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STRATEGIC ENGINEERING STUDY
NO. 103

# HALMAHERA (MOLUKKAS)

# TERRAIN INTELLIGENCE

*Prepared by*
GEOLOGICAL SURVEY, U.S. DEPARTMENT OF THE INTERIOR
*Under direction of*
CHIEF OF ENGINEERS, U.S. ARMY

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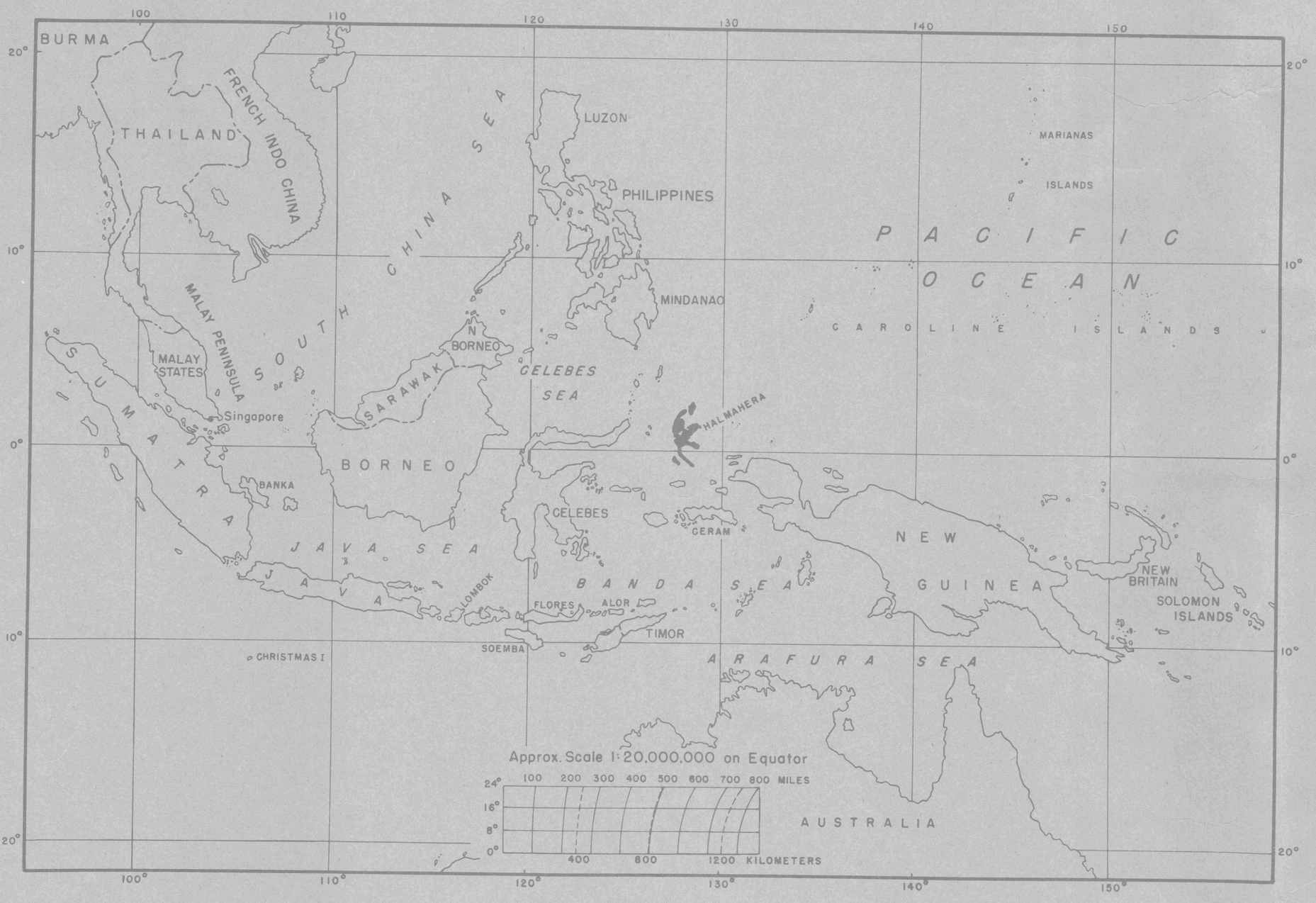


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**NO. 103**

# HALMAHERA (MOLUKKAS)

## TERRAIN INTELLIGENCE

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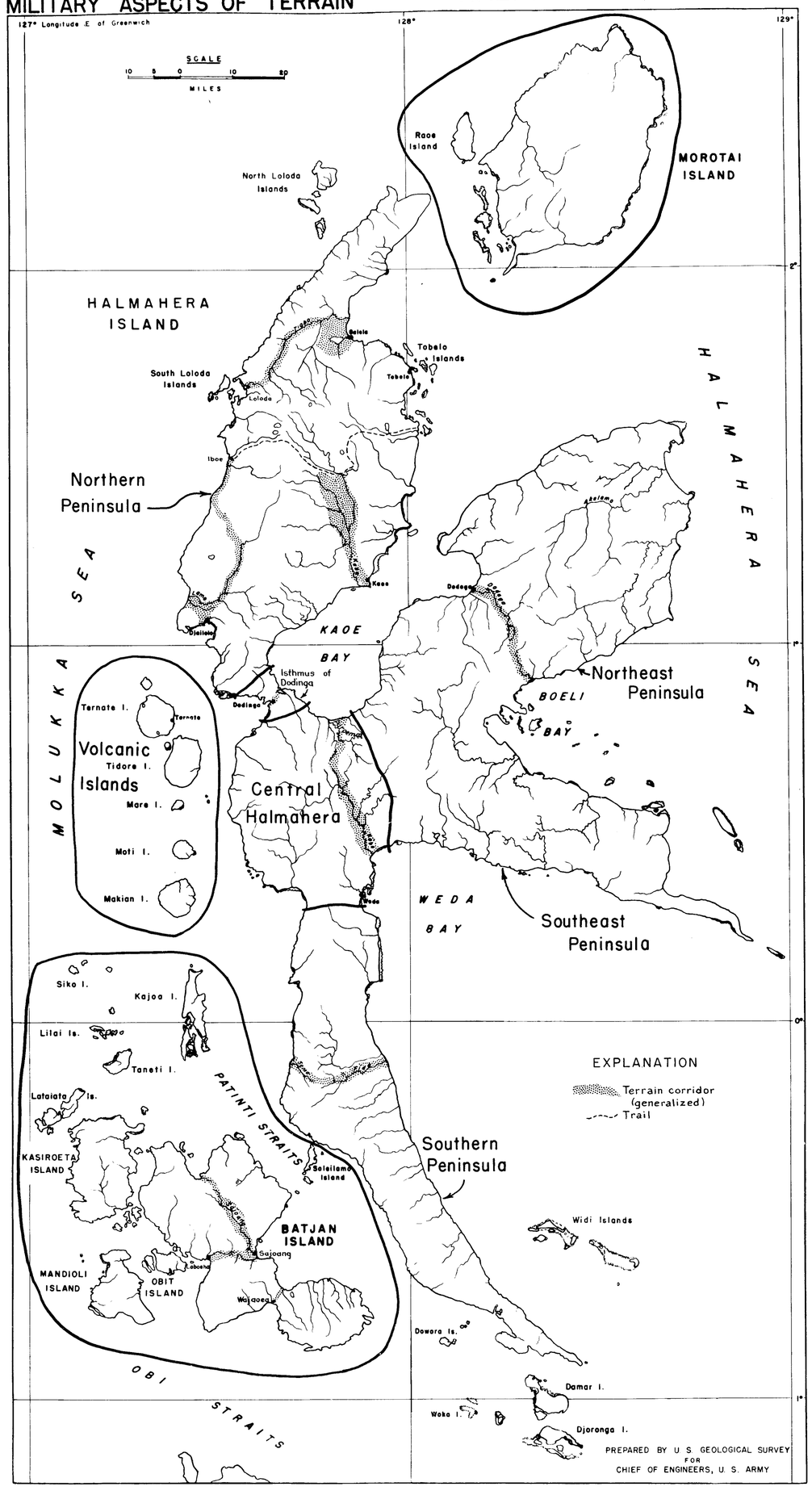
FOREWORD

This folio was rushed to completion on urgent request from the Strategic Intelligence Branch, Office of Chief of Engineers. The geologists, soils scientists, and ground-water hydrologists had completed their studies in manuscript form, but time was not available for editing the folio, coordinating its different parts, or checking it for inconsistencies. Parts of the text have not even been proof-read for typing mistakes.

U. S. Geological Survey

# MILITARY ASPECTS OF TERRAIN — HALMAHERA (MOLUKKAS)



# HALMAHERA (MOLUKKAS)

## MILITARY ASPECTS OF THE TERRAIN

### I. INTRODUCTION.

Halmahera and its adjacent islands form part of the northern Molukkas and control the northern sea lanes between Celebes, New Guinea, and the southern Philippines. The islands are rough and mountainous with level ground restricted to small discontinuous areas on the coast and along the larger rivers. All are heavily forested.

Important settlements such as Ternate, Djailolo, Galela, and Tobelo, are on the coast; few have more than 2,000 inhabitants and most have only a few hundred. Population is sparse and concentrated largely on the island of Ternate and the northern peninsula of Halmahera.

### II. TERRAIN.

Three types of terrain common to Halmahera and its adjacent islands are described below and are recognizable on the accompanying map: coastal lowlands, interior mountains, and valley corridors.

A. Coastal Lowlands.

Topography. Consists of flat to undulatory alluvial plains and narrow irregular terraces cut by small stream gullies. These areas, bounded by steep mountains and rocky headlands, are more numerous and extensive along the east coast of Halmahera than on the west coast, or on the Batjan Islands, where they are mostly small and isolated. Morotai is probably similar to the east coast of Halmahera.

Movement and obstacles. Unimpeded movement of foot troops confined mostly to trails and immediate vicinity of larger settlements. Trails are muddy much of the time. Elsewhere movement difficult because of dense rain forest which covers much of the area; thickest along stream banks. Stream beds where shallow are commonly used for trails. However, some streams near the coast are over 100 ft. wide and too deep to ford. Coconut groves on sandy parts of coast are fairly open, but difficult swamp areas of dense mangrove and nipa palms, occur at many places. Movement along coast for long distances is difficult. Open grassy areas are most common on well drained terrace surfaces and the larger plains such as at Kaoe and Galela.

B. Interior Mountains.

Topography. On Halmahera, Morotai, and the Batjan Islands the interior mountains, which terminate along the coast in high cliffs at many places, are rugged and broken by numerous steep narrow valleys and sharp ridges. Summit altitudes average 2,000 to 3,000 ft. with a maximum of over 6,000 in the Sibela Mountains of Batjan. Ternate, Tidore, Moti, and Makian Islands off west coast of Halmahera form a chain of volcanoes which rise abruptly from the sea and extend diagonally across northern peninsula of Halmahera from Djailolo to Galela.

Movement and obstacles. Movement almost everywhere difficult for foot troops, impossible for vehicles without road construction. Valley bottoms are narrow and confined; trails keep to sharp ridge crests; are muddy much of the time. Steep slopes covered by dense rain forest jungle make going rough. Streams rocky, but fordable.

C. Valley Corridors.

These penetrate or cross the islands in several strategic places. Chief obstacles to movement are dense vegetation, muddy trails, swamps, and river crossings.

1. Northern peninsula of Halmahera.
   a. The narrow valley of the Tiabo River connects a broad plain west of Galela with Loloda on the west coast; low pass.
   b. The broad valley of the Lamo River connects the plain at Djailolo with Tboe on the coast to the north.
   c. The broad plain of the Kaoe River penetrates 25 miles inland to a swampy basin from which trails cross the mountains to north, east, and west.
2. Isthmus of Dodinga. A low, hilly corridor crosses isthmus; 2 miles between Kaoe and Dodinga Bays.
3. Central Halmahera. The broad valley of the Kobe River leads inland from Weda Bay across a low hilly divide to the headwaters of the Paroemal River; the latter opens onto broad marshy plains along the south shore of Kaoe Bay.
4. Northeast peninsula of Halmahera. The valley of the Dodaga River leads inland to a fairly steep pass which opens southward into a narrow valley that leads to the plain bordering Boeli Bay.
5. Southern peninsula of Halmahera. The broad high plains adjacent to the Fida River lead west to a low pass across the mountains to the narrow valley of the Semo River and the west coast.
6. Batjan Island.
   a. A broad swampy plain crosses from Laboeha to Sajoang on the east coast.
   b. The narrow valley of the Sajoang River leads north from Sajoang through a broad interior basin and across a low pass to a north coast bay head.
   c. A narrow plain crosses the 1.5 mile isthmus east of Wajaoea.

### III. CLIMATE.

The islands have a hot moist equatorial climate. Rainfall at sea level varies from 60 to 110 inches, well distributed throughout the year; falls mostly as a steady drizzle during the southeast monsoons (May to October) and as sharp showers during the northwest monsoons (November to April). Cloudiness averages 4 to 6 tenths sky cover ; mean temperature range 69° F. to 84° F.; humidity 70%.

### IV. WATER SUPPLY. Abundant supplies are available.

A. Existing supplies. Main streams perennial, but fluctuate seasonally. In exceptional years many tributaries may at times be very low or dry. A few shallow native wells near villages. Due to prevalence of water-borne diseases all water regardless of source requires treatment to be safe.

B. Potential supplies. Large supplies of ground water can be developed from wells sunk 20 to 40 ft. in alluvial plains or 40 to 100 ft. in nearby foothills and terraces. Wells near coast may be contaminated by salt water if overpumped.

### V. GEOLOGY.

Chain of potentially active volcanoes on islands off west coast of Halmahera extends across northern peninsula to Galela. Interior mountains of Halmahera's four peninsulas and of other larger islands are underlain by deeply weathered igneous rocks; bordering foothills and coastal regions mostly underlain by interbedded sedimentary rocks (conglomerate, sandstone, and limestone).

### VI. SOILS.

Mountain soils mostly sandy clay loams and clay loams, locally stony; are 5 to 20 ft. or more deep, commonly well drained, friable, and fair to good subgrade material. Soils of alluvial plains vary from coarse gravelly sand to fine clay loams and swamp muck. If well drained, have good construction characteristics. Most soils if worked or subjected to heavy traffic when wet become muddy and bog down equipment.

### VII. CONSTRUCTION MATERIALS AVAILABLE.

Trap rock of various qualities is abundant, but not everywhere well exposed; best is on northern peninsula of Halmahera and the volcanic islands. Massive limestone is locally obtainable in the central mountains of Halmahera. Coral limestone, abundant nearly everywhere on hillsides and terraces along coast, is the best all-purpose rock. Gravel and sand can be had from river bars and banks. Gravel also obtainable from conglomerate deposits in the foothill regions of the larger islands and coarse shelly coral sand from many beaches. Large supplies of timber of construction grade are available. Nearest developed source of fuel is Boela oil field on Ceram.

### VIII. PROBLEMS OF ROAD CONSTRUCTION.

There are only about 35 miles of road on the islands. Twenty miles of this total are around Galela, 8 miles on Ternate. Roads require improvement to be suitable for more than light traffic. Good network of existing jungle trails and more frequented paths between settlements. Several natural corridors across Halmahera and Batjan are suitable for road alignment. Swamps abundant along coast, but can generally be by-passed. River crossings, clearing, and mud are major problems on coastal plains. Steep slopes and possibility of landslides are additional obstacles in mountains.

### IX. POSSIBLE AIRFIELD SITES.

There are many sites which appear suitable for airfield construction on Halmahera and its adjacent islands. Most have space for only one runway 6,000 ft. or more long. All are on or readily accessible from the coast, but ship-to-shore transportation necessary. Most of the sites are on sand-clay alluvial soils. Some are on thin finer textured clayey soils overlying coral limestone; a few are on plains of loosely consolidated volcanic ash. The alluvial sites require extensive clearing of rain forest and may have some drainage difficulties, but need little grading and, if well drained, should stabilize easily. The others require less clearing, but more grading is necessary and some are natural grass land. All are well drained and soils will stabilize fairly easily. The best sites are on the extensive plains west of Galela.

### X. OPERATIONAL EFFECTS.

A. Long stretches of steep rocky coast, coral reefs, and mangrove swamps may limit and locally obstruct landings.

B. Mountainous terrain in interior of islands restricts movement to discontinuous coastal plains separated by rocky headlands. Movement along many stretches of coast is difficult.

C. Valley corridors that cross the islands at strategic places integrate otherwise isolated coastal areas.

D. Ample water supplies can be developed everywhere.

E. Vegetation is nearly everywhere dense. Coastal lowlands and inland valleys are swampy in many places.

F. Construction of new roads required in practically all parts of the islands. Trails, except for short distances along coast, will need improvement.

G. Most streams are fordable, but a few are over 100 ft. wide and 8 to 15 ft. deep.

H. Many possible sites for new airfields, but clearing of jungle required.

I. Lack of periodic dry season results in possibility of poor weather conditions at any time of year.

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

## INTRODUCTION

This folio of maps and explanatory tables outlines the principal terrain features of Halmahera and adjacent islands in the northern Molukkas. Each map and table is devoted to a specialized set of problems; together they cover such subjects as terrain appreciation, construction materials, construction problems, water supply and possible airfield sites. The maps and data were compiled by the U.S. Geological Survey during the period from November 1943 to March, 1944. The compilation was under the direction of the Chief of Engineers.

## METHOD OF COMPILATION AND RELIABILITY OF DATA

This folio is based on study of available geologic and topographic information. The reliability of the data presented varies with the adequacy of the source information and the degree of interpretation required. Each sheet is given a reliability rating. The ratings range from Class A, excellent to Class D, poor.

Available literature is scanty. The principal sources used are given below.

## PRINCIPAL SOURCES OF INFORMATION


General

Atlas von Tropisch Nederland, 1938.

Braak, C., Klimakunde von Hinterindien und Insulinde: Band IV, Teil R, Handbuch der Klimatologie in funf Banden, Berlin, 1931.

Brambila, M. The tepetate soils of Mexico: Proceedings of the Sixth Pacific Science Congress. Berkeley, California, 1939.

Brouwer, H. A., Uber gebirgsbildung und vulkanismus in den Molukken: Geologische Rundschau, pp. 197-209, vol. 8, 1917.

Brouwer, H. A., Geologische onderzoekingen op de Sangi eilanden en op en eilanden Ternate en Pisang: Jaarbuch van het Mijnwezen, in Nederlandsch-Oost-Indie, vol. 49, pp. 1-68, 1920.

Campen, C.F.H., De landbouw op Halmahera: Tidschrift voor Nijverheid en Landbouw in Nedeslandsch-Indie, vol XXIX, pp. 1-17, 1884.

Campen, C.F.H., Beschrijoing van de westkust van het Noorder-schiereland van Halmahera: Bijdragen tot do Taal-Land-en Volkenkunde van Nederlandsch-Indie, Vijfde Volgruks, Derde Deel, pp. 154-162, 1888.

Deninger, K., Einige Bemerkungen uber die Stratigraphie der Molukken und uber den Wert paleontalogischer Alterbestimmungen uberhaupt: Neues Jahrbuch fur Mineralogie, Band 11, Heft 1, pp. 1-15, 1910.

Encyclopaedie van Nederlandsch Indie, Vol. I, 1917, pp. 625-626, 733-734, 737, 803. Vol. 2, 1918, pp. 8, 515-516.

Fairchild, David, Garden Islands of the Great East; 1943.

Gogarten, Emil, Der Vulkan "Tolo" auf Halmahera (Molukken): Petermann's Mitteilungen, Vol. 63, pp. 242-246, 1917.

Hoevell, W. R. vau, De Moluksche eilanden Tydschrift voor Nederlandsch Indie, pp. 231-265, 1856.

Hueting, A., De Tobeloriezen in hun denken en doen. Bijdr. tot de Taal, Land, -en Volkenkunde van Nederlandsch Indie, p. 267, Band 77, 1921.

De Jongh, G.J.J. De oostkust van Noord-Halmahera: Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap, 2nd Serie, Deel XXVI, pp. 747-772, 1909, with good bibliography.

Prince Leopoldvde Belgique, Resultats scientifiques du voyageaux Indes Orientales Neerlandaises: Memoires du musee royal d'histoire naturelle de Belgique, Vol.1, Brussels, 1933.

Martin, K., Reisen in den Molukken: Leiden, 1903.

Mededeelingen van het Encyclopaedisch Bureau, Halmahera en Morotai, Afd. XIII, 1917.

Mohr, E. C. Jul., De Bodern der Tropen in het Algemeen en Die van Nederlandsch-Indie in het Bijzonder, deel II, Tweede Stuk; Halmaheira: Koninklyke Vereeniging Kohmiad Institunt, Amsterdam Mededeeling No. XXXI, Afdeeling Handels museum No. 12, pp. 162-174, Amsterdam, 1935.

Ruinen, W., Ovetzicht van de literatuur betreffende de Molukken: Deel I, pp. 1550-1921, 1928.

Verbeek, R.D.M., Rapport sur les Moluques: Edition francaise du Jaarboek van het Mijnwezen in Nederlandsch Oost-Indie, Tome XXXVII, including Atlas, Batavia, 1908.

U. S. Dept. of Agriculture. Climate and Man, 1941 Yearbook of Agriculture.

Wallace, Alfred Russel. The Malay Archipelago: several editions from 1869 to 1890.

Wanner, J., Zur Geologie der Inseln Obimajora und Halmahera in den Molukken: Neues Jahrbuch fur Mineralogie, Geologie und Paleontologie, Beilage-Band, 36, pp. 560-585. 1913.

Zondervan, H., Die Insel Halmahera: Geographische Zeitschrift, vol 35, pp. 596-616, 1929.

Zondervan, H., Het eiland Halmahera: Tijdschrift voor Economische Geographie, 21 ste Jaargang, no. 3, pp. 91-96, 1930.

Intelligence Reports

Allied Geographical Section, Southwest Pacific Area, Area Study of Northern Molukkas (excluding Soela Islands): Terrain Study No. 71, Oct. 23, 1943.

Allied Geographical Section, Southwest Pacific Area, Directorate of Intelligence, Allied Air Forces: Vegetation study, Eastern New Guinea, July 28, 1943.

Division of Naval Intelligence, Office of Chief of Naval Operations: Field Monograph of Netherlands East Indies, March 25, 1941.

Engineer Research Office, Special Report No. 51, Vol. 5, Molucca Group, Sept. 1943.

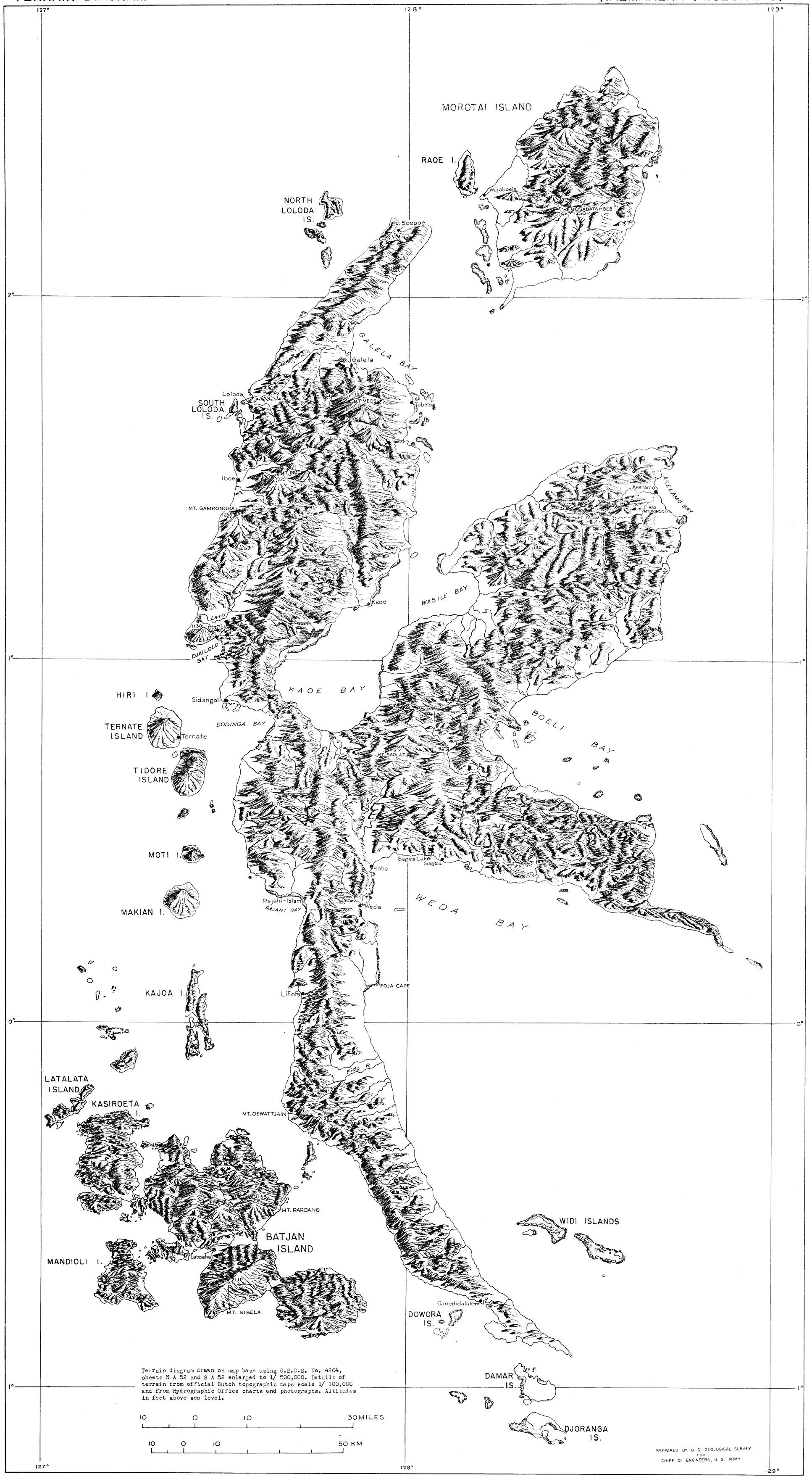
Geographical Section of the Naval Intelligence Division; A Manual of Netherlands India (Dutch East Indies), I.D. 1209, Admiralty, London, 1920.

U. S. Navy Sailing Directions for New Guinea and the islands eastward of Celebes and Timor: H. O. no. 136, 1936, Third edition, Washington, D. C., 1936.


Preliminary text submitted
without checking or editing.
U. S. Geological Survey

# TERRAIN DIAGRAM

# HALMAHERA (MOLUKKAS)



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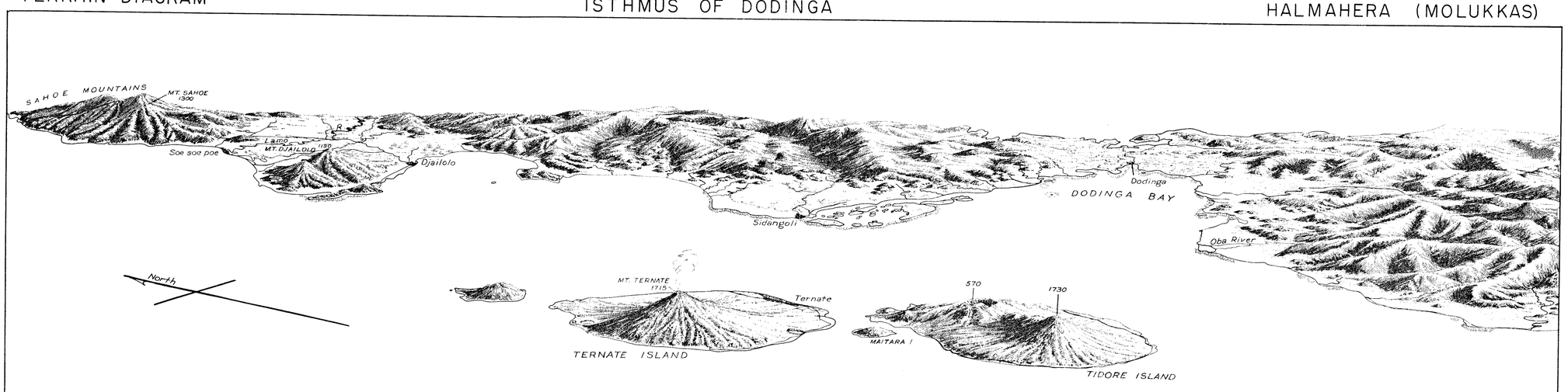
# TERRAIN DIAGRAM

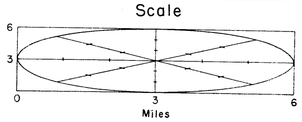
## ISTHMUS OF DODINGA

## HALMAHERA (MOLUKKAS)




Orthographic projection made mechanically from A.M.S. Netherland Indies maps 1:100,000 and from A.M.S. T661 maps 1:20,000 reduced to 1:100,000 with additional data sketched from photographs. Altitudes in feet above sea level. Vertical angle of view 15 degrees. Vertical scale not exaggerated. The scale is a similar orthographic projection of a square and an inscribed circle 6 miles in diameter. Distances on the diagram between points of equal altitude can be scaled along the diameter parallel to the line between the two points.

Scale

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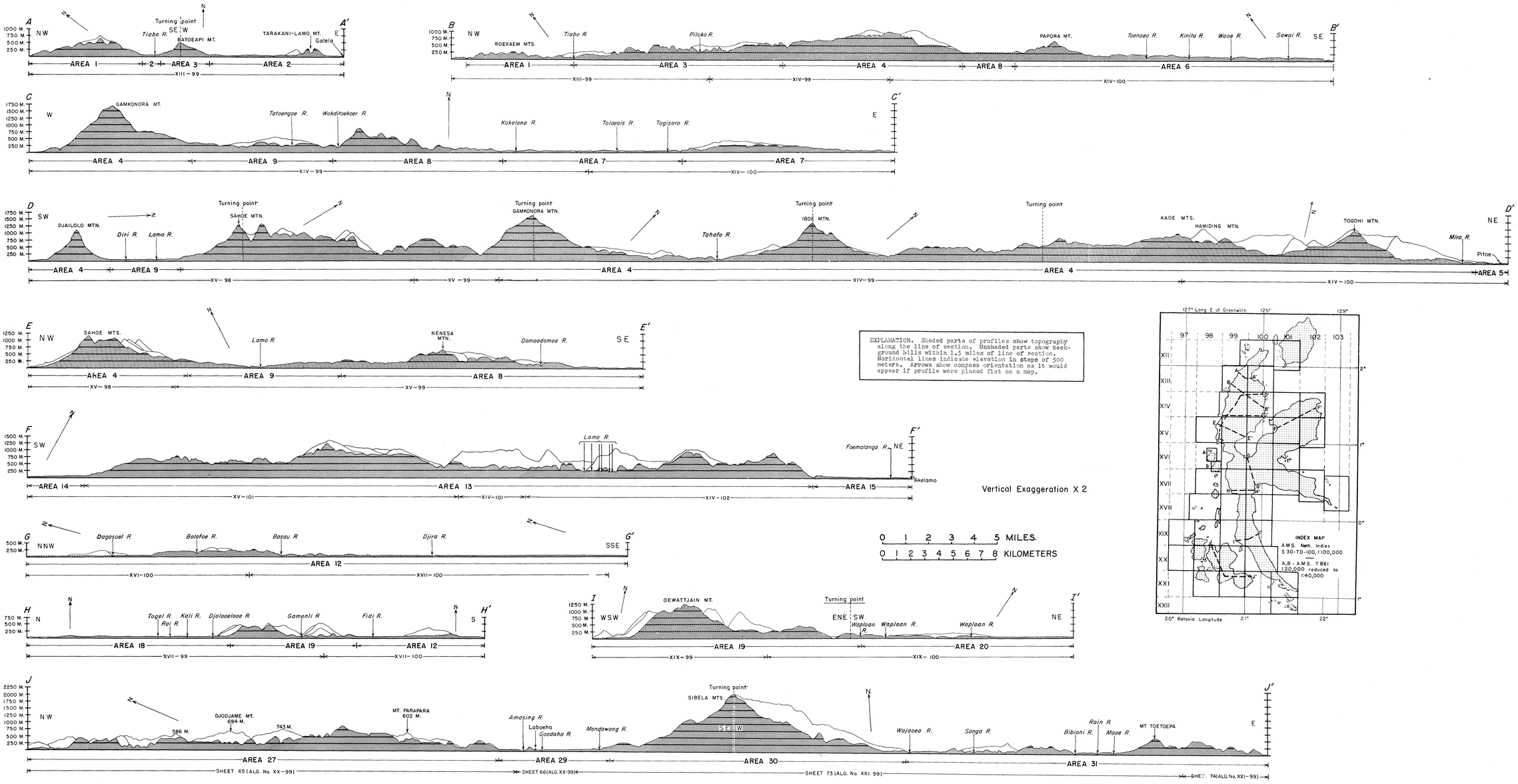


EXPLANATION. Shaded parts of profiles show topography along the line of section. Unshaded parts show background hills within 1.5 miles of line of section. Horizontal lines indicate elevation in steps of 500 meters. Arrows show compass orientation as it would appear if profile were placed flat on a map.




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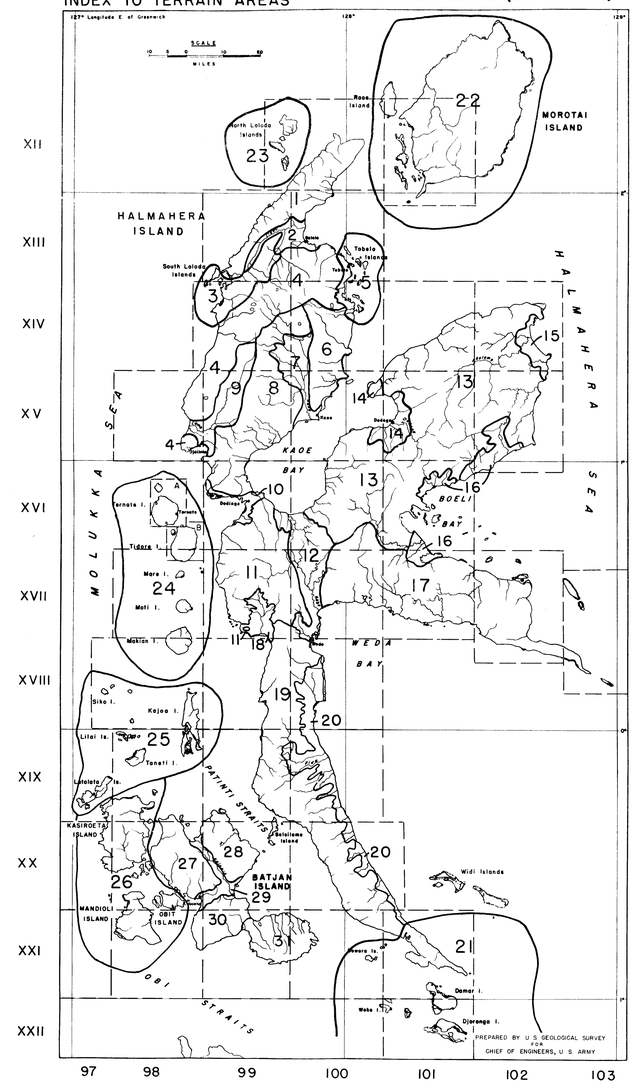
INDEX TO TERRAIN AREAS

# HALMAHERA (MOLUKKAS)

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# HALMAHERA (MOLUKKAS)

# TERRAIN APPRECIATION

## INTRODUCTION

Halmahera and its adjacent islands form part of the northern Molukkas and control the northern sea lanes between Celebes, New Guinea and the southern Philippines. The islands are mountainous and heavily forested. Level ground is restricted to small discontinuous areas along the coast and along the larger river valleys. The topography of the region comprises 31 terrain areas which are discussed in detail in the following quadrangle descriptions, but can be briefly outlined under 8 general geographic units.

## Topography.

1. Northern Peninsula of Halmahera: Composed of four distinct mountain ranges (areas 1, 4, 6 and 8) separated in part by three valley corridors (areas 2,7 and 9) with associated areas of foothills and coastal terraces (areas 3 and 5). Altitudes range from 1500 to 3000 feet, maximum about 4,500 feet in area 4. In areas 1, 6, and 8 the mountains are rough and broken by numerous deep narrow ravines and gullies. Ridges and spurs are steep and have sharp crest lines. The mountains of area 4 are high rugged volcanoes which form a chain from Djailolo to Galela. Regions around the volcanic cones are extremely rough and deeply dissected. The mountain areas for the most part impinge on the coastas steep cliffs or rocky slopes, though east slopes of area 6 are more gentle.

Beaches and flat areas are limited to heads of small coves on the west coast and to discontinuous narrow coastal plains and higher irregular terrace land on east coast. At Galela (area 2) a broad plain extends inland for several miles; north of the town along the coast, it is swampy. From this plain, the narrow valley of the Tiabo River leads inland to a low pass across hilly country to Loloda and nearby marshes along the coast (area 3). Another broad valley leads inland along the Kaoe River (area 7). The coast southwest of the settlement of Kaoe at the river mouth is marshy and overgrown with mangrove. A broad basin near the headwaters of the river is also locally swampy, but the plains bordering the river are mostly flat to rolling and well-drained. From the head of the corridor, good trails traverse low passes to north, east and west. A broad plain at Djailolo (area 9) is continuous inland with the valley of the Lamo River that traverses a rolling interior upland basin. Low passes north and south of Gamkonora volcano provide access to Iboe on the west coast.

2. Central Halmahera : Narrow isthmus of Dodinga (area 10) forms connection between northern penninsula and massive mountains to south ( area 11 ). To east corridor of Paroenasal and Kobe Rivers (area 12) connects Kaoe and Wesa Bays. Low hills of isthmus (area 10) are nearly crossed by narrow plain; distance only 2 miles. Mountains (area 11) are rugged with steep slopes, sharp spurs and high rolling uplands cut by deep narrow gorges. Summit altitudes and relief are 1500 to 3,000 feet. Coastline cliffed or rocky, with a few narrow stretches of coastal plain as at Akelamo. Valley of Paroenasal River (area 12) narrow. Opens onto broad swampy plain along shore or Kaoe Bay with beaches at east near Ekor. Low pass across mountains to broad terraced valley plains along the Kobe River. Low sandy coast. The broad valley of the Bai River (area 18) is enclosed by rough mountains with extensive mangrove swamps along the coast.

3. Northeastern Penninsula: Interior rugged, mountainous (area 13); along coast broad alluvial plains at heads of large bays (areas 14,15 and 16). Altitudes in mountains (area 13) average over 1,500 feet; maximum about 4,500 feet. A rough broken region. No central range, but a series of high ridges and deep narrow valleys having no regularity in orientation. Summits rounded, but secondary spurs are sharp and steep. Foothills in coastal region with local irregular terraces. Cliffs or steep slopes along the shore. Alluvial plains (areas 14, 15 and 16) around bayheads are gently undulating and heavily forested; swampy plains in many places along the coast. Beaches are narrow.

4. Southeastern Penninsula: On west coast mountain range (area 19). On east coast continuous plain ( area 20). Mountains become lower to south and rolling hilly upland ( area 21) forms tip of penninsula

4. Southeastern Penninsula: (area 17) Rugged mountain ranges having no regional orientation; at tip is long narrow ridge jutting into sea. Altitude and relief mostly 1,000 to 2,000 feet. Maximum altitude 4,000 feet in western part. Summits broad, accessory spurs sharp, slopes steep, and valleys deep and narrow. On north side narrow coastal lowland; on south side cliffed headlands along coast separate small alluvial flats in bayheads. Beaches are narrow. No corridors across this area.

5. Southern Penninsula: On west coast mountain range (area19); on east coast continuous plain (area 20). Mountains become lower to south, and rolling hilly upland (area 21) forms tip of penninsula. Damar and Djoronga Islands (area 21) are flat with central knobby hills and swampy southern coasts. Rough mountain range (area 19) rises abruptly along west side of penninsula. Summit altitudes average about 1,700 feet; maximum 4,125 feet; mountains are broken by deep narrow ravines and sharp spurs. Slopes are mostly steep, but eastern slope is gentle with long gravel-covered ridges projecting toward the sea. Broad stream valleys merge with continuous low coastal plain (area 20). Streams are sunk in narrow trenches somewhat below general level of valley floors. Coastal plain is flat to gently rolling with terraces locally against the mountain ridges.

6. Morotai Island: Little is known of Morotai Island (area 22) except that it has a rough mountainous interior broken by numerous sharp ridges and deep valleys. No corridors cross it, though plains along the Tjao (Pilowo), Goegoerina (Tjioe) and Pangoe Rivers penetrate it as broad interior basins. Summit altitudes 2,000 to 3,000 feet; maximum 3,750 feet. Local relief commonly 1,000 feet. Coasts are mostly rocky, though there are broad alluvial plains as at the southeastern corner of the island and at Wajaboela. Numerous discontinuous, irregular terraces along the southwest coast.

7. Batjan Group: A group of mountainous islands (areas 25 to 31) having steep rocky coasts; small swampy plains occur locally along the shore. Batjan, the largest island, is crossed by three valley corridors. Two are in area 29; the third, in area 31, crosses the narrow isthmus at Wajaoea. The mountains of Batjan (areas 27,28,30 and 31) are rough, with altitude and relief commonly 1,500 to 3,000 feet; broken by numerous sharp ridges and short steep balleys. Slopes are eferywhere steep. The Sibella Mountains (area 30) are highest, 6,300 feet and massive. The valley corridorsfrom Laboeha to Sajoang ( area 29) is broad and swampy with higher rolling ground along its southern border. North of Sajoang the valley of the Sajoang River (area 29) is narrow in its southern part, but opens into a broad interior plain. A pass through low hills leads to the valley of the Tjoro River and a narrow plain along the north coast. The isthmus of Wajaoea (in area 31) is only 2 miles wide and is traversed by a narrow valley bordered by low rolling foothills. The hills and mountains of Kasiroeta and Mandioli Islands (area 26) are rounded and relief is less than on Batjan, but the terrain is very broken. The islands of area 25 are rough and in many places along the coast are cliffed. Kajoa has a narrow coastal plain on its notheast side and is crossed by a low open corridor.

## Ground Conditions

Throughout mountain areas soil is generally deep and clayey. However,on volcanic peaks (areas 4 and 24) and on some of the higher ridges of the islands, particularly in the central region of Halmahera ( areas 11,12, and 17) and the Sibela mountains of Batjan ( area 30), the ground is rocky and there are numerous cliffs and ledges. In alluvial areas the soil is sandy and in places gravelly. On terraces along the coast it is fairly thin and clayey, with hard coral limestone locally at or near the surface. Most soils are well drained and provide good footing when dry,but all become muddy and slippery during and after rains. There are large tracts of swamp and marshland on many areas of coastal lowland and along larger river valleys; a few small tracts in upland areas. The swamp (moeras) is very wet and muddy, with standing water at the surface; locally men may sink to shoulder depth. The marshland (drasland) is also muddy, but less deep and there is generally no standing water. In dry seasons the land may become fairly firm and passable, but travel is slow. Beaches are mostly of coarse coral sand,but on west coast of Halmahera are locally rocky or gravelly. Mud banks occur near river mouths and tidal inlets.

A dense tropical rain forest or swamp forest covers most of the islands. Around settlements and on the larger plains there are clearings, gardens and areas of thick, brushy second growth. The virgin rain forest is a mixed stand of hardwood and softwood trees (mostly the latter) intergrown with a tangle of vines, creepers,lianas,ferns and other plants. Tree trunks are tall and straight, broad at base with buttressed roots; crowns form a continuous overhead canopy. Little sunlight penetrates to the ground which is dark and moist. Undergrowth is most dense along streams, in coastal areas and near the borders of the forest. On the higher mountain ridges and on drier terrace land along the coast the forest thins, with trees smaller and farther apart, and undergrowth thicker. Grassy plains (alang-alang) are rare, but may occur in some interior valleys and on coastal terraces. The largest are west of Galela (area 2) and near Kaoe (area7). Along streams dense bamboo thickets are common. Thick stands of sago and cane-like vegetation occur in inland swamps. Near the coast in brackish water swamps grow nipa palms with thick fronds, no trunks, and sharp spikes hidden in the muck. Many tidal swamps have mangrove woods with tangle of prop roots. Coconut palms with little undergrowth border the sandier strips of shore.

## Settlements

The islands are sparsely settled. Ternate and northern Halmahera are the most populated areas. Numerous native villages inhabited by a few score to a few hundred people are scattered along the coast and in a few of the larger interior valleys. The largest settlements are Ternate, Galela, Tobelo and Djailolo, each with several hundred to 1,000 inhabitants. Few modern buildings and residences of officials, missionaries and traders. The native settlements are of thatched huts, flimsily constructed, inflammable and generally closely spaced (views 1-10). Natives are docile, but indolent.

## Movement

Mountainous nature of terrain, dense rain forest jungle and lack of roads restrict mechanized movement to flat areas near the coast. Only roads are on Ternate (area 24), in vicinity of Galela (area 2) and Tobelo (area 5), on the plains at Kaoe (area 7) and on the isthmus of Dodinga (area 10). Other natural corridors suitable for road construction and now occupied by foot trails are outlined under topography.

A good network of other trails penetrates all parts of the area. In the mountains most trails follow the ridges; in valleys, the stream banks or bottoms. Trails are muddy, slippery and wet much of the time; are steep, winding and locally rocky in the mountains. Some rivers have narrow bridges; most can be easily forded. The larger ones may require construction of bridges or use of ferries.

Off trails movement is nearly everywhere difficult. The jungle is dense with many vines, creepers and underbrush; thickest along stream banks. Trails have to be cut. Ground is soggy and sunlight cut out by overhead foliage. In mountains slopes are very steep and broken by ravines and gullies; require much climbing up and down. In valleys and along coast swamps (moeras) and marshes (drasland) can rarely be by-passed and are difficult to cross; dense vegetation and muddy, possibly deep water standing in the swamps. Dry coastal plains and terraces form easiest going; may have more open forest conditions or grass land (alang-alang). Generally open second growth and clearings near villages, and coconut groves lining the coast. Largest open plains are at Galela (area 2) and Kaoe (area 7). There are few extensive beaches; best are on west coast of Halmahera. The majority are small with cliffs at either end. Most are of coarse coral sand and will support equipment; some are rocky. Barriers to landing are high cliffs along much of east coast of Halmahera and Batjan group, and extensive coral reefs or mangrove swamps along west coast of Halmahera and Morotai.

Enemy airfields are known to be e tablished at Galela (area 2), Tobelo (area 5), Miti Island (area 5), Kaoe (area 7) Djailolo (area 9, two strips) and Wasile ( area 13).

## Cover, Concealment and Observation

The broken compartmental nature of the terrain provides regional cover for fairly large troop units. Smaller topographic features such as ridge crests, stream banks and minor irregularities in the ground surface form local cover for small units. The dense jungle on most of the islands offers cover for individuals or small groups; many large trees with buttressed roots. Land is open only on larger plains and in areas under cultivation near settlements. A low step at the head of many beaches where vegetation begins offers some small protection to landing units. Foxholes are easily dug in the coral sand on most beaches, though some are rocky. In the jungle a dense mat of roots and vines makes digging difficult. On grassy plains foxholes are easily excavated. On terraces digging is generally easy, but coral rock may be near the surface. In swampy areas digging is hard because of tangle of roots; mud and water add to difficulties. Block houses readily constructed from materials at hand. In the larger towns a few stone buildings provide some cover for small units.

Excellent possibilities for concealment both from ground and air in jungle. Most trails are hidden by tree tops. Open ground only on larger plains, near settlements and on beaches.

Except on grassy plains and in settlements, ground view is limited because of density of vegetation; may be only a few feet, but more generally is several yards. Air view likewise limited by jungle. Clouds often hang low on higher mountains, but lookout over sea and beaches possible from cliffs along the shore.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Reliability rating: Class B.

Preliminary text submitted without checking or editing
U. S. Geological Survey

PREPARED BY U.S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U.S. ARMY

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Schetskaart van den Topografischen dienst in 1925.

# TERRAIN APPRECIATION

Blad 10 en 11. (Alg. No. XII-99 en 100.)

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

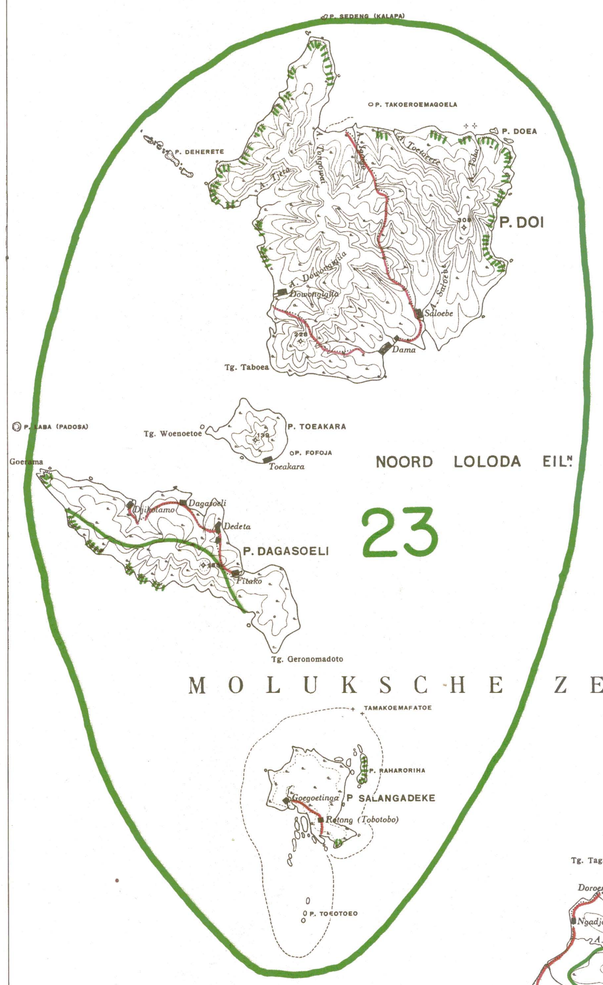
Lake

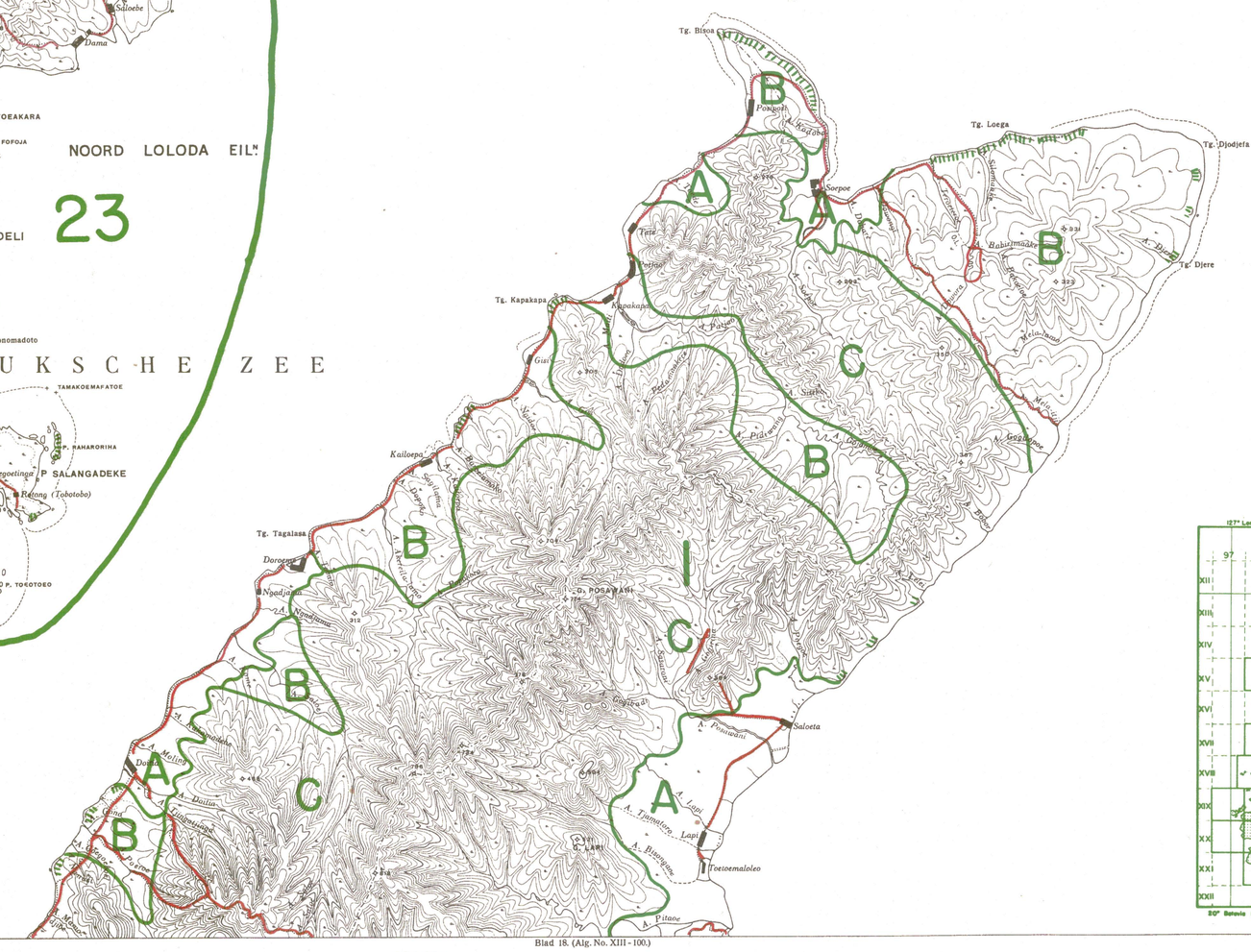
▲▲▲ Rocky area

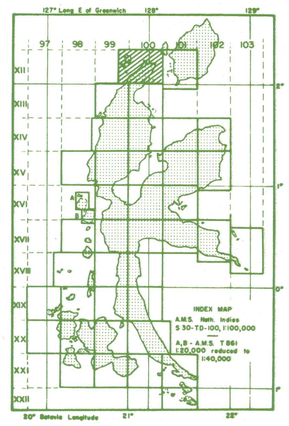
Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain




Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 18. (Alg. No. XIII-100.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600)

B. ADINDEELING.

| | | |
|---|---|---|
| | XI-100 | XI-101 |
| XII-99 | XII-100 | XII-101 |
| XIII-99 | XIII-100 | |

2°40′ N.B. — 1°40′ N.B. — 20°40′ — 21°40′ O.v. Bat.

ADM. INDEELING.

Trail

Road

| | |
|---|---|
| *Afdeeling* | *Ternate.* |
| *Onderafd.* | *Halmahera.* |
| *A. Ressort* | *Djailolo.* |
| *B. Ressort* | *Tobelo.* |

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperboomen* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemara- of Dennen bosch.* *Voetpad.* *Rivier. a. gemeten. b. niet gemeten* *Ressortsgrens.* *Paardenpad. a. duiker of doorlaat van bamboe.* *Bamboe huizen.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer. b. hulphoogtelijn, c. natuurlijke steilte, d. kleine verhevenheden, e. terreinoneffenheden, f. eiland, g. klippen bij laag water zichtbaar, h. klippen altijd boven water, i. laagwaterlijn.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, vooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000, blauwdruk zeekaart No. 1414a schaal 1:100 000 uitgave 1923 en volgens deze kaarten het blad georienteerd.*

VERKORTINGEN.

G. *Goenoeng.* P. *Poelau.* Tg. *Tandjoeng.* A. *Ake.* o.L. *Onderaardsche loop.*

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

**Reliability Rating: Class B**

SHEET NO. XII-100

Area No. 1. Soepoe Peninsula

Topography: Mountainous area with irregular central ridge attaining altitude of 800 m. Toward north ridge swings sharply across to east coast and then back to west coast. Main ridge gives off irregular lateral ridges that branch into innumerable narrow spurs. Slopes moderate at lower elevations, range to very steep at higher elevations. In the interior, valleys deep, valley bottoms narrow, except at head of Gojomoe (Patjao) River.

Streams short and small, with steep gradients flattening out toward coast. Channels narrow, water shallow except after heavy rain. Stream beds cobbly to bouldery along upper stretches, sandy to gravelly toward coast.

Coastal topography differs from point to point. On eastern side at south is broad coastal flat bordered by steep slopes and crossed by several small streams. Toward northeast, coast steepens, and narrow, discontinuous stretches of beach alternate with cliffed spurs. Northeastern tip of island terraced to heights of more than 100 meters. Except at terrace edges, slopes moderate. Locally low coastal cliffs; broad tidal flats offshore. On the western side of peninsula, two narrow coastal flats; elsewhere coast terraced or sloping, with discontinuous low cliffs.

Ground Conditions: Area covered by sandy loam to clay. Thickness ranges from few feet on higher and steeper slopes, and near terraced edges, to tens of feet on gentler slopes and coastal flats. Soil well drained, gives good footing, is moderately muddy when wet. Beaches sandy.

Area largely covered with virgin tropical forest. Near settlements, locally cleared land and second growth forest. Undergrowth generally moderate, but thicker along streams.

Settlements: Eight small native villages on the western coast, one at the north, and 2 on east coastal flat.

Movement: Mountainous backbone of area is barrier to transverse movement. Slopes along west coast and flats along east coast favorable to movement. Tropical forest impedes movement except on the beaches, and heavy rain-flooded streams are obstacles.

Foot paths are only communication lines. One path follows western shore to northern tip of peninsula, then crosses to eastern coast by an inland route. On the east coast short path connects two villages on coastal flat. Grades low on these trails. At the south, a foot path follows ridge route across the peninsula. Eastern part of this path is in quadrangle to south. Away from trails, best going for men on foot is along ridge crests or, during low water, along stream beds.

Landing operations possible on coastal flats on either side of island.

Cover, Concealment, Observation: Cover given by narrow ridges, stream banks, and larger hardwood trees. Field fortifications are feasible at all places, but gravelly soil may slow digging on lower slopes, and tough coral rock may be encountered at shallow depths near edges of terraces.

Dense forest provides complete aerial and ground concealment except in cleared areas near settlements.

Observation greatly impaired by the forest. Treetop observation posts at tops of steep slopes command adjoining coastal flats, but could not detect any activities below the forest ceiling. Projecting points along the shore give limited view of adjacent stretches of shoreline.

Area 23. North Lolada Islands

Topography: Group of 4 main islands with smaller associated islets. Doi at the north, the largest, is about 5 miles across and has a relief of about 300 meters. Topography rough, narrow ridges and spurs alternating with short narrow valleys. Slopes steep except for local terrace surfaces. Much of coast cliffed; practically no flat ground at shore level.

Toeakara is small hilly island, about a mile in diameter. Dagasoeli is about 5 miles long and more than a mile wide; relief 185 meters; slopes moderate at north, locally steep at south; coast cliffed at several places at south and west.

Salangadeke, about 4 miles from the mainland, is a mile in diameter, and of irregular outline; relief less than 50 meters; interior flat to undulatory, but coast has moderate slopes; broad fringing coral reefs.

Ground Conditions: Similar to Area 1, but soils may be muddier when wet.

Settlements: Islands all inhabited; each has one or more small native villages.

Movement: Doi unfavorable for landing operations and to movement. Other islands, more favorable but rather difficult. Forest cover an obstacle at all places. Existing trails are confined to a foot path crossing Doi from north to south, and to short stretches of path connecting villages on Dagasoeli and on Salangadeke.

Cover, Concealment, Observation: Same as Area 1.

**Preliminary text submitted without checking or editing.**
**U. S. Geological Survey**

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

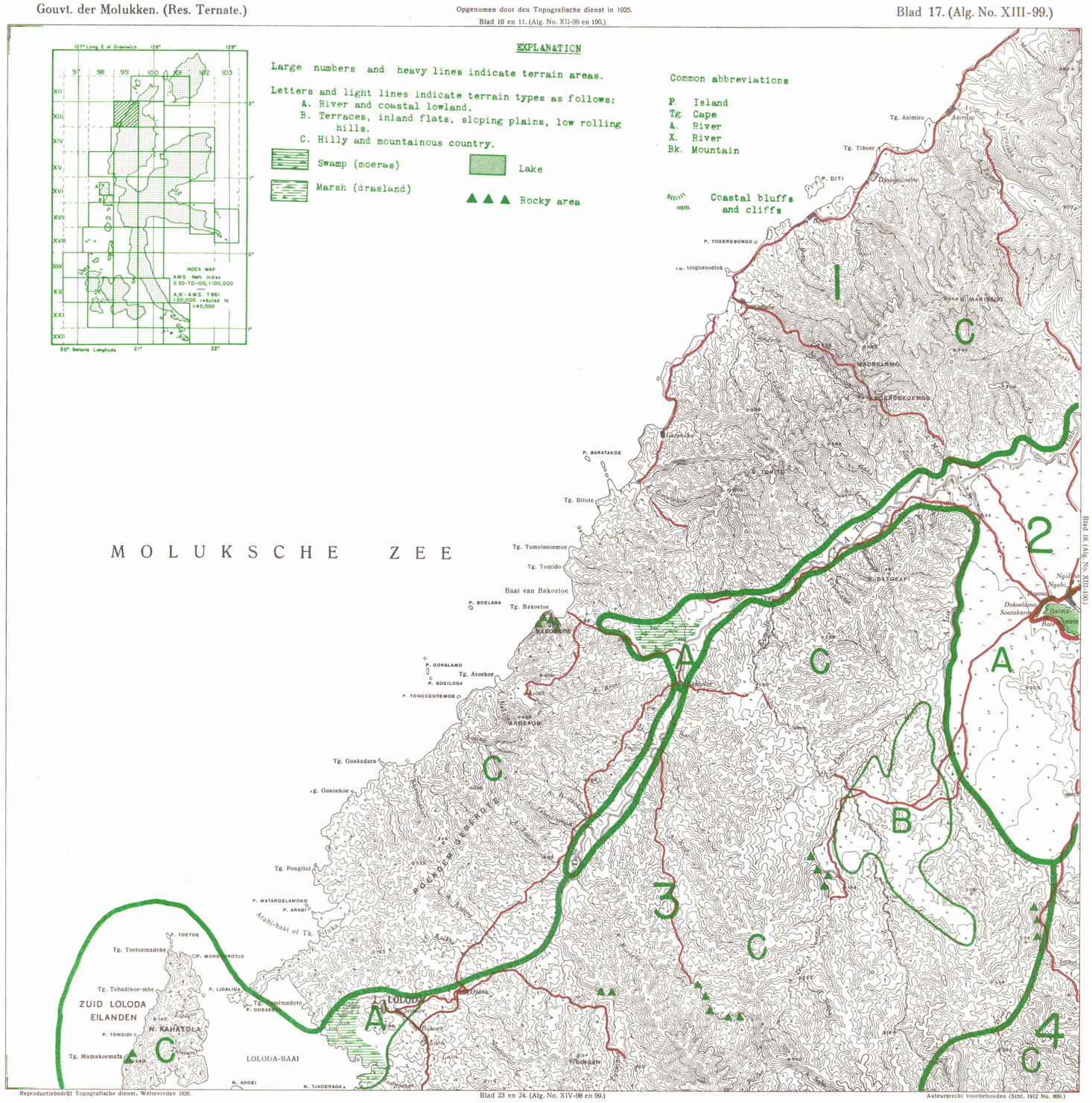
# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografische dienst in 1925.
Blad 10 en 11. (Alg. No. XII-99 en 100.)

# TERRAIN APPRECIATION

Blad 17. (Alg. No. XIII-99.)

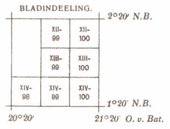



Reproductiebedrijf Topografische dienst, Wellevreden 1926.

Blad 23 en 24. (Alg. No. XIV-98 en 99.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600.)

BLADINDEELING.




ADM. INDEELING.

*Afdeeling Ternate.*
*Onderafd. Halmahera.*
A. *Ressort Djailolo.*
B. *Ressort Tobelo.*

Trail
Road

LEGENDA

*Kampoeng.* *Schaars bewoonde streken.* *Sagoetuin.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemara- of Dennen bosch.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten, c. natuurlijke steilte bij oevers.* *Paardenpad. a. duiker of doorlaat van bamboe.* *Ressortsgrens.* *Alang-alang.* *Meer.* *Drasland.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogteijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. hulphoogtelijn, c. rots. d. eiland. e. klippen bij laag water zichtbaar, f. terreinoneffenheden.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000, blauwdruk zeekaart No 1614 en volgens deze kaarten het blad georiënteerd.*

VERKORTINGEN.

**D.** *Districtshoofd.* **P.** *Poelau.* **N.** *Noesa.* **G.** *Goenoeng.* **Tg.** *Tandjoeng.* **Tk.** *Teloek.* **S.** *Soengai.* **A.** *Ake (rivier.)*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

## TERRAIN APPRECIATION

**Reliability Rating: Class B**

SHEET XIII-99

Area No. 1. Soepoe Peninsula

Topography: Rugged mountainous area with irregular central ridge reaching altitude of about 900 meters (profile $AA^1$). Branch spurs extend to sea on the west and to Tiabo Valley and Galela Plain on the east (Area 2). Slopes are generally steep, topography rough. Valleys short, steep, V-shaped. Shoreline irregular, with many indentations. Coast bold, rugged, and in many places rocky. Small, narrow beaches in places between promontories.

Roekoem Mountains. A somewhat narrow continuation of Soepoe Peninsula ridge, separated from latter by low pass. Topography similar to above, but relief lower, generally less than 400 meters.

Ground Conditions: Stony sandy loams to clay loams and clay. Thickness ranges from a few feet on the higher and steeper slopes to a few tens of feet on the gentler slopes. Rocky cliffs and slopes locally along coast. Soil gives good footing, is well drained, and moderately muddy when wet. Stones and cobbles locally retard excavation.

Area covered with virgin tropical forest, except for a few small clearings near settlements.

Few small stretches of beach are sandy.

Settlements: A few small native villages along the coast to the north.

Movement: Movement impeded by rugged terrain and forest. Best route across the mountains is through a low pass leading from Bakoeloe Bay to Tiabo Valley. Highest point is about 85 meters. This route is followed by a foot path with moderate grades. Farther north, other foot paths cross from west coast to Galela Plain. Routes are partly along stream beds and partly along ridge crests. Grades steep in many places and elevations on main ridge are about 700 meters.

For coastwise movement, a foot path follows shore southward from northern edge of quadrangle.

On the east flank of the Roekoem Mountains, a foot path goes from Loloda to the basin in Tiabo Valley.

Movement off trails slow and difficult. Best routes generally along ridges crests.

Cover, Concealment, Observation: Narrow ridges, stream banks, and larger hardwood trees give cover. Field fortifications feasible, but stony soil may locally retard digging.

Forest gives complete aerial and ground concealment.

Observation poor except locally along the coast. A few places on steep interior slopes provide lookouts of limited range.

Area 2. Galela Plain

Topography: A flat to undulating plain, rising gradually toward south (profile $AA^1$). At middle is western end of Galela Lake; farther south are low, rolling hills. Western boundary of plain is the Ira River, with high, steep banks.

Tiabo Valley. Valley forms the greatly narrowed extension of Galela Plain. River winds from side to side of valley. Banks high and steep at many places. Much of valley bottom is gently sloping rather than flat. Valley narrows upstream; opens into a small basin, partly swampy, which extends westward to a low pass through mountains to sea. Above this basin, main valley continues south-southwest, gradually narrowing.

Ground Conditions: Deep sandy loam to clay. Gives good footing, is well drained, and dries quickly unless disturbed when wet. Moderately muddy when wet. Easily excavated.

Large swamp of tract in local basin along the Tiabo Valley.

Northern part of Galela Plain has widespread grassland. Southern part largely covered with virgin tropical forest, with smaller areas of scrubby brush. Along some bordering streams, bamboo thickets; some coconut palms border Galela Lake.

Settlements: Several native villages around west end of Galela Lake. One small village in upper Tiabo Valley.

Movement: Free movement possible where vegetation does not interfere, as on grassland at north. At the south, brush and forest cover retards movement away from trails. Steep river banks around margins of the area constitute local obstacles. Existing trails radiate from Galela Lake, and are suitable only for foot travel. Two cross mountains to the north and northwest. One leads up Tiabo Valley. Others lead southward.

Along Tiabo Valley, movement is canalized, especially where the river swings against the valley side. A footpath follows the river, and locally descends into the stream bed. At the expansion in the valley, one trail branches to the west coast, another turns south across intervening hills to Lolada.

Cover, Concealment, Observation: Good ground but poor aerial concealment in grassland and brush areas, better for men than for vehicles. Ground and aerial concealment in forest-covered areas.

Cover available only along stream banks near margins of area, and by low hills to the south. Field fortifications feasible at all places.

Ground observation limited by flatness of terrain and by vegetation. Aerial observation good over grasslands.

Area 3. Loloda Foothills.

Topography: Broad rough area transitional to volcanic mountains farther south. Elevations reach about 700 meters. Long, narrow ridges alternate with deep, steep-sided, irregularly branching valleys. Toward east local relief decreases, and some ridges broaden into rounded to flat-topped interstream uplands.

At Loloda is small, pocket-shaped coastal flat hemmed in on landward sides by hills; has low hill near center.

Offshore are the South Loloda Islands; main island on this quadrangle is Kahatola, over 3 miles long and about 1.5 miles long; topography rough and hilly, with a total relief of 240 meters; shoreline irregular; coast steep, locally rocky and cliffed (View 2).

Ground Conditions: Loam to clay loam, locally very stony. Gives good footing, well drained, moderately muddy when wet. Easily excavated except where stony.

The area covered with virgin tropical forest.

Coast along Loloda flat is low and swampy.

Settlements: Loloda is the main settlement. A few smaller villages in same vicinity.

Movement: Interior is an area of difficult movement. Ridge crests offer best going. A few foot paths cross part of the area.

Coastal area near Loloda more favorable, but swamp land is an obstacle. Villages are connected by horse trails.

Cover, Concealment, Observation: Cover same as Area 1. Concealment and observation same as Area 1, except that coastal observation is poor.

Area 4

Topography: Small section of volcanic mountain area. Separated from Area 3 by gradual change in relief and form, and by proximity to mountain mass outside this quadrangle.

Ground Conditions: Same as Area 3.

Settlements: No settlements.

Movement: Same as Area 3.

Cover, Concealment, Observation: Same as Area 3.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 10 en 11. (Alg. No. XII-99 en 100.)

# TERRAIN APPRECIATION

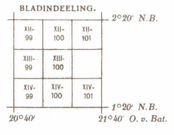
Blad 18. (Alg. No. XIII-100.)

Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 25. (Alg. No. XIV-100.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.




ADM. INDEELING.

*Afdeeling* Ternate.
*Onderafd.* Halmahera.
A. *Ressort* Djailolo.
B. *Ressort* Tobelo.

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagoetuin.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemara of Dennen bosch.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Inlandsche graven* *Pasanggrahan.* *Mesigit.* *Steenen- en bamboe huizen.* *Meer.* *Paardenpad.* *Drasland.* *Moeras.* *Damarboomen.* *Alang-alang.* *Gras.* *Ressortsgrens.* *Verharde weg, waarvan de verharding van 2-4 M. breed, is. a. houten afstandspaal, b. duiker of doorlaat van bamboe.* *Niet verharde weg, in den drogen moessons geschikt voor veldartillerie, van 2-4 M breed.* *Steenen.* *Steenen grenspaal damarconcessie.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikte van 500 M. a. eiland, b. klippen bij laag water zichtbaar, c. langwaterrijn, d. bamboe baken, e. hoogtepunt en hoogtecijfer, f. hulphoogtelijn, g. rots, h. bodemoneffenheden, i. natuurlijke stelite.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 K.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd.*

VERKORTINGEN.

GH. *Gezaghebber.* D. *Districtshoofd.* P. *Poelau.* G. *Goenoeng.* Tg. *Tandjoeng.* O.L. *Onderaardsche loop.* S. *Soengai.* A. *Ake (rivier).*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

# HALMAHERA (MOLUKKAS)

# TERRAIN APPRECIATION

SHEET XIII-100

## Area No. 1. Soepoe Peninsula

Topography: Short section of main ridge of peninsula, together with a long oblique spur trending roughly parallel to the coast, and other subsidiary spurs. Elevations on main ridge attain nearly 900 meters. Slopes steep, ridges narrow, and valleys deep and V-shaped. At northeast, mountains flanked by broad coastal plain which southward narrows abruptly.

Ground Conditions: Sandy loam to clay soil, a few feet deep on the steeper and higher slopes, a few tens of feet on the coastal flat. Soil well drained, gives good footing, moderately muddy when wet. Beaches sandy along coastal flat, gravelly where coast is steep.

Area covered with virgin tropical forest, except for small clearings near settlements.

Settlements: A few small native villages along coast.

Movement: Terrain unfavorable for movement except in coastwise direction. Dense forest cover adds to difficulties of movement. On coastal flat, topography favorable for free movement but the forest restricts effective movement to established roads or trails. Space here ample for dispersal. Plain suitable for landing operations, but communications with other areas limited. South of the main coastal flat a much narrowed coastal tract permits movement along shore.

Existing trails suitable only for foot travel. One follows coast north to Dodowo. The other ascends Aroe Valley and crosses main ridge to west coast; follows stream bed along several stretches, and would be unsuitable at high water unless rerouted.

Cover, Concealment, Observation: Some cover given by ridge crests in hilly section, and stream banks in coastal lowland. Field fortifications feasible at all places.

Good ground and aerial concealment provided by forest cover.

Observation everywhere limited by dense vegetation. Points on ridge nearest shore would command a general view of adjacent coastal lowland.

## Area No. 2. Galela Plain

Topography: Eastern part of this plain. North of Galela, plain essentially flat and featureless, crossed by broad, winding Tiabo River. Coast low and regular. Galela built on a low, rounded beach-dune ridge about 3 meters high (View 1), and similar coastal ridges may occur discontinuously farther north.

Galela Lake is nearly 3 miles long, maximum depth about 50 meters, surface 17 meters above sea level. Lake has extremely irregular shoreline, several small islets; no surface outlet.

Northeast of lake are two small volcanic cones (heights 209 and 294 meters) with straight, steep sides, and summit craters (profile AA$^1$).

South of the lake, the land surface rises gradually toward the mountains, and the general level is interrupted by low rounded hills.

Shore line south of Galela is ragged, rocky, and cliffed. Small patch of swamp borders shoreline at southeast.

Ground Conditions: Area largely covered with deep loam to clay loam. Southeast of Galela, areas of rocky and stony ground near the shore. North of Galela several large tracts of swamp near coast; another at the southeastern corner of area. Except in and near swampy areas, soil fairly well drained, gives good footing, moderately muddy when wet. Beaches north of Galela are of gray sand, but locally southeast of Galela are rocky.

North of Galela, area largely covered with virgin forest and swamp vegetation. In vicinity of Galela Lake, large areas of grassland, scattered stands of coconut palms. In the southern part of the area, virgin forest with scattered clearings and areas of second growth forest.

Settlements: Galela is principal settlement; besides native dwellings (View 1), has native market, copra store, mosque, and officials' buildings.

Numerous small native villages situated along Galela Lake; a few also along coast at north.

Movement: Area permits free movement of both men and motorized equipment. Obstacles are broad Tiabo River near its mouth, patches of impassable swamp land, and, except on trails, extensive forest. Grasslands are areas of easiest movement.

In southern part of the area, communication lines are unusually good. A narrow fair-weather road suitable for light military traffic extends south from Galela to Tobelo and a branch leads west to Galela Lake. A continuous horse trail goes around the lake.

The lower part of the Tiabo River is navigable by small boats. Jap airfield reported between Galela and Tiabo River. Broad tracts of grassland suitable for paratrooper landings.

Beaches at and north of Galela suitable for landing operations; care necessary to avoid swamps just inland. Landings north of Tiabo River would necessitate crossing river unless a long inland detour were made to point where channel is narrower and shallower. South of Galela rocky and cliffed coast unfavorable for landing.

Cover, Concealment, Observation: Limited cover provided by stream banks, by low rounded hills at the south, and, for landing parties by beach ridges (View 1). Excellent local cover provided by crater sides on the two small volcanic cones north of Galela Lake.

Complete ground and aerial concealment where virgin forest is present. Only ground concealment for men and possibly for small vehicles in grassland areas. Little or no concealment in rocky areas south of Galela.

Ground observation very restricted on lowland surface. Summits of volcanic cones north of Lake Galela provide excellent lookout points commanding surrounding territory.

## Area No. 4. Tobello Mountains

Topography: Rugged volcanic mountains. Rising directly from the the coast is Mamoeja Mountain, a roughly cone-shaped peak some 930 meters high, with steep, deeply furrowed sides. Adjoining stretch of shore terraced, marked by low sea cliff.

South and west of Mamoeja is a broad and sprawling assemblage of irregular volcanic peaks and ridges rising to elevations exceeding 1,300 meters. Irregular branching spurs and ridges extend radially outward, producing extremely rough topography. Slopes steep on main mountain mass, but become moderate and gentle around base. Valleys steep, narrow, V-shaped; closely spaced. Streams small, with steep gradients. Locally some follow underground courses. Stream beds bouldery and cobbly toward the headwaters, gravelly and sandy farther down.

Ground Conditions: Stony sandy loam of irregular depth, generally not greater than 5 feet. Rock ledges on many higher slopes, lava rock at or near the surface in many places.

Area covered with virgin tropical forest, which contains numerous damar trees. Vegetation becomes somewhat sparse on the higher ridges. Undergrowth thickest along the valleys.

Settlements: A few small villages on coastal terrace at foot of Mamoeja Mountain.

Movement: Area constitutes barrier to inland movement. Foot paths cross mountains, but grades are steep, elevations range to more than 1,000 meters, and maintenance is uncertain.

On coastal terrace flanking Mamoeja Mountain, low grades permit easy movement in a coastwise direction; this route followed by road. At north route narrow, could be blocked easily. Road reported recently damaged by lava flow. An alternate route, now followed only by foot path, is through gap between Mamoeja and main mountain mass.

Cover, Concealment, Observation: Cover provided by ridge crests and stream banks. Field fortifications feasible in many places, but soil likely to be stony and excavation somewhat slow. At unpredicataole places lava bedrock may lie at shallow depth.

Complete ground and aerial concealment by forest except in local brushy areas on lower slopes, and on high ridges where vegetation becomes sparse. Observation limited by forest.

## Area 5. Tobelo Plain

Topography: North part of broad and curving coastal plain. Area essentially flat and featureless; crossed by a few small streams. Inland, surface rises gradually toward adjacent mountains. At Tobello, beach has maximum width of about 66 feet at low tide, about 3 feet at high tide. The coast fringed in places by coral reefs.

Tobelo Islands, a few miles offshore, range from less than half a mile to about 3 miles in length, and are varied in shape. All are low and flat.

Ground Conditions: The area covered by deep loam, sandy near shore. South of Tobelo, two large tracts of swamp land. Elsewhere, soil well drained, gives good footing, not excessively muddy when wet.

Beach is gray sand.

Grassland widespread at north, coconut palms occupy broad belt along shore. Along streams, bamboo thickets. South of Tobello two tracts of swamp land, with sago palms. Rest of area covered with virgin tropical forest.

Settlements: Tobelo, about 1,000 inhabitants, is principal settlement; contains mission school and hospital, radio station, military barracks, church, mosque, official buildings, and various shops, warehouses, and native dwellings. Mission buildings have stone walls 3 feet high, surmounted with plaster on wire mesh, and roofed with corrugated iron. Government buildings similarly constructed, but with wooden shingle roofs. Native dwellings lightly constructed of wood with thatched roofs. Other native villages, of intermediate size, along shore north and south of Tobelo, and on two outlying islands.

Movement: Broad expanse of flat grassland permits free movement of both men and machines in northern part of area. Broad coastal strip of coconut palms also permits free movement of men and only slightly restricted movement of vehicles. Bamboo thickets along streams, and tracts of swampland constitute local obstacles. A road extends as far south as Pitoe; existing bridges would probably be suitable only for light vehicles. Vehicles must be ferried across Mede River. South of Pitoe is a horse trail.

Grassland areas suitable for landing of paratroopers.

Shores generally suitable for landing operations; least interference from offshore coral reefs north of Tobelo.

Cover, Concealment, Observation: Poor cover except locally along stream banks and beach ridges on shore. Field fortifications feasible at all places except vicinity of swamps.

Aerial concealment good in coconut groves, but ground concealment only fair. Ground concealment good for men and possibly for small vehicles in grassland, but aerial concealment poor. Complete concealment, both ground and aerial, in virgin forest.

Ground observation poor due to flat topography and vegetation. Visibility better in coconut groves than elsewhere. Aerial observation best over grassland areas.

**Reliability Rating: Class B**

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

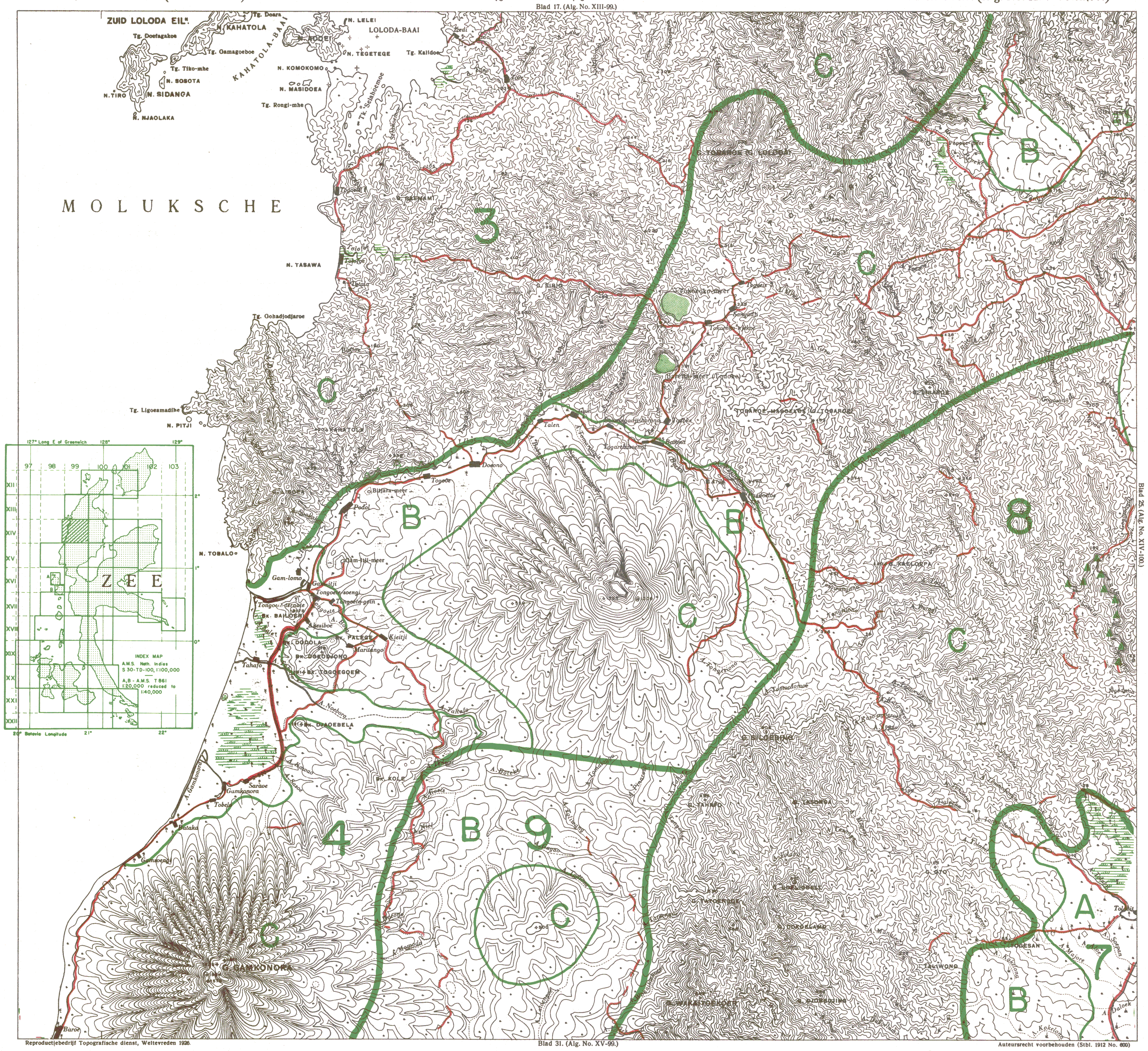
# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 17. (Alg. No. XIII-99.)

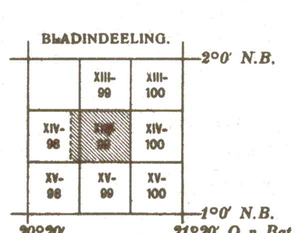
# TERRAIN APPRECIATION

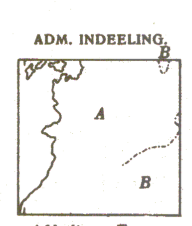
Blad 23 en 24. (Alg. No. XIV-98 en 99.)




Reproductiebedrijf Topografische dienst, Weltevreden 1926

Auteursrecht voorbehouden (Stbl. 1912 No. 600)




Afdeeling Ternate.
Onderafd. Halmahera.
A. Ressort Djailolo.
B. Ressort Tobelo.

Trail

Road

LEGENDA.

Kampoeng. Schaars bewoonde streken. Sagotuin. Arentuin. Klapper-boomen. Bosch. Kreupelhout. Bamboebosch. Moeraspalmen. Tjemara- of Dennen bosch. Voetpad. Rivier, a. gemeten, b. niet gemeten. Meer. Drasland. Moeras. Niet verharde weg, in den drogen moessons geschikt voor veldartillerie, van 2—4 M. breed. Paardenpad. a. duiker of doorlaat van bamboe. Alang-alang. Overige op droog terrein groeiende palmsoorten. Ressortsgrens.

Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. eiland, b. klippen bij laag water zichtbaar, c. klippen altijd boven water, d. zandbank alleen bij laag water droog, e. hoogtepunt en hoogtecijfer, f. hulphoogtelijn, g. rots, h. kleine verhevenheden, i. natuurlijke steilte.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd. De loop van de ressortsgrens is (zuidoostelijke bladrand) gedeeltelijk onbekend.

VERKORTINGEN.

N. Noesa. G. Goenoeng. Bk. Boekoe. Tg. Tandjoeng. Tk. Teloek. W. Wai (Rivier). A. Aek (rivier). P. Pisang.

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

# HALMAHERA (MOLUKKAS)

## TERRAIN APPRECIATION

Reliability Rating: Class B



SHEET NO. XIV-99

Area No. 3. Loloda foothills

Topography: Broad belt of rough, broken terrain rising irregularly from coast to heights of about 500 meters, and merging into the higher slopes of the volcanic mountains of area 4. Slopes moderate, around Loloda Bay; elsewhere steep. Ridges are rounded toward north, but narrower and sharper toward south. Valleys narrow, V-shaped, and irregularly branching. Streams small. The shoreline embayed and irregular; coast steep to cliffed at most places. Short, narrow beaches in some more sheltered coves.

South Loloda Islands. Group of rough, hilly islands of irregular form. Coasts steep; practically no flat ground.

Ground Conditions: Loam to clay loam of moderate depth, locally stony. Gives good footing, well drained, moderately muddy when wet. Dries quickly unless disturbed when wet.

Bedrock outcrops in a few places along valleys and on coast. Area is covered with virgin tropical forest. On the shores of Loloda Bay there is a local patch of swamp. Beaches are sandy.

Settlements: A few small native villages along coast.

Movement: Rough, forested topography unfavorable for movement; crossed by foot paths leading directly or indirectly from coast to Iboe Valley. All trails follow stream beds part way; unusable at high water. Steep and rugged coastal topography bars continuous coastwise movement.

Cover, Concealment, Observation: Cover provided by narrow ridges, stream banks, and larger hardwood trees. Field fortifications feasible in all except rocky sections.

Forest gives complete ground and aerial concealment.

Observation very poor except along the coast, because of forest cover. Good observation of shore from projecting points and offlying islands.

Area No. 4. Sahoe-Tobelo volcanic mountains

Topography: Irregular mountainous belt with prominent individual conical peaks (see profile DD[1]). Gamkonora Mountain (about 1,600 meters) and Iboe Mountain (about 1,300 meters), dominant peaks, are roughly cone-shaped, with moderate lower slopes grading into steep upper slopes. Sides deeply furrowed with radiating ravines; summits have craters. Gamkonora erupted in the 17th century, and further volcanic activity is possible. Between the two peaks is a broad gap with elevation of only about 50 meters along the Tahafo Valley.

Northeast of Iboe is a broad, irregular broken upland with few distinctive peaks. Slopes prevailingly steep but locally moderate; a few small lakes and strips of swamp land.

Principal streams are the Iboe, north of Iboe Mountain, and the Tahafo, between Iboe and Gamkonora. The Iboe has broad, open valley, steep on north side, gentle on south. The lower valley of the Tahafo is broad and symmetrical; narrows somewhat in midcourse.

Flanking gap between Gamkonora and Iboe is broad coastal flat; has very regular shoreline and irregular inner margin. Large sections swampy and marshy. Beach ridges or mounds parallel the shoreline. South of the flat, shoreline is slightly irregular and coastal belt moderately sloping.

Ground Conditions: The mountains have loam to clay loam, locally very stony. Soil is very thin around craters, but thickens moderately downslope. Soil gives good footing, well drained, moderately muddy when wet. Easily excavated except locally where stoniest.

Mountains largely covered with virgin forest. Forest thins toward the higher peaks, and becomes brushier . On basal slopes of the volcanoes, forest alternates with patches of brush and grassland. Some small clearings near settlements. Some bamboo thickets along streams, also scattered stands of coconut and sago palms. On coastal flat, large patches of swamp and marsh land. Coconut palms fringe shore.

Beaches sandy along coastal flat, gravelly at foot of Gamkonora.

Settlements: Several native villages of small to moderate size on inner part of coastal flat, on adjoining slopes, and along the Iboe River and its headward branches.

Movement: Movement channelized through gaps between volcanic peaks and along coastal strip. Grades in these areas low to moderate; principal obstacle, away from trails, is forest cover. In coastal flat, large tracts of marsh and swamp land present additional obstacles.

Iboe Valley followed by horse trail around to northeast side of Iboe Mountain, where it branches into foot paths leading farther inland. A branch of the horse trail leads northward to lake district. Gap between Gamkonora and Iboe followed by foot path from coastal villages to Lamo Valley. On this trail grades are locally steep and stream crossings numerous. On coastal flat, trails connect the various villages with one another and with interior. Along the inner border of the flat is one short stretch of narrow, fair-weather road which at the south is continued by a horse trail following coastal slopes. Lower few miles of Iboe River navigable by small boats. Grassy areas on lower slopes suitable for paratrooper landings. Coastal flat suitable for landing but swamps must be avoided in moving inland.

Cover, Concealment, Observation: Some cover along stream banks. Ridges less effective because broadly rounded. Field fortifications feasible nearly everywhere at lower levels, but locally stony ground may retard digging.

Forest offers complete concealment, both ground and aerial, in most of area. Poor aerial concealment in grassland; spotty, poor to good concealment in brushy areas.

Observation poor except from upper slopes of volcanic peaks, in clear weather.

Area No. 9

Topography: A hilly lowland area lying between the mountains of Areas 4 and 8. Hills broadly rounded and slopes generally moderate. Streams more widely spaced than in adjoining areas. Most of area is below 350 meters, but one low peak reaches 500 meters.

Ground Conditions: Soil same as Area 4. All forested.

Settlements: Uninhabited.

Movement: Topography permits fairly easy movement, but forest cover is an obstacle off trails. Foot path follows western side of area.

Cover, Concealment, Observation: Cover same as Area 4.

Forest gives good ground and aerial concealment.

Observation everywhere poor because of forest cover and low relief.

Area No. 8. Tomoeria-Siloebing Mountains

Topography: Broad, irregular area of tangled ridges and valleys gradually descending eastward. Maximum elevations, at west, range to over 800 meters. Relief decreases and slopes become less steep eastward. Profile CC' shows relation of this area to adjoining areas.

Ground Conditions: Same as Area 3.

Settlements: Uninhabited.

Movement: Mountainous topography generally difficult. Best crossing is thrcugh a low place between Kaeloepa and Siloebing Mountains, east and slightly south of Iboe Mountain; route followed by foot path leading across to Area 7.

Cover, Concealment, Observation: Same as Area 3.

Area No. 7. Kaoe Basin.

Topography: A lowland area of undulatory to rolling topography, locally swampy. See descriptions in adjoining quadrangles for further information.

Ground Conditions: See descriptions in adjoining quadrangle to the east.

Settlements: Uninhabited.

Movement: Topography favorable for movement. Swamp land, bamboo thickets along streams, and forest cover are obstacles. Area crossed by horse trail and foot paths.

Cover, Concealment, Observation: See adjoining quadrangle to east.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S ARMY

# HALMAHERA (MOLUKKAS)

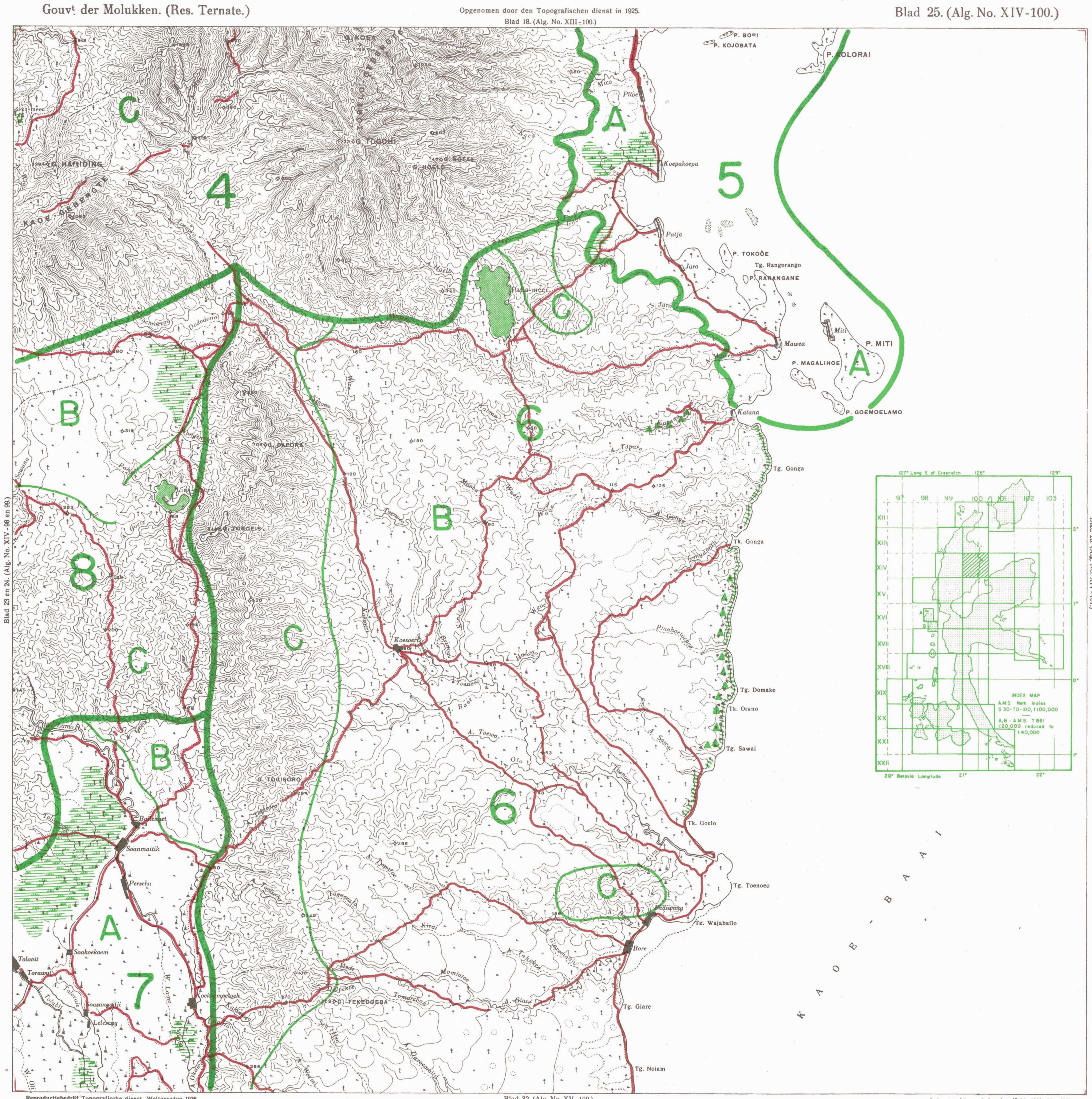
# TERRAIN APPRECIATION

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.

Blad 18. (Alg. No. XIII-100.)

Blad 25. (Alg. No. XIV-100.)




Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 32. (Alg. No. XV-100.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.

| | | |
|---|---|---|
| XIII-99 | XIII-100 | XIII-101 |
| XIV-99 | XIV-100 | XIV-101 |
| XV-99 | XV-100 | XV-101 |

2°0′ N.B. — 1°0′ N.B. — 20°40′ — 21°40′ O. v. Bat.

ADM. INDEELING.

Afdeeling Ternate.
Onderafd Halmahera.
A. Ressort Djailolo.
B. „ Tobelo.

Trail

Road

LEGENDA.

*Kampoeng. Schaars bewoonde streken. Sagotuin. Arentuin. Klapperboomen. Bosch. Kreupelhout. Bamboebosch. Moeraspalmen. Tjemara- of Dennenbosch. Voetpad. Rivier. a. gemeten, b. niet gemeten, Meer. Drasland. Moeras. Overige op droog terrein groeiende palmsoorten. Ressortsgrens Steenen. Paardenpad. a. duiker of doorlaat van bamboe.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. hulphoogtelijn, c. rots, d. bodemoneffenheden, e. natuurlijke steilte, f. warme bron, g. eiland, h. zandbank alleen bij laag water droog, i. laagwaterlijn, k. terreinoneffenheden.*

Schaal 1:100000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500000 en volgens deze kaart het blad georiënteerd.*

VERKORTINGEN.

P. *Poelau.* G. *Goenoeng.* Tg. *Tandjoeng.* Tk. *Teloek.* W. *Wai (rivier).* A. *Ake (rivier).* S. *Soengai.*

PREPARED BY U S GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U S ARMY

EXPLANATION

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- C. Hilly and mountainous country.

Swamp (moeras) — Lake

Marsh (drasland) — Rocky area

Common abbreviations

- P. Island
- Tg. Cape
- A. River
- K. River
- Bk. Mountain

Coastal bluffs and cliffs

# HALMAHERA (MOLUKKAS)

# TERRAIN APPRECIATION

Reliability rating; Class B

SHEET NO. XIV-100

Area No. 4 Sahoe-Tobelo Volcanic mountains

Topography: Area of rugged volcanic peaks ranging up to about 1200 m. in elevation. See profile DD[1]. Sides of peaks deeply grooved by numerous gorges. Slopes very steep toward summits, more moderate toward lower levels. Streams short, with steep gradients and bouldery channels.

Ground Conditions: Loam, locally stony. Depth a few ft. on the higher steeper slopes to a maximum of possibly 10 ft. on the lower and gentler slopes. Well drained, quick drying, gives good footing. Moderately muddy when wet.

Except for highest peaks, area covered with tropical forest. Forest thins out on the upper ridges, and becomes brushy.

Settlements: No settlements.

Movement: Rugged, forested topography constitutes a barrier to any but small-scale movement of foot. Routes least difficult are through gaps between peaks, or along the locally moderate upland slopes. These routes are followed by foot paths.

Cover, Concealment, Observation: Cover provided by narrow ridge crests, and by larger hardwood trees. Field fortifications feasible at all places except on highest points.

Ground and aerial concealment provided by forest cover.

High peaks and ridges provide good lookout points, but forest limits observation.

Area No. 5 Tobelo Plain

Topography: South part of long, curving coastal plain; flat to undulatory; merges gradually into volcanic mountains to west. Area crossed by a few small streams. Shoreline deeply embayed toward south. Near shore are small, low, islands; principal one, Miti, about 2 mi. long.

Ground Conditions: Deep sandy to clayey loam. Gives good footing, is well drained and quick drying except for swampy areas.

Vegetation ranges from virgin tropical forest, which is dominant, to swampy forest with sago palms, scattered stands of coconut palms, and open grassland. On the islands coconut palms predominate.

Beaches are predominantly sandy.

Settlements: A few small to moderate-sized native villages along coast, and one on Miti island.

Movement: Nearly flat topography is excellent for movement, but in most places forest limits movement to existing trails. Clearings and small patches of grassland are exceptions. Swamps constitute most serious local obstacles. A horse trail in part suitable for motor vehicles, is available for coastwise movement, and from it branch foot paths lead to interior. A Jap airfield reported on Miti.

Cover, Concealment, Observation: Little natural cover, but field fortifications feasible except swampy tracts. Water may be encountered at shallow depths in low areas, as near streams.

In forest good ground and aerial concealment; in grassland and cleared areas, poor aerial concealment. Ground concealment also limited among coconut palms.

Ground observation greatly limited by lack of relief and by forest, except along coast. Aerial observation better in more open sections.

Area No. 6 Papora-Togisoro mountain block

Topography: Broad, asymmetric mountain block with steeper side on west. Crest has fairly regular north-south trend; highest, about 700 m., at north. North of this point is rapid descent to about 200 m. in pass around end of mountain; southward is far more gradual descent to about 250 m. Slopes west of crest are steep, notched by numerous short, steep valleys. East of the crest, in marked contrast, long gentle slopes, broken here and there by shallow valleys, that lead down to coast. At the north is a lake about 1.5 miles long. Toward coast, some valleys narrow and deepen. Coastline is fairly regular.

Ground Conditions: Sandy loams to loams, locally stony. Depth irregular, a few ft. to many ft. Gives good footing, is well drained, dries readily if not disturbed when wet, and is easily excavated where not too stony. Outcrops of coral limestone bedrock occur along the cliffed portion of the shore, and along one of the valleys.

Except for a few small patches of grassland, area is forested. Along some streams bamboo thickets predominate. Along flatter parts of coast are coconut palms; other kinds of palms growing on dry ground are locally common on slopes.

Settlements: One small village along coast at northern end, and two somewhat larger at south. One village several miles inland.

Movement: Terrain favorable for movement of both men and vehicles, particularly in an east-west direction. Many valley crossings necessary in north-south movement. Forest is obstacle to foot travel and prevents movement of vehicles off raods. Trails are numerous, but suitable for foot travel only; connect coastal villages and other coastal points with interior and with areas 7 and 8, crossing the area by direct and diagonal routes, and forming an interconnecting network.

Landing operations obstructed by coastal cliffs north of Cape Toenoeo; easier south of that point, where beachheads are continous with gentle slopes leading to ridge positions dominating the Kaoe basin.

Cover, Concealment, Observation: On east side little natural cover except by stream banks. Field fortifications generally practicable, but digging may become difficult in places where bedrock is close to surface. On west side, nests of spurs give some cover.

Good ground and aerial concealment by forest at nearly all places.

Ground observation very poor because of forest and low relief, particularly on east side. Aerial observation might be slightly better for large-scale operations.

Area No. 7. Kaoe basin

Topography: A broad, gently undulatory lowland merging gradually with hilly terrain to the north, and west (in the adjoining quadrangle), (profile CC). Crossed by two main streams, the Lamo and the Tolabit, headward branches of the Kaoe river, also by minor streams, with a single prominent cape, Toenoeo. North of this cape coast is steep, with a sea cliff ranging up to about 100 m. in height. South of cape, coast is gently sloping, with a continuous gradual rise to the main crest of the area.

Ground Conditions: Deep loam to clay. Footing is fairly good. and fairly well drained except in swamp and marshland. Excavation easy, but water may be encountered at shallow depth in lower and flatter parts of area.

Entirely forested except for small clearings near settlements. Bamboo thickets along streams. A large expanse of swamp land at the north, with numerous sago palms. An area of marsh land at the south.

Settlements: Several villages of moderate size near the streams.

Movement: Comparatively flat topography is favorable but forest makes movement difficult off trails. Large tracts of swamp and marsh land are serious obstacles. Good network of foot paths and horse trails.

Cover, Concealment, Observation: Similar to area 5, except for absence of grassland and sparsity of coconut palms.

Area No. 8. Tomoeria-Siloebing mountain area

Topography: A belt of hilly topography merging northward with broad and nearly flat upland. A small lake at east.

Ground Conditions: Soils similar to those of adjoining areas. At the north is a large upland swamp.

Vegetation similar to area 6.

Settlements: No settlements.

Movement: The upland flats are topographically favorable but access is through more difficult hilly country. The forest, however, impedes movement off trails. Large swamp is an additional obstacle. A few foot paths cross area.

Cover, Concealment, Observation: Similar to area 6.

Prepared by U.S. Geological Survey
for Chief of Engineers, U.S. Army.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

# HALMAHERA (MOLUKKAS)

Gouvt der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 23 en 24. (Alg. No. XIV - 98 en 99.)

# TERRAIN APPRECIATION

Blad 30. (Alg. No. XV - 98.)

EXPLANATION

Large numbers and heavy lines indicate terrain areas.

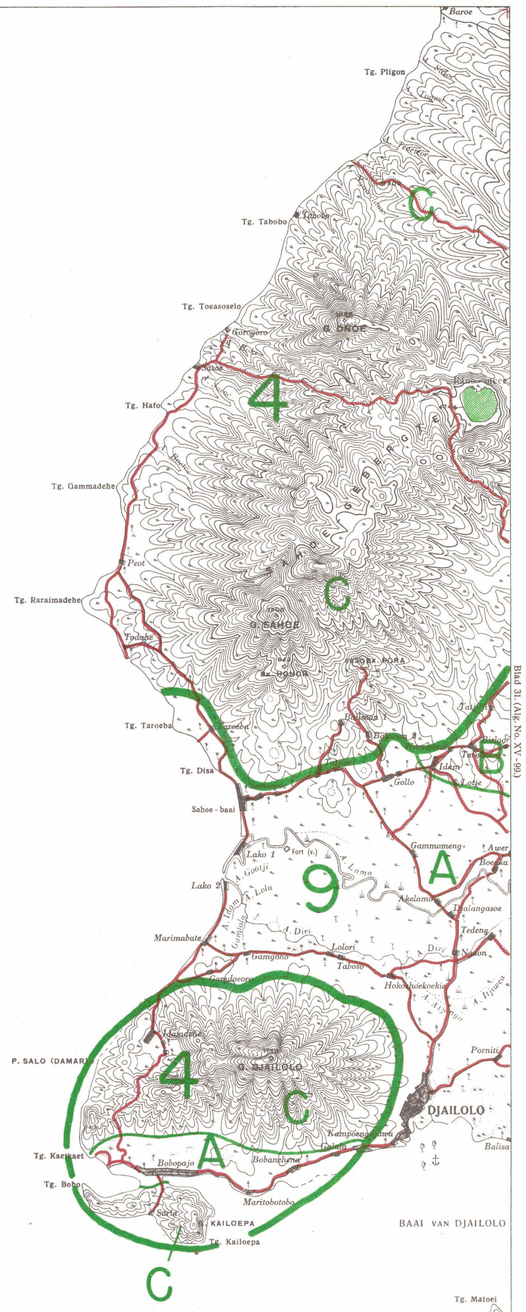
Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

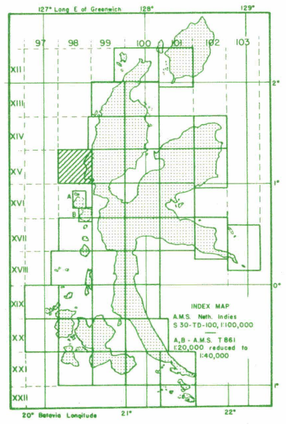
Swamp (moeras)
Lake
Marsh (drasland)
Rocky area
Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

M O L U K S C H E  Z E E




Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 37. (Alg. No. XVI - 98.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600.)

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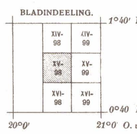
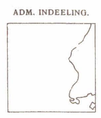



ADM. INDEELING.



Afdeeling Ternate.
Onderafd. Halmahera.
Ressort Djailolo.

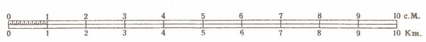
Trail
Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arrentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemaraof Dennen bosch.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Meer.* *Drasland.* *Moeras.* *Paardenpad.* *a. duiker of doorlaat van bamooe.* *Herkenbare boom.* *Ankerplaats en reede.* *Alang-alang.* *Gelagah.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer. b. hulphoogtelijn, c. bron. d. eiland.*

Schaal 1:100 000.




TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, vooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd.*

VERKORTINGEN.

GH. *Gezaghebber.* G. *Goenoeng.* Bk. *Boekoe (berg).* P. *Poelau.* Tg. *Tandjoeng.* A *Ake (rivier).* (v.) *Verlaten.*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: B SHEET NO. XV-98

Area No. 4. Sahoe Mountains

Topography: Rugged mountainous area rising directly from shore; dominated by a cluster of volcanic peaks (profile DD'). Higher elevations attain 1,300 meters. Slopes range from moderate around the base to very steep on the higher peaks. Mountain slopes are deeply furrowed with small, closely-spaced ravines. A lake occupies a steep-sided hollow high on east side. Stream beds mostly dry except for short time after rains. Shore is moderately sloping at most places, but toward the south are narrow, discontinuous coastal flats.

Djailolo Mountain, a detached outlier of the volcanic mountain belt (Views 3 and 4), has height of about 1,100 meters; is roughly cone-shaped, with irregular projecting spurs and subsidiary knobs on the west side. At the south side is a narrow strip of coastal plain, to which is attached a hilly peninsula.

Ground Conditions: Loam of varying depth, locally stony. Gives good footing, is well drained, and is moderately muddy when wet. Easily excavated where not too stony.

Mountain slopes heavily forested except for limited areas of cleared land and second growth forest on the lower slopes (View 4). Forest thins out somewhat on higher ridges and slopes. Local stands of coconut palms along shore, and strips of grassland on the coastal flats south of Djailolo Mountain.

Beaches sandy to gravelly.

Settlements: A few small native villages along coast.

Movement: Essentially a barrier area, owing to high, rugged, forested topography. Movement least difficult along the coast. Stretches of foot path and horse trail are available for some distance north of Soesoepoe, along the coastal slopes, and a horse trail extends from Djailolo west along south side of Djailolo Mountain. The Sahoe Mountains are crossed by trails, but grades are steep and routes arduous.

Cover, Concealment, Observation: Some cover given by ridge crests, and larger hardwood trees. Field fortifications generally feasible.

Good ground and aerial concealment provided by forest cover, except for grassland strip on coastal flat south of Djailolo Mountain.

Higher peaks and ridges offer good vantage points in fair weather, but forest greatly limits observation. Djailolo Mountain commands good view of Area 9.

Area No. 9. Djailolo Plain

Topography: Broad lowland at mouth of Lamo River, extending around the sides of Djailolo Mountain; topography flat to moderately undulatory. Lamo River, about 100 feet wide, winds through central section, and paralleling it farther south is the smaller Diri River. South coast is flat and swampy, and fringed by a coral reef (View 7). West coast more regular, slightly higher and dryer.

Ground Conditions: Deep loam; gives fairly good footing, and is fairly well drained except in marshy and swampy areas and on very low ground. Moderately muddy when wet, but dries quickly unless disturbed when wet. An area of both virgin and second growth forest, interspersed with clearings, cultivated fields, coconut plantations, and grassland (View 7). There is a band of mangrove swamp along the southern shore, and areas of marsh and swamp land in the interior, with various types of swamp palms and other swamp vegetation. Clumps of bamboo along the streams in places. Coconut palms fringe the shore at many places (View 4).

Beaches on the southern side are generally swampy and muddy. On the west side, beaches are locally swampy but generally sandy.

Settlements: Djailolo (Views 4 and 7) is principal settlement. Besides dwellings has hospital, missionary establishment, government buildings, and various shops. Pier is about 200 yards long. Various other native villages along shore and in interior.

Movement: Area of easy movement because of subdued topography, comparatively large proportion of cleared and open land, and numerous paths and trails crossing the area in various directions. View 5 shows one of the horse trails. Local tracts of marsh and swamp land are main obstacles. The Lamo River probably too deep for fording at most places. Free movement of tracked motorized equipment probably possible on dry ground not covered with virgin forest.

Northeast of Djailolo Mountain an airfield was started by the Dutch. Numerous cleared and cultivated areas suitable for paratrooper landings.

Conditions unfavorable for large scale landing operations on the south shore, owing to mangrove swamp fringing coral reef, and surrounding heights favoring defense. West shore more suitable, but marshy area and bar south of mouth of Lamo River should be avoided.

Cover, Concealment, Observation: Little topographic cover except along stream banks. Some buildings in Djailolo might give limited cover. Field fortifications possible except where ground is too low or swampy.

Degree of concealment varies in different places. In virgin and advanced second growth forest, complete ground and aerial concealment. In coconut plantations, aerial concealment fair to good, but ground concealment poor. Both ground and aerial concealment very poor in clearings and in cultivated fields.

Ground observation much restricted by both flatness of topography and by vegetation. Cleared, cultivated, and early second growth areas could be viewed from taller trees of bordering forest. Aerial observation preferable, giving a more connected view of open areas partly or wholly surrounded by trees.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

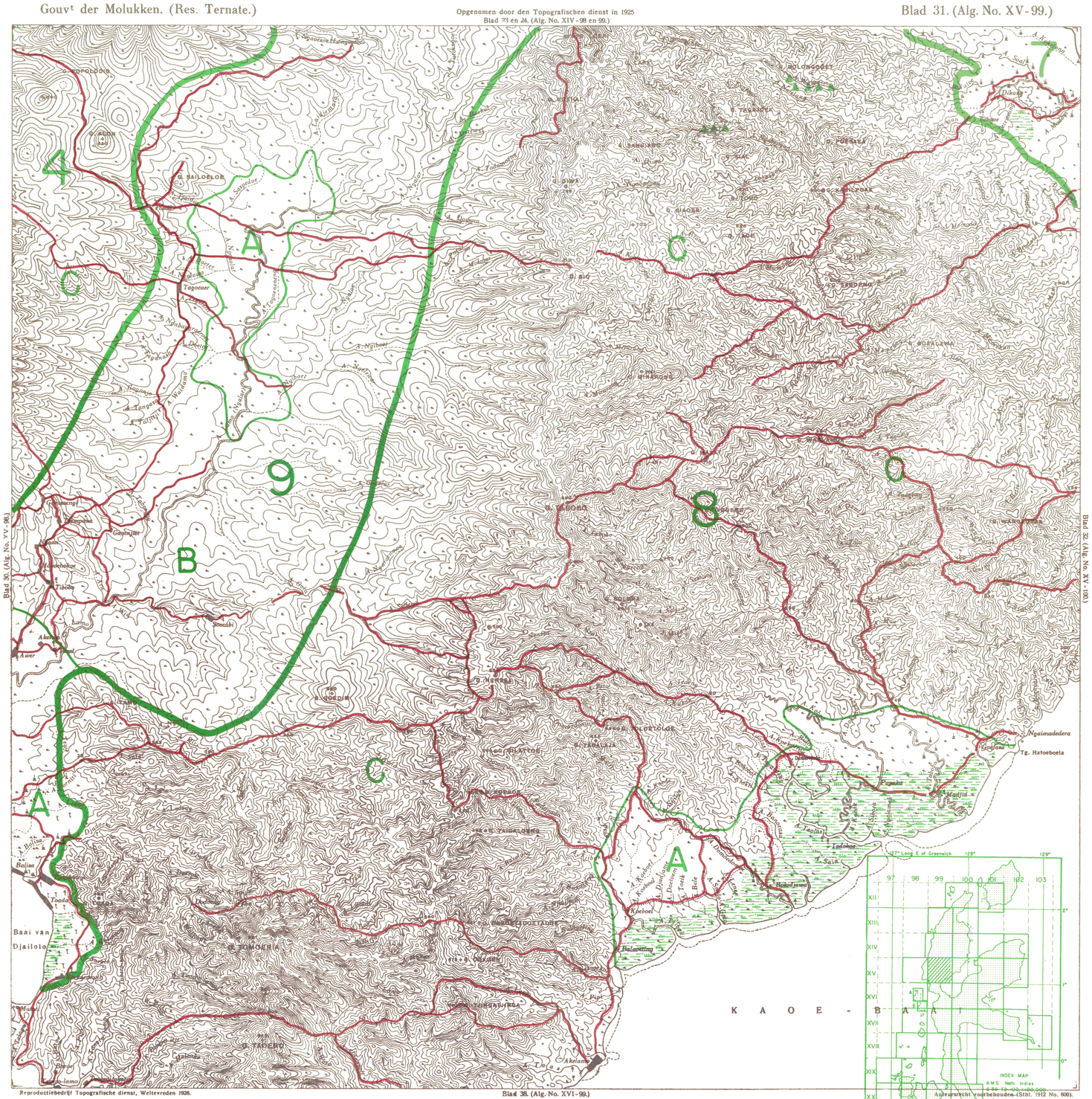
# HALMAHERA (MOLUKKAS)

Gouvt der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925
Blad 23 en 24. (Alg. No. XIV - 98 en 99.)

## TERRAIN APPRECIATION

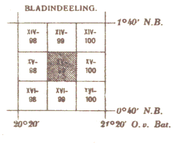
Blad 31. (Alg. No. XV-99.)




Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 38. (Alg. No. XVI - 98.)

BLADINDEELING.




ADM. INDEELING.

*Afdeeling* *Ternate.*
*Onderafd.* *Halmahera.*
*A. Resoort* *Djailolo.*
*B.* " *Tobelo.*

Trail

Road

LEGENDA

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin* *Klapper-boomen.* *Bosch.* *Krapeihout.* *Bamboebosch.* *Aaneengesloten.* *Tjemara- of Dennen bosch.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Paardenpad.* *a. duiker of doorvaat van bamboe.* *Alang-alang.* *Drasland.* *Bamboe huizen.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogteijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. halfhoogteijn, c. rots, d. natuurlijke steilte, e. klippen bij laag water zichtbaar, f. laagwaterlijn, g. warme bron, h. terreinoneffenheden.*

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, sooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd. De loop van de ressortsgrens is onbekend.*

VERKORTINGEN.

*G. Goenoeng.* *Tg. Tandjoeng.* *A. Ake (rivier)*

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

Reliability rating: Class B

SHEET NO. XV-99

Area No.4 Volcanic mountains

Topography: Rounded knobs, ridges, and spurs with moderate to steep slopes and strong relief, continous with the chain of volcanic mountains in adjoining quadrangles.

Ground Conditions: Loams to clay loams of moderate depth locally stony. Give good footing, are well drained and quick drying; are more or less easy to excavate, depending on stoniness.

Area covered with virgin tropical forest.

Settlements: No settlements.

Movement: Terrain favorable to movement; area crossed by trails leading to west coast. Forest is a serious obstacle off trails.

Cover, Concealment, Observation: Topographic cover only fair. Field fortifications feasible but stony soil may slow digging in some places.

Ground and aerial concealment provided by the forest.

Observation poor because of dense forest and broadly rounded ridges.

Area No. 7. Kaoe basin

Topography: Part of a broad, lowland area, locally marshy; main part is in adjoining quadrangles (see adjoining quadrangle XV-100 for further description).

Ground Conditions: Deep sandy loam to clay loam, locally marshy and covered with tropical forest. Bamboo thickets along streams. See quadrangle XV-100 for additional information.

Settlements: One very small native settlement.

Movement: A few foot paths. See also adjoining quadrangle XV-100.

Cover, Concealment, Observation: Some cover by stream banks and low hills. Field fortifications feasible except in marshy area and in low ground.

Concealment good and observation poor.

Area No. 8. Tomoeria-Siloebing Mountains

Topography: Broad rugged hilly to mountainous region extending from coast to coast at the south, and lying between the lowlands of Areas 7 and 9 at the north (see Profile 1). Elevations reach over 900 m., greatest along an irregular divide trending roughly north-south. Slopes are prevailingly steep. Area has complex of narrow, irregular, knobby ridges and winding branching valleys. Local relief ranges up to several hundred meters. Streams are narrow, swift.

At southeast is a broad, marshy coastal plain, bordered by hills of rather moderate relief. This plain is crossed by numerous intricately winding streams, small to moderate in size. On the seaward side are broad tidal flats.

Ground Conditions: Prevailing clay loams, locally coarser. Thickness a few feet on the steeper slopes to a few tens of feet on the more moderate slopes. Give good footing when dry, but may be very slippery when wet. Are well drained and easily excavated.

Mountains covered with dense virgin tropical forest. Small patches of grassland and small stands of coconut palms on coastal flats and slopes.

Mangrove swamps widespread along the shore of the coastal flat; beaches and stream beds near the shore are muddy.

Settlements: One native village on the coast at the south.

Movement: Mountainous barrier area. No easy routes along or across area. Dense forest, steep slopes, and high local relief are obstacles. Area crossed by foot paths permitting slow and small-scale troop movement.

In coastal plain section, extensive marsh land and numerous crossings of broad, muddy-bottomed streams retard movement. Trails available for movement on foot, mainly on the inland side of the area. Muddy beach and marshy shore unsuitable for landing operations.

Cover, Concealment, Observation: In mountainous section, good cover given by narrow ridge crests and stream banks. Poor natural cover in coastal plain section. Field fortifications practicable in both sections, but marshy part of coastal plain should be avoided, also nearby low ground.

Complete ground and aerial concealment by forest.

Observation very poor because of forest. Hills bordering coastal plain would permit limited observation of the latter.

Area No. 9. Lamo valley

Topography: Broad, hilly lowland lying between mountains of Areas 4 and 8; includes Lamo River Valley and bordering slopes. Flat valley floor is broadest toward the north, narrow at the south. In middle part of valley are broad terrace flats. River valley proper bordered by broadly rounded spurs sloping down from the adjoining mountains. Profile EE' shows relations to adjoining areas.

Djailolo Plain. Coastal plain beginning where Lamo Valley widens in its lower course; is flat to undulatory, locally marshy at south. See adjoining quadrangle XV-98, for additional information.

Ground Conditions: Deep sandy loams to clay loams, locally stony. Give good footing, are moderately to well-drained, and easily excavated. In general, moderately muddy when wet, but locally may be very slippery. Along coastal strip is a band of marsh land.

Lamo Valley area covered with virgin tropical forest, except for clearings and tracts of second growth forest around settlements. In coastal plain area is a larger proportion of second growth and cleared land, and bamboo clumps occur at many places along streams. Sago palms common.

Beaches sandy in some places (View 3), but probably muddy in others.

Settlements: Numerous native villages along the coast and on the western slopes of the Lamo Valley.

Movement: A corridor area; relief and grades low to moderate. Main obstacles are forest, and stream and valley crossings. Foot path follows west side of valley, and connects with trails leading through the Gamkonora-Iboe gap. Other trails branch off to mountains of Area 8 on the east. Movement off trails difficult because of forest.

Along the coastal part of the area, more extensive cleared land permits somewhat greater freedom of movement. Large tract of marsh is local obstacle. Not well suited for landing operations.

Cover, Concealment, Observation: Fair topographic cover provided by stream banks. Field fortifications everywhere feasible except in marshy area of coastal plain.

Complete ground and aerial concealment by forest except in clearings around settlements, especially in coastal section.

Observation limited by low relief, moderate slopes, and forest. Bordering hills of area 8 would command limited view of the coastal section.

