STS-8

EARTH OBSERVATIONS PRE-FLIGHT MANUAL
(OCEANOGRAPHY AND GEOLOGY SITES)

PREPARED FOR

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PREFACE

The purpose of this Earth Observations Pre-Flight Manual is to assist the Space Shuttle Crew in becoming familiar with primary viewing earth sites which have been selected by earth scientists. For each selected site, this document presents a brief description, accompanying photographs and maps, and comments on how to observe and photograph the site.

This document was prepared by Lockheed Engineering and Management Services Company, Inc., in Houston, Texas, under contract NAS 9-15800 for the Earth Science and Applications Division of the Space and Life Sciences Directorate at the Lyndon B. Johnson Space Center. It was compiled by C. L. Dailey and W. J. Daley of the Renewable Resources Department. Descriptions of the sites were provided by Mr. John L. Kaltenbach, Space Shuttle Earth Observations Project Manager, NASA/JSC; Dr. Robert E. Stevenson, Oceanographer, Office of Naval Research, LaJolla, California; Mr. Paul D. Scully-Power, Oceanographer, Naval Underwater System Center, New London, Connecticut; Dr. William R. Muehlberger, Geologist, University of Texas, Austin, Texas, and Dr. Charles A. Wood, Volcanologist, Planetary and Earth Sciences Division, NASA/JSC.

STS-8 EARTH OBSERVATIONS PRIMARY VIEWING SITES

Site No.	Atlas Page No.	Lat/Lon.	Location	Feature(s) Of Interest
1A*	37	27°30'S, 6°E	Atlantic Ocean	Oceanography-Seamount (submerged mountain), waves, eddies
1B	36,37	22°30'S, 7°E	Atlantic Ocean	Ocenaography-Sun glitter feature
1C	15	4°10'N, 9°10'E	Cameroon, Africa	Geology-Mt. Cameroon Volcano active volcano, lava flows
1D	15	6°30'N, 11°30'E	Cameroon, Africa	Geology-Shebshi/Gotel Mountains
2A*	37,38	25°S, 29°E	South Africa	Geology-Vredefort-Bushveld structures, meteorite impact craters
2B	39	26°30'S, 31°30'E	South Africa	Geology-Swaziland
3A*	37	1°30'S, 29°15'E	East Africa	Geology-Virunga Volcanoes, active volcanoes, rift features, lakes
3B	16,37,38	3°N, 31°E to 5°S, 29°E to 16°S, 35°E	Africa-Western Rift Valley	Geology-Tectonic features, volcanoes, lakes
3C	16,38	1°N, 36°30'E	Africa-Eastern Rift Valley	Geology-Tectonic features, volcanoes, lakes
4A*	37,38	18°45S, 30°20'E	Africa-Zimbabwe	Geology-Great Dike of Zimbabwe, intrusive igneous rocks
4B	38	28°S, 35°E	Indian Ocean	Oceanography-Agulhas current, ocean current boundary
5*	38	12°15'S, 44°30'E	Comoro Islands	Geology-active shield volcanoes
6A*	39	21°S, 55°30'E	Reunion/Mauritius Islands	Geology-active shield volcanoes
6B	39	22°30'S, 50°E	Indian Ocean	Oceanography-Sun glitter feature
7A	25	7°30'S, 108°E	Indonesia	Geology-Java, volcanoes
7B	27	22°30'S, 110°E	Indian Ocean	Oceanography-Sun glitter feature
8A*	27	Approx. 22°45'S 117°30'E	Western Australia	Geology-Hamersley Range, Precambrian rock formations
8B	27	Approx. 17°S, 130°E	Northwestern Australia	Geology-Fitzroy River, Kimberley Plateau, faults
8C	25,26	2°S, 120°E	Indonesia	Geology-Celebes, major collision zone.

STS-8 EARTH OBSERVATIONS PRIMARY VIEWING SITES

Site No.	Atlas Page No.	Lat/Lon.	Location	Feature(s) Of Interest
9A*	27	23°49'S, 132°18'E	Australia-Gosses Bluff	Geology-meteorite impact crater
9B*	27	24°S, 132°E	Australia-MacDonnell Ranges	Geology-Complex folded mountains
10A*	27	15°12'S, 133°35'E	Northwestern Australia	Geology-Strangways Crater, Meteorite impact crater
10B	26	3°S,140°E to 6°S, 147°E	Papua New Guinea	Geology-Central Mountain Ranges (ocean crust)
11A*	28	17°S, 146°15'E	Australia-Great Barrier Reef	Geology/Oceanography/ Hydrology
11B	28,29	22°30'S, 165°E	Pacific Ocean	Oceanography-Sun glitter featur
11C	29,30	22°30'S, 175°W	Pacific Ocean	Oceanography-Sun glitter featur
11D	30	22°30'S, 157°30'W	Pacific Ocean	Oceanography-Sun glitter featur
12*	31	17°30'S, 149°50'W	Society Islands	Oceanography/Hydrology/ Cartography
13*	32	24°21'S, 128°12'W	Henderson Island	Special mapping site--proposed potential emergency landing sit for future Shuttle missions
14A*	12	0°, 91°W	Galapagos Islands	Geology-active volcanoes, volcanic deposits
14B	13,33	Approx. 3°N, 76°W	Northern Andes Mountains, South America	Geology-Plate tectonics, faults, fractures, volcanoes
14C	33	Approx. 8°30'S, 76°30'W	Northern Andes Mountains, South America	Geology-Plate tectonics, faults, fractures, volcanoes
15A*	33	26°30'S, 80°W	Isla San Felix	Oceanography-island wakes, internal waves, sea mount, small island
15B	33	22°30'S, 75°W	Eastern Pacific Ocean	Oceanography-Sun glitter featur
15C	33	Approx. 26°S, 66°30'W	Argentina-Chile	Geology - Pampean Mountain Ranges, mountain building processes.
16A*	33	Approx. 3°S, 70°W	Brazil	Geology-Upper Amazon Basin, Hydrology-Rio Jurua
16B	13,33	Approx. 1°N, 62°W	Brazil	Geology - Upper Amazon Basin Hydrology - Rio Branco

STS-8 EARTH OBSERVATIONS PRIMARY VIEWING SITES

Site No.	Atlas Page No.	Lat/Lon.	Location	Feature(s) Of Interest
17*	34	16°45'S, 52°59'W	Brazil	Geology - Araguainha Dome, meteorite impact crater
18*	34	8°05'S, 46°52'W	Brazil	Geology - Canghala Crater, meteorite impact crater

*HP Sites

SPECIFIC OCEANOGRAPHY SITES

Atlas Page	Site No.
37	1A

Site: Atlantic-Ridge Seamount (27°30'S, 6°E center point and HP coordinate)

Significance: Submerged features on the sea floor from depths of 20 meters (65.6 ft.) to 3,000 meters (9,842.5 ft.) have produced textural changes at the sea surface that have been imaged by space-borne synthetic aperture radar. Soviet cosmonauts claim to have visually observed such sea-surface textures. They call it "super-transparency." Verification is needed.

Physical Characteristics: This unnamed seamount has a peak approximately 1,000 meters (3,280.8 ft.) below the sea surface. It is on the edge of the Benguela Current that flows northward. The waves over this feature may be modified causing a locally smoother sea surface. Internal waves may also be present.

Observation Technique: Look for subtle changes in the sea surface texture. These changes may be enhanced at the edge of the sun's glitter pattern or by using polarizing dark glasses (if available). Vertical photographs using a 100mm lens should be taken.

Atlas Page	Site No.
38	4B

Site: Agulhas Current (center point 28°S, 35°E)

Significance: Agulhas is the major poleward-flowing current in the Indian Ocean. Sixty percent of the supertankers moving in and out of the Persian Gulf travel this route.

Physical Characteristics: The southerly following current should have a bright, light blue color in contrast to the greenish blue near-shore waters and the deep blue east of 37°-39°E longitude. Depending on the wind, white caps should be visible either in or out of the current.

A distinct color change occurs from the African coast, directly east of Swaziland, across the current into the Indian Ocean.

Observation Techniques: Both vertical and low oblique photographs are useful. Stereo pairs should be taken with the aiming track no more than 15° from nadir. Use a 100 mm lens for all photographs. A high sun elevation would offer the best viewing conditions.

Atlas Page	Site No.
31	12

Site: Society Islands - Tahiti, Moorea (16°S, 155°W to 16°S, 148°W to 18°S, 148°W to 18°S, 155°W. HP coordinate 17°30'S, 149°50'W)

Significance: This series of old volcanic islands is located in the nearly motionless part of the South Pacific current gyre. Currently, there is no spaceborne information on the oceanographic characteristics of these islands. This area needs to be more accurately mapped.

