

Map Unit Properties Table: Petrified Forest National Park

Age	Map Unit (Symbol)	Description	Exposure and Thickness	Paleontological, Mineral, and Cultural Resources	Suitability for Infrastructure and Recreation	Correlation	
QUATERNARY	Surficial deposits, undifferentiated (Qsu)	Unconsolidated sand, silt, mud, and gravel: Includes alluvial surfaces (slopewash and sheet-flow deposits), active stream channels (ephemeral and perennial), colluvium, floodplain deposits, in situ soil development, and deposits of indeterminate origin; may be superficially modified by eolian processes	Alluvium is up to 60 m (200 ft) thick (Martin 2004)		Alluvium produces sufficient water, but would require treatment (Martin 2004); colluvium-covered slopes indicate potential for mass movement		
	Eolian dunes and sand sheets (Qd)	Unconsolidated sand: Deposited in dunes by eolian processes or in extensive sand sheets by mixed alluvial and eolian processes; commonly heavily vegetated	200,000- to 75,000-year-old dunes at higher elevations in north part of the park; 8,000- to 2,000-year-old dunes in drainages (e.g., Lithodendron Wash); <1,000-year-old dunes throughout the park (Ellwein et al. 1997)				
MIOCENE/ PLIOCENE	Bidahochi Formation Volcanic rocks (Mbv)	Basaltic lava and tephra deposits: Likely part of the Hopi Buttes volcanic field	Restricted to north portion of park (e.g., Headquarters Mesa)	Landmark features (e.g., Pilot Rock and Black Knoll)		Equivalent to the informal Member 5 of the Bidahochi Formation (Dallege 1999)	
MIOCENE	Bidahochi Formation Sedimentary rocks (Mbs)	Mudstone and minor siltstone: Deposited in freshwater lake or basin with shallow ephemeral lakes; outcrops generally medium tan to yellow, and locally difficult to distinguish from overlying Quaternary deposits; present as cut-and-fill deposits atop the Petrified Forest Member (TRcpf); usually preserved by volcanic cap rock	Limited outcrops near and south of Headquarters Mesa, on Pilot Rock, and in the northeast corner of the park			Likely equivalent to Members 1 and 2 of Dallege (1999)	
unconformity							
TRIASSIC	Chinle Formation	Owl Rock Member (TRco)	Sandstone and mudstone with minor limestone and siltstone: Lacustrine; mudstones—generally lighter in color than the underlying Petrified Forest Member (TRcpf); sandstones—pale reddish brown, fine-grained, well-sorted litharenites with common trough cross-strata; limestones—generally light-colored, mottled, pisolithic, and massive, locally brecciated and re-cemented; approximately 205 million years old (Bill Parker, Petrified Forest National Park, written communication, June 2009)	Exposed only on Chinde Mesa in the far north part of park, where 80 m (260 ft) are present (Ash 1992)	Limestone with secondary silica in dissolution zones (Dubiel 1993; Tanner 2000); selenite-gypsum lenses and chalcedony nodules; caliche	Bentonite; dissolution zones	
		Petrified Forest Member ¹ (TRcpf)	Mudstone with minor sandstone and siltstone: Deposited in vast, muddy floodplain; primarily pale red to purple mudstone with common thin sandstone interbeds; commonly bright reddish orange north of I-40; commonly light-green mottling in mudstones and large-scale scours in the upper part of the unit; approximately 210 million years old (Bill Parker, Petrified Forest National Park, written communication, June 2009)	Approximately 255 m (840 ft) thick (Ash 1992); exposed in Flattops and Painted Desert areas	Petrified wood; fossil leaves and other plant remains; invertebrate and vertebrate remains and trace fossils; gypsum	Bentonite	Called the Painted Desert Member (Petrified Forest Formation, Chinle Group) by Heckert and Lucas (2002)
		Black Forest Bed (TRcpfbf)	Calcrete-nodule conglomerate and reworked tuffaceous material with sandstone and mudstone interbeds: Black silicified wood gives bed its name; dated isotopically at 213 ± 1.7 million years old (Riggs et al. 2003) and 211 ± 0.7 million years old (Heckert et al. 2009)	Conglomerate up to 13 m (4 ft); sandstone and mudstone (0.1 to 0.2 m [0.3 to 0.7 ft] thick); only exposed in north part of park	Known for permineralized black wood; invertebrate and vertebrate remains		
		Lithodendron Wash Bed (TRcpflw)	Sandstone, conglomerate, and mudstone: Generally fine-grained sandstone with minor conglomerate, coarse-grained sandstone and interbedded mudstone; sandstones pale gray to tan on fresh surfaces, but commonly weather to medium brown; internal cross-stratification is ubiquitous, including trough and planar cross-sets, lateral accretion sets, and rare channel forms; multi-storied or single sets	Present throughout south part of the Petrified Forest Wilderness; total thickness up to 11 m (36 ft); many mesas and buttes of Painted Desert developed in this bed (Heckert and Lucas 2002)		Bentonite	Called Painted Desert Sandstone 3 by Billingsley (1985a) and Johns (1988)
		Goblin Sandstone (TRcpfg)	Sandstone and minor conglomerate: Pale yellowish gray to pale red, fine-grained, well-sorted; planar and trough cross-bedding are common, as are small-scale scours and rip-up conglomerates at the base of coarse-grained beds	Present west of Chinde Point (forms the floor of washes); prominent ledge-former in the Devil's Playground area			May be equivalent to Painted Desert Sandstone 1 of Billingsley (1985a) and Johns (1988)
		Flattops Beds 2–4 (TRcpff)	Sandstone: Generally fine- to medium-grained, moderately to well-sorted brownish gray sandstone; commonly planar and trough cross-strata are common and horizontal and ripple laminae	Flattops Bed 2 laterally extensive; Flattops Beds 3 and 4 restricted to the Flattops Mesa area along the main park road; unit thicknesses laterally variable but typically <10 m (33 ft); Flattops Bed 2 is the thickest (>10 m [33 ft] in some locations)	Unionid bivalves in Flattops Beds 2 and 3		

