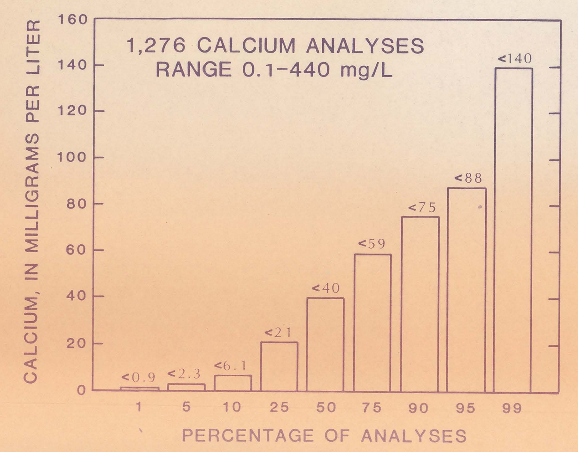
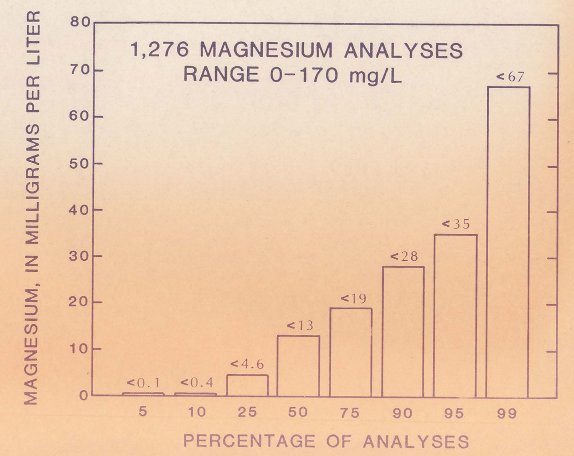
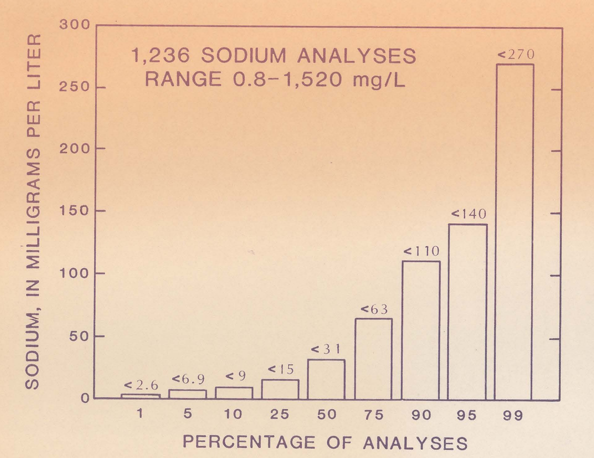
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

