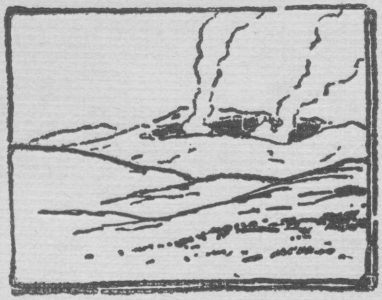
GUIDE-BOOK EXCURSION E-4

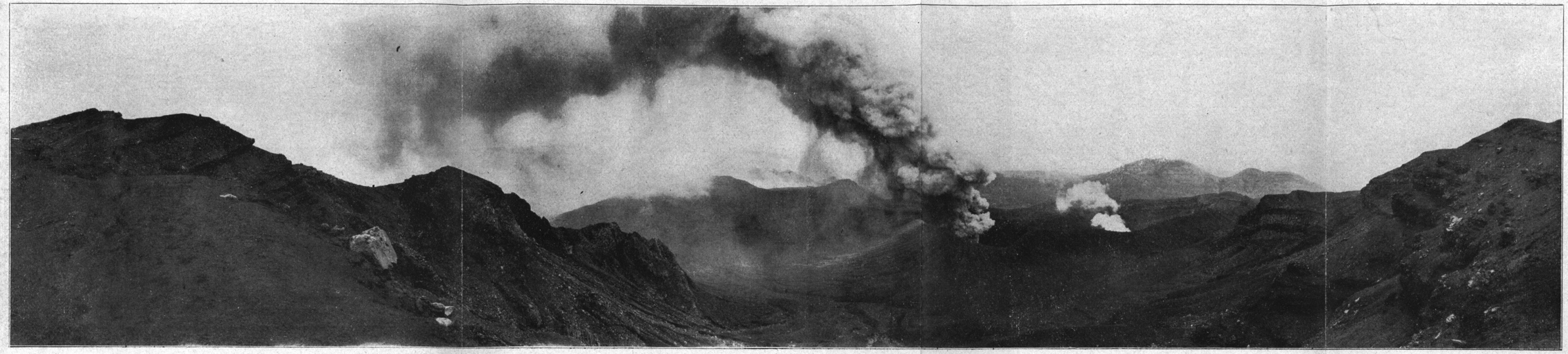
(Nov. 15th–19th, 1926)

ASO VOLCANO



PAN-PACIFIC SCIENCE CONGRESS, 1926

JAPAN



Panoramic view of Naka-dake Craters. (Photo. by M. MASAKI, May 8, 1923).

ASO VOLCANO

CONTENTS :

GEOLOGICAL NOTES ON THE ASO VOLCANO

By Tsunenana Iki

INTRODUCTION Geotectonically the middle part of Kyūshū is traversed by a zone of low land, although it is not now apparent owing to the uprising of Mts. Aso, Kuju and other volcanoes. If the outer covers consisting of volcanic rocks were removed, the lowland would be clearly discernible as a continuation of the depression zone of the Inland Sea, extending from the plain of Kumamoto on the west to the Bay of Beppu on the east. To the south of this lowland zone lies a high rugged mountainous land, the so-called outerzone of Japan, consisting of Crystalline Schist, and Palaeozoic and Mesozoic Formations which are regularly arranged with a NE-SW trending and with comparatively little occurrence of eruptive rocks. In contrast to this region, the northern part of the original lowland belongs to the inner zone of Japan and is of the same geological type as Chūgoku, i.e., it is composed of older sedimentaries with the wide occurrence of granite and other eruptives. It has undergone much erosion resulting in intersected hills and plains. In the troughs is found the Tertiary formation, which is economically an important deposit because of the intercalation of numerous coal seams.

The Aso Volcano has been built up in the lowland zone which is a weak line of the earthcrust. To the east rise Mts. Kuju, Yufu, Tsurumi and Futago, while to the west tower Mts. Kibosan, Unzen and others. All these volcanoes belong to the same volcanic zone as Aso, and the lowland zone was a scene of great volcanic convulsion during the post-Pleistocene.

Situation The Aso Volcano is the largest of the volcanic group above mentioned and also one of the most active volcanoes of Japan, constantly sending forth thick smoke. It stands

over the two provinces of Higo and Bungo, and its base extends 50 km. E-W and 46 km. N-S, covering an area of nearly 2,000 sq. km. By the Aso Volcano is usually understood the conical mountain group 35 km. to the east of Kumamoto. This is, however, nothing more than the central cone of the volcano. The original mountain body of the volcano includes all the surrounding mountains which form its somma.

Somma The outer side of the somma has an extremely gentle slope. Even on the southern side where the inclination is greatest, it is scarcely 10 degrees. The gentlest inclination on the eastern side is 2 or 3 degrees. This is really the piano of the Aso Volcano which forms an extensive rolling plain, though at a glance it has a plateau-like appearance. Outside the somma the development of radiating valleys, characteristic of a volcanic mountain, is well observed. But as the volcano Aso is intercepted by mountain masses except on the western side, the waters flowing through these valleys reunite to form a big river. The waters on the western side which are not intercepted as those in other directions keep up their independent courses far down to the sea.

