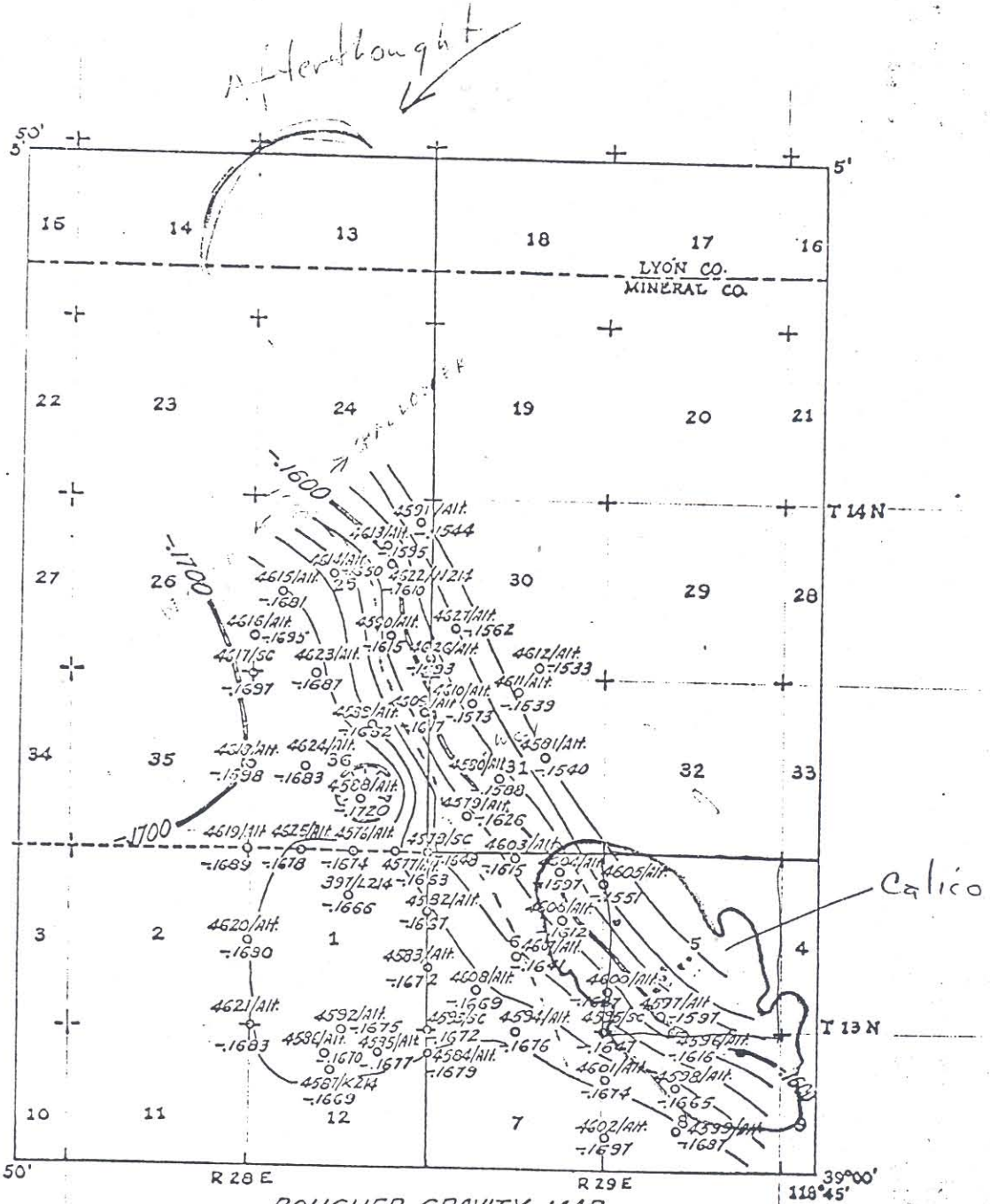
6000 0137 (0890)



BOUGUER GRAVITY MAP
WALKER RIVER RESERVATION AREA
MINERAL COUNTY, NEVADA

Scale: 1:62,500 C.I.=.0020 gals
Density: 2.67 gm/cc No Terrain Correction
Date: Sept. 1965
Data By: K.C.C.

Afterthought

60000 0137 (0890)

Memorandum to R. L. Redmond From: W. L. Wilson

Subject: Down the hole IP Measurements by Bear Creek Mining Co. On Calico.
Date: July 29, 1966

On July 5, 1966, Ton Nettlebeek, District Geologist for Bear Creek Mining Co. delivered to W. L. Wilson the down-the-hole IP and Resistivity logs which they had run on the Drill Holes CA 1 and CA 3, copies of which are attached.

CA 1 This hole was surveyed from 1370 to 1510'. The bottom of the casing was at about 1320'. He reported that CA 1 was dry and that they had to use sponges around the electrodes to make contact with the walls of the hole. Their geophysicist felt that the data was good to 1510', and below that the sponges hung up on the walls and/or did not make adequate contact to take the measurements. The hole was probed to 1900' and was open. They felt that they could make measurements in the future below 1510' if the hole were re-filled with fluid. The outstanding electrical feature of this hole insofar as they were able to make the measurements, is a strong resistivity contrast in the zone 1470-1490. Below this, the resistivity is extremely low, on the order of 1 ohm-foot. Above this zone it was on the order of 8 to 10 ohm-feet. PFE's were from 5 to 9 throughout the zone of measurement.

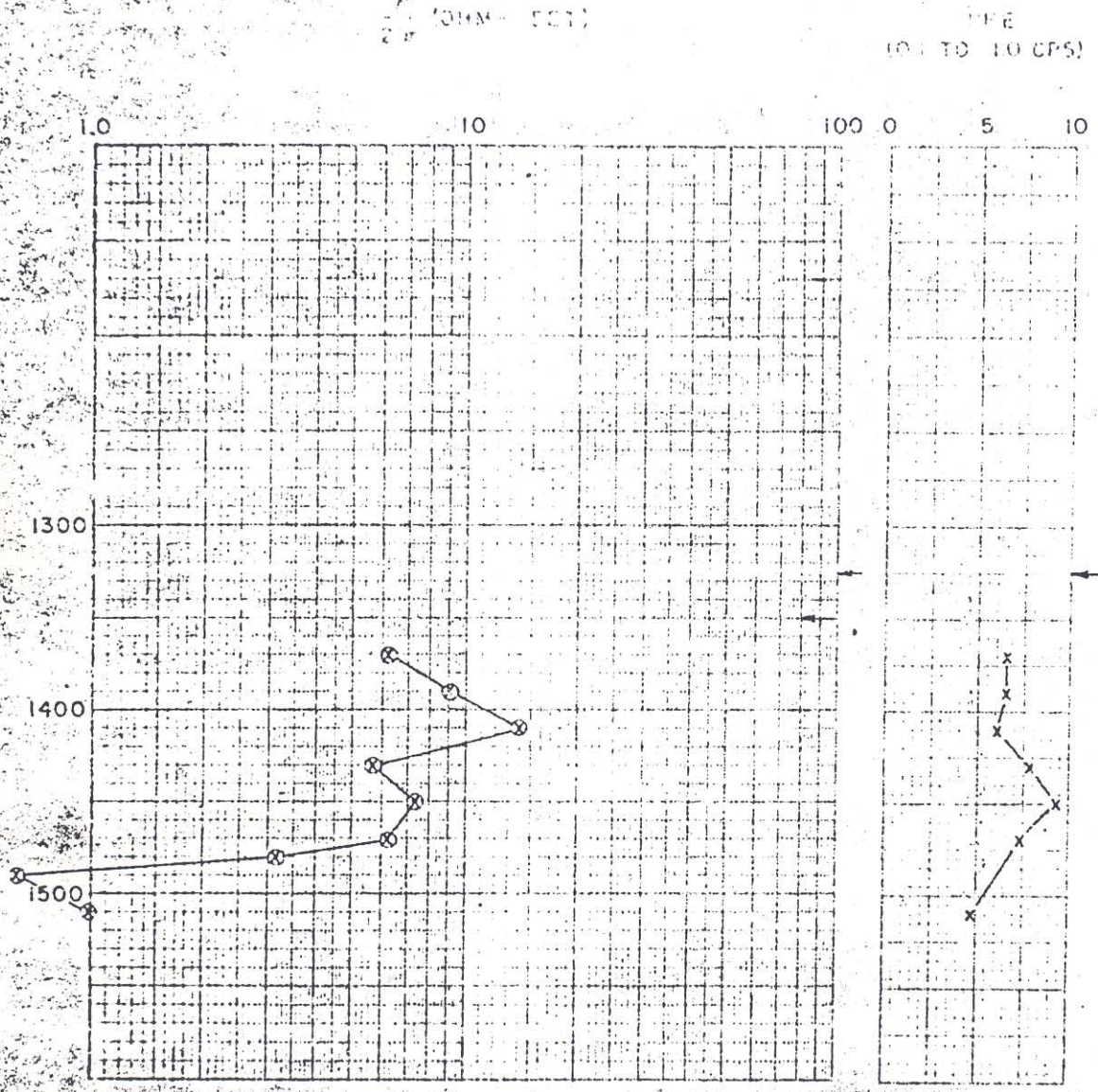
CA 3 This hole was surveyed from 2300 to about 2600'. The bottom of the casing is about 2200'. All resistivities were on the order of 1 ohm-foot or lower. The lowest was 0.3 ohm feet. PFEs were moderate, considering the tenor of mineralization, ranging from about 2.5 to 11%. All measurements in this hole were taken in the ore zone.

The geophysicist who performed the field work (Jerry Van Voorhis) stated that the PFEs would be about 30% higher if they had used the set of frequencies used by McPhar in their surface IP work in this area (0.05 and 1.25 c/s in contrast with the set of 0.1 and 1.0 c/s used by Bear Creek).

W. L. Wilson

W. L. Wilson

6000 0137 (0890)



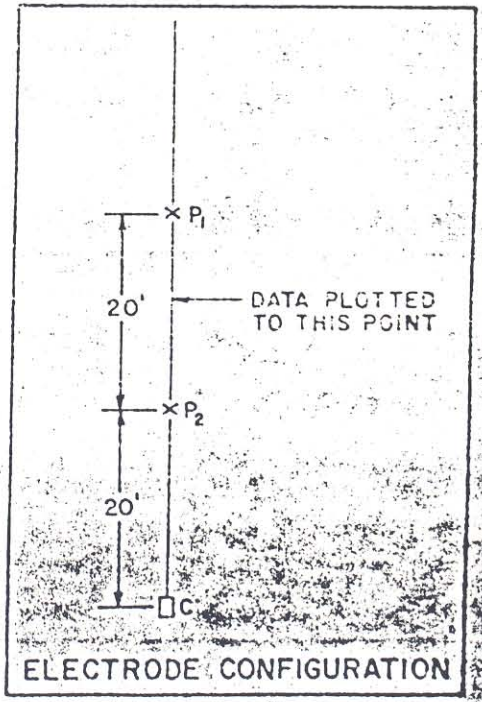
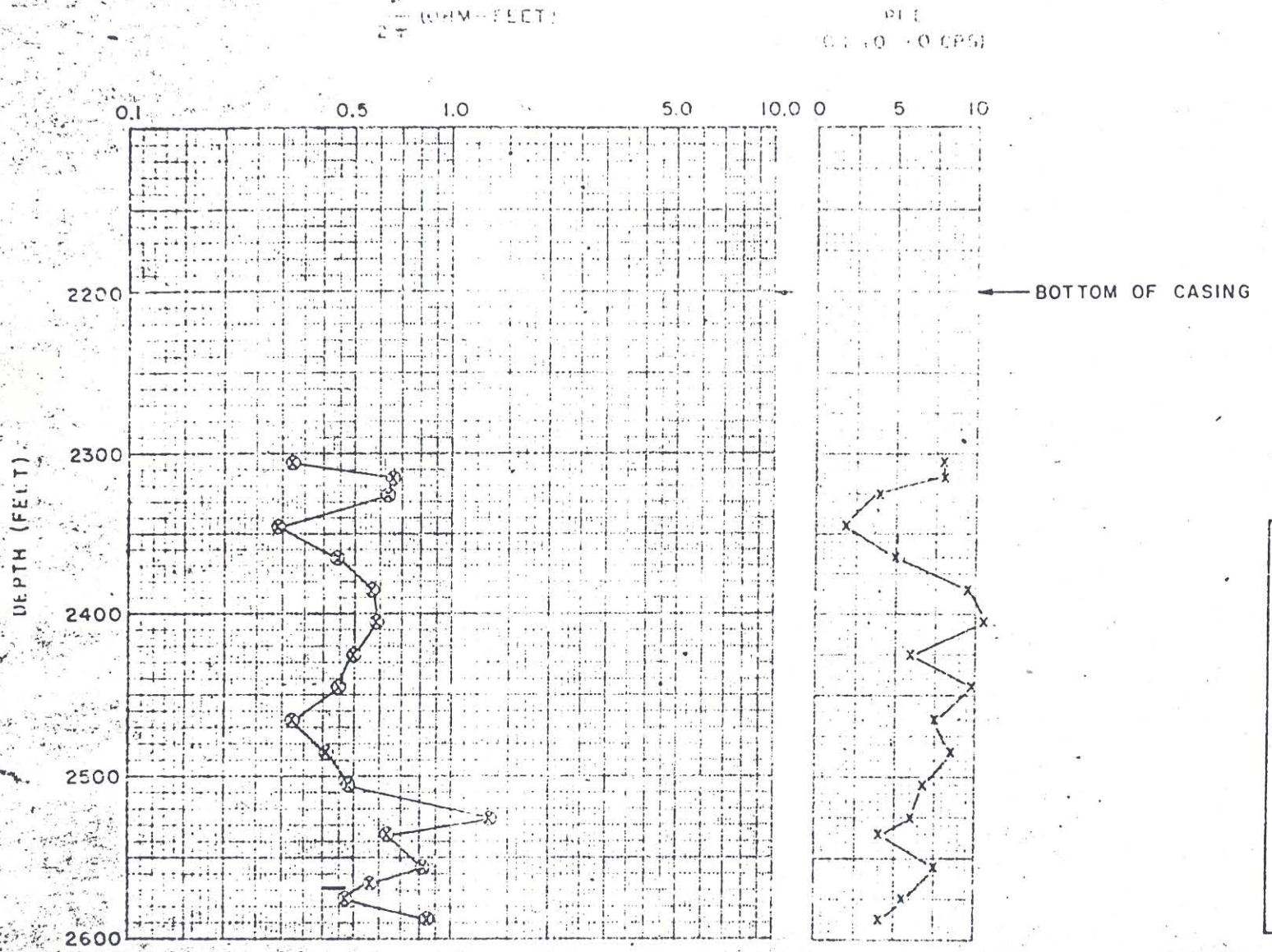


FIGURE 1. ELECTRICAL LOG OF DRILL HOLE CA-1a



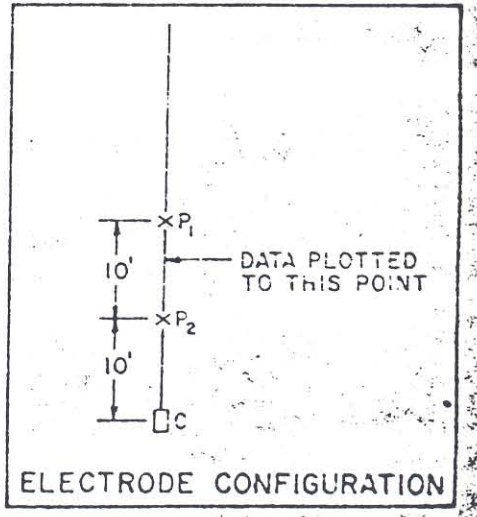


FIGURE 2. ELECTRICAL LOG OF DRILL HOLE CA-3

6000 0137 (0890)

Line Terminal

Line Terminal

MASTEL ZERO.

6000 NW.

CALICO 19

CALICO 18

CALICO 17

TO 1800 SW 5250 NW

TO 1800 NE

TO 1210 SW 5050 NW

TO 1500 NE

TO 1800 SW 4850 NW

TO 1550 NE

TO 1800 SW 4650 NW

TO 1750 NE

4500 NW

TO 1800 SW 4450 NW

TO 1800 NE

CALICO 28

CALICO 27

CALICO 26

U.S.S. DDH LOCATION.

TO 1800 SW 4250 NW

TO 1800 NE

TO 1800 SW 4050 NW

TO 1800 NE

TO 1800 SW 3850 NW

TO 2400 NE

3750 NW

TO 1800 SW 3650 NW

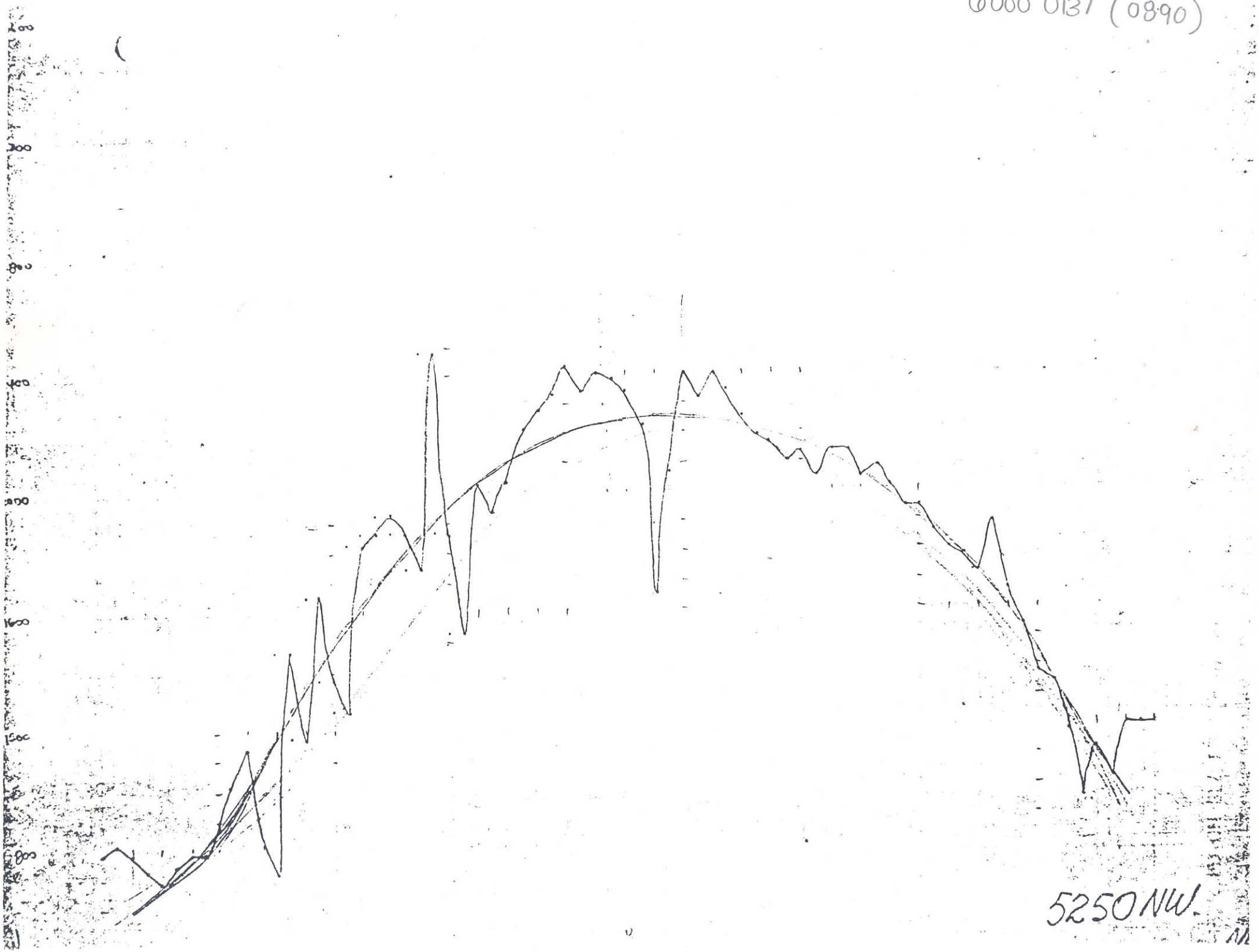
TO 2400 NE

3000 NW

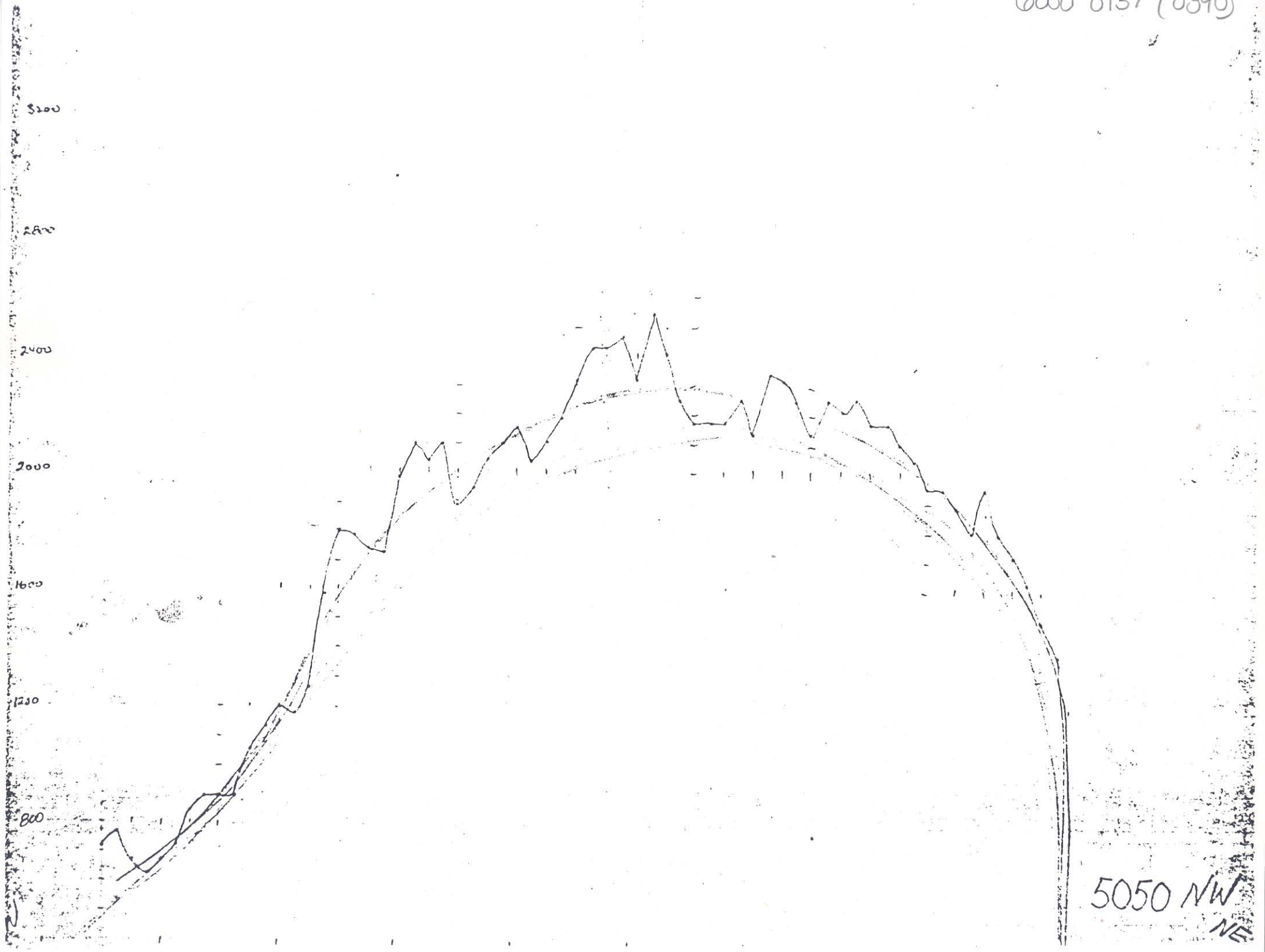
U.S. STEEL HIGH

1800 SW LINE (U.S.S.)

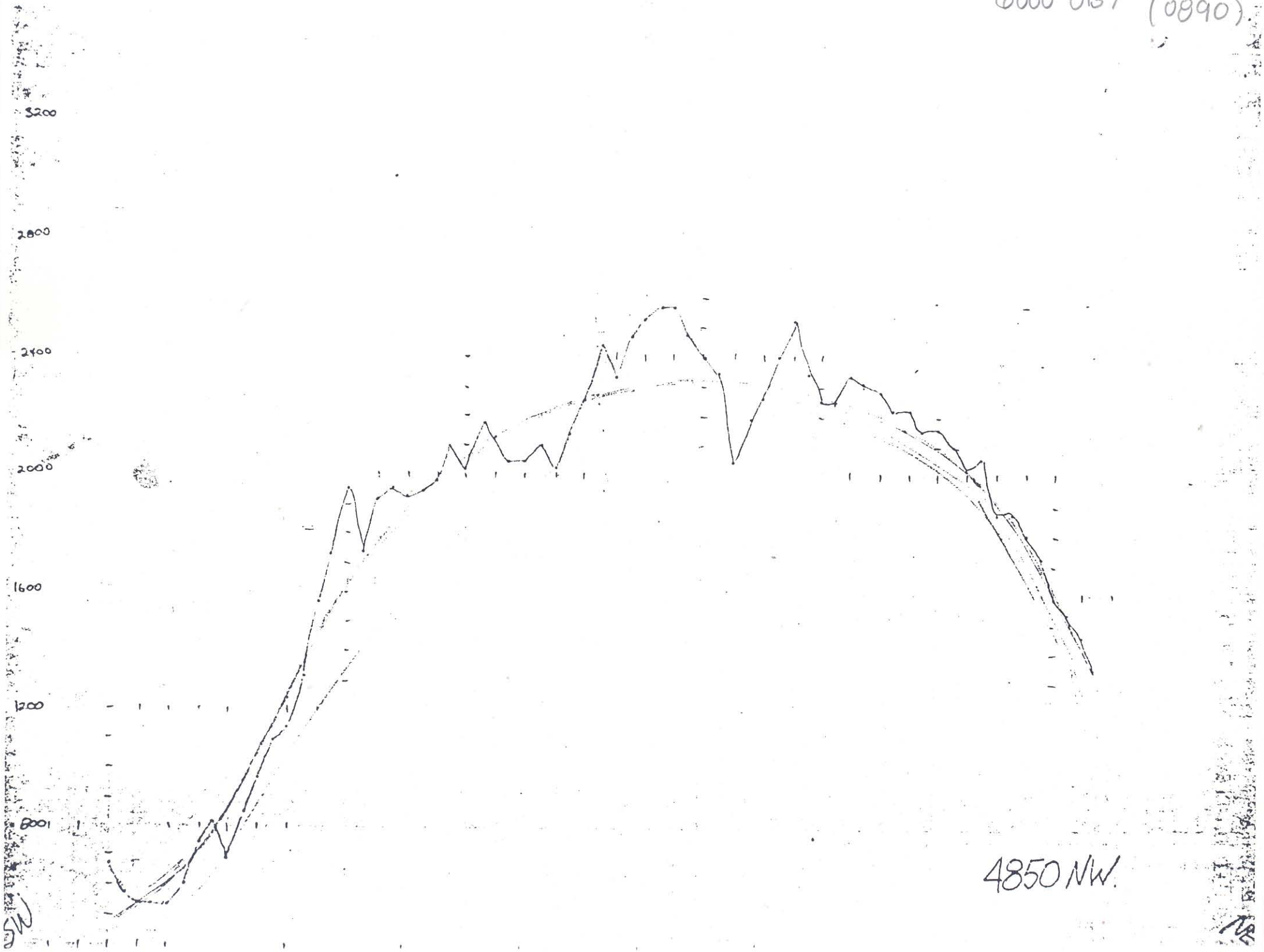
6000 0137 (0890)



