Geology and mineralogy of the J. J. mine, Jo Dandy area, Montrose County, Colorado

By D. P. Elston and Theodore Botinelly

Trace Elements Investigations Report 518

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Geology and Mineralogy

This document consists of 32 pages,
plus 2 figures.
Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GEOLOGY AND MINERALOGY OF THE J. J. MINE, JO DANDY AREA, MONTROSE COUNTY, COLORADO*

By

Donald P. Elston and Theodore Botinelly

September 1955

Trace Elements Investigations Report 518

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

USGS - TEI-518

GEOLOGY AND MINERALOGY

Distribution (Series A)	No. of copies
Atomic Energy Commission, Washington	2
Division of Raw Materials, Albuquerque	1
Division of Raw Materials, Butte	1
Division of Raw Materials, Casper	1
Division of Raw Materials, Denver	1
Division of Raw Materials, Hot Springs	1
Division of Raw Materials, Ishpeming	1
Division of Raw Materials, Phoenix	1
Division of Raw Materials, St. George	1
Division of Raw Materials, Salt Lake City	1
Division of Raw Materials, Washington	3
Exploration Division, Grand Junction Operations Office	6
Grand Junction Operations Office	1
Technical Information Service, Oak Ridge	6
U. S. Geological Survey:	
Fuels Branch, Washington	1
Geochemistry and Petrology Branch, Washington	1
Geophysics Branch, Washington	1
Mineral Classification Branch, Washington	1
Mineral Deposits Branch, Washington	2
E. H. Bailey, Menlo Park	1
A. L. Brokaw, Grand Junction	2
N. M. Denson, Denver	1
R. L. Griggs, Albuquerque	1
M. R. Klepper, Spokane	1
A. H. Koschmann, Denver	1
J. D. Love, Laramie	1
L. R. Page, Washington	1
Q. D. Singewald, Beltsville	1
A. E. Weissenborn, Spokane	1
TEPCO, Denver	2
TEPCO, RPS, Washington, (including master)	2
	48

CONTENTS

ILLUSTRATIONS

TABLES

GEOLOGY AND MINERALOGY OF THE J. J. MINE, JO DANDY AREA, MONTROSE COUNTY, COLORADO

By Donald P. Elston and Theodore Botinelly

ABSTRACT

Vanadium-uranium ore is mined at the J. J. mine in the Jo Dandy area, Montrose County, Colo. The ore is in the upper sandstone layer of the Salt Wash member of the Morrison formation of Late Jurassic age. Permeability and variations in permeability in cross-stratified sandstone units within the sandstone layer have influenced the gross distribution and, in many places, controlled the detailed configuration of ore in the J. J. mine. Carbonized wood apparently has been influential in localization of ore minerals where sedimentary structures have allowed ore solutions access to the wood. The J. J. mine intersects the ground water table, and above the water table where the ore and enclosing sandstone are oxidized, carnotite and "vanadium clay" are the major ore minerals. Below the water table, the ore is unoxidized and montroseite, uraninite, and coffininte are the major ore minerals. An intermediate oxidized zone composed of hydrous vanadium oxides with intermediate valences is thin and poorly defined. The configuration and distribution of ore are little changed by oxidation. The ore minerals were emplaced by mineralizing fluids which moved laterally through the sandstone and which deposited low-valent minerals.

INTRODUCTION

Detailed geologic mine mapping and sampling of the J. J. mine in the Jo Dandy area, Montrose County, Colo., were undertaken to study a vanadium-uranium ore body in terms of the physical relationships of ore to host rock, the paragenetic sequence of ore minerals, and the sequential development of an oxidized suite of ore minerals from unoxidized ore.

The J. J. mine is in the southwest part of the Jo Dandy area in the Bull Canyon mining district and is about 8 miles due west of Naturita, Montrose County, Colo. The Jo Dandy area is an elongate strip of land, about 4 miles in length, bounded on the northeast by the floor of Paradox Valley (elevation 5,600 feet) and on the southwest by the rim of Monogram Mesa (elevation 7,100 feet).

In early 1955, eight mines were active in the Jo Dandy area; in addition many mines and prospects were abandoned or inactive. The J. J. mine is the eastermost mine in the area. Production from the mine since 1949, has been in excess of 10,000 short tons.

Detailed mine mapping was begun in December 1953, and completed by March 1954. Since that time periodic mapping has kept the outline of workings and geology up to date.

Permission to map and sample the J. J. mine was given by Mr. Everett M. Paris of the U. S. Vanadium Company. X-ray analyses were done by M. E. Thompson, U. S. Geological Survey, Grand Junction, Colo.

GENERAL GEOLOGY

Stratigraphy

Rocks exposed in the area range from Pennsylvanian to Early Cretaceous in age (table 1). All the Mesozoic strata present in the area are exposed in faulted blocks along the south margin of Paradox valley. Triassic and Lower Jurassic sediments thin and pinch out toward the axis of the Paradox Valley anticline to the north; the Jurassic Morrison formation and the Cretaceous formations were deposited across the anticline (Cater, 1954).

The mines are located in the upper sandstone layer of the Salt Wash member of the Morrison formation of Late Jurassic age. Locally this sandstone is called the "ore-bearing sandstone." In the vicinity of the J. J. mine, the ore-bearing sandstone is subdivided into two sandstone strata separated by green or green and red mudstone (fig. 1, sec. A). At the mine the ore-bearing sandstone is about 50 feet thick; the upper sandstone stratum ranges from 20 to 30 feet in thickness and contains the principal reserves of the area. The ore body in the J. J. mine is in the lower and middle parts of the upper sandstone stratum.

The ore-bearing sandstone is generally light to dark brown, medium- to fine-grained, and may be stained or speckled by limonite derived from the oxidation of pyrite. In areas where the pyrite has not been oxidized, the sandstone is light gray. Light- to bright-red hematite staining has been observed locally. The sandstone is composed largely of subangular, clear and frosted grains of quartz and, in places, contains, apparently reworked, rounded to sub-rounded grains of quartz. Minor amounts of feldspar

Table 1. Generalized description of Paleozoic and Mesozoic strata, southwest side of Paradox Valley, Jo Dandy area, Montrose County, Colorado. (Data are in part from an unpublished report on the Jo Dandy area by E. M. Shoemaker, 1950.)

Era	System	Group	Formation	Thickness (feet)	Character
Mesozoic	Cretaceous		Burro Canyon formation	175-250	Conglomeratic sandstone with interbedded green mudstone; minor red mudstone near top. VANADIUM-URANIUM BEARING LOCALLY.
		UNCONFORMITY			
	Jurassic		Morrison formation	375-425	Brushy Basin member; red and green mudstone; some sandstone lenses; locally conglomeratic. VANADIUM-URANIUM BEARING LOCALLY.
				205-400	Salt Wash member; red and green mudstone, light-colored sandstone layers persistent near top and base; lenticular strata between. Locally rests on Paradox member of Hermosa formation. VANADIUM-URANIUM BEARING.
		San Rafael group	Summerville formation	50-70	Red with minor green mudstone; light-brown sandstone bed with ripple marks near top.
			Entrada sandstone	0-95	Yellow to light-red very fine- to fine-grained sandstone with subordinate medium-fine, rounded, quartz grains; locally large-scale crossbedding; red silt in basal part equivalent to the Carmel formation(?).
		UNCONFORMITY			
	Jurassic(?)	Glen Canyon group	Kayenta formation	0-200	Lavender-colored micaceous sandstone, light brown locally; thin maroon mudstone beds.
	Triassic		Wingate sandstone	0-300	Red massive sandstone, white locally; irregularly bedded.
			Chinle formation	0-80+	Dark to light-red mudstone and sandstone thin bedded; micaceous locally.
		UNCONFORMITY			
Paleozoic	Pennsylvanian		Hermosa formation	10,000+ locally	Paradox member; gypsum and black to dark-gray contorted shale and limestone; dark colored where overlain by Morrison formation, light colored where overlain by landslide debris.

