Map Unit Properties Table: City of Rocks National Reserve

Age	Unit Name (Symbol)	Features and Description	Erosion Resistance	Suitability for Infrastructure	Hazards	Mineral Specimens	Habitat	Recreation	Geologic Significance
QUATERNARY	Alluvium (**Qal**) Younger alluvial fan deposits (**Qya**) Younger alluvial fan deposits over intermediate alluvial fan deposits (**Qya**/**Qia**) Younger fluvial deposits (**Qyf**) Veneer on pediment (**Qvp**)	Unit **Qal** contains 2–3 m (7–10 ft) of dark-brown sand and mud along active washes and floodplains with some gravel deposited locally. Unit **Qya** includes dark-brown, organic-rich sand, gravel, and silt that form 1- to 4-m- (3- to 13-ft)-thick alluvial fans from steep hills to lower gradient areas. Unit **Qya**/**Qia** is mixed thin (<2 m [7 ft] thick) sheets of younger and intermediate alluvial fan deposits. Unit **Qyf** contains mud, sand, and gravel associated with active river processes. Unit **Qvp** consists of mixed colluvium, alluvium, and alluvial fan deposits as thin (<3 m [10 ft] thick) veneers on nearly flat erosional bedrock surfaces (pediment).	Low unless carbonate cement present.	Units are associated with river environments, such as floodplains and stream banks; avoid for heavy development.	Units are prone to flooding and slumping when undercut. Stream deposits could be prone to liquefaction. May contain shrink-and-swell clays.	Sand, gravel	Units contribute to organic-rich soils along riparian zones; some calcic horizons are present in unit **Qyf**.	Units are associated with active geomorphological processes and fragile riparian areas; avoid for any recreation beyond light seasonal use.	Units contain the Mazama ash layer (eruption that formed what is now Crater Lake in Oregon) dated at approximately 7,700 years old. Unit **Qyf** contains charcoal layers dated at 8,265±35 years before present.
QUATERNARY	Landslide deposits (**Qls**) Colluvium (**Qc**) Talus (**Qt**)	Unit **Qls** contains bouldery, dark-colored deposits less than 10 m (33 ft) thick displaying slump-block morphology in outcrop. Unit **Qc** is light- to dark-brown, unsorted and unconsolidated rubble of rock and soil on steep slopes less than 5 m (16 ft) thick. Unit **Qt** includes white, blocky boulder fields (<5 m [16 ft] thick) on steep slopes with angular edges and an overall lack of a finer grained matrix.	Low	Units are associated with unstable and steep areas and should be avoided for development.	Units are associated with active mass-wasting processes, including repeated slumping, tumbling, rockfall, sheetwash, and slope creep. Some frost wedging also associated with these units.	Boulders	Units are associated with springs and dense vegetation locally. Unit **Qls** is mostly unforested.	Units form stepped slopes at the bases of steeper exposures and should be avoided for most recreational use.	Units are associated with prominent local features, including Twin Sisters.
QUATERNARY	Intermediate alluvial fan deposits (**Qia**) Intermediate alluvial fan deposits over older alluvial fan deposits (**Qia**/**Qoa**) Intermediate alluvial fan deposits over Quaternary and Tertiary alluvium and landslide deposits (**Qia**/**QTa**).	Unit **Qia** includes gravelly sand and sandy loam in medium- to dark-brown, 5- to 10-m-(16- to 33-ft) thick exposures as alluvial fans and some colluvium. Some loess deposits in 20- to 50-cm- (8- to 20-in.)-thick lenses locally. Unit **Qia**/**Qoa** overlies older alluvial-fan deposits with a thin (<2 m [7 ft] thick) sheet of mixed sand and gravel. Unit **Qia**/**Qta** resembles unit **Qia**/**Qoa** in thickness and composition overlying alluvium and landslide deposits.	Low unless carbonate cement present.	Units are present as unstable alluvial fans prone to erosion, mass wasting, and flash flooding and are unsuitable for most development.	Units are associated with flash-flood deposition and active erosion and are prone to gullying.	Gravel, sand, silt	Unit contains decomposed granite and one or two well-developed soils with argillic and calcic horizons. Stage II calcic soil and stage IV soil present.	None documented	Units record history of uplift and erosion throughout the area.
