

FURTHER DATA REGARDING DEEP WELLS IN THE PEKING AREA.

by

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In a previous paper* I have described at some length the geological structure of the Peking plain, and explained how this governs the underground flow of water. The present paper is intended to supplement the earlier one.

In the list given below the numbering is arbitrary, being the reference number on my files more or less in the order in which the information was obtained, except that all the artesian wells have numbers above 100. It should however be pointed out that the term "artesian" is used in the popular sense of "free-flowing", whereas in point of fact all the deep wells are artesian in the sense that the water rises in the well under the pressure of its own head to levels far above its horizon of entry at the well-bottom (usually to within about 40 feet of the surface within the city wall). The highly desirable attribute of a free flow is an accident of the relative positions of ground-surface and the level reached by the water under its "effective head" at the spot in question. At Tsinghua and Yenching water may raise to 16 feet above the surface or may not even reach ground-level, the exact height depending on the local contouring of the ground. A mile north of Peiping city-wall the "effective head" is below ground-level, and south of that point no free-flowing wells are to be expected.

For convenience a complete list of wells for which data are available is given, but data for wells Nos. 1-12 and 19-24 details are not repeated as they can be found in the paper already cited. In other cases the data are revised, amplified or entirely new.

Well Depth

No. feet

- | | | |
|---|-----|-----------------------------------|
| 1 | 231 | Japanese Legation (Well No. 1) |
| 2 | 232 | Japanese Legation Guard Barracks. |
| 3 | | Peking-Hankow Railway Yard. |
| 4 | 210 | Methodist Mission Compound. |
| 5 | 205 | German Legation Guard Barracks. |

* Bull. Geol. Soc. China, vol. 3, (1924) p. 127

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| 6 | | French International Hospital. |
| 7 | 193 | Belgian Legation (Well No. 1). |
| 8 | 200 | Presbyterian Mission Compound, Antingmen. |
| 9 | 230 | Japanese Legation (Well No. 2). |
| 10 | 194 | Belgian Legation (Well No. 2). |
| 11 | | Wang Fu Chin Ta Chieh (Morrison Street). |
| 12 | 150 | American Board Mission (Teng Shih Kou). |
| 13 | 294 | P. U. M. C. (Well No. 1) Power House (See details below). |
| 14 | 289 | P. U. M. C. (Well No. 2) (see below). |
| 15 | 197 | P. U. M. C. (Well No. 3) (see below). |
| 16 | 139 | P. U. M. C. (Well No. 4) no good. |
| 17 | 204 | P. U. M. C. (Well No. 5) Drilled Mar. 1929, deepened Nov. 1929
(for well-log see Barbour, Jour. Assoc. Chinese and Amer.
Eng. Vol. 11, No. 2 (1930) pp. 36) (see below). |
| 18 | 204 | P. U. M. C. (Well No. 6) Drilled April 1929 (for well-log see op.
cit.) (see below). |
| 19 | | P. U. M. C. North Residence Compound. Drilled 1920, 8"
casing yield 6000 gals. per hour, never tested to limit.
See analysis below. |
| 20 | 186 | P. U. M. C. Hsin Kai Lu Compound. See analysis below. |
| 21 | 230 | Ta Yang Mao Hutung, East City. |
| 22 | 225 | Hai Ching Yang Hang, Tung Sze Pailou. |
| 23 | 130 | Chi Ma Hutung, East City. |
| 24 | 190 | Mi Shih Ta Chieh. |
| 25 | 320 | Chinese Red Cross Society, Kan Mien Hutung. |
| 26 | 210 | Hatamen Ta Chieh, 300 yds. south of level-crossing. |
| 27 | 206 | American Legation Guard Barsacks (Well No. 1) West Barracks.
Drilled 1906 by Japanese contractor, 6" casing. |
| 28 | 180 | Peking Club. 4" casing. |
| 29 | 200 | Peking Electric Company, Legation Quarter. Yield 3000 gals.
per hour (Data supplied by Mr. C. A. M. Brondgeest,
Station Engineer). |
| 30 | 179 | Customs Compound (Well No. 1) Hsi Yuan. Drilled 1928 by
Etablissements Arnoult, 4" casing. Bottom in sand and
gravel. |

