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C. S. BISSON[2] AND MARTIN R. HUBERTY[3]

INTRODUCTION

CONCURRENTLY with the 1931–1932 hydrologic investigation of Putah Creek basin, reported by Huberty and Johnston in the accompanying paper (*3*),[4] studies of water quality were being made.[5] The purpose of the study was to determine, from analytical data, the classification of waters of the area as to their chemical composition; the seasonal variation in the character and amount of dissolved salts; and to determine the boron content of the waters, since this element is highly toxic to most plants when present even in minute quantities (*1, 2, 4*).

METHODS OF PROCEDURE

Samples were obtained from the pump discharge of wells penetrating water-bearing formations of various depths. Figure 1 shows the locations of the wells, from which water samples were collected in glass-stoppered bottles for analysis. From a small number of wells, perforated at only one water-bearing stratum, water samples were collected at intervals of from one day to one week to determine the seasonal variation in salt content.

Water samples of from 2 to 4 liters, collected in glass-stoppered bottles were placed in wooden containers and immediately taken to the laboratory where determinations were made for pH, bicarbonate, carbon dioxide, and nitrate. Later analyses were made for calcium, magnesium, sodium, potassium, iron, carbonate, sulfate, chloride, phosphate, nitrate, silicon, aluminum, and boron. The total solids were determined at 105° C.

RESULTS OF THE ANALYSES

The results of the determinations of bicarbonate and chloride ions on samples collected to show seasonal changes in the dissolved salt content are recorded in table 1. Table 2 contains the analyses of well waters obtained within Putah Creek lower basin, and the results are reported

[1] Received for publication October 11, 1940.

[2] Professor of Chemistry, and Chemist in the Experiment Station; died March 13, 1940.

[3] Associate Professor of Irrigation and Associate Irrigation Engineer in the Experiment Station.

[4] Italic numbers in parentheses refer to "Literature Cited" at the end of this paper.

[5] Dr. Walter Dye, former analyst for the Division of Chemistry, made the analyses.

in parts per million. The pH values reported in the second column were obtained soon after the samples reached the laboratory. For the convenience of those not accustomed to interpreting water analysis in parts per million, table 3 is introduced. Table 4 shows the values in table 2 tabulated according to depth of perforation, and table 5 gives the results for boron.

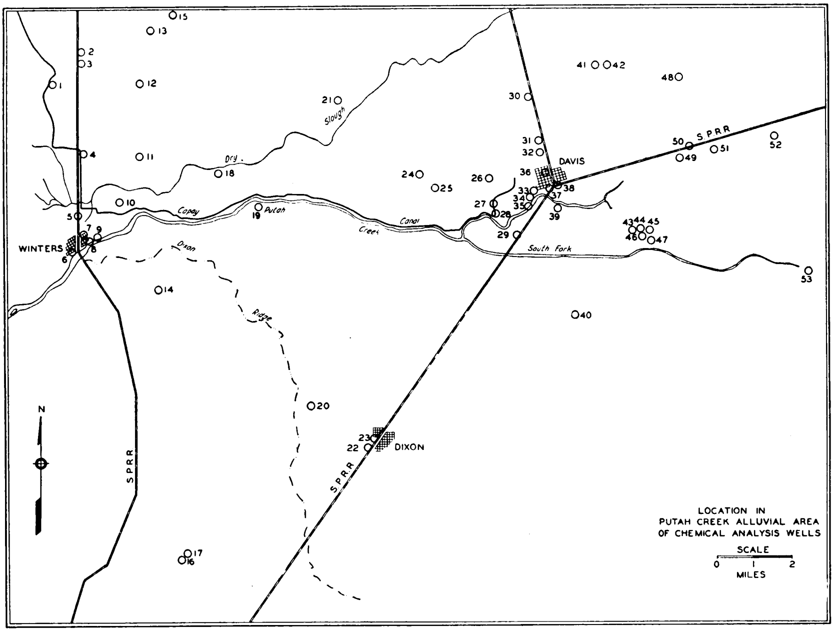

Fig. 1.—Location of wells in Putah Creek lower basin from which water samples for chemical analysis were obtained.