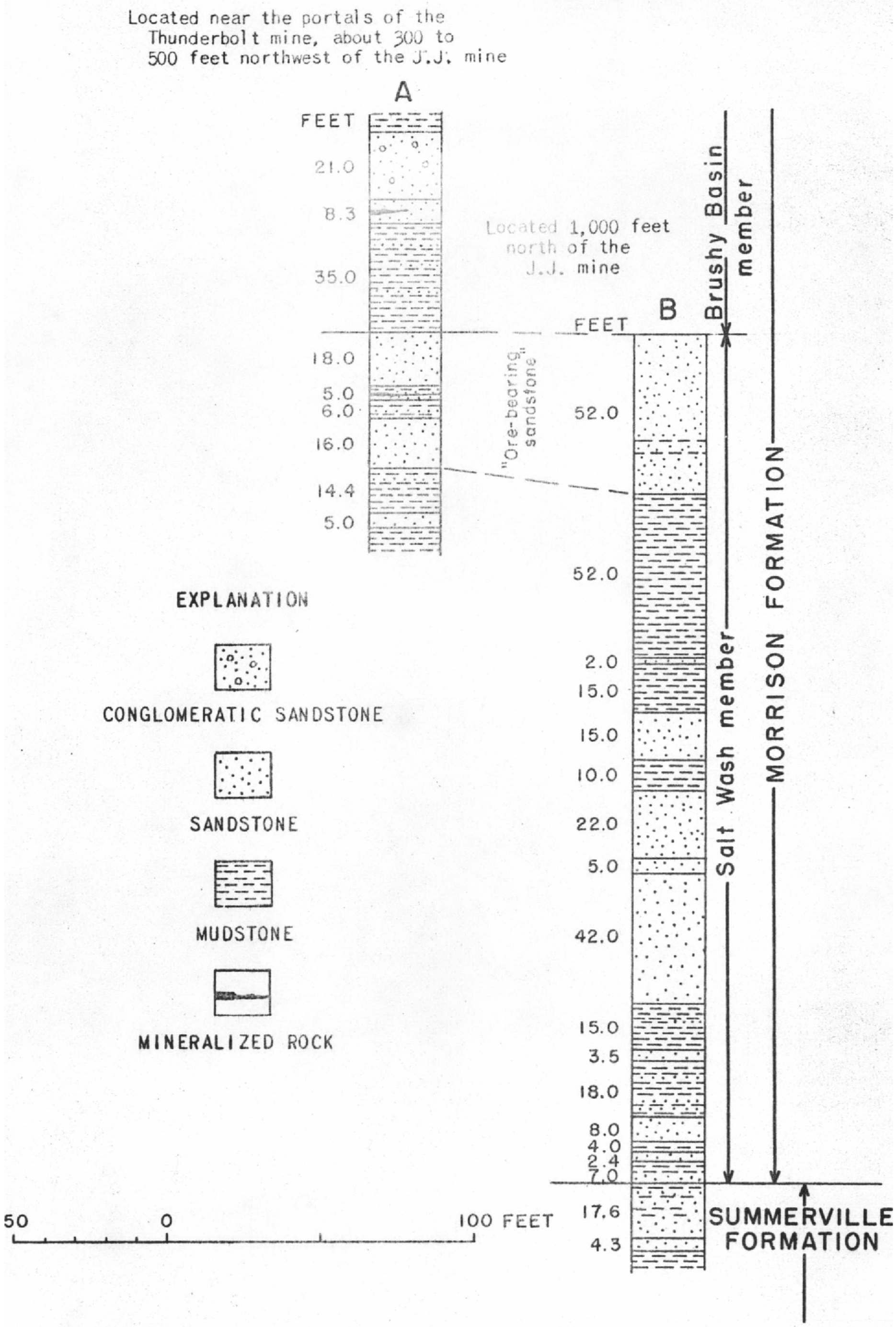

Figure 1. MEASURED SECTIONS NEAR THE J.J. MINE, JO DANDY AREA, MONTROSE COUNTY, COLORADO.

biotite, red and green chert, and opaque minerals are present. Silica and calcite are the most common cementing agents. Where the rock is highly fractured and the pyrite well oxidized, the sandstone is friable, and little cementing material remains. Seams of gypsum occur along many fractures above the water table, and in many places within the J. J. mine gypsum is currently being precipitated as hairline coverings on the mine walls. Soft, white subangular grains, resembling chert fragments altered to clay, occur both in barren and mineralized rock. X-ray analyses[1] on samples of this material collected in the Jo Dandy area from the Salt Wash

[1] Outerbridge, William F., personal communication.

sandstone and Burro Canyon formation give a quartz pattern.

The ore-bearing sandstone is composed of an interbedded sequence of cross-stratified units similar to the simple, planar, and trough cross-stratified units described by McKee and Weir (1952). Discontinuous, interbedded seams of gray-green mudstone, scattered mud-pebbles layers and carbonaceous zones and trash pockets are common. Cross-stratification ranges from laminations a few inches in length, within an individual bed, to trough cross-stratified beds tens of feet in length which crosscut earlier sediments. The trough cross-stratified beds are similar to "festoons" as described by Knight (1929) and Stokes (1953).

Structure

The J. J. Mine is adjacent to faulted strata on the southwest flank of the Paradox Valley anticline. In general the beds strike N. 64° W. and dip 10° to 14° SW. Fractures in the mine generally parallel the long axis of Paradox Valley. The dominant fracture set in the J. J. mine strikes N. 30° to 70° W. and has an average dip of 85° NE (fig. 2). A minor fracture set strikes about N. 30° E. and dips either southeast or northwest. Most fractures show no displacement; a few show displacements of a few inches. In the Jo Dandy area faults displace both the ore and the enclosing sandstones, and no fault or fracture set has been found that clearly predates the ore.

DESCRIPTION OF THE ORE BODY

The ore body is composed of interconnecting and overlapping layers of mineralized rock (fig. 3), which coalesce locally to form minable rock as much as 19 feet thick. Ore minerals are distributed as mineralized spots, streaks, and disseminations and in many places follow bedding laminae within larger sandstone units. Ore is distributed irregularly through cross-stratified sandstone units and generally is bounded top and bottom by less permeable mudstones and sandstones. In places the lower edge of mineralized rock may be 2 to 5 feet above the gray-green mudstone that separates the upper stratum of the ore-bearing sandstone from the lower . In other places the ore is in contact with or penetrates the upper few inches of this mudstone. The upper edge of mineralized rock coincides in places with mudstone seams and mudstone pebble layers (fig. 2, sec. A-A'-A").

