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PROGRESS REPORT ON CARTOGRAPHIC ACTIVITIES BY  
THE UNITED STATES OF AMERICA 1966 - 1972

Report submitted by the Government of the United  
States of America

Change more than any other word seems to characterize our times. Certainly this is true of Africa where, so frequently, change also may be termed progress. World cartography is changing and is making steady, if not spectacular, progress. The further application of computers, the development of semi-automated cartographic processes, and satellite geodesy advances, coupled with older, proven procedures have served to keep cartography generally abreast of scientific and developmental needs. It seems manifest that rate of change will increase and so will the demands on cartography; both as to products and areas. The sharing of knowledge and products offers the only reasonable means of meeting these demands.

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NOTES

1. Organizational changes in US Federal Mapping Agencies effected since 1966 result in new titles for several activities. These new titles are used herein. The changes are:

(a) The Defense Mapping Agency was established and the Defense Intelligence Agency's Directorate of Mapping, Charting and Geodesy was dis-established. The Defense Mapping Agency includes among its components the:

(1) Defense Mapping Agency Topographic Center (DMATC) was formerly the Army Map Service and a major component of the US Army Topographic Command, Corps of Engineers.

(2) Defense Mapping Agency Hydrographic Center (DMAHC) was formerly a major component of the US Naval Oceanographic Office.

(3) Defense Mapping Agency Aerospace Center (DMAAC) was formerly the Aeronautical Chart and Information Center, US Air Force.

(b) National Ocean Survey was formerly the Coast and Geodetic Survey and is a component of the National Oceanic and Atmospheric Administration.

2. The boundaries and names appearing on figures herein are not authoritative.

### GEODESY

As a result of the endorsement, in 1963, by the African nations of the 1960 International Association of Geodesy (IAG) resolution to initiate a primary traverse across Africa along the 12th Parallel (North), the US began discussions with the concerned African nations in late 1964. The primary purpose of the survey was to provide more and better data for defining the size and shape of the earth and to incorporate into a common datum various independent surveys in Africa. The survey was initiated in January 1967 when the US contracted with the French Institut Geographique National to perform the survey work in Chad, Cameroon, Niger, Upper Volta, Mali, and Senegal and with the Federal Survey Department in Nigeria performing the survey in that country. By January 1970, 4653 Km of geodimeter traverse had been completed, composed of 325 stations and 158 La Place stations. Figure 1 shows the route of the survey and lists statistics by countries.

Since June 1966, the National Ocean Survey has been engaged in the establishment of the Worldwide Geometric Satellite Triangulation Network, a worldwide network of geodetic control stations utilizing the strictly geometric technique of passive (sun reflective) satellites photographed against the star background.

The overall objective of the programme is to form a unified three dimensional framework encircling the earth and connecting all major land masses of the world. Four African stations are included in the framework:

Addis Ababa, Ethiopia  
Dakar, Senegal  
Fort Lamy, Chad  
Johannesburg, South Africa

To scale the satellite triangulation properly, several base lines spaced around the world, including one in Africa, were measured. The base line in Africa was a part of the precise geodimeter traverse along the 12th Parallel.

### GEOMAGNETISM

The global character of the magnetic field makes it imperative that both the service and research aspects of geomagnetic programmes be carried out through international cooperation.

During the 1966-1972 time frame, Project MAGNET aircraft collected magnetic data over Africa along the tracks shown on the accompanying index chart, Figure 2. Project MAGNET is a continuing programme of the US Naval Oceanographic Office to collect accurate and current worldwide magnetic data, which is reduced to values of variation, inclination or dip, and horizontal, vertical, and total intensity of the earth's field. All magnetic data collected by Project MAGNET aircraft over any foreign country are forwarded to that country as soon as processing is completed.

The United States National Oceanic and Atmospheric Administration (NOAA) is continuing to digitize analog records (magnetograms) from the worldwide network of magnetic observations. The digitized data, which are point scalings

for every 2.5 minutes of time, are being widely used as an important source of data for various research studies related to solar-terrestrial and lunar phenomena. For this project, magnetograms from 10 African observatories have been digitized using the magnetograms regularly sent to our World Data Center by participating observatories. From September 1966 to date, a total of 35 observatory-years of magnetic data have been received from African observatories. During the same period more than 2500 land magnetic survey measurements were received from 25 countries in Africa. These data, as well as the annual means from 18 observatories and Project MAGNET data, were included in the set of worldwide survey data used in the 1970 series of World Magnetic Charts; compiled by NOAA and published by the Naval Oceanographic Office.

All magnetic observations are made available to the world's scientific community through the World Data Center and US Naval Oceanographic Office Special Publication No. 66. In addition, during this report period, special bibliographies and status reports were prepared for African users. These described the current data holdings by NOAA of African magnetic survey data measured in the continent since the year 1900.

#### GRAVIMETRY

The Geodetic Reference System 1967 which was approved and adopted by the International Association of Geodesy during the XVth General Assembly of the International Union of Geodesy and Geophysics has been adopted by the United States Government. Conversion of gravity anomalies from the Potsdam System, into the Geodetic Reference System 1967, is currently being accomplished.

The United States Government is also adjusting its gravity holdings to agree with the recently completed International Gravity Standardization Net 1971. This network of gravity base stations includes 172 sites at 72 cities on the continent of Africa.

The US Defense Mapping Agency Topographic Center (DMATC), as part of the effort of the US Government support to studies of the earth gravity field, performed gravity surveys in Africa in the following countries:

- (a) Ethiopia - Completed a regional gravity survey of approximately 1,600 stations mainly along level lines. See Figure 3.
- (b) Mali - In co-operation with the French Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM), established nine National Base Reference Stations and observed gravity along the level line between Fana and Koutiala. See Figure 4.
- (c) Liberia - Made an International tie between Washington, D.C., New York, Dakar, and Monrovia; established a 25 station National Gravity Reference net; and completed a regional survey of 417 stations. See Figure 5.
- (d) Chad - In co-operation with ORSTOM established a 12 station National Gravity Reference net. See Figure 6.

The Bouguer Gravity Anomaly Map of Asia was published in August 1971 by the Defense Mapping Agency Aerospace Center (DMAAC). The map is an unique contoured representation of  $1^{\circ} \times 1^{\circ}$  mean Bouguer gravity anomaly values predicted

for the Asian continent using observed gravity data and gravity-geophysical correlation methods. DMAAC reference publication No. 29, August 1971, contains  $1^{\circ} \times 1^{\circ}$  mean free air anomaly values for Africa. Current research into gravity-geophysical correlation technology is directed toward the development of methods for prediction of  $1^{\circ} \times 1^{\circ}$  mean gravity anomaly values in oceanic areas. It is expected that this programme will lead to the first gravity anomaly representation of all oceanic areas which is based solely upon terrestrial data.

United States Government organizations and oceanographic institutions, including some operated by universities, are presently involved in observing ocean area gravity using surface vessels. Ocean area gravity surveys are in progress in the Atlantic and Pacific Oceans as well as in several other high seas areas.

#### GEOLOGY AND GEOLOGIC MAPPING

Below is a summary of US Geological Survey activities in African countries during the period 1966 to 1972.

##### Liberia

As of the end of fiscal year 1972, the US Geological Survey (USGS) concluded the field operations of an extensive geological and geophysical mapping programme in Liberia, conducted under the auspices of the US Agency for International Development and the Government of Liberia. The joint project has had as its major objectives reconnaissance geological, geophysical, and mineral resources studies of the entire country, development of an organization and staff for a national organization, equipping of offices, laboratories, and field support facilities, establishment of a data base consisting of maps, reports, and files for effective use by the Liberian Geological Survey in its geological studies, earth resources evaluation, and geological engineering studies.

This programme conducted in close collaboration with the Geological Survey of the Ministry of Lands and Mines of Liberia since 1963 has involved the services of a total of 44 geologists, geophysicists, and other mapping specialists of the USGS. Their work with various counterparts and trainees has yielded general geological and geophysical studies covering all of Liberia; detailed studies of selected areas of high mineral potential; a participant training programme both in Liberia and in the United States; and installation of various geoscience laboratories and other supporting facilities. The following major products have resulted from these activities: (1) files of basic data (rock samples, thin sections, petrographic and chemical analyses, field notes, analog radiometric and aeromagnetic data, aerial photographs and derivative photogrammetric data), systematic files of geologic information produced during the project and some 70 project reports on topical subjects; (2) radiometric and aeromagnetic maps of Liberia at scales of 1:40,000; 1:125,000, and 1:250,000; (3) geologic maps of Liberia in ten quadrangles at 1:250,000 scale; (4) form-line maps of Liberia at scales of 1:40,000 (505 sheets) and 1:125,000 (10 quadrangles); (5) geographic maps of Liberia at 1:250,000 (10 quadrangles); (6) fourteen professional personnel trained in USA in the participant training

programme and field laboratory assistants trained in-service; (7) petrographic, analytical, and photographic laboratory facilities adequate for the continued activities of the Liberian Geological Survey; and (8) thirty-one published reports. The field programme was completed on June 30, 1972. Map finishing of the geologic and geophysical editions is in progress.