Concentration of Bicarbonate and Chloride Ions at Various Dates of Sampling.—Table 1 shows the bicarbonate and chloride content of well-water samples collected at short intervals of time. Samples from wells perforated at a single stratum within the depth range of 137 to 420 feet are remarkably constant with respect to these two ions. A well whose casing was perforated at several strata shows a considerable variation from day to day, which is very likely owing to a change in the relative amounts of water of different composition drawn from each stratum. Well no. 34, which is perforated at a single stratum, is a good example of wells showing remarkably constant composition with respect to these two radicals. Well no. 35, having more than one perforation, however, is a good example of wells showing considerable variation in composition. Table 3 furnishes additional proof that other chemical constituents are fairly constant in well water from single-stratum wells.

Composition of the Ground Waters.—Tables 2 and 3 show the results of analyses of samples from thirty-three wells in the area investigated, expressed in parts per million, and in milliequivalents per liter respectively. The hardness of nearly all these waters is of the bicarbonate type. This indicates that there is enough bicarbonate present to precipitate

TABLE 1

SEASONAL CHANGES IN CARBONATE AND CHLORIDE OF NUMBERED WELLS, EXPRESSED IN PARTS PER MILLION*

Date	No. 27		No. 28		No. 34		No. 35†	
	HCO_3^-	Cl^-	HCO_3^-	Cl^-	HCO_3^-	Cl^-	HCO_3^-	Cl^-
1931:								
June 30	467	13.1	373	7.5	...	....	393	37.0
July 30	470	12.5	377	8.6	378	13.3	520	27.3
September 18	468	13.0	370	8.0	374	11.2	568	34.0
September 19	....	....	....	....	375	11.2	....	....
September 21	....	....	....	....	375	10.8	....	....
September 22	....	....	....	....	375	10.6	....	....
September 23	....	....	....	....	375	11.5	560	32.8
September 26	468	12.8	371	8.3	378	12.6	604	39.2
September 29	467	13.2	373	8.7	374	13.2	....	....
October 1	....	....	372	10.0	376	13.1	415	27.5
October 3	466	13.4	373	9.3	375	12.1	....	....
October 6	468	14.1	372	9.6	....	....	....	....
October 8	470	13.9	380	9.6	375	12.0	....	....
October 10	468	12.1	369	9.0	375	13.3	....	....
October 12	469	13.8	372	9.4	375	12.5	....	....
October 15	....	....	373	9.5	375	11.9	....	....
October 17	470	13.2	372	9.3	....	....	....	....
October 23	....	....	....	....	375	12.0	....	....
October 30	....	....	376	9.4	....	....	....	....
December 21	....	....	....	....	377	....	....	....
1932:								
January 12	....	....	....	....	375	12.0	....	....
January 23	....	....	....	....	377	11.4	....	....
January 30	....	....	....	....	375	11.7	....	....

* With HCO_3^-, the average deviation between check analysis is 1 p.p.m., and the maximum deviation, 3 p.p.m. With Cl^-, the average deviation between check analysis is 0.2 p.p.m., and the maximum deviation, 0.6 p.p.m.

† Well 35 is perforated at more than one stratum.

the calcium on heating; the addition of lime should precipitate the remaining magnesium and bicarbonate. Well no. 43, the deepest well in the basin (1,030 feet), has the softest water, its hardness being 65 p.p.m. of Ca and Mg calculated as $CaCO_3$. The water from University Farm domestic well, no. 34, and the City of Davis, no. 37, with 255 and 135 p.p.m., respectively, would be called moderately hard. The iron content of the waters of the area is low, as is the nitrogen content, with three interesting exceptions namely, wells 45, 46, and 47. The shallow well, no.

