SECTION I.—AEROLOGY.

THE ERUPTION OF SAKURASHIMA, JANUARY, 1914.

In view of the great interest which violent volcanic explosions have for the modern student of insolation, atmospheric transmissibility, and sky polarization, it seems appropriate for this REVIEW to present briefly the important features of the eruption of Sakurashima so far as they bear upon such problems.

Southern Japan has a great group of volcanoes called Kirishima. Southwestward from that group stretches a volcanic zone along the inner line of the Riukiu arc, and this zone also bears the general name Kirishima. Sakurashima is a volcanic island of this zone, situated in the graben which forms the Bay of Kagoshima, and its volcanoes are the first of those in the zone stretching southwestward from the Kirishima group.

The conical island of Sakurashima, 8½ kilometers from north to south and 11 kilometers from east to west, is built of three volcanic cones, lying so close together along its meridian that from the base they appear as a single cone. From one of the summits the individual cones may be clearly distinguished. The northern volcano is called Mitake or Kita-dake, i. e., Northern Peak; its rim is 1,133 meters above sea level; its crater is 300 meters in diameter and 100 meters deep. The southern volcano is called Minami-dake, or Southern Peak, and has always been active during historic times, giving off a light smoke or steam. Its elliptical crater is 650 by 400 meters, bounded by extraordinarily steep and even perpendicular walls, and the rim stands at an altitude of 1,070 meters above sea level. Between these two lies the third cone, called Nake-dake, or Middle Peak, having a smaller crater that is but 30 meters deep and a correspondingly shallow rim. Other lateral and parasitic cones are also present.

This island of volcanoes is among the most famous of Japan. Historic recorded eruptions go back to 708 A. D., since when at least 20 outbreaks have occurred. Among these the most violent were in 1471–1476 and 1779–1781. The eruption of 1780 was accompanied by a submarine outbreak on the northeast of the island which resulted in the formation of new islands and reefs. During the past 135 years there have been over 10 small outbreaks, and smoke clouds were still ascending from Minami-dake when Prof. Yamasaki's[1] paper was transmitted to the Berlin Geographical Society.

The eruption of January, 1914, was one of the most important lava eruptions of modern times, comparable with its own predecessor of 1779 and that of Asama in 1783. The great eruption of Bandai-san in 1888 was a great steam explosion, and no trace of accompanying lava flows was found. The eruption of Sakurashima of the present year was of the normal lava type, as usually occurring at Vesuvius and Etna. It was immediately preceded by numerous earth shocks on January 10, which greatly increased in number on the 11th. Thus the inhabitants of the island and of Kagoshima had sufficient time to flee to points of safety. Early on the morning of January 12 "smoke" was seen hanging upon the western slopes far below the active crater of Minami-dake. About 10 a. m. there was a tremendous eruption precisely underneath the "smoke," and almost simultaneously came another great eruption on the opposite side of the island. Great masses of steam, darkened by their great load of volcanic ashes and lapilli, rose to great heights. The "smoke" column, made up of thousands of cloud balls, is estimated to have risen to at least 6,000 meters (19,685 feet, or 3.7 miles). Lightning flashes darted in all directions, vertically as well as horizontally and obliquely, within the gray cloud. The heavy concussions and the ash fall greatly changed the landscape. Near the crater the forest trees were stripped of their leaves, branches were bent over, and even strong stems and trunks were broken off. The side of the trees toward the crater suffered complete abrasion of bark and rind, so that only the naked stem remained. In Yokohama the air waves tore up by the roots a well-grown orange tree and carried it up on a hill 60 meters above its former position.

The lofty column of "smoke" spread out in the upper layers of the atmosphere, scattering its ashes far eastward under the influence of the west wind then prevailing. The ash fall not only covered the larger portion of the island of Kiushiu, but also fell upon Shikoku and at various points on Hondo, the principal of the Japanese islands. Early on the morning of January 13, the third day of the eruption, there was a thin fall of ashes at Tokyo, which is about 1,000 kilometers or over 620 miles, from Sakurashima.—[C. A., jr.]

[1] *Yamasaki, N.* Der Ausbruch des Vulkans Sakurashima im Januar, 1914. Ztschr. d. Gesells. f. Erdkunde, Berlin, 1914, No. 4, pp. 295–302, with map.

SOLAR RADIATION INTENSITIES AT MOUNT WEATHER, VA.