- 31 186 Customs Compound (Well No. 2) Tung Yuan. Drilled March 1929
by Etab. Arnoult, 6" casing, Yield 4000 gals. per hour.
- 32 183 Banque de l' Indo-Chine. Drilled 1928 by Etab. Arnoult, 4"
casing. Yield 1500 gals. per hour.
- 33 192 American Legation Guard Barracks (Well No. 2) East Barracks.
Drilled 1929 by Etab. Arnoult, 6" casing, bottom in
gravel. Yield 3000 gals. per hour.
- 34 180 French Girls' School, San Tiao Hutung, 4" casing.
- 35 185 National City Bank of New York, Legation Quarter. Drilled 1928
by Etab. Arnoult, 4" casing. Yield 1500 gals. per hour.

Data for wells 13-18 were kindly furnished by Mr. W. G. Alston, Chief Engineer, P. U. M. C. Mr. Alston also allowed me to inspect the wells, and collect samples of the gravel recently taken from the bottom of No. 17, which give for the first time definite facts regarding the direction of flow of the original stream which deposited the aquifers, and hence the probable general direction of movement of underground water, which proves to have come approximately from the same quarter as the Yung-ting-ho today. (See also Well-log and Analyses, below).

The first well to be drilled (No. 13) was carried down to 708 feet below ground-level, but no water was found below 400 feet. The main supply in the case of Wells 13, 14 and 15 is from 180 ft., but aquifers were also met at -200', -230', -320', -350', etc. (see Well-log, given in Yih, *Geology of the Western Hills of Peking*, Geol. Surv. China Memoir, Series A, No. 1, p. 62). The original casings were 8". My record in 1925 speaks of a single well working with 60-lbs pressure air-lift giving 12,000 gals. per hr. The average yield of four wells in 1926 was 320,000 gals. daily. In Jan. 1930 three wells together yielded 250,300 gals. per day. In all cases the water is pumped from 20 feet below ground-level. The history of Well 5 is of interest. Though within 100 yards of the nearest, and within 200 yards of the rest of the wells, it got little or no water at 180'. What seemed an adequate flow was first struck at 194' but after resting the well for 2 weeks following a continuous period of pumping it was found to have ceased to flow. On deepening, by drilling ten feet deeper, a plentiful supply was struck in coarse gravel, an ideal aquifer with pebbles as much as four inches in length.

It may be noted that some of the P. U. M. C. wells are within 70 yards of each other without apparently causing mutual interference in the supply.

With the exception of Wells Nos. 17 and 18 all the series 13 to 20 were drilled before 1924.

ARTESIAN WELLS

- 100 Ch'ing-ho Woollen Mill. Two wells. Known to be artesian, no other data available.
- 101 Tung-chow. Depth 330 ft. In 1904 a 4" iron casing was put down with foreign rig, and was abandoned with the bottom still in sand at 220 ft. In 1905 a Japanese contractor (probably Ito) drilled down through this, getting water at 330 ft. Water rose through bamboo casing to within 2 feet of the surface and by piping to a point nearby where ground-level was lower a free flow was obtained, which only after 18 years (1923) began to show any appreciable decrease in flow. (Data furnished by Dr. J. H. Ingram).

It is not known whether the decrease latterly is due to silting up or to deterioration of bamboo-casing; the life of bamboo piping is normally not expected to exceed 20 years so that the latter is almost certainly a contributory cause.

- 102 Tsinghua University, Well No. 1 (near gymnasium). Depth 116 ft. Water rises to 21 feet above ground-level (1923). 6" iron casing was put down prior to 1920. Flow reported as 3600 gals per hr. in 1923 and 12000 gals. per hr. in July 1929. See Analysis below.

(The recent data for this and Wells 103 and 104 are supplied by Dean C. S. Yeh of Tsinghua University. Discrepancies between figures in my notes of 1923 and those recently supplied indicate that a change has been made both in the designation of the various wells and in the method of estimating the flow so that the two sets of data are not comparable.)

- 103 Tsinghua University, Well No. 2 (West Compound). Depth 106 feet; 4" casing. (Recorded in 1923 as 121 feet depth).
- 104 Tsinghua University, Well No. 3 (Power House). Depth 126 feet; 6" casing. Flow estimated at 19,000 gals. per hr. in October 1929.

