

*Mt. Maquiling and Its Emissions*¹

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On account of the repair work being done on the premises of the General Inspection Division (Mining Engineer Corps) during the month of May in 1881, it was not possible to carry on any serious investigation work in the office. For this reason and with the object of continuing the study already begun in Central Luzon by the "Inspector General," then absent in the Peninsula [Spain], we made an excursion to the shores of Laguna de Bay and began the study and exploration of Mt. Maquiling which is the first great mountain mass one sees when traveling beyond Manila. We made this choice also on account of the fact that we did not wish to be far from the capital so that we could attend promptly to any emergency work which might arise, since at that time there was no other engineer of the division in the entire Archipelago.

We were able to devote but little time to our field exploration and study because the rains and storms prevailing at that season forced us to leave the slopes of Maquiling and return to Manila. However, we nearly completed the reconnaissance.

In this excursion we were accompanied by assistant Don Secundino Fernandez Miranda who executed the work which we entrusted to him with zeal and exactness. It is apropos also to mention that, thanks to his energy and interest, he was able to reach with a native the highest peak of the mountain, the barometric height of which he took, while we, the rest, dizzy and tired with hard climbing, remained twenty meters below, overlooking the interior wall of the

crater. We ought to mention also the draftsman Martinez, who, not only made good sketches of the mountain and its solfataras, but also helped efficiently in the making of the topographic surveys, thanks to the experience which he had acquired in this kind of work in the survey of Cebu.

We have omitted in the present writing some of the illustrations which we thought at first to be included, because they were found to be not indispensable, and because their completion would retard the presentation of this work which has already been delayed by other more important duties, but which we had always considered a sort of moral obligation that we are fulfilling at present. The topographic and geologic sketch of Maquiling and its vicinity and the view of the mountain seemed to us sufficient to explain and illustrate the data which we have been able to gather and which we have the honor to state in writing as follows:

Location and Exterior Aspects of Mt. Maquiling

On entering Manila Bay on a clear day, one can see to the southeast, rising isolatedly behind a border of low coasts and limiting the horizon, a conical mountain named Maquiling. We cannot, however, consider this mountain as a part of the shore of the great bay, the reason why the mountain can be seen distinctly from the bay being the great elevation of the mountain and the fact that nothing intervenes between it and the bay except the great plains of Manila and the province of Cavite, which extend to the

¹ Translated by Prof. Jose B. Blando, College of Forestry, from the original Spanish, entitled "El monte Maquiling (Filipinas) y sus actuales emanaciones volcanicas" 28pp. 2 pl. Madrid: Tello. 1885. Also Boletín de la Comision de Mapa Geologica de España 12. 28pp. 2 pl. Madrid. 1885.

shores of the bay. In reality, this mountain is situated in the interior of the island of Luzon, rising between two large lakes, improperly called Bay and Bombon, and forming the boundary between the central provinces of Batangas and Laguna.

Its exterior form varies according to the direction from which it is observed. From Laguna de Bay, that is to say, from the north, although one sees it rise between the towns of Bay and Calamba in a conical form truncated by four small peaks, no one would ever suspect its volcanic origin, but when viewed from Bombon Lake or from the SW, the upper part of a crater with craggy edges appears and relieves all doubts as to the character and origin of the mountain and easily explains its other peculiarities as well.

Its isolation, however, is not so absolute that its slopes arise on every side from the level of a lake or of a great plain as do the slopes of other volcanic cones of Luzon.² Although considerably depressed towards the west, it joins the Suñgay mountain in that direction by a mountain pass about 120 meters above sea level; to the east a series of hills connects it with the small mountain chain of Imuc and Calauan; to the south, with the plateau of Tanauan and Alaminos, with an elevation of 130 meters, and some secondary hills join it to Malarayat, and, lastly, to the north, its lower slopes, which are the lowest around the mountain, submerge under the waters of the large Laguna de Bay.

HYDROGRAPHY

Rivers and Creeks

As a result of the above-mentioned circumstances, the hydrography of Maquiling does not absolutely have that radial form which the hydrography of similar cones usually present. Two of the streams which rise in the interior of the crater, coming out from the southwest and southeast, res-

pectively, describe two great curves to the north, bounding the western and eastern flanks of the mountain, and flow over the lowest part of its slopes. These two streams are the most conspicuous of those which form the hydrographic system of the mountain under discussion.

