

No. 41

(English Abstract from the Japanese Original.)

On the Effect of Temperature Changes upon an Altimeter.

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1. Classification of the causes of error.

Aneroids intended for the aeronautical service as altimeters must possess the property of being unaffected by severe vibrations. As they are also exposed to cold air and the range of pressure change is wide, the effect of temperature changes and the elastic fatigue are quite remarkable.

Therefore we can classify the causes of error of an altimeter as follows:

- (1) those due to elasticity,
- (2) temperature changes,
- (3) vibration.

As the aneroid has been known for a long time, the errors due to elasticity have been investigated in detail by many investigators. But, temperature and vibration effects have not yet been studied satisfactorily. The present experiments have been made to investigate the effect of temperature changes.

2. Apparatus and the process of investigation.

The temperature effect was studied in two ways:

- (a) by varying the temperature at constant pressure.
- (b) by repeating the calibration at different temperatures, which were kept constant in each case.

In carrying out the first set of experiments, difficulty occurred in maintaining a constant pressure, other than atmospheric, in a closed vessel (vacuum chamber) which was subjected to a wide range of temperature changes. This difficulty was overcome by using an apparatus shown in Fig. 1 (p. 468), the principal part of which consists of a glass tube, partly filled with mercury, which has eighty small holes at the bottom. The upper end of the glass tube being connected to the vacuum chamber, the air was constantly pumped out from the latter, so that the air entered from the small holes in bubbles through the mercury column. This kept constant the pressure difference between the atmosphere and the vacuum chamber, in spite of any change of temperature of the chamber.

In carrying out the second set of experiments, care was taken, to ensure that the errors due to elasticity were small enough. The apparatus is shown in Fig. 2 (p. 469).

3. Result.

The altimeters examined were: one by Yanagi, Fig. 3 (p. 470) one by *Short & Mason*, one by *Scholz* and one by *Luftweg*, which had all a bimetallic compensation at the arm which forms the elongation of the *D* spring.

The result of the experiment (a) made by varying the temperature at constant pressures is shown in Figs. 4-7 (p. 471). In these figures the readings of the altimeter are plotted as ordinates against temperatures as abscissae. The curves show an over compensation at high altitudes by bimetallic device. The temperature effect of the altimeter decreases with decreasing altitudes, becomes zero at an altitude very near to the sea-level, showing a complete compensation at that pressure.

The result of the experiment (b) made by repeating the calibration at different constant temperatures is shown in Figs. 10-19 (p. 474). Previous to the experiment in each case, the altimeter was made to undergo pressure changes over its full scale range about three times, so that it might be brought in a state, in which the hysteresis loop would maintain an invariable form. Though such a state is never reached in the exact sense, the irregularity of the result could be got rid of by this process. The time rate of the pressure change during the cycles was such that the altimeter reading changed 1 km. in a minute. The pressures in the vacuum chamber were reduced to altitude units by the formula of standard atmosphere calculated by Prof. Tamaru (this report No. 12). From the calibration curves so obtained, the differences, observed readings less calculated heights, were taken as ordinates against calculated heights as abscissae. Then the values of ordinates in the curves corresponding to calculated heights 0.5 km., 1 km., 2 km., 3 km., 4 km., 4.5 km. were picked up and arranged against the temperature as abscissa in Figs. 20-25 (p. 479).

The slopes of the curves resemble those of the curves obtained from the experiment (a) made by varying the temperature at constant pressures, except in so far as the former are steeper than the latter.

This difference is probably due to the fact that the temperature of the aneroid case, where the thermo junction was brought in contact, differed from that of the inner parts of the instrument, so that there was a considerable time lag of temperature. This means that we have to take the result of the experiment (b) in preference to that of (a), in any quantitative investigations.

4. Conclusion.

The temperature coefficient of an altimeter of the form above described is quite large for other pressures than that for which it is compensated, so that if we intend to use it for an accurate service, such as bombing or aerial photography, we have to introduce some devices which compensate the temperature effect *at all altitudes*.

(We are now investigating an altimeter provided with such a device, designed by Prof. Tamaru).

Dai 41 Gô.

(Syowa 3 n. (1928) 9 gt.)

Kôdokei ni oyobosu Ondo no Eikyô ni tuite.

Syoin Rigakusi, SASAKI-Tatudirô,
HATTORI-Kunio,
HAGIWARA-Ikutarô,
TATE-Rinzi.

*Kono Kenkyû wa Tamaru Kyôzuyû no Gosidô ni
yotte okonatta mono de aru.*

I. Hasigaki.

Kôdokei wa hutûno Aneroido-seiukei to onazi Genri ni yotte tukurareta mono de, tada Kiatu no Memori no kawarini Takasa no Memori wo sita dakeno Tigai ga aru. Aneroido-seiukei wa huruku kara sirarete iru kara, sore no Kôzô, Kinô nado mo daibu kuwasiku kenkyûsarete iru.⁽¹⁾ Kôdokei tosite tukau tameniwa Kiatu oyobi Ondo no Henkwa no Han'i ga hiroi si, mata taihen Sindô wo ukeru kara, tokubetuna Kenkyû ga hituyô de aru.⁽²⁾ Mata, ima dewa Kôdokei wa Hikôki no Seinô-siken, Yakan-hikô, Bakudan-tôka matawa Syasin-satuei nado seimituna Kotogara ni tukawareru yôni natta kara, issô kuwasiku kenkyûsuru koto ga hituyôni natta.

Kôdokei ni okoru Gosa no omona mono wa,

(a) Dansei ni kwankeisuru Gosa,

(1) Dictionary of Applied Physics Vol. 3 p. 168.

Hersey: Diaphragms for Aeronautic Instruments. N.A.C.A. No. 165. 1923. Kono Ronbun no nakaniwa ima madeni nasareta Kenkyû ga taihen kuwasiku kaite aru.

(2) Altitude Instruments. N.A.C.A. No. 126, 1922.

(b) Sindô ni yoru Gosa,

(c) Ondo ni yoru Gosa,

nado de aru. Konouti (a) wa taihen hituyôna Mondai de ima madeni takusan kenkyûsarete iru.⁽¹⁾

(b) mo hituyô de aru ga, mada zyûbunna Kenkyû wa nai. Wareware mo kono Mondai ni tuite sukosibakarino Zikken⁽²⁾ wo sita ga, ôkuno Kôdokei wa oyoso ippunkan 1100 gurai no Sindô ni taisite kyômeisuru koto wo sitta. Sikasi, Keiki-toritukeita no ukeru Sindô wa donoyôna mono de aru ka, mada wakaranai node Kenkyû wo susumenaide iru. Tonikaku, Kôdokei ga sore no ukeru Sidô ni kyômeisinaï koto ga hituyô de aru. Mata, tanni Sindô wo ataete Yomi no Kawari wo siraberu Zikken mo takusan okonawarete iru.⁽³⁾

(c) no Kenkyû wa taihen hituyô de aru ga, ima madewa tanni Kensa no Han'i wo denai yô de aru.⁽⁴⁾ Sore de aru kara, wareware wa Ondo ga Kôdokei ni oyobosu Eikyô wo nao kuwasiku kenkyûsite, Ondo ni yoru Gosa wo sukunaku suru koto ni tutometa.

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- (1) Chree: Experiments with aneroid barometers at Kew Observatory, Phil. Trans. Roy. Soc. A, V. 191; 441-499, 1898.
 C. Reihertz: Ueber die Elastische Nachwirkung beim Federbarometer. Zs. f. Instrumentenkunde VII, 153-170, 189-207, 1887.
 II. Jordan: Ueber eine Störung der elastischen Nachwirkung durch elastische Hysteresis. Verhandl. d. Deu. Phys. Ges. 17 Nr. 23, 423-436, 1915.
 K. Bennowitz: Ueber die elastische Nachwirkung. Phys. zs. 20, 703-705, 1920.
 K. Bennowitz: Verfahren zur Kompensation der elastischen Nachwirkung. Phys. zs. 21, 329-332, 1920.
 E. Warburg und W. Heuse: Elastische Nachwirkung und elastische Hysteresis. Verhandl. d. Deu. Phys. Ges. 17 Nr. 11/12 206-213, 1915.
 E. Warburg und W. Heuse: Ueber Aneroide. Zs. f. Instrumentenkunde s. 41, 1919.
 M. D. Hersey: Theory of Stiffness of elastic System. Jour. of the Wagshington Aaademy of Sciences. Vol. VI., p. 569, 1916.
- (2) Sasaki-T.: Kôdokei ni kwansuru Zikken. Kôkûkenkyûsyô Zaturoku, 29.
 (3) Altitude Instruments. N.A.C.A. No. 126, 1922.
 (4) Altitude Instruments. N.A.C.A. No. 126, 1922.
 H. F. Wiebe und P. Hebe: Ueber das Verhalten der Aneroide bei tiefen Temperaturen. Zs. f. Instrumentenkunde s. 331, 1911.
 II. Hartl: Ueber die Temperatur-Coefficienten Naudetschen Aneroide. Zs. f. Instrumentenkunde v. 21. s. 191, 1882.
 Zs. f. Instrumentenkunde v. 18, 183-184, 1898.

II. Dansei ni yoru Gosa no Syuruiwake to Ondo ni yoru Gosa.

Dansei ni yoru Gosa⁽¹⁾ wa huruku kara kenkyûsarete ite, oyoso tugino yôni kubetusarete iru.

1. Zure: aru Kiatu ni nagaku tamotte iru toki Zikan to tomoni Yomi ga kawaru koto.
2. *Hysteresis*: Kiatu wo herasu toki to huyasu toki to no, Zikan ni Kwankei no nai Yomi no Tigai.
3. Nokorino Zure: Kiatu wo herasite mata motono Kiatu made huyasita toki, nokotte iru Zure.
4. Kiatu wo kaeru Hayasa ni yoru Tigai.

Ima made sirarete iru tokoro dewa, *Zure* wa Kiatu wo herasita Ryô ni hireisite, *Hysteresis* towa Kwankei ga nai. Zure wa hotondo Zikan ni taishite sisû-kansû-tekini kawaru ga, roku-syûkan izyô tattemo itteina Atai ni naranai, sikasi 2-3-zikan no notiniwa Henka ga taihen osoi.

Hysteresis wa Kiatu wo herasita Ryô ni hireisi, kono Ryô no hanbun gurai no tokoro de itiban ôkii.

Nokorino Zure wa Kiatu wo herasita Ryô ni hireisi, Hitomawari ni kakatta Zikan ni Kwankeisuru.

Kôdokei no Yomi wa Kiatu wo kaeru *Hayasa* ni yotte tigau. Kono Hayasa ga mugenni hayai tokiniwa *Hysteresis* nomi ga nokoru.

