Additional methods of investigation used to evaluate individual hydrologic features include semi-quantitative mapping (depositional patterns, hydrogeologic units, model parameter zones), quantitative areal interpolation (transpiration by native vegetation), linear regression (precipitation, tributary stream recharge, pumpage), and probability analysis (valleywide runoff).

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DESCRIPTION OF STUDY AREA

The Owens Valley is within the Owens Valley drainage basin area (fig. 1) and occupies the western part of the Great Basin section of the Basin and Range Province (Fenneman, 1931; Fenneman and Johnson, 1946). The Great Basin section typically consists of linear, roughly parallel, north–south mountain ranges separated by valleys, most of which are closed drainage basins (Hunt, 1974). The Owens Valley drainage area, about 3,300 mi^2, includes the mountain areas that extend from the crest of the Sierra Nevada on the west to the crest of the Inyo and the White Mountains on the east. Also included are part of the Haiwee Reservoir and the crest of the Coso Range on the south and the crest of the volcanic hills and mountains that separate the Mono Basin and the Adobe Valley from the Long and the Chalfant Valleys and the Volcanic Tableland (fig. 1). The drainage area includes the Long Valley, the headwaters of the Owens River (fig. 1). The Owens Valley ground-water basin extends northward from the Haiwee Reservoir in the south to include Round, Chalfant, Hammil, and Benton Valleys (fig. 1). The Owens Valley aquifer system, defined by Hollett and others (1991) and discussed extensively in this report, includes the main part of the Owens Valley ground-water basin and extends from the south side of the Alabama Hills to the Volcanic Tableland.

Physiography

Physiographically, the Owens Valley contrasts sharply with the prominent, jagged mountains that surround it (fig. 3). These mountains—the Sierra Nevada on the west and the Inyo and the White Mountains on the east—rise more than 9,000 ft above the valley floor and include Mount Whitney, the highest mountain in the conterminous United States. The valley, characterized as high desert rangeland, ranges in altitude from about 4,500 ft north of Bishop to about 3,500 ft above sea level at the Owens Lake (dry).

The valley floor is incised by one major trunk stream, the Owens River, which meanders southward through the valley. Numerous tributaries that drain the east face of the Sierra Nevada have formed extensive coalesced alluvial fans along the west side of the valley. These fans form prominent alluvial aprons that extend eastward nearly to the center of the valley (fig. 3). In contrast, the tributary streams and related alluvial fans on the east side of the valley are solitary forms with no continuous apron. Consequently, the Inyo and the White Mountains rise abruptly from the valley floor. As a result of this asymmetrical alluvial fan configuration, the Owens River flows on the east side of the valley.

The Owens Valley is a closed drainage system. Prior to the construction of the Los Angeles Aqueduct, water that flowed from the mountains as a result of precipitation was transported by the tributary streams to the Owens River in both the Long and the Owens Valleys and then south to the Owens Lake, the natural terminus of the drainage system. The Coso Range, which has a poorly defined circular form, unlike the linear forms of the Sierra Nevada or the Inyo and the White Mountains (Duffield and others, 1980), forms a barrier at the south end of the Owens Valley (fig. 1). The Coso Range prevents downvalley streamflow at the Owens Lake (dry) and blocks any significant natural ground-water outflow from the lower end of the valley. Prior to 20th-century development in the Owens Valley, the Owens Lake was a large body of water that covered more than 100 mi^2 and exceeded a depth of 20 ft. Diversion of streamflow for irrigation uses in the early 1900's and to the river–aqueduct system after 1913, however, altered the water budget of the lake. Evaporation now exceeds inflow except in very wet years, and the lake is presently (1988) a playa.

The river–aqueduct system in the Owens Valley drainage area is defined for purposes of this report as: (1) the Owens River from its headwaters in the Long Valley to the intake of the Los Angeles Aqueduct; (2) the Mono Craters Tunnel and streamflow diverted from the Mono Basin; (3) the Los Angeles Aqueduct from the intake to the Haiwee Reservoir; and (4) all reservoirs along the defined system (fig. 1). The actual Owens River between the aqueduct intake and the Owens Lake (dry), a reach informally referred to as the "lower Owens River," is not a part of the river–aqueduct system. Flow in the Owens River upstream from the aqueduct intake (fig. 1) is an integral part of the river–aqueduct system and is controlled by releases from Lake Crowley and the Tinemaha Reservoir (fig. 1). Flow in the lower Owens River is dependent on releases from the river–aqueduct system or discharge from the ground-water system.

Several reservoirs along the course of the river–aqueduct system, principally Grant Lake, Lake Crowley, and the Pleasant Valley, the Tinemaha, and the Haiwee Reservoirs (fig. 1), are used primarily to regulate flows and to store water for the river–aqueduct system. Secondary uses include recreation, fishing, and boating.

Geologic Setting

Two principal topographic features represent the surface expression of the geologic setting—the high, prominent mountains on the east and west sides of the valley and the long, narrow intermountain valley floor (fig. 3). The mountains are composed of sedimentary, metamorphic, and granitic rocks that are mantled in part by volcanic rocks and by glacial, talus, and fluvial deposits (fig. 4). The valley floor is underlain by valley fill that consists of unconsolidated to moderately consolidated alluvial fan, transition-zone, glacial and talus, and fluvial and lacustrine deposits (fig. 5). The valley fill also includes interlayered recent volcanic flows and pyroclastic rocks. The valley fill consists mostly of detritus eroded from the surrounding bedrock mountains.

The structure and configuration of the bedrock surface beneath the Owens Valley defines the areal extent and depth of the valley fill and therefore affects the movement and storage of ground water. The bedrock surface beneath the valley is a narrow, steep-sided graben, divided into two structural basins—the Bishop Basin in the north and the Owens Lake Basin in the south—as defined by Hollett and others (1991, fig. 11). The two basins are separated by east–west-trending normal faults, a block of bedrock material (Poverty Hills), and recent olivine basalt flows and cones (Big Pine volcanic field) (fig. 4). The combined effect of the bedrock high created by the normal faults, the upthrown block of the Poverty Hills, and the Pleistocene olivine basaltic rocks forms a "narrows," which separates the sedimentary depositional systems of the two basins (fig. 4). The Bishop Basin includes Round, Chalfant, Hammil, and Benton Valleys, which are partly buried by the Volcanic Tableland, and extends south to the "narrows," opposite the Poverty Hills. The deepest part of the bedrock surface in the Bishop Basin is about 4,000 ft below land surface between Bishop and Big Pine. To the south, the bedrock surface rises to approximately 1,000 to 1,500 ft below land surface in the "narrows." From this saddle, the bedrock surface deepens southward to approximately 8,000 ft below land surface near the Owens Lake (dry). The bedrock of the Coso Mountains forms the south end of the Owens Lake Basin.

