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SOIL SURVEY OF BENGUET PROVINCE, PHILIPPINES

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND NATURAL RESROUCES
BUREAU OF SOILS
Manila

Soil Report 48

SOIL SURVEY OF BENGUET PROVINCE, PHILIPPINES

Reconnaissance Soil Survey and Soil Erosion Survey

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11. SOIL EROSION SURVEY

SOIL SURVEY OF BENGUET PROVINCE

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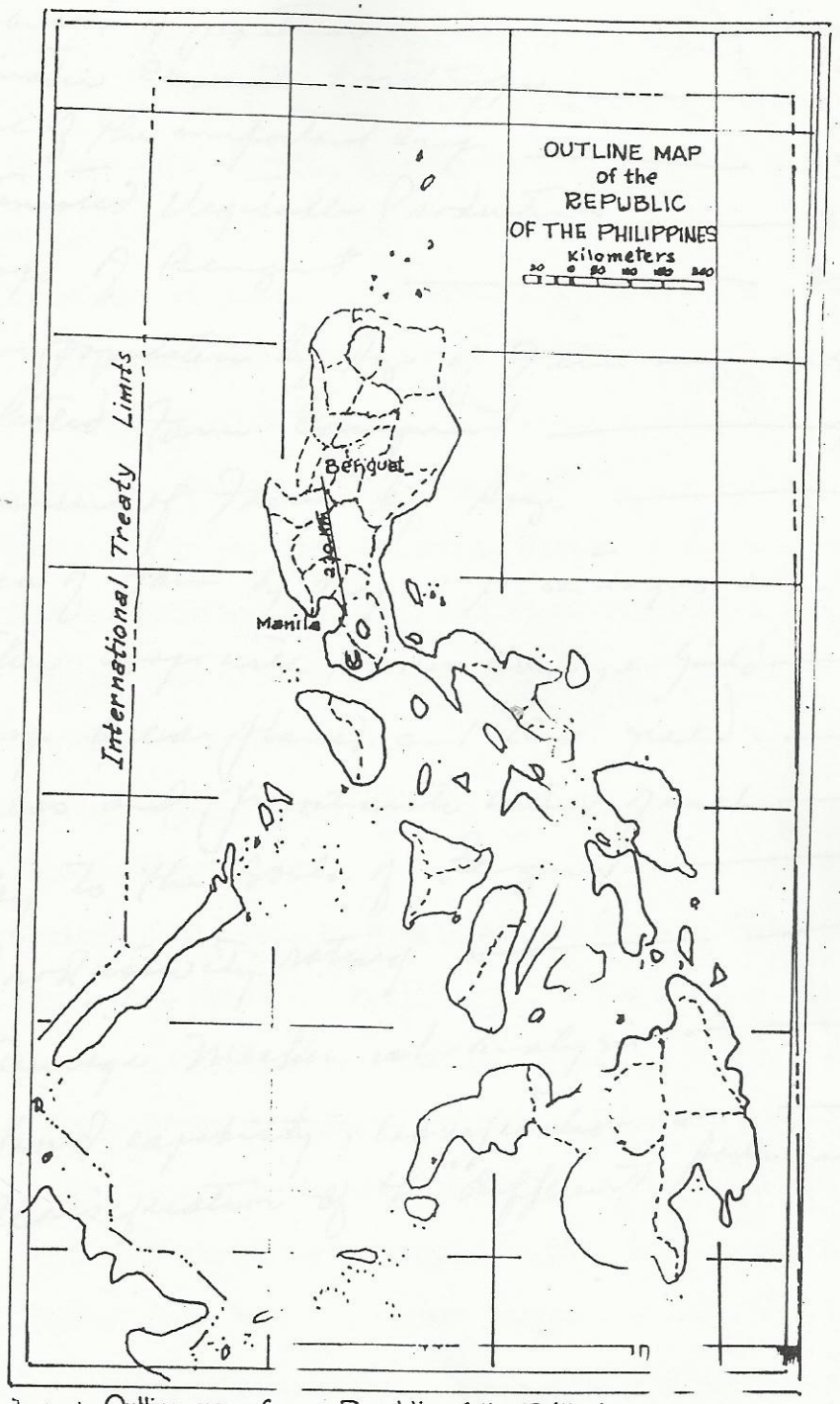


Fig. 1 Outline map of the Republic of the Philippines
Showing the location of Benguet Province

ACKNOWLEDGEMENT

The survey party are indebted to all Officials in Benguet who were very cooperative during the survey of the province. Special mention is given to the Provincial Agriculturist who provided the team with valuable information and data on agriculture in the Province. Mention is also made of the Director of Mines, Baguio City who identified the rocks in Benguet for the survey team and to the editors, Soil Survey Staff.

The Authors

INTRODUCTION

A great problem of the farmers nowadays is to produce in sufficient quantities the basic needs of the rapidly increasing population and at the same time maintain profit, soil fertility and minimize soil loss. To help the farmers solve these problems, a reconnaissance soil classification and erosion survey was conducted to study the physical, chemical and biological properties of the soil so that the different soils can be delineated according to their capabilities and limitations and be utilized to their most profitable uses without sacrificing soil loss and soil fertility. The survey was started June 17, 1966 and completed June 1968.

SUMMARY

Benguet is in the southernmost portion of the former Mountain Province with an area of 265,538 hectares. La Trinidad, the capital is about 230 kilometers north of Manila. Under Act No. 48 dated November 26, 1900, local civil government in the 19 township of Benguet was established. Benguet was created as a sub-province in November 22, 1900. Under Act No. 49 on November 23,1900 the civil government of Benguet was duly established. On June 29, 1901, a ~~province~~ provision was inserted on Act No. 155 providing that a popular representative be elected on July 4, 1901. In 1905, Act No. 49 was repealed by Act No. 1396 known as "The Special Government Act" which organized Benguet. Under Act No. 1646 on May 1907, election of delegates to the constitutional convention to be held on July 1907 was provided. Benguet became a sub-province of Mountain Province with the passage of Act No. 1876 on August 18, 1908. By operation of Act No. 2877 of February 4, 1920, the boundary of Benguet was amended, part was placed under La Union and part was placed under Ilocos Sur. The original 19 towns were reduced to only 13. The town of Baguio became a chartered city in 1909, and in its stead, the town of Tuba was created. The towns of Ambuklao, Adaoay, Balacbac, Daklan, Galiano, Palina and Loo were abolished. Republic Act No. 4695 of June 18, 1966 divided Mountain Province into the provinces of Benguet, Mountain Province, Kalinga-Apayao and Ifugao. The province of Benguet comprises the sub-province of Benguet and the municipalities of Tuba, Sablan, Itogon, La

Trinidad, Tublay, Atok, Beked, Kabayan, Kapangan, Bakun, Kibungan, Mankayan and Buguias. The provincial capital of Bonguot is La Trinidad. Except as hereafter provided, all provisions of Law now or hereafter applicable to regular provinces applies to the province of Bonguet. Bonguet is rolling to hilly and mountainous with only 4 tenth per cent of level areas represented by La Trinidad valley and the valley in Buguias which are alluvial. These plains are surrounded by mountains and hills.

The natural vegetation of the province consists of primary forest, second growth forests of pine trees, Guijo, White lauan, bagtican, mayapis and palosapis. Cogon are the dominant cover of the open areas.

Transportation and communication facilities are available except Bakun. The other towns are served by several buses and jeeps. There are five roads to Bonguet, three of which are first class. There is an air strip in Baguio City. In Baguio City, there are radio stations, radiophones, telegrams and telephones operated by the government and private entities.

The population of Bonguet gradually increased from 539 in 1903; 98,087 in 1939; and 133,261 in 196 . The Bureau of Health claimed that population had increased to 159,762 in 1965.

The climate of Bonguet falls under the first type which includes two pronounced seasons, wet and dry. Dry months are November to April, the other wet, the rest of the year.

The province is also often visited by typhoons. A very strong typhoon passed over the province in 1967. Agriculture is the most

important industry of the province. Important crops grown are rice, corn, camote, potatoes, fruits and vegetables valued at over a hundred million pesos.

The livestock of the province consists of carabaos, cattles, horses, hogs, goats, sheeps, chickens, ducks, geese, rabbits, turkeys and pigeons. Other industries are mining, wood carving, lumbering, grass broom making, basket making, merchandising, quarrying and manufacture of hollow blocks. Majority of the farmers work on farms they consider their own but without land titles.

There are three main physiographic groups of soils, namely (1) soils of the plains and undulating areas, (2) soils of the rolling areas, ~~steep~~ Steep hills and mountains and (3) miscellaneous land types. There are two soil types classified on the plain and undulating areas, 20 soil types on the rolling areas, hills and mountains, and two miscellaneous land types. The soil types of the first group are both important due to their unlimited uses. In the rolling areas, steep hills and mountains, Natubling sandy loam is the most important. The multi-million pesos vegetable industry in Benguet are grown in this soil type. It has an area of 12,867.509 hectares or 4.846 per cent of the total area of Benguet. When the land was prepared for cultivation erosion started and in many places the surface soil is already gone.

Productivity rating of the various soil types were obtained on the basis of the average yields of crops where farm practices do not include the use of commercial fertilizer or amendments. The most productive soils based on their productive ratings are La Trinidad

loam and Umingan sandy loam. The malpractices done on lands and injudicious cutting of timber land to the denudation of forest in the province. The neglect of soil conservation has caused the depletion of their fertility, vegetative cover and organic matter, which would otherwise conserve the water on the land.

Extensive use of irrigation by pumps is not possible in Benguet due to the hilly and mountainous terrain, however, irrigation due to gravity is practical in terraced farms.

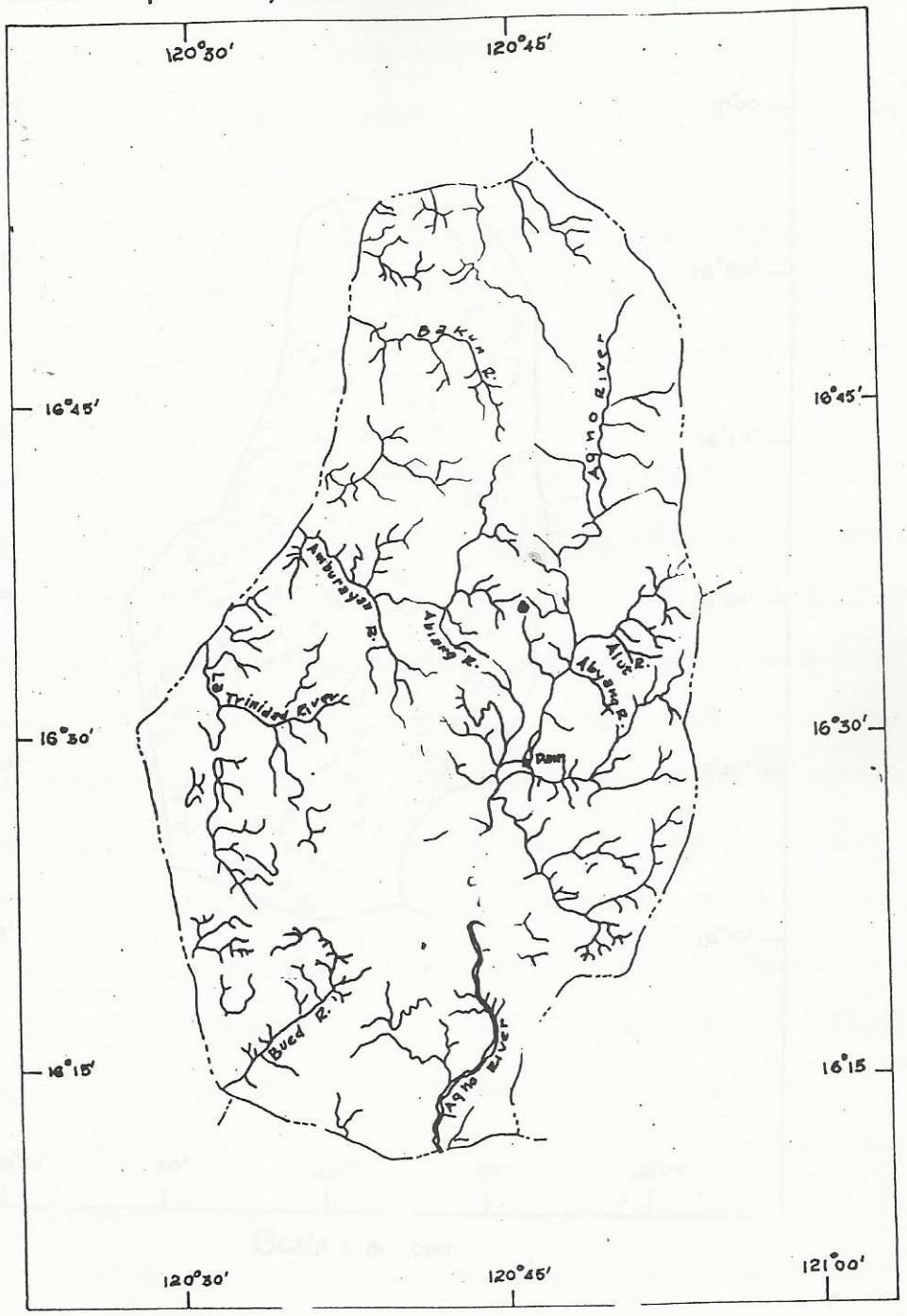
I. RECONNAISSANCE SOIL SURVEY

DESCRIPTION OF THE AREA

Location and extent. - Benguet province is located about 214 kilometers by road north of Manila. The provinces surrounding Benguet are on the north Mountain Province (Bontoc) and Ilocos Sur, east Ifugao and Nueva Vizcaya, south Pangasinan and west La Union and Ilocos Sur. It has an area of 265,538 hectares. La Trinidad is the capital of the province and is accessible by fine highway system as Mountain trail on the northeast, Mankayan road on the north, Kennon road on the south, Kayapa road on the southeast and Naguilian road on the west.

Relief and drainage. - Benguet is a mass of elevated land with a great special agricultural potentiality. It is worthy to note that while the surface extension of the province is wide, most of it is mountainous and a very limited area is agricultural. Mount Pulog the second highest mountain in the Philippines, the highest mountain highway system in the Philippines and the largest man-made dam in the Far East, (mbuclao Dam) are in Benguet. All rivers of Benguet drain into the China sea. Mountainous as it is, agriculture is the main source of livelihood in the province. Major crops are upland rice, camote, potatoes, fruits and vegetables. Upland rice are grown on terraces, hi ls and mountain sides where water is available for irrigation. Potatoes are raised by the harmful kaingin method except in the valley of La Trinidad and

Fig 2 Sketch map of Benguet Province showing drainage system



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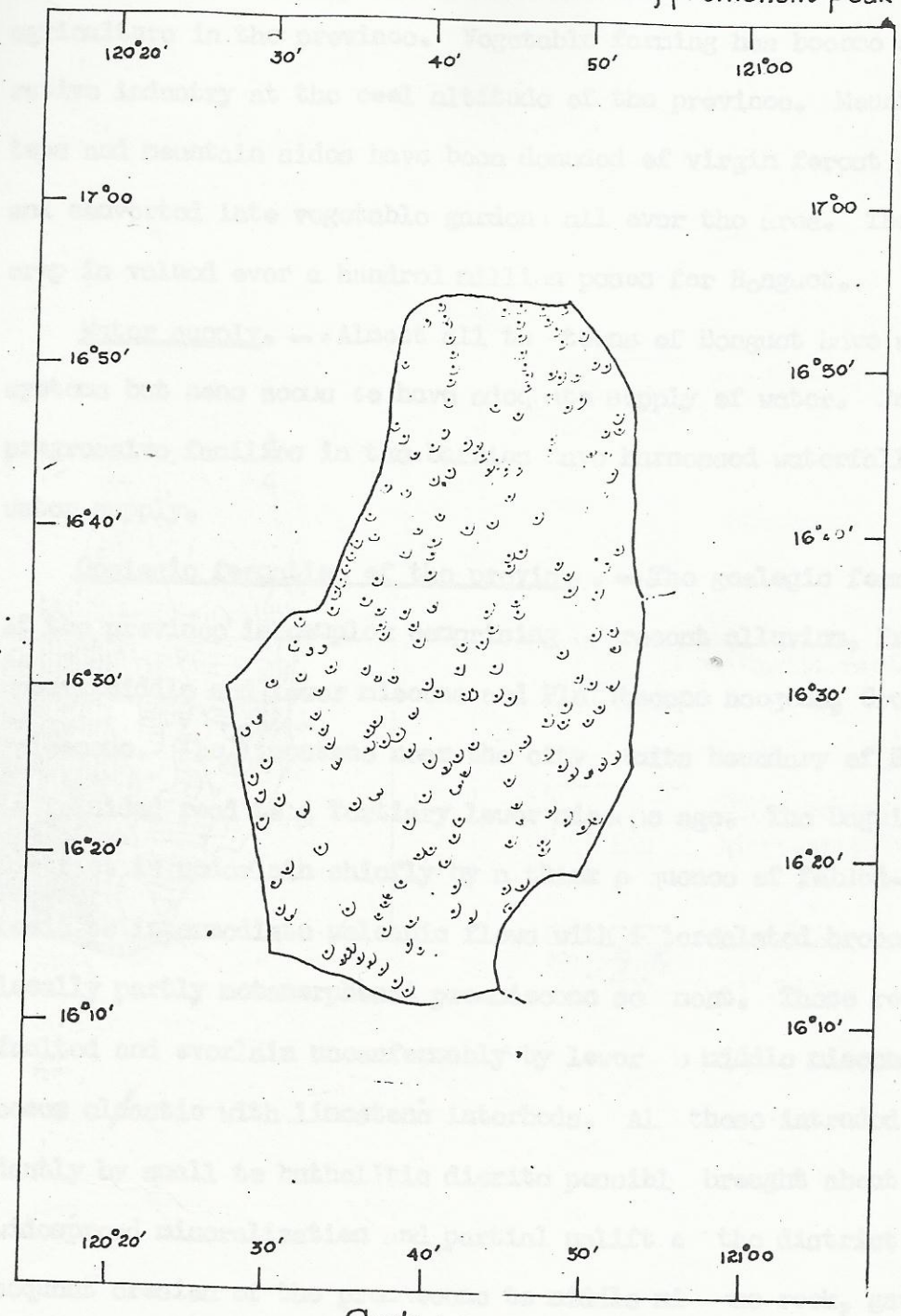
Sketch map of Benguet Province showing promenent peak



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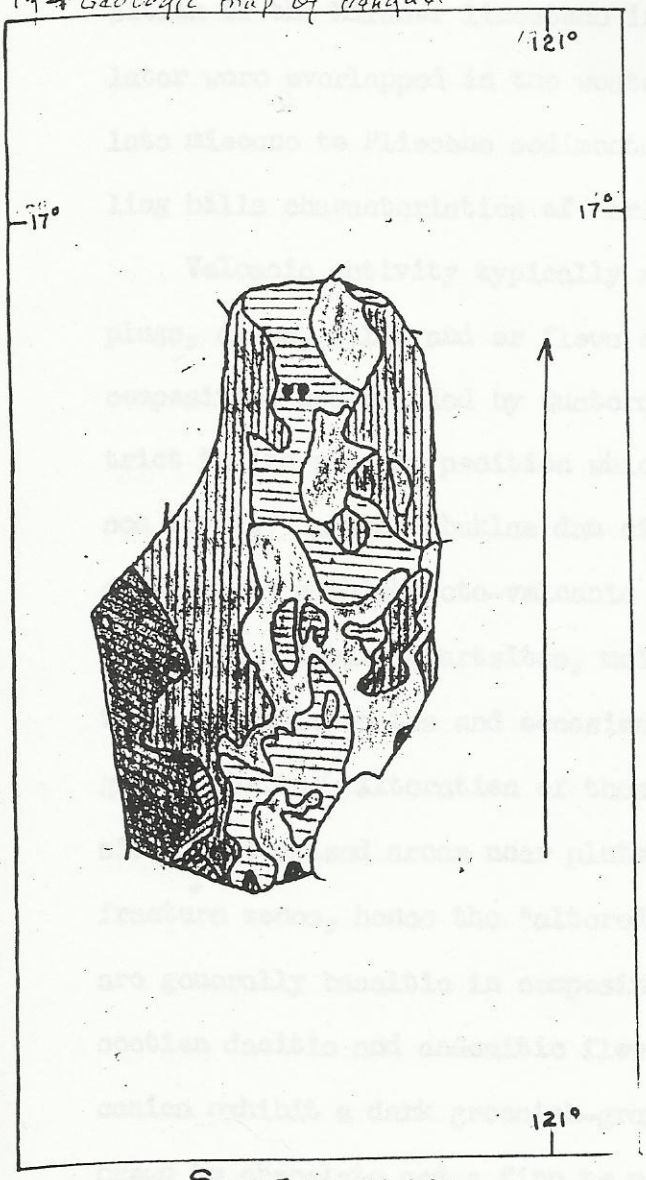
Buguias. Camote vine is a versatile plant. Raising camot, potatoes and vegetables in general are the most promising fields of agriculture in the province. Vegetable farming has become a lucrative industry at the cool altitude of the province. Mountain tops and mountain sides have been denuded of virgin forest growth and converted into vegetable gardens all over the area. The annual crop is valued over a hundred million pesos for Benguet.

Water supply. --Almost all the towns of Benguet have water systems but none seems to have adequate supply of water. Many progressive families in the barrios have harnessed waterfalls for their water supply.

Geologic formation of the province. --The geologic formation of the province is complex comprising recent alluvium, Pre-Miocene, upper, middle and lower miocene and Pliocene neogene, Cretacious Paleocene. The limestone near the city limits boundary of Baguio-La Trinidad road is a Tertiary lower miocene age. The Baguio Gold District is underlain chiefly by a thick sequence of faulted-altered-basic to intermediate volcanic flows with interbedded breccia and locally partly metamorphosed pre-miocene sediment. These rocks were faulted and overlain unconformably by lower to middle miocene tuffaceous clastic with limestone interbeds. All these intruded discordantly by small to bathelitic diorite possibly brought about the widespread mineralization and partial uplift of the district subsequent erosion of the pre-miocene to middle miocene rock, gave rise to the deposition of extensive Klondyke conglomerates and Rosario formation in the western part of the district. However, in these

GEOLOGIC MAP OF BENGUET PROVINCE

Fig 4 Geologic map of Benguet



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QAV Quaternary

N1 Neogene

UV Undifferentiated

Oligocene Miocene

Upper miocene-plioene

upper miocene clastic were being deposited; their embankment of the seas in the Baguio-La Trinidad area favored the deposition of Mirader limestone.

Subsequent subsidence during late miocene favored the deposition of the Mirader limestone in Baguio-La Trinidad area and later were overlapped in the western portion of the district by late miocene to Pliocene sedimentary beds that now form low rolling hills characteristics of early topographic maturity.

Volcanic activity typically represented by cone-shaped plugs, dikes, sills and or flows of dacitic, andesitic to basaltic composition accompanied by Quaternary movement restored the district to its present position which is about 1,000 meters above sea level. In the Ambuklao dam site, the oldest formation in the district is a thick meta-volcanic sequence which locally contain interbedded impure quartzites, metapyroclasic member ranging from tuffs to agglomerates and occasional thin layer of lenses of ferruginous cherts. Alteration of these volcanic rocks are very intensive in localized areas near plutonic intrusive contacts and along fracture zones, hence the "altered volcanic flows". These rocks are generally basaltic in composition a[illegible] along Lopanto-Bontoc road section dacitic and andesitic flows are common. These altered volcanics exhibit a dark greenish-gray color with shades of grayish brown to chocolate and a fine to medium-grained texture. The greatest bulk is usually epidotized and chloritized. Limited outcrops of partly schistose volcanics, most of which are hornfelsic on the

dam site. The composition is usually hornblende-plagioclase hornfels portion of which are crudely schistose although generally the orientation of the amphiboles and plagioclase are erratic. On the road to Philex mine, these altered volcanics seem to be intercalated with partly metamorphosed sedimentary rocks generally consisting of large, light colored, rounded probably recepitalized pebbles and cobbles embedded in an indurate basic matrix.

The zigzag Antamoc formation is typically exposed in the upper Bued River canyon near the Zigzag section of Kennon road and can be traced to the City of Baguio, Bokod area east of Ambuclao and from kilometer post 289 to kilometer post 334 originated in the Baguio-Lepanto road section. Kennon limestone formation consists mostly of thick to massive compacted and poorly sorted conglomerates with interbeds of volcanic graywake, limited calcareous askosic sandstone, red tuffaceous shale with few interbeds of tuffs and some conglomerates and clastics. The conglomerates are composed of altered basalt and andesite phenoclasts in a sandy matrix essentially chloritized. The orbitoid fauna at the Bokod-Kayapa road section indicate the formation of Tertiary (lower to middle miocene).

The Balili sediment is a thick sequence of sedimentary rocks exposed along Balili cliffs on the western flanks of Mount Data. It can be traced from km. 353 to km. 358 along the Lepanto-Bontoc road section and in Buguias-Kabayan area southeast of Mount Data. This formation is about 1,200 meters thick, the lower 900 meters consists of massive, thickly bedded conglomerates and sandstone; the upper 200 meters consists of ball- bedded and banded siltstone

and shale; and the top 100 meters is mainly limestone. The calcareous arkosic sandstone member of this formation taken at the Agno River in Buguias is Tertiary (lower miocene) age. The Kennon limestone which is well exposed near km. 226 along Kennon road which is about 188 meters thick can be traced northward from Bued canyon to Kapangan and to Balakbak is tertiary.

Natural vegetation.- At elevation 2,000 - 6,000 feet pine trees and alnos are growing. At higher elevation shrub oak trees covered with thick growth of mosses are more prevalent than the pine trees. From 4,000 to higher elevation, vegetables, potatoes, and camote grows well in Benguet Province. Below 2,000 feet elevation in Benguet, the climate is similar to the neighboring lowlands and the native vegetation on open lands are usually talahib and cogon. Trees found grown in Benguet are pine trees, guijo, white lauan, bagtican, mayapis and palosapis. The cultivated crops in Benguet are rice, potatoes, camote, cabbage, pechay, carrots, lettuce, green onions, Baguio beans, sweet peas, kintsay, sayote, tomatoes, bananas, cacao, coffee, avocado, passion fruit, carrots, celery, and strawberry, pears and persimon.

Lighting facilities.- Itogon, Baguio and La Trinidad are provided with electricity by the National Power Corporation. Lepanto has its private electric plant. The National Power Corporation also provides electricity to Benguet Consolidated covering Balatoc, Antamoc, Acupan, Sangilo and Philex. Benguet exploration and Black Mountain, Itogon-Suyoc and Baguio Gold also draw their electric power from the National Power Corporation. It is not worthy to state here that the two dams, Ambuklao and Binga which generate an aggregate kilowatt amounting to 175,000 are located in Benguet Province along the Agno River and still other dams are on the schedule to be constructed in the region to generate more electricity.

province. The natives of Benguet were known in preserving dead bodies (mummies). Many lowlanders from almost all provinces of the Philippines and a few foreigners have emigrated to the province.

Transportation and market.- Transportation facilities are available in 12 towns of Benguet. The only towns not served by regular public utility buses and public utility jeeps, is Bakun. However, the road to the town is almost completed and may be served by buses very soon. The Dangwa transportation company and many other jeepneys serve Benguet populace within Benguet Province while other buses as Pantranco, Times, Dacanay express in addition to the Dangwa, serve the people from Baguio to other provinces as far as Manila in the south and Ilocos Provinces in the north. There are hundreds of big freight trucks carrying vegetables from Benguet to markets in the neighboring towns and cities. Benguet has 227 km. of national road 290 km. of provincial road. Some 50 km road is proposed for construction.

Cultural development and improvement.- The opportunities for higher education is very possible in Baguio City which is within the southern end of Benguet Province. There is the Mountain Agricultural College in La Trinidad, an Agricultural school in Kapangan and Buguias. For other avenues of higher learning we have the school of nursing in the Baguio General Hospital and the Philippine Military Academy.

Other schools found in Benguet and Baguio City as of 1967-1968.

Benguet

Public schools 1/	Number	Enrollment
Primary-Elementary	173	27,580
High school	1	708
Baguio City		
Primary-Elementary 2/	12	10,296
High school	12	2,742

1/ Basic data - Bureau of Public Schools, Baguio City

2/ Kindergarten not included.