Figure 3 shows variations in the shape and configuration of mineralized layers of the ore body in part of the J. J. mine. Projected and restored rock in the northeast part of the diagram shows a bedded sequence where mineralized layers of mudstone, and mudstone and sandstone are separated by barren sandstone. From northeast to southwest the mineralized rock can be traced from separate mineralized sandstone layers into a single mineralized layer and then into a layered mineralized and barren sequence. Individual ore layers are more persistent and continuous along rather than across the trend of the sedimentary structures (compare figs. 2,3, and 4). The trend of the main part of the ore body follows these sedimentary structures and crosscuts, at a low angle, the dominant fracture set of the area (fig. 2).

Habits of the ore

Although the boundaries of mineralized rock in many places cut across sedimentary structures, the sedimentary structures seem to control the location of ore both on a broad scale and in detail. Two layers of sandstone are mineralized in the outcrop at the portal of the J. J. mine (fig. 2, sec. A-A'-A"). They are less massive and more intensely cross-stratified than overlying and underlying beds. The lower mineralized layer is more prominently crossbedded, and this layer is extensively mineralized throughout the mine. Near the portal of the mine a flat-layered thin-bedded mineralized sandstone contains a single tabular layer of ore. The upper and lower limits of ore are gently undulating; in detail they cross the bedding at a low angle, but in general parallel the bedding. Ore minerals follow minor cross-laminae within the sandstone layer.

In places in the J. J. mine the distribution of mineralized layers is erratic, and abrupt variations in thickness and sharp crosscutting relationships are prominent (fig. 2, secs. A-A", B-B', D-D'). These configurations are associated in part with trough cross-stratification.

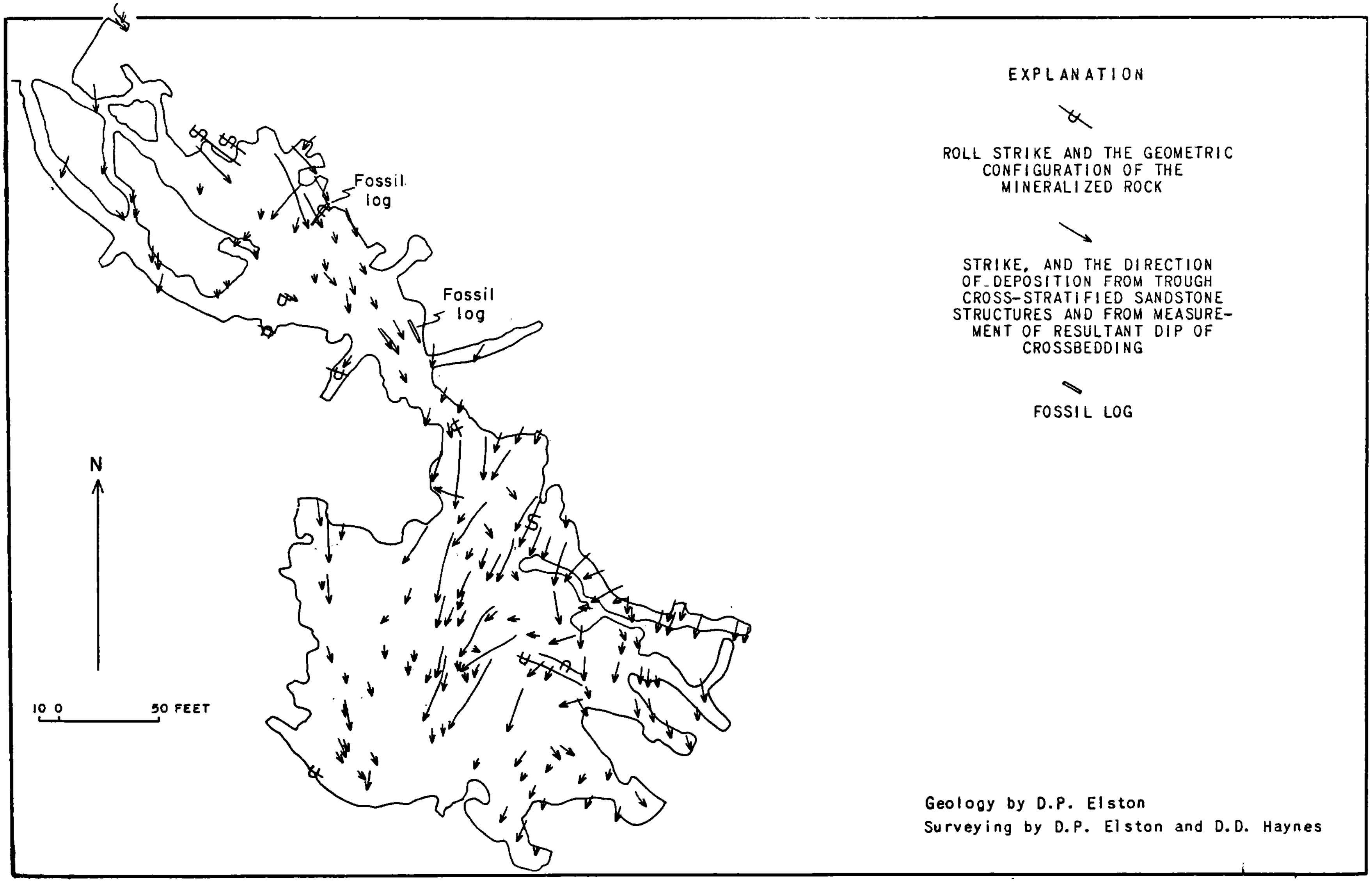

Figure 4. OUTLINE MAP SHOWING TRENDS OF PALEOSTREAMS AS MAPPED FROM TROUGH CROSS-STRATIFIED SANDSTONE BEDS, J.J. MINE, JO DANDY AREA, MONTROSE COUNTY, COLORADO.

The ore minerals follow bedding laminations in detail, but the ore minerals may pinch out against intersecting structures. The erratic configuration of the projected and restored mineralized rock layers in the southwest part of figure 3 is the result of the mineralization of a "festooned" host rock.

In still other places (north part of fig. 3) an alternating sequence of barren and mineralized rock corresponds with a sequence of alternating sandstones and mudstones. Here the ore minerals occur in medium-grained muddy sandstone; the fine-grained sandstone and mudstone beds are more commonly barren.

In mineralized zones, pods of very rich ore are found associated with carbonaceous material. Essentially similar carbonaceous material in barren zones is barren.

Ore controls

The relations described above indicate that the varying permeability of the different sedimentary structures controls the detailed shape of the ore body. The permeability is high, but irregular in sandstones that show trough crossbedding, and in these beds the ore layers and mineralized zones are very irregular. In the sandstones where simple and planar crossbedding are dominant and where the permeability is less variable, the ore layers are tabular and less irregular in shape.

Carbonaceous material has caused, probably by chemical rather than physical means, the precipitation of rich pods of ore where permeable layers have allowed access of solutions to this material.