Preliminary text submitted
without checking or editing
U. S. Geological Survey

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS)

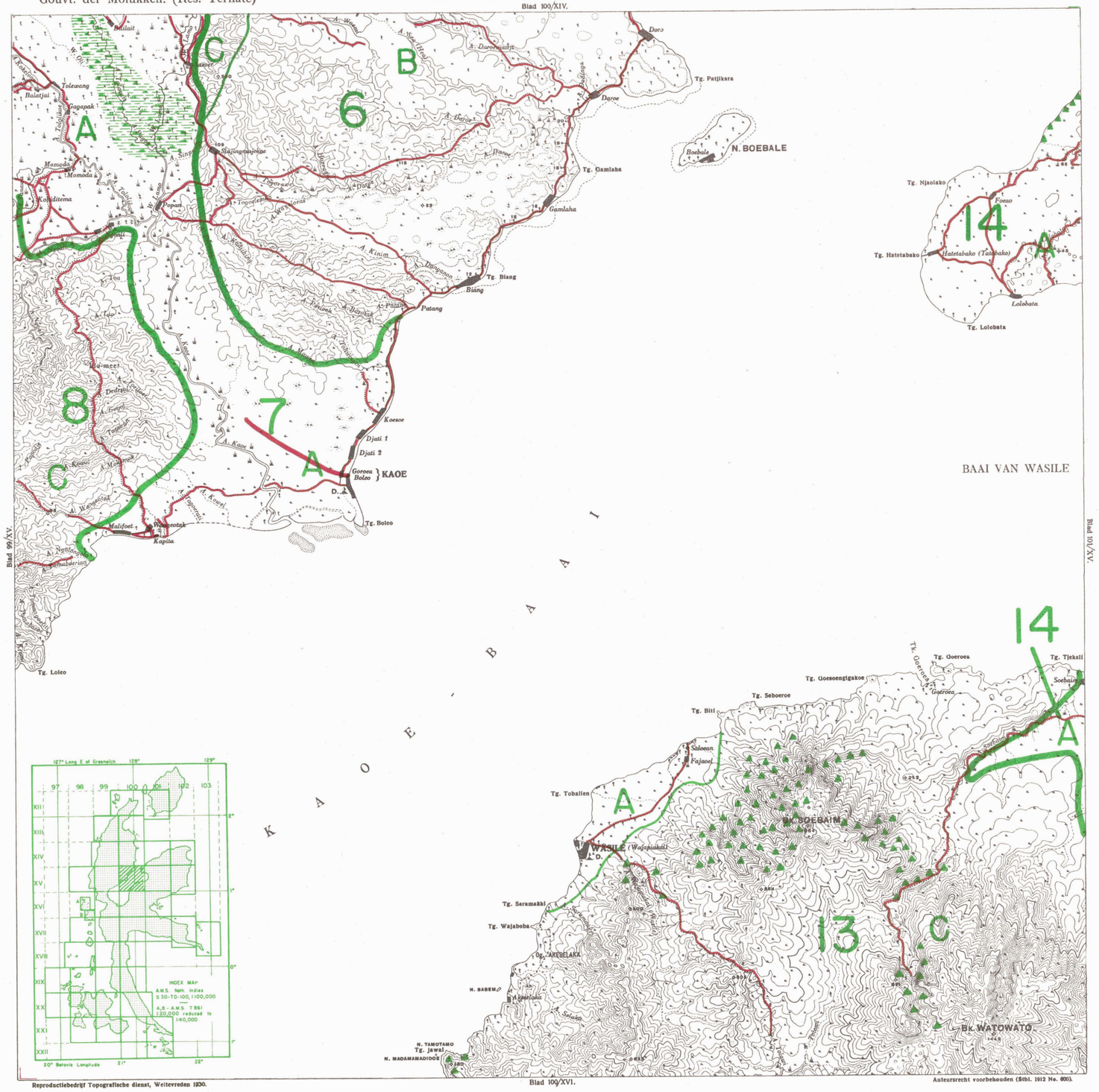
Gouvt. der Molukken. (Res. Ternate)

Schetskaart samengesteld bij den Topografischen dienst in 1925-1926.

Blad 100/XIV.

# TERRAIN APPRECIATION

Blad 100/XV.




Blad 99/XV.

Blad 101/XV.

Blad 100/XVI.




Reproductiebedrijf Topografische dienst, Weltevreden 1930.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.

| | | |
|---|---|---|
| 99/XIV | 100/XIV | 101/XIV |
| 99/XV | 100/XV | 101/XV |
| 99/XVI | 100/XVI | 101/XVI |

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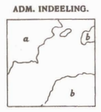



| | |
|---|---|
| Res. (Afd.) | Ternate. |
| Onderafd. | Tobelo. |
| a District | Kaoe. |
| b ,, | Wasile |

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Klapperboomen.* *Bamboebosch.* *Arentuin.* *Sagotuin.* *Tjemara- of Dennen (sparren) bosch.* *Overige op droog terrein groeiende palmsoorten.* *Moeraspalmen.* *Oelagah.* *Bosch.* *Kreupelhout.* *Alangalang.* *Gras.* *Paardenpad, a houten kilometerpaal, b houten- of bamboe duiker.* *Voetpad.* *River, a gemeten, b niet gemeten. c eiland.* *Meer.* *Bamboe haisen.* *Landb. ond. grens.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m; de dikke van 500 m, a hoogtepunt en hoogtecijfer, b halvhoogtelijn, c rots, d drasland, e laagwaterrijn, f eiland, g blijpen bij laag water zichtbaar, h niet gemeten kust, i zandbank alleen bij laag water droog, k kleine verhevenheden, l steile rand en bodemoneffenheden.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, sooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397. 1:500 000 en volgens deze kaart het blad georiënteerd. De naam en grens der cultuurondernemingen is vergeleken met het Handboek voor Cultuur- en Handelsondernemingen in Ned. Indië en met de kadastrale kaart, doch is geschreven volgens de lijst van de „Voornaamste aardrijkskundige namen" in den Nederlandsch-Indischen Archipel.*

AFKORTINGEN.

**D.** *Districtshoofd.* **N.** *Noesa (eiland).* **Bk.** *Boekoe (berg).* **Og.** *Onderneming* **Tg.** *Tandjoeng.* **Tk.** *Teloek.* **A.** *Ake (rivier).* **W.** *Wai (rivier).*

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain



~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B

SHEET NO. XV-100

### Area 6. Papora-Togisoro mountain block

Topography: Flat to moderately hilly area; on the east rises gradually from the shore to an asymmetric crest; on the west descends more steeply to the Kaoe basin. Elevations reach more than 250 meters. Local relief decreases southward and eastward. Much of northeastern part of area almost flat, with stream valleys cut sharply below general level. Roughly triangular-shaped section in the central part, with the apex pointing inland, lies slightly below the level of surrounding areas. Streams small; valleys narrow, with depth increasing inland. Shore low and fringed with narrow coral reefs. The low island of Boebale, nearly 2 miles long, lies a few miles offshore at northeast.

Ground Conditions. Sandy loam to loam, locally stony; depth irregular. Gives good footing, is well drained, dries readily if not disturbed when wet; in most places easily excavated.
Most of area covered with virgin forest, but near settlements are clearings and patches of second growth forest, and broad expanses of grassland at south.
Beaches sandy.

Settlements: Several large native villages are scattered along coast, one on Boebale Island.

Movement: Topography is favorable for movement, although slightly less so than in adjacent area to north. Easiest routes are along the shore and transverse to it. At some distance inland, movement parallel to coast is difficult because of numerous valley crossings. Streams generally fordable except when flooded. Grassland areas permit free movement of both men and vehicles, but bamboo thickets along streams, and forested slopes, retard movement off trails in much of area. A horse trail follows the shore; various foot paths extend inland to area 7. Landing operations possible at most places along the coast.

Cover, Concealment, and Observation: Some topographic cover by stream banks and low hills; in general, broadly rounded contours unfavorable for cover. Field fortifications feasible at all places.
Virgin forest gives complete ground and aerial concealment in most parts of area, but locally in grassland aerial concealment is poor, and little or no concealment in cleared areas near settlements.
Ground observation very poor because of vegetation and low relief. Aerial observation effective over non-forested areas.

### Area 7.

Topography: A major lowland; coastal strip includes a coastal area continued inland along the Kaoe valley. Marked constriction separates coastal and inland portions. Topography flat to gently rolling; relief mostly less than 50 meters. On the east side, lowland bordered by slopes of area 6, which steepen somewhat northward, and on the west by the more abrupt heights of area 8. North of the constriction, several tributary valleys merge with main valley; along one valley is a broad marsh. The Kaoe river system is the largest on the island. Stream channels are up to about 80 feet wide; banks low near mouth, somewhat higher inland. Navigation of small boats possible for some distance inland.

Ground Conditions: Deep loam to clay. Footing fairly good; soil fairly well drained except in and near large marsh at north. Excavation easy, but water may be encountered at shallow depth in lower and flatter parts of area.
Virgin forest alternates with second growth forest, grassland, clearings, and cultivated fields. Bamboo thickets nearly continuous along streams. Some mangroves on south shore.
Beaches sandy to muddy.

Settlements: Kaoe is principal settlement, has residence of a government official; is an important trading center; population about 1,500. A few other smaller villages along coast and in river valleys of interior.

Movement: Topography favorable for movement, but bamboo thickets, forests, marshes, and stream crossings constitute obstacles. A horse trail follows eastern coast as far as Kaoe, and a foot path continues to the west. Trails and paths also in the upper, inland part of the basin, but no trails connecting the two sections except by detouring through Area 8 on the west. Kaoe river in this stretch is navigable by small boats. Land movement on foot without trails slow and uncertain. Best route would be on the low, rounded ridge at the east.
Jap airfield built east of river, near coast, and surfaced road connecting it with shore.
Local grassy tracts in this and adjoining parts of Area 6 suitable for paratrooper landings.
Landing operations would be feasible along the shore north of Kaoe, but the coast west of that place would be generally unsuitable.

Cover, Concealment and Observation: Very little natural cover except by stream banks and, locally along east shore, by low, rounded beach ridges. Field fortifications feasible except in marshy areas and in very low ground.
Concealment complete in forested sections, but poor aerial concealment in grassy areas and little or no concealment in cleared and cultivated areas.
Observation very poor because of vegetation and low relief. Aerial observation better than ground observation.

### Area 8. Tomoeria-Siloebing Mt. area.

Topography: Rough hilly country continuous with the more rugged and mountainous topography of Area 8 in adjoining quadrangle. Relief is about 250 meters. Hills descend abruptly to the Kaoe valley and farther south, to the coast. For further description see quadrangle XV-99.

Ground Conditions: Clay loams of moderate depth; give good footing, easily excavated.
Except for small areas of brush and coconut palms on coast, area is covered with virgin forest.

Settlements: No settlements.

Movement: Forested, hilly topography difficult for movement. Crossed by a few foot paths. Steep coast unsuitable for landing. See also Sheet XV-99 to west.

Cover, Concealment and Observation: Cover given by ridge crests. Field fortifications generally feasible. Complete concealment by forest cover. Observation poor. See also quadrangle XV-99 on west.

### Area 13. Northeastern Mountains.

Topography: Massive, rugged mountainous country sloping steeply down to the coast at the west, but somewhat more gently at the north. Elevations reach over 1,400 meters. Streams more widely spaced than in Area 8. Slopes moderate to steep. Narrow strip of coastal plain around Wasile; smaller coastal flats farther northeast. Beaches narrow and discontinuous except along the strips noted above.

Ground Conditions: Sandy loams to clays, prevailingly shallow on steeper slopes, somewhat thicker on gentler slopes and on coastal flat. Soils give good footing, are well drained, and generally easy to excavate. May be very muddy when wet.
On the steeper slopes many places have rocky ground, with little or no soil.
Area covered with virgin tropical forest. Coconut palms fringe shore at many places.
Beaches sandy.

Settlements: A few very small native villages along coast, and the one large village of Wasile, station of a government official.

Movement: Movement greatly restricted by rugged, forested mountain topography. A few foot paths lead into the mountains. Topography locally favorable for movement in the coastal flat around Wasile, and villages here are connected by a foot path. Coastwise movement east of this section retarded mainly by numerous valley crossings, and by lack of any trails. Coastwise movement to the southwest more difficult, owing to steeper coastal topography. The Wasile flat would be possible as a beachhead, although inadequate communications with other areas introduce limitations.

Cover, Concealment and Observation: Cover given by narrow ridges and knobs in some parts of the area, but in other places contours too broadly rounded for good cover. In rocky areas irregularities give some local cover. Field fortifications practicable except in and near rocky areas.
Good ground observation locally from tops of steep, rocky, open slopes, but poor observation in heavily forested sections.

### Area 14. Dodaga Plain

Topography: Flat to undulatory coastal plain. A large, detached section of this area lies north of Wasile Bay, and a small projection from the larger area on quadrangle XV-101 lies south of the bay. Section north of bay is lowland, with only a few rolling hills rising above 150 feet. Crossed by one small stream. Beaches are probably wide. Coral reefs of different widths fringe area in places.

Ground Conditions: Sandy loam to sandy clay loam, locally stony; of moderate depth. Footing fair to good, drainage good, and excavation easy except in stony ground. Moderately muddy when wet.
Palms fringe shores at many places; along streams, bamboo thickets occur; virgin forest covers rest of area.
Beaches sandy.

Settlements: A few very small native villages.

Movement: Section north of Wasile Bay is practically flat and topographically suitable for movement in any direction, but dense forest vegetation limits systematic movement to trails. The latter, suited for foot use only, cross the area in several directions. For section south of Wasile Bay, see quadrangle XV-101, on the east.

Cover, Concealment and Observation: Little natural cover except low, rounded hills, stream banks, and possible beach ridges along shores. Field fortifications feasible except near sea level.
Inland, forest gives complete ground and aerial concealment; along shores, good aerial concealment with limited ground concealment in coconut groves.
Observation very poor because of forest cover and flat topography.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

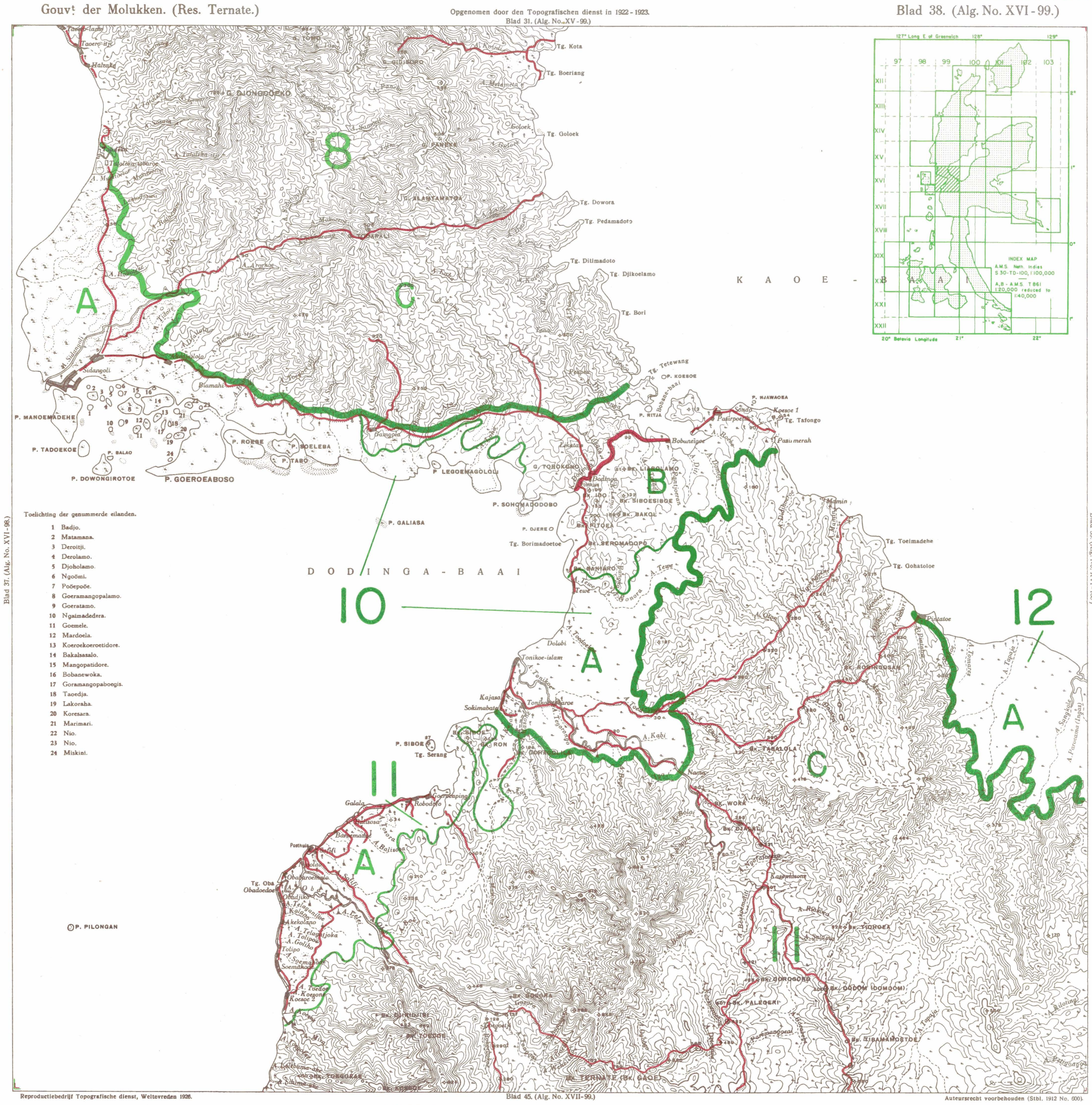
# HALMAHERA (MOLUKKAS)

## TERRAIN APPRECIATION

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1922-1923.

Blad 38. (Alg. No. XVI-99.)




BLADINDEELING.

ADM. INDEELING.

Afdeeling Ternate.
1. Onderafd. Halmahera.
A. Ressort Djailolo.
a. District Djailolo en Sindangoli.
en Dodinga.
b. „ Oba.
B. Ressort Tobelo.
District Wasile.
C. Ressort Weda.
District Weda met Patani.
2. Onderafd. Tidore.

LEGENDA.

Trail

Road

Kampoeng. Scheepvaart (?) Sagoetuin. Arentuin. Klapperboomen. Bosch. Kreupelhout. Bamboebosch. Moeraspalmen. Tjemara- of Dennen bosch. Voetpad. Rivier, a. gemeten. b. niet gemeten. Inlandsche graven. Paardenpad. a. duiker of doorlaat van bamboe. Bamboe huizen. Drasland. Gelagah. Alang-alang. Damarboomen. Ressortsgrens. Districtsgrens.

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogte verschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. hulphoogtelijn, c. rots, d. bron, e. natuurlijke steilte, f. eiland, g. klippen bij laag water zichtbaar, h. zandbank alleen bij laag water droog, i. terreinoneffenheden.*

Schaal 1:100 000.

TOELICHTINGEN.

*Ten noorden van den weg Dodinga-Bobaneigoe oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd. Ten zuiden van genoemden weg samengesteld door den Top. dienst uitgaande van het einde van het paardenpad in kampoeng Bobaneigoe, welk punt uit de zeekaart No. 388 (catalogus 1923) overgenomen werd.*

VERKORTINGEN.

P. Poelau. G. Goenoeng. Bk. Boekoe (berg). Tg. Tandjoeng. A. Ake (rivier). K. Koeala (rivier).

EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
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- C. Hilly and mountainous country.

Swamp (moeras)

Lake

Marsh (drasland)

Rocky area

Coastal bluffs and cliffs

Common abbreviations

- P Island
- Tg. Cape
- A. River
- X. River
- Bk. Mountain

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

Reliability rating: Class B.

SHEET NO. XVI-99

Area No. 8 - Tomoeria-Siloebing Mountains

Topography: Irregular mountainous area rising abruptly from coast to elevations of more than 2,000 feet. Slopes moderate to steep. Valleys rather closely spaced, producing rough topography. Largest stream, the Sidangoli, divides mountains into eastern and western sections. Along lower course, Sidangoli has narrow floodplain; upstream, valley bottom narrows. Other streams small and short, have steep gradients, and flow in narrow-bottomed, steep-sided valleys.

Eastern coast is abrupt and irregular, with many coves and promontories. Western shore somewhat less abrupt, and has very narrow coastal flat.

Ground Conditions: Prevailingly clay loam; locally coarser soils. Depth a few feet on steeper slopes to a few tens of feet on more moderate slopes. Soils give good footing when dry; are well drained and readily excavated. May be very slippery when wet.

Area covered by dense virgin tropical forest.

Settlements: Only a few small native villages along west coast.

Movement: Mountainous area unfavorable for movement. Dense forest largely limits movement to existing trails. One foot trail across the island follows the Sidangoli river partway, then crosses the eastern mountains over a pass about 1,500 feet high. Coastwise movement at the east hindered by lack of coastal flat, and by roughness of routes across spurs and valleys. Coast unsuitable for landing operations.

Cover, Concealment, Observation: Cover provided by ridge crests, stream banks, ravines, and by larger hardwood trees. Field fortifications feasible in all except rocky areas.

Concealment provided by forest except in cleared and second growth tracts near settlements.

Observation everywhere limited by forest. Points on east coast provide lookout over adjoining areas.

Area No. 11 - Mountainsof Central Halmahera

Topography: Irregular dissected ranges rising gradually from isthmus of Dodinga to north (Area 10); bordered on west and northeast by low alluvial plains. Altitudes of summit levels vary considerably; north of Ek. Tabalola commonly less than 1,100 feet; in southeast part, range from 1,600 to 1,900 feet. Highest mountains are in the southwest where peaks north of Ek. Ternate exceed 2,800 feet. Summits and ridge crests commonly rounded but narrow. Slopes moderate to steep, commonly more than 30%. Lowest slopes of main valleys 15% to 30%. Valleys commonly V-shaped with narrow floors.

Ground Conditions: Mountains in northern part have lateritic loam or clay loam, 15 to 30 feet deep over most of area; some bare rock in valley bottoms. In the south, mountains underlain by massive limestone exposed locally in cliffs and ledges; thin soil cover of clay or sandy clay. On western margin of area soil is yellow-brown lateritic sandy or stony loam which overlies conglomeratic or sandy rock at a depth of 10 to 20 feet. On narrow coastal lowlands south of Kajasa, sandy clay loam soil. Soil generally well drained; gives good footing for troops when undisturbed by removal of vegetation cover. In rainy weather deep mud forms in trails but ground dries fairly quickly. Ground on coastal lowland commonly marshy and soft during rainy season; forms deep slow-drying mud in excavations and along trails.

Area largely covered by rain forest; coconut palms along coast; bamboo and sago thickets along stream courses of lowlands. Patches of cleared and grass-covered land around villages; larger areas of second growth forest at various stages of growth.

Settlements: Mountains lack permanent settlements; some temporary camps of damar gum gatherers. Numerous villages of 200 to 300 inhabitants line shore north of Koesoe River.

Movement: Mountains form a barrier area unfavorable for movement of motorized equipment without construction of roads. Several foot trails wind through mountains but cannot be used by motorized units without much construction work. Topography of coastal lowland is suitable for mechanized vehicles but in many parts of area dense vegetation is serious obstacle. Horse trail from the Koesoe River to Goeroeaping probably easily improved for use by light traffic in drier weather; needs considerable improvement for all-weather use by heavy traffic. Limited movement and deployment of motorized units possible in open coconut groves and beaches.

Away from trails foot troops can move only with difficulty. Trail across northern part of mountains from plain of Area 10 to Mamin on Kaoe Bay offers easiest route for men. Other trails winding through the higher parts of the mountains are steep and difficult; offer circuitous routes to Kobe or Rai valleys. Off trails, troops must cut their way in many places through tangled underbrush. Most streams can be forded by men and machines except during brief floods. The Oba River cannot be forded by vehicles and may be unfordable by men except during long dry seasons.

Cover, Concealment, Observation: Rugged broken terrain offers excellent cover for men although at many points trails can be brought under fire from nearby heights; poor cover for machines. Coastal lowland gives little cover for men or machines; beach ridges locally offer a little cover for landing troops.

Dense vegetation gives good concealment for men and vehicles in most parts of area. Open coconut groves, cleared or grass-covered areas, and young second growth around villages give only partial cover for machines.

Observation generally poor. Except for well-used horse trail along coast, trails largely hidden from aerial observation by overlapping crowns of bordering trees. Ground observation generally limited to a few yards.

Area No. 10 - Isthmus of Dodinga and Low plains bordering Dodinga Bay

Topography: Low narrow coastal plains on either side of Dodinga Bay; pass eastward into low hills and terraces of Isthmus of Dodinga.

Coastal plain between the isthmus and the village of Tataleka. Slopes gently seaward from altitudes generally less than 150 feet. Inland margin bordered in most places by low hills and terraces 300 to 400 feet in altitude above which rise the steep mountain sides (Area 8). Relief generally less than 100 feet. At northwest end of area between villages of Tataleka and Sidangoli, plain is about 3/4 mile wide; surface rolling and cut by Ratoemoe and Sidangoli Rivers and a few small intermittent tributaries. Valleys are poorly defined; merge with the intervening stretches of plain that forms low interstream divides. The channel of the Sidangoli has steep banks a few feet high. Coast between Tataleka and Sidangoli low and fairly regular; bordered in part by sandy beach, locally some mangrove swamp. From Sidangoli nearly to isthmus, plain is low, muddy, less than a mile wide; crossed by several small streams some of which disappear into low densely overgrown marshland just before reaching the sea. South and east of Sidangoli village a number of low mangrove-covered islands and reefs front the coast.

Dodinga isthmus. Is made up of many low hills and terraces which merge with coastal plains to the west and southwest and with low mountain ridges to the north and southeast (Areas 8 and 11). At its narrowest point the isthmus is about 1-3/4 miles wide; commonly less than 200 feet in altitude, although point overlooking Bobane Bay exceeds 300 feet. Altitudes generally somewhat higher to north and south; Bk. Pitoea about 675 feet in altitude. Hills broad and rounded with gentle slopes; terraces low with nearly flat or gently undulating surfaces and moderate to gently sloping margins. West coast of the isthmus somewhat embayed; shore low, muddy or sandy. East coast has mumerous coves and small bays. On the east side the largest, Bobane Bay, about two miles long with maximum width of about 1/2 mile; bay has narrow sandy beach and is surrounded by steep rocky slopes.

Southward, hills of the isthmus pass into the small flat alluvial plain of the Toniko lowland bordered on east and south by steep slopes of Area 11. Plain slopes gently seaward to low sandy or muddy shore; crossed near south margin by Toniko and Masone rivers.

Ground Conditions: On isthmus of Dodinga, red-brown lateritic loam or clay loam, 15 to 30 feet deep. Low plains bordering hills and ridges of isthmus have sandy clay loam near mountain front, finer clay soil along coast. Hills of isthmus and higher parts of lowland well-drained. Lower parts of plains bordering isthmus generally poorly drained soil, waterlogged much of the year; marsh and swamp border most of coast between Sohomadodobo and Sidangoli. Islands south and southeast of Sidangoli bordered by coral reefs. Deep mud forms in trails and excavations.

Hills and ridges of isthmus covered by patches of grass and second growth forest; a few small areas of virgin rain forest. Inland margins of coastal plains have some rain forest but plains largely covered by grass and second growth forest. Swamp forest and considerable tracts of mangrove border the Sidangoli plain; islands near coast largely covered by mangrove. Some coconut groves and small plantations near Sidangoli and south of Toniko River.

Settlements: Sprawling village of Sidangoli is largest settlement; center for repairing fishing boats from Ternate and neighboring islands. Small settlement of Dodinga at west end of isthmus; two small villages at east side. A few small villages south of the isthmus.

Movement: Corridor area; relatively easy movement over flat or rolling plains, low hills, and terraces; few areas of dense vegetation.

Most important route probably is the road which crosses isthmus over low broad terraces, through Dodinga to Bobaneigoe; grades gentle to moderate. Short road from pier on southeast side of Bobane Bay to village of Pasir Poeti follows low rolling ground. Both suitable for at least light motorized equipment; probably need some improvement for all-weather use by heavy traffic. Roads probably bordered largely by deep grass and second growth forest, permitting deployment of men and vehicles away from roads in many places.

Horse trail between villages of Tatalek and Sidangoli crosses low rolling plains; probably can be used by light wheeled vehicles between Sidangoli River and the Sidangoli village. Double-tracked trail from Sidangoli to Dodinga probably suitable for light wheeled vehicles; trail follows inland margin of flat muddy coastal plain; in places follows low terraces and foot hills bordering mountains of Area 11. Grades moderate to low; trail probably fairly well drained. Little-known foot trail from Sidangoli crosses Area 8 to the east coast. Foot trails from Dodinga and Pasir Poeti extend short distance along the coastal lowlands. Horse and foot trails from village of Tonika-islam cross the alluvial plain into Area 11. Trails in nearly all parts of the area probably can be easily improved for use by motorized units.

Topography generally suitable for easy movement of motorized units. Slopes generally low, although hills between Dodinga isthmus and Tewe River and those bordering Bobane Bay are moderate to steep. Large grassy tracts in several sections probably suitable for free movement of motorized units off roads. Movement of heavy tracked vehicles possible in second-growth forest. Foot troops can penetrate second-growth forest with difficulty; in many places must cut way. Mangrove swamps bordering the north coast of Dodinga Bay are probably impassable for motorized units; difficult for foot troops. Soft muddy ground underlying many parts of plain between Sidangoli and the isthmus may make going difficult; vegetation may be very dense.

Most streams small, probably not important obstacles; dense vegetation along banks may make approaches difficult. Sidangoli may be difficult to ford during long rainy periods.

Cover, Concealment, Observation: Cover poor in most parts of area; dissected hills and terraces of isthmus offer best available cover for men and machines. Men may locally find cover from low trajectory fire behind stream banks and low rises in ground. Old forts around Dodinga may afford cover for a few men.

Large grass-covered areas north and northeast of Sidangoli and on parts of isthmus give some concealment for men but little for machines. Mangrove and second growth forest bordering the grassed and cleared areas can give good concealment for men. Very young second growth forest gives only incomplete concealment to large numbers of vehicles.

Aerial observation of grass-covered plains near Sidangoli and parts of isthmus generally good; ground observation limited to a few feet. Poor ground and aerial observation in areas of high second growth and mangrove that border most parts of Dodinga Bay.

Area 12: See quadrangle XVI-100.

Preliminary text submitted without checking or editing. U. S. Geological Survey

Prepared by U. S. Geological Survey for Chief of Engineers, U. S. Army.

~~CONFIDENTIAL~~

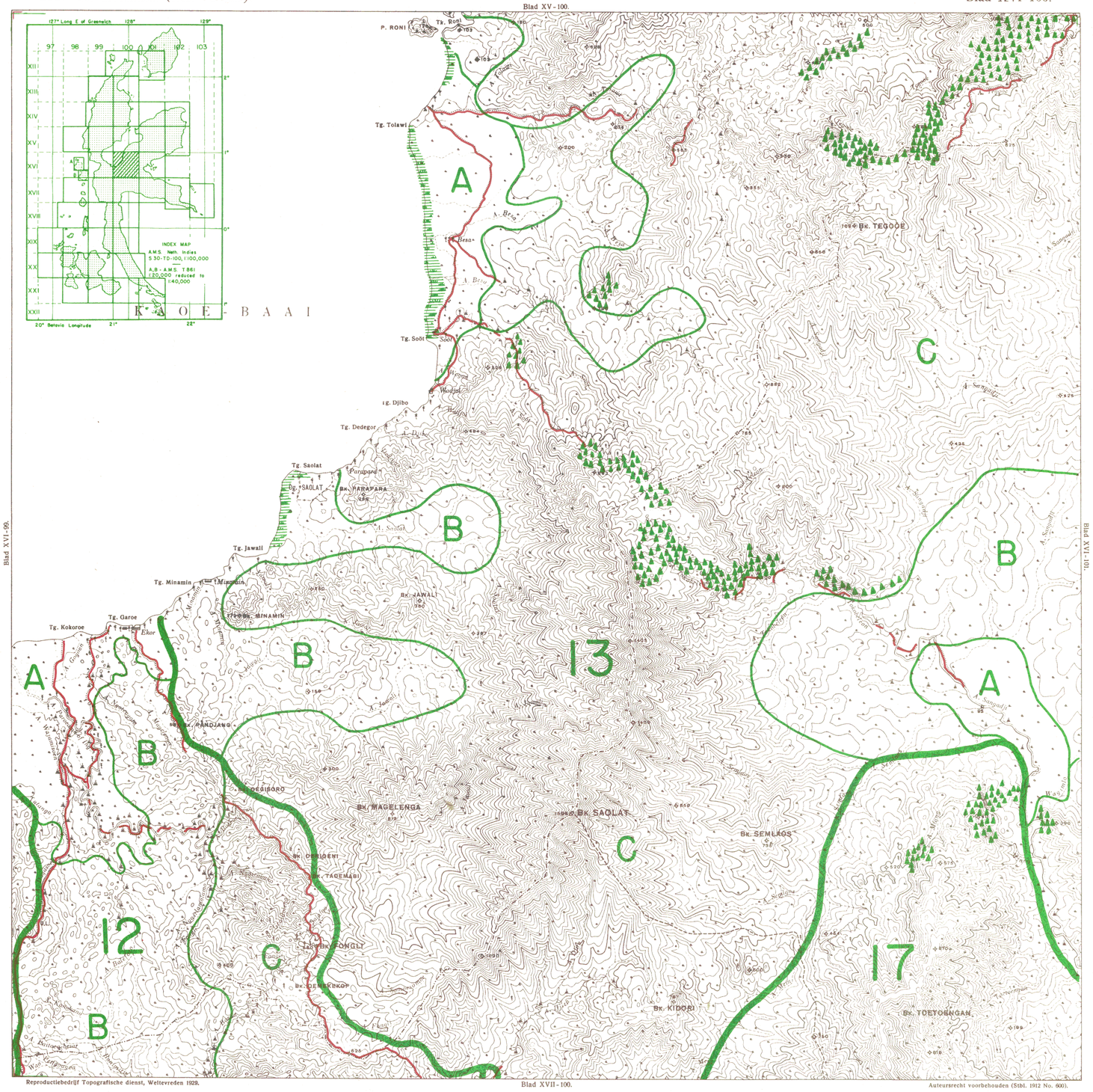
# HALMAHERA (MOLUKKAS)

Gouvt der Molukken. (Res. Ternate).

## TERRAIN APPRECIATION

Blad XVI-100.

Schetskaart samengesteld bij den Topografischen dienst in 1923-1925.




Reproductiebedrijf Topografische dienst, Welteverden 1929.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.

| | | |
|---|---|---|
| XV-99 | XV-100 | XV-101 |
| XVI-99 | XVI-100 | XVI-101 |
| XVII-99 | XVII-100 | XVII-101 |

1°20' N.B.
0°20' N.B.
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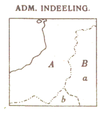
ADM. INDEELING.




Residentie (Afdeeling) Ternate.
A Onderafd. Tobelo.
District Wasile.
B Onderafd. Weda.
a District Maba met Gebe.
b ,, Weda met Patani.

Trail
Road

LEGENDA.

*Kampoeng. Schaars bewoonde streken. Klapperboomen. Tjemara-of Dennen (Sparren) bosch. Bosch. Bamboebosch. Arentuin. Moeraspalmen. Bamboe huizen. Vastpad. Moeras. a Rivier, a gemeten, b niet gemeten, c eiland. Landb. ond. grens. Districtsgrens. Onderafdeelingsgrens. Paardenpad.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogteijnen hebben een onderling hoogteverschil van 50 m; de dikke van 500 m. a hoogtepunt en hoogtecijfer, b hulphoogtelijn, c rots, d eiland.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm
0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397, 1:500 000 en volgens deze kaart het blad georiënteerd. De naam en grens der cultuuronderneming is vergeleken met het Handboek voor Cultuur- en Handelsondernemingen in Ned. Indië en met de kadastrale kaart.*

AFKORTINGEN.

**Bk.** *Boekoe (berg).* *A. Ake (rivier).* Tg. *Tandjoeng.* **P.** *Poelau.* Tk. *Teloek.* **Ot.** *Onderneming.* **O.L.** *Onderaardsche loop.*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

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A. River and coastal lowland.
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C. Hilly and mountainous country.

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Marsh (drasland)
Lake
Rocky area
Coastal bluffs and cliffs

Common abbreviations

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Tg. Cape
A. River
X. River
Bk. Mountain



CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

# TERRAIN APPRECIATION

Reliability rating: Class B.

SHEET NO. XVI-100

Area No. 13 - Northeastern Mountains

Topography: Mountainous area dominated by broad, irregular range trending north-north- east. Elevations highest in south-central stretch, reach about 1,500 meters. East of main range slopes descend to intermontane basin at headwaters of Sangadji River; at west the range descends through irregular spurs, knobs, and foothills to the coast. On higher parts of central ridge, both west and east slopes are steep, but at lower elevations east slopes generally gentler than west ones.

Upper Sangadji basin has central area of flat or nearly flat ground surrounded by gentle slopes which gradually steepen with elevation. Downstream, the valley narrows abruptly and its sides steepen. Sangadji is one of larger streams of Halmahera; has meandering course. Several of its tributaries in the basin are also large; have narrow-bottomed valleys with gently sloping sides; deeper toward mountains.

West slope streams shorter and have smaller valleys. In their upper stretches, some flow roughly parallel to main range. Their valleys differ considerably.

At northwest, is a discontinuous coastal plain widest toward north. Long stretches of coastline swampy, but sandy beach ridges may occur at some places. Topography flat to undulatory, grading into moderately steepened slopes on the inland side.

Ground Conditions: Clay to clay loam , deep except on higher and steeper slopes. Gives good footing, is well drained, and readily excavated; moderately muddy when wet, dry quickly. Some rocky areas on the central ridge and at scattered localities in the bordering hills. In coastal belt, long strips of swamp land. Soil here tends toward sandy loam.

Area covered with tropical forest. On highest part of the ridge possibly transition to moss forest. Coconut palms in strips along the shore.

Settlements: A few small native villages along coast.

Movement: Mountainous area unfavorable for through movement. Dense forest largely limits movement to existing trails. Available routes across mountains to east coast are only fair, and follow low places in the central range. Most direct route is from Soot over pass at about 800 meters elevation to headwaters of Sangadgj, and down that stream to coast. Trail over this route follows spurs, rocky stretches, and stream beds. A less direct route over a lower pass would cross north side of Mt. Togooe; followed only part way by a trail.

Coastwise movement is possible but restricted. Some free movement feasible for men in the long strips of coconut palms; in northern strip of coastal flat is foot path. No roads suitable for motorized equipment. Swamps obstruct movement close to beach for long stretches, and crossings of small streams present minor obstacles.

The swampy beaches bar landing operations along wider parts of coastal strip; other sections probably too narrow for large scale operations.

Cover, Concealment, Observation: Except on flats along coast and in Sangadji basin, cover provided by ravines and ridges. Some additional cover provided by larger hardwood trees and rocks in rocky areas. Field fortifications feasible in all except swampy and rocky areas, but may require drainage on coastal flats.

Concealment provided by trees and forest in all except the rocky areas. Ground concealment incomplete in coconut groves; complete elsewhere.

Observation everywhere limited by the forest. Fair vantage points on some steeper knobs of the foothills, and on higher ridges, but field view limited and anything below treetop level hidden.

Area No. 17 - Mountains of southeastern Halmahera

Topography: High rugged mountain ridges; north end of main ranges of southeastern Halmahera. Altitudes generally 2,600 to 3,000 feet. Summits narrow and rounded. Slopes commonly steep; locally, lower slopes are moderate. Mountain sides deeply cut by numerous steep-sided ravines. Streams very small and short with steep gradients; subject to sudden torrential floods during heavy rain.

Ground Conditions: Same as Area 13.

Movement: Barrier area, unsuited for motorized units. Foot troops can move most easily along ridge crests where vegetation is usually rather open. No known trails or paths. Streams can be forded except when in flood. Thick mat of vegetation in valley bottoms may be more serious obstacle to crossings than streams.

Cover, Concealment, Observation: Same as Area 13.

Area No. 12 - Kobe-Ekor Corridor

Topography: Northern part of area occupied by small alluvial plain of irregular width; southern part has low rounded mountains and ridges with long spurs fingering northward into the plain. No marked topographic break between area and mountains of central and northeastern Halmahera (Areas 12 and 13); boundaries arbitrary.

Plain slopes gently seaward from altitudes generally less than 150 feet. Surface flat or gently undulating, with swamps along the Paroeama River. Coast low; sandy beach ridges east of Tg. Garoe.

Low mountains west of Ngairlamolamo and Ekor River are generally less than 1,200 feet in altitude. Slopes are moderate to low; summits broad and rounded. East of the Ngairlamolamo, where ridges rise toward the mountain mass of Bk. Saolat (Area 13), altitudes increase to nearly 2,000 feet. Slopes much steeper and ridge crests much narrower than to west.

The Paroeama (Ingus) River, the largest in the area, flows through an open valley with low to moderately-sloping walls; river channel is about 100 feet wide in the upper reaches, probably more than 200 feet wide where the stream crosses the coastal lowland. Floodplain 3/4 mile to a few hundred feet wide extends nearly to junction of the Boeboetdeing and the Ngairlamolamo; marshy in many places. Other rivers are generally less than 60 feet wide. Except the Ekor which flows mostly across the coastal lowland, streams have V-shaped valleys with floodplains very small or, commonly, lacking.

Ground Conditions: In the mountains, commonly red-brown clay loam or clay 10 to 30 feet deep; central and southern parts underlain by conglomeratic bedrock; in north and east by limestone. Bare rock is exposed locally in cliffs and ledges; some rock strewn slopes and valley bottoms. Soil is generally well-drained; mud dries fairly rapidly. Soil in north lowland mostly sandy clay loam; coarser soils border the valleys; near center of lowland soils are dominantly fine clays. Drainage is moderately good except for swampy areas around lower course of the Paroeama River. Coarser soils near lowland margins dry fairly rapidly when wet. Finer clays form deep slippery mud which dries slowly.

Rain forest covers all except swampy stretches of the Paroeama, where vegetation is of the swamp forest type. Nipa thickets occupy north margin of the swamp. A few small cultivated and second growth areas near coastal villages.

Movement: Although area is a poor corridor, the relatively low altitudes of the mountains and two good footpaths make it the easiest available land route from Weda Bay and southern part of Halmahera to the Isthmus of Dodinga (Area 10) and northern Halmahera.

Foot path from coast crosses coastal plain then follows Dagasoel valley and low hills to south; cannot be used by motorized equipment without considerable improvement. Foot path from Ekor village follows Ekor River then climbs along the steep spurs on west side of Bk. Fongli; has moderate to steep grades; condition probably somewhat better than Dagasoel valley trail but needs improvement for use by motorized units. Trail south from Tg. Garoe extends up the Paroeama (Ingus) to meet the Ekor River trail; short branch over ridge to Dagasoel trail.

Dense vegetation and (except on coastal lowland) rough broken terrain make area unsuitable for movement of motorized equipment away from roads. Foot troops can move with difficulty and in many places must cut their way through rainforest undergrowth; movement may be easiest on ridge crests.

Except for the lower reaches of the Paroeama, streams can be easily forded in drier season. Flash floods fairly commonly during heavy rains, may make many streams temporarily unfordable. Locally steep stream banks matted with vegetation make approaches difficult for vehicles without construction of short dugways; swamps bordering the lower Paroeama are obstacles.

Cover, Concealment, Observation: Good cover in valleys and ridges of central and southern parts of area, although trails may be covered at many points by fire from nearby commanding heights. Cover on coastal flats is largely lacking; locally a little cover for men behind beach ridges and high stream banks. Trees of the rain forest give a little cover for men. Hasty fortifications may be difficult where jungle floor is covered by dense tangle of roots; soil itself easily excavated in almost any part of area. Rain forest gives excellent concealment in almost all parts of area; coconut palms along the shore give only incomplete concealment to a number of vehicles.

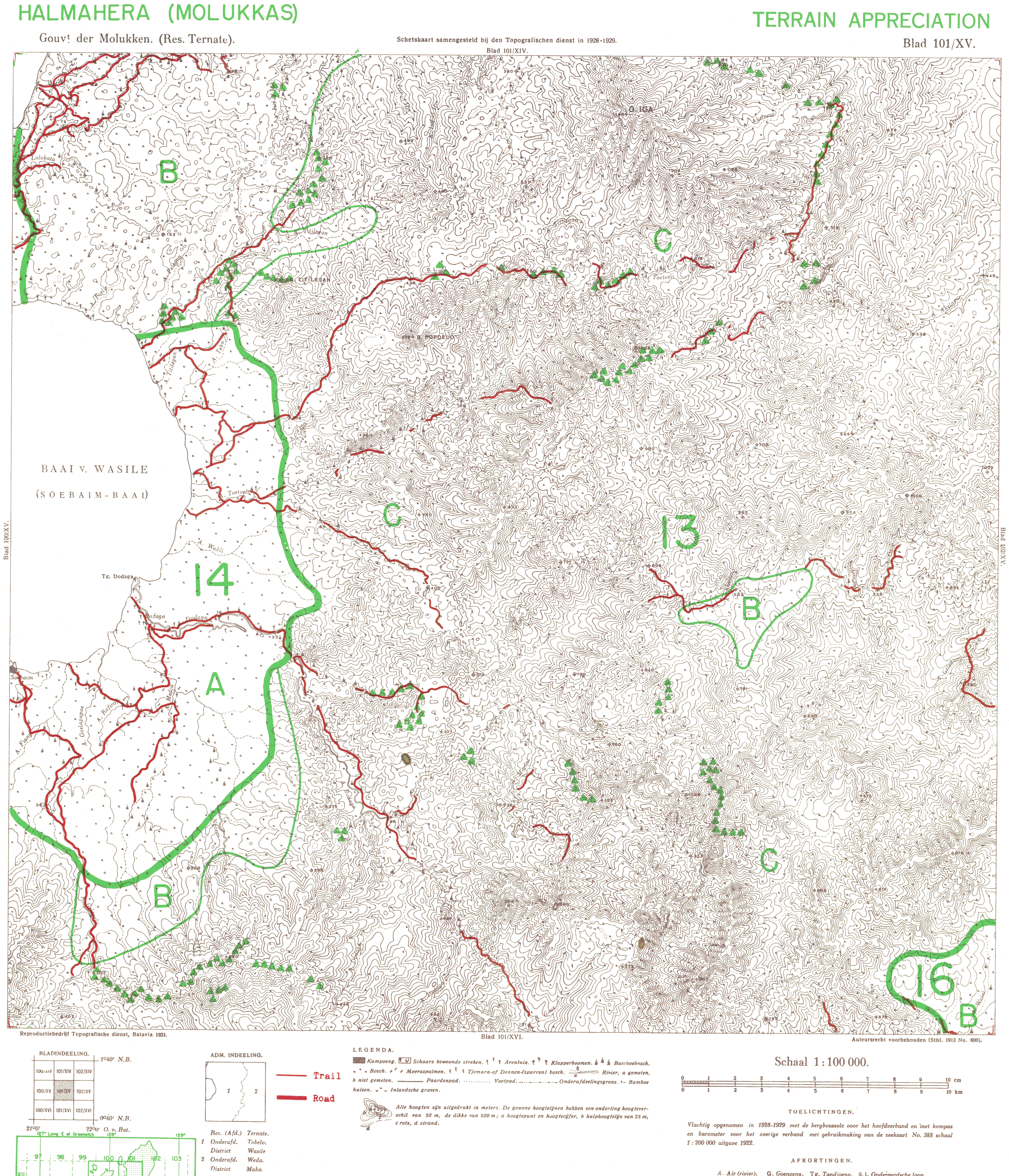
Aerial observation very poor; narrow foot trails are largely hidden by overlapping tree crowns. Ground observation generally limited to a few yards except on beaches.

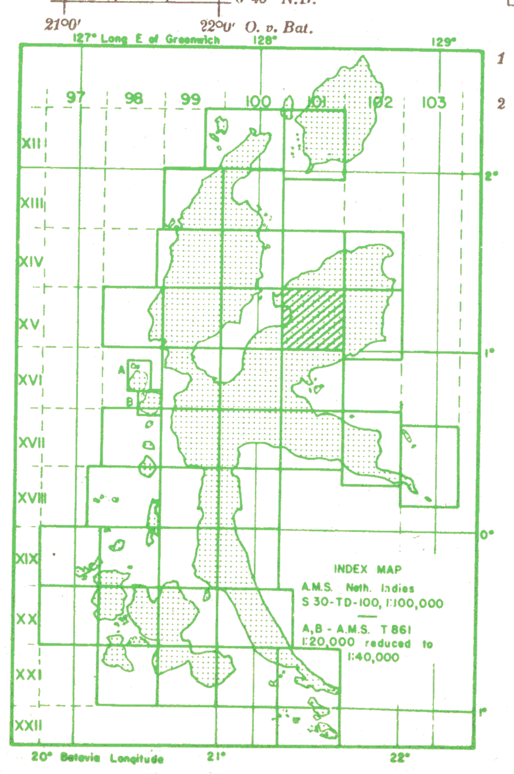
Area No. 11 - Mountains of Central Halmahera

See sheet XVI-99.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey




## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras) — Lake

Marsh (drasland) — Rocky area

Coastal bluffs and cliffs

Common abbreviations

- P. Island
- Tg. Cape
- A. River
- K. River
- Bk. Mountain

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S ARMY

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B

SHEET NO. XV-101

Area No. 13. Northeastern mountains

Topography: High, rugged mountainous area rising steeply from lowlands of area 14, and from the bench land at northwest corner of quadrangle (profile FF'). More than half of area above 500 m. in elevation, and scattered peaks exceed 1,000 m. A divide between east and west drainage crosses the quadrangle, with small, short streams draining west into Wasile Bay, and much longer streams (only the headward sections lie within this quadrangle) draining eastward. Ridges are sprawling, blunt, and irregular; slopes moderate to steep, locally steeper on one side than on the other. Larger valleys are rather widely spaced; their depths exceed 600m. in the interior, but decrease rapidly seaward. Valley bottoms generally narrow. Streams have winding courses, fairly steep gradients. Stream beds bouldery in the interior, become gravelly and sandy toward coast. Locally a few streams flow underground.

At northwest is a somewhat dissected, flat to gently sloping bench land, transitional from the mountains to the sea, and to the coastal plain, area 14. Valleys here are shallow and have gently sloping sides. The coast is steep.

Ground Conditions: Sandy to clayey loams, locally stony in lower parts of area. Colors reddish to brownish. Depths may exceed 20 ft. The soils provide good footing, are well drained, and are moderately muddy when wet. Small areas of bare, rocky ground on some higher ridges, and in scattered places on lower ground.

Except on rocky slopes area covered with virgin tropical forest. Vegetation less dense along higher ridge crests; most dense along streams.

Settlements: None.

Movement: Mountainous barrier area. Movement impracticable except along trails. No natural lines of movement except southeast to Boeli (on adjacent quadrangle to south); route lies through a pass at about 500 m., and is followed by foot path. Other foot paths lead eastward into interior, but do not give direct access to east coast. Boeli trail follows stream bed part way;not usable at high water. The same is true of other trails; however, where local relief is not great nor slopes steep, the latter cut across drainage lines, and follow ridges or rocky ground.

Cover, Concealment, and Observation: Ridge crests, stream banks, and other topographic irregularities provide cover at most places, and larger hardwood trees can give limited cover. Field fortifications feasible except on rocky areas. Depth limited by shallow soils on coastal terraces.

Except for small local rocky areas, forest gives complete concealment from both ground and aerial view.

Observation limited by forest. Points at crests of the higher and steeper slopes provide limited lookouts for adjacent valleys, but activities at ground level would be hidden.

Area No. 14. Wasile Plain

Topography: Large coastal plain widening southward. Topography is flat, gently sloping or undulatory, with elevations ranging up to about 100 m. marginally. The transition to the adjoining mountains is abrupt at the north, more gradual at the south. Plain crossed by two larger streams and several smaller streams. The larger streams have high banks and sandy to gravelly beds. A detached section of this area lies north of Wasile Bay (see quadrangle XV-100).

Ground Conditions: Loamy soil grading down into unconsolidated deposits of variable character. Soil is fairly well drained and easily excavated. Good footing, but muddy when wet.

Area covered with virgin forest, except for small clearings near the village of Soebaim at south. Strips of coconut palms along coast, and bamboo brakes along the streams.

Beaches sandy.

Settlements: One small village along the coast at the south.

Movement: Topographically an area of easy movement. Larger stream channels are minor obstacles, and for ready movement would require dugway approaches or bridges. Tropical forest is main obstacle, particularly bamboo brakes along streams. Movement therefore largely limited to trails, of which several lead from coast inland. In coconut groves along shore, movement would be less restricted. Shore suitable for one or more beachheads.

Cover, Concealment, and Observation: Cover provided only by stream banks, beach ridges, and low banks that mark limit of high tide, also larger hardwood trees.

Complete concealment provided by the forest everywhere except in the coconut groves, where ground visibility is less restricted, particularly for machines.

Visibility limited by forest, except in coconut groves; observation poor.

Area No. 16. Boeli plain

See quadrangle XV-102.

Preliminary text submitted without cnecking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey for Chief of Engineers, U. S. Army.

# HALMAHERA (MOLUKKAS)

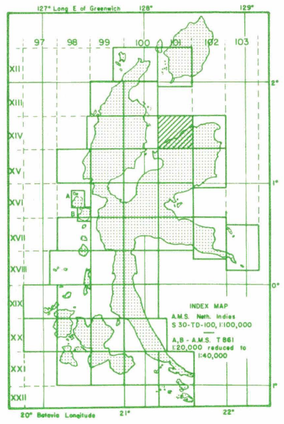
Gouvt der Molukken (Res. Ternate).

Schetskaart samengesteld door den Topografischen dienst in 1929-1930.

Blad 101/XIII.

# TERRAIN APPRECIATION

Blad 101/XIV.




EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

▲▲▲ Rocky area

Coastal bluffs and cliffs

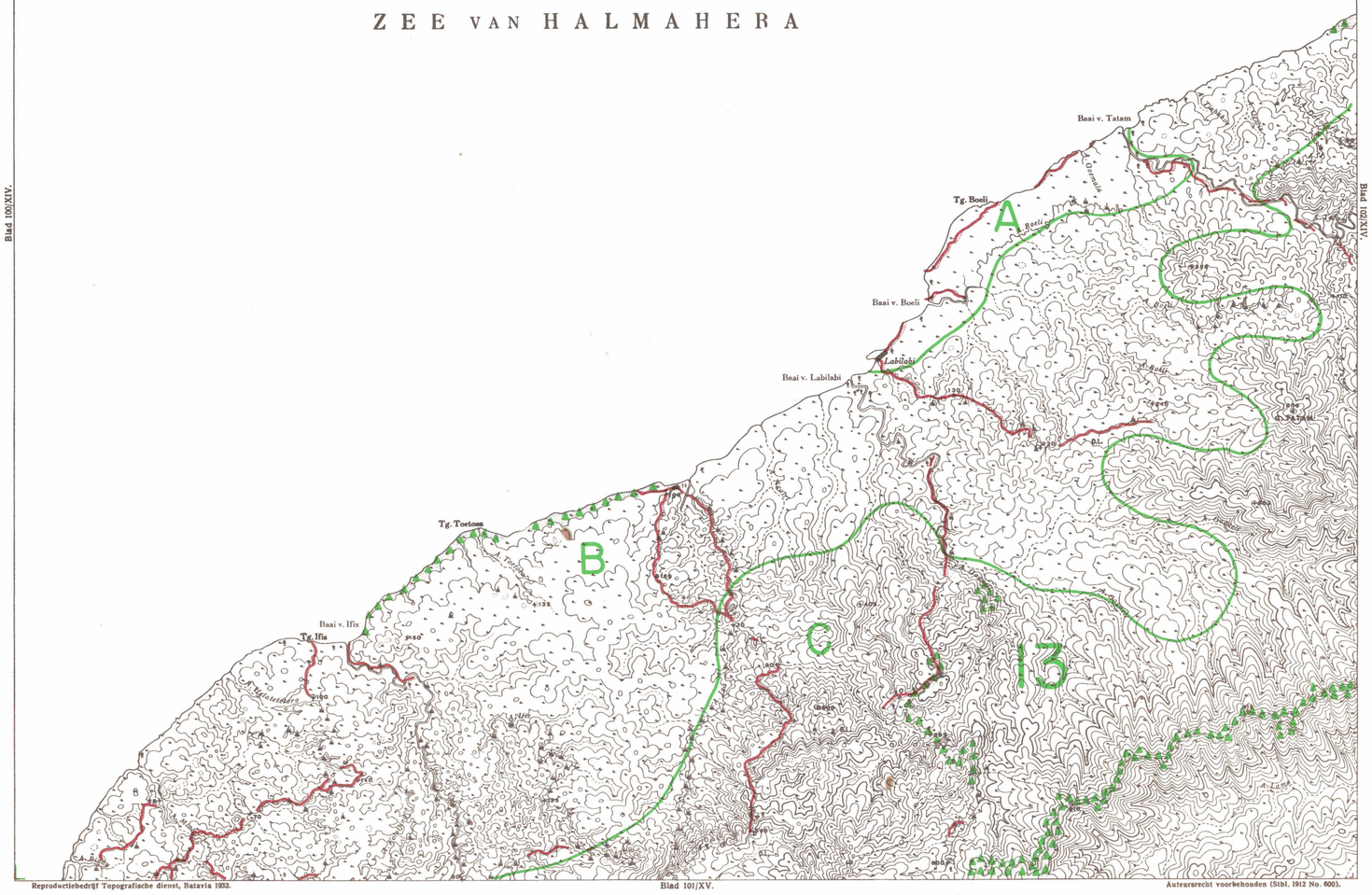
Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

Z E E VAN H A L M A H E R A

Blad 100/XIV.

Blad 102/XIV.




Reproductiebedrijf Topografische dienst, Batavia 1933.

Blad 101/XV.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

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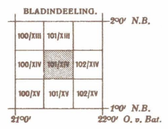


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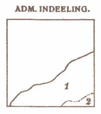



| | Res. (Afd.) | Ternate. |
|---|---|---|
| 1 | Onderafd. | Tobelo. |
| | District | Wasile |
| 2 | Onderafd. | Weda. |
| | District | Maba. |

LEGENDA.

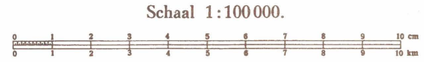
Trail

Road

Kampoeng. Arentuin. Klapperboomen. Bosch. Bamboebosch. Moeraspalmen. Tjemara- of Dennen- (Sparren-) bosch. a Rivier, a gemeten, b niet gemeten. Voetpad. Onderafdeelingsgrens.

Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogteoffer, b halphoogtelijn van 25 m, rots.

Schaal 1:100 000.




TOELICHTINGEN.

Vluchtig opgenomen in 1929-1930 met de bergbouwkompas en barometer voor het hoofdverband en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 387 schaal 1:200 000 uitgave 1929.

AFKORTINGEN.

G. Goenoeng. Tg. Tandjoeng. A. Ake (rivier). O.L. Onderaardsche loop.

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B

SHEET NO. XIV- 101

Area 13. Northeastern mountains

Topography: A broad, low, and undulatory bench land along coast; rises southeastward with increasing steepness to a mountainous ridge, some 900 meters in height. Lower slopes traversed by numerous shallow valleys with gently sloping sides. Interstream areas flat to broadly rounded or knobby; streams, in general, not closely spaced. Farther inland, slopes steeper and tributary streams more closely spaced, but the generally rounded character of topography prevails. Except for the Ifisf, the Tatam and the Gagneli, streams are small; many probably dry part of year. A few streams pass underground along parts of their courses. Along greater part of shoreline, land slopes moderately to water's edge; at northeast is one long narrow strip of coastal plain. Beaches are steep and narrow.

Ground Conditions: Moderate to great depth of sandy loam, locally stony. Soil generally well drained, dries quickly, and provides good footing. Rocky areas along coast between Ifisf and Iga rivers, on crest of the mountain ridge, and along certain valleys of the mountain slopes.

Area covered by tropical forest. Along most larger streams are bamboo brakes. Undergrowth probably not very thick except along streams and near shore. Probably small local patches of cleared land and second growth forest near settlements.

Settlements: Only two small native villages along the coast.

Movement: An area of restricted movement, with difficulties increasing toward the mountains. The tropical forest provides an obstacle everywhere, and numerous valleys are obstacles to coastwise movement, except between Isisf and Iga rivers. At many places, movement from coast inland feasible for some distance, on interstream areas, which have even and almost unbroken rise to the steeper slopes of the mountain front proper. Coastal plain strip at northeast topographically favorable for movement, but is surrounded by less favorable terrain.

Existing communication lines limited to a few foot trails which lead from the coast some distance toward the mountains but end blind; these are of doubtful usefulness. For coastwise movement trail cutting or road construction necessary.

Only coastal plain at northeast suitable for landing; plain at northeast suitable for landing operations, and this has poor communication with other areas.

Cover, Concealment, and Observation: Partial cover provided by ridges, knobs, and stream banks, larger hardwood trees. Field fortifications feasible in all except rocky areas, but may be difficult on thin soils of terraced coastal slopes.

Concealment from both ground and aerial view afforded everywhere by forest.

Observation restricted both by forest and by broadly rounded character of topography. Some steeper mountain slopes might give a limited outlook across surrounding valleys.

Prepared by U.S. Geological Survey
for Chief of Engineers, U.S. Army

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

Gouvt der Molukken (Res. Ternate).

Schetskaart samengesteld door den Topografischen dienst in 1928-1929.

# TERRAIN APPRECIATION

Blad 102/XIV.

EXPLANATION

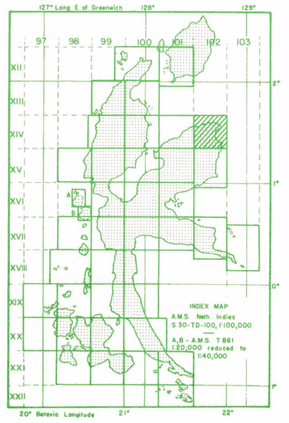
Large numbers and heavy lines indicate terrain areas.

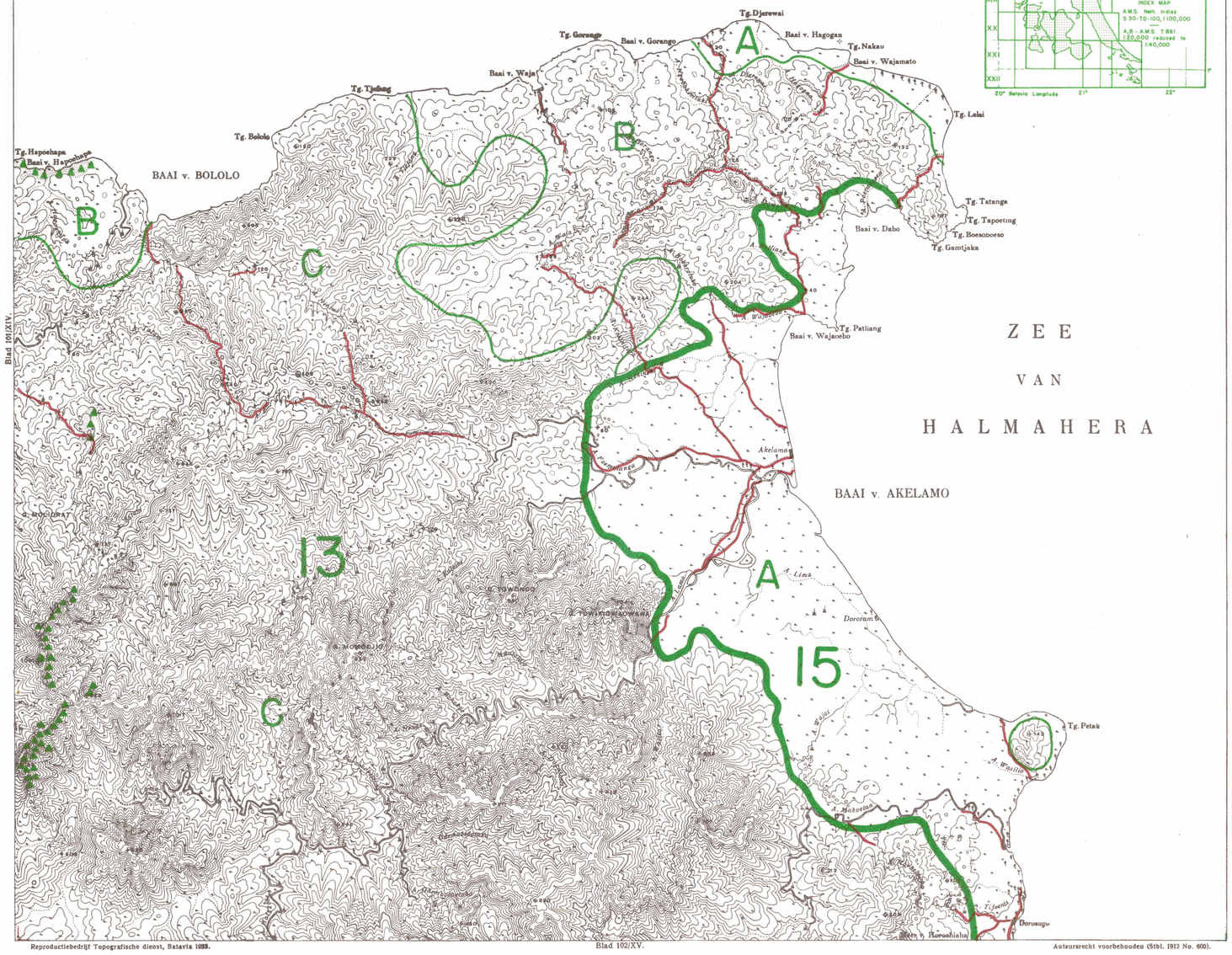
Letters and light lines indicate terrain types as follows:
A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)
Lake
Marsh (drasland)
Rocky area
Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain




Reproductiebedrijf Topografische dienst, Batavia 1929.

Blad 102/XV.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

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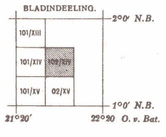


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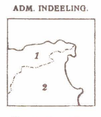



| | | |
|---|---|---|
| | Res. (Afd.) | Ternate. |
| 1 | Onderafd. | Tobelo. |
| | District | Wasile. |
| 2 | Onderafd. | Weda. |
| | District | Maba. |

Trail
Road

LEGENDA.

Kampoeng. Schaars bewoonde streken. Arentuin. Klapperboomen. Bamboebosch. Bosch. Moeraspalmen. Tjemara- of Dennen- (Sparren-) bosch. Rivier, a gemeten, b niet gemeten, c eiland, d steeds vloeiende zoetwaterwel. Meer. Paardenpad. Voetpad. Bamboe huizen. Inlandsche graven. Onderafdeelingsgrens.

Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogtecijfer, b huishoogtelijn van 25 m, c rots, d klip bij laagwater zichtbaar.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm
0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

Vluchtig opgenomen in 1928-1929 met de bergbouzsole voor het hoofdverband en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 387 schaal 1:200 000 uitgave 1929.

AFKORTINGEN.

G. Goenoeng. Tg. Tandjoeng. O.L. Onderaardsche loop. A. Ake (rivier).

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B

SHEET NO. XIV-102

Area No. 13. Northeastern mountains

Topography: Rugged, massive mountainous terrain broken by a few major valleys. Elevations attain about 1,000 m. On the east, the mountains descend abruptly to the lowland of area 15 (profile FF'). On the northeast and north, the descent is generally more gradual, through zone of moderate relief and moderate slopes, partly terraced. Two main valleys, the Lama and the Foemalanga, drain eastward; have moderate to steep sides, narrow bottoms, and reach depths exceeding 500 m. Stream channels meander around small valley-side spurs; slopes gentler on inside of meanders than on outside. Tributaries nearly all small and short, closely spaced, giving terrain an irregular, broken character. Main ridges are narrow, knobby, and irregular. Subsidiary spurs in most places descend steeply into the main valleys.

Draining northward are several small streams heading in the foothill belt. Toward the northeast streams widely spaced, with low, broadly-rounded inter-stream areas; toward the northwest, streams more closely spaced and relief greater, producing rougher topography.

Coastline moderately embayed. At northeast, a narrow, somewhat irregular coastal flat. Elsewhere, shore is moderately sloping; steeply sloping in the Bay of Bololo. Northeastern tip of area fringed by a coral reef.

Ground Conditions: Higher parts of area have clay loam to clay of considerable thickness. In lower sections, soil more sandy; locally is stony. Soils give good footing, are well drained, moderately muddy when wet, and readily excavated except where stony. Soils generally deep on lower slopes, except locally on terraced areas at northeast.

Rocky slopes occur on some higher ridges at west, and along coast at northwest.

Except for local rocky slopes, area is covered with virgin tropical forest. Undergrowth probably moderate except along streams, shores, and highest ridges. Coconut palms on coastal strip at northeast.

Settlements: Uninhabited.

Movement: Barrier area. The rugged, forested mountain topography obstructs movement inland. Coastal topography less unfavorable, but forest is an obstacle. Good routes available for crossing from north shore to lowlands of area 15.

Existing trails are few; suitable only for movement on foot. None extend very far into interior. Most lead from the north shore across to area 15; follow stream beds part way and ridges part way. Sections on stream beds impassable during high water.

Potential beach heads only on narrow coastal plain at northeast.

Cover, Concealment, and Observation: Cover given by knobs, ridge crests, and other topographic irregularities, also by larger hardwood trees. Topographic cover poorest at northeast where slopes are broadly rounded. Field fortifications feasible at all places which are not rocky, but on terraced areas at northeast coralline limestone, difficult to excavate, may be encountered at shallow depth.

Complete ground and aerial concealment given by forest.

Observation greatly limited by forest, and in many places also by the broadly rounded character of the topography. Locally, steep valley sides have lookout points of limited range, and the steep knobs and ridges overlooking area 15 could be used as observation posts. Along the coast, projecting capes would permit observation of adjoining stretches of embayed shore.

Area No. 15. Akelamo Plain

Topography: North part of a broad, flat to undulatory lowland; is crossed by two main streams which unite near shore, and by minor streams. Bordering slopes of area 13 high and steep at south, lower and more moderate at north. Locally are low rolling hills at inner side of plain. Shoreline regular, broadly embayed. Beach ridges may be present locally. At south, one low hill projects above plain, forming Cape Petak.

Ground Conditions: Deep sandy to clayey loam; is fairly well drained, gives fairly good footing, and is easily excavated. Moderately muddy when wet.

Area covered with virgin tropical forest. Locally, coconut palms along shore.

Settlements: Two small native villages widely separated along coast.

Movement: Flat topography favorable for free movement, but forest is a continuous obstacle and limits movement to existing trails. Larger streams at north present additional local obstacles, and are probably too deep for fording. Existing trails are suitable for foot use only, and mostly radiate from Akelamo.

Shore topography suitable for beachheads at nearly all points.

Cover, Concealment, and Observation: Cover given only by stream banks, and possibly along some stretches of shore by beach ridges. Some cover given by the larger hardwood trees. Field fortifications feasible at all places not too near river or sea level.

Complete ground and aerial concealment by forest.

Ground observation poor because of low relief and forest cover. Hill at Cape Petak might serve as a lookout point for local areas. Aerial observation slightly better than ground observation, but largely limited to clearings.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS)

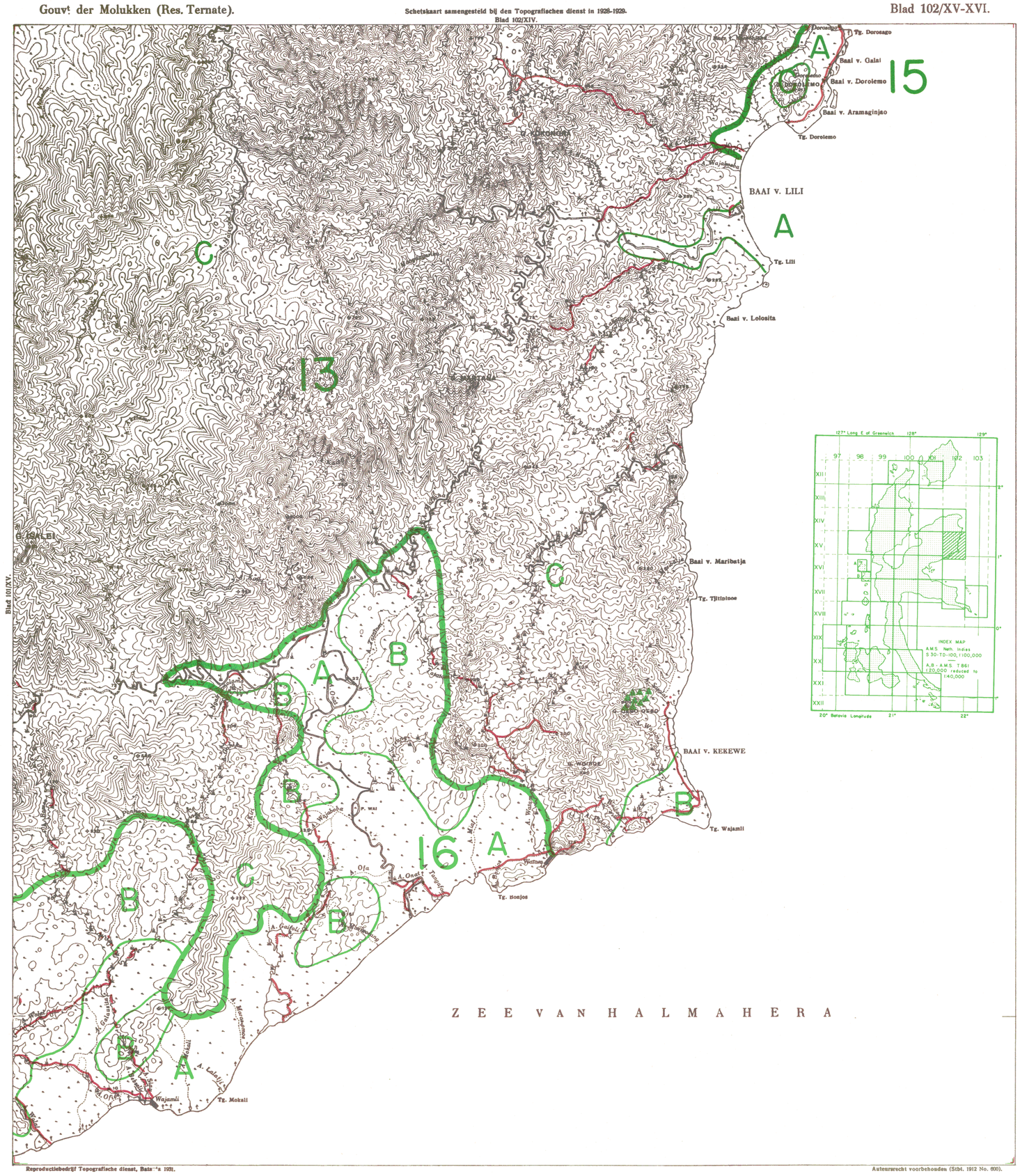
## TERRAIN APPRECIATION

Gouvt der Molukken (Res. Ternate).

Schetskaart samengesteld bij den Topografischen dienst in 1928-1929.

Blad 102/XIV.

Blad 102/XV-XVI.




Reproductiebedrijf Topografische dienst, Batavia 1931.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

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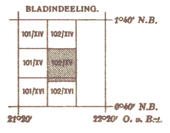



ADM. INDEELING.

Res. (Afd.) Ternate.
Onderafd. Weda.
District Maba.

Trail

Road

LEGENDA.

*Kampoeng. Schaars bewoonde streken. Tjemara-of Dennen-(Sparren) bosch. Arenlain Klapperboomen, Bambusbosch. Bosch. Moerassalmen. Alangalang. Paardenpad, a dalker van hout of bamboe. Voetpad. Rivier, a gemeten, b niet gemeten, c eiland, d meer. Bamboe huizen. Inlandsche graven.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogtecijfer, b halfhoogtelijn van 25 m, c rots, d eiland.*

EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Vlachtig opgenomen in 1928-1929 met de bergbussole voor het hoofdver-band en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 389 Schaal 1:200 000 uitgave 1922.*

AFKORTINGEN.

*G. Goenoeng. P. Poelau. O.L. Onderwaardsche loop. Tg. Tandjoeng. A. Air (rivier).*

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

~~CONFIDENTIAL~~

Reliability Rating: Class B

SHEET NO. XV-102

Area No. 13. Northeastern Mountains.

Topography. Rugged mountainous area, with large portions of the interior rising above 500 m., and a few peaks exceeding 1000 m. Larger valleys widely spaced, and irregular in their pattern. Along some stretches valleys trend nearly parallel to coast, and separate the higher mountains from a foothill belt. The Lili and the Onat have wide floodplains in the foothill belt; smaller streams have narrow valleys. Slopes in the foothill belt are low to moderate, steeper in the mountainous interior. In the mountain area, streams have steep gradients, and gravelly to bouldery beds. In the foothills, gradients flatten, and beds become gravelly to sandy. Stream banks high along lower courses, and channels largely filled during heavy rainfall. Coastal part of area is comparatively steep and abrupt; some short strips of narrow coastal flat, but generally the land rises abruptly from the sea.

Ground conditions. Moderate to deep sandy to clayey loam, locally stony. Soil crumbly except on the limited areas of valley flat; well drained, easily excavated, not excessively slippery when wet, offers good footing, and dries quickly. Few rocky areas.

Area covered with virgin tropical forest. Undergrowth probably not excessively thick except along streams, where also dense bamboo thickets are common. Coconut palms at scattered places along shore.

Settlements. Uninhabited.

Movement. Terrain unfavorable for movement. Tropical forest adds to difficulties. Grades too steep for vehicles except along valley flats and coastal strips, where forest would need to be cleared. Available routes are short, and permit movement only in general coastwise direction. Trails facilitate movement; forests most easily penetrated along ridge crests.

Existing trails suitable for foot use only. Are random in layout, fail to give access to interior, and many end blind. Follow stream beds for considerable distances; here unusable during high water. Elsewhere follow ridges.

Coastal flats too short and narrow for large-scale landing operations; poor communications with possible objectives in areas 15 and 16.

Cover, concealment, observation. Cover provided by ridge crests, ravines, stream banks, and various hills and knobs; also by larger hardwood trees. Field fortifications feasible in nearly all places. Only difficulties would be in cutting through root network of the forest, and in digging gravelly and stony soils of foothill belt.

Complete ground and aerial concealment provided by forest.

Observation everywhere limited by forest. Treetop lookouts on higher and steeper slopes would command a limited field over surrounding valleys, but would permit observation over top of forest only.

Area No. 15.

Topography. South end of the Akelamo coastal plain, more extensive in quadrangle to north. A hill, Mt. Dorolemo, divides the coastal strip midway.

Ground conditions. Soils are loamy; when wet tend to be muddy and slower drying than those of area 13. Easily excavated, but drainage may be poor on low ground.

Forested except for limited tracts of grassland, and clearings, and second growth forest near settlements. Coconut palms along shore, and bamboo thickets along streams.

Settlements. One small village.

Movement. Topography favorable for movement, but forest presents obstacle unless trails are cut or roads built. One trail, along shore. Limited movement possible in scattered strips of coconut palms along coast. Landing possible but beaches commanded by centrally located hill.

Cover, concealment, observation. Cover given only by beach ridges, stream banks, and larger hardwood trees. Field fortifications readily excavated but might be difficult to drain on low ground.

Concealment complete in virgin forest, only partial in coconut groves.

Observation very poor because of topography and forest. Isolated hill provides a local lookout.

Area No. 16. Boeli Plain.

Topography. Coastal plain of varying width, together with contiguous valley flats. Some low hills within the area, and flattened spurs extend into it from foothill belt. Topography mostly flat to gently rolling or sloping. One large stream, the Onat, and several smaller streams cross the plain. Along parts of shore, probably some beach ridges. Beaches narrow. Plain rises gradually to surrounding foothill belt in most places.

Ground conditions. Same as area 15.

Settlements. A few small native villages.

Movement. Similar to area No. 15. Channel of Onat River a local obstacle; would probably require bridging or ferry crossing. Existing trails go inland from coast. Long stretches of shore suitable for landing.

Cover, concealment, observation. Same as area 15.

Preliminary text submitted
without checking or editing
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

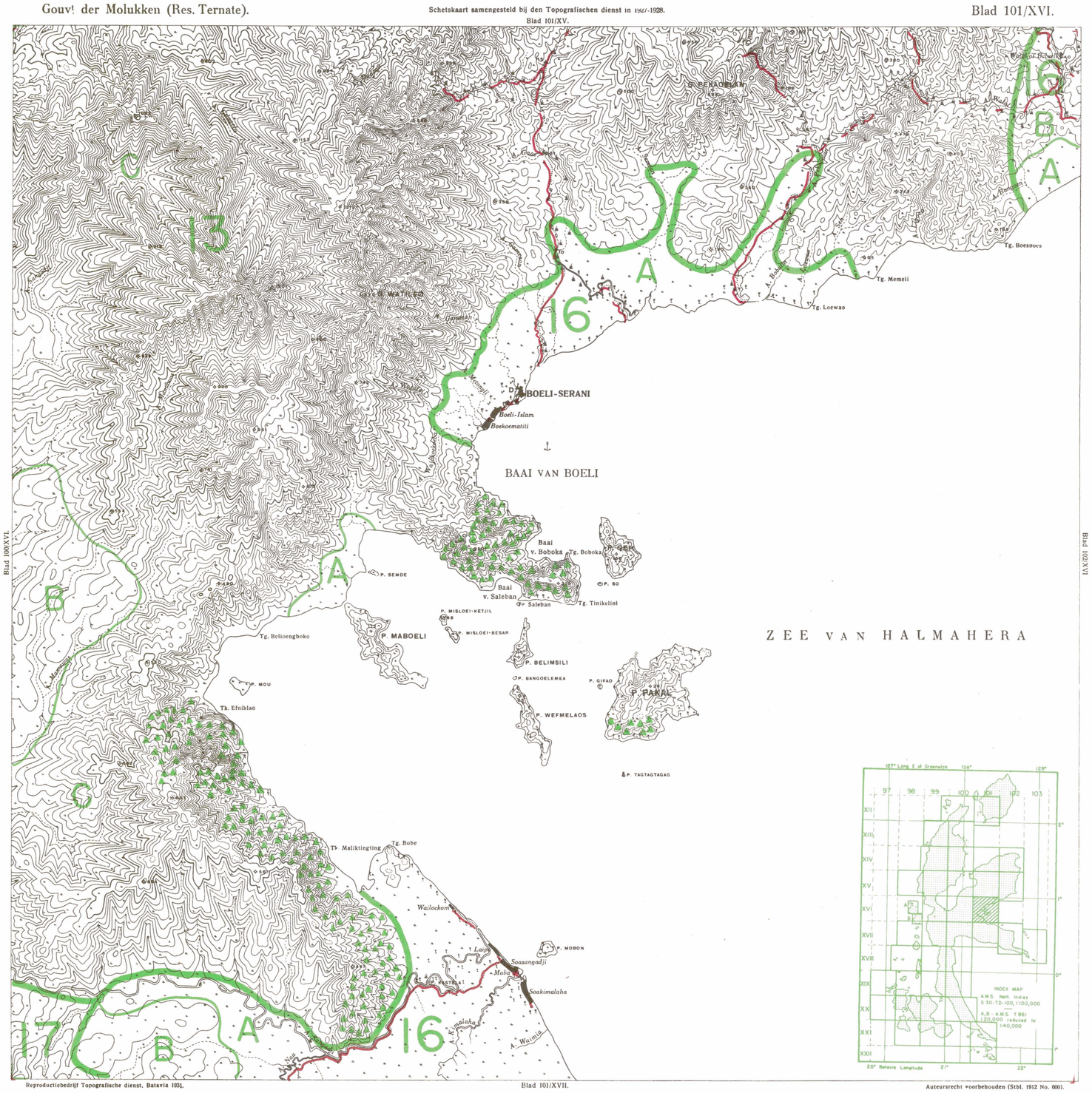
# HALMAHERA (MOLUKKAS)

# TERRAIN APPRECIATION

Gouvt der Molukken (Res. Ternate).

Schetskaart samengesteld bij den Topografischen dienst in 1927-1928.

Blad 101/XVI.





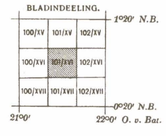


Reproductiebedrijf Topografische dienst, Batavia 1931.

Blad 101/XVII.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDELING.

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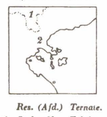


| | | |
|---|---|---|
| Res. (Afd.) | Ternate. | |
| 1 Onderafd. | Tobelo. | |
| District | Wasile. | |
| 2 Onderafd. | Weda. | |
| District | Maba. | |

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Tjemara of Dennen (Spurren) bosch.* *Sagotuin.* *Arentuin.* *Klapperboomen.* *Bamboebosch.* *Bosch.* *Kreupelhout.* *Moeraspalmen.* *Paardenpad, a duiker of vonder van hout of bamboe, b houten brug.* ..... *Voetpad.* *Rivier, a gemeten, b niet gemeten, c eiland.* *Bamboe huizen.* *Christen kerk.* *Mesigit.* *Christen kerkhof.* *Inlandsche graven.* *Onderafdeelingsgrens.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogteijfer, b hulphoogteijfer van 25 m, c rots, d klippen bij laagwater zichtbaar, e eiland, f ankerplaats en reede.*

Schaal 1 : 100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Vluchtig opgenomen in 1927-1928 met de bergboussole voor het hoofdverband en met kompas en barometer voor het overige verband, met gebruikmaking van de zeekaart No. 389 schaal 1 : 200 000 uitgave 1922.*

AFKORTINGEN.

*A. Air.* *Tk. Telock.* *Tg. Tandjoeng.* *G. Goenoeng.* *P. Poelau.* *D. Districtshoofd.*

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

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A. River and coastal lowland.

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C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

▲▲▲ Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

PREPARED BY U.S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U.S. ARMY

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B.

SHEET NO. XVI-101

Area No. 13 - Northeastern Mountains

Topography: Rugged, massive mountains, at east rising abruptly from sea and coastal plain to heights of more than 1,300 meters; at west descending gradually toward intermontain basin along Sangadji valley. Divide so close to Boeli Bay that streams heading a few miles from shore must follow roundabout courses of many miles to the sea by way of Sangadji River. One rocky spur from the mountains projects directly into the bay, dividing it into two parts. Several small islands of similar rocky terrain lie short distances off coast. Streams flowing directly into the bay are small and short, with deep, steep-sided, narrow-bottomed valleys. Mountainous area widest at the north; broad gap between northern and southern parts. Slopes steep on eastern side, somewhat more moderate along parts of western side. Narrow coastal flat borders head of southern part of Boeli Bay.

Ground Conditions: Except on rocky slopes along coast, clayey loam. Depth reaches 20 feet or more, being least on steeper slopes. Soil gives good footing, is well drained, and moderately muddy when wet.

Except for rocky slopes, area covered with virgin tropical forest. Forest growth least dense on higher ridges.

Beaches are sandy where the coast slopes moderately, but locally rocky where the coast is steepest.

Settlements: No settlements.

Movement: Mountainous barrier area; high relief, steep slopes, and dense forest present obstacles. Movement largely restricted to paths and trails. Natural routes few and difficult. One leads from the vicinity of Boeli northwest across the mountains to Wasile Bay, and is followed by a foot path. Another lies along the Sangadji valley and over a high mountain pass to Kaoe Bay, and is followed at least part way by foot paths. A third route possible for movement on foot if trails were cut is over gap at head of Boeli Bay; has disadvantage of steep slopes at start. Movement along coast feasible only at head of bay, where there is a distinct coastal flat; elsewhere coast too rocky and abrupt. Beach at the head of Boeli bay would be suitable for a beachhead but has poor communication with surrounding areas; it is dominated by adjacent heights.

Cover, Concealment, Observation: Cover provided by the numerous ridges and ravines, and to limited extent by larger hardwood trees. Field fortifications feasible, except on rocky slopes.

Ground and aerial concealment provided by the forest except on rocky slopes facing the sea.

Observation limited by the forest in most places. Projecting points at top of steep rocky slopes facing sea would provide excellent lookouts over coast. Higher points on outlying islands also would provide good lookouts toward shore.

Area No. 16 - Boeli Plains

Topography: Discontinuous areas of coastal plain on the northern and southern sides of Boeli Bay. Northern area is the narrower. Its inland margin is irregular, extending inland along stream valleys. Surrounding mountains rise with moderate grades on north, steeper on west.

Southern section is broader, deeply indented along Sangadji valley. Bordering mountains rise precipitously in rocky slopes. Coastal plain is essentially flat. Beach ridges border shore in places, and main streams are slightly incised below the general level. One small island, Mobon, occurs just off shore of southern part, near Maba. The flat Sangadji Valley, continuous with the coastal plain, is broad and open; bordering slopes steep at north, gentle at south.

Ground Conditions: Loamy soil underlain by unconsolidated deposits of considerable thickness. Drainage and footing fair to good. Dries fairly well after rain, and is muddy when wet.

Except for local areas of cleared land and second growth forest near main villages, area covered with virgin forest. Coconut groves occur along the shores, bamboo thickets along some streams, and sago palms at inland places of southern section.

Settlements: Only settlements in the northern section are at Boeli and vicinity. Boeli, shipping point for local jungle products, is seat of a government official.

In the southern section, three large villages close together along coast near mouth of Sangadji River.

Movement: Topographically favorable for movement. Besides forest, obstacles are stream channels, the larger of which would require bridging or building of dugways for rapid crossing. Footpaths cross both areas. Limited movement off trails possible in coconut palm groves, but elsewhere trails must be cut or roads built. Broad flats and good beaches favorable for beachheads, but areas are dominated by adjacent hills particularly at south.

Cover, Concealment, Observation: Cover provided only by larger hardwood trees, discontinuous beach ridges, stream banks, and low banks marking high tide. Field fortifications feasible at most places, but might require artificial drainage to prevent accumulation of rain water.

Concealment, ground and aerial, provided by forest except in cleared areas near settlements, and in coconut groves, where ground concealment is incomplete.

Observation very limited by vegetation. Aerial observation probably better than ground observation.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

# HALMAHERA (MOLUKKAS)

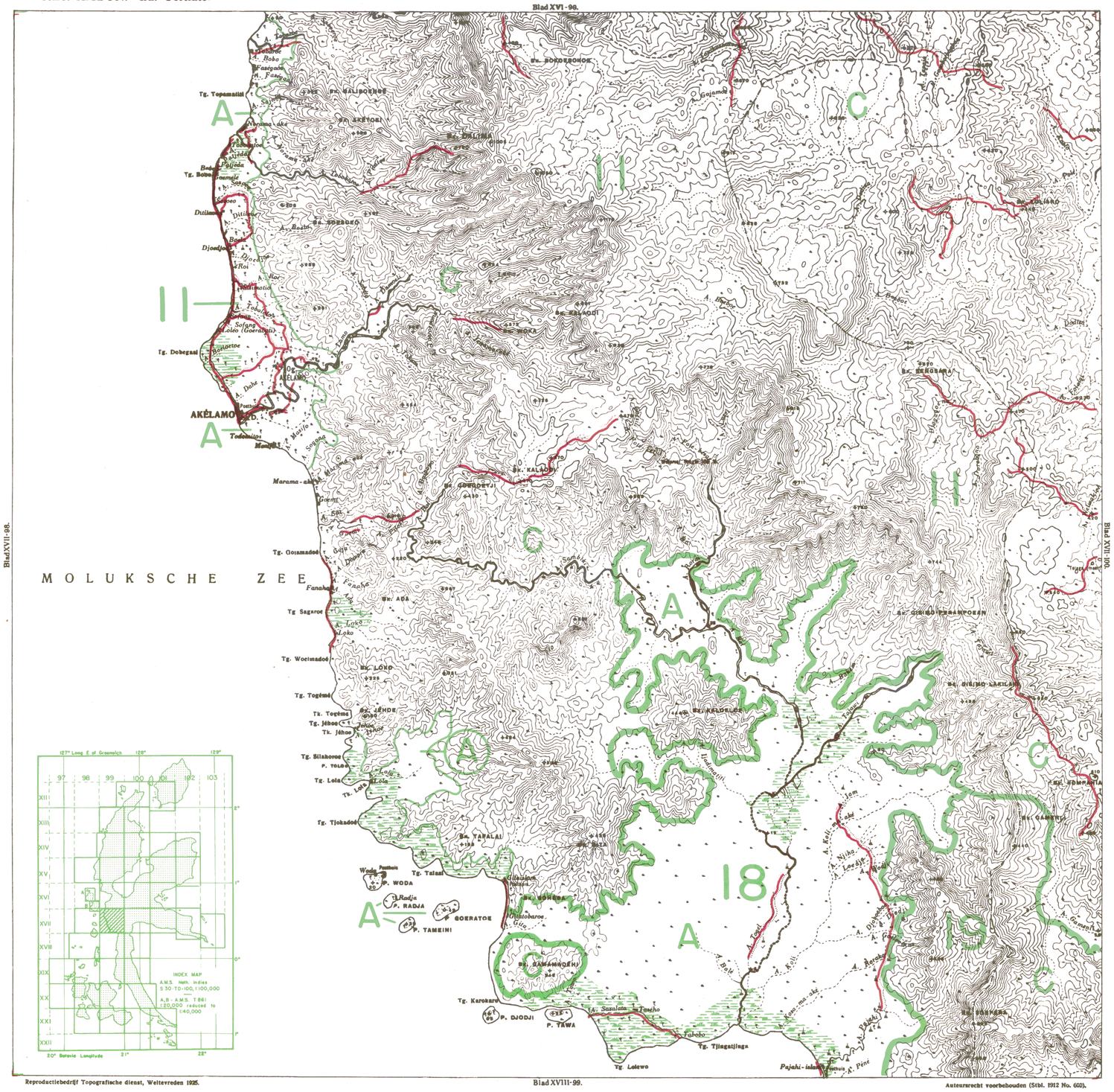
## TERRAIN APPRECIATION

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922 - 1923.

Blad XVII-99.

Blad XVI-99.







Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Blad XVIII-99.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.

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| XVI-98 | XVI-99 | XVI-100 |
| XVII-98 | XVII-99 | XVII-100 |
| XVIII-98 | XVIII-99 | XVIII-100 |

100° N.B.

20°20' | 21°20' O.v. Batavia.

ADMINISTRATIEVE INDEELING.

*Afdeeling* Ternate.
1. *Onderafd* Tidore.
2. ,, Halmahera.
A. *Ressort* Djailolo.
a. *District* Djailolo met Dodinga.
b. ,, Oba.
B. *Ressort* Wéda.
*District* Wéda met Patani.
C. *Ressort* Tobélo.
*District* Weda.

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sawahs.* *Arenbuis.* *Klapperbomen.* *Djatibosch.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Oelegah.* *Alang-alang.* *Gras.* *Moerasplanten.* *Tjemara- of Dennenbosch.* *Drasland.* *Paardspad.* *Voetpad.* *Rivier, a. gemeten, b. niet gemeten c. eiland.* *Steenen- en bamboegebouwen.* *Inlandsche graven.* *Onderafdeelingsgrens.* *Districtsgrens.* *Landb. ond. grens.* *Resortsgrens.*

ZEE. *a. eiland.* *Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikte van 500 M. b. hoogtepunt en hoogtecijfer. c. halfhoogtelijn.*

Schaal 1: 100 000.

0 1 2 3 4 5 6 7 8 9 10 cM.

0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Administratieve indeeling volgens G. B. van 25 Jan. 1934. No. 21. Stbl. No. 29. De namen en grenzen der cultuurondernemingen, erfpachten (en particuliere landerijen) zijn vergeleken met het Handboek voor Cultuur- en Handelsondernemingen in Ned. Indië (Regeeringsalmanak) en met de kadastrale kaarten.*

VERKORTINGEN.

D. *Districtshoofd.* P. *Poelau (eiland).* Bk. *Boekoe (berg).* Tg. *Tandjoeng (kaap).* *Teluk (baai).* *Ake (rivier).*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

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A. River and coastal lowland.
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C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

▲▲▲ Rocky area

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

Coastal bluffs and cliffs

# HALMAHERA (MOLUKKAS)

# TERRAIN APPRECIATION

Reliability rating: Class B.

SHEET NO. XVII-99

Area No. 11 - Mountains of Central Halmahera

Topography: Rugged irregular mountain ranges; on south and west sides are steep-sloped, deeply eroded ridges; on north and east sides high upland is less deeply dissected. Mountains rise from narrow coastal lowlands to altitudes averaging between 2,000 to 2,700 feet; mountain northeast of Akelamo reaches maximum altitude about 3,860 feet. Mountains continue without topographic break into the mountain chain of south Halmahera (Area 20); boundary with Areas 12 and 19 is arbitrary.

In southern and western parts of area, range made up of narrow ridges and spurs; crests are narrow, rounded; slopes moderate to very steep, deeply cut by ravines and small valleys. Larger valleys commonly narrow and deep; in places, valleys have small flat floodplains. Relief commonly 1,500 to 2,000 feet.

Narrow flat coastal plain generally lies between mountains and sea; commonly 1/4 to 3/4 miles wide; reaches maximum width of about 3 miles on delta of Lamo river. Marginal slopes are moderate to steep. Some small swampy areas on coast and along the Lamo river. Coastal plain lacking between villages of Loko and Jehoe; this section occupied by narrow beach.

In northeast and eastern parts, ridges broader and less deeply dissected; relief ranges generally from 1,000 to 1,500 feet. Summits and ridge tops gently rounded, slopes gentle to moderately steep; some valleys broad and open with narrow floors; a few are deep, steep-sided canyons.

Ground Conditions: In south-central part of mountains, red-brown lateritic loam or clay loam 15 to 30 feet deep; grades downward into deeply weathered volcanic rock. Bare rock exposed locally in steep slopes and in valley bottoms. Mountains on east and west margins have a yellow-brown lateritic sandy or stony loam which at depth of a few feet grades into a poorly consolidated conglomerate or sandstone that is locally exposed on steep slopes. Northeast and north-central part of mountains underlain by massive limestone exposed in numerous cliffs and ledges; soil cover on steep slopes is thin, increases to 10 to 20 feet on low slopes and depressions. Soils friable, permeable and well-drained; become plastic and slippery when wet but dry fairly quickly. Excavations easily made with hand tools except on steep slopes where soil is thin and underlain by limestone.

Dense forest cover over most of area. In addition to the usual assemblage of palms, dipterocarps etc. many tropical firs (Djemara) most common in northeast part of area.

On coastal plain and lower slopes of bordering mountains, virgin forest partly cut away; much of area overgrown with grass and second growth jungle. Groves of sago and coconut palms numerous. Some bamboo in small swampy areas near coast and along Lamo River.

Settlements: Interior largely uninhabited; some temporary camps used by natives collecting gum damar.

Several small settlements along the coast. Akelamo, at the mouth of the Lamo River is largest; residence of a district chief.

Movement: Horse trail from Akelamo to village of Norama-ake along coast; foot trails between the other coastal villages. Horse trail may locally be suitable for light motorized vehicles; trails commonly must be widened and graded for dry weather use by light mechanized units; considerable improvement needed for all weather use by heavy traffic. A few foot trails that lead inland along rivers and up steep spurs terminate at survey stations; apparently cut by surveying parties 18 to 20 years ago; now may be thickly overgrown at least in higher more rugged parts; indicate best route to high observation points. Area generally impassable for motorized units without construction of roads; dense vegetation in valleys and steep slopes make movement difficult for foot troops; easiest movement probably on crests. Narrow coastal land with numerous cleared or grass-grown areas permits some movement of motorized units away from roads and relatively easy movement for foot troops.

Cover, Concealment, Observation: Rugged broken topography provides good cover in most of area. Narrow coastal belt exposed to fire from sea or from uplands to west; some cover for men may be found behind low benches commonly present at inland margin of beaches. Large trees can give some cover.

Vegetation gives adequate concealment in nearly all parts of the area; concealment may be poor for large motorized units in cultivated or grass-covered areas. Numerous peaks and high ridges offer views commanding wide areas on the Molucca Sea; some overlook narrow coastal lowlands but commonly vegetation cover and intervening slopes and summits limit observation. Big trees suitable for observation of nearby ground.

Area No. 18 - Rai River Plain

Topography: Broad featureless plain bordering the Rai River and its principal tributaries. Slopes gently seaward from the bordering mountains of Area 11. Greater part of the plain is nearly level and is less then 100 feet in altitude. Locally low hills and terraces lie between the plains and the steep mountain front.

Plain crossed by Rai River and some smaller streams, most of which drain from mountains of plain. Two principal tributaries join the Rai in northern half of area. In the southern half several smaller, short streams flow into the Rai or empty directly into sea. Rai River along part of its course flows in a well defined channel; in places flows through marshy ground where for short distances the channel divides into several subsidiary channels. The Rai and its major tributaries vary in width from 200 to more than 400 feet. Depth variable; in dry years stream shrinks to less than 1/3 of its volume.

Ground Conditions: Alluvial soils of the Rai River plain are generally sandy clay loams; mostly coarser sandy loams near margins of area; and finer, more clayey soils near center. Soils generally over 20 or 30 feet deep; no rock exposures known. Ground, especially along rivers, generally poorly drained and commonly marshy or swampy during rainy seasons; largest marshes (drasland) are around junction of Tajawi and Rai Rivers and along the coast from Pajahi-islam to Tg. Karokaro. Soil forms deep plastic mud on trails and where disturbed by excavations.

Rai River floodplain densely overgrown with vegetation. Extensive areas of virgin forest. Bamboo brakes, sugar and sago palms are especially common; nipa palms in lower reaches of the river within tide range. Groves of coconut and other palms are common on small areas of higher ground in coastal lowlands. Some mangrove locally.

Settlements: A few small native settlements along coast; most important is Pajahi-islam at western terminus of main path from Weda Bay.

Movement: Movement greatly restricted by dense vegetative cover although flat topography favors easy movement. Motorized units cannot move away from roads. A few short trails along the coast and across parts of the plain can be easily improved for use by wheeled vehicles in dry weather but probably need considerable improvement for all-weather use. Motorized units can move through areas covered by grass and young second-growth forest around Pajahi-islam and villages near Gita River.

Foot troops can move with difficulty in most parts of area; must cut their way in many places. Easy deployment from trails restricted to a few yards or less in most places.

Rai River in most places below its junction with the Tajawi cannot be forded except during very dry years. Upper reaches of Rai and its major tributaries probably can be forded at several points during drier weather. Marshy ground and dense mat of vegetation along stream banks are obstacles to crossings; where banks are steep short dugways required.

Cover, Concealment, Observation: Little cover; limited to low hills and terraces near margins of area, and to locally high stream banks.

Dense vegetation gives excellent concealment in most of area. Concealment for vehicles limited in cleared areas around villages and in young second growth forest.

Dense vegetation makes aerial observation poor. Ground observation restricted to a few yards or less.

Area No. 19 - Mountains of Southern Halmahera

Topography: North end of mountain range forming backbone of southern peninsula; grades into mountains of Central Halmahera without topographic break (Area 11). Rugged mountains having altitudes mostly between 500 and 800 meters. Crest of range trends north-south; generally lies within three miles of the Rai River plain (Area 18). Summits are narrow, slopes steep; valleys small and narrow with steep gradients; stream small, subject to sudden floods in rainy seasons.

Ground Conditions: Yellow-brown lateritic sandy or stony loam; grades into soft conglomeratic or sandy rock at depth of 10 to 20 feet. Soil generally well-drained and dries fairly rapidly.

Area largely covered by rain forest.

Settlements: Area uninhabited.

Movement: Barrier area. Steep slopes and dense tropical vegetation unsuitable for movement of motorized units without construction of roads. No known trails. Foot troops can move easiest along ridge crests; in ravines and valleys vegetative tangle commonly difficult to penetrate. Streams can be forded except during short periods of flood.

Cover, Concealment, Observation: Broken rugged topography and dense forest give good cover and concealment. Observation very poor; commonly limited to a few yards.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

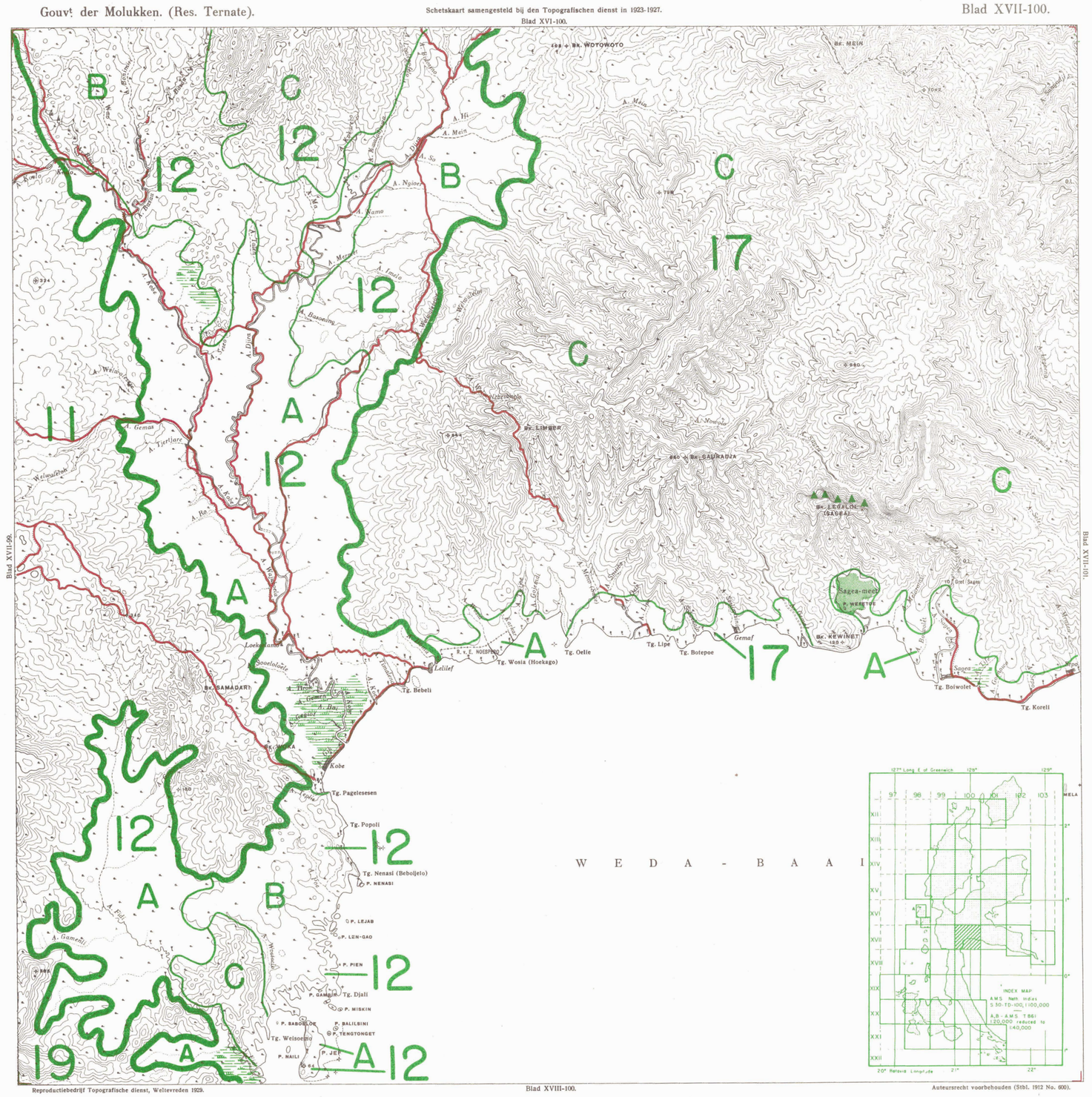
# HALMAHERA (MOLUKKAS)

Gouvt der Molukken. (Res. Ternate).

Schetskaart samengesteld bij den Topografischen dienst in 1923-1927.
Blad XVI-100.

## TERRAIN APPRECIATION

Blad XVII-100.




W E D A - B A A I

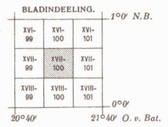



Reproductiebedrijf Topografische dienst, Weltevreden 1929.

Blad XVIII-100.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDELING.

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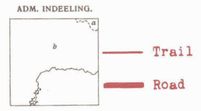


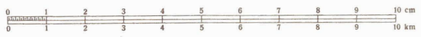

*Res.(Afd.)* Ternate.
*Onderafd.* Weda.
a District Maba met Gebe.
b „ Weda met Patani.

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperboomen.* *Tjemara- of Dennen (Soarren) bosch.* *Bamboebosch.* *Bosch.* *Kregetbout.* *Moeraspalmen* *Herkenbare boom.* *Paardenpad.* *Voetpad.* *Rivier, a gemeten, b niet gemeten, c eiland, d loopbrug.* *Drasland.* *Moeras.* *Meer.* *Bamboe huizen.* *Districtsgrens.* *Landb. ond. grens.* *Grot.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m; de dikke van 500 m, a hoogtepunt en hoogtecijfer, b terreinonevenheden, c halfhoogtelijn, d rots, e eiland, f klippen altijd boven water, g klippen bij laag water zichtbaar, h laagwaterlijn, i zandbank alleen bij laag water droog.*

Schaal 1:100 000.




TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397. 1:500 000 en volgens deze kaart het blad georiënteerd. De naam en grens der erfpacht is vergeleken met het Handboek voor Cultuur- en Handelsondernemingen in Ned. Indië en met de kadastrale kaart.*

AFKORTINGEN.

**Bk.** *Boekoe (berg).* **P.** *Poelau.* **Tg.** *Tandjoeng.* *A. Ake (rivier)* **R.v.E.** *Recht van erfpacht.* **O.L.** *Onderaardsche loop.*

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

▲▲▲ Rocky area

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

Coastal bluffs and cliffs

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

Reliability rating: Class B.

SHEET NO. XVII-100

Area No. 11 - Mountains of Central Halmahera

Topography: Low dissected ridges rising with irregular slopes and poorly defined terraces above lowlands of the Fidi and Kobe Rivers (Area 12); represent eastern margin of the higher ranges of central Halmahera. In the northeast, boundary between central mountains and Area 12 to the east is arbitrary. Altitudes commonly range from 1,000 to 1,300 feet; in a few places exceed 1,500 feet. Ridges have long rounded irregular crests. Slopes commonly moderate; lowest (5 to 15%) are between the Gewa and Koelo Rivers on the west side of the quadrangle; cut by numerous narrow gullies and ravines. Principal valleys are broad, V-shaped; generally have narrow floors.

Ground Conditions: Yellow-brown lateritic sandy- or stony loam which at depth of 10 to 20 feet grades into poorly consolidated conglomerate or sandstone. Bare rock exposed locally in valley bottoms and, rarely, on steep slopes. Ground generally well-drained and dries rapidly.

Vegetation istropical rain forest; undergrowth fairly open except in valley bottoms.

Settlements: Few permanent inhabitants. Possibly some temporary camps or isolated dwellings along the trails or on lower slopes bordering the river.

Movement: A few trails from the Kobe River lowlands cross area; commonly follow upper slopes and mountain crests. Trails up the Woka and Samadari and up the Gemar join to the west (Sheet XVII-99). The trails from Koelo and Djira Rivers cross northern part of area and continue across the peninsula to Kau Bay. None are suitable for motorized vehicles without considerable improvement. Foot troops can move off trails only with difficulty; easiest movement probably along ridge crests. Rivers probably fordable except after long rainy seasons.

Cover, Concealment, Observation: (Area 11 - Sheet XVII-100) Ridges and numerous small valleys give good concealment for men, although at many places trails can be brought under fire from nearby commanding points.

Forest cover and broken topography give excellent concealment. Aerial observation poor, even in case of well-used trails.

Area No. 12 - Kobe-Ekor Corridor and Fidi river plain

Topography: Plain of the Kobe River and its tributaries, with a belt of irregular hills and ridges along the north border; at southwest area includes the valley of the Fidi River. Area is bordered on west by mountains of central Halmahera (Area 11), on the east by ranges of southeastern and northeastern Halmahera (Areas 13 and 17); boundary between the northern hills of Area 12 and the adjacent ranges is arbitrary.

The broad Kobe valley has maximum altitudes commonly less than 150 feet except on east side of the Djira River, where hills and terraces are 150 to 350 feet in altitude. Kobe plain slopes gently south to Weda Bay; surface generally flat or gently undulating except for low marginal hills and terraces which have gentle slopes and broad rounded summits. Valley floor is locally swampy; largest swamp is near mouth of the Kobe River. Kobe and its principal tributaries are 100 to 200 feet wide at north; probably more than 400 feet wide near the mouth. Rivers commonly flow in channels incised a few feet below level of plain; locally rivers lack well-defined channels and spread over a broad zone of marshy or swampy ground. Low sandy beach ridges lie between swamp and the sea. Mountains at head of Kobe plain are irregular in height and slope. West of the Basau River, mountains are generally less than 800 feet in altitude; slopes moderate to low; summits broad and rounded. East of the Basau, where ridges rise toward mountain mass of Bk. Saolat, (Area 13, Sheet XVI-100), altitudes increase nearly to 1,700 feet. Slopes are steep; ridge crests narrow. Mountain streams are small and torrential; flow into Kobe and its principal tributaries.

The Fidi valley floor is generally less than 150 feet in maximum altitude. Between the Fidi and Kobe village, hills and terraces are 500 to 800 feet in altitude. Valley floor flat or rolling; width variable, commonly 3 to 4 miles. Just before stream emerges on coastal lowland, valley floor narrows to width of a few hundred feet between steep-sided hills. Hills and terraces between the Kobe village and the Wostoelo River are low with gentle slopes; merge on west with Fidi valley plain. Southwest of the Wostoelo, hills are much higher and have steep slopes. Old raised coral reefs along the coast; living reefs extend some distance off shore. Small islands off shore are old reefs; rise above sea level a few feet to more than 150 feet (on Jef island).

Ground Conditions: Mountains in northern part of area have red-brown clay loam or clay; at depth of 15 to 30 feet grades into deeply weathered volcanic rock. Soil of broad valley bottoms varies greatly in texture; is mostly sandy clay loam much deeper than in mountains. Coarser sandy loams border valleys near mountains; soils near center of valley flats are dominantly fine clays.

Mountain soils are well drained and dry fairly rapidly, in valleys drainage moderately good except for large swamp near mouth of Kobe, and small areas of swamp and marsh above the junction of the Kobe with the Sesco and near the mouth of the Fidi. Coarser soils near valley margins afford fairly good footing; muddy when wet, but dry fairly rapidly. Finer clays toward center of valleys form deep slippery mud which dries slowly; some of clay areas may be water-logged and swampy during long rainy season. Excavations can be made with hand tools but fill with water and tend to slump in wet weather.

Rain forest covers better-drained parts of area; swamp forest along many parts of the river courses. Nipa thickets occupy parts of swamp within tidal range at mouths of the Kobe and the Fidi. Coconut palms in groves on beach ridges along the coast.

Settlements: A few villages along shore; largest is Kobe village, built on beach ridge between bay and swamps. Interior largely uninhabited; village of Loekoelamo on the lower Kobe probably is the farthest inland permanent settlement.

Movement: A poor corridor but the broad flat valley, the relatively low altitudes of the mountain pass, and two good footpaths make area the easiest land route from Weda Bay and southern part of Halmahera to the Isthmus of Dodinga (Area 10) and northern Halmahera.

Foot trail from coast (Lelilef village) extends up the valley close to the river; several branches start at junctions with principal tributaries. Trails following the upper Kobe and the Djira Rivers cross the mountains to Kau Bay (Sheet XVI-100). Trails probably suitable only for foot or mounted troops; with a little improvement probably can be used by light wheeled and tracked vehicles in drier weather. Considerable improvement probably needed for all-weather use by heavy traffic.

Horse trail between Lelilef and Kobe villages probably can be easily improved for motorized traffic; crossing the mouth of the Kobe may be serious obstacle in long rainy periods. Bordering coconut groves permit some deployment for short distances from trails.

Although topography of Kobe and Fidi valleys is favorable, dense forest and swamps make area unsuitable for movement of motorized units off roads and trails except in patches of grass and young second growth forest. Foot troops can move only with difficulty off trails. Low relief contributes to uniform density of vegetation on all except northern hilly part of area, where foot troops can move most easily along ridge crests.

Streams can easily be forded by men at trail crossings; elsewhere thick tangles of vegetation and swampy ground make approaches difficult. Vehicles probably can ford the streams at many points above the junction of the Kobe and its major tributary (Welwalesewe) except in long rainy seasons; short dugways needed locally. Lower Kobe is fordable at only a few points but can be easily bridged by pontons or other types of temporary bridges. Fidi River can be forded at several points.

Cover, Concealment, Observation: Good cover in valleys and ridges of northern part of area, and in hills between Kobe village and the Fidi River; trails can be covered at many points by fire from nearby commanding heights. Cover largely lacking in most parts of the Kobe and Fidi plains; locally a little cover for men behind beach ridges and high stream banks. Large trees can give some cover. Hasty fortifications may be difficult where jungle floor is covered by dense tangle of roots; soil itself easily excavated throughout area.

Rain forest gives excellent concealment in almost all parts of area; coconut palms along the shore can give incomplete concealment to large number of vehicles.

Aerial observation very poor; narrow foot trails largely hidden by overlaping tree crowns. Ground observation generally limited to a few yards except on the beaches.

Area No. 17 - Mountains of Southeastern Halmahera

Topography: Steep-sided mountain ranges separated by deep valleys. Maximum altitude about 4,000 feet on peaks northeast of Bk. Limber; summits commonly range from 2,500 to 3,400 feet in altitude. At west, mountain slopes form a sharp boundary with the alluvial plain and terraces of Area 12; on the south, mountains rise sharply above a narrow coastal lowland. Relief is commonly 2,000 feet, but more in many parts of area; about 1,500 feet near south and west margins. Summits and ridge crests are commonly narrow but somewhat rounded. Slopes deeply cut by numerous steep-sided ravines. Upper slopes commonly very steep; lower ones moderate to steep. Valleys have narrow V-shape; streams channels generally occupy entire valley floor except near margins of area. Principal streams have moderate or low gradients; are probably fairly shallow. At southeastern edge of the range, Sagea River flows through an underground channel issuing onto the coastal lowland through a small dripstone-filled cavern.

Narrow, low coastal plain at south ranges from a few hundred feet to more than 1-1/4 miles wide; interrupted by the high hill of Bk. Kewinet which rises abruptly from the sea. The small salt lake of Sagea occupies an embayment of the plain. Some low terraces and hills at inland margin of the plain; generally the boundary is sharp.

Ground Conditions: Most of area has red-brown lateritic clay loam or clay soil 15 to 30 feet deep; grades downward into deeply weathered volcanics. Bare rock exposed most commonly in valley bottoms and locally in cliffs, ledges and rock-strewn slopes. On south coast, east of Lelilef, hard massive limestone underlies a large area; forms numerous cliffs and ledges in steep rocy canyons. Soil on limestone is red-brown clay; relatively thin except on gentle slopes and depressions.

Soil is generally well drained; some small areas of marsh on narrow coastal lowland near Sagea. Soil generally becomes slippery and plastic when wet; forms deep mud along well-used trails.

Rain forest covers area except for patches of cleared ground, grass or second growth forest around villages of Gemaf, Sagea and Sepo. Coconut palms border the coast; coconut plantation at Tg. Wosia.

Settlements: Interior has no permanent settlements. A few small villages along coast.

Movement: Trail from Tg. Ripe across Bk. Limber to the Kobe corridor (Area 12) is only known path through mountains; suitable only for foot troops. Short trails follow sections of coast and stream courses on coastal lowlands; if widened, probably can be used by light wheeled vehicles and tracked vehicles in drier weather; probably ground forms deep mud in wet weather.

In the mountains steep slopes and dense vegetation prohibit use of motorized equipment without construction of roads. In most places, foot troops can move only with difficulty; movement probably easiest on ridge crests where forest may be more open.

On coastal lowland, movement of motorized units possible in grass-covered areas, through young second-growth forest, and in coconut groves along coast. Rivers probably can be forded except after long periods of heavy rain.

Cover, Concealment, Observation: Rough, broken terrain offers good cover over most of area. Little cover on coastal plain except where some protection is given by spurs projecting from the mountain front. Low banks at high tide level and locally, stretches of beach ridge around Sagea offer cover from low trajectory fire for landing troops. Limited cover provided by large trees.

Vegetation offers abundant material for camouflage and concealment.

High peaks afford commanding views of Weda Bay to the south. Many vantage points commanding the principal valleys, the coastal lowlands and the Kobe basin. Dense vegetation generally interferes with observation.

Area No. 19 - Mountains of Southern Halmahera

Long irregular ridges trending east and northeast from the range forming backbone of southern peninsula. Described in Sheets XVIII-99 and XVIII-100.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

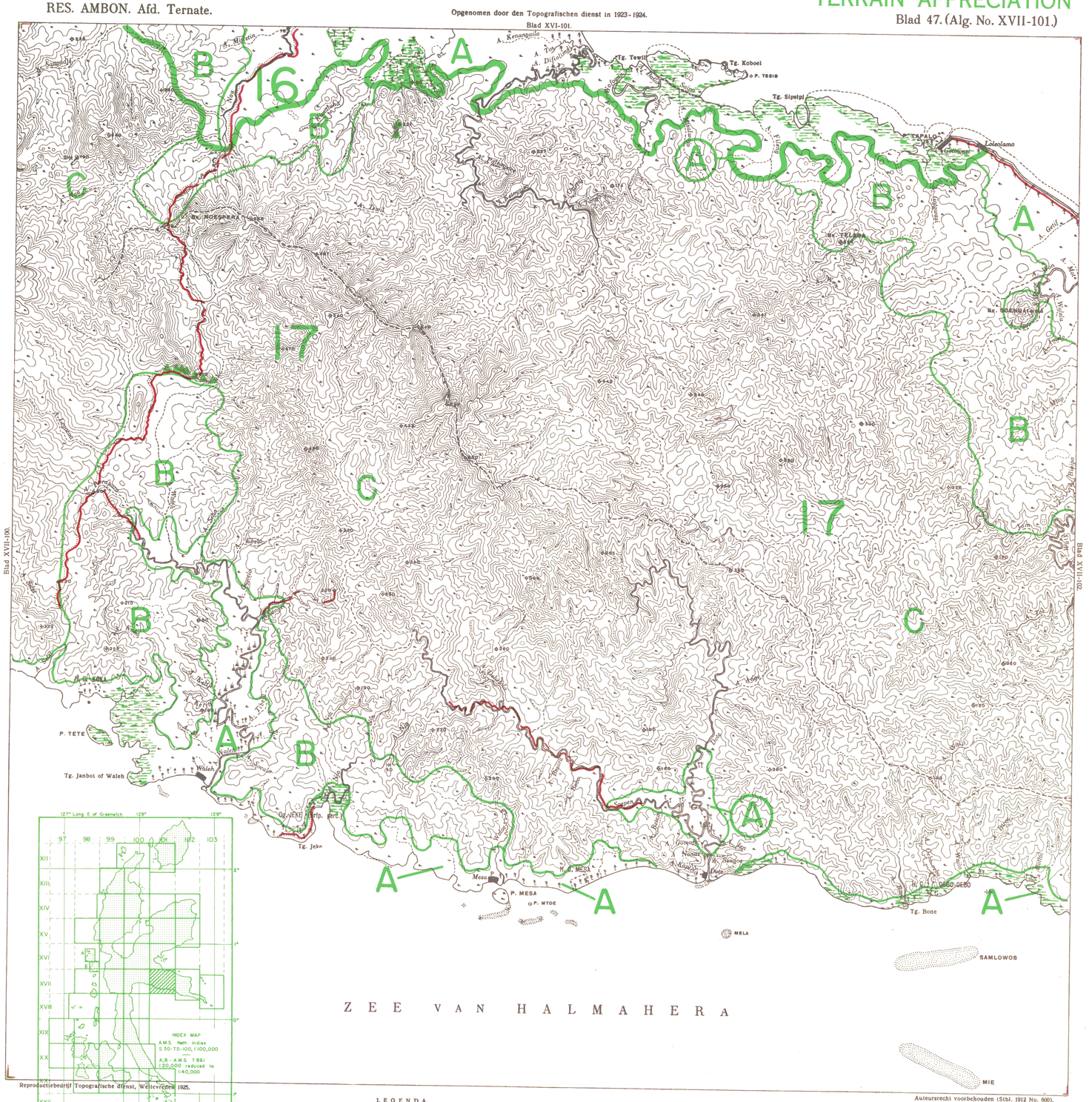
Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

## TERRAIN APPRECIATION

Blad 47. (Alg. No. XVII-101.)







Reproductiebedrijf Topografische dienst, Weltevreden 1925.

BLADINDEELING.

| | | |
|---|---|---|
| XVI-100 | XVI-101 | XVI-102 |
| XVII-100 | XVII-101 | XVII-102 |
| XVIII-100 | XVIII-101 | XVIII-102 |

1°0' N.B. 0°0' 21°0' 22°0' O. v. Batavia.

ADM. INDEELING.

| | | |
|---|---|---|
| Afdeeling | Ternate. | |
| Onderafd. | Halmahera. | |
| Ressort | Weda. | |
| a. District | Weda met Patani. | |
| b. | Maba met Gebe. | |

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperboomen.* *Bamboebosch.* *Bosch.* *Paardenpad.* *a. dasker of doorlaat van bamboe.* *Voetpad.* *Rivier.* *a. gemeten, b. niet gemeten.* *Inlandsche graven.* *Bamboe gebouwen.* *Drasland.* *Landb. ond. grens.* *Districtgrens.*

*ZEE a. eiland, b. klippen bij laagwater zichtbaar. c. zandbank alleen bij laagwater droog. d. laagwaterlijn. Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. e. hoogtepunt en hoogtecijfer, f. halphoogtelijn, g. rots, h. bodemoneffenheden, i. kleine verhevenheden.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.

0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Vluchtig opgenomen in de jaren 1923-1924 met gebruikmaking van enkele punten v/d zeekaarten No. 339 en 390 catalogus 1923. De kustlijnen zijn ingepast tusschen de kaap ten zuiden van kampoeng Waleh, de oostkant v/d monding van A. Dote, Tg. Remdi op blad XVIII-102, de kaap benoorden kampoeng Gotowasi en de monding van A. Kimalaha op blad XVI-101. Administratieve indeeling volgens G.B. van 25 Jan. 1924. no. 21 Stbl. no. 29. De verdere loop van de districtgrens (westelijke bladrand) is niet bekend.*

VERKORTINGEN.

Bk. *Boekoe (berg).* P. *Poelau.* Tg. *Tandjoeng.* A. *Ake.* H.C. *Huurcontract.* P. *Pisang* O.L. *Onderaardsche loop.* Oy. *Onderneming.*

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.

B. Terraces, inland flats, sloping plains, low rolling hills.

C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

Reliability rating: Class B

SHEET NO. XVII-101

Area No. 16 Maba-Soeli Plains.

Topography: Southern part of low alluvial plain on southwest side of Soeli Bay. Plain slopes gently seaward; generally less than 150 feet in altitude although low hills at inland margins are more than 600 feet above sea-level. Surface flat or gently undulating; crossed by several meandering streams. Larger streams (Nou, Ketorgosio) are probably more than 100 feet wide; locally have channels incised a few feet below level of plain. Smaller streams 15 to 40 feet wide. Most rivers bordered by coastal swamps near their mouths; some have bordering swamps extending inland to the mountain front ( Area 17).

