The Scope of the Vulcanological Survey of Japan.

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Japan, being located on the 'girdle of fire of the Pacific,' is the land of typhoons, volcanoes and earthquakes. Grand physical phenomena and Nature's scourges are being displayed in a full degree unparalleled in any other spot of the earth. Not so long ago, in 1854-'56, this country was shaken savagely from the south end of Kiû-shû to the north of Hokkaidô, by shocks accompanied by seismic sea-waves. The calamity of this so-called "Ansei earthquake" is still vividly recalled in the mind of the living generation. In 1891, the earth was suddenly rent along a length of 112 kilométres in Central Japan, and the throwing down of the solid crust along this line of fissure created violent vibrations, shaking down the buildings and embankments of the Mino-Owari province into rubbish.[1]

In such a country as Japan, where the great terrestrial convulsions are of frequent, and small shocks are of daily, occurrence, the best opportunities are afforded for studying the many and varied phenomena connected with the causes of earth-shaking. Studies in these directions began a score of years ago with the founding of the Seismological Society of Japan, and we find in Prof. John Milne its exponent, successfully followed by the late Prof. Sekiya, Prof. Ômori,

1) Milne-Burton, 'The Great Earthquake in Japan, 1891,' Tokyo. Tanakadaté-Nagaoka, 'The Disturbance of Isomagnetics attending the Mino-Owari Earthquake of 1891.' *Jour Sc. Coll.*, Vol. V. Tokyo. Ômori, 'On the After-shocks of Earthquakes.' *ibid.* Vol. VII. B. Kotô, 'On the Cause of the Great Earthquake in Central Japan, 1891,' *ibid.* Vol. VII. Ch. Davison, 'On the Distribution in Space of the Accessory Shocks of the Great Japanese Earthquake of 1891.' *Quart. Journ. Geol. Soc.* Vol. LIII. p. 1 *et seq.*

and many others. Apart from pure scientific interest, the investigations of earthquake-phenomena are of urgent necessity for Japan's welfare. Therefore, in June, 1892, a year after the *Mino-Owari* earthquake, the Earthquake Investigation Committee was appointed by an Imperial Ordinance, in accordance with the petitition of the House of Peers, mainly through the effort of President D. Kikuchi,[1] then Professor, of the Imperial University of Tôkyô.

Since the organization of the Committee, I have been fortunate enough to be one of its members, and to my lot falls the duty of investigating and reporting on the *geological side* of the earthquake phenomena—namely, geological investigations of the causes of earthquakes and the relations of earthquakes to geologic structures, *etc.*

I wish to add a few words by way of explanation of what is already said, that is of immediate concern to me. If we cast an eye upon the progress of geological science in the past, we find a time when most earthquakes were attributed to the expansive power of a gas in the earth's interior, a view which in later periods changed its form into the volcanistic hypothesis. This was prevalent throughout the Middle Ages, and may be considered to have originated from Aristotle and Pliny.[2] During the first half of the present century, two hypotheses went side by side. One of them is that of depression, which was held by men of science, such as Boussingault, Necker, and Volger. Contemporaneous with these thinkers, there were prominent advocates of the volcanic theory of earthquakes in the person of L. v. Buch, A. v. Humboldt, and C. Naumann. To these nature-philosophers,

1) *Publications of the Earthquake Investigating Committee in a Foreign Language, No. I.* The lines of investigation that may fulfil the scope of the Committee are many and various, and there are at present existing several sub-committees, dealing with the following subjects—namely; 1. Collection of facts concerning earthquakes, seismic waves, eruptions, *etc.* 2. Geological investigations of the causes of earthquakes and relations of earthquakes to geological formations, *etc.* 3. Investigations connected with the nature of earthquakes, especially the law of propagation of waves. 4. Magnetic observations. 5. Under-ground temperature observations. 6. Gravity observations. 7. Testing the strengths of various building materials. 8. Testing various structures and joints.

2) R. Hoernes, *Erdbebenkunde*, 1893, S. 12 *et seq.*

earthquake and volcanoes were nothing but the reaction of the earth's interior against the external shell, and both phenomena of nature were attributed to the same cause.