The northern half of the somma is approximately 950 m. above the sea level, surpassing the atrio by approximately 430 m. and keeping an almost uniform height for the entire distance. The southern half, being a little higher than the northern, is approximately 1,000 m. above the sea level, rising above the atrio by approximately 600 m.; it is somewhat uneven on the top. Some peaks such as Mts. Kamuri-dake (1,154 m) and Kura-take (1,119 m) projecting on the somma may be considered as lateral cones formed on the western slope of the Aso volcano.

The huge oval-shaped basin inside the somma is the crater of the volcano. It measures 16 km. E-W and 24 km. N-S, being perhaps the greatest caldera in the world. The wall of the caldera forms a perpendicular cliff, although the lower part of it is of gentle inclination due to talus accumulation. Paths have been opened in various directions from the inside of the crater over the lower part of the wall, all with winding courses. It seems to be most probable that the Aso Volcano was originally several times as high as at present, but recently the greater part of the mountain body has sunk down due to the outflow of an immense volume of the Aso lava, thus forming the great caldera.

On the western side of the caldera there are two breaks. One is the Futaye pass (663 m.), leading from Kumamoto to the Aso valley. This is perhaps a trace of an erosion valley which formerly existed on the western slope of Mt. Aso. The other is Tateno break (379 m), lying to the south of Futaye-pass. Here the two rivers Kuro-kawa from the Aso valley and Shira-kawa from the Nango valley join, and the torrential stream thus formed has eroded the ground, at length breaking through the wall of the caldera and forming the deep valley now known as Tateno Barranco. This baranco lies on the same line as the central cones arranged in the direction of E-W inside the caldera. Moreover, hot springs such as Yunotani, Tochinoki and Toshita occur on this line. From these facts it may be inferred that the formation of the Tateno Barranco was caused by a rupture running in the direction E-W and that it has subsequently been dissected to its present state by the erosive action of the river.

Atrio The extensive plains lying between the central cone and the crater wall are the atrios, of which one on the northen side of the central cone is named Aso-dani (Aso valley) and the other to the south of it is known as Nango-dani. These atrios, being a fertile land, are inhabited today by a large population several tens of thousands, but they were once the main stages of the volcanic activity of Aso. The deposits in the atrios consist of volcanic ashes, sand, lapilli, gravel, etc., which are regularly laid down in horizontal layers, sometimes presenting false bedding. Thus it is evident that these atrios were once the bottom of a lake, which emptied as soon as the Tateno barranco was opened, providing an outlet for the water that filled the lake. The marshy district lying south of Uchinomaki in the Aso vally is a remnant of this lake.

Central Cones The central cones rising in the caldera of the Aso Volcano are comprehensively called the "Five Peaks of Aso." They form two groups according to this alinement in the E-W or N-S direction. On the E-W line, the four cones of Neko-dake, Taka-dake, Naka-dake and Eboshi-dake counted from the east, stand in a row. The Tateno barranco together with the hot springs Yunotani, Tochinoki, and Toshita lie on the western extension of the line, On the N-S line counted from the south, there stand Okamado-yama, Eboshi-dake, Kishima-dake and Ōjō-dake in a line. The intersecting point of the two lines is occupied by Eboshi-dake which is the greatest of the central cones. The supposition is that after the

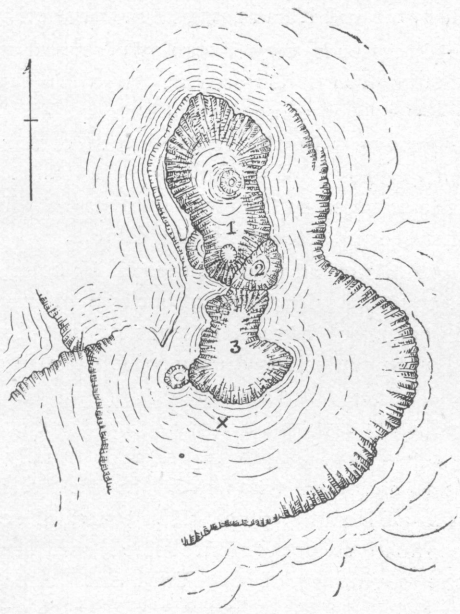
formation of the big caldera as a result of subsidence, new rupture lines running in the two directions mentioned and crossing each other opened up; and the volcanic action took place first at the intersecting point where it was most violent, giving rise to Eboshi-dake, which is the largest and oldest of the central cones.

(a) Neko-dake is situated at the eastern extremity of the E-W row of the central cones. The eruption took place adjacent to the wall of the caldera, a part of the ejected materials accumulating on the wall. The mountain rises 1,409 m. above the sea level. The mountain body consists of alternations of lava and agglomerate, sloping down on all sides from the center. The mountain is, however, considerably dissected by erosion, so that the original crater is beyond recognition. The top of the mountain presents a serrated aspect.

(b) The next cone standing to the west of Naka-dake is Taka-dake. It measures 1,592 m. above the sea level and is the highest of the central cones. The summit is rather flat. It has a full developed piano on all sides except the west which is broken by the eruption of Naka-dake. Between Take-dake and the adjoining Naka-dake there is formed an intercolline valley named Hino-tōge which, attaining a height of 982 m. above the sea level, is the only mountain pass connecting the Aso and Nango valleys. On the summit of Mt. Taka-dake there is an oval-shaped crater, 400 m. E-W and 100 m. N-S in diameter, surrounded by a low wall. The southeastern corner of the crater is broken by another explosion crater, which forms a deep valley constituting the source of the river Shira-kawa in the Nango valley. The mountain body of Taka-dake consists of alternations of lava and agglomerate, sloping down on all sides from its top crater.

