Map Unit Properties Table: Coronado National Memorial

Units that are not mapped within Coronado National Memorial boundaries are colored gray.

Age		Unit Name (Symbol)	Features and Description	Erosion Resistance	Suitability for Infrastructure	Hazards	Paleontological Resources	Cultural Resources	Caves/Karst	Mineral Occurrence	Habitat	Recreation	Geologic Significance
QUATERNARY	Holocene	Colluvium (Qc)	Gravelly sand with abundant cobbles in distributary flow areas of alluvial fans. Deposited at the base of gentle slopes or hillsides.	Sand is less resistant than cobbles.	Roads; Visitor Center.	Potential creep if toe of slope cut.	None documented.	Possible American Indian sites.	None documented.	Sand and gravel.	Gamma grass; lovegrasses.	Hiking in canyon.	Recent deposit.
		Lake deposits (Qls)	Light-olive-brown to orange-brown, commonly fissile shale and siltstone, evaporites, and fine- to very-fine-grained sandstone. Locally gypsiferous.	Low.	Not mapped in the memorial.	None.	Unknown.	Unknown.	None documented.	Gypsum.	Gypsum limits plant growth.	Limited exposure in backcountry.	Records seasonal deposition.
		Talus deposits (Qt)	Unconsolidated rock material derived from and lying at the base of very steep rocky slopes, especially the steep cliffs of Cb. Most mapped talus deposits contain scarp areas as well as slope deposits.	High for unconsolidated sediment.	Low.	Rocks may shift. Overhanging cliff collapse.	None documented.	None documented.	None documented.	None documented.	Habitat for small animals.	Not advisable; rocks may shift; safety issue.	Evidence of mass wasting.
		Debris flow deposits (Qd)	Unsorted to poorly sorted, unstratified to poorly stratified, clay- to boulder-sized matrix-supported deposits formed by sediment-dominated flow. May include nearly intact slumped blocks of bedrock several meters long.	Variable. Clay and silt less resistant than coarser material.	Low. Not advisable to build in debris-flow paths.	Damage to infrastructure if in debris flow paths.	None documented.	None documented.	None documented.	None documented.	Sparse vegetation on recent debris flow deposits.	Past debris flows damaged picnic areas and other infrastructure.	Major process in channel modification.
		Debris fans (Qdp)	Fan-shaped or planar surfaces that are active only during intense periods of precipitation. Mapped on lower canyon slopes well north of the memorial.	Variable grain size and surface cement.	Not mapped in the memorial.	None. Forms gentle slopes.	Unknown.	Possible American Indian sites.	None documented.	Landscape feature (not a lithic unit).	Lower valley vegetation.	Picnic area and secondary road.	Intense precipitation events.
		Alluvium (Qal)	Recent gravels along Holocene stream drainages. Sand, silt, and gravel in narrow washes; material on alluvial fans from season flooding; some talus and colluvium. Mapped in the southwest corner of the map. Primarily San Pedro River channel and floodplain to the east.	Variable. Silt less resistant than sand and gravel.	Low. Associated with stream channels.	Potential flooding.	Unknown, but limited due to flooding and erosion.	Any sites present possibly destroyed by water erosion.	None documented.	Sand and gravel. May contain placer gold deposits.	Riparian vegetation susceptible to flooding.	Hiking along stream channels.	Regional aquifer.
	Pleistocene	Terrace gravels: (Qgy, Qgy2, Qgy1, QgM2b, QgM2, QgM2a; QgM1)	Qgy, Qgy2, and Qgy: Terrace, channel, and alluvial-fan deposits of gravel, gravelly sand, sand, and silt with abundant cobbles and boulders. Ogy is a general designation for areas too small to map at this scale. Qgy2: Modern terrace gravels, channel deposits, and gravel bars. Qgy1: Younger terrace and alluvial-fan deposits. Generally finer-grained toward distal portions of the deposits.	Variable.	Provide relatively flat surfaces but limited areal extent.	Flash flooding could erode terrace.	None documented.	Possible American Indian sites.	None documented.	Gravel. Placer gold deposits discovered outside the memorial.	Gamma grass; lovegrasses.	Suitable for hiking.	The vertical and lateral channel erosion represents periods of climate fluctuations.
			QgM2b: Stream terraces and abandoned fan remnants. Silt, sand, and extremely gravelly sand; abundant cobbles near mountains and in terraces along larger channels; distal deposits are very fine-grained (clay). QgM2: Areas of broadly defined terrace and abandoned fan deposits.	Variable. Finer-grained sediment less resistant.	High. Contains roads; ranches.	Occasional flooding from intense precipitation.	Pleistocene and Holocene fossils possible.	Possible American Indian sites.	None documented.	Sand and gravel.	Gamma grass; lovegrasses and other low-elevation plants.	Suitable for hiking.	
			QgM2a: Older stream terraces and abandoned fan remnants. Very similar to younger QgM2b deposits (same composition). Distinguished by deeper dissection and greater soil-profile development.	Variable. Finer-grained sediment less resistant.	Not mapped in the memorial.	Occasional flooding.	Pleistocene and Holocene fossils possible.	Possible American Indian sites.	None documented.	Sand and gravel.	Low-elevation plants.	Suitable for hiking.	
			QgM1: Mostly fan remnants and local stream terraces. Composed of gravelly to extremely gravelly sand and silt. Concentrations of reddened pebbles and cobbles overlie red clay surfaces. Characterized by relatively narrow, curvilinear, discontinuous uplands dissected by intervening swales and gullies. Depth of dissection is commonly 5 to 8 m (16 to 26 ft).	Silt is less resistant than sand and gravel.	Minor exposures. Associated with swales and gullies.	Minor flooding with occasional intense storm.	Pleistocene and Holocene fossils possible.	Possible American Indian sites.	None documented.	Sand and gravel.	Gamma grass; lovegrasses and other low-elevation plants.	Suitable for hiking.	