During the last half of the present century, tectonical geology has made a marvellous stride, and the structure of mountain-ranges are daily becoming more and more clear. At last, geologists began to inquire into the cause of seismic phenomena through the researches on the formation of mountains. The study in this direction is an effort to bring together into scientific shape the facts ascertained through detailed studies of individual earthquakes, and a comparison of the result obtained therefrom with the facts of the geological structure of the region concerned. The chief merit in this line of study is largely due to the renowned group of geologists, such as A. Bittner, H. Credner, A. Heim, R. Hoernes, Michel-Lévy, E. Suess, F. Toula, and many others too numerous to mention. Hoernes tells us in the concluding remarks of his well-known paper, that earthquakes may take origin from different causes ; at one time the falling in of subterranean cavities, though very rarely, and at another, a volcanic explosion may bring about locally terrible convulsions ; but by far the greater number of earthquakes and the most terrible ones are the direct outcome of the process of mountain-making. Under the last category are included those shakings whose frequency and seismic area are more or less closely connected with certain lines, upon which shakings are repeatedly observed. As they appear to have some direct relation to the activity of mountain-building, the name of *tectonic earthquake* was given.

Nowadays, in Japan, even daily newspapers speak of dislocation-earthquakes whenever a shaking is noticed, so that they are not at all surprised when the Neo fault of 112 km. long was discovered in 1891 in the Mino province, which had caused that great subterranean con-

vulsion. To me it appears that the theory of tectonic earthquake is now established beyond all dispute. The Quetta[1] earthquake in Balúchistán on the 20th December 1892, and the Lokris earthquake of 1894 in Greece[2], are good examples of tectonic shaking. Prof. John Milne is perhaps the only person who still adheres to Humboldt-Naumann's view. As he is a great authority on the modern seismology, the English-speaking circle is now being greatly influenced by his standpoint, so that even the standard text-book of geology by Sir A. Geikie, is coloured with the volcanistic view of earthquakes.

It is unfortunately a common rule rather than an exception, that a theory, however perfect it may be, does not explain all the facts connected with it, so it is in the case of the theory of earthquakes, and there is a growing opinion against the view which I have already too long dwelt upon. It has been said that Prof. Gerland[3] expressed his belief at the recent meeting of the 'Geographen-Tage' in Jena to the effect, that some of the earthquakes had, according to his calculation, their hypocentres *below* the assumed crust of the earth, probably in the transitional zone to another state of aggregation of the crust,—a fact which leads him to say that the mountain-making process has no causal connection with earthquakes, which implies the negation of tectonic shaking ; but there yet remains a question, What is the real thickness of the crust ?

Herr Alphons Stübel's view is also largely at variance with the tectonic hypothesis. I read with great interest his colossal work entitled '*Die Vulkanberg von Ecuador*,' and conceive that the whole tone of his tenet is volcanistic, as may be gathered from the citation

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1) *Rec. Geol. Surv. of India*, 1893, Vol. XXVI, pp. 57-61.

2) 'Die zwei grossen Erdbeben in Lokris' von G. Skuphos, *Zeitschr. d. deutsch. Gesell. f. Erdkunde z. Berlin*, Bd. 29. 1894, s. 409 *et seq.*

3) 'Ueber den heutigen Stand der Erdbebenforschung,' (*Verh. d. XII. deutsch. Geogr-Tages*, 1897). Referred to in the *Neues Jahrbuch für Mineralogie, etc.*, 1898, II, S. 42.

below[1]. Born in a volcanic and earth-shaking country, I cannot, from my own conviction and daily experience, fully agree with him in many points; *firstly*, that although some earthquakes originate in, and coincide with, a *centre of eruption*, as in the earthquake of Kumamoto[2], which shook the whole of Kiû-shiû in 1889, yet a purely volcanic one has a very limited area of shocks, as can be clearly seen in the eruption of Bandai-san in 1888[3]; *secondly*, that tectonic earthquakes usually affect *considerably larger* areas than those of volcanic origin do, in contradiction to the assertion of Stübel's. Without going abroad, I can take a Japanese example in illustration of the point in the case in the great Ansei earthquake of 1854-'56, *i.e.*, a period of Ansei in our annals, when all Japan was being violently shaken; but not one of the volcanoes, of which, of course, there are many, have shewn any remarkable signs of activity ; *thirdly*, that the *strict proof* for the tectonic earthquake can certainly be found in the faulting and shifting of the crust, which needs no farther remark, as I have already spoken sufficiently at length.