During deposition of the valley-fill deposits in the Quaternary Period, the Bishop and the Owens Lake Basins acted as independent loci of deposition, separated by the bedrock high at the "narrows" and, later, by basaltic flows and cones. Both basins supported ancient

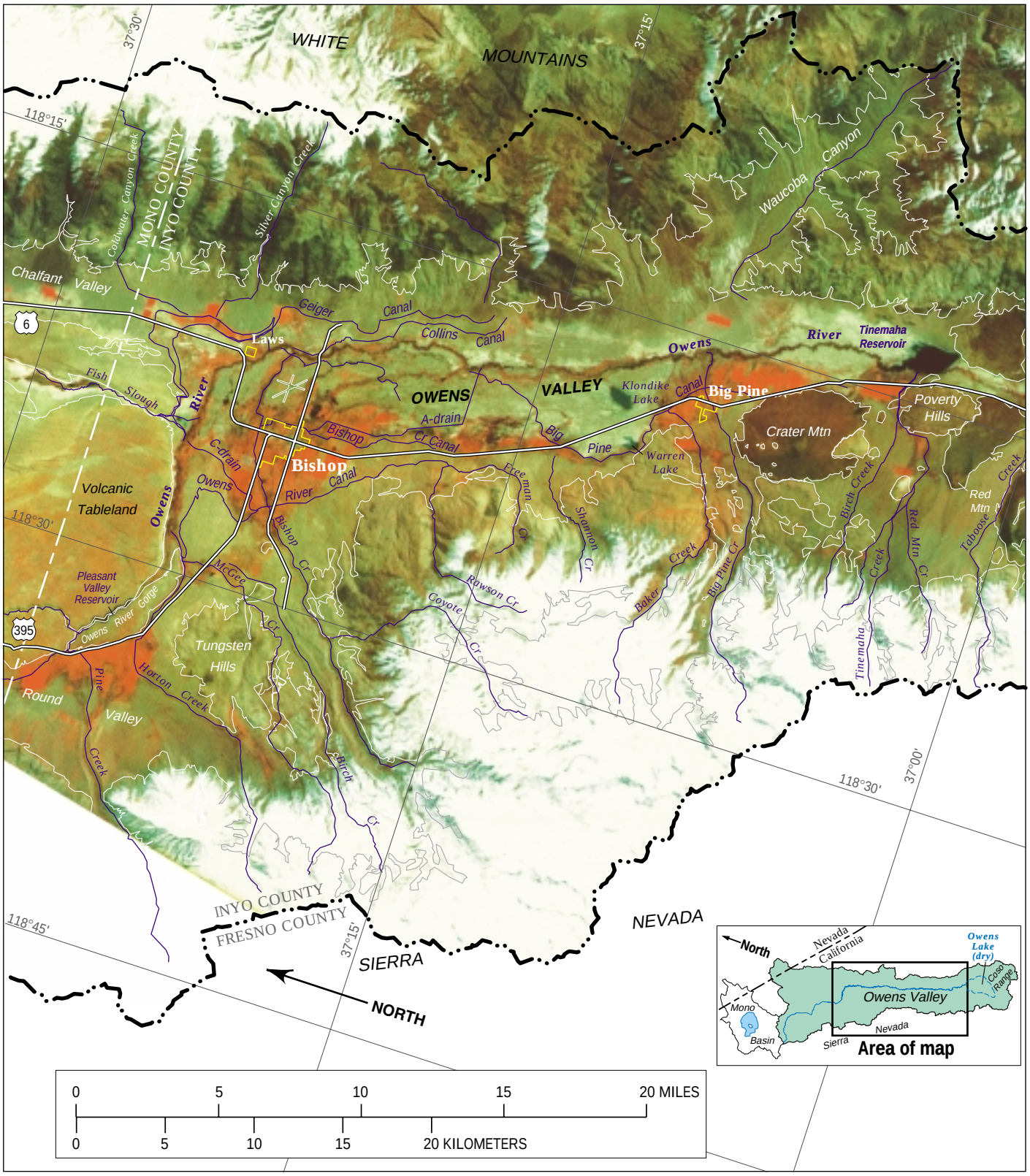
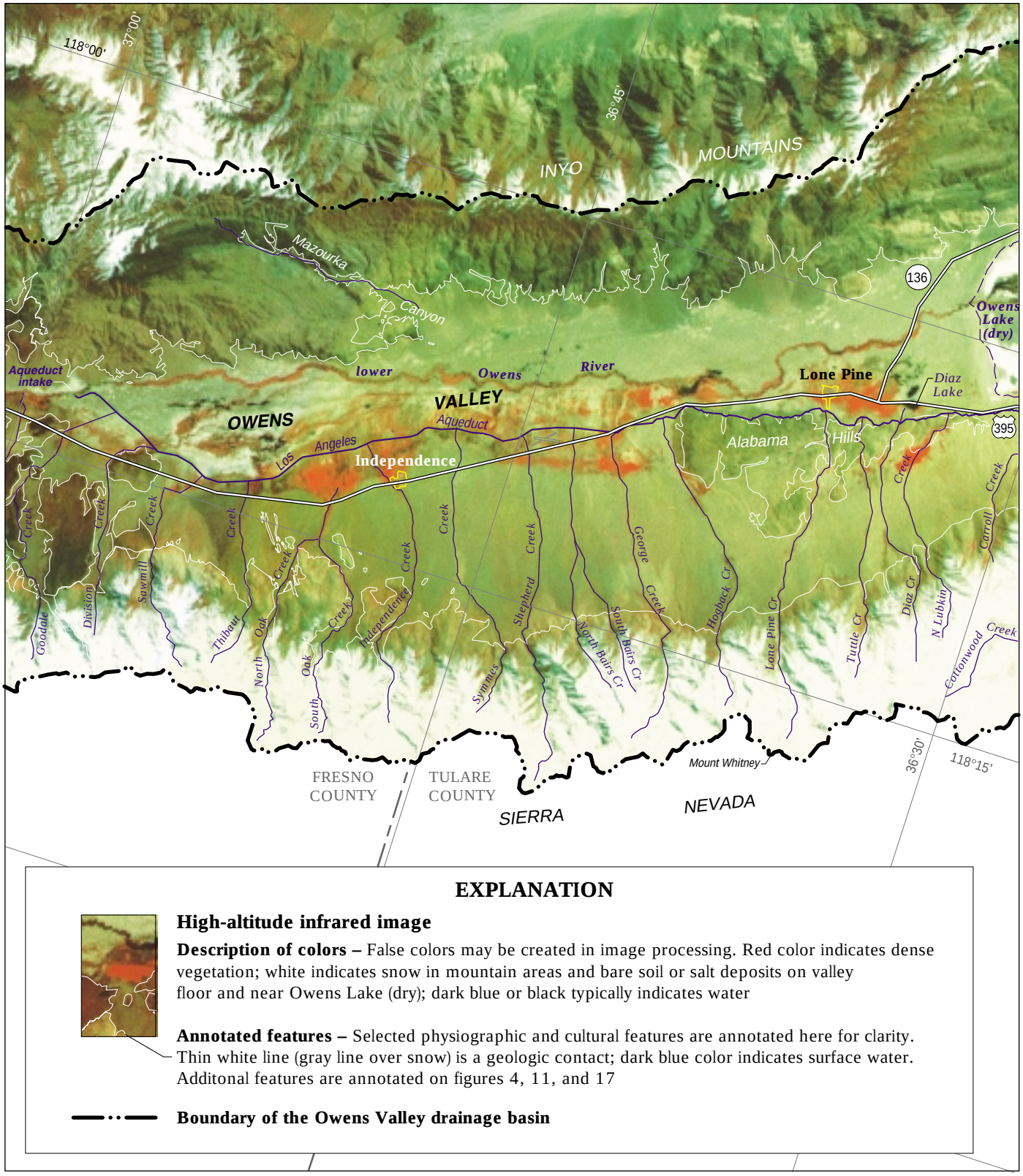


