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A LEAD-URANIUM DEPOSIT AT THE WHITE OAK NO. 1 MINE SANTA CRUZ COUNTY, ARIZONA

By Robert B. Raup

Trace Elements Memorandum Report 511

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geology and Mineralogy

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August 1953

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A LEAD-URANIUM DEPOSIT AT THE WHITE OAK NO. 1 MINE, SANTA CRUZ COUNTY, ARIZONA

By Robert B. Raup, Jr.

ABSTRACT

A small quantity of uranium ore was shipped from the White Oak No. 1 mine, Pajarito mining district, Santa Cruz County, Ariz., in 1952. The uranium is associated with oxidized lead ore in a shear zone that cuts rhyolite-porphyry of Tertiary(?) age. The uranium minerals -- kasolite, uranophane, dumontite, autunite, and possibly radioactive pyromorphite -- are concentrated along small, discontinuous fractures, and accordingly the ore bodies are small and widely dispersed.

The mineralized shear zone on the White Oak property is developed by two main adits -- the White Oak adit and the White Oak No. 1 adit -- which consist of more than 450 feet of underground workings connected by an inaccessible raise. Other small adits and prospects on the property expose only small concentrations of ore minerals. The uranium ore for shipment was extracted from two narrow intersecting fractures in the White Oak No. 1 adit.

Two shipments of uranium ore from the White Oak No. 1 mine were made in 1952. The average grade of the 10.23 tons of ore shipped was 0.43 percent U_3O_8. Recent exploration shows that the ore is discontinuous; no other concentrations of uranium ore have been found.

Inferred ore reserves are 5 to 10 tons of material averaging 0.47 percent uranium.

Four other mines within a mile of the White Oak property do not show significant radioactivity anomalies. The host rock, structure, and ore occurrence at these mines, the Big Steve, St. Patrick, Midnight, and Spelbrink, are similar to those on the White Oak property.

INTRODUCTION

The White Oak property, Pajarito mining district, Santa Cruz County, Ariz., yielded several thousand tons of oxidized lead ore during World War I, but has been largely inactive since that time. Uranium was discovered in the White Oak No. 1 mine by F. R. Brown in 1951, and in 1952 two small shipments were made to Marysvale, Utah, by the Radon Mining Company, the present operator. In August 1952, small scale exploration was being done for uranium-bearing ore in the White Oak No. 1 mine.

The White Oak property is 15 miles northwest of Nogales, Ariz., in Walker Canyon, in the NE¼ sec. 2, T. 24 N., R. 12 E., Gila and Salt River meridian. It can be reached from Nogales by following the road log below:

To Ruby Road via U. S. Highway 89 - approximately 5 miles.
Turn left on Ruby Road.
To Walker Canyon (turn left) - " 13 miles.
Bear right at junction - " 13.5 miles.
White Oak property (abandoned mill) - " 15 miles.