Kôdokei no Yomi wa konoyôna takusanna Gen'in ni yotte tigau kara, Ondo ni yoru Gosa wo siraberu tameniwa, korerano Gen'in ni yoru Gosa wo itteini tamotu koto ga hituyô de aru. Sikasi, korerano Gen'in sonomono mo Ondo no Eikyô wo ukeru kara, Ondo ni yoru Gosa to kubetsusuru koto wa mudakasii. Soreyueni, Ondo no Eikyô no Siken niwa Hôhô wo kimeru Hituyô ga aru.

(1) Maeno Sitagaki wo mii!

Ondo no Eikyô wa, Namigata-bako to Zenmai to no Dansei ga Ondo ni yotte kawaru koto, Kikai no iroirona Bubun no Ookisa ga kawaru koto nado kara okoru. Mata Ondo no Hosei-sôti tosite Nimaigane wo tukatta mono dewa, sore no Eikyô wo kangaeneba naranai. Nimaigane wo tukatta mono dewa, Taikiatsu de Naosi ga dekite itemo, Kiatu ga hikuku naruto Naosi ga kikisugiru yôni naru.

3. Kôdokei no Ondo-keisû no Imi, oyobi sore wo siraberu Hôhō.

Kôdokei no Ondo-keisû wa hutatu ni kubetusareru⁽¹⁾.

(a) Itteina Kiatu ni okeru Yomi no, Ondo ni yoru Kawarikata.

(b) Kiatu wo kaeta Ryô to Kôdokei ni sore no arawareta Ryô to no Kwankei no, Ondo ni yoru Kawarikata.

(a) wo siraberu tameniwa, Kiatu wo itteini site Ondo wo kaete Yomi no Kawari wo mireba yoi. Sikasi, kono Baai ni Taikiatu to tigau Kiatu ni tamotte zikkensuru tokiniwa, Ondo ga kawaru ni sitagatte Sikenbako no Kiatu ga kawaru node, Kiatu wo itteini tamotu Sôti ga hituyô de aru.

(b) wo siraberu tameniwa, Ondo wo itteini site Memoriban no Zentai ni watatte Memori to Kiatu to no Kwankei wo sirabe, kore wo iroirona Ondo ni tuite siraberu koto ga hituyô de aru.

Kono Baai no Zikken wo suru tameniwa, maeni nobeta Dansei ni yoru Eikyô wo itteini suru yôni sinaito, korerano Eikyô no hô ga ôkiku naru kara ikenai. Sonotameni wareware wa Sirabekata wo tugino yôni kimeta.

Kôdokei no Memoriban no itiban takai Yomi made Kiatu wo 3-kwai hodo agesage-site, hobo itteina Eikyû-henkei wo okosaseto notini zikkensuru koto.

(1) Hersey wa kono hutatuno Keisû no aidaniwa sadamatta Kwankei ga aru to iu koto wo rirontekini setumeisite iru. Maeno Sitagaki wo mii!

Kiatu wo kaeru Hayasa wa Ippunkan ni 1000 mêturu agari-ori-suru yôni suru koto.

Gwaikoku dewa Kôdokei wo 2-3-niti oite Eikyû-henkei ga naku-natta tokini zikkensuru yôni site iru keredomo, konoyôni sita no dewa ikkwai Kiatu wo agesage-sita notiwa taihen tigatta Yomi wo ataeru kara, Tugô ga warui. Mata mattaku hukisokuna Gosa ga tokidoki atte komaru. Sore de aru kara, iroirona Gen'in no wakaranai Gosa ga hairanai yôni, narubeku Zikan wo mizikaku site takusanno Kwansoku wo suru koto ga kono Zikken niwa hituyô de aru.

Kikai no Masatu wo sukunaku suru tameni Kôdokei wo karuku tataite mita keredomo, amari Kikime ga nai kara, notiniwa yameta.

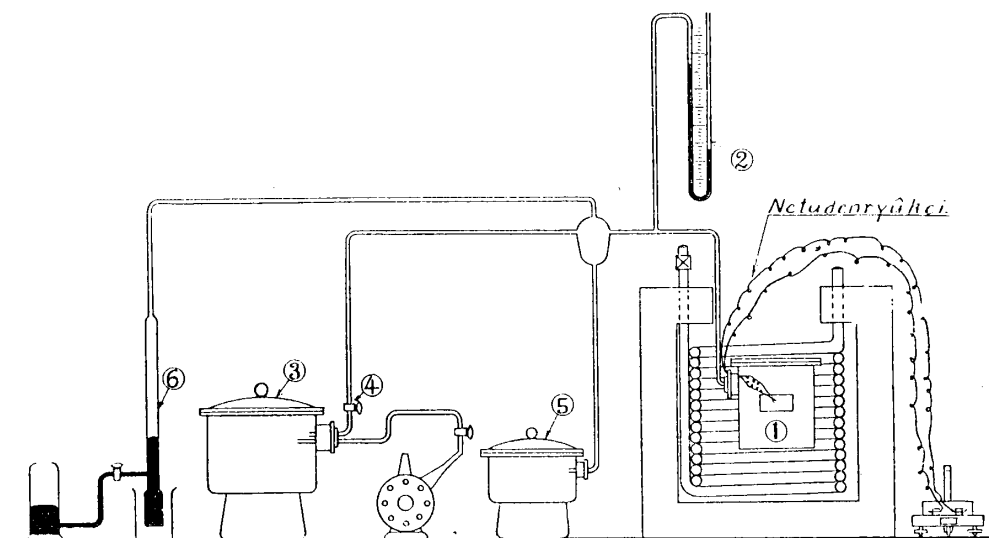
4. Zikken-sôti.

(a) Kiatu wo itteini site Ondo wo kaeru Zikken-sôti.

Du 1 ni oite (1) wa Kûki wo nuite zikkensuru Iremono ("Zikkenbako") de, Kôdokei wo kore no nakani ire, kono Iremono no Sotogawa ni *Brine* matawa tumetai Kûki wo zyunkwansasete Ondo wo sageru. (2) wa *Manometer* de, *Cathetometer* de Suigintyû no Takasa wo yomitoru. (3) wa Sinkû-ponpu ni yotte sizyû taihen hikui Kiatu ni site oku Utuwa ("Sinkûdame") de aru; Karan (4) no Hiraki wo kagensite, Zikkenbako (1) kara sorosoro Kûki wo nuku.

(6) wa, Zikkenbako no Ondo wo kaeta tokini, soko no Kiatu wo zidôtekini itteini tamotu tamenô Sôti de aru. Kore wa Garasukudâ no nakani Suigin wo irete aru. Kuda no Soko niwa Tyokkei 0.35 mm. no Ana ga 80 akete atte, Zikkenbako no Ondo ga sagatte Kiatu ga heru tokiniwa, kono Ana kara Kûki ga haitte, Iremono no nakano Kiatu wo itteini tamotu yôni nari, mata Zikkenbako no nakano Ondo ga agaru Baai niwa, Sinkûdame (3) no hô ni Kûki ga nagarekomi, soko kara Ponpu de suidasareru.

Kono Baai ni Tyôsei ga waruito, *Manometer* no nakano Suigin ga, sindôsite komaru kara, yobunna Heya (5) wo tunaide Sindô wo kesu



Du 1.

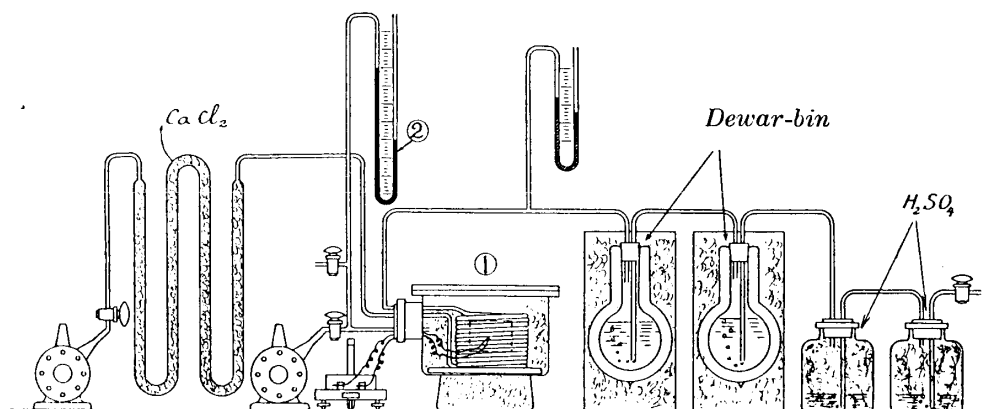
yôni sita. Mata, Kûki ga Garasukuda no Soko no Ana kara nagarekonde iru ka inai ka ni yotte, Mōsaikwan-sayô no tameni, Zikkenbako no Aturyoku ga kawaru kara, Ponpu wo tekitôni kagensite Ana kara Kûki ga itu demo nagarekonde iru yôni, sosite Zikkenbako no nakano Kiatu ga kawaranai yôni sita.

Takai Ondo no tokiniwa Ekitai-kûki no kawarini atatakai Kûki wo tukatta.

(b) Itteino Ondo de Kiatu wo kaete zikkensuru Sôti.

Kono Baai no Zikken-sôti wa Du 2 ni simesu tôri de aru. Hazime niwa Anmoniya de hiyasita Enkwakarusyûmu-eki no nakani Zikkenbako wo hitasite zikkensita ga, Ondo ga -34°C yori sagaranai node, tuginiwa Ondo no Henkwa no Han'i wo hiroku suru tameni Ekitai-kûki wo tukatte tugino yôna Sôti de zikkensita.

