

Map Unit Properties Table: Fort Bowie National Historic Site

This table highlights resource management properties of geologic map units mapped within (indicated by an *) and near Fort Bowie NHS. Geologic unit descriptions for all units included in the GIS data are available in the attached CD in "fobo_geology.pdf."

Age	Unit Name (Symbol)	Features and Description	Topographic Expression	Erosion Resistance	Suitability for Infrastructure	Hazards	Paleontological Resources	Mineral Occurrence	Geologic Significance	
QUATERNARY	Holocene	Gravel, Sand, Silt (Qg)*	Unconsolidated alluvial deposits along drainages and on low terrace.	Along drainages and on low terrace.	Low.	Limited exposure.	Erosion; flash flooding; debris flows.	None documented.	Sand and gravel.	Potential for erosion due to debris flows.
	Pleistocene	Gravel, Sand, Silt (Qgt)*	Unconsolidated alluvial deposits on intermediate terraces, fans, and alluvial aprons; includes extensive deposits of talus in mountains and sheet-wash deposits in intermontane valleys.	Slope aprons; surface of Apache Pass.	Low in areas void of vegetation.	Relatively flat alluvial aprons.	Headward erosion.	None documented.	Sand and gravel.	Mapped beneath fort ruins and historic cemetery.
NEOGENE	Pliocene	Gravel and Sand (QTg)	Alluvial deposits on high terraces, on pediments, and as basin fill. Mapped in Wood Canyon, west of Fort Bowie National Historic Site.	Not mapped within Fort Bowie National Historic Site.						
	Miocene	Conglomerate (Tc, Tcs, Tct)	Very light gray to light-brownish-gray tuffaceous conglomerate and gritty sandstone. Weakly indurated, mostly poorly sorted. Abundant clasts derived from the Rhyolite Canyon Formation (Trus). Exposed south of the park near Sand Wash, southeastern border of the GIS map. <u>Tcs</u> : Sandstone marker bed (easily recognizable stratigraphic layer). <u>Tct</u> : Nearly white, tuffaceous sandstone member. Poorly indurated beds.	Not mapped within Fort Bowie National Historic Site.						Related to Neogene (Tertiary) volcanic and plutonic activity.
		Upper rhyolite ash-flow tuff of Rhyolite Canyon Formation (Trus)	Light-brownish-gray to grayish-red, rhyolite ash-flow tuff. Cliff-forming unit. Firmly welded and columnar jointed to southeast and less welded to northwest. Phenocrysts content 25-30%; mainly quartz and sanidine with some plagioclase, magnetite, apatite, and zircon. Groundmass is vitric (glassy) to cryptocrystalline and rich in shards. Commonly 20-100 m (66-330 ft) thick. Exposed south of the park near Sand Wash, southeastern border of the GIS map.							
		Andesite (Ta)	Dikes of aphanitic (fine-grained) or porphyritic (larger crystals set in a fine-grained groundmass) andesite or other rock of intermediate composition. Exposed in the Ninemile stock, northwest of Fort Bowie National Historic Site.							
		Rhyolite and latite porphyry (Tr)	Dikes of aphanitic (fine-grained) or porphyritic (larger crystals set in a fine-grained groundmass) rhyolite that may include some aplite and older rock. Typically pale-yellowish-brown to very light-gray, containing 1-5% small phenocrysts (larger crystals) of quartz, sanidine, oligoclase, and locally biotite. Limited areal extent; exposed near Bear Spring, southeast of the park, in the Apache Pass fault zone.	Narrow, tabular igneous rock units. Not mapped within Fort Bowie National Historic Site.						
PALEOGENE	Oligocene	Tuffaceous rock of Faraway Ranch Formation (Tft)	Air-fall tuff, tuff breccia, tuffaceous sandstone, and conglomerate. Clasts mainly derived from underlying andesite. Minor exposure mapped near Buckhorn Basin in the southeastern corner of the GIS map, south of the park.	Not mapped within Fort Bowie National Historic Site.						Related to Paleogene (Tertiary) volcanic and plutonic activity.
		Silver Spur Ranch Formation (Tsf, Tsv)	<u>Tsf</u> : Andesitic lava flows. Medium-gray, porphyritic with 15-35% phenocrysts typically of plagioclase, amphibole, pyroxene, and minor amounts of magnetite, apatite, and zircon. Mostly slightly propylitized (altered by low pressure and temperature). About 20-30 m (66-100 ft) thick. <u>Tsv</u> : Sedimentary and volcanic rocks. Principally conglomerate and sandstone that contain clasts derived mainly from andesitic volcanic rocks. Also includes agglomerate (chaotic assemblage of coarse angular clasts), flow breccia, and thin local deposits of air-fall tuff. Probably less than 50 m (160 ft) thick. Both units exposed in the southeastern corner of the GIS map, south of the park.							
		Aplite (Tga)	Pale-yellowish-gray, fine-grained, sugary-textured, closely fractured quartzofeldspathic rock. Minor exposure of limited areal extent in the southeastern corner of the GIS map, south of the park.							
		Granodiorite and Quartz Monzonite (Tg)	Light-pinkish-gray, moderately coarse-grained rock containing (in percent): quartz, 24-29; plagioclase, 38-51; orthoclase, 17-30; biotite, 4-9; magnetite, 0.5-0.9; and trace amounts of apatite, zircon, and in some rocks allanite. Forms the Ninemile stock in the Dos Cabezas Mountains, northwest of Fort Bowie National Historic Site.							