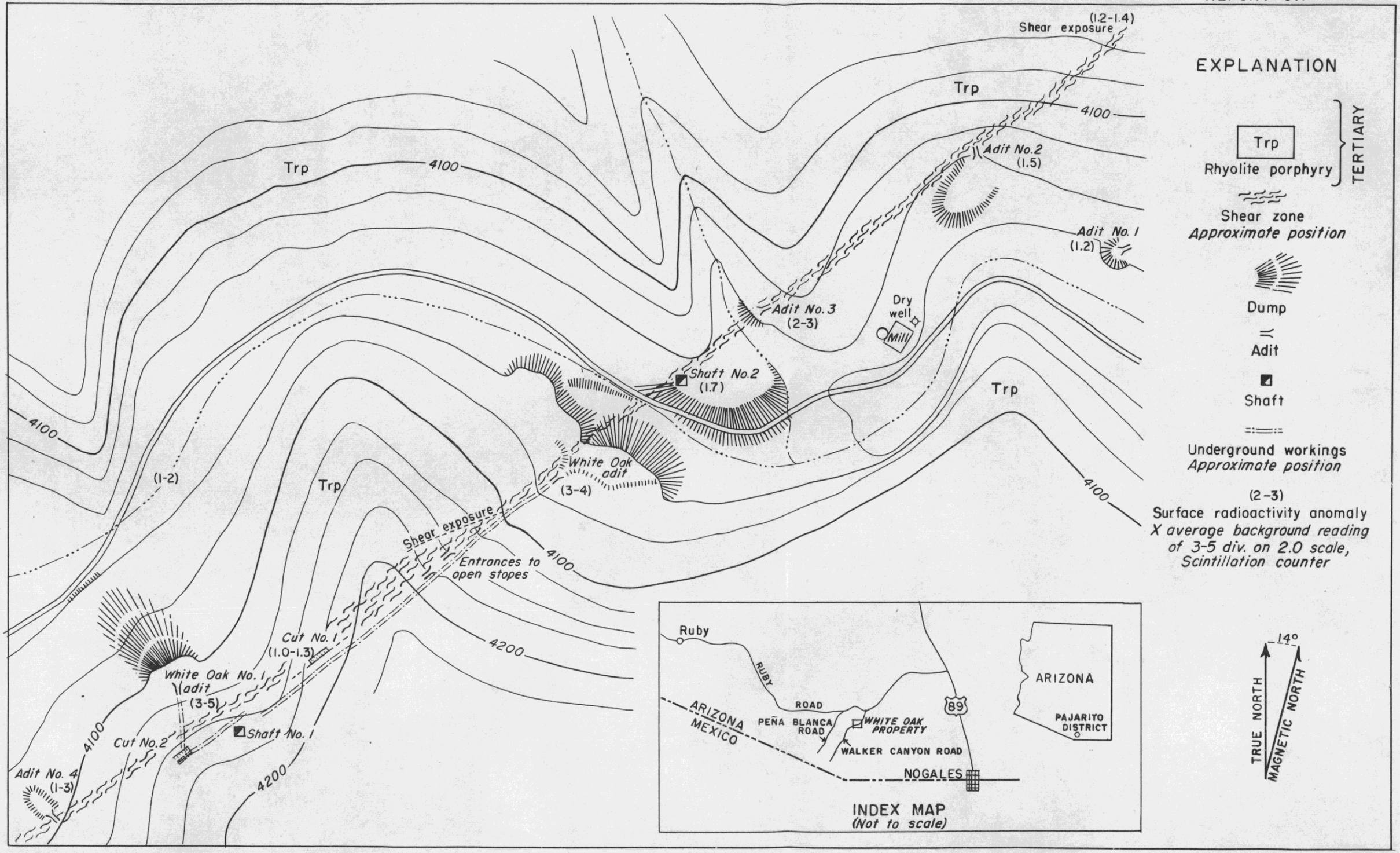
In 1952 the White Oak property was examined briefly by C. A. Rasor of the A. E. C., and he recommended that the Geological Survey make a geologic investigation of both the White Oak No. 1 mine and the surrounding area. Accordingly, the writer, on behalf of the Division of Raw Materials of the

U. S. Atomic Energy Commission, made a geologic reconnaissance and took radioactivity readings of the property between August 11 and 15, 1952. The surface was mapped by tape and compass on a scale of 1 inch to 100 feet, and part of the White Oak No. 1 mine was mapped on a scale of 1 inch to 10 feet. The surface and accessible underground workings were systematically traversed with a scintillation counter.

DESCRIPTION OF PROPERTY

P. J. and W. H. Clarke of Nogales, Ariz., owners of the property, gave a lease and option to F. R. Brown and R. D. Beeson of Picacho, Ariz., on June 14, 1951. Brown and Beeson then subleased the claims to R. C. Campbell and D. K. Lieberman of the Radon Mining Company on February 15, 1952.