Figure 3. High-altitude infrared imagery showing major geologic, hydrologic, and cultural features of the Owens Valley, California. Image taken May 3, 1983, from Landsat by National Aeronautical and Space Administration. Processing and permission by EROS data center, Sioux Falls, South Dakota.



EXPLANATION

High-altitude infrared image

Description of colors – False colors may be created in image processing. Red color indicates dense vegetation; white indicates snow in mountain areas and bare soil or salt deposits on valley floor and near Owens Lake (dry); dark blue or black typically indicates water

Annotated features – Selected physiographic and cultural features are annotated here for clarity. Thin white line (gray line over snow) is a geologic contact; dark blue color indicates surface water. Additonal features are annotated on figures 4, 11, and 17

Boundary of the Owens Valley drainage basin

Figure 3. Continued.

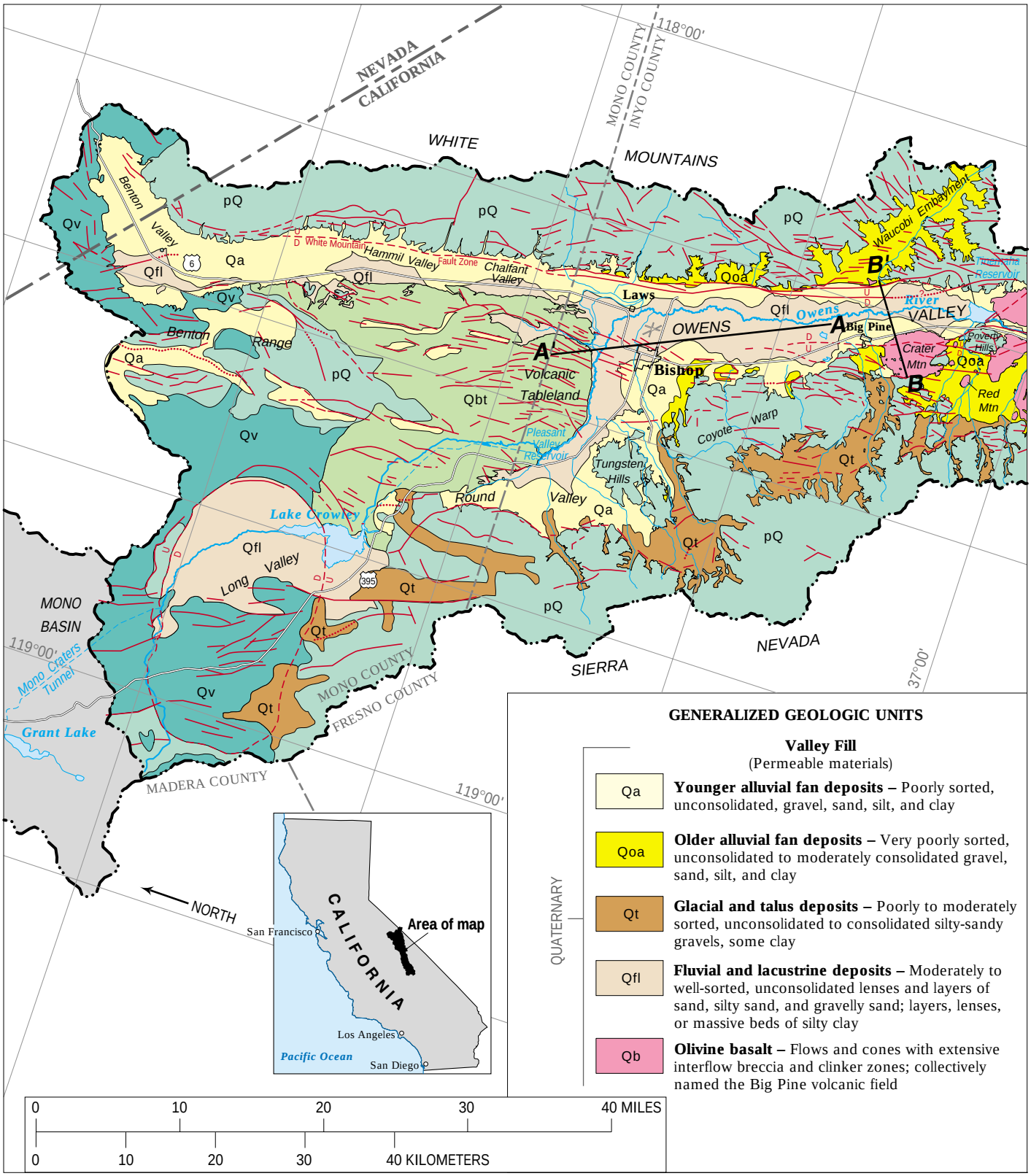


Figure 4. Generalized surficial geology of the Owens Valley drainage basin, California (modified from Hollett and others, 1991).

