JAPAN INTERNATIONAL COOPERATION AGENCY
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

BASIC DESIGN STUDY REPORT
ON
THE RURAL ENVIRONMENTAL SANITATION PROJECT
(PHASE III)
IN
REPUBLIC OF THE PHILIPPINES

JULY, 1994

NIPPON JOGESUIDO SEKKEI CO., LTD.

REPUBLIC OF THE PHILIPPINES BASIC DESIGN STUDY REPORT ON THE RURAL ENVIRONMENTAL SANITATION PROJECT (PHASE III) IN REPUBLIC OF THE PHILIPPINES JULY 1994 NIPPON JOGESUIDO

JAPAN INTERNATIONAL COOPERATION AGENCY
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

BASIC DESIGN STUDY REPORT

ON

THE RURAL ENVILONMENTAL SANITATION PROJECT (PHASE III)

IN

REPUBLIC OF THE PHILIPPINES

JULY, 1994

NIPPON JOGESUIDO SEKKEI CO., LTD.

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a basic design study on the Rural Environmental Sanitation Project (Phase III) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team headed by Mr. Senichi Kimura and constituted by members of Nippon Jogesuido Sekkei Co., Ltd., from February 24 to April 9, 1994.

The team held discussions with the officials concerned of the Government of the Philippines, and conducted a field survey at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to the Philippines in order to discuss a draft report, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the teams.

July, 1994

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

July, 1994

Mr. Kensuke Yanagiya,
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

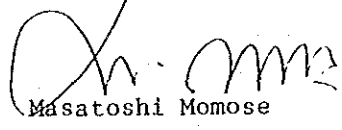
We are pleased to submit to you the basic design study report on the Rural Environmental Sanitation Project (Phase III) in the Republic of the Philippines.

This study was conducted by Nippon Jogesuido Sekkei Co., Ltd., under a contract to JICA, during the period February 10, 1994 to July 29, 1994. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Philippines and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

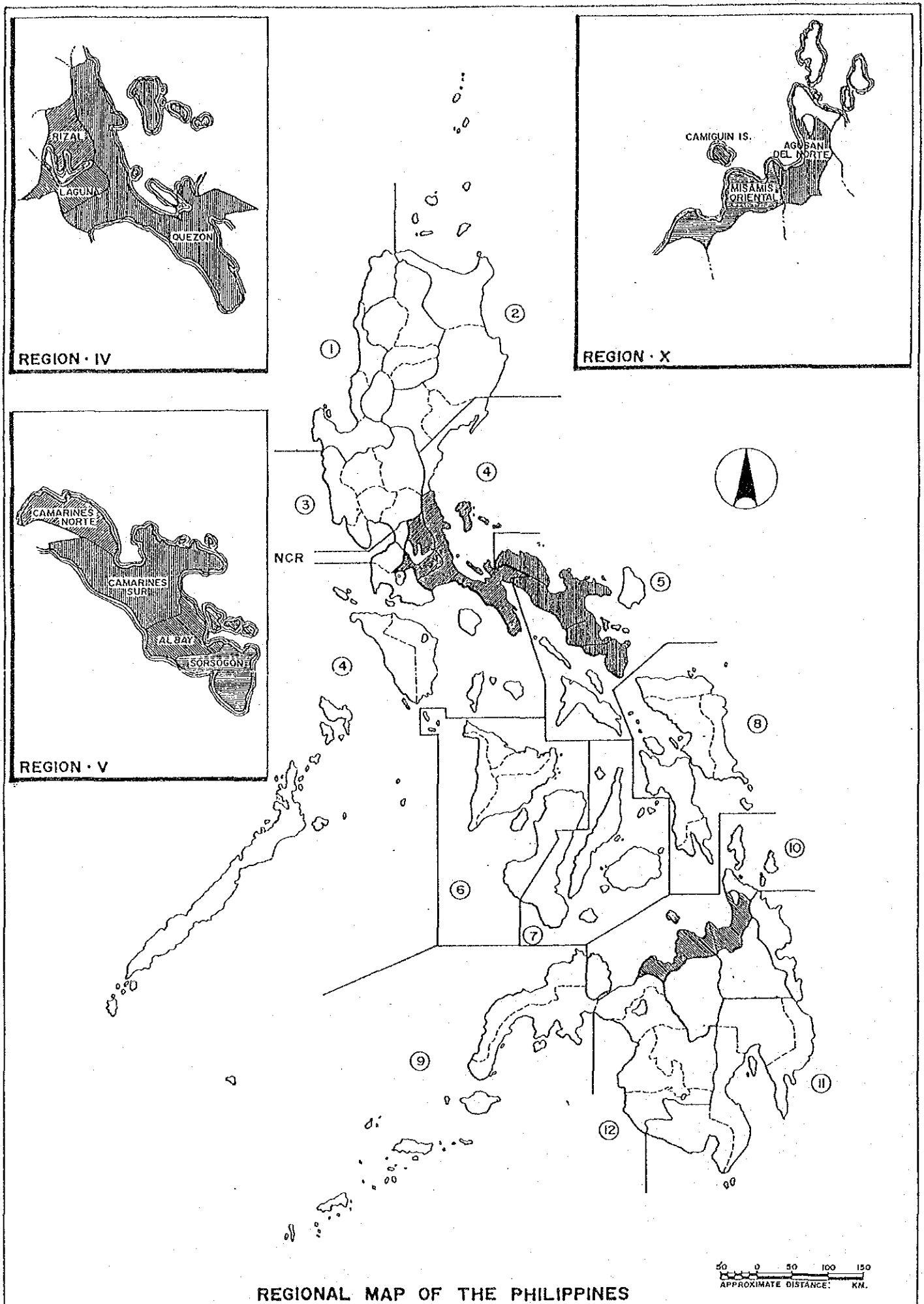
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and the Ministry of Health and Welfare. We would also like to express our gratitude to the officials concerned of the Department of Public Works and Highways, the Department of Health, the JICA Philippine Office and the Embassy of Japan in the Philippines for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,



Masatoshi Momose
Project Manager,
Basic design study team on
the Rural Environmental Sanitation Project
(Phase III),
Nippon Jogesuido Sekkei Co., Ltd.



REGIONAL MAP OF THE PHILIPPINES

LOCATION OF PROPOSED PROJECT SITES (BY REGION / PROVINCE)

BASIC DESIGN STUDY
ON
RURAL ENVIRONMENTAL SANITATION PROJECT
PHASE III

TABLE OF CONTENTS

PAGE

APPENDICES

LIST OF TABLE

LIST OF FIGURE

LIST OF ACRONYMS AND ABBREVIATION

The following abbreviations have been adopted in this report.

Philippine Government Organizations:

DECS	Department of Education, Culture and Sports
DOH	Department of Health
DPWH	Department of Public Works and Highways
EHS	Environmental Health Service (DOH)
LWUA	Local Water Utilities Administration
NAMRIA	National Mapping and Resource Information Authority
NEDA	National Economic and Development Authority
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
NWRB	National Water Resource Board
PHO	Public Health Office
PMO-RWS	Project Management Office for Rural Water Supply (DPWH)

Other Organizations:

ADB	Asian Development Bank
FW4SP	First Water Supply, Severage and Sanitation Sector Project
IBRD	International Bank for Reconstruction and Development
JICA	Japan International Cooperation Agency
OECF	Overseas Economic Cooperation Fund (Japan)
RWS-IV	Rural Water Supply Project-IV
SPRWSSP	Second Island Provinces Rural Water Supply Sector Project

Technical Term:

AMSL	-	Above Mean Sea Level
DF/R	-	Draft Final Report
GNP	-	Gross Natiional Product
IA	-	Implementing Arrangement

IC/R	-	Inception Report
M/P	-	Master Plan
MBGS	-	Meter Below Ground Surface
O&M	-	Operation and Maintenance
PVC	-	Polyvinyl Chloride

Units of Measurements:

°C	-	Degree Celsius	-	Temperature Unit
cm	-	centimeter	-	Lenght Unit
d	-	day	-	Time Unit
ha	-	hectare	-	Area Unit
kg	-	kilogram	-	Weight Unit
km	-	kilometer	-	Lenght Unit
km^2	-	square kilometer	-	Unit Measurement of Area
kV	-	Kilovolt	-	Electrical Potential
kW	-	Kilowatt	-	Power Unit
kWh	-	kilowatt-hour	-	Energy Unit
l	-	liter	-	Volume Unit
m	-	meter	-	Length Unit
mm	-	millimeter	-	Length Unit
m/sec	-	meter per second	-	Velocity Unit
m^2	-	square meter	-	Area Unit
m^3	-	cubic meter	-	Volume Unit
m^3/s	-	cubic meter per second	-	Flow Rate
m^3/d	-	cubic meter per day	-	Flow Rate
m^3/min	-	cubic meter per minute	-	Flow Rate
mg/l	-	milligram per liter	-	Density Unit
s	-	second	-	Time Unit
yr	-	year	-	Time Unit

SUMMARY

In the Republic of the Philippines, as of 1988, about 40 percent of the total population of the Philippines was served by public water supply systems, while about 32 percent were served by private wells. The remaining population, 28 percent, derive water from Dug wells or utilize rain water and river water. In the rural areas, about 30 percent of the population was served by unsafe water sources and are consequently the most affected by waterborne and water-related diseases.

On the other hand, according to the report issued by the Department of Health(DOH) in 1987, 69 percent of the total households in the country had sanitary toilets and 15 percent had unsanitary toilets; 16 percent had no toilet facilities at all.

The Government of the Philippines (GOP) established the 1988-2000 Water Supply, Sewerage and Sanitation Master Plan of the Philippines, and the Three-Year Accelerated Water Supply Program is under implementation, extending original target year. As a contribution to the attainment of the goal set by the national policy, the Rural Environmental Sanitation Projects, provided by the Government of Japan (GOJ) under its Grant Aid Program in two phases, were completed. The Projects covered part of Region III and IV adjacent to Metro Manila, Region I and Region VI areas. A total of 421 facilities, either for water supply or school toilets, serve the beneficiaries in 12 provinces of the covered regions.

The GOP requested the GOJ Phase III Project, as a Grant Aid Program, for the priority areas in the same context of the previous projects. In response to the request, the GOJ decided to conduct a Basic Design Study on the proposal and subsequently, the Japan International Cooperation Agency (JICA) dispatched a Study Team to the Philippines from February 24 to April 9, 1994. Several meetings were held between the Study Team and relevant Philippine officials to establish the terms and framework of the Project. The Study Team conducted a field survey of the Project area and prepared the Draft Final Report including the results of the Study. Discussions on this report were held between the Study Team and Philippine side from July 11 to July 16, 1994. The agreements reached in the meeting form the basis of the Final Report.

For the Study of the contents of the request from the GOP, the criteria for (1) selection of target areas/provinces and (2) prioritizing the respective sites were discussed at the initial stage of the field survey in the Philippines. The agreed Project Area (10 provinces) covers the provinces of Laguna, Quezon and Rizal in Region IV, Camarines Norte, Camarines Sur, Albay and Sorsogon in Region V, and Agusan del Norte, Camiguin and Misamis Oriental in Region X. The respective sites were proposed by the GOP after having screened in terms of (1) unfeasible project in loan application aspects, but needs were high, (2) effective service coverage and (3) field confirmation on the technical requirements. However, finalization of the priority sites for the requested facilities were made by the Study Team through a field survey and discussions with local officials in light of water source availability.

Most of the Study Area is located in or near volcanic belts which were originated in the Cenozoic era. There exist long, moderate to gentle slopes from volcanoes, which are composed of andesites, basalts and pyroclastics. Alluvium is deposited in the lowlands and troughs; however, large alluvial plains are not found in the study area. For groundwater development, aquifers of sand and gravel, gravels and loose boulders are to be selected in the alluvial areas. Aquifers of pyroclastics and basalts are to be used in the volcanic rock area. Although aquifers of sedimentary and metamorphic rocks are well fissured, they are not recommendable due to an insufficient recharge area. Generally, water quality of the groundwater in the study area is fair. However, iron-rich water is found around and downstream of the plutonic rock and hypabyssal rock areas. Saltwater intrusion is found in a limited area along the coast.

Public water supply coverage at present differs from area to area. The provision of Level II and III systems is extended in Camiguin province, while Laguna province, in the vicinity of Manila, is quite behind in public water supply services. Private shallow wells are mainly used in the province, a water source of which is exposed to the dangers of pollution. Waterborne and water-related diseases are consistently among the leading causes of morbidity and mortality in the country. Among digestive organ related diseases, diarrhea is prevalent through the project area and many occurrences of virus-related hepatitis are reported in Regions V and X.

According to a survey conducted by the DOH in 1991, 55 to 80 percent of the total households in the subject provinces had sanitary toilets.

Environmental influences caused by the implementation of the project may be negligible because of its small size and contents. However, the GOP shall make the appropriate arrangements for sludge disposal regarding the septic tank to be constructed for the school toilet facility.

Results of the study disclosed the effectiveness and appropriateness of the proposed facilities in the attainment of objectives including the capability of the existing institutions of the GOP to implement post-construction activities on these facilities as well as the Project's compatibility with the mechanisms of a grant project. Thus, it is recommended for implementation under the Grant Aid Program. The GOP agencies that shall be principally responsible for the implementation of the Project are the DPWH, LWUA and DOH in cooperation with the DILG, DECS and the provincial/municipal councils. Operation, maintenance and management of the facilities shall be handled by the BWSA/RWSA for water supply, and by the DOH and DECS for school toilets. An inter-agency committee, the Project Coordinating Committee (PCC), will be created to provide over-all coordination and direction.

Recommended facilities for the water supply component are 55 Level I systems and 28 Level II systems, as well as 228 toilet units for elementary schools for the sanitation component. Equipment to be procured for monitoring, training and O&M purposes are 3 sets each of pumping test equipment, water quality analysis equipment and water level indicator.

Fundamentals for the planning of the required facilities are given in the following table.

Fundamentals and Conditions for Basic Design of Facilities

Water Supply Facilities		School Toilet Facilities
Water Demand	Facilities	
Design Year : 5-year future according to Philippine design criteria	Pressure Reducing Tank : Installed to ensure static water pressure less than 70 m (2m³ tank)	No. of Toilet Bowls : 20% of pupils use toilet to defecate and 50% to urinate
Design Population : 10% increase of present population (2% annual increase)	Ground Reservoir/Elevated tank : 1/4 of maximum day demand	Water Requirement : 2 lpc for flushing 0.5 lpc for hand washing
Water Consumption Rate : 30 - 40 lpcd for Level I 40 - 60 lpcd for Level II	Pipes : -transmission line -GI/PE -river/road crossing - GI -distribution line under normal condition - PE/PVC -Well casing - GI/PVC/FRP/Steel depending on well depth and substrata conditions	Facility : - dug well - rain water collection - washing basin - toilet bowl and urinal each 1 unit for 30 females - toilet bowl each 1 unit for 30 female - appropriate No. of windows (0.5 m x 0.5m) - non-slip floor with cement tile - separate collection and discharge of floor washing water and wastewater - cistern in the toilet building
Average Day Demand : design population x water consumption rate		
Maximum Day Demand : 1.3 x average day demand	Pump Type and Operation Period : centrifugal pump, 8-10 hours/d	
Maximum Hour Demand : 2.5 x average day demand/24		
Hydraulic Pressure : 5 psi (3.5 m) at end-faucet		

The spring intake, well source, transmission, storage and distribution facilities are involved in the standard water supply system and for the school toilets, four standard types were developed in consideration of the number of beneficiary pupils and in conformity with the DOH standards.

The Project is proposed to be implemented in two stages, each stage to entail a one-year construction period and consists of Region V for the Stage I, and Regions IV and X for the Stage II.

The provision of water supply facilities will enable the inhabitants, where the project by the GOP would be unfeasible in water quality problems and construction cost, to be free from waterborne and related diseases. Furthermore, the promotion of service coverage is expected in the lower priority areas despite the fact that it is an ineffective investment compared with the urban area/rural areas with comparatively higher income levels. School toilet facilities will provide the pupils with direct benefits from the provision of sanitation improvement practices and the reduction of water related diseases. Additionally, families of the pupils may likely be influ-

enced by the favorable results of the Project and ultimately follow suit.

Once completed, the water supply and school toilet facilities will provide benefits to 67,100 people and 80,300 pupils, respectively in 10 provinces of 3 regions. The number of beneficiary pupils will increase yearly. The recipients of water supply facilities are 82 barangays in 64 municipalities, while 228 schools in 125 municipalities are beneficiaries of school toilet facilities. Implementation of continuous works by the agencies of the GOP; DPWH, DOH and DECS will help promote sanitation improvement in the respective jurisdictions of local government units and agencies' local offices through the activities of the personnel in charge of this project. As a fringe benefit, the GOP field personnel will be introduced to proper well construction technology of the open-hole drilling and gravel-pack method.

Taking into account the above effects, the implementation of the Project through a Grant Aid Program is strongly recommended.

However, the GOP should assure at the earliest practicable time the acquisition of land and right-of-access for construction, formation of BWSA/RWSA, adequate training of operation and maintenance personnel, and the periodic collection and disposal of sludge from the septic tank of the school toilet.

CHAPTER 1
BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 Background of the Project

The difference between the urban areas and the rural areas in the Philippines are considerable, not only in the development of economy but also in the provision of basic social infrastructures.

As of 1990, only 72 percent of the population in the rural areas was served by public water supply systems, while 93 percent were served in the urban areas. The DOH reported that 69 percent of households in the rural area in 1987 were provided with sanitary toilet facilities.

Unsanitary conditions are worst during the rainy season when floods brings feces from pit privies and other unsanitary toilet facilities to the surface and contaminate unprotected and improperly constructed wells or other sources of drinking water.

Because of the inadequacy of the public water supply, and of the sanitation facilities, waterborne and water-related diseases like gastroenteritis, diarrhea and infectious hepatitis have consistently ranked high among the leading causes of morbidity and mortality in the Philippines.

The GOP through its various relevant agencies, is currently implementing the 1988-2000 Water Supply, Sewerage and Sanitation Master Plan with the goal of bringing improved living standard and eventually improved health to all Filipinos.

With the explicit goal of promoting proper sanitary practices through the provision of adequate water supply and sanitation facilities to every Filipino, especially for the rural areas, the Government conciered up, and implemented vigorously the massive Three-Year Accelerated Water Supply Program (1989-1991). However, after suffering of huge natural disasters in 1991, the governmental budget fell short of the planned level in the target year, this resulted in the failure of the program's goal with only 53 percent achievement. The GOP, therefore, extended the target year and efforts towards this direction are being exerted to ensure 80 percent of the budget requirements.

In the water supply and sanitation sector, several projects for the rural areas have been implemented under the DPWH and DOH through loan assistance from OECF, ADB and the World Bank. Rural Environmental Sanitation projects, such as the Grant Aid Program of the Japanese Government, were also implemented through two phases in line with the Master Plan mentioned above. The Grant Aid Program is designed especially for the projects which are not economically feasible. The operation and maintenance of the facilities are to be undertaken by the beneficiaries.

The GOP, as it strives to attain its targets set in the Master Plan, and as it tries to replicate the successes of the previous projects, has requested the GOJ for the Phase III Project.

To ensure efficient and effective implementation of the Project, the Project Coordinating Committee (PCC) composed of key officials from the DPWH and the DOH was re-created to provide overall coordination and direction. The Joint Department Order of the DPWH and the DOH creating the said PCC and its composition is shown in Appendix 6.

The implementing arrangement of the GOP during the construction stage of this Project is as follows: i) the DPWH will be responsible for Levels I and II water supply facilities/systems; and ii) the DOH in close coordination with DPWH for school toilets. For the operation and maintenance of the installed water supply facilities/systems, the Department of Interior and Local Government (DILG) will be the primary agency, while the Department of Education, Culture and Sports (DECS) will be the agency responsible for the operation and maintenance of the school toilets.

1.2 Outline of the Request and Main Components

The GOP has requested the Rural Environmental Sanitation Project Phase III for further Grant Aid assistance from the GOJ. This Project is intended to further improve and accelerate the delivery of water and sanitation service to the unserved/underserved rural areas nationwide. The priority areas at the present time proposed by the GOP cover southern and eastern parts of Luzon Island and northern part of Mindanao Island as outlined below.

