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PRELIMINARY GEOLOGIC MAP OF THE HEDGES 7.5′ QUADRANGLE, CHOCOLATE MOUNTAINS, IMPERIAL COUNTY, CALIFORNIA

VERSION 1.0

By
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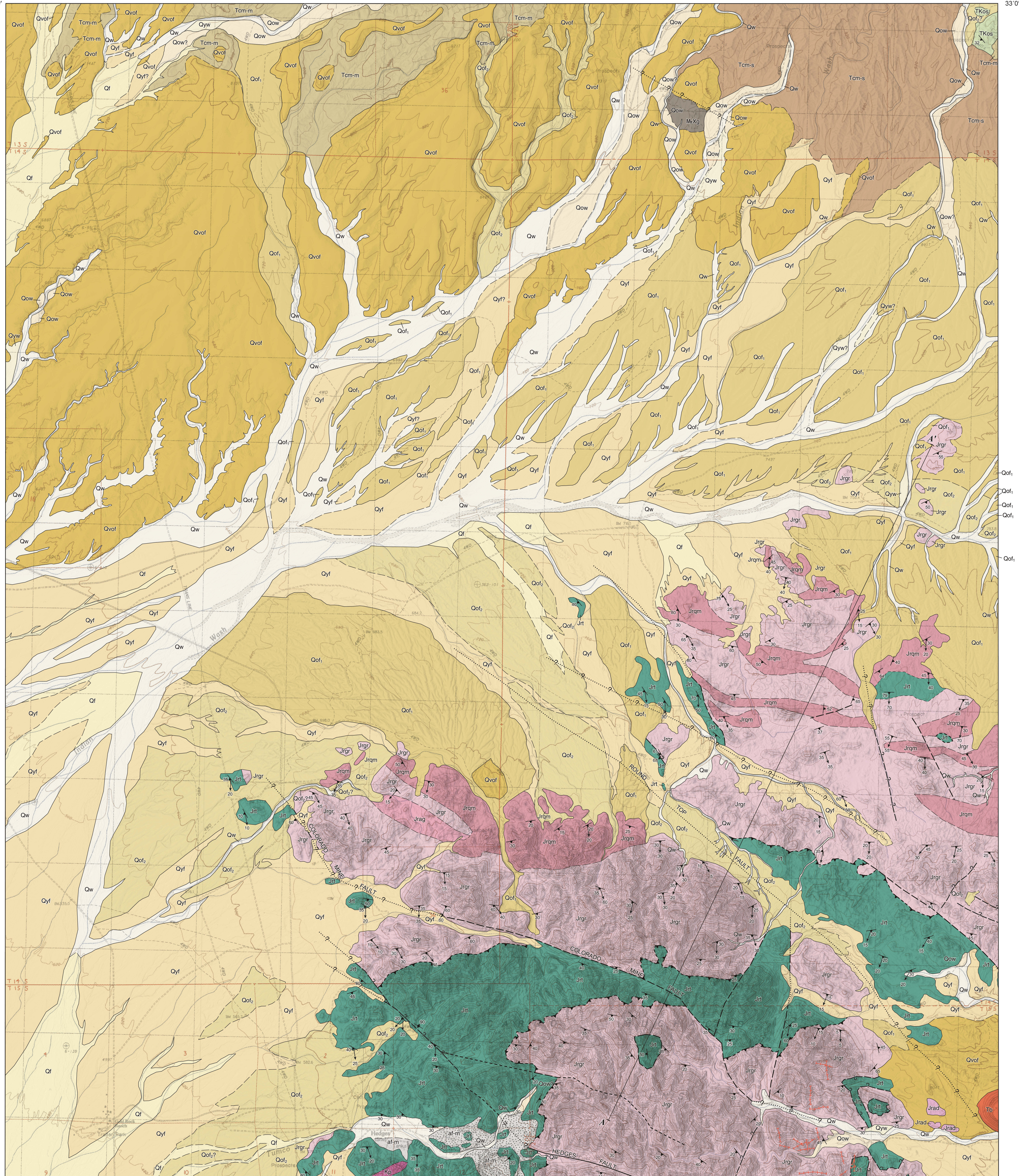
GIS and Digital Preparation by
Heather G. Dean and Rachel Beard