The western stream begins at the southern foot of the cliff which faces the interior of the crater and belongs to the highest peaks on the western rim of the crater, but this stream is not permanent above the three springs which feed it, the only ones existing in that part of the mountain. The first spring, named Guja, situated at an elevation of 483 meters, is very small and in the dry season it disappears in the fissures of rocks a few steps beyond its source. Lower down, two other springs appear: first, the Saimsin at an elevation of 327 meters and then, almost at the same elevation, the Comba, both of which have an abundant supply of running water which transforms the dell called Bisoag into a permanent stream. This then descends S and SW through one of the openings of the crater of the mountain, then unites with the river Tanauan, of which it is one of the principal tributaries.

The Tanauan River and its tributaries

With the name of Tanauan, the stream which we speak of takes a north northwest direction between the adjacent towns of Tanauan and Santo Tomas, bends afterwards towards the northeast and empties, with the name of San Juan, into Laguna de Bay, near Calamba, where its sediments form a pronounced point. The river, in its course through the plateau of Tanauan and Santo Tomas, has a rocky bed embanked between walls 20 to 35 meters high at certain points, but its lower course is shallow and clayey, and its waters spread over the plain between the town and the rich valley of Calamba. This river has abundant tributaries generally coming from the sides of Maquiling, the most important of which is called

² Taal, Corregidor, Pulo, Caballo, and Arayat are examples of this type.

Biga, forming the boundary between Batangas and Laguna.

The Pinguian Creek and its tributaries

The other stream which bounds Maquiling on the east rises from the southeast of the mountain. With the name of Pinguian, it flows towards Barrio Biten, bends north of the hill called Olila towards the northeast, cuts a deep rocky bed through the small chain of hills in the Imuc district, reaches the plain which extends from Calauan to Bay, fertilizing it, and then flows north of this town into Laguna de Bay. Its middle course is called Tigas River, while its lower course, the Mabacan, except that part between the town of Bay and the lake, which is usually called by the name of the town. In its upper and middle parts the Tigas or Mabacan River receives some tributaries of minor importance but, upon reaching the plain, it is joined on the left bank by the important Cayac river which collects all the waters from the northern slopes of the Imuc range west of the Mabacan River, through its two tributaries, called Malanday and La-laog, respectively.

The Cambantoc River

Aside from the aforementioned rivers, the most important river, because of its course and the large volume of water which it carries, is the Cambantoc. It rises from a deep opening on the eastern side of the crater and descends in this direction down the base of the secondary hills called Mabilog and Bulalo and then bends towards the northeast and north successively to empty into the lake, west of the town of Bay. It is deeply entrenched in its middle and lower courses, although not so deeply as the two rivers described above.

Molawin River

It rises very near the head of the Cambantoc and follows a course almost parallel to the latter although it straighten towards

the north and also empties into the lake east of Mayondon hill and point.

Dampalit River

Another river which is well known for its copious waters and beautiful cascade near the town of Los Baños is the Dampalit. It rises north of the peak, flows NNE, with copious waters forming in its lower part a deep gorge, and empties near the town of Los Baños.

Maitim River

On account of its relative importance, it is also worthwhile to mention the Maitim, or Boot River which meanders between Cambantoc and Molawin, bounding on the east the hillocks of Tuntuñgin, and likewise empties into the lake.

Other streams

Lastly there are also, besides those already described, a multitude of secondary streams, some of which are intermittent and others permanent, such as the Pansol, Salunu, and Lecheria streams.

LAKES AND POOLS

Subsidiary features of the hydrography of Mount Maquiling are found in the various lakes and pools, all of which are of volcanic origin and many of which show actual manifestations of volcanic activity.

Alligator Lake

The Alligator Lake, the largest of these lakes and pools, is simply a crater of elliptical form more than one kilometer long and filled with water to approximately the same level as that of Laguna de Bay.

The small hill which contains this crater is shown in all the sketches that we have seen as a small island named Sumili. It is, therefore, probable that the sediments deposited at the strait which probably existed between this small island and the coast of Los Baños in front of the mouth of the copious Dampalit has caused the visible rise ³

³ The ancient town of Bay which is the oldest of those founded along the shores of the lake, is now covered by its water west of the mouth of the river.

of the level of the lake and has produced the existing connection which, in fact, is very low and in many places muddy.

The pools of Tadlac

This phenomenon is observable along the coast between the crateriform hill and the mouth of the Dampalit, where many pools are formed, nearly all of which are hydrothermal and are connected with each other by a wide estuary, called Tadlac.

Other pools and the Natugnos Lake

Some pools of the same type exist near the road from Calamba to Los Baños but we shall deal with them and the muddy lake of Natugnos when we discuss the volcanic phenomena which actually occur in Maquiling, since all of them are caused by the same igneous subterranean action.

