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GEOCHEMISTRY OF SOLID MATERIALS FROM TWO U.S. GEOTHERMAL SYSTEMS AND ITS APPLICATION TO EXPLORATION

Robert W. Bamford

July 1978

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ABSTRACT

This paper describes initial development of geochemical techniques for exploration and exploitation of geothermal systems. The techniques are based on analysis of solid materials. Distributions of Cu, Mo, Pb, Zn, Ag, As, Sb, Co, Ni, Mn, Fe, Bi, B, Te, In, Sn, and W are determined and evaluated for several sample types in a hot water system (Roosevelt Hot Springs, Utah) and a vapor dominated system (Geysers, California). The sample types analysed are magnetic fractions, whole rock samples, and two different heavy liquid separates derived from cuttings composites from geothermal wells and shallow rotary drill holes. The results show that multi-element geochemical zoning is developed at both a relatively small scale of over hundreds of feet around individual steam entries (SEs) and hot water entries (HWEs) in geothermal wells, and at a larger scale of over thousands of feet both vertically and laterally in geothermal systems. Zoning is surprisingly similar for both hot-water and vapor-dominated systems. Trace elements which display the most consistent and useful zoning characteristics are As, Sb, Pb, Zn, Mn, B, and W. Optimum delineation of the zoning is provided by +3.3 heavy liquid (HL) samples compared to the other sample types evaluated. Utilization of +3.3 samples maximizes detection of hydrothermal trace elements and markedly reduces or eliminates chemical signatures specifically related to rock type.

In small-scale zoning around HWEs and SEs, As, Sb, B(?), and W(?) are concentrated at or very close to the entries and Pb and Mn are concentrated between entries or, for Pb at least, near cold water entries (CWEs). Pyrite

abundance is generally greatest at or near HWEs and SEs and has a roughly antithetical relationship to overall magnetite distribution. Much Fe in the pyrite has probably been derived from magnetite which presumably is mainly non-hydrothermal in origin.

Large scale zoning, both vertical and lateral, is apparently characterized by As, Sb, B(?), and W(?) concentration in zones closest to the thermal anomaly and Zn, Mn(?), and Mo(?) concentration in peripheral zones. Pb is more closely associated with As near the thermal anomaly, but may occupy an intermediate zone close to and possibly overlapping the periphery of the high As zone. Comparison of large-scale lateral zoning results for Roosevelt with thermal gradient data shows a good correlation of high As anomalies with high thermal gradients ($>100^{\circ}$C/km) and of high Zn anomalies with lower thermal gradients ($<100^{\circ}$C/km).

Several important applications of these geochemical results to problems of exploration and exploitation of geothermal systems could be attempted during the FY 1978 and 1979 period. These include use for

(1) location of steam or hot water entries in newly drilled geothermal wells,

(2) definition of general and possibly specific drilling targets, and

(3) prediction of approach to steam or hot water entries especially in order to facilitate decisions on additional drilling in

sub-commercial wells as planned total depth is approached. Such applications could significantly contribute to power on stream in 1985 and to cost effectiveness in achieving this goal.

A considerable amount of additional work is required to optimize methods, corroborate results, and make some of these applications routine. Much will be accomplished during FY 1978, but continuation into FY 1979 and 1980 at the present level of effort is required to adequately complete the project. Information to be obtained on depositional processes to aid understanding of the geochemical results should be of significant value in dealing with reservoir engineering problems. Work of this description could be expanded to specifically deal with such problems.

INTRODUCTION

Initial results of work to develop geochemical techniques applicable to exploration and exploitation of geothermal systems are reported. Overall goals of this work are improved systematics and cost-effectiveness, and the need for such improvement is made obvious by the high percentage of dry wells drilled in geothermal exploration programs.

The general approach used is collection and analysis of solid samples, a method which has yet to be properly adapted to geothermal systems despite its demonstrated usefulness in many other kinds of resource assessment. Emphasis is on enhancement of geochemical signatures resulting from geothermal processes, on maximizing probability of detection and definition of weak but useful element distributions, and on multi-element analysis to assure that a sufficient number of useful element distributions are documented to make the technique broadly applicable and consistently predictive.

Evidence that this type of geochemical approach should be applicable to geothermal exploration derives from several important similarities in processes of formation for geothermal and sulfide systems as well as from extensive evaluation and demonstration of its usefulness for locating ore zones within sulfide systems. In sulfide systems a broad spectrum of trace elements are differentially zoned around centrally located ore. Thus, when zoning patterns are adequately understood, ore can be systematically located using geochemical methods. Trace element zoning and ore deposition in sulfide systems is caused by deposition of solid materials from hydrothermal solutions primarily in response to temperature and chemical gradients and to other conditions set up around a heat source, generally an intrusion. Since the majority of known higher temperature (+150°C) geothermal systems in the western U.S. are believed to be related to recent volcanism and to intrusions at depth, and since analysis of scales deposited by thermal waters (e.g., Skinner, et al., 1967; Browne and Ellis, 1970; and Ewers and Keays, 1977) indicates that the spectrum of transported trace elements in geothermal systems is similar to that of ore-forming systems, there is good reason to believe that trace element zoning exists around geothermal systems and that sensitive multi-element geochemical analyses of vein and fracture material in drill hole and surface samples will reveal gradients and zoning useful in exploration and evaluation schemes.

Samples used in this investigation were continuously adjacent composite drill cutting grab samples from four selected commercial geothermal wells. Two wells are in the Roosevelt Hot Springs KGRA, Beaver County, Utah, a hot water system, and two from the vapor dominated system at the Geysers KGRA, Sonoma and Lake Counties, California.

This document is a final report on initial geochemical technique development work subcontracted to UURI/ESL under contract EY-76-S-07-1601 (Task 3-1), but more accurately constitutes a progress report covering the period since inception of the project in July, 1977 through April, 1978; the work is ongoing with subcontract funding for FY 1978 provided under DOE/DGE Contract EG-78-C-07-1701. Because work reported is an initial phase of the project, general conclusions should be considered tentative and subject to modification.

METHODS

Enhancement of hydrothermal geochemical signatures relative to those of original rock has been accomplished to date through separation and analysis of one magnetic and two non-magnetic heavy liquid (HL) concentrate fractions from original whole rock chip composite samples. In this manner rock-forming and alteration silicates completely or relatively barren of hydrothermally derived trace metals are mostly removed leaving samples (the HL concentrates) which contain a large proportion of oxides and sulfides and which are relatively enriched in trace metals of interest even if only weak or spatially limited hydrothermal activity has occurred. These sample fractions have additional virtues in being fairly readily duplicated and produced at relatively small expense. Thus they constitute practical samples for routine exploration use.

Multi-element analysis of the original whole rock sample as well as of all sample fractions facilitates evaluation of the enhancement procedure and allows rapid initial determination of useful geochemical distributions.

Sample Preparation

Drill cutting grab samples (the main type of original sample) are washed (to remove drilling mud and exotic fines), crushed to -4 mesh, cleaned of iron drill bit and drill rod shavings with a hand magnet, and pulverized to -80 mesh. Composite samples are made, each containing 6 to 10 original samples. The total drilling interval represented by each composite sample varies from 100 to 300 feet with shorter total intervals being selected whenever sampling frequency permits. The practice of analyzing composite samples helps smooth potential random sampling biases of the individual original grab samples and decreases the number of samples which must be prepared and analyzed to a practical total while maintaining adequate spatial resolution for defining most types of geochemical distribution patterns.

Twenty to eighty grams of each -80 mesh composite sample are separated into a +3.0 specific gravity HL fraction using a mixture of bromoform (sp. gr. 2.8) and methylene iodide (sp. gr. 3.3). The light fraction (-3.0 sp. gr.) is discarded. Magnetic fractions, consisting mostly of magnetite with minor residual iron shavings, are separated from the +3.0 sp. gr. fraction using a hand magnet. Two HL fractions (+3.3 sp. gr. less mag. and +3.0 -3.3 sp. gr. less mag.) are separated from the non-magnetic portion of the +3.0 sp. gr. fraction using methylene iodide. All sample fractions are weighed and then examined under a binocular microscope to determine their approximate mineralogic composition. This completes routine sample preparation.

Chemical Analyses

Four types of sample from each composite have been routinely analyzed for 16 to 18 minor and trace elements when possible in work to date: the original whole rock sample, the +3.0 -3.3 sp. gr. fraction less magnetics, the +3.3 sp. gr. fraction less magnetics, and the magnetic material separated from the +3.0 sp. gr. fraction. Cu, Mo, Pb, Zn, Ag, Mn, Co, Ni, and Fe were determined by atomic absorption spectrophotometry (AAS) while As was initially determined by a colorimetric method and later along with Sb by a hydride generation method. These analyses and all sample preparation were carried out by Rocky Mountain Geochemical Corporation, Salt Lake City, following specified procedures. Additional analyses for Bi, Te, In, Tl, Sn, W, and, later, B were performed by

COORS Spectro-Chemical Laboratory, Golden, Colorado using a volatile optical emission spectrographic (OES) method. The COORS spectrograph is a 3-meter Baird Atomic (3.2 A^{o}/mm dispersion for 2nd order spectral lines). Element concentrations are determined from calibration curves based on synthetic standards with matrices similar to those of the samples analyzed.

AAS analytical procedures for HL and magnetic fractions were designed to be run using 100 mg of material but often had to be run on less sample, resulting in higher detection limits and in some cases lower precision. OES analyses required 50 mg of sample. For total available sample weights greater than 180 mg, both types of analyses could be run using optimum sample quantities. Samples weighing 120 to 180 mg were divided in half to facilitate both types of analysis. Samples weighing 20 to 120 mg were analyzed by AAS only. Samples smaller than 20 mg were not analyzed. AAS analyses of whole rock samples were run using 1.0 to 1.1 gms of material to achieve good detection limits. OES analyses of whole rock samples were run using 90 mg of material.

Mineralogical Studies

Mineralogical studies of HL concentrate samples have recently been initiated to define principal modes of occurrence of important trace elements and to further determine if, when, and to what degree drill material contamination is a problem. Information gained will aid the understanding and appropriate use of the geochemical results. Emphasis in project work to date, however, has been on acquiring good quality geochemical data and progress with the mineralogic studies is limited to selection and evaluation of methods.

Three techniques are now slated to be routinely applied: reflected light microscopy, electron-microprobe analysis, and X-ray diffraction.

Data Presentation and Interpretation

Two types of computer-generated data presentations are used: bar graph plots for display of data from individual drill holes, and plan plots for display of near-surface data. Drill hole bar graph plots facilitate initial evaluation of relationships between the various types of data themselves and between data and geothermal phenomena, geology, or other possible causative features. Down hole geophysical data and/or general geologic information and locations of known steam or hot water entrances are presented at the scale of the bar graph plots.

Plan plots of near-surface data from Roosevelt Hot Springs incorporate limited data (20 values) and therefore have only been roughly hand-contoured to show approximate data trends. Initial contour values are lowest meaningful values determined by inspection. Each higher contour value is double that of the preceding lower value, thus helping to assure that the data variations delineated are real rather than the product of random sampling and analytical biases. Additional near-surface data are being obtained to improve sample coverage and will be used to generate more comprehensive second-generation geochemical plots for the area.

Interpretations presented in this report are based primarily on inspection of the data graphics described above. No attempt is made to estimate background values, since the data do not necessarily incorporate a background population. Only large consistent changes in geochemistry are interpreted as significant and discussion, in many instances, is confined to these results. Therefore more data is presented than is discussed. This will permit others the opportunity of critically reviewing the work and of possibly commenting on alternative interpretations. Since the work is at an early stage and data are still limited in scope, the interpretations are necessarily incomplete and somewhat tentative. Statistical data analysis routines are being integrated with the computer graphics programs to aid future data evaluation and should permit improved definition and quantification of results.

DETERMINATION OF OPTIMUM SOLID SAMPLE TYPE

The geochemistry of three sample fractions (see above) has been evaluated in order to define an optimum sample type. Criteria are that the sample be easily obtained and characteristically enriched in hydrothermal trace elements. Whole rock sample data serve as the principal standard by which the potential utility of the fractions is judged.

Tables 1, 2, 3, and 4 compare the relative trace element contents of the three HL and magnetic sample fractions with contents of corresponding whole rock composite samples from four geothermal wells, two from Roosevelt Hot Springs and two from the Geysers. Mean ratio values for each element provide an indication of relative enrichments in the various fractions. Standard deviations and minimum/maximum values provide a rough indication of consistency of enrichment.

The greatest enrichments of hydrothermal, non-lithophile elements (Cu, Mo, Pb, Zn, Ag, As, Sb, B, and W) occur in the +3.3 fraction and are commonly 10 to 100 fold. Enrichments are significantly less for the magnetic fraction (commonly around 10 fold) and for the +3.0 -3.3 fraction (commonly less than 10 fold). An important exception to this is the unusually high enrichment of Mo in magnetic fractions from Geysers drill holes G-1 and G-1R which will be specifically investigated in future mineralogic studies. Despite precautions, limited contamination of the magnetic fraction with drill steel occurs and may be the source of some of the Mo.

Consistency of element content enrichment in the three sample fractions relative to whole rock is roughly the same and varies considerably from element to element in the different fractions. Such consistency is not an important criterion of utility for a given sample fraction, however, since relative concentrations of hydrothermal elements in HL, magnetic, and whole rock samples vary independently of each other with differences in degree of hydrothermal modification of the original rock sample and with differences in original rock composition. Thus a wide range of enrichments is to be expected.

The data presented, therefore, reasonably demonstrate that large enhancements of hydrothermal trace element signatures can be achieved through use of specific sample fractions and that a nonmagnetic +3.3 sp. gr. fraction provides the largest enhancement of the sample fractions studied. Proof of the usefulness of such enhancements requires demonstration of concomitant improvement in detection of geochemical anomalies associated with geothermal features and demonstration of a unique utility for the improved result. These will be the principal topics dealt with in discussions which follow.

TRACE ELEMENT DISTRIBUTIONS IN GEOTHERMAL WELLS

Trace element and limited mineralogical data have been generated for continuously adjacent composite samples from four commercial geothermal wells, two from a hot water system (Roosevelt Hot Springs, Utah) and two from a vapor dominated system (Geysers, California). Interpretation completed to date provides initial information both on geochemical anomaly magnitudes for solid materials from geothermal systems and on element and mineral zoning in and around present and paleo (?) hot water and steam channels. Information on larger scale, system-wide zoning is also obtained.

Hot Water System

Geochemical and mineralogical data for two Roosevelt Hot Springs drill holes, DH 14-2 (6100 feet total depth) and DH 72-16 (1254 feet total depth) are presented in Figures 2/14-2 through 14/14-2 and 2/72-16 through 14/72-16, respectively. Sixty 100-foot composite samples were analyzed for DH 14-2 and twelve for DH 72-16. Corresponding generalized geological information, geophysical data, and locations of hot water entries inferred from these data are presented in Figures 1/14-2 and 1/72-16.

Hot water entry zones (HWEs) in drill hole 14-2 are located at 1600 feet, 2900 feet (the best developed?), and possibly at 1000, 1200, 1950, 2500, 4050, 4200, 4450, 5000, 5200, 5800, and 6000 feet. A cold water entry zone (CWE) is located at 700 feet. HWEs in DH 72-16 are probably located at 213, 514, and 628 feet. Significant relationships of geochemical and mineralogical data to the locations of HEWs and the CWE in the Roosevelt wells are described below.

Plus 3.3 HL Sample Results

Arsenic is strongly concentrated at or very near HWEs in +3.3 HL samples (c.f. Figs. 1 and 4/14-2 and /72-16). Assuming that the current interpretation of HWE locations in DH 14-2 is essentially correct, the element appears to be quite specific in indicating HWE location and possibly undergoes only limited dispersion above or around the HWEs. Pb and possibly Mo and Mn appear to be most abundant peripheral to rather than at HWEs (Figs. 3 and 4/14-2 and /72-16). High concentrations of Pb also occur at the CWE in DH 14-2. Spatial relationships of Zn, Sn, and W to HWEs are less clear (Figs. 3 and 5/14-2 and /72-16). Concentrations of Ni, Co, Fe, and probably Cu at or near HWEs are in part a rock type effect related to the distribution of dacite (see discussion of whole rock sample chemistry below).

Other general trace element distribution systematics suggested by DH 14-2 data are that concentrations of Zn, Mo, and Mn are highest within 1000 feet of the surface and pass through minima at intermediate depths, and that Sn, W, and possibly Ag are more concentrated at depth. These trends may represent large scale zoning related in part to a major heat source. Smaller scale zoning related to HWEs is superimposed on the large scale trends.

Whole Rock Sample Results

Whole rock sample geochemistry (Figs. 6, 7, and 8/14-2 and /72-16) displays many of the spatial relationships to water entries described for +3.3 HL samples. The relationships, however, tend to be less clearly defined due to higher relative background element concentrations, rock type effects, and/or to low element concentrations (relative to analytical detection limits). The most serious deficiency of the whole rock samples is that inadequate information is provided on As, the element most diagnostic of HWE location in +3.3 samples, due to concentrations of the element often being below analytical detection limits (c.f. Figs. 4 & 7/14-2 and /72-16).

Close correlation of Co, Ni, Fe, and probably Cu with the distribution of dacite and its probable equivalent in DH 72-16, the meta-quartz diorite (c.f. Figs. 1, 6, and 7/14-2 and /72-16), suggests that the abundance of these elements in whole rock samples primarily reflects original rock chemistry and perhaps reflects rock reactivity as a depositional control. Their apparent correlation with HWEs in DH 14-2 is probably the result of preferred development of HWEs along or near dacite-microgranodiorite contacts (Fig. 1/14-2). No correlation of these elements with HWEs is apparent in DH 72-16 in which meta-quartz diorite and HWE locations are different (Fig. 1/72-16).

Magnetic and +3.0 -3.3 HL Sample Results

Magnetic and +3.3 -3.3 HL samples are generally inferior to +3.3 and whole rock samples in regard to correlation of geochemistry with HWEs (c.f. Figs. 1 thru 14/14-2 and /72-16). The magnetic fractions, however, display several characteristics worthy of mention. Relatively high concentrations of As, Cu, Mo, Pb, W, Co, Ni, or Mn occur in several (often different) magnetic samples originating at or near HWEs (c.f. Figs. 1, 12, 13, and 14/14-2 and /72-16). This, combined with negative spatial correlation between HWEs and magnetite abundance (see below), suggests that the magnetite is an original rock constituent which has partly reacted with thermal fluids and in so doing has provided a preferred site for element deposition. It is also possible that some magnetite has been directly precipitated along with other minerals from the thermal fluids, but direct evidence of this (e.g., magnetite in veins) has yet to be observed. Whatever the cause of these characteristics, it remains possible that magnetite geochemistry might eventually have special utility in geothermal work. Problems with sample contamination by magnetic metal shavings from drill rods and bits may limit but not completely negate this potential utility.

Opaque Mineral Distributions

Opaque mineral data (Figs. 2/14-2, and /72-16) show rough positive correlation of sulfide (pyrite) abundance and possible negative correlation of magnetite abundance with HWE location. Therefore, sulfide minerals at Roosevelt are probably mainly of hydrothermal origin. Magnetite shows fair correlation with rock type (c.f. Figs. 1 and 2/14-2 and /12-16). This positive correlation with lithology and the negative correlation with HWE locations suggest that magnetite is primarily an original rock constituent and that it tends to be destroyed through contact with thermal fluids. Much of the Fe required for sulfide formation is probably derived from original magnetite.

Summary

Plus 3.3 HL samples are superior to other sample types studied for defining hydrothermal geochemical anomalies or zoning patterns at and around HWEs in geothermal wells at Roosevelt Hot Springs. Utilization of +3.3 sample geochemistry improves detection of hydrothermal trace elements and markedly reduces or eliminates chemical signatures specifically related to rock type.

Hydrothermal trace elements which develop consistent zoning in relationship to HWE locations are As and Pb, while Ag, Mn, Mo, and W display fair to poor zoning relationships. Correlation of Co, Ni, and Cu with HWEs in DH 14-2 is largely a rock type effect resulting from preferred development of HWEs near (at?) the contacts of dacite rich in these elements.

Large scale concentration trends for Zn, Mo, Mn, Ag, Sn, and W probably constitute zoning on a system scale. Zoning around HWEs is superimposed on these trends.

Vapor Dominated System

Geochemical and mineralogical data for the two Geysers drill holes, DH G-1 (7665 feet total depth) and its redrill DH G-1R (3527 feet to 7165 feet total depth), are presented in Figures 2/G-1 through 17/G-1 and 2/G-1R through 17/G-1R, respectively. Thirty-nine 180 to 240-foot composite samples were analyzed for DH G-1 and twenty for DH G-1R. Data are presented for Sb and B in addition to elements previously evaluated at Roosevelt. Generalized geologic data and locations of steam entries for these drill holes are presented in Figures 1/G-1 and 1/G-1R.

Steam entry zones (SEs) in DH G-1 are located at 2520, 5120, 6335, 6467, and 7035 feet, and a water entry zone at 7580 feet. In DH G-1R, SEs are located at 4259, 4362, 5480, 5660, 5943, 6731, 6858, and 6980 feet, and WEs at 7094 and 7138 feet. All locations have been established on the basis of drill rig standpipe pressure increases which occur when SEs are intersected during air drilling. Each SE has been ranked according to the magnitude of the pressure increase reported, with this ranking or a related value then being assigned to the sample intervals containing or very close to the SE (see Figs. 1/G-1 and 1/G-2). These rankings provide an indication of the relative importance of a SE and will be used routinely for statistical correlation between SEs and geochemical and mineralogical data as soon as correlation programs can be appropriately modified for this purpose. The following significant relationships of geochemical and mineralogical data to SE and WE locations are based for the present on data graphics.

Plus 3.3 HL Sample Results

As and Sb are clearly shown to be concentrated at or very close to SEs and WEs in +3.3 samples (c.f. Figs. 1 and 5/G-1 and /G-1R). The result for As is very similar to that obtained at Roosevelt despite a high probability of differences in transport mechanisms between hot water and vapor dominated systems (Sb was not determined at Roosevelt but could be expected to provide similar results). The overall magnitude of As anomalies decreases with depth while Sb anomalies remain essentially constant in magnitude. Sb thus provides information on SE location to depths of at least 7600 feet (the maximum depth attained) while As ceases to be useful below about 6000 feet. Strong As and Sb anomalies near 1500 and 2000 feet in DH G-1 coincide with definite zones of alteration and probably either reflect minor present day SEs or WEs which have remained undetected or reflect paleo SEs or WEs. Sb (and As?) gradients are developed above SEs (e.g., Fig. 5/G-1, 3000 to 5000 feet) and may provide a means of predicting approach to SEs during drilling. This predictive capability could facilitate decisions on additional drilling as planned total depth is approached.

W and possibly B show some of the distribution characteristics described above for As and Sb but are less definitive in indicating HWE location, especially at greater depths in the drill holes (c.f. Figs. 1 and 6/G-1 and /G-1R). Upper analytical limits for determination of B of 300 ppm and 1500 ppm (after dilution) were too low to permit adequate definition of B distribution in +3.3 samples. B and W show general trends of increasing concentration in +3.3 samples with depth which is possibly another example of large scale zoning. The proportion of B resident in higher specific gravity phases also increases with depth (c.f. Figs. 6 and 10/G-1).

Cu, Zn, and to a lesser extent Ag, Ni, and Fe tend to be concentrated at or near SEs but not in a consistent manner. Occurrence of a zone of high coincident Cu, Zn, Ag, and Ni concentrations between about 2500 and 3000 feet in DH G-1 (Figs. 3 and 4/G-1) could be partly explained by its association with a small SE in that interval as well as other causes.

In contrast to elements described above, Pb and possibly Mn generally occur in relatively low concentrations at or near SEs and in higher concentrations between SEs (c.f. Figs. 1, 3 and 4/G-1 and /G-1R).

No definite rock type effects are observed in +3.3 sample data. Concentrations of most elements become very low at depths greater than 5000 feet (principal exceptions are Sb, Sn, W, B, and Mn).

Whole Rock Sample Results

Spatial relationships between whole rock sample geochemistry (Figs. 7, 8, 9, and 10/G-1 and /G-1R) and SE locations (Figs. 1/G-1 and /G-1R) are roughly similar to those described for +3.3 samples, but are less consistent and less definitive with the possible exception of B. Whole rock data for the two most definitive elements in +3.3 samples, Sb and As, (Figs. 9/G-1 and /G-1R), provide good illustrations of this; higher Sb values show little or no correlation with SEs and the As correlation is inconsistent.

Boron distribution, however, is well defined in the whole rock data. Unfortunately these results cannot be readily compared to +3.3 results which are incomplete due to concentrations in +3.3 samples exceeding the upper analytical limits for the element. B appears to be concentrated at or near SEs and is possibly dispersed preferentially above SEs as are Sb and As, (c.f. Figs. 1 and 10/G-1 and G-1R) forming rough positive gradients which may be useful in predicting approach to SEs during the drilling of a geothermal well.

Most of the remaining whole rock geochemical results either show little relationship to SE location or are notably inferior to +3.3 sample results. Rock type effects are pronounced for Co, Ni, Fe, and to a lesser extent Mn, and largely obscure any hydrothermal effects for the first three of these elements. Rock type effects for other elements are less significant.

Magnetic and +3.0 -3.3 HL Sample Results

Magnetic and +3.0 -3.3 sample fraction geochemical data also show somewhat similar but less consistent spatial relationships to SE locations than do +3.3 data with a few possibly significant exceptions. Mo, Sb, and to a lesser extent As in +3.0 -3.3 samples display distinct concentration highs at or near SEs. The Sb and As association with SEs is somewhat less clear than that for +3.3 sample data (c.f. Figs. 5 and 12/G-1 and /G-1R), but the Mo association (Figs. 11/G-1 and /G-1R) is better defined than for other sample types. Because this Mo association is unique to the G-1 and G-1R results, no particular significance can be attributed to it without further verification.

Opaque Mineral Distributions

Sulfide (primarily pyrite) abundance is greatest at or near SEs or paleo SEs and decreases generally with depth; sulfide is uniformly less than 0.01% below 4600 feet and has a roughly antithetical relationship to overall magnetite distribution (Figs. 2/G-1 and /G-1R). Much of the Fe in the sulfide has probably been derived from the magnetite which apparently is mainly of non-hydrothermal origin.

Summary

General conclusions are essentially the same as those for Roosevelt Hot Springs and include the observation that +3.3 HL samples are also superior for delineating geochemical zoning at Geysers (see "Summary" in section on Hot Water System).

Sb, As, Mo, Pb, B, Mn, and W, in order of decreasing utility, are shown to develop consistent zoning in relationship to SE locations. Cu, Zn, Ag, Ni, and Fe display fair to poor zoning. Of these elements only Sb, W, and B can be usefully detected to the total depth of drilling (7665 feet); other elements and total sulfide content become extremely low below about 5000 foot depths. Mo is unusual in that its zoning behavior (if typical) is best defined in +3.0 -3.3 sample data while zoning behavior for most other elements is better defined by +3.3 sample data.

Discussion

Similarity of Results for Hot Water and Vapor Dominated Systems

Hot water and vapor dominated geothermal systems are surprisingly similar with regard to the geochemistry of solid materials from commercial wells. Particularly useful trace elements - As, Pb, Mn, probably Sb and B, and possibly W - in both types of systems are essentially the same and show similar zoning in relation to present day HWEs and SEs (see above).

Although investigations have not proceeded far enough to establish reasons for this similarity or to show that it can be expected in all systems, the fact that it is recognized in two such contrasting systems constitutes important progress toward the development of effective geochemical techniques for exploration and evaluation of geothermal systems. It suggests that techniques based on the solids geochemistry of at least several of these elements will be applicable to a broad spectrum of geothermal systems. Broad applicability is an important criterion of all successful techniques.

Comparison with Results of Other Studies

Only one reasonably extensive study of the geochemistry of solid materials from geothermal systems has been reported and this differed sufficiently in design from work described here that only a few general comparisons can be made. The study referred to is an evaluation of trace metal zoning at the Broadlands Geothermal Field, New Zealand, by Ewers and Keays (1977). Their results provide additional limited evidence of the consistent association of strong As and Sb geochemistry with geothermal phenomena and, viewed in conjunction with Roosevelt and Geysers results, suggest that the geochemistry of Tl, Bi, Te, Co, Ag, Pb, Zn, and Cu will be relatively variable from system to system and possibly of less utility than that of As and Sb. No other comparisons can be readily made since the Broadlands work involved analysis of either a sulfide separate or a whole rock sample (not both) from relatively short interval (1 to 3 meter), widely separated samples which did not permit evaluation of spatial relationships between element concentrations and hot water or steam entries.

NEAR-SURFACE TRACE ELEMENT DISTRIBUTIONS

Geochemical data for near-surface samples from 15 thermal gradient drill holes, three diamond drill holes, and two geothermal wells have been plotted to provide initial information on potential use of hydrothermal trace element distributions as exploration guides in geothermal systems. The drill holes and wells are distributed over an approximately 170 sq. mile area centered on the Roosevelt Hot Springs KGRA (see Fig. 1/Plan for locations). Whole rock and +3.3 HL concentrate data were acquired and plotted for depth intervals of approximately 0 to 100 feet, 100 to 200 feet, and 200 to 300 feet. Fairly complete data sets were only obtained for the first two intervals since maximum depth for many of the thermal gradient holes was about 200 feet. Most of the important results derive from these two data sets and especially from the data set for the 100 to 200 feet depth which appears to be less affected by post-depositional supergene modification than that for 0 to 100 feet. To ensure completeness, however, plots of all three data sets are presented (Figs. 2 to 33/Plan). Each figure number, except 1/Plan, refers to three different data plots for a given element, one for each depth interval.

Plus 3.3 HL Samples Results

High As anomalies, open to the west, center on the area near drill holes 72-16, 14-2, 1-A, 1-B, and 76-1 which contains most of the producing wells at Roosevelt (c.f. Figs. 1 and 7/Plan). This is consistent for all three depth intervals. The anomaly appears to be elongated NNE-SSW, parallel to the trend of the dome fault.

Cu, Mo, Pb, and Fe, (Figs. 2, 3, 4, and 11/Plan) yield anomalies roughly similar to As. These, however, are not as specific in delineating the area of producing wells and are less consistently defined at the different depth intervals. Pb anomalies may actually be located somewhat peripherally to the highest As anomalies.

Zn, and less consistently Mn (Figs. 5 and 8/Plan) form prominent but segmented anomalies apparently peripheral to the area of producing wells. If this observation is correct, it constitutes initial recognition of larger scale, lateral trace element zoning at Roosevelt and suggests that potential hot water resources are deeper or cut off towards the south and east. Similar large scale vertical zoning of Zn and Mn were suggested by Roosevelt drill hole data (see section on Hot Water System). W and Sn also appear to form strong peripheral anomalies (Figs. 14 and 15/Plan), but the possibility that these could be in part a rock type effect make the result inconclusive at this time.

Co and Ni concentrations are anomalously low in the immediate vicinity of the producing wells. Data trends for other elements are poorly defined.

Little correlation of +3.3 sample geochemistry with lithology is observed, suggesting that rock type effects are minimal (c.f. Figs. 1/Plan and 2 to 15/Plan). W and Sn are possible exceptions; strong anomalies for these elements may derive directly or indirectly from the Tertiary granitic rocks (c.f. Figs. 1/Plan and 14 and 15/Plan).

Whole Rock Sample Results

Whole rock geochemical trends (Figs. 16 to 28/Plan) are similar to those for +3.3 samples, but do not as clearly or as completely define the anomalous zones. As and Zn anomalies (Figs. 19 and 21/Plan) occur over the area of producing wells and peripheral to this area, respectively, providing corroborative evidence for large scale trace element zoning in geothermal systems indicated by +3.3 geochemical data.

Rock type effects are pronounced for most of the other elements (e.g., c.f. Figs. 1, 2, and 16/Plan) and, along with intrinsically low hydrothermal element concentrations, tend to obscure hydrothermal element distributions.

Opaque Mineral Distribution

Plots of hematite and total magnetic fraction (>75% magnetite) in rock are presented in Figures 31/Plan and 32/Plan. Hematite shows no evidence of useful systematic distribution at this scale. Magnetite is generally lowest near the producing wells, possibly reflecting partial destruction by hydrothermal fluids; its distribution otherwise reflects rock type.

Summary

As, Zn, and possibly Mn apparently display large scale lateral zoning relative to the area containing most producing geothermal wells at Roosevelt. As is concentrated primarily within this area and Zn (+Mn?) is more peripheral to it. Pb may occupy an intermediate zone overlapping the periphery of the As anomalies. These relationships are best displayed in +3.3 HL concentrate data but also can be seen in whole rock data. Comparison of these results with unpublished thermal gradient data from Geothermal Power Co. (1978) for many of the same drill holes shows a good correlation of high As anomalies with high thermal gradients (>100°C/km) and high zinc and, to a lesser extent, manganese anomalies with lower thermal gradients (<100°C/km).

POTENTIAL APPLICATIONS OF GEOCHEMICAL RESULTS

Results described in this report suggest that geochemical techniques based on analysis of solid materials can be developed in the near term to significantly aid (1) location of steam or hot water entries in newly drilled geothermal wells, (2) definition of general and possibly specific drilling targets, and (3) prediction of approach to steam or hot water entries during drilling. Such techniques could significantly contribute to power on stream in 1985 and to cost effectiveness in achieving this result.

Location of Steam or Hot Water Entries

Small scale trace element zoning defined by analysis of +3.3 HL samples from drill cuttings provides consistent indications of hot water entry (HWE) and steam entry (SE) locations. Elements such as As and Sb are concentrated near HWEs and SEs, Pb and possibly manganese between HWEs and SEs. Other element distributions will probably also aid definition.

Applications of the technique could begin immediately, but it would be preferable to optimize procedures for sample collection, compositing, and preparation before this is routinely attempted. It is not known at this stage if size as well as locations of HWEs and SEs can be predicted. Detection of paleo (sealed) HWEs may cause some indeterminancy in interpretation unless criteria can be developed for discrimination.

Definition of Drilling Targets

Larger or system scale trace element zoning can provide information to aid selection of general and possibly specific areas for drilling. Prime general drilling areas would be those characterized by high As and probably Sb (plus B and W?) anomalies with relatively low Zn, Mn(?) and possibly Mo as determined from shallow rotary drill hole cuttings (preferred) or surface samples. The most pronounced anomalies of this type probably define specific target areas containing relatively shallow resources (e.g., see data for Roosevelt DH 72-16) and could be drilled with good probability of success during critical early stages of an evaluation to provide an immediate and direct test of the resource at relatively low cost. Areas characterized by high Zn, Mn(?), and possibly Mo, and low As and Sb (plus B and W?) probably lie farther away from (laterally or above) a potential geothermal resource. These would not necessarily be eliminated from consideration but would constitute lower priority drilling targets which at best would probably require deeper drilling to locate a resource.

Application of this technique should be delayed until additional near-surface data from Roosevelt has been evaluated (ca. Sept. 1978), and possibly also until similar data has been obtained for one other KGRA.

A note of caution in interpretation of large scale geothermal system trace element zoning is that care should be taken to eliminate or at least be aware of possible hydrothermal effects unrelated to the thermal activity. This does not appear to be a problem at Roosevelt where evidence of other types of mineralization is minimal. It could be a problem elsewhere.

Prediction of Approach to Steam or Hot Water Entries

Concentration gradients for Sb, B, As, and possibly other elements above SEs and HWEs may be useful for predicting approach to the entries during drilling. The gradients appear to extend more than 1000 feet above an entry in some instances (e.g., see Sb data, Fig. 5/G-1 and B data, Fig. 10/G-1) and if consistently developed could provide information on approach adequately in advance of an actual intersection with the entry. A principal use of such information would be as the basis for decisions to continue or terminate drilling of sub-commercial wells when planned total depth is approached.

Additional data is needed to establish the validity of the element gradients and the consistency with which they are developed. Work is in progress to obtain the necessary data and should provide a clearer indication of the utility of this approach by the end of FY 1978.

ADDITIONAL WORK UNDERWAY OR SCHEDULED IN FY 1978

Work now in progress or scheduled for the remainder of FY 1978 emphasizes the following: expansion of the data base at both Roosevelt and Geysers, mineralogic study of +3.3 HL concentrate samples, optimization of original sampling and sample compositing, and improvement of data analysis.

Expansion of Data Base

Additional geochemical data will be acquired only for whole rock and +3.3 HL concentrate samples from drill cuttings; magnetic and +3.0 -3.3 HL sample fractions have been shown to be of less utility than the +3.3 HL fraction and will not be further evaluated at this time. At Roosevelt one or more deep drill holes will be studied, possibly including a hot dry well situated in altered rock, to provide more information on the geochemistry of paleo hot water channels. Near-surface data will be expanded by analysis of samples from 10 to 15 additional shallow drill holes and should significantly improve definition of lateral zoning trends.

Three more deep drill holes will be studied at Geysers, two of which will be dry wells in altered rock situated on the periphery of the steam field. Data from these holes will assist in the understanding and perhaps discrimination of geochemical signatures associated with paleo hot water entries, and will provide information on large scale zoning.

Mineralogic Study of +3.3 HL Samples

Identification of mineral species in which the various trace metals reside is being undertaken. Since these minerals are largely of hydrothermal origin, information on their identity along with data on fluid chemistry and temperature and pressure conditions should aid understanding of depositional processes in geothermal systems and enhance overall utilization of trace element data. These studies will also help determine if, when, and/or to what degree sample contamination by drilling materials is a problem.

Information obtained on depositional processes could also be of significant value in understanding and solving reservoir engineering problems. Work described here could be readily expanded to specifically deal with such problems.

ACKNOWLEDGEMENTS

A number of ESL staff contributed directly or indirectly to these studies. Especially important was initial mineralogic work by Regina Capuano and Jeff Hulen, and programming of computer graphics and statistical routines by Terry Killpack and Carol Withrow. Drafting for the report was done by Doris Cullen and John Lopez. The report was reviewed by Odin Christensen, Regina Capuano, and Jim Stringfellow.

The cooperation of Aminoil USA, Inc., and particularly Roger Wall and Mary Twichell of that company, in providing samples and information from Geysers geothermal wells deserves special acknowledgement. Without this assistance much less progress would have been made in this work.

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Table 1 - ELEMENT CONCENTRATION RATIOS FOR H.L. AND MAGNETIC FRACTIONS VS. WHOLE ROCK SAMPLES, ROOSEVELT HOT SPRINGS DH TP 14-2 (100 ft. to 6100 ft.)

ELEMENT (ppm)	+3.3 Sp. Gr. Less Mag./Whole Rock					+3.0-3.3 Sp. Gr. Less Mag./Whole Rock					Magnetic Fraction/Whole Rock				
	Number of Samples	Mean	Stand. Dev.	Min	Max	Number of Samples	Mean	Stand. Dev.	Min	Max	Number of Samples	Mean	Stand. Dev.	Min	Max
Cu	60	65	104	7	629	56	6	6	1	39	56	12	7	1	37
Mo	39	23	22	2	100	35	14	15	2	70	27	26	46	2	230
Pb	60	75	86	3	400	56	4	2	1	11	56	3	2	1	9
Zn	60	5	8	1	54	56	5	3	<1	18	56	2	2	<1	14
Ag	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Mn	60	18	20	1	97	56	9	5	3	28	56	5	4	1	19
Co	55	11	7	1	32	42	6	4	1	20	43	10	15	1	100
Ni	60	10	5	4	35	56	11	10	2	64	56	11	9	2	55
Fe(%)	60	19.2	12.9	5.5	69.2	56	6.5	3.3	1.7	15.2	56	40.7	19.6	13.0	135.3
As	8	31	23	4	82	1	-	-	-	-	1	-	-	-	-
Sb	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Sn	28	19	9	6	40	23	5	4	1	14	22	4	2	1	10
W	14	4	3	2	11	12	1	1	<1	2	8	5	7	1	16
B	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
In	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Bi	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-

Table 2 - ELEMENT CONCENTRATION RATIOS FOR H.L. AND MAGNETIC FRACTIONS VS. WHOLE ROCK SAMPLES, ROOSEVELT HOT SPRINGS DH TP 72-16 (85 ft. to 1244 ft.)

	+3.3 Sp. Gr. Less Mag./Whole Rock					+3.0-3.3 Sp. Gr. Less Mag./Whole Rock					Magnetic Fractions/Whole Rock				
ELEMENT (ppm)	Number of Samples	Mean	Stand. Dev.	Min	Max	Number of Samples	Mean	Stand. Dev.	Min	Max	Number of Samples	Mean	Stand. Dev.	Min	Max
Cu	12	98	148	9	513	8	3	1	2	6	11	11	16	2	59
Mo	12	14	7	7	25	8	8	7	2	23	11	8	6	2	20
Pb	12	18	20	3	64	8	3	2	2	8	11	2	1	1	4
Zn	12	4	4	1	11	8	3	<1	2	3	11	3	3	1	10
Ag	6	36	32	10	80	0	-	-	-	-	4	11	6	5	20
Mn	12	9	13	1	42	8	4	1	3	5	11	6	8	1	23
Co	12	14	14	3	40	8	3	1	1	4	11	12	17	2	60
Ni	12	4	2	2	8	8	3	1	2	6	11	5	5	2	18
Fe(%)	12	17.5	15.7	4.4	46.7	8	2.6	.6	1.8	3.9	11	29.2	19.8	11.4	75.2
As	4	49	23	23	80	0	-	-	-	-	1	-	-	-	-
Sb	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Sn	10	17	23	5	80	7	4	1	2	7	9	2	1	1	5
W	4	4	2	2	6	1	-	-	-	-	2	7	1	6	8
B	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
In	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Bi	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-

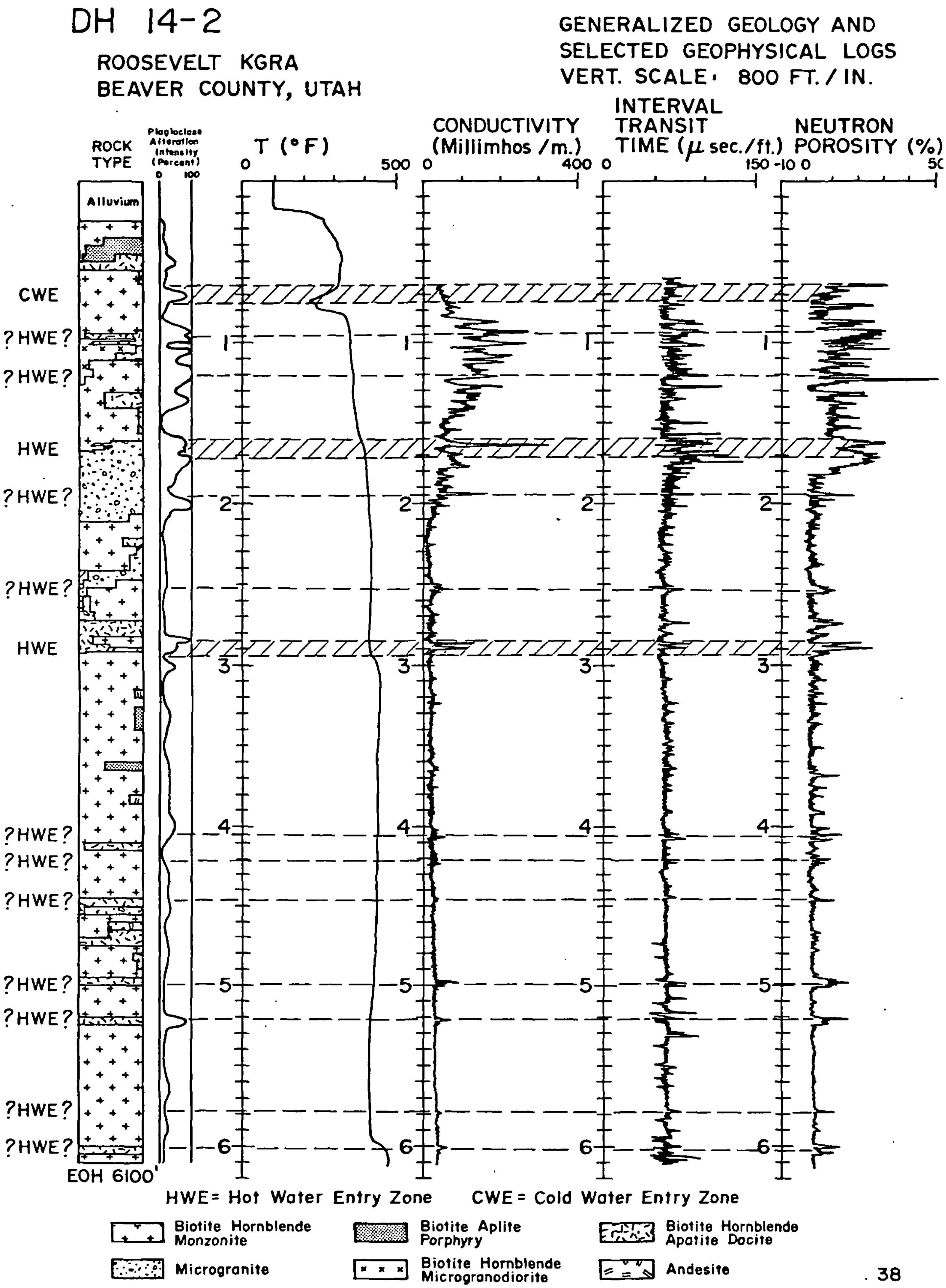
Table 3 - ELEMENT CONCENTRATION RATIOS FOR H.L. AND MAGNETIC FRACTIONS VS. WHOLE ROCK SAMPLES--GEYSERS DH 1 (55 ft. to 7480 ft.)

	+3.3 Sp. Gr. Less Mag./Whole Rock					+3.0-3.3 Sp. Gr. Less Mag./Whole Rock					Magnetic Fraction/Whole Rock				
ELEMENT (ppm)	Number of Samples	Mean	Stand. Dev.	Min	Max	Number of Samples	Mean	Stand. Dev.	Min	Max	Number of Samples	Mean	Stand. Dev.	Min	Max
Cu	37	26	50	1	261	38	2	2	<1	8	16	24	17	7	77
Mo	11	13	14	1	50	32	5	5	<1	20	15	199	108	50	435
Pb	37	73	120	3	700	38	3	2	1	12	16	7	8	1	29
Zn	37	11	18	1	95	37	2	1	1	6	16	6	8	1	35
Ag	4	147	134	15	330	0	-	-	-	-	0	-	-	-	-
Mn	37	5	4	<1	13	37	6	5	<1	18	16	8	6	<1	20
Co	37	11	10	1	43	37	2	1	<1	5	16	39	28	8	109
Ni	37	6	6	1	30	37	2	1	1	5	16	18	6	5	30
Fe(%)	37	4.2	2.6	1.4	12.3	37	2.5	0.8	1.1	4.0	16	17.9	8.3	0.4	27.7
As	37	57	135	2	820	37	11	30	1	192	16	11	17	1	70
Sb	27	48	29	21	148	26	18	11	2	42	12	18	29	3	91
Sn	23	4	3	1	11	27	3	2	1	9	0	-	-	-	-
W	13	28	13	5	45	11	1	<1	<1	2	0	-	-	-	-
B	23	1	1	<1	2	11	1	<1	1	2	0	-	-	-	-
In	23	8	13	1	66	27	3	3	<1	9	0	-	-	-	-
Bi	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-

Table 4 - ELEMENT CONCENTRATION RATIOS FOR H.L. AND MAGNETIC FRACTIONS VS. WHOLE ROCK SAMPLES--GEYSERS DH 1R (3527 ft. to 7148 ft.)

ELEMENT (ppm)	+3.3 Sp. Gr. Less Mag./Whole Rock					+3.0-3.3 Sp. Gr. Less Mag./Whole Rock					Magnetic Fraction/Whole Rock				
	Number of Samples	Mean	Stand. Dev.	Min	Max	Number of Samples	Mean	Stand. Dev.	Min	Max	Number of Samples	Mean	Stand. Dev.	Min	Max
Cu	20	9	7	1	27	20	1	1	1	3	11	22	5	13	30
Mo	8	2	1	1	3	14	2	1	1	7	11	206	109	79	370
Pb	20	47	43	10	169	20	2	1	1	5	11	3	2	1	7
Zn	20	5	2	2	18	20	2	1	1	5	11	2	1	1	6
Ag	2	563	336	325	800	0	-	-	-	-	0	-	-	-	-
Mn	20	11	18	1	83	20	9	5	2	19	11	12	15	4	57
Co	20	5	4	1	19	20	1	1	<1	3	11	102	65	24	204
Ni	20	4	2	1	8	20	1	1	1	3	11	26	4	18	31
Fe(%)	20	2.9	0.8	1.6	5.8	20	2.2	0.4	1.5	3.2	11	17.3	2.8	11.0	21.1
As	20	19	14	7	61	20	4	3	2	15	11	9	3	4	15
Sb	20	41	20	18	92	20	22	13	6	50	7	10	6	3	18
Sn	13	6	2	3	10	18	5	2	2	8	0	-	-	-	-
W	8	23	17	6	53	8	1	1	<1	2	0	-	-	-	-
B	5	1	<1	1	2	0	0	-	-	-	0	-	-	-	-
In	13	7	5	1	19	18	4	3	1	9	0	-	-	-	-
Bi	0	-	-	-	-	0	0	-	-	-	0	-	-	-	-

FIGURE 1/14-2



Geophysical Logs from Thermal Power Co., Deliverable to DOE/DGE Case Studies Program Contract No. EG-77-C-08-1525.
Geology and Alteration Data after Ballantyne and Parry, 1978.

FIGURE 2/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE:
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

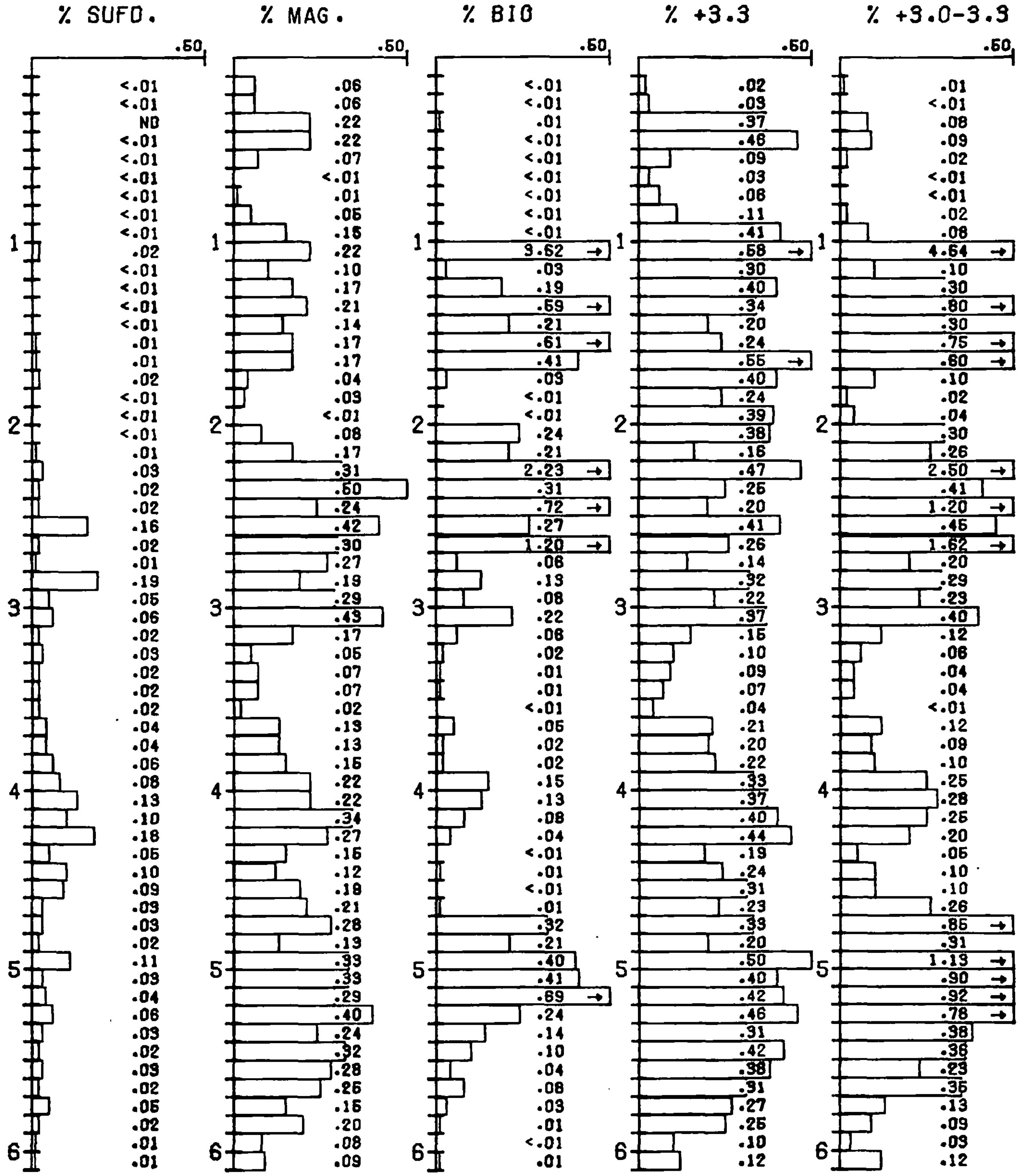


FIGURE 3/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

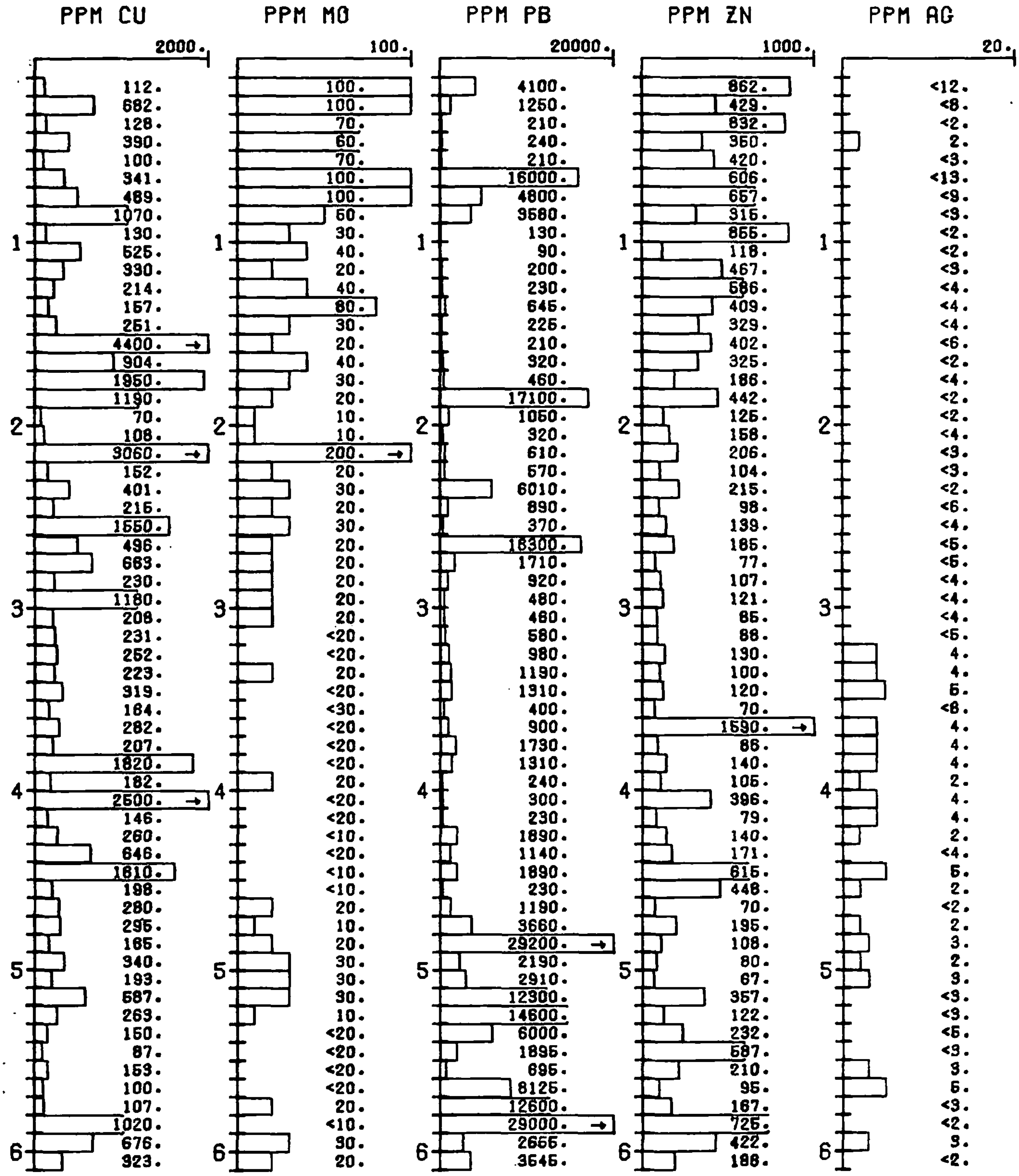


FIGURE 4/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

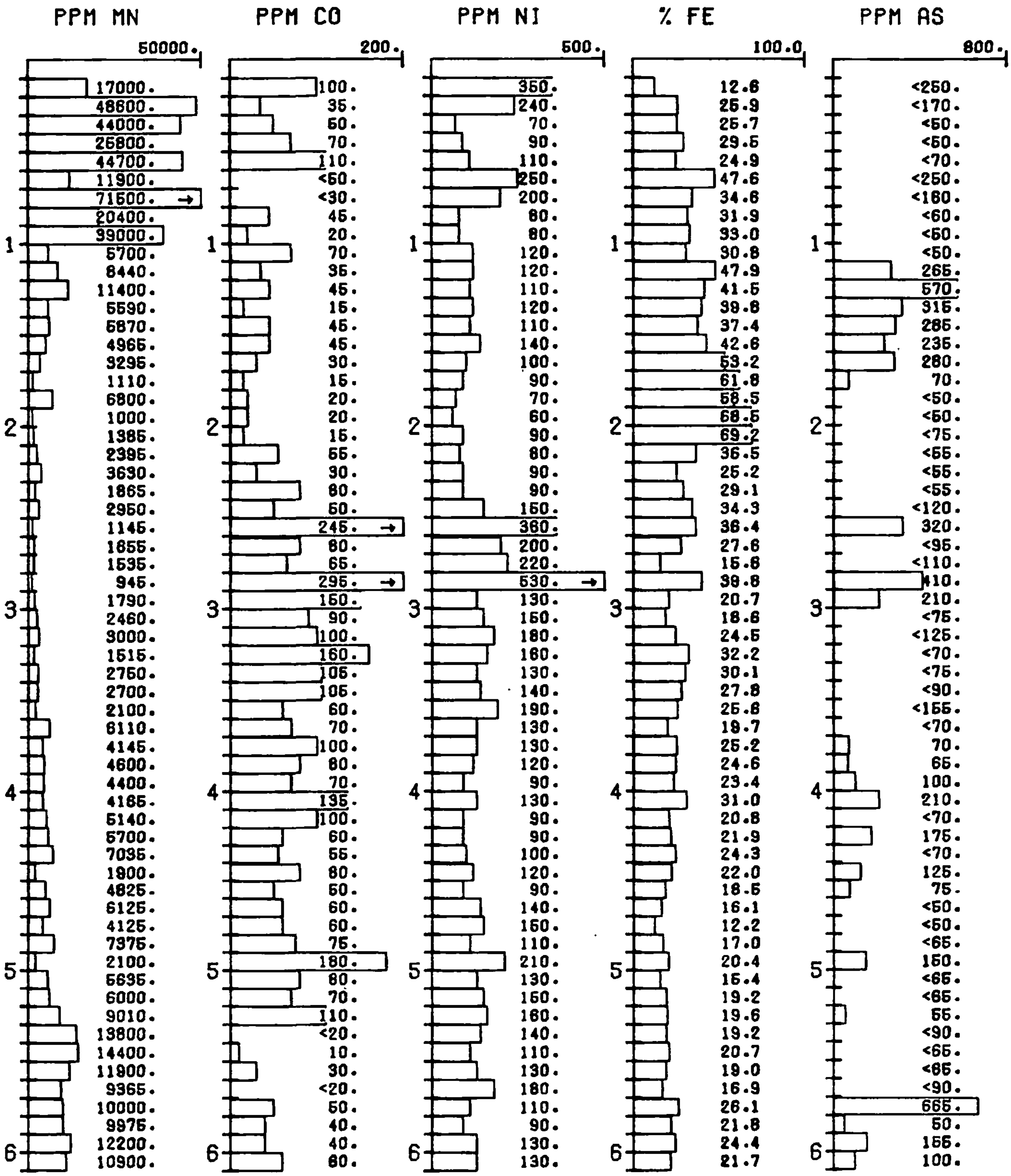


FIGURE 5/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

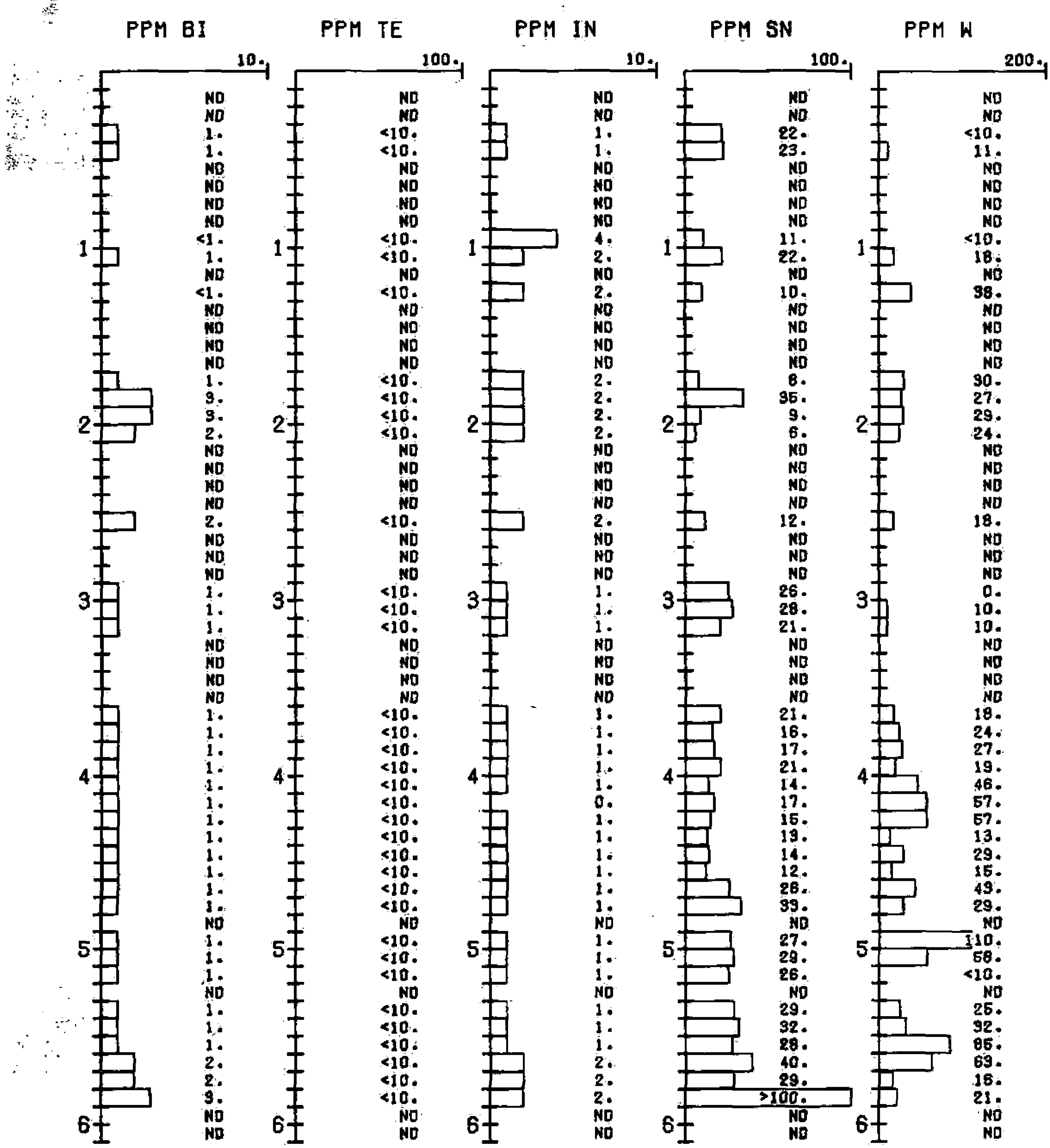


FIGURE 6/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

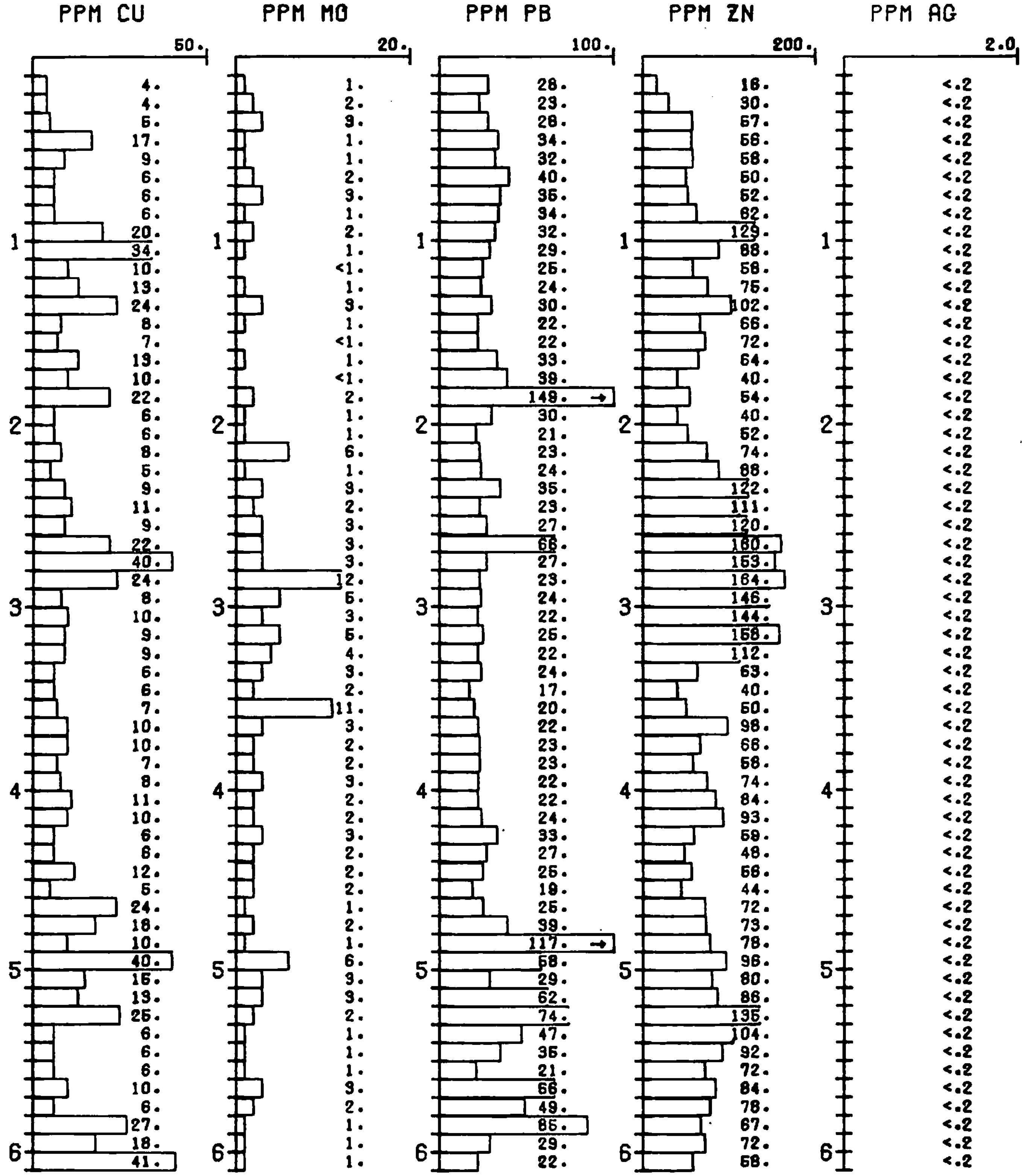
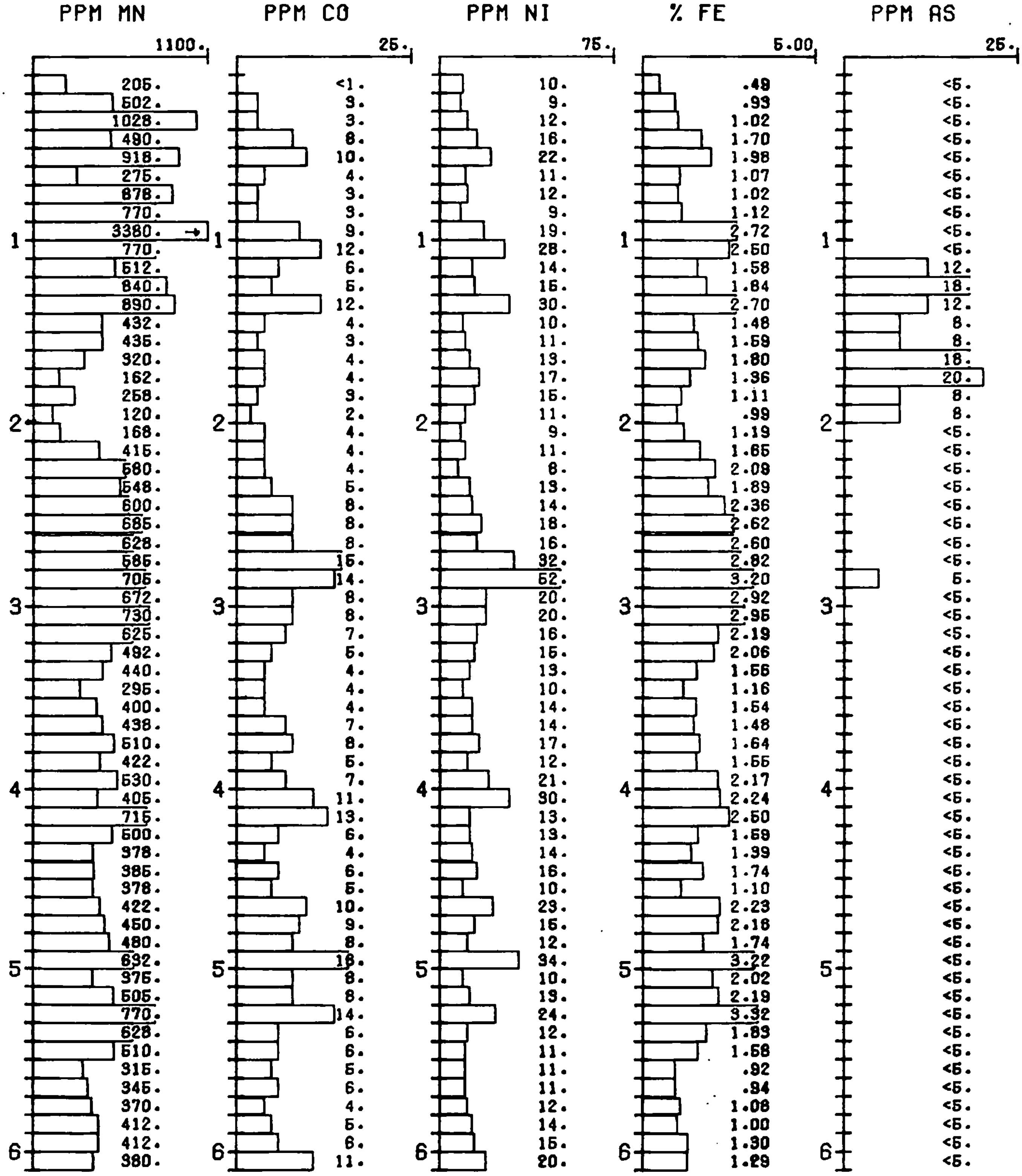


FIGURE 7/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)



PPM MN	PPM CO	PPM NI	% FE	PPM AS
205.	<1.	10.	.49	<5.
502.	3.	9.	.93	<5.
1028.	3.	12.	1.02	<5.
490.	8.	16.	1.70	<5.
918.	10.	22.	1.98	<5.
275.	4.	11.	1.07	<5.
878.	3.	12.	1.02	<5.
770.	3.	9.	1.12	<5.
3380. →	9.	19.	2.72	<5.
770.	12.	28.	2.60	<5.
512.	6.	14.	1.58	12.
840.	5.	15.	1.84	18.
890.	12.	30.	2.70	12.
432.	4.	10.	1.48	8.
436.	3.	11.	1.59	8.
320.	4.	13.	1.80	18.
162.	4.	17.	1.36	20.
258.	3.	15.	1.11	8.
120.	2.	11.	.99	8.
168.	4.	9.	1.19	<5.
415.	4.	11.	1.65	<5.
560.	4.	8.	2.09	<5.
548.	5.	13.	1.89	<5.
600.	8.	14.	2.36	<5.
685.	8.	18.	2.62	<5.
628.	8.	16.	2.60	<5.
585.	15.	32.	2.82	<5.
705.	14.	52.	3.20	5.
672.	8.	20.	2.92	<5.
730.	8.	20.	2.96	<5.
625.	7.	16.	2.19	<5.
492.	5.	15.	2.06	<5.
440.	4.	13.	1.56	<5.
295.	4.	10.	1.16	<5.
400.	4.	14.	1.54	<5.
438.	7.	14.	1.48	<5.
510.	8.	17.	1.64	<5.
422.	5.	12.	1.55	<5.
530.	7.	21.	2.17	<5.
405.	11.	30.	2.24	<5.
715.	13.	13.	2.60	<5.
500.	6.	13.	1.59	<5.
378.	4.	14.	1.39	<5.
385.	6.	16.	1.74	<5.
378.	5.	10.	1.10	<5.
422.	10.	23.	2.23	<5.
450.	9.	15.	2.16	<5.
480.	8.	12.	1.74	<5.
632.	16.	34.	3.22	<5.
375.	8.	10.	2.02	<5.
505.	8.	13.	2.19	<5.
770.	14.	24.	3.32	<5.
628.	6.	12.	1.83	<5.
510.	6.	11.	1.58	<5.
315.	5.	11.	.92	<5.
345.	6.	11.	.94	<5.
370.	4.	12.	1.08	<5.
412.	5.	14.	1.00	<5.
412.	6.	15.	1.30	<5.
380.	11.	20.	1.29	<5.

