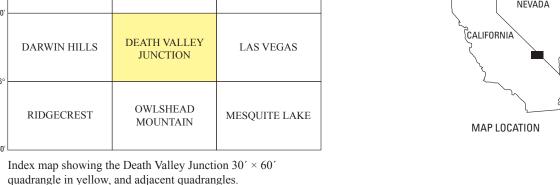
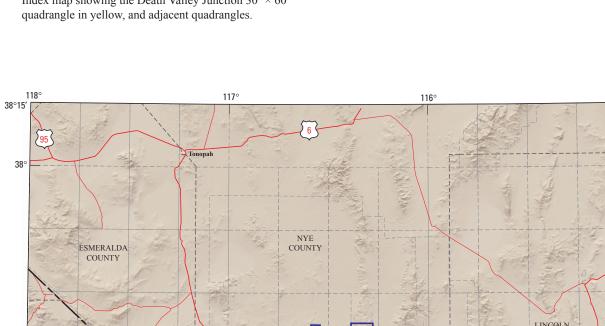


11 37° [8° 11	7° 11	16° 11	1 5 ° 1
000001	SALINE VALLEY	ВЕАТТҮ	INDIAN SPRINGS	
36°30' -	DARWIN HILLS	DEATH VALLEY JUNCTION	LAS VEGAS	
35°30'	RIDGECREST	OWLSHEAD MOUNTAIN	MESQUITE LAKE	

25 000-foot grid ticks based on California coordinate system zone 4, and Nevada coordinate

system, central zone





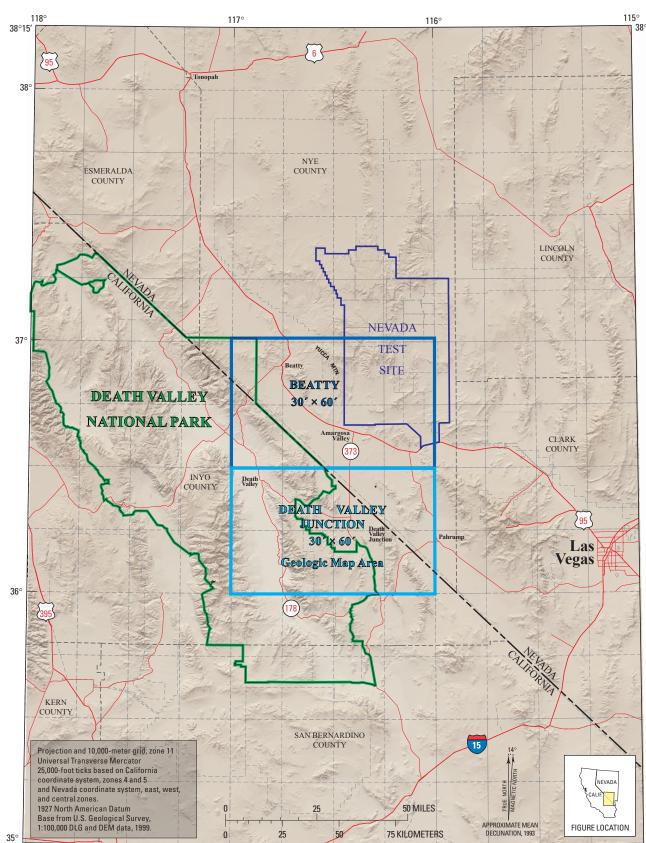


Figure 1. Shaded relief image of location of Death Valley Junction quadrangle (light blue outline) relative to Death Valley National Park (green outline), the Nevada Test Site (purple outline), and the adjoining Beatty $30' \times 60'$ quadrangle (dark blue outline). Roads depicted as