Shore is low and in many places swampy. Locally beach ridges lie between the shoreline and the coastal swamps; long low ridge from Gotowasi village to east margin of area. Raised coralreefs on point of land round Tg. Koboel. Coral reefs at shallow depths extend seaward for some distance from the shore.

Ground Conditions: On plains, deep sandy loam or sandy clay near mountain front (Area 17) to fine clay soil farther north. Drainage fair in southern part but swamps (moeras) and marsh (grass land) occupy considerable areas near coast. Coral sand and old coral reefs along shore east of village of Gotowasi.

Settlements: A few native villages built on beach ridges and raised coral reefs along shore.

Movement: Dense forest and swamp vegetation covering most parts of area make the plain unsuitable for movement of motorized units although topographically the land is favorable. Foottroops can move with difficulty by cutting their way. Trail through forest along the Nou River into Area 17 is only known existing route across plain.

Cover, Concealment, and Observation: Little topographic cover, Low beach ridges and raised reefs afford some cover for men. Little cover can be obtained from the large soft wood trees in the forested areas. Hasty fortifications in most parts of area probably will fill quickly with water.

Forest-covered areas give excellent concealment for men and machines. Limited concealment for machines in open coconut groves along shore.

Observation poor. Ground observation in forested areas generally limited to a few yards.

Area 17. Mountains of Eastern Halmahera

Topography: Rugged region made up of long irregular ridges and spurs separated by narrow V-shaped valleys; forms central part of mountainous eastern arm of Halmahera. Summits commonly less than 1400 feet in altitude and relief; maximum altitudes, about 1800 and 2000 feet, reached by peaks in central and northwest parts of quadrangle. Summits are rounded; slopes generally very steep; locally, especially where mountains descend to coastal plain of Maba (Area 16) and along the Waleh and Soepan River valleys, lower slopes are moderate to gentle. On the north, the mountains are bordered by the Maba alluvial plain (Area 16) and its narrow extension to the east. On the south steep mountain slopes commonly rise abruptly behind the beaches; there are small coastal lowlands between the plantation of Koka and village of Waleh, either side of Mesa village, and east of the Wailo river. South coast is somewhat irregular; indented by many small bays. The Waleh River, the lower courses of its tributaries, and the lower course of the Soepan flow in open V-shaped valleys with floodplains a few hundred feet to more than ½ mile wide. Elsewhere, valleys are narrow and steep-sided with little or no flood plain. Most streams are small with moderate to low gradients except in their upper courses. The larger streams (Waleh, Soepen, Dote on the southern side of the divide, the Wetogriso on the north) are more than 100 feet wide.

Ground Conditions: In central part of range, lateritic clay or clay-loam 15 to 30 feet deep. Bare rock is exposed locally as cliffs, ledges and rock-strewn slopes. Mountains nearer coasts have light colored sandy or stony loam which at depth of 10 to 20 feet grades into loosely cemented conglomerate or sandy bedrock. On north coast and on south coast east of Mesa, coral limestone beds occur in the conglomerate up to altitude of 300 to 500 feet; locally form cliffs or rocky slopes along stream valleys. Soil on limestone is thin red-brown clay. Some sandy loam to clay loam on narrow coastal lowlands.

Ground generally well-drained except for some small marshes or swamps in valley flats of larger rivers, and on coastal lowland (especially near river mouths). Soils generally become slippery and plastic when wet; form deep mud along well-used trails. Ground can be excavated with hand tools except in coastal areas where limestone is covered locally by thin soil.

Tropical rain forest covers area except for patches of cleared ground, grass, or second-growth forest near coastal villages. Some swamp forest along stream bottoms; a little mangrove north of Tg. Jarbot.

Settlements: A few native villages along south coast; small plantations reported at a few points on lowlands. Interior of area has no permanent settlements.

Movement: Barrier area generally unsuited for free movement. Discontinous stretches of lowland and beaches along south coast may possibly be suitable for motorized troops. Open groves of coconut and sandy beaches may permit passage of mechanized vehicles. Foot troops probably can move easily. Marshes (grassland) west of Waleh and in a few other small areas along coast probably impede both men and machines, especially in rainy seasons. Except for short footpath through plantation at Tg. Jeki no coastal trails are known.

In mountainous section motorized units cannot move off roads. Waleh floodplain forms corridor through two thirds of the area, but movement difficult because of dense vegetation and swamp areas. Foot troops can move across country only with difficulty; probably easiest on ridge crests where vegetation is generally less dense. Only known trail over mountains is footpath from Maba plain (Area 16) across watershed at headwaters of the Nou and tributaries of the Waleh; on south side of the divide, trail follows lower slopes of Waleh valley avoiding the densely overgrown valley bottom. At the Tampara River, trail forks, one branch crossing mountains to Seki river, the other continuing down the Waleh. Another foot trail up the Soepen from Dote village crosses to the Waleh valley along its tributary, the Songei. Trails along most sections cannot be used by motorized equipment without extensive improvements. Where paths follow beds of streams, they cannot be used at times of heavy rains.

Small streams probably can be forded except during flash floods. Larger streams are generally shallow; fordable a short distance inland along gravel bars crossing diagonally between the inside of meanders. Near the coast the channels are deeper. Some streams are bordered locally by swamps which make approaches difficult. Locally, steep banks matted with vegetation are obstacles to crossings without building of short causeways or bridges.

Preliminary text submitted without checking or editing U. S. Geological Survey

Prepared by U.S. Geological Survey for Chief of Engineers, U.S. Army

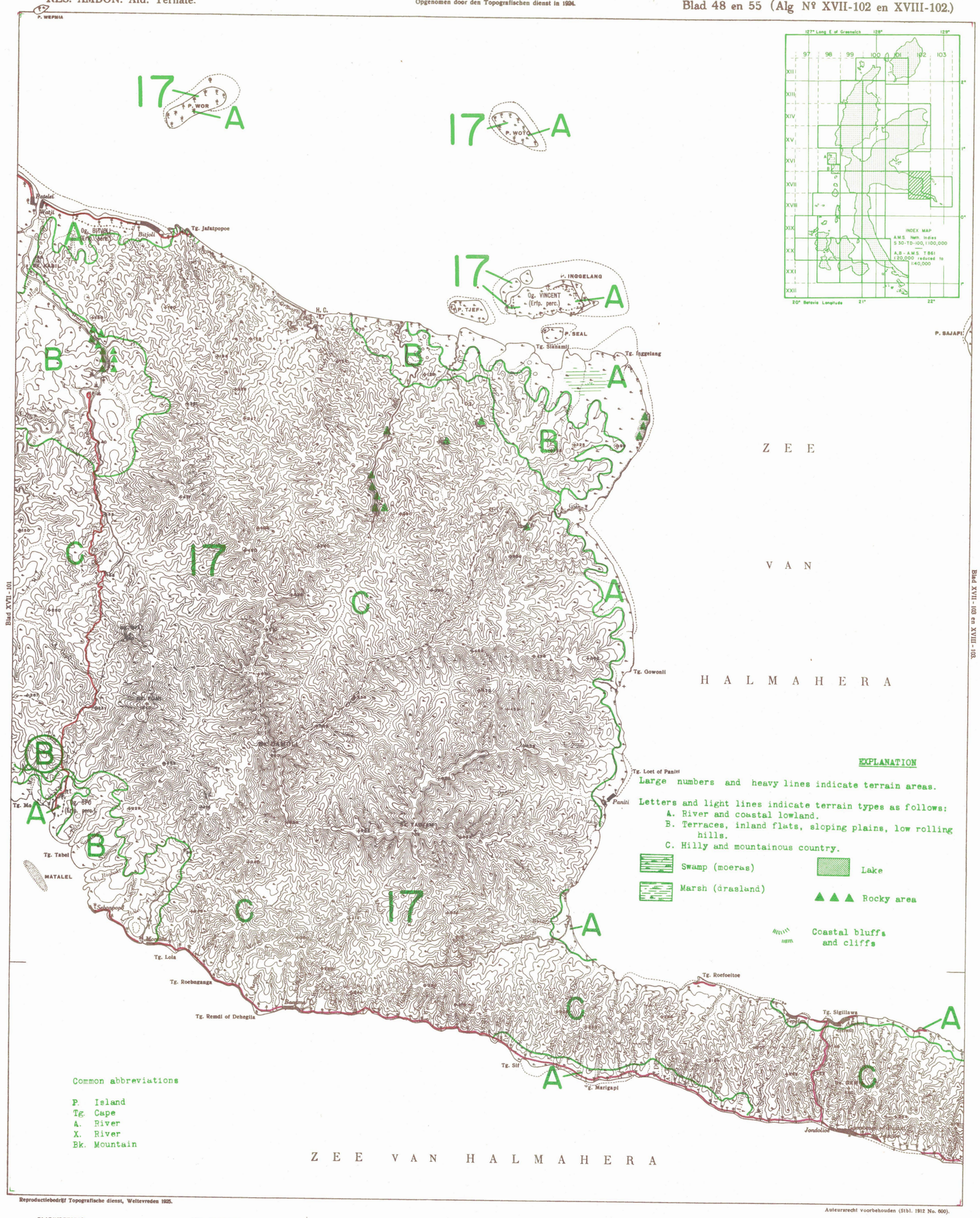
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1924.

## TERRAIN APPRECIATION

Blad 48 en 55 (Alg Nº XVII-102 en XVIII-102.)







### EXPLANATION

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C. Hilly and mountainous country.

Swamp (moeras)
Marsh (drasland)
Lake
▲▲▲ Rocky area
Coastal bluffs and cliffs

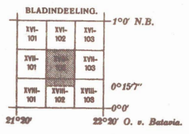
### Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

Reproductiebedrijf Topografische dienst, Wetterveden 1925.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.




ADM. INDEELING.

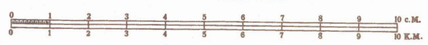
Afdeeling Ternate.
Onderafd. Halmahera.
Ressort Weda.
District Weda met Patani.
Maba met Gebe

Trail
Road

Kampoeng. Schaars bewoonde streken. Sagotalm. Klapperboomen. Drasland. Bosch. Paardenpad. a. duiker of doorlaat van bamboe. Voetpad. Steenen- en bamboe gebouwen. Rivier, a. gemeten, b. niet gemeten. Landb. ond. grens. Districtsgrens.

ZEE. a. eiland, b. klippen altijd boven water, c. zandbank alleen bij laagwater droog, d. laagwaterlijn. Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.e. hoogtepunt en hoogtecijfer, f. huishoogtelijn, g. rots, h. bron.

Schaal 1:100 000.




TOELICHTINGEN.

*Vluchtig opgenomen in de jaren 1923 - 1924 met gebruikmaking van enkele punten van de zeekaarten No. 389 en 390, catalogus 1923. De kustlijnen zijn ingepast tusschen de navolgende punten: Tg. Roefoeitoe - Tg. Inggelang - Tg. Jafatpopoe, het noord - en zuidpunt van Sajafi, (blad XVII - 103); Tg. Remdi of Dehegila - Tg. Ngolopopo (blad XVIII - 103) en Tg. Ngolopopo - Tg. Roefoeitoe.*

*Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21 Stbl. No. 29.*

VERKORTINGEN.

P. Poelau. Bk. Boekoe (berg). Tg. Tandjoeng. A. Ake (rivier). H.C. Haurcontract. Og. Onderneming. O.L. Onderaardsche loop.

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

**Reliability rating:** Class B.

SHEET NO. XVII-102 - XVIII-102

**Area No. 17 - Mountains of southeastern Halmahera**

Topography: Rugged mountainous region, chiefly made up of long ridges and spurs separated by narrow V-shaped valleys, forms termination of the mountainous east arm of Halmahera. Main ridges show various trends; east and north trends are most common. From the southeast corner of the area single unbroken ridge extends eastward into the Sea of Halmahera as a narrow finger of land generally less than 2-1/2 miles wide. Summits commonly 1,000 to 1,600 feet in altitude and relief; maximum altitudes of about 2,240 and 2,390 feet respectively reached by peaks of Damoli and Tadjam. Summits rounded; slopes generally steep; some rocky, especially near valley bottoms. Along the Wadji River and locally near the coasts, slopes are moderate to gentle. The Watji River and lower courses of its tributaries at northwest flow in open V-shaped valleys with small floodplains. Elsewhere, valleys narrow and steep-sided with little or no floodplain. Coast generally low; bordered by narrow sandy beaches or old raised coral reefs. On south coast, steep mountain slopes commonly rise abruptly behind the beaches; along parts of the north and east coasts, lowlands 1-1/2 miles to a few hundred feet wide border the mountain front. Streams generally small with low gradients except in their upper courses. The Watji, the largest river, drains most of the northwest part of the quadrangle. A few streams, draining to the north, flow through short underground courses under old raised coral reefs before reaching the coast.

Low swampy islands of Tjef, Inggelang and Seal lie immediately off northeast tip of area; Woto and Wor lie farther off shore to north. Islands rise only few feet above sea level; commonly rimmed by coral reefs. Reefs extend short distance off shore from most of north coast and locally from east coast.

Ground Conditions: Region of highest altitudes in south-central area has red-brown lateritic clay loam or clay soil 15 to 30 feet deep. Bedrock deeply weathered volcanic rock; outcrops locally as cliffs and rock-strewn slopes and along stream bottoms. Surrounding this region on all except west side and extending along the south side of the narrow "finger" is belt of yellow-brown to red-brown sandy or stony loam which at depth of a few feet grades into poorly consolidated conglomerate and sandstone. On north and east coasts, coral limestone forms layers in the conglomerate up to altitudes of 500 feet; limestone has clay soil, thin except on some gentle slopes and in depressions; limestone outcrops locally as cliffs and ledges.

Ground generally well drained. Soils become slippery when wet but generally dry fairly rapidly. Can be excavated by hand tools except locally in areas of limestone with thin soil cover.

Most of the area covered by tropical rain forest; undergrowth moderate, except in valley bottoms where dense tangle of creepers and bushes is common. Open coconut groves border coasts; coconut plantations reported at Bitjoli and on island of Inggelang. Around villages are areas of grass or second growth forest; around larger settlements such areas fairly extensive.

Settlements: A few native villages along coast; Bitjoli on the north coast, Gamsoengi (Patani) on south coast are probably most important. Some smaller villages inhabited only part of year. Large coconut plantation reported on Inggelang island; smaller plantations near Bitjoli, on Tjef island and at mouth of Spo on south coast. Interior of area uninhabited.

Movement: Barrier area unsuited for free movement.

Narrow gently sloping coastal lowland may be suitable for motorized troops. Open groves of coconut palms and sandy beaches may permit some movement of mechanized vehicles. Foot troops probably can move easily. Marshy ground west of Tg. Inggelang may be difficult to cross in wet weather. Trails have low grades and can be easily improved; new ones readily built in most places. Existing communication lines confined to a few short discontinuous paths and horse trails. On north coast, horse trails from Loleolamo (Sheet XVII-101) through Patelei to Bitjoli; Inggelang island trails extend through the plantation. In southeast part of quadrangle horse trail crosses the narrow finger of land from villages around Tg. Sigillawa to Jondolioe and neighboring villages; another trail on south coast connects Moreala and Banemo.

Most of the area so mountainous that motorized units cannot move without roads. Foot troops can move across country only with difficulty; probably easiest on ridge crests where vegetation may be less dense. Only existing route across the mountains is a footpath from north coast up the Watji River and over mountains to the Spo plantation. Most of the path cannot be used by motorized equipment without extensive improvements; where it follows bed of Watji River, trail cannot be used in heavy rains. Streams probably can be forded at many points except during high water stages and flash floods.

Cover, Concealment, Observation: Broken terrain provides good cover throughout most of area. Trails can be brought under fire at many points. Embankments at inland margins of beaches and beach ridges give some cover for landing foot troops. Hasty fortifications made in deep soil which covers most of area; tangles of roots on jungle floor may slow excavations.

Dense vegetation gives excellent concealment in almost all parts of area. Coconut groves provide only limited concealment for vehicles. Ground observation except from nearby vantage points is very difficult.

Trails largely screened by overlapping crowns of trees.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

CONFIDENTIAL

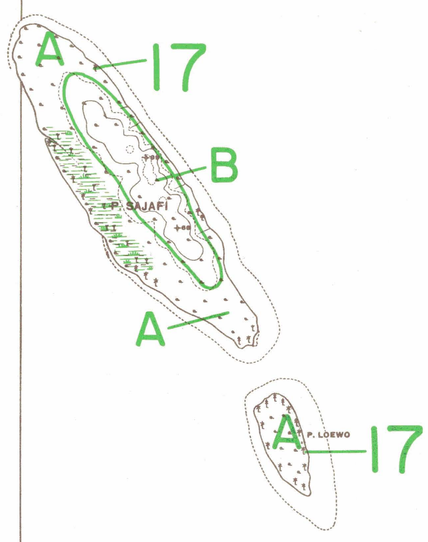
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1924.

## TERRAIN APPRECIATION

Blad 49 en 56.(Alg.№ XVII-103 en XVIII-103.)




EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

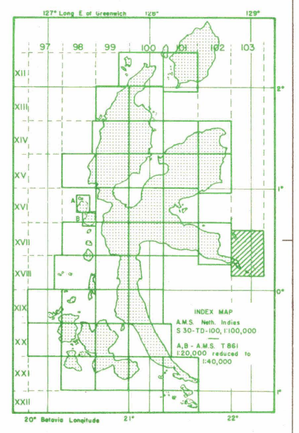
Common abbreviations

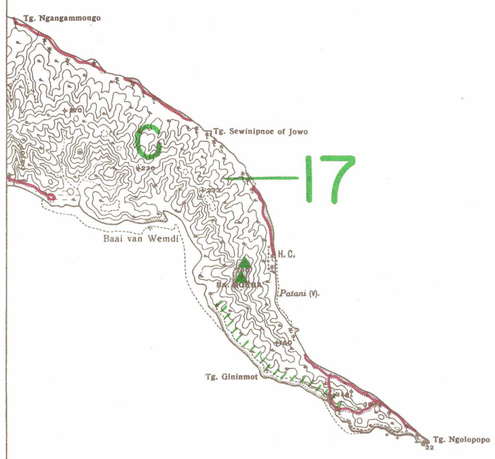
P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

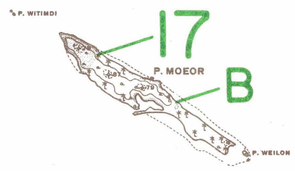
Z E E

V A N

H A L M A H E R A



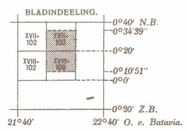




LEGENDA.

*Schaars bewoonde streken. Sagotuin. Klapperboomen. Bosch. Djemara- of Dennen (Sparren) bosch. Drasland. Rivier. a. gemeten, b. niet gemeten. Landb. ond. grens. Voetpad.*

*ZEE. a. eiland, b. klippen bij laagwater zichtbaar, c. klippen altijd boven water, d. laagwaterlijn. Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. e. hoogtepunt en hoogtecijfer, f. halfhoogtelijn, g. rots.*

BLADINDEELING.




ADM. INDEELING.

Trail

Road

*Afdeeling Ternate.*
*Onderafd. Halmahera.*
*Ressort Weda.*
*a. District Wedo met Patani.*
*b. ,, Mabo met Gebe.*

TOELICHTINGEN.

*Vluchtig opgenomen in het jaar 1924 met gebruikmaking van enkele punten van de zeekaart No. 390 catalogus 1923. De kustlijnen zijn ingepast tusschen de navolgende punten: Tg. Remdi (blad XVII-102 en XVIII-102) - Tg. Ngolopopo; Tg. Ngolopopo - Tg. Roefoetoe (blad XVII-102 en XVIII-102); oost- en westpunt van P. Moeor en het noord- en zuidpunt van P. Sajafi. Voor de ligging van P. Loewo werd het zuidelijk punt van het eiland van de zeekaart overgenomen. Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21 Sibl. No. 29.*

VERKORTINGEN.

*Bk. Boekoe (berg). P. Poelau. Tg. Tandjoeng. A. Aké. H.C. Huurcontract. (V). Verlaten.*

Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

Blad XVII - 102 en XVIII - 102.

PREPARED BY U.S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U.S. ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: Class B

SHEET NO. XVII, XVIII-103

Area No. 17. Mountains of Northeastern Halmahera

Topography: Narrow hilly finger of land at southeast tip of eastern Halmahera. West of Bk. Goeba (altitude 924 feet) average altitude is about 700 feet; eastward, elevations decrease to about 100 feet at extreme tip. Hillsides steep; dissected by narrow ravines. Shore low; bordered on south side by reefs extending a few hundred feet out from shore.

Sajafi and Loewo, at north, are low coral islands; Loewo less than 150 feet altitude. Low hills and terraces of east-central Sajafi attain about 330 feet maximum altitude. On east side of Sajafi, slopes are moderate to steep; elsewhere low. Marshy ground behind low beach ridge borders most of west coast. Low coral island of Moeai off tip of the finger. Islands largely bordered by reefs.

Ground Conditions: Area largely underlain by coral limestone interbedded with conglomeratic or sandy rock. Soil is yellow-brown to red-brown sandy loam and sandy clay which at depths of 2 to 4 feet grades into bedrock; soil lacking in many places and bare rock forms low cliffs, rocky slopes, and ledges in valleys and along coast. Southwest margin of peninsula has sandy loam overlying conglomerate.

Islands underlain by coral limestone; have thin cover of coral sand, sandy loam, or clay loam soil.

Ground on islands and on mainland generally well drained except for marshy areas on west side of Sajafi.

Tip of southeastern Halmahera largely covered by open rain forest; bordered by coconut groves. Islands largely covered by coconut palms; small areas of rain forest in interior parts.

Settlements: Only settlement on peninsula is small coconut plantation reported east of Bk. Goeba. Islands have no permanent settlements.

Movement: Dense vegetation and rugged terrain form barrier to movement of mechanized units; foot troops can move with difficulty. On Sajafi and Loewo, dense vegetation makes movement very difficult.

Cover, Concealment, and Observation: Hills and ravines give cover for men on peninsula and in east-central Sajafi. Beach ridges (especially on west coast of Sajafi) and low embankments at inland margin of beaches may give local cover to a few men. Abundant vegetation gives adequate concealment and restricts observation to a few yards.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

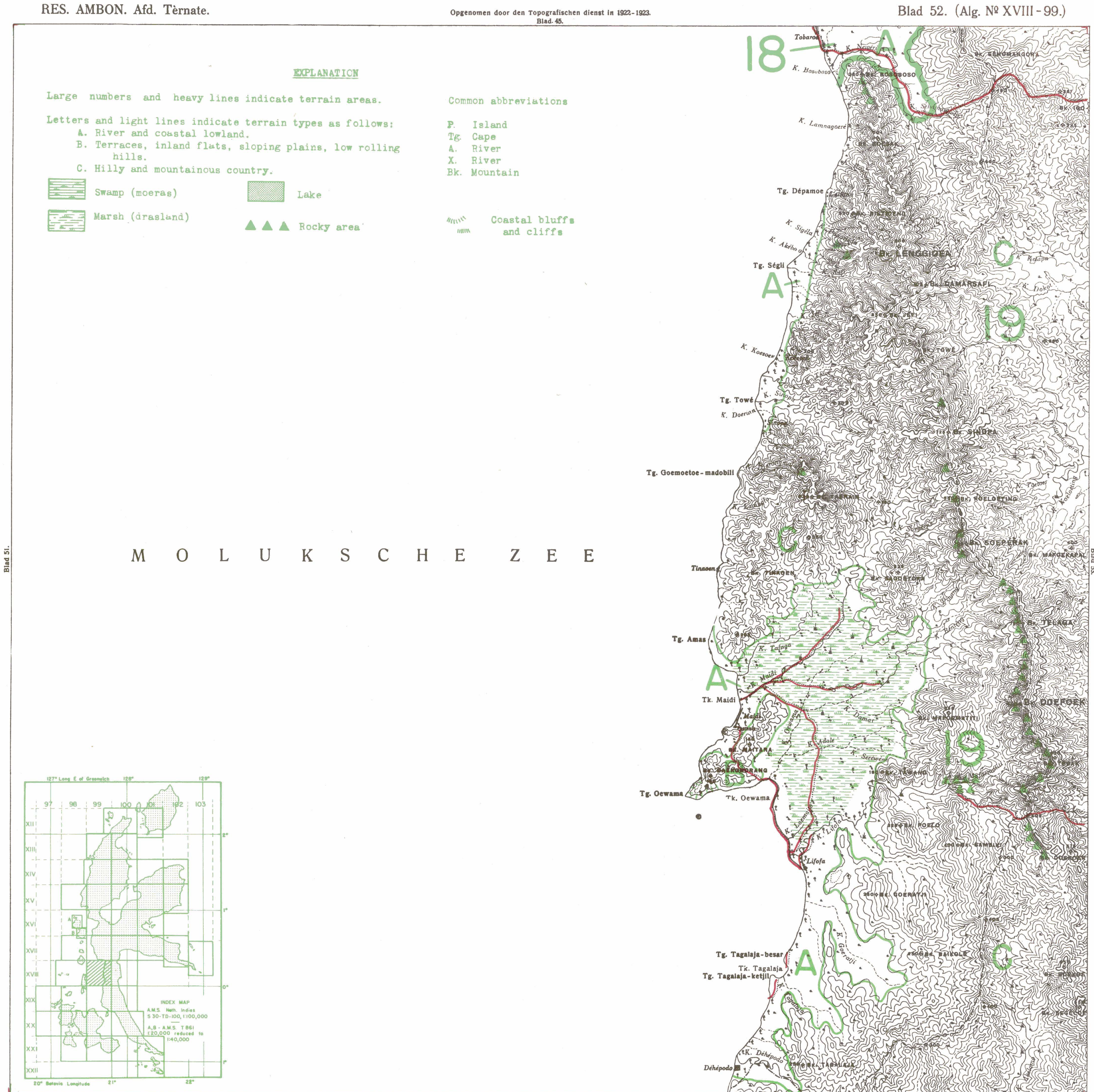
# HALMAHERA (MOLUKKAS)

## TERRAIN APPRECIATION

RES. AMBON. Afd. Tèrnate.

Opgenomen door den Topografischen dienst in 1922-1923.
Blad 45.

Blad 52. (Alg. Nº XVIII-99.)




Topografische Inrichting, Batavia 1924.

Blad 59.

**BLADINDEELING.**

| | | |
|---|---|---|
| 44 | 45 | 46 |
| 51 | 52 | 53 |
| 58 | 59 | 60 |

0°40′ N.B. — 0°0′ — 0°20′ Z.B.
20°20′ — 21°20′ O.L. v. Batavia

**ADMINISTRATIEVE INDEELING.**

| | |
|---|---|
| *Afdeeling* | *Tèrnate.* |
| *I. Onderafd.* | *Halmahéra.* |
| *A. Ressort* | *Djailolo.* |
| *District* | *Oba.* |
| *B. Ressort* | *Wéda.* |
| *a District* | *Wéda met Patani.* |
| *b. ,* | *Gané.* |
| *II. Onderafd* | *Tidore* |

Trail
Road

**LEGENDA**

*Kampoeng. Schaars bewoonde streken. Sagotuin. Arentuin. Klapperboomen. Bosch. Kreupelhout. Bamboebosch. Moeraspalmen. Drasland. Voetpad. Paardenpad. Rivier. a. gemeten b. niet gemeten. Steenen-, en bamboe gebouwen. Inlandsche graven. Ressortsgrens. Onderafdeelingsgrens.*

*ZEE. a. zandbank.*

*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. b. = hoogtepunt en hoogtecijfer, c. = hulphoogtelijn, d. = rots,*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

**VERKORTINGEN**

*K. = Koeala (Rivier) Bk. = Boekoe (Berg.) Tg. = Tandjoeng (Kaap). Tk. = Teloek (Baai).*

**TOELICHTINGEN**

*Administratieve indeeling volgens G B. van 25 Jan. 1924 No. 21. Stbl. No. 29.-*

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: Class B SHEET NO. XVIII-99

Area No. 19. Mountains of Southern Halmahera

Topography: Rough mountains; area is northern part of mountain range forming backbone of southern peninsula. In central part of area maximum altitudes exceed 2,600 feet; at north, more than 2,000 feet; at south, generally less than 2000 feet.

Crest of range trends roughly north-south; commonly 6 miles or less from west coast. Along range crest, summits are narrow, rounded. Steep west slopes rise abruptly from coast r from alluvial plains east and northeast of villages of Maidi and Lifofa. Alluvial plains vary in width from about ½ to 5 miles; slope gently seaward from altitudes generally less than 150 feet; locally small hills and ridges rise 300 to 500 feet above sea level. Between Amas Point and Bosoboso mountain, rocky headlands or small sandy beaches border the coast.

East flank has steep slopes above 500 feet altitude; commonly moderate slopes below that altitude.

Streams commonly short and swift; valleys narrow with steep gradients. On plains around Maidi and Lifofa, streams have low gradients; in places have cut channels several feet below level of plain.

Ground Conditions: Dark red-brown lateritic clay loam or clay on mountain slopes; depth 15 to 30 feet; grades downward into deeply weathered, well-fractured dark-colored trap rock and volcanic rock. Bare rock outcrops locally on steep slopes, seacliffs, and along stream bottoms; on west side along range crest is extensive belt of cliffed or rocky slopes. On Maidi-Lifofa lowland, yellow-brown to red-brown sandy or stoney loam; locally clay or clay loam. Soil in mountain regions is well-drained but will form deep mud in rainy weather where vegetation has been stripped and soil disturbed by excavation, heavy traffic, or excessive slumping.

Large areas of marsh (drasland) cover much of the alluvial plain east of Maidi and Lifofa; plain may be partly under water during the rainy season.

Mountains covered by tropical rain forest, which probably is most dense and has heaviest undergrowth in valley bottoms; vegetation least dense on ridge crests.

Dense bamboo brakes along streams on Maidi-Lifofa plain. Around villages are areas of coarse grass and second-growth jungle with scattered large trees. Coconut palms border coast except where steep slopes and rocky headlands rise directly from the sea.

Settlements: A few small native settlements along the shore; interior uninhabited.

Movement: Barrier area. Steep slopes and dense tropical vegetation unsuited for movement of motorized troops off roads. Good foot path from Pajahi-islam (Area 18, Sheet XVII-99) across the mountains to Weda Bay; grades are moderate, locally steep. Some short foot trails across Maidi-Lifofa plain. Foot trail from Lifofa village crosses range north of Bk. Doekoer; follows bed of Lifofa River nearly to headwaters. Trails probably cannot be used by motorized equipment without considerable improvement. Relocation of trails built in stream beds will be necessary for all-weather use. Some movement of motorized units possible on Maidi-Lifofa plain in cultivated, grass-covered, or young second-growth areas that extend for some distance inland from the villages, and in open coconut groves along shore. Where plain is covered by rain forest or swamp vegetation, motorized equipment probably cannot move easily away from trails in spite of suitable topography. Foot troops can move across most parts of the area; must cut their way in many places. Ridge crests, where vegetation generally is less dense, are probably easiest routes; steep rocky or cliffed slopes near crest of range are serious obstacles even to foot troops.

Streams can probably be forded at many points except during flash floods, which are common during seasons of heaviest rain.

Cover, Concealment, and Observation: Broken mountain topography gives good cover over most of area. On Maidi-Lifofa plain, little cover is available for motorized units; some cover for men provided by high stream banks, hills south and east of Maidi village, and small topographic irregularities of plain.

Dense vegetation affords excellent concealment in areas of rain forest and old second-growth forest. Grass and young second-growth around villages give only incomplete concealment for vehicles.

Observation generally poor. Crowns of trees interlock and largely conceal even well-used trails from aerial observation. Ground observation generally limited to a few yards; men in high grass can see only a few feet ahead.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

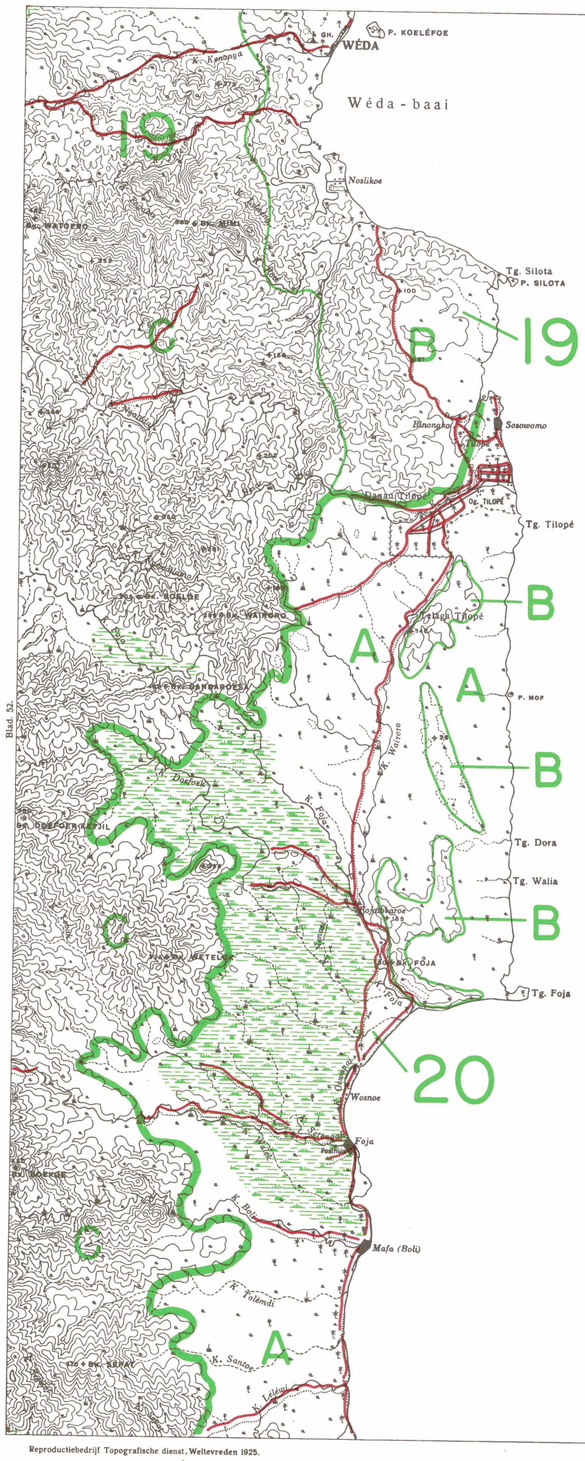
## TERRAIN APPRECIATION

RES. AMBON. Afd. Tèrnate.

Opgenomen door den Topografischen dienst in 1922-1923.

Blad 46.

Blad 53. (Alg. № XVIII-100.)




### EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.

B. Terraces, inland flats, sloping plains, low rolling hills.

C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

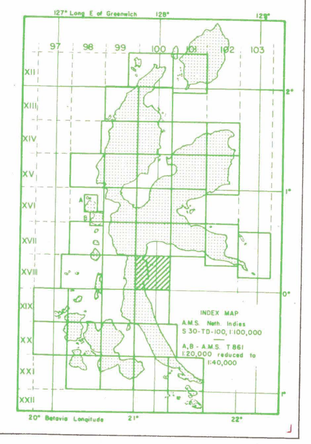
Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

ZEE VAN HALMAHERA




Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Blad 60.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING

| | | |
|---|---|---|
| 45 | 46 | 47 |
| 52 | 53 | 54 |
| 59 | 60 | 61 |

0°40' N.B. — 0°0' — 0°20' Z.B.

20°40' — 21°40' O.L. v. Batavia.

ADMINISTRATIEVE INDEELING.

Trail

Road

*Afdeeling* Tèrnate.
*Onderafd.* Halmahèra.
*Ressort* Wéda.
*District* Wéda met Patani.

LEGENDA

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Kreupelhout.* *Bosch.* *Bamboebosch.* *Moeraspalmen.* *Drasland.* *Moeras.* *Paardenpad.* *Voetpad.* *Rivier, a. gemeten, b niet gemeten.* *Meer.* *Steenen, en 's bamboe gebouwen.* *Inlandsche gruven.* *IJzerdraad versperring.* *Landb. ond. grens.*

*ZEE, a eiland.*

*Alle hoogten zijn uitgedrukt in M. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. b. = hoogtepunt en hoogtecijfer, e. = halfhoogtelijn.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.

0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN

Gn. = *Gunughabber.* Tg. = *Tandjoeng (Kaap.)* Bk. = *Boekoe (Berg.)* Og. = *Onderneming.* P. = *Poelau (Eiland.)* K. = *Kocala (Rivier.)*

TOELICHTINGEN

*Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21, Stbl. No. 29.*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: Class B SHEET NO. XVIII-100

Area No. 19. Mountains of Southern Halmahera

Topography: Long steep-sided ridges, trending generally east to southeast from the crest of the range (Sheet 52- XVIII-99), rise sharply from the coastal lowland on east side of peninsula except in the north where hills and terraces descend directly to the sea, between Weda and Tg. Silota. Altitudes generally 350 to 500 meters.

Summits narrow but generally rounded. Slopes steep; locally, lower slopes moderate to gentle. Ridges furrowed by numerous narrow steep ravines. Principal valleys have steep walls; streams follow narrow valley flats commonly ¼ mile to a few hundred feet wide. Small tributary streams have moderate to steep gradients with numerous small waterfalls; principal streams generally have low, regular gradients.

North of Tilope plantation (Area 20) the sharp ridges break down into irregular groups of low hills and terraces 50 to 100 meters in altitude. The terraces extend north along margins of Weda Bay, forming low cliffs and, around Noslikoe, projecting rocky headlands. Small area of coastal plain around Weda village.

Ground Conditions: Ridges commonly have sandy clay loam or clay which at a depth of 10 to 20 feet grades into conglomeratic or sandy bedrock. Terraces along Weda Bay are underlain by coral limestone and generally have thin sandy or stony clay soil. Bare rock exposed in low cliffs and in stream valleys. Ground generally well drained; mud which forms in trails and excavations during rainy season dries fairly rapidly.

Most of area covered by rain forest with abundant undergrowth. Vegetation least dense on limestone terraces and on sharp ridge crests. Streams commonly bordered by dense growth of vines, bushes, and bamboo thickets.

Settlements: Weda, largest settlement in area, is important native trading and administrative center for the Weda-Patani district. Noslikoe is small village on low coral headland south of Weda. Interior is uninhabited.

Movement: Barrier area unsuitable for movement of motorized equipment without construction of roads. Several trails into and across mountains follow ridge crests and stream bottoms; none are suitable for wheeled vehicles wintout extensive improvements. Trail north from Binongko across terraces toward Noslikoe with a little improvement probably can be used by light wheeled vehicles in dry weather.

Well-used foot trail from Weda up Kenonga River offers best route for foot troops to Pajahi Bay; trail locally follows stream course and these sections may be unusable during rainy season. Foot paths in other parts of area are narrow, more rocky, and commonly steep; generally are more difficult for movement of foot troops. Easy deployment of men off trails though in many places troops must cut way through underbrush.

Streams can generally be forded by men or machines except during flash floods in rainy season.

Cover, Concealment, and Observation: Broken rugged terrain in most parts of area offers good cover for men but little for machines. Low somewhat irregular terraces between Silota and Sosowomo may give some cover for vehicles.

Concealment for men and machines is good in most parts of area. Vegetation cover commonly limits observation to a few yards.

Area 20. Lowlands of Southern Halmahera

Topography: Coastal lowland interrupted by a few low ridges and isolated hills; lies at east base of mountains of area 19. Plain slopes generally eastward from altitudes of 150 feet or less toward the shore; (north of Foja River mouth, slope is toward the open poorly-defined valley of the Wairoro). Plain is nearly flat or gently undulating; interrupted locally by a few isolated hills 150 to 200 feet in altitude. East of the Wairoro, several long low ridges rise 100 to more than 500 feet above the plain; trends are roughly northward to northwestward.

South of Foja Point, coast is low and sandy. North of Foja Point, coast is bordered by old coral reefs in many places; living reefs extend for short distances out from shore.

Ground Conditions: Coastal lowland and broad valleys have yellow-brown to red-brown lateritic sandy or stony loam; grades into conglomeratic rock at depth of few feet. Old coral reefs north of Foja Pt. forming low ridges and hills between Wairoro River and coast with thin clay or sandy clay soil; some low cliffs and ledges of rock locally exposed. Coarse coral sand along beaches south of Foja.

Drainage fair in many parts of area; marsh (drasland) between Foja and Walek Rivers may be partly under water during a long rainy season. Soil tends to form deep mud when wet and, where ground is poorly drained, dries very slowly.

Settlements: Along shore are a few native villages of 200 or 300 inhabitants. A few small villages lie a short distance inland southwest of Sosowomo. Large coconut plantations south and southwest of Sosowomo along Tilope River. Western part of plain uninhabited.

Movement: Dense vegetation is serious obstacle to movement of motorized units without construction of roads, although flat plain is topographically favorable. Foot paths south from Sosowomo through Foja and Mafa probably can be used by light traffic in dry weather with a little improvement; considerable improvement needed for all-weather use. Trails inland along streams probably easily improved for light dry-weather traffic. Motorized units have limited movement in coconut plantations and in open coconut groves along southern part of coast and around Sosowomo. Some cleared land and young second growth forest around villages may be suitable for motorized troops.

Foot troops can move away from trails but must cut their way in many places. Dense growth along stream banks and in marshy area between Mafa and Foja River .

Streams can be forded by men and vehicles in many places during dry weather; larger streams such as the Foja and Wairoro cannot be forded by vehicles and possibly by foot troops during long heavy rains. Muddy bottoms in lower stream courses may be serious obstacles for vehicles.

Cover, Concealment, and Observation: Long low ridges and isolated hills give some cover for vehicles and men; little cover in most parts of area. High stream banks and low beach ridges give a little cover for men.

Forest gives excellent concealment in nearly all parts of area. Coconut groves and plantations and young second growth around villages gives only partial cover for motorized units.

Except in open plantations and grass-covered areas, observation is limited to a few yards. Trails largely concealed from aerial observation except in more open settled and grassy region around Sosowomo and the plantations.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey for Chief of Engineers, U. S. Army

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Tèrnate.

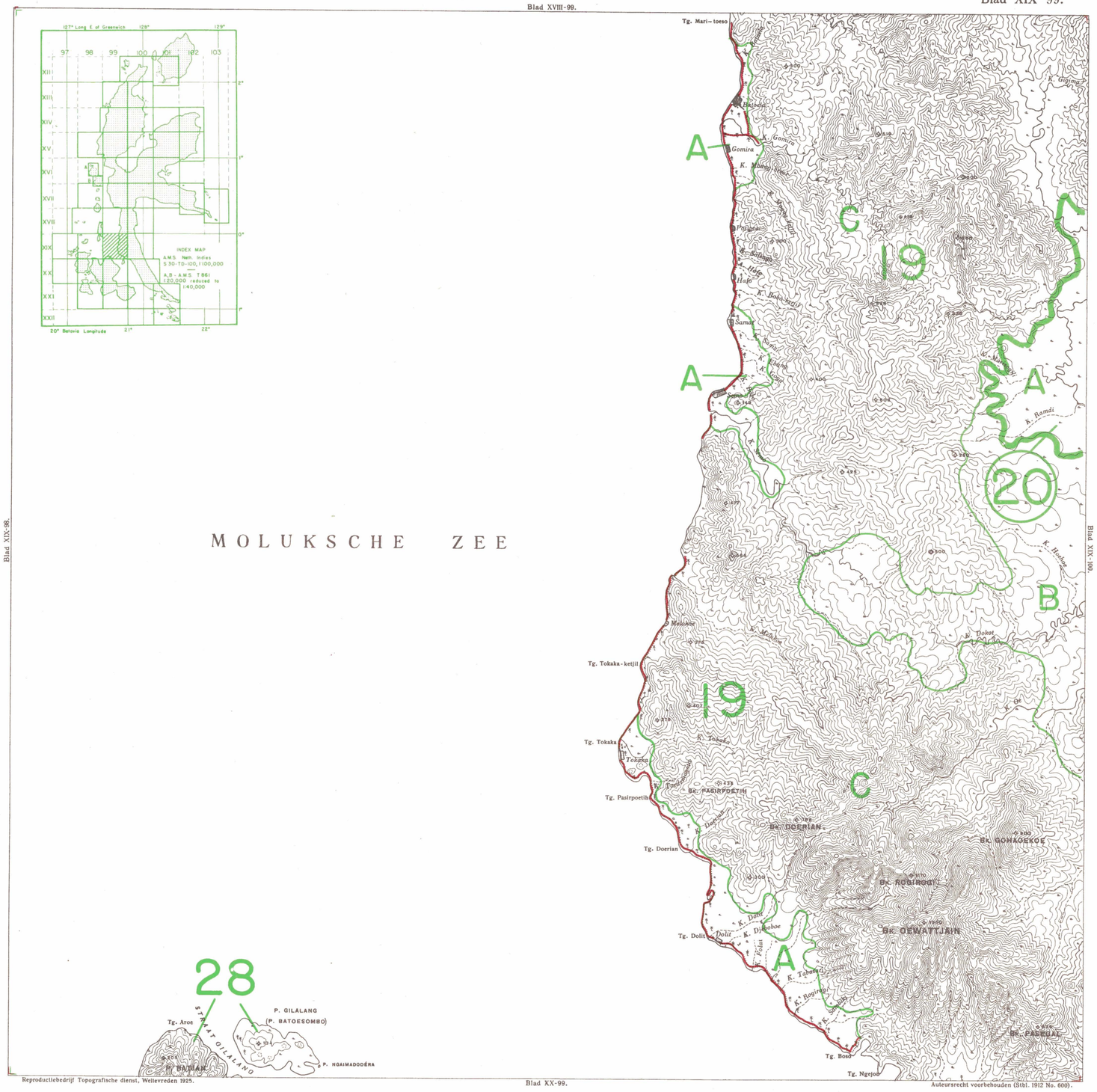
Opgenomen door den Topografischen dienst in 1922-1923.

Blad XVIII-99.

## TERRAIN APPRECIATION

Blad XIX-99.




MOLUKSCHE ZEE

Reproductiebedrijf Topografische dienst, Wetevreden 1925.

Blad XX-99.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.

| | | | |
|---|---|---|---|
| XVIII-98 | XVIII-99 | XVIII-100 | 0°20' N.B. |
| XIX-98 | XIX-99 | XIX-100 | 0°0' |
| XX-98 | XX-99 | XX-100 | 0°40' Z.B. |
| 20°20' | | 21°20 O.L.v. Batavia. | |

ADMINISTRATIEVE INDEELING.

| | |
|---|---|
| *Afdeeling* | *Tèrnate.* |
| 1. *Onderafd.* | *Tidore.* |
| 2. ,, | *Batjan.* |
| 3. ,, | *Halmahèra.* |
| A. *Ressort* | *Djailolo.* |
| *District* | *Oba.* |
| B. *Ressort* | *Wèda.* |
| *District* | *Gané.* |

Trail

Road

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Bosch.*

*Kreupelhout.* *Bamboebosch.* *Gelagah.* *Moeraspalmen.* *Paardenpad.* *Voetpad.*

*Rivier, a. gemeten, b. niet gemeten.* *Bamboe gebouwen.* *Inlandsche graven.*

*Onderafdeelingsgrens.* *Ressortsgrens.*

*ZEE. a = eiland.*

*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. a = hoogtepunt en hoogtecijfer. b. = halphoogtelijn.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.

0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Administratieve indeeling volgens G.B. van 25 Jan. 1924 no.21. Stbl. no. 29.*

VERKORTINGEN.

*P. = Poelau (eiland).* *Bk. = Boekoe (berg).* *Tg. = Tandjoeng (kaap).* *K. = Koeala (rivier).* *A. = Ahé (rivier).*

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.

B. Terraces, inland flats, sloping plains, low rolling hills.

C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

▲▲▲ Rocky area

Coastal bluffs and cliffs

Common abbreviations

P Island
Tg. Cape
A. River
X. River
k. Mountain

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



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# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B. SHEET NO. XIX-99

Area No. 19. Mountains of Southern Halmahera.

Topography: Irregular rugged mountain range; rises steeply from west coast of south Halmahera. Drainage divide trends roughly parallel to coast. Summit altitudes in central and northern parts of quadrangle commonly less than 1,700 feet altitude, locally attain 2,000 feet. Mountain mass of Bk. Oewattjan in south part rises to more than 4,000 feet (1250 meters); several minor summits are more than 3,300 feet above sea level.

Summits rounded, commonly narrow. Slopes generally very steep in the Bk. Oewattjan massif; steep to moderate in central and northern parts of the chain. Mountains are highly dissected by numerous steep-sided ravines and small valleys. East side of divide drained by headwaters of long streams crossing east side of peninsula. On west, streams are short with moderate to steep grades. Along most of west coast, mountains descend abruptly to strip of coastal flat ranging from few hundred feet wide to about a mile wide near Tg. Dolet and Tg. Boso.

Ground Conditions: On mountain slopes, clay loam or clay soil 15 to 30 feet deep, grading downward into deeply-weathered, dark-colored volcanic rocks. Bare rock outcrops locally on steep slopes, sea cliffs, and along stream bottoms. Low ridges in east-central part of area are underlain by conglomerate (volcanic material) and probably have a slightly more sandy soil. Ground is generally well drained but forms deep mud in rainy weather in excavations and well-used trails.

Area mostly covered by tropical rain forest. Around villages are areas of second growth forest, ranging from tangle of brush to forest resembling virgin jungle; locally are grassy or cultivated areas.

Settlements: Some small native villages on coast; most are north of the Semo River. Interior is without permanent settlements.

Movement: Barrier area, without known roads or trails, except a single foot path along coast. Mountains impassable for motorized units without construction of roads. Steep slopes, ravines, and dense vegetation make movement difficult even for foot troops.

Foot path along coast is unsuitable for motorized equipment without widening and grading; probably will require considerable improvement for all-weather use by heavy wheeled vehicles; some deployment possible away from trails, among widely-spaced coconut palms and in areas of grass and light second growth. Locally movement possible along beaches at low tide. Shallow streams can be easily forded except during flash floods.

Cover, Concealment, and Observation: Numerous deep ravines and high ridges offer good cover. Little cover for machines on narrow coastal plains and beaches; beach ridges and low banks at landward margins of beaches can give some cover for men. Throughout area, large trees afford partial cover. Native bamboo or palm houses give concealment but little or no cover.

Dense vegetation gives excellent concealment in almost all parts of area; palm groves and young second growth around villages afford only incomplete concealment for motorized units.

High peaks and ridges afford numerous vantage points commanding coast and Molukka Sea; vegetation cover commonly restricts observation. High relief and dense vegetation make observation very difficult, except at very short distance.

Area No. 20. Lowlands of Southern Halmahera

Described on Sheet No. XIX-1CO.

Preliminary text submitted without checking or editing. U. S. Geolcgical Survey

Prepared by U. S. Geological Survey for Chief of Engineers, U. S. Army

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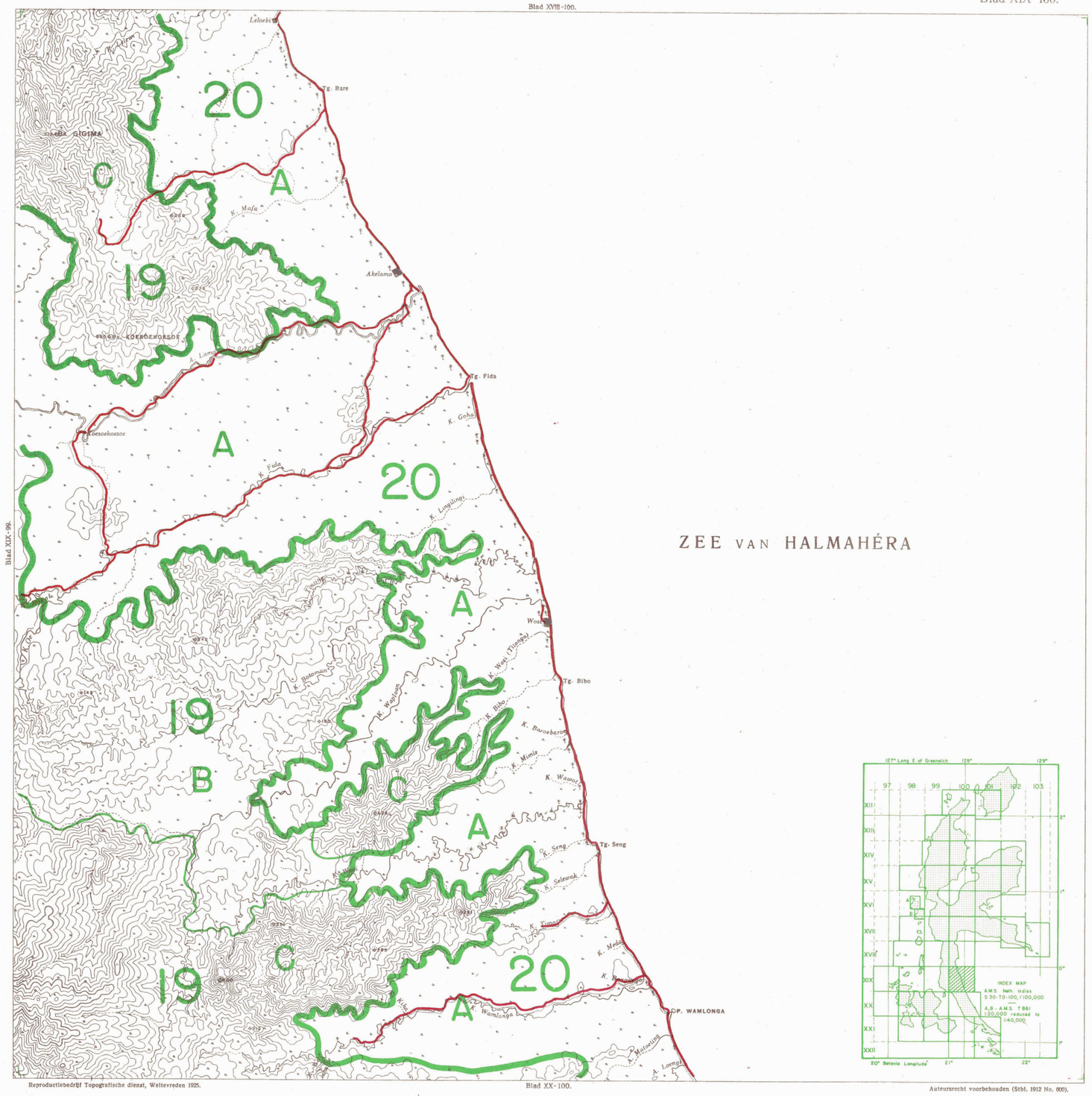
# HALMAHERA (MOLUKKAS)

## TERRAIN APPRECIATION

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1923.
Blad XVIII-100.

Blad XIX-100.




ZEE VAN HALMAHÉRA

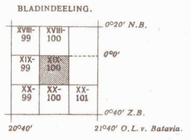



Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Blad XX-100.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDELING.




ADMINISTRATIEVE INDEELING.

Trail
Road

| | |
|---|---|
| *Afdeeling* | *Ternate.* |
| *Onderafd.* | *Halmahera.* |
| *Ressort* | *Weda.* |
| *Distriet* | *Gane.* |

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Gelagah.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Alangalang.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Bamboe gebouwen.*

*ZEE. a. eiland.*
*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. b. hoogtepunt en hoogtecijfer. c. halfhoogtelijn.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21 Stbl. No. 29. Uitgangspunt is het astronomisch station, de vlaggestok te Wéda; de kustlijn werd verder ten opzichte van het geografische noorden gekaarteerd.*

VERKORTINGEN.

**P.** *Poelau (eiland).* **Bk.** *Boekoe (berg).* *K. Koeala (rivier).* *Tg. Tandjoeng (kaap).* *A Alè (rivier).*

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

▲▲▲ Rocky area

Common abbreviations

| | |
|---|---|
| P | Island |
| Tg. | Cape |
| A. | River |
| X. | River |
| Bk. | Mountain |

Coastal bluffs and cliffs

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FOR
CHIEF OF ENGINEERS, U.S. ARMY



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# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating : Class B

SHEET NO. XIX-100

Area No. 19 - Mountains of southern Halamhera

Topography: Rough irregular ridges and hills trending northeast or southeast from the principal north-south crest of the range. (Sheet XIX-99). Maximum altitude about 2300 feet in southwest part of quadrange but altitudes for most part are 1600 to 1000 feet. Most ridges bordered on two or three sides by lowlands of Area 20; in places boundary is sharp, in others the low eastern tips of ridges merge with hills and terraces along margins of plains (Area 20).

Summits commonly rounded; in places broad and flat. Slopes moderate in most places, locally gentle; cut by many narrow gullies. The numerous small streams are tributary to large east-flowing streams which, in southern part of area, have broad open valleys roughly paralleling the ridge crests.

Ground Conditions: Long ridges have dark red-brown slightly sandy clay loam or clay; depth commonly 15 to 30 feet; bedrock exposures largely limited to stream bottoms in upper reaches where valleys are narrow and gradients steep. Higher mountains at southwest have a clayey soil overlying deeply weathered dark-colored volcanic and trap rock; bare rock exposed locally on steep slopes and in stream bottoms. Ground generally well drained; deep mud forms in trails under heavy traffic during rainy season but dries fairly rapidly.

Area covered by tropical rain forest. Undergrowth probably most dense in valley bottoms.

Settlements: Largely uninhabited. No known permanent settlements.

Movement: Barrier area. Rough topography and dense vegetation make area unsuitable for movement of motorized units without construction of roads. Only known foot path is short narrow one crossing spur of Gigima from coastal plain to upper Mafa valley. Foot troops can move only with difficulty; must cut paths in many places. Movement probably easiest on ridge crest where underbrush is less dense. Steep slopes on hillsides and dense vegetation on valley bottoms are principal obstacles.

Small stream can probably be forded except when in flood. Principal east and northeast flowing streams probably difficult to ford during long heavy rains.

Cover, Concealment and Observation: Ridges, spurs and ravines are possible cover for men and machines. Large trees and hasty fortifications offer some cover for troops. Long ridges of this area locally afford cover and concealment from naval fire; their summits command western part of lowland plains (Area 20).

In almost all parts of area forest offers excellent concealment from aerial and ground observation.

Area No. 20 - Lowlands of southern Halmahera

Topography: Low flat or gently rolling coastal plain on east side of peninsula; passes gradually into broad valley flats bordering principal rivers; locally broken by low hills and benches. Commonly one to 4 miles wide; broad valley flats extend 5 to 10 miles inland. Lowlands slope gently seaward from base of rugged mountains. Maximum altitude generally less than 100 feet; near inland margins of plain, low hills and terraces are 100 to 300 feet above sea level. A few high isolated hills rise more than 800 feet above the plain; several are 300 to 600 feet in altitude. Ground generally flat or gently rolling. Slopes generally low; isolated hills have moderate to steep slopes. Boundary between areas 19 and 20 commonly marked by sharp steepening of slope.

Except between high ridges of area 19, stream valleys are commonly poorly defined; merge with the rolling plains of broad interstream areas. In places streams flow in channels incised several feet below level of the plain. Streams generally 100 to 200 feet wide, locally wider; currents usually sluggish.

Coast generally low and sandy; locally low beach ridges rise slightly above the plain.

Ground Conditions: On coastal lowlands and in broad valleys is yellow-brown to red-brown sandy or stony loam which grades into conglomerate rock at a depth of 5 to 10 feet. Ground generally well drained but in rainy seasons water table probably close to surface so that excavations fill with water, and mud in trails dries slowly.

Rainforest covers most of area; dense bamboo brakes and clusters of swamp palms border some streams, expecially near their mouths. Cleared and second growth areas around villages. Coconut palms border coast except in a few localities.

Settlement: Thinly populated. A few small native villages along shore. Remainder of area largely uninhabited; some temporary camps and a few isolated dwellings near trails.

Movement: Topography suitable for free movement of mechanized units but dense vegetation is a serious obstacle to movement off trails and roads.

A foot trail connects villages along coast; continues northward and southward into Sheets XVIII-and XX-100; probably unsuited for motorized equipment without widening and possibly grading. Bordering coconut groves along trail and small clearings near villages permit some deployment of men and machines. Trails extending inland from coast commonly follow stream courses; a few north-south trails connect adjacent river trails. Trails commonly terminate at inland margin of area; none known to cross to west coast. Trails probably unsuited for motorized equipment without improvement; require widening and some grading for use by tracked and light wheeled vehicles in drier weather.

Vehicles probably can move easily along the narrow coastal strip. Around villages movement possible in grass and open brush, and in young second growth forest. Forest and advanced second growth jungle are probably impassable in many places. Foot troops can move with difficulty off paths in most parts of area; most easily along beach and in grassy areas. Rivers probably can be forded at many places in dry weather. Lamo and a few other large streams may not be fordable in heavy rain.

Cover, Concealment and Observation: Little topographic cover; isolated hills afford some protection; trees have little cover value. Hasty fortifications can be made in most places.

Forest and high brush generally afford good concealment.

Observation poor; on the ground limited to a few yards in most places. Vantage points on high ridges of Area 9, bordering the plain, are obstructed by dense vegetation which largely conceals even trails.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U.S. Geological Survey
for Chief of Engineers, U.S. Army

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

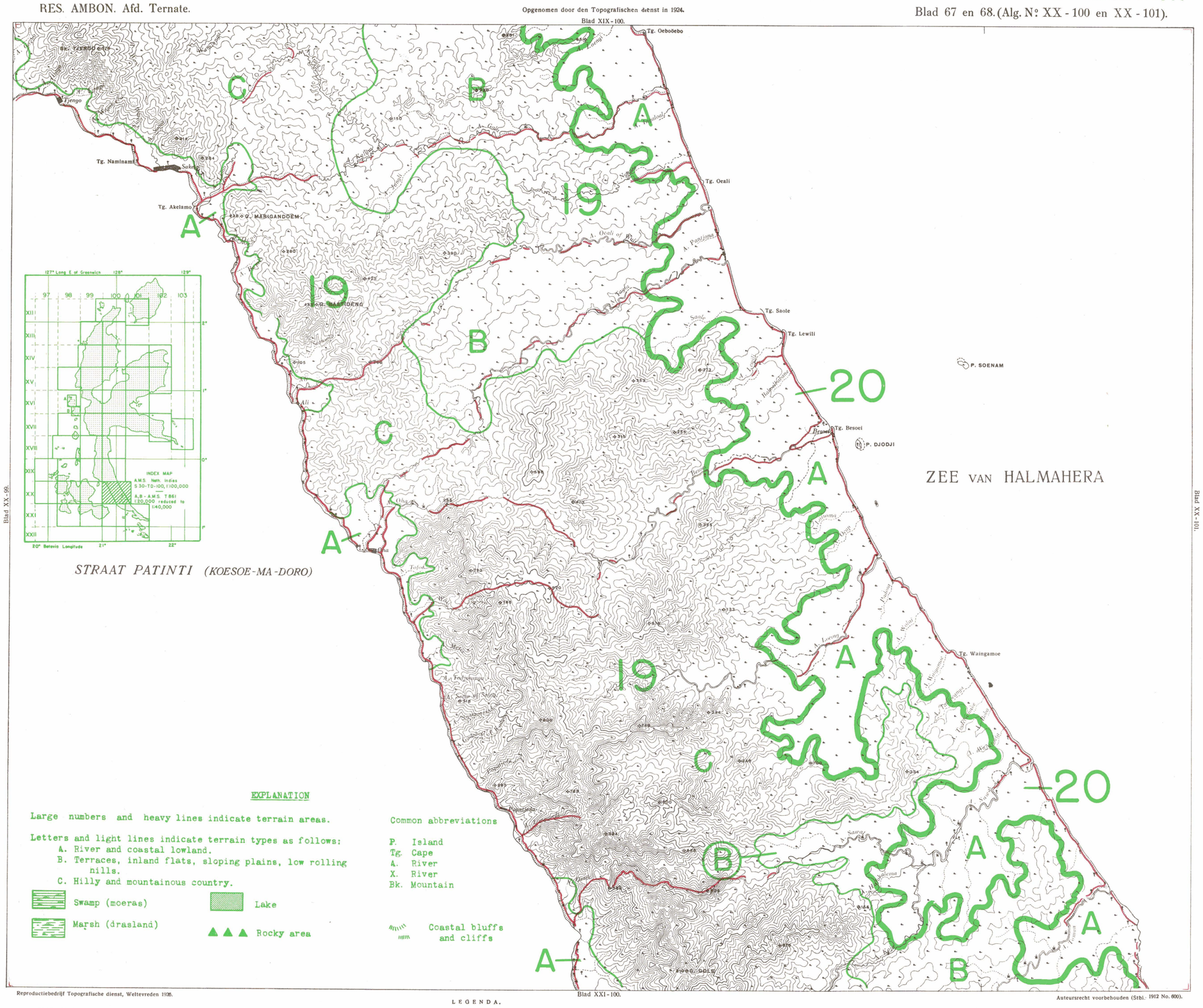
RES. AMBON. Afd. Ternate.

## TERRAIN APPRECIATION

Blad 67 en 68. (Alg. Nº XX - 100 en XX - 101).

Opgenomen door den Topografischen dienst in 1924.

Blad XIX - 100.




Blad XX - 99.

Blad XX - 101.




*STRAAT PATINTI (KOESOE-MA-DORO)*

### EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

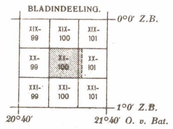
Coastal bluffs and cliffs

Blad XXI - 100.

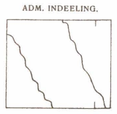
Auteursrecht voorbehouden (Stbl. 1912 No. 600).

Reproductiebedrijf Topografische dienst, Wettevreden 1926.

BLADINDEELING.




ADM. INDEELING.



| | |
|---|---|
| *Afdeeling* | *Ternate.* |
| *Onderafd.* | *Halmahera.* |
| *Ressort* | *Weda.* |
| *District* | *Gane.* |

Trail

Road

LEGENDA.

*Kampoeng. Schaars bewoonde streken. Sagotuin. Klapperboomen. Bamboebosch. Bosch. Arentuin. Bamboe huizen. Inlandsche graven. Paardenpad. .....Voetpad. River, a. gemeten, b. niet gemeten.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. huinhoogtelijn, c. eiland, d. laagwaterlijn, e. klippen altijd boven water, f. zandbank alleen bij laag water droog.*

Schaal 1 : 100 000.

TOELICHTINGEN.

*Vluchtig opgenomen in het jaar 1924.*
*Uitgangspunten voor de kaarteering zijn de astronomische stations: de vlaggestok nabij den steiger van Laboeha op blad XX-99, de vlaggestok te Weda op blad XVIII-100 alsmede het eind van het paardenpad in kampoeng Bobaneigoe, gelegen aan de Bobane-baai, welk laatste punt uit de zeekaart No. 388 (catalogus 1923) overgenomen werd. De meetlijnen van de kusten zijn ten opzichte van het geografische noorden gekaarteerd.*

VERKORTINGEN.

**G.** *Goenoeng.* **Bk** *Boekoe (berg).* **P.** *Poelau.* Tg. *Tandjoeng.* A. *Ake (water).*



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# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B

SHEET NO. XX-100

## Area No. 19 - Mountains of Southern Halamhera

Topography: Mountain range forming backbone of south penisula; has short steep slopes on west and long gentle ridges on east. Altitudes at north generally 900 to 1500 feet; at south 2400 to 2800 feet, maximum (east of Papatjeda) about 3082 feet. In many places local relief is nearly equal to the altitude. Narrow rounded crest of range is near western margin of peninsula, .8 to 2.5 miles from coast. Western slopes rise steeply from sea or from very narrow coastal lowland generally only a few hundred yards wide. Streams are very short with narrow valleys and steep gradients; many are intermittent; lower courses are commonly entrenched in the lowlands. Extending east from the range crest are long ridges with narrow crests and steep slopes; near eastern ends these commonly divide into several short gently rounded spurs which finger into the coastal plain. Ridges dissected by numerous small ravines with intermittent or perennial streams. Principal streams on west slopes flow in open valleys with gently gradients; have some flood plains except in upper reaches; commonly 7 to 8 miles long.

Ground Conditions: On mountain slopes red-brown lateritic clay loam or clay which grades down into deeply weathered rock: depths 10 to 20 feet on higher, steeper slopes, may exceed 30 feet on gentler slopes. Bare rock outcrops locally on steep slopes, sea cliffs and along stream channels. Long ridges on eastern side of range have slightly sandy clay soil underlain by conglomeratic rock. Soil generally well drained; footing fairly good although well-used trails become muddy during rainy seasons. Beaches on west coast sandy to cobbly. Tropical rain forest covers most of area. Forest undergrowth most dense in valley bottoms and on low to moderate slopes of ridges east of crest; least dense on sharp summits near crest of range. Around the coastal villages some patches of second growth forest with dense underbrush and small native gardens. Ground can be easily excavated by hand tools in most places; tangle of roots and creepers on jungle floor locally difficult to penetrate.

Settlements: A few small native villages scattered at wide intervals along the west coast at stream mouths. Interior largely uninhabited.

Movement: Trail along the west coasts follows line of easiest movement; in drier weather probably can be used by tracked and light wheeled vehicles with little improvement except widening; probably very muddy in wet weather. Open coconut groves along coast, and cultivated grass patches around villages locally permit easy deployment of men and vehicles off trails. Several good foot trails from east coast follow principal valleys nearly to their heads then cross ranges along sharp ridges and spurs; paths again follow streams channels for last $\frac{1}{2}$ to $1\frac{1}{2}$ miles before reaching west coast. Short trail south of Papatjeda probably terminates at crest of range. Probably none of the trails suitable for motorized equipment without improvement. Trails from Akelamo Point, Ali, and Oha probably have lowest gradients and easiest routes; probably will require widening and some construction; paths extending along stream channels must be relocated for all weather use. Trails near the Wali and Osari Rivers have steeper gradients across range than those to the north; will require most construction for use by motorized units. Dense vegetation and rough terrain make deployment from trails difficult; foot troops probably must cut their way. Easiest going is on sharp ridges where undergrowth may be less dense. On west slopes streams are shallow and probably can be forded at any point; on east slope principal streams probably can be forded at many points except after long rainy season; locally steep stream banks may make approaches very difficult, making short dugways or bridges necessary.

Cover, Concealment and Observation: Topographic cover is generally good although parts of trails can be brought under fire from adjacent ridges. Dense jungle offers good concealment. Observation within area is very poor because of numerous irregularities of terrain and dense vegetation cover which commonly conceals even well-used trails from all but near-by tree-top observation.

## Area No. 20 - Coastal plain of South Halmahera

Topography: Low coastal plain extending along the east side of the south peninsula; slopes gently seaward from the indented margin of the mountains (Area 20). Altitudes generally less than 300 feet. Width of plain varies from a third of a mile to nearly 3 miles; numerous deep embayments 5 to 10 miles wide, extend between the finger-like ridges of Area 20. Surface flat or rolling; locally, gently rising low hills and terraces merge with the easternmost mountain ridges; in other places the boundary between coastal plain and mountains is well-defined. In western part of plain, stream valleys braod and open, merge upstream with valleys of Area 20. In eastern part, streams separated by very low divides and lack well-defined valleys; channels locally entrenched several feet below general level of plain. Shore is low and regular; along part of the coast. Coral reefs extend offshore for short distance.

Ground Conditions: Coastal lowlands and broad open valleys have yellow-brown to red-brown lateritic sandy or stony loam which grades downward into conglomeratic rock at depth of few feet. Ground is generally well drained although local areas along streams become swampy during rainy season. Soil forms deep mud in rainy weather where vegetation has been stripped and soil disturbed by excavation or by heavy traffic on trails or roads.

Rain forest covers most of the area; undergrowth is dense, most so along stream courses. Coast bordered by open coconut groves. Villages surrounded by areas of grass or second growth forest and by small patches of cultivated ground.

Settlements: Settlement at mouth of Besoei River is only native village in area; possibly a few other scattered dwellings and temporary camps. Remainder of area apparently uninhabited.

Movement: Foot trail follows close to shore for entire length of area; probably can be easily widened for use in drier weather by mechanized units. Beaches and more open groves of coconut palms permit deployment of men and small motorized units. At mouths of principal rivers trails branch off main coastal trail; in part follow close to stream course; in places are in stream bed itself and cannot be used at high water. Probably not suitable for motorized equipment without some improvement; probably necessary to reroute stretches through stream channels.

Bamboo brakes and jungle along trails make deployment of men and material difficult in most places. Except for trial along the Loeing River (which apparently terminates at inland margin of lowlands) footpaths continue across mountains (Area 20) to west coast. Topography generally suitable for free movement but dense vegetation makes movement of motorized units difficult or impossible off roads. Foot troops generally can get through the jungle but in many places must cut their way. Streams probably can be forded at many places except in times of heavy continous rain; steep vegetation-mantled banks of incised channels are obstacles to crossing.

Cover, Concealment, Observation: Locally stream banks and low embankments at inland margins of beaches can give some cover for men from low trajectory fire. South of Loeing and Sawat Rivers ridges of area 20 can give some protection to troops on the river plain.

Dense vegetation offers good concealment and abundant material for camouflage throughout the area.

Observation poor; spreading tree crowns commonly conceal paths from aerial observation or from observation points on ridges (area 20).

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

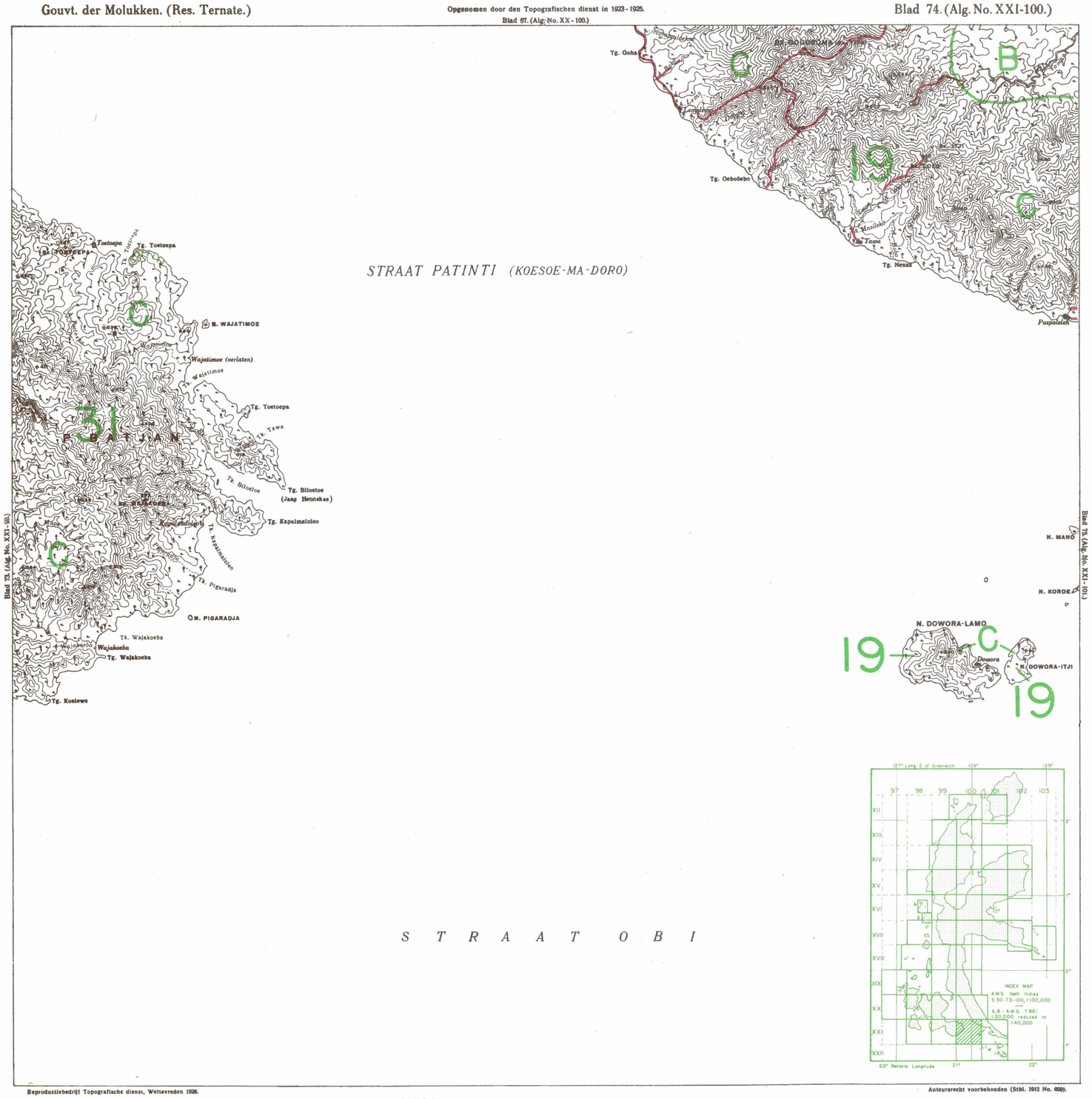
Gouvt. der Molukken. (Res. Ternate.)

## TERRAIN APPRECIATION

Blad 74. (Alg. No. XXI-100.)

Opgenomen door den Topografischen dienst in 1923 - 1925.

Blad 67. (Alg. No. XX - 100.)







Reproductiebedrijf Topografische dienst, Wetteveden 1926.

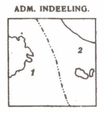
Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.

| | | |
|---|---|---|
| XX 99 | XX 100 | XX 101 |
| XXI 99 | XXI 100 | XXI 101 |
| XXII 99 | XXII 100 | XXII 101 |

0°20' Z.B. — 1°20' Z.B. — 20°40' — 21°40' O. v. Bat.

ADM. INDEELING.




Trail

Road

| | | |
|---|---|---|
| *Afdeeling* | *Ternate.* | |
| 1. | *Onderafd.* | *Batjan.* |
| 2. | .. | *Halmahera.* |
| *Ressort* | | *Weda.* |

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperboomen.* *Bosch.* *Krenpelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemaradennen bosch.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Inlandsche graven.* *Moeras.* *Paardenpad.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogteijfren hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogteijfer, b. huishoogteijfr, c. rots, d. eiland, e. klippen bij laag water zichtbaar, f. laagwaterijfr.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.

0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Uitgangspunten voor de kaartteering zijn geweest: 1e de astronomische stations: de vlaggestok nabij den steiger van Laboeha, blad 66. (Alg. No. XX-99), de vlaggestok te Wada, blad 53, (Alg. No. XVIII-100); 2e het eind van het paardenpad in kampoeng Bobanetigoe, gelegen aan de Bobane-baai, welk punt uit de zeekaart No. 388 (catalogus 1923) overgenomen werd.*

VERKORTINGEN.

**Bk.** *Boekoe (berg.)* **N.** *Noesa (eiland.)* **A.** *Ake (rivier.)* **S.** *Soengai.* **Tg.** *Tandjoeng.* **Tk.** *Teloek.*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: Class B

SHEET NO. XXI-100

Area No. 19. Mountains of Southern Halmahera

Topography: Rugged mountains in west part of peninsula. Altitudes range from 500 meters to more than 850 meters; maximum altitude of 890 meters at Bk. Gogosoma. Summits narrow, generally rounded. Steep western slopes rise directly from sea or from coastal lowland generally only few hundred yards wide. On east side of range, slopes above altitudes of about 250 meters are steep; below 250 meters are moderate to low.

Streams west of divide are short and have steep gradients; Tawa River and tributaries are only streams having generally low to moderate gradients. Valleys small and very steep-sided. East of divide, streams are much longer and have steep gradients only in upper reaches. Toman River valley has moderate to gently-sloping sides; small valley flats border stream in many places. Elsewhere the eastern valleys are narrow and steep-sided.

Small hilly islands of Dowora-Lamo and Dowora-Itji lie to south of Halmahera.

Ground Conditions: On mountain slopes, dark red-brown lateritic clay loam or clay 15 to 30 feet deep; grades downward into deeply weathered dark-colored volcanic and trap rock. Bare rock crops out locally on steep slopes, sea cliffs, and along stream bottoms. Ground is generally well drained; forms deep mud when wet but dries fairly rapidly. Ground can be easily excavated in most places with hand tools; may be subject to slides on steep slopes.

Dense rain forest covers nearly all the area. Patches of grass and second-growth forest border the few scattered villages; some small native cultivated areas. Groves of coconut palms along coast.

Settlements: A few small native villages along coast. Interior uninhabited.

Movement: Area unsuited to movement of motorized units without construction of roads. Foot trail follows coast from north boundary of sheet to Lemo-Lemo village, then swings inland across spurs of Gogosoma Mountain; except along coast is unsuitable for use by motorized equipment without considerable construction. A few other short trails. Some restricted movement of vehicles may be possible in open coconut groves on narrow coastal lowland.

Foot troops can move in most parts of area but must cut their way in many places. Open coconut groves along shore permit easy movement and deployment. Inland, ridge crests offer easiest routes for foot troops; dense vegetation and ravines and valley bottoms are difficult to penetrate.

Most streams can be easily forded by men and vehicles except for short periods of high water.

Cover, Concealment, and Observation: Ridges and spurs offer excellent cover for men in most parts of area; trails across Gogosoma and other ridges generally have little or no cover against fire. Some cover for motorized units may be available in Toman valley.

Rain forest gives good concealment in most parts of area. Observation commonly restricted to a few yards.

Area No. 31. Southeast Batjan

Topography: Eastern end of mountainous southeastern lobe of Batjan Island has irregular ridges and small mountains with winding V-shaped valleys. Altitudes generally 300 to 500 meters; maximum altitude of 559 meters reached by peak west of Bk. Wajakoeba. Summits rounded; in some places broad and nearly flat. Slopes moderate to steep; commonly occupy entire valley floor; locally small valley flats.

Coast is very irregular, indented by numerous coves and deep small bays. In places small sandy lowlands lie at foot of mountains. Old uplifted coral reefs form low cliffs along many parts of shore, in places prominent rocky headlands.

Ground Conditions: Dominantly dark lateritic clay loam and loam, grading downward with increasing abundance of rock fragments into weathered volcanic bedrock. Depth to bedrock variable, generally about 20 feet; soil shallower along streams, where bare rock is locally exposed. Along coast to altitude of about 500 feet, coral limestone interbedded with sand and gravel lies on volcanic rocks; limestone commonly forms terraces with thin clay soil. Bare limestone exposed locally in low cliffs and rocky slopes.

Ground generally well drained; in rainy season forms slippery mud but dries fairly rapidly.

Area covered by rain forest except for small areas of second-growth forest, grass, or gardens around the few small villages.

Settlements: Eastern end of Batjan is largely uninhabited except for a few very small native villages near the coast.

Movement: Broken terrain unsuitable for movement of mechanized units. No trails known within area. Movement easiest for foot troops on limestone hills and terraces where vegetation is less dense; most difficult in dense overgrown valley bottoms. Streams can be readily forded except during flash floods.

Cover, Concealment, and Observation: Numerous ridges and small valleys give good cover for foot troops but poor cover for machines.

Forest cover gives good concealment for men and machines. Observation in most places limited to a few yards.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey for Chief of Engineers, U. S. Army

CONFIDENTIAL

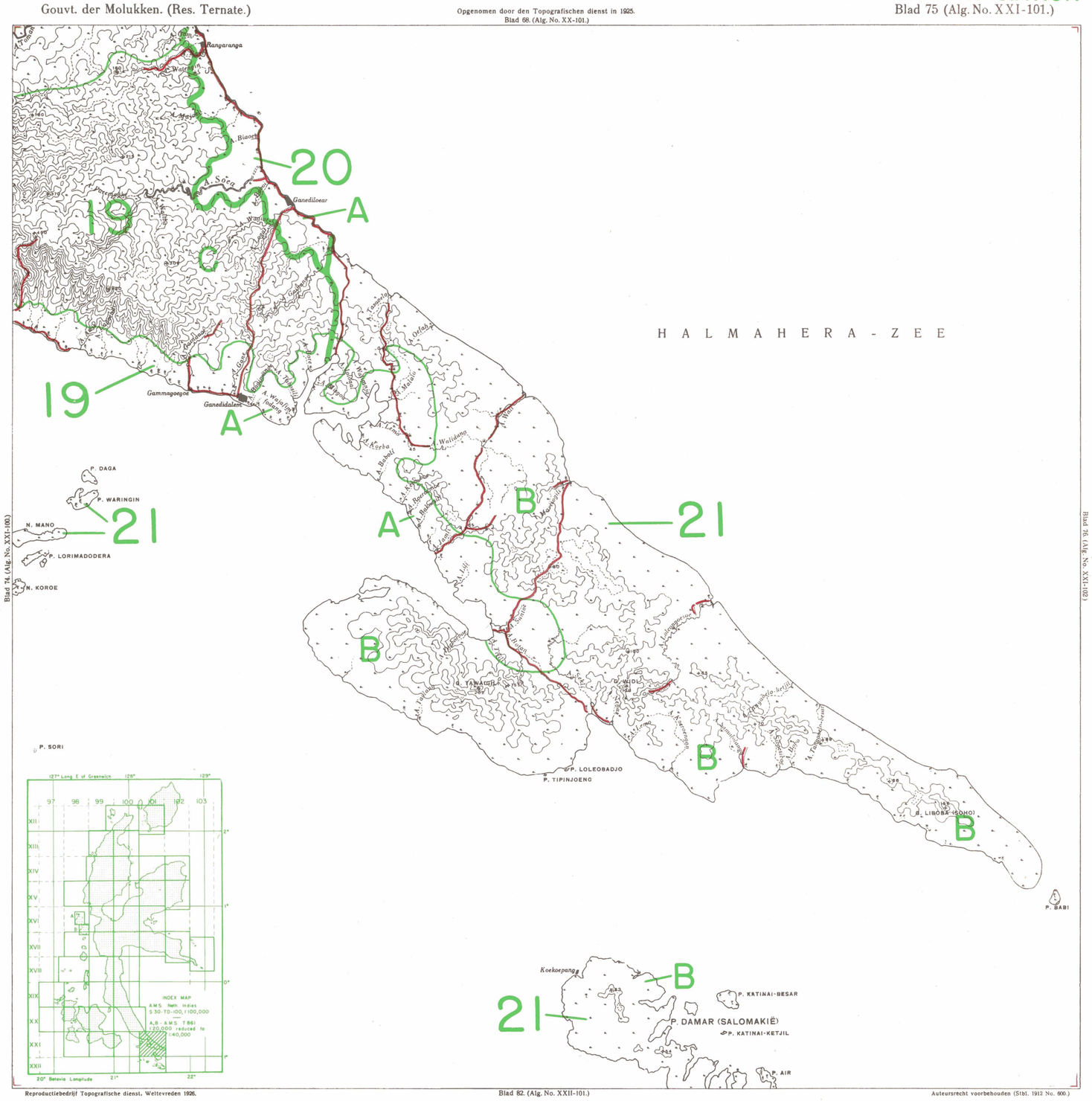
# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 68. (Alg. No. XX-101.)

## TERRAIN APPRECIATION

Blad 75 (Alg. No. XXI-101.)





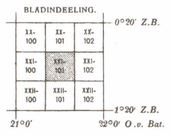


Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 82. (Alg. No. XXII-101.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600.)

BLADINDEELING.




ADM. INDEELING.

*Afdeeling* Ternate.
*Onderafd.* Halmahera.
*Ressort* Weda.

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Klapperboomen.* *Alangalang.* *Bamboebosch.* *Arentuin.* *Bosch.* *Djemara-of Dennen (Sparren) bosch.* *Paardenpad.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Moeras.* *Pasanggrahan.* *Houten- en bamboe hainen.* *Inlandsche graven.*



*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. huishoogtelijn, c. eiland.*

Schaal 1:100 000.

TOELICHTINGEN.

*Vluchtig opgenomen in het jaar 1925 met orienteering op het astronomische punt: de vlaggestok te Weda.*

VERKORTINGEN.

**P.** *Poelau.* **N** *Noesa.* **G.** *Goenoeng.* **A.** *Ake (rivier).*

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

▲▲▲ Rocky area

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

Coastal bluffs and cliffs



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: Class B

SHEET NO. XXI-101

Area No. 19. Mountains of Southern Halmahera

Topography: Low mountains and hills with steep southwest slopes and more gradual northeast slopes; mark south end of back-bone range of south peninsula. Altitudes greatest, about 1,485 feet, at northwest; decrease to less than 350 feet in low hills and terraces of southern part of area. Northwest of Ganedidalem, west slope rises steeply from coastal plain to rounded range crest. East slope is gentle to moderate, dissected by several short streams into roughly parallel northeast-trending ridges with moderately to gently sloping sides. Northeast and east of Ganedidalem, the range passes gradually into a narrow belt of gently rounded hills. Streams on west side are short and small, many less than a mile long, and intermittent. Streams larger on northeast side; Soea River is about 5 miles long.

Ground Conditions: Lateritic clay loam to clay soil in most of area, 15 to 30 feet deep; grades downward into weathered volcanic rock. Soil along coast and eastern part of hills is somewhat more sandy; in eastern part of hills grades downward into conglomerate. Ground generally well-drained; muddy when wet but dries fairly rapidly.

Most of area covered by rain forest; undergrowth generally not dense except along streams and on inland margin of narrow coastal lowland. Open coconut groves border shore.

Settlements: No known permanent settlements; area largely uninhabited.

Movement: Generally unsuitable for motorized units. Three foot trails cross southeast part of area; probably will need some improvement for use by wheeled vehicles. Trail from Ganedidloear to Ganedidalem (Area 20) runs 3½ miles across area, probably has steepest grades and will need most improvements although it is the most used. Some movement of vehicles possible along beaches and through open coconut groves.

Foot troops can deploy away from trails; in places must cut their way through dense forest undergrowth. Easiest movement is along coast, along ridge summits and locally in stream beds during dry season.

Cover, Concealment, and Observation: Good cover for men in rough hilly interior; little cover along coast except for low beach ridges and locally high stream banks. Little cover for motorized units.

Concealment good in most parts of area; some concealment for motorized units possible in coconut groves along coast and in cleared or grassed areas near villages.

Observation generally poor in mountains; forest largely obscures views. Along coast, where vegetation is more open, views possible for distances of a few hundred feet to a few hundred yards.

Area No. 20. Coastal Plain of Southern Halmahera.

Narrow strip of coastal lowland; southern termination of long coastal plain extending along southern peninsula. See Sheet No. XX-100 for description.

Area No. 21. Tip of Southern Peninsula.

Topography: Extreme tip of south peninsula; consists of irregular hills, ridges, and terraces, bordered by old raised coral reefs and sandy lowlands. Altitudes generally less than 150 meters; maximum altitude (262 meters at Bk. Tawagili) on irregular promontory at southwest. Hills have broad rounded summits and gently sloping sides. Terraces are gently undulating and irregular; have moderate to steep dropoff slopes, locally bordered by low ledges. Lowlands gently rolling or somewhat rough; include raised coral reefs locally bordered by low sea cliffs.

Damar Island and small islands west of Ganedidalem are low and gently rolling; have a few small hills rising 25 to 50 meters above general level.

Ground Conditions: On most of area, sandy loam to sandy clay 5 to 10 feet deep; some coarse coral sand along many parts of coast. Fine mud and clay around margins of Gane Bay. Area underlain by coral limestone.

Rain forest with little undergrowth covers most of peninsula and interior of the islands. Coconut groves along shore.

Settlements: No permanent settlements on peninsula; islands are uninhabited.

Movement: Rain forest makes peninsula and islands unsuitable for movement of motorized units without construction of roads, although topography is only locally unfavorable for movement. A few foot trails cross peninsula from coast to coast. Trail between Gane Bay and Ganedidloear is most used, probably usable by wheeled vehicles in dry weather with a little improvement. Some movement of motorized units possible along shores and in open coconut groves.

Foot troops can move with some difficulty through the forest; locally must cut their way. Easiest movement is along beaches and through the coconut groves.

Cover, Concealment, and Observation: Good cover for men and machines in hilly parts of peninsula. Little cover along the low coasts. Concealment generally good except where coastal coconut groves offer only partial concealment for motorized units.

Observation very poor, except in areas of more open vegetation along coasts is commonly limited to a few yards. Trails partly obscured from aerial observation by overlapping crowns of trees.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

CONFIDENTIAL

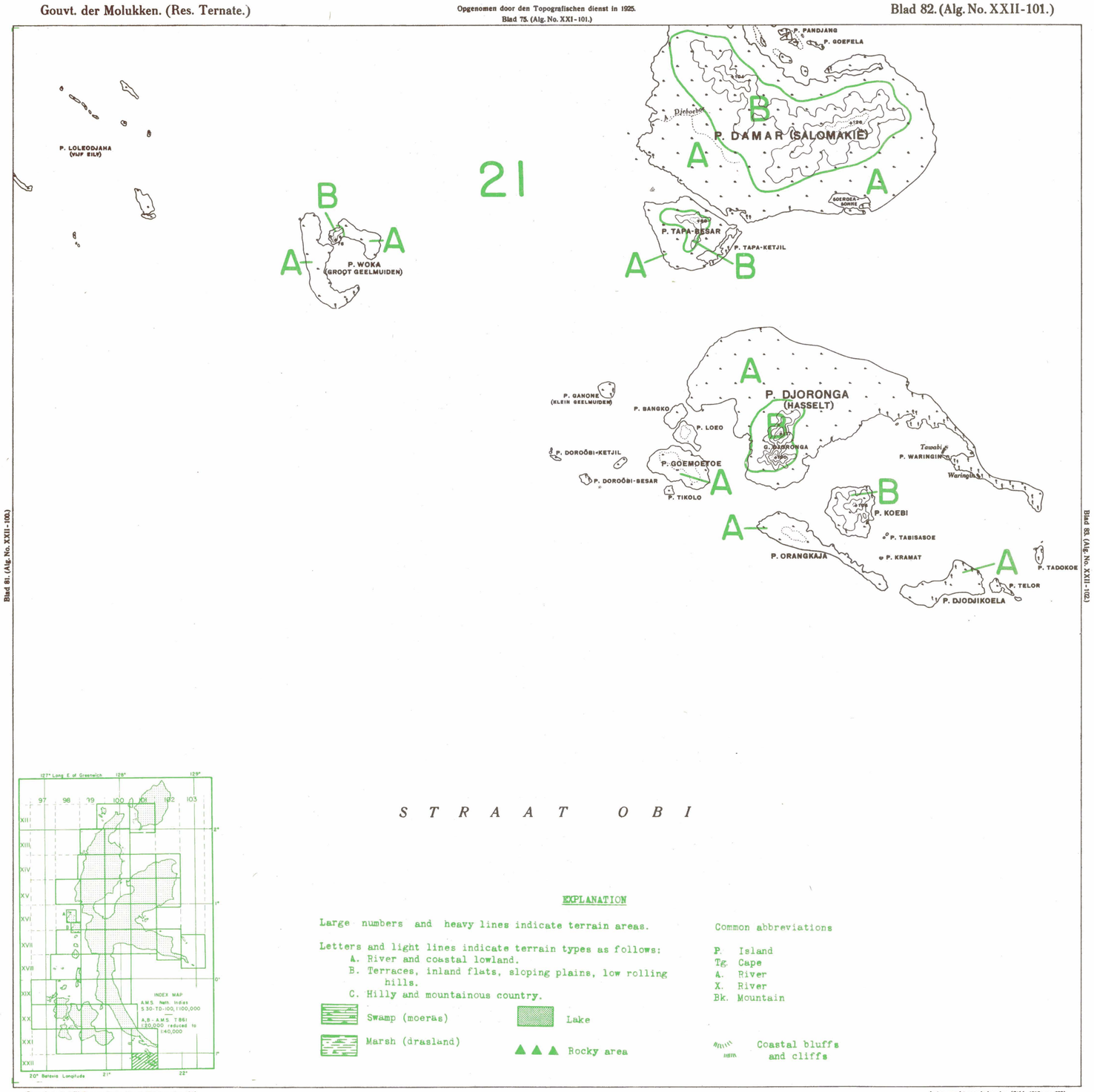
# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 75. (Alg. No. XXI-101.)

## TERRAIN APPRECIATION

Blad 82. (Alg. No. XXII-101.)




Blad 81. (Alg. No. XXII-100.)

Blad 83 (Alg. No. XXII-102)




## *S T R A A T  O B I*

### EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

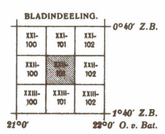
Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

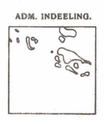
Reproduct ebedrijf Topografische dienst, Weltevreden 1926.

Auteursrecht voorbehouden (Stbl. 1912 no. 600).

BLADINDEELING.




ADM. INDEELING.



*Afdeeling Ternate.*
*Onderafd. Halmahera.*
*Ressort Weda.*

LEGENDA.

*Kampoeng.* *Klapperboomen.* *Tjemara-of Dennen (Sparren) bosch.* *Bosch.* *Herkenbare boom.* *Bamboebosch.* *Inlandsche graven.* *Paardenpad.* *Niet gemeten rivier.* *Moeras.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. halphoogtelijn, c. eiland, d. zandbank alleen bij laagwater droog. e. laagwaterlijn.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Vluchtig opgenomen in het jaar 1925 met oriënteering op het astronomische punt, de vlaggestok te Weda.*

VERKORTINGEN

*P. Poelau.* *G. Goenoeng.* *A. Ake (rivier).*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

**Reliability Rating: Class B**

SHEET NO. XXII-101

Area No. 21. Damar and Djoronga Islands

Topography: Both islands have broad flat heavily forested coastal plains with low rounded hills in the interior. Maximum altitude on Damar 380 feet, on Djoronga 570 feet. The coasts are largely bordered by coral reefs. Some mangrove swamps, which on Damar Island extend inland as permanent swamps (moeras) along the plain of the Djeboeboe River. The surrounding small islands are mostly flat coral islands. Woka island is an atoll.

Ground Conditions: Deep clayey soil covered by dense growth of vines and creepers in thick rain forest or swamp forest. Digging difficult at surface because of roots, becomes easier with depth. Palms on sandier sections of coast provide more open conditions. Ground well drained only on interior hills.

Settlements: No permanent native villages.

Movement: No roads or trails. Foot movement through the dense rain forest jungle is arduous and requires much cutting. Swamps and mud conditions add to difficulties along the coast.

Cover, Concealment and Observation: Large jungle trees and minor irregularities of terrain provide only cover. Natural concealment of thick jungle provides excellent protection from air or ground. Visibility poor and for short distances only.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

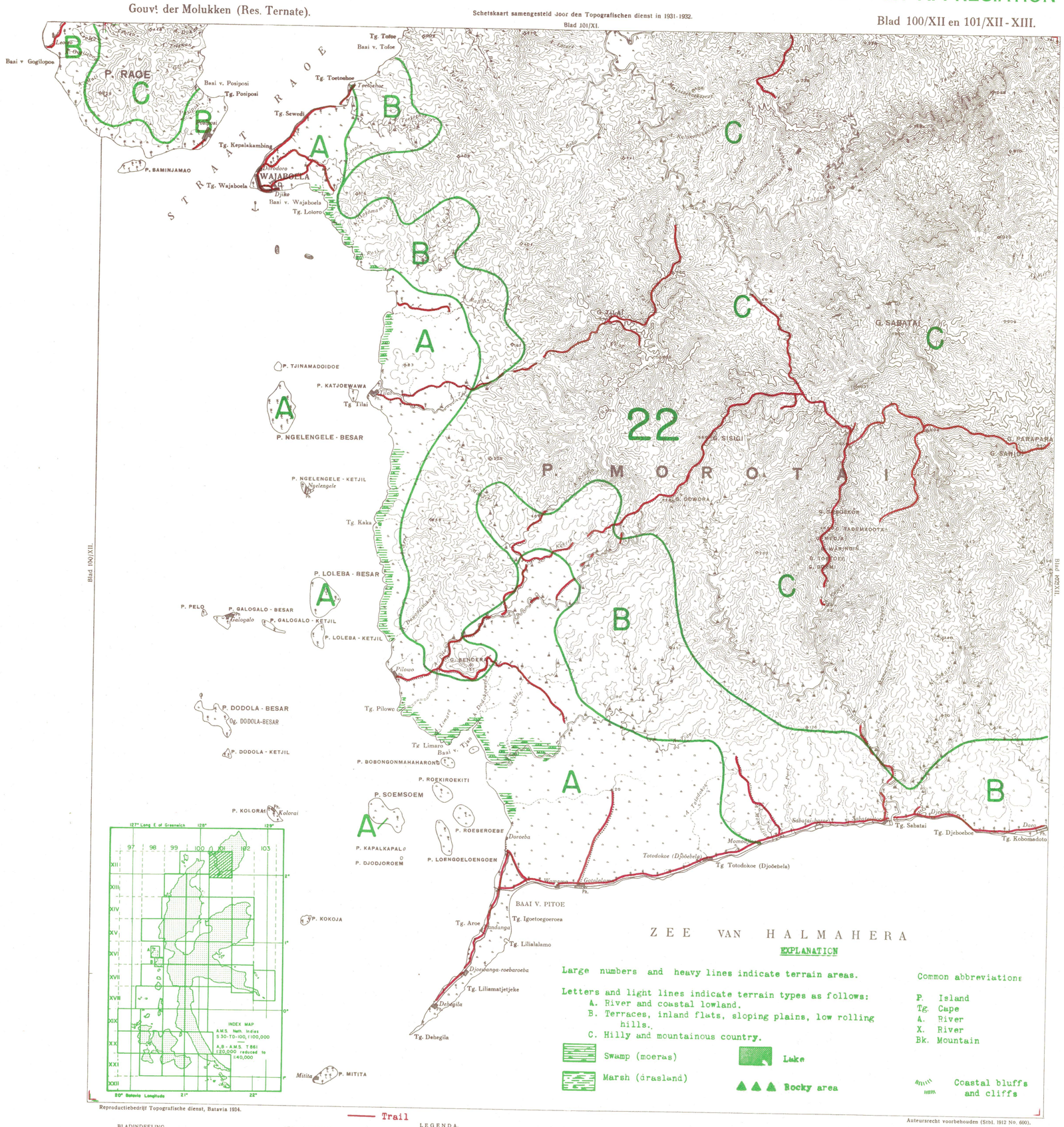
Gouvt der Molukken (Res. Ternate).

Schetskaart samengesteld door den Topografischen dienst in 1931-1932.

Blad 101/XI.

## TERRAIN APPRECIATION

Blad 100/XII en 101/XII - XIII.







Reproductiebedrijf Topografische dienst, Batavia 1934.

### EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

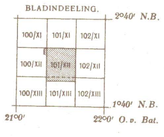
Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

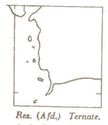
Trail

Road

BLADINDEELING.




ADM. INDEELING.



Res. (Afd.) Ternate.
Onderafd. Tobelo.
District Morotai.

LEGENDA.

Kampoeng. Schaars bewoonde streken. Ladang (tijdelijke nederzettingen met droge rijstvelden). Arenfuin. Klapperboomen. Bosch. Bamboebosch. Moeraspalmen. Tjemara- of Dennen- (Sparren-) bosch. Herkenbare boom. Moeras. Paardenpad. Voetpad. Rivier, a gemeten, b niet gemeten. Bamboe huizen. Inlandsche graven.

Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtenunt en hoogtecijfer, b hulphoogtelijn van 25 m, c eiland, d ankerplaats en reede, e zandbank altijd droog.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm
0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

Vluchtig opgenomen in 1931-1932 met de bergboussole voor het hoofdverband en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 386 schaal 1:200 000 uitgave 1926.

AFKORTINGEN.

D. Districtshoofd. P. Poelau. G. Goenoeng. Ph. Posthuis. Tg. Tandjoeng. A. Ake (rivier). Og. Onderneming.

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B

SHEET NO. XII-101

Area No. 22. Morotai

Topography: Southwestern part of Morotai only quadrangle available for the island. Topography mountainous, with a gradual rise from strips of coastal plain and coastal terraces. Elevations range up to about 1,200 m. Except in coastal belt, topography rough, cut by innumerable closely-spaced valleys and ravines. Slopes are gentle to moderate at lower elevations, steeper with increasing elevations. Mountain mass is irregular in form, a sprawling assemblage of irregularly bending and branching ridges and spurs, mostly narrow crested. At lower elevations, the sharp spurs give way to flat or broadly rounded interstream areas. The main streams are of moderate size, and flow outward from the mountains. Their courses are meandering; valley bottoms are narrow down to the coast or coastal plain; valley sides gentle downstream, steeper upstream. Gradients are low along lower courses, but steepen either gradually or sharply in headward stretches.

Broad strips of coastal plain alternate with narrower coastal flats. The broadest is at the southwest, and has a narrow peninsula jutting out toward the island of Mitita. Next in size is a coastal strip on the west coast, with a low hill near the center. Third is the broad but short strip around Wajaboela. These plains are essentially flat and featureless; grade more or less gradually into the surrounding slopes. Shorelines are fairly regular, and beach ridges occur in places. Numerous low, flat islands short distance off the coast. Narrower strips of coastal flats, slope gently toward the sea; and locally there is a steady rise toward the interior. Coral reefs fringe both islands and mainland.

Raoe Island, in the northwestern corner of quadrangle, is similar in topography to the mainland. The maximum elevation is nearly 450 m. Streams are all short. Coastal lowland very narrow.

Ground Conditions: Except for limited areas of cleared or cultivated land and second growth forest near settlements, the island is covered with virgin forest. Bamboo thickets occur along the streams, and coconut palms fringe the shore at many places (view 14). Damar forests in interior, from which dam gum is collected. Sago forests in coastal plain at southwest.

Settlements: Principal settlement is Wajaboela, a trading center on the coast by the Raoe Straights. Smaller native villages scattered along coast at other places, and on a few outlying islands.

Movement: Interior of island is a mountainous barrier area, but terrain in the coastal belt is more favorable for movement. The virgin forest nearly everywhere presents serious obstacle to movement. Movement easiest on established roads or trails. Several trails lead part way into interior, or fringe mountains; none cross mountains. In various sections trails follow stream beds, ridges, and cross grain of topography; unusable in time of high water. In coastal belt, relief is low, and slopes gentle, with only stream crossings to hinder movement. Larger streams might require bridging. Along southern coast, continuous horse trail follows close to the shore. Foot trails lead inland at various places. On the west coast, no coastwise trails, except in the vicinity of Wajaboela, and such trails as occur go inland across coastal strip.

Several larger streams reported navigable by small boats for varying distances inland. Bars at mouth are obstacles to large boats at low tide. Broader strips of coastal plain suitable for beachheads. Marshy areas obstacle at places. No surrounding heights to aid defenders.

Cover, Concealment, and Observation: In interior, topographic cover provided by ridges and ravines. Along coastal belt, less topographic cover, only widely-spaced stream banks and discontinuous beach ridges and low banks marking high tide. In terraced areas, broadly rounded ridges and gentle valley sides give little cover.

Concealment, both ground and aerial, provided nearly everywhere by virgin forest. In coconut palms on coast and on some smaller islands, however, ground concealment is poor. Field fortifications feasible nearly everywhere.

Observation very poor. Forests limit visibility; and the topography, except on the higher upland slopes, provides few vantage points.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S ARMY

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS)

NETHERLANDS EAST INDIES,
HALMAHERA GROUP 1:20,000

For use by War and Navy Department Agencies only
Not for sale or distribution

Advance edition
Subject to correction

## TERRAIN APPRECIATION

XVI-98-A

TERNATE & HIRI

SCHETSKAART
VAN DE EILANDEN
TERNATE EN HIRI
Schaal 1:20 000.

Opgenomen met de bussole-tranchementangre, zaktkompas, hoogtebarometer
en op den pas door den Ind. Verkenner Mantingu

LEGENDA.
Br. = Brangka (ranja)
T. = Tandjoeng
~·~·~ = Gekapte weg

24

C
B
C
B
A
B
C
C
A
B
A

INCIDENCE OF GRID LETTERS and INDEX TO ADJOINING SHEETS

Trail
Road

Scale 1:20,000

Miles
Kilometers
Yards

Elevations in Meters

Photographed and reprinted from a Dutch map dated 1916 by the Army Map Service, U. S. Army, Washington, D. C., 1942.
Netherlands East Indies, Equatorial Zone Grid (Blue)

Projection: Lambert Conical Orthomorphic
Spheroid: Bessel
Origin: Equator-110°E
False co-ordinates of origin: 3,900,000 meters East, 900,000 meters North

TERNATE & HIRI
N046-E12718/9x6

LEGEND
Settlements
Roads
Trails
Graves Chinese and Natives
Forest
Trees and Grass
Brangka (Ravine)
Tendjoeng (Cape)
Gekapte weg (Surfaced road)

INDEX MAP
A.M.S. Neth. Indies
S-30-TD-100, 1:100,000
—
A.8 - A.M.S. T 861
1:20,000 reduced to 1:40,000

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)
Marsh (drasland)
Lake
▲▲▲ Rocky area

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

Coastal bluffs and cliffs

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B.

SHEET NO. XVI-9S-A

Area No. 24 - Ternate

Topography: Island of Ternate is active volcanic cone about 7 miles in diameter and 1,700 meters high. Slopes along coast are low to moderate; west side steeper than east side. Higher, slopes steepen; most steep toward summit; slope profile therefore somewhat concave upward. Upper slopes deeply furrowed with radial, steep-sided valleys. Intervening ridges narrow, rounded. Small summit crater modified from time to time by renewed volcanic activity. Down slope, valleys shallower and their sides less steep. Near coast, they become gullies or ravines with steep, high banks. Stream beds dry except for short periods after heavy rains; carry coarse, cobbly debris. Lakes at two places on the island: near coast on northwest side, Lake Tolire Djaha, about 0.3 miles in diameter and about 40 meters above sea level; at lower level and nearer shore, the smaller lake, Tolire ketjil. On south side of island, Lake Lagoena, about 0.4 miles long, is just above sea level; separated from sea only by low ridge about 9 meters high; on other sides, bordered by high banks (views 22, 23). On southern and eastern sides of island are coastal flats of limited width, and at southeast one strip of swamp just inland. Beaches covered with cobblestones (view 15). Along many stretches of shoreline, no coastal flat, coast bordered by cliffs a few meters to about 50 meters high (views 17, 19). Narrow fringing coral reefs at several places.

In 18th century, a lava flow descended northeast side of island (views 16, 17), at Verbande Hoek. More recent eruptions have changed crater and upper slopes. Volcanic vapors frequently seen at summit. Earthquakes are common.

Hiri is smaller volcanic island lying about a mile north of Ternate. Roughly cone shaped (view 18); is about 2 miles in diameter, and about 600 meters high. Slopes steep, furrowed by valleys which contain streams only after heavy rain. Shore steep and cliffed at many places.

Ground Conditions: Ternati and Hiri: stony loam. Depth to bedrock is variable, and may reach about 5 feet; locally, along coastal flats, may be greater. In natural state, soil well drained, gives good footing when dry. If disturbed when wet becomes dense, sticky, and slippery. On recent lava flows and some other volcanic deposits, soil is thin or absent, surface rough and rocky (view 16).

Higher slopes of Ternate largely covered with virgin forest, but near the top are grass and brush, and some bare expanses with little or no vegetation. At lower levels, cultivated fields and orchards extensive up to elevations of about 700 meters. Cultivated products include coconuts, bananas, mangoes, nutmegs, pepper, coffee, cloves, and dry rice.

Vegetation on Hiri similar to Ternate, but no cultivated plants. Grass and brush interspersed with virgin forest.

Settlements: Total population of island about 9,000; mainly natives, a few Europeans and some Chinese and Japanese. Principal settlement is Ternate; population (1930) nearly 6,000; town has church, schools, sultan's palace (view 20), small forts, an electric power plant, hospital, radio station, and various government buildings, stores, and dwellings. Buildings are of stone, brick, corrugated iron, and wood. Also some brick and stone ruins of older buildings dating back to a more prosperous period. Piers and coaling facilities for vessels. Numerous small native villages along shore and at shore distances inland.

On Hiri a few small native villages.

Movement: Ternate. Movement easiest along shore and on lower, gentler slopes; only obstacles are coastal bluffs, one small stretch of swamp, steep-banked ravines, and, locally, rough and broken lava flows (view 16). Men and military vehicles can move freely at many places on cultivated, grassy, and brushy areas at lower slopes, particularly on eastern side. In interior, steep slopes and forests constitute barriers.

Good means of communication. Road extends along eastern shore, and narrower road along southern shore. Unbridged horse trail completes circuit around island, and paths lead to inland localities. Streams fordable in dry weather. One path ascends mountain to summit.

Beachheads possible at many points on eastern and southern shores.

Cleared and cultivated areas on the eastern side suitable for landing paratroopers.

Hiri. Steep slopes greatly limit movement. Foot trail follows shore.

Cover, Concealment, Observation: Cover provided by steep banks of ravines, rocky surface of lava flows, beach ridges, low banks that mark high tide level, old brick and stone ruins (view 19), and modern buildings of stone construction. Field fortifications are generally possible, but in many places lava rock is at or near surface.

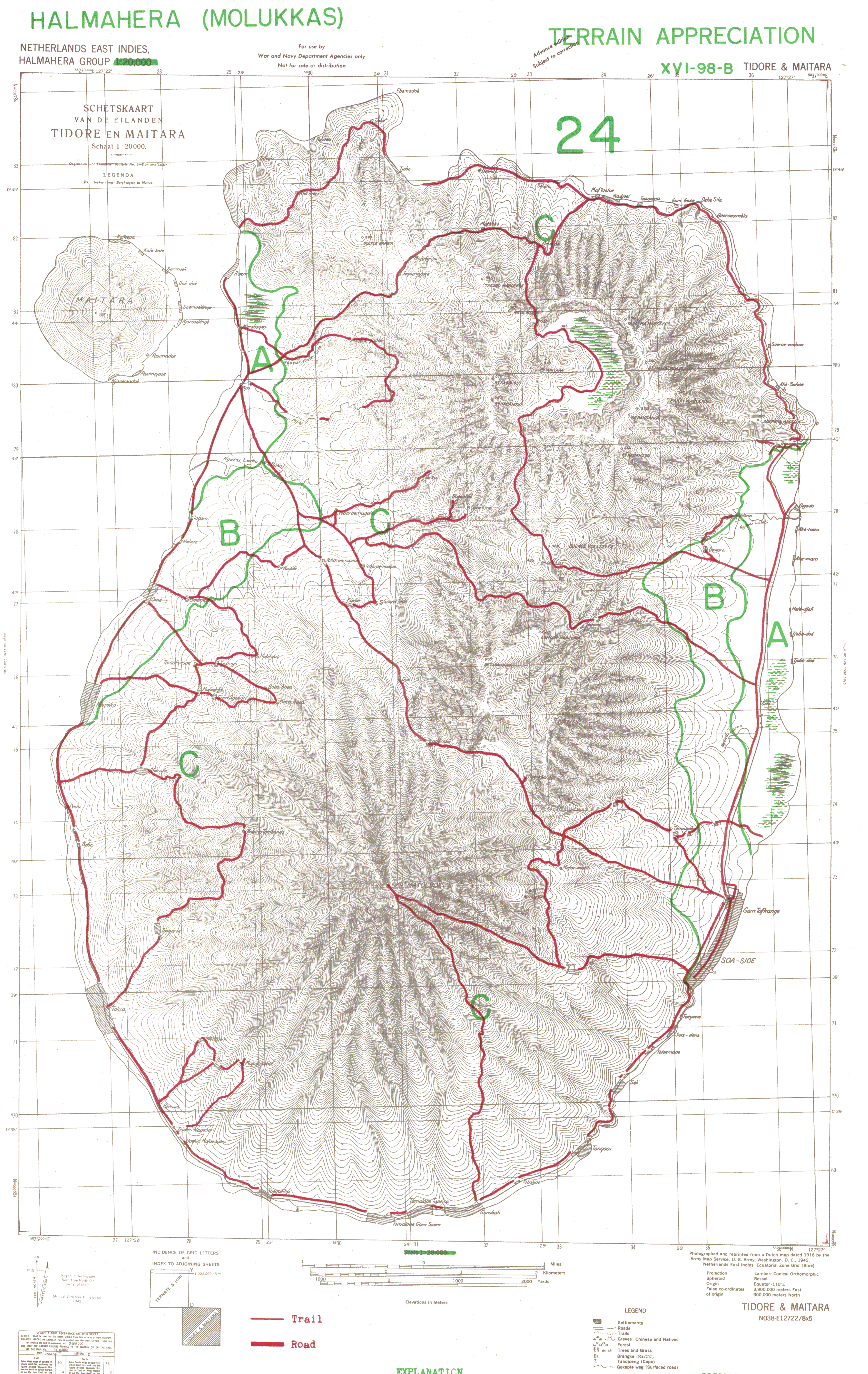
Concealment complete in virgin forest, elsewhere incomplete. Coconut palms along shore provide good aerial concealment, poor ground concealment. Brush and second growth provide good concealment for men, generally not for vehicles.

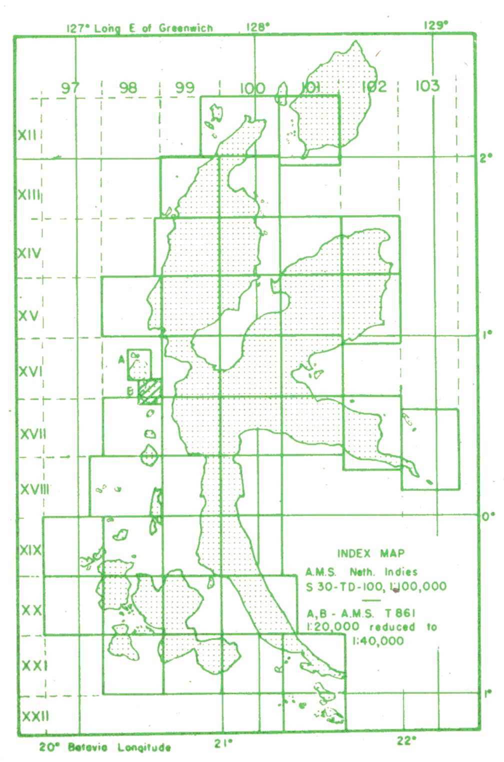
Observation limited to size of cleared areas. Coastal bluffs permit observation along limited stretches of shoreline. Points at or near the summit permit observation over a wide area, including the mainland.

Conditions on Hiri similar to those on Ternate, except for limited cleared or cultivated land.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey




PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B.

SHEET NO. XVI-9S-B

Area No. 24 - Tidore

Topography: Tidore. Roughly oval island; dominated at the south by a high volcanic cone and at the north by a lower, less regular cone with a large crater. Island about 9 miles long, 5.5 miles wide. South cone, Kie Matoeboe, (views 21, 22) regular in form, height 1,730 meters. Sides deeply furrowed with steep-sided, narrow-bottomed valleys which gradually shallow and become gentler toward coast. Slopes very steep above, more moderate below, giving slope a concave profile. North cone truncated, less regular. Crater about a mile in diameter, 200 meters deep; highest point on rim is 680 meters. In the crater are two small peaks, and a broad expanse of swampy, marshy ground. Between the two cones is an irregular divide with several minor peaks. Small coastal flats on east and west sides of island; elsewhere the land rises steeply from the water's edge. Streams dry except after heavy rain.

Maitara is small volcanic cone off northwest side of Tidore. Slopes less steep than on Tidore; and top somewhat rounded. On the east side is a very narrow coastal flat.

Both Maitara and the northern shore of Tidore are fringed by narrow coral reefs.

Ground Conditions: On both islands, stony loam. Depth to bedrock may reach 5 feet on slopes, but varies abruptly and irregularly; generally thinner on higher and steeper slopes. On coastal flats, thickness somewhat greater. In undisturbed state, soil well drained, gives good footing, and dries quickly. If disturbed when wet, it becomes dense, muddy and slippery, and slow drying. Readily excavated, except locally where stony.

Except for cultivated tracts mainly on the east side to about 300 meters elevation, island largely covered with dense forest. Upper slopes bare. On top of Maitara vegetation also sparse.

Settlements: The principal settlements are Soa-Sioe on the east coast and Toloa on the west coast. Numerous other native settlements of small to moderate size scattered along coast, and a few also in interior. Total population of island about 19,000 in 1930.

Movement: Except for narrow strips of flat to moderately sloping ground on the east and west coasts, topography is unfavorable for movement. Forest cover is obstacle over greater part of island, and local tracts of swampy and marsh land along the coast are additional obstacles. In general, movement confined to existing trails. Local tracts of cultivated ground at lower levels, and on the higher and steeper slopes where vegetation is sparse are exceptions.

One horse trail encircles the island, near the shore; bridges at some stream crossings, grades low to moderate. Bridges probably not strong enough for any machines heavier than motorcycles. Several branch foot paths lead inland. One from southeast side leads to the summit of Kie Matoeboe. Others cross island on routes thru gaps between the northern and southern cones.

Fields and cleared areas near eastern and western coasts suitable for paratrooper landings.

Coastal flats suitable for landing operations; have good communications with both coast and interior.

Cover, Concealment, Observation: Some cover provided by valley sides, ridges, beach ridges, and larger hardwood trees. Field fortifications feasible in all places except marshy and swampy ground of coastal flats and on local patches of rocky ground on mountain slopes.

Concealment, both ground and aerial, afforded by forests; little concealment in cultivated fields and cleared areas.

In most places forest limits observation to short distances. In cleared areas, visibility greater. Bare areas on the higher mountain slopes provide a lookout for large areas. Rocky spur at north end of east coastal plain gives lookout over adjoining low areas.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

CONFIDENTIAL

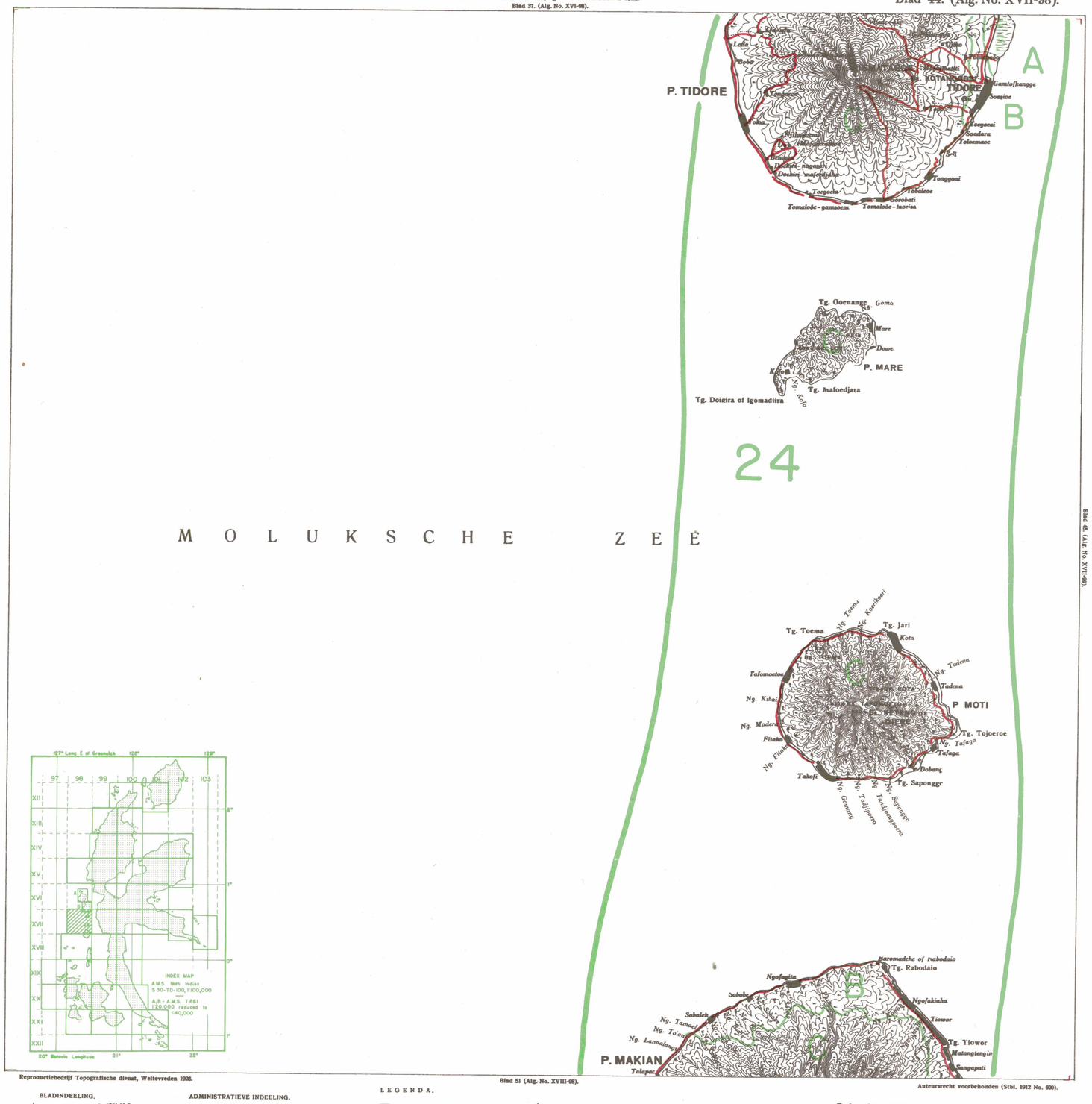
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922.
Blad 37. (Alg. No. XVI-98).