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[Dated Mount Weather, Va., Apr. 17, 1914.]

In Table 1 are summarized the solar radiation measurements made at Mount Weather, Va., with a Marvin pyrheliometer, during January, February, and March, 1914. Measurements have been made with the sun at approximately the following zenith distances whenever it was unobscured by clouds: 80.7°, 79.8°, 78.7°, 77.4°, 75.7°, 73.6°, 70.7°, 66.5°, 60.0°, and 58.3°. The corresponding air masses are 6.0, 5.5, 5.0, 4.5, 4.0, 3.5, 3.0, 2.5, 2.0, and 1.5 (1). Eight readings of the pyrheliometer at minute intervals are usually made, and the results are plotted with the logarithms of the measured radiation intensities as ordinates and the air masses as abscissas. Interpolation of radiation intensities to a zenith distance of the sun corresponding to an air mass that is some multiple of 0.5 is then a simple matter. The exact zenith distance of the sun corresponding to the true solar time at which a pyrheliometric reading was made is determined by the aid of Ball's altitude tables (2).

The Marvin pyrheliometer has been compared frequently with Smithsonian silver disk pyrheliometer No. 1, and the latter has been checked from time to time with pyrheliometers in use at the astrophysical observatory of the Smithsonian Institution. It is therefore believed that the results here given are expressed in units of the Smithsonian revised scale of pyrheliometry (3).

TABLE 1.—*Solar radiation intensities at Mount Weather, Va., expressed in gram-calories per minute per square centimeter of normal surface.*

Date.	Air masses.								
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1914. A. m.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Jan. 6	1.23	{ 1.14	1.05						
9		{ 0.98	0.90	0.83	0.77				
13						0.84	0.77	0.72	0.70
14	1.30	1.22	1.14	1.06	0.99	0.93	0.87		
18	1.25	1.12							
23	0.77	0.62	0.50	0.42	0.35	0.31	0.27		
25			0.98	0.89	0.80				
26	1.08								
29	1.21	1.11	1.03	0.96	0.89	0.80			
Means	1.14	1.03	0.93	0.83	0.76	0.72	0.64	*0.72*	*0.70*
P. m.									
Jan. 6		1.20	1.14	1.03	0.94	0.88	0.83	0.79	0.76
14		1.20	1.14	1.06	0.98	0.92	0.87	0.82	
23	0.93	1.04	0.92	0.86	0.86	0.83			
26	1.16	1.03	0.95	0.87	0.81	0.76	0.71	0.66	0.61
27	1.18								
31		1.21							
Means	1.09	1.14	1.04	0.96	0.90	0.85	0.80	0.76	0.68

Date.	Air masses.									
	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
A. m.	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*	*Gr.-cal.*
Feb. 1		1.23								
2		1.38	1.30	1.21	1.13	1.08	1.00	0.99		
7	1.24	1.13	1.06							
8	1.31	1.22	1.09	0.98	0.88	0.80	0.74	0.60		
9	1.47	1.35	1.25	1.15	1.08	1.02	0.95	0.90	0.85	
12	1.31									
15	1.24	1.21				0.85	0.75	0.69	0.65	
17					1.00	0.94	0.88	0.83	0.78	0.73
21	1.46	1.34	1.22	1.12	1.03	0.95	0.89	0.84	0.79	0.73
24	1.46	1.32								
26	1.42	1.34	1.25	1.13	1.05	0.99	0.94	0.88	0.82	0.77
Means	1.36	1.28	1.20	1.12	1.03	0.95	0.88	0.82	0.78	0.74
P. m.										
Feb. 1		1.29	1.15	1.07	1.01	0.95	0.90	0.85	0.79	0.74
2		1.34	1.25	1.14	1.07	1.02	0.98	0.93	0.87	0.82
7		1.04	0.96	0.87	0.79	0.74		0.62	0.57	0.51
8		1.24	1.13							
9		1.34	1.22	1.13	1.06	0.99	0.92	0.86	0.82	0.80
11		0.97	0.82	0.68	0.60	0.54	0.50	0.46	0.43	0.40
15		1.10	1.02	0.95	0.88	0.81	0.75	0.69	0.66	0.63
16		0.77								
17		1.14	1.05	0.96	0.88	0.81	0.71			
21		1.36	1.28	1.20	1.12	1.05	0.99	0.94	0.89	
24		1.35	1.27	1.20	1.12	1.06	1.00	0.95	0.90	0.85
26	1.40	1.20	1.13			0.97	0.89	0.82	0.76	
Means	*1.40*	1.18	1.12	1.02	0.95	0.89	0.85	0.79	0.74	0.68
A. m.										
Mar. 4	1.25									
10	1.29		1.04	0.94	0.84	0.74				
12	1.44	1.34	1.24	1.15	1.06	0.99				
14		1.13	1.03	0.94	0.86	0.79	0.72	0.67	0.61	0.54
15	1.19	1.00								
18		1.16								
21								0.86		
23				1.01	0.92	0.83	0.76	0.70	0.64	
24	1.25	1.15	1.04	0.95	0.84	0.76	0.68	0.61	0.56	0.52
Means	1.28	1.16	1.09	1.00	0.90	0.82	0.72	0.71	0.60	0.53
P. m.										
Mar. 3	1.28	1.19	1.10	0.99	0.90	0.83	0.76	0.69		
4	1.28	1.09	0.97	0.89	0.80					
7	1.29									
9	1.32									
10	1.28		0.94							
12	1.45	1.34	1.23	1.13	1.05	0.99	0.93	0.87	0.82	0.77
15	1.11	0.99	0.89							
20	1.36	1.19								
24	1.11	0.96	0.83	0.74	0.67	0.60	0.54	0.48	0.43	
Means	1.28	1.13	0.99	0.94	0.86	0.81	0.74	0.68	0.62	*0.77*