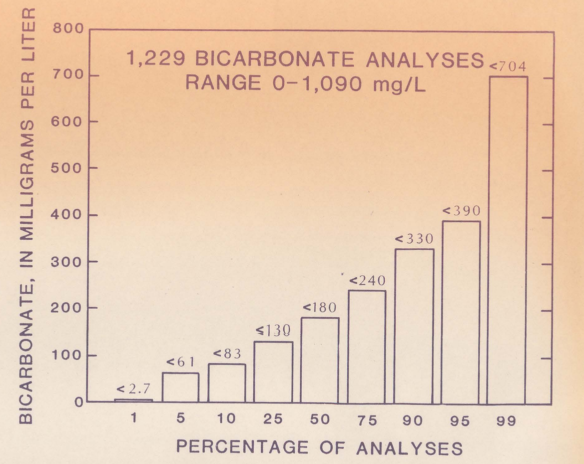
OPEN-FILE REPORT 85-167
SHEET 2 OF 2

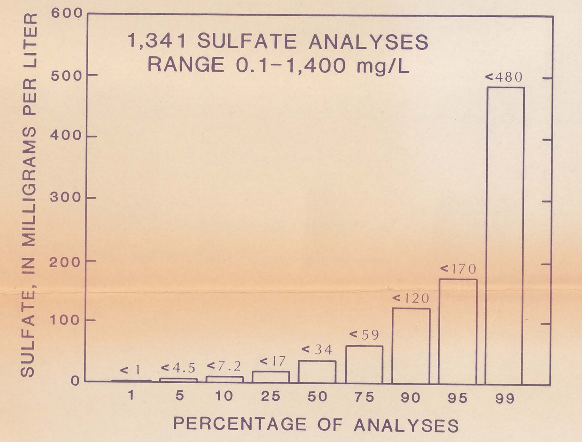
SOLUTES IN GROUND WATER

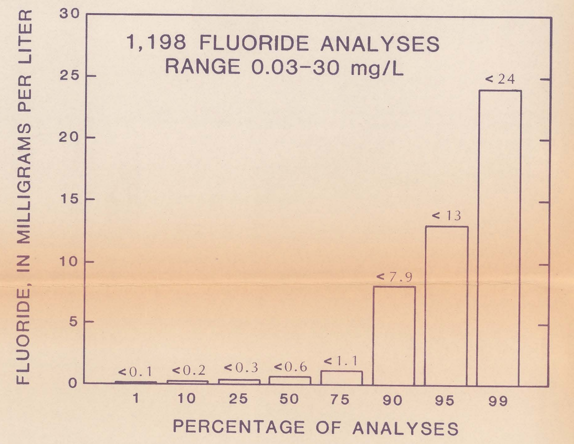


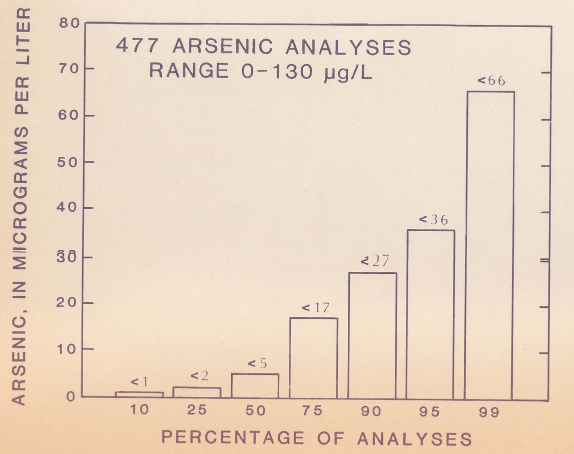


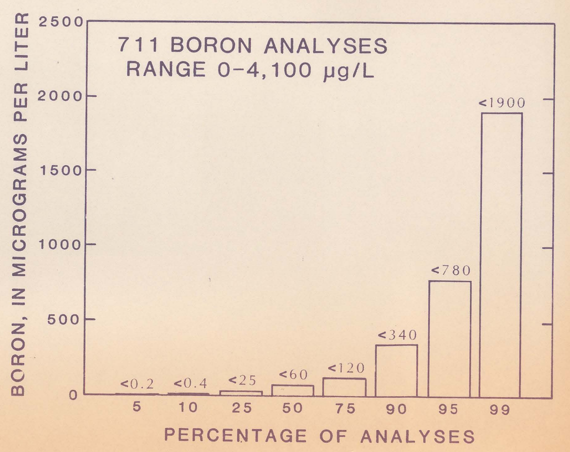


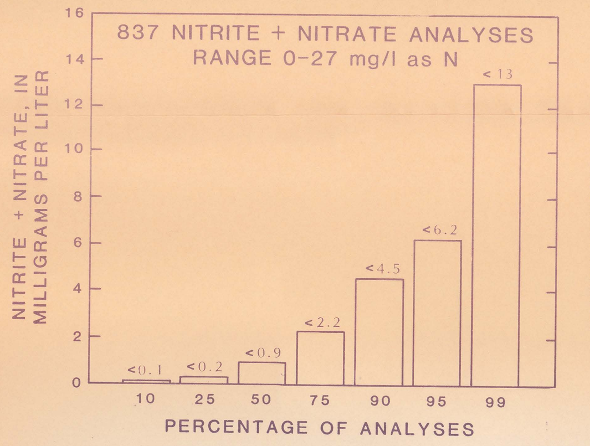


