TM 115

Ore Occurrence Study Mesa 4½ Mines, Lukachukai Mountains, Apache County, Arizona

by

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TECHNICAL MEMORANDUM #115 - ORE OCCURRENCE STUDY MESA 4-1/2 MINES, LUKACHUKAI MOUNTAINS, APACHE COUNTY, ARIZONA

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ABSTRACT

Mine mapping of the tyuyamunite-type deposits in the Salt Wash member of the Jurassic Morrison formation of the Lukachukai Mountains, Apache County, Arizona, revealed recognizable spatial relationships between ore mineralization and: fractured areas, sedimentary features, and interstitial carbonate.

Fractures in ore zones are closely spaced, well-defined, with dips from 80 to 90 degrees. Outward from ore zones, fractures are widely spaced, irregular, and dip less steeply. Ore-bearing sandstone lenses are characterized by gray color and one or more of the following sedimentary features: cross-bedding; channel scours (festoons); and alternating laminae of mudstone and sandstone. Ore occurs where the host rocks are intensely fractured and impregnated by interstitial carbonate, chiefly calcite, having cleavage faces ranging from one to 25 cm. (in diameter).

INTRODUCTION

Location

The mines examined in this study are on Mesa 4-1/2 of the Lukachukai Mountains, Apache County, in northeastern Arizona (fig. 1). The Lukachukai Mountains are essentially a northwesterly extension of the Chuska Mountains and are erosional remnants of Mesozoic and Tertiary sediments. Mesa 4-1/2 is a minor "mesa" near the central part of the northeast side of the mountains.

The mines of Mesa 4-1/2 are known as the 4B, Frank No. 1, Frank No. 2, 709, 1207, and 1212. All but the 1212 mine were held under lease by the Climax Uranium Company. The 1212 mine was under lease to the Navajo Uranium Division, Kerr-McGee Oil Industries, Inc. This paper was prepared in September 1954, and does not include results of later studies.

Scope

The importance of sedimentary features in the localization of carnotite-type deposits in the Morrison formation has been recognized by W. L. Stokes (1953) and J. A. Masters (1953). The relation of fracturing to uranium ore deposition in the Lukachukai Mountains, had not been studied, and a study of the association of interstitial carbonate with ore has not been conclusive (Laverty, 1954).

Mapping of mines on Mesa 4-1/2 was directed toward gathering data on fracture patterns and distribution and on ore directional trends and intensity of mineralization to determine if the ore bodies are spatially related to the fractures.

Five mines, having a total of 4,280 feet of drifts and nearly 44,000 square feet of stopes, were examined during the period March through August, 1954. A transit survey was first made of the mines connecting all the workings, and mine maps were constructed. The sedimentary features and the fracture patterns were recorded on these maps together with the intensity of mineralization and carbonatization. The mineralization was estimated by visual observation and with a Geiger counter. The amount of carbonate present was estimated by visual inspection. Mine long wall sections were made in addition to the plan maps. Sections were sketched through some ore zones by mapping from pillar to pillar and projecting information into the mined areas between.

Acknowledgments

A note of appreciation is due the operators of the six mines studied, Climax Uranium Corporation and the Navajo Uranium Division, Kerr-McGee Oil Industries, Inc. for their cooperation. Credit is due H. D. Pilkington for aid in gathering some data and B. I. Lionberger for able field assistance.

GENERAL GEOLOGY

The section of Mesozoic sedimentary rocks exposed in the Lukachukai Mountains ranges from the Chinle shale and Wingate sandstone of Triassic age upward through the Carmel formation, Entrada sandstone, Summerville formation, Bluff sandstone and the Salt Wash and Recapture members of the Morrison formation, all of Jurassic age.

The area of this study is on the northeastern edge of the Defiance uplift and has been locally warped by a prominent asymmetrical syncline of probable Laramide age. Tertiary Chuska sandstone, a poorly consolidated rock, caps the Lukachukai Mountains and lies unconformably on the folded and eroded Mesozoic rocks.

Several basic volcanic plugs and dikes crop out in the area surrounding the Lukachukai Mountains, and many are well exposed in Red Rock Valley, just northeast of the mountains. The Carrizo Mountains, a Tertiary laccolithic intrusion into Mesozoic rocks, 18 miles north of the Lukachukais, have a core of diorite porphyry.