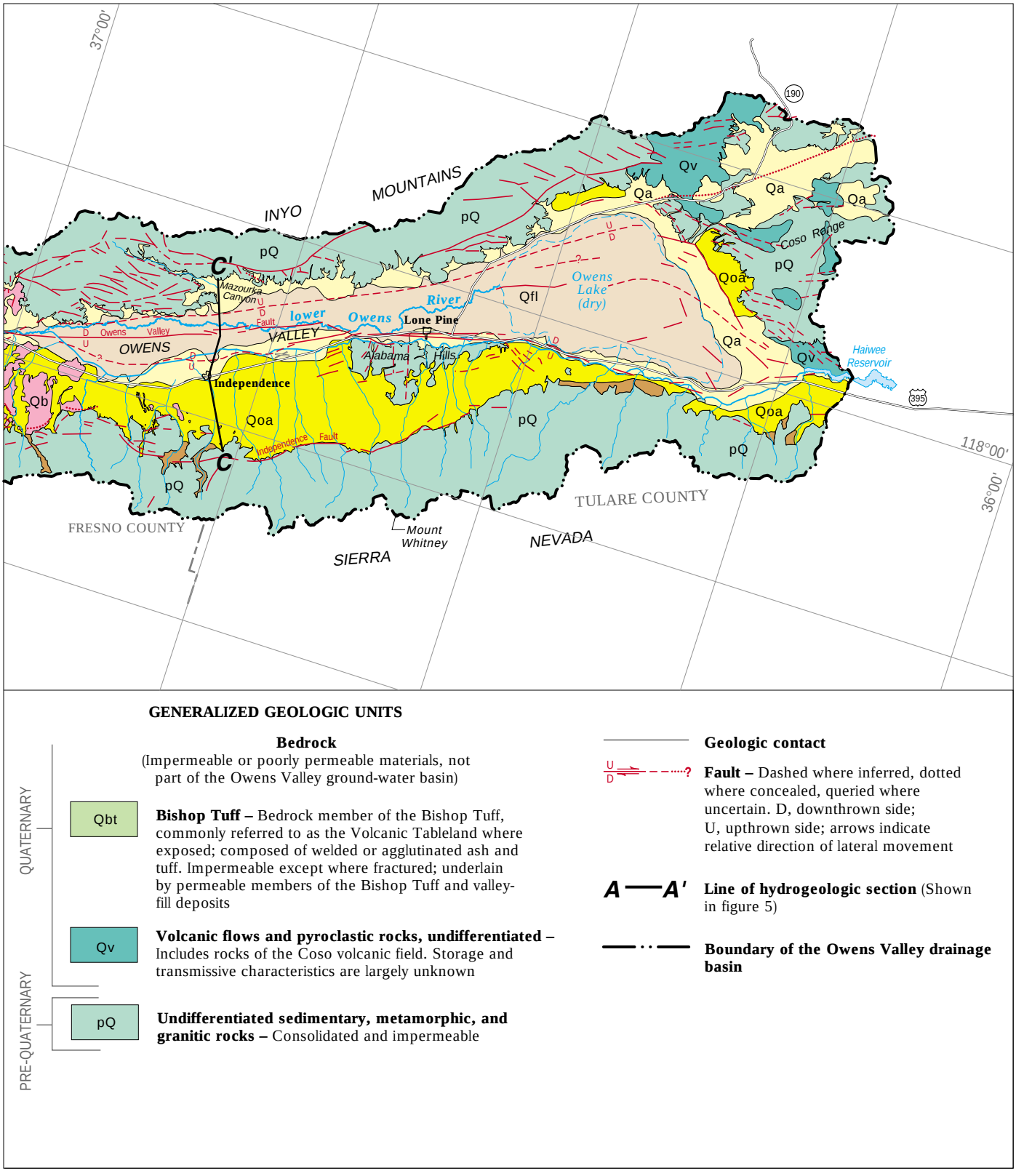


Figure 4. Continued.

