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ENVIRONMENTAL EDUCATION THROUGH GEOGRAPHY[1]

by

DR. JOHN EMERY

> "**Spaceship Earth** is now filled to capacity or beyond and is in danger of running out of food. And yet the people travelling first class are, without thinking, demolishing the ship's already overstrained life-support systems."
>
> (Ehrlich and Ehrlich, 1972:3)

Unfortunately, this description by Ehrlich and Ehrlich of the world's 'environmental crisis' appears to be all too realistic. Most Australians have heard of the major causes — overpopulation, uncontrolled technological development, rapidly declining reserves of known natural resources, too rapid urbanization, and environmental decay — and some have begun to accept 'Doomsday' as inevitable. Doomsday, of course, varies according to one's degree of pessimism, from the extreme of a global nuclear holocaust to the more probable situation in which quality of life will decline rapidly until rising levels of pollution and related factors produce an equally sharp fall in the world's total population, somewhat like a Black Death situation of the Middle Age. Yet, serious through the situation is, all is not lost. The Stockholm Conference, held in 1972, pointed the way towards improving the quality of the environment on a world scale with its action plan of environmental assessment, environmental management and a range of supporting measures. Since then an International Environmental Education Workshop took place at Belgrade in 1975, from which emerged a global framework for environmental education known as *The Belgrade Charter*. Part of this charter reads:

> "We need nothing short of a new global ethic — an ethic which espouses attitudes and behaviour for individuals and societies which are consonant with humanity's place within the biosphere; which recognizes and sensitively responds to the complex and ever changing relationships between humanity and nature and between people."
>
> (U.N.E.S.C.O. 1976:1)

[1] "Reprinted from *Geographical Viewpoints* with permission of the author and the Editor (Copyright 1978, Australian Geography Teachers Association)."

Environmental education has become a major part of the total strategy which aims to abort the occurrence of a Doomsday situation of global dimensions. The general concern about future rates and directions of environmental change can be translated into clearer, more particular perspectives by studies of subjects which impart accurate and objective information about the environment, which examine the consequences of exploitation and adaptation, and which provide a balanced assessment of environmental issues. Geography is one of several subjects which can make a significant contribution to these types of studies. However, before proceeding to investigate the role of geography in environmental education, it could be useful to clarify some of the terms already mentioned. This can be done through a series of questions.

WHAT IS ENVIRONMENT?

A well-known geographer, Thomas Detwyler, defines the environment as "the aggregate of external conditions that influence the life of an individual or population, specifically, the life of man. Environment ultimately determines the quality and survival of life" (Detwyler, 1971: 703-704).

A more detailed description is contained in a brochure issued by the Australian Government entitled, *Everything You Always Wanted to Know About the Environment Protection Act but were Afraid to Ask.* Here the environment is regarded as "a simple way of referring to complex interactions between the natural, material, and social aspects of our surroundings. These factors can exist both independently and interdependently. They can be categorized, although not exhaustively, in this way:

Natural — air, water, land and minerals; animals, birds and fish; trees, plants and grasses.

Material — buildings, machines and products.

Social — health, employment, community, shelter, recreation and privacy."

(Department of Environment, 1975:2)

WHAT IS ENVIRONMENTAL QUALITY?

Environmental quality has become a fashionable term during the 1970's as more people have begun to realize that man's thoughtlessness and greed can endanger many of the environments in which he lives — even in an age of remarkable technological progress. In fact, it is, in part, man's ability to control this progress that has created lower standards in some environments.

Terms such as *smog*, *pollution*, *congestion*, *blight* and *decay* are now commonplace in discussions about environmental quality. Nowadays, most people in western countries have read something about the need to conserve world resources, while some have even become involved in local ecological problems.

Environmental quality may be regarded as the state or condition of a given environment — biophysically, culturally and psychologically.

WHAT IS ENVIRONMENTAL EDUCATION?

The most widely accepted definition is that developed by B. Ray Horn for the International Union for the Conservation of Nature and and Natural Resources Working Meeting, held in Carson City, Nevada, in 1972. It reads as follows:

> "Environmental education is the process of recognizing values and clarifying concepts, in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness between man, his culture and his biophysical surroundings. Environmental education also entails practice in decision-making and self-formulation of a code of behaviour about issues concerning environmental quality."
>
> (Horn, 1970:1)

Many of the thoughts expressed in this definition have been operationalized into a goal in the Belgrade Charter. That goal is:

> "To develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively toward solutions of current problems and the prevention of new one."
>
> (U.N.E.S.C.O., 1967:2)

Both are broad statements which involve wide areas of study, and it is little wonder, therefore, that environmental education is perceived by many people in different ways. Some see it as being synonymous with all 'Education'; others regard it as 'Outdoors Education'; still others perceive it as the means of educating society about life-support systems, that is, as a very relevant way of coming to grips with "resource management" problems. This last-mentioned perception is possibly the most relevant for geographers.

WHAT CAN CONTEMPORARY GEOGRAPHY CONTRIBUTE TO THE STUDY OF ENVIRONMENT?

M.J. Wise keeps the geographical record straight when he states that:

> "We approach current discussions on the need for, and on the organization of, environmental studies with an inherited tradition: we have been pioneers in the field."
>
> (Wise, 1973:294)

Today, geographers employ diverse approaches to geographical inquiry, but each approach still contains the same unifying thread — a concern for earth-space. As Murray McCaskill states:

> "Geography's special justification arises from man's own awareness of earth-space and his curiosity about the arrangement and interactions of the objects and forces that occupy that earth-space."
>
> (McCaskill, 1967:2)

The geographical perspective is *spatial*, and while other studies (e.g. art, architecture, astronomy, geometry, nuclear physics, etc.) contain spatial components, geography is the only discipline which consistently studies the patterns of earth-space and the processes affecting those patterns. This is not only its *raison d'etre* as an academic discipline, but also its major claim for a permanent place in the mainstream of general education, Phillip Bacon reinforces this viewpoint with his contention that:

> "It is geography that focuses attention on the areal association of things and events of unlike origin, and on the interconnections among things and events that are areally associated. No other field of learning accepts this basis as its fundamental concern. The study of geography is certainly not a substitute for other approaches to learning, but it does present a unique perspective regarding position on the planet Earth, and this perspective is basic to general education." (And to Environmental Education as well!)
>
> (Bacon, 1968:21)

In a sentence, geography is that field of study "which focuses on the environment throughout the use of spatial concepts" (Australian Geography Teachers' Association, 1972:2).

It is this spatial perspective which provides a valuable, non-emotive starting point for the study of environmental problems which contain a range of attitudinal stances, some being highly emotive. A geographical approach can thus open the way to fruitful discussions which otherwise may never reach a level higher than prejudicial argument. Underdevelopment, overpopulation, racial and religious tensions, political friction, urban sprawl, industrial pollution, traffic congestion, resource conservation, and environmental quality represent some of the many problems which currently affect people in many parts of the World; and each has a *spatial* component. Peter Haggett's comment that:

> "Geography is uniquely relevant to the current concern both with environment and ecology, and with regional contrasts and imbalance in welfare"
>
> (Haggett, 1972:xiii-xiv)

aptly summarizes those frontiers where increased involvement by geographers could produce valuable outcomes. One must also recognize that environmental problems know no disciplinary boundaries and that geography cannot provide all perspective or possible solutions; geography cannot become environmental studies in name, nor should it be simply absorbed within a core program. It is important to note that geography serves as the gateway between earth sciences and the behavioural sciences by fostering interdisciplinary ties. It is in this setting that the full potential of geography as a discipline can be exploited to the obvious advantages of environmental education.

Geography, as a discipline, provides a range of structures which provide valuable environmental perspectives, both for teachers in the organization of their courses, and for students as they become involved in them. Dr. Don Biddle's article on *Geographical Perspective*, outlines this range of structures, and three of them are particularly well-suited to developing positive environmental attitudes. They are:

The *landscape* structure which emphasizes tangible visible objects, forms, content and the impact of people in their environment.

The *ecosystem* structure which emphasizes processes, linkages, flows of energy, information and matter, and feedback systems. Here, people are an inseparable part of a system consisting of the physical, biological and sociocultural environments.

The *environment, perception and behaviour* structure which emphasises the human variables that influence decision-making and subsequent behaviour. This approach is concerned with people's perceived views of environments and how these views are affected by different life-styles and values.

While each is a useful approach, I will concentrate here on the ecosystem structure as it is a particularly valuable approach to the explanation of environmental problems associated with the life-support systems of planet Earth and the closely-associated questions of resources management.

ECOSYSTEMS

R.F. Dasmann (1972:12-13) defines an ecosystem as a "combination of the biotic community with its physical environment," and a biotic community as "an assemblage of species of plants and animals inhabiting a common area and having, therefore effects upon one another." It may be useful if I apply the ideas expressed in these definitions to a locality near where I live — The Field of Mars Reserve. (See Photo 1)

This is an interesting area because it lies within established suburban Sydney only 12 kilometres from the city centre. Although proclaimed as a reserve for public recreation in 1887, it has only recently been set aside (since 1966) as an area for the conservation of native flora and

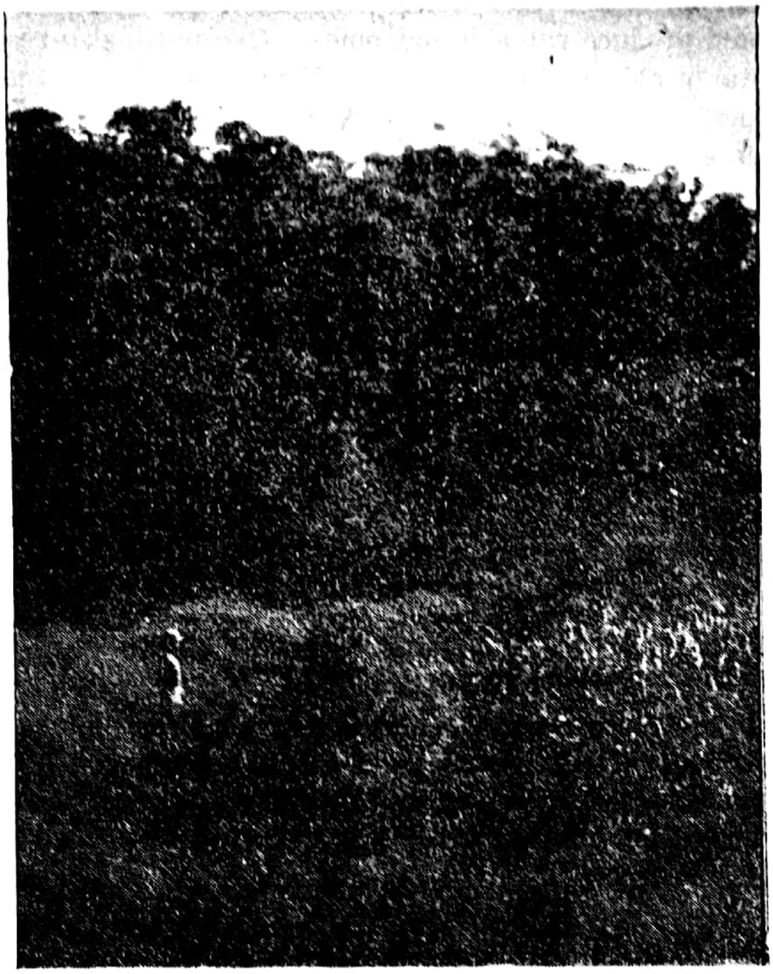

PHOTO 1 FIELD OF MARS RESERVE AT RYDE, NEW SOUTH WALES. THIS NATURAL ENVIRONMENT IS ONLY 12 KMS. FROM THE CENTRE OF SYDNEY.

fauna, and for passive recreation. The area is being restored to its "natural" state following a period of almost 60 years of neglect, in which the fringes were subject to despoilation, pollution and partial reclamation. Despite these abuses, approximately three-quarters of this 46-hectare reserve retains an unspoiled "Sydney bushland" appearance. It is a mixture of hilltop and slope, and includes two creeks that merge to form an estuary prior to entering the Lane Cove River. Walking trails have been developed through heavily wooded areas, and the creeks contain a number of rock pools and small waterfalls. The geological base is predominantly Hawkesbury Sandstone with some Wianamatta Shale and an area of alluvium, and on this base has developed a rich diversity of flora ranging from Mangroves and Casuarinas to Banksias and Grevilleas to Angophoras and Eucalypts. These, in turn, supply food to numerous forms of animal life; in fact, about eighty species of birds have been sighted in the reserve including the Kingfisher, the Eastern Whipbird, the Currawong and the Heron, and a substantial number breed there. Within this reserve there are several distinct habitats or ecosystems, namely, the creek estuary, the wet sclerophyll forest and the dry sclerophyll forest, as well as several distinctly man-modified special purpose zones such as the picnic ground, the parking area, and several reafforestation zones (see Figure 1). By studying these environments from an ecosystem's perspective, geographers can readily emphasize inputs, outputs, linkages and processes, and thereby develop a deeper understanding of the patterns that have evolved over time. This approach is illustrated in Figure 2.

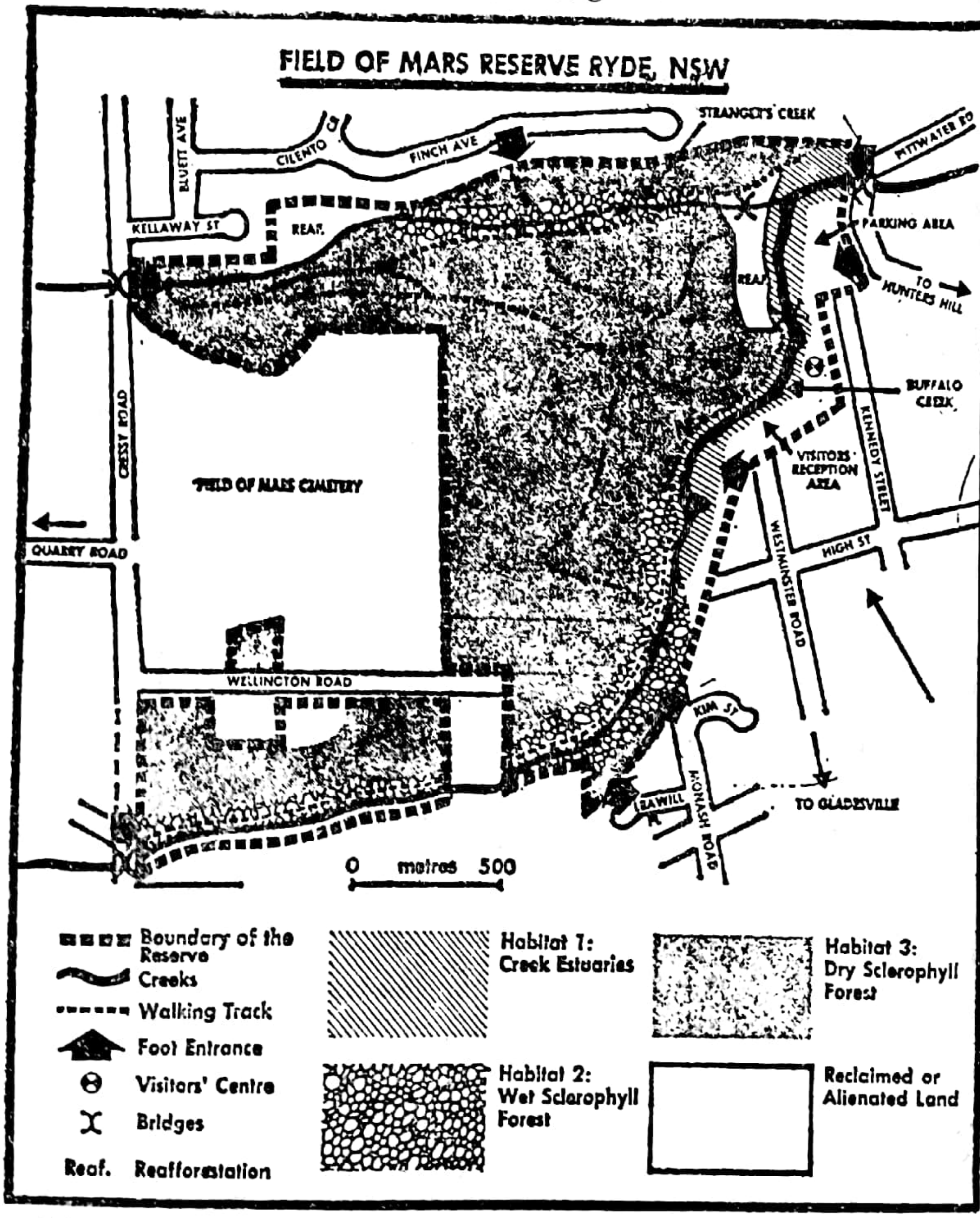

FIGURE 1 SHOWING SEVERAL DISTINCT HABITATS OR ECO-SYSTEMS.

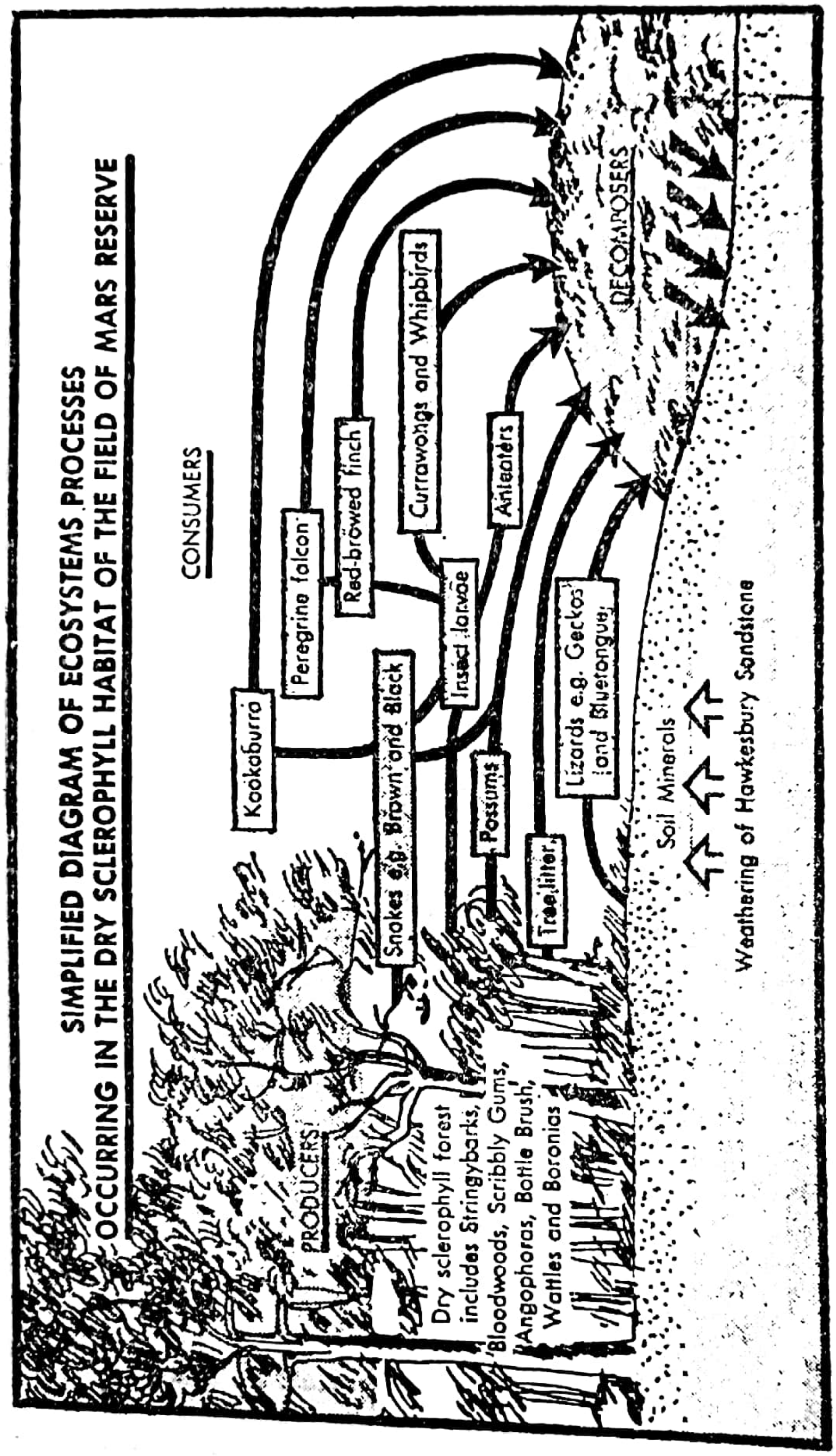
SIMPLIFIED DIAGRAM OF ECOSYSTEMS PROCESSES
OCCURRING IN THE DRY SCLEROPHYLL HABITAT OF THE FIELD OF MARS RESERVE
PRODUCERS
CONSUMERS
DECOMPOSERS
Kookaburra
Peregrine falcon
Red-browed finch
Currawongs and Whipbirds
Anteaters
Insect larvae
Snakes e.g. Brown and Black
Possums
Tree litter
Lizards e.g. Geckos and Bluetongues
Dry sclerophyll forest includes Stringybarks, Bloodwoods, Scribbly Gums, Angophoras, Bottle Brush, Wattles and Boronias
Soil Minerals
Weathering of Hawkesbury Sandstone

FIGURE 2

It is also worth noting some of the external influences that led to the retention and re-development of this 'natural' reserve within an otherwise urbanized, semi-industrial area of metropolitan Sydney. Potential invasions in the forms of housing, active open space utilization and cemetery extensions had been suggested from time to time, but it was not until 1966 that a proposition by Ryde Municipal Council, to pipe Buffalo Creek and 'infill' the valley with garbage, was so strongly resisted by local residents that the flora and fauna concept ultimately became a reality. The conflict situation of 1966 has become one of greater harmony by 1976, with Ryde Council, Ryde-Hunters Hill Flora and Fauna Preservation Society, the Department of Lands, the National Parks and Wildlife Service, and more recently the Department of Education co-operating in the dual development of "wildlife refuge" and "environmental study area". However, the seeds of possible conflict still remain between the Field of Mars Cemetery Trust and Field and Mars Flora and Fauna Reserve in the form of a potentially profitable crematorium company. So far, the retention of this set of naturally-oriented ecosystems within a region that is otherwise dominated by human-oriented ecosystems reflects the value of active environmental involvement by an informed local citizenry.