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QUATERNARY – Pleistocene	Terrace Gravels: (QgO, QgO2, QgO1)	QgO: Piedmont gravels (undefined). Areas of broadly defined lower and upper piedmont deposits.	Low.	Minor, isolated exposure.	None.	Pleistocene fossils possible.	Possible American Indian sites.	None documented.	Possible placer gold deposits outside the memorial.	Gamma grass; lovegrasses.	Hiking.	Deposited during a time of relative landscape stability. Extensive pediment formation. QgO2 may be substantially older than 700,000 years in some places.
		QgO2: Gravels of the lower and middle piedmont. Coarse, carbonate-cemented alluvial gravels, generally less than 1 m (3.3 ft) thick, capping basin fill (QTbf) over a widespread erosional surface. Mapped well north of the memorial.	Moderate to high. (carbonate cement in basin center).	Not mapped in the memorial.	None. Forms gentle slopes in the basin.	Pleistocene and Holocene fossils possible.	Possible American Indian sites.	None documented.	Gravel.	Basin interior vegetation.	Limited due to position within the basin.	
		QgO1: Gravelly sand and silt of the upper and middle piedmont. Generally coarser than younger deposits in those areas. Dark red-stained cobbles overly strongly- reddened surfaces. Relatively narrow, curvilinear ridges, cut by intervening gullies or ravines to depths of 10 to 25 m (33 to 82 ft).	Variable. Silt is less resistant than sand and gravel.	Contains a road, gullies, and ravines.	No major hazards. Infrequent flooding potential.	Pleistocene and Holocene fossils possible.	Possible American Indian sites.	None documented.	Sand and gravel.	Gamma grass; lovegrasses and other low-elevation plants.	Southeast corner of memorial. Potential for hiking.	Reflect a time of relative landscape stability.
	Lower Pleistocene to upper Pliocene clay and fine-grained sandstone (QTbf)	Generally red-colored with local exposures of buried paleosols. If not capped by QgO2, forms gently rounded, eroded hills, up to about 15 m (49 ft) above active channels. Mapped in the northeast corner of the map.	Eroded into gently rounded hills.	Not mapped in the memorial.	None.	Pleistocene and Holocene fossils possible.	Possible American Indian sites.	None documented.	Possible clay for brick making.	Basin interior vegetation.	Limited due to position within basin.	Paleosols formed during relative land-scape stability.
NEOGENE – TERTIARY	Holocene to Oligocene surficial deposits (QTg)	Gravel, sand, and silt. Mainly basin alluvium. Includes some colluvium and landslide deposits. Light-pinkish-gray, weakly indurated, and with poorly rounded clasts. Mapped 10 km (6 mi) east of Montezuma Ranch.	Variable, depending on clast size and surface cement.	Not mapped in the memorial.	Located within the San Pedro floodplain.	Unknown.	Possible prehistoric and early settler sites.	None documented.	Sand and gravel.	Ranching and agricultural influence.	Developed areas (towns, ranches, railroad, roads).	Basin-fill deposits.
PALEOGENE – TERTIARY	Tertiary Quartz rhyolite porphyry (Tkr) Diabase (Tkd)	Tkr: Small stock and dikes of crystal-rich (30%) rhyolite. Intrudes tuff and megabreccia on the southeastern slope of Bob Thompson Peak. Contains 5- to 10-mm (0.2- to 0.4-in) phenocrysts of quartz and potassium feldspar and abundant limestone xenoliths. Tkd: Small plug-like bodies and sills of fine-grained plagioclase and pyroxene diabase. Dusky-red to greenish black. Includes small body of diabase that intrudes Jg on the western side of Montezuma Pass.	High, but minor exposures.	Local, limited exposures near Bob Thompson Peak and Montezuma Pass.	None. Limited areal extent.	None documented. Fossils in extrusive igneous rocks are rare.	None documented.	None documented.	Quartz, potassium feldspar.	Mixed forest of oak, Mexican piñon pine, alligator juniper.	Local exposures near Bob Thompson Peak and Montezuma Pass.	Tkr: May be pyroclastic in origin.
	Tertiary Granodiorite (Tgd) Quartz veins (Tqv) Quartz monzonite (Tqm)	Tgd: Granodiorite to microgranodiorite sills and dikes. Very fine-grained, dark-greenish-gray. Tqv: (Tertiary?) Irregular veins of white quartz. Tqm: Sill and dike rock, fine-grained orange to pinkish-orange. Mapped along the western edge of the map; west of the memorial.	High, except where fractured.	Not mapped in the memorial.	Tqm: potential rockfall.	None.	Limited areal extent of outcrops.	None documented.	Quartz.	May be open woodland environment.	Areal extent limited to a ridge of Tqm. No trails noted on map.	Record Tertiary intrusive events.
CRETACEOUS – Upper	Fort Crittenden Formation (Kfc)	Grayish-yellow and reddish-brown shale, reddish-brown and greenish-gray clay-rich sandstone, and interbedded pebble conglomerate; weathers light brown. More than 460 m (1,500 ft) thick. Mapped in Save Canyon, located on the western edge of map, far from memorial.	Variable depending on clast size and local cementation.	Not mapped in the memorial.	None. Forms gentle slopes.	In general, Kfc is not considered to contain fossils.	Possible prehistoric and early settler sites.	None documented.	No significant minerals.	Lower elevation grasses, shrubs, and mesquite trees.	Limited areal extent. No trails noted.	Initial Laramide Orogeny deposits in the area.