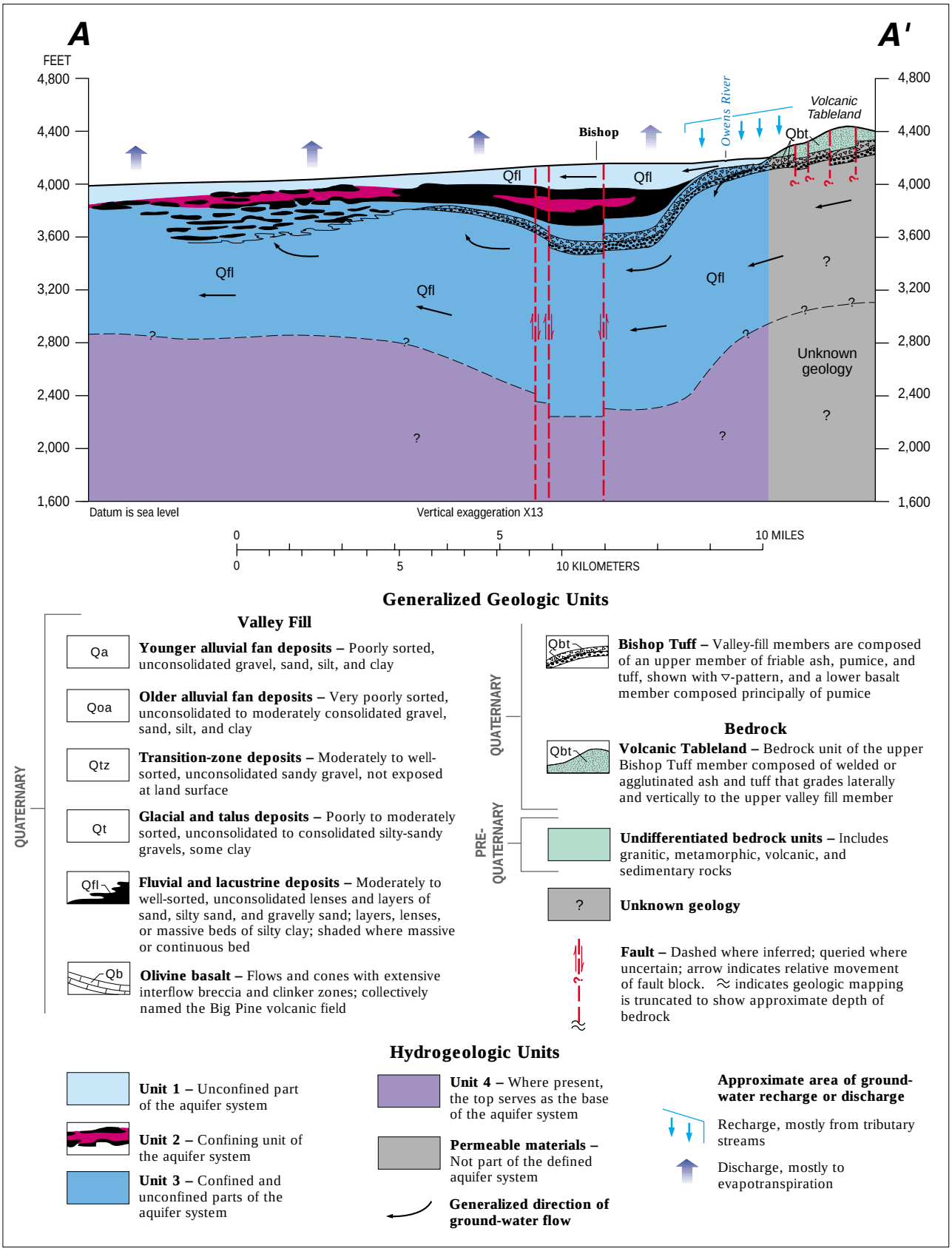


Figure 5. Typical hydrogeologic sections of the Owens Valley, California (modified from Hollett and others, 1991, plates 1 and 2). Sections located on figure 4.

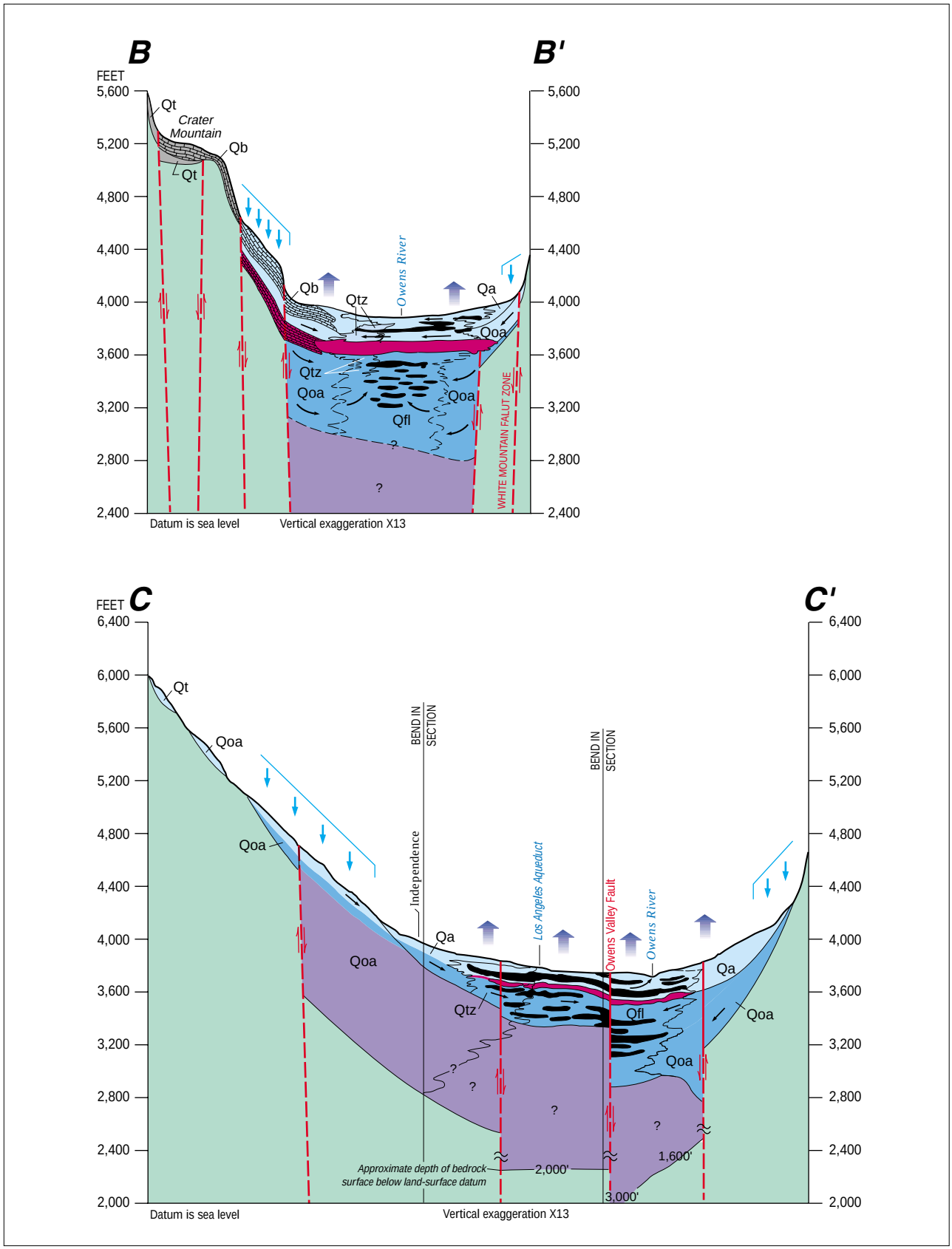


Figure 5. Continued.

shallow lake systems at different times during their geological evolution (Hollett and others, 1991). Lake sedimentation, as evidenced by lacustrine, deltaic, and beach deposits, is interrupted periodically in the geologic section of both basins by fluvial deposits (Hollett and others 1991, fig. 14). Coincident with deposition of lacustrian and fluvial deposits in the center of the basins was alluvial fan deposition and beach, bar, and stream deposition of the transition zones along the margins of each basin. As the mountain blocks were eroded and fronts receded, the alluvial fan deposits thickened. The fans are thicker and more extensive on the wetter, west side of the valley than on the east side and have displaced the Owens River eastward of the center of the valley (figs. 3 and 4).

The valley fill in both basins can be conceptualized by using three depositional models adapted by Hollett and others (1991, fig. 14) from general models suggested by Miall (1981, 1984). The three models are (1) alluvial fan to fluvial and lacustrine plain to trunk river, (2) alluvial fan to lake, and (3) alluvial fan to trunk river to lake margin with localized river-dominated delta. These models depict specific depositional patterns that interrelate and provide a means of subdividing the heterogeneous valley-fill sediments into generalized geologic units with similar lithologic characteristics (fig. 5). The geologic and geophysical signature of each depositional pattern aids in recognizing specific geologic units from field data, and with the aid of the depositional models, the probable occurrence of units can be inferred for parts of the valley were no data are available. The present condition in the Owens Valley is represented by model 1. A more extensive discussion of the geology of the Owens Valley and the surrounding area, as well as a detailed description of the depositional models, is given by Hollett and others (1991).

