WHAT ARE THE MAJOR COASTLINE FEATURES AND WAVE CHARACTERISTICS WHICH INDICATE THAT MARINE EROSION IS ACTIVE ON THE EASTERN SIDE OF THE ENTRANCE TO DISCOVERY BAY HARBOUR IN JAMAICA?

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YEAR OF EXAMINATIONS:	2008
TERRITORY	JAMAICA

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PURPOSE

The main purpose of this study was to determine if erosion by waves is active on the coastline east of the entrance to the bay known as Discovery Bay, in St. Ann, Jamaica, by identifying erosional features on the coastline and destructive wave characteristics These features and patterns were used to determine the extent to which erosion is active on that coast. The aims were therefore to:

1. examine the man-made structures that have been affected by wave activity;
2. look at the natural features produced by wave activity;
3. study the main wave characteristics which influence the occurrence of erosion in the area.

FORM GEOG - 5

CARIBBEAN EXAMINATIONS COUNCIL

SECONDARY EDUCATION CERTIFICATE

SCHOOL-BASED ASSESSMENT

GEOGRAPHY FIELD STUDY

STRATEGY SHEET

To be completed by March 15 of the year of the examination. Insert at cover of field study report.

Make a duplicate copy of this sheet. Your teacher will return a copy to you.

CANDIDATE'S NAME: JEFFREY JOHNSON **REGISTRATION NUMBER:** 100131**1148**

GENERAL TOPIC OF INTEREST: MARINE EROSION

POSSIBLE QUESTION TO BE INVESTIGATED: WHAT COASTAL FEATURES AND WAVE PATTERNS PROVE THAT EROSION IS AN ONGOING PROCESS ON THE EASTERN SIDE OF THE ENTRANCE TO DISCOVERY BAY HARBOUR?

STRATEGY

(A) What is the purpose of your Study?

- *TO FIND WHICH MAN-MADE STRUCTURES ARE AFFECTED BY COASTAL EROSION AT THE STUDY SITE;*
- *TO IDENTIFY NATURAL FEATURES WHICH INDICATE ONGOING EROSION;*
- *TO SEE HOW WAVE PATTERN AFFECT EROSION AT THE SITE.*

(B) How will you obtain data?

Observation checklists, Interviews, Examination of Maps, Checking in Textbooks or on internet.

(C) How do you intend to present the data and findings in your report?

Photographs, Graphs, Charts, Drawings/Diagrams, Tables, Flow Charts, Written Text/ written Presentation

LOCATION OF THE STUDY AREA: At Fort Point, Discovery Bay, St. Ann, Jamaica

EQUIPMENT/RESOURCES REQUIRED: Measuring Instrument, Camera, Video Camera, Voice Recorder, Stop watch

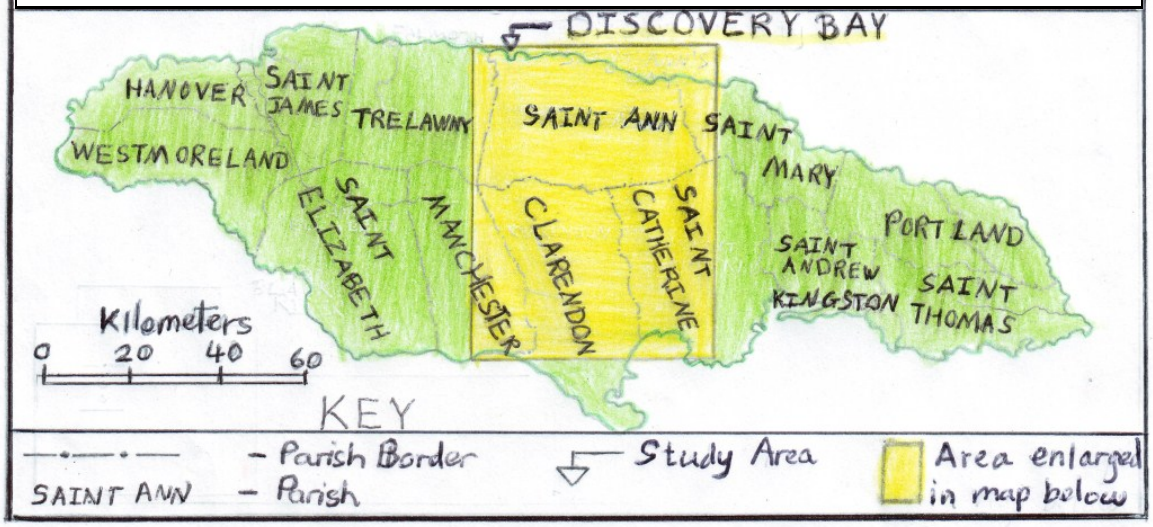
ANTICIPATED CHALLENGES: Wet Weather; Difficulty Finding Persons for Interview; Restricted access to Private Property, No Observation can be made from seaward side; difficulty estimating heights and lengths out at sea

