INDEX OF ANALYSES OF NATURAL WATERS IN THE UNITED STATES, 1926 TO 1931

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INTRODUCTION

This report is intended to serve as a guide to the larger collections of analyses of the mineral content of natural waters in the United States published from 1926 to 1931.[1] Publications up to 1925 are listed in Water-Supply Paper 560–C, which may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents. The numbers of the publications listed for each State are consecutive for the two reports. The two reports include references to some publications that deal with treated waters such as public water supplies and also include a few that contain only incomplete analyses.

The water-supply papers and other publications of the United States Geological Survey contain more analyses of water than any other series of publications. Several State organizations have published collections of analyses and, either alone or in cooperation with the United States Geological Survey, have made comprehensive surveys of the surface and ground waters within their respective States. For other States comparatively little has been published. The list of publications in this paper is intended to cover all reports on water analyses published by Federal and State geological surveys and experiment stations. In addition, references are given to journal articles that contain collections of analyses.

The publications listed have been prepared for various uses. The larger number of Geological Survey water-supply papers that contain analyses are reports prepared to show the ground-water conditions in individual areas. These reports attempt to give data that will serve as a basis for predicting the chance of finding water at any depth, together with an estimate of the probable chemical character of the water found. Some of the other reports relate primarily to the chemical character of waters either in some particular area or in some river system. State reports are generally of similar scope.

[1] All publications issued in 1932 of which information had been received up to the time of going to press (April, 1932) have been included also.

Privately published reports relate almost exclusively to mineral waters. Journal articles may relate to almost any subject that involves analyses of the mineral content of waters.

The term "analysis" used without qualification in this report is intended to refer to reasonably complete analyses of the mineral content of the waters. Analyses in recent publications of the Geological Survey have been made by the methods described in Water-Supply Paper 596-H, "Notes on practical water analysis" (available from the Superintendent of Documents for 10 cents). The older analyses of surface waters were made by the methods described in Water-Supply Paper 236 (general report 8).[2] These analyses include figures for calcium, magnesium, chloride, sulphate, and alkalinity. Most of them give figures for silica and for either iron or iron and aluminum oxides. Sodium and potassium are usually determined by the Geological Survey. It is common practice in publications from other sources to report for sodium the quantity calculated as needed in addition to the calcium and magnesium to balance the acids.

Partial analyses generally include the determination of dissolved solids and a few mineral constituents but not enough to make it possible to calculate the sodium. A large number of partial analyses have been published under the name "assay." These regularly include the determination of the acid radicles and the hardness. Recently a considerable number of "preliminary examinations" have been made in the preparation of Geological Survey reports. These include titrations of chloride and alkalinity with turbidimetric estimation of sulphate and calcium. Sometimes nitrate is determined, and sometimes hardness is determined by the soap method. These very fragmentary examinations are made merely to indicate the general character of a water or to determine the probability of its similarity to some other water in the neighborhood for which a complete analysis is available. "Sanitary" analyses include determinations of nitrogen in various forms, chloride, total dissolved solids, and sometimes iron and total hardness. Publications containing only sanitary analyses have not been listed unless they report investigations of special importance relative to areas for which few mineral analyses are available.

SURFACE WATERS

The most comprehensive older studies of surface waters are reported in United States Geological Survey Water-Supply Papers 236, 237, 239, 273, 274, 339, and 363 (general report 8, California 19,

[2] References in parentheses to reports by number indicate the numbers assigned in this or the previous index (Water-Supply Paper 560–C).

Illinois 13, Kansas 5, general report 10, Washington 4, Oregon 2). Most of the analyses in all these publications except Water-Supply Paper 274 are reprinted in Professional Paper 135 (general report 21). A number of the analyses of surface waters from these papers are also given in Bulletin 770 (general report 22). A comprehensive series of analyses of the Colorado River and its tributaries is still in progress. Results have been published in Water-Supply Papers 596, 636, and 638 (Arizona 18, 19, and 20). A series of analyses of composites of daily samples covering one year at each of 33 stations in Virginia was carried on from April 1, 1929, to March 31, 1931 (Virginia 7). In addition analyses were made of a large number of single samples collected at known stages of streams whose probable relation to the streams from which daily samples were collected was known.

These comprehensive reports on surface water contain analyses of a series of composites of daily samples taken over a period of a year. The most common practice was to make composites of 10 daily samples. For some of the reports composites were made three times each month, with 10, 11, 8, or 9 daily samples in the last composite for the month. A few of the series of analyses were made on 7-day composites. Experience with many studies of this character indicates that composites of 10 daily samples give the most information for the work involved. The added information obtained by making more frequent composites has not seemed to justify the extra work. If the composites cover much longer periods than 10 days changes in character of the water may escape detection. Where waters are extremely variable it is sometimes profitable to determine one characteristic constituent on each of the daily samples. This is most often the chloride. The analyses given in the comprehensive reports bring out clearly the inadequacy of single analyses of river waters or even of a series of analyses made without data for the discharge corresponding to each analysis.

