WATER LEVELS IN BASIN-FILL DEPOSITS

Figure 1.—Water-level contours in basin-fill deposits.

ALTITUDE DATUM

The term "National Geodetic Vertical Datum of 1929" replaces the formerly used term "mean sea level" to describe the datum for altitude measurements. The geodetic datum is derived from a general adjustment of the first-order leveling network of both the United States and Canada. For convenience on this atlas sheet, the datum also is referred to as "sea level."

A product of the Regional Aquifer-Systems Analysis of the Great Basin

CONVERSION FACTORS

"Inch-pound" units of measure used in this report may be converted to International System (metric) units by using the following factors:

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)

INTRODUCTION

The Great Basin Regional Aquifer-System Analysis (RASA) is the tenth study in a national program by the U.S. Geological Survey to analyze regional ground-water systems that compose a major part of the Nation's water supply. The main objectives of the RASA studies are to: (1) Describe the ground-water systems as they exist today, (2) analyze the changes that have led to the system's present condition, (3) combine the results of previous studies in a regional analysis, and (4) provide means by which effects of future ground-water development can be estimated (G.D. Bennett, U.S. Geological Survey, written commun., 1978).

The main purpose of this atlas sheet is to show the general distribution of hydraulic head in basin-fill deposits on a regional scale. The sheet can also be used to evaluate general directions of flow within valleys, to help identify hydrologically closed valleys, to determine hydraulic gradients between valleys, to identify areas of ground-water leakage into bedrock, and to help delineate multivalley flow systems and larger regional flow systems. Sheet 2 of this atlas shows the potentiometric surface of ground water in consolidated rocks of the Carbonate-Rock Province.

This atlas is Chapter B of a three-part series. Chapter A delineates and describes hydrogeologic units in the Great Basin region, and Chapter C shows inferred directions of ground-water flow and individual flow systems.

The writers appreciate the assistance of Gregg Berggren, Lori J. Connolly, Kenneth S. Pringle, Margaret K. Silva, and Richard D. Slates of the U.S. Geological Survey in compiling and plotting data for this atlas sheet.

GENERAL FEATURES

The study area includes approximately 140,000 square miles in parts of Nevada, Utah, California, Idaho, Oregon, and Arizona (fig. 1). The area is bordered on the east by the Wasatch Mountains, on the north by the Snake River Basin, on the west by the Sierra Nevada, on the southwest by the Panamint Range, and on the southeast by parts of the Colorado and Virgin Rivers. Land-surface altitudes range from about 280 feet below sea level in Death Valley to more than 14,000 feet above sea level in the White Mountains, both of which are along the southwestern margin of the study area.

Topography is typified by block-faulted basins bounded by mountains that extend as much as 6,500 feet above the adjacent basin floors. Consolidated rocks compose the surrounding mountains and underlie the basin fill. The region comprises some 240 hydrographic areas (Harrill and others, 1983). The region, most of which is internally drained, includes (1) seven large river systems (the Jordan, Bear, Sevier, Humboldt, Truckee, Carson, and Walker) (2) 14 hydrologically closed individual valleys (3) hydrologically closed areas consisting of several valleys linked by saturated basin fill, permeable bedrock, or large fractures, and (4) a multivalley area that drains to the Colorado River. The seven river systems occupy approximately 34 percent of the study area, the hydrologically closed single-valley and multivalley systems occupy about 58 percent of the study area, and the Colorado River drainage constitutes the remaining 8 percent.

GENERALIZED HYDROGEOLOGY

The Great Basin has had a complex geologic history of sedimentation, igneous activity, orogenic deformation, continental rifting, and, most recently, extensional block faulting. Extensional block faulting began about 17 million years ago and has been continual, forming north-trending mountains separated by alluvium-filled basins (Stewart, 1980, p. 5 and 110). These alternating basins and ranges occupy the Great Basin and are the most prominent characteristic of the region.

Lithologies within the study area may be grouped into two major units on the basis of their general hydrologic properties: basin-fill deposits and consolidated rocks. Basin-fill deposits form large ground-water reservoirs that store and transmit vast amounts of water and contain many productive aquifers. Consolidated rocks generally store and transmit little water compared to the basin-fill deposits; however, carbonate sedimentary rocks (limestone and dolomite) are subject to the development of secondary permeability and in parts of the study area form extensive deep aquifers (see sheet 2). In the study area, volcanic, granitic, and clastic sedimentary rocks are the major types of consolidated rocks that generally store and transmit only small amounts of water and commonly act as barriers to ground-water flow.