### Libya

Professional Paper 660, Geology and Mineral Resources of Libya - A Reconnaissance, was published by the US Geological Survey in 1970. This report by Gus H. Goudarzi was based on data derived from geologic investigations made during the course of a co-operative programme with agencies of the Libyan Government during the period 1954-62, under the auspices of the US Agency for International Development. Fieldwork was limited to investigations of promising mineral deposits and to geological reconnaissance that would aid in the examination and evaluation of the mineral resources. Detailed sampling and geological studies were made on deposits of potential value, and general information was obtained on other mineral resources. A topographic map of Libya was prepared in 1960-61, which was used as a base for a geologic map compiled in 1960-62. Both maps were prepared in co-operation with private oil companies.

At the request of the Government of Libya, a US Geological Survey hydrogeologist provided short-term advisory and consultation services in 1967, 1969 and 1970 to the Government of Libya on problems relating to water resources investigations. The invitations followed the phasing out of the USGS technical assistance programme which began in 1962.

### Ethiopia

One and a half years of teaching and technical advisory services were given by a cartographer of the USGS to the Geological Survey of Ethiopia during 1969-70 in a programme sponsored by the US Agency for International Development. This project resulted in a cartographic staff and laboratory equipped to process geologic data and field surveys to produce geologic maps for printing. Several maps at 1:250,000 scale were published.

Since 1968, the US Geological Survey, Water Resources Division, has provided advisory services of a hydrogeologist to the Water Resources Department of the Ethiopian Ministry of Public Works and Communications.

### Kenya

An evaluation of existing water problems and recommendations for a 4-year investigation of available water resources of selected range lands in the Coast Province of Kenya was reported by USGS hydrogeologist in 1967. A reorientation of policy in early 1968 led to further examination and review of the range-water problems by a team of specialists consisting of two USGS hydrologists and a USAID range-management expert. The scope of the earlier report was broadened and a proposal reported for a regional range-water-development project in the North-Eastern Province of Kenya.

The currently active project in co-operation with the Ministry of Agriculture in the Government of Kenya was initiated in late 1968 by a four-man team consisting of a hydrologist (project chief) and a hydrogeologist from the USGS and a range-planning expert and an agricultural engineer from the US Forest Service. The project consists of both general and specific studies related to water resources and range management for the North-Eastern Province.

#### Morocco

A US Geological Survey hydrogeologist, on a short-term assignment to Morocco at their request, evaluated the current and past hydrologic investigations by the technical and scientific agencies of the Government of Morocco and conducted a field reconnaissance of the geohydrologic features of the major river basins and ground-water systems of the country. The report of these activities stressed the need of further water resources investigations in Morocco.

#### Nigeria

The US Geological Survey water resources programme in Nigeria spanned 8 years, 1961 to 1968. The services of a USGS senior hydrogeologist advisor to the Geological Survey of Nigeria ceased in November 1966. Ground-water investigations in the Northern Region under the guidance of two hydrogeologists continued in the Sokoto basin to May 1967 and in the Chad basin to August 1968, although seriously disrupted by civil strife.

Positive accomplishments for the period 1966 to termination include (1) exploratory drilling, (2) geochemical studies, (3) evaluation of aquifer characteristics, (4) development of water supplies, and (5) training Nigerian hydrogeologists. The Geological Survey of Nigeria was the chief ground-water counterpart agency, but in addition the Regional Ministry of Works and the Sokoto Native Authority were also co-operative in the Sokoto basin. A US Geological Survey chemist in residence June 1965 to August 1968 directed (1) chemical analysis of ground and surface waters from the Northern Region, (2) improvements in water-quality laboratory procedures and equipment, and (3) training of Nigerian chemists and laboratory technicians of the Geological Survey of Nigeria. A major achievement of the water resources programmes in Nigeria has been the preparation of many technical reports on all phases of the investigations.

#### Democratic Republic of the Congo

Following a request by the Democratic Republic of the Congo in 1968, a US Geological Survey hydrogeologist was assigned to make a reconnaissance evaluation of the ground-water problems in several areas of the Congo. A summary report was completed in April 1968.

#### United Arab Republic

Severance of diplomatic relations in 1967 terminated after 8 years the water resources investigation "New Valley Project" of the US Geological Survey with the General Desert Development Authority of the United Arab Republic. The project was staffed during 1966 and 1967 by two USGS hydrogeologists in residence, assisted for brief periods by three short-term USGS specialists. At the

severance of the USGS input, the tangible project achievements were as follows: (1) aerial magnetometric and photographic surveys in Kharga and Kakkla Oases; (2) surface geologic mapping and subsurface geologic studies; (3) surface resistivity, magnetic, and gravimetric surveys; (4) exploratory drilling; (5) aquifer tests; (6) well-corrosion studies; (7) preparation of many reports relating to project activity; and (8) training Egyptian General Desert Development Authority geologists, chemists, and engineers.

#### Zambia

A US Geological Survey, Water Resources Division, surface-water hydrologist was assigned for a 2-year period, 1968-70, as a principal hydrologist of Zambia in the Hydrological Branch, Water Affairs Department, Ministry of Rural Development, to review the overall technical operation of the Hydrological Branch and to plan and implement endorsed changes leading to improvements in the collection, analysis, and availability of surface-water hydrologic data. Of prime importance in this connection was the training of Zambian hydrographers in basic field and office procedures and techniques, lectures to science students in secondary schools and technical students in the Zambian Natural Resources Development College, and the preparation of a basic manual of instructions for hydrological surveys in Zambia, which was distributed to many developing African countries for training of hydrological technicians.

### OCEANOGRAPHY

The National Ocean Survey ship OCEANOGRAPHER made a world scientific voyage in 1967. The following excerpts from the summary of the voyage reflect the interest of African officials, scientists, and students:

#### Port Said to Suez City, UAR

At the stop in Port Said on 19 May, preparatory to passage of the Suez Canal, the OCEANOGRAPHER received aboard 42 officials, scientists, and press representatives for the passage to Suez City. Among the guests were the Deputy Minister and Vice-President of the UAR Supreme Council for Scientific Research and the Director-General, Cairo Institute of Oceanography and Fisheries.

At Suez City on 2 May, after the visitors had disembarked, 12 oceanographic students from the United Arab Republic came aboard the OCEANOGRAPHER for tours and briefings. These young people were most enthusiastic and remained aboard for 2 hours.

#### Massawa, Ethiopia

The OCEANOGRAPHER docked on 23 May, and an official open house was arranged for Thursday, 25 May. The ship's personnel conducted special tours for honor students from Kagnaw Station High School, for local officials, and for officers and midshipmen of the Imperial Ethiopian Navy, Massawa Naval Base. On Thursday, Prince Alexander Desta, grandson of the Emperor of Ethiopia and Deputy Commander, Imperial Ethiopian Navy, was entertained aboard for lunch and conducted on a special tour of the ship and its research facilities.



At the request of geologists of the Gulf Oil Company of Ethiopia, a scientific team composed of three oil company personnel, an officer of the Imperial Ethiopian Navy, and four of the OCEANOGRAPHER's staff made an investigation of Dahlak Kebir Island, mainly in and around the Bay of Ghubbet. A launch from the OCEANOGRAPHER was used for the study.

#### GEOGRAPHICAL NAMES

The first United Nations Conference on the Standardization of Geographical Names was held in September 1967 at Geneva, Switzerland. The conference was attended by representatives and observers from Congo (Kinshasa), Cameroon, Ethiopia, Ghana, Kenya, Liberia, Libya, Madagascar, Senegal, Chad, the United Arab Republic, and forty-three non-African countries. Nigeria submitted a report on its progress in names standardization.

The broad thrust of this first conference was to identify the problems in national and international standardization of names, to stimulate international co-operation in the development of national name authorities, to systematize the terminology and definitions relevant to toponomy, to plan effective permanent committees and regional groupings according to geographical and ethnic criteria to continue momentum achieved, and to form clearing houses for exchange of information on accomplishments and problems encountered preparatory to a projected meeting.