Both the extreme and the mean solar radiation intensities for February and March, 1914, are in fair agreement with corresponding intensities for previous years (4). This is also true of the intensities for the first 18 days in January; but on the 23d of the month a hazy period set in that is worthy of special consideration.

The sunrise on January 23 was most unusual. About 45 minutes before sunrise there was a faint reddish glow in the east, and stars could be seen near the zenith, but none were visible near the horizon. Just before sunrise the sky was nearly colorless, and had the appearance of being overcast with alto-stratus clouds. At sunrise the sun was invisible, but shortly afterwards it appeared as a dull red ball through a layer of dense haze. It gradually increased in brightness, but the red color had not entirely disappeared when the sun was 10° above the horizon. Only a few wisps of cirrus clouds were present, the whiteness of the sky being due to the haze, which was principally above the level of Mount Weather, as objects in the valleys 16 miles distant were distinguishable.

From Table 1 it is seen that radiation intensities were very low during the morning of the 23d, and with air mass 2.0 were only 61 per cent of the average for the first part of the month. They were, in fact, nearly as low as as any that were measured during the haze that prevailed in 1912 (5). The atmosphere cleared rapidly during the afternoon of the 23d, and with air mass 2.5 the radiation intensity was 87 per cent of the average for the first part of the month.

Solar-radiation intensities continued about 15 per cent below the average, for air mass 2.0, until the 29th. On this day there was a dense lower haze that obscured all objects at a greater distance than 6 miles. The sky at the zenith was a deep blue, however, and the polarization of skylight, measured at a point 90° from the sun and in the same vertical circle, had increased to 60 per cent. On the 23d it was only 34 per cent, and on intervening days had been about 50 per cent.

In figure 1, curve I is a reproduction of the record of the total radiation received by a Callendar horizontal recording pyrheliometer from the sun and sky on January 23. Curve II is a record of the radiation received from the sky alone. It was obtained by interposing a screen 4 inches in diameter between the sun and the receiving grids of the pyrheliometer, and about 22 inches from the latter. Curves III and IV represent corresponding data for January 29. There were a few clouds late in the afternoon of the 23d, and a thin sheet of cirrus during most of the afternoon of the 29th.

In Table 2 are brought together for easy comparison radiation intensities read from the above curves when the sun was at the zenith distances indicated in the heading. It will be noted that the deficit in the total radiation on the 23d is small as compared with the excess of sky radiation. In other words, considerably more than half the loss in direct solar radiation, due presumably to scattering by the dust particles, was made up by the increased radiation from the sky. This is what we might expect when the sun is so far from the zenith.