GROUND WATERS

Most ground waters are fairly uniform in composition throughout the year and from year to year. A single analysis of a sample taken at any time is likely, therefore, to be representative of the character of the water obtainable from the same source at any time for many years afterward. A few springs are affected by surface water so that their composition varies with the rainfall. Wells may be affected by failure of the casing at a point where a water may enter that is very different in composition from the water that has been developed as the main supply of the well. This is most likely to happen where salt waters are cased off in order to obtain better water

at a greater depth. A number of wells at different places have been contaminated with water apparently coming from the ocean as a result of heavy pumping. These wells have rarely been restored to their former character.

In addition to the numerous reports that contain analyses of ground waters from individual areas, mention should be made of Geological Survey Water-Supply Paper 489, "The occurrence of ground water in the United States, with a discussion of principles." This report, which is out of print but may be found in many public and university libraries, gives a large amount of general information on the character of waters in different areas.

MINERAL WATERS

Many of the most complete and exhaustive collections of analyses relate to waters that are supposed to have some particular medicinal properties. For many of the best known of these waters there is nothing in the analytical results to suggest any explanation for their supposed remarkable characteristics. Several of the publications that contain collections of analyses recognize this point. One of them (general report 27) in connection with this subject states:

> When the astute physician of the present day reads of the wondrous water and more marvelous cures in an imposing list, as set forth in divers attestations from rejuvenated preachers, restored politicians, and renovated bobbed-haired suffragettes, persons unqualified by study or experience to give valuable testimony, and then carefully studies the analysis and finds that it contains only an infinitesimal amount of lime salts in parts per 1,000,000, is it any wonder that he tosses it into the wastebasket in disgust and assuages his enraged intelligence with an expletive objuration on charlatanry in general and the mineral-spring mountebank in particular? This "cure all" type of advertising, pursued by many proprietors of mineral springs, has contributed largely to bring odium upon mineral waters and to foster incredulity in the minds of the profession. A spring or spa exploiting a really meritorious mineral water, which has hopes for continuous patronage and indorsement of the profession, has no need to resort to exaggerated hyperbole nor to the use of superlatives.

Practically all the books seem to have ignored this consideration in the material printed about individual springs. In general, the analyses of mineral waters are reliable. Many of the statements regarding the therapeutic properties of the waters appear to have been taken by the authors of the books from advertising circulars distributed by the owners of the springs or resorts and not to have been confirmed by observation and experience of the authors. Thus, in referring to these books as sources of information as to the chemical character of the waters and the location of springs it must be understood that some statements regarding the properties of the spring waters are viewed with suspicion by many who have given serious attention to the subject.

A general discussion of the subject of mineral waters at a meeting of the American Chemical Society at Atlanta, Ga., April 7 to 11, 1930, was introduced by Miss Foster's report on some analyses of waters from hot springs (Arkansas 7, Virginia 4). Different phases of the subject were presented in three other papers [3] which together furnish an up-to-date survey of conditions affecting the mineral-water business. These papers will be helpful in evaluating the material relating to mineral waters in the various publications listed below.

Attention might be called to the claims that have been made in the past for special therapeutic properties of mineral waters due to lithium and radioactivity. Both of these topics are discussed in the paper by Sale, just cited. A brief statement on the subject of radioactivity was published by the United States Public Health Service.[4] It is the consensus of opinion of students of the subject, as borne out by publications and decisions of the courts quoted by Sale, that unusual characteristics such as radioactivity or the presence of lithium have not been shown to have any appreciable useful effect in connection with the use of most mineral waters.

Some of the reports containing discussions and analyses of mineral waters are listed below. For the larger reports the number of analyses is indicated in parentheses.

General reports: 1 (850), 3 (450), 4 (100), 7 (54), 11 (38), 14, 22, 27 (871).
Arkansas: 1, 2, 3.
California: 6 (100), 23 (300).
Colorado: 25 (202).
Georgia: 3 (170).
Indiana: 3 (80).
Kansas: 2 (129).
Maine: 2, 4, 7.

PUBLIC SUPPLIES

Although waters for public supplies are practically all treated in some way to make them safe for drinking or to make them more suitable for other uses, they are, nevertheless, in the main, not greatly changed in composition from the time they are taken from their sources until they are delivered to consumers. Many of those who wish to find analyses of waters are more interested in the composition and characteristics of the waters delivered to consumers than they are in the waters as they occur naturally. Therefore reports giving

[3] Sale, J. W., Control of mineral waters and their salts under the Federal food and drugs act: Ind. and Eng. Chemistry, vol. 22, p. 332, 1930. Ingalls, Fay, The development of a spring property as a health and pleasure resort: Ind. and Eng. Chemistry, news ed., vol. 8, No. 10, p. 1, 1930. Eastlake, G. B., Bottled waters for home and office use: Idem, vol. 8, No. 11, p. 2, 1930.