Springs

Likewise we are deferring to that same section the description of the numerous thermo-mineral springs which issue from the slopes of this mountain.

OROGRAPHY

Maquiling does not have that simplicity of form which other perfectly conical volcanoes have, such as the Mayon, for example. The crater of Maquiling is eroded on all sides and its slopes are broken by secondary hills. Besides, Maquiling is covered with thick tropical vegetation which hinders geognostic study.

The Form of the Crater and its Edges

The crater has two deep cuts on the SW and ESE which give way, as we have already said, to the waters which collect within it, presenting in its interior walls abrupt slopes in all directions, especially towards the north, in which they form almost vertical walls of approximately 500 meters elevation. The highest part of the rim is that which faces Calamba and Los Baños, which

is broken into four peaks, the highest of which, according to our barometric observation, has an elevation of 1047 meters or, according to the plan of the Naval Hydrographic Commission, 1135 meters. This rim diminishes in altitude toward the west to 973 meters in the subordinate and conical peak which can be seen from the town of Santo Tomas and through which one can make the ascent to the mountain.

The northern slopes

The exterior slopes towards the north, especially their upper parts which are formed by a rocky wall and are completely inaccessible and covered with rachitic vegetation, are steeper than those that lead to the other directions. And since in the west and south the slopes are much more gentle, although they may have deep narrow valleys and variable undulations, Mount Maquiling appears as if it were leaning toward Laguna de Bay, from which fact it undoubtedly gets its name.⁴

Along the shores of the great lake two small hills rise. One of them is that which we have already cited when we discussed the Alligator Lake inside it and the other is the Pansol, which is situated north of the highest peak of Maquiling.

We have already said that the hill which now forms the Manlilimbos Point has the form of a ring which surrounds the Alligator Lake and rises toward the north, in the same manner as the rim of the crater of Mount Maquiling. The hill of Pansol is dome-shaped and joins the high slopes of the principal mountain by an undulating ridge, called Lalakay Mountain.

The western slopes

The western slopes of Mt. Maquiling are very undulating and contain many secondary hills which are prominent in the middle slopes, and numerous in the lower slopes adjacent to the river, where erosion has acted on materials (tuff) which are softer than those found at higher elevation.

⁴ Maquiling in the dialect of the region means inclined (leaning).

Towards the east the slopes are of even more complicated forms in the series of secondary hills which, parting from Mabilog, not far from the summit and following Bulalo, cross the Tigas River and turns north-east towards the town of Calauan, forming the chain of Imuc and Calauan, which joins Maquiling with San Cristobal and Banahao. The Olila hill which is located on the other side of the river west of Alaminos seems, undoubtedly, to belong to the same class as those which we have mentioned and is likewise subordinate to Maquiling.

The slope at the left of the Cambantoc River presents also some secondary elevations which join together to form a ridge and end at the Tuluñgin Mountains near the lake.

Also, between the Dampalit and Molawin Rivers, there is a pronounced ridge which dips near Los Baños and rises anew along the shores of Laguna de Bay to form the elliptical nipple-shaped Mayondon hill and point.

One may perhaps hazard the hypothesis that this ridge is connected with Talim Island or Jalajala Peninsula, as suggested by Pulo Bay, an intermediate point in this direction, thus correlating those volcanic foci with that of Maquiling. But the form of the bottom of the lake, as it can be conjectured from the few soundings taken of it and with which we are acquainted, seems to belie this hypothesis, which, on the other hand, is reasonable.

GEOLOGY

General composition

Generally, Maquiling is a volcanic mass composed essentially of dolerites, its lower slopes being covered with tufas, peperinos and conglomerates, which are also volcanic.

The ashes, cinders, rapilli (lapilli and bombs?) and volcanic agglomerates, which must have been produced in the eruptions, giving rise to this massive mountain, have disappeared from the places in which they have formed or fallen, and have constituted

the elements of tufas, peperinos and conglomerates surrounding its base now hidden beneath the water of Laguna de Bay and perhaps already covered with recent mud.

The spongy or lavic types of the dolerites can hardly be seen in the upper parts, the forms and structure of which have been conserved by their more compact component rocks, and can only be noted with certainty around Mayondon and Pansol hills which have been, as we shall see later, secondary or subordinate mouths, apparently of more recent origin.

Dolerites

The type of doleritic rock which we have frequently and constantly found is of granitoid texture and of porphyritic aspect, composed of blackish gray or pink magma with generally crystalline and brilliant feldspar, probably labradorite or oligoclase. Projecting from the union of these components are a few black points which are at times hardly perceptible, and at others visibly formed of augite crystals. According to Roth, who classified the samples gathered by Semper and Jagor, the dolerites also contain olivine and magnetite, but these minerals cannot be distinguished with the naked eye. They also contain little flakes of bronze-colored mica which in some samples are very dark.

