Article 162

RELATION OF PERCENT SODIUM TO SOURCE AND MOVEMENT OF GROUND WATER, NATIONAL REACTOR TESTING STATION, IDAHO

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Work done on behalf of the U.S. Atomic Energy Commission

Abstract.—Most of the ground water in the National Reactor Testing Station is of the calcium magnesium bicarbonate type. The percent sodium decreases northwestward, where the source of recharge is a limestone and dolomite terrane, and increases southeastward, where the source is in silicic volcanic rocks and lacustrine deposits.

The National Reactor Testing Station occupies an area of about 900 square miles in the north-central part of the eastern Snake River Plain in Idaho. Ground water occurs in a regional zone of saturation in flat-lying basalt flows and subordinate interbedded sediments of Quaternary age. The most important water-bearing openings are voids in the basalt adjacent to interflow contacts, openings in cinders, scoria, and blocky zones; and interstitial pores in the sedimentary deposits. The upper part of the regional ground-water body is unconfined in most places, but quasi-artesian conditions are common at depths of more than a few tens of feet below the water table. Depths to the water table within the station range from about 200 feet to more than 700 feet. Regional ground-water movement is south to southwest (fig. 162.1), although locally the water moves in other directions for short distances.

A study of the chemical character of ground water in the station was based on analyses of 148 samples collected from 92 wells during the period 1949–61. Most of the water is of the calcium magnesium bicarbonate type, with calcium plus magnesium constituting more than 70 percent of the total cations, in equivalents per million, and bicarbonate more than 70 percent of the total anions. Other chemical types, chiefly chloride waters, are present in some areas as the result of contamination by liquid waste from the operation of atomic facilities, by return flow from irrigation in the Mud Lake area northeast of the station, and probably by natural sources as yet not identified. A small body of ground water with a high sulfate content has been formed by seepage from a waste-disposal pond at one of the atomic facilities. As of 1961, none of this water, which is perched above a layer of basalt, had reached the regional ground-water body.

Except for small bodies of water that are high in chloride or sulfate content and contain as much as 1,000 parts per million of dissolved solids, the range in chemical characteristics of the water is not large. In most of the bicarbonate water the concentration of dissolved solids ranges from about 180 to 240 ppm. The generally low mineralization of the ground water reflects the low solubility of the rocks with which the water has been in contact and the moderate to abundant precipitation in the mountainous areas that furnish the principal recharge. Recharge from precipitation on the Snake River Plain is believed to be minor.

The chemical characteristics of the ground water do not appear to vary greatly with depth except near waste-discharge facilities and where deep wells penetrate thick extensive lacustrine deposits. Percent sodium as high as 80 in water from these wells probably results from cation exchange with the lacustrine clays.

Areal differences in ionic ratios in the ground water beneath the station help to identify the sources of the water and to corroborate the inferred paths of water movement. In this respect, the variation in sodium plus potassium (chiefly sodium) in terms of percent of total cations (in equivalents per million) is particularly revealing.

The available information indicates that at most places the chemical character of the ground water is fairly uniform to depths as great as 200 feet below the water table—that is, in the upper 200 feet of the

ART. 162 *IN* U.S. GEOL. SURVEY PROF. PAPER 475–D, PAGES D186–D188. 1964.