[4] Collins, W. D., The radioactivity of natural waters: Public Health Reports, vol. 41, No. 37, pp. 1937–1939, 1926.

the chemical composition of public water supplies are included in the lists. The more comprehensive reports of this nature are general report 20, Arkansas 6, Illinois 26, Kansas 9, and Ohio 5.

AVAILABILITY OF THE PUBLICATIONS LISTED

Most of the publications listed are available for consultation in the larger public and educational libraries. Many are out of print, some can be purchased, and others are still available for free distribution from the office of publication. The price is given for Geological Survey publications that are for sale. Geologic folios can be purchased only from the Director, United States Geological Survey, Washington, D. C.; all other Survey publications are sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Payment for publications is required in advance.

PUBLICATIONS CONTAINING COLLECTIONS OF MINERAL ANALYSES OF WATERS

[Figures in parentheses alone or followed by "s" indicate number of analyses. For example, "(14s, 22)" means that the report contains 14 series of analyses of surface waters covering a period of about a year for each place, and 22 single analyses of either surface or ground water.]

GENERAL REPORT

NOTE.—The following publications listed in Water-Supply Paper 560–C are now out of print: Nos. 18, 19, 20, and 21. The price of No. 17 is 50 cents.

23. Mills, R. V. A., Protection of oil and gas field equipment against corrosion: U. S. Bur. Mines Bull. 233, 1925 (35 cents). 23 analyses of corrosive and noncorrosive waters in different oil fields of the United States. Most of the analyses have been published elsewhere.
24. Reistle, C. E., jr., Identification of oil-field waters by chemical analysis: U. S. Bur. Mines Tech. Paper 404, 1927 (5 cents). 12 analyses of oil-field waters with interpretation of the analytical results for correlation of the geologic strata from which the samples were obtained.
25. Collins, W. D., and Howard, C. S., Natural sodium bicarbonate waters in the United States: Ind. and Eng. Chemistry, vol. 19, p. 623, 1927. Graphic representation of 10 analyses of typical natural waters of the United States, with description of certain areas where sodium bicarbonate waters may be expected.
26. Meinzer, O. E., Plants as indicators of ground water: U. S. Geol. Survey Water-Supply Paper 577, 1927 (25 cents). Total solids, sulphate, chloride, and black alkali (Na_2CO_3) are reported for 23 waters of Sulphur Spring Valley, Ariz., for 10 waters of the Tularosa Basin in New Mexico, and for 20 waters from Nevada. The analytical data for most of the waters have been published before.
27. Fitch, W. E., Mineral waters of the United States and American spas, Philadelphia and New York, Lea & Febiger, 1927. Analyses of 871 springs expressed in hypothetical combinations of the determined constituents. Many of the analyses have been published elsewhere.

28. Wells, R. C., Bailey, Reginald, and Henderson, E. P., Salinity of the water of Chesapeake Bay: U. S. Geol. Survey Prof. Paper 154, pp. 105–152, 1928 (Prof. Paper 154–C, 15 cents). Chloride determinations and density for samples from different depths at 41 stations in Chesapeake Bay.
29. Thompson, T. G., Johnson, Martin, and Todd, S. P., The sea water at the Puget Sound Biological Station from September, 1926, to September, 1927: Puget Sound Biol. Sta. Pub., vol. 6, pp. 371–391, 1928. Hourly variations in temperature, chlorinity, and specific gravity over two complete tidal cycles and daily variation in chloride and specific gravity for surface and depth samples for a two-month period. Other publications of the Puget Sound Biological Station give data for other years.

ALABAMA

General report: 27 (29).

2. Butts, Charles, U. S. Geol. Survey Geol. Atlas, Bessemer-Vandiver folio (No. 221), 1927 (50 cents). Partial analyses made by R. S. Hodges, of the Alabama Geological Survey, of samples of 38 waters of the Birmingham district.
3. Callan, J. C., and Gordon, H. B., Chemical analysis of the waters of Alabama: Alabama Polytech. Inst. Bull., vol. 27, No. 1, January, 1932. 600 analyses, including those in Alabama 1 and 4, and about 300 from other sources.
4. Johnston, W. D., jr., Ground water in the Paleozoic rocks of northern Alabama: Alabama Geol. Survey Special Rept. 16, 1932. 210 analyses made by Margaret D. Foster and C. S. Howard, U. S. Geological Survey.

ARIZONA

NOTE.—Reports Nos. 7, 8, 10, 15, and 16 for Arizona, listed in Water-Supply Paper 560–C, are out of print.

General reports: 26 (23), 27 (4).