2024

California Department of Conservation
California Geological Survey



32°52′30″ 114°52′30″ — 32°52′30″ 114°45′

Scale 1:24,000

Contour Interval: 40 Feet
National Geodetic Vertical Datum of 1929

10.48° TRUE NORTH MAGNETIC NORTH
Approximate Mean Declination, 2024

Coordinate System:
Universal Transverse Mercator, Zone 11N,
North American Datum 1927

Topographic base from U.S. Geological Survey
Hedges 7.5-minute Quadrangle, 1988
Shaded relief image derived from USGS lidar DEM, 2021

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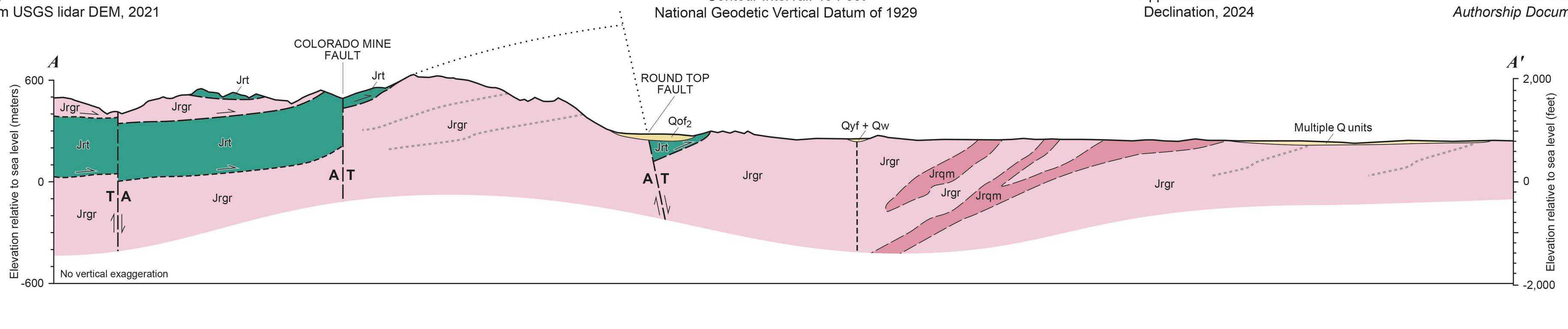


DESCRIPTION OF MAP UNITS

CHOCOLATE MOUNTAINS UNITS

SURFICIAL UNITS

af-m — **Artificial fill, mining related (historic)**—Deposits of fill resulting from mining or quarrying activities, including tailings, waste rock, and fills for associated access roads. Includes local areas of mine-disturbed bedrock of unknown affinity. Includes areas of undifferentiated, mineralized rock exposed at the Tumco Mine, which may include Jrt (Dillon, 1975; Morton, 1977).

Qw — **Wash deposits (late Holocene)**—Unconsolidated, very pale-brown sand, gravel, cobbles, and local boulders deposited in recently active stream channels. Occur as narrow deposits in canyons upstream of the mountain front and as anastomosing to elongate deposits where active flow paths continue beyond the mountain front and traverse older fan deposits but do not form fan-shaped landforms. Sediments are derived from local bedrock or reworked from adjacent older Quaternary materials subject to mobilization and redeposition during storm events; lack soil development and oxidation on clasts, and only support local, sparse vegetation.

Qf — **Alluvial fan deposits (late Holocene)**—Unconsolidated to weakly consolidated, pink (5YR 8/3), poorly sorted deposits of sand, gravel, cobbles, and local boulders with intermixed silt forming active, undissected, alluvial fans. Fan apices form outboard and downgradient of incised older fans. Fans are a mix of sediment-rich stream deposits and poorly bedded, poorly sorted debris flow deposits containing angular to sub-angular pebble- to boulder-size clasts closer to incised older fans. Clasts are typically unweathered with little to no oxidation or desert varnish and are derived from upslope sources and reworked from adjacent, older fan deposits. Local-scale braiding on distributary fan surfaces.