(c) Naka-dake rising on the western side of Taka-dake is at present the center of activity of the Aso volcano. Thick clouds of smoke and vapour are constantly vomited from the top crater, attracting many mountain climbers and visitors who desire to visit the scene of real volcanic action. As shown in the annexed figure, Naka-dake is a composite cone with a somma and central cone. The western half of the somma was destroyed by the eruption of the central cone, while the eastern half is perectly preserved. The inner wall stands in the form of a perpendicular cliff with layers of lava and agglomerate finely exposed. The wall is about 120 m. high, measured from the atrio, and gradually decreases in height to the southward. Within the somma, on the southern side of the central cone, there is a

Sketch Map of the Naka-dake Crater.



Cross mark shows the active centre during the eruption in 1906.
Scale 1:28,000

wide level plain usually known as Senri-ga-hama. This is the atrio.

The central cone rises 70-80 m. above the atrio and it has a slope of nearly 20 degrees, extending far to the northwest. The cone is composed of lavas, mud-flows, sand, etc., mostly sent out from the northern-most crater. Its surface is covered with sand and a volcanic ash locally known as *Yona* which is in some places 2 or 3 m. thick. On the top of the central cone there are three principal craters lying roughly in the meridional direction. These craters are separated from each other by walls. For convenience they may be numbered 1, 2, 3 in consecutive order from the northern end.

The No. 1 crater, at the northern end, is the largest of all, measuring approximately 350 m. E-W and 500 m. N-S and 150 m. deep. There are two holes in the bottom. One opens on the northeastern part of the crater bottom, while the other is located on the foot of a steep cliff at the southern end. This crater was formerly the most active of all, but now remains inactive with small streaks of white vapour rising from the two holes inside.

The No. 2 crater is a small kettle-shaped depression. At times it is filled with water and it has never been very active.

The No. 3 crater is very irregularly shaped with a diameter varying from 300 to 400 m. At present this is the most active of all the craters, constantly sending forth black smoke accompanied by underground roarings. In the southwestern corner of this crater there is a small crater (No. 4) with a shallow bottom. The active crater during the eruption in 1906 was opened at a point cross-marked in the figure, but it is now scarcely recognizable.

According to historical records, there have been 60-70 eruptions of Naka-dake, together with frequent outflows of mud and ejections of fragmental rocks, but never any trace of lava-flow. Most of the eruptions were mere explosions during which the mountain vomited black smoke and rained ashes and cinders. The volcanic dust mixed with smoke is locally known as *Yona*. Great volumes of *Yona* are ejected during the violent eruptions. It falls usually in the vicinity of Mt. Aso, and is often transported as far as Kumamoto and Takeda and other adjacent regions. The center of activity of Naka-dake is not confined to one definite place and has shifted many times since the beginning of the Meiji era. Among the several craters of Naka-dake, the No. 1 crater has been the most active and the No. 3 next. When the writer visited this volcano in 1897, the No. 1 crater was very active vomiting tremendous amounts of smoke and lava fragments from the northern hole, forming a beautiful cinder cone with a hole in the center opening like a funnel. The lava fragments sometimes fell outside the rim of the crater.

Although the central cone of Naka-dake has several craters, the lavas composing the body of the cone are inclined downward on all sides from the No. 1 crater as the center. So the No. 1 crater appears to be the main source of the lava-flows which constitute the mountain body and the others seem to be explosion craters formed on its flank.

(d) Eboshi-dake is situated on the intersecting point of the rupture lines running E-W and N-S inside the Aso crater. Being the oldest cone, it is much dissected. The mountain slope is most extended to the west, reaching the Tateno barranco at the farthest end. On the summit there is a large circular crater measuring nearly 800 m., locally known as Senri-ga-hama. The crater is a shallow depression thickly covered with volcanic ash and sand,

consequently without any rocks exposed to view. On the southern side towers a pointed peak. named Eboshi-dake, 1337 m. above the sea level; it is so called because of its resemblance to an *eboshi* (a form of headgear once worn by Japanese noblemen). This peak consists of glassy lava. As the mountain body also consists of the same rock, it is very likely that the crater before mentioned was formed by a great explosion that blew up the greater part of the mountain. The crater is traversed by a low ridge inside, the eastern part of it being lower than the western. So the crater seems not to be single but duplex in structure.

(e) Okamado-yama, standing on the southern side of Eboshi-dake, is a dissected mountain with a horseshoe-shaped valley opening toward the east. From this valley as the center, the lava-flows extend down in all directions and so it is almost certain that this formed an independent mountain body. The mountain is composed of alternations of lava and agglomerate.

(f) Kishima-dake rises 1,321 m. above the sea level to the north of Eboshi-dake. Viewed from the west it is a perfect cone with a slope of from 20 to 25 degrees. On the summit there is a pit crater, 100 m. in diameter and 20 m. in depth, surrounded by a perpendicular cliff in which several lavas are excellenty exposed. On the eastern slope of the mountain there is an explosion crater named Ō-hachi ("Major basin"), which is somewhat larger than the top crater. Inside the Ō-hachi there is formed another small kettle-shaped crater known as Ko-hachi ("minor basin).