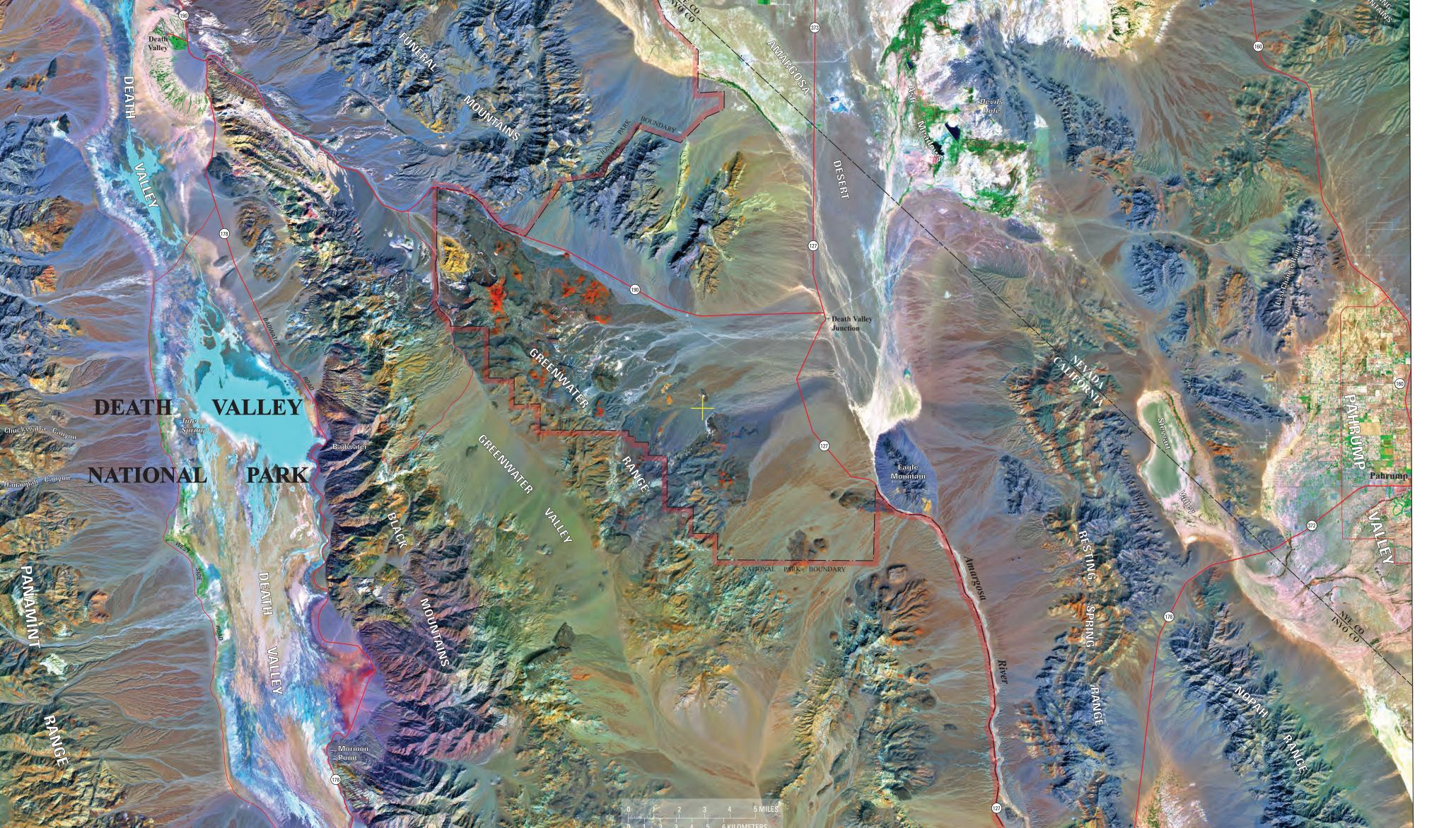


Figure 2. Landsat 7 image of Death Valley Junction 30' x 60' quadrangle, California and Nevada. This image is a false-color composite, which combines bands 7 (SWIR, 2.09–2.35 μm), 4 (near-IR, 0.77–0.90 μm), and 2 (Green, 0.52–0.60 μm) and displays them as red, blue, and green, respectively. The appearance of shaded relief was created using the National Elevation Dataset (NED, http://ned.usgs.gov/), which

is based on digital elevation models that have a resolution of 30 meters. Roads and boundaries were superimposed using the ESRI Data and Maps roads database in ArcInfo. Red lines indicate major roads. Death Valley National Park boundary, latitude and longitude ticks, and scale are approximate.