NAME OF TEACHER: DONAVAN H. JOHNSON

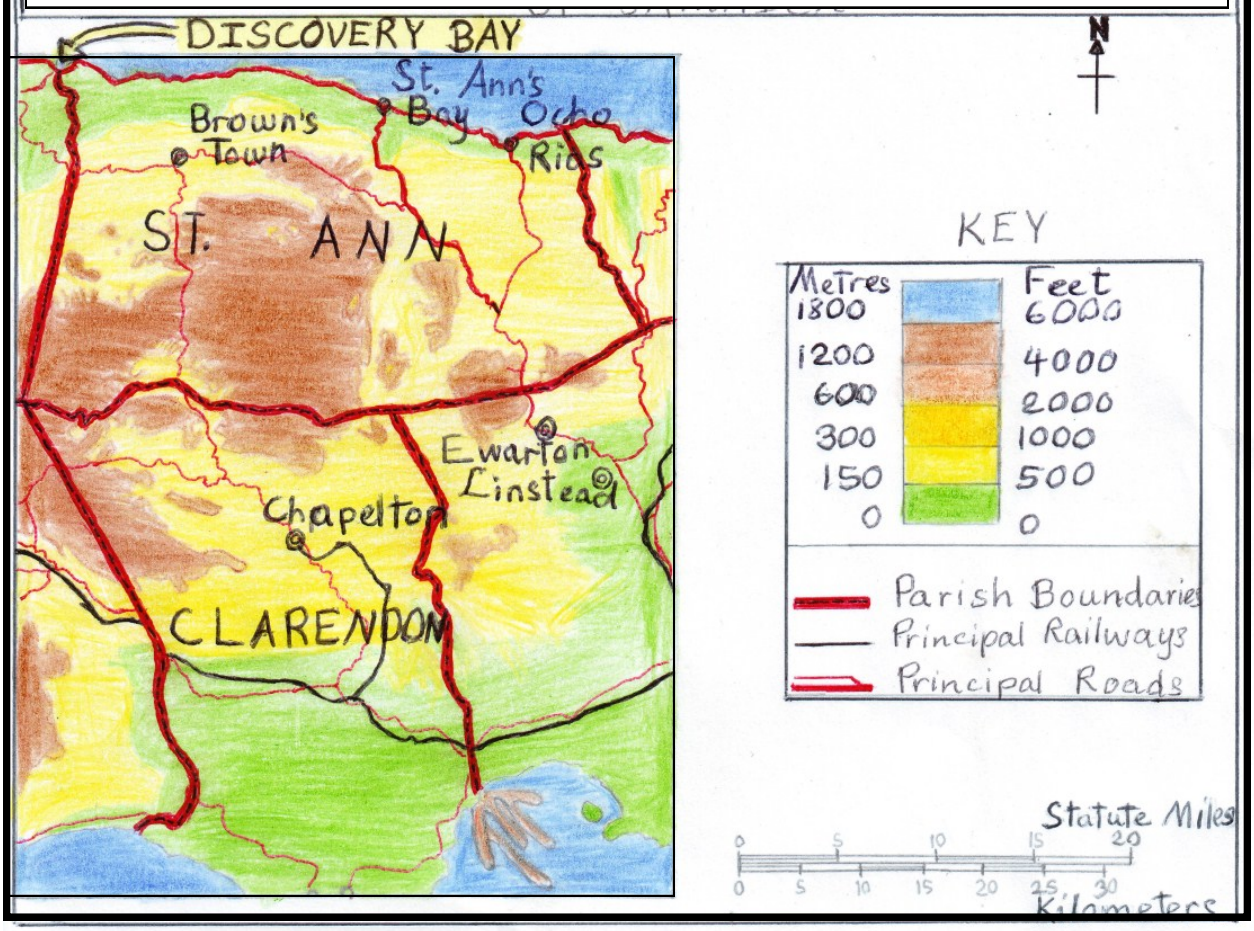
SIGNATURE OF TEACHER : _____ **DATE:** MARCH 21, 2008