FIGURE 8/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

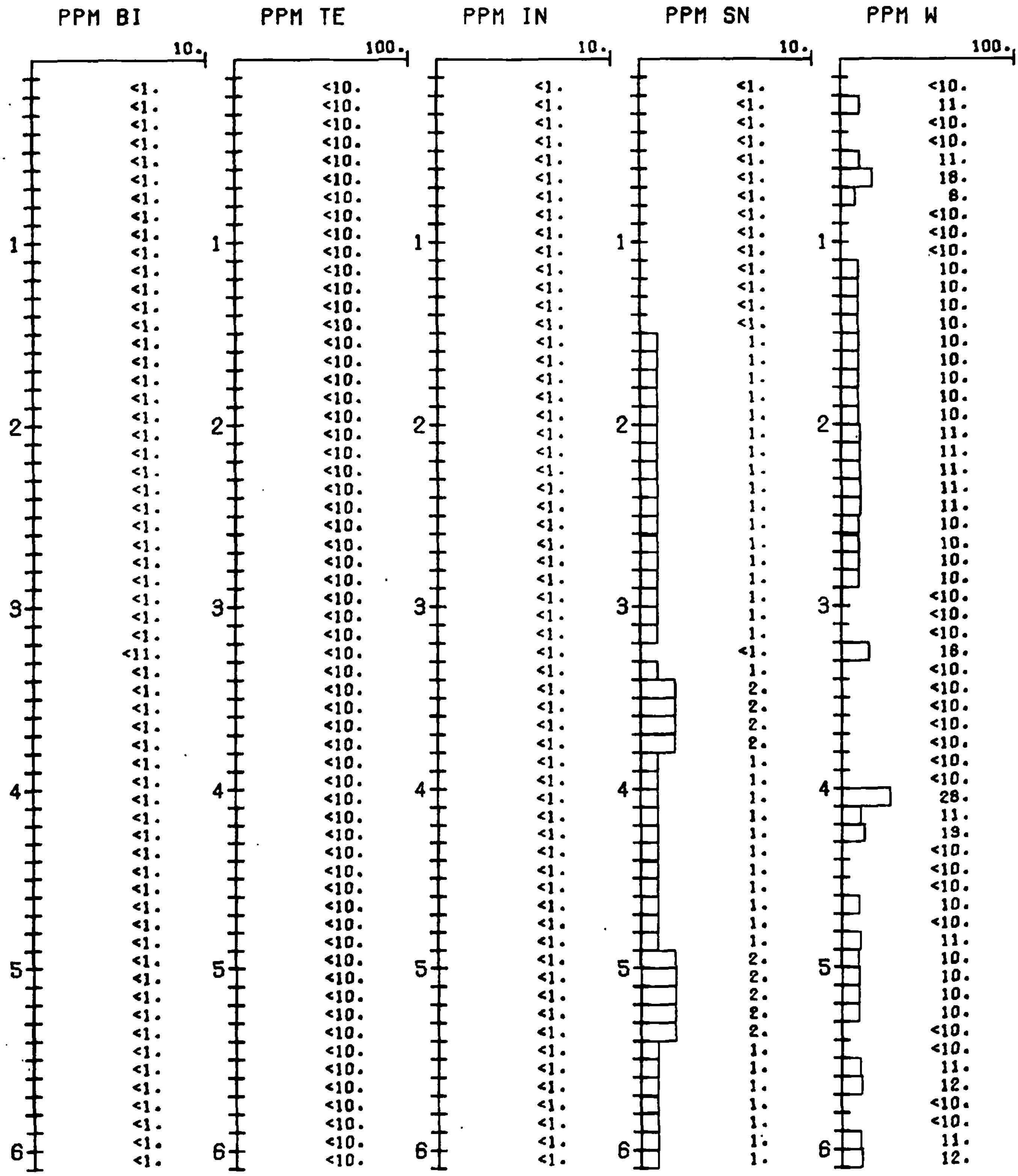


FIGURE 9/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

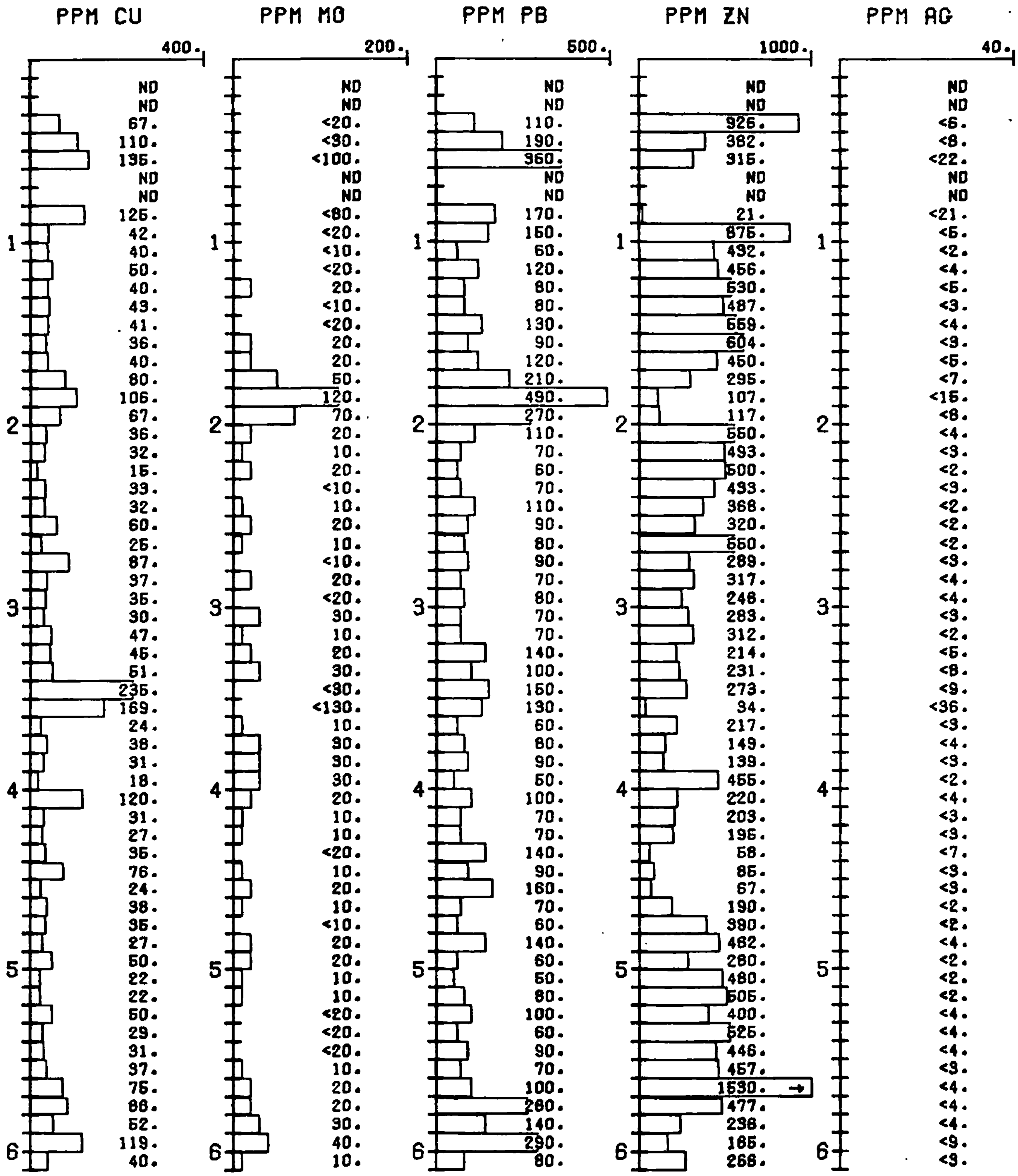


FIGURE 10/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

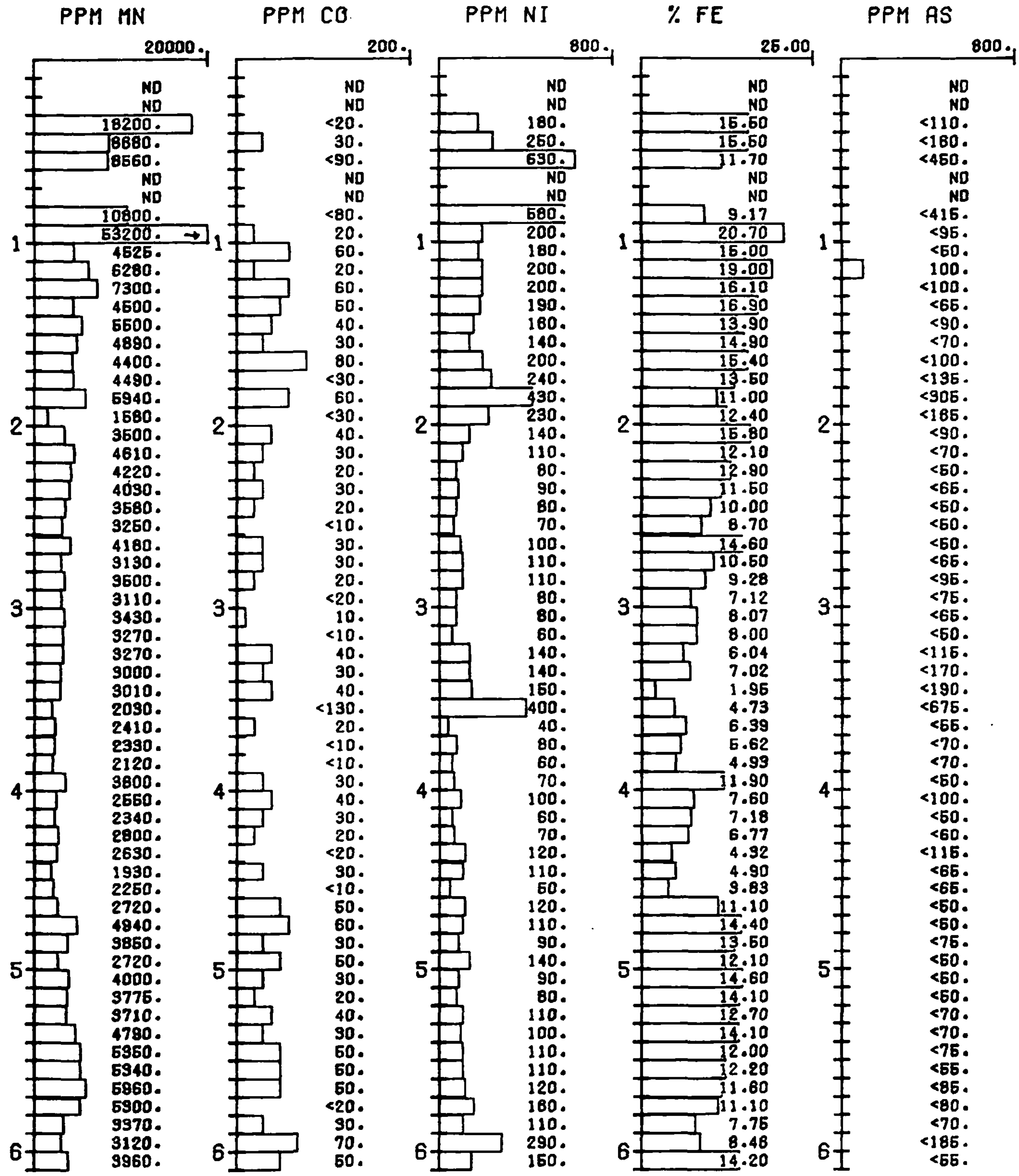
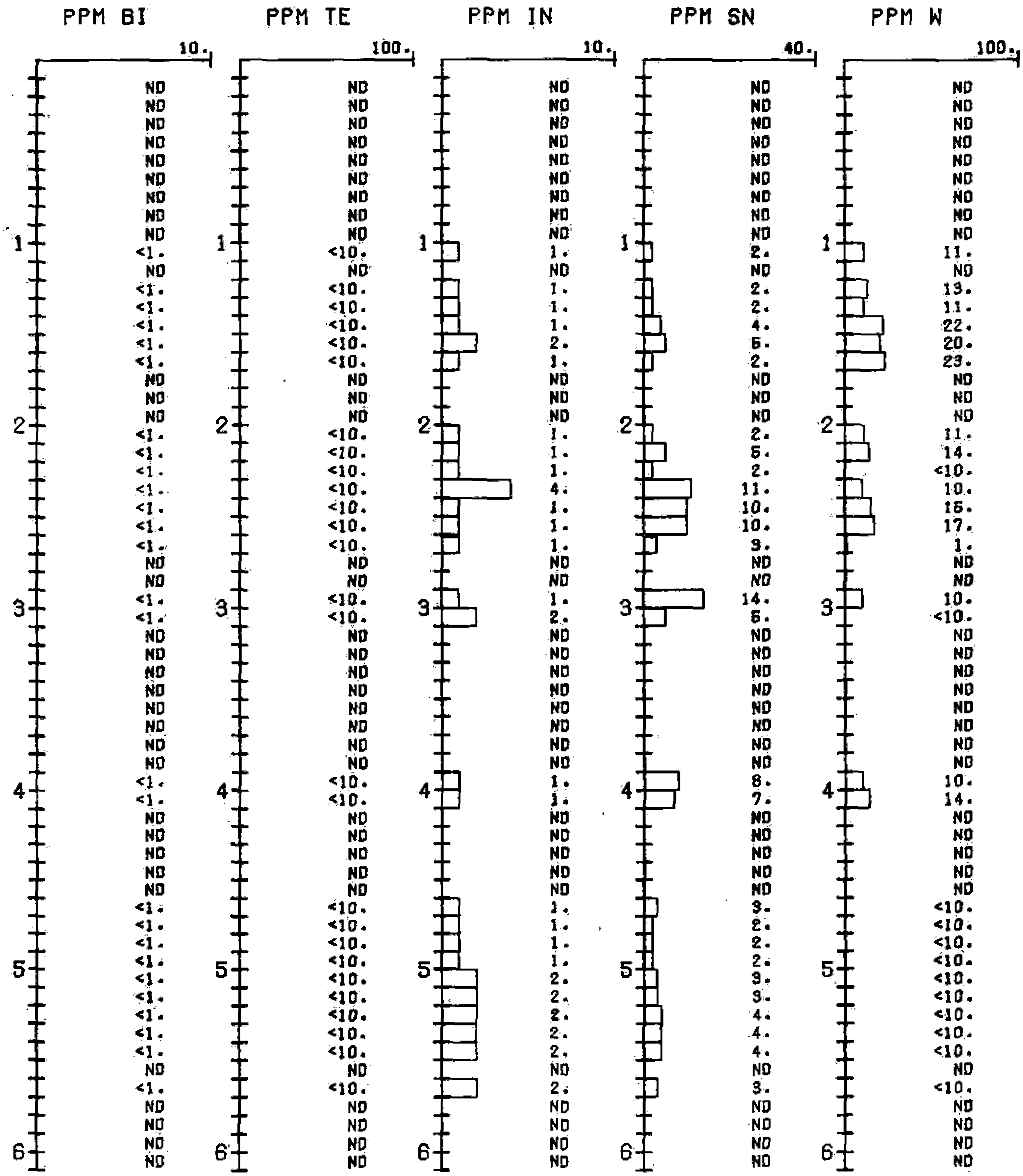


FIGURE 11/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)



PPM BI	PPM TE	PPM IN	PPM SN	PPM W
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	2.	11.
ND	ND	ND	ND	ND
<1.	<10.	1.	2.	13.
<1.	<10.	1.	2.	11.
<1.	<10.	1.	4.	22.
<1.	<10.	2.	5.	20.
<1.	<10.	1.	2.	23.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	2.	11.
<1.	<10.	1.	5.	14.
<1.	<10.	1.	2.	<10.
<1.	<10.	4.	11.	10.
<1.	<10.	1.	10.	15.
<1.	<10.	1.	10.	17.
<1.	<10.	1.	3.	1.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	14.	10.
<1.	<10.	2.	5.	<10.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	8.	10.
<1.	<10.	1.	7.	14.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	3.	<10.
<1.	<10.	1.	2.	<10.
<1.	<10.	1.	2.	<10.
<1.	<10.	1.	2.	<10.
<1.	<10.	2.	3.	<10.
<1.	<10.	2.	3.	<10.
<1.	<10.	2.	4.	<10.
<1.	<10.	2.	4.	<10.
<1.	<10.	2.	4.	<10.
ND	ND	ND	ND	ND
<1.	<10.	2.	3.	<10.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND

FIGURE 12/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

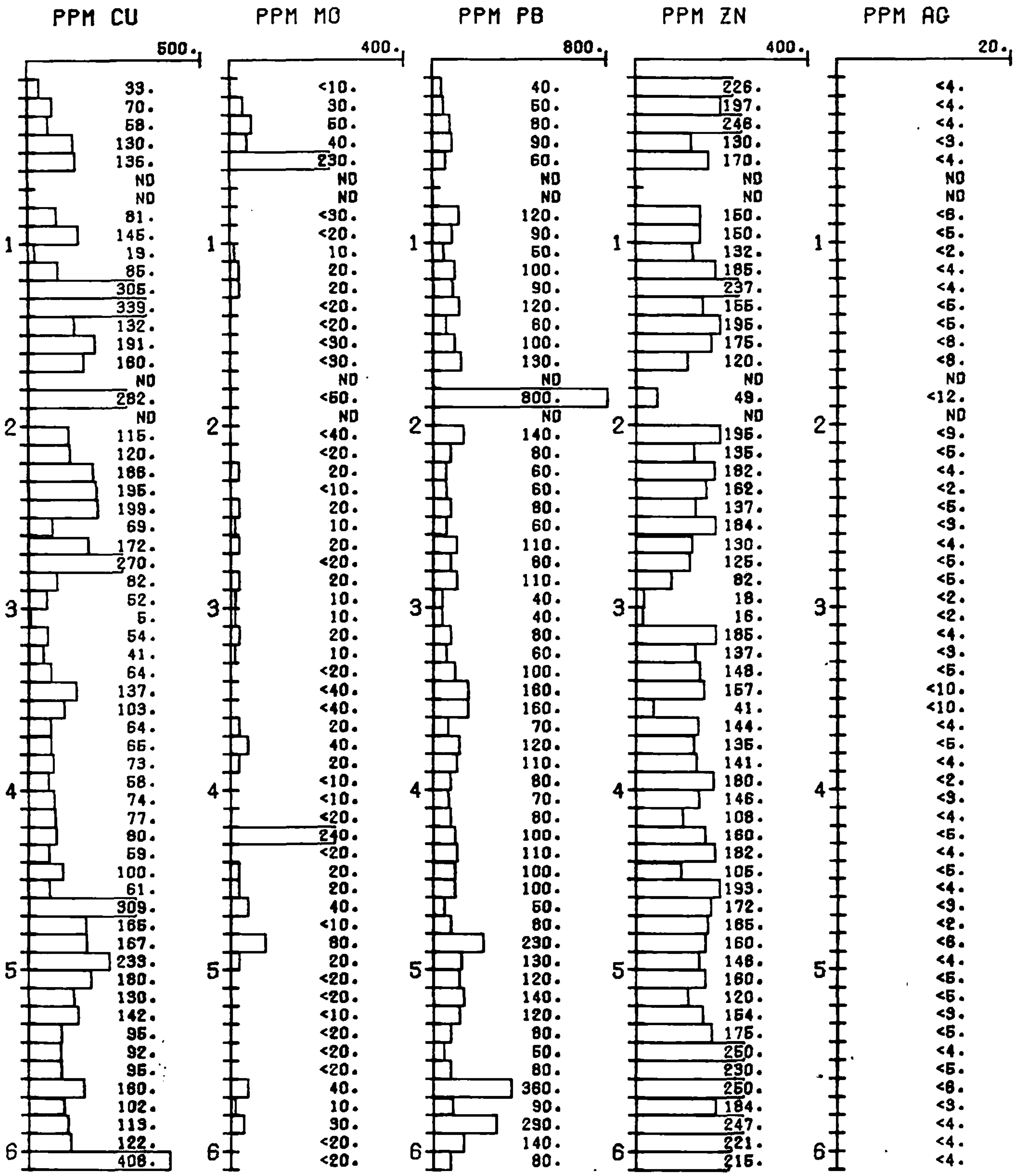


FIGURE 13/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

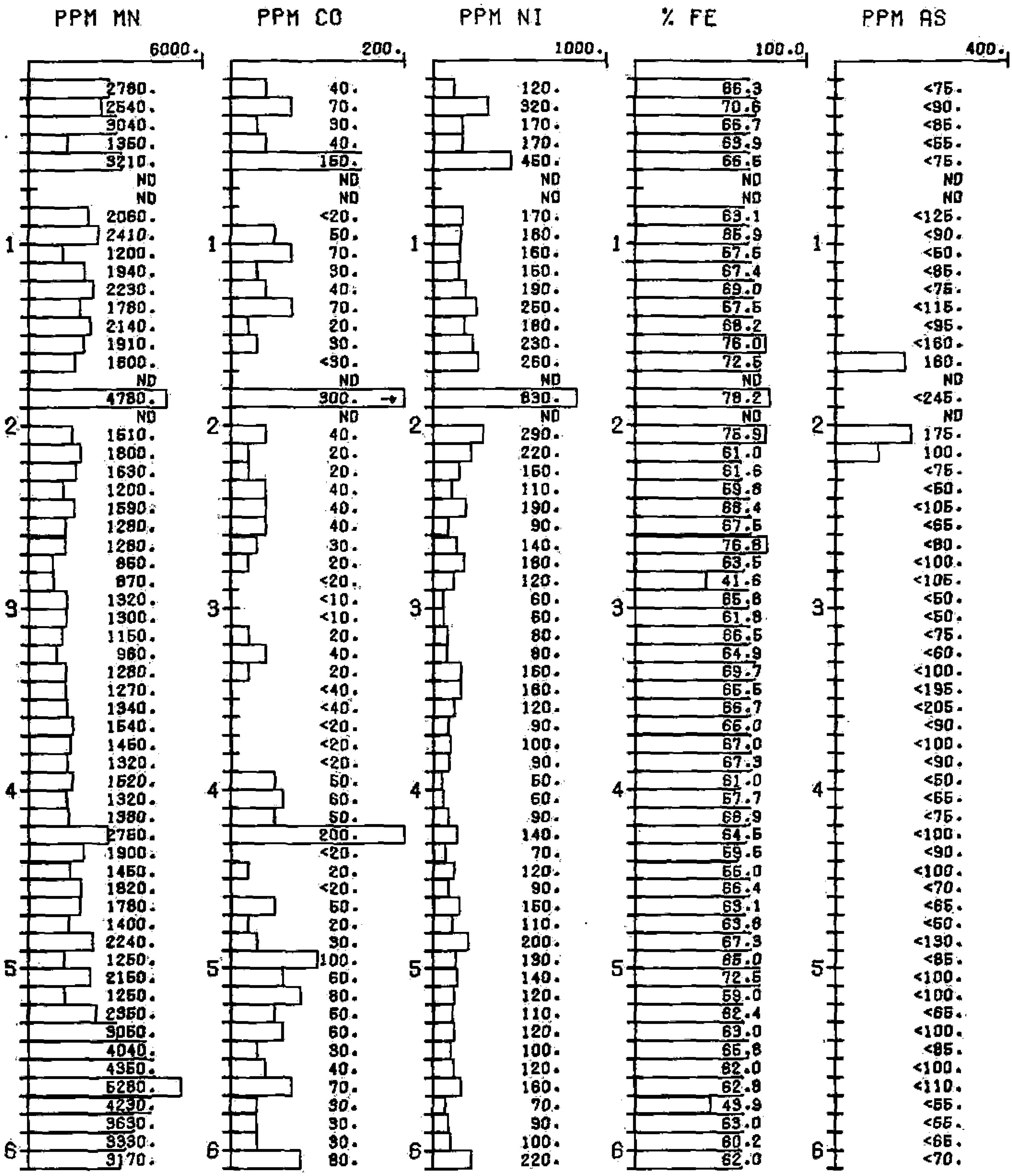


FIGURE 14/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

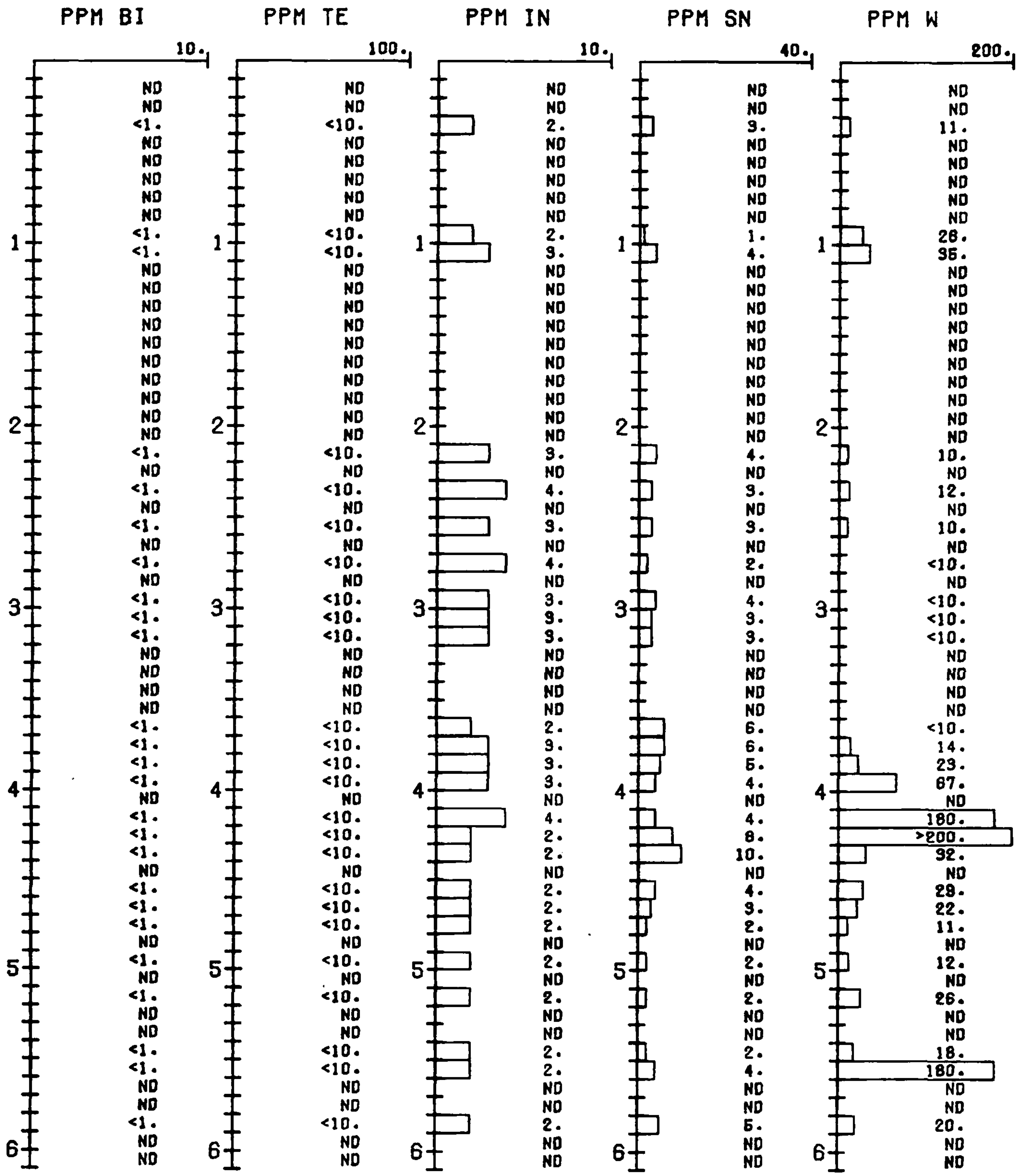
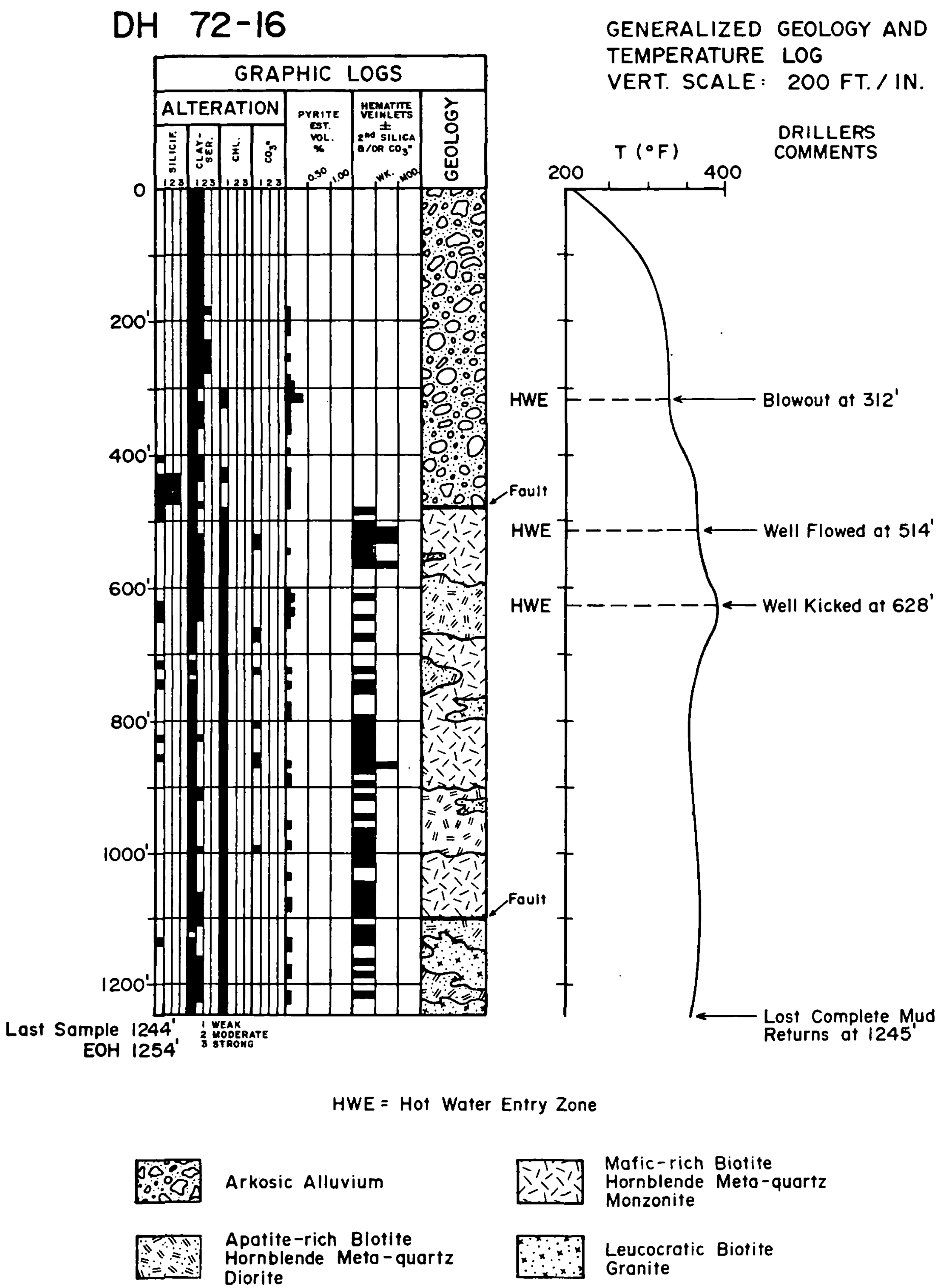


FIGURE 1/72-16

GENERALIZED GEOLOGY AND TEMPERATURE LOG
VERT. SCALE: 200 FT./IN.



Geology and Alteration Data after Moore and Hulen, 1978.

Temperature Log from Thermal Power Co., Deliverable to DOE/DGE Case Studies Program Contract No. EG-77-C-08-1525.

FIGURE 2/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE:
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