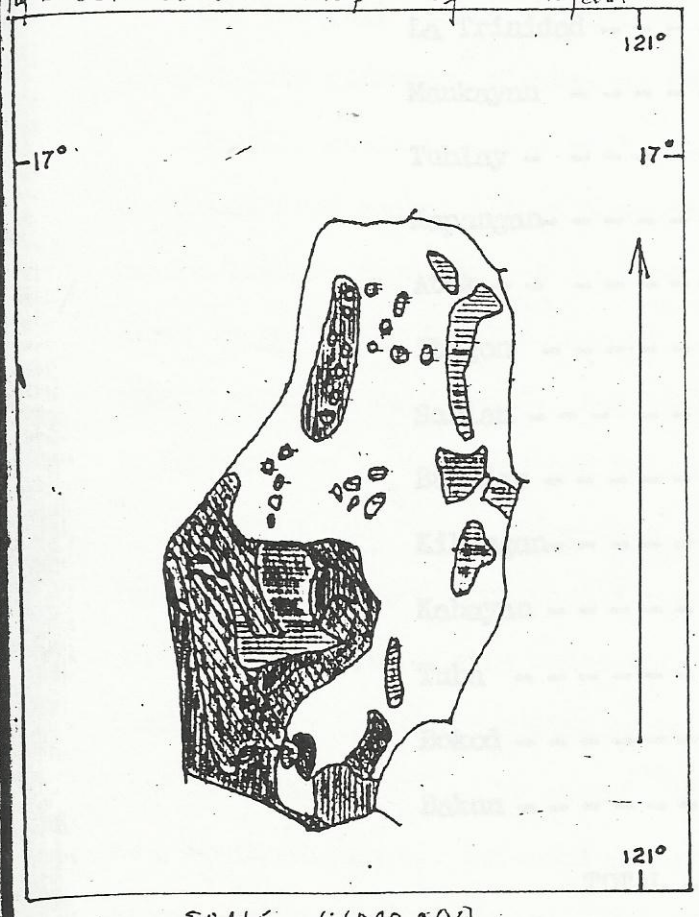
Private school 3/	Number	Enrollment
Primary -Intermediate	21	10,023
High school	19	10,201
High ~~school~~ school	7	10,730
TOTAL	245	72,280

Industries.- Farming is the major industry while mining comes next. Inspite of inhospitable terrain, commercial activity is brisk. The city of Baguio is a trade center, due to vegetable, mining and tourism. Lumbering has a bright future because wood for building constructions and mining needs are in great demand. In Benguet province there are 6 licencee covering 84,670 hectares with 6 sawmills. In 6 months period 1967-1968, 40,840.35 cubic meters of wood was cut with a total of P120,185.00 forest charges for timber and minor forest produces 4/ while the mines operating in Benguet Province produced P172,981,469.00 worth of gold, molybdenum, zinc, cadnium, copper as of calendar year 1963. 5/

3/ Basic data - Bureau of Private Schools, Baguio City
4/ Basic data Bureau of Forestry, Baguio City
5/ Basic data Mineral news service - Value of Philippine of Philippine Calendar 1963 minerals.

SOIL COVER MAP OF BENGUET PROVINCE

Fig 5 - Soil cover map of Benguet



Commercial forest

Cogon and open land

Cultivated

Non-Commercial and brush land

Organization and population of the area. - The population of the province according to the 1960 Census of the Philippines gradually increased from 539 in 1903; 98,087 in 1939 and 133,261 in 1960. The Bureau of Health claimed population had increased to 159,762 in 1965.

Table 1. - Distribution of population in Benguet by Municipality - Census of 1960.

Municipality	
La Trinidad	12,415
Mankayan	13,812
Tublay	5,869
Kapangan	10,707
Atok	3,353
Itogon	2,742
Sablan	1,741
Buguias	,658
Kibungan	,901
Kabayan	,869
Tuba	,307
Bokod	,946
Bakun	,927
TOTAL	3,261

The native people of Benguet are of two tribes, the Ibaloys and Kankanays. The Ibaloys are the agriculturists and have their seat of culture in Kabayan near Mount Pulog. The Kankanays are the miners and occupy the fastness of the northern highlands of the

MORPHOLOGY AND GENESIS OF THE SOILS OF BENGUET PROVINCE

Soil morphology is the study of soils as finished products. It measures, describes, correlates and classifies them.

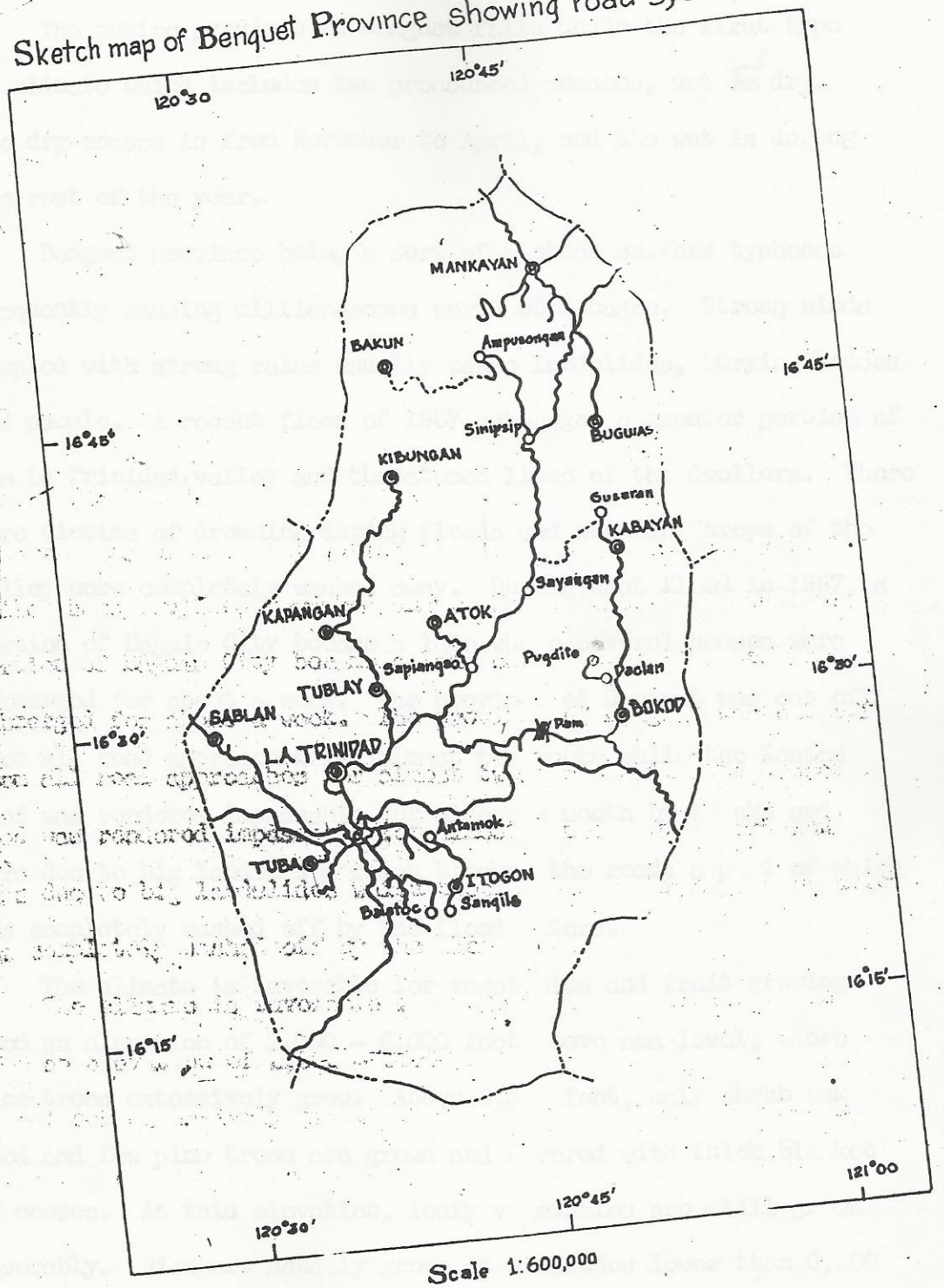
Soil genesis implies a process of the gradual transformation of an inert parent material into a definitely organized dynamic soil, or the various steps involved in the transportation of parent materials into true soils.

All the soil series classified in Benguet province are grouped into different classes as follows:

Profile class A. - The soils under this profile class were developed from recent alluvial deposits. They are of medium to coarse texture from their A down to their C horizon. This profile class is generally level to nearly level. Permeability is moderately rapid to very rapid. Soil series under this class found in Benguet are La Trinidad and Umingan.

Profile class D. - Under this profile class are soils of upland areas developed from hard igneous rocks such as diorite, basalt and andesite. Soils under this profile class are deeply weathered fairly friable; reddish brown, dark brown or red. The relief is usually rolling to steeply rolling, sometimes ending up to a mountain range. External drainage is good to excessive, internal drainage is also good. The permeability of the soil under this class is moderate. The undulating or rolling areas are planted to rice, coffee, Baguio beans, potatoes, camote, cabbages, sweet peas, pineapples, bananas, ginger, gabi. The steep slopes are

Fig 6 Sketch map of Benguet Province showing road system



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CLIMATE

The entire province of Benguet falls under the first type of climate which includes two pronounced seasons, wet and dry. The dry season is from November to April, and the wet is during the rest of the year.

Benguet province being a sort of plateau suffers typhoons frequently causing million-pesos worth of damages. Strong winds coupled with strong rains usually cause landslides, burying houses and people. A recent flood of 1967 submerged a greater portion of the La Trinidad valley and threatened lives of the dwellers. There were victims of drowning during floods and standing crops of the valley were completely washed away. During that flood in 1967, a portion of Baguio City became a lake where several houses were submerged for about a week. The province of Benguet was cut off from all road approaches for almost two weeks while the Kennon road was rendered impassable for almost a month by trucks and cars due to big landslides which blocked the road; a part of which was completely washed off by the flood waters.

The climate is favorable for vegetables and fruit growing from an elevation of 2,000 - 6,000 feet above sea level, where pine trees extensively grow. Above 6,000 feet, only shrub oak wood and few pine trees are grown and covered with thick blanket of mosses. At this elevation, leafy vegetables are still grown favorably. Rice are usually grown at altitudes lower than 6,000 feet elevation above sea level.

CLIMATIC ELEMENTS
FIRST TYPE

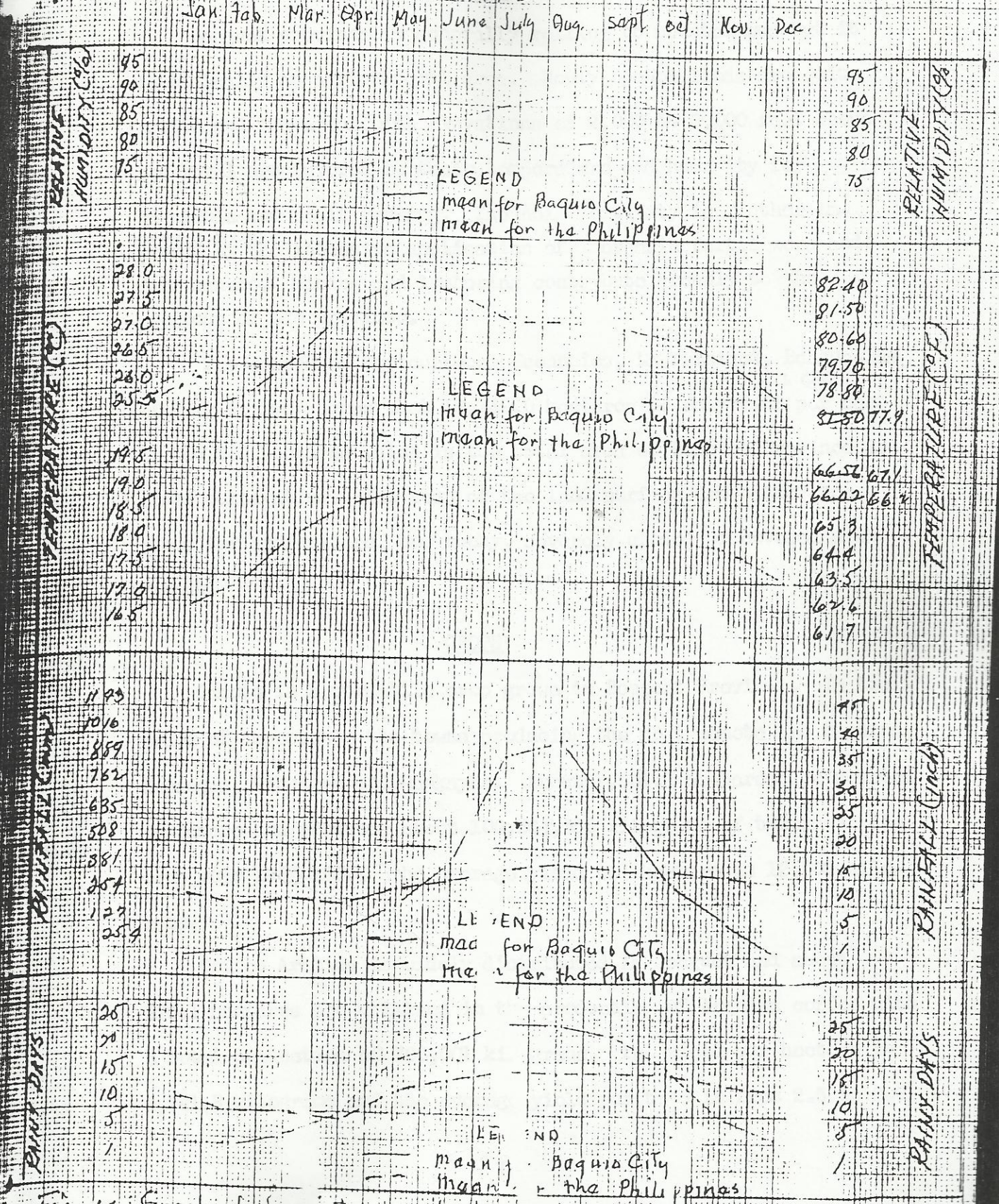

Fig. 14 Graph of the first type of climate in the Philippine and Baguio Prov.

AGRICULTURE

Benguet province is generally rolling to mountainous but it is basically an agricultural area. Newly opened lands are quite fertile and the areas with elevations of 2,000 to 6,000 feet above sea level are favored by their temperature and humidity for vegetable and fruit growing. The soil fertility is further improved by the intensive application of inorganic fertilizers and farm manure. Mining and lumbering contribute greatly to the progress of the province.

The census of Agricultural Economics, La Trinidad, Benguet as of July 1, 1967 shows that 19,749.0 hectares or only 7.43 per cent of 265,533 hectares which is the total area of Benguet Province is under cultivation. The rest of the land surface are either too steep for agriculture, too rocky, severely eroded or covered with forest.

CROPS

Camote is a versatile crop grown in Benguet Province. In the order of importance the towns producing the most camote are Buguias, Kapangan, Kibungan and Mankayan. About 7,601.2 hectares are devoted to camote and produces about 100,364,350 kilograms of tubers in the crop year 1967-1968. The average yield per hectare is 12,607 kilograms.

Coffee Arabica is widely distributed in Benguet and about 273.1 hectares are utilized in the production of Arabica coffee with a total production of 766,001 kilograms. The yield per hectare is 2,741.8 kilograms and the average yield per tree is from 2.5 to 2.8

kilograms. The towns producing coffee Arabica in the order of their importance are Atok, Kabayan, Bakun, La Trinidad and Mankayan.

Robusta, Excelsa and other species of coffee are grown to some 217.7 hectares and produces about 329.469 kilograms in the municipalities of Sablan, Kapangan, Tuba, Itogon and Atok. The average yield per tree is 1.2 to 1.5 kilograms or 3,521.2 kilograms per hectare.

Cacao, though very insignificant in quantity is also grown in Benguet. An aggregate area of 4.5 hectares is cultivated to cacao in Kapangan, Sablan, Tuba, Atok, Itogon and Tublay arranged in the order of their importance. The total produce is about 3,420 kilograms with an average yield of 760 kilograms per hectare or 1.2 to 1.5 kilograms per tree.

Potato (Irish):- This crop is the leading economic crop based on value of products. It is grown extensively on hillsides along the Halsema road from kilometer post 236 to kilometer post 340 nearing the boundary of Benguet and Mountain Province and along the Agno river from Abatan, Buguias to Kabayan. In the Halsema road Fa Cadia alone a record sale of P900,000.00 was attained in 1964-1965. In 1967-1968 Benguet devoted 1,749.5 hectares to the cultivation of potato (Irish) and produced 13,441,348.0 kilograms of tubers. The yield per hectare is 7,0 kilograms. The towns of Buguias, Atok and Kibungan produce the most potato (Irish) in Benguet Province.

Cost of producing potatoes per hectare per harvest under Benguet condition. 1/

A. All field operation - - - - - - - - P 138.20

B. Fertilizer and chemicals - - - - - - ₱1,456.91

T o t a l - - - - - ₱1,595.11

Gross production value/ha./harvest 5,158.1[illegible]

Expected net/ha./harvest - - - - - - 3,563.07

Cabbage.- Cabbage is the second l[illegible]ding crop grow[illegible] side by side with potatoes (Irish) with an estim[illegible]ted value of produce amounting to ₱384,000.00 at Halsema road [illegible]Cdia at Km.90. In the crop year 1967-1968, Benguet devoted 2,06[illegible].2 hectares in the culture of cabbage and produced about 23,151,529 kilograms. The average yield per hectare is 11,242 kilograms. The towns producing the most cabbage are Atok, Buguias, La Trinidad [illegible]d Baktin.

Palay is most widely grown and it is usually grown where irrigation water is available as in Bokod, Itogon, [illegible]guias, Mankayan, Bakun, Tublay, Tuba, Sablan and Kapangan. [illegible]ice is also grown in narrow strips of land [illegible]long rivers and creeks. In the crop year 1967-1968, Benguet dev[illegible]oted 3,637.7 hectare[illegible] in the culture of lowland rice (first crop) w[illegible]th a total production of 98,458 cavans of palay weighing 44 kilo[illegible] per cavan. The average yield is 27 cavans per hectare. For the [illegible]me period, Benguet planted 2,460.9 hectares of lowland (seco[illegible] crop with a total produce of 52,816 cavans. The average yiel[illegible] per hectare is 22.1 cavans per hectare. For the upland crop ye[illegible] 1967-1968, Benguet province cultivated 610.4 hectares of rice a[illegible]t produced 7,746 cavans of palay. The average yield per hecta[illegible]re is 12 cavans per

hectare. Towns producing the most lowland rice arranged in the order of their importance are Kabayan, Bokod, Mankayan, Itogon and Bakun, while the towns producing the most upland rice are Tuba, Sablan and Kapangan arranged in that order.

Corn is another important crop that is grown in the province. For crop year 1967-1968, three crops of corn was produced. First crop, 46.9 hectares was planted producing 333 cavans of 57 kgs. with an average yield of 6.8 cavans per hectare. They are mostly grown in Itogon, Tublay and Sablan in that order of importance. For the second crop 26.8 hectares were devoted to corn producing 247 cavans of 57 kilos per cavan. The average yield is 8.9 cavans per hectare. These were cultivated in the towns of Itogon, Bakun and Tuba arranged in the order of their importance. For the third crop, 64.3 hectares was cultivated and produced 666 cavans with an average yield of 9.3 cavans per hectare. The thirdcrop of corn are usually grown in Itogon, La Trinidad and Mankayan.

Tobacco (native) is grown in Benguet in a very limited extent with only 10.6 hectares with a total produce of 6,690 kilograms and with an average yield of 640 kilograms per hectare. Tobacco is grown in the towns of Bakun, Kapangan and Tuba.

Mungo is grown in the towns of Tuba and La Trinidad. The area cultivated to the crop is 10.1 hectares producing 5,555 kilos with an average yield of 550 kilograms per hectare.

Garlic. - For the crop year 1967-1968, garlic was planted in 0.1 hectare in Kapanga and produced 200 kilograms of bulbs, with

average computed yield of 2,000 kilograms per hectare. This merely shows that garlic may be grown in quantity in the warmer portions of Benguet.

The following vegetables as carrot, pepper (sweet), radish, celery, onion (leek) cauliflower, broccoli, peas and beans (string) are grown in Benguet in quantities but there are no available data on the area devoted to these crops. At km. 90, Halsema Road PaCaMa during drop year 1964-1965, the aggregate production of the above mentioned vegetables was 104,000 kilograms valued at ₱40,450.00.

Table 3 Some of the important crops produced in Benguet Province

Crops	Area Planted - ha.	Production	Value-Pesos
Potato	1,586.0	7,187,220 kg.	2,301,008.00
Mungo	8.1	2,819 "	1,438.00
Camote	7,049.8	47,571,997 "	4,502,878.00
Cabbage	1,528.6	12,543,164 "	2,856,653.00
Arabica and other variety	733.9	208,358 "	385,887.00
Avocado	1,061.0	558,196 "	95,668.00
Papaya	47.7	197,364 "	17,274.00
Mango	81.7	159,444 "	40,666.00
Orange	30.4	46,934 "	15,767.00
Corn	353.6	6,922 Cav.	82,157.00
Palay	7,404.2	241,657 "	25,767.02

Table 4. Estimated Vegetable Production at Km. 90 Benguet Province 1964-1965 1/

KIND	VOLUME in kilos	UNIT PRICE Pesos	AMOUNT Pesos
Cabbage	1,920,000	0.20	384,000.00
Potato (Irish)	3,000,000	0.30	900,000.00
Wongbok	34,000	0.20	4,800.00
Carrot	35,000	0.25	8,750.00
Pepper (Sweet)	35,000	0.30	10,500.00
Raddish	5,000	0.05	250.00
Pechay	2,000	0.10	200.00
Celery	10,000	0.50	5,000.00
Onion (Leek)	5,000	0.20	1,000.00
Cauliflower	2,000	0.50	1,000.00
Broccoli	2,000	0.50	1,000.00
Potato (sweet)	5,000	0.50	250.00
Peas	9,500	1.00	9,500.00
Beans (string)	10,000	0.30	3,000.00
T O T A L	5,074,500		1,329,250.00

1/ Source of Basic Data: Km. 90, Halsey Road FaCoMa.

Table 5. Crops of Benguet Province 1/

CROPS	BENGUET		
	Area Planted ha.	Production kgm.	Yield per ha. kgm.
Camote	7,601.2	100,364,350	12,607.0
Coffee Arabica	273.1	766,001	2,741.8
Robusta, Excelsa & other species	217.7	829,469	3,521.2
Cabbage	2,062.2	23,151,529.	11,242.0
Potato (Irish)	1,749.5	13,411,348	7,066.0
Cacao	4.5	3,420	760.0
Tobacco (native)	10.6	6,690	640.0
Mungo	10.1	5,555	550.0
Garlic	0.1	200	2,000.0
Cassava	439.0	-	-
Pechay	325.9	-	-
Mustard (Wongbok)	104.1	-	-
Tomatoes	70.5	-	-
Eggplant	33.5	-	-
TOTAL	13,902.0		
~~GRAND TOTAL~~	~~14,749.0~~		

1/ Basic data - Bureau of Agricultural Economics, La Trinidad, Benguet as of 1965-1966 and 1967.

Table 6. Crops of Benguet Province 1/

CROPS	BENGUET		
	Area planted ha.	Production Cav.44kgs	Yield/ha.
Rice:			
1st crop	3,637.7	98,433	27.0
2nd crop	2,460.9	52,816	22.1
3rd crop(upland)	610.4	7,746	12.0
Corn 2/			
1st crop	46.9	333	6.8
2nd crop	26.8	247	8.9
3rd crop	64.3	666	9.3
TOTAL	6,847.0		

1/ Basic data - Bureau of Agricultural Economics, La Trinidad, Benguet Province as of July 1, 1967.

2/ A cav. of corn was 57 kilograms.

AGRICULTURAL PRACTICES

Like most other provinces, Bonguot is rugged and mountainous. The kaingin system is the most prevalent practice of opening new lands along slopes of mountains bordering roads. A significant area within forest reserve and national parks along the Halsema road had been invaded by kainginoros and converted into track gardens. When the land is no longer productive the kainginoros abandon the land and open adjacent virgin forest and finally abandoned when the fertility is already depleted. The destruction of forest continues as long as there are virgin forests to be opened. This agricultural practice makes soil erosion a very serious problem.

The native plow and harrow drawn by a carabao is used only in few rice fields and mountain sides that are not very steep. Human power with the use of the spade, fork, hoe, trowel and rake are the most common tools in the cultivation of the land. Sometimes where the soil is very soft and saturated with water, the soil is prepared for planting by trampling over the soil with the bare foot. Mechanized farming is not very practical in Bonguot because the lands are mostly very steep and the landholdings are too small.

Practice of crop rotation and intercropping are not well planned. The use of commercial fertilizers and chemicals is intensive as seen from previous consumption of these items. At km. 90, Halsema road in 1962-1963, estimated fungicide and insecticide worth ₱472,000.00 and ₱7[illegible].000.00 respectively were consumed.

Rice are grown in limited irrigated lands using the wetbed method to germinate palay seeds. In the wetbed method the panicle of palay is pressed to about one centimeter deep in the mud of prepared seedbed. When the palay germinate, water is gradually introduced into the seedbed to check the growth of weeds. The amount of water is regulated so as not to submerge the seedlings. Upland rice is planted direct to the ground by drilling the seeds not necessarily in straight line but more or less equally spaced.

High yielding rice varieties are being experimented in Benguet to determine their adaptability and performance. A few farmers are becoming conscious of the soil analysis of their lands to guide them in the use of fertilizers and/or lime.

Steep mountain side not suited for cultivation are denuded and these should be reforested. Benguet has a few reforestation proje projects as:

Reforestation Projects in Benguet 1/

Location	Area of Project ha.	Area planted ha.	Seedlings handled 1966-1967
Mambolo, Itogon	3,154.0	468.00	1,874,521
Camp 4, Kennon	3,337.2	151.90	1,362,458
Yangyang, Ambuclao Bokod	2,257.0	116.74	1,843,753
Banao, Bokod	3,544.77	140.99	2,136,991
TOTAL	12,272.97	877.63	7,517,703

1/ Source of Information: Reforestation Administration Office, Padal, Baguio City. 1968

LIVESTOCK AND POULTRY INDUSTRY

The rugged landscape of Benguet makes the land more appropriate for grazing than for cultivation. However, livestock raising has not advanced significantly. A few towns like La Trinidad, Tuba and Buguias have started raising pigs, rabbits and chickens on a commercial scale.

Selected livestock and poultry a/

	1964 No.	1967 No.
1. Carabao	14,634	19,470
2. Cattle	29,860	49,321
3. Horses	1,193	1,653
4. Hog	41,706	91,056
5. Goat	3,147	7,333
6. Sheeps	[illegible]	689
7. Rabbits	-	1,054
8. Chickens	243,782	354,563
9. Ducks	1,498	3,301
10. Geese	461	408
11. Turkey	307	333
12. Pigeon	337	774

a/ Basic data, Bureau of Agricultural Economics, La Trinida, Benguet, June 30, 1969.

LAND USE CHANGES

Land-use changes in the province involves the reduction of forest lands and the increase of food crops. The limited arable lands are not enough to grow the needs of the inhabitants. As people increased in number coupled with the migration of people from the adjacent provinces, the people are forced to make new clearings by cutting down trees on steep mountain slopes only to be abandoned after two or three planting seasons. Along steep mountain sides with deep soil terraces are built and planted to vegetables and sometimes fruit trees in lower altitudes.

FARM TENURE

Benguet province has a total area of 205,538 hectares from which 19,749 hectares or 7.43 per cent is cultivated. These farms are operated under the general classes such as: Full owner, part-owner, other types.

Owners are farm operators who own all the land in which they work; part owners are farm operators who own part and rent or lease other parts of the land which they work.