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TRIASSIC	Chinle Formation	Sonsela Member / Petrified Forest Member undifferentiated (TRcspf)	Mudstone and sandstone: Pale greenish gray to bluish gray mudstone with minor to significant sandstone interbeds; commonly tabular bedding and cut-and-fill scours; lateral variation in lithology, becoming generally finer grained to the north	Informal unit mapped only in the Devil's Playground area north of I-40 (Blakey and Raucci 2006)		Bentonite	Transitional interval between the Sonsela and Petrified Forest members (Blakey and Raucci 2006)
		Sonsela Member ³	Deposited in large gravelly river; entirely within Norian Stage (216.5 to 203.6 million years ago), approximately 216 million years ago (Bill Parker, Petrified Forest National Park, written communication, June 2009)	Includes the majority of strata in the central and southern portion of the park as well as the Devils Playground area	Primary source of petrified wood in the park; other plant, invertebrate, and vertebrate remains and trace fossils		
		Flattops 1 Bed (TRcsft1)	Sandstone and conglomerate: Medium- to coarse-grained, moderately to well-sorted, yellow brown to dark brown sandstone; compositionally immature and commonly multi-storied with thin mudstone interbeds; conglomerates comprise calcrete-nodule lags at the base of sandstone beds and discrete lenses of pebble-size clasts; volcanic clasts and intra-formational rip-ups	Individual beds 3 to 5 m (10 to 16 ft) thick; maximum thickness 25 m (80 ft), but appears to pinch out in the southeast and west edges of the south part of the park	Petrified wood and unionid bivalves; chert		Top of the Sonsela Member in Woody (2003); called Agate Bridge Bed by Heckert and Lucas (2002)
		Brown Sandstone (TRcsb)	Sandstone and minor conglomerate: Sandstones generally fine- to medium-grained, but coarse intervals common, especially near the base of scours; pale tan or gray on fresh surfaces, weathers to medium brown; internal structure—massive or weakly laminated to complex cross-stratification; may comprise either multiple stories or a single thick bed; forms prominent blocky ledges	Mapped only in the Devil's Playground area north of I-40 (Blakey and Raucci 2006); total unit thickness up to 6 m (20 ft), but lateral changes in thickness can be abrupt, especially near the northern pinch-out			
		Jasper Forest Bed (TRcsjf)	Sandstone, mudstone, and conglomerate	Caps bluffs at Blue Mesa, Jasper Forest, and Crystal Forest	Main petrified wood-bearing horizon in the central portion of the park; vertebrate remains occur locally		Called the Agate Bridge Bed by Heckert and Lucas (2002); may be analogous to one or more significant, medial sandstones within the Jim Camp Wash Beds in the Rainbow Forest area
		Jim Camp Wash Beds (TRcsjc)	Sandstone, siltstone, and mudstone: Pale gray, purple, and less commonly red mudstone; fine- to medium-grained and poorly sorted sandstone; sandstones—generally not laterally continuous, ribbon architecture common; thicker, more laterally continuous sandstone beds are locally present that are coarser grained, richer in volcanic clasts, and similar to Rainbow or Flattops sandstones from which they may be difficult to distinguish	Total thickness 30 to 45 m (100 to 150 ft), may locally thinner	Unionid bivalve fragments; vertebrate fossils; minor amounts of petrified wood; chert and calcareous nodules	Bentonite	