Region IV : Laguna, Rizal and Quezon Provinces
Region V : Camarines Norte, Camarines Sur, Albay and Sorsogon Provinces
Region X : Agusan del Norte, Agusa del Sur, Surigao del Norte, Camiguin, Misamis Oriental, Misamis Occidental and Bukidnon Provinces

The contents of the request from the GOP consist of construction of water supply and sanitation facilities, and equipment and supporting vehicles as follows:

(1) Water Supply and Sanitation Facilities

1) Water supply facilities (spring or deep well sources) : 134 sites

Level I facilities : 89 sites
Level II system : 45 sites

2) School toilet facilities : 268 sites

The types and physical targets of the request components are shown in Table 1-2-1.

(2) Equipment and Supporting Vehicle

1) Well drilling rig : 2 units

2) Supporting vehicle : 3 units

3) Pumping test equipment, water quality analysis equipment, and water level indicator : 2 units

Table 1-2-1 Contents of Request

Region/Province	Water Supply Facilities				School Toilets	Total
	Level I		Level II			
	Deep Well	Spring	Deep Well/Spring	Sub-total		
Region IV						
Laguna	6	2	3	11	26	37
Rizal	7	1	3	11	3	14
Quezon	9	-	4	13	32	45
Sub-total	22	3	10	35	61	96
Region V						
Camarines Norte	1	5	3	9	15	24
Camarines Sur	3	4	4	11	38	49
Albay	6	3	3	12	21	33
Sorsogon	4	2	4	10	32	42
Sub-total	14	14	14	42	106	148
Region X						
Surigao del Norte	2	3	3	8	23	31
Agusan del Norte	4	1	3	8	13	21
Agusan del Sur	4	1	3	8	9	17
Misamis Oriental	2	3	3	8	16	24
Misamis Occidental	1	4	3	8	13	21
Camiguin	-	5	2	7	8	15
Bukidnon	-	6	4	10	19	29
Sub-total	13	23	21	57	101	158
Total	49	40	45	134	268	402

1.3 Project and/or Program of Other Donors

Currently there are two on-going projects for the rural areas in the relevant sector in the Philippines.

- First Water Supply, Sewerage and Sanitation Sector Project financed by the World Bank (1991-1994)

- Second Island Provinces Rural Water Supply Sector Project financed by ADB (1991-1995)

The scope of these projects in water supply component, limited to Level I facilities, covers well construction and rehabilitation, installation of rain water collector, spring development and preliminary water treatment mainly for iron removal. Among the lending agencies for the rural water supply project, the World Bank, ADB and OECF agreed on the specific areas to be covered, consisting of Luzon Island, Island Provinces, and Visayas and Mindanao areas, respectively.

The sanitation component of the World Bank project entails distribution of toilet bowls to the households in the rural areas nationwide for promotion of sanitary toilet facilities. Furthermore, model work for construction of public toilet and school toilet facilities has been started with an assistance from the same bank in application of the design concept provided by Rural Environmental Sanitation Project (Phase II). In addition to the assistance form the GOJ, these projects are expected to contribute to the relevant sector development in line with the Master Plan and on-going Three-Year Accelerated Water Supply Program.

With reference to Japanese Grant Aid Program, project sites for these projects do not include those where financial recovery is impractical in application of loan due to low income level at the sites. Accordingly, grant aid projects and loan projects supplement each other to provide for increasing water supply service coverage throughout the rural areas.

CHAPTER 2
OUTLINE OF THE PROJECT

CHAPTER 2 OUTLINE OF THE PROJECT

2-1 Objective of the Project

The improvement of sanitation conditions and living standards of the rural population in water supply and sanitation sector is being vigorously exerted by the GOP to attain the goal of "Water Supply, Sewerage and Sanitation Master Plan (1988-2000)".

The GOP is currently implementing the Three-Year Accelerated Water Supply Program. Phase III of the Rural Environmental Sanitation Project has been conceived to help further extend adequate and safe water supply systems, sanitary facilities and health education to the depressed rural areas.

Furthermore, the Project is anticipated to promote the construction/installation of similar projects nationwide, applying the methodologies developed under the Project.

2-2 Study and Examination of the Request

2-2-1 Criteria for Selection of Project Areas and Priority Sites

Selection criteria for the project area and manner of making priority to individual sites were studied and agreed upon by the JICA Study Team and the Philippine side at the initial stage of the field work in the Philippines.

(1) Selection of Project Areas

The area selection on the provincial level was made according to the following criteria:

- Locational and socio-economic conditions in accordance with the principal concept of the Project
- Accessibility to the proposed area for mobilization/demobilization of construction material and equipment/vehicle
- Other potential restrictions

In light of the above conditions, four provinces of Region X (Surigao del Norte, Agusan del Sur, Misamis Occidental and Bukidnon) are excluded from subject provinces.

(2) Manner of Making Priority to Individual Sites

The proposed sites by the GOP were those screened by the joint efforts of local government units and the DPWH Regional/District offices. These are:

1) unfeasible project in loan application, but needs are high,
2) effective service coverage.
3) field confirmation of the technical requirements.

The Study Team, however, examined the sites through the field work focusing on water source availability for all requested components. Replacement of the proposed sites was also considered due to the fact that the sites are located in the vicinity of Metro Manila and other urban areas. Accessibility of well drilling machine to the site was an important condition. In this connection, remote island where assistance by the ADB was provided and those with difficult road conditions were omitted. The possible overlapping of the project sites with other similar projects was carefully reviewed to ensure effective investment. Aside from the common conditions of the concerned components, the following evaluation items were established for field confirmation by project component.

Water Supply Facilities

a) Spring water sources

- To confirm non-existence of potential pollutants at the intake point and within its watershed.

- To meet drinking water quality standards and to ensure stable intake amount required through the year.

- To ensure gravity flow from the spring to service area.

- To ensure water right of the spring and right-of-way for installation of pipeline.

b) Deep well sources

- To confirm no possibility of saltwater intrusion in the coastal area.

- To meet water quality standard in terms of iron content, however, simple treatment facilities may be provided for only Level I system where no alternative water source is available and high iron content is prevalent.

- To ensure an access road for a 10-ton truck to the construction site.

- To ensure land area for construction of well facilities.

c) Level II water supply

- To ensure land area for construction of ground reservoir/elevated tank.

- To confirm the availability of power supply near the site for well source use.

- To ensure beneficiaries' willingness to pay (₱30-₱50/month/household) and establishment of association.

School Toilet Facilities

- To confirm the availability of a dug well at the site.

- The provision of a dug well is a precondition, even if existing Level II/III systems cover the project site. On the other hand, existing deep well at the site may be used in the area where dug well development is not feasible, after field confirmation.

- To ensure land area for construction of toilet facilities in the premises of the school.

- To ensure the willingness of the school officials to participate in O&M of the facilities.

2-2-2 Needs and Appropriateness of the Project

The rationale for the Project as brought forth by the GOP is in line with the framework of the sectoral development in the Philippines. Several concrete items are discussed in this subsection on needs and appropriateness of the Project.

(1) Common Effects of the Project

- Supply of water to meet basic human needs/minimum drinking requirements in the area with groundwater quality problems (mainly in terms of high iron/manganese content).

- Improvement of living standard by reducing the time used for fetching water and increasing the chances for productive works.

- Reduction of medical expenditures and increase of labor productivity brought about by water source protection and sanitation improvement through the provision of a combination of water supply and sanitation facilities.

- Technology transfer to local contractors and officials during construction of facilities, especially for well construction methods and toilet facilities.

- Promotion of service coverage in the area where effective increase of service percentage cannot be expected, but needs are high.

(2) Needs of the Project and Extension of Subject Area in the Philippines

- The project sites, small in size, are distributed in the rural areas far from the urban areas, and are located on many islands.

It will take a long time to promote services throughout the country, but the effects will be steadily extended.

- The needs of the Project are common in any rural area nationwide. The GOP has requested the GOJ those projects selecting the restricted regions with priority, within the framework of the Japanese Grant Aid Program. Thus, the covered areas/Regions are being increased.

- The Grant Aid Program provided by USAID was stopped in the first half of the 1980's. Grant Aid Programs with similar purposes to the above assistance are expected from the GOP.

- The extension of service areas/Regions through this Project, especially in the rural areas, is essentially in line with the GOP's policy to provide services in combination of water supply and sanitation improvement.

- The life of wells constructed by means of traditional methods is rather short. Technology transfer on open-hole gravel-pack method in well construction is a further requirement in the country.

- A series of implementations of the project will help enhance the management system for the provided facilities and promote sanitation concepts in the rural areas.

  Furthermore, assistance to the local government units through the implementation of the Project is considerable in the transferring period of the responsibilities from the DPWH/DOH to local government units.

- The restoration of the damage caused by natural disasters financially hampered the implementation of the projects in the relevant sector programs. Assistance to the projects which are lower in priority by the GOP at present is requested to catch up with the scheduled goals.

(3) Background and Conditions on the Need of Grant Aid Assistance

- Water supply and sanitation projects for the rural areas in application of loan are implemented giving some financial burden to the beneficiaries. Grant Aid assistance is usually proposed for those not to meet such conditions. The procedures to form BWSA/RWSA were established by the GOP.

- Regarding school toilet facilities, the DOH is currently implementing the projects nationwide. However, those in remote rural area are quite low priority due to the existence of a huge number of schools.

- Finalization of project sites shall be done after confirmation of the following conditions to the proposed sites by local government units.

  a) The prospective beneficiaries cannot afford the part of construction cost required by government policy. However, the operation and maintenance fee could be paid.

  b) The construction cost for the facilities is financially unfeasible in loan use, but water sources are available for drinking purpose. Under these conditions, the project is expected to effect the drinking water supply (most cases use spring water sources to reduce the burden of O&M costs).

  c) The sites with water quality problems (iron-rich) and the absence of appropriate well drilling equipment for the sub-strata conditions which hamper the project implementation.

- Immediate effects are expected from a comparatively short period of construction work.

(4) Efficiency in the Provision of School Toilet Facilities

- Prior to the provision of public toilet facilities, practically those for elementary school are designed. This is one of the

effective methods for bottom-up sanitation improvement.

- Provision of school toilet facilities with water-sealed toilet bowls helps pupils promote the improvement of existing toilet conception through performing routine maintenance work by themselves. Influence on the families may also be expected.

- The interrelationships between central government agencies concerned have been developed through the implementation of previous projects. Further reinforcement of the organization not only on the central government level but also on the central-local government agencies' responsibilities will be realized in a practical manner.

Based on the above studies, the proposed project will contribute to the improvement of sanitation conditions in the remote rural areas, a basic human need; within the framework of the relevant plans of the GOP.

2-2-3 Implementation Arrangements

The central government agencies involved in the implementation of rural water supply and sanitation components are the DPWH and the DOH, respectively. The Memorandum of Agreement on the implementation of the Project will be executed by and between the DPWH and DOH in the same manner as Phase II Project. The DOH and DECS will also prepare an agreement for mutual coordination on school toilet facilities. In addition, the responsibilities between the DPWH and DILG, and the DOH and Provincial Health Office (PHO) are defined in local administrative issues.

For the post-construction stage, which entails training of end users, operation and maintenance of the facilities, and monitoring and evaluation of performance, there are several organizations concerned which enumerated below.

(1) Water Supply Facilities: DPWH, LWUA, DOH, PHO, LGU (Local Government Unit) and BWSA/RWSA

DPWH- Assistance in construction of facilities, formation and training of the BWSA/RWSA, and Technical assistance in operation and maintenance works.

LWUA- For Level II systems, assistance both in technical and financial aspects based on the registration of respective systems according to local administrative issues.

DOH- Assistance in construction of facilities including water quality examination at the turn-over stage of facilities, and advice on health and sanitation practices to the beneficiaries through the PHO.

LGU- Assistance to form the beneficiaries' association together with the DPWH receiving registration of BWSAs/RWSAs., and advice to the beneficiaries on the management of the system.

BWSA/RWSA-

Management of the constructed systems entailing water tariff collection from the user households and undertaking of O&M of the facilities.

(2) School Toilet Facilities : DOH, PHO and DECS

DOH/PHO-

Assistance together with the DECS for selection of facility location in the premises of the school, advice to school officials on O&M practices, and monitoring and promotion of sanitation improvement.

DECS- Promotion of health and sanitation improvement program together with PHO officials and annual budgetary arrangement annually for O&M of the facilities.

Generally, the current institutional and budgetary arrangements for the implementation of the components included in Phase III Project appear to be adequate as the functions and responsibilities of all involved agencies are clearly defined. The fund sources for post-construction activities are also

assured. To further ensure the effective and efficient implementation of the Project, the PCC will be created under a Joint Department Order by the DPWH and DOH. The PCC will be charged with the tasks of over-all coordination during construction work with JICA representatives, and effecting smooth transfer of responsibilities to the beneficiaries upon completion of the Project.

2-2-4 Relationship with Similar Locally Funded and Foreign-Assisted Projects

There are a number of rural water supply and/or sanitation projects that are either on-going or are lined up for implementation up to the year 2000 which are included under the Master Plan and the Accelerated Water Supply Program. Among the existing and planned undertakings are the Rural Water Supply and Sanitation Project which is being administered by the DILG, the Rural Water Supply IV Project of the DPWH and the Rural Water Supply Improvement Project of the LWUA, which are all foreign-assisted. Allotments of foreign assisted water supply programs (loan application) on Level I are defined as to areas or provinces covered. For sanitation improvement, the DOH has been distributing toilet bowl throughout the country with an assistance from the World Bank. A construction model of public/school toilet facilities has just commenced in application of the design concept used in Phase II Project.

Although there are duplications/overlaps in water supply project coverage in regional and provincial levels between this Project and World Bank assisted projects. However, the projects to be selected under this project are those that are marginally not cost-effective but of which operation and maintenance cost are affordable to the prospective beneficiaries as proposed by the LGU officials.

The project area for school toilet facilities financed by the World Bank covers entire nation. However, it will take a long time to cover huge number of schools. The schools nominated in the World Bank-assisted project are excluded from this Project.

The Grant Aid Program of the GOJ for construction of school building (the DECS) has been implemented with a provision of toilet facilities. The subject schools are, in principle, not overlapped, since the school building construction project focuses on high school and comparatively large-size

elementary school in urban area, while this Project concentrates on small-size school in rural area.

As a result of the Study, this Project overlaps with similar projects in terms of area coverage and components of the works. However, this Project is to be a feature of pilot project or supplement other similar projects throughout the rural areas of the country.

2-2-5 Composition of the Project

(1) Project Area and Scope of Works

Project area coverage shall be limited to ten (10) provinces of the three (3) regions as mentioned in the previous section. For the recommended project area, the respective total number of Level I and Level II water supply systems, and school toilets in the request shall be considered for the technical study. Based on experience in the number of facilities constructed for the Phase II Project, which took two years to complete, the proposed Phase III Project requires a two-stage implementation period.

(2) Water Supply Facilities

The water supply systems to be constructed shall be limited to Level I and Level II as they are deemed adequate to provide a minimum water requirements in consideration of the present urgent needs of the rural communities and in affordability of the water charges.

(3) School Toilet Facilities

The sanitary facilities shall focus on school toilets in consonance with the concept of existing services on a public/communal system basis and practicality in the initial stage of sanitation improvement in the country.

(4) Equipment

The following equipment will be included in the Phase III Project based on the review and examination of the requested made by the Philippine side:

1) Pumping test equipment : 3 sets

2) Water quality analysis equipment : 3 sets

3) Water level indicator : 3 sets

2-2-6 Requirements for Facilities, Equipment and Supporting Vehicles

The requirements for facilities, equipment and supporting vehicles of the Project are summarized as follows:

(1) Water Supply Facilities

Level I water supply facilities consist of deepwells with handpumps or spring intakes with transmission lines and a public faucet. When any excessive iron is contained in the groundwater, a simplified iron removal facility will be provided to such water sources.

Level II water supply facilities consist of water sources (deepwell with electric motor pump or spring intake), transmission lines, ground reservoir/elevated water tanks, and distribution lines with public faucets. Disinfection apparatuses will be provided to the reservoir/tanks.

For both Level I and Level II water supply facilities, the utilization of spring source will be given first priority among other potential water sources. This is intended to ensure the beneficiaries' self-support and continuity of O&M by the provision of easy and economical system configurations, although the construction costs may be higher than the utilization of other sources.

(2) School Toilet Facilities

The school toilet building will have a partition for boys and girls with a sufficient number of toilet bowls (urinals) corresponding to the number of pupils at each elementary school. The toilet building will be of a standardized structural design having hand washing faucets and a water storage tank within the building. Water for flushing, hand washing and cleaning will be secured by the provision of rain water collection on the roof and shallow wells (dug well) with handpumps, both of which will be connected to the said storage tank. A septic tank with leaching chamber will be provided to every toilet building.

One complete set of school toilet facility as mentioned above will be considered for each elementary school.

(3) Equipment and Supporting Vehicles

The items are pumping test equipment, water quality analysis equipment and water level indicator. These equipment will be granted to the GOP upon completion of construction work.

All the equipment requested by the GOP are throughtly reviewed as described below.

1) Well drilling rig

In view of the implementation method of the Project, several alternative measures of well construction were considered;

- utilization of existing rigs of DPWH,
- utilization of drilling rigs of the Filipino contractor,
- utilization of drilling rigs of the Japanese constructor,
- procurement of new drilling rigs.

The majority of existing drilling rigs of DPWH suitable for well construction of the Project are truck-mounted percussion type procured under the Rural Water Supply Project I in the beginning of 1980s. These rigs are mostly deteriorated because of their usage beyond the normal service-life and have been repaired frequently to prolong their service-life. Thus, the utilization of these rigs is subject to thorough overhauling and repair. Any functioning rig is currently assigned to other on-going projects and therefore not available to utilize for two-year continuous drilling work in the Project. Likewise, the utilization of DPWH's rigs has several constraints and is not practical for the Project.

A cost comparison of the remaining alternatives shows that the utilization of Filipino contractor is the most economical way for the project implementation, while the procurement of new drilling rig is the most expensive case.

The need of new drilling rig of the DPWH for replacement with existing ones and for improvement of implementation capability was also reviewed and recognized, particularly for achieving physical targets set forth by the Accelerated Water Supply Program and the Master Plan, after completing drilling work of this Project.

Resulting from the above, it is determined that the procurement of drilling rig is not suitable for the Project that;

- the principal objective of the requested Project is to improve living environment through provision of rural water supply and school toilet facilities and the drilling rig is therefore considered as a tool to achieve the said objective,

- the repair and overhauling of existing drilling rigs are primarily within O&M program of DPWH and the augmentation of drilling capability shall be so planned and implemented in consonance with the Accelerated Water Supply Program and the Master Plan.

Therefore, the Project shall be implemented with the use of drilling rigs of Filipino contractor and the procurement of new drilling rig shall not be included in this particular project.

2) Pumping test equipment and water level indicator

This equipment is to be used to determine the optimum pumping rate and pumping water level upon completion of the well construction/rehabilitation. A conventional equipment configuration employs a submersible motor pump, but has the principal disadvantage of requiring an external an power supply unless otherwise provided with a generator set. The pumping test on Level I deepwell often reveals the problem that commercial power supply is not available in the vicinity of work site.

Considering the above potential problem, it is recommended that the air-lift pumping method with the use of engine-driven air compressor be adopted instead. The air-lift method has the advantages of;

- mobility, simplicity and economical equipment configuration,
- convertibility to well development/rehabilitation purposes.

The well development is also an indispensable step to finishing the well construction work in that it removes the drilling fluid and cuttings remaining in the well and develops the water course in the aquifer. This is to be conducted just after casing installation and gravel packing and before pumping test. Likewise, the equipment of the air-lift method will be continuously utilized from well development to pumping test.

The recommended equipment configuration was also adopted in the Phase II Project and proved its convenience and usefulness. The DPWH personnel trained in the Project had well acquainted with this equipment.

The number of equipment to be provided under the Project shall be three (3) sets, with one set per each region.

3) Water quality analysis equipment

Physical and chemical examination of water quality are to be conducted by the DPWH during the course of water source identification and construction, while bacteriological examination is to be performed by PHOs upon completion of water source construction. Periodical water quality examination is also obliged to these authorities for safe keeping and monitoring of drinking water supply.

The DPWH, particularly the DEOs in the provinces, have insufficient water quality analysis equipment, although number of water sources have been continuously increasing yearly.

The water quality analysis in water source development is indispensable for the Project, especially confirmation of iron contents and saltwater intrusion in groundwater as well as hardness of spring water. Countermeasures will be selected and taken up based on the result of this analysis.