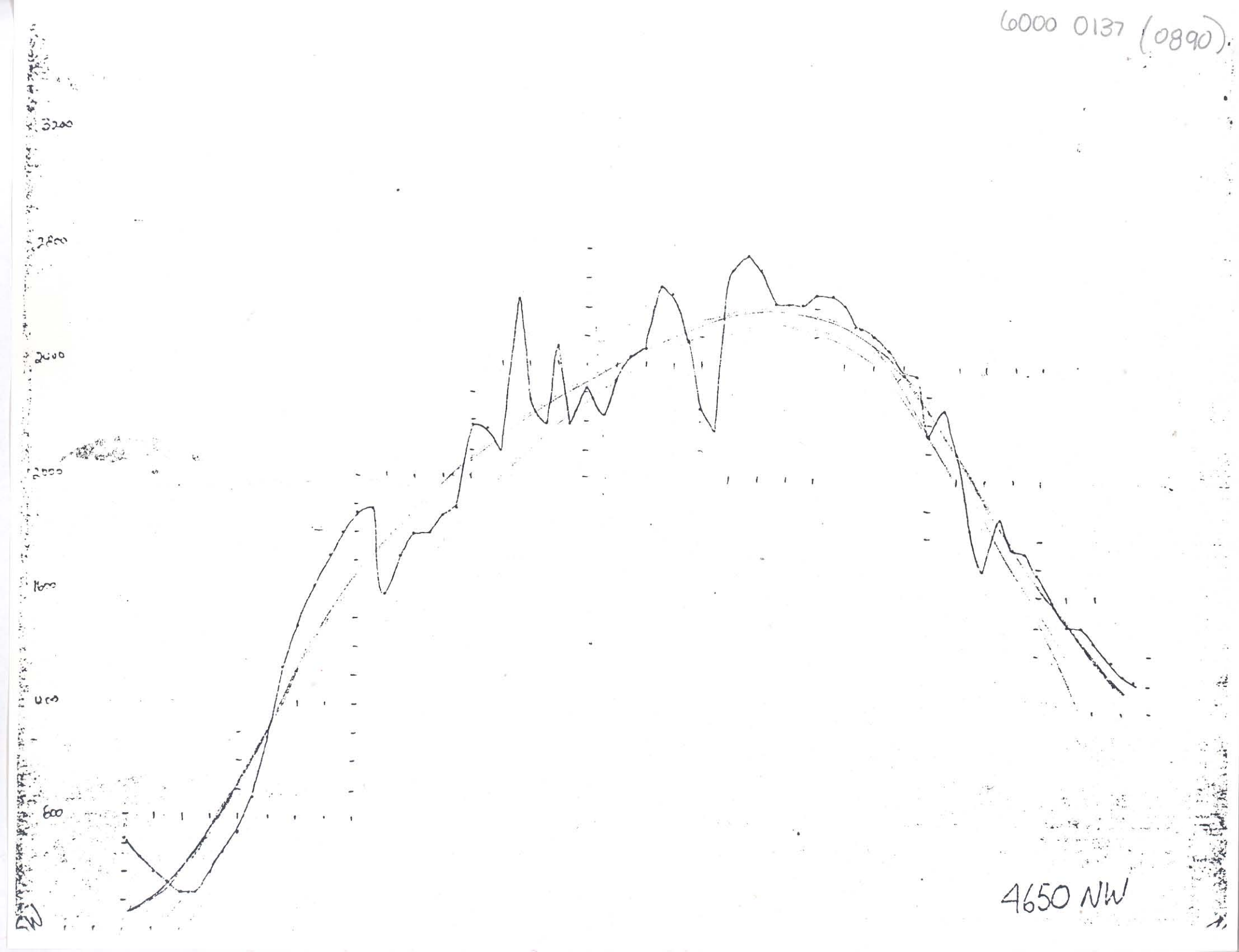
6000 0137 (0890)



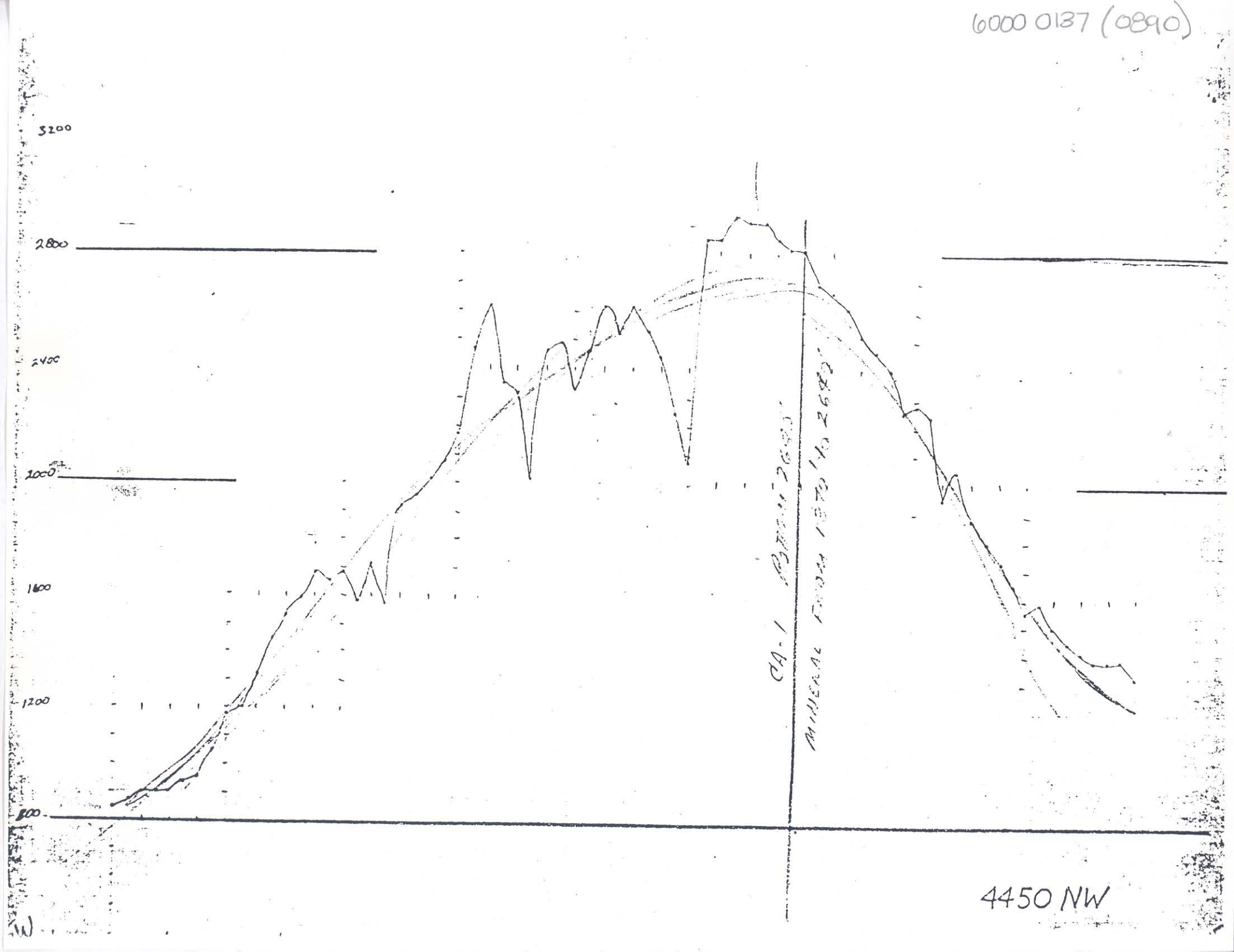
6000 0137 (0890).



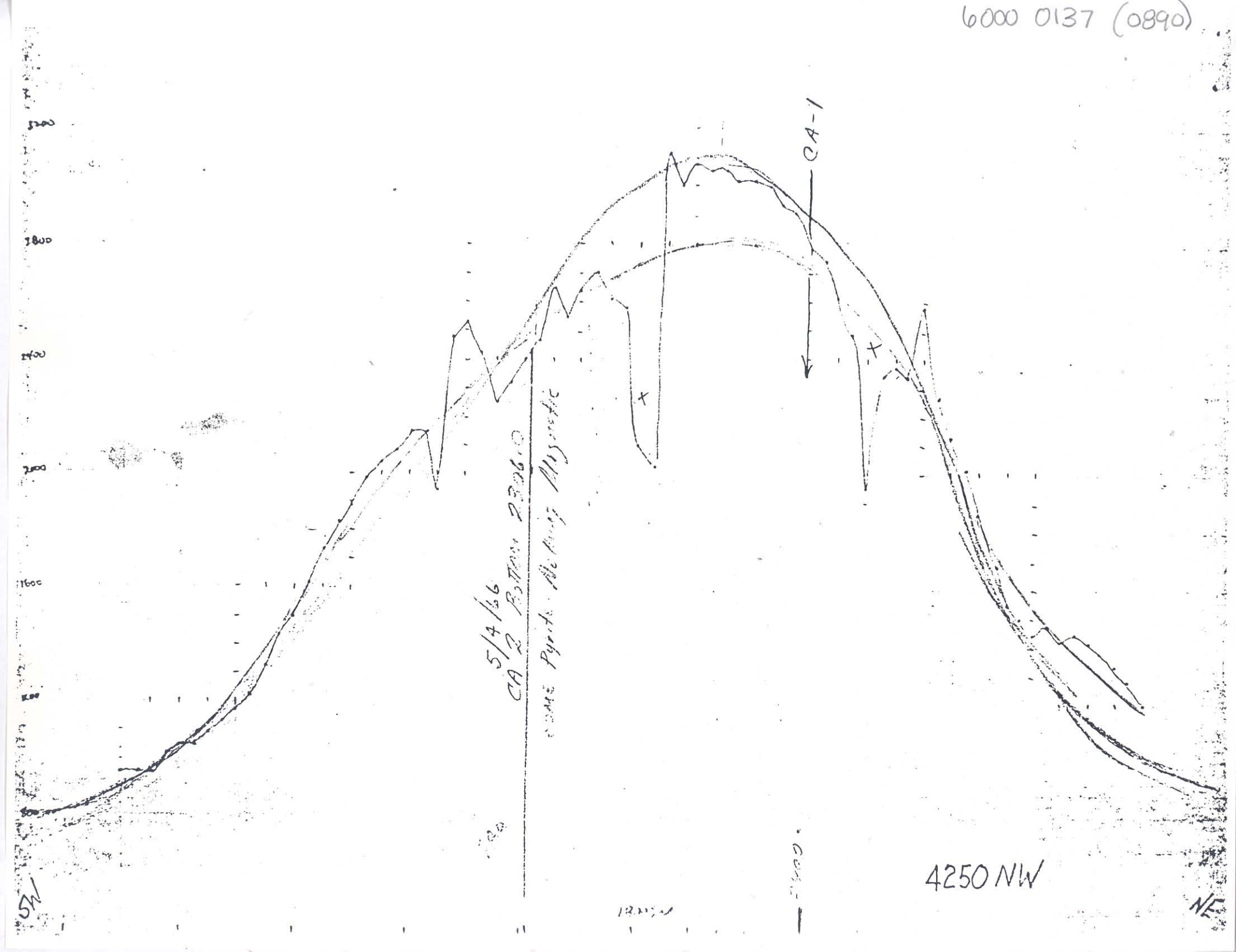
6000 0137 (0890)



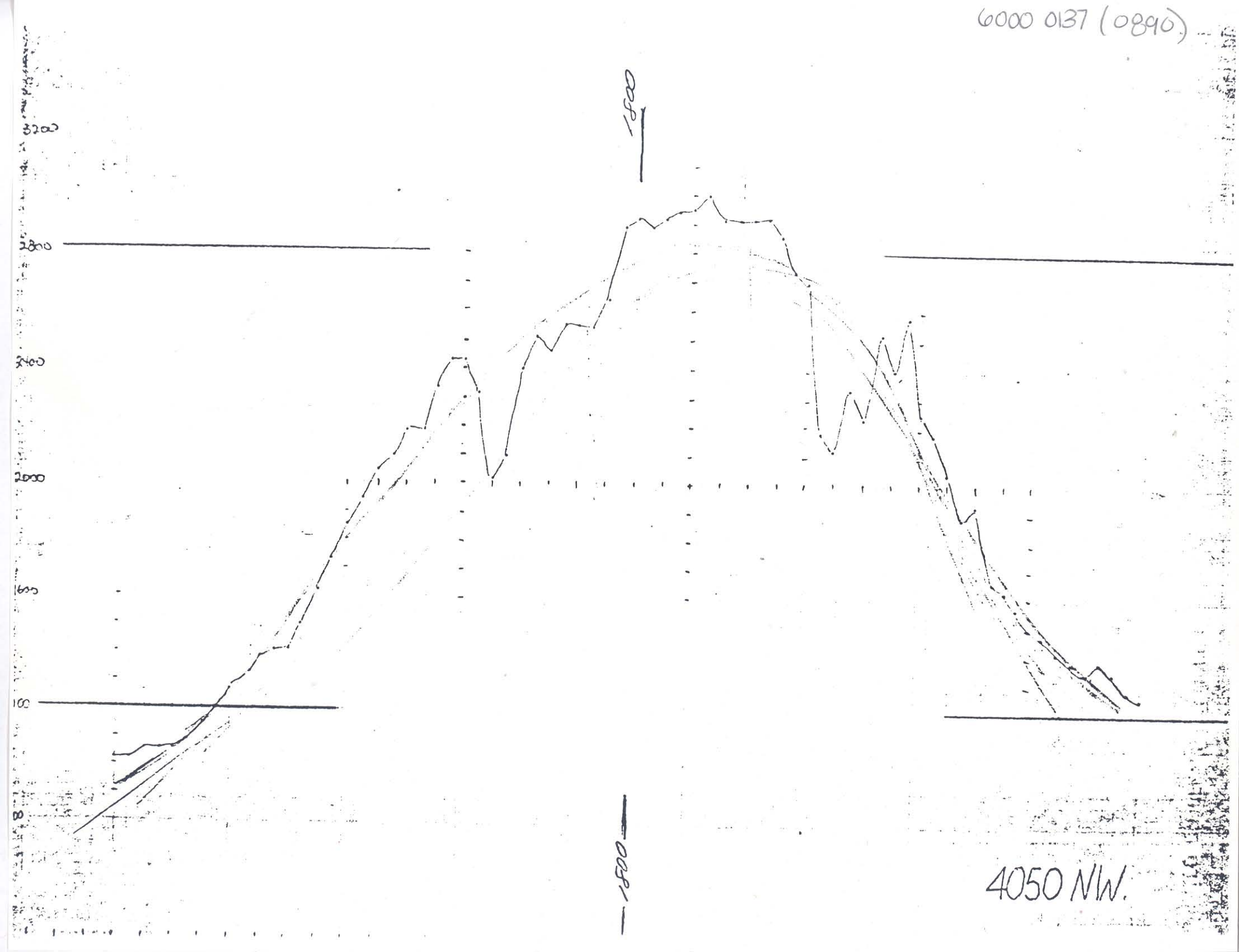
6000 0137 (0890)



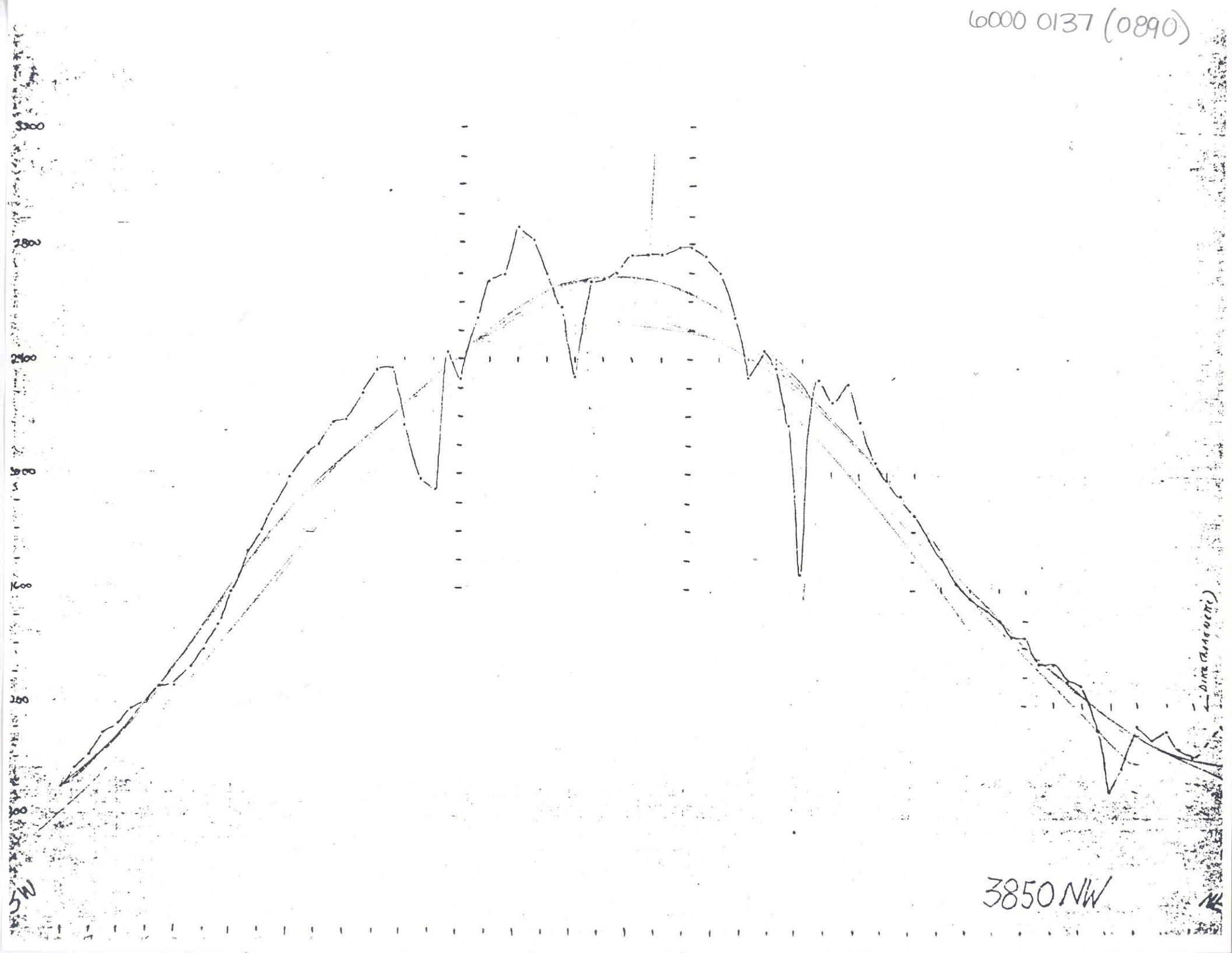
6000 0137 (0890)



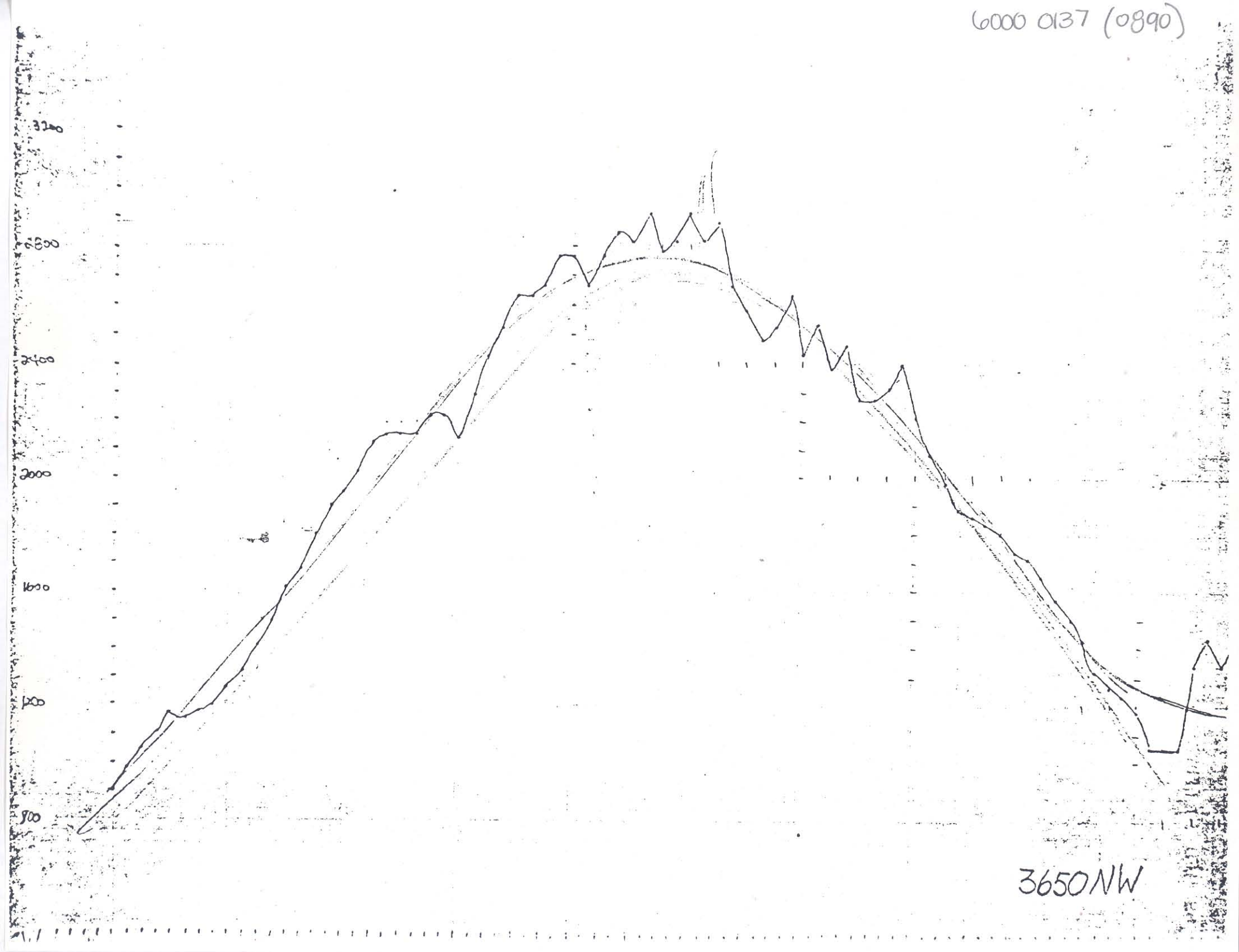
6000 0137 (0890)



