Maps of the Underground Workings, Monument No. 2 Mine, Apache County, Arizona

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with a text by
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Interpretations and conclusions in this report are those of the consultant and do not necessarily coincide with those of the staff of the Arizona Geological Survey

This report is preliminary and has not been edited or reviewed for conformity with Arizona Geological Survey standards

MAPS OF THE UNDERGROUND WORKINGS, MONUMENT NO. 2 MINE, APACHE COUNTY, ARIZONA

INTRODUCTION

The maps in this report were recently located in a plain brown envelope in a flat map file at the U.S. Department of Energy (DOE) complex at Grand Junction, Colorado. As the DOE has no use for these maps they were given to Chenoweth to donate to the Arizona Geological Survey.

During 1953 and 1954 the underground mine workings of the Monument No. 2 mine were mapped by C.Clair Gregg and Charles S. Evensen, geologists with the Grand Junction office of the U.S. Atomic Energy Commission (AEC). Their work was under the supervision of Thomas W. Mitcham, District Geologist. Maps of four other mines near Mounment No. 2 were also made by other AEC geologists, but no geology was shown. The maps are of historical value as the underground workings were later destroyed by open-pit mining at the property.

LOCATION

The Monument No. 2 mine is located on the Navajo Indian Reservation in the extreme northwestern corner of Apache County, Arizona. The mine is in Cane Valley on the eastern flank of the Monument Uplift. The original access to the mine was via a 19 mile dirt road that headed south from the Mexican Hat - Kayenta Indian Service road (now U.S. Highway 163) one mile southwest of Mexican Hat Utah. Another access road went from the mine, over Comb Ridge and connected with the Shiprock - Kayenta Indian Service road (now U.S. Highway 160) near Mexican Water, Arizona. Both these access roads were improved with AEC funding beginning in 1952 (Chenoweth, 1989).

GEOLOGIC SETTING

The Monument No. 2 ore deposit is in the basal Shinarump Member of the Triassic Chinle Formation. The Shinarump here is unusually thick, filling a large and deep erosional depression in the underlying Moenkopi Formation and, at the deepest point, extending down through the Moenkopi to the Permian De Chelly Sandstone. The "paleochannel" or "scour," apparently with closed ends, extends at least 2 miles along the axis of a wider depression. The wider depression is about 3 miles wide and 50 feet deep; the narrower, inner scour is about 30 feet deeper and about 700 wide.

The host rock is "trashy," cross-bedded, conglomeratic sandstone, containing considerable clay and fossil wood. The wood is partly carbonized, but much has been replaced by silica, tyuyamunite, limonite or uraninite.

Generally the ore minerals fill interstices in the sandstone, and coat pebbles and fractures, but the richest concentrations are in elongate, horizontal, flattened

cylindrical "rods," up to 8 feet in diameter and in places more than 100 feet long. Rims of the rods are cemented with limonite around an inner rim of sandstone impregnated with tyuyamunite; the sandstone core generaly appears structureless, or much less distinctly cross-bedded than the enclosing sandstone. The rods are aligned approximately parallel to the N18°W trend of the scour.

Ore occurs at various horizons in the Shinarump, and also extends as much as 7 feet down into the De Chelly Sandstone where this unit is in contact with the Shinarump. The original exposures on both the north and south sides of the Main Ridge gave but slight indication of the large amount of uranium-vanadium ore contained in the channel.

The principal ore minerals are tyuyamunite and carnotite; others include the oxides montroseite, uraninite, navajoite and the hydrous oxides becquerelite and fourmarieite; the vanadates rauvite, volborthite, steigerite, hewettite and corvusite; the silicate uranophane; the phosphate torbernite; and the arsenate metazeunerite. For additional details on the ore occurences and mineralogy the reader is referred to a report by Witkind and Thaden (1963).

HISTORICAL SUMMARY

Luke Yazzie discovered carnotite mineralization southeast of Yazzie Mesa in the eastern part of Monument Valley in 1942 (Figure 1). He told Harry Goulding, a local trader, of this discovery, and he in turn contacted the Vanadium Corporation of America (VCA). As news of this discovery spread other firms and individuals examined the area (Witkind and Thaden, 1963, p. 68-69).

As a result of interest in the area, the Office of Indian Affairs advertised an exploration lease sale for carnotite and related minerals on July 21, 1943. The area in Apache County, Arizona, was described as follows: "beginning at a point south 32°28' east, 28,949.78 feet from mile post 227 on the Utah-Arizona line and running thence north 25°00' east one mile; thence east one and one quarter miles; thence south 25°00' west one mile; thence south one and one quarter miles; thence west one and one quarter miles; thence north one and one quarter miles to the point of beginning, containing approximately 1,845 acres."

Bids were opened on August 3, 1943, with the only bidder being VCA, with a bonus bid of $3,000.00 (GSA, 1981, exhibit 43). At the same time as the Monument Valley lease sale, another sale was being held for some 168 square miles in the northern and western Carrizo Mountains. Vanadium companies such as Wade, Curran and Company and United States Vanadium Company apparently were more interested in the carnotite deposits in the Morrison Formation of the Carrizo Mountains than in the deposits in the Shinarump conglomerate in Monument Valley.

Lease I-149-IND-6204 with VCA was executed on August 6, 1943, effective September 23, 1943, for a period of ten years. The lease was named Monument No. 2 by VCA.

On March 6, 1944, the exploration lease was reduced to a permanent oper-

ating lease with two plots (claims) totalling 42.09 acres selected to be retained. Plot 1, about 39 acres covered the mineralized Shinarump channel on the Main Ridge, and Plot 2, about 3 acres, covered the projection of the channel on South Ridge (Figure 2).

Ore shipments to the Metal Reserve Company's mill at Monticello, Utah, began in October, 1943, and continued until April, 1944. Later shipments were recorded in February and December, 1945, and in January 1946, at which time VCA operted the Monticello mill.

During the interval of the 28 months the mine was active, a total of 489 tons of ore containing 13,737 pounds of V_2O_5 were mined from mineralized outcrops on the lease (GSA, 1981). Chenoweth (1988) has estimated that the ore contained some 3,271 pounds U_3O_8, much of which was recovered by the U.S. Army Corps of Engineers for the Manhattan Project.

Mining at the Monument No.2 lease resumed in October 1947 under the AEC's uranium procurement program. The ore was originally trucked to the company's mill at Naturita, Colorado, a distance of about 185 miles. Some shipments were made to the AEC ore-buying at Monticello, Utah only 87 miles away. Some shipments in 1949 and 1950 were made to the company's mill in Durango, Colorado. By 1951 all ore was shipped to Durango via the Comb Ridge-Shiprock route, a distance of 176 miles.

The early underground mining was very selective and VCA was able to maintain a shipping grade of at least 0.40% U_3O_8 and 1.50% V_2O_5 through the early 1950's. (AEC, unpublished records). Eleven separate underground mines were developed on the Main Ridge and a single mine operated on South Ridge (Figure 1).

About 1950, in response to the developing uranium boom, the Navajo Tribal Council adopted a series of resolution dealing with uranium which were approved by the Commissioner of Indian Affairs. These resolutions developed regulations for prospecting and mining permits, mining leases, and royalty schedules. All prospectors needed to obtain permits for prospecting. Mining permits were granted to only Navajos who could then assign them to non-Navajos. Mining leases were no longer the subject of competitive bidding, but were negotiated with the Tribal Council, subject to approval of the Bureau of Indian Affiars. As a result of these new rules, several Navajos obtained mining permits on the land contiguous with VCA's lease (Table 1). Several mines were developed on these permits (Figure 1). The largest was Cato Sells Tract 1 North, which was operated by Climax Uranium Company of Grand Junction, Colorado (Table 2).

Drilling by the AEC in the vicinity of the Monument No. 2 mine during 1951 and 1952 located considerable ore on Cato Sells' Tract 1 on the Main Ridge and on the South Ridge. Smaller amounts of ore were found on Yazzie and Clani's mining permit on Yazzie Mesa and on VCA's lease on the Main Ridge (Chester and Donnerstag, 1952). All of this ore would be mined in the next few years.

In late 1953, VCA began stripping the area of the North Workings (Figure 1) and by 1954 the entire Main Ridge was converted to an open-pit mine and,

except for a few truckloads per week of shipping grade ore, the mine production ranged in grade from 0.04 to 0.09% U_3O_8 and 0.4 to 0.8% V_2O_5. This mine production was too low grade to ship to the Durango mill. Hence, VCA constructed a mechanical upgrader at the mine site. During the period of operation of the upgrader, from mid-1955 until June 1964, an estimated 1,100,000 tons of low grade mine production were fed to process. Feed grade ranged from 0.04 to 0.09% U_3O_8 and 0.4 to 0.8% V_2O_5. The upgrader operated at a feed rate of about 500 tons per day (tpd), although it is reported that at times the total feed rate exceeded 700 tpd. The product, a slime concentrate, conatined approximately 10% moisture, and assayed 0.25 to 0.30% U_3O_8 and 1.5 to 3.0% V_2O_5, depending on the millfeed grade. Production was 40 to 50 tons per day and an estimated total of 100,000 tons for the life of the upgrader. Recovery was estimated at about 60 % of both uranium and vanadium. The upgrader product (ore slimes) was shipped to the Durango mill until it shut down in March, 1963 and then to the Shiprock mill which VCA purchased from Kerr-McGee Oil Industries, Inc.

Prior to the shutdown of the upgrader, VCA determined that the upgrader sand tailings still contained sufficient values to warrant retreatment. Hence a second plant or concentrator, termed by VCA the "Upflow Batch Leach Plant," was constructed and commenced operation in October, 1964. It operated for three years and was shut down in November, 1967. The uranium and vandium product from the concentrator was shipped to the Shiprock mill.

In 1966, VCA began heap leaching low-grade ore at its Monument Valley operations. The uranium-vanadium precipitate from heap leaching was also processed in the Shiprock mill (Albrethsen and McGinley, 1982).

An estimated 1,100,000 tons of sand tailings and heap leach residues remain at the site. This material is scheduled for remedial action under the Uranium Mill Tailings Radiation Control Act of 1978.

VCA was merged into the Foote Mineral Company in August, 1967 and mining at Monument No. 2 continued until early 1968. The Shiprock mill was closed in April, 1968 as were all Foote mining operations on the Colorado Plateau, including Monument No. 2. A small clean-up shipment from the upgrader site was made to the Western Nuclear, Inc. mill at Jeffery City, Wyoming, in 1969.

Foote cancelled its lease in the early 1970's. When mining ceased, the open-pit on the Main Ridge was nearly 3,500 feet long, 900 feet wide, and averaged about 50 feet in depth. All of the uranium produced at the mine, and related facilities was purchased by the AEC. VCA and/or Foote found their own markets for most of the vanadium. The remainder was purchased by the AEC.

The original lease was modified on July 20, 1959 to include the adjacent mining permits of Cato Sells, Chee Nez, John M. Yazzie, Thomas Clani, Jessie Black, Harvey Blackwater, and Willie Waters (Table 1). The amended lease consisted of three parcels of land totalling 220.69 acres, with a parcel each being located on Yazzie Mesa, Main Ridge, and South Ridge (Figure 2). The amended lease would later be known as VCA's Mining Unit No. 66 for the AEC's allocation program that began in 1962.

Total production from the ammended lease (Mining Unit No. 66) was 773,132 tons of ore that averaged 0.34% U_3O_8 and 1.42% V_2O_5 and contained 5,276,093 pounds of U_3O_8 and 21,915,125 pounds V_2O_5 (AEC unpublished records). Included in these production statistics are products from a mechanical upgrader, a concentrator, and heap leaching which operated at various times at the mine site. The Monument No. 2 lease has produced more uranium than any other mine in Arizona.

It is interesting to note that a U.S. Geological Survey examination of the Monument No. 2 mine in April, 1948, reported that low-grade ore from the mine was being mechanically upgraded at a small plant on the bank of the San Juan River at the Mexican Hat bridge (GSA, 1981, exhibit 52). This upgrader no doubt was a prototype for the plant that began operating in 1955 at the mine site. A 1949 shipment of 676 tons of ore averaging 0.11% U_3O_8 and 0.71% V_2O_5 reported to the AEC as the Mexican Hat Stockpile may have been from the clean-up of this plant.

REFERENCES

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TABLE 1

NAVAJO TRIBAL MINING PERMITS ADJACENT TO VCA'S MONUMENT NO. 2 LEASE

Mine Name	Mining Permit No.	Acres	Permittee	Duration	Operator
Chee Nez No.1	189	11.60	Chee Nez	1955-57	Bee-Sho-Shee Mining Co.
John M. Yazzie No.1	37	11.64	John M. Yazzie & Thomas Clani	1951-54 1954-57	Clani and Yazzie Spencer Uranium Co.
Tract 1 North	55[1]	58.30	Cato Sells	1951-55 1955-58 1959	Climax Uranium Co. Uranium Reserve Co. Cato Sells
Tract 2	55	61.60	Cato Sells	1955, 1957-58	Cato Sells
Black and Blackwater	47	15.50	Jessie Black & Harvey Blackwater	1950-53 1953-54 1955-57	Black and Blackwater B.N. Byler and W.E. Pollack Mex-Air Uranium Co.
Tract 1 South	55	160.0	Cato Sells	1952-53 1953-54	Climax Uranium Co. Cato Sells
Willie Waters[2]	188	20.00	Willie Waters	1954-55	Bee-Sho-Shee Mining Co.