Fortunately, this situation can be repeated for a number of local circumstances elsewhere in Australia, and hopefully it will happen more often in the future as more young people are encouraged to "see" not only the beauty but the problems of their local environments. Geographical studies which involve ecosystem analysis, whether at school or elsewhere, can thus be an extremely valuable part of environmental education.

HUMAN ECOSYSTEMS

Geographers are now experimenting more and more with the application of natural ecosystems methodology in human ecosystems situations. A city, for instance, can be viewed as a human ecosystem which functions because inputs of energy lead to outputs of products and services (see Figure 3). The sources of energy input into any given urban system may be many and varied, but possibly those associated with population growth, capital inflow, technological advance, and planning decisions, are most significant. An increase in population, for example, can generate wide-ranging demands for additional products and services which become translated geographically into increases in urban functions (commerce, manufacturing, residence, etc.) occupying particular areal locations. Similarly, capital may flow naturally towards the expansion of specific industries, or may be directed by government policy into (say) housing, education and health, with subsequent effects upon urban form and function. Likewise, technological advance, i.e., the discovery and implementation of more techniques, can create new demands which generate new inputs of energy into many parts of an urban system (see Photo 2). Furthermore, planning decisions may be instrumental in channelling energy inputs into specific parts of that system and in fact, they very often create new energy inputs which affect the location of new industry, new towns, and urban renewal. The outputs of an urban system can be observed geographically as **distributions** such as commerce, industry, housing and social facilities, and as **networks** such as transport facilities and public utility services.

A system can function, i.e., perform its processes normally, and it can also malfunction, i.e., perform unsatisfactorily or abnormally. If an automobile is viewed as a system, then most of us are only satisfied when it "goes properly" or functions satisfactorily. It can, however, develop a number of faults or malfunctions of varying kinds, for example, the carburettor may receive too much or too little fuel, the king pins in the steering may become worn, or the brakes may become defective, but the car still 'goes' that is, it performs, but not very satisfactorily. It may even break down, that is, not function at all. In a similar way, urban systems function but with varying degrees of malfunction built into them. However, they rarely 'break down' or cease to function.

It is only when a malfunction is observed that we realize a problem exists. Some of the most common current problems within the world's urban systems are:

* traffic congestion (a malfunction of movement);
* urban sprawl (a malfunction of expansion).
* blighted and decayed areas (a malfunction of renewal, the counter-process to obsolescence):

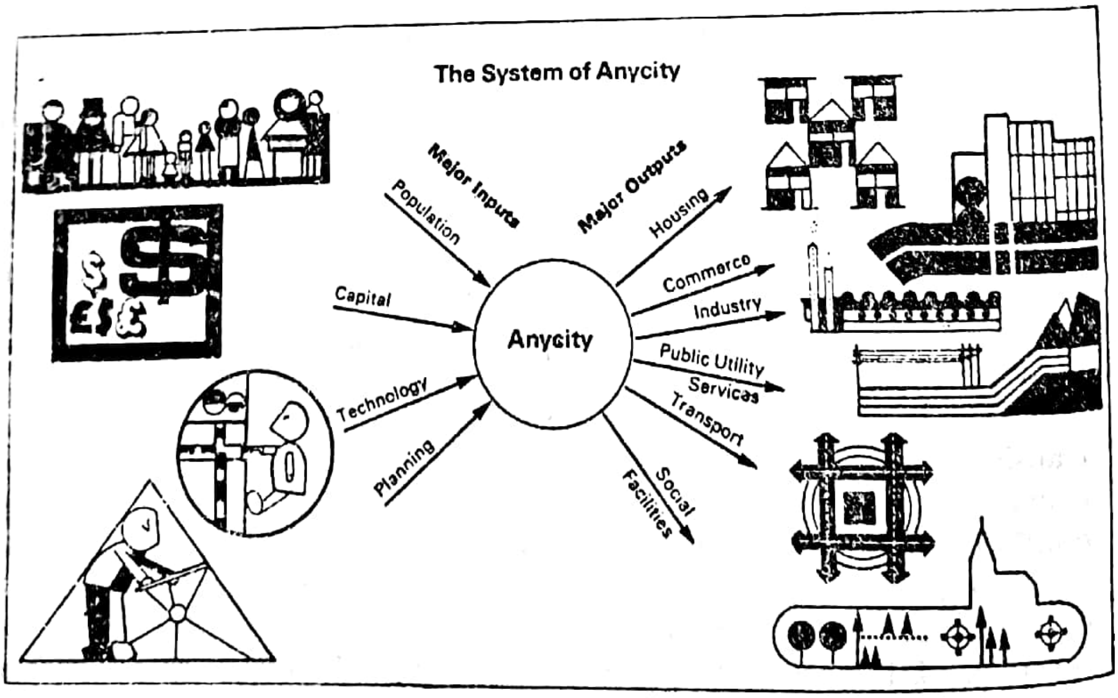

FIGURE 3

* pollution (malfunctions of population density and resource management);
* problems of townscape (malfunction of design and planning); and
* problems of segregated settlement (malfunctions of economics, human relationships and planning).

This simple example of the application of a *human ecosystems* approach to the study of urban geography illustrates how geographers can contribute their spatial expertise towards the solutions of some of the many human, inter-disciplinary environmental problems of our time.

CONCLUSION

Environmental education is a major strategy in a belated attempt to improve environmental quality on planet Earth. Geographers, through their expertise in earth-space relationships, can contribute to a greater understanding of the processes and patterns involved in many of the world's current environmental problems. Some of the structures used by geographers, particularly landscape, ecosystem (as exemplified) and environmental perception, may be exploited more fully, both in research and teaching, in the race against time to improve life-support systems affecting many regions of the world, and in some instances, the whole global community.

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PHOTO 2 CIRCULAR QUAY, SYDNEY FROM THE OPERA HOUSE. A HIGH-RISE, MODERN, BUILT ENVIRONMENT.

(The most decisive step taken by the Philippine Government on Environmental matter was the creation in 1978 of the Ministry of Human Settlement (MHS) with the First Lady Imelda Romualdez Marcos as Minister.

The National Environmental Protection Council (NEPC) previously created by Presidential Decree No. 1121 was placed under the MHS).

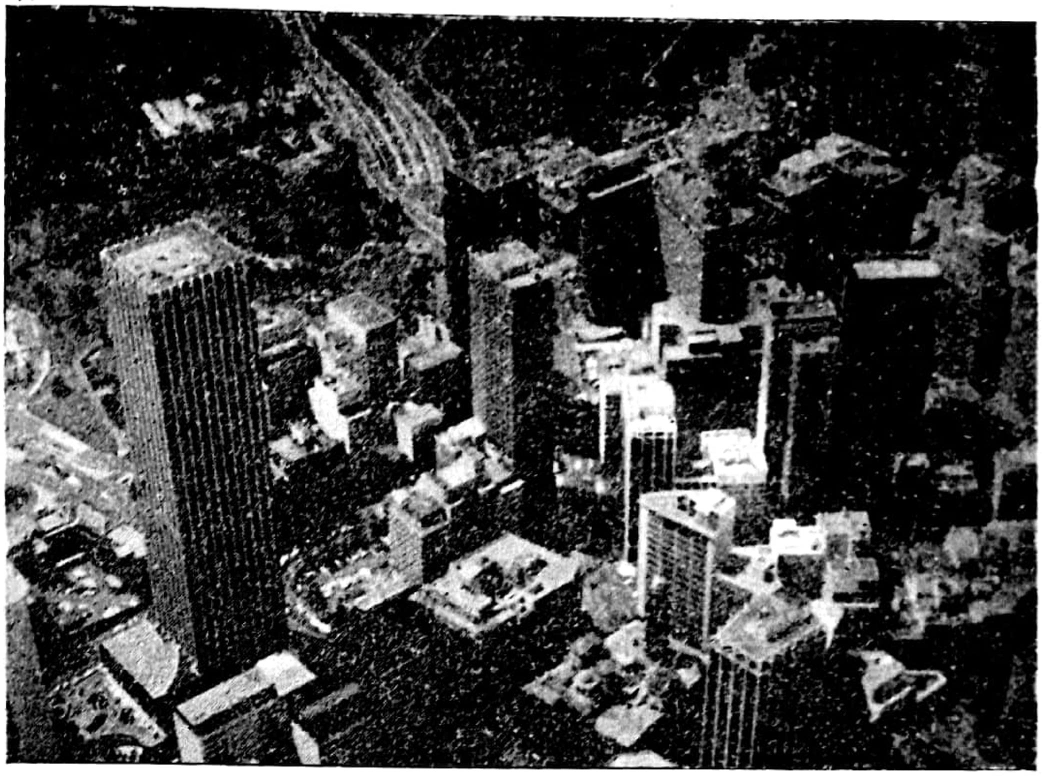

PHOTO 2-A. VERTICAL EXPANSION IN URBAN SYDNEY PART OF THE GROWTH PROCESS OF AN ACTIVE URBAN SYSTEM.

PHOTO 1-A. A "NATURAL" ECOSYSTEM RELICT IN AN URBAN HABITAT.

PHOTO 3 ENVIRONMENTAL DECAY AT ULTIMO, SYDNEY. THIS SCENE DEVELOPED BECAUSE OF THREATENED FREE-WAY EXTENSIONS.

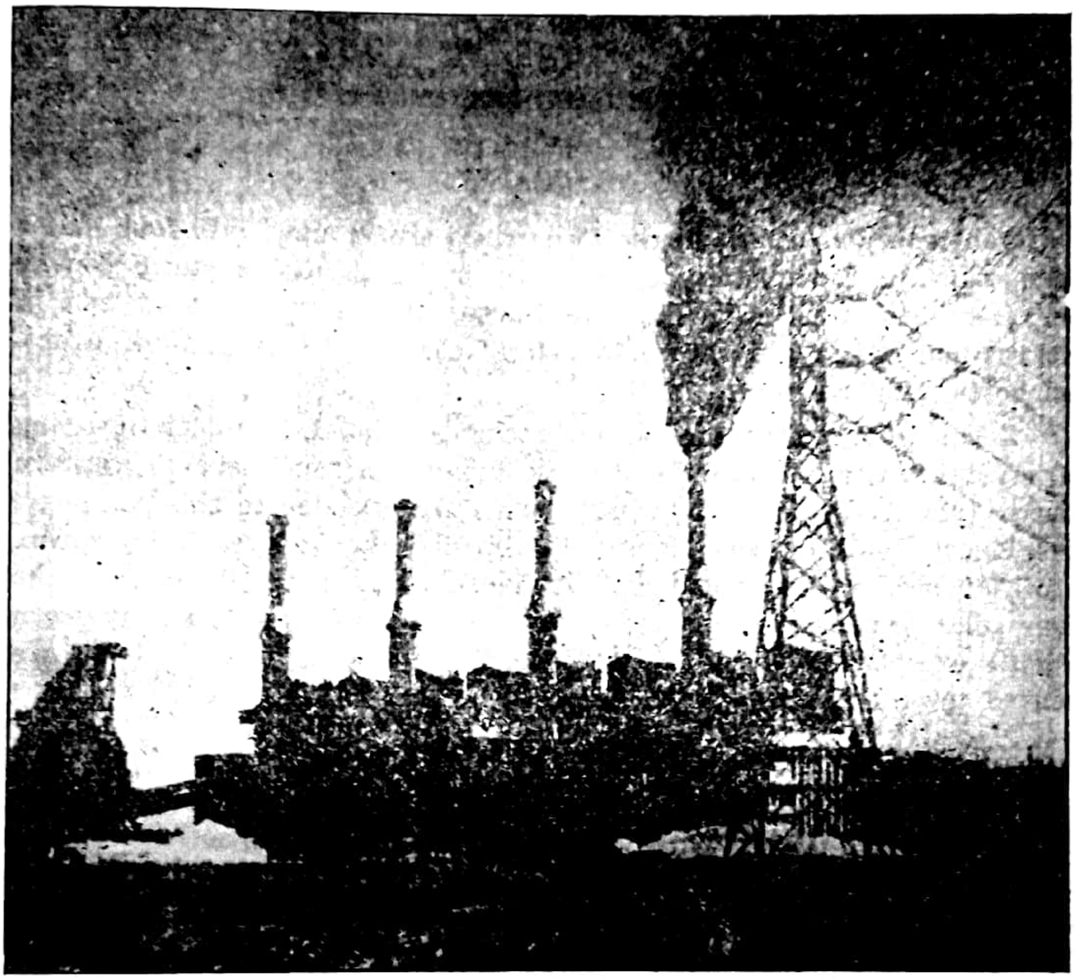

PHOTO 4 ABATTOIRS POWER STATION, SOUTH OF FREMANTLE. THREE GENERATORS ARE USING OIL AND THE FOURTH IS USING COAL.

"The problem of acid deposition starts, most experts agree, with the worldwide burning of coal, oil, and natural gas. Despite general adherence to existing environmental controls, the smokestocks of electrical generating plants, industrial boilers, and smelters release sulfur doixide and nitrogen oxides, the chief precursors of acid rain. Nitrogen oxides also puff from the exhaust pipes of motor vehicles and slowly escape from chemical fertilizer" From How Menacing is Acid Rain — National Geographic, Vol. 160, No. 5, Nov. 1981, p. 657.

QUATERNARY VOLCANOES AND VOLCANIC ROCKS OF THE PHILIPPINES

by

ROGELIO DATUIN AND FERNANDO L. UY

ABSTRACT

Quaternary volcanoes of the Philippines are grouped into four major belts, namely: the westerly convex belt in Luzon, the easterly convex belt from Southern Luzon down to Davao, the westerly convex belt in Negros and Panay and the southeasterly convex belt from Sulu Archipelago to Zamboanga.

Zonal arrangement of volcanic rocks is related to under-thrusting of crustal plates beneath the dipping subduction zone beneath western Luzon (Manila Trench), the west dipping plate related to the Philippine Trench, the east dipping Negros Trench and the southeasterly convex arc associated with the extinct Sulu Trench. Zonal relationship in the four volcanic belts is similar to other known island arcs in the Western Pacific except that the Western volcanic and Negros volcanic belts are convex toward the continental area.

INTRODUCTION

The Philippines lies on the western part of the Circum-Pacific volcanic belt. There are about 220 quaternary active and non-active volcanic cones in the Philippines. Twenty-six (26) of these are active in historic times or in solfataric stage. It is comprised of several island arcs as a result of collision of two major lithospheric plates: the Southeast Asian and Philippine sea plate. Six (6) major subduction appears on this complex volcanic arc and three (3) of them have relation with active volcanism in historic times: The Manila Trench, Negros Trench and the Philippine Trench (see Figure 1). The other subduction zones include the East Luzon Trough and Cotabato Trench. Both trenches became active only recently and lack volcanism and/or developed seismic zone in the mantle. The last major trench is the Sulu Trench which is an extinct arch system. In this paper only subduction zones which have resulted to volcanism will be discussed.

MAJOR VOLCANIC FRONT

There are four major trenches adjacent to Quaternary Volcanoes of the Philippines: the Manila Trench, the Philippine Trench, the Negros Trench and the Sulu Trench. These trenches which have exceptionally steep slopes are located west of Luzon, east of Southern Luzon down to

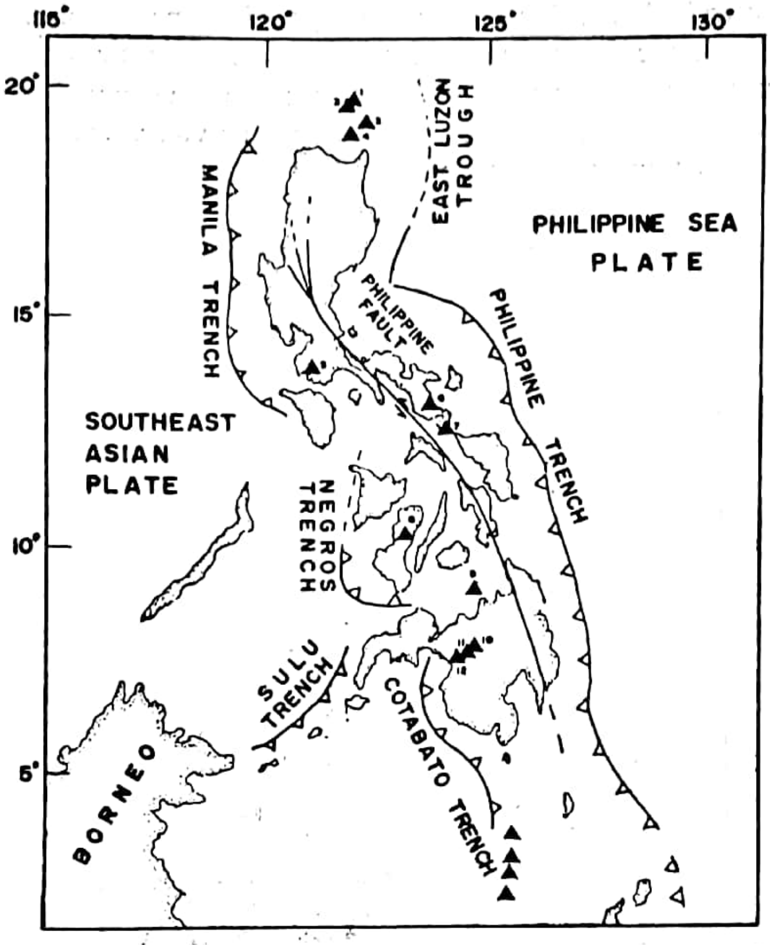

FIGURE 1. MAJOR TECTONIC FEATURES OF THE PHILIPPINES. PHILIPPINE FAULT HAS ARROW SHOWING RELATIVE SENSE OF MOTION. SOLID TRIANGLES REPRESENT ACTIVE VOLCANOES: 1) SMITH, 2) BABUYAN CLARO, 3) DIDICAS, 4) CAMIGUIN DE BABUYANES, 5) TAAL, 6) MAYON, 7) BULUSAN, 8) CANLAON, 9) CAMIGUIN-HIBOK-HIBOK, 10) MUSUAN (CALAYO), 11) RAGANG AND 12) MACATURIN.

eastern Mindanao, west of Negros and Panay islands and north of Sulu Archipelago and Zamboanga Peninsula, respectively. These major trenches are marked by arcuate features that at least four Quaternary volcanic fronts can be delineated as shown in Figure 2.