In those actions pertaining particularly to Africa, the conference recommended that regional and sub-regional conferences be held at appropriate intervals. It suggested division of Africa into the Arabic group and Africa South of the Sahara. Some specific recommendations relative to African countries concerned complete documentation for all geographical names, including all vowels and the notation of unvowelled and double consonants in Arabic. It was recommended that Arabic-speaking countries agree on a single system for the romanization of Arabic geographical names or, failing that, two systems - one based on French and the other on English. The conference took particular note of the problems of recording geographical names from unwritten languages in general and those in African, in particular, and recommended further consideration of the question by the United Nations.

Meetings of the United Nations Group of Experts (on Geographic Names) were held in February 1970 and March 1971. Of particular note were the Regional Meetings of the Organization of Central American States held in Guatemala in October 1968 and Panama in October 1970. At the 1968 meeting, geographic names techniques used successfully by Guatemala were explained and demonstrated. The 1970 meeting reviewed progress in implementing recommendations of the 1968 meeting. The United Nations Group of Experts recommends that similar divisional or sub-regional meetings be held in Africa, and has requested such meetings be scheduled.

A conference of the Arab Experts for Standardization of Names of Geographic Locations in the Arab Countries met in Beirut in August 1971. Jordan, Tunisia, Sudan, Iraq, Saudi Arabia, Syria, Libya, Lebanon, UAR, Palestine and Abu Zaby were represented. A major outcome of the meeting was the establishment of an Arabic Transliteration System, now identified as the Beirut Unified System.

The Second United Nations Conference on the Standardization of Geographical Names, was held in London, May-June 1972. This conference included delegations from Egypt, Ghana, Kenya, Libya, Madagascar, Nigeria, Sierra Leone, Uganda, and Zaire. Among recommendations accepted by the conference were the Beirut Unified System for Arabic Transliteration (as amended), and the Amharic to English Transliteration System, 2nd revised edition, (1962). The conference noted that the thirty-five countries of tropical Africa require increased outside aid if mapping and cartographic toponomy are to become consistent and reliable. Kenya's Geographic Names Committee reported progress on the correction of names in the 1964 gazetteer produced co-operatively by the US Board on Geographic Names (USBGN) and Kenya. Nigeria has a third edition of its gazetteer in printing. Uganda has organized fourteen committees corresponding to the tribes and languages in the country to process names collected in the field. Of particular interest to African countries is the plan of the Institute of Aerial Survey and Earth Sciences at Enschede, Netherlands, to organize a pilot training course in toponomy in English for 20-25 students from developing countries during the summer of 1974. Similar projects are under consideration also in the Scandinavian countries and in Spain.

USBGN gazetteer production since 1966 includes the following publications on Africa:

Gambia - 1968	Niger - 1966
Ghana - 1967	Nigeria - 1971
Liberia - 1968	Portuguese Guinea - 1968
Malawi - 1970	Sierra Leone - 1966
Mali - 1966	Spanish Sahara - 1969
Mauritania - 1966	Togo - 1966
Morocco - 1970	Zambia - 1972
Mozambique - 1969	

African area gazetteers now undergoing revision are those for Algeria, Libya, and Southern Rhodesia.

A publication entitled Africa and Southwest Asia Gazetteer Supplement, 1972 is now in printing. It comprises corrections to all existing USBGN gazetteers for those areas other than the gazetteers under revision.

At the United Nations Group of Experts Meeting on 1 June 1972, immediately after the Second United Nations Conference on the Standardization of Geographical Names, a suggestion was made that the USBGN gazetteers be converted into a United Nations series maintained to agreed standards jointly by the USEGN and the countries covered. This suggestion is on the agenda for the next Group of Experts Meeting scheduled for 6-16 March 1973 at United Nations Headquarters in New York.

#### TOPOGRAPHIC MAPS

During this reporting period, the United States assistance to the ground and aerial photographic surveying programmes in Libya, Liberia and Ethiopia was completed. The mapping programme is complete for Libya and is well underway in Ethiopia and Liberia. Participating United States agencies were the Defense Mapping Agency Topographic Center, the US Air Force's 1370th Photomapping Wing, and the Agency for International Development.

In Ethiopia, 223 pictomaps at 1:25,000 scale were produced and 16 sheets at 1:50,000 scale are in production. Eight medium scale sheets, Series 1501, have been published and the remaining eighty sheets are programmed for completion.

Three city maps (Monrovia, Roberts Field and Buchanan) have been published for Liberia. Two 1:50,000 scale sheets were also published for Liberia in 1972. Current 1:50,000 scale mapping for Liberia consists of 36 sheets and the 1:250,000 scale program includes the compilation of 11 sheets covering the entire country.

The United States 1:250,000 scale programme called the Joint Operations Graphic (JOG) now has extensive coverage of Africa available with more sheets to be produced in 1972-1975 period. The JOG-G (ground) is a medium-scale topographic map and the JOG-A (air) is a medium-scale aeronautical chart. They are both derived from the same basic manuscript. The JOG-A shows contour information in feet, and is overprinted with aeronautical information. The JOG-G shows contours in metres, and has a modified aeronautical overprint.

The Africa 1:2,000,000 scale, Series 2201, is completed. This series covers all of Africa in 36 sheets. While this series has provided a much needed up-to-date general map of Africa, five sheets (13, 14, 17, 18, and 19) are now being revised and will be published in 1973. It is anticipated that six sheets will be revised each year.

As a result of a joint effort by the Defense Mapping Agency Topographic and Hydrographic Centres, a new World Wall Map (Series 1142) in 9 sheets, at the scale of 1:11,000,000, measuring about 8 x 12 feet when joined, was issued in July 1972. Sheets 6 and 9 cover Africa and adjacent areas.

The several United States Government mapping agencies and United States commercial firms have active research programmes to develop more efficient equipment and techniques to meet the increasing demand for cartographic information. Many significant advances have been made, some of which will be covered by papers and exhibits at this conference. Interest is continuing in the development of effective means for accurate and economical topographic mapping areas covered by dense evergreen woods. Various new types of airborne electronic sensors are being considered for obtaining detailed ground information that will supplement the data on panchromatic, infrared or color photographic coverage.

The development phases for a system of analytical aerotriangulation involving an electronic computer programme have been completed, and the system has been introduced into operational mapping procedures. The analytical system provides an iterative, least-squares, simultaneous solution for exposure station positions and for the subsequent computation of the geographic positions and elevations of the photogrammetric control points ("pass points") needed for topographic map compilation. The programme embodies provisions for correcting the systematic lens-distortion and film-distortion errors and for a least square adjustment of random errors in the measured photoco-ordinates. It reduces significantly the ground survey data required for mapping.

### HYDROGRAPHIC CHARTS

The Defense Mapping Agency Hydrographic Centre (DMAHC) has since July 1966 placed on issue some 70 new charts and new editions of nautical charts for Africa and the off-lying islands, bringing the number of United States charts on issue for this important part of the world to over 300. This new coverage is comprised of small-scale general ocean and sailing charts, medium-scale general ocean and sailing charts, medium-scale coastal charts, and large-scale harbour approach and port plans. Figure 7 reflects chart coverage available.

A major effort, dating back to July 1963, has been the completion of a new African coastal series comprised of 61 charts at a scale of 1:300,000 or slightly over 4.1 nautical miles per inch at the Equator. This series was designed to complement coastal coverage already on issue for North Africa and the Red Sea - Gulf of Aden area, and to provide continuous coastal coverage on a matching longitude scale all the way from Sidi Ifni and the Canary Islands southward around the continent to Alula at the eastern entrance to the Gulf of Aden. The matching scale feature was specified to enable the mariner to transfer his navigational plot readily from one chart to the next. Twenty-nine charts of this series were published by July 1966.

During the period covering July 1966 through July 1972, 31 charts of this new series were completed, making the lone unpublished exception a chart covering the approaches to Walvisbaai, Southwest Africa. It is planned that this void area of coastal coverage be filled by reproducing in modified facsimile format, the chart coverage issued by the South African Hydrographic Office.

Small-scale charts issued since July 1966 include new general or sailing charts for the West Coast of Africa from Cabo de Sao Vicente, Portugal to Med-douza, Morocco; and Cape Three Points, Ghana to Cape Lopez, Gabon.

Large-scale charts or plans were issued for a number of ports including Lagos and Port Harcourt, Nigeria; Luanda and Lobito, Angola; Cape Town, Mosselbaai, Port Elizabeth and Durban, Republic of South Africa; Beira, Mozambique; Chismaio, Somalia; Djibouti, French Somaliland and Assab, Ethiopia.