TABLE 2

COMPOSITION OF WELL WATERS IN PUTAH CREEK BASIN EXPRESSED IN PARTS PER MILLION*

Well no.	pH	Cations					Anions					Total solids at 105° C	SiO_2	CO_2	Date (1931)
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Fe^{++} or Fe^{+++}	HCO_3^-	SO_4^{--}	NO_3^-	Cl^-	Al as $H_2AlO_3^-$				
6	8.4	34	48	23	0.0	0.03–0.05	328	22	10	16	3.2	374	38	16	Aug. 6
6	7.9	30	45	22	0.5–1.0	0.08–0.10	308	23	..	19	2.4	347	40	24	Dec. 17
7	8.0	35	40	10	1.0	0–0.03	291	24	2	10	3.0	318	41	11	Aug. 6
8	8.3	38	64	23	0.0	0–0.03	385	31	15	25	2.3	450	..	20	Aug. 6
9	8.4	38	56	24	0.0	0–0.03	358	40	8	17	1.3	414	43	11	Aug. 6
16	8.7	33	83	61	....	0.03–0.04	268	20	0	8	1.3	300	27	12	Sept. 25
17	8.5	30	15	42	....	0.01–0.02	216	8	6	18	2.3	300	62	10	Sept. 25
18	7.7	33	33	48	0.0	0–0.03	254	38	3	37	2.7	361	38	10	Aug. 6
19	8.3	38	42	48	....	0.01–0.02	...	47	2	45	2.0	415	39	12	Sept. 18
22	8.7	47	63	42	....	0–0.04	467	28	19	21	1.7	500	40	25	Sept. 25
22	8.1	44	59	40	0.5–1.0	0.05–0.08	453	26	..	20	3.2	485	37	57	Dec. 17
23	8.7	21	24	47	....	0.01–0.02	258	26	..	12	1.4	300	33	10	Sept. 25
24	7.7	35	68	53	0.0	0–0.03	438	30	5	20	2.7	504	41	17	Aug. 6
25	8.4	34	61	66	0.5–1.0	....	476	29	5	13	6.1	467	38	10	July 31
26	7.9	25	51	53	0.0	0.04–0.08	393	40	0	14	2.4	403	30	8	Aug. 6
27	8.8	36	62	53	0.5–1.0	....	459	40	3	13	5.6	492	41	0	June 30
27	8.6	36	60	50	0.0	....	471	39	4	12	2.6	494	38	9	July 30
27	8.5	31	62	59	0.5–1.0	0.02–0.04	468	22	5	13	3.2	488	36	27	Sept. 18
28	8.6	22	44	45	0.5–1.0	....	373	23	3	8	2.1	377	34	4	June 30
28	8.7	31	54	46	0.5–1.0	....	378	22	0	9	4.1	447	49	5	July 30
28	8.4	29	45	44	0.5–1.0	0.02–0.03	369	23	3	8	3.3	373	33	13	Sept. 18
31	8.5	25	63	71†	....	....	460	60	1	21	6.1	505	38	15	July 30
32	8.9	26	101	131†	....	0–0.02	680	114	6	55	3.8	832	32	18	Aug. 17
32	8.7	25	91	115†	....	0.02–0.03	630	92	4	45	5.6	759	34	22	Aug. 17
33	8.9	28	49	48	0.0	0.04–0.08	385	34	3	13	3.0	407	40	8	July 31
34	8.9	29	45	52	0.0	....	371	30	3	13	4.1	394	48	0	July 30
34	8.5	25	47	47	....	0.01–0.02	375	35	0	11	2.1	390	35	12	Sept. 18
34	8.2	24	46	45	0.5–1.0	0–0.26	377	27	....	11	4.9	384	33	22	Dec. 17
35	8.3	26	62	93	0.5–1.0	....	393	99	5	37	4.1	774	36	16	June 30