In texture, this rock becomes at times coarser or more granitoid, but generally its grains tend to attenuate until they are converted into real mimetites which Doctor Drasche called andesites. He describes them as seen under the microscope as follows: "In the rock is found a mass composed exclusively of plagioclase needles and numerous crystals of magnetite, cementing large crystals of amphibole and augite." According to the said geologist, these andesites have, to the naked eye, something of the structure of obsidian; but all the rocks which we have found, besides the lavic rocks which we shall describe later on, are either granitoid or sandy or compact, and only in the mimesitas which form the wall or crest of the highest peak of the mountain have we seen some,

although scarce, scoriaceous cavities. He adds, "Further on, I found small grey pebbles of fine-grained and porous rock with several small crystals of olivine; the ground mass of the rocks, seen under the microscope, shows the surprising aspect of a fine and regular fabric of plagioclase and amphibole needles, all these crystals being cemented with colorless and amorphous mass. In certain places round grains are also seen, which, by their structure, seem to be products of vitrification, and square pieces of magnetic iron." 5

Basaltic and traphytic types

In some cases the mimesitas have a tendency in many places to become still more compact, losing their gritty structure and turning into real basalt or basanites, like those which are found in Taal Volcano; in other places, because of the predominance of feldspar and the appearance of perfectly visible amphibole, the mimesitas can be taken for true trachytes, inasmuch as the feldspar, on certain occasions, has an appearance similar, if not identical, to pumice, which is well characterized in the tufas at the base of Mt. Maquiling.⁶

Phenolitic type

The banded samples found in abundance in the interior of the crater and in other places are very odd, because when their structure is very fine they constitute real phonolites, which we considered as belonging to the trachyte family.

Trachydolerites

We could perhaps more appropriately call the rocks which constitute Mt. Maquiling grey stones (trachydolerite). It may be observed that those rocks which seem oldest on account of their position are those which

come nearest to the trachytic type, the younger rocks resembling basalt or dolerite, including those rocks of effusive character found in Pansol and Mayondon.

The same thing can be said of the eastern part of Suñgay where the rocks resemble those of Maquiling very much, although they have more phonolite characteristic, so to speak. This fact and the exterior form of the Suñgay Mountain make one suspect that it is older than Maquiling.⁷

Effusive types

In the hills of Mayondon and Pansol and in certain limited areas, as in the summit of Tuluñgin, there are spongy or scoriaceous rocks of more effusive type and younger than the ones cited. In their exterior they present a red or brownish color due to the oxidation of the iron salts which they contain, but in their interior, in the fracture, they show in their scoriaceous cavities a black and compact paste bespattered with minute feldspar crystals, hence constituting real effusive basanites.

Tufas and peperinos

All the tufas which cover and surround the slopes of the mountain are very compact and exactly like those which come from the left margin of the Pasig river in Guadalupe and which are used for construction purposes in Manila. They are generally of fine grain, yellowish or brownish grey color, and form benches which seem to adapt to the undulated forms of the fields which they cover, being composed of a clayey cineritious (ash-colored) paste with pieces of "rapilos", principally pumiceous and feldspathic. In many places these tufas are transformed into real peperinos or conglomerates of pebbles almost exclusively of basalt or dolerite.

5 See fig. No. 1 of plate D., Vol. VII of "Boletin de la Comision del Mapa Geologico de España."

6 Doctor Drasche calls trachyte a rock which he found on the way from Calamba to Santo Tomas, that is to say, at the foot of Mt. Maquiling, and which has come from its slopes.

7 We have not discussed in detail Mt. Suñgay, which we have briefly and partly visited, because D. Jose Centeno, who was in charge of the careful study of Taal Volcano, which should include the hydrographic region of the Bombon Lake, will discuss it in more detail. We have outlined however, the limits of the tufas of its flank, in order to correlate it with Mt. Maquiling.

PRESENT VOLCANIC EMISSIONS

All the foregoing rocks have been transformed and metamorphosed in certain places by numerous manifestations of the same volcanic action which produced them, and, therefore, this igneous subterranean action cannot be considered as completely extinct, in spite of the significant signs of relative antiquity of the extinction of the principal focus of the mountain.

Let us, therefore, examine the phenomena which are produced in these numerous manifestations and which can all be included under the name of volcanic emanations.