The workings on the White Oak property consist of the White Oak adit, the White Oak No. 1 adit, 4 smaller adits, 2 prospect cuts, and 2 shafts (one a prospect and the other a manway). Except for the White Oak No. 1 adit all numbers were arbitrarily assigned to the workings by the writer, to facilitate description (fig. 1). All of the workings follow or intersect a mineralized shear zone, the average strike of which is N. 55° E. The White Oak adit enters the mineralized zone at the base of a steep slope and trends southwest. It extends into the hill for about 350 feet where it is blocked by caved rock. Stopes from the adit reach the surface at two places, but the full extent of the stopes cannot be determined because of their inaccessibility. Inside the adit a winze, now filled with water, is reported by one of the miners to be about 70 feet deep and to have a 30-foot drift at the



Geology and topography by R. B. Raup, 1952

FIGURE 1.- MAP OF WHITE OAK PROPERTY, SANTA CRUZ COUNTY, ARIZONA, SHOWING MINES AND PROSPECTS

100 0 100 200 Feet

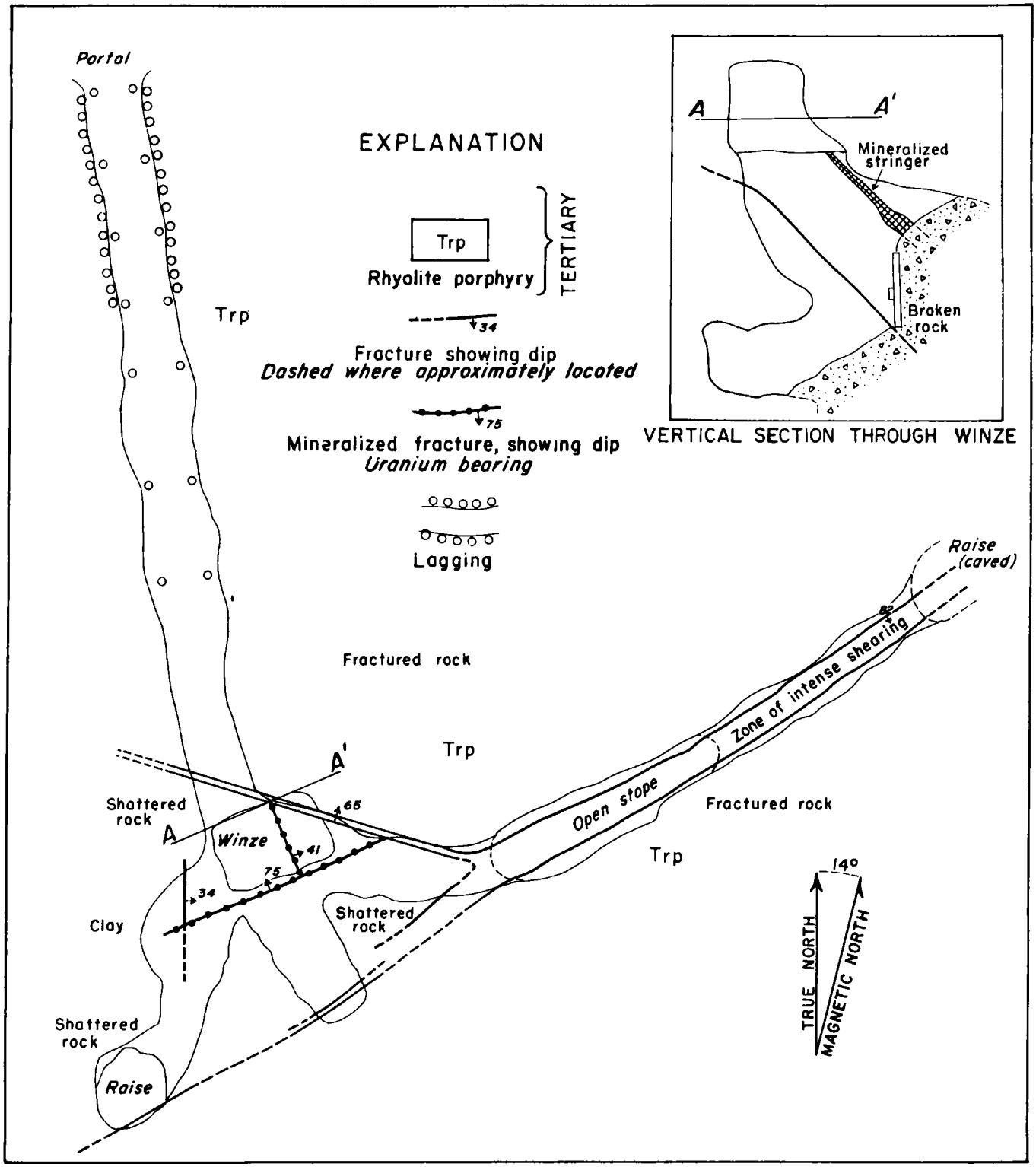
Contour interval 25 feet

Datum is approximate sea level

bottom. Ground that sloughs on exposure, lack of timbering, and large open stopes make geologic work in the White Oak adit hazardous.

The White Oak No. 1 adit (fig. 2), 400 feet southwest and 50 feet higher than the White Oak portal, crosscuts 60 feet in a S. 10° E. direction to the shear zone. An inaccessible winze in the shear zone, 60 feet northeast of the adit-shear zone intersection, connects the White Oak No. 1 workings with those entered by the White Oak adit. Two raises, one 50 feet northeast and the other 10 feet southwest of the adit-shear zone intersection, open into upper-level stopes. A manway, (shaft no. 1, fig. 1), connects these stopes with the surface approximately 60 feet above the adit. Recent development work for uranium has been done in a winze at the intersection of the White Oak No. 1 adit and the shear zone. Its total depth is unknown because of broken rock filling but the section on figure 2 shows the extent of open ground.