Revised 2006-06-23

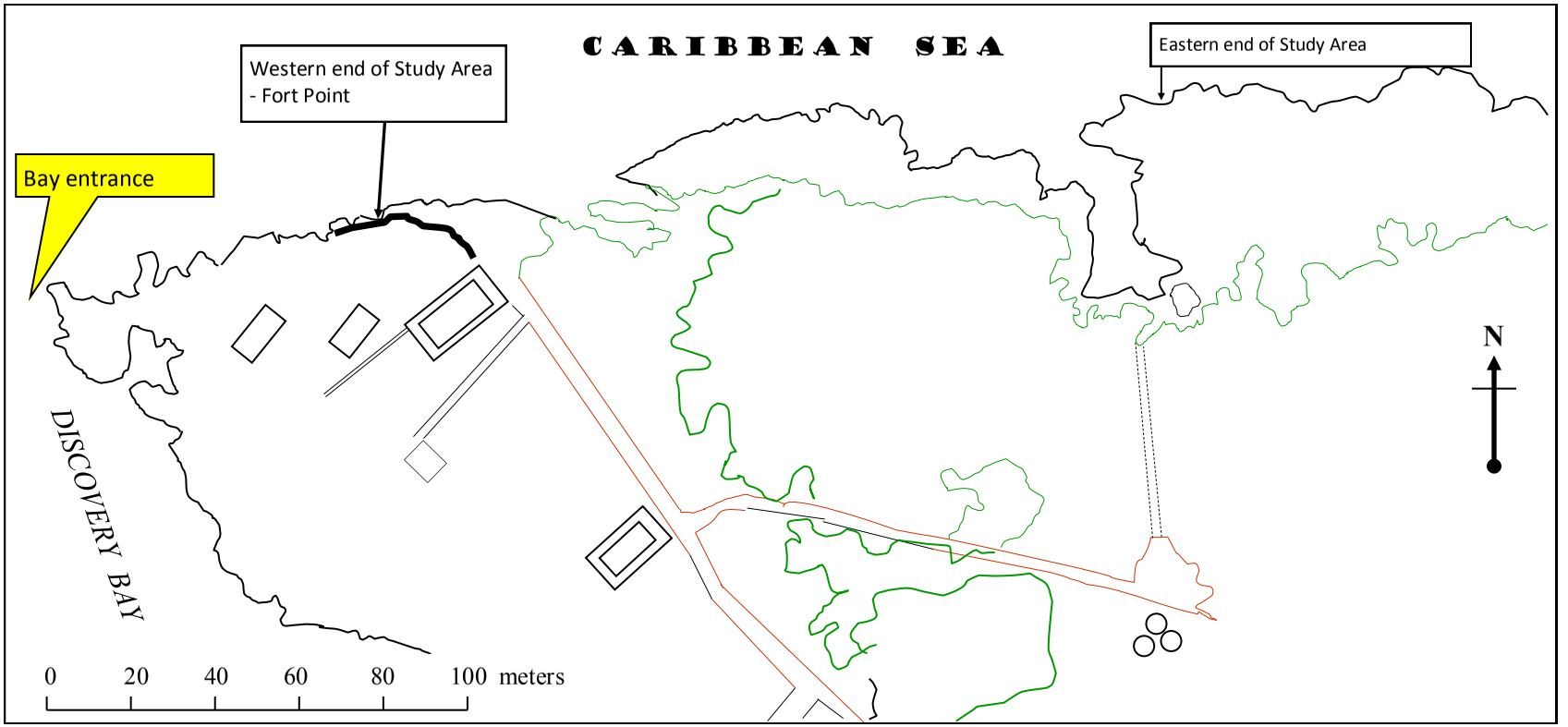
MAP OF JAMAICA SHOWING THE POSITION OF THE STUDY AREA



MAP SHOWING THE LOCATION OF DISCOVERY BAY IN RELATION TO A NORTH-SOUTH VIEW OF THE MID-SECTION OF JAMAICA



MAP SHOWING THE SITE OF THE STUDY AREA



KEY

Tennis Court	Wooded area	Cut-stone wall
Building	Waste Tanks	Footpath Track
Lawn	Road	Coastal Rock

METHODS OF DATA COLLECTION

Discovery Bay is located along the north coast of Jamaica, roughly halfway point between the two ends of the island. The study was based on the section of coastline which lies on the eastern side of the entrance to Discovery Bay harbour. The study started at the north-eastern edge of the cut-stone wall around the old fort at Fort Point and ended where a large cove has developed about 300 meters east of the starting point.

The main visit to the site was on January 31, 2008. However, personal visits were made on December 23, 2007 and again on February 9 and 16, 2008.

At the site, data was collected with the use of the following items or methods:

1. An Observation Checklist
2. An unstructured informal Interview, one in which the man interviewed spoke freely in response to questions that were made up on the spot.
3. A map of Discovery Bat on a scale of 1:50,000
4. Images of the area that were cropped from Google Earth satellite photographs; these images assisted the class in sketching the site.
5. Measurements were taken.

