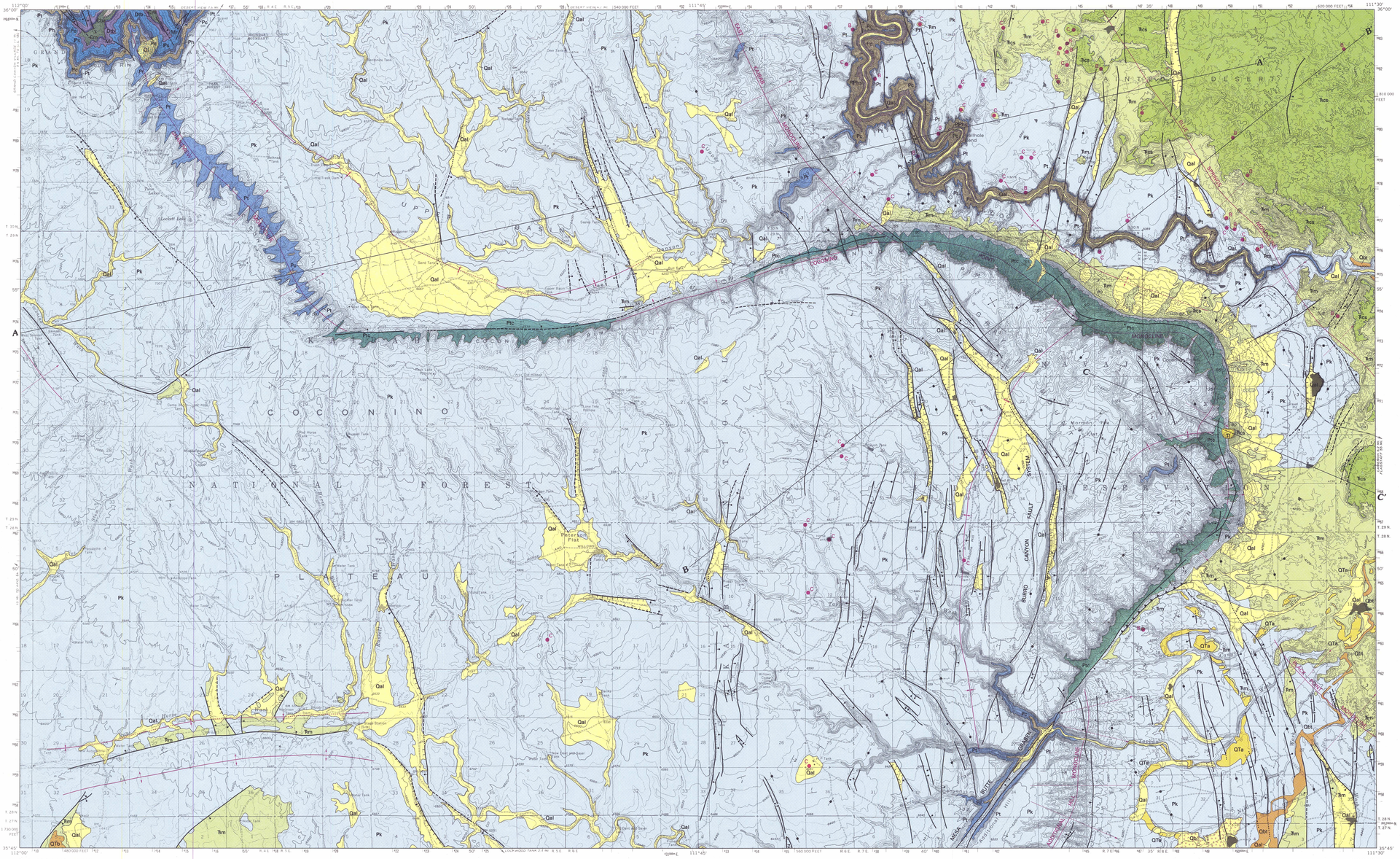
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
UNITED STATES DEPARTMENT OF ENERGY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1644



Base from U.S. Geological Survey, 1:62,500
Grandview Point and Coconino Point, Arizona, 1982
10,000-foot grid based on Arizona coordinate system, central zone