A few more words may properly find the place here. In modern geological teaching, so-called *tectonic fracture lines* play a most important part. It is the key with which the structure and the origin

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1) Seite 24: " Dass die Erdbeben in *ueberwiegenden* Mehrzahl zu den vulkanischen Erscheinungen zu rechnen sind, kann keinem Zweifel unterliegen,—...In vulkanischen Gegenden, besonders in solchen, in denen sich noch thätigen Vulkane befinden, ist es fast zur *Gewissheit* geworden, dass der Ausgangspunkt der Erderschütterung mit den Eruptionscentren dieser Vulkane ueberaus häufig [?] zusammenfällt. Dass es also eine vulkanische Ursache der Erdbeben giebt, ist erwiesen ; dass es aber auch eine andere, zumal eine tektonische geben kann, ist *möglich*, für gewisse Gegenden und *kleine*[?] *Erschutterungskreise* sogar *wahrscheinlich*, der strenge Beweis dafür ist jedoch bisher *nicht* erbracht worden [the fault of Neo valley may, I think, be looked upon as a crusial test], und die Nothwendigkeit dieser Annahme würde erst dann vorliegen, wenn die beobachteten Thatsachen mit den Aeusserungen der vulkanischen Kraft *nicht mehr in Einklang* zu bringen wären."

2) Kotô, 'Cause of the Great Earthquake in Central Japan in 1891.' *Jour. Sc. Coll.* Vol. V., 1893, p. 324.

3) 'The Eruption of Bandai-san.' *Jour. Sc. Coll.*, Vol. III. 1890, p. 91. See also *Transactions of the Seismological Society of Japan*, Vol. XIII., Part II., 1890. p. 139 et seq.

of continents and oceans, mountains and lowlands, tablelands and basins, *etc.*, are disclosed and explained. The study in this direction in deciphering the structure of the crust, in which a strong array of geologists is now working, is indeed the characteristic feature of modern geology. Although the term 'tectonic line' seems often to be much abused, and on account of it to be depreciated in its real value, yet it had already attained many good ends. The great scientific traveller, A. Stübel here again appears to be unwilling to accept the fissure-theory, though his remarks chiefly apply to the linear grouping of the volcanoes of the Andean cordillera[1]. According to him, volcanoes are located not in lines but in groups, beneath the latter lie the so-called peripheric (secondary) hearths of the first, second and third orders, which stand in direct communication with the central hearth[2] below ; and through the act of swelling of volume of magma during the general cooling of the crust, volcanic eruptions and explosions are brought about.

The present moment is the turning point of the doctrine of volcanoes, and the fissure-hypothesis is being attacked from various sides. Sir Archibald Geikie at least doubts the correctness of this hypothesis in saying that " the vents of Britain are usually independent of any faults that traverse at least the upper visible part of the earth's crust. If volcanic vents have, as is possible, risen preferably along lines of fissure in the terrestrial crust, these lines are seldom those of the visible superficial faults, but must lie much deeper, and are not generally prolonged upward to the surface[3]." Prof. Branco made an exhaustive research of numerous embryo-volcanoes at the environs of Urach, and

1) *Die Vulkanberg von Ecuador*, Berlin, 1897, S. 392.

2) Meanwhile it is to be remarked that there might possibly exist chains of secondary hearths of melted magma within the crust comparatively near the surface, which supply lavas and cause eruptions. When the volcanic energy becomes exhausted, these hearths may, I conjecture, be converted into *laccolites. If my assumption is to be justified, the laccolites are nothing but the cooled mass of the once red-hot melted hearth, and the batholites the hardened part of the receding central reservoir.*

3) *Ancient Volcanoes of Great Britain*, London, 1897, Vol. I., p. 69.

his study forces him to state that the *maars* are independent of any fracture-lines. The structure-lines, if any, are of doubtful nature, and they are perhaps entirely absent. Granted that the fissure-lines exist, they should be rather the result but not the cause of eruptions[1]. Prof. E. Fraas[2] verifies Branco's assertion as regards the maars of the Schwabian Albs, and Prof. Bücking holds the same view with respect to the volcanic region of the Rhön. Prof. F. Loewl[3] also says that volcanoes could not rise from fissures, because of the plastic nature of the crust at a comparatively shallow horizon where, as a matter of fact, the formation of any rent is impossible. From what is stated above, we see that the modern tendency revives the old Humboldt-Buch dogma in a somewhat modified form. Prof. Branco[4] says that some volcanoes have indeed a certain relation with fissures ; but the question is whether the observed fissure appeared before or after the volcanoes. It might be created only during the course of eruptions and the earthquakes accompanying the activities, so that the supposed cause may turn out to be the effect, or the fissure might be produced still later.