Qyw — **Young wash deposits (middle Holocene to late Pleistocene)**—Unconsolidated to slightly consolidated and undissected to slightly dissected, pink, sandy and gravelly stream bed sediments locally preserved adjacent to active wash deposits. Sediments are derived from local bedrock or reworked from adjacent older Quaternary deposits and may be subject to remobilization during large storm events.

Qyf — **Young alluvial fan deposits (middle Holocene to late Pleistocene)**—Unconsolidated to weakly consolidated, pink (5YR 7/3), poorly sorted deposits of sand, gravel, cobbles, and local boulders with intermixed silt. Surfaces are undissected to slightly dissected. Clasts are generally weakly weathered with little oxidation and desert varnish. Clasts are derived from upslope sources or reworked from older, adjacent fan deposits. Fans are composed of sediment-laden stream deposits and poorly bedded, poorly sorted debris flow deposits containing pebble- to boulder-size clasts closer to the mountain front.

Qow — **Old wash deposits (late to middle Pleistocene)**—Slightly to moderately consolidated, moderately dissected, light-gray sand and gravel; typically elevated above modern washes.

Old alluvial fan deposits (late to middle Pleistocene)—Slightly to moderately consolidated, poorly sorted deposits of silty, pebbly sand to coarse gravel and boulders. Deposits form broad, isolated fan surfaces that are typically smooth to moderately dissected and isolated by intervening younger fan and wash deposits. Surfaces exhibit desert varnish patinas and desert pavement development. Surfaces are generally elevated at least several meters above active channel grade and not subject to historic flood inundation. Locally differentiated into two subunits.

Qof_2 — **Old alluvial fan deposits, younger facies**—Sediments of Qof_2 are brown to dark brown, less consolidated and fans are less dissected compared to Qof_1. Fan surfaces have sparse and discontinuous desert pavement development compared to Qof_1.

Qof_1 — **Old alluvial fan deposits, older facies**—Sediments of Qof_1 are more consolidated, brown to red brown, and fan surfaces are more dissected. Fan surfaces are smoother and desert pavement development is more continuous compared to Qof_2.

Qvof — **Very old alluvial fan deposits (middle to early Pleistocene)**—Moderately to well-consolidated, light-gray (10YR 7/2) deposits of silt, sand, gravel, cobbles, and boulders. Clasts are derived from local, upslope sources. Fan surfaces are covered in basalt boulders with significant desert varnish. Fans are composed of graded beds that contain imbricated clasts. Finer-grained intervals contain centimeter-scale cross-bedding. Fan surfaces are smooth with well-developed desert pavement and are deeply dissected by active channels. Fan surfaces may extend up to tens of meters above adjacent channel grade.

SOUTHERN CHOCOLATE MOUNTAINS UNITS

TERTIARY SEDIMENTARY UNITS

Bear Canyon conglomerate (Miocene)—The Miocene Bear Canyon conglomerate is the only Tertiary sedimentary unit that crops out in the southern Chocolate Mountains. Bear Canyon conglomerate is an informally named unit first mapped by Crowe (1978) and described in detail by Hughes (1990). This formation contains conglomerates and fluvial gravels composed dominantly of metamorphic and volcanic rock clasts likely sourced from the southern Chocolate Mountains. Ricketts and others (2011) mapped the Bear Canyon conglomerate throughout the southern Chocolate Mountains and divided the formation into three sequences based on clast composition and internal angular unconformities. In Bear Canyon, north of the map area, the uppermost sequence (sequence III) is interbedded with 9.45 Ma basalt flows, and the lowermost sequence (sequence I) rests unconformably on ~23 Ma volcanic rocks (Ricketts and others, 2011).