MINING GEOLOGY

The ore deposits of the Lukachukai Mountains are known to occur only in the Salt Wash member of the Morrison formation. The ore deposits of Mesa 4-1/2 are in the lower third of the Salt Wash

member in a zone ranging in thickness from 5 to 20 feet. This zone dips northeastward at a low angle and is commonly enclosed by gray or green mudstone beds. The ore deposits occur in gray, fine-to very fine-grained sandstone as irregular pods from one to about 8 feet thick, and appear to be localized: (1) where sedimentary features provide a receptive environment; (2) where fracturing of the rocks is most intense; and (3) where calcite and/or other carbonate minerals are present.

Figure 2 is a map of the 4B, the Frank Nos. 1 and 2, and the 709 mines. A general outline of ore pods is indicated by stopes, but in addition sedimentary trends and fractures are also indicated. Figure 3 shows the degree of carbonate mineralization in the mine workings. Figures 4 and 5 are maps of the 1207 and 1212 mines, showing the same features.

Sedimentation Features and Color

The ore bodies on Mesa 4-1/2 are localized in or are adjacent to sandstone exhibiting the following sedimentary features: inclined channel scours (festoons); alternating laminae of mudstone and sandstone; and cross-bedding. These features are illustrated in figures 6 and 7.

The fact that the uranium deposits of the Lukachukai Mountains occur in gray sandstone in contrast to unmineralized red sandstone is described by Masters (1953). Masters also states that extensive bleaching is unfavorable. This color difference is very apparent underground, and ore-bearing gray sandstone can be observed at several places grading within a few feet laterally into barren red sandstone. Figure 8 shows the areas of these color changes in the 4B mine as interpreted from drill hole data and underground mapping.

Fractures

The pattern of fractures in the underground workings of Mesa 4-1/2 suggests a relationship between the intensity of fracturing and ore localization. Fractures may be more apparent in stopes (M. E. McKinstry, personal communication). Fractures in ore are closely spaced, well defined, with nearly vertical dips; fractures in barren ground are more widely spaced, poorly defined, and have generally lower angle dips. The intensity of fracturing rather than the degree of openness of the individual fractures appears to be an important factor in ore localization.

Other mines in the Lukachukai Mountains appear, from general observation, to have a similar relationship between fracturing and ore, although recent mine mapping on Three Point Mesa does not show this relationship.

However, a considerable amount of the ground in nearby Mesa 1 is intensely fractured both in ore and in barren rock, possibly because of proximity to the Lukachukai syncline.

Some of the fracturing near the portals of the Mesa 4-1/2 mines is roughly parallel to the rims of the mesa and, in general, there appears to be a relation between the drainage pattern of the area and a fracture pattern. Of the 22 producing mines in the area 16 are near the innermost part of re-entrant canyons which may be areas of intersecting fracture zones.

Interstitial Carbonate

Carbonate bodies mapped in the Mesa 4-1/2 mines show a wide range in thickness and length (figs. 5, 7, and 8). They range from several inches to 6 or more feet in thickness and from a few inches to 160 feet in length. Most of the bodies are horizontal lenticular masses parallel to or crossing bedding planes. The carbonate varies from colorless to dark red or black. The colorless material is calcite; the red and black carbonate may be a mixture of calcite and iron, manganese, and vanadium oxides; some may be ankerite or siderite.

The carbonate occurs interstitially in and around sand grains which are commonly corroded. At places it occurs as groups of crystals having optically continuous faces ranging from one to as much as 10 inches across.

Figure 8 illustrates two sections through a stope in the 4B mine. The relationship of ore to interstitial carbonate bodies containing iron, manganese, and vanadium oxides is shown. No ore has been observed in this deposit where carbonate is absent.

Megascopic observation of the relation of mineralization to the carbonate bodies suggests that the carbonate may have been a precipitating agent for iron, manganese, vanadium, and uranium from solutions migrating through the sandstone. What appear to be solution fronts of iron, manganese, vanadium and uranium occur at several places in the mines, and many show the appearance of Liesegang rings or reaction rims in or around the carbonate bodies. Figures 9 and 10A illustrate these features. Figure 10B shows a possible paragenetic relationship of mineralization along two sets of fractures. Here, carbonate, interstitial with sandstone, appears to be replaced by hematite which is replaced in part by vanadium minerals; all appear to be invaded by the uranium

mineralization. This sequence, however, is not in accordance with microscopic work done by J. C. Griffiths (personal communication).