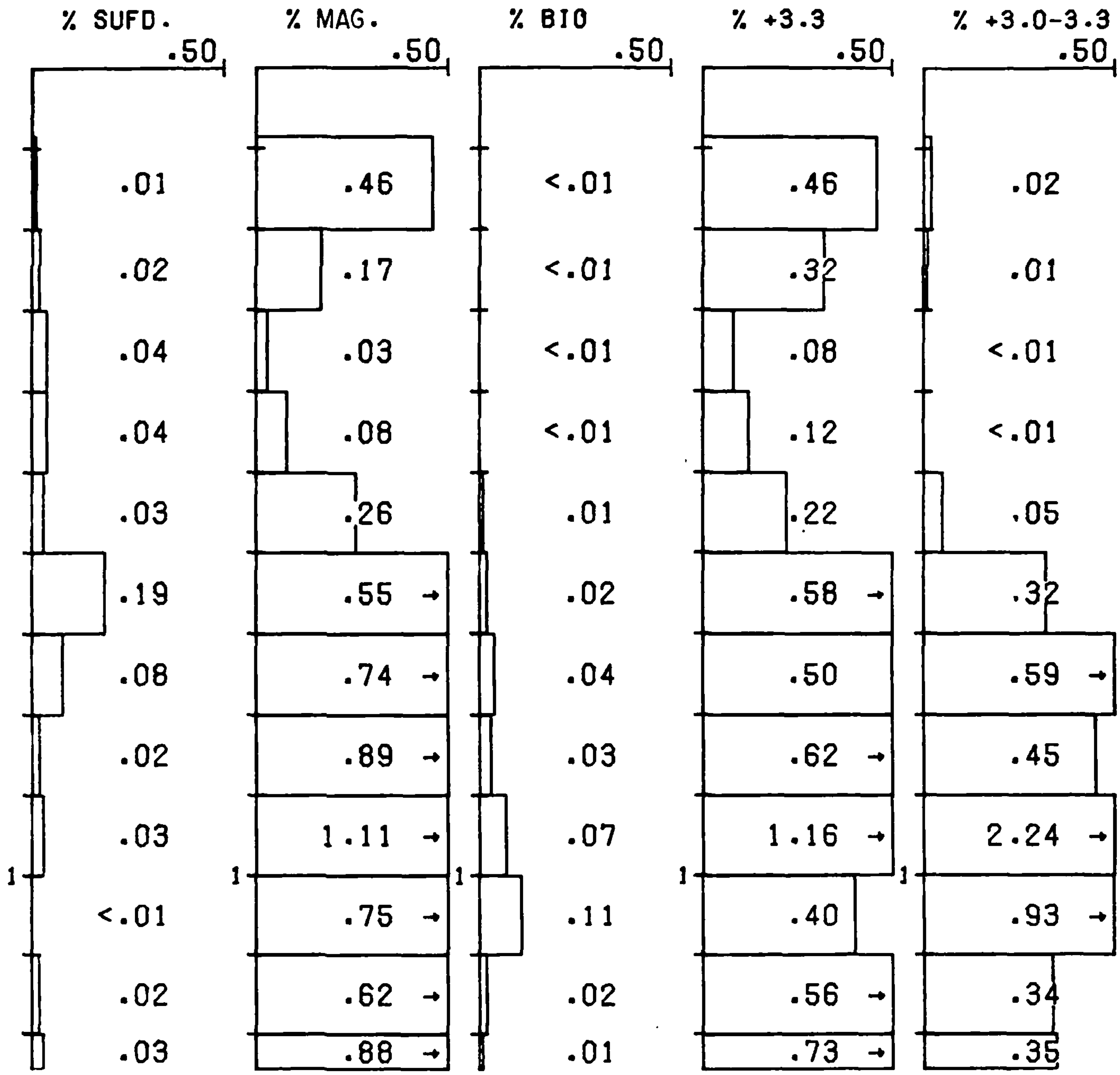


FIGURE 3/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

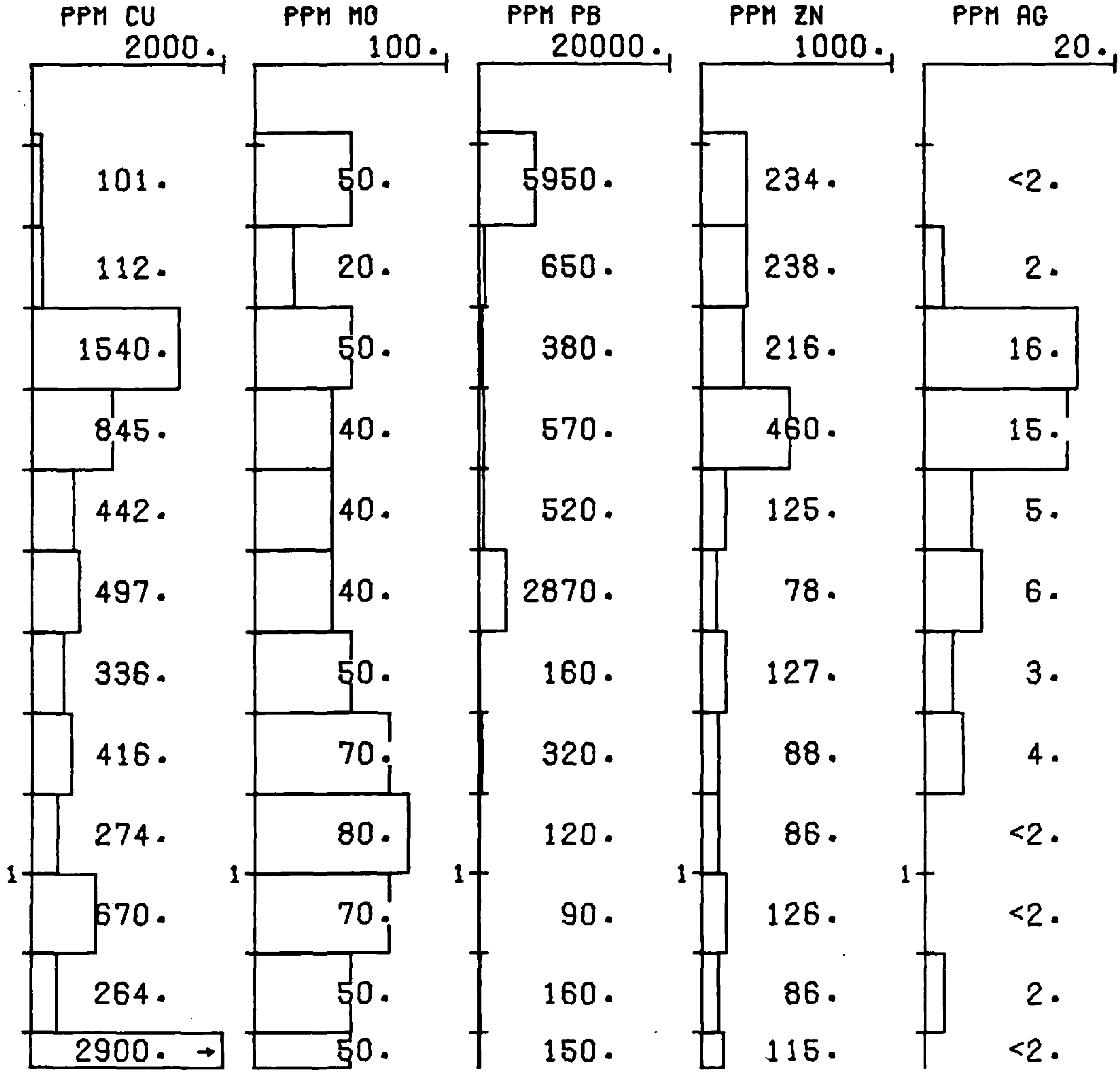


FIGURE 4/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

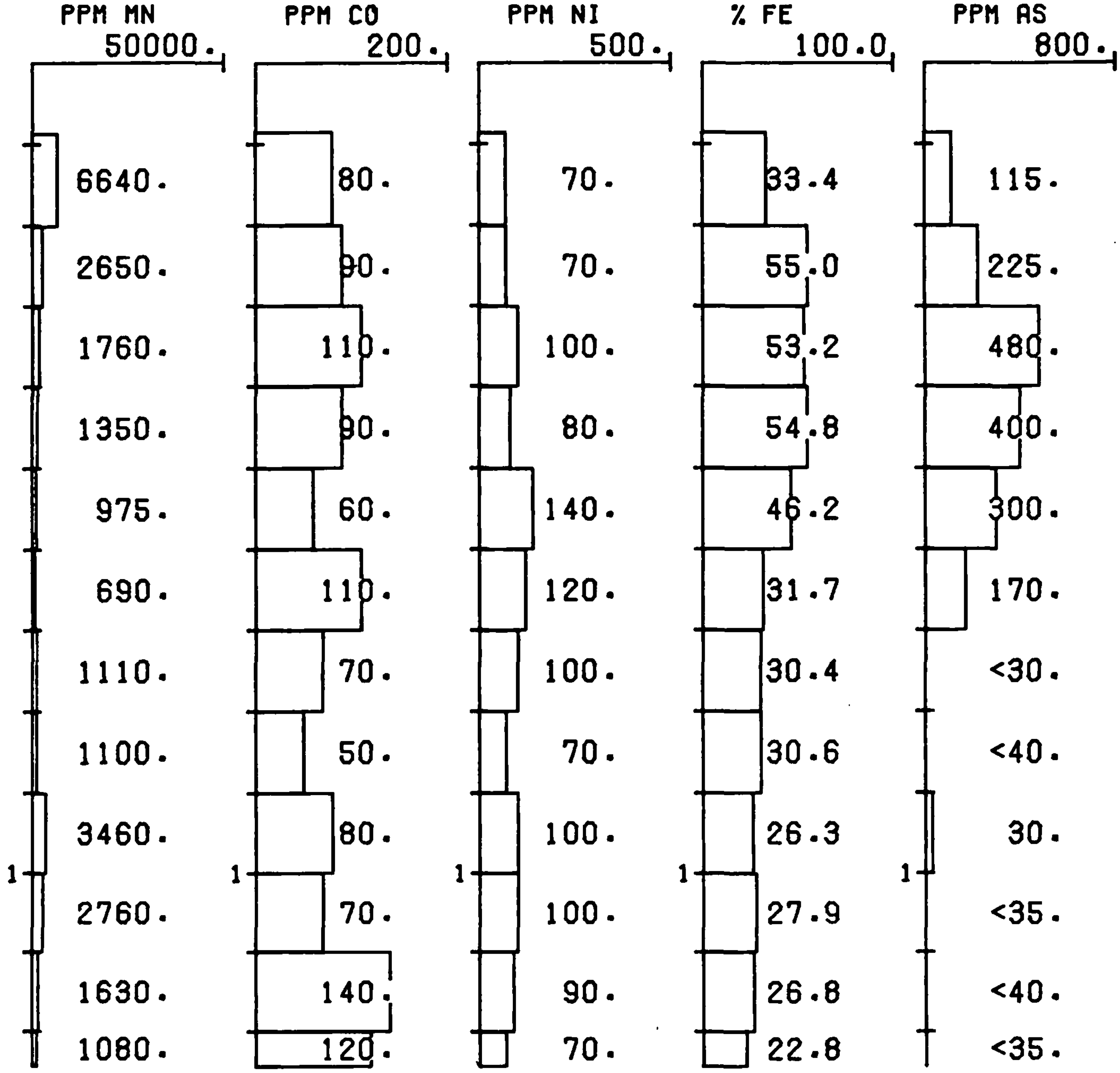


FIGURE 5/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

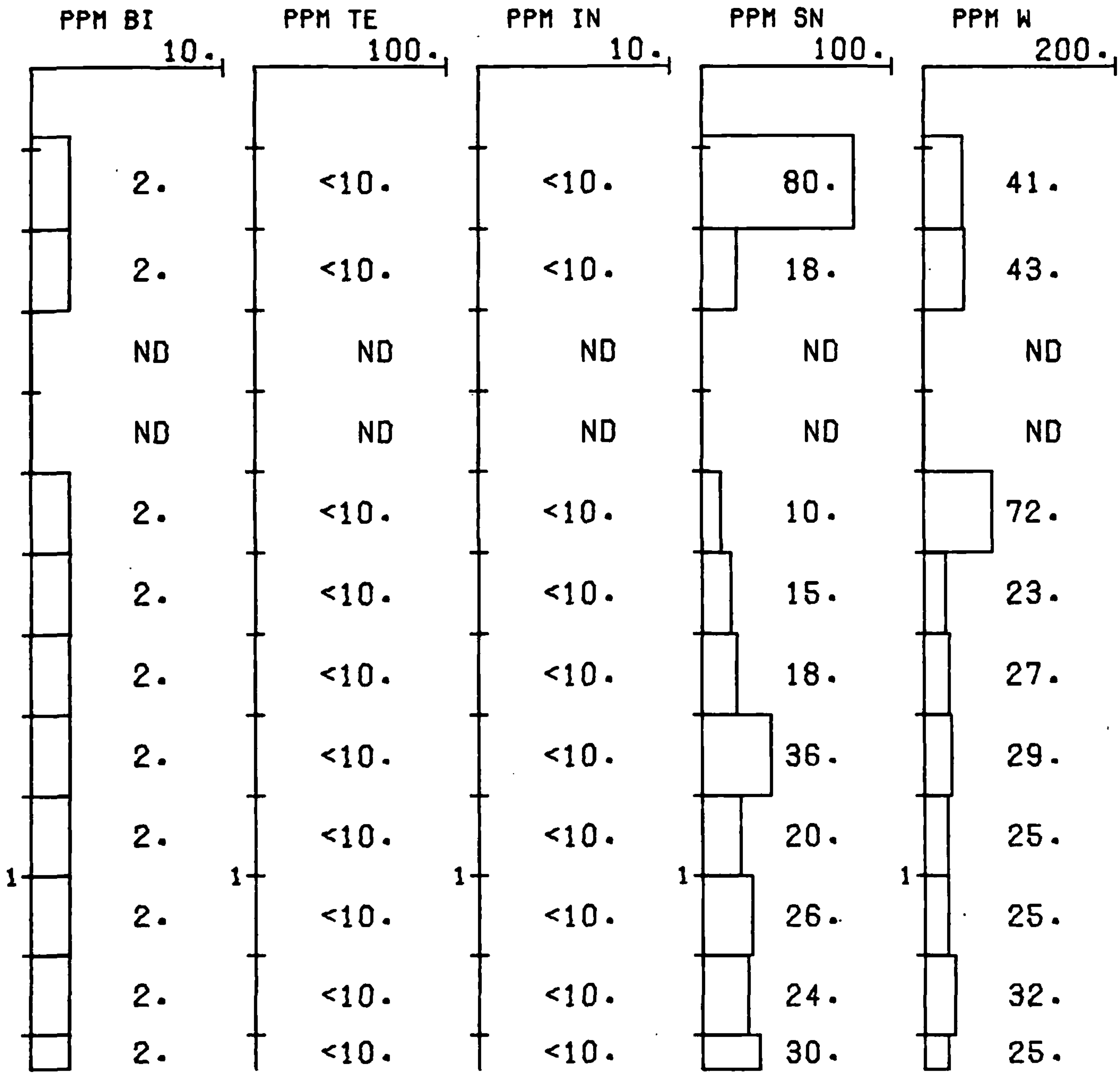


FIGURE 6/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

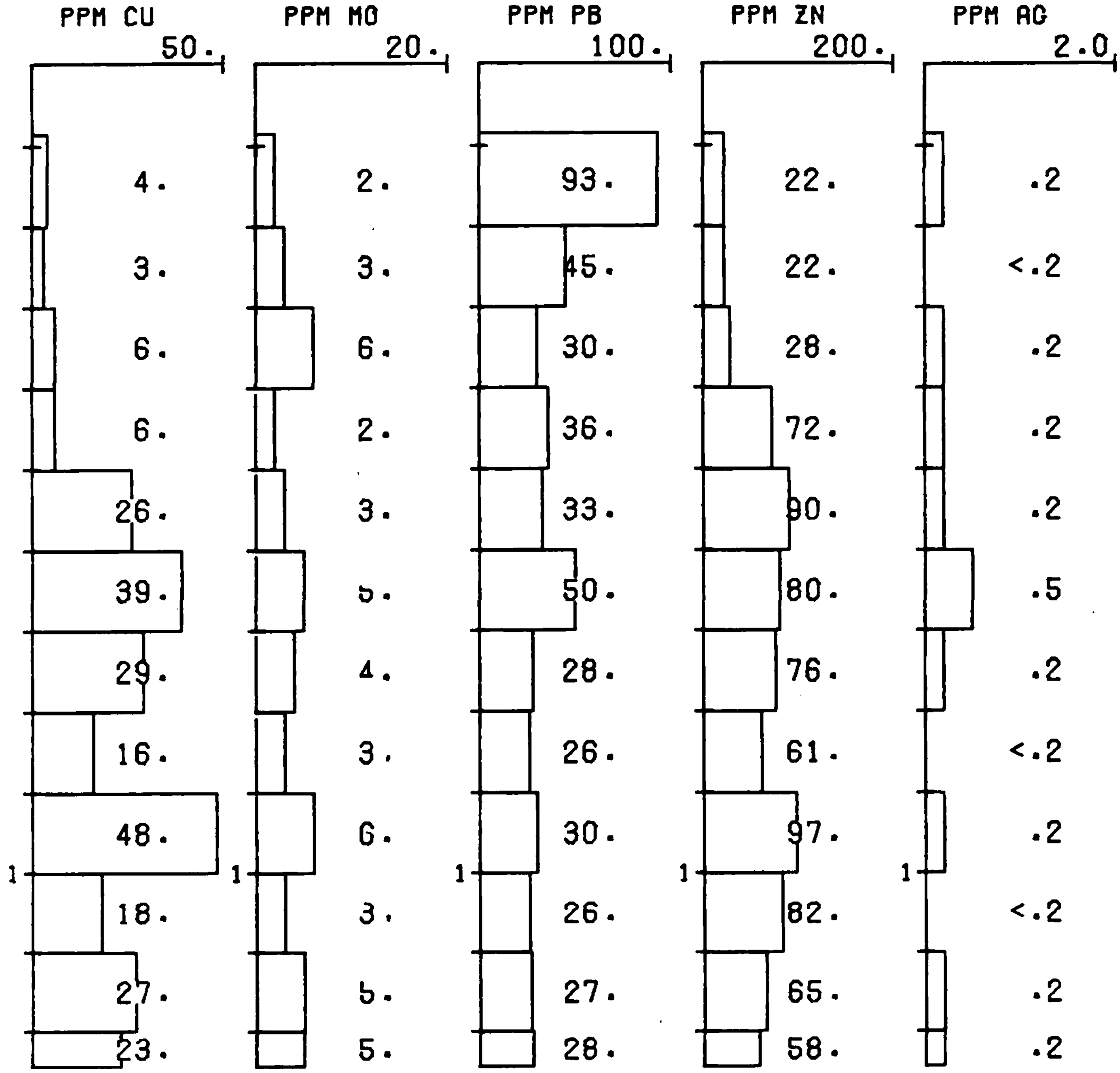


FIGURE 7/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

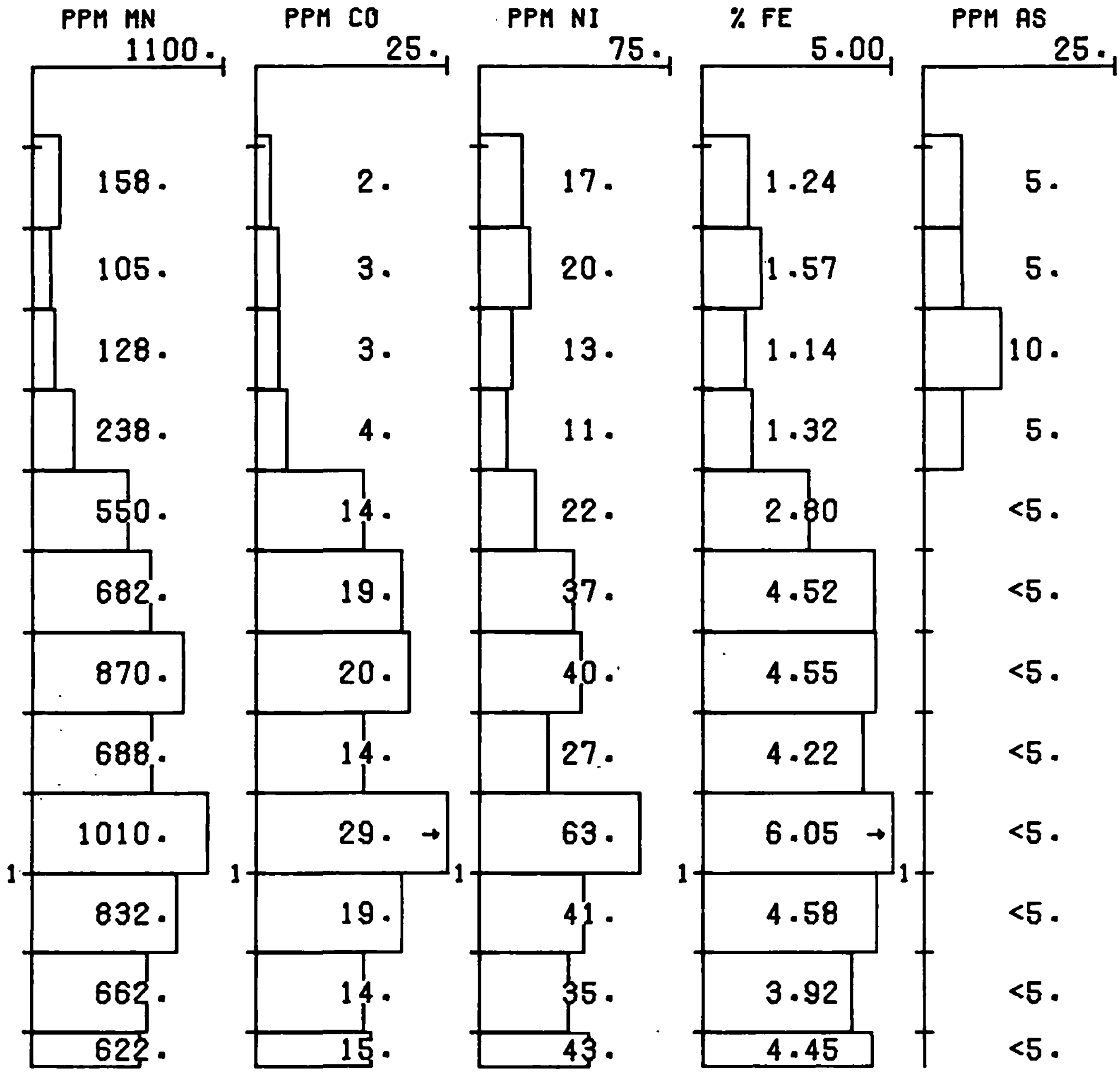


FIGURE 8/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

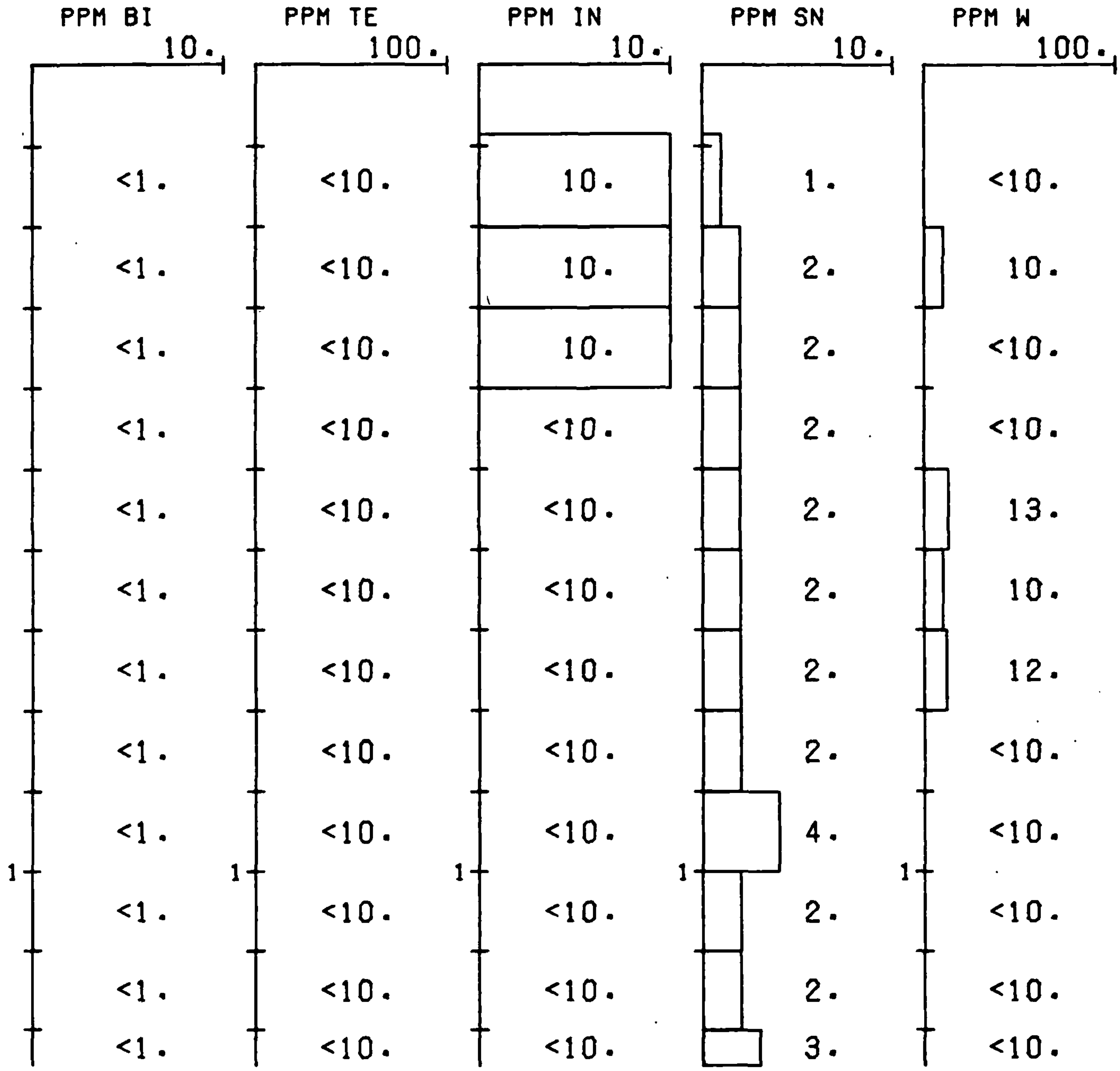


FIGURE 9/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

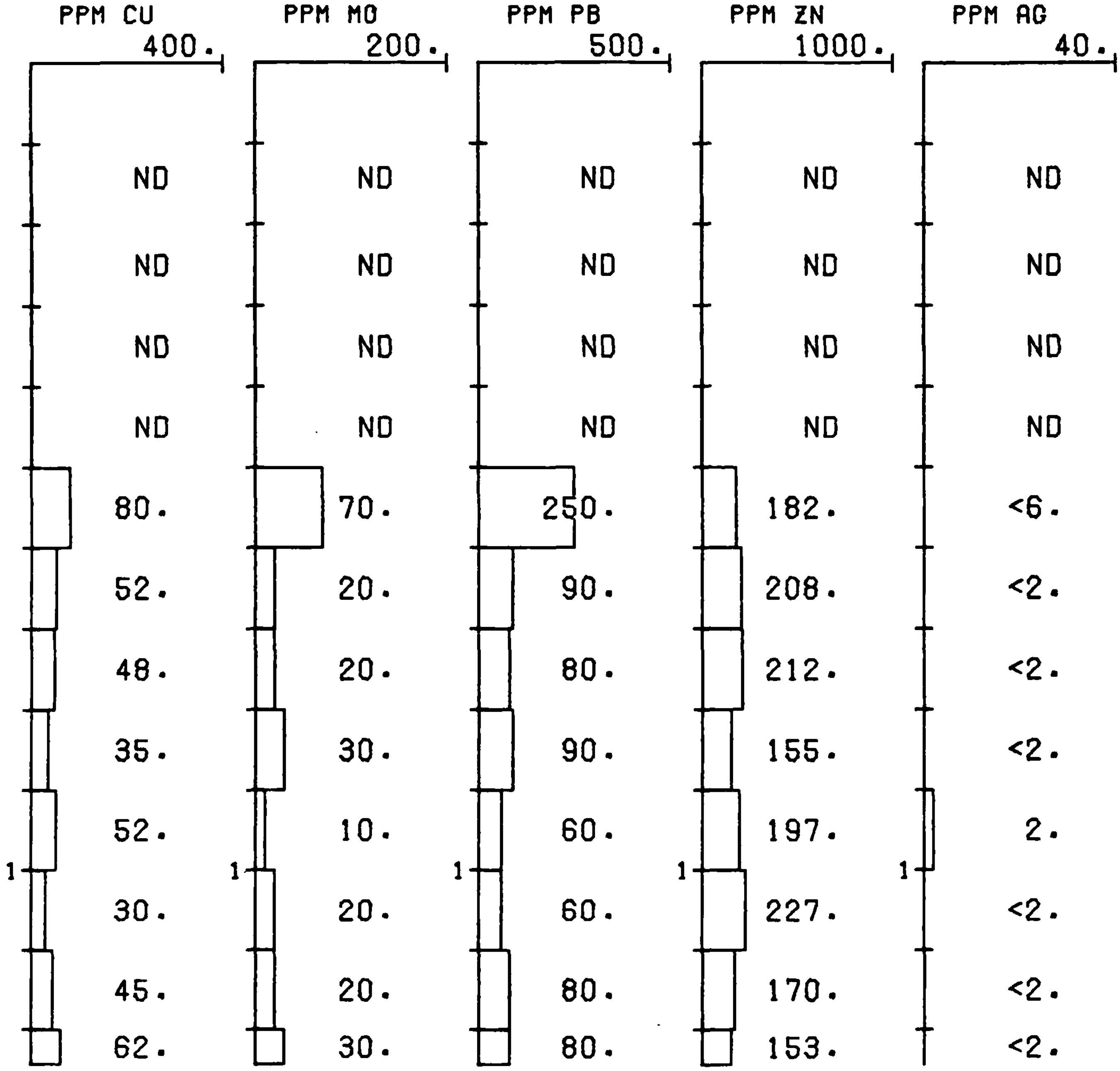


FIGURE 10/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

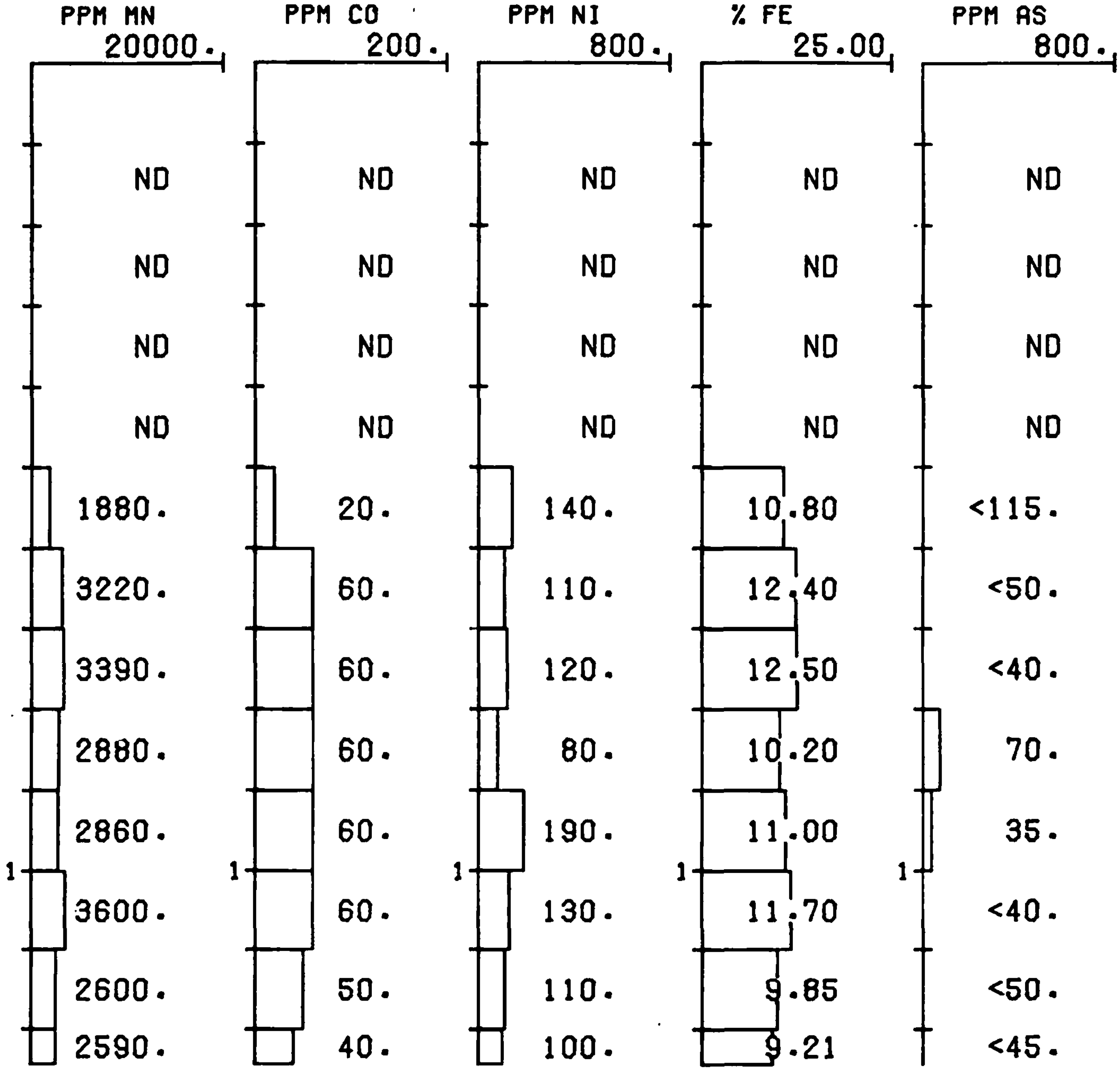


FIGURE 11 72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

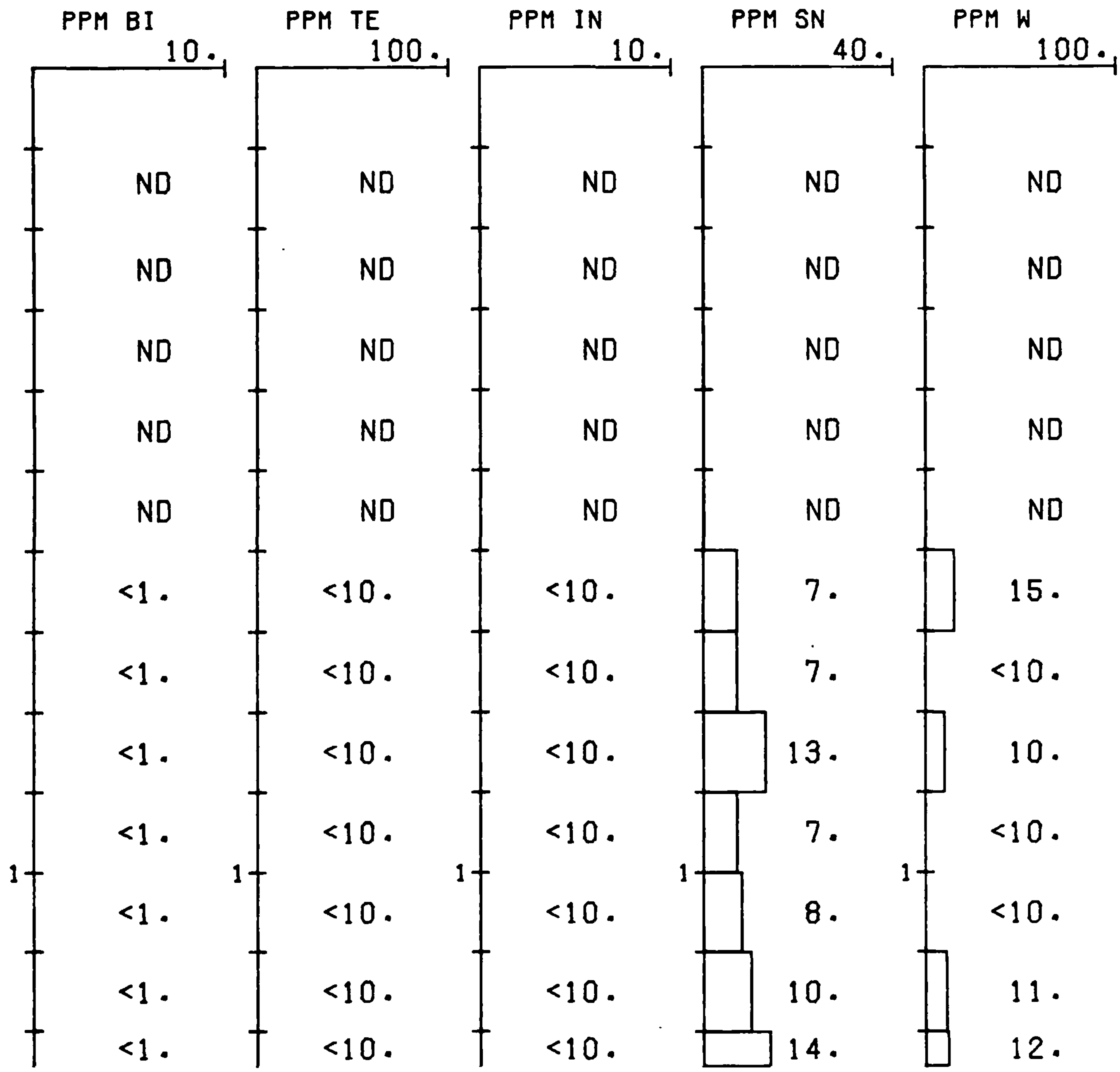


FIGURE 12/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

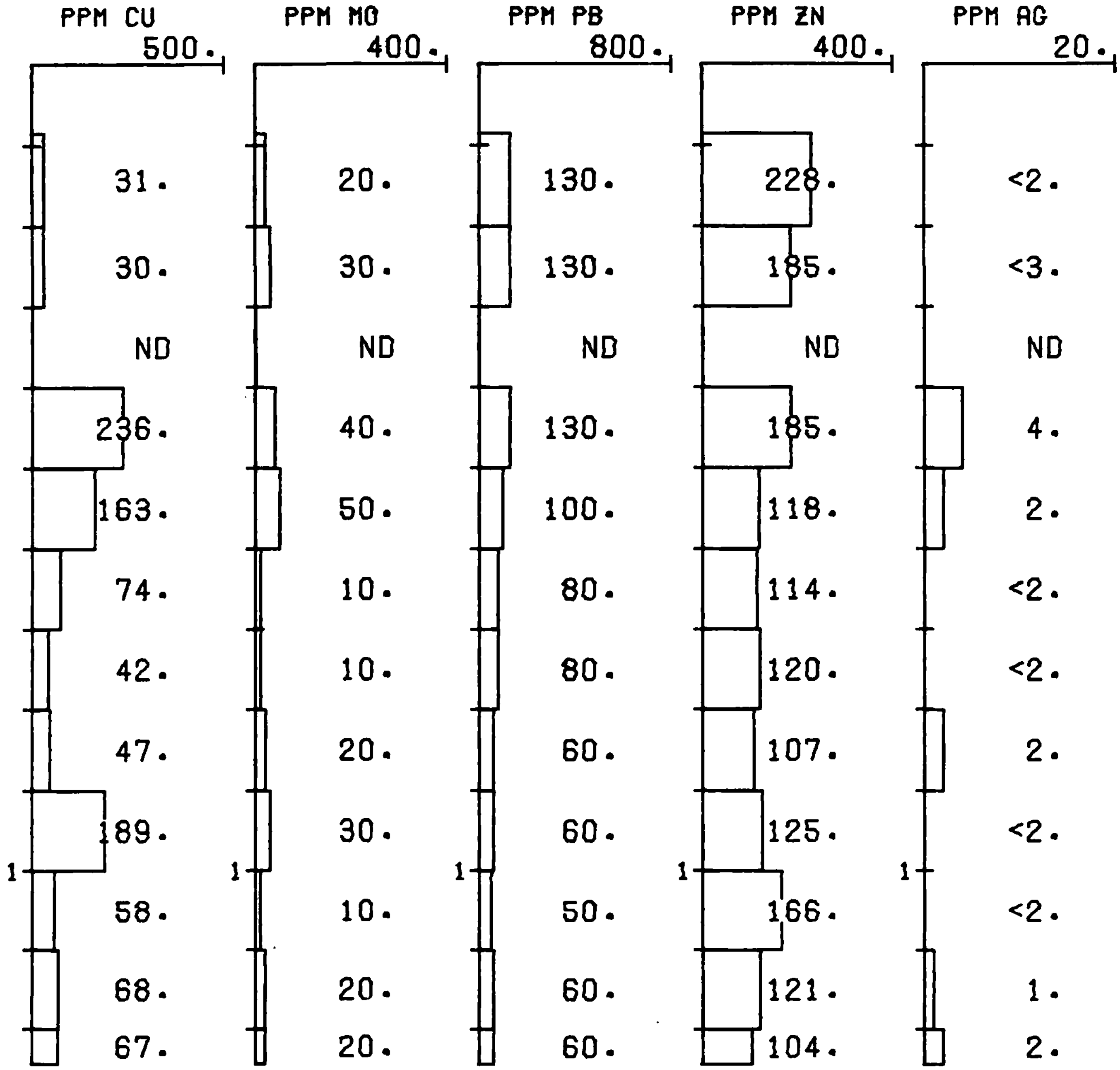


FIGURE 13/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

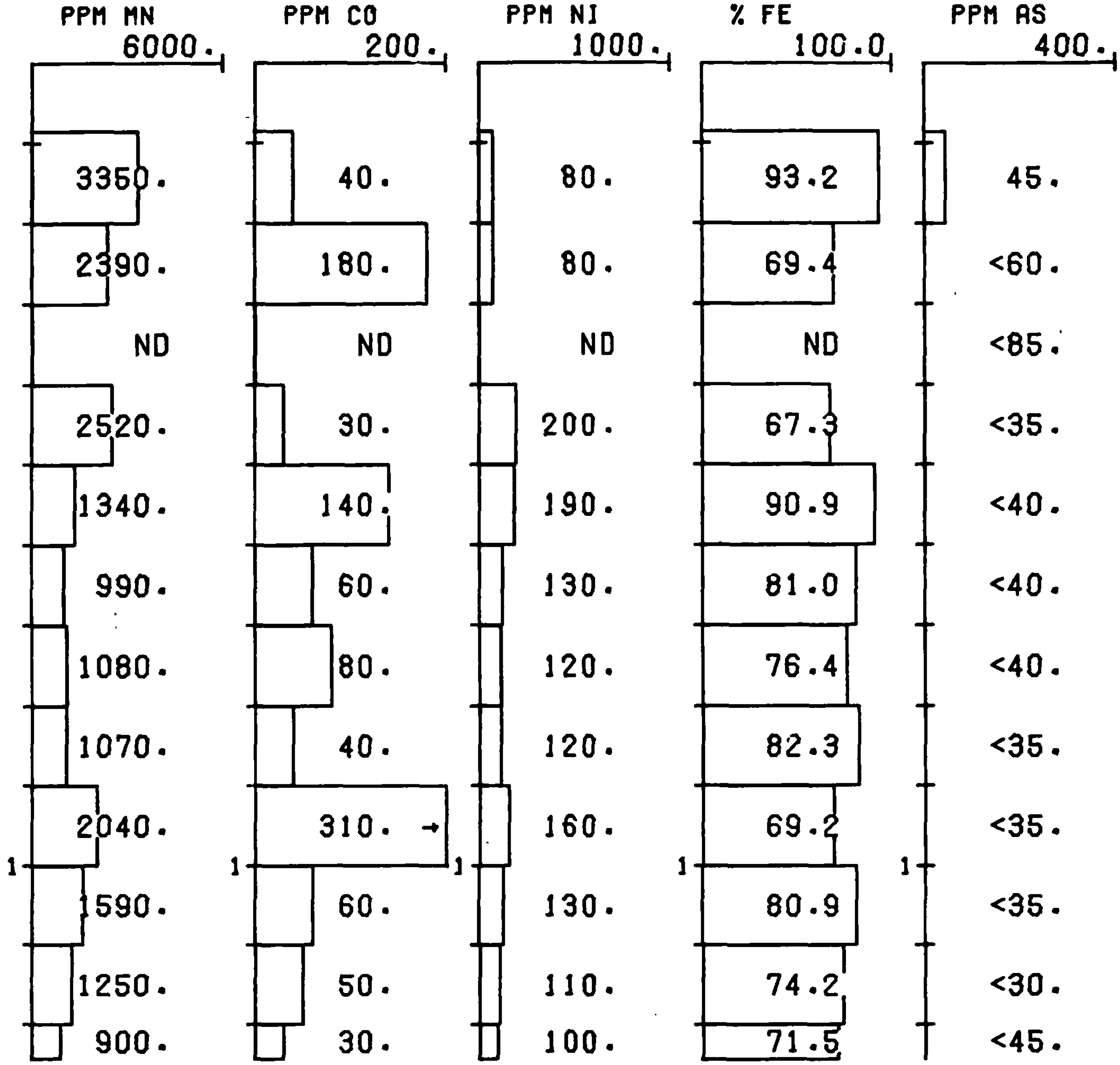


FIGURE 14 /72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

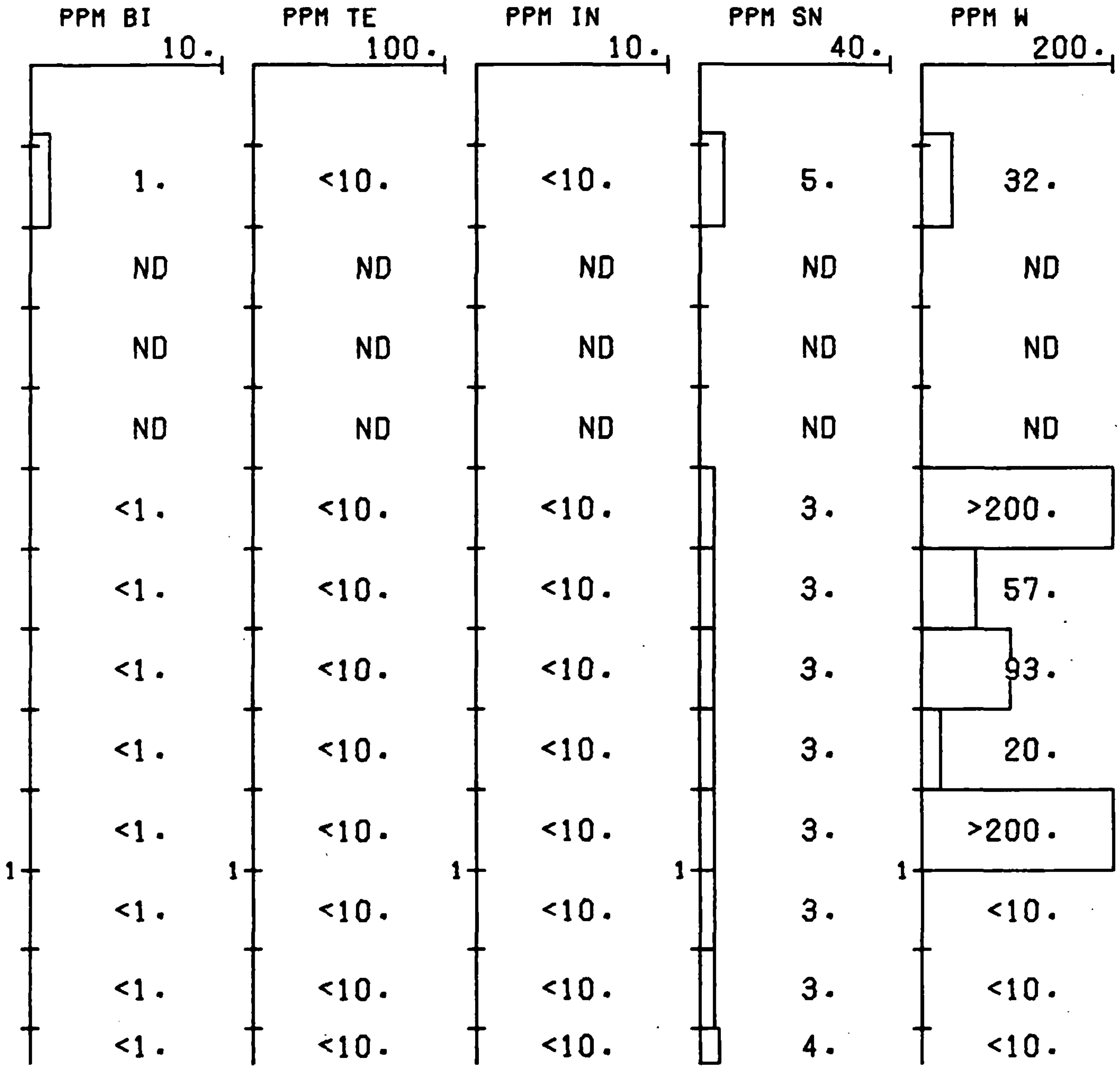
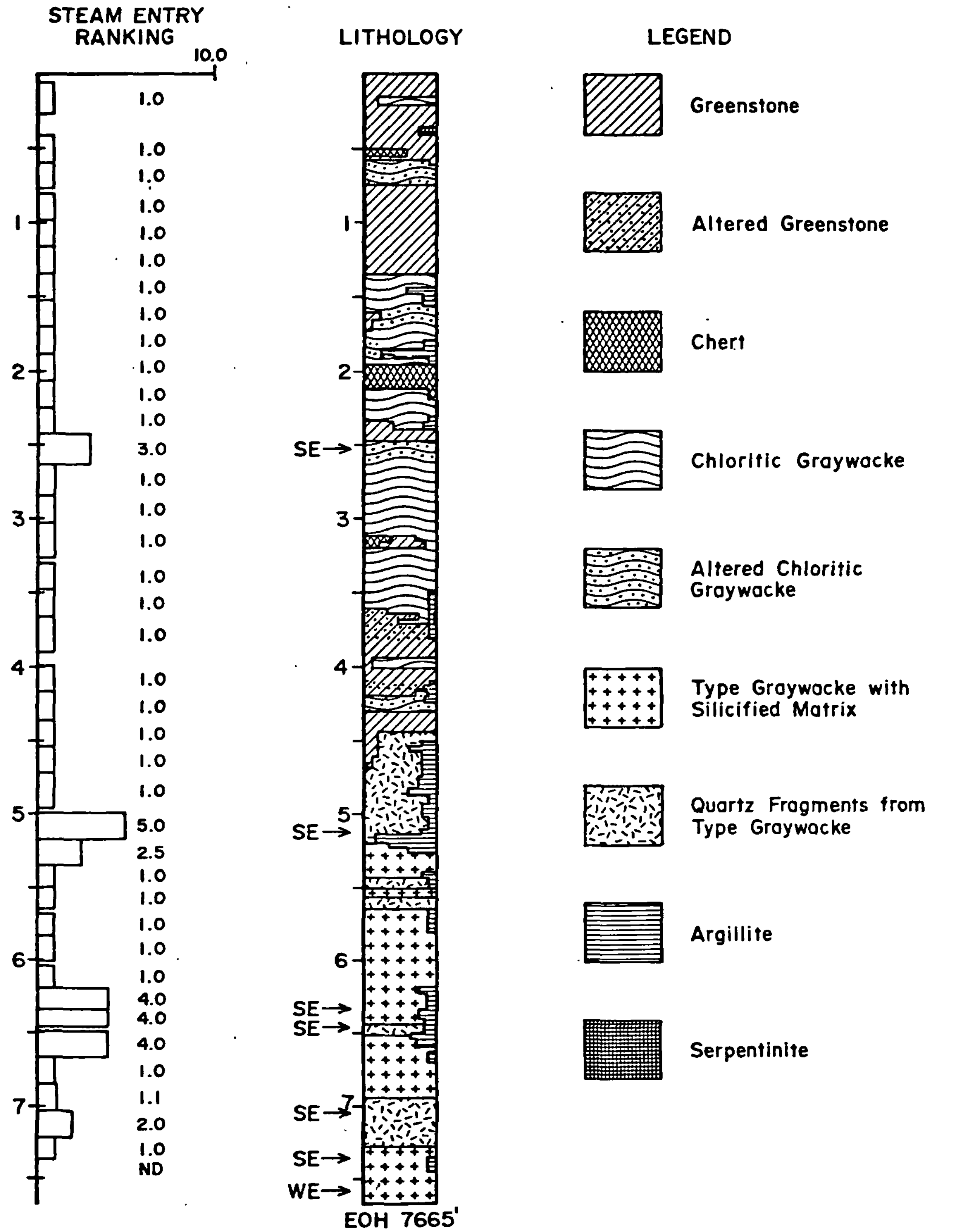


FIGURE 1/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

GENERALIZED GEOLOGY AND
STEAM ENTRY RANKING
VERT. SCALE: 1000 FT./IN.



SE= Steam Entry WE= Water Entry

1.0 = No steam entry within or close to sample interval

2.0 thru 5.0 = Steam entries (SE) within or close to sample interval. *Relative importance of SE indicated by ranking.*

Geology modified from preliminary geologic log by Mary Twichell (Aminoil U.S.A. Inc.).

FIGURE 2/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS.. CALIF.

SAMPLE TYPE:
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

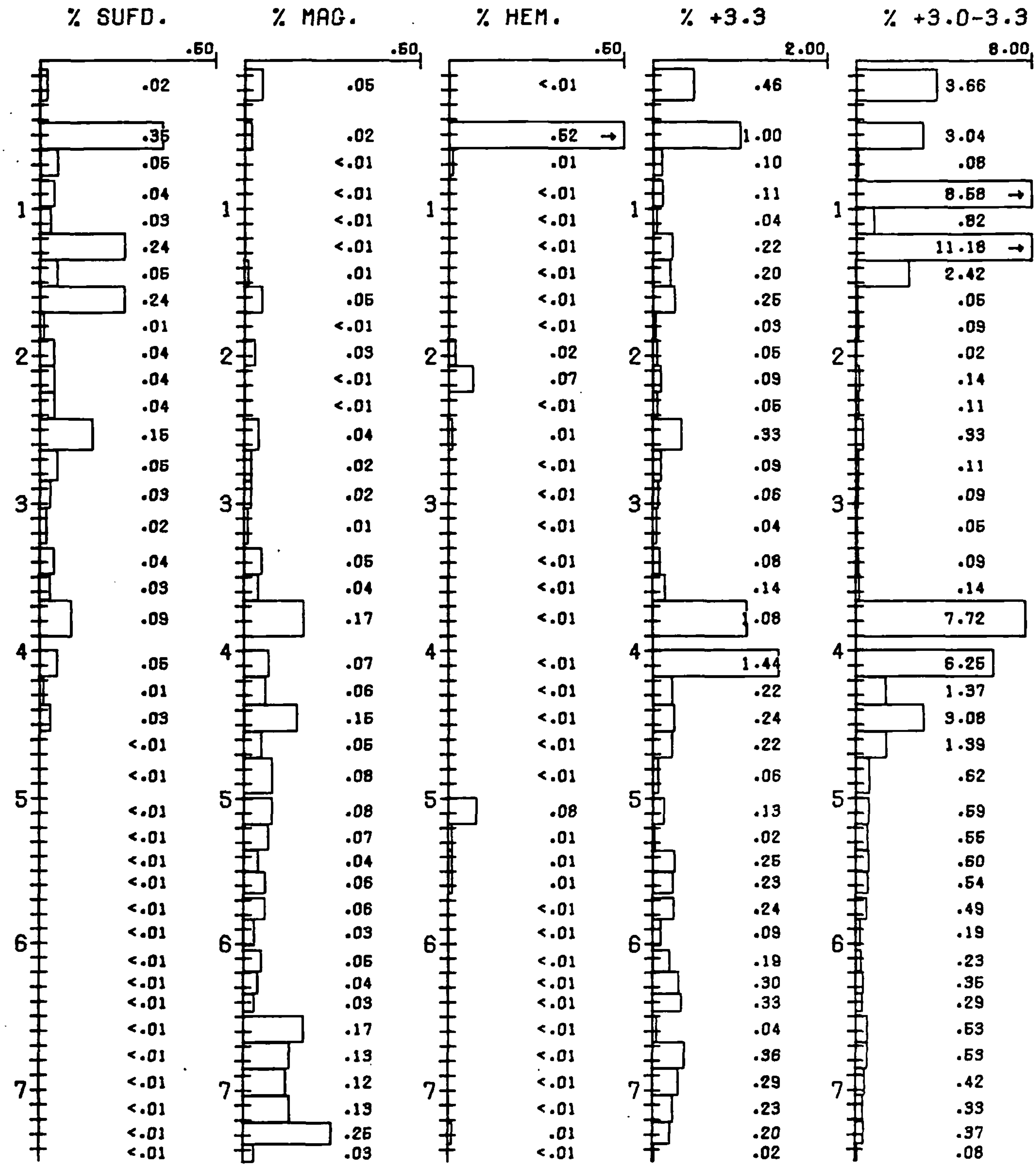


FIGURE 3/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS.. CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

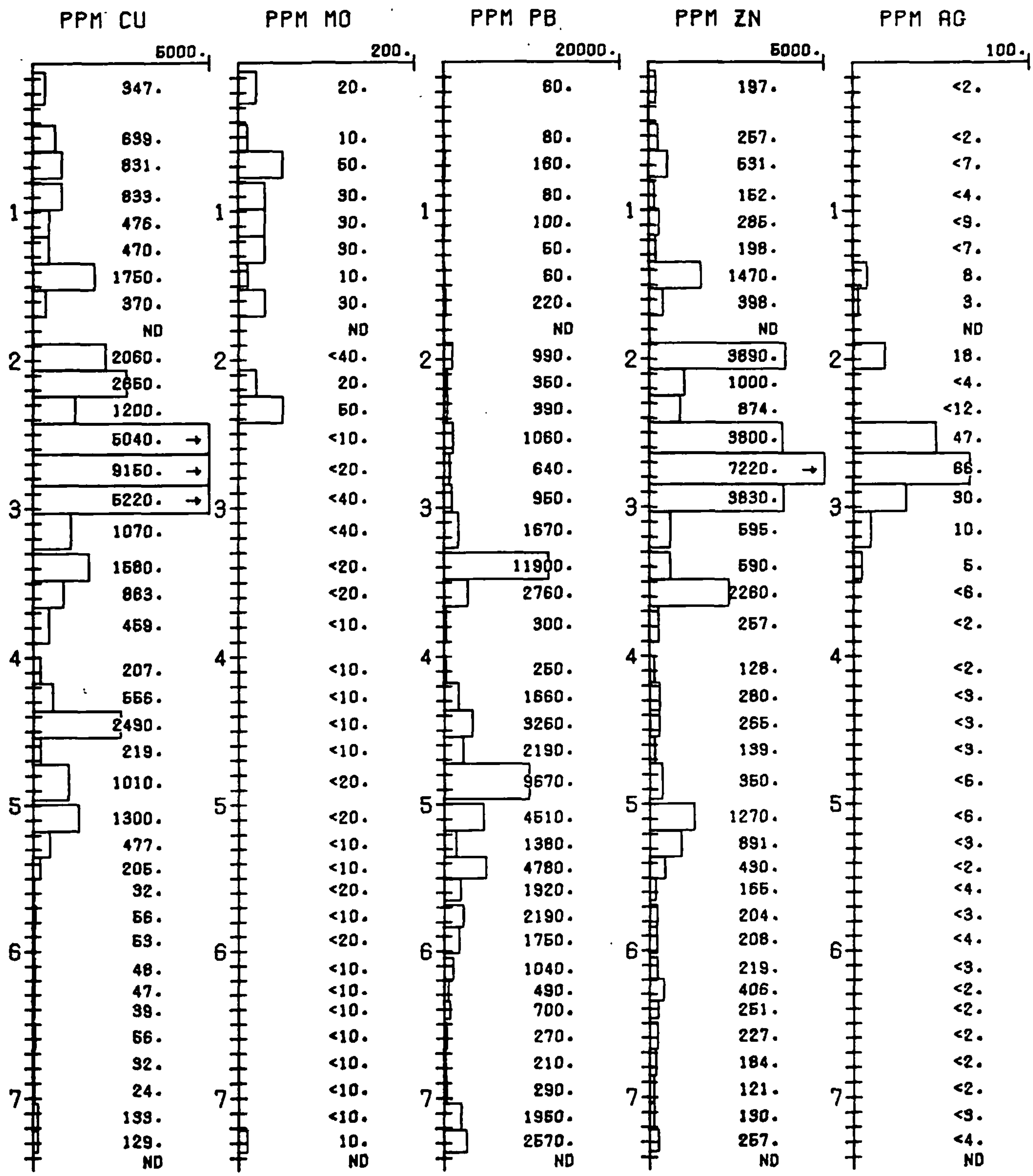


FIGURE 4/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

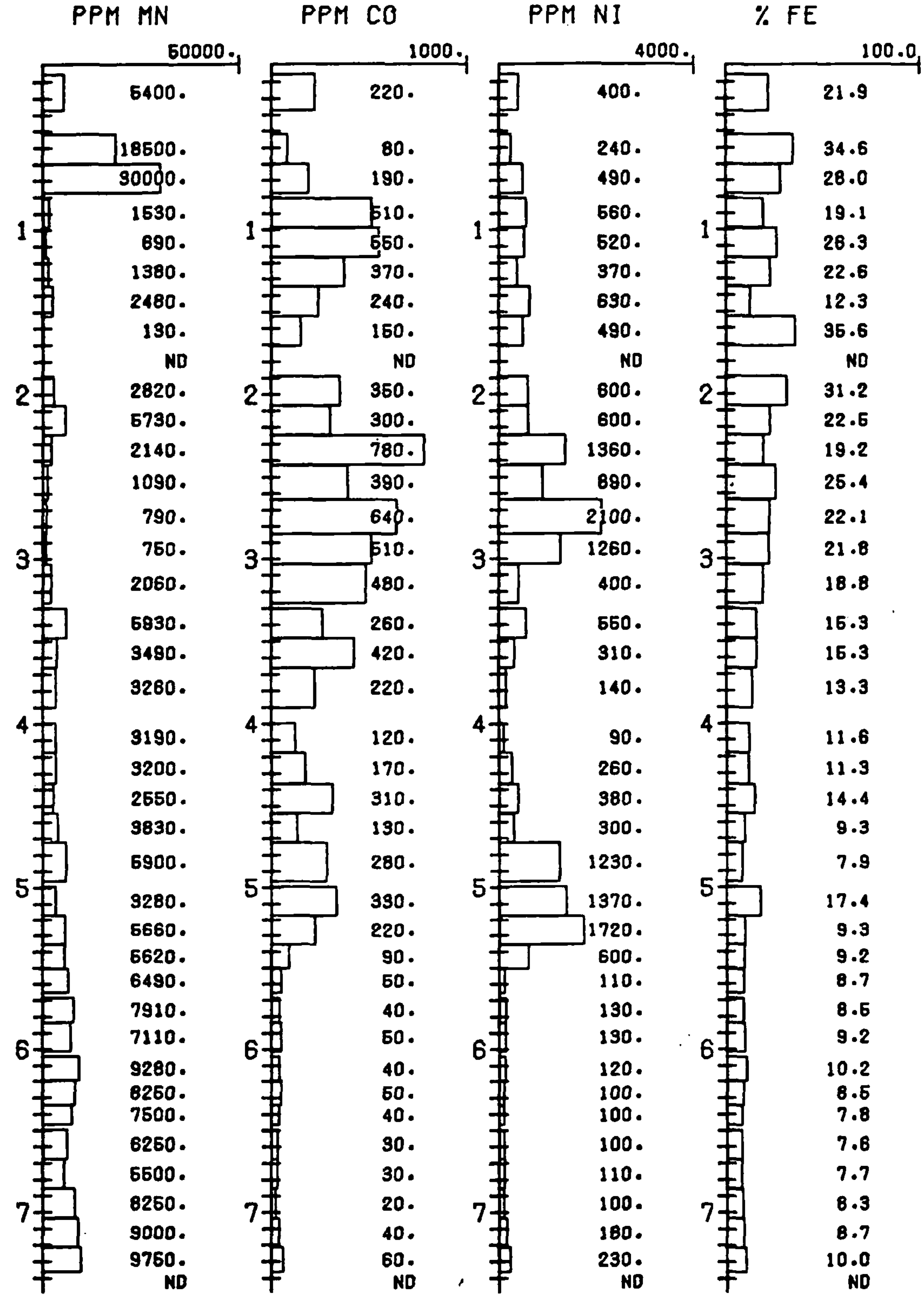


FIGURE 5/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS.. CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

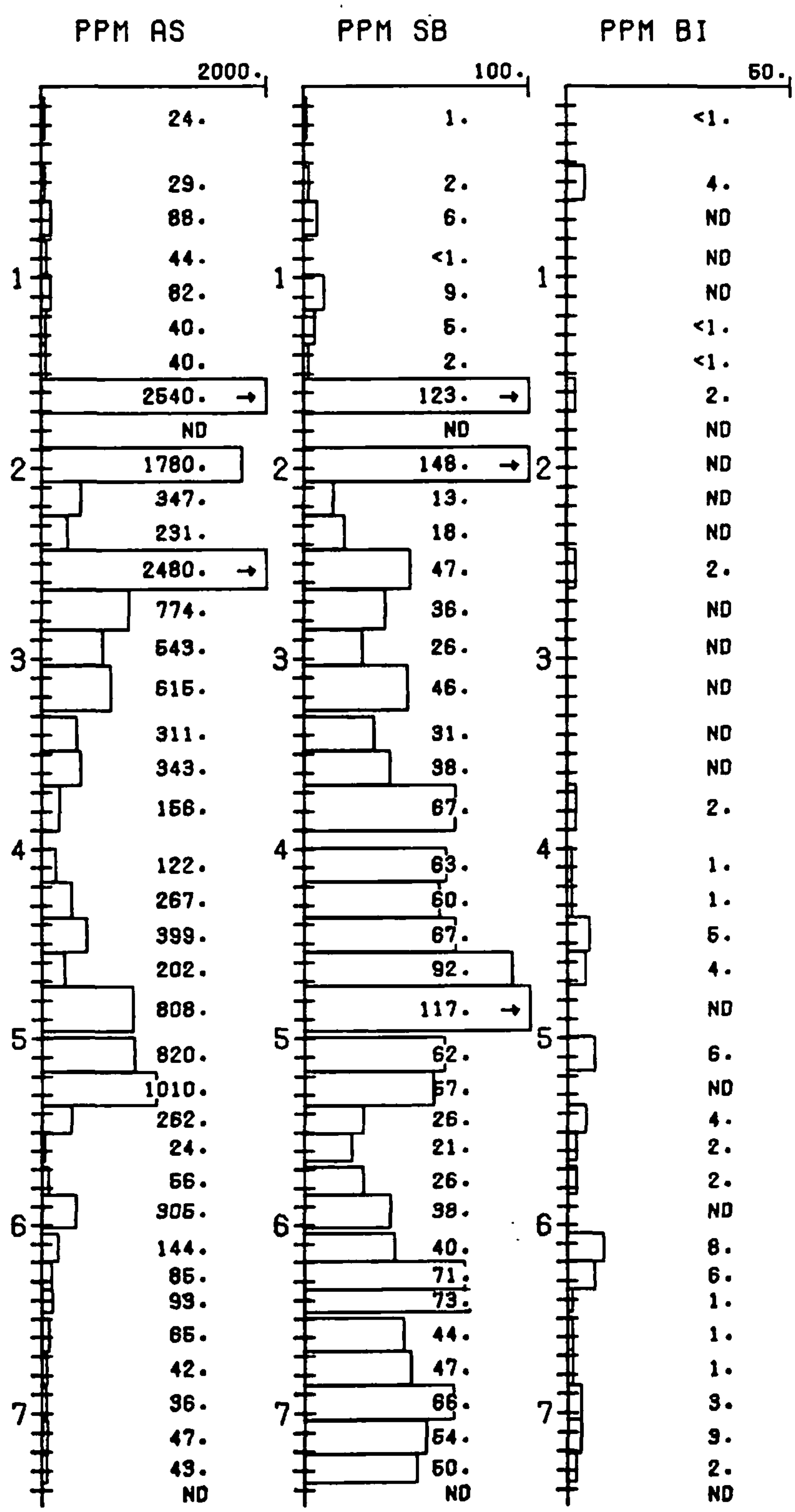


FIGURE 6/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

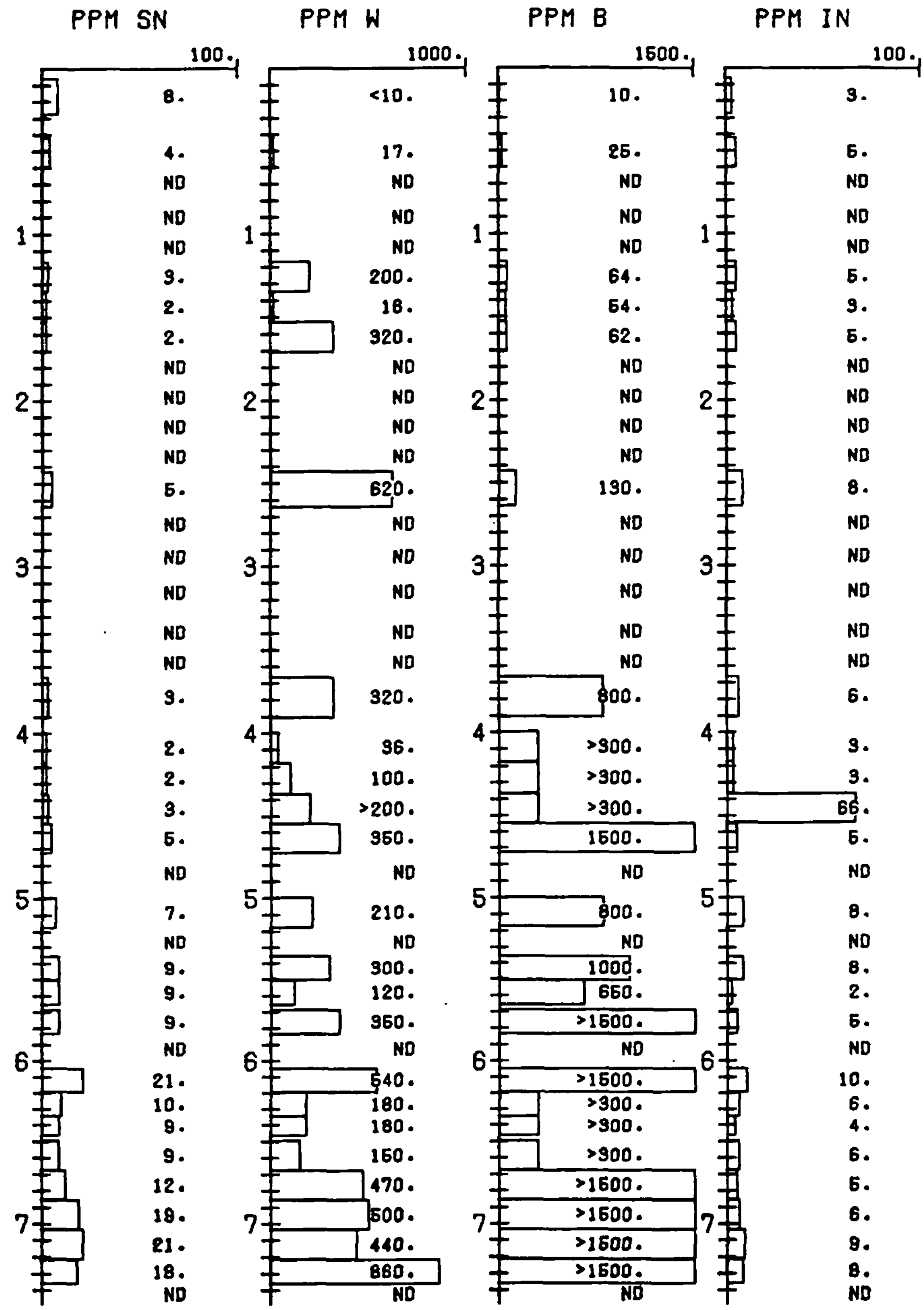


FIGURE 7/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

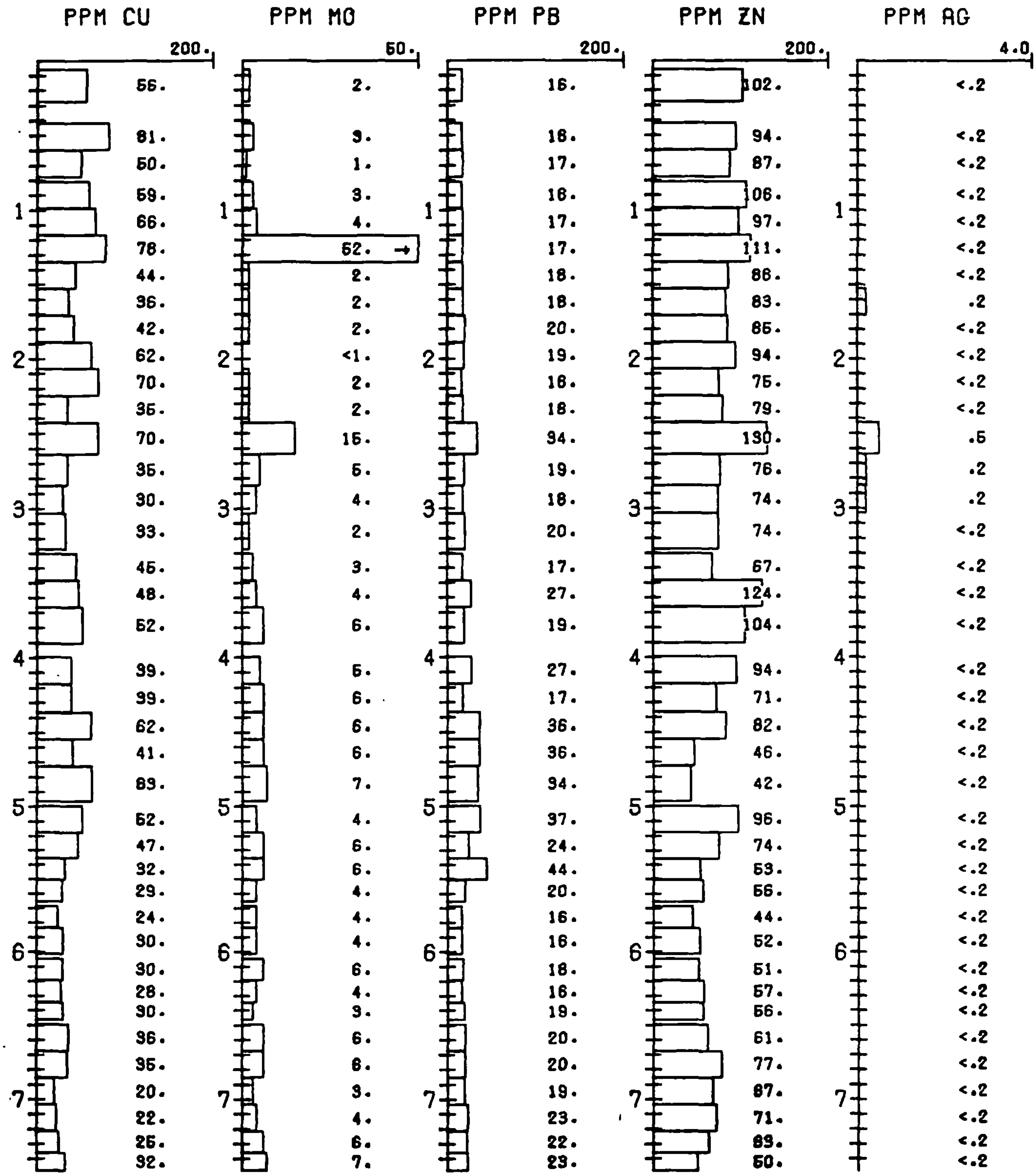


FIGURE 8/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

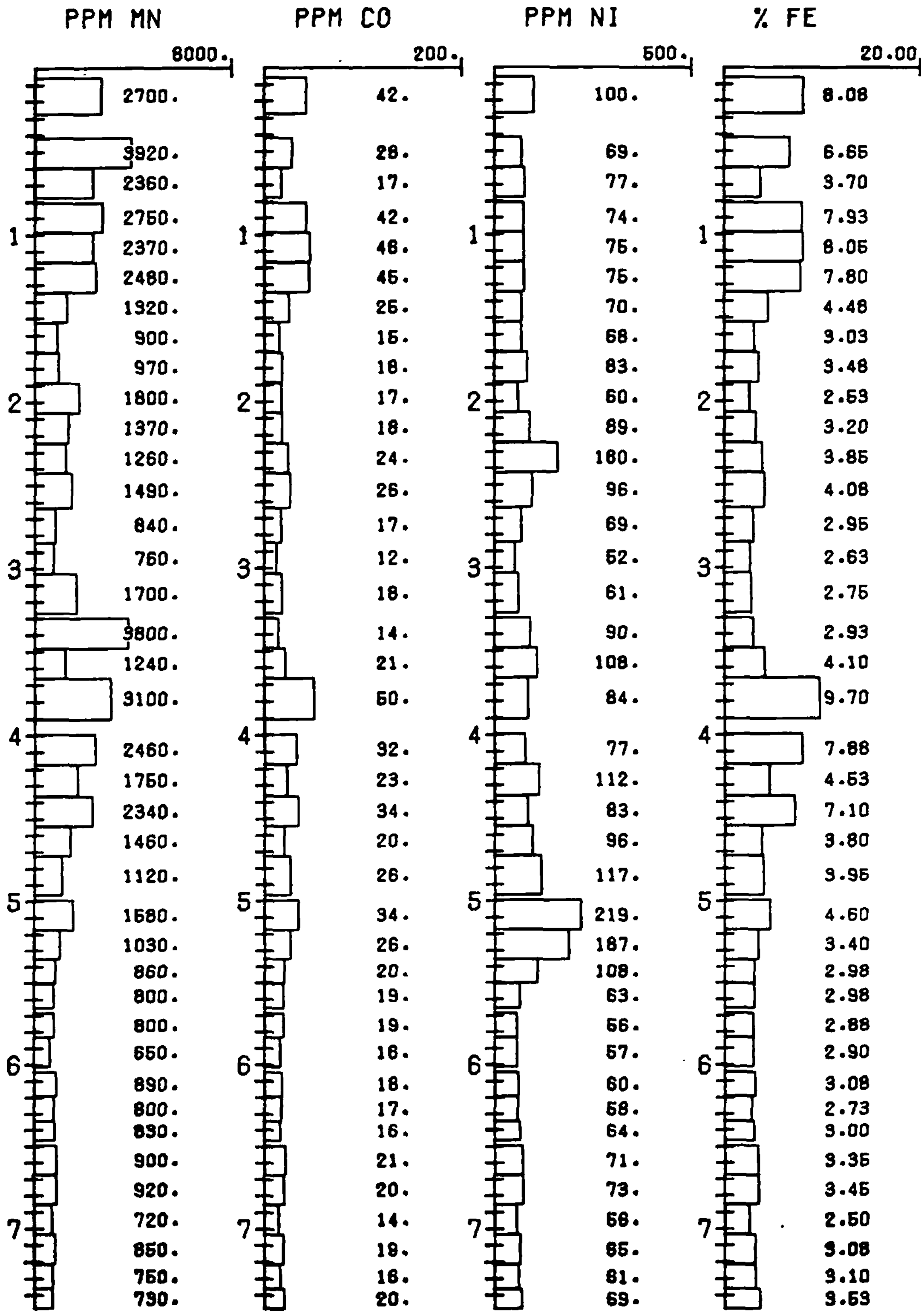


FIGURE 9/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

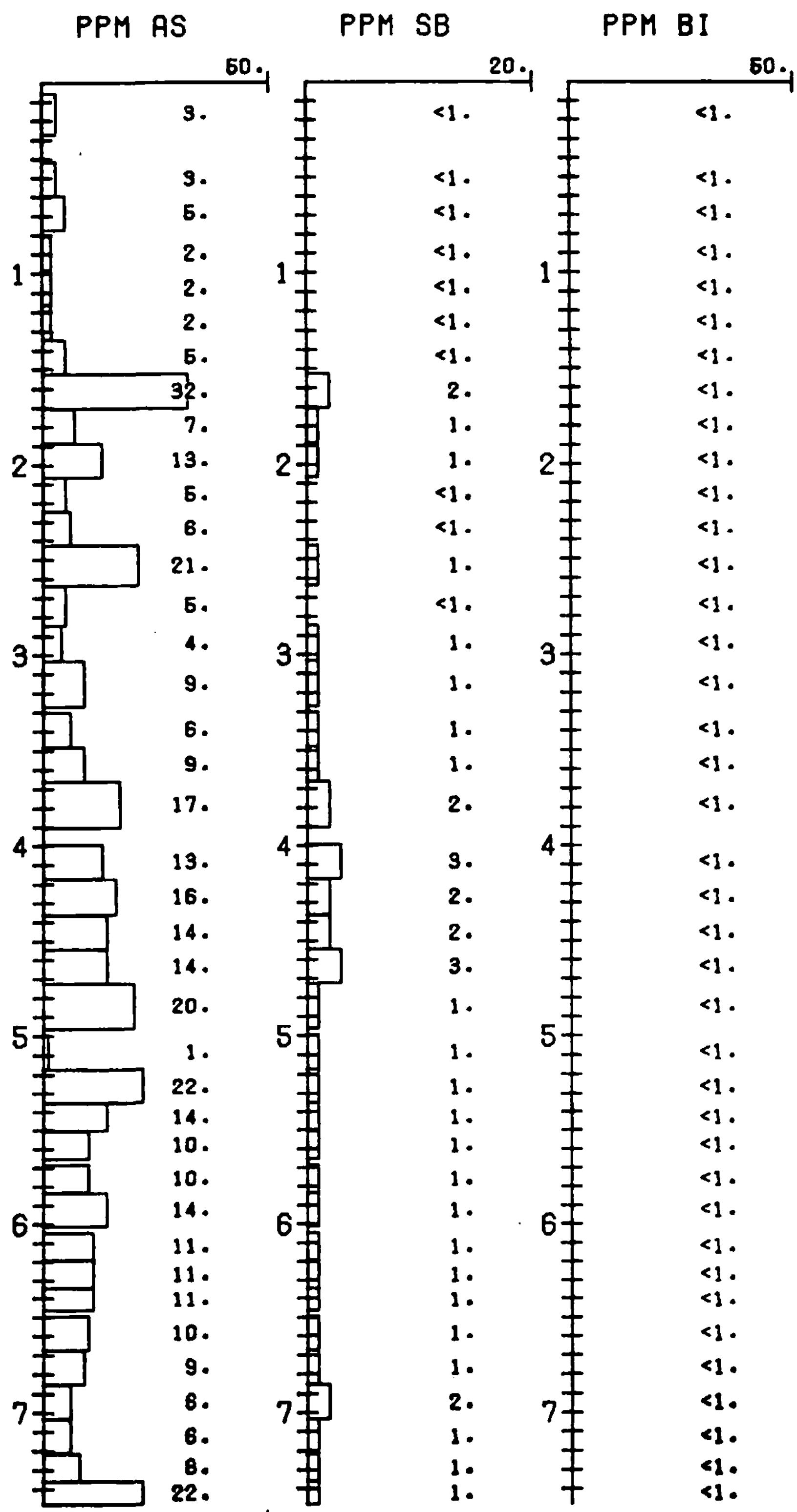


FIGURE 10/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

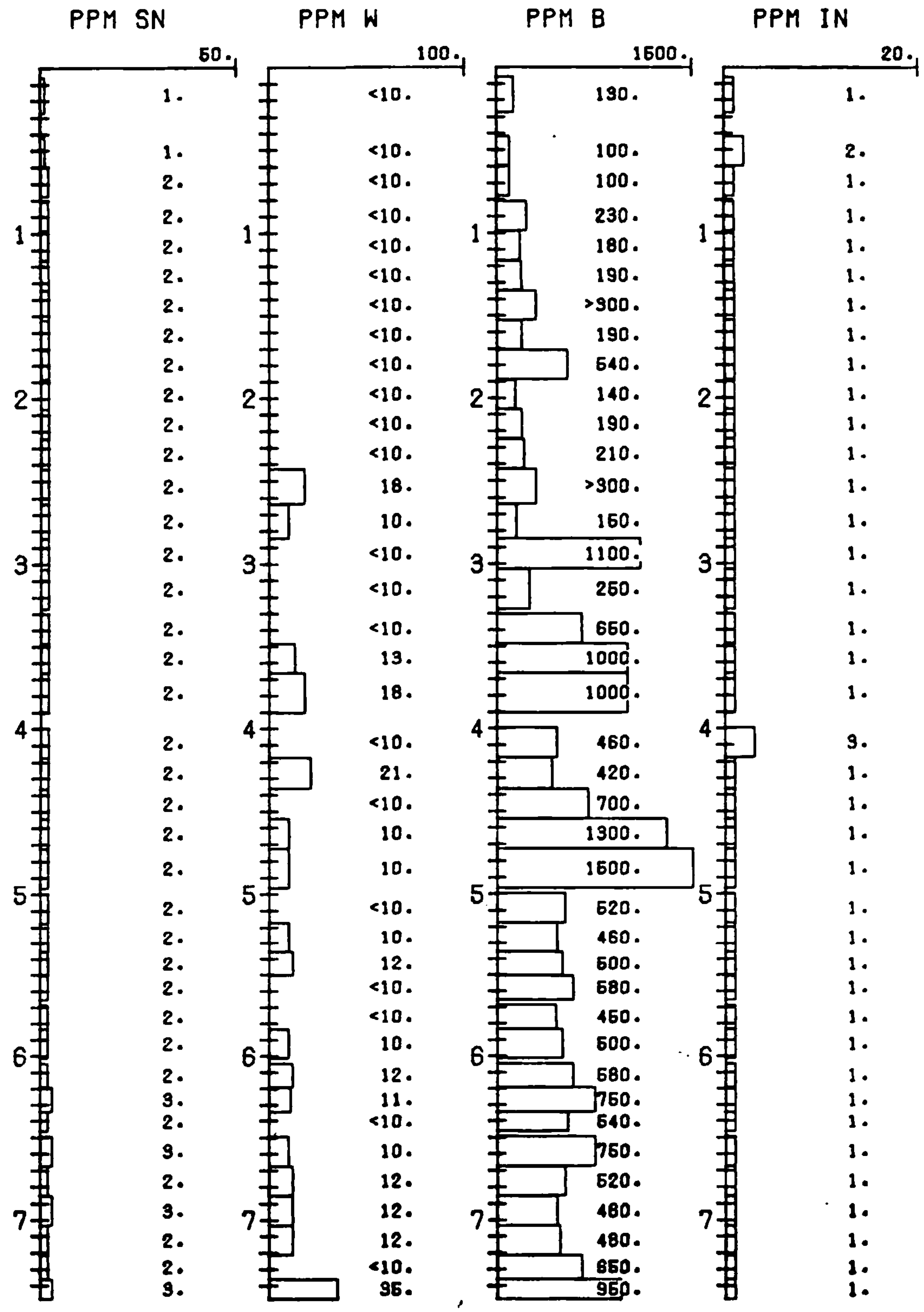


FIGURE 11/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

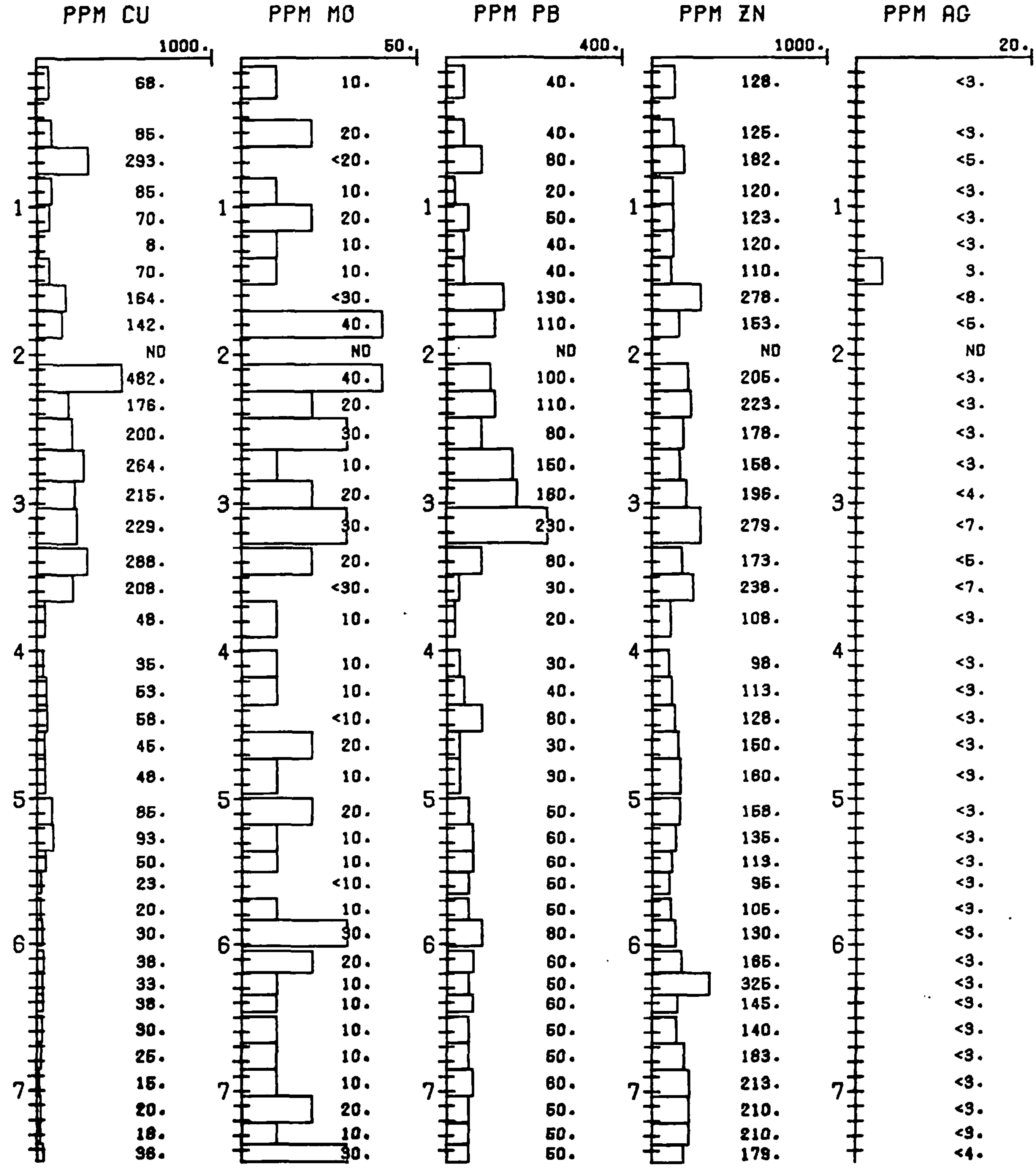


FIGURE 12/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

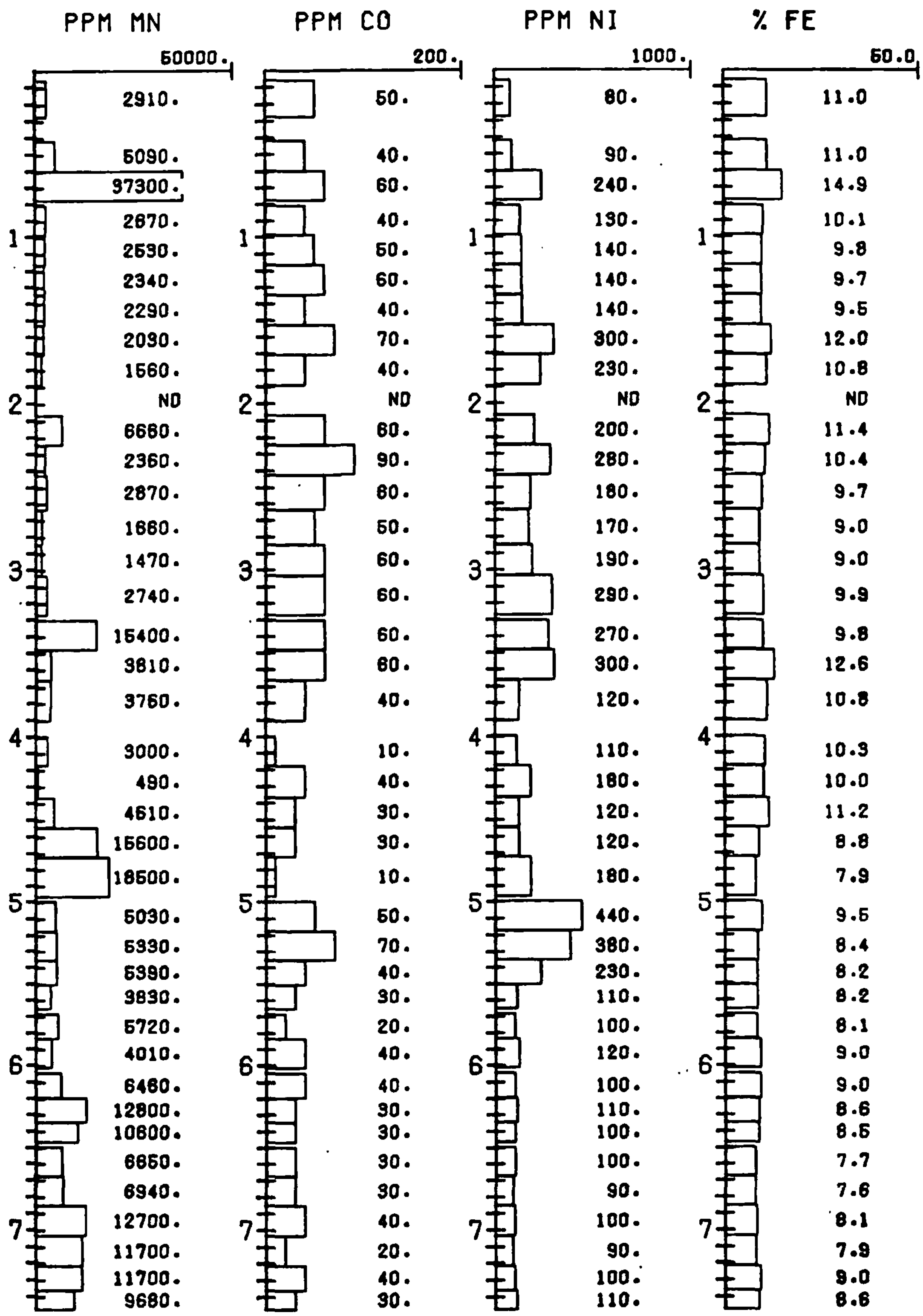


FIGURE 13/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

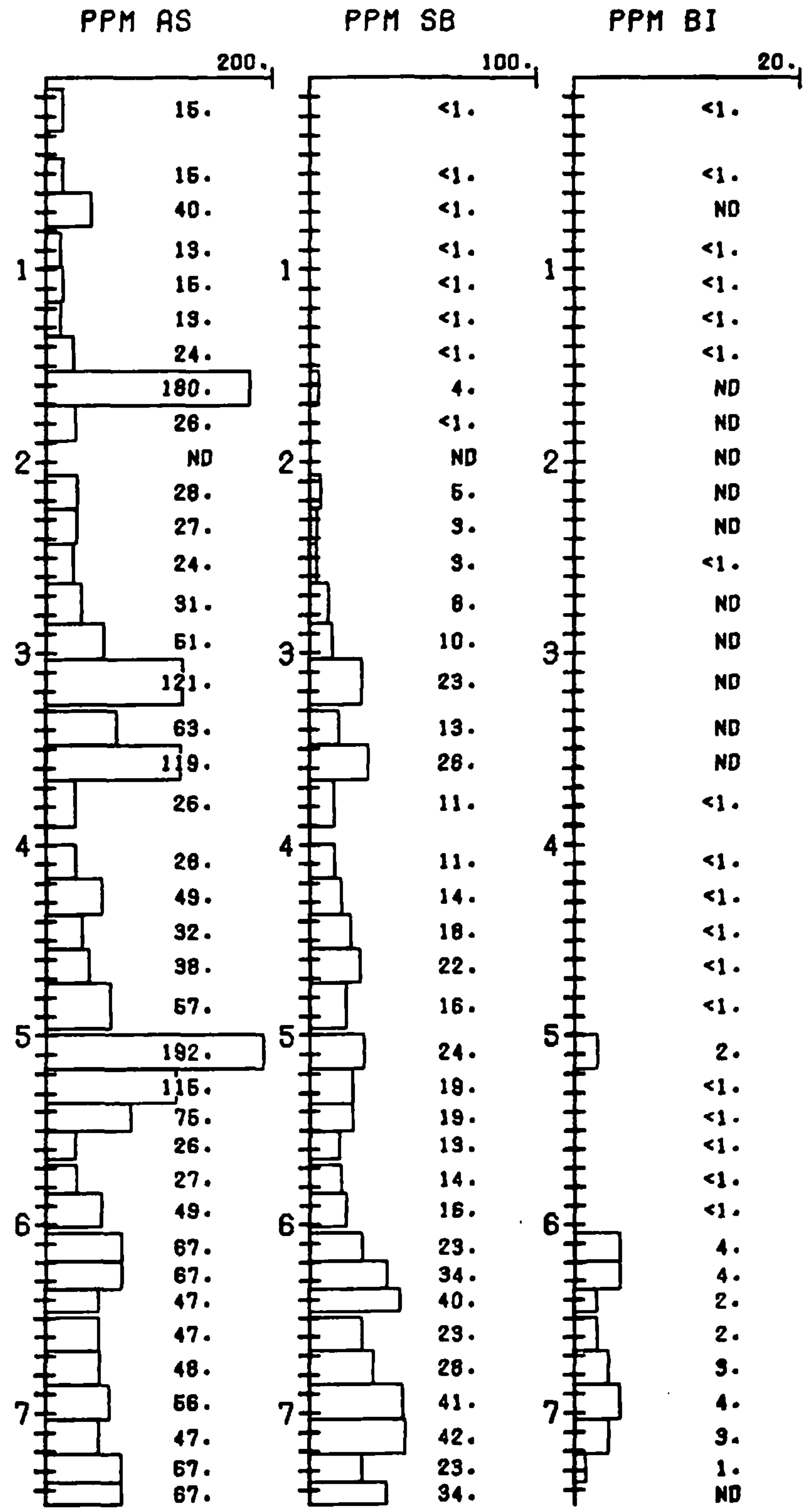


FIGURE 14/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

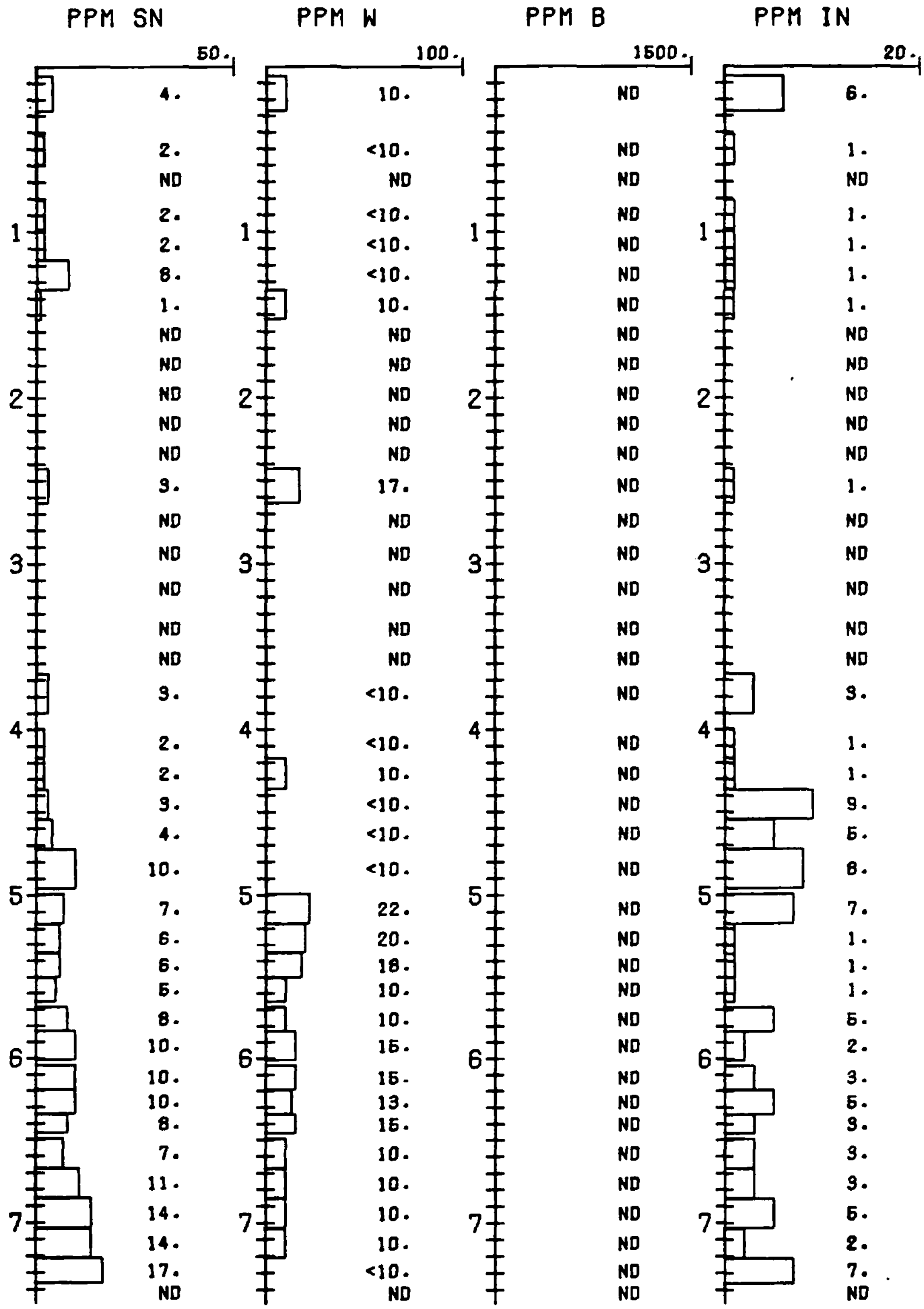


FIGURE 15/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

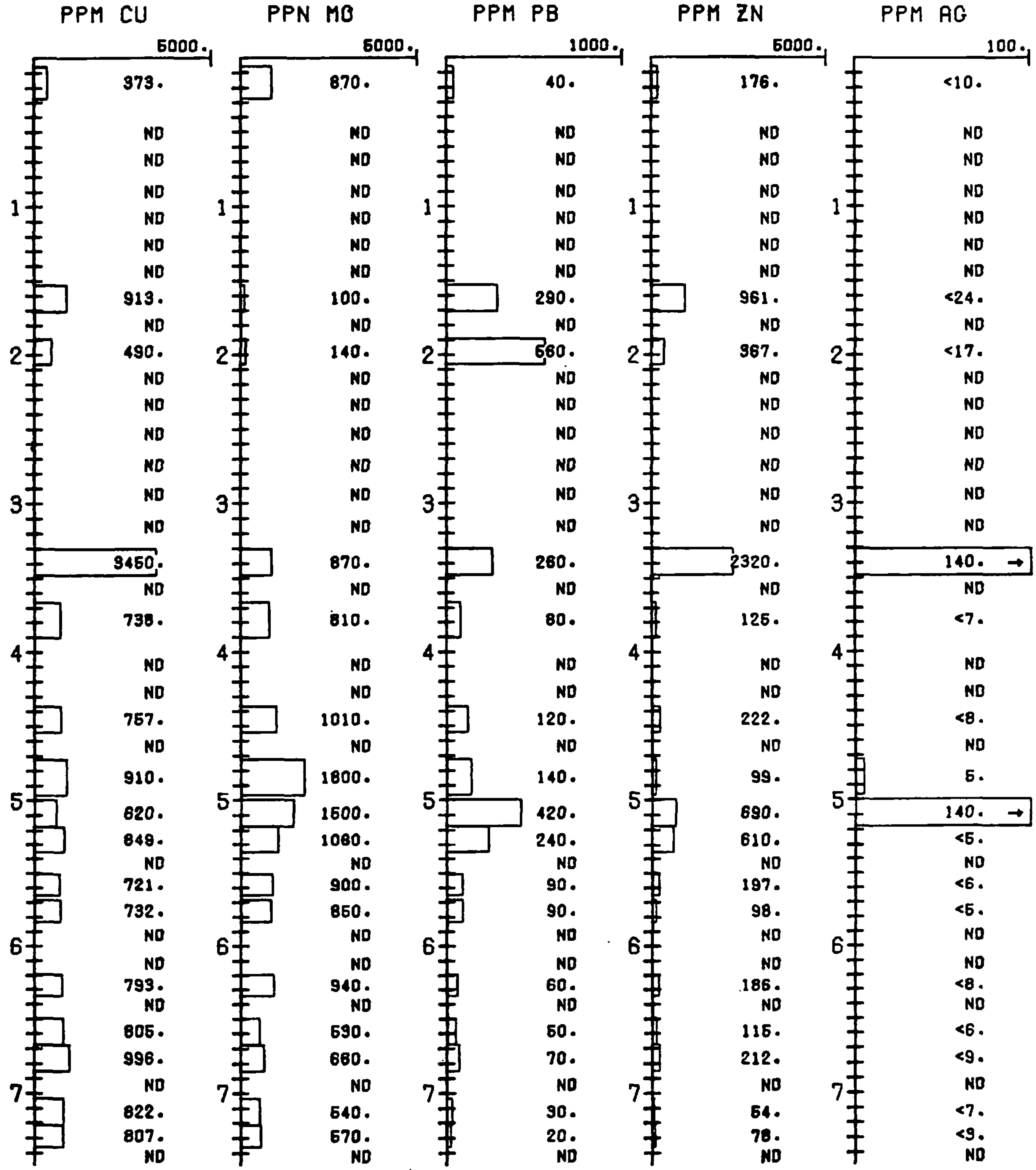


FIGURE 16/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

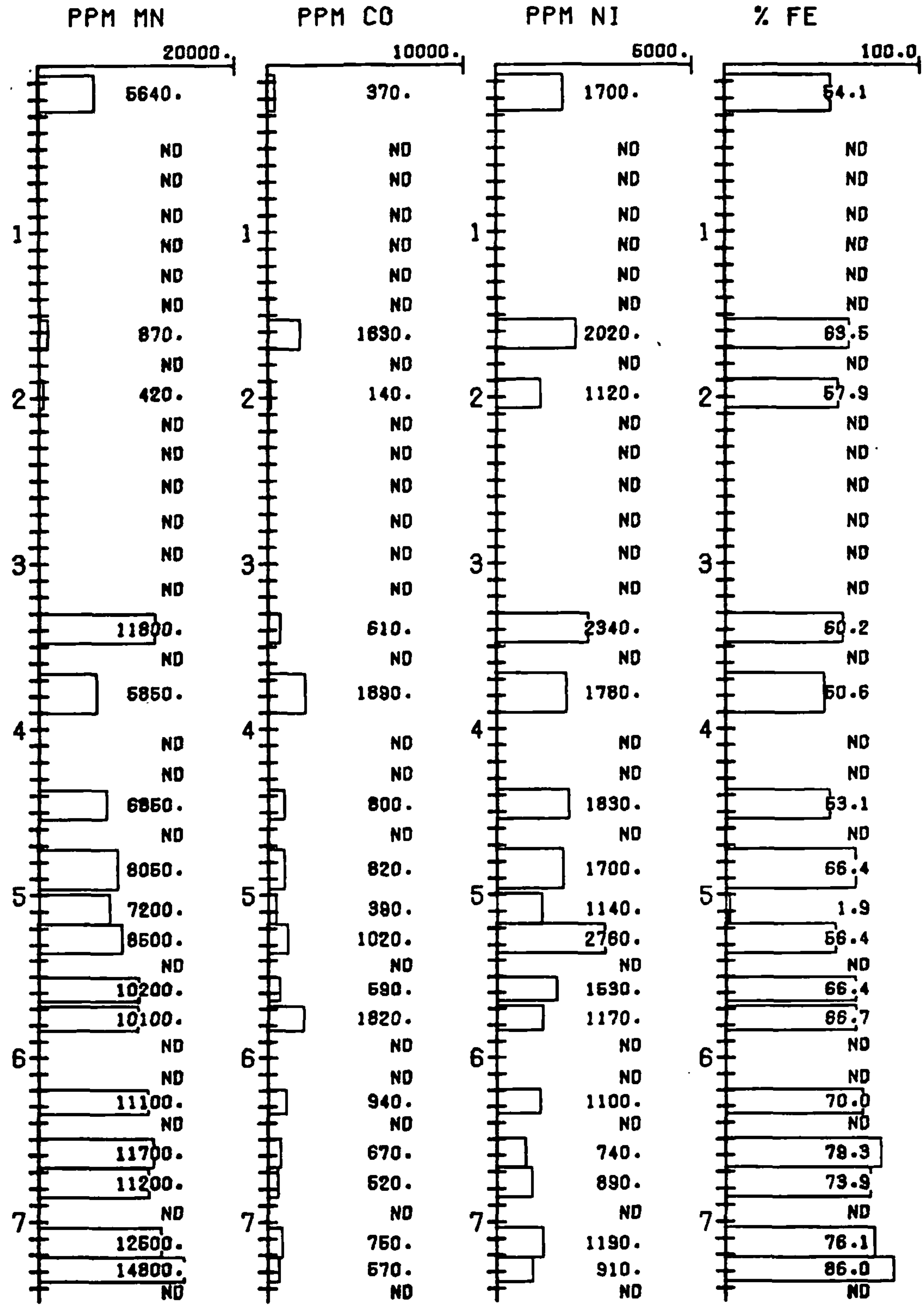


FIGURE 17/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

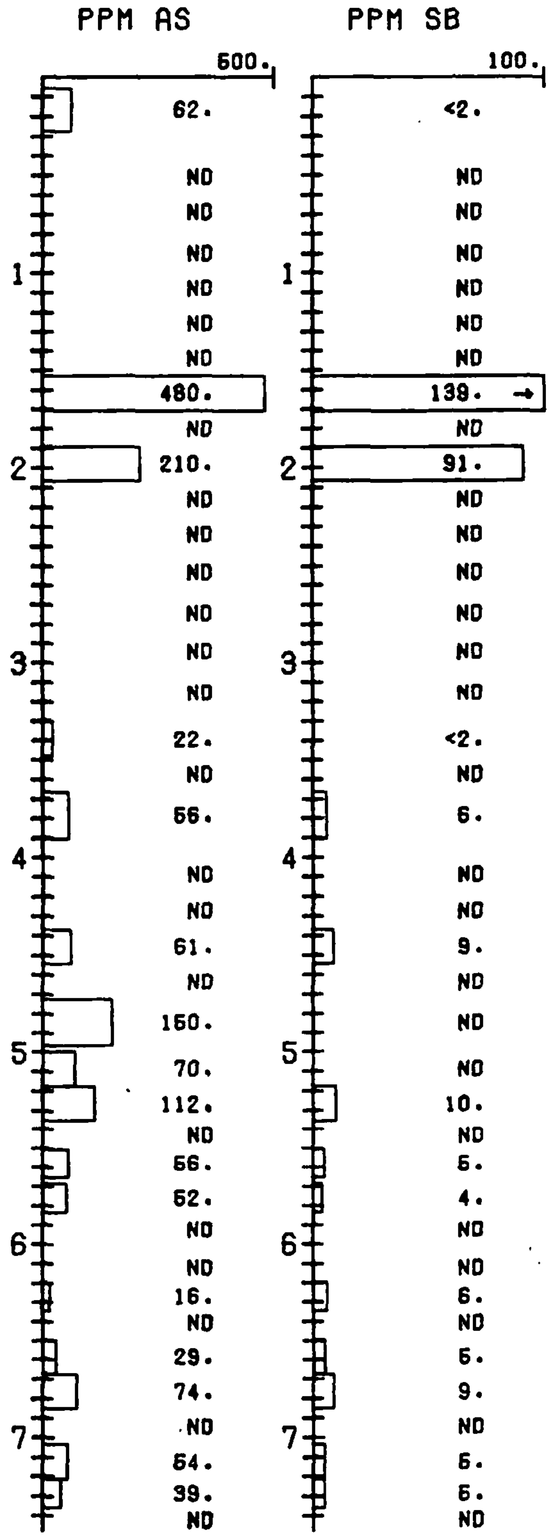
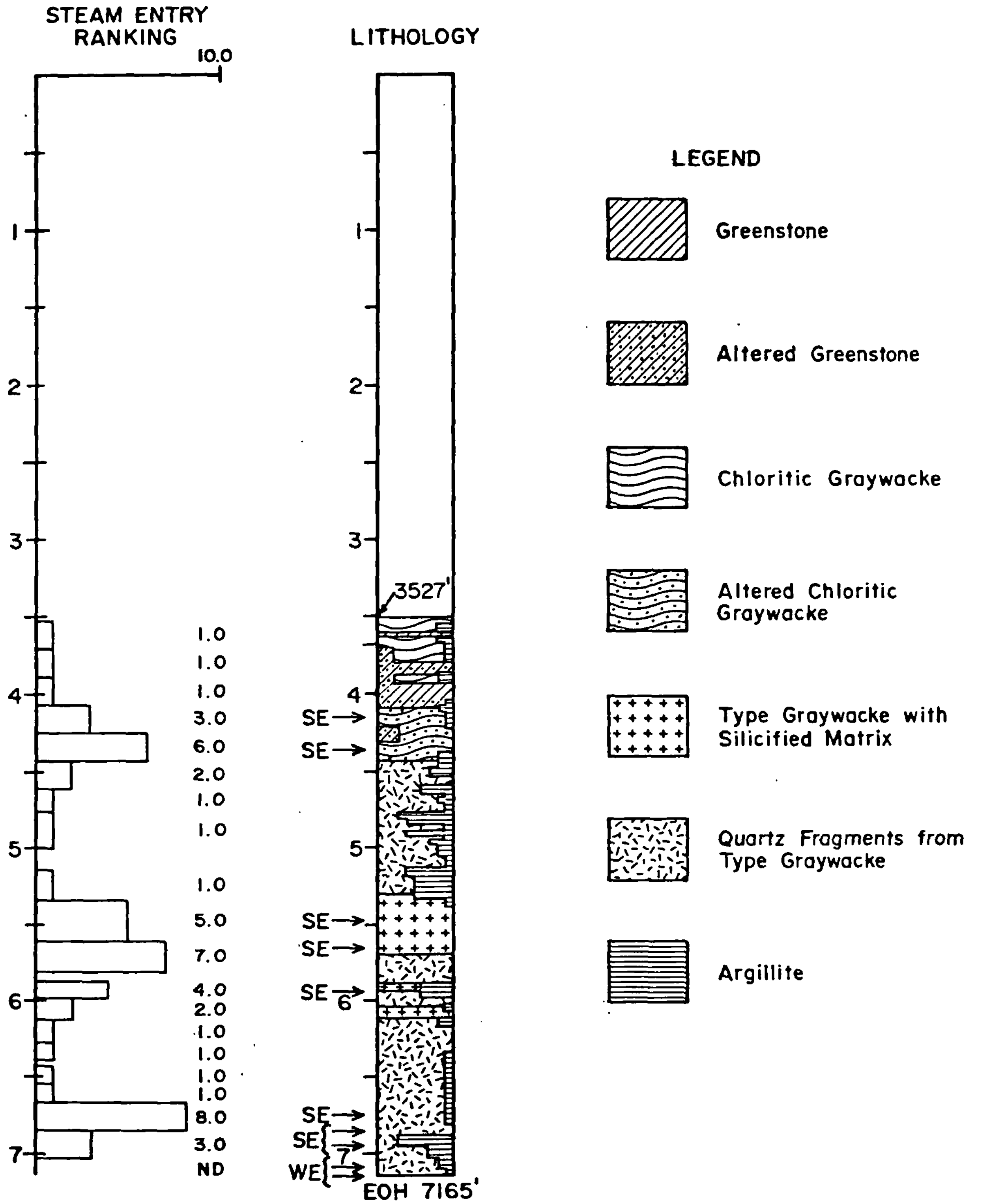


FIGURE 1/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

GENERALIZED GEOLOGY AND
STEAM ENTRY RANKING
VERT. SCALE: 1000 FT./IN.