That Sir A. Geikie's '*puy*' type usually occurs in *groups* is certainly true, and to it the volcanists have hitherto chiefly paid their close attention, excepting Stübel, and here the negation of the existence of tectonic lines appears very plausible. It is also reasonable to assume, in the region infested with the volcanoes of the 'puy' type, the presence of a subterranean hearth, from which a magma made its ways through the thin crust through its own exertion, just like a sieve in the ground.

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1) 'Schwabens 125 Vulkan-Embryonen und deren tufferfüllten Ausbruchsröhren, das grösste Gebiet ehemaliger Maare auf der Erde.'—*Jahreshefte des Vereins für vaterländ. Naturkunde*, Bd. 50, 1894, und Bd. 51, 1895. Also in the *Neues Jahrb. f. Mineralogie, etc.*, I., 1898, S. 175 *et seq.*

2) Cited in Branco's paper in the *Neues Jahrb.*, already referred to.

3) *Verh. d. k. k. geol. Reichsanstalt*, Wien, 1894, S. 469.

4) In Branco's paper, *Neues Jahrb.* S. 185.

I hear much about the volcanists talking their own ways, but they do not at least deny the *structure-lines* as regards the formation of folded and tilted mountains. It is by no means an easy matter to find out the position of these lines in regions geologically uniform. I may cite a remarkable example[1] of the fault produced in a farmer's compound in the Mino province, at the time of the earthquake in 1891, when the solid ground with few trees standing on it was shifted horizontally for about 3 m, nevertheless the line of dislocation is so sharp and appears as if knife-cut, that the owner could scarcely recognize the line and also the reason of the changes of the relative position of trees. The difficulty of pointing out the actual position of the line of dislocation, therefore, cannot be used as a weapon against the fissure-theory. For the arrangement of volcanoes in chains and curves on the sea-board of Eastern Asia, the hearth-hypothesis could scarcely offer a satisfactory and convincing explanation.

To make clear once for all my own standpoint, I must say plainly, that the chains of volcanoes, the systems of mountains, and the non-volcanic earthquakes appear to me to have very intimate and fundamental relations with the so-called tectonic lines.

Therefore, my work in connection with the Earthquake-Investigation-Committee is, as the study of the geological structure of all Japan requires a life-long exertion of perhaps a dozen of geologists, to learn the old and new volcanoes of our country as regards their internal structure, their rocks, their foundations and their modes of distribution; in doing so, I can perhaps get an insight into the structure of the land; and finally, I may be able to construct the geotectonic map, by means of which we could possibly know the condition under-

1). B. Kotô, 'The Cause of the Great Earthquake in Central Japan.' *Jour. Sc. Coll.*. 1893, Vol. V., p. 337. One of the figures may be seen inserted in Credner's *Geologie*, 8 te Auflage, S. 184.

ground, and the causes of the regional shaking and the local points of earthquakes. With these objects in view, I have been and will be for the near future one of the members of the Committee.

Vulcanological Survey.

The scope of the vulcanological survey I have already distinctly stated in the preceding pages ; the prosecution of this projected scheme is then incumbent upon me ; and added to this, there occur not infrequently violent earthquakes, not to mention smaller ones, and landslips, and even sea-waves, which sometimes engage my attention. Through the valuable assistance of some senior students of our University, to each of whom I assign a certain district to be studied in detail, serving also for the graduating theses of these students in the course of geology, I am enabled to carry out the work, besides getting assistance from my colleagues, post-graduates and a few junior students, to these latter I usually allot the localities of interest for field-exercises in geology. To all of them who have given me their active help, I take this opportunity of expressing my best thanks. Though the Committee was called into life in 1892, yet my work actually began two years *later* for various reasons, chiefly owing to paucity of the appropriation for the travelling expenses (in the present fiscal year only 750 *yen* or 1,850 francs).

It has been my endeavour, first of all, to make a complete survey of the NORTHERN HALF OF HONSHÛ, or main island, since it is that portion of Japan, which is particulary abundant in volcanoes, and also most frequently visited by earthquakes. From this point of view, we take up each volcano and carry on investigations in the series, approximately corresponding to C. Naumann's "*eastern system*," of which I will speak in the sequel.

