RESEARCH PROJECT TECHNICAL TERMINATION REPORT
PROJECT A-020-IDA

Hydrogeology of Some Small Ground-water Basins in Idaho

Project Investigator Robert W. Jones

Water Resources Research Institute
University of Idaho
February 1968

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HYDROGEOLOGY OF SOME SMALL GROUND-WATER BASINS IN IDAHO

PRINCIPAL INVESTIGATOR - Robert W. Jones
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PERIOD OF INVESTIGATION - July 1, 1966 to June 30, 1967

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ABSTRACT

HYDROGEOLOGY OF SOME SMALL GROUND-WATER BASINS IN IDAHO

One basin has been studied (Albion basin, Cassia County, Idaho) and the results published as an open file report by the Idaho Bureau of Mines and Geology. Aquifers were delineated, water-table mapped, and preliminary evaluation of the ground-water flow pattern was obtained. Wells range in depth from 11 feet to 700 feet and yields range up 540 gpm. Clay lenses in alluvium create local artesian aquifers. The water can be classified as calcium bicarbonate type and is suitable for domestic and irrigation use. The total dissolved solids content range from 202 ppm to 2294 ppm. Hot springs exist in the Marsh Canyon area. The study should serve as a basis for further investigations utilizing experimental approaches.

The project has been terminated after just one basin investigation because the principal investigator decided to do research in an area other than water resources.

KEYWORDS---*ground water/hydrologic models/hydrologic data/*experimental ground water basins.

INTRODUCTION

This study was initiated as a building effort in a proposed major research study of the ground water in the Snake River plain. It follows an exploratory ground water study of the Moscow Basin in northern Idaho.

OBJECTIVES

The specific objectives of the study were:

(a) To develop field and laboratory techniques adapted to study of hydrogeology of small ground-water basins.

(b) To evaluate some of the smaller ground-water basins of Idaho as outdoor laboratories for use in this study as well as in the future studies in all phases of hydrology.

(c) To use the outdoor laboratories as models for laboratory studies and for areas to field test new ideas, techniques and instruments in all phases of hydrology.

(d) To train student hydrogeologists in basic field techniques.

This project study was to be done in phases with the initial phase to include working in several small basins including:

Cassia County, Idaho - Albion Basin, Oakley Basin, and Heglar Canyon;
Blaine County, Idaho - Fish Creek Basin and Little Wood River Basin;
Oneida County, Idaho - Pocatello Valley;
Valley County, Idaho - Long Valley and Round Valley.

PROCEDURE AND RESULTS

The Albion basin study consisted of a field investigation and geologic mapping of traverses across the valley and the adjacent mountain ranges. Air photos were studied and a complete well inventory made.

The study area consists of four topographic units: the Albion Range, the Malta Range, the East Hills and the Albion basin. The Albion range is metamorphic rocks, the Malta Range is composed of volcanic rocks of three lithologies: a tuffaceous unit, a quartz latite unit, and a thin cap of Snake River basalt. The East Hills consists of quartz latite of the Malta Range

underlain by metamorphic rocks of the "Harrison Series." The lower third of the Albion Basin is filled with alluvial deposits. The valley alluvium is believed to be glacially derived from the Albion and Malta Ranges. Most of the available well logs show four lenses of clay; one well was reported to have had six lenses of clay. These lenses suggest a period of damming of March Creek during glaciation, causing deposition of glacial lake sediments.

The Albion basin is an area that normally receives from 10 to 16 inches of precipitation. Most of the precipitation falls as snow. Records show an averaged measured depth of 23.14 inches during the winter at the Howell Canyon snow station.

Since 1959, the basin has experienced near drought conditions, with snow averaging 14 inches below normal. During the 1966 irrigation season, the flow of Marsh and Howell Creeks was so low that farmers with low-order water rights on the two streams were forced to cease irrigation.

The residents of the valley of the Albion basin and most of the farmers within the basin depend on ground water for domestic supplies. Ground water is used for irrigation by a few farms. Of the 30 wells inventories, only six operating wells were more than 100 feet deep. Detailed numberings, depths and other data are reported in a thesis by Myers (1967).

The wells in the basin are either dug or drilled. Dug wells were mostly constructed by hand, cable tool rigs were used for drilled wells. Drilled wells which yield large quantities of water generally are 16 inches in diameter; for lesser amounts of water, well casings down to four inches in diameter are used. Measurements of some of the chemical and physical properties were taken in the field. Temperature and electrical conductivity were measured on operating wells. Field electrical conductivity ranged from less than 50 micromhos at Howell Spring to more than 2200 micromhos at one well. All wells tested were safe and free from coliform bacteria.