- 105 Yenching Agricultural Station, Nan-yuan (abandoned) south of Peking. Depth 95 ft. 4" casing put down in 1921 with bamboo rig, cost Mex. \$ 170. Water said to rise within 20 feet of surface. (Log—'clay' to 80 ft., then sand, gravel, sand to bottom.) (No details since 1926 when the property changed hands).
- 106 Yenching University, Well No. 1. (Power House). Drilled in August 1923. Depth 122 feet. Rising to 12 feet above ground-level. 6" casing. Flow (over-estimated at 16,000 gals. in 1923) 500 gals per hr. may be raised to over 7000 gals. with air compressor, in November 1929. Temperature 59.2° Fahr. See Log and Analysis below. (The data as to flow and present condition of this well, as also of Wells 108, 109, 110, 111 were supplied by Mr. Louis Holm, Engineer-in-charge). This well gave only a trickle and was given up as a failure till five weeks after drilling it suddenly unsealed, evidently by flushing out the clay tamping used by the drillers and has flowed steadily ever since.
- 107 Ma Feng (31 miles NE of Peiping). Depth 170 feet. Water rising several feet above ground-level. (Data furnished by Mr. E. L. Johnson).
- 108 Yenching University, Well No. 2 (East Compound). Depth 125 feet, water rising 2 feet above ground level; drilled July 1924. 4" casing. (This well was not used after the University water supply was unified; the report estimate of 8000 gals. per hour is probably double the true value).
- 109 Yenching University, Well No. 3 (Agricultural Experiment Station). 4" casing put down in 1923. Not used for several years; connected with main system in Nov. 1929 and after giving only 2000 gals for some time suddenly cleared and now yields (January 1930) 4000 gals at the outlet of the piping 400 yards distant without air compressor.
- 110 Yenching University, Well No. 4 (Lang Jun Yuan). Depth 110 feet. Water rises to 5 feet above ground-level, i. e. 8 feet above the surface of the pond, which stands at water-table

level. This well has never given more than 20 gals. per min. and as much of that comes up outside the casing, poor drilling, clay tamping or quick-sand seem possible explanations; also it seems as if drilling had been stopped a few feet too soon.

- 111 Yenching University, Well No. 5 (Lang Jun Yuan). Depth 100 feet. Never gave more than a trickle, silted up through disuse. Probably not carried deep enough.

- 112 Tsingho Aeronautical Field (see Analysis below)

ANALYSES OF WELL-WATERS.

Through the courtesy of Dean Stanley Wilson and Prof. E. O. Wilson of the Department of Chemistry, Yenching University, analyses are given below of samples from a number of deep-wells in the Peiping area.

The earliest analysis of Yenching University water is one made by Prof. E. O. Wilson of a sample taken from Well No. 106 (Yenching Well No. 1). He has most kindly placed in my hands a copy of his report made soon after the well was drilled in 1923.

For comparison, there is an analysis made of water from the same well in 1928 by Mr. S. N. Wu in the Department of Chemistry, Yenching University. Mr. Wu at the same time analysed a sample from the joint supply of three wells at the P. U. M. C. (Nos. 13, 14 and 15). For both these records I am indebted to Dr. Stanley D. Wilson, who has moreover supplied copies of the check analyses for hardness and alkalinity carried out on the latter supply daily since 1928.

I had hoped that these valuable records would be made the basis of an independent report by them, but pressure of work makes this impossible at the moment. The original analyses, being made for a variety of purposes are not always strictly comparable, since in some cases only a limited number of constituents was determined. But the results are quoted without recalculation of any kind, with only the amount of rearrangement necessary for uniformity. The smallness of any item in such a tabulation is no measure of the amount of work lying behind it. I therefore appreciate very specially the permission to make use of these analyses from private records.

1. P. U. M. C. No. 1 (Well No. 13). Analysis by S. D. Wilson (Sept. 1920).
2. P. U. M. C. No. 2 (Well No. 14). Analysis by S. D. Wilson (Sept. 1920).
3. P. U. M. C. No. 3 (Well No. 15). Analysis by S. D. Wilson (Sept. 1920).

The above three analyses showed presence of much iron in the unfiltered sample, presumably a factor which would decrease rapidly on pumping.

4. Y. M. C. A. Analysis by S. D. Wilson (Sept. 1919).

The high amounts of chlorides, nitrites and nitrates suggest contamination of the supply and a bacteriological study was advised.