The geochemical and paragenetic relations of the ores of the Lukachukai Mountains is not clear, and further studies are needed to determine the genesis of these deposits.

REFERENCES

Laverty, R. A., 1954, Causes of color variations in the Salt Wash and Recapture on the south side mesas, Lukachukai Mountains: U. S. Atomic Energy Comm. memorandum (unpublished).

Masters, J. A., 1953, Geology of the uranium deposits of the Lukachukai Mountains area, northeastern Arizona: U. S. Atomic Energy Comm., RME-27.

Stokes, W. L., 1953, Primary sedimentary trend indicators as applied to ore finding in the Carrizo Mountains, Arizona and New Mexico: U. S. Atomic Energy Comm., RME-3043, Pt. 1, 1953.

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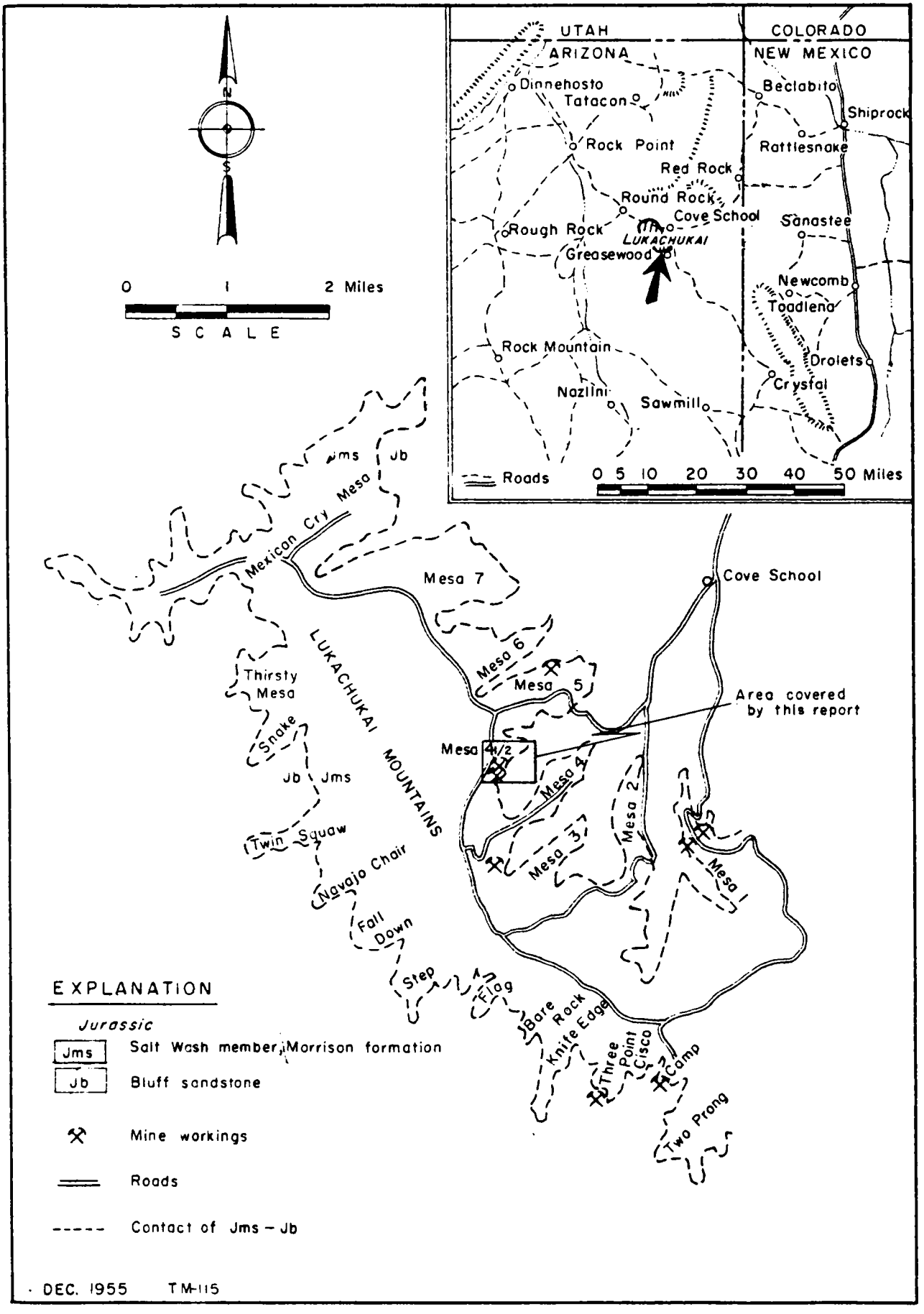