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PALEOGENE	Oligocene	Andesite (TKa) Stocks and dikes of medium-gray to greenish-gray aphanitic to porphyritic andesite containing phenocrysts of plagioclase, amphibole, pyroxene, and some magnetite and apatite. Exposed in the southeastern corner of the GIS map, south of the park.	Not mapped within Fort Bowie National Historic Site.							Early Paleogene igneous activity.	
	Eocene										
	Paleocene										
CRETACEOUS	Upper	Sedimentary and volcanic rocks (Ksv*, Ksvs, Ksvbc, Ksvr) <u>Ksv*</u> : Medium-gray to greenish-gray conglomerate, sandstone, and siltstone; subangular clasts and volcanic detritus. Interlayered with dacitic lava flows and breccia. Moderately metamorphosed. Exposed within the Apache Pass fault zone. May be as much as 3,000 m (10,000 ft) thick in the southern part of the GIS map, south of the park. <u>Ksvs</u> : Marker bed of light-brownish-gray, strongly indurated sandstone. <u>Ksvbc</u> : Conglomerate marker bed. Marks the top of the basal conglomerate. Contains clasts of sandstone derived from the Bisbee Group (Kbu). <u>Ksvr</u> : Rhyolite ash-flow tuff. Strongly altered, grayish-green welded tuff containing less than 1% phenocrysts of plagioclase, quartz, and magnetite. Groundmass is cryptocrystalline granular with relict shard texture. Contains many secondary minerals, such as clay minerals, sericite, calcite, and epidote.	Limited exposure in northern part of park; some steep slopes.	Relatively high (metamorphosed).	Limited exposure.	Rockfall?	None documented.	Locally, large crystals (porphyroblasts) of andalusite.	Fault block in Apache Pass fault system.		
	Lower	Bisbee Group	Upper part, undivided, of the Bisbee Group (Kbu, Kbus, Kbus) <u>Kbu</u> : Shale, siltstone, sandstone, and scattered thin beds of conglomerate. <u>Kbus</u> : Pelecypod-bearing limestone marker bed. Possibly correlative with the Mural Limestone (Kmu). <u>Kbus</u> : Sandstone marker bed. Typically a few meters thick. Forms bold outcrops.	Not mapped within Fort Bowie National Historic Site. Mapped south of the park on the GIS map.							
			Cintura Formation (Kc*, Kcs) <u>Kc*</u> : Dark-gray to reddish-gray or pale-yellowish-gray siltstone and shale, and interbedded light-brownish-gray sandstone; marker beds of sandstone are pale-yellowish brown, crossbedded, and locally quartzitic; where most strongly metamorphosed, around Apache Pass, rock contains mineral specimens including large andalusite porphyroblasts, biotite pseudomorphs after staurolite, chloritoid, some tourmaline, and graphite. Exposed within the Apache Pass fault zone. <u>Kcs</u> : Pale-yellowish-brown sandstone marker bed. Crossbedded and locally quartzitic.	Northwest-southeast-trending ridge.	Variable; quartzitic sandstone is more resistant than siltstone and shale.	Unimproved roads in low areas along ridge; limited exposures.	Unknown.	None documented.	Andalusite, biotite, chloritoid, tourmaline, graphite.	In footwall of thrust fault. Older rocks in hanging wall.	
			Mural Limestone (Kmu*, Kmus, Kmuc, Kmup) <u>Kmu*</u> : Clastic rocks like those in adjacent formations, interbedded with light-gray, thin-bedded, locally fossiliferous limestone beds. <u>Kmus</u> : Pale-yellowish-brown sandstone marker bed. Strongly indurated, locally crossbedded. <u>Kmuc</u> : Conglomerate marker bed. Gray, pebble conglomerate containing limestone clasts derived from Paleozoic formations. <u>Kmup</u> : Pelecypod-bearing rock. Thick-shelled pelecypods typical of the Mural Limestone.	Extremely limited exposure.	High.	Insignificant areal extent.	None.	Thick-shelled pelecypods.	None documented.	Records a marine transgression from the southeast.	
			Morita Formation (Km, Kms, Kmc) <u>Km</u> : Dark-gray to pale-brownish-gray siltstone, shale, and some interbedded sandstone and conglomerate. Exposed east of the park in the Apache Pass fault zone. <u>Kms</u> : Pale-yellowish-brown sandstone marker bed. Crossbedded, strongly indurated, with local graded bedding. <u>Kmc</u> : Conglomerate marker bed. Gray pebble conglomerate containing abundant limestone clasts.	Not mapped within Fort Bowie National Historic Site.							Fluvial and tidal flat environments.
			Glance Conglomerate (Kg)* Gray pebble and cobble conglomerate and some interbedded sandstone and siltstone. Basal unit of the Bisbee Group; locally is time transgressive and interfingers with the overlying Morita Formation and Mural Limestone. Clasts of limestone, dolomite, sandstone, and quartzite detritus originated from underlying Paleozoic formations. Exposed within the hanging wall of a thrust fault. At least 300 m (1,000 ft) thick in the southern part of the map, south of the park.	Limited exposures near ridge top, northern part of park.	High except near fault gouge.	Insignificant areal extent.	None.	Clasts may contain Paleozoic invertebrate fossil fragments.	None documented.	Alluvial-fan environment.	
JURASSIC	Rocks of this age are absent in the Fort Bowie National Historic Site area.										
TRIASSIC	Rocks of this age are absent in the Fort Bowie National Historic Site area.										