In addition to providing new and improved nautical chart coverage for Africa, a number of special charts for this area were issued. A new edition of the small-scale magnetic chart of the world (N.O. 42) was published showing the magnetic variation for the year 1970. Also issued was N.O. Chart 43 which portrays the magnetic variation, epoch 1970.9, with magnetic grid variation (grivation) printed as North and South Polar Chart (Stereographic Projections) on the reverse side.

New editions of the eleven small-scale charts providing complete coverage of the Mediterranean, and showing bathymetry, are in work and are scheduled for completion during Fiscal Year 1973.

A new series of Omega navigational charts, scale 1:2,187,400, has been developed, and those charts covering the north coast of Africa and the west coast, north of the Equator, have been completed.

Supplementing the nautical and special purpose charts for Africa, the Defense Mapping Agency Hydrographic Centre maintained on issue complete navigational publication coverage for Africa and the off-lying islands in the form of Sailing Directions, Pilot Charts, and Light Lists, in addition to regular publication of the weekly Notice to Mariners.

The Sailing Directions for the area have been reformed into a new style with the previous 5 volumes for the Mediterranean area cancelled and replaced with Publication 130, Planning Guide, Mediterranean; Publication 131, Enroute, Western Mediterranean; and Publication 132, Enroute, Eastern Mediterranean.

#### AERONAUTICAL CHARTS

The advent of supersonic aircraft coupled with an increasing number of intercontinental and local flights creates continuing problems in the adequate control of air traffic because of airspace congestion and limitations. Changes in air traffic control procedures, new air navigation systems, and the necessary emphasis on air safety, requires frequent review of charting requirements and modification of aeronautical charts and Flight Information Publications (FLIPS).

The National Ocean Survey maintains Aircraft Position Chart 3071, North Atlantic, scale 1:6,250,000, which covers the west coast of Africa from Morocco to Dakar, Senegal, and serves as a navigational and plotting chart for flights from North America to African terminals within this coverage. Chart 3071 is normally issued on a six-month revision schedule. Thirty-eight editions have been published to date.

The Defense Mapping Agency Aerospace Centre (DMAAC) produces aeronautical charts worldwide and FLIPs covering the free world area. These products, which are produced for the US Department of Defense, are made available to commercial organizations, federal agencies and private individuals. They are also provided to other countries through mutual exchange agreements.

DMAAC produces three distinct series of aeronautical navigation and planning charts over Africa. Complete coverage is available in two of the three series.

There is complete coverage for the 1:5,000,000 scale Global Navigation and Planning Chart. This series of charts was designed primarily for general planning purposes for navigation involving long distances.

The 1:2,000,000 scale Jet Navigation Chart has undergone design characteristic changes since the last report. Shaded relief and ocean depth tints at 10, 100, 500, and 1,000 fathoms have been added to the chart. This series which was designed to meet the requirements of users in high altitude, high speed aircraft, for long-range navigation by radar, celestial, dead reckoning and pilotage charts, are also designed so that a strip chart 300 nautical miles wide (approximately 12 inches) containing all necessary navigational information for any intended course, can be cut from a given chart by the user. Complete coverage of the northern part of Africa is available. The southern portion of Africa is planned for completion during the next two years.

The Defense Mapping Agency Hydrographic Centre (DMAHC) maintains ten Air/Surface Loran Navigation Charts, Series VLC-30, scale 1:2,188,800 (one inch equals thirty nautical miles) that provide Loran C coverage for long-range flights over that portion of Africa north of the Equator, and three Air/Surface Loran Navigation Charts, Series VL 30, scale 1:2,188,800 providing Loran A coverage along the northern and northwestern coasts of Africa. For long-range air navigation plotting in large aircraft, DMAHC maintains eighteen Air Navigation Charts, scale 1:2,188,800, providing complete coverage of the African continent. This latter series will be replaced by the aforementioned Jet Navigation Charts.

Complete coverage of Africa in the 1:1,000,000 scale Operational Navigation Chart is available. This series of charts was designed to satisfy the standard navigation techniques at both high and low altitudes. It is also used for operational planning, briefing, and plotting as well as for flight planning wall displays. Figure 8 depicts sheet areas and publication dates for Africa.

Flight Information Publications (FLIPs) for the continent of Africa are the Africa and Southwest Asia/Europe and North Africa FLIPs. These FLIPs consist of Planning Documents, Planning Charts, and Instrument Approach Procedure Publications which are designed to provide aircrews with the necessary aeronautical information for all phases of flight operations. The Africa and Southwest Asia FLIPs are issued every two months while the Europe and North Africa FLIPs are issued monthly. These products are continually reviewed for modification and improvement to satisfy new and changing patterns in air traffic and navigation systems.

#### INTERNATIONAL MAP OF THE WORLD

The US Geological Survey publishes and distributes a series of topographic maps of the United States at the scale of 1:1,000,000 in two editions. One edition is published as the United States' contribution to the International Map of the World (IMW) and is prepared by the Geological Survey in accordance with the standard specifications for that series. The second edition is based on a series of 1:1,000,000 scale maps compiled by the Defense Mapping Agency for military use. The maps of the second edition, distributed by the Geological Survey for civil use, usually contain more recent information than maps of the IMW series. Although they do not conform to the IMW specifications in all respects, the maps of the second edition will satisfy the same general purpose. Sixty of the 70 maps required to cover the United States are available either in the IMW or military series.

Recent publications of the IMW series include:

NI 16	- Lookout Mountain	- March 1972
NJ 11	- Mount Whitney	- April 1969
NJ 13	- Pikes Peak	- April 1969
NL 19	- Quebec	- September 1971

Four maps are in preparation: NC 16 - Chicago, NK 15 - Des Moines, NK 18 - Hudson River, and NK 17 - Lake Erie.

Recent reprint editions of the 1:1,000,000 scale civil editions are:

NL 13	- Bighorn Mountains	- January 1969
NK 19	- Boston	- August 1969
NO 3,4	- Bristol Bay	- November 1971
NQ 7,8	- Dawson	- November 1971
NQ 5,6	- Fairbanks	- November 1970
NO 5,6	- Kodiak	- November 1970
NQ 3,4	- Nome	- November 1971
NR 5,6	- Umiat	- December 1970

#### NATIONAL ATLAS OF USA

The first official National Atlas of the United States of America was completed and published by the United States Geological Survey in 1970, culminating 8 years of planning and co-operation involving more than 60 federal agencies, specialists, and consultants. The Atlas was compiled as a reference and research tool for use by Congress, government agencies, business and industrial organizations, libraries, educational institutions, and schools. The 431-page, 14-pound, hard-bound volume measures 19 x 14 inches, closed, with many maps on double-page spreads that open to 19 x 28 inches. The Atlas contains 336 pages of general reference and thematic maps at the basic scales of 1:2,000,000, 1:7,500,000, 1:17,000,000, and 1:34,000,000 describing the Nation's salient characteristics, such as: Physical (relief, geology, climate, water resources, soils and vegetation); History (discovery and exploration, territorial growth, settlement, battlefields, and scientific expeditions); Economics (agriculture, industry, resources and transportation); Social (population structure, distribution and change, education and health); Administrative (boundaries and units, including districts and regions for more than 50 federal agencies); Map Coverage (indexes of coverage by the principal sets and series of maps and charts with representative samples, status of aerial photography and geodetic control).

Also provided is a 80-page index with more than 41,000 entries containing geographic co-ordinates, map location codes and, where appropriate, population of places.

The National Atlas of the United States is priced at \$100.00 per volume. A 25 per cent discount is given on orders of 25 or more volumes.

#### EARTH IMAGING SYSTEMS

The NASA Earth Resources Technology Satellite (ERTS) 1 is now in orbit and is producing images of the earth that are of surprisingly good quality. A preliminary analysis of the geometric qualities of the images indicates that when rectified to established ground control these images will meet United States national map accuracy standards for scales as large as 1:250,000. A similar analysis of the Multispectral Scanner System data has not been made, but since spacecraft change altitudes very little and at very low rates, it is likely that these images will also be cartographic quality.

The ERTS system produces monoscopic images that are not suitable for topographic mapping. Overlapping parts of images from adjacent orbits, however, may be viewed stereoscopically to provide general landform information.

Experimentation with photographic data acquired from Apollo and Gemini spacecraft (these data are of approximately the same quality as those from ERTS-1) suggests that the data from ERTS will serve as photoimage planimetric bases, aid in updating existing maps, and improve the geometry of some existing maps at scales as large as 1:250,000.