## TERRAIN APPRECIATION

Blad 44. (Alg. No. XVII-98).







Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 51 (Alg. No. XVIII-98).

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

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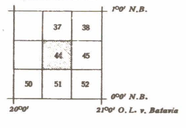
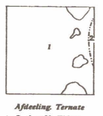



ADMINISTRATIEVE INDEELING.




Afdeeling. Ternate
1. Onderafd. Tidore
2 „ Halmahera

Trail

Road

LEGENDA.

Kampoeng. Schaars bewoonde streken. Klapperboomen. Bosch. Kroepelhout.

Alang-alang. Drasland. Paardenpad. a. dakker of doorlaat van hout. Voetpad.

Rivier. a. gemeten. b. niet gemeten. Bamboe gebouwen. Inlandsche gruven.

Zee. a. eiland. b. hoogtepunt en hoogtecijfer. c. halfhoogtelijn.
Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Administratieve indeeling volgens G.B. van 25 Jan. 1924 No. 21. Stbl. No. 29. Vluchtig opgenomen in het jaar 1922. Uitgangspunten voor de haantering zijn, de astr: stations, de vlaggestok nabij den steiger van Labocha, de vlaggestok te Weda. De meetlijnen van de kusten zijn ten aanzichte van het geografische noorden gehaarteerd en de eilanden door peilingen in onderling verband gebracht.*

VERKORTINGEN.

Gn. Oesoghebber. Ngr. Ngoesi = rivier (Tidoreesch). Tg. Tandjoeng. P. Poelau. Bk. Boekoe = Oenoeng.

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
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- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

- P. Island
- Tg. Cape
- A. River
- X. River
- Bk. Mountain

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



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# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B.

SHEET NO. XVII-9S

Area No. 24 - Volcanic Islands

Topography: Tidore. See quadrangle XVI-9S-B.

Mare. Hilly island of irregular outline, about 2.5 miles long and 1.5 miles wide. Total relief about 300 meters. Shoreline abrupt except for one small locality at southwest; slopes prevailingly steep. Discontinuous coral reefs fringe the island on all except the western side.

Moti. Cone-shaped volcanic island about 3.5 miles in diameter and 950 meters high. Sides deeply furrowed by radiating ravines. Slopes steep above, slightly gentler below. Coastal strip very narrow; land rises steeply from sea at many places.

Makian. See quadrangle XVIII-9S.

Ground Conditions: Tidore. See quadrangle XVI-9S-B.

Mare. Stony loam. Depth to bedrock not more than 5 feet in most places, and varies from place to place. Beaches gravelly. Soil, when undisturbed well drained and gives good footing. Island mostly wooded; small patches of grassland on lower slopes, and small stands of coconut palms along the shore.

Moti. Stony loam, attaining depth of 5 feet, but varying abruptly from place to place. Soil, when undisturbed well drained and gives good footing. Beaches are cobbly. Island mostly forested, but vegetation becomes sparse toward summit; small tracts of grassland and second growth forest on lower slopes, and strips of cocomut palms fringe shore.

Makian. See quadrangle XVIII-9S.

Settlements: Tidore. See quadrangle XVI-9S-B.

Mare. Two small native villages, one at northeast and one at southwest, both near shore.

Moti. Several small to moderate-sized native villages more or less regularly spaced around shore.

Makian. See quadrangle XVIII-9S.

Movement: Tidore. See quadrangle XVI-9S-B.

Mare. Movement restricted by rugged topography, forest cover, and lack of roads and trails.

Moti. Topography and dense forest of interior retard movement, but narrow coastal strip with its continuous horse trail and less continuous forest cover permits ready movement of personnel all around island. Landing operations possible at points where shore is not too steep.

Makian. See quadrangle XVIII-9S.

Cover, Concealment, Observation: Tidore. See quadrangle XVI-9S-B.

Mare and Moti. Cover given by ridges, valley sides, large hardwood trees, and low banks marking high tide. Field fortifications are practicable at most places in the lower slopes.

Concealment provided by forest cover, except in cleared and cultivated areas. Virgin forest gives both ground and aerial concealment; coconut palms along shore give good aerial concealment but only partial ground concealment.

Observation limited by forest cover. Lookout points on summit, however, would provide fair view over lower slopes, and projecting points on shore would command limited view of adjacent shoreline.

Makian. See quadrangle XVIII-9S.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

Preliminary text submitted
without checking or editing
U. S. Geological Survey

CONFIDENTIAL

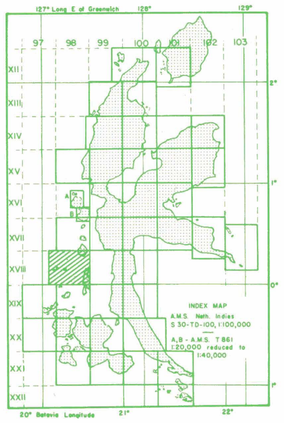
# HALMAHERA (MOLUKKAS)

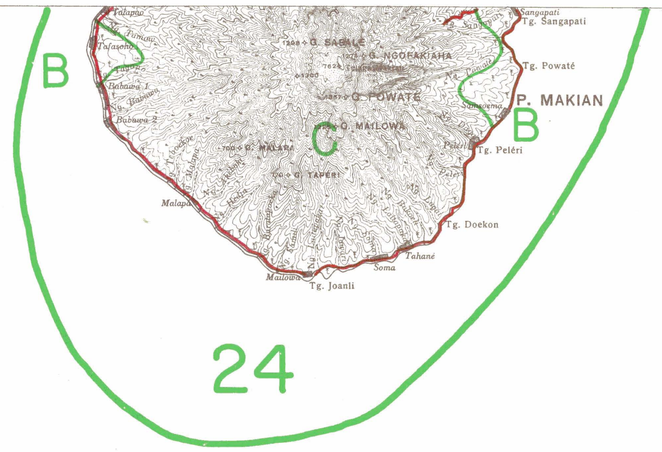
RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922.
Blad 44.

## TERRAIN APPRECIATION

XVIII 97 and 98 Blad 50. en 51.

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Swamp (moeras)

Lake

Marsh (drasland)

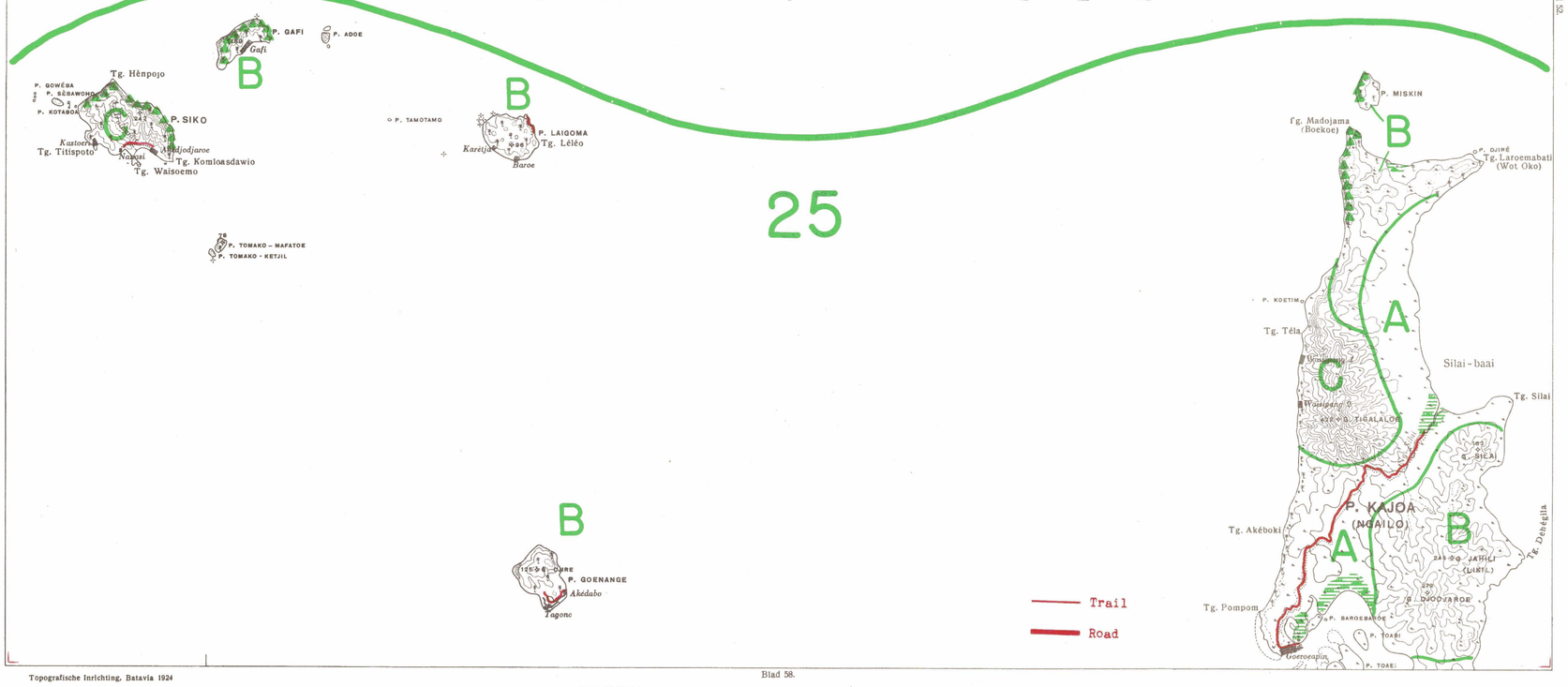
▲▲▲ Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

M O L U K S C H E Z E E

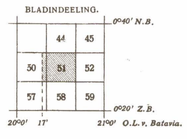



Blad 52.

Blad 58.

Topografische Inrichting. Batavia 1924

BLADINDEELING.




ADMINISTRATIEVE INDEELING.

*Afdeeling Ternate.*
*Onderafd. Tidore.*

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Alang-alang.* *Drasland.* *Moeras.* *Paardenpad.* *Voetpad.* *Rivier. a, gemeten, b, niet gemeten.* *Meer.* *Bamboe gebouwen.* *Mesigit.* *Inlandsche graven.*

*ZEE, a. eiland.*
*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. b. = klippen. c. = laagwaterlijn. d. = hoogtepunt en hoogtecijfer. e. = hulphoogtelijn. f. = rots.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

*A. = Abé.= Rivier, Ng. = Ngoeai = Rivier, G. = Goenoeng = Berg, P. = Poelau = Eiland. Tg. = Tandjoeng = Kaap.*

TOELICHTINGEN

*Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21, Stbl. No. 29*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B.

SHEET NO. XVIII-98

Area No. 24 - Makian

Topography: Active volcanic cone about 7 miles in diameter and about 1,350 meters high. At top is deep crater containing a small lake. Sides of cone deeply grooved by closely-spaced, radiating ravines separated by narrow ridges. Slopes are steep, but on north side, and on small sections of eastern and western sides, slopes somewhat less steep than elsewhere. Valleys are all short and steep; many streams dry along greater part of their courses except after heavy rain. Several volcanic eruptions during last few centuries, one of which blew off top of mountain. Shoreline slightly irregular, and sloping land begins almost at beach.

Ground Conditions: Stony loam which locally reaches depth of about 5 feet. Depth to bedrock varies locally and abruptly. Bare lava rock at surface in many places, particularly around the crater. The soil, when undisturbed, is well drained, gives good footing, and is not excessively muddy when wet. Beaches cobbly. Except for small areas of grassland, second growth forest, and cleared land on the lower slopes near settlements, volcano almost entirely covered with virgin tropical forest. Along shore are bands of coconut palms.

Settlements: Numerous native villages all around shore. Small pier for boats at Ngofakiaha on northeast side. Population about 8,000 in 1905.

Movement: Gentle slopes around shore, coconut palms, and less dense native vegetation are more favorable for movement than steep slopes and dense forest of interior. A continuous horse trail around the island is available for foot troops. Coast narrow, difficult for landing operations, but north side is least unfavorable, owing to gentler slopes.

Cover, Concealment, Observation: Cover is provided by ridge crests, stream banks and low banks marking high tide line. Ground and aerial concealment provided by forest cover in most places. Ground concealment limited in areas of cocomut palms; poor in cultivated areas and grassland.

Observation generally limited by forest. Bare places around crater would provide lookout over lower slopes in clear weather.

Area No. 25

Topography: Kajoa. North end of elongate, irregular island. Hills northwest and southeast are separated by a low gap which is continuous with coastal flats on the northeast and southwest. Northern hills higher and steeper than those at south; reach height of about 420 meters; steeper on west than on east. Hills at south attain height of about 270 meters; somewhat broader and more sprawling than those at north, and less rough.

Coast terraced at north, steep to rocky at northwest, flat at northeast, moderately sloping at southeast, and flat to moderately sloping at southwest.

Other islands. Several small hilly islands in Molukkan sea west of Kajoa. Largest is Siko, about 2 miles long, and with relief of about 240 meters. Slopes asymmetric, much steeper at north than at south. Other islands are of lower relief, and range from about 0.1 to 1.0 miles in length.

Ground Conditions: Kajoa. Island has deep sandy to clayey loam, locally gravelly. Soil well drained in the natural state, and gives good footing when dry; very muddy when wet, and if disturbed when wet becomes dense and sticky, and loses its drainage qualities. Bedrock exposed on western shore at northern end of island. At places along the coasts are small swamps. Beaches muddy to sandy along flat stretches of shore, gravelly to rocky along hilly stretches.

Along many parts of shore are strips of coconut palms. Interior largely covered with virgin forest, with scattered patches of brush.

Other islands. Siko and Gafi are rocky on the north, and covered with loamy soil on the south. Other islands have sandy to loamy soil. Beaches are sandy to pebbly. Cocomut palms are main type of vegetation.

Settlements: Kajoa. A few small native villages on the west coast.

Other islands. Each of the islands has one or more small native villages.

Movement: Kajoa. Coastal flats on northeast and southwest are topographically favorable for movement, but forest cover is obstacle. One foot path connects and crosses these two sections. Movement on foot possible in coconut strips along the southwestern shore. Elsewhere cutting trails or building roads necessary. Small swamps constitute additional local obstacles. Landing operations feasible along the coastal flats where the shore is not swampy or muddy.

Other islands. Movement of foot troops feasible at most places. Landing possible at most places except steep and rocky northern shores of Siko and Gafi.

Cover, Concealment, Observation: Cover provided by ridges and spurs in the hilly parts of the island, and by beach ridges and low cut banks at high tide line along the coast.

Ground and aerial concealment given by forest cover in most places. Concealment least on rocky slopes along the northwestern coast.

Observation obstructed by forest and topography. Projecting points on east side would permit observation of adjoining stretches of shore.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey for Chief of Engineers, U. S. Army.

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

## TERRAIN APPRECIATION

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1923.
Blad 50.

Blad 57.

EXPLANATION

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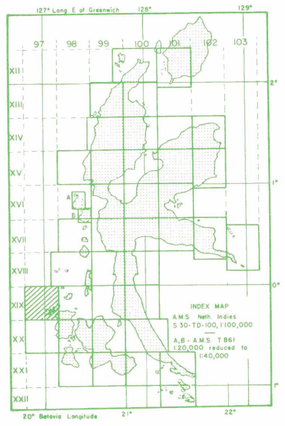
Lake
Marsh (drasland)
Rocky area
Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

M O L U K S C H E Z E E

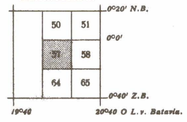
Blad 38.




Blad 64.

Topografische Inrichting, Batavia 1924.

BLADINDELING.




ADMINISTRATIEVE INDEELING.

Trail
Road

*Afdeeling Ternate.*
*1. Onderafd. Tidore.*
*2. „ Bafjan.*

LEGENDA.

*Kampoeng. Schaars bewoonde streken. Arentain. Klapperboomen. Bosch. Kreupelhout. Moeraspalmen. Voetpad. Rivier, a gemeten, b niet gemeten, Bamboe gebouwen. Inlandsche graven. Onderafdeelingsgrens*

*ZEE, a. eiland, b. klippen.*
*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. c. = hoogtepunt en hoogtecijfer d. = hulphoogtelijn, e. = rots.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikte van 500 M.

Schaal 1 : 100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

*A. = Akê = Rivier. P. = Poelau = Eiland. N. = Noesa = Eiland. Tg. = Tandjoeng = Kaap.*
*Tk. = Teloek = Baai. G. = Goenoeng = Berg.*

TOELICHTINGEN.

*Administratieve indeeling volgens O. B. van 25 Jan. 1924 No. 21, Stbl. No. 29.*

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

**Reliability Rating: Class B**
SHEET NO. XIX-97

**Area No. 25. Moeari and Latalata Islands.**

Topography: Two large, mountainous islands, irregularly shaped, separated by narrow strait, and flanked by smaller islands.

Moeari, at northeast, is about 6.5 miles long and from 1 to 3 miles wide. Total relief is nearly 350 meters. Slopes are prevailingly steep, but locally gentler in a pocket-shaped section at the west, and in a transverse strip toward the northeast. Topography rough. Few streams, all small. Shore steep in most places, and coastline irregular.

Latalata is about 5 miles long and as much as 3 miles wide. Total relief nearly 360 meters. Topography similar to Moeari. Hilly southwestern end is separated from main section by low narrow neck. Coastline very irregular, with numerous bays and jutting points.

Ground Conditions: Large areas along shore and on some inland ridges are rocky and comparatively bare. Other parts of islands are covered with sandy to clayey loam soil, from a few feet deep on steep slopes to a few tens of feet deep on gentler slopes. Soil is well drained, gives good footing, and is easily excavated. Locally it may be very muddy when wet. Beaches are rocky. Coconut palms fringe shore, and virgin forest covers interior except for local rocky areas.

Settlements: A few small native villages are scattered along the coast.

Movement: Steepness and roughness of topography unfavorable for movement in greater part of area. Low, narrow necks connecting broader parts of both islands, however, provide natural corridors for crossing the islands. Forest cover is an obstacle; cutting trails desirable for movement of foot troops, and building roads necessary for movement of vehicles. No existing roads or trails. Landing operations possible at either end of corridors mentioned above, but communications with other parts of the islands will be poor.

Cover, Concealment, and Observation: Cover is provided mainly by narrow ridges and valley sides. In rocky areas, some cover probably given locally by projecting rocks. Field fortifications feasible where ground is not rocky.

Forest cover provides complete ground and aerial concealment in the interior. Concealment very poor in rocky areas on and near coast.

Observation in the interior very restricted by forest cover. Along coast, open character of rocky areas and deeply indented shore permits good local observation from the numerous projecting points.

**Area 26. See Sheet XX-98 for all sections.**

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

Preliminary text submitted without checking or editing.
U. S. Geological Survey

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

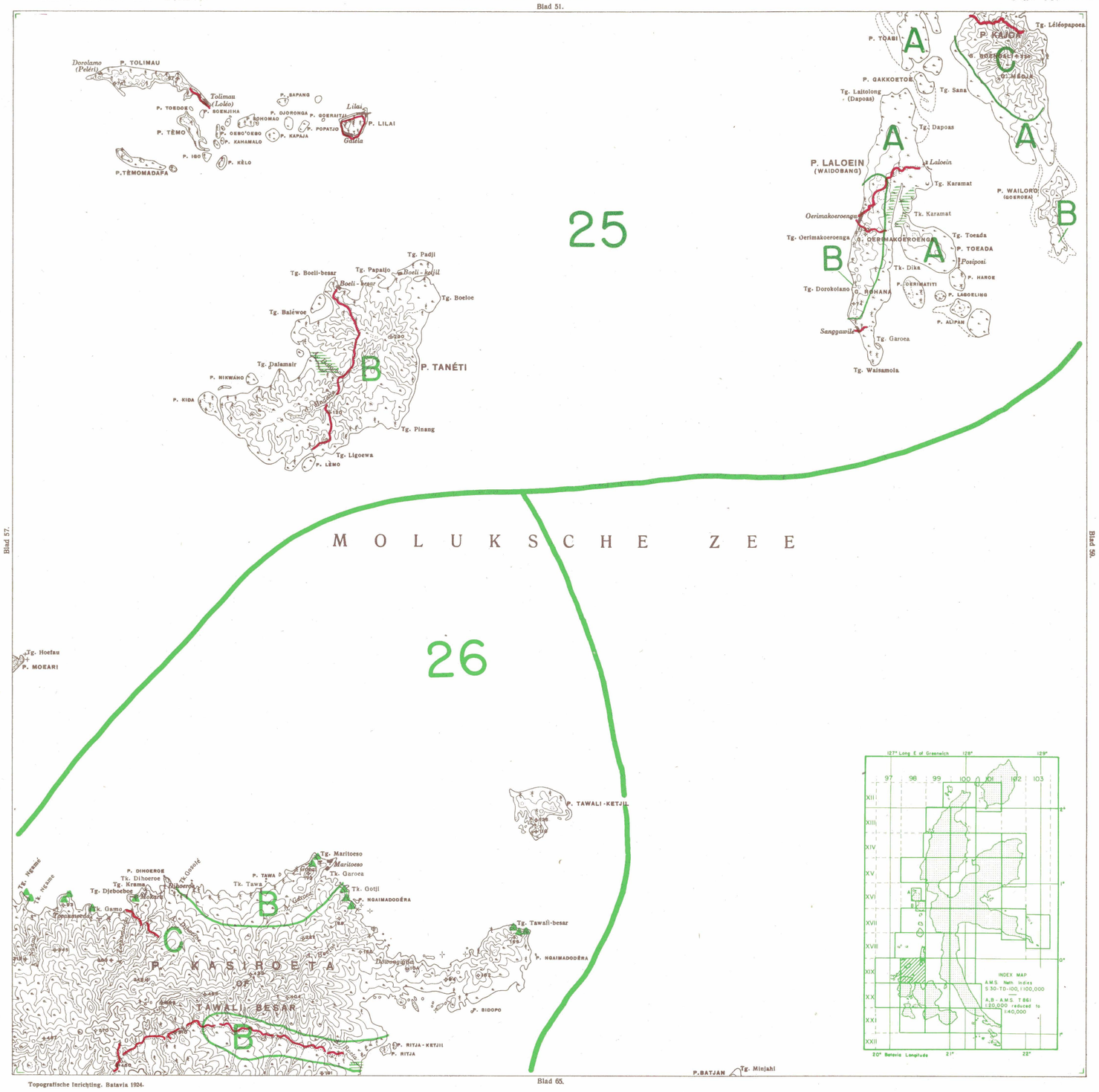
RES. AMBON Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922 - 1923.

Blad 51.

## TERRAIN APPRECIATION

Blad 58. XIX-98




Topografische Inrichting. Batavia 1924.

BLADINDEELING.

| | | |
|---|---|---|
| 50 | 51 | 52 |
| 57 | 58 | 59 |
| 64 | 65 | 66 |

0°20' N.B. — 0°40' Z.B. — 20°00' — 21°00' O.L.v. Batavia.

ADMINISTRATIEVE INDEELING.

1. Onderafd. Ternate.
2. „ Batjan.

Trail

Road

LEGENDA.

Kampoeng. Schaars bewoonde streken. Sagotuin. Klapperboomen. Bosch.
Kreupelhout. Bamboebosch. Gelagah. Alang-alang. Moeraspalmen.
Tjemara-of Dennenbosch. Drasland. Moeras. Paardenpad. Voetpad.
Rivier, a gemeten, b niet gemeten. Bamboe gebouwen. Mestgit. Inlandsche graven.
Onderafdeelingsgrens.
ZEE. a. = eiland, b. = klippen, c. = laagwaterlijn.
Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. d. = hoogtepunt en hoogteцifer, e. = huiphoogtelijn, f. = rots.

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

A.= Aké = Rivier. Tg. = Tandjoeng = Kaap. Tk.= Teloek = Baai. P. = Poelau = Eiland. G.= Goenoeng = Berg.

TOELICHTINGEN.

Administratieve indeeling volgens O. B. van 25 Jan. 1924 No. 21. Stbl. No. 29.




## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

▲▲▲ Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

PREPARED BY U S GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U S ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: Class B SHEET NO. XIX-98

Area No. 25. Kajoa Group.

Topography: Part of Kajoa included in this quadrangle is elongate and hilly; relief about 325 meters. Spurs project outward in all directions from a central peak. No streams of any size. Narrow coastal plain on south and west; shore steep on east.

Laloein is long narrow island with relief of about 130 meters. Slopes steeper on west than on east, gentle to moderate over most of island.

The smaller associated islands are all low-lying, flat to broadly rounded.

Taneti. Hilly island about 6 miles long and 2 to 3 miles wide. Total relief is 200 meters. Slopes gentle to moderate over much of area. Streams all very small. Shore indented and irregular. Small coastal flats at northeast and southeast.

North of Taneti is a group of small low islands of irregular shape. Tolimau, the largest, is about 3 miles long and 0.5 mile wide.

Ground Conditions: Islands covered with moderate to thick mantle of sandy to clayey loam soil, locally pebbly. Soil is well drained and gives good footing, but is muddy when wet, and loses its perviousness if disturbed, particularly when wet. Small patches of swampy ground on Laloein and on Taneti. Coconut palms fringe shore in many places. Interior areas are covered by virgin forest , with some small patches of brush. Beaches sandy to gravelly.

Settlements: Small native villages exist on all the larger islands.

Movement: Topography generally favorable for movement, but locally too steep for mechanized units. Forest cover, however, is an obstacle in most places, although some brush thickets are passable for heavy vehicles. Existing trails are limited to foot paths crossing Laloein and Taneti, and much shorter paths on a few other islands. Landings possible on coastal flats of all the larger islands.

Cover, Concealment, and Observation: Some cover provided by beach ridges and by low rounded hills on Laloein, and by ridges and stream banks on Taneti.

Ground and aerial concealment provided by forest cover in greater part of area. Visibility is very low, except along shore, and there are no satisfactory lookout points inland.

Area No. 26. Kasiroeta.

See Quadrangle No. XX-98 for all sections.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. geological Survey for Chief of Engineers, U. S. Army

CONFIDENTIAL

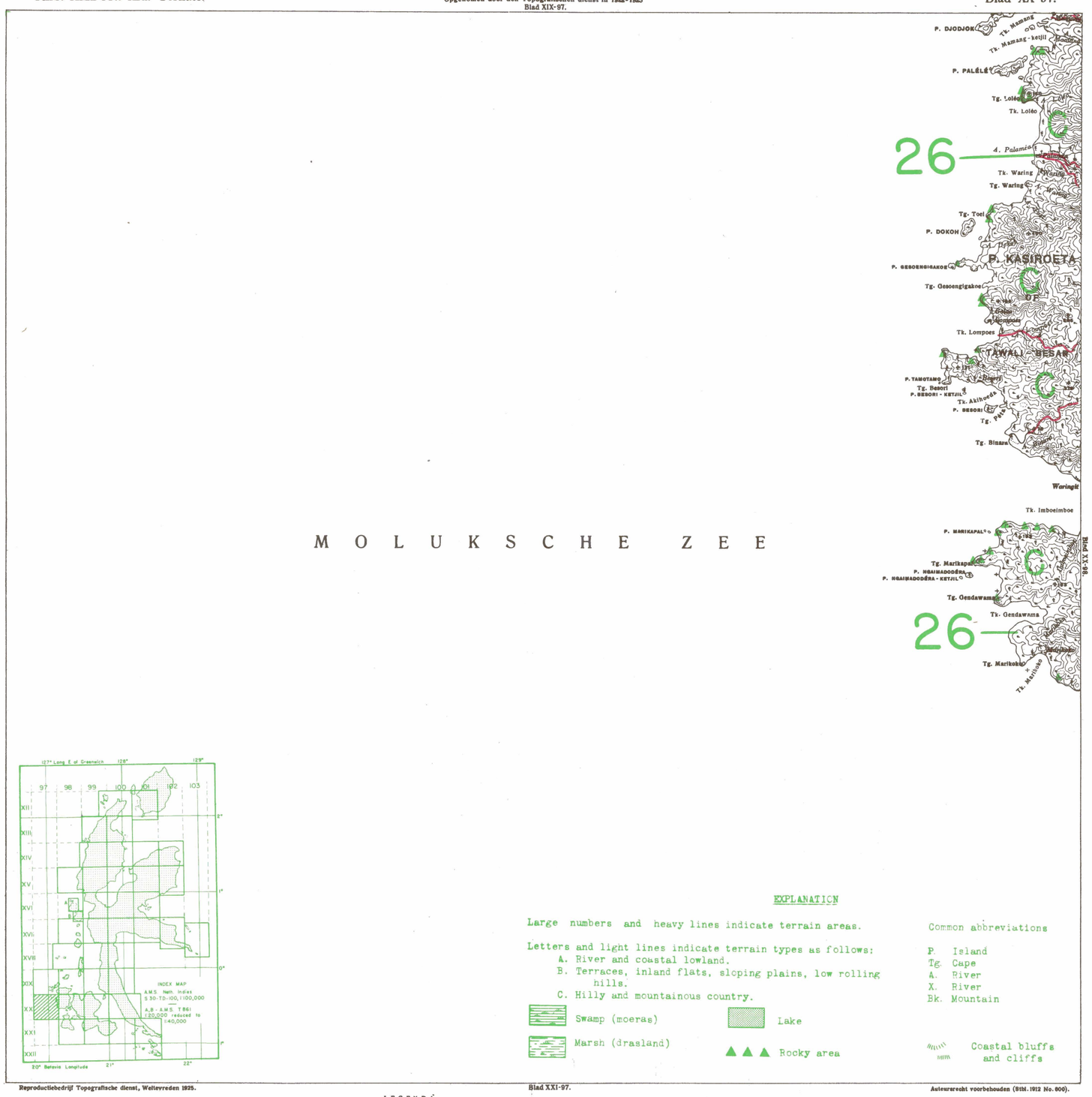
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922-1923
Blad XIX-97.

## TERRAIN APPRECIATION

Blad XX-97.







### EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)
Lake
Marsh (drasland)
Rocky area
Coastal bluffs and cliffs

Common abbreviations

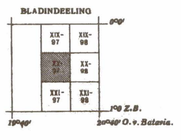
P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Blad XXI-97.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING




ADMINISTRATIEVE INDEELING.

Afdeeling. Ternate.
Onderafd. Batjan.

Trail
Road

LEGENDA.

Kampoeng. Schaars bewoonde streken. Sagotain. Arentain. Klapperbomen. Beteh. Kreupelhout. Bamboebosch. Moeraspalmen. Tjemara- of Dennen bosch. Voetpad. Rivier. a. gemeten, b. niet gemeten. Bamboe gebouwen.

ZEE. a. eiland, b. klippen
Alle hoogten zijn uitgedrukt in M. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikte van 500 M. c. hoogtepunt en hoogtecijfer, d. halphoogtelijn, e. rots.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

A. = Abé = Rivier. Tg. = Tandjoeng = Kaap. Tk. = Teloek = Baai. P. = Poeloe = Eiland.

TOELICHTINGEN.

Administratieve indeeling volgens O. B van 25 jan. 1924 No. 21. Stbl. No. 29.

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# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating; Class B

SHEET NO. XX - 97.

Area No. 26

Only west coastal portion of large Kasiroeta Island is shown on this sheet. Area has rugged mountainous topography and steep, deeply indented coastline; many small, outlying islands. See sheet XX-98 for further description.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

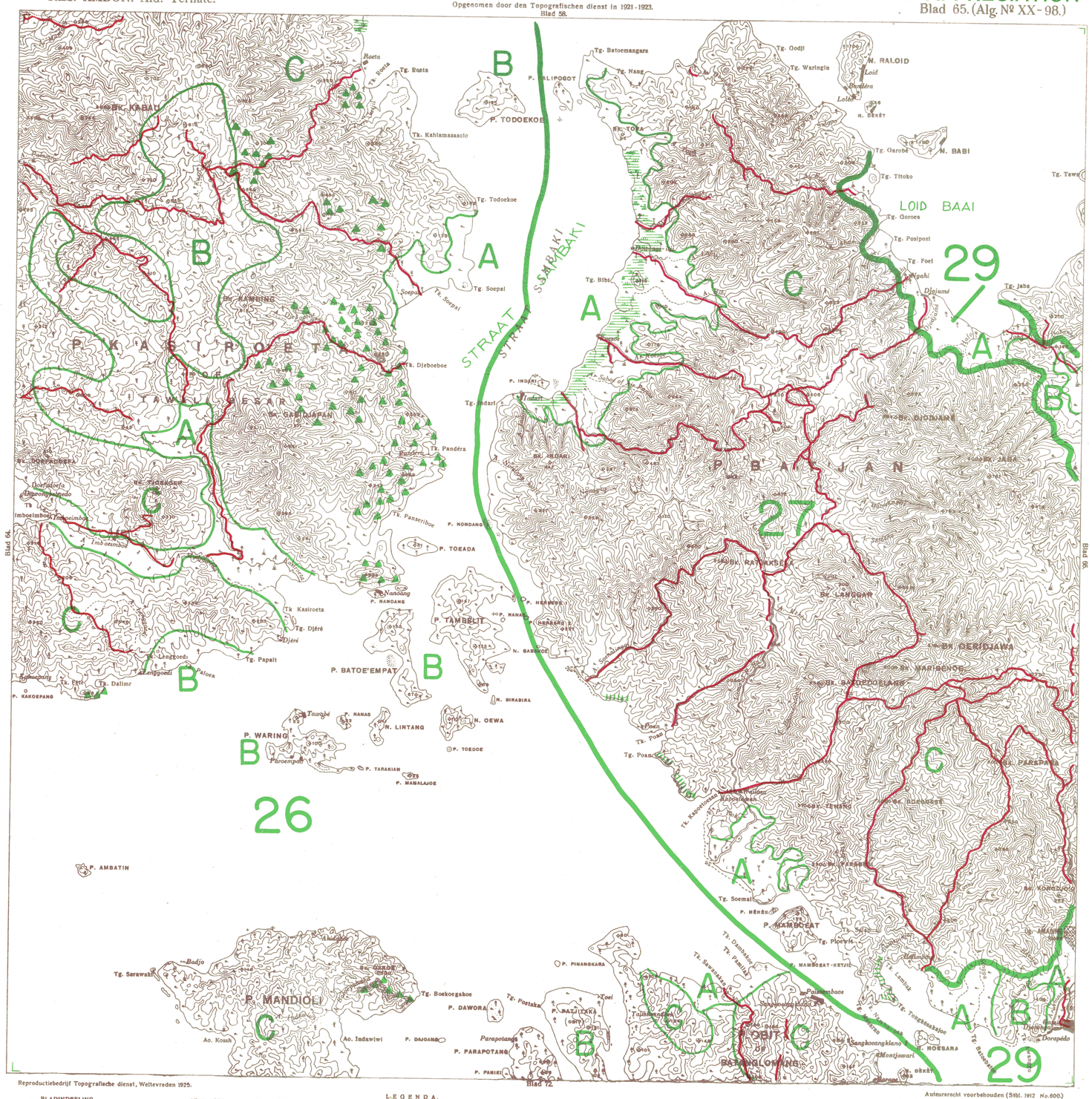
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

## TERRAIN APPRECIATION

Blad 65. (Alg. Nº XX-98.)

Opgenomen door den Topografischen dienst in 1921-1923.
Blad 58.




Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Auteursrecht voorbehouden (Stbl. 1912 No.600.)

BLADINDEELING.

| | | |
|---|---|---|
| 57 | 58 | 59 |
| 64 | 65 | 66 |
| 71 | 72 | 73 |

1°00' Z.B.

2000' 21°00' O.L.v. Batavia. 129°

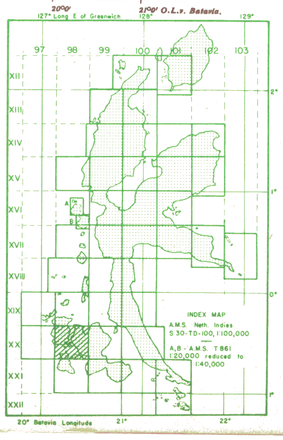
127° Long. E. of Greenwich 128°

ADMINISTRATIEVE INDEELING.

Afdeeling Ternate.
Onderafd. Batjan.

Trail

Road




LEGENDA.

Kampoeng. Schaars bewoonde streken. Sagoetuin. Arentuin. Klapperboomen. Bosch. Kruisselhout. Bamboebosch. Alang-alang. Gras. Moeraspalmen. Bouwland. Regelm. aangelegde tuinen. Tjemara of Dennenbosch. Drasland. Moeras. Paardenpad met houten brug. Voetpad. Rivier, a gemeten, b niet gemeten. Meer. Bamboe gebouwen. Inlandsche graven. Landb. ond. gras. Niet verharde weg, in den drogen moeson geschikt voor veldartillerie. van 2-4 M. breed.

ZEE. a. eiland, b. klippen, c. laagwaterign, d. zandbank.
Alle hoogten zijn uitgedrukt in M. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50M; de dikke van 500M. v. hoogtepunt en hoogtecijfer, f. knikhoogteign. g. rots.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

Bk. Boekoe Berg. P. Poelau Eiland. N. Noesa Eiland. Ao. Ajiko = Baai. Tk. Teloek Baai. Tg. Tandjoeng Kaap. P. Pajoeo Rivier. Oj. Onderneming. A Ahl Rivier.

TOELICHTINGEN.

Administratieve indeeling volgens O B. van 25 jan. 1924 No. 21, Stbl. No. 29.

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

Reliability Rating: Class B

SHEET NO. XX-98.

Area No. 26. Kasiroeta

Topography. Greater part of Kasiroeta Island appears on this sheet; other parts on sheets at north, northwest, and west. Following description applies to entire island.

Broad, mountainous island with ragged margins, separated from Batjan by narrow Sambaki Strait. Elevations up to about 800 m. At south is a detached range of hills separated from central part of island by narrow transverse lowland. Somewhat larger and higher mountainous strip at north is also set apart by transverse valleys.

Central part of island consists of very irregular interior basin; this is perched on an upland from which steep, broken slopes descend to the coast. Slopes within basin prevailingly moderate, indented by broad shallow valleys giving undulatory topography. Basin drains south thru Kasiroeta valley, which narrows sharply just before reaching coastal lowland. Seaward slopes encircling island are rugged and irregular, with innumerable spurs and short, steep valleys. The Kasiroeta is only important river. Toward mouth it winds thru broad valley flat; smaller valley flat just upstream from narrow section. Farther upstream the valley narrows and becomes shallower, with gentler side slopes.

Coastline steep and irregular on all sides, especially on west. Points and peninsulas of various sizes and shapes alternate with coves, islands, and embayments. Coastal flats at only 2 places: mouth of Kasiroeta River, and near center of east coast. Coastal slopes terraced at some places.

Several small, hilly islands of irregular outline east and southeast of Kasiroeta. Slopes moderate, and relief generally less than 150 m.

Hilly island of Obit is about 7 mi. long by 4 mi. wide; borders Laboeha Bay, separated from Batjan by narrow strait. Relief slightly less than 200 m. Hills at east and west, separated by a central gap. Narrow coastal flat at north, and broader one at south (shown on sheet XXI-98). Inland slopes steep on eastern hills, moderate to steep at west. Coastal slopes locally terraced. Two smaller islands west of Obit, separated by narrow channels, have similar topography.

For description of Mandioli see sheet XXI-98.

Ground conditions. Patches of rocky ground widely distributed on east side of Kasiroeta, and also along north and west coasts. Other parts of area have loam soil a few feet to a few tens of feet deep, shallowest on steep slopes and edges of terrace flats. Soil gives good footing, is well drained; may be very muddy when wet.

Beaches sandy to locally rocky.

Coconut palms fringe gentler parts of shore; occur also on low ground farther inland. Except for rocky places, rest of area heavily forested. Bamboo thickets in places along lowland streams.

One small tract of swamp on northeast coast of Kasiroeta.

Settlements. A few small native villages widely scattered along the coast on Kasiroeta, Obit, and Waring.

Movement. Rugged topography on most of Kasiroeta is adverse to movement; forest cover is an added obstacle.

At south end of island, narrow lowland provides corridor between east and west coasts, with continuous gentle grades. At one point this corridor is very narrow. It is followed by a foot path. Bamboo, swamp vegetation, and undergrowth offer difficulties off the trail. East end of path follows bed of Kasiroeta River bed; unusable during high water.

At northern end of island, a poor corridor between east and west coasts, formed by valleys opening eastward and westward. Grades moderate and locally steep; pass at highest point about 400 m. nigh; route followed by foot path.

Kasiroeta valley offers easiest route to interior of island; followed by foot paths which in the interior branch out in different directions, and connect with other paths leading down over steep slopes to both coasts. Off trails, movement on foot easiest on rocky patches and ridge crests.

Areas permitting landing operations are few, rather unsatisfactory. One possibility is coastal flat on east central shore; poor communication with other parts of island. Another possibility is flat at mouth of Kasiroeta River; could be strongly defended from surrounding heights.

On Obit, movement restricted by steep slopes in hilly sections, and by forest in interior. Broad coastal flat at south (sheet No. XXI-98) suitable for landing; also narrower coastal strip at north. One north-south foot path crosses island, following ridge route.

On other islands, slopes generally not too steep for movement, but forest cover on larger islands offers obstacle. Coastal areas permit small-scale landing operations at many places.

Cover, concealment, observation. On Kasiroeta, cover provided by narrow ridges, stream banks, and, locally on small scale, by scattered rocks in rocky tracts. Some cover also by larger hardwood trees. Along coast, numerous points and promontories give some cover from fire in coastwise directions. Field fortifications feasible on gentler slopes, except where rocky; bedrock close to surface near terrace edges.

On Obit and other islands, some cover given by low rounded hills and ridges. Field fortifications generally feasible.

Forest gives complete concealment except in rocky areas, and in coconut groves, where ground concealment is limited.

Observation hindered by forest in most places. Good vantage points only on coastal areas, particularly on Kasiroeta, where many knobs and ridges(especially above slopes that are steep, rocky, and comparatively open), command adjoining coastal areas.

Area No. 27. Mountains of Northwestern Batjan.

Topography. Mountainous terrain of steep sided ridges and peaks; valleys narrow with steep sides. Coastal lowlands lie between mountains and Sambaki Strait; small lowland northwest of Mamboeat Island; elsewhere mountains extend to shore. Most of area less than 500 m. in altitude. Belt of high mountains on eastern side of sheet is between 500 and 900 m.; maximum altitude of 870 m. reached by Oeridjawa Mtn.

Summits and ridge crests rounded, narrow. Slopes generally steep; some moderate on northwest tip and along the Djojame. Slopes cut by numerous ravines. Valleys are narrow and crooked; except along parts of the Djojame and near stream mouths, stream channels occupy entire width of valley floor. Flat or gently undulating coastal lowland between Cape Batoemangara and Cape Indari; bordered on all sides by steep mountain slopes. Plain varies in width from 0.5 to 2.25 mi.; strip of marsh and swamp about 0.5 mi. wide on seaward side of plain. Many streams entering area are lost in swamps without reaching coasts.

Low plain north west of Mamboeat is about 2 mi. long and 1.25 mi. in maximum width.

Along lowlands, coast is low and muddy or sandy; elsewhere mountains rise abruptly from sea or from narrow stony or sandy beach. Small strip of marsh south of the Nondang River.

A few small islands lie a short distance off shore. Salipogot and Indari are 2 low coralline islets less than a square mile in area. At south end of Sambaki Strait is Tambelit, a hilly island about 3 mi. long, with a maximum width of 2 mi.; farther south is small rocky island of Oewa. Mamboeat, between Batjan and north coast of Obit, is rugged island.

Settlements. Several native villages along shores; most are situated on seaward margin of coastal lowlands; villages on Sambaki Strait generally built on beach ridges or raised coral reefs between swamps and sea. Interior largely uninhabited; some temporary camps made by collectors of copal and damar gum.

Movement. In most of area, rugged terrain is barrier to movement of motorized units unless roads are constructed. Several foot trails used by copal and damar gum collectors wind through mountains; most have steep to moderate grades and could not be used by motorized equipment without considerable construction. Many trails in part follow valley bottoms near stream channels; may be impassable during most of rainy season. On coastal lowlands forest and swamps are most serious obstacles to motorized units although topography is favorable. Mangrove swamps along Sambaki Strait are obstacle to landing of men or vehicles.

In higher parts of mountains, foot troops can deploy off paths; movement easiest along ridge crests where vegetation is generally least dense.

Streams are small and can be forded except during periods of sudden high water, during rainy season. Dense vegetation on lowlands and in valley bottoms are most serious obstacles to crossings.

Cover, concealment, and observation. Excellent cover in mountains although trails can be brought under fire at many points from nearby commanding heights. Little cover on lowland plains; locally cover for men behind low beach ridges.

Rain forest gives excellent concealment in nearly all parts of area. Concealment for vehicles incomplete in cleared areas and young second growth tracts around some villages. Trails largely hidden from aerial observation by overlapping crowns of trees.

Ground observation generally restricted to few yards except along occasional straight stretches of trail.

Area No. 29. Sajoang-Tjora Corridor and Laboeha-Sajoang Isthmus.

(For description of main part of area see sheet No. XX-99.

Topography. Northern end of Sajoang-Tjoro valley corridor is separated from narrow coastal lowland around head and west sides of Loid Bay on north coast by groups of low hills 125 to 200 m. in altitude. The narrow coastal plain varies from a few hundred yards to about a mile in width. Ground flat or gently rolling; low sandy beaches along shore.

East of Obit Island (Area No. 26) is the western end of the Laboeha-Sajoang Isthums (sheet XX-99), formed by a low coastal plain. West of Amasing River, plain broken by a small group of low hills and ridges. Hills less than 150 m. high; slopes moderate. Plain is nearly flat; crossed by Amasing River and a few small streams.

Settlements. A few small villages bordering Loid Bay. Some small villages together with west part of Laboeha Town line shore of Laboena Bay, east of Cape Awanggo; rubber plantation situated some distance inland to north.

Movement. Tropical vegetation is principal obstacle to movement of motorized units; terrain generally favorable. Ridges west of Amasing River on Laboeha Bay are only serious obstacle to motorized units. Limited deployment of motorized units possible on beaches and through open coconut groves on coastal lowland of Loid Bay. Trail from the bay into the Sajoang-Tjoro corridor probably can be easily improved for motorized vehicles.

On Laboeha Bay, roads from Laboeha and nearby villages probably can be used in drier weather but need improvement for all-weather use by motorized equipment. Amasing River probably not fordable by vehicles except in very dry years, but can be forded by foot troops.

Cover, concealment, observation. Little cover except in low hills west of Amasing River and at head of pass from Loid Bay to Sajoang-Tjoro valley. Concealment good on most of Loid Bay plain and near the western part of Laboeha Bay lowland. Concealment incomplete in open coconut groves along shore and around villages; probably poor concealment in rubber plantation. Observation generally poor; generally best in large cultivated areas around plantation and villages.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS)

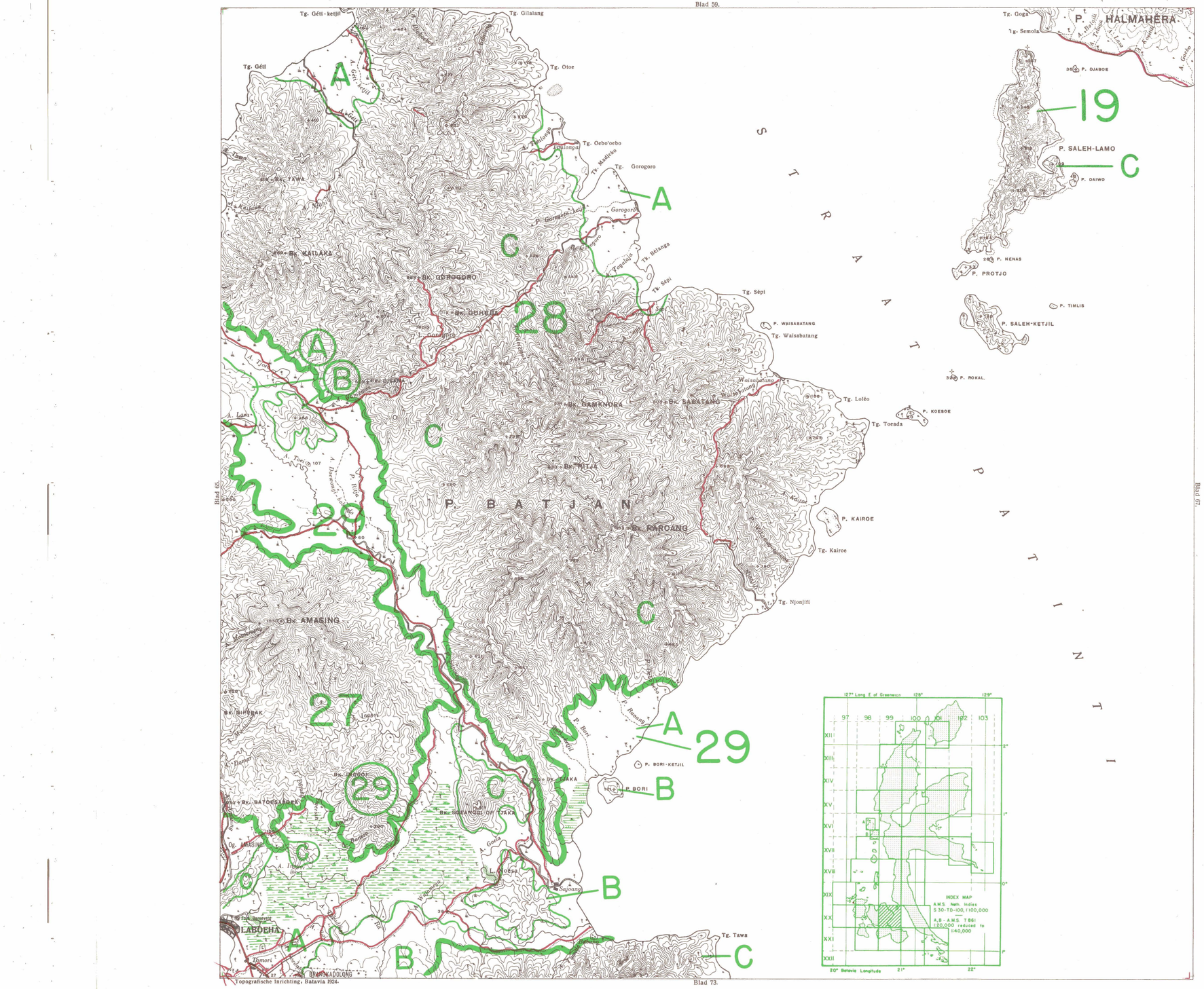
## TERRAIN APPRECIATION

RES. AMBON. Afd. Tèrnate.

Opgenomen door den Topografischen dienst in 1921 - 1923.

Blad 59.

Blad 66.(Alg.№XX-99).







Topografische Inrichting, Batavia 1924.

Blad 73.

Blad 65.

Blad 67.

BLADINDEELING.

| | | |
|---|---|---|
| 58 | 59 | 60 |
| 65 | 66 | 67 |
| 72 | 73 | 74 |

0°0' Z.B.
20°20' 21°20' O.L.v. Batavia.

ADMINISTRATIEVE INDEELING.

Trail
Road

*Afdeeling* Ternate.
1. *Onderafd.* Batjan.
2. " Halmahera.
*Ressort* Wilda.
*District* Gani.

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Kreupelhout.* *Bosch.* *Bamboebosch.* *Sagotuin.* *Tjemara- of Dennenbosch.* *Gelagah.* *Regelm. aangelegde tuinen.* *Koffietuin.* *Djatibosch.* *Moeraspalmen.* *Alang-alang.* *Bouwland (tegal).* *Drasland.* *Moeras.* *Ladang = tijdelijke nederzetting met droge rijstvelden.* *Niet verharde weg, in den drogen moesson geschikt voor veldartillerie van 2 - 4 M. breed.* *Paardenpad.* *Voetpad.* *Rivier. a. gemeten b. niet gemeten.* *Meer.* *Steenen- en bamboe gebouwen.* *Inlandsche graven.* *Onderafdeelingsgrens.* *Landb. ond. grens.*

*ZEE. a. = eiland, b. = laagwaterlijn, c. = klippen, d. = zandbank.*
*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. a. = hoogtepunt en hoogtecijfer, b. = hulphoogtelijn.*

**De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.**

Schaal 1 : 100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Administratieve indeeling volgens G.B. van 25 Jan. 1924. No. 21 Stbl: No. 29.*
*Uitgangspunt A.S. vlaggestok steiger Laboeha 0°39' Z.B. en 20° 40' 1,95" O.L.v. Batavia.*

VERKORTINGEN.

C. = *Controleur.* Bk. = *Boekoe (berg).* P. = *Poelau (eiland).* Tg. = *Tandjoeng (kaap).* Th. = *Teloek (baai).* L. = *Lopa (meer).* P. = *Paloe (rivier).* A. = *Aké (rivier).* Og. = *Onderneming.*

PREPARED BY U.S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U.S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:
- A. River and coastal lowland.
- B. Terraces, inland flats, sloping plains, low rolling hills.
- C. Hilly and mountainous country.

Swamp (moeras)
Marsh (drasland)
Lake
Rocky area
Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability rating: Class B

SHEET NO. XX-99

Area No. 19 - Mountains of Southern Halmahera

Topography: Small group mountainous islands in Patinti Strait, off the coast of Halmahera. Saleh-Lamo, the largest, is about 5½ miles long and has maximum width of about 2¾ miles; altitudes generally less than 300 meters; maximum altitude 319 meters. Two small islands of Saleh-Ketjil and a few tiny islets lie to the south. Saleh-Ketjil is 2½ mile long, 0.6 mile wide; maximum altitude 185 meters.

The mainland of Halmahera has a low coastal plain backed by steep slopes. Area described on sheet XIX-99 and XIX-100.

Ground Conditions: Islands and mainland of Halmahera have red-brown lateritic loam or clay loam overlying deeply weathered volcanic rock which is exposed locally in valley bottoms and, on islands, as rocky headlands. Some sandy or stony clay on narrow coastal lowland of Halmahera. Ground generally well-drained; mud formed in rainy weather dries fairly rapidly.

Coconut palms along coast.

Settlements: Islands have no permanent habitations. A few very small isolated settlements on Halmahera.

Movement: Topography unfavorable to movement of motorized vehicles without construction of roads.

Foot trail extends along the coasts of Halmahera. Probably can be easily improved for use by motorized equipment. Inland, rain forest and steep slopes are unfavorable for movement of motorized units. Streams easily forded except for short periods after heavy rains.

Cover, Concealment, Observation: Rugged terrain gives good cover on islands and part of mainland. Coastal lowland of Halmahera has little cover. Concealment good; observation restricted to a few yards except along the beaches of Halmahera.

Area No. 27 - Mountains of Northwest Batjan

Topography: High mountain of Bk. Amasing surrounded by irregular ridges and deep narrow valleys form the southwest end of the mountains of the northwest lobe of Batjan island (See sheet XX-98 for major portion of the area). Bk. Amasing is about 1030 meters in altitude; most of area is less than 500 meters in altitude. Summits and ridge crests narrow, slopes generally steep. Valleys narrow and crooked. Streams commonly small, with steep gradients.

Ground Conditions: Red-brown lateritic loam and clay loam generally 10 to 20 feet deep, locally deeper. Soils generally well drained. Mud forms where vegetation cover is broken by excavations or trails; dries fairly quickly on slopes. Ground can be easily excavated by hand tools although tangle of creepers and roots on jungle floor may be difficult to penetrate. Slides may develop in excavated areas.

Area covered by rain forest. Undergrowth generally not dense except locally in stream valleys and ravines.

Settlements. Area uninhabited. Natives make temporary camps when gathering damar gum.

Movement: Barrier area unsuitable for movement of motorized units without construction of roads. Foot trails from mountains to west (sheet 65 - XX-98) cross west margin of quadrangle for short distances; unsuitable for mechanized troops without considerable construction.

Foot troops can move with difficulty in many parts of area; must cut their way in some places. Easiest movement is along ridge crests. streams can be forded except during long heavy rains.

Cover, Concealment and Observation: Ridges and deep valley give good cover. Dense forest cover offers excellent concealment. Observation in most parts of area limited to a few yards.

Area No. 28 - Mountains of northeastern Batjan

Topography: Mountainous terrain of steep-sided ridges and peaks with narrow crooked valleys; small coastal lowlands along parts of northwest and northeast coasts; elsewhere mountains extend to shore. Altitudes commonly between 500 and 1000 meters; Bk. Raroang reaches maximum altitude of 1189 meters.

Summits and ridge crests are rounded, narrow; slopes generally very steep, cut by numerous small ravines. Valleys are narrow with steep sides; except near mouths, streams have channels that occupy entire width of valley floors.

Coastal lowland of Geti River forms little pocket about 2¼ miles square on the northwest coast; is flat, bordered by steep mountain slopes. On northeast coast, a narrow strip of coastal lowland lies between Tg. Otoe and Sepi Bay; 3/4 to 2 miles wide; plain or gently undulating, backed by steep mountains. Elsewhere, mountain slopes rise steeply from sea or from narrow strip of beach.

Streams all small; subject to sudden rise during rainy season.

Ground Conditions: Lateritic clay loam or clay, similar to area 27, in mountains. Depth variable; generally about 20 feet, less along streams where bedrock is locally exposed. On narrow coastal lowland soil commonly is sandy clay loam. Natural drainage fairly good throughout area, but where vegetation cover has been broken by excavations or by heavy traffic on trails, soils become plastic and slippery when wet. Slides may develop in excavations.

Area mostly covered by rain forest. Open groves of coconut palms along coast. Small cleared or grass-covered areas around scattered villages; some second growth forest with dense undergrowth of bushes and vilens.

Settlements: A few small villages on seaward margin of coastal lowlands. No permanent settlements in interior; some temporary camps made by natives gathering damar gum in mountains.

Movement: Barrier area unsuited for movement of motorized units without construction of roads. Several trails enter the area; a few cross the mountains from the coastal lowlands to the Sajoang-Tjoro valley ( Area 29). Trails cannot be used by motorized units without considerable construction work. Limited movement and deployment possible in coastal coconut groves.

Foot troops can skirt mountains along beaches and bordering coconut groves. Movement through the mountains probably easiest along ridge crests. Dense vegetation of valleys, ravines and most parts of coastal lowlands are principal obstacles for foot troops.

Streams easily forded by men except during periods of sudden high water in rainy seasons; banks with densely matted vegetation are principal obstacles to crossings.

Cover, Concealment and Observation: Mountainous terrain gives good cover in most parts of area. Little cover on lowlands except locally, behind high stream banks and low embankments at inland margin of beaches.

In almost all of area dense forest gives excellent concealment. Ground observation commonly limited to a few yards.

Area No. 29 - Laboeha isthmus and Sajoang Corrider

Topography: Isthmus between highlands of central and northern Batjan (Area 30, Areas 27 and 28) occupied by low alluvial plains. Sajoang Valley forms corridor extending northwest from the isthmus; separates areas 27 and 28.

Both lowlands are interrupted by isolated groups of hills and low mountains.

The Laboeha-Sajoang isthmus generally less than 50 meters above sea level; some hills rise 100 to 200 meters above the plain; Bk. Soeanggi is 511 meters in altitude. The isthmus between Laboeha and Sajoang is about 8 miles across. The width varies from 2 to more than 5½ miles; the coastal plain on the east side extends more than 6½ miles between Babang and P. Oebooeba. Northern margin of plain bordered by steep ridges and hills (Areas 27 and 28); south side by Sibella mountains. (Area 30). Most of plain is flat or gently undulating; is covered by marsh (drasland) between Laboeha and Lake Noesa; a patch of swamp (moeras) north of Sajoang on east coast. On south side of the marsh low hills and ridges with gentle slopes rise to base of steep Sibella Mountains. Bk. Soeanggi is steep-sided mountain.

The Sajoang-Tjora valley is generally ¾ to 1 mile wide; valley floor is flat or slopes gently inward from the bordering steep-sided mountains (Areas 27 and 28). Gradients are very low; streams have meandering courses. North of the Toei-Tjora junction valley widens to a basin nearly 3½ miles across. Before entering the Laboeha-Sajoang plain, the river flows thru a steep-walled canyon less than 1/3 mile wide.

The Sajoang River, largest in area, is relatively small and shallow in dry weather; in long rainy seasons is more than 400 feet wide in lower reaches, and is navigable by rafts. Channel is well-defined and in many parts north of Bk. Soeanggi is incised several feet below level of the plain. The Inggo, emptying into Bay of Laboeha, is second in importance, although considerably smaller. Its lower course is entirely through marshy lowlands but, in rainy season, is navigable by craft of very shallow draft. Many small streams are tributary to the Inggoi and Sajoang or empty into the sea; few short streams disappear in marshlands of the isthmus. All are subject to rapid changes of level in rainy season.

Ground Conditions: Alluvial soils, generally sandy clay loams overlying sand and gravel stream deposits. Texture variable; coarse upstream and near the flanking hills; considerable fine clay soil on the Laboeha-Sajoang valley, so that ground dries fairly quickly except in periods of long heavy rains. Most of central and western parts of isthmus poorly drained and marshy; locally may be under water during rainy seasons. Deep slippery mud persists for long periods; excavations slump or fill with water.

Most of the Tjoro-Sajoang valley and margins of isthmus are covered by swamp forest. Coconut palms border both coasts. Coconut and coffee plantations on low hills and gentle slopes south of Laboeha.

Settlements: Laboeha, on west side of isthmus is largest and most important settlement in area; is port of call for inter-island steamers, seat of local government, and an important trading center. A few small villages around Laboeha and on east side of isthmus; plantations (coffee, coconut, rubber) north and southeast of Laboeha.

Movement: Marshy ground, dense rain forest and swamp forest are unsuitable for movement of motorized units away from roads although low, open topography make the isthmus and the Sajoang valleys potential natural corridors. Mechanized units probably can move through open vegetation of plantations.

A short road runs through Laboeha to village of Tomori and to the plantations south and east of Laboeha. Foot trails can cross the isthmus to villages of Babang and Sajoang, skirting the areas of marshy ground (drasland); trails from Sajoang and Laboeha join at north side of the isthmus and continue as single trail through the Sajoang-Tjoro valley . Several minor trails cross the isthmus and valley into the mountains (Areas 27 and 28). In drier weather foot and horse trails probably can be used by tracked and light wheeled vehicles with little improvement except widening. Ground forms deep mud when wet, and in many places is poorly drained so trails would require considerable improvement for all-weather use by heavy traffic.

Dense rain forest, swamp forest and other types of marsh vegetation make movement difficult for foot troops away from trails in most parts of area. Plantations are areas of easy movement.

Sajoang and Inggoi rivers can be forded at many points in dry seasons; may be unfordable in rainy seasons except in upper courses. Sajoang and Inggoi can be navigated by craft of very shallow draft in rainy seasons. Small streams are easily fordable except during heavy rains.

Cover, Concealment, Observation: Little cover in many parts of area; isolated groups of hills and high stream banks locally give good cover. Hasty fortifications can be most easily made in cleared ground in and around plantations; elsewhere marshy ground and dense tangled growth covering ground seriously hinder excavations.

Dense forest cover gives excellent concealment in most parts of area; concealment of vehicles incomplete in open vegetation of plantations. Ground observations generally limited to a few feet; on plantations generally good for several yards. Aerial observation very poor; trails largely hidden by overlapping tree crowns. Observation in open plantation groves is fair to poor.

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FOR
CHIEF OF ENGINEERS, U. S. ARMY



Preliminary text submitted
without checking or editing.
U. S. Geological Survey

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# HALMAHERA (MOLUKKAS)

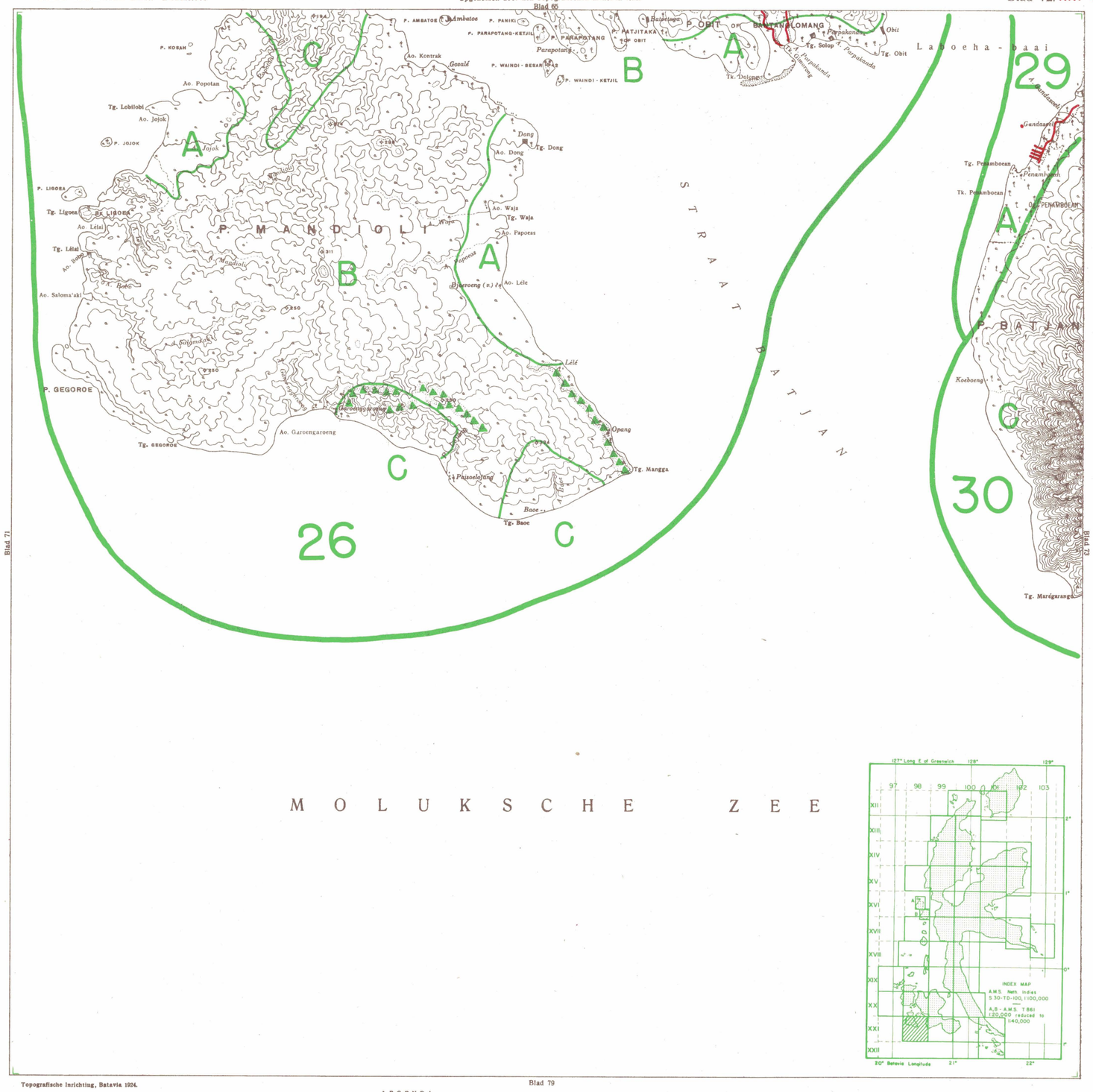
RES. AMBON. Afd. Tèrnate.

## TERRAIN APPRECIATION

Blad 72. XXI-98

Opgenomen door den Topografischen dienst in 1922.

Blad 65

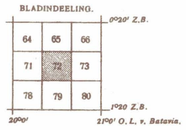



M O L U K S C H E  Z E E




Topografische Inrichting, Batavia 1924.

BLADINDEELING.




ADMINISTRATIEVE INDEELING.

*Afdeeling. Tèrnate*
*Onderafd. Batjan*

Trail

Road

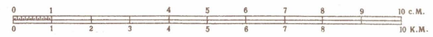
LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* ..... *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Bamboe gebouwen.* *Inlandsche graven.* *Landb. ond. grens.*

*ZEE. a. = eiland, b. = zandbank, c. = laagwaterlijn. Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der dusendtallen van de schaal. d. = hoogtepunt en hoogtecijfer, e. = hulphoogtelijn, f. = rots,*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.




VERKORTINGEN.

*Bk. = Bockoe = Berg. P. = Poelau = Eiland. Tg. = Tandjoeng = Kaap. Tk. = Teloek = Baai, ko. = Ajiko = Baai. A. = Aké = Rivier. P. = Paisoe = Rivier. (v) = Verlaten. Og. = Onderneming.*

TOELICHTINGEN.

*Administratiere indeeling volgens G. B van 25 Jan. 1924 No. 21, Stbl. No. 29.*

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

Letters and light lines indicate terrain types as follows:

A. River and coastal lowland.
B. Terraces, inland flats, sloping plains, low rolling hills.
C. Hilly and mountainous country.

Swamp (moeras)

Marsh (drasland)

Lake

Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

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FOR
CHIEF OF ENGINEERS, U. S. ARMY



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# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: Class B

SHEET NO. XXI-98

Area No. 26

Topography. Mandioli is a roughly triangular island with prevailingly gentle to moderate slopes descending from a low central ridge. At northern end is a hammer-shaped projection with topography somewhat steeper and rougher than elsewhere. Highest point, about 330 m., is at southeast, and elevations only slightly lower are attained along central ridge. Shallow valleys cut into slopes of island, giving a broadly rounded topography. Streams all small and short. Coastal flats on both east and west. Coastline moderately irregular and embayed, and coastal slopes broadly terraced.

Ground conditions. Local tracts of rocky ground at north and southeast. Remainder of island covered by sandy to clayey loam soil, locally gravelly. Thickness ranges from a foot or two on outer surfaces of terraces to several feet elsewhere. Soil well drained, gives good footing. Degree of muddiness when wet varies locally, probably high at some places. Beaches predominantly sandy, locally rocky.

Island covered by forest except for rocky areas. Small stands of coconut palms at scattered points along shores.

Settlements. One small native village on east coast.

Movement. Topographically favorable for movement of both men and military vehicles, except on locally steeper slopes at north and southeast. Local obstacles are steeper slopes at outer edges of terraces, particularly near shore, and forest cover. Best routes on interstream slopes, parallel to streams. Movement on foot slow unless trails are cut, and movement of vehicles impossible unless roads are built. Beachheads could be established on coastal flats at east and west.

Cover, concealment, observation. Topographic cover poor due to broadly rounded slopes. Larger rocks in patches of rocky ground might give limited cover; also larger hardwood trees. Field fortifications feasible except on outer edges of terraces; locally stony ground may retard excavation.

Complete concealment by forest except on rocky areas.

Observation extremely limited both by forest cover and broadly rounded slopes. Coastwise observation possible where prominent points project out into sea.

Areas No. 29 and 30

See adjoining sheets for all sections of description.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

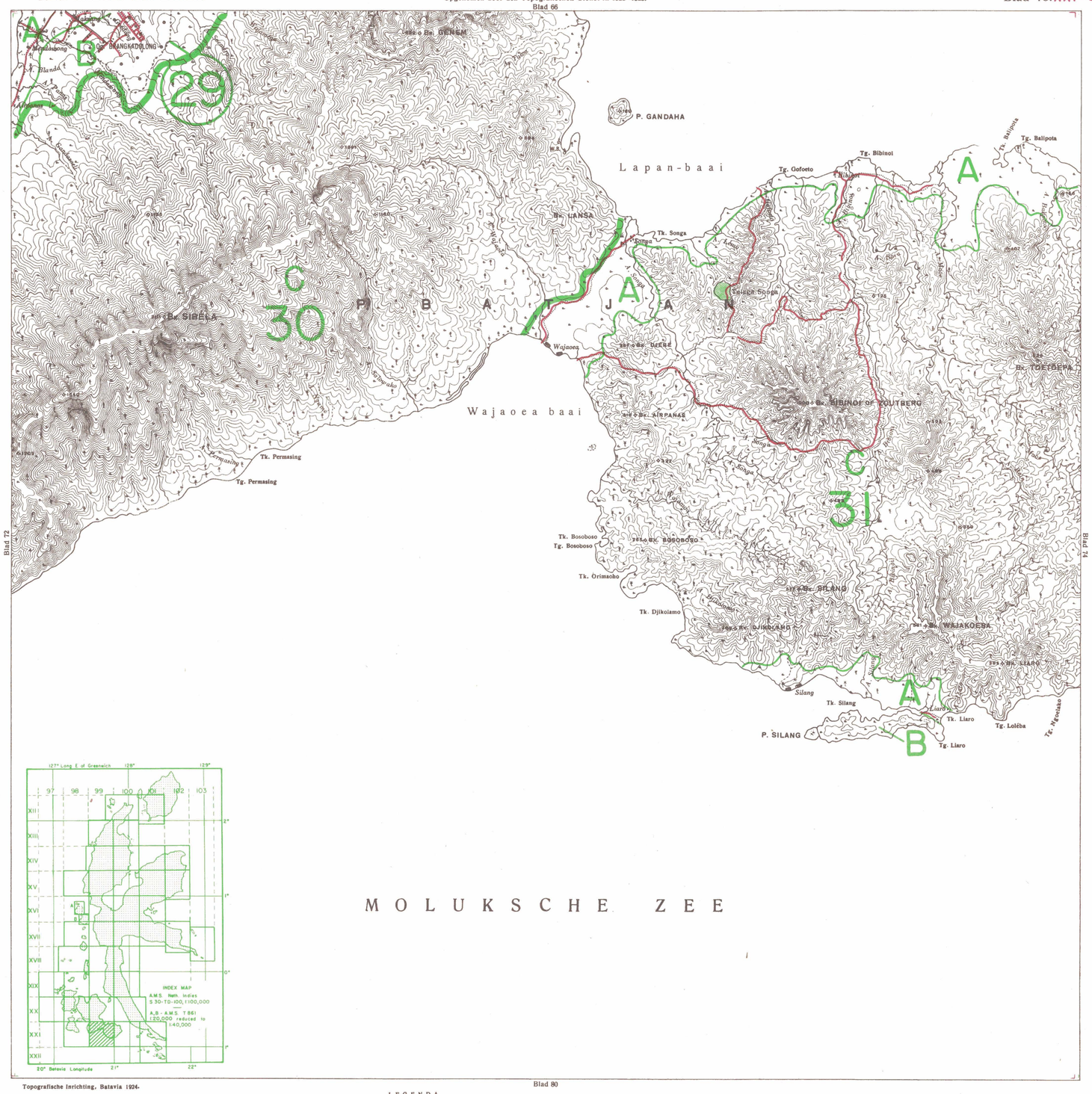
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922-1923.

## TERRAIN APPRECIATION

Blad 73.XXI-99



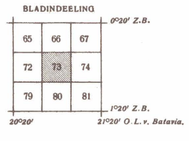




# MOLUKSCHE ZEE

Topografische Inrichting, Batavia 1924.

BLADINDEELING




ADMINISTRATIEVE INDEELING

Afdeeling. Ternate
Onderafd. Batjan

Trail

Road

LEGENDA

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Koffietuin.*
*Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Paardenpad.*
*Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Meer.* *Bamboe gebouwen.*
*Lands, ond, grens.*

*ZEE. a. = eiland, b. = klip.*
*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. c. = hoogtepunt en hoogtecijfer, d. = halfhoogtelijn.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

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TOELICHTINGEN.

*Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21. Stbl, No. 29.*

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

## EXPLANATION

Large numbers and heavy lines indicate terrain areas.

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Lake

▲▲▲ Rocky area

Coastal bluffs and cliffs

Common abbreviations

P. Island
Tg. Cape
A. River
X. River
Bk. Mountain

# HALMAHERA (MOLUKKAS) TERRAIN APPRECIATION

Reliability Rating: Class B

SHEET NO. XXI-99

## Area No. 29. Laboeha-Sajoang River Corridors.

Topography. Rounded hilly ridges sloping gently northwest from Sibela Range; cut by small sub-parallel streams draining across a marshy coastal strip to sea. See sheet XX-99 for complete description of area.

Ground conditions. Area has deep sandy loam or sandy clay soil; generally well drained and dries quickly.

Coconut palms are main type of vegetation. Some swamp palms also. Extensive coffee plantations.

Settlements. Plantations on well-drained, hilly ground back from coast.

Movement. Open vegetation of plantations permits movement of motorized units. Small patches of swamp vegetation on coast are minor obstacles readily by-passed. Little dense forest left in area.

Cover, concealment, observation. Little cover for vehicles in area; ravines and stream banks can give local cover for men.

Concealment generally adequate for small groups of men; inadequate for mechanized units in most parts of area.

Ground observation fairly good in plantations; limited to a few yards in patches of forest or swamp.

## Area No. 30. Sibela Mountains.

Topography. High, unbroken mountain mass with northeast-trending crest; forms central lobe of Batjan Island. At northeast end, major crest divides into two long ridges. Southwest and central parts of area nearly 2000 m. in altitude; Sibela Mtn. reaches maximum altitude of 2111 m.; northeast end is between 1000 and 500 m. in altitude.

Summit narrow; slopes generally very steep, but in places lower slopes more moderate; slopes furrowed by many small rocky ravines and short narrow valleys with steep gradients. Mountain sides rise abruptly from sea or from narrow strip of beach.

Streams short and small; probably subject to sudden floods in rainy seasons. Largest stream, the Watjaoea, is about 6.5 mi. long; flows in V-shaped valley with rocky stream channel occupying nearly entire width of valley floor.

Ground conditions. Fine sandy loam to sandy clay; grade downward into deeply weathered bedrock at depths of 10 to more than 20 ft. Bare rock exposed along valley bottoms and along many parts of range crest. Some rocky headlands and benches. Footing is good when soils are dry. During rainy season soil forms slippery mud but good drainage permits fairly rapid drying.

Mountains heavily forested except on lower north slopes bordering Laboeha-Sajoang Isthmus (Area 29), which are covered locally by dense second growth forest. Fringe of coconut palms along less precipitous parts of coast.

Settlements. No permanent settlements.

Movement. Area is formidable and unbroken barrier; cannot be crossed by motorized units without construction of roads. No trails known to cross or penetrate area. Foot troops probably can skirt area across lower slopes of mountains and along beaches; movement over mountains probably easiest along ridge crests where vegetation is less dense than in ravines and valleys. Streams easily forded except when in flood.

Cover, concealment, observation. Rough forested terrain gives good cover and concealment. Dense vegetation greatly restricts observation; summits of range may serve as observation points commanding seas around island.

## Area No. 31. Southeast Batjan.

Topography. Southeastern lobe of Batjan Island is rough and mountainous with long irregular ridges and a few prominent isolated peaks. Small coastal lowlands on north and south shores; narrow alluvial plain forms isthmus between southern Batjan and Sibela Mountains (Area 30). Altitudes generally less than 500 m. Scattered peaks are 500 to 700 m. in altitude; maximum altitude of more than 900 m. reached by Bibinoi Mtn.

Long narrow ridges with rounded summits and steep upper slopes predominate in most parts of area; lower slopes commonly moderate to gentle along principal valleys. Ridges cut by numerous steep rocky ravines. Bibinoi Mtn., most prominent mountain in area, has a rough conical form with numerous ridges radiating from the central peak.

Streams are fairly short; the Rain River, largest, is a little more than 8 mi. long and heads only 2 mi. from south coast. Most larger streams are between 100 and 200 ft. wide; probably fairly shallow except during heavy rains when they may suddenly rise several feet. Principal streams have open V-shaped valleys with moderate to gentle gradients. In some places valleys have narrow flats bordering the stream; in others, channels occupy entire width of valley floor. Small streams have narrow valleys with steeper gradients.

Isthmus between Wajaoea and Lapan Bays is about 3.5 mi. wide; bordered by Sibela foothills (Area 30) and low elevations at edge of southeast lobe of Batjan. Isthmus is flat or gently rolling. Narrow coastal lowland of variable width extends from isthmus eastward; west of Bibinoi commonly less than 0.2 mi. wide, to east is 0.3 to more than 2.0 mi. wide. On south coast, mountain slopes generally rise steeply from narrow beach, or form rocky headlands. Long hilly spur extends west from village of Liaro to form small bay of Silang. Small coastal lowland on north side of Silang Bay is between 0.2 and 0.5 mi. wide.

Ground conditions. On mountains, lateritic loam and clay loam; becomes increasingly stony at depth, grading into weathered volcanic rock. Depth to bedrock generally about 20 ft., shallower along streams where bare rock is locally exposed. Along coast to a height of about 500 ft., coral limestone interbedded with sand and gravel deposits overlies volcanic rocks; locally forms broad irregular terraces covered with thin stony clay soil. In places coral forms low cliffed headlands and rocky slopes.

The narrow alluvial lowland between Wajoea and Lapan Bays has a sandy clay loam soil.

Soils are permeable and well-drained; become plastic and slippery when wet. Except areas near coast underlain by limestone, ground easily excavated with hand tools; excavations may be subject to slides and slumping in rainy weather; excavations on Wajoea-Lapan isthmus fill with water during rainy season.

Most of area covered by rain forest; undergrowth generally open except in some valley bottoms and on low ground of isthmus. Areas of grass, cleared land or second growth forest border scattered native villages; are most extensive across the isthmus.

Settlements. Several small native villages along coasts. Interior has no permanent settlements; temporary camps of gum-damar collectors common in mountains.

Movement. Rough terrain and dense forest make southeast Batjan unsuitable for free movement of motorized units in most parts of the area.

Wajaoea-Lapan isthmus is only corridor of easy movement in area; dense forest makes isthmus unsuitable for mechanized troops although topography is favorable. Foot troops must cut their way through thick undergrowth in many places. Wide patches of grass and young second growth around the village permit movement of motorized troops; beaches and bordering open coconut groves may permit some coastwise movement and deployment. Good foot path across isthmus probably can be easily improved for use by light vehicles in drier weather; trail probably would fill with deep mud under heavy traffic in wet weather.

Mountainous interior is barrier to motorized troops. Several trails made by damar-gum collectors wind through the area but cannot be used by wheeled vehicles without considerable construction. Away from trails, foot troops probably can move most easily along ridge crests.

Streams can be forded except for short periods after very heavy rains. Densely forested valley bottoms or swampy margins are obstacles to crossings.

Cover, concealment, observation. Cover is good in broken terrain of ridges and valleys which occupies most of area. Little cover on isthmus or coastal plain; locally some topographic irregularities which will protect a few men; hasty fortifications are best source of cover.

Concealment for men and machines is excellent. Locally grass or young second growth is inadequate for vehicles.

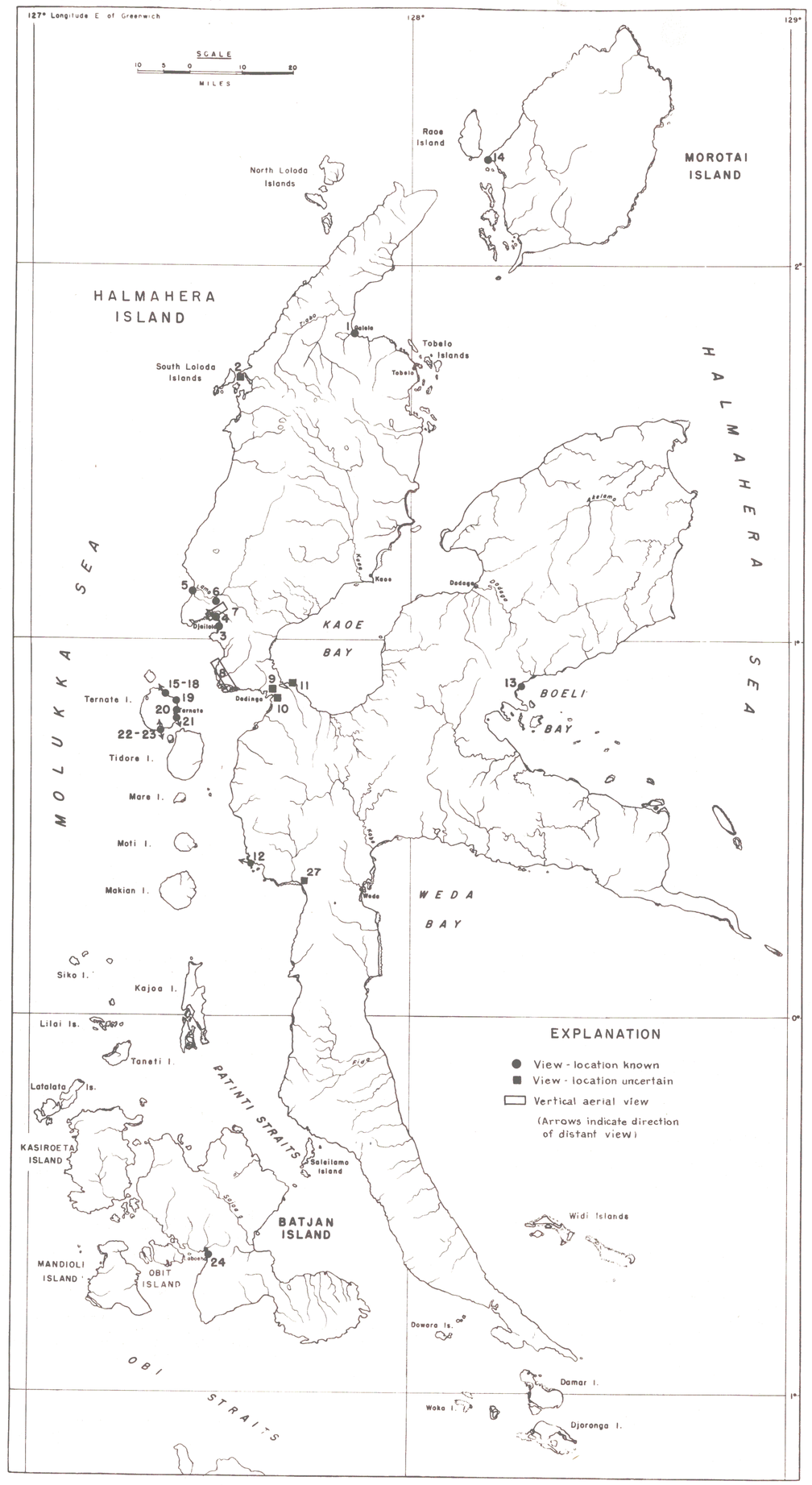
Dense vegetation greatly restricts observation although topography offers many vantage points. Ground observation generally limited to a few yards or less. Tree crowns largely hide even well-used trails from aerial observation.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

# HALMAHERA (MOLUKKAS)

## VIEWS: INDEX MAP

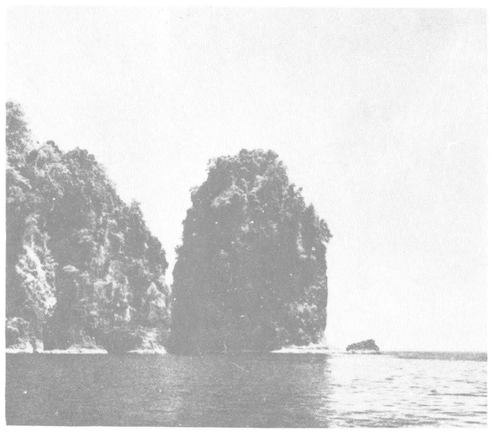



PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

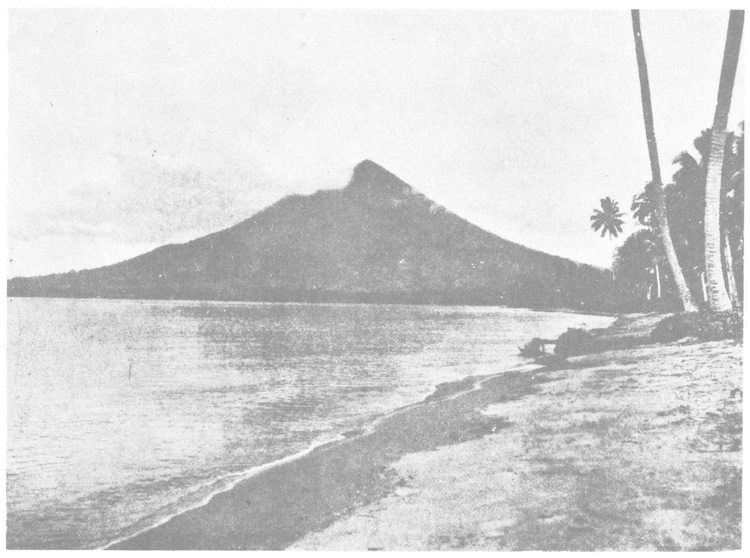
# HALMAHERA (MOLUKKAS)

VIEWS 1-6

1. Shore topography at Galela. Note narrow beach and low, rounded beach ridges, with slightly lower ground on inland side. The trees are coconut palms. Ridge would give some cover for landing parties. (ONI No. 173-717).



2. Sea cliffs and pinnacle on shores of South Loloda Islands. Such cliffs are found also at many places along the coast of Halmahera, and are an obstacle to landing operations. (Fairchild, Garden Islands of the Pacific).



3. Djailolo Peak, viewed from southeast. A cloud covers left side of peak. Note sandy beach in foreground, bordered by coconut palms. Low step where beach cuts against tangled roots of palms gives some cover for landing parties. (Prince Leopold van Belgie, De Reis Door den Indischen Archipel).

4. Djailolo Peak and Djailolo Town. Note coconut palms along shore, steep, forested slopes on peak, and clearings and tracts of second growth forest toward foot of peak. (ONI No. 173-712)

5. Horse trail south of village of Soesoepoe, passing through grove of coconut palms with light undergrowth. Trails similar to this connect many of larger villages. (ONI No. 173-726).

6. Vertical aerial view of airfield site on Djailolo Plain started by Dutch before Japanese occupation. Photo taken in January, 1943. Village labelled Tedeng probably is Ngaon. (ONI No. 143-756).

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7. Strip mosaic of Djailolo Town and territory to northeast. Relief here not greater than a few tens of meters. Features of interest are labelled. (ONI Nos. 203-036 to 042).

8. Terrain and possible airfield site north of Sidangoli (Area 10). A. Swamp forest. B. Second growth forest. C. Mangrove swamp. D. Native clearing with felled trees. E. Alang-alang grass. F. Coconut palms. G. Sidangoli River. H. Trail. I. Stream crossing. J. Border of swamp forest and second growth. K. Fresh water zone of lower trees and brush at center of island. L. Waves breaking on beach. M. Stream mouth. N. Small, narrow coral reef. O. Stream course in swamp. P. Dry stream course. (ONI Nos. 203-045 to 052.)

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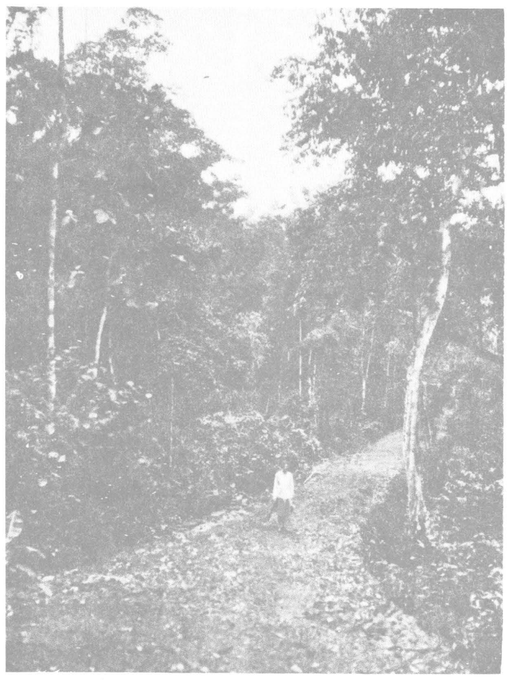
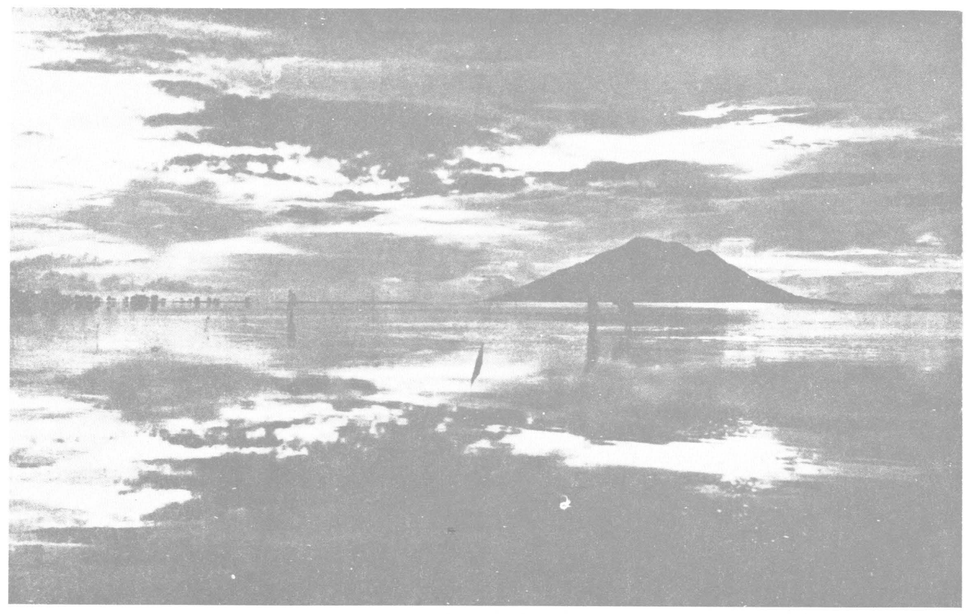


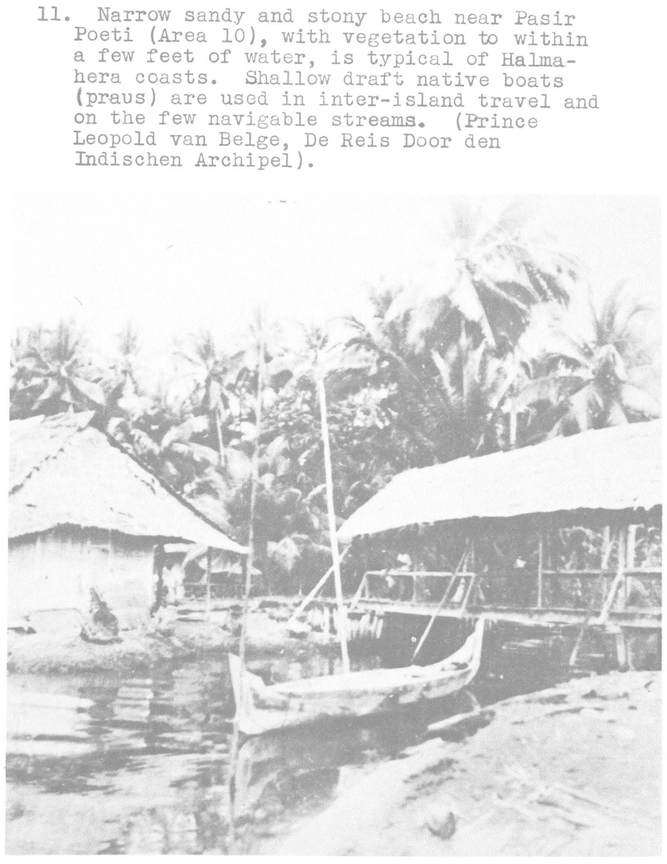
9. Road across narrow Dodinga Isthmus (Area 10), between Dodinga and Kaoe Bays, is one of few routes suitable for light motorized traffic in dry weather; road reported to have been improved since date of photo (1928 or earlier). Dense growth of small to medium sized trees with tangled undergrowth is typical of fairly advanced second growth forest. (Prince Leopold van Belge, De Reis door den Indischen Archipel).

10. Native village on Dodinga Bay at the isthmus (Area 10). Small villages commonly built at inland margin of beaches so as to entail as little clearing of forest as possible. (Prince Leopold van Belge, De Reis Door den Indischen Archipel).

11. Narrow sandy and stony beach near Pasir Poeti (Area 10), with vegetation to within a few feet of water, is typical of Halmahera coasts. Shallow draft native boats (praus) are used in inter-island travel and on the few navigable streams. (Prince Leopold van Belge, De Reis Door den Indischen Archipel).



12. View from Woda Island (Area 11) westward toward small volcanic island of Moti (Area 24). Waders in middle distance indicate shallow depth to which water commonly covers growing coral reefs. (Fairchild, Garden Islands of the Pacific).



13. Village of Boeli, showing native dwelling, covered foot bridge, and small stream with low banks. (ONI No. 173-708).

14. Village of Wajaboela, on west coast of Morotai, looking eastward. Note narrow beach at high tide, and exposed root systems of coconut palms at water's edge. Coastal area here essentially flat. (ONI No. 173-745).

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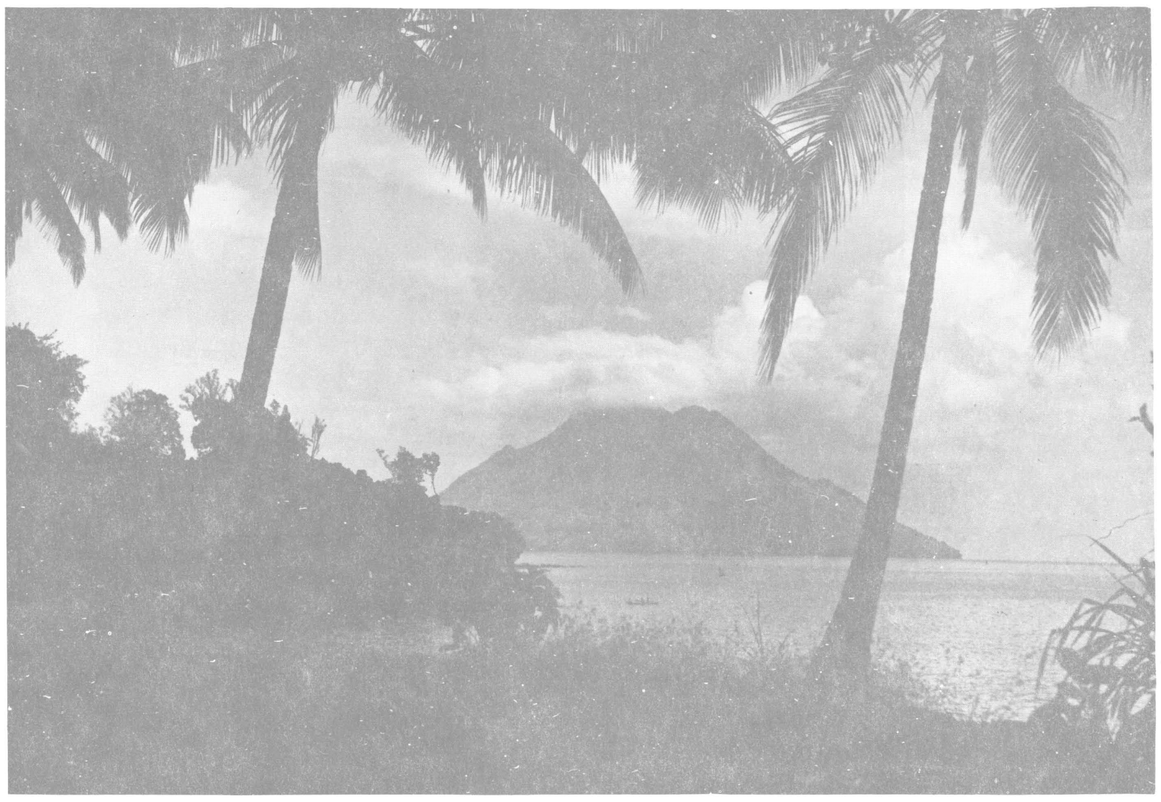
15. Cobbly beach on northeast Ternate Island. Similar beaches found around other volcanic islands and along coastal section of volcanic mountains on Halmahera. (ONI No. 195-202).

17. Low sea cliff at end of lava flow shown in View No. 16. Rocky shores of this type are found at several places around volcanic islands. (Prince Leopold van Belgie, De Reis Door den Indischen Archipel).

16. Rocky, irregular surface on eighteenth century lava flow on northeastern Ternate. Such surfaces found on recent lava flows on other islands and on volcanic peaks of Halmahera, and are difficult to cross. Larger rock projections give cover for men. Note also auto road across lava. (Nat. Geog. Mag., May, 1941, p. 542).



18. Volcanic island of Hiri, north of Ternate. Note steep, rugged slopes down to water's edge. Photographed 1937. (Nat. Geog. Mag. No. 112554-A).

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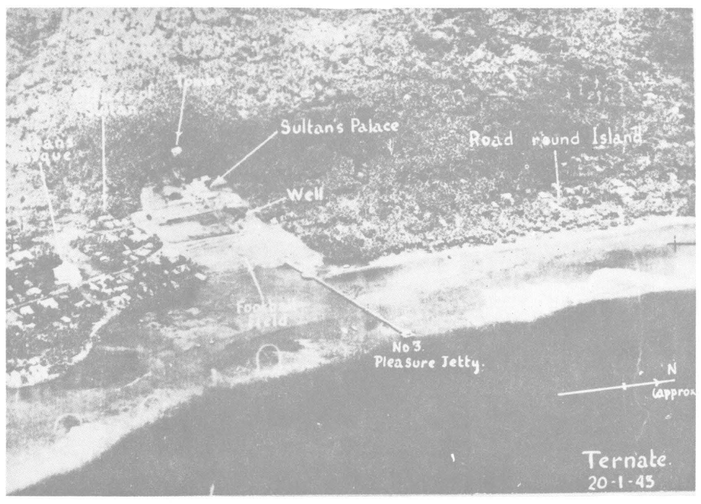
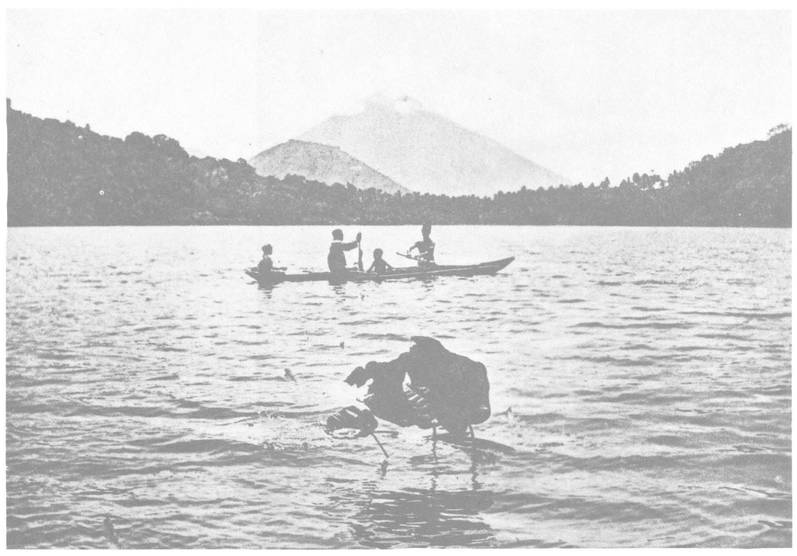
19. Ruins of old stone fort Terlugo as seen from shore. Fort built by Portugese several centuries ago. Could still be used as defensive position. Note also rocky bluffs behind beach. Photographed 1937. (Nat. Geog. Mag. No. 112560-A).




20. Oblique aerial view of Ternate Town, showing Sultan's palace and jetty, together with surrounding buildings and forested slopes in background. Shore fringed by narrow coral reef. (ONI No. 154-115).

21. Looking south across Ternate Harbor to Tidore Island. Note pier in foreground, and rugged volcanic slopes of Tidore in background, with large bare patches. (NEFIS).



22. Looking south over Lake Lagoena toward Tidore Peak. (Prince Leopold van Belgie, De Reis Door den Indischen Archipel).

23. Looking north across Lake Lagoena toward forested slopes of Ternate Peak. Note typical tropical vegetation in foreground, and steep slopes in background. (Prince Leopold van Belgie, De Reis door den Indischen Archipel).

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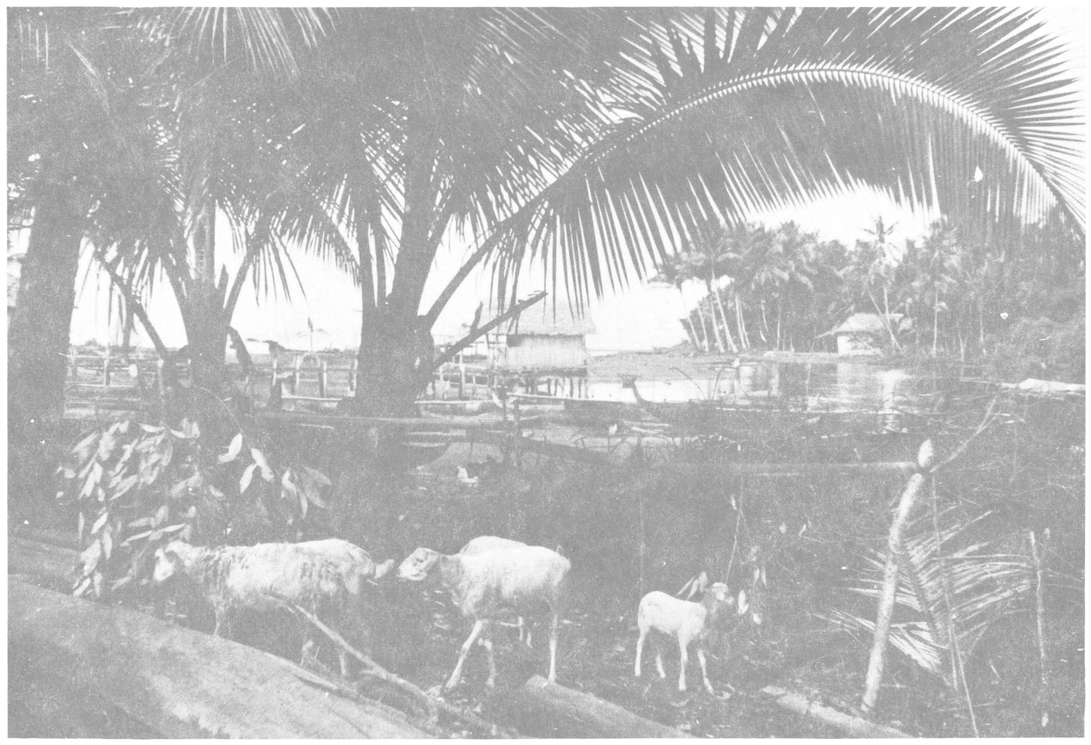
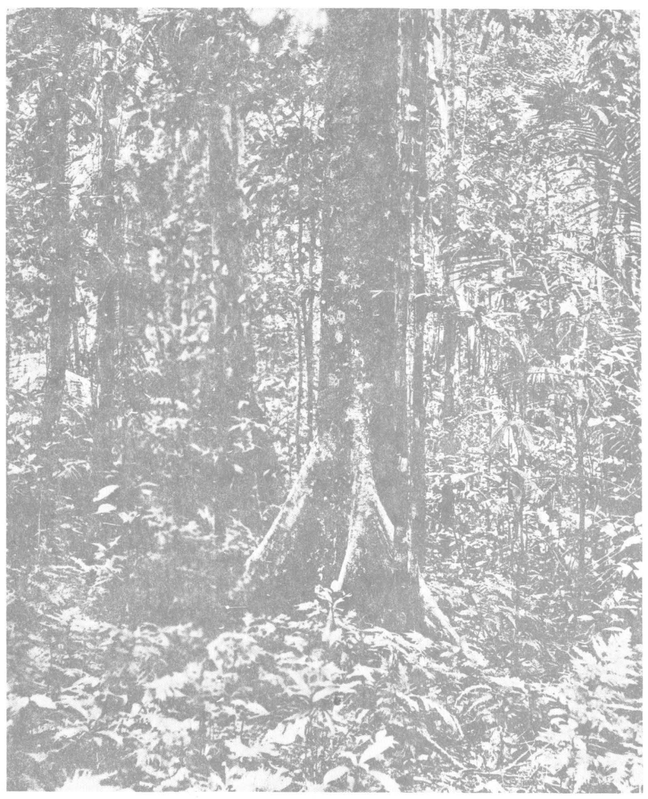
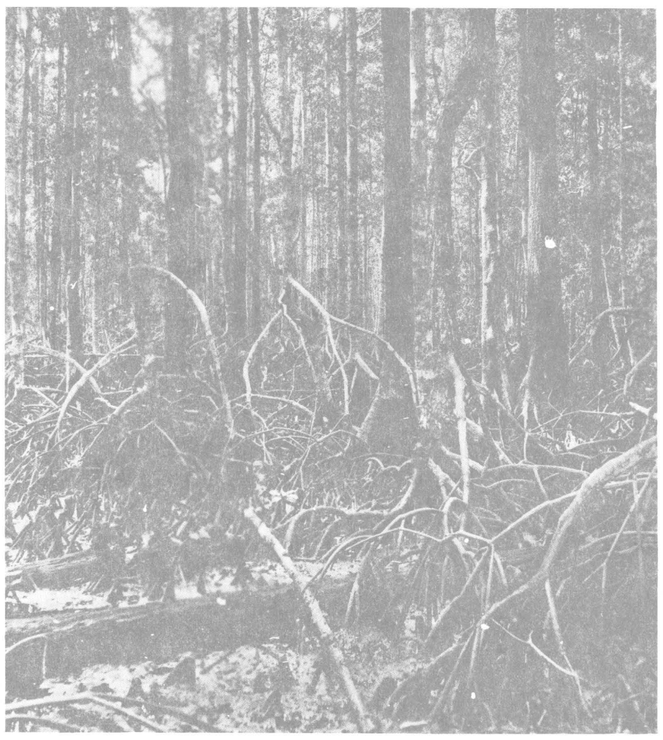


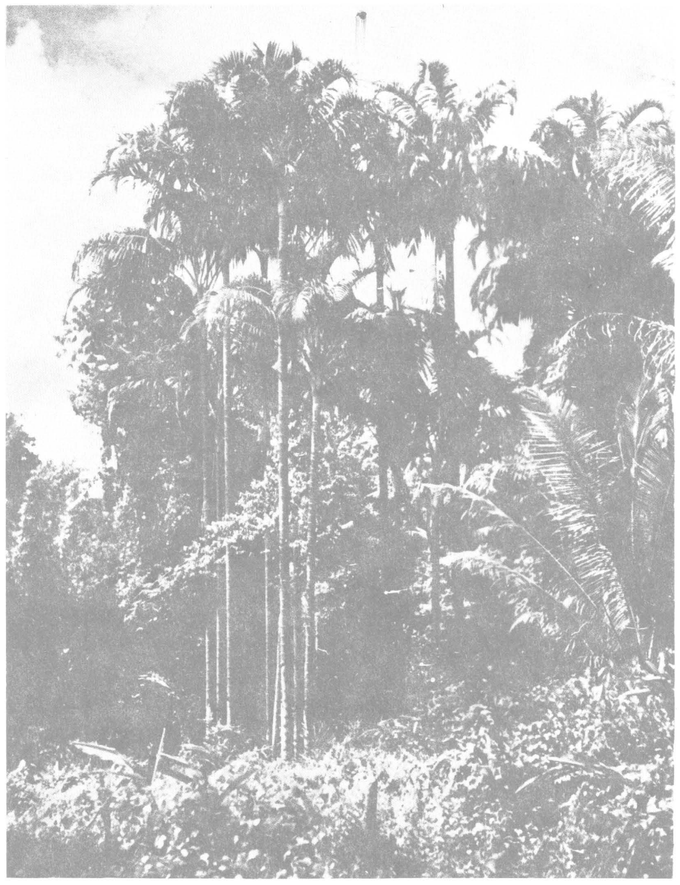
24. Shore of Laboeha Bay (Area 29), showing mud and sand flats and small lagoons developed at low tide level on low, shelving shores. Native houses and catwalks built on stilts are common in villages bordering such tidal flats. Rain forest fronted by belt of palms extending down to narrow strip of beach is common throughout Molukkas except where natural vegetation has been disturbed in clearings around villages. (Nat. Geog. Mag. .No. M637-23).



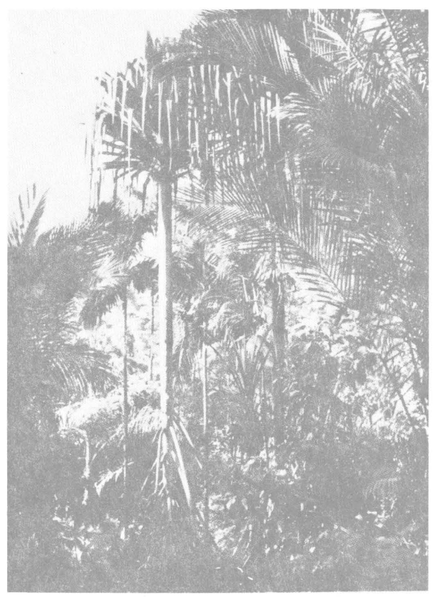
25. Rail forest common to most islands of Dutch East Indes showing typical undergrowth between large trees. (Prince Leopold van Belgie, De Reis door den Indischen Archipel).



26. Typical mangrove swamp at low tide; mangrove occurs locally within tide range at many places along coastal lowlands of Dutch East Indes. Soft muddy ground and dense tangle of roots are serious obstacle to movement. (Prince Leopold van Belgie, De Reis Door den Indischen Archipel).



27. Young second growth trees coming up in old clearing near village of Pajahi-islam (Area 18); bordered by rain forest. (Fairchild, Garden Islands of the Pacific).



28. Assemblage of several types of palms commonly found in tropical forest on broad river plains and coastal lowlands in the Molukkas. (Fairchild, Garden Islands of the Pacific).

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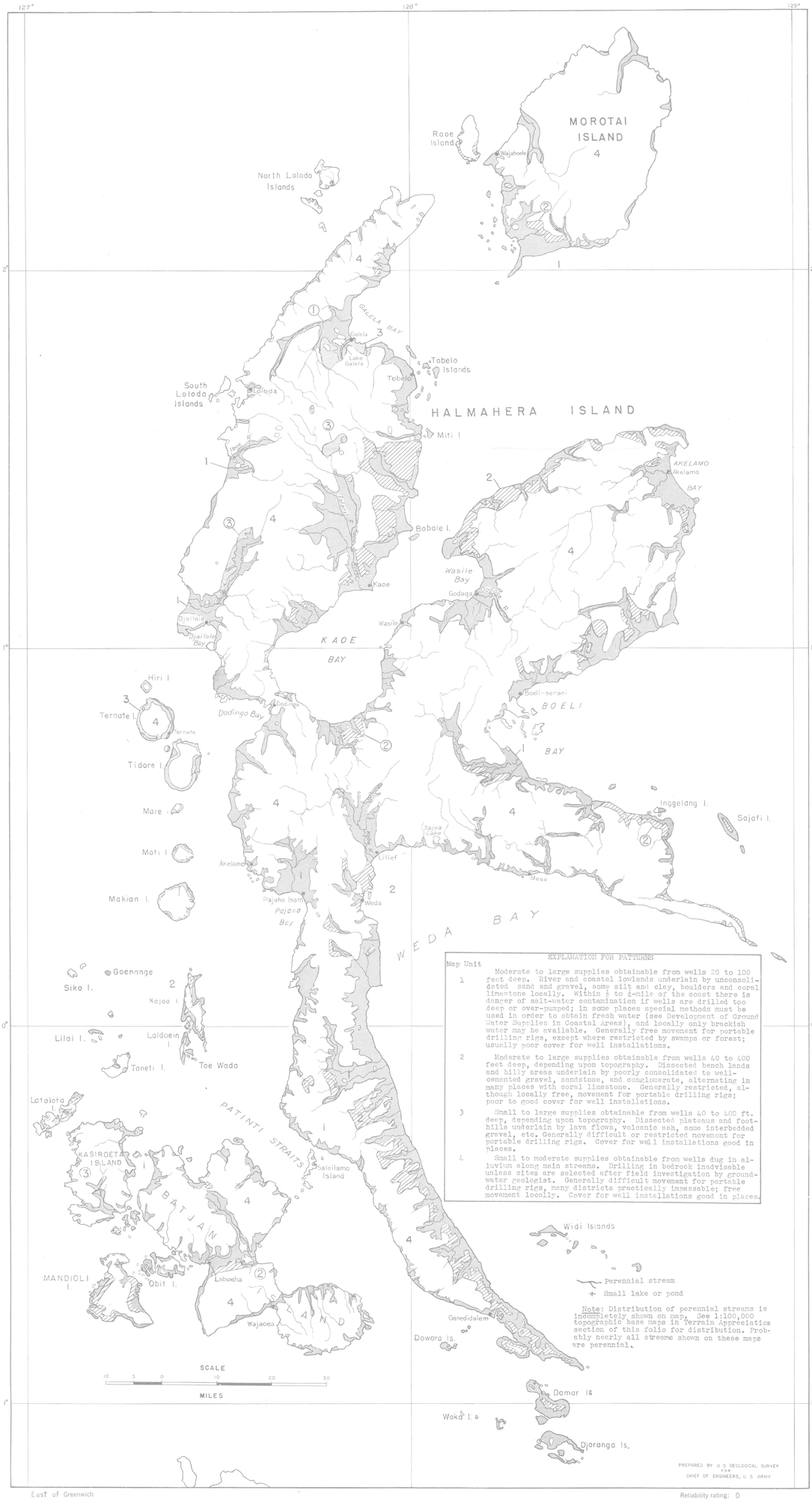


EXPLANATION FOR PATTERNS

Map Unit

1 Moderate to large supplies obtainable from wells 20 to 100 feet deep. River and coastal lowlands underlain by unconsolidated sand and gravel, some silt and clay, boulders and coral limestone locally. Within ½ to ¾-mile of the coast there is danger of salt-water contamination if wells are drilled too deep or over-pumped; in some places special methods must be used in order to obtain fresh water (see Development of Ground Water Supplies in Coastal Areas), and locally only brackish water may be available. Generally free movement for portable drilling rigs, except where restricted by swamps or forest; usually poor cover for well installations.

2 Moderate to large supplies obtainable from wells 40 to 400 feet deep, depending upon topography. Dissected bench lands and hilly areas underlain by poorly consolidated to well-cemented gravel, sandstone, and conglomerate, alternating in many places with coral limestone. Generally restricted, although locally free, movement for portable drilling rigs; poor to good cover for well installations.

3 Small to large supplies obtainable from wells 40 to 400 ft. deep, depending upon topography. Dissected plateaus and foothills underlain by lava flows, volcanic ash, some interbedded gravel, etc. Generally difficult or restricted movement for portable drilling rigs. Cover for well installations good in places.

4 Small to moderate supplies obtainable from wells dug in alluvium along main streams. Drilling in bedrock inadvisable unless sites are selected after field investigation by ground-water geologist. Generally difficult movement for portable drilling rigs, many districts practically impassable; free movement locally. Cover for well installations good in places.

East of Greenwich

Reliability rating: D

SUMMARY

Halmahera, Batjan, Kasiroeta, and Morotai have many perennial streams which will supply large troop units. In numerous areas wells will also provide large supplies, and in most places where large troop concentrations are likely to occur water can be obtained at shallow depth. Ternate, Tidore, Makian, and the smaller islands have few or no perennial streams and ground water is the only source for large supplies. The Well Drilling Guide shows areas favorable for installation of wells.

## RECOMMENDED SOURCES

### Immediate Supply

Immediate supplies are available from perennial streams, lakes, springs, or shallow wells. Perennial streams are numerous on thelarger islands, but are rare or lacking on Ternate, Tidore, Makian,and the smaller islands. Lakes and ponds are uncommon except in some parts of the larger islands, especially on the northern peninsula of Halmahera. For potable supply, water from streams will require filtration and chlorination, water from lakes will need only chlorination. Springs usually are numerous, and many of them large, in inland parts of class 1 areas (Well Drilling Guide) and in class 2 and 3 areas, and are locally present in class 4 areas. At most settlements in class 1 areas shallow wells already exist. They commonly are polluted, and the water must be sterilized before being used for drinking. Additional wells will generally develop moderate to large supplies in class 1 areas, usually within 50 feet of the surface, and can be sunk rapidly in unconsolidated alluvium, either with drive points, by drilling or boring, or by digging with hand tools. Shallow wells also will develop small to large supplies from alluvial deposits along perennial streams in class 2, 3, and 4 areas.

### Permanent Supply

Many sources for immediate supplies also will be suitable for permanent supplies. In class 1 areas wells commonly are preferable to surface water, to avoid the necessity for filtration and extensive transportation. In class 2 and 3 areas wells ordinarily will be drilled only for permanent supplies, and if water is not available from a more convenient source. In these areas wells generally must be 50 to 300 or more feet deep in order to encounter water-bearing material, and drilling will take much time, especially in class 3 areas where much hard lava rock is likely to be encountered. Class 4 areas are largely unsatisfactory for obtaining water from wells (except shallow wells in stream alluvium); however, in some places it may be possible to drill wells producing moderate to large quantities, but locations must be chosen by a ground-water geologist in the field. In places in class 2, 3, and 4 areas where there is no convenient access to perennial streams of adequate yield and where well drilling is inadvisable, it may be feasible to construct small storage reservoirs to store stream run-off. On some of the smaller islands, particularly coral islands less than ½-mile wide, all ground water may be brackish and it will be necessary either to catch rainwater, to install distillation equipment, or to import water.

## INTRODUCTION

### Topography

Halmahera and the other large islands are mostly mountainous. In places the foothills or mountains rise directly from rocky headlands or narrow beaches, but generally a narrow belt of coastal lowland separates them from the shore. At the mouths of most of the large rivers are fairly extensive delta plains. In the mountains the numerous streams have deep narrow valleys and steep gradients. At lower altitudes the gradients decrease rapidly and the larger streams have fairly wide floodplains; near the mouths the banks probably are low natural levees, locally bordered by swamps. The small coral islands are low-lying and flat.

### Population and Development

The Halmahera group is sparsely populated. Most of the larger islands are inhabited only along the coast, and many of the smaller islands are uninhabited or inhabited only during part of the year. In 1930 Halmahera had a population of about 72,000, including 128 Europeans. Over half of the people in the region live on the islands of Ternate, Tidore, and Makian. Ternate, thelargest town and capital of the Ternate Residency (province), had a population of 6,000 in 1930. Most of the region is in a very primitive stage of development and large parts are completely undeveloped. Ternate is theonly town with a municipal water distribution system. Other towns have few public improvements. Roads passable for automobiles are limited to the islands of Ternate and Tidore and the immediate vicinity of some of the larger towns on Halmahera and Batjan.

## SURFACE-WATER SUPPLY

### Precipitation

The Halmahera region has a tropical rain forest climate, slightly modified by monsoon winds, but the monsoon influence appears to be less appreciable than in other parts of the East Indies, and there are no pronounced seasons. Precipitation records from 12 stations, all on the coast (see Climate sheet), show average annual precipitation ranging from about 62 to over 104 inches. At higher altitudes in interior parts of the larger islands precipitation is doubtless greater. The rainfall is distributed fairly evenly through the year, although at most stations April, May, and June are the months of greatest rainfall, and October, November, and December the months of least precipitation. Both the amount and the monthly distribution of rainfall vary considerably from station to station; in general, the annual precipitation is greater in the south than in the north part of the region.

Most rain storms are of marked intensity and short duration and generally occur during the hottest part of the day (mid-afternoon). However, two or more days of nearly continuous rain are not uncommon.

### Streams

Stream distribution is shown by the 1:100,000 scale topographic base maps in the Terrain Appreciation section of this folio. Inasmuch as rainfall is heavy and fairly evenly distributed throughout the year, most of the streams shown are perennial and have large discharges in proportion to the area of their drainage basins. In most parts of the larger islands perennial streams are closely spaced and will readily supply moderate to large concentrations of troops. In some areas, however, the bedrock and soil are very permeable, so that most of the drainage is underground and perennial streams either are lacking or are found only in the larger valleys. Such areas include Ternate, Tidore, Mare, Moti, Makian, and Kajoa, numerous smaller islands, and belts of coral limestone along the coasts of the larger islands.

The majority of streams flow in deeply-incised valleys and have steep gradients almost to their mouths. Lower

(CONT.)



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parts of the larger rivers usually have extensive flood-plains, large deltas, and fairly low gradients. The high-water season is April, May, and June, but high-water and low-water seasons are less pronounced than in most parts of the East Indies, where rainfall is distributed more irregularly though the year. Flash floods are common on interior streams, where torrential rains are frequent and steep slopes and scanty humus cover promote rapid run-off. They may occur at any time of the year, but are especially frequent during April, May, and June. Inasmuch as flood crests tend to flatten out downstream, i.e. , to become less intense and of longer duration, floods on the lower parts of large rivers are less "flashy" and rise and fall more gradually in stage.

Lakes

Fresh-water lakes and ponds are present in some parts of the larger islands. They are especially numerous in the belt of younger volcanics on the northern peninsula of Halmahera. Lake Galela, the largest, is 3 to 3-3/4 miles long and 1 to 2 miles wide, irregular in shape, encloses 6 islands, and has no outlet. The maximum depth is 155 feet and altitude of the water surface 56 feet. Lina Lake feeds an important headwater tributary of the Kau River, is 2,000 feet long by 1,300 feet wide, and maximum depth is 118 feet. Sagea Lake connects with the sea through a short narrow channel and is salty.

On Ternate I. there are three small lakes. Lagouna Lake, at the south end, is fresh, 2,250 feet long by 1,200 feet wide, with water surface at 7 feet altitude. It is separated from the sea by a ridge 30 feet high. Tolire djaha, near the northwest coast, is 1,900 feet long by 1,600 feet wide, fresh water. Tolire keljie, a quarter-mile to the north, is only 900 feet long by 350 feet wide and is so close to the shore that it may be brackish.

