ARCHAEOLOGICAL AND ECOLOGICAL SURVEY OF 'OLOVALU CRATER
ISLAND OF TUTUILA, AMERICAN SAMOA

Prepared by
Edmund J. Ladd and David K. Morris

National Park Service
July 1970
'OLOVALU CRATER, ISLAND OF TUTUILA, AMERICAN SAMOA

A PRELIMINARY SURVEY REPORT

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July 1970
HAWAII GROUP
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December 9, 1970

Honorable John M. Haydon
Governor of American Samoa
Pago Pago, American Samoa 96920

Dear Governor Haydon:

Enclosed are the original and two copies of the reports by Pacific Archaeologist Edmund J. Ladd and Ecologist David K. Morris. We hope that they will be of use to you. I am sorry it took so long to get them in production, but it appears to me that their quality will have been worth the wait. I am taking the liberty of sending a copy of each to the Bishop Museum here in Honolulu.

As I skimmed through the reports, it more than ever made me want to visit American Samoa.

Russ Apple has, I believe, sent you a copy of his status report on his work of last summer which brings us up to date pending receipt of the research material that Russ needs to complete his evaluation of historic sites.

If there is anything we can do to further any of these projects, please let me know.

Sincerely yours,

[Signature]

Robert L. Barre
General Superintendent

Bishop Museum, w/copy reports
CONTENTS

Report 1. 'Olovalu Crater, Island of Tutuila, American Samoa
A Preliminary Survey Report

Edmund J. Ladd

Acknowledgements.............................................1
Introduction......................................................2
General Plan......................................................5
Archeological Features
  Crater Rim.....................................................6
  South Valley...................................................7
  Crater Basin...................................................8
  Saddle........................................................9
General Remarks................................................12
Fig. 1 Map of Putiga and Vicinity
  An over-leaf of undated map.
  Key reference T75.............................................18
Plates 1 through 9 - Selected photos
  of 'Olovalu and vicinity....................................20

Report 2. Ecological Survey of 'Olovalu Crater, Island of
Tutuila, American Samoa

David K. Morris

Preface..........................................................1
Overview of Resources and Needs in
  American Samoa..............................................3
'Olovalu Crater
  Geology......................................................5
  Climate.......................................................6
  Ecological History..........................................7
  Present Vegetation Communities
    Zone 1....................................................10
    Zone 2....................................................12
    Zone 3....................................................14
    Zone 4....................................................15
Wildlife
  Birds........................................................16
  Mammals.....................................................18
  Scenic and Aesthetic Qualities..........................18
  Recommendations...........................................20
  Bibliography................................................22
ACKNOWLEDGEMENT

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INTRODUCTION

On the Island of Tutuila in American Samoa, a volcanic crater sometimes referred to as the Crater near Futiga, as Pago Crater by one resident, and now as 'Olovalu Crater, is a steep sided basin with a narrow opening or gap on the south side. It measures nearly 1000 feet from rim to rim and approximately 190 feet deep. Geologically, the basin is probably a volcanic cone or vent. Running southward from the basin is a valley which appears to have been formed by a collapsed "lava tube". The nearly "fluffy" aa lava, which forms the sub-stratum, indicates the general weakness of the crust and the formation. The lava is "layered" and exfoliates easily and breaks in the same manner. The talus, inside the basin, is very difficult to walk on being composed of very loose chunks of lava. The lush jungle vegetation breaks down the lava forming a fertile deposit which is now cultivated by village members of Futiga.

In the center of the basin there is an area 100 to 150 feet in diameter which we termed the "Swamp". It is the lowest portion of the crater. The rain run-off drains into it and is too wet for cultivation. One resident of Futiga said that from time to time the water overflows from the swamp during the heavy rainy season.
From the toe of one talus to the other, including the swamp, the crater floor is 700 to 800 feet in diameter. This is the primary cultivation zone. Portions of the valley extending southward are also under cultivation.

According to the field guide, foreman and interpreter this region of the island was generally unpopulated until after World War II. It was generally believed by the Samoan people that the crater was the abode of spirits and ghosts. The crater was a dark and ominous place, filled with large ferns, shrubs and trees inhabited only by the tropic bird and the flying fox (fruit bat).

During World War II, a fighter strip was built just to the southwest of the crater where the Midkiff High School now stands. Because of its strategic location and elevation, the entire rim was occupied by the military. It overlooked the air-strip and the coast to the village of Leone on the west, and beyond the village of Vaitoga to the east. Evidence of this occupation are a large concrete bunker, which was probably the main control center for the coast watchers, and numerous smaller bunkers, trenches, tunnels and other defensive works. The trails established by the military, although overgrown, can still be easily followed from one structure to another. Plastic coated telephone wire in various stages of decomposition, and 55 gallon barrels were noted everywhere.
The horticultural practices of the Samoans using the crater is such that probably no more than 25 per cent of the available space in the bottom of the crater is planted at any time. Small plots, averaging 50 by 50 feet square are cleared of the heavy vine cover before planting. The plot is left fallow once the crop has been harvested.
GENERAL PLAN

The survey team arrived at the Tafuna airport, American Samoa, on Sunday morning, July 5 at 6:00 A.M. and returned to Honolulu July 15, at 6:00 A.M. A total of nine working days were expended on the Colovalu project.

Because of the heavy jungle growth, the relatively large area to be covered, and the uncertainty of the types of archeological features that might be encountered, I decided to make a general "walkthrough" survey of the rim, the crater floor, and the low valley toward the south (Plate 1).