CRETACEOUS – Lower	Bisbee Group: Cintura Formation (Kc)	Pale-red mudstone and siltstone, grayish-pink cross-laminated arkosic sandstone, and minor light-olive-gray clay-rich sandstone. Thin beds of clay-rich limestone in lower part. Thickness: 180 to 370 m (600 to 1,200 ft).	Variable. Mudstone low; limestone high.	Not mapped in the memorial.	None. Forms gentle slopes.	Unknown.	Limited areal extent.	None documented.	No significant minerals.	Low-elevation grasses, shrubs, and mesquite.	Mapped in Save Canyon, west of the memorial.	Marine regression.

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CRETACEOUS	Lower	Mural Limestone (Kmu)	Medium-gray limestone, greenish-gray calcareous siltstone, and minor reddish-brown mudstone. Limestone dominant in upper part; shale and siltstone dominant in lower part. About 180 m (600 ft) thick.	Variable. Mudstone low; limestone high.	Not mapped in the memorial.	None. Limited areal extent.	Unknown. May contain mollusk fossils.	Limited areal extent.	None documented.	No significant minerals.	Low-elevation grasses, shrubs, and mesquite.	Mapped in Save Canyon, west of the memorial.	Maximum marine transgression in the Bisbee basin.
CRETACEOUS	Lower	Morita Formation (Km)	Fine- to medium-grained, well-sorted, quartz sandstone interbedded with red to maroon siltstone and shale. Exposed in a series of complex fault slices in a zone of imbricate reverse faults within Montezuma Canyon. Fractures in shale layers are at high angles to sandstone beds. Rests on coarse volcaniclastic conglomerate of Jg. Unconformable contacts locally.	High.	Low. Exposures in fault slices on slopes in Montezuma Canyon.	Potential rockfall in Miller Peak area and slumping in canyon.	Oyster-bearing limestone in upper part. Petrified wood outside of memorial.	Possible artifacts from the State of Texas mine. Possible prehistoric sites.	None reported in the southern Huachuca Mountains.	New Hartford and New Reef mineral districts. North of the memorial, pyrite sphalerite, hematite, galena, chalcopyrite, limonite, scheelite in quartz veins.	Low- to mid-elevation vegetation types (grasses to open woodlands).	Exposed along the Coronado Cave Trail and hiking trails on Miller Peak.	Deposited on a slowly subsiding deltaic plain.
JURASSIC	Bisbee Group	Glance Conglom-erate (Jga, Jgbi, Jg, Jgbp)	Jga: Aphyric (without phenocrysts) basaltic andesite sills intruding Jg. In other areas, similar flows lie between Jg and the chert-bearing basal conglomerate of Km. Mapped northwest of the memorial.	Less resistant than the main body of Jg.	Not mapped in the memorial.	Rockfall potential.	None documented. Fossils in extrusive igneous rocks are rare.	Potential cultural sites (prehistoric hunting locations) on steep slopes.	None documented.	No significant minerals.	Steep slopes may limit vegetation.	Backcountry hiking and camping potential.	Emplacement into wet Jg sediment.
JURASSIC	Bisbee Group	Glance Conglom-erate (Jga, Jgbi, Jg, Jgbp)	Jgbi: Aphyric, dark-colored to rusty brown, medium- to fine-grained basaltic andesite sills. Mapped on western and southern slopes of Montezuma Pass and Coronado Peak, southwestern part of memorial.	Less resistant than the main body of Jg.	Low. Linear outcrop on steep slope.	Rockfall potential.	None documented. Fossils in extrusive igneous rocks are rare.	Minimal exposure on steep slopes.	None documented.	No phenocrysts.	Rocky slopes limit vegetation.	Limited exposure on remote slopes.	Intrudes and is younger than Jg.
JURASSIC	Bisbee Group	Glance Conglom-erate (Jga, Jgbi, Jg, Jgbp)	Jg: Main body of Glance Conglomerate. Volcaniclastic conglomerate. Thick unit of cobble- to boulder-sized conglomerate. Clasts range from pebbles to 1- to 2-m (3.3- to 6.6-ft) diameter boulders. Clasts are quartz rhyolite and crystal-poor rhyolite tuffs and fragments of the intervening lithic-rich tuff and arkosic sandstone. Clasts of Paleozoic limestone are generally absent in the lower 50 to 100 m (160 to 330 ft). Gradual upward transition from non-stratified, matrix-supported conglomerate to crudely stratified, poorly sorted, clast-supported conglomerate. Dacite tuff, andesitic-dacitic lava clasts, and increased occurrence of Paleozoic limestone clasts replace the dominant rhyolite clasts. Above the landslide breccia units, the dominant clasts are andesitic to dacite lavas that include an increasing component of porphyritic intrusive rocks.	High.	Steep slopes prohibit excessive development. Roads, trails, and overlook with facilities exist on Jg.	Potential rockfall and landsliding in ephemeral stream drainages. Abandoned mines along Crest Trail present a potential visitor-safety hazard.	No in-situ flora or fauna. Clasts of Paleozoic Naco Group limestone may contain fossils (Tweet et al. 2008).	Possible prehistoric sites and artifacts from late 19th century to early 20th century mining activity.	No natural caves.	Crest Trail contains shafts, adits, and tailing piles from past mining activity for lead and zinc ores. North of the memorial: galena, scheelite, chalcopyrite, bornite, and ores of gold, silver, and tungsten in quartz veins (New Reef mineral district).	Mid-elevation open oak woodlands to upper-elevation rocky hillsides and mixed forest of oak, Mexican piñon pine, and alligator juniper.	Montezuma Pass overlook; hiking; .	Deposition in alluvial-fan systems that rimmed local fault-block mountain ranges.