Quaternary volcanoes are distributed inside the arcs as defined by the volcanic fronts. Volcanoes associated with the Manila Trench are relatively small with predominantly dacite and andesite cones. In Batangas and Laguna, composite volcanoes are clustered in the Laguna Bay depression and the adjacent basins. Although volcanism was smaller in magnitude in the eastern foothills of Zambales-Pangasinan range, eruptions where more intense southward as shown by voluminous amount of basalt-andesite lava flow and associated pyroclastic materials erupted from the present site of Taal, Makiling and Banahaw. The origin of the extensive water laid tuff deposits in Batangas, Laguna, Rizal and Bulacan is deduced to come from this general area of volcanic clusters. The southern extension of the west volcanic front is also manifested by the smaller volcanic cones in Mindoro while submarine volcanism characterizes the northern extremity of the arc.

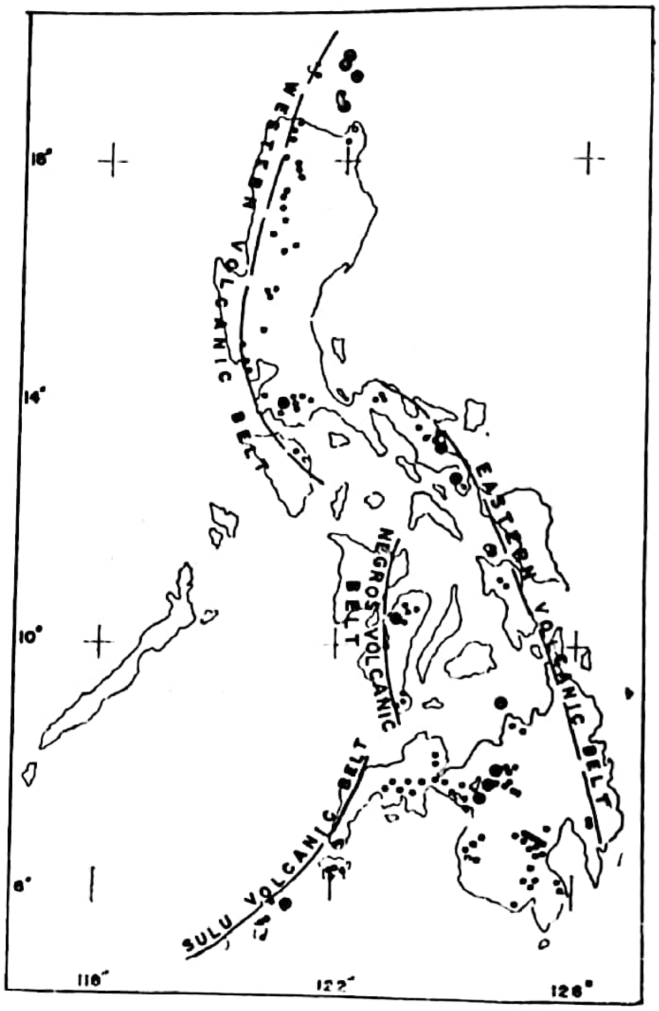

FIGURE 2. DISTRIBUTION OF QUATERNARY VOLCANOES IN THE PHILIPPINES SHOWING ITS FOUR VOLCANIC FRONTS (BROKEN LINE). OPEN CIRCLES INDICATE NON-ACTIVE VOLCANOES. SOLID CIRCLE INDICATE ACTIVE VOLCANOES.

The eastern Philippine volcanic front from Camarines Norte down to Davao is associated on the immediate vicinity with Quaternary volcanoes that include Labo, Isarog, Iriga, Malinao, Mayon and Bulusan; Apo and other smaller cones in Mindanao.

The southwest Philippine volcanic front in the Sulu archipelago is associated with the volcanoes of Bud Dajo and other volcanic cones in Sulu Archipelago and Zamboanga Peninsula.

The Philippine fault has no obvious direct relation to Quaternary volcanoes except possibly the Leyte volcanoes such as Buliran and Cabalian. The Philippine fault zone appears to be an arc transform fault as manifested by the eastern and western volcanic fronts related to opposite senses of subduction and convexity.

In late Pliocene and Quaternary Period, many large andesitic composite volcanoes and dacitic plugs of calc-alkali rock series affinity were formed throughout the four volcanic belts. In Quaternary, plateau basalts flowed also in Lanao and Zamboanga. The volcanoes related to the eastern and Sulu volcanic belts are more mafic compared to those of the western volcanic belt.

VOLCANIC SUITES

Zonal arrangement of volcanic suites sub-parallel to the volcanic fronts had been recognized to be related to the concept of plate subduction in island arc (Kuno, 1959). Chemical data tabulated in Table 2 were plotted to delineate the volcanic suites using total alkali — $Si0_2$ relation diagram of Kuno (Figure 3). On the basis of existing data results indicated that spatial arrangement of volcanoes related to the west and east volcanic fronts are consistent with other island arcs of the Western Pacific. The degree of silica saturation decreases gradually away from the volcanic front. On the other hand, alkali content increases toward the back arc.

WEST LUZON ARC AND THE WESTERN VOLCANIC BELT SUITES

The West Luzon Arc is a west — facing island arc system where the oceanic crust of the South China Basin is being subducted at the Manila Trench. Landward of the trench are a well — developed non-volcanic outer — arc ridge and a sediment — filled forearc basin, the Luzon Trough (Ludwig, et al., 1967; Karig, 1973). The Zambales range on the west coast of Luzon is composed of an ophiolite slab, probably of late Eocene age, representing oceanic crust originating from the lowest (Schweller and Karig, 1979). The volcanic inner — arc is marked by presently active volcanoes and Quaternary volcanic cones extending from Mindoro Island and Marinduque Island in the south through central Luzon and continues northward from northeastern Luzon into the Babuyan Island group and the Batan Island group (north of Babuyan Island).

In response to movement of the South China Sea plate in Miocene to Pliocene Period, eastward subduction at the Manila Trench resulted

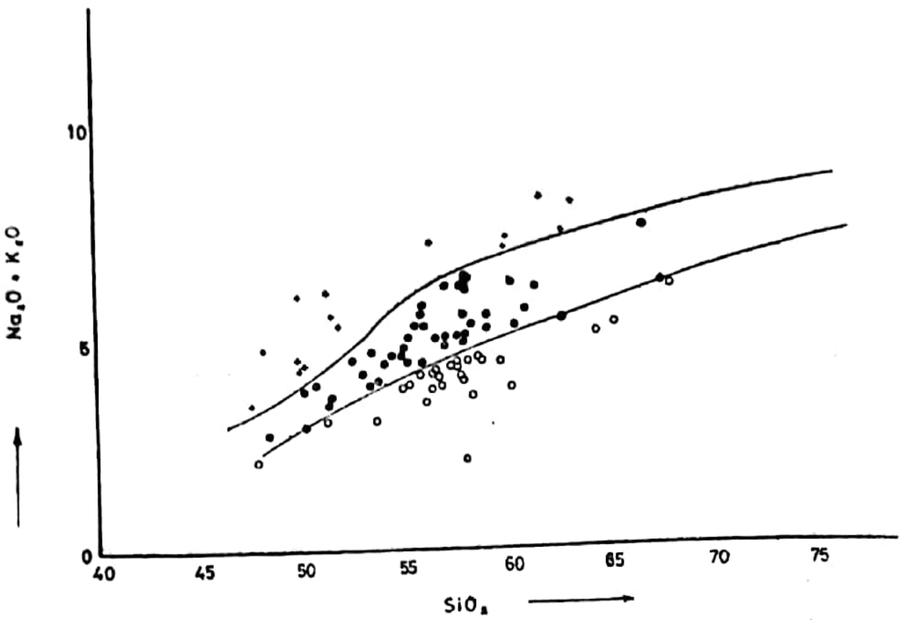

FIGURE 3. TOTAL ALKALI-SiO_2 RELATION DIAGRAM

in the development of an outer tholeiitic rock suite. Since then volcanic activity along the west coast migrated eastward changing from tholeiitic to calc-alkali rock suites. Almoradie (personal communication, 1978) noticed the same migration direction of volcanic centers in Laguna-Quezon volcanic district.

The western volcanic belt is divided into three volcanic suites as shown in Figure 4. The tholeiitic suite faces the South China Sea and the alkali suite is on the Luzon central physiographic suite province. Tho calc-alkali lies between and overlaps both tholeiitic and alkali rock suites.

Volcanic rocks of tholeiitic affinity are mostly basalt, andesite, and pyroclastic ejecta. Odom (1977) placed the age of these rocks from 0.6-7 million years. Representative volcanoes of this suite are western Mariveles and its adventive cones, western Natib volcanic complex, Carilao and Namiranlic.

Active and inactive strato volcanoes of basalt-andesite and dacite rocks predominantly characterized the calc-alkali suite. Age data from calc-alkali volcanoes ranges from four million to less than 10,000 years. The typical volcanoes of the suite are the eastern part of Natib complex, eastern Mariveles including Samat, Orion, Limay, Pinatubo, Mapingon, Atimba, Cuyapo, Balungao, San Audre, Makiling and Dumali. Taal rocks are calc-alkali but quite near the tholeiitic basalt on the basis of microscopic study.

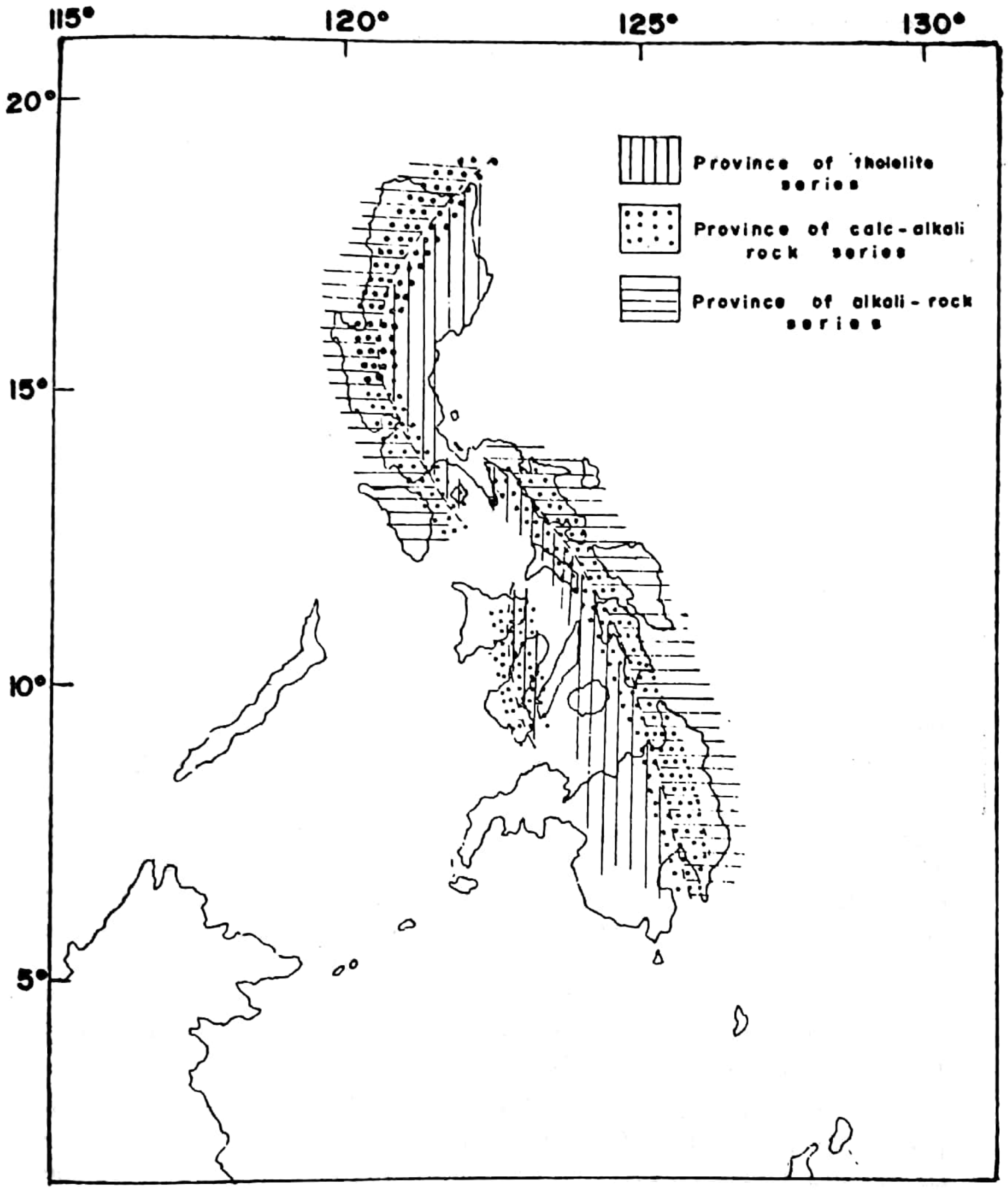

FIGURE 4. PETROGRAPHIC PROVINCES IN THE PHILIPPINES.

Extrusive rocks associated with the volcanoes of the inner alkali suite are basalt, trachyte and latite. Representative volcanoes are Sembrano, Banahaw, San Cristobal and Arayat.

The volcanic centers of central Luzon lie above the portion of the seismic zone that is slightly deeper than 100 km. However, Taal and other volcanoes in southwestern Luzon appear to lie over significantly deeper portions of the seismic zone (Sardwell, et al., in press).

PHILIPPINE ISLAND ARC AND THE EASTERN VOLCANIC BELT SUITES

The Philippine Arc is an east facing island arc system where the oceanic crust of the Philippine basin is being subducted at the Philippine Trench (Fitch, 1970, 1972). A line of active and non-active volcanoes appeared from the Bicol region to Leyte. Subduction on the southern portion of Philippine Trench started only recently which explains the absence of Quaternary volcanoes in southwestern Mindanao (Cardwell, et al., in press).

Sugimura (1968) delineated in passing the different Quaternary volcanic suites associated to subduction zones in Western Pacific by means of petrochemical index. The petrochemical index proposed by Sugimura is similar in effects to Kuno's total alkali — SiO_2 relation diagram, hence can be used as equivalent technique in the determination of the different zonal arrangement of volcanic rock suites in island arcs. With slight modification, the zonal distribution of Sugimura for volcanic rock suites related to the Philippine subduction zone are in close arrangement with this paper.

Most of the volcanoes of the eastern volcanic belt from the Bicol peninsula down to eastern Mindanao are basalt-andesite-dacite association of calc-alkali rock series. Representative volcanoes are Mayon and Malinao in Luzon, eastern volcanic complex of the island province of Camiguin, and the volcanoes of Leyte and Northern Davao. Judging from the geomorphology of the volcanoes of the Bicol peninsula, the eruptive activity of the volcanic centers shifted from the north to south with Mayon and Bulusan as active volcanoes. In Camiguin province the migration of the sites of eruption was from southeast to northwest (MacDonald and Alcaraz, 1956).

The extrusive rock suites of the eastern volcanic belt arranged subparallel to the volcanic front are tholeiitic rock series on the outer eastern arc, calc-alkali rocks on the central arc, and alkali rocks on the backdeep arc.

NEGROS ISLAND ARC AND ITS VOLCANIC BELT SUITES

The Negros Arc is a west — facing island arc system located where the Sulu Basin is being subducted at the Negros Trench. The arc is comprised of the islands of Negros and most of Panay and has all the morphologic features of an active subduction system including a trench, outer — arc ridge, forearc basin, and active volcanic arc. The Negros Arc has been an active subduction zone since the Miocene (Hamilton, 1979).

Rock samples taken from Negros for petrographic analysis indicate that most volcanic rock of the province belong to the calc-alkaline suite (Reyes, personal communication). However, chemical analysis of rock sample from Canlaon volcano also indicate the presence of an alkali suite. No tholeiitic has been found so far in this volcanic belt. This could be explained possible by the fact that most of the tholeiitic volcanoes have ceased their activity very early and were eroded or covered.

Similar to the other volcanic belts, the alkalic rock can be found in the inner side of the arc followed by the calc-alkali suite. No attempt was made to delineate the approximate boundary of the tholeiitic suite due to lack of data.

SULU ARC AND ITS VOLCANIC BELT SUITES

The Sulu Arc is an extinct northwest facing island arc system occurring along the Sulu ridge from northeast Borneo to the Zamboanga peninsula. It is marked by paired belts of subduction meliange and magmatic rock. It was formed by subduction of the oceanic crust of the Sulu sea in late cenozoic plastocene (Hamilton, 1979).