Climate

The climate in the Owens Valley is greatly influenced by the Sierra Nevada. Precipitation is derived chiefly from moisture-laden airmasses that originate over the Pacific Ocean and move eastward. Because of the orographic effect of the Sierra Nevada, a rain shadow is present east of the crest; precipitation on the valley floor and on the Inyo and the White Mountains and the Coso Range is appreciably less than that west of the crest (figs. 1 and 3). Average precipitation ranges from more than 30 in/yr at the crest of the Sierra Nevada, to about 7 to 14 in/yr in the Inyo and the White Mountains, to approximately 5 in/yr on the valley floor (Hollett and others, 1991, fig. 3). Consequently, the climate in the valley is semiarid to arid and is characterized by low precipitation, abundant sunshine, frequent winds, moderate to low humidity, and high potential evapotranspiration.

Air temperature in the valley also varies greatly. Continuous records from 1931 to 1985 at Bishop and Independence National Weather Bureau stations indicate that daily temperatures can fall to as low as -2°F in winter and can rise to as high as 107°F in summer; these conditions are typical of the semiarid to arid climate in high desert basins. Even within a single day, temperatures can span more than 50°F. Average monthly air temperature ranges from near freezing in winter to more than 80°F in summer. The average monthly air temperatures are generally 1 to 3°F lower in the Bishop area than in the Independence area, but the seasonal pattern and amplitudes are similar (Duell, 1990, fig. 4).

Wind direction, commonly westerly, can be variable depending on the type of storm and the amount of deflection caused by the surrounding mountains. Studies by Duell (1990) during the years 1984 through 1985 indicated that windspeeds in the valley ranged from zero to more than 30 mi/h. Windspeed was found to be highly variable, even within a single day, and no seasonal trend was evident. High windspeeds can occur any time during the year, but generally accompany a winter or a spring storm.

Relative humidity ranges from 6 to 100 percent and averages less than 30 percent during the summer months and more than 40 percent during the winter months (Duell, 1990). Actual water-vapor content in air can be expressed in terms of vapor density. In the Owens Valley, average vapor density in 1984 was about 4.5 g/m^3 and one-half-hour average vapor density ranged from 0.5 g/m^3 (during winter months) to 17.4 g/m^3 (in August) (Duell, 1990). Relative humidity and vapor density of the air are important factors not only in characterizing the climate of the Owens Valley, but also in transporting energy and in determining the type and health of native vegetation in the valley (Miller, 1981).

Vegetation

Vegetation in the Owens Valley is controlled largely by the arid to semiarid conditions, the high salinity of soil in many locations, and the presence of a shallow water table beneath the valley floor. Much of the native vegetation in the valley has been

characterized as phreatophytes—defined by Meinzer (1923) as plants that regularly obtain water from the zone of saturation. Recent studies by Sorenson and others (1989, 1991) and Dileanis and Groeneveld (1989) suggest that use of water by "phreatophytes" in the Owens Valley may be more complex. The plants seem to preferentially use infiltration of direct precipitation, which is primarily rainfall. Then, if necessary, the plants use water from the lower part of the soil-moisture zone that is replenished by capillarity from the water table and recharge from overland flow, stream courses, or excess direct precipitation (Groeneveld and others, 1986a; Groeneveld, 1990; Sorenson and others, 1991). Some plants seem to be capable of subsisting on water in a soil-moisture zone that has been denied significant replenishment for as much as 2 or 3 years, including replenishment from the water table (Sorenson and others, 1991). In this way, the "phreatophytes" of the Owens Valley are similar to desert plants growing in xerophytic environments above a water table (Sorenson and others, 1991), and they do not follow the strict definition of a phreatophyte (Meinzer, 1923; Robinson, 1958).

Many of the plants growing on the floor of the Owens Valley, however, do require occasional replenishment of soil moisture from the water table. Extensive field studies done as part of the overall investigation (Sorenson and others, 1991) included an artificial lowering of the water table and a detailed monitoring of the overlying vegetation at selected sites (table 1). Results of the monitoring showed that the native vegetation was affected adversely by the decline in water table. Most plants lost leaves, and some plants, in particular rubber rabbitbrush (*Chrysothamnus nauseosus*), died (Sorenson and others, 1991, p. G35).

Extensive mapping of vegetation during 1983–87 by the Los Angeles Department of Water and Power (R.H. Rawson, written commun., 1988) identified more than 300 plant species in the valley. The dominant species found on the valley floor include salt grass (*Distichlis spicata* var. *stricta*), Alkali sacaton (*Sporobolus airoides*), rubber rabbitbrush (*Chrysothamnus nauseosus*), greasewood (*Sarcobatus vermiculatus*), Nevada saltbush (*Atriplex torreyi*), big sagebrush (*Artemisia tridentata*) and shadscale (*Atriplex confertifolia*). Many of these plants display a high tolerance to salt and can extract soil moisture at osmotic pressures greater than 300 lb/in^2 (Branson and others, 1988). These and other valley-floor species have been grouped into one of four plant communities by Griepentrog and Groeneveld (1981). The groupings were based on the two dominant factors that control plant growth on the valley floor—soil water and salinity. A representative photograph of each of the four plant communities is shown in figure 6, and the main characteristics are listed in table 3. In addition to these general plant communities, many variations are present in different parts of the valley depending on local variations in the physical and chemical characteristics of the soil. The interaction of plants and soil water is described in detail by Kramer (1983) and Slatyer (1967).

As of 1988, a few irrigated fields of alfalfa are maintained on or near the valley floor—for example, in the Bishop area, south of Big Pine, and near Shepherd Creek south of Independence. Additional alfalfa fields are being planned by the Los Angeles Department of Water and Power and Inyo County near Independence in order to mitigate areas of native vegetation adversely affected by pumpage. In many areas of the valley floor, isolated stands of willows or saltcedar trees mark previous ranch houses or water courses. Some previously irrigated lands have reverted to an abundance of rubber rabbitbrush (*Chrysothamnus nauseosus*), an intrusive species (P. J. Novak, Los Angeles Department of Water and Power, oral commun., 1986).

On the sides of the valley, plants subsist solely on direct precipitation or percolation from overland flow or nearby stream courses. The water table in these areas, which are primarily alluvial fans, is many hundreds of feet below land surface and does not provide any water to plants. Large trees are present near the heads of the alluvial fans and along tributary stream channels, and large shrubs and grasses are present along depressions in the land surface that collect small quantities of runoff. Most of the volcanic deposits (fig. 4) are sparsely covered with vegetation that probably subsists solely on direct precipitation because few stream courses have eroded the recent flows. Meadow areas are found in isolated areas west of Crater Mountain and the Alabama Hills. Dense vegetation, shown in red in figure 3, is present along and downslope from springlines caused by faults.