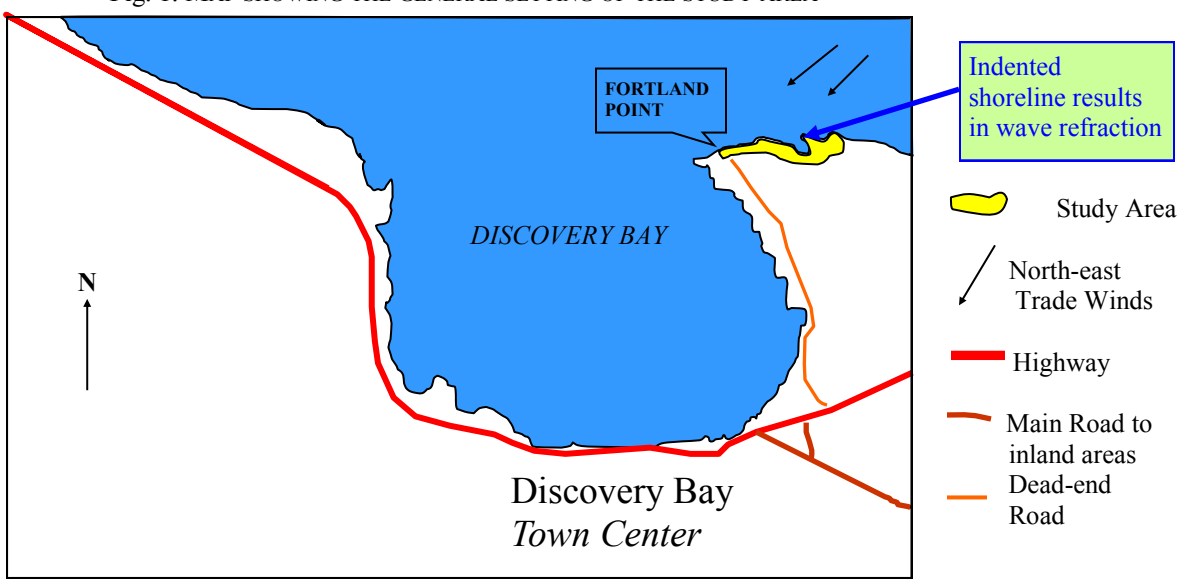
General information was obtained from textbooks, the internet and from atlases. The teacher also gave information during teaching sessions and SBA meetings.

A copy of the Observation Checklist is included in the Appendix.

PRESENTATION OF DATA

The target area of this study was the triangular headland on the north-eastern section of a bay named *Discovery Bay*. (At the head of this bay lies the town of the same name.) This headland forms the eastern side of the entrance to *Discovery Bay*. The section of the headland which faces the open sea runs due east from a point called Fort Point or Fortlands, to join a straighter piece of coastline called The Bull. Figure 1 shows the general features of the study area.

Fig. 1. MAP SHOWING THE GENERAL SETTING OF THE STUDY AREA



In order to find out the degree of erosional activity at the study area, three activities were carried out**:**

1. Checks were made to find out how man-made structures have been affected by wave action.
2. Waves were examined for those characteristics which would make them highly erosive, including refraction pattern, frequency and height;
3. Observations were done to identify the active erosional processes and the effect of these processes on the existing erosional features.