QUATERNARY	Intermediate fluvial deposits (**Qif**) Older alluvial fan deposits (**Qoa**) Older fluvial deposits (**Qof**).	Unit **Qif** contains sand, gravel, and mud with some Bt and calcic (stage II) soil horizons in uppermost layers of the deposit. Unit contains characteristic surficial pavements and gray mud beds atop well-sorted pebble to cobble gravel. Unit **Qoa** contains 15–25 m (49–82 ft) of medium-brown, gravelly sand deposited as alluvial fans and colluvial layers in steeper areas. Coarser cobbles and boulders form an erosional surface on rounded crests with sand and loam matrix. Unit **Qof** contains rounded clasts, mixed with adjacent alluvium, and loess caps greater than 1 m [3 ft] thick.	Low	Units are highly permeable and may be unsuitable for waste-water treatment-facility development.	Units are prone to slumping and slope creep if undercut or exposed on slopes.	Sand, gravel, mud, cobbles, pebbles, loam.	Unit **Qoa** contains well-developed calcic horizon in soils including more than 1.4 m of stage IV calcic soil. Unit **Qof** contains loess-rich areas.	Boulder fields are unstable and unsafe trail base and should be avoided for recreational use.	Unit **Qif** may contain glacial deposits recording activity in the Raft River Mountains. Unit **Qoa** contains soils that may be several hundred thousand years old. Units are used to determine erosional and depositional history of the area.
QUATERNARY -TERTIARY	Alluvium and landslide deposits (**QTa**) Fluvial deposits (**QTf**).	Unit **Qta** includes boulder and gravel deposits forming high hills that are light colored in outcrop exposures as thick as 25 m (82 ft). Unit **QTf** is a 10-m-(33 ft) thick mixture of brown sand, gravelly sand, gravel, and silt with some bedding and cross-lamination depositional structures. Well to moderately sorted. Brown sand of this unit is of wind-blown origin and overlies river (fluvial) deposits.	Moderately low.	Units are highly unsorted and heterogeneous and may be unstable if undercut for foundation construction.	Units contain large boulders atop less competent layers and may be prone to mass wasting during extreme precipitation.	Quartzite boulders, gravel, fine sand, silt.	Unit **QTf** resembles rounded terraces and contains stage III or stage IV calcic soil horizons.	Unit **QTa** is flanked by large boulders (1–5 m diameter) that may be unsuitable for trails and other uses.	Unit **QTa** associated with Smokey Mountain and Twin Sisters with deposits from now-eroded heights.

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TERTIARY	Rhyolite (**Tr**) Sedimentary deposits (**Ts**) Granite (**Tg**)	Unit **Tr** consists of bright-red, brownish-red, to gray welded rhyolite tuff with some black vitrophyre near the base and top, locally. Lithic fragments of granite as large as 1.5 cm (0.6 in.) within vesicular (flattened) central unit. Unit ranges in thickness from 9 m to 17–20 m (30 ft to 56–66 ft). Unit **Ts** includes cobbly sand in light-brown, slope-forming deposits. Boulders from this unit are as large as 4 m (13 ft) in diameter in 5- to 10-m- (16- to 33-ft)-thick deposits. Unit **Tg** is white to light-gray granite of the Almo pluton. Compositions range from biotite granite, to biotite-muscovite granite, to muscovite granite in massive, banded outcrops. Dikes of pegmatite and aplite intrude locally.	High for units **Tr** and **Tg**, low for unit **Ts**.	Igneous units may weather to radon-producing soils and should be evaluated prior to any infrastructure construction.	Unit **Ts** is prone to slumping and sliding if exposed on slopes or undercut. Unit **Tg** may be present as large blocks and slabs that may be subject to frost wedging and rockfall. Units may weather to produce shrink-and-swell clays.	Smoky quartz (3–6 mm), pumice (vesicles may be filled with secondary minerals locally), quartzite boulders, biotite, muscovite, garnet, granite, pegmatite.	None documented	Granitic exposures form much of the "City of Rocks" features. They are popular for rock-climbing.	Nearby rocks similar to unit **Tr** were dated to 8.8 million years old. Unit **Tg** represents the Almo pluton and has a Rubidium-Strontium radiometric age of 28.6±1.0 million years and forms the younger of the Twin Sisters.
ORDOVICIAN	Metamorphosed Pogonip Group (**Op**)	Unit contains brown to bluish-gray, calcitic marble in 10-m- (33-ft)-thick, narrow outcrops.	Moderate	Unit may contain dissolved conduits and should be investigated before any infrastructure construction.	Unit could dissolve away from beneath intact rocks and present a rockfall hazard.	Brown ,micaceous marble; gray, pure marble; calcite; dolomite; phlogopite.	Unit weathers to produce calcium- and magnesium-rich soils. Dissolved crevices may provide bat habitat.	Unit may be subject to karst dissolution that may produce caves or small cavities that could attract visitors.	Unit represents clean and silty limestone deposition in a marine environment.