Within the United States, we intend to experiment with the production of photoimage maps and maps combining conventional line maps with photoimages at a variety of scales. As a part of an experiment formulated by William McDonald for mapping of polar regions, the data will be tested for usefulness in Antarctic mapping and for cartographic representations of arctic ice distributions.

In addition, the Earth Resources Observation Systems (EROS) Programme of the United States Department of the Interior, in co-operation with Inter American Geodetic Survey (IAGS) is undertaking the development of experimental cartographic products in 19 South and Central American nations. The results of these experiments may lead to the development of a useful and timely photoimage supplement to the International Map of the World.

To aid in the use of the ERTS satellite data, the EROS Programme will offer training at the EROS Data Centre located in Sioux Falls, South Dakota, (write R.W. Fary, Assistant Programme Manager for Technical Information Management, US Geological Survey, Room 815, 1717 'H' Street, N.W., Washington, D.C. 20242 for details).

EROS Programme experimentation also includes the preparation of orthophoto quadrangle maps from very high-altitude aircraft photographs. These maps at scales of 1:24,000, 1:50,000 and 1:250,000 are expected to be economical and useful supplements to existing topographic maps. Information concerning these maps may be obtained from Dr. A.P. Colvocoresses, US Geological Survey, 1340 Old Chain Bridge Road, McLean, Virginia 22101.

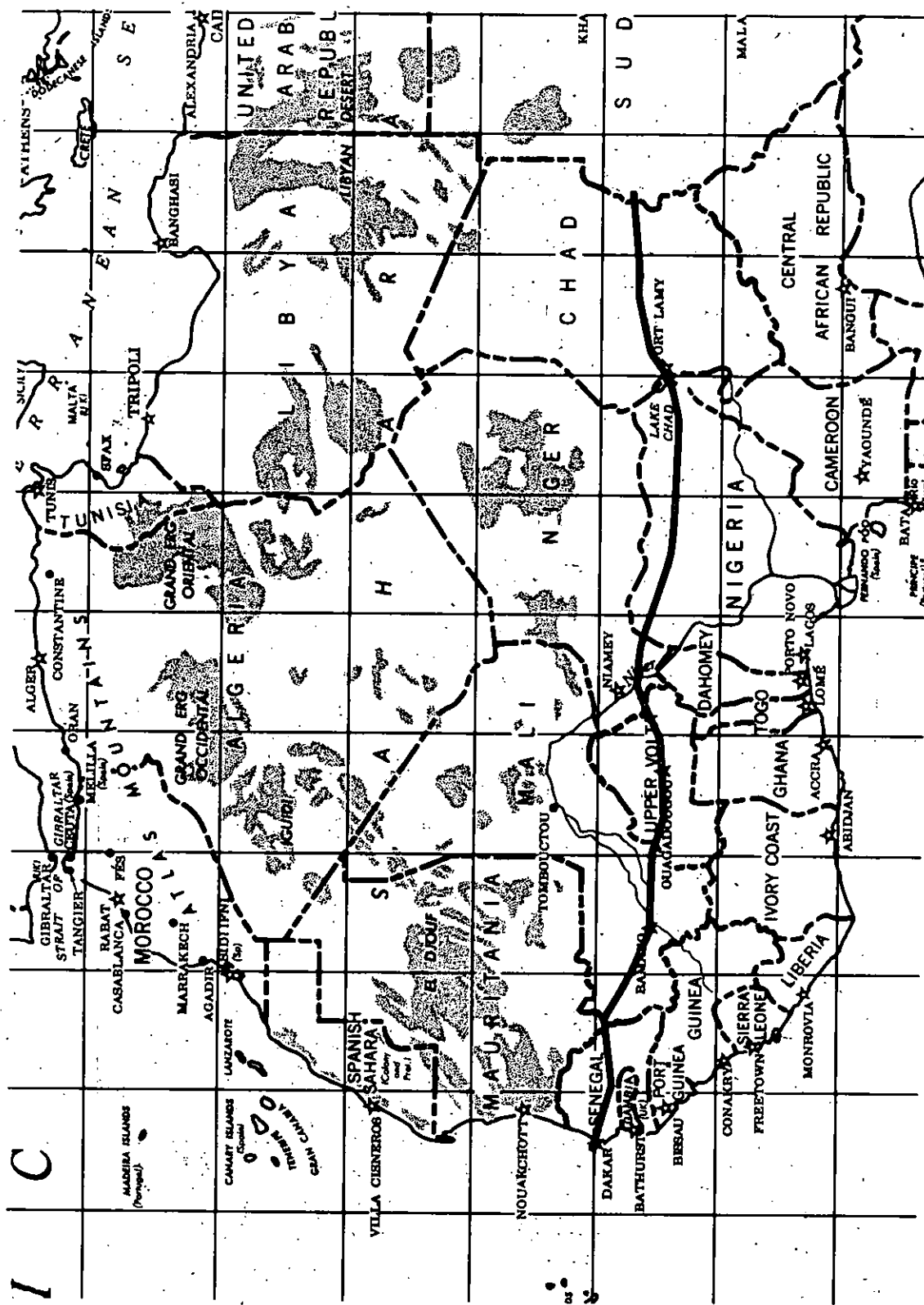
Plans call for the launch of SKYLAB-A in March of 1973. SKYLAB will carry cameras that will produce experimental photographs having greater resolution than ERTS images. The systems to be employed on SKYLAB have recently been described by Dr. Colvocoresses<sup>1/</sup> and Frederick Doyle<sup>2/</sup> of the US Geological Survey as well as by various NASA publications. SKYLAB data will also be used to produce various experimental cartographic products.

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<sup>1/</sup> Colvocoresses, A.P., "Image Resolutions for ERTS, SKYLAB and GEMINI/APOLLO," Photogrammetric Engineering, January 1972, p. 33-35.

<sup>2/</sup> Doyle, F.J., "Imaging Sensors for Space Vehicles," XII Congress of International Society for Photogrammetry, Ottawa, Canada, July-August 1972.





## TWELFTH PARALLEL SURVEY

Chad	833 Kilometers	55 Traverse Stations	28 Laplace Observations:	Upper Volta 679 Kilometers	47 Traverse Stations	23 Laplace Observations				
Cameroon	14	2	"	Mali	926	76	"	36	"	
Nigeria	1201	81	"	Senegal	613	"	45	"	21	"
Niger	273	19	"	(7 Boundary Crossings)	115	"	"	"	"	"
				TOTALS	4653	325 Traverse Stations	168 Laplace Observations			