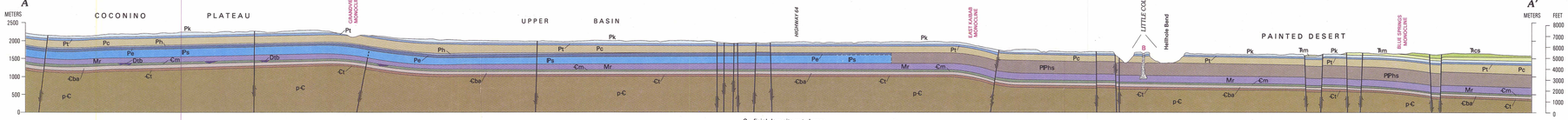
SCALE 1:62 500

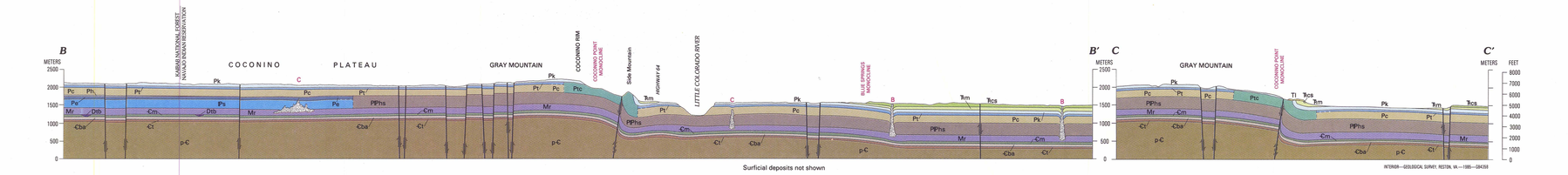
1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 KILOMETERS

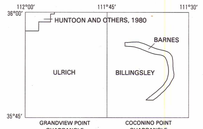
CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

APPROXIMATE MEAN DECLINATION, 1985

ARIZONA
QUADRANGLE LOCATION







INDEX TO GEOLOGIC MAPPING

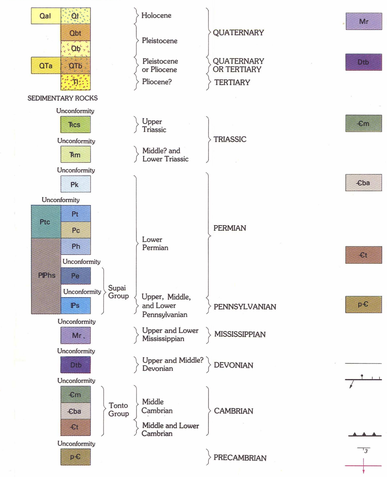
GEOLOGIC MAP OF THE COCONINO POINT AND GRANDVIEW POINT QUADRANGLES, COCONINO COUNTY, ARIZONA

By

G.H. Billingsley, C.W. Barnes, and G.E. Ulrich

1985

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

SURFICIAL AND VOLCANIC DEPOSITS

Qal SILT, SAND, GRAVEL, AND BOULDERS (HOLOCENE AND PLEISTOCENE)—Includes alluvium, colluvium, and eolian deposits. Faults shown as bounding alluvium do not offset alluvium. Not all alluvium is shown

Qtr LANDSLIDE DEBRIS (PLEISTOCENE)—Unsorted rock debris in Grand Canyon, in northwest corner of map

Qbt TAPPAN BASALT FLOW (PLEISTOCENE)—Basalt flow in Cedar Wash drainage area in southeastern corner of map. Flow originated at a vent on the east flank of Kendrick Peak, 26 mi (43 km) southwest of the map area. The flow continued into the adjoining Cameron quadrangle (Akers and others, 1962), where it flowed into an early channel of the Little Colorado River, terminating just inside the eastern edge of the map area. Thickness ranges from 3 to about 30 ft (1 to about 10 m). The basalt is aphyric with a coarse felty groundmass containing abundant plagioclase, and some clinopyroxene, olivine, and opaque oxides. Potassium-argon age of 0.53± 0.08 m.y. (Damon and others, 1974). Magnetic polarity is normal (T. Onstott, unpublished data, 1978), and the flow is interpreted as belonging to the Brunhes Chronozone

