Map Unit Properties Table—Backreef Deposits

Age	Map Unit (Symbol)			Description	Paleontological Resources	Mineral and Economic Resources	Cave and Karst Resources	Hazards	Suitability for Development/Recreation
PERMIAN, GUADALUPIAN	Artesia Group (supersedes "Carlsbad Limestone" and "Carlsbad Group")	Tansill Formation (Pt)		Dolomite and siltstone; grades from carbonates to evaporites laterally toward backreef	Rare or absent near evaporite facies; relatively abundant fossils toward Capitan Limestone: fusulinids, pelecypods, gastropods, and scaphopods are the most abundant; brachiopods (though less abundant than in Capitan Limestone), sponges, cephalopods, trilobites, and pisolites (of algal origin [?])	Flaggy dolomite used as building stone; oil and gas potential (Scholle 2000)	Cave dissolution at the transition between Artesia Group and Capitan Limestone and in Seven Rivers (immediately beneath Yates)	Solution cavities	Development unsuitable because of cave resources; recreation suitable (see "Cave Resources and Protection" section)
		Yates Formation (Pya)		One of the best known and widespread key stratigraphic units in the Permian Basin; divisible into three distinctive beds of dolomite (A, B, C) separated by persistent beds of quartz sandstone (Newell et al. 1953); contains tepee structures; siltstone and sandstone beds locally contain numerous limonite and goethite nodules (pseudomorphs after pyrite)		Base metals; dolomite used as building stone; oil and gas potential (Scholle 2000)			
		Seven Rivers Formation	Evaporite facies (Pse)	Gypsum with subsurface anhydrite		Dolomite used as building stone; copper minerals and intensely mineralized rock; base metals; oil and gas potential (Scholle 2000)			
			Carbonate facies (Psc)	Yellowish gray dolomite weathers to light olive with a few beds of pale orange quartzose siltstone cemented with dolomite; contains tepee structures; change from carbonate facies to evaporite facies takes place within a few hundred feet laterally					
		Queen Formation (Pq)		Very pale orange, compact, very finely textured dolomite that weathers pale yellowish brown; clastic rocks of pale orange to reddish brown, fine- grained sandstone and siltstone that weather pale yellowish brown and are cemented with carbonate; gypsum replaces dolomite in places	Silicified fossils and fusulinid molds; also crinoids, echinoids, bryozoans, pelecypods, gastropods, scaphopods, and algae	Oil and gas potential (Scholle 2000)			
		Grayburg Formation (Pg)		Pale orange to gray, finely textured dolomite and fine- grained, calcareous or dolomitic quartz sandstone; some gypsum	Fusulinid molds, oolites, crinoids, brachiopods, pelecypods, gastropods, nautiloids, and algae	Oil and gas potential (Scholle 2000)			
	San Andres Limestone (Psa)		Upper member (Psau)	Dolomite and dolomitic limestone with sandstone; grades laterally into sandstone tongue of Cherry Creek Formation (of the reef/forereef)	Recrystalized (silicified) fusulinids and fusulinid molds	Oil and gas potential (Scholle 2000)	Paleokarst (Hill 1996)		
CISURALIAN			Lower cherty member (Psal)	Dolomite and dolomitic limestone with rusty gray chert nodules or thin lenticular beds; chert more abundant near top of member; contains layers of siltstone and claystone					
	Yeso Formation (Py)			Gray to white dolomite, often gypsiferous	Some dolomitized fusulinids; crinoid columns				Not present in park

Map Unit Properties Table—Reef/Forereef Deposits

Age	Map Unit (Symbol)		Description	Paleontological Resources	Mineral and Economic Resources	Cave and Karst Resources	Hazards	Suitability for Development/Recreation
PERMIAN, GUADALUPIAN	Capitan Limestone (Pc) with massive layers (Pcm) (reef), passes locally into breccia (Pcbr) (forereef)		Thick- bedded or massive limestone forms nearly vertical cliffs; isolated sandstone in dikes and pockets—fills original voids; massive and breccia members are transitional into each other both laterally and vertically; breccia member grades southeastward into Bell Canyon Formation of the Delaware Basin; massive member: unbedded (forms smooth cliffs); breccia member: thick beds that dip • 20° to 30° (forms ragged slopes)	Fusulinids, sponges, corals, crinoids, bryozoans, brachiopods, mollusks, trilobites, algae, and stromatolites	Significant regional aquifer; potential as cement limestone; oil and gas reservoir	Cave dissolution	Solution cavities; intensely fractured; supplies rockfall debris	Development unsuitable because of cave resources; recreation suitable (see "Cave Resources and Protection" section)
	Goat Seep Dolomite (supersedes "limestone") (Pg)		Thick- bedded to massive dolomite in part sandy; reef and forereef talus facies (Newell et al. 1953)	Predominantly brachiopods, sponges, and fusulinid molds; algae (and stromatolites?)		Northwestern part of Lechuguilla Cave may be in Goat Seep (DuChene 2000)		Development probably unsuitable because of potential cave resources
	Sandstone tongue of Cherry Canyon Formation (Pcc)		Moderately resistant, indistinctly bedded, grayish orange, very fine grained, well-sorted quartz sandstone with scattered irregular chert nodules	Some of the chert nodules include abundant silicified fusulinids; Darton and Reeside (1926) listed 35 species of fossils, including 18 different kinds of brachiopods				
	Cutoff Formation (supersedes "Cutoff shaly member of Bone Spring Limestone" [Pcb]); partially removed from slopes	Williams Ranch Member	Thin- bedded limestone interbedded with dark siliceous shale, sandy shale, and soft- weathered sandstone	Thicker limestone beds contain brachiopods, mollusks, and other fossils; thinner beds may contain fusulinids or no fossils; scattered fish fossils in base; poorly preserved pelecypod imprints				
		El Centro Member						
CISURALIAN		Shumard Member						
	Victorio Peak Formation (supersedes "gray member of Bone Spring limestone" [Pbv])		Light gray, fine- grained, sometimes dolomitic limestone	Fossils in many beds; productids and other brachiopods; fusulinids, sponges		Iron Ball and Glori Caves in Shumard Canyon	Ledge- forming (Boyd 1958), supplies rockfall debris	

