

GRAND CANYON NATURE NOTES



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Volume 9, Number 8
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Park Naturalist

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C. E. Van Gundy, Berkeley, California

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Map and titles By Walter Wagner

SOME OBSERVATIONS Of The UNKAR GROUP Of The GRAND CANYON ALGONKIAN

By C. E. Van Gundy
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INTRODUCTION

THE study of the Unkar group was undertaken at the suggestion of Dr. N. E. A. Hinds of the University of California who has outlined a program* of pre-Cambrian research in connection with the general educational program in the Grand Canyon National Park. This program was initiated by Dr. J. C. Merriam, President of the Carnegie Institution of Washington, and the research has been made possible through grants from that institution. E. D. McKee and other members of the National Park Service have extended innumerable courtesies to all members of the party while at the Grand Canyon for which we are extremely grateful. During 1933, the Bright Angel, Nankoweap Valley, and Tanner trail areas were examined.

GEOGRAPHICAL DISTRIBUTION

The rocks of the Grand Canyon which have been assigned to Algonkian age are divided into two main groups; the lower division, called the Unkar group by C. D. Walcott¹ after a valley of that name in which its finest exposures occur and the upper division for which Major J. W. Powell² proposed the name Chuar group.

The Unkar group is exposed in several localities along the Colorado River and in tributary canyons: Shinumo Creek³, Tapeats Creek, Crystal Creek, Bright Angel Creek, Clear Creek, Vishnu Creek. The largest area of Algonkian rocks is exposed in the eastern portion of Grand Canyon, and it is here that the type sections of the Unkar and Chuar groups are found. This is the only district in which the Chuar

group is known to occur. The Unkar group is exposed on both sides of the Colorado River from the mouth of Hance Canyon almost to the mouth of the Little Colorado River, however, the type section where the best exposures are found, lies north of the river in the vicinity of Unkar Creek. The upper portion of the Unkar group is exposed in Nankoweap Valley, near the Marble Canyon. The only known exposures of the Chuar group are located west of the Colorado River from a point between Unkar and Chuar Creeks to Nankoweap Valley. A complete section is not present due to the removal of an unknown thickness of strata by post Chuar-pre Tapeats sandstone erosion.

The Tapeats sandstone overlies the Algonkian rocks with a distinct angular unconformity, and has been assigned to the Middle Cambrian. The basal beds of the Unkar group rest upon an even surface of very low relief which has been cut into the Archean gneisses, schists, quartzites, amphibolites, and associated igneous rocks. These are standing in an almost vertical position and are known as the Vishnu schists.

OUTLINE OF FIELD WORK

The exposures of Algonkian rocks occur near the bottom of the Grand Canyon, and with the exception of the Bright Angel district, are reached only by trails which are hazardous and almost impassable, necessitating clearing and rebuilding.