(1) wa Zikkenbako de, kore no nakano Kiatu wo agesage-si, sore no Kiatu wa *Manometer* (2) de yomu. Kono Iremono no nakano Ondo wo sageru tameniwa, sore no nakani akaganeno Zyakan wo ire, sono Kuda no hitotuno Hazi wo Ekitai-kûki wo irete aru *Dewar-bin* ni tunagi, hokano Hazi wo Sinkû-ponpu ni tunaide, *Dewar-bin* kara



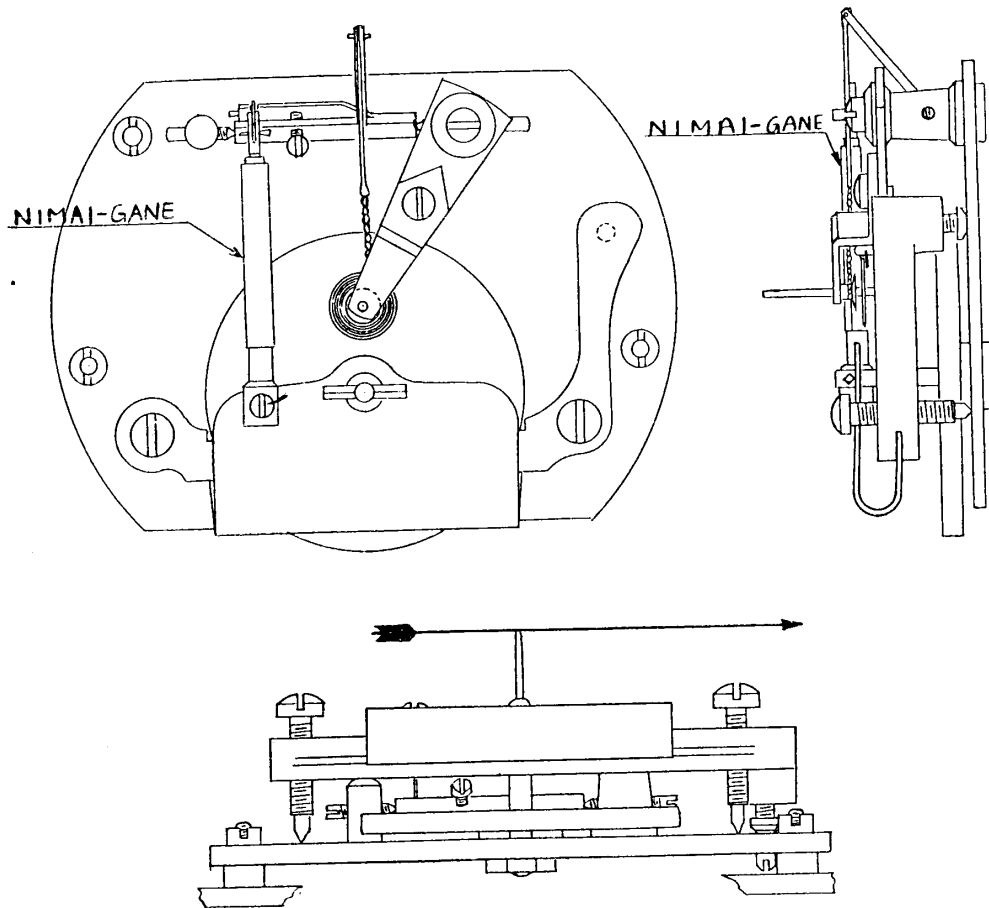
Du 2.

Ekitai-kûki ga zyôhatusite Zyakwan no naka wo tôri, Ponpu ni yotte hikidasareru Sikake ni natte iru. Kôdokei wa kono Zyakwan wo maita nakani ire, Kuda to Kôdokei to no aida wo nureta Wata de mitasite Netu no Tutawari wo yoku sita.

Kôdokei no Ondo wo sokuteisuru tameniwa Kôdokei no Sotogawa ni Sintyû no tiisana Kanamono wo torituke, sore no nakani tiisana Ana wo ake, kono Ana no nakani Netudenryûkei no hitotuno Tugime wo ireta.

5. Zikken ni tukatta Kodokei.

Nippon no Yanagi-seino mono wo omoni zikkensita. Sore to no Hikaku ni *Short & Mason*, *Scholz*, *Luftweg* nado gwaikokuseino mono womo tukatte mita. Kono Yanagi-seino Kôdokei wa, yoku sirarete iru *Naudet* matawa *Short & Mason* no Kata, sunawati *D-gata-zenmai* no tuita mono de, Du 3 ni simesu tôri de aru. Memoriban no Memori wa Takasa ga hikui Tokoro dewa araku, takai Tokoro dewa komakaku naru yôni, itiyôna Haba de naku, kizande aru. Namigata-bako no Tyokkei wa 48mm., Ude niwa Nimai-gane no Ondo-hosei-sôti ga tukete aru. Korekara noberu Zikken no Kekkwa wa kono Kôdokei ni tuite okonatta mono de aru.

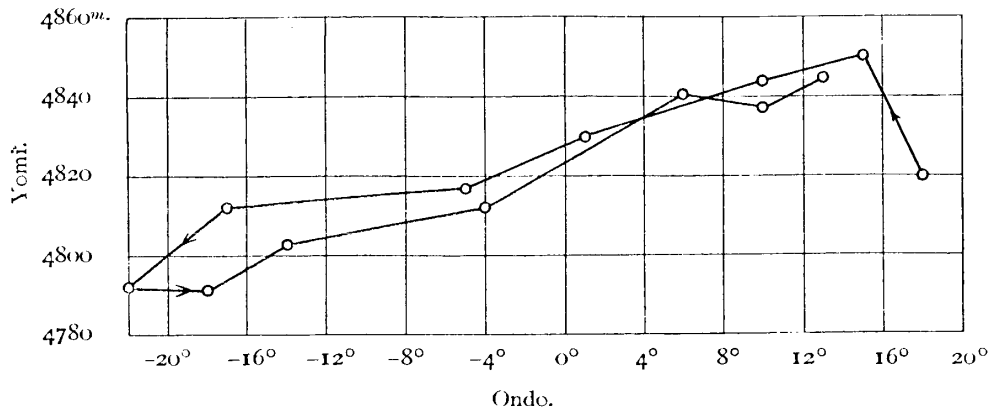


Du 3.

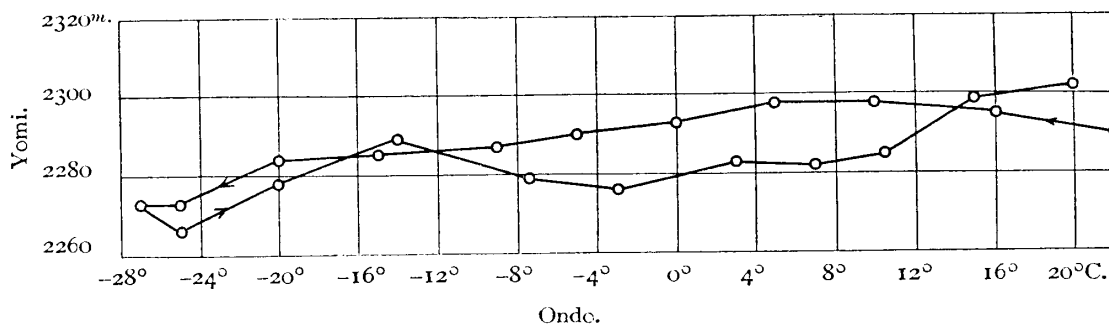
6. Zikken no Kekkwa.

(a) Kiatu wo itteini site Ondo wo kaeta Zikken.

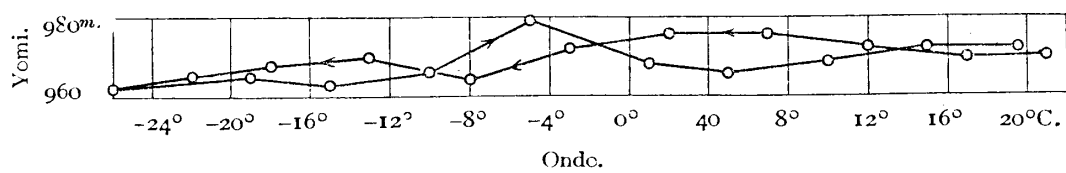
Du 4, 5, 6, 7 wa Kiatu wo sorezore 414.6 mm., 528.7 mm., 679.2 mm. 761.5 mm. ni itteini tamotte, Ondo no Henkwa hitomawari wo yaku roku-zikan no Hayasa de okonatta Kekkwa de, Yokodiku wa Ondo, Tatediku wa Kôdokei no Yomi wo arawasu. Kiatu wa, maeni nobeta Zikken-sôti ni yotte itteini tamotareru yôni site aru keredomo, ikurakano Henkwa ga aru kara, sono henkwasita Ryô wo Takasa no Tigai ni keisansi-naosite syûseisite-arû.



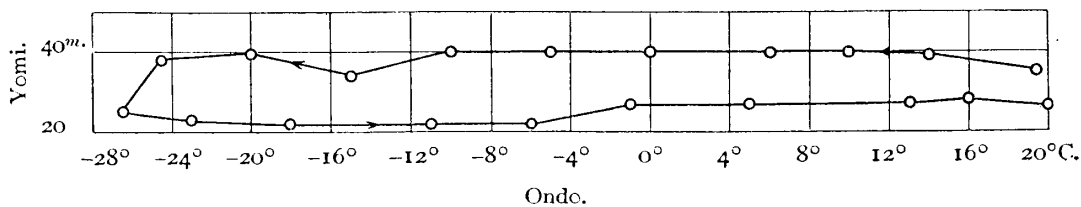
Du. 4.



Du. 5.



Du. 6.

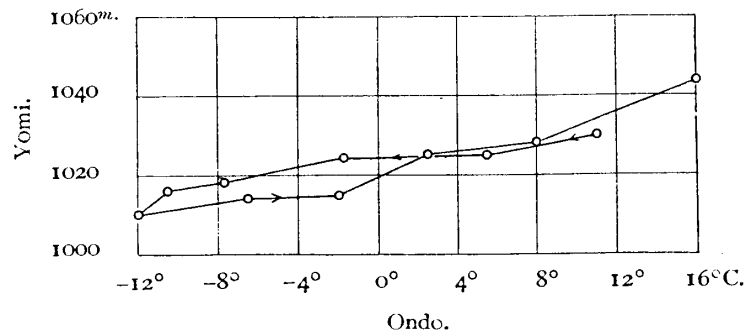


Du. 7.

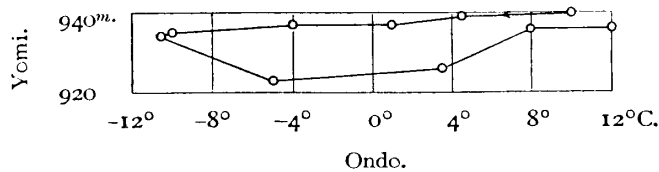
Kiatu wa, sore wo itteini tamotu koto ga taihen mudukasii tameni, tuneni henkwasuru, sosite Henkwa ga hayaito *Manometer* no Takasa no Kawari no hô ga okureru kara, sukosibakarino Tigai ga dekuru.

Du 4, 5, 6, 7 ni simesita no wa Tyôsei ga taihen umaku itta mono de aru ga, kore demo namerakana Kyokusen niwa naranai. Nimaigane wo tukatte Ondo wo hoseisita mono dewa, Kiatu no hikui Tokoro dewa Hosei ga kiki-sugiru koto ga wakaruru. Yomi no Kawari-kata wa hobo tyokusenteki de aru. Konoyôni site okonatta Zikken wa, Ondo wo kaeru Hayasa ni kwankeisuru koto wo kangaeru Hituyô ga aru. Nazenaraba Kôdokei no Hako no Ondo wa Zenmai, Nami-gatabako, Teko-zikake nado to onazi Ondo ni naranai kara de aru.

Kono Kwankei wo siraberu tameni, Ondo wo kaeru Hayasa wo iroiro kaete zikkensita. Tadasi, Ondo wo kaeru Hayasa wo itteini suru yôni tyôsetusuru koto wa, taihen mudukasii node, daitaino Hayasa wo kimete zikkensita. Du 8 wa hutatuno Kwansoku no aidano Zikan ga 30-pun, Du 9 wa 15-hun de aru kara, atono hô ga sukosi hayaku henkwasite iru.