JURASSIC	Bisbee Group	Glance Conglom-erate (Jga, Jgbi, Jg, Jgbp)	Jgbp: Dark-colored, coarsely porphyritic andesite with plagioclase and weathered hornblende phenocrysts in a dark-gray groundmass.	Least resistant unit in Jg.	Not mapped in the memorial.	Steep slopes: Rockfall potential.	None documented. Fossils in extrusive igneous rocks are rare.	Narrow outcrop; limited access.	None documented.	Hornblende	Rocky slopes.	Steep slopes; back-country hiking.	Volcanic activity.
JURASSIC	Bisbee Group	Glance Conglom-erate (Jgbr, Jgq, Jgbdq, Jgbq, Jgbd, Jgba, Jgbls, Jgbss)	Jgbr: Blocks of orange arkosic to arenitic sandstone and lithic-rich, sparse quartz rhyolite tuff. Jgbd: Blocks of crystal-rich dacite tuff. Jgba: Blocks of pre-Montezuma Caldera andesite and dacite lava. Jgbls: Blocks of Paleozoic limestone.	High.	Low. Narrow unit within Jg on steep slopes.	Potential rockfall and landsliding in ephemeral stream drainages.	Possible marine invertebrate fossils in Paleozoic limestone blocks.	Possible American Indian sites (e.g., hunting structures on steep slopes).	None documented.	Quartz.	Rocky slopes. Mid-elevation vegetation.	Crossed by road to Montezuma Pass and trail to Coronado Peak.	Wedge- and sheet- deposits derived from Montezuma Caldera collapse to the south. Nearly instantaneous deposition, as from a large earthquake.
JURASSIC	Bisbee Group	Landslide breccias (Jgbr, Jgq, Jgbdq, Jgbq, Jgbd, Jgba, Jgbls, Jgbss)	Blocks of landslide breccia found near the mouth of Copper Canyon, southwestern part of the map. Not mapped in the memorial. Jgq: Quartz-bearing rhyolite porphyry lava found. Jgbdq: Brecciated dacite and quartz-bearing lavas. Jgbq: Quartz and potassium feldspar-bearing rhyolite porphyry. Jgbss: Slightly calcareous, tan quartzose sandstone, probably largely derived from the Permian Scherrer Formation (Ps).	High	Not mapped in the memorial.	Isolated outcrops of limited distribution. Minor rockfall potential.	None documented. Fossils in extrusive igneous rocks are rare.	Potential historic mining sites. Prospect pits nearby.	None documented.	Quartz; potassium feldspar.	Rocky slopes with south-western aspect.	Localized, limited exposures. Steep slopes.	

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JURASSIC	Jurassic intrusive and volcanic rocks (Jq)	Rhyolite porphyry. Irregular dikes and small stocks of flow-banded rhyolite porphyry containing 10-15% small, 1- to 3-mm (0.04- to 0.1-in) phenocrysts of quartz and potassium feldspar.	High.	Low. Linear features.	Minor exposures in remote northern areas.	None documented. Fossils in extrusive igneous rocks are rare.	Doubtful. Local exposures in northern area.	None documented.	Quartz, potassium feldspar.	Higher elevation vegetation.	Remote area. Minor exposures.	Igneous intrusive dike.
	Jurassic intrusive and volcanic rocks (Jrp, Jqr, Jr, Jd)	Jrp: Rhyolite porphyry. Pale-red, aphanitic, with prominent quartz and feldspar phenocrysts intruded into coarse-grained granite. Jqr: Quartz rhyolite porphyry intrusions. No detailed description. Jr: Irregular dikes of flow-banded dacite porphyry. Contains 10-15% phenocrysts of potassium and plagioclase feldspar. Jd: Dikes. Mainly rhyolitic porphyry dikes and sills. Isolated outcrops located northwest of the memorial.	High.	Not mapped in the memorial.	Linear dikes of limited extent pose little hazard.	None documented. Fossils in extrusive igneous rocks are rare.	Potential for cultural sites is low. Outcrops are linear features with limited areal extent.	None documented.	Potassium and plagioclase feldspar; quartz.	Igneous dikes offer limited opportunity for plant growth.	Limited. Most exposures are too small to be mapped at a scale of 1:24,000.	Jurassic intrusions into Jurassic granite.
	Huachuca Granite (Jhgb, Jhgp)	Jhgb: Equigranular granite. Pink to pinkish-gray, medium- to coarse-grained [3 to 6 mm, (0.1 to 0.2 in)]. Contains quartz, potassium and plagioclase feldspar, and lesser biotite. Cut by narrow aplites. Sparse mafic inclusions. Pods [1 to 2 m, (3.3 to 6.6 ft)] of coarse pegmatite mapped near the top of the pluton near Montezuma Peak. Jhgp: Porphyritic granite. Gray to grayish-pink. Phenocrysts [1 to 3 cm, (0.4 to 1.2 in)] of potassium feldspar in a coarse-grained [5 mm, (0.2 in)] matrix of potassium feldspar, plagioclase, quartz, biotite, and amphibole. Contains mafic inclusions; only rarely cut by aplite.	High.	Low. Rugged topography in the memorial's northern part; steep slopes.	Potential rock fall, debris-flow scarps, and landsliding	None.	Possible prehistoric sites and artifacts from past mining activity.	None documented.	Potassium feldspar, galena, pyrite, sphalerite. North of memorial, minor gold-silver ore produced from Paleogene quartz veins.	High elevation vegetation: mixed forest of oak, Mexican piñon pine, and alligator juniper.	Exposed along the Coronado Cave Trail, but primarily exposed in remote, northern part of the memorial.	Intruded into the Naco Group following the collapse of the Montezuma Caldera.