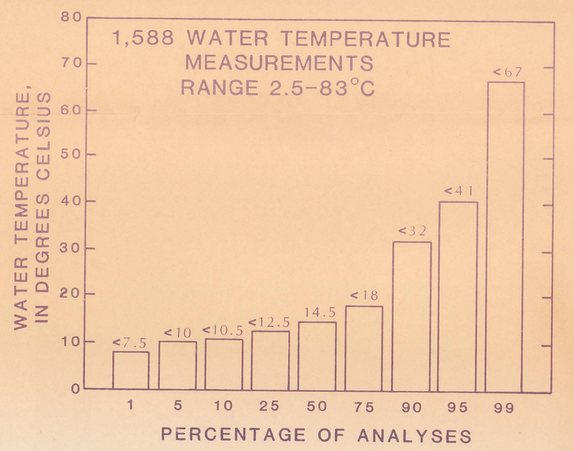








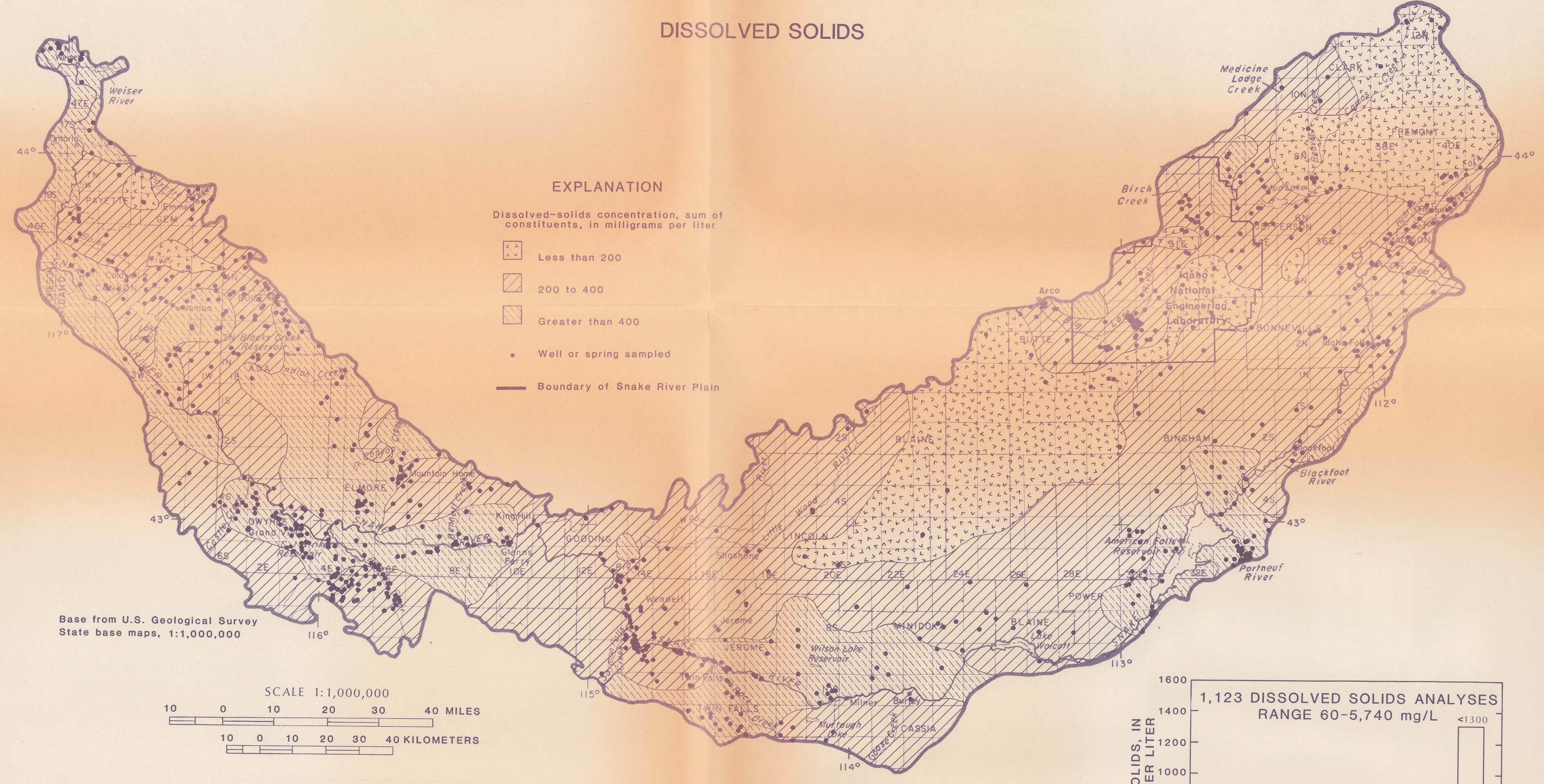




PERCENTAGE OF SOLUTE CONCENTRATIONS

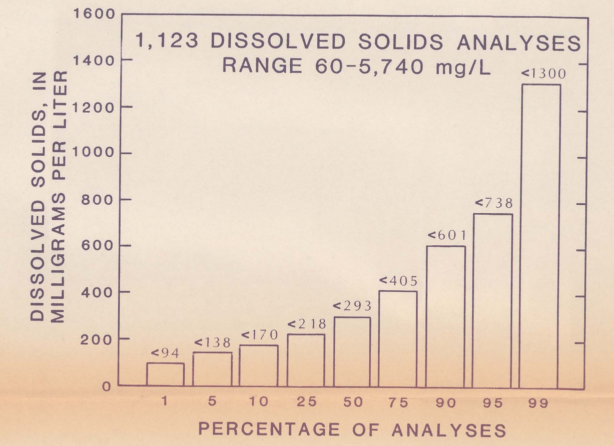
The bar graphs indicate percentage ranges for water temperature, concentrations of dissolved solids, major ions, and arsenic, boron, and nitrite plus nitrate in the Snake River Plain aquifer system. For example, 50 percent of the 837 nitrite plus nitrate analyses have concentrations less than 0.9 mg/L (shown as <0.9 on the 50 percent bar). Data are from wells of various depths sampled between the early 1950's and 1980. Where wells were sampled repeatedly, the median concentration is shown in the bar graphs.