It is therefore recommended to procure the requested equipment in this Project. The number of equipment shall be three (3) sets as one set per region considering the area coverage and distance to respective sites within each region.

4) Supporting vehicles

The need of supporting vehicles shall be assessed in due consideration of the work load to be increased by the implementation of the Project in addition to the current activities, and in connection with of availability of existing vehicles of the DPWH and the DOH.
A particular need for supporting vehicles arises from the need for effective and efficient transportation and utilization of the various equipment to be procured under the Project mentioned above. Such equipment shall be utilized at every well drilling site corresponding to the progress of construction work. Water quality analysis equipment will be used at all water source development sites (both spring and deepwell).

The equipment will be particularly used by respective DEOs and will be transferred among DEOs most likely every two to three months for shared use. However, frequency of such equipment transportation is deemed within the capability of regional and district offices of DPWH. O&M activities with the use of the said equipment for water supply facilities of the Project will be carried out along with the annual schedule which includes more than one thousand of existing facilities. When the work load of O&M to be added by the Project is taken into account, it will not cause significant increase to current activities of each DEO and shall be thoroughly taken care of by DPWH and BWSA/RWSA themselves.

On the other hand, supporting vehicles being allocated to every DEOs at 1 to 2 units each are usually deteriorated and insufficient to meet with the realistic condition of field works.

Considering the above mentioned situation on O&M activities and supporting vehicles, it is strongly recommended to the Philippine side to

improve their implementation capability of O&M for fulfillment of agency responsibility. In this connection, the requested supporting vehicles are to be primarily arranged among the existing vehicles and not included in the scope of the Project.

With regard to the same request (one unit of supporting vehicle) from the DOH, the other major activities during and after construction work are to conduct campaign and seminar/workshop at regional, provincial and municipal levels of field personnel and to provide health education to pupils as well as guidance on proper O&M of school toilet facilities. Most of these activities will be performed in close coordination with DECS by mobilizing the manpower resources in every locality. Therefore, the need for supporting vehicle will be concentrated on the transportation this manpower and such need can be mostly met by the use of the existing public transportation system.

Considering the above mentioned scope of activities to be undertaken by the DOH, transportation shall be taken care of through the maximum utilization of the existing vehicles and public transport. Thus, the procurement of supporting vehicles is not recommended under this Project.

2-2-7 Needs of the Technical Cooperation

JICA dispatched two long-term Japanese experts to the DPWH, particularly to its PMO-RWS, from 1989 to 1993 with assignment on overall aspects of rural water supply development throughout the country. This technical cooperation coincided with the basic design and implementation of the Phase II Project.

Aside from the said Japanese technical cooperation, there have been technology transfers and guidance through projects financed by the World Bank, ADB, OECF, etc.

In relation to this Project, the following technical cooperation (technology transfer) is deemed necessary during the course of construction work:

- Introduction of and familiarization with the open-hole drilling and gravel-pack method of well construction. This will take place in the

manner of OJT for local officials of respective DEOs.

- Proper guidance and OJT for the beneficiaries (BWSAs/RWSAs) with the use of a manual for O&M of the water supply facilities.

2-3 Project Description

2-3-1 Executing Agency and Operational Structure

The executing agency of the GOP for the Project consists of the Department of Public Works and Highways (DPWH) for the water supply component and the Department of Health (DOH) for the sanitation (school toilet) component. Among these agencies, the DPWH plays the role of the leading agency for overall project implementation and coordination.

(1) DPWH

The DPWH has several Project Management Offices (PMOs) to implement various sector projects. The PMO for Rural Water Supply (PMO-RWS) is exclusively designated for undertaking rural water supply sector projects throughout the country.

The operational structures of the DPWH and the PMO-RWS are shown in Appendix 7 and staffing of the PMO-RWS is presented in Table 2-3-1.

Table 2-3-1 Staffing of PMO-RWS

Field of Staffing	No. of Personnel
Administrative & Financing	21
Engineering	42
- Institutional & Survey	11
- Planning & Coordination	7
- Inspection & Supervision	11
- Procurement	13
Total	63

The PMO-RWS acts as the national center for planning, coordination, budgeting, procurement, project administration, man-power development/training and negotiation with foreign donors/financing institutions. Actual implementation of rural water supply development is undertaken by the water supply section of each District Engineer's Office (DEO). The Regional Director's Office (RDO) located in every administrative region, coordinates with the PMO-RWS and the respective DEOs within the region.

(2) DOH

The Environmental Health Services (EHS) is a division of the DOH central office for the formulation of plans, policies, programs, operating standards and techniques for environmental health and sanitation. It also provides consultative and advisory services and training to implementing arms; monitors and evaluates environmental health programs/projects; and, develops/conducts researches and special projects in environmental health.

In every region, the DOH has Regional Health Offices (RHOs) which coordinate with the Provincial Health Offices (PHOs). The PHOs have recently been transferred from the DOH to the respective provincial governments in compliance with the promulgation of the New Local Government Code. Every PHO has several district hospitals and rural health units in each rural area to deliver public health services to local residents.

Structural set-up of the DOH and the EHS is presented in Appendix 7 and staffing of the EHS is shown in Table 2-3-2.

Table 2-3-2 Staffing of EHS

Field of Staffing	No. of Personnel
Administrative	14
Environmental Sanitation	14
Support Services	15
Total	43

2-3-2 Project Components and Physical Targets

Contents of the project components (water supply and school toilet facilities) together with the respective service population and the number of pupils in each province are summarized in Table 2-3-3 These comprise, for Regions IV, V and X, 55 Level I and 28 Level II water supply facilities and 228 school toilet facilities. The water supply and school toilet facilities are expected to benefit 67,100 persons and 80,300 pupils, respectively. Results of field survey on proposed sites and selected alternative sites are shown in Appendix 9.

Table 2-3-3 Summary of Physical Targets and Population/Pupils to be Served by Facility

Stage/Region/ Phyince	Water Supply										School Toilet	
	Level I				Level II				Total		Number of Facility	Population
	Deepwell		Spring		Deepwell		Spring					
	No. of Facility	Population	No. of Facility	Population	No. of Facility	Population	No. of Facility	Population	No. of Facility	Population		
Stage 1												
Region V												
Camarines Norte	3	880	2	1,730	—	—	3	5,230	8	7,840	17	6,424
Camarines Sur	4	1,210	2	2,200	*2 1	1,380	3	8,250	10	13,040	42	18,460
Albay	4	1,210	3	1,160	—	—	3	4,350	10	6,720	24	10,833
Sorsogon	3	1,540	1	220	—	—	1	1,280	5	3,040	36	11,421
Total	14	4,840	8	5,310	1	1,380	10	19,110	33	30,640	119	47,138
Stage 2												
Region IV												
Rizal	6	2,760	1	250	2	1,130	1	1,650	10	5,790	5	2,917
Laguna	6	1,350	1	170	1	1,210	2	1,620	10	4,350	26	8,240
Quezon	7	*1 3,030	2	330	—	—	3	6,160	12	9,520	35	8,663
Region X												
Agusan del Norte	1	550	4	2,560	1	1,650	3	3,300	9	8,060	15	5,461
Misamis Oriental	2	1,210	2	1,430	1	1,930	2	2,780	7	7,350	18	5,937
Camiguin	—		1	150	—	—	1	1,270	2	1,420	10	1,960
Total	22	8,900	11	4,890	5	5,920	12	16,780	50	36,490	109	33,178
Grand Total	36	13,740	19	10,200	6	7,300	22	35,890	83	67,130	228	80,316

Note) *1 Dug Well for Municipality Mauban, Palo Barangay
*2 Infiltration Gallery

Recommended equipment to be procured under the Project are:

1.	Pumping Test Equipment	3 sets
2.	Portable Water Quality Analysis Equipment	3 sets
3.	Water Level Indicator	3 sets

2-3-3 Location and General Conditions of the Selected Provinces

(1) Water Supply Facilities

A complete list of the rural barangays to be provided with water supply facilities is presented in Table 2-3-4. The list also provides pertinent information on each project site, such as the service level, the proposed type of water sources, and the planned population to be served by the respective water supply facilities, while their location maps are presented in Appendix 8.

The principal sources of livelihood for people in these barangays are agriculture, fishery and other self-employment in small scale cottage industries. Income level in these areas ranges from 2,200 Pesos to 4,400 Pesos per month per household.

The planned population to be served by the Level I water supply facilities ranges from 110 persons to 1,300 persons per facility with the average service population per facility being 730 persons. The Level II water supply facility, on the other hand, is estimated to serve 360 persons to 3,300 persons, with an average of 1,540 persons per facility.

In the provinces of Camarines Norte, Camarines Sur, Albay and Agusan del Norte, springs are potential water sources, owing to the mountainous topographic conditions. Deep wells are predominant in the provinces of Rizal, Laguna and Quezon due to the limited availability of groundwater at shallow depth.

Information on the coverage of water supply facilities by municipality and barangay, as well as the population to be served by such facilities in every province, are summarized in Table 2-3-5.

Table 2-3-4 List of Selected Barangays and Schools

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
REGION IV							
RIZAL	1) Tanay	Sitio Alas-Asin, Daraitan	I	SP	45		
	2) Baras	Sitio Calumpang, San Jose	I	DW	20		
	3) Baras	Sitio Malalim, San Jose	I	DW	50		
	4) Antipolo	Sitio Pagnay Mayamot	I	DW	150		
	5) Antipolo	De la Paz	I	DW	120		
	6) San Mateo	Ampid II	I	DW	100		
	7) San Mateo	Ampid II	I	DW	62		
	8) Pililla	Quisao	II	DW	135		
	9) Morong	Bombongan	II	DW	70		
	10) Antipolo	Sitio Old Boso-Boso, San Jose	II	SP	300		
	1) Morong	Maybancal Maybancal E/S				C	457
	2) Binangonan	Libis Libis E/S				D	795
	3) Angono	San Vicente San Vicente E/S				D	886
	4) Angono	San Roque Doña Justo-Guido MS				C	479
	5) Teresa	Bagumbayan Bagumbayan E/S				B	300
LAGUNA	1) Liliw	Ilayang San Roque	I	SP	30		
	2) Pagsanjan	Layugan	I	DW	25		
	3) Pakil	Bliss, Casa Real	I	DW	20		
	4) Famy	Batuhan	I	DW	100		
	5) Siniloan	Macatad	I	DW	40		
	6) Calauan	Perez	I	DW	40		
	7) Alaminos	Palma I	I	DW	20		
	8) Pangil	Balian	II	DW	220		
	9) Majayjay	Malinao	II	SP	66		
	10) Nagcarlan	Maiit, Alumbrado Talahib	II	SP	228		
	1) Mabitac	Paagahan Paagahan E/S				C	502
	2) Mabitac	Matalatala Matalatala E/S				C	417
	3) Siniloan	Kapatalan Kapatalan E/S				B	331
	4) Pangil	Mabato-Asupre Mabato-Asupre E/S				B	242
	5) Pangil	Dambo Dambo E/S				B	165
	6) Pakil	Kabulusan Kabulusan E/S				C	535
	7) Kalayaan	Longos Longos E/S				C	517
	8) Lumban	Wawa Wawa E/S				D	930
	9) Lumban	Maytalang Maytalang E/S				B	287
	10) Cavinte	Inao-Awan Inao-Awan E/S				A	87

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
LAGUNA	11) Luisiana	San Isidro San Isidro E/S				B	261
	12) Luisiana	San Antonio San Antonio E/S				B	228
	13) Magdalena	Poblacion Ricardo Pronove E/S				C	572
	14) Majayjay	Gagalot Gagalot–Taytay E/S				A	102
	15) Majayjay	Bokia Bokia–Botocan E/S				A	132
	16) Liliw	Moson Moson E/S				B	288
	17) Nagcarlan	Banca–Banca Banca–Banca E/S				B	226
	18) Nagcarlan	Wakat Wakat E/S				A	97
	19) Nagcarlan	Sta. Lucia Sta. Lucia E/S				C	417
	20) Nagcarlan	Malinao Malinao E/S				C	422
	21) Rizal	Antipolo Antipolo Sulsigin E/S				B	269
	22) Victoria	Pagalangan Pagalangan E/S				B	181
	23) Calauan	Sto. Tomas Sto. Tomas E/S				B	219
	24) Alaminos	San Roque San Roque E/S				A	136
	25) Alaminos	Sta. Rosa Sta. Rosa E/S				C	453
	26) Alaminos	San Ildefonso San Ildefonso E/S				B	224
QUEZON	1) Infanta	Agos–Agos I	I	DW	30		
	2) Infanta	Agos–Agos II	I	DW	30		
	3) Mauban	Santol	I	DW	120		
	4) Real	Capalong	I	SP	30		
	5) Tiaong	Lagalag	I	DW	40		
	6) Candelaria	Mayabobo	I	DW	40		
	7) Mauban	Polo	I	SP	30		
	8) Sariaya	Tumbaga I	I	DW	240		
	9) Candelaria	Mangilag Norte	I	DW	50		
	10) Lopez	Mal–ay	II	SP	240		
	11) Gen. Nakar	Poblacion	II	SP	600		
	12) Sariaya	Mamala I	II	SP	280		
	1) Gen. Nakar	Catablingan Catablingan E/S				B	240
	2) Infanta	Binonoan Binonoan E/S				B	228
	3) Infanta	Lual Lual E/S				B	188
	4) Infanta	Tongohin Tongohin E/S				B	231
	5) Real	Cawayan Cawayan E/S				B	182
	6) Real	Capalong Capalong E/S				B	192
	7) Real	Mapalad Mapalad E/S				A	68
	8) Mauban	San Miguel San Miguel E/S				A	136

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
	9) Mauban	Cagsiay I				B	354
QUEZON		Cagsiay I E/S					
	10) Mauban	Polo				B	292
		Polo E/S					
	11) Atimonan	Caridad Ilaya				B	175
		Caridad Ilaya E/S					
	12) Atimonan	Mangalayan				A	114
		Mangalayan E/S					
	13) Plaridel	Ilosong				B	196
		Ilosong E/S					
	14) Plaridel	Concepcion				B	216
		Concepcion E/S					
	15) Gumaca	Camohaguin				B	323
		Camohaguin E/S					
	16) Lopez	Esperanza				A	121
		Esperanza E/S					
	17) Lopez	San Francisco				B	277
		San Francisco E/S					
	18) Lopez	Villa Espina				A	74
		Villa Espina E/S					
	19) Calauag	Sto. Angel				B	245
		Sto. Angel E/S					
	20) Calauag	Tiniguiban				B	243
		Tiniguiban E/S					
	21) Calauag	Tanbansak				B	223
		Tanbansak E/S					
	22) Macalelon	Amontay				B	221
		Amontay E/S					
	23) Pitogo	Cabulihan				B	218
		Cabulihan E/S					
	24) Unisan	Panaon Ibaba				C	516
		Panaon Ibaba E/S					
	25) Unisan	Rizal Ilaya				A	56
		Rizal Ilaya E/S					
	26) Agdangan	Salvacion				B	187
		Salvacion E/S					
	27) Padre Burgos	Sipa				A	191
		Sipa E/S					
	28) Padre Burgos	Hingiwin				B	375
		Hingiwin E/S					
	29) Pagbilao	Iba Paslabangon				C	442
		Iba Paslabangon E/S					
	30) Sariaya	Mamala I				B	350
		Mamala I E/S					
	31) Candelaria	Pahinga Sur				B	196
		Pahinga Sur E/S					
	32) San Antonio	Sinturisan				B	246
		Sinturisan E/S					
	33) Pagbilao	parang-Pinagbayanan				C	396
		parang-Pinagbayanan E/S					
	34) Gen. Luna	Bagong Ilaya				B	306
		Bagong Ilaya E/S					
	35) Gen Luna	San Isidro (Ilaya)				D	645
		San Isidro (Ilaya) E/S					

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
REGION V							
CAMARINES NORTE	1) Sta. Elena	Basiad	I	DW	40		
	2) Basud	Laniton	I	DW	50		
	3) Basud	Pinagwarasan	I	DW	70		
	4) Paracale	Dalnac	I	SP	195		
	5) Jose Panganiban	Calerio	I	SP	120		
	6) Sta. Elena	Poblacion	II	SP	480		
	7) Labo	Talobatib	II	SP	250		
	8) Paracale	Capacuan	II	SP	220		
	1) J. Panganiban	San Mauricio				B	284
		San Mauricio E/S					
	2) Mercedes	Tagontong				B	390
		Tagontong E/S					
	3) Mercedes	San Roque				C	422
		San Roque E/S					
	4) J. Panganiban	Osmeña				B	235
		Osmeña E/S					
	5) San Vicente	L. Opeda				B	248
		L. Opeda E/S					
	6) Talisay	F. David				B	370
		F. David E/S					
	7) Talisay	San Isidro				B	257
		San Isidro E/S					
	8) Vinzons	Sto. Domingo				C	431
		Sto. Domingo E/S					
	9) Basud	San Felipe				D	620
		San Felipe E/S					
	10) Capalonga	Tolento-Roll				B	398
		Tolento-Roll E/S					
	11 Capalonga	Calabaca				C	527
		Calabaca E/S					
	12) Paracale	Dalnac				C	411
		Dalnac E/S					
	13) Paracale	Tawig				B	382
		Tawig E/S					
	14) Basud	Don Juan Pimentel				B	255
		Don Juan Pimentel E/S					
	15) Labo	Talobatib				C	539
		Talobatib E/S					
	16) Sta. Elena	Rizal				C	455
		Rizal E/S					
	17) J. Panganiban	Sta. Milagrosa				B	200
		Sta. Milagrosa E/S					
MARINES SUR	1) Lagonoy	Manamoc	I	SP	150		
	2) Bato	Agos	I	DW	40		
	3) Minalabac	San Juan	I	DW	60		
	4) Lagonoy	Loho	I	DW	40		
	5) Pamplona	Ssan Gabriel	I	SP	250		
	6) Tigaon	San Rafael	I	DW	80		
	7) Bato	San Juan	II	SP	600		
	8) Pamplona	San Isidro	II	DW	250		
	9) Tigaon	Panagan	II	SP	500		
	10) Ocampo	Villaflorida	II	SP	400		
	1) Lagonoy	Cabatonan				B	296
		Cabatonan E/S					
	2) Lagonoy	Sipaco				B	353
		Sipaco E/S					
	3) San Jose	Kinalansan				C	509
		Kinalansan E/S					
	4) San Jose	Obias (Pugay)				B	244
		Obias (Pugay) E/S					
	5) Goa	Catagbacon				C	464
		Catagbacon E/S					

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
CAMARINES SUR	6) Tigaon	Mabalodbalod Mabalodbalod E/S				D	736
	7) Tigaon	Tinawagan Tinawagan E/S				C	556
	8) Tigaon	Salvacio Salvacio E/S				D	680
	9) Ocampo	Hibago Hibago E/S				C	516
	10) Ocampo	Hinawan Hinawan E/S				D	655
	11) Buhi	Sagrada Sagrada E/S				C	479
	12) Baao	Salvacion Salvacion E/S				B	286
	13) Baao	San Isidro – Sta. Teresita Sta. Rita–Sta. Teresita E/S				D	620
	14) Baao	San Juan San Juan E/S				B	280
	15) Bato	San Vicente San Vicente E/S				B	222
	16) Bato	Agos Agos E/S				B	193
	17) Bato	San Miguel San Miguel E/S				B	220
	18) Nabua	Madawon Madawon C/S				A	150
	19) Nabua	Dolorosa Dolorosa E/S				B	228
	20) Nabua	Sta. Cruz Sta. Cruz E/S				B	250
	21) Nabua	Santiago E/S Santiago E/S				B	188
	22) Minalabac	Antipolo Antipolo E/S				D	758
	23) Minalabac	Mataoroc Mataoroc E/S				C	445
	24) Minalabac	Hobo Hobo E/S				D	804
	25) Pasacao	Quitang E/S Quitang E/S				B	354
	26) Pamplona	San Gabriel San Gabriel E/S				C	440
	27) Pamplona	San Vicente San Vicente E/S				C	521
	28) Libmanan	Mambulo Nuevo Mambulo Nuevo E/S				D	700
	29) Libwaran	Bahay Bahay E/S				C	421
	30) Sipocot	Gaongan Gaongan E/S				B	298
	31) Cabusao	Barcelonita Barcelonita E/S				D	878
	32) Cabusao	Castillo Castillo E/S				C	550
	33) Calabanga	Cagsao Cagsao E/S				C	400
	34) Calabanga	Salvacion–Baybay Salvacion–Baybay E/S				B	309
	35) Calabanga	San Roque Taculod E/S				C	482
	36) Canaman	Poro Poro E/S				B	224
	37) Tinambac	Bagacay Bagacay E/S				C	541
	38) Milaor	San Antonio San Antonio E/S				C	459
	39) Pili	Anayan–Sagrada Anayan–Sagrada E/S				C	439
	40) Pasacao	Balogo Balogo E/S				B	375
	41) Buhi	Tambo Tambo E/S				C	506
	42) Bula	Bagumbayan Bagumbayan E/S				C	431

