.1025
1935	0.1086	0.0965	0.1086	0.0929	0.1267	0.0971	0.1025
1936	0.1086	0.0905	0.1146	0.0947	0.1267	0.1001	0.1025
1937	0.1025	0.0905	0.1086	0.0935	0.1267	0.0977	0.1025
1938	0.1025	0.0965	0.1086	0.0923	0.1267	0.1025	0.1025
1939	0.1086	0.0905	0.1086	0.0923	0.1327	0.1031	0.1025
1940	0.1086	0.0905	0.1025	0.0965		0.1013	0.1025
1941	0.1146	0.0844	0.1086	0.0935	0.1327	0.1055	0.1025
1942	0.1086	0.0905	0.1086	0.0965	0.1327	0.1019	0.1086
1943	0.1086	0.0905	0.1086	0.0947	0.1387	0.1031	0.1025
1944	0.1086	0.0905	0.1025	0.0947	0.1327	0.1025	0.1025
1945	0.1086	0.0905	0.1086	0.0923	0.1267	0.1019	0.1086
1946	0.1086	0.0905	0.1086	0.0959	0.1206	0.1013	0.1025
1947	0.1086	0.0905	0.1086	0.0977	0.1206	0.1019	0.1086
1948	0.1086	0.0905	0.1086	0.1007	0.1206	0.1074	0.1086
1949	0.1146	0.0844	0.1086	0.0989	0.1267	0.1007	0.1025
1950	0.1146	0.0844	0.1086	0.1007	0.1267	0.1025	0.1086
1951	0.1086	0.0905	0.1086	0.0971	0.1267	0.1043	0.1086
1952	0.1025	0.0905	0.1086	0.0983	0.1267	0.0995	0.1086
1953	0.0965	0.0905	0.1025	0.1037	0.1267	0.1001	0.1025
1954	0.1025	0.0965	0.1086	0.1025	0.1267	0.0977	0.1025
1955	0.1025	0.0905	0.1086	0.1037	0.1327	0.0965	0.0965
1956	0.1025	0.0905	0.1086	0.1110	0.1447	0.0971	0.1025
1957	0.1025	0.0905	0.1086	0.0989	0.1327	0.0959	0.1025
1958	0.1086	0.0844	0.1086	0.1043	0.1447	0.1001	0.0965
1959	0.1086	0.0844	0.1086	0.1025		0.0971	0.0965
1960	0.1025	0.0844	0.1086	0.1049	0.1267	0.0977	0.1025
1961	0.1086	0.0844	0.1086	0.1031	0.1206	0.0965	0.1025
1962	0.1086	0.0905	0.1086	0.1013	0.1267	0.0959	0.1025
1963	0.1146	0.0905	0.1086	0.1001	0.1267	0.0971	0.1025

% MAGNESIUM							
YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1964	0.1086	0.0905	0.1086	0.1067	0.1267	0.0959	0.1025
1965	0.1146	0.0905	0.1086	0.1031	0.1267	0.1013	0.1025
1966	0.1146	0.0905	0.1086	0.1019	0.1327	0.0971	0.1025
1967	0.1086	0.1146	0.1146	0.1013	0.1327	0.1001	0.0965
1968	0.1086	0.1508	0.1086	0.1025	0.1206	0.0965	0.1025
1969	0.1025	0.0965	0.1086	0.0983	0.1267	0.0971	0.0965
1970	0.1025	0.1387	0.1146	0.1019	0.1267	0.0989	0.0965
1971	0.1025	0.1206	0.1146	0.1019	0.1267	0.0965	0.0965
1972	0.1025	0.1568	0.1146	0.0989	0.1206	0.0947	0.0965
1973	0.1025	0.1508	0.1146	0.0995	0.1267	0.0971	0.0965
1974	0.1025	0.1146	0.1146	0.1019	0.1206	0.0995	0.1025
1975	0.1025	0.1327	0.1086	0.1019	0.1267	0.0947	0.0965
1976	0.1025	0.1387	0.1086	0.1037	0.1267	0.0941	0.0965
1977		0.0965	0.1146	0.1043	0.1267	0.0977	0.0965
1978	0.0965	0.0965	0.1146	0.1055	0.1267	0.0983	0.0965
1979	0.0965	0.0905	0.1086	0.1001	0.1206	0.0995	0.1025
1980	0.0965	0.0905	0.1086	0.1001	0.1267	0.1001	0.0965
1981	0.0965	0.1146	0.1146	0.1013	0.1387	0.0983	0.0965
1982	0.1025	0.1025	0.1086	0.0995	0.1267	0.0989	0.1025
1983	0.1025	0.0965	0.1146	0.0989	0.1267	0.0995	0.1025
1984	0.1025	0.0965	0.1086	0.1007	0.1327	0.1007	0.1025
1985	0.1025	0.0965	0.1146	0.1007	0.1267	0.1019	0.1025
1986	0.1025	0.0965	0.1206	0.1031	0.1327	0.1037	0.1025
1987	0.1086	0.0965	0.1206	0.1110	0.1387	0.1037	0.1025
AVG	0.1054	0.0957	0.1087	0.0988	0.1250	0.0995	0.1044
STD.DEV	0.0049	0.0133	0.0035	0.0045	0.0087	0.0028	0.0051

SODIUM

% SODIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1814					0.4303		
1815					0.4303		
1816					0.4377		
1817					0.4377		
1818					0.4525		
1819					0.4451		
1820					0.4674		
1821					0.4525		
1822					0.4748		
1823					0.4599		
1824					0.4303		
1825					0.4451		
1826					0.4525		
1827			0.4674		0.4525		
1828			0.4525		0.4377		
1829			0.4451		0.4525		
1830			0.4525		0.4599		
1831			0.4674		0.4377		
1832			0.4748		0.4674		
1833			0.4674		0.4451		
1834			0.4748		0.4377		
1835			0.4674		0.4525		
1836			0.4674		0.4451		
1837			0.4599		0.4451		
1838			0.4674		0.4525		
1839			0.4599		0.4599		
1940			0.4599		0.4822		
1841			0.4451		0.4822		
1842			0.4674		0.4970		
1843			0.4599		0.5119		

% SODIUM							
YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1844			0.4599		0.5045		
1845			0.4674		0.4970		
1846			0.4525		0.4599		
1847			0.4599		0.4896		
1848			0.4674		0.4822		
1849			0.4674		0.4970		
1850			0.4599		0.5045		
1851			0.4599		0.4970		
1852			0.4525		0.4674		
1853			0.4599		0.4674		0.5786
1854			0.4674		0.4970		0.5416
1855			0.4674		0.4748		0.5416
1856			0.4525		0.4748		0.5416
1857			0.4377		0.4674		0.5341
1858			0.4674		0.4748		0.5193
1859			0.4599		0.4748		0.5119
1860			0.4599		0.4822		0.5267
1861			0.4599		0.4822		0.5267
1862			0.4599		0.4748		0.5341
1863			0.4599		0.4748		0.5416
1864			0.4674		0.4748		0.5341
1865			0.4674		0.4674		0.5416
1866			0.4748		0.4674		0.5416
1867			0.4970		0.4599		0.5416
1868			0.4896		0.4748		0.5267
1869			0.4822		0.4748		0.5267
1870			0.4822		0.4748		0.5341
1871			0.4896		0.4748		0.5490
1872			0.4896		0.4674		0.5341
1873			0.4822		0.4674		0.5564

% SODIUM							
YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1874			0.4748		0.4599		0.5638
1875			0.4674		0.4599		0.6009
1876		0.4451	0.4674		0.4748		0.5861
1877		0.4377	0.4822		0.4674		0.6306
1878		0.4377	0.4748		0.4674		0.6751
1879		0.4451	0.4748		0.4674		0.6973
1880		0.4451	0.4822		0.4674		0.6009
1881		0.4377	0.4674		0.4748		0.5935
1882		0.4451	0.4748		0.4822		0.5712
1883		0.4525	0.4748		0.4822		0.5490
1884		0.4599	0.4748		0.4674		0.5416
1885		0.4377	0.4748		0.4599		0.5416
1886		0.4377	0.4674		0.4674		0.5267
1887		0.4377	0.4525		0.4748		0.5193
1888		0.4451	0.4748		0.4896		0.5267
1889		0.4451	0.4674		0.4822		0.5193
1890		0.4451	0.4748		0.4896		0.5193
1891		0.4674	0.4748		0.4748		0.5119
1892	0.4674	0.4674	0.4748		0.5045		0.5045
1893	0.5045	0.4599	0.4599		0.5267		0.5045
1894	0.4822	0.4525	0.4674		0.5341		0.5045
1895	0.4970	0.4377	0.4674		0.5712		0.4970
1896	0.4970	0.4525	0.4674		0.6083		0.4896
1897	0.4822	0.4599	0.4748		0.6157		0.4970
1898	0.4822	0.4451	0.4748		0.6083		0.4896
1899	0.4674	0.4377	0.4674		0.5416		0.4970
1900	0.4748	0.4451	0.4748		0.4896		0.4970
1901	0.4599	0.4451	0.4674		0.5267		0.5045
1902	0.4674	0.4451	0.4896		0.5267		0.5119
1903	0.4674	0.4451	0.4822		0.4896		0.5045

% SODIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1904	0.4748	0.4451	0.4822		0.4822		0.4970
1905	0.4599	0.4451	0.4896		0.4748		0.5193
1906	0.4822	0.4525	0.4970		0.4674		0.5119
1907	0.4748	0.4451	0.4822		0.4599		0.5193
1908	0.4748	0.4377	0.4822		0.4674		0.5119
1909	0.4674	0.4377	0.4822		0.4674		0.5119
1910	0.4674	0.4303	0.4748		0.4674		0.5045
1911	0.4748	0.4377	0.4748		0.4599		0.5193
1912	0.4599	0.4377	0.4822		0.4748		0.5119
1913	0.4748	0.4303	0.4822	0.4859	0.4525		0.5341
1914	0.4748	0.4451	0.4748	0.4807	0.4674		0.5341
1915	0.4748	0.4525	0.4674	0.4592	0.4451		0.5638
1916	0.4822	0.4377	0.4674	0.4622	0.4674		0.5861
1917	0.4822	0.4451	0.4822	0.4644	0.4525		0.6083
1918	0.4674	0.4451	0.4822	0.4644	0.4525		0.6157
1919	0.4599	0.4525	0.4822	0.4577	0.4599		0.6157
1920	0.4674	0.4377	0.4822	0.4637	0.4748		0.5786
1921	0.4674	0.4525	0.4748	0.4956	0.4451		0.5712
1922	0.4748	0.4970	0.4748	0.5453	0.4525		0.5490
1923	0.4674	0.4599	0.4748	0.4622			0.5490
1924	0.4599	0.5712	0.4674	0.4659			0.5341
1925	0.4674	0.4674	0.4674	0.4510			0.5490
1926	0.4748	0.4970	0.4822	0.4496	0.4599		0.5341
1927	0.4748	0.5193	0.4674	0.4481	0.4525		0.5119
1928	0.4748	0.4377	0.4674	0.4444	0.4896		0.5119
1929	0.4674	0.5119	0.4748	0.4436	0.4674		0.5193
1930	0.4822	0.4599	0.4748	0.4429	0.4748	0.4644	0.5193
1931	0.4822	0.4674	0.4748	0.6677	0.4748	0.4763	0.5193
1932	0.4896	0.4748	0.4748	0.4399	0.4822	0.4473	0.5119
1933	0.4896	0.4599	0.4748	0.4436	0.4748	0.4496	0.5119

% SODIUM							
YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1934	0.4970	0.5119	0.4748	0.4407	0.4748	0.4503	0.5119
1935	0.5119	0.4599	0.4674	0.4436	0.4822	0.4399	0.5119
1936	0.5119	0.4674	0.4674	0.4414	0.4748	0.4444	0.5119
1937	0.4896	0.4451	0.4748	0.4384	0.4970	0.4421	0.5045
1938	0.4822	0.4896	0.4748	0.4436	0.4896	0.4510	0.5193
1939	0.4896	0.4377	0.4748	0.4392	0.4748	0.4651	0.5193
1940	0.4822	0.4377	0.4599	0.4384		0.4763	0.5193
1941	0.4970	0.4303	0.4748	0.4466	0.4599	0.4889	0.5193
1942	0.4748	0.4377	0.4748	0.4607	0.4599	0.4822	0.5119
1943	0.4748	0.4451	0.4748	0.4444	0.4674	0.4852	0.5119
1944	0.4822	0.4451	0.4674	0.4525	0.4674	0.4740	0.5045
1945	0.4896	0.4229	0.4674	0.4518	0.4599	0.4607	0.5341
1946	0.4822	0.4377	0.4674	0.4570	0.4525	0.4599	0.5193
1947	0.4896	0.4377	0.4599	0.4689	0.4525	0.4444	0.5267
1948	0.4896	0.4377	0.4451	0.4562	0.4599	0.4570	0.5267
1949	0.4748	0.4303	0.4599	0.4644	0.4599	0.4540	0.5341
1950	0.4674	0.4451	0.4451	0.4548	0.4303	0.4481	0.5416
1951	0.4525	0.4377	0.4451	0.4488	0.4377	0.4466	0.5341
1952	0.4525	0.4377	0.4599	0.4637	0.4451	0.4459	0.5045
1953	0.4451	0.4377	0.4451	0.4726	0.4451	0.4540	0.4822
1954	0.4525	0.4377	0.4525	0.4696	0.4377	0.4355	0.4896
1955	0.4525	0.4451	0.4451	0.4681	0.4525	0.4421	0.4822
1956	0.4599	0.4451	0.4451	0.5334	0.4229	0.4473	0.4674
1957	0.4525	0.4377	0.4525	0.4800	0.4303	0.4310	0.4748
1958	0.4674	0.4303	0.4525	0.4703	0.4377	0.4399	0.4748
1959	0.4674	0.4303	0.4674	0.4889		0.4459	0.4674
1960	0.4674	0.4451	0.4674	0.4867	0.4599	0.4370	0.4748
1961	0.4525	0.4229	0.4599	0.4852	0.4451	0.4459	0.4748
1962	0.4525	0.4303	0.4599	0.4740	0.4599	0.4407	0.4748
1963	0.4748	0.4377	0.4748	0.4681	0.4525	0.4318	0.4748

% SODIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1964	0.4674	0.4303	0.4674	0.4792	0.4674	0.4518	0.4674
1965	0.4674	0.4377	0.4674	0.4778	0.4599	0.4570	0.4674
1966	0.4750	0.4377	0.4674	0.4778	0.4674	0.4503	0.4748
1967	0.4674	0.4303	0.4599	0.4629	0.4748	0.4473	0.4674
1968	0.4674	0.4451	0.4599	0.4607	0.4599	0.4466	0.4674
1969	0.4599	0.4748	0.4599	0.4651	0.4822	0.4444	0.4822
1970	0.4525	0.4525	0.4674	0.4540	0.4822	0.4444	0.4748
1971	0.4525	0.4599	0.4748	0.4577	0.4674	0.4421	0.4748
1972	0.4599	0.4451	0.4674	0.4599	0.4674	0.4429	0.4674
1973	0.4525	0.4229	0.4748	0.4570	0.4674	0.4518	0.4748
1974	0.4674	0.4303	0.4674	0.4674	0.4674	0.4340	0.4822
1975	0.4599	0.4377	0.4674	0.4637	0.4822	0.4303	0.4748
1976	0.4599	0.4451	0.4748	0.4689	0.4748	0.4370	0.4525
1977		0.4674	0.4896	0.4718	0.4674	0.4436	0.4748
1978	0.4674	0.4822	0.4748	0.4852	0.4748	0.4421	0.4748
1979	0.4599	0.4748	0.4674	0.4599	0.4822	0.4407	0.5193
1980	0.4599	0.4674	0.4599	0.4548	0.4822	0.4585	0.4822
1981	0.4599	0.4303	0.4599	0.4614	0.4970	0.4473	0.4599
1982	0.4674	0.4451	0.4748	0.4488	0.5045	0.4377	0.4748
1983	0.4822	0.4599	0.4822	0.4659	0.5045	0.4607	0.4896
1984	0.4822	0.4896	0.4748	0.4629	0.5267	0.4325	0.4896
1985	0.4822	0.4748	0.4896	0.4659	0.5045	0.4548	0.4896
1986	0.4822	0.4822	0.4896	0.4622	0.5267	0.4533	0.5119
1987	0.4822	0.4674	0.4896	0.4718	0.5638	0.4518	0.5193
AVG	0.4728	0.4508	0.4693	0.4660	0.4736	0.4501	0.5208
STD.DEV	0.0136	0.0220	0.0112	0.0298	0.0301	0.0132	0.0408

POTASSIUM

% POTASSIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1814					0.0050		
1815					0.0042		
1816					0.0042		
1817					0.0042		
1818					0.0042		
1819					0.0050		
1820					0.0058		
1821					0.0042		
1822					0.0042		
1823					0.0066		
1824					0.0042		
1825					0.0058		
1826					0.0042		
1827			0.0058		0.0058		
1828			0.0058		0.0058		
1829			0.0066		0.0058		
1830			0.0058		0.0042		
1831			0.0058		0.0050		
1832			0.0066		0.0108		
1833			0.0066		0.0050		
1834			0.0058		0.0050		
1835			0.0058		0.0042		
1836			0.0058		0.0042		
1837			0.0058		0.0042		
1838			0.0058		0.0066		
1839			0.0058		0.0050		
1940			0.0058		0.0050		
1841			0.0058		0.0066		
1842			0.0058		0.0058		
1843			0.0058		0.0075		

% POTASSIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1844			0.0058		0.0058		
1845			0.0058		0.0075		
1846			0.0058		0.0050		
1847			0.0058		0.0058		
1848			0.0066		0.0058		
1849			0.0058		0.0058		
1850			0.0058		0.0066		
1851			0.0058		0.0058		
1852			0.0058		0.0058		
1853			0.0058		0.0058		0.0066
1854			0.0058		0.0075		0.0058
1855			0.0058		0.0050		0.0058
1856			0.0058		0.0050		0.0058
1857			0.0058		0.0058		0.0050
1858			0.0058		0.0058		0.0050
1859			0.0058		0.0058		0.0050
1860			0.0058		0.0050		0.0050
1861			0.0058		0.0050		0.0050
1862			0.0058		0.0066		0.0050
1863			0.0050		0.0058		0.0042
1864			0.0075		0.0058		0.0042
1865			0.0075		0.0066		0.0042
1866			0.0075		0.0050		0.0058
1867			0.0083		0.0058		0.0058
1868			0.0083		0.0050		0.0042
1869			0.0075		0.0050		0.0042
1870			0.0075		0.0050		0.0050
1871			0.0075		0.0066		0.0025
1872			0.0075		0.0050		0.0050
1873			0.0075		0.0042		0.0058

% POTASSIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1874			0.0075		0.0058		0.0058
1875			0.0075		0.0066		0.0075
1876		0.0066	0.0066		0.0058		0.0066
1877		0.0066	0.0075		0.0042		0.0083
1878		0.0066	0.0066		0.0042		0.0091
1879		0.0075	0.0066		0.0058		0.0091
1880		0.0066	0.0066		0.0042		0.0075
1881		0.0066	0.0075		0.0058		0.0075
1882		0.0066	0.0075		0.0058		0.0058
1883		0.0066	0.0066		0.0058		0.0066
1884		0.0066	0.0075		0.0058		0.0058
1885		0.0066	0.0066		0.0058		0.0042
1886		0.0066	0.0075		0.0042		0.0058
1887		0.0066	0.0075		0.0058		0.0050
1888		0.0066	0.0066		0.0058		0.0050
1889		0.0066	0.0066		0.0058		0.0042
1890		0.0066	0.0075		0.0075		0.0042
1891		0.0083	0.0075		0.0058		0.0050
1892	0.0075	0.0075	0.0075		0.0058		0.0033
1893	0.0083	0.0075	0.0066		0.0083		0.0042
1894	0.0083	0.0075	0.0075		0.0091		0.0033
1895	0.0091	0.0066	0.0075		0.0091		0.0042
1896	0.0083	0.0075	0.0058		0.0108		0.0042
1897	0.0083	0.0066	0.0075		0.0116		0.0033
1898	0.0075	0.0066	0.0075		0.0108		0.0042
1899	0.0075	0.0066	0.0075		0.0083		0.0033
1900	0.0075	0.0066	0.0075		0.0091		0.0033
1901	0.0075	0.0066	0.0075		0.0075		0.0050
1902	0.0075	0.0066	0.0075		0.0075		0.0042
1903	0.0075	0.0066	0.0075		0.0058		0.0050

% POTASSIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1904	0.0075	0.0066	0.0075		0.0058		0.0042
1905	0.0075	0.0083	0.0075		0.0050		0.0042
1906	0.0083	0.0075	0.0083		0.0042		0.0050
1907	0.0075	0.0058	0.0075		0.0058		0.0050
1908	0.0075	0.0058	0.0066		0.0058		0.0042
1909	0.0075	0.0058	0.0066		0.0058		0.0042
1910	0.0075	0.0058	0.0066		0.0058		0.0033
1911	0.0066	0.0058	0.0075		0.0058		0.0042
1912	0.0075	0.0058	0.0075		0.0050		0.0042
1913	0.0066	0.0058	0.0075	0.0083	0.0058		0.0042
1914	0.0083	0.0075	0.0075	0.0066	0.0058		0.0050
1915	0.0083	0.0066	0.0075	0.0058	0.0042		0.0058
1916	0.0083	0.0066	0.0075	0.0066	0.0050		0.0075
1917	0.0075	0.0058	0.0075	0.0075	0.0042		0.0075
1918	0.0083	0.0058	0.0075	0.0066	0.0058		0.0075
1919	0.0075	0.0066	0.0075	0.0075	0.0050		0.0075
1920	0.0075	0.0058	0.0066	0.0066	0.0042		0.0058
1921	0.0066	0.0066	0.0075	0.0066	0.0058		0.0066
1922	0.0083	0.0091	0.0066	0.0083	0.0050		0.0058
1923	0.0075	0.0066	0.0066	0.0066			0.0058
1924	0.0083	0.0100	0.0066	0.0050			0.0058
1925	0.0075	0.0075	0.0066	0.0058			0.0058
1926	0.0075	0.0100	0.0066	0.0050	0.0042		0.0066
1927	0.0083	0.0091	0.0066	0.0050	0.0058		0.0042
1928	0.0083	0.0066	0.0066	0.0050	.0058		0.0058
1929	0.0083	0.0091	0.0066	0.0058	0.0058		0.0050
1930	0.0083	0.0075	0.0066	0.0058	0.0058	0.0042	0.0050
1931	0.0075	0.0091	0.0066	0.0050	0.0058	0.0042	0.0058
1932	0.0083	0.0083	0.0066	0.0058	0.0058	0.0042	0.0050
1933	0.0083	0.0083	0.0066	0.0050	0.0042	0.0042	0.0058

% POTASSIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1934	0.0066	0.0091	0.0066	0.0050	0.0058	0.0050	0.0042
1935	0.0083	0.0075	0.0066	0.0058	0.0075	0.0042	0.0050
1936	0.0083	0.0066	0.0066	0.0058	0.0058	0.0042	0.0042
1937	0.0075	0.0075	0.0066	0.0058	0.0066	0.0042	0.0042
1938	0.0083	0.0083	0.0066	0.0050	0.0075	0.0042	0.0050
1939	0.0075	0.0083	0.0075	0.0050	0.0058	0.0050	0.0050
1940	0.0075	0.0083	0.0066	0.0050	0.0042	0.0042	0.0042
1941	0.0066	0.0058	0.0075	0.0066	0.0058	0.0050	0.0042
1942	0.0075	0.0066	0.0066	0.0050	0.0066	0.0050	0.0042
1943	0.0066	0.0066	0.0066	0.0058	0.0066	0.0050	0.0042
1944	0.0075	0.0066	0.0066	0.0050	0.0058	0.0058	0.0042
1945	0.0066	0.0066	0.0066	0.0050	0.0058	0.0050	0.0042
1946	0.0075	0.0066	0.0066	0.0058	0.0050	0.0050	0.0042
1947	0.0066	0.0066	0.0066	0.0066	0.0058	0.0050	0.0042
1948	0.0075	0.0075	0.0058	0.0058	0.0042	0.0066	0.0050
1949	0.0075	0.0066	0.0058	0.0058	0.0075	0.0042	0.0058
1950	0.0066	0.0075	0.0058	0.0058	0.0050	0.0042	0.0058
1951	0.0066	0.0066	0.0066	0.0050	0.0050	0.0042	0.0033
1952	0.0066	0.0066	0.0058	0.0058	0.0042	0.0042	0.0042
1953	0.0066	0.0075	0.0058	0.0066	0.0042	0.0042	0.0033
1954	0.0066	0.0075	0.0058	0.0058	0.0075	0.0042	0.0042
1955	0.0066	0.0075	0.0058	0.0058	0.0050	0.0033	0.0025
1956	0.0066	0.0066	0.0058	0.0075	0.0075	0.0050	0.0025
1957	0.0066	0.0075	0.0058	0.0066	0.0066	0.0042	0.0033
1958	0.0075	0.0075	0.0058	0.0066	0.0075	0.0050	0.0017
1959	0.0066	0.0075	0.0058	0.0066	0.0042	0.0042	0.0033
1960	0.0066	0.0075	0.0058	0.0066	0.0033	0.0033	0.0025
1961	0.0066	0.0075	0.0066	0.0066	0.0058	0.0033	0.0025
1962	0.0066	0.0075	0.0058	0.0058	0.0042	0.0042	0.0042
1963	0.0066	0.0066	0.0058	0.0058	0.0050	0.0050	0.0017

% POTASSIUM

YEAR	NO NAME REEF	GREEN IS	UPOLU CAY	HASTINGS REEF	BATT REEF	THETFORD REEF	BROOK IS
1964	0.0066	0.0075	0.0066	0.0066	0.0042	0.0042	0.0025
1965	0.0066	0.0075	0.0058	0.0058	0.0042	0.0042	0.0025
1966	0.0075	0.0066	0.0066	0.0058	0.0075	0.0050	0.0042
1967	0.0075	0.0100	0.0066	0.0058	0.0058	0.0042	0.0025
1968	0.0075	0.0216	0.0058	0.0058	0.0058	0.0042	0.0025
1969	0.0066	0.0091	0.0058	0.0058	0.0058	0.0042	0.0033
1970	0.0075	0.0125	0.0066	0.0058	0.0066	0.0042	0.0033
1971	0.0066	0.0108	0.0066	0.0050	0.0066	0.0042	0.0058
1972	0.0066	0.0133	0.0066	0.0058	0.0042	0.0050	0.0025
1973	0.0075	0.0133	0.0066	0.0058	0.0050	0.0042	0.0025
1974	0.0066	0.0100	0.0058	0.0058	0.0050	0.0042	0.0033
1975	0.0066	0.0116	0.0066	0.0058	0.0058	0.0042	0.0025
1976	0.0075	0.0116	0.0066	0.0050	0.0058	0.0042	0.0025
1977		0.0083	0.0066	0.0058	0.0058	0.0042	0.0042
1978	0.0075	0.0091	0.0116	0.0075	0.0075	0.0050	0.0025
1979	0.0075	0.0091	0.0066	0.0066	0.0066	0.0042	0.0025
1980	0.0075	0.0108	0.0075	0.0058	0.0058	0.0050	0.0025
1981	0.0066	0.0091	0.0075	0.0058	0.0116	0.0042	0.0025
1982	0.0075	0.0083	0.0075	0.0066	0.0091	0.0050	0.0042
1983	0.0075	0.0083	0.0075	0.0058	0.0066	0.0042	0.0042
1984	0.0075	0.0100	0.0075	0.0066	0.0083	0.0050	0.0033
1985	0.0075	0.0100	0.0075	0.0066	0.0091	0.0042	0.0025
1986	0.0083	0.0108	0.0066	0.0075	0.0100	0.0050	0.0050
1987	0.0083	0.0100	0.0075	0.0066	0.0108	0.0042	0.0042
AVG	0.0074	0.0078	0.0067	0.0060	0.0059	0.0044	0.0046
STD.DEV	0.0006	0.0021	0.0008	0.0008	0.0016	0.0006	0.0015