	Huachuca Granite (Jhb, Jhga, Jhgf, Jhgh, Jhu)	Units of Huachuca Granite. Isolated exposures of limited areal extent. Mapped north of the memorial. Jhb: Dark-greenish-black basalt dikes. 1- to 2-mm (0.04- to 0.08-in) phenocrysts of plagioclase and pyroxene in aphanitic matrix. Jhga: Light-tan to pale-gray, fine-grained equigranular aplite. Forms discontinuous dikes and sill-like bodies. Jhgf: Pinkish-gray to buff-colored, fine-grained granite; equal amounts of quartz, potassium and plagioclase feldspar; lesser biotite. Jhgh: Dark- to medium-gray, equigranular amphibole granite. Hornblende, potassium feldspar, plagioclase; lesser quartz, biotite. Jhu: Undifferentiated granitic intrusive.	High.	Not mapped in the memorial.	Potential rockfall and landsliding in Jhu, the dominant unit.	None.	Jhu: Possible prehistoric sites and artifacts from past mining activity.	None documented.	Hornblende, potassium feldspar, plagioclase, quartz, biotite, pyroxene. Huachuca granite is in the New Hartford and New Reef mineral districts.	High elevation vegetation: mixed forest of oak, Mexican piñon pine, and alligator juniper.	Jhu: Backcountry recreation.	Jhb: Some irregular contacts suggest emplacement into granite that was still cooling.
	Parker Canyon Caldera Quartz rhyolite tuff (Jpt)	Crystal-rich, red-brown rhyolite tuff. Contains 20-30% phenocrysts of quartz and potassium feldspar with minor plagioclase and sparse biotite. Caps the volcanic sequence in this area: 30 to 40 m (100 to 130 ft) thick.	High.	Low. Thin outcrop band on steep slopes. Overlies Jqlt.	Rockfall potential.	None documented. Fossils in extrusive igneous rocks are rare.	None documented. Relatively thin outcrop layer on steep slopes.	None documented.	Quartz, plagioclase, potassium feldspar.	Thin outcrop band. Rocky slopes; sparse vegetation.	Crossed by Joe's Canyon Trail.	Ponded within the Montezuma Caldera.
	Sandstone and lithic-rich tuff (Jqlt)	Interbedded orange to red-orange arkosic and quartz sandstones, siltstones, and conglomerate interbedded with pink to pinkish-gray, thin, poorly to moderately welded, lithic-rich ash-flow tuffs. Tuffs contain sparse (less than 10%), 1- to 2-mm (0.04- to 0.08-in) phenocrysts of quartz and potassium feldspar. Tuff layers include thin-bedded [10 to 50 cm, (3.4 to 5.9 in)] ash-fall tuffs.	High. Welded tuff more resistant than sandstone and siltstone.	Low. Thin outcrop band parallels Jpt on steep slopes.	Rockfall potential.	None documented. Fossils in extrusive igneous rocks are rare.	None documented. Relatively thin outcrop layer on steep slopes.	None documented.	Quartz, potassium feldspar.	Thin outcrop band. Rocky slopes; sparse vegetation.	Crossed by Joe's Canyon Trail.	Tuffs may be early eruptive phases from the Parker Canyon Caldera.
	Turkey Canyon Caldera Crystal-poor rhyolite tuff (Jrt)	Grey to red-gray, crystal-poor rhyolite tuff containing about 5-10% phenocrysts of potassium feldspar. Present only in the southern part of the memorial where it directly overlies Jhl.	High.	Low. Thin outcrop band parallels Jqlt on steep slopes.	Rockfall potential.	None documented. Fossils in extrusive igneous rocks are rare.	None documented. Relatively thin outcrop layer on steep slopes.	None documented.	Potassium feldspar.	Thin outcrop band. Rocky slopes; sparse vegetation.	Crossed by Joe's Canyon Trail.	Turkey Canyon Caldera volcanic deposit.
	Montezuma Caldera Crystal-rich dacite tuff and associated collapse breccia (Jhl)	Crystal-rich dacite tuff. Red-brown to dark-greenish-gray to dark-green dacite tuff containing about 30% phenocrysts of plagioclase, minor biotite, and sparse quartz. Lithic content varies from less than 5% to 30%. Mapped south of Montezuma Canyon, along the ridge to Montezuma Peak, on Bob Thompson Peak, and east of Miller Peak. Low-grade metamorphism north of Montezuma Canyon.	High.	Low in the northern Montezuma Peak area; more accessible south of Montezuma Canyon.	Debris chutes and rockfall potential in rugged topography north of Montezuma Canyon.	None documented.	Possible prehistoric sites and remnants of past mining activity.	None documented.	Plagioclase, quartz, biotite, epidote.	North: Rocky debris slides and high elevation vegetation. South: Mid-elevation vegetation.	Crossed by the Arizona Crest Trail (northwest) and by Joe's Canyon Trail.	Records synchronous infilling of the collapsing Montezuma Caldera.

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JURASSIC	Montezuma Caldera Sandstone and limestone mega-breccia (Jhmsl)	Mixed blocks of meter- to several meter-sized well-sorted quartz sandstone and limestone megabreccia of Montezuma Caldera. Mapped in Hunter Canyon, well north of the memorial.	High.	Not mapped in the memorial.	Rockfall on steep slopes.	Possible fossils in limestone megabreccia.	Exposures of limited areal extent.	None documented.	None documented.	Mixed elevation vegetation.	Crossed by unimproved road.	Associated with Jhl.