Qtk KEETSO TANK BASALT FLOW (PLEISTOCENE)—Basalt flow in southeast part of map area. Probable source is a fissure vent at Lockett Tank, 3.5 mi (5.7 km) southwest of the map area. Thickness ranges from 3 to 15 ft (1 to 5 m). The basalt is porphyritic with scattered phenocrysts of plagioclase, sparse olivine, and rare clinopyroxene. Flow occupies an old drainage 28 ft (8.5 m) higher than Tappan basalt flow and is displaced by pre-Tappan faulting at one location just south of map area. Magnetic polarity is normal (T. Onstott, unpublished data, 1978), and flow is interpreted as belonging to Brunhes Chronozone

QTa ALLUVIUM (PLEISTOCENE OR UPPER PLIOCENE)—Silt, sand, gravel, and boulder detritus from Moenkopi and Kaibab Formations. Occupies abandoned stream channels

QTb BASALT FLOW (PLEISTOCENE OR PLIOCENE)—Basalt flow in southwestern corner of map area. Small outcrop is terminus of flow derived from cinder cone just south of map boundary. Basalt is porphyritic with abundant olivine and sparse clinopyroxene phenocrysts in a feldspathic groundmass. Magnetic polarity of vent is reversed (K. Tanaka, unpublished data, 1980) and flow is interpreted as belonging to Matuyama Chronozone

Tl LANDSLIDE DEPOSITS (PLIOCENE?)—Coherent slumped mass on eastern, downfolded side of Coconino Point monocline. Consists of horizontal Kaibab Formation overlying upturned beds of Chinle, Moenkopi, and Kaibab Formations. High nonerosional relief indicates pre-Pleistocene age

SEDIMENTARY ROCKS

Trcs CHINLE FORMATION (UPPER TRIASSIC)—Shinarump Member—Light-gray to yellowish-gray sandstone and conglomerate, and reddish-purple and purple siltstone and sandstone. Forms resistant ledges. Erosional remnants from 20 to 150 ft (6 to 46 m) thick

Trm MOENKOPI FORMATION (MIDDLE? AND LOWER TRIASSIC)—Consists of three units; top and bottom units are reddish-brown, thin-bedded mudstone, siltstone, and sandstone; middle unit is light-gray silty sandstone and calcareous sandstone, the "lower massive sandstone" of McKee (1954). Thickness is 240 ft near Little Colorado gorge (73 m), thinning eastward to 130 ft (40 m)

Pk KAIBAB FORMATION (LOWER PERMIAN)—Yellowish-gray to light-gray, silty dolomite, dolomitic sandstone, minor sandstone and dolomitic limestone. Chert lenses and nodules common; beds of chert breccia common at top, near Gray Mountain. Abundant fossils, thin-bedded, and cross-laminated in upper third of unit. Forms a ledgy cliff in canyons. Thickness 265 ft (80 m)

Pt TOROWEAP FORMATION (LOWER PERMIAN)—Consists of three lithologic units in the Grand Canyon area: upper unit slope-forming, red to pale-yellow, calcareous siltstone and sandstone with minor amounts of gypsum, 140 ft (43 m) thick; middle unit cliff-forming, light-gray, dolomitic limestone, 60 ft (18 m) thick; lower unit yellowish-gray and red, cross-stratified siltstone and sandstone, 30 ft (9 m) thick. Units not recognizable to the east, where formation becomes more sandy, lighter in color, and more cross-bedded than in Grand Canyon area; in places along Coconino Point monocline it is indistinguishable from the underlying Coconino Sandstone because of intense jointing and similar weathering. Eastern facies forms cliff in Little Colorado River canyon and maintains a constant thickness as western facies, forming shear cliffs shown on map by a line

Pc COCONINO SANDSTONE (LOWER PERMIAN)—Yellowish-white, fine-grained, cross-stratified sandstone. Forms prominent light-colored cliff near rim of Grand Canyon. From 600 to 1,000 ft (183 to 305 m) thick