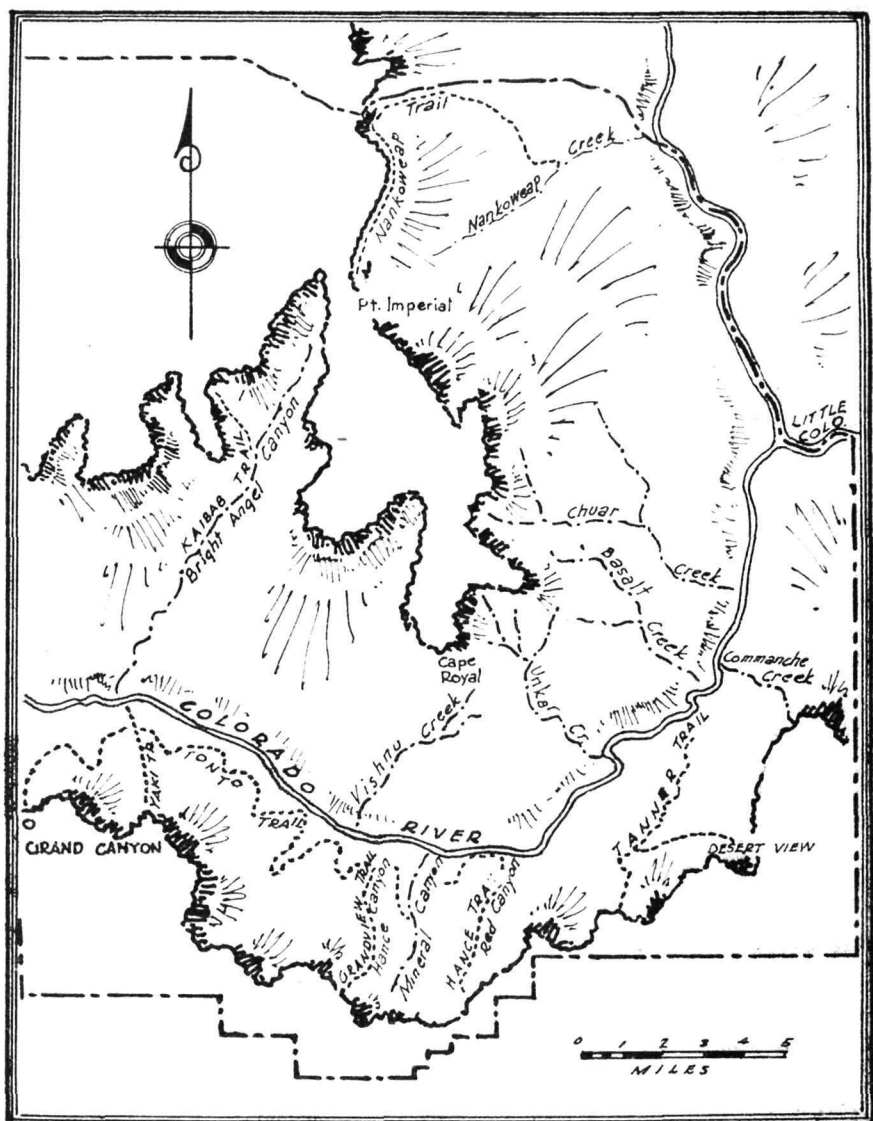
- * Grand Canyon Nature Notes Vol. 8, No. 6 August, 1933
Science, News Series September, 1933
- 1. Walcott, C. D., Pre-Cambrian Igneous Rocks of the Grand Canyon; U.S.G.S. 14th Ann. Rept. Part 2 (1894) pp. 508
- 2. Powell, J.W., Exploration of the Colorado River of the West, Washington (1875)
- 3. Noble, L. F., The Shinumo Quadrangle
U.S.G.S. Bulletin 549 (1914)

ing in many places. The Bright Angel district is readily accessible from the Yaki and Kaibab trails.

The eastern portion of the Grand Canyon is reached by the Tanner, Hance, Grandview, and Nankoweap trails, of which only the first and last are now passable for pack animals. A branch of the Tanner trail leaves the South Rim at Lipan Point, and the upper portion of the Unkar group may be examined from this trail. Hay and grain for animals must be packed into this area, and as there are no springs or streams, it is necessary to use the muddy water of the "silvery Colorado River". This area was mapped and studied during the latter part of August and first part of September 1933 by Howard Childers, packer, and the writer. It is not possible to reach the lower portion of the Unkar group by this trail.

The lower portion of the Unkar group was mapped and examined in May 1934. The most direct route to this area (Hance, Mineral, and Red Canyons) is by way of the Hance or Grandview trails. Considerable doubt existed as to whether either of these trails were passable for pack animals. One other route is possible, but is considerably longer. This follows the Yaki trail to the Tonto platform, and thence eastward along what remains of the Tonto trail which is now a dim path beaten by wild burros. This route was taken by Ed. Cummings, packer, and four mules, while the writer hiked down the Grandview trail meeting him the second day at the junction of the two trails. The Grandview trail is not passable for mules above the Redwall limestone.