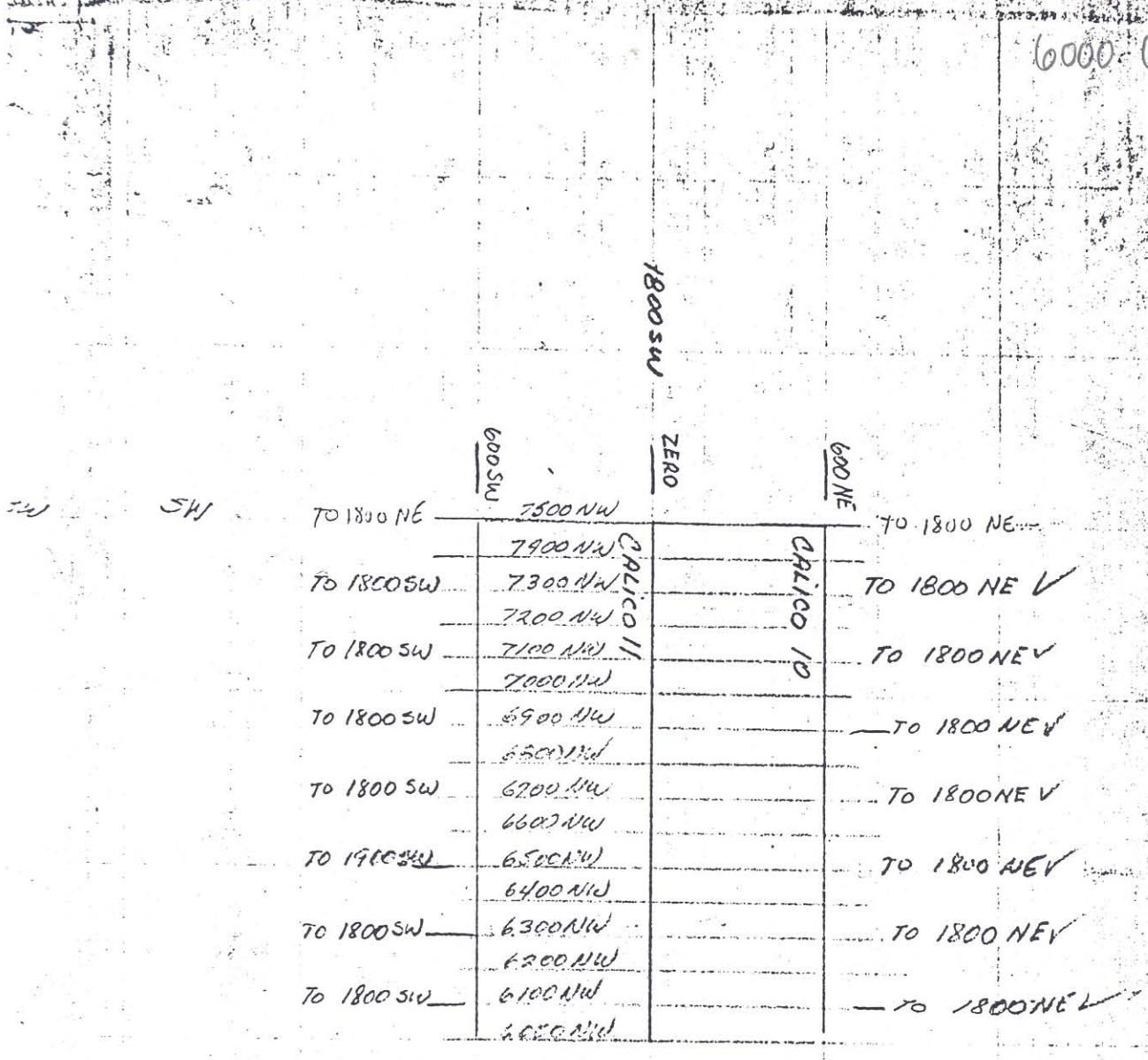
6000 0137 (0890)



6000 0137 (0890)

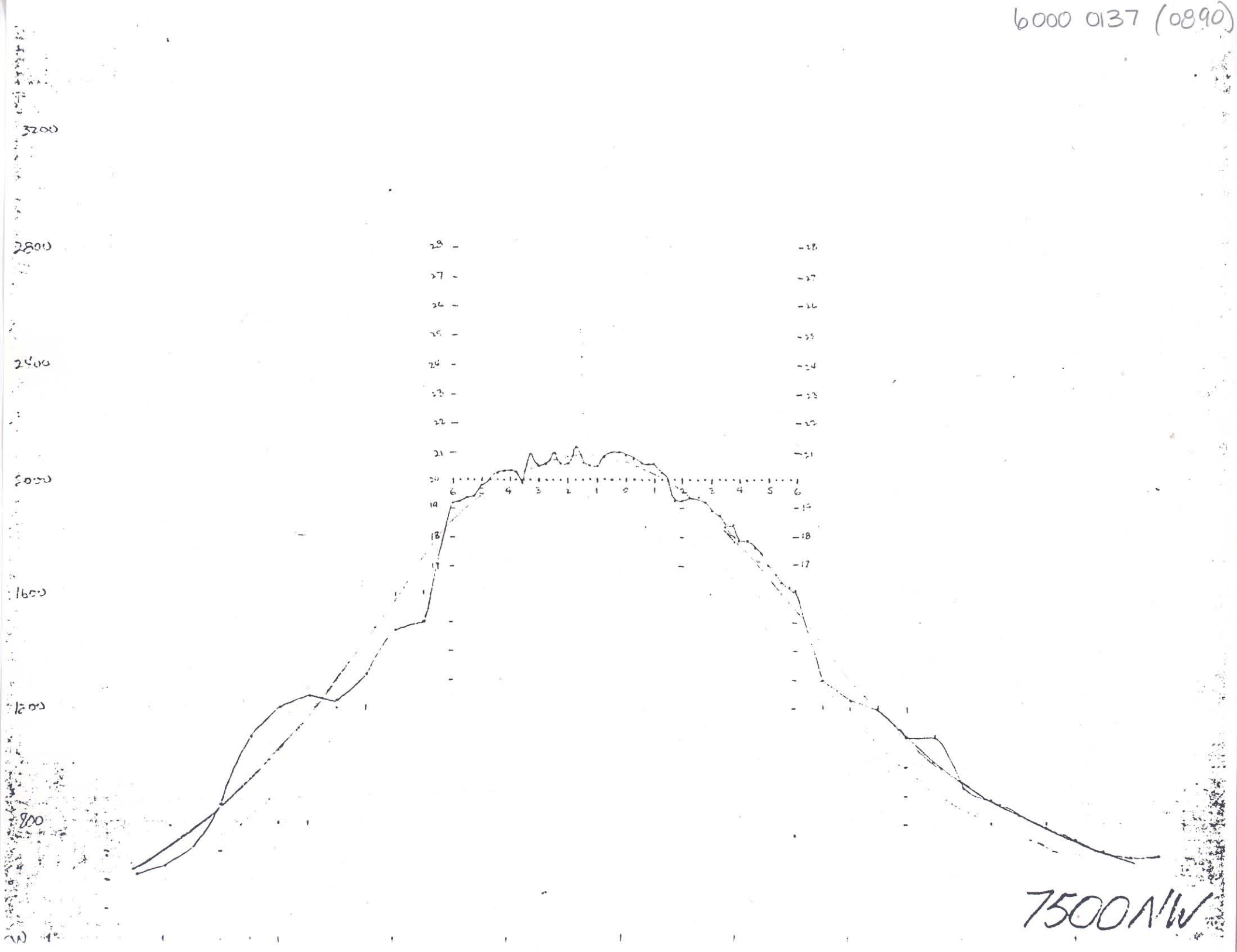


6000-0137 (0887)

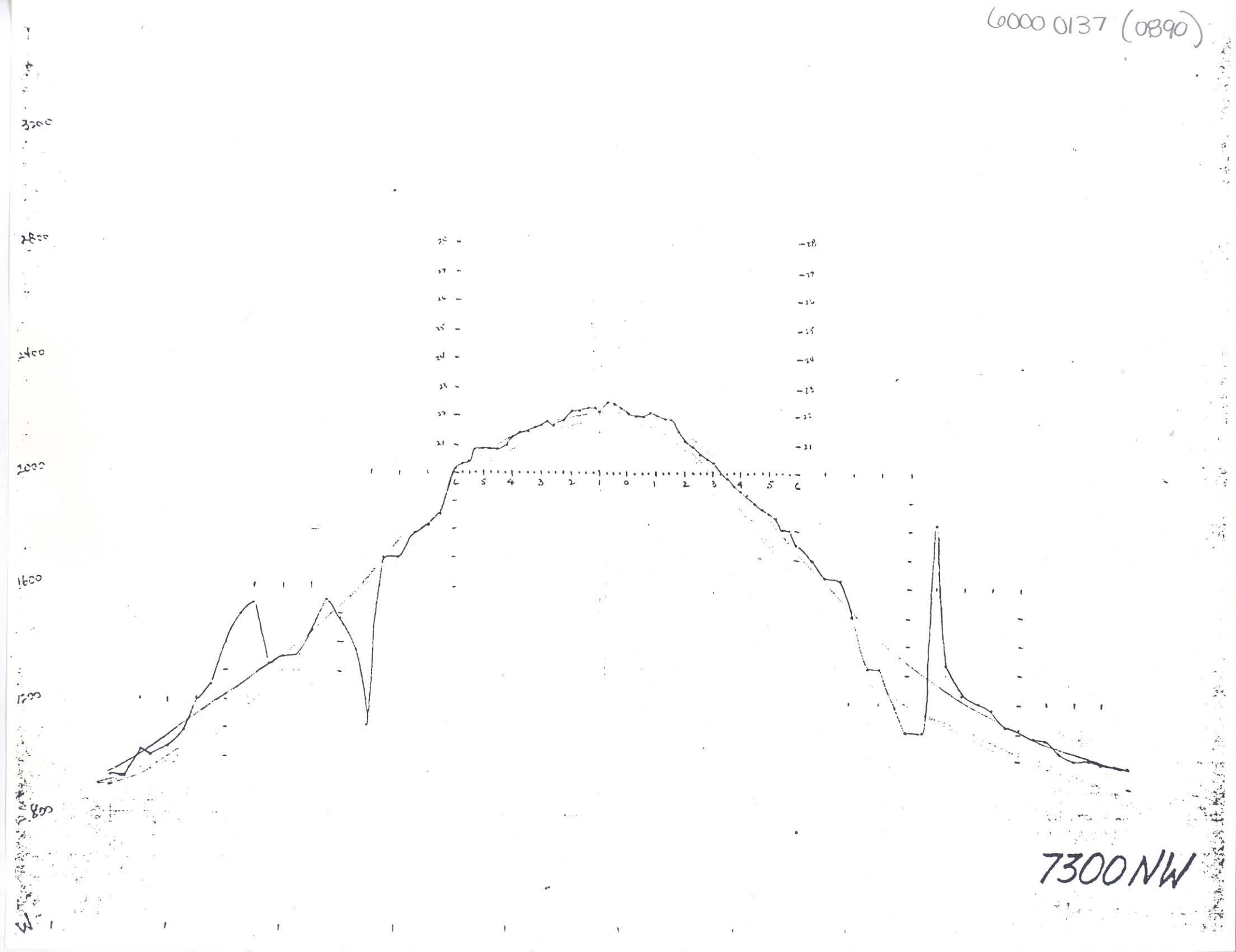


Scale 1" = 400'

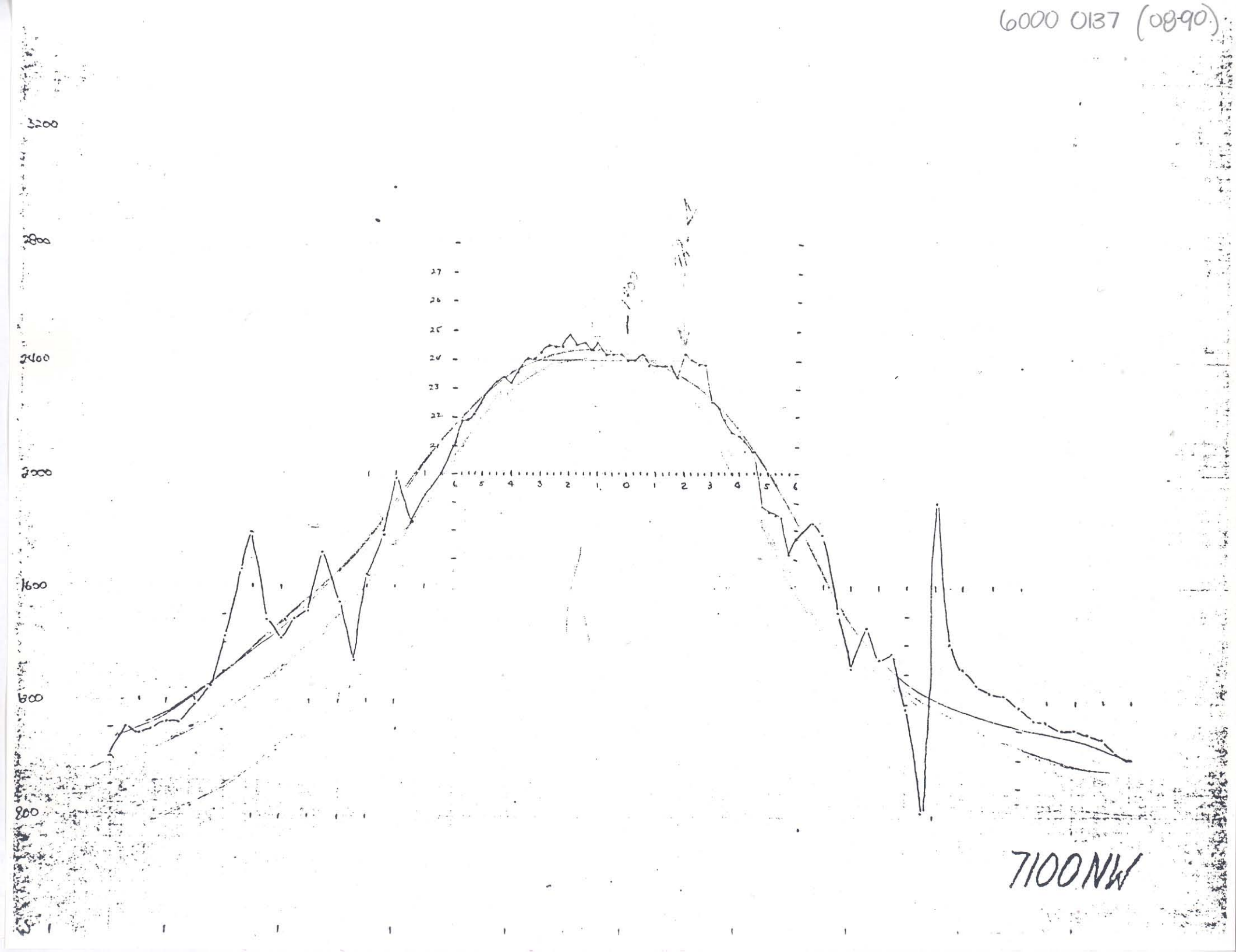
6000 0137 (0890)



60000137 (0890)

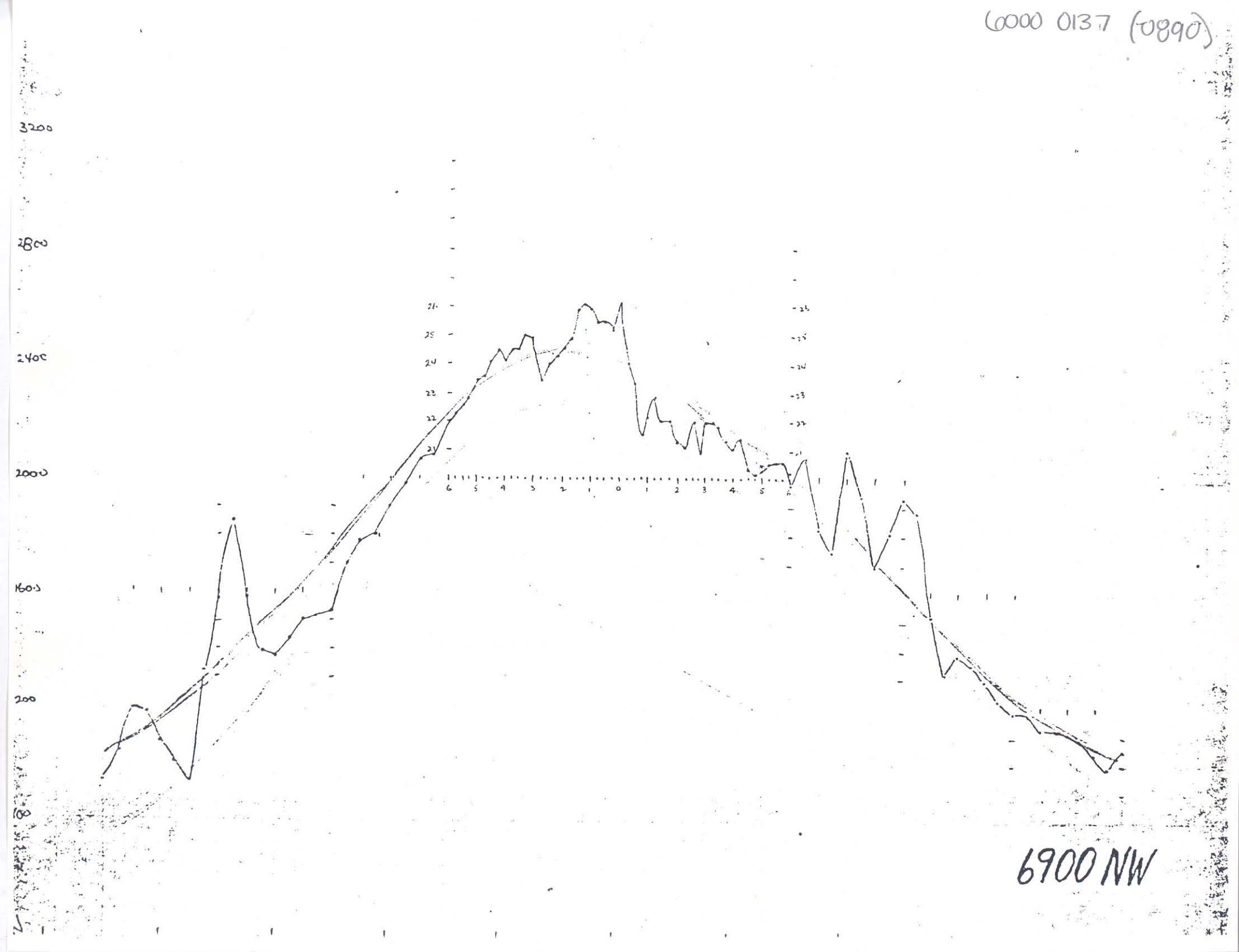


6000 0137 (08-90)

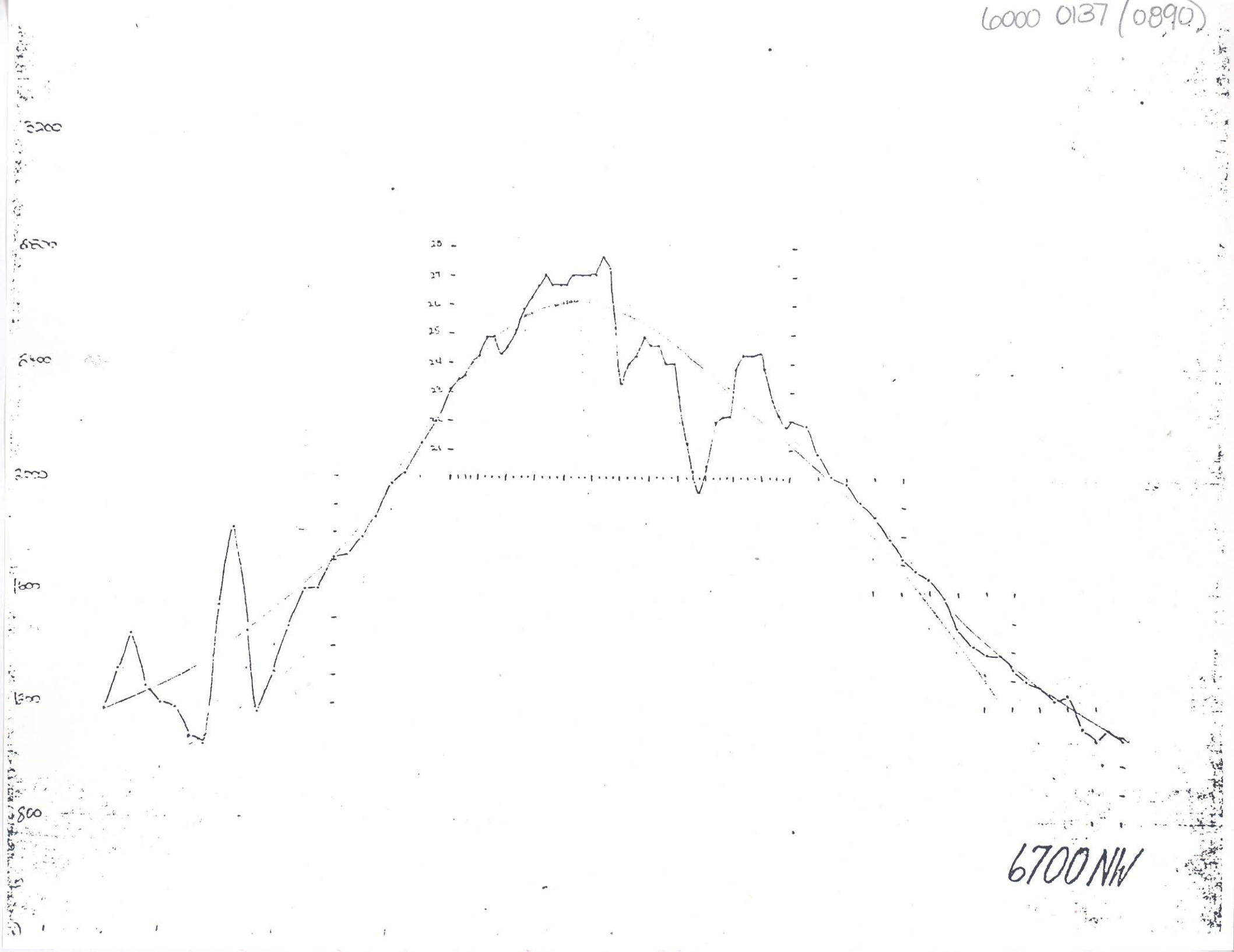


7100 NW

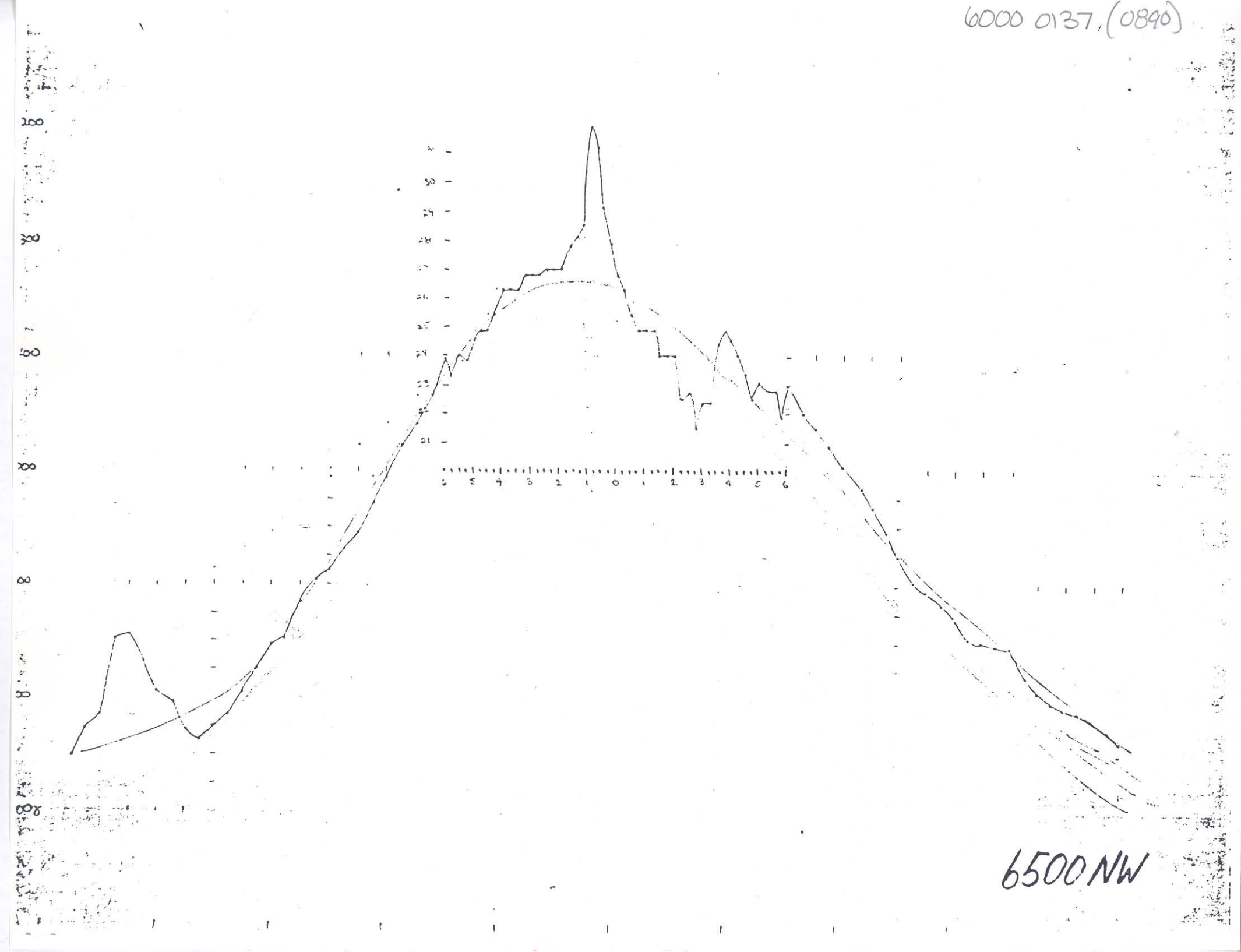
(0000 0137 (0890)