DISSOLVED SOLIDS

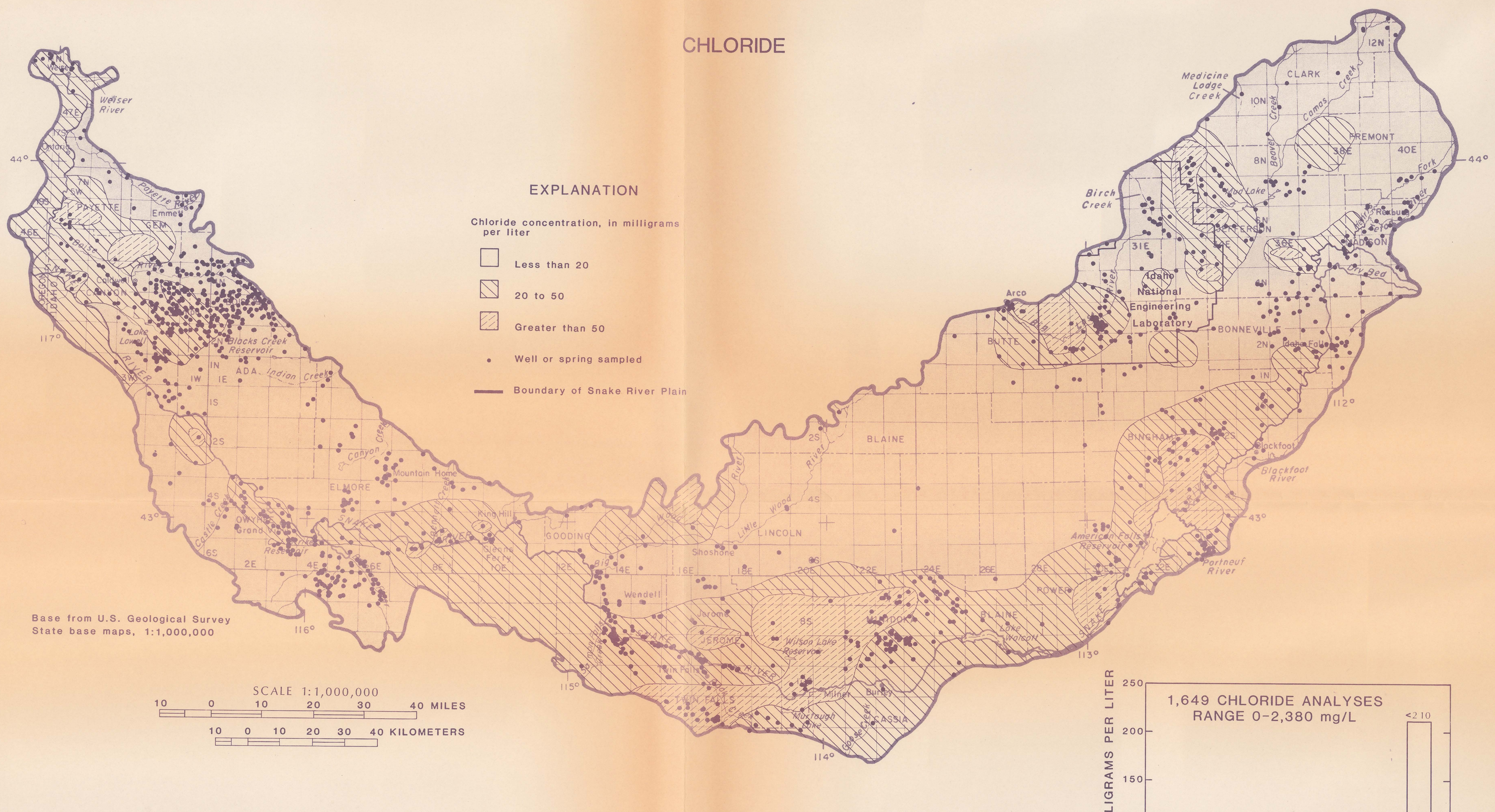


The above areal distribution is based on mean dissolved-solids concentrations in water from 1,123 wells and springs. Minimum, median, and maximum concentrations are 60, 293, and 5,740 mg/L (see bar graph at left). Dissolved-solids concentrations are less than 200 mg/L at 18 percent of the sites, between 200 and 400 mg/L at 56 percent of the sites, and greater than 400 mg/L at 26 percent of the sites. Less than 1 percent of all the analyses equal or exceed 1,300 mg/L.

Dissolved-solids concentration represents the total amount of dissolved ions in water. In some areas, ground water is more mineralized, probably as a result of aquifer lithology or land-use activities. Dissolved-solids concentration as a criterion for water quality is most significant for agricultural, industrial, and public drinking-water supplies. Concentrations of certain dissolved solids such as sodium, calcium, and magnesium may limit use of ground water for irrigation or steam generation. Concentrations of total dissolved solids greater than 500 mg/L are not recommended for drinking water when better quality water is available (U.S. Environmental Protection Agency, 1977).