Ptc TOROWEAP FORMATION AND COCONINO SANDSTONE UNDIVIDED (LOWER PERMIAN)—Yellowish-white, pink, and light-brown, fine-grained, cross-stratified sandstone. The two formations cannot easily be distinguished along Coconino Point and Grandview monoclines. Combined unit forms saddles and strike valleys. Thickness approximately 700 to 800 ft (213 to 244 m)

Ph HERMIT SHALE (LOWER PERMIAN)—Red-brown, slope-forming fine-grained siltstone and sandstone; thickness from 60 to 0 ft (18 to 0 m), thinning eastward

Pe ESPLANADE SANDSTONE (LOWER PERMIAN)—Light red to red-brown, cliff-forming, cross-stratified, medium- to fine-grained sandstone; 200 ft (61 m) thick

PPhs WESCOGAME, MANAKACHA, AND WATAHOMIGI FORMATIONS UNDIVIDED (UPPER, MIDDLE, AND LOWER PENNSYLVANIAN)
- Wescogame Formation—Red to pale-red siltstones and shales interbedded with massive beds of fine-grained, calcareous sandstone
- Manakacha Formation—Reddish-brown, massive-bedded, fine-grained sandstone, cross-bedded dolomitic sandstone, and a few beds of purple-red shale
- Watahomigi Formation—Gray, interbedded, calcareous siltstone and sandstone and a few beds of cherty limestone

Total thickness of three formations approximately 600 ft (183 m). Forms alternating slopes and ledges

PPhs HERMIT SHALE AND SUPAI GROUP UNDIVIDED (LOWER PERMIAN AND PENNSYLVANIAN)—Includes thin Hermit Shale, Esplanade Sandstone, Wescogame, Manakacha, and Watahomigi Formations. From 800 to 1,000 ft (244 to 305 m) thick

Mr REDWALL LIMESTONE (UPPER AND LOWER MISSISSIPPIAN)—Light-gray, cliff-forming, massive light-gray thick-bedded, aphanitic limestone and dolomite. Contains marine fossils throughout; cherty in middle part. From 450 to 500 ft (137 to 160 m) thick

Dtb TEMPLE BUTTE LIMESTONE (UPPER AND MIDDLE? DEVONIAN)—Interbedded light-gray to purple dolomite, dolomitic sandstone, sandy limestone, reddish-brown siltstone, and gray sandstone. Occurs as thin ledges and occupies small channels, as much as 140 ft (43 m) deep, cut into underlying Muav Limestone in Grand Canyon area

Cm MUAV LIMESTONE (MIDDLE CAMBRIAN)—Mottled gray and purple dolomitic limestone. Lower part contains tongues of Bright Angel Shale that consist of green shale and a few beds of rusty-brown, coarse-grained sandstone (not shown on cross section). Forms alternating cliffs and slopes. Thickness approximately 300 ft (91 m)

Cba BRIGHT ANGEL SHALE (MIDDLE CAMBRIAN)—Green and purplish-red, fissile siltstone; interbedded with a few light-brown, coarse-grained sandstone beds in lower part. Contains dolomite tongues of Muav in upper part. Unit forms uniform slope; has gradational contacts with Muav Limestone and Tapeats Sandstone. Thickness approximately 200 ft (61 m)

Ct TAPEATS SANDSTONE (MIDDLE AND LOWER CAMBRIAN)—Medium- to coarse-grained sandstone and pebble conglomerate. Occurs only in subsurface (shown only on cross section). Thickness from 0 to 250 ft (0 to 76 m) in the Grand Canyon

p-C PRECAMBRIAN ROCKS UNDIVIDED—Sedimentary, igneous, and metamorphic rocks. Occur only in subsurface (shown only on cross section)

CONTACT

FAULT—Dashed where inferred; dotted where concealed; bar and ball on downthrown side. Arrow indicates direction of displacement. Faults shown as bounding alluvium do not offset alluvium; hachured on downthrown side where fault predates alluvium

THRUST FAULT—Sawteeth on upper plate

STRIKE AND DIP OF BEDS

MONOCLINE—Located approximately midway between top and bottom hinges of fold. Length of arrows indicates distance between hinges. Dotted where concealed