Du. 8.



Du. 9.

Kore de miruto, Ondo no Henkwa wo osoku sita hô ga, ikuraka Katamuki ga ôkii yô de aru. Du 8 wa Kiatu 674.6 mm., Du 9 wa 682.1 mm. no Baai de, Kiatu ga ikuraka tigatte iru keredomo, daitai niyotte iru kara, Ondo no Henkwa no Hayasa no Eikyô wo siru koto ga dekiru.

(b) Ondo wo itteini site Kiatu wo agesage-suru Zikken.

Kono Zikken wo okonau Baai niwa, maeni nobeta yôni, Ondo igaino Eikyô wo narubeku itteini suru koto ga hituyô de aru. Kono Tyûi wo yoku mamotte okonatta Zikken wa, kanari yoku Ondo no Eikyô wo arawasu mono de aru koto wo sitta.

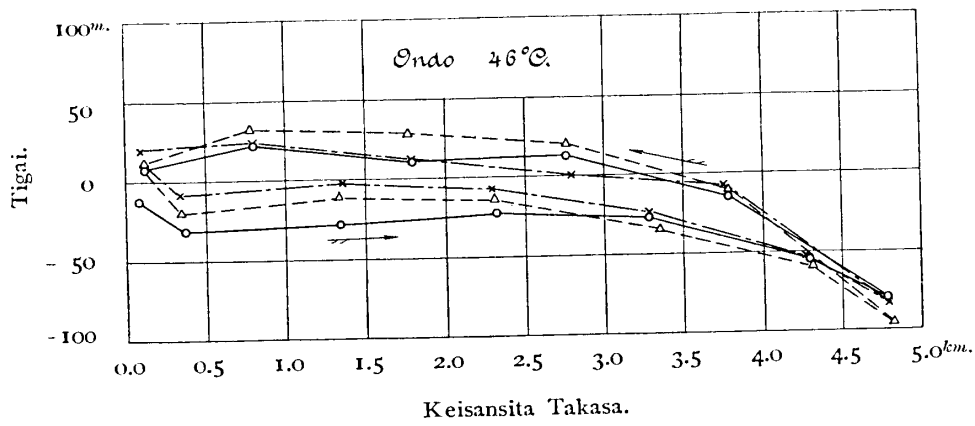
Du 10 kara 19 made wa iroirona Ondo ni itteini tamotte *Calibration* wo okonatta Kekkwa de aru. Yokodiku niwa Kiatu to Ondo to kara Hyôzyun-taiki no Hyô⁽¹⁾ wo tukatte keisansita Takasa, Tatediku niwa keisansita Takasa to Kôdokei no Yomi to no Tigai wo simesu. Kono Kekkwa kara Kiatu ga 0.5 km. 1 km., 2 km., 3 km., 4 km., 4.5 km. ni sôtosuru Baai no Gosa wo Ondo no Kansû tosite arawaseba, Du 20-25 no yôni naru. Motiron, Kiatu ga hikuku naru Baai to takaku naru Baai to dewa, Yomi ga tiguu kara, hutatuno Syurui no Kyokusen ga dekiru. Du 20-25 de ueno Sen wa Kiatu ga sâgaru Baai, sitano Sen wa agaru Baai no Kyokusen de aru.

Du 19 ni oite Kyokusen ga taihen gizagizasite iru no wa Ondo ga hikui tameni Hari no Ugokikata ga waruku natta tame de aru. Sunawati, konoyôni hikui Ondo (-44°C.) dewa kono Kôdokei wa motiirarenai koto ga wakarû.

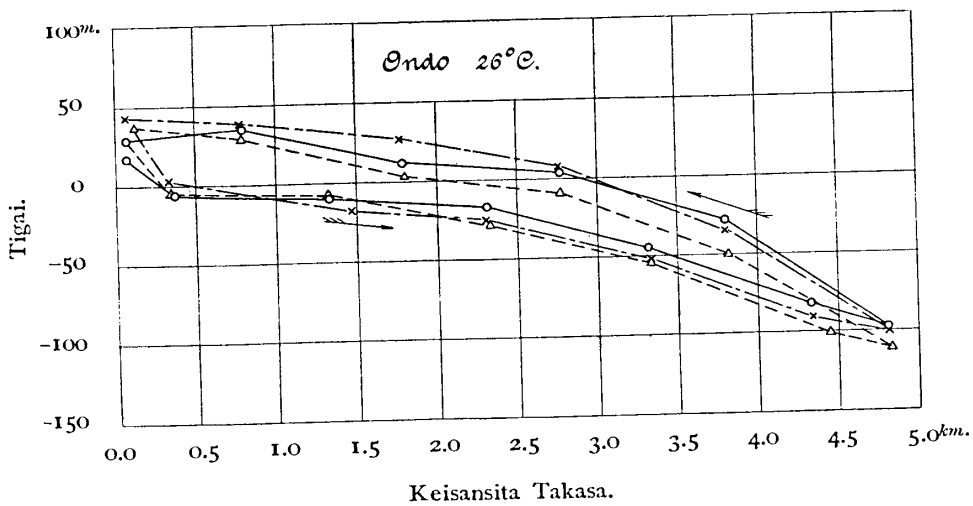
(b) no Zikken no Kekkwa wo, maeno Kiatu wo itteini site Ondo wo agesage-site okonatta Zikken no Kekkwa to hikakusite miruto, yoku nite iru koto ga wakarû. Kono Zikken dewa, Ondo wo hikakutekini nagaku itteini tamotta kara, Kôdokei no Hako no Ondo to Zenmai nado no Ondo to hobo itiyôni natte iru mono to kangaerareru.

(1) Tamaru-Takurô: Hyôzyun-Taiki oyobi Kôdokei no Yomi no Naosi. Kôkûkenkyûsyô Hôkoku 12 Gô.

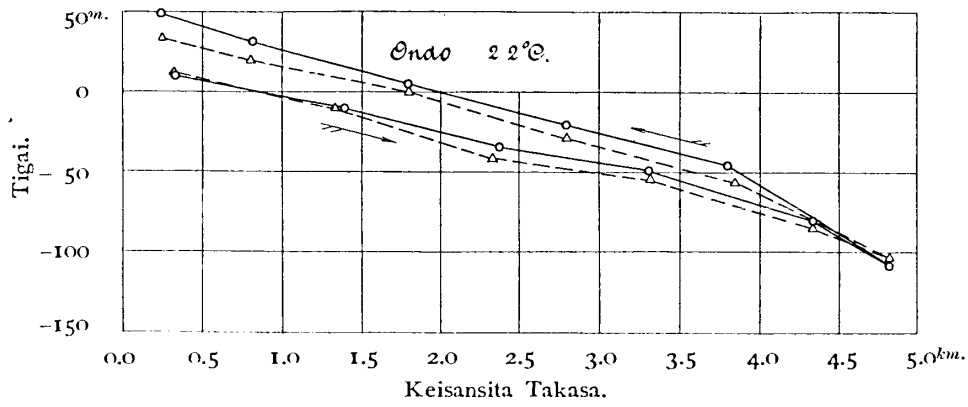
Sosite, Ondo igai no Eikyô wa, hobo itteini suru yôni site aru kara, Kiatu wo itteini site Ondo wo kaeru Zikken demo, Ondo no Henkwa wo taihen osoku site, sonoue Ondo igaino Eikyô wo naku suru yôni sita naraba, kore to onazyôna Kekkwa ga erareru koto to omou.



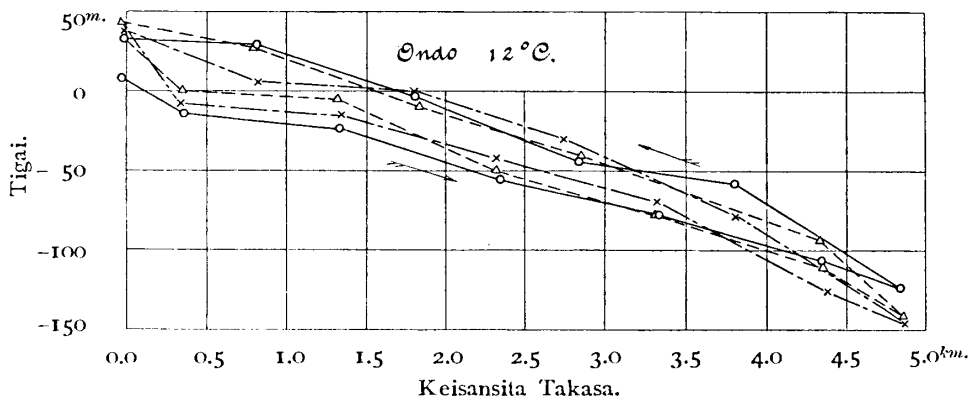
Du. 10.



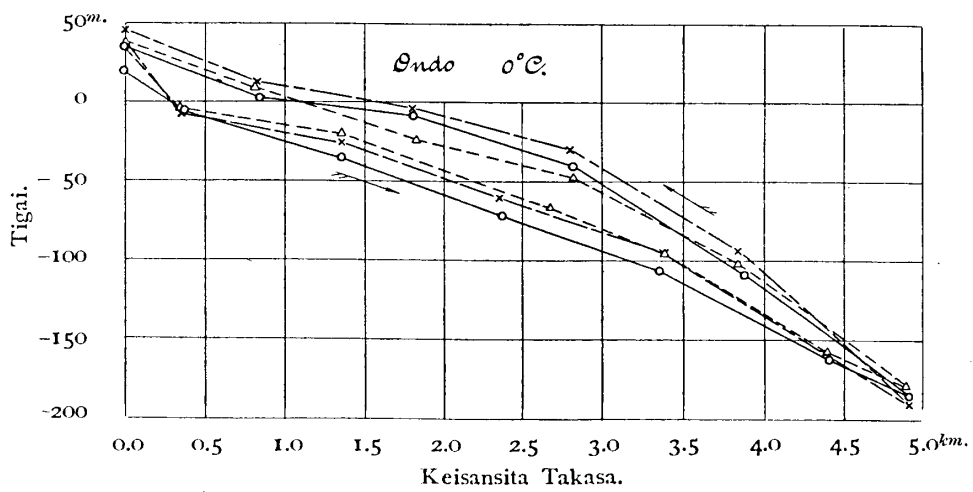
Du. 11.