Physical Characteristics: This northwest to southeast trending set of volcanic islands are situated in the South Pacific tradewinds. The largest island in the chain, Tahiti, is to the east in the chain with a series of islands with barrier reefs to the west. The islands can be identified by their color which are emerald green surrounded by turquoise surrounded by the azure blue ocean.

Observation Techniques: Near vertical stereo pictures should be taken using the 100 mm lens. A high sun elevation would offer the best photographing condition.

Atlas Page	Site No.
33	15A

Site: Isla San Felix (26°30'S, 80°W center point and HP coordinate)

Significance: This island group is located in the southeast Pacific Ocean for which there is no marine geologic or oceanographic data of substance. Photographs will be used to map this site.

Physical Characteristics: Isla San Felix is one of a group of volcanic peaks located on the western edge of the cold Humboldt Current. Any island wakes will extend to the north. The islands are small and not easily seen but they should stand out against the intense blue ocean in the afternoon sun. Generally there is little or no cumulus build-up over the islands.

Observation Techniques: Near vertical, stereo pictures should be taken of the entire island group using the 250 mm lens.

GENERAL AREAS FOR OCEAN FEATURE OBSERVATIONS AND PHOTOGRAPHY

#	Title	Coordinates	Ocean Features	Atlas Page
1B	Eastern Atlantic Ocean West Africa Coast	17°S, 0° to 17°S, 12°E to 28°S, 16°E to 28°S, 0°	Internal waves, eddies	36,37
6B	Western Indian Ocean Near Madagascar	17°S, 49°E to 17°S, 60°E to 28°S, 60°E to 28°S, 40°E to 25°S, 40°E to 25°S, 47°E	Eddies	39
7B	Eastern Indian Ocean West Australia Coast	17°S, 105°E to 17°S, 122°E to 19°S, 122°E to 21°S, 115°E to 24°S, 113°E to 28°S, 114°E to 28°S, 105°E	Internal waves, eddies, spiral eddies	27
11B	Western Pacific Ocean East Australia Coast	17°S, 146°E to 17°S, 175°E to 28°S, 175°E to 28°S, 153°E	Spiral eddies, eddies, fronts, current boundaries, island wakes	28,29
11C	Western Pacific Ocean	17°S, 175°E to 17°S, 165°W to 28°S, 165°W to 28°, 175°E	Eddies, spiral eddies, island wakes	29,30
11D	Central Pacific Ocean Cook Islands	17°S, 165°W to 17°S, 150°W to 28°S, 150°W to 28°S, 165°W	Eddies, island wakes	30
15B	Eastern Pacific Ocean	17°S, 80°W to 17°S, 72°W to 19°S, 70°W to 28°S, 71°W to 28°S, 80°W	Internal waves, eddies	33

THE SUN'S REFLECTION

by

R. E. Stevenson

The sun's reflection from the surface of the sea, termed as sun glitter/ glint, has proved to be the most valuable tool in the visual observation of the ocean from space. Not only can the fine details of nearshore turbulence be examined, but it is the only method by which turbulence in the open ocean and around islands can be seen.

In the golden center of the sun's reflection, a smooth sea surface reflects brighter than that which is roughened by waves. The sun is reflecting directly back to the observer as it would from a mirror. Thus, sea slicks or water moving with the wind will reflect brightly, whereas water flowing against the wind, and therefore, with choppy waves at the surface, will have a diffuse, or duller, reflection. Not only are these reflective differences easily seen visually, but they have been caught many times on images from polar-orbiting satellites.

On the edge of the sun's reflection, the golden colors change to blues. In this part of the glitter pattern, smooth water has a dark blue color (the angle of the sun permits the light to penetrate into the sea) and roughened water has a light blue color. The glare into the lens, both eye and camera, is far less on the edge of the reflection than in the very center. Fine details of sea-surface turbulence can be lost, then, in the central glare of the sun's reflection. Whereever the glitter pattern is complex, therefore, it is better to <u>observe/ photograph the surface phenomena on the edge of the reflection field</u>.

OCEAN CURRENTS

The major currents in the world's oceans are driven by the wind. The most prominent currents; such as, the Gulf Stream, Kuroshio, Peru, Canary, and equatorial currents, are products of prevailing winds, of which the trade winds--north and south of the equator--are the most constant. As a result, the equatorial ocean currents flow more consistently than any others.

The tremendous momentum in the equatorial currents, and the vast volumes of water transported across the oceans, causes sea level to be higher on the western side of ocean basins (eastern shores of the continents). In response to the Earth's rotation (Coriolis effect) and this "piling-up" of the sea, strong currents flow away from the equator toward the polar regions; such as, the Gulf Stream and the Kuroshio Current.

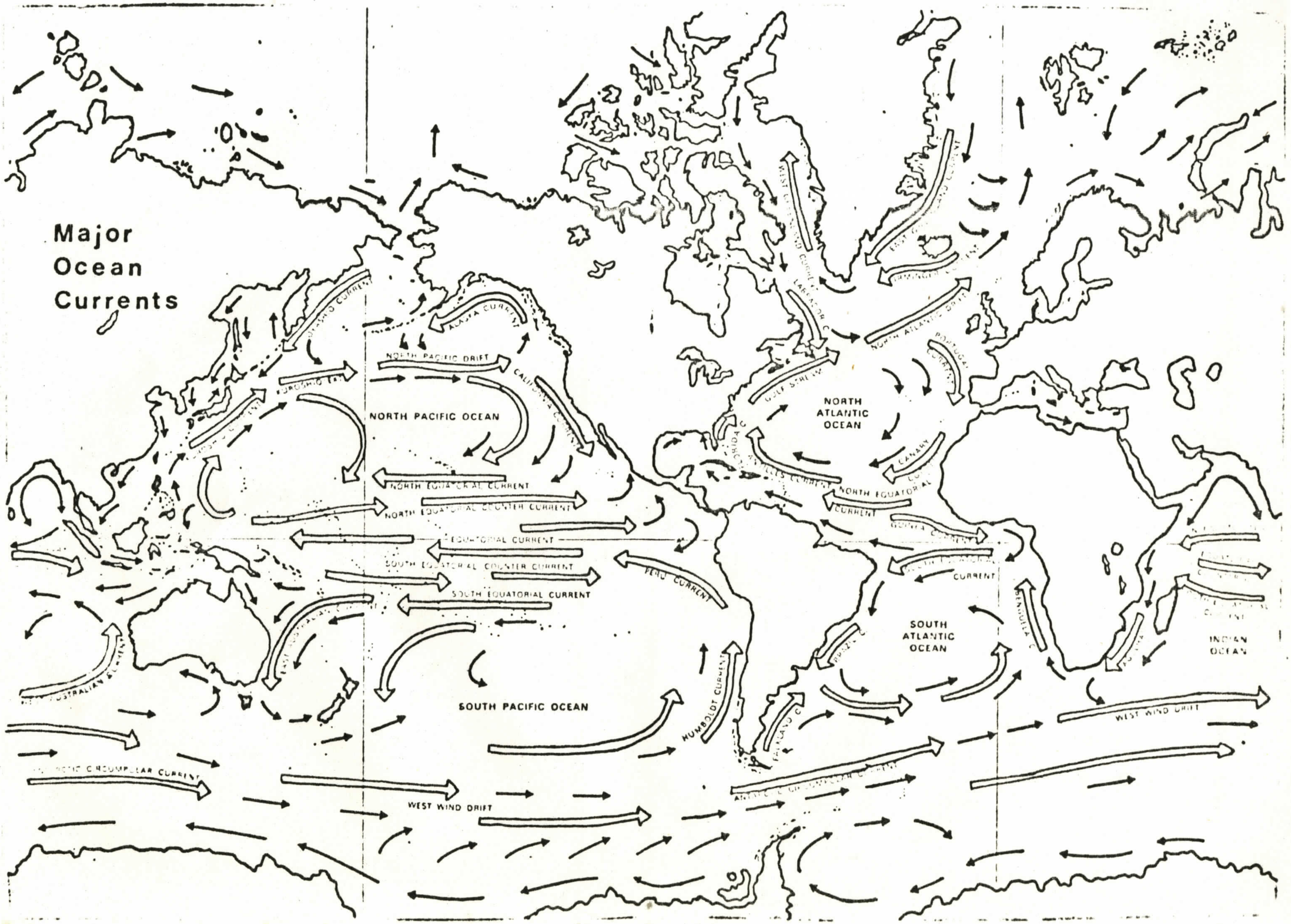
In the major ocean basins, the Atlantic, Pacific, and Indian, the higher sea level along the western boundaries than the eastern side of the ocean also produces a "counter-current" flowing along the equator, but to the east rather than west. In the Indian Ocean, this easterly counter-current is wide and persistently at the surface. In the Pacific Ocean, it is relatively narrow and flows beneath the westerly surface currents more often than not. The equatorial width of the Atlantic Ocean is not nearly that of the other two oceans and the counter-current is consequently not as well developed.