CONTOUR INTERVAL 50 METERS

Fable 1. Summary of surfa 30'× 60' minute quadrangl		ve height, and landscape po.	sition of alluvial units in the	e Death Valley Junction	includes evaporative surface crusts of salt or carbonate. Thickness indeterminate, estimated at 1 to 10 m; base not exposed or drilled	
Alluvial unit	Surface morphology	Tone (on aerial photography)	Relative height (topographic position)	Landscape position	Lacustrine deposits Lacustrine beach deposits (late and late-middle Pleistocene)—Gravel, sand, and silt; poorly to moderately bedded; light gray, and yellowish to grayish brown, weakly to moderately well consolidated. Clasts are moderately to well sorted, subrounded to rounded, reflecting nearshore depositional environments. Locally cemented by soil carbonate and tufa. Similar to unit Qai, but is locally higher	
Qay —Young alluvial deposits (Holocene)	Bar-and-swale near range fronts; braided sand plains in basins.	Light, in general, due to no or little rock varnish; can appear variegated.	Lowest unit above active channel where surfaces are incised.	Emanates from fan apices; includes active channels where they are too small to map separately.	and more dissected; has generally finer textured gravel, is better sorted and be rounding of coarse fraction. This unit is poorly preserved in Death Valley who we infer that it has been covered by unit Qai or eroded. We mapped a west-sid remnant on the Hanaupah Canyon, Calif., 7.5-minute quadrangle near the toe Chuckwalla Canyon fans above Tule Spring, and 160–185 ka lake-stand conglomerates on the east side of the valley at Mormon Point. Other sites (Machette and others, 2001) for example, at Badwater, are too small to portray 1:100,000 scale. At Hanaupah Canyon, the deposit forms a bar, which was recognized by Ibbeken and others (1998) and Ibbeken and Warnke (2000) who noted that the pebbles on the surface are better sorted than those of adjacent (lower) alluvial surfaces, units Qay to the north and Qai to the south. The upp part of the bar comprises a series of gently east-dipping planar surfaces and intervening slopes, which probably represent paleoshorelines of a once more extensive north-trending bar complex derived from streams emanating from Hanaupah Canyon. The uppermost (highest) surface of the bar at is +30 m absea level (asl) (on the +100 ft topographic contour), well below the uraniumseries dated (Ku and others, 1998), oxygen-isotope stage (OIS) 6 shorelines the are uplifted at Mormon Point (Knott and others, 2001, 2002). Terrestrial cosmogenic-nuclide (TCN) ³⁶ Cl depth-profile dating establishes the age of the lacustrine bar complex at Hanaupah Canyon to be 130 ka (Machette and other 2008). Estimated thickness 5–15 m	
Qayy —Young alluvial deposits, younger part (late Holocene)	Pristine bar-and-swale bedforms in modern channels.	Light, due to no or little rock varnish, or to presence of young or exhumed marl (QTm) deposits.	Lowest unit	Forms active channels		
Qayo—Young alluvial deposits, older part (middle and early Holocene)	Faint bar-and-swale to nearly smooth.	Light to medium due to weak to moderate accumulation of rock varnish.	Intermediate; higher than Qay, but lower than Qai.	Progressively older units flank younger units.	Colluvial deposits Colluvium (Holocene to Pliocene)—Angular to subangular, granule- to boulder-sized clasts with variable amounts of sand, silt, and clay as matrix. Generally unsorted and nonbedded to poorly bedded; locally cemented by soil carbonate. Matrix probably partly of eolian origin. Forms talus and thin mantle of debris along flanks and bases of steep slopes; deposited by rainwash, sheetwash, creep, and mass wasting. Colluvium-mantled surfaces commonly have ribbed or fluted appearance due to gullying and development of stony surface lags. Locally	
Qai—Younger intermediate alluvial deposits (late and late-middle? Pleistocene)	Planar, smooth appearance; locally dissected.	Medium, in general, due to moderate accumulation of rock varnish.	Intermediate; higher than Qayo, but lower than Qao.	Progressively older units flank younger units.	includes bedrock outcrops too small to map separately. Most deposits are probably of Holocene to middle Pleistocene age, but the lack of dates and juxtaposition with QTa makes even older ages possible. Thickness varies, but generally less than 3 m Marl Marl deposits (Pleistocene and Pliocene)—Marl, pale yellowish brown, weathers white to very light gray, silty to sandy, soft, plastic when wet. Consists of calcite various clay minerals, quartz and opaline silica, silt, and sand-sized rock fragments. Includes several thin chalk beds as much as 1 m thick and discontinuous	
Qao—Older alluvial deposits (late? to early? Plesitocene)	Generally planar form, but surface dissected and interfluves rounded.	Medium to dark, in general, due to moderate to strong accumulation of rock varnish; locally light due to erosional exposure of soil-carbonate horizon or lack of varnish development on carbonate clasts.	Intermediate; higher than Qai , but lower thatn QTa .	Progressively older units flank younger units.	beds of small, irregular limestone nodules. Unit includes yellowish-gray to grayish-orange, locally calcareous silt, in part clayey, mostly unconsolidated; locally interbedded with sandy marl. Locally contains sparse to common pencil-sized calcareous cylinders that probably are calcified plant stems or inso burrows. This unit is thought to represent deposits and precipitates formed in areas of ground-water discharge, including paludal (marsh) environments. Thi undivided unit varies greatly in age: ranging from Pleistocene (90 to greater th 200 ka and 15–60 ka; Paces and others, 1997; Nelson and others, 2001) to Pliocene (2.1–3.8 Ma based on fission-track and K-Ar ages on interbedded ash Swadley and Carr, 1987; Marvin and others, 1989). In the Amargosa Desert, exposed thickness is as much as 50 m (Hay and others, 1986), but the base of the standard contains the same proposed thickness is as much as 50 m (Hay and others, 1986), but the base of the same proposed thickness is as much as 50 m (Hay and others, 1986), but the base of the same proposed thickness is as much as 50 m (Hay and others, 1986), but the base of the same proposed thickness is as much as 50 m (Hay and others, 1986), but the base of the same proposed thickness is a same proposed the same proposed the same proposed thickness is a same proposed the same propos	
QTa—Oldest alluvial deposits (middle to early Pleistocene and Pliocene?)	Typically ballena (whaleback) form; locally planar.	Light, in general, due to erosional exposure of soil-carbonate horizon.	Highest where surfaces are incised.	Older units typically preserved close to the range fronts.	——————————————————————————————————————	