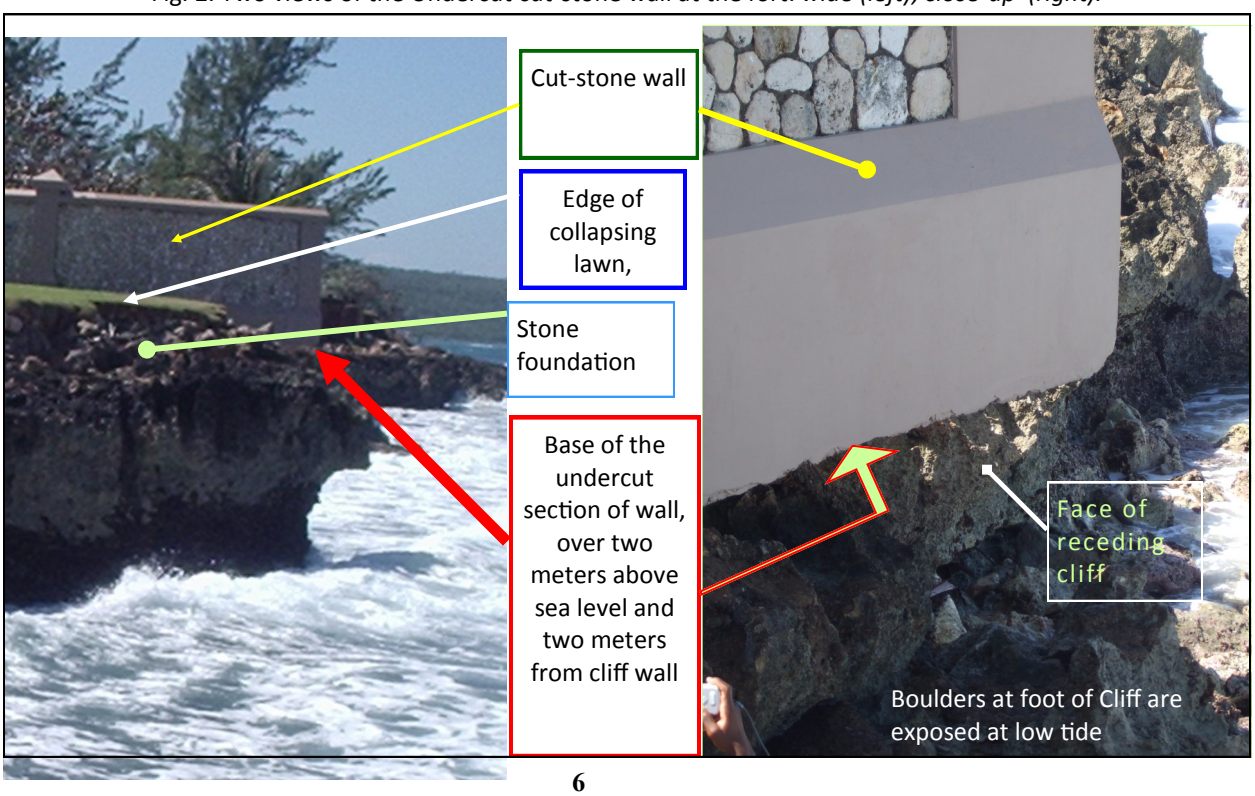
.EFFECT OF WAVE ACTION ON MAN-MADE STRUCTURES

One indication of on-going erosion is the removal of man-made structures on the coastline. When the study area was surveyed, three man-made structures were present:

- ◊ a **cut-stone wall** around the old fort;
- ◊ a **pile of boulders** which was used as a revetment to slow down cliff recession at a point where the sea had cut in landward to a great extent;
- ◊ a **lawn,** which sits on a foundation of loose stones as well as on the revetment.

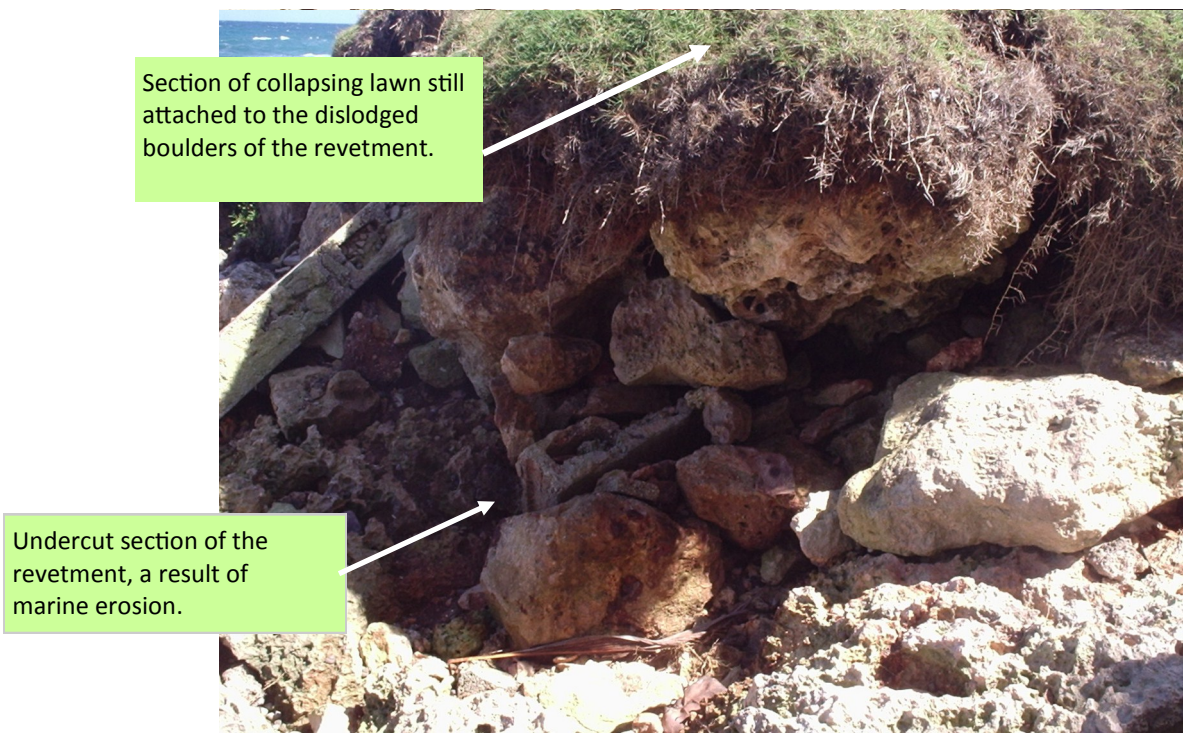
EROSION OF THE CUT-STONE WALL: The cut-stone wall built around the fort has been undercut at its north-eastern corner for more than two meters, by breaking waves. This undercut section of the wall forms an overhang, under which are boulders on the sea bad. The sharp edges of the boulders indicate that any collapse is fairly recent, as attrition has not yet rounded the edges of the rock **Figure 2** shows the effect of erosion on the wall.