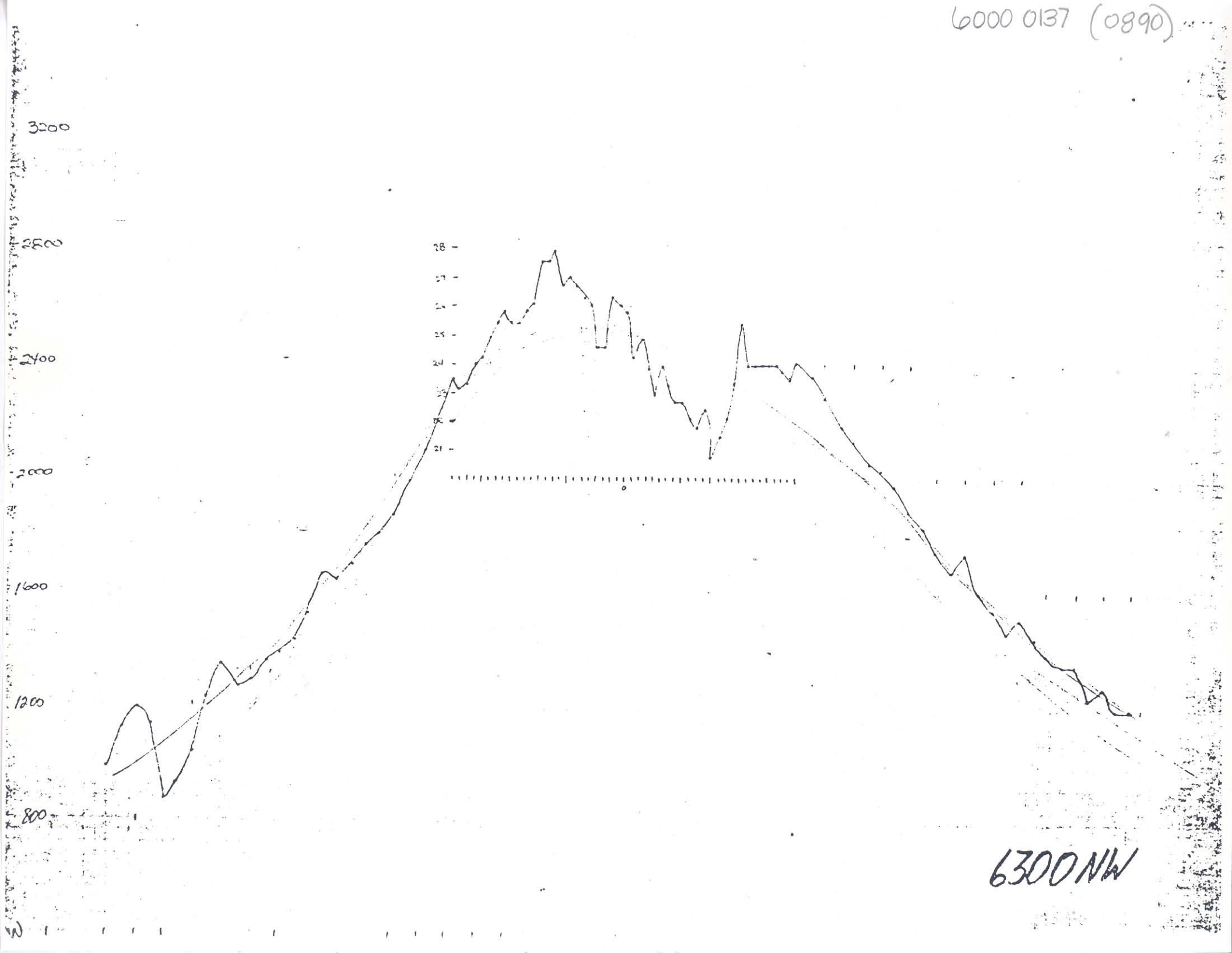
6000 0137 (0890)



6000 0137, (0890)

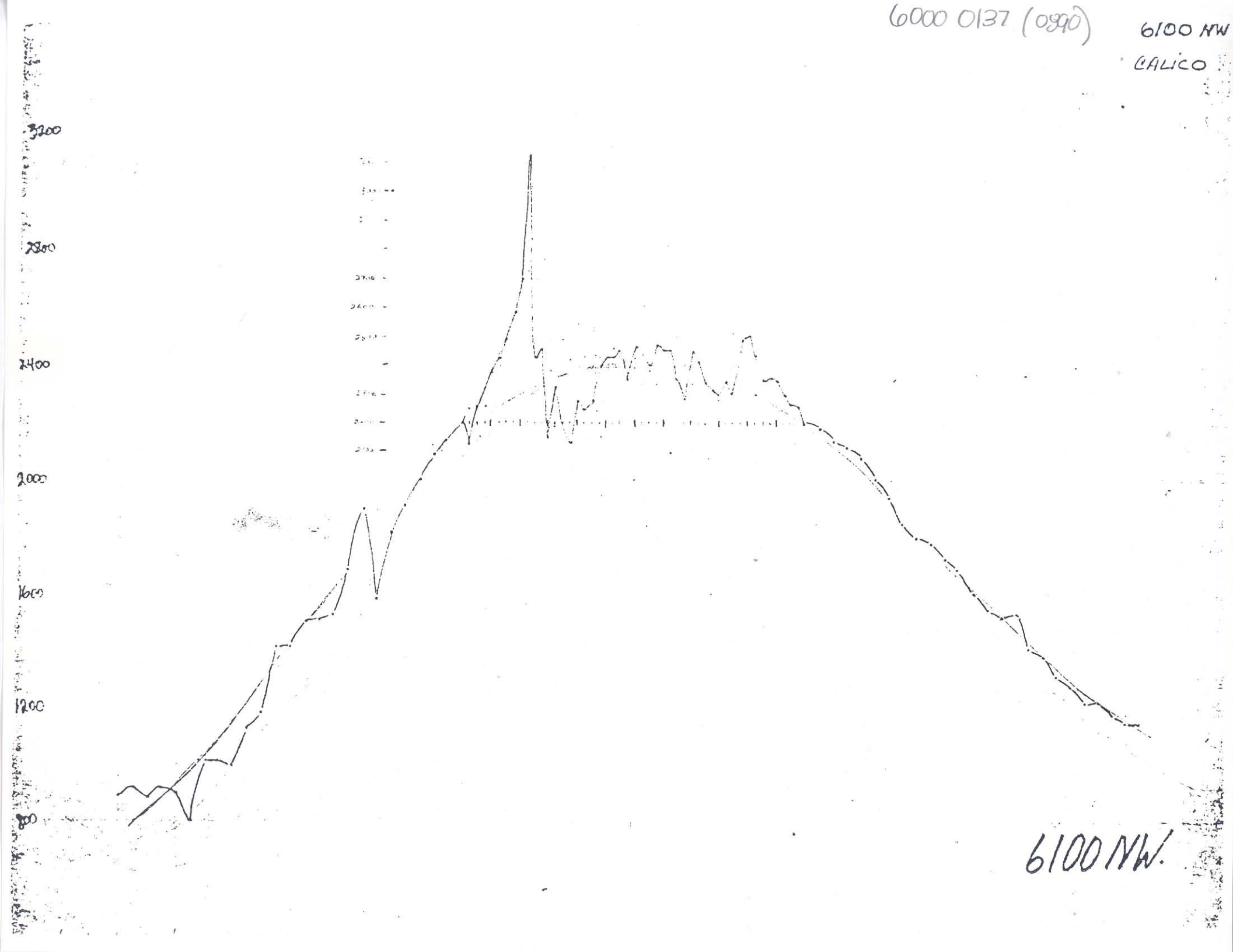


6000 0137 (0890)

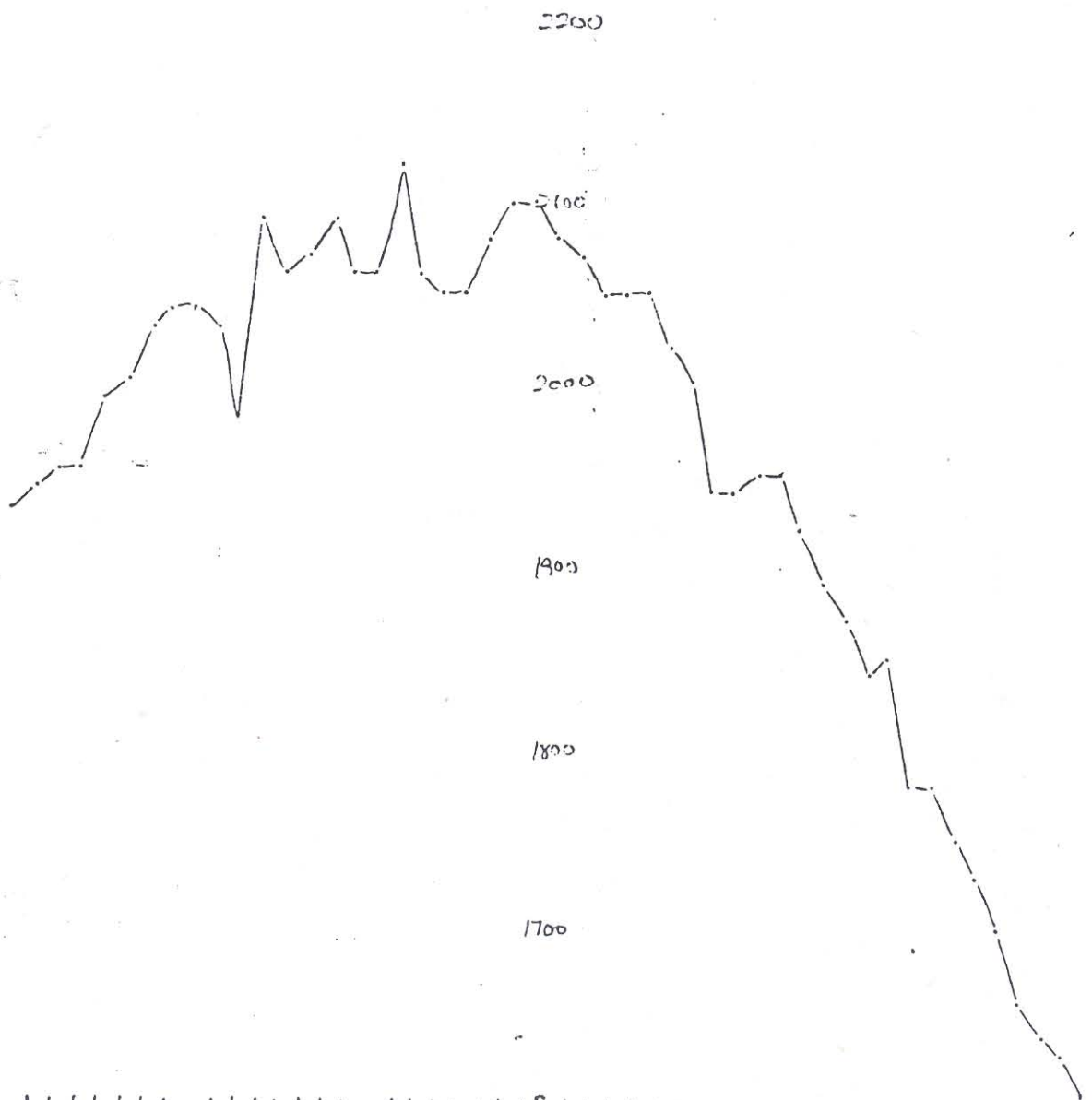


6000 0137 (0890)

6100 NW
CALICO

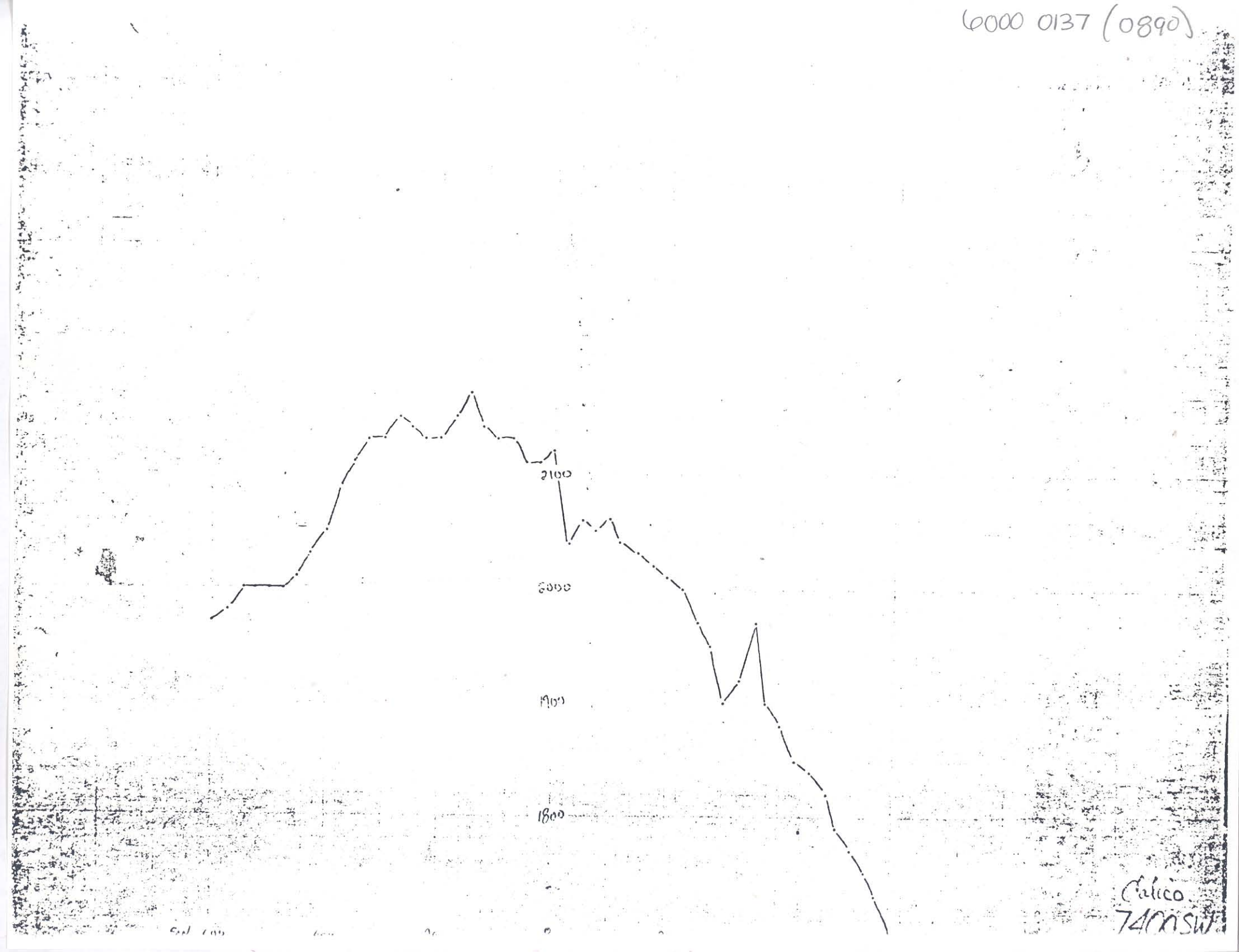


6000 0137, (0890)



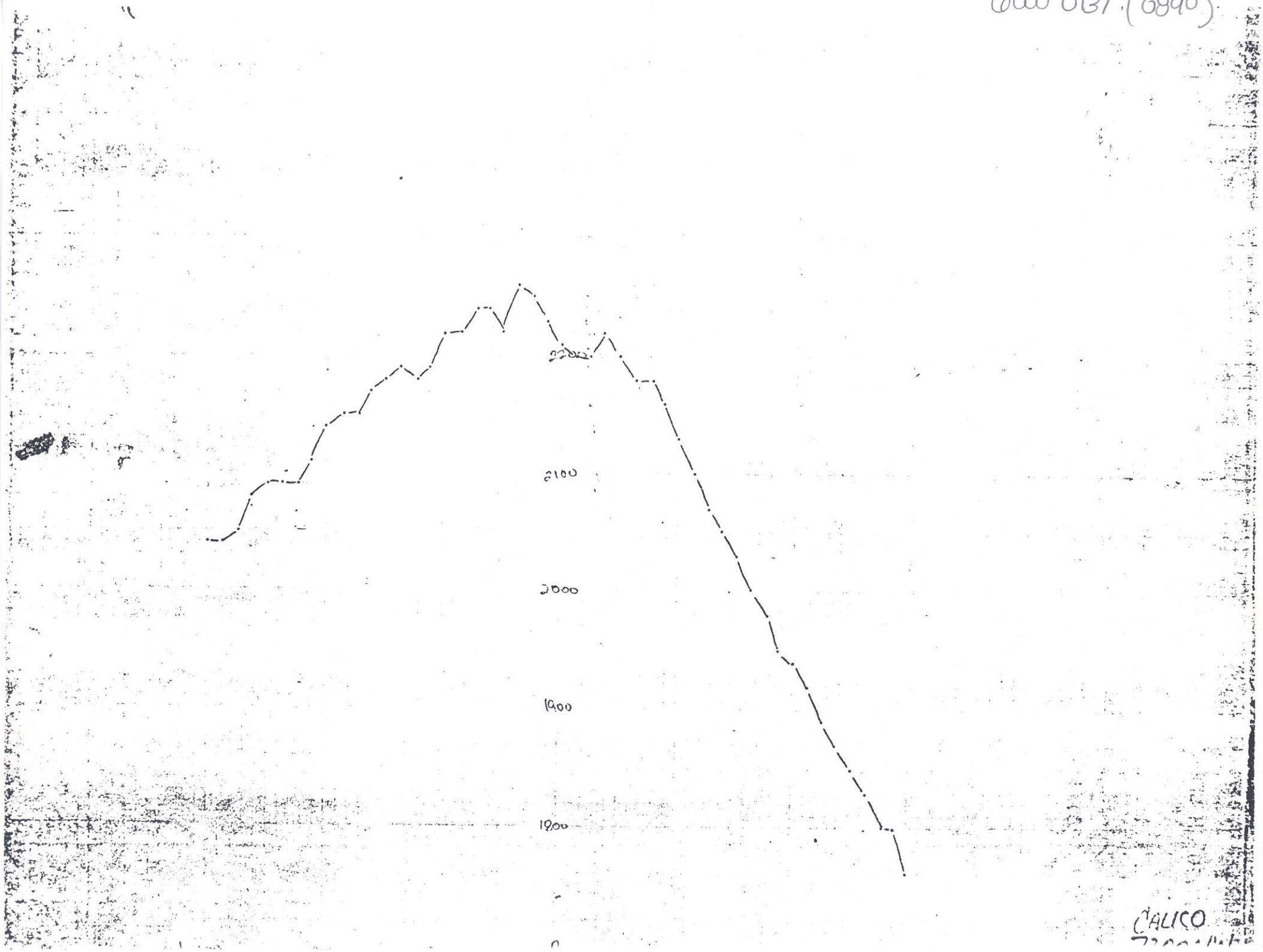
ALICO

6000 0137 (0890)



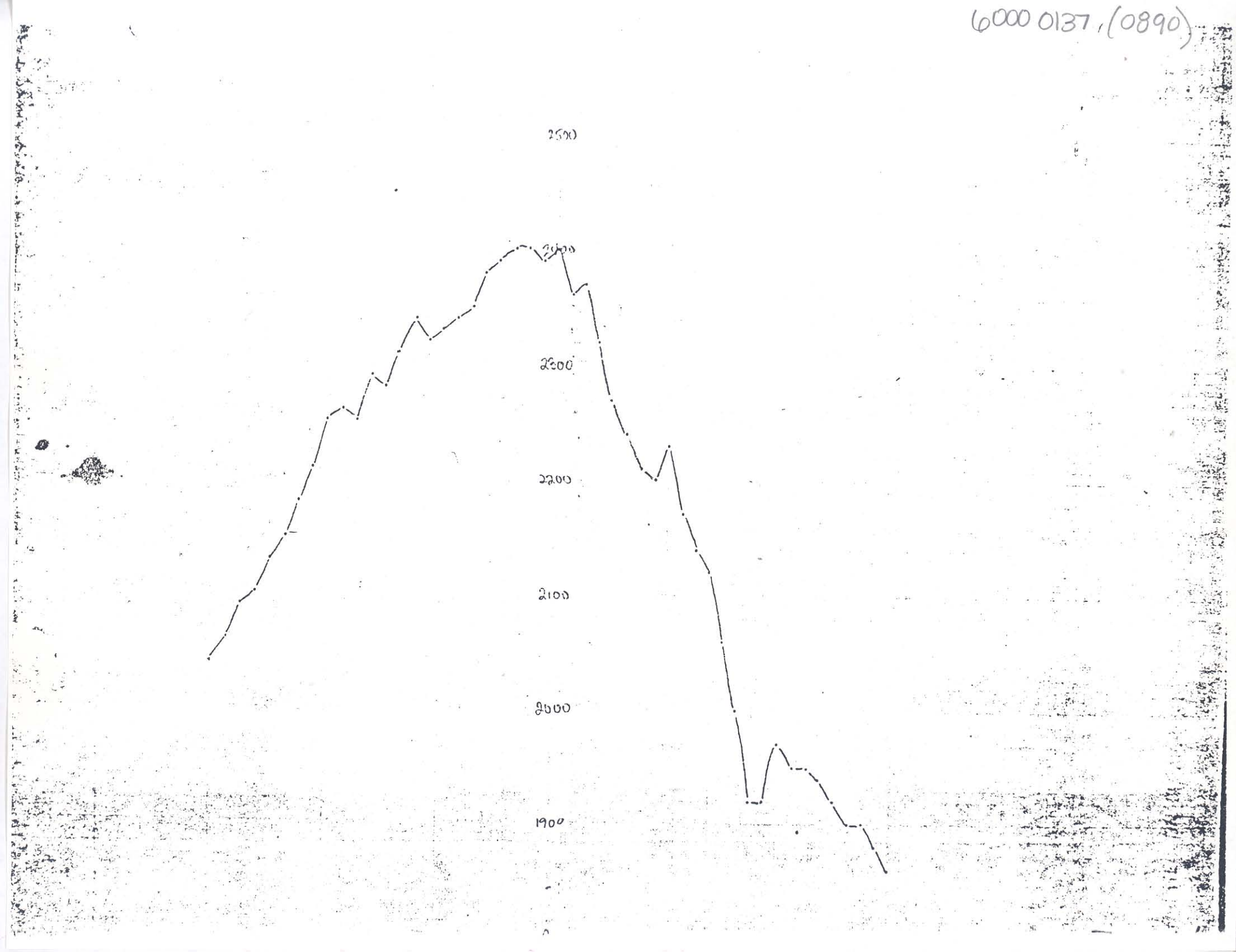
Calico
7401 SW

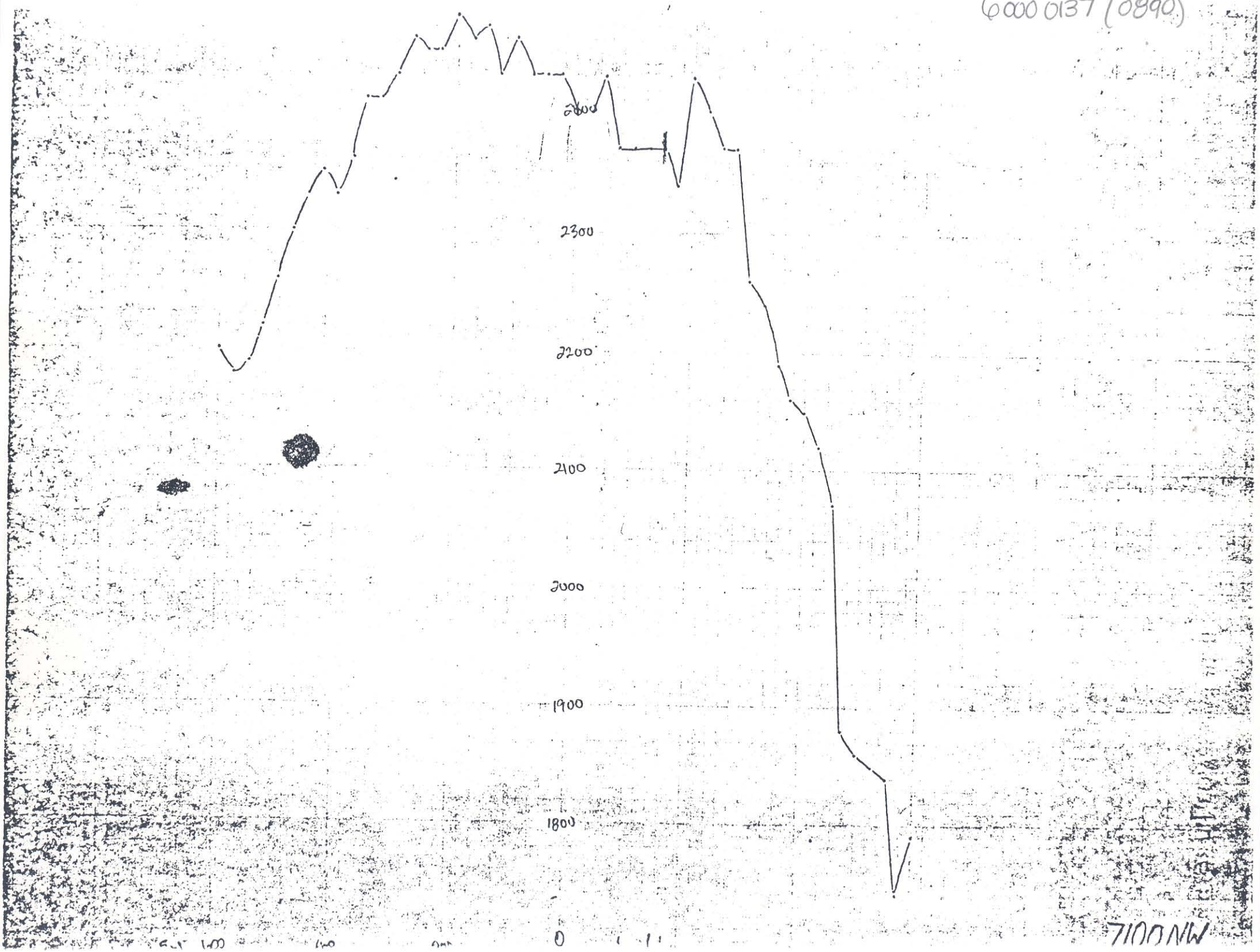
6000 0137 (0890)