Complete sequences of the Bear Canyon conglomerate as documented by Ricketts and others (2011) were not observed in the Hedges Quadrangle. Subunits in the study area are described and mapped based on clast and matrix composition and relative stratigraphic position observed in the field. North of the map area in the Indian Pass Wilderness, Tcm-s is overlain by the 9.45 Ma Black Mountain Basalt. Approximately 2 km east-southeast of the prospects around Indian Wash, deposits of Tcm-m and Tcm-s interfinger. Tcm-m and Tcm-s in the study area are tentatively correlated with lower and upper subunits within sequence II of Ricketts and others (2011). More work is needed to determine the internal stratigraphic relationships between the subunits mapped to definitively correlate them with sequences defined by Ricketts and others (2011).

Tcm-s — **Bear Canyon conglomerate, muscovite schist**—Moderately to well-consolidated, light-gray gravels deposited by fluvial processes and debris flows. Surface exposure is a conspicuously light gray to white color in NAIP imagery. Clast-supported fluvial deposits are dominantly comprised of subrounded coarse sand and cobbles and local boulders in a buff-colored, silty-clay matrix. Clasts in fluvial gravel and debris flow intervals are 70% volcanics and 30% muscovite schist, gneiss, and quartz fragments. This unit contains rounded cobble- to boulder-size clasts of kyanite schist and dumortierite. Fluvial gravel intervals contain graded beds approximately 30 cm thick.

Tcm-m — **Bear Canyon conglomerate, mixed**—Moderately consolidated, well-indurated conglomerates deposited by debris flows, and as fluvial gravels; clasts composed dominantly of metamorphic and volcanic rock. Conglomerate intervals are matrix-supported and contain angular to subangular, pebble- to boulder-size clasts with a tan, silty-clay matrix. Fluvial gravels contain interbedded sandy intervals with graded beds approximately 0.5 m thick, with centimeter-scale cross-bedding in silty intervals.

TERTIARY VOLCANIC UNITS

Tb — **Basalt (Miocene)**—Vesicular, dark-gray, aphanitic basalt with phenocrysts of plagioclase (15%), olivine (<1%), and pyroxene (<1%). Vesicle abundance is 20% of the rock and vesicles range in size from 1 mm to 1 cm. Olivine crystals are 1 mm or smaller with iddingsite rims. Plagioclase phenocrysts are translucent and acicular to prismatic. Tb outcrops form mesas ranging from ~0.5 to 1 square km in area and consist of blocky, broken-up flows west of the central and southern Cargo Muchacho Mountains, and as a monogenetic cone to the east of the central Cargo Muchacho Mountains. Tentatively correlated with the Black Mountain basalt in the Chocolate Mountains (Muela (2011) reported an age of 9.45 +/- 0.27 Ma using $^{40}Ar/^{39}Ar$) based on petrographic similarities (Olmstead and others, 1973; Dillon, 1975).

INTRUSIVE AND METAMORPHIC ROCKS – EARLY TERTIARY AND OLDER

TKos — **Orocopia Schist (Paleocene to Late Cretaceous)**—Muscovite-biotite-quartz schist. Well-developed schistosity defined by 1- to 2-mm-diameter crystals of muscovite and biotite with scattered amphibole. Weathers into platy fragments that are 2–5 cm thick by 12–30 cm wide. Unit is cut by veins of massive milky white quartz and iron oxide-cemented breccia, which are often parallel to and within foliation. Correlative with the "Pelona-Orocopia Schist" of Haxel and Dillon (1978). U-Pb analyses of detrital zircons from samples of Orocopia schist collected in Marcus Wash north of the map area indicate a maximum depositional age of approximately 71 Ma (Grove and others, 2003).

MzXg — **Mafic orthogneiss (Mesozoic to Proterozoic(?))**—Gneiss and muscovite schist. Gneiss contains dark bands of mafic minerals roughly one centimeter apart, which define foliation. Schist contains millimeter-size intergrown grains of quartz and feldspar with roughly 15% 1- to 2-mm-diameter platy muscovite and/or biotite growing along foliation. In the modern exploration workings at Indian Pass, the contact between gneiss and schist is not exposed but both are intensely brecciated and cut by pegmatite dikes. Pegmatite dikes may be correlative to the granite phase of the Paleocene or Eocene "Marcus Wash Granite" described by Haxel (1977).