Quality of Water

All the surface water is low in mineral content, except within the zone of salt-water tidal invasion at mouths of rivers. The water in streams is turbid at high-water stages on account of much suspended fine sediment, but at low-water stages it usually is relatively silt-free. However, decided color and unpleasant odor and taste generally are present even at low-water stages, because of dissolved and suspended organic matter. The organic matter cannot be completely removed by ordinary purification methods. All surface water is liable to pollution and should be chlorinated if used for drinking.

Development Problems

Only the beaches, the drier parts of the deltas, and the lower foothill region are easily accessible. In most interior parts of the large islands movement of wheeled vehicles will be extremely difficult, hence only small supplies which can be treated by Lister bags are likely to be needed. In the accessible parts, mobile purification units can be used on perennial streams. Commonly, however, water supplies can be developed more quickly and easily by sinking shallow wells (drive points, drilled, or dug wells) in floodplain alluvium than by constructing reservoirs. If properly located, wells will provide supplies safe from flood damage and interruptions of operation by clogging. The natural filtration which occurs will make the water much more amenable to treatment and will release mobile purification units for other uses.

Small reservoirs to impound stream run-off during the rainy season or from flash floods can be constructed by damming constricted parts of canyons in hilly or mountainous districts. They should be located on small streams and should have large spill-ways, in order to avoid frequent wash-outs. Intakes must be protected against plugging from vegetative debris, and against high current velocities; on floodplains where streams have developed braided channels, provision should be made for possible shift and abandonment of existing channels. Where feasible it will be advisable to locate the main storage reservoir off the main channel, for instance in a small tributary gulch, and divert the water into it by an unpretentious and easily replaced diversion dam and canal. Plunge-pools in mountain streams offer storage facilities, the capacity of which commonly can be increased by small dams.

In areas underlain by permeable or badly fractured rock, such as gravel, conglomerate, or cavernous limestone, seepage losses from reservoirs may be high. They can be reduced by a blanket of clay or clay loam, protected by gravel or rip rap where subject to current action. Suitable blanketing material generally is available either as lenses in floodplain alluvium or as residual mantles overlying limestone, shale, old volcanic rocks, or schist. In limestone areas construction of reservoirs may not be feasible in some places because of large solution channels which cannot be effectively sealed.

GROUND WATER SUPPLY

Geology and Ground-Water Conditions

On the Well Drilling Guide various areas have been differentiated on the basis of geology and ground-water conditions. Class 1, 2, and 3 areas are favorable for obtaining supplies from wells at feasible drilling depth. Some places in class 4 areas also are favorable, but such sites must be determined after field study by a ground-water geologist. In this section, only the characteristics of the rock formations which influence the occurrence and recovery of water are discussed; further description and also the distribution of the formations is given in the Geology section of the folio.

Class 1 areas are coastal and river lowlands (floodplains, beaches, and low benches) underlain principally by unconsolidated or partly consolidated gravel, sand, silt, and clay (called "Quaternary alluvium" in Geology section). Locally there are small bedrock exposures, such as coral limestone, conglomerate, lava rock, etc. In the outer parts of the larger deltas the alluvial deposits are chiefly sand, silt, and clay; farther inland they are mainly sand and gravel, and in places contain boulders as much as several feet in diameter. The gravel and sand strata are moderately to highly permeable, except where they have a very silty or clayey matrix. Interbeds of silt and clay are impermeable. Depth to water rarely exceeds 30 feet on floodplains along perennial streams, but locally is as much as 100 feet beneath uplands. Class 1 areas are the most favorable for rapid development of large supplies of water by wells. Similar alluvial deposits also occur in river valleys and small basins in class 2, 3, and 4 areas, in patches too small to be differentiated on the Well Drilling Guide and Geology map. In class 4 areas they commonly will be the only possible sources for ground-water supplies.

Class 2 areas are bench lands and lower foothills underlain by partly consolidated to consolidated gravel, sand, and conglomerate, in places interbedded with coral limestone ("Pliocene and Quaternary conglomerate and reef limestone" and "Pliocene and Quaternary conglomerate" in Geology section). Many of the smaller islands are underlain entirely by coral limestone and coral sand. Most coral limestone and some gravel beds are highly permeable, but much of the conglomerate, gravel, and sandstone is only moderately permeable, and some beds contain



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so much silt and clay or are so tightly cemented that they are almost impermeable. Depth to water ranges from a few feet along perennial streams to as much as 300 feet beneath the higher hills or benches. Alternation of permeable with less permeable beds causes part of the ground water to be held up above the main water table as "perched ground water." Where valleys cut deeply enough, the perched ground water emerges in places as springs or zones of seepage.

Class 3 areas are foothills or low plateaus underlain by lava flows, commonly interbedded with thick deposits of volcanic ash, with some gravel in places. Some zones in lava rock and many gravel beds are moderately to highly permeable, but the ashy beds generally are impermeable. In general, water-bearing horizons are much less numerous than in class 2 areas. Depth to water ranges from a few feet along perennial streams, to as much as 300 feet beneath higher hills and plateaus.

Class 4 areas: In the interior uplands a wide variety of rock formations are exposed. In general, the rocks either are impermeable or any water-bearing horizons they contain are below feasible drilling depth. However, the geology is very imperfectly known, and it is possible that in some places wells can be drilled that will yield considerable amounts of water. Field geological study will be necessary to locate such places. The following resume of ground-water conditions in the formations exposed in class 4 areas is intended as an aid to the ground-water geologist making such an investigation. ■ Water-bearing formations: (1) Gravel and conglomerate, and (at lower altitudes along the coast) interbedded coral limestone; same formations as in class 2 areas, with similar water-bearing properties, except relief is so great that the water-table generally is more than 300 feet below the surface. Exposed in foothill zone near coast. (2) Young volcanic rocks, similar to those in class 3 areas and with similar water-bearing properties, except high relief causes water-table to be generally more than 300 feet below the surface. These rocks make up the islands Makian to Ternate, and also the central part of north peninsula of Halmahera from Djaillolo Bay to Galela Bay. (3) Limestone, clayey limestone, shale, and sandstone ("Miocene shale and sandstone" and "Early Tertiary limestone"), exposed over large areas in central Halmahera, especially near south coast of Kaoe Bay and north coast of Weda Bay. Some sandstone beds are moderately permeable, but most probably are too clayey to yield much water. Many limestone beds are cavernous and transmit water along solution openings and fractures; these rocks are highly permeable where such openings are numerous. Shale, clayey limestone, and clayey sandstone are practically impermeable. ■ Impermeable formations: The other formations ("Mid-Tertiary volcanics," "Pre-Permian granite," "Pre-Permian mafic igneous rocks," and "Basement schists") are generally impermeable, although locally fractures in massive types may be pervious. Shallow ground water is available from alluvial deposits along perennial streams.

## Quality of Ground Water

The ground water generally is of good chemical quality, although in limestone areas it usually is hard. Most thermal springs contain more or less dissolved sodium chloride, hydrogen sulfide, or other compounds, and few are potable; a few non-thermal springs near the coast are saline. Sanitation standards are low in native settlements and many wells are highly polluted. Some springs, particularly those issuing from coral limestone near settlements, are liable to pollution.

Near the sea, ground water usually is salty at depth, but a lens of fresh ground water floats on the salty ground water. Occurrence and methods of procuring the fresh ground water are discussed in Development of Ground Water Supply in Coastal Areas, below. Very near the coast or on small coral islands it may not be possible to develop fresh water.

## Springs

Springs probably are numerous in many parts of the region, although locations of only a few are known. The number, distribution, size, and permanence of springs vary with local geologic conditions. Some fairly large springs occur at or near the inland margins of class 1 areas, along the base of coral limestone and conglomerate or lava-rock hills and escarpments. Moderate-sized to large springs are numerous in many deep valleys and along escarpments of permeable beds in class 2 and 3 areas and in parts of class 4 areas designated on the Geology map as "Pliocene and Quaternary conglomerate," "Pliocene and Quaternary reef limestone and conglomerate," "Quaternary volcanics," and "Early Tertiary limestone." In areas of other rock formations in class 4 areas there are very few large springs, but numerous small seeps in places. Probably many native settlements in interiors of the larger islands obtain water from springs, but apparently relatively few coastal settlements.

Thermal springs: Thermal springs are fairly numerous in some parts of the region, particularly in the volcanic belt extending across the northern peninsula of Halmahera from Djaillolo Bay to Galela Bay. The majority are not potable. Two thermal springs issue at the base of Djaillolo (Gunung Kjai) volcano near Gofasa village. On the peninsula west of Dodinga Bay are several hot springs. Another hot spring issues on the east coast of Tidore, near Akiasohou.. Several hot springs and geysers are said to be on Batjan, but locations are not known.

Improvement of springs: Yields of many small springs and seeps can be increased by digging trenches, pits, or galleries to concentrate the flow and to insure relatively unimpeded discharge. The excavation should be properly lined and timbered to prevent collapse, and in inhabited regions the watershed of a small area around the spring should be restricted and surface run-off diverted to avoid possibility of pollution. Storage reservoirs may be desirable.

## Wells

Existing wells: Apparently in most Europeanized settlements and plantations and in many native villages water supplies are obtained from wells, mostly large-diameter dug type. In some settlements, such as Tobelo, practically every house has its own well, but in others one or two wells may serve the whole community. Settlements in which wells are definitely known to exist are: Babang (E. coast of Batjan), Katinai (Damar I.), Galela, Tobelo, and Weda (Halmahera), Ternate (Ternate), and Wajaboela and Sangowo (Morotai). Practically all wells are on coastal or river plains (class 1 areas), and usually less than 40 feet deep. Water generally is raised by bucket and rope, lift pump, or other primitive means. Many wells will yield several hundred gallons a minute with modern pumping equipment. Sanitary conditions commonly are bad, and dysentery and other water-bourne diseases are common, hence the well water should be sterilized before drinking. Probably there are almost no existing wells in class 2, 3, and 4 areas, except locally in alluvium along streams.

Development of additional supplies by wells: Larger yields can be obtained from many existing wells by deepening, but ordinarily it will be more rapid and easier to sink new wells. Well-drilling prospects are indicated on the Well Drilling Guide. Boundaries of areas are only approximate because of the rough

(CONT.)



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reconnaissance character of the available geologic information.

Class 1 areas: Coastal and river lowlands underlain by unconsolidated alluvial sediments are the most favorable places for rapid development of water supplies by wells. Abundant supplies generally can be obtained at depths of 20 to 100 feet. Rotary drilling rigs or drive-points will be most rapid, but near foothills or in mountain valleys boulders may necessitate use of percussion rigs or digging by hand. Local thick lenses of quicksand may cause difficulty by caving and possibly may prevent installation of any type of well. Wells will require casing, also properly sized screens if sand aquifers are developed. Proper development (surging, heavy pumping, back-washing, etc.) of wells after drilling is completed commonly will materially increase their yield, but heavy pumping should be avoided within half a mile of the coast to avoid salt-water invasion. Within half a mile of the coast, wells should not be sunk below the zone of fresh ground water overlying salty ground water, and special methods may be needed if large supplies are to be developed (see Development of Ground-Water Supplies in Coastal Areas). Within 1/8-mile of the coast and on coral islands less than ½-mile wide, tidal fluctuations may cause mixing of fresh and salt water so that only brackish water is available.

Class 2 and 3 areas: Wells in conglomerate-limestone (class 2) and younger volcanic (class 3) areas generally can be drilled most effectively with percussion drilling rigs, because the rock formations contain boulders and hard beds not easily penetrated by rotary drills. In hard limestone, conglomerate, sandstone, or lava-rock, blasting at or below the water level after the well is drilled may aid in opening fractures and improve well capacity. In soft sandstone, conglomerate, or gravel, however, blasting is likely to have the opposite effect, and development should be by heavy pumping, surging, or back-washing. Casing may not be necessary below the soil zone unless unconsolidated strata are encountered. Depth to water is too great in most places for dug wells, although in local depressions or along perennial streams the ground water may be near enough the surface so that dug wells will be feasible.

Class 4 areas: Wells can be dug in places along larger streams to obtain water from the alluvium. Drilling in bedrock is inadvisable unless sites are selected in the field by a ground-water geologist. Percussion drilling rigs generally will give most effective results.

## WATER DISTRIBUTION SYSTEMS

### Ternate

Town of Ternate has only water distribution system in region. Water is pumped from two shallow dug wells and treated, probably by chlorination. In 1913, well yield was only about 3 gpm. Waterworks, in same building that houses electric power station and ice plant, is 200 yards from shore, on south side of street extending inland from main pier. Directly behind building is a 12-foot (approximately) pressure tank. System serves only small part of population of about 6,000. Water is piped onto main pier and in 1940 could be supplied to ships at rate of 175 gallons a minute (40 metric tons per hour). The balance of the population is served by private and community wells. The supply is said to have become low at times of unusual drought.

DIAGRAM 1: OCCURRENCE AND DEVELOPMENT OF FRESH GROUND-WATER IN COASTAL AREAS

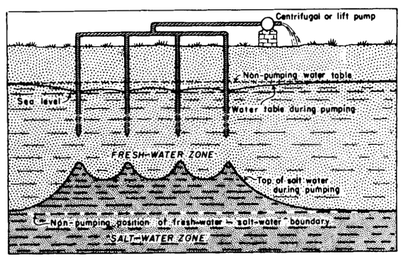



Figure A. Diagram showing relation of salt-water and fresh-water zones during pumping by sand point wells. Note that the rise of the salt water is many times the decline in the water table.

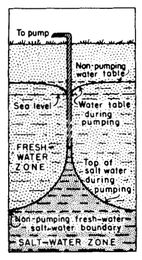



Figure B. Diagram showing how excessive pumping of wells may cause contamination by salt water.

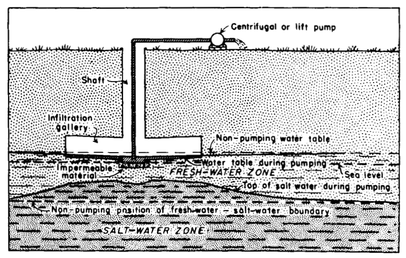


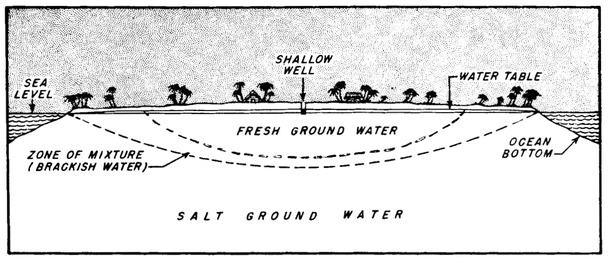

Figure C. Diagram showing infiltration galleries and relation of the salt-water and fresh-water zones during pumping. Note that the rise of the salt water is much less than when sand points are used. The shaft is sunk below the water table and galleries are driven from it. The floors of the galleries are inclined so the water can be collected in a central sump. The highest parts of the floors should be below the lowest level of the water table during the year, but the floors should not extend below sea-level. The sump may be below sea-level or even in the salt-water zone if lined with impervious material. In unconsolidated deposits or loose rock it is essential to provide adequate timbering or other support for walls and roof.

EXPLANATION

In coastal areas where permeable material at sea level is thick, fresh water generally is encountered slightly above sea level and extends to a considerable depth below sea level. Shallow wells drilled in these areas obtain fresh water, but deep wells, even a considerable distance from the coast, obtain brackish or salty water. Furthermore, many wells that originally yielded fresh water begin to yield salty water after a period of pumping. In many coastal areas, however, large quantities of potable water are pumped from shallow wells and in many places this is the only source of potable water. Consequently, the occurrence of fresh water under these conditions has received much careful study.

The underground fresh water floats on salt water because of the difference in density. The thickness of the fresh-water zone is roughly a function of the height of the water table above mean sea level and the density of the sea water. In permeable materials, about 40 feet of fresh water lie below sea level for each foot of fresh water above sea level. Hence the thickness of the fresh-water zone may be roughly determined if the height of the water table above sea level is known. Also, if the water table is lowered the contact between the fresh water and the underlying salt water rises in the ratio of about 40 to 1, so if a well is pumped excessively salt water will enter the well and ruin it, perhaps permanently (see figure B). Therefore, in obtaining water supplies in coastal areas the water level should be lowered as little as possible by spreading the pumpage over a wide area. Where the fresh-water zone is relatively thick and pumping by suction is possible, widely spaced sand-point wells provide an effective and economical means of spreading the pumpage (see figure A ). Where the zone of fresh water is thin, the fresh water can be skimmed off by infiltration galleries, as illustrated in figure C, or by sand points driven horizontally from the bottom of the shaft. Where the water table is close to the land surface, the fresh water can be collected from trenches. The diagrams are not to scale.

DIAGRAM 2: OCCURRENCE AND DEVELOPMENT OF FRESH GROUND-WATER IN CORAL ISLANDS




Fresh ground-water body, derived and replenished by downward percolation of local precipitation, "floats" in hydrostatic equilibrium upon salt water Theoretically, fresh water should extend about 40 feet below sea level for each foot the water table lies above sea level. However, some mixing with salt water takes place at the bottom of the fresh-water layer, chiefly because tidal fluctuations disturb equilibrium, and the actual thickness of the fresh-water layer is always somewhat less than the theoretical thickness. The zone of mixture is thickest near the shore and thinnest in the center of an island. On islands less than ½-mile wide, where the tidal fluctuation is large, no fresh ground water may be available.

Wells should be located along the axis of the island and should not extend more than a foot below sea level. Pumping should be moderate, because if the water level is lowered below sea level salt water will enter the well from below. Pumping only during low tide decreases possibility of salt-water contamination. Supply can be increased by using drainage galleries or several wells spaced at least 200 feet apart. The presence of consolidated coral sand or "beach rock" along the strand favors a thick fresh-water layer and a good water supply. Some plants, for example, mangroves and nipa palms, indicate salt or brackish water; whereas taro plants grow only where ground water is fresh.

Preliminary text submitted without checking or editing.
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Reliability rating: Class D.

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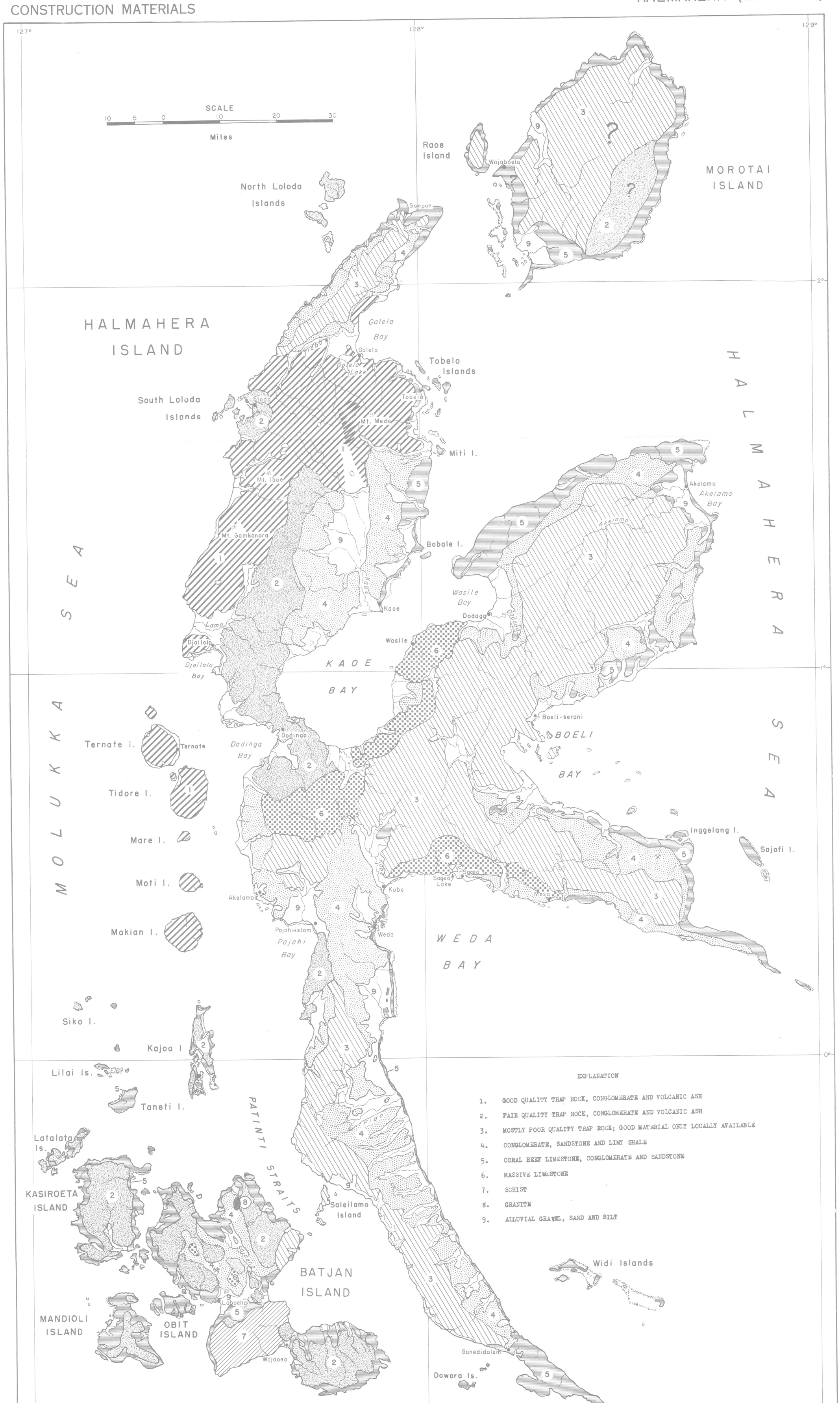
# CONSTRUCTION MATERIALS

# HALMAHERA (MOLUKKAS)




EXPLANATION

1. GOOD QUALITY TRAP ROCK, CONGLOMERATE AND VOLCANIC ASH
2. FAIR QUALITY TRAP ROCK, CONGLOMERATE AND VOLCANIC ASH
3. MOSTLY POOR QUALITY TRAP ROCK; GOOD MATERIAL ONLY LOCALLY AVAILABLE
4. CONGLOMERATE, SANDSTONE AND LIMY SHALE
5. CORAL REEF LIMESTONE, CONGLOMERATE AND SANDSTONE
6. MASSIVE LIMESTONE
7. SCHIST
8. GRANITE
9. ALLUVIAL GRAVEL, SAND AND SILT

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

East of Greenwich

Reliability rating: C

# HALMAHERA (MOLUKKAS)

## CONSTRUCTION MATERIALS

| | KIND OF MATERIAL | AVAILABILITY | SAND AND GRAVEL | CONCRETE AGGREGATE | SURFACING, BASE COURSE AND SUBGRADES: ROADS AND AIRFIELDS | RIPRAP | STONE MASONRY | LIME AND CEMENT |
|---|---|---|---|---|---|---|---|---|
| 1 | Good quality trap rock. Hard, dark, massive tough rock (mostly basalt and andesite with some rhyolite) occuring in layers 10 to 30 feet thick. May have closely spaced, near-vertical fractures. Locally there may be thin, very porous, slaggy layers which may contain zeolite material. In a few localities fresh rock occurs at the surface as fields of large angular fragments and blocks on which little vegetation has developed. Interbedded with the lava rocks are beds of coarse and fine loosely consolidated volcanic materials. | Good trap rock available in many places from recent lava flows and blocky lava fields. Elsewhere may be covered by a few feet of red clayey soil which supports considerable vegetation; stripping necessary to establish a quarry. Spacing and direction of fractures may affect efficiency of blasting and kind of breakage. Rock may locally be deeply weathered on hillsides along fractures, but should be fresh and sound along stream gullies. | Unconsolidated beds of fine pumice and impure sandstone may be suitable. Selected or screened material from coarse volcanic conglomerate and boulder beds makes suitable gravel. | Both massive layers and coarse boulder beds are an excellent and abundant source; very porous material containing zeolite should be avoided except for very temporary construction. Massive rock will require blasting for excavation and crushing. Boulder beds require crushing only but care should be taken to avoid weathered material. | Excellent source; massive layers will require much crushing for use as surfacing. Drilling and blasting will produce excellent material for subgrades or rock fills. Boulder beds and coarser volcanic ash possibly could be worked by power shovel and, without further processing, provide excellent material for surfacing or subgrades. Large fragments could be readily removed by a grizzly. | Massive layers are excellent source; require drilling and blasting for excavation. Boulder beds may be adequate locally, but most of finer interbedded material is unsuitable. | Boulder beds and massive layers are excellent source; latter require drilling and blasting for excavation. Finer material unsuitable. | Not suitable. |
| 2 | Fair quality trap rock. Hard massive tough lava rock (mostly andesite) occurring in thick layers and interbedded with abundant widespread coarse and fine volcanic ash conglomerate, sandstone, and shale. | In most places covered by deep clayey soil as much as 30 feet thick which supports thick forest growth. Stripping necessary. Quarry face difficult to establish in many places because rock is deeply weathered along joints and fractures. Freshest material found along stream gullies. Only a small percentage of the deposit is trap rock; mostly volcanic ash products. | Most of material too weathered to be suitable. Locally, some sandstone may be broken down to form sand. Selected or screened material from unconsolidated volcanic conglomerate and boulder beds may be suitable gravel. | Generally poor material because of deep weathering; locally along streams an adequate quarry can be developed. Massive layers will require drilling and blasting for excavation. Boulder beds suitable. Finer poorly-consolidated materials are probably unsuitable. | Much is unsuitable because of deep weathering. Volcanic boulder beds and ash may provide adequate surfacing material after screening out large fragments with a grizzly. Massive layers and boulder beds occasionally exposed along streams suitable, when fresh, for base course and subgrade material. Will probably require drilling, blasting and crushing. Large residual boulders on slopes may also be suitable when crushed. | Much is unsuitable because rock is weakened by deep weathering. May be adequate where fresh rock is exposed along stream beds. Large residual boulders on slopes may also be suitable. | Mostly unsuitable. May be adequate locally where fresh massive rock is exposed along stream beds. Will require drilling and blasting for excavation. | Not suitable. |
| 3 | Poor quality trap rock. Dark colored granular or platy rocks, (Gabbro diorite and peridotite) rather weak and non-resilient. Some (serpentine ) are strongly sheared and have a soapy or greasy appearance; have low crushing strength. | In most places covered by deep clayey soil as much as 30 feet thick which supports a thick forest growth. Stripping necessary. Quarry face difficult to establish as rock in hills is deeply weathered and rubbly. A few exposures along stream gullies. | Probably not suitable. | For most part a poor source. Locally dark massive tough rocks (gabbro and diorite), if in fresh state and sound are suitable material; require drilling, blasting and crushing. | Mostly not suitable because of deep weathering. May provide adequate surfacing material but probably contains too much clay. Bedrock, exposed at surface only along streams, is in part (gabbro and diorite) suitable when fresh for subgrade and base course materials. Will require drilling, blasting and crushing. The strongly sheared rocks (serpentine and some peridotite ) are not suitable. | Mostly not suitable because rock is weakened by deep weathering. May be adequate where exposed and fresh along stream beds. Large residual boulders on slopes may be suitable. Will require drilling and blasting for excavation. | Mostly unsuitable; may be locally adequate where fresh massive tough rocks (gabbro or diorite) are exposed along stream beds. Will require drilling and blasting for excavation. | Not suitable. |
| 4 | Conglomerate, sandstone, and limy shale. Loosely consolidated deposits underlying foothills between mountains and coast on all the larger islands. Boulders in conglomerate are composed of volcanic rocks derived from the higher mountainous interior and range considerably in size. | Widely distributed and readily available along stream gullies. Gravels may be rotten on slopes to a considerable depth. Moderately thick weathered rock overburden and dense forest growth will require stripping. | Much of material unsuitable because of deep weathering. Conglomerate and sandstone where fresh and loosely consolidated should provide sources of gravel and sand. | Boulder beds and sand are suitable aggregate material when fresh. | Finer materials suitable for surfacing; probably poorly consolidated and would require only power shovel for excavation. Coarse conglomerate suitable for base course when crushed. | Probably unsuitable. | Unsuitable. | Not suitable. |
| 5 | Coral reef limestone with interbedded sand, gravel, boulder beds, and calcareous clay. Reefs are composed of irregularly layered soft and hard material with massive or blocky structure. | Probably most readily available of all construction materials; everywhere abundant. Forms bench terraces up to 500 feet altitude which support thin clay soil; bordered in many places by cliffs and ledges. Surface layers may be weathered and crumbly. Should be fairly easy to establish a quarry face. Little stripping necessary. | Interbedded sand and gravel suitable; can be handled by hand tools or power shovel | Interbedded sand and gravel suitable, can be worked by hand tools or power shovel. Coral limestone generally poor because of high content of fines when crushed; suitable where hard and massive. | Interbedded sand and finer gravel excellent surfacing material. Coarser gravels may be crushed for base course. Can be worked by hand tools or power shovel. Coral limestone excellent material for base course and subgrade. Can be excavated by jack hammer or pneumatic drills. | Beds of large boulders of trap-rock or residual boulders on surface of ground may be locally adequate if sound material. Coral limestone excellent material; can be excavated by jack hammer and pneumatic drills. | Large boulders may be locally suitable after breaking. Coral limestone for rough structures can be worked by jack hammer or pneumatic drills. | Coral limestone an excellent and abundant source Readily excavated by jack hammer or pneumatic drills. |

(CONT.)

# CONSTRUCTION MATERIALS

# HALMAHERA (MOLUKKAS)

| | KIND OF MATERIAL | AVAILABILITY | SAND AND GRAVEL | CONCRETE AGGREGATE | SURFACING, BASE COURSE AND SUBGRADES: ROADS AND AIRFIELDS | RIPRAP | STONE MASONRY | LIME AND CEMENT |
|---|---|---|---|---|---|---|---|---|
| 6 | Massive limestone. Hard, massive, light blue-gray, dense to granular, rock with few fractures. Small clay-filled or open caves may be encountered in drilling. | Readily available where found but very local in distribution. Supports thin stony clay soil and forms steep slopes or cliffs in which quarries could be easily established. Transportation problems render general use of material difficult. | Not suitable. | Excellent source but distribution limited; requires drilling, blasting and crushing. | Excellent material for base course or subgrade; requires drilling, blasting for excavation. | Excellent material; requires drilling and blasting for excavation. | Excellent material; requires drilling and blasting for excavation. | Excellent source but local in distribution; will require drilling and blasting for excavation before crushing. |
| 7 | Schist (flaky, thinly-layered rock) (Batjan Island only) Several varieties of schist with strong linear cleavages along which they tend to split. Considerable variation in hardness, strength and other physical properties. Contains considerable mica and other platy minerals. Locally some areas of more massive, coarse-grained, dark, granite-like rock. | Much of material is deeply weathered and covered by thick sandy soil which supports forest growth. Some cliffs and rock knobs in summit areas. Best outcrops along streams and along crests of ridges, available only in Sibela Mountains of Batjan Island south of Laboeha. | Not suitable. | Not suitable because of tendency to splinter and break along well defined cleavage planes. | Suitable material for subgrades or rock fills; requires drilling and blasting for excavation. Tendency to break along well defined cleavage planes renders most of it unsuitable for crushing. | Adequate material requires drilling and blasting for excavation. Tends to break into slabs. | Adequate material requires drilling and blasting for excavation. Tends to break into slabs. | Not suitable. |
| 8 | Granite (Batjan I. only). Hard massive coarsely-granular light-colored rock occurring on Ceti River in northeastern Batjan. Probably cut by numerous joints along which rock may be disintegrated. | Not readily available and extremely local in distribution. Could be quarried only along stream bed. Elsewhere thick clay soil overlies rock which is also deeply weathered along joints. | Weathered material may locally be adequate substitute for sand though high in clay and other impurities. Possibly improved by screening. | Suitable where fresh and sound, but is commonly deeply weathered. Requires drilling and blasting for excavation. Very restricted distribution. | Weathered material may locally be used for surfacing. Very restricted distribution. | Suitable where fresh and sound but is for the most part deeply weathered. Requires drilling and blasting for excavation. Very restricted distribution. | Suitable where fresh and sound but is for the most part deeply weathered. Requires drilling and blasting for excavation. Very restricted distribution. | Not suitable. |
| 9 | Stream, terrace and flood plain deposits. Unconsolidated deposits of gravel, sand, and finer alluvial materials, often well sorted but more generally well graded; has high content of volcanic ash. Boulders and gravel are nearly all volcanic rock derived from nearby mountains. Coarser materials generally found in stream beds or on terraces; finer materials on flood plains. | Terrace gravel readily available and widely distributed throughout islands; locally support sandy soil and vegetation. Some stripping may be necessary to establish a pit. Top few feet of gravel may be weathered and unsound. In some places boulders and gravel occur at the surface. Gravel and sand readily available at foot of mountains on most streams. On plains mostly finer material. | Though much of material is fine alluvial silt and loam, gravel and sand along streams and on terraces along valley sides are generally suitable. Gravel may require washing if clean material is desired. Sand in many places is impure and contains considerable silt, clay and volcanic ash. In some places large boulders may be strewn on surface. All material can be worked by hand tools or power shovel. | Gravel deposits suitable material; may require washing to get rid of fines. Care should be taken to select only those deposits in which gravel is sound and hard. Much may be deeply weathered and rotted. Quartz sand suitable but generally impure. Beach sands are locally of coral and shell which are less suitable. Can be worked by hand tools or power shovel. | Generally suitable for surfacing after removal of larger boulders. Gravel are adequate for base course; may require crushing. Large boulders on some terrace surfaces suitable for subgrade material. Can be worked by hand tools or power shovel. | Large boulder beds or scattered boulders on surface are suitable material if sound. | Large boulder beds or scattered boulders on surface are suitable for rough masonry if sound. May require breaking. Can be worked with hand tools or power shovel. | Not suitable. |

## FUELS

A poor grade of lignite occurs on Batjan 4½ miles north of Laboeha near the junction of the Amasing and the Mambiang Rivers. In the latter part of the 19th century two attempts were made to exploit this deposit for fuel by a Dutch steamship company. Both were without success. The road constructed to the site of the mine pits required a great deal of upkeep and is probably washed out and overgrown with jungle at present. The lignite occurs in seams only a few inches thick which dip variably 5° to 15° south and west. It is interbedded with Miocene calcareous clay and sandstone. Much stripping would be required to obtain lignite in any quantity.

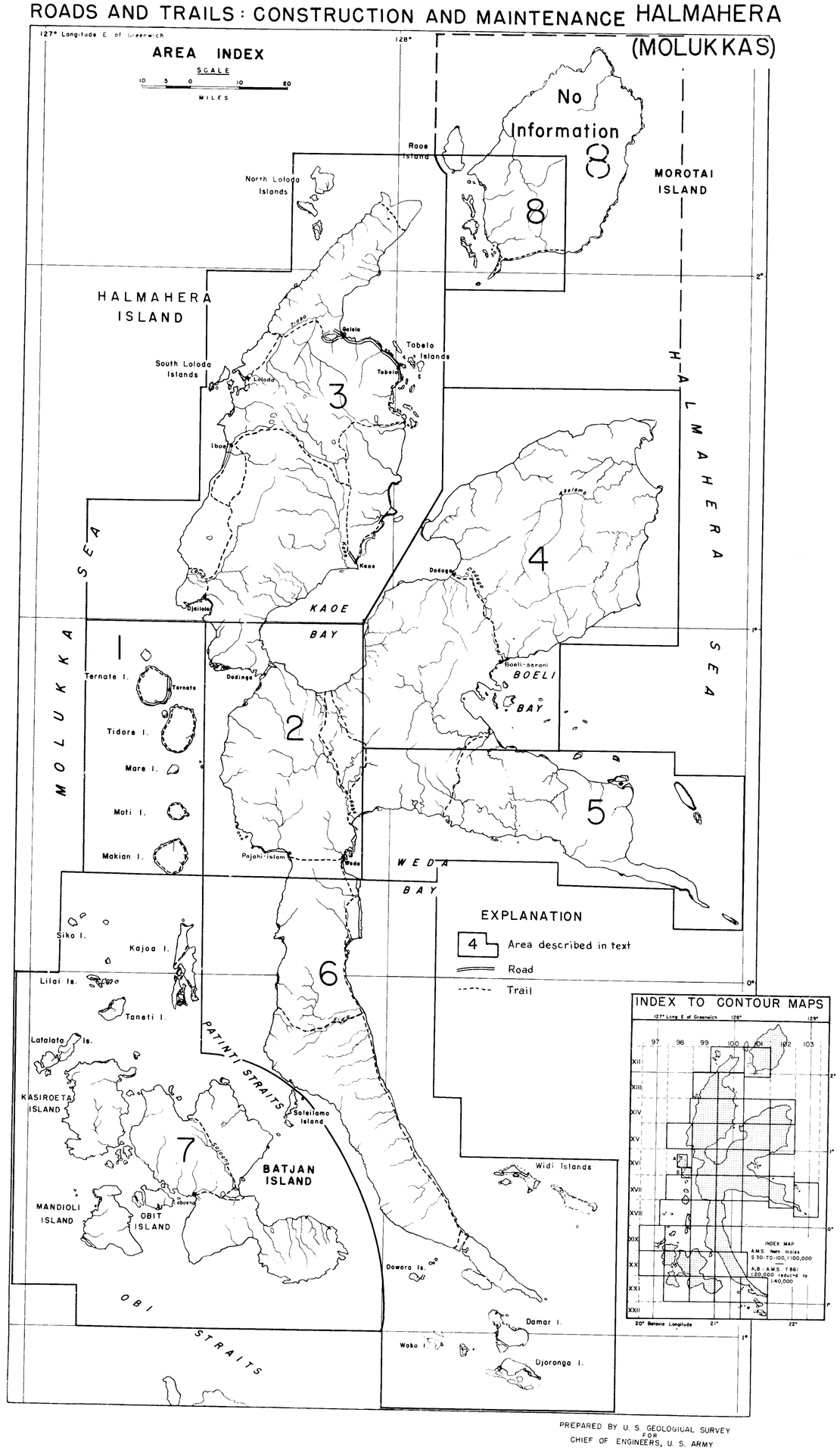
Lignite has also been reported along the headwaters of the Bim River in the mountains west of Cape Inngelang on the southeast peninsula of Halmahera. Nothing is known of its occurrence or quality.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U.S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# ROADS AND TRAILS: CONSTRUCTION AND MAINTENANCE HALMAHERA (MOLUKKAS)

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS) ROADS AND TRAILS: CONSTRUCTION AND MAINTENANCE

INTRODUCTION

## Existing Conditions

There are only about 35 miles of road on Halmahera and adjacent islands. 20 miles are in vicinity of Galela, 8 on island of Ternate. Nearly all of it would require widening and better drainage to adequately support military traffic. Construction of new roads difficult over most of area. The volcanic islands (Area 1 on map) are rough conical peaks. Road construction is possible only around their coasts. Larger islands have rough mountainous interior bordered by narrow discontinuous coastal plains. Ridges are steep and sharp, valleys narrow. Along a few of the larger rivers broad flood plains penetrate some distance inland. The peninsula habit of Halmahera increases its accessibility by sea. Good trails crossing the peninsulas are outlined on the Area Index map. Most occupy topographic corridors suitable for road alignments, but trail from Pajahi-Islam to Weda (area 2) and those crossing northeast and southeast peninsulas (areas 4 and 5) cross steep, rough mountains 600 to 1000 ft. high. Two valley corridors suitable for road alignments cross central and northern parts of Batjan island (area 7). No interior corridors are known on Morotai (area 8). Each island is thoroughly integrated by a good network of foot trails which are mostly narrow, steep, winding, and locally overgrown with brush; they are very slippery and muddy in wet weather. Best trails connect villages along coast.

## Construction Problems

Clearing of dense tropical rain forest necessary for almost any proposed alignment. Forest consists of thick stand of trees 100 to 140 ft. tall with tops locked together by vines and creepers, trunks 2 to 8 ft. thick at base, and large buttressed roots. Where undergrowth is not too dense, bulldozers and tree-dozers can handle most of work, avoiding larger trees which provide excellent camouflage. A thick ground mat of roots, vines, and rotting debris must be stripped to expose underlying soil. Clearing easiest near villages and along coast where there are native clearings, second growth jungle, and numerous stands of coconut palms. Little grading required on coastal plains, but in mountains considerable cut and fill necessary for even a pilot road. Sharp curves and steep grades probably needed to negotiate steep ridges and valleys. Soils mostly sandy clay loams and clay loams (A-4 to A-6) that may be locally stony (A-2). In most places they are quite deep, 5 to 30 ft. or more overlying soft, deeply weathered rock in mountains and sandy alluvium in the larger valleys. In higher mountains, soils are thinner and more stony with scattered rock exposures at surface. Because of high, well distributed annual rainfall, all soils are in constant state of wetting and drying. If worked or subjected to traffic when wet the clay soils become plastic, sticky, and intractable and tend to form ruts and mud holes and to bog down equipment. Great difficulties may be encountered if roads are not well drained. Numerous small slides are to be expected where cut banks are steep and fills are constantly subject to failure or washout. Large culverts will be required for the many gullies.

## Materials Available

Good quality trap rock is abundant on the volcanic islands (area 1) and over northeast and west parts of northern Halmahera (area 3). Pumice and volcanic cinder are also obtainable in these areas. A poorer quality trap is locally available in central parts of all peninsulas of Halmahera and larger adjacent islands. Along the coasts of all islands except volcanic islands (area 1) to an altitude of about 500 ft. are scattered coral limestone deposits suitable for all general construction purposes. A better grade of hard massive limestone is abundantly available in central part of Halmahera (area 2), along south coast of Kaoe Bay (area 4), and along north coast of Weda Bay (area 5). Gravel can be obtained from beds and banks of many streams near coast. Large deposits of gravel are available in foothill regions, but a considerable percentage of the cobbles may be partly disintegrated and the material has a high content of fines; it would require screening. Sand of good quality is scarce, but can be found along some stream beds. Coarse shelly coral sand is abundant on beaches on east coast of Halmahera, on Batjan Island Group (area 7), and on Morotai (area 8). Ample timber is available for temporary bridges, corduroy roads and other construction purposes. Water supplies are abundant. Supplies from surface streams require filtering and chlorination to be potable. Large ground water supplies are easily developed in coastal regions of all islands at depth of 20 to 40 ft. in alluvial areas and 40 to 100 ft. on terraces and lower hill country near coast.

Map Area 1 Ternate, Tidore, Moti and Makian

## Alignment and Grade

A group of roughly circular islands dominated by one or, as on Tidore, several volcanic peaks which rise abruptly from the sea. Slopes on all islands are steep, deeply gullied, heavily forested except for the summits of Ternate and Tidore. Construction of a road up any of these peaks would be extremely difficult involving much cut and fill, numerous culverts and bridges, many sharp curves, and steep grades. Narrow plains and foothills parallel the coast in many places affording relatively simple construction conditions. Ternate could probably be encompassed by improvement of existing narrow road on east side of the island and present trail around west side. Construction would be most difficult on west coast. Construction on the island of Hiri is impractical because steep rocky slopes descend abruptly to sea. A road could be constructed around Tidore following present trail along coast. Swamps on plains on east and west coasts of Tidore could easily be by-passed. Numerous steep slopes and cliffed headlands at north and south ends of island are more difficult to by-pass and would require considerable rock cut and fill, many curves and locally steep grades. There are no pronounced coastal plains on Moti and Makian; slopes descend abruptly to the sea; there are some cliffed headlands.

## Streams and Stream Crossings

Streams on all islands are short, steep, and torrential. Most carry water only during and after heavy rains, and can be readily crossed at other times. Banks are steep and require dugways for approaches. Stream bottoms are rocky or gravelly; channels are narrow; floods will cover crossings with boulders and other debris.

## Foundations and Subgrades

Soil on all islands is a red-brown lateritic stony clay loam (A-4 to A-6) becoming denser and more stony with depth. It is generally thin with rock near or at the surface over wide areas, but may be several feet deep in depressions and on coastal plains. Rock is largely volcanic ash, conglomerate and layers of massive trap rock; it outcrops abundantly only on steep ridges and cliffs along coast and in summit areas. Soil is permeable and well drained in undisturbed state; it becomes plastic and slippery if worked when wet. Equipment should be capable of handling wet loads in deep mud. Rock excavation in trap rock will require blasting; in other types of rock it can be accomplished by bulldozers and graders. Drainage is necessary to carry off heavy almost daily rainfall. Culverts should be large, bridges high. Slides may occur where steep slopes are undercut by excavation, particularly after heavy rains; where bedrock is volcanic ash, slides may involve large masses of material. Cutting low slopes on road banks may reduce slides.

## Clearing and Grubbing

Dense rain forest over most of area. Larger trees will require use of power saws or heavy tree-dozers. Stumps may need blasting. Dense mat of roots and creepers in upper layer of soil makes use of hand tools difficult. Lower slopes of Ternate and Tidore are largely covered by second growth jungle and small native clearings which can easily be worked with a bulldozer. Moti and Makian are little inhabited and hence little cleared. Japanese may have improved roads on Ternate.

## Existing Roads and Trails

A fairly good auto road about 10 feet wide extends along east coast of Ternate from Castela, west of Lake Lagoena, to Batoe angoes Point passing through the town of Ternate, principal center of the islands. Road has a pumice gravel surface. Fairly well drained. Good foot trails parallel coast around island. Intricate net of native trails over lower slopes on east side of mountain. Hiri, Tidore, Moti and Makian are similarly encircled by coastal trails. Two trails cross Tidore through steep passes between volcanic peaks. Trails are easy to follow if much used, but become rapidly overgrown with brush and grass if deserted. Are muddy and slippery in wet weather; steep and winding on mountain slopes, rocky in summit areas. Are probably best on Ternate.

## Construction Materials Available

Trap rock suitable for all construction purposes abundant on all islands; exposed in cliffs and ledges, in stream gulleys, and along coast. Fields of broken lava rock on northeast side of Ternate provide a good local source of road material. More massive trap will require drilling, blasting and crushing. Coarse angular gravel may be obtained from deposits of volcanic conglomerate; much will disintegrate easily. Small gravel deposits occur along streams near coast. Sand is not abundant.

Reliability Rating: C (CONT.)

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# ROADS AND TRAILS: CONSTRUCTION AND MAINTENANCE — HALMAHERA (MOLUKKAS)

Map Area 2 Central Halmahera

## Alignments and Grades

Central Halmahera is a little known mountainous region. Summit altitudes 1500 to 2500 ft. with maximum of nearly 4000 ft. Slopes are steep, ridges sharp and narrow; generally unsuited for road alignments and crossed by few trails. Bordering central mountainous area are three important corridors. To the north the isthmus of Dodinga, two mi. wide, seperates Dodinga and Kaoe Beys. It is a region of low hills, broad valleys and coastal terraces. Highest point on divide about 300 ft. Present narrow road could easily be improved. Rugged mountains of northern peninsula rise abruptly north of isthmus; their eastern slopes descend steeply to the sea. To the west, coastal lowlands are marshy, confining trails to foothills. A second corridor connects Kaoe and Weda Bays by way of the Dagasoeli and Kobe River valleys. On Kaoe Bay a broad forested plain is formed by junction of several streams. Larger rivers are paralleled by extensive permanent swamps which prevent coastwise construction. Inland the valley of the Dagasoeli River narrows between low rolling limestone hills with maximum altitude of about 500 ft. South of the divide the broad rolling Kobe River plain opens southward to the coast. Construction on the plain presents few topographic difficulties. In the hills moderate grades and some sharp curves will be necessary to attain the broad rolling ridge summits which are the best alignments. Permanent coastal swamps (moeras) at mouth of the Kobe restrict construction for two mi. inland, but passage may be effected along beach. Very rugged mountains rise abruptly east of the Kobe plain and its northeastward extension along the Djira River. The third and most difficult corridor crosses the mountains between Weda and Pajahi-islam. Approaches to mountains across open valleys and hills locally require moderate grades and curves. Five mile stretch across mountains has steep slopes, sharp ridges, and many deep ravines and gullies, all heavily forested. Steep grades, sharp curves, numerous culverts or short bridges, and much side-hill cut and fill necessary. Ridge crests provide best road alignments. Summit divide 700 to 800 ft. above adjacent valley floors. Broad plain north of Pajahi-islam leads inland for several miles, but does not lead across mountains. Seasonal marshes (drasland) probably necessating corduroy roads, occur along major streams and along coast.

## Streams and Stream Crossings

Streams in mountains are torrential and flash floods occur after heavy rains. Trails along stream beds are impassable at these times. In limestone areas streams are fewer; many disappear into underground channels. Mountain streams mostly small with steep banks and rocky bottoms. On plains larger streams may be 100 feet or more wide and of variable depth; generally fordable but may require bridges or ferries. At the coast a sand bar invariably lies across river mouth. In upper reaches the bottoms are gravelly or sandy; near the coast they may be muddy with some areas of quicksand. Banks in general are steep but firm, five to fifteen feet high and make good footings for bridges except along the coast and locally in the interior where they are bordered by swamps. Vegetation generally densest along stream banks. Numerous bamboo thickets or brakes along larger streams on plains.

## Foundations and Subgrade

On the isthmus of Dodinga the soil is a red-brown lateritic loam or clay loam (A-4 to A-6) which is 15 to 30 ft. thick over most of that region. Some coral limestone is said to form ledges on margins of the plain. Hard lava rock may occur in the mountains to the north or along the east coast. To the south the broad range of mountains trending east-west between Weda and Kaoe Beys is underlain by massive limestone exposed in numerous cliffs and ledges. Steep slopes support a thin red-brown lateritic sandy clay soil (A-4) that is deepest in valleys and depressions. East of the river the soil, a red-brown lateritic clay loam (A-6), is deeper and there are fewer outcrops. The mountainous pass between Weda and Pajahi Bays is underlain by a yellow-brown lateritic sandy or stony loam (A-3 to A-4) a few feet thick which grades downward into poorly consolidated conglomerate or sandstone that may be exposed on steep slopes. In the larger valleys and coastal plains the alluvial soil varies greatly in texture (A-2 to A-7) though most are sandy clay loams. It is much deeper than in the mountains, and may locally be waterlogged or even flooded much of the year. All upland soils are friable, permeable, and well drained in the undisturbed state, but become plastic and slippery if worked when wet. The plains soils are less permeable and more plastic. All except the swamp mucks are suitable for asphalt or mechanical stabilization if worked under optimum moisture conditions; may be locally too high in clay. Can be worked by bull dozer, but earth-moving equipment should be capable of handling heavy wet loads under conditions of heavy daily rainfall and deep mud. Except for the limestone, most of the bedrock is sufficiently weathered for handling by bull dozers or hand tools. Blasting will be required only locally. Large culverts and ditches will be necessary to accomodate the heavy rains. In swamp areas along the coast soft muck (A-6) may be many feet deep; can be corduroyed. Ample forest materials at hand. Shores of the main bayheads are bordered by mangrove swamps and soft mud banks; few good beaches.

## Clearing and Grubbing

Dense rain forest or swamp forest over most of the area offers major problem of clearing. Large trees will require power saws or heavy tree dozers. Stumps may need additional blasting. Dense mat of roots and creepers in the upper layer of the soil make use of hand tools difficult. Some large areas of tall alang-alang grass in valleys. Strips along coast of the four major bayheads behind the coastal swamps are most populated and hence have some cleared land and large areas of second-growth forest that is easily cleared. Japanese probably have improved roads on the peninsula north of Dodinga Bay.

## Existing Roads and Trails

A narrow hard-surfaced road about 2½ miles long crosses the isthmus of Dodinga. It is 12 to 15 ft. wide and has moderate grades and probably few curves. Suitable for one-way light military traffic. The main trails follow the natural topographic corridors. Only a few penetrate the interior. Two foot trails cross the mountains from Ekor on Kaoe Bay to Kobe on Weda Bay. Another crosses the divide from Weda to Pajahi. Trails along the coast are discontinuous. The most frequented connect settlements from Akelamo to Dodinga and north along the west coast. Trails in the mountains are narrow, steep, and winding; may be locally overgrown with dense brush or grass requiring the use of a machete; become very muddy and slippery when wet. On the plains they tend to follow the river beds to avoid the denser jungle on the banks; may likewise be muddy and overgrown. Along the coast they tend to follow the beach ridges and terraces; in swamps they connect small areas of high ground.

## Construction Materials Available

Massive limestone suitable for crushed aggregate, road metal, or rock masonry abundantly available in mountains south of Kaoe Bay. Crops out as cliffs and ledges. Will require drilling and blasting for excavation. Coral limestone, a more easily worked rock, occurs along the coast near Weda. In the mountains east of the Kobe River there is little exposed rock and that is of poor quality. A good grade of gravel can be obtained along most of major streams. Large quantities of a poorer grade of gravel are available from deposits in the hills west of the Kobe River, on the mountain pass between Weda and Pajahi Bays, and along the west coast from Akelamo to Dodinga. A fairly high percentage of this disintigrates easily. On the Dodinga Isthmus trap rock of fair quality occurs with volcanic ash and conglomerate. The volcanic conglomerate is a suitable source of gravel. Might require screening to remove larger fragments. Sand of good quality can be screened from stream deposits. A coarse shelly beach sand may be found locally along the coast. Ample timber is available for construction purposes; much is of poor quality and rots quickly. Ample surface water available. In the central limestone mountains some streams disappear underground. Ground water is available from unconsolidated alluvial deposits along the coast at a depth of from 30 to 40 feet.

Reliability Rating: C

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Area 3 Northern Peninsula

Alignment and Grades

The mountains of the northern peninsula form distinct groups. Along west coast from Djailolo to Loloda Bay and east across to Galola Bay is a line of high volcanoes. Their slopes are steep and well dissected by steep-walled ravines and gullies. Summit altitudes range from about 4000 to 5000 ft. Passes suitable for road alignment occur north and south of Gam Konora, the highest peak. Both are at present utilized by trails connecting Djailolo with the north coast by way of the Lamo valley. Road construction would require steep grades, many curves and much cut and fill. Construction along the coast is impractical because, for long distances, the mountains descend steeply to cliffs above the sea. The Djailolo Plain and Lamo River valley is a possible interior corridor. The Djailolo plain is flat to rolling and about 4 miles wide; marshy along the coast, but well drained inland with the ground surface at least 15 to 25 feet above the streams which are intrenched. Djailolo is an important town with unloading pier and nearby airfield. The Lamo valley is narrow in its lower part, but widens into a broad rolling interior basin in which a road could be constructed with moderate grades, open curves and few cuts or fills. A second range of mountains extends north of the Tiabo River to the tip of the peninsula. The topography is rugged and well dissected; slopes rise steeply from both coasts to an average altitude of 2500 feet. Ridges are sharp and steep, valleys are narrow and steep-walled. There are no suitable alignments across the range except near the tip and road construction would be extremely difficult. A road might be developed along either coast on discontinuous narrow plain connecting numerous small beaches. Much cut and fill and some blasting would be required to effect a passage where mountains descend steeply to cliffs above the sea. The head of Galela Bay is bordered by extensive coastal swamps (moeras) but inland a broad gently undulating plain 6 miles wide rises gradually westward and southward to the mountain front. Although most of the plain is forested there are large areas of grassland where road construction would present no difficulties. The town of Galela is an important center. It is connected by a poor motor road with smaller settlements around Lake Galela and with Tobela to the south along the coast. A possible but difficult alignment, at present followed only by a trail, connects Galela with Loloda on the west coast by way of the Tiabo River valley. Because of the narrowness of the valley and its locally swampy nature any road would have to follow the slopes, involving many curves and continuous, but not deep cuts and fills. Grades could be moderate to low. Many culverts or short bridges would be needed. A third range of mountains forms the central divide of the peninsula as far north as the Tiabo River. It is thoroughly dissected by countless closely spaced streams in deep ravines or canyons averaging 1000 to 1200 ft. in depth. Slopes are very steep, valley bottoms narrow, ridge crests sharp. Summit altitudes range from 1500 to 2700 ft. Only practical pass along its entire length connects the valley of the Iboe River on the west coast with the swampy inland basin of the Kaoe River across a rough divide at an elevation of about 1100 ft. A road on the eastern slope would require much cut and fill, many sharp curves, steep grades and many culverts and bridges. The west slope down the broad flat valley of the Iboe River is readily accessible and is followed by a good horse trail. East of these mountains are the interior forested plains of the Kaoe River basin into which a road could easily be constructed from the south, though there are extensive swamps (moeras) at its head and occasional marshes (Drasland) along its course. Two passes, east and west through the mountains, at the head of this basin, are possibly suitable for road alignments. A fourth mountain range rises abruptly along a scarp on the east side of the Kaoe River basin. Altitudes increase northward from 600 to 2200 ft. Its western front is steep and gullied. A narrow corridor having a summit elevation of only 600 ft. extends along the Dodonodo and connects the Kaoe River Basin with the east coast. The eastern side of the mountains is a dissected surface sloping gradually to the sea. Streams are intrenched at least 60 to 100 ft. below the general ground level. Road construction along terraces above the east coast as far south as the Kaoe River plain would be relatively easy except for crossing deep ravines and numerous small swamps (moeras) and marshes (Drasland). Good horse trails exist over most of the area. Steep mountains or broad mangrove swamps along the coast south of the Kaoe River form difficult barriers.

Streams and Stream Crossings

Streams throughout the mountains have steep gradients and swift currents. Normally most are 15 to 30 ft. wide and are readily forded by wheeled vehicles after some clearing of the bed and excavation of dugways through banks. Flash floods are common after heavy rains when streams become torrential and the water may rise several feet in a few minutes. Many streams are in deep ravines or gullies. Steep sides of gullies and banks of streams generally support dense vegetation. In the plains areas streams are larger. The Kaoe, Lamo (Djailolo plain), Tiabo and Iboe Rivers are probably more than 100 ft. wide at their mouths. Vary greatly in depth. Most streams can be forded but some are too deep. Bottoms are gravelly or sandy inland and become silty or muddy near the coast; may be some local quicksand. A sand bar lies across mouth of nearly all streams. Banks are 5 to 15 feet high and steep; are generally firm except where bordered by swamps and provide good footing for bridges.

Existing Roads and Trails

The northern peninsula is the most settled part of the island and boasts a few miles of road. A narrow auto road constructed shortly before the invasion follows the coast from Galela to Tobela and Efi Efi. It is probably about 16 feet wide. As far as the Oewo River it is built through a lava field and is very rough; beyond it follows coastal sand ridges and limestone terraces. Foundations are adequate for military traffic and naturally well drained. It is probably surfaced in part with broken trap rock, in part with fine gravel and sand. Probably requires improvement and widening in southern part. Some of the larger streams are bridged though the Oewo River and another beyond Tobela are known not to be. Another narrow gravel surfaced road connects Galela with the settlements and plantations on the south side of Galela Lake 1½ miles to the west. Numerous tracks and trails cross the plain to the west. A narrow and poorly drained dirt road, variably 8 to 12 ft. wide, crosses the swampy plain south of Gam-itji on the Iboe River; has numerous poorly constructed culverts and small bridges. Other narrow dirt roads probably exist on the Djailolo plain connecting the town with the airfield. The main one crosses the Lamo river by a narrow steel bridge.

All overland movement is accomplished by trail with porters or the small native horses. Good horse trails penetrate the interior along the Lamo, Iboe and Kaoe Rivers. Less used foot trails cross the mountains in many places (see detail maps). They are narrow and generally muddy; may be overgrown locally with dense brush or tall grass. In the mountains they follow ridges or spurs wherever possible; are winding and very steep, in places rocky or cliffed. Those which might serve as suitable military road alignments have been pointed out above. In the valleys trails tend to follow gravelly or rocky stream beds between high banks. Along the coast the trails connecting villages are more frequently used and pass through more open country. However, the rougher more mountainous sections of the coast have no trails along them so that passage by land along the coast is discontinuous.

Foundations and Subgrades

The soil of the central volcanic region is a red-brown lateritic stony clay loam (A-4 to A-6) becoming denser and more stony with depth. Normally only a few feet deep. No sharp break against sound rock. Soil grades down into a zone in which hard kernels of rock surrounded by flaky weathered material increase in size with depth to unweathered fractured rock. Bedrock is variably a good trap rock interbedded with volcanic ash and conglomerate. Soils are deeper and rock more weathered in southern part of peninsula. Mountains in northern part underlain by red-brown lateritic clay loam and clay (A-6) 15 to 30 ft. deep overlying a deeply weathered poor grade of trap rock. The borders of these mountains and the mountainous country on either side of the Kaoe River basin are underlain by yellowish-brown to red-brown lateritic sandy or stony loam (A-3 to A-4) with some calcareous cementation at depth. This soil in most places merges imperceptibly at a depth of few feet with conglomerate or soft sandstone bedrock. Near the coast to an elevation of about 500 ft. layers of limestone occur irregularly in the conglomerate. On this limestone the top of sound rock is sharp. In the larger valleys such as the Lamo, Kaoe, and Tiabo Rivers the alluvial soils vary greatly in texture (A-2 to A-7) though they are probably mostly sandy clay loams on the plains, stony or gravelly loams against the foothills, and muck or fine silts in the swamps. Soil on the plains is much deeper than in the mountains. All upland soils are friable, permeable, and well drained in the undisturbed state, but become plastic and slippery if worked when wet. The plains soils are less permeable and more plastic. All except the swamp mucks are suitable for asphalt or mechanical stabilization if worked under conditions of optimum moisture; may be locally too high in clay. Can be worked by bull dozer or any equipment capable of handling wet loads under conditions of heavy rainfall and deep mud. Most of the bedrock encountered will be sufficiently weathered to be excavated with hand tools or by bull dozer. Blasting will be required, however, in central volcanic area where there is much sound trap rock exposed at the surface and in the limestone beds which underlie terraces along the coast. Large culverts and ditches will be necessary to accomodate the heavy rains. In swampy areas the soft muck (A-6) may be too deep for military vehicles. Corduroy roads are feasible where needed with ample forest materials suitable for temporary structures at hand. The sand on the shore of Galela Bay and on other isolated small beaches along coast is well packed and possibly suitable for passage of light military vehicles. Many beaches, however, are either rocky or soft mud.

Clearing and Grubbing

Dense rain forest over most of area offers major clearing problem; large trees will require use of power saws or heavy tree dozers. Stumps probably need additional blasting. Dense mat of roots and creepers in upper layer of soil makes use of hand tools difficult. Extensive grassy areas on plains near Galela Lake and locally in Kaoe River basin are easily stripped. Coastal areas, particularly near settlements are most open terrain with numerous native trails, patches of cleared land, and much second growth forest which is easily cleared. Japanese activity on the plains near Djailolo and Galela have probably resulted in increased clearing and improvement of road conditions in those areas.

Construction Materials Available

Along west coast from Djailolo to Loloda and across island to coast from Galela to Tobela a good grade of trap rock is abundantly available. Occurs in layers (lava flows) or as fields of broken lava rock. Layers will require drilling and blasting for excavation. On northern arm of peninsula coral rock is abundantly available along coast and is good all-purpose rock that can be readily crushed by hand if necessary. On mountain divide rock is poor quality trap mostly covered by deep soil. Along west coast from Galela to Kaoe coral rock is available from hills along coast. Gravel and sand are obtainable from stream beds near coast or along inland valleys. Sand screened from gravelly deposits is probably high in fines. Gravel can also be obtained from extensive deposits in hills surrounding Kaoe River basin, in hills along north coast of Kaoe Bay as far as Tobelo, and in foothills against main divide of northern arm of peninsula. There are some coralline sand deposits high in calcium on small beaches along the coast. However, most of beaches are stony. Timber for construction purpose abundant, but mostly of poor quality. Ample surface water for construction purposes. Ground water available from unconsolidated alluvial deposits on plains along coast and inland valleys at depth of from 30 to 40 ft.

Reliability Rating: C

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## Area 4 Northeast Peninsula

### Alignments and Grades

The northeast peninsula is rough mountainous area having no distinct longitudinal divide, but rather a group of irregular ridges and valleys oriented more or less at random. Summit altitudes vary from 1500 to 5000 ft., highest to west. Road construction is difficult because of dense tropical rain forest, heavy daily rainfall and steep slopes. Ridges are sharp and steep; mountain valleys narrow and steep-walled. There are no good corridors across the mountains. A foot trail crosses from Boeli-serani to Dodaga over a steep rough pass at 660 ft. altitude; probably not a satisfactory road alignment. Sangadji River valley, relatively flat, provides access to the broad interior basin at its head. A foot trail crosses a rough steep and rocky mountain pass having an altitude of about 2500 ft. to the settlement of Soot on Kaoe Bay. Broad marginal plains at the heads of the deep bays indent an otherwise rugged mountainous coastline. The plains are more or less isolated, but some are connected by interior valley corridors or narrow high coastal terraces or benches. Along southeast coast of peninsula streams heading inland from coast turn abruptly northeast or southwest parallel to mountain front. Along north coast they maintain straight courses to sea. Swamps (moeras) border the coastal lowlands along Kaoe Bay from Saolat to Roni Point. On the wide rolling plains at the heads of the many bays problems of road construction are less severe; involve mostly clearing of the rain forest and crossing the large streams. Terrain is most open along the coast where there are numerous settlements, native clearings, coconut strips and areas of second growth that are more easily cleared but passage along the coast is difficult because of steep slopes and rocky cliffed headlands. Native trails are discontinuous. Much cut and fill and blasting required. Many streams in gullies and ravines are subject to flash floods and would require bridges or large culverts for all-weather use.

### Streams and Stream Crossings

Streams in the mountains are torrential and may rise several feet in a few minutes after heavy rains. Trails following in the stream beds become impassible at these times. The smaller streams, 15 to 30 ft. wide, are readily forded by wheeled vehicles after removal of larger rocks. Current normally swift; bottoms gravelly or rocky. Banks are high and fords would require excavated approaches. Bridges or large culverts necessary for all-season use. The Akelamo, Sangadji, Dodaga and Onad rivers are probably over 200 feet wide. Larger streams may be normally over 100 ft. wide; all streams are generally shallow and fordable inland along gravel bars. Near the coast they become deeper but there are always sand bars across their mouths. Bottoms are gravelly or sandy, become muddy near the sea. May be locally bordered by coastal swamps making approaches difficult. Inland the banks are firm sand or gravel under surface soil; excellent footings for bridges. Vegetation generally densest along stream banks. Numerous bamboo thickets or brakes along larger streams in the interior.

### Existing Roads and Trails

There are no roads on the northeast peninsula and no trails suitable for the passage of military vehicles for any distance. Two trails cross the peninsula; one from Boeli Serani to Dodaga, the other up the Sangadji River and across the mountains to Soot on Kaoe Bay. Both would require major engineering improvements to convert to use by military vehicles. A number of other trails in the interior have purely local significance. They tend to follow the ridges wherever possible. Trails in the mountains are steep, winding and locally rocky. Numerous ledges and rocky slopes covered with mossy vegetation and forest in the higher regions. In the lower hills they may be considerably overgrown and become very muddy and slippery with much use. Many trails are discontinuous. Those between settlements on plains along the coast are generally more easily followed and more frequented. Some coastal towns such as Wasile are connected with other settlements by trails along interior valleys which parallel the coast. All valley trails tend to follow largely in stream beds as they are most open avenues through jungle. Some improvement in trail conditions may be expected from reported Japanese activities on the plain near Akelamo village.

### Foundations and Subgrades

Over most of mountainous interior soil is red-brown lateritic clay loam or clay (A-6) having depth of 15 to 30 ft. though bedrock, a poor or medium grade of trap that is probably well fractured, may outcrop abundantly in the higher regions on steep slopes or ledges, in cliffs along the coast, or along stream bottoms in the mountains. In hill lands along and well back from coast, soil is yellowish-brown to red-brown lateritic sandy or stony loam (A-3 to A-4) with some calcareous cementation at depth. In most places it merges imperceptibly at depth of few feet with conglomerate or soft sandstone bedrock but, where underlain by limestone, top of sound rock is distinct. The limestone occurs as layers in the conglomerate formation underlying hills along coast. All upland soils are friable, permeable, and well drained in the undisturbed state, but become plastic and slippery if worked when wet; are suitable for asphalt or mechanical stabilisation if worked under conditions of optimum moisture. May locally be too high in clay. Along interior valleys and on plains along the coast the alluvial soils are deeper than the mountain soils and are probably less permeable and more plastic. Great range in texture (A-2 to A-7) and engineering properties. Most soils can be worked by bulldozer, though moving equipment should be capable of handling heavy wet loads under conditions of heavy daily rainfall and deep mud. Most bedrock encountered will be sufficiently weathered to handle with bulldozers or power shovel. Locally some blasting may be required, particularly in the limestone layers. Proper road drainage cannot be overemphasized; large culverts and ditches will be necessary to accomodate heavy daily rainfall. In swampy areas soft muck (A-6) may be many feet deep. Corduroy roads are quite feasible with ample forest materials on hand. Along the coast small beaches are locally sandy and hard enough to bear traffic, but most are narrow and rocky or gravelly and bordered by rough hills or coral reefs at either end. Soft mud banks with local areas of mangrove swamp border parts of the larger bay heads.

### Clearing and Grubbing

Dense rain forest over most of area offers major problem of clearing. Large trees will recuire use of power saws or heavy tree dozers. Stumps may need additional blasting. Dense mat of roots and creepers in upper layers of soil make use of hand tools difficult. Along coast are some already partially cleared strips and areas of second growth which is easier to clear. Vegetation around northern end of peninsula is thought to be more open than normal. Plains around Wasile and Akelamo Bays may be locally grassy. Reported Japanese activity in both these areas have probably resulted in further clearing and generally improved road conditions

### Construction Materials Available

Limestone suitable for crushed aggregate, road metal or rock masonry abundantly available from mountains or terraced hills along coast, particularly on north side of peninsula. Will require drilling and blasting for excavation. In interior the bedrock, a poor grade of trap, is little exposed and is mostly deeply weathered or much fractured; disintegrates easily. Gravel can be obtained from many of streams or from deposits in hills back from coast. Sand can be screened from river deposits, but is high in fines. Also is available locally from beaches where it is a coarse shelly coral sand. Many beaches, however, are stony. In vicinity of Dadaga, Akelamo, and Boeli-Serani rock will probably have to be brought from nearby hills, though sand and gravel should be available locally from streams on the plains. Ample timber is available for construction purposes though much is poor quality and rots quickly. Ample surface water available. Ground water obtainable from unconsolidated alluvial deposits along coast or inland valleys at depth of 30 to 40 ft.

## Area 5 Southeastern Peninsula

### Alignments and Grades

Southeastern peninsula, 75 mi. long and 18 to 24 mi. wide, is terminated by long narrow tip 20 mi. long and 3 mi. wide. Entire area is rough and mountainous and attains altitudes as high as 2700 ft. in western part. Spurs and ridges trending irregularly away from central divide are seperated by narrow canyons. Slopes are steep, locally rocky or cliffed and covered by dense rain forest jungle. Ridges are sharp and narrow. Much of interior has never been surveyed even roughly. Road construction would be extremely difficult. A possible pass across the mountains lies between headwaters of Waleh and Nou Rivers though in region of divide this is probably too rough for satisfactory road alignment. Passage along coast is rendered difficult by cliffed headlands where the mountains slope to the sea. Much side-hill cut and fill, in some places blasting, would be required. Small landslides would be constant menace. Many gullies and small streams subject to flash flood would recuire culverts, short bridges or dugways for fords. Rainfall is heavy and frequent. Narrow discontinuous stretches of coastal plain occur along coast and extend inland short distance along larger streams. Only along Waleh and Nou Rivers is there any extensive valley corridor into mountains. Numerous and locally extensive marshes (drasland) likewise impede coastwise construction though they may be dry in years of little rainfall and are generally passable with corduroy construction. Narrow mountainous ridge forming narrow tip of peninsula is crossed near its center by a well used but extremely steep and winding horse trail.

### Streams and Stream Crossings

Streams are torrential and flash floods are a common feature during heavy rains. The water becomes turbid and rises several feet in few minutes. Many native trails follow stream beds sunk deep between high banks or in steep-walled ravines; should be avoided during heavy rains. Most streams are 15 to 30 ft. wide and, with a little preparation of bed,can be readily forded by wheeled vehicles. Currents are normally swift. The bottoms are gravelly or sandy except at coast where they are muddy. In interior they may become rocky with waterfalls at intervals. Banks are steep and 3 to 15 feet high requiring excavation of dugways for fords. The larger streams may be over 100 feet wide and vary greatly in depth from place to place. Generally shallow and fordable. Near coast channels may become deeper, bottoms muddy, and are apt to be bordered by coastal swamps which make approaches difficult. Sand bar generally across mouth. On normal floodplains banks are of well-packed gravel beneath few feet of surface soil; make excellent foundations for bridge footing. Vegetation is more dense along margin of streams than on adjacent valley bottom.

### Foundations and Subgrades

Soil along mountainous divide is red-brown lateritic clay loam or clay (A-6), having depth of 15 to 10 ft; bedrock, a weathered poor grade of trap, outcrops abundantly as cliffs and ledges. Mountains nearer coast support yellow-brown to red-brown sandy or stony loam (A-3 to A-4) which merges at depth of few feet with loosely cemented conglomerate or sandy bedrock. Along the coast, particularly on north side, to an elevation of about 500 ft., coral limestone layers in the conglomerate tend to form cliffs along stream valleys. On south side, west of settlement of Mesa, large area along coast is underlain by hard massive limestone which forms numerous cliffs, ledges, and very steep rocky canyon walls. On gentle slopes and depressions it supports fairly thick red-brown clayey soil (A-6). All soils are well drained in the undisturbed state though the vegetation retains much water. Surface runoff is high. Most soils become plastic and slippery when wet, but dry quickly. Soil along coast, except in marshy areas is probably suitable for stabilization under conditions of optimum moisture. Can be worked by bulldozer though moving equipment should be capable of handling heavy wet loads under conditions of heavy daily rainfall and deep mud. Most of bedrock encountered will be weathered sufficiently to handle with bulldozers or power shovels. Locally some blasting may be required, particularly in limestone areas. Large culverts and ditches will be needed to accomodate runoff from heavy daily rainfall. In swampy areas soft muck (A-6) may be many feet deep. Corduroy roads are probably feasible; ample forest materials. Land locally dry and low ridges may provide route most of way across; can probably be detected by differences in vegetation. Sand beaches are locally hard enough to bear traffic, but most are narrow, rocky or gravelly and bordered by rough hills or coral reefs at either end.

### Clearing and Grubbing

Clearing and grubbing of dense rain forest and swamp forest over most of area is very arduous. Large trees require use of power saws or heavy tree dozers. Stumps will need blasting. Dense mat of roots and creepers make us of hand tools difficult. Along coast some advantage can be gained in small areas of second growth, native clearings and coconut strips. Parts of valley bottoms may be grassy.

### Existing Roads and Trails

There are no roads on southeast peninsula and no trails suitable for passage of vehicles for any distance. A good, but steep and winding trail crosses the narrow tip of the peninsula from Jondolioe to Sigillawa. Two other trails cross mountains over 1000 ft. passes between headwaters of Waleh and Nou Rivers and between Spo and Watji Rivers respectively. Attain altitudes of over 1000 ft. Are little used, narrow, rocky and steep; may locally be overgrown by dense brush or grass and are variably muddy. In valleys, they follow in stream courses. Trails are not continuous along coast, but occur between settlements; are well used, fairly wide and some stretches could be adapted for use by light vehicles with little improvement.

### Construction Materials Available

Coral limestone found on terraces along hillsides on north of peninsula or from reefs along coast is most readily available material for rock fills, rip-rap and crushed stone for road metal. Can be worked with hand tools, but may require blasting locally. Massive limestone along north shore of Wede Bay west of Mesa is accessible and well exposed, but is more difficult to work. Gravel can be obtained from larger stream courses and beaches or in large quantities from deposits in hills along coast. A fairly high percentage disintegrates easily and would be unsatisfactory for aggregate. Beach sand is generally poor and coarse grained. A poor grade of trap rock underlies the higher mountains of interior. Where exposed in cliffs it may be suitable, but where overlain by much soil it is probably deeply weathered. Timber for construction purposes abundant, but mostly of poor quality. Ample surface water for construction purposes, though many streams disappear underground into the limestone along the coast. Ground water available from unconsolidated alluvial deposits along the coast and interior valleys at depth of 30 to 40 feet.

Reliability Rating: C

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(CONT.)

# HALMAHERA (MOLUKKAS) — ROADS AND TRAILS: CONSTRUCTION AND MAINTENANCE

Area 6 Southern Peninsula

## Alignments and Grades

The southern peninsula of Halmahera is 105 miles long and about 15 miles wide, narrowing southward. A rough mountain range rises steeply above the west coast to an average altitude of 1700 ft., though several peaks are over 4000 ft. high at widest part of peninsula. Road construction extremely difficult because of dense tropical rain forest, heavy daily rainfall and steep slopes. Ridges are sharp and steep; mountain valleys narrow and steep-walled. Four passes which might prove suitable for roads across the range occur east of the small settlements of Oha and Ali and across the headwaters of the Lamo and Semo Rivers. Here slopes are less steep and valleys more open. However, steep grades, many curves and much side-hill cut and fill would probably be necessary. Many deep secondary gullies and ravines would require culverts, short bridges or dugways for fords.

Passage along west coast difficult because in many places mountains descend abruptly to cliffs above sea. Narrow, discontinuous, heavily forested coastal plains pass into mountain canyons only short distance inland. Streams subject to flash flood after heavy rains. Extensive marsh (grasland), covering entire plain inland from Oewana Point to mountains, is crossed by several foot trails, but they would require some form of corduroy construction for vehicles. A trail follows most of coast, but converting it to a road would be difficult, involve considerable side-hill cut and fill, some rock blasting, many bridges and fords, and, on headlands, continual danger from slides on clay covered steep slopes.

Conditions less severe along east coast. A continuous rolling plain, 1 to 5 mi. wide, slopes gradually seaward to palm fringed coast. Inland, broad forested stream valleys extend into mountains. High jungle-covered gravel ridges separate major valleys, but reach coast only above south shore of Weda Bay. Few grades or curves needed; most general problems are clearing and grubbing dense rain forest and crossing the many streams. Going is easiest along coast because of many small settlements with their clearings. Extensive marsh (grasland) covering plain from Foja Point south to Mafa probably most serious obstacle to road construction. Locally, beaches may be suitable for light traffic, though much of shore bordered by rough coral reefs.

Southern tip of peninsula south of Ganedidalem is rolling plateau with altitude of 200 to 300 ft., crossed by many trails. Few streams and vegetation not very dense.

## Streams and Stream Crossings

Streams on west coast more or less torrential; flash floods follow heavy rains. Gradients steep and currents swift. Most of these streams are less than 30 ft. wide and, with a little preparation of bed, are readily fordable by wheeled vehicles. Bottoms are generally gravelly or rocky; near coast currents become sluggish and stream beds muddy. Banks are steep and generally 5 to 15 ft. high, requiring excavation of shallow dugways. Footings for bridges consist of well-packed gravel under surface soil. Vegetation denser along banks than on adjacent small alluvial plains.

Streams of east coast are somewhat longer and larger. Some are locally 80 to 100 ft. wide and require bridges or ferries. Most are fordable during normal flow, but are subject to flash floods. They vary greatly in depth but most are shallow. Bottoms are gravelly or sandy and fords are best made along gravel bars. A bar nearly always across mouth of stream at coast. Most streams have steep banks 5 to 15 ft. high, becoming lower near coast. Some may be as much as 20 to 30 ft. high with dense vegetation growing on walls. Some trails along streams are compared to being in a tunnel. Footings for bridges will be on sound gravel and sand under surface soil.

## Foundations and Subgrades

Soil in mountains is dark red-brown, lateritic clay loam or clay (A-6) 15 to 10 ft. deep. Bedrock, a deeply weathered, well fractured, poor grade of trap, may outcrop on steep slopes, sea cliffs, and along stream bottoms. Along coasts and in valley regions on east side of peninsula soil is yellowish-brown to red-brown, lateritic, sandy or stony loam (A-3 to A-4) with some calcareous cementation at depth. In most places it grades imperceptibly at depth of few feet into conglomerate bedrock; where underlain by layered limestone, top of sound rock is distinct. All soils are permeable and well drained in undisturbed state, but the mountain soils in particular become plastic and slippery if worked when wet. All soils suitable for asphalt or mechanical stabilization if worked under conditions of optimum moisture. Mountain soils may be too high in clay. Can be worked by bulldozer, though moving equipment should be capable of handling heavy wet loads under conditions of heavy daily rainfall and deep mud. Most of bedrock encountered will be weathered sufficiently to handle with bulldozer or power shovel. Locally, some blasting may be required, particularly in limestone layers. Adequate ditching and large culverts necessary to accomodate heavy rains. In the two swampy areas roads probably should be corduroyed. Materials available for temporary purposes locally; rot quickly. Though there is no dry season ground is firm enough to support equipment at times; when flooded, water and mud vary greatly in depth from place to place. In mountains or along west coast slides may result if slopes are undercut too steeply. Such slides may recur over long periods of time after heavy rains and involve large masses of material. Some sand beaches may be hard enough to bear traffic, but most are narrow, rocky or gravelly and bordered by rough hills or coral reefs at either end.

## Clearing and Grubbing

Dense rain forest covers most of area. Large trees require use of power saws or heavy tree dozers and rooters. Stumps will need blasting. Along coast are some small areas of second growth, native clearings, and coconut groves where brush, small trees and fallen partially burned logs can be handled by bulldozer.

## Existing Roads and Trails

There are no roads on southern peninsula and no trails suitable for passage of vehicles except for short distance. Below Ganedidalem 4 foot paths cross southern tip. North to the bulge 8 trails traverse mountains; but from there north to Weda-Pajahe pass there are only two trails, one from Semo to Fida, the other from Lilofa to Foja. Both cross divide at about 1500 ft. altitude. Footpaths are narrow, only seasonally used, and may be overgrown with dense brush. In mountains most of them follow ridges and spurs. Are winding and very steep, in places rocky or cliffed; muddy most of time as there is no dry season. In valleys they tend to follow stream beds - which are rocky or gravelly between steep, high banks covered with dense vegetation. In grassy (alang alang) areas trails are easily lost if little used. Trails connecting villages along coast are probably most easily adaptable to military use; are wider, more frequently used, and pass through more open country requiring less clearing.

## Construction Materials Available

Most readily available material for roadbeds, rock fills, rip-rap and crushed stone for road metal is the coral limestone capping ridges and forming ridges along coast to elevation of approximately 500 ft. Gravel easily obtainable from streams and beaches and makes a fair aggregate, though a fairly high percentage of cobbles will disintegrate easily. Beach sand is generally coarse and of poor quality, high in shell fragments and mud fines, but is suitable for general purposes. Sound rock, other than coral limestone, suitable for quarrying is hard to locate, but some fair quality trap is known southeast of Pajahe Bay. Timber for construction abundant, but mostly of poor quality. Ample surface water for construction purposes except on southern tip. Ground water available on plains along coast at depth of 30 to 40 ft. in unconsolidated alluvial deposits.

Reliability Rating: C

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(CONT.)

# ROADS AND TRAILS: CONSTRUCTION AND MAINTENANCE — HALMAHERA (MOLUKKAS)

## Area 7 Batjan Island Group

### Alignments and Grades

Batjan, largest of mountainous group of islands off southwest coast of Halmahera, is made up of four mountain blocks separated by three valley corridors. A broad swampy plain bounded on south by rolling foothills crosses island from Laboeha to east coast. An alignment through foothills would provide dry ground, allow moderate grades, and require only a few bridges. From this plain north valleys of Sajoang and Tjoro Rivers form a corridor between northeast and northwest mountains to coast. It is narrow and restricted at either end where rivers pass through foothills, but opens into an interior broad forested plain. To south narrow isthmus between Lapan and Wajoea Bays is a low flat forested plain variably ½ to 1½ mi. wide and only three mi. across by trail. Thought to be mostly dry ground. The Sibela central block, by far the most rugged of the four mountain barriers, rises to maximum altitude of about 6900 ft. Easiest crossing could probably be made around east coast. Southern, northwestern, and northeastern mountains are volcanic and generally similar in nature; having steep slopes, deep ravines and canyons, narrow ridges and spurs generally unsuited to road construction. Northwest mountains are more thoroughly traversed by trails and a north-south alignment might be effected with difficulty west of Mount Amassing up Amassing River from Laboeha. Grades would be steep, sharp curves locally necessary. Much cut and fill. Coast mostly mountainous, but narrow coastal plains occur at intervals. Except for those at ends of corridors, they are isolated areas, but roads could be constructed over many of them. The plain along Sambaki Straits at northeast end of island is very swampy; others are mostly firm ground.

Kasiroeta Island is rough and mountainous. Near its south end a flat, but locally marshy, plain about ½ to 1 mi. wide extends across island and forms only corridor. Some trails lead inland through the sparsely inhabited mountains.

Mandioli Island is mountainous, but topography not as rough or steep as on other islands. Hills are more rounded and slopes are steep only along central divide and at north end of island where a rugged peninsula juts east-west into sea. Heavily forested, but roads could be constructed in many places along coast.

Obit Island is similar to Mandioli.

Sali Lamo Island in the Patinti Straits is very steep, rocky and mountainous.

Latalata and Moeari Islands, to north, are rocky and mountainous; are most easily crossed through low hills at head of Boho Bay (Latalata) and at head of Boesoea Bay (Moeari).

Taneti Island is hilly, but not rough. Has a central corridor along Dalamair River from north.

Kajoa Island has mountains along northwest coast; also central and southern mountain groups. A broad corridor leads northeast on dry ground, from Goerceapin on the swampy southwest bayhead, through low rolling hills to swampy coast along Silai Bay. A second low corridor crosses on dry ground between central and southern mountains.

Laloein Island is low and hilly.

### Streams and Stream Crossings

Most of streams in islands are short, have steep gradients, and are torrential in nature. Are easily forded except during and immediately after heavy rains. Bottoms are rocky or gravelly in upper courses, may need some clearing of bed for fording; are sandy or muddy with possibly some quicksand in lower courses. Banks are high and steep requiring dugways for approaches in most places. Water normally shallow, but rises during heavy rains. Rock subgrades may have to be built up for passage of vehicles. Vegetation generally dense along banks. Swamps are common along stream courses near coast and locally on inland plains, make approaches difficult, but generally can be negotiated by corduroy roadbeds. Ample timber available for construction. Bridges needed only where streams are too deeply intrenched or at few places where too deep to ford. Sajoang and Inggoi Rivers on Batjan may need bridges for crossings in lower courses. Most streams only 15 to 30 ft. wide. Larger ones may be as much as 100 ft. wide in places.

### Foundations and Subgrades

Soil throughout most of mountainous islands is red-brown lateritic loam and clay loam (A-4 to A-6); friable and crumbly with increasing abundance of rock fragments at depth. Depth to bedrock variably about 20 ft., shallower along streams. In Sibela mountains soil is quite thin, 3 to 4 ft., and is more sandy and stony (A-4) with abundant rock outcrops. The alluvial soils of the valley corridors are quite variable (A-2 to A-6), being coarser upstream and near the flanking hills. Is generally sandy clay loam overlying sand and gravel stream deposits. Bedrock is for most part volcanic ash, conglomerate and layered trap rock. Sibela Mountains are an area of schist and gneiss. Along coast to height of about 500 ft., and in some cases covering smaller islands, coral limestone interbedded with sand and gravel deposits overlie the volcanic rocks. The trap rock, schist and limestone generally require blasting for excavation. The other rocks can be worked by hand tools or excavated by bulldozer; are generally deeply weathered. All soils are permeable and well drained in the undisturbed state, but become plastic and slippery if worked when wet. Equipment should be capable of working in deep mud. Adequate drainage of completed roads necessary to support military traffic for any length of time. This is particularly true in hilly areas where development of slides on excavated slopes is an added hazard. Allowing roads to dry for a few hours after heavy rains whenever possible greatly improves their condition.

### Clearing and Grubbing

Dense rain forest covers most of area. Larger trees will require use of power saws or heavy tree dozers. Stumps will require blasting. Dense mat of roots and creepers in upper layer of soil make use of hand tools difficult. Area around Laboeha and other settlements more open due to second growth and native clearings. Swampy areas on plains may be covered with swamp forest or dense stands of sago palms. In swamps near the coast these give way to still more dense thickets of Nipah palms and mangroves. Along the drier low coastlands are more open coconut strips. Some dense moss forest similar to that on New Guinea probably exists on the higher parts of the Sibela mountains.

### Existing Roads and Trails

The only roads in the Batjan Island group suitable for light military vehicles are short stretches of narrow dirt plantation roads and wheel tracks in the vicinity of Laboeha. Well developed footpaths cross the two narrow isthmuses of Batjan Island keeping to the drier ground of the foothills along margin of these corridors. Other trails parallel the Sajoang and Amassing Rivers. There are no trails in the Sibela Mountains and few of any consequence in the mountains to the south. The northwest mountains are penetrated by numerous steep narrow foot trails; traversed by four. These trails follow stream courses through the foothill region and swing onto ridges in the mountains. In the northeast mountains a single trail crosses the rough mountainous divide from Gorogoro to the interior plain of the Sajoang River. Kasiroeta Island is thoroughly traversed by trails. Mandioli has very few. Interior trails are little used and may be overgrown with dense brush; indistinct in many places and clearing with machete generally necessary. Are muddy much of time and become slippery with use. None of trails through mountains would be suitable road alignments. They ascend steep slopes to passes over 2000 ft. high, traverse narrow rocky ravine bottoms and follow very narrow ridge crests. Throughout the Batjan group no trails follow the coastline which is cliffed in many places.

### Construction Materials Available

Coral limestone suitable for crushed aggregate, road metal and rough rock masonry is the most abundant and easily obtainable construction material. It occurs in the hills along the coasts of nearly all the islands. A fair grade of trap rock which is also suitable occurs in the interior of the islands, but has fewer outcrops because of the deep soil developed on it. There are good deposits in the small recent volcanoes at the east ends of the two isthmian corridors. Gravel and sand can be screened from river beds and coral sand is available on some beaches, though many are rocky. Gravel can also be obtained from volcanic conglomerate deposits common in interior. Outcrops best on steep walls of valleys. Irregular size of fragments may require use of grizzly for sizing. Much of this kind of gravel is weathered and disintegrates quickly under wear. Ample timber is available for construction purposes; much is of poor quality. Ample surface water available. Ground water is obtainable from unconsolidated alluvial deposits along the coast and on plains in interior at depth of 30 to 40 ft.

## Area 8 Morotai Island

### Alignments and Grades

Little is known of topography and only southwestern quarter has been mapped in any detail. Very mountainous island, much of it over 2000 ft. in altitude; maximum altitude 4100 ft. Rugged relief. Along coast, cliffed headlands alternate with narrow strips of cobbly or coarse sandy beaches. Inland terraces form benches against mountains in many places. Southwest end is a flat forested plain which extends inland for 3 to 4 miles. The narrow peninsula jutting out to southwest is similarly flat. Another plain occurs along the Goeggerona (Tjioe) River on northwest coast, and a third along Pangeo River at northeast end of island. Road construction in mountains would be extremely difficult because of numerous deep ravines and canyons. Slopes are steep, ridges sharp and narrow. Many culverts and bridges would be required for all-season crossings of numerous streams subject to flash flood after heavy rains. On plains construction problem is largely one of clearing rain forest and crossing rivers. Cleared or second growth areas between settlements along coast are easiest going.

### Streams and Stream Crossings

Stream conditions in mountains unknown; presumed to be same as in mountainous regions of Halmahera. Streams probably easily forded except in flood. Bottoms gravelly or rocky, banks steep. Approaches locally difficult because of steepness and depth of ravines. On plains, larger streams are over 100 ft. wide and may require bridges or ferries. In upper parts, are shallow and easily forded on gravel bottoms. Small streams are mostly fordable and all streams have a bar across mouth at coast. Vegetation generally densest along stream courses.

### Foundations and Subgrades

Most of the soil in the interior mountainous part of Morotai is a red-brown lateritic clay loam or clay (A-6) having a depth of 15 to 30 ft. Bedrock, probably various kinds of trap and locally some volcanic ash and conglomerate, outcrops at the surface abundantly in the higher regions and along streams. In many places along coast are limestone terraces which support a yellow-brown lateritic sandy loam. All soils are friable and permeable in undisturbed state but become plastic and slippery if worked when wet. Can generally be worked by bulldozers, though moving equipment should be capable of handling heavy wet loads under conditions of heavy daily rainfall and deep mud. With exception of limestone most of bedrock encountered will be sufficiently weathered to handle with bull dozers or power shovels. Limestone may locally require blasting. The alluvial soils on plains areas are deep and probably less permeable than the mountain soils. Wide range in texture, but mostly silty clay loams overlying gravelly deposits. Adequate drainage of roads and trails is an important factor. Culverts should be large and bridges as high as possible. Beaches are mostly stony or of coral sand; not firm enough to support equipment.

### Clearing and Grubbing

Dense rain forest over most of area offers major problem of clearing. Large trees will require use of power saws or heavy tree dozers; stumps will need blasting. Dense mat of roots and creepers in upper layer of soil makes use of hand tools difficult. Some partially cleared areas and second growth is easier to clear along southwest coast near settlements.

### Existing Roads and Trails

Only road on Morotai for passage of military vehicles connects Sangowo and Sambibi on south coast. It is 10 to 15 ft. wide and has wooden bridges and culverts. Narrow foot-trails are known to follow coast in southeastern part of island and may similarly occur in other parts. Little used and probably much overgrown foot trails cross mountains from Sabatai and Tilai Rivers on southwest coast to plain of Goegoerina River on west coast.

### Construction Materials Available

Corel limestone found on terraces on hillsides all along coast is most readily available material for road beds, rock fills, rip rap and crushed stone for road metal. Can be worked with hand tools, but may require blasting locally. Is abundant on southern peninsula. Other rock is not abundant though outcrops of trap can be found in interior, especially in higher mountains. Much of it is deeply weathered and of poor quality. Sand and gravel are obtainable from beds of larger streams; may require screening. Some beach sand is available locally on coast; contains much shell material. Timber for construction purposes abundant, but mostly of poor quality. Ample surface water for construction purposes. Ground water available from unconsolidated alluvial deposits along coast at depth of 30 to 40 ft.

Reliability Rating: C

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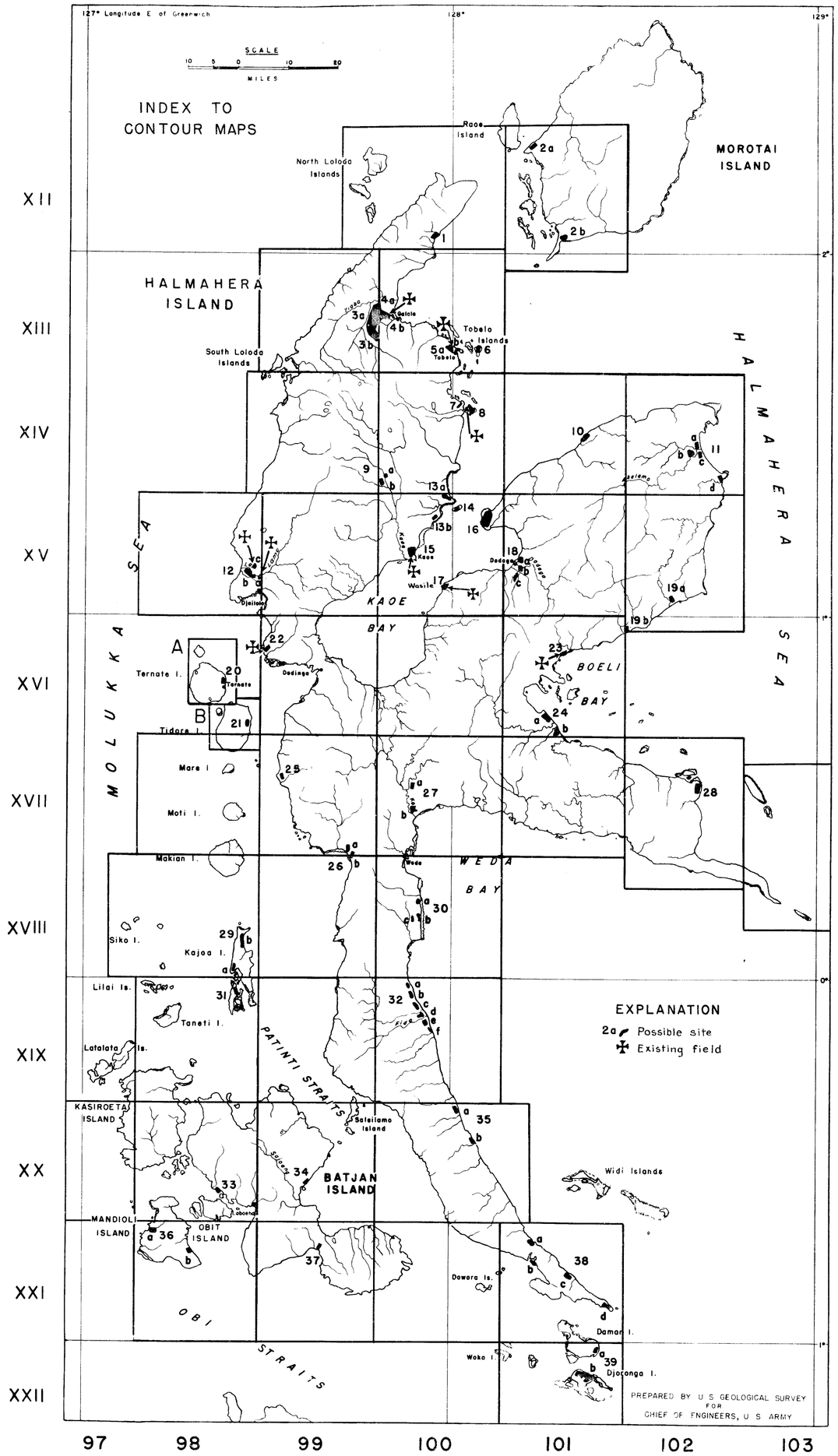
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# POSSIBLE AIRFIELD SITES INDEX

## HALMAHERA (MOLUKKAS)



# HALMAHERA (MOLUKKAS)

# POSSIBLE AIRFIELD SITES

INTRODUCTION a/

## General Nature of the Terrain and Accessibility

Halmahera and its adjacent islands are extremely mountainous. Flat areas suitable for landing strips are for the most part confined to narrow terraced coastal plains bordered by steep sloped ridges and spurs from the mountains or to broad alluvial plains along the larger rivers near the sea. The only possible sites farther inland are on the plains around Lake Galela and in the broader parts of the Kaoe and Kobe River valleys. Most sites are suitable for only one runway; some are large enough for two or three, but only a few have space for runways in any direction. Nearly all sites are directly accessible to landing barges and other shallow draft vessels along the coast. Fringing coral reefs form obstacles in places. At no place except Ternate can steamers dock directly at a pier. Ship to shore transportation is invariably necessary. Streams are navigable only to prahoes having a 3-4 foot draft and there is invariably a bar across their mouths at the coast. There are only a few miles of poor road in the islands. All transportation is by native carrier on foot trails. The best trails connect villages along the coast. Footpaths across the mountainous peninsulas provide ready access to most parts of the island. However, several sites are virtually isolated except from the sea. The use of military vehicles anywhere except on Ternate and in the immediate vicinity of Galela will require the construction of roads or at least considerable improvement of the short stretches of existing roads.

## Basis for selection of sites

Possible sites have been selected only where accessible and where topographic maps having a 50 meter contour interval indicate the ground to be reasonably flat and probably well enough drained to obviate difficult construction problems. All sites are for landing strips at least 6000 feet long and 2,000 feet wide with approaches free from major topographic obstacles, unless otherwise stated. There is ample space at all sites for standard dispersal areas and taxiways. Sites have been rated "excellent", "good" and "fair" on the basis of their accessibility, ease of construction, water supply and available construction materials. Since obtainable information on recent Japanese installations in the island is extremely sketchy, existing fields have not been considered in detail.

## Improvements needed.

At most sites the strip will have to be cleared through dense rain forest, a thick growth of large trees 100 to 140 feet tall with dense overhead canopy of leaves and branches locked together by vines and creepers which trail down to the ground. In the approach zones topping of the taller trees may be all that is necessary. Trees have large radiating roots; stumps may be from 2 to 8 feet in diameter. Wood is mostly soft, and pulpy, and jams a saw easily. Some is very hard and fine-grained; most is quite heavy. The ground is covered by a closely woven mat of roots vines, and creepers in a thick carpet of rotting vegetation that has to be stripped to expose the soil. This material if spoiled in piles at the borders of the site burns with difficulty. In some places where the ground is low are sago swamps, a dense tangle of palm fronds, sharp suckers and spikes sticking up through the soft ground. Open grass lands on some of the coastal terrace sites require the least clearing.

## Improvements needed.(continued)

Grading at most sites can be done by bulldozers and scrapers; consists of leveling low knolls and filling shallow depressions or gullies. Locally a little rock excavation requiring light blasting and a power shovel may be needed.

Drainage is particularly important because of the heavy rainfall. Filled gullies should have rock cores where possible and the streams, if perennial, should be diverted around or away from the site. Rock, or other select permeable fill, should be used also to raise subgrade over damp swampy spots after organic debris has been removed. Lateral drains will speed drying and lower the ground water table. An impervious surfacing is advised where time and materials permit, as it prevents the extreme mud conditions that would develop on even an internally well-drained site, if much used, because of the intensity of the rainfall. Coral sand surfaces require a strong binder to reduce the dust hazard to engines that is created by prop wash in the loose material. Sites on coral limestone terraces have the best natural drainage and stability, but if these are low next to the coast shell craters may fill with water because of the high ground water table.

## Soil conditions.

The soil conditions described for each site represent the probably dominant soil type and range of differences within that site. The majority of sites selected lie upon alluvial deposits on which coarse-textured sandy loams, and fine sandy loams, A-2, some A-4 (SF,ML), that may be locally stony and gravelly, develop (Ia on map). Some sites are on medium-textured, poorly graded friable loams and clay loams , A-2, A-4 (SF , ML, some CL), developed on fine alluvium beneath (Ib on map). Local deviations in soil character over short distances and also with depth are to be expected. Local topographic differences not shown on the maps may also affect soil characteristics unpredictably. Other possible sites are on interbedded coral limestone, sand, and gravel. The exact disposition of these materials and hence of the soils upon them is not certain. The predominant soil types are friable sandy loams and clay loams that may be locally gravelly or stony, A-2,A-4 (SF, ML) (VI on map); some variation from place to place within a site must be expected. A few sites are on compact but friable loam and clay loam soils derived from volcanic rocks (e.g. on the plain west of Galela Lake) and a few are on coarse sand and sandy loam, A-2,A-3 (SF, SP) occurring on coastal coral islands ( e.g. Miti). These areas probably show the least variable soil conditions. Because of a well-distributed high annual rainfall the soils of this region are in a constant state of wetting and drying. The clayey soils, when worked or subjected to traffic, display the properties of plasticity, stickiness, intractability, tendency to mud up wheels, to form ruts and mud holes, depending on the amount and kind of clay content. In other similar tropical areas, in general, the red or red-brown clays are considered somewhat less difficult to work than the light gray, light brown and other light colored clays which exhibit wide volume changes during wetting and drying and and highly colloidal. It is probable that on Halmahera the most intractable, sticky, and plastic clays occur in the lowest areas with the poorest drainage, and the more tractable, less plastic, and more friable clays will occupy the better-drained positions. See Soils: Basic Data and Engineering Properties sheets of this folio for more detailed description of soils and their properties.

## Construction materials.

At most sites good quality construction materials, rock or gravel deposits, are available in abundance close by. Coral limestone (VI on the map) is the most common rock available. It is extremely variable in character, but is good for most purposes, occurs as hard, massive, fine-grained beds, irregular masses of rock fragments and coral heads in a soft or hard matrix, and as layers of consolidated coarse shell fragments. Interbedded with these are beds of loosely consolidated soft sandstone and conglomerate. The harder limestone beds commonly outcrop along the margins of terraces or as ledges on the hillsides and small quarries are easily developed in them. The material can be worked in small amounts by hand tools, but quarrying is better accomplished by blasting and power shovel. Coral rock found along the shore near some sites provides similar material. Various grades of trap rock (II, III, IV on map) are available near some sites. In general it is difficult to obtain, either because of its inaccessibilty or because of a deep soil cover. In the vicinity of Galela, Tobela, and Djailolo, however good quality trap rock (II on map) is readily and abundantly available; requires blasting for excavation. Gravel of good quality is obtainable from many streams; can be crushed or used directly; is poorly sorted. Deposits of gravel or conglomerate in the hillsides (V on map) are in many places covered by thick soil; these outcrop mostly on steep slopes of ravines. The material is poorly sorted and very variable in size; is interbedded with sandstone and probably contains a high percentage of fines. The cobbles are apt to be in various stages of decomposition near the surface and often a considerable yardage has to be stripped to expose suitable material. Pumice and volcanic cinder (II on map) are available in quantity in the general vicinity of Galela and nearby plains. Good sand is not abundant; some can be obtained from streams, Coral sand along the coast is coarse and full of shell fragments.

## Water Supply

Water fromeither surface or underground sources is obtainable at all the possible airfield sites. Surface water is available at most sites from nearby perennial streams, and at a few sites from fresh water lakes; requires filtration and chlorination to be potable. Ground water at nearly all sites can be obtained quickly and easily and does not require filtration; at some sites it is the only possible supply. Water usually can be obtained at a depth of a few feet from unconsolidated sand and gravel, or, at a few sites, from coral limestone or conglomerate. At most sites wells can be installed most efficiently and rapidly by using drive-points or rotary drilling rigs, but in some places boulder beds or hard coral limestone will necessitate use of percussion drilling rigs or hand tools. At sites near the coast, special precautions should be taken to avoid salt-water contamination and wells should be located at least 1,000 feet from the coast. See Water Supply section of this folio for more detailed description of occurrence and development of surface and ground-water supplies.

**Reliability Rating: C**

Preliminary text submitted without checking or editing.
U. S. Geological Survey

a/ For latest data on existing airfields and installations consult other intelligence sources.

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

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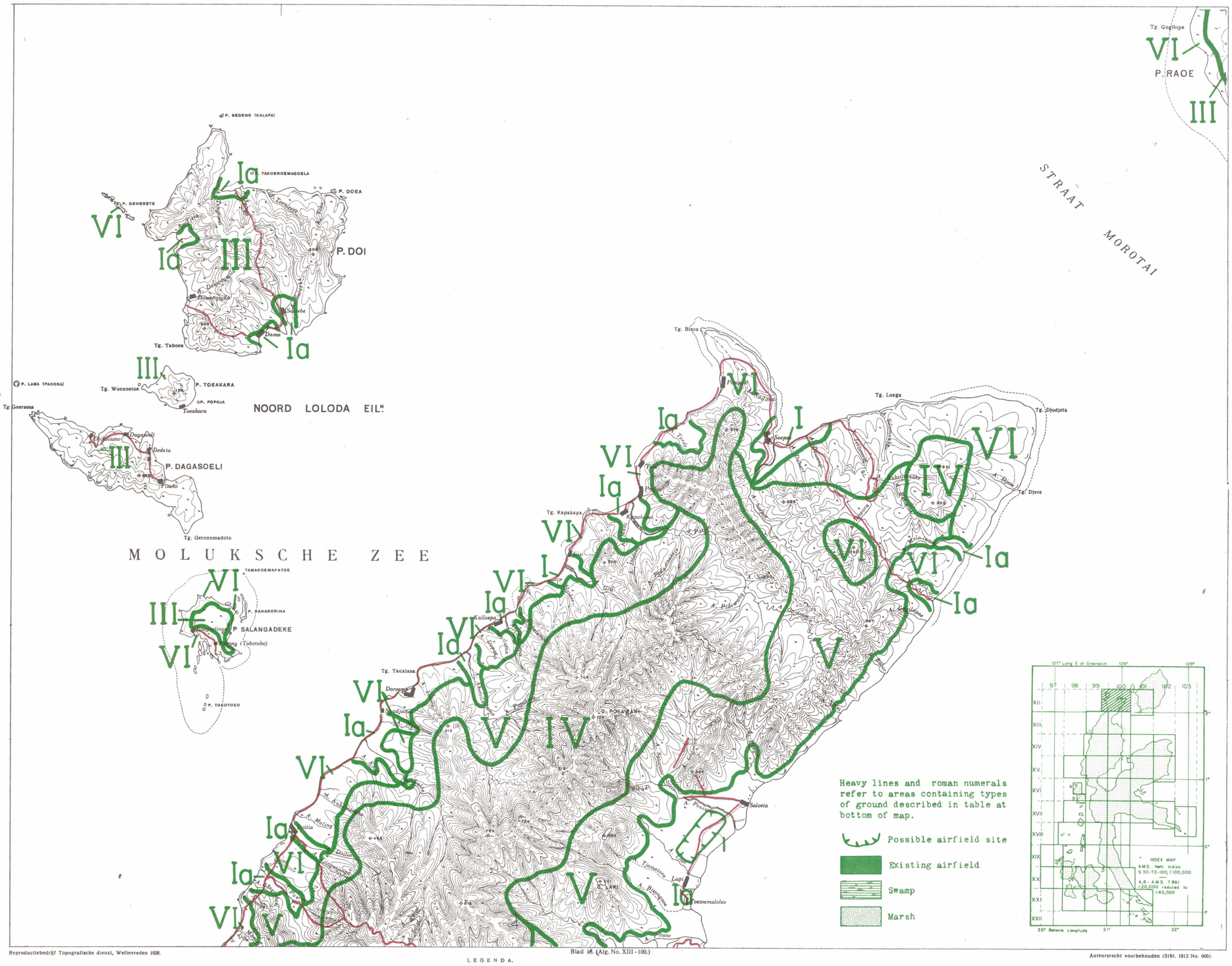
# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Schetskaart van den Topografischen dienst in 1925.

# POSSIBLE AIRFIELD SITES

Blad 10 en 11. (Alg. No. XII-99 en 100.)

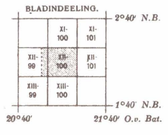



Reproductiebedrijf Topografische dienst, Weltevreden 1926.

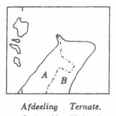
Blad 18. (Alg. No. XIII-100.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.




ADM. INDEELING.



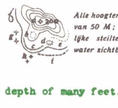

Trail

Road

*Afdeeling* Ternate.
*Onderafd.* Halmahera.
A. *Ressort* Djailolo.
B *Ressort* Tobelo.

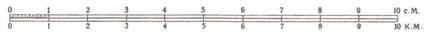
LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemaraof Dennen bosch.* *Voetpad.* *Rivier, a. gemeten. b. niet gemeten.* *Ressortsgrens.* *Paardenpad. a. dakker of doorlaat van bamboe.* *Bamboe huizen.*



*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikte van 500 M. a. hoogtepunt en hoogtecijfer, b. halfhoogtelijn, c. natuurlijke steilte, d. kleine verhevenheden, e. terreinoneffenheden, f. eiland, g. klippen bij laag water zichtbaar, h. klippen altijd boven water, i. laagwaterrifs.*

Schaal 1:100 000.




TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, tooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000, blauwdruk zeekaart No. 1414a schaal 1:100 000 uitgave 1925 en volgens deze kaarten het blad georienteerd.*

VERKORTINGEN.

G. *Goenoeng.* P. *Poelau.* Tg. *Tandjoeng.* A. *Ake.* O.L. *Onderaardsche loop.*

PREPARED BY U.S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U.S. ARMY

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.



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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITE 1 Sheet XII-99,100

Rating: Fair

Accessibility: Site about 500 yards from coast which is accessible to landing barges. Slight rise up to general level of site. Trail crosses site, but does not continue along coast beyond borderof plain. Area isolated.

Topography: Flat to rolling plain rising inland from the coast. Slope at site mostly less than 1.5%. May be low rise at center of site. Few sluggish streams may cross site; banks 1 to 6 feet high. Site is bordered at both ends by rivers 30 feet wide between banks 8 to 15 feet high. Single runway can be oriented northeast-southwest Altitude probably 10 to 25 feet.

Approaches: Free approaches in both directions for a distance of about 2 miles where mountains rise abruptly along the coast to altitude of 1,000 feet. Higher mountains rise parallel to site 1 mile to northwest.

Clearing and Grubbing: Dense tropical rain forest; larger trees 3 feet or more in diameter. Stumps probably not deeply set. Dense mat of roots and vines at ground surface requires stripping. Brush densest along streams and at coast except where forest may give way to coconut palms along beach.

Grading: General leveling of rolling surface and filling of minor depressions and gullies. Sandy soil readily worked by bulldozers and scrapers. No bedrock excavation.

Foundation Conditions: Soils at each end of field and along southeast side probably coarsest grained and mostly sandy: A-2, A-3 (SF,SW). Near middle and along northwest side soil probably finer: A-4 (ML). Many variations possible locally.

Stabilization and Surfacing: Soil compacts well when brought to right moisture content for optimum density. Not difficult to manipulate if short time is allowed for drainage after rains. Sand suitable for bituminous mix and surface course may be found on or near site.

Drainage: Ground naturally well drained except near coast and requires few improvements. Areas around small streams and gullies that head on site may be soft and require lead-off ditches.

Construction Materials Available: No rock available at site. Gravel may be obtained from nearby stream beds or from deposits exposed along ravines in mountains surrounding plain.

Water Supply: Posawani River may supply adequate perennial source; intake should be above level of salt water limit. Better source may be wells sunk 20 to 25 feet in alluvium; wells should be 1,000 feet or farther inland and should extend only a few feet below water level. Should be pumped as lightly as possible to minimize danger of salt water contamination.

Reliability Rating: C

Preliminary text submitted without checking or editing
U. S. Geological Survey

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CHIEF OF ENGINEERS, U S ARMY

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# HALMAHERA (MOLUKKAS)

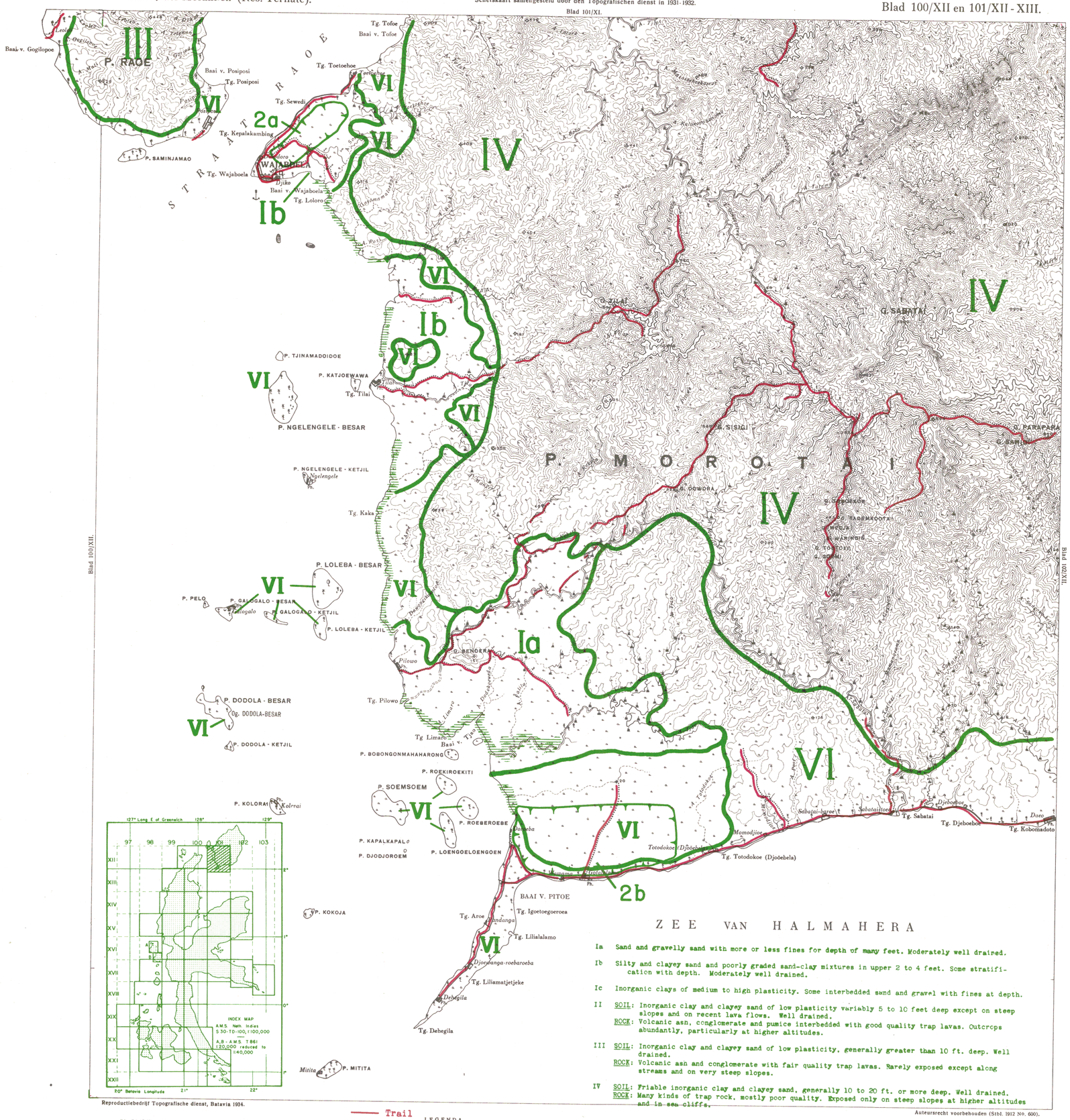
Gouvt der Molukken (Res. Ternate).

Schetskaart samengesteld door den Topografischen dienst in 1931-1932.

Blad 101/XI.

# POSSIBLE AIRFIELD SITES

Blad 100/XII en 101/XII - XIII.







Reproductiebedrijf Topografische dienst, Batavia 1934.

ZEE VAN HALMAHERA

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

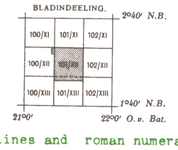
II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDELING.




Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

ADM. INDEELING.

Res. (Afd.) Ternate. Onderafd. Tobelo. District Morotai.

Trail

Road

LEGENDA.

Kampoeng. Schaars bewoonde streken. Ladang (tijdelijke nederzettingen met droge rijstveelden). Arentuin. Klapperboomen. Bosch. Bamboebosch. Moeraspalmen. Tjemara- of Dennen- (Sparren-) bosch. Herkenbare boom. Moeras. Paardenpad. Voetpad. Rivier, a gemeten, b niet gemeten. Bamboe huizen. Inlandsche graven.

Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogtecijfer, b hulphoogtelijn van 25 m, c eiland, d ankerplaats en reede, e zandbank altijd droog.

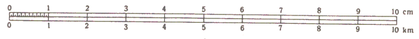
V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near or at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

Schaal 1:100 000.




TOELICHTINGEN.

Vluchtig opgenomen in 1931-1932 met de bergboussole voor het hoofdverband en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 386 schaal 1:200 000 uitgave 1926.

AFKORTINGEN.

D. Districtshoofd. P. Poelau. G. Goenoeng. Ph. Posthuis. Tg. Tandjoeng. A. Ake (rivier). Og. Onderneming.

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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITE 2a.

Sheet XII-101
~~XIII-101~~

Rating: Good.

Accessibility: Directly accessible from coast. Barges can land without difficulty at Wajaboela. Good trail along coastal margin of site not continuous north or south; area isolated.

Topography: Site is situated on low sandy promontory; space for one or possibly two runways oriented northeast. Ground gently rolling though somewhat irregular locally; grades less than 1.5%. Altitudes between 20 and 80 feet.

Approaches: Approaches clear from the southwest. Low terraces and hills rise 150 to 250 feet within $\frac{1}{4}$ to 1 mile northeast of the site.

Clearing and Grubbing: Dense rain forest over most of area. Larger trees three or four feet in diameter; stumps may require blasting. Dense mat of roots and vines at surface of ground requires stripping. Considerable thick underbrush. Some more open areas of second growth; native clearings and coconut groves along coast, near Wajaboela.

Grading: Little grading other than minor leveling required. Loam soil readily worked by bulldozers and scrapers. Some small gullies may need filling. No rock excavation.

Foundation Conditions: Soils chiefly medium to coarse in texture, A-4, A-2 (ML,SF); developed on alluvium. Deviations towards coarser texture likely at SW end near village of Wajaboela and along NW side.

Stabilization and Surfacing: Soil may be compacted to optimum density fairly readily but has poor bearing ratio. Not suited for bitumen or cement mix, although sand for use with bitumen may be obtained along shore. Soil not sticky.

Drainage: Drainage fair, but may not dry out quickly after rain. Installing French drains and use of lateral lead-off ditches will improve conditions locally.

Construction Material Available: Coral limestone probably available along coast. Can be worked by hand tools in small quantities. Some gravel may be obtained locally from streams.

Water Supply: Nearby streams probably are not adequate perennial source. Adequate supply obtainable from wells 30 to 60 feet deep, in alluvium and possibly in coral limestone. Wells should be at least 1000 feet from coast; they should not extend more than a few feet below water level and should be pumped as lightly as possible to minimize danger of salt-water contamination.

SITE 2b.

Rating: Excellent.

Accessibility: Directly accessible from coast. Landing barges would have to follow channels through narrow fringing reef at Gotalalamo. No reefs at Doroeba. Good trail along coast to east. No bridges, but streams are fordable.

Topography: Coastal lowland bordered by broad terraces and low hills. Site is suitable for runways in any direction. Ground nearly flat or gently undulating; grades less than 1%. Altitudes between 20 and 50 feet.

Approaches: Approaches clear except on the northeast and east where low terraces $1\frac{1}{2}$ to 3 miles from margins of the site may be minor hazards.

Clearing and Grubbing: Dense tropical rain forest over most of area. Larger trees three or more feet in diameter. Stumps mostly not deeply rooted but some will require blasting. Dense mat of roots and vines at ground surfacing requires stripping. Some open areas of second growth and native clearings. Coconut stands along the coast.

Grading: Little grading other than minor leveling and filling of small gullies. On south side soil may be shallow with weathered coral rock near surface. Soil can be worked with bulldozers and scrapers. Deep excavations possible except in coral rock which requires light blasting.

Foundation Conditions: Probably A-2, A-4, possibly A-1 (SF, ML, SC) but wide range of soil types possible. Binder content low.

Stabilization and Surfacing: Soil gives good subgrade after compaction at optimum moisture. Sand suitable for bitumen mix may be found at or near site. Soil not sticky.

Drainage: Soil mostly well-drained and dries quickly after rains. May be a few wet spots in northern part of site.

Construction Material Available: Coral limestone available in quantity in terraces east of site and along coast. Requires drilling and blasting for extensive quarrying, but can be worked by hand on small scale. Sand available locally from small beaches.

Water Supply: Tjao River may not be adequate perennial source; if surface water used, may be necessary to pipe or haul water from Pilowa and Sabatai Rivers: intake should be above salt-water limit. Better source is wells 30 to 50 feet deep which should be at least 1000 feet from shore; they should not extend more than a few feet below water level and should be pumped as lightly as possible to minimize danger of salt-water contamination.

Reliability Rating:C

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografische dienst in 1925.
Blad 10 en 11. (Alg. No. XII-99 en 100.)

## POSSIBLE AIRFIELD SITES

Blad 17. (Alg. No. XIII-99.)



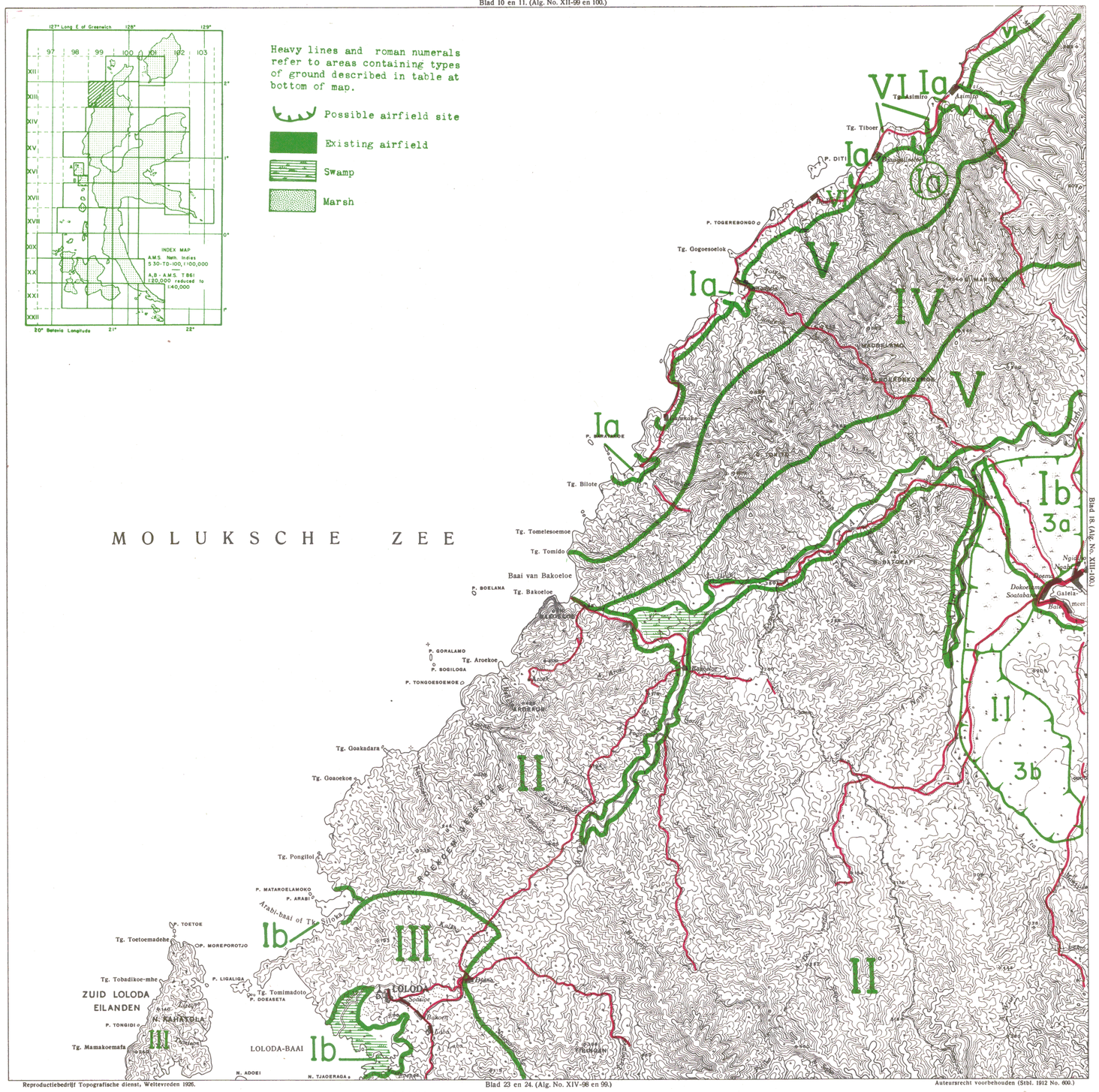

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

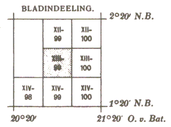



Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 23 en 24. (Alg. No. XIV-98 en 99.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600.)