IRON

% IRON

	NONAME	GREEN	UPOLU	HASTINGS	BATT	THETFORD	BROOK
1814					0.0070		
1815					0.0086		
1816					0.0062		
1817					0.0070		
1818					0.0062		
1819					0.0047		
1820					0.0054		
1821					0.0062		
1822					0.0047		
1823					0.0047		
1824					0.0039		
1825					0.0086		
1826					0.0062		
1827			0.0039		0.0078		
1828			0.0039		0.0047		
1829			0.0039		0.0070		
1830			0.0039		0.0109		
1831			0.0039		0.0124		
1832			0.0039		0.0086		
1833			0.0039		0.0093		
1834			0.0039		0.0086		
1835			0.0039		0.0078		
1836			0.0039		0.0078		
1837			0.0039		0.0078		
1838			0.0039		0.0109		
1839			0.0039		0.0070		
1940			0.0039		0.0062		
1841			0.0039		0.0070		
1842			0.0039		0.0078		
1843			0.0039		0.0078		

% IRON

	NONAME	GREEN	UPOLU	HASTINGS	BATT	THETFORD	BROOK
1844			0.0039		0.0070		
1845			0.0039		0.0070		
1846			0.0039		0.0070		
1847			0.0039		0.0070		
1848			0.0039		0.0109		
1849			0.0039		0.0078		
1850			0.0039		0.0062		
1851			0.0039		0.0062		
1852			0.0039		0.0078		
1853			0.0039		0.0086		0.0039
1854			0.0039		0.0086		0.0039
1855			0.0039		0.0070		0.0039
1856			0.0039		0.0086		0.0039
1857			0.0039		0.0086		0.0039
1858			0.0039		0.0078		0.0039
1859			0.0039		0.0117		0.0039
1860			0.0039		0.0109		0.0039
1861			0.0039		0.0109		0.0039
1862			0.0039		0.0124		0.0039
1863			0.0039		0.0132		0.0039
1864			0.0039		0.0078		0.0039
1865			0.0039		0.0078		0.0039
1866			0.0039		0.0109		0.0039
1867			0.0039		0.0086		0.0039
1868			0.0039		0.0078		0.0039
1869			0.0039		0.0078		0.0039
1870			0.0039		0.0086		0.0039
1871			0.0039		0.0062		0.0039
1872			0.0039		0.0054		0.0039
1873			0.0039		0.0078		0.0039

% IRON

	NONAME	GREEN	UPOLU	HASTINGS	BATT	THETFORD	BROOK
1874			0.0039		0.0078		0.0039
1875			0.0039		0.0062		0.0039
1876		0.0054	0.0039		0.0062		0.0039
1877		0.0039	0.0039		0.0062		0.0039
1878		0.0039	0.0039		0.0047		0.0039
1879		0.0039	0.0039		0.0054		0.0039
1880		0.0039	0.0039		0.0078		0.0039
1881		0.0039	0.0039		0.0062		0.0039
1882		0.0039	0.0039		0.0070		0.0039
1883		0.0039	0.0039		0.0054		0.0039
1884		0.0039	0.0039		0.0078		0.0039
1885		0.0039	0.0039		0.0062		0.0039
1886		0.0039	0.0039		0.0070		0.0039
1887		0.0039	0.0039		0.0062		0.0039
1888		0.0039	0.0039		0.0086		0.0039
1889		0.0039	0.0039		0.0086		0.0039
1890		0.0039	0.0039		0.0086		0.0039
1891		0.0039	0.0039		0.0078		0.0039
1892	0.0039	0.0039	0.0039		0.0086		0.0039
1893	0.0039	0.0039	0.0039		0.0086		0.0039
1894	0.0039	0.0039	0.0039		0.0078		0.0039
1895	0.0039	0.0039	0.0039		0.0086		0.0039
1896	0.0039	0.0039	0.0039		0.0124		0.0039
1897	0.0039	0.0039	0.0039		0.0132		0.0039
1898	0.0039	0.0039	0.0039		0.0187		0.0039
1899	0.0039	0.0039	0.0039		0.0140		0.0039
1900	0.0039	0.0039	0.0039		0.0054		0.0039
1901	0.0039	0.0039	0.0039		0.0117		0.0039
1902	0.0039	0.0039	0.0039		0.0124		0.0039
1903	0.0039	0.0039	0.0039		0.0062		0.0039

% IRON							
	NONAME	GREEN	UPOLU	HASTINGS	BATT	THETFORD	BROOK
1904	0.0039	0.0039	0.0039		0.0070		0.0039
1905	0.0039	0.0039	0.0039		0.0062		0.0039
1906	0.0039	0.0039	0.0039		0.0054		0.0039
1907	0.0039	0.0039	0.0039		0.0070		0.0039
1908	0.0039	0.0039	0.0039		0.0054		0.0039
1909	0.0039	0.0039	0.0039		0.0062		0.0039
1910	0.0039	0.0039	0.0039		0.0070		0.0039
1911	0.0039	0.0039	0.0039		0.0062		0.0039
1912	0.0039	0.0039	0.0039		0.0070		0.0039
1913	0.0039	0.0039	0.0039	0.0078	0.0078		0.0039
1914	0.0039	0.0039	0.0039	0.0078	0.0070		0.0039
1915	0.0039	0.0039	0.0039	0.0078	0.0062		0.0039
1916	0.0039	0.0039	0.0039	0.0078	0.0078		0.0039
1917	0.0039	0.0039	0.0039	0.0078	0.0070		0.0039
1918	0.0039	0.0039	0.0039	0.0078	0.0078		0.0039
1919	0.0039	0.0039	0.0039	0.0078	0.0062		0.0039
1920	0.0039	0.0039	0.0039	0.0078	0.0070		0.0039
1921	0.0039	0.0039	0.0039	0.0078	0.0054		0.0039
1922	0.0039	0.0039	0.0039	0.0078	0.0086		0.0039
1923	0.0039	0.0039	0.0039	0.0078			0.0039
1924	0.0039	0.0039	0.0039	0.0078			0.0039
1925	0.0039	0.0039	0.0039	0.0078			0.0039
1926	0.0039	0.0039	0.0039	0.0078	0.0078		0.0039
1927	0.0039	0.0039	0.0039	0.0078	0.0140		0.0039
1928	0.0039	0.0039	0.0039	0.0078	0.0109		0.0039
1929	0.0039	0.0039	0.0039	0.0078	0.0078		0.0039
1930	0.0039	0.0039	0.0039	0.0078	0.0070	0.0070	0.0039
1931	0.0039	0.0039	0.0039	0.0078	0.0062	0.0039	0.0039
1932	0.0039	0.0039	0.0039	0.0078	0.0078	0.0054	0.0039
1933	0.0039	0.0039	0.0039	0.0078	0.0062	0.0031	0.0039

% IRON							
	NONAME	GREEN	UPOLU	HASTINGS	BATT	THETFORD	BROOK
1934	0.0039	0.0039	0.0039	0.0078	0.0078	0.0054	0.0039
1935	0.0039	0.0039	0.0039	0.0078	0.0078	0.0047	0.0039
1936	0.0039	0.0039	0.0039	0.0078	0.0078	0.0047	0.0039
1937	0.0039	0.0039	0.0039	0.0078	0.0086	0.0047	0.0039
1938	0.0039	0.0039	0.0039	0.0078	0.0078	0.0054	0.0039
1939	0.0039	0.0039	0.0039	0.0078	0.0086	0.0054	0.0039
1940	0.0039	0.0039	0.0039	0.0078	0.0042	0.0054	0.0039
1941	0.0039	0.0039	0.0039	0.0078	0.0093	0.0062	0.0039
1942	0.0039	0.0039	0.0039	0.0078	0.0093	0.0039	0.0039
1943	0.0039	0.0039	0.0039	0.0078	0.0093	0.0062	0.0039
1944	0.0039	0.0039	0.0039	0.0078	0.0086	0.0047	0.0039
1945	0.0039	0.0039	0.0039	0.0078	0.0070	0.0070	0.0039
1946	0.0039	0.0039	0.0039	0.0078	0.0078	0.0070	0.0039
1947	0.0039	0.0039	0.0039	0.0078	0.0078	0.0062	0.0039
1948	0.0039	0.0039	0.0039	0.0078	0.0086	0.0163	0.0039
1949	0.0039	0.0039	0.0039	0.0078	0.0117	0.0054	0.0039
1950	0.0039	0.0039	0.0039	0.0078	0.0101	0.0086	0.0039
1951	0.0039	0.0039	0.0039	0.0078	0.0093	0.0047	0.0039
1952	0.0039	0.0039	0.0039	0.0078	0.0062	0.0047	0.0039
1953	0.0039	0.0039	0.0039	0.0078	0.0078	0.0047	0.0039
1954	0.0039	0.0132	0.0039	0.0078	0.0078	0.0039	0.0039
1955	0.0039	0.0039	0.0039	0.0078	0.0093	0.0031	0.0039
1956	0.0039	0.0039	0.0039	0.0078	0.0016	0.0039	0.0039
1957	0.0039	0.0039	0.0039	0.0078	0.0132	0.0062	0.0039
1958	0.0039	0.0039	0.0039	0.0078	0.0365	0.0109	0.0039
1959	0.0039	0.0039	0.0039	0.0233	0.0042	0.0054	0.0039
1960	0.0039	0.0039	0.0039	0.0078	0.0078	0.0047	0.0039
1961	0.0039	0.0039	0.0039	0.0078	0.0078	0.0047	0.0039
1962	0.0039	0.0039	0.0039	0.0078	0.0109	0.0062	0.0039
1963	0.0039	0.0039	0.0039	0.0078	0.0117	0.0062	0.0039