(a) Ōjō-dake is a truncated cone to the north of Kishima-dake, rising 1238 m. above the sea level. Near the top it has a slope of about 25 degrees, but becoming gentler as it descends, the piano is widely extended toward the northwest. There are three apical craters on a line running E-W. The western two are in a circular form adjoining each other and of nearly equal size having a diameter of about 10 m. The one on the east is roughly oval in shape with diameters of 80–100 m., and its crater wall has a deep fissure valley on the northeastern side. The lavas composing the main body of this mountain have been forced out from this crater, and the other two are explosion craters.

(h) Komezuka (954 m) is a parasitic cone at the northwestern foot of Ōjō-dake. It is a beautiful perfect cone with an inclination of 30 degrees. On the summit there is a small oval-shaped crater,

measuring, the longer diameter 40 m. and the shorter 20 m., with a depth of 10 m. The mountain is a cinder cone formed entirely of lappili and scoriae.

Fumaroles, Solfataras and Hot Springs

Inside the Aso crater there occur fumaroles, solfataras and hot springs at different places. The hot spring, Yunotani, located on the western slope of Eboshi-dake was formerly, about 1897, a fumarole emitting vapour very actively, but now the activity has almost ceased and we find only a hot spring. The hot springs Tochinoki and Toshita, near the Tateno barranco, issue from a fissure in the andesite composing the somma. At the foot of Eboshi-dake, there are hot springs, *Jigoku* ("Hells") and Tarutama which belong rather to the rupture line of N-S. *Jigoku* are highly sulphurous hot springs having a solfataric action and emitting sulphurous vapour. Beside these, there are other hot springs such as Uchinomaki in the Aso valley. This spring comes up from bore-holes at a depth of about 75 m.

Evolution of Volcano Aso

The somma of Aso Volcano, being composed of lava, agglomerate and volcanic ashes, shows a structure of typical strato volcano. The agglomerate, which is widely exposed at the base of the crater wall on the southern side of the somma, is the oldest material composing the volcano. It seems that at the time this material accumulated the mountain was still in on embryonic stage, or in other words, the first phase of the growth of the Aso Volcano. Then followed a period of eruption during which lavas and fragmental materials were ejected, the accumulation of which resulted in the formation of a huge conical mountain. In the latter part of the period occurred lateral eruptions forming several lava cones such as Mts. Kamurai-dake, Kura-take, Ono-dake and Ōgi-dake. Meanwhile erosive action effected irregularity in the morphology of the mountain. This is the close of the second phase. Then an immense outpouring of lavas and mud-flows took place twice or thrice from the top crater of the volcano, causing a disturbance in the subterranean equilibrium and resulting in the subsidence of the greater part of the mountain body. The great caldera of the Aso Volcano was thus formed, leaving only the piano of the original mountain. This marks the close of the third phase, and probably took place in the post-Pleistocene age. The violent activity of the volcano still continued and created two rupture lines, running in the directions E-W and N-S, along which

several central cones have been built up. This is the fourth phase. Since then the activity has gradually weakened, but some energy is still manifested in the constant vomiting of abundant clouds of smoke from the top of Naka-dake, with occasional outbursts.

Rocks There are more than 40 principal lava-flows composing the mountain body of the Aso Volcano. Petrographically they are grouped as follows: Olivine augite-andesite, olivine two pyroxene-andesite, angite-andesite, two pyroxene-andesite, hornblende two pyroxene-andesite and andesite glass. This grouping is based simply on the predominating components, consequently there is no distinct demarkation between them. It is noteworthy that all the lavas composing the somma except one, belong to the two pyroxene-andesite and hornblede two pyroxene-andesite, while those occurring in the central cones are olivine-bearing in most cases and comparatively basic. Though two pyroxene-andesite is occasionally found in the central cones, the variety containing hornblende is never met with.

There is one important lava, the Aso lava, which requires some explanation concerning its mode of occurrence. The Aso lava covers almost the entire surface outside the somma. Although the greater part of it is hidden under volcanic detritus and is therefore not clearly visible, it is exposed everywhere in the valleys, or along the river beds. The rock varies from brown to dark gray in colour. The dark variety is the andesite glass, but the light-grey rock exhibits an aspect like a consolidated volcanic ash containing many lenses of obsidian with a fluidal structure and is usually known as ash-stone. The dark kind usually occurs in the lower part of the lava flows, while the light coloured is found toward the top, often accompanied by mud-flows and mixed with various rock fragments. An analysis of the lava is as follows:

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
Dark gray glass	68.4	18.03	2.62	2.40	0.04
Brownish glass	64.23	18.29	5.25	2.52	0.11

The Aso lava is well exposed on the northern crater wall, the characteristic uniform height of which is mainly due to the occurrence of this lava. There are two or three flows of this lava alternating with agglomerate and mud-flow. The top flow has a thickness of 2 or 3 m., while the lower one is more than 4 m. thick. Among these lava-flows the lowest one—the first flow of the lava—reached the farthest point. Its volume was tremendous, filling up all