SE= Steam Entry WE= Water Entry

1.0 = No steam entry within or close to sample interval

2.0 thru 8.0 = Steam entries (SE) within or close to sample interval. Relative importance of SE indicated by ranking.

Geology modified from preliminary geologic log by Mary Twichell (Aminoil U.S.A. Inc.).

FIGURE 2/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE:
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

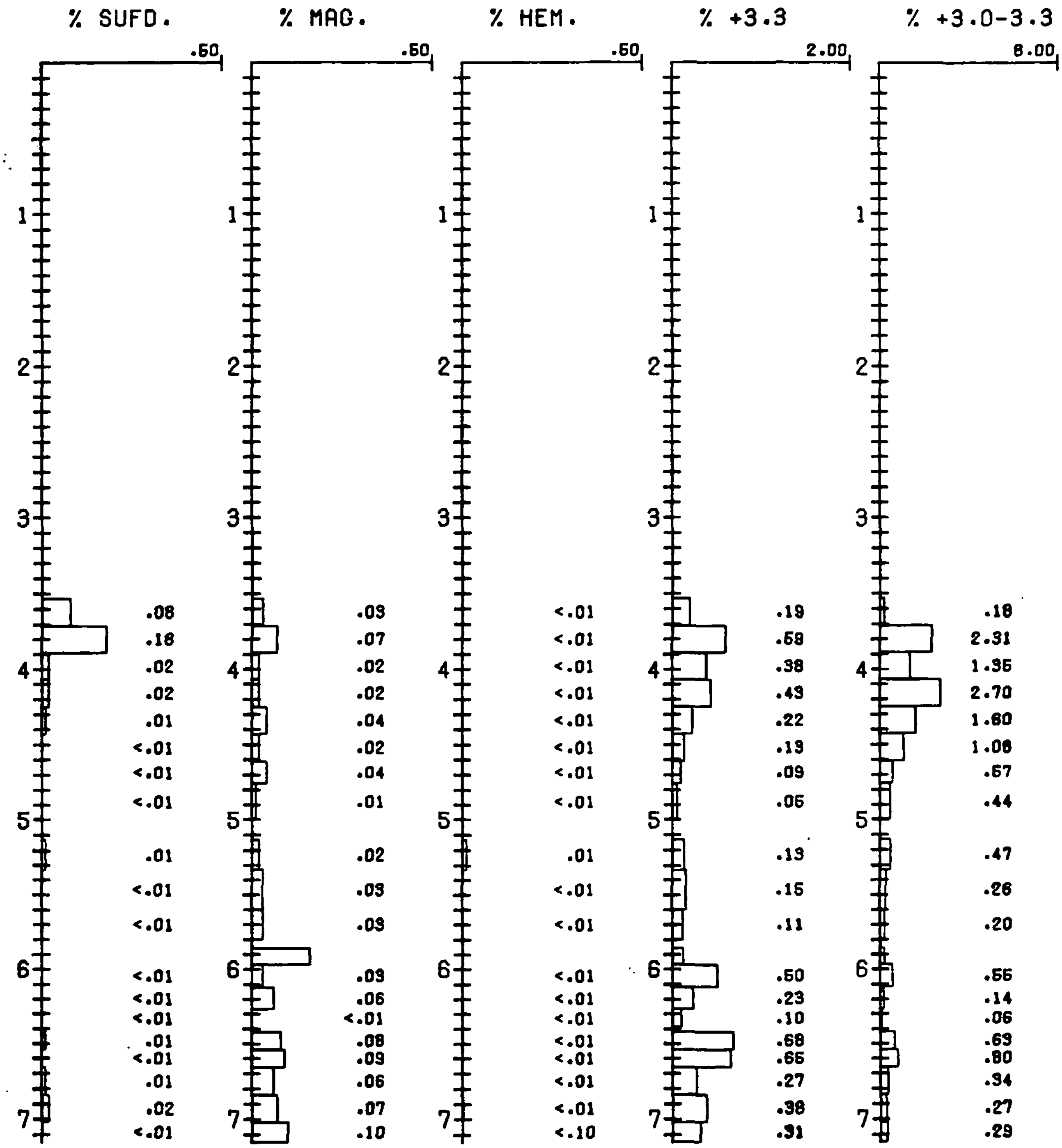


FIGURE 3/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

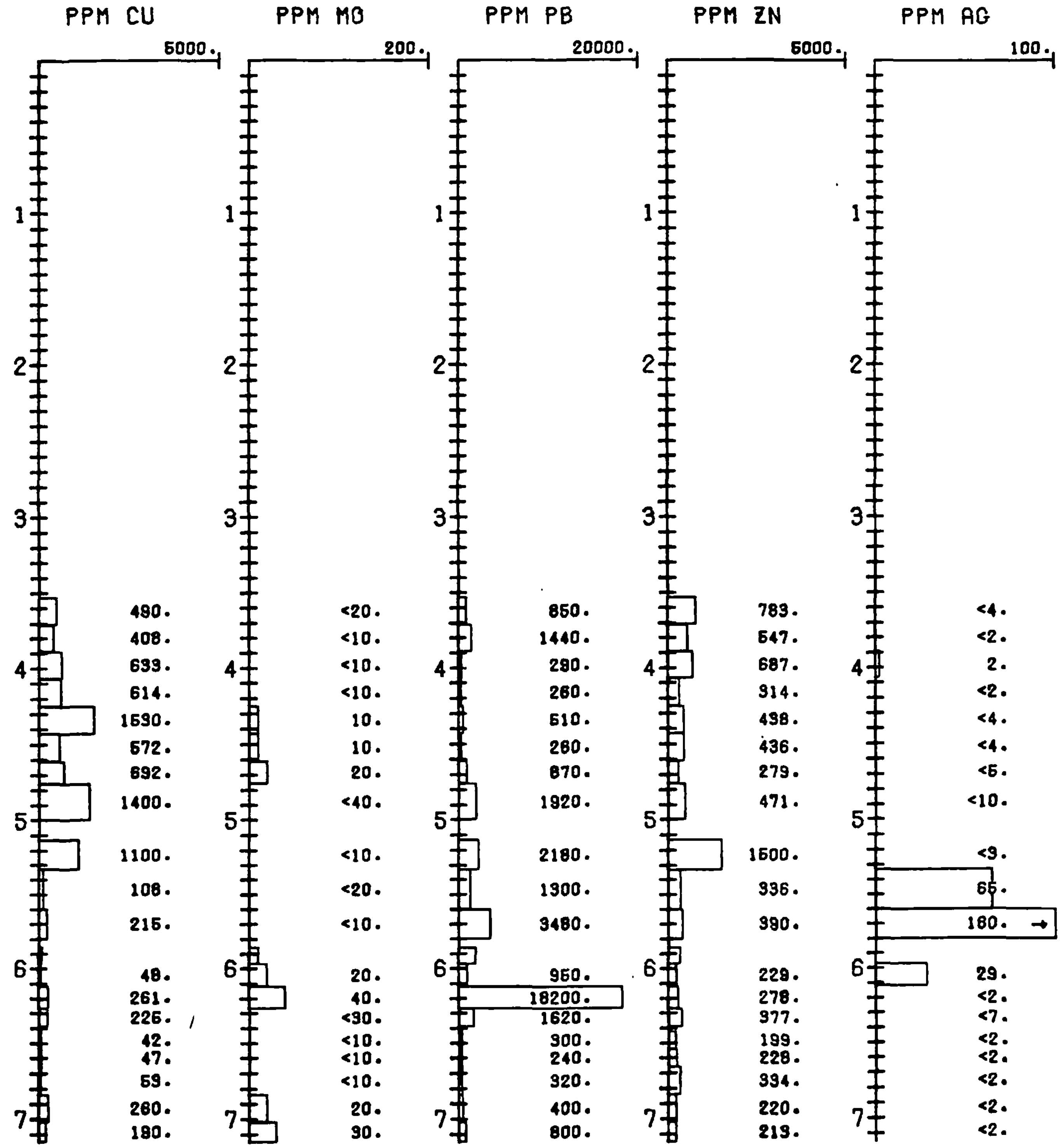


FIGURE 4/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

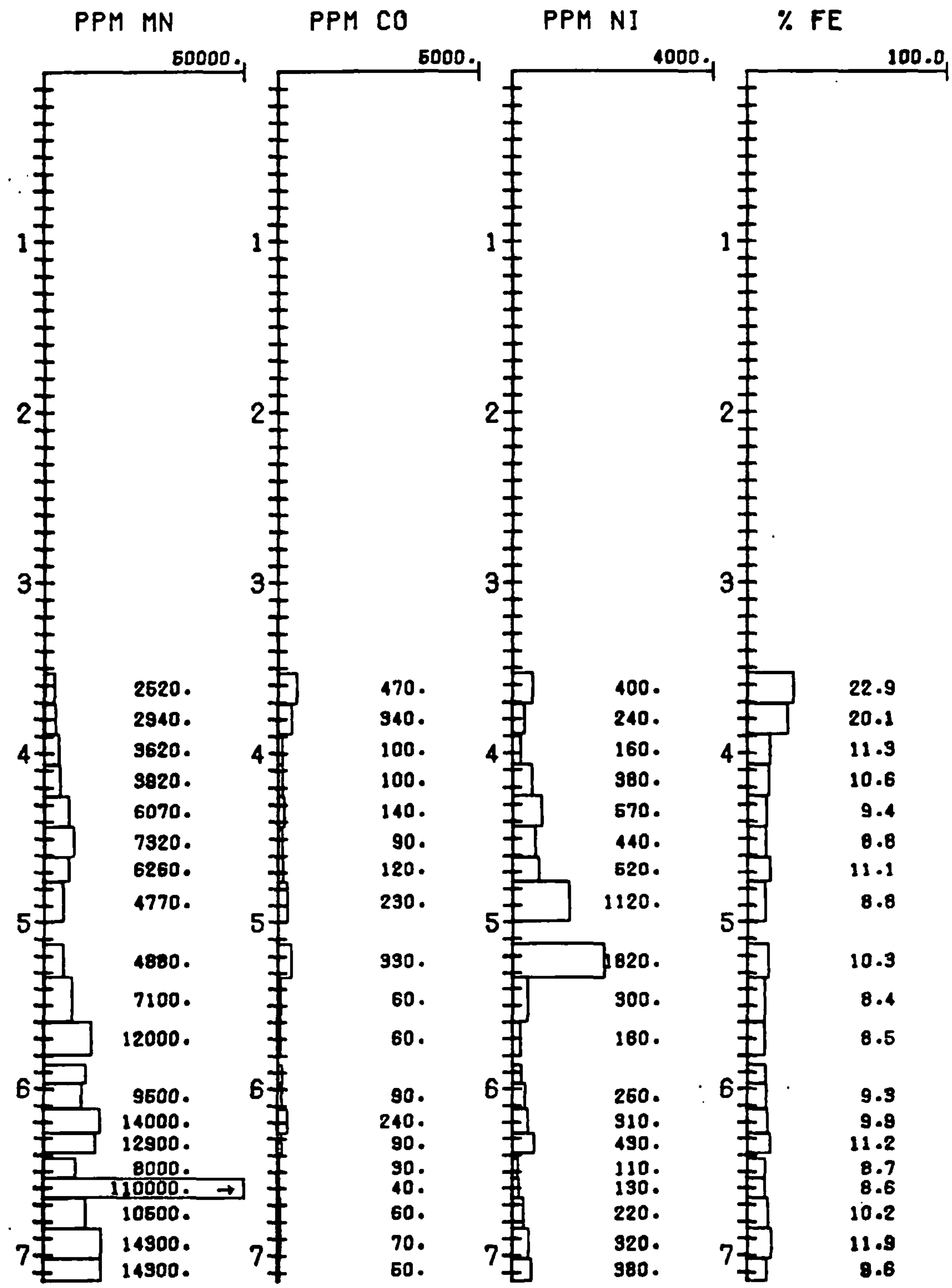


FIGURE 5/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

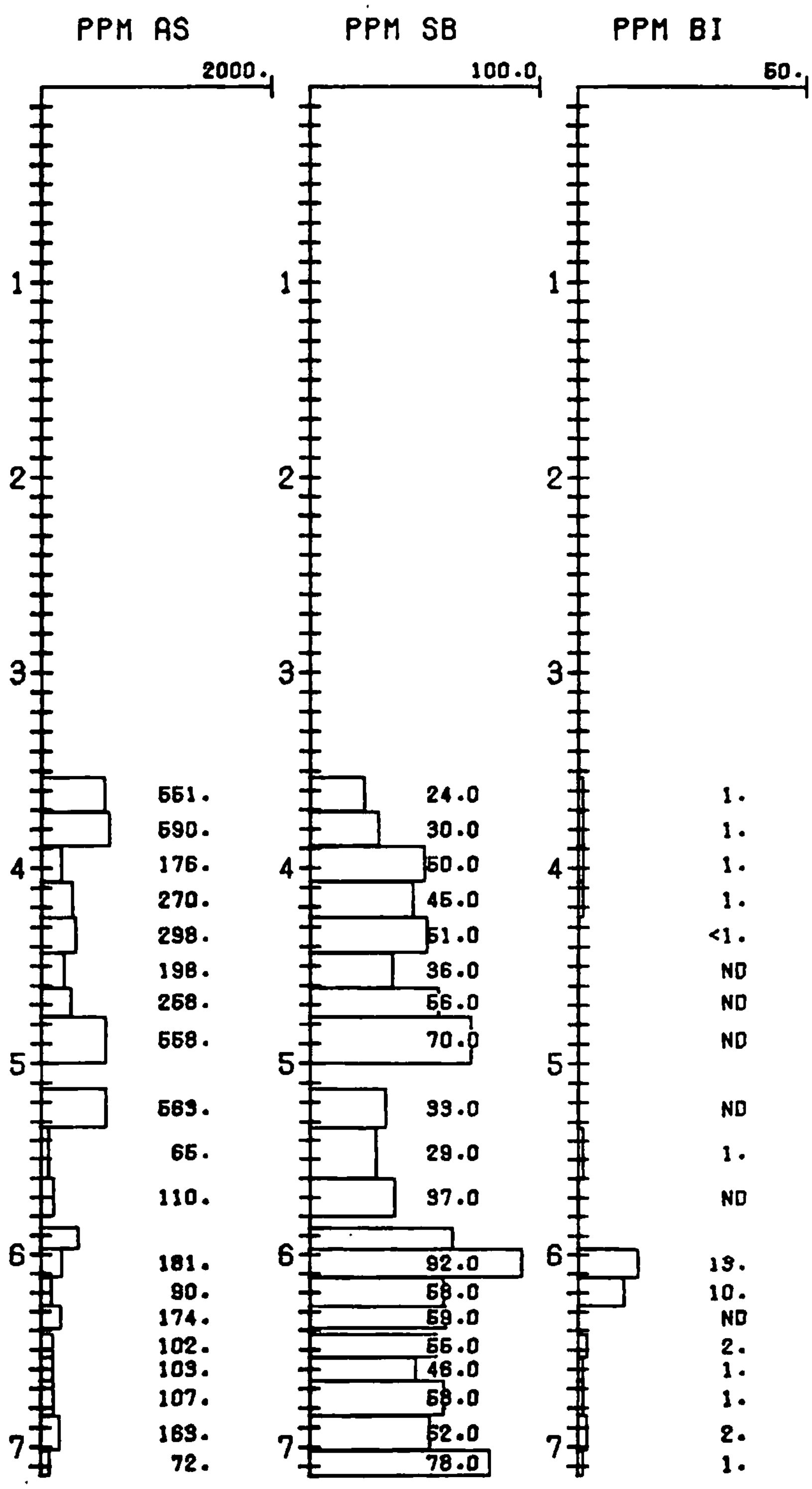


FIGURE 6/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

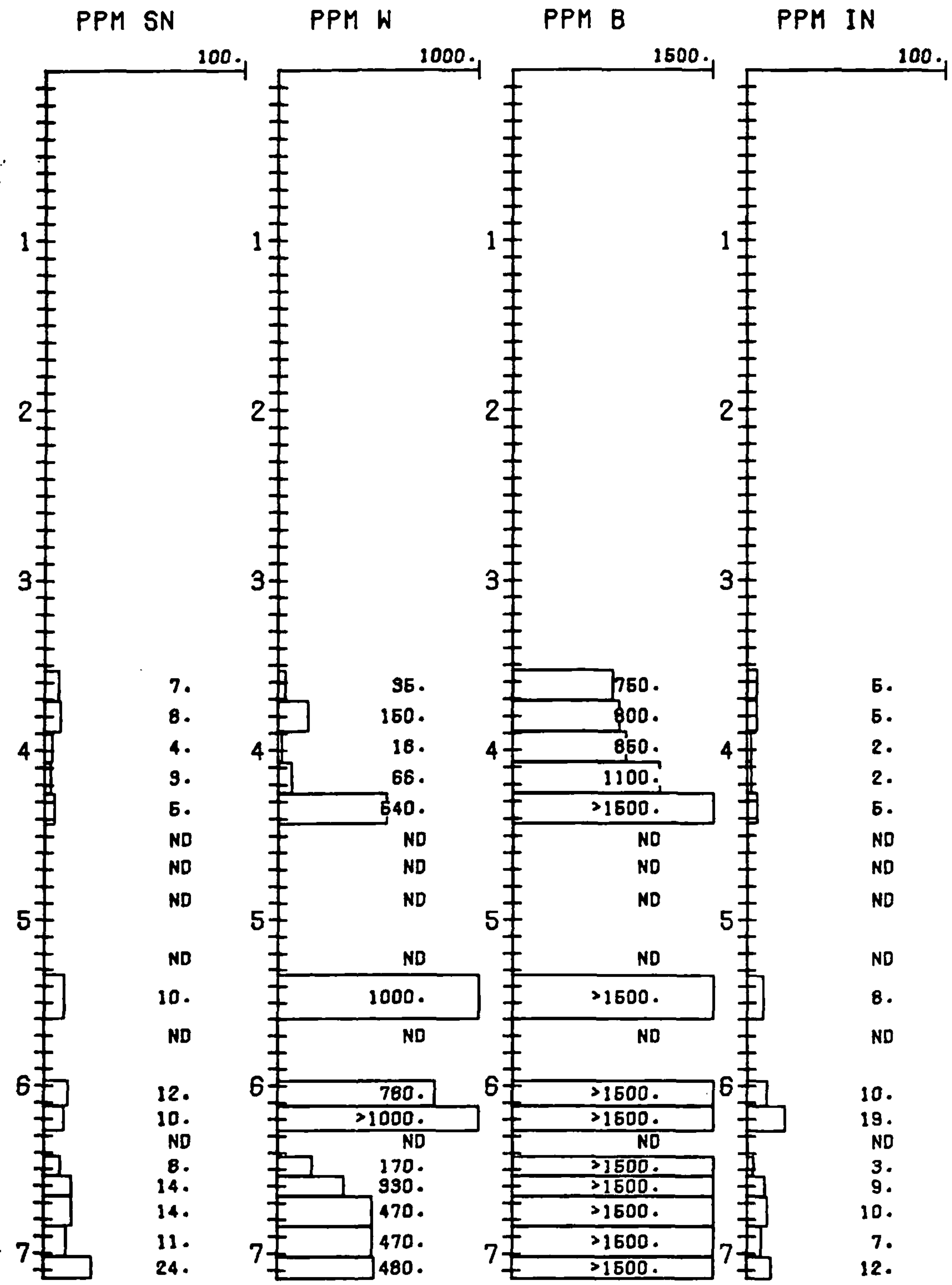


FIGURE 7/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

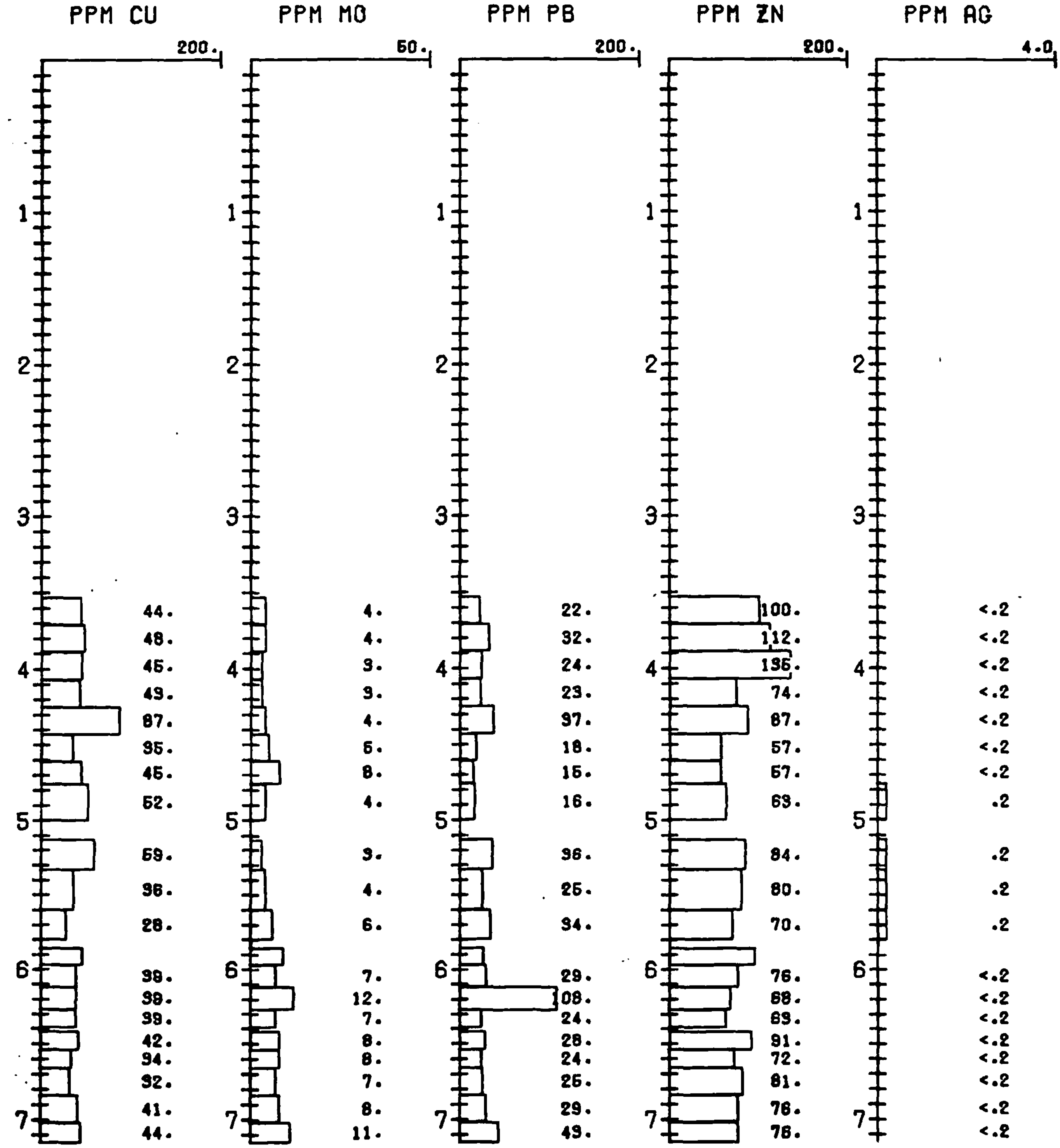


FIGURE 8/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

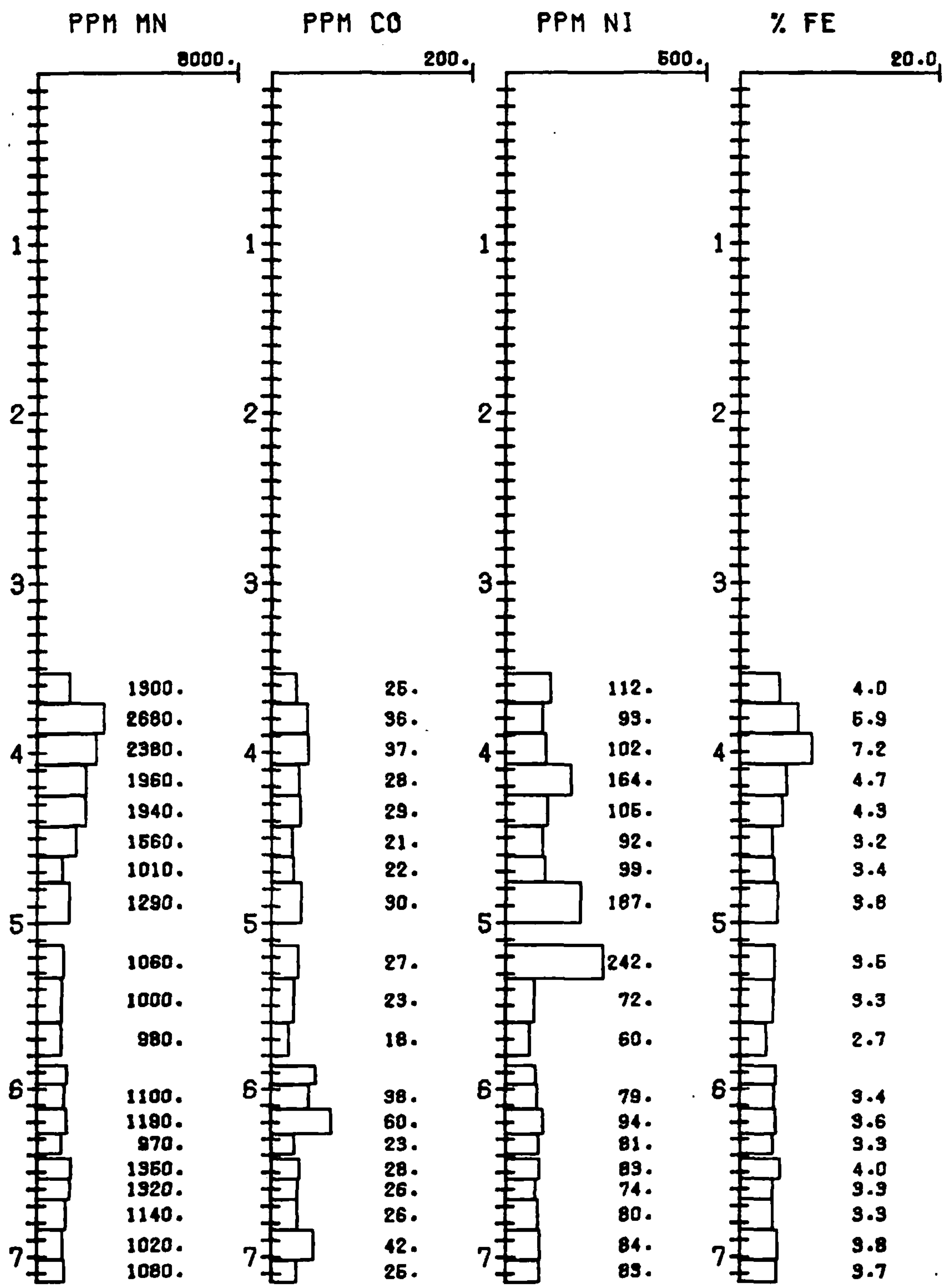


FIGURE 9/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

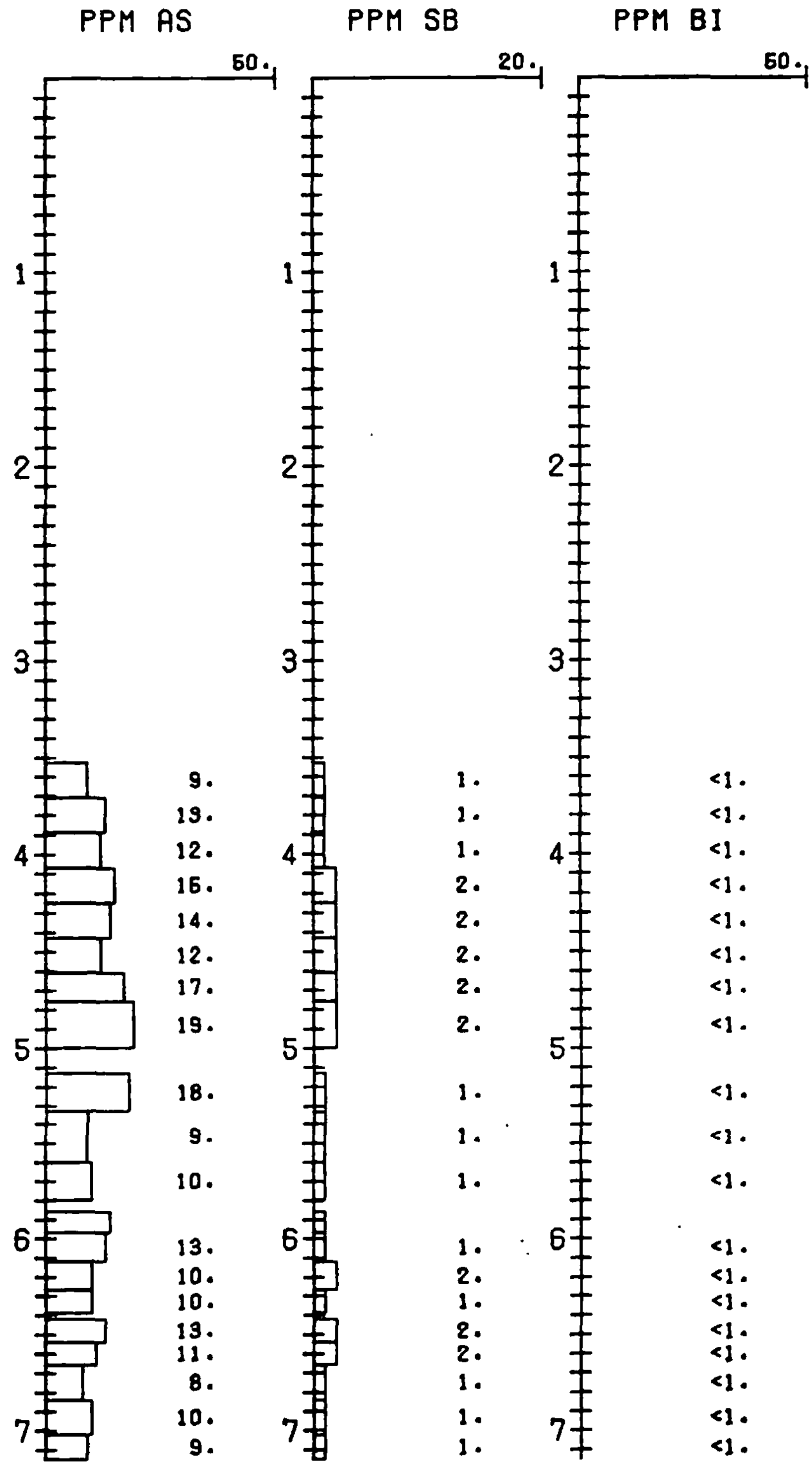


FIGURE 10/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

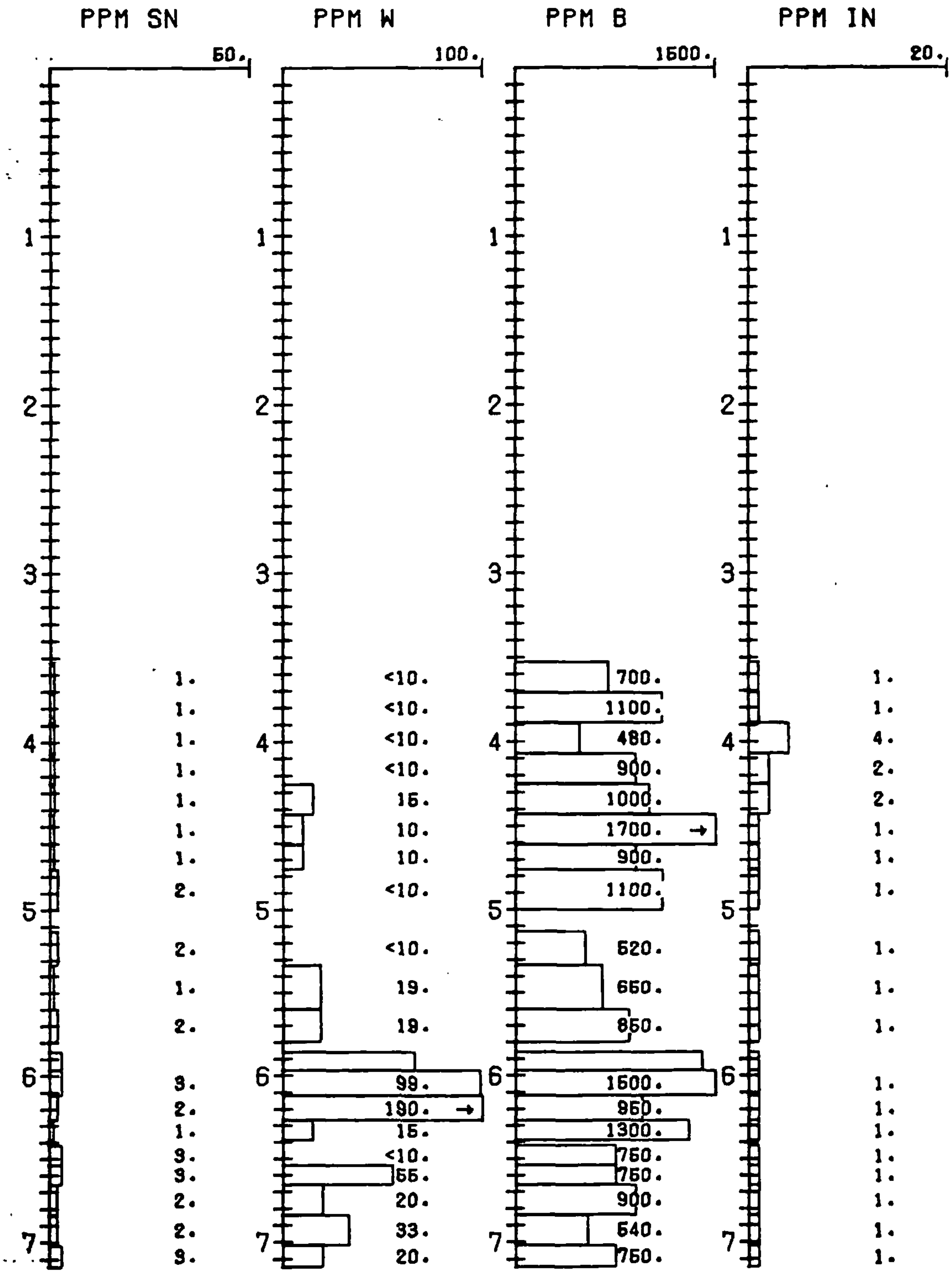


FIGURE 11/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS.. CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

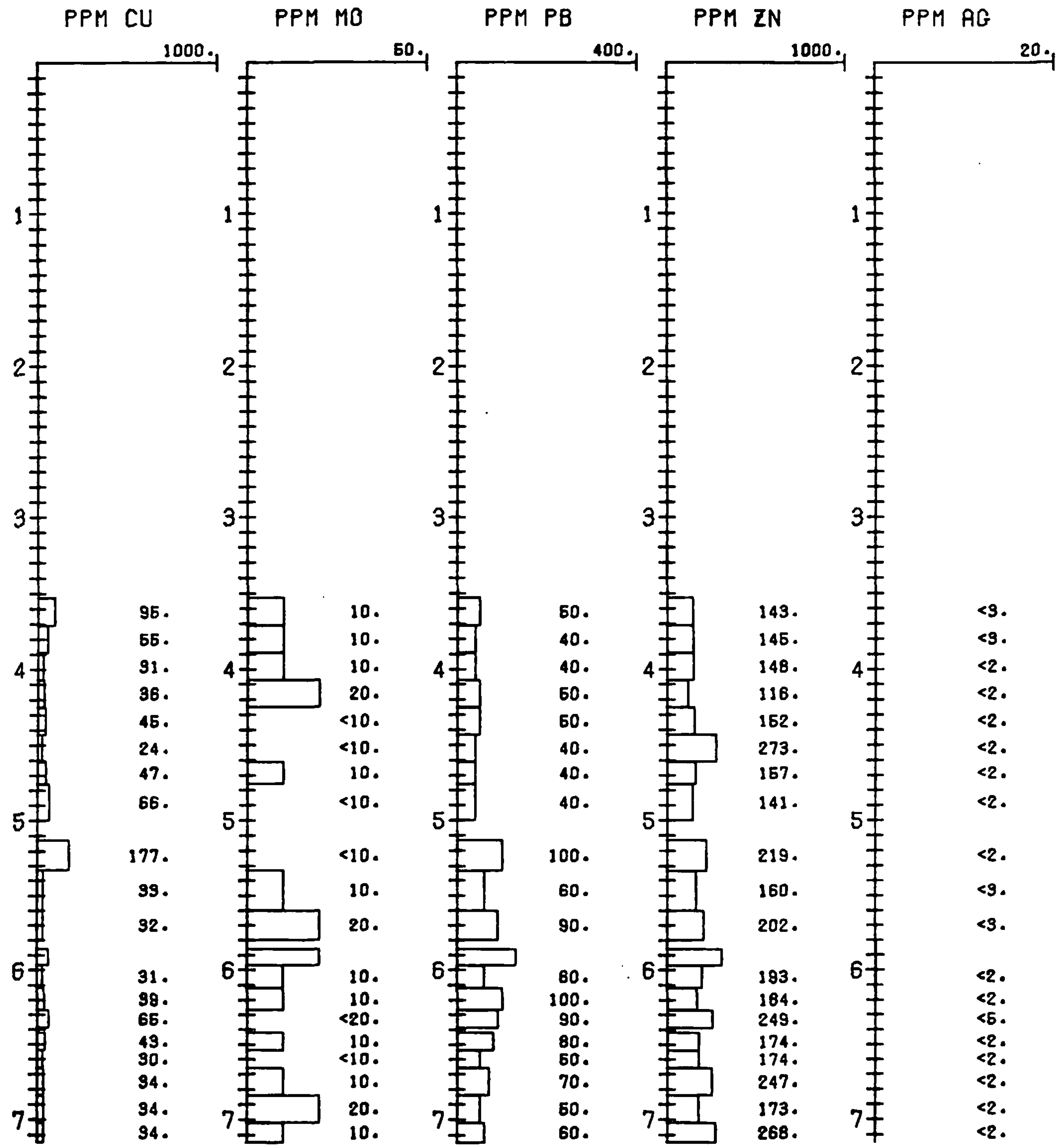


FIGURE 12/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS.. CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

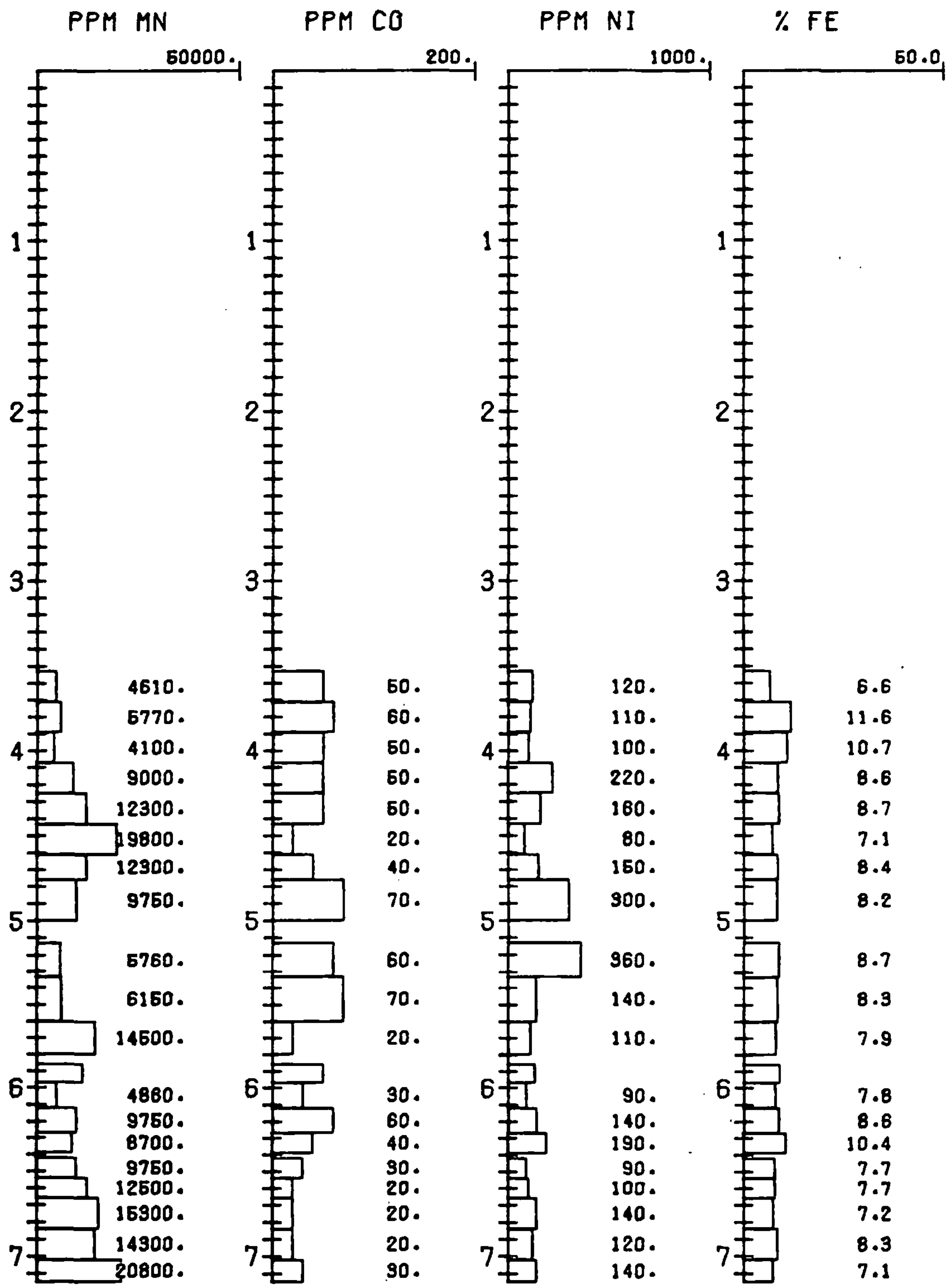


FIGURE 13/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

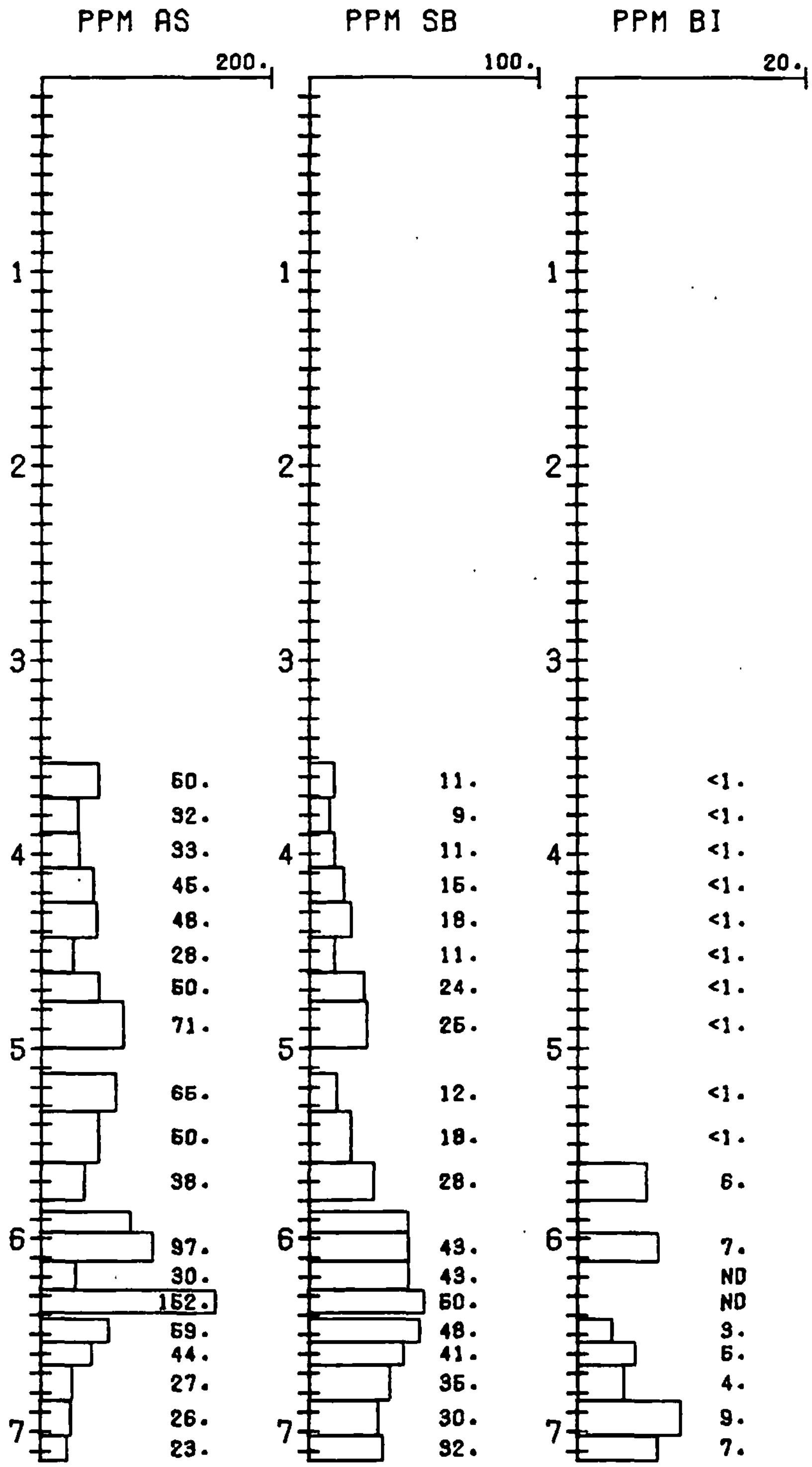


FIGURE 14/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

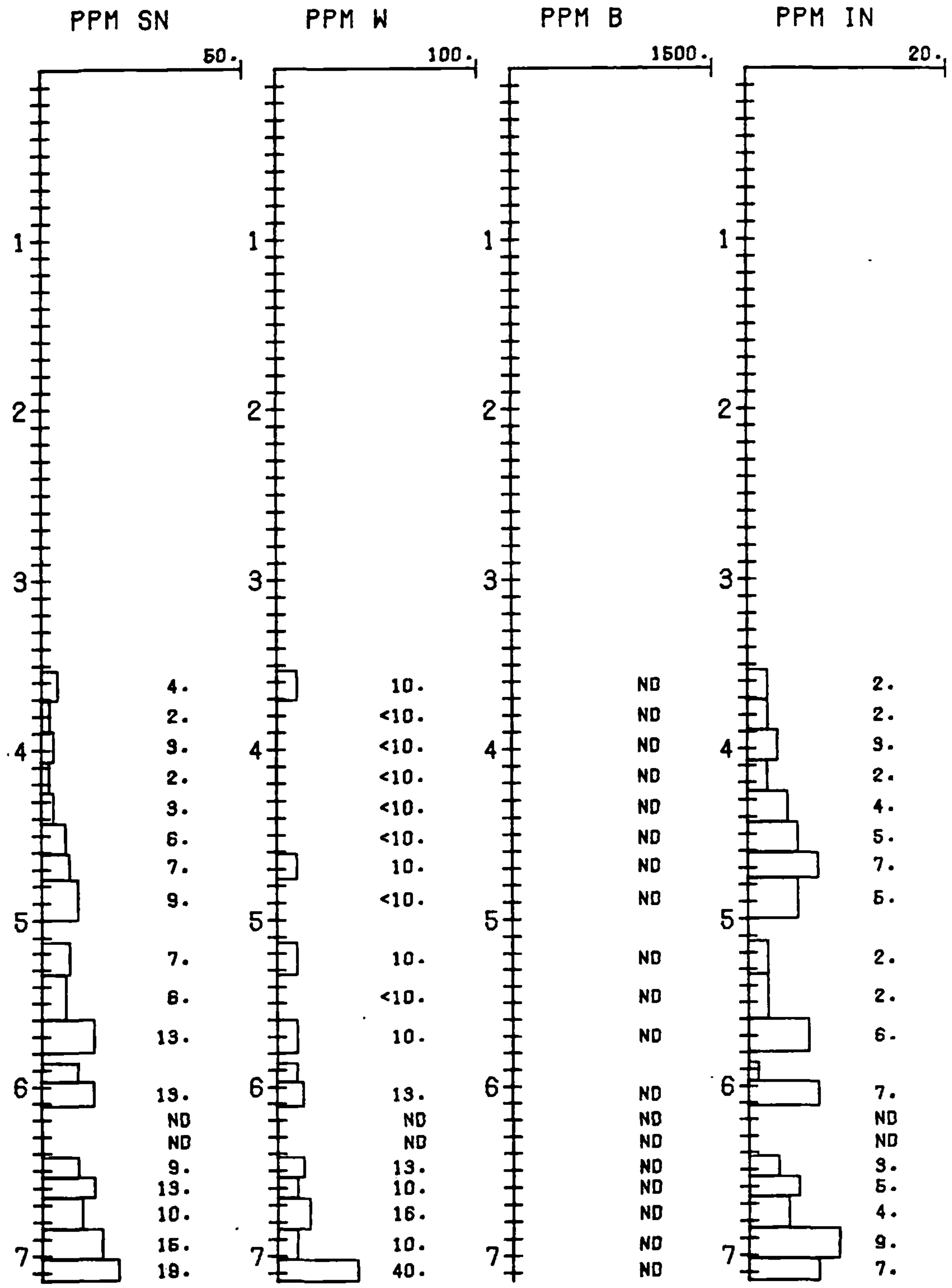
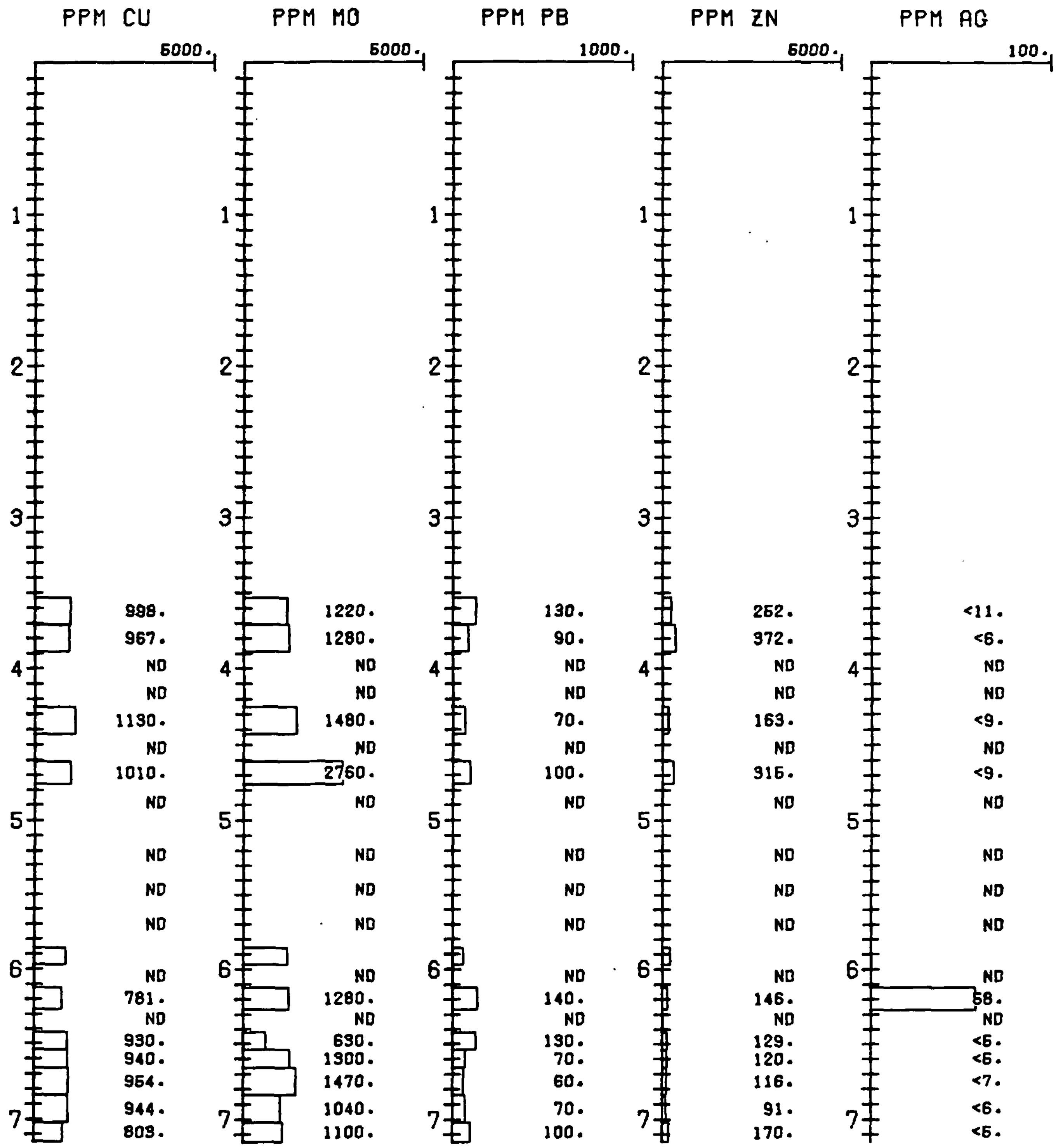


FIGURE 15/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)



DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

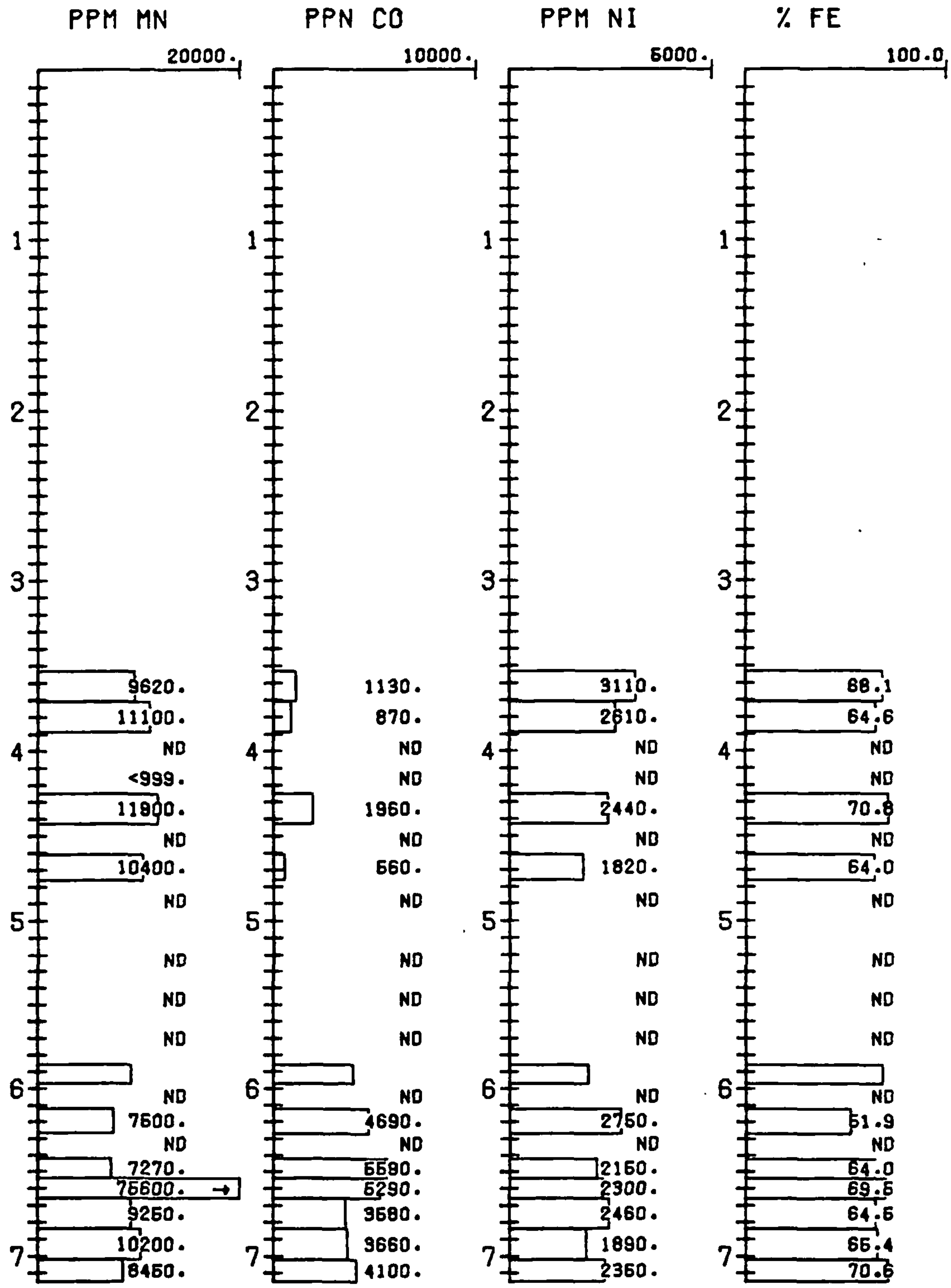
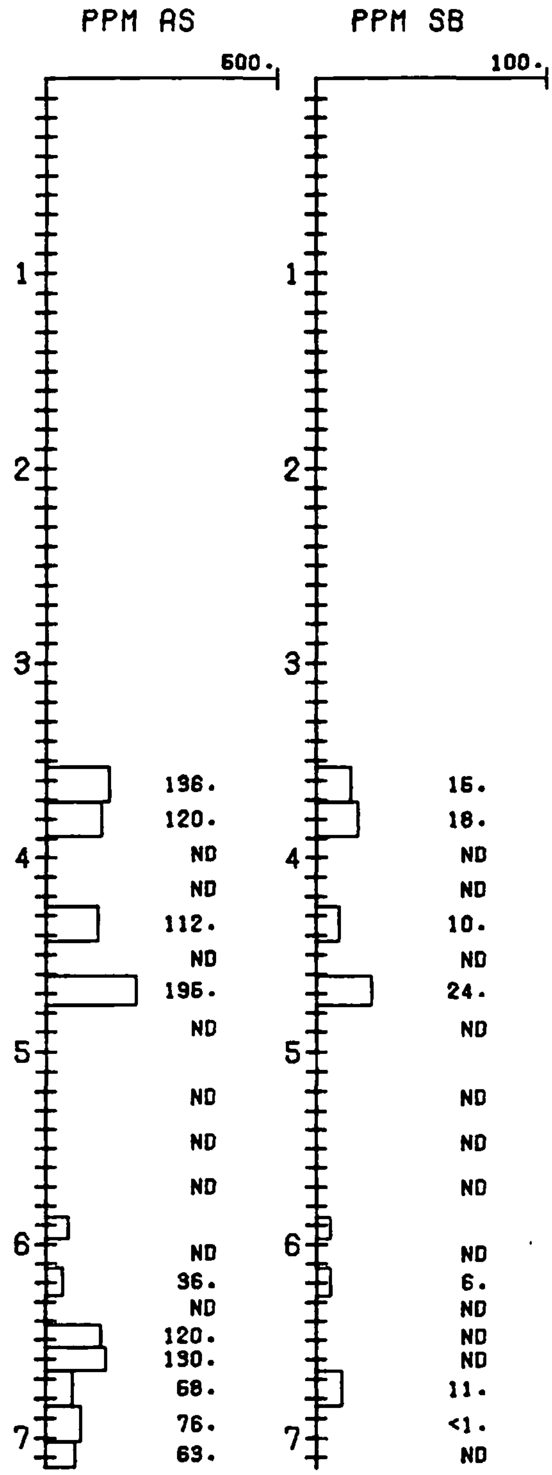