The type section of the Unkar group lies on the north side of the Colorado River and is reached by the Nankoweap trail which leaves the North Rim three miles north of Point Imperial. This is the trail built by Major Powell in 1882, and used by C. D. Walcott in 1882-1883 when he studied the rocks of this region, however, they entered from House Rock Valley via South Canyon. The trail is extremely narrow and follows along the brink of a cliff where a stumble or false step would have sent man or animal over a cliff 500-1000 feet in height and down a slope one hundred feet or more. Late in May, 1934, the party composed of R. A. Bramkamp, field assistant, Howard Childers and "Shorty" Yarberry, packers, and the



AREA INVOLVED IN RECENT STUDIES
OF ALGONKIAN STRATA IN GRAND CANYON

writer, with ten mules, went into this area with supplies for one month. The first night we stopped at the camp in Nankoweap Valley which we had used in 1933. The next camp was established in Kwagunt Creek. From this point, our route was unknown and it was necessary to clear the trail as we proceeded until Chuar Creek was reached. Shorty Yarberry returned to the North Rim with six mules. There are several springs in Chuar Valley, but none between there and Kwagunt Creek. A rude trail was built along the Tonto platform on the east side of Venus and Appollo Temples to a fork of Unkar Creek, where mules could proceed no farther. From this point it was necessary to pack supplies on foot. Thirty-four days were spent in the Nankoweap-Unkar creek areas, and the entire party returned to the North Rim at the end of June.

The statements made in this paper are based almost entirely upon field evidence. In many cases, these are dependent upon laboratory study for verification, so that details and conclusions cannot be satisfactorily advanced until a future date.

STRATIGRAPHY

The Unkar group has been separated into five divisions by L. F. Noble⁴ in the Shinumo quadrangle. With the exception of the Hautauta conglomerate which is included in the Bass limestone, these divisions have been recognized in the eastern areas. The contacts are not always sharp, and are often gradational, however, the units as a whole are distinctive and easily recognized in the field. Because of the lack of fossils, correlation must be based entirely upon lithology.

BASS LIMESTONE: This is predominantly a light-gray or brownish, dolomitic limestone which is buff colored on weathered surfaces and often exhibits chert lentils which present a rough etched surface. The Bass contains interbeds of red, sandy shales, blue or purplish shales, and thin-bedded, arkosic sandstones. Conglomerate occurs at the base and contains fragments of mica schist, pegmatite, quartzite, and amphibolite which have been derived from the underlying Archean complex. Conglomerate occurs at one higher horizon in the Bright Angel district and at two higher horizons in Min-

eral Canyon. Algal structures, ripple marks, and mud cracks are common. Deoxidation spheres are sparingly present.

SHINUMO QUARTZITE: This division consists of massive, compact, brown, buff, purplish, and white quartzites forming two principal cliffs which are separated by thin-bedded quartzites and sandstones. Pebble conglomerates are locally present. Ripple marks and deoxidation spheres are common.

DOX SANDSTONE: This is the thickest and most variable member of the Unkar group and is characterized throughout by the presence of micas. The Dox consists of thin-bedded, dark green to drab colored sandstones with gnarled and twisted layers in the lower portions, massive, medium to fine-grained, brown and purplish sandstone with shaly interbeds, brick red to vermillion sandstones which are thin-bedded or massive in character, and impure, gray limestones. Ripple marks, mud cracks, deoxidation spheres, and pseudomorphs of salt crystals are common.

IGNEOUS ROCKS

BASALT: A sequence of volcanic rocks having the composition of a basalt are exposed in the eastern portions of the Grand Canyon below the mouth of the Little Colorado River forming the black cliffs which are conspicuous from Desert View on the South Rim. Another exposure of limited extent occurs in Nankoweap Valley several miles to the north. The basalts exhibit considerable variation in megascopic appearance. The color ranges from dark greenish or bluish gray to black. Some are vesicular and amygdaloidal, others brecciated or scoriaceous. Numerous veins of calcite, quartz, and serpentine occur in the lavas. Columnar jointing is well developed in several flows. The texture varies from aphanitic to medium grained intersertal.