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
ALBAY	1) Guinobatan	Doña Mercedes	I	SP	75		
	2) Libon	Magallang	I	SP	70		
	3) Manito	Cawayan	I	SP	65		
	4) Ligao	Malama	I	DW	80		
	5) Polangui	San Roque	I	DW	30		
	6) Guinobatan	Lomacao	I	DW	70		
	7) Polangui	Cepres	I	DW	40		
	8) Malilipot	San Jose	II	SP	240		
	9) Ligao	Mahaba	II	SP	300		
	10) Libon	Sagrada Familia	II	SP	250		
	1) Tiwi	Naga				D	853
		Naga E/S					
	2) Tiwi	Baybay				B	381
		Baybay E/S					
	3) Tiwi	Bariis				B	343
		Bariis E/S					
	4) Malinao	Tuliw				B	222
		Tuliw E/S					
	5) Malinao	Balading				B	396
		Balading E/S					
	6) Malinao	Honop				B	352
		Honop E/S					
	7) Malinao	Tanawan				C	599
		Tanawan E/S					
	8) Tabaco	Fatima				C	493
		Fatima E/S					
	9) Tabaco	San Lorenzo				D	724
		San Lorenzo E/S					
	10) Malilipot	San Isidro				C	516
		San Isidro E/S					
	11) Malilipot	San Francisco				C	421
		San Francisco E/S					
	12) Malilipot	San Roque				B	340
		San Roque E/S					
	13) Bacacay	Pili Ilawod				B	345
		Pili E/S					
	14) Bacacay	Igang				B	268
		Igang E/S					
	15) Bacacay	Sogod				C	569
		Sogod E/S					
	16) Sto. Domingo	Calayucay				B	175
		Calayucay E/S					
	17) Sto. Domingo	Lidong				B	295
		Lidong E/S					
	18) Daraga	Salvacion				C	435
		Impact Learning Ctr.					
	19) Ligao	Pandan				D	767
		Pandan E/S					
	20) Ligao	Cavasi				D	667
		Cavasi E/S					
	21) Pulangui	Balinad				C	399
		Balinad E/S					
	22) Jovellar	Cabraran				B	366
		Cabraran E/S					
	23) Manito	Buyo				C	527
		Buyo E/S					
	24) Oas	Cagmanaba				B	380
		Cagmanaba E/S					

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
SORSOGON	1) Castilla	San Roque	I	DW	80		
	2) Bulan	Gate	I	DW	50		
	3) Castilla	San Roque	I	DW	150		
	4) Magallanes	Tula-Tula	I	SP	40		
	5) Juban	Añog	II	SP	232		
	1) Gubat	Cota na Daco Bonifacio E/S				B	294
	2) Gubat	Bagacay Bagacay E/S				B	396
	3) Gubat	Sta. Ana Sta. Ana E/S				B	182
	4) Barcelona	Macabari Macabari E/S				B	239
	5) Bulusan	Dancalan Dancalan E/S				B	222
	6) Sta. Magdalena	Talaonga Talaonga E/S				D	945
	7) Sta. Magdalena	San Isidro San Isidro E/S				B	261
	8) Sta. Magdalena	San Rafael San Rafael E/S				B	179
	9) Matnog	Laboy Laboy E/S				B	258
	10) Matnog	Sisigon Sisigon E/S				B	218
	11) Irosin	Monbon Monbon E/S				C	585
	12) Irosin	Bolos Bolos E/S				A	142
	13) Bulan	Otavi Otavi E/S				C	512
	14) Bulan	J.P. Laurel J.P. Laurel E/S				B	379
	15) Magallanes	Caditaan Caditaan E/S				C	514
	16) Magallanes	Bacalon Bacalon E/S				B	154
	17) Magallanes	Pili Pili E/S				B	254
	18) Pilar	Mabanate Mabanate E/S				B	213
	19) Pilar	Komapo-Kapo Komapo-Kapo E/S				B	184
	20) Donsol	Dancalan Dancalan E/S				B	321
	21) Donsol	Ogod Ogod E/S				B	283
	22) Donsol	Rawis Rawis E/S				B	265
	23) Castilla	Dinapa Dinapa E/S				B	395
	24) Castilla	San Vicente San Vicente E/S				B	192
	25) Juban	Guruyan Guruyan E/S				C	419
	26) Juban	Bacolod Bacolod E/S				C	500
	27) Casiguran	San Juan San Juan E/S				B	385
	28) Bacon	San Juan San Juan E/S				B	285
	29) Bacon	San Isidro San Isidro E/S				B	347
	30) Bacon	Buenavista Buenavista E/S				B	222
	31) Bacon	Gatbo Gatbo E/S				B	351
	32) Prieto Diaz	Lupi Lupi E/S				B	178
	33) Barcelona	Tagdon Tagdon E/S				B	263
	34) Bulusan	Porog Porog E/S				A	105
	35) Casiguran	Sta. Cruz Sta. Cruz E/S				B	356
	36) Irosin	Patag Patag E/S				C	423

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
REGION X							
AGUSAN DEL NORTE	1) Jabonga	Maraiging	I	SP	50		
	2) R.T. Romualdez	Tagbongabong	I	SP	85		
	3) Nasipit	Aclan	I	SP	80		
	4) Carmen	Manoligao	I	SP	250		
	5) Buenavista	Talo-Ao	I	DW	100		
	6) Santiago	Jagupit	II	SP	160		
	7) Tubay	Sta. Ana	II	SP	200		
	8) Cabadbaran	La Union	II	DW	300		
	9) La Nieves	Lingayao	II	SP	240		
	1) Nasipit	Amontay Amontay E/S				B	233
	2) Butuan City	Bit-os Bit-os E/S				B	302
	3) Butuan City	Dulag Dulag E/S				B	268
	4) Las Nieves	Lingayao Lingayao E/S				C	411
	5) Las Nieves	Mat-i Mat-1 E/S				C	500
	6) Carmen	Cahayagan Cahayagan E/S				B	332
	7) Tubay	La Praternida La Praternida E/S				B	248
	8) Cabadbaran	Caasinan Caasinan E/S				B	300
	9) Cabadbaran	Calibunan Calibunan E/S				C	400
	10) Cabadbaran	Sanghan Sanghan E/S				B	344
	11) Cabadbaran	Tolosa Tolosa E/S				C	509
	12) Carmen	Manoligao Manoligao E/S				B	304
	13) Carmen	Tagcatong Tagcatong E/S				B	300
	14) Magallanes	Buhang Buhang E/S				D	657
	15) R.T. Romualdez	Tagbongabong Tagbongabong E/S				B	353

REGION AND PROVINCES	MUNICIPALITY	BARANGAY/ SCHOOL NAME	WATER SUPPLY			SCHOOL TOILET	
			SERVICE LEVEL	WATER SOURCE	POPULATION SERVED (HH)	TOILET TYPE	NO. OF PUPILS
MISAMIS ORIENTAL	1) *Salay*	*Limpatugao*	*I*	*DW*	*100*		
	2) Balingasag	Napaliran	I	DW	120		
	3) Gitagum	G. Pelaez	I	SP	40		
	4) Claveria	Panampawan/Rizal	I	SP	220		
	5) Tagoloan	Rosario	II	SP	115		
	6) Balingasag	San Juan, Linabo	II	SP	390		
	7) Medina	Upper Maanas	II	DW	350		
	1) Gitagum	Matangad				C	466
		Matangad E/S					
	2) Lagonglong	Taboc				B	214
		Taboc E/S					
	3) Balingasag	Calacala				B	352
		Calacala E/S					
	4) Balingasag	Rosario				B	184
		Rosario E/S					
	5) Jasaan	Kimaya				C	486
		Kimaya E/S					
	6) Initao	Kamelon				B	187
		Kamelon E/S					
	7) Balingoan	Magtangale				B	191
		Magtangale E/S					
	8) Magsaysay	Consuelo				C	419
		Consuelo E/S					
	9) Claveria	Hinaplanan				C	432
		Hinaplanan E/S					
	10) Tagoloan	Rosario				B	216
		Rosario P/S					
	11) Claveria	Rizal				B	233
		Rizal E/S					
	12) Gingoog City	Bal-ason				C	464
		Bal-ason E/S					
	13) *Gingoog City*	*Minsapinit*				B	165
		Minsapinit E/S					
	14) Ginagoog City	Pangasihan				B	240
		Pangasihan E/S					
	15) Naawan	Tagbalogo				B	202
		Tagbalogo E/S					
	16) Libertad	Tangcub				A	79
		Tangcub E/S					
	17) Alubijid	Poblacion				D	946
		Alubijid E/S					
	18) Laguindingan	Mauswagan				C	461
		Mauswagan E/S					
CAMIGUIN	1) Sagay	Tan-awan	I	SP	27		
	2) *Sagay*	*Bacnit & Bugang*	II	SP	*230*		
	1) Mambajao	Balbagon				B	236
		Balbagon E/S					
	2) Mambajao	Magting				B	265
		Magting E/S					
	3) Catarman	Lawigan				A	135
		Lawigan E/S					
	4) Catarman	Compol				B	162
		Compol E/S					
	5 Sagay	Alangilan				B	191
		Alangilan E/S					
	6) Sagay	Bugang				B	153
		Bugang E/S					
	7) Guinsiliban	Maac				B	177
		Maac E/S					
	8) Mahinog	Benoni				B	329
		Benoni E/S					
	9) *Catarman*	*Tangaro*				B	160
		Tangaro E/S					
	10) Sagay	Bacnit				A	132
		Bacnit E/S					

Table 2-3-5 Coverage of Water Supply Facilities

REGION/ PROVINCE	NO.OF MUNICIPALITY	NO.OF BARANGAY	POP.TO BE SERVED
REGION IV			
RIZAL	6	9	5,790
LAGUNA	10	10	4,350
QUEZON	9	12	9,520
SUB-TOTAL	25	31	19,660
REGION V			
CAMARINES NORTE	5	8	7,840
CAMARINES SUR	8	10	13,040
ALBAY	6	10	6,720
SORSOGON	4	5	3,040
SUB-TOTAL	23	33	30,640
REGION X			
AGUSAN DEL NORTE	9	9	8,060
CAMIGUIN	1	2	1,420
MISAMIS ORIENTAL	6	7	7,350
SUB-TOTAL	16	18	16,830
TOTAL	64	82	67,130

(2) School Toilet Facilities

A complete list of the elementary/primary schools to be provided with school toilets facilities is presented in Table 2-3-4. This list also included information on the location, the required type of toilet facility and the school population. Location maps for these schools by provinces are shown in Appendix 8.

The school population varies from 56 pupils to 946 pupils, with an average of 325 pupils per school. The required type of toilet facility is determined considering the size of school population. Larger-scale schools, these having more than 500 pupils, are found mainly in the provinces of Rizal, Laguna, Camarines Sur, Albay, and Misamis Oriental, where the provincial population exceeds 800,000 persons.

Information on the coverage of school toilet facilities by municipality including the required toilet type and the school population is summarized in Table 2-3-6.

Table 2-3-6 Coverage of School Toilet Facilities

REGION/ PROVINCE	NO.OF MUNICIPALITY	NO.OF BARANGAY	POP.TO BE TOILETS UNITS	POP.TO BE SERVED
REGION IV				
RIZAL	4	5	5	2,917
LAGUNA	16	26	26	8,240
QUEZON	19	35	35	8,663
SUB-TOTAL	39	66	66	19,820
REGION V				
CAMARINES NORTE	10	17	17	6,424
CAMARINES SUR	20	42	42	18,460
ALBAY	12	24	24	10,833
SORSOGON	15	36	36	11,421
SUB-TOTAL	57	119	119	47,138
REGION X				
AGUSAN DEL NORTE	9	15	15	5,461
CAMIGUIN	5	10	10	1,960
MISAMIS ORIENTAL	15	18	18	5,937
SUB-TOTAL	29	43	43	13,358
TOTAL	125	228	228	80,316

2-3-4 Natural Conditions

(1) Climate

The tropical monsoon climate prevailing in the Philippines can be classified into four types according to the pattern of rainfall occurrence, which is characterized as follows:

Type I: has 2 pronounced seasons, which are dry from November to April and wet for the rest of the year.

Type II : is characterized by a very pronounced (maximum) rainfall from November to January with indistinct dry season.

Type III : is characterized by not very pronounced seasons, which is relatively dry from November to April and wet for the rest of the year.

Type IV : is characterized by a more or less evenly rainfall distribution throughout the year.

Figure 2.3.1 shows the map and charts of the climatological zoning and rainfall patterns affecting the Project Area. The climate changes from Type II along the areas on the Pacific Ocean to Type I along the areas on the South China Sea, through Type IV and Type III. This zonation is chiefly caused by the growth of high-pressure air mass on the mainland China that causes the dry season in the Philippines. The province of Laguna and majority of Rizal Province experience Type I climate. Quezon Province has 2 types of climate, Type II prevails on the southern part of the province and Type IV is prevalent on the the eastern part and the northern part of it. In the Bicol region, Type II climate affects most of the Camarines Norte Province, northern and eastern part of Camarines Sur Province, western part of Albay Province and the entire province of Sorsogon; while Type IV climate predominates on southern and western part of Camarines Sur Province, and western part of Albay Province. The provinces of Agusan del Norte and Camiguin have Type II climate while Misamis Oriental Province has a prevalent Type III climate in the central and western part and a prevalent Type III in the eastern part.

Annual rainfall in the Philippines is greatly influenced by the number of typhoons hitting the country. The provinces of Camarines Norte and Albay are the most prone to storm surge. Table 2.3.7 shows the meteorological

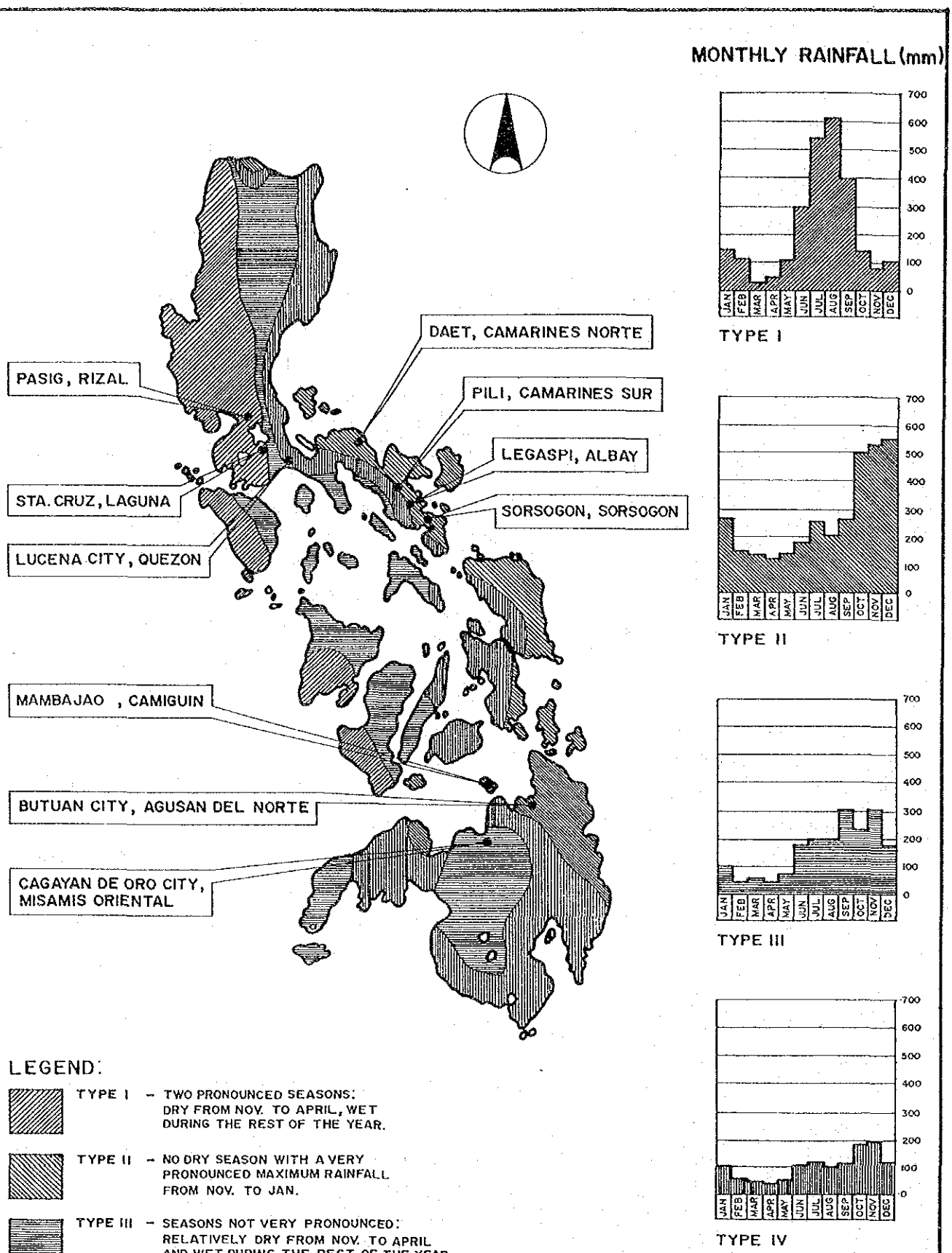


Figure 2-3-1
Climate in the Philippines

Table 2-3-7 *Meteorological Data*

1) Rainfall (mm); 2) Air Temp. (C); 3) Rel. Humidity (%)

PROVINCE	LOCATION		JUN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL AVERAGE
RIZAL	NAIA *	1	11.2	4.2	7.5	15.8	110.8	260.8	363.4	388.0	315.7	223.8	119.4	62.2	156.9
		2													27.6
		3													77.0
LAGUNA	AMBULONG BATANGAS	1	16.1	8.2	18.6	34.3	104.0	231.9	313.1	311.6	292.7	240.0	164.7	108.5	1,828.0
		2													27.6
		3													
QUEZON	LUCENA CITY	1	65.0	50.6	32.0	24.1	87.0	165.7	202.5	204.1	276.5	338.5	332.4	243.0	2,021.4
		2													27.0
		3													
CAMARINES NORTE	DAET	1	272.5	147.5	132.1	126.9	148.6	184.1	243.7	203.7	261.5	501.3	539.7	548.9	3,216.8
		2													
		3													
ALBAY	LEGASPI CITY	1	320.3	183.8	165.8	152.1	168.0	318.4	276.0	260.5	271.6	336.2	475.9	474.7	3,403.3
		2													
		3													
SORSOGON	SORSOGON **	1	233.2	134.5	54.2	46.9	128.0	120.5	327.7	275.7	209.3	184.4	–	–	1,714.4
		2	25.4	25.6	26.9	28.1	28.5	28.2	26.9	27.8	26.7	26.8	–	–	27.1
		3	84.0	82.0	81.0	79.0	81.0	82.0	86.0	83.0	84.0	87.0	–	–	83.0
AGUSAN DEL NORTE	BUTUAN CITY	1	367.9	177.9	133.9	79.1	119.8	147.6	142.8	87.7	145.5	222.2	211.3	238.4	1,980.8
		2	25.60	24.76	26.48	27.68	28.22	27.70	27.25	27.60	27.47	27.19	26.82	26.07	26.90
		3	87.86	82.56	84.67	80.11	80.00	82.11	83.00	82.10	83.00	84.20	86.10	87.80	83.63
CAMIGUIN	MAMBAJAO **	1	36.6	45.8	22.3	35.1	55.8	201.5	170.9	126.0	211.3	484.2	391.8	393.8	2,175.0
		2	24.4	25.0	24.8	25.0	25.6	26.1	25.8	25.4	24.3	25.5	24.5	22.5	24.9
		3													80.0
MISAMIS ORIENTAL	CAGAYAN DE ORO CITY	1	117.3	69.2	46.2	34.0	96.1	218.4	206.8	231.4	211.6	189.0	159.6	90.3	1,663.0
		2	26.8	26.9	27.1	28.7	29.0	28.3	27.9	28.2	28.0	27.9	27.4	27.1	27.8
		3	82.0	81.0	79.0	78.0	76.0	79.0	80.0	80.0	81.0	80.0	81.0	79.0	80.0

SOURCE : PAG–ASA

* Ninoy Aquino International Airport

** From Provincial Socio/Economic Profile

data of the Project Area, however, data from Camarines Sur Province is not available. The mean annual rainfall in the Project Area varies from 1,669.9 mm at Cagayan de Oro City in Misamis Oriental Province to 3,403.3 mm at Legaspi City in Albay Province. The maximum average monthly rainfall of 548.9 mm occurs in December at Daet in Camarines Norte Province.