FIG. 1

FIG. 1

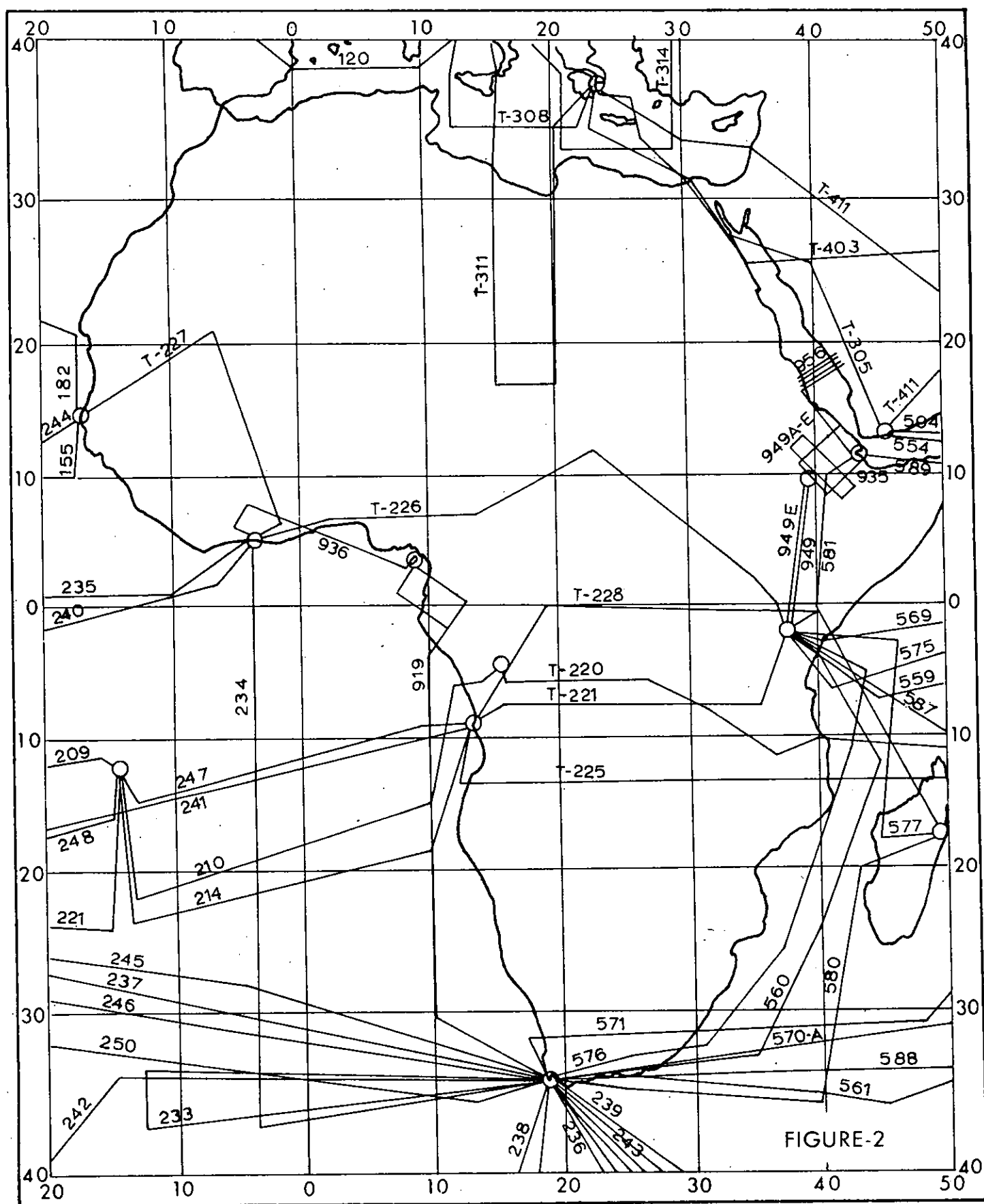
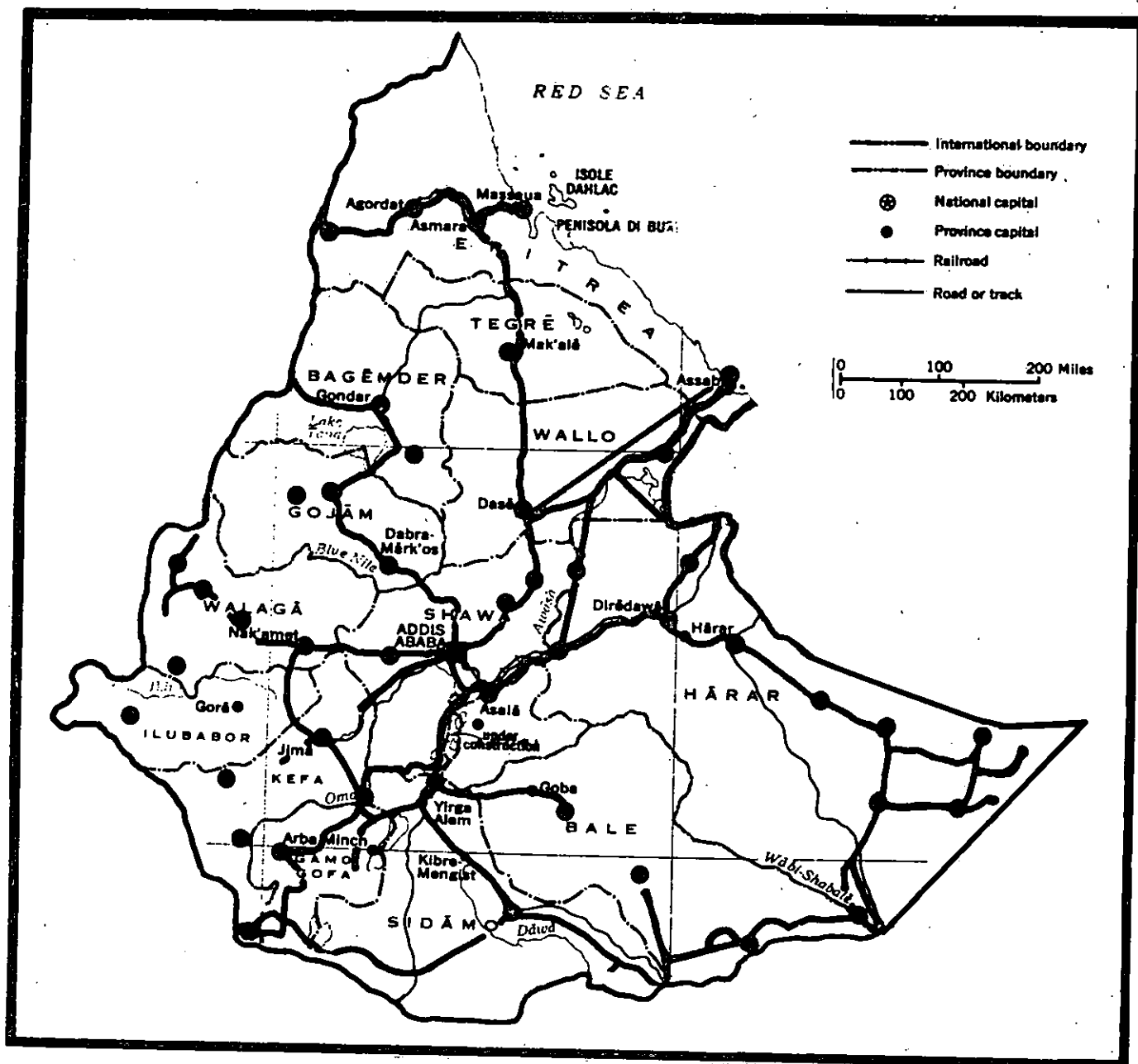


FIGURE-2

# ETHIOPIA GRAVITY

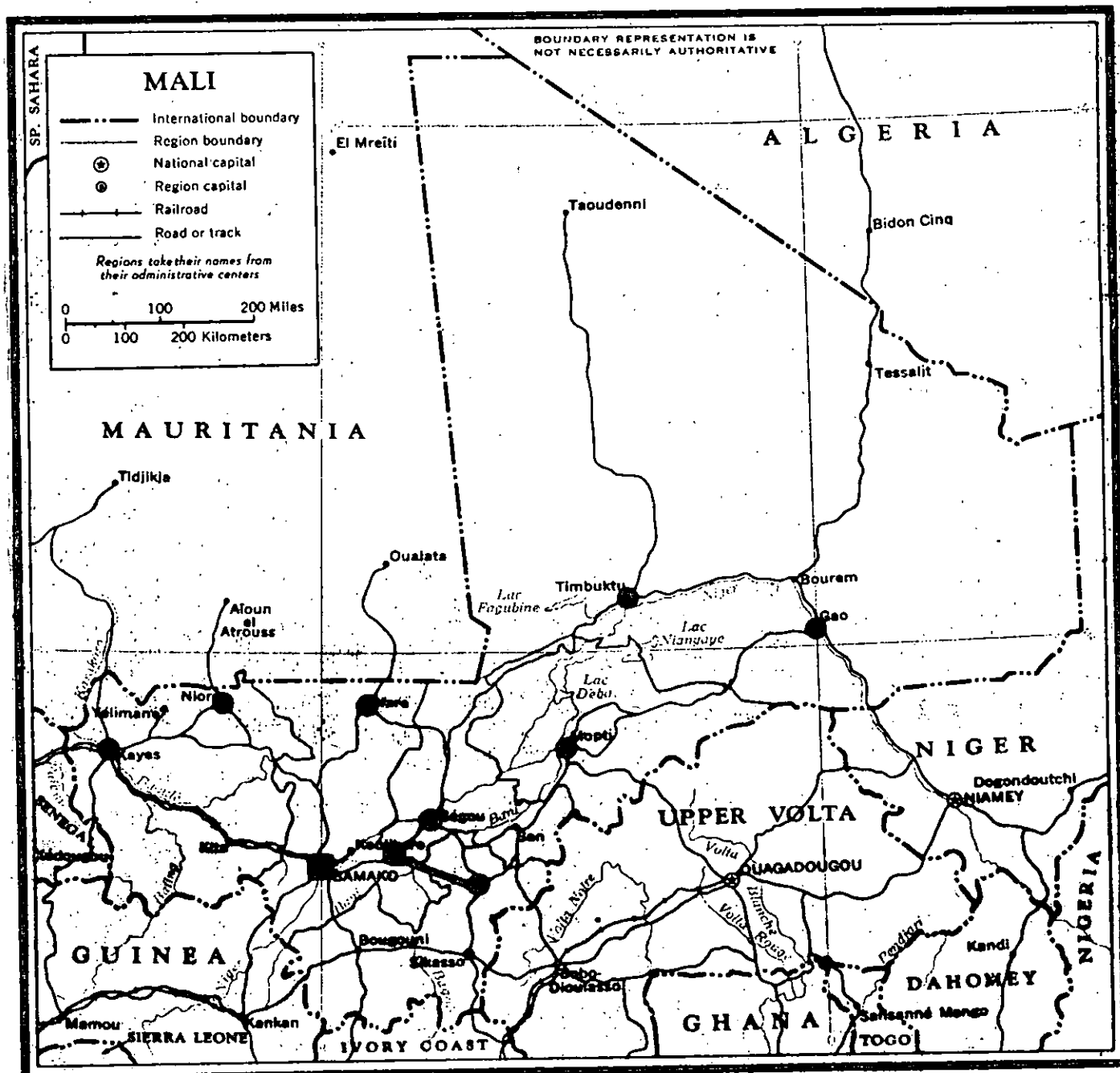
- Fundamental Gravity Base
- National Gravity Base Reference Station (NGBR)
- Gravity surveys performed over established level lines