% IRON

	NONAME	GREEN	UPOLU	HASTINGS	BATT	THETFORD	BROOK
1964	0.0039	0.0039	0.0039	0.0078	0.0140	0.0047	0.0039
1965	0.0039	0.0039	0.0039	0.0078	0.0140	0.0062	0.0039
1966	0.0039	0.0039	0.0039	0.0078	0.0117	0.0047	0.0039
1967	0.0039	0.0140	0.0039	0.0078	0.0086	0.0070	0.0039
1968	0.0039	0.0529	0.0039	0.0078	0.0062	0.0047	0.0039
1969	0.0039	0.0288	0.0039	0.0078	0.0086	0.0054	0.0039
1970	0.0039	0.0241	0.0039	0.0078	0.0078	0.0054	0.0039
1971	0.0039	0.0148	0.0039	0.0078	0.0109	0.0062	0.0039
1972	0.0039	0.0272	0.0039	0.0078	0.0054	0.0062	0.0039
1973	0.0039	0.0272	0.0039	0.0078	0.0062	0.0070	0.0039
1974	0.0039	0.0093	0.0039	0.0078	0.0062	0.0062	0.0039
1975	0.0039	0.0171	0.0039	0.0078	0.0078	0.0070	0.0039
1976	0.0039	0.0225	0.0039	0.0078	0.0070	0.0062	0.0039
1977		0.0039	0.0078	0.0078	0.0086	0.0054	0.0039
1978	0.0039	0.0039	0.0039	0.0078	0.0054	0.0054	0.0039
1979	0.0039	0.0039	0.0039	0.0078	0.0070	0.0054	0.0039
1980	0.0039	0.0039	0.0039	0.0078	0.0062	0.0117	0.0039
1981	0.0039	0.0101	0.0039	0.0078	0.0358	0.0039	0.0039
1982	0.0039	0.0047	0.0039	0.0078	0.0086	0.0109	0.0039
1983	0.0039	0.0039	0.0039	0.0078	0.0078	0.0031	0.0039
1984	0.0039	0.0039	0.0039	0.0078	0.0093	0.0086	0.0039
1985	0.0039	0.0039	0.0039	0.0078	0.0078	0.0078	0.0039
1986	0.0039	0.0047	0.0039	0.0078	0.0078	0.0070	0.0039
1987	0.0039	0.0039	0.0039	0.0078	0.0148	0.0132	0.0039
AVG	0.0039	0.0058	0.0039	0.0080	0.0083	0.0061	0.0039
STD.DEV	0.0000	0.0067	0.0003	0.0018	0.0038	0.0024	0.0000

APPENDIX K

XRD ARAGONITE (111) REFLECTION ANOMALIES FROM GREEN ISLAND AND NO NAME REEF CORALS WITH CLIMATIC VARIABLES

XRD ARAGONITE (111) REFLECTION ANOMALIES FROM GREEN ISLAND AND NO NAME REEF CORALS WITH CLIMATIC VARIABLES FROM AUSTRALIAN BUREAU OF METEOROLOGY

YEAR	GREEN IS XRD ANOMALY	NO NAME XRD ANOMALY	DARWIN MSLP hP (Annual Average)	TOWNSVILLE MSLP hP (Annual Average)	SOI (Annual Average)	SOI (June,July August Average)
1876	-0.01					
1877	0.01					
1878	-0.04					
1879	-0.03					
1880	-0.06					
1881	-0.07					
1882	-0.03		994.08		-4.88	-18.53
1883	0.04		992.92		-0.21	-1.87
1884	-0.05		1001.92		-3.38	-0.03
1885	-0.03		1008.83		-6.35	-8.83
1886	0.02		991.58		7.25	7.97
1887	0.02		996.92		4.73	4.30
1888	0.07		1006.58		-10.50	-12.80
1889	0.00		997.50		2.17	7.37
1890	0.00		991.50		5.60	-0.13
1891	0.00		1008.50		-2.52	-5.27
1892	0.00	-0.02	995.75			9.73
1893	-0.03	-0.02	996.08			
1894	0.00	-0.10	1006.83			
1895	-0.04	-0.04	1002.33			
1896	-0.04	-0.03	1008.83		-9.19	-16.07
1897	-0.06	-0.06	1004.42		-5.48	-0.57
1898	-0.04	-0.05	993.25		3.37	1.80
1899	0.00	-0.13	1000.92		1.79	-8.07
1900	-0.04	-0.05	1002.42		-5.74	13.07
1901	-0.05	0.00	1001.08		0.23	13.23

XRD ARAGONITE (111) REFLECTION ANOMALIES FROM GREEN ISLAND AND NO NAME REEF CORALS WITH CLIMATIC VARIABLES FROM AUSTRALIAN BUREAU OF METEOROLOGY

YEAR	GREEN IS XRD ANOMALY	NO NAME XRD ANOMALY	DARWIN MSLP hP (Annual Average)	TOWNSVILLE MSLP hP (Annual Average)	SOI (Annual Average)	SOI (June,July August Average)
1902	-0.05	-0.05	1008.92		-0.03	-1.67
1903	-0.02	-0.09	996.08		4.32	1.67
1904	0.04	-0.02	996.83		3.87	-4.73
1905	-0.04	-0.01	1008.42		-18.93	-18.30
1906	-0.05	0.01	994.83			5.83
1907	-0.10	-0.02	995.67			
1908	-0.10	-0.11	996.33		5.48	
1909	-0.02	-0.05	992.42		3.23	12.97
1910	-0.02	-0.10	987.08		12.33	15.77
1911	-0.04	0.00	1001.42		-5.38	-11.40
1912	-0.04	-0.02827	1005.00		-8.33	-4.47
1913	-0.04	-0.11	1004.50		-6.12	-4.13
1914	-0.12	-0.03	1012.58			
1915	-0.01	-0.02	1000.33		-2.60	
1916	-0.04	-0.03	986.67		6.92	15.70
1917	-0.04	-0.02	986.75		22.39	37.00
1918	-0.04	-0.04	1001.67		0.79	-7.30
1919	0.06	-0.05	1004.92		-9.24	-8.10
1920	-0.08	0.05	990.75		1.75	6.40
1921	-0.12	-0.01	993.25			
1922	-0.04	0.02	992.58		3.95	1.93
1923	-0.10	0.01	997.33		-2.84	-9.27
1924	-0.12	0.05	996.17		4.15	7.90
1925	-0.03	-0.02	995.50		-1.80	-9.10
1926	-0.04	-0.04	1001.42		-13.35	-15.17
1927	-0.04	-0.02	996.83			

XRD ARAGONITE (111) REFLECTION ANOMALIES FROM GREEN ISLAND AND NO NAME REEF CORALS WITH CLIMATIC VARIABLES FROM AUSTRALIAN BUREAU OF METEOROLOGY							
YEAR	GREEN IS XRD ANOMALY	NO NAME XRD ANOMALY	DARWIN MSLP hP (Annual Average)	TOWNSVILLE MSLP hP (Annual Average)	SOI (Annual Average)	SOI (June,July August Average)	
1928	-0.06	-0.01	998.33		4.32	0.53	
1929	-0.04	-0.02	995.58		4.58	0.70	
1930	-0.11	-0.09	1004.08		0.38	-3.63	
1931	-0.04	-0.03	1000.75			12.20	
1932	0.00	-0.10	999.00				
1933	-0.12	-0.03	995.42		1.61	-0.27	
1934	-0.09	-0.07	998.00		0.11	-3.17	
1935	-0.02	-0.04	998.17		1.57	-0.23	
1936	-0.07	-0.05	996.83		0.47	-2.00	
1937	0.00	-0.05	996.67		1.00	0.17	
1938	-0.04	-0.02	991.75		8.58	14.97	
1939	0.06	-0.11	997.50		0.33	1.87	
1940	0.01	-0.04	1011.42		-13.58	-16.37	
1941	-0.14	-0.02	1011.83		-12.57	-16.80	
1942	0.08	-0.03	999.42		1.13	3.20	
1943	-0.09	-0.02	994.00		4.05	0.97	
1944	0.00	0.00	1002.42		-2.08	-2.97	
1945	0.00	0.00	997.67		4.17	7.07	
1946	-0.04	-0.01	1003.17		-6.63	-7.47	
1947	0.00	-0.06	997.75		1.88	5.87	
1948	-0.04	-0.02	996.92		-1.49	-3.20	
1949	-0.04	0.00	996.67		-1.16	-5.50	
1950	0.04	-0.10	983.33		14.41	18.20	
1951	0.00	-0.07	998.92		-0.93	-1.40	
1952	-0.08	-0.03	999.08	1013.07	-2.52	1.97	
1953	-0.04	-0.03	1004.67	1014.15	-6.76	-6.50	