CARGO MUCHACHO MOUNTAINS UNITS

INTRUSIVE AND METAMORPHIC ROCKS – MESOZOIC AND OLDER

Kp — **Pegmatite (Late Cretaceous)**—Coarse-grained, centimeter- to meter-wide pegmatite dikes that crosscut the Tumco Formation (Jrt) and Gold Rock Ranch granite (Jrgr) (Cawood and others, 2022). Contains very coarse-grained (up to 10 cm) quartz and feldspar, and minor fine- to coarse-grained muscovite, biotite, and accessory garnet. U-Pb cooling age on apatite of 60 +/- 3.5 Ma (Cawood and others, 2022). Fold orientations suggest intrusion was synkinematic with thrusting on the American Girl fault (Cawood and others, 2022). A series of dikes mapped as lines within Jrgr may belong to this unit.

Jrgr — **Gold Rock Ranch granite (Late to Middle Jurassic)**—Foliated biotite granite exposed in the northern Cargo Muchacho Mountains (Tosdal and Wooden, 2015; Cawood and others, 2022). Foliation defined in part by discontinuous, millimeter-thick by 2-cm-long bands of biotite crystals (20%). Individual biotite grains are ~1 mm in diameter. 2- to 5-mm crystals of feldspar (40%) and quartz (40%), with coarser feldspar grains occurring in deuterically altered zones in the vicinity of the American Girl fault. Weathers into rectangular blocks with joints cutting foliation. This unit was mapped in detail by Dillon (1975) as coarse- to medium-grained, leucocratic biotite granite orthogneiss ("Jrbg", Jrbf") observed cross-cutting the Araz Wash granodiorite (Jrag), Araz Wash diorite (Jrad), and Tumco Formation (Jrt) (Dillon, 1975). Emplacement age of 163.8 +/-1.2 Ma based on U-Pb dating of zircons (Tosdal and Wooden, 2015). In the southeast corner of the quadrangle, Jrgr is intruded by numerous dikes of variable orientation and unknown age. These dikes may be correlative to Kp or the unit KJrd mapped in the Ogilby Quadrangle (Cantwell and Key, 2024).

Jrag — **Araz Wash granodiorite (Jurassic)**—Whitish-green hornblende-biotite-quartz granodiorite (Tosdal and Wooden 2015; Cawood and others, 2022). Weakly foliated, with 30% 0.3- to 1-cm glomerocrysts of biotite, hornblende, and sphene. Anhedral quartz (25%) and anhedral to subhedral feldspar (45%) both range in size up to 1 cm. Unit contains scattered mafic inclusions up to 10 cm in diameter and is cut by quartz veins up to 30 cm wide. Weathered surfaces are dark grey to brown. Weathering is pervasive along weak foliation. Up to 30% of feldspar grains show light-green saussuritization. This unit was mapped as quartz monzonite ("Mzqm") by Dillon (1975) and crosscuts Araz Wash diorite (Jrad). Emplacement age 172 +/- 4.8 Ma based on U-Pb dating of zircons (Tosdal and Wooden, 2015).

Jrad — **Araz Wash diorite (Jurassic)**—Hornblende-biotite quartz diorite (Dillon, 1975). Unit is weakly to moderately foliated with very fine-grained needles of amphibole intergrown into glomerocrysts elongated parallel to foliation and lesser biotite and sphene. Glomerocrysts range in size from 0.1 to 1 cm. Hornblende also occurs as disseminated, fine, needle-like crystals oriented within the plane of foliation; 2- to 3-mm intergrown crystals of quartz and feldspar are difficult to distinguish. Scattered euhedral plagioclase crystals up to 8 mm are also present. In thin section, quartz displays fine recrystallization texture, and plagioclase displays partial saussuritization. Unit is weakly to moderately foliated. Correlative with unit "d" of Dillon (1975). U-Pb dating of zircons from Jrad produced a mean weighted average age of 173.7 +/- 1.9 [3.5] Ma (MSWD = 0.8) (age +/-internal 2SE uncertainty [total 2% uncertainty]; analyses were conducted using laser ablation ICP-MS analyses at the CSUN Laser Lab (J. Schwartz, written commun., 2024)).