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PERMIAN	Middle and Upper	Rocks of this age are absent in the Fort Bowie National Historic Site area.								
	Cisuralian (Lower)	Concha Limestone (Pcn)*	Medium-gray, moderately thickbedded, fine-to medium-grained cherty limestone.	Limited exposure in Apache Pass fault zone.	High except near fault gouge.	Insignificant areal extent.	Limited exposure.	Large dictyoclostid brachiopods.	None documented.	Mapped in fault slices within the Apache Pass fault zone. Record episodes of marine transgression and regression into the area.
		Scherrer Formation (Ps)*	Light-gray to pinkish-gray, fine-grained sandstone and quartzite.				None documented.			
		Colina Limestone (Pc)*	Light-gray to pinkish-gray, fine-grained sandstone and quartzite.				Rockfall potential where beds are overturned.	Echinoid spines and euomphalid gastropods.		
		Epitaph Formation (Pe)	Dark- to light-gray dolomite and dolomitic limestone, thin- to moderately thick-bedded, mostly fine-grained and cherty.	Limited exposure.	None documented.					
		Earp Formation (Pea)*	Light-colored, thin-bedded, and weakly indurated marlstone, shale, and some limestone.	Rockfall where overturned?						
		Horquilla Limestone, Undivided (PPNh)	Metamorphosed limestone in outcrops within fault blocks of limited areal extent.	In fault blocks of limited areal extent.	High.	Limited exposure.				
Horquilla Limestone (Upper Member) (Phu*, Phuf)	Light-gray, fine- to medium-grained, cherty, fossiliferous limestone and interbedded pale-reddish-gray shale and siltstone, mostly moderately recrystallized. Limestone units are typically 1-3 m (3-10 ft) thick. Siltstone units are mainly less than 1 m (3 ft) thick. <u>Phuf</u> : Key fossil-bearing formation with large fusulinids, probably of Permian age.	Forms Overlook Ridge.	Variable. Cherty limestone more resistant than shale.	Low; overturned and steeply dipping strata.	Rockfall, especially where steeply dipping.	Corals, bryozoan, brachiopods, and fusulinids.				
PENNSYLVANIAN	Upper	Horquilla Limestone (Lower Member) (PNhl*, PNhlc)	Light-gray, fine- to medium-grained, medium-bedded, cherty fossiliferous limestone, mostly moderately recrystallized. Sparse reddish-gray siltstone. Chert forms light-gray to pinkish-gray small nodules and thin lentils. <u>PNhlc</u> : Key fossil horizon or site. <i>Chaetetes milliporaceous</i> coral bed.	Forms Overlook Ridge.	High.	Low; overturned and steeply dipping strata.	Rockfall, especially where steeply dipping.	Corals, brachiopods, and fusulinids.		
	Lower and Middle	Rocks of this age are absent in the Fort Bowie National Historic Site area.								
MISSISSIPPIAN	Upper	Paradise Formation (Mp)	Light-brownish-gray, thin-bedded, fine-grained limestone and gray to pale-yellowish-brown shale. Exposed in a very thin layer within the Apache Pass fault zone southeast of the park.	Not mapped within Fort Bowie National Historic Site.					Deposited during a marine regression.	
	Lower	Escabrosa Limestone (Me*, Mew, Meg)	<u>Me</u> *: Very light-gray to medium-gray, coarse-grained, medium-bedded to massive, coarsely cherty, crinoidal recrystallized limestone; mostly covered by Qg in the park. May also be Upper Mississippian. About 190 m (620 ft) thick. <u>Mew</u> : Marker horizon. Base of white to very light-gray beds at one or several horizons. <u>Meg</u> : Marker horizon. Base of medium-gray beds at one or several horizons.	Typically forms cliffs.	High.	Insignificant areal extent.	None.	Crinoids.	None documented.	Records a marine transgression into the area.
DEVONIAN	Upper	Portal Formation (Dp)	Brownish-gray, thin-bedded, fine-grained limestone and interbedded olive-gray shale; typically forms gentle slopes beneath Escabrosa Limestone. Exposed within the Apache Pass fault zone but not within Fort Bowie National Historic Site. About 120 m (390 ft) thick.	Not mapped within Fort Bowie National Historic Site.					Deposited during a marine transgression.	