35	8.6	38	75	71	0.0	....	520	71	3	27	3.2	602	36	10	July 30
35	8.7	42	86	80	0.5–1.0	0–0.02	568	88	4	34	6.1	688	37	26	Sept. 18
36	8.9	24	69	62	0.0	0.04–0.08	418	52	3	26	4.0	479	40	13	July 31
37	8.1	18	23	57	0.5–1.0	0–0.02	258	38	..	10	...	288	..	0	Aug. 28
37	8.3	19	23	68†	0.5–1.0	0.01–0.02	274	25	..	12	1.7	321	29	7	Oct. 13
37	7.6	15	22	57	0.5–1.0	0.08–0.10	272	25	..	11	5.2	293	30	5	Dec. 17
38	8.7	26	46	53	0.5–1.0	0.04–0.08	373	73	3	12	2.9	399	34	10	July 31
38	8.5	24	46	50	....	0.02–0.04	368	30	2	12	1.8	374	35	13	Sept. 18
38	7.9	23	44	49	0.5–1.0	0.04–0.05	373	28	..	12	4.7	372	34	34	Dec. 22
39	8.9	34	74	76†	....	0.02–0.03	540	67	5	24	2.4	598	38	12	Aug. 3
40	8.3	26	68	44	0.5–1.0	0–0.02	470	28	1	12	3.8	458	40	16	Aug. 7
43	8.6	16	6	97	0.0	....	251	35	0	18	3.0	349	56	0	Aug. 1
45	8.6	33	118	66	0.0	....	625	65	136	10	5.6	502	38	16	July 30
46	8.3	39	89	70	0.0	....	584	64	8	27	5.6	668	38	13	June 30
47	8.3	44	97	34†	....	....	544	77	20	30	2.0	732	35	16	July 30
49	8.5	19	53	96	0.0	....	387	66	0	32	4.1	495	56	5	June 30
51	8.4	22	45	70	0.0	....	368	43	0	26	4.1	436	39	7	June 30
52	8.2	19	62	98	0.0	0.02–0.03	438	92	0	37	2.7	579	34	18	Aug. 7
53	8.5	25	51	63	0.5–1.0	....	358	57	0	28	5.6	782	42	3	June 30
53	8.5	26	52	60†	0.0	0.04–0.08	362	65	1	29	3.0	447	43	8	July 31

* Phosphorus (as PO_4^{---}) was less than 1.0 p.p.m. in all samples. Carbonate (as CO_3^{--}) was less than 0.5 p.p.m. for all samples except in the case of well no. 43, which had 6 p.p.m.

† Calculated.