The gross control for the localization of mineralized ground is not evident. Although the ore body is elongate in the general direction of the dominant fracture set, which in turn parallels the Paradox Valley anticline, the trend of the thicker or main parts of the ore body crosscuts the fractures. The southward and southeastward extension of the ore body, as known from drilling, supports the mapped and observed data in the mine. The trend of the best ore is parallel to the stream trends as determined by mapping of the sedimentary structures (fig. 4). Lateral separation of the ore body, from a single mineralized layer into two or more thinner mineralized layers, is more abrupt and more pronounced across rather than along the trend of the sedimentary structures. The trend of the best ore is southeastward in the northern part of the mine and swings to a more southerly direction in the southern part of the mine. The sedimentary structures do not represent a clearly defined channel in the ore-bearing sandstone, but they seem to define a composite channel trend developed at the time of deposition of the sediment. As such they would present a zone of greater permeability to laterally moving mineralizing solutions.

Rolls

The term roll (Fischer, 1942, p. 380-384) is applied to mineralized rock where the edges of mineralized rock, or the configurations of leaner and richer material within mineralized rock, cut across bedding and usually describe a geometric figure (e.g. C-shaped, S-shaped). The formation of some rolls in the J. J. mine can be attributed to primary sedimentary structures (fig. 5a and b). Some may be the result of localization of ore minerals around fossil trees (S-roll around fossil tree, fig. 4). Figures 6

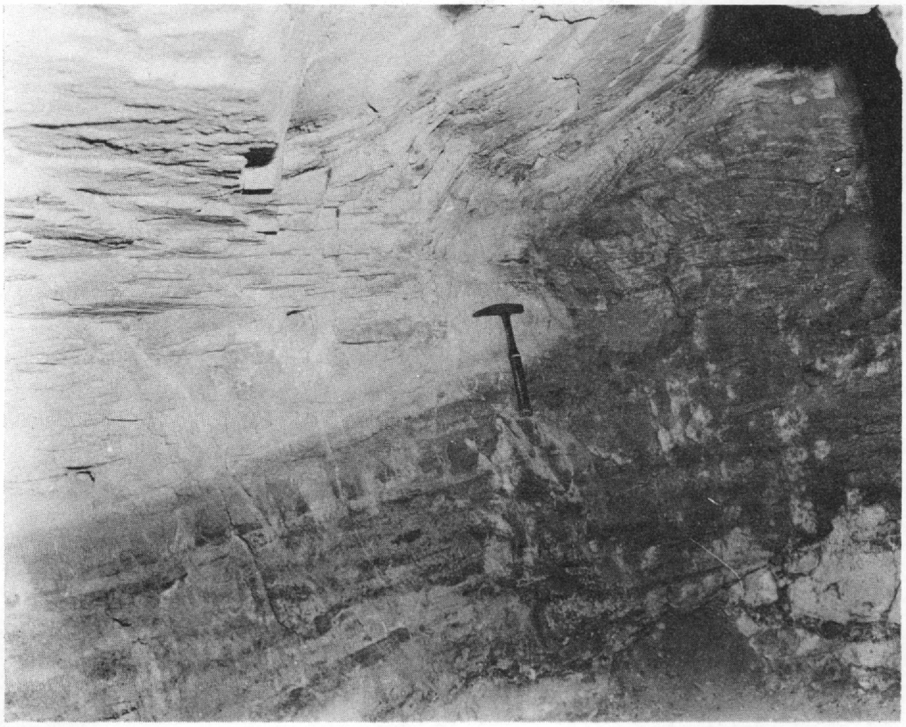

Figure 5. a. Ore minerals deflected into a diffuse S-roll at the base of an overlying trough cross-stratified sandstone bed (bed strikes into picture).

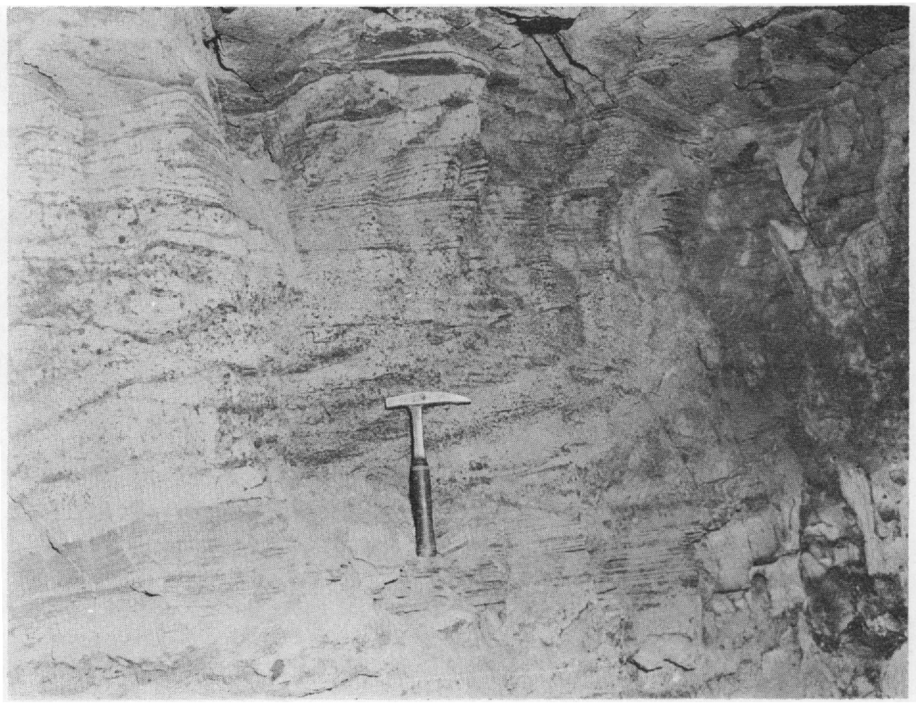

Figure 5. b. Diffuse S-rolls, which reflect the S-roll configuration of figure 5a.

and 7 show views of C-roll in the J. J. mine. Other rolls may be the result of local redistribution of vanadium (fig. 5b). Still others are unexplained.

The axes of the roll surfaces in the J. J. mine (fig.4) parallel the regional structure, are normal to the "Uravan mineral belt" (Fischer and Hilpert, 1952), and parallel the long axis of the trend of mineralized ground in the mine which in turn generally parallels the trend of the sedimentary structures. One roll, which has an anomalous strike, contains a thin, mineralized tree along its axis. The tree seems to have been trapped and buried in sandstone at an angle to the stream flow of that time.

A set of S-shaped roll surfaces in oxidized sandstone (fig. 5a and b) has diffused bands of gray "vanadium clay" which in part crosscuts the bedding and obscures the remnants of primary spotted and streaked disseminations similar to those in unoxidized ore. No similar S-rolls have been found in unoxidized parts of the mine. Several modes of formation can be postulated for the S-shaped rolls: (1) the rolls are primary and represent periods of pulsation and temporary stagnation of an edge of a mineralizing solution; (2) the rolls represent a slightly later pulsing movement of the mineralizing solutions which caused a partial redistribution of the ore minerals into the poorly defined S-shaped bands with a partial depletion of the ore minerals from the intervening areas; or (3) the roll surfaces are the result of a partial redistribution of ore minerals during oxidation and were superimposed on original spotted and streaked mineralized rock. In any event, the field relations indicate that the configuration of these S-rolls is the result of a deflection of solutions by an over-lying partly intersecting, trough crossbedded sandstone structure.

Figure 6. C-roll in black ore; ore minerals are partly oxidized in upper part of roll.

Figure 7. Ore minerals with a double C-roll configuration connecting two mineralized layers. Ore is partly oxidized.