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For more information concerning this publication, contact: Or visit the Earth Surface Processes Team Web site at:

CORRELATION OF MAP UNITS **Table 2.** Correlations of alluvial surficial-deposit units in the Death Valley 30' × 60' quadrangle to surficial-deposit stratigraphic sequences in studies proximal to the Death Valley area that have SURFICIAL DEPOSITS [Numbers in parentheses refer to minimum and maximum age estimates (in ka); number after range is preferred age estimate(s) where given. Some correlations adopted from Taylor (1986), and Klinger and Piety (1996). No mapping unit is identified for time periods denoted by dashes. Table modified from Menges and others, 2001.] (this report)

> Pliocene > TERTIARY

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Alluvial deposits

interbedded. Grayish brown, pale yellowish brown, and light brownish gray to

close to mountain fronts. Sand and silt present as matrix and lenses; rarely form continuous beds. Surface commonly is irregular; bar-and-swale topography and

development except near dust sources such as the playa sediments of Amargosa Valley, Stewart Valley and Pahrump Valley. Death Valley apparently is too dry

for such processes to take place along the toe slopes of unit Qay there. Thickness

generally ranges from less than 1 m to 20 m; locally as much as 30 m adjacent to

braided channels are common. Has little or no pavement, varnish, or soil

Young alluvial deposits, younger part (late Holocene)—Gravel, sand and silt;

intermixed and interbedded as discrete layers. Grayish brown, pale yellowish

brown, and light brownish gray to light gray; unconsolidated to poorly consoli-

cross-bedded. Clasts are commonly angular to subrounded; locally well rounded.