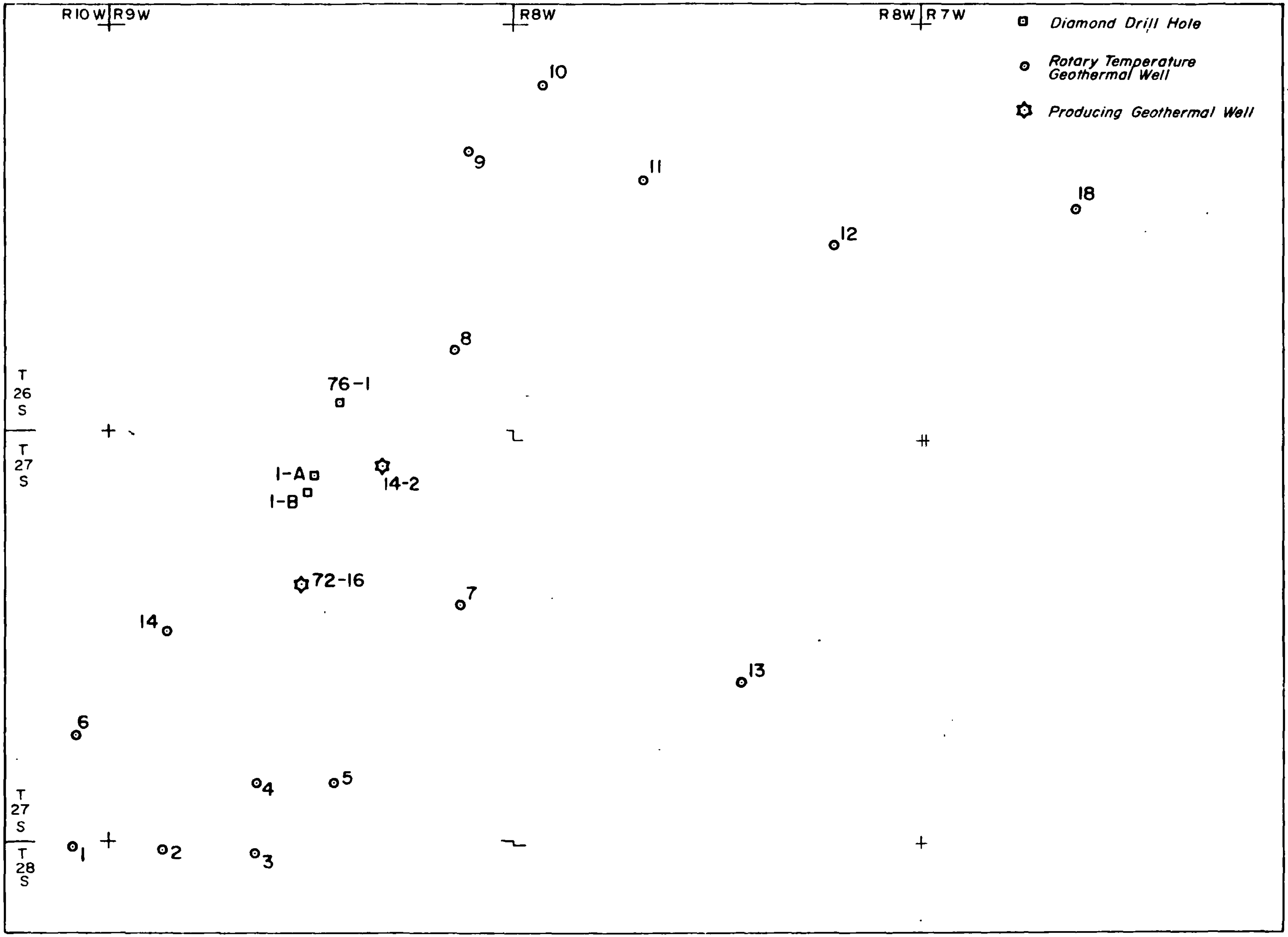
FIGURE 17/G-1R

DH G-1R

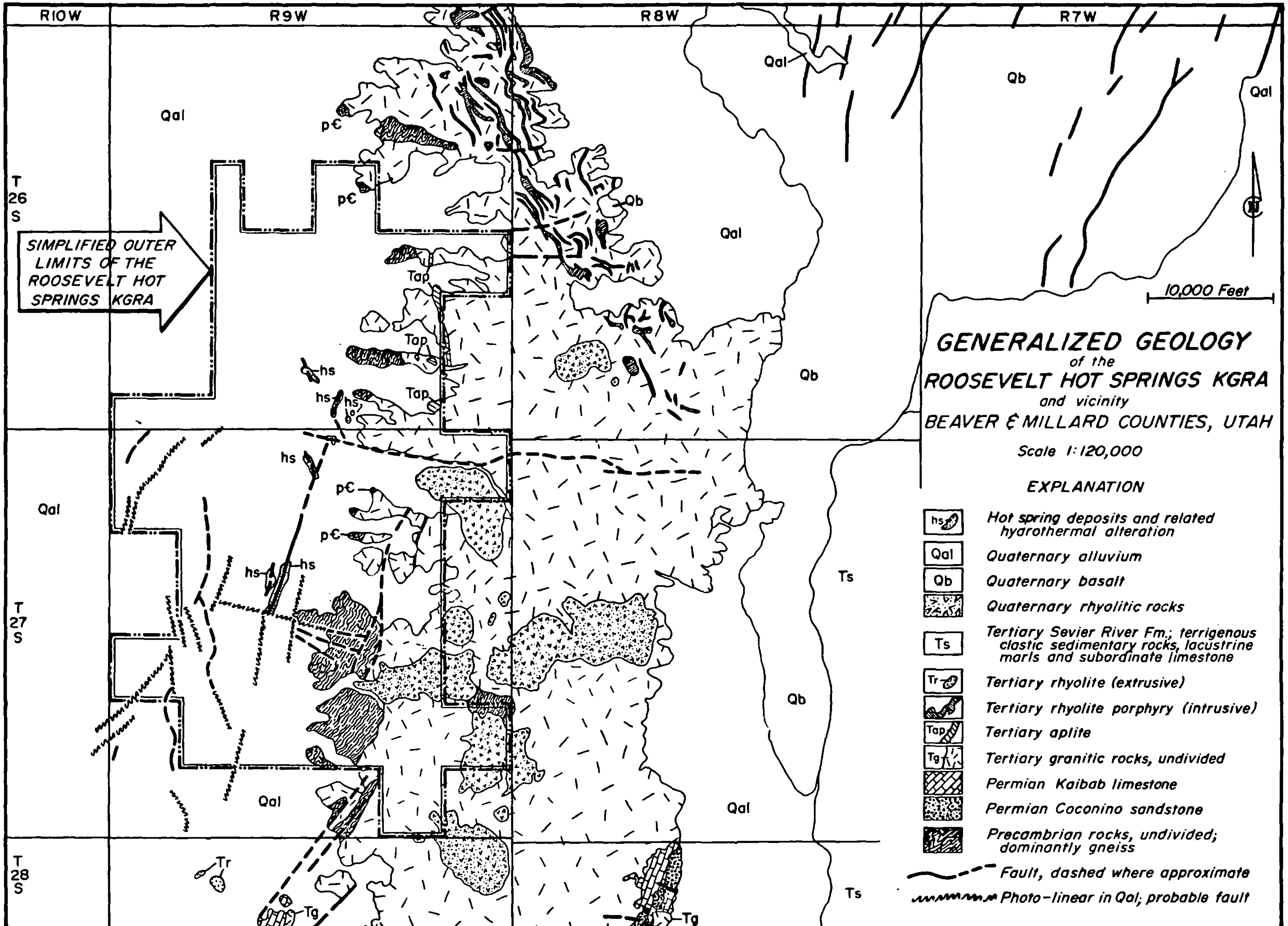
GEYSERS KGRA
SONOMA & LAKE COS.. CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)



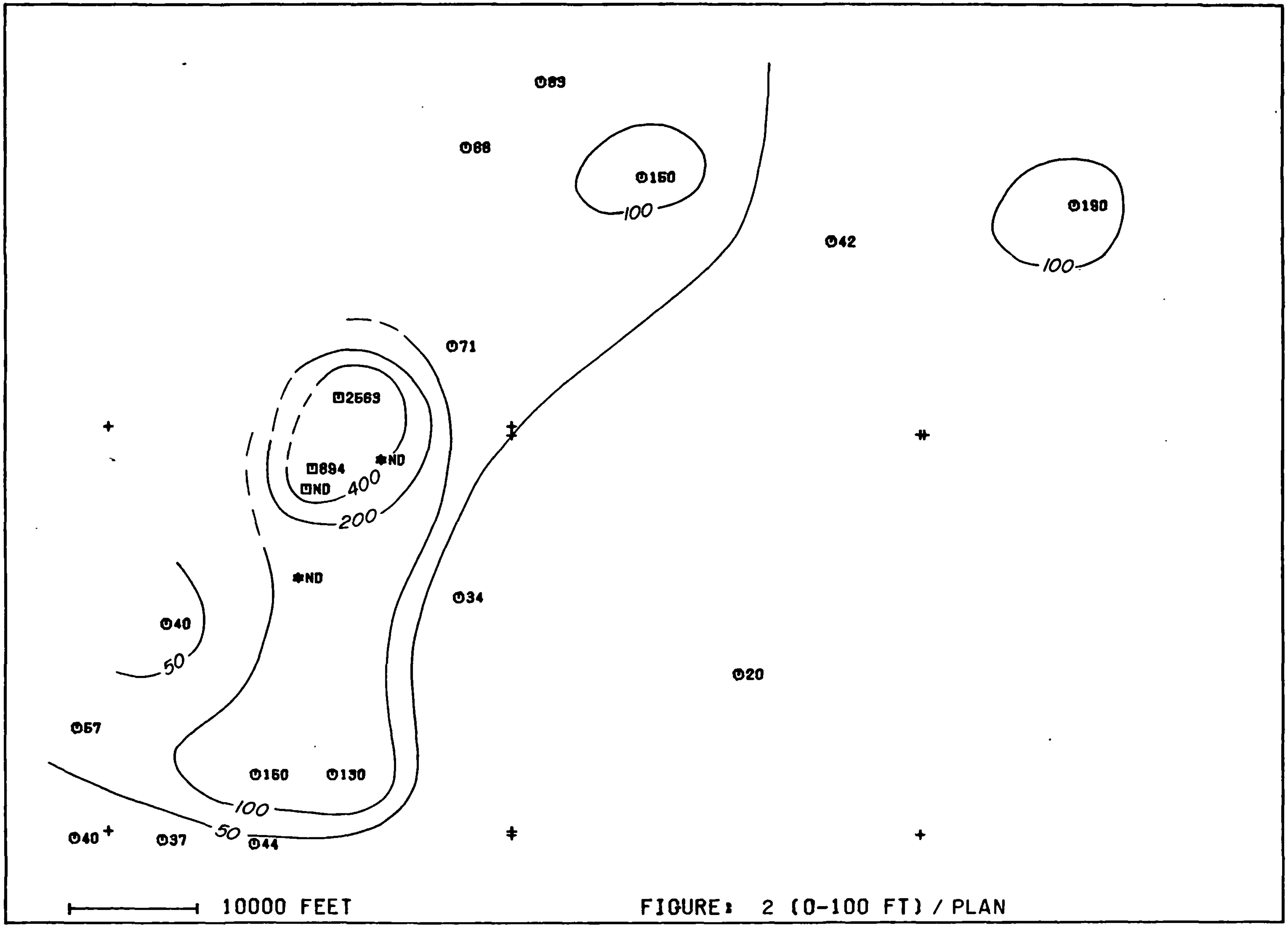


OVERLAY TO FIGURE 1/PLAN



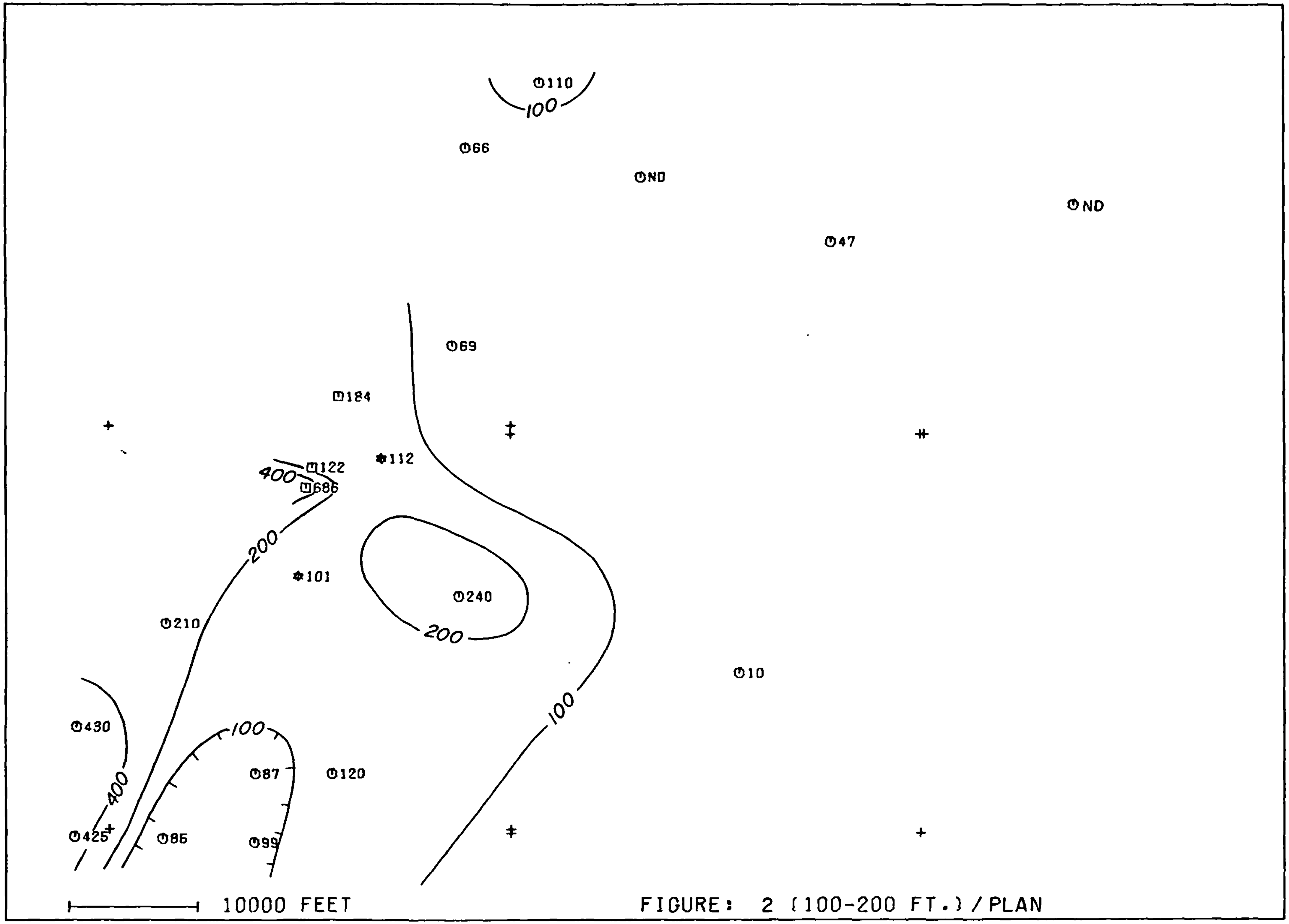
Geology modified by J.B. HULEN from Liese, 1957; Hintze, 1963, 1975; Evans et al, 1977

FIGURE I / PLAN



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

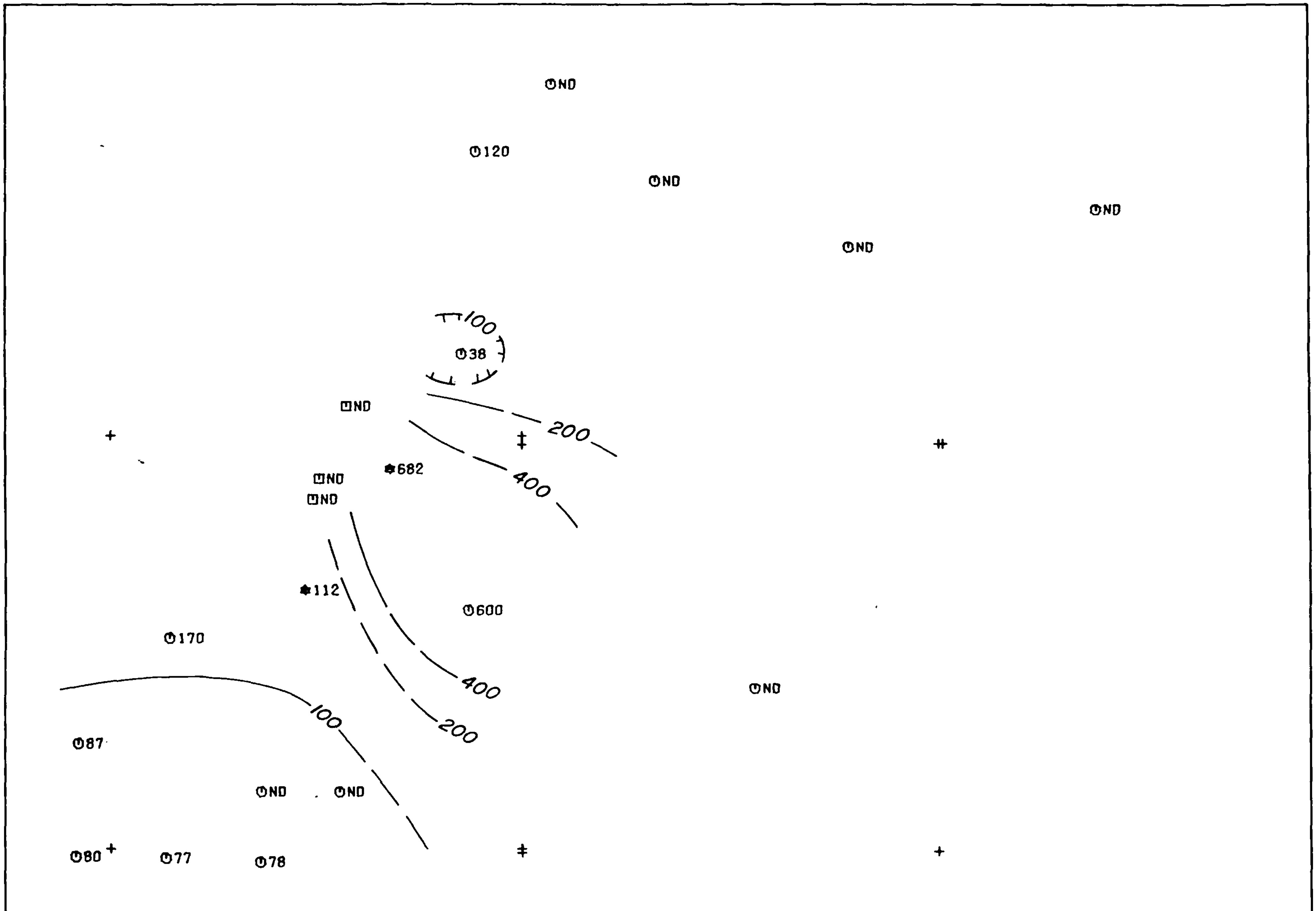
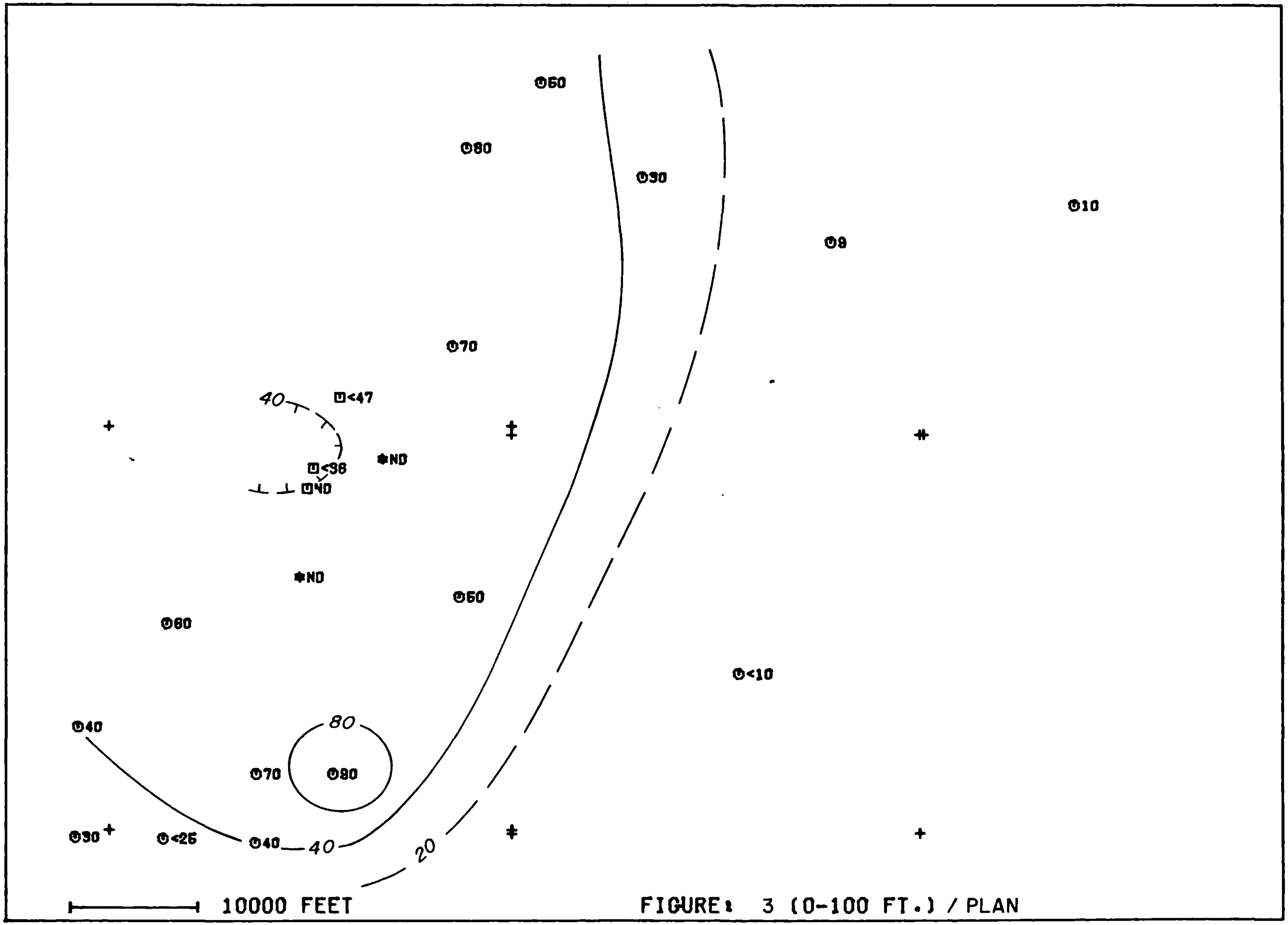


FIGURE: 2 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

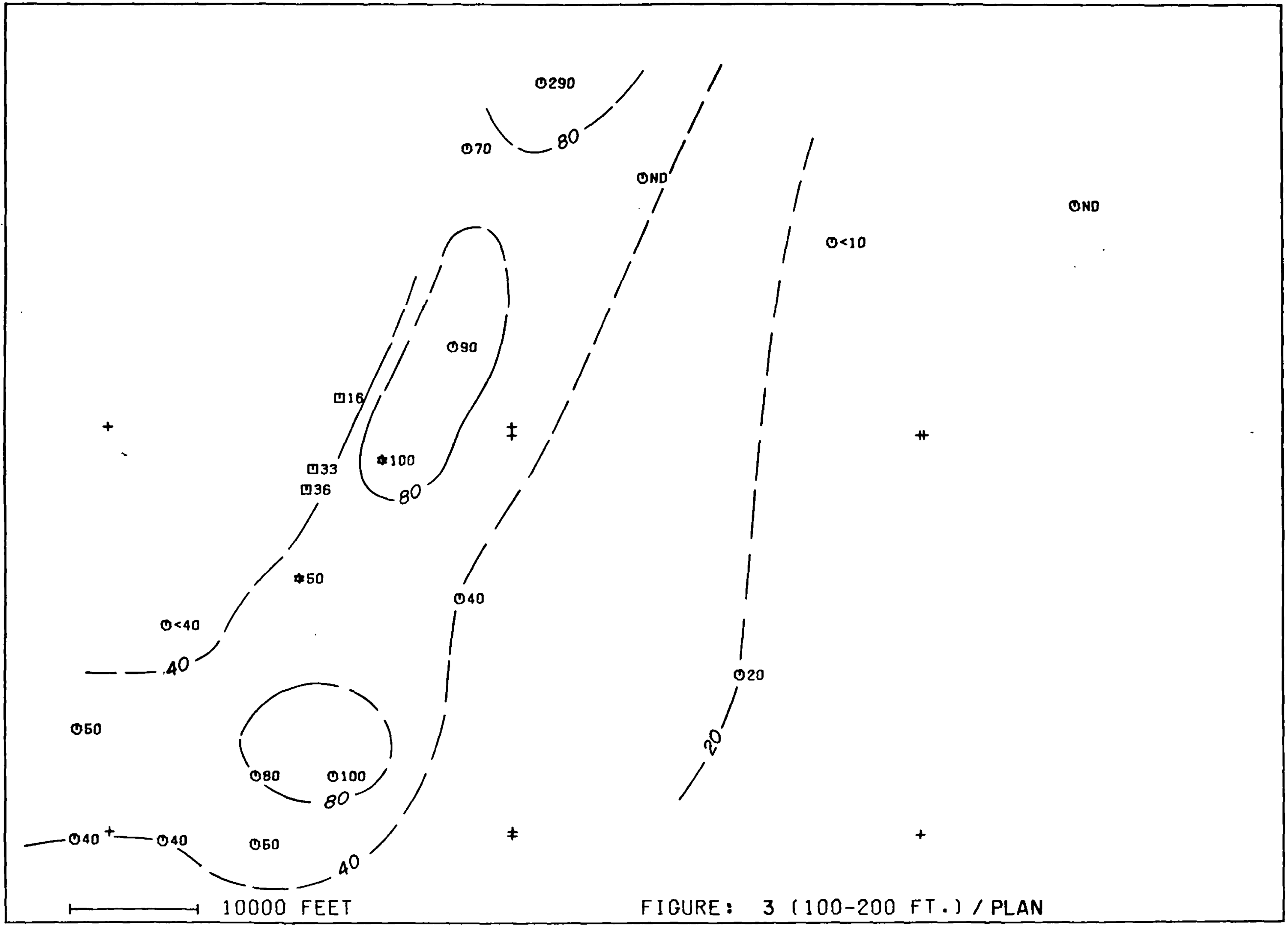
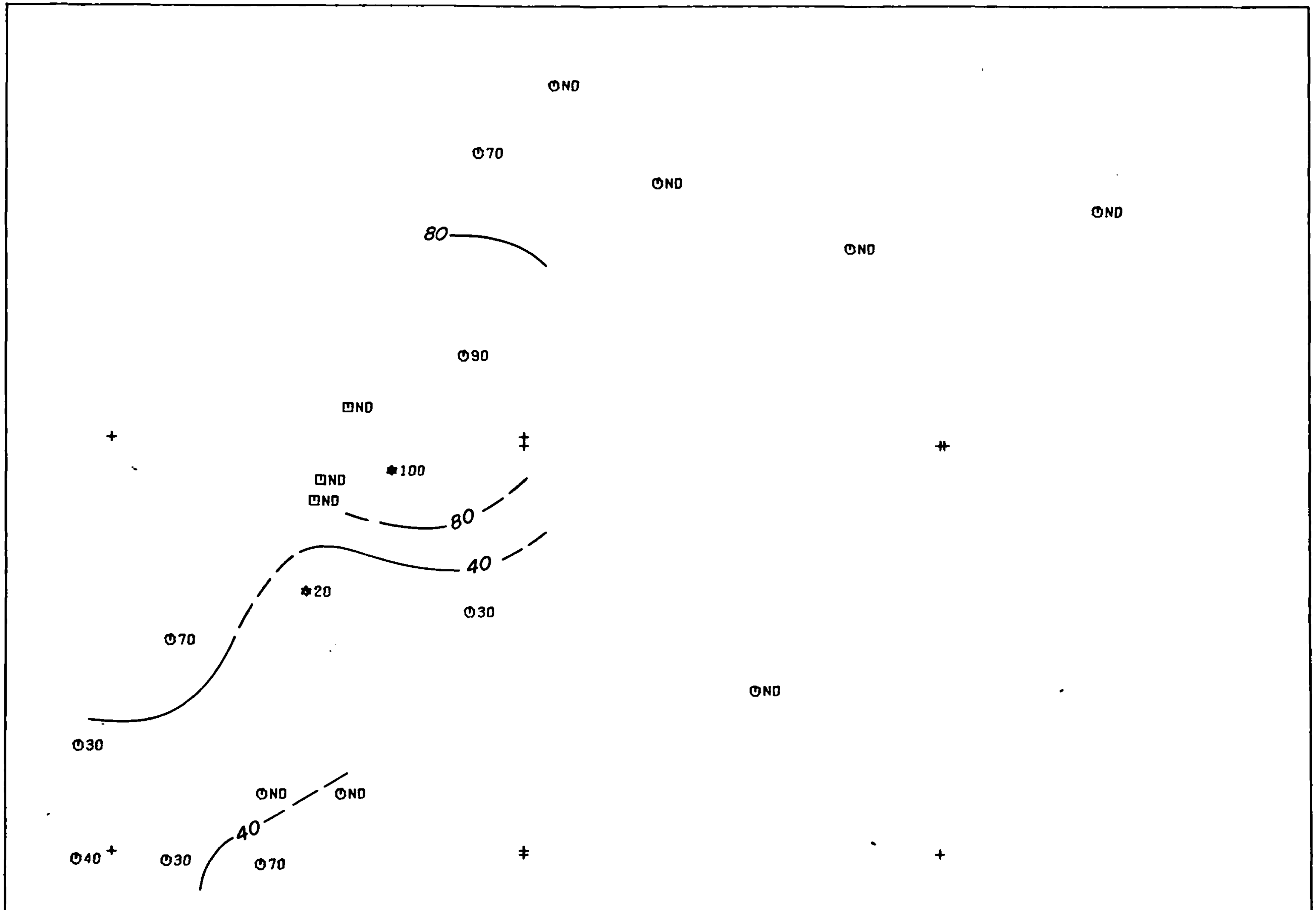


FIGURE: 3 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

105

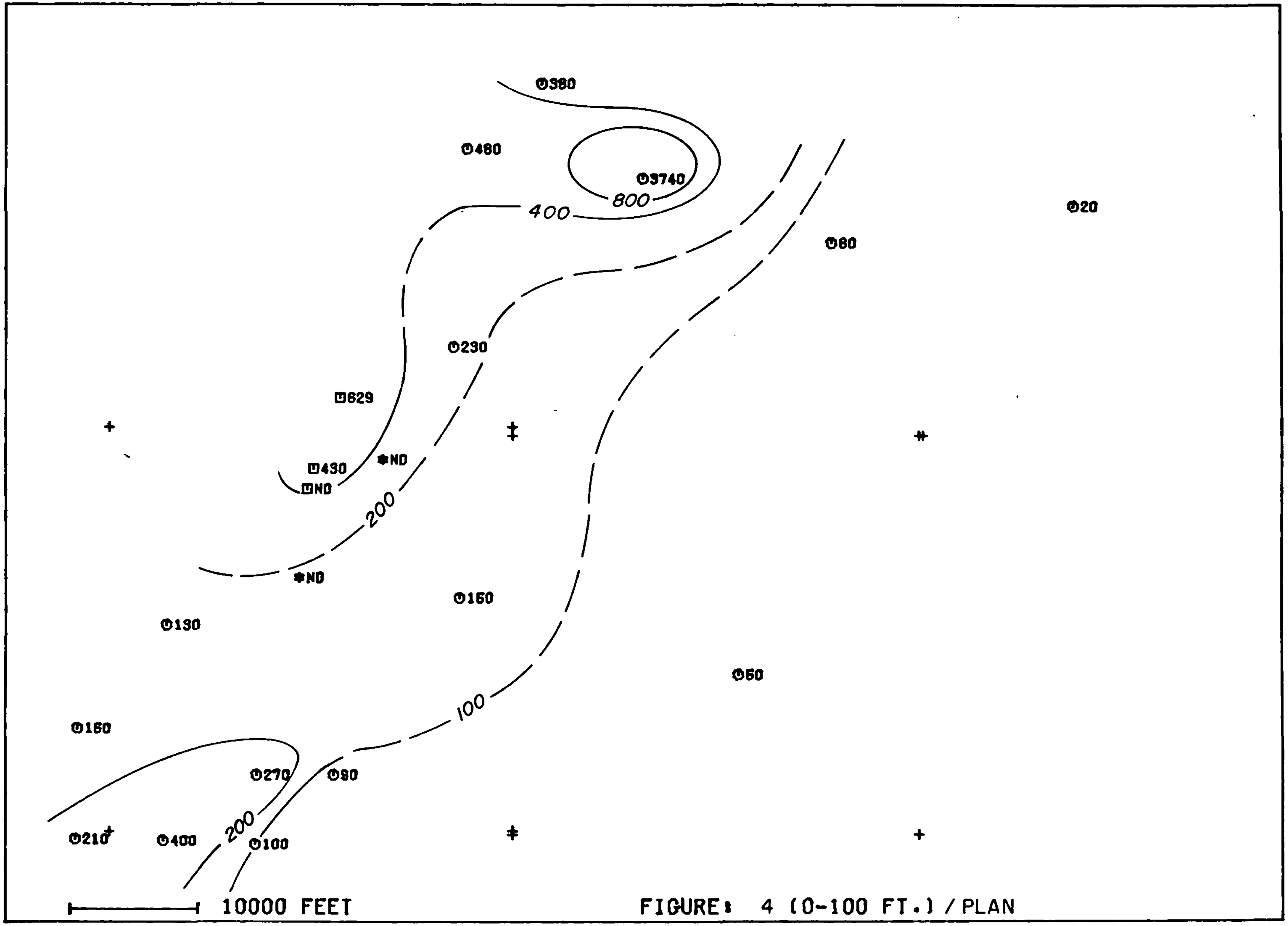


10000 FEET

FIGURE: 3 (200-300 FT.) / PLAN

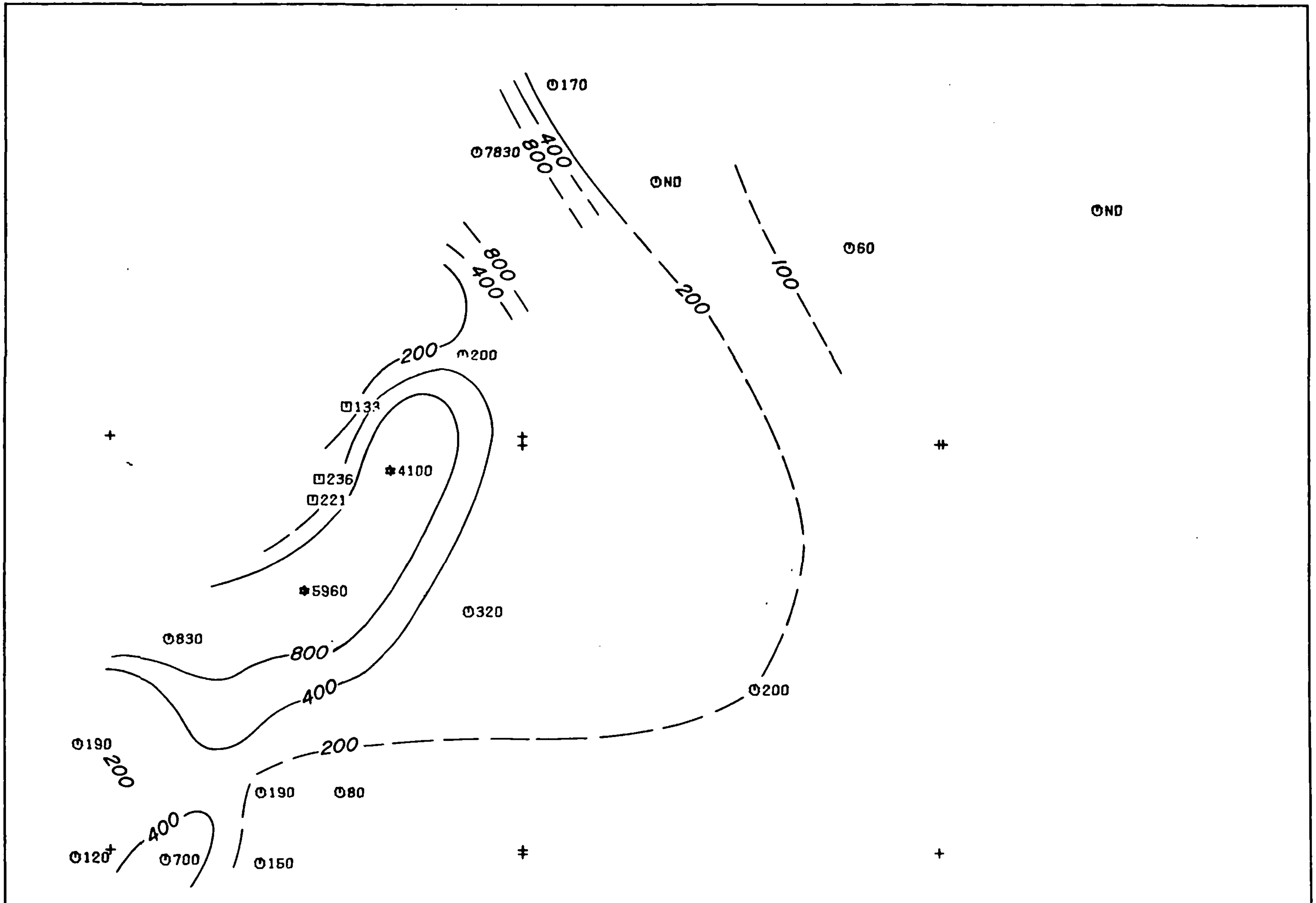
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 4 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

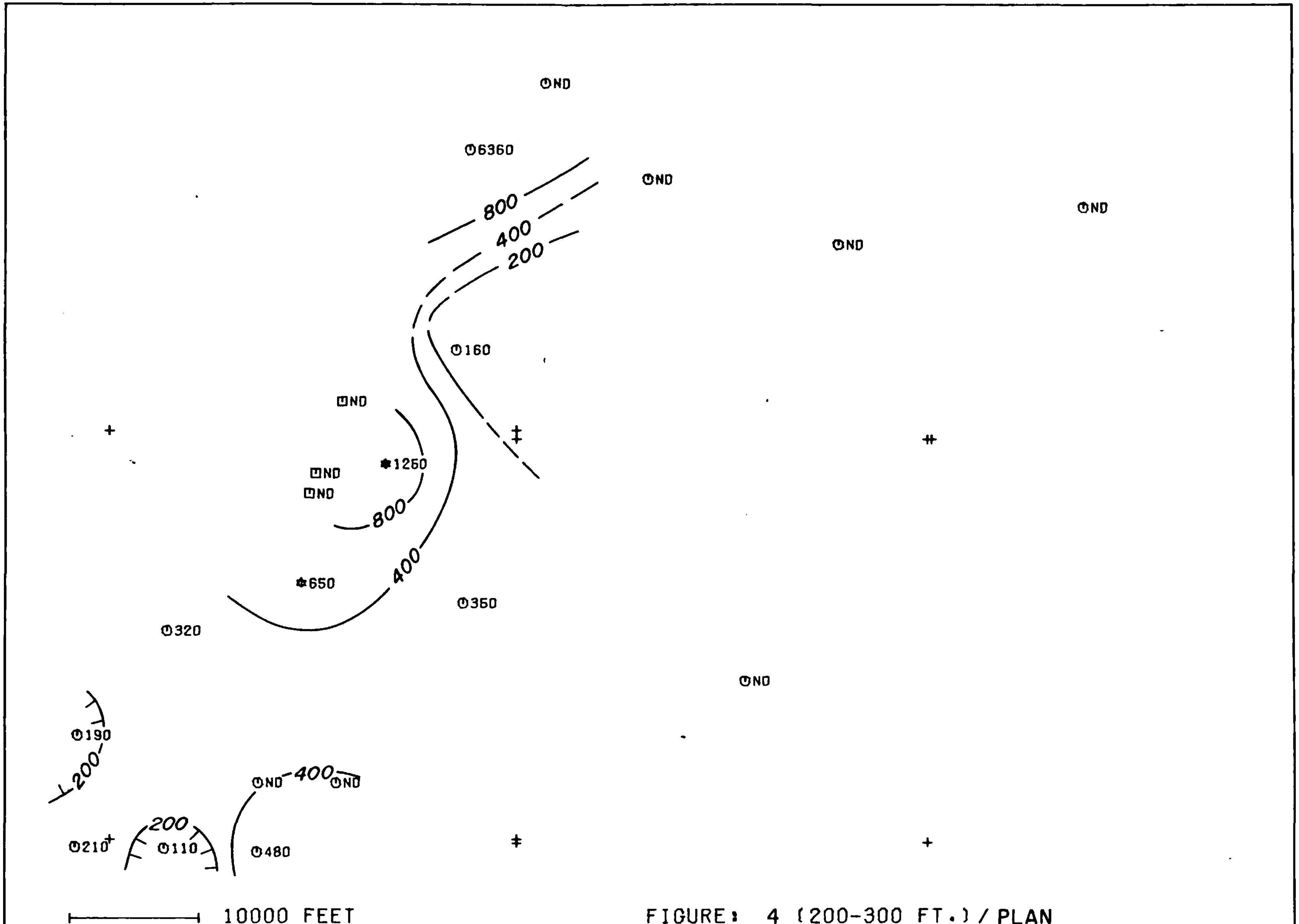


FIGURE: 4 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

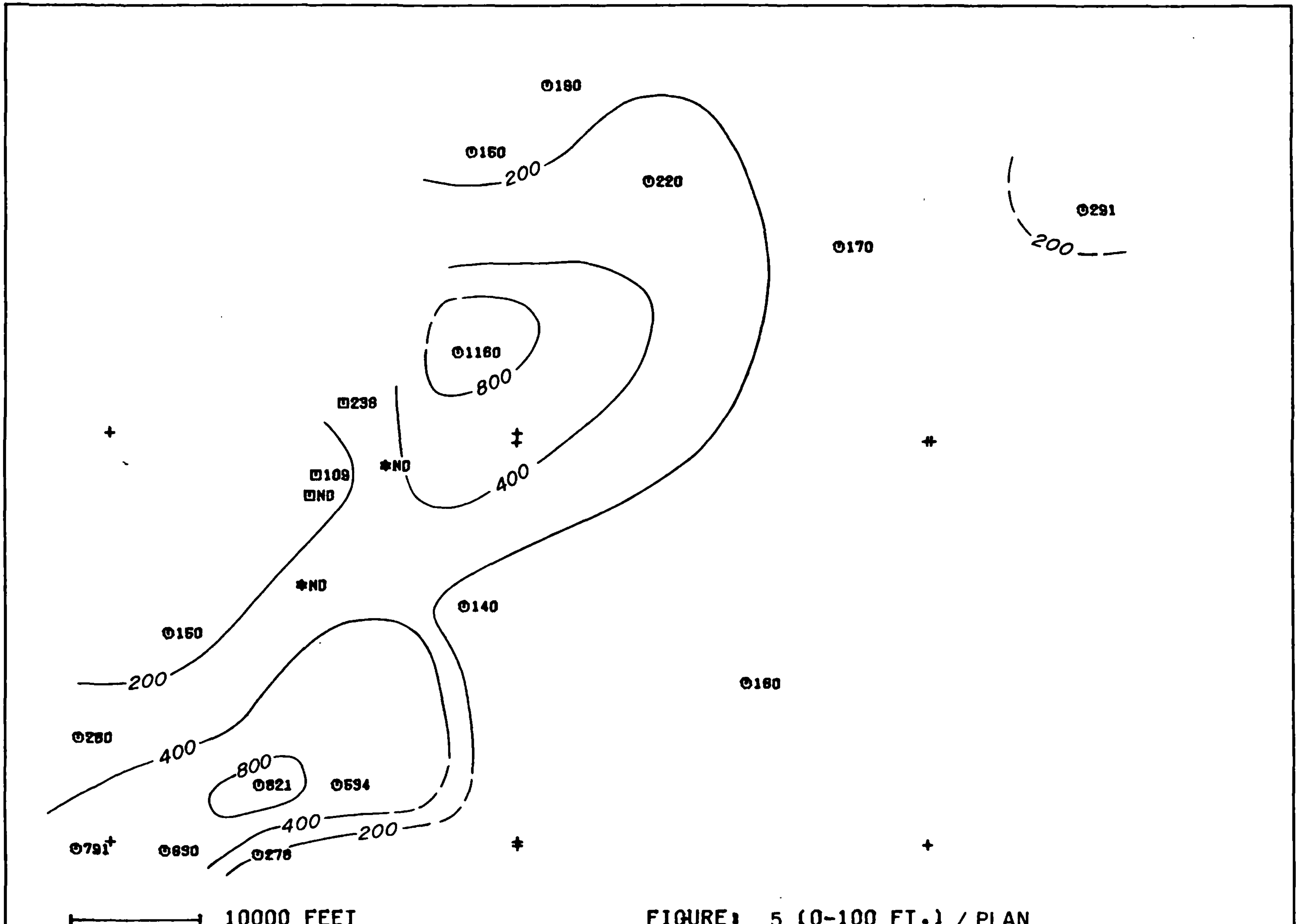
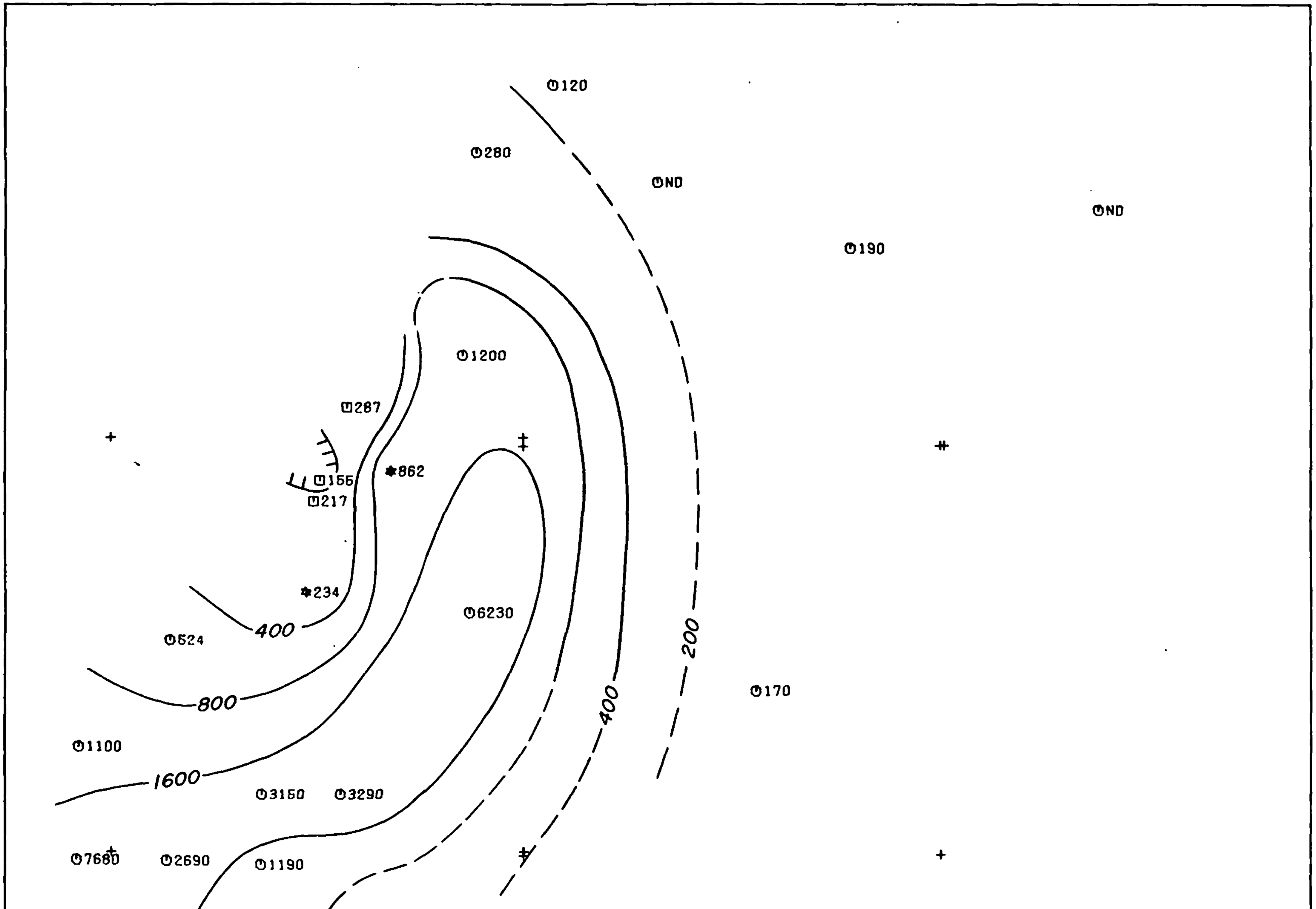


FIGURE: 5 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

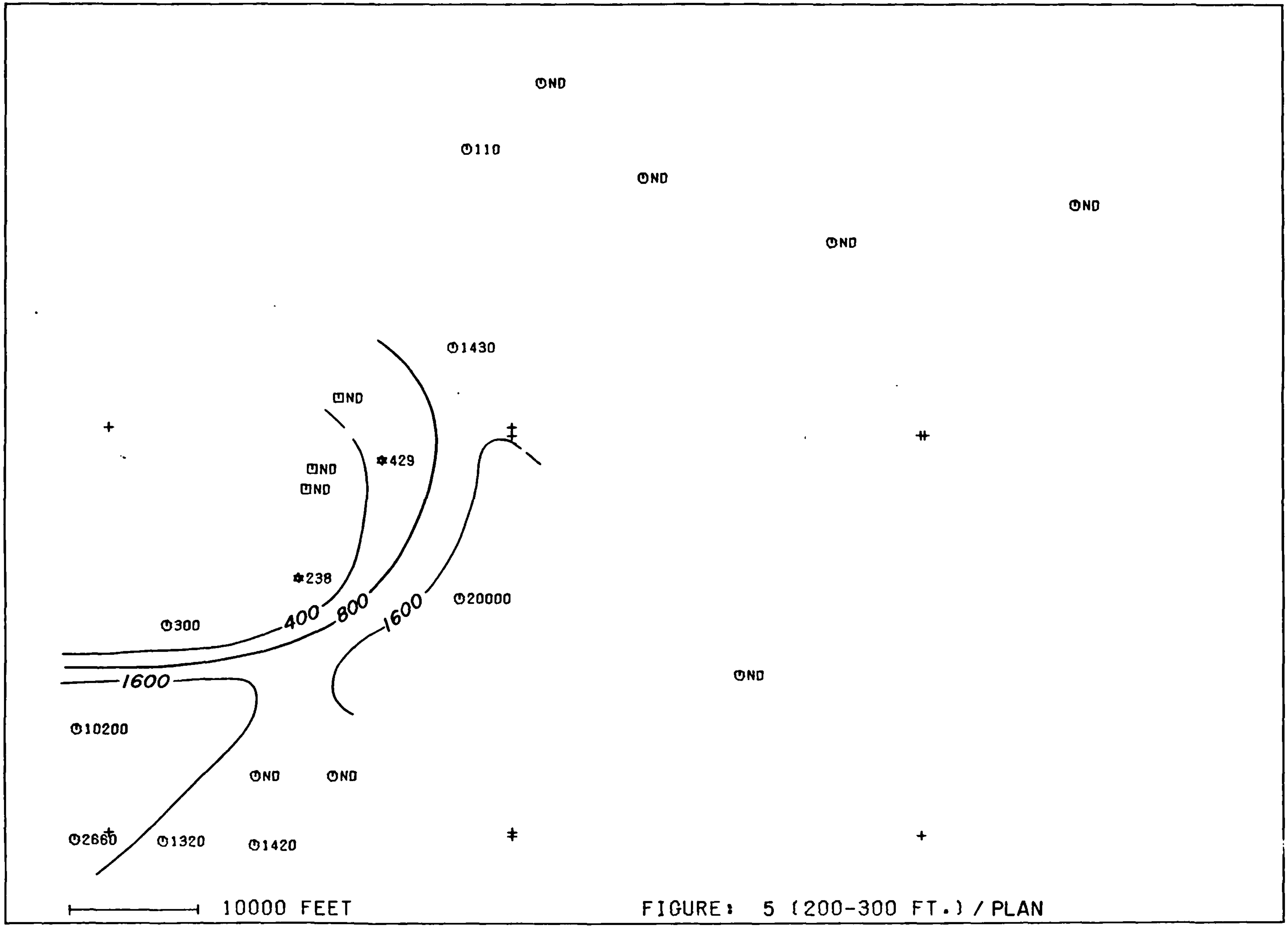


10000 FEET

FIGURE: 5 (100-200 FT.) / PLAN

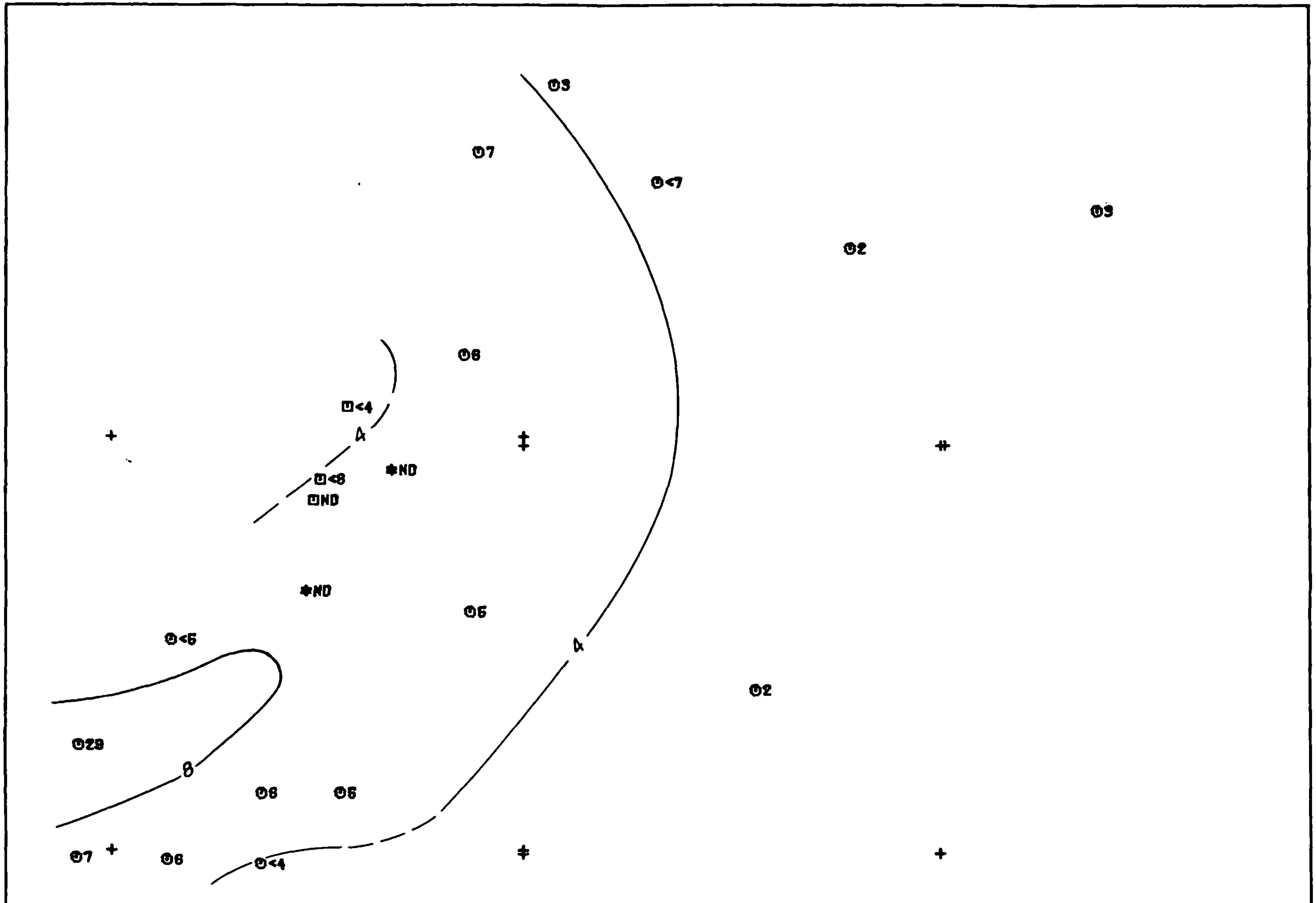
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 6 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

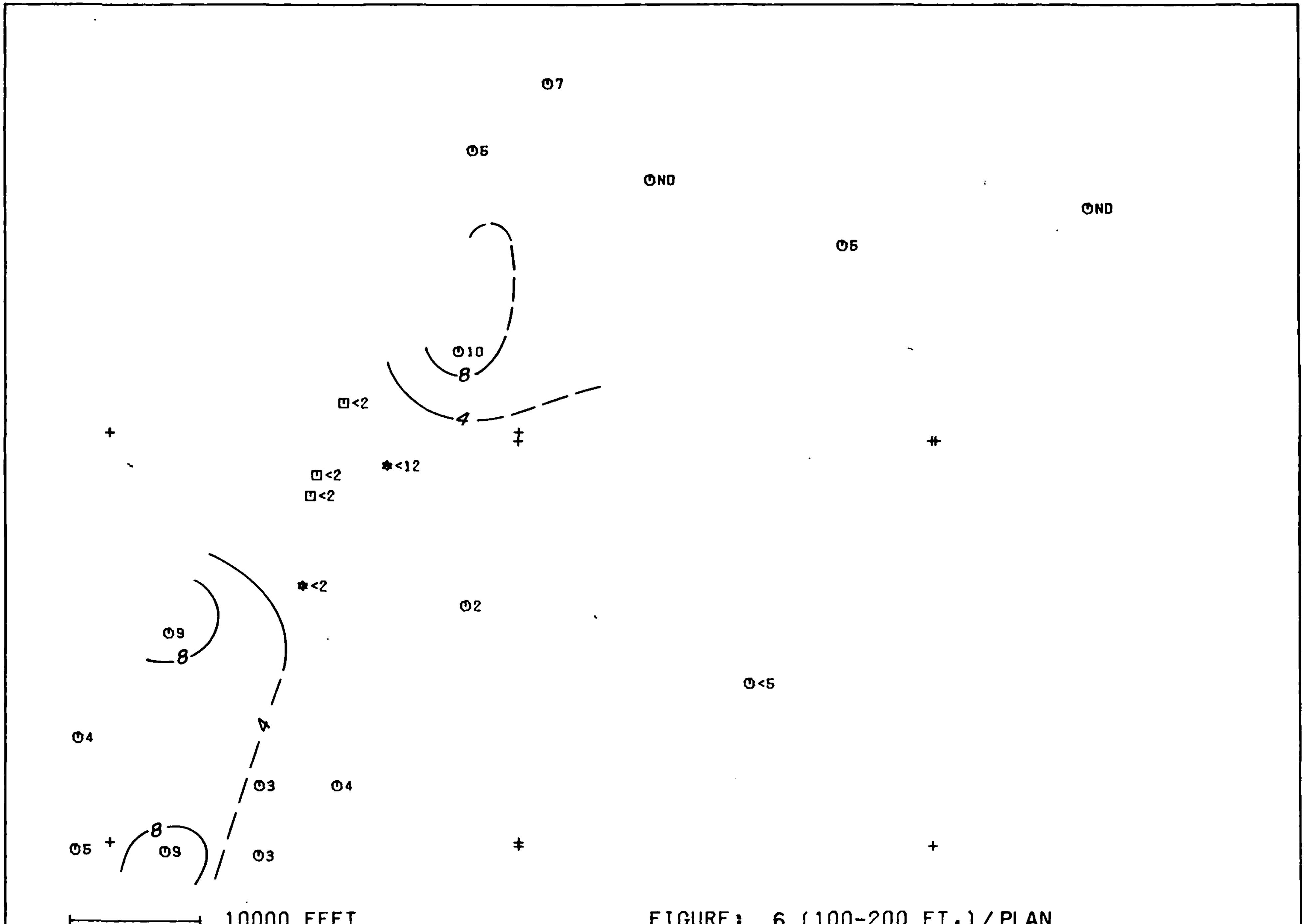
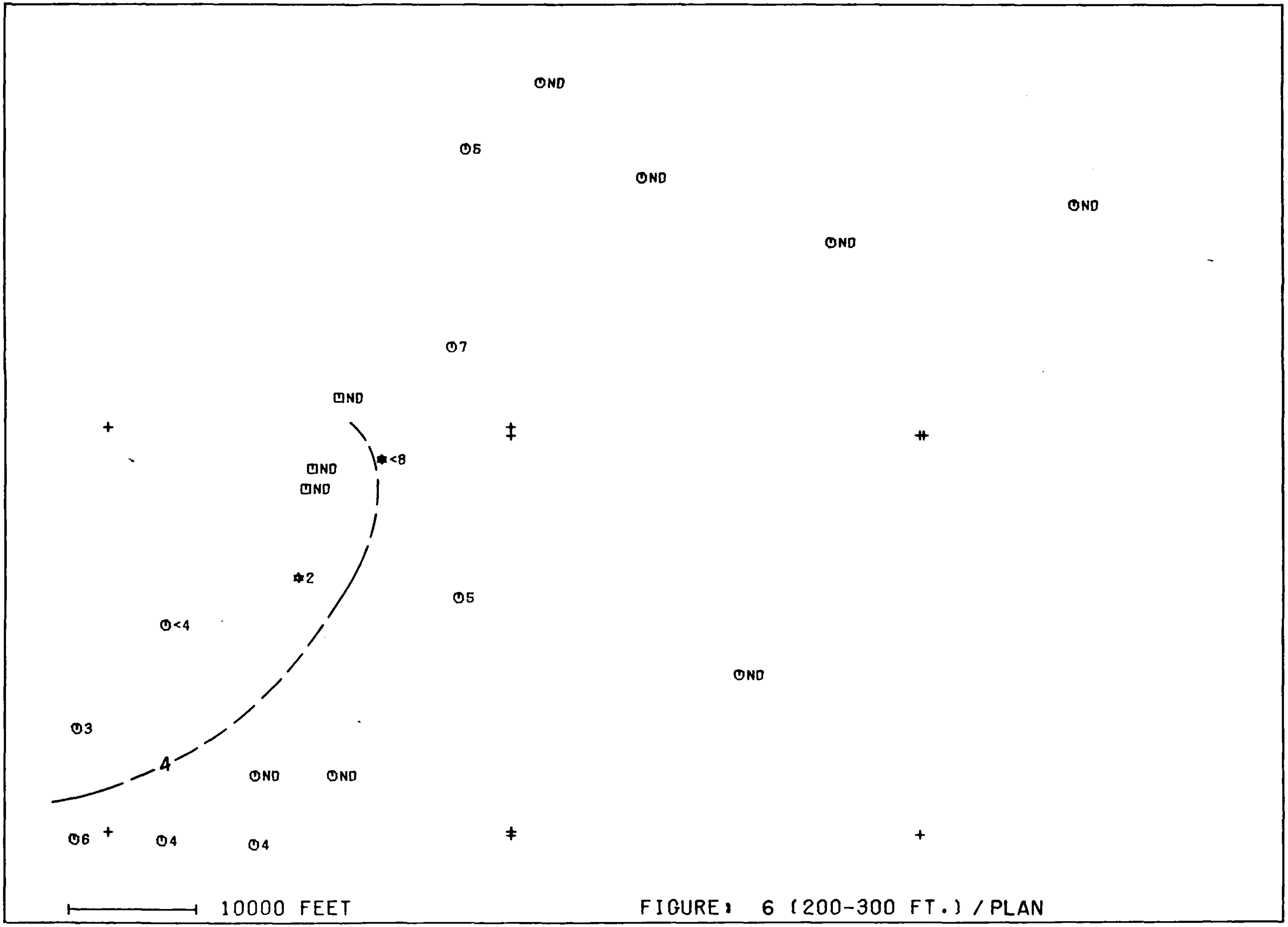


FIGURE: 6 (100-200 FT.)/PLAN

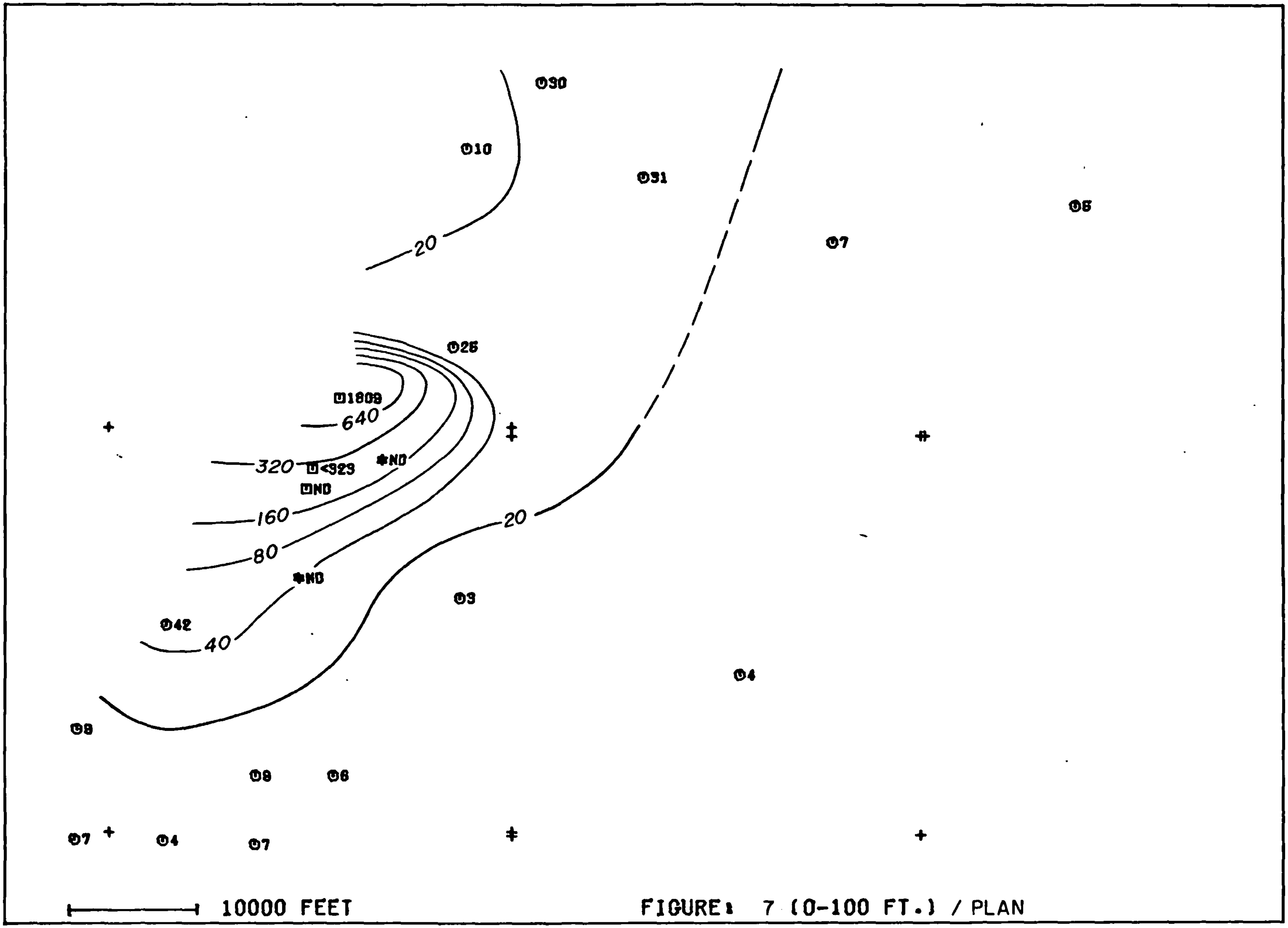
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: COLOR

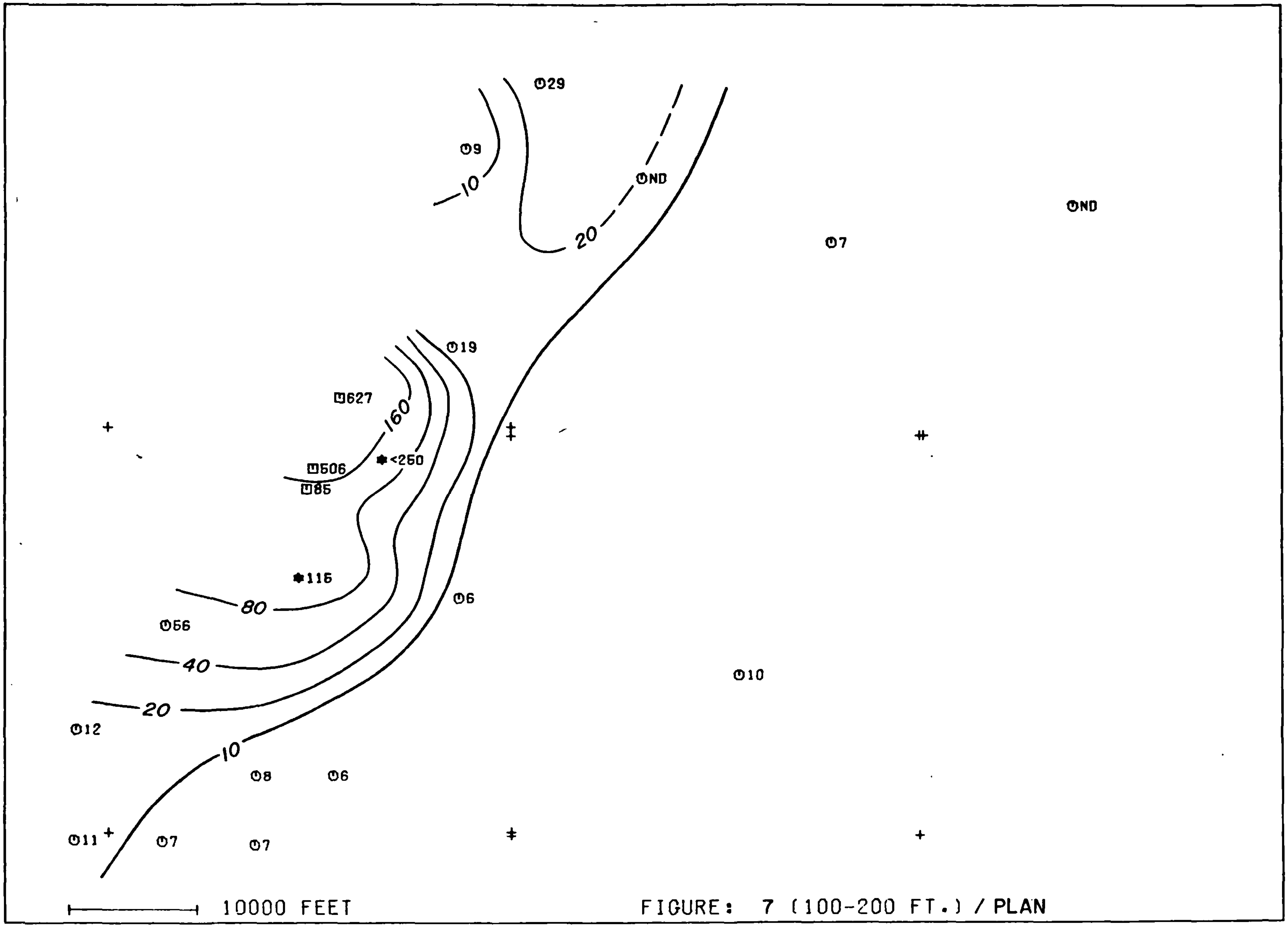
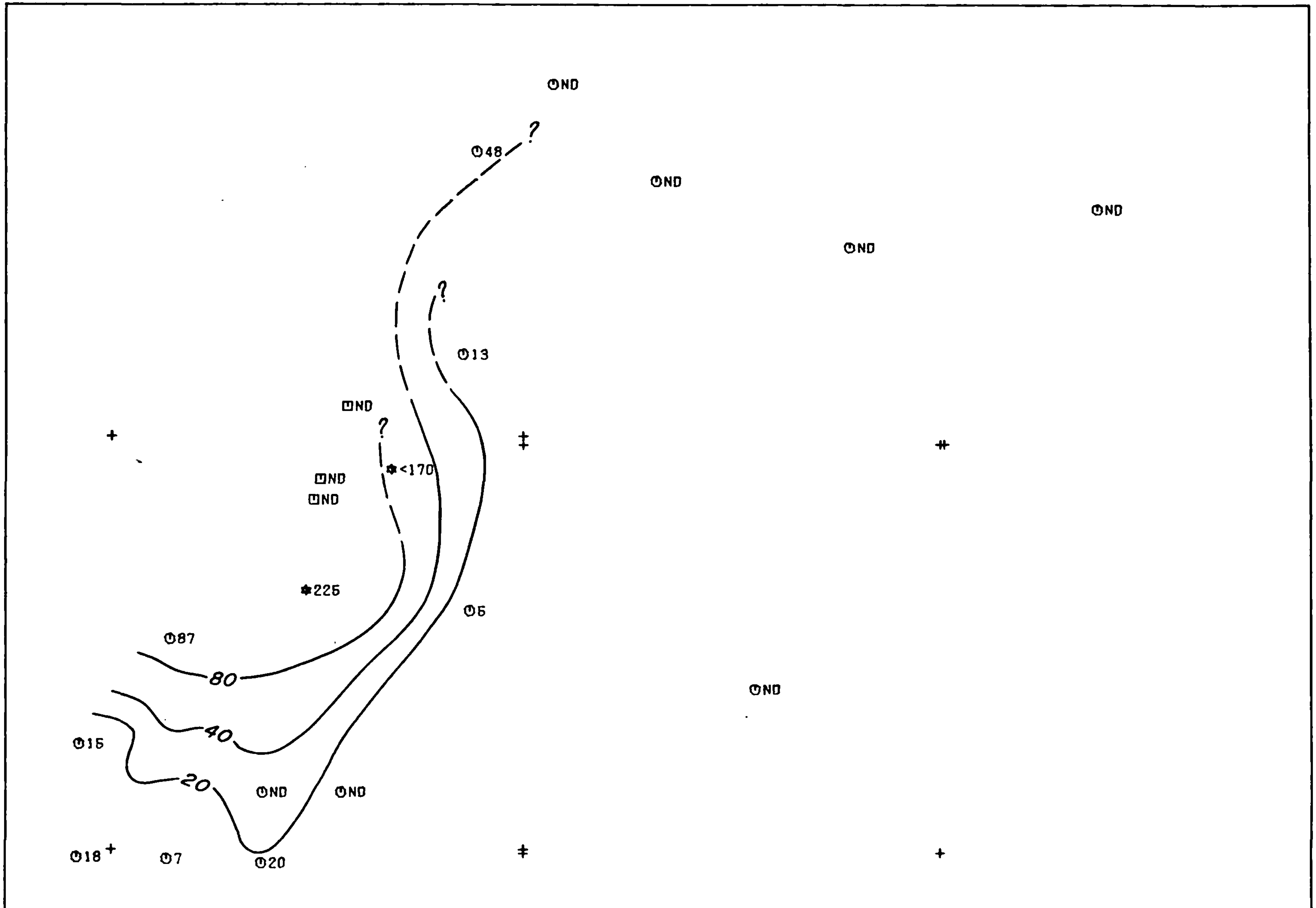