The air temperature throughout the archipelago does not vary very much. Likewise, annual change of the temperature in the Project Area is minimal. The mean annual temperature varies from 24.9oC at Mambajao in Camiguin Province and 27.8oC at Cagayan de Oro City in Misamis Oriental Province, which are the minimum and maximum among the provinces of the Project Area.

Since the Philippines is surrounded by the sea, then the country is humid throughout the year. For instance, in Tayabas, Quezon Province, the relative daily humidity ranges from 75% to 96%.

(2) Topography and Geology

The Philippine archipelago is situated in the eastern end of Eurasian Plate. This archipelago is bounded by three plates, Philippine Plate, i.e. a part of Pacific Plate on the east, Eurasian Plate on the west and Indo-Australian Plate on the south. The westward movement of Pacific Plate chiefly caused the emergence of this archipelago and the deep Philippine-East Luzon Trench on the east during the Mesozoic era. The uplifting also made the folding, faulting, and volcanic activities in the region which then formed sub-parallel ridges, faults and the volcanic belts with intrusives and plugs emerged in and along the volcanic belts parallel to the trench. As the result, the geomorphology and geological structure of this archipelago are pretty much controlled by the tectonic activity surrounding it, e.g. shore-lines with many irregularly-shaped peninsulas, rugged-terrain areas, short rivers, and elongation of geological formation following the structure of fold-fault trend, to name some.

Figure 2.3.2 shows the volcanic belts in the Philippines. Most of the Project Area is located in or near the volcanic belts; Region IV in the Central Luzon Belt, Region V and Agusan del Norte Province of Region X in or near the Bicol Belt and Misamis Oriental Province and Camiguin Province of Region X in or near the Mindanao Central Cordillera. Most of the volcanoes are originated in the Cenozoic era and have a long moderate to gentle

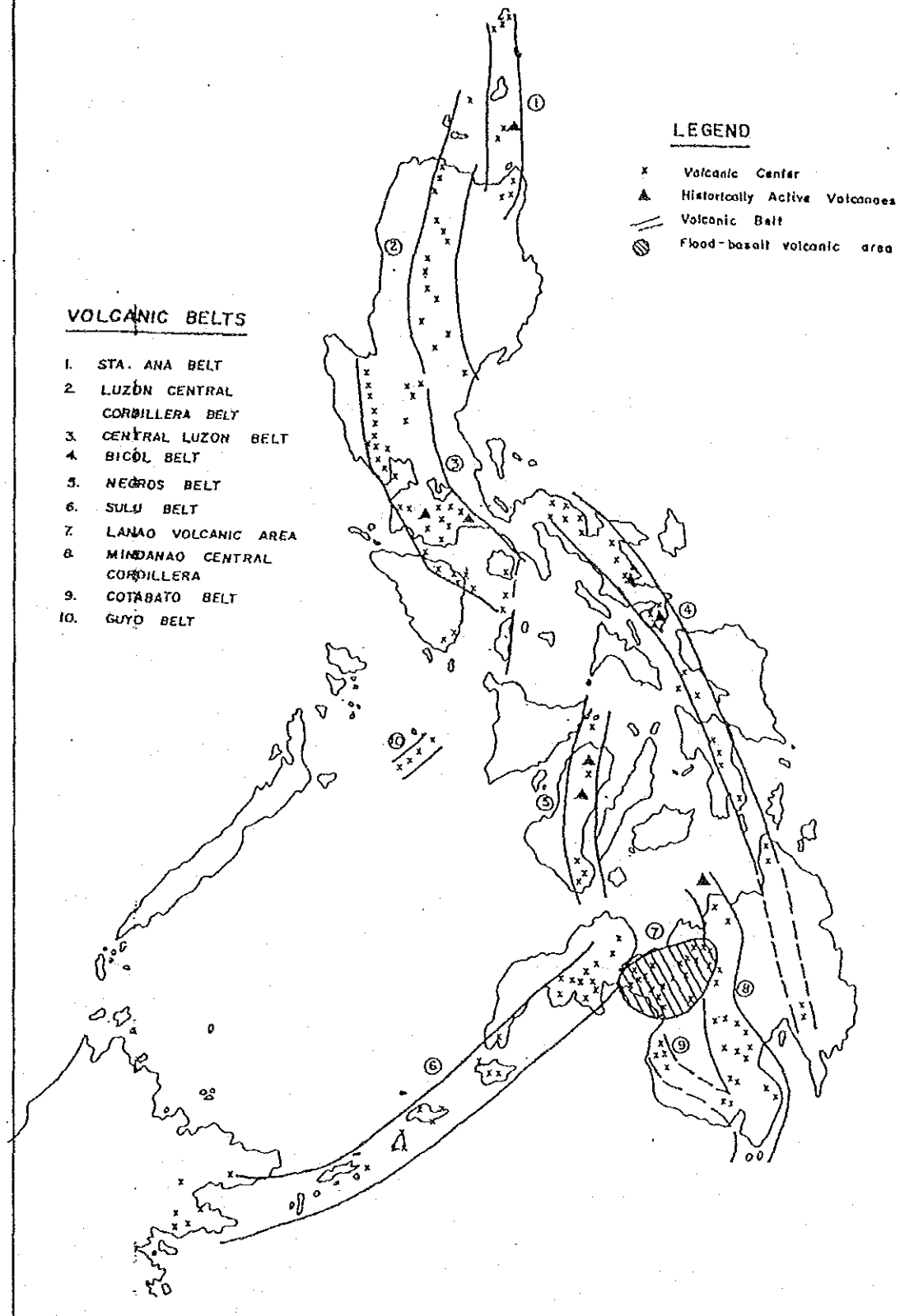


Figure 2-3-2
Location of Vocalic Belts

slopes, comprising of andesites, basalts and pyroclastics. There are active volcanoes which are still erupting such as Mayon Volcano, Mt. Camiguin-Hibok Hibok.

Mesozoic sedimentary rocks are mostly of marine origin and metamorphosed. Tertiary sedimentary rocks are both marine and terrestrial. Alluvium is deposited in the lowlands and troughs. However, large alluvial plains are not developed in the Project Area, because the basins are very much dissected by those rocky ridges and volcanoes. The relatively large alluvial plains are limited to the coastal area of Laguna Province, the eastern part of Camarines Norte Province, the Bicol Plain of Camarines Sur Province, and the floodplain of Agusan River in Agusan del Norte Province.

Below are the topographical and geological information for each province in the Project Area.

A. Rizal

The province of Rizal is mostly related to the central physiographic province and partly related to the eastern physiographic province. The provinces in the central physiographic province have mixed topographical features, because of The central setting. The western part of this province is characteristically low and flat, like the areas bounding the Laguna de Bay which are either narrow coastal plains or small headlands. The rest is an area dissected by spurs and ridges of southern tail of Sierra Madre Mountains. Moreover, the principal rivers draining the province are the Pasig and Marikina River which empty into Manila Bay and Laguna de Bay.

The oldest rocks in southern Sierra Madre consisting of metavolcanics are conformably overlain by Cretaceous Kinabuan Formation consisting of greywacke intercalated with spilites along with spilitic basalt intercalated with greywackes. Kinabuan Formation is widely spread in the central part of the province particularly the eastern part of Antipolo and Tanay, San Mateo, and northern part of Montalban.

Unconformably overlying the Kinabuan Formation is the Oligocene formation that is characteristically composed of andesite flows often with pyroclastics and cherts. This formation can be found in the western

part of the province covering portions of Montalban, San Mateo, Antipolo, and Taytay.

Then Oligocene-Miocene formation of wackes, shales, reef limestones, and other major limestone bodies followed. The wackes-shales-reef limestones area can be found in the northern tip of Montalban and eastern portion of Antipolo and Tanay, while major limestone bodies are usually found underlying the municipalities of Angono, Antipolo, and Morong.

A series of intrusion occurred in Tertiary. The Paleogene intrusion of mostly quartz-diorite can be found extensively in the eastern part of the province covering the mountainous belt. Miocene quartz-diorite mostly in the form of batholith and stocks can be found in San Mateo and Montalban.

During Upper Miocene-Pliocene, marine clastics overlain by pyroclastics chiefly tuff and tuffites were deposited. The Pliocene-Quaternary formation of chiefly pyroclastics and/or volcanic debris can be found extensively exposed in Talim Island, Jala Jala, Pililla, Binangonan, Cardona, Teresa, Baras, and Tanay. This is the most widespread deposits in Rizal Province.

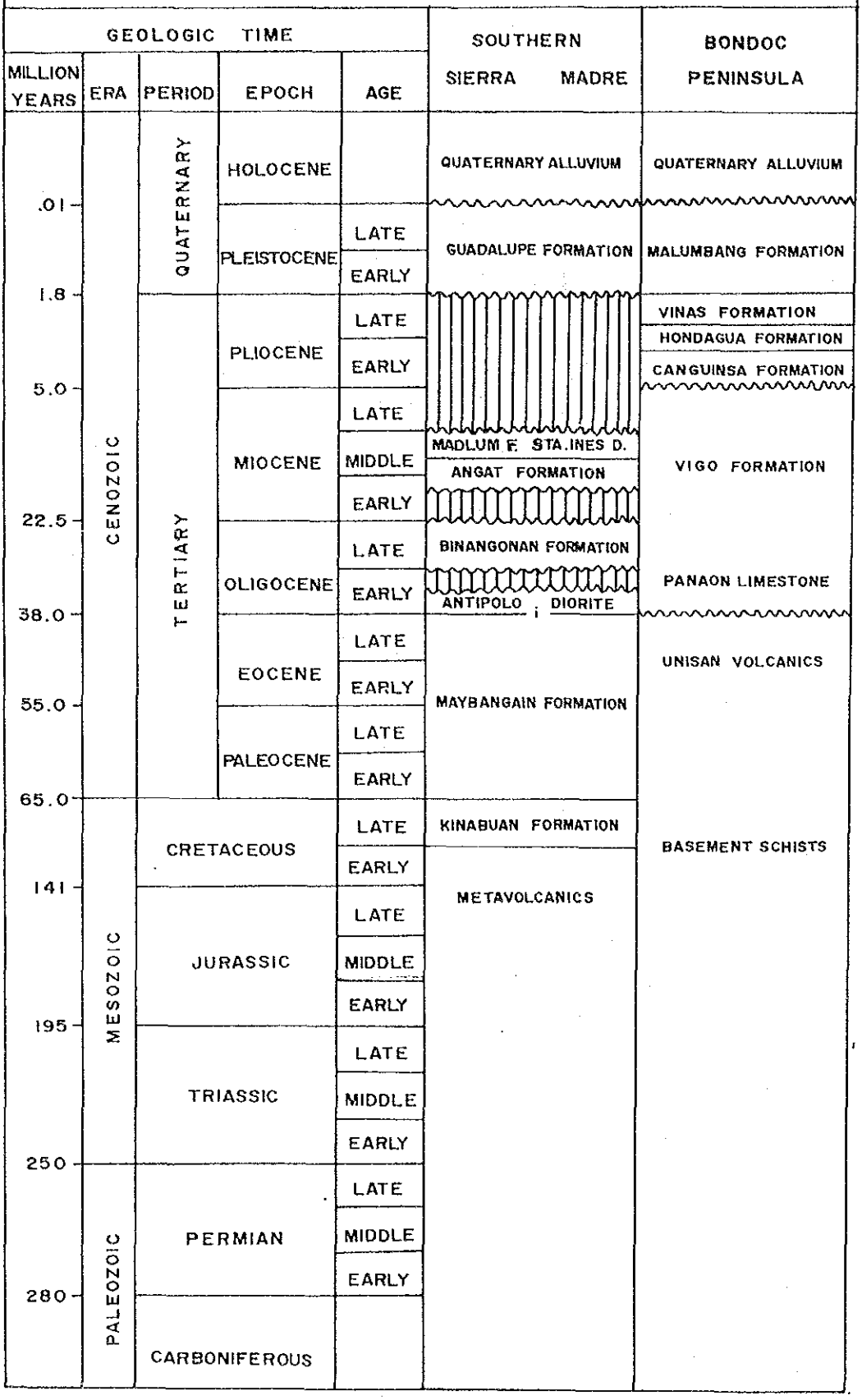
The recent formation of unconsolidated sand, gravel, and beach deposits covers flat lying areas particularly in the western part of the province, namely Montalban, San Mateo, Cainta, and Taytay; which followed the Pliocene-Pleistocene formation of reworked tuff.

Shown in Figure 2.3.4 is the geological map of Rizal while Figure 2.3.3 presents the stratigraphy of the Southern Sierra Madre physiographic province that constitutes most part of this province.

B. Laguna

Basically, the province of Laguna belongs to the central physiographic province. Its morphology is largely controlled by the presence of Quaternary volcanic activities such as Mt. Banahaw and Mt. Makiling, and by movements along faults on the west and southeast of Laguna de Bay namely Marikina and Lipa Fault. The topography of south of Laguna

Figure 2-3-3 Stratigraphy in Rizal, Laguna and Quezon



SOURCE : MINES AND GEO-SCIENCES BUREAU

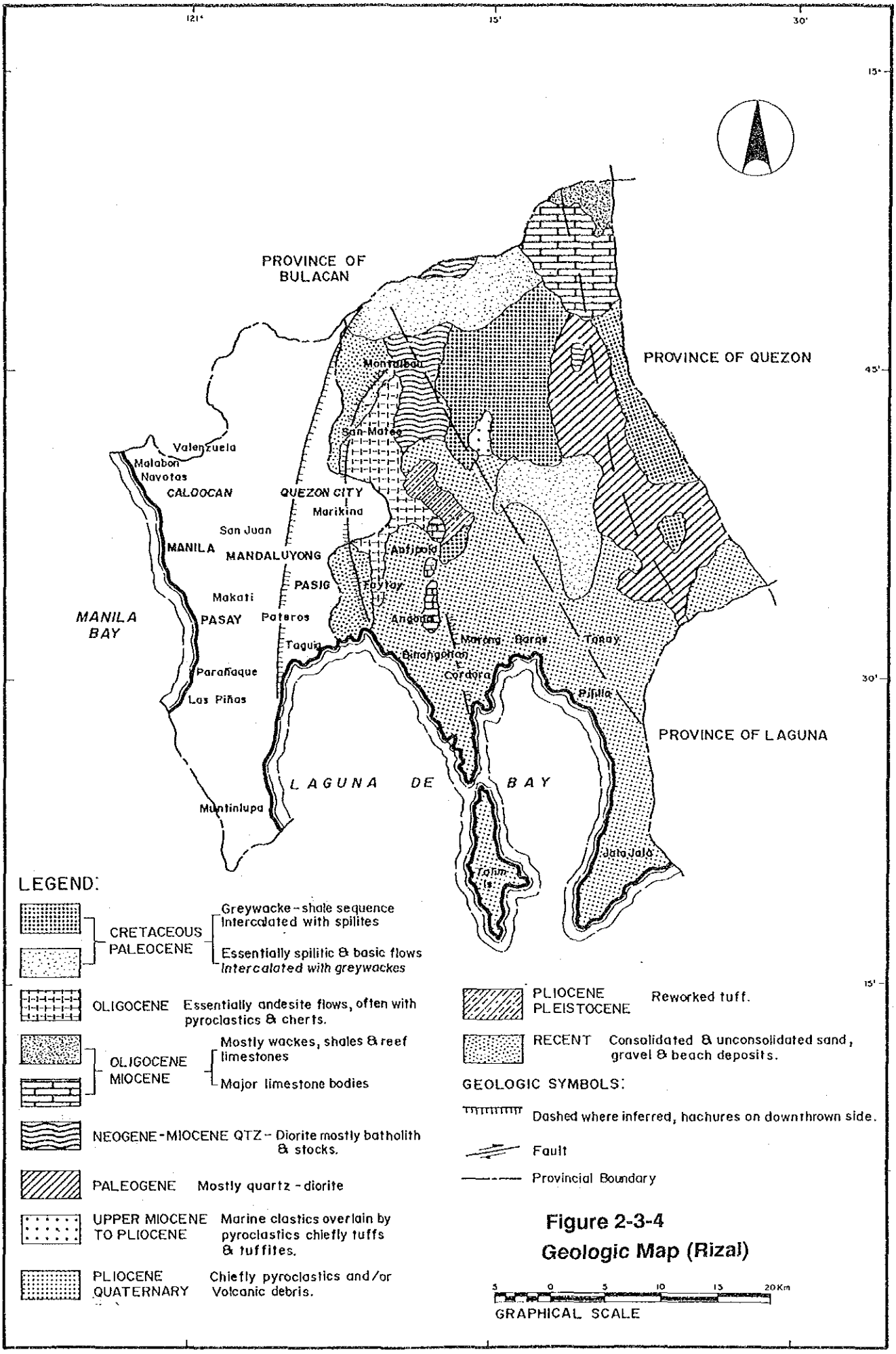


Figure 2-3-4
Geologic Map (Rizal)

de Bay gradually changes from nearly flat plain to a rolling ground towards Calumpang, Dayap, and Calauan and then to steeper slope on Mt. Makiling (elevation 1,109 m amsl.), Atimba (elevation 654 m amsl.), Nagcarlan (elevation 629 m amsl.), Mt. San Cristobal (elevation 1,408 m amsl.), and the foothills of Mt. Banahaw (elevation 2,166 m amsl.). Mt. Banahaw lies at the southtern boundary of Laguna Province and Quezon Province. Conversely, eastern Laguna is characterized by a narrow plain and swampy area and an abrupt rise along Lipa Fault to a plateau east of the fault. Moreover, most of the rivers draining the province originate and are discharging into Laguna de Bay.

Laguna Province is vastly underlain by Quaternary volcanic and volcanoclastic rocks. The Pliocene formation of marine and terrestrial sediments with extensive Pleistocene formation of reef limestone and sporadic terrace gravel deposits are the only sedimentary rocks in the province which cover small portion on western part of Laguna.

The formation of Quaternary Volcanic Plain (Pliocene-Quaternary) is chiefly composed of pyroclastics and/or volcanic materials interbedded with tuffaceous sedimentary rocks and volcanic debris at foot of volcanoes. This formation is the most widespread in the province and is unconformably overlying the older rock series. The Quaternary Volcanics Formation constitutes of cones and/or plugs that are situated near the volcanic areas of Laguna Province. The cones and plugs of volcanoes in the province are essentially basalt, andesite and volcanic breccia and are considered inactive volcanic cones. This formation usually is found in the areas of Mt. Makiling, Mt. Atimba, Mt. Nagcarlan, and Mt. Lagula.

Quaternary Active Volcano formation constitutes a very small portion of the province near Mt. Cristobal and Mt. Banahaw on the southeastern part of the province. Recent alluvial deposits consisting of beds of sand, occasional lenses of gravel and appreciable amount of clay and silt derived from pre-existing rocks were deposited along the southern shores of Laguna de Bay which makes-up the northern boundary of the province.

The geological map of Laguna Province is shown in Figure 2.3.5.