FIG. 3



# MALI GRAVITY

- Fundamental Gravity Base
- National Gravity Base Reference Station (NGBR)
- Gravity surveys performed over established level lines.

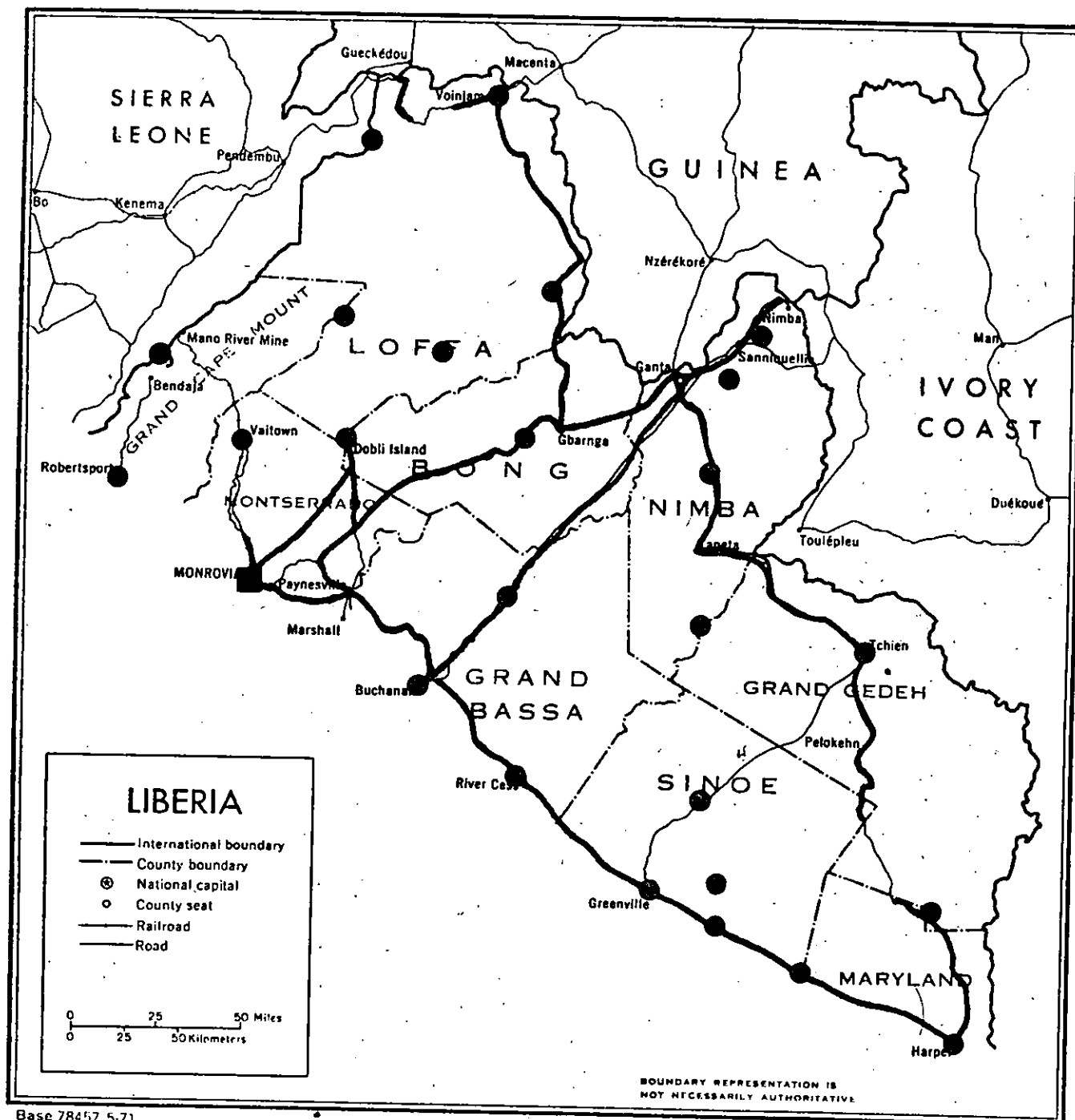


Base 39310 8-64

FIG. 4

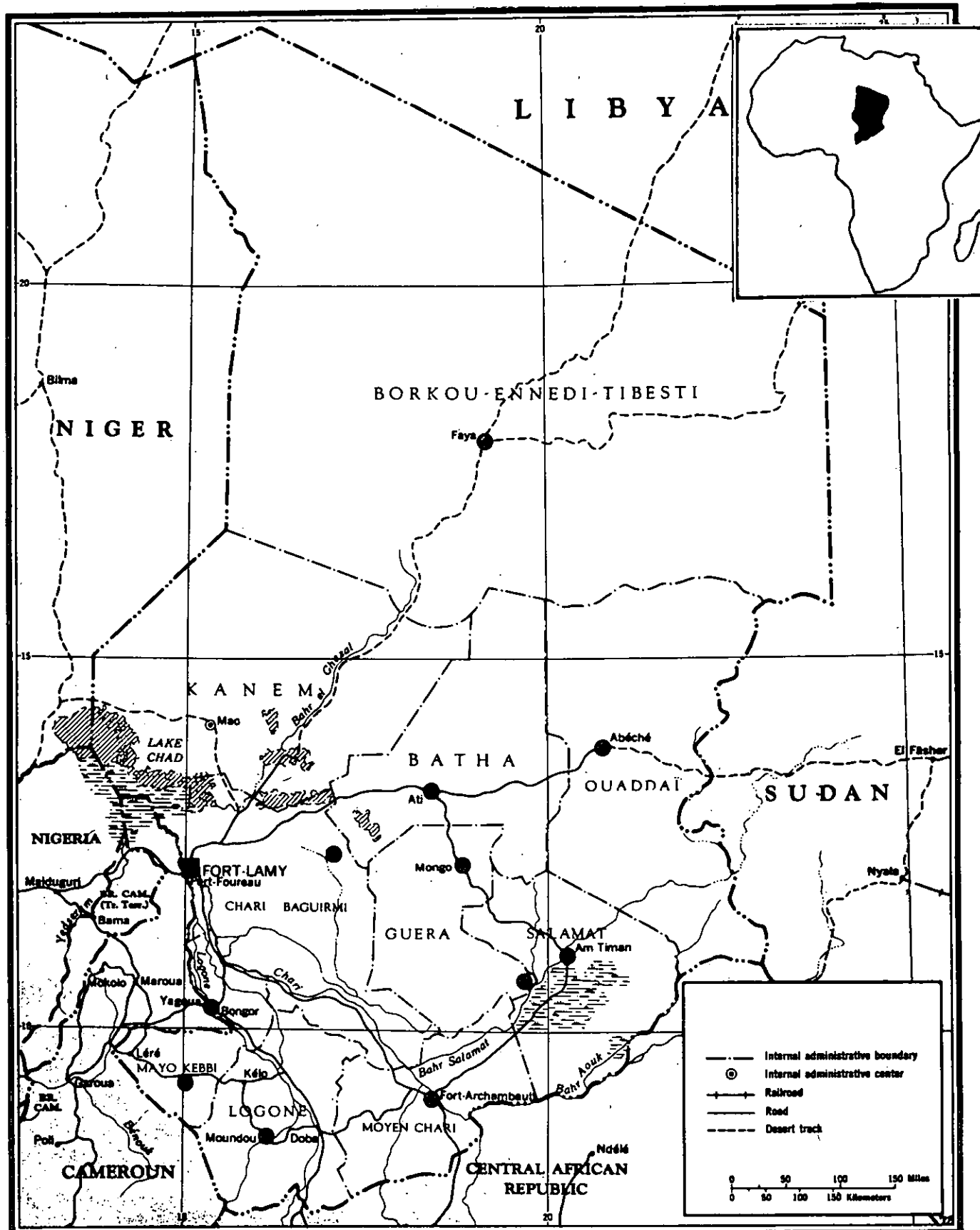
# LIBERIA GRAVITY

- Fundamental Gravity Base
- National Gravity Base Reference Station (NGBR)
- Gravity surveys performed over established level lines.