Nearly three-quarters of a century ago, v. Buch enumerated Japanese volcanoes with short descriptive notes.[1] Thirty years later, C. Naumann[2] divided the band of volcanoes of South-east Asia into a number of systems, and the volcanoes of Japan falls in his '*eastern system*,' excluding from it, however, a few of those of Hokkaidô, which are brought under the '*north-eastern*.' Furthermore, he constructed a branch system which is made to shoot off from the middle of Honshû, in a south-easterly direction, embrancing in it the "Seven Islands" or Shichi-tô of Idzu, and Hachijô, Ogasawara-jima (Bonin), and the Sulphur Islands, and after a short interruption under the Tropic of Cancer, the somewhat easterly lying Mariannes. It did not escape the observant eye of the Saxon geologist in recognising the persistence of this meridional chain of volcanoes, which apparently continues to the volcanic regions of New Guinea, to those of the Cape of York, and of Bass Straits; while in the opposite direction the chain is lengthened to the island of Tarakai, and Ochotsk. The prolongation of this volcanic line beyond the Caroline '*Graben*' in one direction and to the Amur Lands in the another is as yet not rigidly tested in the field in the light of modern science, nor have they ever been since taken up again and discussed by any scientists. We will see afterwards that Carl Naumann's eastern system approximately coincides with the '*Meridiankette von Nordjapan*' of Edmund Naumann.

It is a great merit of the last-mentioned geologist, whose name is inseparable from the history of Japanese geology, to have recognised the distinctive features of *North* and *South Japan*, and also to have fixed the boundary between them by his *fossa magna*[3] which is supposed to traverse right through the middle of Hon-shû, in the north-westerly direction from Japan Sea to the Pacific Ocean. Though the

1) *Gesammelte Schriften*, Bd. III., S. 584.
2) *Geognosie*, 2te Auflage, Bd. I., S. 91.
3) Ed. Naumann, *Ueber den Bau und die Entstehung der japanischen Inseln*, Berlin, 1885.

true nature of the *fossa magna* remains yet to be solved, the existence of an important tectonic line through the provinces of Suruga, Shinano, and Echigo is beyond all doubt; and it is also my endeavour, in connection with the vulcanological survey, to examine critically and dispassionately the region of "*Grossen Graben*," which the late Dr Harada[1] advocated, polemically against Ed. Naumann, in favour of the view of a *mountain-confluence*.

As I have already stated, Dr Ed. Naumann calls that portion of *Hon-shû*, lying east to the great '*Graben*,' *North Japan*, through which runs his '*Meridional Chain*,' carrying on it a great number of both extinct and active craters. Just a year before the publication of E. Naumann's work, I gave, for want of a better one, a provisional name[2] of the Sachalin System to the whole of North Japan, which is built up mainly of a meridional volcanic chain with its co-ordinate ridges and stumped mountains; and this was followed, four years later, by the late Dr Harada[3], though he often employed the term of *Nordjapanischen Bogen* for its synonym.

A mere glance at the topographic map of Japan will lead one to suppose that Hon-shû is a gigantic arc with Hokkaidô and Kiû-shû at the north and south ends as the homologous appendages; and the line of the Fuji-Ogasawara volcanoes pierces right through the middle of main island. But, as geological knowledge accumulates little by little with time, our primitive notion comes to be largely modified; and, at present, we can say positively that North and South Japan differ in that the prevailing direction of the South is greatly influenced by the *folding axes* while that of the North is by the *meridional ruptural lines*.

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1) *Sonderabdruck aus dem akademischen Anzeiger*, Nr. XVII, Wien, 1887.

2) In a small treatise of mineralogy "*Kin-seki-gaku*," Tokyo, 1884, p. 137. At the time, when I wrote the small book, our knowledge of Japanese geology was still very fragmentary, and the *formational* map not yet in existence. I simply included also in my Sachalin System some meridional ridges in *South* Japan.

3) *Versuch einer geotektonischen Gliederung der japanischen Inseln*, Tokyo. 1888.

The external side of North Japan, in contrast to the regular succession of geologicàl formations of the South, consists of three tectonic blocks,—that of the Paleozoic Chichibu (Kwantô), of the Archæan Abukuma, and of the Mesozoic and Paleozoic Kitakami ; and these are the gigantic *crustal* clods that bound the Pacific sea-board, each forming a geological unit, and an independent upland region. The geographical back-bone and the main water-shed of North Japan, lie, however, westwards of the discontinuous ectoperipheral zone, and is mainly built up of the *quartz-bearing tuffites of a Tertiary age.* These remarkably constant pyroclastics constitute the foundation, through which the various Andesitic lavas have welled out in *post-Tertiary times* in a nearly meridional direction, creating a long series of overtowering mighty cones.