No. 1 adit, 200 feet east of the abandoned mill, has been driven N. 78° E. about 12 feet into the hillside on what probably was a discontinuous mineralized fracture. Adit no. 2, 150 feet northeast of the mill, is on the main shear zone. It bears N. 10° W. along a mineralized fracture but the main zone is not strongly mineralized at the point of intersection with this fracture just inside the short adit. Caved material partially blocks the entrance. No. 3 adit, 125 feet west of the mill, follows several shears containing ore minerals for about 25 feet N. 78° E. No. 4 adit, 150 feet southwest of the White Oak No. 1 adit, is a 30-foot crosscut (S. 65° E.) to a part of the shear zone that contains only a small concentration of ore minerals.



Geology by R. B Raup, 1952

FIGURE 2.-MAP OF UNDERGROUND WORKINGS, WHITE OAK NO. 1 MINE, SANTA CRUZ COUNTY, ARIZONA

10 0 10 Feet

Prospect cut no. 1, 125 feet east of the White Oak No. 1 adit, follows a narrow exposure of mineralized rock for 20 feet; cut no. 2, 70 feet south of the White Oak No. 1 adit, follows a less distinct exposure for 25 feet. At a point 200 feet west of the mill a prospect shaft (shaft no. 2, fig. 1) has been sunk approximately 25 feet in mineralized rock along the shear zone. The small mill, now in bad repair, consists of a jaw crusher and a concentration table.

P. J. Clarke, who was in charge of the mining during World War I, states that several thousand tons of oxidized lead ore were removed at that time. Clarke also reports that the lead ore was amenable to 70-percent table concentration and a small amount of silver was recovered; the lead content of the ore before milling was not known.

GEOLOGY OF WHITE OAK PROPERTY

The White Oak property is in an area of volcanic rocks of Cretaceous and Tertiary age. Intermittent streams have worn deep, steep-walled valleys into these rocks. The relief is about 1,000 feet.