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TABLE 1. LIST OF VOLCANOES WITH KNOWN NAMES
WESTERN VOLCANIC BELT

Name	*Location* *Latitude*	*Longitude*	*Present Activity*
Mt. Iraya	20°27′N	120°01′E	Inactive
Smith Volcano	19°32.2′N	121°54′E	Active
Babuyan Claro	19°30′N	121°57′E	Active
Didicas Volcano	19°05′N	122°10′E	Active
Camiguin de Babuyanes	18°55′N	121°52′E	Active
Cagua Volcano	18°13′N	122°08′E	Inactive
Mt. Santo Tomas	16°20′N	121°33′E	Solfataric
Mt. Arayat	15°15.13′N	120°44.15′E	Inactive
Mt. Balungao	15°51.45′N	120°40.30′E	Inactive
Mt. Cuyapo	15°48.00′N	120°39.19′E	Inactive
Mt. Bangcay	15°46.45′N	120°43.30′E	Inactive
Mt. Pinatubo	15°08.00′N	120°20.43′E	Solfataric
Mt. Natib Complex	14°42.37′N	120°24.15′E	Inactive
Mt. Mariveles Complex	14°31.35′N	120°28.33′E	Inactive
Mt. Batulao	14°02.52′N	120°48.03′E	Inactive
Mt. Carilao	14°17.00′N	120°45.53′E	Inactive
Mt. Palaypay	14°12.53′N	120°39.54′E	Inactive
Mt. Makiling	14°08′N	121°11′E	Solfataric
Mt. Banahao-Cristobal Complex	14°04′N	121°29′E	Solfataric
Taal Volcano	14°04′N	120°56.6′E	Active
San Audre	13°34′	121.5	Inactive
Dumali	13°7	121.3	Inactive

EASTERN VOLCANIC BELT

Name	*Location* *Latitude*	*Longitude*	*Present Activity*
Mayon Volcano	13°15.4′N	123°41′E	Active
Mt. Malinao	13°25.3′N	125°35.8′E	Solfataric
Bulusan Volcano	12°46.2′N	124°03′E	Active
Biliran Volcano	11°46.2′N	124°32.1′E	Solfataric
Mt. Mahagnao	10°57′N	124°52′E	Solfataric
Labo	14°2′	122°48	Inactive
Isarog	13°39′	123°22	Inactive
Iriga	13°27′	123°24	Inactive
Parker	6°6′	124°54	Inactive
Matutum	6°22	125°5	Inactive
Cabalian Volcano	10°17.2′N	125°13′E	Solfataric
Camiguin-Hibok Hibok	09°12.2′N	124°40.4′E	Active
Ragang Volcano	07°43′N	124°32′E	Active
Macaturin Volcano	07°38.8	124°19′E	Solfataric
Calayo Volcano	07°49.8′N	124°40.8′E	Solfataric
Mt. Apo	06°59.2′N	125°16.4′E	Solfataric
NEGROS VOLCANIC BELT			
Canlaon Volcano	10°24.7′N	123°07.9′E	Active
Mandalagan	10°39′N	123°13.0′E	Solfataric
Cuernos de Negros	09°15.5′N	123°11.1′E	Solfataric
SULU VOLCANIC BELT			
Bud Dajo	05°59′N	121°13′E	Solfataric

TABLE 2. CHEMICAL COMPOSITION

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TOTALS	AGE IN M. Y.
MT NATIB	55.73	.61	16.62	6.00	3.64	8.27	2.75	.83	94.45	.91 + .07
MT. NATIB	59.50	.63	17.67	6.28	2.88	5.36	3.62	.80	96.74	.98 + .06
MT. NATIB	53.70	.57	15.14	6.06	3.35	8.37	2.25	.77	90.21	.96 + .07
MT. NATIB	50.15	1.01	17.91	10.07	5.12	10.57	2.81	1.03	98.67	1.76 + .11
MT. NATIB	56.24	.74	19.82	6.87	2.15	8.23	3.63	1.29	98.97	1.98 + .11
MT. NATIB	56.84	.72	19.96	7.15	2.23	8.24	3.56	1.28	99.98	2.14 + .08
MT. NATIB	57.53	.57	18.05	7.02	2.50	7.67	3.85	1.51	98.70	.92 + .05
MT. NATIB	56.85	.57	17.64	6.45	3.19	6.52	3.24	1.64	96.10	1.42 + .08
MT. NATIB	67.87	.49	16.59	4.51	2.54	5.03	4.49	1.49	98.01	.65 + .05
MT. NATIB	57.67	.62	17.91	7.39	3.17	8.06	3.65	1.15	100.22	1.24 + .09
MT. NATIB	57.71	.58	18.32	7.52	3.77	6.86	3.39	.87	99.01	1.16 + .09
MT. NATIB	57.79	.57	17.95	7.44	3.66	6.96	3.33	.81	98.51	1.70 + .30
MT. NATIB	55.79	.71	18.00	8.01	3.89	7.63	3.25	.87	97.57	1.10 + .07
MT. NATIB	57.70	.63	17.91	7.40	3.66	6.93	3.26	.78	98.27	1.13 + .05
MT. NATIB	56.75	.53	18.19	8.07	3.33	7.81	3.51	.57	98.76	.68 + .06
MT. NATIB	58.73	.55	17.57	5.80	3.59	7.67	3.57	1.62	99.10	.54 + .08
MT. NATIB	58.90	.54	17.50	5.47	2.71	7.06	3.78	1.62	97.58	1.60 + .08
MT. NATIB	60.53	.60	18.18	4.88	2.84	7.26	3.83	1.69	99.81	.98 + .01
MT. NATIB	64.30	.48	17.52	4.82	.95	4.72	3.70	1.23	97.72	2.26 + .11
MT. NATIB	65.08	.47	17.18	4.29	.95	5.25	3.95	1.30	99.10	2.16 + .10
MT. NATIB	60.32	.60	17.74	6.10	3.65	7.19	3.68	1.45	100.64	.58 + .06
MT. NATIB	55.64	.67	18.62	7.79	3.27	8.29	3.52	.92	98.72	2.06 + .20
MT. NATIB	47.92	.87	18.63	12.16	5.07	10.09	1.99	.22	97.95	2.10 + .40
MT. NATIB	53.76	.95	17.88	9.26	4.85	9.35	3.16	.98	100.19	2.17 + .35
MT. NATIB	53.41	.87	17.88	9.51	5.19	9.52	3.05	.95	100.38	2.06 + .15
MT. NATIB	57.61	.70	17.93	8.09	3.99	7.55	3.90	.81	100.58	.93 + .05
MT. NATIB	58.00	.69	17.18	8.24	3.96	7.09	3.69	.83	99.68	.76 + .06
MT. NATIB	57.87	.64	17.92	7.56	3.93	7.51	3.54	.91	99.88	.92 + .10
MT. NATIB	51.66	.71	17.50	8.24	3.96	7.39	3.98	.80	100.27	.94 + .05
MT. NATIB	57.78	.70	17.52	7.67	3.35	6.91	3.78	.80	98.51	.88 + .09

Table 2 (Cont'd.) CHEMICAL COMPOSITION

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TOTALS	AGE IN M. Y.
PINATUBO	61.26	.56	17.04	5.95	2.61	5.66	4.11	1.90	99.09	1.10 + .09
ATIMBIA	57.49	.97	16.20	8.97	1.75	5.53	3.45	2.67	97.03	1.05 + .05
CUYAPO	59.22	.47	18.18	5.21	2.33	5.59	4.77	1.63	97.40	1.59 + .29
AMORONG	51.67	1.10	17.89	9.41	5.03	7.34	3.63	1.60	97.67	1.14 + .08
MARIVELES	57.93	.71	17.26	8.62	4.13	8.10	3.39	1.01	101.15	.97 + .08
MARIVELES	54.94	.63	17.98	7.25	2.05	12.13	2.97	.99	98.94	.88 + .08
MARIVELES	56.46	.55	18.01	8.83	3.53	8.08	3.13	1.15	99.74	.41 + .08
MARIVELES	58.65	.54	18.23	8.08	3.29	7.73	3.38	1.12	101.02	.19 + .04
MARIVELES	57.65	.61	17.05	8.31	5.58	7.61	3.12	1.37	101.30	3.34 + .10
MARIVELES	56.11	.40	16.80	6.69	3.18	8.28	2.88	.95	95.29	
MARIVELES	58.63	.67	18.09	8.13	3.42	7.32	3.43	1.15	100.84	3.44 + .24
MARIVELES	50.03	.69	18.97	10.40	4.84	9.98	2.70	.96	98.57	1.10 + .10
MARIVELES	57.23	.60	17.83	8.68	3.81	8.18	3.02	1.22	100.57	3.90 +
MARIVELES	56.30	.64	18.45	8.70	3.81	8.66	2.85	1.28	100.69	4.10 + .30
MARIVELES	55.80	.73	17.39	8.89	3.91	8.35	3.13	1.03	99.23	3.26 + .04
MARIVELES	57.19	.54	17.98	8.53	4.00	7.58	3.31	1.69	100.92	1.08 + .08
ORION	51.30	.79	17.92	11.06	5.95	11.06	2.36	.61	101.05	1.05 + .09
LIMAY	48.28	.73	18.42	11.52	6.05	11.32	2.16	.63	99.11	.95 + .09
SAMAT	50.53	.84	18.56	11.20	5.16	9.69	2.91	.90	99.79	
STA. RITA	62.52	.28	17.26	4.47	2.39	5.10	4.29	1.03	97.34	1.22 + .20
ARAYAT	51.09	1.03	17.11	11.08	5.81	10.34	3.13	1.31	100.90	.53 + .05
DUMALI IN MINDORO	56.58	.58	18.68	7.45	2.66	7.69	3.97	1.92	99.53	.82 + .07
CARILAO	55.17	.76	16.95	9.59	4.55	8.23	2.81	1.09	99.15	1.34 + .12
BATULAO	56.83	1.03	17.72	8.88	3.80	8.13	2.40	1.71	100.50	3.40 + .20
PALAY-PALAY	56.67	.53	17.28	7.75	2.67	6.41	2.79	1.13	95.23	2.91 + .17
PALAY-PALAY	57.45	.61	17.36	7.73	2.71	2.71	3.15	1.43	97.83	2.92 + .16
SEMBRANO	59.94	1.06	16.71	7.59	2.04	5.33	3.86	3.45	99.98	1.70 + .07
SEMBRANO	59.13	1.05	16.69	8.41	1.38	4.57	3.94	3.16	98.33	.10 + .06
CRISTOBAL	51.06	.93	10.50	9.60	5.81	9.74	3.19	1.06	99.89	1.31 + .21
MALEPUNYO	60.17	.63	16.72	7.07	2.33	6.27	3.67	2.62	99.48	.63 + .04
MAKILING	56.83	.80	17.98	7.26	3.64	7.15	3.51	2.54	99.77	
MAKILING	66.40	.49	15.69	3.97	.92	3.35	4.51	2.79	98.62	.18 + .02
MAKILING	61.37	.62	16.41	6.46	2.03	5.05	4.03	3.99	98.76	.51 + .04
TAAL	51.14	.78	15.17	11.57	6.97	11.01	2.19	.82	99.65	

Analyst: P. Ragland

Table 2 (Cont'd.) CHEMICAL COMPOSITION

	SiO_2	FeO	Fe_2O_3	Al_2O_3	TiO_2	P_2O_5	CaO	MgO	MnO	Na_2O	K_2O	H_2O + 110°C	H_2O — 110°C	TOTAL
DIDICAS	57.18	3.86	4.02	17.11	.66	.48	8.00	2.11	.60	4.31	1.12	.20	.30	99.95
DIDICAS	59.76	2.03	3.78	18.12	.22	.22	8.40	2.72	.42	2.21	.80	.50	.16	99.36
ARAYAT	47.90	5.99	21.98		.48	.70	9.04	1.59	.64	3.63	1.23	1.20	.70	100.16
ARAYAT	51.32	4.38	20.13		.40	.72	9.85	1.90	.60	4.30	1.25	.32	.20	99.97
ARAYAT	49.80	3.27	21.30		.56	.46	8.85	1.37	.66	4.42	1.57			
ARAYAT	49.70	6.17	19.99		.72	.64	9.06	1.19	.60	3.19	1.31	.90	.40	100.98
MAKILING	63.00	2.56	3.15	14.90	.15	.82	3.50	.72	.42	5.73	2.32	1.50	.10	98.87
MAKILING	47.50	4.98	5.42	20.40	.66	.98	12.68	1.74	.44	2.76	.91	1.14	.40	99.91
BULUSAN	58.36	3.47	2.90	20.81			7.05	1.05		2.76	1.02			99.69
BULUSAN	58.10	3.71	1.36	19.60	.35	.40	7.15	1.75	.14	4.68	1.80	.42	.10	99.56
BULUSAN	62.56	1.79	1.31	16.53	.30	.52	6.07	.87	.40	5.14	2.22	.90	.80	99.15
HIBOK-HIBOK	55.90	2.04	3.47	20.95	.48	.42	7.47	1.05	.36	5.12	2.24	.30	.10	99.90
HIBOK-HIBOK	55.70	4.61	3.53	17.16	.62	.46	9.10	1.83	.52	4.14	1.63	.44	.22	99.96
HIBOK-HIBOK	57.80	3.98	3.63	14.01	.61	.62	8.30	3.62	.44	4.15	1.97	1.04	.10	100.27
HIBOK-HIBOK	57.78	3.21	4.92	18.05	.71	.65	6.85	.83	.46	5.37	1.03	.10	.06	100.02
HIBOK-HIBOK	55.87	4.21	3.92	18.55	.58	.72	6.51	1.83	.54	4.37	1.09	.90	.46	100.55
HIBOK-HIBOK	54.98	3.99	3.96	19.59	.80	.77	7.05	1.94	.48	3.98	1.02	1.28	.12	98.94
MAKILING	65.82		7.26	17.98	.80		7.15	3.64		3.51	2.54			99.77
										Analyst:	B. Quinones			
TAAL	51.39	7.27	2.40	15.28	.81	.11	11.65	7.35	.10	2.56	.87	.60	.01	100.46
										Analyst:	Hirano			
MAYON	54.90	.64	19.04	7.47		.15	4.05	8.62		3.40	1.13	.26	.04	99.70
MAYON	54.19	.70	19.28	7.75		.17	4.28	8.63		3.36	1.08	.38	.30	100.12
MAYON	53.15	.56	19.45	7.55		.16	4.78	9.79		3.28	.91	.32	.15	100.10
MAYON	54.7	.81	20.25	8.14		.14	3.68	6.32		3.51	1.08	.00	.00	98.63
MAYON	53.32	.69	19.05	8.18		.16	3.84	9.27		3.81	1.03	.00	.00	99.35
MAYON	54.71	.66	19.16	7.74		.17	3.79	8.67		3.55	1.16	.39	.77	100.77
MAYON	54.32	.61	19.52	7.70		.17	3.82	8.66		3.52	1.16	.36	.45	100.33

Analyst: C. Hewhall

Table 2 (Cont'd.)

DIDICAS		
SiO_2	57.18	59.76
FeO	3.86	2.03
Fe_2O_3	4.02	3.78
Al_2O_3	17.11	18.12
TiO_2	.66	.22
P_2O_5	.48	.22
CaO	8.00	8.4
MgO	2.11	2.72
MnO	.60	.42
Na_2O	4.31	2.21
K_2O	1.12	.80
$H_2O + 110°C$	.2	.50
$H_2O - 110°C$	.3	.16
TOTAL	99.95	99.36

Analyst: B. Quinones

Table 2 (Cont'd.)

	PINATUBO	ATIMBIA	CUYAPO	AMORONG
SiO_2	61.26	57.49	59.22	51.67
TiO_2	0.56	0.97	0.47	1.10
Al_2O_3	17.04	16.20	18.18	17.89
Fe_2O_3	5.95	8.97	5.21	9.41
MgO	2.61	1.75	2.33	5.03
CaO	5.66	5.53	5.59	7.34
Na_2O	4.11	3.45	4.77	3.63
K_2O	1.90	2.67	1.63	1.60
TOTALS	99.09	97.03	97.40	97.67
AGE IN M.Y.	1.1 + .09	1.05 + .05	1.59 + .29	1.14 + .08

Analyst: Ragland

Table 2 (Cont'd.)

ARAYAT				
SiO_2	47.9	51.32	49.8	49.7
FeO	5.99	4.38	3.27	6.17
Fe_2O_3	21.98	20.13	21.30	19.99
TiO_2	.48	.4	.56	.72
P_2O_5	.70	.72	.46	.64
CaO	9.04	9.85	8.85	9.06
MgO	1.59	1.9	1.37	1.19
MnO	.64	.60	.66	.6
Na_2O	3.63	4.3	4.42	3.19
K_2O	1.23	1.25	1.57	1.31

$H_2O + 110°C$	1.2	.32		.9
$H_2O — 110°C$	.7	.20		.4
TOTAL	100.16	99.97		100.98

Analyst: B. Quinones

Table 2 (Cont'd.)

MT. NATIB

SiO_2	53.41	57.61	58.00	57.87	51.66	57.78
TiO_2	0.87	0.70	0.69	0.64	0.71	0.70
Al_2O_3	17.88	17.93	17.18	17.92	17.50	17.52
Fe_2O_3	9.51	8.09	8.24	7.56	8.24	7.67
MgO	5.19	3.99	3.96	3.93	3.96	3.35
CaO	9.52	7.55	7.09	7.51	7.39	6.91
Na_2O	3.05	3.90	3.69	3.54	3.98	3.78
K_2O	0.95	0.81	0.83	0.91	0.80	0.80
TOTALS	100.38	100.58	99.68	99.88	100.27	98.51
AGE IN M.Y.	2.06 + .15	.93 + .05	.76 + .06	.92 + .1	.94 + .05	.88 + .09

Analyst: Ragland

Table 2 (Cont'd.)

MT. NATIB

SiO_2	64.30	65.08	60.32	55.64	47.92	53.76
TiO_2	0.48	0.47	0.60	0.67	0.87	0.95
Al_2O_3	17.52	17.18	17.74	18.62	18.63	17.88
Fe_2O_3	4.82	4.29	6.10	7.79	12.16	9.26
MgO	0.95	0.95	3.65	3.27	5.07	4.85
CaO	4.72	5.25	7.19	8.29	10.09	9.35
Na_2O	3.70	3.95	3.63	3.52	1.99	3.16
K_2O	1.23	1.30	1.45	0.92	0.22	0.98
TOTALS	97.72	99.10	100.64	98.72	97.95	100.19
AGE IN M.Y.	2.26+.11	2.16+0.1	.53+0.06	2.06+.2	2.1+.4	2.17+.35

Analyst: Ragland

Table 2 (Cont'd.)

MT. NATIB

SiO_2	55.79	57.70	56.75	58.73	58.90	60.53
TiO_2	0.71	0.63	0.53	0.55	0.54	0.60
Al_2O_3	18.00	17.91	18.19	17.57	17.50	18.18
Fe_2O_3	8.01	7.40	8.07	5.80	5.47	4.88
MgO	3.89	3.66	3.33	3.59	2.71	2.84
CaO	7.63	6.93	7.81	7.67	7.06	7.26
Na_2O	3.25	3.26	3.51	3.57	3.78	3.83
K_2O	0.87	0.78	0.57	1.62	1.62	1.69
TOTALS	97.57	98.27	98.76	99.10	97.58	99.81
AGE IN M.Y.	1.1+.07	1.13+.05	.68+.06	.54+.08	1.6+.08	.98+.01

Analyst: Ragland

Table 2 (Cont'd.)

MT. NATIB

$Si0_2$	57.53	56.85	67.87	57.67	57.71	57.79
$Ti0_2$	0.57	0.57	0.49	0.62	0.58	0.57
Al_20_3	18.05	17.64	16.59	17.91	18.32	17.95
Fe_20_3	7.02	6.45	4.51	7.39	7.52	7.44
Mg0	2.50	3.19	2.54	3.17	3.77	3.66
Ca0	7.67	6.52	5.03	8.06	6.86	6.96
Na_20	3.85	3.24	4.49	3.65	3.39	3.33
K_20	1.51	1.64	1.49	1.15	0.87	0.81
TOTALS	98.70	96.10	98.01	100.22	99.01	98.51
AGE IN M.Y.	.92+.05	1.42+.08	0.65+.05	2.24+0.09	1.16+0.09	1.7+0.3

Analyst: Ragland

Table 2 (Cont'd.)

MT. NATIB

$Si0_2$	55.73	59.50	53.70	50.15	56.24	56.84
$Ti0_2$	0.61	0.63	0.57	1.01	0.74	0.72
Al_20_3	16.62	17.67	15.14	17.91	19.82	19.96
Fe_20_3	6.00	6.28	6.06	10.07	6.87	7.15
Mg0	3.64	2.88	3.35	5.12	2.15	2.23
Ca0	8.27	5.36	8.37	10.57	8.23	8.24
Na_20	2.75	3.62	2.25	2.81	3.63	3.56
K_20	0.83	0.80	0.77	1.03	1.29	1.28
TOTALS	94.45	96.74	90.21	98.67	98.97	99.98
AGE IN M.Y.	.91+.07	.96+.06	.96+0.07	1.76+.1	1.98+.11	2.14+.08

Analyst: Ragland

Table 2 (Cont'd.)

MARIVELES

$Si0_2$	58.63	50.03	57.23	56.30	55.80	57.19
$Ti0_2$	0.67	0.69	0.60	0.64	0.73	0.54
Al_20_3	18.09	18.97	17.83	18.45	17.39	17.98
Fe_20_3	8.13	10.40	8.68	8.70	8.89	8.53
Mg0	3.42	4.84	3.81	3.81	3.91	4.00
Ca0	7.32	9.98	8.18	8.66	8.35	7.58
Na_20	3.43	2.70	3.02	2.85	3.13	3.31
K_20	1.15	0.96	1.22	1.28	1.03	1.69
TOTALS	100.84	98.57	100.57	100.69	99.23	100.92
AGE IN M.Y.	3.44 + .24	1.1 + .1	3.9	4.1 + .3	3.26 + .04	1.08 + .08

Analyst: Ragland

Table 2 (Cont'd.)