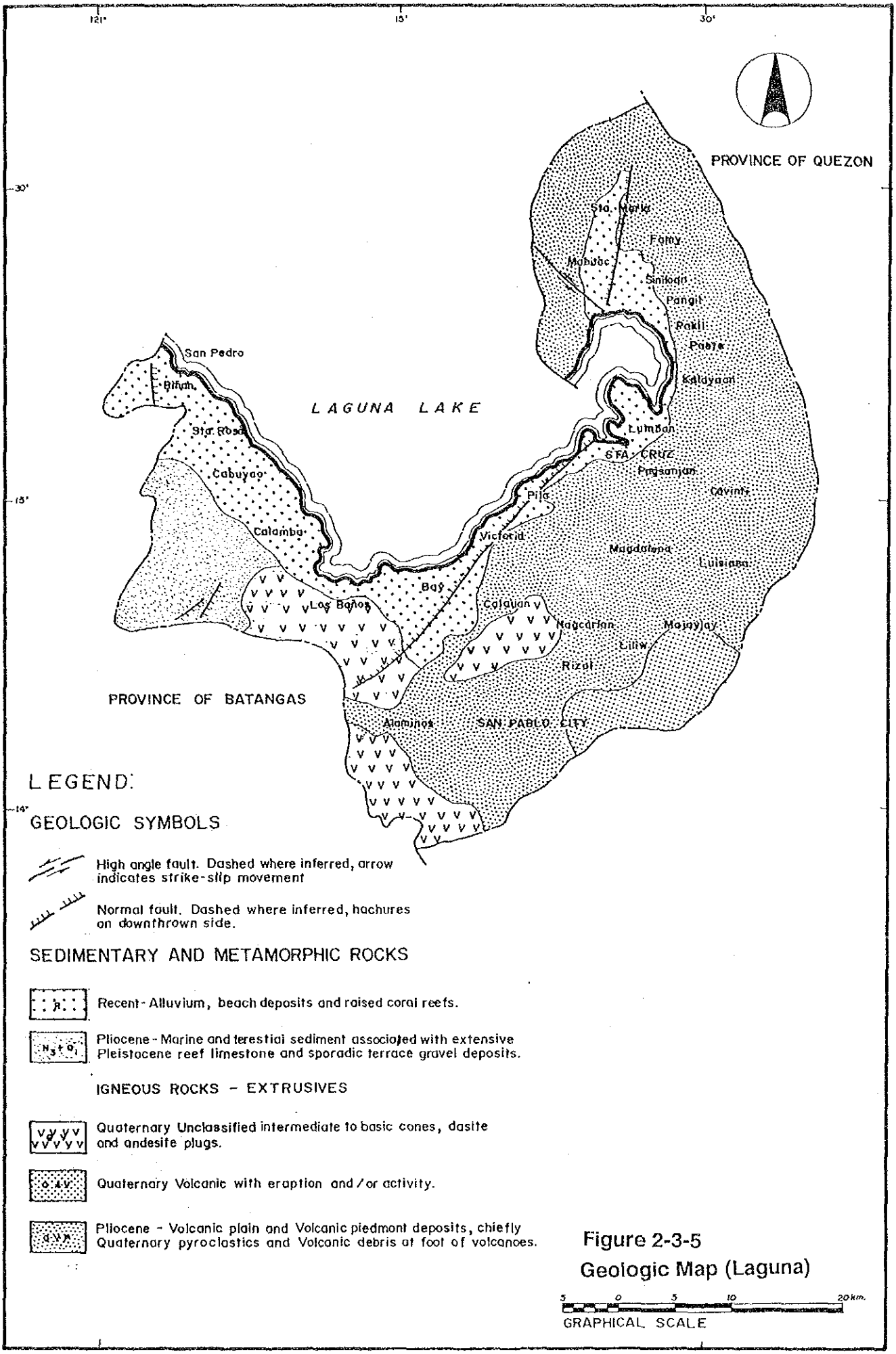


Figure 2-3-5
Geologic Map (Laguna)

C. Quezon

Quezon is situated within two physiographic provinces. The northwestern part covering Southern Sierra Madre and the eastern Tagkawayan area belong to the eastern physiographic province while the west-southwestern portion encompassing Bondoc Peninsula is within the central physiographic province.

In the north and the east the province has rugged topography with narrow coasts, valleys, and mountain ridges. Mt. Banahaw is the most prominent volcano of the province (elevation 2,166 m amsl.) located at the boundary of Laguna Province. The volcanic deposits forms a very large fan area in the southwest. Furthermore, important rivers draining the province into the Pacific Ocean and Ragay Gulf are Cabatangan, Agos, Calabangan, Ditali, Ramaga, Dibalo, Dingalan and Umiray.

The groundwork of Bondoc Peninsula is composed of amphiboles, gneiss and spilitic rocks including pillow lava, greywacke and cherts which are regarded as Cretaceous. Unisan Volcanics, predominantly andesite and basalt with occasional interbeds of tuffaceous sandstone and conglomerate, is also considered as the basement rocks of the province. It is believed to be emplaced before Oligocene period.

The igneous and volcanic rocks areas are scattered around the province. They take the form of batholiths and stocks to plugs/cones and flows and mostly ultramafic and mafic in composition. The most widespread formation is the Upper Miocene-Pliocene of marine clastic deposits overlain by pyroclastics and tuffaceous sedimentary rocks. Next is the Pliocene-Quaternary of pyroclastics and/or volcanic debris at foot of volcano. It covers the area nearby and northern of Mt. Banahaw. Major limestone bodies of Oligocene-Miocene and Pliocene-Pleistocene ages can be found in the Sierra Madre Mountains and on the eastern part of this province. On the coastal and flat areas, the recent alluvium is deposited.

The geology of the province and stratigraphy of Bondoc Peninsula are shown in Figure 2.3.6 and Figure 2.3.3, respectively.

LEGEND:

SEDIMENTARY AND METAMORPHIC ROCKS

	RECENT	Alluvium, beach and river deposits.
	PLIOCENE TO PLEISTOCENE	Mostly conglomerate, tuffoceous sandstone, tuff
		Major limestone bodies
	UPPER MIOCENE TO PLIOCENE	Largely marine clastic deposits overlain by pyroclastics and tuffaceous sedimentary rocks.
	OLIGOCENE - MIOCENE	Largely wackes, shales, reef limestones.
	OLIGOCENE - MIOCENE	Major limestone bodies
	UNDIFFERENTIATED	Largely graywackes and metamorphosed shale.
	CRETACEOUS	Interbedded graywackes, schist and volcanic rocks.
	BASEMENT COMPLEX	Amphibolite chlorite schists.

IGNEOUS ROCKS

	NEOGENE	Largely miocene diorite bodies, mostly of batholites and stocks.
	PALEOGENE	Mostly quartz diorite bodies.
	CRETACEOUS PALEOGENE	Undifferentiate ultramafic and mafic plutonic rocks.

VOLCANIC ROCKS

	PLIOCENE QUATERNARY	Chiefly pyroclastics and/or volcanic debris at foot of volcanoes.
	PLIOCENE QUATERNARY	None active cones andesite and/or dacitic plugs.
v v v v v v v v v v v v	OLIGOCENE MIOCENE	Mostly submarine andesite and/or basalt flows. Intercolated with pyroclastics and clastic sedimentary rocks.
v v v v v v v v v v v v	CRETACEOUS PALEOCENE	Essentially spilitic and basic flows. Usually intercolated w/ graywackes.

SYMBOLS:

FAULT Dashed where inferred, arrow indicates strike-slip.

THRUST FAULT Dashed where inferred saw-teeth on over riding side.

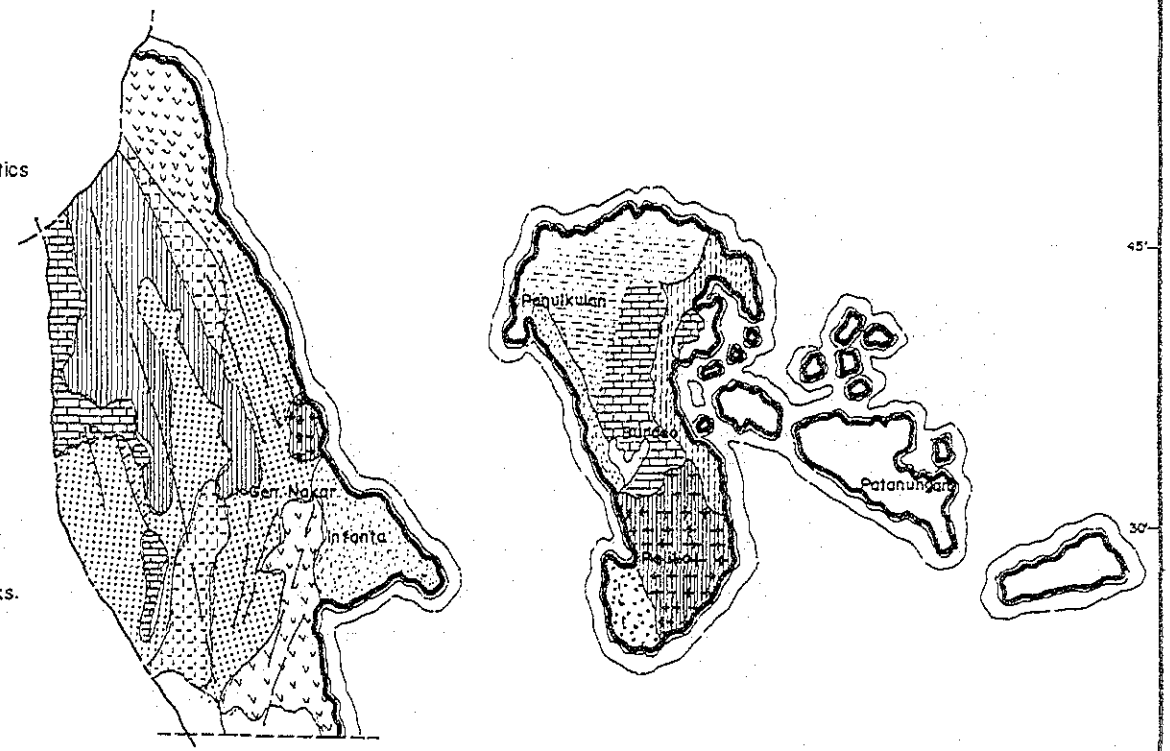


Figure 2-3-6
Geologic Map (Quezon) 1/2

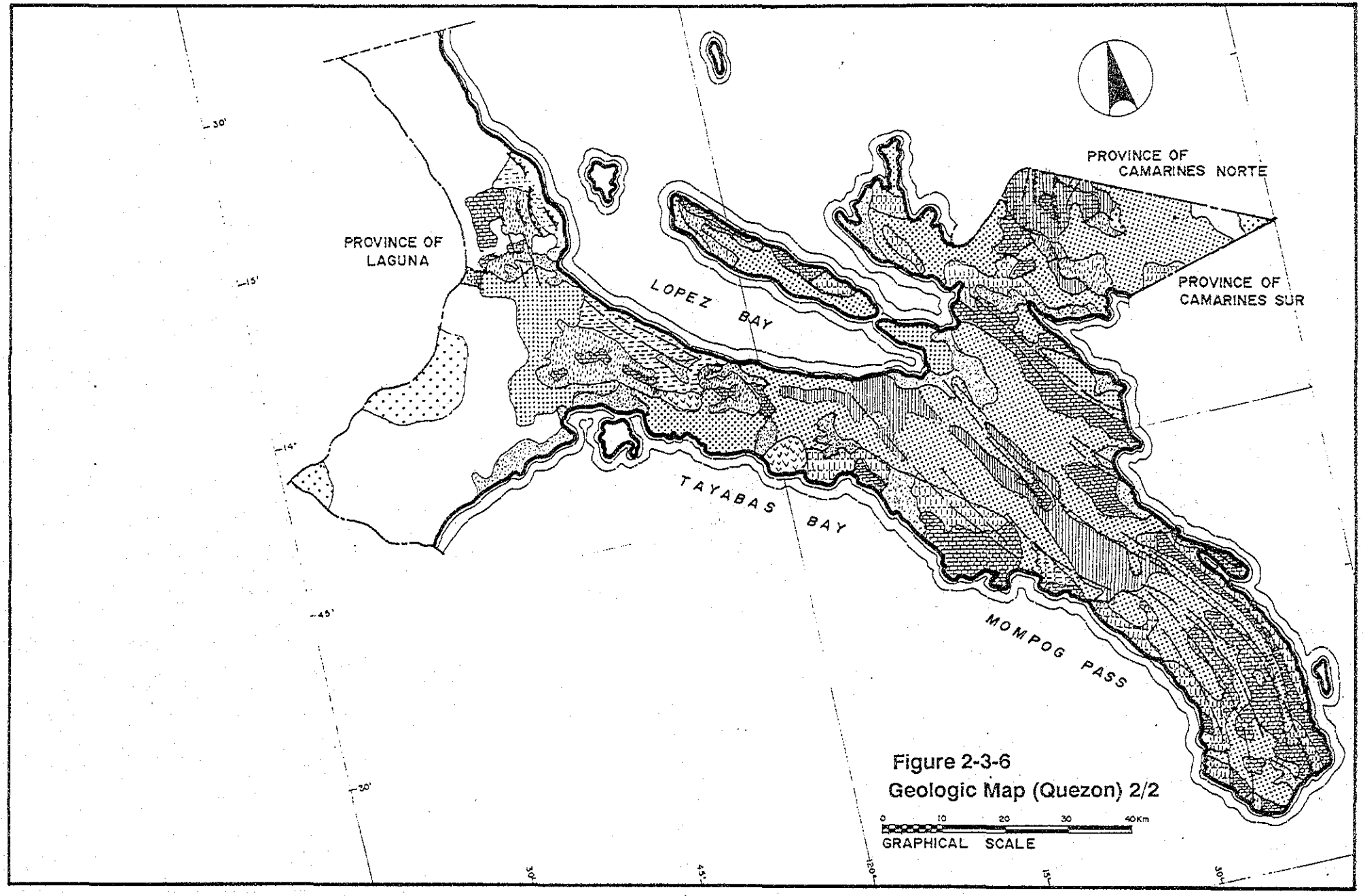


Figure 2-3-6
Geologic Map (Quezon) 2/2

D. Camarines Norte

The province of Camarines Norte is related to the eastern physiographic province of the Philippines. Its topography is classified into plains and mountains. A large alluvial volcanic plain is formed by Basud and Labo River on the east, fringing Mt. Labo and Mt. Bagacay. The plain elevation ranges from 5 to 50 meters above sea level. The mountainous area takes the form of gently rolling to moderately rugged mountains.

In the north, the shorelines are bounded by swamps and coral reefs. The southern part is towered by Mt. Labo (elevation 1,544 m amsl.) and the western part by Mt. Cadig (elevation 726 m amsl.). The topography between these two mountains is moderately rugged with peaks ranging from 200-600 m. Labo, Basud, Daet, and Talisay River drain the eastern side of the province. The central part is drained by Bosigon River which is a tributary of Labo River. The northern and western side are largely drained by smaller rivers emptying into the Philippine Sea. The drainage pattern is predominantly controlled by the NW-SE trend. Radial drainage pattern exists around Mt. Labo.

Schist and quartzite of pre-Cretaceous age are the basement rocks exposed in the province of Camarines Norte. Unconformably lying over the basement rocks is sequence of greywackes, spilite, schist, andesite, cherty limestone, black tuffaceous shale and arkosic sandstone of Tigbinan Formation which is Cretaceous in age. Ultramafic Complex of serpentinized ultramafics found in Mt. Cadig is also Creataceous in age. Paracale-Jose Panganiban area and Mt. Cadig area is thrusted over the basement rocks and the Ultramafic Complex.

Paleocene-Eocene Universal Formation which consists of conglomerates, fine to medium grained arkose, and silty tuffaceous is lying in Paracale-Jose Panganiban area and the area near Labo. The formation of Paracale Granodiorite of Early Oligocene and Larap Volcanics of Late Oligocene soon followed. Paracale Granodiorite usually occurs as stocks and dikes of medium to coarse grained. Larap Volcanics is constituted of thermally altered andesite, andesite flows, breccias, and tuffs.

Lower Miocene Bosigon Formation unconformably overlying the above mentioned formation. This is the most extensive formation in the province, which composes of conglomerate, sandstone, black calcareous shale and limestone as lower member and thick intercalation of basaltic flows, volcanic wackes, tuff-breccia, chert and limestone as the upper member. Intruding Universal Formation, Larap Volcanics and Bosigon Formation is the Miocene Tamisan Diorite which occurs as stocks, dikes and sills of quartz-diorite and dacite. The Late Miocene Sta. Elena Formation, which consists of thick interbedded sequence of conglomerate, sandstone, shale and rarely limestone, unconformably superimposed on Bosigon Formation.

Pliocene formation of Viñas Formation, Macogon Formation and Bagacay Andesite followed afterward. Viñas Formation composed of the series of sandy limestone alternating with calcareous sandstone and shale, gravelly limestone and conglomerate at the base, can be found on the southern part of Sta. Elena area. Bagacay Andesite occupying the top and slopes of Mt. Bagacay, whereas Macogon Formation occupies the central area of Labo municipality, composing essentially of andesitic pyroclastics.

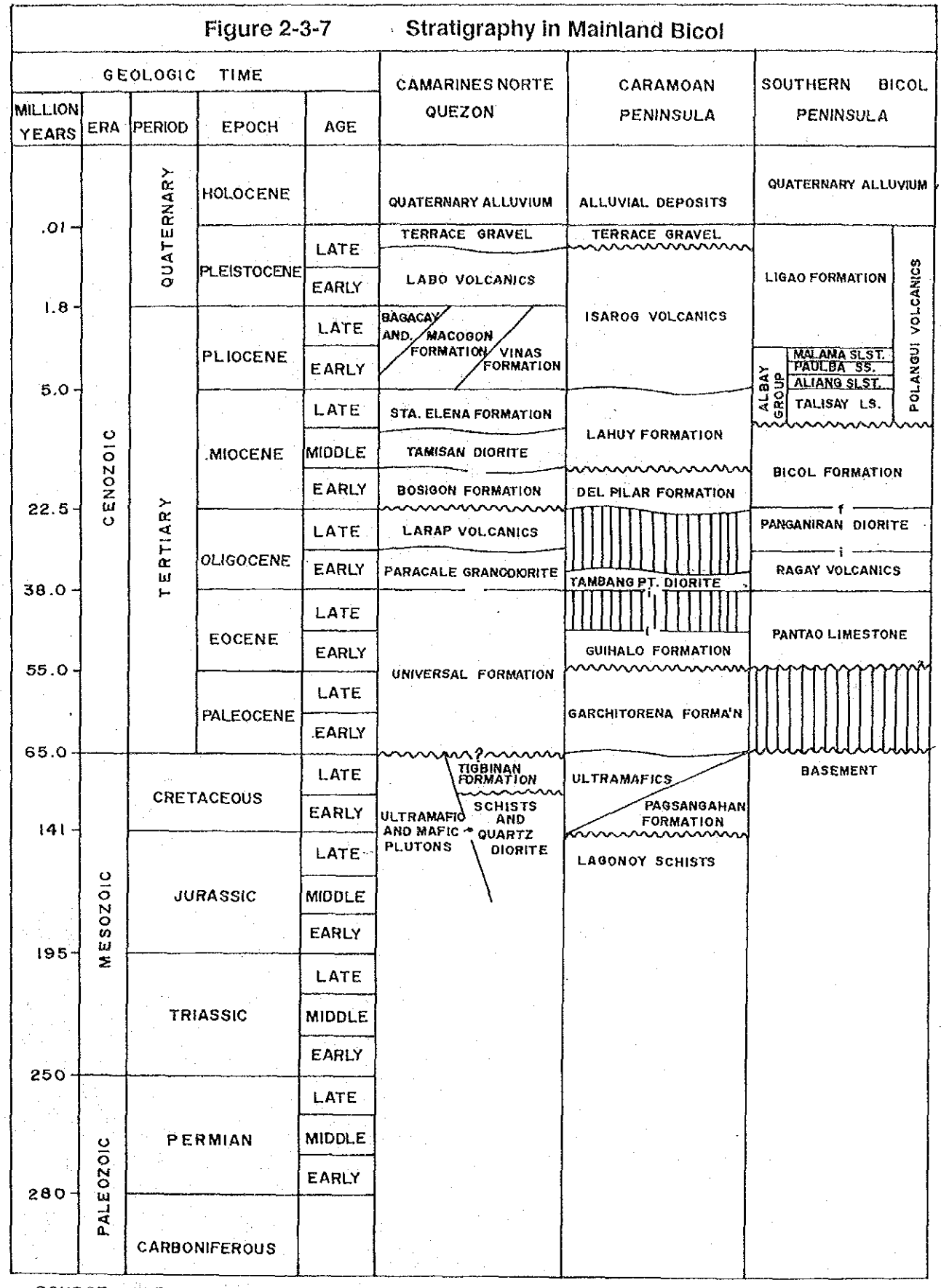
The formation of Labo Volcanics and Labo Volcano are dominating the southern area of the province, consisting of interlayered massive andesite and dacite flows, and poorly-consolidated andesitic tuffs and pyroclastics. The volcanic debris and pyroclastics form the mountain slopes. Alluvium is consisting of very poorly to poorly sorted and unconsolidated soil, silt, sand, and gravel deposits along flood plains and the coasts in the northwest.