These flows lie upon the red beds of the Dox sandstone and have been described by J.P. Iddings⁵ from samples provided by C. D. Walcott. The flows vary in thickness from less than 400 feet in Commanche Creek to approximately 1000 feet at Chuar Lava Hill. The base is not exposed in Nankoweap Valley, so that the total thickness here is unknown. In Unkar Creek, agglomerates occur in the basalt sequence.

Interbedded with the basalts, are lenses of maroon and brown sandstones, some of which reach a thickness of 30 feet. In most cases, the surface of the underlying basalts is irregular and weathered and occasionally a pebble conglomerate containing pebbles of basalt is present. These lenses vary in thickness laterally and contain an abundance of ripple marks.

C. D. Walcott⁶ suggests that the basal lava flow was poured out into the water in which the clastic materials of the underlying sandstones were deposited. The writer agrees with this conclusion. The "Dolerite", 80 feet thick in the Bass limestone opposite Red, Mineral and Hance Canyons, was included with the extrusive succession by Walcott. This mass transgresses the bedding of the Bass limestone, has baked the adjacent sediments and has developed asbestos which has been mined in the past. It is an intrusive sill of diabase rather than extrusive lava. N. H. Darton⁷ states "The dolerite appears to me to be an intrusive sill."

Numerous dikes having the same petrological character as the basalt cut the sediments below the lavas, especially in the vicinity of Unkar Valley. These often constitute small sills by running parallel to the bedding for several feet, and either pinch out or transgress the bedding again as they proceed upward. In no instance has the actual connection between the dikes and flows been observed. The nearest

4. Noble, L. F. The Shinumo Quadrangle
U.S.G.S. Bulletin 549 (1914)
5. Iddings, J. P. U.S.G.S. 14th Annual Report
Part 2, pp 520-524 (1895)
6. Walcott, C. D. U.S.G.S. 14th Annual Report
Part 2, (1895)
7. Darton, N. H. Resume of Arizona Geology
Arizona Bureau of Mines, pp. 26

approach occurs between Unkar Valley and Basalt Canyon where a dike is exposed 100 feet below the base of the lavas. In spite of this lack of direct evidence, the presence of numerous dikes in the vicinity of the lavas, the fact that they are found below and not above the lavas, and the similarity in petrology, leaves little doubt that some of them are feeder dikes for the lava sequence above.

DIABASE: Diabase occurs at several localities, as sills which have intruded the Unkar strata. These vary from a few feet to four hundred feet in thickness, and are found at all horizons of the group. The sills have intruded the Bass limestone in the vicinity of Mineral Canyon; the Hakatai shale is intruded in Bright Angel and Red Canyons; the Shinumo quartzite in Phantom Canyon, and the Dox sandstone in the vicinity of Unkar Creek. Noble, has described several sills in the Shinumo quadrangle. Dikes from these sills cut through the overlying sediments. Columnar jointing is well developed in several of these sills.

The typical diabase is olive green on the weathered surfaces and gray or black on fresh surfaces. Plagioclase feldspar, olivine, augite, and magnetite are the chief constituents. Locally lumps or balls are present and give the diabase a warty appearance. These are composed of ophitic intergrowths of coarse augite and plagioclase crystals. Stringers of pink seyenite are present in the Bright Angel sill. The contact effects upon the surrounding rocks consist of baking and silicification of the shales and sandstones, and recrystallization of the limestone with local development of serpentine.