Through the efforts of Bingham Tuisamatatele, we were escorted into the crater by Maafala, a gentleman perhaps 80 years of age and a long time resident of Futiga, who was very helpful in pointing out a number of features which later proved to be of much significance.

Armed with a bush knife we walked through the lower crater floor, the rim and the south valley, and searched likely areas for any archeological features. Overgrown areas as well as presently planted sections were searched.
ARCHEOLOGICAL FEATURES

CRATER RIM

The trail to the crater and the rim starts from the residence of Maafala at about the 340 foot elevation. The trail slippery when wet, which is most of the time, rises to an elevation of about 390 feet above sea level to a knife edge ridge. At this point (see map) there is a large concrete bunker through which the trail leads into the crater. Headed by Bingham and his swinging bush knife, we started off in a northerly direction from the large concrete bunker. About 100 feet from the bunker along a sheer edge of the crater, there is a natural break in the rim which may have been part of an old trail. There is an indication of slabs of stone having once been stacked. The feature is poorly preserved and the scattered slabs rest upon the base rock making identification as a wall uncertain. Under the pile of stones a section of plastic coated telephone wire was found. A few feet beyond the gap and the suspect wall, there is a slit-trench with several 55 gallon drums in the bottom. Along this ridge, facing the east coast line for the next 500 to 600 feet are a number of smaller bunkers and trenches. According to Bingham, along the north rim and parallel to the present gravel pit, the military had cleared and leveled at one time. The vegetation growing here indicates strongly that this is the case. If there were any prehistoric structures or features in this area, they have long since been destroyed.
Just beyond the leveled section, at about the 480 foot contour, there is a well-constructed stone platform. Adjoining the platform are a number of trenches. This was probably an emplacement for a large gun, or an observation point overlooking the cleared area below. On the west side of the crater, just above the 400 foot contour is a small shelf of land that is under cultivation. At the highest point along this portion of the crater, there is a stack of stones which may be a grave site. Because there are no other features associated with the possible grave area, it was only cleared of vegetation and noted on the map. Telephone wire in the vicinity makes the feature highly suspect as a modern structure.

There were no structures or features on the rim that could be definitely associated with the Samoan prehistory.

**SOUTH VALLEY**

At the toe of the talus forming the saddle which separates the crater basin and the south valley is the first feature that could be identified as a Samoan structure; this is a stone wall, noted as wall number 6 on the map.

Wall 6. The wall runs in an irregular line across the valley from east to west. It is of dry-layed construction made of unmodified chunks of lava. The downhill side of the face is 5.9 feet high and the inside, or uphill side, is from 0 to
1.6 feet high. Due to limited time, it was not determined how much of the inside face had been buried by erosion from the higher elevation. The valley at this point is about 106.6 feet wide. The wall is of double faced, rubble-filled construction.

About 91 feet down valley of Wall 6, there are numbers of small stone mounds along the edge of a newly planted taro patch. From this patch to the mouth of the valley is a continuous taro patch divided by the next stone wall, Wall 7. Near the bend in the valley, and about 91 feet up from Wall 7, there are the remains of a stone structure, probably a pig pen. The walls are of the double faced, rubble-filled construction.

Wall 7. This wall, also of the double faced, rubble-filled construction, is the better constructed and the better preserved of the two walls. In the center, it is 5.9 feet high on the downhill side, and about 2.6 feet high on the uphill side. The wall is constructed of large slabs of dry-layed lava. The foot trail along the bottom of the valley and over the wall joins the main highway near the residence of High Chief, Fuimaono.

CRATER BASIN

Except for a natural erosion mound near the base on the west side of the crater, and the wooden remains of an abandoned shelter on the east, there were no other significant archeological remains on the crater floor. The crater floor is now under
cultivation, and probably has been under cultivation for a number of years. There are some newly planted banana and taro patches on the east side of the basin while the west and north sides are fallow. "Wild taro" is in evidence throughout the areas which are being left fallow.

The wooden structure in the crater could still be used as a shelter from heat and rain as well as a temporary storage area for harvested crops; therefore, it is probably not completely abandoned.

SADDLE

The saddle between the crater and the south valley is near the 380 foot contour line. It forms a narrow plateau about 196.8 feet across the valley, and about 49.2 feet wide. A number of features on the saddle appear to be old.

Feature A. This is a stone wall, 60.3 feet long with an average height of 2 feet and 2.4 feet in width, parallel with the trail into the crater and running at a slight angle up the east slope (Plate 2).

The wall borders a newly planted taro patch (Plate 3). The northwest end, closest to the edge of the crater basin, may have cornered and extended up the east slope; however, fallen trees and clearing for planting has completely destroyed any evidence.
The southeast end blends into the hillside and ends. This wall is also of the dry-layed, bifaced, rubble-filled construction.

**Feature B.** This feature is composed of four stone mounds in a nearly straight line across the gap of the plateau between the east and west slope (Plate 4). They average 4.26 feet high and 5.90 feet in diameter (Plate 5). They are evenly spaced near the inside edge of the plateau. The distance from the northwest end of Feature A to the first mound, going east to west, measures 32.8 feet; from Mound 1 to Mound 2, 32.8 feet; from Mound 2 to Mound 3, 31.48 feet; from Mound 3 to Mound 4, the widest gap, 42.64 feet. From Mound 4 to the base of the west slope and onto what appears to be a man-made soil mound, also measures 32.8 feet. All four mounds are less than 4.9 feet from the edge of the crater basin.