Volcanic, granitic, and clastic sedimentary rocks predominate in the western part of the study area, and carbonate rocks, overlain and intruded by volcanic rocks, predominate in the eastern part. The area containing predominately carbonate rocks is referred to as the Carbonate-Rock Province (see sheet 2). Noncarbonate rocks generally form poorly permeable units beneath and surrounding many of the valleys, resulting in closed hydrologic flow systems in the basin-fill deposits. These flow systems consist of single-valley circulation cells and, where basins are hydraulically interconnected, multivalley systems with ground water flowing between valleys through the saturated unconsolidated deposits. In contrast, the carbonate rocks are more permeable, and water flows through bedrock aquifers beneath and adjacent to the basin fill. Consequently, large areas containing several valleys can be hydraulically connected by way of the carbonate rocks, forming deep regional ground-water flow systems.

Basin-fill reservoirs are structural depressions that may contain as much as 10,000 feet of unconsolidated and partly consolidated deposits derived from erosion of adjacent mountains. They are typically elongate in a north-south direction and are generally 5 to 15 miles wide and 20 to 60 miles long. Most are bounded on the east and west by north-trending mountains and on the north and south by basin fill or low bedrock hills. Basin-fill deposits that underlie topographic divides between valleys extend below the water table in many places, allowing ground water in the unconsolidated deposits to flow between basin-fill reservoirs. Grain size of basin-fill deposits ranges from clay and silt in playa areas to cobbles and boulders in alluvial fans bordering mountain blocks. Basin fill was deposited by fluvial, lacustrine, eolian, and volcanic processes. It generally consists of Miocene and Pliocene deposits, overlain by deposits of late Pliocene and Quaternary age.

WATER-LEVEL CONTOURS

The contours in figure 1 are based on measurements in wells completed in basin-fill deposits and represent water levels of the principal aquifer (the interval of unconsolidated deposits in which the majority of wells are completed) in the basin fill. There is commonly a downward component of flow in recharge areas around the margins of the basins and an upward component of flow near discharge areas in the central parts of basins. Water levels in these areas vary with well depth and, consequently, measurements in individual wells may differ from the basin-wide water levels shown in this report by several tens of feet. Most of the data were compiled from reports published from 1960 to 1981, and were supplemented by miscellaneous measurements between 1980 and 1982. Most of the data were gathered over a period of 21 years; data for some undeveloped basins, however, date back to 1935. With the exception of areas of localized heavy pumping, net water-level changes between 1935 and 1981 are on the order of only several feet. The type of ground-water flow system in a given valley may be inferred from the configuration of the water-level contours because they indicate the general direction of ground-water flow. Ground water may flow beneath a topographic divide if a hydraulic gradient extends from one valley to another. The type of flow system is largely dependent on hydraulic characteristics of the consolidated rocks adjacent to and underlying the basin fill.

Water-level depressions depicted by closed water-level contours commonly indicate the terminus of a ground-water flow system. Water-level depressions are found at the terminus of single-valley, multivalley, and regional flow systems. Fourteen valleys in the study area are hydrologically closed; that is, virtually no ground water or surface water flows into or out of the valleys. These valleys contain a water-level depression that is indicated, where enough data exist, by closed contours. Recharge is supplied primarily by infiltration of precipitation and melting snow in mountains and on adjacent alluvial fans. Ground water is discharged by evapotranspiration, primarily from the valley floor. Hydrologically closed valleys are most common in areas of volcanic, granitic, and clastic sedimentary rocks and least common in areas of carbonate rocks. Smith Creek Valley in west-central Nevada is an example of a single-valley system in which the basin-fill reservoir is adjacent to and underlain by volcanic rocks. Figure 2 shows the locations of the different representative types of flow systems in the study area.

A hydraulic gradient extending through several valleys, depicted by open water-level contours in the basin-fill deposits, indicates intrabasin flow of ground water. The basin-fill reservoirs may be connected by (1) saturated basin fill, (2) permeable consolidated rocks, (3) fractures, or (4) a major river to form multivalley and even larger, regional ground-water flow systems. Recharge is supplied primarily by infiltration of precipitation and melting snow in mountains and on adjacent alluvial fans. Ground water is discharged by large springs, by evapotranspiration near terminal sink areas at the downgradient end of flow systems, and by ground-water flow into rivers and lakes.