Clasts commonly less than 0.5 m in diameter, but as much as 2 m in diameter at

and near base of steep slopes, and close to mountain fronts. Along large alluvial

channels boulders are present several kilometers from the mountain front. Sand

and silt present as matrix and lenses and rarely as continuous beds. Surface

morphology commonly is irregular; bar-and-swale topography and braided

channels are common. No pavement, varnish, or soil development. Generally

associated with modern channels wide enough to map separately. In places Qayy

includes older Holocene deposits between modern channels that are too narrow

to map separately. Along the Amargosa River and in Ash Meadows, may include

exhumed (Pleistocene or older) marsh deposits (QTm) or young spring deposits (marls). Thickness generally 1 to 10 m; maximum thickness about 30 m

and silt; intermixed and interbedded. Pale yellowish brown, light brownish gray,

pinkish gray, and grayish brown, unconsolidated to weakly consolidated, poorly

Clasts are commonly angular to subrounded; locally well rounded. The surface

moderately packed desert pavement. Pavement clasts are weakly to moderately varnished. Soil typically has cambic B horizon and stage I carbonate horizon.

Thickness generally ranges from less than a meter to 10 m, but may be as much

sand, and silt; intermixed and interbedded, light gray, pinkish gray, and yellowish

to grayish brown, weakly to moderately well consolidated. Clasts are unsorted to

moderately well sorted, nonbedded to well bedded, angular to rounded. Clasts

commonly less than 0.5 m in diameter, but locally as much as 2 m in diameter;

silty. Surface is planar; locally dissected. Moderately packed to densely packed desert pavement; pavement clasts are moderately varnished. Locally, thin eolian sand deposits mantle the surface. Soil development varies from profiles with a cambic B horizon and a stage I to II carbonate (Bk) horizon to those with an argillic (Bt) horizon and an approximately 1-m-thick, stage III to IV carbonate (Bk to K) horizon. Terrestrial cosmogenic-nuclide (TCN) ³⁶Cl depth-profile dates of unit Qai fans along the west side of Death Valley range from about 40 ka to 100 ka (with a mean age of about 70 ka), and thus post-date the marine OIS 6 cycle of Pleistocene Lake Manly, but predate the lesser, OIS 2 successor

matrix is sandy to silty. Sand is discontinuously to moderately well bedded,

locally crossbedded, moderately well sorted; commonly gravelly and locally

intermixed and interbedded, light gray, pinkish gray, and yellowish to grayish brown, moderately well consolidated. Clasts are unsorted to moderately well sorted, nonbedded to well bedded, angular to rounded. Clasts commonly less than 0.5 m in diameter, but locally as much as 2 m in diameter; matrix is sandy to silty. Sand is discontinuously to moderately well bedded, locally cross-bedded, moderately well sorted; commonly gravelly and locally silty. Surface is generally planar; dissected and interfluves are rounded. Densely packed desert pavement; pavement clasts are well varnished making this unit medium to dark colored, due to moderate to strong accumulation of rock varnish; locally light due to erosional exposure of soil-carbonate horizon or lack of varnish development on carbonate clasts. Locally, thin eolian sand deposits mantle the surface. Soil development varies from a well-developed cambic (Bw) horizon and a stage II carbonate (Bk) horizon to an argillic (Bt) horizon and an approximately 1-m-thick, stage III to IV carbonate (Bk to K) horizon. Thickness less than 1 m –

(Machette and others, 2008). Thickness less than 1 m to 10 m Older alluvial deposits (late? to early? Pleistocene)—Gravel, sand, and silt;

Oldest alluvial deposits (middle to early Pleistocene and Pliocene?)—Gravel,

Eolian deposits

Playa-related deposits **Op Playa deposits (Holocene)**—Fine sand, silt, and clay; poorly to moderately well