In the Atlantic Ocean, water from both north and south of the equator flows into the Caribbean Sea to form the Gulf Stream. This difference from the other oceans is the result of the shape of the east coast of South America; the point of Brazil being just south of the equator, diverting the main current to the north. The southerly flowing "western boundary current" (Brazil Current) is, therefore, much less dominant than that flowing to the north.

The geography of the western Pacific Basin and the seasonal monsoons of Asia modify the general flow of the currents in the southwest Pacific and northwest Indian oceans. New Guinea, New Britain, and the Solomon Islands create a "filter" so that as the equatorial waters turn south (responding to the high sea level and the Coriolis effect), the flow is disrupted. Consequently, there is no truly "western boundary current" in the Coral Sea; between New Guinea, Australia, and New Caledonia. Only in the Tasman Sea is there a semblence of a good current, but even there it develops into a system of eddies. In the Pacific, as in the Atlantic, therefore, the northerly flowing current in the western ocean is far stronger than the one flowing to the south.

In the western Indian Ocean, the currents north of the equator are controlled more by the seasonal monsoons than by the dynamical effect of the equatorial current. In the winter, then, northeast winds from the Asian mainland drive the waters south along the Somali Coast. In this ocean, the southerly flowing "western boundary current" (the Algulhas), moving between Africa and Mozambique, is dominant. A reversal takes place in the summer when really strong and persistent southwest winds result in currents flowing from the Somali Coast into the northern Arabian Sea. These winds and currents create the complicated eddies seen by John Young in April 1981.

In summary, the strongest and steadiest currents in the oceans are the Atlantic and Pacific equatorial currents, the northern hemisphere western boundary currents (Gulf Stream and Kuroshio), and the southern hemisphere eastern boundary currents (Peru-Humboldt and Benguela).


Major Ocean Currents
ALASKA CURRENT
NORTH PACIFIC DRIFT
CALIFORNIA CURRENT
NORTH PACIFIC OCEAN
NORTH EQUATORIAL CURRENT
NORTH EQUATORIAL COUNTER CURRENT
EQUATORIAL CURRENT
SOUTH EQUATORIAL COUNTER CURRENT
SOUTH EQUATORIAL CURRENT
PERU CURRENT
SOUTH PACIFIC OCEAN
HUMBOLDT CURRENT
WEST WIND DRIFT
GULF STREAM
NORTH ATLANTIC OCEAN
NORTH ATLANTIC DRIFT
CANARY
NORTH EQUATORIAL CURRENT
SOUTH ATLANTIC OCEAN
CURRENT
INDIAN OCEAN
WEST WIND DRIFT

EDDIES AND WAKES

Turbulence behind islands and on the boundaries of major ocean currents are of great interest, and exciting to see. The eddies, wakes, and vortices are the processes by which thermal energy is transported both through and across the ocean, and by which the momentum of currents is dissipated. Because these features move with the currents, form and dissipate, and vary in size in response to variations in the energy input from the atmosphere, repeated views every few days of the turbulent features are desirable for quantitative studies.

The easiest views to repeat are those of island wakes, because the observer can locate the island with little trouble. These wakes, and the resulting vortices, are useful from two points of view. First, the shape and size of the turbulence is likely to be repeated regularly so that a few measurements from a series of photographs probably represent long-term conditions. Second, in the major currents, island wakes create turbulence to considerable depths (1,000 feet, or more) and, therefore, bring nutrients into surface waters. Wakes from several islands can produce conditions that are not only suitable for the existence of major fisheries, but disrupt underwater acoustics. Such is the case downstream from the Cape Verde Islands in the eastern tropical Atlantic.

In some cases, when all of the oceanographic and observational conditions are right, bow waves as well as wakes can be observed. Islands that lie in an ocean current act like a ship ploughing through the water. Peeling away from that end of the island that heads into the current will be V-shaped waves that spread downstream. If the sun's reflection is right, a bow wave can be observed from both sides of the island.

Island wakes and vortices should be most noticeable in the Tropical Pacific, especially around Samoa, the Marshalls, Carolines, and Gilberts, and southwest Pacific, around the Solomons, Fiji's, and New Calednonia.

Current eddies should be most noticeable west of Peru and off southwest Africa. However, they can be seen also in every ocean area away from the major currents given the right viewing conditions. The continued documentation of eddies throughout the oceans is of keen interest to all oceanographers.

INTERNAL WAVES

Just as there are waves on the sea's surface, generated by the wind, so too are there waves below the surface. There, internal waves are most obvious at a density interface within the ocean; such as, the base of the upper mixed layer because at that surface we can measure the up and down, wavy motion of an isotherm. That interface will have a far smaller density gradient than the one between the ocean and the overlying air. Additionally, the waves at the subsurface (internal) interface will be far more subdued in frequency than surface waves. The lack of direct interaction with winds leads to a "smooth" internal wave surface while the lesser density than at the air-water interface permits the waves to reach greater heights than those at the sea surface.

Internal waves may have a complete spectrum of wavelengths, but those that are the most obvious have crest-to-crest lengths of from one to four nautical miles, and they occur in packets of four to eight waves. Where the density interface (usually the thermocline) is shallow enough to permit the internal wave crests to interact with the sea surface, then the waves can be seen in the resulting textural change. This manifestation in the surface roughness is easily viewed in the sun's glitter pattern.

SOLITONS

Fundamentally, solitons are non-linear localized travelling waves that maintain their shape and identity through a balance between the non-linear and dispersive wave effects. Oceanic solitons or V-Brand waves manifest themselves as large internal (or subsurface) waves with only a small surface expression.

Typically, these waves come in groups of six, the first being the most intense. Each wave in the pocket is approximately 100 nautical miles in linear extent across the ocean, with wave to wave spacing (or wavelength) of about 5 nautical miles. The subsurface vertical amplitude of these waves can reach as high as 350 ft, and the whole packet moves as a group with a speed of about 5 knots. Seen from low earth orbit, they appear as long parallel bands of roughened water interspaced with alternate bands of calm water.

Observation Techniques: For the large areas designated for ocean feature identification, both sun glitter and ocean color techniques can be used. Generally, the 100 mm lens will give the best results for looking at these mesoscale features. Take more than one picture of the feature, stereo is preferred but pictures from different angles contain valuable information also.

For site 11B off the east coast of Australia, spiral eddies should be present near the Great Barrier Reef. Use a 250 mm lens in photographing these features, again taking more than one photograph. Also in this area is the East Australian current which can probably be observed using both the sun glitter to identify the sheared front and ocean color (the current will be deeper blue).

GEOLOGY SITES

Atlas Page	Site No.
15	1C

Site: Mt. Cameroon Volcano, W. Africa (4°10'N, 9°10'E)

Significance: After 23 years, Mt. Cameroon began erupting at the end of October 1982. The eruption site is a fissure at 2,600 meters (8,530 ft.) elevation on the SW side of the summit (4 km elevation). Ash deposited and new cones built at the fissure and lava flows may have reached the sea. There is little chance that the eruption can be properly documented on the ground.

Physical Characteristics: The 4 km (2.5 miles) high volcano is at the southern end of a 1000 km (621 miles) long line of progressively older volcanoes cutting NNE into Africa. The same trend extends another 1000 km as a string of volcanoes into the Gulf of Guinea. New lava flows and ash should be visible.

Observation Techniques: Vertical photos of Mt. Cameroon and its flows are valuable, and oblique views of the volcanic line are needed.

Atlas Page	Site No.
15	1D

Site: Cameroon Volcanic Line; Shebshi/Gotel Mountains (10°N, 12°E to 8°N, 15°E to 5°N, 13°E to 4°N, 11°E to 5°N, 8°E to 8°N, 9°E)

Significance: The linear mountain ranges of the Shebshi/Gotel Mountains are 1,000 kilometer (625 miles) long lines of volcanoes and volcanic roots. The region is not a hot spot trace as the ages of the volcanoes do not increase progressively in either direction.

Physical Characteristics: The line of volcanic mountains, ranging in elevation to over 2,286 meters (7,500 feet), is poorly known. Calderas vary from 5 to 8 kilometers (3 to 5 miles) in diameter and have yet to be described. Elevation of volcanoes descreases toward the northeast. The mountains are located near the boundary between Nigeria and Cameroon.

Observation Techniques: Because of frequent clouds, little to no space photographs exist. Need both oblique images of the entire mountain ranges and detailed views of each volcano. Direction of oblique photographs taken should be from the south to the northeast if possible.