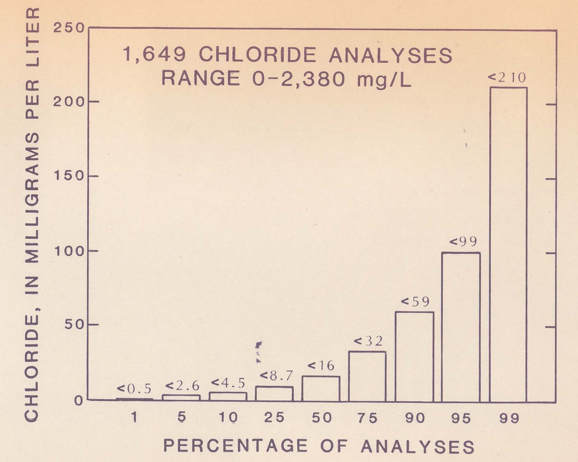


CHLORIDE



The above areal distribution is based on mean chloride concentrations in water from 1,649 wells and springs. Minimum, median, and maximum concentrations are less than 0.1, 16, and 2,380 mg/L (see bar graph at left). Chloride concentrations are less than 20 mg/L at 60 percent of the sites, between 20 and 50 mg/L at 27 percent of the sites, and greater than 50 mg/L at 13 percent of the sites. Chloride concentrations in about 5 percent of the analyses are greater than 99 mg/L.

Chloride ions are conservative and react little with aquifer material. In areas of the Snake River Plain where there is little or no land-use activity (Lindholm and Goodell, 1984), chloride probably is derived from precipitation or fluid inclusions in the rock-aquifer matrix. In other areas, chloride concentrations may be related to land-use activities. Highest chloride concentrations generally are observed in areas of intensive irrigation. Irrigated areas on the Snake River Plain are shown in a report by Lindholm and Goodell (1984).



GROUND-WATER QUALITY

Solutes in the Snake River Plain aquifer system are derived from seepage of streams entering the plain, underflow from tributary drainage basins, precipitation, weathering of minerals in the aquifer, and various land-use activities, primarily irrigation. Robertson and others (1974) concluded that solutes in ground water are derived largely from tributary drainage basins north and east of the eastern plain.

About 3,600 chemical analyses of water from about 1,750 wells and springs provided the basis for preparing maps and bar graphs shown on this sheet. These analyses were obtained during investigations between the early 1950's and 1980. Repeat samples were collected from some wells and springs during this 30-year period and were analyzed for various chemical constituents. Mean concentrations for repeat samples were used on the maps, and median concentrations were used on the graphs. Repeat-sample sites include springs between Twin Falls and King Hill, and wells at INEL (Idaho National Engineering Laboratory) southeast of Arco, in the eastern Snake River Plain upstream from Blackfoot, in the eastern half of the western plain, and in the Boise River valley from Lucky Peak Reservoir to the Snake River. Because the maps are based on water samples collected during a 30-year period, they depict only the general distribution of solutes, not necessarily present (1981) solute concentrations. The maps reflect natural as well as man's influences on solute concentrations.

Temporal changes in solute concentrations in regional ground water do not appear to be significant. Parliman (1983b) described temporal changes in ground-water quality in the eastern Snake River Plain as minor and localized. Parliman (U.S. Geological Survey, written commun., 1984) also concluded that temporal variations in ground-water quality in the eastern half of the western plain and the Boise River valley are due to changes in the source or amount of recharge to the aquifers. For more information on temporal changes in ground-water quality, refer to Yee and Souza (1983).

Chloride concentration in water from a spring near King Hill has not changed discernibly with time. Between 1950 and 1980, the mean chloride concentration in 17 samples was 18 mg/L, the maximum was 22 mg/L, and the minimum was 11 mg/L. Chloride concentration in water from a spring near Twin Falls increased slightly from 1950 to 1980. Before 1962, 16 chloride samples averaged 40 mg/L; after 1967, 31 chloride samples averaged 46 mg/L. The mean chloride concentration for the period of record was 44 mg/L.

Areal variations in solute concentrations are greatest in water from sedimentary-rock aquifers. Sedimentary rocks are generally intercalated with basaltic rocks along much of the Snake River, at the mouths of tributary drainage basins, in the Mud Lake area in the eastern plain, and in parts of the western plain. Coincidentally, these areas are some of the most intensively irrigated areas on the Snake River Plain (Lindholm and Goodell, 1984). Therefore, it is difficult to identify sources of variations in dissolved solids by chemical methods. Mean dissolved-solids concentration in the eastern plain is about 350 mg/L and, in the western plain, about 400 mg/L. Over the entire plain, the mean dissolved-solids concentration is about 370 mg/L.

