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M. R. Tillotson,
Superintendent.

Edwin D. McKee,
Park Naturalist

Table of Contents

Illustrations by Barbara H. McKee

THE ANITA COPPER MINE

By H. H. Waesche, Ranger Naturalist

A NUMBER OF COPPER deposits have been discovered in the vicinity of the Grand Canyon. Several of these are located below the rim, others are found on the surfaces of the Kaibab and Coconino plateaus. Mining operations on a small scale have been attempted at not less than five different localities.

Much of the copper ore of Grand Canyon -- including that discussed in this article -- occurs in the Kaibab limestone of Permian Age which composes the surfaces of the plateaus. This is the same formation seen as the topmost stratum in the Grand Canyon. It is a comparatively sandy limestone about five hundred and fifty feet thick. The Kaibab as well as the other Paleozoic sediments in the Grand Canyon are nearly flat-lying, showing only rarely indications of dynamic disturbance. Evidence of such disturbance is seen in the existence of several faults which cut across the plateau in a north-south direction. Besides the faulting, there has been slight folding in some places as may be readily seen at Grand View. It is quite likely that both the faulting and folding have a direct bearing on the origin of the copper ores.

The ore minerals are almost exclusively the carbonates, azurite and malachite. Some sulfide, chalcopyrite, has been noted by E. P. Jennings* in the plateau copper deposits. Associated with the copper carbonates is brown limonite which colors most of the rock not stained by the blue and green copper. Dendrites of manganese oxide are plentiful. Traces of gold are said to be present in siliceous materials. The ore minerals are found disseminated in the limestone and in a sandy phase of the same horizon, thus they are of two types, calcareous and siliceous.

One of the most accessible and interesting deposits of copper in the Grand Canyon area is at the Anita mine, near Anita, Arizona. This place is a water station on the Santa Fe

Head frame and shaft with hand operated skip, Emerald Mine, Anita.

Opening of mine into Canyon wall.

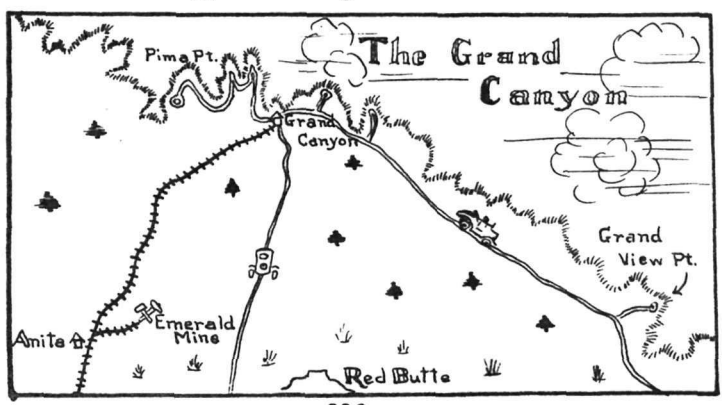
railroad, about fifteen miles south of Grand Canyon. The mine is located about two miles from the station, on the south rim of a small canyon through which winds the old highway to Grand Canyon.

The Kaibab limestone in the vicinity of Anita is very much brecciated but no definite fault has been observed. The brecciation occurs in a zone running northeast-southwest, an undetermined distance, probably not great, and having a width of several hundred feet with concentration of ore minerals greatest near the center of the zone. Other zones are said to parallel this one in the same region. It is likely that the disturbance here is related to the faulting and folding of the plateau previously mentioned. The sandy, brecciated material, southwest of the lime area, contains definite sand grains and rounded pebbles which may indicate a previously existing stream bed. There is room for speculation as to just what the source of these pebbles may have been.

It seems quite likely that the copper may have gained access to the Kaibab limestone along the channels created by the jointing and brecciation of the sediments. The copper-bearing solutions have replaced the more soluble parts of the limestone, leaving small lenses and stringers of carbonate ore. The ore is richest along these fracture lines. Certain beds seem to have been affected more than others and in some cases the replacement has followed bedding planes. According

to the owner, Mr. Lockridge, the mineralization extends to a depth of one hundred and sixty feet below the surface. The source of this ore is doubtful. It is hardly possible that it could have been derived directly from igneous materials. The pre-Cambrian granite intrusion of the Vishnu schist and the forming of diabase sills in the Algonkian rocks occurred long before the Paleozoic sediments were deposited and no later igneous activity is known in the immediate vicinity. The minerals themselves indicate that the ore is not related to igneous activity. No gangue minerals such as fluorite, tourmaline, or apatite, which are commonly associated with ores of igneous origin, have been observed. Chalcopyrite is the only sulfide found and since it is often present in rocks not associated with igneous activity, it indicates nothing. No arsenic or antimony compounds are found, suggesting further that the ores are not of magmatic origin.