The tenants are further classified into seven groups; namely: (a) Cash tenants or those who rent the land they cultivate and pay as rent a specific amount of money or a definite quantity of the crops grown, (b) Fixed amount of products or those who rent the land they cultivate and pay as rent a fixed quantity of the product, (c) Share of produce or those who rent the land they cultivate and pay as rent portion of whatever is produced,

Table 7. Farm Population, By Size of Farm: May 1960

Size of Farm - ha.	Total No. of Farms
Under 0.2	622
0.2 and under 0.5	3,506
0.5 and under 1.0	7,333
1.0 and under 2.0	[illegible],366
2.0 and under 3.0	14,340
3.0 and under 4.0	7,[illegible]0
4.0 and under 5.0	4,1[illegible]
5.0 and under 10.0	9,30[illegible]
10.0 and under 15.0	2,331
15.0 and under 20.0	552
20.0 and under 25.0	173
25.0 and under 50.0	113
50.0 and under 100.0	57
100.0 and under 200.0	36
200.0 and above	25

Table 8. Selected Farm Equipment: [illegible]y 1960

Equipment	Number
Plows	6,795
Harrows	6,479
Tractors	7
Thresher	5
Carts	210
Motor vehicle	92
Sugar cane crush[illegible]s	18
Sprayers	2,0[illegible]3
Incubators	[illegible]6

Table 9. Number of farms by size, by _____ Tenure of farm operator: May 1966

SIZE OF FARM IN HA.	Total No. of Farms	Full Owner	Part Owner	Total All Types	NUMBER OF FARMS BY TENURE OF FARM OPERATOR						
					Cash	Fixed Amount of Product	Share of Produce	Cash & Share Products	Rent Fee	Others	Managed Manager
Under 0.2	2,263	2,061	3	175	9	-	152	-	11		-
0.2 and under 0.5	5,521	4,997	240	255	60	[illegible]	144	[illegible]	[illegible]	12	-
0.5 and under 1.0	6,389	5,862	212	276	[illegible]	[illegible]	[illegible]	-	67	12	-
1.0 and under 2.0	17,848	15,641	915	1,145	51	24	804	9	131	66	-
2.0 and under 3.0	8,529	7,352	418	687	12	30	580	-	44	21	-
3.0 and under 4.0	4,418	3,893	165	291	3	13	238	6	19	12	-
4.0 and under 5.0	2,821	2,571	109	117	6	9	96	3	2	-	-
5.0 and under 10.0	4,346	3,990	166	118	12	-	97	-	6	3	-
10.0 and under 15.0	1,000	935	38	13	4	-	6	2	-	-	4
15.0 and under 20.0	143	127	3	2	1	-	1	-	-	-	3
20.0 and under 25.0	74	64	3	-	0	-	-	-	-	-	[illegible]
25.0 and under 50.0	55	48	2	-	-	-	-	-	-	-	[illegible]
50.0 and under 100.0	26	21	2	-	-	-	-	-	-	-	2
100.0 and under 200.0	16	13	-	-	-	-	-	-	-	-	2
200.0 and over	21	18	[illegible]	-	-	-	-	-	-	-	1
TOTAL	33,470	47,593	2,277	3,079	195	82	2,332	20	320	130	[illegible]

Basic data - Bureau of Agricultural Economics, La Trinidad, Benguet as of May 1966.

(d) Cash share tenants or those who rent all the land they work and pay as rent a share of the crop in addition to specified amount of money, (e) Rent free - Under this system of rental in the province of Benguet, it is not well known. The landlord furnishes work animals, seeds, and implements and the tenant receives one-half of the product. Under another system, the tenant furnishes everything and he gets three-fourths of the crop while the landlord gets one-fourth, (f) other forms or any other form which could not be classified under any of the above, and (g) managers or those farm operators who supervise the working of the farm of the landowner receiving wages or salaries or part of the crop for the service.

~~NOTE: The percentages of the type of sharing could not be determined as there is no available data on the area covered by each type of tenant.~~

FARM INVESTMENT

Farm investment of the farmers are mostly human labor, farm manure, commercial fertilizers, insecticides, constructing private roads, terracing their farms and hand tools which includes fork, trowel, hoes and spade.

Table 16. Area of farm by crops 1/ and percentage

	Area, Has.	Per cent
Rice	6,709.0	33.971
Corn	138.0	.698
Camote	7,601.2	38.489
Coffee arabica	273.1	1.382
Robusta, excelsa & sp.	217.7	1.102
Cabbage	2,062.2	10.442
Potatoes (Irish)	1,749.5	8.858
Cacao	4.5	.022
Tobacco (native)	10.6	.053
Mango	10.1	.051
Garlic	.1	.001
Cassava	459.0	2.325
Pechay	325.9	1.650
Mustard (wongbok)	104.1	.527
Tomatoes	70.5	.357
Eggplant	33.5	.174
TOTAL	19,749.0	100.000

1/ Basic data – Bureau of Agricultural Economics, La Trinidad, Benguet – 1965-1967.

Table 8. - Other crops with known average yield per hectare for the soil type

Soil Type No.	Soil Types	CROPS									
		Pechay kgm.	Tomatoes kgm.	Onions kgm.	Straw-berry kgm.	Cabbages kgm.	Potatoes kgm.	Baguio beans kgm.	Sweet Peas kgm.	Sayote kgm.	Ginger kgm.
1044	La Trinidad loam 1/		20,000	15,715	4,369	36,000	24,873	22,667	8,632		
1036	Ambasador silt loam	3,000				5,000				10,000	
1041	Atok sandy loam					10,000				10,000	
1045	Bakakong sandy clay loam	3,000				10,000		1,000			
1042	Balili gravelly loam					5,000					
1033	Boneng loam							1,000			
151	Burgos clay										10,000
1032	Buyugan clay loam	10,000				10,000				10,000	
1046	Gainacang sandy loam					30,000					
1037	Halsema loam	10,000				10,000				10,000	
1048	Mirador clay loam					10,000		1,000		10,000	
1034	Nangalisan gravelly loam					6,000		1,000			
1039	Natubling sandy loam					25,000			1,000		
1043	Pacay sandy loam					25,000			1,000		
1031	Puguis gravelly loam	5,000				2,000					
1033	Tacdian loam	10,000		12,000		10,000		1,000			

1/ Figures for average yield in La Trinidad were obtained from the Mountain Agricultural College.

Table 12.

BENGUET AS OF JULY 1, 1969

Crops, Area planted and average yield per hectare

CROPS	AREA PLANTED IN HECTARES	YIELD PER HECTARE
Lowland rice 1st crop	3,565.4	27 cavans
Lowland rice 2nd crop	2,383.8	22 cavans
Upland Kaingin palay	612.5	11 cavans
Corn 1st crop	46.8	7.2 cavans
Corn 2nd crop	26.8	9.2 cavans
Corn 3rd crop	64.4	10.3 cavans
Tobacco (native	10.6	631.1 kgm.
Camote	7,711.7	12,270.0 kgm.
Mango	9.9	544.0 kgm.
Irish potato	2,231.4	7,457.0 kgm.
Coffee (Arabica variety)	488.3	2,444.0 kgm.
Coffee (Robusta variety)	224.2	3,698.0 kgm.
Cacao	4.5	760.0 kgm.
Cabbage	2,462.4	9,291.0 kgm.
Cassava	380.0	13,751.0 kgm.
Baguio beans	344.8	3,311.0 kgm.
Pechay	276.1	6,639.0 kgm.
Sweet peas	18.3	2,215.8 kgm.
Tomatoes (w/O) native)	130.4	5,860.9 kgm.
Mustard	75.2	7,756.5 kgm.
Lettuce	113.5	3,799.0 kgm.
Celery	54.0	6,687.8 kgm.
Pepper (sweet)	40.1	2,918.5 kgm.
Eggplant	30.	5,875.0 kgm.
Bananas	1,298.	8,034.7 kgm.
Pineapple	486.	5,045.0 kgm.

SOILS OF BENGUET PROVINCE

The soils of Benguet Province are classified into three groups based on their relief, namely: (1) soils of the plains and valleys, (2) soils of the uplands and (3) miscellaneous land types. There are two soil types under the first group; nineteen soil types and one soil complex in the uplands and two miscellaneous.

SOIL TYPES

1. Soils of the plains and valleys:

*1044 - La Trinidad loam
100 - Umingan sandy loam

2. Soils of the uplands, hills and mountains:

*1036 - Ambasador silt loam
98 - Annam clay loam
1041 - Atok sandy loam
*1045 - Bakakeng sandy clay loam
1040 - Balakbak gravelly clay loam
1042 - Balili gravelly loam
*1033 - Beneng loam
151 - Burgos clay
*1032 - Buyagan clay loam
218 - Cervantes loam
1038 - Daklan clay
524 - Guimbalaon-Annam complex
1046 - Guingoang sandy loam
*1037 - Halsema loam
1048 - Mirador clay loam
1034 - Nangalisan clay
1039 - Natubling sandy loam
1043 - Pacay sandy loam
*1031 - Puguis gravelly loam
*1035 - Tacdian loam

3. Miscellaneous land types:

*202 - Rough mountainous land
45 - Mountain soil undifferentiated

Table. 13. - Area and proportionate extent of each soil or miscellaneous land types of Benguet Province.

Soil Mapping No.	Soil Types	Area Ha.	Per Cent
1044	La Trinidad loam	499.479	0.188
100	Uningan sandy loam	570.834	0.214
1036	Ambasador silt loam	10,489.076	3.950
98	Annam clay loam	7,159.209	2.697
1041	Atok sandy loam	1,355.730	0.520
1045	Bakakong sandy clay loam	13,557.327	5.106
1040	Balabbak gravelly loam	761.112	0.286
1042	Balili gravelly loam	166.493	0.062
1033	Benéng loam	451.910	0.180
151	Burgos clay	3,876.914	1.470
1032	Buyagan clay loam	523.264	0.197
218	Cervantes loam	1,022.744	0.385
1038	Daklan clay	7,397.057	2.786
1046	Guingoang sandy loam	14,484.932	5.455
1037	Halsema loam	451.910	0.152
1048	Mirador clay loam	6,635.945	2.499
1034	Mangalisan gravelly clay	547.049	0.206
1039	Natubling sandy loam	12,867.569	4.846
1043	Peggy sandy loam	118.923	0.054
1031	Puguis gravelly loam	6,088.896	2.294
1035	Naodia loam	1,831.425	0.690
524	Quimbalnon-Annam Complex	2,616.521	0.985
202	Rough mountainous land	34,488.887	12.989
45	Mountain soils undifferentiated	137,574.994	51.819
	TOTAL	265,558.000	100.000

SOILS OF THE PLAINS AND VALLEYS

Soils under this group have level to nearly level relief. They were developed from alluvial deposits which have been washed down from the surrounding uplands, ~~underlain by different kinds of rocks.~~

These soils occupy a total area of 1070.313 hectares, or about 0.402 per cent of the land area of the province.

LA TRINIDAD SERIES - (Bw)

The soil of this series is formed from alluvial deposit. The relief is flat or almost flat and it occupies the valley of La Trinidad. It collects water from the surrounding uplands during rainy season and the water remains stagnant for sometime at the valley floors due to poor drainage. Vegetables and flowering plants are grown throughout the year on the elevated portion and the valley floor is planted only during dry season to vegetables.

The surface soils down to the substratum are medium textured and the predominating colors are brown, dark brown and reddish brown. Only one soil type is mapped under this series.

The typical profile characteristics of the series are as follows:

Depth (cm.) — Physical characteristics

0-22 Surface soil - Brown (10YR4/) dark brown (10YR3/3) fine granular firm loam. Dry - ...llo brown (10YR6/3) light yellowish brown (10YR6/4) hard Wet - Slightly sticky, slightly plastic brown (10YR4/3). Boundary diffused. Few very fine pores and medium plentiful ...oots.

22-77 Subsoil - Dark brown (10YR3/3) fine granular friable firm loam. Dry - hard brown (7.5YR5/4). Wet - Slightly sticky non-plastic dark brown (10YR3/3). Difussed boundary. Few very fine pores and plentiful medium roots.

77-108 Lower subsoil - Dark brown (7.5YR3/3) fine granular friable sandy loam. Dry - Hard brown (7.5YR5/4) dark brown (7.5YR4/4). Wet - Dark brown (10YR3/3) dark yellowish brown (10YR3/4) slightly sticky and non-plastic. Abrupt and wavy boundary. Few very fine pores and small few roots.

108-127 Upper substratum - Reddish brown (5YR4/4) fine granular friable sandy loam with gravels 5% by volume and few small roots. Dry - soft dark brown (10YR4/3). Smooth boundary. Wet - slightly sticky, non-plastic brown (10YR4/3).

127-150 Lower substratum - Dark brown (10YR3/3) friable loam and few color mottlings. Dry - Hard brown (7.5YR5/4). Wet - slightly sticky non-plastic brown (10YR4/3) with few mottlings. Few very fine roots and few fine pores.

La Trinidad loam (1044). - This soil type was mapped in La Trinidad valley. It has an area of 499.479 hectares or 0.183 per cent of the total area of Benguet. It is at an elevation of 4,500 feet. It is level to nearly level with a depressed area. Drainage is good but the depressed portion where water accumulates during the rainy season remains stagnant for sometimes. Organic matter content is 1.17%.

The surface soil is brown to dark brown, fine granular friable firm loam. When dry, it is pale brown to light yellowish brown and

hard. Slightly sticky and slightly plastic when wet. Depth is 0-22 centimeters from the surface. Subsoil is dark brown, fine granular friable loam. Hard and brown when dry. When wet, it is slightly sticky and slightly plastic. Depth is 22-77 centimeters from the surface. Lower subsoil is dark brown, fine granular friable sandy loam. Hard and brown to dark brown when dry. Dark brown to dark yellowish slightly sticky and non-plastic when wet. Depth is 77-108 centimeters from the surface. Upper substratum is reddish brown fine granular friable sandy loam with gravels about 5 per cent by volume. When dry, it is soft and dark brown. When wet, it is slightly sticky and non-plastic and brown. Depth is 108-127 centimeters from the surface. Lower substratum is dark brown, friable loam with few color mottlings. Hard and brown when dry. Slightly sticky non-plastic brown with color mottlings when wet. It is planted to various crops with the following average yields per hectare, sweet potatoes, 24,875 kilograms; onions-15,715 kilograms; Baguio beans - 22,667 kilograms; sweet peas - 8,652 kilograms; tomatoes- 20,000 kilograms and strawberry - 4,569 kilograms.

The soil type is adapted to many other crops. It needs streambank protection and simple farm management practices to maintain high yield.

Data secured from the Mountain Agricultural College.

UMINGAN SERIES

This soil is formed from alluvial deposits washed down from the surrounding uplands. It is level to slightly undulating found along one of the tributaries of the Agno River in Loo, Buguias. It is cultivated to lowland rice and potatoes.

The typical profile characteristics of the series are as follows:

Depth (cm.) Physical characteristics

0-25 Surface soil - Brown (10YR5/3) yellowish brown (10YR5/4) friable, fine granular sandy loam. Dry - loose light brownish gray (2.5Y6/2). Wet - non-sticky, non-plastic. Plentiful fine roots and plentiful very fine pores. Boundary diffused.

25-85 Subsoil - Brown (10YR5/3) light yellowish brown (5YR5/4) friable sandy loam to fine sand. Dry - Loose light gray (10YR6/1) with strong brown (7.5YR5/6) streaks. Wet - non-sticky, non-plastic. Few fine roots, and few very fine pores. Boundary wavy.

85-150 Substratum - Brown (10YR5/3), dark brown (10YR4/3) sand to coarse sand. Dry - Loose light gray (10YR6/1) with strong brown (7.5YR5/6) streaks. Wet - non-plastic and non-sticky. Few fine roots.

Umingan sandy loam (100). - This soil type was mapped in Loo, Buguias. It has an area of 570.834 hectares, or 0.214 per cent of the total area of the province. It is found at an elevation of 4,000 feet. Drainage is good. It is level to slightly undulating.

The surface soil is brown to yellowish brown, friable fine granular sandy loam. When dry, it is loose light brownish gray and when wet, it is non-sticky and non-plastic. Depth is ~~0 - 45~~ 0 - 25 centimeters from the surface. Subsoil - Brown to light yellowish brown, friable sandy loam to fine sand. Dry - Loose light gray with strong brown streaks. Wet - non-sticky and non-plastic. Depth is 25 - 35 centimeters deep. Substratum - Brown to dark brown sand to coarse sand. Dry - Loose light gray with strong brown streaks. Wet - non-sticky and non-plastic. It is planted to rice and potatoes. It is irrigated. Average rice yield is 60 cavans per hectare. Potatoes - 17 tons to a hectare.

SOILS OF THE UPLANDS, HILLS & MOUNTAINS

AMBASADOR SERIES - (M)

Soil of this series is derived from highly weathered diorite and quartz diorite. It is 4,800 feet above sea level. This series is mostly second growth forest of pine trees. Patches of cultivated portions are planted to cabbage, pechay and camote. Grasses in addition to pine trees cover the uncultivated portions. angular blocky

Dark brown, yellowish red, light red and weak red are the dominant colors found within the profile. Fine granular friable silt loam is the dominant texture.

The soil is somewhat excessively drained externally and well-drained internally. Only one soil type is mapped under this series and the profile characteristics of which is as follows:

Depth (cm.) Physical characteristics

0-15 Surface soil - Dark brown (7.5YR3/2) fine granular friable silt loam. Dry - Brown (10YR5/2). Soft. Wet - slightly plastic and slightly sticky. Boundary diffused. Few very fine pores and plentiful small roots.

15-36 Subsoil - Yellowish red (5YR5/6) fine granular friable silty clay loam. Dry - Yellow (10YR7/6) slightly hard. Wet - slightly plastic and slightly sticky. Boundary diffused. Few fine pores and plentiful small roots.

36-90 Lower Subsoil - Light red (2.5YR6/8), red (2.5YR5/8) fine granular friable silt loam with highly weathered parent materials. Dry - reddish yellow (5YR6/6) slightly hard. Wet - slightly sticky and slightly plastic. Boundary diffused. Few very fine pores and few fine roots.

90-150 Substratum - Yellowish red (5YR5/6), (5YR5/8), fine granular friable silt loam with highly weathered parent materials. Dry - Reddish yellow (5YR7/6), soft. Wet - Slightly sticky and slightly plastic. Boundary diffused. Very few fine pores.

150-150 Lower substratum - Weak red (7.5YR5/4) coarse angular blocky loam. Dry - Soft, pale red (7.5YR6/4). Wet - non-sticky and non-plastic. Few very fine pores.

Ambasador silt loam (1036). This soil type was first observed and described in Bo. Ambasador, Tuel Lay, Bonguot at kilometer post number 266.8 Bonguot-Bontoc road. It covers an area of 10,489.076 hectares of 5.950 per cent of the total area of the province. The relief is moderately steep to very steep with a slope crest of 5-8

per cent. Drainage is good. Organic matter content is 9.37 per cent.

The surface soil is dark brown, fine granular friable silt loam. It is 0-15 centimeters from the surface. The subsoil is yellowish red, fine granular friable silty clay loam. Slightly sticky and slightly plastic when wet. It is 15-36 centimeters from the surface. The lower subsoil is light red to red, fine granular friable silt loam with highly weathered parent materials. Slightly sticky and slightly plastic when wet, 36-90 centimeters from the surface. The substratum is yellowish red, fine granular friable silt loam with highly weathered parent materials. Slightly sticky and slightly plastic when wet, 90-130 centimeters from the surface. The lower substratum is weak red coarse angular blocky loam. Non-sticky and non-plastic when wet.

Pechay, cabbage and sayote are the principal crops with an average yield of 3 tons, 5 tons and 10 tons per hectare respectively. The soil type is subject to erosion hazard and special management practices should be applied to minimize soil erosion.

ANNAM SERIES

The Annam series is an extension of the series described in the eastern portion of Pangasinan Province. The soil is developed from the weathering of basalt, tuffaceous rocks, and sandstones. The relief is moderately steep to very steep. Some portions are planted to rice, avocado, bananas, and mangoes. Drainage is good to excessive. It is at an elevation of 200 foot above sea level.

The typical profile characteristics of this series are as follows:

Depth (cm.) Physical characteristics

0-25 Surface soil - Brown (10YR5/3) grayish brown (10YR5/2)

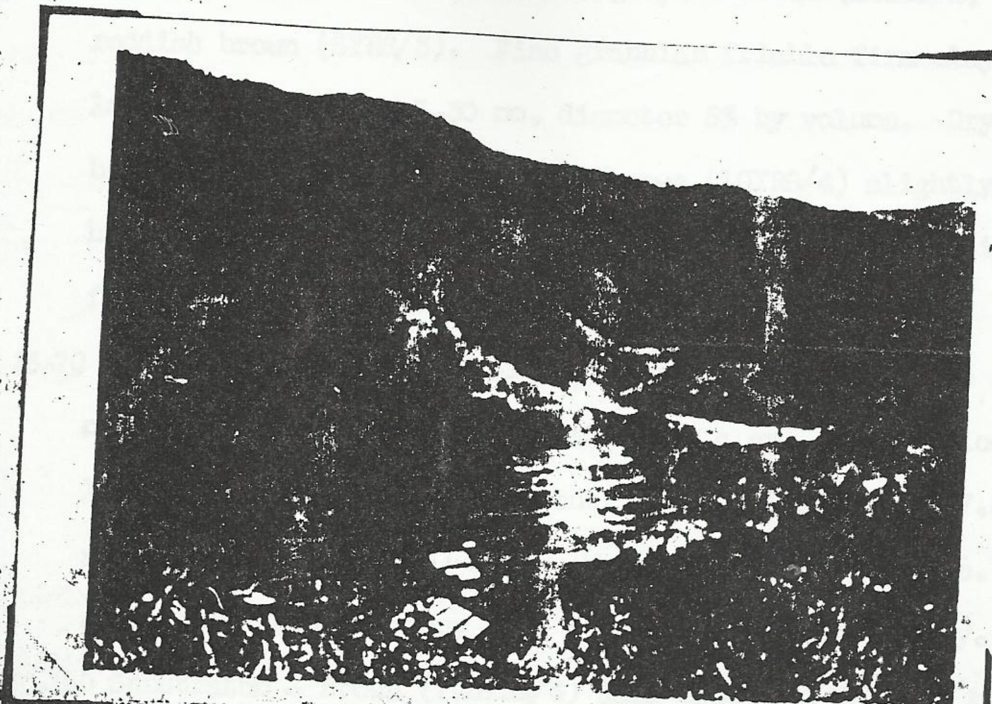

Fig. 16 Typical Relief, Ambasador Series Bonnie Ambasador, Tublay, Ifugao forgot

Fig. 17 Typical Soil Profile Ambasador Series, Tublay, Ifugao

The typical profile characteristics of this series are as follows:

Depth (cm.)	Physical characteristics
0-35	Surface soil - Brown (10YR5/3) grayish brown (10YR5/2) reddish brown (5YR6/3). Fine granular friable firm clay loam. Fine pebbles 5-30 mm. diameter 5% by volume. Dry-brown (10YR5/3) light yellowish brown (10YR6/4) slightly hard. Wet-slightly sticky and slightly plastic. Plentiful small roots and few big pores. Boundary diffused.
35-70	Subsoil - Dark brown (7.5YR4/2) reddish brown (5YR4/3) medium sub-angular blocky friable firm clay. Few pebbles like the above layer are present. Dry - Light brown (7.5YR6/4) reddish yellow (5YR6/6) hard. Wet - Sticky and plastic. Few small roots and few very fine pores. Diffused boundary.
70-150	Substratum - Brown (7.5YR4/4) dark brown, (7.5YR3/2) medium sub-angular blocky friable frim clay. Coarse skeleton 5% by volume is present. Dry - Yellowish red (5YR5/6) red (5YR5/8) hard. Wet - Sticky and plastic. Few medium roots and few very fine pores.

Ahuan clay loam (98). Only one soil type under the series was mapped. It was mapped in Brgy. Saytan, Tuba, Bonga at in the vicinity of the gate to Kennon Road. Relief is moderately steep to very steep. Drainage is good to excessive. It has an area of 7,159.209 hectares or 2.697 per cent of the provincial total area.

The surface soil is brown, grayish brown, reddish brown fine granular friable firma clay loam. Fine pebbles 5-30 mm. diameter

5% by volume are present. Depth is 23-35 centimeters from the surface. The subsoil is dark brown to reddish brown, medium sub-angular blocky friable firm clay. Few pebbles 5% by volume are present in this layer. Hard when dry, sticky and plastic when wet. Depth is 35-70 centimeters from the surface. The substratum is brown to dark brown, medium, sub-angular blocky friable firm clay. Coarse skeleton 5% by volume is present. Hard when dry, sticky and plastic when wet.

Rice, bananas, avocado and mangoes are grown with the following average yield. Rice 20 cavans and bananas - 400 bunches.

ATOK SERIES

The soil under this series was developed from highly weathered diorite materials. The relief is steep to very steep. External drainage is good to excessive while internal drainage is good. It is located along the road to Atok starting from the junction of Benguet-Bontoc road and Atok road up to Atok poblacion and along the Amburayan River. It is also found in the town of Kapangan. The soil is mostly barren with patches of pine trees. Rice terraces along the Amburayan River are planted to rice while steep slopes are planted to coffee, cabbage and sayote. It is at an elevation of 4,175 feet above sea level.

Depth (cm.) Physical characteristics

0-15 Surface soil - Dark reddish brown (5YR3/4) medium granular friable (firm) sandy loam. Dry - Brown (7.5YR5/4) slightly hard. Wet - Dusky red (2.5 YR3/2) slightly sticky. Few very fine pores and few small roots. Boundary diffused.

15-38 Subsoil - Dark roddish brown (5YR3/4) friable coarse sub-angular blocky clay loam. Dry - Roddish yellow (5YR6/8) slightly hard. Wet - Yellowish rod (~~5YR6/8~~ 5YR4/4) sticky and plastic. Few very fine pores and few small roots. Boundary diffused.

38-65 Lower subsoil - Rod (2.5YR4/8) coarse sub-angular friable clay loam. Dry - Light rod (2.5YR6/8) slightly hard. Wet - Rod (2.5YR5/8) sticky and plastic. Few very fine pores and few fine roots. Boundary diffused.

65-150 Substratum - Rod (2.5YR4/8) coarse sub-angular blocky friable loam. Dry - Light rod (2.5YR6/6) slightly hard. Wet - Rod (10YR4/6) slightly sticky and slightly plastic. Few very fine pores and few fine roots.

Atok sandy loam (104) . - This is the only type delineated under the series. It is found along the road to Atok starting from the junction of Bonguot-Buntoc road up to Atok poblacion and along the Amburayan River and in Kapangan. It has an area of 1,355.730 hectares or 0.520 per cent of the provincial total. The relief is steep to very steep. Excessive external drainage and good internal drainage. It is found at an elevation of 4,175 feet above sea level. Organic matter content is 5.83 per cent.