**Feature C.** This is an elevated area at the base of the west face of the crater rim (Plate 6). It appears to be a natural rise. However, along the north side or edge of the mound, there is a very poorly defined line of stones which could be a low wall (Plate 7). The surface area is covered with fist size stones but, in no definable pattern. Near the "wall", on the surface, a length of baling wire and some plastic coated World War II telephone wire were found.

**Feature D.** About 36.08 feet down valley of the fourth mound along the edge of the crater, and parallel to the eastwest
alignment of stone mounds, there are the remains of a stone wall (Plate 8). The portions that are intact are in a very poor state of preservation. The upper surface, behind the wall, between Mound 4 and Feature D had been cleared, planted in taro and is now fallow.

The first fragment of wall is 19.68 feet long and 5.9 feet high. Since the top has been badly disturbed, it could not be determined if this was of biface construction or not. At this time, it appears to be a terrace, or retaining wall, that is, it is faced only on the down hill side and filled in behind with small stones and soil. There is a 11.8 foot gap between this and the next intact portion. The next portion is 13.77 feet long and 3.93 feet high. From the end of the latter portion to a large flat stone, probably a part of the original wall, it is 19.68 feet. No other stones occur between the large flat stone and the base of the east slope or Feature A (Plate 9).
GENERAL REMARKS

Although 'Olovalu Crater is not archeologically pristine as originally thought, there are some remains which are of significance.

First of all - it is interesting to note that there were only one or two people who could remember the military occupation of the crater during World War II. And, I, from a third hand source, was told that the name of the crater was originally Pago Crater. Other sources which I consulted simply referred to it as "the Crater at Futiga" or "the Crater near Futiga Village". William K. Kikuchi, in his survey report, simply lists the name "'Olovalu" under his discussion of place names in American Samoa which used 'Olo, fort or refuge, as a prefix (Kikuchi, 1963, p. 67). In another section he mentions that "A tapu stone, ST-121, was reported on the ridge of the volcanic crater at Futiga Village..." (Kikuchi 1963, p. 84, my underline). If the crater was called by any name at the time Kikuchi made his survey in 1963, he makes no mention of it. To the best of my knowledge, the name "'Olovalu" appears for the first time on a map prepared by the National Park Service in May, 1965.

There is no archeological evidence to support the thesis that the crater was used as a "fortified" village. However, even had the crater served such a function, we need not expect to find archeological evidence of it. "Warfare" in ancient Samoa was characterized
more by raiding activities than by pitched battle between
organized armies.

Refuge areas were apparently only temporarily used (Kikuchi,
1963, p. 72), and it is likely that permanent structures were
not erected. Perhaps the temporary refugees "lived under the
trees", as suggested by our guide, Bingham. Even had shelters
been built, say on the pattern of those in use in the valley
today (with a raised, pole floor), their remains might not have
survived.

The only other habitation remains that we might reasonably
expect to survive the destruction of time and the jungle are the
fire-cracked stones associated with cooking. These stones are
of a distinctive kind of basaltic lava which could have been
easily spotted against the contrasting soft, aa lava. No such
evidence was recorded in our survey.

The most evident factor which would explain the lack of
archeological remains, is that the crater basin has been under
cultivation for a number of years. It has not been long, however.
According to local information, no one would go into the crater or
valley because it was the home of the aitu, demons and ghosts,
and was a place to be avoided at all cost. It was not until after
World War II that people began to use the crater because "the
military made it safe".
The two walls, Wall 6 and 7, traversing the valley are substantially constructed and are in good condition. Wall 7 appears to be younger only in the fact that the deposition behind the wall is considerably less in relation to Wall 6. However, the degree of slope must be taken into account in comparing the two walls. The slope immediately behind Wall 6 is approximately 40 degrees, whereas the slope behind Wall 7 is probably less than 15 degrees. There is no opening or gate in the walls. In both cases steps are formed by rough layed stones on the down hill side of the wall.

If these are defensive walls there is little or no evidence to support the theory. "Apparently war defense walls pa taua, are recent introductions into Samoan culture because pre-European villages do not display any walls that indicate defensive purposes. However, while any wall can be effectively used in war, it was only with the introduction of rifles and cannons that walls began to play a larger part in Samoan warfare" (Kikuchi, 1963, p. 46). The only documented pa taua in American Samoa is on the island of Aunu'u (Ibid., p. 47).

I agree with Kikuchi that "... any wall can be effectively used in war..." even a pig wall or an agricultural wall. Walls 6 and 7 now serve very nicely as agricultural walls. The walls and the very steep scarp on either side of the valley form an
enclosed area planted with taro. The area was, and is, probably also used as a pa pua'a, a pig wall. Several stone mounds, the results of land clearing, are in evidence throughout the area. In addition, Kikuchi also points out that "most stone walls result from agricultural land being cleared, and serve to mark family plantations and keep pigs from damaging plants. The walls vary in extent and in size, but normally stand 4 to 5 feet high and 2 to 3 feet wide..." (Kikuchi, 1963, p. 46). I, unfortunately, was unable to check "ownership" boundaries, but Walls 6 and 7 may form boundaries of a family land-use plot, beside being a pig enclosure. The dimensions of the agricultural walls reported by Kikuchi are interesting. Walls 6 and 7 are about 5 feet high and therefore conform - this is also just about as high as an "average" man can reach or lift a stone with ease. Also, this would indicate that both walls were "free standing" when constructed even though the back is now buried.