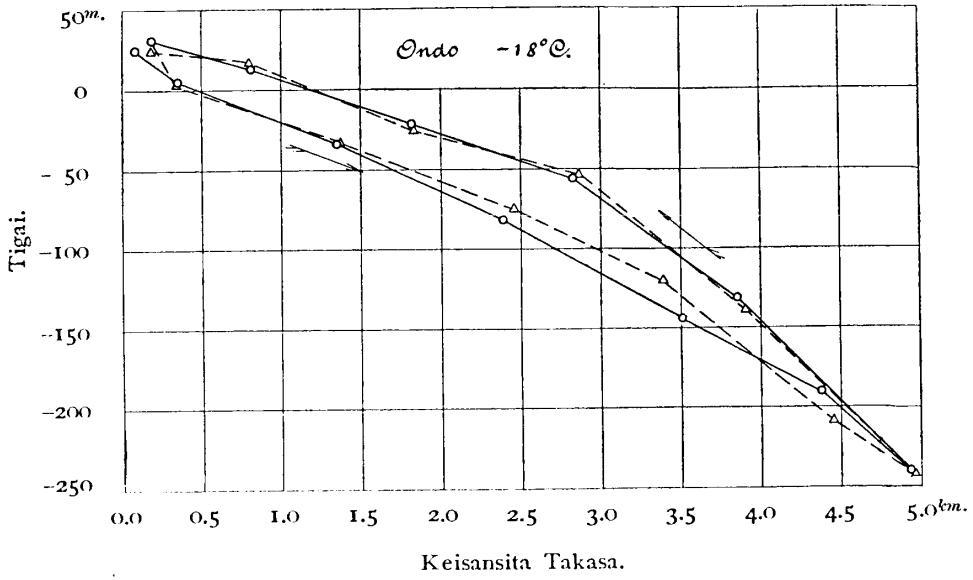
Du. 12.



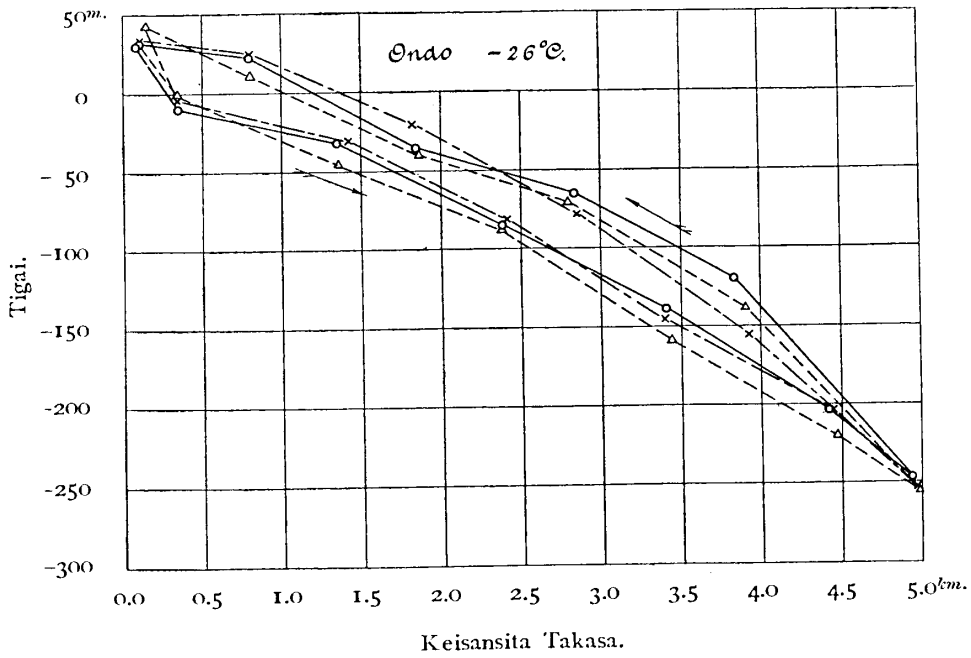
Du. 13.



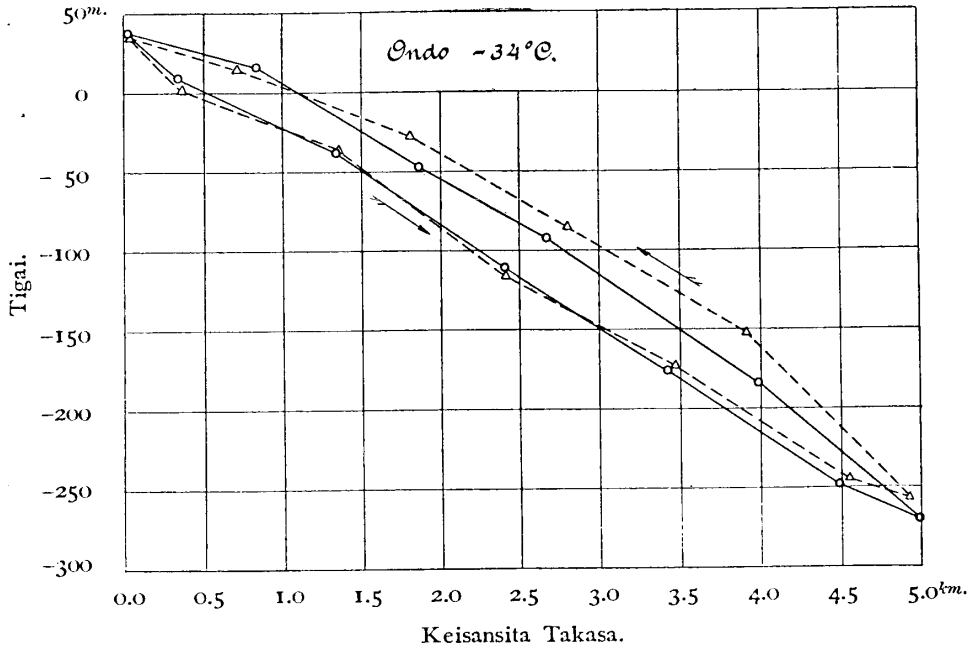
Du. 14.



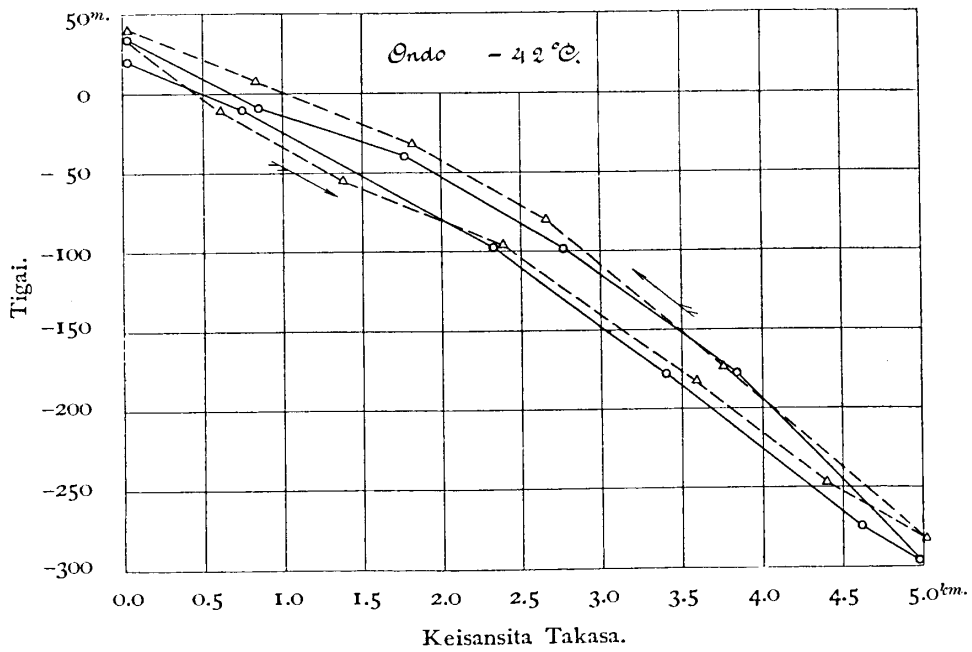
Du 15.



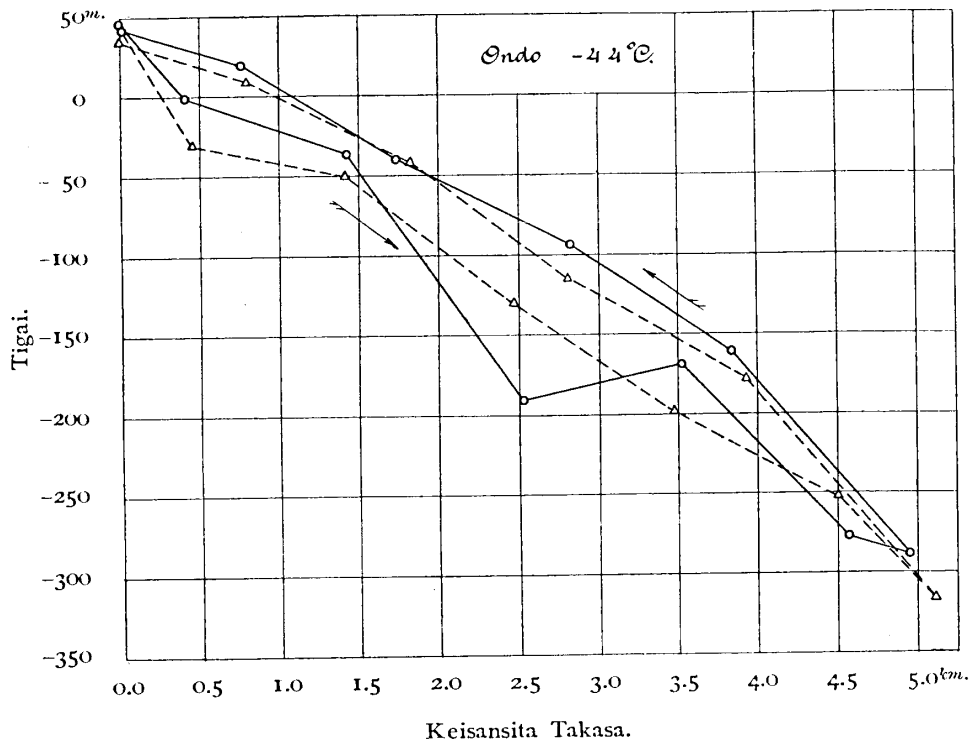
Du 16.



Du 17.



Du 18.

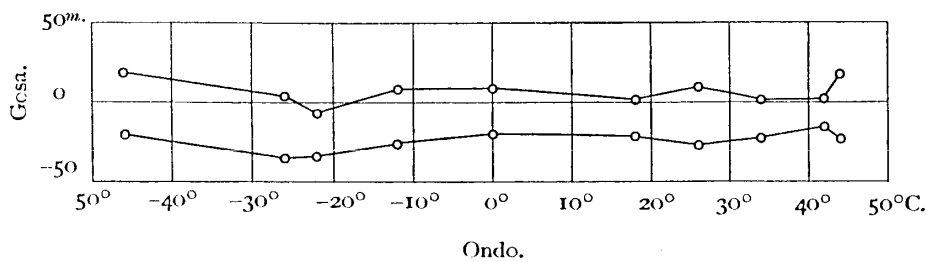


Du 19.