The volcanic rock on the White Oak property is a rhyolite porphyry. From a distance there is a suggestion of flow structure in the rhyolite but none is visible at close range. Outside of the mineralized zone the freshly broken porphyry is gray-red, mainly because of the color of the aphanitic groundmass and a fairly high percentage (30-50 percent) of 0.01- to 0.05-inch phenocrysts of salmon-colored orthoclase feldspar. Gray-white feldspar phenocrysts of the same size occur in smaller quantities but these are probably the result of the early stages of weathering and bleaching of the

pink feldspar. As much as 20 percent of the rock consists of 0.02- to 0.15-inch quartz phenocrysts which vary markedly in color and size. Cloudy varieties are most common but clear crystals are also present as well as nearly black phenocrysts. Black minerals, probably hornblende and biotite, are barely visible in specimens viewed with a hand lens. Weathering of the feldspar on exposed surfaces commonly leaves voids where the resulting clay minerals have been washed away.

The mineralized shear zone on the White Oak property (fig. 1) has an average strike of N. 55° E. and an average dip of 80° SE; the dip ranges from 70° SE to vertical. The shear zone is not visible on the surface except in a few scattered outcrops. However, from underground exposures, the shear zone can be traced for at least 1,500 feet across the property. The shear is a complex, variable zone as much as 30 feet in width. The most intense shearing is concentrated in a zone as much as 3 feet wide within the over-all shear zone; this narrower zone is composed predominantly of breccia and gouge. At places the gouge constitutes clay pods and lenses as much as 6 feet in diameter. Throughout the narrow, intensely sheared zone and in parts of the over-all shear, individual structures are partly obscured by the ore minerals and by the alteration; much of the zone is highly weathered. Fracturing of the volcanic rocks outside of the shear zone is conspicuous but these fracture patterns were not studied and plotted during this investigation.

Mineralogy

Ore minerals in the shear zone are principally in the form of fissure fillings, but in small part they are replacements of the gouge and host rock. Most of the ore is secondary; it occurs either in soft clayey and earthy material or as a thin incrustation on minor fracture planes. The greatest concentrations of ore minerals are in the most intensely sheared part of the shear zone. The width of the shear zone is quite varied, but the width of the vein material (intense shearing) is fairly constant, ranging from 2 to 3 feet between the White Oak and White Oak No. 1 adits. Northeast of the White Oak adit the zone of vein material, where exposed, is much narrower and is not as constant in width. A few small fracture planes adjacent to the intensely sheared rock are coated with secondary ore minerals (fig. 2). Most of the ore minerals in the northeast area are in small, discontinuous fractures.

The most abundant uranium minerals in the White Oak No. 1 mine are kasolite $Pb(UO_2)SiO_4 \cdot H_2O$ and uranophane $Ca(UO_2)_2Si_2O_7 \cdot 6H_2O$; smaller amounts of dumontite $Pb_2(UO_2)_3(PO_4)_2(OH)_4 \cdot 3H_2O$ and autunite $Ca(UO_2)_2(PO_4)_2 \cdot 10\text{-}12H_2O$ are present. These minerals, characteristically deep-yellow to brilliant-orange, occur as earthy or hard-surfaced incrustations on fracture planes; a greasy luster is typical of the hard-surfaced occurrences. In a few places the uranium minerals form as aggregates of minute radiating crystals. Rare pieces of massive yellow-orange material as much as an inch square, are highly radioactive. The only large specimen of this type seen by the writer had been taken out earlier by one of the miners, so its precise location and relationships could not be determined.

The lead minerals that have been recognized are cerussite and pyromorphite, which occur as white to pale-yellow and greenish-brown fissure fillings and disseminations. Pyromorphite may be a source of some radioactivity. Other lead minerals probably exist in small quantities.

Non-radioactive iron stain is common in the underground workings and only slightly less common on the surface outcrops; non-radioactive pyrolusite stains are also evident.