The fragmentary remains of a wall near the summit and below the brow of the crater basin forming the saddle is interesting. This is not a wall in the same sense as Walls 6 and 7, but is more of a retaining face or terrace face. That is, the face wall was constructed and the space behind filled with stones and soil to form a level area. As will become evident below, there is no doubt that this terrace wall extended across the valley.
Is Feature D a defensive wall? Could be. If it is, it must be pre-European. Certainly there is no place to hide from a rifle ball or a cannon. However, by standing on top of the terrace one could make a strong defense if there were only spears and clubs to combat. I must hasten to add, however, that it could have been constructed to keep pigs out of the main crater area and/or it could have been constructed to create a good sized taro patch, 36 by 195 feet. The surface of the present terrace shows every sign of having been recently under cultivation.

Perhaps the most significant archeological features located during this brief survey are the four stone mounds on the summit of the saddle, Feature B (Plates 4 and 5). These, according to Maafala, were used for netting pea'a, the large fruit bat that inhabits the crater. When Maafala came to live at Futiga from another district "many years ago", the mounds were already constructed. These, he thought, had been constructed of stones removed from a wall in back of the mounds (Feature D). He had participated in capturing pea'a. Because of time limitations, I was unable to ascertain all details regarding this activity. However, he did briefly describe the method of capture as follows: Two long poles were used between which a net was stretched. The net was kept down along side the mound until a bat was seen approaching. Standing on top of the mound, the trapper timed the flight, raised
the net in front of the approaching bat, moved the net forward and in the same motion "folded" the net thereby snaring the bat. A helper would then remove the bat from the net. How the bat was killed, how it was cooked, etc., were not determined at that time.

Kikuchi notes briefly that "a very large cave at Malaeloa, called 'Bat Cave', ST-102, is the abode of bats, and the favorite hunting ground of the people of Malaeloa who are termed 'bat eaters' (Kikuchi, 1963, p. 70). Our guide pointed out that the bats at Malaeloa cave are the smaller pea'a pea'a, and not the fruit bat of 'Olovalu Crater.

It must be understood that this is only a preliminary study. There is, however, some justification for the establishment of the crater as an ethnobotanical park. It could be annexed to the Matautuloa Point Park, proposed in 1965. Interpretation of the crater and its features could encompass archeological remains, the World War II remains, the Botany, and Samoan history and prehistory. Several of the archeological features should be excavated, especially Feature D, for a better understanding of the construction and if possible to recover datable material. The next logical step should be the preparation of a detailed "Interpretive Prospectus" (See recommendations, report #2, p. 20).
1. The volcanic crater referred to at various times as the Crater near Futiga, Pago Crater, and now called 'Olovalu Crater is nearly 1000 feet wide from rim to rim and over 190 feet deep. The Crater basin is now cultivated by village members of Futiga.
2. Feature A is a stone wall 60.35 feet long, 2 feet high and 2.4 feet wide. The northeast end of the wall blends into the hill side and the northwest end is at the edge of the crater basin.

3. Parallel to Feature A is the trail into the crater and on the down hill side is a newly planted taro patch.
4. Feature B is composed of four stone mounds across the saddle.

5. The stone mounds are near the inside edge of the saddle and are 4.26 feet and 5.90 feet in diameter. They were used in netting the pea'a, fruit bats.
6. Feature C is a soil and stone mound at the west end of the saddle.

7. The mound was cleared. At the inside edge of the mound is a crudely constructed wall. A fragment of baling wire and World War II telephone wire were found on the surface.
8. Feature D consists of two short sections of poorly constructed and poorly preserved walls which crossed the saddle.

9. From the east end of the broken wall (Feature D) to the toe of the talus on the east side of the valley, there are no other indications of walls. The wall according to one resident was removed to build the bat netting mounds.
ECOLOGICAL SURVEY OF OLOVALU CRATER
ISLAND OF TUTUILA, AMERICAN SAMOA

PREPARED BY

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JULY 1970
Preface

This report is the result of a recognition by Governor John Haydon of the need to carefully evaluate the existing archeological and natural resources of American Samoa. With the continually accelerating 'development' of American Samoa, the opportunity to locate, describe and preserve historic and contemporary aspects of the landscape is fast disappearing. As the Governor recognizes, it is especially important that development progress with an eye toward the recreational and aesthetic needs of the native Samoans as well as the increasing number of visitors.

Specifically, this study focuses upon the archeological (separate report) and ecological values of Olovalu Crater on the island of Tutuila. Originally considered as a possible garbage disposal site, several cursory observations suggested the presence of both archeological and botanical values. Basic information contained in this report was developed during a field study by Pacific Archeologist Edmund Ladd and the undersigned from July 6 through July 14, 1970, and by a review of applicable literature. The two principal objectives of this portion of the study were:

1. To gather basic information on the distribution and character of the biotic associations in Olovalu Crater.

2. To integrate these data with information on the physical factors into an ecological overview of the area.
Sincere thanks are extended to County Agent Bingham Tuisamatatele for his invaluable assistance as interpreter-guide and in identifying unfamiliar plants. Thanks are also due Farm Superintendent Maina Atafua for clarifying and assisting in plant identification. Appreciation is extended to District Governor High Chief Fuimeono for offering the services of the above mentioned men and for helping to piece together the contemporary history of the crater. Special thanks go to Chief Maafala, longtime steward of Olovalu Crater, for his cooperation and assistance.