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DEVONIAN	Lower	Rocks of this age are absent in the Fort Bowie National Historic Site area.								
	SILURIAN									
ORDOVICIAN	Middle and Upper									
	Lower	El Paso Formation (Oe)	Light-brownish-gray, fine- to medium-grained, thin- to medium- bedded, slightly cherty and sparsely fossiliferous dolomitic limestone and dolomite. Exposed within the Apache Pass fault zone but not within Fort Bowie National Historic Site.				Not mapped within Fort Bowie National Historic Site.		Deposited in subtidal and intertidal environments.	
CAMBRIAN	Upper	Coronado Sandstone (Cc, Ccs, Ccq)	<p><u>Cc</u>: Light-gray to brownish-gray sandstone and interbedded siltstone and shale in the upper part. Includes calcareous and arkosic (feldspar-rich) beds. Some medium- to thick-beds are crossbedded and graded. Conglomerate, typically at or near base, contains clasts of subrounded pebbles and cobbles of quartzose rock. West of Bowie Mountain a basal conglomerate forms a cobble and boulder wedge at least 5 m (16 ft) thick; elsewhere pebble and cobble conglomerate occurs in units as much as 1 m (3.3 ft) thick at and above the base. Exposed within the Apache Pass fault zone. About 100-200 m (330-660 ft) thick..</p> <p><u>Ccs</u>: Sandstone marker bed. Thick-bedded, indurated unit.</p> <p><u>Ccq</u>: Brownish-gray to light- and purplish-gray, coarse-grained, thick-bedded arkosic or quartzitic sandstone, quartzite, and some conglomerate in the lower part. Clasts in the conglomerate are mainly subrounded pebble and cobbles of quartzite. Forms cliffs at the base of the formation. Thickness unknown.</p>				Not mapped within Fort Bowie National Historic Site.		Deposited on the cratonic platform in fluvial, beach, and nearshore environments.	
	Lower and Middle	Rocks of this age are absent in the Fort Bowie National Historic Site area.								
PROTEROZOIC EON	Neoproterozoic Era	Rocks of this age are absent in the Fort Bowie National Historic Site area.								
	Mesoproterozoic Era	Proterozoic Y (Yg*, Yga*, Ygg)	<p><u>Yg*</u>: Granodiorite. Includes quartz monzonite, granodiorite porphyry, and small bodies of aplite and lamprophyre dikes; some granodiorite west of Apache Pass is identified as a rapakivi type (large crystals of potassium feldspar surrounded by a rim of sodic plagioclase and set in a fine-grained matrix). Typically, light-gray, coarse-grained, weathers to grus. Comprised primarily of plagioclase, microcline, quartz, and biotite with minor amounts of magnetite, apatite, sphene, a trace of zircon, and, in some rocks, a trace of allanite. Mapped by Drewes (1984) as Rattlesnake Point Granodiorite.</p> <p><u>Yga*</u>: Aplite. Large masses of light-colored, fine-grained rock containing mainly feldspars and quartz.</p> <p><u>Ygg</u>: Gneissic quartz monzonite. Includes some granite and small bodies of aplite. Light-brownish-gray, medium-grained, slightly porphyritic rock containing flow-aligned crystals.</p>	Dominant rock type in western part of park, west of Apache Pass Fault.	High.	Stable basement rock with few faults.	None.	None.	Large crystals are commonly porphyroblasts of microcline feldspar.	Apache Springs discharges in Yg. One of the oldest units in Arizona (1,375±30 million years old). Age based on analysis of rubidium and strontium isotopes.