PROTEROZOIC	Schist of Mahogany Peaks (**Zmp**) Quartzite of Clarks Basin (**Zcb**)	Unit **Zmp** contains black schist with coarse-grained textures. Unit **Zcb** includes thinly layered, flaggy 20-m- (66-ft)-thick quartzite with mica-rich joints or layers. Unit appears silvery white and tan to light gray.	Moderate, moderately high for quartzite.	Heterogeneous and locally schistose nature of these units may render them unsuitable for infrastructure.	Mica-rich joints and layers may provide planes of weakness within resistant quartzite that may present rockfall hazards.	Quartzite	None documented	Quartzites may form resistant ledges and ridges that may provide nesting habitat or attract climbers.	Units record mixed marine and near-shore depositional environments.
PROTEROZOIC	Schist of Stevens Spring (**Zss**) Quartzite of Yost (**Zy**)	Unit **Zss** is brown to silvery-brown schist with coarse-grained, wavy to knobby textures. Near the base of this unit is distinctive amphibolite. Unit is approximately 300 m (980 ft) thick. Unit **Zy** is pure white quartzite. Scant muscovite (mica) layers define the thin bedding of this 40-m- (130-ft)-thick unit.	Moderate to high for quartzite.	Coarse-grained schist may prove too friable locally for infrastructure.	Quartzite is susceptible to blockfall if undercut on slopes. Schist can pose mass-wasting problems, especially if slope is aligned parallel to schistosity.	Muscovite, sillimanite, biotite, garnet, andalusite, kyanite in 2- to 7-cm- (0.8- to 2.8-in.) wide lenses, white quartzite.	None documented	Quartzite may form resistant ledges and ridges that may provide nesting habitat.	Unit **Zss** records a complex regional metamorphic history.
PROTEROZOIC	Schist of the Upper Narrows (**Zun**) Elba Quartzite of Armstrong (**Ze**)	Unit **Zun** includes thinly layered, quartz-rich muscovite-biotite schist and (2- to 12-cm- [0.8- to 4.7-in.]-thick) schistose quartzite that appears light to dark brown and grayish brown in outcrop. Unit is approximately 70 m (230 ft) thick. Pure limestone marble is present locally. Unit **Ze** is approximately 200 m (660 ft) of white to pale gray and grayish-brown quartzite in thick beds. Unit grades from vitreous (glassy) quartzite beds at the base to darker, less pure, thick quartzite beds. Some tabular cross lamination and schist interbeds present locally.	High	Layered and weathered nature of these units may render them unsuitable for infrastructure.	Quartzite is subject to blockfalls and frost wedging. The presence of unit **Ze** clasts in younger units suggest it is deeply eroded. Schist can pose mass wasting problems if slope is aligned parallel to schistosity.	Muscovite, biotite, quartzite, pure limestone marble, feldspar, epidote, actinolite.	Unit **Ze** tends to underlie well-drained high ridges due to its high resistance to erosion.	Unit forms resistant ridges that may be attractive to climbers.	Unit **Zun** may have been part of a shallow marine depositional environment with laminated sand and silt. In unit **Ze**, muscovite schist may represent metamorphosed argillaceous soil horizon above Archean rocks.
ARCHEAN	Amphibolite (**Wga**) Granite and granite gneiss (**Wgg**) Schist (**Wgs**)	Unit **Wga** includes black hornblende-plagioclase and hornblende-plagioclase-garnet metamorphosed mafic rock with coarse- to medium-grained textures. Unit appears as linear, dark bands in granite and is a few tens of meters wide. Unit **Wgg** is porphyritic biotite granite that appears light to dark gray and coarse grained in outcrop. Large crystals are aligned as magmatic foliation. Granite is locally deformed to augen gneiss. Unit **Wgs** contains coarse-grained muscovite-biotite schist that appears dark brown in outcrop. Schist locally contains veins, stringers, and knots of feldspar and quartz and is intruded by unit **Wgg**.	High to moderately high for schist.	Granitic unit may weather to produce radon-emitting soils and should be tested prior to basement construction.	Unit subject to blockfall if undercut on slope. Weathered exposures can be friable and unstable on slopes. Mica-rich joints and layers may provide planes of weakness within resistant granite and quartzite that may present rockfall hazards.	Hornblende, plagioclase, garnet, quartz, 5x2-cm (2x0.8-in.) microcline phenocrysts, biotite, coarse granite.	None documented	Units are suitable for most recreation; large crystals may attract illegal sampling.	Archean rocks are among the oldest in North America. Unit **Wga** likely represents dike swarms intruding the granite. Unit **Wgg** is 2.5 billion years old and forms the older of the Twin Sisters.