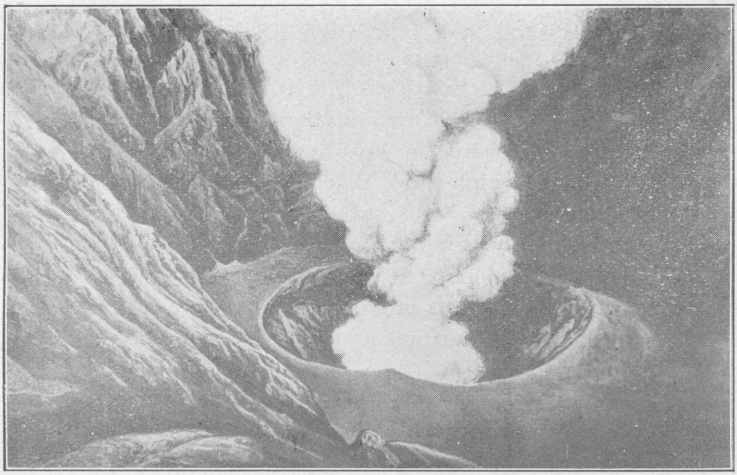
the valleys on the way, reaching as far as Ōita and Nobeoka, about 60 km. on the east, and the plain of Kumamoto close to the Bay of Ariake on the west. Southward it travelled over the mountain passes as high as 600-1000 m. and then down to the rivers Kuma and Mimitsu. Northward the lava-flow passed likewise a mountain range over 600 m. high and reached the Kusu basin. From a consideration of these distributions of the Aso lava, it is evident that at this time the middle part of Kyūshū already presented topographic features similar to the present. The fact that the Aso lava rests upon the terrace gravel beds at different places seems to show that it flowed out during the post-Pleistocene age.

Together with the Aso lava, a large volume of mud-flow came out and formed the upland round the base of Mt. Aso. Sometimes they are so closely related that it is difficult to distinguish between them and thus the term *Aso mud-lava* may be preferable to the term *Aso lava*.

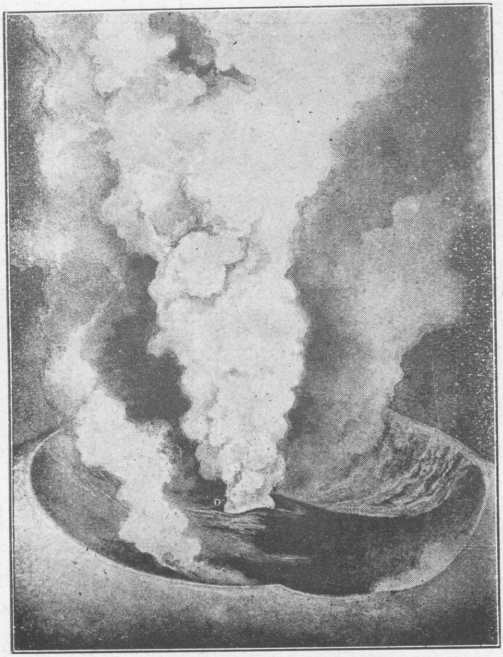
ITINERARY

We leave Kumamoto by train nerly in the morning. As far as Ōtsu the train passes over a terrace consisting of tuffaceous sand, gravel, loam, etc. On this section of the train trip, we notice on the right an isolated hill of 190 m. composed of Tertiary strata. From the Seta station the train runs along the right bank of the river Shira-kawa, going up a gentle slope. Now the train proceeds, entering valley, and the mountains on both sides become higher and the valleys deeper. It is easily recognized that the whole district way up to Tateno station consists of andesite.

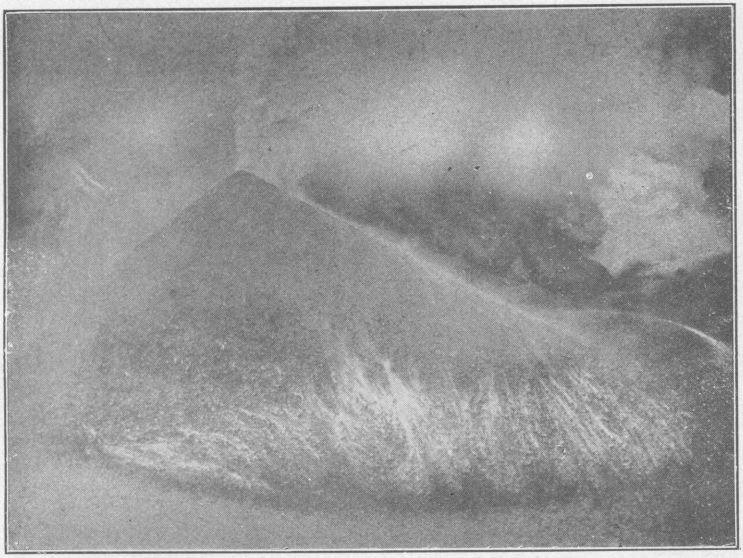
Tateno station is located within the barranco on the right side of the river Shira-kawa. Here is the entrance to the great caldera of Aso, the roads leading leftward to the Aso valley and rightward to the Nango valley. The waters of the two valleys flowing down through the Kuro-kawa and Shira-kawa, join here forming a gorge some 200 m. deep, with a torrential stream. At this point the train is switched back and aseends about 100 m., going leftward into the Aso valley. The cliff looking over the river at the entrance is composed of black coloured andesite-glass with columnar joints. Inside the barranco there were once the two famous waterfalls of Sukaru and Aigayeshi in the Kuro-kawa and Shira-kawa