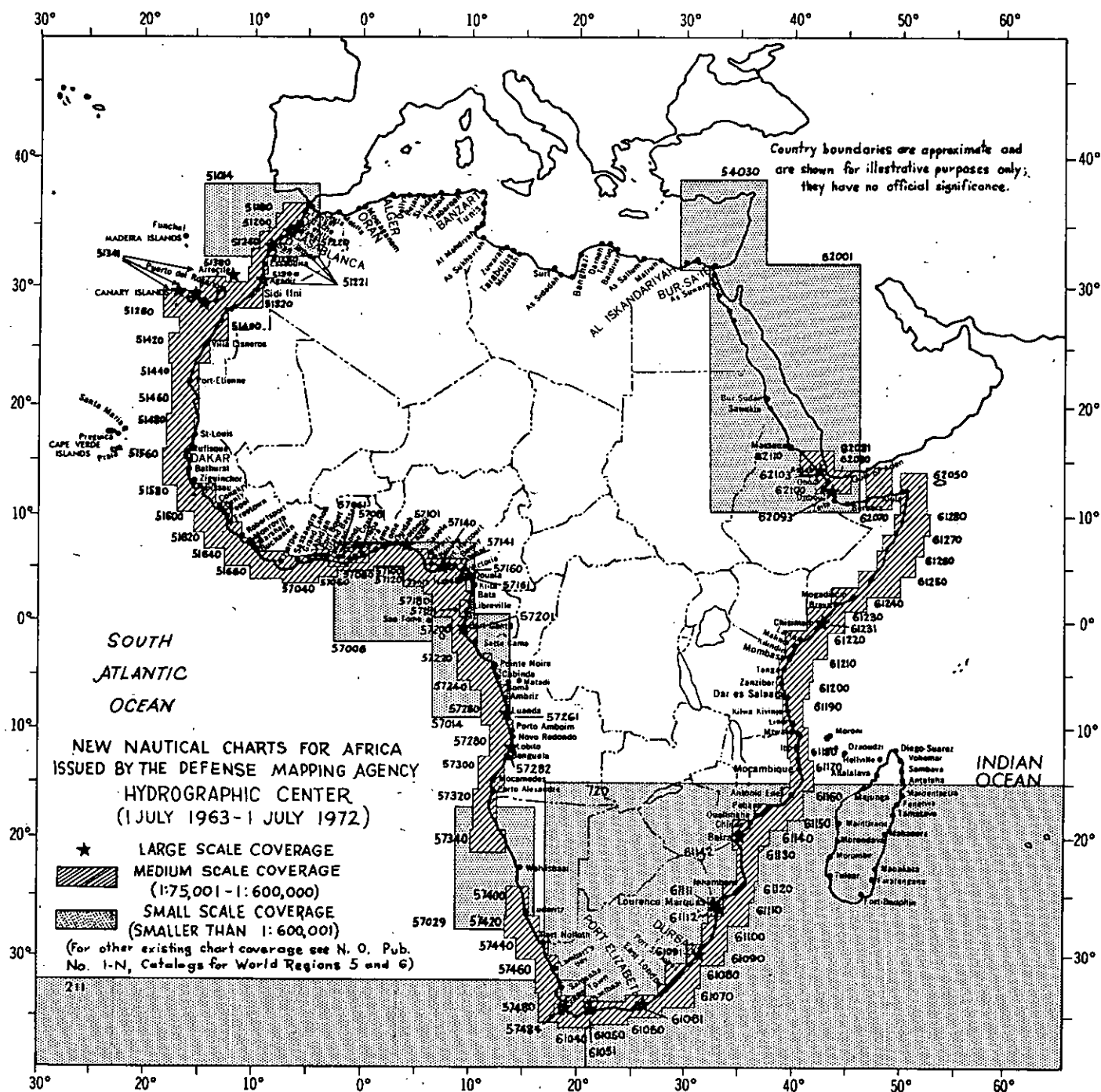


Base 78457 5-71

FIG. 5



■ Fundamental Gravity Base      ● National Gravity Base Reference Station (NGBR)



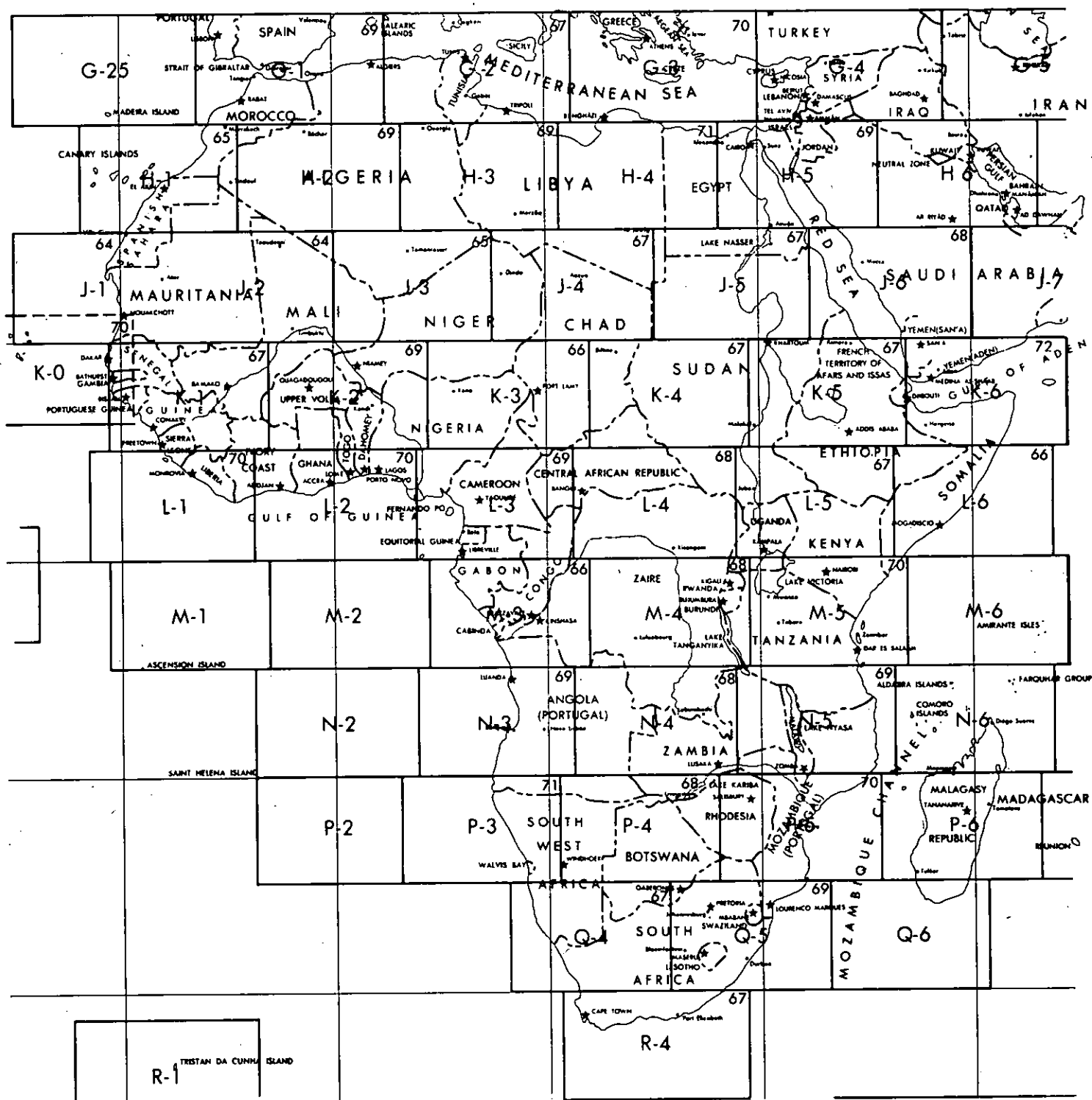


FIGURE- 8