The gangue materials are quartz and clay minerals as well as small fragments of brecciated country rock, which are common in the zone of most intense shearing.

Radioactivity

Three samples, taken by C. A. Rasor / or sent to him by the lessee,

/ Memorandum from Rasor to F. H. MacPherson, Manager CRMO AEC, on the White Oak uranium property, Santa Cruz Co., Ariz., April 24, 1952.

were analyzed as follows:

Sample number	U_3O_8 (percent)	Pb (percent)
CR - 510	5.67	---
CR - 875	14.78	17.07
CR - 876-A	1.59	---

Rasor also reports that a sample selected by R. C. Campbell, of the Radon Mining Company, and sent to the American Smelting and Refining Company laboratory for assaying contained 12.49 percent U_3O_8. These samples probably came from the White Oak No. 1 mine although specific locations are not mentioned.

Surface traversing for radioactivity data was done with a Geiger counter converted to a scintillation counter by the Survey's Denver Radiation Laboratory. Data recorded from surface traverses are given in table 1.

Table 1.--Data on radioactivity at surface, White Oak property, Santa Cruz County, Arizona

Location		Radioactivity 2/ (milliroentgens per hour)
Mineralized shear zone northeast of adit no. 2	-	0.48 - 0.55
Dump at adit no. 1	-	0.50
Dump at adit no. 2	-	0.60
Dump at adit no. 3	-	1.00 - 1.40
Dump at adit no. 4	-	0.52
Dump at White Oak adit	-	1.20 - 1.60
Dump at White Oak No. 1 adit	-	1.20 - 2.00
Cut no. 1	-	no increase
Cut no. 2	-	0.40 - 0.52
Shaft no. 1	-	no increase
Shaft no. 2	-	0.68
Wash north of White Oak No. 1 dump (float)	-	0.40 - 0.80
Mineralized shear zone on hill southeast of White Oak adit	-	0.40 - 0.80

1/ Locations shown in figure 1.

2/ Background as recorded by scintillation counter (not calibrated) is 0.40 mr./hr.

Underground study of radioactivity was limited to the three adits that had the largest radioactivity anomalies at the surface. Readings were taken within an inch of the sampled area with a Geiger counter and an unshielded 6-inch probe.

The anomaly recorded on the dump at adit no. 3 is larger than the anomaly in the workings. A background of 0.04 - 0.06 mr./hr. was recorded and the highest readings underground were 0.08 - 0.18 mr./hr.; the average reading underground was 0.10 mr./hr.

Similarly, the dump at the White Oak adit shows a distinct anomaly, although the underground workings show very little abnormal radioactivity. At the place where the drift is blocked by caved rock, however, a slight increase in radioactivity is evident. No particular stringer or spot of ore minerals could be isolated although the Geiger counter registered a general increase of as much as 0.06 mr./hr. above the 0.05 - 0.06 mr./hr. background. Perhaps there is a concentration of uranium minerals underneath the broken rock or in the walls of the inaccessible open stope above. Another possibility is the presence of radon gas.

The only uranium minerals visible on the White Oak property are in the White Oak No. 1 adit. These dark-yellow to orange minerals, which are the source of highest radioactivity, are concentrated along two narrow intersecting fractures in zones as much as 10 inches wide. Readings as much as 17.50 mr./hr., or 350 times the background of 0.05 mr./hr., were obtained where the uranium minerals are most highly concentrated; average readings are 0.50 to 2.50 mr./hr. Except for these two fractures, readings in the adit are less than 0.25 mr./hr.