In Table 3 are given light intensity measurements made with a Sharpe-Millar photometer on these two days, with the translucent glass plate in the end of the photometer tube horizontal. The illumination from the sky was obtained by interposing the 4-inch screen above referred to between this plate and the sun, and at a distance of about 2 feet from the former. On the 23d, sky illumination was in excess of solar illumination until after noon, and with the sun below zenith distance 70° a horizontal surface was only slightly illuminated by direct solar radiation. On the 29th with the sun at zenith distance 70.7° solar illumination was nearly twice as great as sky illumination, and over 12 times the corresponding solar illumination on the 23d. Evidently the haze on the 23d nearly extinguished the visible rays in the solar spectrum when the sun was low. In fact, with the sun 10° above the horizon it was impossible to make the usual adjustment of the Marvin pyrheliometer by means of a beam of light through a pinhole falling upon a cross mark on white paper.

TABLE 3.—*Photometric measurements at Mount Weather, Va., of the illumination from the sun and sky on Jan. 23 and 29, 1914.*

Date.	Sun's zenith distance.		
A. m.	60.0°	66.5°	70.7°
	TOTAL ILLUMINATION. (*Foot candles.*)		
Jan. 23	3,450	2,300	1,680
Jan. 29	4,160	2,920	2,280
	SKY ILLUMINATION.		
Jan. 23	2,120	1,820	1,560
Jan. 29	980	900	790
	SOLAR ILLUMINATION.		
Jan. 23	1,330	480	120
Jan. 29	3,180	2,020	1,490

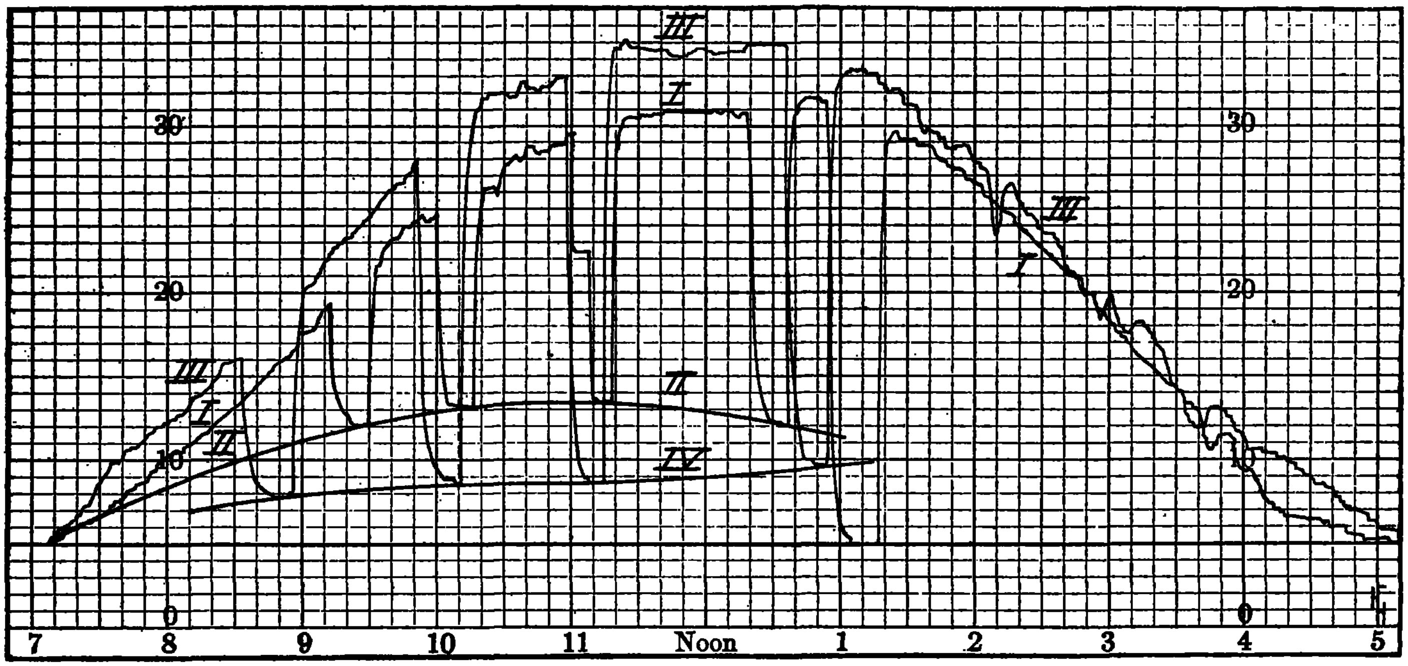

FIG. 1. Curves from a Callendar horizontal recording pyrheliometer at Mount Weather, Va., on Jan. 23 [I and II] and 29 [III and IV], 1914.
I and III, Total radiation received from sun and sky.
II and IV, Radiation from the sky alone, obtained by intermittently screening the grids from the sun.