[1]Cato Sells' Mining Permit No. 55 contained three separate parcels totalling 135.9 acres.
[2]After Cato Sells cancelled the portion (160 acres) of Mining Permit No. 55 covering the South Ridge in 1954, Willie Waters then claimed the same 160 acres as Mining Permit No. 188. The area of the permit was later reduced to 20.00 acres.

Source: Unpublished records, U.S. Atomic Energy Commission, Grand Junction office.

TABLE 2

1950-59 PRODUCTION FROM MINES ADJACENT TO THE ORIGINAL MONUMENT NO.2 MINE, APACHE COUNTY, ARIZONA

Name[1]	Tons of Ore	Pounds U_3O_8	% U_3O_8	Pounds V_2O_5	% V_2O_5
Chee Nez No. 1	638	4,001	0.31	15,634	1.22
John M. Yazzie No.1[2]	2,559	17,664	0.40	40,701	0.79
Black & Blackwater[3]	5,450	32,766	0.30	126,265	1.16
Cato Sells					
Tract 1 North	17,958	104,156	0.29	423,809	1.18
Tract 2	295	1,770	0.30	2,891	0.49
Tract 1 South	8,049	64,392	0.40	244,690	1.52
Willie Waters[4]	1,990	9,163	0.23	48,995	1.22
TOTALS	36,939	233,912	0.32	902,985	1.22

[1]See Figure 1 for locations.
[2]Includes 1955 production by Spencer Uranium Co. identified as Lease No. 1.
[3]Bureau of Indian Affairs records indicate a 1953 shipment called Marion, by Byler and Pollack, came from the Black and Blackwater mine, and is included here.
[4]The majority of ore credited to Willie Waters came from an open pit located 500 feet south of Cato Sells' Tract 1 South adit. Some ore also was produced as the result of clean-up mining in the underground workings of the former Tract 1 South mine.

Source: Unpublished records, U.S. Atomic Energy Commission, Grand Junction Office.

EXPLANATION OF MAP SYMBOLS
(for mapping by Gregg and Evensen)

Fractures

Dip of fracture

Cross-bedding direction

Mudstone Color

gy	Gray
gn	Green
blk	Black

Silicified fossil wood

Ore-filled rod

Foot of raise

Head of raise

Waste, surface

Waste, underground

Brunton compass survey point

Coordinate system arbitrarily established by the Vanadium Corporation of America.

SCALE 1"=40'

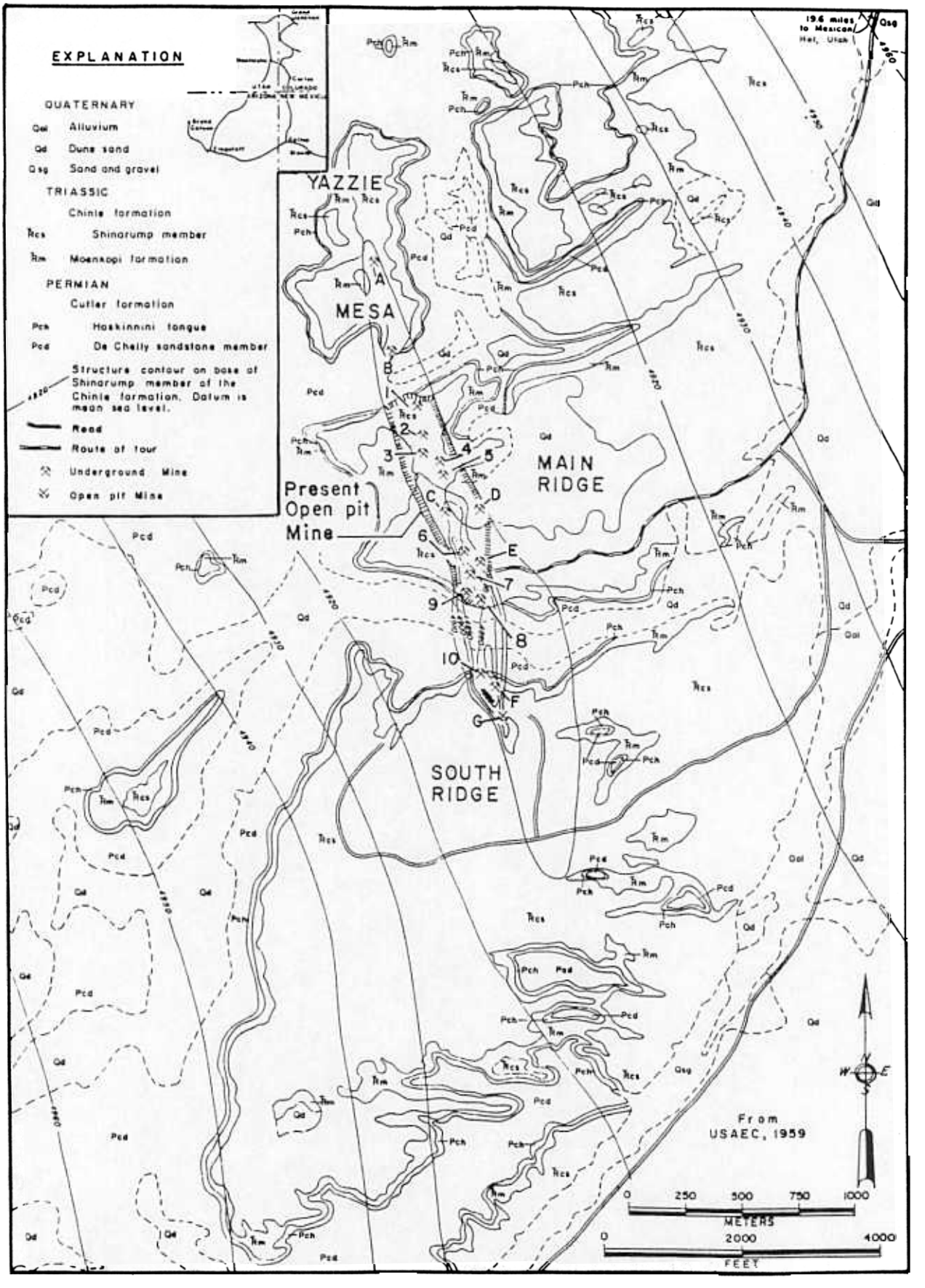


FIGURE 1, GEOLOGIC MAP OF THE AREA OF THE MONUMENT NO. 2 MINE SHOWING THE LOCATIONS OF THE EARLY UNDERGROUND MINES

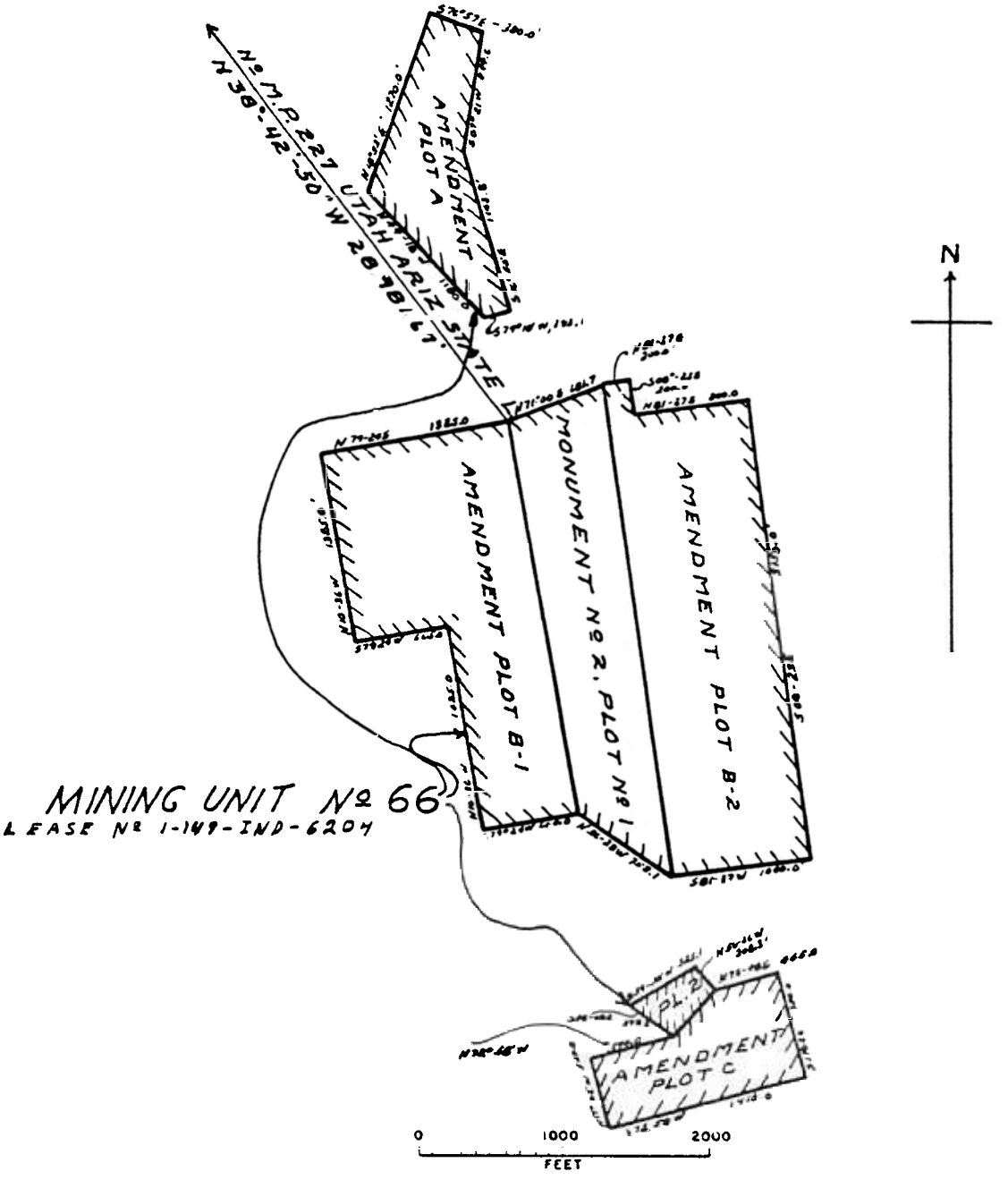
EXPLANATION FOR FIGURE 2

Plots of original operating lease:

Plot No. 1
Plot No. 2

Land originally covered by mining permits held by individual Navajos:

Plot A	-	Chee Nez, John M. Yazzie and Thomas Clani
Plot B-1	-	Cato Sells Tract 2
Plot B-2	-	Cato Sells Tract 1 North, Jessie Black and Harvey Blackwater
Plot C		Willie Waters



Mining unit boundary line

NOTE: Each mining unit is identified by its number and is defined as the volume within the vertical projection of the mining unit boundary lines as set forth on this map.

Location of Mining Unit

NAVAJO INDIAN RESERVATION

Section_____ T._____ R._____ M._____

County: Apache State: Arizona

FIGURE 2, MAP OF THE MONUMENT NO. 2 LEASE, AMENDED.