Land and Water Use

Most of the land in the Owens Valley drainage basin area is owned by either the U.S. Government or the Los Angeles Department of Water and Power (Hollett and others, 1991, fig. 5). Considerably less land is owned by municipalities or private citizens.

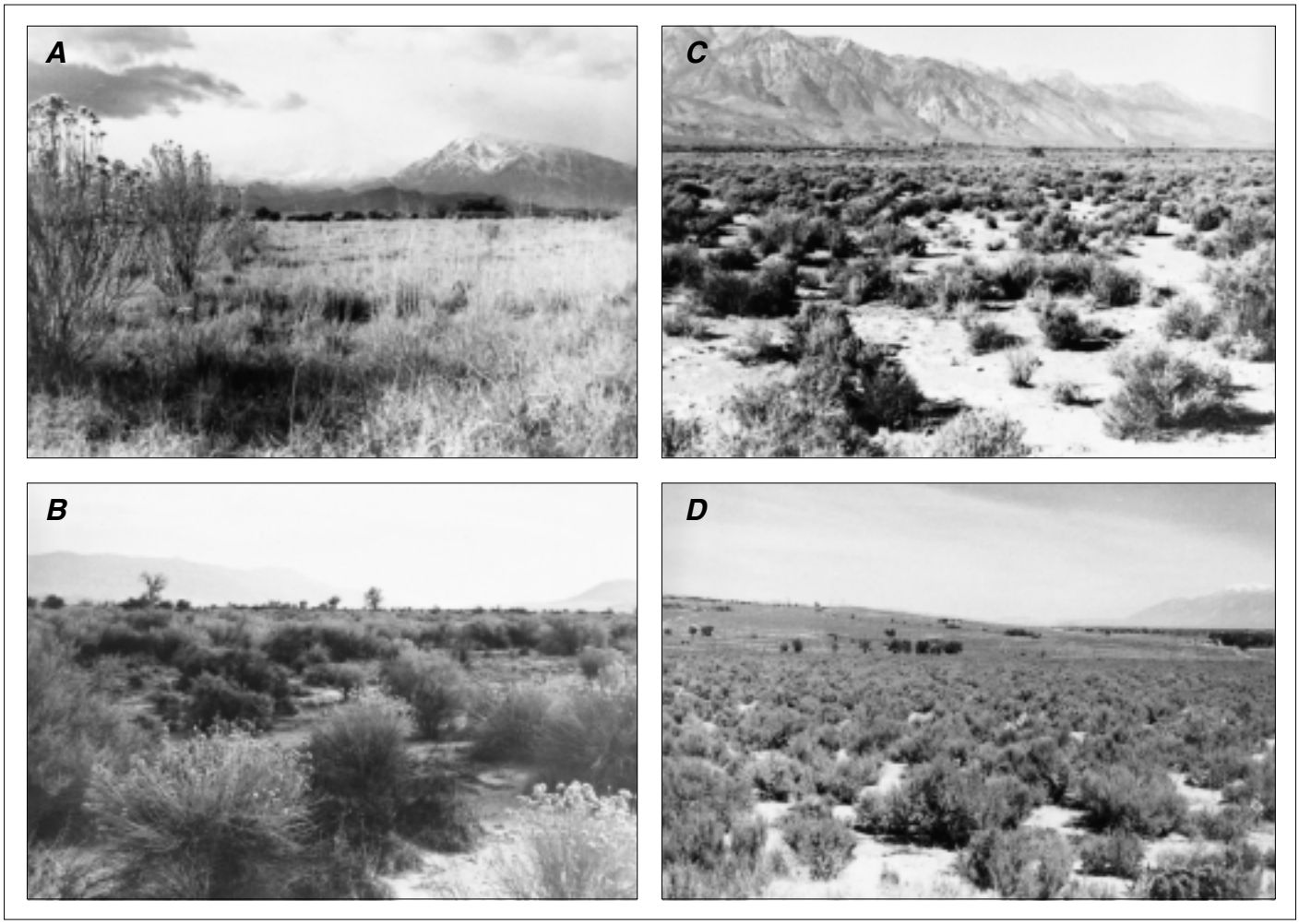


Figure 6. Native plant communities in the Owens Valley, California. ***A,*** High-ground-water alkaline meadow. ***B,*** High-ground-water alkaline scrub. ***C,*** Dryland alkaline scrub. ***D,*** Dryland nonalkaline scrub.

U.S. Government lands, either Forest Service or Bureau of Land Management, are located generally in the mountains and along the edge of the mountains or on the Volcanic Tableland. Of the 307,000 acres owned by the Los Angeles Department of Water and Power in the Owens Valley and the Mono Basin drainage basins, most of the land (240,000 acres) is located on the valley floor of the Owens Valley.

The main economic activities in the valley are livestock ranching and tourism. About 190,000 acres of the valley floor is leased by the Los Angeles Department of Water and Power to ranchers for grazing and about 12,400 additional acres is leased for growing alfalfa pasture. Access to most lands in the mountains and the valley is open to the public, and tens of thousands of people each year utilize the many recreational benefits such as hunting, fishing, skiing, and camping.

Since the early 1900's, water use in the Owens Valley has changed from meeting local needs, such as ranching and farming, to exporting some surface water, to exporting a greater quantity of both surface and ground water. The major historical periods with similar water use are summarized in table 4.

As of 1988, water use within the valley involves both surface-water diversions and ground-water pumping. About 1,200 to 2,000 acre-ft/yr of ground water is supplied to the four major towns in the valley—Bishop, population 10,352; Big Pine, population 1,610; Independence, population 655; and Lone Pine, population 2,062 (U.S. Department of Commerce, 1990). Other in-valley uses of water are for Indian reservations and for stockwater, irrigation of pastures, and cultivation of alfalfa. Fish Springs and Blackrock fish hatcheries rely on ground water, and the Mt. Whitney fish hatchery

uses surface water diverted from tributary runoff from the Sierra Nevada. Numerous private wells in the valley, which are not maintained or monitored by the Los Angeles Department of Water and Power, are used mostly for domestic water supply, primarily at Mt. Whitney fish hatchery, on isolated ranches, in Bishop, and on the four small Indian reservations in the valley. The reservations are about 1 mi^2 or less in size and are

Table 3. Native plant communities in the Owens Valley, California

[Adapted from Sorenson and others, 1991]