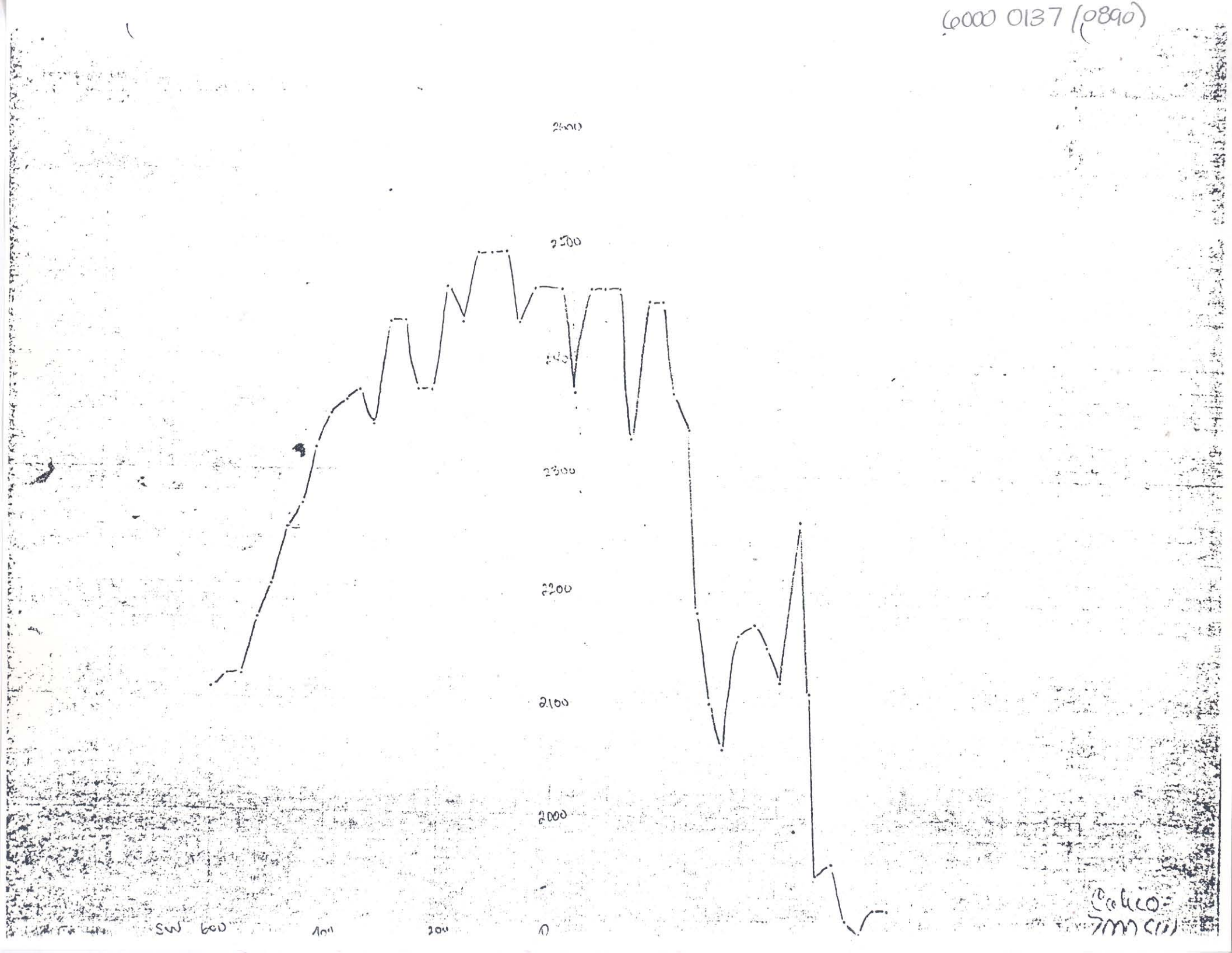
CALICO

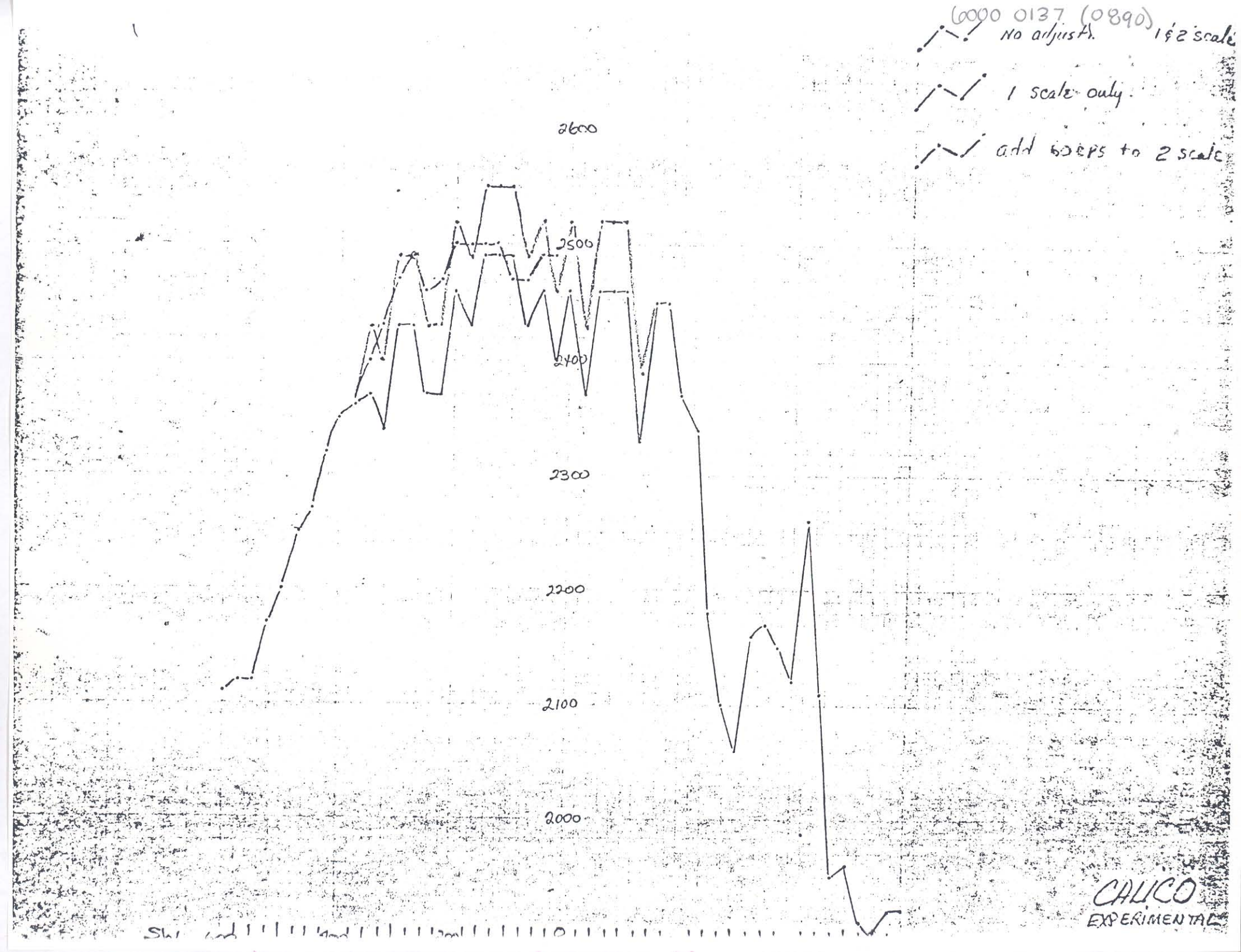
6000 0137, (0890)



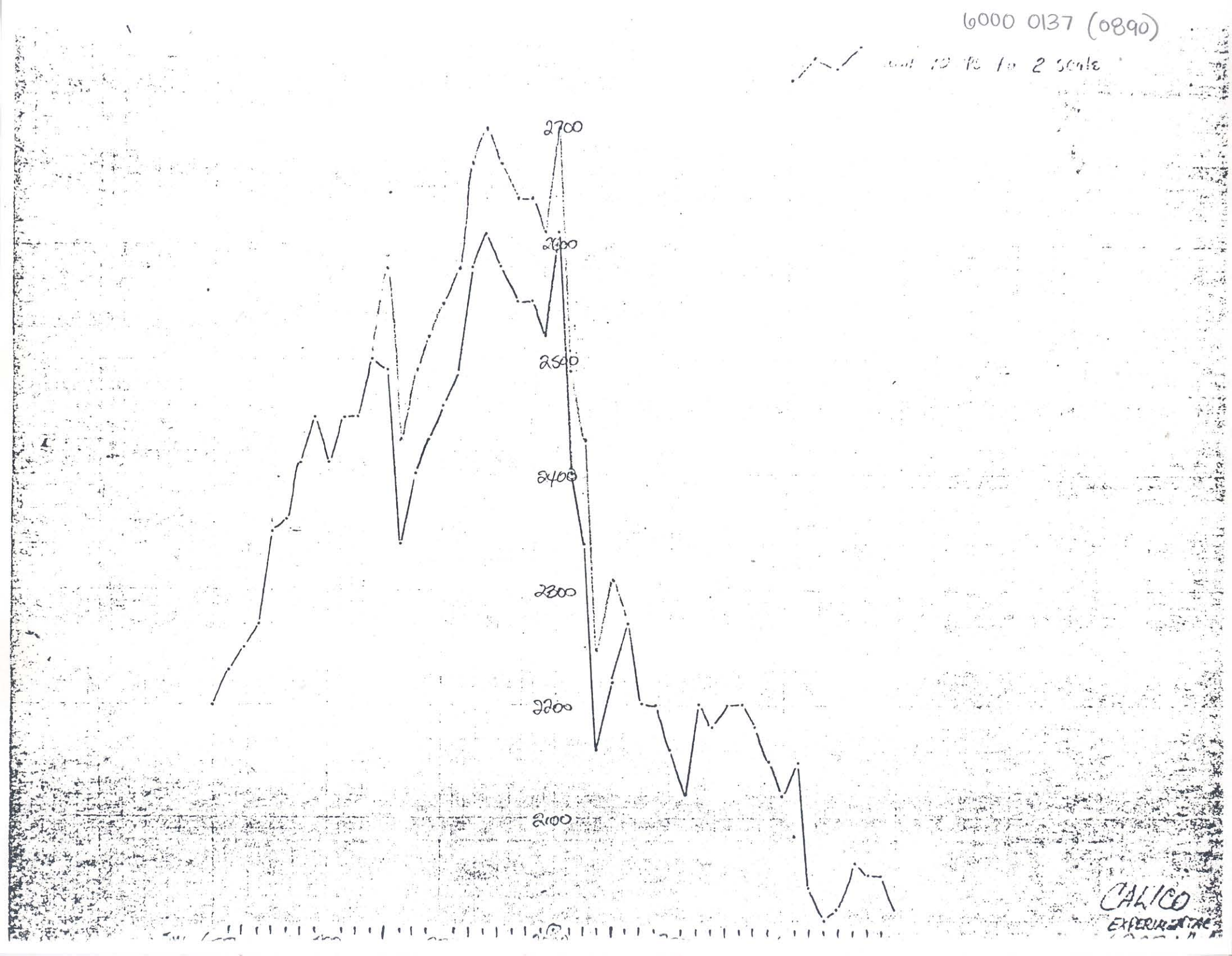


6000 0137 (0890)

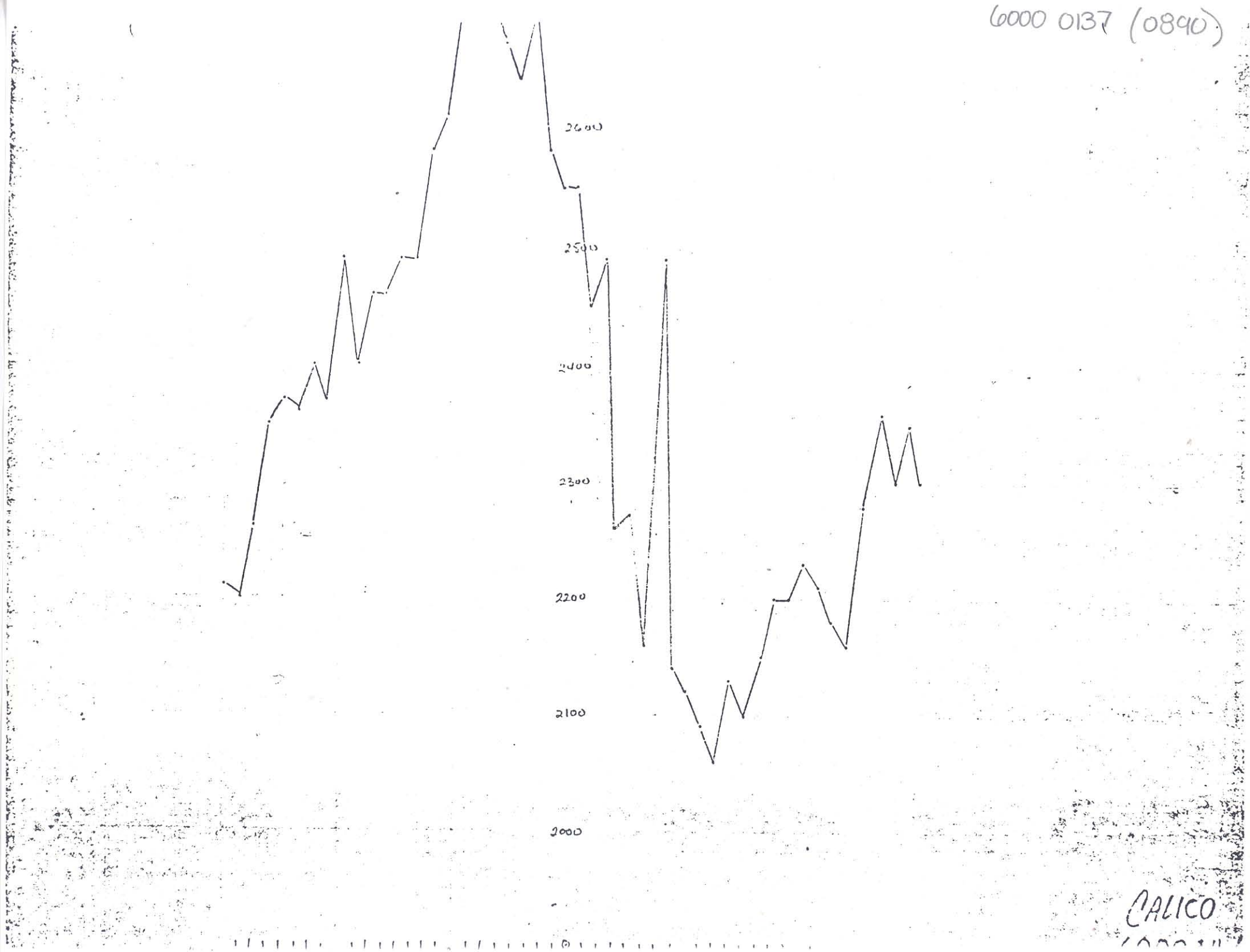



(6000 0137 (0890)
No adjusth. 1&2 scale
1 scale only.
add beeps to 2 scale
2600
2500
2400
2300
2200
2100
2000
CALICO
EXPERIMENTAL

6000 0137 (0890)

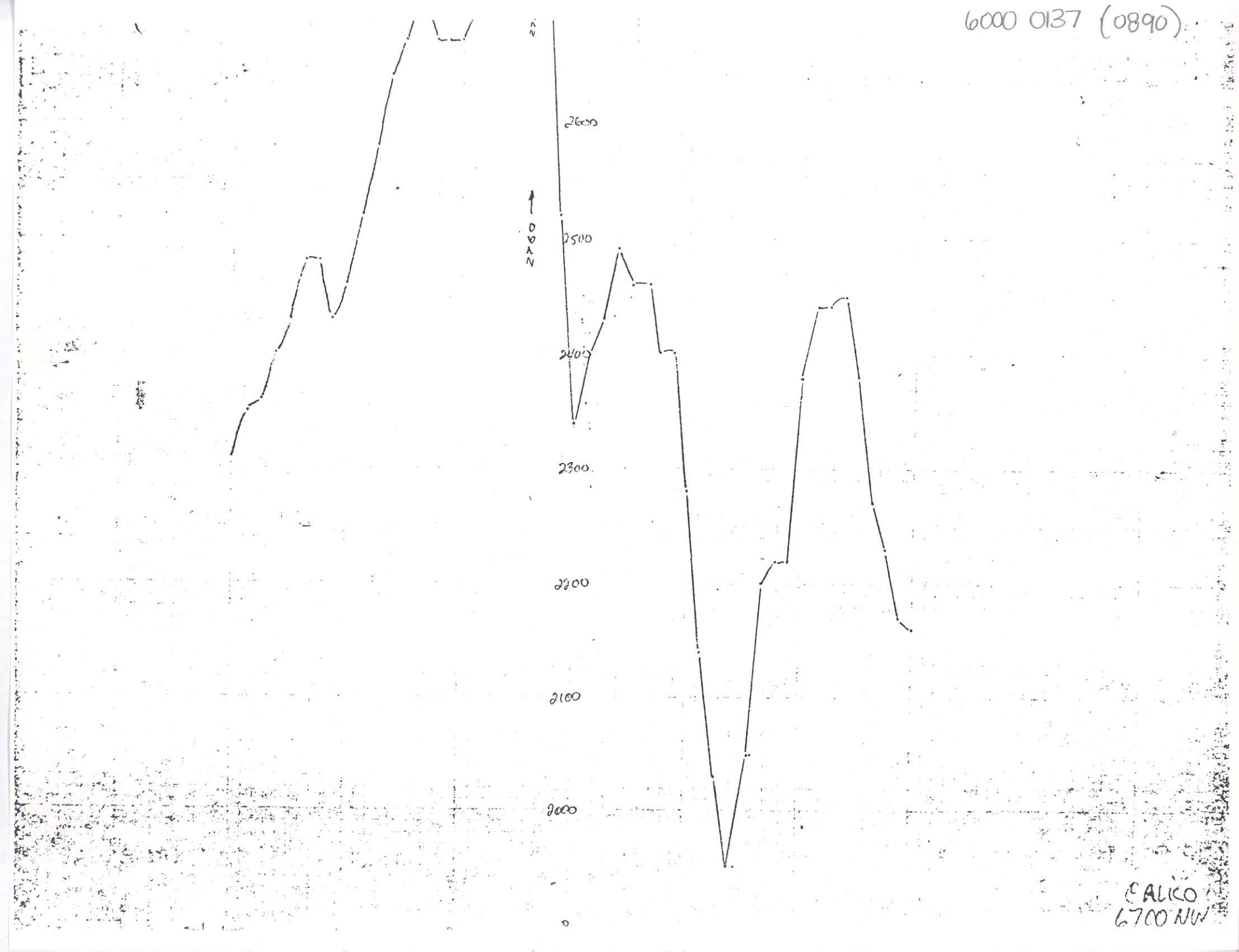


6000 0137 (0890)



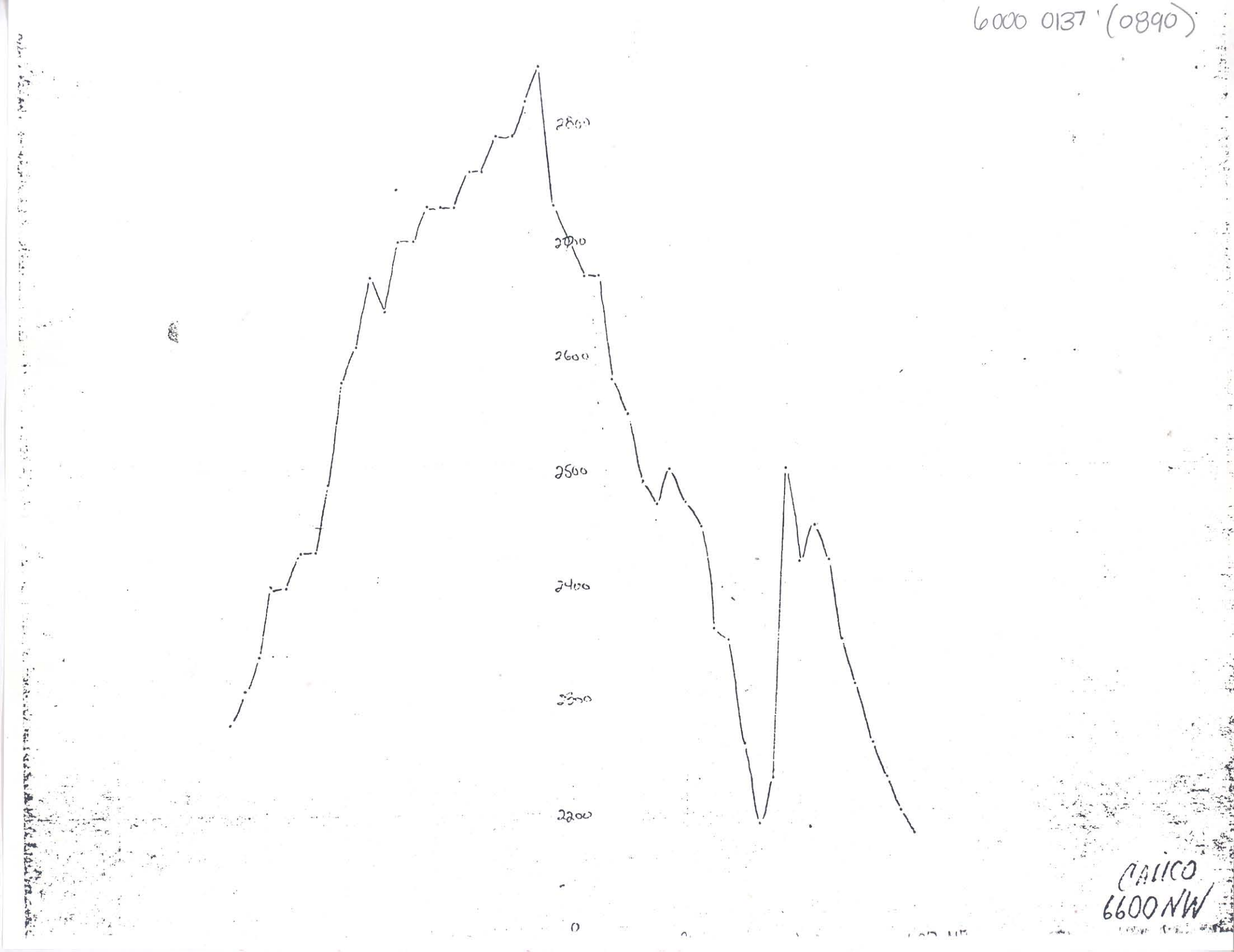
CALICO

6000 0137 (0890)



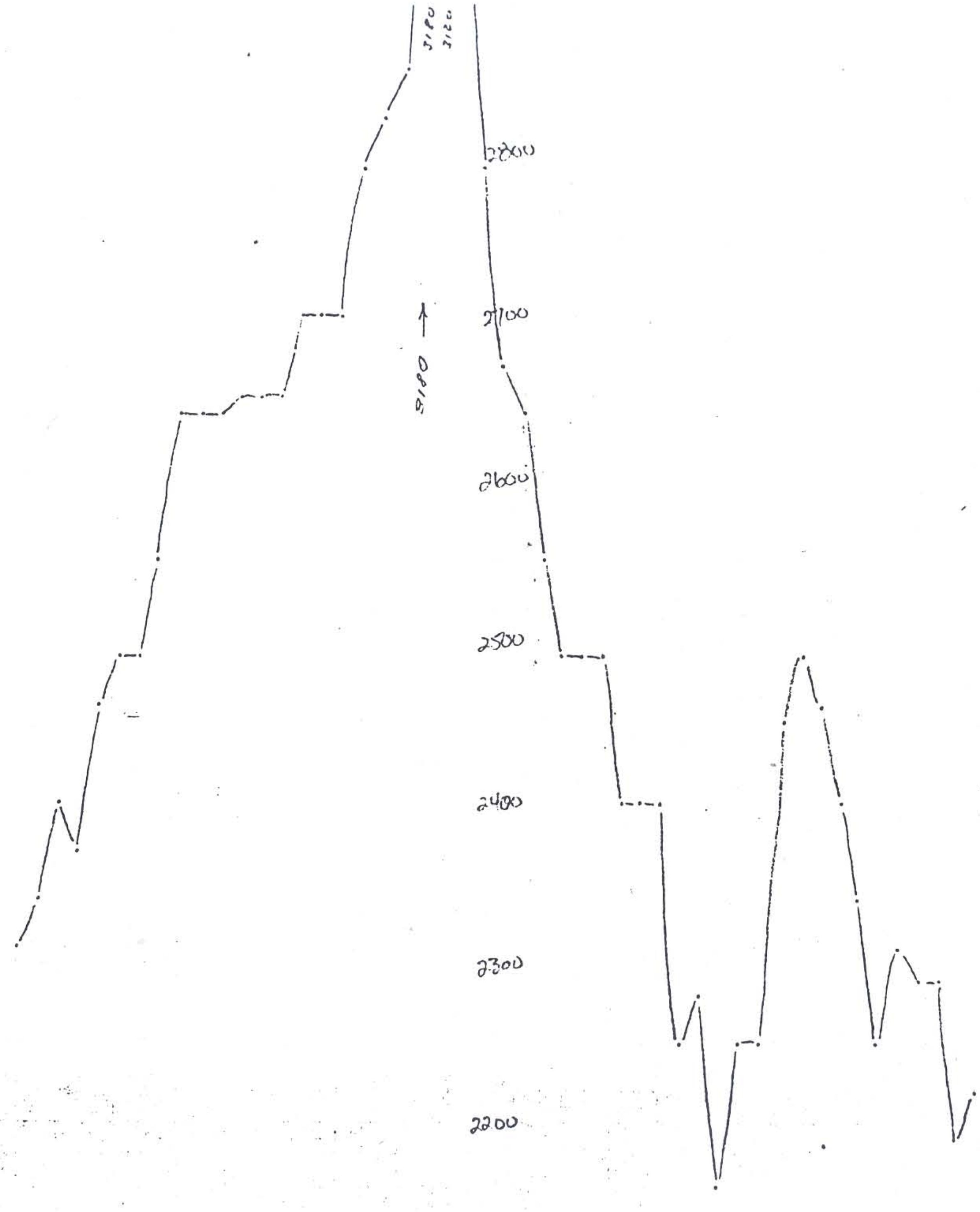
CALICO
6700 NW

6000 0137 (0890)