The team is especially grateful to Governor Haydon for not only creating the opportunity for the project but for offering housing, transportation and many other courtesies. We commend the Governor for his sensitivity to the resource needs at this critical juncture in the growth of American Samoa.
Overview of resources and needs in American Samoa

American Samoa is the eastern part of the Samoan group of islands, a chain of volcanic islands running in a general northwest-southeast direction and extending over a distance of 200 miles. Located approximately 2,600 miles southwest of Hawaii and 1,600 miles northeast of New Zealand, Samoa is situated in the heart of Polynesia. Collectively, Samoa comprises two political groupings. Western Samoa consists of Savaii, Upolo and five smaller islands; American Samoa is made up of Tutuila, Aunuu, the Manua archipelago and Rose and Swain atolls. The area of each island generally decreases from the northwest island of Savaii to the southeast Manua group.

Of the American Samoa group, Tutuila is by far the largest in both land area and population. The capital and Government administrative offices are on Tutuila at Pago Pago. In general, Tutuila consists of an irregular and somewhat twisted volcanic ridge, with spurs and short lateral ridges culminating in 2,141 foot Matafao and Pioa peaks. It is just over 20 miles long, with a width ranging from 1 to 2 miles in the eastern half and 2 to 5 miles in the western. Geologically, Tutuila is the oldest Samoan island and is characterized by deep valleys, narrow ridges and broad amphitheaters eroded from the original dome-shaped land mass. The topography, heavy rainfall and high humidity are conducive to dense tropical growth.
Largely due to the difficult topography and dense vegetation, much of the interior of the island is nearly inaccessible and is of marginal quality for the traditional methods of agriculture. Consequently, extensive portions of Tutuila are still relatively pristine. However, population growth and economic development have reached the point where major degradation of the environment is occurring associated with the more densely populated areas. The population of American Samoa has grown from 5700 in 1900 to nearly 30,000 today. This increase is outstripping the ability of the natural environment to cope with the wastes and land altering activities. A continuing infusion of modern technology has to date far outdistanced the implementation of compensatory protective measures.

All of the islands of American Samoa are very small. Many plants and animals have developed that do not naturally occur elsewhere. Like most oceanic, insular environments, the indigenous ecosystems are generally less complex and consequently less stable than those in large continental areas.

Water pollution from improper sewage collection and treatment, oil pollution in Pago Pago harbor, fertilizers and insecticides, erosion on disturbed slopes, and reef destruction are several deleterious influences of immediate concern. While none of these is as yet an obvious threat to the biota of Olovalu Crater, it is precarious to mentally divide an island as small as Tutuila, or any of the even
smaller outlying islands, into separate biological compartments. The effects of environmental mismanagement can rarely be confined to one geographic area or one resource. The land and water must collectively be treated as a unit.

OLOVALU CRATER

Geology:

Olovalu is the recent name for a crater located on the south side of Tutuila at the base of the dominant ridge. The small village of Futiga is situated about one-half mile below the south side of the crater. The crater itself is about 200 feet deep and 1,000 feet across, indented at the summit of a cone about one-half mile in diameter. Three smaller cones are aligned along the same fissure. The large cone was evidently the product of a short-lived magmatic explosion that blasted lavas from the main chamber. (Stearns, 1942). The spatter indicates that the explosions died down to a fire fountain. Later, ash fell from craters at higher elevations. Similar tuff lies in the floor of the crater also. There is evidence that ocean water repeatedly entered the vent and blast after blast occurred.

Quarry deposits on the southeast slope consist of irregular, stony masses of essentially olivine basalt ranging in size from small pellets to irregular chunks 2 feet across and angular blocks of ancient basalt up to 7 feet across.
Erosion and disintegration have been responsible for a soil which, at best, is shallow over much of the area. Most soils are the weathered remains of usually vesicular basaltic rocks and shales (Setchell, 1924). For the most part the crater wall substrate is regosolic, though a weakly developed Al horizon has developed in small depressions. The rim has an almost continuous layer of shallow (6-10 inches), poorly developed loamy soil. There is little erosional dissection of the crater landscape. The crater floor has much deeper soils in which moisture and humus content depart widely from other types.

Climate:

Climatological data for Olovalu crater must be extrapolated from the nearest weather stations. The following is a narrative summary of the general weather patterns.

American Samoa has a maritime climate with abundant rain and warm, humid days and nights. Rainfall, usually falling as showers, averages above 125 inches annually at the airport, but varies greatly over small distances owing to topography. Thus, Pago Pago, less than four air miles north of the airport, and at the head of a hill-encircled harbor open to the prevailing wind, averages nearly 200 inches annually. The crest of the range receives well above 250 inches.

The driest months are June through September, and the wettest, December through March. However, the seasonal rainfall may vary widely in individual years and heavy showers and long rainy periods can occur in any month.

The average annual temperature is near 80°F. June, July, and August are the coolest months and January, February, and March the warmest.
but the mean annual range of temperature is only about 30°F. The highest temperatures recorded are in the low nineties and the lowest near 60.

The prevailing winds throughout the year are the easterly trades, though interruptions occur in both summer and winter.

Relative humidity varies little through the year. During afternoon hours, with maximum wind and sun, it averages 78% and during the still night averages a muggy 88%.

These data probably fairly closely approximate conditions in Olovalu Crater, which is less than 3 miles from the airport weather station. Due to the physiography, doubtlessly the daytime relative humidity remains slightly higher in the crater, though moderate breezes were experienced. Rainfall may also be slightly higher because of the upward incline.