Atlas Page	Site No.
37 & 38	2A

Site: Vredefort - Bushveld Structures, South Africa
(23°S, 26°E to 23°S, 31°E to 27°30'S, 31°E to 27°30'S, 26°E/
HP coordinate 25°S, 29°E)

Significance: This site has been hypothesized to be one of the largest impact structures on earth. This large site may be a combination of two to four impact craters formed simultaneously, approximately two billion years ago. These features are famous igneous (subsurface volcanism) complexes, but the new theory is that the igneous activity resulted from large scale crustal disruption due to impact.

Bushveld carries the largest world reserves of chromite and platinum. Vredefort sediments contain the world's largest concentration of gold.

Physical Characteristics: The Vredefort - Bushveld complex consists of four circular structures (Figure 1), each with a central uplift of 70 to 150 km (43.5 to 932 miles) across, surrounded by concentric ridges with diameters up to 300 km (186.4 miles). These are huge structures.

Johannesburg is located on the boundary between Vredefort and Bushveld. The center of the Vredefort structure is near the town of Parys on the Vaal River.

Observation Techniques: Because these are large features, synoptic obliques using 50 mm or 100 mm lenses and overlapping near vertical shots using a 100 mm lens would be best. An oblique view from approximately 28°S looking north along the structures would be excellent.

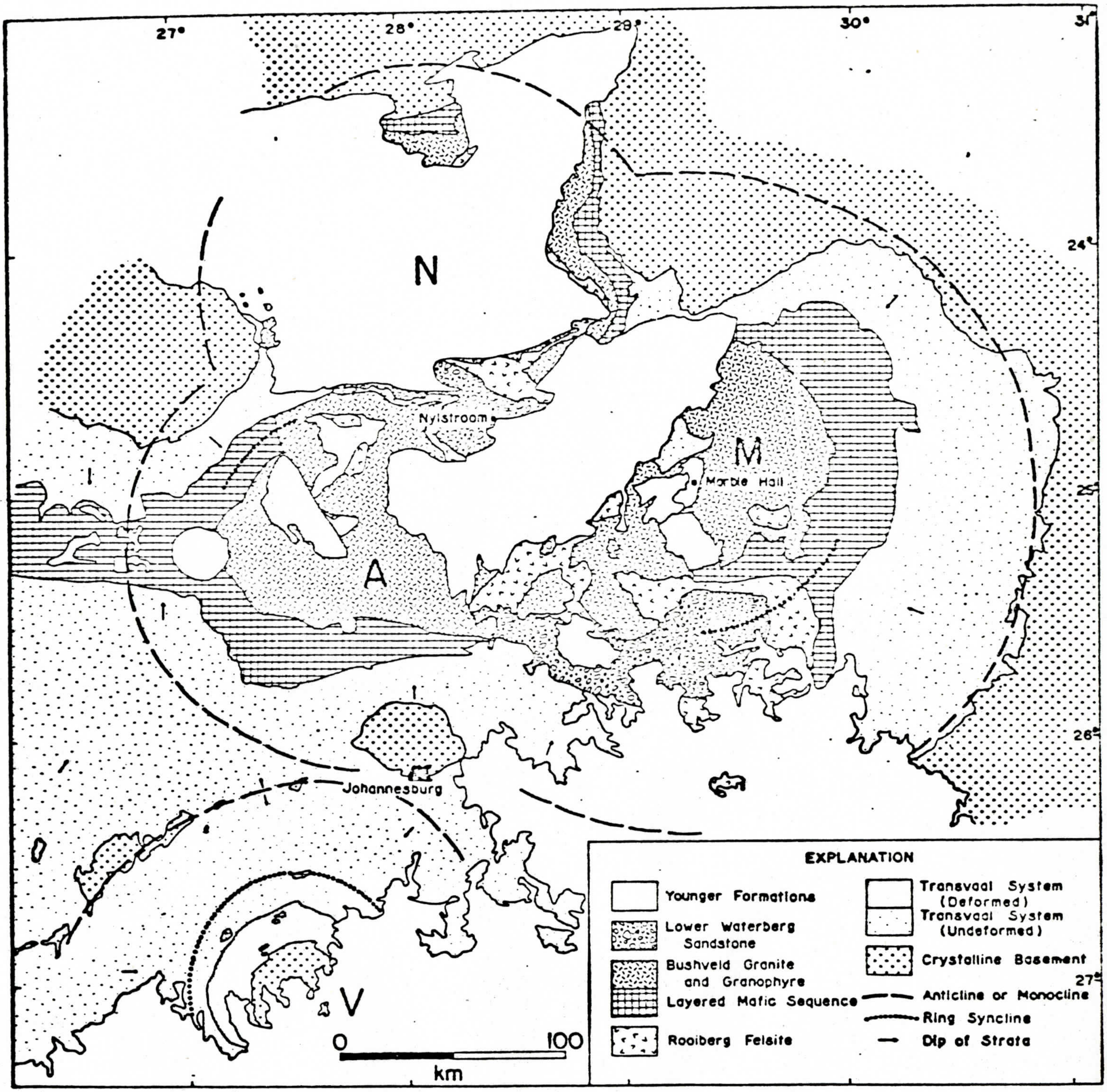


Figure 1. Generalized geologic map of Bushveld-Vredefort complex, South Africa. V = Vredefort Ring, A = Assen Ring, M = Marble Hall Ring, N = Northern Ring. [1]

[1] Reproduced from Rodney C. Rhodes, 'New Evidence for Impact Origin of the Bushveld Complex, South Africa', Geology, October 1975.

Atlas Page	Site No.
38	2B

Site: Swaziland (center point 26°30'S, 31°30'E)

Significance: The small (17,366 km^2/6,705 miles) Kingdom of Swaziland located on the eastern periphery of the African High Veld has a complex geologic history with some rock units exposed on the surface which date back 3.4 billion years. A new national geologic atlas is currently being prepared for Swaziland. Fortuitously, the STS-2 Shuttle Imaging Radar-A imaged a 50 km (31.25 mile) wide swath over the exact center of the country, providing a detailed regional view of the structural geology. Though only a few faults are shown on previous structural geology maps, the SIR-A imagery can be used to locate more than 200 faults and joint fractures. Hasselblad photographs with a 60% frame overlap for stereoscopic analysis will allow the displacement along these faults to be calculated and will aid in the differentiation of rock units. The combined Space Shuttle reconnaissance will become the foundation of the new structural geology mapping that will assist the future development of Swaziland's resource base.

Physical Characteristics: Though Swaziland is a small country, it is topographically diverse. Western Swaziland contains outliers of the Eastern Transvaal High Veld (approximately 1,400 meters/4,593 ft.) which are best viewed along fault-controlled ridges trending northwest-southeast in the southwestern quadrant of the kingdom. In the middle of the country lies the gently rolling plain (approximately 600 meters/1,968.5 ft.) of the Bushveld which terminates abruptly against the excarpment of the eastern-bounding Lembombo mountains, a prominent north-south trending monocline. A northwest orbital approach will cross the northeastern Vredefort region, the Johannesburg/Pretoria urban area and a string of playa basins (Lake Chrissie) along the Umpilusi River drainage before encountering Swaziland with the Lembombo escarpment on the horizon. A southwest orbital approach will cross south of the Johannesburg/Pretoria area and transect Swaziland in the southwestern region of northwest-southeast faulting with the Lebombo escarpment on the horizon.

Areas where photographs would be particularly beneficial are:

1) A southwestern region of northwest-southeast faulting across rugged outliers of the High Veld, 2) A 40 km-wide rolling plain elongated north-south in the center of the country (Bushveld) and 3) The prominent north-south trending Lebombo Mountain escarpment on the eastern side forming the boundary between Swaziland and Mozambique.

Observation Techniques: Analysis of this region calls for precise vertical photography using the 250 mm lens for a resolution of approximately 23 meters and insuring a 60% frame overlap for optimum stereoscopic performance. Several image-making passes with different sun angles will be extremely useful.

Atlas Page	Site No.
37	3A

Site: Virunga Volcanoes, East Africa
(1°S, 29°E to 1°S, 30°E to 2°S, 30°E to 2°S, 29°E
HP coordinate-1°30'S, 29°15'E)

Significance: Virunga volcano field is the major group of volcanoes in east-central Africa. Two volcanoes, in highly populated areas, erupt frequently. In 1977, more than 100 people were buried by the molten lava. These volcanoes are poorly known because of frequent cloud cover and they need to be examined in relation to the Rift Valley structure.

This area is proposed as a site for the SIR-B radar study in 1984.