Figure 2.3.8 and Figure 2.3.7 are the geological map and stratigraphic column of Camarines Norte.

E. Camarines Sur

The province of Camarines Sur is situated in the middle of Bicol Peninsula and belongs to the eastern physiographic province. Generally, the province has hilly and mountainous terrain but it levels off to an extensive plain, namely Bicol Plain, which cuts across the central portion of Camarines Sur. On the west, the plain is bounded

Figure 2-3-7 Stratigraphy in Mainland Bicol



SOURCE : MINES AND GEO-SCIENCES BUREAU

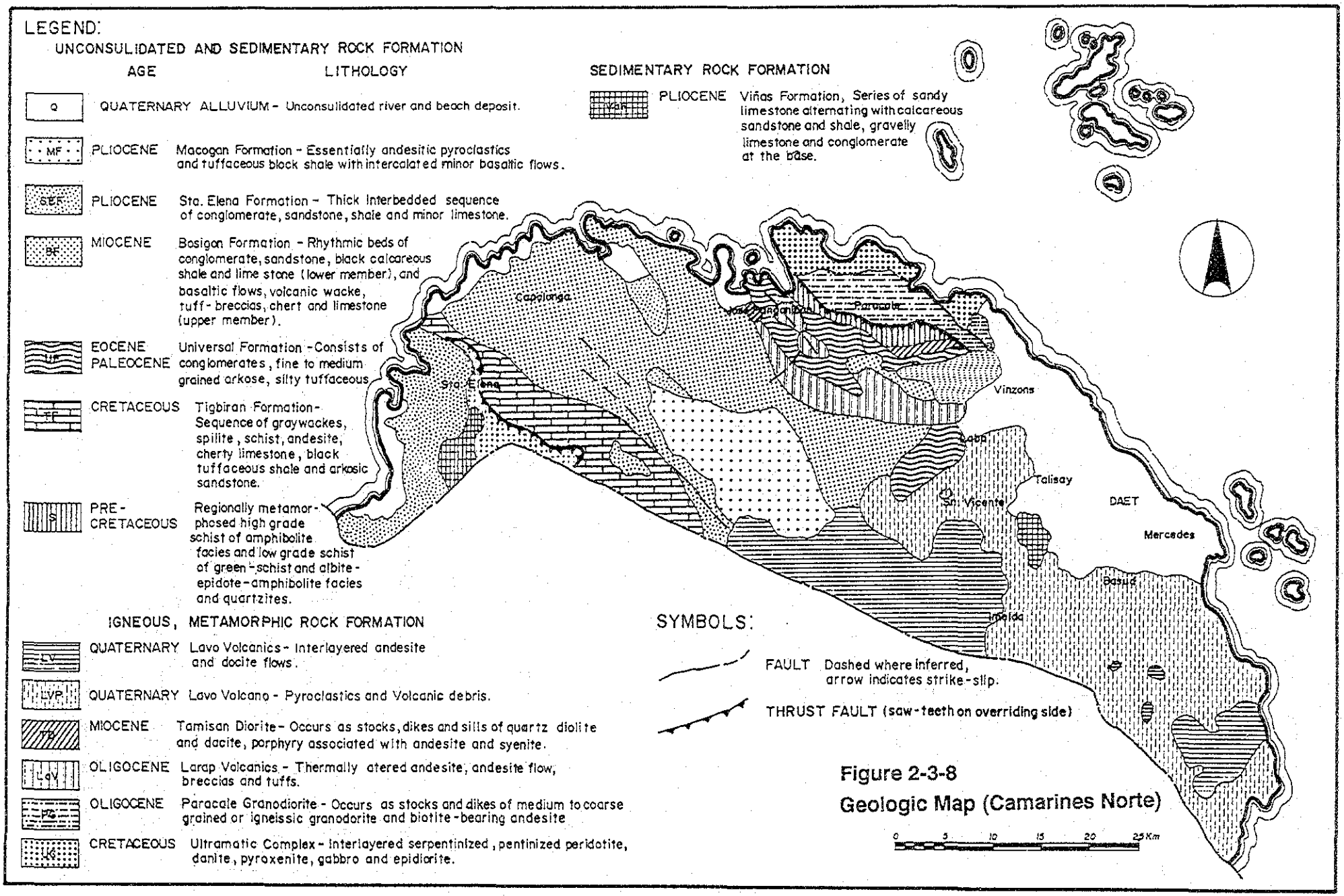


Figure 2-3-8
Geologic Map (Camarines Norte)

by Ragay Hills. The eastern part of the plain is bordered by Eastern Bicol Cordilleras, a volcanic chain featuring the extinct volcanoes of Mt. Isarog (elevation 1,976 m amsl.) and Mt. Iriga (elevation 1,196 m amsl.). In the central part of the province, the Bicol River encroaches through the cordillera and flood plain into the tidal estuary before entering San Miguel Bay. Caramoan Peninsula which is situated in the northeast of the province has very rugged terrain.

The oldest rock unit in the province belongs to the pre-Cretaceous Lagonoy Schists composed of undifferentiated amphibolite, quartzofeldspathic, and mica schist. The schist is disposed following the NW-SE elongation of the Caramoan Peninsula and can be found across the peninsula from Siruma to Presentacion. It was intruded by altered quartz-diorite and ultramafics. Unconformably lying over the basement rock is the Pagsangahan Formation composed of greywacke and metamorphosed shale interbedded and/or intercalated with spilitic and basic flows.

Then came a series of formation deposition filled up the basin, either sedimentary and/or igneous processes. The composition of formation ranges from coralline limestone and calcareous limestone on the eastern tip of Caramoan Peninsula, the rolling and hilly area in the western part of the province from San Fernando to the upper section of Libmanan, and around the vicinity of Sipocot to Ragay; to the pyroclastics and dacite-andesite-basalt flows around and nearby Mt. Iriga and Mt. Isarog. The Bicol Peninsula is very much dissected by intrusives and volcanic rocks, and as the result anticlinal-synclinal foldings and faults are common features in this province.

The recent formation of lenticular river, beach, outwash, valley fill and swamps deposits of clay, silt, sand, gravel, coral reef fragments, and other organic remains are laid along Bicol River and the flood plain in the central part of the province.

The geological map and stratigraphic column of the province are shown in *Figure 2.3.9* and *Figure 2.3.7*, *respectively*.

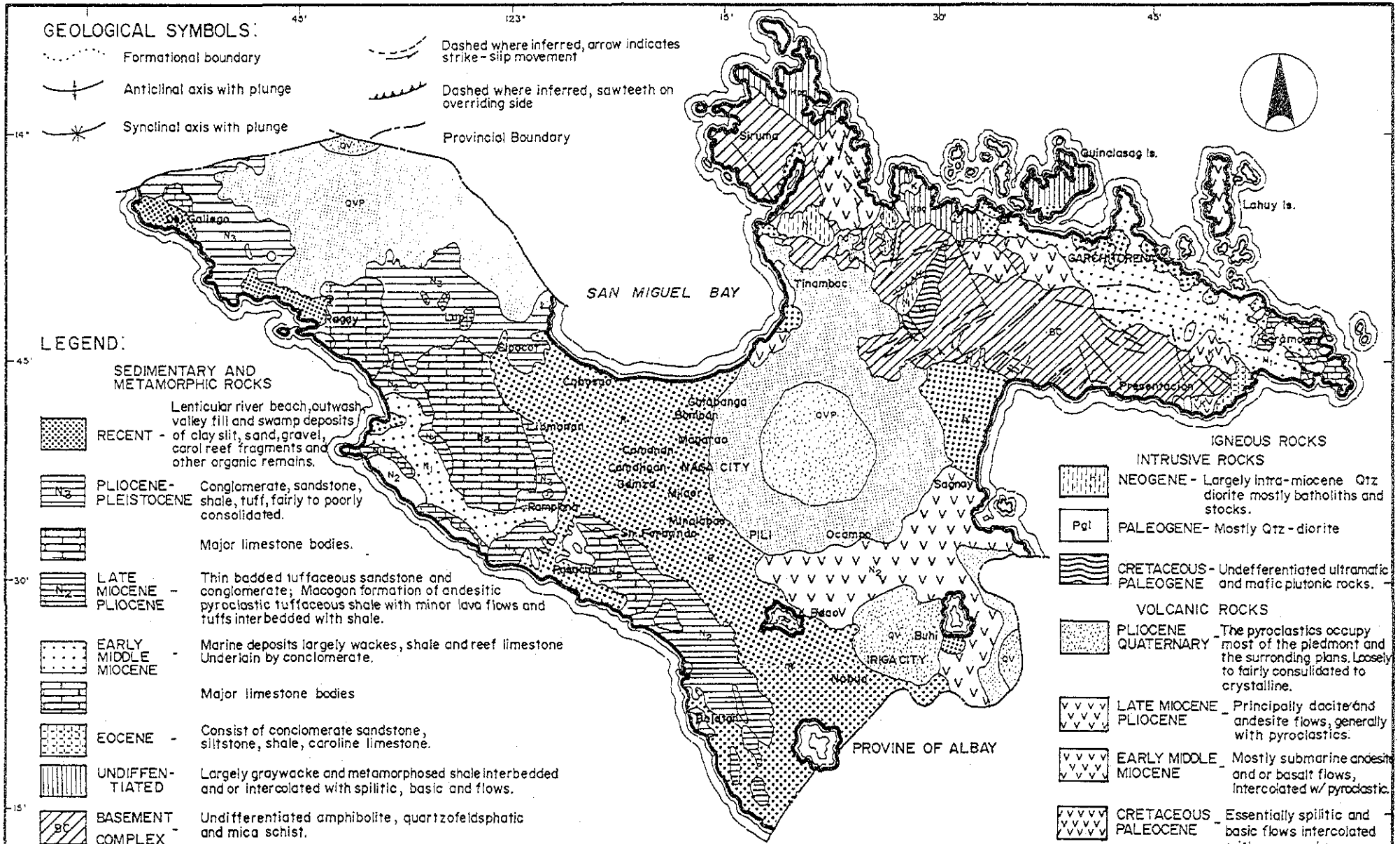


Figure 2-3-9 Geologic Map (Camarines Sur)

F. Albay

The province of Albay comprises the Southern Bicol Peninsula of the eastern physiographic province. The most prominent topographic feature in Albay Province is Mt. Mayon (elevation 2,421 m amsl.) with entrenched stream suggesting youthful stage of geomorphologic development. Along the eastern and western coastline, the landform is undulated attaining maximum elevation of 500 meters. The north trending volcanic range is characterized by rugged and varied topography with a peak elevation of 1,337 meters in Mt. Masagara and 1,500 meters near Tiwi Geothermal area. Moreover, the province is well to excessively drained by Calauan, Yawa, Soboc, Ugat, Lagonoy and Quinale Rivers.

The oldest rocks in this province is the pre-Tertiary and Tertiary sedimentary and metamorphic of mostly marine clastics, wackes, conglomerate with reefal limestone and undifferentiated schists and quartzite. This formation can be found extensively in the islands of Rapu Rapu, Batan, Cagraray, San Miguel, and the western part of the province. Later it was intruded by ultramafic complex rocks predominantly peridotite and serpentinized diorite. The Miocene volcanic deposit of rock, lava, and pyroclastics unconformably overlying it. This formation can be found widespread around Mt. Masaraga, Legaspi City and the eastern part of the border with Sorsogon Province.

The Pliocene-Pleistocene formation of marine with terrestrial sandstone, shale with reefal limestone, and sporadic terrace gravel deposits covers the southern part of the province. The most widespread formation is the Pliocene-Quaternary volcanics which is composed of agglomerate, volcanic breccia, pumice, cinders, andesite, and pyroclastic layers. This formation originated from Mt. Mayon explosion. The recent formation of sand, gravel, silt, clay, beach deposit, and raised coral reefs covers the most of the flood plains and areas along the coast of Lagonoy Bay, Albay Gulf, Burias Pass, and Lake Bato.

The geological map of the province is shown on Figure 2.3.10 and the stratigraphy is shown on Figure 2.3.7.

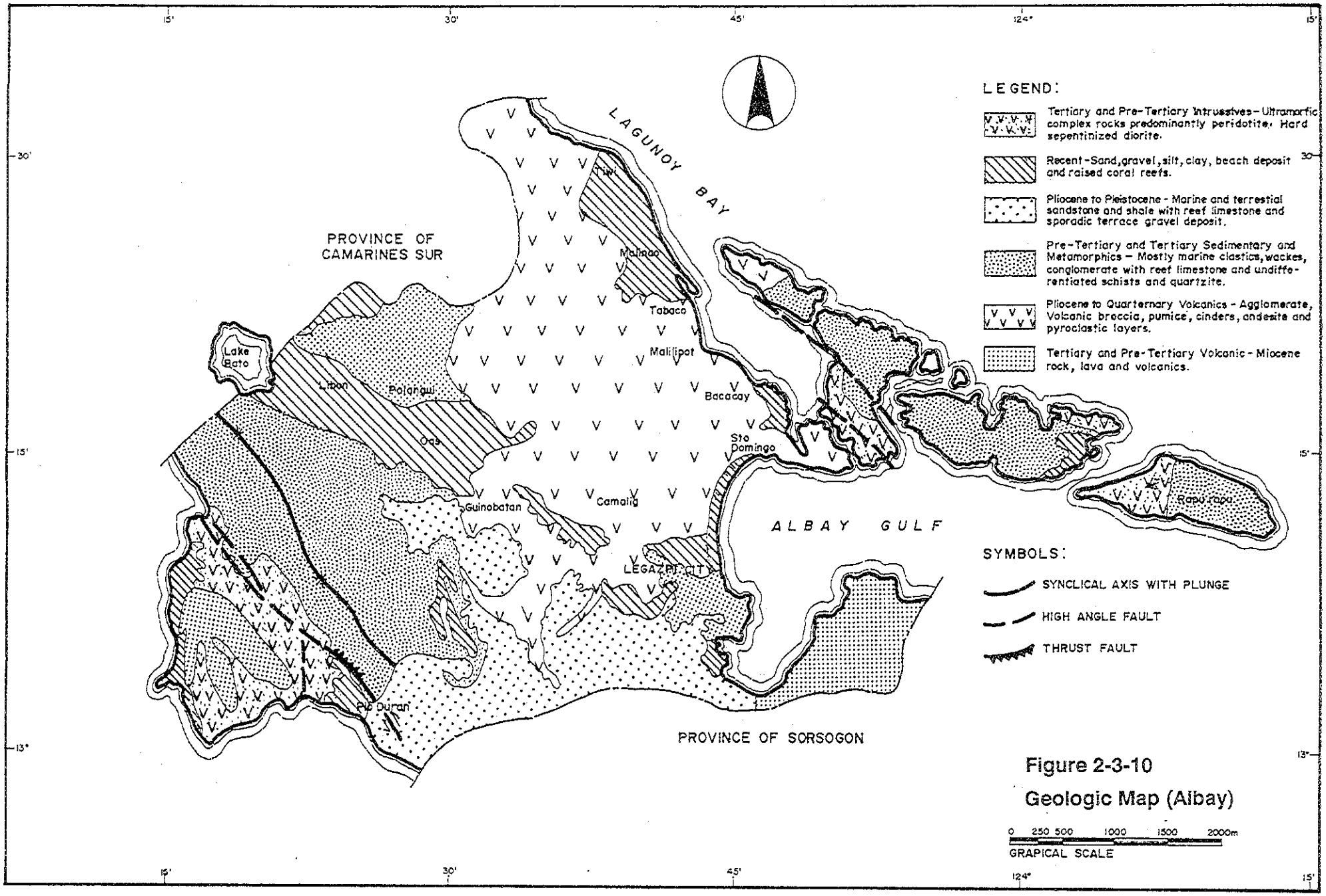


Figure 2-3-10

Geologic Map (Albay)

G. Sorsogon

The province of Sorsogon comprises the Southern Bicol Peninsula of the eastern physiographic province. Sorsogon Peninsula is dominated by clusters of volcanic cones. A less extensive low, gently rolling terrain from northwestern boundary with Albay to the isthmus between Sorsogon and Gubat Bay separates the north-south clusters of mountains. The highest peak in the province is Mt. Bulusan (elevation 1,558 m amsl.) and is still active. Narrow, swampy coastal plains outline a portion of Sorsogon Bay.

The composition of formation in this province is largely controlled by the volcanic activities. The oldest exposed rock is the Oligocene-Miocene of submarine andesite and/or basalt, intercalated with pyroclastics and clastic sedimentary rock and/or reef limestone lenses. The Upper Miocene-Pliocene formation of dacite and/or andesite flows with pyroclastics can be found in the northern part of the province and western part of the peninsula. The Pliocene-Quaternary Volcanics of various formations can be found especially on the elevated part of the peninsula. They usually consists of basic cones, dacite, andesite plugs, pyroclastics, and volcanic debris at foot of volcanoes. The Polangui Volcanics is a series of volcanic flows and agglomerate which includes Mayon Volcano in Albay and Bulusan Volcano in Sorsogon.

The Pliocene-Pleistocene of marine and terrestrial sediment associated with extensive reefal limestone and sporadic terrace gravel deposit can be found widespread on the western to eastern part of the province. The Recent deposits are chiefly disintegrated fragments derived from clastic sediments, limestone, volcanics, and diorite.

Figure 2.3.11 shows the geology of Sorsogon and the stratigraphy is shown on Figure 2.3.7.

H. Agusan del Norte

The province of Agusan del Norte belongs to the central physiographic province. It is a long broad valley bounded on the east by Bicol volcanic belt and on the west by Mindanao Central Cordillera. There are two groups of mountains in the province, the Hilonghilong on the

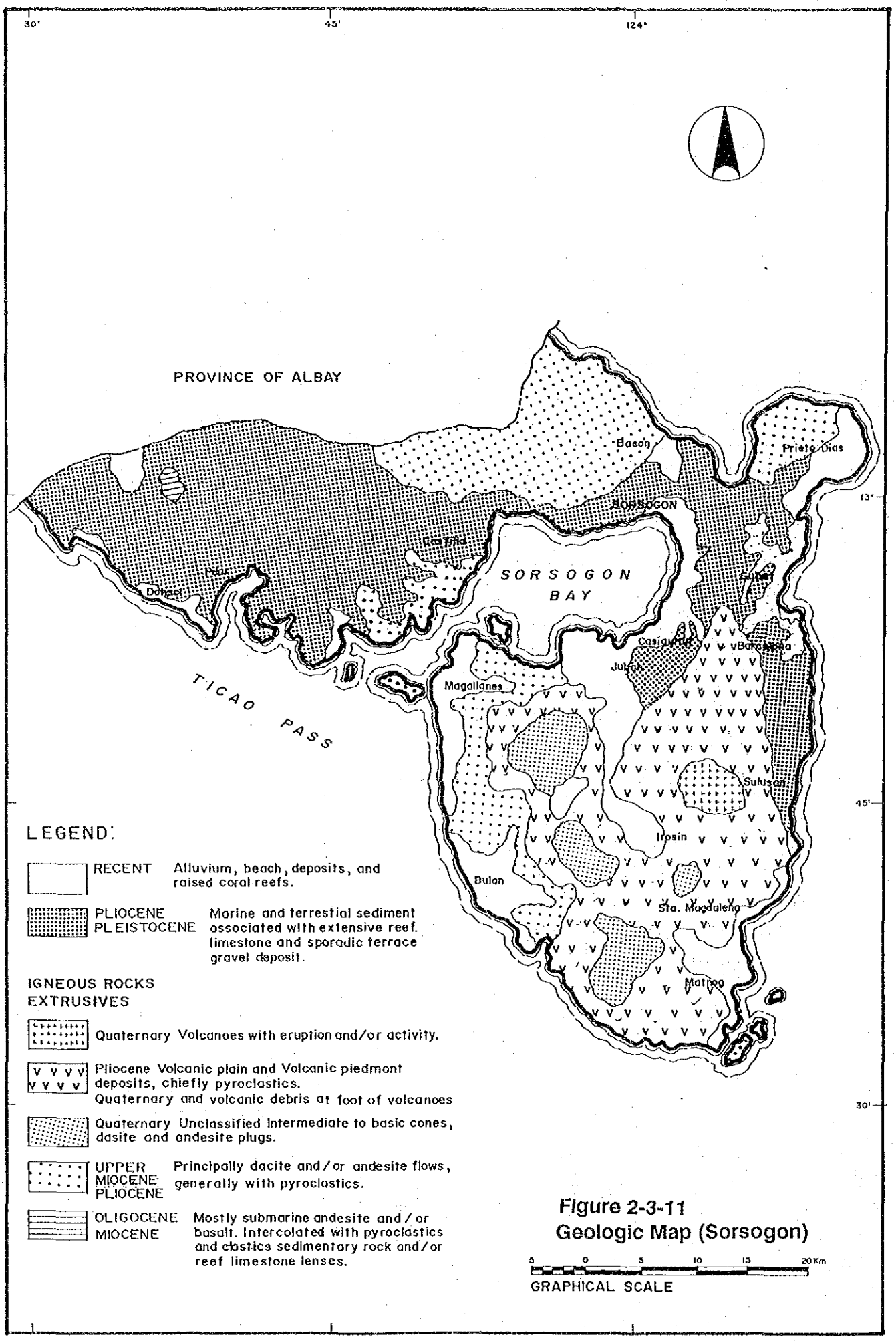


Figure 2-3-11
Geologic Map (Sorsogon)

east and Maiyapay on the west. Agusan River, the third largest river in the country, is the main drainage of the Mindanao passing through the middle of Agusan Valley. It follows a long course, rising from southern mountains and draining northward into Butuan City. On the north, Tubay River rising from Mainit Lake and its tributaries provide the principal drainage.