MINERALOGY

The ore in the J. J. mine ranges from oxidized ore in the upper part of the mine to unoxidized ore below the water table (fig. 8). The major uranium minerals are carnotite, $K_2(UO_2)_2(VO_4)_2 \cdot 1\text{-}3H_2O$, tyuyamunite, $Ca(UO_2)_2(VO_4)_2 \cdot 7\text{-}10\ 1/2H_2O$, uraninite, UO_2, (Weeks and Thompson, 1954); and coffinite, $U(SiO_4)_{1-x}(OH)_{4x}$, (Stieff, Stern, and Sherwood, 1955). The major vanadium minerals are montroseite, $VO(OH)$ or $(V,Fe)O(OH)$, vanadium silicates 1/, and corvusite, $V_2O_4 \cdot 6V_2O_5 \cdot nH_2O(?)$, (Weeks and Thompson, 1954).

1/ Vanadium silicates here denote the fine-grained, nonmetallic, vanadium-bearing matrix material of the sandstone and includes one or more of the following: vanadium mica, vanadium-bearing chlorite and clay minerals, and clay minerals with adsorbed vanadium.

Accessory vanadium minerals are melanovanadite, $2CaO \cdot 2V_2O_4 \cdot 3V_2O_5$, hewettite, $CaV_6O_{16} \cdot 9H_2O$, and several unnamed vanadate minerals. Nonmetallic gangue minerals are quartz, gypsum, calcite, barite, clay minerals, and limonite. Carbonaceous material is widely distributed through the mine in small quantities. Metallic gangue minerals include pyrite, marcasite, galena, sphalerite, and native selenium.

The black, unoxidized ore containing montroseite, coffinite, and uraninite occurs below the water table. Immediately above the water table is a thin discontinuous zone of partly oxidized ore. Above this zone is the zone of oxidized ore containing carnotite, tyuyamunite, and vanadium silicates. Minor exceptions to this distribution occur; in black ore,

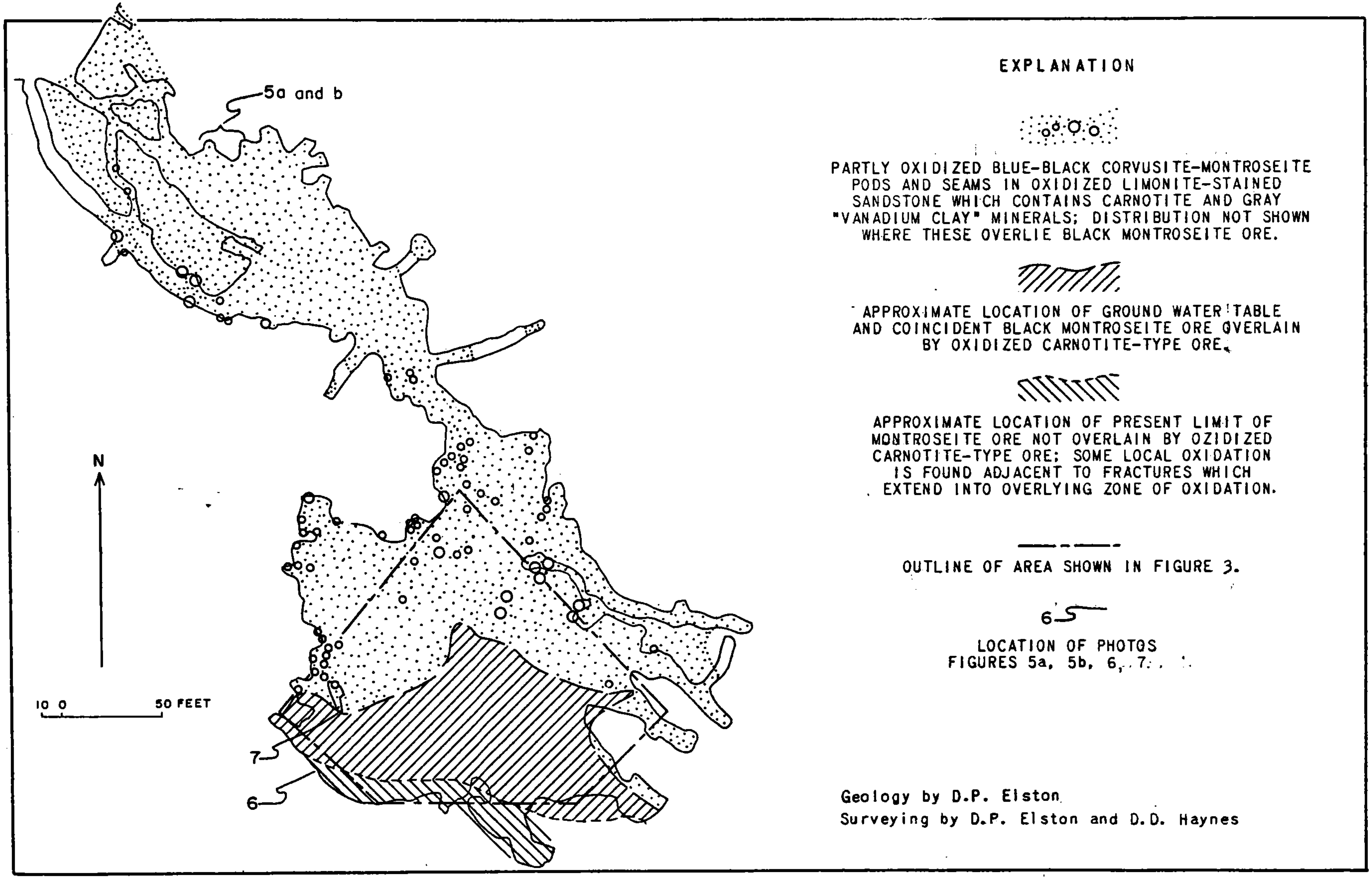

Figure 8. OUTLINE MAP SHOWING LOCATION OF ORE TYPES AND WATER TABLE, J.J. MINE, JO DANDY AREA, MONTROSE COUNTY, COLORADO.

high-valent minerals occur close to some through-going fractures. In oxidized ore, pods of unoxidized or partly oxidized ore occur where carbonaceous material has reduced oxidizing solutions or an impermeable area has prevented the oxidizing solutions from reaching the ore.

Unoxidized ore

Ore minerals of the black unoxidized ores are montroseite, uraninite, coffinite, and vanadium silicates. Quartz, calcite, gypsum, clay minerals, and barite are the major gangue minerals. Pyrite and marcasite are prominent locally. Galena and sphalerite occur sparsely distributed through the ore.

Characteristic microtextures of unoxidized ore show montroseite in intergranular areas either by filling or by replacement of the clay mineral matrix. A few specimens show corrosion of the quartz grains (fig. 9) and some show montroseite crystals penetrating silica overgrowth on the quartz grains (fig. 10).

Montroseite occurs typically as bladed crystals in radial arrangement. A few crystals show terminal faces; typically the ends are ragged or fibrous.

Uraninite and coffinite were studied in polished sections of organic material; uraninite with montroseite fills cell interiors and coffinite replaces cell walls. Where cell textures are obscure, coffinite occurs as fine dark shreds in a lighter-colored matrix (fig. 11). A few minute grains tentatively identified as uraninite were seen in sandstone.