Fig. 2. Two views of the Undercut cut-stone wall at the fort: *wide (left); close-up (right).*



COLLAPSE OF THE REVETMENT AND LAWN: At the site we first noticed that a lawn which grew right up to the edge of the cliff had long cracks running parallel to the shore. A closer look showed that the lawn was planted on a foundation of packed boulders which were being undercut and scattered by the waves. From a discussion with a foreigner who has a summer home nearby, it was learnt that Hurricane Allen in 1979 and Hurricane Gilbert in 1988 did a lot of damage to the area, including the erosion of the revetment and lawn. The lawn has been breaking away, slipping into the sea with the moving rocks. **Figure 3** shows the appearance of the collapsing lawn and revetment. The picture was taken from a ledge just above the high tide mark.

Fig. 3: Photograph of section of break-away lawn and revetment.



NATURAL COASTAL FEATURES AS EVIDENCE OF MARINE EROSION

An observation checklist was used to identify erosional features on the coast in the study area. (See Appendix). The Table in Figure 4 shows the main features that were identified:

Fig. 4

EROSIONAL FEATURE	DESCRIPTION	OTHER FEATURES	EXPLANATION
Cliffs	Heights vary from less than a meter to over two meters; they get lower in an easterly direction.	-Undercutting occurs at the area between the high and low tide marks	Erosion is greatest when waves break at the foot of a cliff
		-Some of the overhangs have collapsed recently, a conclusion based on the clean rock face at point of breakaway and the sharp angular edges on the fallen fragments.	As the notch increases inwards the weight of the cliffs above become too much and the cliff collapses.
Coves	-Narrow opening, less than 6 meters	Waves continue to undercut both sides of entrance to the two largest coves	Resistant rock at cove entrances creates refraction
	Longest branch has cut over 40 meters inland	Many branches develop where resistant rocks alternate with eroded channels.	The softer rocks are being eroded at a rapid rate, mainly along the original joints
Wave-cut Platform	Seaward length is over 15 meters before it begins to slope downwards	Visible when the waves are retreating (as a backwash).	Wave-cut platforms are produced as the cliffs recede or are eroded landwards. These platforms are an indication of the degree of erosion: the longer the platform, the greater the erosion
Blow Holes	Several exist but only two are open to the surface	Loud sound like that of a bull are heard when the water forced into the narrow passage; water caused platform to vibrate.	Formed by hydraulic action along vertical joints. The compression of air in the joints forces water through on the landward side

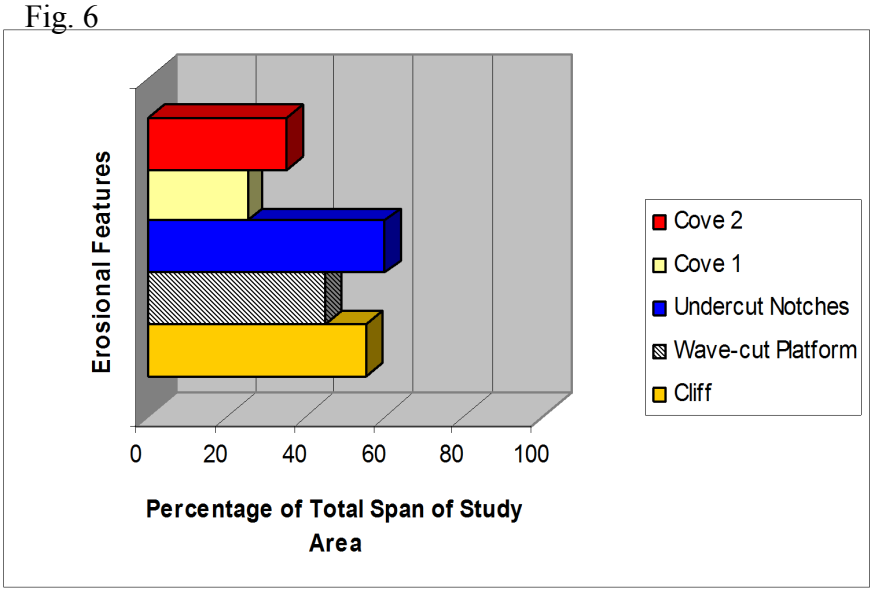
The various erosional features were observed and marked on a satellite photograph of the study area. Figure 5 shows the results, including the main position of each feature. It appears that undercut notches occurs over the greatest proportion of the area, including within the coves and at the foot of the cliffs. The wave-cut platform stretches for the entire length of the coastline.

FIG. 5. POSITIONS AND VARIETIES OF EROSIONAL FEATURES FOUND AT THE STUDY AREA

LINE COLOUR	FEATURE REPRESENTED	LINE COLOUR	FEATURE REPRESENTED
	Wave-cut platform		Cliff
	Undercut notches		Cove # 2
	Cove # 1		

The chart in Figure 6 below shows the lengths of the erosional features compared to each other.

