Appendix C: Paleozoic Stratigraphic Units and Descriptions

Ma	Period	Grp	Formation	Member	Thick	Description	Paleoenvrionment	Upper Contact
251	Permian		Kaibab Fm	Harrisburg	300-80 ft	Forms the uppermost cliffs and slopey ledges. Eastward-thinning, alternating red and yellow mudstone, thin bedded red sandstone, laminated aphanitic limestone and dolomite beds, and white gypsum deposits.	Lateral, eastward progression from open marine conditions to shallow, restricted-circulation shoreline. Fossils: bryozoans, clams, cephalopods, gastropods, trilobites, corals, brachs, sponges, annelid worms, urchins, and crinoids.	The Triassic Moenkopi Fm overlies the Kaibab in N. AZ and UT, but not at the Grand Canyon.
				Fossil Mtn	300-250 ft	An eastward-thinning gray, fossiliferous, medium-bedded, cherty limestone cliff.		Conformable; white/tan/red chert nodules or beds marks it.
			Toroweap Fm	Woods Ranch	180 ft	Vegetated slope of red and white fg sandstone and siltstone with limestone beds <6in thick and interbedded gypsum, eastward transition to x-bed sandstone.	Shoreline facies of cyclical marine incursions from the west. Contains one marine bivalve-bearing bed.	Locally disconformable but largely conformable. Contact is between W.R. gypsum or ss and Kaibab cherty limestone or ss
				Brady Cyn	280-0 ft	Cliff-forming, medium grained, gray fossiliferous limestone cliff, transitioning eastward to fg dolomite. Westward thickening proportional to Woods Ranch Mbr.	Similar environment, western open marine fossils: brachs, bryozoans, crinoids, and horn corals. Eastern intertidal fauna: bivalves, gastropods, few scaphopods and cephalopods.	Gradational upper contact
				Seligman	< 45 ft	Red and yellow fine grained sandstone grading up a into silty sandstone and mudstone slope, which is vegetated. with interbedded carbonates and gypsum.	Shoreline facies of cyclical marine incursions from the west.	Gradational upper contact
			Coconino Ss		0-600 ft	Westward thinning, but laterally variable thickness, white to tan, fine grained, well sorted, rounded, cross stratified, cliff forming quartz sandstone with minor K feldspar. It has large-scale dune features, such as high-angle sets of planar tabular and planar wedge cross stratification and small scale ripple features as well	Vast Coconino desert spread from AZ to Canada - wind transport direct was north to south. It preserved tracks of mammal-like reptiles, scorpions, spiders, millipedes.	Locally unconformable with Toroweap Fm, planar truncation of underlying cross stratified beds, but in places interfingering with the Toroweap. Conformable with Kaibab Ls in eastern localities where Toroweap is absent.
			Hermit Fm		900-100 ft	The westward thickening, slope-forming Hermit Fm contains alternating light red silty sandstone with dark red sandy mudstone. Thin bedded, cross laminated/stratified in places. Local carbonate-pebble conglomerate lenses.	Lowland river floodplain system with land plant fossils, possible amphibian trackways, and fronds and stems of seed ferns, pines, and gingkos.	A sharp disconformable break to the Coconino Ss (or Toroweap Formation where Coconinio is absent).
299		Supai Group	Esplanade Ss		1350-950 ft	Fine grained, cross stratified sandstone forms a massive cliff except where Pakoon limestone intertongues. The base alternates reddish sandstone and siltstone. Main cliff is thick bedded, cross stratified, well-sorted quartz sand. Upper 200ft is a red, gypsiferous shale slope capped with red and white fine grained sandstone cliff.	Clastic deposition similar to the Manakacha Fm. Evaporites likely formed in either coastal or continental sabkha environments. Non-marine arenaceous limestones in aeolian envs.	Unconformable with the Hermit Shale, and has deep (>45ft) erosional channels scoured into it.
299	Pennsylvanian		Wescogame Fm		200-100 ft	Red, cross bedded, calcareous dolomitic sandstone. The upper half is red shale slopes and ss cliffs. Lower half is a prominent ss cliff. It preserves an E to W gradation from redbeds to sandstone and red mudstone to sandy limestone.	Likely similar environments to the Manakacha Fm.	Well-developed erosional upper contact is carved with channels 50 ft deep filled with limestone-pebble conglomerate. Is likely the actual Penn-Permian unconformity.
			Manakacha Fm		150-300 ft	Westward thinning series of ledges and slopes of thin to thick-bedded, cross-stratified, fine grained, reddish sandstone with micritic limestone and calcareous shale components.	Cross-stratified sandstone units are aeolian. Redbeds, laminated sandston, and bioturbated sandstones have unclear non-aeolian origins. Limestones from low-energy open marine settings.	The upper erosional contact is unconformable and often obscured by debris. A gap of Middle Penn. time is marked by erosional, conglomeratic channels with up to 50 ft relief.