Ops Saline playa deposits (Holocene)—Silt, fine sand, and clay; white to light gray and

and saline playa deposits with lacustrine deposits

Locally at least 20 m thick

sand, and silt; intermixed and interbedded, light brownish gray to light gray. Clasts are angular to subrounded, clasts more than 1 m in diameter are common at and near base of steep slopes. Generally poorly sorted, nonbedded to poorly bedded, and moderately to well cemented with carbonate. Locally consists of moderately well bedded, poorly to moderately well-sorted pebble to cobble gravel in a sand and silt matrix. Surface is eroded and dissected; commonly

forms rounded ridges known as ballenas. Where preserved, desert pavement is generally moderately to densely packed and includes tabular fragments cemented by pedogenic carbonate and opaline silica. Varnish on pavement clasts is variable but commonly strongly developed. Soils typically consist of a stage III to IV carbonate (Bk to K) horizon as much as 2 m thick; argillic (Bt) horizons, where present, postdate much of the erosion. Thickness may exceed 40 m

Eolian sand deposits (Holocene)—Silty fine to medium sand, pale yellowish brown to yellowish gray, well sorted, massive to poorly bedded; locally includes a few cobbles and pebbles near exposed bedrock. Forms sheets, dunes, and

consolidated, light grayish brown, calcareous, moderately well sorted, thinly bedded; polygonal desiccation cracks common. Locally contains sparse thin beds or lenses of pebbly coarse sand. Generally restricted to areas of active deposition in the interior of poorly drained basins; for example, in the Amargosa Valley and Stewart and Pahrump Valleys in the eastern part of the quadrangle.

light brownish gray, gypsiferous and calcareous, moderately well sorted, thinly

bedded. Includes sandy playa or lake deposits, gypsum and other sulfate salts,

Mabey, 1966; Wright and Troxel, 1993). Generally restricted to areas of active

deposition in the interior of extremely arid, poorly drained basins; for example,

Valley (DV93-1, Lowenstein and others, 1999) consisted of alternating mud flat

minor lenses of pebble gravel and spring (marls and tufa) deposits. Light gray to

light brownish gray, moderately sorted. Mapped adjacent to active playas (Qp), and includes minor alluvium deposited by axial streams draining basin interiors.

This unit fringes the saline playa deposits of Death Valley (Qps) except at Badwater, Calif., where alluvium is deposited adjacent to unit Qps. Unit Qpx is

also mapped along the valley axis between the playa deposits (Qp) of Stewart

Valley and Pahrump Valley as well as adjacent to parts of those playas. Locally includes evaporative surface crusts of salt or carbonate. Thickness indetermi-

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Inactive playa deposits (Holocene)—Silt, fine sand, and clay; locally contains

sodium carbonate and other carbonate salts, and rock salt (halite) (Hunt and

vegetation-stabilized mounds (coppice) near playa (Qp) and marl deposits (QTm) in the eastern half of the map area. Thickness probably less than 10 m

(1) has faint bar-and-swale topography with cobbles marking former bars that are

to moderately well sorted, nonbedded to well bedded, locally cross-bedded.

slightly higher than pebbly swales, or (2) is planar with slightly to locally

as 20 m at the head of fans adjacent to tectonically active mountain fronts

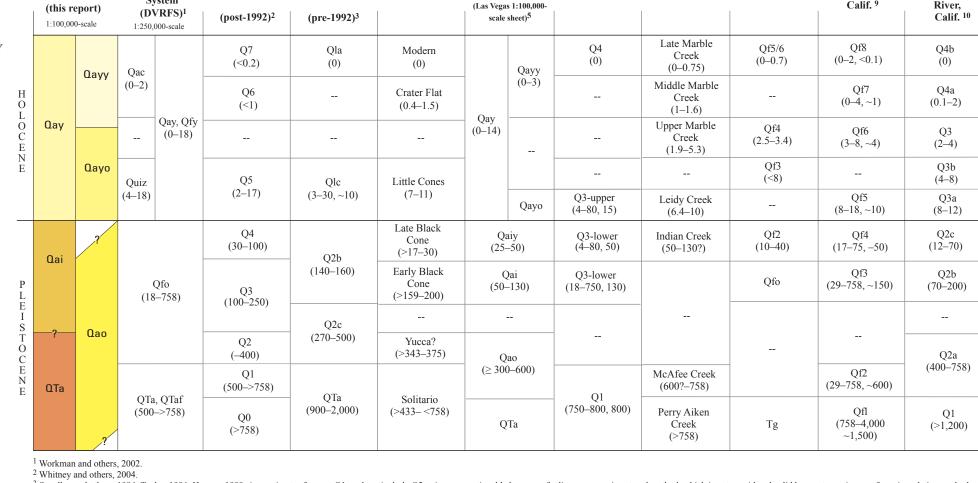
Younger intermediate alluvial deposits (late and late-middle? Pleistocene)—Gravel,