The surface soil is dark roddish brown medium granular friable firm sandy loam, slightly hard when dry. Slightly sticky when wet. Depth is 0-15 centimeters from the surface. The subsoil is dark roddish brown friable coarse sub-angular blocky clay loam. Slightly hard when dry, sticky and plastic when wet. Depth is 15-38 centimeters from the surface. The lower subsoil is friable coarse sub-angular

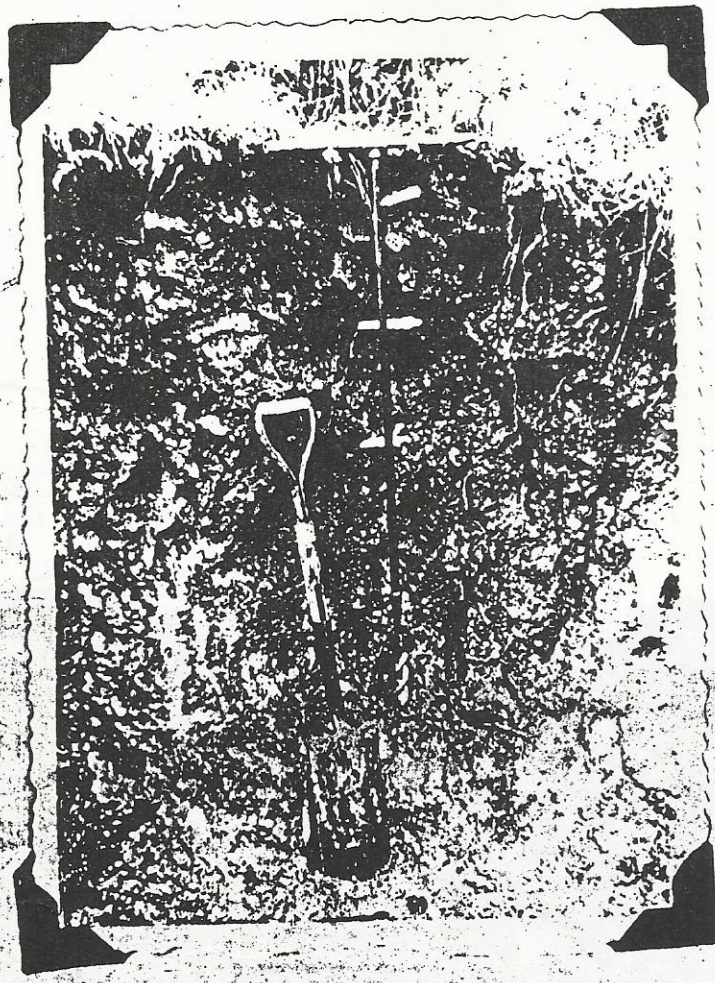

Fig. 18 Atok soil profile

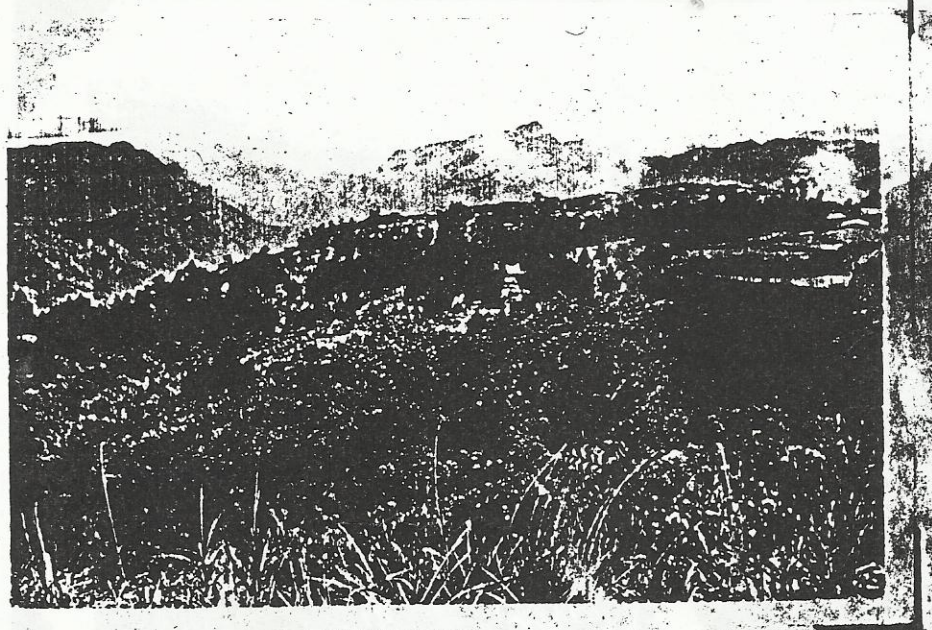

Fig. 19 Physiography of Atok series

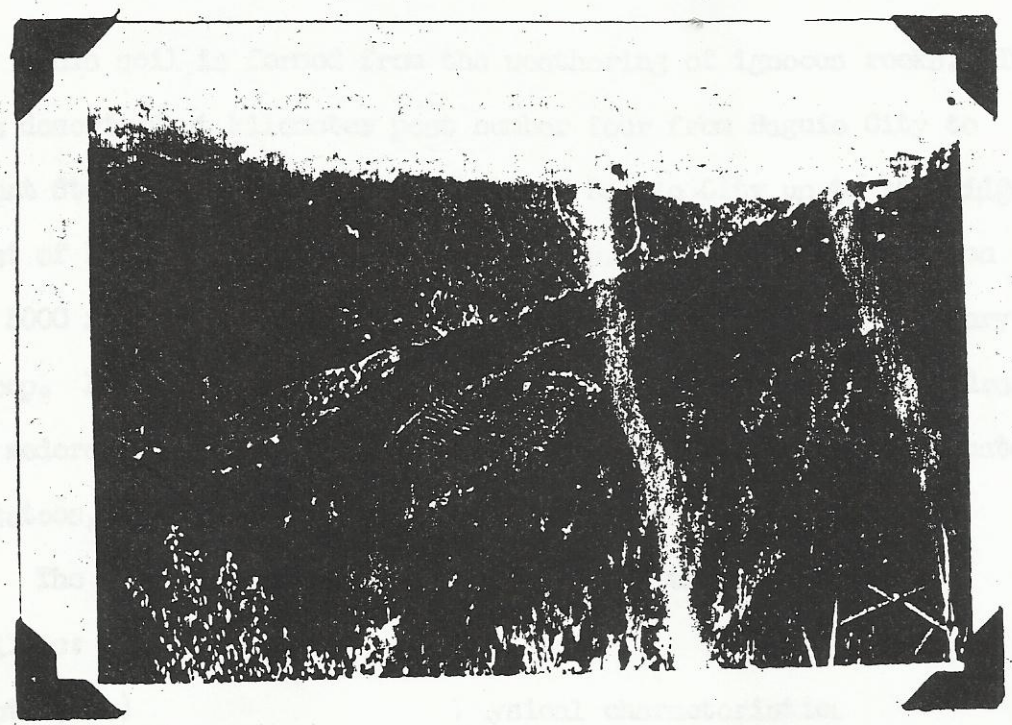

Fig. 2p New kaingin in Atok, Benguet

friable clay loam. Slightly hard when dry, sticky and plastic when wet. Depth is 38-65 centimeters. The substratum is red coarse, sub-angular blocky friable loam. Slightly hard when dry. Slightly sticky and slightly plastic when wet. ~~Slightly hard when dry. Slightly sticky and slightly plastic when wet.~~

The crops produced from this soil type are coffee, rice, cabbage and sayote with the following average yield per hectare. Coffee - 1 ton, rice - 25 cavans, cabbage - 10 tons and sayote - 10 tons. All the soils are subject to erosion and permanent trees are recommended to be planted. However, those planted to annual crops should be protected from erosion.

BAKAKENG SERIES - (M)

This soil is formed from the weathering of igneous rocks. It was described at kilometer post number four from Baguio City to Mount Sto. Tomas. The eastern half of Baguio City up to the ridge west of Binga Dam represents this series. It is at an elevation of 5000 feet above sea level. Relief is moderately steep to very steep. External drainage is good to excessive while internal drainage is moderately slow. Crops grown are cabbage, Baguio beans, tomatoes, potatoes, camote coffee, raddish and flowering plants.

The typical profile characteristics of the series are as follows:

Depth (cm.)	Physical characteristics
0-23	Dark reddish brown (2.5YR3/4) to dark red (2.5YR3/6) fine granular friable sandy clay loam. Dry - Very hard reddish brown (5YR4/4). Wet - Very sticky and plastic, yellowish red

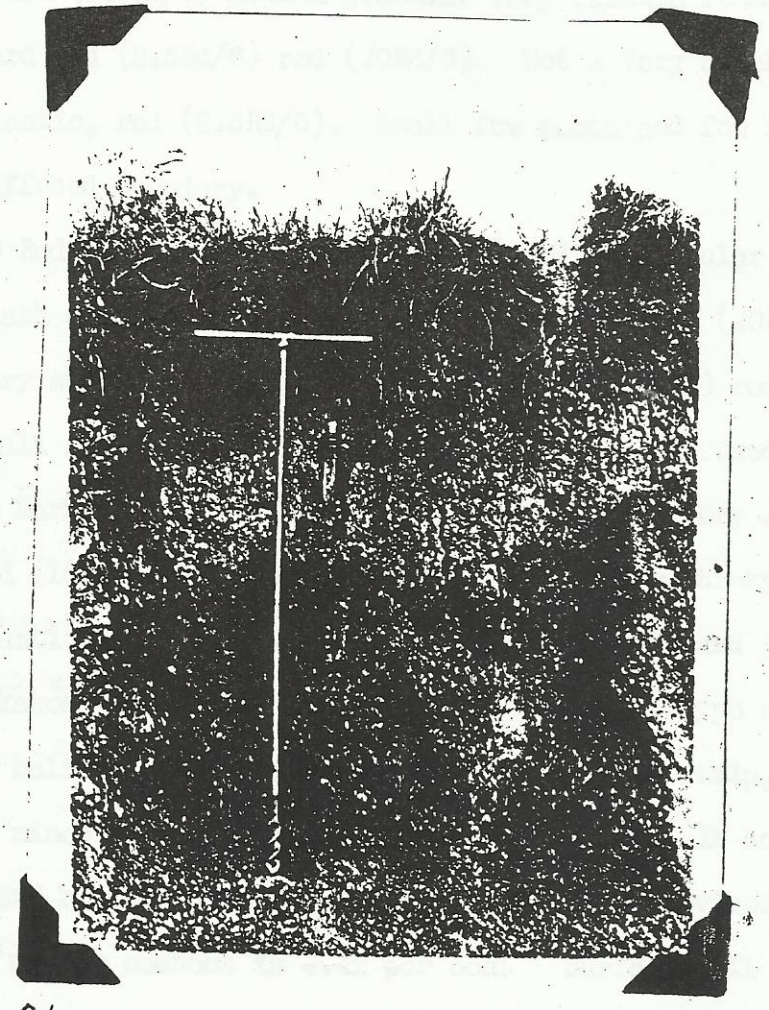

Fig. 2/ Bakakeng soil profile Baguio City

(5YR4/6). Large plentiful roots and few very fine pores. Diffused boundary.

21-65 (2.5YR4/6) (2.5YR4/8) medium granular very firm clay loam. Dry - Very hard rod (2.5R4/6) rod (2.5R4/8). Wet - Very sticky and plastic. Rod (2.5R4/6). Small few roots and few very fine pores. Boundary diffused.

65-122 Rod (2.5R5/6) medium granular very friable loam. Dry - Very hard rod (2.5R4/6) rod (10R4/8). Wet - Very sticky and slightly plastic, rod (2.5R5/6). Small few roots and few fine pores. Diffused boundary.

122-140 Rod (2.5R5/6) to rod (2.5R4/8) medium granular loam with black concretions. Dry - Very hard, weak rod (10R4/4). Wet - Very sticky and slightly plastic rod (2.5YR4/6) rod (2.5YR4/8). Small few roots and few very fine pores. Diffused boundary.

140-150 Dark rod (2.5YR3/6) medium granular loam. Dry - Hard, pale rod (10R6/3) pale rod (10R6/4). Wet - Very sticky and slightly plastic dark rod (2.5R3/6). Small few roots and few fine pores.

Bakakeng sandy clay loam (1045). This soil type occupies the eastern half of Baguio City including Loakan air strip, Antamok and Balatoc mines up to the ridge west of Binga Dam. It has an area of 13,557.827 hectares, or 5.106 per cent of the provincial total. Organic matter content is 4.42 per cent. Surface soil - Dark reddish brown to dark red fine granular friable sandy clay loam. Dry - Very hard, very sticky and plastic when wet. Depth is 21-35 centimeters from the surface. Upper subsoil - red medium granular very firm clay loam. Dry - Very hard and red, wet very sticky and

23-65

plastic when wet. Depth is ~~21-23~~ centimeters from the surface. Lower subsoil - Red medium granular loam with balck concretions. When dry it is red to weak red and very hard. Wet - Very sticky and slightly plastic. Depth is 65-140 centimeters from the surface. The substratum is dark red medium granular loam. When dry it is hard and pale red and when wet very sticky and slightly plastic dark red. The crops with their average yield per hectare are as follows: Camote 5 tons, coffee 1 ton, Baguio beans 1 ton, pechay 3 tons, cabbages 10 tons and potatoes 15 tons.

This soil type is more adopted to permanent crops but due to the favorable climate for vegetables great care should be applied to minimize soil erosion.

Balacbak Series (M)

This soil is formed from the weathering of limestones. It is found along Kapangan-Kibungan road starting from Bo. Balacbak, Kapangan up to Bo. Sagpat, Kibungan. It is found at an elevation of 3,100 feet above sea level. Relief is moderately steep to very steep. External drainage is good to excessive while internal drainage is moderately slow due to high water table. Boulders of limestones characterize the soil series. Lowland rice is the principal crop and it is planted two times a year with good irrigation water.

Other crops grown are Baguio beans and sweet potatoes.

Depth (cm.) Physical characteristics

0-25 Surface soil - Dark brown (7.5YR4/2) medium granular friable firm gravelly loam. Gravel occupies 30% by volume. Dry - Dark brown (7.5YR3/3) slightly hard. Wet - Dark brown (7.5YR3/2) slightly plastic and slightly sticky. Boundary diffuse. Very few pores and abundant medium roots.

25-150 - Yellowish brown (10YR5/8) medium granular friable loam. Dry - Dark yellowish brown (10YR4/4) slightly hard. Limestone gravels 30% by volume are embedded in this horizon. Wet - Brown (7.5YR4/4) slightly sticky and slightly plastic. Few very fine pores and few fine roots.

Balakbak gravelly loam (1040). This is the only soil type mapped under the series. It is found in Bo. Balakbak, Kapangan and in Sagpat, Kibungan. They are mapped in three different places along Kapangan-Kibungan road. It has an aggregate area of 761.112 hectares or 0.286 per cent of the total area of the province. It is found at an elevation of 3,100 feet above sea level. Relief is moderately steep to very steep. Drainage is excessive externally and moderately slow internally due to high water table. Organic matter content is 1.94%.

The surface soil is dark brown medium granular friable firm gravelly loam with 30% gravel by volume. Slightly hard when dry, plastic and slightly sticky when wet. Depth is 0-25 centimeters from the surface. The second layer 25-150 centimeters below the surface is yellowish brown medium granular friable loam. Slightly hard when dry. Limestone gravels 30% by volume are present. Organic matter content is 3.9%.

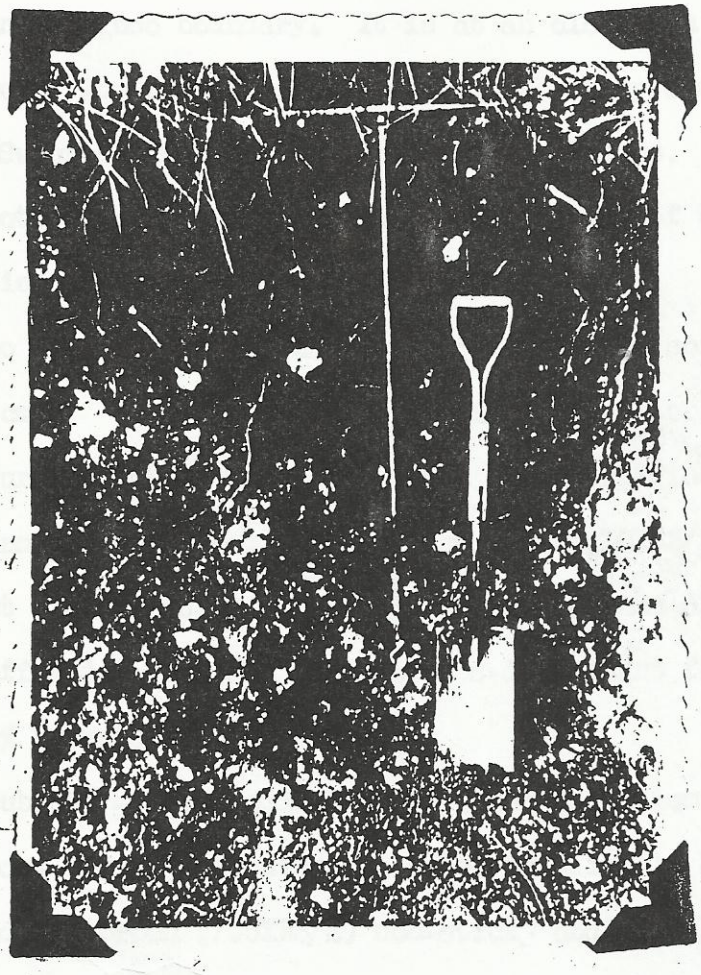

Fig. 22 Balakbak soil profile

organic matter is 3.94%.

Slightly sticky and slightly plastic when wet. The average yield per hectare are as follows: Rice, 25 cavans; sweet potatoes, 5 tons. The soil type is conducive to soil erosion and great care should be given to minimize soil erosion.

BALILI SERIES (M1

The soil is formed from the weathering of conglomerates. It is found northeast of Mankayan in Bo. Balili, Mankayan along Benguet-Mountain Province boundary. It is at an elevation of 4850 feet above sea level. The relief is sloping to moderately steep. Drainage is good. Sweet potatoes is the most important crop. Other crops grown are camote, pechay, and cabbage. Some portion of the series is with irrigation water.

The typical profile characteristics of the series are as follows:

Depth (cm.) Physical characteristics

0-24 Surface soil - Very dark brown (10YR2/2) fine granular friable firm gravelly loam. Dry - Dark brown (10YR3/3) slightly hard. Wet - Black (5YR2/1) slightly sticky and non-plastic. Boundary diffused. Very few fine pores and abundant fine roots. Gravels 30% by volume are present.

24-84 Subsoil - Dark reddish brown (5YR3/4) medium granular sandy loam. Dry - Yellowish red (5YR4/8) slightly hard. Wet - Dark reddish brown (7.5YR3/2) non-sticky and non-plastic. Few very fine pores and few fine roots. Diffused boundary.

84-150 Substratum - Reddish brown (5YR4/4) medium granular friable sandy loam. Dry - Reddish brown slightly hard. Wet - Reddish brown (5YR4/3) with few very fine pores.

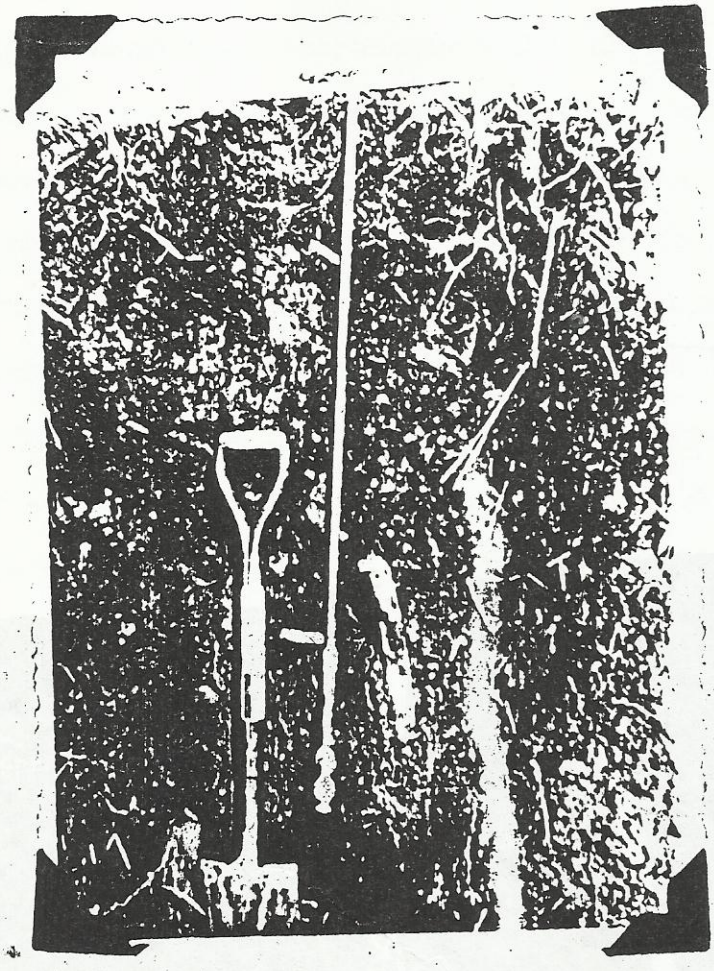

Fig. 23/24 Balili soil profile in Mankayan, Benguet

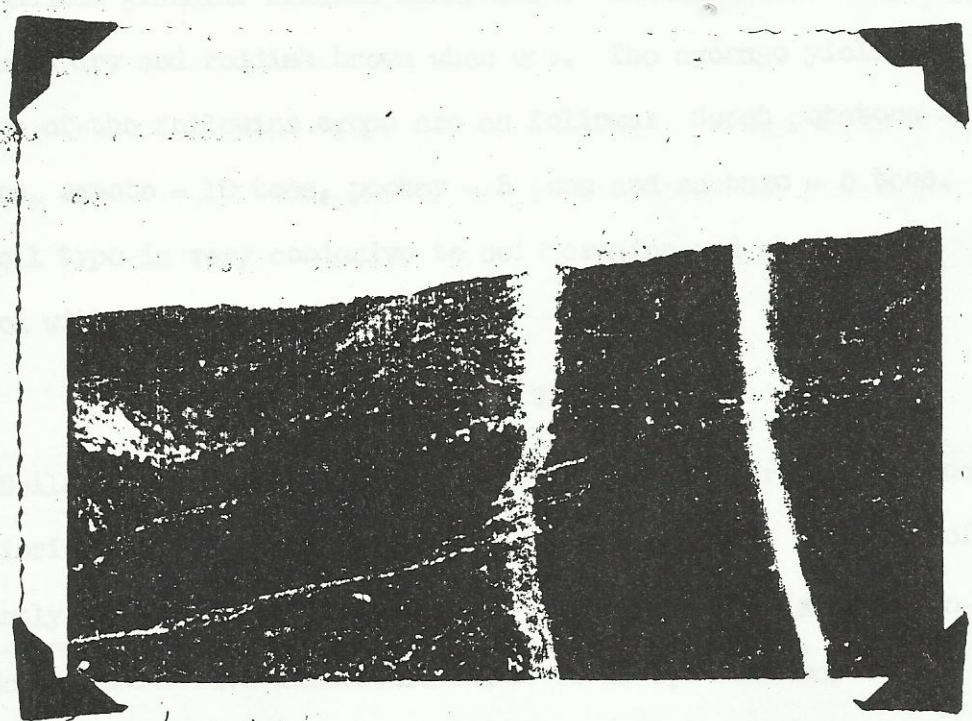

Fig. 23 Physiography of Balili series in Mankayan, Benguet

Balili gravelly loam (1042). This is the only soil type under the series. It is mapped northeast of Mankayan town in Bo. Balili near the Benguet-Mountain Province boundary. It has an area of 166.493 hectares or 0.062 per cent of the provincial total. Organic matter content is 1.03%.

The surface soil is very dark brown fine granular friable firm gravelly loam. Gravel is about 30% by volume. When dry, it is dark brown and slightly hard. When wet it is black slightly and non-plastic. Depth is 20-24 centimeters from the surface. The subsoil is dark reddish brown medium granular sandy loam. Yellowish red slightly hard when dry. Dark reddish brown when wet. Depth is 24-84 centimeters from the surface. The substratum is reddish brown medium granular friable sandy loam. Reddish brown slightly hard when dry and reddish brown when wet. The average yield per hectare of the following crops are as follows: Sweet potatoes - 20 tons, camote - 10 tons, pechay - 5 tons and cabbage - 5 tons. The soil type is very conducive to soil erosion and should be handled with great care.

BENING SERIES - (102)

Soils of this series were developed from weathered sandstone and diorite. It is about 3,500 feet above sea level. The relief is gently sloping to sloping with good drainage. It is found in Bo. Bonong about five kilometers north of La Trinidad capitol. Rice and Baguio beans are the principal crops. Coffee is also grown.

The typical profile characteristics of the series are as follows:

Depth (cm.) Physical characteristics

0-20 Surface soil - Reddish brown (5YR3/4) (5YR4/4) fine granular friable loam. Few pebbles are present. Dry - Dark brown (7.5YR4/4) friable to slightly hard. Wet - Dark brown (7.5YR3/2). Boundary diffused. Few fine small roots and abundant very fine pores.

20-60 Subsoil - Yellowish red (5YR4/3) (5YR4/1) fine granular friable sandy loam. Pebbles are present about 10 per cent by volume. Dry - Strong brown (7.5YR5/6) medium granular to sub-angular blocky, slightly hard. Wet - Reddish brown (5YR4/4) yelowish red (5YR4/6). Boundary diffused. Abundant very fine pores and few fine roots.

60-90 Lower subsoil - Yellowish red (5YR5/6) (10YR4/4) dark yellowish brown medium sub-angular blocky friable sandy loam with rounded pebbles 10% by volume. Dry - Yellow (10YR7/6) (10YR7/6) slightly hard. Wet - Yellowish red (5YR4/6). Boundary diffused, abundant very fine pores and few fine roots.

90-120 Upper substratum - Dark brown (10YR4/3), dark yellowish brown (10YR4/4) medium sub-angular blocky friable sandy loam with pebbles, 10% by volume. Dry - Pale yellow (2.5YR8/4), pale yellow (2.5Y7/4) slightly hard. Wet - Yellowish brown (10YR5/4). Boundary diffused. Abundant very fine pores.

120-150 Lower substratum - Dark yellowish brown (10YR4/4), strong

brown (7.5YR5/6) medium sub-angular blocky very friable clay loam. Dry - Yellowish (10YR7/6) brownish yellow (10YR6/6), slightly hard. Wet - Yellowish brown (10YR5/8) sticky and plastic. Abundant very fine pores.

Bonsing loam (1033). This is the only soil type mapped under the series. It is found north of La Trinidad Capitol in Bo. Bonsing about 5 kilometers from the capitol. The land is gently sloping to sloping. It is found at an elevation of 3,500 feet above sea level. It has an area of 451.910 hectares or 0.180 per cent of the provincial total. External drainage is excessive while internal drainage is fair. Organic matter content is 3.66 per cent.

The surface soil is reddish brown fine granular friable loam. Few pebbles are present. Friable and slightly hard when dry. Depth is 17-20 centimeters from the surface. The subsoil is yellowish red fine granular friable sandy loam. Pebbles are present about 10 per cent by volume. Slightly hard when dry. Depth is ~~17~~ 20-60 centimeters from the surface. The lower subsoil is yellowish red, dark yellowish brown medium sub-angular blocky friable sandy loam with rounded pebbles 10% by volume. Slightly hard when dry. Yellowish red when wet. Depth is 60-90 centimeters from the surface. The upper sub-stratum is dark brown, dark yellowish brown medium sub-angular blocky friable sandy loam with pebbles 10% by volume. When dry pale yellow and slightly hard. Yellowish brown when wet. Depth is 90-120 centimeters from the surface. The lower substratum is dark yellowish brown to strong brown medium sub-angular blocky friable clay loam. Dry - yellow to brownish yellow slightly hard. Yellowish

brown sticky and plastic when wet.

Gently sloping areas are terraced and planted to rice while the sloping areas are planted to Baguio beans and coffee with the following average yield per hectare. Rice 20 cavans, coffee one ton and Baguio beans one ton. To maintain soil fertility and improve the yield the appropriate fertilizer should be applied. Strip cropping and cover cropping should be practiced on cultivated sloping grounds to minimize erosion.

BURGOS SERIES

This soil is developed from weathered andesite, basalt and diorite. It is found along the Aguilian road starting from the vicinity of barrio Banangan, Sablan down to the boundary of Benguet and La Union. It is an extension of the Burgos series described in La Union. Relief is moderately steep to very steep. External drainage is good to excessive while internal drainage is moderately slow. Elevation is 1,800 feet above sea level. Important crops are pineapples, bananas, ginger and coffee. Natural vegetation is ~~a specie of grass~~ (Tiger grass) made into brooms and cogon.

The typical soil profile characteristics of the series is as follows:

Depth (cm.) Physical characteristics

0-30 Reddish brown (5YR5/4) medium coarse granular slightly compact clay. Dry - Light reddish brown (5YR6/3) and friable. Wet - Reddish brown (5YR4/) to yellowish brown (5Y /6) sticky and plastic. Boundary diffused. Few very fine pores and abundant small roots.

30-60 Yellowish red (5YR5/6) to (5YR5/8) coarse granular friable to sticky clay loam to clay. Dry - Reddish yellow (5YR6/6) yellowish red (5YR4/6) and hard. Wet - reddish brown (5YR5/4) sticky and plastic. Diffused boundary. Few very fine pores and few small roots.

60-150 Yellowish red (5YR5/8) reddish yellow (5YR6/8) coarse granular friable to sticky clay loam to clay. Dry - yellowish red (5YR5/8) and hard. Wet - red (2.5YR5/8) sticky and plastic. Few very fine pores and few fine roots.

Burgos clay (151). This is the only soil type mapped under the series. It is found along Naguilian road starting from Bo. Bannangan, Sablan down to the boundary of Benguet and La Union. Relief is moderately steep to very steep. External drainage is good to excessive while internal drainage is moderately slow. Organic matter content is 2.82%. It occupies an area of 3,878.914 hectares or 1.470 per cent of the provincial total.

The surface soil is reddish brown medium coarse granular slightly compact clay. Light reddish brown and friable when dry. Reddish brown to yellowish brown sticky and plastic when wet. Depth is 20-30 centimeters from the surface. The subsoil is yellowish red coarse granular friable to sticky clay loam to clay. Reddish yellow to yellowish red and hard when dry. Reddish brown sticky and plastic when wet. Depth is 30-60 centimeters from the surface. The substratum is reddish yellow coarse granular friable to sticky clay loam to clay. Yellowish red and hard when dry. Red

sticky and plastic when wet. The crops grown give the following average yields per hectare. Pineapples 1,500 fruits, coffee one ton, ginger 10 tons and bananas 750 bunches.

The crops cultivated easily exhaust the fertility of the soil and application of the appropriate fertilizers is a must. Bench terraces should be constructed before starting to cultivate the land to regulate the flow of water and minimize soil erosion.

BUYAGAN SERIES - (Ca)

This soil is formed from the weathering of limestone rocks. It is moderately steep to very steep. Native vegetations are pine trees and grasses. Drainage is good to excessive. It is at an elevation of 4,125 feet above sea level. It was mapped in La Trinidad, Benguet and includes the site of the Capitol building north of Pico road and extends westward up to barrio Buyagan. Cabbage, pechay, coffee and sayote are grown. South portion of the series is being developed for the expansion of La Trinidad population. Few limestone outcrops characterize the series.

The typical soil profile characteristics are as follows:

Depth (cm.) — Physical characteristics

0-30 Reddish brown (5YR4/4) to yellowish red (5YR5/6) coarse to fine granular friable clay loam. Dry - Reddish yellow (7.5YR6/6) to reddish yellow (5YR7/6) and slightly hard. Wet - Sticky and plastic. Abundant large roots, many very fine pores. Diffused boundary.