It has been observed that the geology west of the Agusan River is different from that in the east. The eastern part has been active orogenically compared to the western area. The oldest (basement) rock of Cretaceous can be found in the northern coast, composed of phyllite and minor marble overlying massive greenstone, foliated greenschist and metaconglomerate. The Cretaceous-Paleogene formation of undifferentiated greywackes and metamorphosed shale with spilite, basic flow and pyroclastics can be found on the eastern corner of the province. Two other formation with somewhat same age also exist in the province, one is the intrusive rock of generally thrusted or upfaulted ultramafic and mafic plutonic rock, the other is the extrusive rock of spilitic and basic flows intercalated with greywacke. While both rocks can be found on the eastern part of the province, only the extrusive type found on the western part of the province.

The eastern part is more complicated than the westrn part. It varies from intrusives and extrusives of basic-acidic igneous rocks to marine and terrestrial sediments. The sediments mostly comprised of reefal limestone, pyroclastics, conglomerate, mafic flows, shales, and wackes. The Upper Miocene formation of marine clastics overlain by pyroclastics associated with silty limestone is widespread on the western portion of Agusan River, followed by the Pliocene-Pleistocene of marine and terrestrial sediments associated with extensive reefal limestone and sporadic terrace gravel deposits. The Recent formation of alluvium, beach sand deposits, and raised coral reef covers the central part extensively.

The geological map and stratigraphic column of the province are shown in Figure 2.3.13 and Figure 2.3.12, respectively.

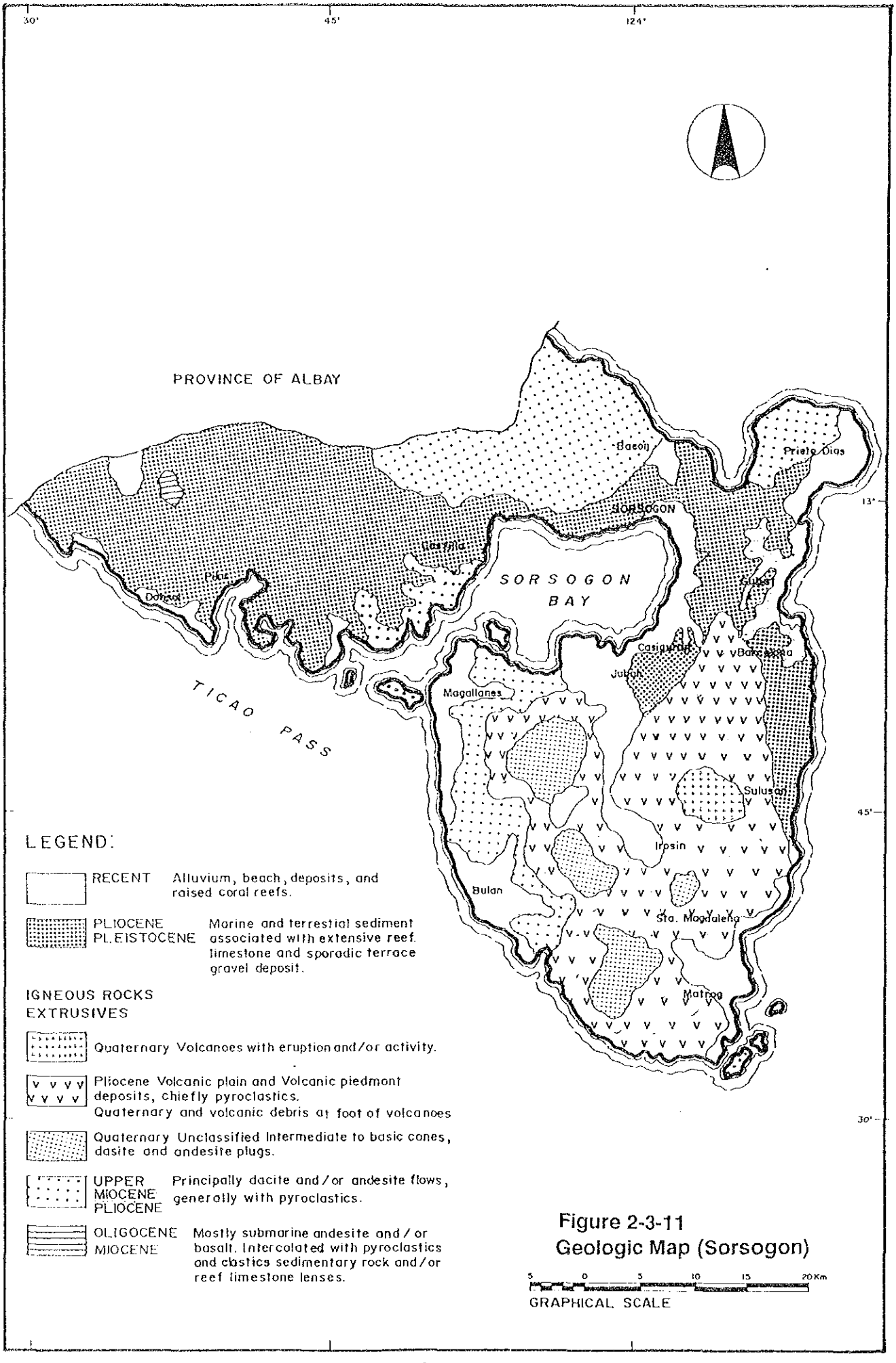
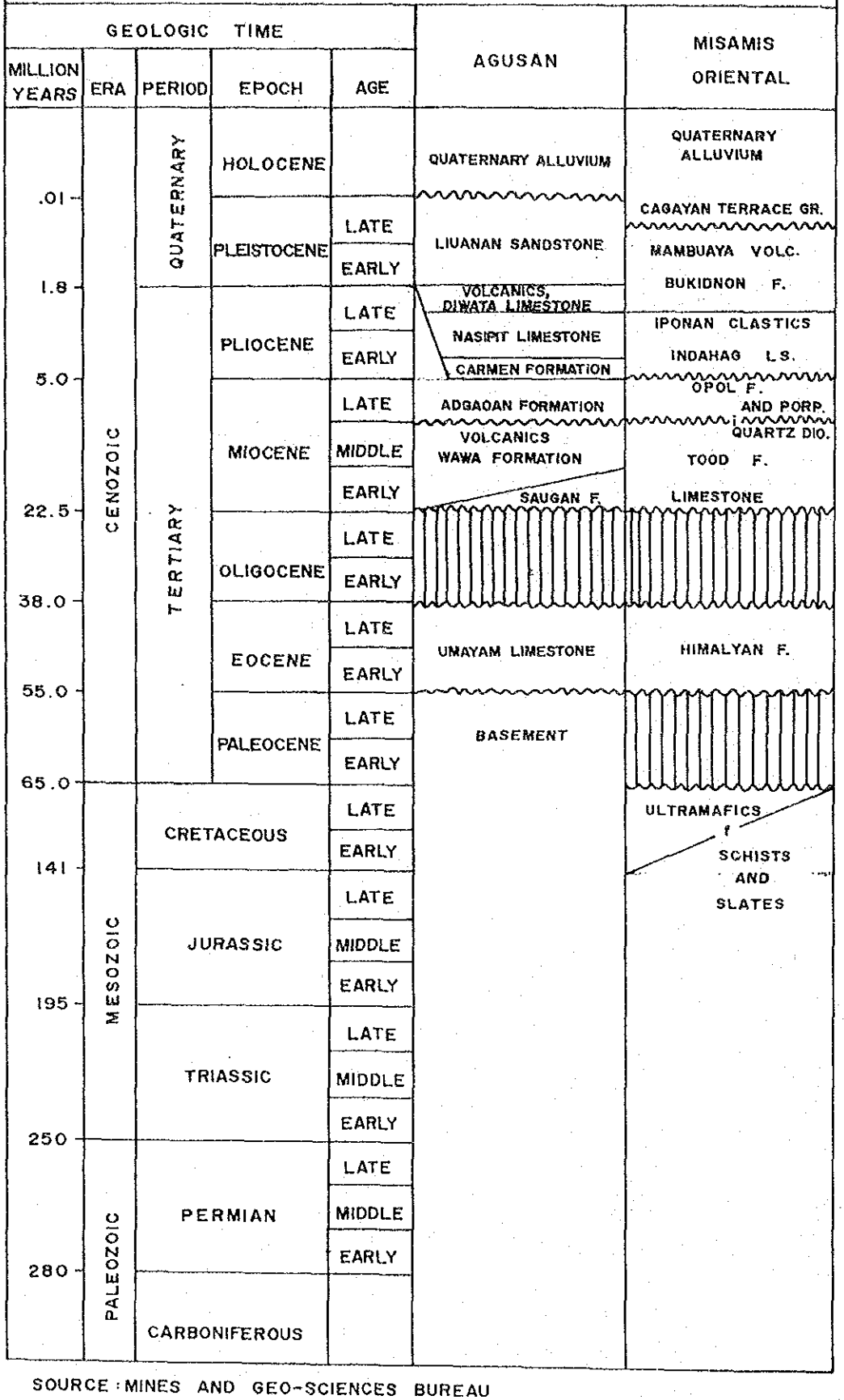


Figure 2-3-11
Geologic Map (Sorsogon)

Figure 2-3-12 Stratigraphy in Agusan and Misamis Oriental



SOURCE : MINES AND GEO-SCIENCES BUREAU

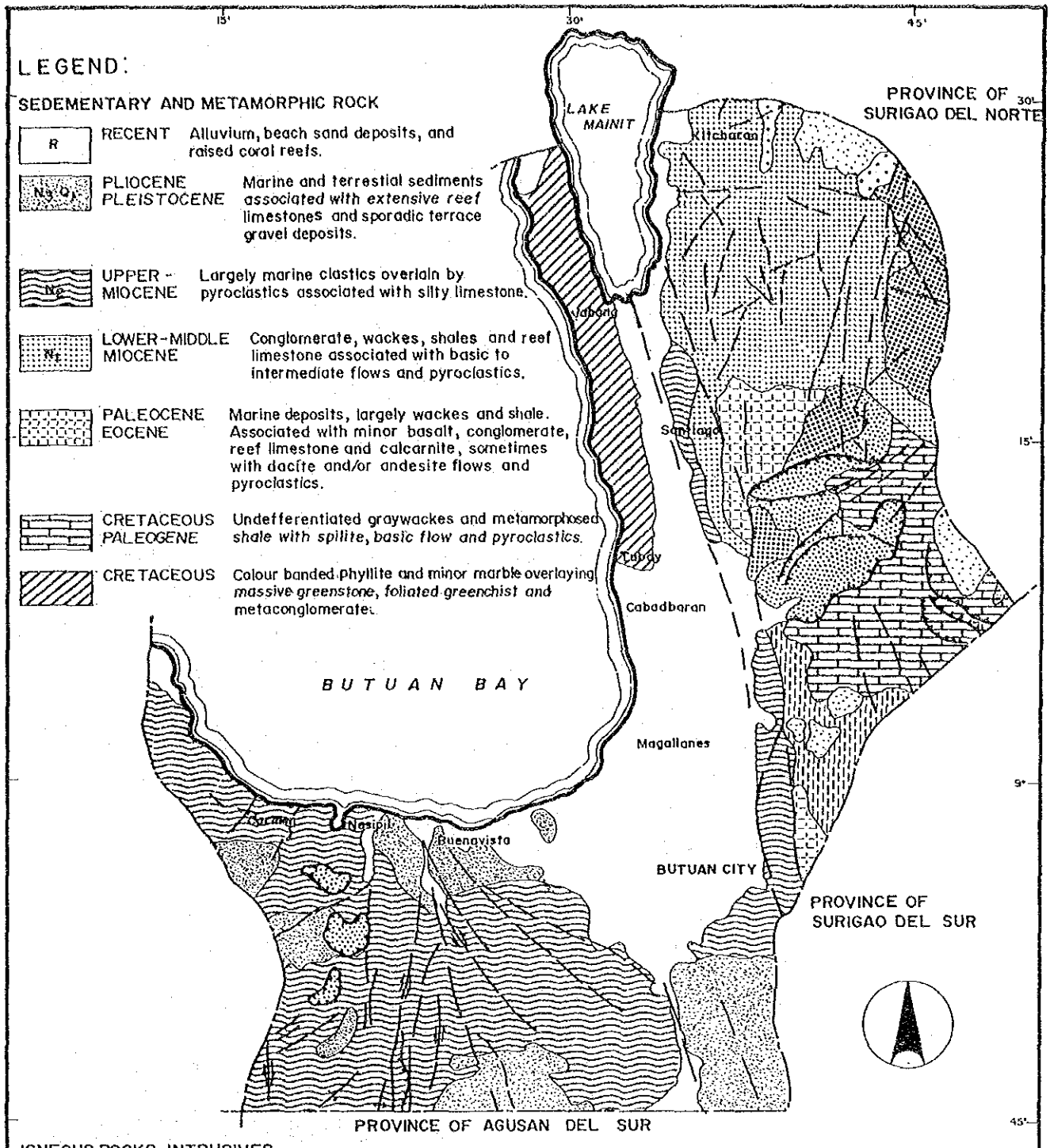


Figure 2-3-13

Geologic Map (Agusan del Norte)

I. Camiguin

Camiguin Province is an island located in the northern tip of Misamis Oriental. Its morphology is dominated by seven volcanoes, one of which namely Hibok Hibok (elevation 1,713 m amsl.) is still active. The outer edge of the island is characterized by gently sloping, irregular coastal plain along with lava rocks. Generally, streams in Camiguin are narrow and limited in length and usually have the radially drainage pattern. A great portion of the coastal area is surrounded by coral reefs.

Basically there are two type of formation in this province. One is the Pliocene-Pleistocene and Recent volcanic deposits which composed of mostly andesites, basalts, associated with dacites and rhyodacites in some places. This formation, occurring mainly as lava flows in volcanic centers and pyroclastics in their aprons, is covering this province extensively. They are produced through violent phases of volcanism. The other is the Quaternary alluvial chiefly composed of volcanic clastic deposits. It covers the narrow band along the coast.

The geological map of Camiguin Province is shown on Figure 2.3.14.

J. Misamis Oriental

Misamis Oriental Province belongs to the Central physiographic province. In general it is a typical of volcanic regions with plateau areas headed by Balatucan mountains. There are many large springs in the mountain feet of the volcanoes in particular along the Macajalar Bay. The volcanic peaks are usually dissected by deep, narrow canyons with precipitous walls. The terrain is generally rugged and hilly. The steep slopes usually separate the highland and lowland areas. The coastal plain is narrow and can be found facing Macajalar Bay, nearby Cagayan de Oro City. Several deep and steep river valleys traverse the province. The general draining trend is northward with Linugos, Odiongan, Gingoog, Lanao, Balatucan, Cabulig, Tagoloan, Iponan, Alubijid, Initao, Talabaar, and Cagayan River as the natural drainage systems.

The geologic setting of the southwestern portion of the province is

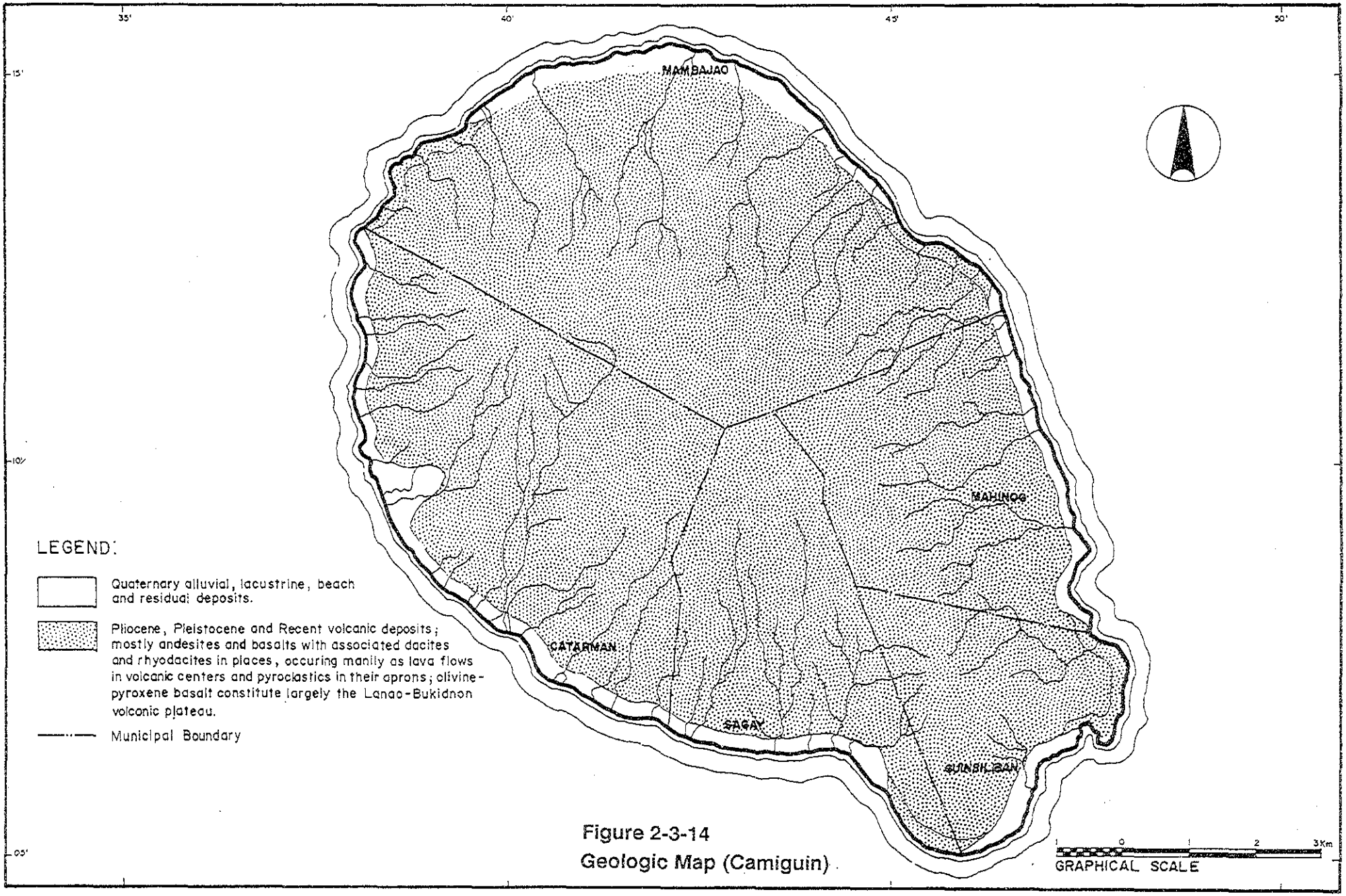


Figure 2-3-14
Geologic Map (Camiguin)