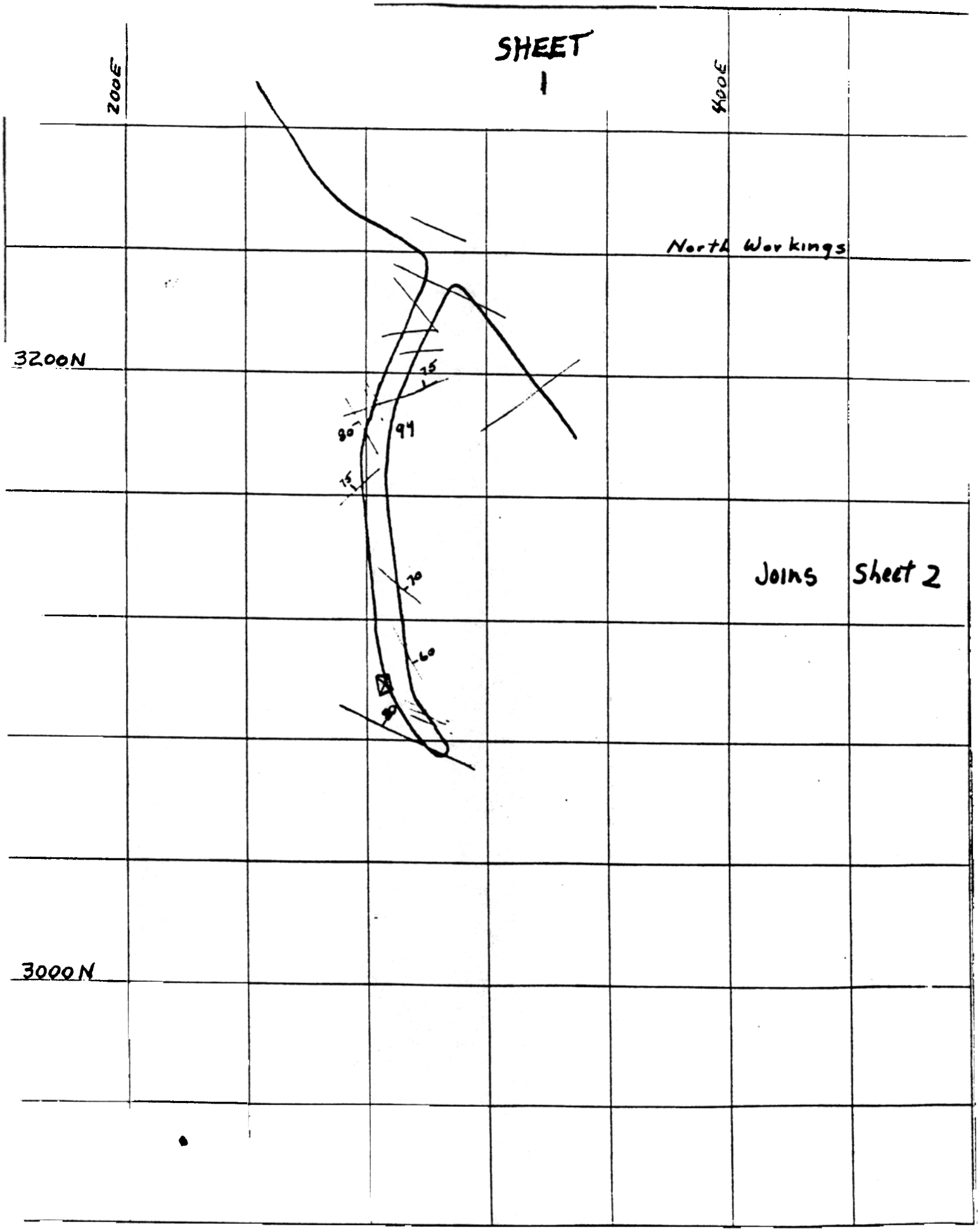
INDEX TO MINE MAPS[1]

Number on Figure 1	Name	Sheet No.[1]
1	North Workings	1, 2
2	North Drift	Not Mapped
3	West Red Oxide Workings	3,4
4	East & South Red Oxide Workings	5
5	Incline No. 3 & Central Workings	6
6	Incline No. 1	7, 8, 9, 10
7	Incline No. 2	15, 16, 17
8	South Workings	11, 12, 18
9	Bobcat Workings	13, 14
10	South Extension Workings	19

Mines Outside Original VCA Lease

A	Chee Nez No.1	Not Mapped
B	John M.Yazzie No. 1	21
C	Cato Sells Tract No. 2	22
D	Cato Sells Tract No. 1 North	Not Mapped
E	Black & Blackwater	23
F	Cato Sells Tract No. 1 South	19,20
G	Willie Water	Not Mapped

[1]Mine maps and sheet numbers refer to the mapping of Gregg and Evensen following Figure 2.



Monument No. 2 – sheet 1

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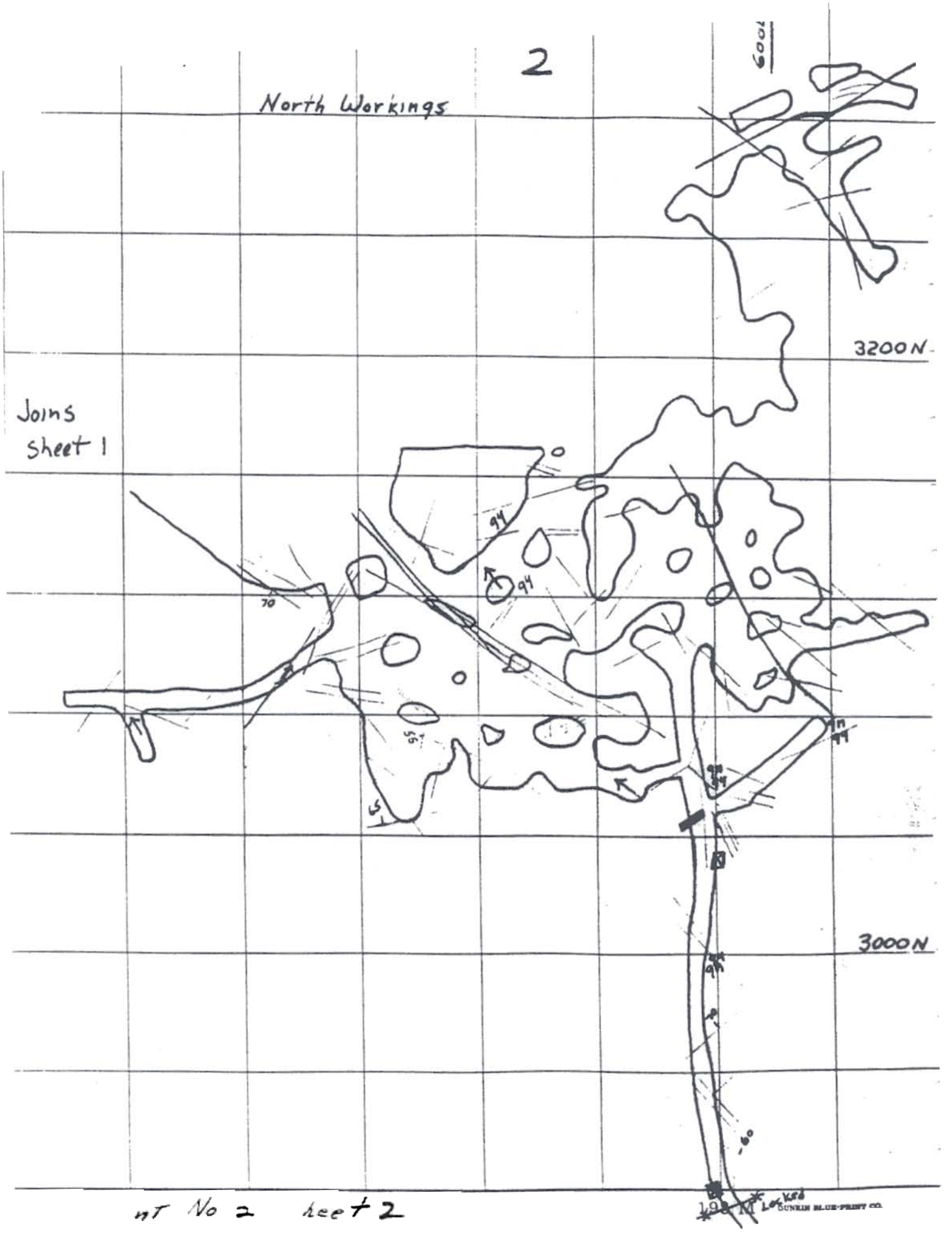


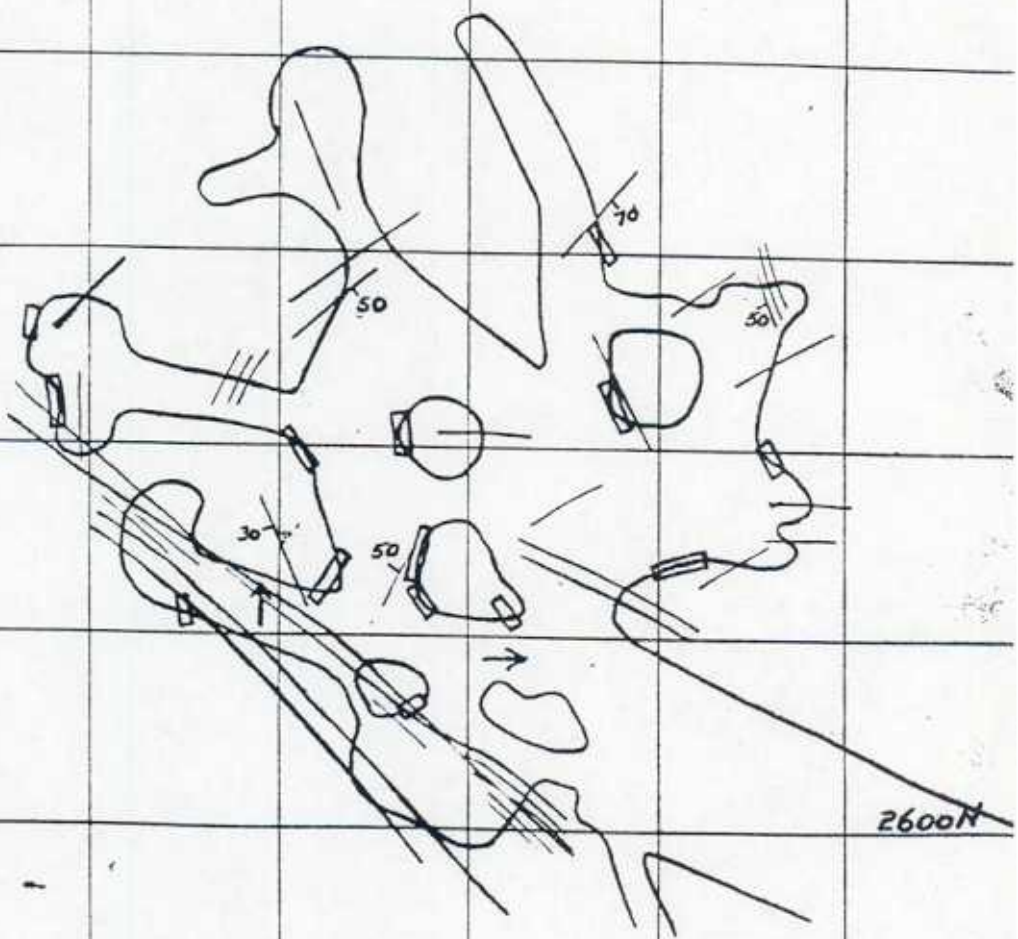
nT No 2 Sheet 2

SHEET 3

Incline #5

West Red Oxide Workings

2800 N



2600 N

Joins Sheet 4

200 E

400 E

Transcript No. 2 – Sheet 3

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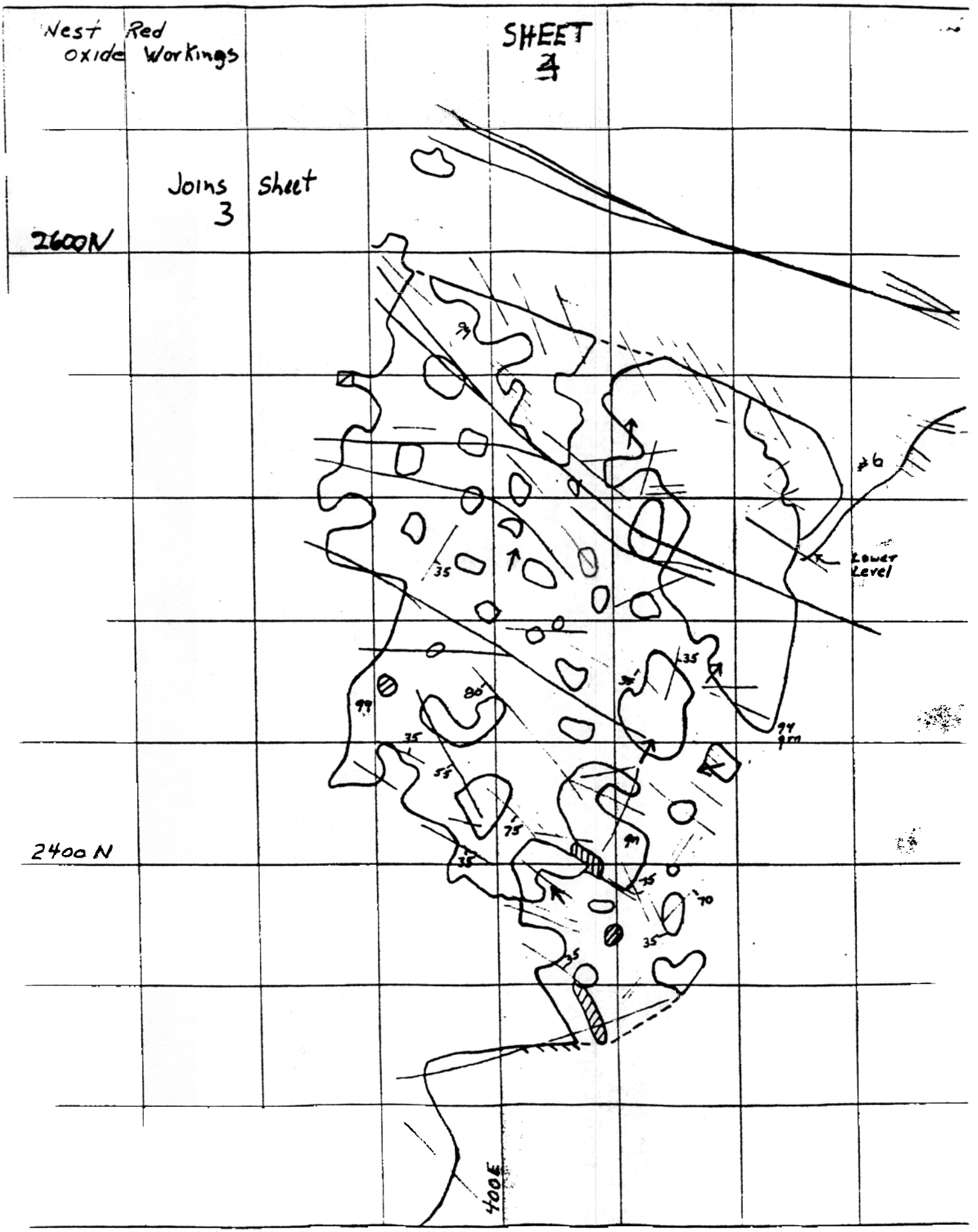