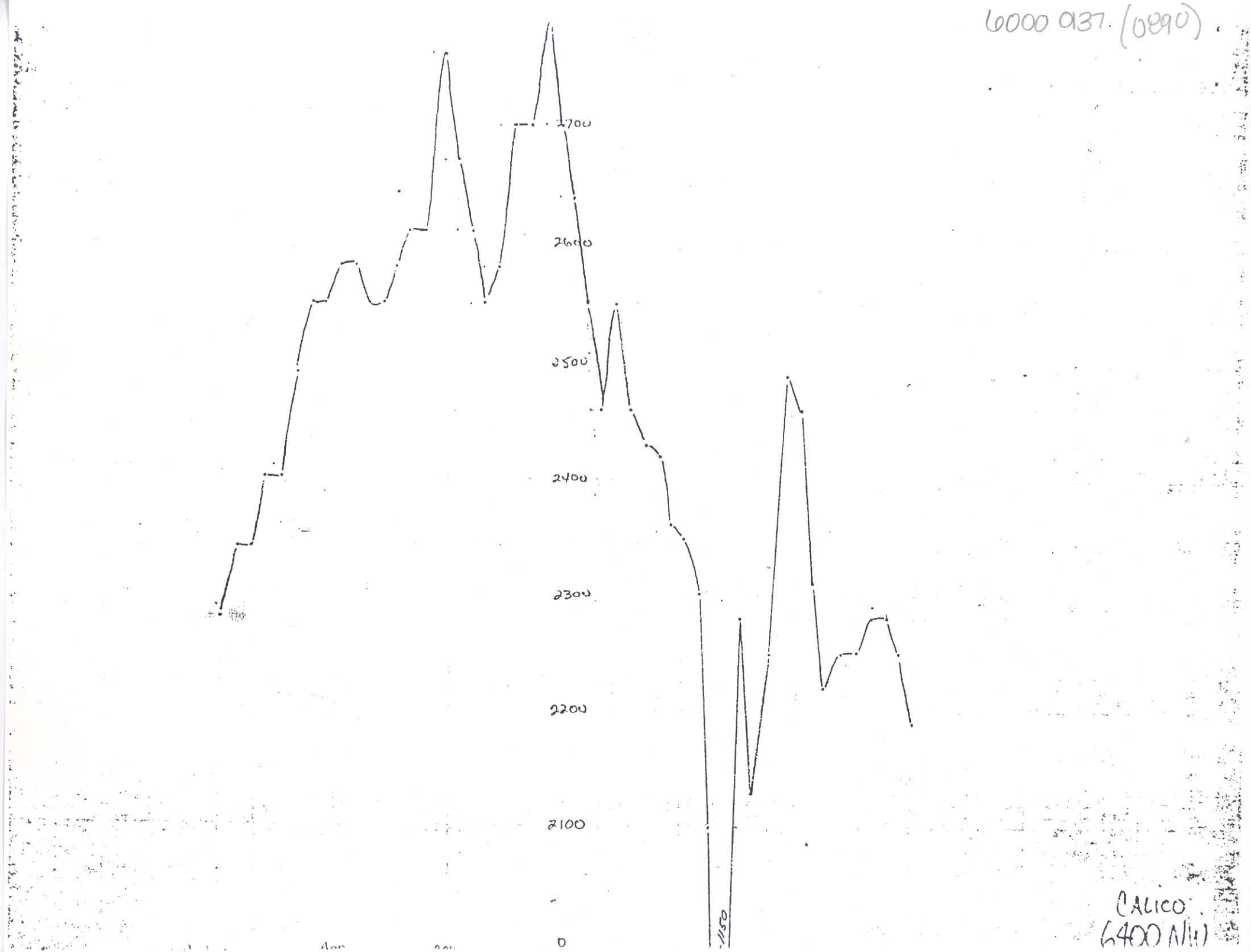


CALICO
6600 NW

6000 0137 (0890)

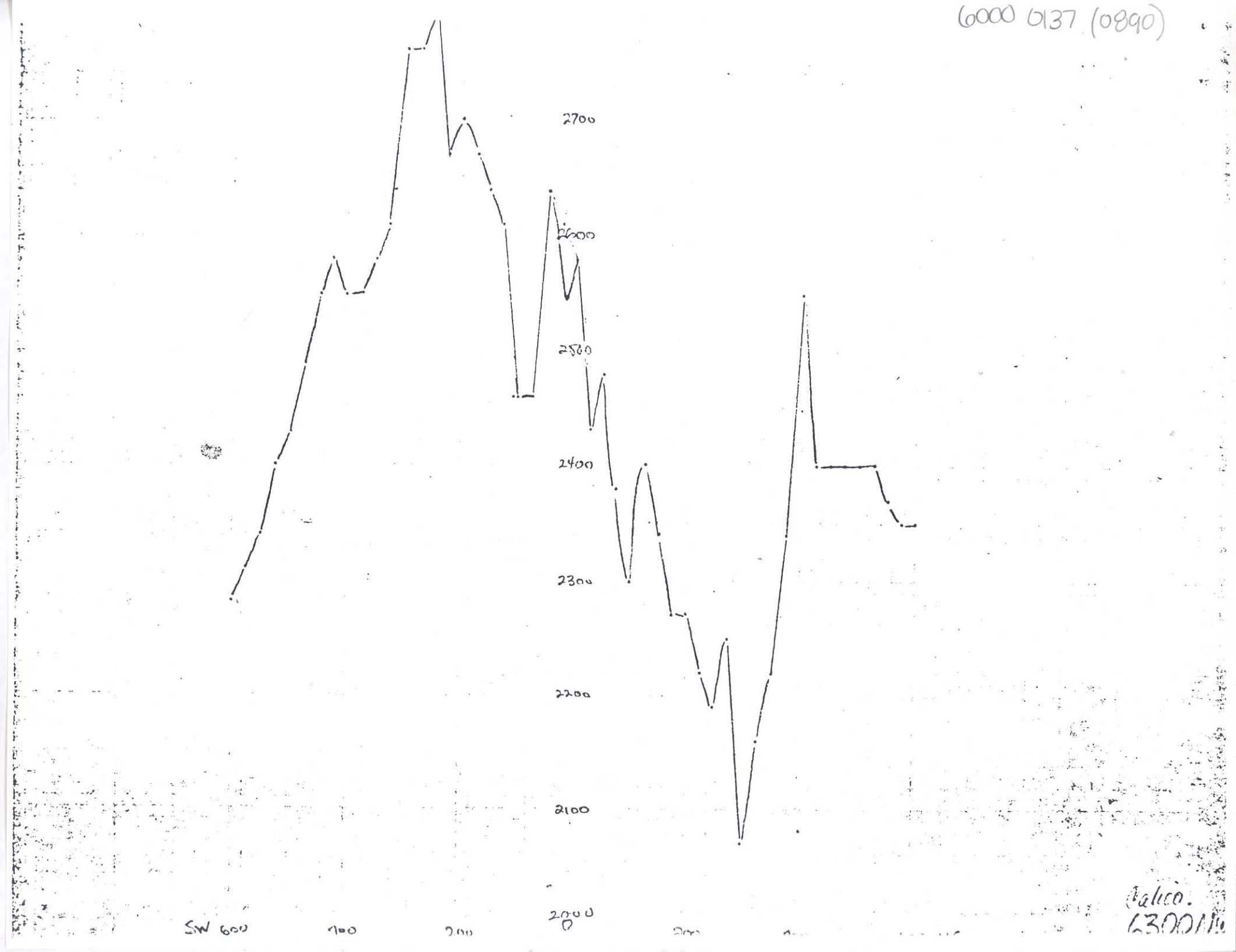


6000 037 (0890)

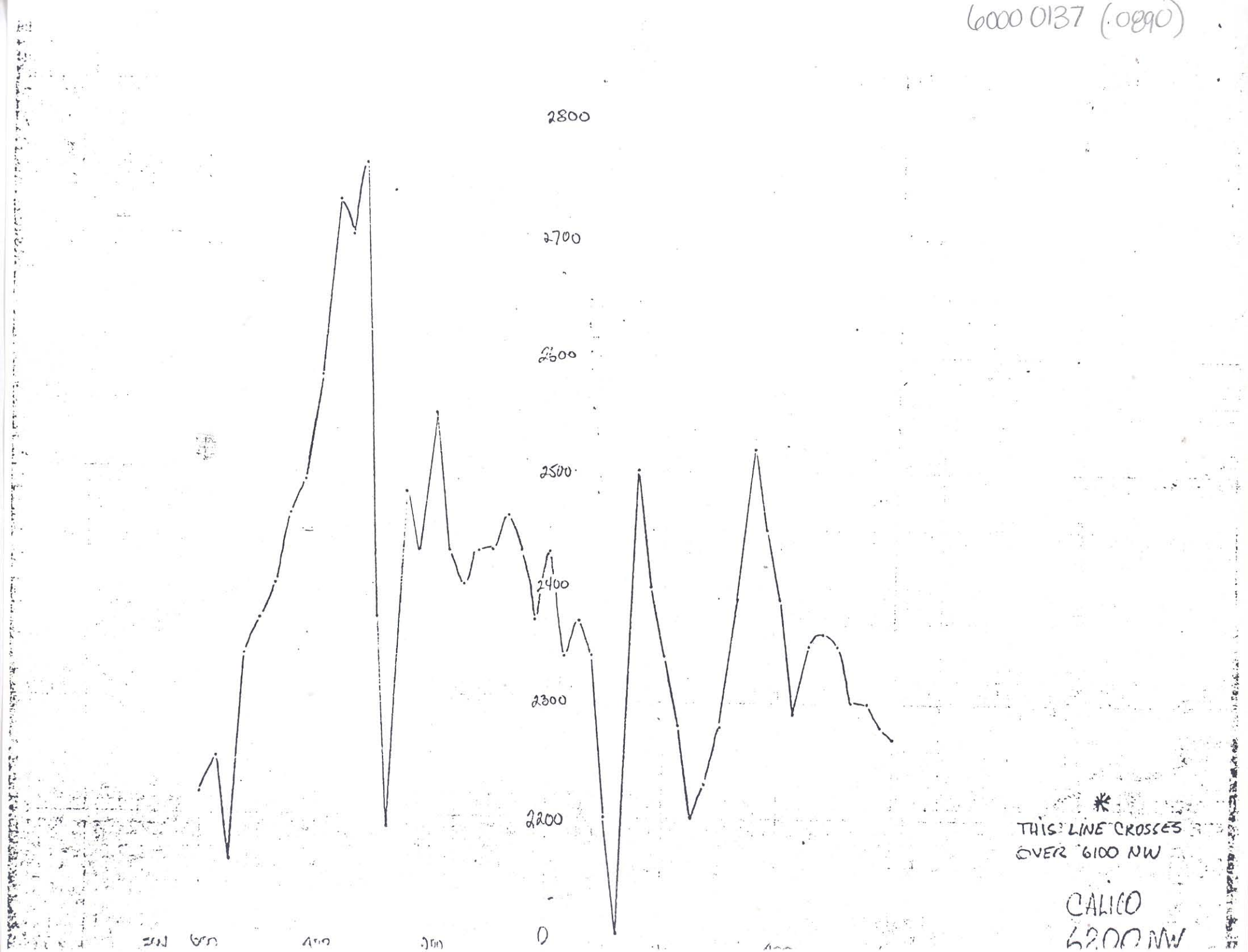


CALICO
6400 MHz

6000 0137 (0890)



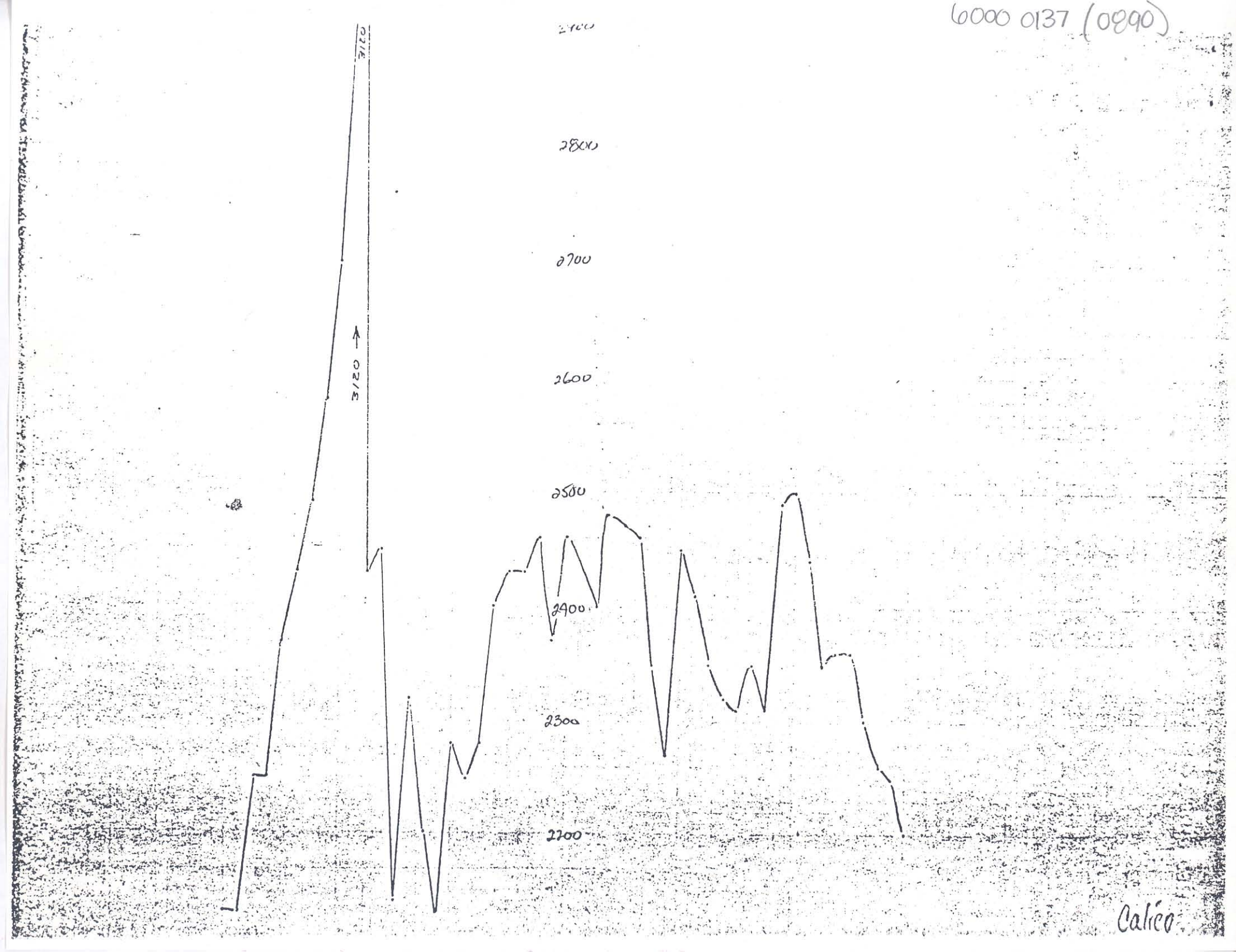
6000 0137 (.0890)



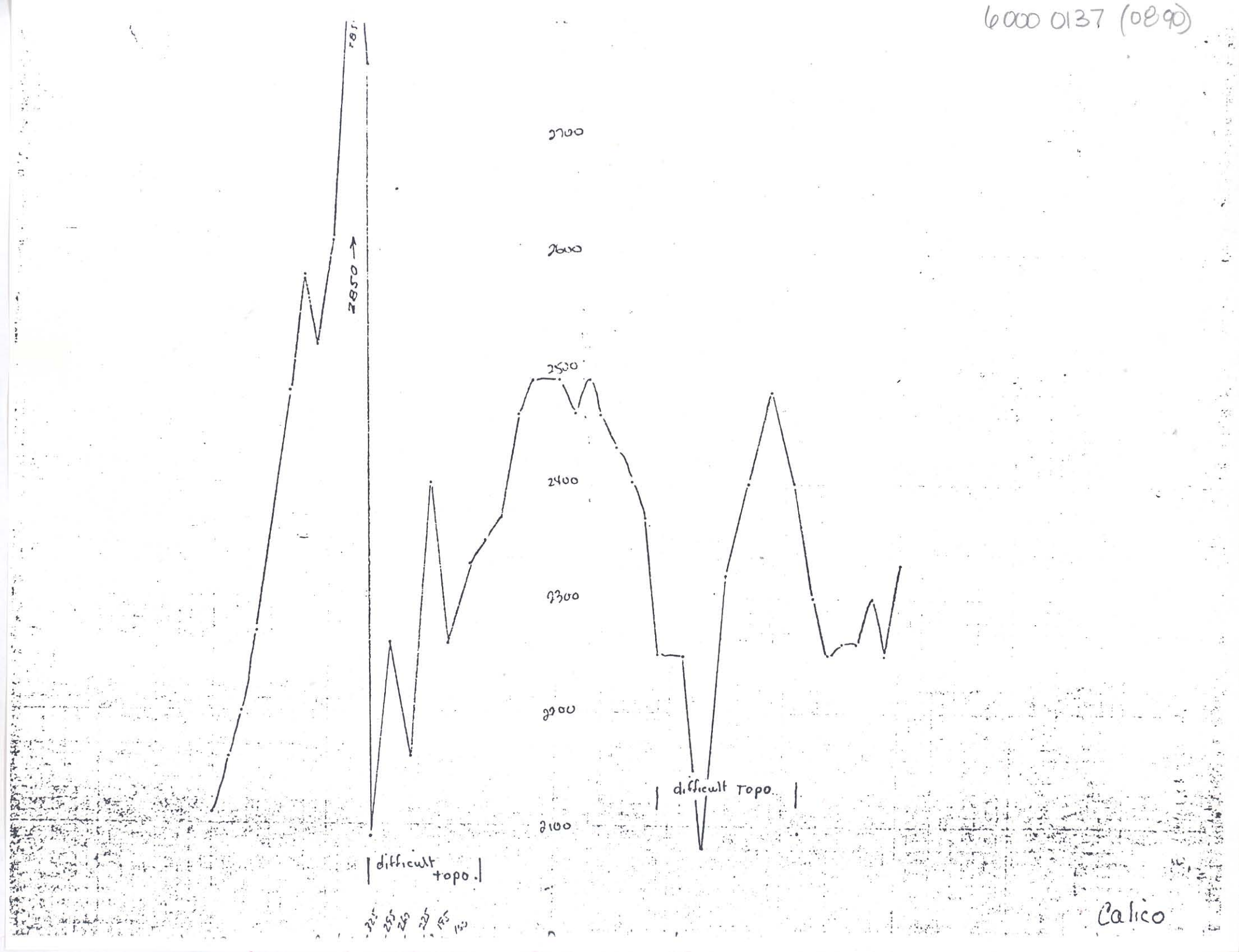
* THIS LINE CROSSES OVER 6100 NW

CALICO
6200 NW

6000 0137 (0890)



6000 0137 (0890)



SEISMIC FEASIBILITY STUDY
CALICO MINING DISTRICT
IN THE
WALKER RIVER INDIAN RESERVATION
NEAR
SCHURZ, NEVADA

September, 1966

Prepared by:

J. W. Cooksley, Jr.

J. W. COOKSLEY, JR.
GEOPHYSICIST

CALICO MINING DISTRICT

INTRODUCTION

Refraction and reflection seismic studies were conducted on the Walker River Indian Reservation near Schurz, Nevada, during August, 1966, under the terms of an engineering agreement between the Walker Martel Mining Company and the Geophysical Engineering firm of J. W. Cooksley, Jr. These studies were performed on selected areas in the Afterthought, Calico, and West Calico properties.

The purpose of the investigation was to determine whether seismic methods could be effectively employed in the mapping of subsurface geology and ore deposits in the district, and to furnish some preliminary information concerning the geologic structure and the depth to pre-Tertiary units.

PREVIOUS AND CURRENT SEISMIC WORK PERTINENT TO MINING

Until about five years ago, seismic exploration in mining had been largely restricted to the exploration of placer deposits and to the preliminary phases of extensive drilling programs. Seismic methods have only recently been applied to other mining exploration problems, but it is reasonable to expect that these methods will be used commonly as the depth to exploration targets increases.

The following are some of the published and unpublished geological and geophysical investigations employing seismic work which have some relation to the present study:

Kruger and Linehan in 1941 in the Bulletin of the Geological Society of America describe the delineation of the lower contact of a sill-like intrusive using the reflection method.

Pakiser and Black in 1957 in Geophysics discuss the application of the refraction method to finding ancient uranium-bearing river channels in sedimentary strata of Triassic age.

Dudley and McGinnis in 1962 and 1964 in the Technical Reports series of the Desert Research Institute describe several seismic surveys applied to the exploration of basin and pediment areas in Nevada.

Crosby and Cavin in 1960, published by the Washington State Research Institute, reported on reflection exploration to depths of about 2000 feet. The survey was part of a hydrological study in a basin filled with basalt flows and pyroclastics.

Mayne, in 1964, unpublished, described a study conducted for the Atomic Energy Commission in central Idaho. Both refraction and reflection methods were employed on an area which is underlain by a section of volcanics in excess of 5,000 feet.

Cooksley, in 1962, 1963, and 1964, unpublished, used refraction surveys for delineating phosphate deposits and mapping subsurface structure in southeastern Idaho.

Cooksley, in 1965, unpublished, employed refraction methods to delineate faulting and alteration. This work was pertinent to base metal exploration in north-central Nevada.

GEOLOGIC SETTING

The subject site is located in the extreme western portion of the Basin and Range province. This region is typified by rather broad valleys and by mountain ranges which trend N30°W. Normal faults which strike approximately N30°W appear to be the main influence on the present land form. Some thrust faults have been mapped in the pre-Tertiary rocks by Ferguson and Muller of the U. S. Geological Survey. The reader is referred to the Geological Map of Mineral County compiled by Ross (1960).

The areas investigated are situated in the Calico Hills, a low range located about six miles northeast of Schurz, Nevada. This N45°W-trending range is composed mainly of siliceous to intermediate volcanics of Tertiary age which rise about 300 feet above the immediate valley. Outcrops of pre-Tertiary metamorphic and igneous rocks are common in the northwestern portion of the range.

In the pediment along the southwestern flank of the range, the normal geologic section is:

0 to 30 feet of unconsolidated eolean and alluvial deposits of Quaternary age.

0 to 50+ feet of lake beds of Pleistocene age.

0 to 2,000+ feet of volcanic rocks of Tertiary age.

basement consisting of metamorphic and intrusive rocks of pre-Tertiary age.

Two fault systems are readily apparent from the geologic map of E. G. Lawrence, Consulting Geologist, Reno, Nevada. The predominant system is coincident with the regional structure and strikes N30°W to N45°W. The other system strikes N40°E to N70°E. The age of faulting ranges into late Tertiary or Quaternary.

VELOCITY CORRELATION CHART

	AFTERTHOUGHT	CALICO	WEST CALICO
Surficial deposit	about 1.0 fpms*	1.0 to 2.0 fpms	1.2 fpms
Lake beds	1.5 fpms, if present	2.0 fpms, if present	2.0 to 2.5 fpms
Volcanics	3.6 to 10.0 fpms	6.1 to 10.0 fpms	3.1 to 5.5 fpms
Metamorphic and intrusive rocks	10.0 to 16.0 fpms		14.8 fpms

* fpms = feet per millisecond

SEISMIC INVESTIGATION

Scope

Approximately six thousand line feet of seismic profile was shot in the course of this study. Both refraction and reflection methods were employed. The profile lines were placed in such a manner as to test the more significant geologic rock units and structural features.

The equipment used consisted of a 24-channel GA-11 seismic system manufactured by Southwestern Industrial Electronics Co., Houston, Texas. This instrument is capable of handling both reflection and some types of refraction surveys.

Objectives of Study

The purpose of the study was to determine the feasibility of applying seismic methods to mining exploration in the Calico Hills. The two main items of investigation were to measure the characteristic seismic velocities of the various geologic units and to determine which units were the most likely to furnish usable seismic refractions and reflections. It was anticipated that the Pre-Tertiary surface could be mapped using refraction and reflection methods and that areas of brecciation and alteration might be resolved as low-velocity and low-amplitude anomalies.

Theoretical Basis and Considerations

The mathematical expression relating the velocity of longitudinal seismic waves to elastic constants of the propagating material is

$$V_L = \sqrt{\frac{k + (4/3)n}{d}}$$

Where k = bulk modulus
n = shear modulus
d = density

Because the Pre-Tertiary igneous and metamorphic complex appears to be much harder than the overlying volcanic and sedimentary units, it seems reasonable that the Pre-Tertiary complex would possess a higher seismic velocity. This was found to be true; however, locally, some massive andesite units possess velocities approaching those of the Pre-Tertiary units. Due to the fact that the seismic velocity is a function of the strength of the rock, it also follows that the brecciation and alteration attendant to mineralization would be resolved as lower velocities. Also, post-mineral fracturing and faulting would be expected to cause lower velocities.

Seismic Traverses

Afterthought Traverse 1 -- 600 feet: Unweathered Pre-Tertiary igneous and metamorphic rocks were encountered at depths ranging from 20 to 50 feet. The seismic velocity ranged from 10.0 to 15.0 fpms in this unit. The unweathered layer is covered by a weathered layer to from 10 to 50 feet thick possessing a rather uniform seismic velocity of 5.0 fpms. An intensely weathered zone of Pre-Tertiary rock about 5 or 10 feet thick was encountered at the northeast end of the traverse. Velocity of 1.8 fpms was measured in this material.