If we were asked what is the mother-rock which supplied the material to the tuffites, we can only say that it is the *Rhyolite* which had been poured out at the bottom of the Neogene sea, and whose derivatives, the tuffites, had been deposited in so vast an extent as to serve for the foundation of nearly the whole of North Japan, excepting the three uplands, already mentioned. The Rhyolite is a whitish, biotite or hornblende-bearing effusive of a rough, porous structure, with a very important and characteristic component, the *quartz*, which occurs in the bipyramidal form or in rounded grains, of such a large size as to lead one take the rock for a Quartz-porphyry. The rock varies greatly in its structure and also in its mineralogical composition. Some are compact and lithoidal, while others are coarse-granular, consequently *Nevadıtic ;* but the typical porphyritic structure seems to be exceedingly rare. Among the felspars, the plagioclase never fails to enter into the compostion of the rock, sometimes even to the exclusion of orthoclase. The plagioclase-rich varieties may with appropriateness be called *Dacite*, for which indeed they are often taken and describ-

ed as such; but it is practically impossible to discriminate, on the geological ground, the Dacitic varieties from the normal Rhyolitic ones. Therefore, I am compelled to put together all these multifarious varieties under one head of Rhyolite, which, when collectively taken, form a geologic unit, being the effusives of a particular geological period, and constitute a well defined petrographical province.

Of all the Rhyolites under consideration, *the plagioclase-bearing type is the most abundant and wide-spread, and built up the cones of Neogene times; but being of a remote geological age, these Tertiary craters were ruined and overflown by the Andesitic lavas of the post-Tertiary volcanoes*, forming the chains of the imposing lofty cones of the North-east, many among them still keep their activity down to the present moment.

Having spoken broadly about the geological feature of NORTH JAPAN, the next step will be to give an account of its volcanoes, of which we have many special reports in our Committee's publications, all written in Japanese. Our Survey is now at the very threshold of its work, and it will take probably five years more to complete the details even of a series of craters, which roughly corresponds to Carl Naumann's *middle system*. Under such circumstances, I consider it to be premature at present to give even the general outline of the results, attained by our Survey. I will leave the detailed discussions to another occasion, and will now simply give the list of the papers on the subject-matter relating mainly to vulcanology.

The reports already handed over through me to the Committee, and hitherto published, all in Japanese, from the year 1895 to the present moment are, arranged after the date of their appearance, the following :—

A.—Vulcanological :

1. On the Geology of the Volcanoes of the Myô-kô Group. By N. Yamasaki, 1896.
2. On the Geology of the Volcano Yoné-yama. By I. Iwasaki, 1896.
3. On the Geology of the Volcanoes of the Kénashi Group. By S. Shimidzu, 1896.
4. On the Geology of the Volcanic Island Ôshima (Vries Island). By N. Yamasaki, 1896.
5. On the Geology of the Volcanoes Haruna and Tsuno-otoshi. By J. Iwasaki, 1897.
6. On the Geology of the Volcanoes Hakoné and Atami. By T. Hirabayashi, 1898.
7. On the Geology of the Volcanoes in the Izu Peninsula. By H. Ishiwara, 1898.
8. On the Geology of the Akagi Volcanoes. By Y. Saitô, 1898.
9. On the Geology of the Dissected Volcano Arafuné. By E. Sakawa, 1898.
10. On the Geology of the Volcanic Group of Yatsu-ga-daké. By N. Yamasaki, 1898.
11. On the Geology of Fuji-san and Ashidaka. By T. Hirabayashi, 1899.
12. On the Geology of the Volcanoes of the Nikkô Group. By Y. Saitô, 1899.

To these, it will be added still four papers, *viz.*,

13. On the Geology of the Volcano Takahara. By N. Kanéhara. *Under press.*

14. On the Geology of the Volcanoes of the Nasu Group. By S. Matsuda. *Under press.*
15. On the Geology of the Volcano of Aso. By T. Iki. *In preparation.*
16. On the Geology of the Volcanoes of the Nambu-Fuji Group. By H. Sakurai. *In preparation.*

B.—Seismological :

17. On the Earthquake of Shô-nai in 1895. By B. Kotô, 1896.
18. On the Earthquake of Akita and Iwadé in 1896. By N. Yamasaki, 1897.
19. On the Earthquake of Fukuoka in 1898. By T. Iki, 1899.

C.—On Sea-wave :

20. On the Great Sea-wave on the North-east Coast of Japan in 1897. By T. Iki, 1897.

D.—On the geology of well-boring :

21. First Report on the Geology of the Deep Well within the University-grounds. By N. Yamasaki, 1894.
22. Second Report on the Geology of the Deep Well within the University-grounds. By N. Yamasaki, 1898.

Tōkyō, December, 1899.