All the organic material examined shows some indication of woody texture. Samples of organic material with low radioactivity are brownish black in color and contain small amounts of metallic minerals. Samples of

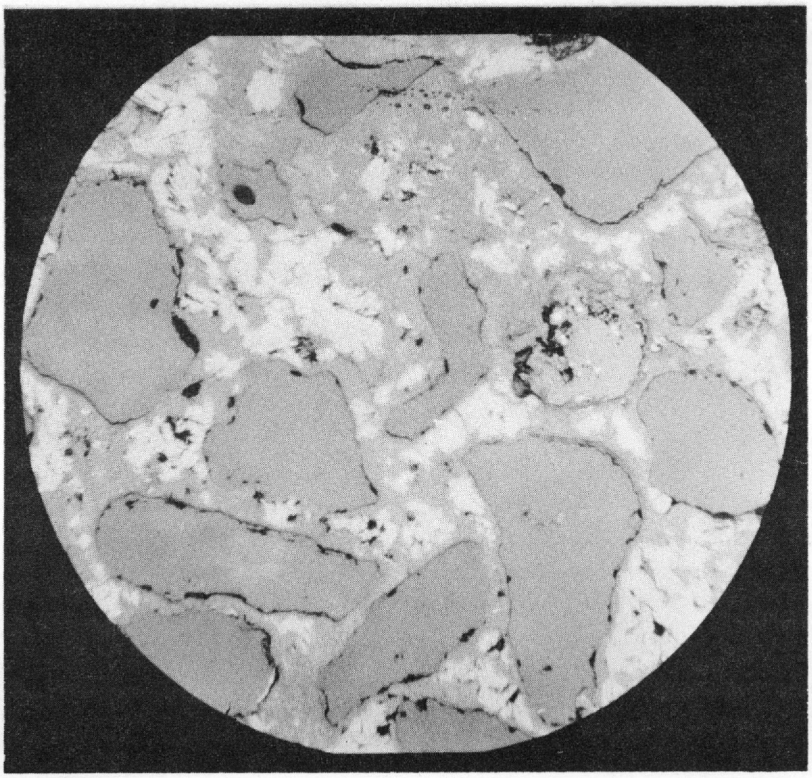

Figure 9. Corroded quartz grains (dark gray) surrounded by clay (gray) with montroseite crystals (white). (Black are pits in section.) Polished section, 470X, plain light, green filter.

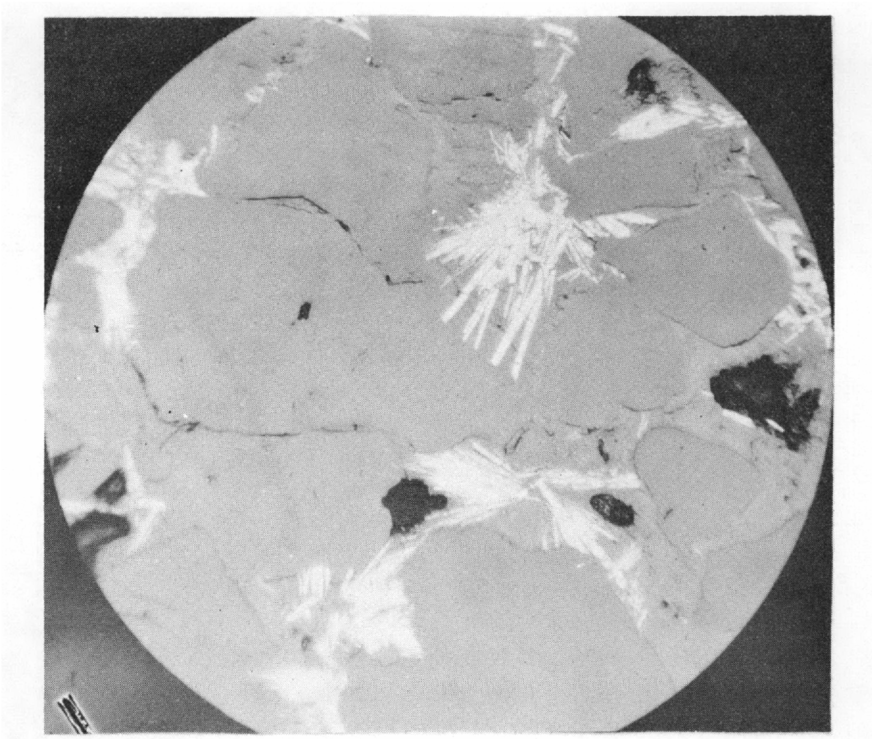

Figure 10. Montroseite crystals (white) penetrating quartz overgrowths (gray). Clay and quartz are same shade of gray. (Black are pits in section.) Polished section, 165X, plain light, green filter.

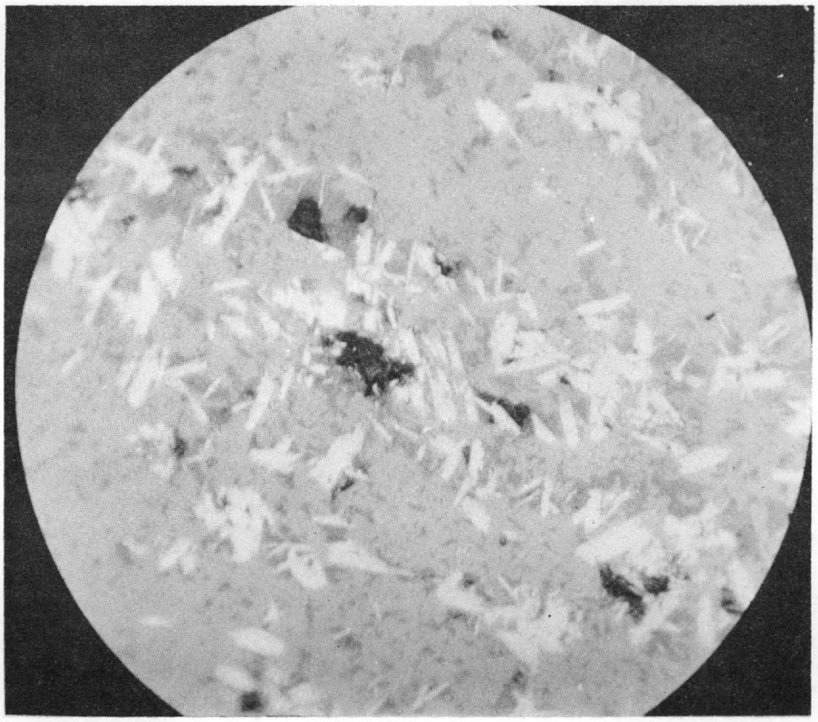

Figure 11. Montroseite (white) in organic material (gray) with coffinite (dark gray). (Black are pits in section.) Polished section, 470X, plain light, green filter.

organic material with high radioactivity are black, and contain a larger amount of metallic minerals. Under the reflecting microscope, the brownish-black material is gray and isotropic; the black material is olive tan and strongly anisotropic.

Overgrowths on quartz grains are common, and in areas a few millimeters across, the rock type approaches a quartzite. Partial crystal outlines are common.