Jrqm — **Biotite-hornblende quartz monzonite orthogneiss (Jurassic)**—Foliated coarse-grained orthogneiss. Coarse-grained (up to 3 cm) microcline and plagioclase and 10% hornblende, biotite, and accessory minerals including epidote, chlorite, sphene, apatite, zircon, calcite, and opaques (Dillon, 1975). Dillon notes that Jrqm intrudes Jrt and is cut by Jrgr.

Jrt — **Tumco Formation (Jurassic)**—Laminated, grayish-orange, quartzofeldspathic gneiss (Dillon, 1975). Laminations defined by parallel alignment of fine- to medium-grained (up to 1 mm) biotite (30%). Quartz and feldspar grains are slightly coarser than biotite (1–2 mm), with scattered quartz and feldspar augens 0.2 cm by 5 cm wide. Millimeter- to centimeter-scale gneissic banding present. In thin section, partial sericitization of feldspar and chloritization of biotite are visible, as well as the presence of very fine-grained accessory garnet and scattered fine-grained amphibole. Relict depositional layering combined with preserved magmatic phenocryst textures suggest a volcanic or volcaniclastic protolith (Dillon, 1975; Tosdal and Wooden, 2015). Weathers into large meter-scale blocks. Unit is pervasively cut by felsic dikes that range from centimeter-scale ptygmatic veinlets to large features tens of meters wide, extending over one km in length (including Late Cretaceous pegmatites (Kp) of Cawood and others (2022)). Based on work by previous authors (Dillon, 1975; Cawood and others, 2022) it appears that there are at least three distinct compositions of these dikes, which include Kp; more work is needed to resolve the spatial and chemical distribution of dikes within the Tumco Formation. Dillon (1975) observed local zones of interbedded quartzite, marble, and amphibolite throughout the unit, as well as a series of amphibolite dikes cutting the Tumco Formation (Jrt) in the southeastern Cargo Muchacho Mountains. Tosdal and Wooden (2015) obtained a rock age of 185 +/- 2.9 Ma from U-Pb dating of seven zircons in a quartzofeldspathic gneiss from the Tumco mine that they interpreted as meta-dacite.

MAP SYMBOLS

Contact between map units – Solid where accurately located; long dash where approximately located; short dash where inferred; dotted where concealed

Fault – Solid where accurately located; long dash where approximately located; short dash where inferred; dotted where concealed; queried where uncertain

Thrust Fault – Sawteeth on upper (tectonically higher) plate; long dash where approximately located; short dash where inferred; dotted where concealed; queried where uncertain