TABLE 2.—*Comparison of radiation intensities recorded at Mount Weather, Va., by a Callendar horizontal recording pyrheliometer on Jan. 23 and 29, 1914.*

Date.	Sun's zenith distance.					
A. m.	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°
	SOLAR RADIATION. (*Scale divisions.*)					
Jan. 23	16.1	11.4	8.0	5.2	4.3	3.3
Jan. 29	23.9	17.1	12.5	9.8	8.6	7.0
	SKY RADIATION.					
Jan. 23	8.6	7.6	6.6	5.7	5.1	4.7
Jan. 29	3.5	3.1	2.8	2.5	2.3	2.2
Difference	5.1	4.5	3.8	3.2	2.8	2.5
	TOTAL RADIATION.					
Jan. 23	24.7	19.0	14.6	10.9	9.4	8.0
Jan. 29	27.4	20.2	15.3	12.3	10.9	9.2
Difference	2.7	1.2	0.7	1.4	1.5	1.2

Unusually brilliant red twilight colors were observed at Mount Weather on the evening of January 28 and the morning of the 29th. Brilliant sunsets were also observed by Prof. Abbe and others in Washington, D. C., during the latter part of the month.

The haze of January 23, 1914, was similar in its appearance and in its effects upon solar radiation intensities and skylight polarization to the dense haze of June 10–11, 1912, following the eruption of Katmai volcano, in Alaska, on the 6th of the same month. It occurred about 250 hours after the most violent eruptions of Sakurashima volcano, in Japan, on January 12, 1914, or at about the time we might expect dust from that eruption to reach the United States.

So far as I am aware, no unusual optical conditions of the atmosphere were observed elsewhere in the United States at this time; and until observational data from other countries is at hand, such as I understand is being collected by Dr. Chr. Jensen, of Hamburg, it is hardly profitable to speculate as to the cause of the unusual haze observed at Mount Weather during the latter part of January, 1914.

REFERENCES.

(1) Air masses have been computed from the equation

$$m=\frac{\text{atmospheric refraction (in seconds)}}{58.36'' \times \sin Z}$$

(2) Ball, Frederick. Altitude tables. London, 1907.
(3) Abbot, C. G., and Aldrich, L. B. Smithsonian pyrheliometry revised. Smithsonian Misc. Collection. v. 60, No. 18. Washington, 1913.
(4) See Table 2. Bulletin Mount Weather Observatory. Washington, 1912. v. 5, p. 303-311.
(5) Kimball, Herbert H. The dense haze of June 10-11, 1912. Bull. Mount Weather Obsy., Washington, 1912. v. 5, p. 161-165.

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STANDARD UNITS IN AEROLOGY.

The views and practice of some American physicists are probably well presented in the following extracts and articles from Profs. T. W. Richards and A. E. Kennelly, both of Harvard University, and which we now publish with their permission.—EDITOR.

1. [*Extract from* "New method for determining compressibility," by Theodore William Richards and Wilfred Newsome Stull. Carnegie Institution of Washington. Publication No. 7. Washington. December, 1903. p. 42-43.]

"It is a matter of great regret that the scientific world has not agreed upon a less arbitrary unit of pressure than the 'atmosphere.' The difficulty is now increased by the frequent technical use of this word to designate the pressure of a kilogram per square centimeter. The growing tendency toward the adoption of the C. G. S. system suggests the use of a consistent unit for this dimension also. Might not the pressure of a dyne per square centimeter be suitably called a *bar* (Greek *βαρος*, pressure, weight)? This suggestion is made because the practical use of a unit is always much facilitated by a definite verbal designation. In this case the pressure of a megadyne per square centimeter would be called a *megabar,* a name no more cumbrous than 'atmosphere,' and far more definite. This unit, though unnamed, has long been advocated by Ostwald (Grundriss Allgem. Chem., p. 54, 1899) as a more scientific one than the present standard. The megabar is 1,000 ÷ 980.6 = 101.98 per cent of a kilogram per square centimeter, or 101.98 ÷ 1033.2 = 98.703 per cent of an atmosphere, or the pressure measured by 75.015 centimeters of mercury at 0° C. at sea level, and latitude 45°. This pressure is more nearly the average atmospheric pressure at the laboratories of the world than the arbitrary 'atmosphere' usually taken. A megabar, acting through the volume of a cubic centimeter or milliliter, performs a megerg of work, or one-tenth of a joule."