Ecological history:
There is no compilation of historical activities or conditions with, or directly related to, Olovalu Crater. However, regional history combined with bits of information gathered from scattered sources provides a limited knowledge of human pressures.

Early references to the crater (Stearns, 1942, MacDonald, 1942) do not use the name Olovalu; in fact, no name other than "the cone above Futiga" is used. According to Chief Fulmeono, the crater was called Pago Crater before World War II. Prior to the war, natives reportedly
did not venture into the crater because of a aitu or spiritual taboo.
Details as to the nature or duration of this period of superstition
are lacking. The vegetation on the crater floor before it was dis-
turbed is said to have been dominated by a mixed forest of asi
(Endiandra eleocarpa), aoa (Ficus graeffii warburg), mosoii'
(Canangium odoratum) and fau (Hibiscus tiliaceus) trees. During
World War II American troops established a network of observation
pillboxes on top of the crater walls, especially along the east side.
Partially as a result of this occupation, the native Samoans set
aside their traditional fears.

The appearance of the crater markedly changed following the war.
Most of the large trees were removed and used in the building of
fales (Samoan houses). Except for a poorly drained area near the
center, nearly all of the crater floor was cleared of native vegetation
and turned to agriculture. Coconut trees were planted.

The present appearance of the floor, except for the limited swamp-
forest middle portion, bears little resemblance to pristine conditions.
Taro (Colocasia sp.) is the principal crop, interspersed with bananas
(Musa sp.), breadfruit trees (Artocarpus communis), papaya (Carica
papaya) and tapioca (Mahihot utilissima). An estimated 20-25% of the
floor was actually under taro during the period of this study, though
it is obvious that all of the cultivatable land has been cleared and
planted in turn. Several species of exotic and pantropic plants
have invaded the disturbed areas and now dominate the ground cover
in areas not currently planted.
The lower strata of the swamp-forest have probably changed little despite the several trails dissecting this zone. A very few, scattered mature trees and several younger examples of asi and mosoi' in the lower strata suggest that a conspicuous upper canopy may have formerly existed.

Trails and openings established incident to the observation boxes on the crater rim have left noticeable scars. Several cleared areas have persisted with a complete break in canopy. Despite the extremely high productivity of these tropical native forests, they do not normally regenerate quickly in the impoverished soil of clearings. Where the forests used to be are large clumps of 6 foot 'U' grass (*Miscanthus japonicas*) or the exotic fue-saina (*Mikania micrantha*). There appears to be an imbalance of floristic composition which is probably due to selected or random tree removal in the past.

An anomaly in this connection is the puzzling mosaic of successional stages and species associations that have developed around some of the disturbed sites. Additional study may correlate these patterns to soil distribution, local deficiencies of trace elements, or differences in land use during the disturbance period.

Though poorly documented, the more suitable trees have evidently been felled and removed from the more accessible portions of the rim. Least affected by man's impact are the inner walls of the crater. These walls are all but inaccessible due to their incline (15-35%),
the dense tangle of vegetation, and the loose rocky substrate.
As a result, this zone has been spared the human endeavors which
have altered the remainder of the crater.

Present vegetation communities:
For reasons of clarity and convenience, the crater is divided into
four zones. This is an artificial division based on both natural
and man-made boundaries. Each zone is described relative to species
composition and dominance.

Scientific and Samoan names are those used by E. E. Bryan in his 1935
paper "Samoan and Scientific names of plants found in Samoa."

Zone 1:
A nearly circular, dense jungle covers approximately 25% of the crater
floor near its center. It is underlain by a deep, hydromorphic,
clayey soil which is reportedly unsuitable for agriculture. Though
no surface water was visible during this study, the area is interlaced
with spongy stream beds. Following heavy rains the entire swamp-
forest may be inundated for several days.

A mixed forest dominated by fau (Hibiscus tiliaceus) is the pre-
dominant vegetation type. Atone (Myristica inutilis), and tavai
(Rhus taitensis) reach codominant status with fau at the south end.
A few mosoi trees occur throughout the forest. Beneath this canopy
is a layer composed of scattered filimoto trees (Flacourtia rukam),
matilafi (Psychotria samoana), mati (Ficus tinctoria) and the spectacular olioli' fern (Angiopteris evecta). Conspicuous under-
story species include ti (Cordyline terminalis), birds nest fern
(Asplenium nidus) and soga (Pipterus argentea). Several species of
fern comprise the rather sparse ground cover, including Polypodium sp.,
Nephrolepis sp. and Dryopteris sp.. The avaava'itutu (Piper tutuilae)
and fue manogi (Hoya sp.) are vines commonly associated with the
arborescent forms. Two examples of the large vine Rhabidophora
graefei were supported by stone trees. Notable epiphytes included
a species of orchid (Dendrobium sp.) and the birds nest fern.

Few exotics have become established in this 'closed' ecosystem except
in localized disturbance sites. Here, fue saina and the native
morning glory (Ipomoea conjesta) provide a dense ground cover.
Significantly, three mature guava bushes (Psidium guajava) grow at
the periphery of the forest. They probably grow on long neglected
disturbed sites and offer a hint as to an eventual dense shrub stage
in the absence of continued cultivation.

Despite the human impact, this zone is still significant. The
atypical soil which has developed here under unusual conditions of
drainage and microclimate is geographically limited in American
Samoa. Likewise, the vegetative expression of this soil is noticeably
different in aspect than the forests associated with the better
drained soils. Moreover, like Hawaiian kipukas, it offers a rela-
tively simple ecosystem for a more in depth study or for the
appreciation of the lay visitor.
Zone 2: Surrounding zone 1 and extending to the base of the crater walls is a zone which for all practical purposes has been completely modified by agriculture. Less than 25% of this zone is actively cultivated at one time; however, the remainder is covered by a veneer of introduced and pantropic species not natural to the crater. The soil in this zone is also deep, but is more loamy in texture.