17. Catlin, C. N., Character of the ground-water resources of Arizona: Arizona Univ. Agr. Exper. Sta. Bull. 114, 1926. 850 reports of total solids, chloride, and hardness and 240 partial analyses of well waters. The analyses were made by or under the direction of the author at the experiment station.
18. Collins, W. D., and Howard, C. S., Quality of water of Colorado River in 1925–26: U. S. Geol. Survey Water-Supply Paper 596, pp. 33–43, 1928 (50 cents). Analyses made in the water-resources laboratory of the U. S. Geological Survey of composites of samples of water from the Colorado River collected daily at Grand Canyon and Topock and at less frequent intervals at other stations.
19. Howard, C. S., Quality of water of the Colorado River in 1926–1928: U. S. Geol. Survey Water-Supply Paper 636, pp. 1–14, 1930 (Water-Supply Paper 636–A, 5 cents). Continuation of the work reported in Arizona 18. Analyses made in the water-resources laboratory of the U. S. Geological Survey of composites of samples collected daily from the Colorado River at Grand Canyon, Topock, and Yuma and of samples collected at less frequent intervals at other stations.
20. Howard, C. S., Quality of water of Colorado River in 1928–1930: U. S. Geol. Survey Water-Supply Paper 638, pp. 145–158, 1932 (Water-Supply Paper 638–D, 5 cents). Continuation of the work reported in Arizona 18 and 19. Analyses made in the water-resources laboratory of the U. S. Geological Survey of composites of samples of water from the Colorado River and its tributaries collected daily at Lees Ferry and Grand Canyon, Ariz., and Bluff, Cisco, and Green River, Utah.

ARKANSAS

General report: 27 (36).

6. Hale, Harrison, City water supplies of Arkansas: Arkansas Univ. Eng. Exper. Sta. Bull. 2, 1926. Analyses made at the University of Arkansas, under the direction of the author, of 95 samples from 82 cities and towns of the State.
7. Foster, M. D., Chemical character of the hot springs of Arkansas and Virginia: Ind. and Eng. Chemistry, vol. 22, pp. 632–633, 1930. 17 complete analyses by the author and others representing some of the springs at Hot Springs, Ark.

CALIFORNIA

NOTE.—Reports Nos. 13, 15, 16, 19, 23, 24, 29, 33, 35, and 36 for California, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (82).

37. Day, A. L., and Allen, E. T., The volcanic activity and hot springs of Lassen Peak: Carnegie Inst. Pub. 360, 1925. 23 analyses made by the authors of hot-spring waters of the Lassen region.
38. Hudson, F. S., and Taliaferro, N. L., Calcium chloride waters from certain oil fields in Ventura County, Calif.: Am. Assoc. Petroleum Geologists Bull., vol. 9, pp. 1071–1088, 1925. 21 analyses of typical waters from wells drilled into the Sespe formation in Ventura County made by M. T. Kendall at Ventura refinery. About 20 analyses, from various sources, of waters from other localities.
39. Miller, R. C., Ramage, W. D., and Lazier, E. L., Study of physical and chemical conditions in San Francisco Bay, especially in relation to the tides: California Univ. Pub. Zoology 31, pp. 201–267, 1928. Salinity, temperature, turbidity, oxygen, and hydrogen sulphide at five selected places in San Francisco Bay.
40. Thompson, D. G., The Mohave Desert region, Calif., a geographic, geologic, and hydrologic reconnaissance: U. S. Geol. Survey Water-Supply Paper 578, 1929 (out of print). About 150 analyses of samples from wells and springs of the region. 105 of these analyses were made in the water-resources laboratory of the U. S. Geological Survey.

COLORADO

NOTE.—Reports Nos. 6, 22, and 26 for Colorado, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (94).

28. Patton, H. B., Underground water possibilities for stock and domestic purposes in the La Junta area, Colo.: Colorado Geol. Survey Bull. 27, pt. 1, 1924. 10 analyses of "Dakota" waters reprinted from Colorado 17, and 24 analyses made by commercial chemists of waters from shallow wells and springs of the State.

CONNECTICUT

NOTE.—Reports Nos. 3 and 7 for Connecticut, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (7).

9. Brown, J. S., Ground water in the New Haven area, Conn.: U. S. Geol. Survey Water-Supply Paper 540, 1928 (60 cents). Analyses of samples of ground water from 49 sources and of 2 surface waters. The analyses were made in the water-resources laboratory of the U. S. Geological Survey.

10. Meinzer, O. E., and Stearns, N. D., A study of ground water in the Pomperaug Basin, Conn., with special reference to intake and discharge: U. S. Geol. Survey Water-Supply Paper 597, pp. 73–146, 1929 (Water-Supply Paper 597–B, 35 cents). 10 analyses of samples of ground water made by Margaret D. Foster, and an analysis of a composite sample from Nonewaug River made by S. C. Dinsmore.