Natugnos

One of the most remarkable of these emanations is undoubtedly that which is found in the place called Natugnos. In that place, at the right bank of the upper course of the Molawin River at an elevation of about 310 meters, and not far from its bed, there is a small lake having a diameter of about 20 meters, in the proximity of which a faint sulphurous odor can be perceived. Inside the small lake one can see leaden grey muds in active ebullition the bubbles from which burst at the surface, with a peculiar sound and throw forth at the borders and out of them a semi-liquid and pasty mud, the temperature of which reaches 84°C. This bubbling activity must have had some periods of increased intensity, because from the margin of the lake to the Molawin creek a wide trail of deposits and concretions (*moyas*) with rough surface similar to that of the pasty lava flow of active volcanoes can be seen, as if the whole lake had flowed over the sides in the direction of the slope.

In the vicinity of this principal lake there are many others of smaller size, some like

wells and simple mouths of smoke, always muddy, from which vapors gush at high tension and in which the bubbling mud shows different colors, such as red, yellow, brown and sometimes, although seldom, pure white.⁸

Concretions

The nature of these *moyas* or deposits and concretions, formed by the mud of the lakes, are consigned, from the geologic point of view, in the description of the samples collected in the field, which we include at the end of this article; but, furthermore, we deem it useful to insert here the minute and precise description of these substances by Roth from a chemical point of view, based on the samples collected by Semper and Jagor in their travels. "There are places in which the rocks has been transformed by iron oxide into a gray or yellowish gray mass of clayey nature, brittle and with cavities or crevices which contain opal. In the surface of the rock the water⁹ has deposited a crust the exterior part of which is wavy. The bluish gray deposits of tufas¹⁰ of hydrated silica with small quantities of basic sulphate of iron oxide alternate with other yellowish-red strata, rich in iron. The bluish gray color comes from a mixture of fine powder, which can be verified by testing the samples with acids and alkali. The tufa has, according to this test, a composition similar to that of the siliceous tufa of Iceland which has been studied by Bickel, a fact which proves the similarity of the phenomena or processes which have occurred in both places. The said rock, when decomposed and it has a yellowish grey color, gives gypsum when placed in water; the reddish brown variety when tested with hydrochloric acid reveals a great quantity of sulphuric acid, and in both varieties iron is found as acid sulphates.

⁸ There is a description of this place written in 1739, which is kept in the archives of the Convent of the Franciscans in Manila and to which the majority of the travelers, who have cited it, refer: "There is a hill called Natugnos on the top of which is a lake about 400 square feet, in continuous movement on account of the intense vapor that it emits. The mass in it is an extremely white earth which, with the force of the vapor, now and then rises a yard or a yard and a half in queer forms and fall in small pieces upon coming in contact with the surrounding cold air." (Estado geografico etc., by the PP. Francisca-nos. Binondo, 1865).

⁹ He should say the volcanic mud of the lake.

¹⁰ Turfaceous sinter, not volcanic tufa.

Comparison with those of Tiwi and Iceland

The similarity which Roth establishes between the phenomena which produces these concretions and the phenomena which produces those of Iceland would make us believe that they are also similar to those which formed the siliceous cones of Naglagbong in the town of Tiwi, Albay, which we had the opportunity of describing in the "Emanaciones Volcanicas de Malinao", and which we compared also with those of Iceland. However, the white cones of Naglagbong come from the water of saline and transparent lakes, the scale-forming elements of which are found in exclusively chemical solution, while the siliceous *moyas* of Natugnos come principally from waters, which, although they contain also elements in solution, contain mud or *moyas* in mixture or in dilution. Aside from this, in Naglagbong the abundance and the beauty of the siliceous deposits should be attributed essentially to the salts contained in sea water, while in Natugnos we cannot nor is there any necessity of invoking such cause, since the presence of sulphurous vapors in the fumaroles acting on the doleritic rocks suffices to explain the formation of the *moyas* and the relatively scant quantities of silica which their concretions contain. These concretions, without doubt, on account of the fumaroles, have acquired neither the growth nor the predominant siliceous element which they acquired in Naglagbong.

Only by the more ferruginous and clayey nature of the deposits of Natugnos could we perhaps compare them with those of the silicic-ferruginous springs of Naglagbong which produced the "cono rojo" (red cone) but always with the essential distinction that on the latter, salt waters have intervened, although probably at a much lower degree than they have in the springs of the "conos blancos" (white cones).