Chalcopyrite, which is found in surface deposits of the plateau, may have been derived from oxidized sulfate solutions brought down from overlying strata or it may have been derived from concentration of copper present in the Kaibab itself. It is possible that chalcopyrite was the original copper mineral present and was later oxidized to form the existing ores. The distribution of the replacements suggest that they were deposited in the limestone by descending meteoric waters. The veins of copper follow brecciation zones which are vertical or steeply inclined above but which branch and assume a more horizontal position as they descend. The idea of deposition by descending waters is supported by the fact that Triassic sediments present to the north of the Grand Canyon and which at one time extended over the Kaibab are known to be copper-bearing*. From this it would seem that



at some time after the Triassic sediments had been deposited above the Kaibab, the region was subjected to deformation resulting in the dome shape of the plateau as well as the faulting and folding evidenced. The fracture zones which resulted from this disturbance could have offered easy access to meteoric waters carrying the copper from the Triassic sandstones to the Paleozoic strata below.

The Anita copper deposit was discovered by Bucky O'Neill, one of the earlier settlers of the Grand Canyon region. The exact date of discovery is unknown but the property was in the possession of a Mr. Nellis in 1890. Mr. Nellis was a pioneer in the town of Williams. The property then passed into the hands of William Nesmith of New York and in 1912 the present owner, Mr. W. H. Lockridge of Anita, came into possession.

The Anita mine is a small one consisting only of one level, the main part of which is a tunnel driven south about eight hundred feet from the edge of the small canyon on the rim of which the operation is located. Little or no development work has been done. Apparently the ore was removed as discovered. Several very short crosscuts have been driven at intervals along the main drift. The surface is honeycombed by holes sunk to the various crosscuts and to the main tunnel. A timbered shaft, six feet square and thirty-five feet deep, has been sunk to the working level about four hundred feet south of the tunnel entrance. This shaft is the deepest hole associated with the workings. The ore was brought to the surface in a bucket by a hand-operated hoist. At a number of places not supported by props, the brecciated material of the unsound roof has caved, partially filling the tunnel and crosscuts.

In the early history of the mine a smelter was constructed at Williams to handle the ore but this was never operated. The ore was hauled in a small car from the face of the workings to the original tunnel opening. The tracks for this car have since been pulled up and removed from the mine. After being brought to the surface the ore was placed in a series of trailers, attached to a tractor, and hauled to Williams, Arizona. The tractor was powered with steam generated by a wood fire. Wood was piled at intervals along the road to

Williams for fuel purposes. A railroad spur was later constructed from the Grand Canyon branch of the Santa Fe railroad but was used little or none. All that now remains of the spur is the grade as the rails have been removed.

Mining methods were quite simple and on a small scale. Stoping was in evidence, but none of the stopes were greater than twenty feet across or ten feet in height. The ore was shot down with forty per cent dynamite and then removed with pick and shovel. Drilling was done by hand. In recent operations most of the work was done by Mr. Lockridge and his family, employing around two or three people altogether. The material was removed from the face to the shaft in wheelbarrows and from there, after being sorted by hand, it was transferred to trucks and hauled to the railroad spur at Anita. Ore has also been shipped to smelters at El Paso, Texas, and to Hayden, Arizona. At times it was hauled by truck two hundred miles to Kingman, Arizona. The last shipment was made three years ago, to Hayden.