Figure 1. Index map of Lukachukai Mountains area, Apache County, Arizona, showing location of Mesa 4 1/2

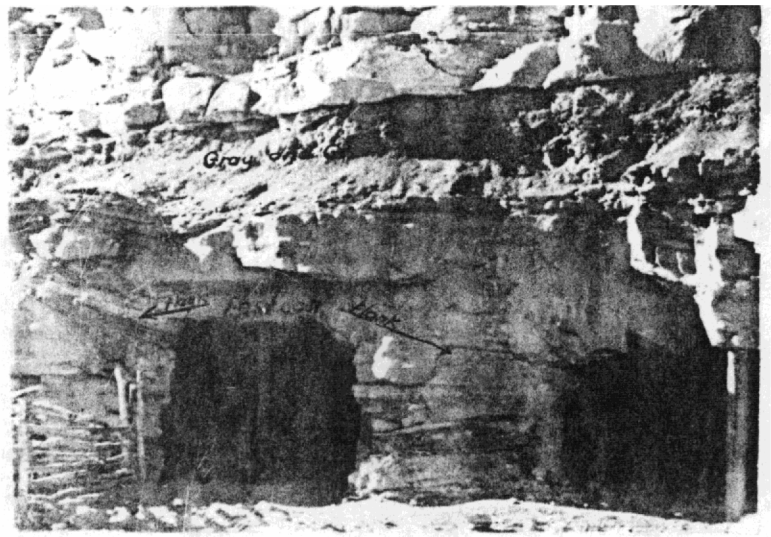

Figure 6A. Portal of Frank No. 1 mine. Gray and green mudstone occurs above an ore zone, arrows indicate the flanks of a channel scour (festoon).