PROPOSED "NANKOWEAP GROUP"

Fully four hundred feet of thin-bedded, brown, well indurated sandstone with interbeds of sandy shale, light-gray, reddish or purplish brown in color; also medium to fine grained, massive quartzite, light-gray to white, cross-bedded sandstones, and thin-bedded, light-gray, sandy limestone containing thin laminae of green shale, overlies the basalt sequence. The basal beds lie upon an irregular weathered surface of the basalt with little or no structural break. The

upper thin-bedded limestone is overlain by a massive gray, to reddish-brown, magnesian limestone containing chert lentils (Upper Unkar magnesian limestone of Walcott). The base consists of a limestone conglomerate containing angular fragments of the underlying limestone. This conglomerate lies upon an irregular surface having a differential variation of at least three feet, and clearly shows the presence of an erosional unconformity below the upper magnesian limestone. No structural break appears to be present. These sediments are ripple marked throughout, and contain an abundance of mud cracks and cross-bedding, denoting deposition in shallow water.

The sequence of beds described above, separated from the basalts below and the magnesian limestone above by erosional unconformities, constitutes a separate and distinct unit from the other sediments of the Unkar group. Although it is subordinate in thickness to the Unkar and Chuar groups, it is of equal importance and the writer proposes the name "Nankoweap Group" for this sequence. The type section occurs in Basalt Canyon, where a complete and undisturbed section is well exposed. A complete section is also exposed on the north side of Nankoweap Valley. Partial sections are exposed in Unkar Creek, Commanche Creek, and west of Tanner Canyon.

UNKAR - CHUAR CONTACT

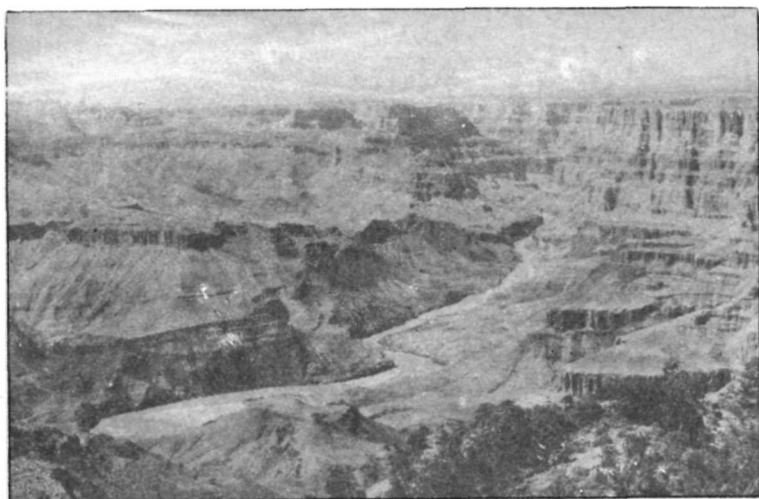
The contact of the Unkar and Chuar groups was placed at the top of the magnesian limestone by C. D. Walcott, who states "With the exception of a trace of unconformity by erosion at the summit of the Unkar terrane, there is no recognized interruption in the sedimentation" from the base of the Unkar terrane to the summit of the Chuar terrane. This contact is exposed northeast of Unkar Creek, in Basalt Canyon, on the south side of Chuar Valley, and in Nankoweap Valley.

The magnesian limestone previously referred to is overlain by thin-bedded, black, carbonaceous shales containing sulphur and gypsum, with a six inch lense of limestone near the base. The surface of the magnesian limestone is very irregular. Circular, mushroom-shaped masses of coarse-grained, pink limestone containing chert nodules rise above the surface of the massive, brown, magnesian limestone, which

also contains lentils of chert. This irregular surface, on first sight suggests an erosional break, however, the irregularity may have been formed during the process of limestone deposition as well as by erosion. No change in attitude of the bedding was noted except in the vicinity of faults where small local folds have been produced in the thin, incompetent shales while the massive limestone has not been perceptibly disturbed and has acted as a competent buttress. No basal conglomerate of any sort was observed lying upon the magnesian limestone, however, chert nodules were found on recently eroded surfaces of the magnesian limestone. The absence of a basal conglomerate, a change in attitude, and the existence of similar black shales overlying the magnesian limestone seems to be evidence against, rather than for, an erosional break between the magnesian limestone (Unkar of Walcott) and the Chuar sediments.