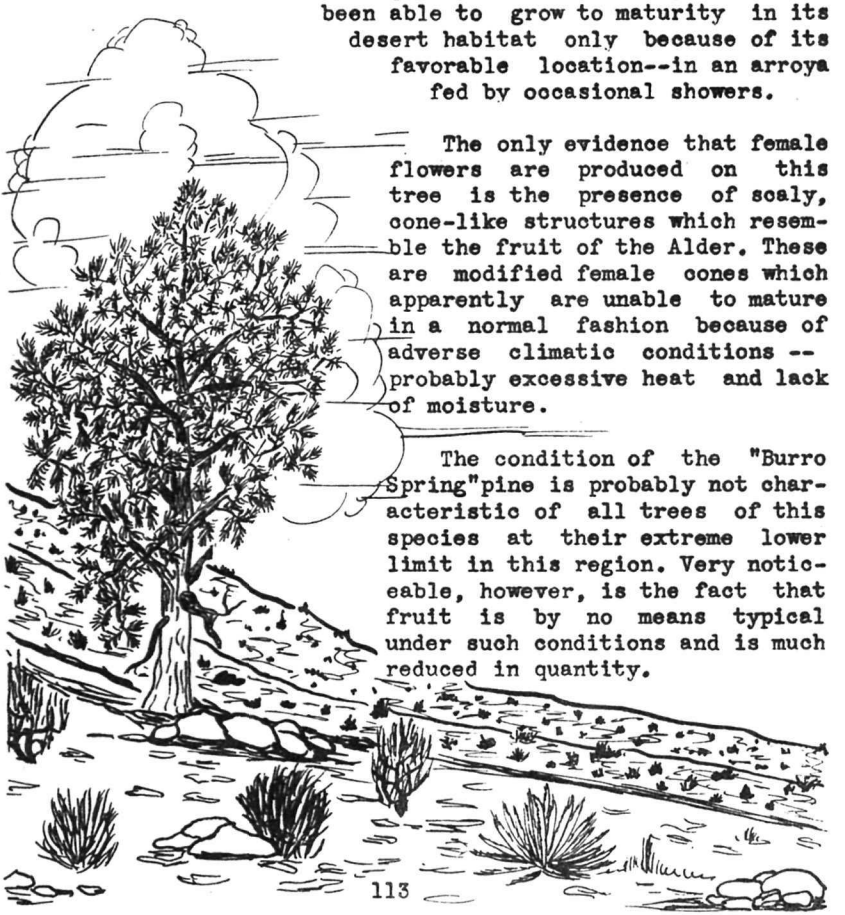
In 1914 Mr. Lockridge had a contract for thirty tons of ore per day. The mine was operated to this extent for ninety days, during which time fifteen to twenty men were employed. This is the most extensive work done at any time. At no time has the mine been what would be called a paying proposition and, as is usual with such ventures, law suits have been common. In a recent suit the present owner obtained $2100.00 for thirty tons of ore. He has also won several first prizes at the Northern Arizona State Fair for his exhibition of copper minerals.

* Copper Deposits of the Kaibab Plateau, Arizona, by E. P. Jennings, Salt Lake City, Utah. Transactions of the American Institute of Mining Engineers, New York Meeting, October, 1903.

THE "BURRO SPRING" PINE

By A. R. Croft, Ranger Naturalist

AT BURRO SPRING, on the Tonto Plateau, 3500 feet below the South Rim of Grand Canyon, there is a large Pinyon Pine (Pinus edulis) that has probably not produced a single mature seed during its entire lifetime, and its age must be more than two hundred years. This tree is located a considerable distance below the natural range of its kind and probably has been able to grow to maturity in its desert habitat only because of its favorable location--in an arroya fed by occasional showers.



The only evidence that female flowers are produced on this tree is the presence of scaly, cone-like structures which resemble the fruit of the Alder. These are modified female cones which apparently are unable to mature in a normal fashion because of adverse climatic conditions -- probably excessive heat and lack of moisture.

The condition of the "Burro Spring" pine is probably not characteristic of all trees of this species at their extreme lower limit in this region. Very noticeable, however, is the fact that fruit is by no means typical under such conditions and is much reduced in quantity.

BIRD BANDING IN NORTHERN ARIZONA

PART I, FLAGSTAFF STATION

By Lyndon L. Hargrave, Field Director,
Museum of Northern Arizona.

MARKING BIRDS with serially numbered metal bands as a method of studying their movements through the years is sponsored and supported by the Biological Survey of the United States Department of Agriculture. Through the application of this method much is learned concerning the movements of individual birds -- knowledge which could be gained in no other way. Advantages for personal study of both migratory and resident birds, moreover, are offered to one who has an interest in ornithology. From the aesthetic view point, familiarity with the personalities of birds -- for they do have personality -- through the continued handling of individuals gives one a pleasure not otherwise experienced; and a full appreciation of the beauty of plumage can be had only by closely observing a bird in full vigor of life as held in the hand.

My interest in this method of studying was a direct result of observing juncos at my winter feeding station outside my office window. I naturally wished to recognize the different species, but a thorough study of several good books on birds completely confused me. I then came to the realization that even closer examination of individual birds would be necessary before I could name the bird on sight. Bird-banding offered a solution to my difficulties. I had for some time known that Mr.Randolph Jenks had been banding birds in southern Arizona, so through his assistance I was duly authorized to collaborate with the Biological Survey. Thus was established the Museum of Northern Arizona Bird-Banding Station.

By this time winter had passed and I was in the field conducting archaeological researches. My first banding work, therefore, was with summer birds and, strangely enough, my first bird, banded June 3, 1931, was Grace's Warbler (Dendro-

ica graciae graciae), the first of this species ever to be banded. Five others were banded during the summer. A number of birds of several other species were also banded this first summer.