Monument No. 2 – sheet 4

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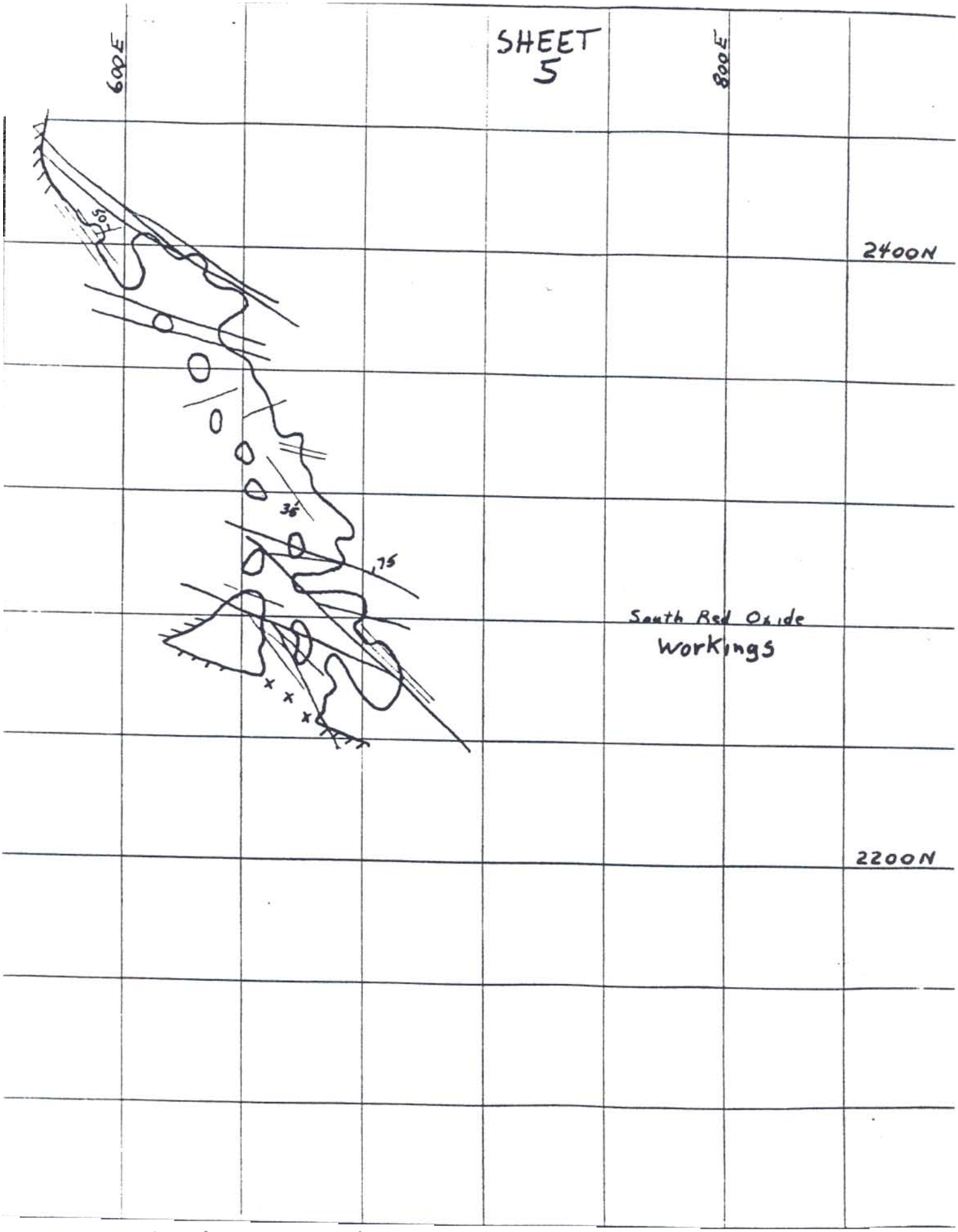
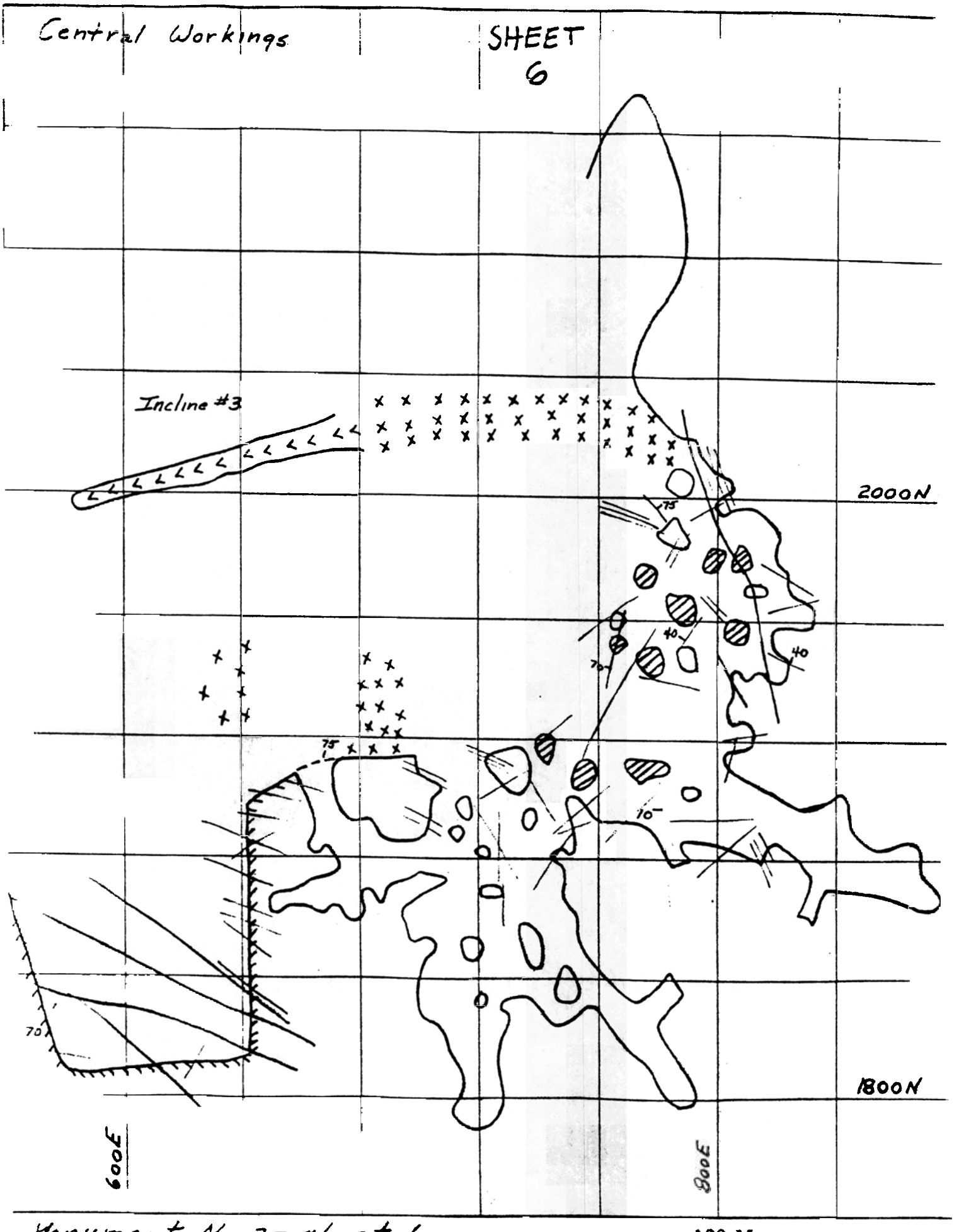

SHEET 5
600E
800E
2400N
2200N
50
36
75
South Red Oxide
Workings

m + No 2 – 4 + 5

M



Monument No. 2 - sheet 6

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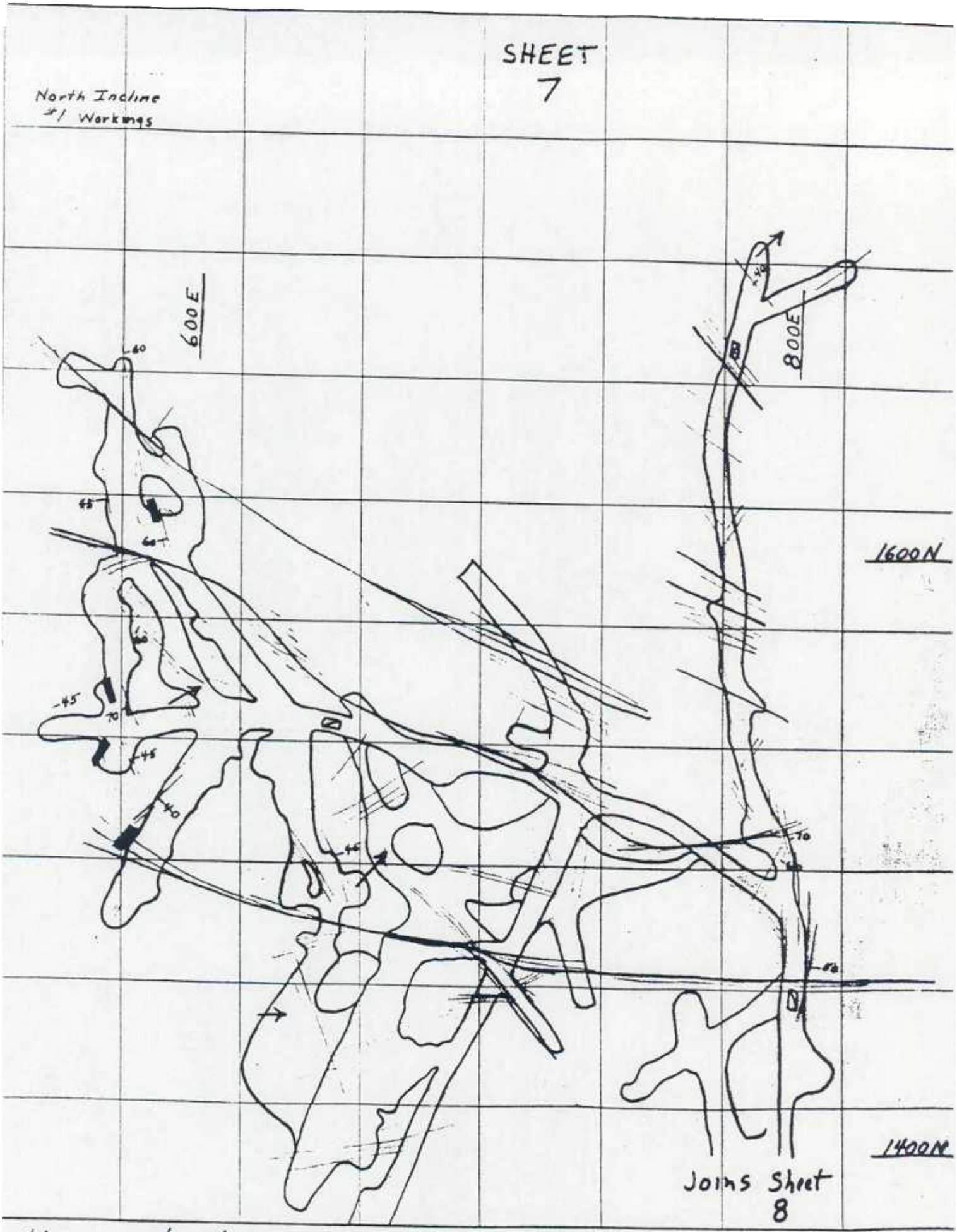