TABLE 3

COMPOSITION OF WELL WATERS IN PUTAH CREEK BASIN EXPRESSED IN MILLIEQUIVALENTS PER LITER

Well no.	Cations			Anions					Per cent			Date (1931)
	Ca^{++}	Mg^{++}	Na^{+}	HCO_3^-	SO_4^{--}	Cl^-	NO_3^-	$H_2AlO_3^-$	Na	Ca	Mg	
6	1.7	4.0	1.0	5.38	0.45	0.45	0.17	0.08	15	25	60	Aug. 6
6	1.5	3.7	1.0	5.05	0.48	0.53	....	0.06	16	24	60	Dec. 17
7	1.7	3.3	0.8	4.77	0.49	0.30	0.03	0.08	14	29	57	Aug. 6
8	1.9	5.3	1.0	6.31	0.64	0.70	0.24	0.06	12	23	65	Aug. 6
9	1.9	4.6	1.0	5.87	0.84	0.49	0.13	0.04	13	25	61	Aug. 6
16	1.6	0.7	2.7	4.40	0.41	0.22	....	0.04	54	32	14	Sept. 25
17	1.5	1.3	1.8	3.54	0.16	0.51	0.10	0.06	39	33	28	Sept. 25
18	1.7	2.7	2.1	4.16	0.80	1.04	0.05	0.07	32	26	41	Aug. 6
19	1.9	3.4	2.1	....	0.98	1.31	0.03	0.05	28	26	46	Sept. 18
22	2.4	5.2	1.8	7.66	0.59	0.58	0.30	0.04	19	26	55	Sept. 25
22	2.2	4.9	1.7	7.43	0.54	0.56	....	0.08	19	25	56	Dec. 17
23	1.0	2.0	2.0	4.23	0.54	0.54	....	0.04	40	20	40	Sept. 25
24	1.8	5.6	2.3	7.18	0.62	0.56	0.08	0.07	24	19	58	Aug. 6
25	1.7	5.0	2.9	7.80	0.60	0.37	0.08	0.16	30	18	52	July 31
26	1.2	4.2	2.3	6.44	0.82	0.40	....	0.06	30	16	54	Aug. 6
27	1.8	5.1	2.3	7.53	0.84	0.37	0.05	0.15	25	20	55	June 30
27	1.8	5.0	2.2	7.72	0.82	0.34	0.06	0.07	24	20	56	July 30
27	1.6	5.1	2.6	7.68	0.46	0.37	0.08	0.08	28	17	55	Sept. 18
28	1.1	3.6	2.0	6.12	0.47	0.23	0.05	0.05	30	16	54	June 30
28	1.6	4.4	2.0	6.20	0.47	0.23	....	0.11	25	20	55	July 30
28	1.4	3.7	1.9	6.05	0.49	0.23	0.04	0.09	27	20	53	Sept. 18
31	1.3	5.2	3.1*	7.54	1.24	0.60	0.02	0.16	32	14	54	July 30
32	1.3	8.3	5.7*	11.15	2.38	1.54	0.10	0.10	37	9	54	Aug. 17
32*a*	1.2	7.5	5.0*	10.32	1.91	1.28	0.06	0.15	37	8	55	Aug. 17
33	1.4	4.1	2.1	6.31	0.71	0.38	0.05	0.08	28	18	54	July 31
34	1.4	3.7	2.3	6.08	0.63	0.37	0.05	0.11	31	19	50	July 30
34	1.2	3.8	2.0	6.15	0.73	0.31	....	0.06	29	17	54	Sept. 18
34	1.2	3.8	2.0	6.18	0.56	0.31	....	0.13	29	17	54	Dec. 17
35	1.3	5.1	4.0	6.44	2.07	1.00	0.08	0.11	38	13	49	June 30
35	1.9	6.1	3.1	8.52	1.49	0.76	0.05	0.09	28	17	55	July 30

35	2.1	7.1	3.5	9.31	1.82	0.96	0.06	0.16	28	16	56	Sept. 18
36	1.2	5.7	2.7	6.86	1.08	0.73	0.05	0.10	28	13	59	July 31
37	0.9	1.9	2.5	4.23	0.80	0.28	....	....	47	17	36	Aug. 28
37	1.0	1.9	2.6*	4.50	0.52	0.34	....	0.04	47	18	35	Oct. 13
37	0.8	1.8	2.5	4.46	0.51	0.31	....	0.14	49	16	35	Dec. 17
38	1.3	3.8	2.3	6.12	1.52	0.34	0.05	0.08	31	18	51	July 31
38	1.2	3.8	2.2	6.04	0.63	0.34	0.03	0.05	30	17	53	Sept. 18
38	1.1	3.7	2.1	6.12	0.58	0.34	....	0.12	30	16	54	Dec. 22
39	1.7	6.1	3.3*	8.85	1.41	0.68	0.08	0.06	30	15	55	Aug. 3
40	1.3	5.6	1.9	7.70	0.58	0.34	0.02	0.10	22	15	63	Aug. 7
43	0.8	0.5	4.2	4.12	0.73	0.51	....	0.08	76	15	9	Aug. 1
45	1.6	9.7	2.9	10.20	1.36	0.28	2.19	0.15	20	11	68	July 30
46	2.0	7.3	3.1	9.57	1.34	0.76	0.13	0.15	25	16	59	June 30
47	2.2	8.0	1.5*	8.92	1.60	0.85	0.32	0.05	13	19	69	July 30
49	0.9	4.4	4.2	6.34	1.34	0.90	....	0.11	44	10	46	June 30
51	1.1	3.7	3.1	6.03	0.90	0.73	....	0.11	39	14	47	June 30
52	1.0	5.1	4.3	7.18	1.92	1.04	0.00	0.07	41	10	49	Aug. 7
53	1.2	4.2	2.7	5.87	1.20	0.79	....	0.15	33	15	52	June 30
53	1.3	4.3	2.6*	5.94	1.35	0.82	0.02	0.08	32	16	52	July 31

* Calculated.