BLADINDEELING.




ADM. INDEELING.

*Afdeeling* Ternate.
*Onderafd.* Halmahera.
A. *Ressort* Djailolo.
B. *Ressort* Tobelo.

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemara- of Dennen bosch.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten, c. natuurlijke steilte bij oevers.* *Moeras.* *Paardenpad. a. duiker of doorlaat van bamboe.* *Ressortgrens.* *Alang-alang.* *Meer.* *Drasland.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. a. hoogteaant en hoogtegetal. b. hulphoogtelijn. c. rots. d. eiland. e. klippen bij laag water zichtbaar. f. terreinoneffenheden.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, sooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000, blauwdruk zeekaart No 1414a. en volgens deze kaarten het blad georiënteerd.*

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

VERKORTINGEN.

*D. Districtshoofd. P. Poelau. N. Noesa. G. Goenoeng. Tg. Tandjoeng. Tk. Teloek. S. Soengai. A. Ake (rivier.)*

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XIII-99
SITES 3a and 3b.

Rating: Site 3a excellent, 3b fair.

Accessibility: Site 3a accessible by narrow road from Galela; would need improvement for use by military traffic. Site 3b accessible by trail 2 miles from road. Galela has good beaches and at least one small pier accessible to lighters or barges.

Topography: Broad plain bordered by steep mountains. Site 3a on northern part of plain has space for runways in any direction. Ground gently undulating. Slopes are to north and east at grades of 1.5% or less. Ground is somewhat more rolling and irregular in southern part; is crossed by a few broad gullies 5 to 20 feet deep. Altitude between 100 and 200 feet. Site 3b is suitable for runways oriented northwest to northeast. Ground rolling and hilly, but grades mostly less than 1.5%. Site crossedby gullies 10 to 25 feet deep. Altitude between 200 and 350 feet.

Approaches: Site 3a has clear approaches to east. Mountains 1400 to 1600 feet in altitude border west and north sides, but are not hazards to landings. Hills 600 feet high lie about 3 miles to southwest. 3b has clear approaches for 4 miles or more to north. Hills 500 to 700 feet in altitude are minor obstacles to east. Hills 500 to 1000 feet high border west and south sides of site.

Clearing and Grubbing: Site 3a covered by grassy plains, sparse trees, and patches of woods and coconut palms. Site 3b is covered by tropical rain forest with some open areas of brush, bamboo thickets, and grass in northern part; becomes dense tropical forest to south. Larger trees may be 3 feet or more in diameter; stumps will require blasting. Dense ground mat of roots, vines, and creepers makes difficult clearing.

Grading: Little or no grading required at 3a. Leveling of naturally rolling surface and filling of small gullies and depressions necessary at 3b. Sandy soil and volcanic ash bedrock are easily worked by bulldozers and scrapers.

Foundation Conditions: Site 3a on medium textured soil, A-4 (ML), with possibly some A-6 (CL) near Galela Lake. On south side soil may be stony, A-4 (CL, ML). At 3b soil is stony and medium-textured, friable A-4 (ML, CL).

Stabilization and Surfacing: At 3a soil compacts fairly well at right moisture content; has binder of fair quality; good subgrade material in general requiring shallow base course. Soil not sticky unless very wet. At 3b soil compacts fairly well at right moisture content. Binder of fair quality abundant. Soil not sticky unless very wet.

Drainage: Both sites naturally well-drained and dry quickly after heavy rains. Field, unless surfaced, will probably become slippery and rutted during rains.

Construction Materials Available: Good quality trap rock is available from volcanic cone northeast of Lake Galela, from volcanic cone east of 3b, and locally in hills west of both sites where it is interbedded with a more abundant volcanic ash and conglomerate. Pumice and fragmental volcanic debris suitable for surfacing also found on flanks of cones. Gravel may be obtained from Tiabo River banks or bed.

Water Supplies: Adequate perennial supplies available from Ira or Tiabo Rivers or from Lake Galela. Maximum lift of 150 feet and possibly 3 miles of pipeline required. Water requires chlorination and filtration for potability. River water silty after heavy rains. Adequate supplies of potable water can probably be obtained at site 3a from wells drilled anywhere on the site to a depth of about 150 feet or less. Wells at site 3b would probably provide only small supplies since the rocks there are rather impermeable.

Reliability Rating: C.

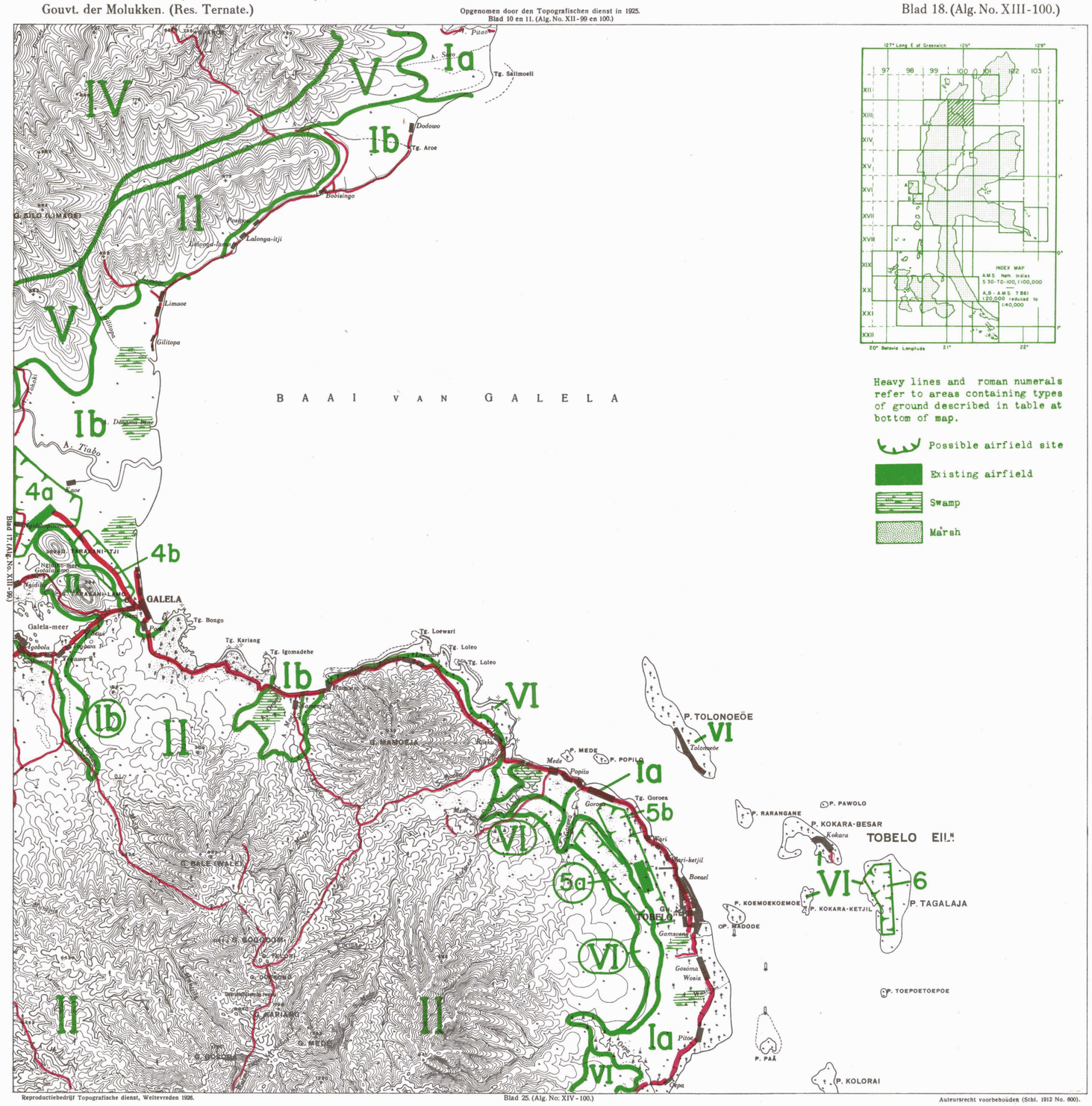
Preliminary text submitted
without checking or editing
U. S. Geological Survey

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S ARMY

# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 10 en 11. (Alg. No. XII-99 en 100.)




## POSSIBLE AIRFIELD SITES

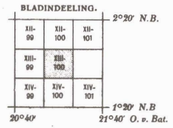
Blad 18. (Alg. No. XIII-100.)



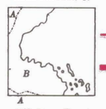

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

BLADINDEELING.




ADM. INDEELING.



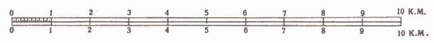

*Afdeeling* Ternate.
*Onderafd.* Halmahera.
A. *Ressort* Djailolo.
B. *Ressort* Tobelo.

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klopperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemara of Dennen bosch.* *Voetpad.* *Rivier.* *a. gemeten, b. niet gemeten.* *Inlandsche graven* *Pasanggrahan.* *Mesigit.* *Steenen- en bamboe huizen.* *Meer.* *Paardenpad.* *Drasland.* *Moeras.* *Damarboomen.* *Alang-alang.* *Gras.* *Ressortsgrens.* *Verharde weg, waarvan de verharding van 2-4 M. breed, is. a. houten aftandspaal, b. duiker of doorlaat van bamboe.* *Niet verharde weg, in den drogen moessons geschikt voor veldartillerie,van 2-4M breed.* *Steenen.* *Steenen grenspaal dama-concessie.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. a. eiland, b. klippen bij laag water zichtbaar, c. laagwaterlijn, d. bamboe baken, e. hoogtepunt en hoogtecijfer, f. huiphoogtelijn, g. rots, h. bodemoneffenheden, i. natuurlijke steilte.*

Schaal 1:100 000.




TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd.*

VERKORTINGEN.

Gh. *Geraghebber.* D. *Districtshoofd.* P. *Poelau.* G. *Goenoeng.* Tg. *Tandjoeng.* oL. *Onderaardsche loop.* S. *Soengai.* A. *Ake (rivier).*

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Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

Reproductiebedrijf Topografische dienst, Weltevreden 1926. Blad 25. (Alg. No: XIV-100.)
Auteursrecht voorbehouden (Stbl. 1912 No. 600).

# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

Sheet XIII-100

### SITES 4a and 4b

Rating: 4a excellent; 4b fair.

Accesibility: Both sites accessible by truck road 2.5 miles from Galela built by Japanese to supply existing field shown on site 4a. Shallow draft boats can land at Galela. There are 2 jetties.

Topography: Broad coastal plains bordered by rugged mountains; interrupted at south side by 2 small steep volcanic hills. Site 4a is suitable for runways in any direction. Japanese landing strip 4,000 feet long by 250 feet wide oriented northeast on northwest side of Tarakanitji is reported. Site 4b is suitable for one or possibly two runways oriented northwest. Ground nearly flat or gently undulating; near margins of volcanic cones may be slightly rougher and more irregular. Grades generally less than 1%. Altitudes commonly between 10 and 60 feet; on edges of cones may be as much as 100 feet.

Approaches: Sites have clear approaches from northeast, east, and southeast. Approach to site 4a is clear for about 2 1/4 miles to west where steep hills 600 to 1,500 feet in altitude rise from margin of plain. Approach clear on south except for steep volcanic cones on southeast. Site 4b has clear approach for more than 3 miles to northwest; steep volcanic hills on southwest side are possible hazards.

Clearing and Grubbing: Site 4a already well cleared with only patches of second growth, farming areas and alang-alang grass. Good possibility for extending existing field. 4b is more heavily forested with second growth and brush; some small areas of alang-alang grass.

Grading: Little to no grading other than minor leveling necessary at 4a. Some leveling possibly required on west side of 4b near volcanoes. Loam soil readily worked by bulldozers and srapers. No bedrock excavation.

Foundation Conditions: On south and southwest parts of both sites soils chiefly A-4, A-2 (ML, SF); may approach A-6, A-7 (CL, CH) on north side of site 4a and on northeast side of site 4b where drainage is poor; probably more sandy near Galela. Binder of intermediate quality.

Stabilization and Surfacing: These soils generally show good response to mechanical stabilization, but special attention is needed in low places and depressions to insulate surface from foundation. Base course may be necessary.

Drainage: Site 4a mostly well drained and quick-drying after rains. 4b mostly fairly well drained, but low east border may be swampy. Raised subgrade may be necessary locally in addition to lateral drains.

Construction Materials Available: A good grade of trap rock can be obtained from broken lavas on the volcanic cones south of the sites. Volcanic cinders suitable for surfacing likewise available from cones.

Water Supply: Large perennial supply available from Tiabo River and Galela Lake; intake on Tiabo River should be above limit of tidal invasion. Wells sunk 20 to 50 feet in alluvium at sites will provide large supplies.

### SITES 5a and 5b

Rating: 5a excellent; 5b excellent.

Accessibility: Both sites accessible to narrow coastal road from Galela to Tobelo which would require improvement for use by military traffic. Tobelo has landing facilities for shallow draft boats and good beaches. Japanese field reported under construction near Tobelo; may be on one of these sites.

Topography: Narrow coastal lowland bordered by coral limestone terraces; high volcanic peaks rise behind terraces to west.

Site 5a, situated on the lower terrace is suitable for runway oriented northwest. Ground slightly irregular and rough, but grades are generally less than 1.5%. A few gullies 10 to 20 feet deep cross the sites. Terraces are between 50 and 80 feet in altitude.

Site 5b, situated on coastal lowland below the lowest terrace, is suitable for one or possibly two runways oriented north-northwest. Ground gently undulating; furrowed by a few shallow gullies 5 to 15 feet deep. Lowland site is between 10 and 30 feet in altitude.

Approaches: Site 5a has clear approaches on southwest; volcanic cone, (Mamoeja) rises to more than 3,000 feet about 5 miles north of site; foot of cone about 3 1/2 miles away. Site 5b has clear approaches.

Clearing and Grubbing: Both sites largely grassy (alang-alang) with dense rain forest having much underbrush on west side of 5a. Coconut plantations on east and south side of 5b. Some patches of second growth. Fairly easy clearing.

Grading: Leveling of minor irregularities in surface and filling of small gullies, particularly at 5a. Thin soil and rotted coral rock at 5a probably can be worked by bulldozers and graders. Deep excavations will require power shovel or blasting. Loam soil readily worked by light equipment.

Foundation Conditions : Coarse sandy soils: A-2, A-1 (SF, SC) probably extend over most of these two sites. Possibly some GF and GC on 5a. Finer sandy soil: A-2, A-1 (SF, SC) probably predominates on site 5b

Stabilization and Surfacing : Soil is suited to mechanical stabilization and compacts well to optimum density at proper moisture content. May be sufficiently sandy on site 5b for cement or bitumin mix. Soils are generally friable; except when soil is very wet, it should not be difficult to work with machinery.

Drainage: Soil on both sites well drained. Probably no improvements necessary.

Construction Materials Available : Coral limestone available locally along the coast and from terraces against the hills to the west is good all-purpose rock and can be worked in small quantities by hand tools. Trap rock can be obtained from lavas on the flanks of Mount Mamoeja and Mount Mede; requires drilling and blasting for quarrying. Volcanic cinder for surfacing also available from these mountains.

Water Supply: Wells 30 to 150 feet deep in gravel and coral limestone at sites will provide adequate supplies. To minimize danger of salt water contamination wells should be at least 1,000 feet from coast. should be sunk only a few feet below water level, and should be pumped as lightly as possible.

### SITE 6

Rating: Fair.

Accessibility: Island can be approached by landing barges. A few narrow reefs are present but can be avoided.

Topography: Low sandy coral island a few miles off Tobelo. Site is suitable for single north-south runway. Ground is gently undulating; slightly irregular in places. Slope less than 1% from center of the island. Altitude between 10 and 40 ft.

Approaches: Approaches clear.

Clearing and Grubbing: Mostly coconut groves and some fairly open rain forest over site. Few large trees, but some stumps require blasting. Underbrush densest along coast.

Grading: Only minor leveling needed. Sandy soil readily worked by bulldozers and scrapers. Underlying coral rock may locally require blasting for excavation.

Foundation Conditions: Soil coarse to medium in texture; types A-2, A-1, possibly some A-4 (SF, SC, ML). Commonly some coral rock at or near surface.

Subgrade and Stabilization: Suitable for compaction. Base course requirements generally moderate. Binder content low and addition of binder may be necessary for stabilization. Sand suitable for bitumen mix at or near site.

Drainage: Site generally well drained but ground water table is near surface and shell holes may fill with water.

Construction Materials Available: Coral limestone available along coast. Can be quarried and crushed in small quantities by hand tools. Some sand obtainable at or near site.

Water Supply: No surface water. Wells in center of island and extending not more than 1 ft. below sea level may provide small supply of fresh water; water may become brackish if over-pumped or if pumped during high tide; may become brackish in spite of all precautions during dry season.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

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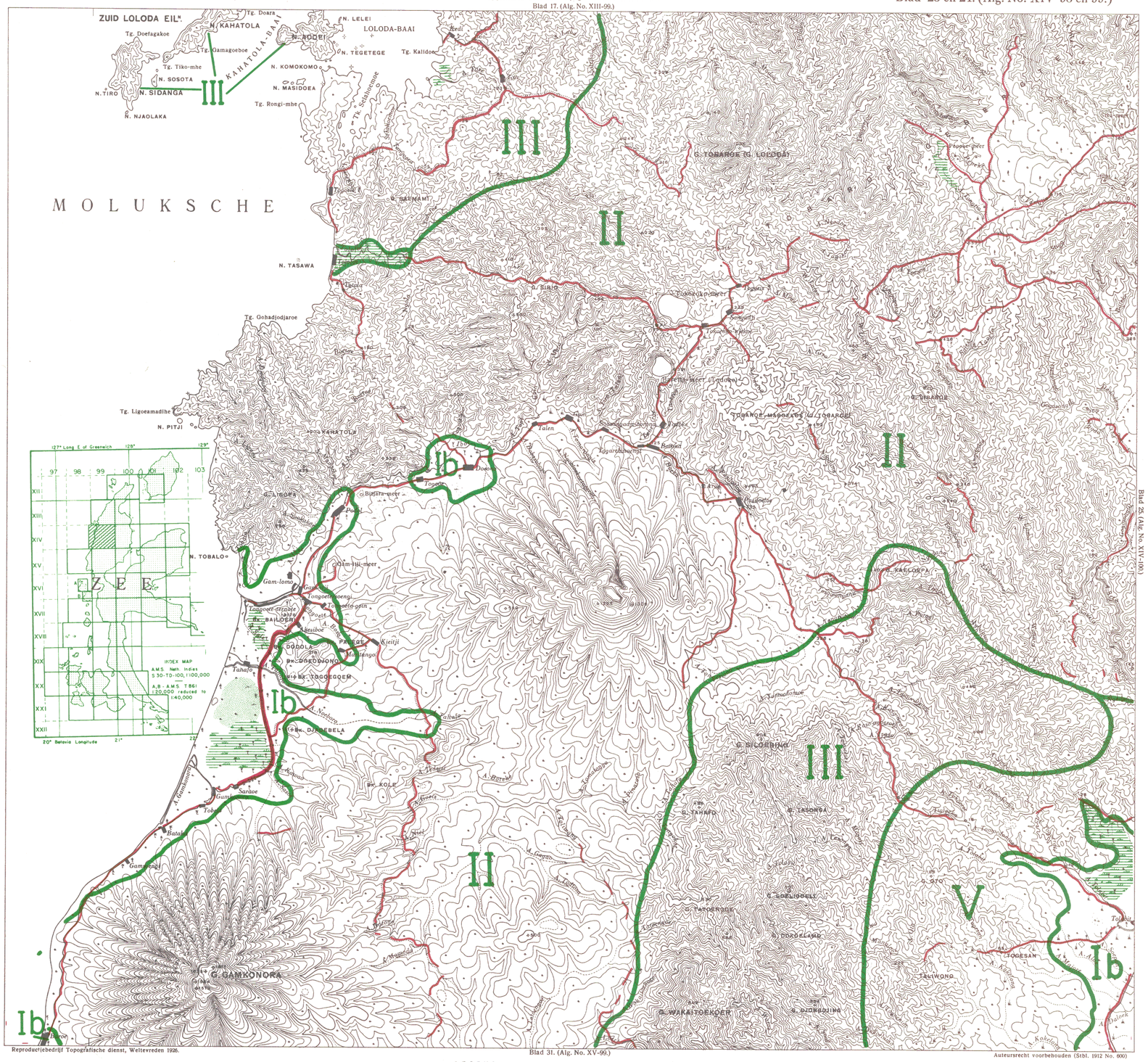
# HALMAHERA (MOLUKKAS)

Gouvt der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 17. (Alg. No. XIII-99.)

# POSSIBLE AIRFIELD SITES

Blad 23 en 24. (Alg. No. XIV-98 en 99.)

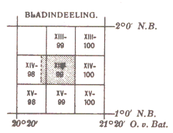



Reproductiebedrijf Topografische dienst, Weltevreden 1926.

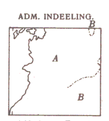
Blad 31. (Alg. No. XV-99.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600)

BLADINDEELING.




ADM. INDEELING.




*Afdeeling* Ternate.
*Onderafd.* Halmahera.
A. *Ressort* Djailolo.
B. *Ressort* Tobelo.

Trail

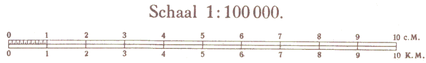
Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kroepelbout.* *Bamboebosch.* *Moeraspalmen.* *Tjemaraof Dennen bosch.* *Voetpad.* *Rivier, a. gemeten, b. niet gemeten.* *Meer.* *Drasland.* *Moeras.* *Niet verharde weg, in den drogen moessons geschikt voor veldartillerie, van 2—4 M. breed.* *Paardenpad. a. duiker of doo aat van bamboe.* *Alang-alang.* *Overige op droog terrein groeiende palmsoorten.* *Ressortsgrens.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. a. eiland, b. klippen bij laag water zichtbaar, c. klippen altijd boven water, d. zandbank alleen bij laag water droog, e. hoogtepunt en hoogtecijfer, f. huiphoogtelijn, g. rots, h. kleine verhevenheden, i. natuurlijke steile.*

Schaal 1:100 000.




TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, vooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd. De loop van de ressortsgrens is (zuidoostelijke bladrand) gedeeltelijk onbekend.*

VERKORTINGEN.

**N.** *Noesa.* **G.** *Goenoeng.* **Bk.** *Boekoe.* Tg. *Tandjoeng.* Tk. *Teloek.* W. *Wai (Rivier).* A. *Aek (rivier).* P. *Pisang.*

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

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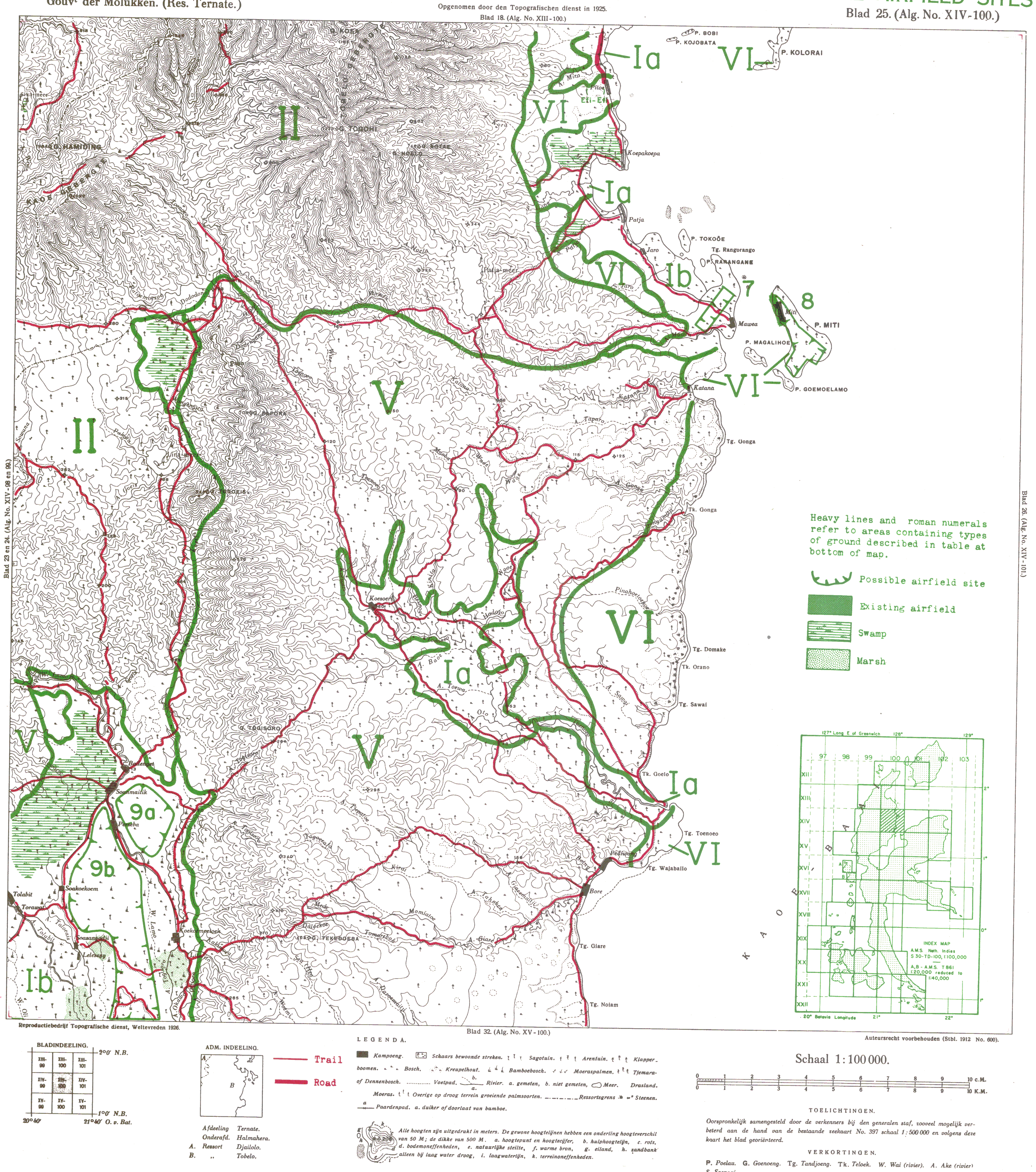
# HALMAHERA (MOLUKKAS)

Gouvt der Molukken. (Res. Ternate.)

# POSSIBLE AIRFIELD SITES

Blad 25. (Alg. No. XIV-100.)




Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

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# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

Sheet XIV-100

### Site 7.

**Rating:** Good.

**Accessibility:** Coast accessible to landing barges at or south of Mawea. Point to north fringed with coral reefs. Good trails along coast to north; none to south. Trails lead inland to south and west from site.

**Topography:** Coastal lowland bordered by low hills and terraces. Space for single runway oriented north-south. Ground low and gently undulating. Slope is mostly less than 1%. Altitude between 30 and 60 feet.

**Approaches:** Approaches clear to northeast. Low terraces and hills rise 150 to 200 feet about ¼ to ½ mile to the southwest.

**Clearing and Grubbing:** Fairly open rain forest with extensive coconut palms. Small areas of second growth brush jungle and native clearings along coast near Mawea.

**Grading:** Only minor leveling needed. Sandy loam soil readily worked by bulldozers and scrapers.

**Foundation Conditions:** Medium-textured soil on alluvium; groups A-4, A-2 (ML,SF) probably predominate, but A-3 (SP) may occur in substratum and A-6 at surface. Binder fairly abundant. Soil probably sandier at north end of site.

**Stabilization and Surfacing:** Soil well suited to compaction, easily worked; moisture control not difficult. Soil not sticky.

**Drainage:** Fair to good natural drainage. Soil dries quickly after rains, but becomes rutted and slippery during rains if site is not surfaced. Lateral drains would facilitate surface runoff.

**Construction Material Available:** Some coral limestone may be available along coast or from terraces to west. Trap rock interbedded with volcanic ash and conglomerate can be found in mountains to west. Small quantities of gravel may be available from the Mawea River. No good rock at site; may be some gravel.

**Water Supply:** Small perennial supply available from Mawea River; intake should be above salt-water limit. Requires treatment to be potable. Adequate supply of potable water obtainable from wells 20 to 50 feet deep in unconsolidated alluvium at site. To reduce danger of contamination by salt water, wells should be at least 1000 feet from shore; should not penetrate more than a few feet below water level and should be pumped as lightly as possible.

### Site 8.

**Rating:** Good.

**Accessibility:** Coast accessible to landing barges. Reefs mostly on NE.

**Topography:** Low sandy island about 3/4 mile off Halmahera coast. Japanese operational field reported on this site which is suitable for single runway oriented north-south; existing field 4500 feet long by 480 feet wide. Gently undulating ground slopes from center of island at less than 1%. Altitude between 10 and 50 feet.

**Approaches:** Clear.

**Clearing and Grubbing:** Mostly coconut palms with scattered patches of brush. Denser rain forest in southern part of the island. Small native clearings near Miti village. Island may have been extensively cleared by Japanese. Extension of landing field not possible.

**Grading:** General leveling of minor irregularities in topography. Thin sandy soil easily worked by bulldozers. Coral rock beneath requires power shovel or light blasting for excavation.

**Foundation Conditions:** Coarse-textured soil of group A-2 (SF, GF may be present locally). Content of fines low, but coral has good natural binding properties and forms excellent foundation. Soil may be shallow and rock may be at the surface.

**Stabilization and Surfacing:** Where deep, soil compacts well under controlled moisture; can be improved by addition of fines. Thick base course probably not necessary. Shallow soil with coral rock near the surface may present difficulties. Material suitable for bitumen-mix surface course. Natural surface very dusty.

**Drainage:** Naturally well-drained. Soil slippery when wet but dries quickly.

**Construction Material Available:** Coral limestone abundant at site; can be worked in small quantities by hand tools, but requires drilling and blasting for excavation in quantity. Coarse coral sand obtainable from surface or from beaches.

**Water Supply:** No surface water. Moderate amounts of fresh water may be obtainable in center of island from wells sunk to a depth of not more than 1 foot below sea level, but this may be brackish. Wells should not be overpumped, especially during high tide. It may be necessary to transport water from mainland.

Sheet XIV-100

### SITES 9a and 9b.

**Rating:** Site 9a fair, 9b fair.

**Accessibility:** Sites accessible by foot trails leading out of valley in all directions, but most of these are steep and difficult. Best approach for supply road is up Lamo (Kaoe) River valley from south.

**Topography:** Broad plain of Lamo River bordered by steep hills. Both sites suitable for landing strips oriented in several directions. Ground nearly flat or gently undulating; grades less than 1%. Altitudes between 50 and 100 feet.

**Approaches:** Approaches to both sites clear to south and west. Hills and mountains rise 600 to 1200 feet within 1½ to 3 miles to east. North of 9a, low hills rise 150 to 300 feet. North approach to 9b clear for about 2 miles.

**Clearing and Grubbing:** Dense tropical rain forest with undergrowth at both sites. Site 9b has some more open grassy areas, but also many dense stands of bamboo and sago palms. Larger trees in rain forest may be over three feet in diameter; stumps require blasting. Most of trees, however, can be felled or uprooted by angledozer or treedozer.

**Grading:** General leveling of low knolls on gently rolling plain and filling of small gullies and depressions probably necessary at both sites. Loam soil easily worked by bulldozers and scrapers.

**Foundation Conditions:** Medium-textured soil of group A-4 (ML) on alluvium at both sites. Loam soil easily worked by bulldozers. Soil probably shows local textural variations and may be A-2 (SF) near the Lamo River, southwest of Site 9a and east and northeast of 9b.

**Stabilization and Surfacing:** More sandy soils are more easily compacted to optimum density. Finer-grained soils present more stabilization problems. Fill for higher grade and insulating base course may be necessary owing to poor drainage.

**Drainage:** Soils may not be well-drained naturally. Installation of rock drains beneath sites and lateral drains at border of runways may improve conditions. Soil quickly becomes rutted and slippery during rains. Gravel base course may be necessary.

**Construction Material Available:** Gravel may be obtained from river beds and from deposits in hills to east. No rock available close by.

**Water Supply:** Large perennial supply available from Lamo River. Moderate to large supplies obtainable from wells sunk 20 to 50 feet in unconsolidated alluvium at sites.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

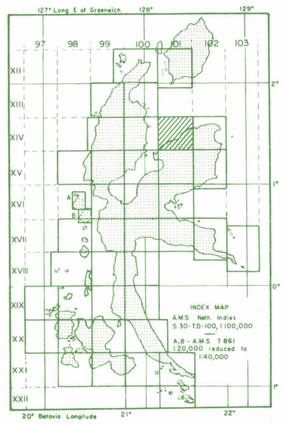
Gouvt der Molukken (Res. Ternate).

Schetskaart samengesteld door den Topografischen dienst in 1929-1930.

Blad 101/XIII.

# POSSIBLE AIRFIELD SITES

Blad 101/XIV.




Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

Z E E VAN H A L M A H E R A

Blad 100/XIV.

Blad 102/XIV.

Baai v. Tatam

Tg. Boeli

Baai v. Boeli

Labilabi

Baai v. Labilabi

Tg. Toetoea

Baai v. Ifis

Tg. Ifis

Ia

VI

10

V

IV

Blad 101/XV.

Reproductiebedrijf Topografische dienst, Batavia 1933.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.

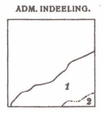
| | | |
|---|---|---|
| 100/XIII | 101/XIII | |
| 100/XIV | 101/XIV | 102/XIV |
| 100/XV | 101/XV | 102/XV |

2°00' N.B.

2°00' N.B.

21°00' 22°00' O. v. Bat.

ADM. INDEELING.




| | | |
|---|---|---|
| | *Res. (Afd.)* | *Ternate.* |
| 1 | *Onderafd.* | *Tobelo.* |
| | *District* | *Wasile* |
| 2 | *Onderafd.* | *Weda.* |
| | *District* | *Maba.* |

LEGENDA.

Trail

Road

*Kampoeng.* *Arentuin.* *Klapperboomen.* *Bosch.* *Bamboebosch.* *Moeraspalmen.* *Tjemara- of Dennen- (Sparren-) bosch.* *Rivier, a gemeten, b niet gemeten.* *Voetpad.* *Onderafdeelingsgrens.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogtecijfer, b halphoogtelijn van 25 m, c rots.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Vluchtig opgenomen in 1929-1930 met de bergbussole voor het hoofdoerband en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 387 schaal 1:300 000 uitgave 1929.*

PREPARED BY U.S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

AFKORTINGEN.

G. *Goenoeng.* Tg. *Tandjoeng.* A. *Ake (rivier).* ɑL. *Onderaardsche loop.*

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XIV-101

SITE 10.

Rating: Fair

Accessibility: Site directly accessible to landing barges on coast. Poor, discontinous trails both along coast and into interior.

Topography: Narrow coastal lowland bordered by low hills and terraces. Site has space for single landing strip oriented northeast. Ground nearly flat; locally rough and irregular. Grade less than 1%. A few small gullies on southeast side; generally less then 15 feet deep. Altitude between 20 and 50 feet.

Approaches: Approaches clear. Terraces and low hills 1 to 2 miles to northeast reach altitudes of 150 to 350 feet.

Clearing and Grubbing: Fairly open rain forest and brush becoming denser with bamboo thickets toward Boeli River. Some trees may be over 3 feet in diameter at base.

Grading: Some leveling of low knolls and depressions may be necessery. Soil and rotted coral rock underlying site can be readily worked by bulldozers and scrapers.

Foundations Conditions: Soil, coarse to medium in texture, includes groups A-2, A-1, and some A-4 (SF, SC, ML ). Fineness and depth of soil may show local variation. Moderate amounts of binder.

Subgrade and Stabilization: Soil compacts well under controlled moisture condition ; not sticky. Where coral rock is near surface, is sandier, gravelly soil may provide suitable surface material for bitumen mix.

Drainage: Soil naturally well drained: may form ruts during rains but drys quickly. Lateral drains may speed runoff to south toward Boeli River.

Construction Material Available: Coral limestone abundant at or near site. Good all-purpose rock; can be worked in small quantities with hand tools, but extensive quarrying requires drilling and blasting. Some gravel deposits may be found along Boeli River or in hills to south.

Water Supply: Adequate perennial supply available from Tatem River and possibly from Boeli River; intakes should be above salt-water limit. Adequate supply also obtainable at site from wells sunk 20 to 50 feet, and if possible at least 1000 feet from the shore. The wells should extend only a few feet below water level, and should be pumped as lightly as possible to minimize danger of salt-water contamination.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

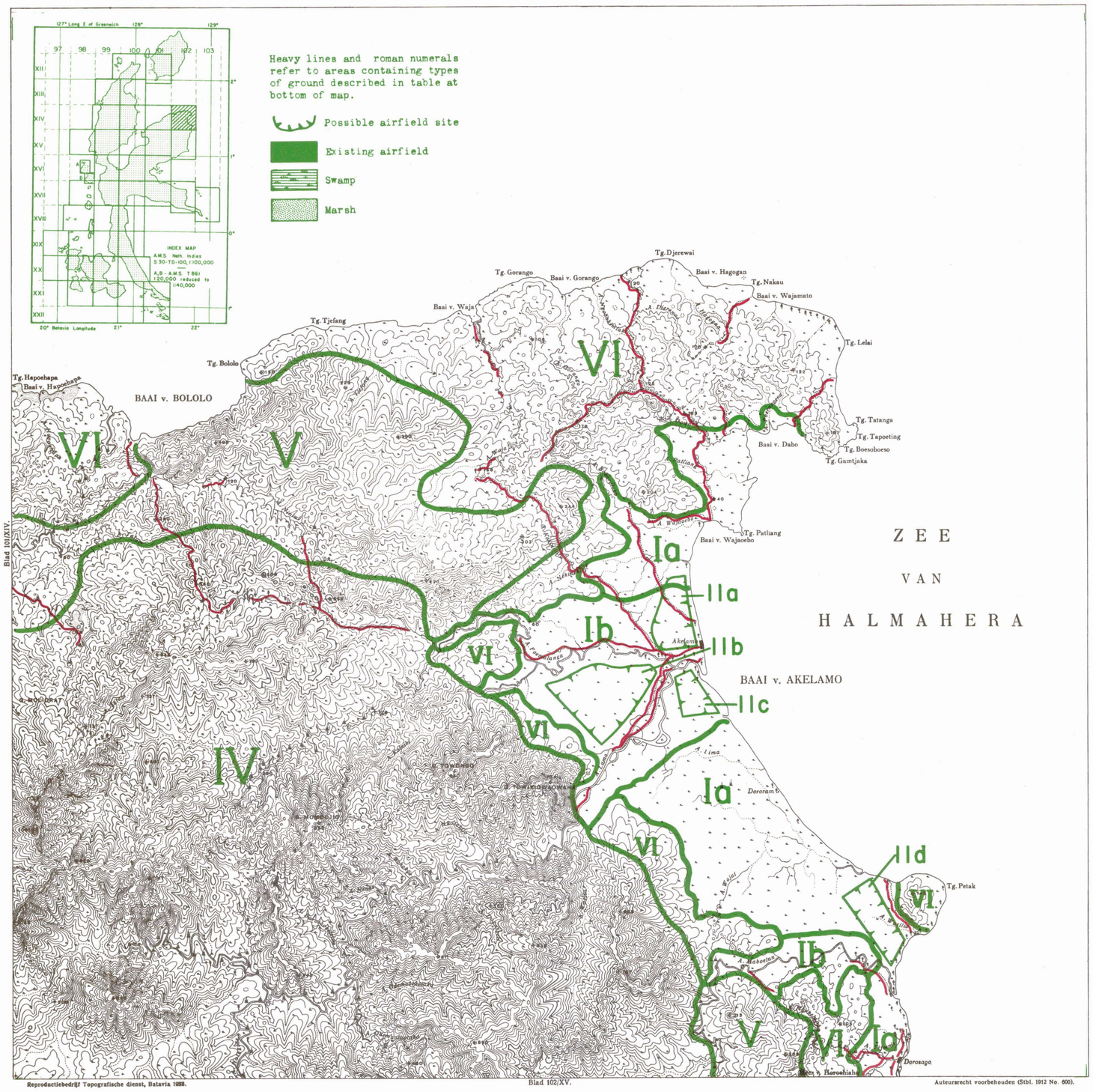
# HALMAHERA (MOLUKKAS)

**Gouvt der Molukken (Res. Ternate).**

Schetskaart samengesteld door den Topografischen dienst in 1928-1929.

# POSSIBLE AIRFIELD SITES

Blad 102/XIV.

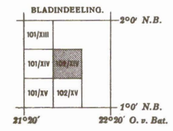



Reproductiebedrijf Topografische dienst, Batavia 1933.

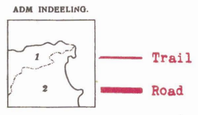
Blad 102/XV.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.




ADM INDEELING.




| | | |
|---|---|---|
| | Res. (Afd.) | Ternate. |
| 1 | Onderafd. | Tobelo. |
| | District | Wasile. |
| 2 | Onderafd. | Weda. |
| | District | Maba. |

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Arentain.* *Klapperbomen.* *Bamboebosch.* *Bosch.* *Moerassalmen.* *Tjemara- of Dennen- (Sparren-) bosch.* *Rivier, a gemeten, b niet gemeten, c eiland, d steeds vloeiende zoetwaterwel.* *Meer.* *Paarsenpad.* *Voetpad.* *Bamboe huizen.* *Inlandsche graven.* *Onderafdeelingsgrens.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogtecijfer, b huishoogtelijn van 25 m, c rots, d klip bij laagwater zichtbaar.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Vluchtig opgenomen in 1928-1929 met de bergbousole voor het hoofdverband en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 387 schaal 1:200 000 uitgave 1929.*

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

AFKORTINGEN.

G. Goenoeng. Tg. Tandjoeng. O.L. Onderaardsche loop. A. Ake (rivier).

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.



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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XIV-102

SITES 11a, 11b, 11c, and 11d.

Rating: 11a Good, 11b Fair, 11c Good, 11d Fair.

Accessibility: 11a, 11c, and 11d on coast of reef-lined Akelamo Bay. Barges can perhaps cross reefs to shore or follow channel of Foemalange River to sites 11a, 11b, and 11c. Site 11b is approximately 1 mile inland by foot trail; site 11d probably most easily accessible to landing barges on south side of Pelak Point, possibly at mouth of Makoelan River. From Akelamo plain, foot trails lead north across mountains to coast and south along coast.

Topography: Roughly crescentic coastal plain bordered by steep mountains. Site 11a is suitable for one or perhaps two landing strips oriented north to northeast. Site 11b suitable for runways in several directions; site 11c and 11d for one or possibly two runways oriented north to northwest. Ground is nearly flat or gently undulating. Grades are generally less than 1%; on site 11b, less than 1½%. Sites 11b and 11d are crossed by a few gullies 10 to 20 feet deep; sites 11a and 11c probably have a few shallow gullies less than 15 feet deep. Sites 11a, 11c, and 11d are between 1 and 50 feet in altitude; site 11b is between 20 and 80 feet.

Approaches: Site 11a has clear approach to south; hills rising 400 to 600 feet about 1½ miles from north end of site are possible hazards. Site 11b has clear approaches from northeast, east and southeast. Mountains 1600 to 2300 feet in altitude are ½ to 1¼ miles to southwest and south; foothills 600 to 1400 feet in altitude rise above plain on west and north. Sites 11c and 11d have clear approaches except for minor hazard of hills 400 to 500 feet in altitude on east side of site 11d.

Clearing and Grubbing: All sites covered by dense rain forests and thick ground mat of roots, vines, and creepers that require stripping. Coconut plantations, second growth, and some native clearing near Akelamo and along coast.

Grading: Only minor leveling necessary. Soil easily worked by bulldozers and graders except during and after heavy storms. No bedrock excavation.

Foundation Conditions: On sites 11a, 11b, and 11c medium-textured soils of group A-4 (ML) probably predominate; many local variations and gradations to more sandy soils of groups A-2, A-3 (SF, SP) toward coast and stream banks ( north, south, and southeast sides of site 11a; north and southeast side of site 11b; north and northeast sides of site 11c. On site 11d, soil is probably coarser in texture than at other sites, chiefly A-4, A-2 (ML,SF); sandiest at southeast end.

Subgrade and Stabilization: Soils at sites 11a, 11b and 11c are generally suitable for compaction, particularly if sandy. Sand suitable for surface course or bitumen mix may be obtainable on or near site. On site 11d, soil compacts readily; is relatively non-plastic, easily worked and fairly well drained and offers no special difficulty to machinery unless very wet.

Drainage: Sites 11a, c, and d fairly well drained naturally. Special drainage may be necessary on 11b, which will probably require insulation of surface from subgrade. Unless surfaced, runways will be very muddy during,and for a few hours after heavy rains.

Construction Material Available: Little rock available at or near any site except 11d. Some gravel may be obtained from stream beds where rivers enter plain from the mountains. Coral limestone is available on the point east of site 11d and also from hills on the peninsula east of Dabo Bay.

Water Supply: Large perennial supplies available from Maboelau, Foemalanga and Lamo Rivers. Intake should be above salt-water limit. Wells 20 to 50 feet deep (drive-point, dug, or drilled) in unconsolidated alluvium, will provide large supplies, but should be at least 1000 feet from coast and should extend not more than a few feet below water-level, to minimize danger of salt-water contamination.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

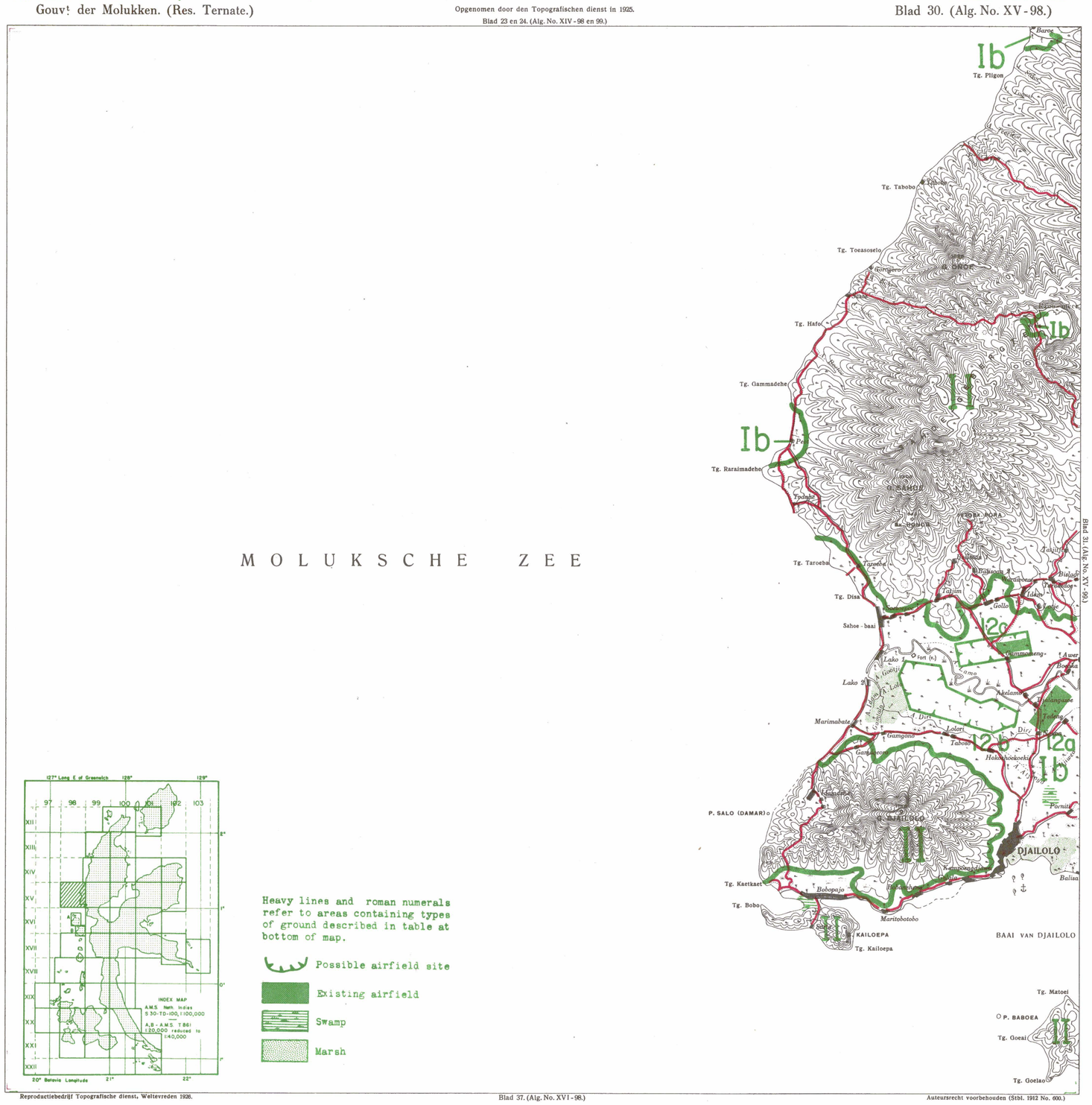
# HALMAHERA (MOLUKKAS)

Gouvt der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 23 en 24. (Alg. No. XIV-98 en 99.)

## POSSIBLE AIRFIELD SITES

Blad 30. (Alg. No. XV-98.)







Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

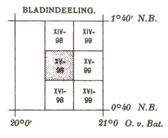
- Possible airfield site
- Existing airfield
- Swamp
- Marsh

Reproductiebedrijf Topografische dienst, Weltevreden 1926.

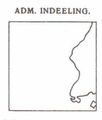
Blad 37. (Alg. No. XVI-98.)

Auteursrecht voorbehouden (Stbl. 1912 No. 600.)

BLADINDEELING.




ADM. INDEELING.



*Afdeeling* Ternate.
*Onderafd.* Halmahera.
*Ressort* Djailolo.

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagoetin.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemara- of Dennen bosch.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Meer.* *Drasland.* *Moeras.* *Paardenpad.* *a. duiker of doorlaat van bamboe.* *Herkenbare boom.* *Ankerplaats en reede.* *Alang-alang.* *Gelegah.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogteoffer, b. halfhoogtelijn, c. bron. d. eiland.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm
0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, vooreel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd.*

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

VERKORTINGEN.

**Gh.** *Gezaghebber.* **G.** *Goenoeng.* **Bk.** *Boekoe (berg).* **P.** *Poelau.* **Tg.** *Tandjoeng.* *A Ake (rivier).* *(v.) Verlaten.*

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near or at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITES 12a, b, and c. Sheet XV-9S

Rating: 12a excellent, 12b fair, 12c good.

Accessibility: Sites accessible from Djailolo by poor road which, if widened, could be converted to military use; Lamo River is crossed by narrow steel bridge. Good anchorage off Djailolo; barge transportation necessary to shore. Good trails through Lamo valley to interior; trails along coast are poor and discontinuous.

Topography: Broad valley plains bordered by steep volcanic peaks. Site 12a has space for single runway oriented northeast. Landing strip started by the Dutch reported completed by Japanese; about a mile long. Site 12b suitable for runways in several directions; on site 12c runways can be oriented east-west to east-northeast. The existing field, 4950 feet long and oriented east-northeast was started by the Dutch and may have been completed by the Japanese. Ground flat to gently undulating; sites crossed by a few small gullies 5 to 15 feet deep. Grades less than 1%. Altitudes between 30 and 80 feet.

Approaches: Site 12a has clear approaches for 3 or 4 miles to northeast up the Lamo Valley. Hills 200 to nearly 300 feet high lie 1 to 1½ miles from north and east margins. Base of Djailolo mountain is about 1½ miles to the southwest; summit 3733 feet in altitude. Sites 12b and 12c have clear approaches to west. Hills 300 to 900 feet high lie 1½ to 2½ miles to east. Steep hills lie about 1½ miles north of 12b; attain altitudes of more than 2000 feet within 3 miles of site margin. Djailolo peak is about ½ to 3/4 miles south of 12b.

Clearing and Grubbing: Existing field cleared by Dutch at site 12a is on a grassy (alang-alang) plain with patches of coconuts and clumps of second growth. Sites 12b and 12c are covered mostly by second growth jungle, coconuts and dense patches of sago palms or bamboo. Site 12c was cleared in part by the Dutch. Stumps of larger jungle trees will need blasting. Dense ground mat of roots, vines, and creepers requires stripping.

Grading: Only minor levelling of gently rolling plain necessary. Loam soil readily worked by bulldozers and scrapers.

Foundation Conditions: Soil at sites 12a and 12c generally of group A-4 (ML) with many local differences. In middle part of site 12b material of groups A-6, A-7 (CL,CH) may be present. On NW side and at south end, probably somewhat coarser in texture.

Stabilization and Surfacing: Soils suitable for compaction, fairly easily worked and give moderately good bearing ratio, with exception of A-6, A-7 (CL, CH) on Site 12b. A-7 may require special drainage, heavy base course, and possibly much local fill. This soil is plastic and sticky and hence not readily worked with machinery. Remaining soil is friable except when wet, and is easy to work.

Drainage: Site 12a and 12c naturally well-drained and require few improvements. Site 12b, in part, poorly drained and may locally require raised subgrades and lateral ditches.

Construction Materials Available: Good trap rock (basalt) probably available from mountain west of Djailolo and possibly from hills north of site 12c. Gravel would require screening and possibly removal of larger boulders by a grizzly. Some gravel may be obtainable along Lamo River at east end of plain.

Water Supply: Large perennial supply available from Lamo River; filtration and chlorination necessary for potability. Intake should be above salt water limit. Wells 20 to 50 feet deep will yield large supplies from unconsolidated alluvium; can be located anywhere on sites; chlorination needed for potability.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Reliability Rating:C.

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

~~CONFIDENTIAL~~

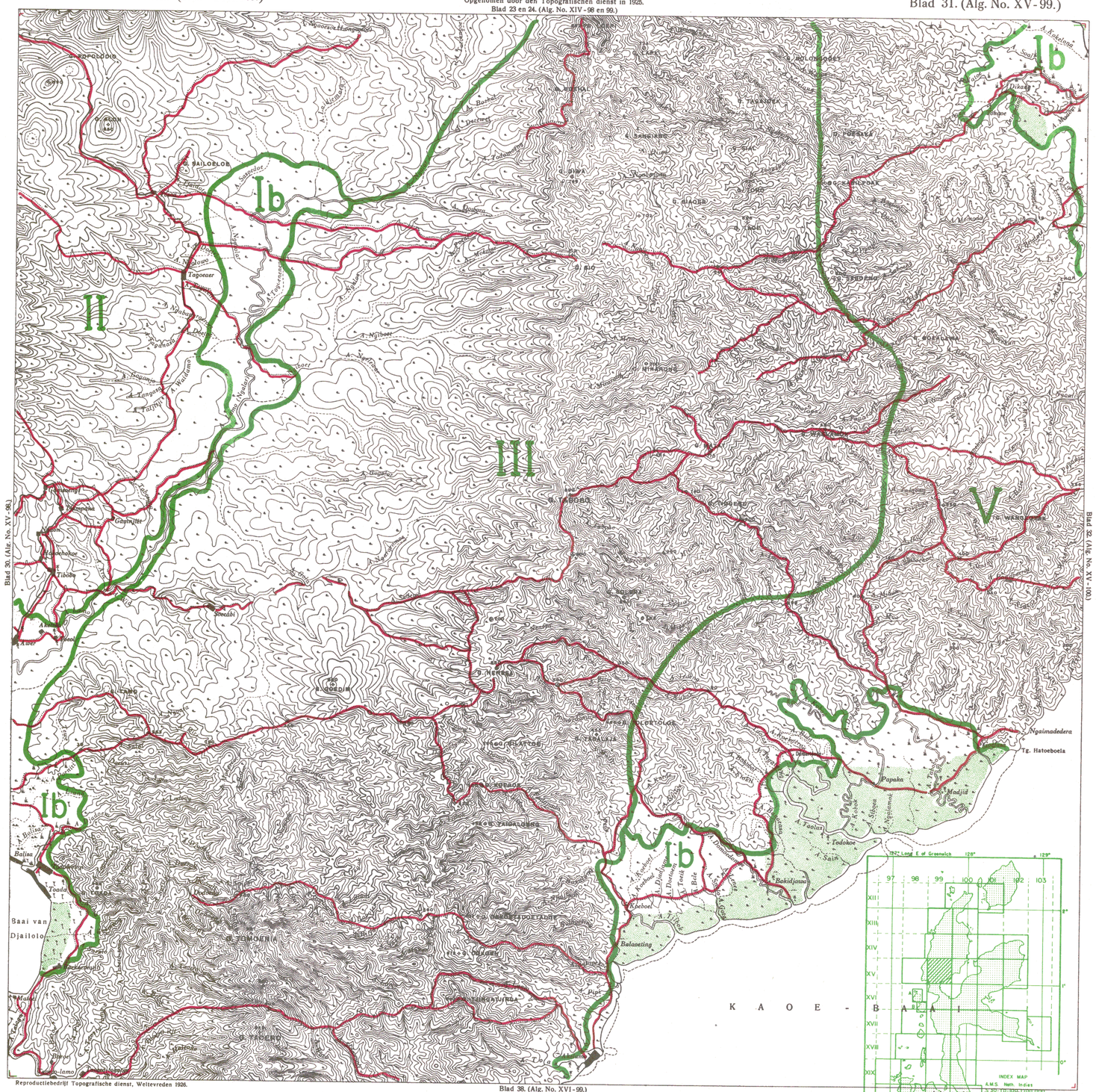
# HALMAHERA (MOLUKKAS)

Gouvt der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 23 en 24. (Alg. No. XIV-98 en 99.)

## POSSIBLE AIRFIELD SITES

Blad 31. (Alg. No. XV-99.)

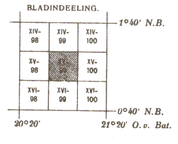



INDEX MAP
A.M.S. Neth. Indies
A.B-A.M.S. T861
1:20,000 reduced to 1:40,000

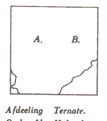
Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

BLADINDEELING.




ADM. INDEELING.




*Afdeeling* Ternate.
*Onderafd.* Halmahera.
A. *Ressort* Djailolo.
B. „ Tobelo.

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin* *Klapperboomen.* *Bosch.* *Kruipelhout.* *Bamboebosch.* *Moeraspalmen.* *Tjemara- of Dennen bosch.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Paardenpad.* *a. duiker of doorlaat van bamboe.* *Alang-alang.* *Drasland.* *Bamboe huizen.*

Trail
Road

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. hulphoogtelijn, c. rots, d. natuurlijke stelitte, e. klippen bij laag water sichtbaar, f. laagwaterlijn, g. warme bron, h. terreinoneffenheden.*

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, sooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397 schaal 1:500 000 en volgens deze kaart het blad georiënteerd. De loop van de reasortsgrens is onbekend.*

VERKORTINGEN.

G. *Goenoeng.* Tg. *Tandjoeng.* A. *Ake (rivier).*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site
Existing airfield
Swamp
Marsh

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.



~~CONFIDENTIAL~~

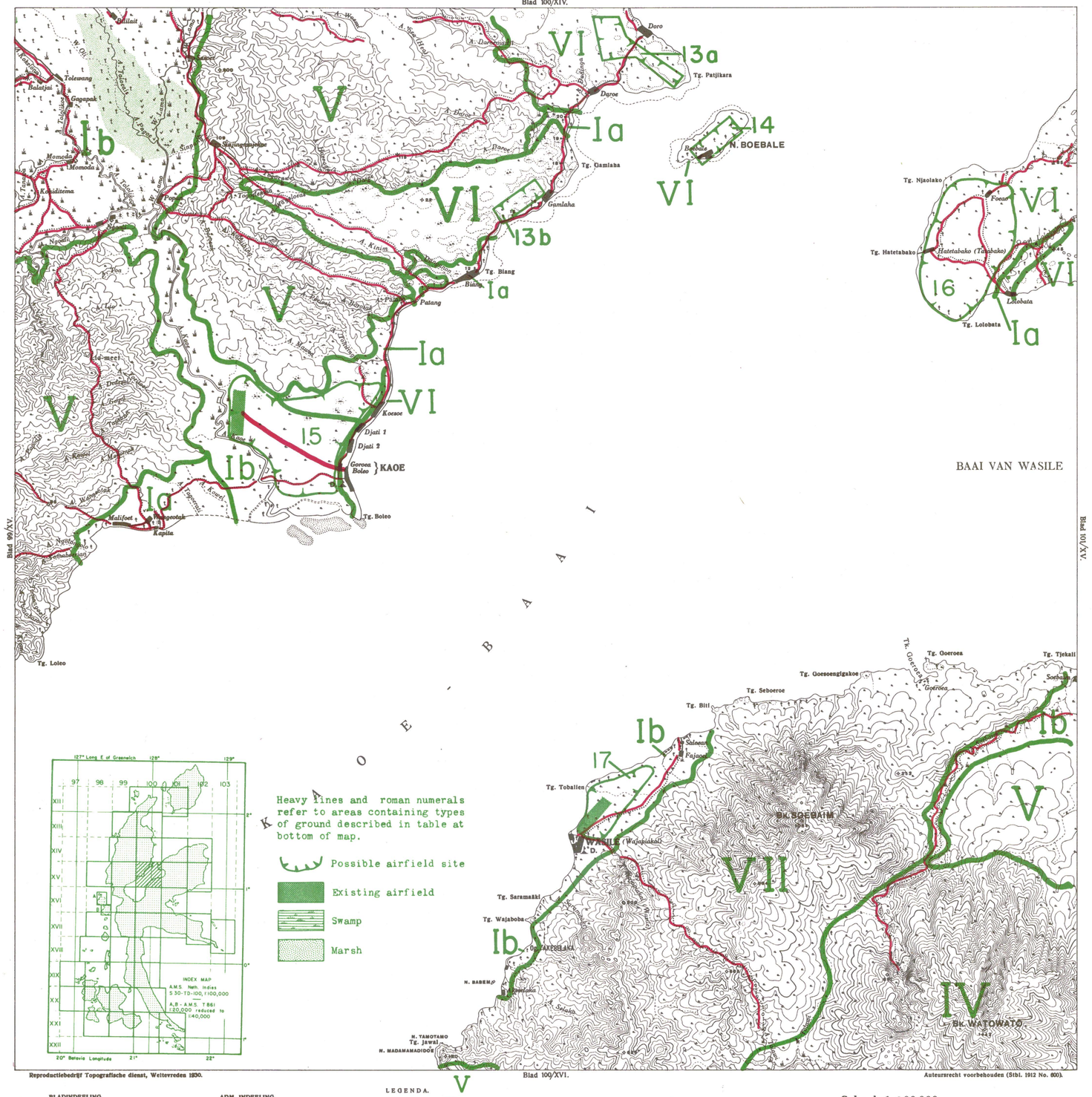
# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate)

Schetskaart samengesteld bij den Topografischen dienst in 1925-1926.

## POSSIBLE AIRFIELD SITES

Blad 100/XV.







Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

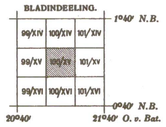
Possible airfield site

Existing airfield

Swamp

Marsh

BLADINDEELING.




ADM. INDEELING.

*Res. (Afd.) Ternate.*
*Onderafd. Tobelo.*
*a District Kaoe.*
*b ,, Wasile*

Trail

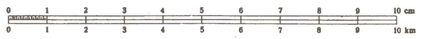
Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Klapperbomen.* *Bamboebosch.* *Arentuin.* *Sagotuin.* *Tjemara- of Dennen (sparren) bosch.* *Overige op droog terrein groeiende palmsoorten.* *Moeraspalmen.* *Gelagah.* *Bosch.* *Kreupelhout.* *Alangalang.* *Oras.* *Paardenpad, a houten kilometerpaal, b houten- of bamboe duiker.* *Voetpad.* *Rivier, a gemeten, b niet gemeten, c eiland.* *Meer.* *Bamboe hutten.* *Landsch. ond. grens.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m; de dikke van 500 m, a hoogtepunt en hoogtecijfer, b hulphoogtelijn, c rots, d drasland, e laagwaterlijn, f eiland, g blijven bij laag water zichtbaar, h niet gemeten kust, i zandbank alleen bij laag water droog, k kleine verhevenheden, l stelle rand en bodemonevenheden.*

Schaal 1:100 000.




TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397. 1:500 000 en volgens deze kaart het blad georiënteerd. De naam en grens der cultuurondernerneming is vergeleken met het Handboek voor Cultuur- en Handelsondernemingen in Ned. Indië en met de kadastrale kaart, doch is geschreven volgens de lijst van de „Voornaamste aardrijkskundige namen" in den Nederlandsch-Indischen Archipel.*

AFKORTINGEN.

*D. Districtshoofd. N. Noesa (eiland). Bk. Boekoe (berg). Og. Ondernemning Tg. Tandjoeng. Tk. Teloek. A. Ake (rivier). W. Wai (rivier).*

PREPARED BY U S GEOLOGICAL SUR
FOR
CHIEF OF ENGINEERS, U. S. ARMY

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

Sheet XV-100

### SITES 13a and 13b

Rating: Good

Accessibility: Both sites accessible to landing barges which can pass between small reefs off the coast; good trail along the coast to Kaoe.

Topography: Sites on terraces along coast 20 to 80 feet above sea level. Site 13a suitable for two runways oriented norhtwest and north-south. On site 13b strip could be oriented northeast. Ground is somehwat rough and irregular, but grade is less than 1.5 percent. Sites crossed by few shallow gullies 5 to 15 feet deep.

Approaches: Clear

Clearing and Grubbing: Sites covered by clumps of sparse jungle, brush, and alang-alang grass. Scattered stands of coconut on site 13a. Clearing not difficult and can be handled by bulldozers.

Grading: Much grading of low knobs, hollows, and gullies probably necessary; requires angledozers or other heavy equipment. Soil easily handled, but coral bedrock near surface, though rotted, is hard. Blasting may be necessary locally.

Foundation Conditions: Soils are coarse to medium in texture, of groups A-2, A-1, and some A-4 (SF,SC,ML) Bedrock differences affect uniformity, fineness, and depth of soil.

Stabilization and Surfacing: Soil compacts well under controlled moisture conditions and makes good foundation. Content of relatively non-plastic clays increases friability and reduces stickiness except when soil is very wet. Soil foundation should be compacted before surfacing.

Drainage: Site naturally well drained. Soils dry quickly after rains.

Construction Materials Available: Coral limestone at site is best source of rock for aggregate, riprap, or masonry. Small quantities can be broken with hand tools, Excavation of storage tunnels or quarries will require drilling and blasting. Gravel can probably be obtained from banks of Daroe River or from hills west of Daroe. Sand along coast not abundant and of poor quality.

Water Supplies: No readily available perennial surface water. Wells 40 to 100 feet deep will furnish adequate supplies; can be located anywhere at or near site, but should be at least 1,000 feet from coast to minimize danger of contamination by salt water.

### SITE 14

Rating: Fair

Accessibility: Accessible to landing barges which can pass through fringing coral reefs.

Topography: Low coral island; space for single runway oriented northeast. Ground is nearly flat with only minor irregularities. Slopes are less than 1 percent. Altitude between 10 and 40 feet.

Approaches: Clear

Clearing and Grubbing: Site mostly covered with coconut palms; some rain forest and second-growth jungle. Roots not deeply imbedded. Clearing can probably be accomplished by angledozers; little sawing necessary.

Grading: Only minor leveling of small surface irregularities necessary. Soil easily worked by bulldozers and scrapers.

Foundation Conditions: Soils are coarse to medium in texture, of groups A-2, A-1, some A-4 (SF,SC,ML) Coral limestone bedrock may locally be near surface.

Stabilization and Surfacing: Disturbed soil compacts well under controlled moisture conditions, makes good foundation. Content of relatively non-plastic clay increases friability and reduces stickiness unless very wet. Soil foundation should be compacted before surfacing.

Drainage: Naturally well drained, but water table is near surface and shell holes may fill with water.

Construction Materials Available: Coral rock for general purposes available along coast; can be broken by hand for small quantities of aggregate. A coarse coral sand is fairly abundant.

Water Supplies: No surface water. Wells dug in center of island, extending not more than 1 foot below water level, may provide limited supplies of fresh water. Water may turn brackish, especially if wells are over-pumped. Water may have to be brought from mainland.

### SITE 15

Rating: Excellent

Accessibility: Japanese field at west end of site is served by well-surfaced military road 1½ miles from Kaoe where there are good beaches and trail connections to north along coast. No trails to south.

Topography: Alluvial plain at mouth of the Kaoe River. Space for runways in any direction. Japanese operational field reported in western part of site is oriented north-south; 4,500 feet long, 2,000 feet are graded and surfaced. Ground is flat or gently rolling; grade less than 1.5 percent. Site may be crossed by a few small gullies 5 to 15 feet deep. Altitude between 10 and 50 feet.

Approaches: East and south approaches clear. Low hills and ridges 150 to 350 feet high along north side and 1 to 1½ miles west of the site.

Clearing and Grubbing: Dense rain forest on western part of site near Kaoe River. Jungle becomes more open eastward, giving way to sparse clumps of trees, second growth, and alang-alang grass. Stands of coconuts along coast. Eastern part relatively easy clearing.

Grading: Only minor leveling and filling of small gullies necessary. Sandy soil easily handled by bulldozers and scrapers.

Foundation Conditions: In south and west medium-textured soil of groups A-4 and A-2 (ML,SF) prevails; probably sandier along Kaoe River and behind Kaoe village. Northeast part probably coarse-textured throughout; A-2, A-3 (SF,SW). Entire site on soil derived from alluvium which shows much local variation in texture. Gravel usually absent at surface, but may be present in substratum. Binder content low.

Stabilization and Surfacing: Good compaction at conditions of optimum moisture. Finer textured parts of soil are more likely to be sticky, but friability of clay prevents extreme stickiness. Sand suitable for bitumen mix may be found along coast.

Drainage: Site only fairly well drained. Unless surfaced ground will be muddy and slippery during rains. Dries slowly after rains. Lateral ditches may improve run-off.

Construction Materials Available: Coral limestone along coast northeast of Kaoe is best all-purpose rock material at hand. Can be broken with hand tools for small quantities of aggregate. Some deposits of gravel and sand may be found in hills northeast of site along Kaoe River. Coarse coral sand obtainable along beach near Kaoe.

Water Supplies: Kaoe River will furnish large perennial supply; filtration and chlorination necessary. Intake should be located above limit of salt water. Abundant supply of fresh potable water available from wells 20 to 60 feet deep in unconsolidated alluvium. Wells can be located anywhere on site, but should be at least 1,000 feet from coast to minimize danger of contamination by salt water.

### SITE 16

Rating: Good

Accessibility: Site is on coast accessible to landing barges at south end near settlement of Lolobata. Dangerous coral reefs fringe north end of point. Good trail connections along shore in both directions. No trails into interior.

Topography: Low promontory on Kaoe Bay. Space for runways in any direction. Ground is nearly flat or gently undulating, in places slightly rough and irregular. Grades are less than 1 percent. Altitude mostly between 10 and 50 feet, but in southeast corner may reach 100 feet.

Approaches: Clear

Clearing and Grubbing: Site covered by dense rain forest difficult to clear because of scattered large trees more than three feet in diameter and dense tangle of roots, vines, and creepers. Stumps would need blasting. Stands of coconut trees on sandy soil along the coast.

Grading: Leveling of minor irregularities can be largely done by bulldozers and scrapers. Difficult in wet weather. Coral rock where near the surface, can probably be graded with hand tools, though very deep excavation would require blasting or use of power shovel.

Foundation Conditions: Soils are coarse to medium in texture, including depth, and uniformity.

Stabilization and Surfacing: Disturbed soil compacts well under controlled moisture conditions; makes good foundation. Relatively non-plastic clay content increases friability and reduces stickiness unless very wet. Soil foundation should be compacted before surfacing.

Drainage: Soil naturally well drained, but field will be muddy during and after rains unless surfaced. Adequate surface grading may improve runoff.

Construction Materials Available: Coral limestone available at site or along coast is best all-purpose rock material at hand. Can be broken with hand tools for small quantities of aggregate. Drilling and blasting necessary to establish a large quarry.

Water Supplies: Lobata River a possible perennial source; to be potable, water requires filtration and chlorination. Adequate supplies available from wells 30 to 100 feet deep; there should be at least 1,000 feet from shore and not more than a few feet below water level to minimize danger of contamination by salt water.

### SITE 17

Rating: Excellent

Accessibility: Site accessible to landing barges at Wasile. No trails along coast or into interior.

Topography: Narrow coastal lowland bordered by steep mountains. Site suitable for one, possibly two, landing strips oriented northeast; Japanese operational field reported under construction at this site. Ground is flat or gently undulating; grade less than 1.5%. Altitude between 20 and 80 feet.

Approaches: Approaches clear. Steep mountains rising to altitude of 2,000 to more than 3,000 ft. south and east of site are possibly hazards.

Clearing and Grubbing: Rain forest at site mostly dense, but in southwest part forest is interspersed with stands of coconut palms and brush. Probably much second-growth forest and some native clearings around Wasile.

Grading: Only leveling of minor irregularities and filling of small gullies are necessary. Loam soil readily worked by bulldozers and scrapers, but manipulating difficult when wet.

Foundation Conditions: In central and northeastern part of site soil is variably medium-textured, including groups A-4, A-2 (ML,SF). Soil probably sandier along north and west sides, south side and along stream banks, including groups A-2, A-3 (SF, SW).

Stabilization and Surfacing: Good compaction at optimum moisture conditions. Friability of clay prevents extreme stickiness when working.

Drainage: Soil naturally fairly well drained. Some gullies may require rock drains before filling or diversion around site. Unless surfaced, field will be muddy during and after rains.

Construction Materials Available: Hard massive limestone obtainable from hills southeast of site and west of Wasile is well exposed in cliffs and ledges. Requires drilling and blasting for excavation. Small amounts of gravel obtainable from beds of small streams. Little or no sand at hand.

Water Supplies: Wofafeakol River possible source, but may not be adequate perennial supply; requires filtration and chlorination for potability. Adequate supplies avilable from wells 30 to 100 feet deep in the alluvium; wells should be at least 1,000 feet from shore and should be not more than a few feet below water level to minimize danger of contamination by salt water.

Reliability Rating: C

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

PREPARED BY U.S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

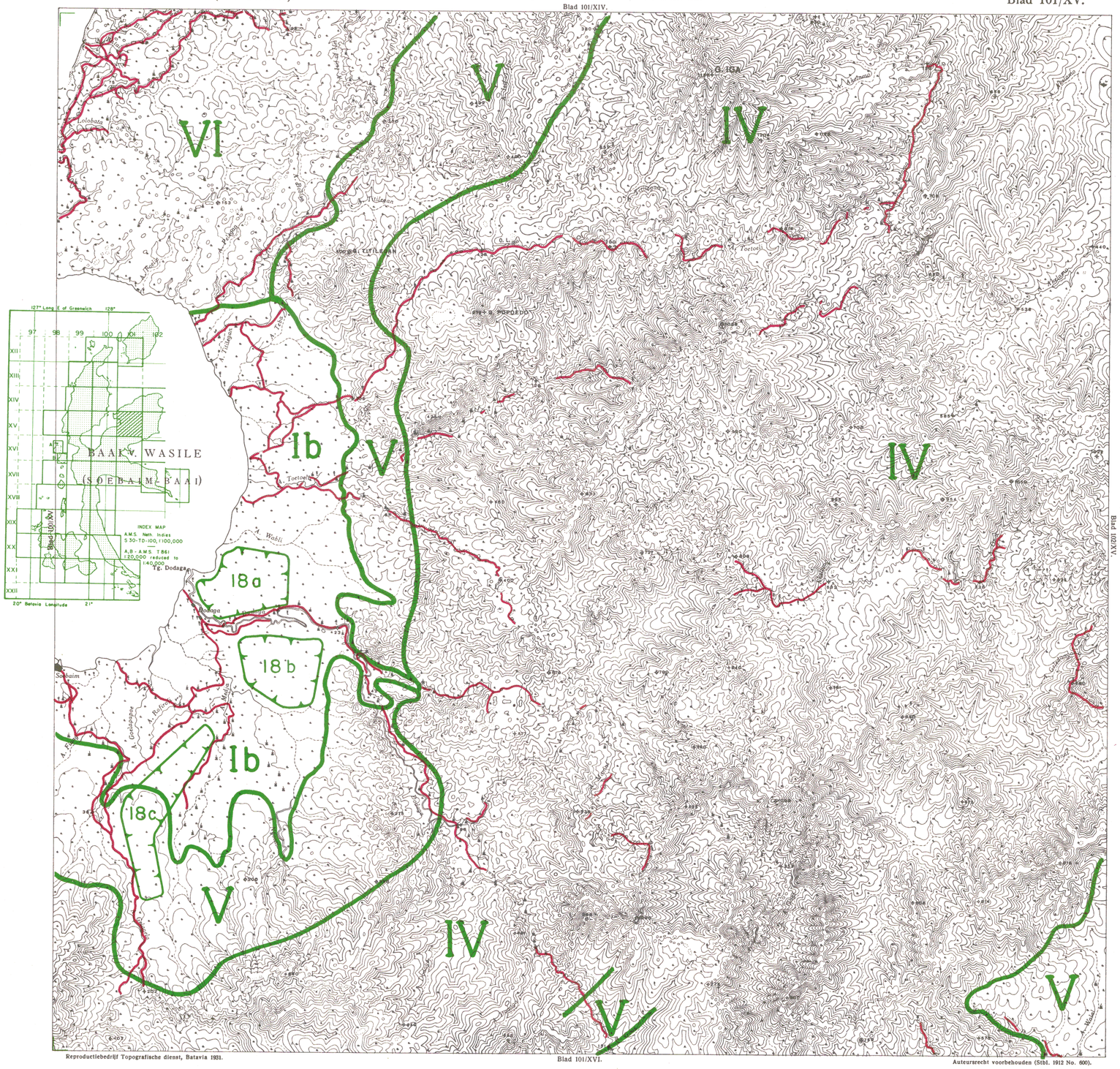
Gouvt der Molukken. (Res. Ternate).

Schetskaart samengesteld bij den Topografischen dienst in 1928-1929.

Blad 101/XIV.

## POSSIBLE AIRFIELD SITES

Blad 101/XV.

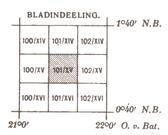



Reproductiebedrijf Topografische dienst, Batavia 1931.

Blad 101/XVI.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDELING.

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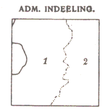


| | | |
|---|---|---|
| | Res. (Afd.) | Ternate. |
| 1 | Onderafd. | Tobelo. |
| | District | Wasile. |
| 2 | Onderafd. | Weda. |
| | District | Maba. |

Trail

Road

LEGENDA.

*Kampoeng.* V *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Bamboebosch.* *Bosch.* *Moeraspalmen.* *Tjemara-of Dennen-(sparren) bosch.* *Rivier, a gemeten, b niet gemeten.* *Paardenpad.* *Voetpad.* *Onderafdeelingsgrens.* *Bamboe huizen.* *Inlandsche graven.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogtecijfer, b hulphoogtepunt van 25 m, c rots, d strand.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Vluchtig opgenomen in 1928-1929 met de bergbousole voor het hoofdverband en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 388 schaal 1:200 000 uitgave 1922.*

AFKORTINGEN.

*A. Air (rivier).* **G.** *Goenoeng.* **Tg.** *Tandjoeng.* **O. L.** *Onderaardsche loop.*

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

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**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and i cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on stone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticit Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and led

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plastic Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weath granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

**Sheet XV-101**

SITES 18a, b, and c.

Rating: Sites 18a and b excellent, 18c fair.

Accessibility: Coast at site 18a directly accessible to landing barges. Good trail connections to sites 18b and c which are 1½ and 4 miles respectively inland. Trails along coast discontinuous; fair trail crosses mountains to Boeli-Serani on Boeli Bay.

Topography: Coastal plain bordered by rugged mountains. Sites 18a and b are suitable for runways in any direction. Ground flat or gently undulating; site 18b furrowed by a few shallow gullies 5 to 15 feet deep. Grades for most part less than 1.5%. Altitude of site 18a between 10 and 60 feet, of 18b between 20 and 100 feet. Site 18c is suitable for runways oriented north and northeast; ground gently rolling and in the south somewhat hilly, but grades are mostly less than 1.5%; site crossed by a few gullies 10 to 25 feet deep. Altitudes between 100 and 300 feet.

Approaches: Sites 18a and b have clear approaches on north and west. Hills 600 to 1500 feet in altitude rise 3½ to 5½ miles to south and about ½ mile to the east. Site 18c has has clear approaches on north and northeast. Hills 400 to 1000 feet in altitude ½ to 2 miles to south and west.

Clearing and Grubbing: Dense tropical rain forest on all three sites. Clearing difficult; some trees more than three feet in diameter; stumps will require blasting. Dense layer of vines and roots at ground surface is hard to strip. Site 18 a near village of Dodaga may be partly cleared or covered with second-growth jungle; small cultivated areas.

Grading: Only minor leveling at sites 18a and b. More extensive grading of low ridges and hollows necessary at 18c. Loam soil easily worked by bulldozers and scrapers. Rocky or stony soil in southern extension of site 18c may be somewhat more difficult to work. No rock excavations necessary.

Foundation Conditions: At sites 18a and b chiefly medium-textured soil developed on alluvium, but much variation in grain size. Group A-4 (ML) probably predominates grading into sandier soil of group A-2 (SF), near Dodaga River and smaller streams to north and south. Binder abundant. At site 18c soil developed on recent alluvium includes groups A-4 to A-2 ( ML to SF); probably quite variable in southern part of site. Locally some gravel and cobbles in southern part.

Stabilization and Surfacing: Soil at sites 18a and b is fairly readily compacted, especially where sand content is high and moisture content is easily controlled. May be necessary to provide a fairly high-level profile and granular base course for insulation between subgrade and surface. Soil of intermediate stickiness when wet. At site 18c soil forms good subgrade after compaction. Probably most attention to bearing Course constituents necessary in northeast part. Soil moderately friable, low in plasticity and stickiness, in southern part.

Drainage: Natural drainage fair at all sites, probably best at 18c. Some wet spots at 18a and 18b may need raised subgrades locally. Lateral drains will improve drainage. Unless surfaced, fields will be muddy during and after heavy rains.

Construction Materials Available: Probably no rock available at sites. Gravel obtainable from stream beds or from deposits in hills to south and east; generally exposed along steep slopes or where ravines empty from hills onto plains. Nearest source of rock is coral limestone deposits on peninsula to north or hard massive limestone from mountains along coast southwest of Wasile Bay.

Water Supplies: Perennial supply available from Dodaga River and possibly other larger streams. Intakes should be above salt-water limit. Large supplies available from wells 20 to 100 feet deep in alluvium of plain. Wells should be at least 1000 feet from coast to reduce danger of salt-water contamination.

Reliability Rating: 6.

Preliminary text submitted
without checking or editing.
U. S. Geolcgical Survey

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS)

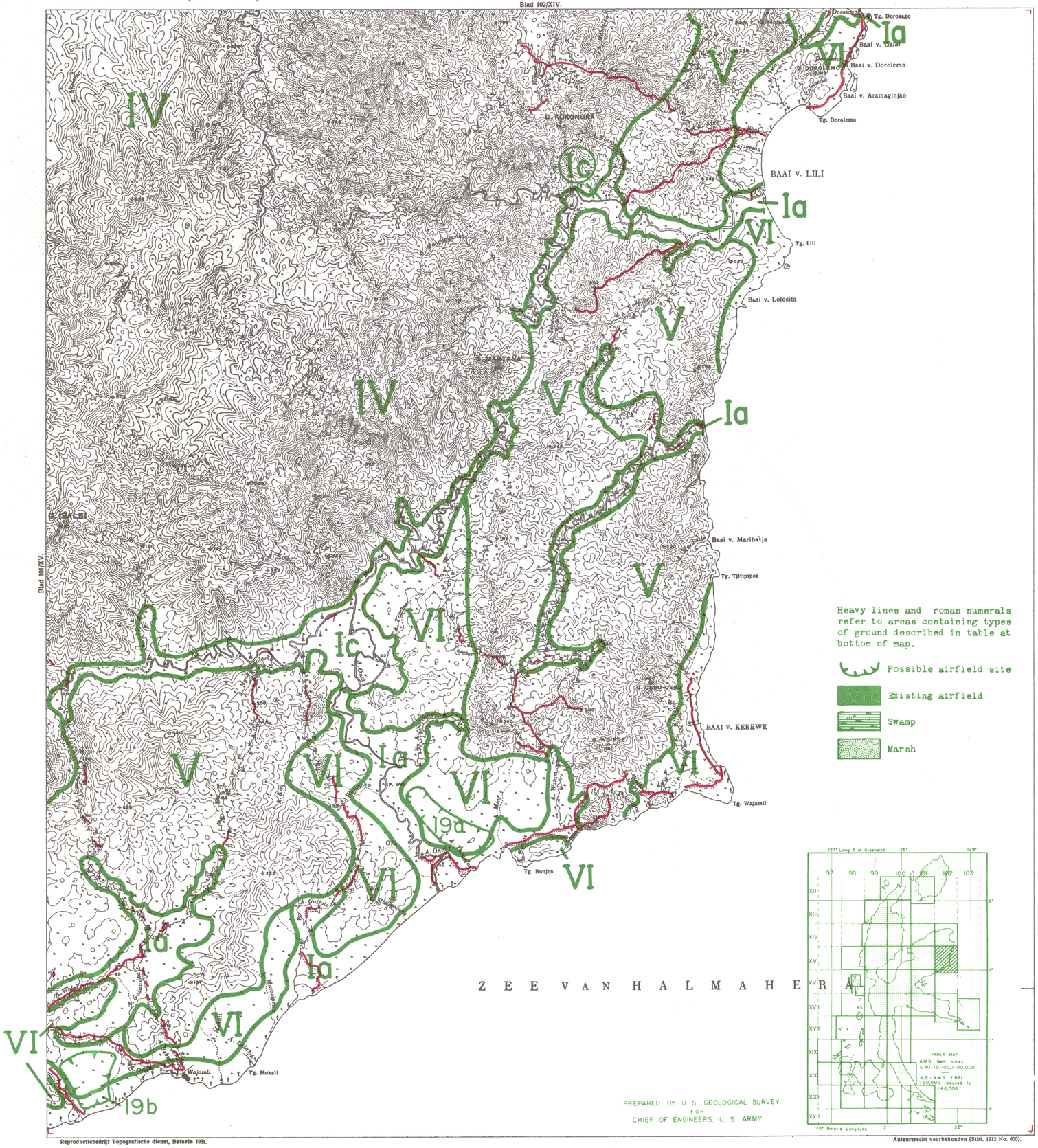
Gouvt der Molukken (Res. Ternate).

Schetskaart samengesteld bij den Topografischen dienst in 1928-1929.

Blad 102/XIV.

# POSSIBLE AIRFIELD SITES

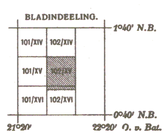
Blad 102/XV-XVI.



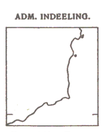

Reproductiebedrijf Topografische dienst, Batavia 1931.

Auteursrecht voorbehouden (Sibl. 1912 No. 600).

BLADINDEELING.




ADM. INDEELING.



Res. (Afd.) Ternate.
Onderafd. Weda.
District Maba.

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Tjemara-of Dennen-(Sparren) bosch.* *Arentain.* *Klapperboomen.* *Bamboebosch.* *Bosch.* *Moerassalmen.* *Alangalang.* *a Paardenpad, a dalker van hout of bamboe.* *Voetpad.* *Rivier, a gemeten, b niet gemeten, c eiland, d meer.* *Bamboe hatsen.* *Inlandsche graven.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogtecijfer, b halphoogtelijn van 25 m, c rots, d eiland.*

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Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Vlachtig opgenomen in 1928-1929 met de bergboussole voor het hoofdverband en met kompas en barometer voor het overige verband met gebruikmaking van de zeekaart No. 389 Schaal 1:200 000 uitgave 1922.*

AFKORTINGEN.

*G. Goenoeng,* *P. Poelau.* *O.L. Onderaardsche loop.* *Tg. Tandjoeng.* *A. Air (rivier).*

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near or at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITES 19a and b. Sheet XV, XVI-102

Rating: Fair.

Accessibility: Both sites near coast, which can be reached by landing barges passing through channels between coral reefs. Sites not well connected with interior or other points along the coast. Trails are discontinuous.

Topography: Sites on small coastal plains. Site 19a suitable for one or possibly two runways oriented northwest. Ground gently rolling; crossed by some gullies 10 to 25 feet deep. Land slopes gently to south and southeast at grades generally less than 1.5%. Altitude between 20 and 50 feet. Site 19b is suitable for runways in several directions. Ground gently undulating to nearly flat; crossed by a few small gullies 5 to 10 feet deep. Slope to southeast less than 1%. Altitude between 10 and 50 feet.

Approaches: Southeast approaches to site 19a are clear; northwest approach clear for nearly 4 miles. Low ridges 150 to 400 feet in altitude ¼ to 1½ miles to southwest and northeast. At 19b approaches clear to east and southeast. Hills 500 to 1,000 feet in altitude rise about 1½ miles to southwest. Hills 300 to 600 feet in altitude lie ¼ to 1 mile northeast and west of the site. From north end of site a narrow approach zone is clear for a little over 3 miles up the Calausita River.

Clearing and Grubbing: Dense tropical rain forest with undergrowth covers both sites. Some trees greater than 3 feet in diameter; stumps will require blasting. Thick ground mat of roots vines, and creepers requires stripping. Topping or felling of taller trees in approach zones probably necessary.

Grading: Minor leveling of low knolls and filling of depressions necessary. Soil, rotted coral rock underlying both sites mostly workable with bulldozers. Deeper excavations may require power shovel or light blasting.

Foundation Conditions: Both sites have similar sandy soils, mainly A-1, A-2 and some A-4 (SC, SF, ML) with possibility of considerable local difference. On south and southeast sides of both sites and on west and east sides of site 19b, soil tends to be sandier.

Stabilization and Surfacing: Soils compact well and are fairly readily brought to the required moisture content for optimum compaction; friable; plasticity and stickiness low. Base course requirements differ locally.

Drainage: Fair natural drainage; unless surfaced ground will be muddy during and after rains. Lateral drains may improve runoff. Diversion ditches may be necessary where gullies have to be filled.

Construction Materials Available: Little rock available at or near site. Some poorly exposed coral limestone may be found along coast or inland against hills. Some gravel deposits may be found along steep ravine banks in the hills. Difficult to find and may disintegrate easily with wear.

Water Supplies: Large perennial supplies available from Onat and Walal Rivers but require purification to be potable. Intakes should be above salt-water limit. Wells 20 to 50 feet deep in unconsolidated alluvium of plains would supply adequate potable water; wells shouldbe at least 1,000 feet from coast to minimize danger of contamination by salt-water.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Reliability Rating: C .

PREPARED BY U S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

~~CONFIDENTIAL~~

# HALMAHERA (MOLUKKAS)

NETHERLANDS EAST INDIES,
HALMAHERA GROUP 1:20,000

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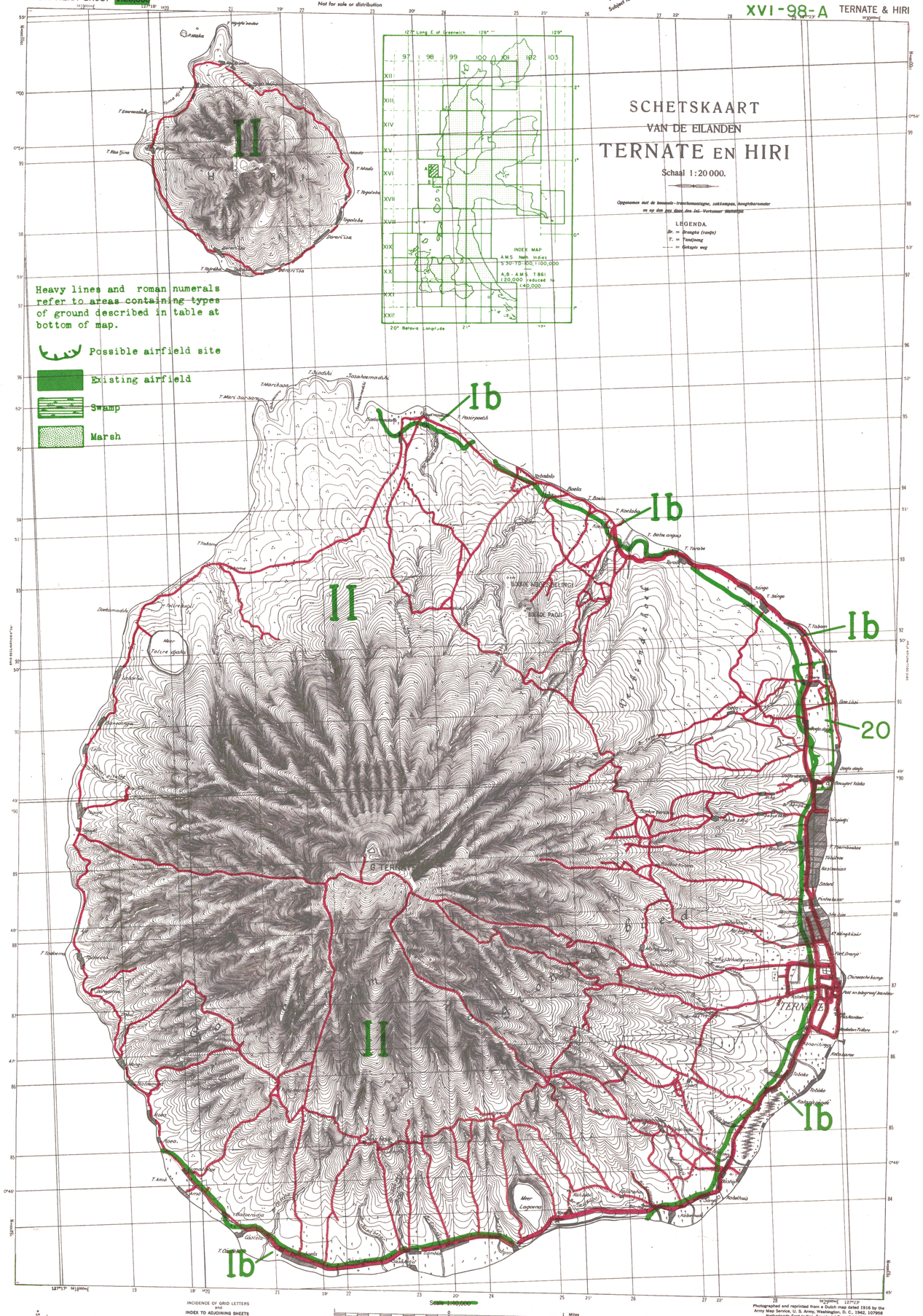
Advance edition
Subject to correction

## POSSIBLE AIRFIELD SITES

XVI-98-A TERNATE & HIRI




Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XVI-98-A

SITE 20

Rating: Fair.

Accessibility: Coast at site is directly accessible to landing barges. Site is reached by narrow auto road which extends from Batoe Angoes point to Lake Lagoena. Ternate is largest center of trade in islands; has pier facilities for steamers.

Topography: Narrow coastal lowland at foot of volcano; altitude between 20 and 60 feet. Space for single landing strip oriented north-south. Ground is nearly flat; ravine 20 to 30 feet deep near south end; a few small gullies 5 to 15 feet deep in northern part.

Approaches: Approaches clear.

Clearing and Grubbing: Clearing relatively easy; mostly second-growth jungle, native clearings, and stands of coconuts that can be rapidly handled by bulldozers.

Grading: Some leveling may be necessary along west side of site, where strip borders lower slopes of mountain. Large gully crossing site near S. end would require filling. Soil readily worked by bulldozers and scrapers.

Foundation Conditions: Site on well-drained friable clay loam to loam of group A-4 (ML); relatively uniform in texture, but sandier, group A-2 (SF), along eastern side.

Stabilization and Surfacing: After compaction this soil makes good foundations having good internal drainage. Base course requirements probably light. Binder is friable clay, and not very sticky except when extremely wet.

Drainage. Naturally well drained but muddy during and after rain. Diversion of streams heading in mountains necessary. Large gully will probably require permeable rock drains at bottom if it is to be filled.

Construction Materials Available: Good quality trap rock available from deposits two miles to north on coast. Some gravel may may be screened from deposits in slopes rising steeply to west of site, or from detritus along gullies at edge of plain. Volcanic black sand available locally from beaches.

Water Supply: No perennial surface water supply. Adequate supplies obtainable by sinking wells 30 to 40 feet deep in unconsolidated or partly consolidated alluvium. Wells must be cased; should be at least 1000 feet from shore and only few feet below water level, to minimize danger of contamination by salt water. Existing wells may be usable, but many run dry during the dry season.

Reliability Rating: C

Preliminary text submitted without checking or editing U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

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# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

NETHERLANDS EAST INDIES,
HALMAHERA GROUP 1:20,000

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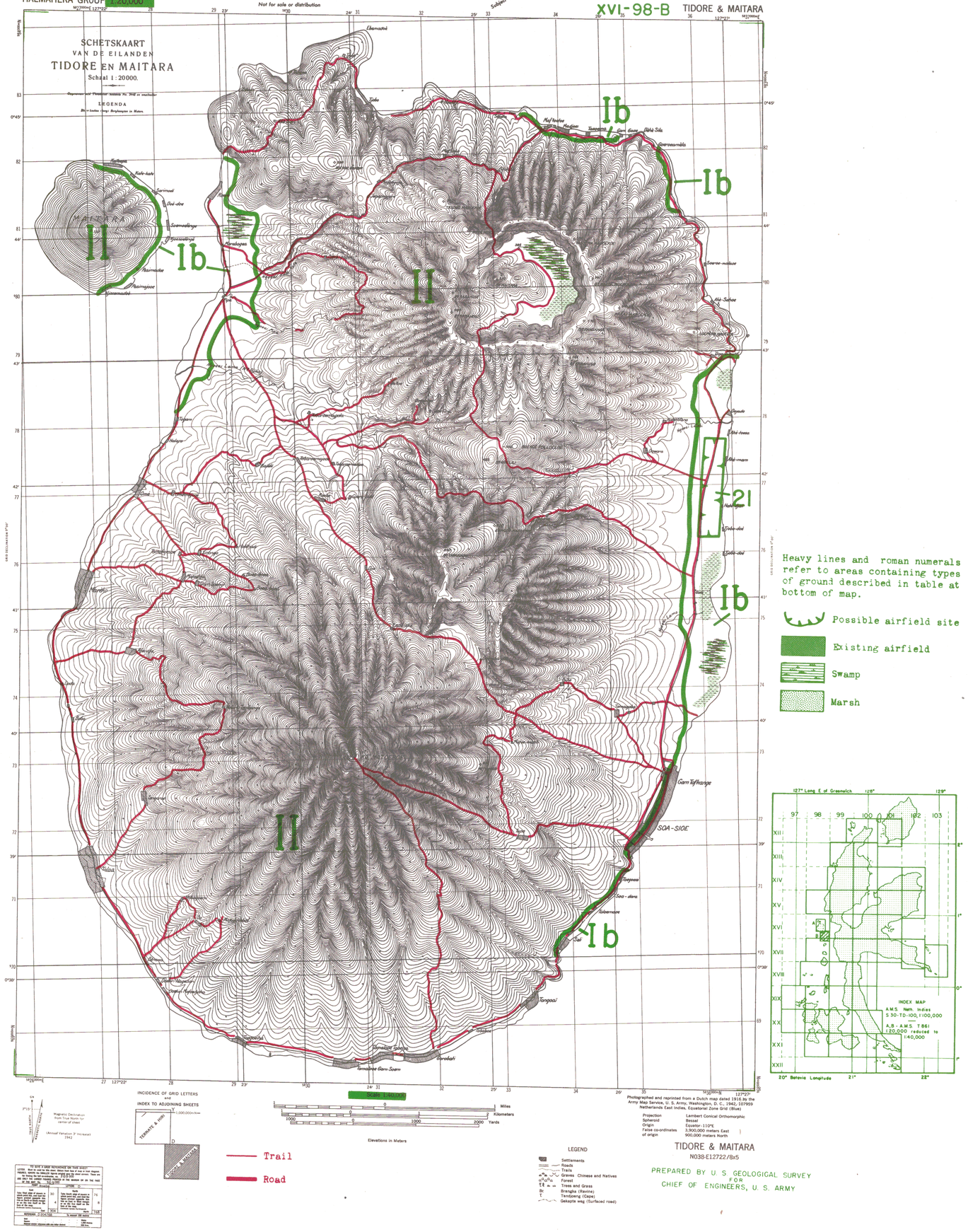
XVI-98-B TIDORE & MAITARA




Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh




LEGEND
Settlements
Roads
Trails
Graves Chinese and Natives
Forest
Trees and Grass
Br Brangka (Ravine)
T. Tandjoeng (Cape)
Gekapte weg (Surfaced road)

Photographed and reprinted from a Dutch map dated 1918 by the Army Map Service, U. S. Army, Washington, D. C., 1942, 107959
Netherlands East Indies, Equatorial Zone Grid (Blue)

| | |
|---|---|
| Projection | Lambert Conical Orthomorphic |
| Spheroid | Bessel |
| Origin | Equator-110°E |
| False co-ordinates of origin | 3,900,000 meters East<br>900,000 meters North |

TIDORE & MAITARA
N038-E12722/8x5

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.



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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XVI-98-B

SITE 21

Rating: Fair.

Accessibility: Coastal beaches at site directly accessible to landing barges. Good trails connect all important points of island.

Topography: Narrow strip of coastal lowland at the foot of the volcanoes; space for a north-south runway. Ground nearly flat; locally slightly irregular or undulating. Area crossed by a few shallow gullies 10 to 15 feet deep. Altitude between 20 and 50 feet.

Approaches: South approach is clear. On north, steep ridges more than 300 feet high rise about half mile from site.

Clearing and Grubbing: Site covered mostly by second growth jungle and small native clearings; stands of coconuts along the coast. Some patches of rain forest with undergrowth near mountains.

Grading: Little leveling except filling of small gullies necessary. Loamy soil easily worked by bulldozers and scrapers. Some select fill to raise subgrade may be required for wet spots.

Foundation conditions: Soil a friable clay loam to loam of group A-4 (ML) showing some local differences in texture.

Stabilization and Surfacing: After compaction soil makes good foundation having good internal drainage. Base course requirements probably light except locally in small depressions and draws which may be scattered over sites. Binder is a friable clay and is not very sticky except when extremely wet.

Drainage: Soil naturally well drained but unless surfaced will become muddy during and for a short time after rains. Becomes hard when dry. Ground may be wetter at northern end of site and require local lateral ditches. Streams crossing site from hills to west must be diverted.

Construction Materials Available: A good grade of trap rock (basalt) should be available from point to north. Gravel requiring screening probably obtainable from steep banks of ravines in hills to north and west. Small quantities of gravel may be present along stream just north of site.

Water Supply: Perennial surface water probably not available. Adequate supply can be obtained from wells 20 to 40 feet deep in alluvium; these should be at least 1,000 feet from shore and should penetrate not more than few feet below water level, to minimize danger of salt-water contamination.

Reliability Rating: C

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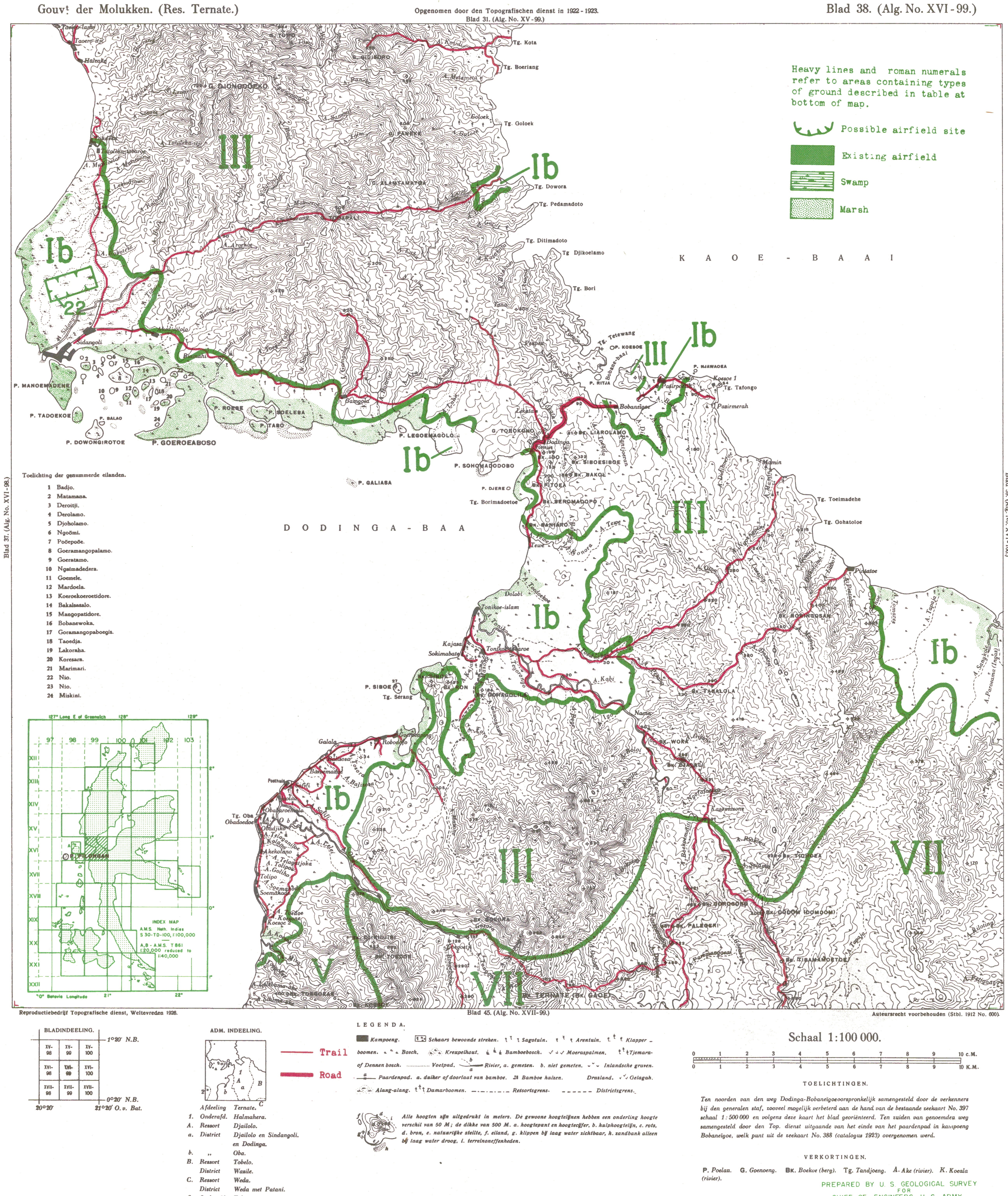
# HALMAHERA (MOLUKKAS)

# POSSIBLE AIRFIELD SITES

Gouvt der Molukken. (Res. Ternate.) Opgenomen door den Topografischen dienst in 1922-1923. Blad 31. (Alg. No. XV-99.) Blad 38. (Alg. No. XVI-99.)




Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or m[...] Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravi[...] cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; sh[...] stone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sands[...] shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to $1\frac{1}{2}$ feet into clayey sand of low [...] Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliff[...]

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of lo[...] Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan dee[...] granite exposed only along streams.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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XVI-99

SITE 22

Rating: Good

Accessibility: Readily accessible by trail from Sidangoli where barges can land at mouth of river. River may have to be bridged as road is constructed to site.

Topography: Small terraced coastal lowland bordered by mangrove swamps and coral reefs. Site is on broad low terrace and has space for single landing strip oriented east to northeast. Ground is gently rolling ; cut by several small gullies 5 to 20 feet deep. Land slopes generally to west and south at a grade less than 1.5%. Altitude between 75 and 100 feet.

Approaches: Clear approach at west end of site; hills and ridges 300 to 500 feet in altitude $\frac{1}{2}$ to $\frac{3}{4}$ mile from the east end and are possible flying hazards.

Clearing and Grubbing: Open grass land with patches of trees and brush. Small coconut plantations and areas of second growth. Site largely already cleared for possible use as landing field.

Grading: Considerable leveling of irregular low topography necessary if field is not already established. Excavation of soft bedrock, if required, can be handled by bulldozers and scrapers.

Foundation Conditions: Soils are developed on relatively thin alluvium; are probably of intermediate texture, group A-4 (ML). Binder clay is friable.

Stabilization and Surfacing: Stabilization should not be difficult as soils are well drained and have good permeability. Light base course requirements may be anticipated. Soil sticky when very wet, but dries fairly rapidly.

Drainage: Site naturally well drained; few improvements necessary. If not surfaced may be muddy during and for a short time after heavy rains.

Construction Materials Available: Coral limestone along coast is good all-purpose material. Volcanic conglomerate in the hills to east is source of gravel; requires screening, may disintegrate easily on wear.

Water Supplies: Adequate perennial supply available from Sidangoli River about 1000 feet from site; silty at high-water stage and requires filtration and chlorination to be potable. Intake should be located above salt-water limit. Abundant potable supplies available from wells sunk 100 to 150 feet at site.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U.S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

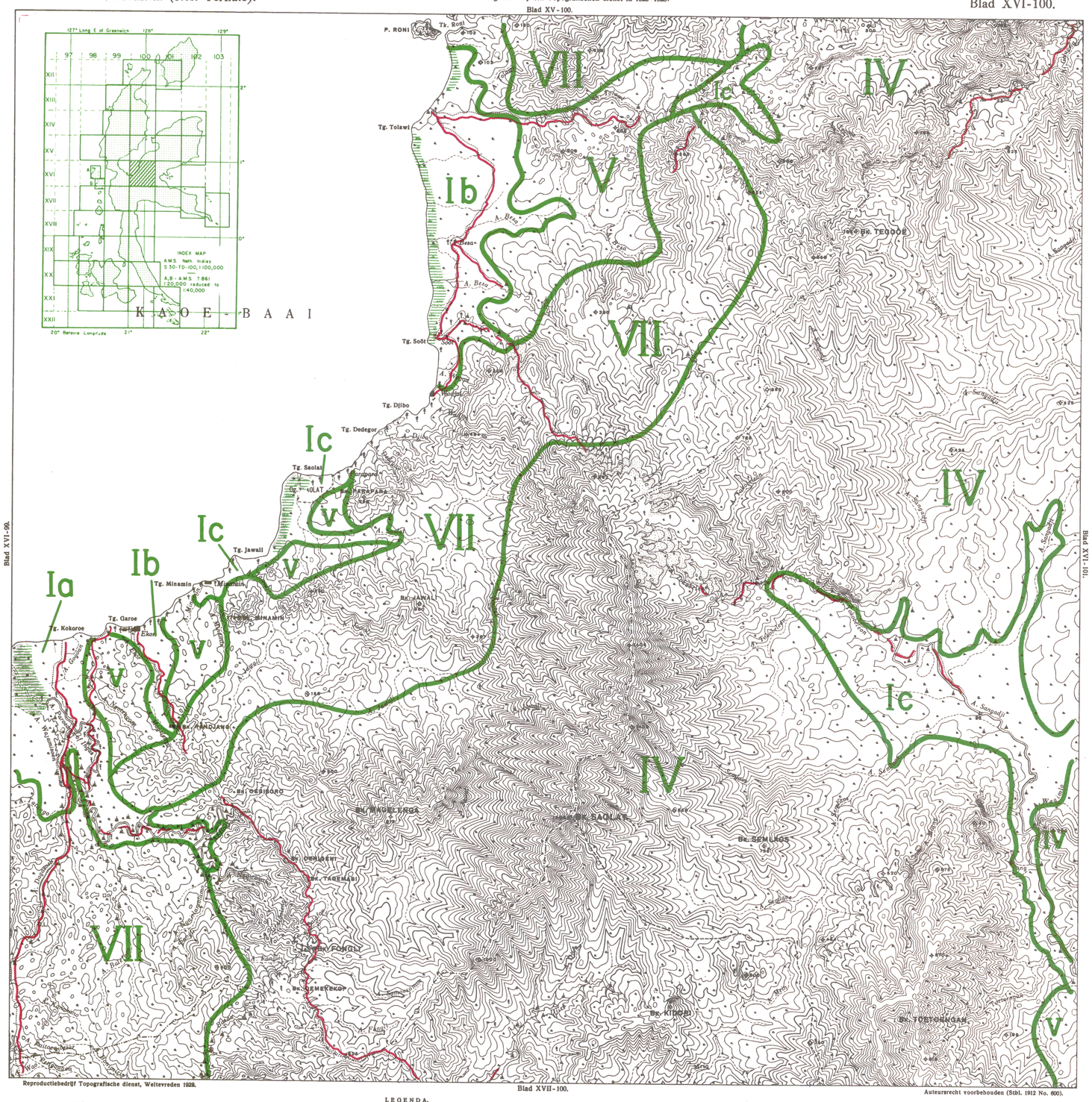
Gouvt der Molukken. (Res. Ternate).

Schetskaart samengesteld bij den Topografischen dienst in 1923-1925.

Blad XV-100.

## POSSIBLE AIRFIELD SITES

Blad XVI-100.







BLADINDEELING.

| | | |
|---|---|---|
| XV-99 | XV-100 | XV-101 |
| XVI-99 | XVI-100 | XVI-101 |
| XVII-99 | XVII-100 | XVII-101 |

1°30' N.B. — 0°30' N.B. — 20°40' — 21°40' O. v. Bat.

ADM. INDEELING.

*Residentie (Afdeeling) Ternate.*
*A Onderafd. Tobelo.*
*District Wasile.*
*B Onderafd. Weda.*
*a District Maba met Gebe.*
*b Weda met Patani.*

Trail

Road

LEGENDA.

*Kampoeng. Schaars bewoonde streken. Klapperbomen. Djemara-of Dennen (Sparren) bosch. Bosch. Bamboebosch. Arenlain. Moraspalmen. Bamboe haisen. Voetpad. Moras. Rivier, a gemeten, b niet gemeten, c eiland. Landb. ond. grens. Districtsgrens. Onderafdeelingsgrens. Paardenpad.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m; de dikke van 500 m. a hoogtepunt en hoogtecijfer, b haiphoogtelijn, c rots, d eiland.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, vooreel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397. 1:500 000 en volgens deze kaart het blad georiënteerd. De naam en grens der cultuurondernemingen is vergeleken met het Handboek voor Cultuur- en Handelsondernemingen in Ned. Indië en met de kadastrale kaart.*

AFKORTINGEN.

*Bk. Boekoe (berg). A. Ake (rivier) Tg. Tandjoeng. P. Poelau. Tk. Teloek. Ot. Onderneming. O.L. Onderaardsche loop.*

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FOR
CHIEF OF ENGINEERS, U.S. ARMY

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

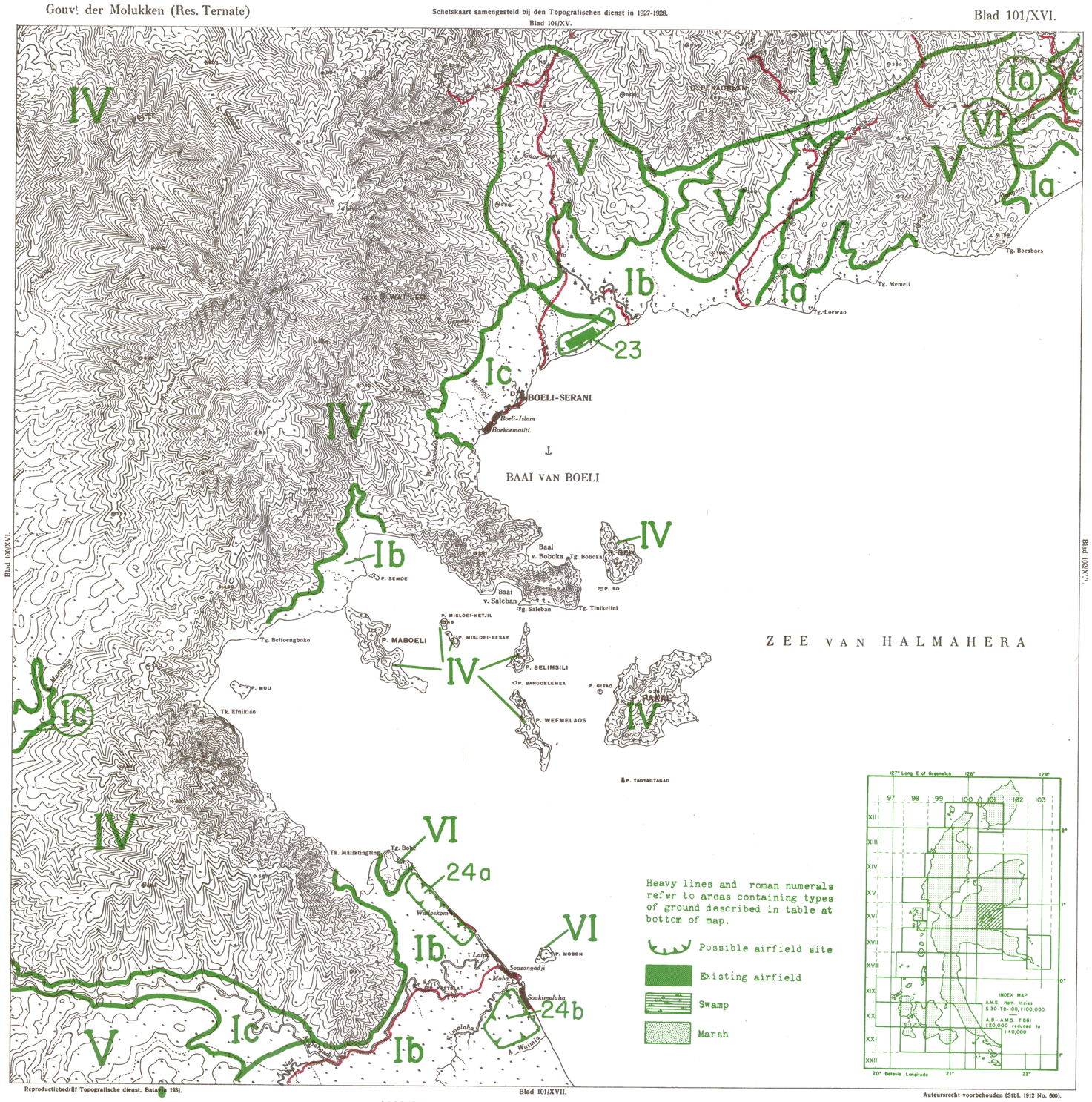
# POSSIBLE AIRFIELD SITES

Gouvt der Molukken (Res. Ternate)

Schetskaart samengesteld bij den Topografischen dienst in 1927-1928.

Blad 101/XVI.

Blad 101/XV.




Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

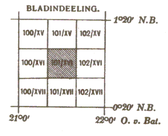
- Possible airfield site
- Existing airfield
- Swamp
- Marsh




Reproductiebedrijf Topografische dienst, Batavia 1931.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.




ADM. INDEELING.

| | Res. (Afd.) | Ternate. |
|---|---|---|
| 1 | Onderafd. | Tobelo. |
| | District | Wasile. |
| 2 | Onderafd. | Weda. |
| | District | Maba. |

Trail

Road

LEGENDA.

*Kempoeng.* *Schaars bewoonde streken.* *Tjemara of Dennen (Sparren) bosch.* *Sagotuin.* *Arentuin.* *Klapperbouwen.* *Bamboebosch.* *Bosch.* *Kreuzelhout.* *Moerasplanten.* *Paardenpad, a dniker of vonder van hout of bamboe, b houten brug.* *Vestpad.* *Rivier, a gemeten, c niet gemeten, c eiland.* *Bamboe huizen.* *Christen kerk.* *Mesigit.* *Christen kerkhof.* *Inlandsche graven.* *Onderafdeelingsgrens.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtecijfers hebben een onderling hoogteverschil van 50 m, de dikke van 500 m; a hoogtepunt en hoogtecijfer, b hulphoogtecijfer van 25 m, c rots, d klippen bij laagwater zichtbaar, e eiland, f ankerplaats en reede.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Vluchtig opgenomen in 1927-1928 met de bergboussole voor het hoofdverband en met kompas en barometer voor het overige verband, met gebruikmaking van de zeekaart No. 389 schaal 1:200 000 uitgave 1922.*

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AFKORTINGEN.

*A. Air.* *Tk. Telook.* *Tg. Tandjoeng.* *G. Goenoeng.* *P. Poelau.* *D. Districtshoofd.*

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; small stone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandston shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low pla Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs a

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low p Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply granite exposed only along streams.



CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

Sheet XVI-101

### SITE 23

Rating: Fair.

Accessibility: On coast accessible to landing barges by way of channels through the coral reefs. Boeli-Serani is important native village. Connections across peninsula by foot trail to north. Japanese field reported near Boeli but exact location and nature are unknown.

Topography: Coastal lowland bordered by steep mountains. Site is roughly parallel to coast; space for single runway oriented northeast. Ground nearly flat or gently rolling; a few shallow gullies 5 to 10 feet deep. Slope less than 1%. Altitude less than 30 feet.

Approaches: Clear approaches for about 1.8 miles to northwest where ridges about 600 feet high rise above the plain. Approaches to south clear for about 3 miles where hills 600 to 700 feet high rise along the coast. About 2 miles west of site mountains rise to 700 feet.

Clearing and Grubbing: Dense rain forest covers inland part of site. Clearing difficult because of scattered large trees over 3 feet in diameter and dense tangle of roots, vines, and creepers which mesh tree tops together and also form a dense ground mat. Large stumps will need blasting. Along coast and near settlements stands of coconuts and small areas of second-growth jungle and alang-alang grass make easier clearing.

Grading: General leveling of rolling surface, filling of gullies and minor depressions necessary. Clay soil easily handled by bulldozers and scrapers when dry, but working difficult during and after heavy rains.

Foundation Conditions: Soil sandy, of group A-2 (SF), along southeast side near shore; probably much higher in fines, including groups A-6, A-7 (CL), in northwest part where drainage may be poor.

Stabilization and Surfacing: Well-insulated surface course may be especially needed in northwest part of site. Low fill may be necessary. Away from coast soil may be plastic and sticky, and may have low bearing ratio.

Drainage: Soil not naturally well drained; may be local wet spots in northern part. Conditions can be improved by lateral drains and if necessary by raising the subgrade in the low places. Site becomes muddy during rains, dries slowly.

Construction Materials Available: A dark trap rock of fair quality is abundant in hills northwest of Boeli-Serani and on peninsula to south. Is fairly well exposed: quarrying requires drilling and blasting. Small deposits of gravel may be available along local streams at foot of mountains. Sand obtainable from beaches along coast.

Water Supplies: Perennial supply available from river 3 miles northeast of Boeli-Serani. Intake should be above salt-water limit. Other streams may not provide adequate perennial supplies. Wells sunk 20 to 50 feet at the site will provide adequate supplies from the alluvium. Should be at least 1000 feet from the coast and should penetrate only a few feet below water level to minimize danger of contamination by salt water.

### SITES 24 a and b

Rating: Good.

Accessibility: Both sites on coast accessible to landing barges. Foot trail from Maba across peninsula to Sepo on Weda Bay.

Topography: Coastal lowland. Site has space for single runway oriented northwest; site 24b for runways in any direction. Ground is flat or gently undulating. Grades less than 1%. Altitude less than 30 feet.

Approaches: Clear approaches to site 24a from southeast. Group of low hills 200 to 300 feet in altitude are minor hazard at northwest end of site. Steep ridge about 1500 feet in altitude about a mile to the southwest.