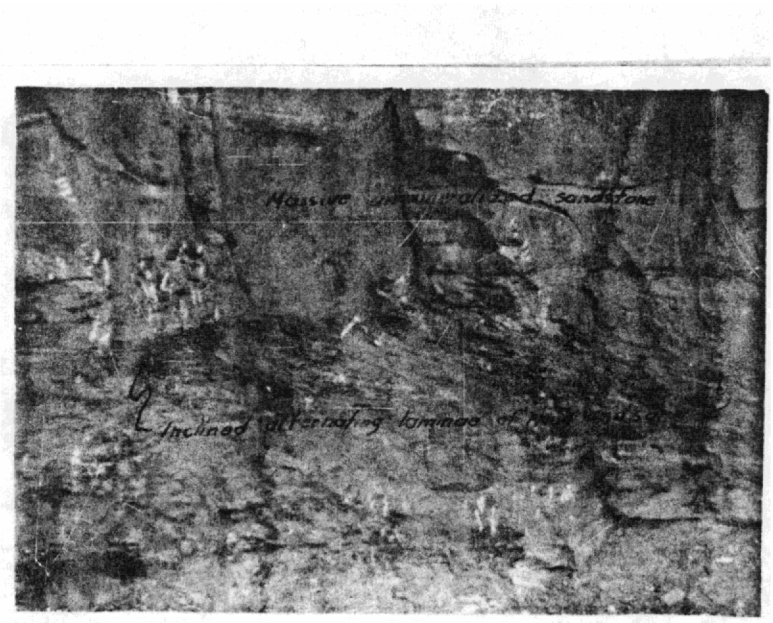

Figure 6B. Inclined alternating laminae of mudstone and sandstone at the portal of the 4B mine
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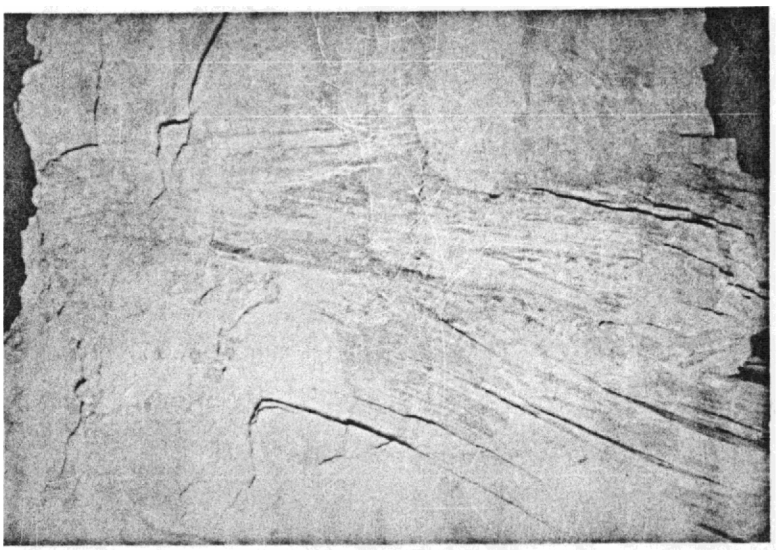

Figure 7A. Inclined bedding in a pillar, 4B mine.

0 1 2 Feet

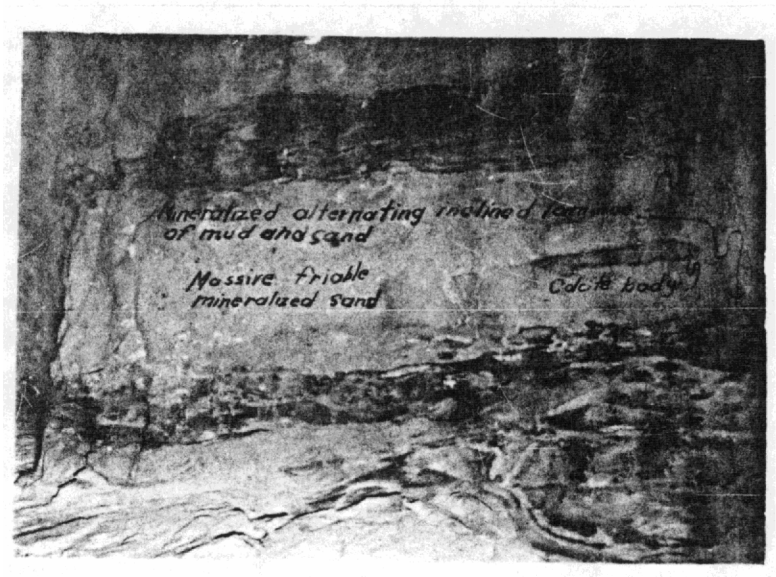

Figure 7B. Massive friable sandstone between two mineralized zones of alternating laminae of mudstone and sandstone, 4B mine.

0 1 2 3 4 Feet

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Figure 9A. Hematitic solution fronts invading an interstitial calcite body in the 4B mine.

0 1 2 Feet

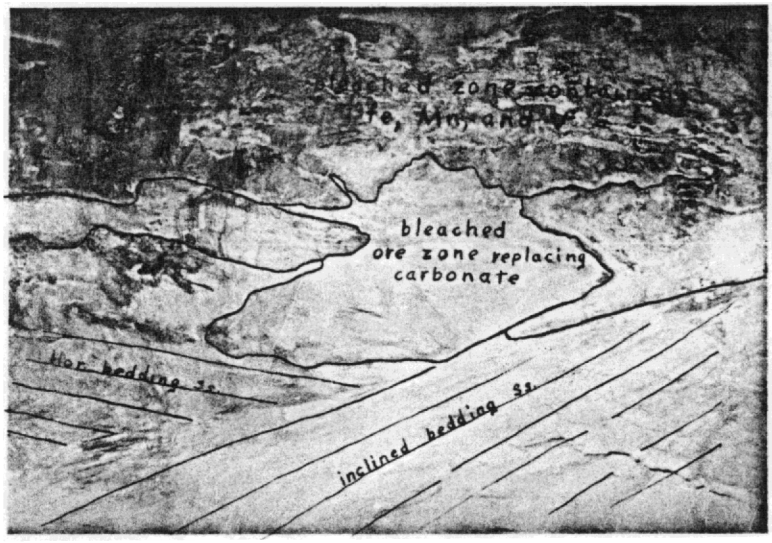

Figure 9B. Interstitial carbonate body partly replaced by ore and by a bleached zone containing Fe, Mn and V(?), 4B mine.