30-60 Yellowish red (5YR5/6) to (2.5YR5/8) red, fine granular friable clay loam. Dry - Reddish yellow (5YR5/6) (5YR6/6)

fine granular slightly hard. Wet - Sticky and plastic. Boundary diffused. Many very fine pores and many fine roots.

60-150 Red (2.5YR5/8) (2.5YR4/6) red fine granular, very friable loam. Dry - Soft, light red (2.5YR6/8), (2.5YR5/8) red, concretions of pinkish white (7.5YR8/2) with highly weathered parent materials (10YR7/4) very pale brown, (10YR6/4) light yellowish brown. Wet - non-sticky and non-plastic. Many fine pores and few fine roots.

Buyagan clay loam (1032). Only one soil type was mapped under the series. It was mapped from La Trinidad Capital building and extends westward north of Pico road up to Bo. Buyagan, La Trinidad. It has good to excessive drainage. Area is 523.264 hectares or 0.192 per cent of the provincial total. Organic matter content is 6.81%.

The surface soil is reddish brown to yellowish brown to yellowish red, coarse to fine granular friable clay loam. Reddish yellow slightly hard when dry. Sticky and plastic when wet. Depth is 20-30 centimeters from the surface. The subsoil is yellowish red to red fine granular friable clay loam. Reddish yellow and slightly hard when dry. Sticky and plastic when wet. Depth is 20-60 centimeters from the surface. The substratum is red, fine granular very friable loam. Light red to red and soft when dry. Pinkish white concretions with very pale brown light yellowish brown highly weathered parent materials. Non-sticky

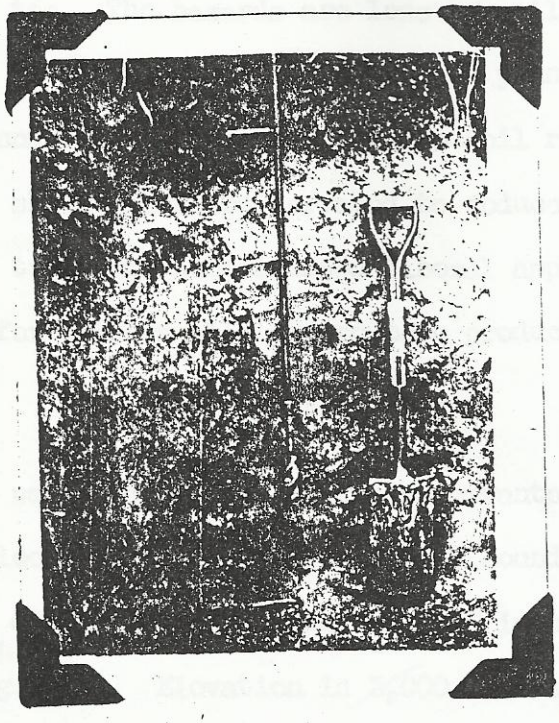

Fig. 75 Buyagan soil profile, Buyagan, La Trinidad

Fig. 76 Buya an physiography

and non-plastic when wet. Crops grown give the following average yield per hectare; cabbage 10 tons, sayote 10 tons, pechay 10 tons and coffee one ton. The hazards are loss of soil fertility and soil erosion. Preferably the soil should be planted to fruit trees to avoid frequent cultivation and minimize soil runoff. For annual crops the land should first be terraced to reduce soil erosion. In both permanent trees and annual crops liberal application of organic and inorganic fertilizers will insure more produce.

CERVANTES SERIES

This soil was mapped along Mankayan-Cervantes road in Bo. Bayoyos and Palocao near Benguet-Ilocos Sur boundary. It is formed from weathered diorite and andesite. Relief is hilly to mountainous with undulating areas. Elevation is 3,000 feet above sea level. Drainage is good to excessive. Vegetation is second growth forest and grassland. Crops grown are patches of lowland rice along the river, pineapples, camote and bananas.

The typical soil profile of the series are as follows:

Depth (cm.) Physical Characteristics

0-15 Reddish brown (2.5YR5/4) red (2.5YR5/8) very friable coarse fragmental loam. Dry - Friable light reddish brown (2.5YR6/4) light red (2.5YR6/6). Wet - Non-sticky and non-plastic. Plentiful small roots, abundant small pores. Diffuse boundary.

15-120 Red (10R5/6) red (10R5/8) friable columnar clay loam to clay. Few rounded gravels are present 5% by volume. Dry - Friable weak red (10R5/4) weak red (10R4/4). Wet - slightly sticky and slightly plastic. Plentiful small roots and plen-

tiful fine pores. Diffused boundary.

120-150 Light gray (10YR6/1) light brownish gray (10YR6/2) loose sandy material which crashes like powder. Dry - Friable light gray (10YR7/1) light gray (10YR6/1). Wet - Non-sticky and non-plastic. Few fine roots and few fine pores.

Corvantes loam (218). This is the only soil type mapped under the series. It is an extension of the Corvantes series described in Corvantes, Ilocos Sur. It is found along Mankayan-Corvantes road in Bo. Bayoyos and Palocao, Mankayan near the boundary of Ilocos Sur and Benguet. Relief is hilly to mountainous with undulating portions. Elevation is 5,000 feet. It has an area of 1,022.744 hectares of 0.385 per cent of the provincial total. Vegetation is mostly grassland. Organic matter content is 2.56%.

The surface soil is reddish brown to red very friable coarse, fragmental loam. Light reddish brown to light red and friable when dry. Non-sticky and non-plastic when wet. Depth is 10-15 centimeters from the surface. The subsoil is red friable columnar clay loam to clay. Few rounded gravels are present 5% by volume. Weak red and friable when dry. Slightly sticky and slightly plastic when wet. Depth is 15-120 centimeters from the surface. The substratum is light gray to light brownish gray, loose sandy material which crashes easily like powder. Light gray friable and gray when dry. Wet - Non-sticky and non-plastic.

The crops grown on the soil type gives the average yield per hectare as follows: Rice, 25 cavans, pineapples, 5,000 fruits, camote, 5 tons and bananas, 300 bunches. The steep areas are

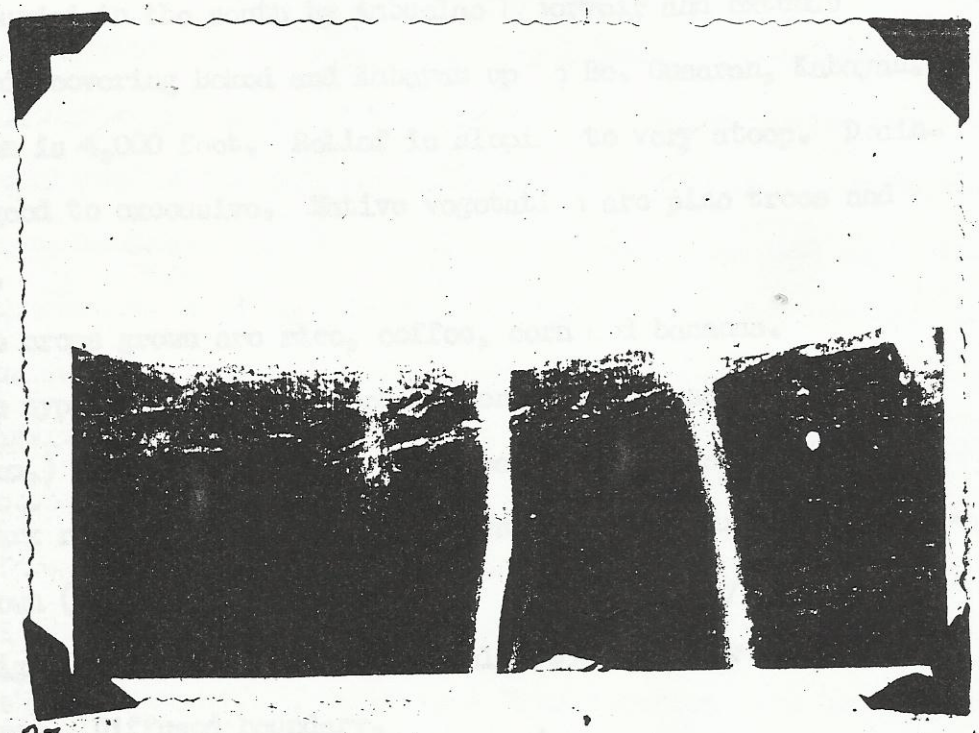

Fig. 27 Physiography of Cervantes series

recommended for permanent tree planting. The undulating areas should first be terraced before they are planted to annual crops to minimize soil erosion. Apply the recommended kind and amount of fertilizer to improve the fertility of the soil and increase yield.

DAKLAN SERIES (Ca)

Daclan series is formed from weathered quartz and diorite. It is bounded in the south by Ambuclao Reservoir and extends northwards covering Bokod and Kabayan up to Bo. Gusaran, Kabayan. Elevation is 4,000 feet. Relief is sloping to very steep. Drainage is good to excessive. Native vegetation are pine trees and grasses.

The crops grown are rice, coffee, corn and bananas.

The typical soil profile characteristics are as follows:

Depth (cm.) Physical characteristics

0-58 Dark reddish brown (5YR3/4) coarse granular firm clay. Dry - Brown (7.5YR5/4), slightly hard. Wet - Slightly sticky and slightly plastic. Plentiful small roots and few very fine pores. Diffused boundary.

58-84 Yellowish red (5YR4/6)(5YR4/8) sub-angular blocky friable clay with few highly weathered parent materials. Dry - Reddish yellow (5YR6/6) slightly hard. Wet - Sticky and plastic. Few fine roots and few very fine pores. Diffused boundary.

84-120 Yellowish red (5YR5/6) (5YR5/8) with big red spots (2.5YR4/6) (2.5YR4/8) friable sub-angular blocky silty clay, slightly compact with few gravels of highly weathered

parent materials. Dry - Reddish yellow (5YR7/6) slightly hard. Wet - sticky and plastic. Few very fine pores and few fine roots. Boundary diffused.

120-150 Reddish brown (5YR4/4) very friable coarse granular clay loam with pinkish gray (5YR6/2) parent materials. Dry - light-reddish yellow (7.5YR7/6) slightly hard. Wet - Slightly sticky and slightly plastic. Few very fine pores.

Datlan clay (1038). This is the only soil type mapped under the series. It is sloping to very steep with undulating areas. It was mapped north of the Ambuclao reservoir and extends northward passing through the towns of Bokod and Kabayan up to Bo. Gusaran, Kabayan. Relief is sloping to very steep with undulating areas. It is at an elevation of 4,000 feet. Drainage is good to excessive. Undulating areas are terraced and planted to rice while sloping areas are planted to coffee, corn and bananas. Organic matter content is 3.70%.

Surface soil is dark reddish brown coarse granular firm clay. Brown and slightly hard when dry. Slightly sticky and slightly plastic when wet. Depth is 0 - 38 centimeters from the surface. Subsoil is yellowish and friable clay sub-angular blocky with few highly weathered parent materials. Reddish yellow and slightly hard when dry. Sticky and plastic when wet. Depth is 38-84 centimeters from the surface. Lower subsoil is yellowish red with red big spots friable sub- angular blocky clay, slightly compact with few gravels of highly weathered parent materials. Reddish yellow slightly hard when dry. Sticky and plastic when wet.

Depth is 84-120 centimeters from the surface. Substratum is reddish brown very friable coarse granular clay loam with pinkish gray parent materials. Reddish yellow slightly hard when dry. Slightly sticky and slightly plastic when wet. The crops grown give the following average yield per hectare: Rice 25 cavans, coffee one ton, corn 10 cavans and bananas 400 bunches.

The soil needs liberal use of organic and inorganic fertilizers to improve soil fertility and increase production. Cover crops should be planted between the coffee and bananas to retard soil runoff and conserve soil moisture.

GUINAOANG SERIES -(M)

This series is derived from igneous rocks mostly diorite. It was described in Bo. Guinaoang, Mankayan. It extends from the vicinity of Bo. Baculi, Buguias to Bo. Tolalo, Mankayan near the boundary of Benguet and Ilocos Sur. The drainage is good to excessive externally while the internal drainage is good. The vegetation are primary and secondary forest. The relief is rolling to mountainous. The areas which do not have very steep slope are being cleared and planted to cabbage, camotoes, Baguio beans and sweet peas.

The typical profile characteristics of the series are as follows:

Depth (cm.) Physical characteristics

0-17 Surface soil, very dark brown (10YR2/2) fine granular friable sandy loam with medium plentiful roots and very few fine pores. Slightly sticky and plastic when wet. Soft when dry, Diffused boundary.

17-74 Subsoil, yellowish red (5YR4/6) yellowish red (5YR4/8) coarse sub-angular blocky friable clay sticky and plastic when wet, hard when dry. Medium plentiful roots and few fine pores. Diffused boundary.

74-105 Lower subsoil, red (2.5YR5/6) red (2.5R4/6) coarse, sub-angular blocky friable clay, sticky and plastic when wet, hard when dry. Few fine roots and few very fine pores. Diffused boundary. Coarse skeleton are present in this layer.

105-150 Substratum, light red (2.5YR6/6) red (2.5YR5/6) coarse sub-angular blocky friable clay with concretions. Sticky and plastic when wet and hard when dry. Few fine roots and few very fine pores.

Guinacang sandy loam (1046). Only one soil type was mapped under the series. It is located along mountain trail starting from Bo. Baculi, Buguias and extends northward up to the vicinity of Bo. Calalo, Mankayan. It has an area of 14,484.02 hectares or 5.455 per cent of the provincial total. Elevation is 4,000 feet. Drainage is good to excessive. Organic matter content is 10.89%.

The surface soil is very dark brown fine granular friable sandy loam with medium plentiful roots and few very fine pores. Slightly sticky and plastic when wet. Soft when dry. Depth is 8-17 centimeters from the surface. The subsoil is yellowish red coarse sub-angular blocky friable clay. Sticky and plastic

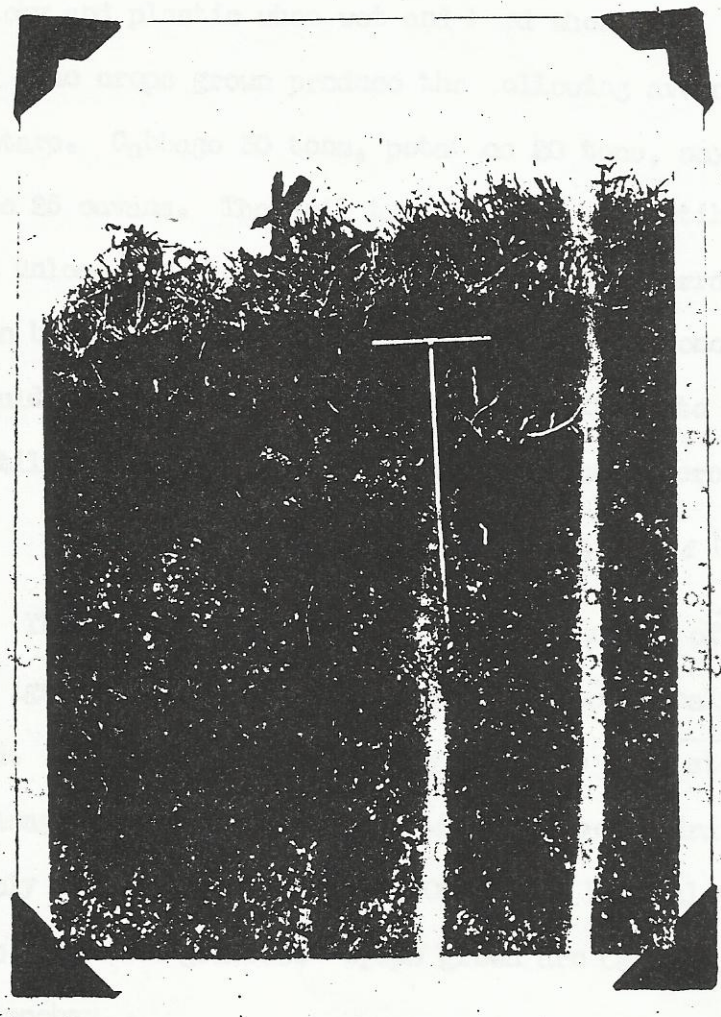

Fig. 30 Guinaoang soil profile in Bugu as, Benguet
Gwk

when wet, hard when dry. Depth is 17-74 centimeters from the surface. The lower subsoil is red coarse sub-angular blocky friable clay, sticky and plastic when wet, hard when dry. Depth is 74-105 centimeters from the surface. The substratum is light red coarse sub-angular blocky friable clay with concretions. Sticky and plastic when wet and hard when dry.

The crops grown produce the following average yields per hectare. Cabbage 30 tons, potatoes 20 tons, sayote 10 tons and rice 25 cavans. The soil type is very susceptible to soil erosion and unless the slopes being cultivated are terraced, the land will soon become unproductive and ultimately abandoned. Graded terrace should be practiced on this farm in addition to the application of fertilizers to maintain soil fertility and increase production.

HALSEMA SERIES - (Ca)

This soil was formed from the weathering of conglomerates and igneous rocks. It was mapped in Acop, Tubaly along Halsema road. The relief is moderately steep to very steep. External drainage is good to excessive while internal drainage is moderately slow. Elevation is 4,300 feet. Natural vegetations are pine trees and grasses. Crops grown are cabbage, potatoes, sayote and pechay.

The typical soil profile characteristics are as follows:

Depth (cm.) Physical characteristics

0-21 Surface soil, dark brown (7.5YR3/2) friable, firm, fine, granular loam. Dry - Dark reddish brown (5YR 3) and hard. Wet-

Slightly sticky and slightly plastic. Few very fine pores and plentiful medium roots. Boundary diffused.

17-34 Subsoil, dark reddish brown (5YR3/4) coarse granular firm clay loam. Dry - Dark reddish brown (2.5YR3/4) and very hard. Wet - Sticky and plastic. Few gravels 5% by volume are in this layer. Few very fine pores and plentiful fine roots. Boundary diffused.

34-84 Substratum, red (2.5YR5/3) fine granular silt loam which is friable. Gravels of about 5% by volume are present. Dry - Dark red (2.5YR3/6), very hard. Wet - Sticky and plastic. Few fine pores and plentiful fine roots. Boundary diffused.

84-150 Lower substratum, reddish brown (5YR4/4) fine granular friable loam. /Highly weathered parent materials are weak red (7.5YR5/4), pale brown (10YR8/4) with black mixture of (10YR2/1) 1-2 mm. diameter. Dry - weak red (10YR4/3) very hard. Wet - Sticky and plastic. Few very fine pores.

Halsema loam (103%). The only soil type under the Halsema series. Area is 451.910 hectares or 0.132 per cent of the provincial total. It is in Acop, Tublay along Halsema road. Drainage is good to excessive. Internal drainage is moderately slow. Elevation is 4,300 feet above sea level. Organic Matter content is 2.18 per cent.

The surface soil is dark brown, friable, firm, fine granular loam. Very hard and dark reddish brown when dry. Slightly sticky and slightly plastic when wet. Depth is 17-21 centimeters from

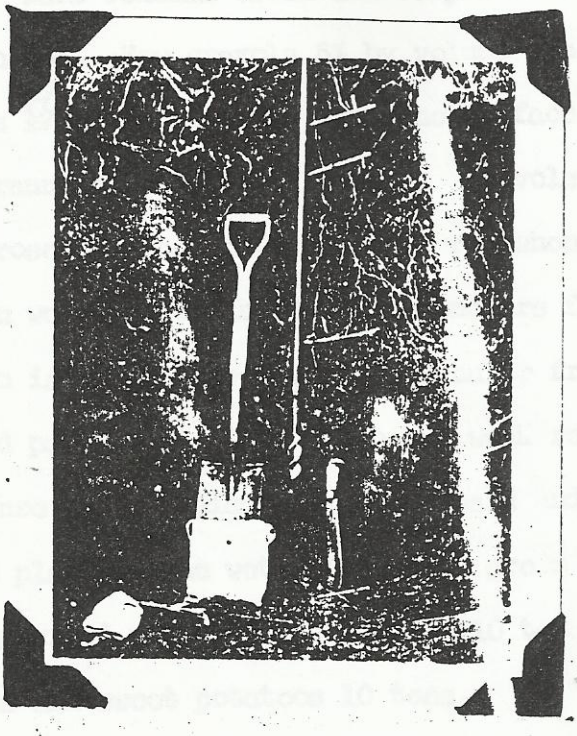

Fig. 34 Halsema soil profile, Acop, Tubla.

Fig. 35 Halsema ~~Mangalisan soil profi~~ , Tuba, Benguet

the surface. The subsoil is dark, reddish brown, coarse, granular, firm clay loam. Dark reddish brown and very hard when dry. Sticky and plastic when wet. Few gravels 5% by volume are present in this layer. Depth is 27-34 centimeters from the surface. Substratum is red, fine, granular, friable silt loam. Gravels of about 5% by volume are present. Very hard and dark red when dry. Sticky and plastic when wet. Depth is 34-84 centimeters from the surface. Lower substratum is reddish brown, fine granular friable loam. Highly weathered parent materials which are weak red to pale brown with black mixture 1-2 mm. diameter. Very hard and weak red when dry. Sticky and plastic when wet. The crops grown give the following average crop yield per hectare. Pechay 10 tons, sayote, 10 tons, cabbage, 10 tons and sweet potatoes 10 tons.

This soil type needs ordinary and special farm management practices to conserve the soil fertility and maintain high yield. There are liberal application of organic and inorganic fertilizers and construction of terraces to regulate the flow of water and minimize soil erosion.

MIRADOR SERIES BM

Mirador series is developed from the weathering of limestone in the vicinity of Mirador hill, Baguio City, including the site of Tuba poblacion and extends southward on the western side of Kennon road down to Twin Peaks. Elevation is 4,500 feet. Relief is moderately steep to very steep. External drainage is good to excessive while internal drainage is slow. Native vegetation are pine trees and grasses. The crops grown are Baguio beans, cabbage,

sayote and sweet potatoes.

The typical soil profile characteristics are as follows:

Depth (cm.) Physical characteristics

0-24 Reddish brown (5YR4/4) yellowish red (5YR4/6) medium granular friable firm clay loam with distinct mottlings. Dry - hard and brown (7.5YR5/4). Wet - sticky and plastic brown (7.5YR5/4) dark brown (7.5YR4/4). Diffused boundary. Small plentiful roots and few very fine pores.

24-48 Yellowish red (5YR5/6) yellowish red (5YR5/8) medium sub-angular blocky firm clay with many fine distinct reddish mottlings. Dry - Hard yellowish red (5YR4/6) yellowish red (5YR4/8). Wet - Very sticky and plastic, reddish yellow (7.5YR6/6). Medium plentiful roots and few very fine pores. Diffused boundary.

48-81 Reddish yellow (5YR6/6) reddish yellow (5YR6/8) coarse, sub-angular blocky very firm clay loam with few faint fine reddish mottlings. Dry - Hard yellowish red (5YR5/6) yellowish red (5YR5/8). Wet - Very sticky and plastic reddish yellow (7.5YR6/8). Medium few roots and few very fine pores. Diffused boundary.

81-150 Mixture of reddish yellow (5YR6/8) to reddish yellow (5YR6/8) and red (10R4/6) red (10R4/8) fine sub-angular blocky very friable sandy loam with fine common distinct reddish mottlings. Dry - Hard reddish yellow (7.5YR6/8). Wet - Very sticky and very plastic mixture of red (2.5YR4/6) and yellowish brown (10YR5/6). Few fine pores.

Mirador clay loam (1048). Only one soil type under the Mirador series was mapped. Located in the vicinity of Mirador Hill, Baguio City including the site of Tuba poblacion and extends southward following the western side of Kennon road down to Twin Peaks. External drainage is good to excessive while internal drainage is slow. It covers an area of 6,6[illegible].945 hectares or 2.449 per cent of the provincial total. Organic matter content is 6.98 per cent.

The surface soil is reddish brown to yellowish red, medium granular friable firm clay loam with common distinct color mottlings. Hard and brown when dry. Brown to dark brown sticky and plastic when wet. Depth is 0-24 centimeters from the surface. The subsoil is yellowish red medium sub-angular blocky fine clay with many fine distinct reddish mottlings. Yellowish red and hard when dry. Reddish yellow sticky and plastic when wet. Depth is 24-48 centimeters from the surface. Lower subsoil is reddish yellow, coarse, sub-angular blocky very firm clay loam with few faint fine reddish mottlings. Yellowish red and hard when dry. Reddish yellow, sticky and plastic when wet. Depth is 48-81 centimeters from the surface. Substratum is a mixture of reddish yellow and red fine sub-angular blocky very friable sandy loam with fine common distinct reddish mottlings. Reddish yellow and hard when dry. Very sticky and plastic mixture of red and yellowish brown when wet. Patches of terraced areas are planted to crops with average yield per hectare as follows: Baguio beans 1 t[illegible] cabbage

10 tons, sayote 10 tons and sweet potatoes 10 tons. Areas that are not terraced may be planted to trees as pine trees, avocado, cacao, cainito, citrus, coffee, jack fruit and apples, pears and persimon. Cover crops should be planted around the trees to cover the ground completely so that soil runoff will be controlled. The terraced areas planted to annual crops should be fertilized, judiciously to improve the yield.

NANGALISAN SERIES -(M)

This soil is developed from weathered diorite and sandstone. It is located in Nangalisan, Tuba starting from the famous hot spring of Asin, Tuba and extends westward along a road to the boundary of Benguet and La Union in Bo. Nangalisan, Tuba. Relief is steep to very steep with patches of undulating areas. Elevation is 1,900 feet. External drainage is good to excessive, while internal drainage is poor. Crops grown are rice, coffee, Baguio beans and cabbage.

The typical soil profile characteristics are as follows:

Depth (cm.) Physical characteristics

0-40 Surface soil, dark brown (10YR4/3) medium granular firm, gravelly clay. Dry - hard and very pale brown. (10YR7/3) to pale brown (10YR5/3). Angular gravel is about 30% by volume. Very sticky and very plastic when wet. Large abundant roots and few very fine pores. Diffused boundary.

40-90 Subsoil, brown (10YR5/3) medium, sub-angular blocky firm gravelly clay loam. Angular gravels of highly weathered

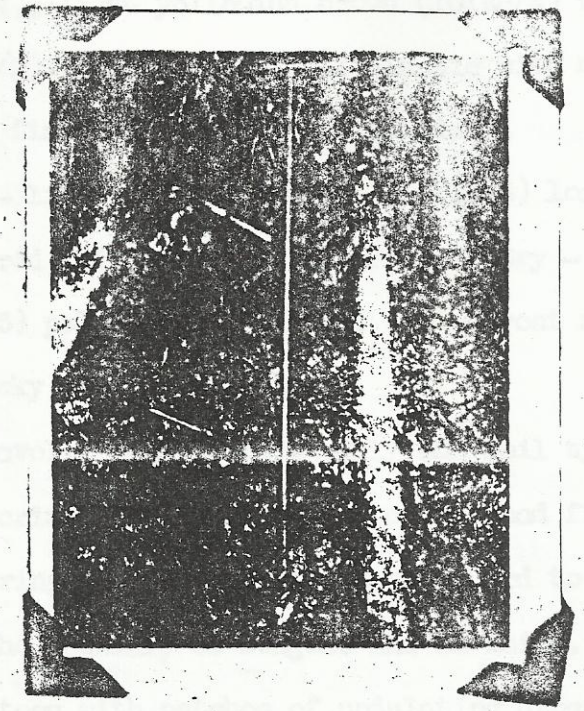

Fig. 36 Nangalisan soil profile, Nangalisan, Tuba, Benguet

parent materials are about 30% by volume. Dry - Hard and very pale brown (10YR7/4), light yellowish brown (10YR6/4) with white concretions (10YR8/2). Wet - Sticky and plastic with many very fine pores and few fine roots. Diffused boundary.

90-150 Substratum - light yellowish brown (10YR6/4) loam with highly weathered friable parent materials. Dry - very pale brown (10YR7/3) pale brown (10YR6/3) hard parent materials. Wet - non-sticky and non-plastic.

Mangalisan gravelly clay (1034). Only one soil type was mapped under the series. It is located along a road from the famous Asin hot spring in Tuba and stretch westward to Bo. Mangalisan, Tuba near the boundary of Benguet and La Union. Relief is steep to very steep with patches of undulating areas. It is an elevation of 1,900 feet. External drainage is good to excessive while internal drainage is poor. Area is 547.049 hectares or 0.206 per cent of the provincial total. Organic matter content is 2.48%.