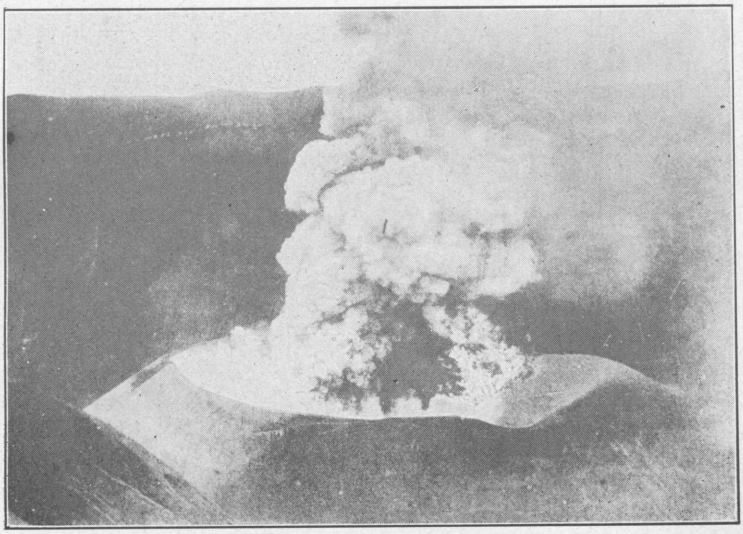
Active Crater of Naka-dake. October, 1897.



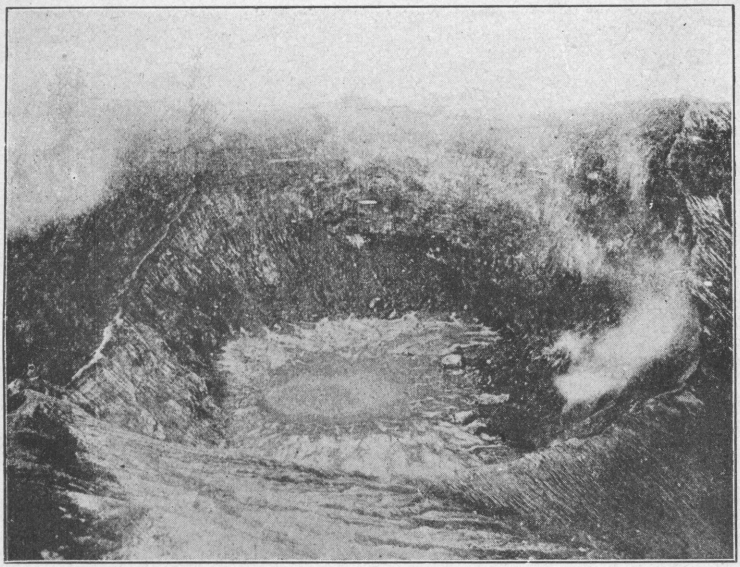
Active Crater of Naka-dake, showing embryonal cinder cone inside the crater. August, 1898.



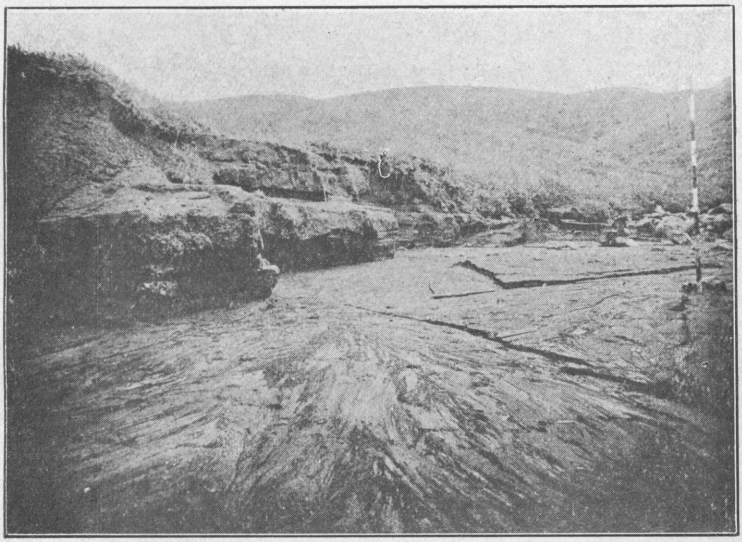
Active Crater of Naka-dake. A beautiful cinder cone, 75 m. high, has been built up inside the crater. November, 1898.



Active Crater of Naka-dake. Top of the cinder cone was blown out, forming funnel-shaped crater-hole. April, 1899.



Crater 2, Naka-dake.



Mud-flows frequently poured out of the Naka-dake Crater.

respectively. The former is now, however, dry, due to the construction of an electric power plant.

At Akamizu station, we see in front the vast plain of the Aso valley or atrio. The steep cliff standing far beyond this valley is the crater wall inside the somma. The grassy plain on the right side is the diano of the central cone. The lava exposed here and there is one that flowed out from Ōjō-dake. In the neighbourhood of Uchinomaki station we see to the south a beautiful parasitic cone called Komezuka, together with Kishima-dake and Ōjō-dake standing behind.