XRD ARAGONITE (111) REFLECTION ANOMALIES FROM GREEN ISLAND AND NO NAME REEF CORALS WITH CLIMATIC VARIABLES FROM AUSTRALIAN BUREAU OF METEOROLOGY

YEAR	*GREEN IS XRD ANOMALY*	*NO NAME XRD ANOMALY*	*DARWIN MSLP hP (Annual Average)*	*TOWNSVILLE MSLP hP (Annual Average)*	*SOI (Annual Average)*	*SOI (June,July August Average)*
1954	0.08	-0.03	993.67	1013.40	3.71	4.07
1955	-0.08	-0.06	988.67	1012.02	10.04	15.33
1956	-0.08	-0.12	986.00	1010.40	10.07	10.90
1957	-0.09	0.03	1002.75	1012.96	-4.00	-3.47
1958	-0.16	0.02	997.67	1012.52	-3.46	3.13
1959	-0.14	0.02	997.17	1012.59	-0.28	-5.10
1960	-0.06	0.03	994.67	1013.18	3.40	2.83
1961	-0.06	0.05	1000.50	1013.13	0.71	-0.23
1962	-0.04	0.05	994.00	1012.45	5.08	2.67
1963	-0.14	-0.05	1002.50	1013.00	-2.27	-3.97
1964	-0.04	-0.02	993.58	1011.92	5.67	8.67
1965	-0.06	0.02	1005.92	1013.83	-8.22	-14.50
1966	-0.01	0.00	1003.08	1014.00	-4.28	1.10
1967	-0.06	0.00	998.33	1012.64	2.83	4.13
1968	-0.02	-0.03	995.50	1013.26	2.67	5.83
1969	-0.06	0.02	1001.08	1013.71	-5.51	-3.87
1970	-0.04	0.02	993.75	1012.85	3.60	2.23
1971	-0.14	0.00	988.58	1011.56	10.21	5.80
1972	-0.14	-0.06	1005.58	1013.80	-7.28	-12.23
1973	0.00	0.03	989.08	1013.03	6.78	9.23
1974	-0.04	-0.04	988.33	1011.76	9.25	6.50
1975	-0.13	-0.05	988.17	1012.30	12.78	17.53
1976	-0.02	-0.06	996.58	1011.89	0.85	-7.87
1977	0.08	-0.03	1003.75	1013.10	-9.59	-13.67
1978	0.06	0.01	999.67	1013.05	-1.94	3.93
1979	0.01	0.01	1002.17	1014.01	-2.04	-2.60

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS								
YEAR *DENOTES ENSO ACTIVITY	GREEN IS XRD ANOMALY	NO NAME REEF XRD ANOMALY	GREEN IS REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.04)	NO NAME REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.03)	DARWIN MSLP	TOWNSVILLE MSLP	SOUTHERN OSCILLATION INDEX (SOI)	SOI WINTER AVERAGE (JUNE,JULY, AUGUST)
1956	-0.08	-0.12	-0.04		986.00	1010.40	10.07	10.90
*1957	-0.09	0.03	-0.05	0.03	1002.75	1012.96	-4.00	-3.47
1958	-0.16	0.02	-0.12	0.02	997.67	1012.52	-3.46	3.13
1959	-0.14	0.02	-0.10	0.02	997.17	1012.59	-0.28	-5.10
1960	-0.06	0.03	-0.02	0.03	994.67	1013.18	3.40	2.83
1961	-0.06	0.05	-0.02	0.05	1000.50	1013.13	0.71	-0.23
1962	-0.04	0.05		0.05	994.00	1012.45	5.08	2.67
1963	-0.14	-0.05	-0.10		1002.50	1013.00	-2.27	-3.97
1964	-0.04	-0.02		-0.02	993.58	1011.92	5.67	8.67
*1965	-0.06	0.02	-0.02	0.02	1005.92	1013.83	-8.22	-14.50
*1966	-0.01	0.00	+0.03	0.00	1003.08	1014.00	-4.28	1.10
1967	-0.06	0.00	-0.02	0.00	998.33	1012.64	2.83	4.13
1968	-0.02	-0.03	+0.02	-0.03	995.50	1013.26	2.67	5.83
1969	-0.06	0.02	-0.02	0.02	1001.08	1013.71	-5.51	-3.87
1970	-0.04	0.02		0.02	993.75	1012.85	3.60	2.23
1971	-0.14	0.00	-0.10	0.00	988.58	1011.56	10.21	5.80
*1972	-0.14	-0.06	-0.10		1005.58	1013.80	-7.28	-12.23
*1973	0.00	0.03	+0.04	0.03	989.08	1013.03	6.78	9.23
1974	-0.04	-0.04			988.33	1011.76	9.25	6.50
1975	-0.13	-0.05	-0.09		988.17	1012.30	12.78	17.53

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS								
YEAR *DENOTES ENSO ACTIVITY	GREEN IS XRD ANOMALY	NO NAME REEF XRD ANOMALY	GREEN IS REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.04)	NO NAME REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.03)	DARWIN MSLP	TOWNSVILLE MSLP	SOUTHERN OSCILLATION INDEX (SOI)	SOI WINTER AVERAGE (JUNE,JULY, AUGUST)
*1976	-0.02	-0.06			996.58	1011.89	0.85	-7.87
*1977	0.08	-0.03	+0.12	-0.03	1003.75	1013.10	-9.59	-13.67
1978	0.06	0.01	+0.10	0.01	999.67	1013.05	-1.94	3.93
1979	0.01	0.01	+0.05	0.01	1002.17	1014.01	-2.04	-2.60
1980	0.11	-0.03	+0.15	-0.03	999.50	1013.85	-3.03	-1.57
1981	0.00	-0.06	+0.04		996.17	1013.16	1.53	8.00
*1982	-0.04	-0.05			1011.00	1014.32	-12.85	-19.47
*1983	-0.09	-0.06	-0.05		1012.17	1014.28	-8.06	-3.33
1984	-0.02	0.01		0.01	997.75	1013.13	-0.27	-1.10
1985	-0.04	-0.03		-0.03	994.17	1012.94	0.58	-0.97
*1986	-0.14	0.03	-0.10	0.03	999.00	1013.21	-2.70	1.30
*1987	-0.08	-0.05	-0.04		1010.75	1014.68	-12.48	-16.20

APPENDIX N

PEARSON'S PRODUCT MOMENT CORRELATIONS

PEARSON'S PRODUCT MOMENT CORRELATIONS

N.B: AN "M" IS DISPLAYED WHEN A COEFFICIENT CANNOT BE COMPUTED

NO NAME REEF

	CA	SR	NA	MG	K	FE	SR+MG
CA	1.0000						
SR	-0.0910	1.0000					
NA	0.0640	0.3438#	1.0000				
MG	-0.0522	-0.1155	0.4553#	1.0000			
K	0.2477	0.0260	0.4697#	0.1862	1.0000		
FE	M	M	M	M	M	1.0000	
SRMG	-0.1086	0.8435#	0.5576#	0.4355#	0.1217	M	1.0000

CASES INCLUDED 95 MISSING CASES 1 # = 95% SL

GREEN ISLAND REEF

	CA	SR	NA	MG	K	FE	SR+MG
CA	1.0000						
SR	-0.1509	1.0000					
NA	-0.0740	0.0183	1.0000				
MG	-0.1672*	-0.2336#	0.0783	1.0000			
K	-0.0381	-0.2440#	0.2798#	0.8211#	1.0000		
FE	-0.1096	-0.2425#	-0.0709	0.8304#	0.8058#	1.0000	
SRMG	-0.2472#	0.3400#	0.0862	0.8350#	0.6561#	0.6661#	01.0000

CASES INCLUDED 112 MISSING CASES 0 # = 95% SL

UPOLU REEF

	CA	SR	NA	MG	K	FE	SR+MG
CA	1.0000						
SR	-0.1078	1.0000					
NA	-0.2214#	0.1361	1.0000				
MG	-0.0015	0.0853	0.0502	1.0000			
K	-0.2130#	0.3216#	0.5850#	0.0016	1.0000		
FE	-0.2563#	0.2984#	0.1436	0.1345	-0.0076	1.0000	
SRMG	-0.0932	0.8934#	0.1383	0.5237#	0.2743#	0.3168#	1.0000