The surface soil is dark brown, medium granular firm gravelly clay. Angular gravels is about 30% by volume. Hard and very pale brown when dry. Very sticky and very plastic when wet. Depth is 20-40 centimeters from the surface. Subsoil is brown, medium, subangular, blocky, firm gravelly clay loam. Angular gravels of highly weathered parent materials is about 30% by volume. Very hard pale brown to light yellowish brown with white concretions when dry. Sticky and plastic when wet. Depth is 40-90 centimeters from the surface. Substratum is light yellowish brown loam with highly

weathered friable parent materials. Very pale brown to pale brown hard parent materials. Sticky and plastic when wet. The crops grown give the following average yields per hectare. Rice, 30 cavans; cabbage, 6 tons; coffee, 1 ton and baguio beans, 1 ton. This soil type needs special care aside from the application of liberal organic and inorganic fertilizers. The soil should be terraced to minimize runoff.

NATUBLING SERIES (Cd)

Natubling series is developed from weathered diorite, andesite and conglomerates. It was mapped along the Mountain trail starting in the vicinity of Patapat, Atok and extends northward beyond Sinipsip, Buguias. Relief is moderately steep to very steep. Good to excessive drainage. Elevation is 6,950 feet. Area is 12,867.569 hectares or 4.846% of the provincial total. The important crops are cabbage, sweet potatoes, sweet peas and cala lilies.

The typical soil profile is as follows:

Depth (cm.)	Physical characteristics
0-34	Surface soil - brown (10YR4/3) very friable single grained sandy loam. Dry - pale brown (10YR6/3) and loose. Wet - dark brown (10YR3/3) non-stick and non-plastic. Abundant small roots. Abrupt boundary.
34-56	Second layer, dark reddish brown (5YR2/2) fine granular friable silt loam. Dry - dark reddish brown (5YR3/2) and friable. Wet - very dusky red (10YR2/2) non sticky and non-plastic. Abundant fine roots and few very fine pores. Boundary abrupt.

56-75 Third layer, brownish yellow (10YR6/6), fine, gra
friable sandy loam with fine pebbles. Wet - brownish
(10YR6/6) non-sticky and non-plastic. Boundary abr
wavy. Few very fine pores and few fine roots.

75-110 Fourth layer, dark brown (7.5YR3/2) medium granu
loamy sand. Dry - very pale brown (10YR7/4) slight
Wet - reddish yellow (7.5YR6/6). Few very fine pore
few fine roots. Boundary diffused.

110-150 Substratum, yellowish red (5YR4/8), fine granular
clay. Dry - strong brown (7.5YR5/6) slightly hard. Wet -
slightly sticky and slightly plastic. Few fine pore

Natubling sandy loam (1039). This is the only soil type under the Natubling series. It was mapped along Mountain trail starting in the vicinity of Bo. Patapat, Atok and extends northward beyond Bo. Sinipsip, Buguias. Relief is moderately steep to very steep. Good excessive drainage. Elevation is 6,950 foot. Area is 1,367.569 hectares or 4.846 per cent of the provincial total. Organic matter content is 7.26%.

Surface soil is brown, very friable, single grained sandy loam. Pale brown and loose when dry. Dark brown, non-sticky and non-plastic when wet. Depth is 13-34 centimeters from the surface. Subsoil is dark reddish brown fine granular friable silt loam. ~~Dark reddish brown and friable brown, fine granular friable silt loam.~~ Dark reddish brown and friable when dry. Very dusky red, non-sticky and non-plastic when wet. Depth is 34-56 centimeters from the surface. Lower subsoil is brownish yellow fine, granular fri sandy

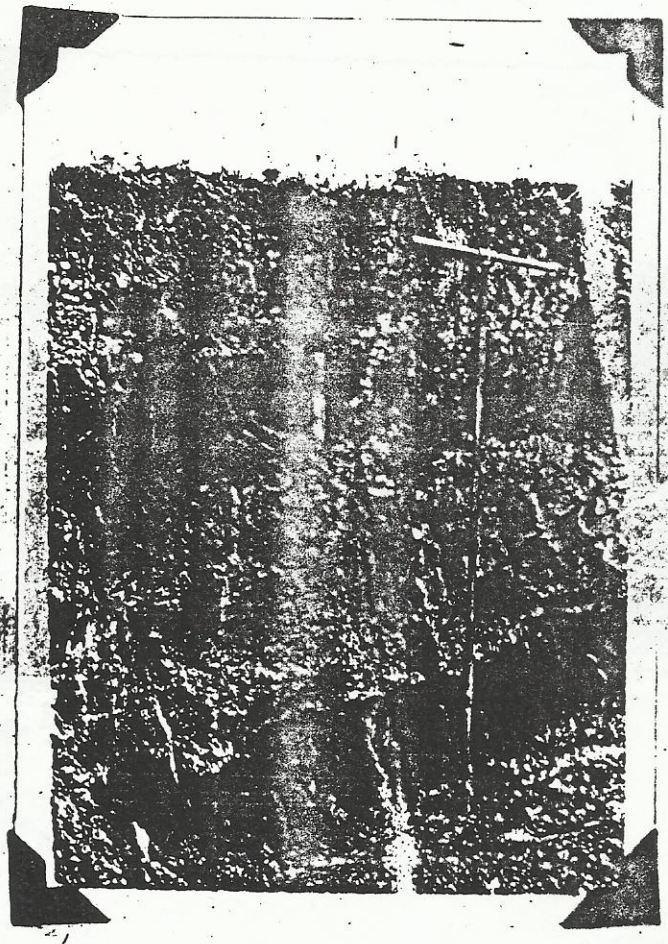

Fig. 38 Natubling soil profile

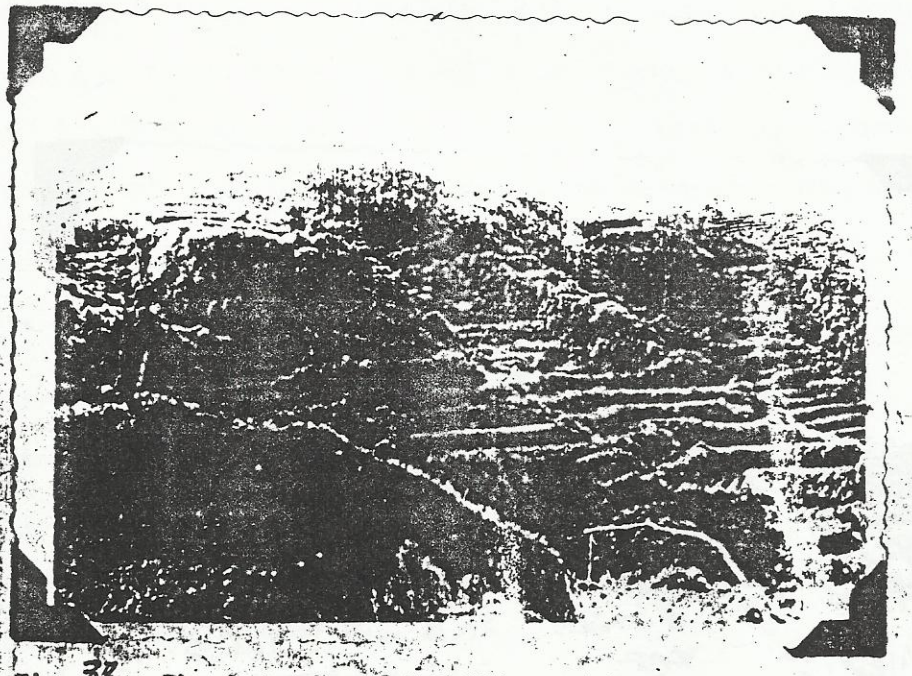

Fig. 34 Physiography of Natubli g series

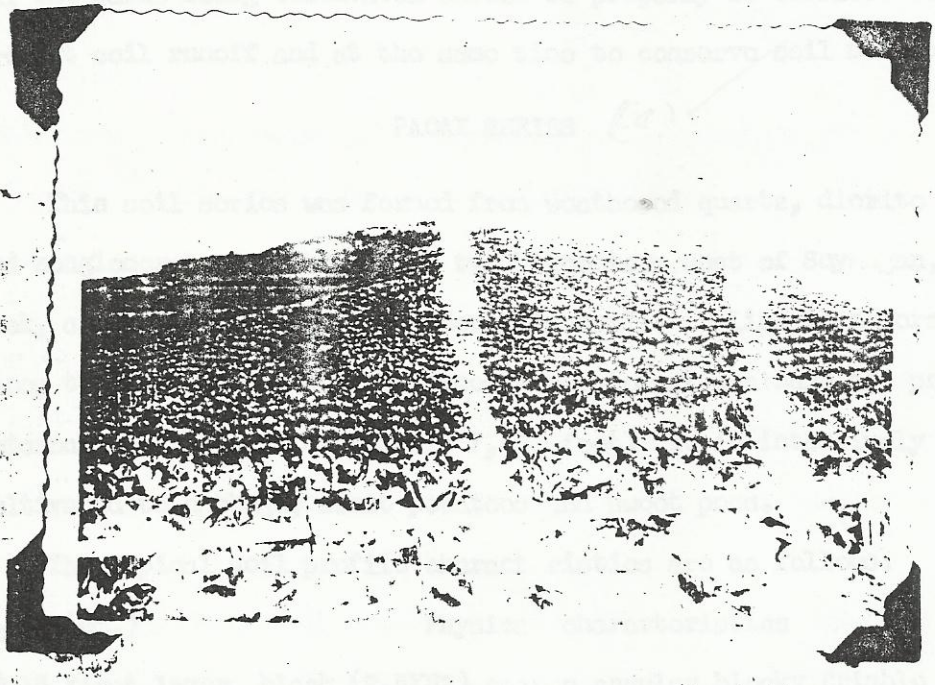

Fig. 39 Cabbage track gardens on Atublin, Atok, Benguet

loam with fine pebbles. Brownish yellow, non-sticky and non-plastic when wet. Depth is 56-75 centimeters from the surface. Second lower subsoil is dark brown granular friable loamy sand. Very pale brown, slightly hard when dry. Reddish yellow when wet. Depth is 75-110 centimeters from the surface. Substratum is yellowish red, fine, granular, friable clay. Strong brown and slightly hard when dry. Slightly sticky and slightly plastic when wet.

The crops grown give the following average yield per hectare. Cabbage, 25 tons; sweet potatoes, 30 tons; sweet peas, 1 ton; and cala lilies, two tons. This soil type is subject to soil erosion. All the farms being cultivated should be properly be terraced to prevent soil runoff and at the same time to conserve soil moisture.

PAOAY SERIES (Pa)

This soil series was formed from weathered quartz, diorite and conglomerates. It is about two kilometers west of Sayaagan, Itok, a popular bus stop along Mountain trail. Relief is moderately steep to very steep. Good to excessive external drainage and poor internal drainage. Elevation is 7,4[illegible] feet. It is intensively cultivated to cabbage, sweet potatoes and sweet peas.

The typical soil profile characteristics are as follows:

Depth (cm.) Physical characteristics

0-15 First layer, black (2.5YN2) coarse angular blocky friable firm loam. Dry - black (7.5YR2) slightly hard. Wet - non-plastic and non-sticky. Plentiful small roots and few very fine pores. Diffused boundary.

15-36 Second layer, very dark grayish brown (2.5Y3/2) to dark grayish brown (2.5Y3/2) to dark grayish brown (2.5Y4/2), fine, sub-angular, blocky friable sandy loam. Dry - Very dark grayish brown (10YR3/2) slightly hard. Wet - non-sticky and non-plastic. Numerous small roots and few very fine pores. Boundary abrupt.

36-60 Third layer, yellowish brown (10YR5/2), fine, sub-angular blocky, friable coarse sand with highly weathered parent materials. Wet - non-plastic and non-sticky. Dry - Pale brown (10YR6/3), light yellowish brown (10YR6/4) and soft. Few very fine pores and few fine roots. Clear and wavy boundary.

60-86 Fourth layer, black (5YR2/1), fine, sub-angular, blocky friable sandy loam. Dry - black (10YR2/1) and hard. Wet - non-plastic and non-sticky. Few very fine pores. Boundary diffused.

86-100 Fifth layer, very dark brown (10YR2/2) coarse, sub-angular blocky friable loam. Dry - very dark brown (10YR2/2), slightly hard. Wet - non-plastic and non-sticky. Boundary diffused. Few very fine pores.

100-116 Sixth layer, dark grayish brown (2.5YR4/2) fine, sub-angular blocky friable sandy loam. Dry - very dark brown (10YR2/2) slightly hard, mixed with pale brown (10YR6/3) yellow (10YR7/6) brownish yellow (10YR6/6). Wet - non-plastic and non-sticky. Boundary clear.

116-150 Seventh layer, black (10YR2/1) to very dark brown (10YR2/2) compact, medium, sub-angular blocky loamy sand. Dry - very

dark brown (10YR2/2) and hard. Wet – non-plastic and non-sticky. Few very fine pores.

/Paccy sandy loam (104S). This is the only soil type [illegible] under the Paccy series. It is found about two kilometers west of Bo. Sayangan, Atok a popular bus stop along Mountain trail. Relief is moderately steep to very steep. Good to excessive external drainage and poor internal drainage. Area is 118.923 hectares of 0.054 per cent of the provincial total. Elevation is 7,[illegible] feet above sea level. Organic matter content is 5.09%.

The surface soil is black coarse angular blocky, friable firm loam, slightly hard and black when dry. When wet, it is non-sticky and non-plastic. Depth is 10-15 centimeters from the surface. Second layer is very dark grayish brown to dark grayish brown, fine, sub-angular blocky, friable sandy loam. Slightly hard, very dark grayish brown when dry. Non-sticky and non-plastic when wet. Depth is 15-35 centimeters from the surface. Third layer is yellowish brown, fine, sub-angular, blocky, friable coarse sand with highly weathered parent materials. Pale brown to light yellowish brown and soft when dry. Non-sticky and non-plastic when wet. Depth is 55-60 centimeters from the surface. Fourth layer is black, fine, sub-angular blockay friable sandy loam. Black and hard when dry. Non-sticky and non-plastic when wet. Depth is 60-80 centimeters from the surface. Fifth layer is very dark brown, coarse, sub-angular, blocky friable loam. Very dark brown mixed with pale brown, yellow, brownish yellow and slightly hard when dry. Non-sticky and non-plastic when wet. Depth is 80-100 centimeters from the surface.

Sixth layer is dark grayish brown, fine, sub-angular blocky friable sandy loam. Very dark brown mixed with pale brown yellow brownish yellow and slightly hard when dry. Non-sticky and non-plastic when wet. Depth is 100-116 centimeters from the surface. Seventh layer is black to very dark brown compact medium sub-angular blocky sandy loam. Dark brown and hard when dry. Non-sticky and non-plastic when wet. The crops grown give the following average yield per hectare. Cabbage, 25 tons, sweet potatoes, 25 tons and sweet peas, 1 ton. The soil may be protected by carefully planned terraces and the proper application of the amount and quality of fertilizers recommended.

PUGUIS SERIES - 'M'

Puguis series is developed from conglomerates, sandstones and diorite. It is found in Bo. Puguis about one and one half kilometer west of La Trinidad capitol building. It is also found west of La Trinidad-Tublay road starting in the vicinity of Acop, Tublay south of Tublay gate and extends northward up to Bontuag junction in Kapangan. The soil series appears again just east of Kapangan poblacion up to the vicinity of Balakbak, Kapangan.

The typical soil profile characteristics are as follows:

Depth (cm.) Physical characteristics

0-20 Surface soil, strong brown (7.5YR4/4), fine, friable gravelly loam. Gravels is about 20% by volume. Dry - strong brown (7.5YR5/8) and soft. Wet - dark brown (7.5YR4/4). Medium plentiful roots and many very fine pores. Diffused boundary.

20-80 Subsoil is reddish brown (5YR4/4) to yellowish red (5YR4/6) fine, granular and friable loam with gravels 7-10 per cent by volume. Dry - brown (7.5YR4/4) and soft. Wet - reddish brown (5YR4/4). Abundant fine pores and medium few roots. Boundary diffused.

80-150 Substratum is yellowish red (5YR4/6) yellowish red (5YR4/8) sandy loam with 15 per cent gravles by volume. Dry - Brown (7.5YR5/4) and soft. Wet - dark yellowish brown (10YR4/4). Few fine pores.

Puguis gravelly loam (105). Only one soil type was mapped under this series. It is found in Bo. Puguis about one and one half kilometers west of La Trainidad capital building. It is also found along La Trinidad Kibungan road starting west of Bo. Acop, Tublay to Bontuag junction, Kapangan. Then starting east of Kapangan poblacion, it extends northward up to the vicinity of Balakbak, Kapangan. Relief is moderately stoop to very stoop with undulating areas. Good to excessive drainage. Area is 6,038.396 hectares or 2.294 per cent of the principal total. Elevation is 4,500 feet. Organic matter content is 7.62%.

The surface soil is brown, fine friable gravelly loam. Gravel is about 20 per cent by volume. Strong brown and soft when dry. Dark brown and slightly sticky when wet. Depth is 10-20 centimeters from the surface. The subsoil is reddish brown to yellowish red, fine, granular and friable loam with 7-10 per cent gravels by volume. Brown and soft when dry. Reddish brown and slightly sticky when wet. Depth is 20-80 centimeters from the surface.

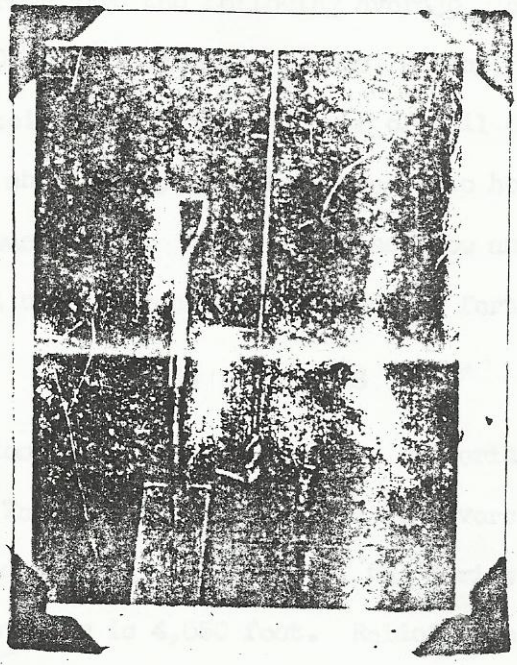

Fig. 42 Poguis soil profile, Poguis , La Trinidad, Benguet

Fig. 43 Poguis Physiography

Substratum is yellowish red sandy loam with 15% gravels by volume. Brown and soft when dry. Dark yellowish brown and slightly sticky when wet.

The crops grown give the following average yield per hectare. Pineapples, 5,000 fruits, cabbage, 2 tons, pechay, 5 tons and rice, 25 cavans. The soil type have the danger of soil erosion. All cultivated areas should be propperly terraced to hold the surface soil from being washed off. Yield is rather low and should be improved by liberal use of organic and inorganic fertilizers.

TACDLAN SERIES (Ca)

Tacdian series is developed from the weathering of limestones. It was mapped in Tacdian, La Trinidad and it covers east and south of the La Trinidad valley. A portion of the series is in Bo. Guinsad, Baguio City. Elevation is 4,050 feet. Relief is sloping to very steep. External drainage is good to excessive, internal is moderately slow. It has an area of 1,831.425 hectares or 0.690 per cent of the provincial total. It is characterize by presence of rough boulder outcrops. The crops grown are pechay, onions, Baguio beans, gabi and sayote.

The typical soil profile characteristics are as follows:

Depth (cm.) Physical characteristics

0-10 Dark reddish brown (5YR3/3) fine granular, friable loam with few pebbles 5% by volume. Dry - dark reddish brown (5YR3/4) dark brown (7.5YR3/) very hard. Wet - slightly plastic and slightly sticky. Plentiful fine roots and few very fine pores. Boundary diffused.

10-50 Dark roddish brown (5YR3/4) dark brown (7.5YR3/2) fine granular clay loam with few pebbles 5% by volume. Dry - roddish brown (5YR3/3) very hard. Wet - sticky and plastic. Very few fine roots and few very fine pores. Boundary diffused.

50-120 Yellowish red (5YR4/3) to red (2.5YR4/6), firm silty clay loam with black concretions (2.5YR2) and white limestone gravels 5% by volume and fragments of highly weathered parent materials. Dry - dark red (2.5YR3/6) very hard. Wet - sticky and slightly plastic. Few very fine pores. Boundary distinct and smooth.

120-150 Dark roddish brown (5YR3/4) firm clay loam with gravels of limestone 80% by volume. Dry - dark roddish brown (5YR3/4) and hard. Wet - Yellowish red (5YR4/6) sticky and plastic. Few very fine pores.

Tacdian loam (1035). Only one soil type was mapped under the Tacdian loam (1035). It is found on the east and south side of the La Trinidad valley. Portion of the soil type is in Bo. Guisad, Baguio City. Area is 1,831.425 hectares or 0.690 per cent of the provincial total. External drainage is good to excessive. Internal drainage is moderately slow. Elevation is 4,050 feet. Organic matter content is 4.04%.

Surface soil is dark roddish brown, fine, granular, friable loam with few pebbles 5% by volume. Dark roddish brown to dark brown and very hard when dry. Slightly sticky and slightly plastic when wet. Depth is 6-10 centimeters from the surface. Second layer

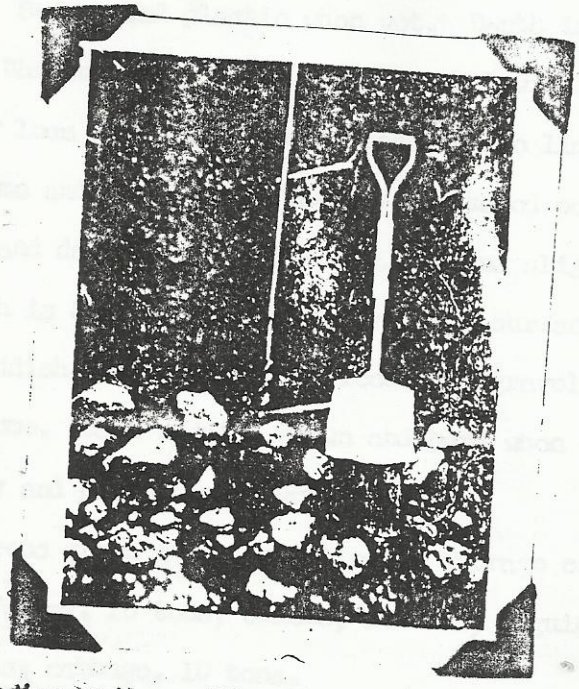

Fig. 44 Tacdian soil profile, Tacdian, La Trinidad

Fig. 45 ~~Buyagan soil profile, Buya~~ , La Trinidad

is dark reddish brown to dark brown, fine granular, firm clay loam with few pebbles 5% by volume. Reddish brown and very hard when dry. Sticky and plastic when wet. Depth is 10-50 centimeters from the surface. Third layer is yellowish red to red firm, silty clay loam with black concretions, white limestone gravels 5% by volume and fragments of highly weathered parent materials. Very hard and dark red when dry. Sticky and slightly plastic when wet. Depth is 50-120 centimeters from the surface. Fourth layer is dark reddish brown, firm clay loam with gravels of limestone 80% by volume. Dark reddish brown and hard when dry. Yellowish red, sticky and plastic when wet.

The crops grown give the following average crop yield per hectare. Pechay, 10 tons; onions, 12 tons; Baguio beans, 1 ton; gabi, 5 tons; cabbage, 10 tons.

This soil type is very critical when it comes to erosion. The surface soil is very thin and unless it is guarded carefully, the top soil may be washed off after a few strong rains. All cultivated areas should be terraced properly to minimize soil erosion.

SOIL COMPLEXES

Guimbalaon-Annam Complex (524). This soil complex is an association of Guimbalaon and Annam soils. It is found in Bo. Bobok, Bokod along the Ambuclao-Cayapa road, starting from Bo. Bobok up to the boundary of Bokod and Cayapa. It is an extension of the Guimbalaon-Annam Complex described in Cayapa, Nueva Vizcaya. Relief is moderately steep to very steep. Elevation is 5,000 feet.

Drainage is good to excessive. Area is 2,616.321 hectares or 0.985 per cent of the provincial total. In some places, boulder outcrops are present, a principal characteristic of Guimbalaon series. The soil complex is presently covered with pine trees and no cultivation is observed. Once deforested it may be converted into terraces for rice or vegetables like those found in Cayapa, Nueva Vizcaya.

MISCELLANEOUS LAND TYPES

Rough mountainous land (202). These lands are very rough and may be best utilized for wildlife, forest and watershed. There are precipitous escarpment, high cliffs where slopes exceed 186 per cent. They are found along Kennon road, along Naguilian road starting about 1 kilometer north of Tuba down to Bo. Amsalsal, Sablan and roads eastward to Tublay and then northward to Kibungan. It is also found east of Mountain Trail starting from the vicinity of Bo. Patapat, Bokol up to the vicinity of the proposed road in the vicinity of Sayangan, Atok to Gucaran, Kabayan. It is also found in the immediate vicinity of Binga and Ambuklao Dams and along the road from Bo. Calisipan Kibungan to Bakun. It has an area of 34,488.887 hectares or 12.98 per cent of the provincial total.

Mountain soils undifferentiated (45). These soils are heavily forested or inaccessible due to lack of roads or trails. Their agricultural value is not yet known. It is found scattered mostly along the boundary of the province. It has an area of 137,574.994 hectares or 51.819 per cent of the provincial total.

Table 14 Key to the soils of Benguet and their Vegetative Cover

Soil type or Miscellaneous land types	Parent Material	Relief	Drainage		Present use of vegetation
			Internal	External	
La Trinidad loam	Recent alluvial deposit	Level to nearly level	Good	Good to fair	Vegetables, corn, flowering plants.
Umiangan sandy loam	Diorite, Quartz diorite	Moderately stoop to very stoop	Good to excessive	Good	Rice, potatoes
Ambasador silt loam	Basalt, tuffaceous rock, sanstone				Pine trees, vegetables and pastures
Annam clay loam	Diorite				Rice, fruit trees
Atok sandy loam	Igneous rock			Moderately slow	Rice, coffee, vegetables, pine trees
Bakakeng sandy clay loam	Limestone				Vegetables, coffee, pine trees
Balakbak gravelly clay loam	Conglomerates	Sloping to moderately stoop	Good	Good	Rice, beans, potatoes
Balili gravelly loam	sandstone, diorite	Gently sloping to sloping			Potatoes, vegetables, coffee
Bonding loam	Andesite, basalt, diorite	Moderately stoop to very stoop	Good to excessive	Moderately slow	Rice, vegetables, coffee
Burgos clay	Limestone				Bananas, coffee, pineapple, broom grass
Buyuzan clay loam	Diorite, andesite	Hilly to mountainous		Good	Vegetables, coffee
Corvantes loam	Quartz, diorite	Sloping to very steep			Rice, coffee, corn, bananas
Daklan clay		Rolling to mountainous			
Guinaoang sandy loam	Conglomerate, Igneous rocks	Moderately stoop to very stoop		Moderately slow	Vegetables, pine trees
Halsema loam	Limestone				
Mirador clay loam					

Soil type and Miscellaneous land type No.	Soil type or Miscellaneous	Parent Material	Relief	Drainage Internal	Drainage External	Present use of vegetation
[illegible]	Naagalisan gravelly clay	Diorite, sandstone	Moderately steep to very steep	Good to excessive	Poor	Rice, coffee, vegetables
[illegible]	Natubling sandy loam	Diorite, andesite, conglomerates			Good	Vegetables, flowering plants, pine trees
[illegible]	Pacoy sandy loam	Quartz, diorite, conglomerates			Poor	Vegetables
[illegible]	Puguis gravelly loam	Diorite, sandstone conglomerate			Good	Pineapple, rice, vegetables
[illegible]	Tacdian loam	Limestone	Sloping to very steep		Moderately slow	Vegetables
[illegible]	Guinbalaon-Annam complex	Sandstone, diorite	Moderately steep to very steep		Good	Pine trees
[illegible]	Rough mountainous land		Mountainous			Primary & secondary forest, grassland
[illegible]	Mountain soils undifferentiated					

either grasslands, primary or secondary forest and the trees are mostly pine trees.

The soil types under this profile class found in Benguet are Ambasador silt loam, Annam clay loam, Atok sandy loam, Bakakeng sandy clay loam, Burgos clay, Cervantes loam, Daclan clay, Guinacang sandy loam, Natubling sandy loam, Pacay sandy loam, Guinbalaoan - Annam complex.

Profile class F. - Under the profile class are soils of older terrace or uplands which were developed through the weathering of limestone. Their relief is undulating on the lower terrace and steeply rolling on the upper terrace. The soils of Benguet found under this profile class are Balakbak gravelly clay loam, Buyagan clay loam, Mirador clay loam and Tacdian loam.