MARIVELES

SiO_2	57.93	54.94	56.46	58.65	57.65	56.11
TiO_2	0.71	0.63	0.55	0.54	0.61	0.40
Al_2O_3	17.26	17.98	18.01	18.23	17.05	16.80
Fe_2O_3	8.62	7.25	8.83	8.08	8.31	6.69
MgO	4.13	2.05	3.53	3.29	5.58	3.18
CaO	8.10	12.13	8.08	7.73	7.61	8.28
Na_2O	3.39	2.97	3.13	3.38	3.12	2.88
K_2O	1.01	0.99	1.15	1.12	1.37	0.95
TOTALS	101.15	98.94	99.74	101.02	101.30	95.29
AGE IN M.Y.	.97 + .08	.88 + .08	.41 + .08	.19 + .04	3.34 + .1	2.8

Analyst: Ragland

Table 2 (Cont'd.)

	ARAYAT	DUMALI IN MINDORO
SiO_2	51.09	56.58
TiO_2	1.03	0.58
Al_2O_3	17.11	18.68
Fe_2O_3	11.08	7.45
MgO	5.81	2.66
CaO	10.34	7.69
Na_2O	3.13	3.97
K_2O	1.31	1.92
TOTALS	100.90	99.53
AGE IN M.Y.	.53 + .05	.82 + .07

Analyst: Ragland

Table 2 (Cont'd.)

	TAAL	TAAL
SiO_2	51.39	
FeO	7.27	51.14
Fe_2O_3	2.4	
Al_2O_3	15.28	11.57
TiO_2	.81	15.17
P_2O_5	.11	.78
CaO	11.65	
MgO	7.35	11.01
MnO	.10	6.97
Na_2O	2.56	
K_2O	.87	2.19
H_2O + 110°C	.60	.82
H_2O — 110°C	.01	
TOTAL	100.46	99.65

Analyst: Hirano

Analyst: Regland (1977)

TABLE 1. LIST OF VOLCANOES WITH KNOWN NAMES
WESTERN VOLCANIC BELT

Name	*Location* *Latitude*	*Longitude*	*Present Activity*
Mt. Iraya	20°27′N	120°01′E	Inactive
Smith Volcano	19°32.2′N	121°54′E	Active
Babuyan Claro	19°30′N	121°57′E	Active
Didicas Volcano	19°05′N	122°10′E	Active
Camiguin de Babuyanes	18°55′N	121°52′E	Active
Cagua Volcano	18°13′N	122°08′E	Inactive
Mt. Santo Tomas	16°20′N	121°33′E	Solfataric
Mt. Arayat	15°15.13′N	120°44.15′E	Inactive
Mt. Balungao	15°51.45′N	120°40.30′E	Inactive
Mt. Cuyapo	15°48.00′N	120°39.19′E	Inactive
Mt. Bangcay	15°46.45′N	120°43.30′E	Inactive
Mt. Pinatubo	15°08.00′N	120°20.43′E	Solfataric
Mt. Natib Complex	14°42.37′N	120°24.15′E	Inactive
Mt. Mariveles Complex	14°31.35′N	120°28.33′E	Inactive
Mt. Batulao	14°02.52′N	120°48.03′E	Inactive
Mt. Carilao	14°17.00′N	120°45.53′E	Inactive
Mt. Palaypay	14°12.53′N	120°39.54′E	Inactive
Mt. Makiling	14°08′N	121°11′E	Solfataric
Mt. Banahao-Cristobal Complex	14°04′N	121°29′E	Solfataric
Taal Volcano	14°04′N	120°56.6′E	Active
San Audre	13°34′	121.5	Inactive
Dumali	13°7	121.3	Inactive

EASTERN VOLCANIC BELT

Name	*Location* *Latitude*	*Longitude*	*Present Activity*
Mayon Volcano	13°15.4′N	123°41′E	Active
Mt. Malinao	13°25.3′N	125°35.8′E	Solfataric
Bulusan Volcano	12°46.2′N	124°03′E	Active
Biliran Volcano	11°46.2′N	124°32.1′E	Solfataric
Mt. Mahagnao	10°57′N	124°52′E	Solfataric
Labo	14°2′	122°48	Inactive
Isarog	13°39′	123°22	Inactive
Iriga	13°27′	123°24	Inactive
Parker	6°6′	124°54	Inactive
Matutum	6°22	125°5	Inactive
Cabalian Volcano	10°17.2′N	125°13′E	Solfataric
Camiguin-Hibok Hibok	09°12.2′N	124°40.4′E	Active
Ragang Volcano	07°43′N	124°32′E	Active
Macaturin Volcano	07°38.8	124°19′E	Solfataric
Calayo Volcano	07°49.8′N	124°40.8′E	Solfataric
Mt. Apo	06°59.2′N	125°16.4′E	Solfataric
NEGROS VOLCANIC BELT			
Canlaon Volcano	10°24.7′N	123°07.9′E	Active
Mandalagan	10°39′N	123°13.0′E	Solfataric
Cuernos de Negros	09°15.5′N	123°11.1′E	Solfataric
SULU VOLCANIC BELT			
Bud Dajo	05°59′N	121°13′E	Solfataric

TABLE 2. CHEMICAL COMPOSITION

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TOTALS	AGE IN M. Y.
MT NATIB	55.73	.61	16.62	6.00	3.64	8.27	2.75	.83	94.45	.91 + .07
MT. NATIB	59.50	.63	17.67	6.28	2.88	5.36	3.62	.80	96.74	.98 + .06
MT. NATIB	53.70	.57	15.14	6.06	3.35	8.37	2.25	.77	90.21	.96 + .07
MT. NATIB	50.15	1.01	17.91	10.07	5.12	10.57	2.81	1.03	98.67	1.76 + .11
MT. NATIB	56.24	.74	19.82	6.87	2.15	8.23	3.63	1.29	98.97	1.98 + .11
MT. NATIB	56.84	.72	19.96	7.15	2.23	8.24	3.56	1.28	99.98	2.14 + .08
MT. NATIB	57.53	.57	18.05	7.02	2.50	7.67	3.85	1.51	98.70	.92 + .05
MT. NATIB	56.85	.57	17.64	6.45	3.19	6.52	3.24	1.64	96.10	1.42 + .08
MT. NATIB	67.87	.49	16.59	4.51	2.54	5.03	4.49	1.49	98.01	.65 + .05
MT. NATIB	57.67	.62	17.91	7.39	3.17	8.06	3.65	1.15	100.22	1.24 + .09
MT. NATIB	57.71	.58	18.32	7.52	3.77	6.86	3.39	.87	99.01	1.16 + .09
MT. NATIB	57.79	.57	17.95	7.44	3.66	6.96	3.33	.81	98.51	1.70 + .30
MT. NATIB	55.79	.71	18.00	8.01	3.89	7.63	3.25	.87	97.57	1.10 + .07
MT. NATIB	57.70	.63	17.91	7.40	3.66	6.93	3.26	.78	98.27	1.13 + .05
MT. NATIB	56.75	.53	18.19	8.07	3.33	7.81	3.51	.57	98.76	.68 + .06
MT. NATIB	58.73	.55	17.57	5.80	3.59	7.67	3.57	1.62	99.10	.54 + .08
MT. NATIB	58.90	.54	17.50	5.47	2.71	7.06	3.78	1.62	97.58	1.60 + .08
MT. NATIB	60.53	.60	18.18	4.88	2.84	7.26	3.83	1.69	99.81	.98 + .01
MT. NATIB	64.30	.48	17.52	4.82	.95	4.72	3.70	1.23	97.72	2.26 + .11
MT. NATIB	65.08	.47	17.18	4.29	.95	5.25	3.95	1.30	99.10	2.16 + .10
MT. NATIB	60.32	.60	17.74	6.10	3.65	7.19	3.68	1.45	100.64	.58 + .06
MT. NATIB	55.64	.67	18.62	7.79	3.27	8.29	3.52	.92	98.72	2.06 + .20
MT. NATIB	47.92	.87	18.63	12.16	5.07	10.09	1.99	.22	97.95	2.10 + .40
MT. NATIB	53.76	.95	17.88	9.26	4.85	9.35	3.16	.98	100.19	2.17 + .35
MT. NATIB	53.41	.87	17.88	9.51	5.19	9.52	3.05	.95	100.38	2.06 + .15
MT. NATIB	57.61	.70	17.93	8.09	3.99	7.55	3.90	.81	100.58	.93 + .05
MT. NATIB	58.00	.69	17.18	8.24	3.96	7.09	3.69	.83	99.68	.76 + .06
MT. NATIB	57.87	.64	17.92	7.56	3.93	7.51	3.54	.91	99.88	.92 + .10
MT. NATIB	51.66	.71	17.50	8.24	3.96	7.39	3.98	.80	100.27	.94 + .05
MT. NATIB	57.78	.70	17.52	7.67	3.35	6.91	3.78	.80	98.51	.88 + .09

Table 2 (Cont'd.) CHEMICAL COMPOSITION

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TOTALS	AGE IN M. Y.
PINATUBO	61.26	.56	17.04	5.95	2.61	5.66	4.11	1.90	99.09	1.10 + .09
ATIMBIA	57.49	.97	16.20	8.97	1.75	5.53	3.45	2.67	97.03	1.05 + .05
CUYAPO	59.22	.47	18.18	5.21	2.33	5.59	4.77	1.63	97.40	1.59 + .29
AMORONG	51.67	1.10	17.89	9.41	5.03	7.34	3.63	1.60	97.67	1.14 + .08
MARIVELES	57.93	.71	17.26	8.62	4.13	8.10	3.39	1.01	101.15	.97 + .08
MARIVELES	54.94	.63	17.98	7.25	2.05	12.13	2.97	.99	98.94	.88 + .08
MARIVELES	56.46	.55	18.01	8.83	3.53	8.08	3.13	1.15	99.74	.41 + .08
MARIVELES	58.65	.54	18.23	8.08	3.29	7.73	3.38	1.12	101.02	.19 + .04
MARIVELES	57.65	.61	17.05	8.31	5.58	7.61	3.12	1.37	101.30	3.34 + .10
MARIVELES	56.11	.40	16.80	6.69	3.18	8.28	2.88	.95	95.29	
MARIVELES	58.63	.67	18.09	8.13	3.42	7.32	3.43	1.15	100.84	3.44 + .24
MARIVELES	50.03	.69	18.97	10.40	4.84	9.98	2.70	.96	98.57	1.10 + .10
MARIVELES	57.23	.60	17.83	8.68	3.81	8.18	3.02	1.22	100.57	3.90 +
MARIVELES	56.30	.64	18.45	8.70	3.81	8.66	2.85	1.28	100.69	4.10 + .30
MARIVELES	55.80	.73	17.39	8.89	3.91	8.35	3.13	1.03	99.23	3.26 + .04
MARIVELES	57.19	.54	17.98	8.53	4.00	7.58	3.31	1.69	100.92	1.08 + .08
ORION	51.30	.79	17.92	11.06	5.95	11.06	2.36	.61	101.05	1.05 + .09
LIMAY	48.28	.73	18.42	11.52	6.05	11.32	2.16	.63	99.11	.95 + .09
SAMAT	50.53	.84	18.56	11.20	5.16	9.69	2.91	.90	99.79	
STA. RITA	62.52	.28	17.26	4.47	2.39	5.10	4.29	1.03	97.34	1.22 + .20
ARAYAT	51.09	1.03	17.11	11.08	5.81	10.34	3.13	1.31	100.90	.53 + .05
DUMALI IN MINDORO	56.58	.58	18.68	7.45	2.66	7.69	3.97	1.92	99.53	.82 + .07
CARILAO	55.17	.76	16.95	9.59	4.55	8.23	2.81	1.09	99.15	1.34 + .12
BATULAO	56.83	1.03	17.72	8.88	3.80	8.13	2.40	1.71	100.50	3.40 + .20
PALAY-PALAY	56.67	.53	17.28	7.75	2.67	6.41	2.79	1.13	95.23	2.91 + .17
PALAY-PALAY	57.45	.61	17.36	7.73	2.71	2.71	3.15	1.43	97.83	2.92 + .16
SEMBRANO	59.94	1.06	16.71	7.59	2.04	5.33	3.86	3.45	99.98	1.70 + .07
SEMBRANO	59.13	1.05	16.69	8.41	1.38	4.57	3.94	3.16	98.33	.10 + .06
CRISTOBAL	51.06	.93	10.50	9.60	5.81	9.74	3.19	1.06	99.89	1.31 + .21
MALEPUNYO	60.17	.63	16.72	7.07	2.33	6.27	3.67	2.62	99.48	.63 + .04
MAKILING	56.83	.80	17.98	7.26	3.64	7.15	3.51	2.54	99.77	
MAKILING	66.40	.49	15.69	3.97	.92	3.35	4.51	2.79	98.62	.18 + .02
MAKILING	61.37	.62	16.41	6.46	2.03	5.05	4.03	3.99	98.76	.51 + .04
TAAL	51.14	.78	15.17	11.57	6.97	11.01	2.19	.82	99.65	

Analyst: P. Ragland

Table 2 (Cont'd.) CHEMICAL COMPOSITION

	SiO_2	FeO	Fe_2O_3	Al_2O_3	TiO_2	P_2O_5	CaO	MgO	MnO	Na_2O	K_2O	H_2O + 110°C	H_2O — 110°C	TOTAL
DIDICAS	57.18	3.86	4.02	17.11	.66	.48	8.00	2.11	.60	4.31	1.12	.20	.30	99.95
DIDICAS	59.76	2.03	3.78	18.12	.22	.22	8.40	2.72	.42	2.21	.80	.50	.16	99.36
ARAYAT	47.90	5.99	21.98		.48	.70	9.04	1.59	.64	3.63	1.23	1.20	.70	100.16
ARAYAT	51.32	4.38	20.13		.40	.72	9.85	1.90	.60	4.30	1.25	.32	.20	99.97
ARAYAT	49.80	3.27	21.30		.56	.46	8.85	1.37	.66	4.42	1.57			
ARAYAT	49.70	6.17	19.99		.72	.64	9.06	1.19	.60	3.19	1.31	.90	.40	100.98
MAKILING	63.00	2.56	3.15	14.90	.15	.82	3.50	.72	.42	5.73	2.32	1.50	.10	98.87
MAKILING	47.50	4.98	5.42	20.40	.66	.98	12.68	1.74	.44	2.76	.91	1.14	.40	99.91
BULUSAN	58.36	3.47	2.90	20.81			7.05	1.05		2.76	1.02			99.69
BULUSAN	58.10	3.71	1.36	19.60	.35	.40	7.15	1.75	.14	4.68	1.80	.42	.10	99.56
BULUSAN	62.56	1.79	1.31	16.53	.30	.52	6.07	.87	.40	5.14	2.22	.90	.80	99.15
HIBOK-HIBOK	55.90	2.04	3.47	20.95	.48	.42	7.47	1.05	.36	5.12	2.24	.30	.10	99.90
HIBOK-HIBOK	55.70	4.61	3.53	17.16	.62	.46	9.10	1.83	.52	4.14	1.63	.44	.22	99.96
HIBOK-HIBOK	57.80	3.98	3.63	14.01	.61	.62	8.30	3.62	.44	4.15	1.97	1.04	.10	100.27
HIBOK-HIBOK	57.78	3.21	4.92	18.05	.71	.65	6.85	.83	.46	5.37	1.03	.10	.06	100.02
HIBOK-HIBOK	55.87	4.21	3.92	18.55	.58	.72	6.51	1.83	.54	4.37	1.09	.90	.46	100.55
HIBOK-HIBOK	54.98	3.99	3.96	19.59	.80	.77	7.05	1.94	.48	3.98	1.02	1.28	.12	98.94
MAKILING	65.82		7.26	17.98	.80		7.15	3.64		3.51	2.54			99.77
										Analyst:	B. Quinones			
TAAL	51.39	7.27	2.40	15.28	.81	.11	11.65	7.35	.10	2.56	.87	.60	.01	100.46
										Analyst:	Hirano			
MAYON	54.90	.64	19.04	7.47		.15	4.05	8.62		3.40	1.13	.26	.04	99.70
MAYON	54.19	.70	19.28	7.75		.17	4.28	8.63		3.36	1.08	.38	.30	100.12
MAYON	53.15	.56	19.45	7.55		.16	4.78	9.79		3.28	.91	.32	.15	100.10
MAYON	54.7	.81	20.25	8.14		.14	3.68	6.32		3.51	1.08	.00	.00	98.63
MAYON	53.32	.69	19.05	8.18		.16	3.84	9.27		3.81	1.03	.00	.00	99.35
MAYON	54.71	.66	19.16	7.74		.17	3.79	8.67		3.55	1.16	.39	.77	100.77
MAYON	54.32	.61	19.52	7.70		.17	3.82	8.66		3.52	1.16	.36	.45	100.33
										Analyst:	C. Hewhall			

Table 2 (Cont'd.)

DIDICAS		
SiO_2	57.18	59.76
FeO	3.86	2.03
Fe_2O_3	4.02	3.78
Al_2O_3	17.11	18.12
TiO_2	.66	.22
P_2O_5	.48	.22
CaO	8.00	8.4
MgO	2.11	2.72
MnO	.60	.42
Na_2O	4.31	2.21
K_2O	1.12	.80
H_2O + 110°C	.2	.50
H_2O — 110°C	.3	.16
TOTAL	99.95	99.36

Analyst: B. Quinones

Table 2 (Cont'd.)

	PINATUBO	ATIMBIA	CUYAPO	AMORONG
SiO_2	61.26	57.49	59.22	51.67
TiO_2	0.56	0.97	0.47	1.10
Al_2O_3	17.04	16.20	18.18	17.89
Fe_2O_3	5.95	8.97	5.21	9.41
MgO	2.61	1.75	2.33	5.03
CaO	5.66	5.53	5.59	7.34
Na_2O	4.11	3.45	4.77	3.63
K_2O	1.90	2.67	1.63	1.60
TOTALS	99.09	97.03	97.40	97.67
AGE IN M.Y.	1.1 + .09	1.05 + .05	1.59 + .29	1.14 + .08

Analyst: Ragland

Table 2 (Cont'd.)

ARAYAT				
SiO_2	47.9	51.32	49.8	49.7
FeO	5.99	4.38	3.27	6.17
Fe_2O_3	21.98	20.13	21.30	19.99
TiO_2	.48	.4	.56	.72
P_2O_5	.70	.72	.46	.64
CaO	9.04	9.85	8.85	9.06
MgO	1.59	1.9	1.37	1.19
MnO	.64	.60	.66	.6
Na_2O	3.63	4.3	4.42	3.19
K_2O	1.23	1.25	1.57	1.31

H_2O + 110°C	1.2	.32	.9
H_2O — 110°C	.7	.20	.4
TOTAL	100.16	99.97	100.98

Analyst: B. Quinones

Table 2 (Cont'd.)

MT. NATIB

SiO_2	53.41	57.61	58.00	57.87	51.66	57.78
TiO_2	0.87	0.70	0.69	0.64	0.71	0.70
Al_2O_3	17.88	17.93	17.18	17.92	17.50	17.52
Fe_2O_3	9.51	8.09	8.24	7.56	8.24	7.67
MgO	5.19	3.99	3.96	3.93	3.96	3.35
CaO	9.52	7.55	7.09	7.51	7.39	6.91
Na_2O	3.05	3.90	3.69	3.54	3.98	3.78
K_2O	0.95	0.81	0.83	0.91	0.80	0.80
TOTALS	100.38	100.58	99.68	99.88	100.27	98.51
AGE IN M.Y.	2.06 + .15	.93 + .05	.76 + .06	.92 + .1	.94 + .05	.88 + .09

Analyst: Ragland

Table 2 (Cont'd.)