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PROTEROZOIC EON Paleoproterozoic Era	Proterozoic X (Xa, Xp, Xpq, Xpqw, Xpqg, Xpp, Xpv)	<p><u>Xa</u>: Amphibolite. Dark-greenish-gray to dark-gray, amphibole-rich rock. Probably includes some altered lava flows and altered intrusive rocks, and large areas of amphibolites may include some small masses of other rocks.</p> <p><u>Xp</u>: Pinal Schist. Schist, phyllite, and some metaquartzite, metavolcanics, and granitic gneiss. Mostly medium brownish-gray. Forms gentle slopes and low hills. Thickness unknown.</p> <p><u>Xpq</u>: Quartzite member of Pinal Schist. Light-gray to very pale yellowish-gray, thick-bedded to massive metaquartzite. Includes quartzitic sandstone, and conglomeratic quartzite. Locally has crossbedding and graded bedding. Forms bold outcrops.</p> <p><u>Xpqw</u>: Marker horizon. Base of white to very light gray quartzite beds.</p> <p><u>Xpqg</u>: Marker horizon. Base of medium-gray quartzite beds interbedded with thin phyllitic quartzite beds.</p> <p><u>Xpp</u>: Phyllite. Medium-gray to light-brownish-gray polytomic, mostly finely micaceous, but locally schistose. Locally includes some arkosic rock and small bodies of quartzite, meta-igneous rock, and amphibolites.</p> <p><u>Xpv</u>: Metavolcanic rock. Medium-gray, slightly porphyritic foliated rock. Includes some metasedimentary rock and may include some intrusive rock.</p>	Not mapped within Fort Bowie National Historic Site. Brackets the Apache Pass fault zone in the Chiricahua Mountains.						Pinal Schist is the oldest unit in southeastern Arizona (1,650 million years old).
NEOGENE to PRECAMBRIAN	Quartz (q)*	Quartz in veins and pods, locally mineralized. A wide range of ages are encompassed by the quartz veins and pods.	Veins and pods in limited exposures.	High.	Insignificant exposure.	None.	None.	Local mineralization.	None.

Map references:

Drewes, H. 1984. Geologic map and sections of the Bowie Mountain North quadrangle, Cochise County, Arizona. U.S. Geological Survey Miscellaneous Investigations Series Map I-1492 (scale 1:24,000).

Drewes, H. 1981. Geologic map and sections of the Bowie Mountain South quadrangle, Cochise County, Arizona. U.S. Geological Survey Miscellaneous Investigations Series Map I-1363 (scale 1:24,000).