Map Unit Properties Table—Basin Deposits

Age	Map Unit (Symbol)			Description	Paleontological Resources	Mineral and Economic Resources	Cave and Karst Resources	Hazards	Suitability for Development/Recreation
QUATERNARY	Younger alluvial deposits (Qya) (Pleistocene and Holocene)		Stream alluvium and cover of younger pediments (Qal)	Alluvial deposits on the flood plains of the modern streams; composition reflects local bedrock; typically uncemented but some tufa (calcareous) cement and localized calcretes (Hayes 1964)		Limestone gravel		Small solution cavities	
			Dunes of quartz sand (Qqd)	Composed of red quartz and white gypsum on basin floor; maximum height 30 ft (9 m)					Susceptible to deflation
			Dunes of gypsum sand (Qgd)						Susceptible to deflation
			Younger slope deposits (Qys)	Closely packed cobbles and pebbles of resistant limestone washed out from the Guadalupe Mountains, cemented in many places by caliche; stand as sloping plains scored by narrow ravines or where more greatly reduced, as flat-topped patches on divides					Potentially unstable on excessive grades; resistant to erosion
			Alkali flats (Qaf)	Beds of intermittent lakes, somewhat modified by wind erosion					Seasonally or intermittently flooded
			Younger fanglomerate (Qyf)	Salt Basin area; forms bajada along western base of mountains; bordered downslope by meadowland (Qm), underlain by clay					
			Terrace deposits (Qt)	Intermediate in age and position between older gravel-covered pediment and present stream channels					
			Lacustrine deposits (Ql) with beach ridges (Qb)	Gray gypsiferous clay (Ob) and brown clay (Ol)		Salt deposits (gypsum)			
	Older alluvial deposits (Qoa) (Early Pleistocene)		Gravels deposited on older pediments (Qg)	Poorly sorted detritus from silt to cobbles from Capitan Limestone and carbonate facies of Artesia Group; on gravel plain southeast of Guadalupe Mountains and west of Delaware Mountains		Limestone gravel			
			Older slope deposits (Qos)	Fanglomerate west of mountains; slope deposits and gravel within mountain area					Excessive grades and potentially unstable
			Older fanglomerate (Qof)	Fanglomerate on the bajada along the edge of the mountains; consists mostly of great blocks of massive Capitan limestone, but include a few blocks of sandstone from the Delaware Mountain group; rather firmly cemented by caliche; resemble the older slope deposits and are probably of the same age					
			Higher gravels (Qhg)	Poorly sorted detritus from silt to cobbles from Capitan Limestone and carbonate facies of Artesia Group; on remnants standing above main gravel plain southeast of Guadalupe Mountains		Limestone gravel			
TERTIARY	Intrusive igneous rocks (Ti); "dikes" (Hayes, 1964)			Intrusive dikes of alkali trachyte intrude Castile Formation (Hayes 1964); the only Tertiary rocks exposed in area; appear as brown- weathering soil; stocks and laccoliths of alkaline syenite, trachyte, or basalt in and west of Dell City intrude Lower Permian limestones					Not present in park
PERMIAN – LOPINGIAN	Rustler Formation (Pr)			Dolomite with gypsum, also sandstone and siltstone	Rare fossils				Not present in park
	Salado Formation			Reddish brown solution breccia mapped as part of Castile Formation (Hayes 1964); thick salt beds almost entirely dissolved by surface and near- surface solution		Major deposits of potash and salt			Not present in park
	Castile Formation (Pcs)			Laminated anhydrite, altered to gypsum on outcrop; some limestone	No Lopingian- age fossils but contains Cretaceous- age marine fossils in ancient sinkhole fill	Vast deposits of gypsum; rich brine of sodium and magnesium sulfates	Highly soluble; numerous cave and karst features; gypsum caves and sulfur-hosting paleokarst (Hill 1996)	Disrupted by faults; potential hidden sinkholes	Occurs in very limited areas in and around the Patterson Hills
PERMIAN – GUADALUPIAN	Delaware Group	Bell Canyon Formation (Pdb)	Reef Trail Member (supersedes "post-Lamar beds") (Wilde et al., 1999)	Basal siltstone with fine to coarse grainstone and silty black petroliferous limestone	Brachiopods, ammonoids, hexactinellid sponges, scaphopods (Bell et al. 2006)				
			Lamar Member (Pdb8)	Gray, dark gray, or black, fine- grained limestone; weathers brown; some chert nodules and interbedded sandstone	Brachiopods; some gastropods, pelecypods, bryozoans, fusulinids, and trilobites; Holocene fossils in caves	Bell Canyon Formation has oil and gas potential (Scholle 2000)	Cave formation possible (e.g., Pratt Cave)	Intensely fractured	
			McCombs Member (supersedes "flaggy limestone bed" [Pdb7])	Gray, fine- grained limestone in part sandy; forms flaggy beds a few inches thick	Brachiopods, fusulinids	"Flags" used for building stone			