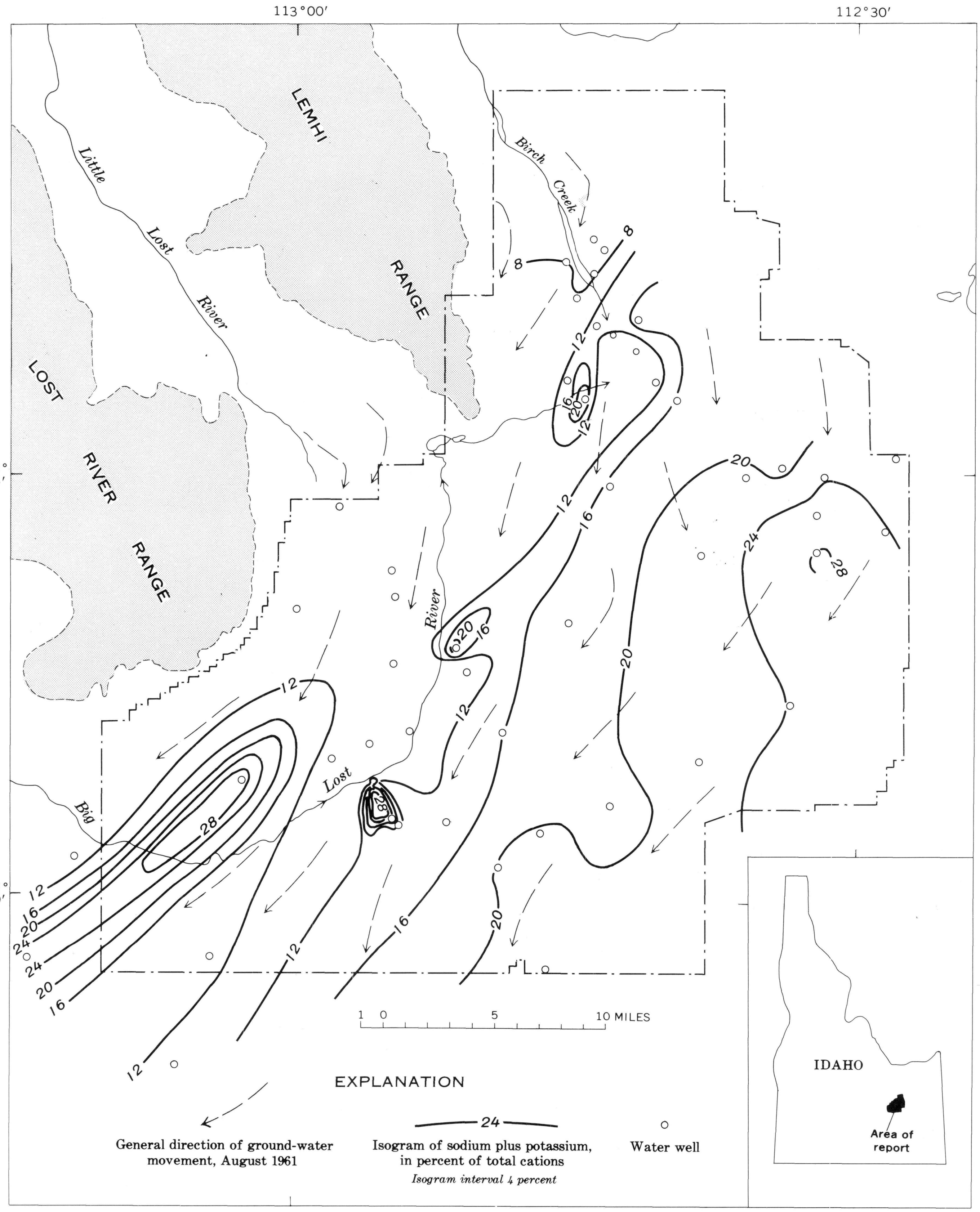

FIGURE 162.1.—Map of the National Reactor Testing Station, Idaho, showing percent sodium plus potassium in ground water in the upper 200 feet of the ground-water body.

regional ground-water body. The chemical character of the water below that zone is not well known; accordingly, only analyses of ground water in the zone from the water table to 200 feet below the water table were used in the present study (fig. 162.1).

In general, the percent sodium plus potassium increases gradually from about 8 percent along the northwest boundary of the station to more than 24 percent in the southeast. Exceptions to this general pattern are the two southernmost bodies of water high in percent sodium, which consist of contaminated water also high in chloride, and two small bodies of high-sodium water farther northeast, which are believed to be affected by upward flow in wells of sodium bicarbonate water from depths greater than 200 feet below the water table.

The isograms in figure 162.1 have a general south-southwesterly trend—parallel to the regional ground-water flow lines inferred from water-level contour maps. The lower percent sodium plus potassium in the water beneath the northwestern part of the station reflects the extensively exposed limestone and dolomite in the Lost River and Lemhi Ranges to the northwest, and the higher percent sodium plus potassium in the water beneath the southeastern part of the station reflects the abundance of silicic volcanic rocks in the region to the north and northeast. Some of the water from the north and northeast also has moved through a considerable volume of fine-grained lacustrine deposits in the Mud Lake region and, therefore, may have been affected by cation exchange. The basalt, which forms the main aquifer system, appears to have little effect on the chemical character of the water moving through it.

The gradual, rather than abrupt, southeastward increase in percent sodium plus potassium in the upper 200 feet of the ground-water body is believed to indicate a progressive decrease in the proportion of low-sodium water derived from the northwest and a progressive increase in the proportion of water higher in sodium content derived from the north and northeast. Variations in the rate of replenishment from these sources are indicated by substantial changes with time in the direction of ground-water flow, which are inferred from observed changes in the configuration of the water table in the northern part of the station.