0 1 2 Feet

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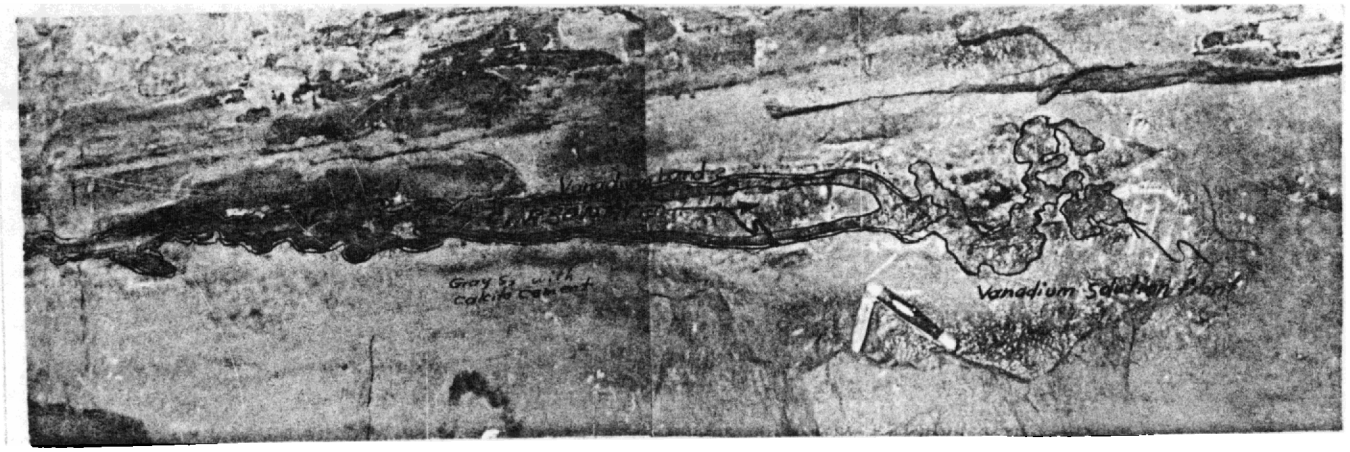

Figure 10A. A small interstitial carbonate body in the 4B mine with reaction rims and a solution front

0 1 2 Feet

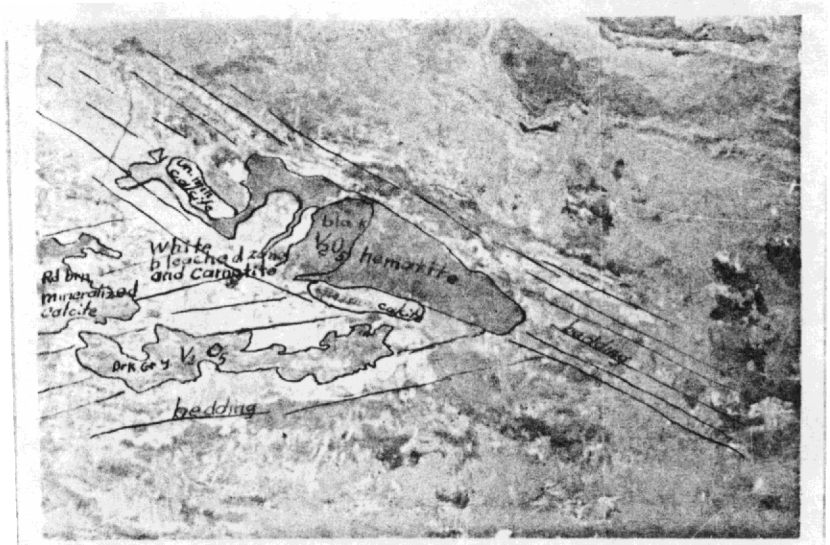

Figure 10B. Mineralized zone at the intersection of two sets of inclined bedding planes in the 4B mine

0 1 2 Feet

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195,950 E

196,350 E

N

S

0 100 200 Feet

SCALE

N 111,000

709 mine

Limit of mine workings

OUTCROP

Frank No. 2 mine

N 110,500

4 B mine

EXPLANATION

Fractures; vertical except where dip is indicated

Festoon trend

Lineation trend

Strike and dip of bed

Foot of raise

OUTCROP

N 110,000

Frank No. 1 mine

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Figure 2. Plan showing fracture patterns and sedimentary trends in vicinity of 4B, 709, Frank No. 1 and Frank No. 2 mines, Apache County, Arizona