Chemical analysis of fourteen wells was made and ion percentages applied to Piper Water analysis Diagrams show the water to be in the secondary carbonate alkalinity section of the diagram. The water is very consistent in percentage composition; only two samplers were in secondary salinity section and are calcium sulphate waters.

Flow Pattern

Most of the recharge in the basin is from precipitation which falls on the Albion Range, in the vicinity of Mount Harrison. Numerous springs issue from joints and fractures in quartzites that crop out on the flanks of the Albion Range. Three of these springs form the source of Howell Creek, one of the major streams in the basin.

The Malta Range makes little contribution to the hydrologic system of the basin. Because of the blocking effect of the Albion Range, only minor amounts of snow fall on the Malta Range during the winter months. Because of the lower elevation of the Malta Range, the snow melts rapidly and water flows down numerous small gullies in the range and enters the basin primarily as surface water and in some instances may recharge the ground water aquifer.

Local residents state that Marsh and Howell Creeks show some fluctuation in total flow throughout the year. This variation has little reported affect on the unconfined water table. This lack of reaction to spring high-water and summer low-flow conditions suggests that the streams have poor hydrologic connection with the free water table. However, in the vicinity of the Village of Albion, the flow of Marsh Creek is notably reduced. In this area numerous shallow wells penetrate the shallow aquifer and possibly induce recharge from the stream. Farther downstream, at the point where Marsh Creek enters Marsh Canyon, the total flow of the stream is increased to about its former level. The lack of good hydrologic connection through most of the basin suggests that Marsh Creek contributes little to ground-water recharge in the basin.

Aquifer Characteristics

The alluvial area of the basin contains a number of local ground-water zones. The only zone of wide extent is a shallow water table aquifer. Most of the wells utilize this aquifer. Deeper wells within the basin penetrate different local artesian aquifers. The number of wells penetrating the confined aquifers is slowly increasing, but the confined aquifers seem to be capable of further development.

An upper water table aquifer is present in much of the alluvium in the lower part of the basin. The shape of a water table is commonly assumed to be a subdued replica of the land surface.

In portions of the Albion basin, few wells are present to indicate the depth to water in the unconfined aquifer. Toth (1963), by use of a mathematical

model, showed that, under certain boundary conditions, the location of the free water table in a basin may approximate a sine curve. Portions of the Albion basin meet the requirements of isotropy, homogeneity, and hydrogeologic boundaries prerequisite to the application of the model set forth by Toth. He postulates that a basin will be divided into recharge and discharge areas by a line approximately half way down the slope of the basin. This condition is indicated in the Albion basin by a line of springs about one third of the way down the valley slope. The applicability of Toth's model is probably limited in the lower reaches of the basin. By adjusting Toth's assumption of a horizontal, impermeable, lower boundary for a sloping and for anisotropic conditions, these limitations could be overcome.

Water from the unconfined aquifer is generally of good quality. Temperatures are 57 $\pm$ 1°F. and electrical conductivity is 360 $\pm$ 50 micromhos throughout the aquifer.

The unconfined aquifer is tapped by dug wells that rarely exceed a depth of twenty feet below land surface. These wells have been adequate for domestic use. Under prolonged pumping they do go dry, but after pumping ceases they refill to their former levels within a few hours.

Detailed aquifer characteristics could not be determined due to a lack of data and lack of opportunity to conduct pumping tests. Certain properties can be inferred from the available information. The high rate of drawdown and recovery in wells utilizing the shallow aquifer suggests a low coefficient of transmissibility. This is also indicated by the absence of interaction between adjacent wells.

Confined Aquifers

Several local confined aquifers are present in the alluvial deposits of Albion basin. The presence of these aquifers is deduced from drillers' reports of head differentials across several impermeable clay lenses. Most drillers' logs report from one to four impermeable layers in the first 200 feet of penetration. One well penetrated six layers in 280 feet. The clays are presumed to be lenses and may not extend between wells. Drillers did not report the actual head differences in feet, but noted only a rise or fall of the water level in the wells after passing through a clay layer.

Water from the confined aquifers is of poorer quality than that of the unconfined aquifers. The temperatures range from 62° to 74°F. Electrical

conductivity ranges from 425 to 2200 micromhos. According to the hypothesis of Chebotarev (1955) and Back (1960) the well with the highest total dissolved solids (TDS) content in a given basin should be the well farthest from the area of recharge. In the Albion basin, if Toth's model is in fact applicable, this is found to be the case, the bottom of the well having the highest TDS is the lowest in elevation and farthest from the area of recharge.