2. [*Extract from* "The convection of heat from small copper wires." By A. E. Kennelly, C. A. Wright, and J. S. Van Bylevelt, in Proc. Am. instit. electr. eng., June, 1909, v. 28, p. 706.]

"*Air pressure in absolute measure.*—In column II of the foregoing table the air pressure in the tank is recorded in megabars. The C. G. S. unit of pressure, 1 dyne per square centimeter has been called the 'bar'; so that a megabar is 10^6 dynes per square centimeter. According to the recently published data of the Bureau International des Poids et Mesures (Les Recents Progrés de 1907, pp. 30-31), a column of mercury 760 mm. (29.92 inches) high, at sea level, in latitude 45°, exerts a pressure of 1.0132 megabars. Consequently 1 megabar represents the pressure of a column of mercury of 750.09 mm. (29.53 inches) under the same conditions. For most practical purposes, therefore, a megabar may be taken as 1 atmosphere. *It is actually* 0.987 *of an atmosphere* of 760 mm. [under apparent gravity] at sea level and 45° latitude."

3. STANDARD UNITS IN AEROLOGY.

By Prof. A. E. KENNELLY.

[Dated Cambridge, Mass., Mar. 25, 1914.]

In "Science" for March 13, 1914 (p. 391), Prof. Alexander McAdie calls attention to the confusion which is likely to be produced in scientific literature by the use of the term "bar" as a unit of pressure, with two distinct significations. I beg the privilege of indorsing in your columns the views there expressed, and of adding a few remarks.

It is generally agreed that the "bar" should be the name of a unit of pressure, in some simple numerical relation of dynes per square centimeter. The question is as to whether it should be applied to the C. G. S. unit (1 dyne per square centimeter) or to a pressure one million times greater. If it is given to the C. G. S. unit, then the standard atmospheric pressure, as hitherto adopted, would be the megabar of 750.09 mm. of mercury. On the other hand, if it is given to this latter standard atmosphere, then the C. G. S. unit of pressure would become equal to a microbar.

It is submitted that in view of (1) the history of the term, (2) of scientific consistency, (3) of existing usage, the "bar" should be adopted as the name of the C. G. S. unit, making the standard atmosphere a megabar.

History.—Prof. McAdie has pointed out that the term "barad" was proposed for the C. G. S. unit by a committee of the British Association in 1888. The International Physical Congress of Paris, in 1900, reported in favor of the "barie" as the name of the C. G. S. unit, (see vol. I of Proceedings, p. 100). The following is quoted from page 31 of Guillaume's "Recents Progres du Systeme Métrique" (Paris, Gauthier-Villars, 1907), a report presented to the Fourth Convention of Weights and Measures in Paris October, 1907:

Cette relation permet de calculer immédiatement la valeur en baries (unite C. G. S. de pression, egale à une dyne par centimetre carré) de la pression exercée par une colonne de mercure de la hauteur normale de 76 cm. dans les conditions de la pesanteur qui résultent de l'ensemble des stations considerées par M. Helmert. On trouve ainsi

$$P \text{ normal} = 1\,013\,211 \text{ baries.}$$

On peut calculer aussi, en posant P égal a l'unité, la hauteur de mercure qui exerce l'unité de pression. On trouve ainsi 0.75009μ. La megabarie normale serait donc exerçée par une colonne de mercure de 750.09 mm., à la température de la glace fondante, sous la latitude de 45°, et au niveau de la mer; l'intensité de pesanteur pour laquelle la colonne de mercure, exerçant une pression égale à une megabarie serait de 750.09 mm. devrait avoir la valeur:

$$g = 980.738 \text{ cm. sec}^{-2}.$$

In 1903 Prof. T. W. Richards independently originated and adopted the name "bar" for the C. G. S. unit of pressure in his chemical work.

Scientific consistency.—It is generally admitted that the C. G. S. system is the most generally and internationally recognized physical system of units in use at the present time, and the system most frequently employed in theoretical discussions of physical quantities. The system is strengthened when its unit magnitudes receive internationally recognized names. It necessarily becomes weakened when such names are assigned to unit magnitudes outside the system, even if decimally connected therewith. For example, the C. G. S. system