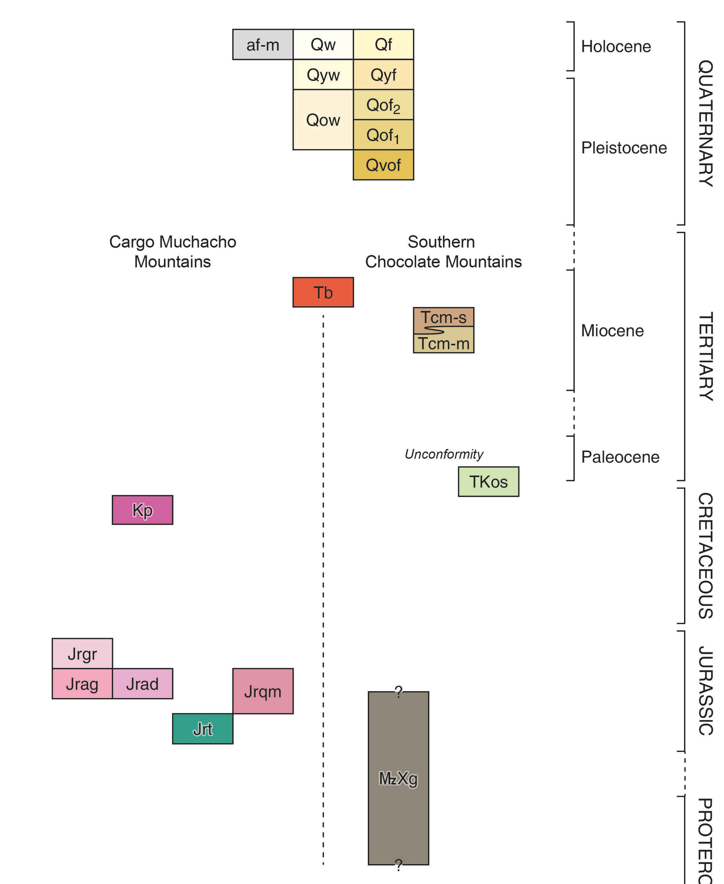
Dike – Solid where accurately located

Area disturbed by mining

Strike and dip of geologic structure; number indicates strike or dip angle in degrees

25 / 50 — Metamorphic foliation; may locally represent mylonitic foliation. Trend and plunge of metamorphic lineation. Foliation and lineation orientations digitized from Dillon (1975)

CORRELATION OF MAP UNITS



SELECTED REFERENCES

Cawood, T.K., Moser, A., Borsook, A., and Rooney, A.D., 2022, New constraints on the timing and character of the Laramide orogeny and associated gold mineralization in SE California, USA: Geological Society of America Bulletin, v. 134, no. 11-12, p. 3221-3241., map scale 1:24,000.

Cantwell, C.A., Key, E.L., 2024, Preliminary Geologic Map of the Ogilby 7.5′ Quadrangle, Cargo Muchacho Mountains, Imperial County, California: California Geological Survey Preliminary Geologic Map 24-05, Scale 1:24,000.

Crowe, B.M., 1978, Cenozoic volcanic geology and probable age of inception of basin-range faulting in the southeasternmost Chocolate Mountains, California: Geological Society of America Bulletin, v. 89, no. 2, p. 251-264., map scale 1:24,000.

Dillon, J.T., 1975, Geology of the Chocolate and Cargo Muchacho Mountains, southeasternmost California [Ph.D. dissertation]: Santa Barbara, University of California, 405 p., map scale 1:24,000. Drobeck, P. A., Hillemeyer, F. L., Frost, E. G., and Liebler, G. S., 1986, The Picacho Mine: A Gold Mineralized Detachment in Southeastern California, in Beatty, B. and Wilkinson, P.A. K., eds., Frontiers in Geology and Ore Deposits of Arizona and Southwest: Arizona Geological Society Digest 16, p. 187-221.

Grove, M., Jacobson, C.E., Barth, A.P., and Vucic, A., 2003, Temporal and spatial trends of Late Cretaceous–early Tertiary underplating of Pelona and related schist beneath southern California and southwestern Arizona, in Johnson, S.E., et al., eds., Tectonic Evolution of Northwestern Mexico and the Southwestern USA: Geological Society of America Special Papers, v. 374, p. 381–406.

Haxel, G.B., 1977, The Orocopia Schist and the Chocolate Mountain thrust, Picacho-Peter Kane Mountain area, southeasternmost California [Ph.D. dissertation]: Santa Barbara, University of California, 277 p., map scale 1:24,000.

Haxel, G.B., and Dillon, J.T., 1978, The Pelona-Orocopia Schist and Vincent–Chocolate Mountain thrust system, southern California, in Howell, D.G., and McDougall, K.A., eds., Mesozoic paleogeography of the western United States: Pacific Section, Society of Economic Paleontologists and Mineralogists Pacific Coast Paleogeography Symposium 2, p. 453-469.

Haxel, G.B., Tosdal, R.M., and Dillon, J.T., 1985, Tectonic setting and lithology of the Winterhaven Formation; a new Mesozoic stratigraphic unit in southeasternmost California and southwestern Arizona: U.S. Geological Survey Bulletin 1599, 13 p.