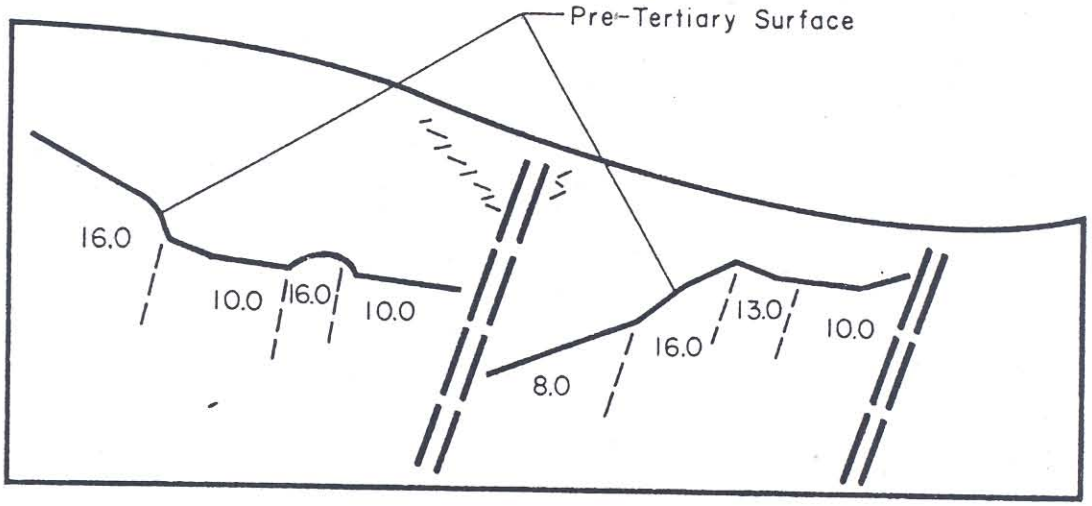


Figure 1. A generalized section showing the Pre-Tertiary surface and the velocity units with their respective transmission velocities along this surface as covered in the discussion of Afterthought Traverse 2. Theoretically, these units coincide with rock units or geologic structural features.

Afterthought Traverse 2 -- 3,000 feet: The surface of the Pre-Tertiary units was found to plunge away from the mountain front to a depth in excess of 300 feet near Sta. 900. West of this point the Pre-Tertiary surface was displaced downward along a normal fault.

The Pre-Tertiary surface may be subdivided into units herein described as velocity units. Each zone has its respective characteristic seismic velocity and probably represents one or more rock units. These velocities range from 8.0 fpms to 16.0 fpms. It is believed that the narrow 8.0 fpms velocity zone near Sta. 2500 is characteristic of a zone of weakness such as a fault zone. The 10.0 fpms velocity zone at Sta. 900 to 1400 is indicative of a zone of alteration or extensive brecciation, possibly associated with mineralization. The weathered zone over the 11.4 fpms velocity zone at Sta. 3000 was observed to be a fine-grained intrusive rock.

Also west of Sta. 900, a massive andesite flow (?) crops at the surface. The velocity in the flow was measured at 10.0 fpms. Both the volcanics and the weathered zone of the Pre-Tertiary units have a velocity of about 4.0 fpms. This velocity suggests that these units are above the water table.

Afterthought Traverse 3 -- 750 feet: The Pre-Tertiary surface was found to slope from 270 feet to 420 feet in a southwesterly direction. Unfortunately, due to the manner in which the geophone lines were layed out, there are no computable points within 90 feet of Drill Hole No. 6. The shots from the shot point at the north end indicate the presence of a lower velocity zone from about Sta. 200 to Sta. 450.

Three seismic units were distinguishable in the volcanics. From top to bottom, these had velocities of 1.5 fpms, 3.6 fpms, and 7.1 fpms.

The refraction method was the principal method used on this traverse. The reflection method was tried, but the exploration targets were too close to the surface for effective use of this method.

Calico Traverse 1 -- 600 feet: The main purpose of this traverse was to investigate the applicability of reflection seismic methods to exploration in the Calico Hills. Test boring Calico No. 3 was made available as a shot hole. Six hundred feet of profile line was shot using two 12-detector spreads and 2 1/2-pound explosive charges.

The shot hole was caved at a depth of 25 feet, hence it was not possible to obtain any up-hole velocity data in the volcanic units. The large diameter of the drill hole precluded ideal seismic coupling with the ground. Nevertheless, usable and distinct reflections were

obtained, even with the shallow burial of the shot, absence of stemming, and poor seismic coupling.

Assuming that the average velocity of the volcanics below the depth of 200 feet is 10.0 fpms, reflection horizons were calculated to be at depths of 850 feet, 1,305 feet, and 1,960 feet. The reflection at 1,960 feet is quite strong in relation to the two above and is therefore thought to be the surface of the Pre-Tertiary units. The upper reflections are believed to be caused by more competent units within the volcanics.

Calico Traverse 2 - 600 feet: The purpose of this traverse was the same as the preceeding traverse, but this line was shot without the benefit of a drilled shot hole. The 2 1/2-pound shots were buried at a depth of only four feet. The reflections were not distinct and were of much poorer quality than those obtained from the deeper shot hole on Calico Traverse 1. The travel times on six recordings varied over a range of 20% for the A Reflection, about 15% for the B Reflection, and about 25% for the C Reflection.

Due to the poor record quality, the geologic findings of this traverse are extremely limited and are subject to question. It is apparent, however, that the depths to the A, B, and C Reflections are greater than in Calico Traverse 1. This is to be expected because Calico Traverse 2 is further out in the valley. A drop of 260 feet is indicated on the Pre-Tertiary surface between Calico Traverse 1 and Calico Traverse 2.

West Calico Traverse -- 700 feet: The purpose of this traverse was to investigate the applicability of the refraction method to mapping the Pre-Tertiary surface at depths to 500 feet. About 700 feet of profile was shot using two colinear 275-foot long, 12 detector spreads, about 100 feet apart at the middle of the traverse. One- to 2 1/2-pound charges were shot from shallow shot holes about 4 feet deep.

Good velocity and depth resolution was obtained where the Pre-Tertiary surface was not steep. Unfortunately the refracting surface becomes quite steep west of drill hole WC-1 and the velocity zones along this surface could not be computed due to the absence of two-way travel-times in this part of the traverse. A velocity of 14.8 fpms was assumed on the Pre-Tertiary surface west of WC-1 for the purpose of calculating points from a one-way time-distance plot. Better information could be obtained in these steep areas as the areal coverage of the survey is increased.

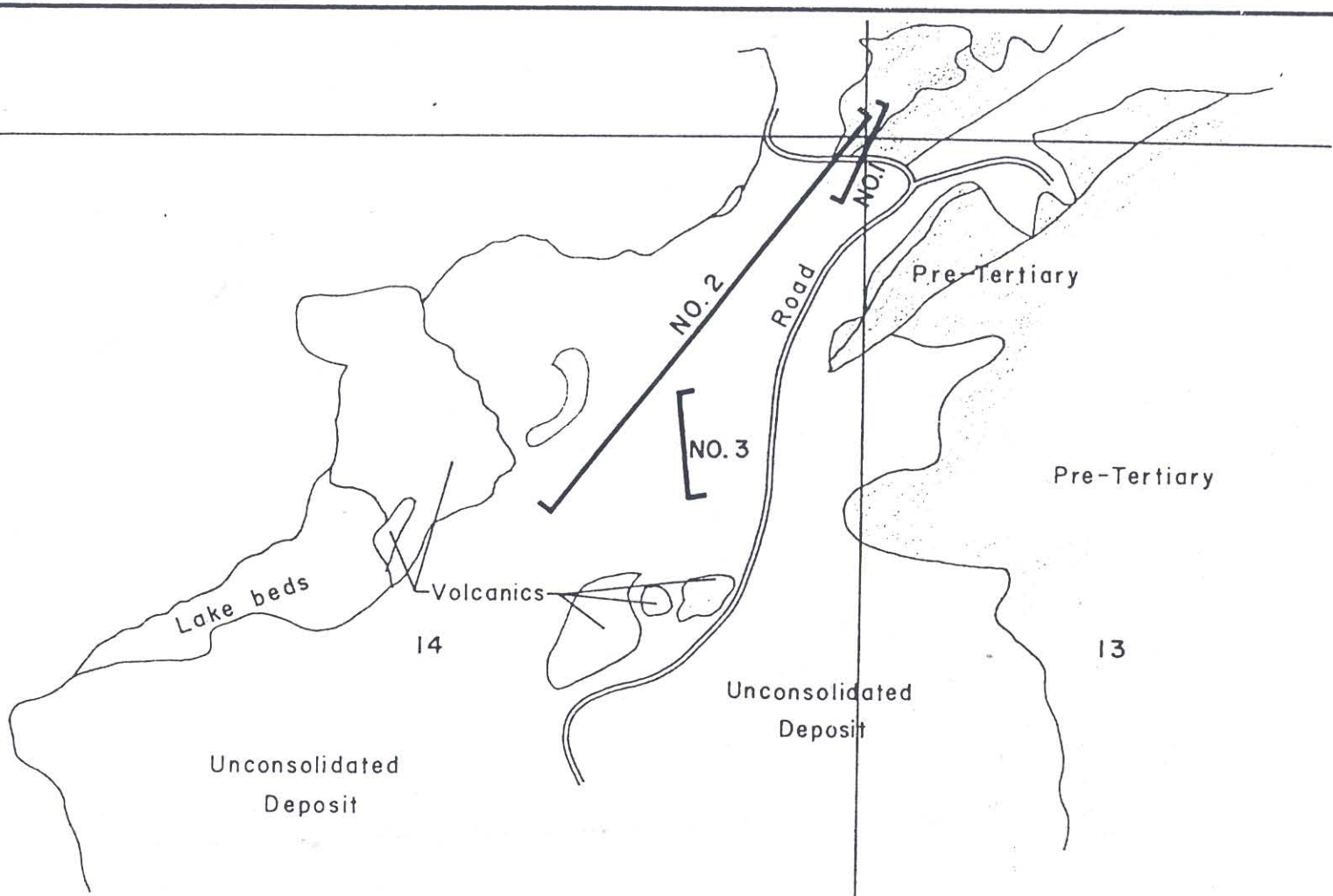


PLATE NO. 1

J. W. COOKSLEY, JR.

GEOPHYSICIST

LOCATION MAP
AFTERTHOUGHT PROSPECT
SEISMIC PROFILES

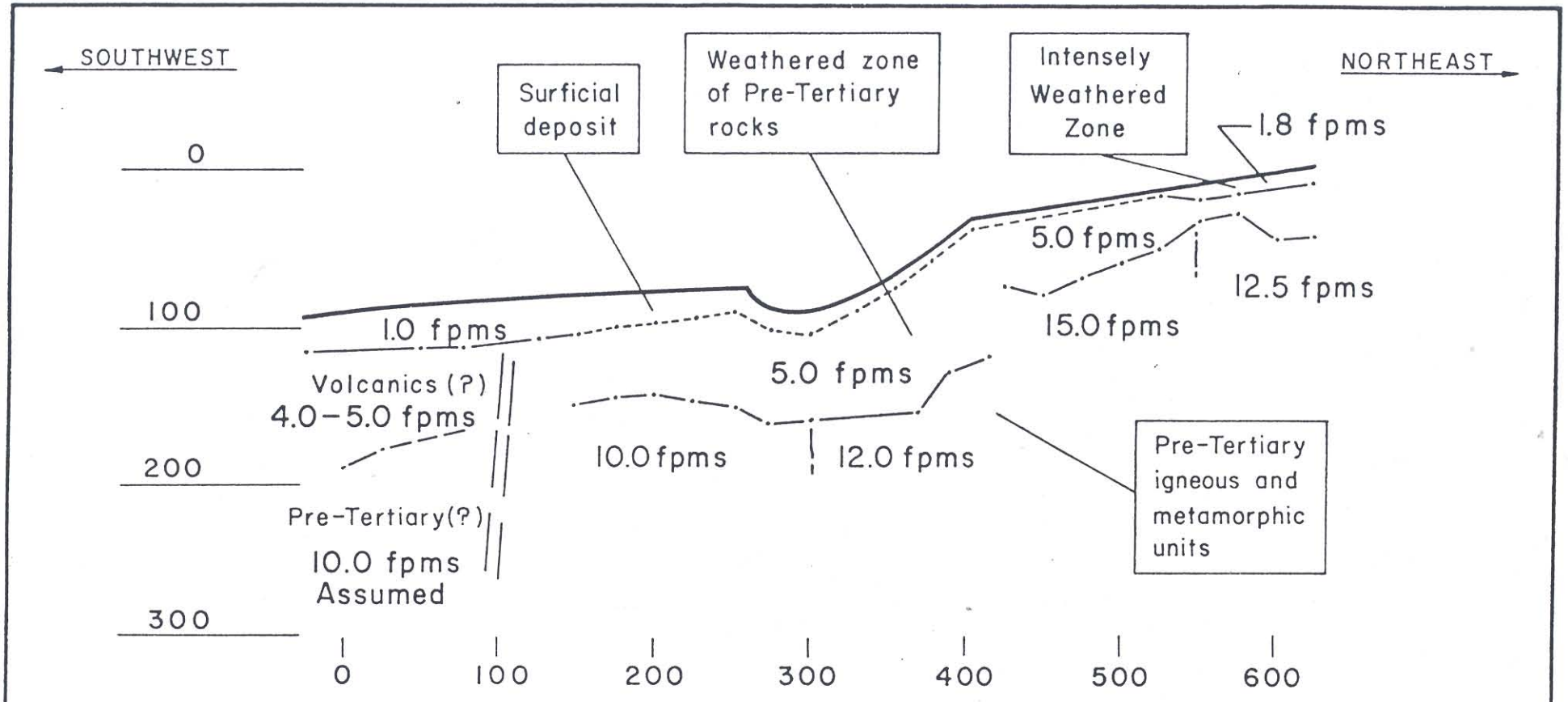


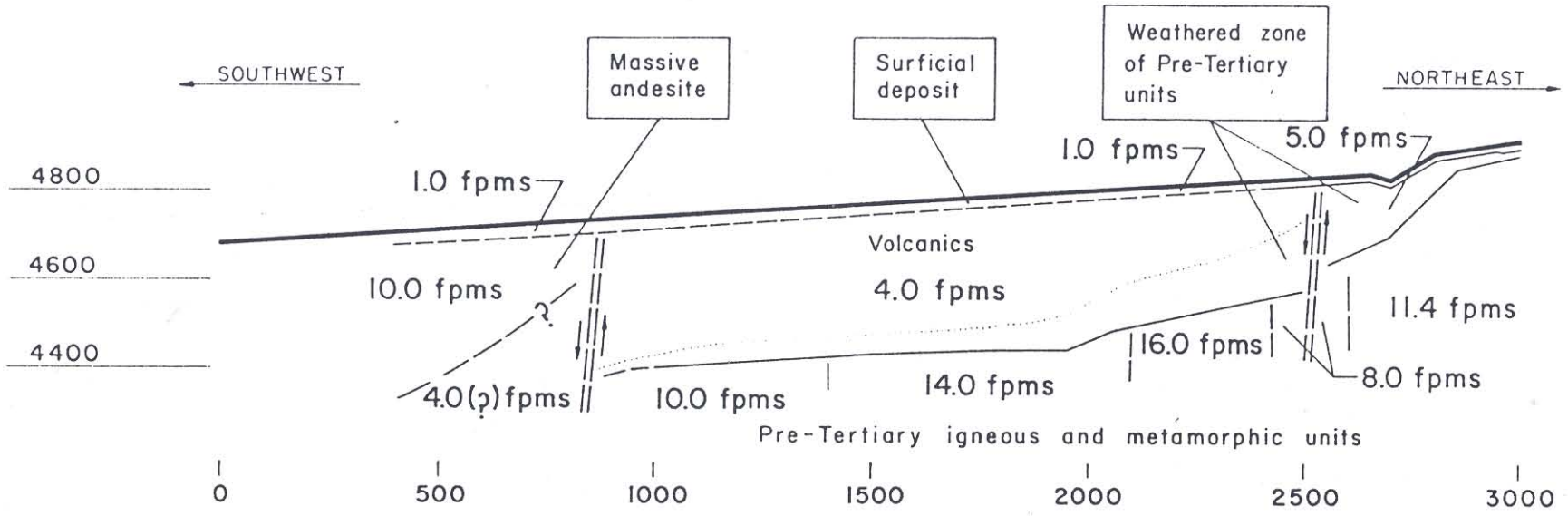
PLATE NO. 2

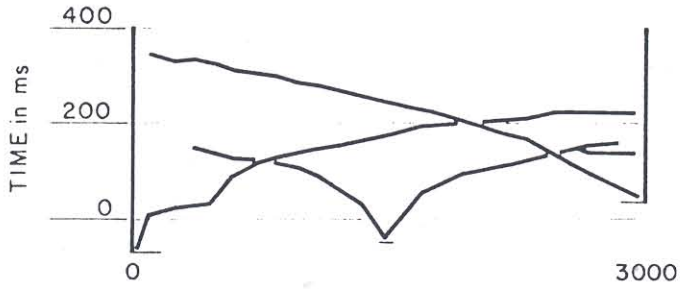
J. W. COOKSLEY, JR.

GEOPHYSICIST

SEISMIC PROFILE AT AFTERTHOUGHT PROSPECT

TRAVERSE NO. 1





TIME DISTANCE GRAPH A.P. NO. 2

PLATE NO. 3

J.W. COOKSLEY, JR.
GEOPHYSICIST

SEISMIC PROFILE AT AFTERTHOUGHT PROSPECT

TRAVERSE NO. 2

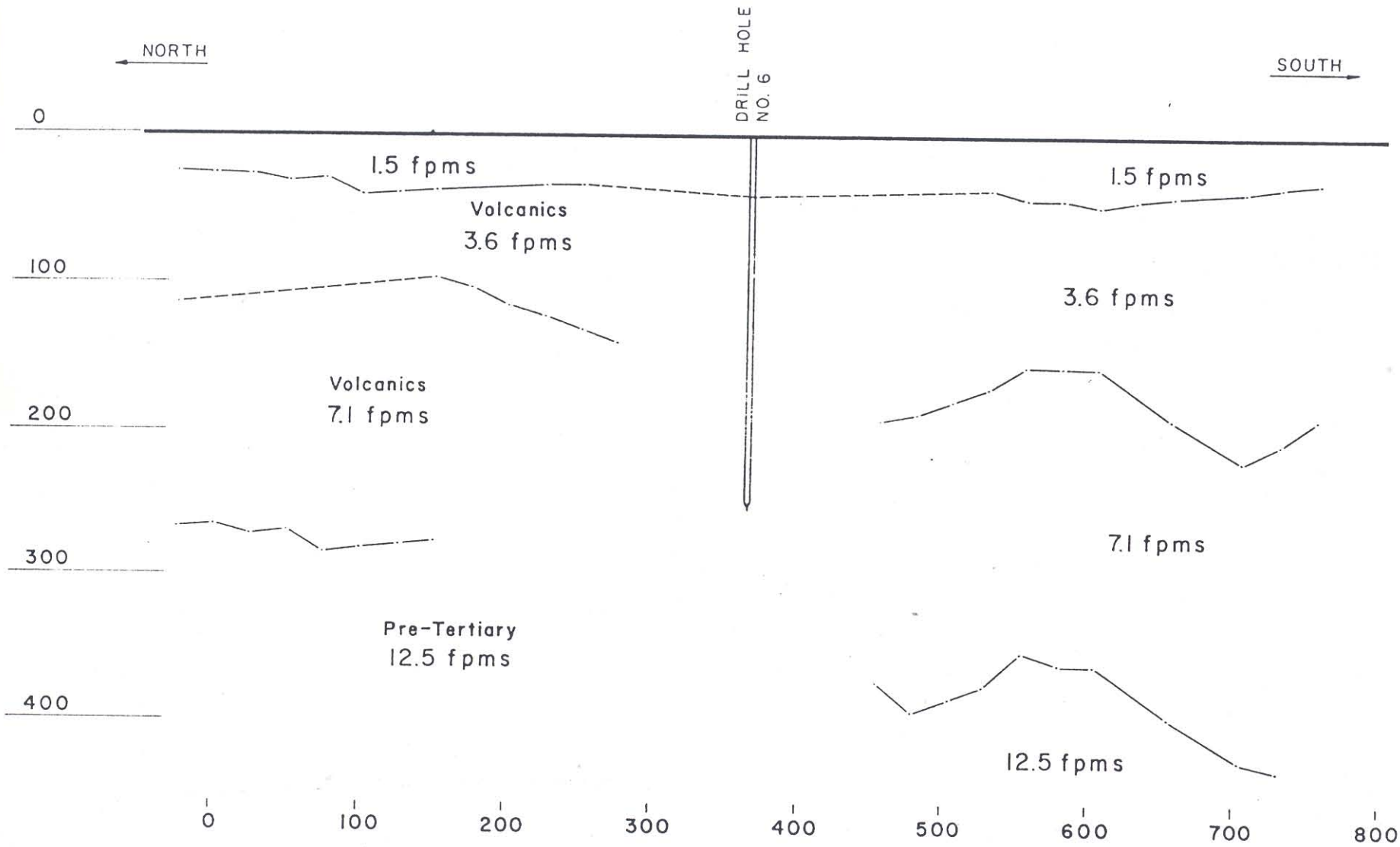


PLATE NO. 4

J.W. COOKSLEY, JR.
GEOPHYSICIST

SEISMIC PROFILE AT AFTERTHOUGHT PROSPECT

TRAVERSE NO. 3

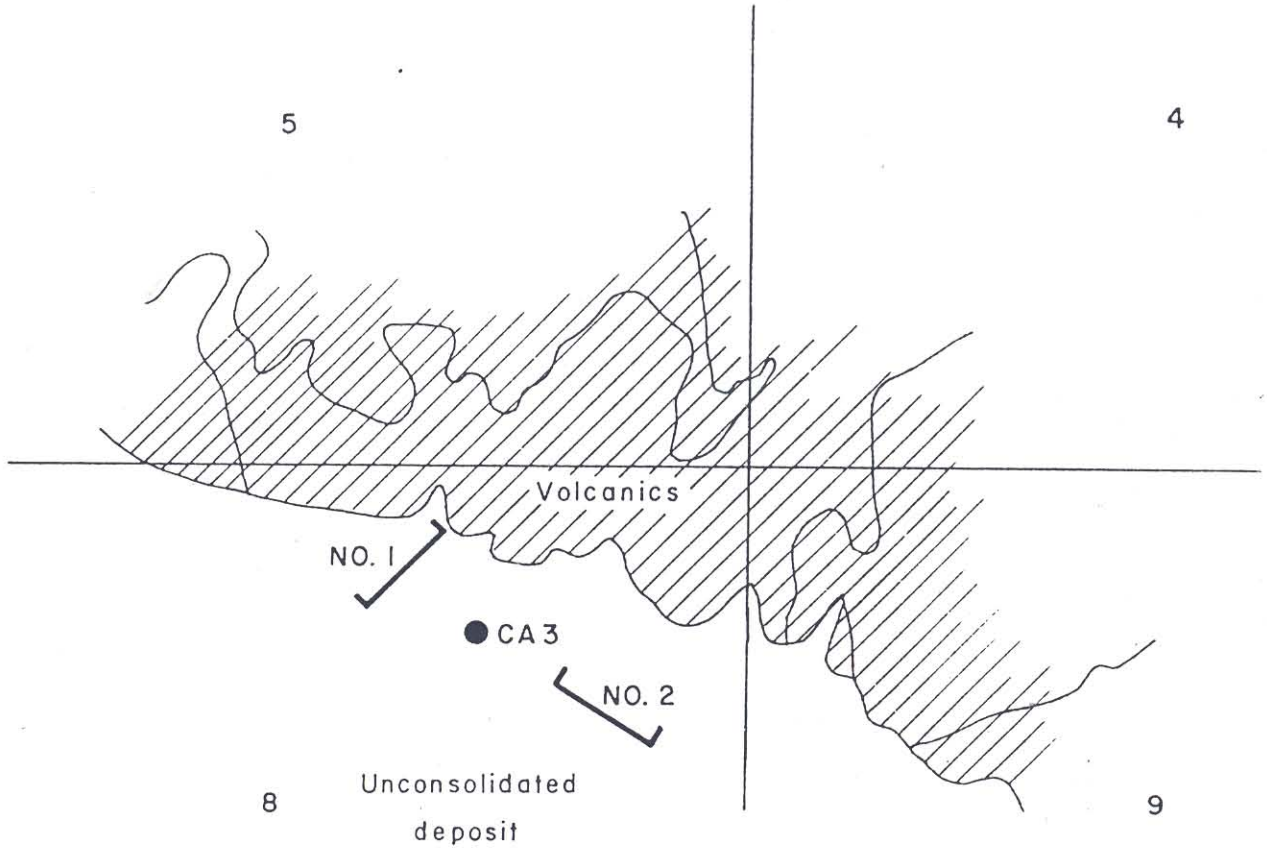
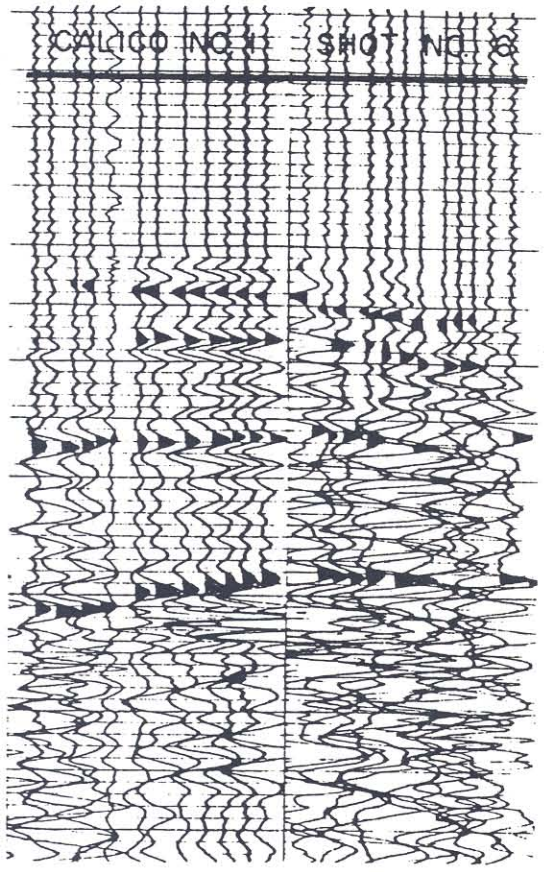


PLATE NO. 5

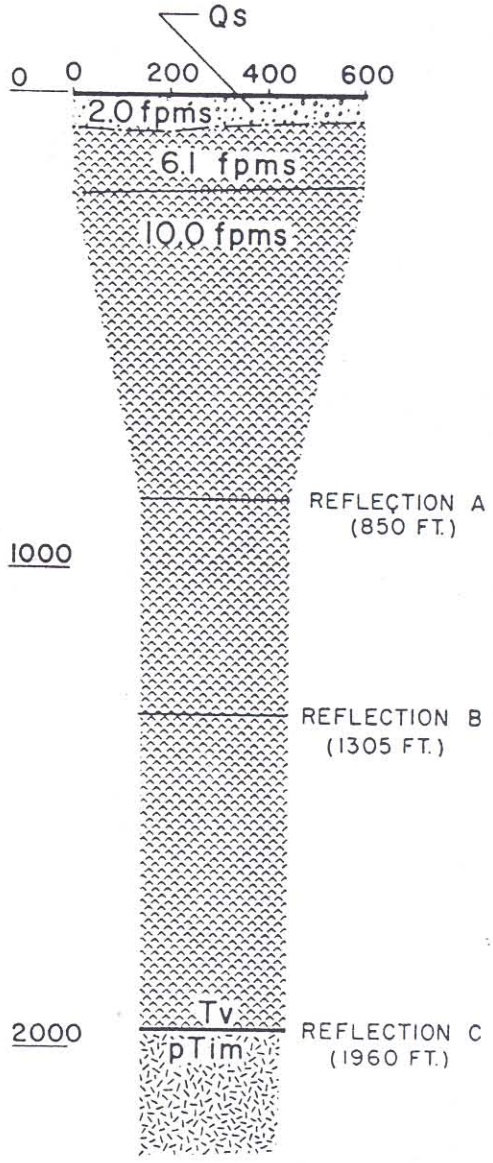
J. W. COOKSLEY, JR.