The staple crop is taro (Alocasia sp.). Other cultivated plants include bananas, papaya, breadfruit, tapioca, yams, and coconuts. Several small fala (Pandanus sp.) and nonu (Morinda citrifolia) were probably also planted by human hands.

Vestiges of the former vegetation exist in the form of scattered soga, tavai, asi, mosoi, fau, and one immense aoa tree.

An interesting and reasonably consistent secondary succession occurs on cultivated and subsequently temporarily abandoned land. Almost immediately after clearing, ma'u'u tonga (Commelina nudiflora) and fue saina appear, joined in moister areas by la' au-solosolo-i-ie-vai (Pepperomia pallida) and in the dryer sites by la'au-fai-pale (Euphorbia hirta). While the fue saina persists, the Commelina and Pepperomia are gradually displaced by morning glory interspersed with the dominant grass Paspalum conjugatum, plus Panicum sanguinale and a species of Digitaria. In what must be considered a temporary disturbance climax, a species of sword fern (Nephrolepis), pepe toa (Asclepias corassavica),
pate (Coleus blumei), and fua-lele-lili'i (Emelia sonchifolia)
become scattered in varying densities through the dominant mat of
fue saina and morning glory.

Along the frequently used trails, with dryer soil regimes, the exotic
vaofefe (Mimosa pudica), exotic vaq-papalangi (Cenchrus echinatus)
and Sida rhombifolia are well established.

Achieving co-dominance with fue saina at the northern end of the
crater floor is fue fuss (Vigna marina). No satisfactory explanation
for this seemingly atypical situation could be determined.

In general, the border between zone 2 and the crater slopes (zone 3)
is quite distinct, except where cleared sites extend part way up the
slopes. Here, fue saina and especially morning glory gain access
and form a thick mat on the indigenous trees.

It is difficult to access the long term effect of cultivation and
the concommitant dominance of introduced fue saina. A number of
investigators attribute the lack of forest regeneration in cleared
areas to the smothering density of this species (Caum, 1940). It
has been known to smother and even kill breadfruit trees in aban-
doned fields. Without doubt, this more seasoned biotic competitor
is able to displace native species in disturbed areas; however, as
has been demonstrated elsewhere in the crater, it cannot successfully
invade an undisturbed ecosystem. Moreover, it may prove to be a
soil enriching agent with cumulative effects sufficient to improve poorly used soils to a condition adequate for forest re-growth.

Zone 3: As was mentioned earlier, this is unquestionably the zone manifesting the least alteration by man. The same factors that have held earlier human intrusion in abeyance likewise discouraged this investigator from making extensive forays up the slope. Even with limited coverage, the diversity of this forest was most apparent.

There are no constant stratum dominant throughout the zone. It appears as a complex mosaic of overlapping species associations that defy correlation with physiographic factors. Among the more conspicuous upper stratum components are: atone, mosoii, malili (*Terminalia richii*), ifi (*Inocarpus edulis*), and ala'a (*Charisessa samoensis*). Lower to middle stratum tree species include: fa'uui (*Grewia crenata*), tavai, mamalava (*Planchonella garberi*), matalaf (*Psychotria samoana*), fisoa (*Colubrina asiatica*), lagali (*Aglaios samoensis*), soga, and masama (*Glechidion ramiflorum*). Relative abundance estimates were not realistically possible due to the difficult access.

Beneath the tree canopy are scattered at least three types of tree ferns, all locally called olioli'. These are *Angiopteris evecta*, *Alsophila* sp. and *Cyathea* sp.. Common in the more open sites is the banana like lau-fao (*Heliconia bihai*). The ubiquitous vines are largely fuen manongi (*Hoya* sp.) and avaava'itutu. Another very common climbing shrub is the maile (*Alyxia* sp.). Less frequent but notable is the i'e i'e (*Freylinetia* sp.). At least 10 different species of ferns were observed at both ground level and epiphytically. These included examples from the following genera: *Polypodium*, *Pteris*,
Dryopteris, Asplenium, Elaphoglossum, Cyclophorus, and Mircrolepis. Species of Dendrobium and Bulbophyllum orchids were frequently seen growing epiphytically.

These slopes probably support one of the better remaining samples of lowland forest left on the South side of Tutuila. Although it is not primevil in every sense of the word, it offers an area where disturbance by exotic plants and animals is minimal, hence allowing the studying, viewing and enjoyment of a site not dominated by the hand of man.

Zone 4:
The vegetation associated with the circular summit ridge is similar in many ways to that described in zone 3, but with a few notable exceptions. Two factors combine to render the physiognomy of this zone noticeably different. The first of these is the aforementioned disturbance during World War II. Several formerly cleared sites are now covered with 'U' grass (Miscanthus japonicus) or a dense profusion of fue saina and morning glory. Many coconut trees are scattered along the rim and probably date to plantings made during the war.