Undulating areas are planted to rice, gabi, onions, beans, pechay, and sweet peas. Upper terraces are usually covered with big boulders and grass with few pine trees.

Profile class G. - Soils belonging to this profile class were developed from sandstone and are poor to medium in fertility. The solum is sandy clay with compact B horizon. Runoff is excessive and soil erosion is a problem. The natural vegetation are grasses and pine trees. The less steep areas are planted to rice, beans, cabbage and potatoes.

The soils in Benguet Province under this profile class are Balili gravelly loam, Bonong loam, Malaeon loam, Mangalisan gravelly clay, and Puguis gravelly loam.

LAND USE CHANGES

Land use changes in the province includes destruction of forests, expansion of cultivated areas and abandonment of depleted grounds due to uncontrolled soil erosion. The people used to open up and cultivate forest lands, without any soil conservation measure, thus rendering the land unproductive after several croppings.

The population explosion which is true everywhere requires more land from which to produce sufficient food. Inspite of the prohibitive slopes of most of the total land surface area of Benguet, the land is still cultivated for crop production. Forested areas are being cleared by Kainginoros to be converted to new farm. Benguet has only about one thousand hectares of level areas located in La Trinidad and Buguias.

In some places along mountain trails the government have allowed the farmers to cultivate even steep slopes provided the farmers terraced their farms. A few who could afford the expansive terracing partly complied but most of the farmers failed because they cannot afford the expenses incurred inspite of the daily food ration given to those who terraced their farms. Vegetables like potatoes, cabbage, pechay, wongbok, sweet peas and Baguio beans are raised extensively, ~~thereby improving the soil to a great extent~~. Chicken manure is used as a source of fertilizer and applied at the rate of 1-3 tons per hectare, varying of course according to the needs of the soil. However, commercial fertilizers, insecticides and pesticides are widely used. In general, horticultural practices are very well managed in all vegetable plantations.

Cultivation by means of hoe, fork, spade, rake and trowel are mostly done, but rarely working animals.

Soils of the plains are of recent alluvium. They are fertile and permit continuous cropping. The soil fertility is maintained by adding chicken manure in addition to the commercial fertilizers. It is these plains where the use of the cattles to plow the field is possible. However, garden cultivations are mostly done by human hands.

In La Trinidad valley the crops are varied and the most common are cabbage, pechay, wongbok, green onions, sweet pepper, sweet peas, Baguio beans, strawberry, tomatoes, celery, roses and other flowering plants. In the limited plain in Buguias the most important crops are rice, potatoes, cabbages, wongbok and pechay.

In all the farms in Benguet, crop rotation, cover cropping, green manuring or buffer and strip cropping are not commonly practiced.

WATER CONTROL ON THE LAND

In the plains, runoff is not much a problem but streambank erosion reduces part of the plains every year due to flush floods. The streambank should be planted to deep rooting grasses to minimize streambank erosion. In the rolling to very steep cultivated area, some are properly terraced and the flow of water is minimized, thus reducing the soil erosion. The dikes are quickly covered with johnson grass and this helps to control runoff. Uncontrolled runoff during heavy rains ultimately influence poor crop yields. The mountainous topography of the province causes the rapid surface

runoff during heavy rains. Opening kaingin areas exposes the rich topsoil to erosion. The soils are carried down to the rivers. During heavy rains the rivers overflow and the plains along the rivers are enriched but sometimes streambank erosion also occur. In the uplands and rolling areas, runoff is brought about by improper land use and poor soil management. Some steep slopes cultivated to annual crops which disturb the soil facilitate surface runoff. Absorption terraces are built across the slopes to conserve the water during rains.

PRODUCTIVITY RATING OF THE SOILS OF BENGUET PROVINCE

Productivity of a soil is its capability to produce a specified crop or sequence of crops under a specified system of management. In this report, soil productivity rating is based on the average crop yield of a soil type in relation to national standards established - the yield being obtained without the use of fertilizer or soil amendments. Yield predictions are arrived at in two principal ways namely, (1) through judgments based upon evidence afforded by actual yield data from sample areas of the soil mapping units, and (2) through judgments based on comparisons of the characteristics of soils and basic knowledge of plant requirements.

Table 15 indicates the productivity ratings of the soils of Benguet for the major crops grown in the province. The productivity ratings were developed mainly from estimates based upon observations and interviews supplemented by a few records of provincial statistician

thus their reliability maybe only considered fair. The soil productivity rating or index for a given crop is expressed in terms of a standard index of 100 for a given crop. Thus, a productivity rating of 75 for a certain crop means that a soil is about three fourths as productive relative to the national standard, or in terms of production the soil could produce 45 cavans of palay or lowland rice while the national standard 60 cavans of palay is produced.

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Table 1 . - Productivity Rating of the Soils of Benguet

Soil Mapping No.	Soil Type	Crop Productivity Index For 1/							
		Lowland Rice 100=60 Cavans	Cropland Rice 100=20 Cavans	Camote 100=8 tons	Bananas 100=900 bunches	Coffee 100=800 kgm.	Sweet 2/ Potatoes 100=8 tons	Pineapple 100=7500 Fruits	Corn 100=17 Cavans
1044	La Trinidad loam						303		
100	Uningan sandy loam	100					212		
98	Annam clay loam		100		44				
1041	Atok sandy loam	41				125			
1045	Bakakong sandy clay loam			62		125	185		
1040	Balakbak gravelly loam	41					62		
1042	Balili gravelly loam			125			250		
1033	Bonéng loam		100			125			
151	Burgos clay				83	125		100	
1032	Buyagan clay loam					125			
218	Corvantos loam	41		62	33			66	
1033	Daklan clay		125		44	125			58
1046	Guinaoang sandy loam		125				250		
1037	Halsema loam						125		
1048	Mirador clay loam						125		
1034	Mangalisan gravelly loam	50				125			
1039	Natubling sandy loam						375		
1043	Paoay sandy loam						312		
1031	Puguis gravelly loam		125					66	
1033	Tacdian loam								
524	Guinbalaoan-Annam complex								

1/ Soils are given
2/ Crop Productivity index for sweet potatoes was based on fertilized crops.

FIELD DETERMINATION OF SOIL TEXTURAL CLASS

The determination of the soil textural class is made in the field mainly by feeling the soil with the fingers. While this requires skill and experience, accuracy can be had if the field scientist frequently checks his field textural classification against laboratory results.

Hereunder are definitions of the basic soil textural classes in terms of field determinations.

Sand. - Sand is loose and single-grained. The individual grains can readily be seen or felt. Squeezed in the hand when dry, individual particles will fall apart when the pressure is released. Squeezed when moist, the particles will form a cast, but will crumble when touched.

Sandy loam. - Sandy loam contains much sand with enough silt and clay to make it somewhat coherent. The individual sand grains can be readily seen and felt. Squeezed when dry, the soil paticles will form a cast which readily falls apart, but if squeezed when moist, a cast can be formed which will bear careful handling without breaking.

Loam. - Loam consists of relatively even mixture of different grades of sand, silt, and clay. It is mellow with a somewhat gritty feel, yet fairly smooth and slightly plastic. Squeezed when dry, the soil particles will form a cast that will bear careful handling, while the cast formed by squeezing the moist soil can be handled quite freely without breaking.

Silt loam. - Silt loam contains a [illegible] amount of the fine grades of sand and only a small amount of [illegible] over half of the particles being of the soil separate called silt. When dry, it may appear cloddy but the lumps can be readily broken and when pulverized it feels soft and floury. When wet the soil readily runs together and puddles. Either dry or moist, the soil particles will form into a cast which can be freely handled without breaking. When moistened and squeezed between the fingers, it will not "ribbon" but will give a broken appearance.

Clay loam. - Clay loam is a fine-textured soil which usually breaks into clods or lumps that are hard when dry. When the moist soil is pinched between the thumb and finger it will form a thin "ribbon" which breaks readily, barely supporting its own weight. The moist soil is plastic and can be formed into a cast that will bear much handling. When kneaded in the hand it does not crumble readily but tends to form into a heavy compact mass.

Clay. - Clay is a fine-textured soil that usually forms very hard lumps or clods when dry, and it is quite plastic and usually sticky when wet. When the moist soil is pinched between the thumb and fingers, it will form into a long, flexible "ribbon". Some fine clays very high in colloids are friable and lack plasticity under all conditions of moisture.

The above definitions are descriptive only. None could be made in these or similar terms that would apply adequately to all soils. The dependable definitions, to date, are those developed from mechanical analyses.

MECHANICAL ANALYSIS

Accuracy in the determination of textural classes of soils delineated during the soil survey is attained through mechanical analysis. Generally, field classification coincides with the results of the mechanical analyses. However, there are instances when field classification and laboratory classification vary. Some soils exhibit clayey textures in the field. They are sticky and plastic when wet, hard or brittle when dry, but actually when analyzed, their clay contents are low. Under these circumstances, the field classifications are maintained except when their clay contents are so low that their final textural classifications are those established by the laboratory.

The soil separates are sand, silt and clay. Sand includes particles from 2.0 millimeters to 0.05 millimeters in diameter; silt from 0.05 to 0.002 millimeters and clay, particles smaller than 0.002 millimeters in diameter. Particles larger than 2.0 millimeters such as gravels, pebbles and cobbles are considered coarse skeleton. Class names such as sand, silt, silt loam, clay loam, clay sandy loam, etc., are determined by the proportionate amount of the different separates present in the soil. A soil with an analysis of 30 per cent or more of clay fraction is considered a clay soil. Lately, however, this percentage was changed to 40, so that all soils containing 40 per cent or more of clay are classified as clay soils.

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The modified Bouyoucos method was employed in the mechanical analysis wherein the conventional jar, hydrometer and thermometer were used. Analysis was made without removing the organic from the soil.

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Table 4 - Average mechanical analysis of the surface soils of the different soil types of Benguet by the Bouyoucos Method.

Soil Type No.	Soil Types	Sand (2.00-0.05 mm.) %	Silt (2.00-0.05 mm.) %	Clay (0.002 mm.) %
1044	La Trinidad loam	39.8	42.6	17.6
100	Umingan sandy loam	54.4	30.4	15.2
1036	Ambasador silt loam	24.7	52.8	19.8
98	Annam clay loam	32.4	32.4	35.2
1041	Atok sandy loam	53.2	32.8	14.0
1045	Bakakong sandy clay loam	66.4	15.2	18.4
1040	Balakbak gravelly loam	43.2	42.8	14.0
1042	Balili gravelly loam	49.2	39.8	11.0
1033	Bonong loam	49.8	33.6	16.11
151	Burgos clay	31.8	26.6	41.6
1032	Buyagan clay loam	32.4	36.8	30.8
218	Cervantes loam	42.4	32.4	25.2
1038	Daklan clay	23.8	27.6	48.6
1046	Guinaoang sandy loam	62.6	25.2	12.2
1037	Halsema loam	42.4	36.4	21.2
1048	Mirador clay loam	31.0	23.2	45.8
1034	Mangalisan gravelly loam	28.8	29.6	41.6
1039	Natubling sandy loam	68.8	23.6	7.6
1043	Pacoy sandy loam	73.6	18.0	8.4
1031	Puguis gravelly loam	47.4	35.8	16.8
1035	Tacdian loam	43.4	33.8	22.8
524	Guimbalaoo-Annam Complex	34.6	41.2	24.2

Previous to 1938, the United States Department of Agriculture used the 0.05 to 0.005 millimeter for the size of silt and smaller than 0.005 millimeter for clay.

II. SOIL EROSION SURVEY

SOIL EROSION DEFINED

Soil erosion is defined as the process of soil detachment and transportation by either wind or water. There are two kinds of erosion; namely, normal or geologic and accelerated erosion.

Normal or geologic erosion. - Normal or geologic erosion takes place in a natural or undisturbed condition under the canopy of forest, grass, ground, litter and in underground network of binding roots. Geologic erosion is a slow process; the removal of the soil by either water or wind is balanced by the formation of soil from the parent material underneath. This kind of erosion is beneficial in the sense that there is a constant renewal of the fertility of the soil.

Accelerated erosion. - Accelerated erosion is the process brought about by man's activities on the land, thereby disturbing the equilibrium between soil building and soil removal. This kind of erosion is destructive as it removes soil particles very much faster than the formation of soils from the material underneath. The loss of the surface soil which contains most of the fertility means also the decline in crop yields. Soil erosion in the Philippines is caused mainly by water. The different kinds of accelerated soil erosion are: sheet, rill, gully and streambank erosion.

Sheet erosion. - This is the washing away in a more or less uniform depth, of the upper part of the soil in the croplands. It occurs when farmers cultivate their sloping lands without applying

any means of controlling the flow of the surface water or runoff. At the beginning, this kind of erosion is slow and not noticeable, but it is treacherously destructive.

Rill erosion. - This kind of erosion is the washing off of the soil by the formation of tiny incisions of a few inches depth and width which run down the slopes of an unprotected cultivated land. This is attributed to the method of planning and arranging the furrows along the slope of the land. Such rills may be erased by ordinary plowing. This type of erosion marks the beginning of the formation of more serious kinds of erosion.

Gully erosion. - This erosion occurs on paths of concentrated flow down a slope and is the cutting of deep narrow strips or gullies on the face thereof. Gullies occur both on alluvial plains as well as on uplands. On a plain where drainage outlets are not protected, the edges of the plain are gradually eroded which consequently form into deep vertical cuts. These gullies, if not checked gradually destroy the plain. On uplands, gullying occurs mostly on slopes where runoff continuously drain. This happens when farmers plow their rice fields up and down the slopes. Some gullies are small, but others are so big that farm animals cannot cross. Gullies grow bigger each year.

Stream bank erosion. - This kind of erosion occurs along the banks of streams and rivers. It is very destructive particularly on such lands where the substratum are of course or medium textured soils. The flowing water undermines the lower part of the river

or stream bank particularly along its outer thus causing the upper part to fall by its own weight.

FACTORS AFFECTING SOIL EROSION

Soil erosion occurs when water runs over the surface of a sloping land. This water running over the surface is called run-off. The rate of soil erosion will depend upon the speed of surface runoff. The volume of runoff as well as its speed depends upon the soil, slope, vegetation and intensity of rainfall in the area.

SOIL

The soil possesses certain physical characteristics which influence its erodibility. Under similar conditions of climate, relief and vegetative cover, there are marked differences in the erodibility of different soils. In some cases sandy loam soils are more susceptible to erosion than clay loam soils. Porosity and permeability are important factors in the formation of runoff. The higher the absorbing quality of the soil or infiltration of water into the soil the less runoff will be formed. Different soil types differ in porosity and permeability. Also soils rich in organic matter are porous and will absorb more water readily than those poor in it.

SLOPE

Slope has a great influence on erosion. Runoff flows faster on

Table 17. Land capability classification of the different soil types of Benguet.

Soil Type No.	Soil Type	Possible soil units, slope, erosion class	Land Capability class
1044	La Trinidad loam	a-o	B_w
100	Umingan Sandy ~~Annam clay~~ loam		B_s
1036	Ambasador silt loam		
98	Annam clay loam		
1041	Atok sandy loam		
1045	Bakakong sandy clay loam		
1040	Balakbak gravelly loam		
1042	Balili gravelly loam		
1033	Bonéng loam	c-o	
151	Burgos clay	d-o	
1032	Buyagan clay loam	c-o	
218	Cervantes loam	c-1	
1038	Daklan clay	d-1	C_o
1046	Guinaoang sandy loam	c-1	D_o
			M_o
1057	Halsema loam	c-2	
1048	Mirador clay loam	d-2	
1054	Nangalisan gravelly clay	c-2	
1059	Natubling sandy loam		
1043	Pacay sandy loam		
1051	Puguis gravelly loam		
1055	Tacdian loam		
524	Guimbalaon annam complex		
202	Rough mountainous land	g-4	
45	Mountain soils undifferentiated	g-2	Y

The slope erosion classes are the possible conditions that may exist for each soil type. Any other unit with an erosion class more than the one specified above will be classed under the next capability class. The Umingan sandy loam with an a-o classification will be classed as B_s.

a steeper slope than on one with lesser grade. Taking other erosion factors equal, soil loss is greatest where runoff is faster. Furthermore, on farm lands with the same grades of slopes, one with a longer slope will erode more than one with a shorter slope. This is so because as runoff acquires momentum its cutting power as well as the soil carrying capacity is increased considerably. A slope unprotected by vegetation or some mechanical devices to decrease the velocity of runoff suffers heavily during a heavy rainfall.

VEGETATION

The density of the vegetative cover of an area contributes a great deal to its resistance to erosion. In the heavily wooded portions of our forests the rate of soil loss is balanced by the formation of soil underneath. On cultivated farms the crops offer very little protection for the soil. Crops that can cover the ground well will give some protection for the soil but clean tilled row crops are conducive to erosion. Lands on slopes exposed or bare of vegetative cover suffers heavy soil losses.

Crop rotation in the province is seldom practiced. Rice, tobacco and corn are planted from year to year. Sometimes the field is followed after the rice crop. A good rotation of crops which includes a soil building legume helps conserve the soil.

The pasture lands are overgrazed. As a result, hillsides have very scanty grass cover and erosion is very much in evidence.

Kaingin. - This is another factor contributing to the destruction of soil and forest. Very often, kaingin clearings are made on steep slopes. The trees and other vegetation are burned, leaving the area cleared and entirely bare. When it rains, runoff rushes downhill and generates quite a tremendous cutting power that detaches and carries a great deal of surface soil. Rills and sometimes gullies often result after one heavy rain.

SOIL EROSION SURVEY METHODS

The primary purpose of the soil erosion survey is to determine the degree of erosion in the different soils of the province, that is, the extent to which removal of the surface or subsoil has progressed as well as the mount of gullying with special reference to its effects on the cultivation of the land.

The present depths of the different soil types under cultivation in the (province) watershed were compared to the depth of the virgin soils or soils with normal profiles. The depths of different soils under normal profiles were established after various determinations over a wide area by boring with the soil auger, studying road cuts, pits, open wells and stream banks.

Variations in the depth of soil caused by erosion together with the presence of gullies are considered in mapping the different erosion classes. The depth and frequency of occurrence of gullies are noted as they affects the cultivation of the land.

In the open areas where cogon predominated very little erosion takes place. The thick growth of cogon is quite adequate protection

of the land. Even on steep slopes the grass cover if preserved and improved will give good protection.

INTENSITY OF RAINFALL

Rainfall intensity is a factor in erosion. A region with rainfall evenly distributed throughout the year will have less soil erosion than another area where the same amount of rain occurs but only within a period of six months. In the latter area the intensity of rainfall is much bigger and hence the amount of runoff is correspondingly greater. In the former case, the intensity of rainfall is less giving more time for the water to infiltrate into the soil, hence, less runoff.

How much of the rain falls, runoff on the surface is shown by investigations conducted by the United States Department of Agriculture. At Yazoo River Watershed, 27 inches of rain caused a disastrous flood, where 62 per cent of the rain water immediately ran off cultivated fields and carried soil at the rate of 54 tons per acre. Runoff from plots on barren abandoned fields was 54 per cent of the total rainfall. Surface runoff during the most intense rains increased from 75 to 95 per cent of the total precipitation. On undisturbed oak forest, only 0.5 per cent of the 7 inches of rain ran off the experimental plots while soil removed was only 75 pounds per acre.

FACTORS PROMOTING SOIL EROSION

System of farming land. - In the province, most of the farms

are rolling and hilly. These are planted to upland rice, corn, camote, cacao and fruit trees which are the erosion prompting crops. No means of protection is employed in farming these sloping lands. Erosion is aggravated by the common farm practices of plowing up and down hill and laying the furrows along the slopes. The classification of the different degrees of soil erosion used in this survey are as follows:

Erosion Class	Degree of Erosion	Description
0	No apparent erosion; no gullies	No apparent erosion; no gullies
I	Slight erosion	Less than 1/4 of original surface soil eroded; occasional crossable gullies present.
2	Moderate erosion	From 1/4 to 3/4 of original surface soil eroded.
3	Severe erosion	From 3/4 of original surface soil to 1/4 of subsoil eroded.
4	Very severe erosion	All of the surface soil to 3/4 of the subsoil eroded.
5	Excessive erosion	All of the surface soil and over 3/4 of the subsoil eroded.
W	Normal erosion	Balance between soil erosion and soil formation is maintained.
Q	Erosion, undifferentiated	Erosion conditions change as often as floods occur.

Table 47. Classification of the different soils and miscellaneous land types of Benguet

Erosion Class	0-No apparent Erosion	1- Slight Erosion	2- Moderate Erosion	3-Severe Erosion	4- Very Severe Erosion	5-Excessive Erosion	6-Nor Erosi
Relief	Land nearly level to gently undulating	Undulating gently rolling to hilly	Rolling to hilly	Rolling to hilly to mountainous	Hilly to mountainous	Hilly	Nearly vel to ly to tainous
Present land use	Row crops	Row crops, second growth forest, grass, bottle palms	Row crops, grass, forest	Grasses, second growth forest, shrubs	Grasses, second growth forest, shrubs	Grasses and shrubs	Wildli primar rest, grass
Soil type	1044-La Trinidad loam 100-Umingan loam	1041-Atok sandy loam 1045-Bakakong sandy clay loam 1042-Balili gravelly loam 1032-Buyagan clay loam 1058-Daklan clay 1046-Guinacong sandy loam 1048-Mirador clay loam 1038-Natubling sandy loam 1031-Puguis gravelly loam 524-Guinbalaan-Annan complex	1036-Ambasador silt loam 98-Annan clay loam 1041-Atok sandy loam 1045-Bakakong sandy clayloam 1040-Balakbak gravelly loam 1033-Bansoglam 151-Burgos clay 218-Cervantes loam 1058-Daklan clay 1046-Guinacong sandy loam 1037-Kalsoma loam 1034-Mangalisan gravelly clay 1038-Natubling sandy loam 1045-Paoay loam 1031-Puguis gravelly loam 1035-Tacdian loam		202-Rough mountainous land		45-Mt. undiffe tiated

Soil Type	Soil Type No.	Degree of Erosion
Soils of the plains and valleys		
La Trinidad loam	1044	Erosion-0 No apparent erosion
Umingan sandy loam	100	
Soils of the uplands, hills and mountains		
Ambasador silt loam	1036	
Guinaoang sandy loam	1046	Erosion-0 No apparent erosion
Guimbalan-Annam complex	52f	
Atok sandy loam	1041	
Bakakong sandy clay loam	1045	
Balili gravelly loam	1042	
Buyagan clay loam	1032	
Daklan clay	1038	Erosion-1 No apparent erosion
Guinaoang sandy loam	1046	
Mirador clay loam	1048	
Natubling sandy loam	1039	
Puguis gravelly loam	1031	
Ambasador silt loam	1036	Erosion-2 No apparent erosion
Annam clay loam	98	
Atok sandy loam	1041	
Bakakong sandy clay loam	1045	
Balakbak gravelly loam	1040	
Bonong loam	1035	
Burgos clay	151	
Cervantes loam	218	
Daklan clay	1038	
Guinaoang sandy loam	1046	
Halsema loam	1037	
Mirador clay loam	1048	
Mangalisan gravelly clay loam	1034	
Natubling sandy loam	1039	
Paoay sandy loam	1043	
Puguis gravelly loam	1031	
Tacdian loam	1035	
Mountain soils undifferentiated	45	Normal erosion
Rough mountainous lands	202	Erosion-4 All of the topsoil to 75 per cent of the subsoil is removed

To supplement table ~~5~~ 18, the locations where the soils were mapped are listed below.

La Trinidad loam (1044). This soil type is in La Trinidad Benguet. It is the valley around the City Hall of La Trinidad.

Umingan sandy loam (~~100~~ 180). It is found along the Abatan-Buguias road, starting in Bo. Loo, Buguias and extends southward towards Buguias town.

Ambasador silt loam (1036). The soil was described in Bo. ~~Acop~~ Ambasador, Tablay and then stretches southward up to the Bo. of ~~Bokol~~ Beckel along the Baguio-Ambuclao road.

Annam clay loam (98). It is found along the boundary of Benguet and Pangasinan.

Atok sandy loam (1041). It is found along the junction of Atok road and Mountain trail, up to Atok poblacion. It is also found around the town of Kapangan, Benguet. It is also found along the Amburayan river in the vicinity of Atok town.

Bakakong sandy clay loam (1045). This occupies the eastern half of Baguio City including Loakan air strip, Antamoc and Balatoc mines up to the ridge west of Binga Dam.

Balakbak gravelly clay loam (1040). It is found in the Bos. of Balakbak, Kapangan and in Sagpat, Kibungan. They are mapped in three different places along Kapangan-Kibungan road.

Balili gravelly loam (1042). It is found northeast of Mankayan in Bo. Balili, Mankayan along Benguet and Mountain Province boundary.

Boneng loam (1033). It is found north of La ~~Trinidad~~ in

Bo. Banang about five kilometers from the Capitol Building of La Trinidad.

Burgos clay (151). It is found along Naguilian road starting from the vicinity of Bo. Banangan, Sablan down to the boundary of Benguet and La Union.

Buyagan clay loam (1032). It is found in La Trinidad starting from the Capitol Building and extends westward north of Pico road to Bo. Buyagan, La Trinidad.

Cervantes loam (218). This soil was mapped along Mankayan-Cervantes road in Bos. Bagoyos and Palococ near Benguet-Ilocos Sur boundary.

~~Rough mountainous land (202). They are found along Kennon road, along Naguilian road starting about one kilometer north of Tuba down to Bo. Amsalsal, Sablan and it is eastward to Tublay and then northward to Kibungan.~~

Daklan clay (1038). It is found south of Ambuclan Reservoir and extends northward covering Bokod and Kabayan town up to Bo. Gusaran, Kabayan.

Guinacang sandy loam (1046). It was described in Bo. Guinacang, Mankayan. It extends from the vicinity of Bo. Baculi, Buguias to Bo. Colalo Mankayan near the boundary of Benguet and Ilocos Sur. From Baculi, Buguias, it stretches eastward along the Mountain Trail up to the boundary of Benguet and Bontoc province.

Halsema loam (1037). It was mapped in Aco, Tublay along Halsema road.

Mirador clay loam (1048). It is located in the vicinity of Mirador Hill, Baguio City including the site of Tuba poblacion and extends southward following the western side Kennon road down to Twin Peak.

Nangalisan gravelly clay (1034). It is found along a road from the famous Asin hot spring in the town of Tuba and stretches westward to Bo. Nangalisan, Tuba near the boundary of Benguet and La Union.

Natubling sandy loam (1039). It was mapped in Bo. Natubling along mountain trail starting in the vicinity of Bo. Patapat, Atok and extends northward beyond Bo. Sinipsip, Buguias.

Paoay sandy loam (1043). It is found in Bo Paoay about two kilometers west of Bo. Sayangan, Atok a popular bus stop along Mountain trail.

Puguis gravelly loam (1031). It is f nd in Bo. Puguis, in La Trinidad about one and one half kilomete s west of a Trinidad Capitol Building. It is also found along L Trinidad-Kabungan road starting west of Bo. Acop, Tublay to B tuag juncti n, Kapangan. Then starting east of Kapangan po acion it exte ds northward up to the vicinity of Balakbak, pangan.

Taodian loam (1036). It ~~is found on t~~ it was described in o. Taodian a found east and sout side of La Trinidad Valley. A portion of the series is in Bo. Guisad, Baguio City

Guimbalaon-Annam complex (524). It is fo d in Bo. Bobo , Bokod, along Ambuclao-Cayapa road, starting fr Bo. Bobok up to the boundary of Bobok, Bokod and Cayapa, Nuev Vizcaya.

~~The extent as well the degree of soil ero ion will increase each year unless ontrol measures are insti ted and~~ practiced.

Rough mountainous land (202). They are found along Kennon Road, along Naguilian road starting about one kilometer north of Tuba to Bo. Amsalaal, Sa and Benda

SOIL EROSION IN THE DIFFERENT AREAS

The soils of ~~Ifugao~~ Benguet Province have undergone erosion, normal or geologic and accelerated, at one time or another. The erosion survey of the province was conducted to determine the degree of erosion to which the different soils have been subjected. However, due to the numerous factors responsible for erosion accurate erosion losses by individual fields cannot be presented but rather the general distribution of such losses. So much so that one can expect that the same soil type in different areas may have different degrees of erosion, or two different but adjacent soil types may have different degrees of erosion and one soil type may have different degrees of erosion within its boundaries.

The degree of erosion to which the different soil types of the province may have been subjected are shown in table ~~5~~ 8.

Mountain soils undifferentiated (4[illegible]). This land type covers the western portion and central portion of the province of ~~Ifugao~~ Benguet.

EFFECTS OF SOIL ER SION

Soil erosion has an exhausting influ ence on agriculture. Previously, most of us have had so little oncern about its adverse effects: it was only recently that we became aware of the fact that erosion if left uncontrolled will eventually deplete our agricultural lands of their productivit thereby affecting the nation's economic stability and prosper y.