Lupang Puti of Los Baños

East of Natugnos, at an elevation of 374 meters and already in the water shed of the

Maitim River, there is a place called Lupang Puti (white earth), in which the inhabitants dig small wells, tunnels and large trenches in order to obtain "bianquettos" (white bricks) which are used for whitewashing the buildings in the province and in Manila. Two places, called Matanda (old) and Bata (young), are preferred, for these are small exploitations and in them the rocks are whitened or kaolinized by the action of the fumaroles, which, properly speaking, no longer exist, although it may be noticed that in many places the ground is still very hot. This fact proves that vapors still emit in the interior at a low tension and scatter in or impregnate the crevices and the interstices of the rocks without manifesting themselves in the form of real fumaroles.

The clays, which are perhaps selinitic, are not all perfectly white in these places but are blue, gray, red or yellow in certain points, with pure, uniform or porphyritic tints which do not disappear in kneading. These properties make them appropriate for painting and making stucco for marble and colored jasper imitations.

Bitin

In the barrio of Bitin of the town of Bay, near the Pinguian creek and at an elevation of 240 meters, there are also very intense volcanic emanations in the form of solfataras containing the corresponding "bianquettos", which the natives exploit for whitewashing, as in Lupang Puti, Los Baños.

Lupang Puti of Bay

In this place the volcanic activity is more varied than in Natugnos. In this place which the natives also call Lupang Puti, a short distance south of Pinguian Creek, there is a vast barren place in which many fumaroles, some mild and other strong, issue, producing the hissing sound of gases which pass from a high to a low pressure. Wherever the ground is touched, the temperature is high and in the vicinity of the fumaroles it reaches more than 100°C. All the ground is covered with sulphur deposits of varie-

gated color, the most outstanding of which being white, red and yellow, and with beautiful concretions of sulphur, basic sulphate of iron and of perfectly white and yellow featherlike alum crystals.

Pinquian Creek

Its activity extends north through several mild fumaroles as far as a small tributary of the Pinquian, near which the energy of these fumaroles recrudescs considerably. In fact, some fumaroles are found with mouths of more than 80 cm. in diameter, which produce true eruptions of water and boiling yellowish liquid mud which are projected to a short distance, producing concretions similar to those in Natugnos and, in addition, sulphur and alum crystals.

Pinagrialan

Lastly, to the NE of the municipality of Santo Tomas, at an elevation of 253 meters, on the western slopes of Maquiling, there is a place called Pinagrialan, in which another solfatara is found with phenomena and concretions similar to those of Bitin and Puting Lupa, and in which some communal development of the white earth is being made for whitewashing buildings. We need not, therefore, dwell upon its description.

Hot springs

Let us now proceed to describe the other kind of volcanic manifestations which consist of numerous hot springs found on the flanks of Mt. Maquiling. We can and must consider them as the result of interior fumaroles which, instead of coming out, expend themselves in raising the temperature of the waters of the subterranean streams and increasing their solvent power towards certain substances. The hot springs are, so to speak, the last vestiges of the activity of the volcanic foci.

Aguas Santas (Holy Waters)—its history

The most important springs and also the best known for their medicinal properties

are those which come out in the town of Los Baños and which were already known by the natives in the time of the conquest and called Mainit by them, which means hot. In 1593 the Franciscans built in this place a small sanatorium, but having had some misunderstanding with the Augustinians, who formerly were in charge of the spiritual administration of the town of Bay, to which Los Baños depended, they, in order to obviate further misunderstanding, obtained its formal concession in 1627 and in 1671 erected a hospital and a chapel named Aguas Santas. A few years later, the Royal Patronage took possession of this health establishment and the State took charge of it till 1727, when it was destroyed by fire. This condition of things remained until the arrival of General Moriones, who proposed to restore it, and for this purpose resorted to public charity and actually built, with the proceeds of the collections, three hothouses, and edifice named "Pabellon del General" (The General's Pavilion) and another of large proportions intended for a hospital, which has never been completed.

Temperature and analysis

The waters which were used in the old establishment of the friars were conveyed through a short conduit of masonry, which still exists. They leave the conduit at a temperature of 91.32°C., and fall into the ruins of an old piscina constructed along the shores of the lake; here the temperature is reduced to 83.75°C. From the piscina the waters, still steaming, flow and mix with those of the lake.

In an analysis of these waters made in Manila in 1787 by a Frenchman,¹¹ the exterior and organoleptic character of the waters are described with sufficient exactness, but a much lower temperature than that which we have verified has been noted down for the water of the spring.