Partly oxidized ore

Partly oxidized ore as it occurs in the mine is a mixture of low-, intermediate-, and high-valent minerals. The chief vanadium minerals of this stage is corvusite which gives the ore a blue-black color. Uranium occurs in uraninite and coffinite as relicts of unoxidized ore, and in carnotite and tyuyamunite where some oxidation has occurred. Accessory vanadium minerals are melanovanadite and other vanadate minerals. Gangue minerals are limonite, native selenium (rare), and gypsum. Some sulfides, such as pyrite, may remain from the primary ore.

Many of the textures of unoxidized ore are retained in the partly oxidized ore. Shreds and corroded fragments of montroseite remain in the clay matrix; carbonized wood is apparently not changed by oxidation. Carnotite and tyuyamunite occur in sandstone as disseminations and seams.

Oxidized ore

Carnotite and tyuyamunite are the major uranium minerals in oxidized ore; the major vanadium minerals are vanadium silicates. Common gangue minerals are gypsum and limonite. A small amount of hewettite occurs disseminated in seams.

Oxidized ore is primarily an intergranular filling. Seams of the bright yellow uranyl vanadates are conspicuous, but most of the ore minerals are disseminated through the sandstone.

Paragenesis

Paragenesis of the ore and gangue minerals is shown in outline form in table 2. The minerals of each stage are approximately contemporaneous; minerals of an early stage may persist into a later stage. No textural evidence was found to indicate any separation in time of emplacement of the low-valent uranium and vanadium minerals. Some minerals such as pyrite and gypsum may have formed in several stages.

Oxidation of ore

The ore minerals were originally distributed as spotted and streaked disseminations in sandstone, as local high-grade zones or bands in sandstone, and as pods or irregular masses of high-grade ore associated with carbonaceous material.

Spotted and streaked montroseite-type ore oxidizes from black through varying stages of gray, to a light- and dark-gray colored ore faintly speckled with carnotite. This sequence can be observed in a

Table 2. Paragenesis of the ore and gangue minerals in the J. J. mine, Jo Dandy area, Montrose County, Colorado.

Paragenetic stage		Mineral	Mode of occurrence
Sedimentary	1	quartz feldspar clay minerals carbonaceous material	detrital minerals, sand grains, and intergranular material
Diagenetic	2	gypsum calcite	as cements and intergranular material
		quartz	overgrowths on quartz grains
		pyrite	as disseminated grains, replacing wood
Mineralization	3	montroseite	as crystals in intergranular material, in cells in wood, in quartz overgrowths
		vanadium silicates	in intergranular area
		uraninite	in carbonaceous (woody) material, in wood cells
		coffinite	in carbonaceous (woody) material, in cell walls
		sulfides	disseminated and massive, replacing wood, quartz, and in intergranular space
Partly oxidized	4	corvusite	disseminated, in seams, massive
		melanovanadite	rosettes in veins (rare)
		new vanadate minerals	surrounding quartz and other vanadium minerals, in fine-grained irregular masses (rare)
		native selenium	disseminated, banding (rare)
		limonite	disseminated, replacing pyrite or marcasite
Oxidized	5	carnotite tyuyamunite	coatings on fractures, veins, disseminated in sandstone
		gypsum hewettite	crusts, veins, disseminated in sandstone

vertical space of about 10 feet at places in the mine where stoping has intersected the ground water table. The gross physical appearance of such spotted and streaked disseminations is not changed by oxidation.

Blue-black corvusite ore is not megascopically apparent where disseminated ore minerals have been oxidized. If a corvusite stage does form during oxidation of all montroseite-type ore, it may be short lived and megascopically inconspicuous in places where the ore minerals are disseminated in sandstone.

Blue-black corvusite pods, masses, and seams are distributed through the oxidized light-gray carnotite-vanadium clay part of the mine (fig. 8). The pods contain corvusite, montroseite, pyrite, marcasite, and carbon. These are the little or partly oxidized equivalents of black high-grade montroseite pods and seams of ore which have been protected from rapid oxidation by a combination of physical and chemical means. Oxidation proceeds slowly within these pods and the change from a black to a blue black is coupled with a decrease of montroseite and an increase of corvusite. A thin disseminated red to red-brown band is formed adjacent to the main mass of the montroseite; outside of this is a thin diffuse band of native selenium and outside of this a yellow zone. Further oxidation causes removal of the native selenium and the unidentified red band. Vestiges of these pods are represented by high-grade pods of carnotite developed when the uranium and vanadium are oxidized to U^{+6} and V^{+5}.

CONCLUSIONS

In the J. J. mine sedimentary structures have, in many places, influenced the detailed configuration of the ore and are probably the cause of the gross localization of the ore. The permeability and the variation in permeability are the major controlling features of the sedimentary structures. Fractures show no controlling relation to ore. Carbonized wood has caused deposition of rich ore where mineralizing solutions have had access to the carbon.

The ore was deposited as low-valence oxides and silicates of uranium and vanadium. Oxidation by ground water has caused the present distribution of minerals. The carnotite assemblage is in the oxidized zone and the montroseite assemblage is in the unoxidized zone. Oxidation has caused no important change in either the gross or the detailed configuration of the ore, however, some minor redistribution of vanadium and uranium occurs during oxidation.

LITERATURE CITED

Cater, F. W., 1954, Geology of the Bull Canyon quadrangle, Colorado: U. S. Geol. Survey Geol. Quadrangle Map GQ 33.

Fischer, R. P., 1942, Vanadium deposits of Colorado and Utah: U. S. Geol. Survey Bull. 936-P.

Fischer, R. P., and Hilpert, L. S., 1952, Geology of the Uravan mineral belt: U. S. Geol. Survey Bull. 988-A.

Knight, S. H., 1929, The Fountain and Casper formations of the Laramie basin: Univ. Wyoming Pub. Sci., Geol., v. 1, p.56-74.

McKee, E. P., and Weir, G. W., 1952, Terminology for stratification and cross-stratification in sedimentary rock: Geol. Soc. America Bull., v. 64, p. 381-390.

Stieff, L. R., Stern, T. W., and Sherwood, A. M., 1955, Preliminary description of coffinite--a new mineral: Science, v. 121, p. 608-609.

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, Tech. Inf. Service, Oak Ridge, Tenn.

Weeks, A. D., and Thompson, M. E., 1954, Identification and occurrence of uranium and vanadium minerals from the Colorado Plateau: U. S. Geol. Survey Bull. 1009-B.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COLORADO PLATEAU
TRACE ELEMENTS INVESTIGATIONS REPORT 518
SEPTEMBER 1955