Clearing and Grubbing: Dense rain forest at both sites generally difficult to clear. Most open along coast, where interspersed wth native clearings, and coconut stands.

Grading: Only minor leveling required at either site. Loam soil readily handled by bulldozers and scrapers. Some coral rock excavation on hill north of site 24a necessary to clear approaches in that direction.

Foundation Conditions: Soil generally medium-textured, of group, A-4 (ML), in southwest parts of these sites, but much sandier along shore. On northwest and southeast sides of site 24b, along Kimalaha and Sangadji Rivers, there may be coarser sandy sediments.

Stabilization and Surfacing: Soil will stabilize well provided optimum moisture conditions and adequate drainage, Coastal strips may supply sufficiently clean sand for bitumen-mix surface course.

Drainage: Soil fairly well drained naturally. Lateral drains will improve surface runoff. Ground probably muddy during and after heavy rains.

Construction Material Available: Coral limestone may occur in hill north of site 24a along coast. If so this is best source of all-purpose material; can be worked in small quantities by hand. A fair to poor grade of trap rock occurs in mountains to west, but is probably poorly exposed on lower slopes. Some gravel may be obtainable from local streams.. Sand available along beaches.

Water Supplies: Perennial supplies available from Sangadji and possibly from Kimalaha River. Intake should be above salt-water limit. Will require treatment to be potable. Wells sunk 20 to 50 feet in alluvium at sites should supply adequate potable supply; wells should be at least 1000 feet from the coast and should penetrate only a few feet below water level to minimize danger of salt-water contamination.

Reliability Rating: C

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

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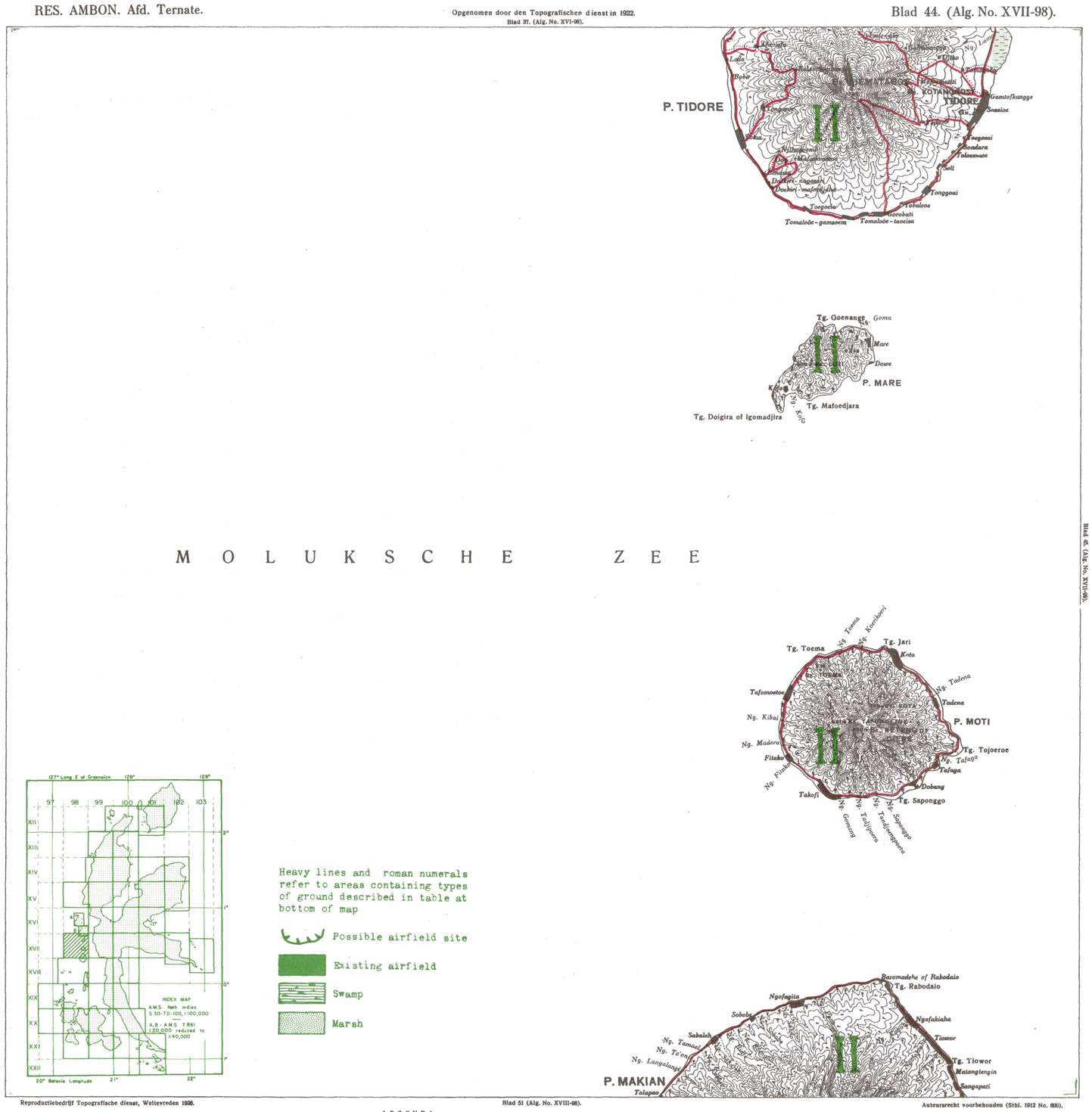
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922.
Blad 37. (Alg. No. XVI-98).

## POSSIBLE AIRFIELD SITES

Blad 44. (Alg. No. XVII-98).



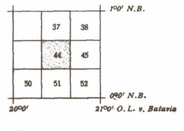

Blad 45. (Alg. No. XVII-98).

Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Blad 51 (Alg. No. XVIII-98).

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.




ADMINISTRATIEVE INDEELING.

Trail
Road

LEGENDA.

Kampoeng. Schaars bewoonde strekén. Klapperbooman. Bosch. Kreupelhout.
Alang-alang. Drasland. Paardenpad. a. duiker of doorlaat van hout. Voetpad.
Rivier. a. gemeten. b. niet gemeten. Jn Bamboe gebouwen. Inlandsche graven.
Zee. a. eiland. b. hoogtepunt en hoogtecijfer. c. halfhoogtelijn.
Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Administratieve indeeling volgens G.B. van 25 Jan. 1924 No. 21. Stbl. No. 29. Vlachtig opgenomen in het jaar 1922. Uitgangspunten voor de kaartering zijn, de astr: stations, de vlaggestok naast den steiger van Labocha, de vlaggestok te Weda. De meetlijnen van de kusten zijn ten opzichte van het geografische noorden gekaarteerd en de eilanden door peilingen in onderling verband gebracht.*

VERKORTINGEN.

Gn. *Gunughobbor.* Ngr. *Ngoeal = rivier (Tidorees ch).* Tg. *Tandjoeng.* P. *Poelau.* Bk. *Boekoe = Goenoeng.*

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

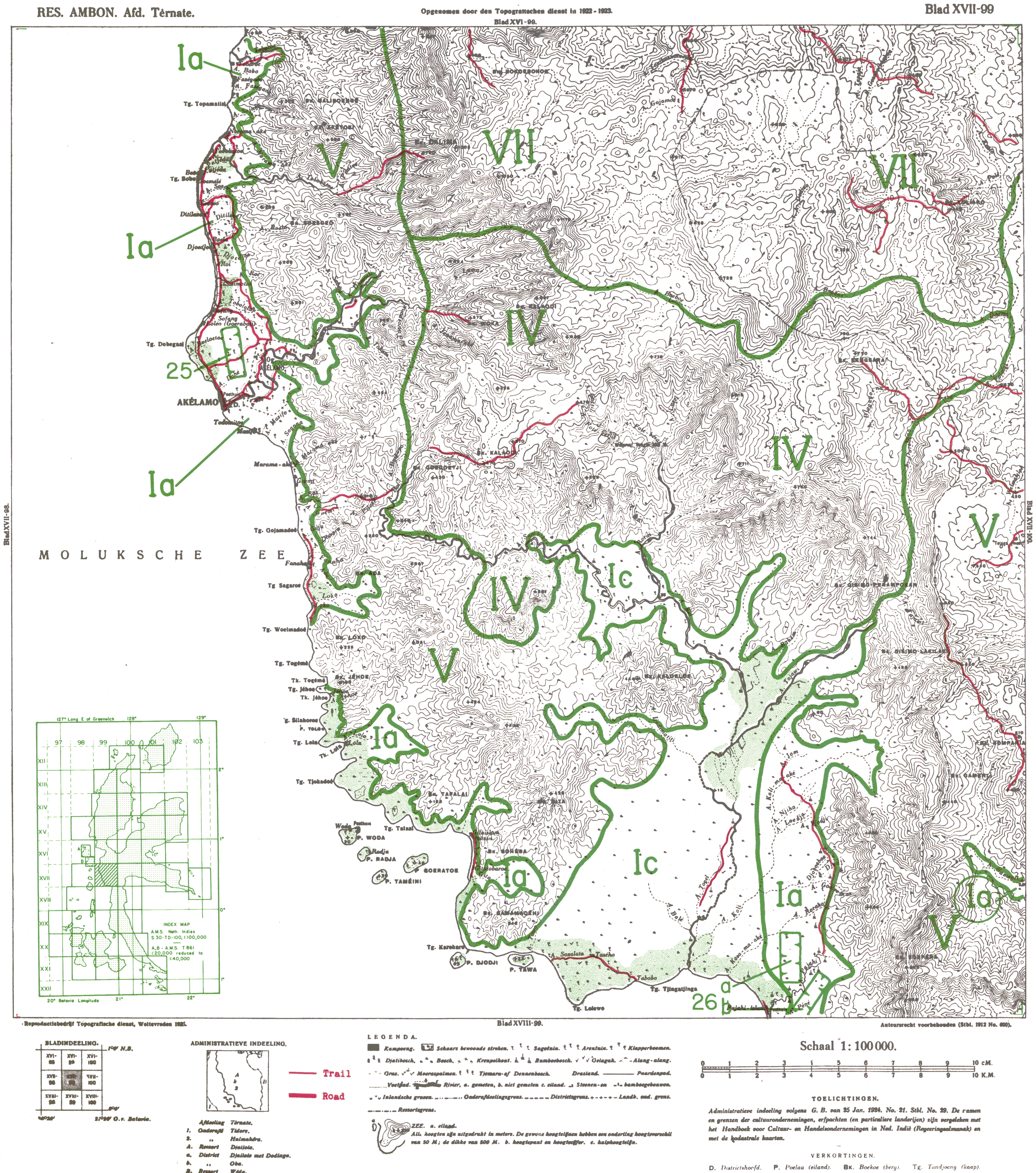
PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

# POSSIBLE AIRFIELD SITES




PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

| | | |
|---|---|---|
| Ia | | Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained. |
| Ib | | Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained. |
| Ic | | Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth. |
| II | SOIL: | Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained. |
| | ROCK: | Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes. |
| III | SOIL: | Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained. |
| | ROCK: | Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes. |
| IV | SOIL: | Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained. |
| | ROCK: | Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs. |
| V | SOIL: | Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained. |
| | ROCK: | Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs. |
| VI | SOIL: | Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained. |
| | ROCK: | Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces. |
| VII | SOIL: | Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow. |
| | ROCK: | Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges. |
| VIII | SOIL: | Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained. |
| | ROCK: | In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams. |

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XVII-99

## SITE 25

Rating: Excellent.

Accessibility: Site accessible by trail from Akelamo where there is a good beach. Trails along coast to north, but no connection to south or to interior. Roads would have to be constructed.

Topography: Small coastal lowland; space for single runway oriented north northwest. Ground flat to gently rolling; furrowed by a few gullies 10 to 20 feet deep. Slopes are less than 1% toward the sea. Altitude between 30 and 80 feet.

Approaches: Approaches clear. High steep ridges rise 600 to 1200 feet ¼ to ½ miles from east side of site.

Clearing and Grubbing: Mostly second growth jungle and coconut plantations that are readily cleared. Little or no dense jungle.

Grading: Only grading of gently undulating ground surface necessary at northeast end. No rock excavation. Sandy soil can be readily worked by bulldozers and scrapers.

Foundation Conditions: Predominantly coarse to medium coarse grained soils of groups A-2, A-4 (SF, ML), with many local variations in texture. May be more sandy in southeast near the Lamo River.

Stabilization and Surfacing: Soils generally compact well and are readily brought to desired moisture content for compaction. Not sticky unless very wet.

Drainage: Site naturally well-drained though there may be some small swampy spots requiring fill.

Construction Materials Available: Some gravel and sand available along Lamo River; requires screening. Deposits of loosely consolidated conglomerate may be exposed in bluffs above the Lamo River to east; if found, could be developed for larger supplies of gravel and sand.

Water Supplies: Lamo River will furnish perennial supply, but requires chlorination and filtration for potability; may also be very silty after heavy rains. Large potable ground water supply obtainable from wells sunk to a depth of 30 to 50 feet at or near site.

Reliability Rating: C

## SITES 26 a and b

Rating: Fair.

Accessibility: Barges can land at Pajahi-Islam though there are some reefs along the shore. Site is not more than ½ mile from this village. Road could readily be constructed, but Pajahi River would have to be bridged.

Topography: Broad, open valley bordered by steep mountain slopes 300 to 500 m. in altitude.

Site 26a suitable for one or more parallel runways oriented north-south. Ground gently rolling; slopes to south and southwest at less than 4% grade. Altitude between 50 and 100 ft.

Site 26b on coastal plain south of Pajahi River is suitable for landing strip oriented northeast. Ground is undulating and furrowed by a few shallow ravines. Land slopes northwest and west toward Pajahi River and the sea; gradient less than 3%. Altitude between 50 and 100 ft.

Approaches: Site 26a has clear approaches to north and west; clear for about 2 mi. to south (see sheet X VIII-99). Steep hills about 1200 ft. in altitude rise sharply a mile to 1.25 mi. east of site. Pajahi River at south end is minor hazard.

Site 26b has clear approach on the southwest; clear to the north. Steep hills about 1200 ft. high are hazards about 1 mi. to northeast. Hills 400 to 1000 ft. high lie on east and south; in places are less than ½ mi. of the site (see sheet XVIII-99).

Clearing and grubbing: Fairly open jungle brush and bamboo thickets cover the site; is particularly dense along Pajahi River. Some large trees but much of clearing can be handled by bulldozers; 26b more open than 26a.

Grading: General leveling of low irregularities only necessary grading; some swampy spots and possibly shallow gullies may need filling. Can be handled by bulldozers and scrapers.

Foundation conditions: Soil on both sites very similar, A-2, A-4 (SF,ML), probably sandier along Pajahi River. Local differences in grain size common. Aggregate absent at sites; may be present on map area V near site 26b. Binder content medium to low.

Stabilization and surfacing: Soils are suitable for compaction. Moisture content needed to bring to optimum density readily controlled. Bearing ratio fair, may be good. Soils not sticky and easily mainpulated with machinery.

Drainage: Both sites for most part fairly well drained. Low spots occurring locally can be filled. Lateral drains probably necessary.

Construction materials available: Some gravel and sand available along Pajahi River; will require screening. Conglomerate deposits exposed along ravines in hills to east can be developed for large supplies of gravel.

Water supplies: Pajahi river may yield adequate perennial supply. Water for potable supply must be filtered and chlorinated. Better source is wells 30 to 50 ft. deep, in unconsolidated alluvium underlying site.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS)

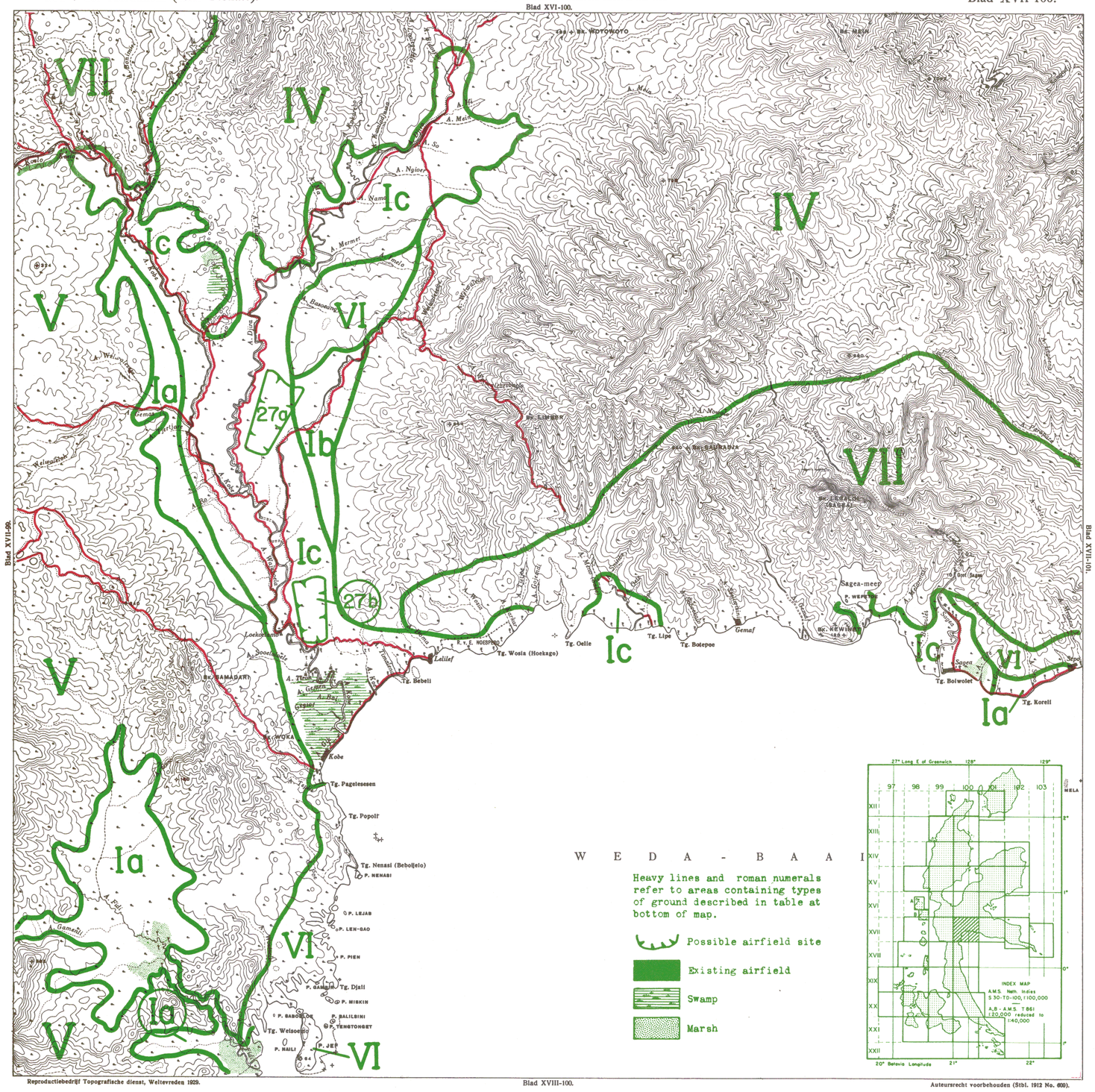
## POSSIBLE AIRFIELD SITES

Gouvt der Molukken. (Res. Ternate).

Schetskaart samengesteld bij den Topografischen dienst in 1923-1927.

Blad XVII-100.

Blad XVI-100.




Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh




Reproductiebedrijf Topografische dienst, Weltevreden 1929.

Blad XVIII-100.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.

| | | |
|---|---|---|
| XVI-99 | XVI-100 | XVI-101 |
| XVII-99 | XVII-100 | XVII-101 |
| XVIII-99 | XVIII-100 | XVIII-101 |

1°00' N.B.

0°00'

200 40' 210 40' O. v. Bat.

ADM. INDEELING.

Trail

Road

*Res.(Afd.) Ternate.*
*Onderafd. Weda.*
*a District Maba met Gebe.*
*b ,, Weda met Patani.*

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagoelan.* *Arentuin.* *Klapperboomen.* *Tjemara- of Dennen (Sparren) bosch.* *Bamboebosch.* *Bosch.* *Kruyddelhout.* *Moeraspalmen.* *Herkenbare boom.* *Paardenpad.* *Voetpad.* *Rivier, a gemeten, b niet gemeten, c eiland, d loopbrug.* *Drasland.* *Moeras.* *Meer.* *Bamboe huizen.* *Districtsgrens.* *Landb. ond. grens.* *Grot.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 m; de dikke van 500 m, a hoogtepunt en hoogtecijfer, b terreinonregelmatigheden, c hulphoogtelijn, d rots, e eiland, f hiltopen altijd boven water, g hiltopen bij laag water zichtbaar, h laagwaterlijn, i zandbank alleen bij laag water droog.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 cm

0 1 2 3 4 5 6 7 8 9 10 km

TOELICHTINGEN.

*Oorspronkelijk samengesteld door de verkenners bij den generalen staf, zooveel mogelijk verbeterd aan de hand van de bestaande zeekaart No. 397. 1:500 000 en volgens deze kaart het blad georiënteerd. De naam en grens der erfpacht is overgenomen met het Handboek voor Cultuur- en Handelsondernemingen in Ned. Indië en met de kadastrale kaart.*

AFKORTINGEN.

**Bk.** *Boekoe (berg).* **P.** *Poelau.* **Tg.** *Tandjoeng.* *A. Ake (rivier)* **E.R.v.E.** *Recht van erfpacht.* **O.L.** *Onderaardsche loop.*

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

PREPARED BY U.S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XVII-100
SITES 27 a and b

Rating: 27 a - fair; 27 b - good.

Accessibility: Sites are two and six miles inland from coast, which is accessible to landing barges at Lelilef. Foot trails lead to both sites and cross mountains to north to Ekor on Kaoe Bay. No continuous trail along shore of Weda Bay.

Topography: Broad, flat to rolling valley of the Kobe River and its tributaries; altitude 100 to 140 feet. Margins are terraced; valley is bordered by high ranges. Site 27a is suitable for one or more landing strips oriented north to northeast. Ground flat or gently undulating; probably crossed by a few small shallow gullies. Slopes from center line towards the bordering Djira and Wewaleswe rivers are, for most part, less than 1.5%.

Site 27b is suitable for single runway with north-south orientation. Rolling slope to south and west 1½% or less. Altitude less than 100 feet.

Approaches: Site 27a has clear approaches for more than 3 miles to south and west; steep mountains reach 800 to 1100 feet altitude within 2 to 2½ miles distance from the east side. Low hills and terrace 150 to 300 feet in altitude at the north end of site may be flying hazards. Bordering rivers are possible hazards.

Site 27b has clear approaches to north and south; high ridges 1¼ or ¾ mile from site on west and east are local hazards.

Clearing and Grubbing: Dense tropical rain forest; possibly swamp forest along Kobe river; larger trees three or more feet in diameter. Stumps not deeply set, but some will require blasting. Dense mat of roots and vines at ground surface requires stripping. Densest brush along streams.

Grading: Some general leveling at north end of site 27a and along east side of site 27b probably necessary. Small gullies need filling. No rock excavation. Soil worked with difficulty by bulldozers and scrapers.

Foundation Conditions: Fine-textured soil of groups A-6, A-7 (CL, CH) showing some local differences due to alluvial origin. Binder abundant and plastic.

Stabilization and Surfacing: If these plastic soils are used for fills special care is required in compaction. Good, well insulated base course material is particularly desirable owing to probability of wet subgrade and sluggish water movement after rain. Soils probably sticky.

Drainage: Ground wet and probably poorly drained. Lateral lead-off ditches may improve drainage. Raised subgrades may be locally necessary. Surface run-off slow; ground becomes muddy and dries slowly. Conditions better at site 27b than at site 27a; site is better drained naturally; is higher above the river.

Construction Materials Available: Little rock available near either site. Coral limestone may occur on flat-topped ridge north of site 27a and along the coast east of the plain of the Kobe River. A poor grade of trap may occur in the ridge east of site 27b. Gravel should be plentiful from river beds near site 27a, less so at site 27b. Coral sand available from beaches along the coast.

Water Supply: Large perennial supplies available from Djira River and Kobe Rivers; for potability water must be filtered and chlorinated. Wells 20 to 50 feet deep in unconsolidated alluvium will yield large potable supply.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

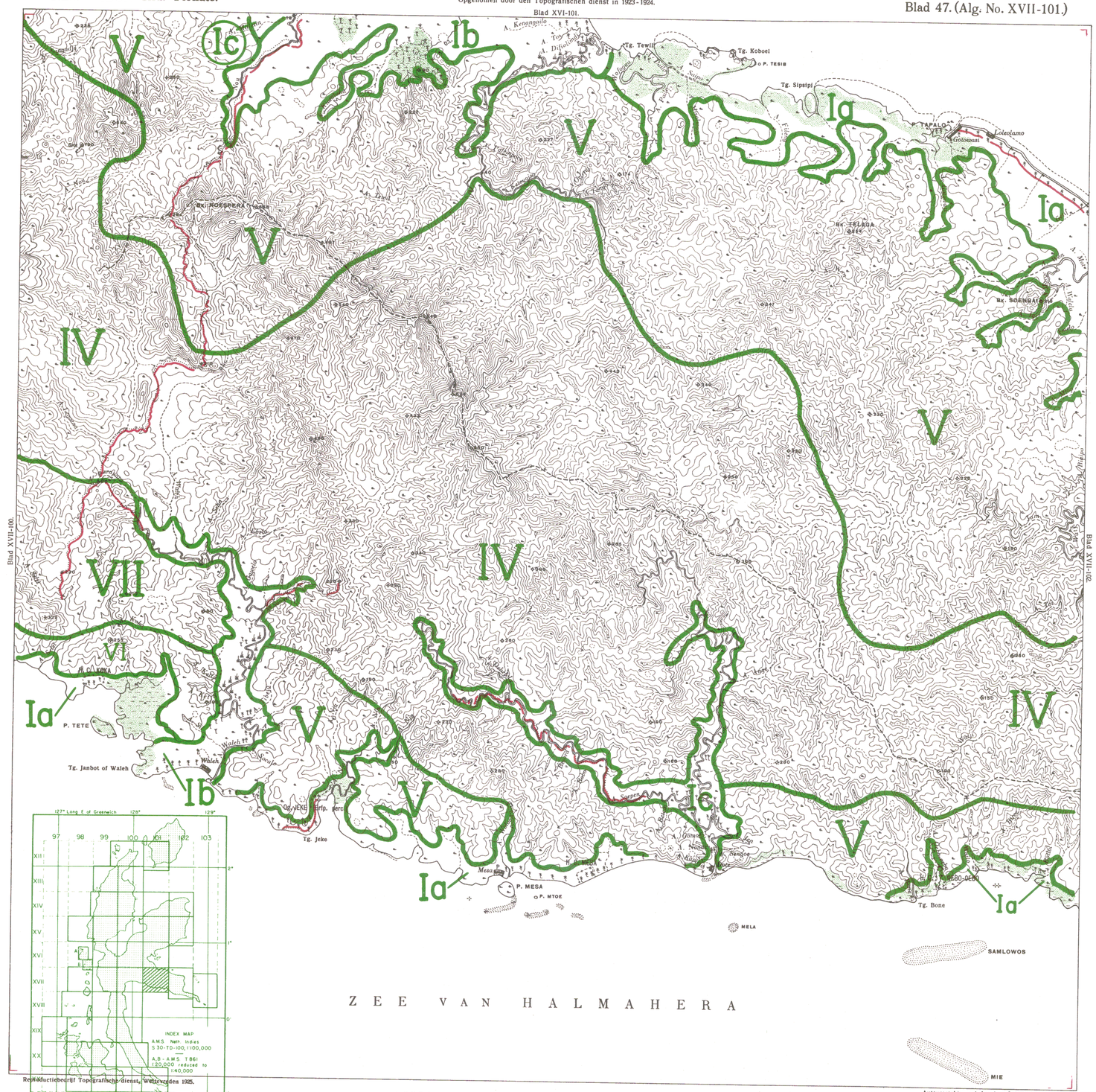
# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1923-1924.

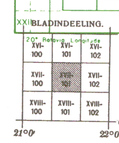
Blad 47. (Alg. No. XVII-101.)



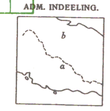




BLADINDELING.




ADM. INDEELING.



*Afdeeling* Ternate.
*Onderafd.* Halmahera.
*Ressort* Weda.
a. *District* Weda met Patani.
b. ,, Maba met Gebe.

Trail
Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagoïalin.* *Arentuin.* *Klapperboomen.*
*Bamboebosch.* *Bosch.* *Paardenpad.* *a. duiker of doorlaat van bamboe.* *Voetpad.*
*Rivier.* *a. gemeten, b. niet gemeten.* *Inlandsche graven.* *Bamboe gebouwen.* *Drasland.*
*Landb. ond. grens.* *Districtsgrens.*
*ZEE a. eiland, b. klippen bij laagwater zichtbaar. c. zandbank alleen bij laagwater droog. d. laagwatertijn. Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. e. hoogtepunt en hoogtecijfer, f. hulphoogtelijn, g. rots, h. bodemoneffenheden, i. kleine verhevenheden.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M

TOELICHTINGEN.

*Vluchtig opgenomen in de jaren 1923-1924 met gebruikmaking van enkele punten vld teekaarten No. 389 en 390 catalogus 1923. De kustlijnen zijn ingepast tusschen de kaap ten zuiden van kampoeng Waleh, de oostkant vld monding van A. Dote, Tg. Remdi op blad XVIII-102, de kaap benoorden kampoeng Gotowasi en de monding van A. Kimalaha op blad XVI-101. Administratieve indeeling volgens G.B. van 25 Jan. 1924. no. 21 Stbl. no. 29. De verdere loop van de districtsgrens (westelijke bladrand) is niet bekend.*

VERKORTINGEN.

Bk. *Boekoe (berg).* P. *Poelau.* Tg. *Tandjoeng.* A. *Ake.* K.G. *Haurcontract.* P. *Pisang.* O.L. *Onderaardsche loop.* Ond. *Onderneming.*

PREPARED BY U. S. GEOLOGICAL SUR
FOR
CHIEF OF ENGINEERS, U. S. ARMY

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site
Existing airfield
Swamp
Marsh

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).



CONFIDENTIAL

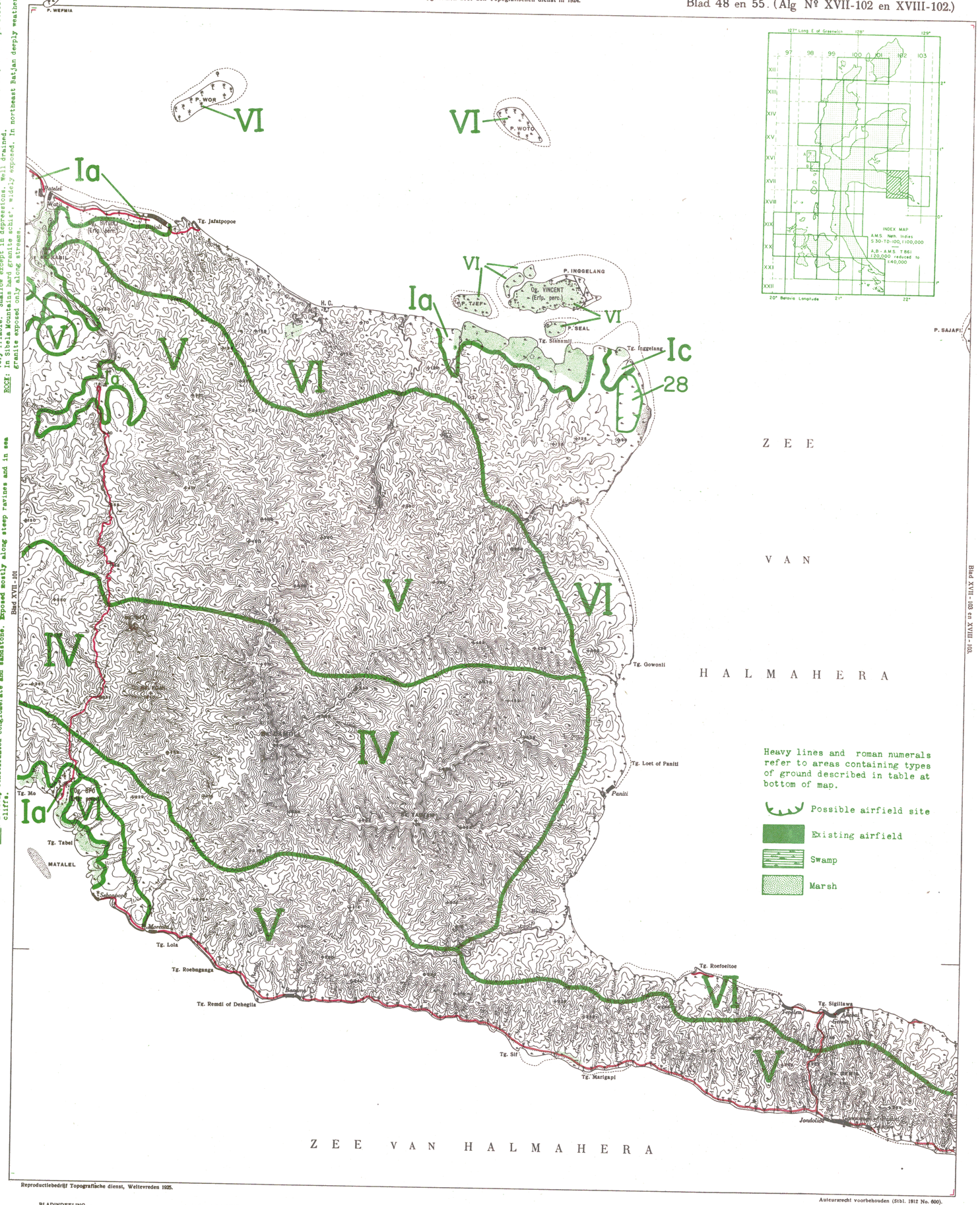
# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1924.

Blad 48 en 55. (Alg Nº XVII-102 en XVIII-102.)







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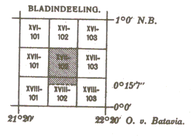
BLADINDEELING.




ADM. INDEELING.

*Afdeeling Ternate.*
*Onderafd. Halmahera.*
*Ressort Weda.*
*a. District Weda met Patani.*
*b. „ Maba met Gebe*

Trail

Road

*Kampong.* *Schaars bewoonde streken.* *Sagotuin.* *Klapperboomen.* *Drasland.*
*Bosch.* *Paardenpad. a. dalker of doorlaat van bamboe.* *Voetpad.* *Steenen- en bamboe gebouwen.* *Rivier, a. gemeten, b. niet gemeten.* *Landb. ond. grens.* *Districtsgrens.*

*ZEE. a. eiland, b. klippen altijd boven water, c. zandbank alleen bij laagwater droog, d. laagwaterlijn. Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M.v. hoogtepunt en hoogtecijfer, f. halvehoogtelijn, g. rots, h. bron.*

Schaal 1:100 000.

TOELICHTINGEN.

*Vluchtig opgenomen in de jaren 1923 - 1924 met gebruikmaking van enkele punten van de zeekaarten No. 389 en 390, catalogus 1923. De kustlijnen zijn ingepast tusschen de navolgende punten: Tg. Roefoeitoe - Tg. Inggelang - Tg. Jafatpopoe, het noord- en suidpunt van Sajafi, (blad XVII - 103); Tg. Remdi of Dehegila - Tg. Ngolopopo (blad XVIII - 103) en Tg. Ngolopopo - Tg. Roefoeitoe.*
*Administratieve indeeling volgens G.B. van 25 Jan. 1924 No. 21 Stbl. No. 29.*

VERKORTINGEN.

*P. Poelau.* *Bk. Boekoe (berg).* *Tg. Tandjoeng.* *A. Ake (rivier).* *H.C. Hawcontract.* *Ok. Onderneming.* *O.L. Onderaardsche loop.*

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XVII-1°2
XVIII-102

SITE 28

Rating: Good

Accessibility: Directly accessible by landing barge from east; extensive coral reefs off Inggelang Point to north. Area isolated, very sparsely inhabited, and has few trails.

Topography: Small coastal lowland on the northeast tip of southeast peninsula. Site 28, near the east part of the lowland, has space for single north-oriented landing strip. Ground is somewhat irregular and rocky but grades are less than 1½ percent. A few small gullies 5 to 10 feet deep cut across the site; deepest probably at north end of site. Altitudes between 20 and 80 feet.

Approaches: Approaches are clear. Low rocky bluffs on east side are minor hazard; low hills 50 to 500 feet high are located a few hundred feet to ¼ mile from west margin.

Clearing and Grubbing: Fairly open rainforest over most of site with some areas of brush. Some trees over 3 feet in diameter at base. Stumps will require blasting but are probably not deeply set. Dense ground-mat of roots, vines, and creepers will require stripping; more open coconut palm stands along coast to northeast. Rocky limestone area along southeast border of site.

Grading: Some leveling of rolling ground at southern end necessary. Soil generally thin and underlain by rotted coral rock. Shallow excavation can be handled by bulldozers and scrapers. Deeper excavations can be handled by handtools with aid of light blasting.

Foundation Conditions: Coarse to medium textured soil of groups A-2, A-1, some A-4 (SF, SC, ML). Fineness and depth of soil may show much local variation. Medium amount of binder.

Stabilization and Surfacing: Soil compacts readily to optimum density under controlled moisture conditions; relatively friable and not sticky unless very wet. Sand for surface course of bitumen sand mix obtainable on NE side.

Drainage: Soil naturally well drained but muddy during and after heavy rains. Streams from mountains which cross site will require diversion.

Construction Materials Available: Coral limestone abundantly available at or near site. Is suitable for crushed aggregate, rock masonry, riprap or rock fill; can be worked in small quantities by handtools, but requires drilling and blasting for extensive quarrying.

Water Supply: Adequate supplies obtainable from wells 30 to 80 feet deep, in partly consolidated gravel and coral limestone; should be at least 1000 feet from shore and should penetrate not more than a few feet below water level, to minimize danger of salt-water contamination. Adequate surface water supplies not available.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

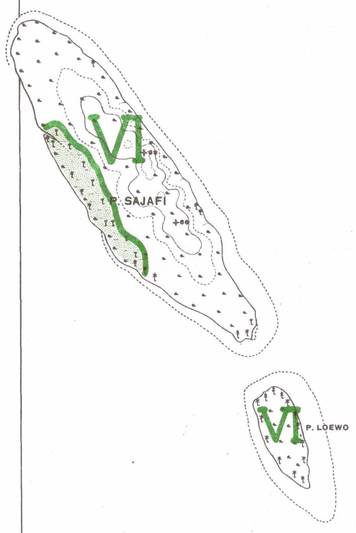
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1924.

# POSSIBLE AIRFIELD SITES

Blad 49 en 56.(Alg.№ XVII - 103 en XVIII - 103.)




Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

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ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

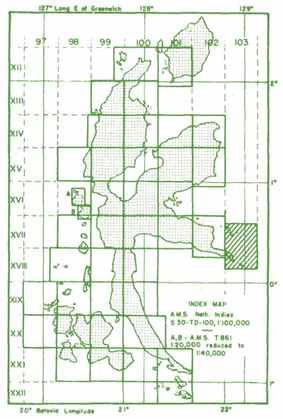
Swamp

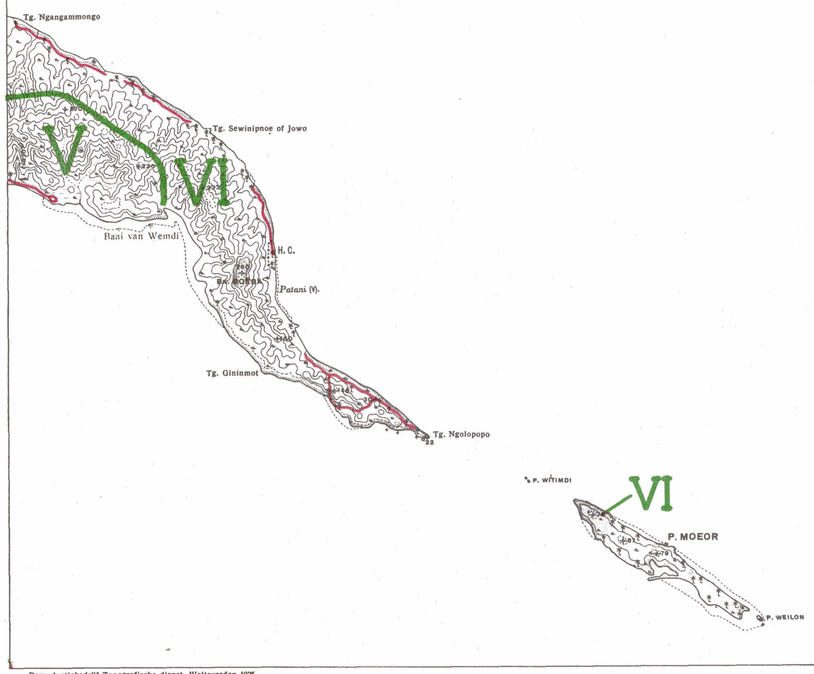
Marsh

Z E E

V A N

H A L M A H E R A



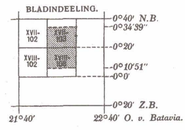




LEGENDA.

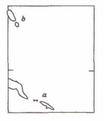
Schaars bewoonde streken. Sagoluin. Klapperboomen. Bosch. Tjemara- of Dennen (Sparren) bosch. Drasland. Rivier. a. gemeten, b. niet gemeten. Landb. ond. grens. Voetpad.

ZEE. a. eiland, b. klippen bij laagwater zichtbaar, c. klippen altijd boven water, d. laagwaterlijn. Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. e. hoogtepunt en hoogtecijfer, f. halvehoogtelijn, g. rots.

BLADINDEELING.




ADM. INDEELING.




Afdeeling Ternate.
Onderafd. Halmahera.
Ressort Weda.
a. District Weda met Patani.
b. ,, Maba met Gebe.

Trail

Road

TOELICHTINGEN.

Vluchtig opgenomen in het jaar 1924 met gebruikmaking van enkele punten van de zeekaart No. 390 catalogus 1923. De kustlijnen zijn ingepast tusschen de navolgende punten: Tg. Remdi (blad XVII-102 en XVIII-102) - Tg. Ngolopopo; Tg. Ngolopopo - Tg. Roefoeitoe (blad XVII-102 en XVIII-102); oost- en westpunt van P. Moeor en het noord- en zuidpunt van P. Sajafi. Voor de ligging van P. Loewo werd het zuidelijk punt van het eiland van de zeekaart overgenomen. Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21 Stbl. No. 29.

VERKORTINGEN.

Bk. Boekoe (berg). P. Poelau. Tg. Tandjoeng. A. Ake. H.C. Huurcontract. (V). Verlaten.

Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

PREPARED BY U.S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U.S. ARMY

Blad XVII - 102 en XVIII - 102.



CONFIDENTIAL

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922.
Blad 44.

# POSSIBLE AIRFIELD SITES

XVIII - 97/98

Blad 50. en 51.

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

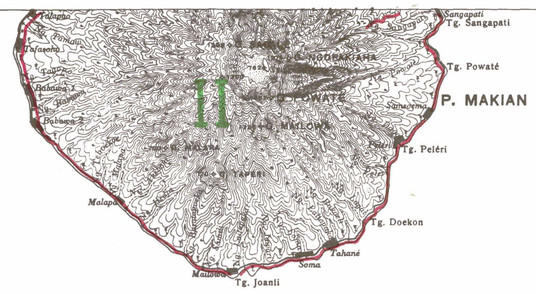
IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

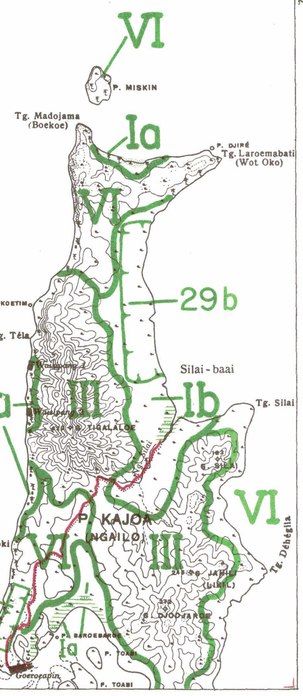
VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

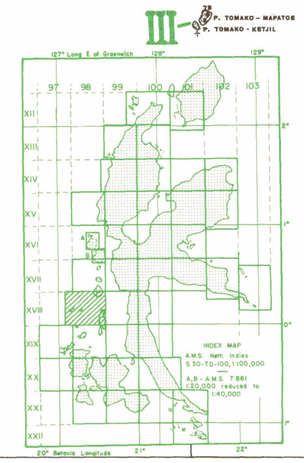
VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.




M O L U K S C H E Z E E



Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

Trail

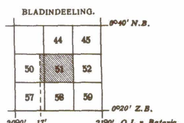
Road

Blad 52.

Blad 58.

Topografische Inrichting, Batavia 1924.

BLADINDEELING.




ADMINISTRATIEVE INDEELING.

*Afdeeling Ternate.*
*Onderafd. Tidore.*

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Alang-alang.* *Drasland.* *Moeras.* *Paardenpad.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Meer.* *Bamboe gebouwen.* *Mesigit.* *Inlandsche graven.*

*ZEE, a. eiland.*

*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. b. = klippen. c. = laagwaterlijn, d. = hoogtepunt en hoogtecijfer, s. = halphoogtelijn, f. = rots.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

*A. = Abé, = Rivier. Ng. = Ngoesi = Rivier. G. = Goenoeng = Berg. P. = Poelau = Eiland. Tg. = Tandjoeng = Kaap.*

PREPARED BY U.S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U.S. ARMY

TOELICHTINGEN

*Administratieve indeeling volgens G.B. van 25 Jan. 1924 No. 21, Stbl. No. 29.*



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES



SITES 29a and 29b

Rating: 29c Fair, 29b Fair

Accessibility: Both sites directly accessible to coast, which can be reached by landing barges though shores of both bays are probably muddy. Good trail connects sites across low corridor.

Topography: Site 29a, on low coral terrace, has space for single runway oriented north-northeast. Ground slightly irregular and rough; slopes southward at gradient less than 1½%. Altitude between 75 and 100 feet.

Site 29b, on a narrow coastal plain on east side of the island, has space for a single north-south landing strip. Ground is flat or gently rolling: Land slopes gently eastward at less than 1%. Altitude below 30 feet.

Approaches: Site 29b has clear approach for 1 to 1½ miles to south where hills about 500 feet high are possible hazards. Low hills about 150 feet high ½ mile from north end. West side bordered by hills and ridges 150 to 1,000 feet in altitude.

Clearing and Grubbing: Dense rain forest over both sites is difficult to clear. Large trees, dense undergrowth of vines, creepers and roots. Stumps require blasting. Some second growth and small native clearings with stands of coconut lie back of coast at site 29a.

Grading: Leveling of low knoll probably necessary at site 29a. Coral bedrock may require power shovel or blasting for excavation on part of strip. Leveling of minor irregularities and filling of some low damp areas at site 29b. Mud may locally bog down equipment during heavy rains.

Foundation Conditions: Both sites are probably on coarse to medium textured soils of groups A-2, A-1, some A-4 (SF,SC,ML). Coarser soils probably prevail on site 26a which has sandy beach on NW side. Fineness and depth of soil show may differences from place to place on site.

Stabilization and Surfacing: Moisture content needed to bring to optimum density during compaction fairly readily controlled owing to friability of soils. At Site 29b soil is relatively non-plastic but may be muddy because of poor drainage. Base coarse requirements may be considerable in some places.

Drainage: 29a naturally well drained, few improvements needed. Water table near surface at 29b and ground may locally be swampy and require a raised subgrade. Lateral ditches will improve surface runoff which would otherwise be poor.

Construction Materials Available: Coral limestone abundantly available at or near site 29a. Requires drilling and blasting for excavation. Probably no rock at or near 29b. Some trap rock or volcanic conglomerate may be exposed in mountains, but would probably not be well exposed. Sand available at Site 29a.

Water Supply: No adequate surface-water supplies. Adequate supplies obtainable from wells 30 to 50 feet deep, which probably must be drilled or dug in partly consolidated gravel and coral limestone; should be at least 1,000 feet from shore and should penetrate not more than a few feet below water level, to minimize danger of salt-water contamination.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

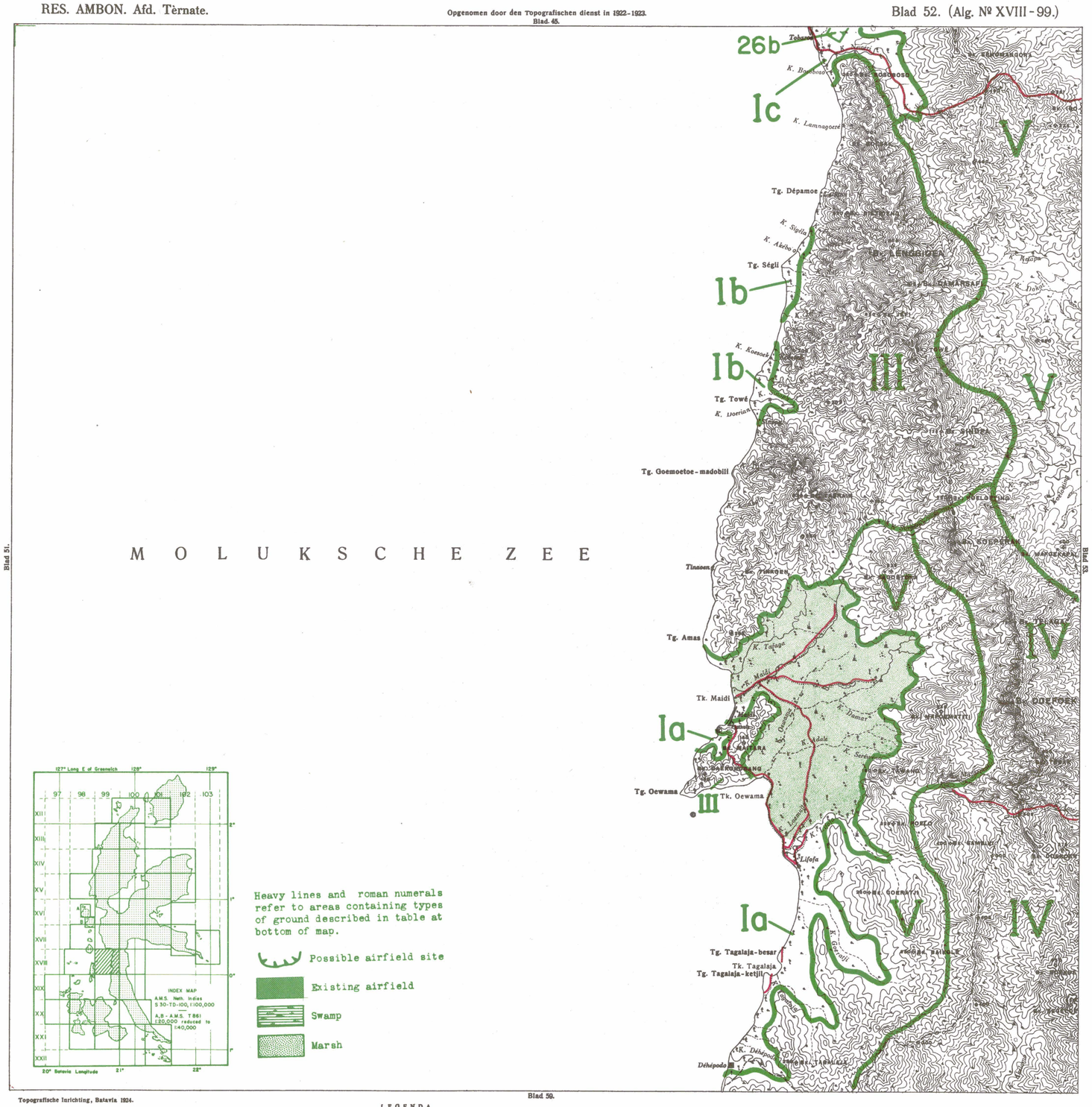
# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

RES. AMBON. Afd. Tèrnate.

Opgenomen door den Topografischen dienst in 1922-1923.
Blad 45.

Blad 52. (Alg. Nº XVIII-99.)







Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

Trail

Road

Blad 50.

Topografische Inrichting, Batavia 1924.

BLADINDEELING.

| | | |
|---|---|---|
| 44 | 45 | 46 |
| 51 | 52 | 53 |
| 58 | 59 | 60 |

0°40' N.B.
0°0'
0°20' Z.B.
20°20' 21°20' O.L. v. Batavia

ADMINISTRATIEVE INDEELING.

| | |
|---|---|
| *Afdeeling* | *Tèrnate.* |
| *I. Onderafd.* | *Halmahèra.* |
| *A. Ressort* | *Djailolo.* |
| *District* | *Oba.* |
| *B. Ressort* | *Wéda.* |
| *a. District* | *Wéda met Patani.* |
| | *Gand.* |
| *II. Onderafd* | *Tidore* |

LEGENDA

*Kampoeng.* *Schaars bewoonde streken.* *Sagoeïn.* *Arenlain.* *Klapperboomen.*

*Bosch.* *Krenpelhout.* *Bamboebosch.* *Moeraspalmen.* *Drasland.* *Voetpad.*

*Paardenpad.* *Rivier. a. gemeten b. niet gemeten* *Steenen, en bamboe gebouwen.*

*Inlandsche graven.* *Ressortsgrens.* *Onderafdeelingsgrens.*

*ZEE, a. zandbank.*

*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogteljnen bedraagt de helft der dalzendtallen van de schaal. b. = hoogtepunt en hoogtecijfer, c. = halpheogtelijn, d. = rots,*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikte van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN

*K. = Koeala (Rivier)* *Bk. = Boekoe (Berg.)* *Tg. = Tandjoeng (Kaap).* *Tk. = Teloek (Baai).*

TOELICHTINGEN

*Administratieve indeeling volgens G. B. van 25 jan. 1924 No. 21, Stbl, No. 29.*

PREPARED BY U.S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.



CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

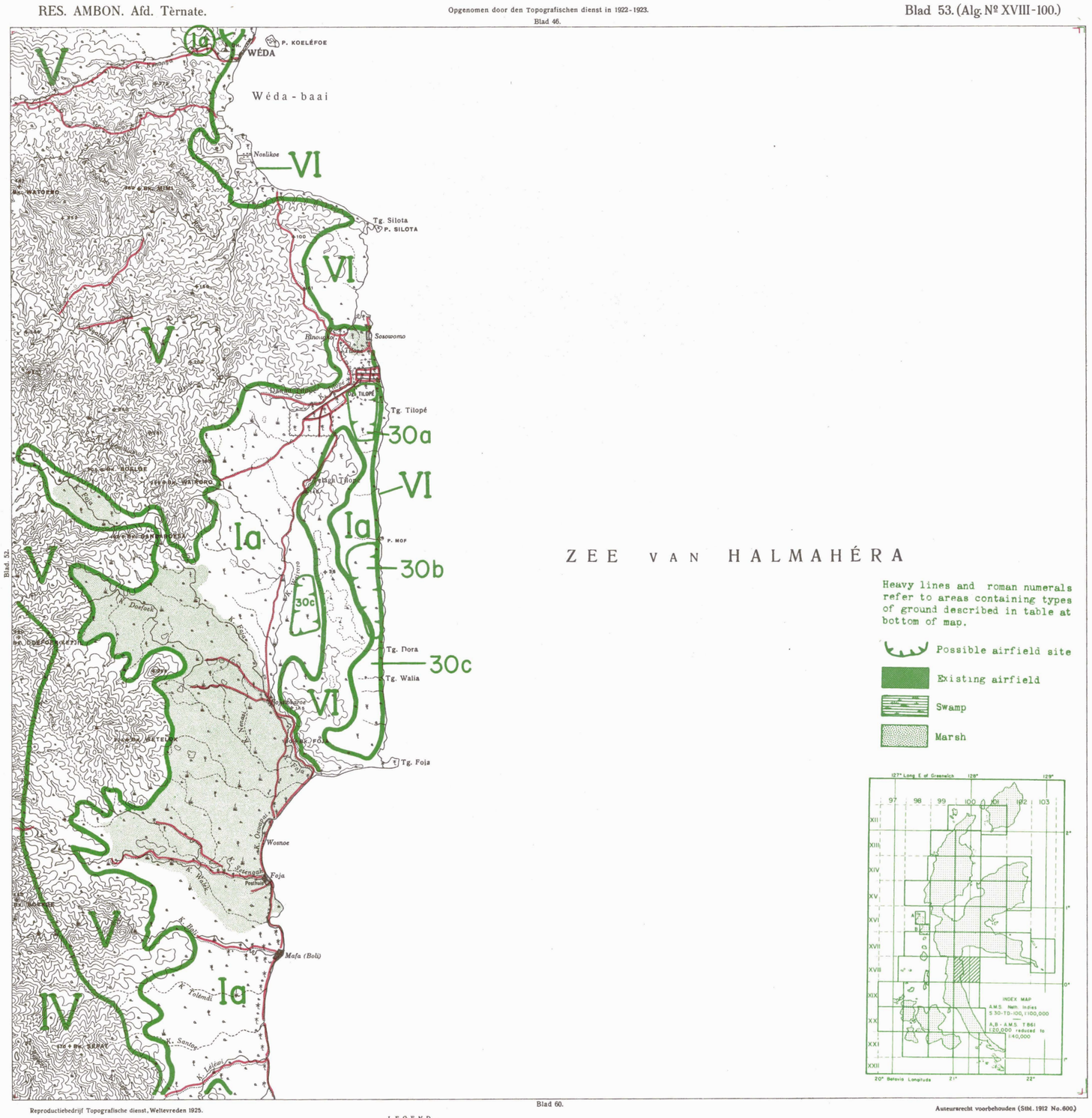
## POSSIBLE AIRFIELD SITES

RES. AMBON. Afd. Tèrnate.

Opgenomen door den Topografischen dienst in 1922-1923.

Blad 46.

Blad 53. (Alg. Nº XVIII-100.)




ZEE VAN HALMAHÉRA

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh




Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Auteursrecht voorbehouden (Stbl. 1912 No. 600.)

BLADINDEELING

| | | |
|---|---|---|
| 45 | 46 | 47 |
| 52 | 53 | 54 |
| 59 | 60 | 61 |

0°40' N.B. — 0°0' — 0°20' Z.B. — 20°40' — 21°40' O.L. v. Batavia.

ADMINISTRATIEVE INDEELING.

Trail

Road

*Afdeeling* Ternate. *Onderafd.* Halmaahira. *Ressort* Weda. *District* Weda met Patani.

LEGEND.

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Kreupelhout.* *Bosch.* *Bamboebosch.* *Moraspalmen.* *Drasland.* *Moeras.* *Paardenpad.* *Voetpad.* *Rivier, a gemeten, b niet gemeten.* *Meer.* *Steenen, en -'s bamboe gebouwen.* *Inlandsche graven.* *IJzerdraad versperring.* *Landb. ond. grens.*

*ZEE, a eiland.*

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Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.

0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN

Gn. = *Gunughebber.* Tg. = *Tandjoeng (Kaap.)* Bk. = *Boekoe (Berg.)* Ot. = *Ondernemng.* P. = *Poelau (Eiland.)* K. = *Ketala (Rivier.)*

TOELICHTINGEN

*Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21, Stbl. No. 29.*

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

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**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

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ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SHEET NO. XVIII-100

SITES 30a, 30b, and 30c

Rating: 30a Good, 30b Good, 30c Fair

Accessibility: 30a accessible to landing barges at mouth of Tilope River. Reefs would make landing at 30b or elsewhere along this sector of coast difficult, except at mouth of Foja River. 30c accessible by truck from Tilope or mouth of Foja River. Trail connections along coast are good to south, poor to north. No connections to interior.

Topography: Broad coastal lowland interrupted locally by isolated hills and ridges. Sites are suitable for one or possibly two landing strips oriented north-south. Ground nearly flat or gently undulating; crossed by a few small gullies 5 to 10 feet deep. Gradient generally less than 2%. At sites 30a and 30b land slopes eastward to sea; 30c slopes west to Wairoro River. Altitudes of 30a and 30 b between 10 and 70 feet; b probably over 100 feet above sealevel.

Approaches: North, south approaches clear on sites 30a and 30c. Hills 200 meters high about 1/3 mile west of 30a are possible hazard; low ridge 75 to 125 feet high a few hundred feet west of 30b. Hills approximately 300 feet high north and south of site 30c; approaches clear for only about a mile. Low hills parallel site to east; clear for 3 to 4½ miles to the west.

Clearing and Grubbing: Dense rain forest over all sites; some swamp forest and bamboo thickets on west border of 30c. Some second growth, cleared land, and coconut plantations at north end of 30a.

Grading: Some leveling of rolling ground surface probably necessary at all sites; least at 30a. Small gullies will need filling; sandy soil easily worked by bulldozers and scrapers; no rock excavation.

Foundation Conditions: Many local differences in fineness of grain in these soils which are developed on alluvium, but groups A-2, A-3, A-1 and some A-4 (SF,SW, SC, ML) probably predominate. Binder content low.

Stabilization and Surfacing: These soils compact well and moisture needed to bring to optimum density is readily controlled during consolidation of subgrade. Fills needed locally may require special attention to construction of adequate base course for insulation of pavement. Soils not sticky.

Drainage: All sites naturally well-drained but may become muddy during and after heavy rains. Lateral drains would improve conditions. Any small streams crossing sites will require diversion or rock drains at base of fill in gullies Ground dries fairly quickly after rains.

Construction Materials Available: Coral limestone readily available at or near all sites; is good all-purpose rock. Can be worked in small quantities with hand tools. Requires drilling and blasting for extensive quarrying and crushing for use as aggregate. Sand is obtainable locally from small beaches along the coast.

Water Supply: Adequate surface water not available at 30a and 30b; supply available from Wairoro River at 30c, but may not be perennial. Wells sunk 30 to 60 feet will yield adequate supplies at all sites; should be at least 1,000 feet from shore to minimize danger of salt water contamination.

Reliability Rating: C

Preliminary text submitted
without checking or editing
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

RES. AMBON. Afd. Tèrnate.

Opgenomen door den Topografischen dienst in 1923.

Blad 50.

Blad 57.

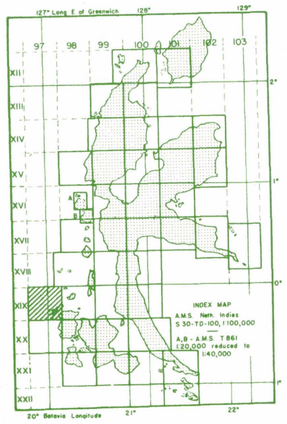
Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh




M O L U K S C H E  Z E E

Blad 58.

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

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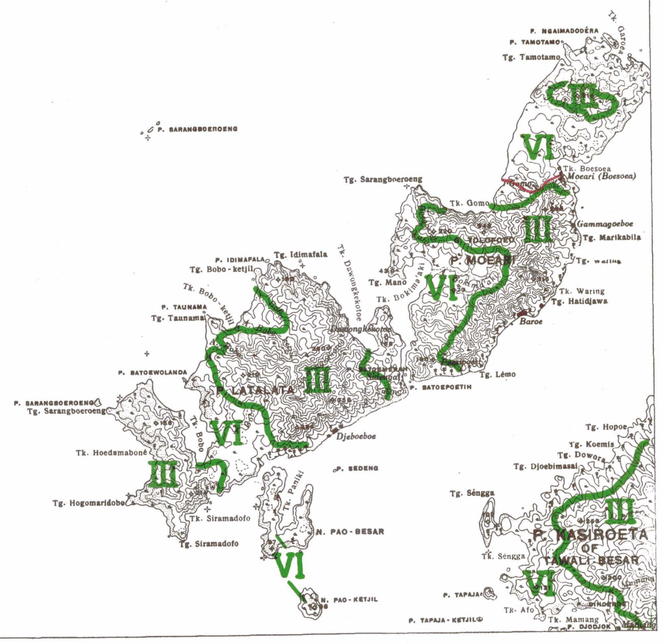
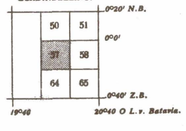
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.




Blad 64.

Topografische Inrichting, Batavia 1924.

BLADINDEELING.




ADMINISTRATIEVE INDEELING.

Trail

Road

*Afdeeling* *Tèrnate.*
*1. Onderafd.* *Tidore.*
*2. ,,* *Batjan.*

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Moeraspalmen.* *Voetpad.* *Rivier, a gemeten, b niet gemeten.* *Bamboe gebouwen.* *Inlandsche graven.* *Onderafdeelingsgrens*

*ZEE, a. eiland, b. klippen.*
*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. c. = hoogtepunt en hoogtecijfer d. = halphoogtelijn, e. = rots.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M.

Schaal 1 : 100 000.

VERKORTINGEN.

*A. = Ahd = Rivier.* *P. = Poelau = Eiland.* *N. = Noesa = Eiland.* *Tg. = Tandjoeng = Kaap.* *Tk. = Teloek = Baai.* *G. = Goenoeng = Berg.*

TOELICHTINGEN.

*Administratieve indeeling volgens O. B. van 25 Jan. 1924 No. 21, Stbl. No. 29.*

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



CONFIDENTIAL

CONFIDENTIAL

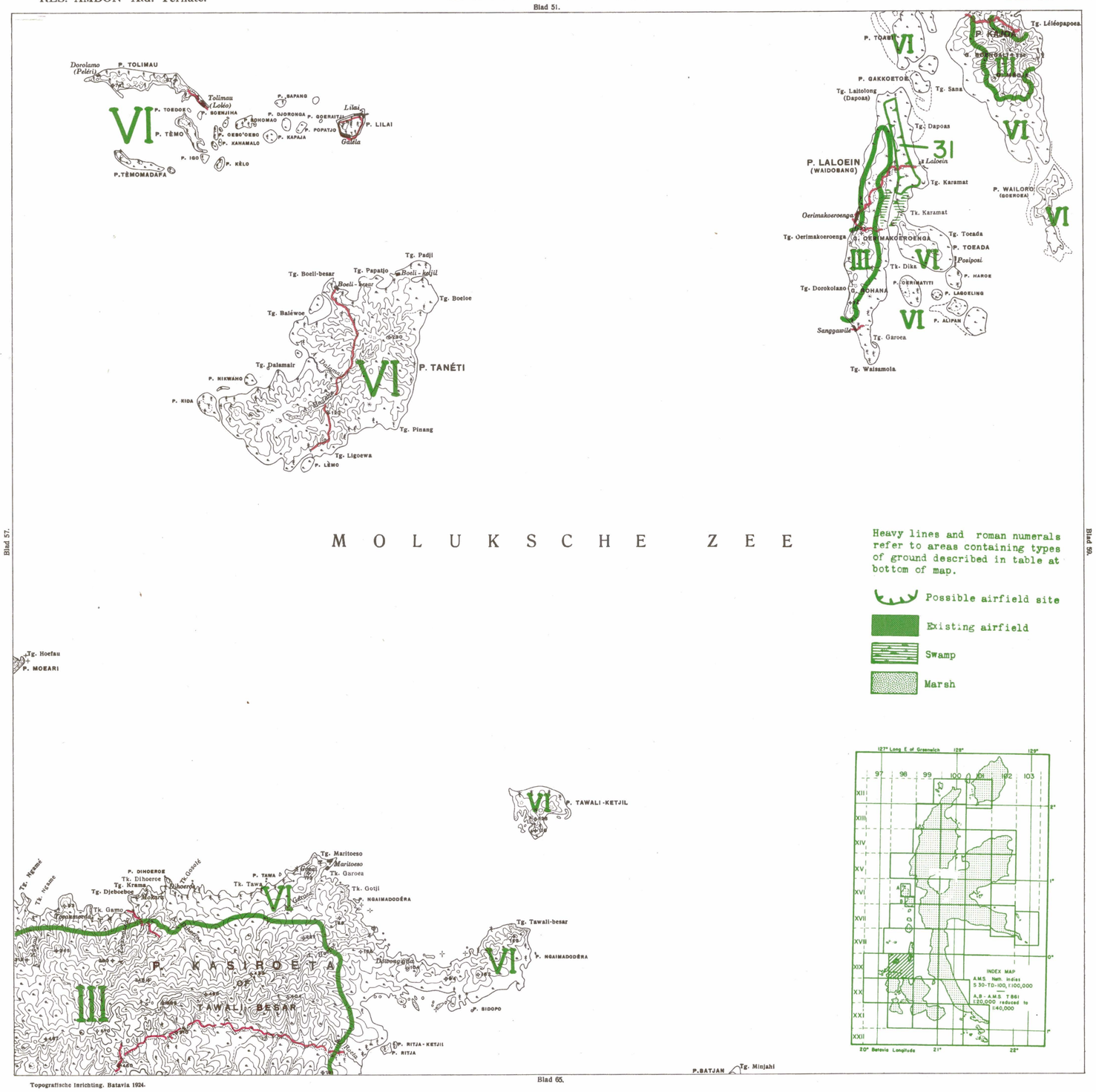
# HALMAHERA (MOLUKKAS)

# POSSIBLE AIRFIELD SITES

RES. AMBON Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922 - 1923.
Blad 51.

Blad 58. XIX-98




Blad 57.

Blad 59.

M O L U K S C H E Z E E

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh




Topografische Inrichting. Batavia 1924.

Blad 65.

BLADINDEELING.

| | | |
|---|---|---|
| 50 | 51 | 52 |
| 57 | 58 | 59 |
| 64 | 65 | 66 |

0°20' N.B.
0°0'
0°40' Z.B.
120°0'
121°0' O.L.v. Batavia.

ADMINISTRATIEVE INDEELING.

Afdeeling Ternate.
1. Onderafd. Tidore.
2. ,, Batjan.

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Gelagah.* *Alang-alang.* *Moeraspalmen.* *Tjemara-of Dennenbosch.* *Drasland.* *Moeras.* *Paardenpad.* *Voetpad.* *Rivier, a gemeten, b niet gemeten.* *Bamboe gebouwen.* *Mesigit.* *Inlandsche graven.* *Onderafdeelingsgrens.*

*ZEE. a. = eiland, b. = klippen, c. = laagwaterlijn.*

*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. d. = hoogtepunt en hoogtecijfer, e. = haiphoogtelijn, f. = rots.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikte van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

*A. = Akê = Rivier.* *Tg. = Tandjoeng = Kaap.* *Tk. = Telook = Baai.* *P. = Poelau = Eiland.* *G. = Goenoeng = Berg.*

TOELICHTINGEN.

*Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21. Stbl. No. 29.*

PREPARED BY U. S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near or at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.



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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XIX-98

SITE 31

Rating: Fair

Accessibility: Locally accessible to landing barges along coast, though these are extensive reefs off north and northeast end of Laitolong point. Good trail across center of island.

Topography: Narrow coastal plain; space for single runway oriented northwest. Ground nearly flat or gently undulating; slightly higher and rougher to west near low hills. Slopes to south and east at gradient less than 1½%. Altitude between 20 and 80 feet.

Approaches: Approaches are clear. Low ridge 150 to 225 feet in altitude at west margin of site is possible topographic hazard.

Clearing and Grubbing: Dense tropical rain forest over most of site. Difficult clearing because of scattered large trees and dense tangle of roots, vines, and creepers. Southern half of site more open with patches of brush, second growth, and a few small native clearings.

Grading: Some leveling of minor irregularities in surface necessary; soil and underlying rotted coral rock in most places can be worked by bulldozers and scrapers. Any extensive excavation in coral rock will require power shovel aided locally by light blasting.

Foundation Conditions: Coarse to medium textured soil, A-2, A-1, A-4 (SF,SC,ML). Possible tendency for shallow stony soil to exist in strips having NW-SE orientation. Medium amount of binder of fair quality.

Stabilization and Surfacing: Soil in general not sticky except when very wet; fines are friable clays. Compacts well and does not need thick base course. Coarse soil, suitable for bitumin mix as surface course, obtainable locally.

Drainage: Good natural drainage. Runoff can be improved by lateral ditches.

Water Supply: No adequate surface water. Wells(preferably large diameter dug wells) 20 to 80 feet deep in gravel and coral limestone will probably provide adequate supplies, but must be at least 1,000 feet from coast and penetrate not more than a few feet below water level, to minimize danger of salt-water contamination. Wells should be pumped as lightly as possible.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

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# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Tèrnate.

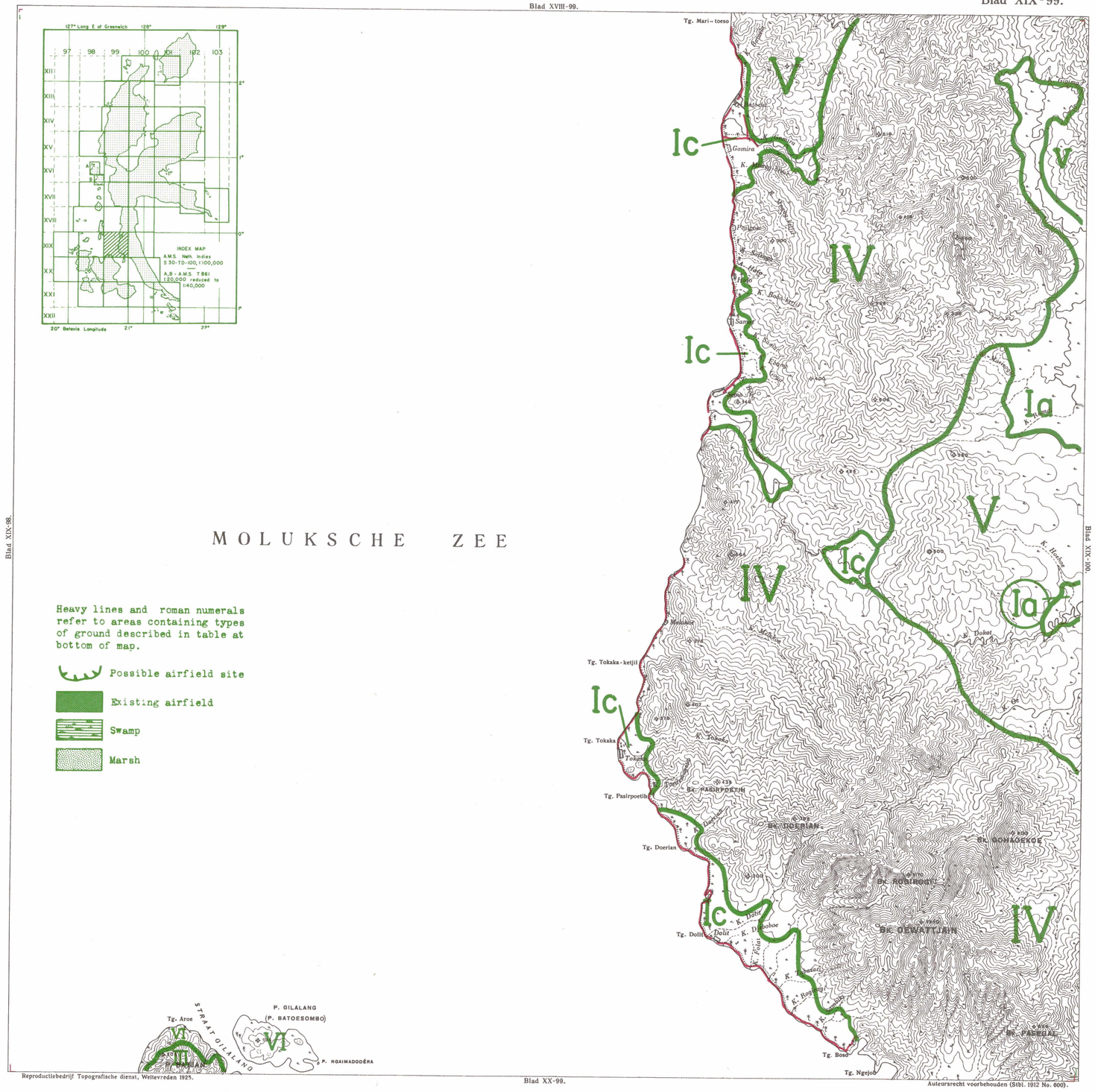
Opgenomen door den Topografischen dienst in 1922 - 1923.

Blad XVIII-99.

## POSSIBLE AIRFIELD SITES

Blad XIX - 99.




Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

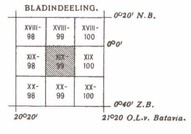



Reproductiebedrijf Topografische dienst, Wellevreden 1925.

Blad XX-99.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.




ADMINISTRATIEVE INDEELING.

| | | |
|---|---|---|
| | *Afdeeling* | *Tèrnate.* |
| 1. | *Onderafd.* | *Tidore.* |
| 2. | ,, | *Batjan.* |
| 3. | ,, | *Halmahèra.* |
| A. | *Ressort* | *Djailolo.* |
| | *District* | *Oba.* |
| B. | *Ressort* | *Wèda.* |
| | *District* | *Gané.* |

Trail

Road

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Bosch.*
*Krenpelhout.* *Bamboebosch.* *Gelaguh.* *Moeraspalmen.* *Paardenpad.* *Voetpad.*
*Rivier, a. gemeten, b. niet gemeten.* *Bamboe gebouwen.* *Inlandsche graven.*
*Onderafdeelingsgrens,* *Ressortsgrens.*

*ZEE. a. = eiland,*
*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. a = hoogtepunt en hoogtecijfer. b. = hulphoogtelijn.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.

TOELICHTINGEN.

*Administratieve indeeling volgens G.B. van 25 Jan. 1924 no.21. Stbl. no. 24.*

VERKORTINGEN.

*P. = Poelau (eiland).* *Bk. = Bockoe (berg).* *Tg. = Tandjoeng (kaap)* *K. = Koeala (rivier).*
*A. = Aké (rivier).*

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
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ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

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ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

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**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S ARMY



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# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

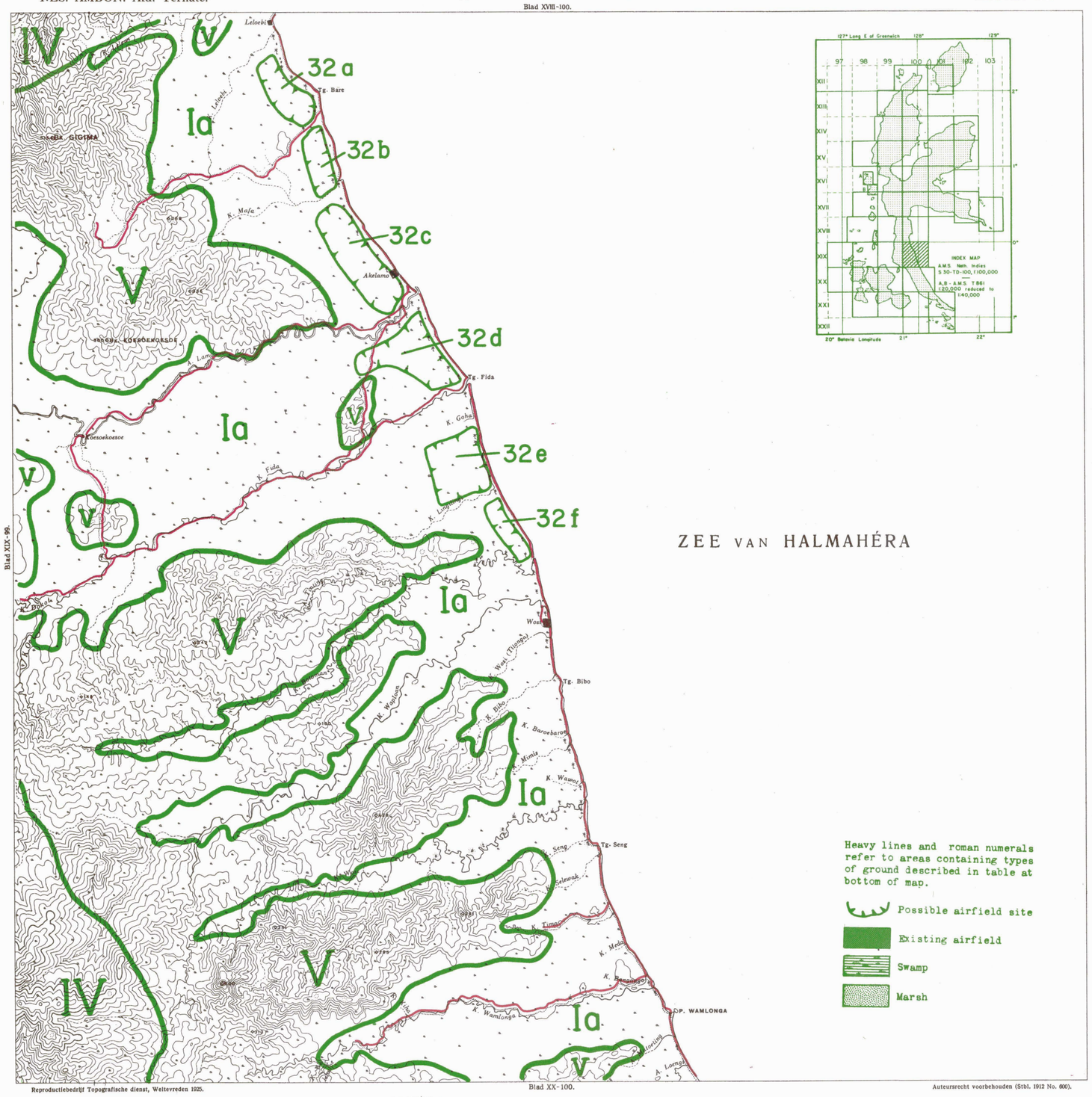
Opgenomen door den Topografischen dienst in 1923.

Blad XVIII-100.

# POSSIBLE AIRFIELD SITES

Blad XIX-100.




ZEE VAN HALMAHÉRA

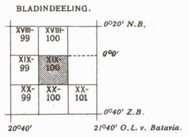
Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

Reproductiebedrijf Topografische dienst, Weltevreden 1925.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDEELING.




ADMINISTRATIEVE INDEELING.

*Afdeeling* *Ternate.*
*Onderafd.* *Halmahera.*
*Ressort* *Weda.*
*District* *Gane.*

Trail

Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Arenstuin.* *Klapperboomen.* *Gelagah.*
*Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Alangalang.* *Voetpad.*
*Rivier. a. gemeten, b. niet gemeten.* *Bamboe gebouwen.*

*ZEE. a. eiland.*
*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikke van 500 M. b. hoogtepunt en hoogtecijfer. c. hulphoogtelijn.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Administratieve indeeling volgens G. B. van 25 Jan. 1924 No. 21 Stbl. No. 29. Uitgangspunt is het astronomisch station, de vlaggestok te Weda; de kustlijn werd verder ten opzichte van het geografische noorden gekaarteerd.*

VERKORTINGEN.

P. *Poelau (eiland).* BK. *Boekoe (berg).* K. *Koeala (rivier).* Tg. *Tandjoeng (kaap).* A. *Aïé (rivier).*

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ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XIX-100

SITES 32a, 32b, 32c, 32d, 32e, 32f

Rating: 32c Excellent; 32a, 32b, 32d, 32e, 32f, Good

Accessibility: All sites directly accessible from coast, which can be reached by landing barges. Few narrow reefs off shore can be avoided. Good trail along coast in both directions links sites. Several possible trails up rivers and across mountains to west coast.

Topography: Coastal plain of variable width. Sites have space for one or possibly two runways (except site 32) oriented north or northwest. Sites 32d and 32e are suitable for 6,000 foot runways in several directions. Ground flat or gently undulating with only minor irregularities. Slopes generally less than 1%; 32f has gradient up to 1½%. Altitude less than 50 feet.

Approaches: Approaches are clear on all sites. Low hills and ridges 150 to 300 feet high are minor hazards on southwest side of 32d and west side 32f. Ridges and hills rise 300 to 1,000 feet ½ to 2 miles west of sites 32a, 32b, and 32c.

Clearing and Grubbing: All sites covered with dense tropical rain forest with considerable undergrowth. Dense ground mat of roots, vines, and creepers requires stripping. Larger trees may be over 3 feet in diameter, but most can be handled by tree dozer. Roots for most part are not deeply set though stumps may require blasting. Thick stands of coconut trees along coast. Some small native clearings and areas of second growth.

Grading: Little grading other than minor leveling and filling of small gullies necessary at any sites. Sandy soil easily worked by bulldozers and scrapers. No rock excavation.

Foundation Conditions: All sites on coarse to medium coarse alluvium, but many texture differences possible.. Sandiest on seaward side where beach ridges may be present, and along stream banks which commonly bound ends of fields and may intersect them. Soil groups A-2, A-3, A-1 (SF, SW, SC), probably predominate, some A-4 (ML) may be present. Binder content probably low.

Stabilization and Surfacing: Soils compact well and moisture control usually is simple; not sticky. Sand for bitumen surface mix present on or near sites.

Drainage: All sites probably well drained naturally but may be muddy during and after heavy rains. Lateral drains will improve runoff and drying conditions.

Construction Materials Available: Coral limestone available locally along the coast is best all-purpose material. Can be worked in small quantities with hand tools. Drilling and blasting required for extensive quarrying. Conglomerate in ridges west of sites is probable source of gravel; will require screening. Sand locally available from small beaches along the coast.

Water Supply: Abundant supplies available from wells sunk 30 to 100 feet are best source; in order to minimize danger of salt-water contamination wells should be at least 1,000 feet from shore and should not be drilled below water level. Perennial surface water probably not available at 32a and 32b; probably available at 32e, and 32f, from Fida River and Tinting River, but these streams may go dry in dry season, when it may be necessary to use shallow wells or pits in river gravel to obtain water from underflow. At 32a and 32d, Lamo River will furnish large perennial supply. Intakes in rivers should be above limit of salt water.

Reliability Rating: C

Preliminary text submitted
without checking or editing.
U. S. Geological Survey

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FOR
CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

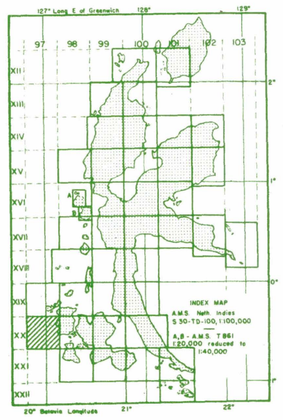
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922-1923
Blad XIX-97.

# POSSIBLE AIRFIELD SITES

Blad XX-97.




Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

M O L U K S C H E Z E E

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**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

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**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
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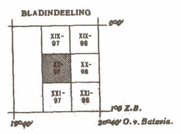
Reproductiebedrijf Topografische dienst, Wellevreden 1925.

Blad XXI-97.

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

BLADINDELING




ADMINISTRATIEVE INDEELING.

Trail

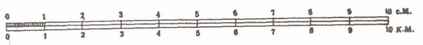
Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Arentuin.* *Klapperbeomen.* *Bánk.* *Krenpelhout.* *Bamboeboseh.* *Moeraspalmen.* *Tjemaraof Dennen boseh.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Bamboe gebouwen.*

*ZEE. a. eiland, b. klippen*
*Alle hoogten zijn uitgedrukt in M. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. c. hoogtepunt en hoogteopfer; d. hulphoogtelijn, e. rots.*

Schaal 1:100 000.




VERKORTINGEN.

*A. = Ahé = Rivier. Tg. = Tandjoeng = Kaap. Tk. = Teloek = Baai. P. = Poelau = Eiland.*

TOELICHTINGEN.

*Administratieve indeeling volgens O. B van 25 jan. 1924 No. 21. Stbl. No. 39.*

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S. ARMY



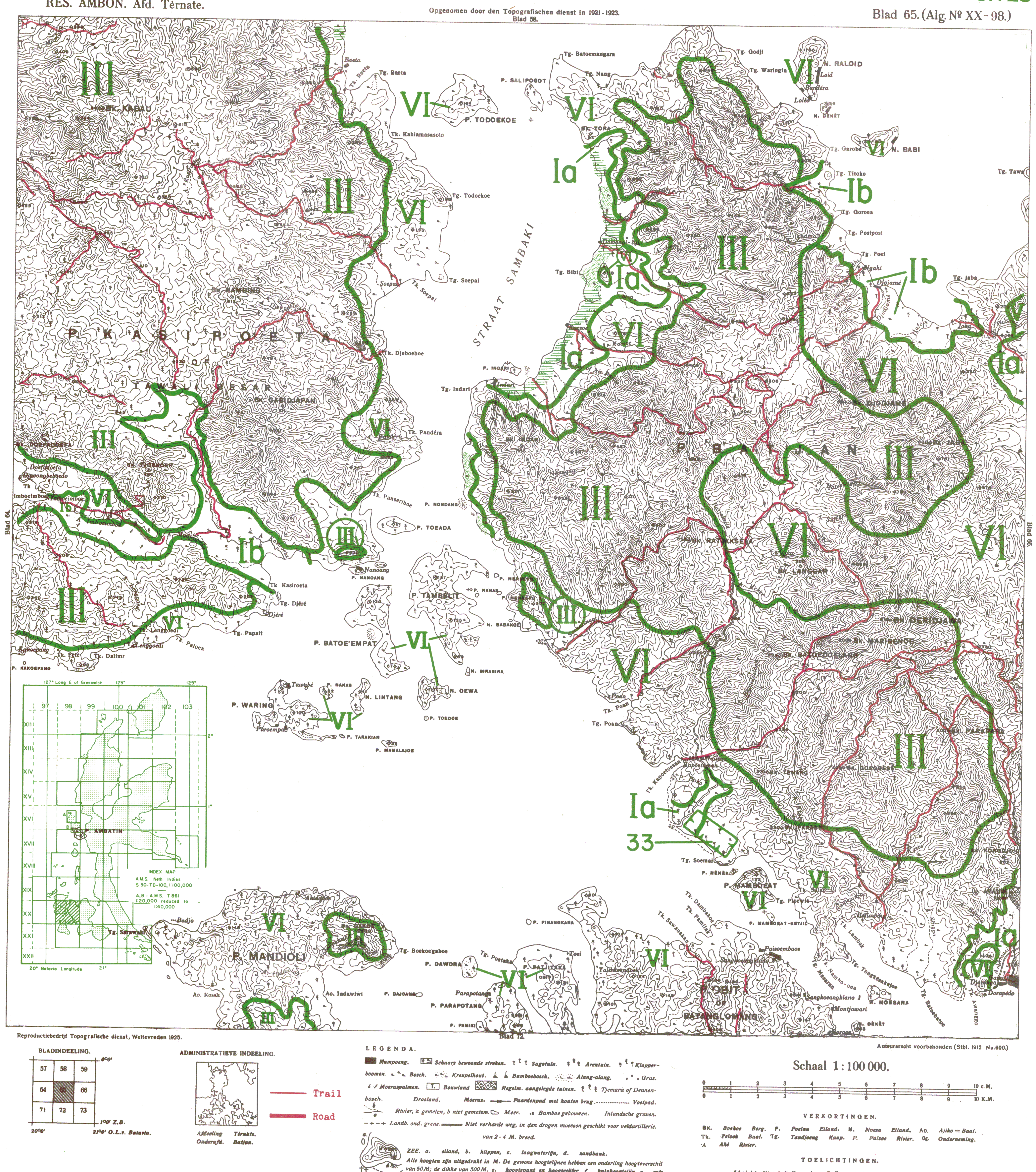
CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Tèrnate.

# POSSIBLE AIRFIELD SITES

Blad 65. (Alg. Nº XX-98.)




PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
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**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
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**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITE 34 Sheet XX-99

Rating: Fair

Accessibility: Coast directly accessible to landing barges. Trail connections to site poor, but important trails across island to northwest start from Sajoang three miles south along coast.

Topography: Small coastal lowland. Site suitable for single landing strip oriented northeast. Ground flat to gently rolling, trenched by a few shallow gullies 5 to 15 feet deep. Land slopes gently seaward at gradient of less than 1%. Altitude between 10 and 30 feet.

Clearing and Grubbing: Dense tropical rain forest over most of site with extensive coconut groves along the coast. Some trees over three feet in diameter; stumps will require blasting. Taller trees may have to be cleared from approach zones.

Grading: Only minor leveling required. Clay soil and rotted coral limestone can for the most part be worked by bulldozers and scrapers. Deeper excavations may require drilling and blasting.

Foundation Conditions: Coarse to medium textured soils, A-1, A-2, some A-4 (SF,SC,ML). Differences in fineness and depth due to variability of underlying rock. Probably coarser and shallower on seaward side.

Stabilization and Surfacing: Soil generally compacts well; is not sticky except when very wet and does not require heavy base course.

Drainage: Site naturally fairly well-drained. Small streams issuing from hills across the site may have to be diverted. Ground will be muddy during and after heavy rains unless surfaced.

Construction Materials Available: Coral limestone probably obtainable along coast and from ridges west of site above Sajoang River where it is interbedded with gravel and soft sandstone deposits. Gravel will require screening. Gravel should also be available from bed of Sajoang River or other large streams. Limestone can be worked with hand tools for small quantities, but requires drilling and blasting for any extensive quarrying.

Water Supplies: Nearby streams will probably not yield perennial supply. Water can be piped or hauled from Sajoang River; will have to be treated to be potable and intake should be above salt water limit. Adequate supply of potable water obtainable from wells 20 to 100 feet deep; these should be at least 1,000 feet from the shore to minimize danger of salt-water contamination.

Reliability Rating: C

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

CONFIDENTIAL

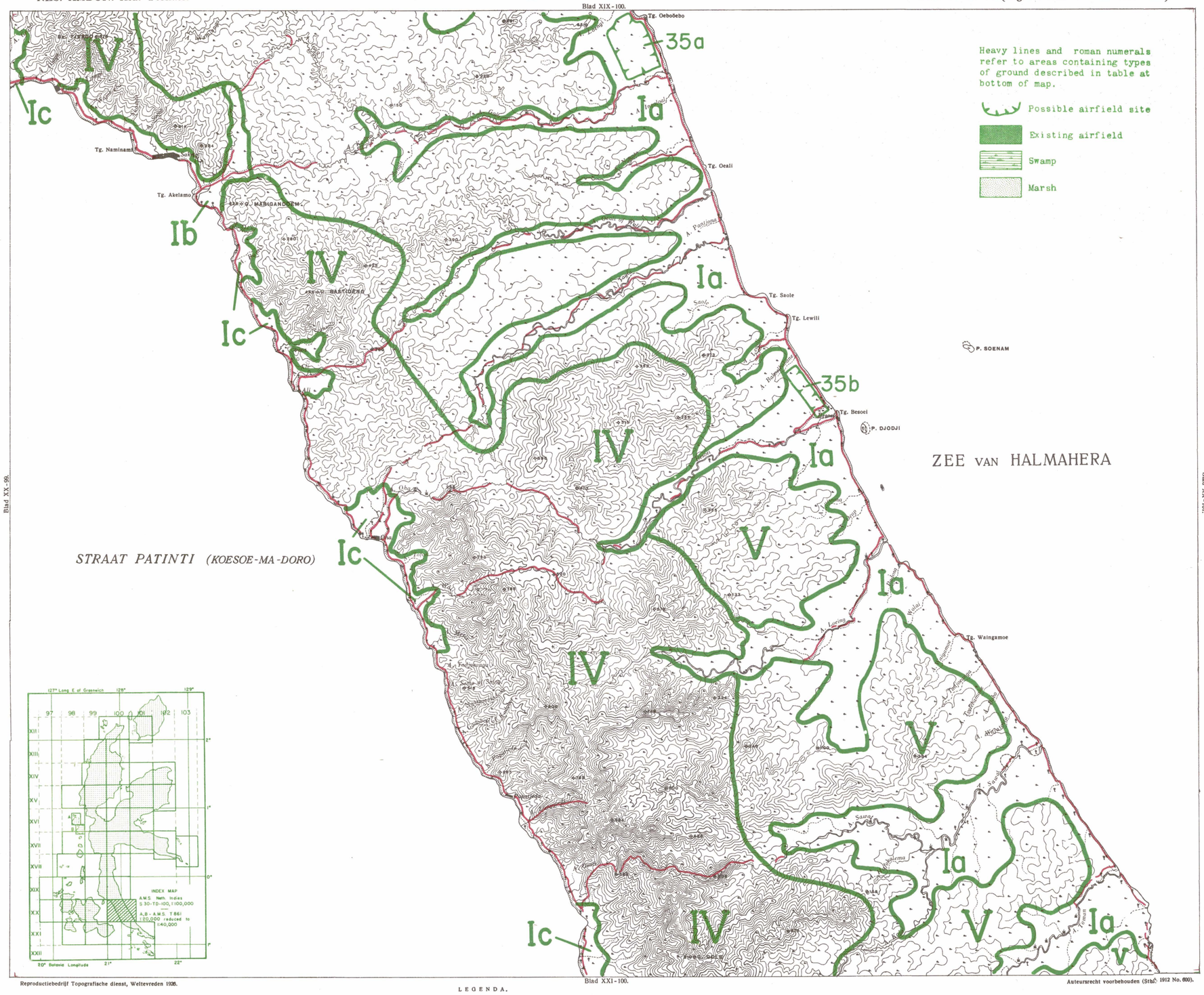
# HALMAHERA (MOLUKKAS)

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1924.

# POSSIBLE AIRFIELD SITES

Blad 67 en 68. (Alg. N° XX - 100 en XX - 101).







Reproductiebedrijf Topografische dienst, Weltevreden 1926.

BLADINDEELING.

| | | |
|---|---|---|
| XIX-99 | XIX-100 | XIX-101 |
| XX-99 | XX-100 | XX-101 |
| XXI-99 | XXI-100 | XXI-101 |

0°0' Z.B.
1°0' Z.B.
20°40' 21°40' O. v. Bat

ADM. INDEELING.

*Afdeeling* *Ternate.*
*Onderafd.* *Halmahera.*
*Ressort* *Weda.*
*District* *Gane.*

Trail
Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotuin.* *Klapperbomen.* *Bamboebosch.* *Bosch.* *Arentuin.* *Bamboe huizen.* *Inlandsche graven.* *Voetpad.* *Rivier, a. gemeten, b. niet gemeten.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M.; de dikte van 500 M. a. hoogtepunt en hoogtecijfer, b. halfhoogtelijn, c. eiland, d. laagwaterlijn, e. klinpen altijd boven water, f. zandbank alleen bij laag water droog.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Vluchtig opgenomen in het jaar 1924.*
*Uitgangspunten voor de kaartteering zijn de astronomische stations: de vlaggestok nabij den steiger van Laboeha op blad XX-99, de vlaggestok te Weda op blad XVIII-100 alsmede het eind van het paardenpad in kampoeng Bobaneigoe, gelegen aan de Bobane-baai, welk laatste punt uit de zeekaart No. 388 (catalogus 1923) overgenomen werd. De meetlijnen van de kusten zijn ten opzichte van het geografische noorden gekaarteerd.*

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

VERKORTINGEN.

G. *Goenoeng.* Bk. *Boekoe (berg).* P. *Poelau.* Tg. *Tandjoeng.* A.

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

Auteursrecht voorbehouden (Stb^ 1912 No. 600).



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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITE 33 Sheet XX-98

Rating: Fair

Accessibility: Site on coast directly accessible to landing barges, though shore is muddy and water shallow near mouth of river. No trails along coast, but fair trail leads inland across island 1 mile north of site.

Topography: Small strip of coastal lowland backed by steep mountain slopes.

Space available for single landing strip oriented northwest. Ground flat or gently undulating may be trenched by a few gullies 5 to 20 feet deep. Slopes generally less than 1½%; may be as much as 3% in extreme southern corner where low hill more than 150 in altitude rises above the plain. Elsewhere altitude between 25 and 50 feet.

Approaches: Low hills 150 to 250 feet in altitude abutting against the southern end of the site are hazards; very steep north face of Mamboeat Island about 3/4 mile southeast is more than 400 feet in altitude and is possible hazard to landings and take-offs. Southwest side clear; on northeast, steep ridges nearly 500 feet high are within a few hundred feet to ¼ mile of the site.

Clearing and Grubbing: Dense rain forest with abundant sago palms. Some large trees but mostly smaller growth. Coconut stands along the coast. Fairly difficult clearing.

Grading: Considerable cutting may be necessary to adequately clear approaches at south end of site. Power shovel or blasting required for coral rock. Site itself needs only minor leveling which can be accomplished by bulldozers and graders.

Foundation Conditions: Soil medium to coarse textured A-4, A-2 (ML,SF). Probably coarsest on NW, SW, and NE sides. Central part of strip may be finer in texture.

Stabilization and Surfacing: Soil probably compacts well giving good bearing ratio. Thickness and quality of base course will probably vary with local drainage. Coral sand suitable for surface course with bitumen may be present along shore.

Drainage: Not well drained naturally because water table is near surface; some low spots may be swamps. Coarse fills may be necessary locally. Lateral drains will improve surface runoff and drying. Unless surfaced field will be muddy during and after rains.

Construction Materials Available: Coral limestone available in quantity at south end of site; quarry easily established; is best material for aggregate, riprap, and rock masonry or fill. Small quantities of gravel may be available from stream at north end of site.

Water Supply: Large perennial supply available from P. Ra River, but to be potable will require filtration and chlorination. Intake should be above salt water limit. Wells sunk 25 to 75 feet in lowland part of site will have moderate to large yields from unconsolidated sand and gravel; will require chlorination but not filtration to be potable. Wells must be cased. Should be at least 1,000 feet from shore to minimize danger of salt-water contamination.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

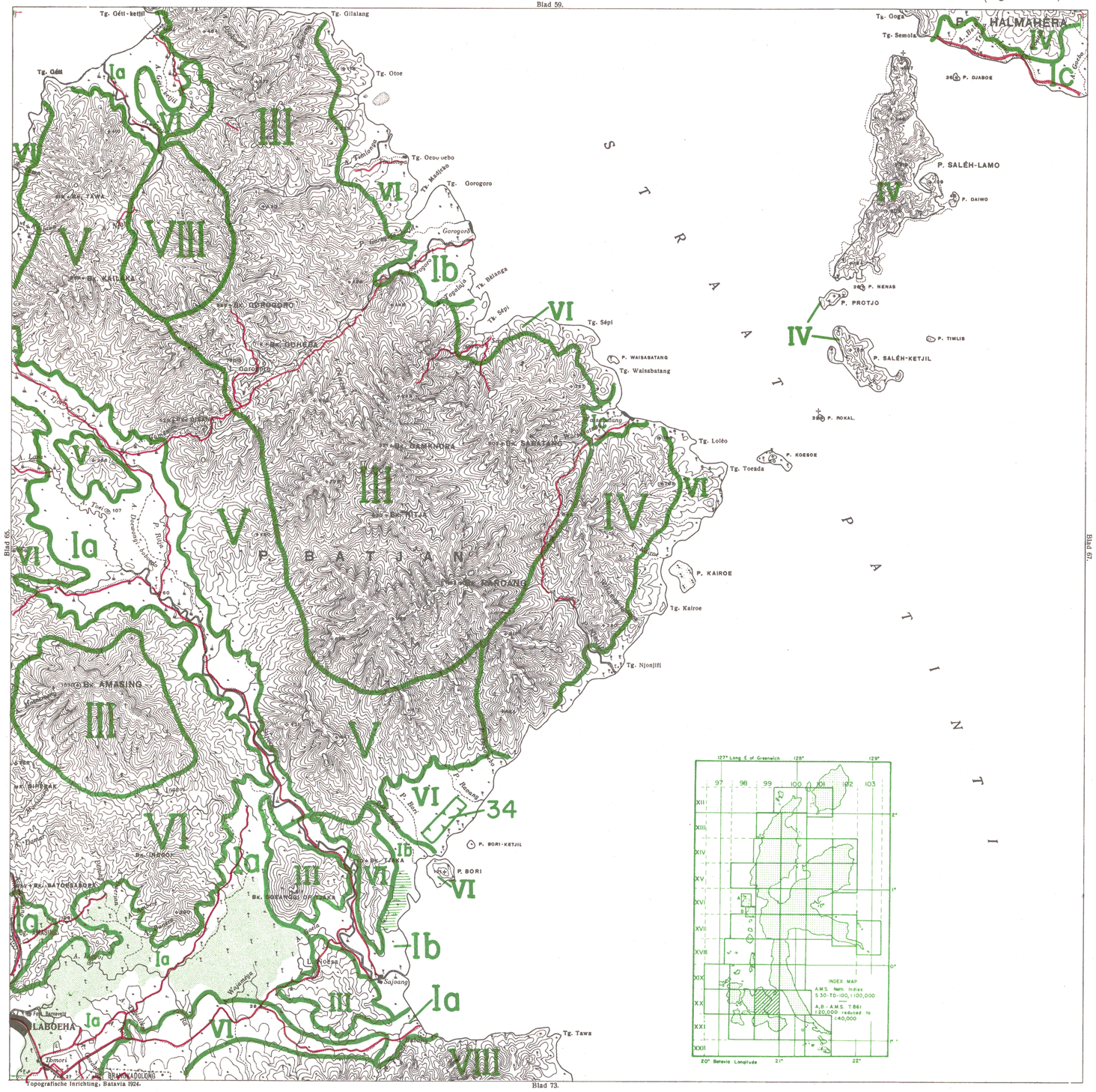
RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1921 - 1923.

Blad 59.

## POSSIBLE AIRFIELD SITES

Blad 66. (Alg. No XX-99).







BLADINDEELING.

| | | |
|---|---|---|
| 58 | 59 | 60 |
| 65 | 66 | 67 |
| 72 | 73 | 74 |

0°0' — 1°0' Z.B. — 30°20' — 21°20' O.L.v. Batavia.

ADMINISTRATIEVE INDEELING.

Trail

Road

*Afdeeling Ternate.*
1. *Onderafd. Batjan.*
2. *" Halmahera.*
*Ressort Weda.*
*District Gane.*

*Kampoeng.* *Schaars bewoonde streken.* *Arentuin.* *Klapperboomen.* *Kreupelhout.* *Bosch.* *Bamboebosch.* *Sagotuin.* *Tjemara- of Dennenbosch.* *Gelagah.* *Regm. aangelegde tuinen.* *Koffietuin.* *Djatibosch.* *Moeraspalmen.* *Alang-alang.* *Bouwland (tegal).* *Drasland.* *Moeras.* *Ladang = tijdelijke nedersetting met droge rijstvelden.* *Niet verharde weg, in den drogen moesson geschikt voor veldartillerie van 2 - 4 M. breed.* *Paardenpad.* *Voetpad.* *Rivier. a. gemeten b. niet gemeten.* *Meer.* *Steenen- en bamboe gebouwen.* *Inlandsche graven.* *Onderafdeelingsgrens.* *Landb. ond. grens.*

*ZEE. a. = eiland, b. = laagwaterlijn, c. = klippen, d. = zandbank.*
*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duisendtallen van de schaal. a. = hoogtepunt en hoogtecijfer, b. = hulphoogtelijn.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikte van 500 M.

Schaal 1 : 100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Administratieve indeeling volgens G.B. van 25 jan. 1924. No. 21 Stbl: No. 29.*
*Uitgangspunt A.S. vlaggestok steiger Laboeha 0°39' Z.B. en 20° 40' 1,95" O.L.v. Batavia.*

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

VERKORTINGEN.

*C. = Controleur.* *Bk. = Boekoe (berg).* *P. = Poelau (eiland).* *Tg. = Tandjoeng (kaap).* *Tk. = Teloek (baai).* *L. = Lapa (meer).* *P. = Paloe (rivier).* *A. = Aké (rivier).* *Ond. = Onderneming.*

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity Well drained. Shallow.
ROCK: Hard massive limestone generally near or at the surface. Widely exposed in cliffs and ledg

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plastici Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathe granite exposed only along streams.



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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITES 35a and 35b Sheet XX-100,101

Rating: 35a Good, 35b Good

Accessibility: Both sites directly accessible from coast, which can be reached by landing barges passing through channels in narrow offshore reefs. Good trails along coast in both directions and several trails up rivers and across mountains to west coast.

Topography: Narrow coastal plain sites have space for at least one landing strip oriented northwest. Ground nearly flat or gently undulating. Site 35a trenched by a few gullies 5 to 15 feet deep. Land slopes less than 1.5% to east. Altitude between 10 and 50 feet.

Approaches: Both sites have clear approaches. Hills rise gradually to west. No serious topographic hazards.

Clearing and Grubbing: Dense rain forest on both sites is difficult to clear. Larger trees over three feet in diameter; stumps will require blasting. Much brush and vines. Land more open at south end of 35b with second growth and small native clearings.

Grading: Only minor leveling and filling of small gullies needed. Sandy soil readily worked by bulldozers and scrapers. No rock excavation.

Foundation Conditions: Soils vary greatly over short distances. Probably mostly A-2, A-3 (SP, SW); possibly some A-4 (ML) present. Near coast soils probably sandier. Binder content low.

Stabilization and Surfacing: Good compaction at optimum moisture content. Soil not sticky, easily worked. Sand available for bitumen-mix surface.

Drainage: Sites naturally well-drained, but ground is muddy during and after heavy rains. Surfacing will improve runoff.

Construction Materials Available: Little rock available at either site, though some coral limestone may occur along the coast. Gravel and sand readily obtained from stream beds or from deposits in ridges extending toward the coast.

Water Supplies: Probably Gola and Besoei Rivers will yield adequate perennial water supplies, water requires treatment to be potable. Intake should be above salt-water limit. Wells sunk 20 to 40 feet into alluvium underlying sites will provide adequate supplies of potable water. Wells should be at least 1,000 feet from coast to minimize danger of contamination by salt water.

Reliability Rating: C

Preliminary text submitted without checking or editing
U. S. Geological Survey

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

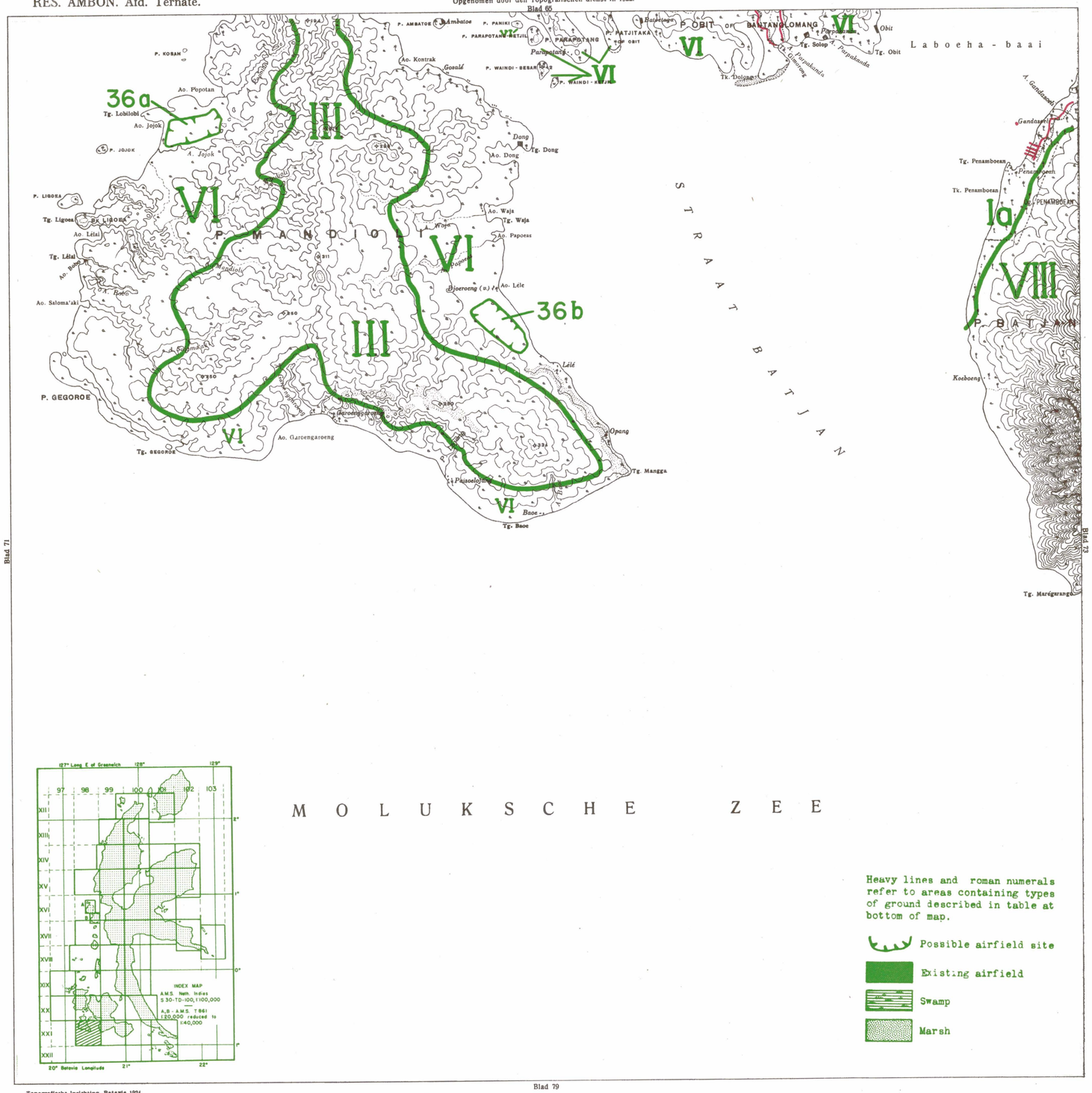
RES. AMBON. Afd. Ternate.

## POSSIBLE AIRFIELD SITES

Blad 72. XXI-98

Opgenomen door den Topografischen dienst in 1922.

Blad 65







# M O L U K S C H E  Z E E

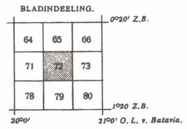
Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

Blad 79

Topografische Inrichting, Batavia 1924.

BLADINDEELING.




ADMINISTRATIEVE INDEELING.

*Afdeeling. Ternate*
*Onderafd. Batjan*

Trail

Road

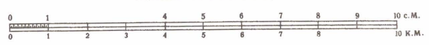
LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Sagotain.* *Arentuin.* *Klapperboomen.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* ..... *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Bamboe gebouwen.* *Inlandsche graven.* *Landb. ond. grens.*

*ZEE. a. = eiland, b. = zandbank, c. = laagwaterrif. Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. d. = hoogtepunt en hoogtecijfer, e. = hulphoogtelijn, f. = rots.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.




VERKORTINGEN.

Bk. = *Boekoe* = *Berg.* P. = *Poeloe* = *Eiland.* Tg. = *Tandjoeng* = *Kaap.* Tk. = *Teloek* = *Baai.* Ao. = *Ajiko* = *Baai.* A. = *Aké* = *Rivier.* P. = *Poisoe* = *Rivier.* (t) = *Verlaten.* Ond. = *Onderneming.*

TOELICHTINGEN.

*Administratieve indeeling volgens G. B van 25 jan. 1924 No. 21, Stbl. No. 29.*

PREPARED BY U S GEOLOGICAL SURV
FOR
CHIEF OF ENGINEERS, U. S. ARMY

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near or at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.



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# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITES 36a and b. Sheet XXI-98

Rating: Site 36a good, 36 b good.

Accessibility: Both sites on coast; some coral reefs off site 36a, none off 36b. Only a few trails into interior of island are reported.

Topography: Small coastal lowland. Site 36a has space for one, possibly two, runways oriented east to northeast. Ground flat to gently undulating, slightly more irregular and rough in the northwest part of site. Area crossed by a few shallow gullies 5 to 10 feet deep. Land slopes generally southwest at gradient less than 1.5%. Altitude between 25 and 75 feet. Site 36b has space for runway oriented northwest. Surface similar to 36a. Altitude between 20 and 50 feet.

Approaches: Site 36a has clear approach to west and north. Low hills up to 300 feet in altitude about $\frac{1}{2}$ mile to the east and about $1\frac{1}{2}$ miles to the south. Site 36b has clear approach from southeast. About a mile northwest is low hill 150 to 200 feet in altitude.

Clearing and Grubbing: Dense rain forest covers both sites. Clearing difficult because of large trees 3 feet or more in diameter and dense tangle of vines, creepers and roots at the ground surface that has to be cut through. Stumps will require blasting.

Grading: Little leveling necessary except at east end of site 36a. Clay soil easily worked by bulldozers and scrapers. Underlying coral rock may be near the surface; extensive excavation of this would require power shovel and light blasting.

Foundation Conditions: Coarse to medium-textured soils of groups A-2, A-1, some A-4 (SF, SC, ML). Locally clay beds present containing more fines. Soil thin and variably hard coral rock may be near the surface at site 36b.

Stabilization and Surfacing: Soil compacts well under controlled moisture conditions and does not need thick base course. Adequate binder in fairly friable clay. Stickiness relatively low except when very wet.

Drainage: Both sites naturally well-drained. Small streams issuing from hills cross sites; may have to be diverted and their gullies filled with rock or other permeable material. Near coast water table may be high so that shell holes will fill with water.

Construction Materials Available: Little rock locally available at site 36a. Some coral limestone may occur locally along coast or cap ridges along edge of plain. Ample broken coral rock south of 36b along coast.

Water Supplies: Probably no adequate source of surface water. Potable water obtainable from wells sunk 20 to 100 feet in coral limestone and unconsolidated gravel and sand underlying sites. Wells should be located at least 1,000 feet from the coast and should not penetrate more than a few feet below water level to reduce possibility of contamination by salt water.

Reliability Rating: C.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

CONFIDENTIAL

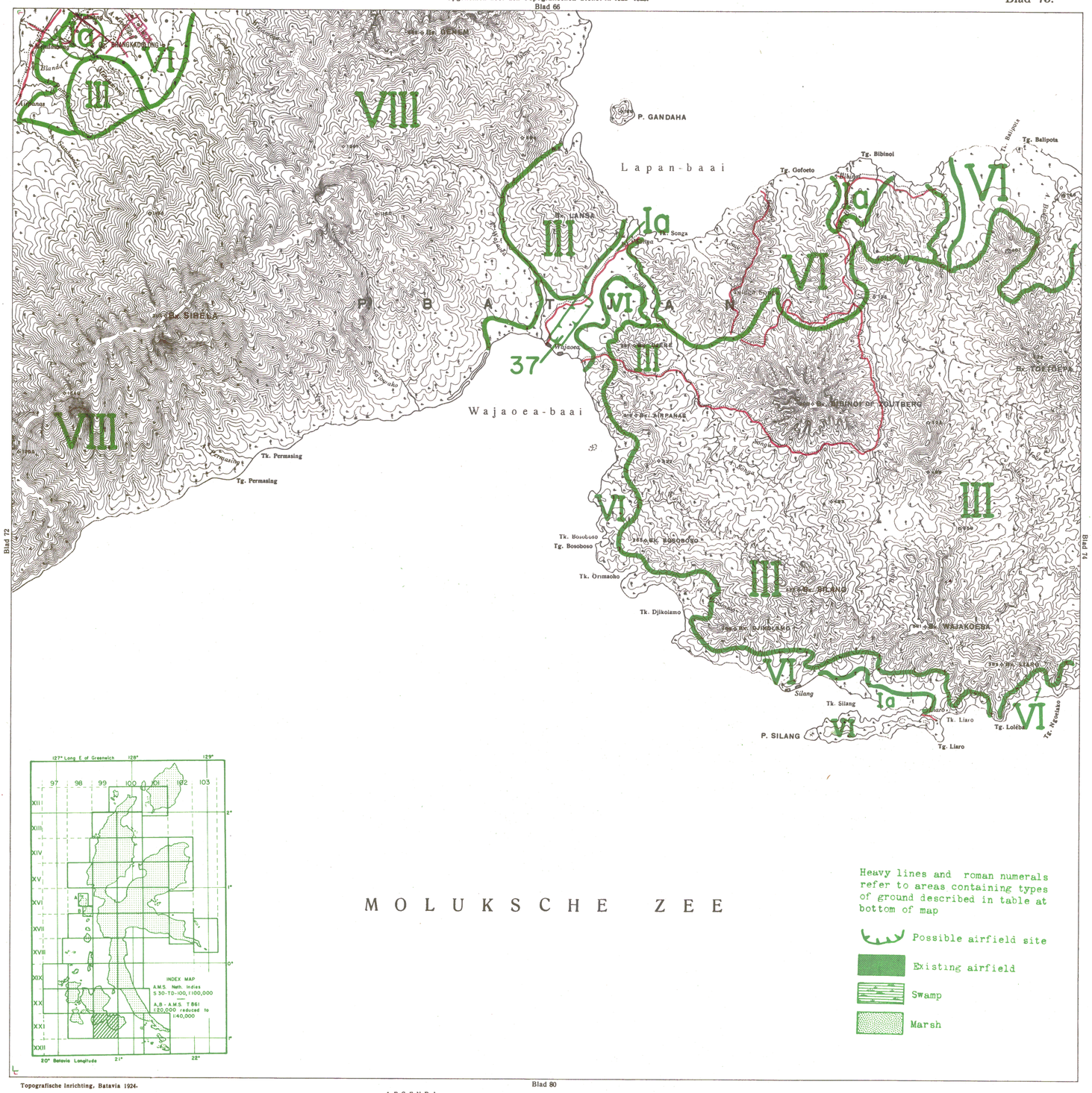
# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

RES. AMBON. Afd. Ternate.

Opgenomen door den Topografischen dienst in 1922 - 1923.

Blad 73.







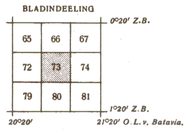
M O L U K S C H E  Z E E

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

Topografische Inrichting, Batavia 1924.

BLADINDEELING




ADMINISTRATIEVE INDEELING

Trail

Road

LEGENDA

*Kampoeng.* *Schaars bewoonde streken.* *Arenluin.* *Klapperboomen.* *Koffietuin.* *Bosch.* *Kreupelhout.* *Bamboebosch.* *Moeraspalmen.* *Paardenpad.* *Voetpad.* *Rivier.* *a. gemeten, b. niet gemeten.* *Meer.* *Bamboe gebouwen.* *Lands. ond. grens.*

*ZEE. a. = eiland, b. = bilj.*

*Alle hoogten zijn uitgedrukt in M. De onderlinge afstand der hoogtelijnen bedraagt de helft der duizendtallen van de schaal. c. = hoogtepunt en hoogtecijfer, d. = huishoogteijn.*

De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M.

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.

0 1 2 3 4 5 6 7 8 9 10 K.M.

VERKORTINGEN.

Bk. = *Boekoe = Berg.* P. = *Poelau = Eiland.* Tg. = *Tandjoeng = Kaap.* Tk = *Teloek = Baai.* Og. = *Onderneming.* W.B. = *Warme bron.* A. = *Aké = Rivier.*

TOELICHTINGEN.

*Administratieve indeeling volgens G. B. van 25 jan. 1924 No. 21. Stbl. No. 29.*

PREPARED BY U S GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U S ARMY

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.



CONFIDENTIAL

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

SITE 37. Sheet XXI-99

Rating: Good.

Accessibility: Site within short distance of coast at Wajaoea where landing barges can land. Good trail across isthmus to Songa on Lapan Bay. No trails along coast.

Topography: Low alluvial plain forms narrow isthmus between the mountains of southern and central Batjan. Site is on western side of isthmus; space suitable for single runway oriented northeast. Ground gently undulating; slopes gently west and south at gradients generally less than 1½%. Site may be crossed by a few gullies 5 to 20 feet deep. Altitude between 25 and 75 feet.

Approaches: Approaches are clear. Terraces 150 to 300 feet in altitude and hills as much as 500 feet in altitude are potential hazards within a few hundred yards of sides of site.

Clearing and Grubbing: Dense tropical rain forest; some trees over three feet in diameter. Thick mat of roots, vines, and creepers will require stripping. Stumps will need blasting. Some clearing of approach zone to northeast may be necessary.

Grading: Minor leveling necessary along south border; sandy soil readily worked by bulldozers and scrapers. No rock excavation.

Foundation Conditions: Soils coarse textured A-2, rarely A-4 (SF, GF, ML) and generally low in fines, except at NE end where binder might be obtained if needed. Local differences in texture and related properties probable, however, owing to alluvial origin of material.

Stabilization and Surfacing: Soil is not sticky and compacts well. Desired moisture distribution easily obtained. Makes good foundation when combined. Does not require thick base course.

Drainage: Natural drainage probably good, but unless surfaced, field will be muddy during and after rains. Streams crossing site must be diverted;channels filled with permeable material.

Construction Materials Available: Trap rock boulder deposits in hills to north could be quarried and broken up for aggregate. Trap rock ledges may be found on volcanic mountain east of site. Requires blasting for excavation. Granite and gneiss gravels may be available along Wajaoea and Songa Rivers. Some coral limestone may occur underlying terraces southeast of Wajaoea.

Water Supplies: Adequate perennial supplies probably available from Wajaoea River and Songa River. Intake should be located above salt-water limit. Adequate supply available from wells sunk 20 to 40 feet in unconsolidated alluvium; wells should be located at least 1,000 feet from the coast to minimize danger of salt-water contamination.

Preliminary text submitted without cnecking or editing.
U. S. Geological Survey

Reliability Rating: C.