	Montezuma Caldera Collapse Breccia (Jmbls, Jmbl, Jmbcs, Jmbc, Jmbmv, Jmbv, Jmbsr, Jmbss, Jmbs, Jmbmp, Jmbp)	Jmbls: Masses of dark-gray to white limestone blocks up to 1 km (0.6 mi) long near Montezuma Canyon. Thick breccia lenses of mixed limestone and andesite south of Montezuma Canyon; smaller limestone masses completely enclosed by dacite tuff near Montezuma Peak. Limestone is strongly foliated and recrystallized to marble northeast of a major (Cochise) thrust fault. Jmbl:. Small, less than 1 m (3.3 ft) to several-meter-sized individual blocks of undistinguishable limestone.	High.	Suitable on gentle slopes adjacent to international border.	Exposures on steep slopes may contribute to rockfall or landslides.	Possible marine invertebrate fossils if limestone not recrystalized to marble.	Possible prehistoric sites although exposures are of limited areal extent.	None documented.	Marble.	Variety of elevations from slopes adjacent to alluvial fans to high elevations east of Miller Peak.	Exposures near the Montezuma Canyon Road. Isolated exposures off-trail in other parts of the memorial.	Unit resulted from collapse of the Montezuma Caldera.
		Jmbcs: Blocks of light-green to greenish-white, aphanitic hornfels with boulder to mega-block inclusions of recrystallized limestone. Includes coarse skarn-type calc-silicate rock in contact metamorphosed megabreccia adjacent to Huachuca granite. Jmbc: Fine-grained to aphanitic greenish-white hornfels; strongly foliated, probably metavolcanic in origin.	High.	Low. Steep slopes south of Bob Thompson Peak.	Rockfall and landslide potential	None documented.	Exposures of limited areal extent on steep slopes. None documented.	None documented.	Garnet, vesuvianite, epidote, pyroxene.	High-elevation vegetation and rocky slopes.	No formal trails. Backcountry hiking.	Probably formed from hot fluids in contact with clayey limestone megablocks.
		Jmbmv: Red-brown to dark-gray shattered blocks of pre-caldera andesite and dacite lava. Mapped south of Montezuma Canyon, on Montezuma Pass, as isolated blocks 10 to 500 m (33 to 1,600 ft) thick enclosed by tuff near Montezuma Peak, and as fragments within limestone megabreccia near Bob Thompson and Miller Peaks. Most common lava type contains 20-30% angular plagioclase phenocrysts [2 to 3 mm, (0.08 to 0.1 in)] in a red-brown matrix. Fine-grained, red-gray to gray lava collapse breccia on Montezuma Pass. Blocks of gray lava with 5-15% subangular plagioclase phenocrysts [2 to 3 mm, (0.8 to 0.1 in)] are widespread, but less common than other lava types. Jmbv: Individual small, less than 1 m (3.3 ft) to several meter-sized blocks of pre-caldera andesite and dacite lava.	High.	Isolated outcrops of limited areal extent on steep slopes north of Montezuma Canyon or adjacent to international border.	Rockfall potential north of Montezuma Canyon.	None documented.	Limited exposures on steep slopes. None documented.	None documented.	Plagioclase.	High-elevation vegetation and rocky slopes.	Near Arizona Crest Trail in northwestern part of memorial. Remote outcrops.	Abundance of andesitic-dacitic blocks near the southern margin of the caldera suggests that a locus of volcanic centers may have been present in this area prior to caldera collapse.
		Jmbsr: Large blocks of laminated sandstone interbedded with siltstone and red shale, marl, and limestone-clast conglomerate. Tan, finely laminated, well-sorted feldspathic arenite. Red to red-brown siltstones and shales with well-developed fractures and small folds related to later thrusting.	Variable. Sandstone more resistant than siltstone and shale.	Low. Steep slopes near fault south of Bob Thompson Peak.	Rockfall and landslide potential.	None documented.	Possible archeological remains of mobile foragers.	Paleokarst features on blocks of lime-stone conglom-erate.	None documented.	High-elevation vegetation and rocky slopes.	No trails. Backcountry hiking.	Paleokarst deposits formed prior to caldera collapse.
		Jmbss: Smaller blocks and shattered masses of tan, well-sorted, quartz sandstone. Probably originally derived from Ps. Jmbs: Individual, small, less than 1-m (3.3-ft) blocks of tan, well-sorted sandstone similar to Jmbss. Neither unit is mapped in the memorial.	Sandstone weakly cemented, will erode more easily than rest of unit.	Not mapped in the memorial.	Unknown. Outcrops too small to map at map scale.	Unknown, but highly unlikely to find fossils in megabreccia.	Limited areal extent.	Unknown.	None documented.	Unknown. Limited areal extent.	Unknown. Limited areal extent.	May have derived from the Scherrer Formation (Ps).
		Jmbmp: Blocks of green phyllite and red shale/siltstone intermixed with limestone megabreccia. Jmbp: Individual, 1 m (3.3 ft) to several meter-sized blocks of red and green shale and phyllite.	The areal extents of these two units are too small to be represented on the 1:24,000 scale of the reference map.									Chaotic blocks of caldera-collapse breccia.