Hughes, K.M., 1990, The Bear Canyon conglomerate as a record of tectonics and sedimentation during initiation of the Salton Trough [M.S. thesis]: San Diego State University, San Diego, California, 104 p.

Jacobson, C.E., Sherrod, D.R., Tosdal, R.M., Lishansky, R., Beard, L.S., Haxel, G.B., Harding, C., Grove, M.J., and Tian, B., 2022, Geologic map and geochronology of the Picacho, Picacho NW, Picacho SW, and Hidden Valley 7.5-minute Quadrangles, Arizona and California: Arizona Geological Survey Contributed Report CR-22-C, 33 p., scale 1:50,000, with GIS database.

Khanchuk, A.I., and MacDonald, J.H., eds., Late Jurassic Margin of Laurentia—A Record of Faulting Accommodating Plate Rotation: Geological Society of America Special Paper 513, p. 189–221.

Morton, P.K., 1977, Geology and mineral resources of Imperial County, California: California Division of Mines and Geology County Report 7, 104 p., map scale 1:100,000.

Muela, K.K., 2011, Timing and style of Miocene deformation, Indian Pass and Picacho State Recreation Area, SE California, U.S.A. [M.S. thesis]: San Diego State University, San Diego, California, 44 p.

Olmsted, F.H., Loeltz, O.J., and Irelan, B., 1973, Geohydrology of the Yuma area, Arizona and California: U.S. Geological Survey Professional Paper 486-H, 227 p.

Ricketts, J.W., Girty, G.H., Sainsbury, J.S., Muela, K.K., Sutton, L.A., and Biggs., M.A., 2011, Episodic growth of the Chocolate Mountains anticlinorium recorded by the Neogene Bear Canyon Conglomerate, southeastern California, U.S.A.: Journal of Sedimentary Research, v. 81, no. 12, p. 859-873., map scale 1:24,000.

Tosdal, R.M., and Wooden, J.L., 2015, Construction of the Jurassic magmatic arc, southeast California and southwest Arizona, in Anderson, T.H., Didenko, A.N., Johnson, C.L.

IMAGERY

U.S. Department of Agriculture, 2020, Farm Service Agency–Aerial Photography Field Office, National Agriculture Imagery Program (NAIP), 60cm resolution. http://datagateway.nrcs.usda.gov/

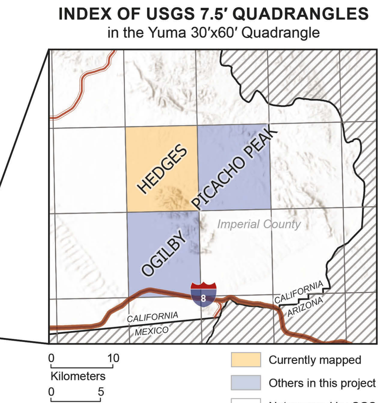
U.S. Geological Survey, 2023, USGS Lidar Point Cloud CA Salton Sea: U.S. Geological Survey.

U.S. Geological Survey, 2011, Imperial County high resolution orthoimagery, 30cm resolution.

Project Location

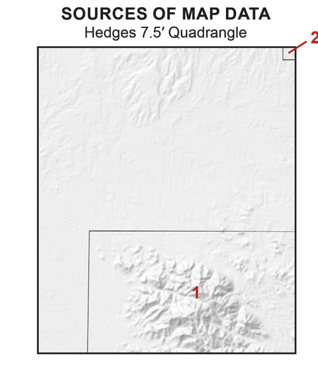
INDEX OF USGS 7.5′ QUADRANGLES

in the Yuma 30′x60′ Quadrangle



SOURCES OF MAP DATA

Hedges 7.5′ Quadrangle



1. Cawood and others, 2022
2. Haxel, 1977

Data sources that cover the entire quadrangle:
Dillon, 1975
Key and Cantwell, 2024

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Preliminary Geologic Map 24-04

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