CASES INCLUDED 161 MISSING CASES 0 # = 95% SL

PEARSON'S PRODUCT MOMENT CORRELATIONS

HASTINGS REEF

	CA	SR	NA	MG	K	FE	SRMG
CA	1.0000						
SR	-0.2667#	1.0000					
NA	0.0202	-0.0948	1.0000				
MG	0.1420	-0.4863#	0.3842#	1.0000			
K	-0.2401#	-0.0127	0.2715#	0.4387#	1.0000		
FE	0.1080	0.0597	0.0893	0.0970	0.0854	1.0000	
SRMG	-0.2114*	0.8207#	0.1428	0.1001	0.2724#	0.1321	1.0000

CASES INCLUDED 75 MISSING CASES 0 # = 95% SL * = 90% SL

BATT REEF

	CA	SR	NA	MG	K	FE	SRMG
CA	1.0000						
SR	0.3183#	1.0000					
NA	-0.1071	-0.0681	1.0000				
MG	-0.1517	-0.2380#	0.6471#	1.0000			
K	-0.1168	-0.0372	0.6930#	0.6237#	1.0000		
FE	-0.1699*	-0.1427	0.2142#	0.4094#	0.3934#	1.0000	
SRMG	0.2088#	0.8027#	0.3325#	0.3882#	0.3476#	0.1163	1.0000

CASES INCLUDED 169 MISSING CASES 5 # = 95% SL * = 90% SL

THETFORD REEF

	CA	SR	NA	MG	K	FE	SRMG
CA	1.0000						
SR	0.1088	1.0000					
NA	0.2244*	0.0783	1.0000				
MG	0.1673	-0.1088	0.6237#	1.0000			
K	0.1583	0.1481	0.3150#	0.4559#	1.0000		
FE	-0.0451	0.0276#	-0.0368	0.3813#	0.4834#	1.0000	
SRMG	0.1492	0.9704#	0.2299*	0.1346	0.2579#	0.1197	1.0000

CASES INCLUDED 58 MISSING CASES 0 # = 95% SL * = 90% SL

PEARSON'S PRODUCT MOMENT CORRELATIONS

BROOK REEF

	CA	SR	NA	MG	K	FE	SRMG
CA	1.0000						
SR	-0.0541	1.0000					
NA	-0.2682#	-0.1714*	1.0000				
MG	-0.2192#	-0.1786#	0.8136#	1.0000			
K	-0.2415#	-0.0929	0.8658#	0.6992#	1.0000		
FE	M	M	M	M	M	1.0000	
SRMG	-0.1216	0.9537#	0.0760	0.1256	0.1202	M	1.0000
CASES INCLUDED 135	MISSING CASES 0		# = 95% SL		* = 90% SL		

APPENDIX M

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS								
YEAR *DENOTES ENSO ACTIVITY	GREEN IS XRD ANOMALY	NO NAME REEF XRD ANOMALY	GREEN IS REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.04)	NO NAME REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.03)	DARWIN MSLP	TOWNSVILLE MSLP	SOUTHERN OSCILLATION INDEX (SOI)	SOI WINTER AVERAGE (JUNE,JULY, AUGUST)
1876	-0.01		+0.03					
*1877	0.01		+0.05					
*1878	-0.04							
1879	-0.03							
*1880	-0.06		-0.02					
1881	-0.07		-0.03					
1882	-0.03				994.08		-4.88	-18.53
1883	0.04		+0.08		992.92		-0.21	-1.87
*1884	-0.05				1001.92		-3.38	-0.03
*1885	-0.03				1008.83		-6.35	-8.83
1886	0.02		+0.06		991.58		7.25	7.97
*1887	0.02		+0.06		996.92		4.73	4.30
*1888	0.07		+0.11		1006.58		-10.50	-12.80
*1889	0.00		+0.04		997.50		2.17	7.37
1890	0.00		+0.04		991.50		5.60	-0.13
*1891	0.00		+0.04		1008.50		-2.52	-5.27
1892	0.00	-0.02	+0.04	-0.02	995.75		-0.21	9.73
1893	-0.03	-0.02		-0.02	996.08		-0.21	-0.02
1894	0.00	-0.10	+0.04		1006.83		-0.21	-0.02
1895	-0.04	-0.04			1002.33		-0.21	-0.02

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS								
YEAR *DENOTES ENSO ACTIVITY	GREEN IS XRD ANOMALY	NO NAME REEF XRD ANOMALY	GREEN IS REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.04)	NO NAME REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.03)	DARWIN MSLP	TOWNSVILLE MSLP	SOUTHERN OSCILLATION INDEX (SOI)	SOI WINTER AVERAGE (JUNE,JULY, AUGUST)
*1896	-0.04	-0.03		-0.03	1008.83		-9.19	-16.07
1897	-0.06	-0.06	-0.02		1004.42		-5.48	-0.57
1898	-0.04	-0.05			993.25		3.37	1.80
1899	0.00	-0.13	+0.04		1000.92		1.79	-8.07
1900	-0.04	-0.05			1002.42		-5.74	13.07
1901	-0.05	0.00		0.00	1001.08		0.23	13.23
*1902	-0.05	-0.05			1008.92		-0.03	-1.67
1903	-0.02	-0.09	+0.02		996.08		4.32	1.67
1904	0.04	-0.02	+0.08	-0.02	996.83		3.87	-4.73
*1905	-0.04	-0.01		-0.01	1008.42		-18.93	-18.30
1906	-0.05	0.01		0.01	994.83		-0.21	5.83
1907	-0.10	-0.02	-0.06	-0.02	995.67		-0.21	-0.02
1908	-0.10	-0.11	-0.06		996.33		5.48	-0.02
1909	-0.02	-0.05	+0.02		992.42		3.23	12.97
1910	-0.02	-0.10	+0.02		987.08		12.33	15.77
1911	-0.04	0.00			1001.42		-5.38	-11.40
1912	-0.04	-0.02827			1005.00		-8.33	-4.47
1913	-0.04	-0.11			1004.50		-6.12	-4.13
*1914	-0.12	-0.03	-0.08	-0.03	1012.58		-0.21	-0.02
1915	-0.01	-0.02	+0.03	-0.02	1000.33		-2.60	-0.02

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS								
YEAR *DENOTES ENSO ACTIVITY	GREEN IS XRD ANOMALY	NO NAME REEF XRD ANOMALY	GREEN IS REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.04)	NO NAME REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.03)	DARWIN MSLP	TOWNSVILLE MSLP	SOUTHERN OSCILLATION INDEX (SOI)	SOI WINTER AVERAGE (JUNE,JULY, AUGUST)
1916	-0.04	-0.03		-0.03	986.67		6.92	15.70
1917	-0.04	-0.02		-0.02	986.75		22.39	37.00
*1918	-0.04	-0.04			1001.67		0.79	-7.30
*1919	0.06	-0.05	+0.10		1004.92		-9.24	-8.10
1920	-0.08	0.05	-0.04	0.05	990.75		1.75	6.40
1921	-0.12	-0.01	-0.08	-0.01	993.25		-0.21	-0.02
1922	-0.04	0.02		0.02	992.58		3.95	1.93
*1923	-0.10	0.01	-0.06	0.01	997.33		-2.84	-9.27
1924	-0.12	0.05	-0.08	0.05	996.17		4.15	7.90
*1925	-0.03	-0.02		-0.02	995.50		-1.80	-9.10
*1926	-0.04	-0.04			1001.42		-13.35	-15.17
1927	-0.04	-0.02		-0.02	996.83		-0.21	-0.02
1928	-0.06	-0.01	-0.02	-0.01	998.33		4.32	0.53
*1929	-0.04	-0.02		-0.02	995.58		4.58	0.70
*1930	-0.11	-0.09	-0.07		1004.08		0.38	-3.63
1931	-0.04	-0.03		-0.03	1000.75		-0.21	12.20
*1932	0.00	-0.10	+0.04		999.00		-0.21	-0.02
1933	-0.12	-0.03	-0.08	-0.03	995.42		1.61	-0.27
1934	-0.09	-0.07	-0.05		998.00		0.11	-3.17
1935	-0.02	-0.04			998.17		1.57	-0.23

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS								
YEAR *DENOTES ENSO ACTIVITY	GREEN IS XRD ANOMALY	NO NAME REEF XRD ANOMALY	GREEN IS REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.04)	NO NAME REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.03)	DARWIN MSLP	TOWNSVILLE MSLP	SOUTHERN OSCILLATION INDEX (SOI)	SOI WINTER AVERAGE (JUNE,JULY, AUGUST)
1936	-0.07	-0.05	-0.03		996.83		0.47	-2.00
1937	0.00	-0.05	+0.04		996.67		1.00	0.17
1938	-0.04	-0.02		-0.02	991.75		8.58	14.97
*1939	0.06	-0.11	+0.10		997.50		0.33	1.87
*1940	0.01	-0.04	+0.05		1011.42		-13.58	-16.37
*1941	-0.14	-0.02	-0.10	-0.02	1011.83		-12.57	-16.80
1942	0.08	-0.03	+0.12	-0.03	999.42		1.13	3.20
*1943	-0.09	-0.02	-0.05	-0.02	994.00		4.05	0.97
*1944	0.00	0.00	+0.04	0.00	1002.42		-2.08	-2.97
1945	0.00	0.00	+0.04	0.00	997.67		4.17	7.07
*1946	-0.04	-0.01		-0.01	1003.17		-6.63	-7.47
1947	0.00	-0.06	+0.04		997.75		1.88	5.87
1948	-0.04	-0.02		-0.04	996.92		-1.49	-3.20
1949	-0.04	0.00		-0.04	996.67		-1.16	-5.50
1950	0.04	-0.10	+0.08		983.33		14.41	18.20
1951	0.00	-0.07	+0.04		998.92		-0.93	-1.40
1952	-0.08	-0.03	-0.04	-0.03	999.08	1013.07	-2.52	1.97
*1953	-0.04	-0.03		-0.03	1004.67	1014.15	-6.76	-6.50
*1954	0.08	-0.03	+0.12	-0.03	993.67	1013.40	3.71	4.07
*1955	-0.08	-0.06	-0.04		988.67	1012.02	10.04	15.33