318			Watahomigi Fm		300-100 ft	Light gray, thick bedded, fine grained to oolitic, cliff-forming limestone and dolomite with lenses of red chert. Limestone beds are separated by thin, reddish purple, slope-forming siltstones and mudstones.	The clastic sediments interbedded with shallow marine limestone probably represent a low coastal environment beginning in mid-Penn time. Diverse brachiopod fauna preserved.	Likely conformable, defined by a zone of gray, jasper-bearing limestone, bright orange sandstone, and red mudstone.
318	Mississippian		Surprise Cyn Fm		up to 300 ft	Terrestrial conglomerates and fossiliferous marine limestone and siltstone filling in a series of paleochannels carved into the then-exposed upper Redwall limestone, averaging 1000ft wide and nearly 300 feet deep.	Westward-draining river system turned to estuaries flooded by transgressing sea. >60 fossil spp: brachs, gastropods, clams, corals, bryozoans, crinoids, stromatolites, trilobites, bones, teeth, terr. plants, microfossils.	Fossil biomarkers indicate an unconformity between Miss. and Penn. strata. Talus often obscures the contact, but in places a low angle unconformity is recognizable.
			Redwall Ls	Horseshoe Mesa	125-45 ft	Westward thickening, thin bedded, fine grained, light gray limestone beds that form receding ledges.	Rare spiriferid brachiopods, bivalves, and corals, as well as 16 species of foraminifera preserved in this regressive deposit.	Upper Redwall Ls is heavily eroded and carved by paleochannels, where the Surprise Canyon fills in.
				Mooney Falls	400-200 ft	Main section of Redwall Limestone. Thick bedded, nearly pure limestone with local dolomitization and thin zones of chert lenses in upper portion	2nd Redwall transgression. Invertebrates: solitary and colonial corals, spiriferid brachiopods, crinoids, and microfossils.	Conformable and difficult to identify.
				Thunder Springs	150-100 ft	Westward thickening, alternating light and dark beds of carbonate and chert. The carbonate is thin bedded limestone to the west, dolomite to the east.	Very diverse and abundant life in a regressing sea, especially preserved in the chert beds. Fossils: corals, bryozoans, cephalopods, gastropods, brachiopods, and crinoids.	Unconformable with Mooney Falls Member. Generally a disconformity with local low-angle unconformities.
359				Whitmore Wash	200-100 ft	Westward thickening, light gray, thick-bedded, fine grained limestone in the west, but dolomite in central and eastern Grand Canyon. A pure carbonate lithology with virtually no siliciclastics, it forms a resistant cliff.	Eastward transgressing shallow sea. Few, poorly preserved fossils of brachiopods, corals, and crinoids.	Conformable, but recognizable but chert beds in the lower Thunder Springs Member.
359	Devonian		Temple Butte Fm		450-0 ft	Westward thickening, moderately thick, irregular beds of olive-gray, medmium grained dolomite and quartz-dolomite sandstone. Sugary texture on weathered surfaces, forms a series of ledges and steep slopes.	Likely represents a very shallow marine basin to the west and super-tidal/estuarine conditions eastward. Rare fossils (fish, stromatolites, conodonts).	Clear, unconformable upper boundary. It is characterized by a distinct transition in lithology to Redwall limestone and an irregular erosoinal surface with 5 to 20 feet of relief.
416								
488	Cambrian	Tonto Group	Muav Ls		1400-650 ft	Westward thickening, gray, irregular, thin-bedded, very fine grained, dolomitic limestone beds weather to dark gray at the surface and form sheer cliffs. Thin beds and lenses of flat pebble conglomerates are locally present. Tongues of Bright Angel Shale form slopes within the limestone cliffs.	Trace fossils present; Rare fragments of sponges, molluscs, echinoderms, and algae.	A disconformity marked by 15-30 ft thick erosional channels filled with Devonian sediment. Probably represents time lost from the Late Cambrian, Ordovician, Silurian, to the mid Devonian.
			Bright Angel Shl		450-270 ft	Westward thickening, green, fine grained, glauconitic, fissile shale interbedded with medium grained red-brown sandstone. Rust colored dolomite tongues form occasional ledges in the otherwise slope-forming shale.	Represents an offshore marine environment in the Tonto Sea (<100ft deep). 47 spp trilobites, trace fossils, and brachiopods, with rare fragments of sponges, molluscs, echinoderms, and algae.	The upper contact with the Muav limestone is fairly arbitrary because of the interfingering of the units – it changes with location in the canyon.
542			Tapeats Ss		150-250 ft	Westward thinning, sheer to ledgy, gray-brown to red-brown cliff-forming ss. Coarse-grained with minor conglomerate lenses. Locally cemented with silica to form quartite-like areas. Small-scale cross bedding is common.	Beach to intertidal shoreline environments. Trace fossils can be common. Rare body fossils.	Upper contact is transitional rather than abrupt. In places, Bright Angel Shale is interbedded with Tapeats ss. There, the upper contact is defined as the highest occurrence of Tapeats.