Age	Map Unit (Symbol)			Description	Paleontological Resources	Mineral and Economic Resources	Cave and Karst Resources	Hazards	Suitability for Development/Recreation
PERMIAN, GUADALUPIAN	Delaware Group	Cherry Canyon Formation (Pdc)	Rader Member (Pdb6)	Light gray, granular limestone with numerous rounded pebbles; apple- green silicified volcanic ash	Brachiopods, sponges, bryozoans, rugose corals, and fusulinids				
			Pinery Member (Pdb5)	Gray, granular limestone; contains GSSP for global stratotype of base of Capitanian Stage	Brachiopods, sponges, bryozoans, rugose corals, fusulinids, and small crinoids	Aquifer (e.g., Smith Spring)			
			Hegler Member (Pdb4)	Dark gray, fine- grained limestone	Fusulinids, brachiopods, bryozoans, rugose corals, and occasional calyces of small crinoids	Vugs filled with fluorite			
			Manzanita Member (Pdc3) with lumpy gray limestone phase (Pdc3a)	Dense, greenish gray nodular limestone that weathers to orange or yellow; thin orange to yellow dolostone beds; sandstone interbeds; 2–5 thin beds of volcanic ash (green chert)	Occasional imprints of ammonoids and crinoids	Geodes in cracks and cavities Aquifer (e.g., Manzanita and Pine Springs) in sandstone below Manzanita Member		Broken by strike faults of small displacement; limestones intensely fractured, sandstones slightly less affected but local jointing present	
			South Wells Member(Pdc2)	Massive, buff, sandy dolomitic limestone locally with brown chert; thick brown calcareous sandstone beds; black dolomitic limestone interbedded with sandstone; one volcanic ash bed	Ammonoids, sponges, fusulinids, rugose corals, and brachiopods				
			Indurated sandstone ("quartzite") (Pdcq)	Thin beds of "quartzite" separately mapped in places between South Wells and Getaway Members southeast of Getaway Gap					
			Getaway Member(Pdc1)	Nearly continuous limestone with interbedded sandstone; contains GSSP for global stratotype of base of Wordian Stage	First abundantly fossiliferous layer in section: brachiopods, mollusks, conodonts, sponges, rugose corals, and fusulinids				
			Sandstone tongue (Pcc)	Moderately resistant, indistinctly bedded, grayish orange, very fine grained, well- sorted quartz sandstone with scattered irregular chert nodules; grades laterally into San Andres limestone in reef/forereef	Some chert nodules include abundant silicified fusulinids; various fossils including brachiopods				
		Brushy Canyon Formation (Pdy) with some limestone lenses (Pdyls) and basal Pipeline Shale Member (Hayes 1964; Warren 1955)		Tan to black, interbedded, fine- grained, massive and thin-bedded quartz sandstone and shaly sandstones (Newell et al. 1953)	Fusulinids, crinoid stems, brachiopods, bryozoans, rugose corals, ammonoids, pelecypods, gastropods, and fish fragments	Aquifer (source of Bone Spring); small amount of zircon		Cut by many strike faults in Delaware Mountains; supplies rockfall debris	
	Cutoff Formation (Harris 2000)		Williams Ranch Member	Black petroliferous limestones with minor dolostone replacement and minor brown chert; conglomerates of carbonate clasts at top	Ammonoids, brachiopods, bryozoans, fusulinids, sponges, trilobites, and nautiloids				
			El Centro Member	Black shale with middle black limestone unit; latter contains GSSP for global stratotype of base of Guadalupian Series and base of Roadian Stage	Conodonts				
CISURALIAN			Shumard Member	Black petroliferous limestones with abundant dark chert; localized thick megabreccia bodies at base	Bryozoans, brachiopods, nautiloids, sponges				
	Bone Spring Formation			Thin- bedded limestone, in part shaly	Nearly barren of fossils but striking for abundance of ammonoids; some nautiloids associated with ammonoids; fusulinids are nearly absent	Potential production for oil and gas (Hayes 1964); ammonoids in some lenses have free oil; sandstone grains chiefly quartz with some microcline and plagioclase, and small but noteworthy zircon, tourmaline, and apatite			