MT. NATIB

SiO_2	64.30	65.08	60.32	55.64	47.92	53.76
TiO_2	0.48	0.47	0.60	0.67	0.87	0.95
Al_2O_3	17.52	17.18	17.74	18.62	18.63	17.88
Fe_2O_3	4.82	4.29	6.10	7.79	12.16	9.26
MgO	0.95	0.95	3.65	3.27	5.07	4.85
CaO	4.72	5.25	7.19	8.29	10.09	9.35
Na_2O	3.70	3.95	3.63	3.52	1.99	3.16
K_2O	1.23	1.30	1.45	0.92	0.22	0.98
TOTALS	97.72	99.10	100.64	98.72	97.95	100.19
AGE IN M.Y.	2.26+.11	2.16+0.1	.53+0.06	2.06+.2	2.1+.4	2.17+.35

Analyst: Ragland

Table 2 (Cont'd.)

MT. NATIB

SiO_2	55.79	57.70	56.75	58.73	58.90	60.53
TiO_2	0.71	0.63	0.53	0.55	0.54	0.60
Al_2O_3	18.00	17.91	18.19	17.57	17.50	18.18
Fe_2O_3	8.01	7.40	8.07	5.80	5.47	4.88
MgO	3.89	3.66	3.33	3.59	2.71	2.84
CaO	7.63	6.93	7.81	7.67	7.06	7.26
Na_2O	3.25	3.26	3.51	3.57	3.78	3.83
K_2O	0.87	0.78	0.57	1.62	1.62	1.69
TOTALS	97.57	98.27	98.76	99.10	97.58	99.81
AGE IN M.Y.	1.1+.07	1.13+.05	.68+.06	.54+.08	1.6+.08	.98+.01

Analyst: Ragland

Table 2 (Cont'd.)

MT. NATIB

$Si0_2$	57.53	56.85	67.87	57.67	57.71	57.79
$Ti0_2$	0.57	0.57	0.49	0.62	0.58	0.57
Al_20_3	18.05	17.64	16.59	17.91	18.32	17.95
Fe_20_3	7.02	6.45	4.51	7.39	7.52	7.44
Mg0	2.50	3.19	2.54	3.17	3.77	3.66
Ca0	7.67	6.52	5.03	8.06	6.86	6.96
Na_20	3.85	3.24	4.49	3.65	3.39	3.33
K_20	1.51	1.64	1.49	1.15	0.87	0.81
TOTALS	98.70	96.10	98.01	100.22	99.01	98.51
AGE IN M.Y.	.92+.05	1.42+.08	0.65+.05	2.24+0.09	1.16+0.09	1.7+0.3

Analyst: Ragland

Table 2 (Cont'd.)

MT. NATIB

$Si0_2$	55.73	59.50	53.70	50.15	56.24	56.84
$Ti0_2$	0.61	0.63	0.57	1.01	0.74	0.72
Al_20_3	16.62	17.67	15.14	17.91	19.82	19.96
Fe_20_3	6.00	6.28	6.06	10.07	6.87	7.15
Mg0	3.64	2.88	3.35	5.12	2.15	2.23
Ca0	8.27	5.36	8.37	10.57	8.23	8.24
Na_20	2.75	3.62	2.25	2.81	3.63	3.56
K_20	0.83	0.80	0.77	1.03	1.29	1.28
TOTALS	94.45	96.74	90.21	98.67	98.97	99.98
AGE IN M.Y.	.91+.07	.96+.06	.96+0.07	1.76+.1	1.98+.11	2.14+.08

Analyst: Ragland

Table 2 (Cont'd.)

MARIVELES

$Si0_2$	58.63	50.03	57.23	56.30	55.80	57.19
$Ti0_2$	0.67	0.69	0.60	0.64	0.73	0.54
Al_20_3	18.09	18.97	17.83	18.45	17.39	17.98
Fe_20_3	8.13	10.40	8.68	8.70	8.89	8.53
Mg0	3.42	4.84	3.81	3.81	3.91	4.00
Ca0	7.32	9.98	8.18	8.66	8.35	7.58
Na_20	3.43	2.70	3.02	2.85	3.13	3.31
K_20	1.15	0.96	1.22	1.28	1.03	1.69
TOTALS	100.84	98.57	100.57	100.69	99.23	100.92
AGE IN M.Y.	3.44 + .24	1.1 + .1	3.9	4.1 + .3	3.26 + .04	1.08 + .08

Analyst: Ragland

Table 2 (Cont'd.)

	MARIVELES					
SiO_2	57.93	54.94	56.46	58.65	57.65	56.11
TiO_2	0.71	0.63	0.55	0.54	0.61	0.40
Al_2O_3	17.26	17.98	18.01	18.23	17.05	16.80
Fe_2O_3	8.62	7.25	8.83	8.08	8.31	6.69
MgO	4.13	2.05	3.53	3.29	5.58	3.18
CaO	8.10	12.13	8.08	7.73	7.61	8.28
Na_2O	3.39	2.97	3.13	3.38	3.12	2.88
K_2O	1.01	0.99	1.15	1.12	1.37	0.95
TOTALS	101.15	98.94	99.74	101.02	101.30	95.29
AGE IN M.Y.	.97 + .08	.88 + .08	.41 + .08	.19 + .04	3.34 + .1	2.8

Analyst: Ragland

Table 2 (Cont'd.)

	ARAYAT	DUMALI IN MINDORO
SiO_2	51.09	56.58
TiO_2	1.03	0.58
Al_2O_3	17.11	18.68
Fe_2O_3	11.08	7.45
MgO	5.81	2.66
CaO	10.34	7.69
Na_2O	3.13	3.97
K_2O	1.31	1.92
TOTALS	100.90	99.53
AGE IN M.Y.	.53 + .05	.82 + .07

Analyst: Ragland

Table 2 (Cont'd.)

	TAAL	TAAL
SiO_2	51.39	51.14
FeO	7.27	
Fe_2O_3	2.4	11.57
Al_2O_3	15.28	15.17
TiO_2	.81	.78
P_2O_5	.11	
CaO	11.65	11.01
MgO	7.35	6.97
MnO	.10	
Na_2O	2.56	2.19
K_2O	.87	.82
$H_2O + 110°C$	.60	
$H_2O - 110°C$	.01	
TOTAL	100.46	99.65
	Analyst: Hirano	Analyst: Regland (1977)

Table 2 (Cont'd.)

	MAKILING	
SiO_2	63.00	47.50
FeO	2.56	4.98
Fe_2O_3	3.15	5.42
Al_2O_3	14.90	20.40
TiO_2	.15	.66
P_2O_5	.82	.98
CaO	3.50	12.68
MgO	.72	1.74
MnO	.42	.44
Na_2O	5.73	2.76
K_2O	2.32	.91
H_2O + 110°C	1.50	1.14
H_2O — 110°C	.10	.40
TOTAL	98.87	99.91

Analyst: B. Quinones

Table 2 (Cont'd.)

	ORION	LIMAY	SAMAT	STA. RITA
SiO_2	51.30	48.28	50.53	62.52
TiO_2	0.79	0.73	0.84	0.28
Al_2O_3	17.92	18.42	18.56	17.26
Fe_2O_3	11.06	11.52	11.20	4.47
MgO	5.95	6.05	5.16	2.39
CaO	11.06	11.32	9.69	5.10
Na_2O	2.36	2.16	2.91	4.29
K_2O	0.61	0.63	0.90	1.03
TOTALS	101.05	99.11	99.79	97.34
AGE IN M.Y.	1.05 + .09	.95 + .09	0.9	1.22 + 0.20

Analyst: Ragland

Table 2 (Cont'd.)

	Carilao	Batulao	Palay Palay	Palay Palay	Palay-Palay
SiO_2	55.17	56.83	56.52	56.67	57.45
TiO_2	0.76	1.03	0.63	0.53	0.61
Al_2O_3	16.95	17.72	17.41	17.28	17.36
Fe_2O_3	9.59	8.88	8.05	7.75	7.73
MgO	4.55	3.80	3.36	2.67	2.71
CaO	8.23	8.13	7.84	6.41	2.71
Na_2O	2.81	2.40	3.10	2.79	3.15
K_2O	1.09	1.71	1.28	1.13	1.43
TOTALS	99.15	100.50	98.19	95.23	97.83
AGE IN M.Y.	1.34 + 0.12	3.4 + .2	2.95 + .12	2.91 + .17	2.92 + .16

Analyst: Ragland

Table 2 (Cont'd.)

	Sembrano	Sembrano	Cristobal	Malepunyo
SiO_2	59.94	59.13	51.06	60.17
TiO_2	1.06	1.05	0.93	0.63
Al_2O_3	16.71	16.69	10.50	16.72
Fe_2O_3	7.59	8.41	9.60	7.07
MgO	2.04	1.38	5.81	2.33
CaO	5.33	4.57	9.74	6.27
Na_2O	3.86	3.94	3.19	3.67
K_2O	3.45	3.16	1.06	2.62
TOTALS	99.98	98.33	99.89	99.48
AGE IN M.Y.	1.7 + .07	.1 + .06	1.31 + .21	.63 + .04

Analyst: Ragland

Table 2 (Cont'd.)

	BULUSAN	BULUSAN	CANLAON
SiO_2	58.36	58.10	62.56
FϵO	3.47	3.71	1.79
Fe_2O_3	2.90	1.36	1.31
Al_2O_3	20.81	19.60	16.53
TiO_2		0.35	0.30
P_2O_5		0.40	0.52
CaO	7.05	7.15	6.07
MgO	1.52	1.75	0.87
MnO		0.14	0.40
Na_2O	2.76	4.68	5.14
K_2O	1.02	1.80	2.22
H_2O + 110°C		0.42	0.90
H_2O — 110°C		0.10	0.8
LOI	1.8		
TOTAL	99.69	99.56	99.15

Table 2 (Cont'd.)

HIBOK-HIBOK

SiO_2	55.9	55.70	57.80	57.78	55.87	54.98
FeO	2.04	4 61	3.98	3.21	4.21	3.99
Fe_2O_3	3.47	3.53	3.63	4.92	3.92	3.96
Al_2O_3	20.95	17.16	14.01	18.05	18.55	19.59
TiO_2	.48	.62	.61	.71	.58	.8
P_2O_5	.42	.46	.62	.65	.72	.77

CaO	7.47	9.10	8.30	6.85	6.51	7.05
MgO	1.05	1.83	3.62	0.83	1.83	1.94
MnO	.36	.52	.44	.46	.54	.48
Na_2O	5.12	4.14	4.15	5.37	4.37	3.98
K_2O	2.24	1.63	1.97	1.03	1.09	1.02
H_2O + 110°C	.3	.44	1.04	.10	.9	1.28
H_2O — 110°C	.1	.22	.10	.06	.46	.12
TOTAL	99.9	99.96	100.27	100.02	100.55	98.94

Analyst: B. Quinones (unpublished)

Table 2 (Cont'd.)

MAYON

SiO_2	54.9	54.19	53.15	54.7	53.32	54.71	54.32
TiO_2	0.64	0.70	0.56	0.81	0.69	0.66	0.61
Al_2O_3	19.04	19.28	19.45	20.25	19.05	19.16	19.52
FeO	7.47	7.75	7.55	8.14	8.18	7.74	7.7
MnO	0.15	0.17	0.16	0.14	0.16	0.17	0.17
MgO	4.05	4.28	4.78	3.68	3.84	3.79	3.82
CaO	8.62	8.63	9.79	6.32	9.27	8.67	8.66
Na_2O	3.4	3.36	3.28	3.51	3.81	3.55	3.52
K_2O	1.13	1.08	0.91	1.08	1.03	1.16	1.16
P_2O_5	0.26	0.38	0.32	0.0	0.0	0.39	0.36
H_2O	0.04	0.30	0.15	0.0	0.0	0.77	0.45
TOTAL	99.70	100.12	100.10	98.63	99.35	100.77	100.33

Analyst: C. Newhall (1970)

Table 2 (Cont'd.)

	MAKILING	MAKILING	MAKILING
SiO_2	56.83	66.40	61.37
TiO_2	0.80	0.49	0.62
Al_2O_3	17.98	15.69	16.41
Fe_2O_3	7.26	3.97	6.46
MgO	3.64	0.92	2.08
CaO	7.15	3.35	5.05
Na_2O	3.51	4.51	4.03
K_2O	2.54	2.79	3.99
TOTAL	99.77	98.62	98.76
		.18 + .02	.51 + .04
		Analyst: Quinones	Analyst: Ragland

MANGO AND ITS RELATIVES IN THE PHILIPPINES

by

NESTOR D. BONDAD[1]

BOTANICAL POSITION

Mango is a dicot botanically designated as **Mangifera indica** L. It belongs to the family Anacardiaceae which has two other fruit crop members grown in the Philippines: **Anacardium occidentale** L. (cashew) and **Spondias purpurea** L. (Spanish plum or "sinigwelas"). Recent estimates of the number of species of **Mangifera** vary from 41 (Mukherji, 1949) to 62 (Purseglove, 1968). All fruits of commerce referred to as mango are produced by the single species **M. indica** although the following also yield edible fruits (Purseglove, 1968; Singh, 1960; Singh, 1974):

- **M. duperreana** Pierre
- **M. pentandra** Hook. f.
- **M. cochinchinensis** Engl.
- **M. longipes** Griff.
- **M. caloneura** Kurz
- **M. siamensis** Warbg. ex Craib
- **M. oblongifolia** Hook. f.
- **M. zeylanica** Hook. f.
- **M. similis** Blume
- **M. altissima** Blanco
- **M. lagenifera** Griff.
- **M. foetida** Lour.
- **M. odorata** Griff.
- **M. caesia** Jack
- **M. superba** Hook. f.

BOTANICAL DESCRIPTIONS

Mango has been described in many publications (see e.g. Chandler, 1958; Popenoe, 1920; Ochse, et al., 1961; Purseglove, 1968; Singh, 1960) but the work of Mukherji (1949), who made a critical survey of the species, is adopted here:

> A spreading **tree** 20 to 45 m high; all parts glabrous except inflorescence. **Leaves** thinly coriaceous or membranaceous, variable in size and shape; oblong-lanceolate to oblong, acute or acuminate rarely subacute, margins undulate or straight, base cuneate rarely subcuneate; shining above; lamina 15 to 30 x 3.5 to 6.5 cm; petiole 1.5 to 6 cm long, much longer in wild types than in the cultivated varieties. **Panicle** terminal, polygamous, densely flowered; minutely

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tomentose, pubescent or glabrescent; variable in length (generally 20 to 35 cm), branches variable (6 to 15 cm), spreading, pyramidal; bracteoles lanceolate, acute. **Flowers** yellowish or cream colored, variable in size; pedicel articulated, 1.5 to 3 mm long. **Sepals** 5, ovate-lanceolate, concave, pubescent outside, variable in size (1.5 to 3 x 1.5 to 2 mm). **Petals** 5, reflexed above the calyx, oblong to oblong-lanceolate, subacute; ridges not ending into tuberculate excrescences, variable in color and pattern; size variable (generally 3 to 5 x 1.5 to 2 mm). **Disc** fleshy, 5-lobed; lobes distinct in male. **Stamens** 5; 1, rarely 2 or more fertile, the rest reduced to short filaments with sterile knoblike anthers. **Ovary** glabrous, obliquely ovoid; style subterminal almost as long as the fertile stamen. **Drupe** large, oblong or subreniform; flesh thick with sweet juice; very variable in size, shape and coloration of the epicarp in the different cultivars; stone fibrous, very hard, the fibres are very long in the wild types and inferior in cultivated types; cotyledons two, rarely many, unequal.

HORTICULTURAL DESCRIPTIONS

The preceding descriptions are taxonomic and therefore rely heavily on reproductive characters. A brief summary of the other features of the crop follows.

The Tree. — Mango grown from seed is an erect evergreen tree with somewhat upright branches. Except for few cultivated types like 'Julie', robust growth is characteristic of the species. A mango tree frequently shows an impressive growth and stands bolder than nearby plants. Mango is the largest of fruit crops, reaching a height of up to 45 m and spreading to 35 m when grown alone. Very large seedling trees have been reported. Popenoe (1920) observed a tree in Brazil which has a spread of 18 m and trunk 7.6 m in circumference. This is considered large by comparison with existing trees in the area. But it is dwarf by measurements of mango in India where one, named "Chappar", has a trunk 9.8 m in girth, with branches 1.5 to 3.7 m in circumference and 21.3 to 24.4 m long. The crown covers an area of 2,257 m^2 (Rhandawa, 1949). Another large Indian mango has a trunk 8.5 m in circumference with a spread of 36.6 x 45.8 m (Singh, 1960).

In the Philippines very large trees are not common. Some of the largest (Table 1) have much smaller measurements than Indian mangoes.

Grafted trees are shorter, more spreading, and have lower-lying branches than those grown from seeds. Comparative measurements of grafted and seedling trees under relatively similar growing conditions are in Table 1.

The Root. — Mango has a very long tap root reaching a depth of 6 m (Singh, 1960). The root system also extends laterally to considerable distances, up to 7.6 m. However, feeder roots are at the periphery of the trunk. In 8- and 25-year-old trees in India, the greatest concentration of feeder roots is within 60 cm from the trunk and top 15 cm layer of soil (Bojappa and Singh, 1975). The feeder roots decrease with increasing distance from the tree and ground level. The older trees have

TABLE 1. CANOPY SPREAD, HEIGHT, TRUNK CIRCUMFERENCE, AND HEIGHT OF BRANCHES OF 48 YR OLD GRAFTED AND SEEDLING 'CARABAO' MANGO TREES UNDER SIMILAR CONDITIONS AT WESTERN LUZON AGRICULTURAL COLLEGE, SAN MARCELINO, ZAMBALES

Tree No.	Canopy spread (m)		Tree height[a] (m)	Trunk circumference[b] (m)	Branch height[c] (m)
	East-West	North-South			
			Seedling		
1	19.25	22.80	19.93	3.20	1.72
2	22.24	22.24	21.03	3.27	2.42
3	18.99	17.20	19.51	2.77	1.91
4	24.21	17.96	21.07	2.54	2.10
5	16.70	19.30	19.30	2.26	1.90
Ave.	20.28	19.90	20.17	2.81	2.01
			Grafted		
1	16.50	17.12	14.60	2.90	1.00
2	14.71	14.18	10.61	2.33	1.30
3	11.00	12.67	9.46	1.79	1.00
4	15.13	14.23	9.37	1.98	1.00
5	16.39	17.23	10.47	2.17	1.35
6	11.49	12.74	10.27	1.86	1.70
7	15.17	15.49	11.43	2.15	1.60
8	14.81	17.13	11.37	2.30	1.30
9	14.0	13.18	10.0	2.14	1.70
Ave.	14.66	14.88	10.84	2.18	1.33

[a] From ground level
[b] Taken 1 m from ground level
[c] Average height of main branches from ground level

a greater density of feeder roots close to the trunk in the top 15 cm layer than younger trees. Locally-grown mangoes in Masin, Candelaria, Quezon differ in having feeder roots mostly concentrated 30 cm deep and 1.0 m from the trunk (Mercado, 1981). Bojappa and Singh (1975) gave no description of the soil used and, therefore, could not be compared with the local work which was done in Guadalupe clay loam. The soil surface extends down to 30 cm depth and this layer has cloddy and hard structure when dry, sticky and plastic when wet (Renales, et al., 1973). Technique of placement, sampling, and analysis, amnog others, may play significant roles in the variations of data observed but Mercado (1980) speculated that cultivar, vigor, embryony, and physiology are important factors.

Leaf and shoot. — Mature 'Carabao' mango leaves are dark green, borne by nodes arranged alternately on a stem, widely spaced at the proximal end, and closely arranged at the tip giving the distal portion a crowded appearance. About 10 leaves make up a shoot (Astudillo, 1978). Upon emergence, young shoots, called "flushes", bear all the leaves that reach maturity. Thus the notion that terminal leaves are younger than basal leaves may be unfounded. A survey of flushing in Rizal, Bulacan, Batangas, Laguna, Quezon and Cavite revealed that flushes are yellow-green to green from bud emergence to full expansion (Tolentino, 1979). No red or crimson flushes, characteristics of mango in India (Singh and Gha, 1939) and elsewhere (Taylor, 1970), were observed, although Agati (1937) reported that leaves are purple at emergence, purplish green 3 to 5 days after; light green on the 15th to the 19th day, and dark green 4 months later. We failed to confirm Agati's (1979) claim in 5 years of observations, locations other than Tolentino's (1979) work, and daily examination of flushes from bud emergence (day 0) to estabilization (day 60) of leaf color to dark green.