TABLE 4

VARIATION IN COMPOSITION OF WELL WATERS FROM PUTAH CREEK BASIN WITH DEPTH OF WELL AND DEPTH OF PERFORATION*

(Composition expressed in parts per million)

Depth of well, feet	Depth of perforation, feet	Well no.	Cations					Anions					Total solids, at 105° C	SiO_2	Hardness, as $CaCO_3$		Date (1931)
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Fe^{++} or Fe^{+++}	HCO_3^-	SO_4^{--}	Cl^-	NO_2^- or NO_3^-	Al as $H_2AlO_3^-$			Total	Non-carbonates	
70	35– 69	8	38	64	23	0.0	0–0.03	385	31	25	15	2.3	450	..	368	52	Aug. 6
80	....	45	33	118	66	0.0	....	625	65	10	136	5.6	502	38	565	42	July 30
...	55– 70	19	38	42	48	....	0.01–0.02	...	47	45	2	2.0	415	39	266	0	Sept. 18
96	80– 90	18	33	33	48	0.0	0–0.03	254	38	37	3	2.7	361	38	221	13	Aug. 6
105	81–101	46	39	89	70	0.0	....	584	64	27	8	5.6	668	38	362	0	June 30
120	100–120	25	34	61	66	0.5–1.0	....	476	29	13	5	6.1	467	38	333	0	July 31
137	126–137	27	36	62	53	0.5–1.0	....	459	40	13	3	5.6	492	41	341	0	June 30
137	126–137	27	36	60	50	0.0	....	471	39	12	4	2.6	494	38	337	0	July 30
137	126–137	27	31	62	59	0.5–1.0	0.02–0.04	468	22	13	5	3.2	488	36	334	0	Sept. 18
164	144–164	7	35	40	19	1	0–0.03	291	24	10	2	3.0	318	41	250	12	Aug. 6
...	146–180	53	25	51	63	0.5–1.0	....	358	57	28	0	5.6	782	42	274	0	June 30
...	146–180	53	26	52	60†	0.0	0.04–0.08	362	65	29	1	3.0	447	43	280	0	July 31
175	151–171	31	25	63	71†	....	....	460	60	21	1	6.1	505	38	324	0	July 30
226	212–220	40	26	68	44	0.5–1.0	0–0.02	470	28	12	1	3.8	458	40	341	0	Aug. 7
240	204–240	51	22	45	70	0.0	....	368	43	26	0	4.1	436	39	240	0	June 30
260	236–254	36	24	69	62	0.0	0.04–0.08	418	52	26	3	4.0	479	40	343	0	July 31
268	262–268	28	22	44	45	0.5–1.0	....	373	23	8	3	2.1	377	34	236	0	June 30
268	262–268	28	31	54	46	0.5–1.0	....	378	22	9	0	4.1	447	49	300	0	July 30
268	262–268	28	29	45	44	0.5–1.0	0.02–0.03	369	23	8	3	3.3	373	33	255	0	Sept. 18
369	311–323	34	29	45	52	0.0	....	371	30	13	3	4.1	394	48	258	0	July 30
369	311–323	34	25	47	47	....	0.01–0.02	375	35	11	0	2.1	390	35	254	0	Sept. 18
369	311–323	34	24	46	45	0.5–1.0	0–0.26	377	27	11	..	4.9	384	33	250	0	Dec. 17
...	312–324	38	26	46	53	0.5–1.0	0.04–0.08	373	73	12	3	2.9	399	34	252	0	July 31
...	312–324	38	24	46	50	....	0.02–0.04	368	30	12	2	1.8	374	35	248	0	Sept. 18
...	312–324	38	23	44	49	0.5–1.0	0.04–0.05	373	28	12	..	4.7	372	34	249	0	Dec. 17
420	400–420	26	25	51	53	0.0	0.04–0.08	393	40	14	0	2.4	403	30	272	0	Aug. 6
552	430–450	37	18	23	57	0.5–1.0	0.00–0.02	258	38	10	..	...	288	..	140	0	Aug. 28
552	430–450	37	19	23	68†	0.5–1.0	0.01–0.02	274	25	12	..	1.7	321	29	142	0	Oct. 13
552	430–450	37	15	22	57	0.5–1.0	0.08–1.00	172	25	11	..	5.2	293	30	130	0	Dec. 17
...	466–511	23	21	24	47	....	0.01–0.02	258	26	12	..	1.4	300	33	151	0	Sept. 25
1,030	546– 557 653– 666 767– 776 803– 813 898– 910 1,004–1,020	43	16	6	97	0.0	0.0	251	35	18	0	3.0	349	56	65	0	Aug. 1