Monument No. 2 - sheet 7

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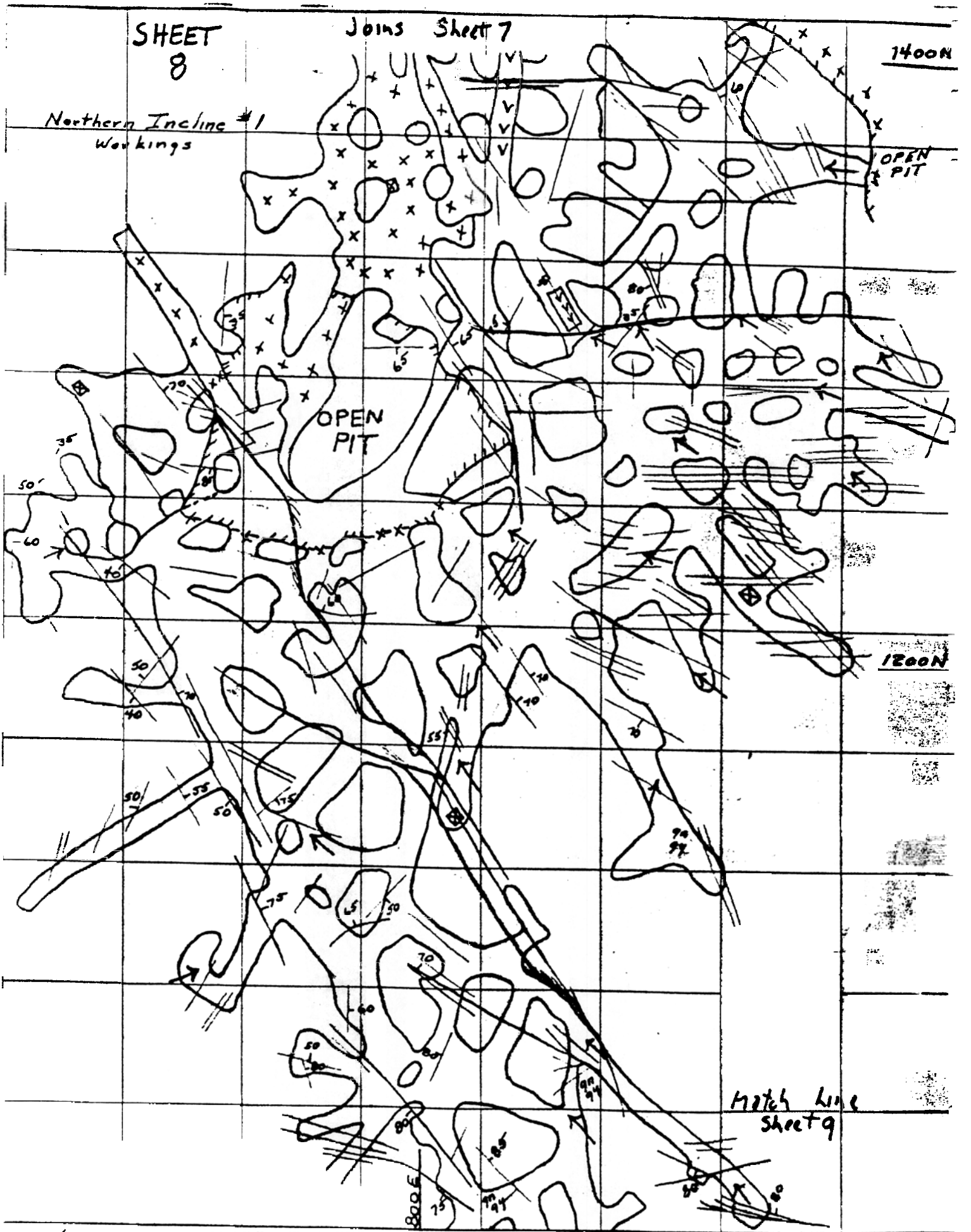
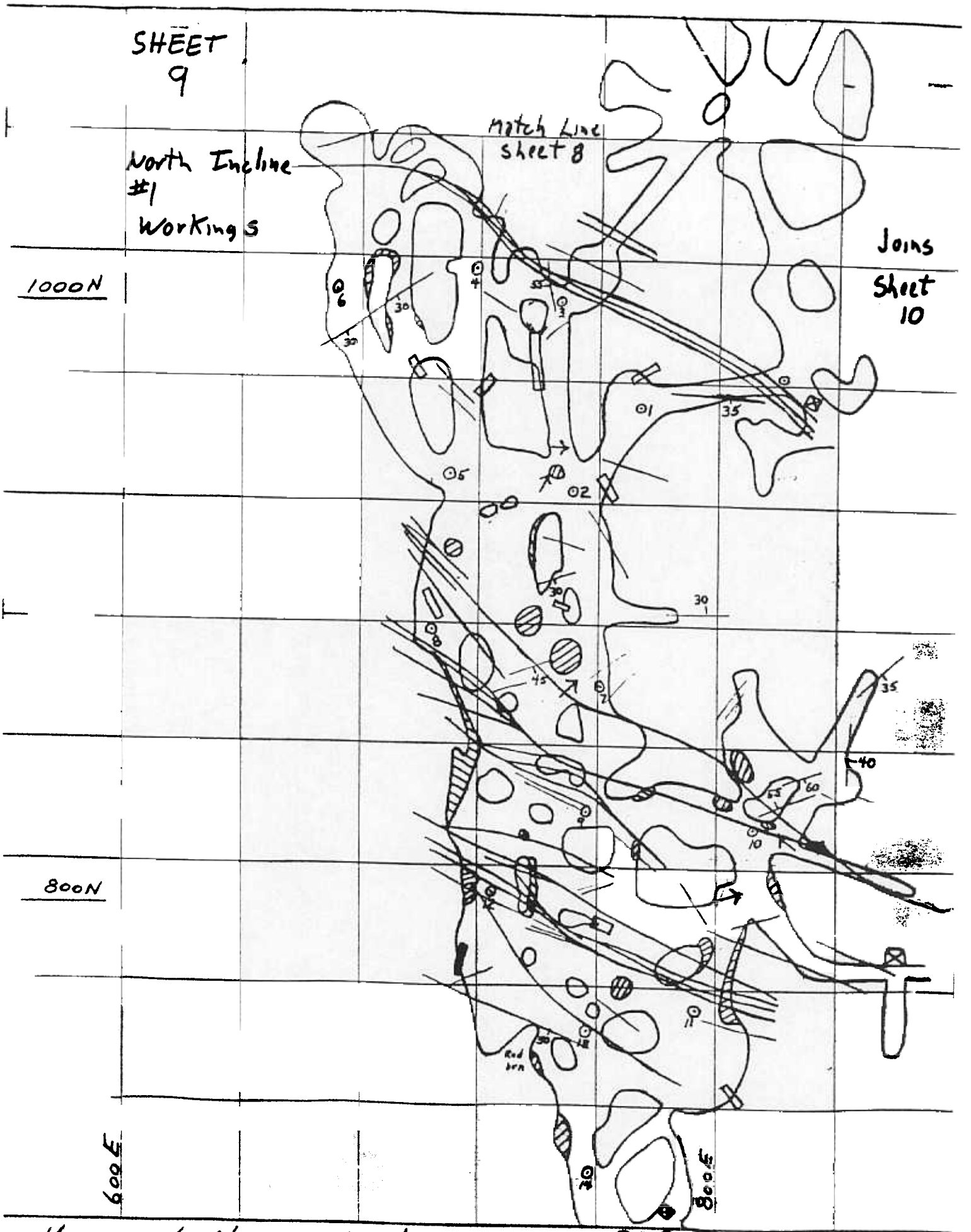
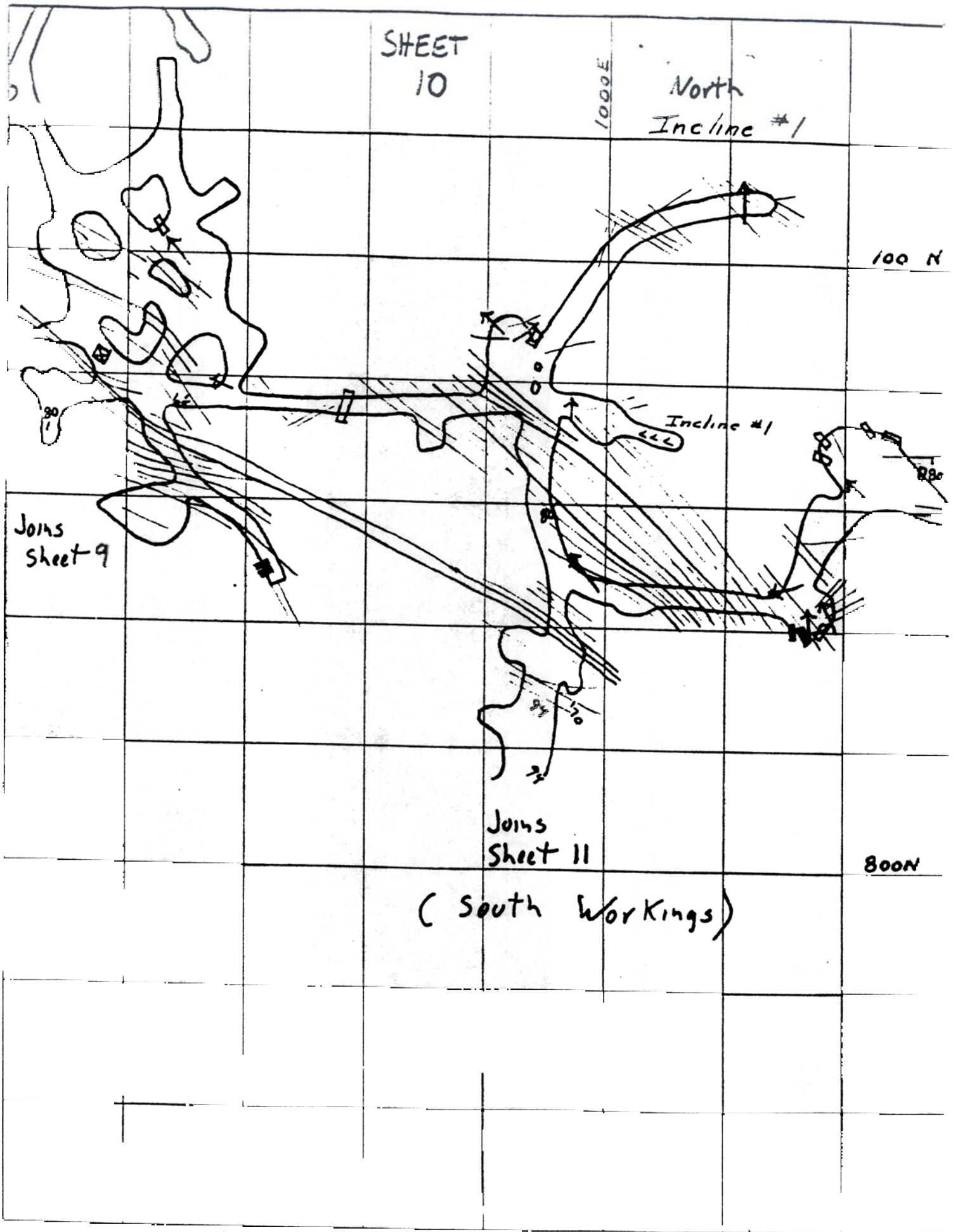


Monument No. 2 - Sheet 8

198 M

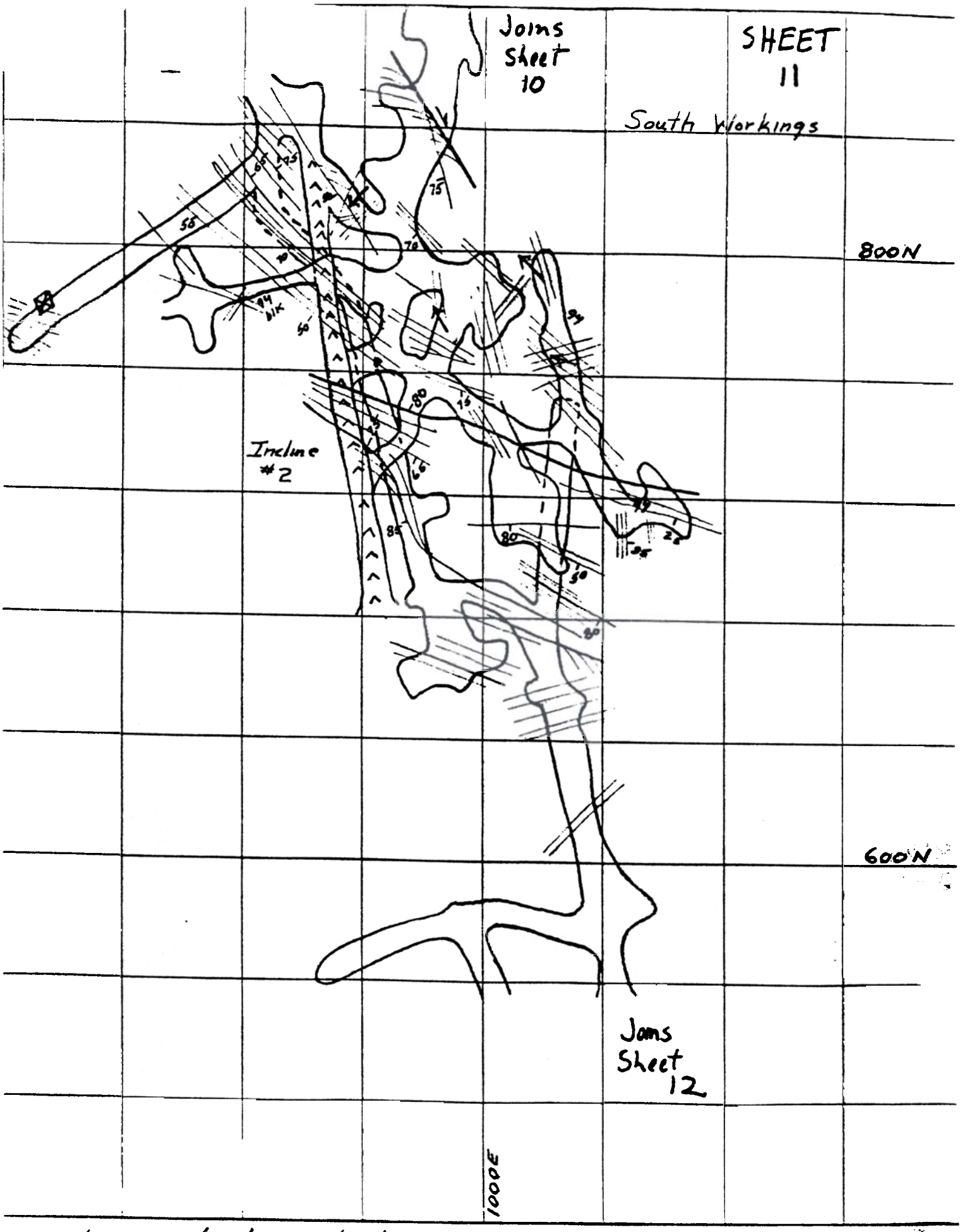


Monument No. 2 - sheet 9


SHEET
10
1000E
North
Incline #1
100 N
Incline #1
Joins
Sheet 9
Joins
Sheet 11
800N
(South Workings)