The two uranium-bearing fractures are exposed in the roof of the drift and in the winze where the adit intersects the shear zone (fig. 2). According to R. C. Campbell of the Radon Mining Company, the second and higher grade uranium ore shipment came from the winze where the two ore-bearing fractures intersect. The recent development operations that have removed additional material from this location indicate that the more prominent of the two fractures, which strikes N. 67° E. and dips 75° NW., terminates to the northeast and down-dip against pre-ore fractures; it is lost in a mass of gouge and clay to the southwest, and contains fewer and fewer ore minerals up-dip. The smaller fracture, which strikes N. 22° W. and dips 41° NE., decreases so rapidly in intensity that it cannot be recognized more than a few feet from the larger fracture.

PRODUCTION AND RESERVES

Two uranium ore shipments were made from the White Oak No. 1 mine in 1952 by the Radon Mining Company. On January 16, 6.81 tons of ore that assayed 0.23 percent U_3O_8 were shipped to Marysvale, Utah; on March 4, 3.52 tons of 0.82 percent uranium ore were shipped to Marysvale. Two men were doing development work in August 1952, for uranium in the White Oak No. 1 adit, but the known radioactive fracture fillings were discontinuous, and attempts to locate new ore were not successful.

The ore remaining in the exposed fracture fillings is estimated to be 5 to 10 tons. A chip sample from these exposures was assayed in the U. S. Geological Survey's Trace Elements Denver Laboratory. The sample contained 0.47 percent uranium and 2.29 percent lead.

OTHER MINES IN THE PAJARITO MINING DISTRICT

Four mines within a radius of 1 mile from the White Oak property were checked for radioactivity because the host rock and general character of the ore are the same as those at the White Oak property.

The Big Steve mine, 0.3 mile northwest of the White Oak property, was leased on June 21, 1951, to F. R. Brown and R. D. Beeson under the name of the Red Oak No. 1 claim. The mine consists of a completely caved adit and open stopes that are caved at the surface for a lateral distance of 100 feet. Oxidized lead minerals apparently occur in a narrow shear zone that strikes N. 60° E. and dips 80° SE. Sampling for radioactivity with a scintillation counter showed no anomalies greater than 0.20 mr./hr. above the 0.40 mr./hr. background.

The St. Patrick mine on Pena Blanca Road is a mile south of Ruby Road at a point 2 miles west of the Walker Canyon turnoff. The present claim was located as the Midnight Mining claim by Val and Margaret Cason on October 16, 1947. A shallow shaft, now filled with water, and prospect cuts on a shear zone in rhyolite porphyry are the only workings. The shear zone averages 12 feet wide, strikes N. 28° E. and dips 79° SE. A scintillation counter shows only a slight increase over the 0.40 mr./hr. background.

The Morning mine consists of a short adit 0.3 mile south of Pena Blanca Road at a point 0.4 mile from Ruby Road. The concentration of secondary lead minerals is smaller than elsewhere in the district. There is no abnormal radioactivity.

The Spelbrink claim, approximately a mile west of the White Oak property, was visited in 1950 by R. J. Wright (1950) of the AEC. He reports only minor radioactivity anomalies.

CONCLUSIONS AND RECOMMENDATIONS

Uranium minerals are concentrated locally along small, discontinuous fractures in the shear zone on the White Oak property; these concentrations are small and widely dispersed, however, and prospecting for them by drilling or by underground drifting is expensive and generally unrewarding. The White Oak No. 1 adit probably enters the most favorable part of the shear zone. Additional fractures that contain small concentrations of uranium minerals may exist above, below, and a short distance in either direction from the adit. The radioactive stope in the White Oak adit is near the White Oak No. 1 workings, and 50 feet lower, which further suggests that the uranium is concentrated in the shear zone near the White Oak No. 1 adit.

No abnormal radioactivity was detected at other properties in the area.

It is believed that the possibilities for commercial production of uranium from the White Oak property are slight. It is recommended, therefore, that the government should not participate in any exploration at this property, unless significant new uranium showings are discovered by the operators.

UNPUBLISHED REPORT

Wright, R. J., 1950, Reconnaissance of certain uranium deposits in Arizona: U. S. Atomic Energy Commission RMO-679 (open-filed report).