Yields from the confined aquifers differ from well to well. Most of the wells seem to draw water from a depth of about 120 feet, regardless of pumping rate. Three large irrigation wells in operation in the basin produce up to 1.2 cubic feet per second. Recovery times in these wells are very short and can be measured in minutes.

Springs

Hot springs are present along the western edge of the Malta Range, near the point where Marsh Creek flows out of the basin in sec. 14, T 11 S., R. 25 E. The water from these springs has about the same electrical conductivity as water from the confined aquifers, but the temperature is 87°F. The proximity of the hot springs to the Malta Range fault block indicates that water rising along faults might be responsible for the higher temperature. The hot springs in the Albion basin have not been exploited but the possibility for future development exists and should not be over-looked.

Status of Water Withdrawl

The Albion basin ground-water system lies between two ground-water regions that have been declared "critical" by the Idaho State Reclamation Engineer. In 1962, the Albion basin was closed to further ground-water development for any purpose other than domestic supply. In the summer of 1966, the Village of Albion applied for a drilling permit to obtain additional water to meet its demands and for possible emergencies. Because the area was considered to be within the boundaries of a water-critical area, the request for a permit was denied. After consultation with the residents of the basin in a formal hearing, the Idaho State Reclamation Engineer removed the Albion basin from the "critical" classification. This action was taken on the condition that observation wells and a stream gaging station were to be installed to monitor the basin. If any "significant and substantial" lowering of water levels occurs, then the basin will be reinstated as a water critical area.

CONCLUSIONS AND RECOMMENDATIONS

This basin has definite hydrologic boundaries and thus could serve as an excellent outdoor laboratory; one of the original objectives of the study.

Lack of observation wells limited the collection of data but sources, recharge areas, and quality of the ground water resource in the area have been defined. With the installation of observation wells required by the Idaho State Reclamation Engineer, data should become available to provide a more accurate quantification of the water resource of the Albion basin.

The application of a modification to Toth's model to the upper reaches of the Albion basin would be a logical future study of the ground water regimes of the basin.

Due to the change of interest area of the principal investigator the project has been terminated and latter phases of the project will not be pursued at this time.

LITERATURE CITATIONS

Back, W., 1960, Origin of hydrothermal facies of groundwater in the Atlantic Coastal Plain: Report of the 21st Session, International Geology Congress, Part I, Copenhagen, p. 87-95.

Chebotarev, I. I., 1955, Metamorphism of natural waters in the crust of wathering: Geochim et Cosmochim, Acta, V. 8, p. 22-48, 137-170, 198-212.

Toth, J., 1963, A Theoretical Analysis of Groundwater Flow in pSmall Drainage Basins: Journal of Geophysical Research, V. 68, No. 16, p. 4795-4812.

LIST OF RESULTING PUBLICATIONS

Myers, D. A., 1967, "The Geology and Hydrogeology of the Albion Basin, Cassia County, Idaho. M. S. Thesis, University of Idaho and Open File Report of Idaho Bureau of Mines and Geology.

FORM OW-301

FINAL TIME AND COST REPORT - ANNUAL ALLOTMENT (SEC. 100) PROJECT

Project No. A-020-IDA State: Idaho Date: February, 1968

Project Title: Hydrogeology of Some Small Ground Water Basins in Idaho

Principal Investigator: R. W. Jones

Project Began (Mo.-Yr.): July, 1966 Project Ended (Mo.-Yr.): June, 1967

Indicated below is how Federal Sec. 100 annual allotment funds were applied in support of project accomplishment.

Cost Category Items	Funds Expended All Years
A. Salaries and Wages:	
Principal Investigator----------No. 1 - Man-yrs. 0.05--$	102.50
Graduate Research Assistants---------No. 1 - Man-yrs. 0.5 --$	2,700.00
Undergraduate Research Assistants----No. 2 - Man-yrs. 0.1 --$	298.25
Sub-total (A)----------	(3,100.75)
B. Non-Expendable Equipment Items:---Sub-total (B)----------	(-)
C. Expendable Materials & Supplies:--Sub-total (C)----------	(228.68)
D. Other Costs: (Specify - such as travel, printing, contractual services, equipment rental, etc.)	
Travel	$ 702.80
Publication Costs (Estimated portion of charges for reproduction)	$ 100.00
Sub-total (D)----------	(802.80)
TOTAL ANNUAL ALLOTMENT (SEC. 100) FUNDS APPLIED TO PROJECT--------$	4,132.23

Non-Federal funds expended on this project during the period of the projects operation is estimated at $1700. This includes employ fringe benefits borne by State funds of the University and time of principal investigator that was contributed time by the University of Idaho.