An erosional break is present at the base of the magnesian limestone. This is evidenced by:

1. Presence of basal conglomerate containing angular fragments of the underlying limestone.
2. Irregular surface upon which magnesian limestone is deposited.
3. Disappearance of thin-bedded, buff shales between the magnesian limestone and underlying, thin-bedded limestone.
4. Variation in thickness of the magnesian limestone. Furthermore, the magnesian limestone is massive and blocky, and resembles limestones found higher up in the Chuar sequence. No limestones resembling this have been observed in the underlying sediments. The writer believes that the magnesian limestone should be included with the Chuar group, and the basal contact of the Chuar group should be placed at the erosional unconformity at the base of the magnesian limestone.



View looking northward from Navajo Point. River is cutting in Doo sandstone. Note basalts on north side of river cut off on the east by the Butte Fault.

CONDITIONS OF DEPOSITION

Ripple marks are abundant in the Unkar sequence and consist mainly of shallow water types showing the effect of cross current action. Asymmetric types are predominant and frequent changes in the direction of currents occur. Mud cracks or shrinkage cracks are common throughout the sequence and are often superimposed upon the ripple marks. These sediments are often cross-bedded. In the upper portion, beds lens out in very short distances. This is apparently due to river channeling. Pseudomorphs of what were apparently salt crystals, formed during deposition of the sediments, are present at various horizons throughout the sequence. This indicates that the sediments of the Unkar group, in part if not all, were deposited under shallow water conditions, subject to the action of cross currents. Mud cracks show that there was a fluctuation in water level, exposing the mud and silt to the sun's rays with the development of cracks by shrinkage caused by evaporation. Pseudomorphs of salt crystals indicate

saline waters. At the present time, the evidence is not conclusive as to whether this basin was marine or a large inland lake. The scarcity of fossils in comparison to the overlying Cambrian strata is perhaps a point in favor of the latter. Portions of the Dox sandstone may represent river deposits. The same sequence of sediments, with similar conditions of deposition occurs in more or less disconnected areas from the Shinumo quadrangle to Nankoweap Valley, a distance of approximately sixty miles. This gives a minimum measurement for the area of Unkar deposition.

STRUCTURE

The Algonkian rocks are involved in a large syncline whose axis trends northwest-southeast. This is not continuous but is interrupted by two systems of faults, one striking N. 10 E., and the other N. 60 W. Movement has occurred along these same zones at two different periods: during the post Algonkian-preTapeats sandstone interval with the production of fault block mountains, and after the close of the Paleozoic Era. Monadnocks which have been formed by the resistance of the Shinumo quartzite to erosion, and formed ridges and hills that stood out as islands during the deposition of the Tapeats sandstone, are exposed in several localities. One of the best examples of this is seen in the cliffs immediately west of Phantom Ranch in Bright Angel Canyon. Here two small blocks are tilted so that their sediments dip toward each other. Parallel ridges composed of Shinumo quartzite were formed by erosion and later covered by the deposition of Middle Cambrian sediments which now lie in an essentially horizontal position. Two of the major faults in this region; Bright Angel fault and Butte fault* (East Kaibab fault of Darton) show a reversal of movement from one period of faulting to the other. Both of these were downthrown on the west during pre-Tapeats faulting, and downthrown on the east during the later period of faulting. In some instances, the Paleozoic sediments which truncate pre-Tapeats faults, have not been fractured by the post-Paleozoic movement, but have been slightly folded in the immediate vicinity of the underlying fault.

* Walcott, C. D., Geological Society of America
Vol. 1, page 56, (1890)