GEOPHYSICIST

LOCATION MAP
CALICO PROSPECT
SEISMIC PROFILES



REFLECTION RECORDING
CALICO NO. 1, SHOT NO. 6



Qs SURFICIAL DEPOSIT

UNCONFORMITY

Tv VOLCANIC ROCKS CONSISTING OF PYROCLASTIC AND FLOW UNITS

UNCONFORMITY

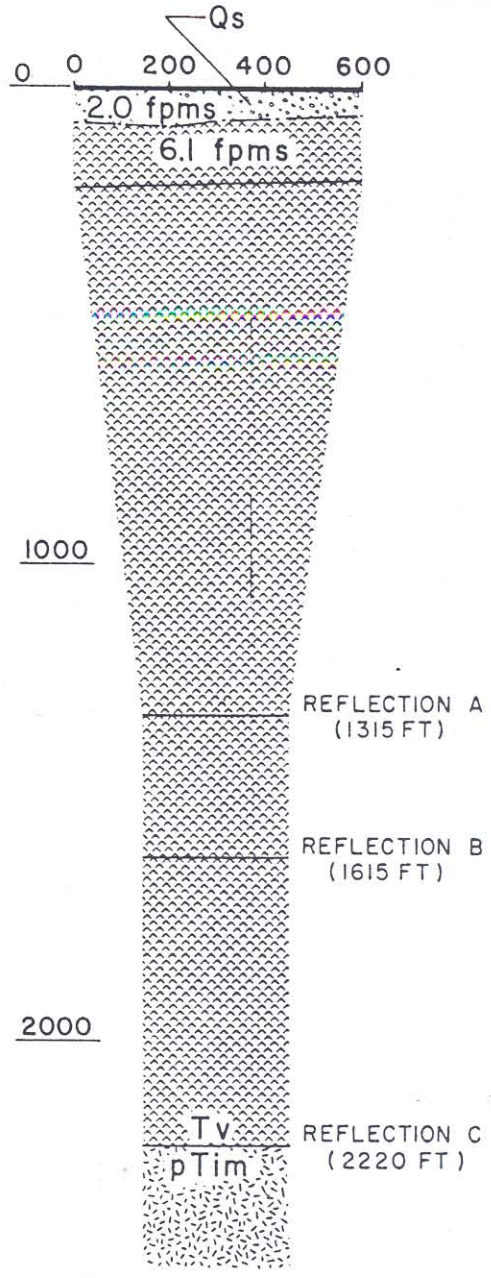
pTim INTRUSIVE IGNEOUS AND METAMORPHIC ROCKS

J.W. COOKSLEY, JR.
GEOPHYSICIST

SEISMIC PROFILE AT CALICO PROSPECT

TRAVERSE NO. 1

PLATE NO. 6

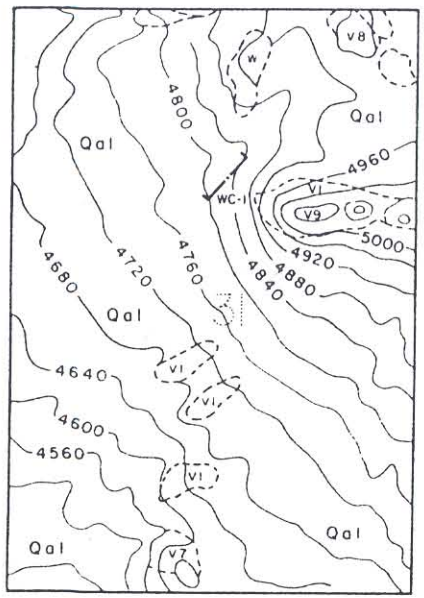


J.W. COOKSLEY, JR.
GEOPHYSICIST

SEISMIC PROFILE AT CALICO PROSPECT

TRAVERSE NO. 2

PLATE NO. 7



MAP SHOWING LOCATION OF SEISMIC PROFILE AT WEST CALICO

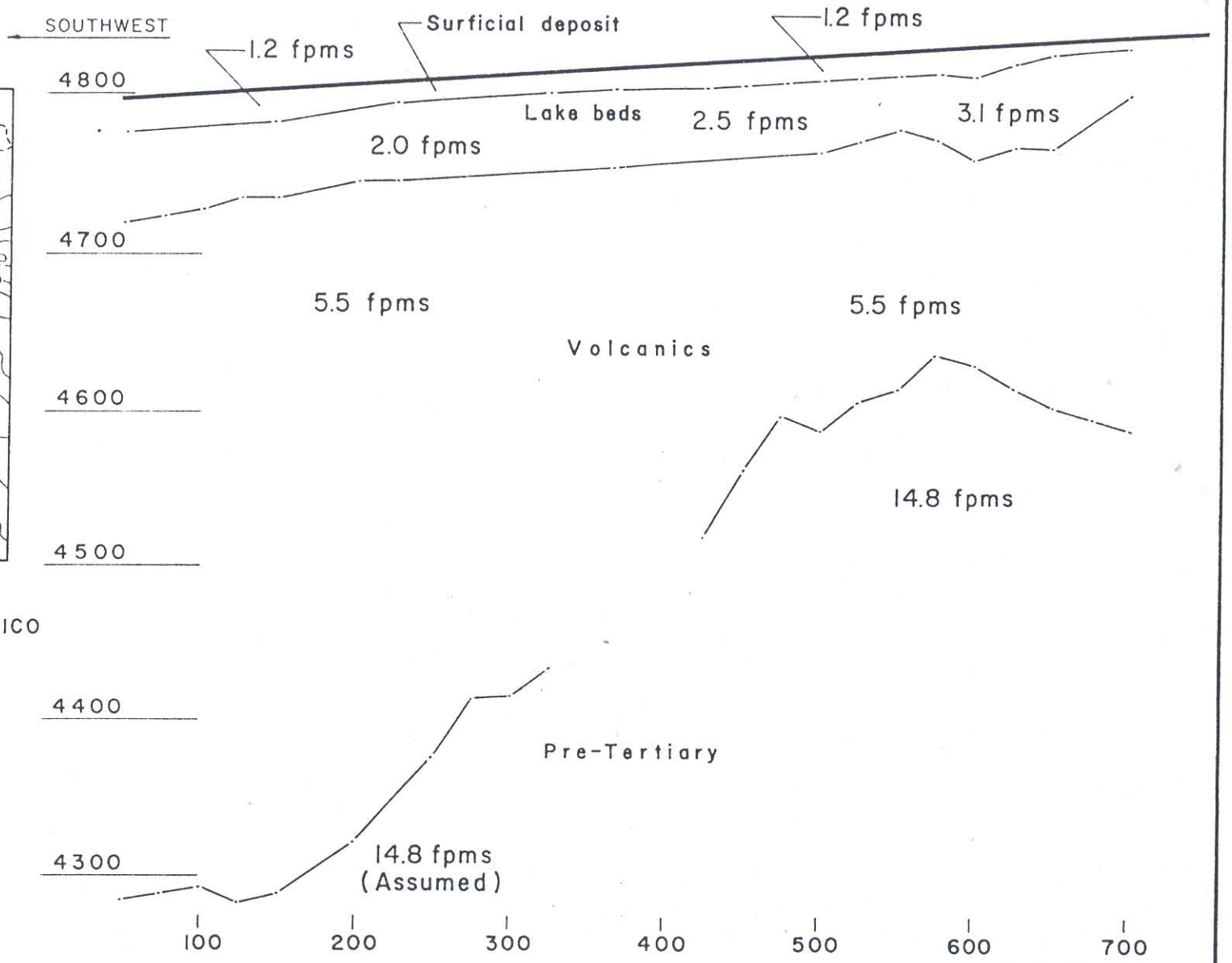
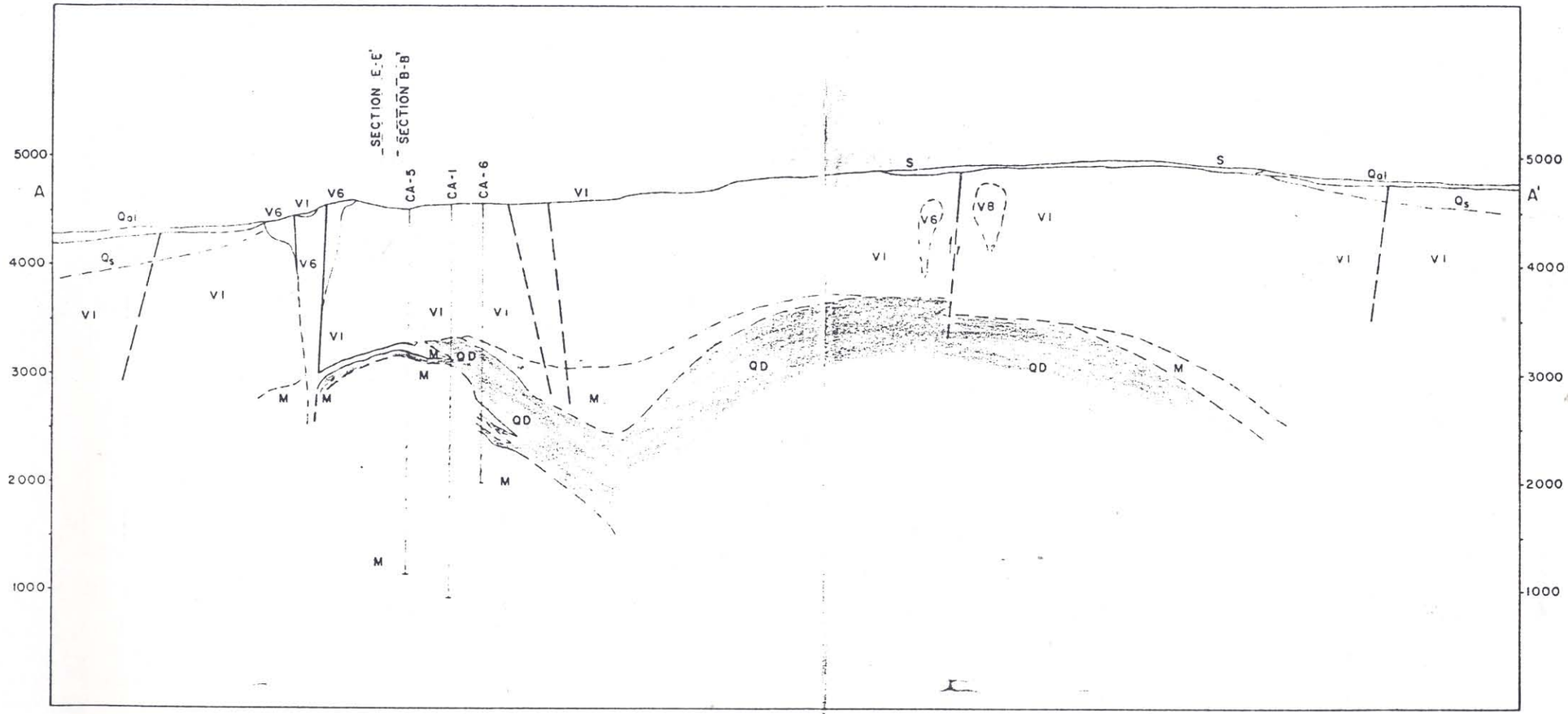


PLATE NO. 8

J.W. COOKSLEY, JR. GEOPHYSICIST	SEISMIC PROFILE AT WEST CALICO

6000 0137 (0890)

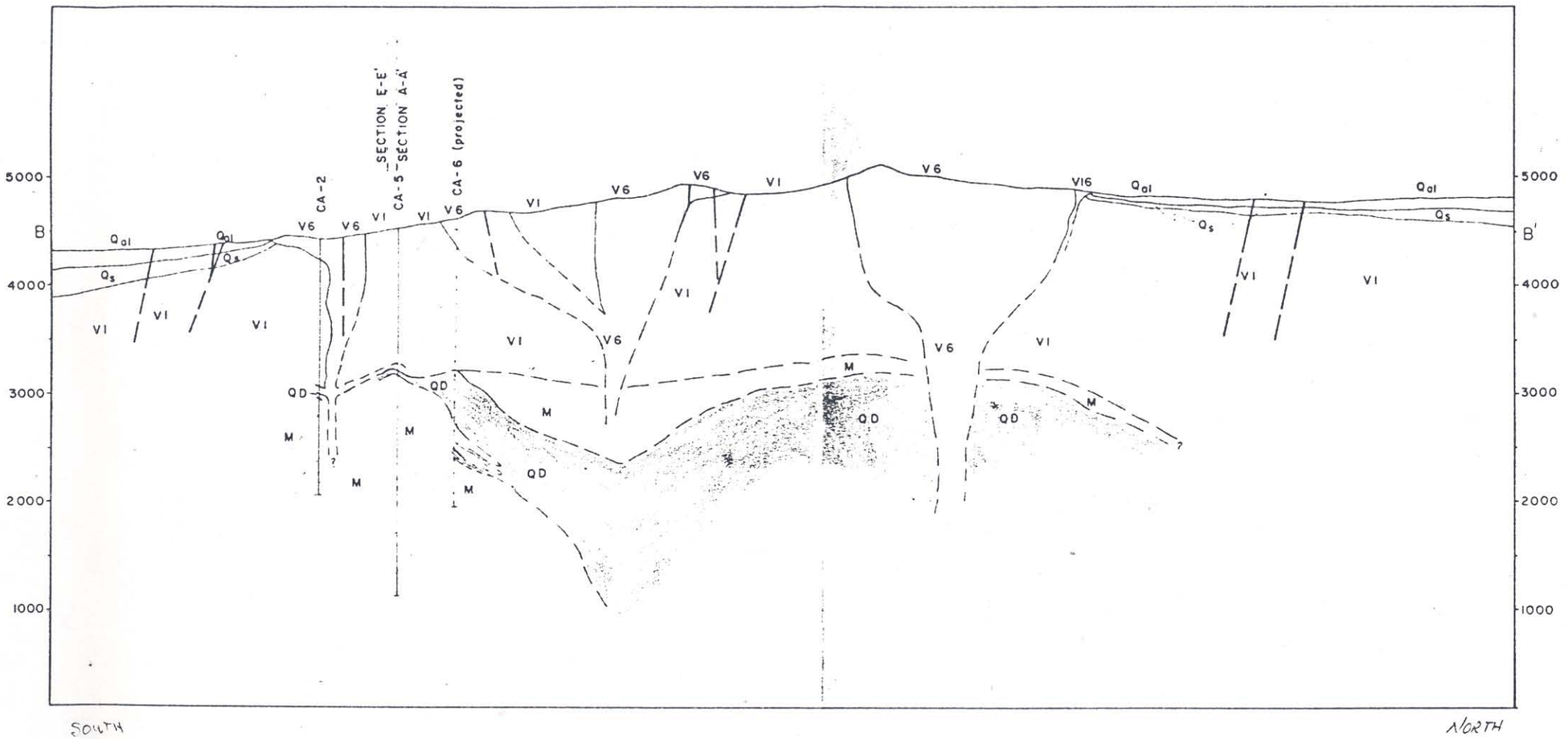


CALICO AREA, WALKER RIVER PAIUTE RESERVATION, NEVADA

SCALE 1:12000

1000 0 1000 2000 3000 4000 feet

6000 0137 (0890)

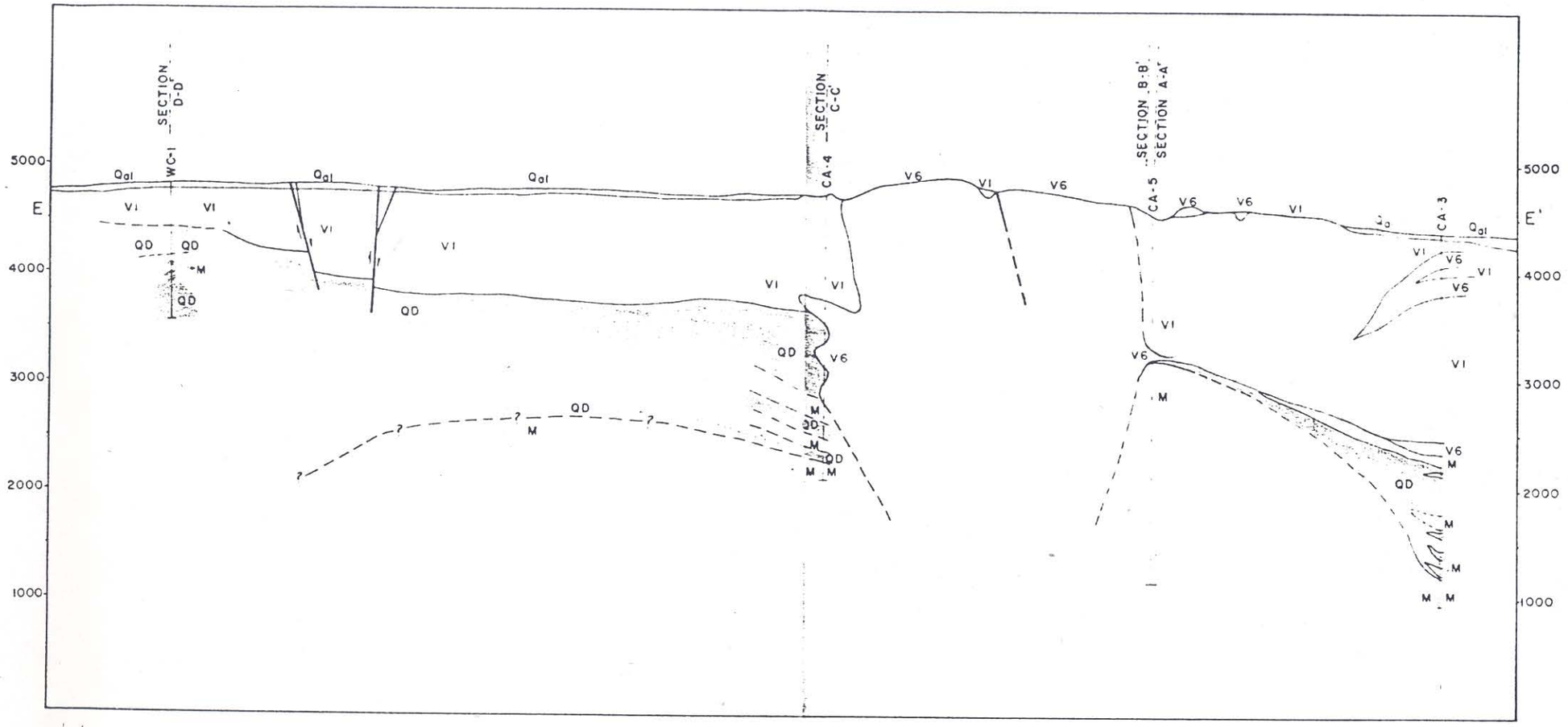


CALICO AREA, WALKER RIVER PAIUTE RESERVATION, NEVADA

SCALE 1:2000

1000 0 1000 2000 3000 4000 feet

6000 0137 (0890)

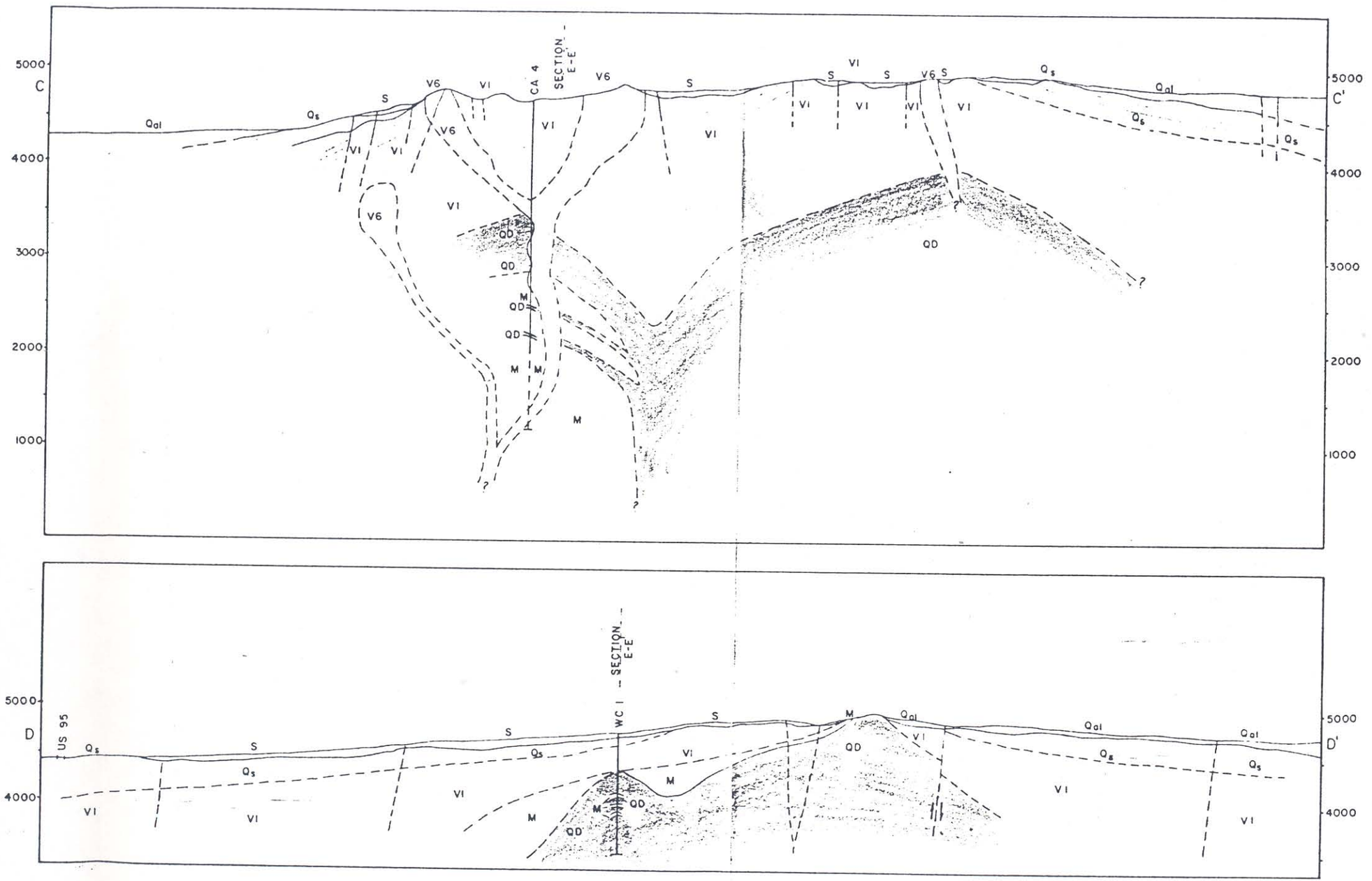


CALICO AREA, WALKER RIVER PAIUTE RESERVATION, NEVADA

SCALE 1:12000

1000 0 1000 2000 3000 4000 feet

6000 0137 (0890)



CALICO AREA, WALKER RIVER PAIUTE RESERVATION, NEVADA

SCALE : 1:12,000

1000 0 1000 2000 3000 4000 feet