FIGURE: 7 (100-200 FT.) / **PLAN**

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: COLOR

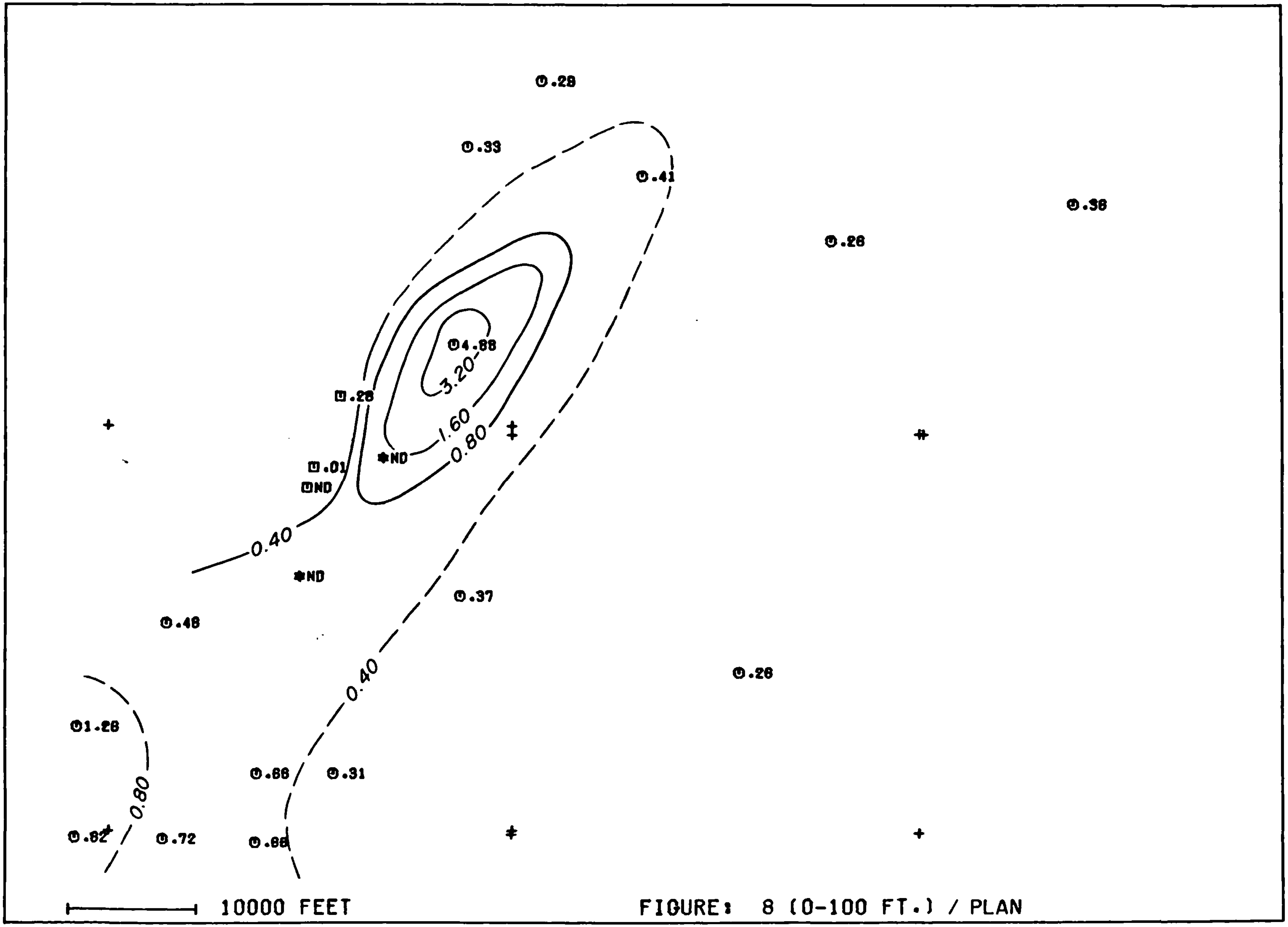


10000 FEET

FIGURE: 7 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: COLOR



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

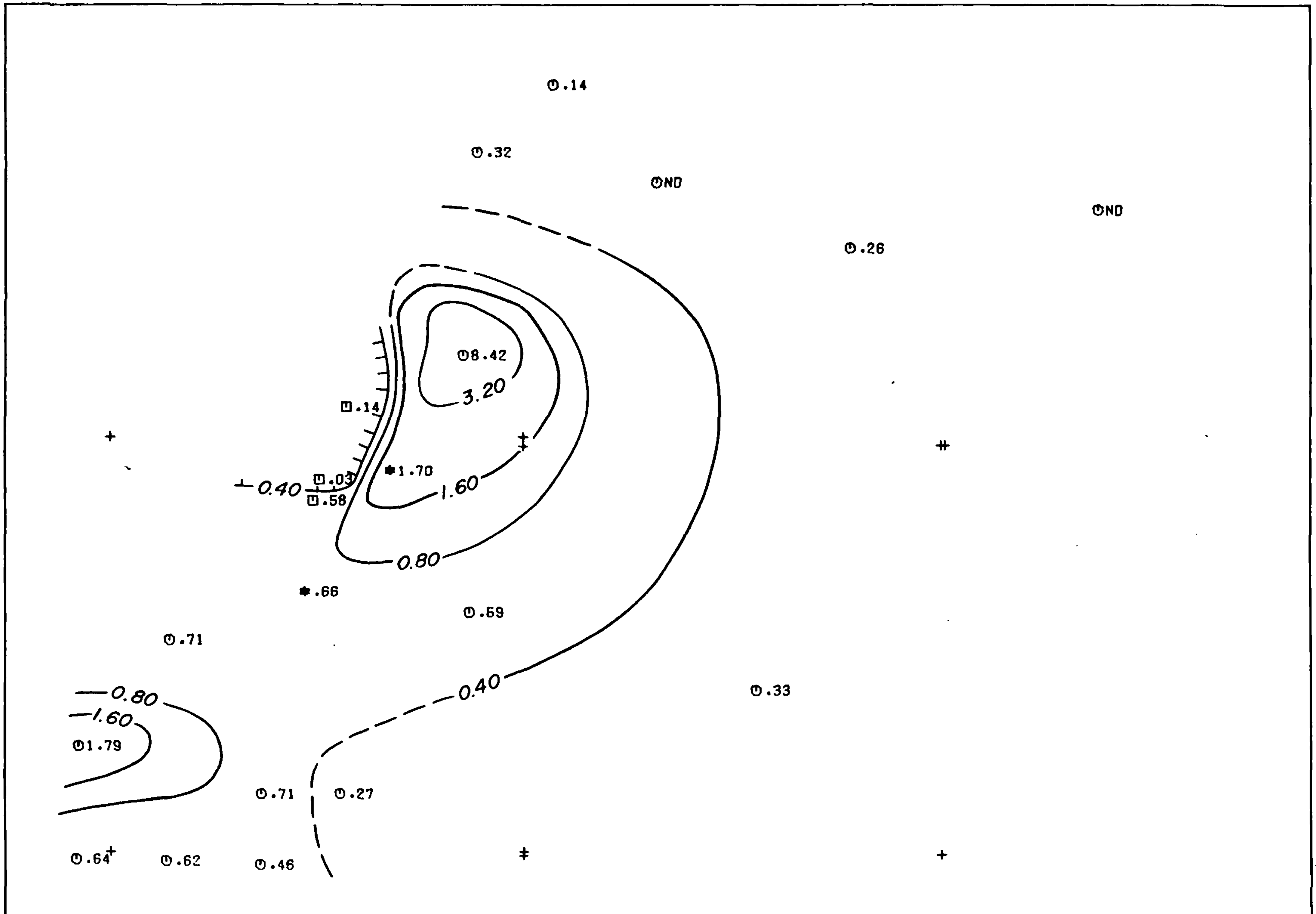


FIGURE: 8 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

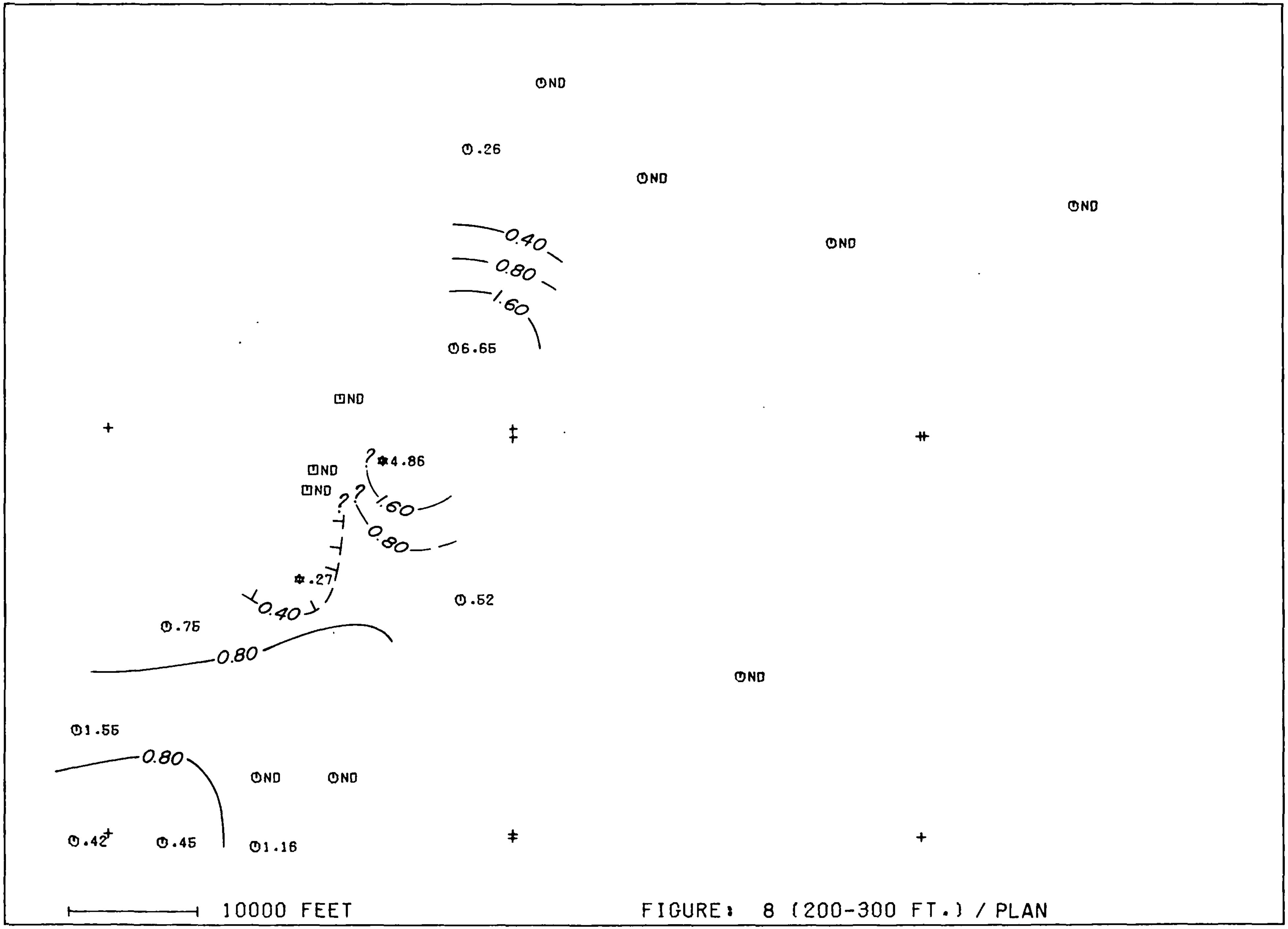
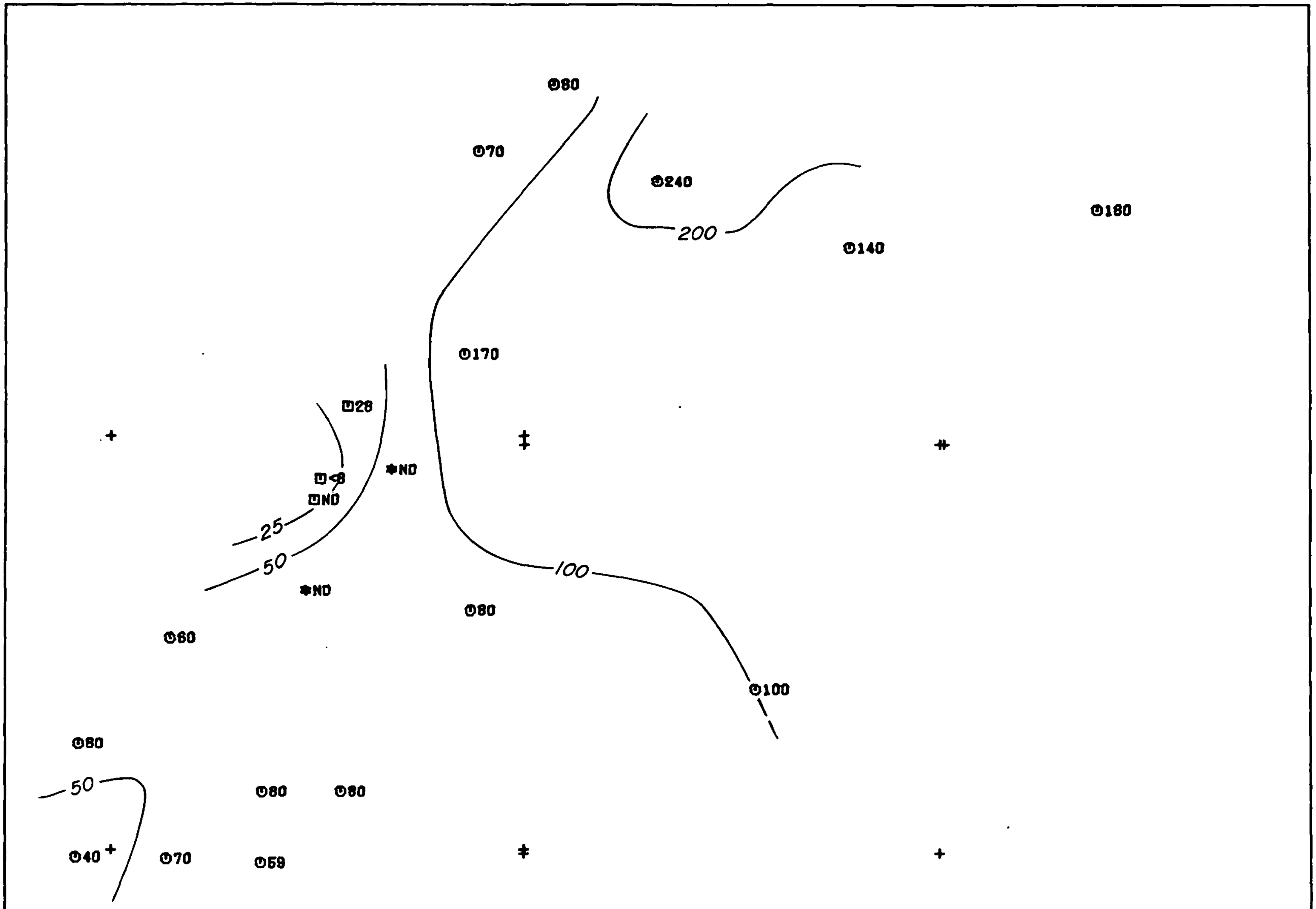


FIGURE: 8 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 9 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

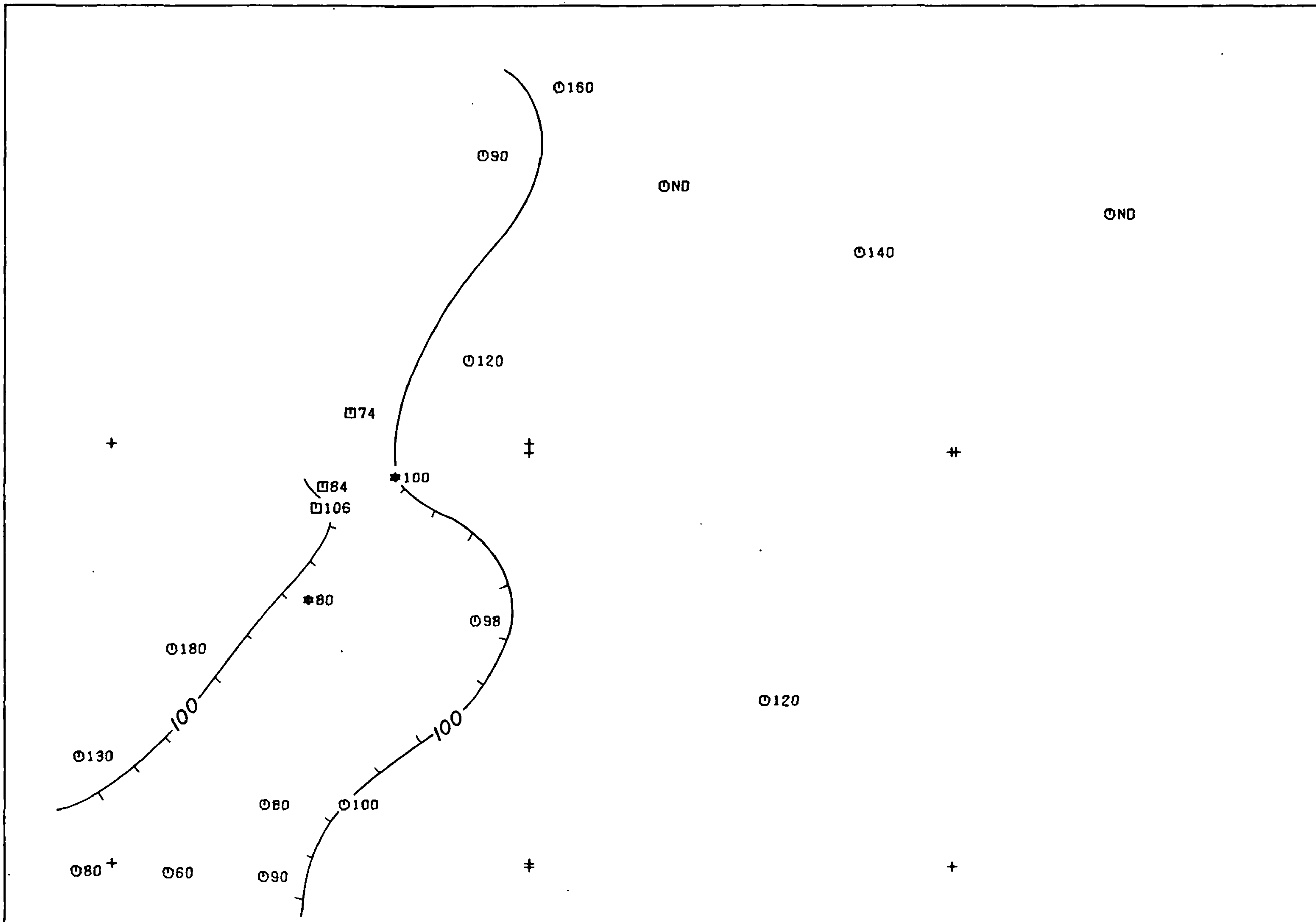
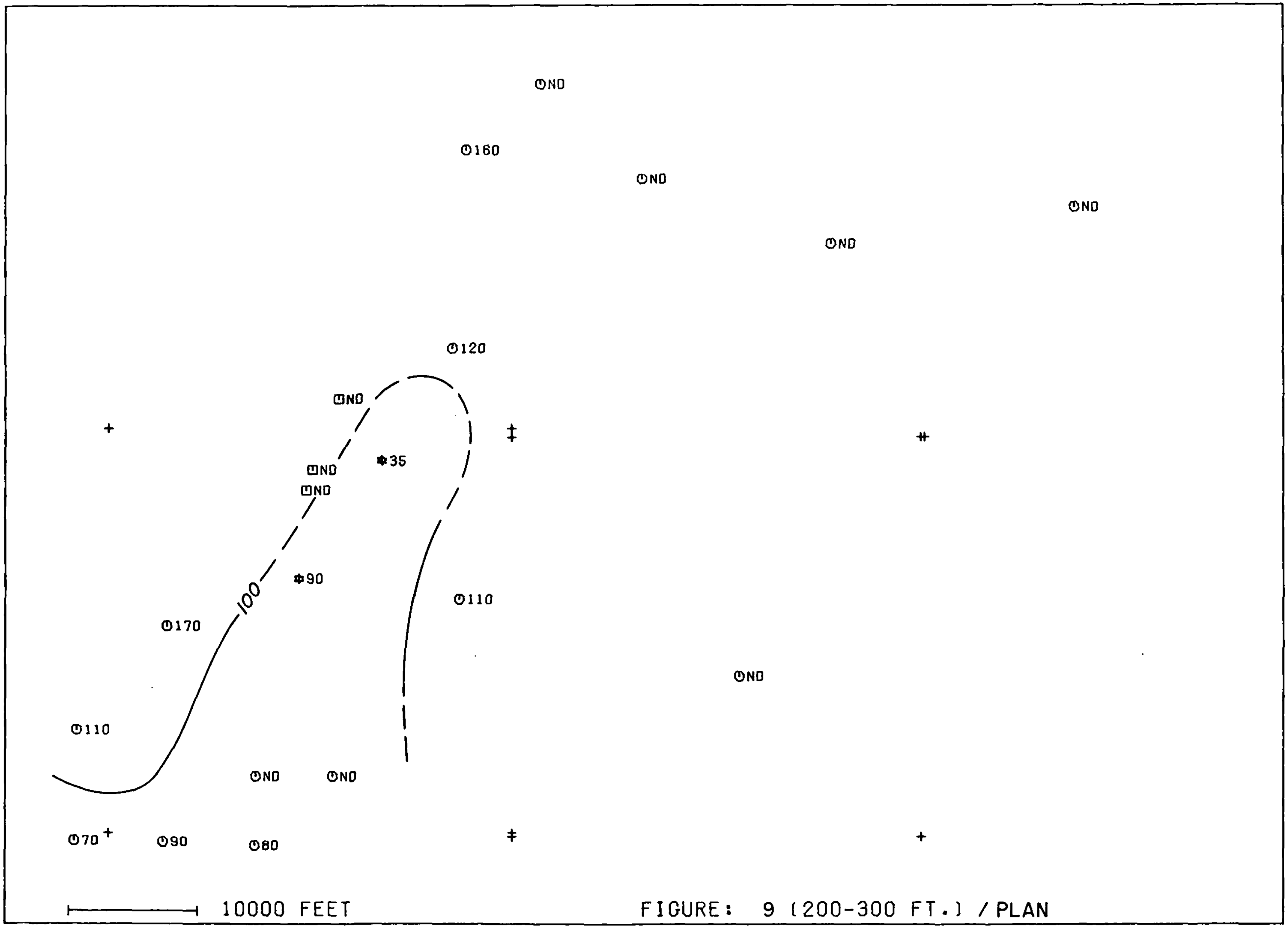


FIGURE: 9 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

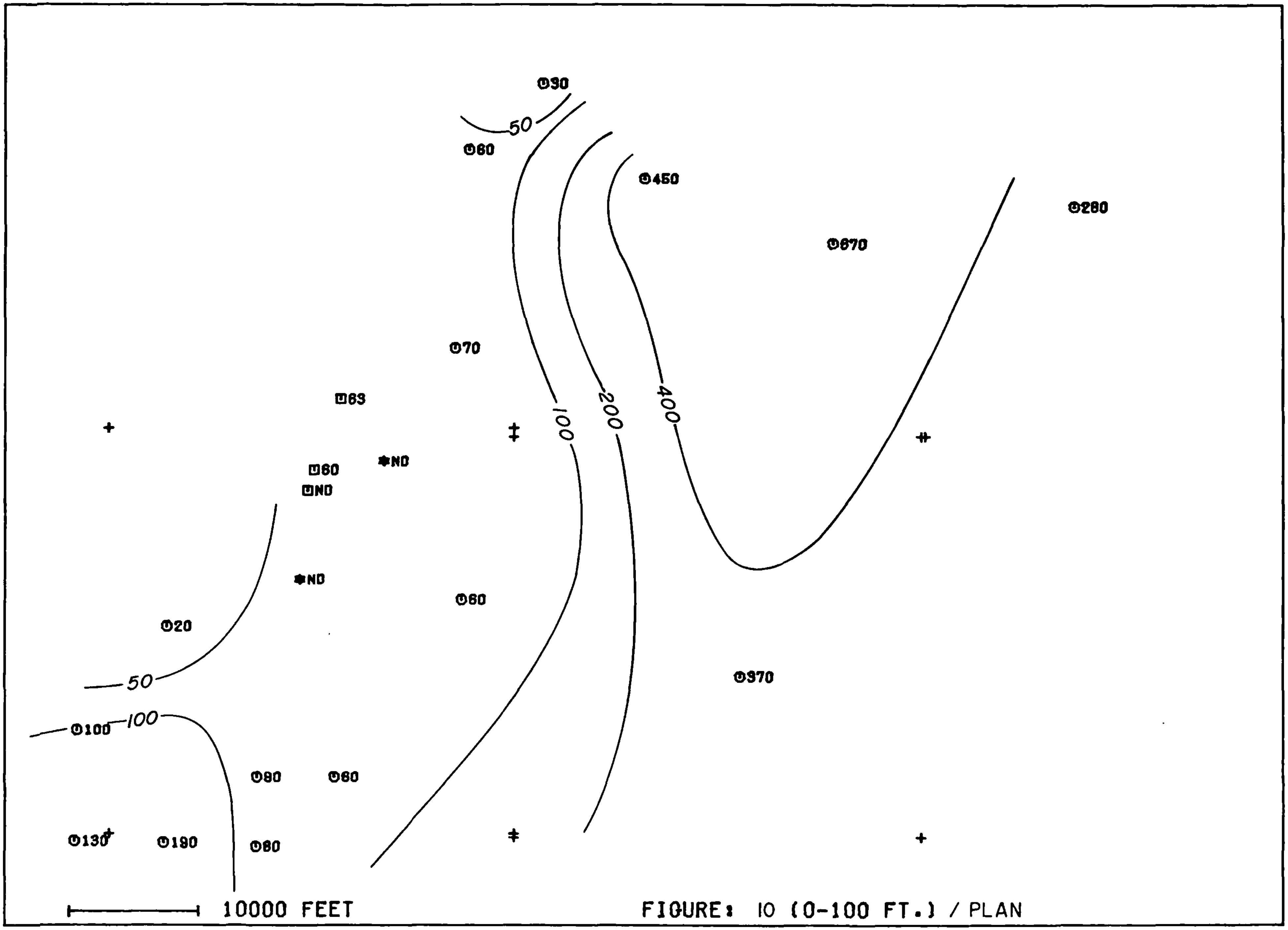


FIGURE: 10 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

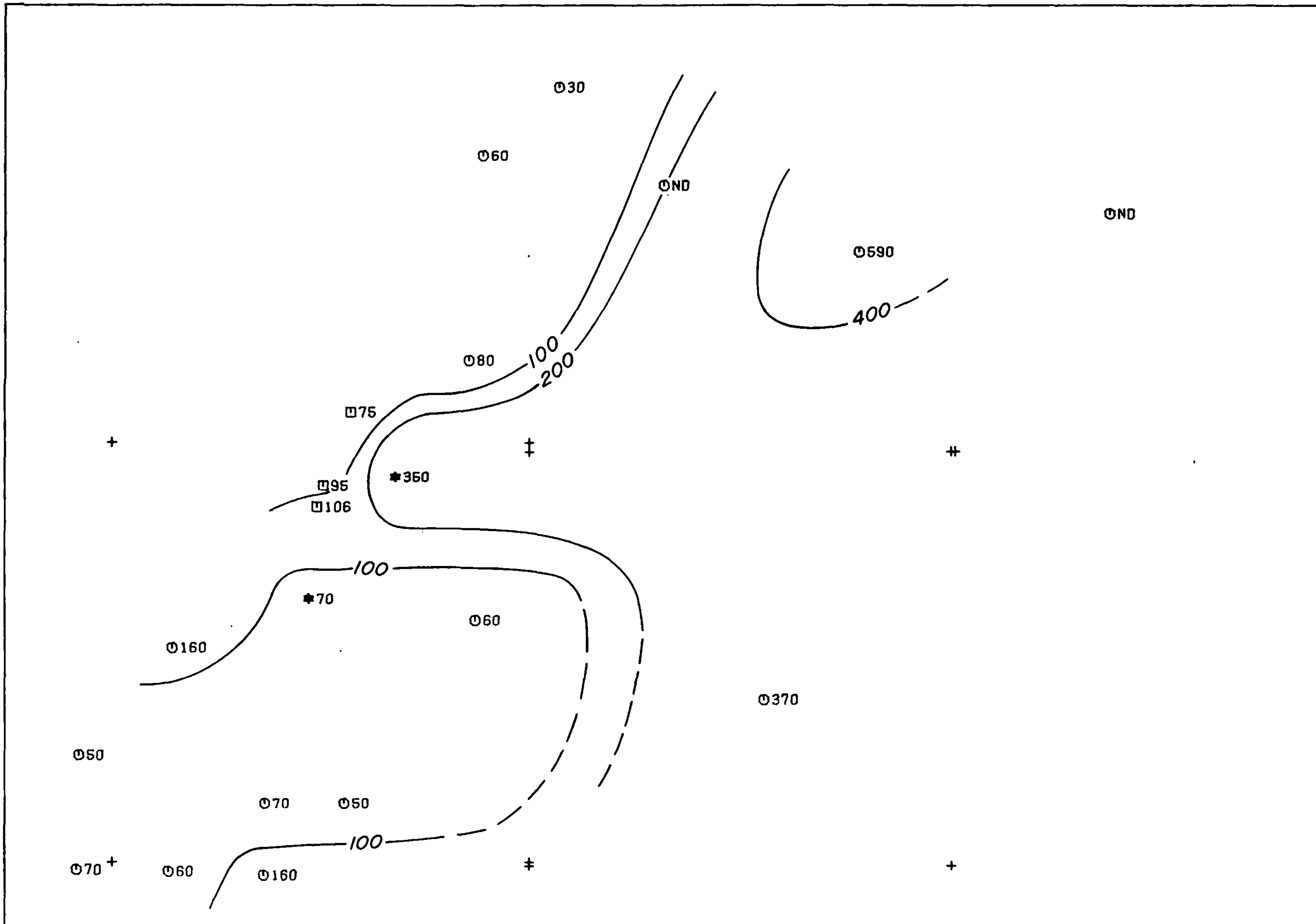


FIGURE: 10 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

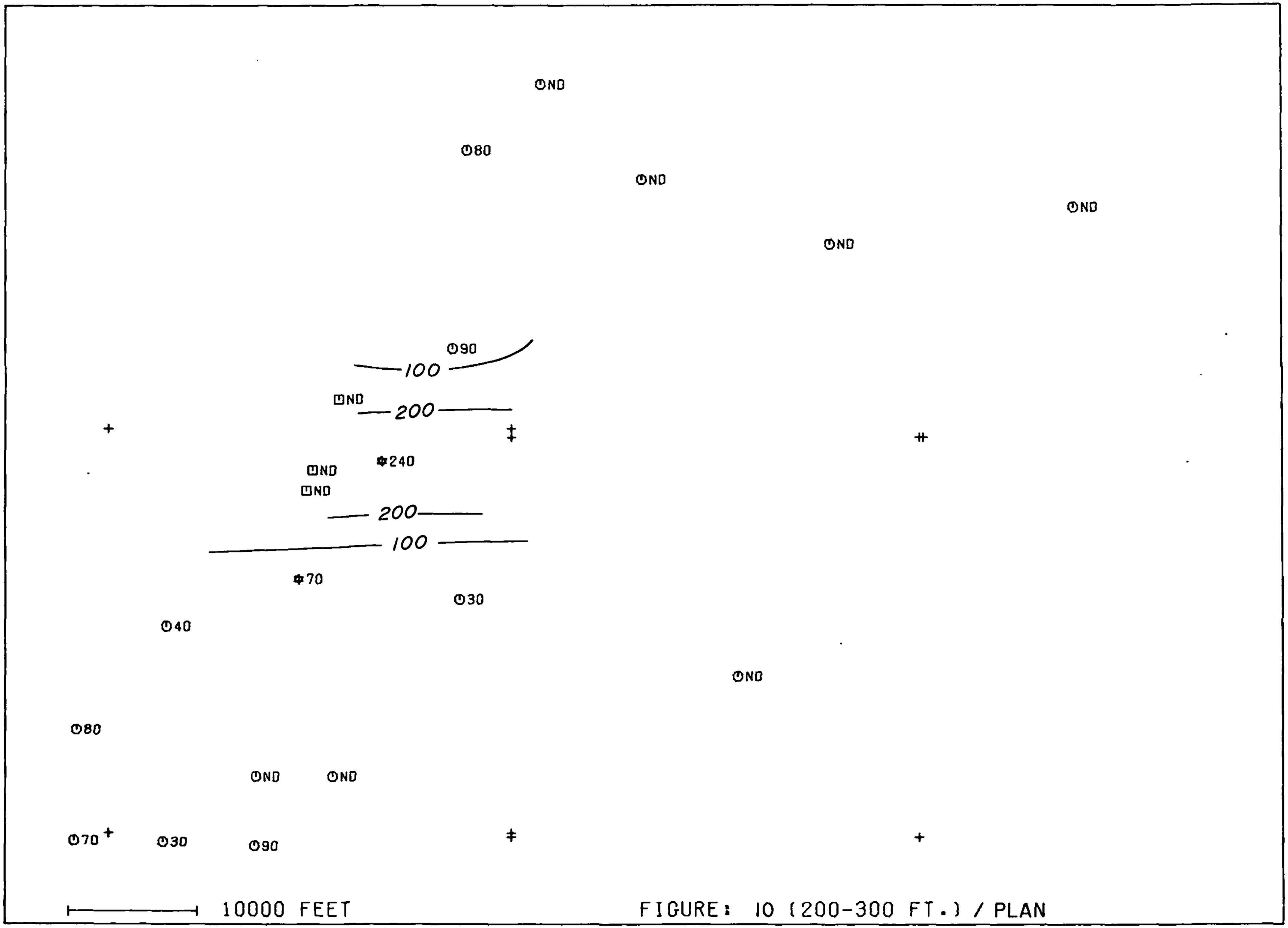
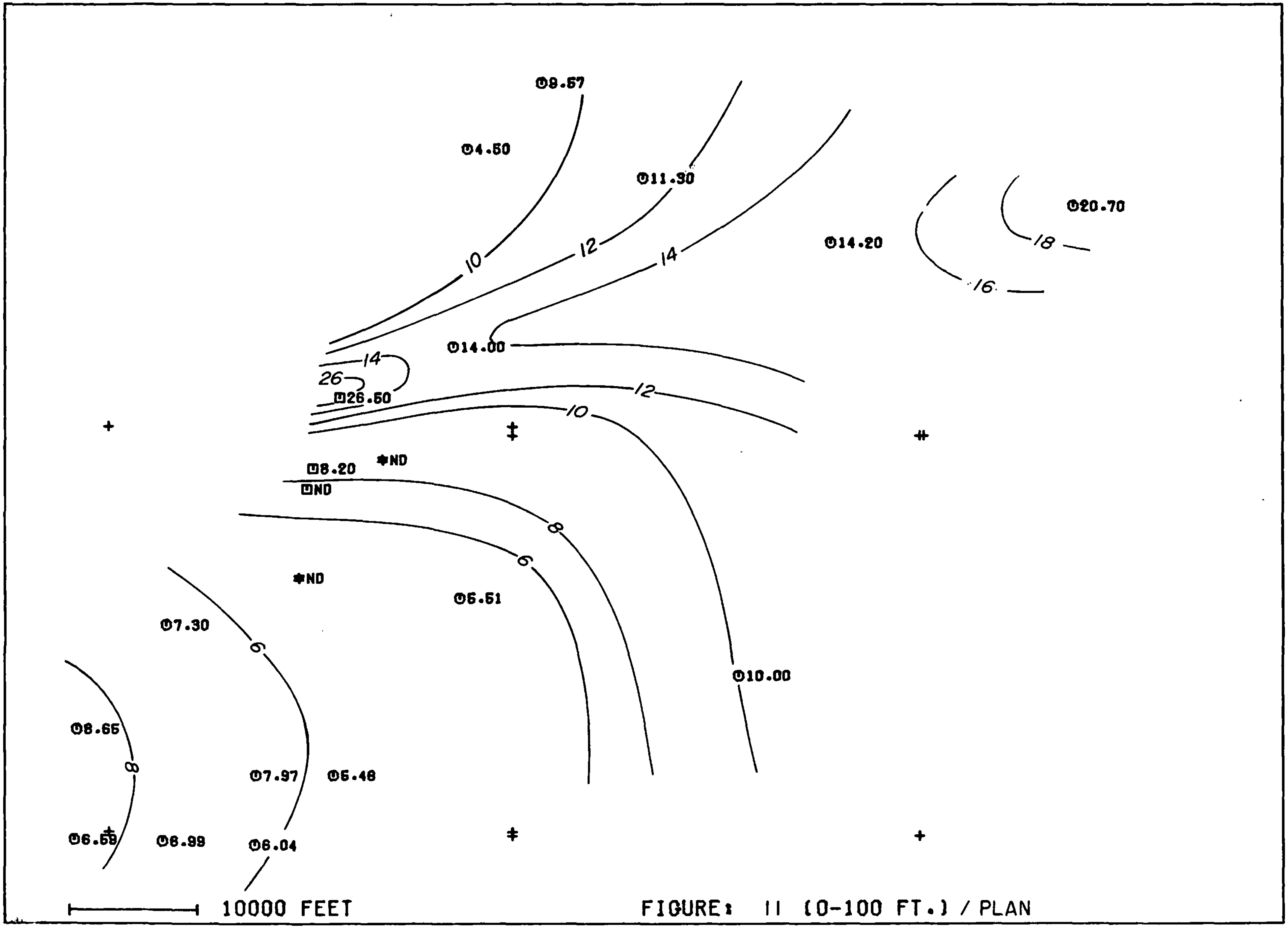


FIGURE: 10 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

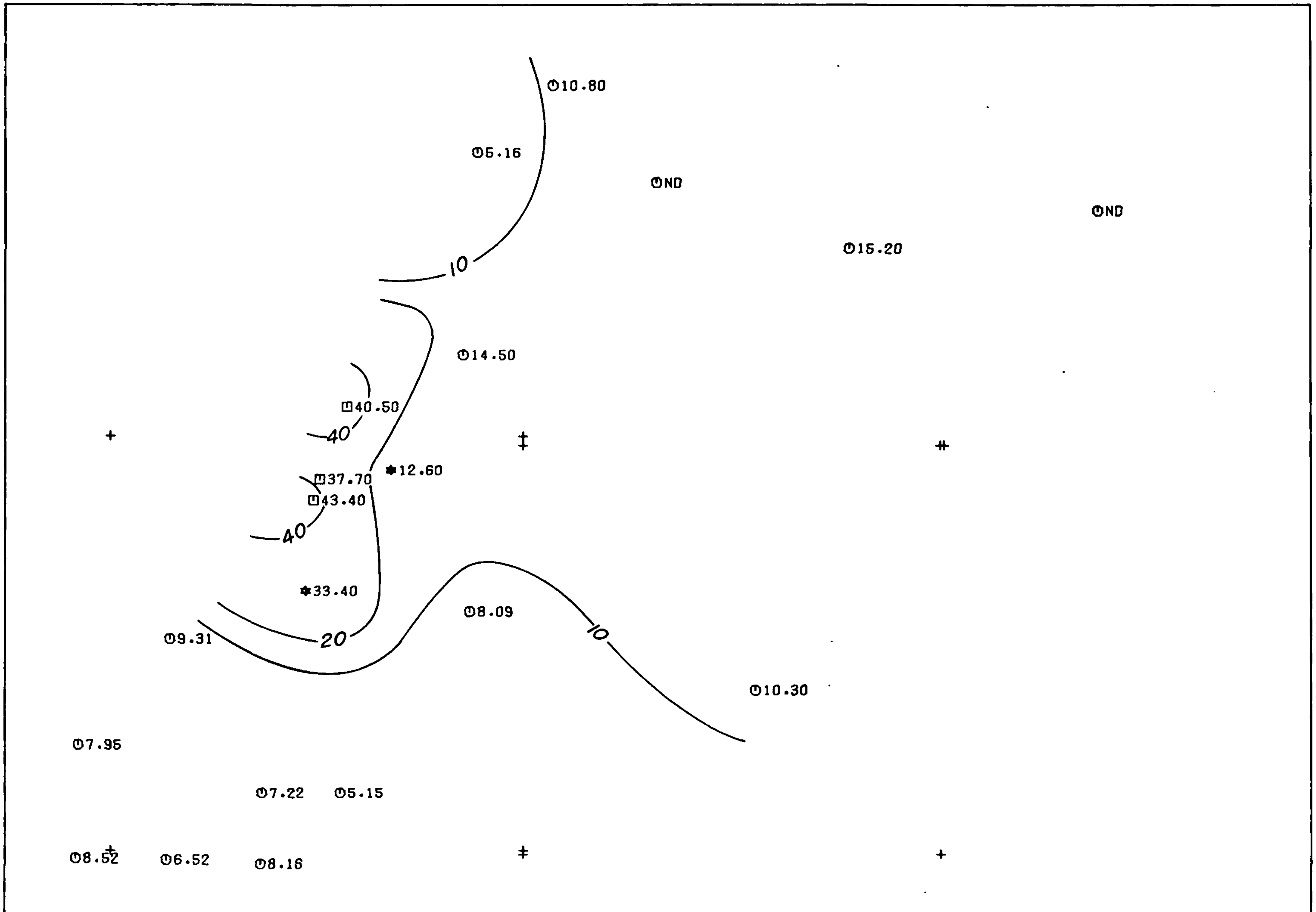
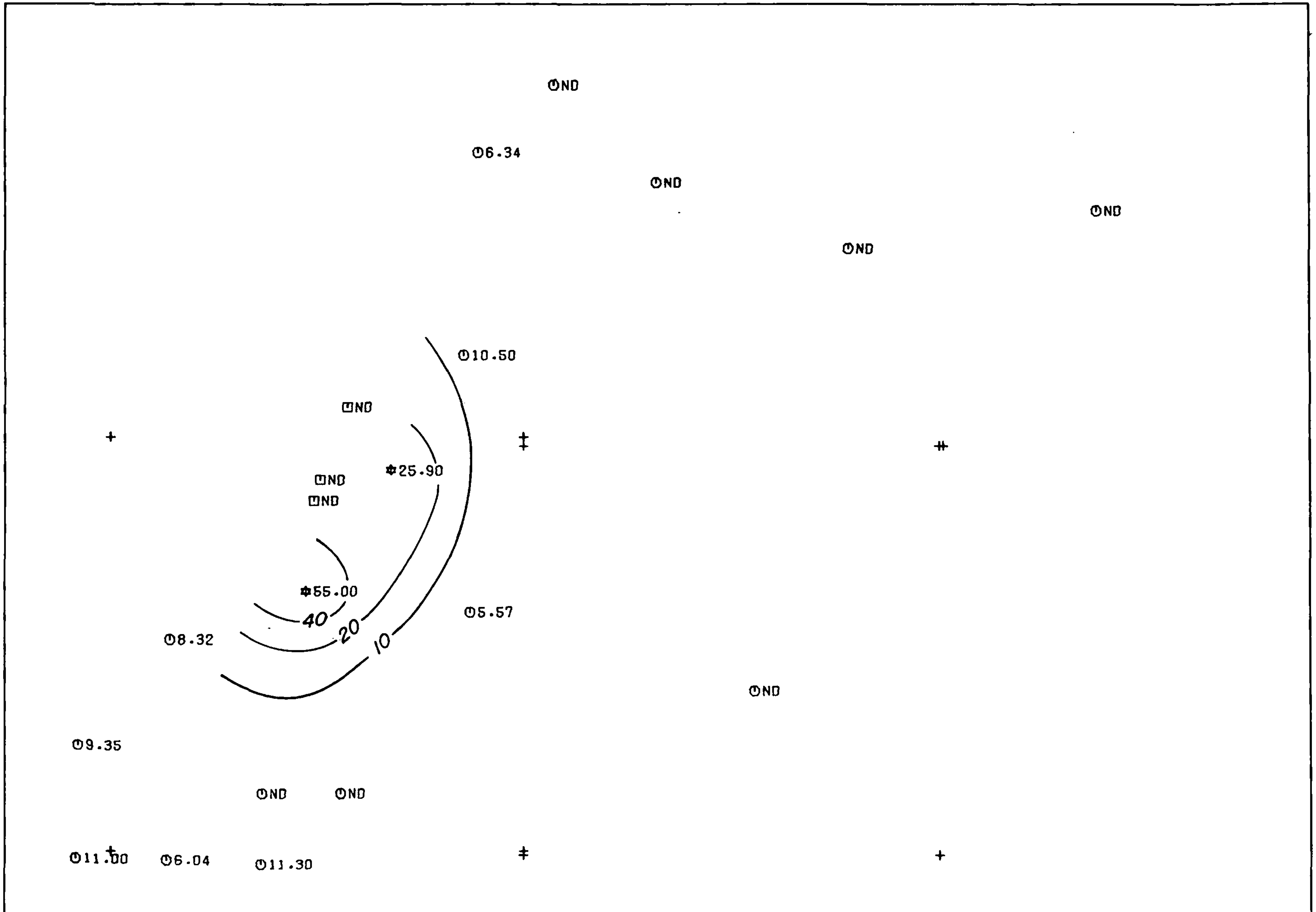


FIGURE: II (100-200 FT.)/PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

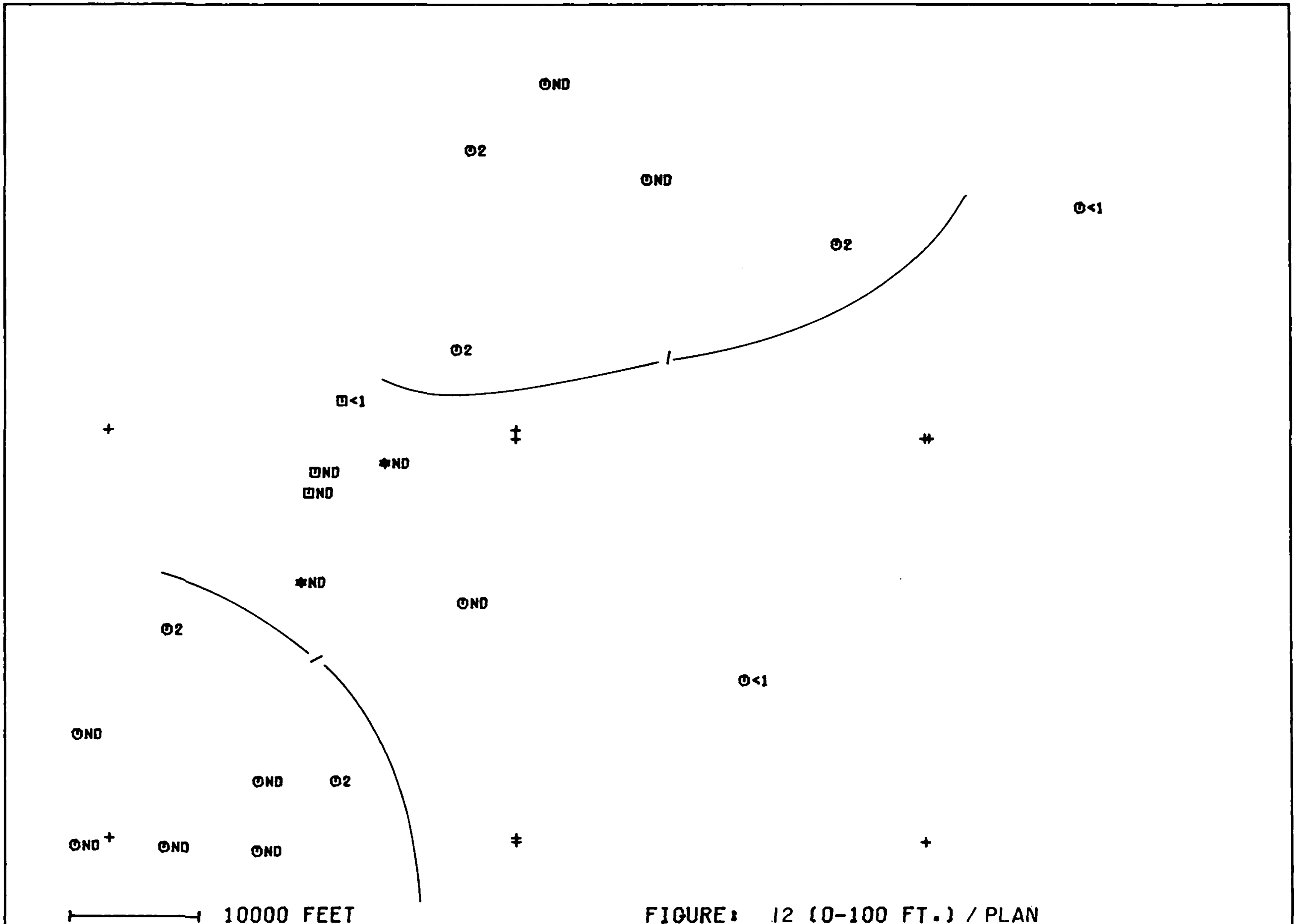


10000 FEET

FIGURE: 11 (200-300 FT.) / PLAN

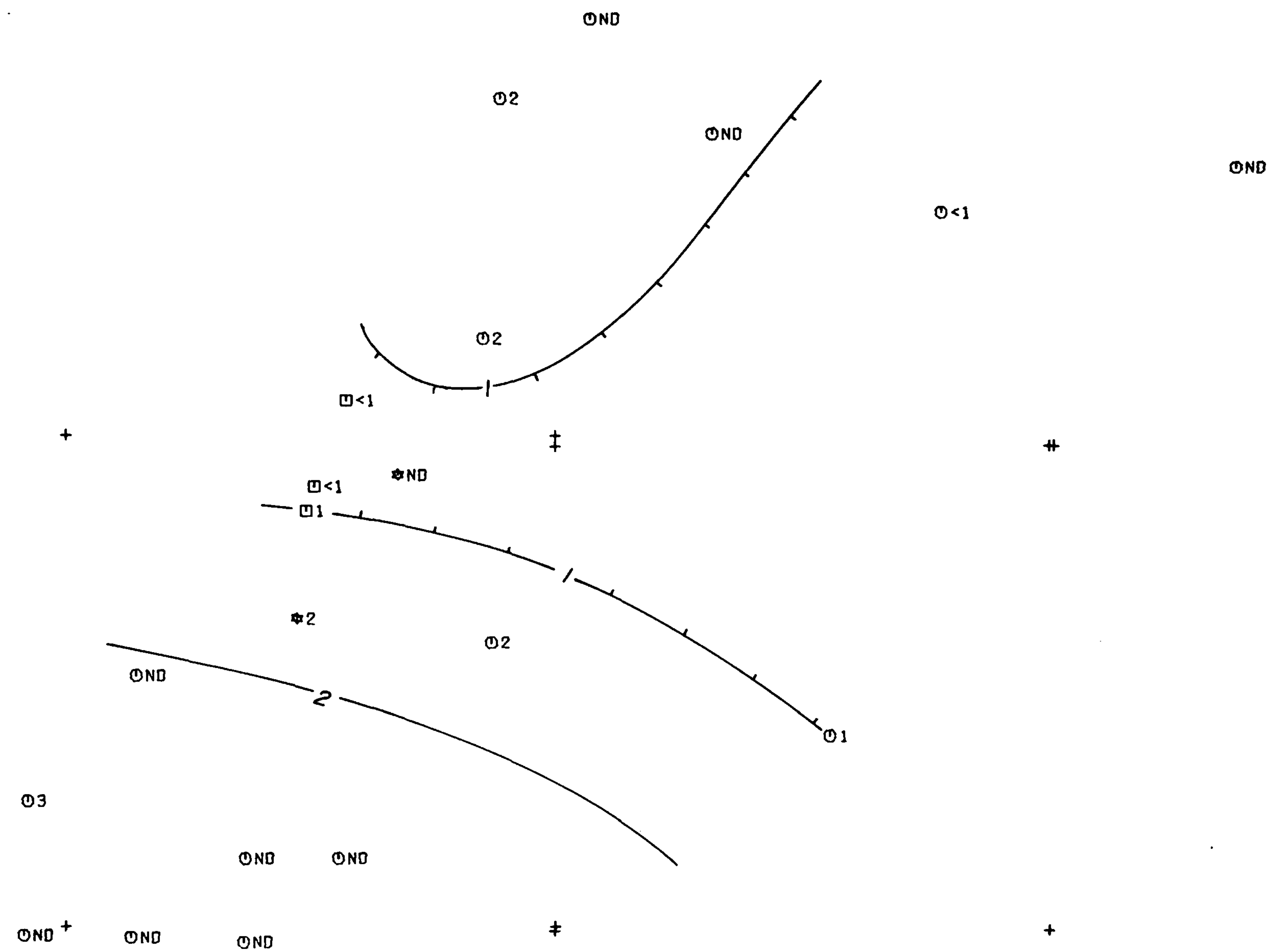
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

BISMUTH (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

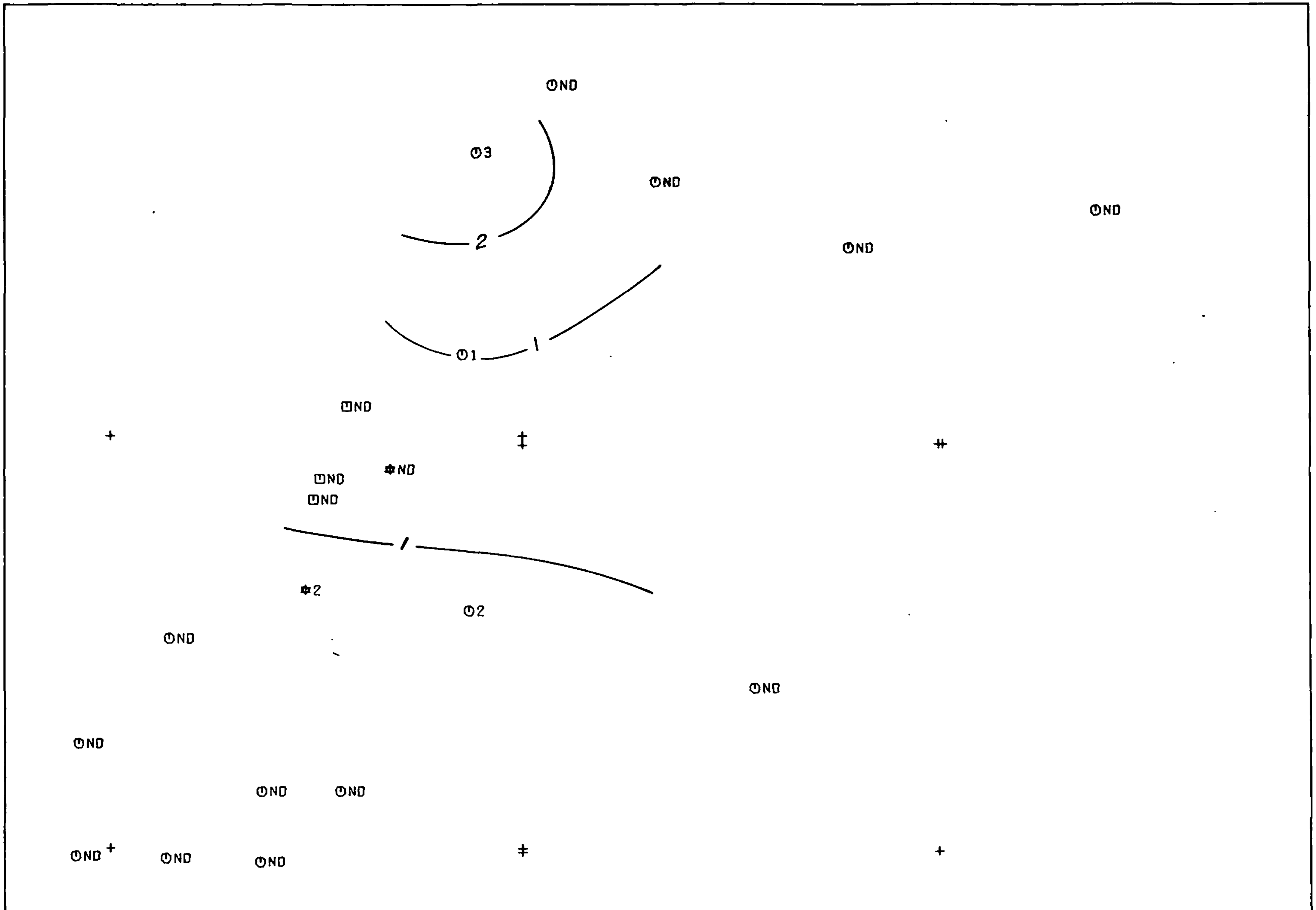


10000 FEET

FIGURE: 12 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

BISMUTH (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES



10000 FEET

FIGURE: 12 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

BISMUTH (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

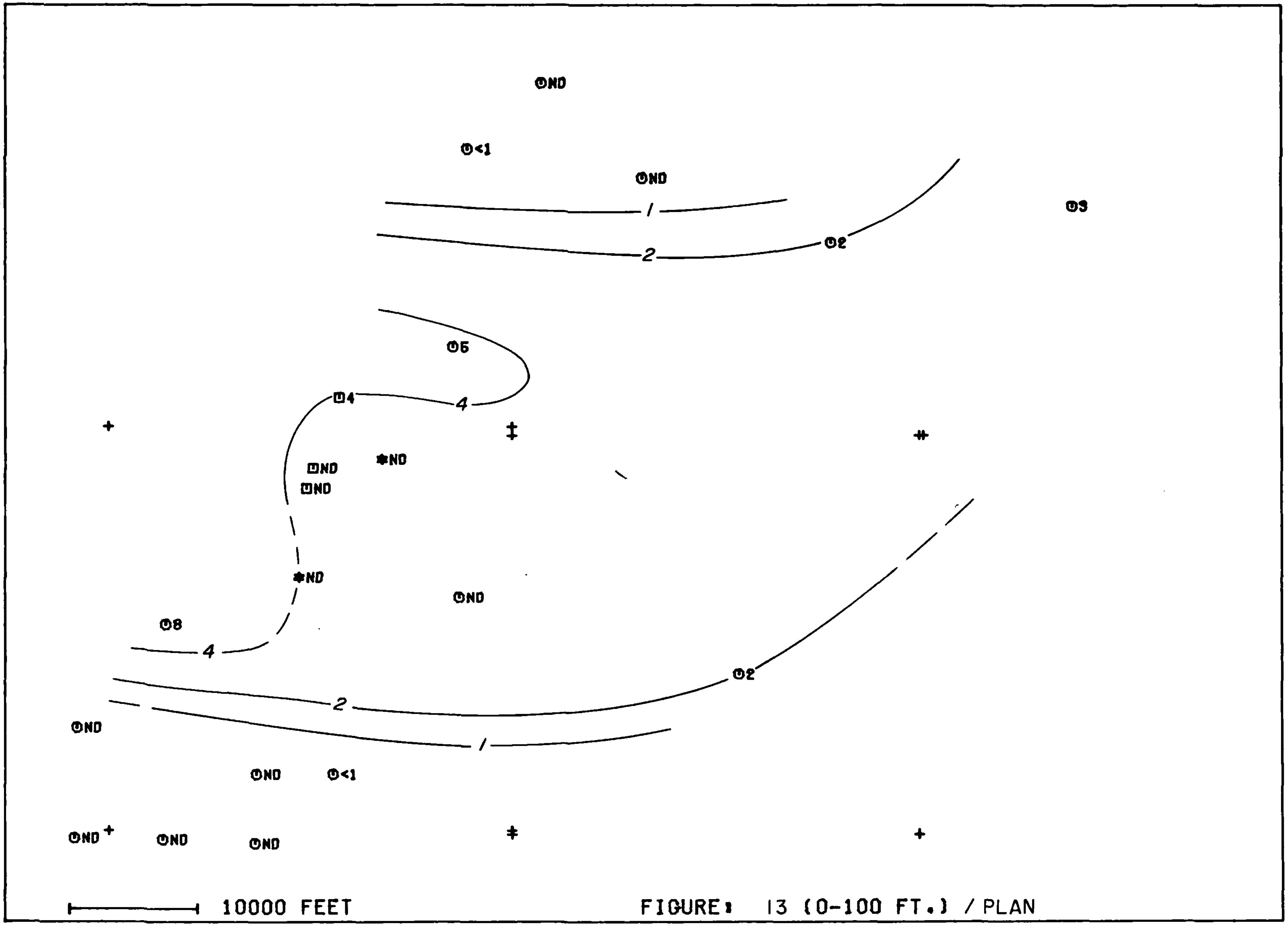


FIGURE: 13 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

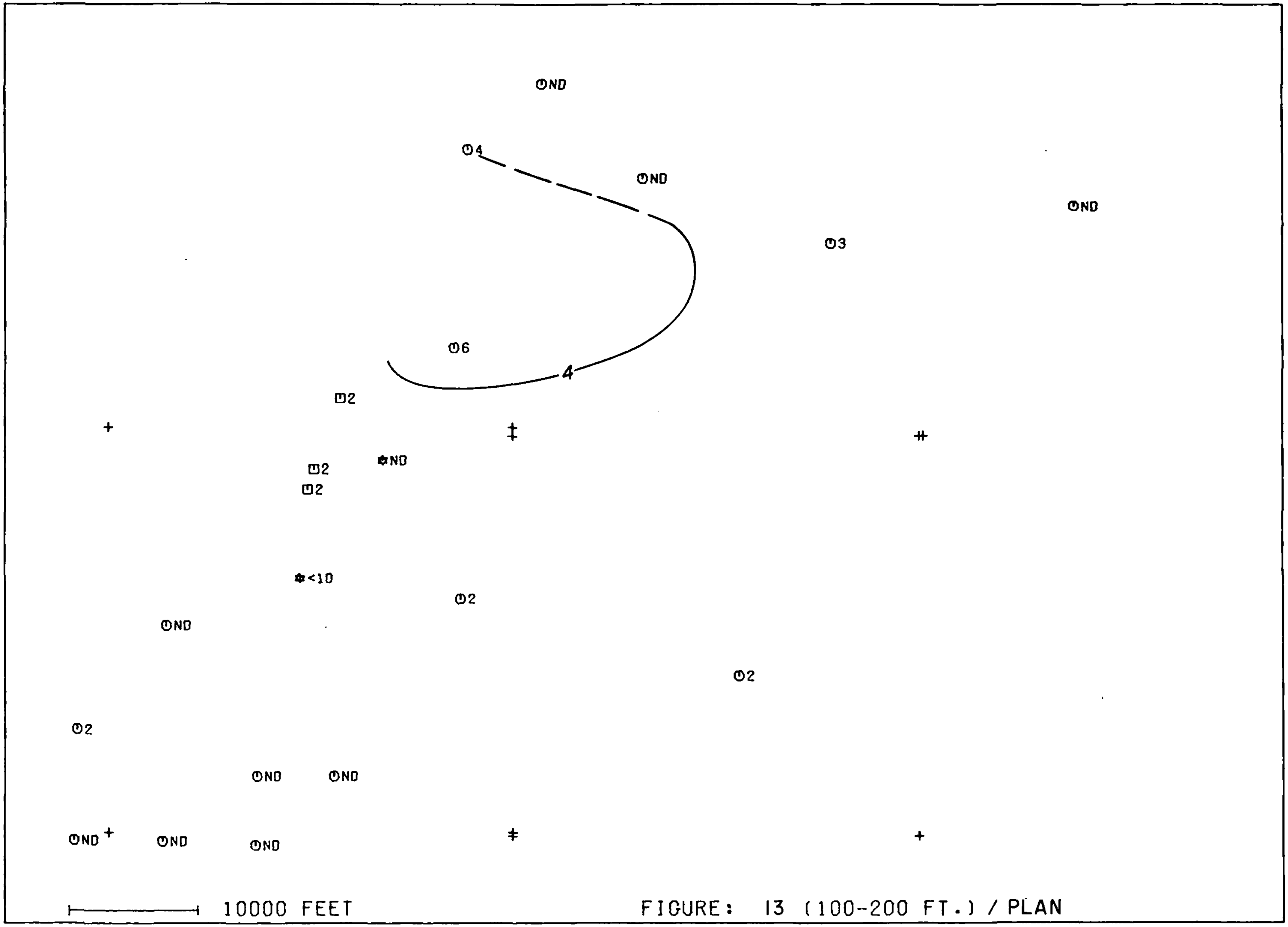
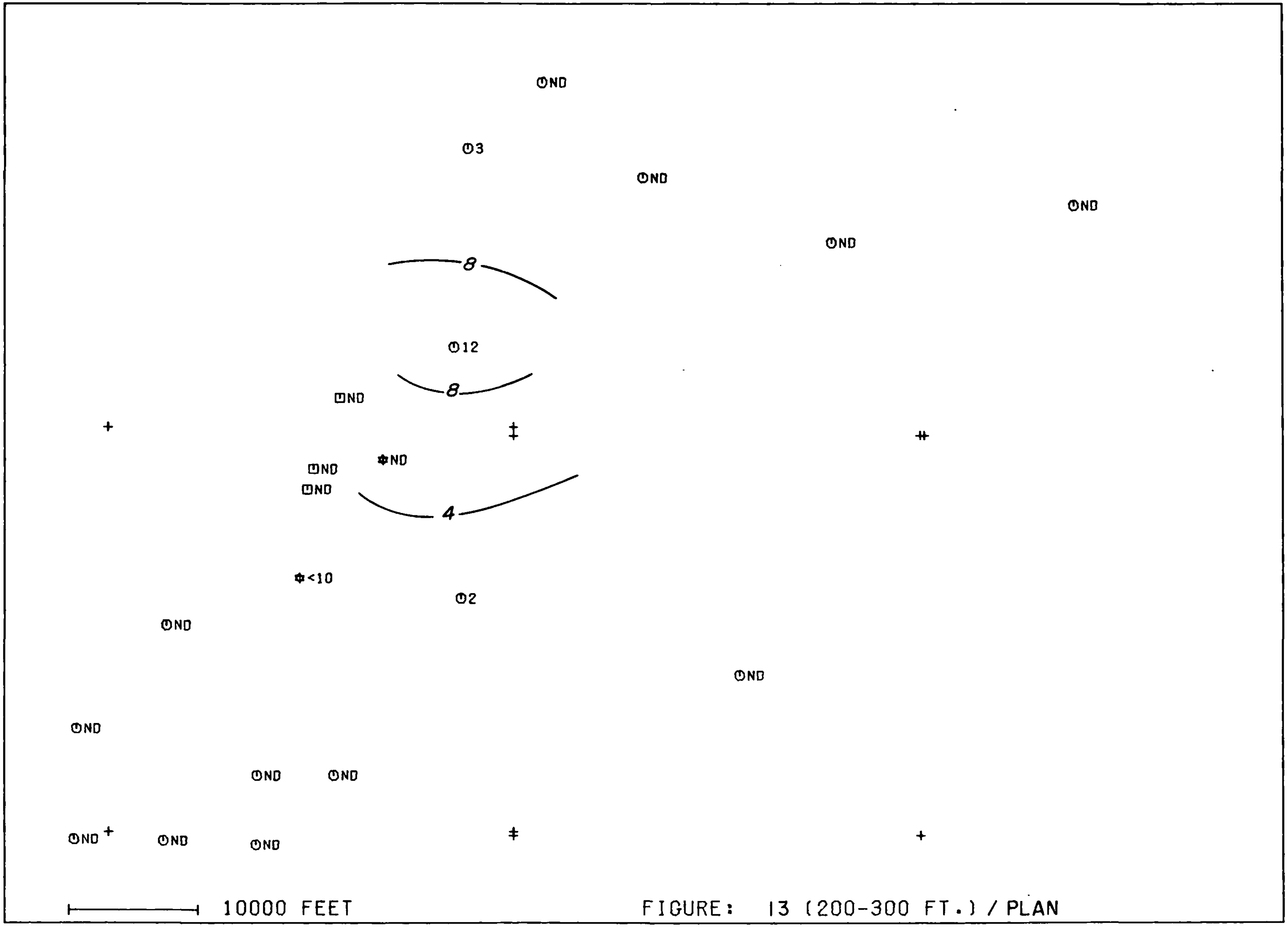