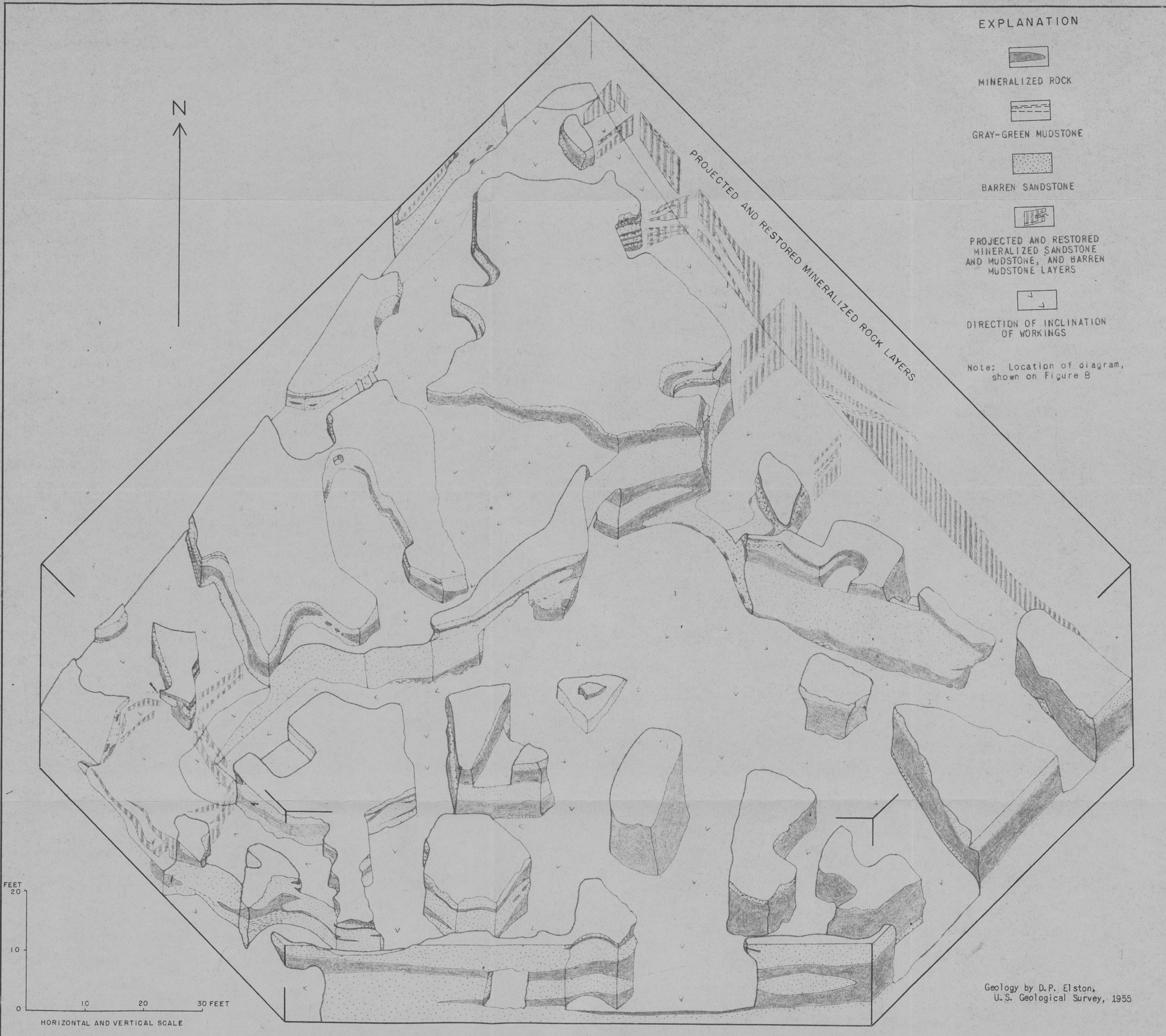

Figure 3. BLOCK DIAGRAM SHOWING THE INTERRELATION OF MINERALIZED LAYERS IN PART OF THE J.J. MINE, JO DANDY AREA, MONTROSE COUNTY, COLORADO

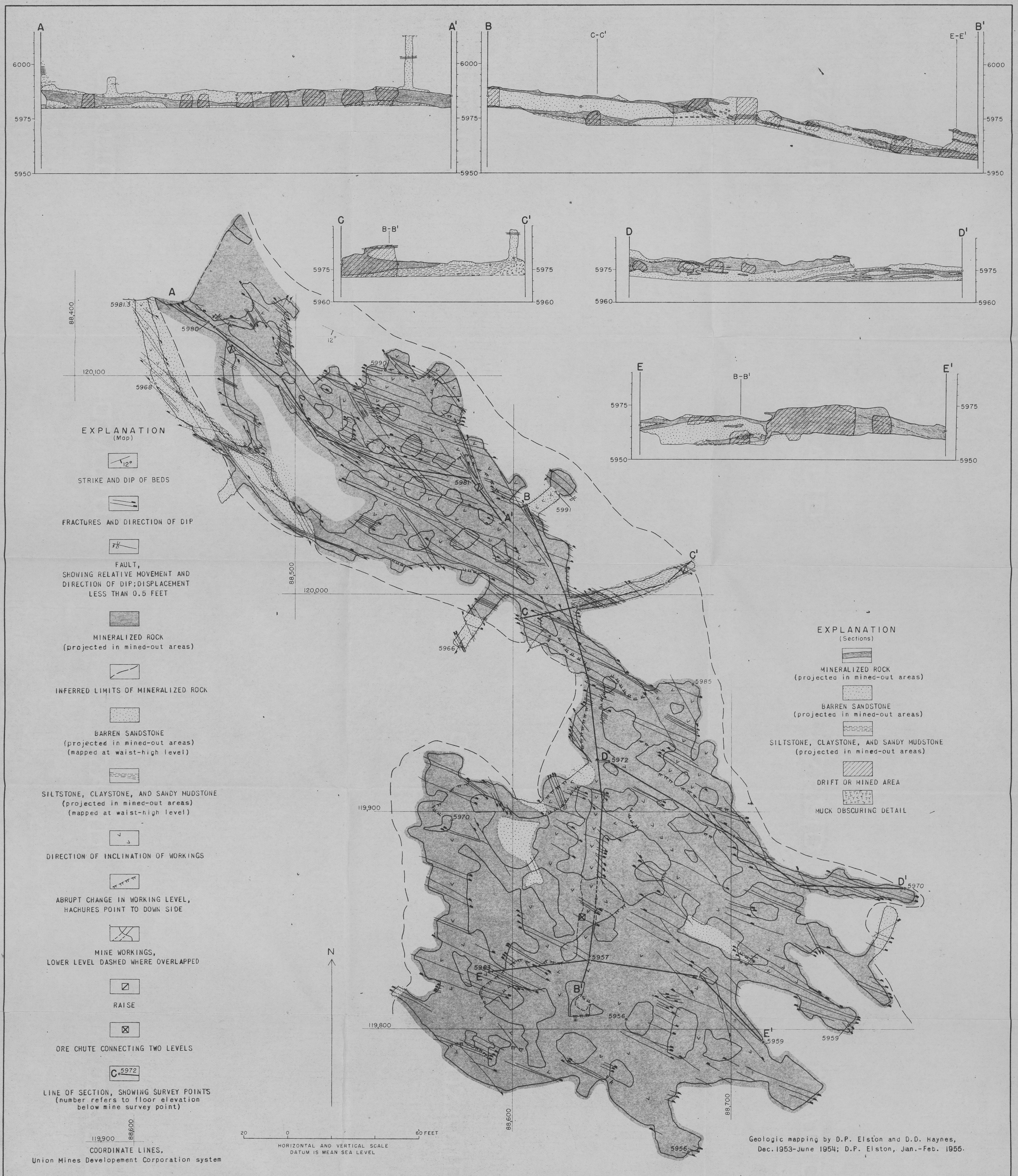

Figure 2. GEOLOGIC MAP AND SECTIONS OF THE J. J. MINE, JO DANDY AREA, MONTROSE COUNTY, COLORADO.