DELAWARE

1. Eastman, A. S., and Beckett, R. C., Public water supplies of Delaware, 1931, Delaware Univ. and State Board of Health, 1932. 30 analyses of public water supplies in Delaware, made by D. W. Weaver, University of Delaware.

FLORIDA

General report: 27 (14).

9. Collins, W. D., and Howard, C. S., Chemical character of waters of Florida: U. S. Geol. Survey Water-Supply Paper 596, pp. 177–233, 1928 (Water-Supply Paper 596–G, 10 cents). 458 analyses of ground and surface waters of the State. Most of the analyses were made for the report in the water-resources laboratory of the U. S. Geological Survey.

GEORGIA

General report: 27 (44).

IDAHO

General report: 27 (2).

ILLINOIS

NOTE.—Reports Nos. 13 and 15 for Illinois, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (35).

24. Tough, F. H., Williston, S. H., and Savage, T. E., in cooperation with U. S. Bureau of Mines, Experiments in water control in the Flat Rock Pool, Crawford County: Illinois Geol. Survey Bull. 40, pp. 97–140, 1919. 6 analyses of oil well waters.
25. Habermeyer, G. C., Public ground-water supplies in Illinois: Illinois Univ. State Water Survey Bull. 21, 1925. Analyses made in the laboratory of the Water Survey for about 450 public ground-water supplies of the State. Many of the analyses have been published in earlier reports of the Water Survey.
26. Mylius, L. A., Oil and gas development and possibilities in east central Illinois: Illinois Geol. Survey Bull. 54, 1927. 10 analyses of oil-field waters.
27. Lamar, J. E., and Clark, C. R., Corrosion in the eastern Illinois oil fields: Illinois Geol. Survey Press Bull. ser., Illinois Petroleum, No. 15, pp. 9–22, 1928. 8 analyses.
28. Wanless, H. R., Geology and mineral resources of the Alexis quadrangle: Illinois Geol. Survey Bull. 57, 1929. 9 analyses.

INDIANA

NOTE.—Report No. 4 for Indiana, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (20).

IOWA

NOTE.—Report No. 2 for Iowa, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (6).

7. Norton, W. H., Deep wells of Iowa—a supplementary report, with a chapter on well-water recessions in Iowa by J. H. Lees, and a table of Iowa towns giving municipal water supplies: Iowa Geol. Survey, vol. 33, 1928. About 50 analyses of ground waters of the State made in various laboratories.

KANSAS

NOTE.—Report No. 5 for Kansas, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (33).

9. Gottlieb, Selma, Mineral analyses of municipal water supplies in Kansas: Kansas Univ. Chemical Research Div. Bull. 5 (Eng. Bull. 17), 1928. Determinations made by the State Board of Health of hardness, calcium, magnesium, and chloride for about 300 municipal water supplies of Kansas.

KENTUCKY

NOTE.—Reports Nos. 7 and 8 for Kentucky, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (30).

LOUISIANA

NOTE.—Report No. 3 for Louisiana, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (1).

MAINE

NOTE.—Report No. 4 for Maine, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (9).

8. Campbell, E. W., Public water supplies of Maine: New England Water Works Assoc. Jour., vol. 41, pp. 99–128, 1927. Chloride, hardness, and color for over 150 public supplies of Maine.

MARYLAND

General report: 27 (5).

MASSACHUSETTS

General report: 27 (5).

MICHIGAN

NOTE.—Reports Nos. 2, 3, 4, and 5 for Michigan, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (17).

9. McNamee, R. L., The surface waters of Michigan, hydrology and qualitative characteristics and purification for public use: Michigan Univ. Eng. Research Bull. 16, 1930. More than 350 analyses of surface waters of Michigan. The analyses were collected from various laboratories and published sources.

MINNESOTA

NOTE.—Reports Nos. 1, 2, and 3 for Minnesota, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (4).

MISSISSIPPI

General report: 27 (15).

4. Stephenson, L. W., Logan, W. N., and Waring, G. A., The ground-water resources of Mississippi, with discussions of the chemical character of the waters by C. S. Howard: U. S. Geol. Survey Water-Supply Paper 576, 1928 (90 cents). 6 analyses of surface waters and over 200 analyses of ground waters of the State. A great many of the analyses were made for this report in the water-resources laboratory of the U. S. Geological Survey, others were made at the University of Mississippi, and a few have been published in other places.

MISSOURI

NOTE.—Report No. 6 for Missouri, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (21).

9. Beckman, H. C., Water resources of Missouri, 1857–1926: Missouri Bur. Geology and Mines, 2d ser., vol. 20, 1927. Analyses of about 200 samples of water from rivers and springs of the State. Analyses by H. W. Mundt and W. D. Turner, of the State Board of Health.

MONTANA

NOTE.—Reports Nos. 1, 2, and 6 for Montana, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (10).