* Phosphorus (as PO_4^{---}) was less than 1.0 p.p.m. for all samples. Carbonate (as CO_3^{--}) was less than 0.5 p.p.m. for all samples except in the case of well no. 43, which had 6 p.p.m.

† Calculated.

45, showed 136 p.p.m. of N calculated as NO_3^-, or nitrate nitrogen. A sample from this well was tested by Dr. C. S. Mudge[6] and the *Bacillus coli* group of organisms was not isolated.

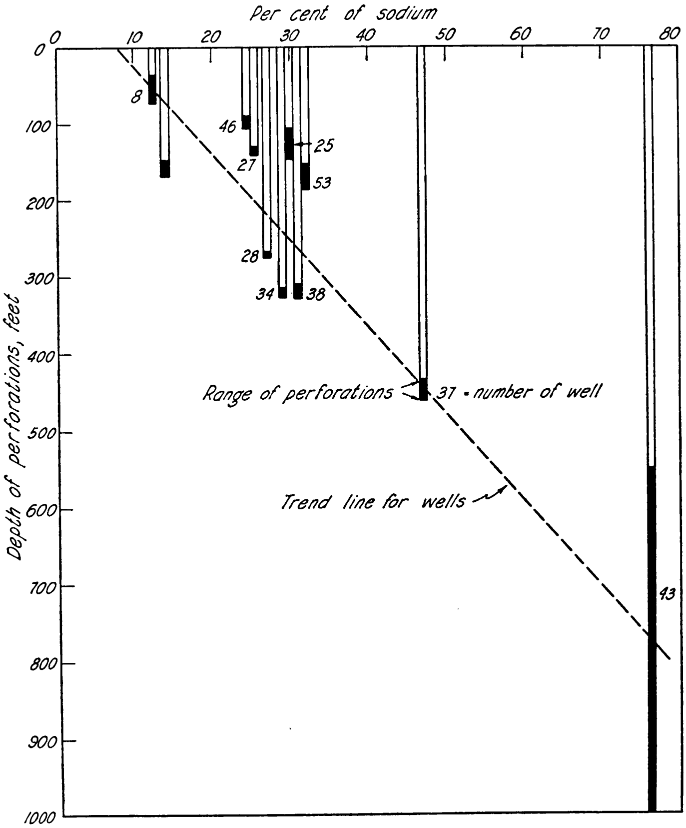

Fig. 2.—Relation between depth of water-bearing formation and the amount of sodium of the well waters. "Per cent of sodium" refers to the ratio between the number of milliequivalents per liter of sodium ions and the total number of equivalents of positive ions in the solution expressed as percentage. The solid bars indicate the range in depths of performations.

Table 4 shows the results of tabulating the wells of this area with respect to depth and chemical constituents. The range of depth is from 35 feet to 1,030 feet, and with the exception of well no. 43, involves only wells perforated at one stratum. It is clearly evident that the ratio of calcium and magnesium to sodium is lower in the water from deep wells

[6] Associate Professor of Dairy Industry and Dairy Bacteriologist in the Experiment Station.