" nt No 2 6 + 0

M



Monument No 2 - sheet 11

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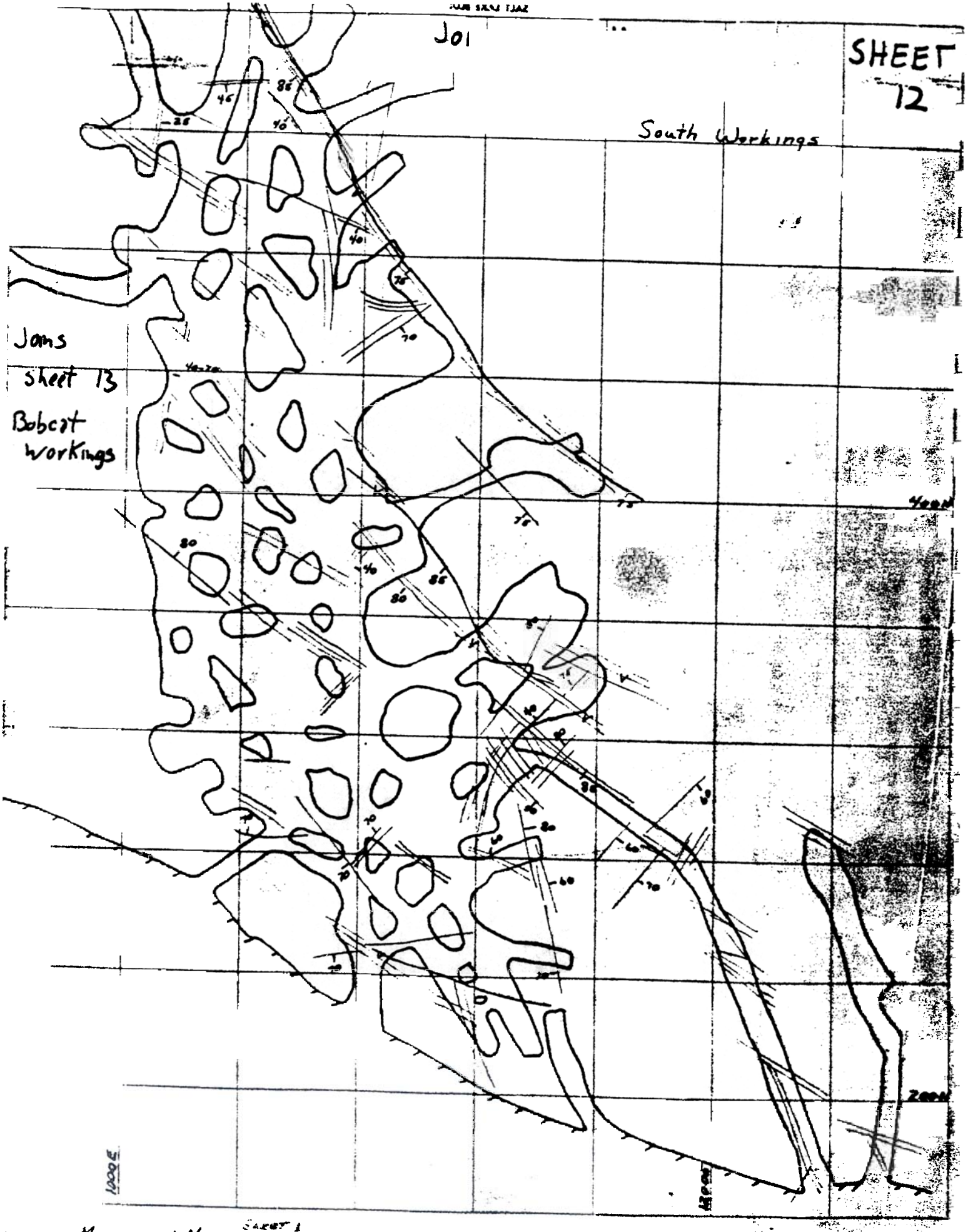


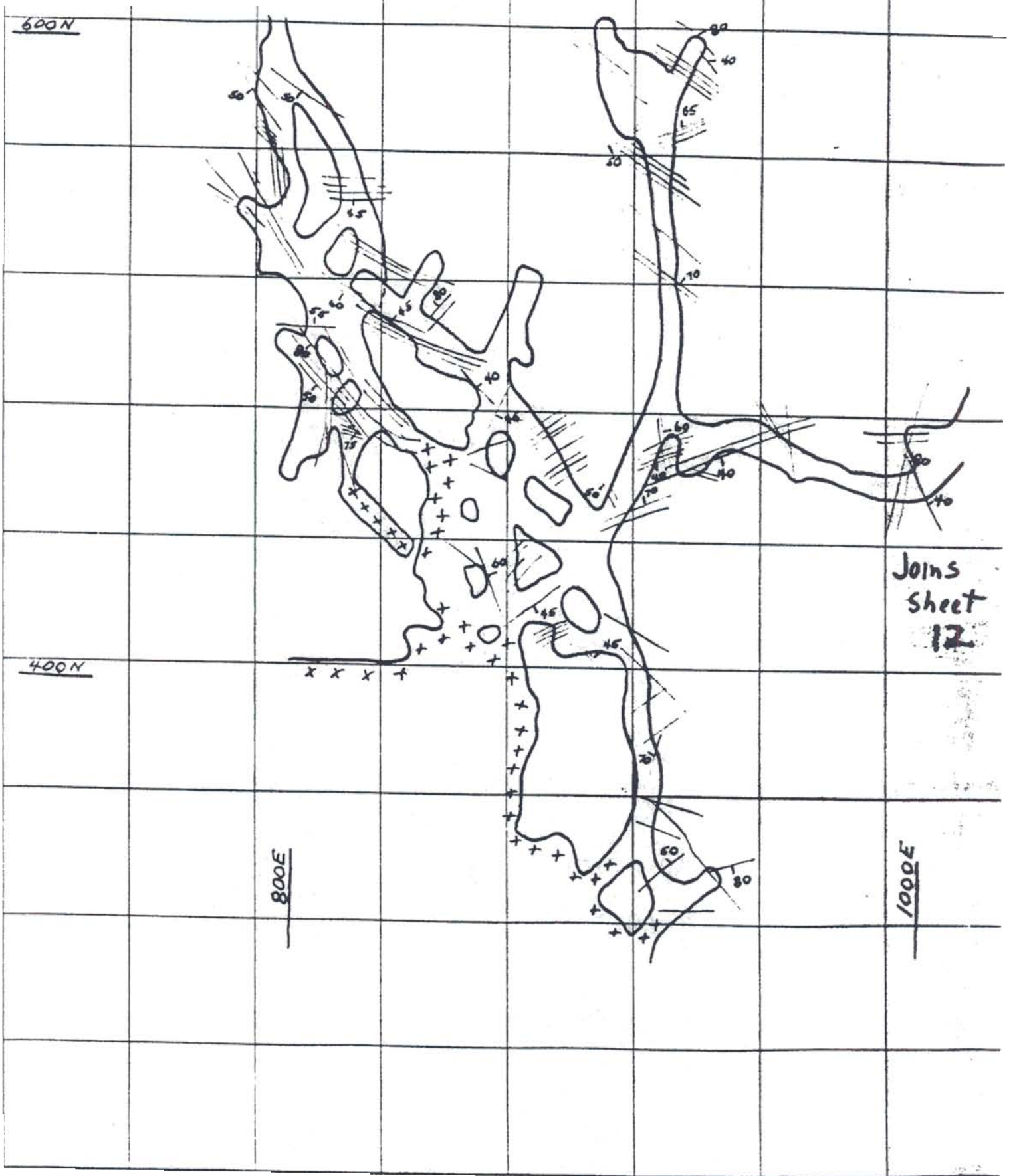
MINE Monument No. 2 LOCATION Monument Valley LEVEL Lower

GEOLOGY BY Mitelam, Evensen.