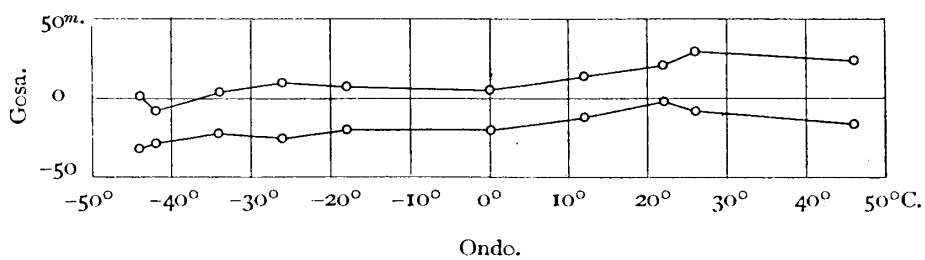
Ondo wo itteini site Kiatu wo agesage-suru Zikken wa, Kiatu wo itteini site Ondo wo agesage-suru Zikken yorimo, taihen yasaki, sitagatte yoku tyûisite zikkensureba Ayamari mo sukunai. Sikamo, maeni nobeta hutatuno Ondo-keisû ga erareru Rieki ga aru kara, (b) no Zikken-hôhô no hô ga yûri de aru.

Zikkenbako wo, Anmoniya de hiyasita Enkwakarusyûmu-eki ni hitasite ueno Zikken wo okonau Baai niwa, Ondo no Hure ga hotondo nai keredomo, Ekitai-kûki wo tukau tokiwa 2°C. hodo aru.

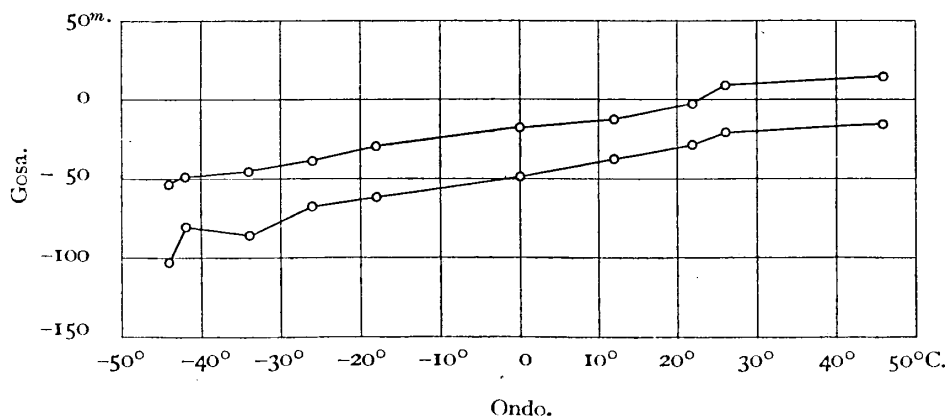
Ekitai-kûki wo tukau niwa, iroiro zikkensita Kekkwa, maeni nobeta Hôhô ga itiban benri de atta, Kono Hôhô dewa, Ondo ga itteini naru madeni 30-pun kara 1-zikan made no Zikan wo yôsi, 2-rittoru no Ekitai-kûki de 30-pun kara 1-zikan no aida itteino Ondo ni tamotu koto ga dekuru.



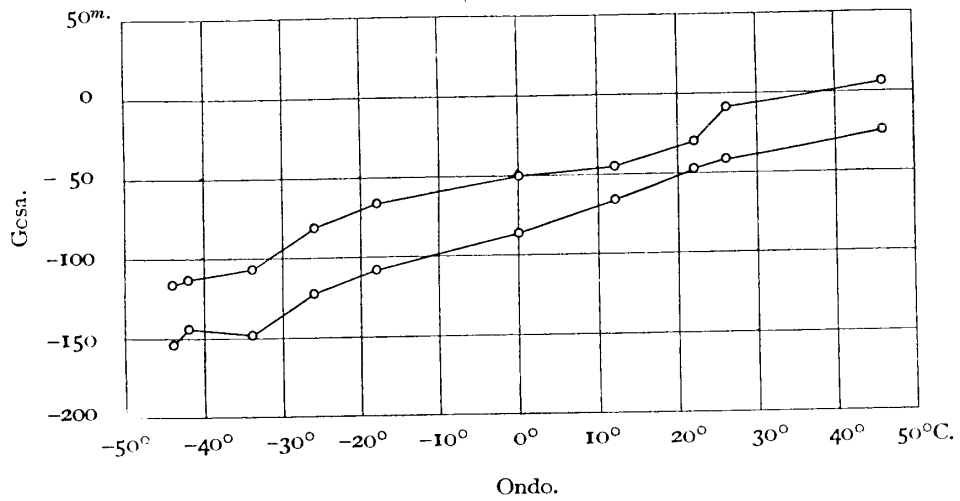
Du 20. Takasa 0.5 km. ni okeru Gosa.



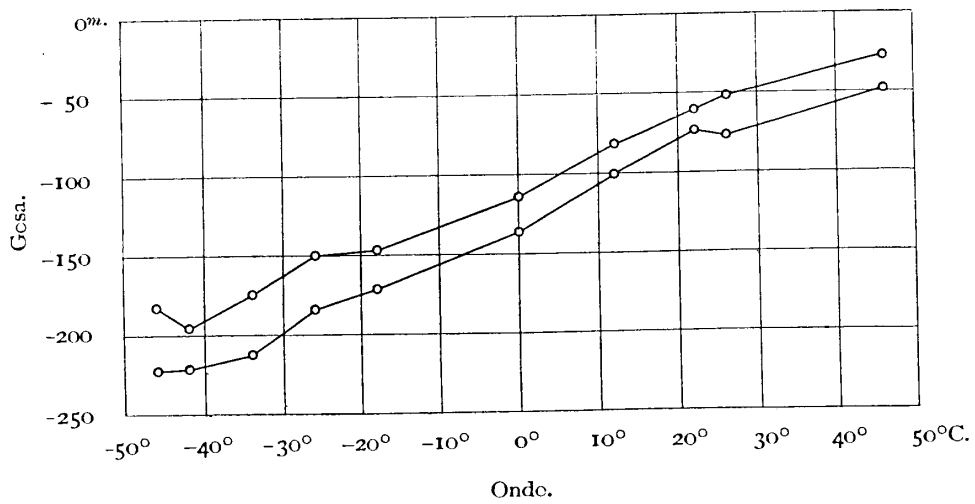
Du 21. Takasa 1 km. ni okeru Gosa.



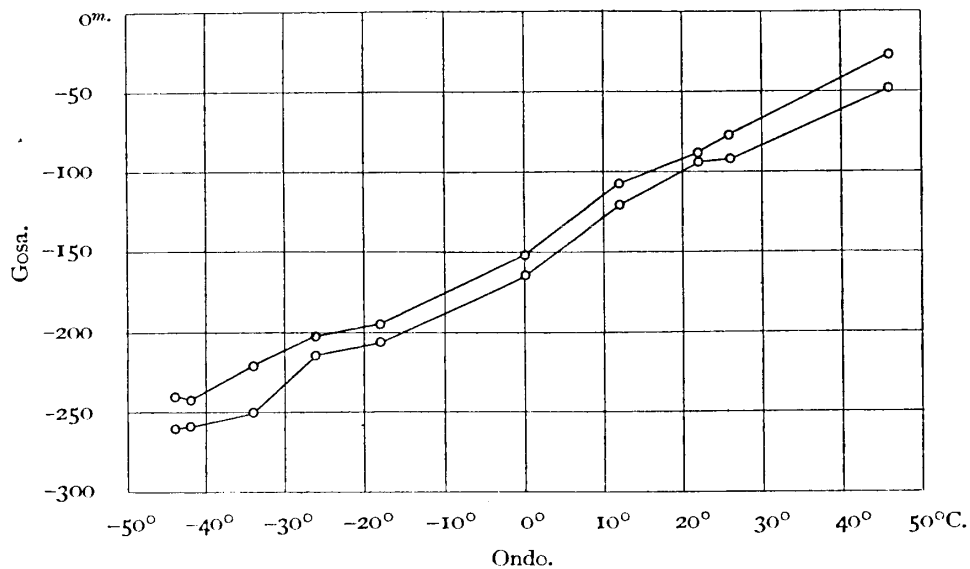
Du 22. Takasa 2 km. ni okeru Gosa.



Du 23. Takasa 3 km. ni okeru Gosa.



Du 24. Takasa 4 km. ni okeru Gosa.

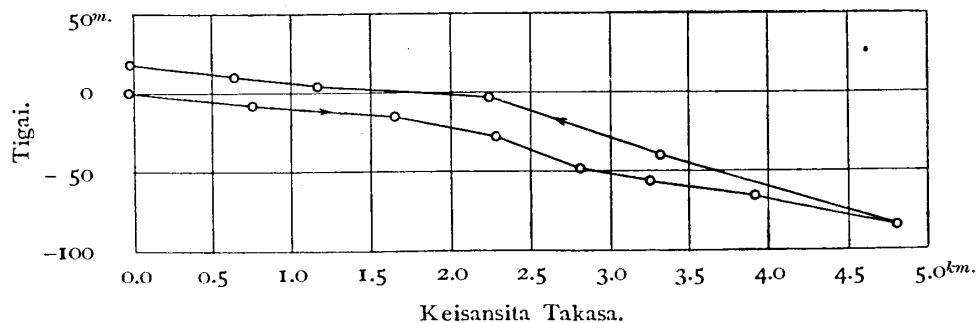


Du 25. Takasa 4.5 km. ni okeru Gosa.

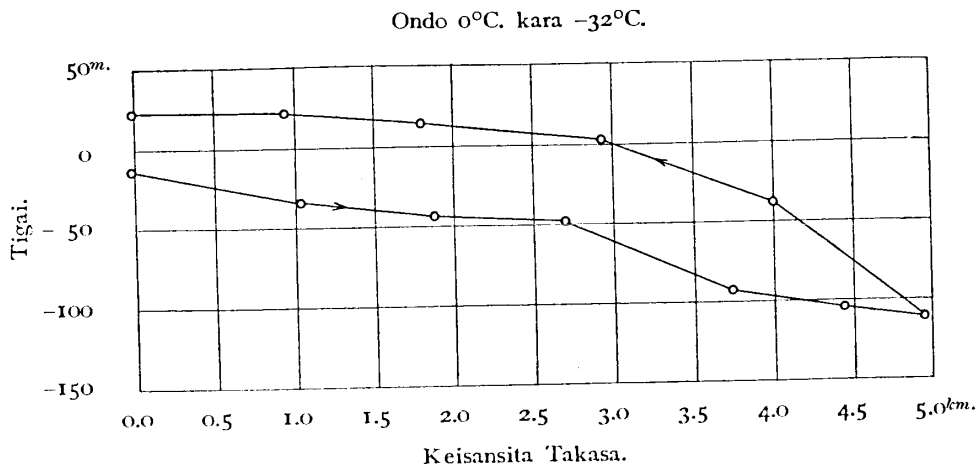
(c) Kiatu wo kaeru to dôzini Hyôzyun-taiki ni okeru yôni Ondo wo kaeta Zikken.