PHYSICAL EFFECTS

To the average farmer, the physical effects of erosion are not very apparent. Yields decline from year to year on areas that have been farmed for a long time. The farmers hardly notice his losses from his farm due to lack of farm record.

Sheet erosion is the most common that occurs (in Benguet) Irugdo. Most of the cultivated soils are Benaue and Mayoyao series. (Both series are deep with reddish brown color but they differ in their texture.) The farmers do not notice the uniform loss of the top soil because the color of the subsoil is almost the same as the top soil. It is not easy for the common farmer to detect that the surface soil are all gone and that he is already cultivating the subsoil. Sheet erosion is harder to detect than rill or gully erosion.

The burning and overgrazing of the grasses have caused the less resistant but desired grasses to succumb and other less palatable grasses appear. The reduction of cattle population during the war up to now is giving chance to the pasture lands to rejuvenate their grass cover and ultimately the returns to normal erosion. Where erosion exists, the land is robbed of its fertile surface soil. This means that not only the inherent fertility of the soil is lost but costly commercial fertilizers added are wasted as well. If only a little of the surface soil and more of the subsoil which is less fertile, there will be more difficulty in maintaining a satisfactory physical condition of the soil. Eroded soil materials sometimes cover plants in lower levels causing

great damage and inconvenience in subsequent cultivation. One noticeable effect of soil erosion is the filling up of reservoirs with soil materials which reduces their storage capacity, length of service and increase the cost of their upkeep. Gullying and stream bank cutting of agricultural lands have reduced some farms to riverwash and river beds which means great loss on the part of the farmer. Roads are sometimes washed out due to big gullies or stream bank cutting or sometimes roads are completely blocked due to landslides thus curtailing transportation facilities temporarily.

ECONOMIC AND CULTURAL EFFECTS

The defects of accelerated soil erosion are clear but many people take the existence of soil for granted. It is true, the supply of air is always abundant but the productivity of the soil cannot last forever unless we realize the danger of soil erosion.

Soil conditions help to shape the pattern of a nation's existence. Their effects to agriculture may very well enhance the economic and social aspects as well. This is so because agricultural, economic and social conditions are closely interrelated so much so that it is difficult to separate them too sharply. Erodibility being one of many soil conditions, should be born in mind as much as fertility.

Our basic needs, food, clothing and shelter come from the soil. Soil lost to us, if taken in terms of the economic value of production of these basic needs surely would amount to enormous

figures. With increase in population, soil must be conserved in order to produce more food. Over working the soil inevitably results in decline of productivity. Soil erosion then commences and if unchecked, the people simply abandon the affected area and move to other places. This may happen once or more than once within a generation. What has started as an agricultural problem also becomes an economic and social problem.

Industry, especially the manufacture of consumer goods need plenty of raw materials produced from the soil. Industry, therefore is affected directly or indirectly by soil erosion.

Soil erosion therefore, is not the problem of an individual farmer alone. While he cannot produce enough food to meet the needs of his family and his social obligations, erosion becomes a community's, a province's and finally a nation's agricultural, economic and social concern.

METHODS OF EROSION CONTROL

There are two general ways of erosion control in cultivated lands: namely, (1) vegetative measures and (2) mechanical means. Vegetative measures are easier to apply, while mechanical means usually requires engineering aids, tools and machinery. The vegetative measures are employed on lands that are nearly level to gently rolling, while the latter is adapted to rolling and undulating land, sometimes both means are employed simultaneously or one in support of the other depending upon circumstances.

VEGETATIVE MEASURES

Control of erosion by vegetative means deals with the use of plants following the normal farm operations and use of ordinary implements and machinery.

Cover cropping. - Vegetative cover is the first protection against runoff and erosion. Cover crops are usually planted after the harvest of row tilled or seasoned crops. There are also permanent cover crops which are mostly planted in orchards. When planting cover crops mulches of dead stems, leaves or straw are necessary since cover crops offer protection only after they have attained considerable growth.

Strip cropping. - This vegetative method of erosion control is the alternate cultivation of clean tilled crops on one strip and dense close growing crops on the next strip. This alternation breaks up a relatively large sloping field into small narrow bands lying across the slope. They serve to check the momentum of runoff and to filter out the soil particles. The subsequent loss of the speed or runoff allows rain water to penetrate into the soil rather than readily flow down the slope. Soil and water are thus conserved.

Buffer strip cropping. - Buffer strip are established bands usually on the contour, two or three meters wide, planted to perennial grass or other erosion-resistant vegetation. They are arranged in regular alternation with relatively wider strips of row tilled crops. Buffer strips are adapted to land with slopes up to eight per cent. When the slope is long, a combination of

vegetation and some mechanical means is necessary. Grasses such as Guinea grass, Napier, Brown-top, Bermuda grass, Ipil-ipil (periodically trimmed to about a foot high) are recommended.

Grassed waterways. - Waterways in soils work are either natural or man-made depressions on sloping areas which serve as passageways for water that goes through a farm from adjacent or accumulating on it due to rain. They are important in any scheme of soil and water conservation. Naturally located depressions serve the purpose best. Man-made canals strategically laid are also necessary for more efficient discharge of runoff. The establishment of a dense vegetative cover over all waterways is imperative. Grasses readily adaptable to the area should be used, but whenever practicable those species which form a dense are preferable. In as much as waterways are supposed to carry heavy flows during certain periods they should be designed to handle maximum runoff from the heaviest rainfall occuring in the locality once about eight to ten years. Grassed waterways are essential wherever excess runoff accumulates such as in strip cropped fields.

MECHANICAL MEASURES

On steep slopes, vegetative measures offer inadequate protection for the soil. Mechanical means of erosion control are therefore essential in connection with vegetative phase.

Contour tillage. - Contour tillage is plowing and planting on the contour. This is an erosion control measure which is most

effective on two to eight per cent slopes and less than 100 meters long. Ridges formed by the tillage implements retard the downhill flow of water. These ridges serve adequately when rainfall are intense or heavy. Contouring is not enough prevention especially when slopes are not uniform and above eight per cent, when the fields are already eroded, or when subsoil are clayey and compact. In these cases, excess runoff may break through the ridges thus necessitating the adoption of other mechanical conservation measures like terracing.

Terracing. - Terraces are mechanical measures of soil conservation and are differentiated into three types: namely, (1) absorptive, (2) bench and (3) drainage.

Absorptive terrace or ridge type is designed for moisture conservation. It is adapted to gentler slopes and absorptive soils. Bench terraces are constructed on the contour. It has a steep drop and adapted to steeper slopes.

Drainage terrace or broad channel type is designed to conduct water from a field at low velocity.

As used in this text, terrace may denote a ridge type or a combination of ridge and channel types.

Terraces are built across a slope. They are either level or graded depending upon the purpose for which they are made. Graded terraces lead runoff from the field at non-erosive velocities. Level terraces impound most of the water giving it time to soak into the soil. Where the average annual rainfall is less than 30 inches, level terraces are recommended.

Dimensions of terraces are also of utmost importance. They should be large to avoid overstopping. Usually, the runoff which may be expected from the heaviest rain occuring on an average of once in 10 years is used as basis. Their shape is generally based on the farming equipment used.

Terrace construction requires technical skill, financing, and special implements and machinery. Aside from these considerations, one must realize that all slopes and all soils cannot be successfully or economically terraced. Sandy, stony and shallow soils, fields dotted by lumps or mounds, or slopes with different vegetation and steepness every 30 meters are impractical to build terraces.

Diversion ditches. - Diversion ditches or diversion terraces are built to intercept the runoff from drainage areas. They are usually larger than field terraces. They are designed to protect cultivated fields from hillside runoff by providing for a passageway of the water from the field to other nearby areas where it is spread or dispersed. Where adjacent slopes generate runoff towards a terraced area, diversion ditches carry the water away from the terrace system, or if towards a gully diverting the water assist in controlling its enlargement.

OTHER ASPECTS OF EROSION CONTROL

Whereas erosion depletes the soil of its inherent fertility, low fertility also brings about soil erosion. Infertile soils invariably mean poor vegetation, thus more surface soil is exposed

to direct rain and wind action. Therefore, soils of low fertility when tilled are highly erodible. In this case proper and adequate fertilization can minimize erosion.

The regular application of farm manures and the practice of green manuring increase the organic matter content of the soil. Organic matter, aside from enhancing soil fertility, also improves tilth and maintain if not improve soil structure. Stable and favorable soil structure means higher porosity and better permeability. When soils are porous and permable, plant root penetration is improved. All of these favorable physical conditions when attained promote the soils water absorbing and water holding capacities or in other words surface runoff is minimized.

Crop rotation should essentially be a part of every farm program. A well planned scheme of crop rotation, aside from providing a practical means of utilizing green manures and fertilizers, counteracting possible development of toxic substances and improving crop quality and increasing yield, also minimize or help control erosion. This farm practice keeps the soil in suitable physical condition, helps maintain the supply of organic matter and nitrogen in the soil, provides vegetative cover, and changes the location of the feeding ranges of roots.

The physical effects of liming such as the promotion of soil granulation of fine textured soils and the modification and improvement of the structure of coarse textured soil thus making them lighter to work subsequently contribute much to erosion control.

An efficient system of soil management in support to vegetative and mechanical measures is indeed necessary to combat soil erosion. The different practices followed or adopted should form a farm program that as a unit could fit the kind of soil or kinds of soils within a farm so that the end attained in the combined beneficial effects of the many interacting processes involved. Each farmer, therefore, should first appraise the erosion hazards of his farm, then plan a cropping system and supporting conservation practices to reduce or off-set the erosion hazards.

GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN BENGUET

Avocado – Persia americana Mill Lauraceae

Apitong – Dipterocarpus grandiflorus Balnco Dipterocarpaceae

Banana – Musa sapientum Linn Musaceae

Bolo – Schizostachyum lumampao (Balnco) Merr. Graminoae

Cabbage – Brassica oleracea Hort Cruciferae

Cacao – Theobroma cacao Linn Sterculiaceae

Caimito – Chrysophyllum caimito Linn Sapotaceae

Cauliflower – Brassica oleracea Linn. Var. Botrytis Linn. Cruciferaceae

Casoy – Anacardium occidentale Linn. Anacardiaceae

Chico – Achras sapota Linn. Sapotaceae

Coffee – Coffea arabica Linn. Rubiaceae

Cogon – Imperata cylindrica (Linn.) Beauv Graminae

Coconut – Cocos nucifera Linn. Palmae

Corn – Zea mays Linn. Graminae

Eggplant – Solanum melongena Linn. Solanaceae

Gabi – Colocasia esculenta (Linn.) Schott Araceae

Garlic – Allium sativum Linn. Liliaceae

Ginger – Zingiber officinale Rosc. Scitaminaceae

Malayo – Vitex parviflora Juss Verbenaceae

Lauan – Anisoptera thurifera (Blanco) Blume Dipterocarpaceae

Mandarin – Citrus nobilis Lour Rutaceae

Mango – Mangifera indica Linn. Anacardiaceae

Munggo – Phaseolus aureous Roxb. Leguminosae

Mustard – Brassica integrifolia (West) O.E. Schultz Cruciferae

Narra - Pterocarpus indicus Willd Leguminosae

Onion - Allium cepa Linn. Liliaceae

Pechay - Brassica chinensis Linn. Cruciferae

Pepino - Cucumis sativus Linn. Cucurbitaceae

Pepper (sili) - Capsicum annum Linn. Solanaceae

Pineapple - Ananas comosus (Linn.) Mur. Bromeliaceae

Pine trees - Pinus insularies Endl. Pinaceae

Papaya - Carica papaya Linn. Caricaceae

Potato - Solanum tuberosum Linn. Solanaceae

Reddish - Raphanus sativus Linn. Cruciferaceae

Rice - Oryza sativa Linn. Graminae

Roses - Fragoria Vesca Rotaceae

Santol - Sandoricum Koetjape Merr. Meliaceae

Suha (Lusban) Citrus maxima (Brum) Merr. Rutaceae

Sweet potato - Ipomea batatas (Linn.) Poir Convolvulaceae

Talahib - Saccharum spontaneum Linn. Graminae

Tangile - Shorea polysperma Merr. Dipterocarpaceae

Tindalo - Pahudia rhomboidea Prain Leguminosae

Tomatoes - Lycopersicum esculentum Mill Solanaceae

Kalamansi - Citrus microcarpa Bunge Rutaceae

Lettuce - Lactuca sativa Linn. Compositae

BIBLIOGRAPHY

UNITED STATES DEPARTMENT OF AGRICULTURE. Soil Survey Manual. Soil Survey Staff. Government Printing Office, Washington.

[illegible], R. M., and others. Soil Survey of Pangasinan Province, Philippines. Department of Agriculture and Commerce, Soil Report No. 7.

[illegible] DEPARTMENT OF AGRICULTURE. Soil Survey Manual. U. S. Department of Agriculture, Miscellaneous Publication No. 247. Washington D. C.: Government Printing Office, 1937.

[illegible], R. M., and others. Soil Survey of La Union Province, Philippines. Department of Agriculture and Natural Resources, Soil Report No. 12. Manila: Bureau of Printing, 1950.

BARRERA, ALFREDO. Hand Book of Soil Survey for the Philippines. Manila: Bureau of Printing, 1961.

DAGDAG, B. G., and others. Soil Survey of Nueva Vizcaya Province, Philippines. Department of Agriculture and Natural Resources, Soil Report No. 32. Manila: Bureau of Printing, 1965.

MANLONGAT, A. P., and others. Soil Survey of Ilocos Norte Province, Philippines. Department of Agriculture and Natural Resources, Soil Report No. 39. Manila: Bureau of Printing, 1966.

PEARL, R. M., Rocks and Minerals, Barnes & Noble, Inc. New York Publisher (Copy right 1956 - Fourth edition 1959).

UNITED STATES DEPARTMENT OF AGRICULTURE. Soils and Men. The Yearbook of Agriculture: 1938. Washington: Government Printing Office, (n.d.).

UNITED STATES DEPARTMENT OF AGRICULTURE. Science in Farming. The Yearbook of Agriculture: 1943-1947. U. S. Government Printing Office: Washington 1947.

BUREAU OF THE CENSUS AND STATISTICS. Census of the Philippines: 1960, Agriculture. Vol. I, Report by province, Mountain Province, 21. Manila: Bureau of the Census and Statistics, [illegible].

HISTORY OF BENGUET PROVINCE

Under Act No. 48, dated November 22, 1900, local civil governments in the following township of Benguet were established: Baguio, La Trinidad, Caliano, Itogon, Tublay, Atok, Kapangan, Balakbak, Palina, Ampucongan, Loo, Kabayan, Buguias, Adaoay, Bokod, Daklan, Sablan, Kibungan and Ambuklao. Under Act No. 49 of November 25, 1900, the civil government of Benguet was duly established. On June 29, 1901, a province was inserted on Act No. 155 providing that a popular representative be elected on July 4, 1901. Act No. 49 was repealed by Act. No. 1396 on September 14,1905. The province of Benguet was then organized under the provision of Act No. 1396 known as "The Special Government Act". Under Act No. 1646, dated May 15, 1907, election of delegates to the constitutional convention to be held on July 13, 1907 was provided. Benguet became a sub-province of Mountain Province with the passage of Act No. 1876 on August 18, 1908. The sub-provinces embraced by Mountain province under the Act were Amburayan, Apayao, Benguet, Bontoc, Ifugao, Kalinga and Lipanto. By operation of Act No. 2877 of February 4, 1920, the boundary of Benguet was amended, part of Amburayan was placed under La Union and part of Lipanto was placed under Ilocos Sur. In the course of time, the original 19 towns of Benguet were reduced to 13. The town of Baguio became a chartered city in 1909, and in its stead, the town of Tuba was created. The towns of Ambuclao, Adaoay, Balakbak, Daclan, Caliano,

Palina and Loo was abolished under executive orders issued by the Governor General of the Philippines.

Republic Act 4695 of June 18, 1966 divided Mountain Provinces into the provinces of Benguet, Mountain Province, Kalinga-Apayao and Ifugao. The law provides that the remaining assets and liabilities will be divided equitably amongthe four provinces. The elective officials are to serve in the province to which they belong, ethnically and the appointive officials and personnel will have to choose where to continue serving. The province of Benguet shall comprise the sub-province of Benguet and the municipalities of Tuba, Sablan, Itogon, La Trinidad, Tublay, Atok, Bokod, Kabayan, Kapangan, Bakun, Kibungan, Mankayan and Buguias. The Provincial capital of Benguet is La Trinidad. Except as hereafter provided, all provisions of law now or hereafter applicable to regular provinces apply to the province of Benguet.

The present elective provincial offices of Mountain Province shall, until their successor shall have been elected and shall have qualified, be assigned to and perform their duties as such offices in the corresponding province herein created, to which said elective provincial officers belong as a member of the particular tribe or ethnic group inhabiting said province. Benguet being a newly created province has the position of provincial governor and in accordance with the law of succession of this act, the vice governor automatically succeeded the position of governor in the province and held office as such un il his successor shall

Benguet

	Parent material	Profile Class
La Trinidad	Alluvium	A
Ammungan	"	A
Ambassador	Diorite, quartz diorite	D
Amian	Basalt, tuffaceous rock, sandstone	D
Atok	Diorite	D
Bakakeng	Igneous rock	D
Balakbak	Limestone	F
Baliti	Conglomerate	G
Benning	Sandstone, diorite	G
Bugo	Andesite, basalt, diorite	D
Buyagan	Limestone	F
Cervantes	Diorite & andesite	D
Daklan	Quartz diorite	D
Guinzadan	Diorite	D
Halsema	Conglomerate, igneous rock	G
Mirador	Limestone	F
Nangalisan	Diorite, sandstone	G
Natubleng	Diorite, andesite, sandstone	D
Pacso	Quartz, diorite, sandstone	D
Paytan	Conglomerate, sandstone & diorite	G
Tacdian	Limestone	F
Dumbatson	Ambuklao Complex - Diorite	D

fale

UNSF SOIL FERTILITY SURVEY AND RESEARCH PROJECT
SOIL PROFILE LABORATORY ANALYSIS SHEET

Soil ....

Profile No. .... Location ....

Benguet Prov.

Lab. Sample No.	Profile Sample No.	Depth cm.	Horizon	pH Sat. paste	pH H_2O 1:1	pH $CaCl_2$ 1:1	pH KCl 1:1	Elect. Cond. of Sat Extr $EC \times 10^3$	Organic Matter: Organic Carbon %	Organic Matter %	Nitrogen %	C/N ratio
297	A	Balili gravelly loam			4.9	6.0	4.2					
298	B.	"	"	"	5.4	5.9	4.0		0.60	1.03	.107	
313.	A	Asuinasang sandy loam			5.2	6.2	4.7		0.81	1.4	.102	
314	B								6.04	10.39	.052	
-		"	"	"	5.7	6.5	4.8		0.66	1.27	.035	

Lab. Sample No.	Profile Sample No.	Cation Exch. Capac. meq/100 gm	Ca++	Mg++	Na+	K+	H+	% Base Saturation	Total P p.p.m.	Available P p.p.m.	Free Fe_2O_3 %	$CaCO_3$ Equiv. %
297	A	37.5	1.62	T	0.23	0.70	14.7					
298	B	35.0	4.13	1.3	0.27	0.13	18.54			2.0		
313	A	16.0	1.13	.72	0.06	0.29	15.70			T		
314	B	39.4	1.13	T	0.11	0.06	9.19			T		
										T		

(Exchangeable Cations meq/100 gm: Ca++, Mg++, Na+, K+, H+)

Lab. Sample No.	Profile Sample No.	Total K p.p.m.
297	A	300
294	B	172
313	A	122
314	B	100

Date Sample Submitted ....

Date Tests Completed .... Analyst(s) Incharge ....

UNSF SOIL FERTILITY SURVEY AND RESEARCH PROJECT
SOIL PROFILE LABORATORY ANALYSIS SHEET

Soil ..... Location .....

Profile No. ..... Soil samples from Benguet Province

Lab. Sample No.	Profile Sample No.	Depth cm.	Horizon	pH Sat. paste	pH H_2O 1:1	pH $CaCl_2$ 1:1	pH KCl 1:1	Elect. Cond. of Sat. Extr. EC x 10^3	Organic Matter Organic Carbon %	Organic Matter %	Nitrogen %	C/N ratio
4394	A	Bauan clay			5.1		4.7		2.15	3.17		
4395	B	"	"		5.0		4.4		0.74	1.27		
4396	A	Holcema Loam *			4.6		4.2		1.27	2.18		
4358	B	"	"		4.8		4.4		1.58	2.72		
[illegible]	A	La Trinidad Loam			6.0		5.2		0.68	1.17		
4361	B	"	"		5.8		5.4		0.86	1.48		
4364	A	Mangcayan clay			5.5		4.9		1.44	2.48		
4398	B	"	"		6.0		5.0		0.34	0.58		

Lab. Sample No.	Profile Sample No.	Cation Exch. Capac. meq/100 gm	Exchangeable Cations meq/100 gm. Ca^{++}	Mg^{++}	Na^{+}	K^{+}	H^{+}	% Base Saturation	Total P p.p.m.	Available P p.p.m.	Free Fe_2O_3 %	$CaCO_3$ Equiv. %
4394	7.03	23.33	7.50	1.2	0.24	0.09	14.3	38.71		T		
4395	12.87	33.17	5.00	6.5	0.20	0.09	20.7	37.59		1.5		
4396	1.03	55.40	0.62	T	0.31	0.10	54.37	1.59		T		
4358	0.33	51.68	T	T	0.27	0.06	51.35	~~2.5~~ 0.64		* 20		
4397	23.86	30.28	23.1	0.34	0.28	0.14	6.42	78.5		T		
4361	33.07	47.33	27.5	4.79	0.65	0.13	14.26	69.87		2.5		
4364	20.56	28.40	14.3	4.04	1.52	0.70	7.84	77.39		2.6		
4398	20.67	22.10	18.1	1.27	1.09	0.21	1.43	93.53		10.3		

Lab. Sample No.	Profile Sample No.	Total K p.p.m.

Date Sample Submitted .....

Date Tests Completed ..... Analyst(s) Incharge .....

UNSF FERTILITY SURVEY AND RESEARCH PROJECT
SOIL PROFILE LABORATORY ANALYSIS SHEET

Soil ..... Location .....

Profile No. ..... Soil Samples from Benguet Province

Lab. Sample No.	Profile Sample No.	Depth cm.	Horizon	pH Sat. paste	pH H_2O 1:1	pH $CaCl_2$ 1:1	pH KCl 1:1	Elect. Cond. of Sat. Extr. EC x 10^3	Organic Matter Organic Carbon %	Organic Matter %	Nitrogen %	C/N ratio
399	A	Mirador clay loam			5.3		4.9		2.06	3.55	0.18	
365	B	"	"	"	5.3		5.2		0.24	1.71		
400	A	Naturbleng sandy loam			5.7		5.5		4.12	7.26		
368	B	"	"	"	6.2		6.1		0.66	1.12		
374	A	Burgos clay			5.4		5.1		1.64	2.82		
395	B	"	"		4.9		4.5		1.08	2.20		
401 ✓	A	Sandy loam			5.7		6.0		2.96	5.09		
402 ✓	B	"	"	"	5.0		4.9		6.76	11.52		

Lab. Sample No.	Profile Sample No.	Cation Exch. Capac. meq/100 gm	Exchangeable Cations meq/100 gm. Ca^{++}	Mg^{++}	Na^{+}	K^{+}	H^{+}	% Base Saturation	Total P p.p.m.	Available P p.p.m.	Free Fe_2O_3 %	$CaCO_3$ Equiv. %
399	30.49	55.81	2.8	2.67	0.44	0.58	25.32	54.63		T		
365	21.58	27.05	1.5	3.59	0.31	0.18	5.47	8.72		T		
400	7.48	46.44	3.75	T	0.42	0.31	41.46	7.49		10.9		
368	3.86	15.51	T	3.29	0.31	0.06	11.65	2.58		2.1		
374	11.67	23.80	7.35	3.08	0.22	1.12	12.23	4.23		2.1		
395	6.05	24.06	1.00	4.79	0.20	0.06	18.31	24.72		3.0		
401 ✓	0.98	23.92	0.62	T	0.22	0.14	22.96	4.1		5.0		
402 ✓	1.35	56.27	0.62	T	0.44	0.88	54.92	2.4		T		

Lab. Sample No.	Profile Sample No.	Total K P.P.M.

Date Sample Submitted .....

Date Tests Completed .....

Analyst(s) ..... Discharge .....

UNSP[illegible] FERTILITY SURVEY AND RESEARCH PROJECT
SOIL PROFILE LABORATORY ANALYSIS SHEET

Location .....

...ll .....

...filè No. ..... Soil sample from Benguet Province

Lab. Sample No.	Profile Sample No.	Depth cm.	Horizon	pH Sat. paste	pH H_2O 1:1	pH $CaCl_2$ 1:1	pH KCl 1:1	Elect. Cond. of Sat Extr ECx10³	Organic Matter: Organic Carbon %	Organic Matter %	Nitrogen %	C/N ratio
403	A	Tacdian loam			7.6	7.3			2.35	4.04		
376	B	"	"		5.2	4.4			2.51	4.32		
404	A	Ambaguio silt loam			5.0	4.4			5.45	9.37		
405	B	"	"	"	5.1	4.5			1.56	2.68		
356	A	Cervantes loam			5.4	4.5			1.49	2.56		

Lab. Sample No.	Profile Sample No.	Cation Exch. Capac. meq/100 gm	Exchangeable Cations meq/100 gm. Ca^{++}	Mg^{++}	Na^{+}	K^{+}	H^{+}	% Base Saturation	Total P p.p.m.	Available P p.p.m.	Free Fe_2O_3 %	$CaCO_3$ Equiv. %
403	52.23	109.41	51.2	T	0.46	0.57	57.18	47.74		8.0		
376	14.03	23.20	10.0	3.59	0.31	0.13	9.27	60.71		0.9		
404	1.07	32.57	0.27	T	0.38	0.42	31.50	3.85		T		
405	2.51	18.80	0.75	1.27	0.33	0.16	16.29	13.35		1.9		
356	5.06	26.46	1.25	3.49	0.22	0.10	21.40	19.12		1.5		

Total K p.p.m.

A

Date Sample Submitted .....

Date Tests Completed .....

Analyst(s) Incharge .....

UNSF SOIL FERTILITY SURVEY AND RESEARCH PROJECT
SOIL PROFILE LABORATORY ANALYSIS SHEET

Soil .....

Profile No. .....

Location .....

Soil samples from Benguet Province

Lab. Sample No.	Profile Sample No.	Depth cm.	Horizon	pH Sat. paste	pH H_2O 1:1	pH $CaCl_2$ 1:1	pH KCl 1:1	Elect. Cond. of Sat. Ext. $EC \times 10^3$	Organic Matter: Organic Carbon %	Organic Matter %	Nitrogen %	C/N ratio
#394	A	Buclan clay			5.1		4.7		2.15	3.17		
#395	B	"	"		5.0		4.4		0.74	1.27		
#396	A	Holsems loam *			4.6		4.2		1.27	2.18		
#358	B	"	"		4.8		4.4		1.58	2.72		
#397	A	Ar Tinulad loam			6.0		5.2		0.68	1.17		
#361	B	"	"		5.8		5.4		0.86	1.48		
#364	A	Mangalasan clay			5.5		4.9		1.44	2.48		
#398	B	"	"		6.0		5.0		0.34	0.58		

Lab. Sample No.	Profile Sample No.	Cation Exch. Capac. meq./100 gm	Exchangeable Cations meq/100 gm. Ca^{++}	Mg^{++}	Na^{+}	K^{+}	H^{+}	% Base Saturation	Total P p.p.m.	Available P p.p.m.	Free Fe_2O_3 %	$CaCO_3$ Equiv. %
#394	9.03	33.33	7.50	1.2	0.24	0.09	14.3	38.71		T		
#395	12.87	33.17	5.60	6.5	0.20	0.09	20.7	37.59		1.5		
#396*	1.03	55.40	0.62	T	0.31	0.10	54.37	18.57		T		
#358	0.33	51.68	T	T	0.27	0.06	51.35	2.15	.064	20		
#397	23.86	30.28	23.1	0.34	0.28	0.14	6.42	78.5		T		
#361	33.07	47.33	27.5	4.79	0.65	0.13	14.26	69.8		2.5		
#364	20.56	28.40	14.3	4.04	1.52	0.70	7.84	72.39		1.6		
#398	20.67	22.10	18.1	1.27	1.09	0.21	1.43	93.53		1.3		

Lab. Sample No.	Total K p.p.m.

Date Sample Submitted .....

Date Tests Completed .....

Analyst(s) Incharge .....