The description says thus: "The multitude of springs which come out near the

¹¹ Estado geografico de los PP. Franciscanos, etc.

town called Los Baños have the same origin, but they differ in temperature. The principal spring has a temperature of 67°, according to Reaumur thermometer, while the spring of minimum temperature has 29°. The water is clear, almost crystalline white and its odor is somewhat like that of lye, but its taste when fresh is not unpleasant and one can scarcely notice its salt content. When the water cools due to the loss of a great amount of air it becomes tasteless." In referring to the composition of the water, the description continues as follows: "The analysis made by reaction as well as by evaporation has given the same result. Six lbs. of water have given 101½ grains of residue in this way:

Sea salt, calcareous	60	grains
Sea salt, of magnesium	2½	"
Sea salt, common	26	"
Selenites	4½	"
Iron	½	"
Calcium, clay	8	"
	<hr/>	
	10½	"

In 1877 the study of these waters from the medical point of view was entrusted to the military physician Doctor Franco and his report was published in one of the Manila periodicals. According to said report, the water on leaving the spring has a temperature of 89°C

Supposing that this temperature and that of the Frenchman were taken accurately, since there is no reason to doubt it, we may surmise the remarkable fact that the water which in 1787 had a temperature of only 83.75°C. (67°R.), had 89°C. in 1877 and 91.32° in 1881, that is to say, the temperature of the water is rising.

If this fact could be duly verified, it might lead us to some important geologic conclusion.

In the said report of Doctor Franco the result of the analyses of the waters made by the pharmacist D. Leon Guerrero is also inserted. Here are the results:

From 1,000 grams of water a residue of

the following weight and composition was found:

	<i>gram</i>
Sodium chloride	0.60
Calcium chloride	0.26
Magnesium chloride	0.04
Sodium sulfate	0.05
Calcium sulfate	0.10
Magnesium sulfate	0.03
Silica	0.02
	<hr/>
	1.10
Loss	0.04

Besides, in the 1,000 grams of water, 0.02 cubic meters of atmospheric air and traces of hydrosulphuric (sulfhidrico) and carbonic acids are found, and also traces of ferrous salts, phosphates and undetermined organic substances.

The same Doctor Franco, who calls these waters *salino-cloruradas-termales*, prescribes them as proper remedies for the following ailments: internally for malarial fevers, kidney and spleen infarcts (obstructions), diarrhea and chronic dysentery, atony (weakness) of the digestive tract, gastritis, chronic hepatitis and other afflictions; as baths or sudatory for rheumatism, gout, muscular atrophy, atonic ulcers and old wounds.

Aside from these springs there are also in Los Baños and in certain parts of Calamba and Bay a multitude of thermal springs of diverse temperature and probably also of varied composition, since in the report of Doctor Franco, the following composition which was determined by the pharmacist who made the former analysis is given for the waters of a spring the location of which is not ascertained:

Solid residue	1.14
Ferrous carbonate	0.47
Calcium carbonate	0.45
Magnesium carbonate	0.17
Calcium sulfate	0.49
Magnesium sulfate	0.35
Sodium chloride	0.23
Magnesium chloride	0.15
Silica	0.38
Undetermined substances	0.40 (?)
	<hr/>
Loss	0.20
Solid residue	3.29

Tadlac and Sucot

In the neighborhood of the hill in which the Alligator Lake is located we have seen many hot springs, some in the margins of the Tadlac Creek with a temperature of as high as 49°C and others to the SSW, in a place called Sucot, with 88°C, temperature and of very ferruginous character, judging from the color of the deposits which they produce and, above all, by the astringent taste of the waters.

Mayondon

At the base of Mayondon Hill several springs with 57°C and 40°C temperature are also seen. The waters of these springs have hardly any taste and do not produce concretions.

Bacon

Likewise, in a place called Bacon, located near the road to Calamba, several springs can be seen emitting bubbles which cannot be produced by water vapor, as the temperature in the middle of the spring is only 58°C. Beside this spring is another with only 44°C temperature.

In the same place, on trying to pry a hard crust which has been deposited apparently by an exhausted spring, a dart of vapor gushed up with force and blew the hammer off our hands and reopened immediately a spring with a temperature of 95°C which probably would cool off gradually.

Pansol

In the neighborhood of Pansol Hill, especially towards the west, numerous springs flow, all of which are almost always ferruginous and more or less thermal, the temperatures which we have verified varying from 33° to 47°C. These springs unite with a small stream which comes from another spring called Tigbi, at a higher elevation, and flow down the hill into the lake.

Bucal

In the town of Calamba, alongside the road which leads to Los Baños, a depression

is found in a place called Bucal¹² which has been formed by the meeting of several springs of moderate temperature, ranging from 32 to 36°C. Towards the lake these springs form a copious stream which is utilized as motive power for the sugar mills situated there.