5. P. U. M. C. North Residence Compound (Well No. 19). Analysis by S. D. Wilson (May 1920).
6. P. U. M. C. Wenham Hall (Well No. 20). Analysis by S. D. Wilson (Mar. 1925)
7. Chingho Artesian Well (Well No. 112). Analysis by S. D. Wilson (Dec. 1920).

Well used by Construction Section, Aeronautic Dept. Peking.

8. Yenching University No. 1 (Well No. 106). Analysis by E. O. Wilson (1923).

The water was colorless and odorless and was analyzed without filtering. A slight reddish sediment did, however, accumulate after the water had stood for some time. The water contains considerable permanent hardness and is not suited for use in boilers (without treatment). Hardness calculated.

9. Same well as Analysis 8, five years later. Analysis by S. N. Wu (1928)
Hardness by soap method.
10. P. U. M. C. Nos. 1, 2 and 3 (Wells No. 13, 14 and 15). Analysis by S. N. Wu (1928). Hardness by soap method.
11. Yenching University, Lang Jun Yuan (Well No. 110). Analysis by Miss Chen Shen-chao (1929).
12. Tsinghua University, Drinking supply. Analysis by Yang En-fu. (1929).

Analyses and comments regarding the Peking shallow-well water supply will be found in the paper already cited.

ANALYSES OF WELL-WATERS.

(All amounts are given as parts per million. For conversion to grains per gallon multiply by factor .0583.)

	1	2	3	4	5	6	7	8	9	10	11	12
Total Hardness	237.0	239.0	231.0	247.0	151.2	185.3	542.7	—	190.00	206.0	249.0	234.1
Temporary	216.0	203.0	199.0	161.0	116.0	156.0	297.6	127.0	—	—	—	—
Permanent	21.0	36.0	32.0	86.0	35.2	29.3	245.1	—	—	—	—	—
Alkalinity	239.0	232.0	228.0	242.0	212.0	219.0	297.6	203.6	205.0	230.0	—	—
Total Solids	219.0	365.0	357.0	519.0	412.0	352.0	864.0	—	340.0	348.0	—	—
Chlorides	—	—	—	47.7	32.0	22.2	96.8	10.54	11.42	21.96	12.0	21.8
Sulphates	—	—	—	tr.	43.2	35.0	119.6	127.0	65.6	41.3	44.0	46.4
Nitrites	—	—	—	much	—	—	—	—	0.0	0.0	—	—
Nitrates	—	—	—	10.00	3.20	14.0	0.0	0.0	1.0	3.0	0.09	0.4
Free Ammon.	—	—	—	0.015	0.0	0.0	0.0	0.0	0.033	0.0	0.0088	—
Album. Ammon.	—	—	—	0.073	0.0	0.0	0.0	0.0	0.1	0.04	—	—
Silica	—	—	—	—	28.6	28.1	13.5	14.0	5.9	8.2	13.0	13.0
Iron	—	—	—	—	tr.	tr.	tr.	8.	1.7	2.0	1.1	0.75
Alumin.	0.05	0.55	0.10	—	fr. amt	—	—	—	—	—	—	—
Lime	—	—	—	—	72.8	62.0	153.7	58.3	63.0	63.6	59.0	57.6
Magnesium	—	—	—	—	15.3	25.25	38.7	20.0	20.9	23.4	24.8	21.9
Soda, Potass.	—	—	—	—	—	—	60.1	21.8	21.3	28.3	7.9	24.2
Carbonate	—	—	—	—	—	—	178.6	122.16	—	—	177.8	119.5

WELL-LOGS.

As is to be expected, very great variations occur even between wells driven in close proximity. When to this is added the variety of opinion among contractors as to how any particular sediment is to be described, comparison becomes still more difficult. But after all what matters is the depth of the aquifer below ground-level.

Since few well-logs are accessible, I have presented in diagrammatic form the information available for six of the wells listed above, which may be taken as typical. The two from the P. U. M. C. (Nos. 17 and 18), though 80 yards apart, show remarkable agreement except in the quicksand layers near the bottom of the well; this record I owe to Mr. W. G. Alston, Chief Engineer, who supervised the recent work. The log of P. U. M. C. Well No. 1 (No. 12 on this list) will be found in the Geological Survey of China Memoir Series A No. 1 (1920).