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS								
YEAR *DENOTES ENSO ACTIVITY	GREEN IS XRD ANOMALY	NO NAME REEF XRD ANOMALY	GREEN IS REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.04)	NO NAME REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.03)	DARWIN MSLP	TOWNSVILLE MSLP	SOUTHERN OSCILLATION INDEX (SOI)	SOI WINTER AVERAGE (JUNE,JULY, AUGUST)
1956	-0.08	-0.12	-0.04		986.00	1010.40	10.07	10.90
*1957	-0.09	0.03	-0.05	0.03	1002.75	1012.96	-4.00	-3.47
1958	-0.16	0.02	-0.12	0.02	997.67	1012.52	-3.46	3.13
1959	-0.14	0.02	-0.10	0.02	997.17	1012.59	-0.28	-5.10
1960	-0.06	0.03	-0.02	0.03	994.67	1013.18	3.40	2.83
1961	-0.06	0.05	-0.02	0.05	1000.50	1013.13	0.71	-0.23
1962	-0.04	0.05		0.05	994.00	1012.45	5.08	2.67
1963	-0.14	-0.05	-0.10		1002.50	1013.00	-2.27	-3.97
1964	-0.04	-0.02		-0.02	993.58	1011.92	5.67	8.67
*1965	-0.06	0.02	-0.02	0.02	1005.92	1013.83	-8.22	-14.50
*1966	-0.01	0.00	+0.03	0.00	1003.08	1014.00	-4.28	1.10
1967	-0.06	0.00	-0.02	0.00	998.33	1012.64	2.83	4.13
1968	-0.02	-0.03	+0.02	-0.03	995.50	1013.26	2.67	5.83
1969	-0.06	0.02	-0.02	0.02	1001.08	1013.71	-5.51	-3.87
1970	-0.04	0.02		0.02	993.75	1012.85	3.60	2.23
1971	-0.14	0.00	-0.10	0.00	988.58	1011.56	10.21	5.80
*1972	-0.14	-0.06	-0.10		1005.58	1013.80	-7.28	-12.23
*1973	0.00	0.03	+0.04	0.03	989.08	1013.03	6.78	9.23
1974	-0.04	-0.04			988.33	1011.76	9.25	6.50
1975	-0.13	-0.05	-0.09		988.17	1012.30	12.78	17.53

PERIODS OF ENSO ACTIVITY WITH ANOMALOUS XRD RESULTS								
YEAR *DENOTES ENSO ACTIVITY	GREEN IS XRD ANOMALY	NO NAME REEF XRD ANOMALY	GREEN IS REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.04)	NO NAME REEF XRD ANOMALOUS VALUES 0.02° 2θ, OR GREATER, FROM THE MEAN (-0.03)	DARWIN MSLP	TOWNSVILLE MSLP	SOUTHERN OSCILLATION INDEX (SOI)	SOI WINTER AVERAGE (JUNE,JULY, AUGUST)
*1976	-0.02	-0.06			996.58	1011.89	0.85	-7.87
*1977	0.08	-0.03	+0.12	-0.03	1003.75	1013.10	-9.59	-13.67
1978	0.06	0.01	+0.10	0.01	999.67	1013.05	-1.94	3.93
1979	0.01	0.01	+0.05	0.01	1002.17	1014.01	-2.04	-2.60
1980	0.11	-0.03	+0.15	-0.03	999.50	1013.85	-3.03	-1.57
1981	0.00	-0.06	+0.04		996.17	1013.16	1.53	8.00
*1982	-0.04	-0.05			1011.00	1014.32	-12.85	-19.47
*1983	-0.09	-0.06	-0.05		1012.17	1014.28	-8.06	-3.33
1984	-0.02	0.01		0.01	997.75	1013.13	-0.27	-1.10
1985	-0.04	-0.03		-0.03	994.17	1012.94	0.58	-0.97
*1986	-0.14	0.03	-0.10	0.03	999.00	1013.21	-2.70	1.30
*1987	-0.08	-0.05	-0.04		1010.75	1014.68	-12.48	-16.20

APPENDIX N

PEARSON'S PRODUCT MOMENT CORRELATIONS

PEARSON'S PRODUCT MOMENT CORRELATIONS

N.B: AN "M" IS DISPLAYED WHEN A COEFFICIENT CANNOT BE COMPUTED

NO NAME REEF

	CA	SR	NA	MG	K	FE	SR+MG
CA	1.0000						
SR	-0.0910	1.0000					
NA	0.0640	0.3438#	1.0000				
MG	-0.0522	-0.1155	0.4553#	1.0000			
K	0.2477	0.0260	0.4697#	0.1862	1.0000		
FE	M	M	M	M	M	1.0000	
SRMG	-0.1086	0.8435#	0.5576#	0.4355#	0.1217	M	1.0000
CASES INCLUDED 95		MISSING CASES 1		# = 95% SL			

GREEN ISLAND REEF

	CA	SR	NA	MG	K	FE	SR+MG
CA	1.0000						
SR	-0.1509	1.0000					
NA	-0.0740	0.0183	1.0000				
MG	-0.1672*	-0.2336#	0.0783	1.0000			
K	-0.0381	-0.2440#	0.2798#	0.8211#	1.0000		
FE	-0.1096	-0.2425#	-0.0709	0.8304#	0.8058#	1.0000	
SRMG	-0.2472#	0.3400#	0.0862	0.8350#	0.6561#	0.6661#	01.0000
CASES INCLUDED 112		MISSING CASES 0		# = 95% SL			

UPOLU REEF

	CA	SR	NA	MG	K	FE	SR+MG
CA	1.0000						
SR	-0.1078	1.0000					
NA	-0.2214#	0.1361	1.0000				
MG	-0.0015	0.0853	0.0502	1.0000			
K	-0.2130#	0.3216#	0.5850#	0.0016	1.0000		
FE	-0.2563#	0.2984#	0.1436	0.1345	-0.0076	1.0000	
SRMG	-0.0932	0.8934#	0.1383	0.5237#	0.2743#	0.3168#	1.0000
CASES INCLUDED 161		MISSING CASES 0		# = 95% SL			

PEARSON'S PRODUCT MOMENT CORRELATIONS

HASTINGS REEF

	CA	SR	NA	MG	K	FE	SRMG
CA	1.0000						
SR	-0.2667#	1.0000					
NA	0.0202	-0.0948	1.0000				
MG	0.1420	-0.4863#	0.3842#	1.0000			
K	-0.2401#	-0.0127	0.2715#	0.4387#	1.0000		
FE	0.1080	0.0597	0.0893	0.0970	0.0854	1.0000	
SRMG	-0.2114*	0.8207#	0.1428	0.1001	0.2724#	0.1321	1.0000
CASES INCLUDED 75	MISSING CASES 0		# = 95% SL		* = 90% SL		

BATT REEF

	CA	SR	NA	MG	K	FE	SRMG
CA	1.0000						
SR	0.3183#	1.0000					
NA	-0.1071	-0.0681	1.0000				
MG	-0.1517	-0.2380#	0.6471#	1.0000			
K	-0.1168	-0.0372	0.6930#	0.6237#	1.0000		
FE	-0.1699*	-0.1427	0.2142#	0.4094#	0.3934#	1.0000	
SRMG	0.2088#	0.8027#	0.3325#	0.3882#	0.3476#	0.1163	1.0000
CASES INCLUDED 169	MISSING CASES 5		# = 95% SL		* = 90% SL		

THETFORD REEF

	CA	SR	NA	MG	K	FE	SRMG
CA	1.0000						
SR	0.1088	1.0000					
NA	0.2244*	0.0783	1.0000				
MG	0.1673	-0.1088	0.6237#	1.0000			
K	0.1583	0.1481	0.3150#	0.4559#	1.0000		
FE	-0.0451	0.0276#	-0.0368	0.3813#	0.4834#	1.0000	
SRMG	0.1492	0.9704#	0.2299*	0.1346	0.2579#	0.1197	1.0000
CASES INCLUDED 58	MISSING CASES 0		# = 95% SL		* = 90% SL		

PEARSON'S PRODUCT MOMENT CORRELATIONS

BROOK REEF

.	CA	SR	NA	MG	K	FE	SRMG
CA	1.0000						
SR	-0.0541	1.0000					
NA	-0.2682#	-0.1714*	1.0000				
MG	-0.2192#	-0.1786#	0.8136#	1.0000			
K	-0.2415#	-0.0929	0.8658#	0.6992#	1.0000		
FE	M	M	M	M	M	1.0000	
SRMG	-0.1216	0.9537#	0.0760	0.1256	0.1202	M	1.0000
CASES INCLUDED 135	MISSING CASES 0		# = 95% SL		* = 90% SL		