Qayo Young alluvial deposits, older part (middle and early Holocene)—Gravel, sand,

dated, poorly to moderately well sorted, nonbedded to well bedded, locally

Qay Young alluvial deposits (Holocene)—Gravel, sand, and silt; intermixed and

tectonically active mountain fronts



³ Swadley and others, 1984; Taylor, 1986; Hoover, 1989. Age estimates for post-Q1, and particularly Q2 units are questionable because of reliance on uranium-trend method, which is not considered valid by most practioners of uranium-dating methods, ⁴ Peterson, 1988; Peterson and others, 1995. Age estimates are uncertain for some units due to use of ¹⁴C varnish-dating method, which is currently considered unreliable. Page and others, 2005. Slate, 1991; Reheis and Sawyer, 1997.

light gray; unconsolidated to poorly consolidated, poorly to moderately well sorted, non-bedded to well bedded, locally cross-bedded. Clasts are commonly Wells and others, 1990. McDonald and Fadden, 1994; Wang and others, 1996. angular to subrounded; locally well rounded. Clasts commonly less than 0.5 m ¹⁰ Bull and Ku, 1975; Ku and others, 1979; Bull, 1991. in diameter, but as much as 2 m in diameter at and near base of steep slopes, and

GEOLOGIC SUMMARY INTRODUCTION This surficial geologic map of the Death Valley Junction 30' × 60' quadrangle was compiled digitally at 1:100,000 scale. The map area covers the central part of Death Valley and adjacent mountain ranges—the Panamint Range on the west and the Funeral Mountains on the east—as well as areas east of Death Valley including some of the Amargosa Desert, the Spring Mountains and Pahrump Valley (fig. 2). Shaded relief delineates the topography and appears as gray tones in the mountain ranges where the bedrock is undifferentiated and depicted as a single unit. This geologic map augments and extends previous regional surficial geologic mapping of parts of the same area (Hunt and Mabey, 1966; Wright and Troxel, 1993; Workman and others, 2002) by providing updated and (or) more detailed Quaternary geology, and improved GIS coverages. Data collection,

data analysis, and map compilation were funded primarily by the National Cooperative Geologic Mapping Program (NCGMP) of the U.S. Geological Survey (USGS) and to a lesser extent by the National Park Service (NPS). The primary purpose of this updated geologic framework is to aid interpretation of ground-water flow through Death Valley. The Nevada Test Site (NTS), north of the mapped quadrangle (fig. 1), is centrally located within the area of the Death Valley regional groundwater-flow system of southwestern Nevada and adjacent California (Slate and others, 1999; Workman and others, 2002). During the past 40 years, the U.S. Department of Energy and its predecessor agencies conducted about 900 nuclear detonation tests on the NTS, of which 100 were atmospheric tests and the rest

were underground (Laczniak and others, 1996). More than 200 were at or beneath the water table, contaminants introduced by these tests may move into water supplies off the NTS, rates and directions of ground-water flow must be determined. Knowledge about the ground water also is needed to properly appraise potential future effects of the possible nuclear-waste repository at Yucca Mountain, adjacent to the NTS. Furthermore, hydrologists need to determine the effects of the withdrawal of ground water from upstream parts of the flow system on water levels and thus on endangered animal and plant species in springs in downstream areas such as Devils Hole, Nev., and Death Valley, Calif. This study continued previous work by the Geologic Division and Water Resources Division of the USGS, in cooperation with other Federal, State, and County agencies and private contractors (Laczniak and others, 1996; Trudeau and Rowley, 1998; D'Agnese and Faunt, 1999; Faunt and others, 1999; O'Brien and others, 1999; Rowley and others, 1999). Because 95 percent of Death Valley National Park is designated as Wilderness Area as well as much of the rest of the quadrangle outside of park boundaries, the road network is sparse thereby