REGIONAL UNCONFORMITY												
PERMIAN Cisuralian (Lower)	Naco Group Scherrer Formation (Ps)	Quartzose sandstone and medium-gray dolomite. White to yellowish-gray upper sandstone unit; light-brown lower sandstone unit. Both units are laminated to thinly bedded and locally cross-laminated. Contains medium-gray dolomite beds and red mudstone at base; quartz and chert nodules common. Mapped as isolated knobs of bedrock on the ridge bordering Sawmill Canyon, northwest section of the reference map.	High, but less resistant than surrounding dolomite of Pe.	Not mapped in or near the memorial.	Limited areal extent, but steep slopes may contain unstable talus slopes.	Echinoid spines, bryozoans, brachiopods, crinoids, and burrows.	Possible prehistoric lithic-processing sites.	None documented.	Chert.	High-elevation vegetation; rocky knobs.	Backcountry use in Coronado National Forest.	Marine transgression.

Units that are not mapped within Coronado National Memorial boundaries are colored gray.

Age		Unit Name (Symbol)		Features and Description	Erosion Resistance	Suitability for Infrastructure	Hazards	Paleontological Resources	Cultural Resources	Caves/Karst	Mineral Occurrence	Habitat	Recreation	Geologic Significance
PERMIAN	Cisuralian (Lower)	Naco Group	Epitaph Dolomite (Pe)	Upper member: medium- to dark-gray, medium- to thick-bedded resistant dolomite and limestone; local chert and quartz nodules. Middle member: yellowish-gray to pale-pink marl, siltstone, and argillaceous dolomite; local beds of gypsum. Lower member: medium- and dark-gray to brownish gray medium- to thin-bedded dolomite. Total thickness about 260 m (860 ft). Surrounds the knobs of Ps in Sawmill Canyon.	Variable. Dolomite and limestone more resistant than marl, siltstone, and gypsum.	Not mapped in or near the memorial.	Potential rockfall and landslides.	Gastropods, corals, brachiopods, and echinoids. Less fossiliferous than Ps and Pc.	Limited areal extent but possible prehistoric and early mining activity sites.	None documented, but dissolution caves possible if the dolomite is fractured.	Chert, gypsum.	Steep rocky slopes; high-elevation vegetation.	Backcountry use in Coronado National Forest.	Cross-beds, ripple marks, and fossils indicate shallow-water, restricted marine environ-ments.
PERMIAN	Cisuralian (Lower)	Naco Group	Colina Limestone (Pc)	Medium- to dark-gray limestone. Up to 53-m (175-ft) thicknesses of Pe dolomite locally mapped with Pc in the Huachuca Mountains; total mapped unit about 320 m (1,050 ft) thick. Forms steep slopes in Sawmill Canyon.	High.	Not mapped in or near the memorial.	Potential rockfall and landslides.	Conodonts, brachiopods, mollusks, and echinoids.	Possible prehistoric (hunting) and early mining activity sites.	Dissolution caves possible, espec-ially in fractured limestone.	None documented.	Steep rocky slopes; high-elevation vegetation.	Backcountry use in Coronado National Forest.	Deposition on an open marine carbonate shelf.
PERMIAN-PENNSYLVANIAN		Naco Group	Earp Formation (PPNe)	Pale-red calcareous siltstone and mudstone. Minor thin-bedded limestone and marl. Thin, locally prominent, chert-pebble conglomerate about 60 m (200 ft) below the top. May be 120 m (400 ft) thick in Huachuca Mountains.	The areal extents of the Earp Formation and Horquilla Limestone are too small to be represented on the 1:24,000 scale of the reference map.									Cyles of trans-gressions and regressions.
PERMIAN-PENNSYLVANIAN		Naco Group	Horquilla Limestone (PPNh)	Medium-light-gray limestone with interbedded pale-red calcareous siltstone and silty limestone. May be 180 m (600 ft) thick in Huachuca Mountains.										
PERMIAN-PENNSYLVANIAN		Naco Group	Undiffer-entiated Naco Group (PZl)	Large blocks of altered limestone and dolomitic limestone surrounded by Huachuca granite. Contact metamorphism formed magnetite, hematite, and Fe-sulfide replacement skarn bodies. Other beds within the blocks have been selectively altered to garnet-epidote-vesuvianite-pyroxene skarn or fine-grained calc-silicate hornfels. Limestone mostly recrystallized to marble; strongly foliated. Original chert layers within the limestones have been boudinaged, dismembered, and locally folded. Insufficient information to identify specific formations within Naco Group.	High, but less resistant than granite.	Low. Isolated exposures surrounded by granite; caves; fractures.	Potential cave collapse from rare earthquakes.	Possible algal stromatolites (layered algal colonies) along Coronado Cave Trail; marine invertebrates possible in limestone not recrystallized to marble.	Prehistoric projectile points found in the past. Legends of cave use by Apache Indians. Cave in dire need of restoration.	Coronado Cave and associated speleothems (e.g., stalactites, stalagmites, flowstones, and helictites).	Ore at State of Texas mine was mostly zinc with minor amounts of lead, copper, silver, tungsten, manganese, and gold. Calcite, galena, garnet, sphalerite pyrite, willemite, and chalcopyrite.	Caves provide habitat for diverse community of insects and small animals, including bats.	Coronado Cave and trail.	Naco Group units represent transgression and regression events. Units are in the footwall of a regional thrust fault. Intrusion of Huachuca granite caused mineralization.