We leave the train at Bōjū station and from there ascend to the crater of Naka-dake at a distance of about 18 km. In the vicinity of Bōjū are visible four of the five peaks of Aso, i.e., Neko-dake, Taka-dake and Kishima-dake. Eboshi-dake which completes the list remains hidden from sight. The ascent from Bōjū is an easy gentle slope. For the first kilometer the road goes through a coppice; it then enters a grassy field without a single tree to interrupt the broad view. In front we see a black column of smoke rising from Naka-dake. To the right tower Ōjō-dake and Kishima-dake. Backward we look down on the broad panorama of the entire Aso valley, which is beautifully cultivated with rice fields and dotted with several towns and villages. Beyond the valley the somma has a uniform height, the view resembling to the horizon in the sea. Farther beyond is seen the volcano Kuju standing behind the somma. The mountain path to Naka-dake is thickly covered with ash and sand, and therefore there is no exposure of rocks; but down the valley is observed some lava flow. The last kilometer to the crater is rather steep. In this part there is no plant life owing to the raining of ashes and sand. It is a bare ground with fine exposures of lava and mud-flow that poured out from the crater of Naka-dake.

Going up a somewhat steep declivity, we reach the northern extremity of the Naka-dake crater, and we can fully examine the condition of the No. 1 crater. The activity of this crater has remarkably declined in recent years, a small streak of white smoke only issuing at present. The active hole has a funnel-shaped opening on the northeastern side of the crater and is elevated to some extent. To the south of it there is another hole emitting some vapour. Going along the western rim of the crater, we come to the No. 2 and No. 3 craters. The latter is the most active at present. Accompanied by constant roaring, black and sulphurous smoke rises violently with rains of ashes and sand.

After the observation of the craters, we come down to the rest house at the northwestern foot of the central cones. After tiffin, we ascend to the crater of Eboshi-dake, about 1 km. from the rest house, whence we can obtain a general view of the Tateno barranco and a sight of Mts. Kimpo-san and Unzen-dake in far distance. Thus is ended our general observation of the Aso Volcano. We go down to Bōjū and return to Kumamoto in the evening.

BOTANICAL NOTES ON MT. ASO

By Kwan Koriba and Zentaro Tashiro

As Mt. Aso is of relatively recent origin and still active, its vegetation is fairly simple with fewer floral elements. This is especially the case on the central cones. Cultivation, plantation and pasturing have also modified the vegetation of the crater basins and other gentle slopes.

On the way from Bôchû (535 m.), a village on the north atrio, to Nakadaké (1,323 m.), one of the central cones, the road, after passing through a *Cryptomeria*-plantation, leads to grassland of *Miscanthus sinensis* and *Arundinella anomala*. The flora here is rather scanty. Only some ten species of shrubs and thirty herbs are found. Of the former may be mentioned: *Diervilla floribunda* var. *versicolor*, *Deutzia scabra*, *Spiraea japonica* var. *alpina*, *Elaeagnus umbellata*, *Salix Sieboldiana*, *S. repens* var. *subopposita*, *Smilax China*, *Lespedeza bicolor*, *Rubus incisus*, and from 1000 m. upward *Rhododendron kiusianum*. Among the herbs there are: *Polygonum Reynourtria*, *Cynanchum amplexcaule*, *Artemisia vulgaris* var. *kiusiana*, *Achillea ptarmicoides brevidens*, *Cirsium kiusianum*, *Asparagus oligoctonos*, *Maianthemum bifolium*, *Calamagrostis autumnalis*, *Miscanthus Matsumurae*, *Carex brepharicarpa*, etc. As the slope ascends, the vegetation tends to be more open in consequence of the poisonous gas from the crater. The chief constituent of the gas here concerned is sulfurous acid, the pungent smell of which is occasionally noticeable several kilometers away.

From Hondô (1,150 m.) onwards, the vegetation is extremely open, what may be called "a sulfurous atmosphere consociation." The chief elements in it are the following: *Polygonum Reynoutria*, *Carex brepharicarpa*, *Miscanthus Matsumurae*, *Calamagrostis autumnalis*, *Alnus firma*, *Maianthemum bifolium*, *Rhododendron kiusianum*, and *Miscanthus sinensis*.

Of these species, *Polygonum* is the most resistant and approaches much closer to the crater than any of the others. These latter follow nearly in the order given above. Most of them grow so as to form a cushon on the rough soil, and their one-sided development facing downhill of the slope, or away from the direction of the gas flow, is quite peculiar.

A sulfurous atmosphere consociation.

Returning to Bojū, a few km. from there, on the south side of the road, a swamp is to be seen at Senchô-muta. It is the remnant of a lake that formerly existed in the basin. Though most of the area has been cultivated for rice-fields, its central part still remains untouched and contains many swamp and meadow plants, such as *Phragmites*, *Molinia*, *Miscanthus*, and *Juncus*. Some bog plants such as *Utricularia*, *Menyanthus* and *Habenaria* are said to have occurred