The second factor is the presence of a discontinuous layer of soil of varying depth. Possibly as a consequence, several species were recorded here that were not observed elsewhere. Fau trees assume a local dominance, seemingly correlated with the deeper soil. This species is all but absent on the predominantly regosolic substrates of zone 3.
Another new species conspicuous along the rim is the ngatae tree (Erythrina variegata orientalis). Its coral blossoms provide a stark and delightful contrast against the green jungle growth. One example of the ifelele tree (Intsia bijuga) was observed. Though this was the only example seen, this survey was hardly adequate to draw conclusions on its abundance or distribution. Masoa (Tasea pinnatifida) was the only herbaceous form collected here which was not recorded from other zones.

Other than these few deviations, the floristic structure of this forest appears as a slightly depauperate replica of zone 3. A detailed repetition of the species composition would serve little purpose. Few mature trees of the large, commercially valuable species are evident, particularly adjacent to the formerly disturbed areas.

Notwithstanding the disturbances of 25 plus years ago, much of value remains. The very absence of the disturbance indicator, fæ saina, over large segments of this forest attests to its value as a natural reserve for indigenous ecological processes. Further, the previously noted anomalies in secondary succession patterns in the disturbed areas make this an outstanding laboratory for students of tropical ecology.

**Wildlife:**

Birds - Very little information has been published on the present status, numbers and habits of Samoan birds. Ashmole (1963) published
a compendium based on a literature review and specimens in the Bernice P. Bishop Museum, Honolulu. Her paper, plus two short annotated lists (Keith, 1957; Dunmire, 1960), plus notes by Clapp and Sibley (1966) constitute nearly all the contemporary notes. These papers, supplemented by the Mayr Field Guide to Western South Pacific Birds (1945), did provide sufficient help in identification and distribution to allow at least a preliminary survey of Olovalu Crater.

The most frequently seen and heard species was the Samoan starling (*Aplonis atrifuscus*). Less frequent but still common was the white-rumped swiftlet (*Collocalia spodiopygia*). The most conspicuous birds observed were the white-tailed tropic bird (*Phaethon lepturus*) and the fairy or white tern (*Gygis alba*). Both were seen daily in the crater. Tropic birds were observed entering and leaving tree openings, possibly nests. Occasional sightings of the Polynesian starling (*Aplonis tabuensis*), white-collared kingfisher (*Halcyon chloris*), cardinal honeyeater (*Myzomela cardinalis*), and banded rail (*Rallus philippensis*) rounded out the species of birds recorded from the crater.

Although all of the birds observed during this study are reportedly common over much of Tutuila, the tragic demise of Hawaii's native avifauna well illustrates the vulnerability of island residents. It is significant that all of the species noted are native to Samoa. A key to their survival will be the perpetuation of adequate natural habitat.
Mammals:

To the uninitiated, one of the most fascinating forms of wildlife in Samoa is the large fruit bat (Pteropus sp.). A number were seen flying adjacent to the inside walls of the crater. Historical notes indicate large fluctuations in bat populations, running from extremely common to rarely sighted. One low point in the 19th century was attributed to an outbreak of a disease of European origin. (Carter, 1945) What effect the increased use of pesticides and herbicides, plus the inevitable habitat modification will have on the bats is not known.

The native vegetation of Samoa has benefited from the diligence of its Samoan landlords. By not allowing a large population of feral pigs to become established in the forests, a major disturbance factor, prevalent on other Pacific Islands, is not an important influence in Samoa.

Scenic and aesthetic qualities:

The island of Tutuila possesses some of the most fascinating and captivating landscapes in Polynesia. Practically every scene reveals the omnipresence of natural forces. Given this idyllic setting, it is difficult to hone in on geographically limited sites, but nevertheless necessary if one is to really appreciate the larger scene.
For the visitor wishing this more personal experience, Olovalu Crater has artistic and philosophical appeal. The sculpturing of the land emphasizes the causative factors. The vegetation pattern is an expression of both these factors and the influence of the Samoan way of life. Further, the crater is so situated that the rim is an excellent observation platform for viewing the lowlands of Tutuila. One has only to hike into the crater to dissolve completely the sights and sounds of 20th century technology.
Recommendations:

1. There is a need to set aside a representative sample of lowland Samoan forest for future study and enjoyment. Even with the recent human impact, - of interest in its own right - the forest on the rim and along the crater walls offers this opportunity in an extremely pleasing geographic setting.

2. Retaining, and even encouraging, agriculture activity on the crater floor is not necessarily inconsistent with preserving the surrounding forest. However, this should be allowed to develop and evolve naturally. People should not be paid to put on demonstrations; the demonstration aspects of interpretation can best be handled elsewhere. The emphasis here should be on the natural setting and continuing the Samoan way under the most natural conditions.

3. Every effort should be made to halt further destruction of the limited swamp-forest on the crater floor.

4. Visitor access to the crater might best originate from the cinder pit with a foot path ending at Futiga Village. (see attached maps) The proposed trail should lead visitors to the vicinity of World War II defensive fortifications and structures associated with recent Samoan history. Interpretation of these sites would be an integral part of the visitors experience.
Regardless of the route selected, the path should be as inconspicuous as possible. Of equal importance, access routes must be developed with as little disturbance as possible.

5. A continuous effort should be made to prevent the intentional or accidental introduction of additional new species, parasites or diseases.

6. Use of persistent herbicides or pesticides should be prohibited in the crater. There is little hope of perpetuating the varied resources as a natural system beneath a periodic application of poison.

7. Should Olovalu Crater be established as an archeological-natural reserve, it is recommended that a much more detailed, multi-disciplined study be conducted to fully analyze the archeological, historical, and ecological resources and how each might be most successfully perpetuated, protected and interpreted for visitor enjoyment.
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