Kono Zikken ni yoreba zissaino Baai ni okoru Zyôtai ga arawareru hazu de aru ga, Ondo wo kaeru Hayasa ga taihen osoi kara Zikan no Eikyô, sunawati Zuro no Eikyô ga kanari kiku koto ni naru. Du 26 wa Dimen no Ondo ga 10°C. no toki Hyôzyun-taiki no Zyôtai de zikkensita Kekkwa de aru. Du 27 wa onazikoto wo Dimen no Ondo ga 0°C. no yôni site zikkensita Kekkwa de aru. Korerano Kekkwa

Ondo 10°C. kara -22°C.



Du 26.



Du 27.

ni yotte miruto, Ondo wo itteini site Kiatu wo henkwasita Baai ni okoru, onazi Kiatu, onazi Ondo no Yomi to yohodo kawatte iru. Kore wa Ondo wo kaeru Baai niwa, maeni nobeta yôni, Okure ga aru tameni, kikai no omona Bubun ga Netu-ondo-kei ni arawareta Ondo towa tigatta Ondo ni aru tame de arô. Kono Zikken demo Oohuku ni 6-zikan hodo kakatte iru kara, Zikan no Eikyô mo aru koto wa motiron de aru.

7. Keturon.

Gwaikoku-sei demo Nippon-sei demo, Yanagi-sei to onaziyôna Kôzô de Nimai-gane wo tukatta Kôdokei dewa onaziyôna Kekkwa wo eta. Konoyôna Kôzô no mono dewa, Ondo-keisû ga taihen ôkii kara, Zituyô niwa Ondo no Eikyô ga sukunai mono wo tukururu koto ga hituyô de aru. Motiron, hutûno Hikôki dewa, takai Tokoro de ikurakano Ondo ni yoru Gosa ga attemo, Dimen de yoku hosei dekite ireba, Dimen no mienai yôna Baai in tyakurikusuru no nimo, Kodôkei wo tayotte ireba taihenna Kiken wo okasanai de arô. Sikasi, Bakudan-tôka, Syasin-satuei nado no Baai niwa ikanaru Kôdo demo, Ondo no Hosei ga dekite iru koto ga hituyô de aru.

(Tamaru Kyôzyu wa kono Ten ni tuite kangaerare, ikanaru Kôdo demo Ondo ga hosei dekuru yôna Sôti wo kangaedasareta. Wareware wa ima kono Sôti ni tuite zikkentyû de aru.)

Hyô I. Kiatu wo itteini site Ondo wo kaeta Zikken no Kekkwa.

(Du 4 ni sôtôsuru).

Kôdekei no Ondo.	Aturyoku.	Takasa no Naosi.	Yomi. (nacsita).
18°C.	414.6 mm.	0 m.	4820 m.
15	414.6	0	4850
10	414.8	4	4844
1	414.6	0	4830
— 5	414.4	— 3	4817
— 17	414.7	2	4812
— 22	413.6	— 18	4792
— 18	413.0	— 29	4791
— 12	413.9	— 12	4803
— 4	413.6	— 18	4812
6	415.7	20	4840
10	416.1	27	4837
13	416.0	25	4845

Hyô II. Kiatu wo itteini site Ondo wo kaeta Zikken no Kekkwa.

(Du 5 ni sôtôsuru).

Kôdekei no Ondo.	Aturyoku.	Takasa no Naosi.	Yomi. (nacsita).
22°C.	528.7 mm.	0 m.	2990 m.
16	527.7	— 15	2995
10	527.9	— 12	2998
5	527.9	— 12	2998
0	528.2	— 7	2993
— 5	528.0	— 10	2990
— 9	527.8	— 13	2987
— 15	527.7	— 15	2985
— 20	527.6	— 16	2984
— 25	526.9	— 27	2973
— 27	526.9	— 27	2973
— 23	525.7	— 44	2966
— 20	527.9	— 12	2978
— 14	526.6	— 31	2989
— 7.5	526.6	— 31	2979
— 3	526.4	— 34	2976
3	526.2	— 37	2983
7	526.1	— 38	2982
10.5	526.3	— 35	2985
15	526.6	— 31	2999
20	526.8	— 28	3002

Hyô III. Kiatu wo itteini site Ondo wo kaeta Zikken no Kekkwa.

(Du 6 ni sôtôsuru).

Kôdokei no Ondo.	Aturyokn.	Takasa no Naosi.	Yomi. (naosita.)
21°C.	679.2 mm.	— 0 m.	970 m.
17	678.4	— 10	970
12	678.8	— 5	975
7	678.9	— 4	976
2	678.9	— 4	976
— 3	678.6	— 8	972
— 8	677.9	— 16	964
— 13	678.4	— 10	970
— 18	678.2	— 12	968
— 22	678.0	— 15	965
— 26	677.8	— 18	962
— 19	677.2	— 25	965
— 15	677.0	— 27	963
— 10	677.3	— 24	966
— 5	677.5	— 21	979
1	677.4	— 22	968
5	677.3	— 24	966
10	677.5	— 21	969
15	677.8	— 18	972
19.5	677.8	— 18	972

Hyô IV. Kiatu wo itteini site Ondo wo kaeta Zikken no Kekkwa.

(Du 7 ni sôtôsuru).

Kôdokei no Ondo.	Aturyoku.	Takasa no Naosi.	Yomi. (naosita.)
19.°5C.	761.5 m.m.	0 m.	35 m.
14	761.4	— 1	39
10	761.5	0	40
6	761.5	0	40
0	761.5	0	40
— 5	761.5	0	40
— 10	761.5	0	40
— 15	761.4	— 1	34
— 20	761.5	0	40
— 24.5	761.3	— 2	38
— 26.5	760.2	— 15	25
— 23	760.0	— 17	23
— 18	759.9	— 18	22
— 11	759.9	— 18	22
— 6	759.9	— 18	22
— 1	760.1	— 18	27
5	760.1	— 18	27
13	760.1	— 18	27
16	760.0	— 17	28
20	759.8	— 19	26

Hyô V. Kiatu wo itteini site Ondo wo kaeta Zikken no Kekkwa.
(Du 8 ni sôtôsuru.)

Kôdokei no Ondo.	Aturyoku.	Takasa no Nacsi.	Yomi. (nacsi).
11°C.	674.6 mm.	0 m.	1030 m.
5.5	673.9	— 5	1025
— 1.7	674.2	— 6	1024
— 7.7	673.6	— 12	1018
— 10.5	672.6	— 24	1016
— 12	672.1	— 30	1010
— 6.5	672.7	— 21	1014
— 2	672.4	— 25	1015
2.5	672.4	— 25	1025
8	671.2	— 42	1028
16	672.5	— 26	1044

Hyô VI. Kiatu wo itteini site Ondo wo kaeta Zikken no Kekkwa.
(Du 9 ni sôtôsuru.)

Kôdokei no Ondo.	Aturyoku.	Takasa no Nacsi.	Yomi. (nacsi).
10°C.	682.1 mm.	0 m.	940 m.
4.5	682.0	1	939
1	681.9	3	937
— 4	681.9	3	937
— 10	681.3	10	935
— 10.5	682.0	1	934
— 5	680.7	17	923
3.5	681.0	14	926
8	681.0	14	936
12	681.0	14	936

Hyô VII. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.
(Du io ni sôtôruru).

Kôdokei no Ondo.	Aturyoku.	Keisansita Takasa.	Yomi.	Tigai.
46.°5 C.	752.2 mm.	77 m.	65 m.	— 12 m.
	727.7	365	333	— 32
	646.5	1344	1315	— 29
	573.4	2315	2292	— 23
	507.3	3282	3255	— 27
	445.2	4290	4235	— 55
	417.3	4780	4700	— 80
	475.8	3780	3765	— 15
	542.0	2762	2775	13
	612.0	1790	1800	10
	690.9	798	820	22
	749.0	123	130	7
	728.7	353	333	— 20
	647.1	1336	1325	— 11
	574.0	2306	2292	— 14
	503.2	3345	3310	— 35
	444.3	4305	4245	— 60
	415.3	4816	4720	— 96
	476.0	3776	3765	— 11
	46.°0	542.5	2755	2775
613.4		1772	1800	28
691.7		788	820	32
749.4		119	130	11
45.°5	729.7	342	333	— 9
	645.1	1362	1360	— 2
	575.2	2289	2282	— 7
	506.9	3289	3275	— 24
	446.6	4265	4212	— 53
45.°0	416.0	4804	4720	— 84
	477.7	3750	3743	— 7
	540.4	2785	2785	0
	612.1	1789	1800	11
	691.0	797	820	23
45.°0	751.9	90	110	20

Hyô VIII. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.
(Dn 11 ni sôtôsuru).

Kôdokei no Ondo.	Aturuoku.	Keisansita Takasa.	Yomi.	Tigai.
25°·7 C.	754·2 mm.	65 m.	82 m.	17 m.
	728·5	356	350	— 6
25°·8	648·0	1325	1315	— 10
25°·9	573·8	2309	2292	— 17
	504·8	3320	3275	— 45
	443·0	4327	4245	— 82
	415·8	4808	4710	— 98
	475·0	3793	3765	— 28
	541·4	2771	2775	4
	612·1	1789	1800	11
	692·0	785	820	35
	753·6	71	100	29
	729·9	340	335	— 5
	648·2	1323	1315	— 8
	572·4	2329	2300	— 29
	504·2	3330	3275	— 55
	436·1	4446	4340	— 101
26°·0	414·5	4831	4720	— 111
	473·6	3815	3765	— 50
	541·6	2768	2758	— 10
	611·5	1797	1800	3
	691·4	792	820	28
	749·0	123	160	37
	730·7	330	333	3
	636·4	1473	1455	— 18
	574·8	2295	2270	— 25
	504·4	3327	3275	— 52
	442·5	4336	4245	— 91
	415·1	4820	4720	— 100
	474·5	3800	3765	— 35
	542·2	2760	2768	8
	613·3	1773	1800	27
	692·2	782	820	38
26°·0	754·0	67	110	43

Hyô IX. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.

(Du 12 ni sotôsuru).