OTHER CULTIVATED SPECIES

While **M. indica** is the only species of real commercial significance, the following are grown to some extent especially in areas south of the country:

Mangifera caesia ("bauno", "bayuno", "baluno"). A large tree sometimes exceeding 12 m in height with a trunk 50 cm in diameter, growing in inundated regions in several parts of Mindanao, being particularly abundant around Butuan and in many places in the Agusan Valley and Davao, and occurring also in the Sulu Archipelago. The bauno resembles the mango in habit and appearance though it is somewhat more upright in habit, of sparser foliage, more gnarled, and less attractive in appearance than the mango. The leaves are 12 to 18 cm long, elliptical to lanceolate or oblanceolate, coriaceous, smooth, with a prominent midrib. The flowers are small, blue, and appear in terminal panicles like the mango. There is considerable variation in the appearance, size, and quality of the fruit in the numerous trees. The fruit of the best is somewhat larger than a 'Carabao' mango, from 11 to sometimes exceeding 13 cm in length, with an equatorial diameter of 7 to 8 cm, oblong oval to pyriform; stem usually inserted obliquely in a more or less irregular sinus; stigmatic area depressed; surface smooth; color yellowish green; lenticels numerous, small; skin very thin and tender, adhering closely to flesh; flesh white, very juicy, rich sub-acid, quite aromatic, of excellent flavor, partaking somewhat of the flavor of apricot and soursop combined; the single seed is monoembryonic, large, oblong, and encased in matted coarse fibers that penetrate the flesh rather extensively. The tree blooms in July and August and the fruit ripens in August and September (Wester, 1912).

Wester (1912) obtained the largest and best flavored bauno in Zamboanga; very good fruits in Davao and Butuan; and some very poor ones in Butuan and Surigao. The bauno is evidently very variable pomologically and the trees also seem to differ greatly in productiveness.

Wester (1912) concluded that the excellent flavor of the bauno assures this fruit a place among the tropical fruits on a par with the mango, as soon as a facile method of propagating the species asexually shall have been discovered so that material of the best seedlings may be obtained and systematic breeding begun, reducing the fiber in the fruit. None of these has been realized.

Bauno (**M. caesia** Jack var. **verticillata** [C.B. Robinson] Mukherji) in the Philippines has a distinct leaf character and is considered by Mukherji (1949) as a variety of **M. caesia**.

Mangifera odorata ("huani", "juany"). A medium to large tree, growing on the south coast of Mindanao and the Sulu Archipelago, differing but slightly from the mango in habit and foliage. The fruit is of about the size of the average mango, roundish oblique, a trifle flattened; surface smooth; color green with a few large lenticels; skin very thick and tough; flesh yellowish, sweet, juicy, very resinous and very fibrous, odorous rather than aromatic, and to the novice at least, the flavor partakes altogether of too much turpentine to be agreeable; seed large and covered with abundant coarse fiber (Wester, 1912).

Wester (1912) considers the huani as far inferior to the mango, and reluctant to recommend it where the mango will grow. Nevertheless he found it more frequently than the mango on well drained land in Zamboanga, Davao, and in several other points as far as Mati on the east coast of Mindanao.

Mangifera foetida ("bachang") is another relatively important species widely growing elsewhere but is practically unknown in the Philippines.

NATIVE SPECIES

Mangifera altissima is a locally-important species believed to be native to the Philippines. This species has also been reported to occur in the wild in Lesser Sunda Islands, Sulawesi, Mollucas, New Guinea, and British Solomon Islands (Meijer, 1975; Wester, 1920).

There is a confusion about the indentity of **M. altissima**. At an early date, Wester (1912) mentioned the name "paho". Unfortunately, many authors (Agaloos and Nepomuceno, 1977; Brown, 1954; Eusebio, 1977; Popenoe, 1920; Roces, 1977; Salvosa, 1963; Singh, 1960; Tameses and Aguilar, 1951) use "pahutan" as common name for **M. altissima.** These authors are undoubtedly referring to **M. altissima** except Roces (1977) who described it but provided illustrations which are obviously fruits of **M. indica** L. cv. Pahutan (mango).

'Pahutan' is a valid cultivar name of mango described by Wester (1920). Its use follows the rules of the International Code of Nomenclature of Cultivated Plants (International Code) which requires, among others, enclosure within single quotation marks or placing the abbreviation cv. before the cultivar name (Gilmour, et al., 1969). Common names of species are not regulated by the International Code but use of pahutan for **M. altissima** causes much confusion. It has resulted to improper identification of specimens (Roces, 1977) and its continued appearance in publications could lead to further inaccuracies.

When Wester (1916) briefly described and named the species as **M. altissima** he gave priority to paho as common name over several others. The spelling "pajo" was never mentioned in any of Wester's work. Pajo is evidently a Spanish corruption of the native name since the species is considered indigenous to the Philippines (Wester, 1916). In the Spanish language "j" is the equivalent of "h" and the Filipino language has no letter "j".

Fruits which fit the descriptions of paho were apparently mentioned as early as 1609 (Wester, 1920). About 120 years later Blanco (1937) designated the species as **M. altissima.** Villar changed the binomial to

M. longipes (Merrill, 1905) but the latter is a distinct species now recognized commonly as "apali" (Wester, 1920; Singh, 1960). Thus the identity of paho remained obscure and no accurate descriptions were available to Wester in 1912. Paho seldom flowers and Blanco never preserved botanical materials he studied (Mukherji, 1949).

Paho remained practically unknown for nearly 349 years after its first mention in the literature. Only in 1949 was a full description of paho became available with the publication of Mukherji's (1949) monograph of the genus **Mangifera L.** But confusion took over obscurity when many authors used pahutan. Mukherji (1949) himself, probably attempting to avoid inaccuracy, used both pajo and pahutan. His preference for pajo may be owing to the fact that this spelling appeared earlier but as pointed out, it is a Spanish corruption of the native name paho. According to Mukherji (1949) paho (pajo) means wild. This is no longer true. One now finds it under cultivation in some orchards and backyards. We have used grafted and seedling trees of bearing age in various experiments in Lamot, Calauan, Laguna and Masin, Candelaria, Quezon. About 150 grafted trees are grown at Medrano's Farm, Tulay, Ibaan, Batangas. It is not surprising if a cultivar of paho is soon announced. The need to adopt the common name paho would be greater by then.

Arguments should be cleared by Wester's (1916) short reference to paho in an article on Philippine food plants. He mentioned pahutan as a trivial name for **M. altissima** together with several others; but quickly added that there is a cultivar of mango called 'Pahutan' which is quite distinct from paho.

Paho is an acceptable and unambiguous name published at an early date. Ethical standards in scientific writing demands its adoption. It is the common name used in the trading of fruits in many public markets in Batangas, Laguna and Quezon. Paho is also the Filipino word accepted by the National Language Institute and adopted by Panganiban (1973) in his encyclopedic Filipino-English dictionary.

To avoid further confusion, the names paho and 'Pahutan' should be used for plants, their parts and products that fit the accompanying descriptions and data (Table 2, 3) showing their distinct differences (Bondad, et al., 1979; Mukherji, 1949; Tameses and Aguilar, 1951; Villegas, 1979; Wester, 1920). The taxonomic descriptions of paho below may be compared with similar taxonomic account of **M. indica** in the preceding pages. Horticultural descriptions of the species are in Table 3.

Paho (Mangifera altissima. Tree; branches angular when young, leaf-scars prominent; bud-scales prominent; velvety. **Leaves** coriaceous, oblong-lanceolate darker green above, tip obtuse, base subcuneate; midrib very conspicuous at base; lateral nerves about 15 pairs, relatively faint; reticulations obsolete above, quite conspicuous beneath; lamina 20 to 25 x 5 to 6 cm; petiole subterete or compressed, 3 to 5 cm long. **Panicle** terminal as also axillary, sessile; branches 3 to 4, fascicled at base and subtended by a crown of velvety scales, briefly tawny-pubescent, 10 to 25 cm long. **Flowers** white or creamy white, in groups of 4 to 5 on secondary branches; pedicel slender, not exceeding 5 mm; bracts tomentose, sharply acuminate. **Sepals** 4, greenish deeply spoon-shaped, acute, glabrous, imbricate, 1.5 to 2.5 mm long, persistent in fruit. **Petals** 4, free,

TABLE 2. SOME QUANTITATIVE CHARACTERS OF PANICLES AND RIPE FRUITS OF M. ALTISSIMA (PAHO) AND M. INDICA CV. PAHUTAN (MANGO)[a]

Character	Paho[b]	'Pahutan'
Panicle		
length (cm)	21 — 27	18 — 27
width (cm)	15.4 — 19.2	22.2
Fruit		
weight (g)	29.5 — 35.7	66.3 — 84.5
length (cm)	4.8 — 5.6	7.9 — 9.1
width (cm)	3.4 — 4.0	4.3 — 4.7
thickness (cm)	2.7 — 3.3	3.3 — 3.8
ripening (days)[c]	78	90
Flesh		
weight (g)	13.5 — 21.5	42.0 — 56.5
soluble solids (%)	8.5 — 12.5	19.4 — 23.6
titratable acidity (ml 0.1 N Na0H)	4.6 — 5.4	2.6 — 3.0
Seed		
weight (g)	4.4 — 8.4	9.1 — 13.7
length (cm)	4.2 — 4.8	6.4 — 7.5
width (cm)	2.3 — 2.7	2.5 — 2.8
thickness (cm)	0.9 — 1.5	1.4 — 1.5

[a] Data obtained from panicles and fruits produced by KNO_3 spraying
[b] Adopted from Bondad, et al. (1979)
[c] Reckoned from full bloom

TABLE 3. SOME QUALITATIVE CHARACTERS OF M. ALTISSIMA (PAHO) AND M. INDICA CV. PAHUTAN (MANGO)

Character	Paho[a]	'Pahutan'
Bud		
color	whitish green	dark green
shape	taper pointed, slightly curved	plump, curved star-shaped
Panicle		
color	whitish, tinged with green	dark green
shape	broad-based, triangular	tapering
odor	faint	stronger
resistance to pests	very resistant	susceptible
Fruit		
retention	very high	low
resistance to drop	very resistant	susceptible
resistance to pests	very resistant	resistant
stage consumed	immature	ripe
stage harvested	immature	mature
shape	roundish, flat-sided	oblong, thick
apex	rounded	pointed
beak	present	absent
skin color	greenish	orange yellow tinged with green
Flesh		
fiber	absent	very fibrous
flavor	flat	very sweet
adherence to skin	tightly adherent	does not adhere
texture	tender	tender
color	light yellow	pale orange yellow
Foliage color	dark green	lighter green
Tree growth habit	upright	spreading
Branching	oblique, upward	parallel to drooping
Response to KNO_3	difficult to induce	very easy to induce

[a] Adopted in part from Bondad, et al. (1979)

white, ovate-oblong, glabrous 3 to 5 mm long; ridges closely adjacent, with glandular thickenings at apex. **Stamens** 4; 1 fertile, inserted at the base of a thickened 4-lobed disc; rest very much reduced; filament 1.5 mm long, glabrous; anther subelliptic. **Ovary** glabrous, slightly oblique; style subterminal, 2 mm long. **Drupe** smooth, green or somewhat yellow when ripe, ovoid or ellipsoid, slightly compressed, 5.5 to 8 x 4 to 6 cm; exocarp fleshy, rather firm, white; mesocarp not at all stringy; frequently the point of insertion of the style persists in ripened fruit as a small protuberance below the apex (Mukherji, 1949); **Timber**; it is tall, straight and attains a diameter of 90 cm with a clear length of 15 to 20 m. **Sapwood**, rather thick, 10 to 15 cm, light colored and distinctly marked off from the heartwood, which is dark brown or coffee color with alternating dark and light colored bands; comparatively fine; glossy; no taste or smell; hard and heavy, weighing 815 kilograms per cubic meter, air-dry. Can be classed with apitong in strength. The wood seasons well; easy to work, holds nail well and takes a high polish. The sapwood is readily damaged by drywood termites, the heartwood is very durable for interior work. The heartwood of pahutan (sic) is in demand for fine furniture, cabinet work of all kinds and veneers. It can be employed as a substitute for walnut which it resembles closely (Tameses and Aguilar, 1951).

'Pahutan' (**Mangifera indica**). Size small, length up to about 90 mm, breadth 45 mm, weight averaging 90 g, with a maximum of 120 g; form oblong oval, asymmetrical; stem inserted obliquely; base rounded; dorsal shoulder usually short and sloping; ventral shoulder fairly prominent, apex sloping toward beak; this usually an obtuse point, not frequently coincident with apex; nak slightly elevated, well above apex; surface smooth; color orange yellow tinged with green and finely netted with brownish veins, or the fruit matures green; lenticels small, buff yellow, mostly toward apex; skin moderately thick, tough; flesh pale orange yellow, tender, very sweet, rich and aromatic; fiber medium coarse, profuse; seed large, polyembryonic (Wester, 1920).

Other species native to the Philippines but have not been brought to domestication include (Mukherji, 1949):

Mangifera longipes. A **tree** 24 m or more in height. **Leaf** thinly coriaceous or membranaceous, oblong-lanceolate shortly acuminate, margins minutely subundulate, base cuneate, more shining above; lateral nerves 61 to 20 pairs thin, distinct especially below; 15 to 20 x 4 to 6 cm; petiole 1.5 to 4 cm long, slender. **Panicle** terminal, lax, longer than leaves (20 cm); branches slender, glabrous. **Flowers** aggregated in ultimate cymules; pedicel pubescent, 1.5 mm long; bracts linear-subulate. **Sepals** 5, pubescent, ovate, acute, 2 to 2.5 x 1 mm. **Petals** 5, linear-oblong reflexed below tip; ridges 3 to 4 confluent at a broad, yellow base; 4.5 x 1.5 mm. **Stamens** 5; 1 fertile, longer than petals; staminodes 2, shorter, with knoblike anthers. **Disc** fleshy, rugose, 5-lobed. **Ovary** subglobose; style subterminal, thrice the length of ovary. **Drupe** globose or oblique, smaller than common mango (5 to 6 x 4 cm); epicarp and mesocarp thin; stone almost wholly filling up the fruit.

Mangifera merrillii Mukherji. Tree up to 25 m high. **Leaves** subcoriaceous, elliptic-acuminate, 5 to 10 x 2 to 3 cm, subequally narrowed to the acute or somewhat decurrent base; apex acuminate; lateral nerves about 10 pairs, slender, distinct, elevated on both surfaces; reticulations rather distinct; petiole 1.5 to 2.5 cm long. **Panicle** terminal, pubescent, 4 to 9 cm long. **Flowers** white, 4-merous. **Sepals** 4, oblong-ovate to oblong-lanceolate obtuse, glabrous, 2.5 mm long. **Petals** 4, elliptic oblong-elliptic, obtuse, 3.5 mm long; ridges 3, prominent, confluent at broad base, with 2 slender lateral nerves not thickened into distinct ridges. **Disc** 4-lobed, wider than ovary; lobes fleshy, tuberculate. **Stamens** 4; 1 fertile, 3 mm long; staminodes 3, 0.5 mm or less in length. **Ovary** ovoid, inequilateral; style lateral. **Drupe** ellipsoid, 2 cm long when young; seed compressed, apparently smooth.

Mangifera monandra Merrill. **Tree** medium sized entirely glabrous, branches greyish-brown. **Leaves** thinly coriaceous, lanceolate or obovate-lanceolate, acute or very shortly and bluntly acuminate, narrowed to cuneate base; nerves 11 to 13 pairs about 1 cm apart; reticulations fine, distinct beneath nearly obsolete above; 9 to 16 x 2.5 to 6.5 cm; petiole 1 to 4 cm long, rugose. **Panicle** glabrous, terminal as also axillary; sessile with 3 to 4 fascicled branches; laxly flowered; 10 cm long or less, reaching up to 20 cm during fruiting; secondary branches about 3 cm long with 2 short tertiary branches. **Flowers** white, 3.5 mm long; pedicels about 1 mm long. **Sepals** 4, broadly ovate, acute, 2 to 2.5 x 1 to 1.5 mm, hyaline at margins. **Petals** 4, ovate, obtuse; ridges 5 to 7, prominent, confluent at a broad base, not extending up to middle; 3 x 1.5 mm. **Disc** swollen, obscurely lobed; 2 x 1 mm. **Stamen** fertile 1 rarely 2, filament about 1 mm long; staminodes 2 to 3, very minute, teeth-like, or obsolete. **Ovary** globose, glabrous; style subterminal, 1.5 mm long. "**Drupe** ellipsoid, subcompressed, inequilateral; 3.5 x 1.8 x 1.5 cm, the pulp very thin." (Merrill).

Mangifera monandra var. **fasciculata** Mukherji. **Paniculae** dense florigerae, sessiles; rami circiter 12, fasciculati. **Staminodia** 7 to 8, brevissima, dentata; filamenta sinuosa.

Panicle densely flowered, sessile; branches about 12, fascicle. **Staminodes** 7 to 8, very short, teeth-like; filament sinuos.

Economic uses. — The timber, which is locally used, is not of a good quality (Burkill).

Mangifera philippinensis Mukherji. **Tree** 13 m high, 15 cm diam. at breast height. **Leaves** big, thinly coriaceous, elliptic, shortly acuminate, narrowed to the cuneate base; nerves about

12 pairs slightly prominent beneath, spreading, arched at margins; reticulations fine, prominent on both surfaces, especially beneath; lamina 13 to 19 x 7 to 8 cm; petiole stout, thickened at base, 2 to 5.5 cm long. **Panicle** terminal, glabrous; a fascicle of 5 to 6 stout erect branches, 11 to 19 cm long; secondary branches 3 to 4 cm long with more than 3 tertiary branches. **Flowers** 3 on ultimate cymules 4.5 mm long; pedicel 1 mm long. **Sepals** 4, ovate, obtuse, 2 x 1.5 mm. **Petals** 4, elliptic, acute, the tip incurved to form a boat-like structure; ridges 5, 3 at the center prominent, reaching up to the middle, divergent from a broad base; 3.5 x 2 mm. **Disc** swollen cupular, almost covering the ovary, 1.5 mm high, obscurely 4-lobed, lobes shallow, 1 deeper. **Stamens** 4; 1 fertile 2.5 mm long; staminodes 2, minute teeth-like. **Ovary** globose; style lateral, 3 mm long. **Fruit** unknown.

The occurrence of **M. timorensis** Blume in the Philippines (Meijer, 1975) is not supported by previous works (Mukherji, 1949; Wester, 1920) or current unpublished observations. This is probably a typographic error based on the total number of wild and cultivated species at the bottom of the table which Meijer (1975) presented.

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THE CITY OF BAGUIO[1]

The **inibalois** of the Central Cordillera called the original townsite **Kafagway**, is a composite of 21 rancherias of grass and pasture land and extensive pine stands. Moss in their highland dialect is **bagsiw**; **bagyu** is typhoon to the native and the lowland Iloko and Pangasinense.

To the founding Americans, the City of Baguio is that tract of land, forty-nine square kilometers (19 square miles) of combined table-land, valley and steep mountain slope chartered as a city on September 1, 1909. A member of the Philippine Commission of the United States, Dean C. Worcester, originally conceived of the city as a temperate respite from the summer heat and a spa for the military.

At an altitude of 4,921.3 feet above sea level, the city rises up from the Ilocos Coast by some 35 kilometers, two-hundred fifty kilometers north of Manila and 149 kilometers south of the old Mountain Province capital of Bontoc.