SHEET 3

Bobcat Workings

Joins Sheet 14



Document No. 2 sheet 13

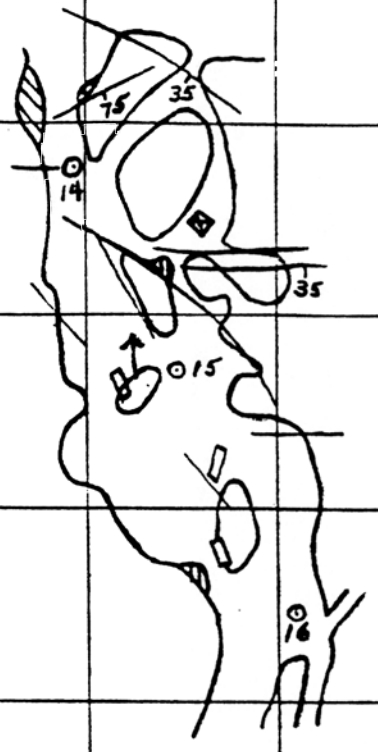
800N

600E

Upper Bobcat Workings

800E

SHEET 14



600N

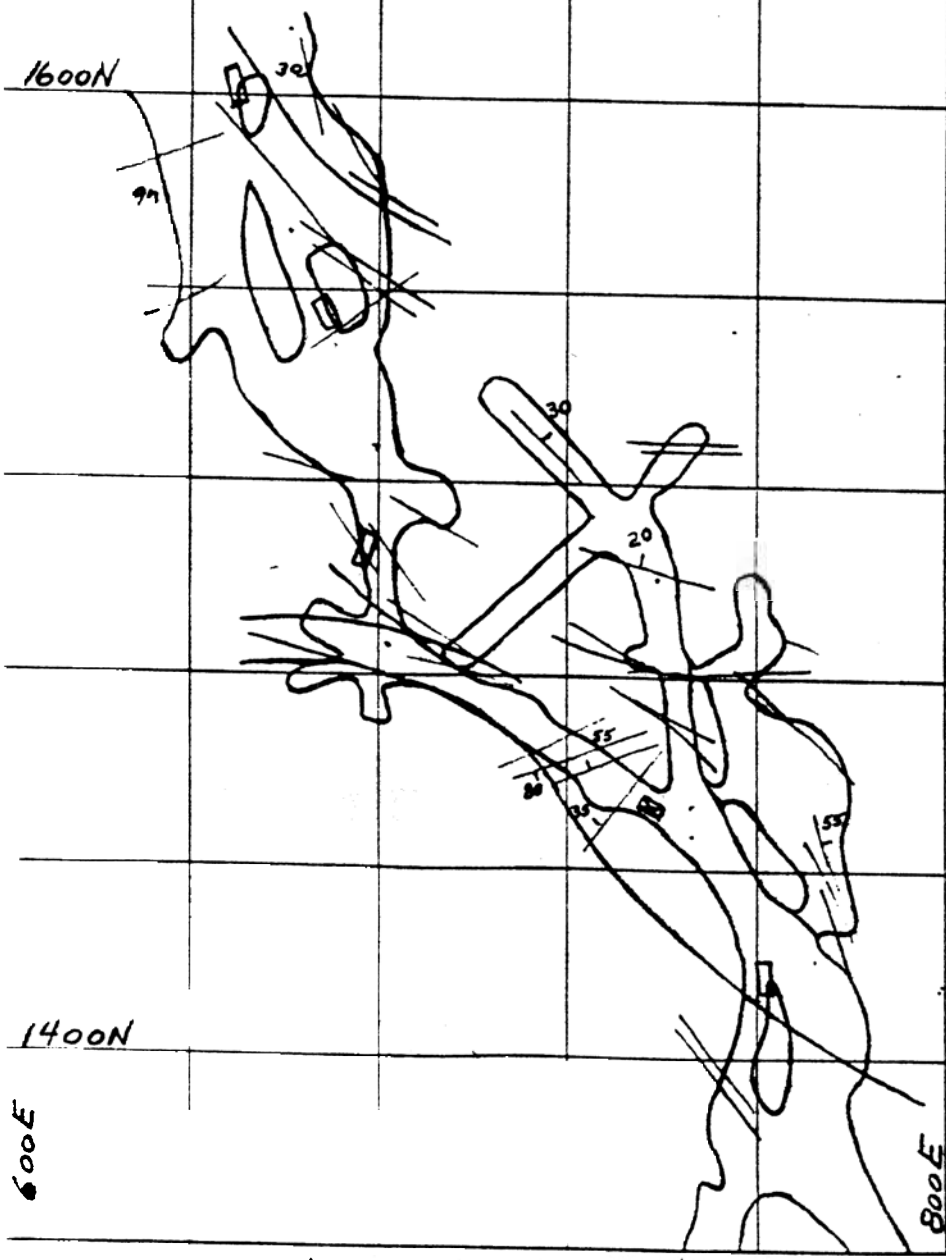
Joins Sheet 13

Monument No. 2 – Sheet 13

198 M DUNKIN BLUE-PRINT CO. - Grand Junction

SHEET
15

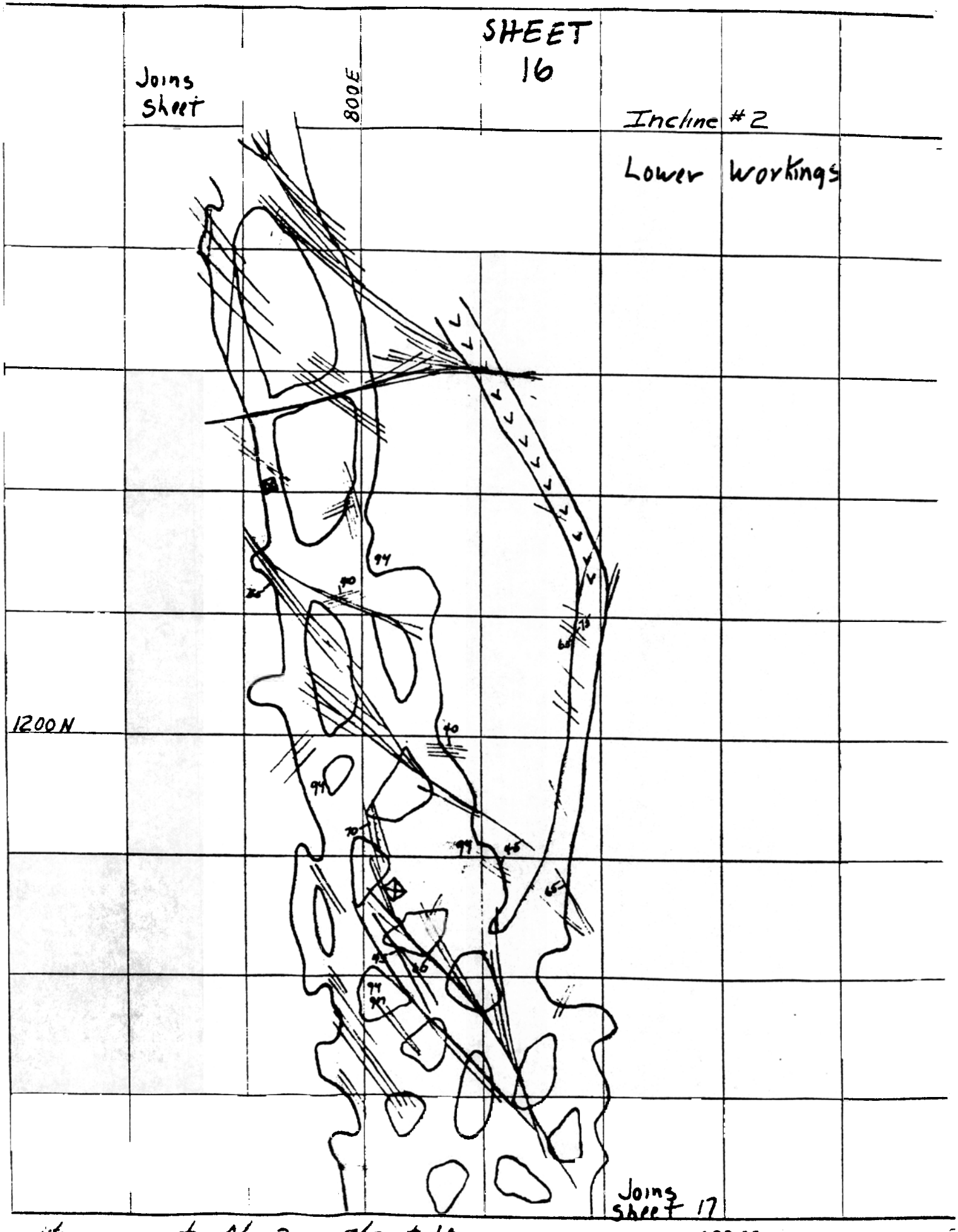
Incline #2
Lower workings



Joins sheet 16

Monument No. 2 – sheet 15

198 M DUNKIN BLUE-PRINT CO. - Grand Junction



Monument No. 2 — sheet 16

198 M

Joins sheet 16

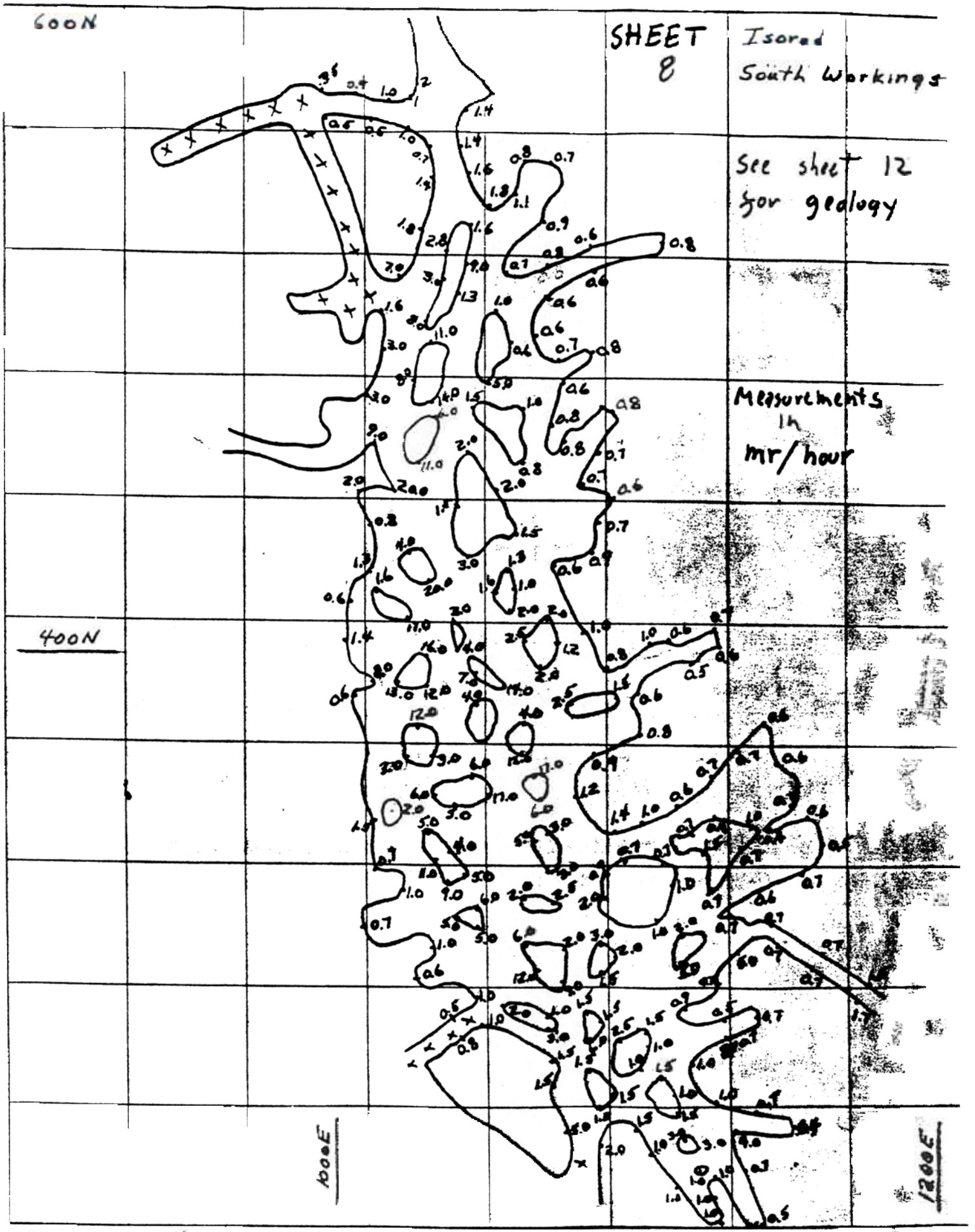
SHEET 17

Incline No 2

Lower Workings

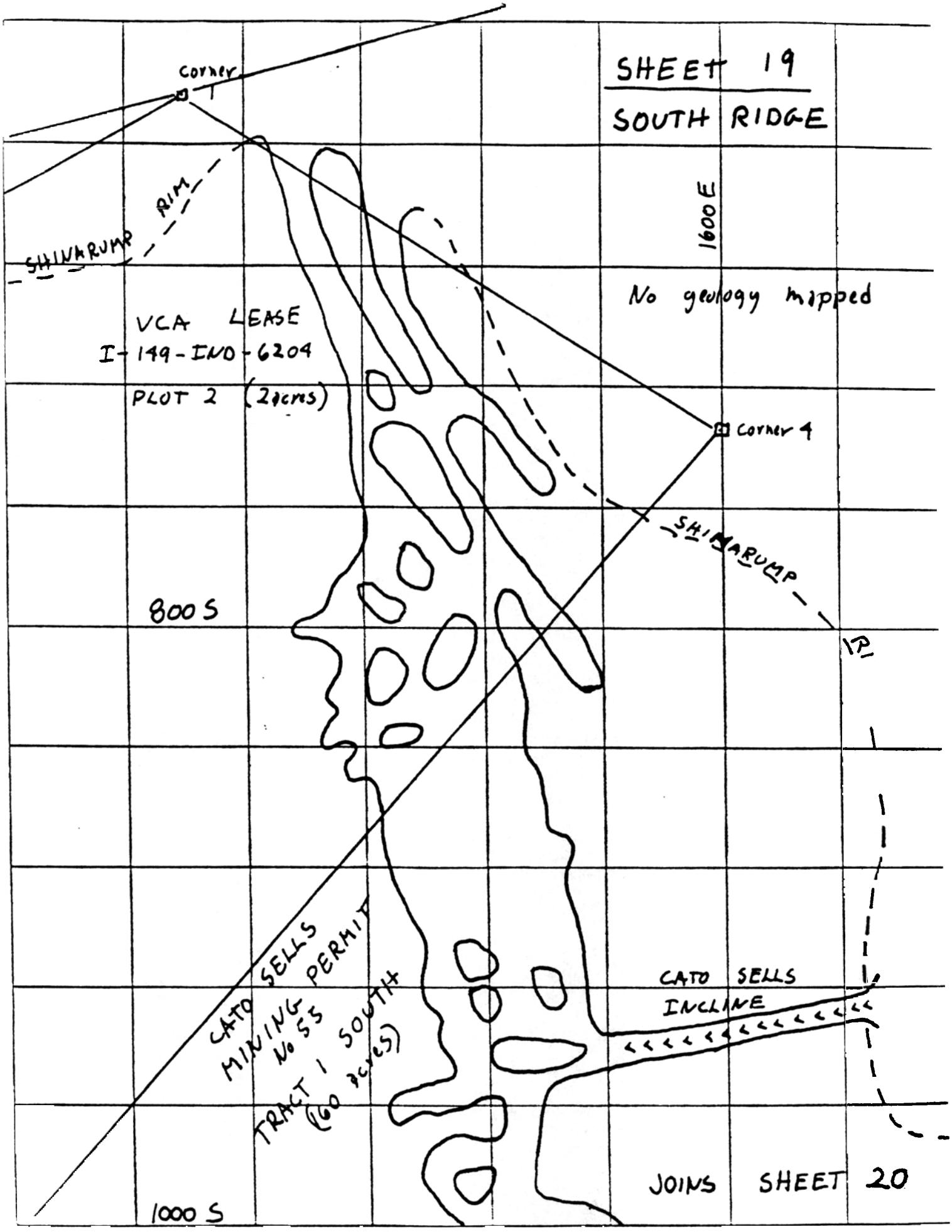
Monument No. 2 - sheet 17

198 M

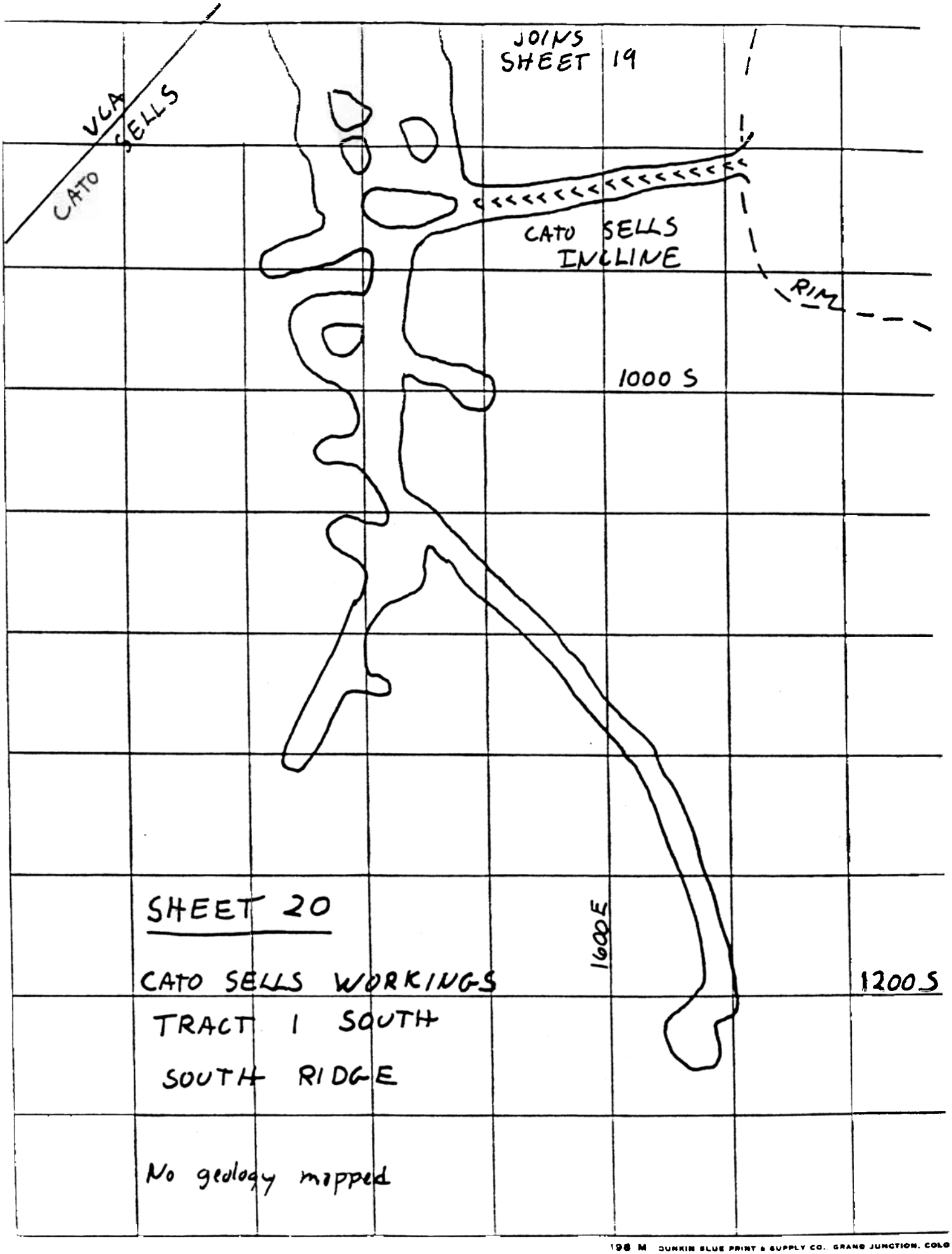


Monument No 2 sheet 18

198 M