Physical Characteristics: Eight major volcanoes run in a 100 km (62 miles) long east-west line across the Western Rift Valley of East Africa. The volcanoes are just north of Lake Kivu and south of Lake Edward and should be quite distinctive mountains. Most important are the two western-most volcanoes--Nyamuragira and Nyiragongo.

Observation Techniques: Both near-vertical and low oblique photography should be taken using the 100 mm lens and/or the 250 mm lens. High resolution (250 mm lens) photographs of each of the volcanoes would be particularly useful to show/examine the lava flows because their areas and volumes are poorly known.

INTRODUCTION

The Virunga (Birunga) volcanic field is situated in the Great Western Rift Valley of Central Africa where the territories of Zaire, Uganda and Rwanda meet (Fig. 1). The active volcano Mt. Nyiragongo, near the northern shore of Lake

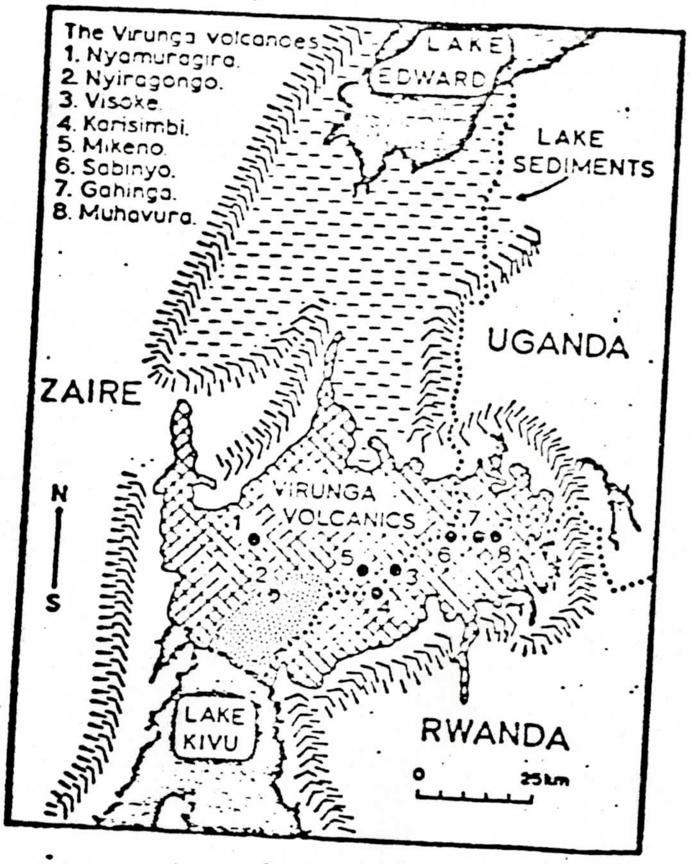


Fig. 1. Sketch map of the Virunga volcanic field. Dotted: the Nyiragongo area.

Kivu in Zaire, represents one of the eight major volcanoes of this field. With its two tributaries, Mt. Shaheru and Mt. Baruta, the Nyiragongo mountain complex is topographically most impressive with its top some 2000 m above the level of the lake (Fig. 2). The Nyiragongo area, *i. e.*, the area covered by the Nyiragongo type lavas, includes the mountain complex and the lava plain between the mountain and the lake (*cf.* Fig. 1).

Atlas Page	Site No.
16, 37, 38	3B & 3C

Site: B) Western Rift Valley, Zaire/Uganda/Tanzania/Malawi/Mozambique/ Zambia, Africa

(3°N, 30°E to 3°N, 33°E to 1°S, 31°E to 7°S, 31°E to 7°S, 36°E to 16°S, 36°E to 16°S, 34°E to 11°S, 32°E to 10°S, 26°E to 1°S, 26°E)

C) Eastern Rift Valley, Kenya/Tanzania, Africa

(6°N, 34°E to 4°N, 39°E to 0°, 39°E to 5°S, 38°E to 5°S, 34°E to 0°, 35°E)

Significance: Intraplate rifting has occurred in the area for the last 30 million years, and is very active today. Study of this system provides an analogue for older events thought to have caused the opening of ocean basins.

Physical Characteristics: The Rift Valley is an enormous trench-like fracture in the earth's crust. It extends about 4,800 miles (7,700 km) from northern Syria across east Africa to southern Mozambique averaging 25 to 30 miles (40 to 55 km) wide. The valley is typically bounded by high cliffs or tiers of cliffs that in places rise thousands of feet above the valley floor. Fractures along the edges of the valley localize very large volcanoes of several different types.

The eastern and western portions of the Rift Valley are separated by Lake Victoria at the equator. The western part of the Rift Valley curves along the border of Zaire, Zambia, and Malawi and contains a chain of large lakes. The eastern part of the Rift Valley is located in central Kenya and southward into the eastern portion of Tanzania.

Observation Techniques:

(1) Vertical photographs at different sun azimuths, for better understanding of fracture patterns.
(2) General oblique photographs along the valleys for distribution of land forms, rock types, and vegetation patterns.
(3) Photographs of junction of Kenyan and Ethiopian Rift east and west of Lake Rudolph (3°N, 36°E).
(4) Few photographs from space exist over this geologically significant region due to clouds. Any photographs would be very beneficial.
(5) The STS-2 crew obtained excellent images of the N. Kenya Rift. The area from about 1°N to about 5°S are needed along with the area north-northeast of Lake Rudolph.
(6) Any photos of the western Rift are valuable.

Atlas Page	Site No.
37, 38	4A

Site: Great Dike of Zimbabwe (16°25'S, 31°10'E to 20°55'S, 29°35'E
HP coordinate 18°45'S, 30°20'E)

Significance: This dike, a linear fissure filled with igneous rock is remarkably long (500 km/310.7 miles) and thin (6 km/3.7 miles). Speculation is that this unique feature was probably the feeder volcanoes along an ancient eroded rift valley. The dike which holds one of the most important chromite deposits on Earth, is estimated to have formed about 2.5 billion years ago.

Physical Characteristics: The linearity of the dike should be identifiable from space. The dike is rugged to smooth along its northeast-southwest trending length. The surrounding countryside to the west is more flat and to the east is the edge of hilly terrain. The dike passes west of Salisbury, Zimbabwe.

Observation Techniques: Photograph the structure with near vertical photos in stereo using the 100 mm and/or the 250 mm lens. Low oblique photographs should be taken looking northwest up the dike using either the 50 mm or 100 mm lens. Low or high sun elevations are exceptable. Also, low obliques looking southwest down the dike would be helpful.

Atlas Page	Site No.
38	5

Site: Comoros Islands (11°S, 42°30'E to 11°S, 46°E to 13°30'S, 46°E to 13°30'S, 42°30'E; HP coordinate 12°15'S, 44°30'E)

Significance: Hawaiian type shield volcanoes with 22 known eruptions (the last in 1977); but the islands themselves are a little known hot spot volcanic chain. This is a good opportunity to document two active volcanoes and the erosional stages of older ones.

Physical Characteristics: Four volcanic islands between Africa and northern Madagascar. Westernmost island (the largest, about 70 km (43.75 miles) long) has two main calderas rising 2.4 (1.5 miles) and 1.1 km (7 miles) above sea level. Three remaining islands are progressively older and more eroded.

Observation Techniques: Any photographs will be useful - no space views exist. Views of each island should be taken with the 250 mm lens. Wide angle views with the 100 mm lens of the entire chain should also be taken.

Atlas Page	Site No.
38-39	6A

Site: Reunion Island (HP coordinate 21°S, 55°30'E)
Mauritius Island (20°15'S, 57°30'E)

Significance: Like the Comoros Islands, Reunion Island is a very active volcano in the Indian Ocean that is relatively unstudied. The island is composed of two separate volcanoes, an older eroded one to the NW, and an active one, to the SW, with a caldera 10 x 15 km (6.2 x 9.3 miles) sloping down to the sea. The latest eruption occurred in 1981; an eruption could occur at any time.

Physical Characteristics: The island is 75 km (46.9 miles) long and relatively heavily vegetated except to the SE where lava flows coat the surface. 250 km (156.25 miles) to the NE is Mauritius, a similar size extinct volcanic island.

Observation Techniques: Vertical and/or oblique views will show general structure of Reunion. The 100 mm lens or 250 mm lens is recommended. Also, photograph Mauritius if possible.

Atlas Page	Site No.
25-26	7A

Site: Indonesian Volcanoes (see description for coordinates)

Significance: Indonesia has more active volcanoes than any other nation on Earth, thus providing frequent opportunities for investigation of eruption dynamics.