REGIONAL UNCONFORMITY														
MISSISSIPPIAN			Escabrosa Limestone (Me)	Medium- to light-gray thick-bedded crinoidal limestone and minor medium- to dark-gray thin-bedded limestone. Probably more than 150 m (500 ft) thick. Mapped to the north in the hanging walls of regional thrust faults.	Thick beds more resistant than thinner beds.	Not mapped in the memorial.	Rockfall and landslide potential on steep slopes.	Crinoids.	Possible prehistoric and early mining sites.	Cave/karst development possible.	Sphalerite and galena at State of Texas mine.	High-elevation vegetation and rocky slopes.	Backcountry use. Forms summit of Ramsey Peak.	Represent a major marine trans-gression from the southeast. During the Laramide Orogeny, these units were thrust over younger Mesozoic and Paleozoic units.
DEVONIAN			Martin Limestone (Dm)	Medium- to dark-gray dolomite and sandy dolomite with a few thin beds of sandstone and siltstone. About 98 m (320 ft) thick. Mapped in the hanging walls of regional thrust faults, well north of the memorial.	Siltstone less resistant than sandstone and limestone.	Not mapped in the memorial.	Rockfall and landslide potential on steep slopes.	Small brachiopods and some corals.	Possible prehistoric and early mining activity sites.	Dissolution caves in Devonian limestone are common in the southwest.	New Reef mineral district. Scheelite, galena, pyrite, sphalerite, goethite, hematite, limonite, and malachite occur in quartz veins.	High-elevation vegetation and rocky slopes.	Backcountry use in Coronado National Forest.	
REGIONAL UNCONFORMITY														

Units that are not mapped within Coronado National Memorial boundaries are colored gray.

Age	Unit Name (Symbol)	Features and Description	Erosion Resistance	Suitability for Infrastructure	Hazards	Paleontological Resources	Cultural Resources	Caves/Karst	Mineral Occurrence	Habitat	Recreation	Geologic Significance
CAMBRIAN	Abrigo Limestone (Ca)	Upper part: medium-gray limestone with numerous thin layers of light-brown-weathering silty limestone. Lower part: yellowish-brown shale with minor silty limestone and dolomite strata. Mapped in the hanging walls of regional thrust faults, well north of the memorial.	Variable. Limestone is more resistant to erosion than silty limestone and shale.	Not mapped in the memorial.	Steep slopes may generate rock fall and landslides.	Trilobites, brachiopods.	Possible prehistoric (hunting) and early mining activity sites.	Dissolution caves possible in the limestone.	New Reef mineral district. Scheelite, galena; ores of tungsten, gold, and silver in veins.	Mixed forest in higher elevations.	Backcountry use in Coronado National Forest.	Represent a major marine trans-gression from the southeast. During the Laramide Orogeny, these units were thrust over younger Mesozoic and Paleozoic units.
	Bolsa Quartzite (Cb)	Resistant yellowish- to reddish-brown-weathering siliceous sandstone. About 145 m (475 ft) thick. Mapped in the hanging walls of regional thrust faults, well north of the memorial.	Moderately high.	Not mapped in the memorial.	Potential rockfall and landslides from steep slopes.	Metamorphism of sandstone to quartzite destroyed any fossils.	Possible prehistoric (hunting) and early mining activity sites.	Unknown.	None documented in the southern Huachuca Mountains.	Forest of oak, Mexican piñon pine and alligator juniper.	Backcountry use in Coronado National Forest.	
REGIONAL UNCONFORMITY												
PROTEROZOIC EON, MESOPROTEROZOIC ERA	Fine-grained alaskite (Yga)	Fine-grained alkali feldspar granite (alaskite). Composed of quartz and feldspar crystals (holocrystalline). No glassy part. Occurs in a fault sliver. Sheared, metamorphosed, and may be related to Yg.	High.	Not mapped in the memorial.	Minor exposures along faults.	None.	Limited areal extent.	Unlikely due to limited areal extent.	New Reef mineral district. Scheelite, galena, pyrite, earthy hematite, calcite, ores of tungsten and minor gold in quartz veins.	Vegetation may mark fault trace on the surface.	Limited areal extent.	Precambrian igneous intru-sions indicate deformation about 1.4 billion years ago.
	Porphyritic granite (Yg)	Yellowish- to pinkish-gray coarse-grained porphyritic granite; includes some unmapped areas of fine-grained alaskite. Main map unit north of Miller Canyon. Mapped in the hanging walls of regional thrust faults.	High.	Not mapped in the memorial.	Rockfall and land-slide potential.	None.	Possible prehistoric and early mining activity sites.	Unknown.		Open oak woodlands and mixed forests.	Secondary roads, trails, and other backcountry use in national forest.	
PALEOZOIC ERA	Sedimentary rocks, undifferentiated (PZu)	Rain Valley (Lower Permian) to Bolsa Quartzite (Middle Cambrian), undifferentiated sedimentary rock.	Variable.	Not mapped in the memorial.	Minor exposures along faults.	None documented.	Unknown.	Unknown.	Unknown.	Unknown.	Limited areal extent.	Only found in fault slices through Yg.
AGE UNCERTAIN	thin seams of basalt (tsb)	Thin seams of basalt. No further description given in Hon et al. (2007).	Moderately high.	Linear features of limited areal extent.	Potential for rock fall on steep slopes.	None.	Unknown.	Linear features of limited areal extent.	Unknown.	Linear features of limited areal extent.	Linear features of limited areal extent.	Primarily found in rocks of Jurassic (Huachuca Granite and Montezuma Caldera) and Meso-proterozoic (porphyritic granite) age.

Reference map: Hon, K.A., F. Gray, K.S. Bolm, K.A. Dempsey, and P.A. Pearthree. 2007. A digital geologic map of the Miller Peak, Nicksville, Bob Thompson Peak, and Montezuma Pass Quadrangles, Arizona. U.S. Geological Survey Scientific Investigations Map, SIM unpublished (scale 1:24,000).