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

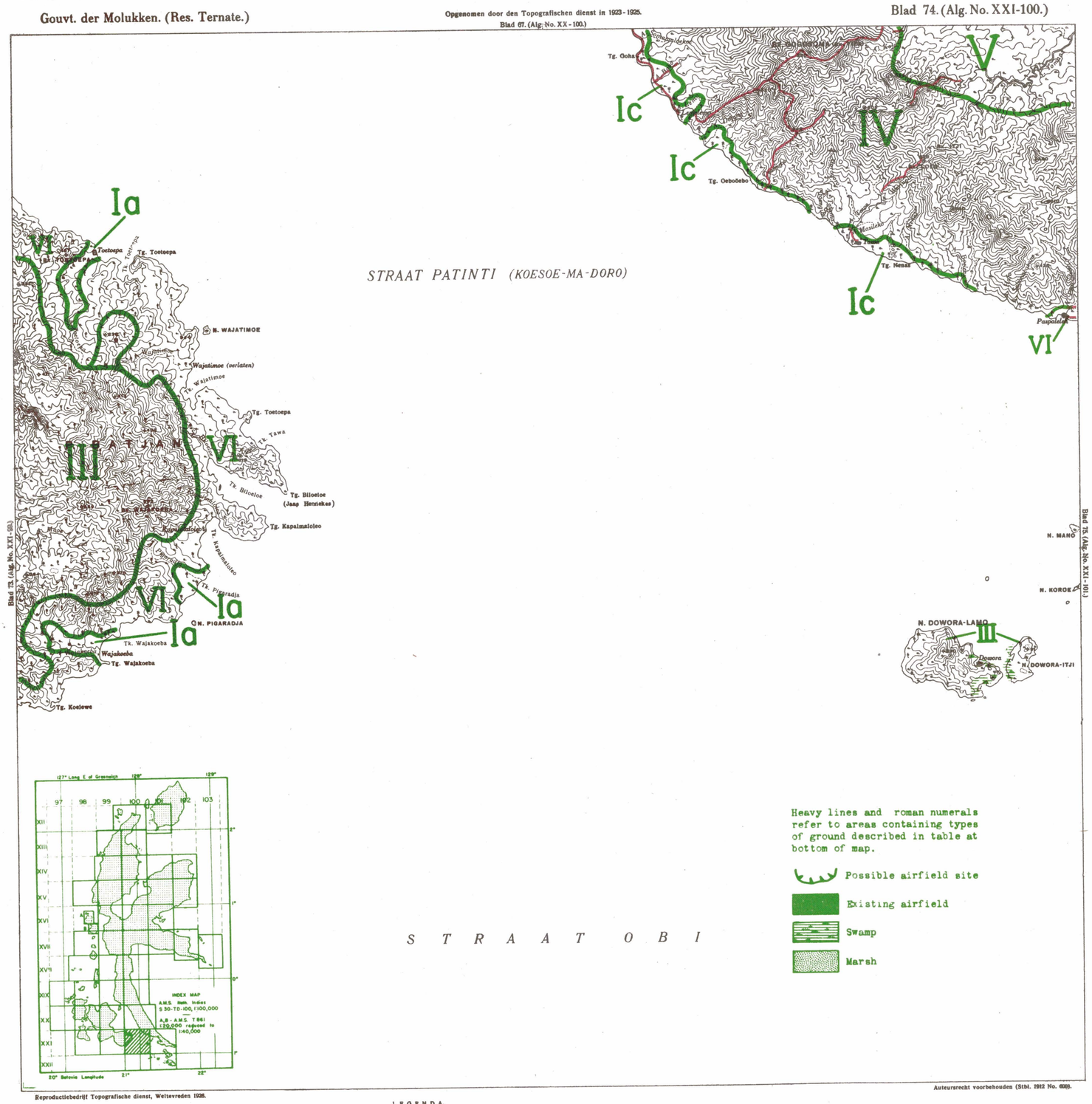
## POSSIBLE AIRFIELD SITES

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1923-1925.

Blad 74. (Alg. No. XXI-100.)

Blad 67. (Alg. No. XX-100.)







Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

Possible airfield site

Existing airfield

Swamp

Marsh

Auteursrecht voorbehouden (Stbl. 1912 No. 600).

Reproductiebedrijf Topografische dienst, Weltevreden 1926.

BLADINDEELING.

| | | |
|---|---|---|
| XX 99 | XX 100 | XX 101 |
| XXI 99 | XXI 100 | XXI 101 |
| XXII 99 | XXII 100 | XXII 101 |

0°20' Z.B. — 1°20' Z.B. — 20°40' — 21°40' O. v. Bat.

ADM. INDEELING.

1 — Afdeeling Ternate.
1. Onderafd. Batjan.
2. .. Halmahera.
Ressort Weda.

Trail

Road

LEGENDA.

Kampoeng. Schaars bewoonde streken. Sagotuin. Arentuin. Klapperboomen. Bosch. Krenpelhout. Bamboebosch. Moeraspalmen. Tjemaratjemara. Dennen bosch. Voetpad. Rivier. a. gemeten, b. niet gemeten. Inlandsche graven. Moeras. Paardenpad.

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogtelijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. hulphoogtelijn, c. rots, d. eiland, e. klippen bij laag water zichtbaar, f. laagwaterlijn.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.

0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Uitgangspunten voor de kaartering zijn geweest: 1e de astronomische stations: de vlaggestok nabij den steiger van Labocha, blad 66. (Alg. No. XX-99), de vlaggestok te Weda, blad 53, (Alg. No. XVIII-100); 2e het eind van het paardenpad in kampoeng Bobanetgoe, gelegen aan de Bobans-baai, welk punt uit de zeekaart No. 388 (catalogus 1923) overgenomen werd.*

VERKORTINGEN.

Bk. *Boekoe (berg.)* N. *Noesa (eiland.)* A. *Ake (rivier.)* S. *Soengai.* Tg. *Tandjoeng.* Tk. *Teloek.*

**Ia** Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

**Ib** Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

**Ic** Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

**II** SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

**III** SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

**IV** SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

**V** SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

**VI** SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

**VII** SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near ot at the surface. Widely exposed in cliffs and ledges.

**VIII** SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

PREPARED BY U.S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U.S. ARMY



CONFIDENTIAL

# HALMAHERA (MOLUKKAS)

Gouvt. der Molukken. (Res. Ternate.)

## POSSIBLE AIRFIELD SITES

Blad 75 (Alg. No. XXI-101.)

Opgenomen door den Topografischen dienst in 1925.
Blad 68. (Alg. No. XX-101.)

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

Reproductiebedrijf Topografische dienst, Weltevreden 1926.

Auteursrecht voorbehouden (Stbl. 1912 No. 600.)

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M

BLADINDEELING.

| | | |
|---|---|---|
| II-100 | II-101 | II-102 |
| III-100 | III-101 | III-102 |
| IIIb-100 | IIIb-101 | IIIb-102 |

0°20' Z.B.
1°20' Z.B.
21°0' 22°0' O.v. Bat.

ADM. INDEELING.

Afdeeling Ternate.
Onderafd. Halmahera.
Resort Weda.

Trail
Road

LEGENDA.

*Kampoeng.* *Schaars bewoonde streken.* *Klapperbomen.* *Alangalang.* *Bamboebosch.* *Arentuin.* *Bosch.* *Tjemara-of Dennen (Sparren) bosch.* *Paardenpad.* *Voetpad.* *Rivier. a. gemeten, b. niet gemeten.* *Moeras.* *Pasanggrahan.* *Hoeven- en bamboe huizen.* *Inlandsche graven.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogteijnen hebben een onderling hoogteverschil van 50 M; de dikke van 500 M. a. hoogtepunt en hoogtecijfer, b. hulphoogtecijfer, c. eiland.*

TOELICHTINGEN.

*Vluchtig opgenomen in het jaar 1925 met oriënteering op het astronomische punt: de vlaggestok te Weda.*

VERKORTINGEN.

**P.** *Poelau.* **N.** *Noesa.* **G.** *Goenoeng.* **A.** *Ake (rivier).*

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

VI SOIL: Sand with fines, poorly to well graded sand-clay mixtures of variable depths; shallow on limestone. Friable; well drained.
ROCK: Coral limestone layers interbedded with loosely consolidated conglomerate, sandstone and shale. Limestone exposed as ledges on terrace faces.

VII SOIL: Sand and some gravel with fines grading at 1 to 1½ feet into clayey sand of low plasticity. Well drained. Shallow.
ROCK: Hard massive limestone generally near or at the surface. Widely exposed in cliffs and ledges.

VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XXI-101

SITES 38a, 38b, 38c, and 38d

Rating: 38a Good, 38b, 38c, 38d Fair

Accessibility: All sites border coast, which is accessible to landing barges. Site 38a is connected by foot trail with points north along coast and with Gave Bay by trail across peninsula.

Topography: Groups of low irregular hills bordered by narrow coastal lowlands and coral limestone terraces.

Sites have space for single landing strips oriented northwest. Ground is slightly rough and irregular but grades are generally less than 1%. Altitudes between 20 and 80 feet.

Approaches: Low hills 150 to 250 feet in altitude about a mile from northwest end of site 38a are minor hazard. Southeast approach clear on south except for low hills 150 to 250 feet in altitude near the south corner of the site. Site 38b has clear approaches on the southeast; clear for nearly 3 miles on the northwest. Sites 38c and 38d have clear approaches.

Clearing and Grubbing: Fairly open rain forest over all sites possibly some areas of grass and brush. Clearing difficult because of scattered large trees and dense tangle of vines and creepers in rain forest.

Grading: Some leveling of irregularities necessary at all sites. Thin soil and coral rock probably can be worked by bull dozers and scrapers but deep excavation will require power-shovel or blasting.

Foundation Conditions: Coarse to medium textured soils of groups A-2, A-1, some A-4 (SF,SC,ML), On coral limestone terrace are many rocks affecting fineness and depth of soil. Soil may be shallow with coral rock near surface along NE sides of 38a and 38c and over all of 38d.

Stabilization and Surfacing: This soil probably compacts well and moisture content needed to bring to optimum density is readily controlled. Probably friable, relatively non-plastic clays predominate in binder, reducing stickiness in wet state.

Drainage: Good natural drainage. Shallow gullies crossing site will need fills of permeable material. Any perennial streams should be diverted. Ground probably will be muddy during and for a short time after rains. 38b may be low and locally swampy. Water table is near surface and shell craters may fill with water.

Construction Materials Available: Coral limestone, a good all-purpose rock, available at or near or all sites. Can be worked in small quantities by hand tools. Requires drilling and blasting for extensive quarrying and crushing for use as aggregate.

Water Supply: No adequate surface supplies available. Wells 20 to 50 feet deep, in coral limestone and gravel, will provide adequate supplies, but these should be at least 1,000 feet from shore and should penetrate only a few feet below water level to reduce danger of salt-water contamination.

Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U S ARMY

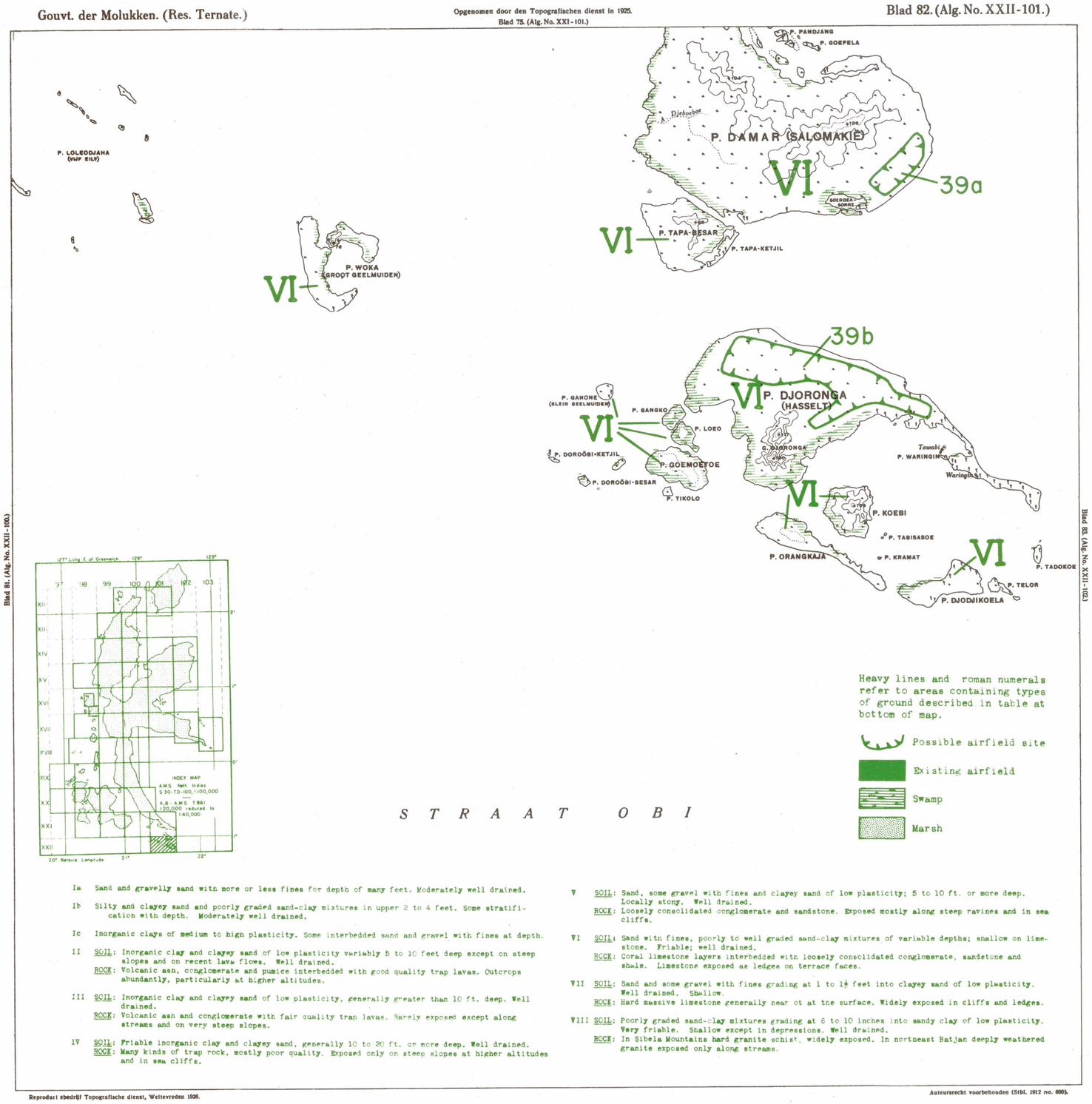
# HALMAHERA (MOLUKKAS)

## POSSIBLE AIRFIELD SITES

Gouvt. der Molukken. (Res. Ternate.)

Opgenomen door den Topografischen dienst in 1925.
Blad 75. (Alg. No. XXI-101.)

Blad 82. (Alg. No. XXII-101.)




*S T R A A T  O B I*

Heavy lines and roman numerals refer to areas containing types of ground described in table at bottom of map.

- Possible airfield site
- Existing airfield
- Swamp
- Marsh

Ia Sand and gravelly sand with more or less fines for depth of many feet. Moderately well drained.

Ib Silty and clayey sand and poorly graded sand-clay mixtures in upper 2 to 4 feet. Some stratification with depth. Moderately well drained.

Ic Inorganic clays of medium to high plasticity. Some interbedded sand and gravel with fines at depth.

II SOIL: Inorganic clay and clayey sand of low plasticity variably 5 to 10 feet deep except on steep slopes and on recent lava flows. Well drained.
ROCK: Volcanic ash, conglomerate and pumice interbedded with good quality trap lavas. Outcrops abundantly, particularly at higher altitudes.

III SOIL: Inorganic clay and clayey sand of low plasticity, generally greater than 10 ft. deep. Well drained.
ROCK: Volcanic ash and conglomerate with fair quality trap lavas. Rarely exposed except along streams and on very steep slopes.

IV SOIL: Friable inorganic clay and clayey sand, generally 10 to 20 ft. or more deep. Well drained.
ROCK: Many kinds of trap rock, mostly poor quality. Exposed only on steep slopes at higher altitudes and in sea cliffs.

V SOIL: Sand, some gravel with fines and clayey sand of low plasticity; 5 to 10 ft. or more deep. Locally stony. Well drained.
ROCK: Loosely consolidated conglomerate and sandstone. Exposed mostly along steep ravines and in sea cliffs.

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VIII SOIL: Poorly graded sand-clay mixtures grading at 6 to 10 inches into sandy clay of low plasticity. Very friable. Shallow except in depressions. Well drained.
ROCK: In Sibela Mountains hard granite schist, widely exposed. In northeast Batjan deeply weathered granite exposed only along streams.

Auteursrecht voorbehouden (Stbl. 1912 no. 600).

Reproduct ebedrijf Topografische dienst, Weltevreden 1926.

BLADINDELING.

| | | |
|---|---|---|
| XII-100 | XII-101 | XII-102 |
| XIII-100 | XIII-101 | XIII-102 |
| XIIIB-100 | XIIIB-101 | XIIIB-102 |

0°40' Z.B.
1°40' Z.B.
21°0' 22°0' O. v. Bat.

ADM. INDEELING.

Afdeeling Ternate.
Onderafd. Halmahera.
Ressort Weda.

LEGENDA.

*Kampoeng. Klapperboomen. Tjemara-of Dennen (Sparren) bosch. Bosch. Herkenbare boom. Bamboebosch. Inlandsche graven. Paardenpad. Niet gemeten rivier. Moeras.*

*Alle hoogten zijn uitgedrukt in meters. De gewone hoogteijnen hebben een onderling hoogteverschil van 50 M; de dikte van 500 M. a. hoogtepunt en hoogtecijfer, b. hulphoogteijn, c. eiland, d. zandbank alleen bij laagwater droog. e. laagwaterrijn.*

Schaal 1:100 000.

0 1 2 3 4 5 6 7 8 9 10 c.M.
0 1 2 3 4 5 6 7 8 9 10 K.M.

TOELICHTINGEN.

*Vluchtig opgenomen in het jaar 1925 met oriënteering op het astronomische punt, de vlaggestok te Weda.*

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

VERKORTINGEN

*P. Poelau. G. Goenoeng. A. Ake (rivier).*

# HALMAHERA (MOLUKKAS) POSSIBLE AIRFIELD SITES

Sheet XXII-101

SITES 39a and 39b

Rating: 39a and 39b Fair

Accessibility: Coast along both sites accessible to landing barges. No reefs known here.

Topography: Coral islands off southern tip of Halmahera. At site 39a, on Damar Island, possible runways can be oriented NE only. Site 39b, on north coast of Djoronga Island has space for runways oriented in any direction. Ground is rough and slightly irregular, but grades are less than 1%. Altitude between 20 and 100 feet.

Approaches: Approaches are clear. Steep hills 400 to over 550 feet in altitude south of site 39b and northwest of 39a.

Clearing and Grubbing: Dense rain forest covers both sites particularly in interior. Some trees may be over 3 feet in diameter; stumps will need blasting. Thick ground mat of roots, vines and creepers will require stripping. Difficult clearing. East end of site 39b somewhat more open with many coconut trees near shore Felling of taller trees may be necessary to clear approaches.

Grading: General leveling of irregular ground surface probably necessary. Soil and rotted coral rock near surface can be worked by bulldozers and scrapers. Larger rock fragments may have to be removed by blasting.

Foundation Conditions: Both sites on soils from coral limestone. Coarse to medium textured soil types: A-2, some A-4 (SF, ML, GF may be present locally). Soil may be very shallow in places.

Subgrades and Stabilization: Where deep, soil compacts well under controlled moisture conditions. Thick base course probably unnecessary. Where soil is shallow and coral near surface there may be difficulties in preparing desired grade; also possibility of local drainage problems. Soil not sticky unless very wet. Material suitable for bitumen-mix surface course may be found locally.

Drainage: Both sites naturally well drained but, where ground is low, water table may be near surface and shell craters may fill with water. Some spots may be swampy. Small streams which may cross sites will have to be diverted.

Construction Material Available: Coral rock and coarse coral sand abundant along coast. Rock is good material for aggregate, riprap, rock masonry, or fill. Can be broken up by hand tools.

Water Supply: Streams are ephemeral. Adequate supplies available from wells 50 to 150 feet deep; should be drilled not more than few feet below water level and at least 1,000 feet from shore to minimize danger of salt-water contamination. Drilling will be partly in hard coral limestone, partly in poorly consolidated gravel and sand. Wells must be cased.

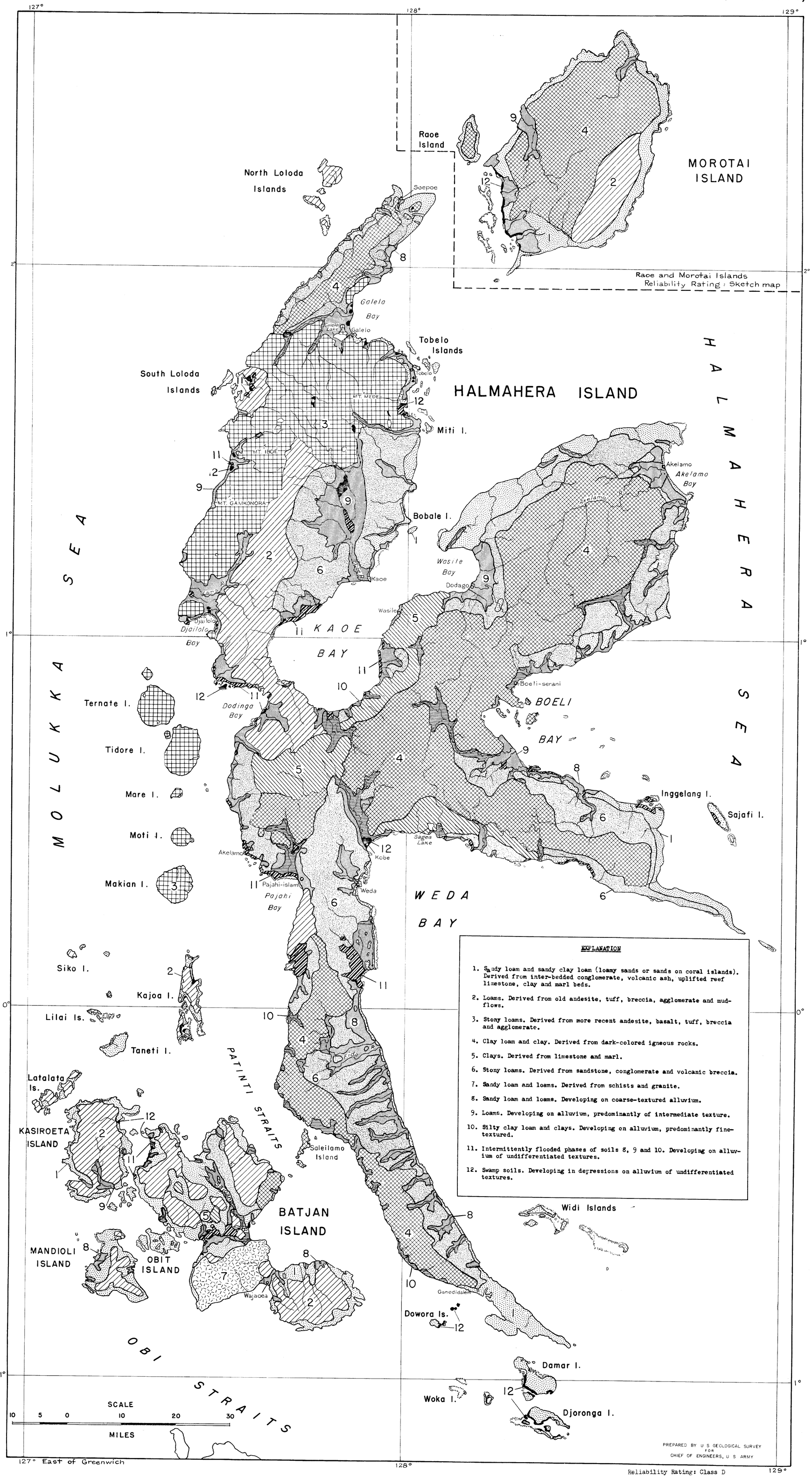
Reliability Rating: C

Preliminary text submitted without checking or editing.
U. S. Geological Survey

Prepared by U. S. Geological Survey
for Chief of Engineers, U. S. Army

# SOILS

# HALMAHERA (MOLUKKAS)




## EXPLANATION

1. Sandy loam and sandy clay loam (loamy sands or sands on coral islands). Derived from inter-bedded conglomerate, volcanic ash, uplifted reef limestone, clay and marl beds.
2. Loams. Derived from old andesite, tuff, breccia, agglomerate and mud-flows.
3. Stony loams. Derived from more recent andesite, basalt, tuff, breccia and agglomerate.
4. Clay loam and clay. Derived from dark-colored igneous rocks.
5. Clays. Derived from limestone and marl.
6. Stony loams. Derived from sandstone, conglomerate and volcanic breccia.
7. Sandy loam and loams. Derived from schists and granite.
8. Sandy loam and loams. Developing on coarse-textured alluvium.
9. Loams. Developing on alluvium, predominantly of intermediate texture.
10. Silty clay loam and clays. Developing on alluvium, predominantly fine-textured.
11. Intermittently flooded phases of soils 8, 9 and 10. Developing on alluvium of undifferentiated textures.
12. Swamp soils. Developing in depressions on alluvium of undifferentiated textures.

## Introduction

No soil map, based upon direct examination of the soils of Halmahera and its neighboring islands, has been made of that region. Some descriptions of soils in widely scattered places were published in 1849, but they referred to so few soils and were so general and so brief as to be of small value. Recently Mohr has given a short general description of some of the probable characteristics of the soils of Halmahera based upon inferences and analogies drawn from what he considered to be similar soil-forming conditions in existence elsewhere, but these too, are extremely general and include no quantitative data on the soils.

The soil descriptions and map contained in this folio result from consideration of the literature already mentioned, published reports of travelers who have visited the region and have contributed scattered observations upon its soils, and have published studies of soils in nearby regions or in others known to possess environmental conditions generally similar to Halmahera with respect to soil formation processes(see list of references). In addition, existing knowledge of the influence of the soil-forming factors: geology, topography, climate, vegetation and relative duration of various kinds of soil-forming processes, has been applied to the conditions of Halmahera.

Although the main geologic, topographic and climatic characteristics of the Halmahera region are known in a general way, detailed information is lacking in many instances. With respect to the areal distribution and relative abundance of lithologic types within a geologic group, for example, very little is known. The position of boundaries between major geologic groups is in several instances not known exactly and in certain cases (e.g. on the island of Morotai) the existence of these boundaries is only speculative.

On all but a very few small islands of the Halmahera group altitudes are indicated to within ± 50 meters (±165 feet) but no closer. On the basis of topographic information, therefore, the extent of coastal plains and alluvium cannot be drawn with much accuracy. Information concerning vegetation is extremely incomplete. Prediction of the probable kind and distribution of soil types is handicapped by such gaps in knowledge of the conditions controlling soil formation, and the properties assigned to the soil types which are shown on the soil map must be interpreted in the light of these facts. Soil type boundaries are only approximately placed. Profile diagrams are to be regarded as fairly representative of the probable soil conditions over the majority of the area to which a particular soil type is assigned. Probable deviations are mentioned in the descriptive matter accompanying the diagram. Complete knowledge of the characteristics and distribution of soils can at present only be obtained by direct field inspection of the soils themselves.

Owing to the high mean temperature and relatively narrow temperature range, soil formation in the tropics is characterized by intensity of chemical weathering, particularly where rainfall is frequent and abundant. In the absence of erosion the rock beneath well-drained upland soils weathers to very great depths, organic matter decomposes rapidly, and the mineral part of the soil is almost depleted of base-forming cations. In cooler regions of high altitude the changes take place less rapidly but are similar in trend. Silica, except in quartz, is removed fairly rapidly but iron-oxide and alumina tend to accumulate. The clay fraction, whose composition is affected by this type of change, shows certain chemical and physical properties which are either lacking, or not exhibited to the same extent, in more silica-rich soils. Outstanding physical properties of such tropical clays are the following: a tendency to form small clusters, or granules, which persist or reform during or after working; comparatively low plasticity and correspondingly high friability; comparatively low swelling and shrinking on wetting and drying; comparatively high permeability to water. Poorly drained soils in which the water table is high may have undergone some silica enrichment and contain clays of different composition. The clays are more likely to be sticky when wet, to have higher plasticity and to be much less friable, to show greater shrinking and swelling, and to possess lower permeability. Frequently the organic content of these wet soils is higher. On steeper slopes, erosion may remove the soil so rapidly that the underlying rock is exposed at the ground surface; it is generally sufficiently active that the depth of accumulated soil is much less in such places than it is where the slopes are more gentle. On the gentler slopes considerable depths of soil may accumulate and the unaltered bedrock may be very deeply buried. The character of the rock and the duration of the soil-forming processes are, however, of great importance. For example. uplifted coral reef limestone, composed almost entirely of calcium carbonate, weathers to leave very little residue. Shallow, sandy soils are common on this rock type.

Most of the soils (types nos. 2,3,4,7) on Halmahera, Batjan and Kasiroeta have been formed by the weathering in place of numerous non-sedimentary rocks (see Geology Map). Tertiary and more recent volcanic rocks, and mafic igneous rocks some of which are metamorphosed, predominate. Soils (types nos. 8,9,10,11,12) forming upon recent alluvium are less abundant in extent. Where present, the characteristics assigned to them are due to the consideration of the source of the alluvium, the size assortment which it has received and the prevailing drainage conditions. Ground water laterites, originating in soils having periodically fluctuating water tables whereby dissolved iron is precipitated as the result of oxidation, are probably of very limited occurrence on Halmahera. They may occur, in an early stage of formation, on the coastal lowland with soil types 10 and 11, and on the margins of type 12.

Classification of the soils is shown in the following table:-

Soils of the uplands

Well-drained, Zonal; red to red-brown lateritic. Friable.

1. Sandy loam and sandy clay loam. (Light-colored loamy sands or sands on coral islands). Derived from interbedded conglomerate, volcanic ash, uplifted reef limestone, clay and marl beds.
2. Loams. Derived from old (mid-Tertiary) andesite, tuff, breccia, agglomerate and mud-flows.
3. Stony loams. Derived from more recent (Quaternary and Recent) basalts, andesite, tuff, breccia and agglomerate.
4. Clay loam and clay. Derived from dark-colored igneous rocks.
5. Clays. Derived from limestone and marl.

Well-drained, Zonal; red-brown to gray-brown lateritic. Friable.

6. Stony loams. Derived from sandstone, conglomerate and volcanic breccia.
7. Sandy loam and loams. Derived from schist and granite.

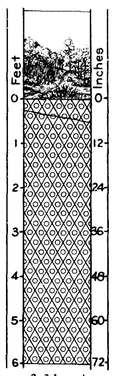
Soils of the river valleys and coastal lowlands

Moderately well-drained, Azonal; brown. Loose to friable.

8. Sandy loams and loams. Developing on alluvium, predominantly coarse-textured.
9. Loams. Developing on alluvium, predominantly of intermediate texture.

Poorly-drained. Azonal; brown to gray. Plastic.

10. Silty clay loam and clays. Developing on alluvium, predominantly fine-textured.
11. Intermittently flooded phases of nos. 8, 9, 10. Developing on alluvium; of undifferentiated textures.
12. Swamp soils. Developing in depressions on alluvium of undifferentiated textures.




### Soil Type 1

Sandy loams and sandy clay loam

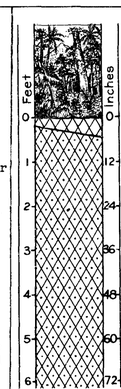
0 to (3-6) ins: Red-brown sandy loam containing small amounts of organic matter. May be stony or gravelly.
(3-6) ins. and below: Brown-red, less commonly red, friable sandy loam to clay loam. May be stony or gravelly and contain some small, soft iron-oxide concretions at depths of 12 to 24 inches. Weathered Pliocene and Quaternary strata may occur at any depth in the profile, largely depending upon position, slope and erosion. These strata consist of tuffaceous sandstone having a wide range in particle size, marly clay, conglomerate and interbedded reef limestone. The soils are probably particularly shallow and sandy along terrace rims where reef limestone may be very close to surface and upon coral islands. In such places shallow, sandy soils, consisting mainly of coral fragments, probably develop and blocks of coral and irregular, rough outcrops of coral rock may be found. Elsewhere, and where level, soil is deeper and contains more clay.

Differences in the parent rock of thissoil type may be very great as indicated in the profile description. In addition to the rocks mentioned, locally (e.g. north central Batjan Island) there may be thin lignite seams. If near the surface lignite will probably contribute toward a darkening of the soil and have a loosening effect upon it, tending to make it more friable. Evidently the surface soil which has developed upon such differently composed stratified rocks may bear no relation to the rock which at present forms its substratum. No estimates are available of the areal extent of the different rocks contributing to this formation; they are considered as a single group and the possibility of variations in the soil profile must be recognized.

Properties: The permeability of the soils is relatively high. They have a medium to low water-holding capacity with relatively high wilting point, are friable and probably of intermediate to low natural productivity. Reaction probably neutral except in surface few inches where slightly acid; presence of shell fragments or calcareous rock in profile disturbs regular trend of acidity with depth.

Relief: Chiefly terraces along sea-coast and extending several miles inland. May terminate in steep cliffs on coastal side. Some escarpments and low cliffs within the type. North and west of large isthmus, in interior of Batjan, type is hilly with steep gullied ridges and rolling upland valleys. Altitude range: 0 to 825 ft.

Vegetation: First and second growth forest, some interspersed grasses and shrubs in more open forest. Alang-alang (cogon).




### Soil Type 2

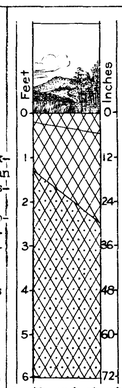
Loams

0 to (2-5) ins: Friable loam or clay loam. Color is brown to light-brown on steep slopes, brown-red on gentle slopes. The organic matter content is low but sufficient to produce a darker color in the surface soil than in the deeper horizons. Its presence also adds to the crumbly character of the layer. On steepest slopes erosion may have limited the formation of this horizon and produced a sandier surface soil than exists elsewhere on the type. Nodular concretions of iron-oxide may be present on less steep slopes.
(2-5) ins. and below: Yellow-brown and red-brown, locally purplish red and in places almost gray (where poorly drained) fairly friable clay loam, locally coarser. Contains dark-brown or rust-brown iron-oxide concretions of different degrees of hardness, and also rock fragments. Abundance of concretions decreases, that of rock fragments increases with depth. For many feet in depth traces of original rock structure can be seen but material can be cut with spade. Hard bedrock is found at a variety of depths, lying deepest at the lower altitudes. The mid-Tertiary parent rock may consist of andesite, interbedded layers of tuff, coarse volcanic breccia, agglomerate and mudflows, any of which may possess great thickness. In places these deposits have been reworked by streams and washed downslope and, because of the interbedding, the soil may have been formed from a superjacent bed not identical with the present substratum. Soil erosion at the higher altitudes has there produced shallower soils, and moderately hard andesite rock or boulders and stones from agglomerates and mudflows, may be exposed at the surface. The abundance of iron-oxide concretions is probably less in this soil type than in type 4. Their pH may be somewhat lower, particularly in the surface layers.

Properties: Permeability and water retention high to moderately high. Complete dispersion i.e. breaking down of clusters and groups of soil particles into component parts, is difficult in these soils and a high degree puddling is rare, so that the soils tend to preserve a friable state. Plasticity index or plasticity number is of uncertain significance in these soils. Wilting point probably relatively high.

Relief: Hilly and mountainous; well-drained mountain valleys. Altitude range: 0 to 2600 ft.

Vegetation: Probably dense rain forest. Possibly some moss forest at highest altitudes on northwest or southeast slopes. At lower altitudes cultivation may have resulted in second growth forest conditions and alang-alang (cogon) grass cover.




### Soil Type 3

Stony loam and stony clay loam

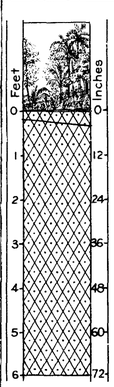
0 to (2-5) ins: Brown, friable, loose loam. Organic matter content low.
(2-5) to (15-30) ins: Brown, chocolate-brown, or yellow-brown rather compact loam or clay loam which crumbles into a fairly friable, loose mass when disturbed. May contain small rust-brown or brown iron oxide concretions and many stones and boulders.
(15 - 30) ins. and below: Red-brown to brown rather compact clay loam containing many weathered stone fragments of different degrees of hardness and size. Iron-oxide concretions may be disseminated through upper part of layer, except in youngest profiles. Depth and stoniness vary with slope; steeper slopes have shallower and more stony soils. The profile description is based on a soil developed upon older Quaternary basalt or andesite, which has been but little affected by erosion. The volcanic rocks which comprise the parent rock of these soils are, however, not constant in composition and in many instances the rock is very young Quaternary or even Recent. Breccias, tuffs and mudflows are commonly interbedded with lava flows. Hence stoniness and textural composition of soil profile will show many and at times wide differences from place to place. Recent aa-like flows may extend from high to very much lower altitudes and have no soil cover whatever (see photograph no. 16 of flow on Ternate). Soil color is probably very light brown to gray, and texture is coarser upon the younger volcanic formations. At higher altitudes, and on steepest slopes elsewhere, erosion has removed soil almost or quite as rapidly as it has been formed, so that the soil is very thin or absent. The extent and occurrence of these deviations in soil characteristics cannot be predicted upon the basis of the available information.

High temperature and continuously moist climate have combined to produce desilicification and relative enrichment with iron-oxide and alumina. Differences in lithology and age of parent rock have prevented the development of uniform soil conditions so that both chemical and physical properties show differences from place to place. It is probable that the more felsic as well as the most recent rocks have soils which are lowest in iron-oxide and alumina and are amongst the lesspermeable. Resilicification of tuff beds by ground water during the early stages of active soil formation upon them may have helped produce less permeable subsoils and substrata on these materials.

Properties: Soils are generally permeable, have a medium high field capacity and probably a wilting which is rather high relative to the field capacity. They are friable and possess a natural crumbly structure which is not readily destroyed. Natural productivity probably relatively low but widely variable and reaction slightly acid, particularly in surface layers.

Relief: Hilly and mountainous; steep, dissected ridges; plateaus. Altitude range: 0 to 500 ft.

Vegetation: Probably moderately open rain forest, densest in valleys and on northwest and southeast facing slopes. Alang-alang (cogon) and some second-growth at lower altitudes where few, scattered, cultivated areas may exist. Barren on some recent lava flows.




### Soil Type 4

Clay loam and clays

0 to (2-4) ins: Red-brown, friable clay loam or clay, containing small amount of organic matter and partly stained thereby on its breakage surfaces.
(2-4) ins. and below: Red-brown to purple-brown, or deep red, friable clay loam or clay containing sand, gravel and pebble-sized iron-oxide concretions. The color becomes yellower with increasing depth but is darker next to the basic parent rock. Except in localities of steepest slope and and most pronounced relief where erosion may have been severe the weathered bedrock probably lies at depths of 15 to 20 feet and is covered by altered rock and soil.
These soils are probably the most extremely weathered of any of the soils of the upland areas of Halmahera and nearby islands and provide, particularly upon peridotite and serpentine, a good illustration of the effect in upland positions, of tropical weathering processes on basic rocks in which the removal of silica and accumulation of iron-oxide and alumina have gone to an advanced stage. Iron-oxide concretions are probably more abundant in the second and third feet of the profile, unless exposed at the surface by erosion. The amounts differ, however, owing to local environmental differences. They are a partial indication of the extent to which soil formation has progressed and range in size from sub-microscopic dimensions to many centimeters in diameter. They differ in hardness: some are already hard, others may harden on exposure to the air.

It is probable that this group of soils is similar to the Nipe soils of Puerto Rico and Cuba and, in many respects, to certain of the deep-red, older soils on basic rocks elsewhere in the Netherlands Indies. Ferruginous concretions in such soils are termed "perdigones" in Puerto Rico and Cuba, and "krikils" in Sumatra.

Properties: These soils are permeable, have a high field capacity and air-dry moisture content and probably a high wilting point. They are friable despite their high clay content, since they are difficultly dispersed and puddled by comparison with most of the equally clay-rich soils of higher latitudes. The plasticity index, or plasticity number, of these soils is of doubtful significance in relation to their engineering behavior and should be interpreted with caution. The soils are probably of low natural productivity and slightly acid to neutral, but most acid in their surface layers.

Relief: Hilly and mountainous, including well drained high mountain valleys. Altitude range 0 to 4700 ft.

Vegetation: Rain forest. Some sparse second growth and grass areas at lower altitudes.

Preliminary text submitted without checking or editing.
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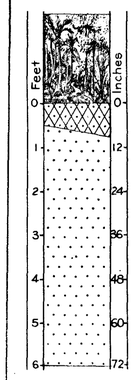
(CONT.)

## Soil Type 5

### Clays




0 to (6-10) ins: Dark brown or gray-brown, friable clay loam to sandy clay loam. Organic matter content probably low. Horizon is absent on very steep slopes.
(6-10) ins. and below: Brown-red to red clay or sandy clay, rarely sandy loam, containing ferruginous concretions in the upper part. Abundance, size and hardness of concretions differ from place to place. Parent rock of early Tertiary limestone and associated sedimentary rocks is encountered at depths ranging from few inches to several feet, depending upon slope, erosion and composition of parent rock. More gently sloping regions, depressions, sink-holes and interbedded marly layers in parent rock are associated with deeper soil. In places sandy layers are interbedded and have produced soils of coarser texture.

These soils are in many respects similar to the soils of Type 1 in the coastal regions. The parent rock group of Soil Type 5 includes more limestone, however, and the soils are influenced accordingly. A clay-rich residue generally remains after weathering of great depths of calcium carbonate rock. Interbedded layers of calcareous sand give rise to sandier soil. The soils of this group may be expected to show many similarities to the Matanzas soils of Cuba and Puerto Rico where the weathering of limestone has resulted in extremely deep accumulations of residual clay soil. The steeper slopes may consist of limestone rock practically denuded of soil.

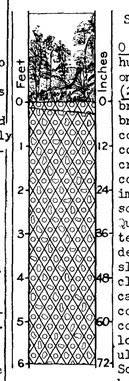
Properties: The soil is friable and easily crumbled, despite its high clay content. Permeability to water is high. Field water-holding capacity is medium high to high, and wilting point probably high. The clay particles are collected into small clusters which resist dispersion, contribute greatly to the friable and permeable character of the material and tend to produce a soil which is comparatively resistant to erosion. On steep slopes and in absence of vegetation, or where vegetation is sparse, erosion may have been considerable. Marly phases subject to slide badly. Some evidence of karst-like topography: sinks, underground streams, bare rock.

Relief: Steeply sloping hills with many cliffs and ledges. Topography may be karst-like. Altitude range: 0 to 4900 ft.

Vegetation: Moderately dense rain forest. Some second growth and alang-alang (cogon).

## Soil Type 6

### Stony sandy loams and stony loam




0 to (2-3) ins: Brown, slightly humous sandy loam to loam, commonly stony. Fine earth is friable.
(2-3) ins. and below: Yellow-brown to brown, rarely gray-brown, stony sandy loam and loam containing few brown iron-oxide concretions, soft and easily crumbled extending downward for considerable depth and merging imperceptibly with deep, unconsolidated, sub-aerial or marine, Quaternary sediments. Clay content probably increases with depth, especially on gently sloping areas. The sediments include sands, conglomerates, volcanic breccia with interbedded cobblestones. Parent rock not constant and may cause distinct local soil differences, particularly with respect to stoniness. Some calcareous cementation probably occurs locally in deeper layers.

This is a young soil developed on predominantly coarse-textured parent rock. Sedimentation peculiarities at time of deposition may have caused some stratification, but this is to be distinguished from soil horizon differentiation, which is usually not pronounced. Adjacent to Recent alluvium, slope wash has probably caused an apparent gradual transition to the soils which have formed on the Recent alluvium. The separation indicated on the maps between this soil and soils 8, 9, 10, is based primarily on altitude. Owing to the wide contour interval (165 ft.) there are almost certainly inclusions of Soil Type 6 with the generally lower lying Soil Types 8, 9, 10.

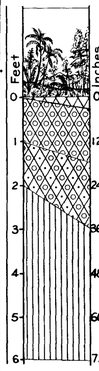
Properties: The soil is generally loose, friable permeable and has intermediate water-holding capacity. Wilting point is probably relatively low, reaction moderately to strongly acid to depths of many feet except in immediate vicinity of calcareous layers.

Relief: Uplifted terraces, deeply dissected at higher altitudes to form narrow, steeply-sloped ridges which form foothills to interior mountains. At lower altitudes the inter-gullied areas are broader and may be fairly flat. Altitude range: 0 to 3300 ft.

Vegetation: Rain forest of intermediate density, in places open with second growth. Locally alang-alang grass (cogon) may be abundant.

## Soil Type 7

### Sandy loam and loams




0 to (1-3) ins: Dark brown to brown slightly humous loam. Absent on very steep slopes.
(1-3) to (12-18) ins: Brown, gray-brown or red-brown sandy loam to loam containing quartz sand and gravel, some mica. In the moist state, locally, greasy to the feel where mica-rich.
(12-18) to (24-36) ins: Brown or red-brown sandy clay loam. Similar to layer above but contains more clay and may contain iron-oxide concretions, particularly where parent rock is mafic (e.g. amphibolite, diabasic tuff). Clay content though not high, probably reaches a maximum in the second foot of soil.
(24-36) ins. and below: Decomposing rock, stained brown to red-brown, extending to 10 feet or deeper and probably in upper part greatest proportion of colloidal clay and other fines. Texture approximately sandy loam to sandy clay loam. Becomes increasingly sandy and stony with depth. The weathered rock lies deeply buried. The pre-Permian rock in the Sibela Mountains region includes, in addition to amphibolite and diabasic tuff, quartzite, quartz mica schist, hornblende schist and diorite gneiss. Near the Geti River in northeast Batjan the soils are formed upon pre-Permian hornblende granite and are probably of greater depth and coarser textured.

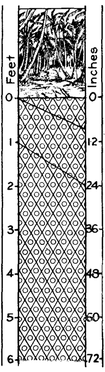
Properties: These soils are old and highly leached. They are permeable and have intermediate to low field moisture capacity and wilting point. Friability less than that of soils nos. 1 to 5. They are the most acid of the residual soils throughout their profiles.

Relief: Steep, rugged, mountainous in Sibela Mountains; less steep, with smoother topography along Geti River. Altitude range: 0 to 6650 ft.

Vegetation: Rain forest. Probably some alang-alang (cogon) on gentle slopes.

## Soil Type 8

### Sandy loams and loams




0 to (0-8) ins: Dark brown to brown, somewhat humous sandy loam to very fine sandy loam. Textural grades within the sandy loam group may include gravelly sandy loam. Loose, open structure.
(0-8) to (12-24) ins: Brown or red-brown. Texture range similar to that of overlying soil. Structure more compact and slightly less permeable than in upper layers.
(12-24) ins. and below: Brown or yellow-brown fairly compact sandy loam to clay loam. Locally gravelly sandy loam or gravelly sand. A poorly drained phase of this soil, of gray color with rust-brown stains and markings in subsoil, may occur on level areas. It is grouped with similar phases of soils 9 and 10 under Soil Type 11. Only the large areas of these poorly drained phases are shown on the map. Where soil 11 occurs adjacent to soil 8, the texture of Soil Type 11 is similar to that of Soil Type 8. The soil merges imperceptibly at depths of several feet with the underlying Recent river and valley alluvium which has been deposited by slope wash and erosion from adjacent slopes and higher-lying ground elsewhere. The alluvium may be stratified owing to deposition of differently textured layers. It is derived chiefly from the surface and subsoil layers which were formed upon loosely consolidated Quaternary subaerial and marine sediments: conglomerate, sandstone and some uplifted reef deposits upon which soils 5 and 1 have developed. In places, which cannot be determined by existing information, soils 8, 6, 1 are intricately inter-fingered but have been shown as Soil Type 8. Substrata may be calcareous adjacent to Soil Type 1.

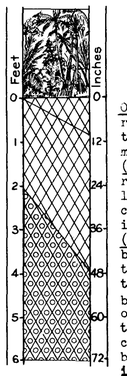
Properties: The soils are young and fairly uniform throughout the profile. Differences which exist are chiefly due to vertical differences in organic matter content and, locally, to fluctuating water table. Stratification brought about by sedimentation may be found in the relatively unaltered alluvium and also, but less commonly, in the upper part of the profile. They are permeable and possess low water-holding capacity, and probably low wilting point. They are generally well-drained but in low-lying positions away from stream channels they may have gray-brown subsoils with rusty markings and a water table within 2 or 3 feet of the surface. Reaction probably slightly acid.

Relief: Level to gently sloping. Altitude range: 0 to 330 ft.

Vegetation: Coconut palm, rain forest, grass.

## Soil Type 9

### Loams




0 to (0-10) ins: Dark brown, rarely black-brown, friable loam to clay loam, containing organic matter. Fairly open structure.
(0-10) to (24-48) ins: Brown to red-brown friable loam to clay loam. Structure somewhat more compact and density greater than in uppermost layer.
(24-48) ins. and below: Red-brown to yellow-brown sandy loam to clay loam. Density greater than that of overlying layers, but soil crumbles quite readily on drying. The alluvium extends to considerable depths and except where reduction has been brought about by a high or periodically high water table is generally brown to yellow-brown or red-brown. A poorly drained phase of this soil, gray in color with yellow-brown and brown stains in subsoil may occur in level areas. It is grouped with similar phases of soils 8 and 10 under Soil Type 11. Only the larger areas of these poorly drained phases are shown on the map. Where soil 11 occurs adjacent to soil 9 the texture of soil 11 is similar to that of soil 9. The parent material of this group of soils results from the erosion of upland areas upon which Soil Types 2 and 3 are the main types. Included with Soil Type 9 as described are some areas of Soil Type 6 occurring on small bodies of upland which it has not been possible to differentiate. In places where the soil has formed entirely on wash from adjacent slopes surface drainage is superior. Along coast, narrow strips of sandy soil, too narrow to indicate on map, may be found locally, adjacent to this type.

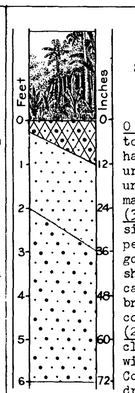
Properties: The soils are young and exhibit very little profile development, in this respect being similar to soils 8 and 10. These soils possess higher friability and permeability than their texture might suggest, but are less permeable than the sandy loams of type 8. They have moderately hogh to high water-holding capacity and probably a relatively high wilting point. Drainage is moderately good, particular-adjoining stream channels. Depressions, between drainage ways and adjacent upland, are less well drained and may have high water table. Reaction probably slightly acid throughout.

Relief: Level to gently sloping. Less commonly, distinctly sloping. Altitude range: 0 to 330 ft.

Vegetation: Rain forest, bamboo, coconut palm.

## Soil Type 10

### Silty clay loam and clays




0 to (3-12) ins: Dark gray-brown to gray silty clay loam to clay, having moderately porous structure in upper part where undisturbed. Relatively high organic matter content.
(3-12) to (24-36) ins: Clay to silty clay loam with color dependent upon drainage. Under good drainage color is some shade of brown; poor drainage causes gray flecked with rust-brown markings. May contain soft concretions of iron-oxide.
(24-36) ins. and below: Silty clay and clay; may be stratified with fine sand, sand or gravel. Compact. Color affected by drainage. Probably gray to yellow gray, mottled with brown, black, and green markings at depth of about 5 feet or more. Extends with little change into deep bed of alluvium generally showing similar color peculiarities, locally not mottled. An intermittently flooded phase of this soil, gray with rust-brown streaks and iron-oxide concretions in the subsoil and of noticeably inferior drainage, has been grouped with similar phases of 8 and 9 under Soil Type 11. Only the large areas of these phases are shown on the map. Where soil 11 occurs adjacent to soil 10 the texture of soil 11 is similar to that of soil 10.

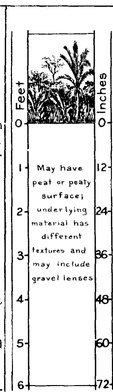
Properties: Surface soil of this type probably contains more organic matter than that of soils 8 and 9. The soil is young and is developing very slowly, chiefly upon the fine-textured alluvium which has been deposited after erosion and slope wash of soils 4 and 5. It is commonly affected by a high water table and drains slowly, particularly away from existing stream channels. The soils are plastic, easily puddled and return but slowly upon drying to a more granular state. They have a high water-holding capacity and wilting point and low permeability. Probably distinctly acid in upper 2 feet of profile; neutral to slightly alkaline at greater depths. Areas of Soil Types 6 and 5 may be included locally with these soils.

Relief: Level to gently sloping. Some depressions. Altitude range: 0 to 330 ft.

Vegetation: Rain forest, bamboo, sago palm, some grassy areas.

## Soil Type 11

### Inter mittently flooded phases of undifferentiated soils on alluvium




0 to (12-24) ins: Dark gray to gray compact soil, of a variety of textures. Rarely, may be covered by several inches of peat.
(12-24) ins. and below: Gray to pale blue-gray or green-gray soil. Different textures. Where this soil occurs adjacent to soils 8, 9 or 10 its texture will be similar to, or slightly finer than, that of the adjacent soils. Some stratification. Gravel lenses not uncommon, particularly below sandy surface soils.

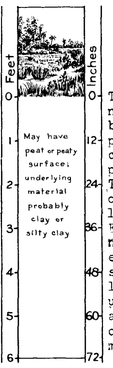
Properties: These soils are found in low-lying positions in valleys and coastal depressions. In some places near coast they may be saline. They are closely associated with the other soils on alluvium and comprise a group which are somewhat better drained than the swamp soils but less well drained than soils 8, 9 and 10. They are frequently flooded and always have a high water table, probably within 12 inches of the surface. Possibility exists of precipitation of iron-oxide in finer-textured soils of this group, particularly where surrounded by clay of Soil Type 10 and by upland areas of clay loams and clay (Soil Type 4). Iron-oxide, as nodules and layers, probably soft if present.

Relief: Flats and depressions. Altitude range: 0 to 175 ft.

Vegetation: Rain forest, sago palm, some grassy areas.

## Soil Type 12

### Swamp soils




These soils possess any one of numerous textures but it is probable that fine-textured classes predominate. They may have a covering of peat. In places, particularly adjacent to Soil Type 1, along the southern shore of Boeli Bay, they may be underlain by coral limestone or clay. Elsewhere they are found in pronounced depressions and are deeper having fine-textured substrata of low permeability, or lie adjacent to underground aquifers. They are water-logged and are usually inundated throughout the year. Near coast they may be saline.

Relief: Flats and depressions. Altitude range: 0 to 100 ft.

Vegetation: Swamp vegetation, including sago-palm and, near coast, may include mangrove and other rhizophores, and nipah palm.

EXPLANATION OF PATTERNS USED IN SOIL DIAGRAMS

LOAM · GRAVEL · SAND · SILT · CLAY

**Reliability Rating: Class D**

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S ARMY

## INTRODUCTION

The texture, or particle size distribution is probably the most useful single indication of the engineering properties of a soil. The textures of the soils of Halmahera have been estimated together with their engineering group classification, for which the symbols used in the Public Roads Administration Group Classification (See Principles of Highway Construction, Public Roads Administration, Federal Works Agency, June, 1943) and the Aviation Engineers Technical Manual TM 5-255, respectively have been used, and are given for each type. Interpretation of the engineering properties of these tropical soils depends primia..ily, however, on the experience of soils workers and engineers in more temperate regions; much has yet to be learned of the properties of tropical soils, particularly of the red, red-brown, yellow, and yellow-brown soils. It is known that the clay fraction of these soils has a much lower silica content than that of most temperate-region soils, and is correspondingly very much higher in hydrated oxides of iron and aluminum, and in certain other compounds of iron, aluminum, and silicon. The behavior of the clay during construction operations is greatly affected by these peculiarities in composition. All soils containing clay become more or less plastic when moistened sufficiently, but in general, the clays of the red, red-brown and yellow-brown soils are less plastic and more friable, i.e., less affected by water absorption than the clays of the temperate regions and the generally more silica-rich soils of the tropical lowlands. This difference is manifested by a lower degree of stickiness, less swelling on wetting, less shrinkage on drying, and higher permeability. They tend to flocculate, to remain flocculated and to return to the flocculated state more re readily than the more siliceous soil clays.

The estimated engineering properties of the soils before construction treatment take into consideration differences from one soil horizon to another. Void ratios, the ratio of void space to actual volume of solid in a soil, are given in round numbers. Void ratio=(1-V)/V, in which V equals the volume of solid in a cubic foot of the soil as calculated from the original field-dry weight and assuming a specific gravity for soil grains of 2.65. Porosity is the fractional mount of voids present in the soil, 1-V/1.

Moisture retention, or field moisture capacity as percentage, dry weight basis, is chiefly dependent upon particle-size distribution and organic matter content but the calculation extended to the volume basis and given as inches of water retained per foot in depth of soil is calculated from both percentage and field-dry weight of soil. The moisture-retention data for different kinds of soils are based on experiments that have determined the percentage of water retained respectively by the sand, silt, and clay components of the soil. These data are particularly useful because they enable the engineer to estimate (1) the water retained by a well-drained soil within a day or two after a deep-penetrating rain and (2) the moisture content below which the soil cannot be uniformly wetted simply by the addition of water to the surface of the soil. For example, if the minimum water retention of a level mass of uniform soil after free drainage is 3 inches per foot, and the soil is desired to be uniformly wetted to that moisture content to a depth of 4 feet, then 12 inches of water may be applied to a completely dry soil and the desired result attained. The addition of only 6 inches of water to the same soil would only wet 2 feet of the soil to an equivalent of 3 inches per foot; the lower 2 feet of soil would remain unwetted. The amount of water present in air-dry soil may also be estimated, for at an air humidity of 50 percent, the water content of the soil is about one-fourth to one-fifth of the moisture retention percentage.

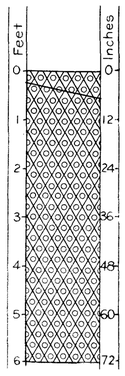
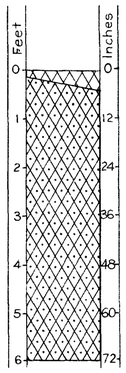
The estimated properties of the soils after construction treatment, i.e., dry weight and moisture percentage at optimum compaction and also bearing-ratio percentage, are obtained from Technical Manual 5-255 for soil of the appropriate classification group. The conversion of moisture percentage at optimum compaction to inches of water per foot of soil has been calculated in the same manner as before but by use of the corresponding optimum compaction values. Void ratio has been calculated on the same basis as before but refers here to optimum compaction conditions. Bearing ratio represents the load supporting power of the soil in comparison with that of crushed rock.

Most available soils information concerning particle-size distribution disposes of the amounts of particles coarser than a few millimeters in diameter by use of the terms "stony" or "gravelly." All estimates in this table are based upon material finer than 2 mm. diameter and soils described as gravelly or stony will have estimates which are too low for weights per cubic foot and bearing ratios, and too high for void ratios and water retention values.

(CONT.)

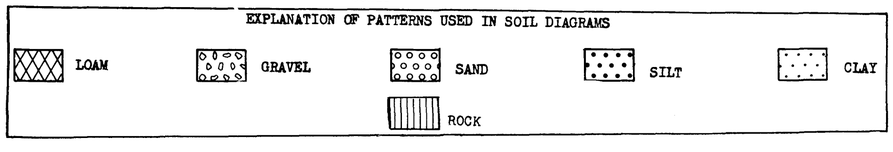
# HALMAHERA (MOLUKKAS)

## SOILS: ENGINEERING PROPERTIES

| Soil number and type name | | | 1. Sandy loams and sandy clay loam | | 2. Loams | |
|---|---|---|---|---|---|---|
| Soil Profile | | |  | |  | |
| Depth (inches) | | | 0 to (3-6) ins. | (3-6) ins. and below: | 0 to (2-5) ins. | (2-5) ins. and below: |
| Engineering names and group symbol [a/] | | | Sand with fines; poorly graded sand clay mixtures with small amount of organic matter. SF (A-2) | Sand-clay mixtures, poorly to well graded. ML, SF, SC (A-4, A-2, A-1) | Sand with fines; contains small amount of organic matter SF (A-2) | Inorganic clay loams of low plasticity; high friability CL (A-4) |
| Engineering Properties | Before construction treatment | Cohesion in dry state | Low | Low | Low | Low to intermediate |
| | | Foundation value | Fair to good | Fairly good to excellent | Fair to good | Fair to good |
| | | Expansion and shrinkage | Very low | Low | Very low | Low |
| | | Permeability | Medium | Medium | High | High |
| | | Weight, lbs/cu. ft. | 70 - 85 | 75 - 100 | 70 - 85 | 70 - 85 |
| | | Void ratio | 0.95 - 1.4 | 0.65 - 1.2 | 0.95 - 1.4 | 0.95 - 1.4 |
| | | Water retention % | 8 - 16 | 6 - 15 | 15 - 25 | 18 - 30 |
| | | Water retention ins./ft. | 1.1 - 2.6 | 0.9 - 2.9 | 2 - 4 | 2.4 - 4.9 |
| | Depending on Construction Treatment (at optimum compaction) | Weight, lbs/cu.ft. | 110 - 125 | SF: 110-125 SC: 125< | 110 - 125 | 100 - 120 |
| | | Void ratio | 0.33 - 0.5 | SF: 0.33 - 0.5 SC:<0.33 | 0.33 - 0.5 | 0.39 - 0.66 |
| | | Water retention % | 11 - 17 | SF: 11 - 17; SC:<11 | 11 - 17 | 13 - 22 |
| | | Water retention ins./ft. | 2.3 - 3 | SF: 2.3 - 3.; SC:<2.6 | 2.3 - 3 | 2.5 - 4.7 |
| | | Bearing ratio, percent | 8 - 30 | SF: 8 - 30 ; SC:20-50 | 8 - 30 | 4 - 20 |
| Soil properties as affecting construction problems | | | AGGREGATE AND BINDER: Locally, considerable aggregate may be present in soil, partly in form of iron concretions. Gravel, pebble and cobble beds (unconsolidated conglomerate) also generally common; of fair crushing quality. Amount of binder in soil adequate for stabilization, quality fair, except on coral islands. Better binder exists in soil type 10 and maybe used where conveniently situated. MECHANICAL STABILIZATION OF LOOSE MATERIAL: Admixture of binder generally not necessary except on coral islands. Well suited to compaction and does not require very close moisture control. Bearing ratio fair to good, locally excellent (see Local materials table and TM 5-255, fig. 102). Permeability good. A special case exists where limestone near surface provides good foundation but may require special drainage treatment. Soils become dusty after prolonged dry period. SUITABILITY FOR SUBGRADE AND BASE COURSE: Good subgrade material, commonly suitable without scarification and blending. Compaction of foundation not alwaysnnecessary. Where clay beds near surface suitability for subgrade is reduced and necessity for a thick base course is increased. SUITABILITY FOR STABILIZATION WITH PORTLAND CEMENT OR BITUMEN: The most sandy and gravelly representatives of type are suited to such stabilization. Some clay rich members not so well adapted. | | AGGREGATE AND BINDER: Hard, higher quality aggregate not abundant except locally and at higher altitudes; should be tested for quality before use. Soil high in content of binder of medium quality. Fines are too friable for best binder. MECHANICAL STABILIZATION OF LOOSE MATERIAL: Fairly well suited to compaction; moisture control not difficult. Bearing ratio fair to good (See local Material Table and TM 5-255, fig. 102). Permeability good, permitting fairly rapid distribution of moisture up to field capacity. Internal drainage good. SUITABILITY FOR SUBGRADE AND BASE COURSE: Good subgrade material, and after compaction to optimum will probably require relatively shallow base course owing to friable character of clay. SUITABILITY FOR STABILIZATION WITH BITUMEN OR PORTLAND CEMENT: Probably not well suited for either kinds of treatment. | |

[a/] Symbols for soil types are those used in TM 5-255, and in publications of the Public Roads Administration. Reference is made to aggregate (material (coarser than No. 10 sieve) and binder already present in soil.

EXPLANATION OF PATTERNS USED IN SOIL DIAGRAMS



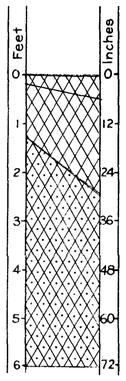
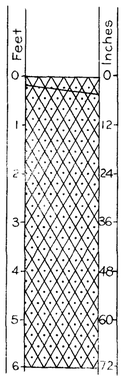

Reliability Rating: Class D

Preliminary text submitted without checking or editing.
U. S. Geological Survey

(CONT.)

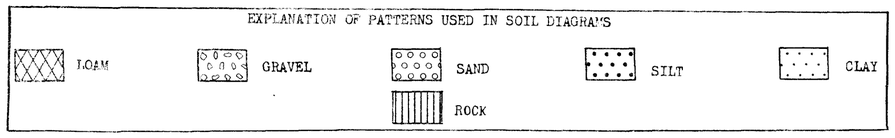
# SOILS: ENGINEERING PROPERTIES

## HALMAHERA (MOLUKKAS)

| Soil number and type name | | | 3. Stony loam and stony clay loam | | | 4. Clay loam and clays | |
|---|---|---|---|---|---|---|---|
| Soil Profile | | |  | | |  | |
| Depth (inches) | | | 0 to (2-5) ins.: | (2-5) ins. to (15-30)ins.: | (15-30) and below: | 0 to(2-4) ins. | (2-4)ins. and below: |
| Engineering names and group symbol a/ | | | Sand with fines; organic matter content low; stony SF (A-2) | Inorganic clay loam of low plasticity, high friability. Stony CL (A-4) | Inorganic clay loam of low plasticity, high friability. Stony CL (A-4) | Friable clay loam or clay with small amount of organic matter. CL (A-4) | Inorganic clay loam, or clay of low plasticity, high friability. CL (A-4) |
| Engineering Properties | Before construction treatment | Cohesion in dry state | Low | Low to intermediate | Intermediate | Low to intermediate | Low to intermediate |
| | | Foundation value | Good | Fair to good | Fair to good | Fair to good | Fair to good |
| | | Expansion and shrinkage | Low | Low | Low | Low, rarely medium | Low, rarely medium |
| | | Permeability | High | Medium to high | Medium to high | High | High |
| | | Weight, lbs/cu. ft. | 65 - 85 | 70 - 90 | 70 - 90 | 65 - 80 | 70 - 90 |
| | | Void ratio | 0.95 - 1.6 | 0.85 - 1.4 | 0.85 - 1.4 | 1.1 - 1.6 | 0.85 - 1.4 |
| | | Water retention % | 15 - 22 | 18 - 30 | 18 - 30 | 22- 34 | 22 - 35 |
| | | Water retention ins./ft. | 1.9 - 3.6 | 2.4 - 5.2 | 2.4 - 5.2 | 2.8 - 5.2 | 3 - 5.5 |
| | Depending on Construction Treatment (at optimum compaction) | Weight, lbs/cu. ft. | 110 - 125 | 100 - 120 | 100 - 120 | 100 - 120 | 100 - 120 |
| | | Void ratio | 0.33 - 0.5 | 0.39 - 0.66 | 0.39 - 0.66 | 0.39 - 0.66 | 0.39 - 0.66 |
| | | Water retention % | 11 - 17 | 13 - 22 | 13 - 22 | 13 - 22 | 13 - 22 |
| | | Water retention ins./ft. | 2.3 - 3 | 2.5 - 4.7 | 2.5 - 4.7 | 2.5 - 4.7 | 2.5 - 4.7 |
| | | Bearing ratio | 8 - 30 | 4 - 20 | 4 - 20 | 4 - 20 | 4 - 20 |
| Soil properties as affecting construction problems | | | AGGREGATE AND BINDER: Large boulders generally abundant but need crushing to produce suitable aggregate. Aggregate of satisfactory size for immediate use rare. Some indurated volcanic ash (tuff) easier to crush than boulders, locally obtainable by shallow excavation, provides lower grade aggregate. Fair quality binder provided by soil. MECHANICAL STABILIZATION OF LOOSE MATERIAL: Fairly well suited to compaction; moisture control not difficult. Bearing ratio fair to good. (See Local Materials Table and TM 5-255, fig. 102). Permeability good, permitting fairly rapid distribution of moisture up to field capacity. Internal drainage good. After continuous dry weather unsurfaced roads made from this soil become dusty. SUITABILITY FOR SUBGRADE AND BASE COURSE: This soil provides good subgrade material and requires only a rather shallow base course before surfacing. Owing to its permeable character, low volume changes with wetting and drying, it should support heavy traffic when well surfaced. SUITABILITY FOR STABILIZATION WITH BITUMEN OR PORTLAND CEMENT: Probably unsuited for either treatment. | | | AGGREGATE AND BINDER: Aggregate material scarce except for iron concretions. Rock outcrops at higher altitudes or on steep slopes provide source for crushed rock. Soil contains abundant binder of fair quality. MECHANICAL STABILIZATION OF LOOSE MATERIAL: Requires much rolling with sheepsfoot for adequate compaction and fairly close moisture control at that time. Bearing ratio fair to good. (See Local Materials Table and TM 5-255, fig. 102). Permeability and internal drainage generally remarkably good for soil of such high clay content. SUITABILITY FOR SUBGRADE AND BASE COURSE: Soils similar to these under tropical conditions elsewhere are said to provide excellent subgrade for road construction, due to their relatively low plasticity, low shrinkage and expansion and high permeability, permitting rapid drainage. Importation of aggregate necessary for heavy base course particularly in heavy duty road construction. Light traffic roads built on subgrade of this kind should not require a thick base course. SUITABILITY FOR STABILIZATION WITH BITUMEN OR PORTLAND CEMENT: Probably unsuited for either treatment. | |

a/ Symbols for soil types are those used in TM 5-255, and in publications of the Public Roads Administration. Reference is made to aggregate (material coarser than No. 10 sieve) and binder already present in soil.

EXPLANATION OF PATTERNS USED IN SOIL DIAGRAMS



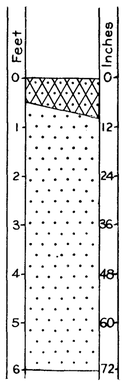
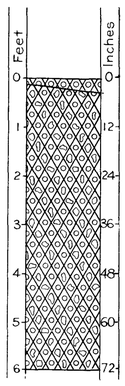

**Reliability Rating: Class D**

Preliminary text submitted without checking or editing.
U. S. Geological Survey

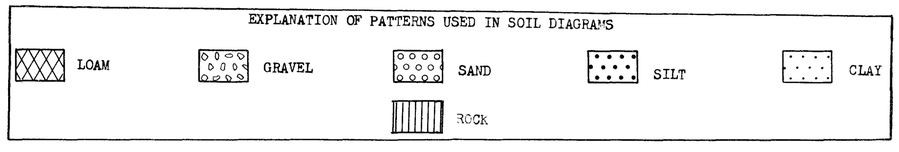
(CONT.)

# HALMAHERA (MOLUKKAS)

## SOILS: ENGINEERING PROPERTIES

| Soil number and type name | | | 5. Clays | | 6. Stony sandy loams and stony loam | |
|---|---|---|---|---|---|---|
| Soil Profile | | |  | |  | |
| Depth (inches) | | | 0 to (6-10) ins.: | (6-10)ins. and below: | 0 to (2-3) ins.: | (2-3) ins., and below: |
| Engineering names and group symbol a/ | | | Clayey sands and poorly graded sand-clay mixtures SF, ML (A-2,A-4) | Inorganic clays and sandy clays of low plasticity, high friability. CL (A-4) | Sand (some gravel) with fines; contains organic matter. SF, some GF (A-2) | Sand (some gravel) with fines; clayey sands of low plasticity and high friability SF, GF, ML (A-2, A-4) |
| Engineering Properties | Before construction treatment | Cohesion in dry state | Intermediate | Intermediate | Low | Low to intermediate |
| | | Foundation value | Fair to good | Fair to good | Good | Fair to good |
| | | Expansion and shrinkage | Low to medium | Low | Low to very low | Low |
| | | Permeability | High | Medium to high | Medium | Medium to high |
| | | Weight, lbs/cu. ft. | 65 - 85 | 75 - 90 | 75 - 85 | 75 - 90 |
| | | Void ratio | 0.95 - 1.1 | 0.85 - 1.2 | 0.95 - 1.2 | 0.85 - 1.2 |
| | | Water retention % | 18 - 25 | 15 - 30 | 12 - 22 | 8 - 20 |
| | | Water retention ins./ft. | 2.3 - 4.1 | 2.2 - 5.2 | 1.7 - 3.6 | 1.2 - 3.5 |
| | Depending on Construction Treatment (at optimum compaction) | Weight, lbs/cu. ft. | 100 - 125 | 100 - 120 | 110 - 130 | 100 - 130 |
| | | Void ratio | 0.33 - 0.66 | 0.39 - 0.66 | 0.27 - 0.5 | 0.27 - 0.66 |
| | | Water retention % | 11 - 22 | 13 - 22 | 9 - 17 | 9 - 22 |
| | | Water retention ins./ft. | 2.1 - 3 | 2.5 - 4.7 | 1.9 - 2.8 | 1.7 - 2.8 |
| | | Bearing ratio, percent | 4 - 30 | 4 - 15 | SF: 8 - 30<br>GF: 20 - 60 | 6 - 30<br>GF: 20 - 60 |
| Soil properties as affecting construction problems | | | AGGREGATE AND BINDER: Aggregate probably scarce where present consists of limestone fragments. Soil supplies abundant binder material of fair quality.<br>MECHANICAL STABILIZATION: Heavy rolling with sheeps foot probably necessary. Control of moisture when bringing to optimum compaction needs close attention, but moisture distribution should not be difficult. Bearing ratio fair to good, locally excellent (See Materials Table and TM 5-255). Permeability and internal drainage good and much superior to those of lowland soils of correspondingly high fines content.<br>SUITABILITY FOR SUBGRADE AND BASE COURSE: General behavior in subgrade construction probably very similar to soils of Type No. 4 and probability of subgrade failure small. Importation of aggregate for base course construction may be desirable for local conditions and also as treatment for heavy duty use. Owing to good internal drainage of these soils, it is unlikely thick base course is needed for light traffic roads.<br>SUITABILITY FOR STABILIZATION WITH BITUMEN OR PORTLAND CEMENT: Probably unsuited for either treatment, particularly for soil cement. | | AGGREGATE AND BINDER: Cobbles, fragments of lava rock and gravel all of fair to good quality commonly present, but differ in abundance from place to place on the soil type. Binder of fairly good quality contributed by soil.<br>MECHANICAL STABILIZATION OF LOOSE MATERIAL: Soil fairly well graded and usually requires admixtures of fines or aggregate for stabilization. Locally subsoil considerably higher in clay content. Soil compacts well; moisture control during this process simple. Bearing ratio good to very good; excellent for GF (See Local Materials Table, and TM 5-255). Permeability and natural drainage good.<br>SUITABILITY FOR SUBGRADE: Good subgrade material, after proper compaction. Requires bearing course of moderate thickness before surfacing.<br>SUITABILITY FOR STABILIZATION WITH BITUMEN OR PORTLAND CEMENT: Fairly well adapted, particularly in localities of sandy and gravelly soils for bitumen and cement stabilization. may require preliminary screening. | |

a/ Symbols for soil types are those used in TM 5-255, and in publications of the Public Roads Administration. Reference is made to aggregate (material coarser than No. 10 sieve) and binder already present in soil.

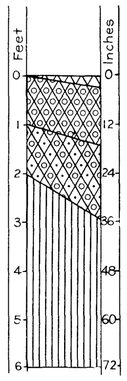



**Reliability Rating: Class D**

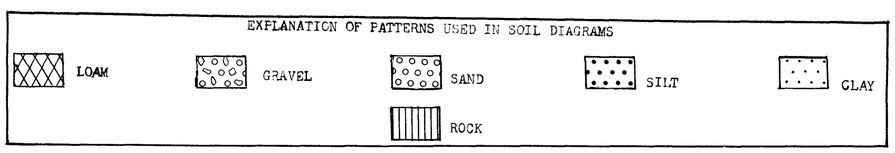
Preliminary text submitted without checking or editing.
U. S. Geological Survey

(CONT.)

# SOILS: ENGINEERING PROPERTIES — HALMAHERA (MOLUKKAS)

| Soil number and type name | | | 7. Sandy loam and loams | | | |
|---|---|---|---|---|---|---|
| Soil Profile | | |   | | | |
| Depth (inches) | | | 0 to (1-3) ins.: | (1-3) ins. to (12-18) ins.: | (12-18)ins. to (24-36) ins.: | (24-36) ins. and below: |
| Engineering names and group symbol a/ | | | Sand (some gravel) with fines SF, GF (A-2) | Sand (some gravel) with fines; clayey sands SF, ML (A-2, A-4) | Sand with fines; clayey sands of low plasticity and moderately high friability SF, ML (A-2, A-4) | Sand and gravel with fines; poorly graded mixtures. Fragments of rock easily shattered. SF, GF (A-2) |
| Engineering Properties | Before construction treatment | Cohesion in dry state | Low | Low | Intermediate | Low to intermediate |
| | | Foundation value | Good | Good | Fair to good | Good |
| | | Expansion and shrinkage | Low | Low | Low to medium | Low |
| | | Permeability | High | Medium to high | Medium, locally low | Medium to high |
| | | Weight, lbs/cu. ft. | 65 - 80 | 70 - 85 | 70 - 90 | 75 - 95 |
| | | Voidratio | 1.1 - 1.6 | 0.95 - 1.4 | 0.85 - 1.4 | 0.75 - 1.2 |
| | | Water retention % | 15 - 20 | 12 - 18 | 10 - 20 | 4 - 8 |
| | | Water retention ins./ft. | 1.9 - 3.1 | 1.6 - 2.9 | 1.3 - 3.5 | 0.6 - 1.5 |
| | Depending on Construction Treatment (at optimum compaction) | Weight, lbs/cu. ft. | 110 - 130 | 110 - 125 | 100 - 125 | 110 - 130 |
| | | Void ratio | 0.27 - 0.5 | 0.33 - 0.5 | 0.33 - 0.66 | 0.27 - 0.5 |
| | | Water retention % | 9 - 17 | 11 - 17 | 11 - 22 | 9 - 17 |
| | | Water retention ins./ft. | 1.9 - 2.8 | 2.3 - 3 | 2.1 - 3 | 1.9 - 2.8 |
| | | Bearing ratio, percent | SF: 8 - 30; GF: 20 - 60 | 8 - 30 | 6 - 30 | SF: 8 - 30; GF: 20 - 60 |
| Soil properties as affecting construction problems | | | AGGREGATE AND BINDER: Amount of fair quality aggregate in soil differs with locality. In favorable places on steep slopes where soil is relatively shallow, soft, coarse sand and gravel may be found above altered parent rock. On gentle slopes soil probably too deep to permit profitable excavation. Binder supply probably adequate except possibly in surface few inches in which soil is also highest in organic matter. Quality of binder medium.<br>MECHANICAL STABILIZATION OF LOOSE MATERIAL: Possible need for additional binder should be considered. Soil should compact well and maintainence of the moisture content necessary for optimum compaction should give no difficulty. Bearing ratio fair to very good, probably excellent where gravelly, and generally good (see Local Materials Table, and TM 5-255, fig. 102). Permeability fairly good, to good. May have to guard against effects of local seepage; drainage conditions otherwise good.<br>SUITABILITY FOR SUBGRADE AND BASE COURSE: Good subgrade material. Requires compaction and where surface 12 to 18 inches has been removed, may require special attention in this respect, and a thicker base course before completing surface.<br>SUITABILITY FOR STABILIZATION WITH BITUMEN OR PORTLAND CEMENT: Clean, organic matter-free, subsoil makes good soil cement, and where sandy, but lacking coarse gravel, good bitumen mixture. | | | |

a/ Symbols for soil types are those used in TM 5-255, and in publications of the Public Roads Administration. Reference is made to aggregate (material coarser than No. 10 sieve) and binder already present in soil.



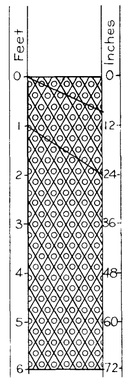
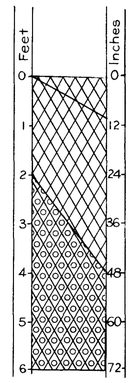

**Reliability Rating: Class D**

Preliminary text submitted without checking or editing.
U. S. Geological Survey

(CONT.)

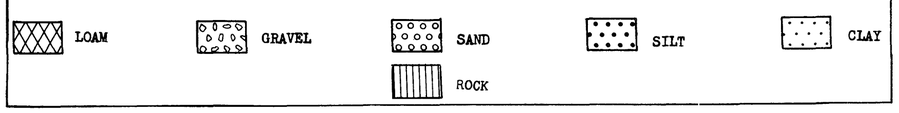
# HALMAHERA (MOLUKKAS)

## SOILS: ENGINEERING PROPERTIES

| Soil number and type name | | 8. Sandy loams and loams | | | 9. Loams | | |
|---|---|---|---|---|---|---|---|
| Soil Profile | |   | | |   | | |
| Depth (inches) | | 0 to (0-10) ins.: | (0-10) ins. to (12-24) ins.: | (12-24) ins. and below: | 0 to (0-10) ins.: | (0-10) ins. to (24-48) ins.: | (24-48) ins. and below: |
| Engineering names and group symbols a/ | | Sand with more or less fines; clayey sands SF, some ML (A-2, some A-4) | Sand with more or less fines; clayey sands SF, some ML (A-2, some A-4) | Many texture types may be represented SF, SW, SC, ML (A-2, A-3, A-1, A-4) | Silty and clayey sands containing some organic matter. SF, ML, some CL (A-2, A-4) | Silty and clayey sands SF, ML, some CL (A-2, A-4) | Sands with fines and clayey sands SF, ML, some CL (A-2, A-4) |
| Engineering Properties — Before construction treatment | Cohesion in dry state | Low | Low | Low | Intermediate | Intermediate | Intermediate |
| | Foundation value | Good to very good | Good to very good | Good to very good | Fair to good | Fair to good | Fair to good |
| | Expansion and shrinkage | Very low to low | Very low to low | Very low to low | Low to medium | Low | Low |
| | Permeability | High | High | High | Medium | Medium | Medium |
| | Weight, lbs/cu. ft. | 75 - 85 | 80 - 90 | 80 - 90 | 70 - 80 | 70 - 85 | 75 - 90 |
| | Void ratio | 0.95 - 1.2 | 0.85 - 1.1 | 0.85 - 1.1 | 1.1 - 1.4 | 0.95 - 1.4 | 0.85 - 1.2 |
| | Water retention % | 5 - 12 | 5 - 10 | 3 - 12 | 16 - 25 | 12 - 24 | 12 - 24 |
| | Water retention ins./ft. | 0.7 - 2 | 0.8 - 1.8 | 0.45 - 2.1 | 2.2 - 3.9 | 1.6 - 3.9 | 1.7 - 4.1 |
| Engineering Properties — Depending on Construction Treatment (at optimum compaction) | Weight, lbs./cu. ft. | 110 - 125 (or higher for SW) | 110 - 125 (or higher for SW) | 110 - 125 (or higher for SW) | 100 - 125 | 100 - 125 | 100 - 125 |
| | Void ratio | 0.33 - 0.5 | 0.33 - 0.5 | 0.33 - 0.5 | 0.33 - 0.66 | 0.33 - 0.66 | 0.33 - 0.66 |
| | Water retention % | 11 - 17 | 11 - 17 | 11 - 17 | 11 - 22 | 11 - 22 | 11 - 22 |
| | Water retention ins./ft. | 2.3 - 3 | 2.3 - 3 | 2.3 - 3 | 2.1 - 3 | 2.1 - 3 | 2.1 - 3 |
| | Bearing ratio, percent | SF: 8 - 30 | SF: 8 - 30 | 8 - 50 | 6 - 30 | 6 - 30 | 6 - 30 |
| Soil properties as affecting construction problems | | AGGREGATE AND BINDER: Aggregate absent at surface, locally may be found as substratum and obtained by excavation. Where present quality intermediate. Binder content of soil generally low. MECHANICAL STABILIZATION OF LOOSE MATERIAL: Locally admixture of aggregate may be desirable, in general unnecessary. Soil is well suited to compaction and moisture needed to produce optimum density can be readily controlled. Permeability of undisturbed soil relatively high and under drainage good. Bearing ratio after compaction fair to good. (See Local Materials Table, and TM 5-255, fig. 102). SUITABILITY FOR SUBGRADE AND BASE COURSE: Undisturbed soil not suitable for subgrade but requires compaction. Base course may be constructed from soil; usually benefitted by binder additions, may require aggregate locally. SUITABILITY FOR STABILIZATION WITH BITUMEN OR PORTLAND CEMENT: The most sandy representatives of this group are suited to stabilization by either material. Soil-cement mixtures can probably be prepared with moderate success from all soils within the group. | | | AGGREGATE AND BINDER: Aggregate scarce or lacking. Binder abundant but intermediate quality. MECHANICAL STABILIZATION OF LOOSE MATERIAL: Admixture of aggregate generally desirable. Soil fairly well suited to compaction and moisture control not difficult during process. Permeability of undisturbed soil intermediate and drainage fair. After compacting bearing ratio good (see Local Materials Table and TM 5-255, fig. 102). SUITABILITY FOR SUBGRADE AND BASE COURSE: Natural soil provides inferior subgrade unless dry. Requires compaction and is benefitted by addition of aggregate. Suitable base course requires aggregate admixture. SUITABILITY FOR STABILIZATION WITH BITUMEN AND PORTLAND CEMENT: Unsuited for stabilization with either material. | | |

a/ Symbols for soil types are those used in TM 5-255, and in publications of the Public Roads Administration. Reference is made to aggregate (material coarser than No. 10 sieve) and binder already present in soil.

EXPLANATION OF PATTERNS USED IN SOIL DIAGRAMS



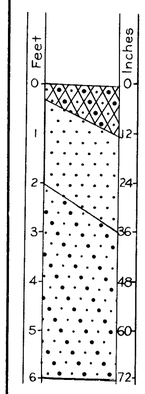
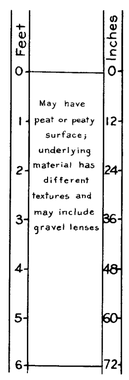
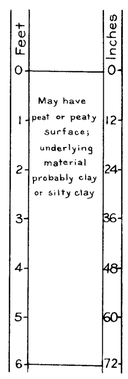

**Reliability Rating: Class D**

Preliminary text submitted without checking or editing.
U. S. Geological Survey

(CONT.)

# SOILS: ENGINEERING PROPERTIES

# HALMAHERA (MOLUKKAS)

| Soil number and type name | 10. Silty clay loam and clays | | | 11. Intermittently flooded phases of soils on alluvium. | 12. Swamp soils | |
|---|---|---|---|---|---|---|
| Soil Profile |   | | |   |   | |
| Depth (inches) | 0 to (3-12) ins.: | (3-12) ins. to (24-36) ins.: | (24-36) ins. and below: | | | |
| Engineering names and group symbols [a/] | Inorganic clays of medium to high plasticity; contain organic matter CL (A-6, A-7) | Inorganic clays of medium to high plasticity. CL, CH (A-6, A-7) | Many texture types may be represented. SF, GF, SP, GP, ML, CL (A-2, A-3, A-4, A-6) | Many texture types may be represented. See soils 8, 9, and 10. | Many texture types may be represented. See soils 8, 9, and 10. Peat may be present at surface. | |
| Engineering Properties — Before construction treatment — Cohesion in dry state | Medium to high | Medium to high | Medium to high | Very low to high | Very low to high | |
| Foundation value | Fair to poor | Fair to poor | Poor to very good | Poor | Very poor | |
| Expansion and shrinkage | Medium to high | Medium to high | Low to moderately high | Low to moderately high | Low to moderately high | |
| Permeability | Low | Low | Low | See soils Nos. 8, 9,10 | See soils Nos. 8,9, 10 | |
| Weight, lbs/cu. ft. | 65 - 80 | 70 - 85 | 70 - 90 | See soils Nos. 8,9, 10 | See soils Nos. 8,9, 10 | |
| Void ratio | 1.1 - 1.6 | 0.95 - 1.4 | 0.85 - 1.4 | See soils Nos. 8,9, 10 | See soils Nos. 8, 9, 10 | |
| Water retention % | 25 - 35 | 22 - 35 | 10 - 40 | See soils Nos. 8,9, 10 | See soils Nos. 8, 9,10 | |
| Water retention ins./ft. | 3.1 - 5.4 | 3 - 5.7 | 1.4 - 5.5 | See soils Nos. 8,9, 10 | See soils Nos. 8,9, 10 | |
| Engineering Properties — Depending on Construction Treatment (at optimum compaction) — Weight, lbs./cu. ft. | 100 - 120 | 80 - 120 | wide range of values | wide range of values | wide range of values | |
| Void ratio | 0.39 - 0.66 | 0.39 - 1.1 | wide range of values | wide range of values | wide range of values | |
| Water retention % | 13 - 22 | over 13 | wide range of values | wide range of values | wide range of values | |
| Water retention ins./ft. | 2.5 - 3.4 | 2 - 3.4 | " " " " | " " " " | " " " " | |
| Bearing ratio, percent | 4 - 15 | up to 15 | wide range of values | wide range of values | wide range of values | |
| Soil properties as affecting construction problems | AGGREGATE AND BINDER: Aggregate material probably lacking. If required for stabilizer must be obtained from other types (e.g. from types 1 and 6 and from beaches). Rarely gravel may be obtained by excavation. Soil high in binder content. MECHANICAL STABILIZATION OF LOOSE MATERIAL: Construction of suitable roadway or runway pavement depends upon suitable base course. Importation of suitable aggregate necessary for preparation of insulating layer between natural soil foundation and base course. In many places low fills should be constructed to aid insulation. Locally, drainage must be provided. Subgrade will not compact readily and close moisture control is necessary. Care is needed to avoid ponding of water during this process owing to low permeability of soil and danger of creating unstable soft spots in subgrade. Bearing ratio poor (see Local Materials Table and TM 5-255, fig. 102). SUITABILITY FOR SUBGRADE AND BASE COURSE: This soil provides inferior subgrade and if used in base course construction, addition and thorough mixing of aggregate are necessary. SUITABILITY FOR STABILIZATION WITH BITUMEN AND PORTLAND CEMENT: Unsuited for stabilization with either material. | | | Soils of this group have engineering properties similar to those of adjacent soils. They differ from surrounding soils mainly in regard to drainage, which is inadequate. It is possible that precipitation of iron to form a somewhat indurated pan at a depth of two or three feet from the surface may have taken place in these soils locally where surrounded by soil type 4 (e.g., 6 miles inland and north of Pajahi Bay). It is unlikely that such material would have any aggregate value. Before any construction is contemplated, on these soils the possibility of installing workable drainage systems must be investigated. Main additional considerations depend upon the need for insulating road or runway surface and base course, from wet foundation. In general a thick base course will be required. For other engineering properties see Soil types, 8, 9, and 10. | Construction should be avoided on swamp soils. No satisfactory earth construction can be accompalished on these soils unless drainage is first provided; frequently this is not possible without diking and pumping. Peat layers (A-8;Pt) must be removed if present, since their stabilization is impracticable. If drainage is provided construction procedure may be guided by consideration of engineering properties of soils 9 and 10. | |

[a/] Symbols for soil types are those used in TM 5-255, and in publications of the Public Roads Administration. Reference is made to aggregate (material coarser than No. 10 sieve) and binder already present in soil.

EXPLANATION OF PATTERNS USED IN SOIL DIAGRAMS

LOAM GRAVEL SAND SILT CLAY ROCK

Reliability Rating: Class D

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY FOR CHIEF OF ENGINEERS, U. S. ARMY

# GEOLOGY

# HALMAHERA (MOLUKKAS)

SCALE
10 5 0 10 20 30
Miles

127° 128° 129° 2° 1° 0°

HALMAHERA ISLAND
MOROTAI ISLAND
Raoe Island
North Loloda Islands
South Loloda Islands
Tobelo Islands
Miti I.
Bobale I.
Kaoe
Galela Bay
Galela
Tobelo
Loloda
Mt Mede
Mt Iboe
Gamkonora
Soepoe
Wajaboelo
Akelamo
Akelamo Bay
Wasile Bay
Dodaga
Wasile
Djailolo
Djailolo Bay
KAOE BAY
Dodinga
Dodinga Bay
BOELI BAY
Boeli-serani
Sagea
Sagea Lake
Kobe
Mesa
Pajahi-islam
Pajahi Bay
Weda
WEDA BAY
Inggelang I.
Sajafi I.
Ternate I.
Ternate
Tidore I.
Mare I.
Moti I.
Makian I.
Siko I.
Kajoa I.
Lilai Is.
Taneti I.
Latalata Is.
KASIROETA ISLAND
MANDIOLI ISLAND
OBIT ISLAND
BATJAN ISLAND
Laboeha
Wajaoea
Saleilamo Island
PATINTI STRAITS
Widi Islands
Ganedidalem
Dowora Is
Damar Is.
Woka
Djoronga Is.
SEA OF MOLUKKA
OBI STRAITS

EXPLANATION

| | |
|---|---|
| Qal | QUATERNARY ALLUVIUM |
| Qv | QUATERNARY VOLCANICS |
| TQc | PLIOCENE AND QUATERNARY CONGLOMERATE AND SANDSTONE |
| TQl | PLIOCENE AND QUATERNARY CORAL LIMESTONE, CONGLOMERATE AND SANDSTONE |
| Tv | MID-TERTIARY VOLCANICS |
| Tc | MIOCENE CLAY, SHALE AND SANDSTONE |
| Tl | EARLY TERTIARY LIMESTONE |
| gr | PRE-PERMIAN GRANITE |
| maf | PRE-PERMIAN BASIC IGNEOUS ROCKS |
| sch | BASEMENT SCHISTS |

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

East of Greenwich

Reliability rating: C

# HALMAHERA (MOLUKKAS)

## GEOLOGY

| | ROCK FORMATION | STRUCTURE AND BEDDING | SURFICIAL DEPOSITS | TOPOGRAPHIC EXPRESSION | ENGINEERING ASPECTS |
|---|---|---|---|---|---|
| Qal | Quaternary Alluvium. Beach deposits: Silt and mud, coarse coral sand, fine shingle or coarse subangular boulders. Swamp deposits:- fine silt and mud. Floodplain deposits:- sand, silt and clay mixtures on broad coastal areas becoming coarser upstream; mostly gravel in foothills and bouldery in the mountains. | Unconsolidated irregularly bedded deposits. | Soil in swamps is black organic muck., on plains varies from stony sandy loam to clay loam; may be many feet deep. | Beaches:- Gentle to moderate sloped beaches with low bank against vegetation at head.<br><br>Swamos:- Low undrained depressions.<br><br>Floodplains:- Flat to gently rolling; streams may be incised in gullies. | All material readily excavated. Coarser deposits on gravel terraces and along stream beds are excellent source of sand and gravel. Foundation conditions fair to poor; heavy installations subject to failure. All material permeable; considerable seepage where excavations intersect ground water table, which on lower parts of plains along coast and on beaches may be within a few feet of the ground surface. |
| Qv | Quaternary Volcanics. Basaltic and andesitic blocky or massive flows interbedded with coarse and fine volcanic breccia, agglomerate, tuff, and lapilli. Some intrusive sills and dikes. | Volcanic cones and craters with typical associated collapse and faulted structures. Flows with typical columnar fractures and bedded pyroclastics on flanks. Dip $10^{\circ}$ to $20^{\circ}$ or more. Probably some radiating dikes. Plateau areas underlain by tuffs, agglomerates, and breccia; flat or with low dip. | Red-brown lateritic stony clay loam becoming denser and more stony with depth. Normally 5 to 10 feet to bedrock, but very variable with many rock outcrops. Soil permeable and normally well drained. Becomes dense and plastic when wet. | Conical or rounded mountains with radial drainage and steep-sloped ridges dissected by many gullies. Bordered locally by flat to rolling plateau-like areas. | All common excavation to sound rock, most of which requires drilling and blasting for excavation. Some agglomerates and tuffs can be worked by hand tools or power shovel. Andesites and basalts are suitable for crushed aggregate, rock fill, and stone masonry; provide excellent foundation conditions though rock may shatter under impact. Other rock types are poor foundations. Small slides, slump, and creep are features common to the overburden. The rock is fairly permeable; considerable seepage where excavations intersect the ground water table. |
| TQc | Pliocene and Quaternary Conglomerate. Coarse and fine loosely consolidated sandstone, conglomerate, and volcanic breccia. Materials derived from older rocks of mountainous regions, either the pre-Permian basic intrusives or the mid-Tertiary volcanics. Deposits poorly sorted and unevenly bedded. Cobbles are sub-rounded to sub-angular in a sandy clay matrix. | Thick detrital deposits forming fans, deltas, and floodplains in intermontane basins; have been regionally uplifted and locally tilted. Dips mostly low. | Yellow-brown lateritic stony sandy loam and sandy loam, 5 to 10 feet or more in depth. Surface layers friable and loose; some calcareous cementation in deep sub-soil. Soil merges imperceptibly with bedrock; has medium to low water retention. | Narrow steep-sloped gullied ridges which form foothills to higher mountains. Dissected alluvial fans. Conspicous fault scarp formed along eastern margin of Kaoe River basin on Halmahera. | For most part can be worked by hand tools or power shovel. Some layers may require blasting. Coarse material suitable for rock fill or crushed aggregate. Finer fraction is excellent sand and gravel; may require washing if clean material is desired. Formation is a rather poor foundation and heavier installations would be subject to failure. Material is highly permeable; considerable seepage probable where excavation intersects the ground water table. |
| TQl | **Pliocene and Quaternary coral limestone and conglomerate:** Massive or blocky coral reef limestone composed of large fragmental coral heads, coral sand, shell fragments, calcareous clay, silt, sand, and volcanic ash. Bound by a tough calcareous cement. Occur as discontinuous horizons from sea level, where living reefs fringe the coast in many places, to 500 feet altitude and locally higher; are interbedded with coarse and find tuffaceous sandstone and conglomerate similar to those of TQc. | Similar to TQc. Coral limestone reefs are irregular in distribution and interbedded with gravel and sand. Have been relatively uplifted to a maximum altitude of 1,000 feet by Quaternary and recent tectonic movements and by eustatic changes in sea level. General occurrence is to about 500 feet altitude. Form broad benches or terraces that are mostly horizontal although the higher ones are in several places tilted $5^{\circ}$ to $6^{\circ}$ and in a few places $10^{\circ}$ to $11^{\circ}$. | Red-brown lateritic sandy loam and sandy clay loam, sandy or gravelly at the surface and with scattered iron concretions at a depth of from 12 to 24 inches. May be gravelly or stony; is friable and permeable with low water retention properties. Soil generally more shallow on limestone than elsewhere. | Coral limestone forms conspicuous terraces at intervals from sea level to a maximum altitude of over 1,000 feet, though most are below 500 feet. Along coast between beaches limestone forms rugged cliffs in many places over 100 feet high, may be bare, but more commonly are covered by a tangle of vines, creepers, and small trees. | Limestone can be worked by hand tools, but deep excavations require drilling and blasting. Massive material suitable for crushed aggregate, rock fill, and rough stone masonry. Coral reef limestone forms excellent foundation for structures and crumbles gradually without shattering under impact. Rock is permeable and small caves may be encountered locally. Conglomerate and sandstone beds are a suitable and readily worked source of sand and gravel, but form poor foundations. |
| Tv | Mid-Tertiary Volcanics: Hornblende and pyroxene andesite flows with abundant interbedded tuffs, coarse volcanic breccias, agglomerates and mud flows. Deposits in part reworked by streams. | Formeroded remnants of cones, craters, and calderas which in some places are base for younger volcanic cones. Dips generally low, $10^{\circ}$ to $20^{\circ}$ Locally uplifted along faults to form prominent scarps. The more massive flows are much fractured. | Red-brown lateritic loam and clay loam with a few iron concretions in upper layers. Friable and crumbly with pseudo-sandy structure. Increasing abundance of weathered rock fragments with depth. Depth to bedrock 10 to 20 feet. Shallower along streams. | Deeply eroded, steep-sloped irregular hills and mountains with narrow V-shaped valleys. Streams rocky with steep gradients. | All common excavation to sound rock, most of which requires drilling and blasting for excavation; some agglomerates and tuffs can be worked by hand tools or power shovel. Andesites and agglomerates are suitable for crushed aggregate, rock fill, and stone masonry. Andesite is an excellent foundation, but weathered material overlying it is extremely weak; footings not based on sound rock are subject to failure. Small slides and slips are common on steeper slopes. Rocks are fairly permeable locally, but seepage probably localized along fractures. |
| Tc | Miocene clay and sandstone: Fossiliferous calcareous clay shale, and marly limestone. Sandstone and conglomerate derived from older rocks in flanking mountains. Some thin lignite seams of poor quality. Formation occurs only in north-central Batjan Island. | Rocks tilted and folded with dips probably up to $30^{\circ}$ to $40^{\circ}$ in many places. | Red-brown sandy loam and sandy clay loam with small concretions in upper 20 inches. Permeable, crumbly, and friable. Merges gradually with bedrock at about 5 feet. | Forms steep-sloped irregular hills around base of higher mountains; sharp crests, gullied flanks, and rolling valley basins. Locally limestone may form higher, more rugged ridges. | Deposits can mostly be worked by hand tools, power shovel, or bull-dozer though some beds may locally require blasting. Conglomerate and some of limestone are only suitable construction materials. Foundation conditions adequate for light construction. Heavy emplacements subject to failure. Sandstone and conglomerate beds probably permeable and may locally carry ground water. |

(CONT.)

# GEOLOGY

# HALMAHERA (MOLUKKAS)

| | ROCK FORMATION | STRUCTURE AND BEDDING | SURFICIAL DEPOSITS | TOPOGRAPHIC EXPRESSION | ENGINEERING ASPECTS |
|---|---|---|---|---|---|
| Tl | Early Tertiary Limestone: Generally massive, irregularly bedded, granular marine limestone with some reefy material locally. Has a few marly or sandy layers. Eocene and Miocene fossils have been recognised, but units have not been separately mapped. | Thick massive beds that may be locally well fractured and faulted. Are gently folded and tilted with dips as high as 30° to 40° in some places along the coast. | Red-brown lateritic clay and sandy clay, humus-enriched in upper layers, friable and permeable. Sharp contact with bedrock. Generally shallow with numerous rock outcrops on steeper slopes. | Form steep-sloped rugged hills with numerous cliffs and ledges. Possibly some karst topography. Little or no surface water but numerous underground streams. Springs common along the outcrop of the base of the formation. | Bedrock in most places near surface will require drilling and blasting for excavation. Material suitable for crushed aggregate, rock fill, and stone masonry. Rock provides excellent foundation and does not shatter under impact. Small caves partially filled with clay or sand may be encountered in excavation and may weaken footings. Rock permeable; little surface water; numerous underground streams follow fractures or bedding. |
| gr | Pre-Permian Granite: Massive, medium-grained hornblende granite of unknown age. Occurs only along Geti River in northeastern Batjan Island. | Massive rocks probably having several sets of parallel fractures along which weathering may be deep. | Red-brown sandy loam and sandy clay loam with small concretions in upper 20 inches; permeable, crumbly and friable. Merges gradually with bedrock at 5 to 10 feet. | Forms rounded slopes and irregular valleys along Geti River. | All common excavation to sound rock which will require drilling and blasting for excavation. Material suitable for crushed aggregate, rock fill, and stone masonry. Rock is excellent foundation material and does not shatter easily. Overburden provides fair foundations. Rock fairly permeable; seepage along fractures, though many of these are probably filled with clay. |
| maf | Pre-Permian basic igneous rocks: A basement complex forming the core of the islands beneath younger rocks. Outcrops mostly along mountain ridges and also forms cliffs in places along the coast. Irregular masses of peridotite, serpentine, gabbro, quartz diorite, quartz diabase, porphyritic diabase with some volcanic breccias and tuffs. Rocks locally chloritized or otherwise altered, and cut by quartz veins and stringers. | Massive rocks that are probably strongly fractured and locally crushed and sheared along faults. Rocks occur as large and small irregular intrusive masses; are locally cut by younger diabase dikes and sills and quartz veins or stringers. | Red-brown to purple clay loam and clay with abundant small iron concretions in upper 2 to 3 feet. Friable, permeable; dries quickly. Depth to bedrock averages 10 to 20 feet. A few rock outcrops on steeper slopes and at higher elevations. | Steep-sloped mountains generally with rounded summits rarely over 3,500 feet in altitude. Broken by numerous, narrow, closely spaced secondary ridges and short V-shaped valleys, generally with steep gradients. Larger streams have broader valleys and lower gradients. | All common excavation to sound rock which will require drilling and blasting for excavation. Select material suitable for crushed aggregate, rock fill, and masonry. Where sound, rock is fair to good for foundations, but deep weathered zone renders most localities useless. Rock is relatively impermeable with little or no seepage. Small landslides, slump and soil creep are common in the overburden. |
| sch | Basement Schists (Age unknown); Predominantly hornblende and quartz-mica schists, locally graphitic with interbanded amphibolites. Some altered diabasic tuffs and quartzites. Gneissic diorite and granite gneiss less extensive. Schists are strongly foliated; all rocks regionally metamorphosed. Occur only in Sibela Mountains of Batjan Island. | Foliation strongly contorted; trends generally northeast and dips at a high angle. Rock may locally be much fractured. Rocks probably form lenticular or irregular masses of variable size. No detailed structure known. | Red-brown to yellow-brown lateritic loam and quartz sandy loam with a few iron concretions; well leached; fairly permeable, but less so where micaceous. Bedrock at 5 to 10 feet on lowlands. Shallower with many rock outcrops on steep slopes. Water retention medium to low. | Forms highest mountains in the area; steep slopes, narrow crests, and deep narrow valleys. Trend of topography is northeast-southwest. Some "moss forest" or jungle covered cliffs. | All common excavation to sound rock which will require drilling and blasting for excavation. Select material suitable for rock fill and rough stone masony. Rock in most places provides good foundation, but inclination of cleavage and possibility of failure along it must be considered. Rock relatively impermeable. Seepage occurs locally along joints. |

Structure: The four peninsulas of Halmahera and the central mountains of Morotai are underlain by a core or basement complex of pre-Permian basic and ultrabasic rocks. Similar rocks on Saleilamo Island and in northeastern Batjan and the occurrence of older schists striking northeast-southwest in the Sibela Mountains of Central Batjan suggest a continuation of the complex to the southwest. In the central part of Halmahera the plutonic core is overlain by an early Tertiary (Eocene and Miocene) series of somewhat folded and tilted marine limestones that extend eastward along the shores of Kaoe and Weda Bays. Along the west coast of Halmahera a broad belt of Miocene volcanics extends from the Batjan Group through Pajahe, Djololo and Loloda Bays, (considered by Verbeek to be collapsed craters), and northeast across the island to the east coast of Morotai where very little is known of its distribution. Pleistocene and Recent vulcanism has occurred along this same line on the eroded remnants of the Miocene Volcanoes. The present potentially active volcanoes Makian, Moti, Mare, Tidore, Ternate and the long line of cones and craters which cross the northern penninsula of Halmahera and culminate in Gamkonora, belong to this series. Though rarely in eruption, they constitute a zone of frequent earthquakes which occasionally are severe.

Flanking the pre-Permian and early Tertiary rocks are thick Pliocene and Quaternary alluvial fan and basin deposits of conglomerate. Near the coast they are intercalated with beds of reef limestone. Intermittent orogenic movements have uplifted and slightly tilted these deposits, in some places along distinct fault lines, so that reef limestone is now found at altitudes of as much as 500 feet and locally 1,000 feet. It is fairly apparent from topographic and geologic maps that the west coasts of the northern and southern peninsulas of Halmahera have been uplifted along faults and tilted eastward; similarly a scarp over 2,000 feet high along the eastern margin of the Kaoe River basin suggests that a fault striking north-south and upthrown to the east has cut the Pliocene-Quaternary conglomerate from the town of Kaoe north toward Galela. Little can be deduced concerning the structure of the Batjan Group or of Morotai Island. Throughout all the islands it should be emphasized that observed dips and strikes on surficial structures may be much distorted by slump, creep, and landslides.

Geomorphology: A combination of irregular tilting and warping, together with eustatic changes in sea level during the late Tertiary and Quaternary has affected the normal geomorphic history of vulcanism and stream erosion. Though the details are little known, dissected high-level coral terraces, raised beaches, Pleistocene fault scarps and stream meanders intrenched in recent alluvial plains indicate changes in baselevel followed by adjustments in stream grade. The present cycle is mostly one of youthful dissection though there are local basins of subsidence and accumulation such as the lower Kaoe River Valley.

In general the subdued rounded summits developed during an earlier cycle on the basement rocks are cut by narrow valleys with steep gradients. The more resistant schists of the Sibela Mountains of Batjan yield a more rugged topography.

Limestone forms cliffed mountains, sharp peaks, or plateaus having thin soil and little surface water or vegetation. Sink holes and underground streams are common.

The early Tertiary volcanics are so dissected by a fine-textured drainage that little can be distinguished of their original forms. Quaternary and Recent volcanics are eroded to different degrees, generally less severe. The flanks of the volcanic cones are deeply gullied but many of the more recent lava flows, mud flows, craters, cinder cones, tuff plateaus and other features appear well preserved.

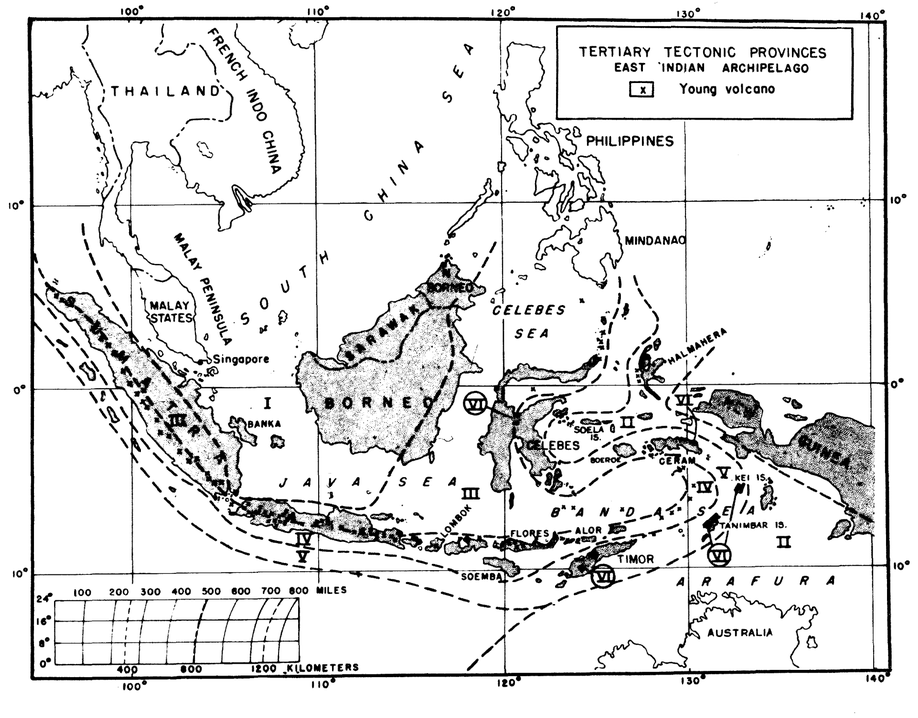
The thick coalescing alluvial fans and piedmont plains which developed against the front of the mountains during late Pliocene and Pleistocene time show a fine textured topography due to recent dissection by rejuvenated streams, locally as much as 1,000 feet. This characteristic applies equally to the raised coral reef terraces which occur along the coast to an average maximum altitude of 500 feet, locally to 1,000 feet. The coral terraces are dry and well drained, and support for the most part a sparse growth of trees, clumps of brush and open grass land.

On the west coast of Halmahera the shore line is in most places undergoing active erosion of headlands so that long stretches of the coast are cliffed with small rocky beaches in the bayheads; on the east coast though there are abundant cliffed headlands; long stretches of the coast are low. Mangrove swamps alternate with sand beaches in the several large bayheads. Coral reefs fringe much of Halmahera and many of the smaller islands.

(CONT.)

# HALMAHERA (MOLUKKAS)






General Geologic History of East Indian Archipelago

The East Indian Archipelago is a segment of the tectonic belt that extends from the Himalayas and Burma through the Indies, the Philippines, and the circum-Pacific mountain chain. The Paleozoic history of the archipelago is virtually unknown, the Mesozoic incompletely known; the Tertiary and Quaternary history is fairly clear.

Mesozoic: A geosynclinal zone connecting Timor and East Celebes passes through Tanimber and Kei Islands, Misool, Ceram, Boeroe, and southeast Celebes; it contains some nearly continuous Mesozoic sedimentary sequences, including shallow and deep-water marine and some terrestrial rocks. In regions outside this zone Mesozoic formations are extensive, but conformable sequences represent comparatively short time intervals; these regions underwent several transgressions and uplifts, and at intervals contributed sediments to the Timor-East Celebes zone. In the geosynclinal area Mesozoic intrusions are mostly ultrabasic; outside the geosyncline they are commonly silicic.

Tertiary: Earliest Tertiary strata are nearly everywhere unconformable on older rocks. Deposition generally began with continental clastics and continued with marine near-shore and shallow-water beds. No deep-water beds are known. Several tectonic provinces, each with a distinctive Tertiary history, extend across the archipelago and into Burma and the Philippines, as shown on the map. They are:

I - Asiatic continental shelf; stable area, above sea level during Tertiary; local epeiric marine invasions (S. and N. Borneo) left late Tertiary beds that show little or no folding. II - Australian continental shelf; stable area of shallow sea during Tertiary; strata show little or no folding. III - Belt of deep sedimentary basins; very thick, uninterrupted sequences, largely of shallow water and littoral deposits; gentle Pliocene folds contain principal oil fields; deepest basins are in north and southeast Sumatra, north Java, the east half of South Celebes, and several in east Borneo; between these basins Tertiary formations are thin or absent. IV - Belt of thin Tertiary formations involved in weak Miocene and late Pliocene foldings; north margin of belt was elevated by Miocene and later folding and became the site of most of the late Tertiary and Quaternary volcanism. V - Belt of deep basins containing very thick Tertiary deposits, but sequences interrupted by three orogenies: weak folding in early Tertiary, intensive folding with thrusting in Miocene, weak folding near end of Pliocene. VI - Pliocene grabens containing late Tertiary marine deposits; tilted and uplifted through late Pleistocene.

Quaternary: East half of archipelago acquired present form through upfaulting and through depression of large areas; for example, Banda Sea is more than 18,000 feet deep, and Pleistocene coral reefs are as high as 4,000 feet. Asiatic continental shelf and parts of Province III were extensively eroded in early Pleistocene and subsequently partly submerged to form the shallow seas south and west of Borneo. Volcanism and diastrophism continued throughout Quaternary.

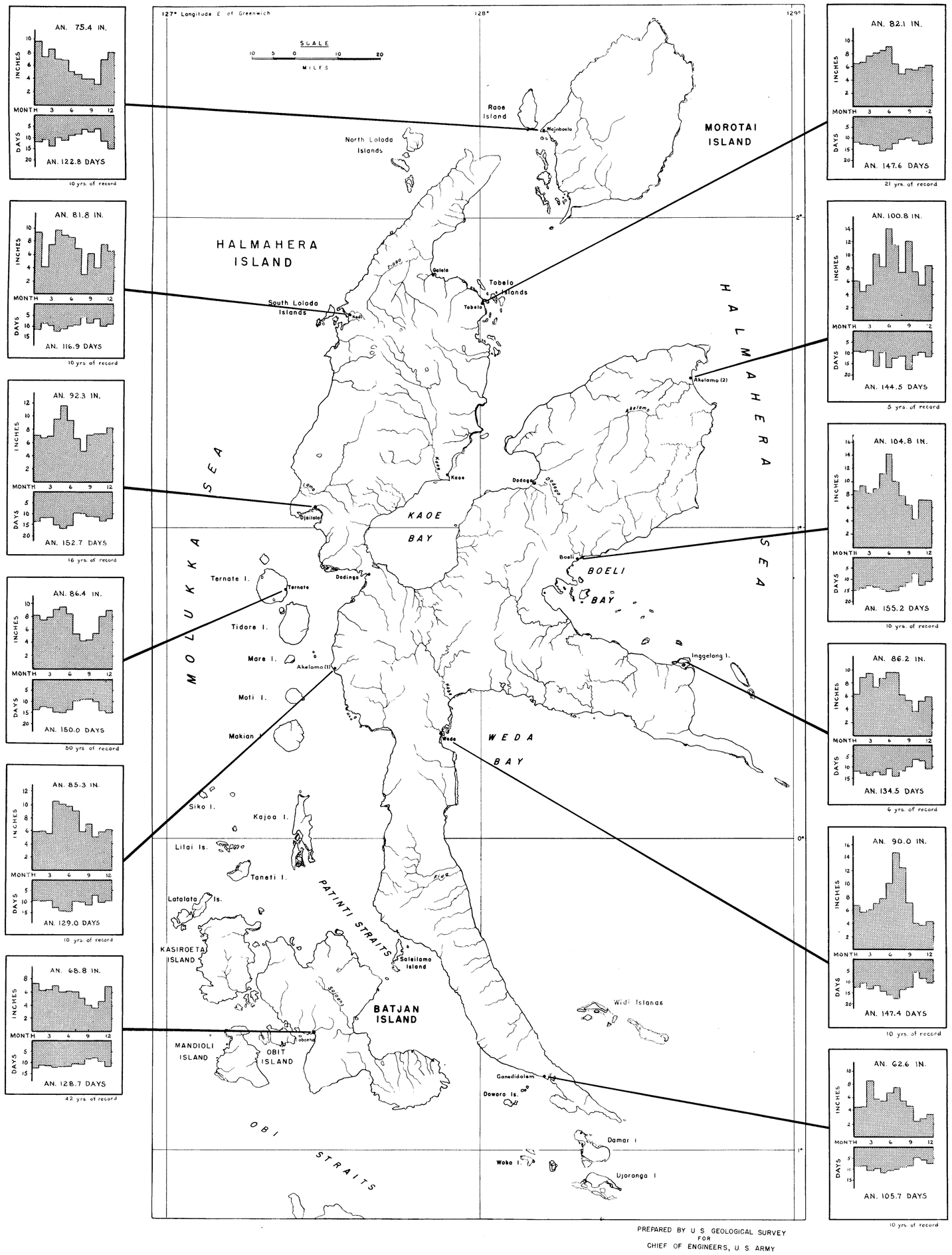
Geologic History of Halmahera

The North Moluccas, questionably part of belt II above, has been a landmass throughout most of its known history. The time of intrusion of the basic and ultrabasic igneous core has not been determined locally, but similar rocks elsewhere in the archipelago are considered to be pre-Permian. There are no known Mesozoic deposits and the landmass probably underwent erosion during that time. Transgression of the sea possibly in the Eocene and again definitely in the Miocene resulted in the deposition of limestone in the central part of Halmahera and of clastic sediments on Batjan. Extensive vulcanism occurred initially in the late Miocene and again in the Pliocene. It has been intermittently continuous to the present. Recent cones are constructed on the dissected remnants of older cones. Differential uplift and tilting of the region has accompanied vulcanism to the present. The products of erosion of the rising landmass accumulated during the late Tertiary and Quaternary and thick alluvial fans were built against the flanks of the mountains. The influence of Tectonic and Eustatic movements have not been differentiated in this area. At present the land is for the most part undergoing dissection by rejuvenated streams, though in the Kaoe River valley and locally in swamps along the coast deposition is taking place.

Preliminary text submitted without checking or editing.
U. S. Geological Survey

PREPARED BY U. S. GEOLOGICAL SURVEY
FOR
CHIEF OF ENGINEERS, U. S. ARMY

# CLIMATE — RAINFALL MAP — HALMAHERA (MOLUKKAS)






10 yrs. of record



10 yrs. of record



16 yrs. of record



50 yrs. of record



10 yrs. of record



42 yrs. of record



21 yrs. of record



5 yrs. of record



10 yrs. of record



6 yrs. of record



10 yrs. of record



10 yrs. of record

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FOR
CHIEF OF ENGINEERS, U S ARMY

# HALMAHERA (MOLUKKAS)

## CLIMATE

### INTRODUCTION

Halmahera and neighboring islands have a hot, moist, equatorial climate. The area lies between two great monsoon centers of southeastern Asia and northern Australia, and its climate is influenced by both. The transition periods between monsoons are characterized by 2 to 6 weeks of variable winds and calms. Throughout the year winds seldom exceed a moderate breeze (12-16 mph) and gales are rare. Temperatures are high and uniform; average for the coldest month is more than 79°F. However, temperatures of over a hundred degrees are uncommon. Humidity seldom falls below 50% and averages above 70%. Cloudiness averages about 5/10 during the year; cumulus and cumulo-nimbus clouds are the most common forms. Records from 12 stations show that average annual precipitation ranges from 62 to 105 inches. Most moisture comes in showers, but rains of several hours duration with short periods of intense downpour are not uncommon. Available climatic data is summarized in the tables and histogra

### WINDS

Monsoon winds: The northwest monsoon usually begins in November, reaches a peak in February and March and ends in late April. The southeast monsoon usually commences during May, reaches a peak in August and ends in October. The periods of transition, characterized by variable weak winds, occur in October and November. During the northwest monsoon the winds blow from the west through northwest to northeast; west is the least frequent direction. The southeast monsoon is from east to southwest. There are many local peculiarities of wind direction due to land forms diverting prevailing winds. The monsoon winds are usually steady; southeast monsoon winds are the strongest and steadiest. August, at the height of the southeast monsoon season, is the windiest month, with mean wind velocities of about 9 mph. November is the least windy month with a mean wind velocity of about 4.5 mph. Near the larger islands well-marked land and sea breezes are superimposed on the monsoon circulations. The land breezes begin during the night and abate about 9 am; between 9 and 10 am the sea breezes gain control, reach a peak between 2 and 3 pm and then decline until about 6 pm. Near the larger islands the effect of these breezes may be felt as far as twenty miles at sea.

Typhoons: Typhoons are rare; usually their effect is limited to periods of squally westerly winds and unsettled weather. They are most likely to occur from November to January and may persist for a few days.

Squalls: Squalls are most severe during the southeast monsoons, but are most frequent during monsoonal changes. They may burst without warning with gusts of 40 or 50 mph. They arise at any hour of the day but are most common at night and early morning. Thunder squalls with gusty periods lasting from 5 to 15 minutes are common. Frequently the gusty periods follow each other at short intervals without clearing of the clouds during the intervening calms.

### TEMPERATURE

Temperatures near sea level on the islands are high and uniform. The warmest seasons are in the changes of the monsoons. During the northwest monsoon the mean maximum and minimum temperatures fall between 82 and 86, and 71 and 75 degrees Fahrenheit respectively, with diurnal ranges between 12 and 21°. During the southeast monsoon the mean maximum and minimum temperatures range from 79 to 84° and from 69 to 75° respectively, with diurnal fluctuations between 6 and 18°. Temperatures in excess of 100° are rare. During the day they rise slowly from shortly after sunrise to about 1 or 2 pm, then decline gradually to about 6 am. Up to 1,800 feet, temperature changes are slight but become greater at higher altitudes; at 5,000 feet they may be uncomfortably low.

### RELATIVE HUMIDITY

Relative humidity varies little throughout the year. At 9 am it is generally between 70 and 75% and lessens from 2 to 20% during the afternoon. Inland it may fall to 50% in the afternoon on hot, sunny days. During the night it frequently rises to the saturation point; heavy dews are common on still nights.

### BAROMETRIC PRESSURE

At sea level barometric pressures on the islands average about 29.87 inches for the year. Daily range averages about 12 inches. Maxima periods during the day are at 9 am and 9 pm and minima periods at 3 am and 3 pm. During January, February and March the pressure is higher in the north; from June to September inclusive, it is higher in the south. In December and March there is little or no difference.

### CLOUDINESS, FOG AND HAZE

Cloudiness averages between 4/10 and 6/10. Cumulus and cumulo-nimbus are the most common cloud forms. At about 9 am they form over the land, and in the middle of the afternoon frequently give rise to thunder showers. Maximum cloud development is between 3,000 and 6,000 feet. Base of the cumulus clouds averages about 2,000 feet over the sea and about 3,000 feet over the land. Ordinarily above 7,000 feet the skies are clear and visibility is excellent. Windward flanks of mountains are often shrouded in clouds at altitudes between 2,000 and 3,000 feet where they form a cloud fog. Fogs are rare at sea and at low altitudes (below 2,000 ft.) over the land. Haze is common on the coast and at sea, particularly during the southeast monsoon; skies are hazy during both monsoon periods. Haze does not generally interfere seriously with visibility.

### RAINFALL

Average annual precipitation ranges from about 62 to 105 in. It is well distributed throughout the year but is slightly heavier from April to June and lighter from August to October. (See Rainfall map and histograms op.p.). No definite regional pattern of rainfall exists and precipitation is controlled by local land masses and convection currents. All weather stations are at sea level; precipitation at higher altitudes is undoubtedly considerably greater. Thunderstorms in conjunction with squalls are often severe and of high frequency. They occur at sea more often at night, and over the land in late afternoon, but are not fixed and drift from one locale to another.

For more detailed information see other intelligence reports.

Sources for text, tables and histograms:

Boerema, J., Rainfall in the Netherlands Indies: Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia, Publ. No. 24, Vol. 1, 1931.

Naval Air Pilot, New Guinea Area, Weather Summary for H.O. Pub. No. 276, 1943.

**Reliability Rating: B**

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U. S. Geological Survey

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