SUMMARY

Dissolved-solids concentrations in 26 tributaries to and 3 sites along the Snake River range from 50 mg/L in the Boise River basin to more than 400 mg/L in the Owyhee and Raft River basins. Weathering processes produce solutes characteristic of rock units in tributary drainage basins. Surface water from most basins surrounding the Snake River Plain is predominantly a calcium bicarbonate or calcium-magnesium bicarbonate type. Surface water from the Falls, Owyhee, and Malheur River basins is a sodium bicarbonate or sodium-calcium bicarbonate type. All surface water in the Snake River basin is suitable for most uses, including irrigated agriculture.

Solutes in the Snake River Plain aquifer system originate from tributary drainage basins, precipitation, weathering of aquifer minerals, and various land-use activities. The greatest areal variations in solute concentrations coincide with intensively irrigated areas. Temporal changes in solute concentrations are not obvious.

Minimum, median, and maximum concentrations of dissolved solids are 60, 293, and 5,740 mg/L. Minimum, median, and maximum concentrations of chloride are less than 0.1, 16, and 2,380 mg/L. Ground water in the Snake River Plain is generally suitable for most uses.

REFERENCES CITED

Barraclough, J. T., and Jensen, R. G., 1976, Hydrologic data for the Idaho National Engineering Laboratory site, Idaho: U.S. Geological Survey Open-File Report 75-318 (IDO-22055), 52 p.

Barraclough, J. T., Lewis, B. D., and Jensen, R. G., 1982, Hydrologic conditions at the Idaho National Engineering Laboratory, Idaho-Emphasis, 1974-1978: U.S. Geological Survey Water-Supply Paper 2191, 52 p.

Chapman, S. L., and Ralston, D. R., 1970, Ground-water resources of the Blue Gulch area in eastern Owyhee and western Twin Falls Counties, Idaho: Idaho Department of Water Administration, Water Information Bulletin no. 20, 36 p.

Cressman, E. R., 1964, Geology of the Georgetown Canyon-Snowdrift Mountain area, southeastern Idaho: U.S. Geological Survey Bulletin 1153, 105 p.

Dion, N. P., 1972, Some effects of land-use changes on the shallow ground-water system in the Boise-Nampa area, Idaho: Idaho Department of Water Administration, Water Information Bulletin no. 26, 47 p.

Dyer, K. L., 1973, An evaluation of water-quality data obtained at four streamflow daily-record stations in Idaho: U.S. Geological Survey Water-Resources Investigations Report 30-73, 51 p.

Dyer, K. L., and Young, H. W., 1971, A reconnaissance of the quality of water from irrigation wells and springs in the Snake Plain aquifer, southeastern Idaho: U.S. Geological Survey Open-File Report, 29 p.

Ekren, E. B., McIntyre, D. H., Bennett, E. H., and Malde, H. E., 1981, Geologic map of Owyhee County, Idaho, west of longitude 116: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-1256, 2 sheets.

Fenneman, N. M., 1931, Physiography of the Western United States: New York, McGraw-Hill Book Co., 534 p.

Graham, W. G., 1979, The impact of intensive disposal well use on the quality of domestic ground water supplies in southeast Minidoka County, Idaho: Idaho Department of Water Resources, 35 p.

Kjelstrom, L. C., 1984, Flow characteristics of the Snake River and water budget for the Snake River Plain, Idaho and eastern Oregon: U.S. Geological Survey Open-File Report 84-052, scale 1:1,000,000, 2 sheets.

Laird, L. B., 1964, Chemical quality of the surface water of the Snake River basin: U.S. Geological Survey Professional Paper 417-D, 47 p.

Lindholm, G. F., Garabedian, S. P., Newton, G. D., and Whitehead, R. L., 1983, Configuration of the water table, March 1980, in the Snake River Plain regional aquifer system, Idaho and eastern Oregon: U.S. Geological Survey Open-File Report 82-1022, scale 1:500,000.