ANTICLINE—Showing axial plane. Dotted where concealed

SYNCLINE—Showing axial plane. Dotted where concealed

DOME

COLLAPSE STRUCTURE—Circular depression with inward-dipping beds

BRECCIA PIPE—Collapse structure with exposed breccia

PRECCIA PIPE—Shown in cross sections only

STRIKE OF VERTICAL JOINTS

EARLIEST MOVEMENT ON BASEMENT FAULTS IN CROSS SECTION ***B-B'*** and ***C-C'***

GEOLOGIC SETTING

The Coconino Point and Grandview Point quadrangles encompass approximately 500 square miles of the southern Colorado Plateau between Grand Canyon National Park and Cameron, Arizona. The map area is entirely within federally managed land: Grand Canyon National Park land is located in the extreme northwest corner; the Kaibab National Forest includes much of the western half of the map area; and the Navajo Indian Reservation, the largest landholding, includes most of the eastern half of the map area.

The area can be divided into three geomorphic subprovinces: the Little Colorado River valley-Painted Desert area (northeastern quarter of the map), a small part of the Grand Canyon (extreme northwest corner of the map), and the Coconino Plateau-Gray Mountain area. Elevations range from 3,800 ft (1,158 m) at the bottom of the Little Colorado River gorge to 7,500 ft (2,286 m) at Grandview Lookout Tower. The canyon of the Little Colorado River has a maximum depth of 1,600 ft (488 m).

Rocks exposed in the map area were deposited between early Paleozoic and late Cenozoic time. Cambrian, Devonian, Mississippian, and Pennsylvanian rocks are exposed only in the Grand Canyon and the Little Colorado River canyon areas. The Kaibab Formation, of Permian age, forms the resistant erosional surface in approximately three quarters of the map area. Rocks of Triassic age occur mostly in the Painted Desert and at a few scattered localities on the Coconino Plateau. Upper Cenozoic deposits include three basaltic lava flows, landslides, and alluvium. Alluvial deposits are interpreted to have late Tertiary to Holocene ages.

Drainage streams have eroded the week Triassic sedimentary rocks and are superimposed upon the resistant Kaibab surface. Drainages incised on this surface are generally dendritic near the Grand Canyon and Painted Desert areas. Abandoned meandering drainages in the southeast are probably late Tertiary or Pleistocene in age. These drainages may have been tributaries of the Little Colorado River at a time when it was closer to the eastern flank of Gray Mountain.

STRUCTURAL GEOLOGY

The most conspicuous structural feature in the area is Gray Mountain, which is bounded on three sides by faulted and steeply dipping to overturned Permian and Triassic strata. Elsewhere dips are generally low, as reflected by the stripped surface of the Kaibab Formation throughout most of the map area. Broad open folds and normal faults of small displacement characterize the areas adjoining Gray Mountain.

Gray Mountain is a complex of structural blocks localized at the intersection of the Grandview, East Kaibab, Coconino Point, and Additional Hill monoclines and also has structural interrelationships with the Black Point and Blue Springs monoclines. Barnes (1974) concluded that Gray Mountain originated as an uplifted block in late Precambrian time; was again uplifted during the Permian; and was transported northeastward and upward by compressive forces active during Laramide deformation when the monoclines were formed. This last deformation resulted in overturning, outward thrusting, and gravity gliding; later landsliding on the eastern nose of Gray Mountain. In addition, in the late Pleistocene, Gray Mountain underwent tensional faulting that may have continued to the present.

Several collapse structures are concentrated in the vicinity of the Little Colorado River gorge, east of the East Kaibab and Coconino Point monoclines. Collapse structures (breccia pipes) result from the collapse of the rock surrounding solution cavities in the Redwall Limestone (Barrington and Kerr, 1963; Bowles, 1965; Hoffman, 1977; and Wenrich-Verbeek and Verbeek, 1982). These structures are generally circular in shape and are rimmed by inward-dipping strata. Exposed brecciated rock consists of very large to very small angular clasts composed of unsorted fragmental rock material from adjacent or overlying strata, with a carbonate and ferruginous matrix. Contacts between the brecciated material and the wall rock are sharp, nearly vertical, pipelike, and shaped like inverted cones. Some of the collapse structures have breccia outcrops at the surface and are mapped as breccia pipes similar to those described by Barrington and Kerr (1963).

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