Kôdokei no Ondo.	Aturyoku.	Keisansita Takasa.	Yomi.	Tigai.
22°C.	731.2 mm.	325 m.	335 m.	10 m.
	642.8	1390	1380	-- 10
	569.6	2369	2335	-- 34
	505.3	3313	3265	-- 48
	443.1	4325	4245	-- 80
	415.2	4818	4710	-- 108
	474.6	3800	3755	-- 45
	539.7	2795	2775	-- 20
	611.6	1795	1800	5
	690.2	806	840	34
	739.0	236	285	49
	731.3	323	335	12
	647.3	1334	1325	-- 9
	572.1	2333	2290	-- 43
	504.8	3320	3265	-- 55
	442.8	4330	4245	85
	414.9	4824	4720	104
	472.3	3836	3780	-- 56
	539.1	2804	2775	-- 29
	611.3	1800	1800	0
	690.9	798	820	22
22°	737.7	251	285	34

Hyô X. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.

(Du 13 ni sôtôsuru).

Kôdokei no Ondô.	Aturyeku.	Keisansita Takasa.	Yemi.	Tigai.
12°C.	763.0 mm.	- 33 m.	- 25 m.	8 m.
	727.8	364	350	- 14
	647.8	1328	1305	- 23
	571.1	2347	2292	- 55
	503.3	3343	3265	- 78
	442.2	4341	4235	- 106
	413.8	4843	4720	- 123
	474.6	3800	3742	- 58
	536.8	2839	2795	- 44
	611.0	1803	1800	- 3
	689.7	811	840	29
	761.7	- 18	15	33
	729.0	350	350	0
	648.4	1320	1305	- 5
	573.4	2315	2265	- 50
	505.6	3308	3230	- 78
	441.9	4346	4235	- 111
	412.8	4861	4720	- 141
	442.9	4329	4235	- 94
	536.4	2845	2804	- 41
	609.4	1825	1815	- 10
	691.3	793	820	27
	762.5	- 28	15	43
	729.8	341	333	- 8
	646.8	1340	1325	- 15
	572.9	2322	2280	- 42
	504.7	3322	3253	- 69
	440.1	4376	4250	- 126
	412.5	4866	4720	- 146
	474.0	3809	3730	- 79
	542.8	2750	2720	- 30
	611.2	1800	1800	0
	689.0	820	825	5
12°	762.1	- 23	15	38

Hyô XI. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.
(Du 14 ni sôtôsuru).

Kôdokei no Ondo.	Aturyoku.	Keisansita Takasa.	Yomi.	Tigai.
-1°C.	761.3 mm.	-15 m.	5 m.	20 m.
	728.2	355	340	- 5
	646.0	1350	1315	- 35
	569.4	2371	2300	- 71
	502.8	3351	3245	-106
	438.9	4397	4235	-162
	410.5	4905	4720	-185
	469.4	3884	3775	-109
	538.4	2815	2775	- 40
	611.4	1798	1790	- 8
	688.4	837	840	3
	760.9	-10	25	35
	730.1	337	333	- 4
	646.4	1345	1325	- 20
1°	548.6	2666	2600	- 66
	500.9	3381	3285	- 96
	439.2	4392	4235	-157
	410.8	4899	4720	-179
	472.3	3837	3735	-102
	537.9	2822	2775	- 47
	609.5	1824	1800	- 24
	639.7	811	820	9
	761.2	-13	25	38
1°	729.3	347	340	- 7
	646.0	1350	1325	- 25
	570.9	2350	2290	- 60
	501.7	3369	3275	- 94
	440.0	4378	4220	-158
	410.2	4910	4720	-190
	472.2	3838	3745	- 93
	539.6	2797	2768	- 29
	611.7	1794	1790	- 4
	689.3	815	828	13
0°	761.0	-11	55	46

Hyô XII. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.

(Du 15 ni sôtôsuru).

Kôdokei no Ondo.	Aturyoku.	Keisansita Takasa.	Yomi.	Tigai.
- 20°C.	753.3 mm.	75 m.	100 m.	25 m.
	729.4	345	350	5
	646.1	1349	1315	- 34
	568.3	2387	2305	- 82
	492.3	3512	3370	- 142
- 19°	440.2	4375	4185	- 190
	408.5	4940	4700	- 240
	470.8	3861	3730	- 131
	537.3	2831	2775	- 56
	609.7	1821	1800	- 21
- 18°	690.1	807	820	13
	743.0	191	220	29
	730.2	336	340	4
	645.3	1359	1325	- 34
	563.0	2460	2385	- 75
- 17°	500.7	3385	3265	- 120
	435.7	4453	4245	- 208
	407.3	4962	4720	- 242
	467.6	3914	3775	- 139
	534.8	2869	2795	- 74
- 16°	609.3	1826	1800	- 26
	690.5	803	820	17
	744.3	176	200	24

Hyô XIII. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.
(Du 16 ni sôtôsuru).

Kôdkei no Ondo.	Aturyoku.	Keisansita Takasa.	Yomi.	Tigai.
-24°C.	752.9 mm.	80 m.	100 m.	30 m.
	729.0	350	340	— 10
	646.3	1347	1315	— 32
	569.0	2377	2290	— 87
-25°	498.8	3414	3275	— 139
	437.4	4424	4220	— 204
	408.4	4942	4695	— 247
	472.2	3839	3720	— 119
	536.7	2840	2775	— 65
	608.6	1835	1800	— 35
	691.0	797	820	23
-26°	751.2	98	130	32
	730.0	339	340	1
	645.1	1361	1315	— 46
-26°.5	568.8	2380	2290	— 88
	496.9	3444	3285	— 159
	435.0	4465	4245	— 220
	406.6	4975	4720	— 255
	468.3	3903	3765	— 138
-26°.5	539.7	2796	2725	— 71
	607.1	1855	1815	— 40
	689.9	810	820	10
	747.8	137	180	43
	730.2	336	330	— 6
-27°	640.7	1418	1387	— 31
	566.7	2409	2330	— 81
	500.0	3395	3250	— 145
	436.0	4448	4245	— 203
	406.7	4973	4720	— 253
	467.2	3920	3765	— 155
	535.9	2853	2775	— 78
	609.7	1820	1800	— 20
	691.2	795	820	25
	750.4	107	140	33
-26°.3	750.4	107	140	33

Hyō XIV. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.

(Du 17 ni sōtōsuru).

Kōdokei no Ondo.	Aturyoku.	Keisansita Takasa.	Yomi.	Tigai.
-34°·8C.	758·3 mm.	19 m.	57 m.	38 m.
	729·8	341	350	9
-44°·3	646·6	1343	1305	- 39
	567·3	2400	2290	-110
	498·6	3416	3240	-176
	433·4	4493	4245	-248
	405·7	4990	4720	-270
	462·7	3994	3810	-184
	548·1	2672	2580	- 92
	605·9	1872	1825	- 47
	688·0	832	848	16
	757·5	28	65	37
	728·2	359	360	1
-33°·8	645·9	1352	1315	- 37
	566·9	2407	2290	-117
	495·0	3473	3300	-173
	430·2	4550	4305	-245
	408·5	4940	4683	-257
	467·9	3908	3755	-153
	539·6	2796	2710	- 86
	610·6	1809	1780	- 29
	698·5	706	720	14
	757·3	30	65	35

Hyô XV. Ondo wo itteini site Kiatu wo kaeta Zikken no Kekkwa.

(Du 18 ni sôtôsuru).

Kôdokei no Ondo.	Aturyoku.	Keisansita Takasa	Yomi.	Tigai.
-45°C.	757.5 mm.	28 m.	48 m.	20 m.
-45°	694.9	750	740	- 10
	572.4	2329	2232	- 97
	499.5	3403	3225	-178
-42°·5	426.5	4615	4340	-275
	406.3	4980	4684	-296
	472.1	3840	3662	-178
	541.5	2769	2670	- 99
-41°·5	613.4	1772	1732	- 40
-41°	686.8	847	838	- 9
	757.2	31	65	34
-40°	706.4	614	603	- 11
	643.6	1380	1325	- 55
	568.2	2388	2292	- 96
-41°	488.4	3577	3394	-183
-41°·5	438.6	4402	4155	-247
-42°·5	404.0	5022	4740	-282
-43°	476.8	3764	3590	-174
	549.0	2660	2580	- 80
	609.6	1822	1790	- 32
	688.2	830	838	8
-43°	757.0	33	73	40

Hyô XVI. Ondo wo itteini site Kiatsu wo kaeta Zikken no Kekkwa.

(Du 19 ni sôtôsuru).

Kôdokei no Ondo.	Aturyoku.	Keisansita Takasa.	Yemi.	Tigai.
-44°C.	760.4 mm.	-4 m.	38 m.	42 m.
	725.0	396	395	- 1
	640.8	1416	1380	- 36
	561.4	2483	2292	-191
	492.1	3519	3350	-169
	429.2	4567	4290	-277
	407.8	4953	4665	-288
	472.0	3841	3680	-161
	537.8	2824	2730	- 94
	615.9	1740	1700	- 40
	694.8	751	770	19
	760.8	-9	37	46
	720.3	450	420	- 30
	641.3	1410	1360	- 50
	563.4	2455	2325	-130
	495.0	3473	3275	-198
	432.6	4507	4245	-252
	399.5	5106	4790	-316
	465.8	3943	3765	-178
	539.7	2795	2680	-115
	609.6	1822	1780	- 42
	691.5	791	800	9
-44°	760.9	-10	25	35

Hyô XVII. Hyôzyun-Taiki to onazi Zyôtai de okonatta
Zikken no Kekkwa.

(Du 26 ni sôtôsuru).

Kôdokei no Ondo.	Aturyoku.	Keisansita Takasa.	Yomi.	Tigai.
10°C.	762.9 mm.	-32 m.	-32 m.	0 m.
5°	694.2	758	750	- 8
- 1°	621.9	1651	1635	-15
- 5°·2	575.2	2289	2260	-29
- 9°·5	538.8	2809	2760	-49
-11°·5	510.3	3236	3180	-56
-16°	467.0	3924	3860	-64
-22°	415.4	4815	4730	-85
-11°·5	505.8	3305	3265	-40
- 5°	578.6	2242	2240	- 2
1°·5	660.6	1166	1170	4
5°	703.3	650	660	10
10°	761.8	-20	- 2	18

Hyô XVIII. Hyôzyun-Taiki to onazi Zyôtai de okonatta
Zikken no Kekkwa.

(Du 27 ni sôtôsusu).

Kôdokei no Ondo.	Aturyoku.	Keisansita Takasa.	Yomi.	Tigai.
0°C.	761.7 mm.	-19 m.	-32 m.	- 13 m.
- 7°	671.4	1034	1000	- 34
-12°	605.4	1878	1835	- 43
-17°·5	546.1	2702	2655	- 47
-24°	477.5	3752	3660	- 92
-28°·5	436.3	4443	4340	-103
-32°	408.0	4950	4840	-110
-26°	462.5	3997	3960	- 37
-19°·5	530.8	2927	2930	3
-12°	611.6	1795	1810	15
- 6°·5	679.2	938	960	22
0°	761.0	-11	2	23