Others

Lastly, between the towns of Los Baños and Bay and between those of Bay and Calamba, in the plain and in places of medium elevation, likewise a multitude of more or less thermal springs flow, the detailed enumeration of which would not only be tiresome but fruitless. It is sufficient to know that they exist along the Cambantoc, Lalaog and Tigbi rivers and in the plain of Calauan.

SUMMARY AND CONCLUSION

Summing up the facts and the circumstances which we have just enumerated, one may conclude in the first place that Mt. Maquiling, because of its orographic forms and component rocks, is a recent volcanic mountain in the geologic sense of the word, but, on the other hand, the absence of true effusive rocks in the interior of its crater and in its upper flanks indicate that it has been extinct for a relatively long time, as confirmed by the tradition which is not very ancient in these regions, and by the old vegetation in the crater and slopes of the mountain.

The existence of the Maquiling and Pansol hills and above all that of the Alligator Lake and the effusive rocks which compose them, show also that after the beginning of the activity of the principal focus of Maquiling, and perhaps after its partial or total extinction, other foci of less intense activity subordinated to the principal focus have appeared, the last of which is, without doubt, the anular craterlike hill of the Alligator Lake. This lake aside from the aforesaid effusive type of its rocks, still retain the characteristic rapilli, cinerites, and peperinos of recent activity.

¹² Tagalog word for fountains or spring.

Probably also, during the interval between the two events, that is between the beginning and extinction of the volcanic activity of Mt. Maquiling, a gradual rise of the adjoining territory including the volcano itself began, because it seems very credible, to us at least, that the mantle of tufas which surround the Maquiling is not of sub-aerial formation but has been deposited at the bottom of a sea which was not very deep and was somewhat stirred, if one is to judge by the big and small haphazardly inter-mixed but perfectly stratified pieces of tufa which composed the volcanic "peperinos" (consolidated volcanic ejecta) and conglomerates of the mountain which do not only exist at the base of Mt. Maquiling, but extend over the southern shore of the lake and the left bank of the Pasig River as far as the outskirts of Manila. Otherwise, it could not be satisfactorily explained how the mere production of volcanic ash carried away by the winds and waters, with the aid of consequent corrosions, could have produced such uniformity and relative compactness of the texture and structure of the tufas and peperinos and such uniformity of the strata, separated by true beds of subaqueous formation.

We believe also that, in favor of this point of view, many other reasons such as the extension and composition of the tufaceous strata of Central Luzon could be adduced, but we do not indicate them here because they would have to be related to other foci which bound, so to speak, the great central plain from the Arayat to the Banahao Mt.

The extinction of the exterior manifestations and, so to speak, effusive activities of the secondary foci of Mayondon, Pansol, the hill of the Alligator Lake and several others in other parts of the mountain, did not cause the sudden extinction of the central interior activities. Much weakened to produce new ruptures and powerful emission of gases and liquids and, we might say, pasty rocks, they limited themselves to issue through the weakest part of former ruptures and through those nearest the principal and

secondary foci or at least through parts that offer the least resistance. These exterior manifestations also issue vapors charged with acid and corrosive substances which metamorphosed the volcanic rocks that have already cooled off, producing in them varied effects. The vapors sometimes succeed in reaching the surface to form solfataras, and at other times merely raise the temperature of the subterranean waters, saturating them with vapors and corrosive substances and making them able to dissolve other new substances contained in the rocks which they encounter in their subterranean passages. These passages likewise become metamorphosed in a greater or smaller zone.

The manifestations of these volcanic phenomena can be plainly seen in Natugnos, in the Pinquian stream, in Pinagrialan and the two Puting Lupa, the principal and dominant points of the solfataric activity, and in the numerous and very hot springs which issue along the shores of Laguna de Bay, the weakest of these solfataric manifestations.

Can we, therefore, consider Maquiling as a completely extinct volcano?

Unfortunately, there is no sign by which we can be sure of the true extinction of a volcanic focus, in the sense that no paroxysm similar to that which produced the volcanic mass itself will recur. While its external manifestations of igneous and gaseous emanations are still manifest with certain degree of energy, as they are in Maquiling, we believe that we cannot or should not consider a volcano completely extinct. It could be said that Maquiling is a volcano which does not produce true eruptions today and that the exterior of its crater is completely extinct, but we must not forget that Spartacus camped with 10,000 gladiators in the interior of the crater of Vesuvius which was then covered with beautiful vegetation, and that today this crater is full of other substances and is the scene of another kind of events which are more natural and certainly had not been foreseen by Spartacus and his gladiators.