Three volcanic areas are particularly important targets for satellite photography:

1) Krakatau (6°10'S, 105°25'E)

2) Galunggung (7°15'S, 108°E)

3) Lewotolo (8°16'S, 123°30'E)

One of the largest volcanic eruptions of historic time occurred 100 years ago on Krakatau, between Sumatra and Java. Twenty-nine smaller eruptions have occurred this century, the latest in 1980. The ash deposits and tidal waves of the 1983 eruption destroyed all vegetation up to 100 meters above sea level on adjacent islands. The purpose of the requested photography is to document the remnant volcanic islands of Krakatau, record any current activity, and to look at the extent of recovery of the zones where vegetation was destroyed.

Galunggung has had more than 50 eruptions since becoming active in early 1982 (after a dormancy of 64 years), and observations are needed to document the extent of ash falls to date.

Lewotolo's last known eruption was in 1951, but the STS-1 crew photographed an apparently unrecorded eruption plume in April 1981. Additional images are important to check for effects of the suspected 1981 eruption, and for possible new activity.

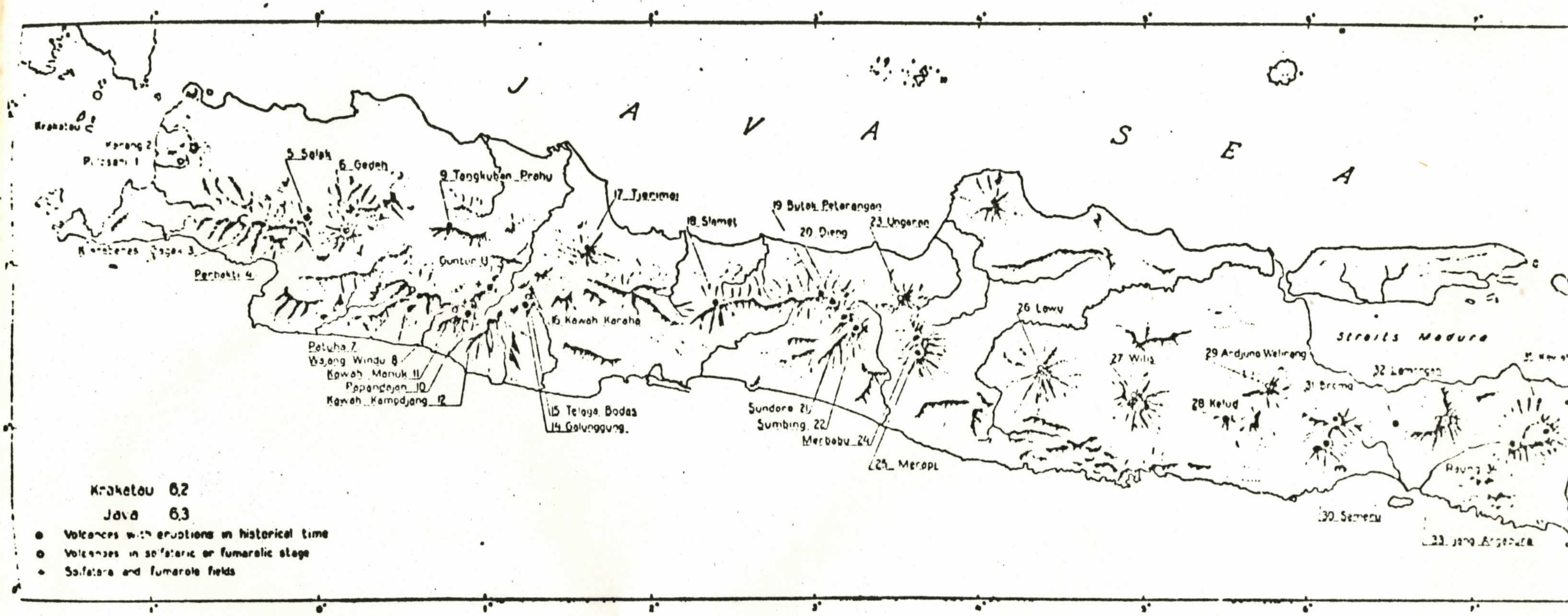
Eruptions from other Indonesian volcanoes are possible, although poorly recorded. Any volcanic activity should be noted. As an example, Soputan Volcano (1°06'N, 124°42'E) has just started an eruption in mid-September 1982, the first in 9 years. Little is known of the eruption type or intensity.

Physical Characteristics: Three small islands between Sumatra and Java comprise what is known as "sons of Krakatau." Adjacent coastlines are also of interest.

Galunggung is 1,800 m (6,000 ft.) above sea level, and Lewotolo is 1,300 m (4333.3 ft.) high. Fresh ash deposits and/or eruption plumes should contrast with heavy vegetation. Soputan is 1,780 m (5,933.3 ft.) high.

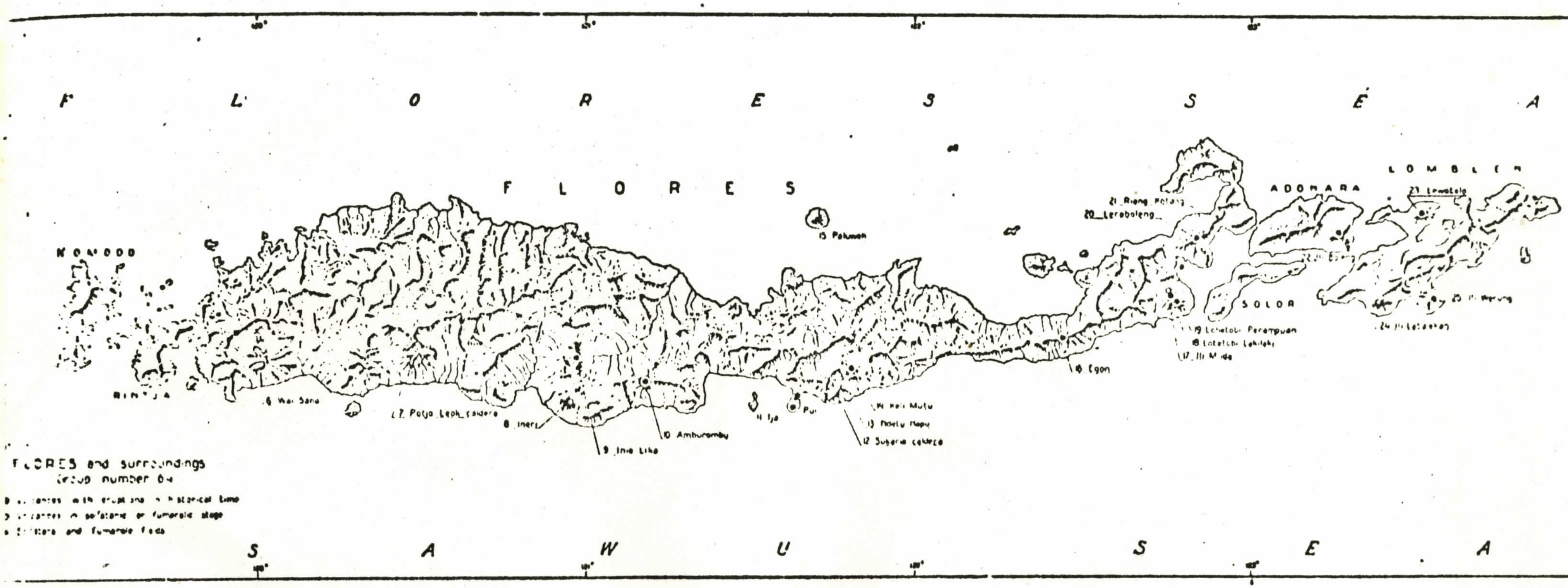
Observation Techniques: Use the 250 mm lens to take pictures of the islands and nearby coasts.

Any photographs are useful to document ash distribution or detect eruption plumes. If any plumes are sighted, they should be photographed from two or more positions so that stereo can be used to reconstruct cloud heights. The region is typically clear in the mornings but clouds up by noon. If cloud-free, low sun views should be obtained; photograph as much of the archipelago as possible.



Z.B. = Southern latitude.

Reproduced from Catalogue of the Active Volcanoes of the World Including Solfatara Fields. Part 1 Indonesia, Dr. M. Neumann Van Padang, International Volcanological Association Via Tasso 199, Napoli, Italia 1951.



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Atlas Page	Site No.
27	8A

Site: Western Australia - Hamersley Range (21°S, 115°E to 21°S, 120°30'E to 24°30'S, 120°30'E to 24°30'S, 115°E. HP coordinate 22°45'S, 117°30'S)

Significance: The Precambrian rocks found in these folded mountains are believed to be part of the old basement complex of Australia. The range is also believed to represent the second earliest tectonic activity in Australia. Information about this region will be used in comparative studies about the formation of the Canadian Shield of North America.

The Hamersley is a major iron deposit region.