7. Riffenburg, H. B., Chemical character of ground waters of the northern Great Plains: U. S. Geol. Survey Water-Supply Paper 560, pp. 31–52, 1925 (Water-Supply Paper 560–B, 5 cents). Discussion based on about 400 complete and 700 partial analyses of North Dakota and Montana ground waters. Range of quantities of sulphate, chloride, and pH for 23 samples of rain water collected in 1923–24 in Washington, D. C. Typical analyses for waters from different formations of the Great Plains.
8. Renick, B. C., Base exchange in ground water by silicates as illustrated in Montana: U. S. Geol. Survey Water-Supply Paper 520, pp. 53–72, 1925 (Water-Supply Paper 520–D, 10 cents). Graphic representation of 20 samples from the Lance formation and 10 samples from the Fort Union formation in Montana. The analytical data for these analyses are given in Montana 10.
9. Hall, G. M., and Howard, C. S., Ground water in Yellowstone and Treasure Counties, Mont.; U. S. Geol. Survey Water-Supply Paper 599, 1929 (25 cents). About 100 analyses of water from wells and springs in these counties. Most of the analyses were made in the water-resources laboratory of the U. S. Geological Survey.
10. Renick, B. C., Geology and ground-water resources of central and southern Rosebud County, Mont., with chemical analyses of the waters by H. B. Riffenburg: U. S. Geol. Survey Water-Supply Paper 600, 1929 (out of print). About 120 analyses of samples of ground water of the region. Most of the analyses were made in the water-resources laboratory of the U. S. Geological Survey.

NEBRASKA

NOTE.—Report No. 2 for Nebraska, issued in Water-Supply Paper 560–C, is out of print.

4. Hicks, W. B., Potash resources of Nebraska: U. S. Geol. Survey Bull. 715, pp. 125–139, 1921 (out of print). Composition of 15 potash brines and of 10 ground and surface waters of the Nebraska potash region. Analyses made by E. T. Erickson, of the U. S. Geological Survey.

NEVADA

NOTE.—Reports Nos. 6 and 8 for Nevada, listed in Water-Supply Paper 560–C, are out of print.

General reports: 26 (20), 27 (6).

NEW HAMPSHIRE

General report: 27 (11).

NEW JERSEY

General report: 27 (1).

7. North Jersey District Water Supply Commission of the State of New Jersey, Report for the period May 5, 1916, to June 30, 1925, 1925. Sanitary analyses for 43 sampling points in 8 drainage basins of the region, giving the maximum, minimum, and average quantities for a year.
8. Thompson, D. G., Ground-water supplies of the Atlantic City region: New Jersey Dept. Conservation and Development Bull. 30, 1928. Analyses of 5 samples of surface and ground water and graphical representation of increase in chloride for certain wells of the region.
9. Collins, W. D., and Howard, C. S., Quality of the surface waters of New Jersey: U. S. Geol. Survey Water-Supply Paper 596, pp. 89–119, 1928 (Water-Supply Paper 596–E, 5 cents). About 120 analyses representing single samples taken at different stages for all the streams in the State on which gaging stations were being maintained. Analyses by C. S. Howard.
10. Hartwell, O. W., Surface water supply of New Jersey to September 30, 1928: New Jersey Dept. Conservation and Development Bull. 33, 1929. Analyses of typical surface waters of New Jersey reprinted from New Jersey 9.
11. Thompson, D. G., Ground-water supplies in the vicinity of Asbury Park: New Jersey Dept. Conservation and Development Bull. 35, 1930. 8 analyses representing water from 3 important aquifers of the region. Analyses made by C. S. Howard.

NEW MEXICO

NOTE.—Reports Nos. 10 and 11 for New Mexico, listed in Water-Supply Paper 560–C, are out of print.

General reports: 26 (10), 27 (19).

14. Renick, B. C., Geology and ground-water resources of western Sandoval County, N. Mex.: U. S. Geol. Survey Water-Supply Paper 620, 1931 (35 cents). 21 analyses of spring and well waters and 1 analysis of a river water. The analyses were made in the water-resources laboratory of the U. S. Geological Survey.

NEW YORK

General report: 27 (48).

NORTH CAROLINA

General report: 27 (35).

4. Foster, M. D., Surface waters of western North Carolina: Ind. and Eng. Chemistry, vol. 19, p. 885, 1927. 18 analyses of surface waters of the State made by the author and analyses representing maximum and minimum quantities found in two rivers of the State during an earlier survey.
5. Ray, C. E., jr., and Randolph, E. E., Preliminary report on the chemical quality of the surface waters of North Carolina with relation to industrial use: North Carolina Dept. Conservation and Development Econ. Paper 61, 1927. 174 analyses of surface waters and 11 analyses of ground waters of the State. 60 analyses were made by Margaret D. Foster, of the U. S. Geological Survey, a few were furnished by the Southern Railway, and the remainder were made by Mr. Randolph.