Baguio is 18 degrees fahrenheit cooler in any month on the average than any place in the lowlands. The lowest temperature reading made by the local weather bureau was 43.3 degrees F. recorded on January 18, 1961. This is only 11.3 degrees F. above freezing point.

Since 1909, the city continued to gain other modes of existence. Not only Americans, but local and other foreign tourists came up, earning its sobriquet: Summer Capital of the Philippines. Besides becoming the major tourist destination north of Manila, it became the seedbed of a massive Christianization sortie into the central highlands.

Allied endeavors followed. Now also known as the educational center of Northern Luzon, there are found in the city four universities, two colleges, several high schools and a number of elementary schools. The multi-million-peso "Baguio" vegetable industry passes thru here from their points of origin along Halsema or Mountain Trail to their destinations all over the country.

Its population is motley. Now past the 120 thousand-soul mark, the city welcomed several waves of immigration since its founding. The native **inibaloi** remains. Some pioneer Americans, Lebanese, Germans and Japanese decided to stay. Immigrants streamed in from the west and the east; the Iloko and the Pangasinense; Bontoc, Ifugao and Kankanai tribesmen from the north; Visaya, Bicol, Batangueño, Bulakeño, Pampango and Zambal from the south. Late in the 70's, a new emergent minority known collectively as Muslims came in.

Ilocano and English remain to be the principal languages but Filipino is gaining a good hold. Cultures and traditions which may not initially have blended continue to exist side-by-side.

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[1] Provided to the journal by the City Mayor of Baguio, Brig. Gen. Bueno as written by Baguio City Public Information office.

The city government has a budget of close to 30 million pesos in 1982. Its income is derived chiefly from realty taxes, collections from the city market and its share from taxes paid to the national government by mining agglomerates operating just a kilometer or two away from its periphery.

The first American mayors gradually developed the main features of Baguio.

Between 1900 to 1910 telephone and water systems were installed. In 1913, a race course girding Burnham Park was established. In 1916, the public market was opened. In 1917, the first concrete building was set up near Kayang Street.

In 1937, along with the Filipinization program, E.J. Halsema, mayor since 1922, was relieved by Sergio Bayan, an engineer. During his incumbency, the Rizal Memorial Health Center, Asin Bathhouse and the Skating Rink (now an orchidarium) at Burnham Park and the Athletic Bowl were established.

In 1945, the Baguio Council was set up on an appointive basis. In 1959, the city election was held with Luis L. Lardizabal elected as its first mayor.

The incumbent, retired brigadier general Ernesto H. Bueno from the Philippine Air Force will fill the position up to 1986.

As early as 1902, studies were undertaken to find the possibility of finding new routes to Baguio. Following the river Bued, Col. L. W. V. Kennon with the help of the natives under the direction of a Father Lomax, determined to construct a road. Kennon Road was open to traffic in 1905 after a staggering amount of over two million pesos was spent.

Other routes were constructed meanwhile. The western approach from the Ilocos branches off from the national highway at Bauang. In the mid-70's the now completely concrete Marcos highway was begun. The Mountain Trail links Baguio to the hinter-towns of Benguet, the Mountain Province, Ifugao and Kalinga-Apayao. Ambuklao Road brings in from the east, busses from Nueva Vizcaya and Isabela.

The Loakan Airport is managed by the Bureau of Air Transportation. It averages eight commercial flights daily, but it also manages as many as 25 planes with the BAC III being the largest that can be taken in for landing. It was made operational for domestic flights in 1948.

Once Baguio's accessibility had been established, the city experienced a boost in trade and commerce. The areas of Session Road, Magsaysay Avenue and the city market comprise the trade center of the city.

POINTS OF INTEREST

The recently constructed **Convention Center** exudes a roof-top with ethnic flavor. It gained international prominence when two chess titans struggled for the world championship: Viktor Korchnoi and Anatoly Karpov.

Across the Convention Center is **Sunshine Park** adjacent to the **Baguio-Benguet Mountain Province Museum** which houses artifacts, period pieces, archeological finds related to the five cultural groupings of the Central Cordilleras.

The **Baguio Cathedral** stands out easily as the most prominent and imposing edifice in the heart of the city. Constructed after the Gothic style of architecture and embellished by a distinct Belgian influence, the altar, pews and even the huge pipe organ are distinctly European. Most of its icons and bas-reliefs, however, are unique and special because they were handed-carved by a native of Hapao, Banaue, Ifugao, Francisco Payaye.

Sprawling below the skyline is **Burnham Park**, made historic last year when the Pope, John Paul II celebrated mass and addressed himself to the ethnic minorities of the country. As part of Kafagway, it once belonged to the Cariño family. Its development began as early as 1913 when Charles Stones, one-time manager of Pines Hotel initiated a drive to construct a horsetrack in what was then a marsh-land. In 1915 a grandstand was constructed for the first carnival which took place. The park was named after world-renown American architect who drew up city plans for Chicago and San Francisco. It continues to be the center of recreation to the present day.

The **City Hall** is another structure that no one can miss. The original city hall was destroyed during the Second World War. The present building, still part of the Burnham development plan, was inaugurated in 1950.

Mirador Hill towers on the western sector of the city challenged only by the old **Dominican Hill**. Up near its top is a replica of the grotto at Lourdes where thousands have since made a pilgrimage. Noted Jesuit historian, Horacio de la Costa calls it prospect point which metamorphosed from a mere meteorological station, then a villa or rest house, a college for displaced Jesuits of the Chinese province, then as a retreat house.

On the eastern side, there is **Imelda Park** which originated as a zoological and botanical garden. The place offers visitors a quick tour into the cultural folk art and architecture of the Igorots and a cool and relaxing respite from tourist travel. Further up Leonard Wood is **Wright Park** named in honor of Gen. Luke E. Wright, Governor General of the Philippines in 1901 to 1905. There, so-called Marlboro Country is found where more than a hundred horse owners hire out their animals for a tour under towering pines. **Mansion House** lies on one end of **Wright Park.** This is the official summer residence of the President of the

Philippines. A little further Mansion House is **Mines View Park,** a rocky ledge from which one scans the wide Amburayan River and the number of mining companies which are operating in the area.

John Hay is an experience aside. Named after a Secretary of State, the **John Hay Air Station** is a 600-acre military reservation just a jeepney ride away from the center of the city. On December 8, 1941, 27 Japanese planes bombed John Hay. A few weeks after the bombing, John Hay became a concentration camp and later the Japanese Army post. Rehabilitation of the camp continued after the war and on November 17, 1957, Camp John Hay was renamed John Hay Air Base. Within it is the Voice of American relay station. On the outer skirts near the Loakan Airport may be seen two cemeteries where 579 Philippine Scouts, U.S. nationals, and civilian members of their families are buried. On January 9, 1979, the base was returned to the Philippines.

Session Road is the city's main street. Completed in 1929, the road stretched over one kilometer from Magsaysay Avenue to the gate of John Hay. Since it was the main access to the sessions being conducted by the Philippine High Commission at **Baden Powell Hall** the road became to be known by its present name.

Separate mention should be made for the **Philippine Military Academy** which is approximately 14.5 kilometers away from the city. It is here where the "elite de corps" are trained to become future officer components of the Armed Forces of the Philippines. The academy occupies 363 hectares of hilly areas in Fort del Pilar. There is a weekly morning parade of the cadets.

Baguio also abounds with a lot of churches, seminaries, convents and religious institutions which reflect on the spirit of ecumenism obtaining in the city. Not less than 30 religious denominations in the city attest to the fact. Baguio offers an ideal locale for spiritual meditation and contemplation.

PUBLIC INFORMATION OFFICE
City of Baguio

BAGUIO IN A CAPSULE

Area	:	49 square kilometers
Location	:	250 kilometers north of Manila
Elevation	:	5,000 feet above sea level
Average Temperature	:	16 degrees centigrade
Population	:	118,636 (57,575 males, 61,061 females) as of 1980 census
Founded	:	September 1, 1909
City Mayor	:	Hon. Ernesto H. Bueno

Baguio, known as the Summer Capital of the Philippines, is also an important tourism, vacation, convention, commercial, and educational center north of Manila. Its natural beauty and temperate climate led to its fast development and emergence as a favorite mountain resort for thousands of vacationists who visit Baguio every year.

The city is relatively new and small in size compared to other cities. It received its charter only on September 1, 1909, barely nine years after an expeditionary force of Americans first reached the area. Lured by tales of a Shangrila-like place, as Spaniards described the place, Dean C. Worcester, member of the First Philippine Commission, led the expedition and immediately reportedly "left the tropics behind us and came out into a wonderful region of pine parks." Following the expedition, the American government, through the Philippine Commission, declared Baguio the Summer Capital of the Philippines. Architects, road builders and construction teams were dispatched immediately to develop the area as such — as a vacation and recreation center during warm season. The chief architect was Daniel H. Burnham, who laid out the present plan of the city.

Seventy-two years after its founding, Baguio has become known worldwide as a tourist center and as the gateway to the Cordillera Mountain Range, home of the five major highland tribes known as the Igorots. Aside from its natural landscape and beauty, man-made scenic spots have been introduced, adding to its atmosphere as a resort and vacation center. Hotels, amusement places, business establishments and other infrastructure needs have also been built to meet necessities of its growing population and its visitors.

Tourism, its main industry, reaches its peak during the dry season (from March to May) when thousands of visitors from other parts of the country, together with foreign tourists, come up to escape the tropical heat in the lowlands and enjoy the city's temperate climate. Tourism has also resulted to the development of the city's cottage industry. Igorot woodcarvings, handwoven clothing materials, Baguio strawberries, brooms and souvenir items find their way to other parts of the country and the world. Around the city are also found numerous mining camps extracting gold, silver and copper from the bowels of the earth.

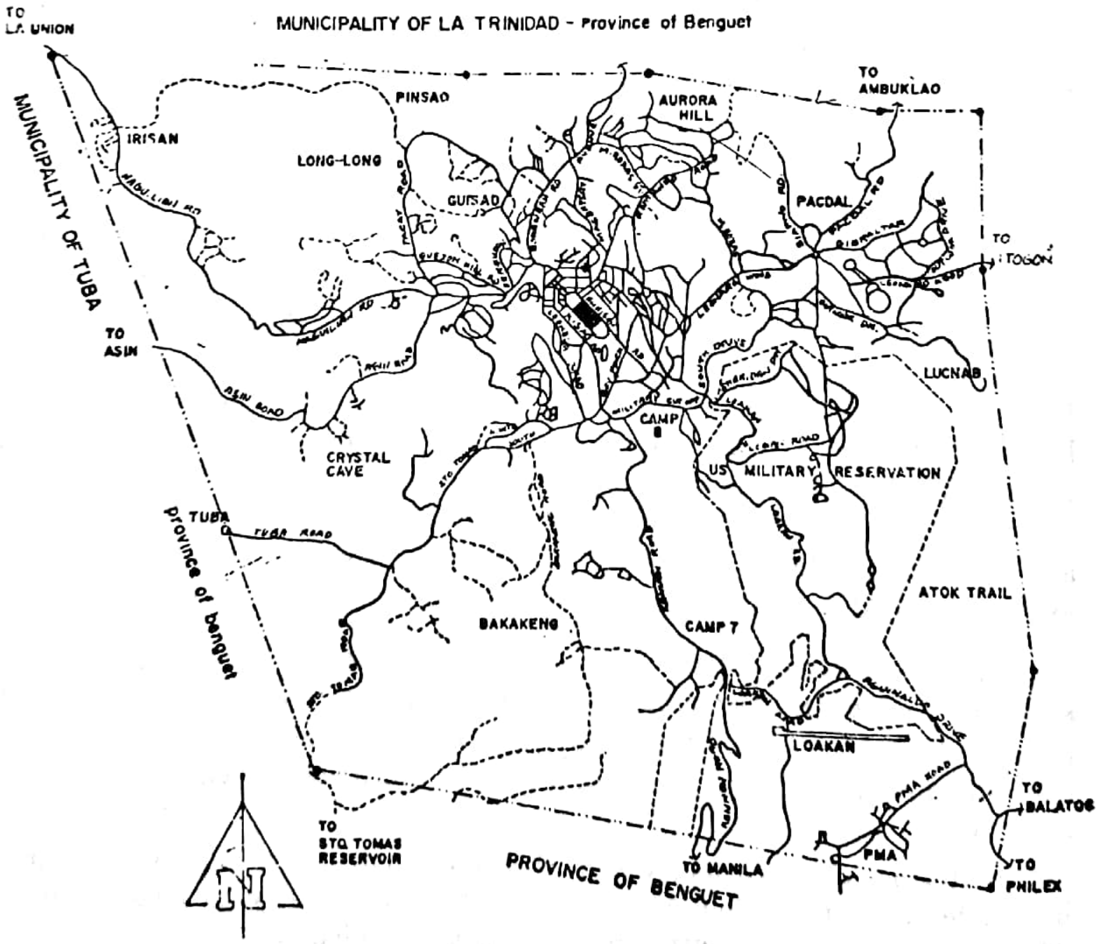
As a convention center, rarely a day passes that a business, religious, social and civic meeting among national and international groups is not being held in the city. Convention, hotel and accommodation facilities can compare with those of older and far more developed cities in the country.

In terms of education, the city has 12 institutions of higher learning aside from its various secondary, elementary, and vocational schools. Almost one half of the city's population are students.

Transportation facilities in the city also continue to increase and develop. There are four major road arteries leading to the city and mobility is complemented by a domestic airport. Considering that the city was originally planned for a population of only about 25,000, city streets are, however narrow, prompting the city government to start this year a year-long study on the traffic problem, aimed at evolving and implementing a systematized traffic plan for the city road network.

Bulk of the city's population is composed of migrants from the Ilocos Region, Pangasinan, Batangas and other parts of the country, including the four Mountain Provinces. The natives here are called the Benguets, one of the five major hilltribes along the Cordilleras. The Benguets are further divided into two — the Kankana-eys and the Ibalois who used to own vast tracks of land used for cattle raising. Americans, Japanese, Spaniards and people from other parts of the world have also built their permanent residences here.

Baguio's name was adopted from the word "Bah-giw", a Benguet term which means "moss" and from the Ibaloy term "Bagyu" which means a slimy waterplant found abundant in various parts of the city at the turn of the century.



OBITUARY

Ramon L. Samaniego
1918-1982

It is with deep regret and a profound sense of loss to the Philippine Geographical Society (PGS) and the staff of the Philippine Geographical Journal (PGJ) the passing of Dr. Ramon Lualhati Samaniego — professor, writer, scientist, and an elected director, PGS, on April 24, 1982.

Born in Manila on April 16, 1918, he received his Bachelor of Science in Agriculture (BSA) from the U.P. College of Agriculture in Los Baños in 1939, his Master of Science (MS) in Agronomy (Soils) from the North Carolina State College of Agriculture and Engineering, USA in 1955 as ICA-PHILCUSA scholar, and Doktor der Landwirstschaft (Dr. Agr.) from Rheinischen Friedrich-Wilhelms Universitat Bonn, Germany, in 1960, as scholar of the German Government and the Philippine Government. He also attended the X'ray Diffraction School conducted by the North American Philips Co., Inc. (NORELCO) at Mt. Vernon, N.Y. on April 4-8, 1955.

Dr. Samaniego studied Nuclear Physics, Radioisotope Techniques and Advanced Mathematics with the Philippine Nuclear Research and Training Committee, Manila in 1957. He also undertook a Secondary Supervisory Development Training Course at the U.P. College of Agriculture on June 4-July 9, 1966, and the International Atomic Energy Agency (IAEA) Regional Training Course on tht Use of Isotopes and Radiation for the Development of Industrially-Useful Microorganisms in Manila from October 13 to December 1, 1972.

His professional career was both rich and diverse and reflected his numerous interests. He served the government in various capacities at the Bureau of Soils — Soil Technologist, Soil Physicist, Soil Chemist until he became Head Soil Technologist and Chief, Soil Research Division, Bureau of Soils. In 1964, having terminated his service in the Bureau he devoted full time to his teaching activities by transferring to the College of Agriculture, UPLB.

His teaching started in 1939 as assistant instructor in the U.P. College of Agriculture where he handled laboratory classes in general chemistry, qualitative analysis, technical analysis (food and feeds, fertilizers, soils, pesticides), and handled the same classes in the U.P. College of Liberal Arts, Manila in 1944. He taught and lectured on physical chemistry, analytical geometry, calculus, modern physics, etc., at the Philippine Women's University; lectured on soil and fertilizer technology at the UST College of Liberal Arts; was professorial lecturer on molecular biology, advanced theoretical and physical chemistry, radiochemical techniques, advanced colloid chemistry at the Adamson University Graduate School, Manila, and served as professor on agricultural analysis, physical chemistry, general chemistry, mineralogy, sugar by-products, radioisotope techniques and special problems at the College of Sciences and Humanities of the U.P. at Los Baños from 1968 up to the time of his passing away. He was also at the time, associate director of the Sugar Technology Program.

He served as managing editor of the *Chemist Quarterly* (Philippines), the *Soil Science Society of the Philippines*, and was critic to manuscripts on soils, fertilizer, chemistry, etc., of the *Philippine Agriculturist.*

Dr. Samaniego was the recipient of numerous awards and citations which include, among others, 2nd Prize, Best Technical Paper Award at the Philsutech 19th Annual Convention (Aug. 18-21, 1971); a citation for being instrumental in organizing the Los Banos Chapter of the Chemical Society of the Philippines (Dec. 11, 1971); 3rd Place, Graduate Research Award at the Chemical Society of the Philippines Annual Convention (April 4-5, 1972); Plaque of Merit as Outstanding Administrator, 1974-75 from UPLB, and Distinguished Alumnus for government research of the UPCA Alumni Association (October 10, 1975).

He was a member of honor societies such as the Phi Kappa Phi, University of the Philippines Chapter, Sigma Xi and Gamma Sigma Delta, North Carolina Chapter. He was a charter member of the Soil Science Society of the Philippines and also of the Philippine Geographical Society, founder fellow of the Philippine Association for the Advancement of Science (PHILAAS), regular member of the National Research Council of the Philippines, and member of such societies and organizations as the Radioisotope Society of the Philippines, Chemical Society of the Philippines, Philippine Society for Microbiology, International Society of Sugarcane Technologists, Biology Teachers' Association of the Philippines, Philippine Association of Food Technologists, to name a few. He was also a member of the North Carolina State University Alumni Association, was Grand Knight of the Knights of Columbus, St. Therese Council No. 5377, member of the Christian Family Movement of the Philippines, and the Rotary Club of Los Baños.

His expertise was widely recognized and utilized. He was the Philippine Government representative to the Expert's Meeting on the Establishment of ASPAC Food and Fertilizer Technology Center at Taipei, Taiwan, on February 23 — March 1, 1969 during which he was elected Vice-Chairman, and as an expert on Tropical Soils, he attended the Scientific Committee on Problems of the Environment (SCOPE) Workshop on Biogeochemical Cycling of Carbon held at Ratzeburg/Hamburg, Germany, March 21-26, 1977.

A scientist continually seeking answers to questions, solutions to problems, he had undertaken a number of researches, either as project leader or co-researcher, on chemical characteristics of the soils of Bulacan, Oriental Mindoro and other provinces, particle board, and sugarcane baggasse, among others. He had authorized (or co-authored) a large number of publications on fertilizers, activated carbon, soils, trace elements, sugarcane and isotopes in research.

Dr. Samaniego was 64 at the time of his demise. He is survived by his widow, Dra. Laura Ancheta-Samaniego, and six children, Nikki, Sonya, Lorna, Erwin, Ramon, Jr. and Ester. His memory will remain in the hearts of those whose lives he had touched and those who are beneficiaries of the results of his untiring research efforts.

AURORA S. TOLENTINO

Greetings

To *Asian Geographer*

on its

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from

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and

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(Sgd.) DOMINADOR Z. ROSELL
Editor-in-Chief & Business Manager

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