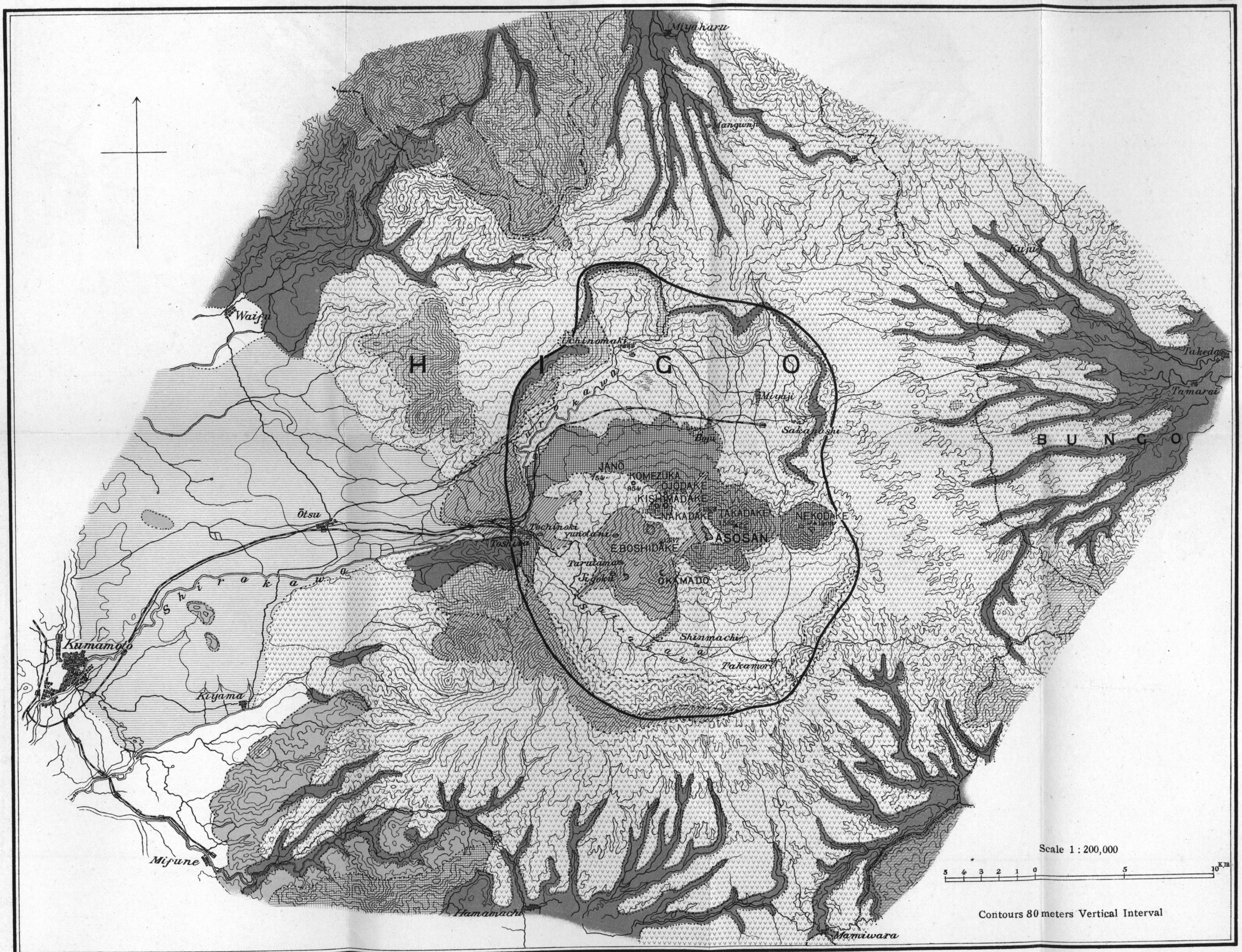
formerly, though they are now extinct. This fact implies the gradual changing of the area from bog to meadow, caused chiefly by drainage. The subsoil of this region consists of a deep layer of peat.

Along the steep valley and on the outer slope of the somma, forests occur in various grades of development. In number the deciduous trees far surpass the evergreens.

In regard to distribution, it is a peculiar fact, that the northern slope of the mountain has some affinity with Korea and continental Asia, while on the southern slope this affinity is not manifested. This fact is considered to be due to the orographical conditions of a past geological era. According to geographical evidence, Kyushū was formerly divided into two islands by the so-called Tsukushi Channel, until Mt. Aso rose in the midst of it and united the two into one. Naturally the floras differ in these two islands. The northern one received many Korean elements, such as *Aster Maackii*, *A. tartaricus*, *Echinops dahuribus*, *Campanula glomerata*, *Viola xanthopetala* and others, which flourish on Mt. Kujû (1,764 m.), about 20 km. NE of Mt. Aso. That mountain is considered to be the main source, from which is propagated the mountainous flora of North Kyushū, not only of Mt. Aso, but also of Mts. Yufu, Tsurumi, and others. The two islands were indeed connected in the Diluvial, but the flora has not propagated readily, partly on account of volcanic activity, so that there still remains a marked contrast between the two slopes, north, and south, the latter of which is said to have received its flora mainly from the Sobo Range (1,758 m.), about 20 km. SE of Mt. Aso, and is therefore more closely related to Shikoku.

TOPOGRAPHICAL AND GEOLOGICAL SKETCH-MAP OF VOLCANO ASO.

1926



Olivine Andesite

Hypersthene Andesite

Aso-lava (Glassy Andesite) and Mud-flow

Agglomerate

Hornblende Andesite

Volcanic Detritus

Quartz-porphyry

Granite

Alluvium

Diluvium

Tertiary

Palaeozoic

Crystalline-Schist.

Hotspring

Outline of the Caldera

Crater of Central Cone.

大正十五年十二月二十日印行
大正十五年十二月二十五日發行
第三回汎太平洋學術會議
印刷者 木下憲
東京市日本橋區兜町二番地
印刷所 東京印刷株式會社
東京市日本橋區兜町二番地
發賣所 東京地學協會
東京市京橋區木挽町九丁目二十九番地

Executive Office: Rooms of the National Research Council,
Department of Education, Tokyo

CABLE ADDRESS:—KENKYU, TOKYO.

Printed by the Tokyo Printing Co., Ltd.