Fig. 6



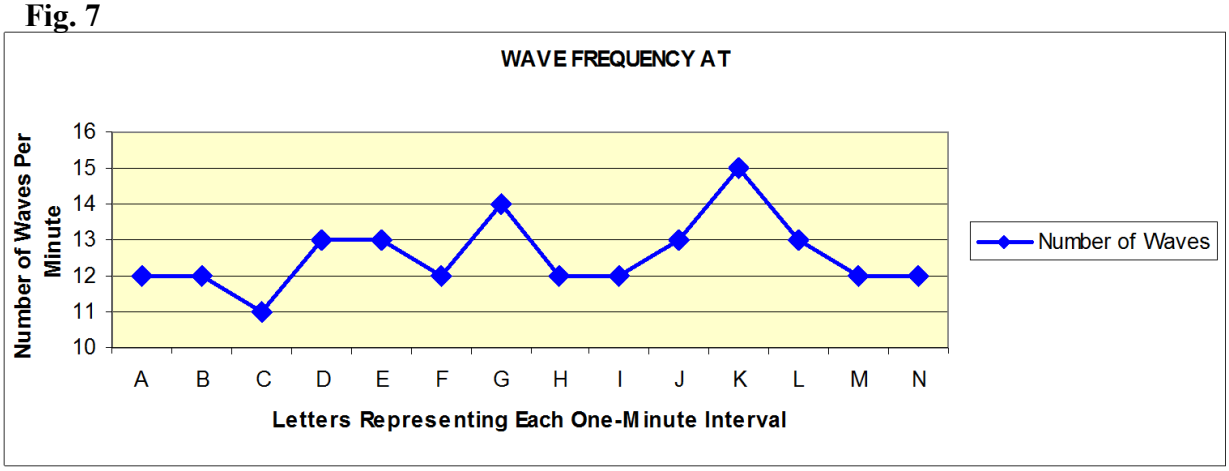
The figures were worked out using data on Figure 5. The entire area is affected by erosion, as the data shows in both Figures 5 and 6.

RELATIONSHIP BETWEEN WAVES PATTERN AND EROSION

The headland is directly exposed to the north-east Trade Winds, as shown in Figure 1 on page 5, so it gets the full strength of the waves generated by these winds. Two characteristics of the waves were examined, these being the frequency and the refraction patterns.

HIGH WAVE FREQUENCY PROMOTES EROSION: The waves seen were very powerful. The line graph below (Fig 7) shows the wave frequency, based on a series of observations (fourteen). Each observation was timed with a stopwatch for a one-minute interval, followed by a break of two to four minutes, between 12 p.m. and 1: 15 p.m. on January 31, 2008. The spot selected for the count and timing was where the waves made first contact