Lindholm, G. F., and Goodell, S. A., 1984, Irrigated acreage and other land uses in 1980 on the Snake River Plain, Idaho and eastern Oregon: U.S. Geological Survey Open-File Report 84-452, scale 1:1,000,000, 2 sheets.

Low, W. H., 1980, Water-quality conditions in the Milner reach, Snake River, south-central Idaho, October 18-21, 1977: U.S. Geological Survey Open-File Report 80-510-W, 35 p.

Malde, H. E., 1968, The catastrophic late Pleistocene Bonneville flood in the Snake River Plain, Idaho: U.S. Geological Survey Professional Paper 596, 52 p.

McConnell, J. B., 1967, Chemical-quality investigations of surface water in Idaho, 1965-1966: U.S. Geological Survey Open-File Report, 25 p.

Mundorff, M. J., Crosthwaite, E. G., and Kilburn, Chabot, 1964, Ground water for irrigation in the Snake River basin in Idaho: U.S. Geological Survey Water-Supply Paper 1654, 224 p.

Nace, R. L., Voegeli, P. T., Jones, J. R., and Deutsch, Morris, 1975, Generalized geologic framework of the National Reactor Testing Station, Idaho, in Subitzky, Seymour, ed., Geology, hydrology, and waste management at the National Reactor Testing Station, Idaho: U.S. Geological Survey Professional Paper 725-B, 49 p.

Newcombe, R. C., 1972, Quality of the ground water in basalt of the Columbia River Group, Washington, Oregon, and Idaho: U.S. Geological Survey Water-Supply Paper 1999-N, 71 p.

Parliman, D. J., 1983a, Ground-water quality in the western Snake River basin, Swan Falls to Glenns Ferry, Idaho: U.S. Geological Survey Water-Resources Investigations Report 83-4062, 85 p.

-----1983b, Reconnaissance of ground-water quality, eastern Snake River basin, Idaho: U.S. Geological Survey Water-Resources Investigations Report 82-4004, 100 p.

Robertson, J. B., Schoen, Robert, and Barraclough, J. T., 1974, The influence of liquid waste disposal on the geochemistry of water at the National Reactor Testing Station, Idaho, 1952-1972: U.S. Geological Survey Open-File Report IDO-22053, 231 p.

Ross, C. P., 1937, Geology and ore deposits of the Bayhorse region, Custer County, Idaho: U.S. Geological Survey Bulletin 877, 161 p.

-----1963, Modal composition of the Idaho batholith: U.S. Geological Survey Professional Paper 475-C, p. 86C-90C.

Seitz, H. R., and Norvitch, R. F., 1979, Ground-water quality in Bannock, Bear Lake, Caribou, and part of Power Counties, southeastern Idaho: U.S. Geological Survey Water-Resources Investigations Report 79-14, 53 p.

U.S. Department of Interior and U.S. Department of Agriculture, 1977, Final environmental impact statement--development of phosphate resources in southeastern Idaho: Washington, U.S. Government Printing Office, v. IV.

U.S. Environmental Protection Agency, 1977, National secondary drinking water regulations: Federal Register, v. 42, no. 62, p. 17143-17147.

U.S. Geological Survey, 1975, WATSTORE user's guide: Reston, Va., Open-File Report 75-426, v. 3.

Whitehead, R. L., 1984, Geohydrologic framework of the Snake River Plain, Idaho and eastern Oregon: U.S. Geological Survey Open-File Report 84-051, scale 1:1,000,000, 3 sheets.

Witkind, I. J., 1972, Geologic map of the Henrys Lake quadrangle, Idaho and Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-781-A, 2 sheets.

Yee, J. J. S., and Souza, W. R., 1983, Quality of ground water in Idaho: U.S. Geological Survey Open-File Report 83-50, 77 p.

SOLUTE DISTRIBUTION IN GROUND AND SURFACE WATER IN THE SNAKE RIVER BASIN, IDAHO AND EASTERN OREGON

By
Walton H. Low