NORTH DAKOTA

7. Riffenburg, H. B., Chemical character of ground waters of the northern Great Plains: U. S. Geol. Survey Water-Supply Paper 560, pp. 31–52, 1925 (Water-Supply Paper 560–B, 5 cents). Discussion based on about 400 complete and 700 partial analyses of ground waters of North Dakota and Montana. Range of quantities of sulphate, chloride, and pH for 23 samples of rain water collected in 1923–24 in Washington, D. C. Typical analyses for waters from different water-bearing formations of the Great Plains.
8. Simpson, H. E., Geology and ground-water resources of North Dakota, with a discussion of the chemical character of the water by H. B. Riffenburg: U. S. Geol. Survey Water-Supply Paper 598, 1929 (out of print). 196 complete mineral analyses of ground waters of the State, made by H. B. Riffenburg and others in the water-resources laboratory of the U. S. Geological Survey.

OHIO

NOTE.—Report No. 3 for Ohio, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (9).

5. Foulk, C. W., Industrial water supplies of Ohio: Ohio Geol. Survey, 4th ser., Bull. 29, 1925. More than 500 analyses of surface and ground waters of the State made under the direction of the author in his laboratory at the Ohio State University.

OKLAHOMA

NOTE.—Report No. 6 for Oklahoma, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (8).

OREGON

NOTE.—Report No. 1 for Oregon, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (5).

3. Piper, A. M., Geology and ground-water resources of the Dalles region, Oreg.: U. S. Geol. Survey Water-Supply Paper 659, pp. 107–189, 1932 (Water-Supply Paper 659–B. 9 analyses made by Margaret D. Foster, U. S. Geological Survey.

PENNSYLVANIA

General report: 27 (23).

3. Torrey, P. D., Oil-field waters of the Bradford pool: Am. Inst. Min. and Met. Eng. Tech. Pub. 38, 1927. 16 analyses showing the chemical character of the connate and ground waters and also the changes that take place with flooding operations.
4. Leitch, R. D., Observations on acid mine drainage in western Pennsylvania: U. S. Bur. Mines Repts. Inv. 2889, 1928. Acidity expressed in parts per million and as pH for waters from 68 mines in Pennsylvania.
5. Leitch, R. D., and Yant, W. P., A comparison of the acidity of waters from some active and abandoned coal mines: U. S. Bur. Mines Repts. Inv. 2895, 1928. Acidity expressed in parts per million and as pH, total iron, and oxygen for waters from 24 mines in Pennsylvania.

RHODE ISLAND

General report: 27 (2).

SOUTH CAROLINA

General report: 27 (9).

SOUTH DAKOTA

NOTE.—Reports Nos. 5 and 6 for South Dakota, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (4).

12. Meinzer, O. E., Problems of the soft-water supply of the Dakota sandstone, with special reference to the conditions at Canton, S. Dak.: U. S. Geol. Survey Water-Supply Paper 597, pp. 147–170, 1929, 75 cents. 8 analyses made by Margaret D. Foster, of the U. S. Geological Survey.

TENNESSEE

NOTE.—Report No. 1 for Tennessee, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (19).

3. Wells, F. G., A preliminary report on the artesian water supply of Memphis, Tenn.: U. S. Geol. Survey Water-Supply Paper 638, pp. 1–34, 1931 (Water-Supply Paper 638–A, 15 cents). 7 analyses by Margaret D. Foster, U. S. Geological Survey, and 3 analyses made for the Tennessee Geological Survey.
4. Piper, A. M., Ground water in north-central Tennessee: U. S. Geol. Survey Water-Supply Paper 640 (in press). 50 analyses by Margaret D. Foster, U. S. Geological Survey, and 50 analyses made for the Tennessee Geological Survey.
5. Wells, F. G., Ground-water resources of western Tennessee: U. S. Geol. Survey Water-Supply Paper 656 (in preparation). 121 analyses by Margaret D. Foster, U. S. Geological Survey, and 57 analyses made for the Tennessee Geological Survey.

TEXAS

NOTE.—Report No. 11 for Texas, listed in Water-Supply Paper 560–C, is out of print.

General report: 27 (20).

17. Collins, W. D., and Riffenburg, H. B., Quality of water of Pecos River in Texas: U. S. Geol. Survey Water-Supply Paper 596, pp. 67–88, 1928

(Water-Supply Paper 596–D, 10 cents). 224 analyses of water from the Pecos River representing different stages at 6 gaging stations, 14 analyses from tributaries of the Pecos. The analyses were made by H. B. Riffenburg.

18. Cohen, Chester, Chemical analyses of Texas well waters, Texas Dept. of Health, 1931. A compilation of 1,168 analyses reported in hypothetical combinations in parts per million. 735 analyses were furnished by the International Filter Co., 273 were furnished by 19 other organizations, 140 are not credited to any laboratory. Locations are given for some wells for which no analyses are given.