198 M DUNKIN BLUE PRINT & SUPPLY CO., GRAND JUNCTION, COLO.



SHEET 20

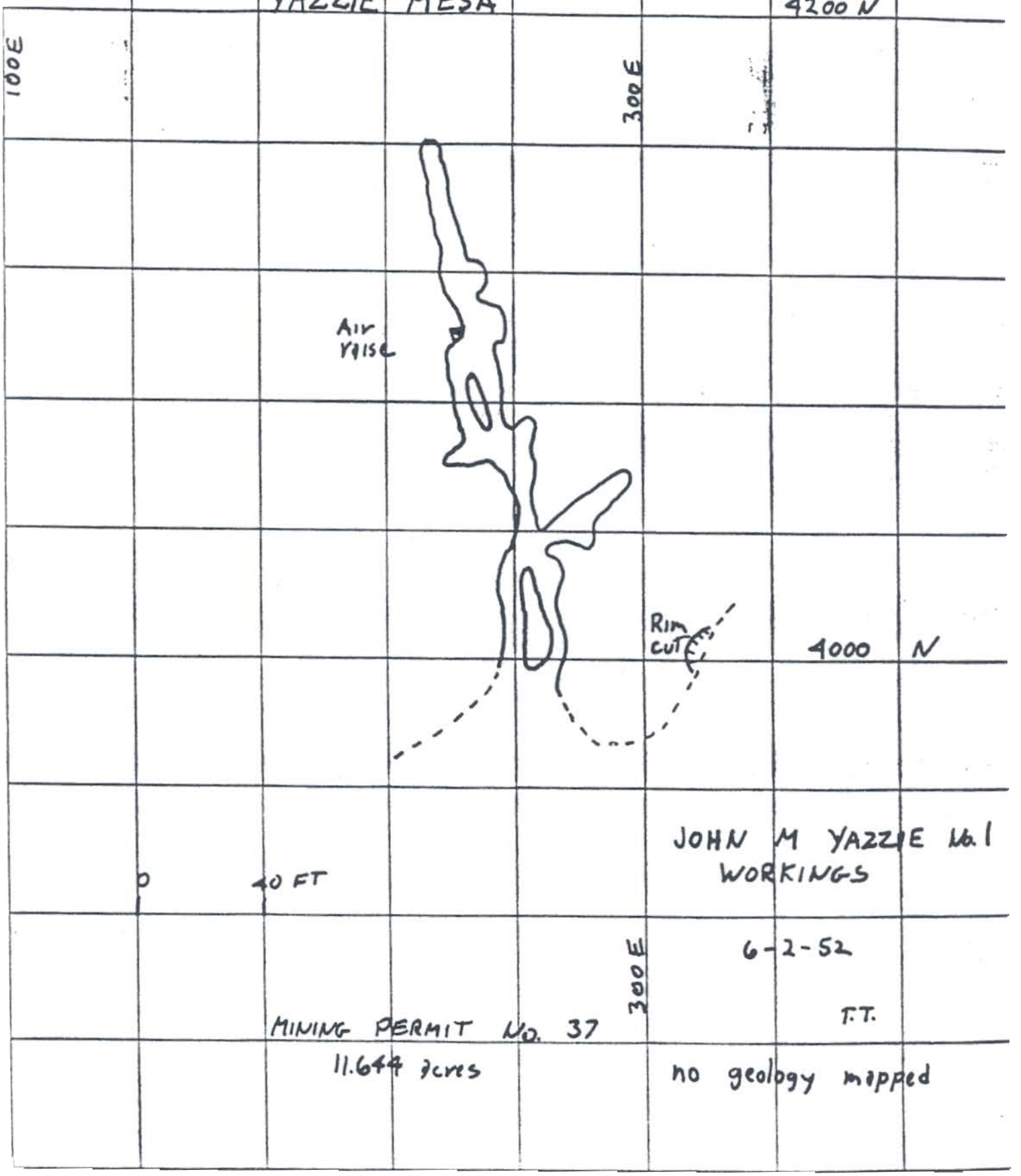
CATO SELLS WORKINGS
TRACT 1 SOUTH
SOUTH RIDGE

No geology mapped

198 M DUNKIN BLUE PRINT & SUPPLY CO. GRAND JUNCTION, COLO

SHEET 21

YAZZIE MESA



JOHN M YAZZIE No. 1
WORKINGS

6-2-52

T.T.

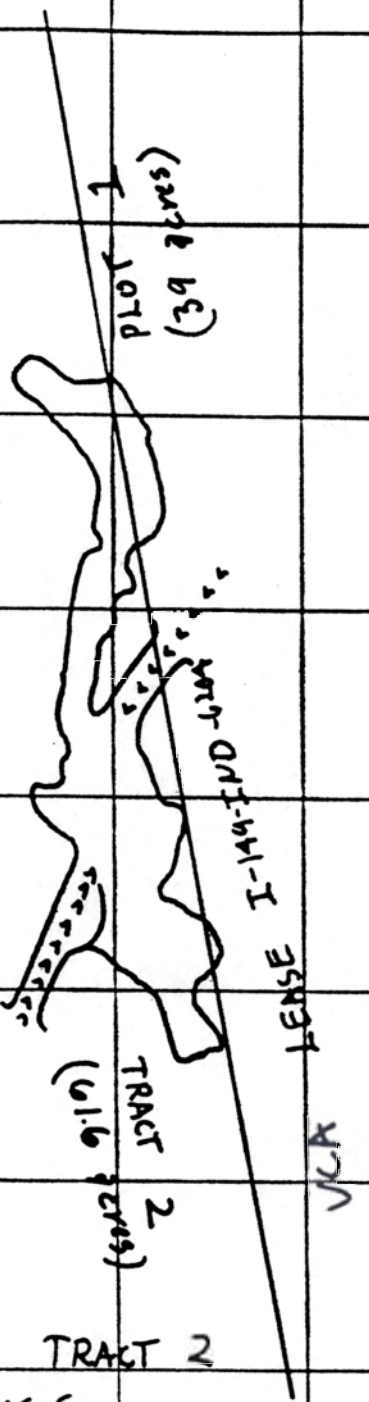
MINING PERMIT No. 37

11.644 acres

no geology mapped

DUNKIN BLUE PRINT & SUPPL

SHEET 22



CATO SELLS TRACT 2
WORKINGS

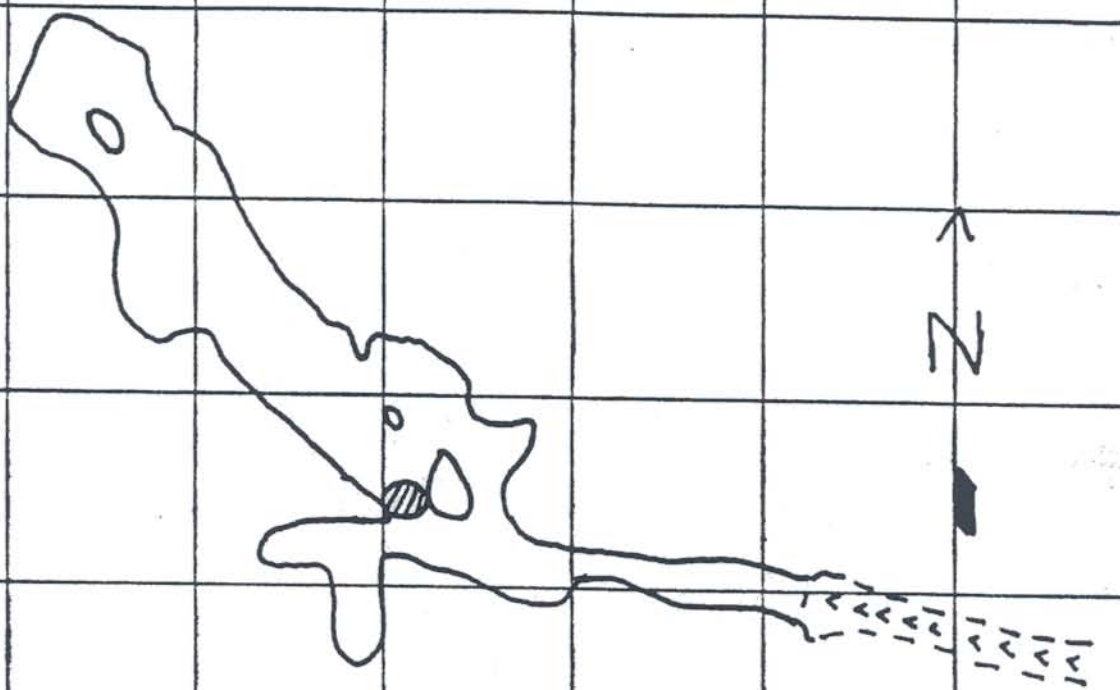
(No geology shown)

No coordinates shown

1958 M.E.C.

198 M DUNKIN BLUE PRINT & SUPPLY CO. GRAND JUNCTION, COLO.

SHEET 23



0 40 FT

BLACK and BLACKWATER
WORKINGS
11-15-51

MINING PERMIT No. 47
(15.5 acres)

No geology mapped
No coordinates shown

R.L.