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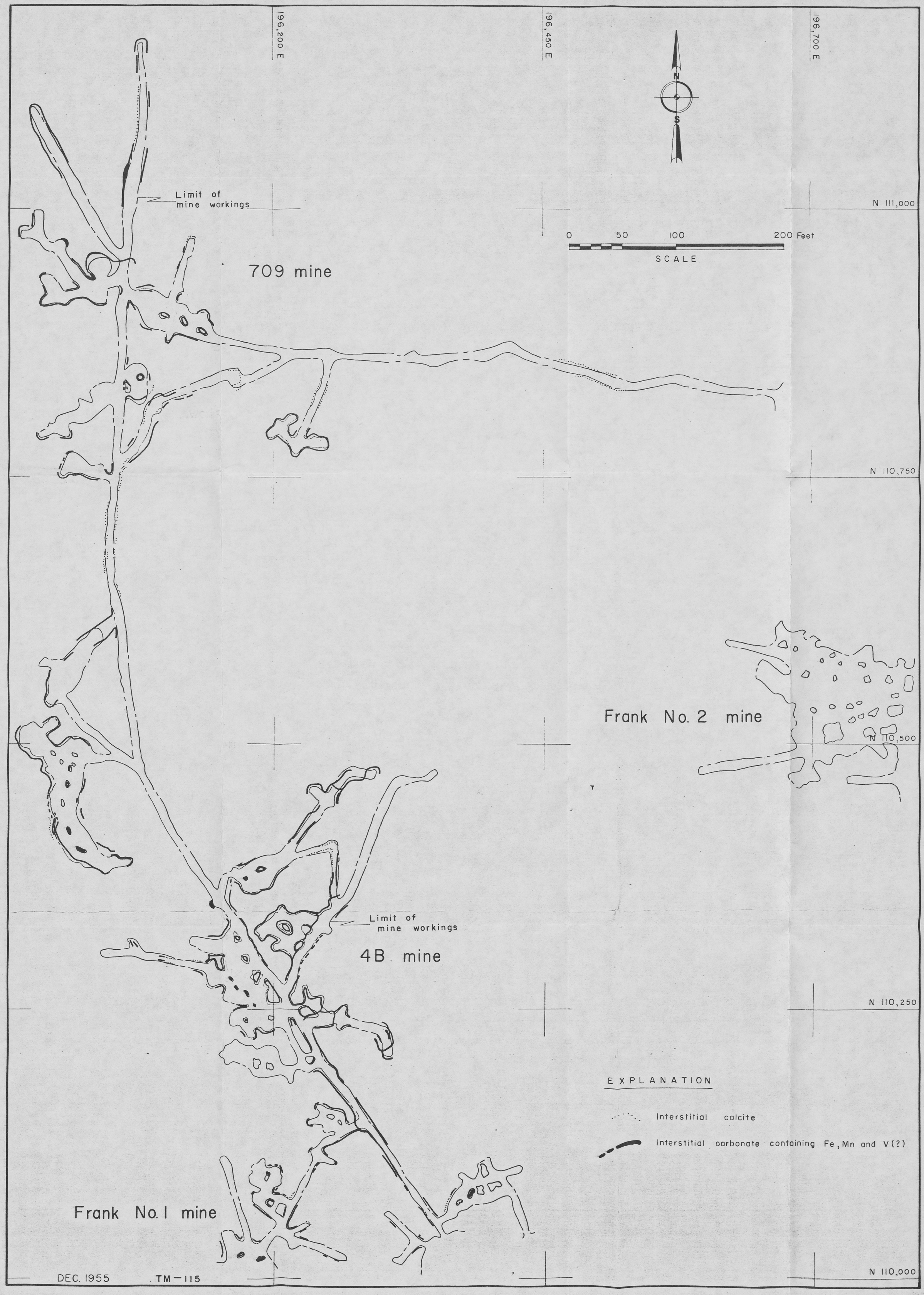

Figure 3 Plan showing interstitial calcite and iron, manganese and vanadium (?) in vicinity of 4B, 709, Frank No. 1 and Frank No. 2 mines, Apache County, Arizona