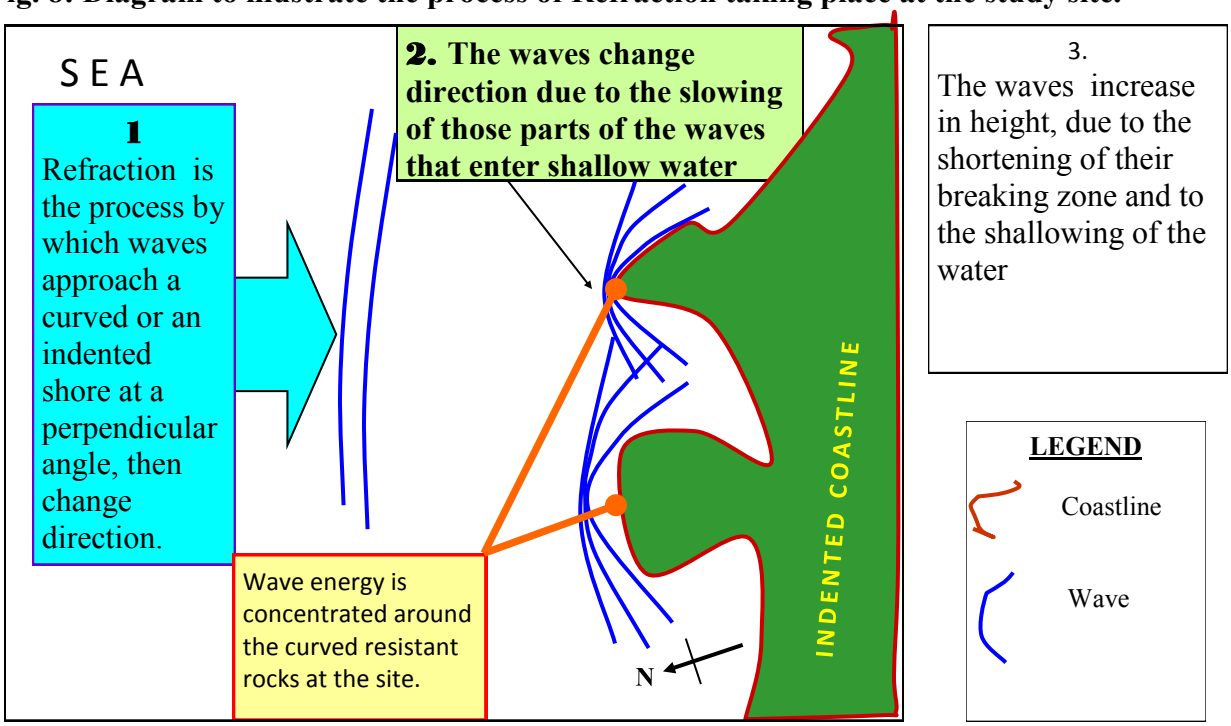
Fig. 7



The frequency graph in Figure 7 shows that the average number of waves was 12-13 per minute. Waves at such a high frequency pound the coast and erode the coastal rocks through processes such as hydraulic action and corrosion.

WAVE REFRACTION INFLUENCES EROSION: . The waves at the site developed their high energy through a process called refraction. The waves had crests which reached over one-and-a-half meters in height. Figure 8 (on the following page) explains the relationship between wave energy and the process of refraction.

Fig. 8: Diagram to illustrate the process of Refraction taking place at the study site.



UNDERCUTTING: One result of refraction has been the undercutting of the resistant rocks which jut out into the sea. These resistant rocks are the remains of large platforms which have now been divided into channels by erosion. These rocks run length-wise in an east-west direction, almost parallel to the original shoreline. The powerful waves continue to attack lines of weakness on these tough rocks, through the process of hydraulic action. Figure 9 is a photograph of a section of resistant rock, which has developed a deep undercut notch between the high and low tide levels.

Fig. 9

CONCLUSION

The findings from the field study showed that marine erosion is a very active process on the eastern headland at the entrance to Discovery Bay harbour. The effects of marine erosion can be seen on both man-made structures and natural features. The damage to the wall and revetment is fairly recent, showing that the erosion of the section of coast is a continuous process and not just a past action by the sea. The collapsed revetment has taken the topsoil and lawn down with it.

There was a variety of erosional features in the study area. The main features were cliffs, undercut notches, elongated coves, wave-cut platforms and blowholes. The cliffs showed signs of recession or retreat. The evidence that cliff recession was occurring included the deep undercut notches, the wide wave-cut platform, the collapsing wall and heaps of boulders resulting from the collapse of overhangs. The sharp edges of the boulders at certain points could be taken as a sign that overhangs have fallen off recently. The rocks were supposed to have smoother edges if the breakaway was older.

The waves that were observed were very powerful, with wave frequency averaging 12 to 13 per minute on the day of the observation. We could certainly conclude that this was the everyday pattern of the waves. The wave crests followed close to each other, and rose to over one meter.

The wide variety of features and the characteristics of the waves were more than enough to convince one that erosion is the active marine process at Fort Point. The long term effect of erosion includes the destruction of man-made structures, as well as the straightening of that stretch of coast as the resistant rocks are removed.

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Maps: **Jamaica 1:50000 (metric edition), Sheet 4, DOS 1991**

Shell Jamaica Road Map, 1:250,000,

Atlas: **Longman Atlas for Caribbean Examination Essex, Longman Group UK Ltd 1991.**

OBSERVATION GUIDE

FOR FIELD TRIP TO FORT POINT, DISCOVERY BAY. Jan 31,2008

	FEATURE OR PATTERN TO BE IDENTIFIED OR EXAMINED		DETAILS
1	How high is the top of the land's edge above the sea level? **Minimum:**		
2	Is a wave-cut platform	(a) present?	
		(b) visible?	
3	Undercut Notches	(a) present?	
		(b) visible ?	
		(c) inner depth	
		(d) location	
4	Are arches present?		
5	Blowholes	Number seen:	
		Diameter (meters)	
		Distance from Water's edge	
6	Stacks	Number seen:	
		Dimensions- (meters): Longest:	
		Widest:	
		Lowest:	
		Highest:	
7	Coves:	Dimensions Number seen:	
		Longest:	
		Widest:	
8	Caves	Number seen:	
		Dimensions- Longest: Widest: (meters)	
		Location:	

9	Enlarged Vertical Joints	Farthest Length Inland	
		Width (range):	
10	Enlarged Horizontal Bedding or Joints	Length:	
		Width:	
11	Estimated Heights of waves (Meters)	Maximum: Minimum:	
12	What direction are the waves coming from?		
13	What directions do waves turn in when they hit the outlying rocks?		
14	What non-erosional marine features are present?		

WAVE FREQUENCY OBSERVATIONS

	MINUTE LABEL	TIMED FROM	TIMED TO	**NUMBER OF WAVES**
	A			
	B			
	C			
	D			
	E			
	F			
	G			
	H			
	I			
	J			
	K			
	L			
	M			
	N			