With the coming of fall, a permanent winter station was established at Coyote Range, the estate of Dr. H. S. Colton, Director of the Museum. This station has been operated with gratifying results since its establishment. Most birds banded during the winter months have been juncos. During the late spring and summer banding activities have been almost exclusively confined to localities being studied by the Museum research expeditions.

In the past nineteen months 1504 individual birds of fifty species and subspecies have been banded. Of this number 1067 were juncos. The most important results to date have to do with this genus. The data collected deal principally with problems of movements on winter feeding grounds. There are so few banding stations in the Great Basin that information on movements of great length is general, and will remain so until banded birds are captured while migrating. Though the San Francisco Mountains occupy a strategic position for the study of migrating birds which favor conifer forests, the value of the work would be vastly increased if a chain of stations could be established from the breeding grounds of migratory species to the wintering grounds of

Arizona. The banding station at the Grand Canyon occupies a position of equal importance. These two stations being within the winter range of several races of juncos and also being intermediate between the breeding and wintering grounds of many individuals, the importance of cooperation between them cannot be over emphasized, especially in a study of the migration of the genus Junco. Many local problems may also be studied, each station serving as a check upon the other.

Both stations have recently been established and it is hoped that as the years go by, they will be able to materially increase our knowledge of juncos and other species which migrate through this region.

THE HERMIT OF HORN CREEK

By Edwin D. McKee, Park Naturalist

ALTHOUGH there are comparatively few records of the Mexican Spotted Owl,(Strix o. lucida), from the state of Arizona, Dr. Harry S. Swarth in writing "A Distributional List of the Birds of Arizona"[1] in 1914 considered it as "probably not very uncommon in the higher mountains of southeastern Arizona". At that time, nevertheless, there were published records of its occurrence only from the vicinity of Tucson[2] and from the Huachuca Mountains[3]. Since then only three other references[4] to it in southern Arizona have appeared in ornithological literature.

On June 20, 1929, the known range of the interesting Spotted Owl was extended considerably to the northward in Arizona when Mr. Joe Sefton of the San Diego Society of Natural History collected one from an aspen tree in the vicinity of San Francisco Mountain. This specimen was subsequently recorded by Mr. L. M. Huey[5]. Last year the northward range of this species was still further extended when a Spotted Owl was found near Indian Gardens in Grand Canyon[6].

In late October, 1932, another Mexican Spotted Owl was found in Grand Canyon - apparently the second record from the canyon and the third from northern Arizona. This time the specimen was not collected but was photographed with such success that the validity of the identification cannot be disputed. The picture was taken by Dr. John Maxson, geologist of the California Institute of Technology, who writes the following description of the occurrence:

Photo by J. Maxson

The Hermit

"I was amazed that it (owl) showed little inclination to desert the rocky crag upon which I surprised it. Both the Owl and I were startled; the owl because of the unprecedented interruption of the solitude of Horn Creek, and I because my footholds and handholds were very precarious. I set up my tripod in order to focus exactly and he became somewhat perturbed, ruffling his feathers slightly but keeping his eyes shut. He, of course, faced in my direction constantly and stayed at a distance of about ten feet. Not until Dr. Campbell, who was with me, came up on the cliff back of him, did he become really disturbed. Then he could not watch both of us at once but had to turn his head hither and yon to keep track of us. At the coincidence of movement by both of us, he ruffled his feathers till he was oval, opened his eyes very wide, and had a thorough evacuation. As we left, he resumed his sleep."

1. H. S. Swarth, Pacific Coast Avifauna, No. 10, 1914, p. 29.

2. Robert Ridgway, "Two Rare Owls from Arizona", Amer. Naturalist VII, 1874, pp. 239-40.
C. E. Bendire, "Life Histories of Amer. Birds", Spec. Bul., No. 1, U. S. Nat'l. Mus.

3. H. S. Swarth, "Two New Owls from Arizona, etc." Univ. of Calif. Publ. Zool., VII, pp. 1-8.

4. H. S. Swarth, "The Status of the Ariz. Spotted Owl", The Condor, Vol. XVI, pp. 15-19.
J. E. Law, "Notes on the Arizona Spotted Owl", The Condor, Vol. XIX, 1917 p. 69.
L. M. Huey, The Condor, Vol. XXXIV, p. 100-101.

5. L. M. Huey, "Notes from the Vicinity of S. F. Mtns., Ariz.", The Condor, Vol. XXXII, p. 128.

6. Edwin D. McKee, Grand Canyon Nature Notes, Vol. 6, No. 3, p. 28, Jan. 1932.

ADDITIONS TO GRAND CANYON HERBARIUM.

Eighty-three new plants have recently been added to the Grand Canyon Herbarium. The specimens represent collections from both rims and from the interior of the canyon. They were identified at the National Herbarium in Washington through the courtesy of Dr. Frederick Coville.