limiting access for field studies. Owing to limited access, we compiled the surficial geology mostly by interpreting aerial photography and field-checking along roads and geologically significant sites. We used 1:80,000-scale aerial photographs that were flown in 1983 for the USGS National High-Altitude Photography (NHAP) program. We mapped the contacts of the surficial units using diapositive-film format photographs, which have significantly better resolution than paper prints at the same scale. Digital files of the contacts were made using a computerized photogrammetric mapping system that consists of Carl Zeiss Inc. VrOne® software and a digital Kern model PG-2 stereoplotter. Stereo pairs of aerial photographs were mounted on the PG-2 and scaled to 1:24,000 DLG (digital line graph) files for the topographic base. This system enabled us to save time and reduce error by eliminating the steps needed to convert data from analog to digital ACKNOWLEDGMENTS

Chris Fridrich informally reviewed the map and made valuable contributions with regard to faults. Jeremy Workman consulted on faults in the eastern part of the quadrangle. David W. Moore and Michael N. Machette formally reviewed the map, and we thank them. Emily Taylor helped to develop an earlier version of table 2. GEOLOGIC MAPPING OF ALLUVIAL UNITS

We mapped six alluvial units (Qay, Qayy, Qayo, Qai, Qao, and QTa), an eolian unit (Qe), three playa or playa-related units (Ωp, Qps, and Ωpx), lacustrine beach deposits (Ωlb), colluvium (ΩTc), and marl (QTm). Alluvial units Qay, Qai, and QTa are based on those of Slate and Berry (1999) and Slate and others (1999); the additional alluvial units (Qayy, Qayo, and Qao) were mapped to aid interpretation of surficial processes and geologic history. Our regional mapping is consistent with detailed drainage-basin scale mapping of Knott (1998) and Klinger (2002). Alluvial units may include multiple periods of deposition that were not mapped separately because of the scale of our mapping. Additionally, some map units may include other surficial deposits that are too small to be shown separately, or are so thin (less than 0.5 m) that surface characteristics are controlled by the underlying mapped unit. Interpretation of surface morphology, tone, relative height, and landscape position in aerial photography enabled us to differentiate among the alluvial units (table 1). These in the map area, are highly generalized. Surface morphology of alluvium is a product of both depositional and post-depositional processes. Stream flows, debris flows, or some combination of the two are the main processes that deposit alluvial units. Post-depositional processes include weathering, eolian additions (surface accretion), winnowing by wind (deflation), reworking and erosion by water, creep, and bioturbation. Nevertheless, the systematic variations in alluvial surface morphology with age permit us to map and correlate geomorphic surfaces (Bull, 1991; table 2). Lithologic variations across the map area influence the tone of the alluvial units. Although young alluvial units are often light-toned due to an absence or paucity of rock varnish, they may appear dark where the source rocks are dark. Lithology also influences the development of rock varnish; fine-grained or aphanitic rocks, such as quartzite or basalt, tend to become varnished more quickly than rocks such as limestone or granite. Granite commonly disaggregates to grus before becoming varnished and limestone becomes etched. Relative height (topographic position) is useful for mapping in individual drainage basins near range fronts, but basinward, especially in tectonically inactive areas, most surfaces grade to the same base level, and relative height differs little among the alluvial units. Faulting, both the magnitude and location, also affects the map pattern of alluvial units. As faulting uplifts ranges relative to the basins, streams adjust to new base levels, abandoning and incising older alluvial units, thus preserving them on the footwall block of the fault. In tectonically inactive areas, streams continue to grade to the same level or aggrade, thus progressively burying older alluvial units. Therefore, map pattern of alluvial units is an important tool to evaluate late-phase basin evolution in the Basin and Range province.



Coalescing alluvial fans form bajada at Hanaupah Canyon, west side of Death Valley (fig. 2). A fault scarp cuts across the dark-toned fans in the bottom half of the photo. The West Side Road follows the line of vegetation (near the bottom of the photo), which marks locations of springs at the lowest reaches of the bajada. Photograph by Marli Bryant Miller, 2005.

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