Physical Characteristics: The Hamersley Range begins near the western coast of Australia. The chain of mountains trends almost directly east-west and is bounded by two rivers which converge east of the mountains. The Precambrian rocks which make up the east-trending folds contain bands of iron formations.

Observation Techniques: Near vertical and oblique views of the patterns of structures will be useful for geological studies. Obliques taken along the major folds in the east-west direction are recommended.

Atlas Page	Site No.
27	8B

Site: The Kimberly Plateau, Northwestern Australia (13°S, 131°E to 15°S, 131°E to 20°S, 126°E to 19°S, 122°E to 17°S, 122°E to 14°S, 127°E)

Significance: The Fitzroy River marks the southern edge of a major basin which extends northwest into the Indian Ocean.

The coastline to the northeast as far as Darwin is believed to be the edge of the zone where the sub-continent of India has pulled away.

Physical Characteristics: Along the northwestern coast of Australia, there is a series of faults and other structures which form an L-shaped zone of disturbance. The deformed margin of this zone is parallel to and bounded on the south by the Fitzroy River (see map). Major folds also occur in this area.

Observation Techniques: Photos parallel to the principal structures in both the northeast and northwest directions will assist in geological interpretation. Both near vertical and oblique views would be of benefit. The main folds and the deformed margin are of main interest.

Atlas Page	Site No.
25,26	8C

Site: Celebes Island (2°S, 120°E center point)

Significance: This five-armed island is a resulting combination of continental and oceanic fragments situated in a major tectonic collision zone.

Physical Characteristics: On the northeast corner of the northern-most arm is a cluster of active volcanoes about which relatively little is known.

The Palu fault, splitting the west central part of the island, is a major northwest trending strike slip fault and is poorly mapped.

The central and southeastern arms are fragments of oceanic crust thrust to the surface. They should be distinguishable by the lack of vegetation relative to the rest of this tropical region.

Observation Techniques: Vertical pictures taken in stereo of the different island features would yield the most useful information.

Atlas Page	Site No.
27	9A

Site: Gosses Bluff, Australia (23°49'S, 132°18'E center point and HP coordinate)

Significance: Gosses Bluff is a moderate size multi-ring impact crater.

Physical Characteristics: Gosses Bluff is one of several impact craters which occur in this region of Australia. It is located approximately 160 km (100 miles) west of Alice Springs and just east of the Kutta Putta airstrip. Gosses Bluff is an isolated circular ridge about 5 km (3.1 miles) in diameter with faint concentric rings of 11 to 12 km (6.9 to 7.5 miles) in diameter. This crater formed on the flat Missionary Plain between the MacDonnall Ranges to the north and the James Ranges to the south.

Observation Techniques: Near vertical photographs should be taken with a 250 mm lens. Low sun elevation offers the best condition to see the subtle outer ring structures.

Atlas Page	Site No.
27	9B

Site: MacDonnell Ranges, Australia (22°S, 128°E to 22°S, 136°E to 26°S, 136°E to 26°S, 128°E)

Significance: Complex folded mountains made up of Precambrian and lower Palezoil sediments.

Physical Characteristics: The MacDonnell Ranges of central Australia are very old eroded folded mountains. Surrounded by mostly gently rolling to flat deserts, except the Musgrave Range to the south, the MacDonnell Range has peaks that are amongst the highest in central Australia. Mount Ziel at 1,486.5 m (4,955 feet) and Mount Liebig at 1,500 m (5,000 feet), both of which are located in the western part, are the highest mountains within the range. To the northwest of the range is the Great Sandy Desert. Two lakes (mostly dry salt), Lake White and Lake Mackay are visible. During periods of rainfall these lake basins will become filled with water.

Salt has influenced some of the folded shapes of the range. One salt dome has been folded over dry lake beds to the north and south of the range (Lake Eaton to the north, and Lakes Neal and Amadeus to the south). The town of Alice Springs is located at the eastern end of the range. The Amadeus' basin lying within the site, and just to the south of the ranges, should also be observed and photographed.

Just south of the range is the Amadeus Basin. This area is characterized by low ridges which are a series of folds. Lake Amadeus which is located in the basin is usually dry.

Observations Techniques: Near vertical and oblique views of structural patterns are requested. Use 100 and/or 250 mm lens.

Other: The interior deserts of Australia have an amazing network of usually dry river channel and lake basins. If these channels are ever in flood; TAKE PICTURES!!!

Atlas Page	Site No.
27	10A

Site: Strangways Crater, Australia (15°12'S, 133°35'E center point)

Significance: Strangways is a 24 km (15 miles) wide impact crater formed 150 million years ago. This feature has not been thoroughly studied we are uncertain if it is actually 16 or 24 km (10 or 15 miles) across. The crater is difficult to reach on the ground and too large to be readily comprehended. We need the synoptic view from space.

Physical Characteristics: The crater forms a nearly complete circular ring between 16 to 24 km (10 to 15 miles) wide. The structures are up to 70 m (233.3 ft.) high and surrounded by a broader zone of disturbance. Small scale structural features formed by extreme shock indicate an impact origin.

Observations Techniques: Near-vertical photography in a low sun angle condition should be taken. Both 100 mm and 250 mm lenses should be used. Any photo of this structure would be useful.

Atlas Page	Site No.
26	10B

Site: Papua New Guinea (3°S, 140°E to 3°S, 147°E to 6°S, 147°E to 6°S, 140°E)

Significance: In this region, oceanic crust has been thrust onto land. Major reserves of copper, chromium and nickel have been discovered recently in these rocks.

Physical Characteristics: Ocean crust ends to inhibit the growth of vegetation and is characterized, in this region, as having dark red-brown soils. Thus the area of interest should be identifiable in the heavy jungles of this region by lack of vegetation and distinctive soil color. Also the areas may appear as elongated belts of low vegetation.

Observation Techniques: Near vertical stereo photography would best document these features. High sun elevation is preferred.

Atlas Page	Site No.
28	11A

Site: Great Barrier Reef, Australia (9°30'S, 142°E to 9°30'S, 146°E to 15°S, 146°30'E to 24°S, 157°E to 24°S, 151°E to 17°S, 144°30'E. HP coordinates 17°S, 146°15'E)

Significance: This feature is the largest barrier reef in the world. It is similar to the large reef formed during Cretaceous time that ringed the Gulf of Mexico northward up the Arlantic coast of the United States to southern Canada. Sediment and water movement patterns will be of use to both geologists and oceanographers.

Physical Characteristics: The Great Barrier Reef begins just north of 10°S latitude and follows the northeastern Australia coast southward to near Fraser Island at 25°S latitude. The reef can be distinguished by the change in ocean color around it.

Observation Techniques: Near vertical pictures should be taken in stereo of reef shapes. Also oblique views can be useful. The photographs should include views of the Australian coast line to assist in determining the reef's location.

Atlas Page	Site No.
32	13

Site: Henderson Island (center point & HP coordinate 24°21'S, 128°19'W)

Significance: Henderson Island (United Kingdom) has been proposed as a potential emergency landing site for Shuttle launches from Vandenberg Air Force Base. The Shuttle Landing Support Group at JSC has requested that photography of the island be taken for evaluation and mapping purposes.

Physical Characteristics: The island is located in the South Pacific, south and east of French Polynesia. Its size is about 4.8 by 8 km (3 by 5 miles).

Observation Techniques: Vertical photographs should be taken with a 250 mm lens. Stereo coverage would offer maximum information for mapping. Oblique photographs (using 250 lens) approaching the island would be used for flight operations purposes.

Atlas Page	Site No.
12	14A

Site: Galapagos Islands (2°N, 92°W to 2°N, 89°W to 2°S, 89°W to 2°S, 92°W. HP coordinate 0°, 91°W)

Significance: Six active shield volcanoes with frequent, poorly observed eruptions comprise the 2 westernmost islands. A September 1982 eruption of Wolf volcano--the northern-most volcano on the J-shaped Isabela Island--needs photo documentation (for estimates of area and volume of flows), as do recent, poorly mapped eruption deposits on the southestern flank of Fernandina and northeastern flope of Sierra Negra.

Physical Characteristics: These islands are located in the eastern Pacific about 965 km (600 miles) west of the Ecuador coast. The islands are volcanoes with tan colored soil where not covered with dark lava flows. The volcanoes have large summit calderas.

Observation Techniques: Vertical, low sun angle photographs with the 250 mm lens are preferred for mapping of new deposits, but any photographs at any lighting condition can be useful.