TABLE 5

BORON CONTENT OF WELL WATERS IN PUTAH CREEK BASIN

Well no.	Boron p.p.m.	Well depth, feet	Perforation depth, feet	Date (1932)	Well no.	Boron, p.p.m.	Well depth, feet	Perforation depth, feet	Date (1932)
1	0.83	...	....	Sept. 18	30	0.74	...	....	Sept. 24
2	0.07	...	....	Sept. 18	33	0.37	330	....	Sept. 15
3	0.17	...	....	Sept. 18	34	0.52	369	311–323	Sept. 14
4	0.41	...	....	Sept. 18	35	1.04	322	Several strata	Sept. 15
5	0.00	...	....	Sept. 18	37	0.28	552	430–450	Sept. 18
6	0.00	...	....	Sept. 18	38	0.34	...	312–324	Sept. 16
7	0.16	...	....	Sept. 18	39	0.57	...	....	Sept. 16
8	0.09	70	35– 69	Sept. 18	40	0.22	226	212–220	Sept. 18
9	0.46	170	....	Sept. 18	41	0.69	125	....	Sept. 28
10	0.20	...	....	Sept. 18	42	0.34	125	....	Sept. 28
11	0.14	...	....	Sept. 18				546– 557	
12	0.04	...	....	Sept. 18				653– 666	
13	0.46	...	....	Sept. 18	43	1.03	1,030	767– 776	Sept. 16
14	0.56	...	....	Sept. 24				803– 813	
15	0.24	...	....	Sept. 18				898– 910	
16	0.04	...	....	Sept. 16				1,004–1,020	
17	0.00	...	....	Sept. 16	45	1.12	80	....	Sept. 15
18	0.15	96	80– 90	Sept. 16	46	0.49	105	81–101	Sept. 15
20	0.32	138	....	Sept. 24	48	0.50	...	....	Sept. 24
21	0.36	...	....	Sept. 24	49	0.86	...	....	Sept. 15
22	0.07	...	....	Sept. 16	50	2.02	...	....	Sept. 15
23	0.11	...	466–511	Sept. 18	51	0.96	240	204–240	Sept. 15
24	0.04	100	70– 77	Sept. 16	52	0.94	...	....	Sept. 18
25	0.30	120	100–120	Sept. 16	53	0.30	...	146–180	Sept. 16
26	0.48	420	400–420	Sept. 18					
27	0.65	137	126–137	Sept. 15					
28	0.44	268	262–268	Sept. 15					
29	0.49	123	107–120	Sept. 15					

than that from shallow wells. This is clearly shown in figure 2, which was constructed from data of analyses of waters from a few wells of various depths located near the channel of Putah Creek. The average depth of water-bearing strata varied from 50 to 770 feet below the ground surface. Percentage of sodium refers to the ratio between the number of milliequivalents per liter of sodium ions and the total number of equivalents of positive ions in the solution expressed as percentage. The graph indicates that the sodium percentage increases with increases in depth of water-bearing strata, the variation being from 12 per cent for the shallow aquifers to 76 per cent for the deepest water-bearing stratum.

The boron content of the well waters is given in table 5. From the data obtained it appears that the area of highest boron content is east of Davis several miles. The wells having the lowest boron content are in the vicinity of Dixon and Winters. It was not possible to correlate depth of perforation with boron content.

CONCLUSIONS

Within the period of time covered by these studies, water from wells perforated at one stratum only, but of various depths, is remarkably constant with respect to chemical composition. Wells perforated at more than one strata show a variable salt content.

In general, the ground waters of Putah Creek basin are of good quality for irrigation. The total salt content is relatively low as is the sodium percentage. Some well waters, however, contain sufficient boron to cause injury to many crop plants.

The well waters of this area are characterized by a relatively high bicarbonate content. The sodium percentage increases with depth of water-bearing formation. The boron content varied between 0 and 2.02 parts per million.

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