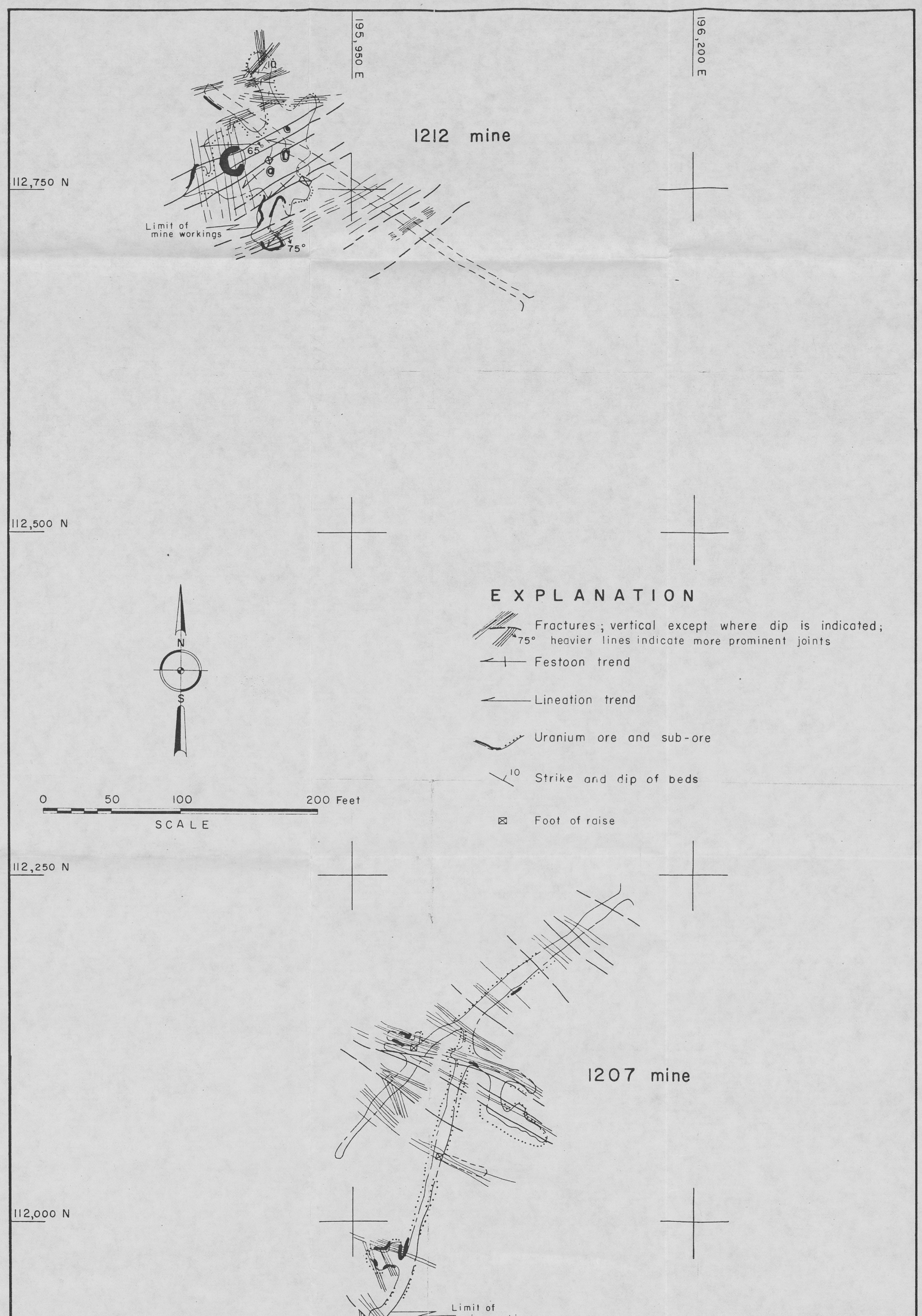

Figure 4. Plan showing sedimentary trends, fracture patterns and uranium distribution at the 1212 and 1207 mines, Apache County, Arizona

195,700 E

195,950 E

196,200 E

N 112,750

N 112,500

N 112,250

N 112,000

Limit of mine workings

1212 mine

1207 mine

Limit of mine workings

EXPLANATION

..... Interstitial calcite

Interstitial carbonate containing Fe, Mn and V(?)

Foot of raise

N

S

0 50 100 200 Feet

SCALE

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Figure 5. Plan of the 1207 and 1212 mines, showing distribution of interstilial calcite and iron, manganese and vanadium (?) carbonate, Apache County, Arizona