Atlas Page	Site No.
13, 33	14B & 14C

Site: B) Northern Andes Mountains (11°30'N, 74°W to 11°N, 68°W to 4°S, 77°30'W to 4°S, 81°W)

C) Northern Andes Mountains (4°S, 81°W to 4°S, 77°W to 13°S, 71°W to 13°S, 76°30'W)

Significance: The Northern Andes are the least well known of the Andean chain because of dense vegetation and frequent cloud cover. However, they are important tectonically in that their western forelands, fronting the Pacific Ocean, may be uplifted ocean floor, and the mountain summits and valleys are apparently controlled by continental continuations of oceanic fractures. The existence and locations of volcanoes and major faults are only poorly known, and good photography is urgently needed to define the basic plate tectonic structure of this region. Two areas in particular require photography, the mountains of central and southern Colombia, and the inter-Andean valleys of southern Ecuador. No adequate photography exists for either area.

Physical Characteristics: The Andes are a series of tall mountain chains and high plateaus. The northern section is split into three major ranges: the Occidental, Central, and Oriental. Twin rows of volcanoes flank the long inter-Andean valley. Vegetation is heavy to the east and west, but colors ranging from desert tan to green are seen within valleys, depending on the season.

Observation Techniques: Take vertical and oblique photography. The early morning is not as subject to cloudy conditions as later in the morning and afternoon.

Atlas Page	Site No.
33	15C

Site: Pampas Regions (22°S, 68°W to 22°S, 62°W to 33°S, 62°W to 33°S, 71°W)

Significance: Within the area of interest lies the Pampean Mountain Ranges and their associated valley regions of Western Argentina and Northeastern Chile. This region is of particular interest, as the Pampean Ranges are current day geologic models which represent, to structural geologists, how the mountains in the states of Wyoming and Colorado were formed several million years ago. The process of early mountain building, of these still-forming ranges, is what is sought.

Physical Characteristics: Major mountain ranges, trending generally north-south in the western part of the area with less-rugged topography in the eastern part. (Similar to the western extent of the Great Plains in the United States). Large tectonic features (e.g., faults, alignments, and stream patterns) should be easily observable.

Observation Techniques: Take near-vertical or low oblique photographs at lower sun angles for optimum expression of tectonic features. Photography looking north or south parallel to the trend of the tectonic structures is preferred.

Note: Approximately one half of the site area is south of the flight path.

Atlas Page	Site No.
13-33	16A & B

Site: Upper Amazon River Basins

A) (0°, 74°W to 0°, 67°W to 2°S, 64°W to 7°S, 67°W to 7°S, 72°W to 4°S, 74°W HP coordinate 3°S, 70°W)

B) 4°N, 62°W to 4°N, 59°W to 4°S, 59°W to 4°S, 62°W to 0°, 65°W)

Significance: Part of the world's largest river drainage basin, the tributaries of the upper Amazon River Basin have very anomalous courses that suggest fault control. Discharge variability and bank stability (related to both vegetation and lithology) appear to be the dominant factors in accounting for channel pattern variations in the Amazon River Basin.

Physical Characteristics: The Amazon is truly a giant among rivers. Only the Nile is longer--and only slightly longer. But the length of the Amazon, almost 4,000 miles (6,500 kilometers) is still impressive. Its drainage basin is fed by more than 1,000 tributaries, including 7 that are themselves more than 1,000 miles (1,600 kilometers) long. Its total drainage basin of 2,722,000 square miles (7,050,000 square kilometers) encompasses about one-third of South America.

At the town of Iquitos in eastern Peru, the Rio Ucayali and the Rio Maranon, the two main headwaters of the Amazon, unite to form a truly major river. Iquitos is the point farthest upstream that shallow-draft freighters and passenger vessels can penetrate. All of the tributaries, including the main river itself seem to have very anomalous courses that suggest fault control. The Rio Jurna appears to meander along a ridge, as all near rivers curve away from it.

On its journey to the sea, the Amazon also varies in color. Some of its tributaries are called Rios Blancos (white rivers), though their color is oftener a murky yellow or tan. Others are known as Rios Negros (black rivers), their waters dark but crystal clear. The white rivers rise in the Andes, and their turbidity results from the heavy loads of mud and silt they carry. The black rivers, in contrast, rise in areas of ancient basement rock where little sediment remains to be washed away; only dissolved organic matter stains their clarity.

Clearly the most dramatic union of black water and white water occurs at Manaus where the Rio Negro flows into the muddy Amazon. For many miles the black and white waters flow side by side in separate, clearly defined streams before they finally intermingle.

Observation Techniques: Remote sensing from space has obvious advantages for monitoring this highly dynamic hydrological environment. Near vertical to low oblique photos using both 100 mm or 250 mm lens should aid in understanding the control of underlying structures. Also try to photograph the black water/white water mixing near Manaus. The STS-5 crew has gathered the best photos to date. Early morning stratocumulus and afternoon build-up of cumulus thunderstorm clouds over sections of the basin may pose problems. Any photos which show streams and stream patterns will be most beneficial.

Atlas Page	Site No.
34	17

Site: Araguainha Dome, Brazil (16°45'S, 52°59'W center point and HP coordinate)

Significance: The Araguainha Dome is a large ancient multi-ring impact crater located in the Brazilian jungle. Such large craters are common on Mars and the Moon but are rare on Earth.

Physical Characteristics: A central uplift area approximately 10 km across is surrounded by an annular ring which is hard to see and which is roughly 40 km across. Shock features have been found in the rocks of these structures, indicating an impact origin. Scientists are interested in whether larger additional rings exist in this multi-ring structure.

Observation Techniques: Both the 100 mm and 250 mm lenses should be used in taking pictures. Near vertical and low oblique pictures are desirable. The low obliques can be taken in any direction; any information will be useful. A low sun angle offers the best lighting condition.

Atlas Page	Site No.
34	18

Site: Canghala Crater, Brazil (Center point 8°05'S, 46°52'W)

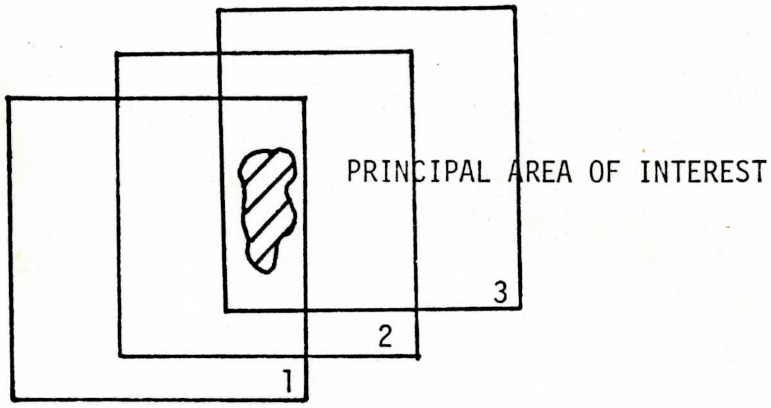
Significance: Canghala is a moderate size (12 km wide) impact crater in the Brazilian jungles.

Much of northern Brazil is ancient Precambrian age rocks. Within similar age rocks in Canada, many impact craters have been found. Only two are known in Brazil, but many more probably await discovery. Observations from space offer the best opportunity to identify such craters.

Physical Descriptions: The crater's central complex is 5 km (3.1 miles) wide, 350 m (1,167 ft.) high, and surrounded by a rim 12 km (7.5 miles) wide. Actually the 5 km (3.1 miles) central structure looks like a crater itself. The entire structure is said to be remarkably impressive with a high degree of circularity. The region located between the outer rim and the inner peak is relatively smooth and depressed compared to the surrounding terrain.

Observation Techniques: Both near-vertical and low oblique photographs should be taken using the 100 mm and/or the 250 mm lenses. Obliques from any direction would be of use. Although any sun elevation is acceptable, low sun would probably produce the best information.

PROCEDURE FOR TAKING A SET OF 3 STEREO PHOTOS



A. Hold camera at approximately the same angle.
B. Take first frame when area of interest is on one side of camera field of view.
C. Take second frame when area is in center of camera field of view.
D. Take third frame when area is on other side of camera field of view.

(To time each frame, the following guidelines are recommended:

At 160 nautical mile altitude:
- For a 250 mm lens, wait 4 seconds between frames
- For a 100 mm lens, wait 9 seconds between frames

At 120 nautical mile altitude:
- For a 250 mm lens, wait 3 seconds between frames
- For a 100 mm lens, wait 7 seconds between frames

HINTS FOR GOOD EARTH-LOOKING PHOTOGRAPHY

1. Avoid taking photos within 5 minutes of sunrise or sunset, unless there is a special reason to secure them.

2. Check the camera settings before taking pictures. If you have changed from the standard setting during a photo session, remember to reset the camera at the end of that session.

3. Properly set the F-stop and speed - F.11 at 1/250 of a second is a good general setting if it is inconvenient to use the spot meter.

4. Be aware of what is in the frame of picture. Try to avoid obscuring the earth view with the edge of the window.