FIGURE: 13 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

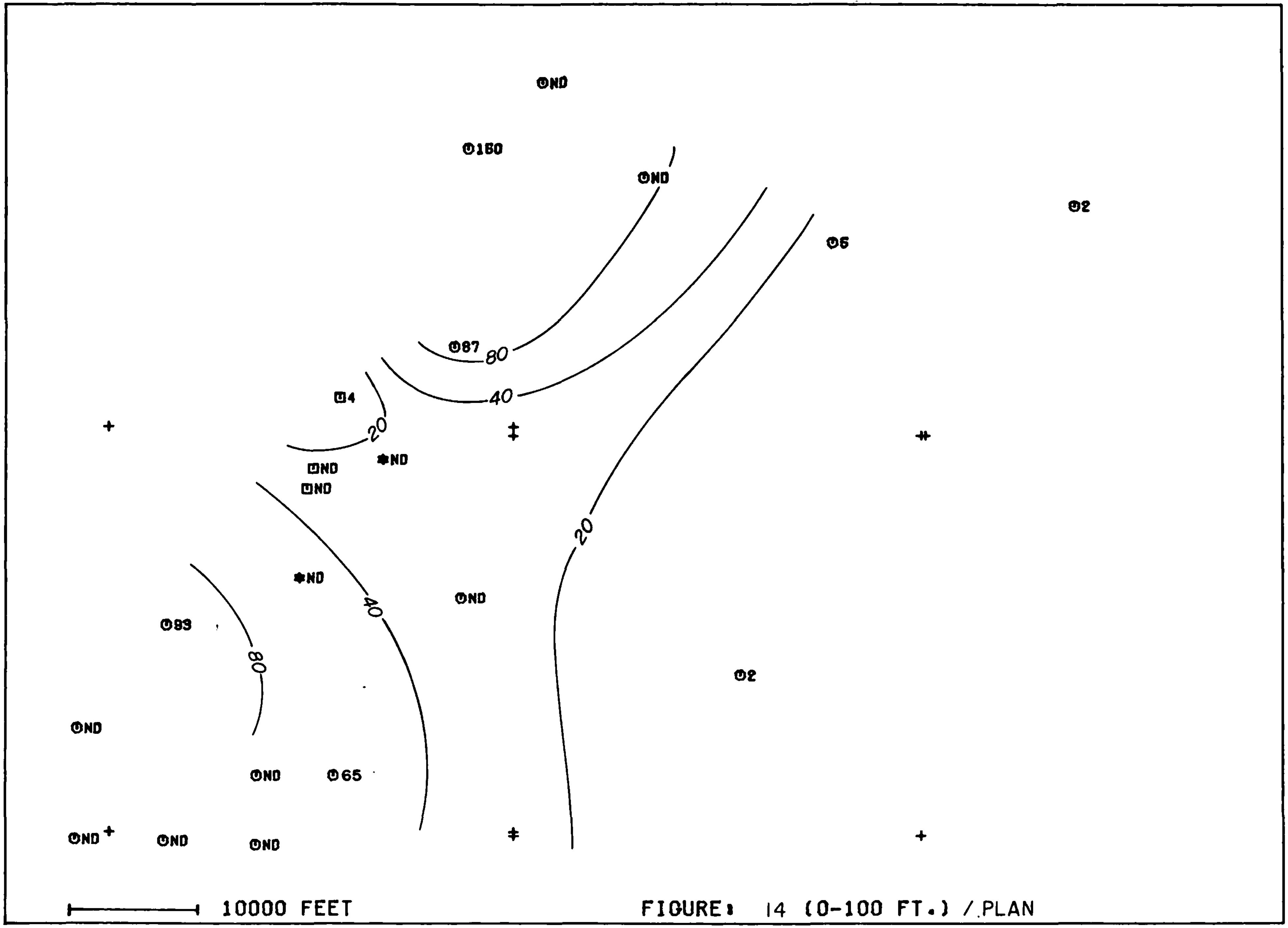


FIGURE: 14 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

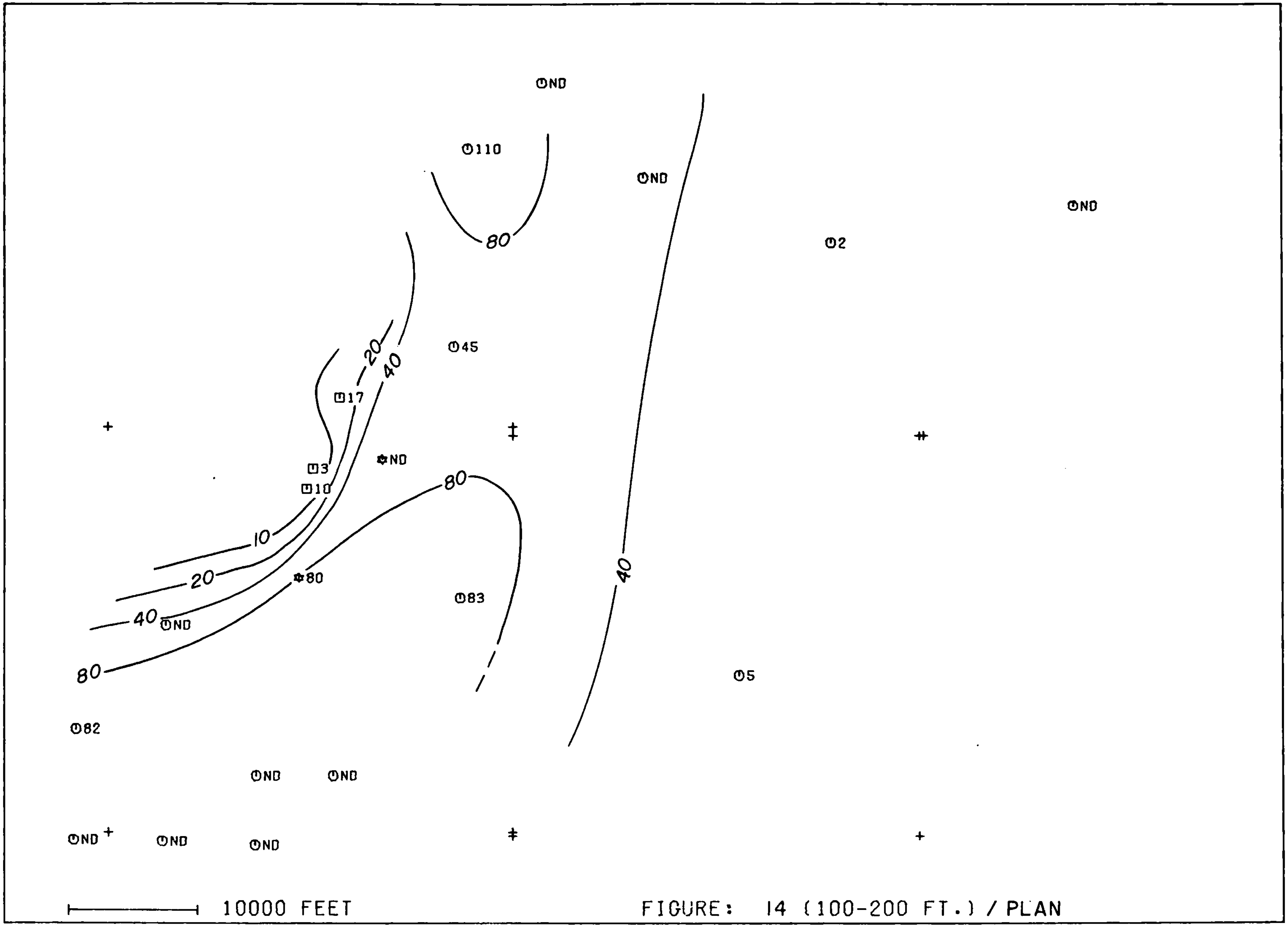


FIGURE: 14 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

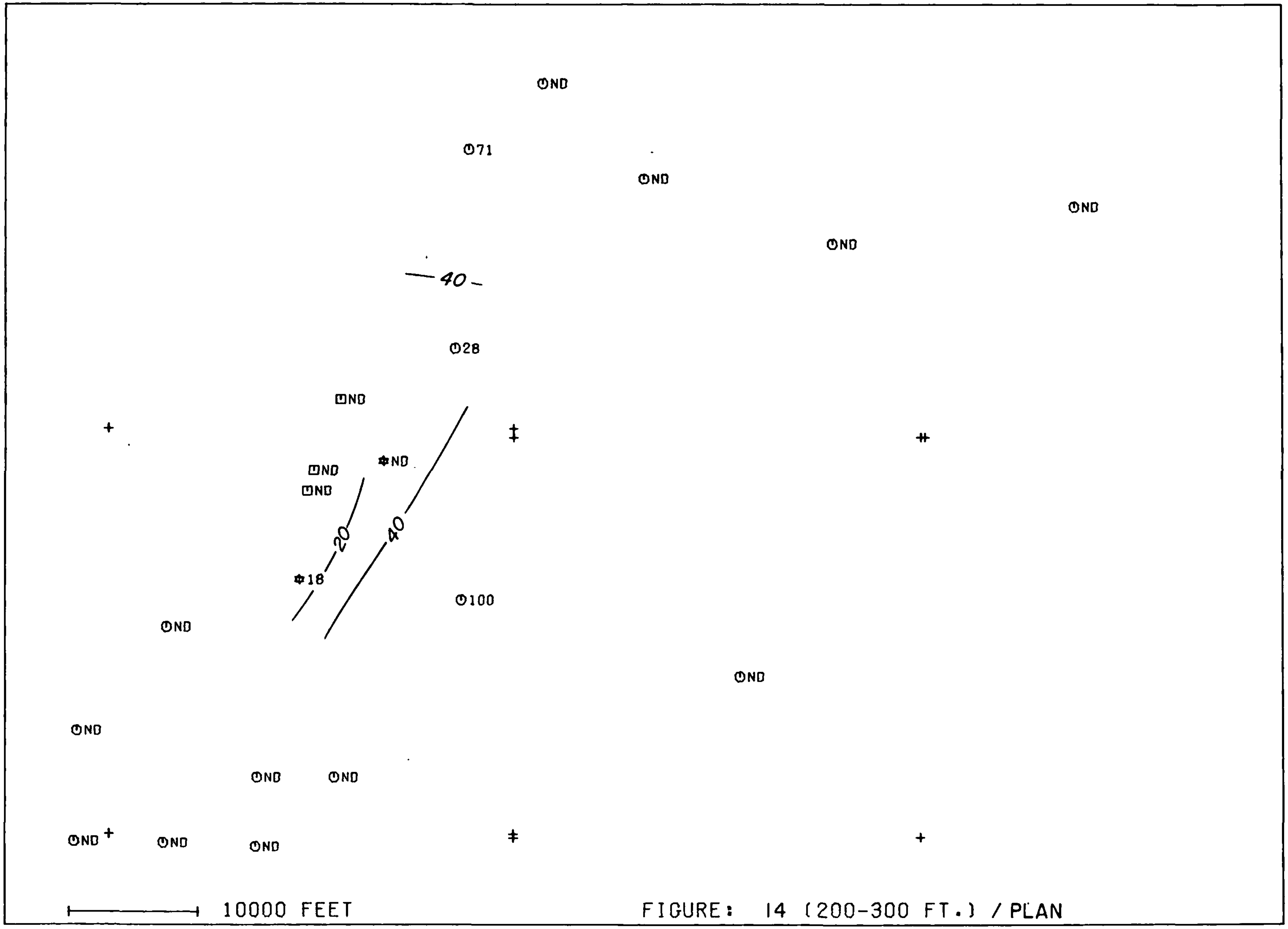


FIGURE: 14 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

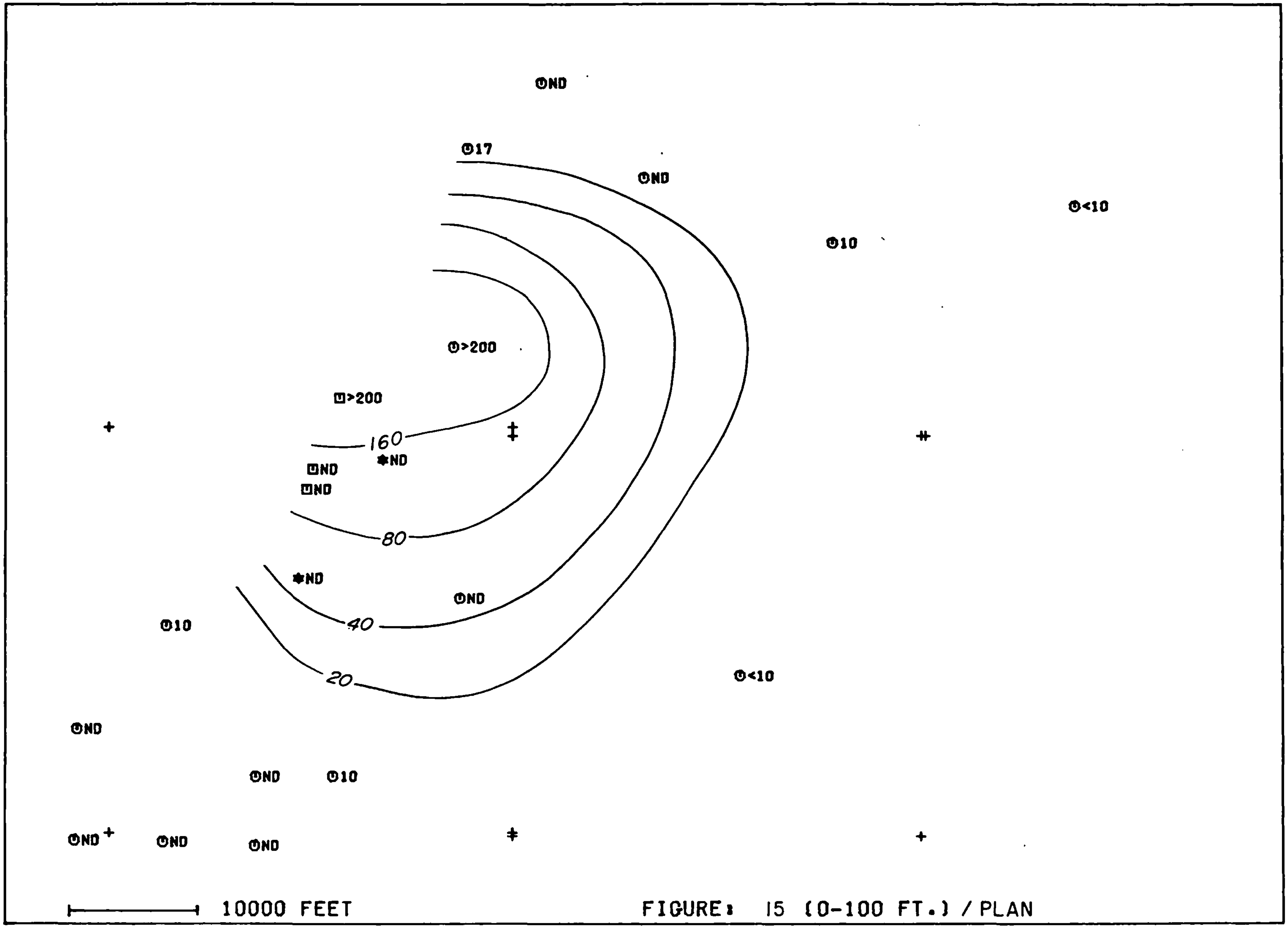


FIGURE: 15 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG
ANALYTICAL METHOD: OES

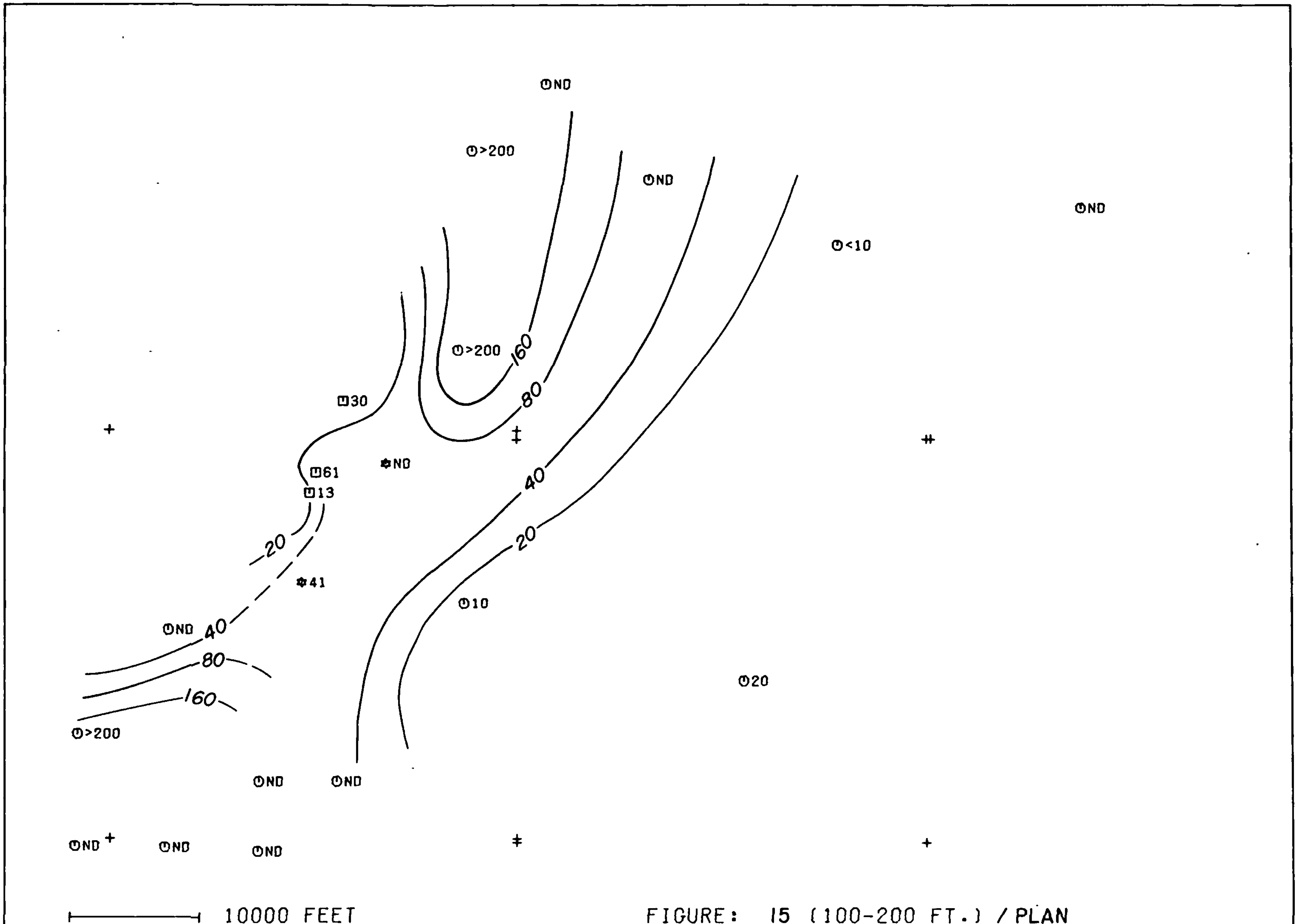


FIGURE: 15 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

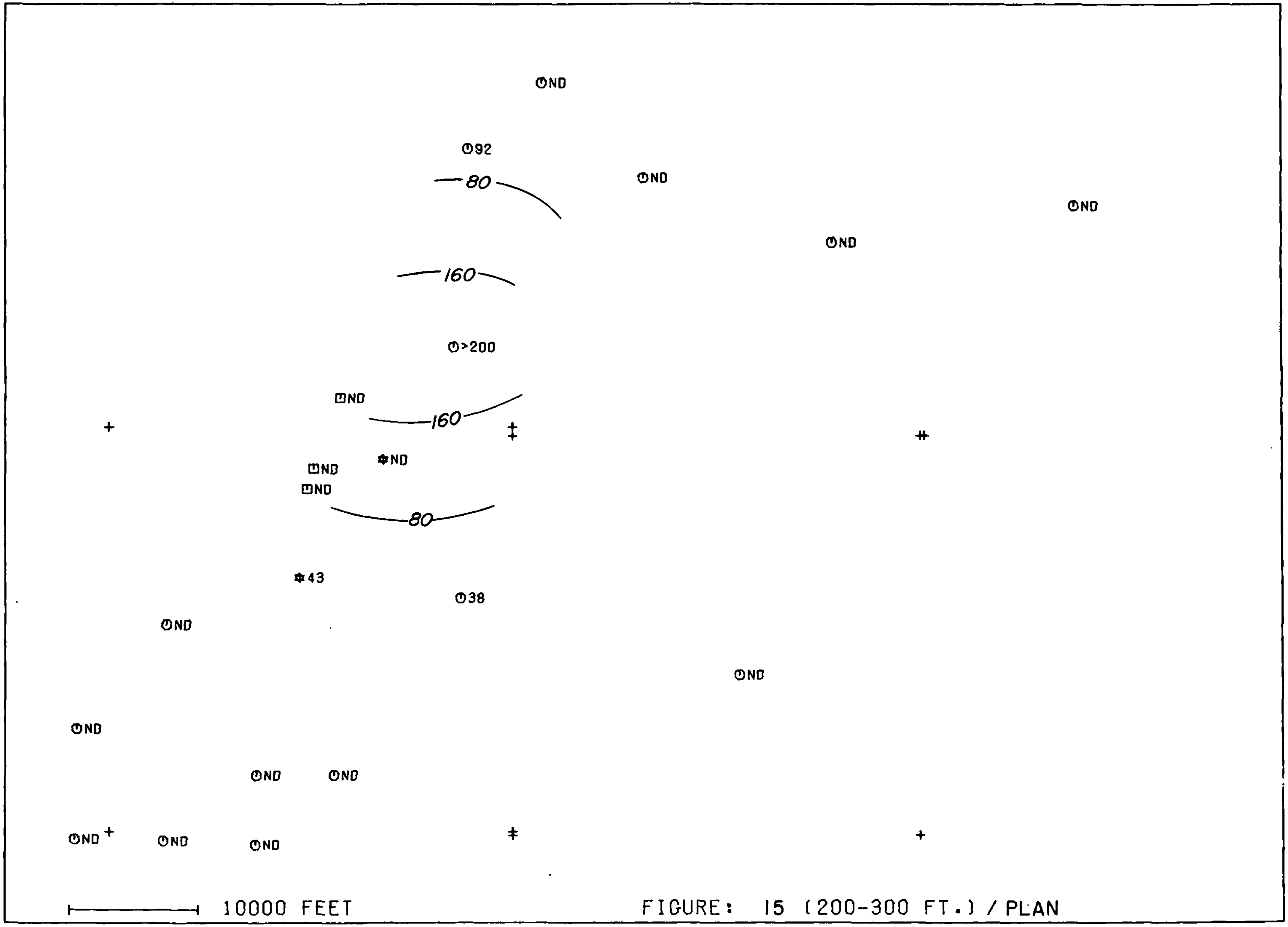
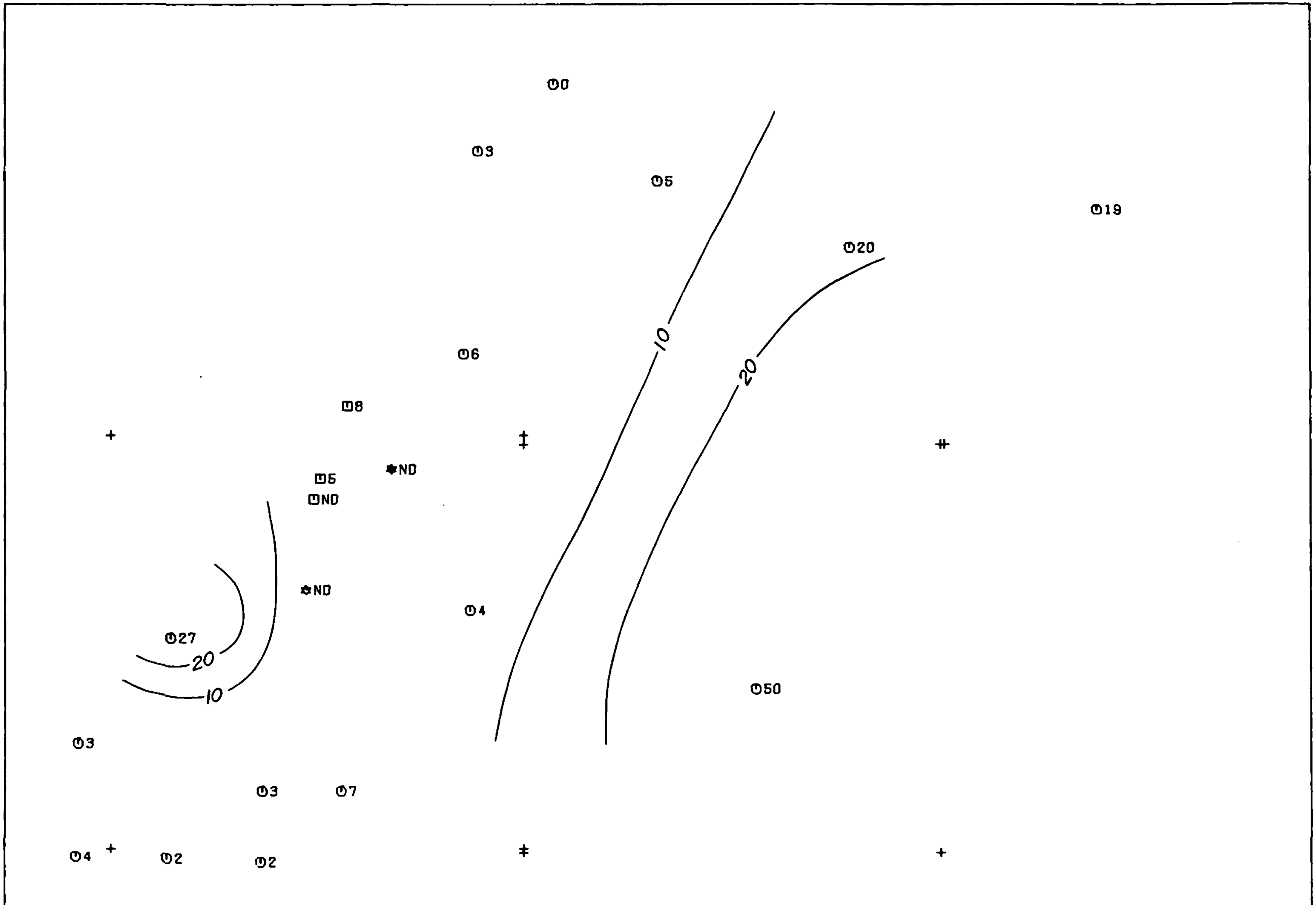


FIGURE: 15 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES



10000 FEET

FIGURE: 16 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

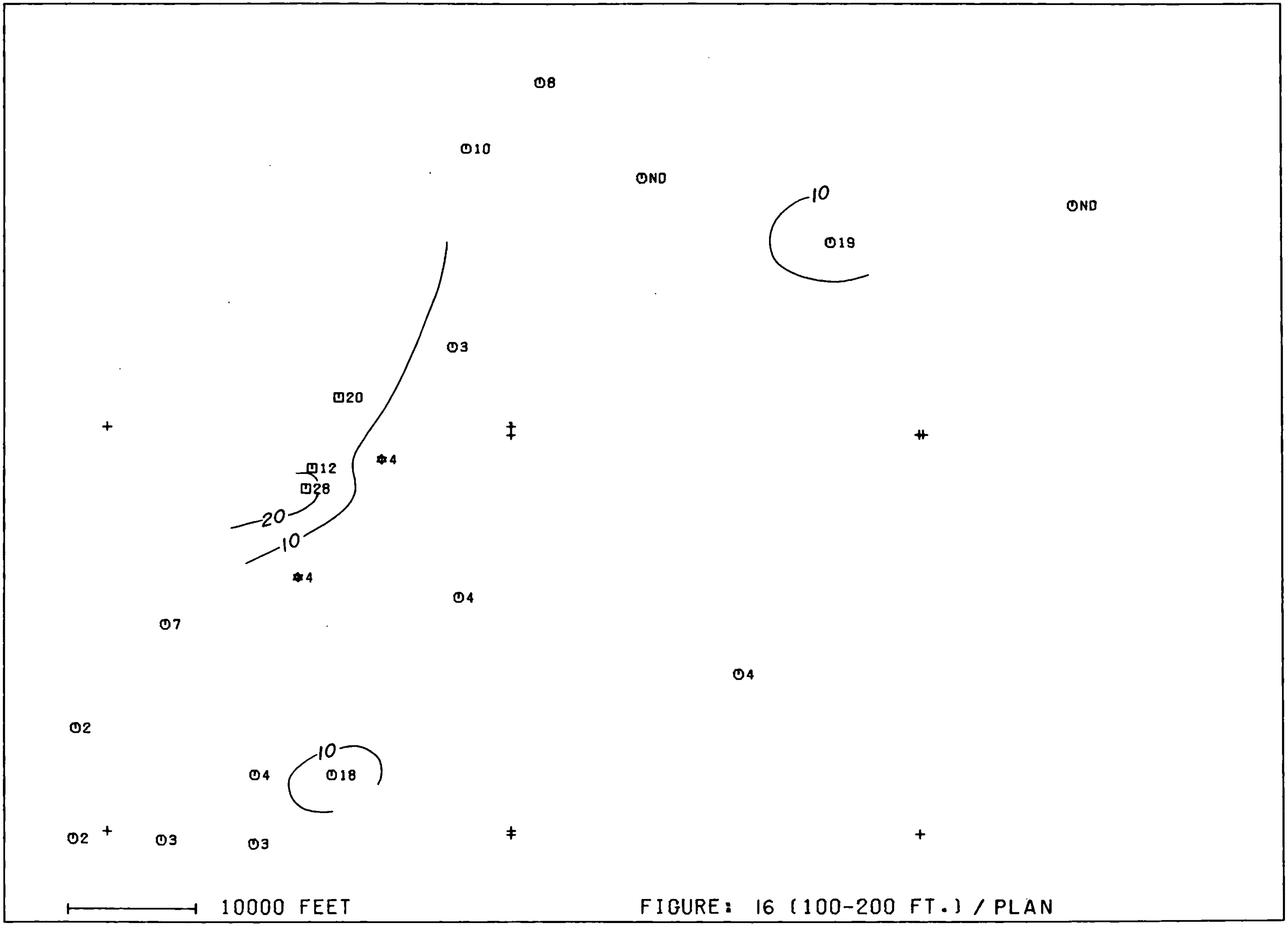
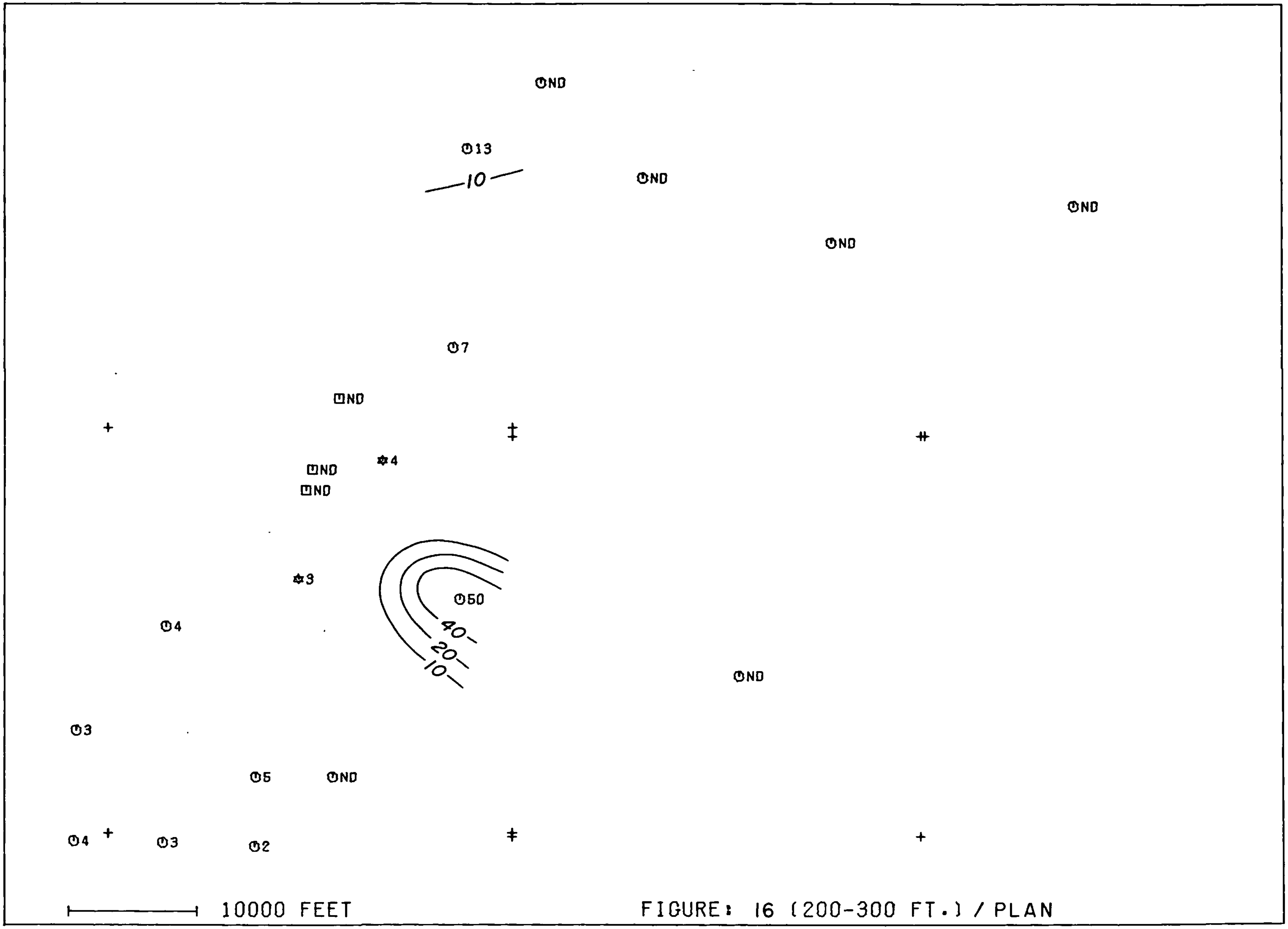


FIGURE: 16 (100-200 FT.) / PLAN

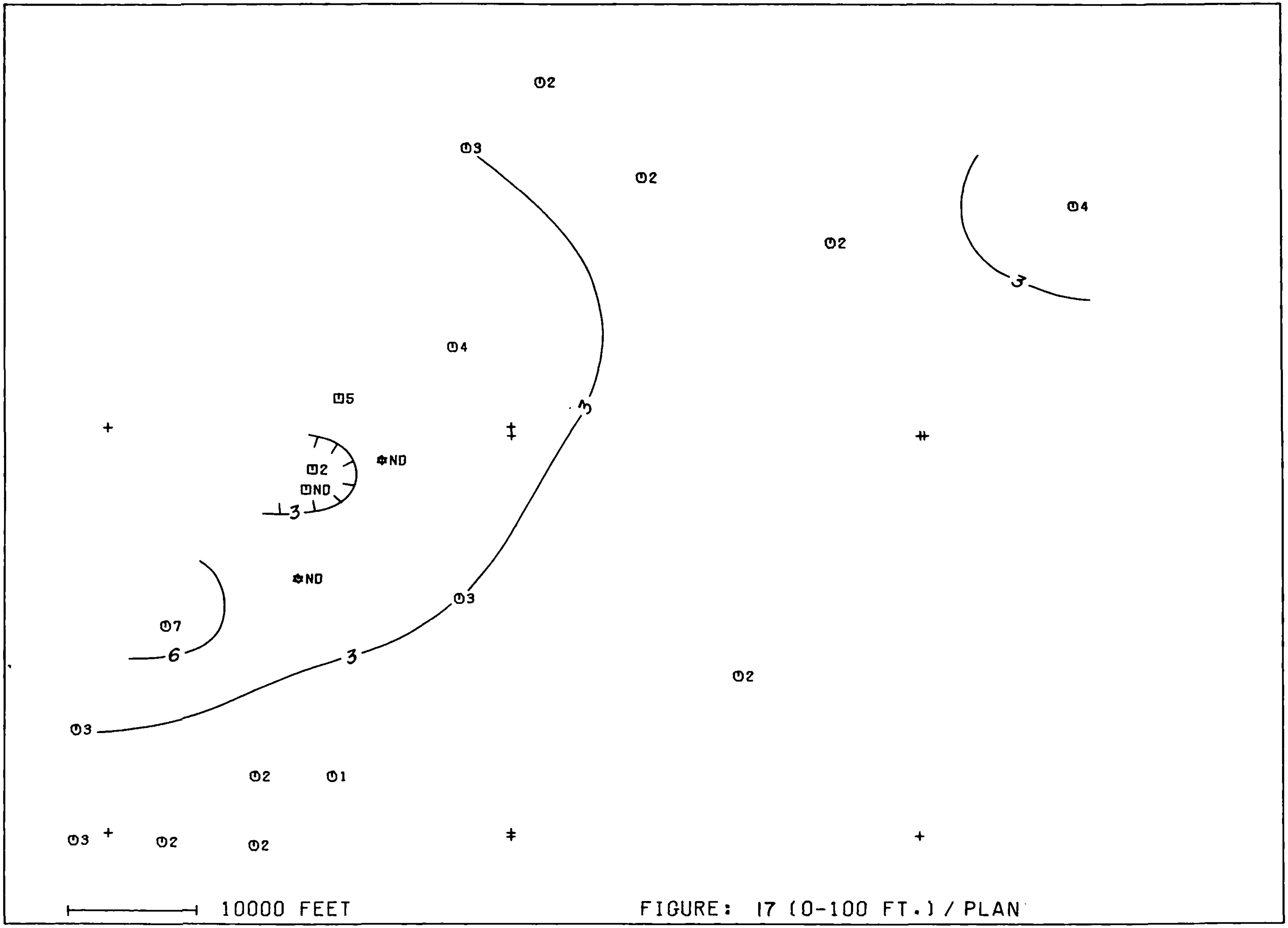
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



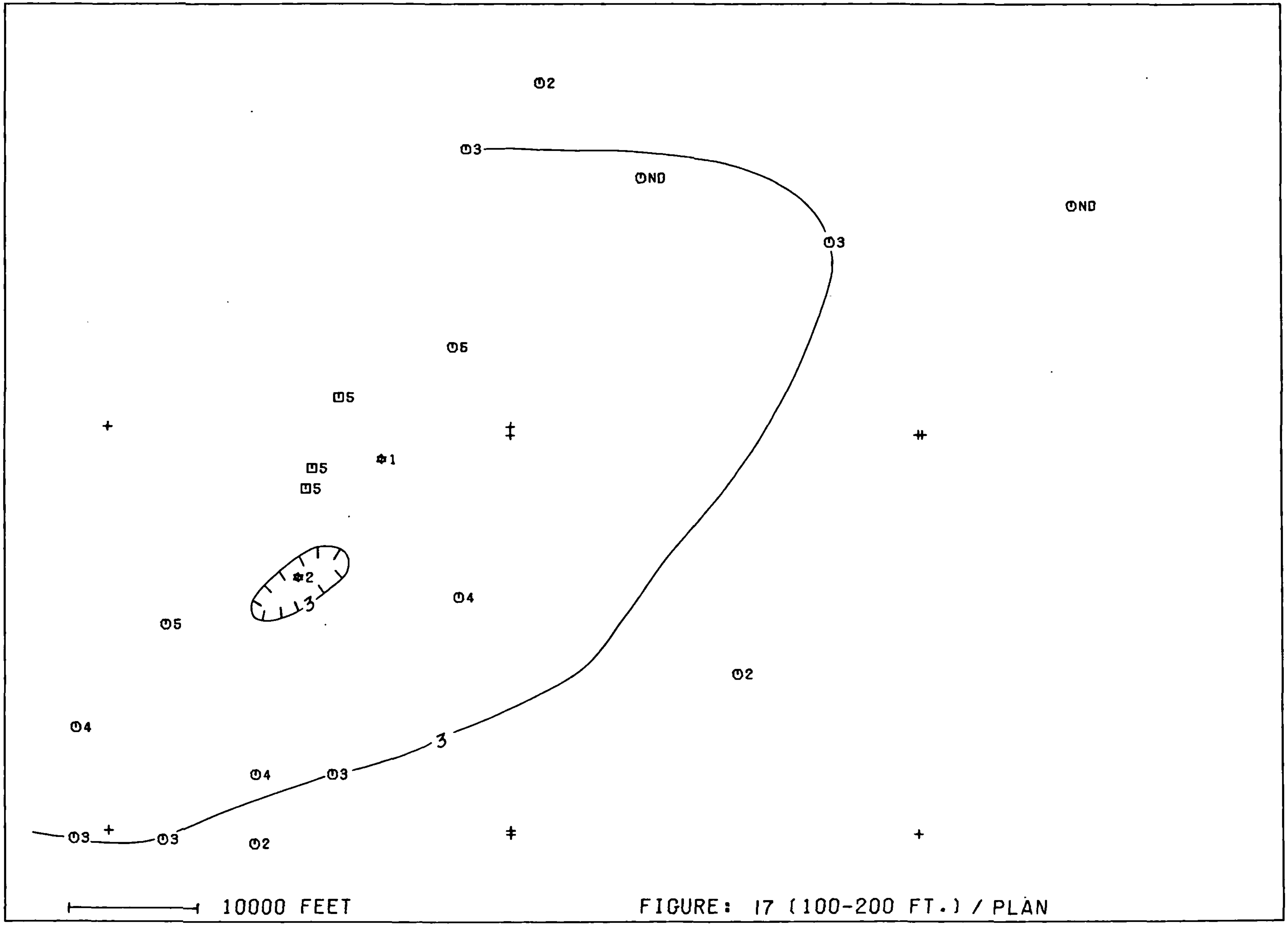
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



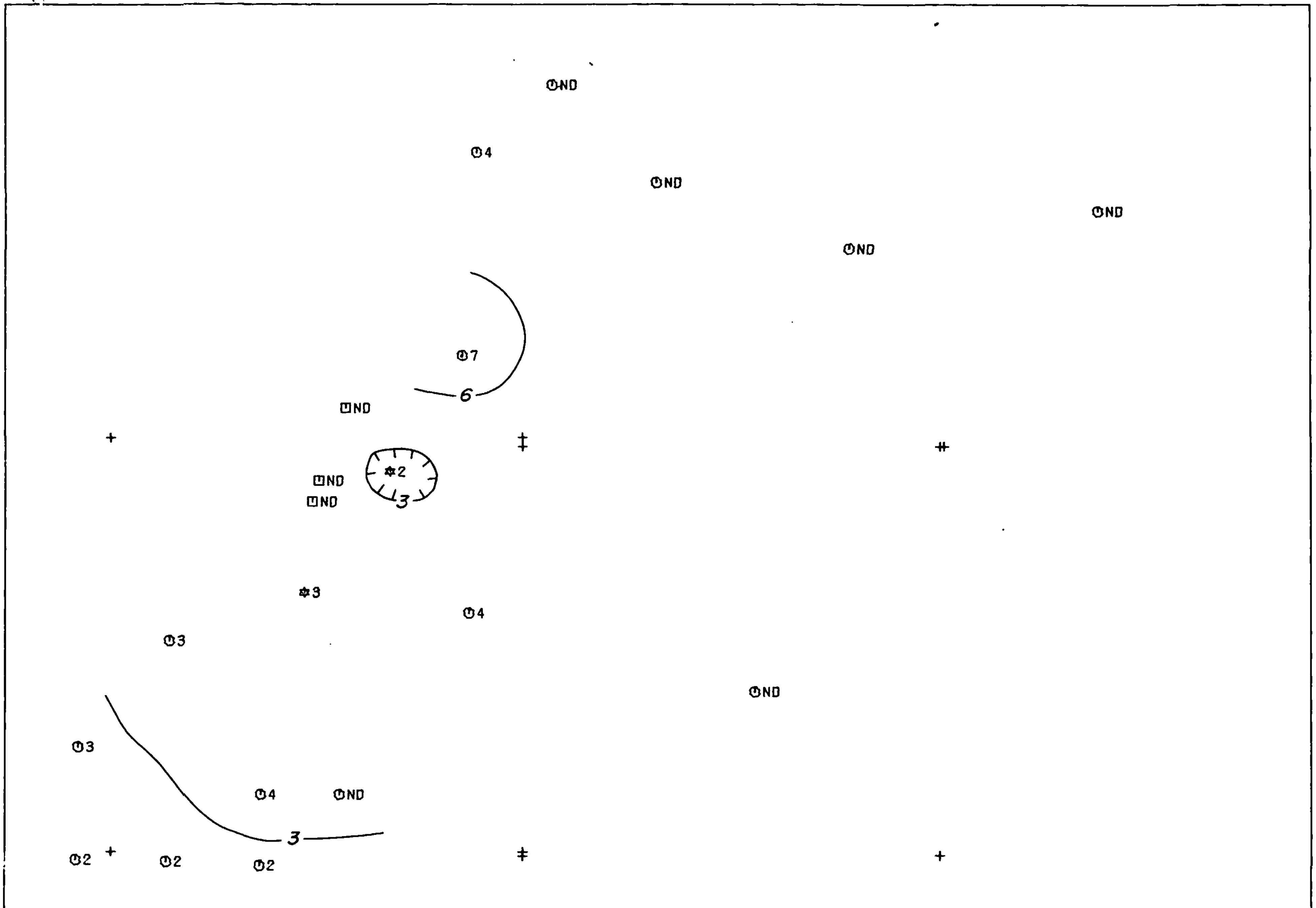
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 17 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

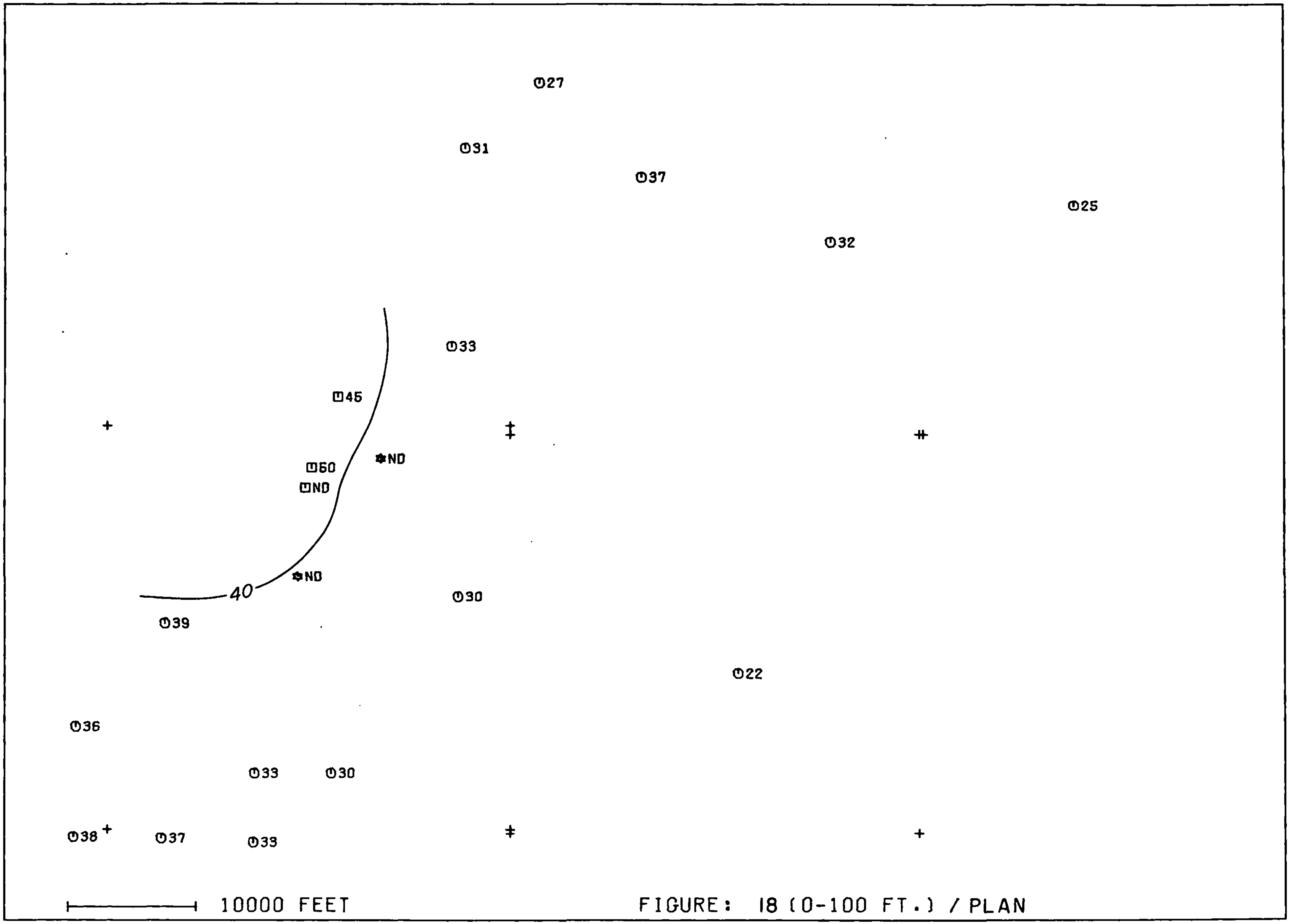


FIGURE: 18 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY.UTAH

LEAD (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

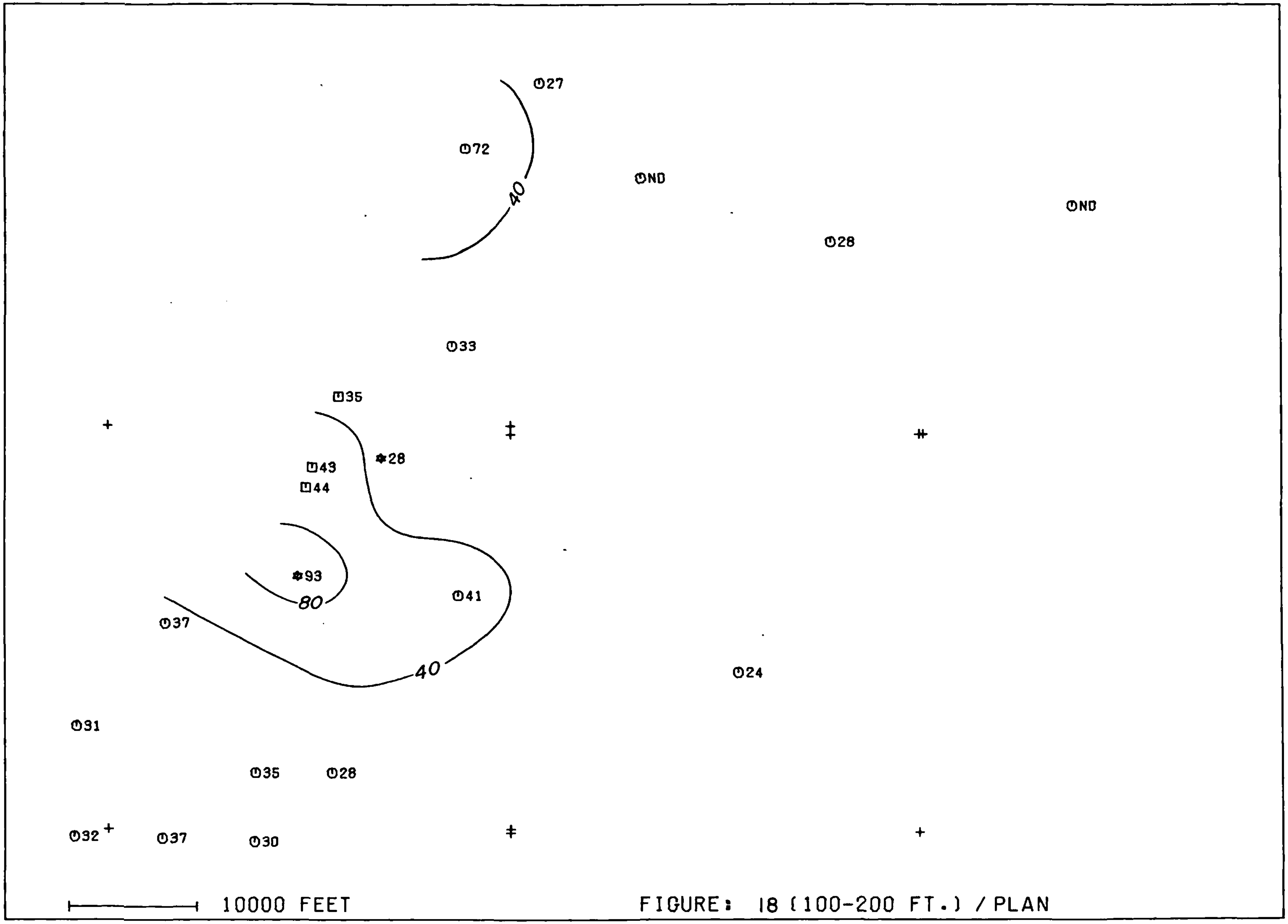
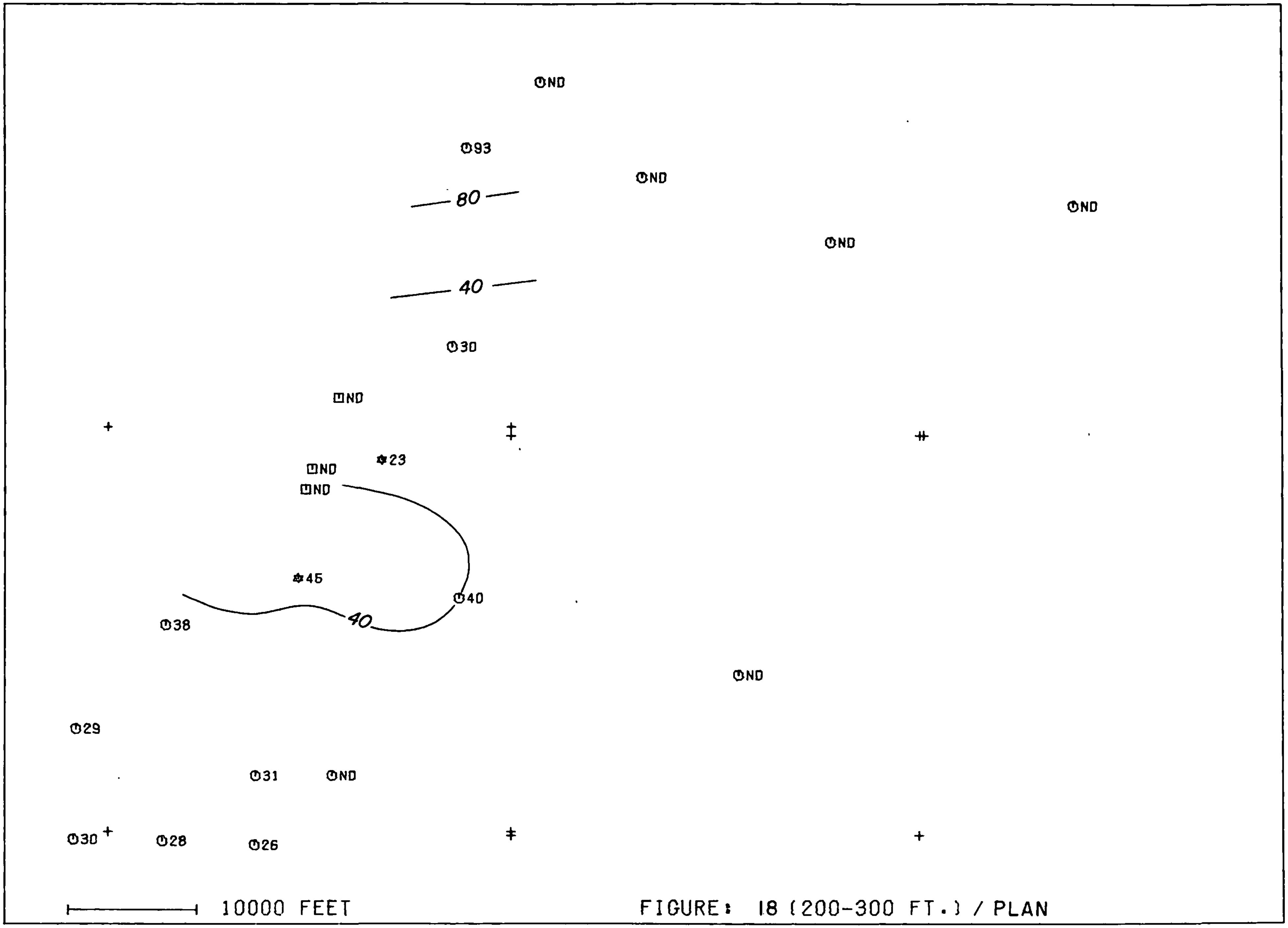


FIGURE: 18 (100-200 FT.) / PLAN

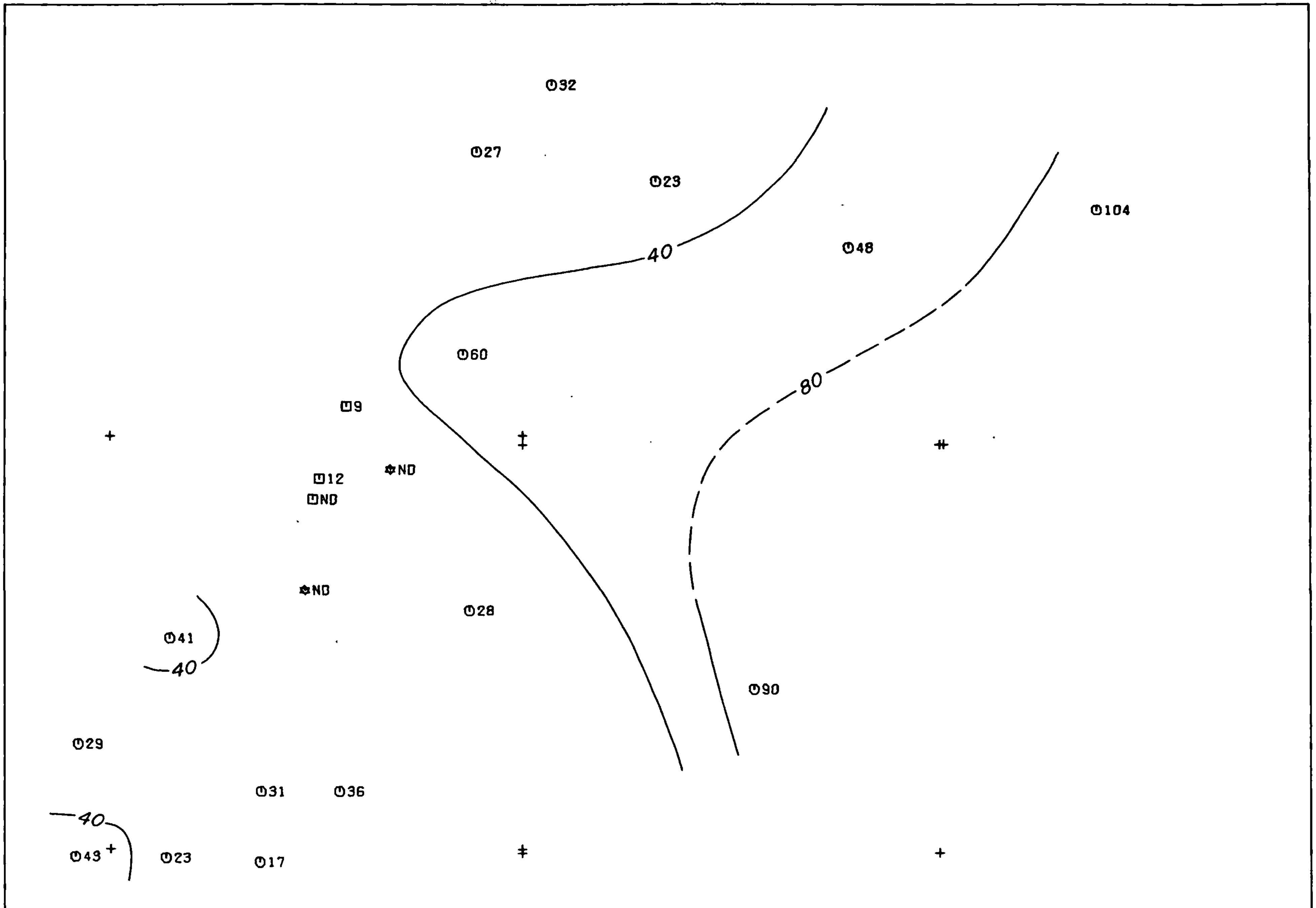
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 19 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

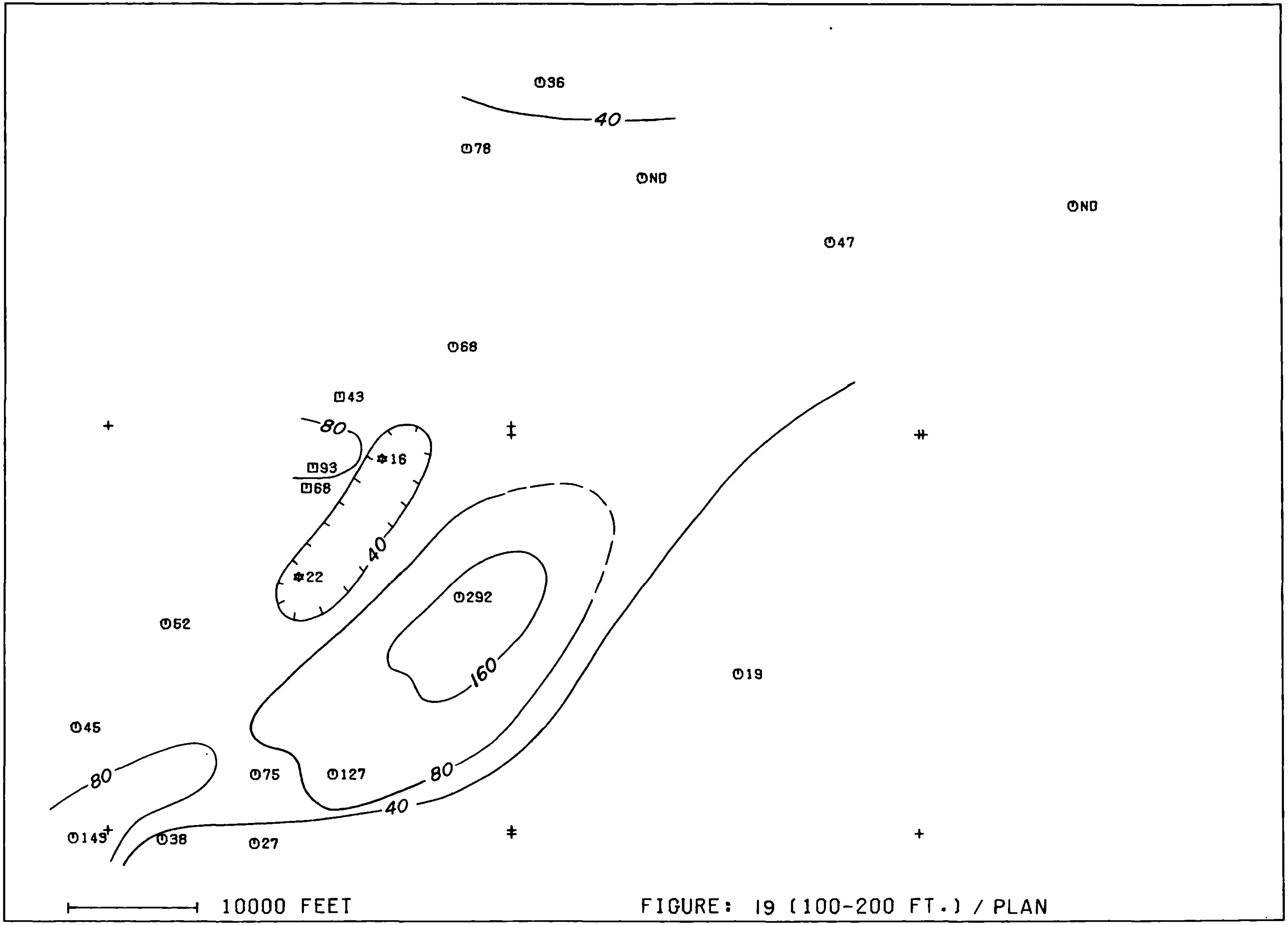


FIGURE: 19 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

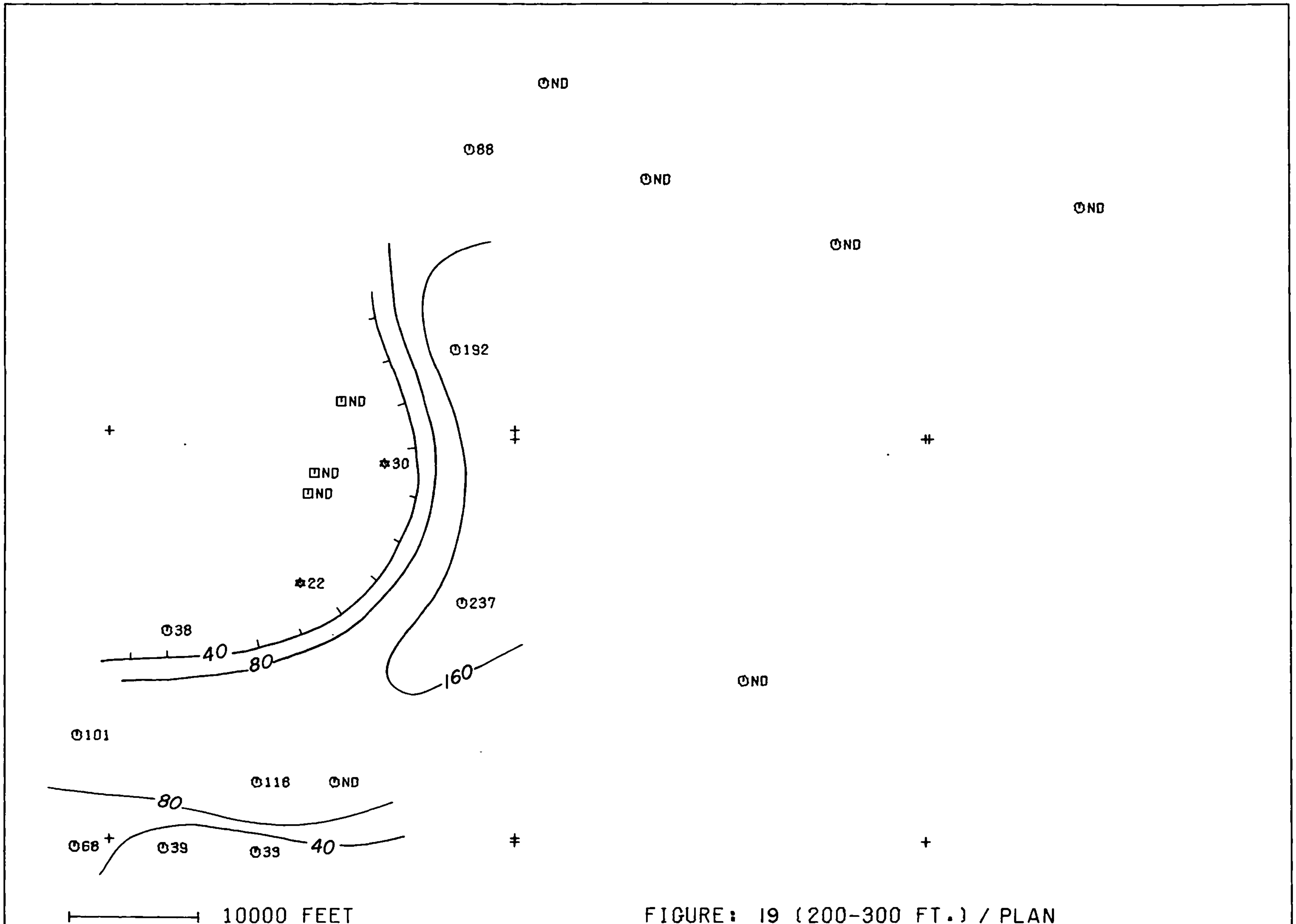
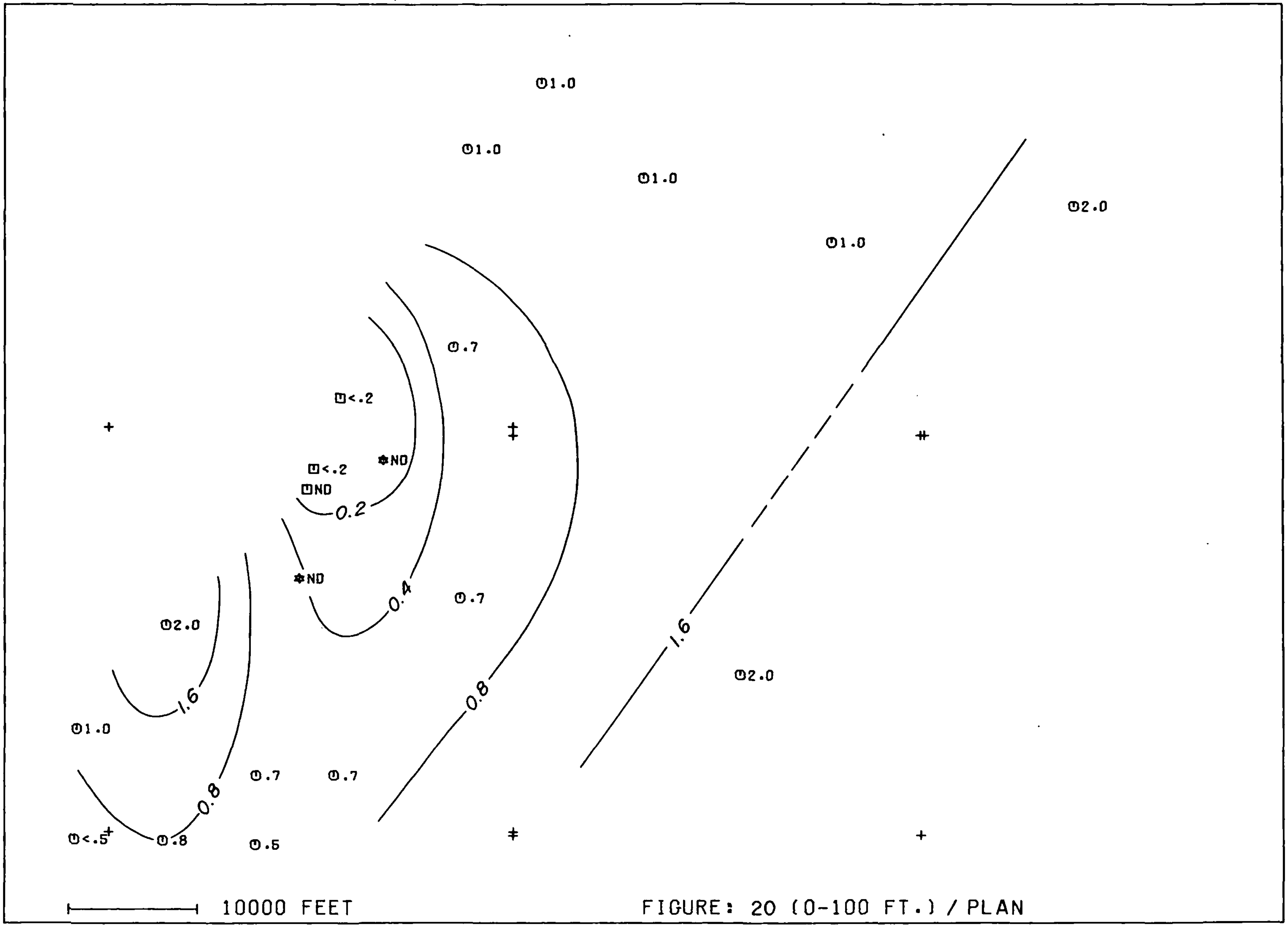