		Rainbow Forest Beds (TRcsrf)	Sandstone and conglomerate: Fine- to medium-grained, moderately well-sorted, pale gray sandstone; locally trough and planar cross-stratified	Individual beds are generally 1 to 4 m (3 to 13 ft) thick; total thickness up to 15 m (50 ft)	Main wood-bearing horizon in southern end of park, contains nearly all the more colorful specimens; andesite, rhyolite, chert, and quartzite in conglomerate		Basal bed of the Sonsela Member; tentatively includes the Camp Butte sandstone (Murry 1990)
		Blue Mesa Member (TRcbm)	Mudstone with minor siltstone and sandstone: Deposited in muddy floodplain, ancient soils; banded dark blue, gray, yellow, and red; structureless beds; base is approximately 219 million years old (Irmis and Mundi 2008)	Individual beds generally >2 m (7 ft) thick; total thickness 80 m (260 ft); base rarely exposed in park, best exposed in the Tepees area	Contains majority of fossil-leaf localities, as well as abundant petrified wood, including stumps in growth position, amber, pollen, and spores; vertebrate remains common in some horizons	Bentonite	
		Newspaper Rock Bed (TRcbmn)	Sandstone, shales, mudstone, and conglomerate: Deposited in meandering fluvial system; complex internal geometry, including trough cross-strata, stacked ripple laminations, and lenticular bedding	Up to 20 m (66 ft) thick, and includes prominent red paleosol horizon in the Tepees and Blue Mesa areas; lowest persistent ledge-forming sandstone in the park	Contains majority of fossil-leaf localities; fossil plants and fungi; vertebrate tracks	Sandstone facies prone to cliff retreat	Prominent bed in the Blue Mesa Member
		Lower sandstone unit ⁴ (TRcls)	Sandstone: Coarse-grained quartzite with significant quartz overgrowths; irregular and lenticular bedding and trough cross-strata	Exposed in a single isolated outcrop east of the Haystacks; total thickness up to 2 m (7 ft); individual beds 0.5 to 1 m (2 to 3 ft) thick, cross-bedding in 20- to 40-cm (8- to 16-in) sets			
Mesa Redondo Member (TRclrm)	Pale-red mudstone: Deposited in a combination of fluvial environments; >219 million years ago (Bill Parker, Petrified Forest National Park, written communication, June 2009)	Uncertain thickness; only the top of the unit is exposed in the park					

¹Since mapping by Blakey and Raucci (2006), Martz and Parker (2010) have reinterpreted the Petrified Forest Member as (from oldest to youngest) Flattops Bed 2, Flattops Bed 3, and Flattops Bed 4.

²Mapped by Blakey and Raucci (2006) as an informal unit only in the Devil's Playground area north of I-40.

³Since mapping by Blakey and Raucci (2006), Martz and Parker (2010) revised the Sonsela Member into the following beds (from oldest to youngest): Camp Butte beds, Lot's Wife beds, Jasper Forest bed / Rainbow Forest Bed, Jim Camp beds, and Martha's Butte beds.

⁴Lower sandstone unit mapped by Blakey and Raucci (2006) is probably within the lower part of the Blue Mesa Member (Bill Parker, Petrified Forest National Park, written communication, September 3, 2009).