UTAH

NOTE.—Reports Nos. 3, 4, and 5 for Utah, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (6).

10. Howard, C. S., Quality of water of Colorado River in 1928–1930: U. S. Geol. Survey Water-Supply Paper 638, pp. 145–158, 1932 (Water-Supply Paper 638–D, 5 cents). Continuation of the work reported in Arizona 18 and 19. Analyses made in the water-resources laboratory of the U. S. Geological Survey of composites of samples of water from the Colorado River and its tributaries collected daily at Bluff, Cisco, and Green River, Utah, and at Lees Ferry and Grand Canyon, Ariz.

VERMONT

General report: 27 (5).

VIRGINIA

General report: 27 (46).

3. Hall, G. M., Ground water in the Ordovician rocks near Woodstock, Va.: U. S. Geol. Survey Water-Supply Paper 596, pp. 45–66, 1928. (Water-Supply Paper 596–C, 15 cents.) Analyses by H. B. Riffenburg of waters from 6 wells in the vicinity of Woodstock.
4. Foster, M. D., Chemical character of the hot springs of Arkansas and Virginia: Ind. and Eng. Chemistry, vol. 22, pp. 632–633, 1930. 11 analyses, made by the author in the water-resources laboratory of the U. S. Geological Survey, of samples from some of the hot springs of Virginia.
5. Collins, W. D., Foster, M. D., Reeves, Frank, and Meacham, R. P., Springs of Virginia, a report on the discharge, temperature, and chemical character of springs in the southern part of the Great Valley: Virginia State Comm. Conservation and Development, Div. Water Resources and Power, Bull. 1, 1930. Partial analyses, made by Margaret D. Foster, for more than 400 springs of the Great Valley.
6. Collins, W. D., Williams, K. T., and Lohr, E. W., Chemical character of surface waters of Virginia, preliminary report: Virginia State Comm. Conservation and Development, Div. Water Resources and Power, Bull. 2, 1930. Analyses of 36 composite samples for each of 16 gaging stations at which daily samples were collected for a year. The analyses were made in the water-resources laboratory of the U. S. Geological Survey.
7. Collins, W. D., Lohr, E. W., Williams, K. T., Haller, H. S., and Kenworthy, O. C., Chemical character of surface waters of Virginia: Virginia State Comm. Conservation and Development, Div. Water Resources and Power,

Bull. 3, 1932. Analyses of 36 composite samples for each of 33 gaging stations at which daily samples were collected for a year. (Includes analyses in Virginia 6.) Analyses of 150 samples from other gaging stations representing high and low discharge.

WASHINGTON

NOTE.—Reports Nos. 3 and 4 for Washington, listed in Water-Supply Paper 560–C, are out of print.

General report: 27 (5).

5. Smith, E. V., and Thompson, T. G., Salinity of the Lake Washington ship canal: Washington Univ. Eng. Exper. Sta. Bull. 41, 1927. Chloride determinations for various depths at many stations in the canal to determine the conditions affecting the flow of sea water into the canal system.
6. Wright, C. C., Surface and subsurface waters of the Yakima and Klamath reclamation projects: Washington Agr. Exper. Sta. Bull. 228, 1928. Determinations by E. W. Knight (superintendent, U. S. field station at Fallon, Nev.) of total solids, chloride, sulphate, and total hardness for over 250 samples of irrigation, ground, and drainage waters of the Yakima and Klamath projects.

WEST VIRGINIA

General report: 27 (18).

WISCONSIN

General report: 27 (18).

WYOMING

General report: 27 (21).

10. Estabrook, E. L., Analyses of Wyoming oil-field waters: Am. Assoc. Petroleum Geologists Bull., vol. 9, pp. 235–246, 1925. 24 analyses of oil-field waters, made in the Caspar laboratory of the Standard Oil Co.
11. Parks, E. M., Water analyses in oil production and some analyses from Poison Spider, Wyo.: Am. Assoc. Petroleum Geologists Bull., vol. 9, pp. 927–946, 1925. 19 analyses of waters from different geologic horizons are tabulated and discussed.
12. Ross, J. S., and Swedenborg, E. A., Analyses of waters of the Salt Creek field applied to underground problems: Am. Inst. Min. and Met. Eng. Tech. Pub. 157, 1928. 15 analyses of typical samples of oil-field waters.
13. Thom, W. T., jr., and Spieker, E. M., The significance of geologic conditions in Naval Petroleum Reserve No. 3, Wyo., with a section on the waters of the Salt Creek-Teapot Dome uplift, by Herman Stabler: U. S. Geol. Survey Prof. Paper 163, 1931 ($1.25). Analyses were made mainly by chemists of the U. S. Geological Survey in the laboratory at Casper, Wyo. 240 samples from various geologic formations.

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