Native plant community	Species name	Common name	Characteristics
High-ground-water alkaline meadow.	*Distichlis spicata*	Saltgrass	Vegetation is highly salt tolerant and grows in areas where the water table ranges from land surface to 4 feet below land surface most of the year. Site L (figure 2) is an example.
	Glycyrrhiza lepidota	Wild licorice	
	Juncus balticus	Wire rush	
	Sida leprosa	Alkali mallow	
	Sporobolus airoides	Alkali sacaton	
High-ground-water alkaline scrub.	*Atriplex torreyi*	Nevada saltbush	Vegetation is highly tolerant of alkalinity and salinity; generally found where the water table ranges from 3 to 10 feet below land surface. Predominant plant species are phreatophytic and require contact between the rooting zone and the water table. Community also may contain plant species characteristic of the high-ground-water alkaline meadow community. Sites B, H, and K (figure 2) are examples.
	Sarcobatus vermiculatus	Greasewood	
	Chrysothamnus nauseosus	Rubber rabbitbrush	
	Suaeda torreyana	Inkweed	
Dryland alkaline scrub	*Ambrosia dumosa*	Burrobush	Vegetation is found where there is no connection between the water table and the rooting zone. Soils are well drained and usually alkaline or saline. Site K (figure 2) has some of these species.
	Artemisia spinescens	Bud sage	
	Atriplex confertifolia	Shadscale	
	Atriplex polycarpa	Allscale	
	Ceratoides lanata	Winterfat	
	Hymenoclea salsola	Cheesebush	
	Lycium cooperi	Peach thorn	
	Psorothamnus sp.	Dalea	
	Stephanomeria pauciflora	Desert milkaster	
Dryland nonalkaline scrub	*Artemisia tridentata*	Big sagebrush	Vegetation generally is intolerant of high alkalinity or salinity. Found on coarse, well-drained soils, often on alluvial fans that border the valley.
	Chrysothamnus teretifolius	Green rabbitbrush	
	Eriogonum fasciculatum	California buckwheat	
	Ephedra nevadensis	Nevada squawtea	
	Purshia glandulosa	Desert bitterbrush	

Table 4. Historical periods of similar water use in the Owens Valley, California

Time period	Characteristics of water use
Pre-1913	Prior to the first export of water from the Owens Valley. Installation of canals to dewater the valley floor and supply water for farming and ranching.
1913–69	Export of surface water from the Owens Valley by diversion of the Owens River and tributary streams into the Los Angeles Aqueduct. General decrease of farming and ranching in the valley. Brief periods of pumping to augment local surface-water supplies.
1970–84	Export of some additional surface water. Beginning export of ground water with the addition of new wells and second aqueduct. Major fish hatcheries switch supply from surface water to ground water. Decrease in consumptive use of water by remaining ranches.
1985–88	Continued export of surface and ground water. Design of cooperative water-management plan between Inyo County and the Los Angeles Department of Water and Power. Installation and initial operation of enhancement and mitigation wells.

located near Bishop, near Big Pine, north of Independence, and near Lone Pine (Hollett and others, 1991, fig. 5).

HYDROLOGIC SYSTEM

The hydrologic system of the Owens Valley can be conceptualized as having three parts: (1) an unsaturated zone affected by precipitation and evapotranspiration; (2) a surface-water system composed of the Owens River, the Los Angeles Aqueduct, tributary streams, canals, ditches, and ponds; and (3) a saturated ground-water system contained in the valley fill.

The following evaluation identifies key components of the hydrologic system, describes their interaction, and quantifies their spatial and temporal variations. Discussion of the unsaturated zone is limited to precipitation and evapotranspiration. The evaluation also includes the interaction between the hydrologic system, much of which has been altered by human activity, and the native vegetation; this interaction is the subject of recent controversy and litigation.

For purposes of organization, the surface-water and ground-water systems are presented separately. For items that have both a surface-water and a ground-water component, such as the river–aqueduct system, the discussion is presented in the section entitled "Surface-Water System"; included in this convention is the quantification of ground-water recharge and discharge. All water-budget calculations are for the area defined by Hollett and others (1991) as the aquifer system (figs. 4 and 5). Three key periods—water years 1963–69, water years 1970–84, and water years 1985–88—were used to calculate historical water budgets, to calibrate the valleywide ground-water flow model, to verify performance of the model, and to evaluate past and possible future changes in the surface-water and ground-water systems (table 4). A complete description of the ground-water flow model is included in the section entitled "Ground-Water System."

Precipitation and Evapotranspiration

Precipitation

The pattern of precipitation throughout the Owens Valley is strongly influenced by altitude, and precipitation varies in a predictable manner from approximately 4 to 6 in/yr on the valley floor to more than 30 in/yr at the crest of the Sierra Nevada on the west side of the valley (Groeneveld and others, 1986a, 1986b; Duell, 1990; Hollett and others, 1991, fig. 3). On the east side of the valley, precipitation follows a similar pattern, but with somewhat lower rates of 7 to 14 in/yr because of the lower altitude of the Inyo and the White Mountains and the rain-shadow effect caused by the Sierra Nevada. Snow, when present on the Sierra Nevada and the White Mountains, commonly is absent on the Inyo Mountains (fig. 3) and the Coso Range. Of the total average annual precipitation in the Owens Valley drainage area, about 60 to 80 percent falls as snow or rain in the Sierra Nevada, primarily during the period October to April. A lesser quantity falls during summer thunderstorms.

As shown in figure 7*A*, the pattern of average precipitation is well defined by the more than 20 precipitation and snow-survey stations that have been monitored routinely, many for more than 50 years (fig. 7*C*). Average precipitation tends to increase from south to north, much as does altitude of the land surface. The strong correlation between altitude and recent mean annual precipitation can be seen in figure 7*B* and can be described by the regression equation,

$$P_i^{RAVE} = 0.00245\ LSD_i - 3.205\ , \qquad (1)$$

where

P^{RAVE} is recent mean annual precipitation, in inches per year, on the basis of data for rain years 1963–84;

LSD is altitude of land surface, in feet above sea level; and

i is an index referring to location.

Regression equation 1 was fitted by hand from figure 7*B*, which is a graph of data presented in figure 7*C*, with an emphasis on data from the west side of the valley where the bulk of the more transmissive materials of the ground-water system are present (fig. 4). Predictably, the White Mountain Stations 1 and 2 (sites 19 and 20, fig. 7*B*) fall somewhat below the line. A similar relation that more accurately represents precipitation falling on the east side of the valley could be developed (Lopes, 1988, fig. 3). However, that relation would need to account for the difference between the quantity of precipitation falling on the White Mountains and farther south on the Inyo Mountains