Hydraulic gradients that extend through several valleys are in areas of:

1. Linked basin-fill reservoirs, such as the Dixie Valley area in west-central Nevada, in which ground water moves between basins through saturated unconsolidated deposits overlying less permeable consolidated rocks.
2. Permeable consolidated rocks, such as the White River flow system in the Carbonate-Rock Province (Eakin, 1966), in which ground water flows southward through both carbonate rocks and basin-fill deposits.
3. Highly-fractured, predominantly volcanic rocks that transmit water between basin-fill reservoirs along fracture zones, such as the south-central marsh area on the southwestern border of the study area.
4. Major rivers that flow through several valleys, such as the Humboldt River that flows westward across northern Nevada, in which ground water and surface water interact over the entire length of the river.

The specific ground-water flow systems listed above as examples are shown in figure 2.

SOURCE OF DATA

The data used for this map were compiled from: (1) Water Resources-Reconnaissance Reports 1 through 60 and Water Resources Bulletins 12, 13, 31, 32, 34, 35, 37, 38, 41, 42, 43, and 44 of the Nevada Department of Conservation and Natural Resources; (2) Technical Publications 14, 16, 17, 18, 23, 24, 28, 29, 30, 31, 33, 35, 36, 37, 38, 40, 41, 42, 43, 44, 45, 47, 51, 56, 59, 60, 61, 63, 64, 69, 71 and Basic-Data Releases 5, 9, 11, 12, 13, 15, 16, 17, 21, 23, 28, 30, and 35 of the Utah Department of Natural Resources; (3) U.S. Geological Survey reports by Bjorklund and Robinson (1968), Blankennagel and Weir (1973), Dinwiddie and Schroder (1971), Eakin (1966), Harrill (1982), Lines (1979), Miller (1977), Mower (1965), Mower and Feltis (1968), Moyle (1974), Olmsted and others (1975), Snyder (1963), Welch and others (1981), and Winograd and Thordarson (1975); (4) the U.S. Geological Survey Ground-Water Site Inventory Data File for Utah, which contains yearly water-level measurements from an observation well network; (5) Idaho Department of Water Resources Basic-Data Release 3; (6) U.S Geological Survey annual water-resources data report for Idaho, water year 1978 (vol. 1); (7) records of selected wells drilled for the MX Missile Project by Ertec Western, Inc. (Bunch and Harrill, 1984); (8) miscellaneous water-level measurements recorded by the U.S. Geological Survey between 1980 and 1982; and (9) water levels reported on well drillers' logs in areas otherwise having no water-level data.

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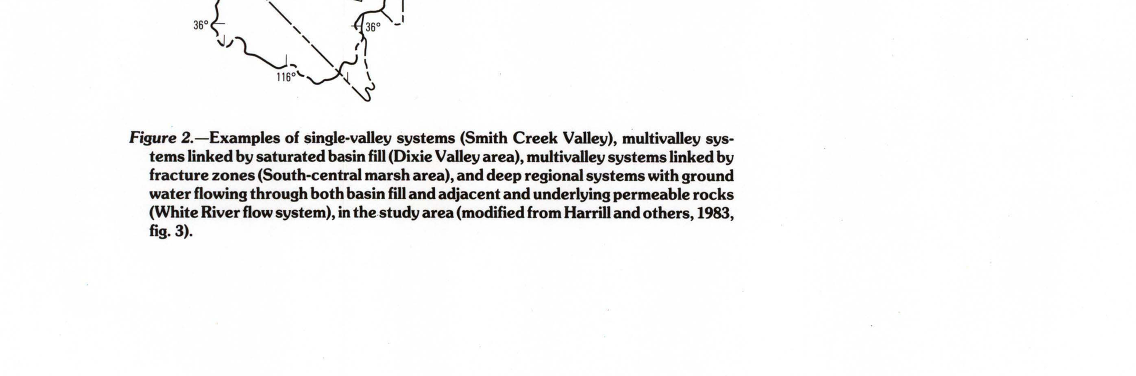

Figure 2.—Examples of single-valley systems (Smith Creek Valley), multivalley systems linked by saturated basin fill (Dixie Valley area), multivalley systems linked by fracture zones (South-central marsh area), and deep regional systems with ground water flowing through both basin fill and adjacent and underlying permeable rocks (White River flow system), in the study area (modified from Harrill and others, 1983, fig. 3).

Base from U.S. Geological Survey
State maps 1:1,000,000

Geology modified from C.W. Jennings (1977), G.W. Walker (1977), J.G. Bond (1978), J.H. Stewart and J.E. Carlson (1978), and L.F. Hintze (1980)

GROUND-WATER LEVELS IN THE GREAT BASIN REGION OF NEVADA, UTAH, AND ADJACENT STATES

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