FIGURE: 19 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

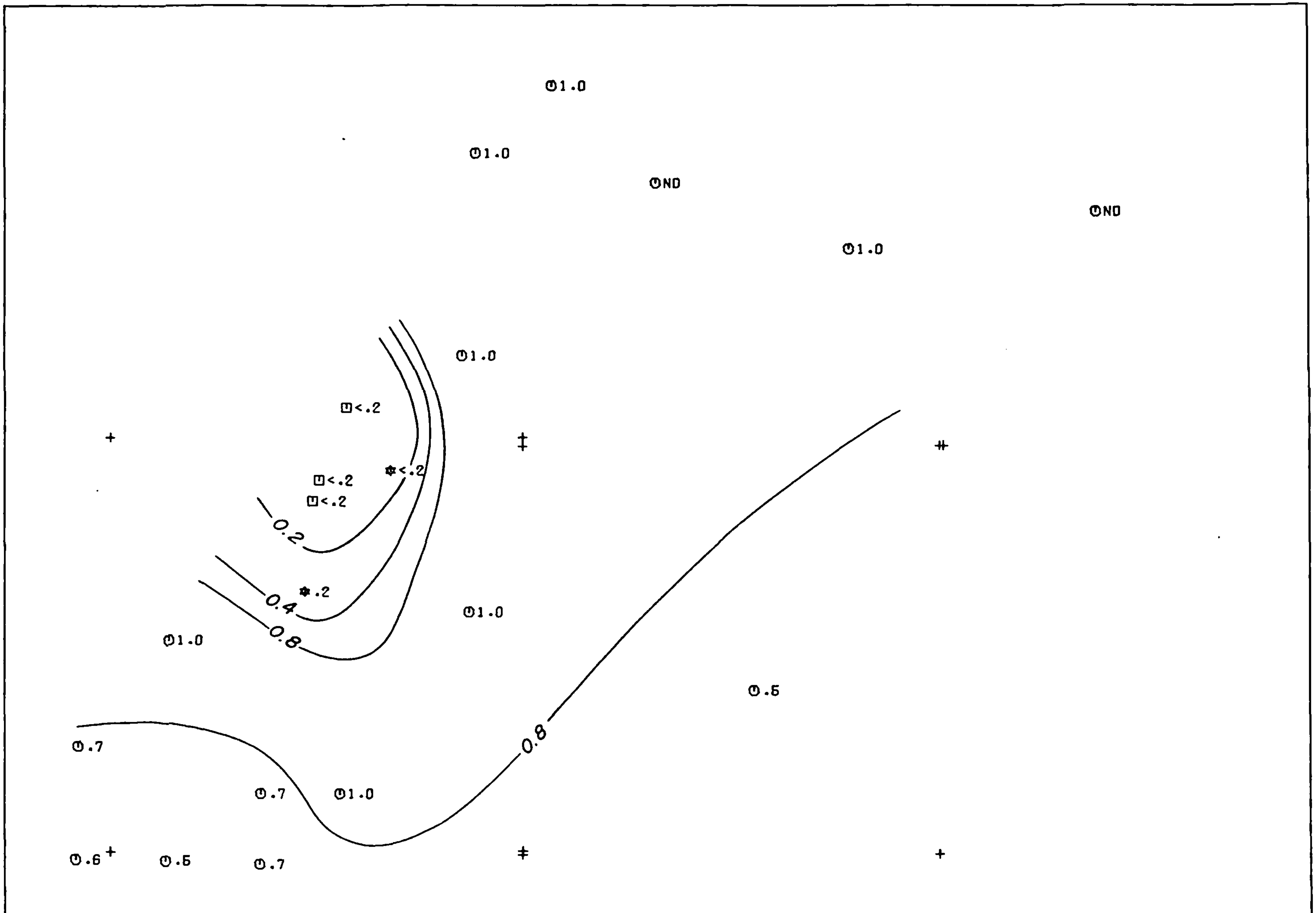
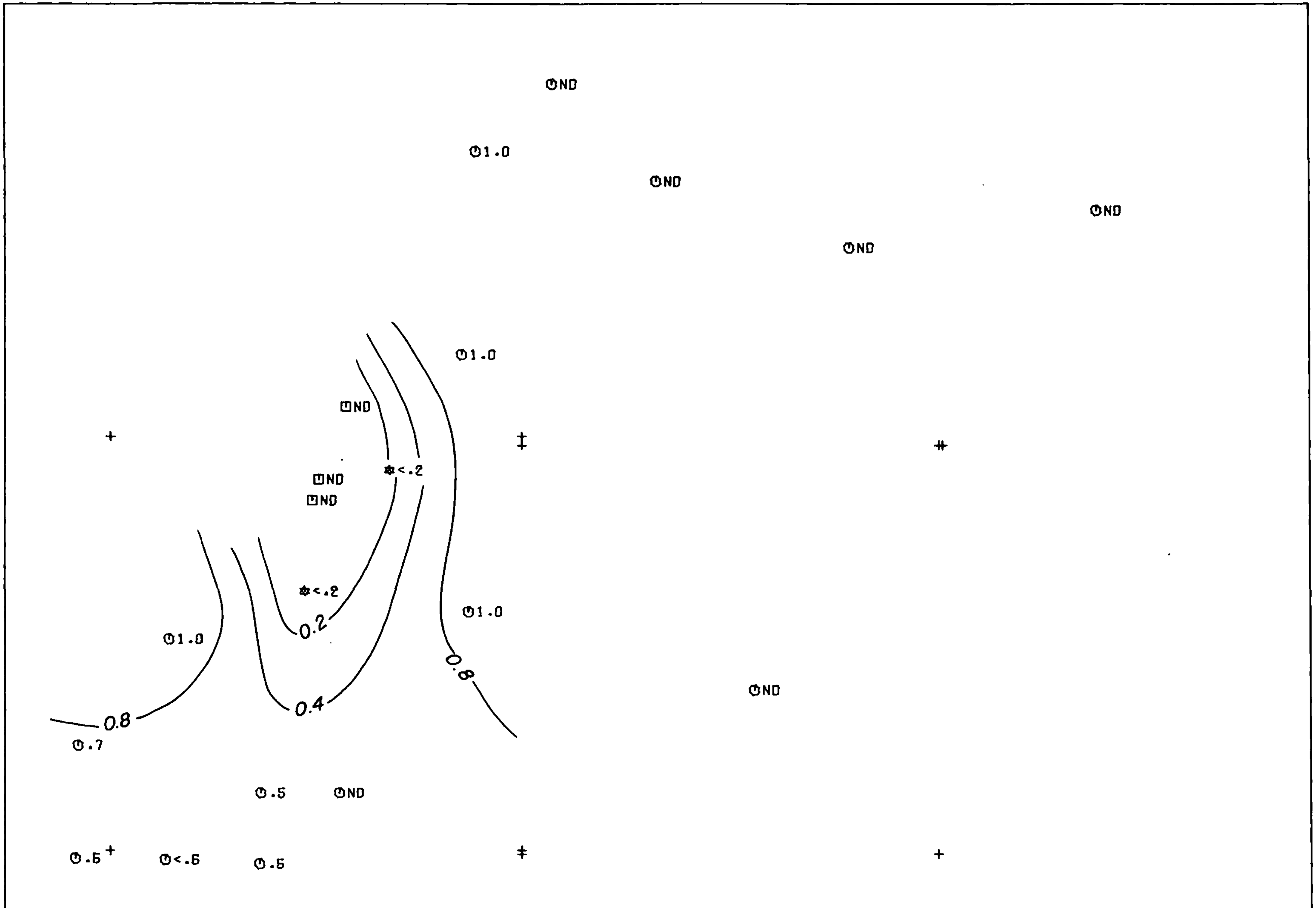


FIGURE: 20 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

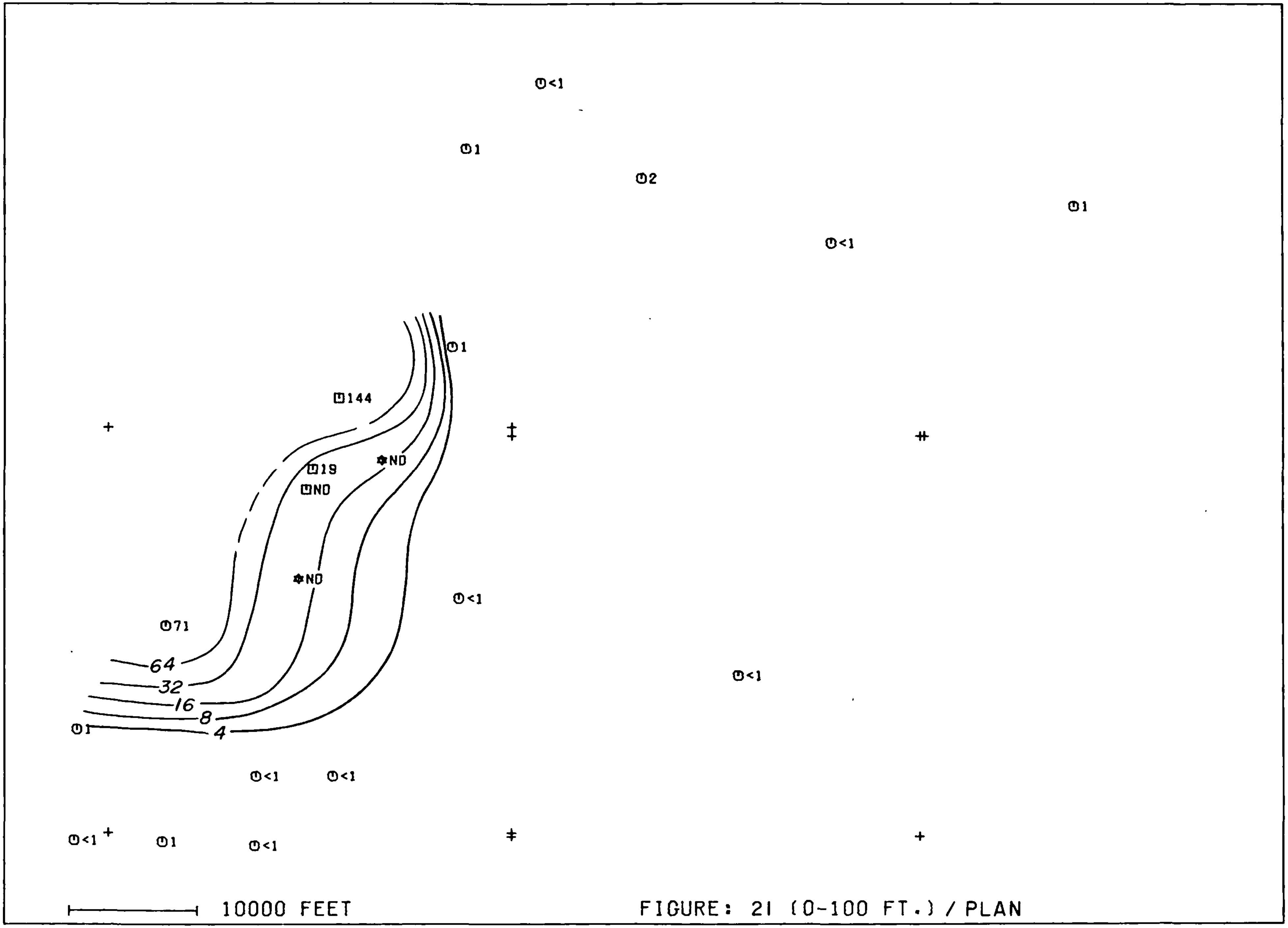


10000 FEET

FIGURE: 20 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: COLOR

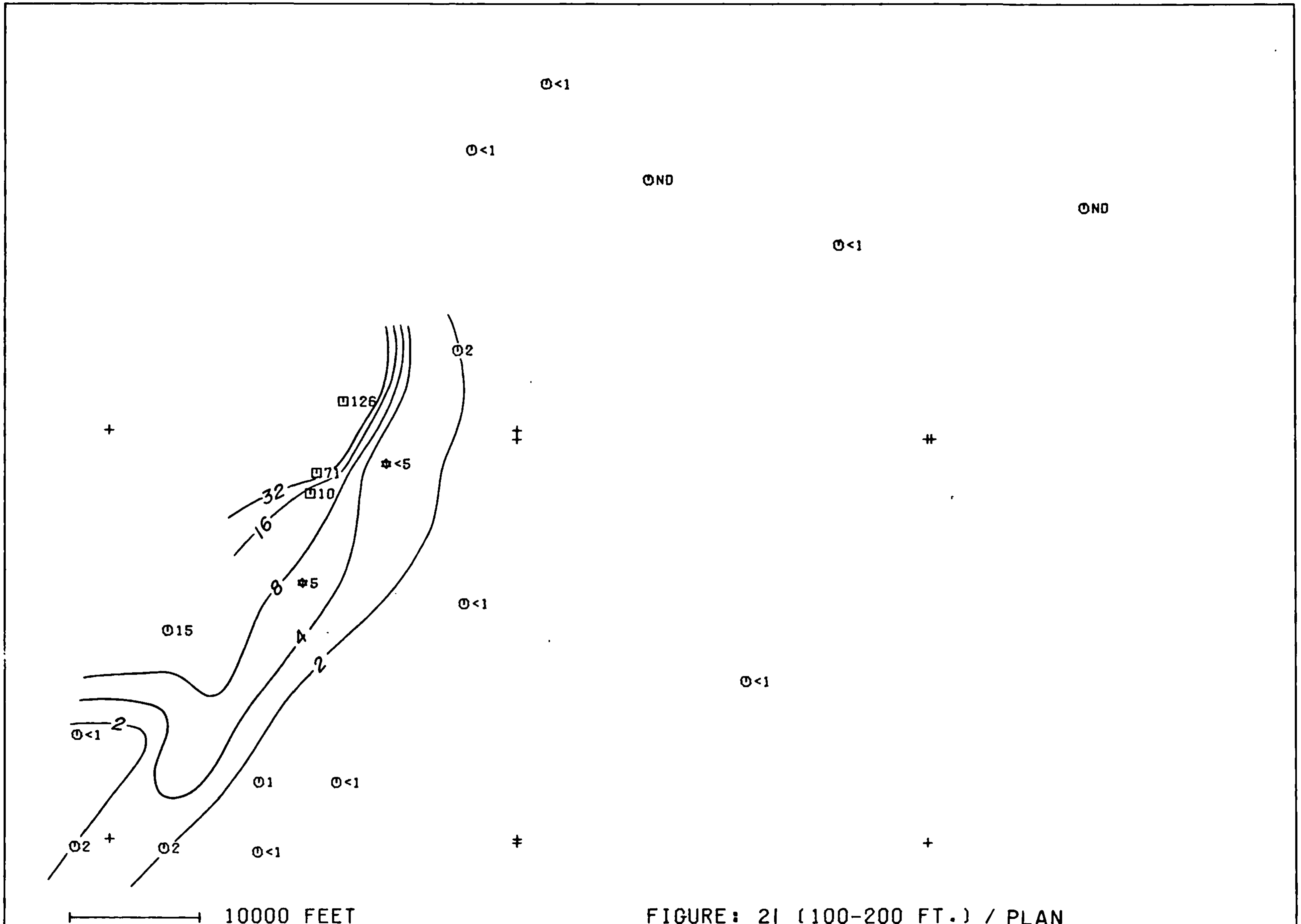


FIGURE: 21 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: COLOR

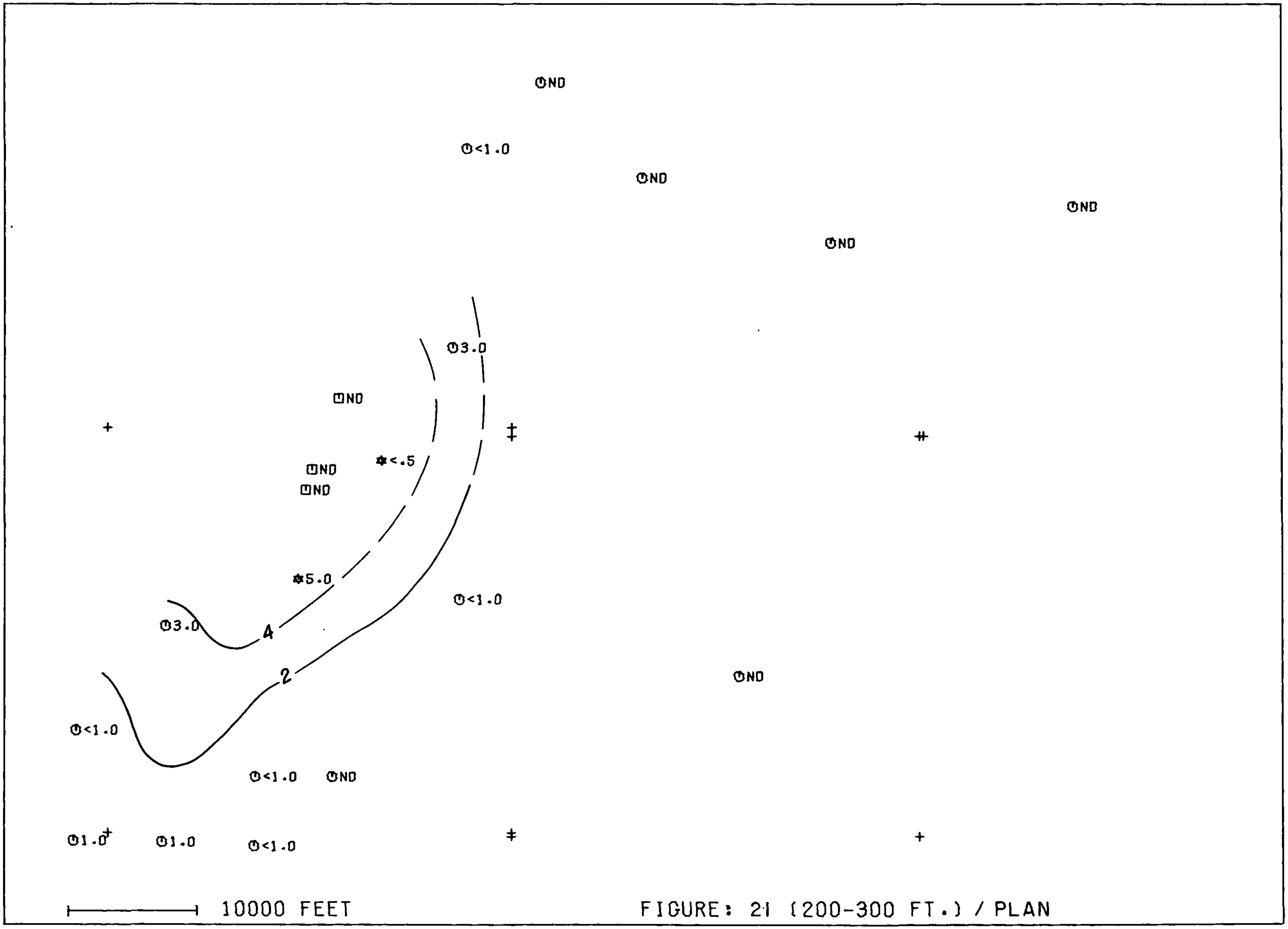


FIGURE: 21 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: COLOR

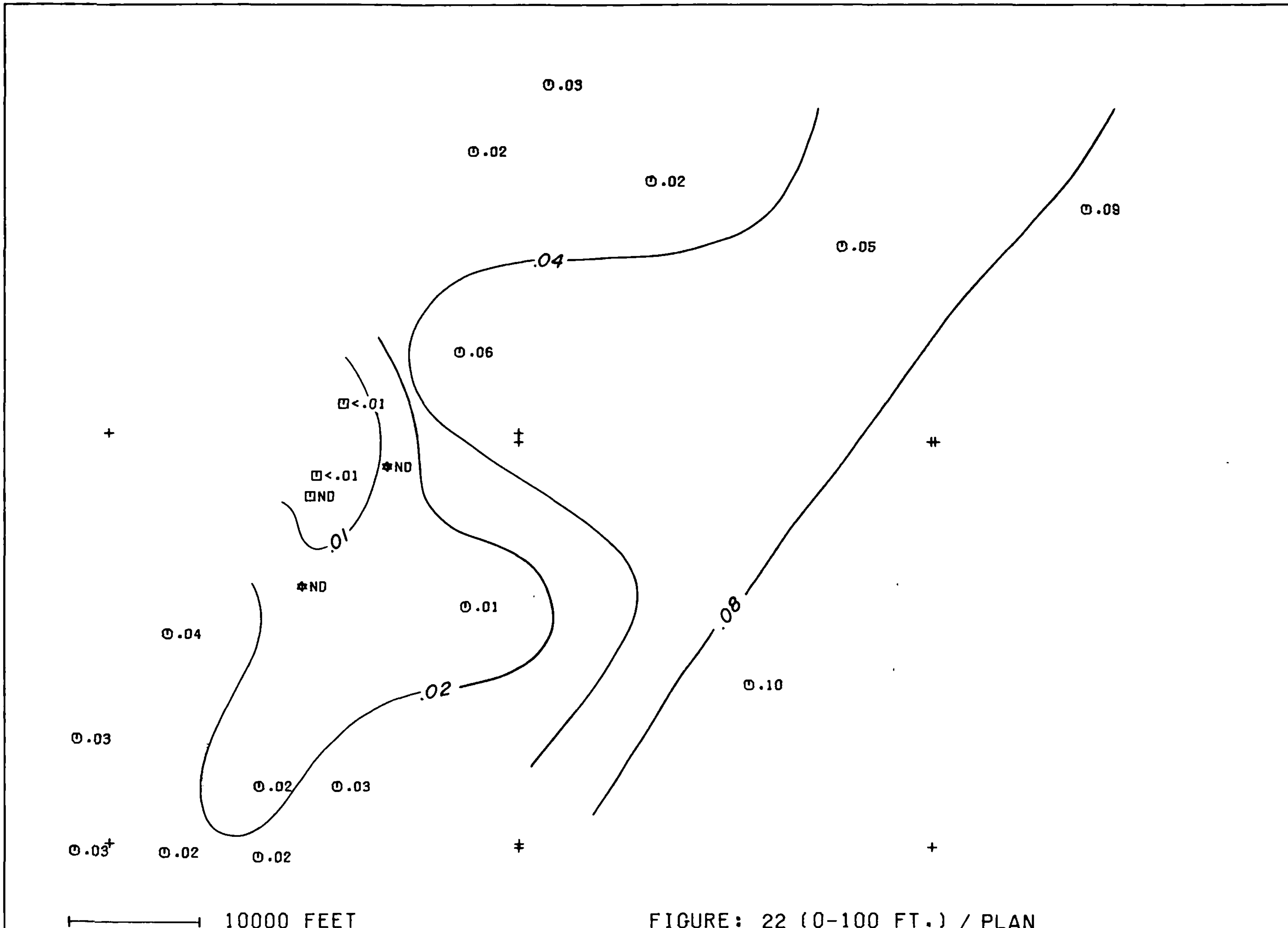


FIGURE: 22 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

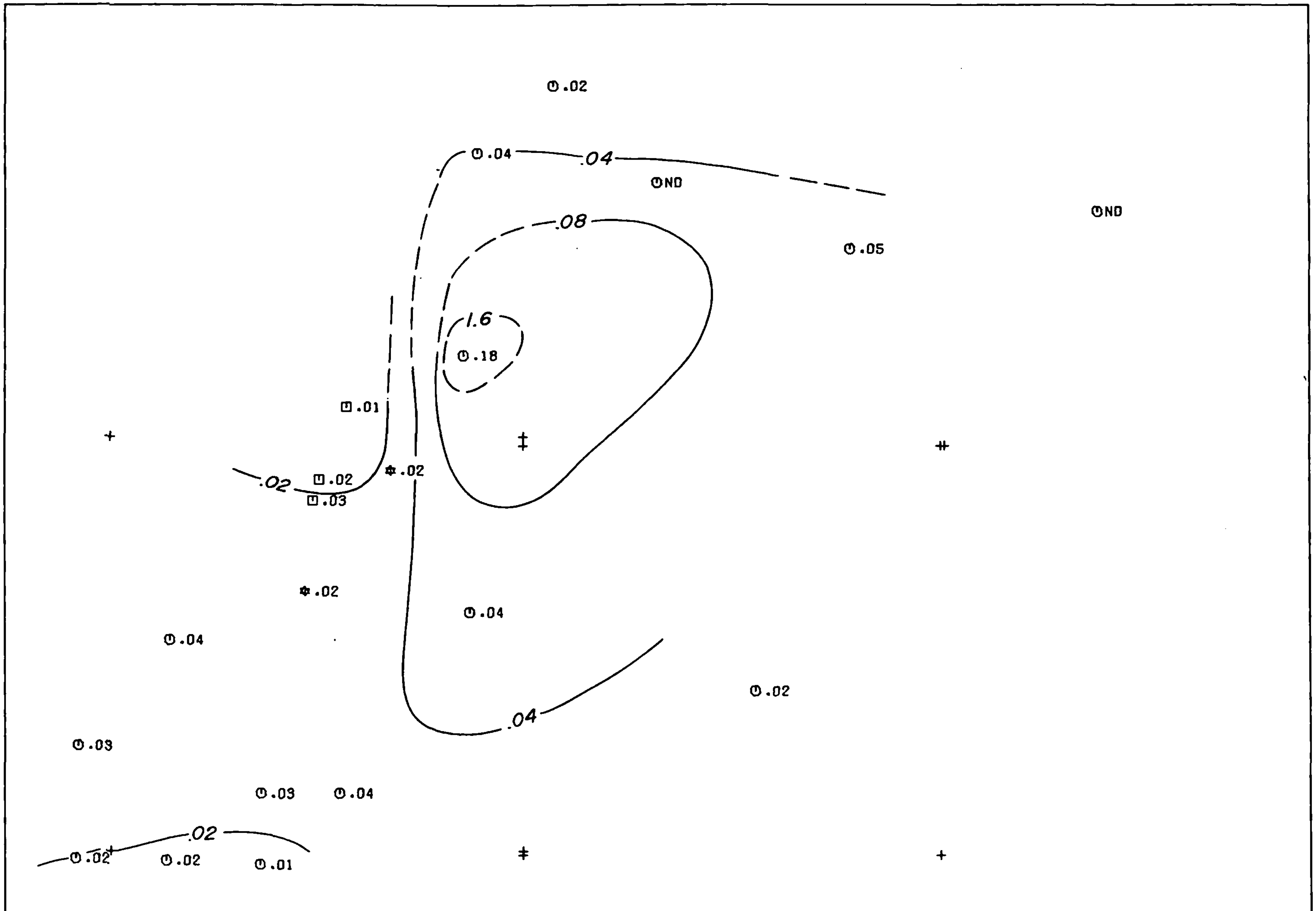
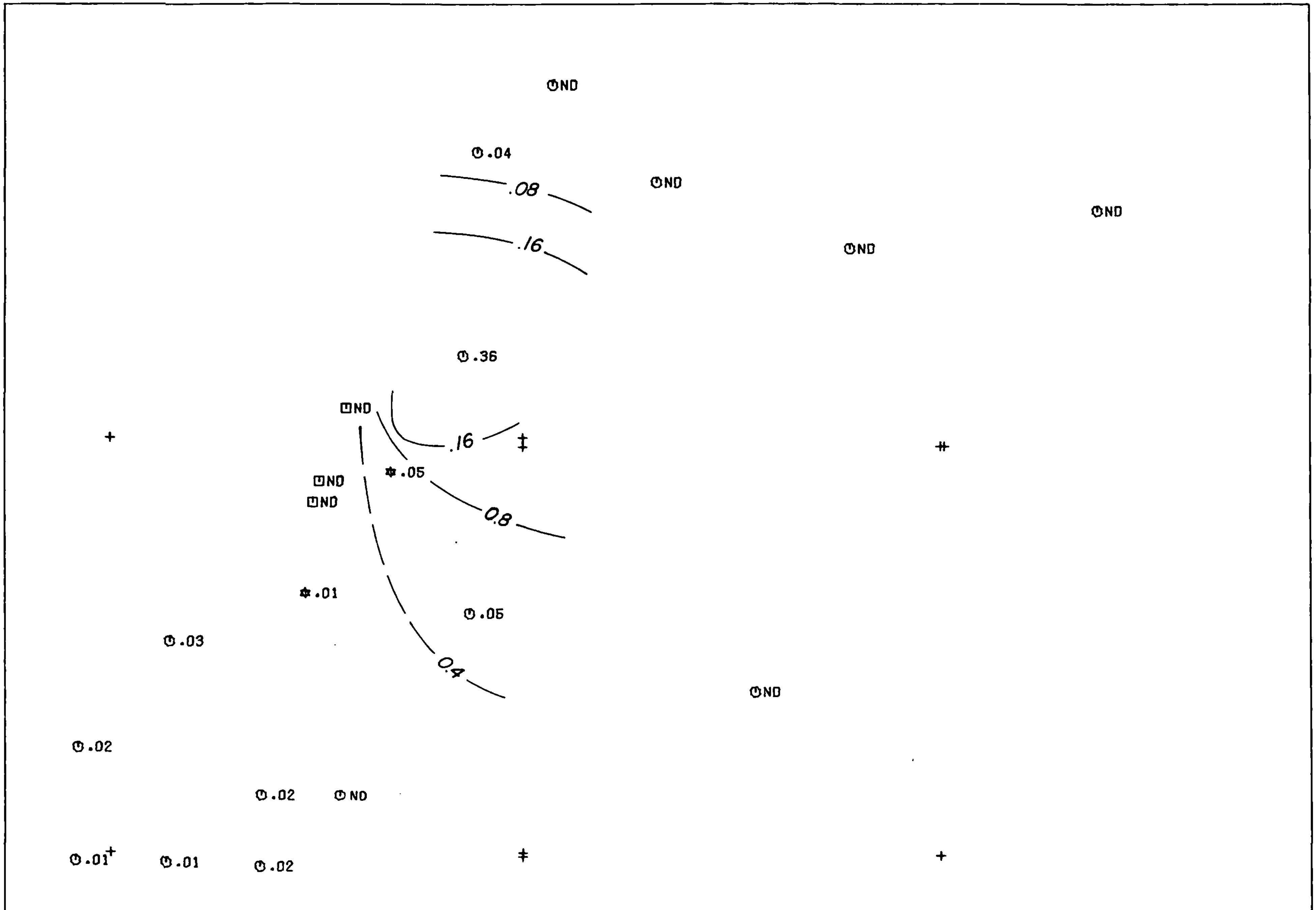


FIGURE: 22 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 22 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

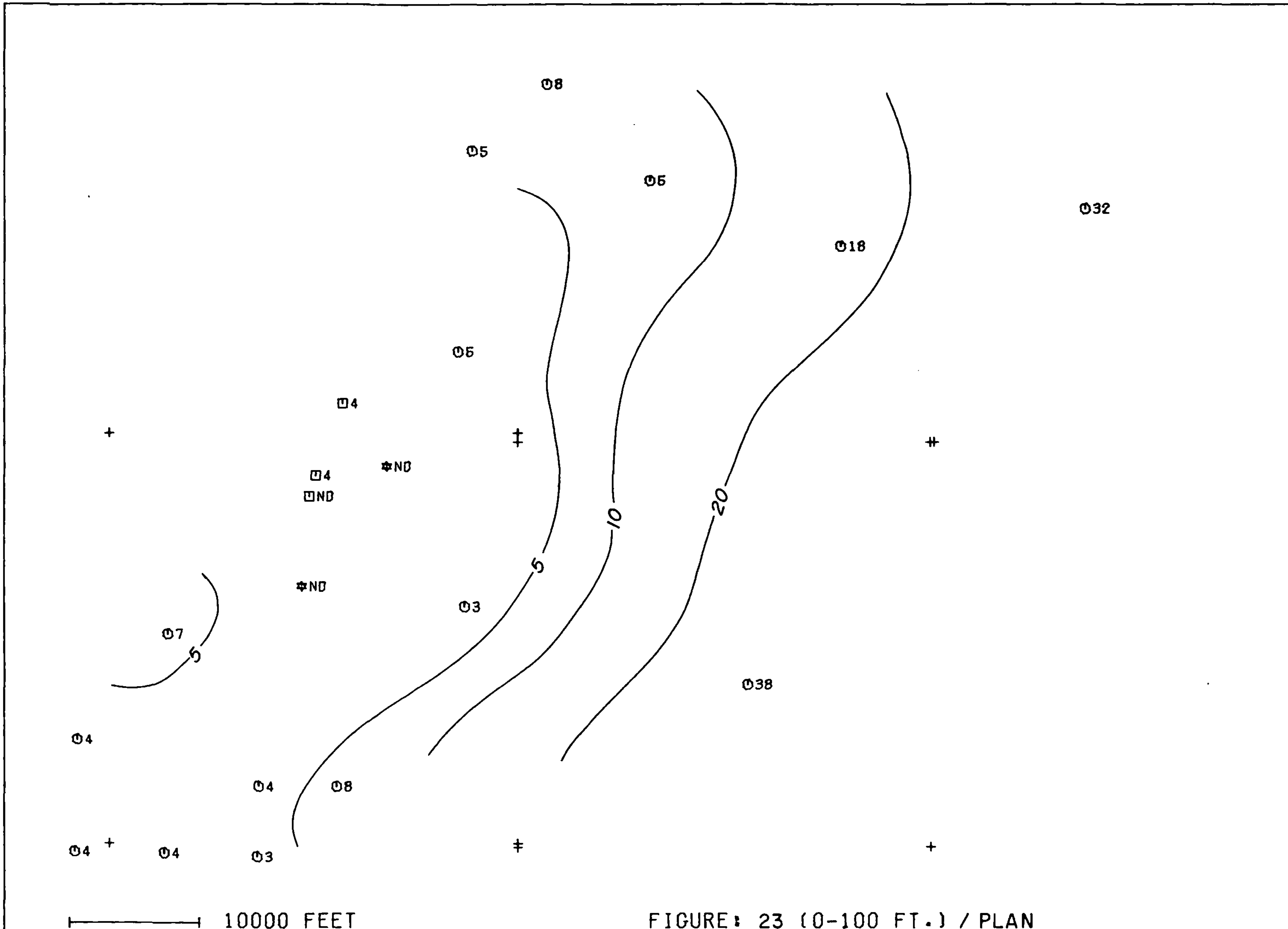


FIGURE: 23 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

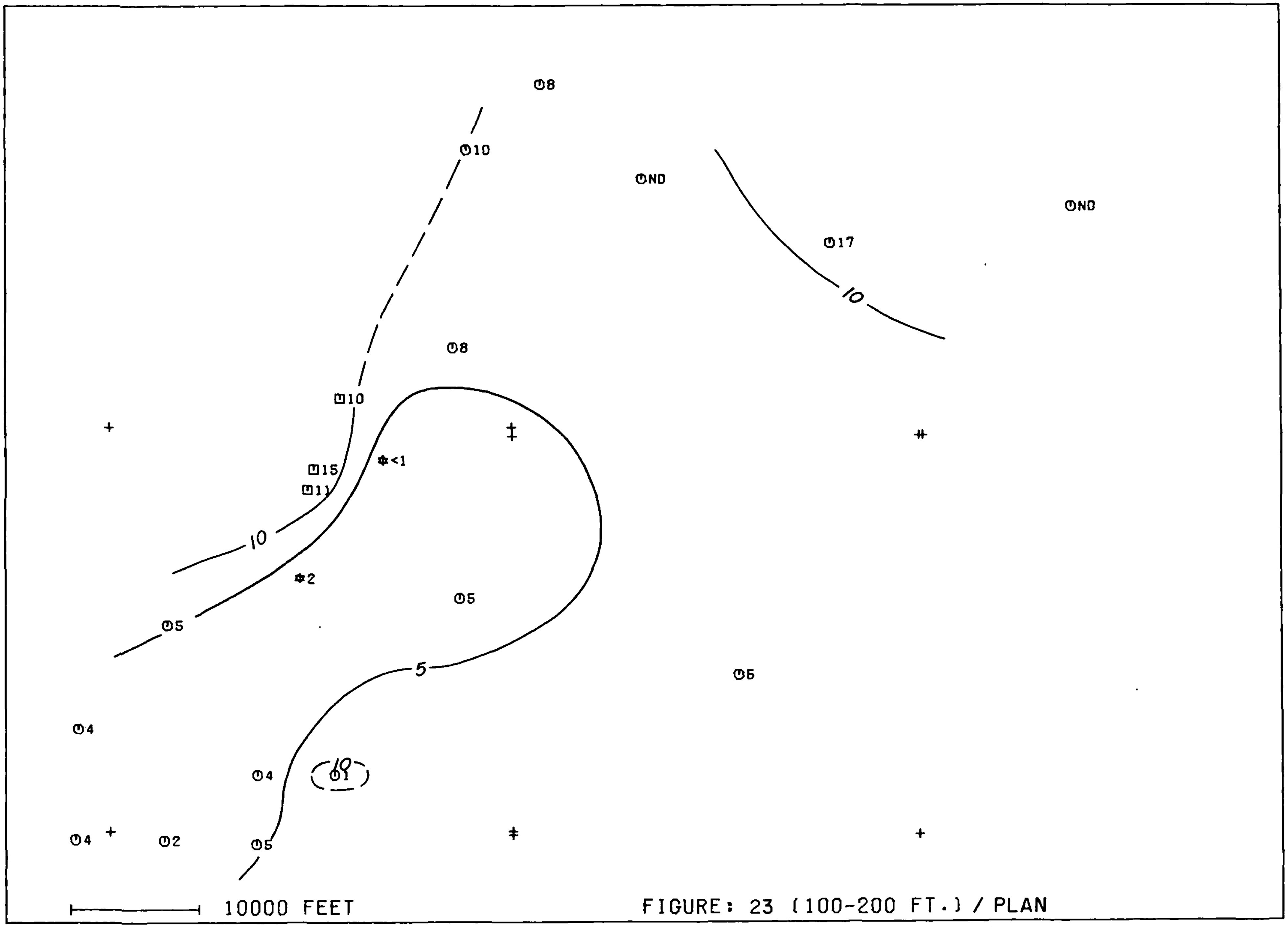
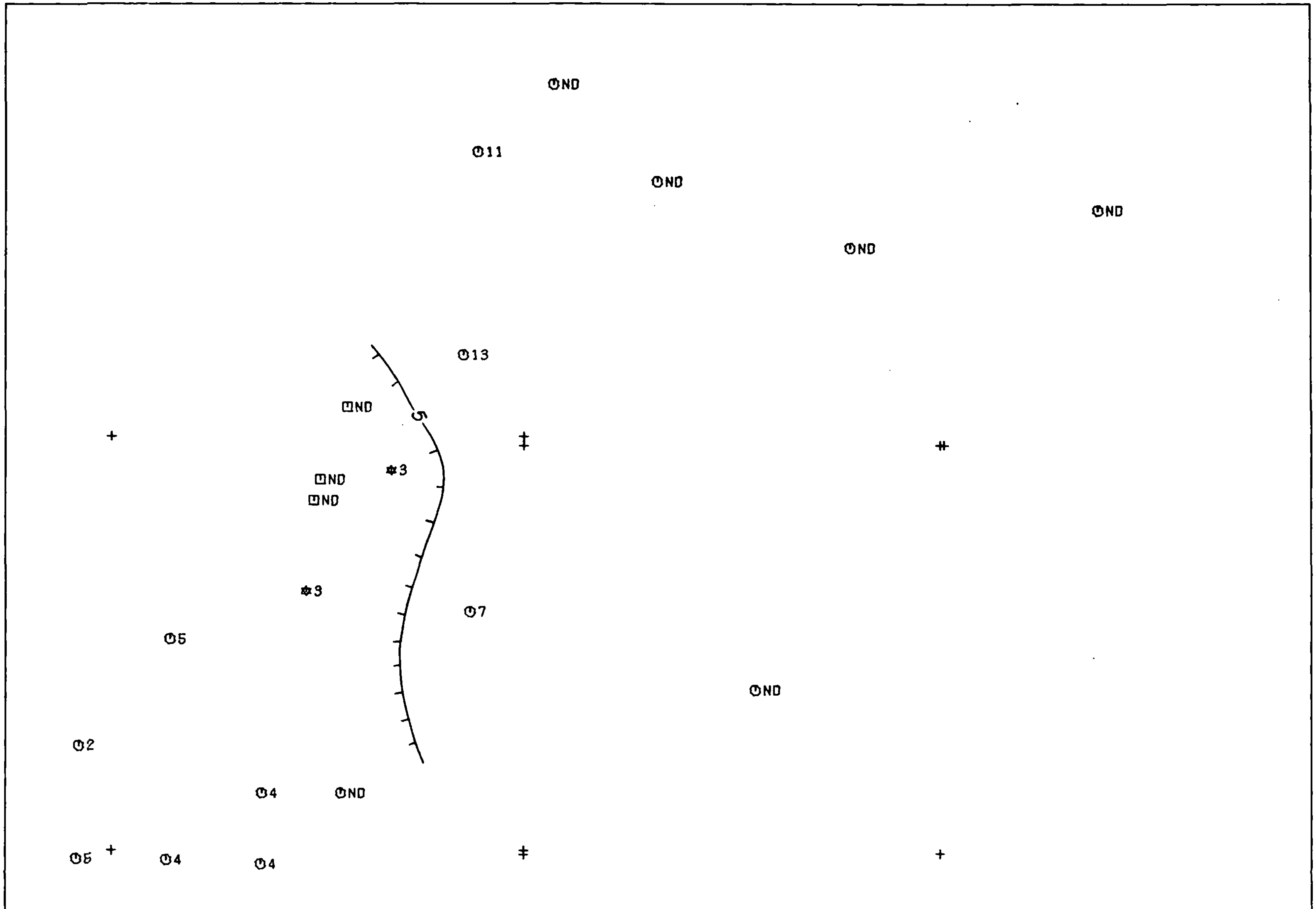


FIGURE: 23 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 23 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

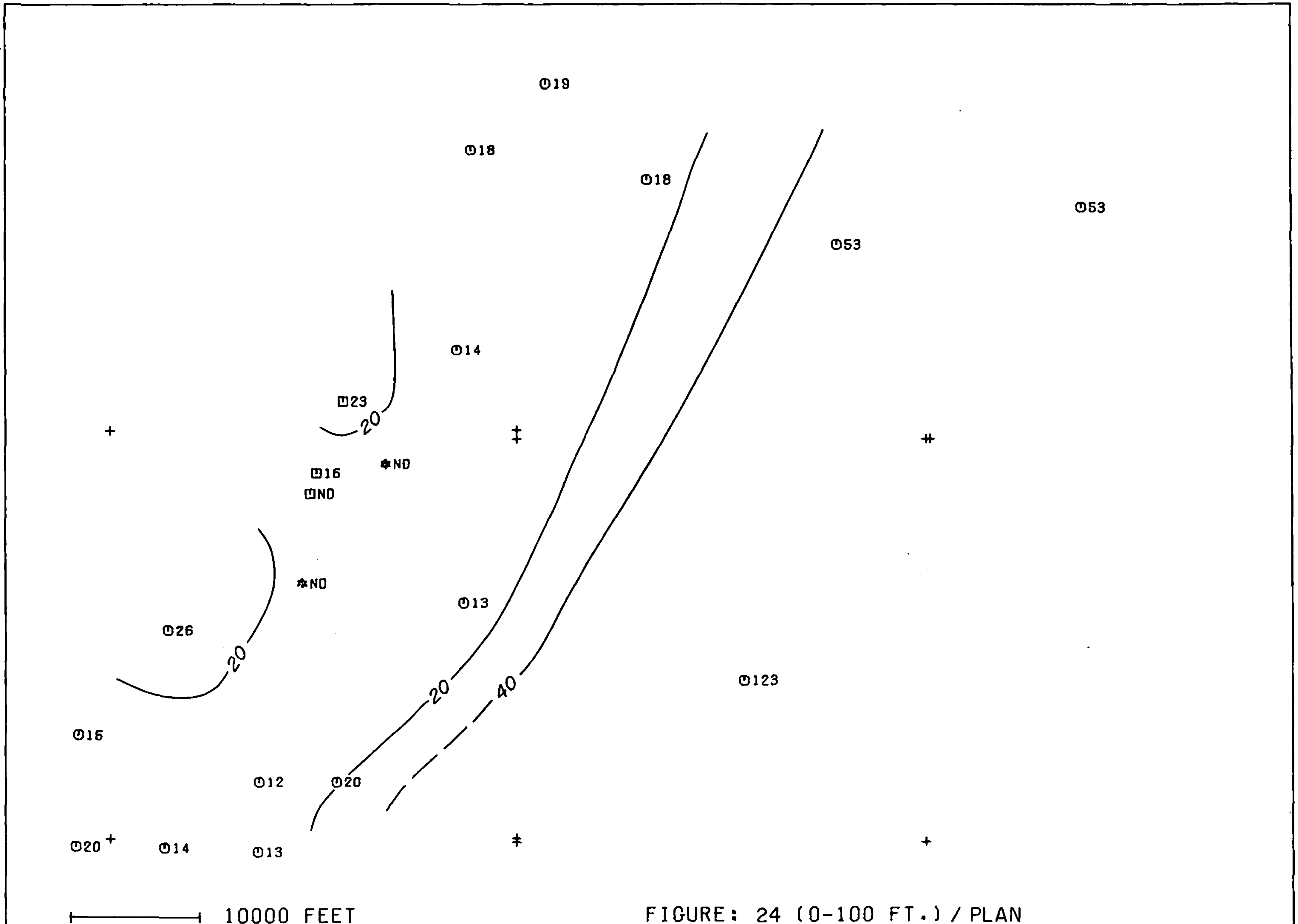
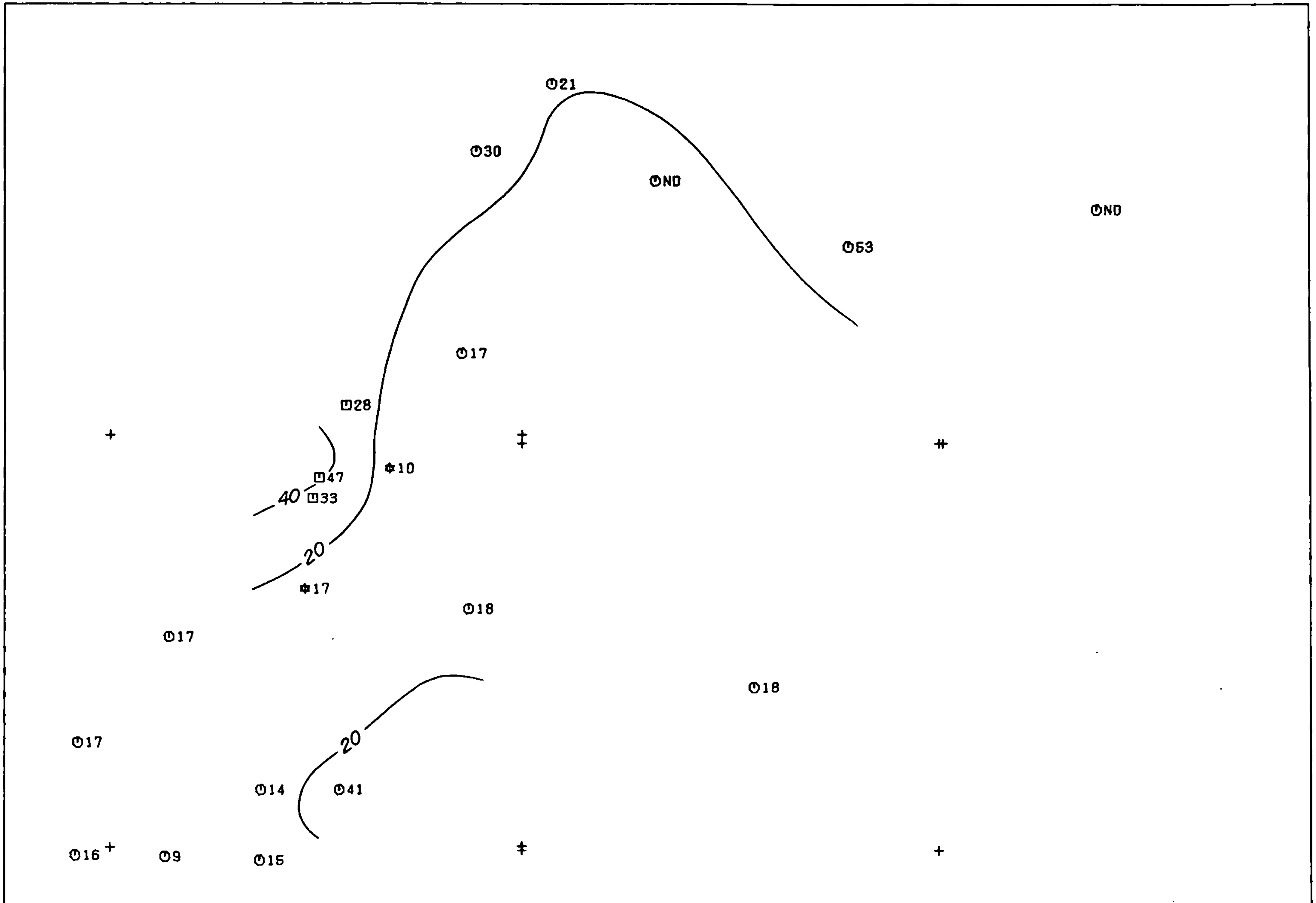


FIGURE: 24 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

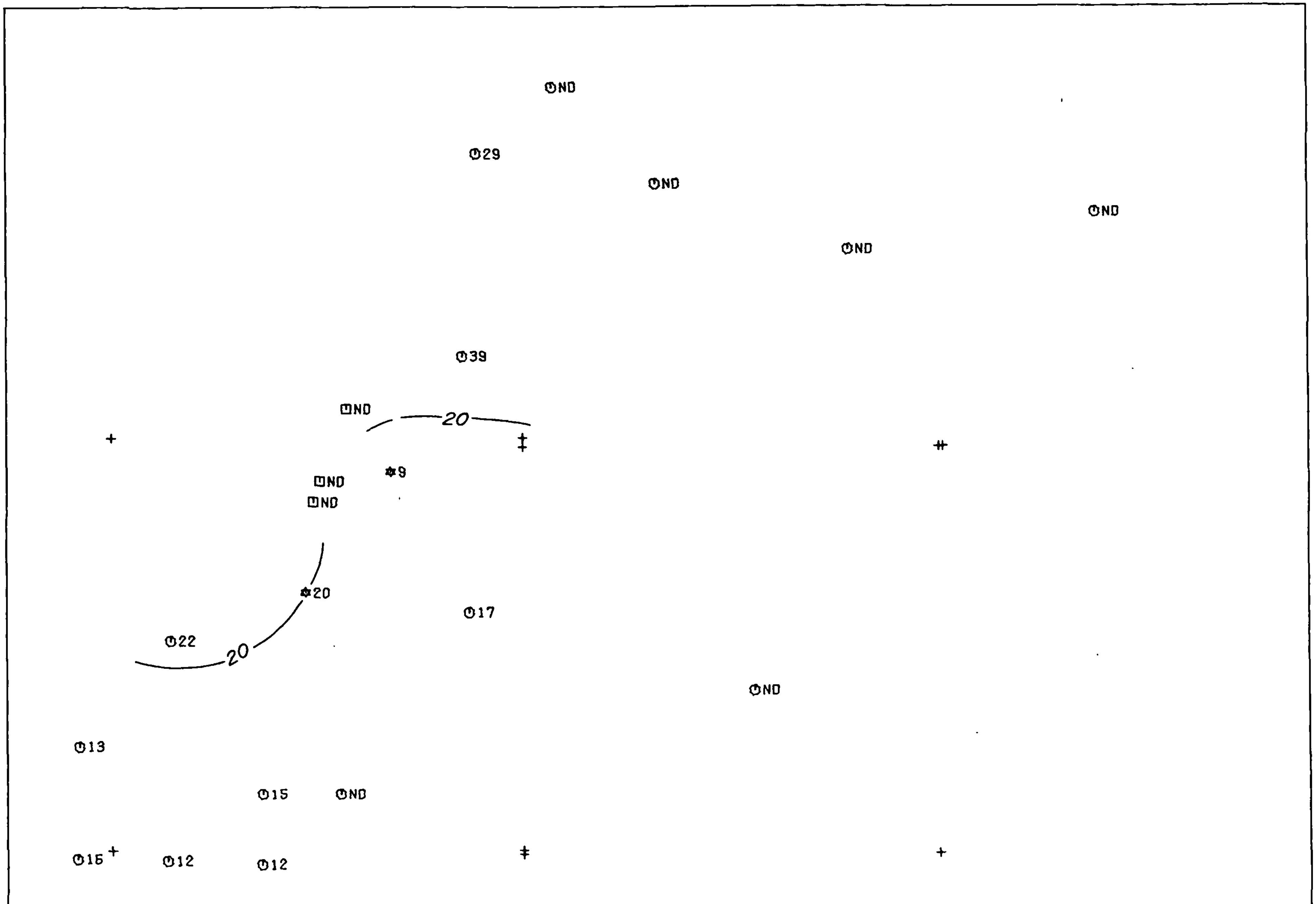


10000 FEET

FIGURE: 24 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY,UTAH

NICKEL (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 24 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

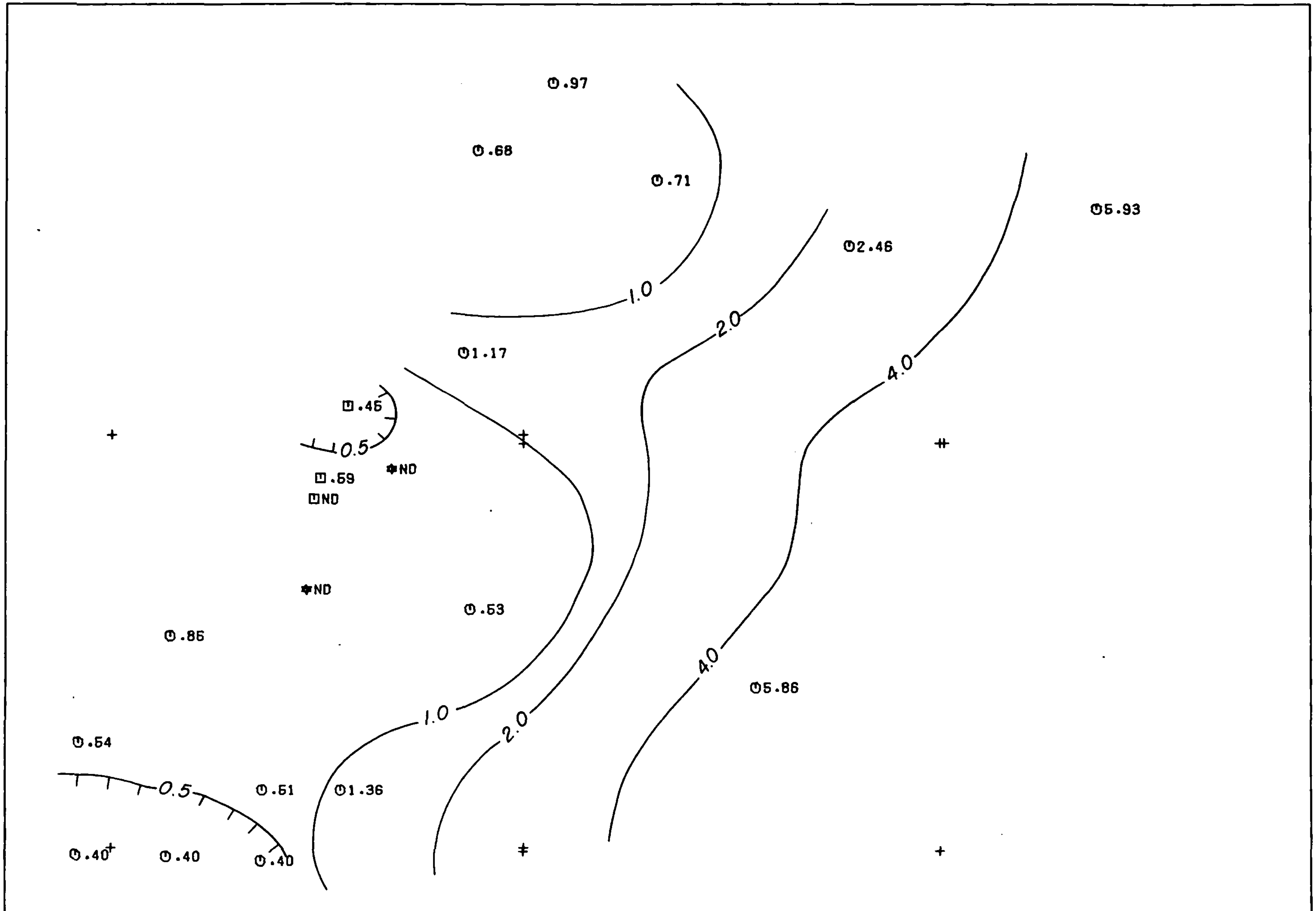
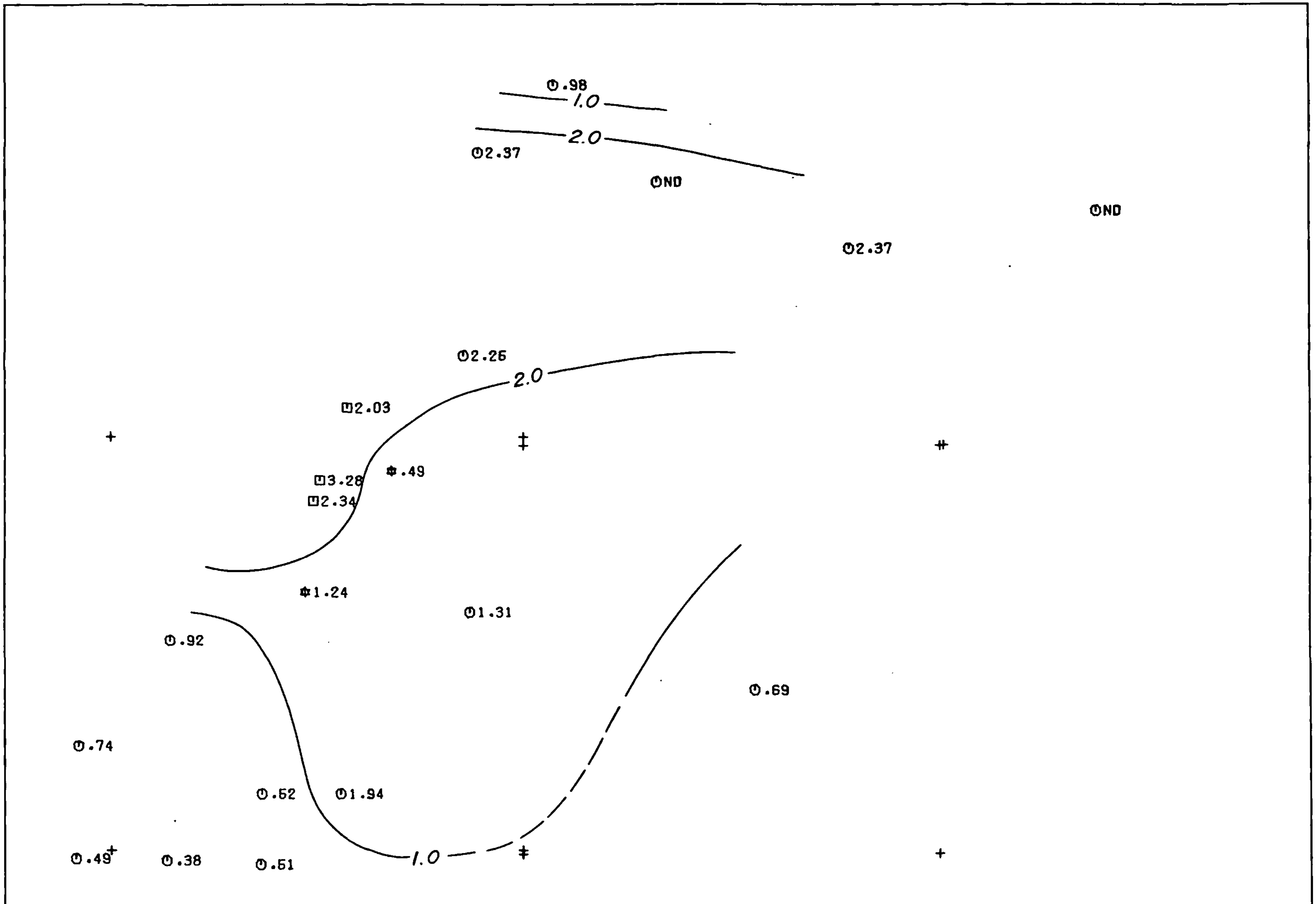


FIGURE: 25 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 25 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

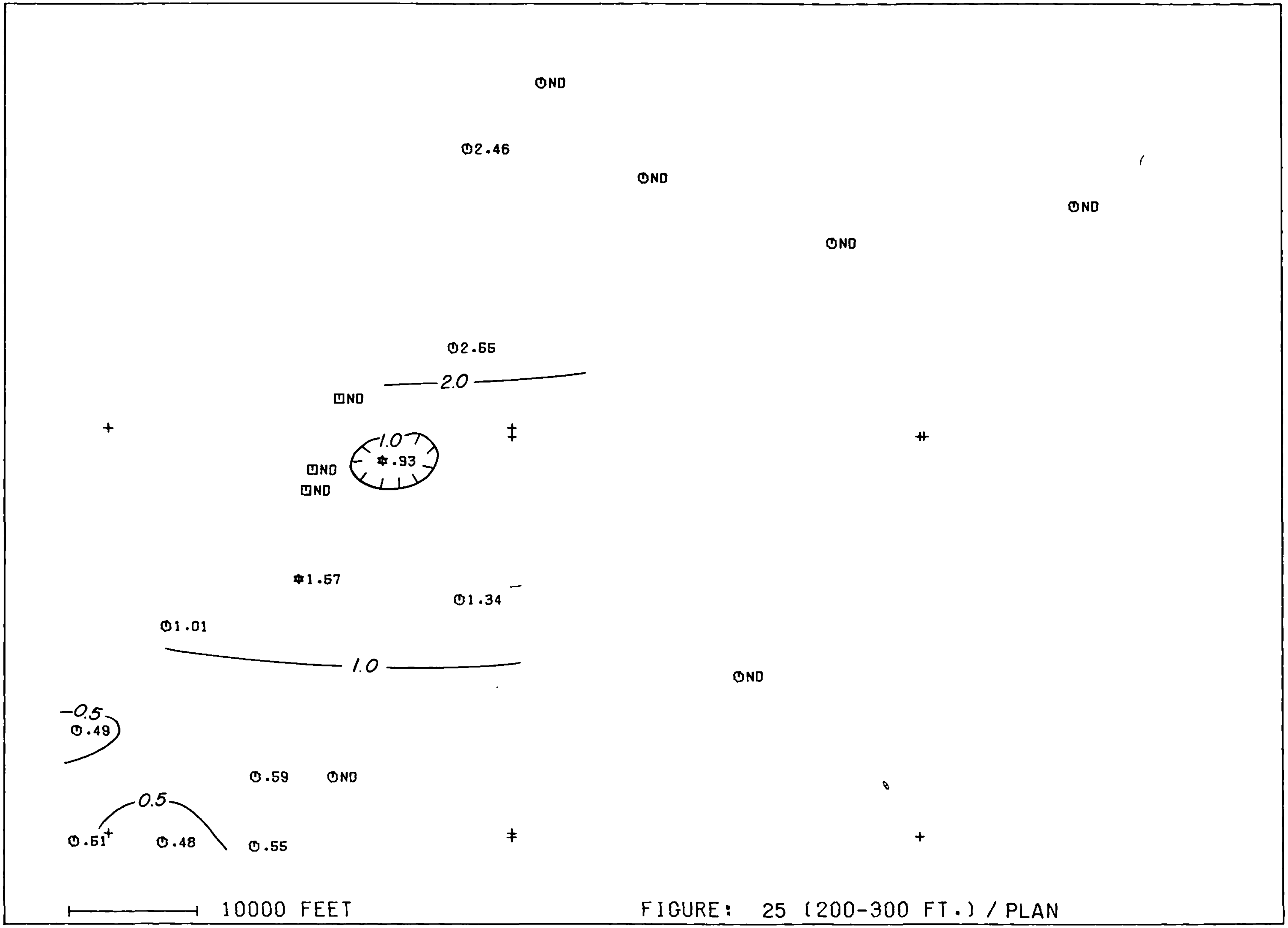


FIGURE: 25 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

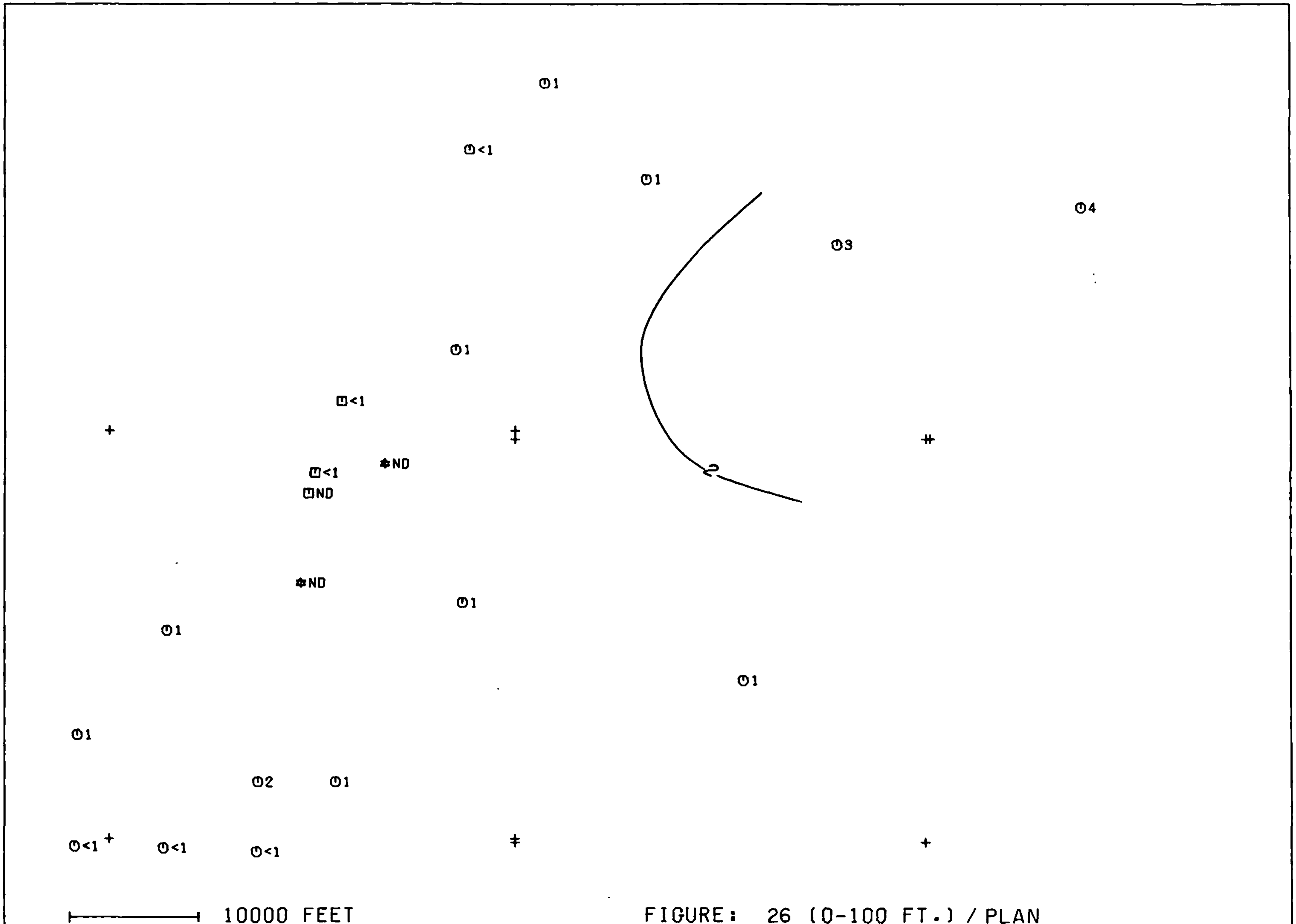


FIGURE: 26 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

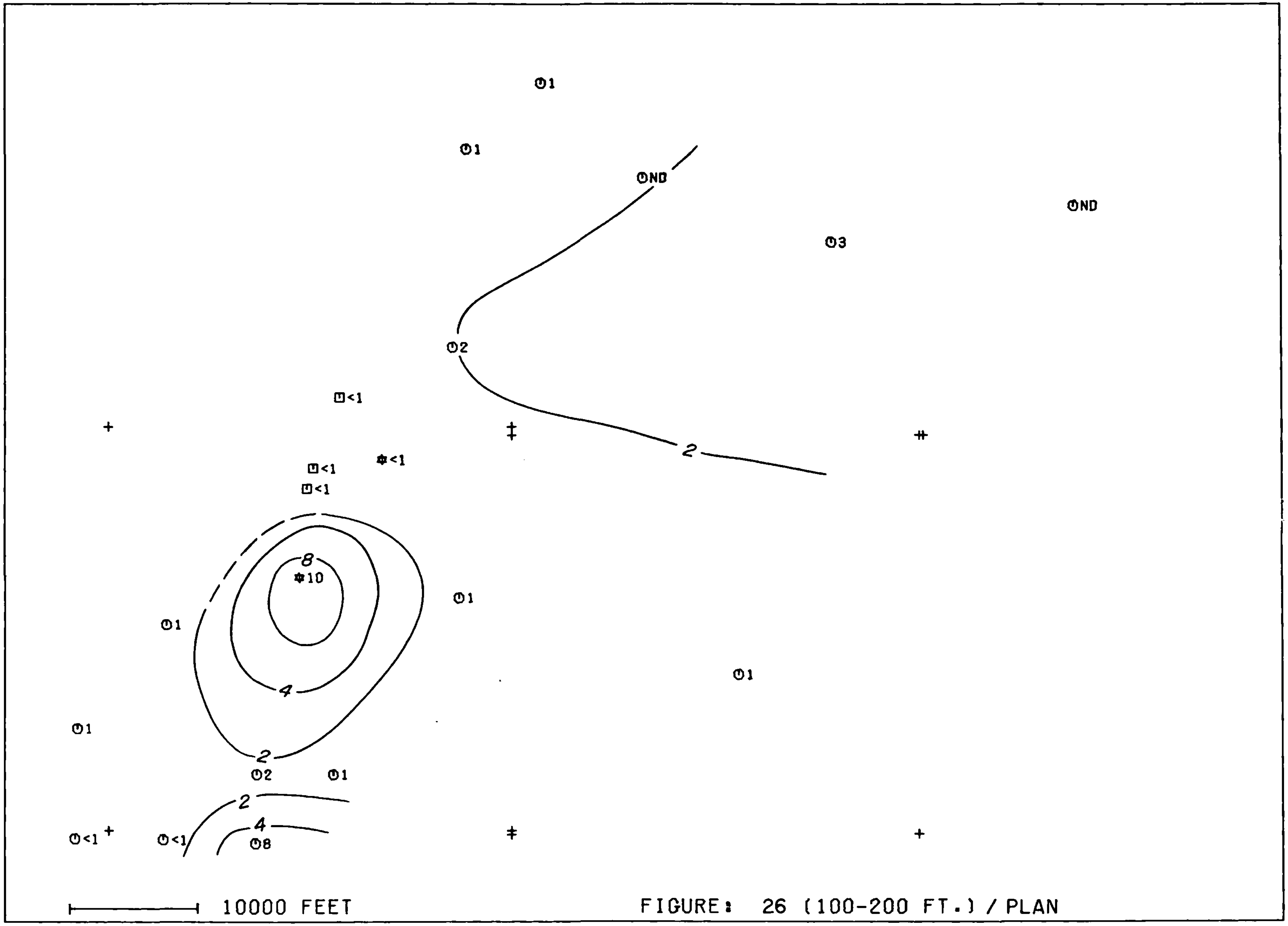
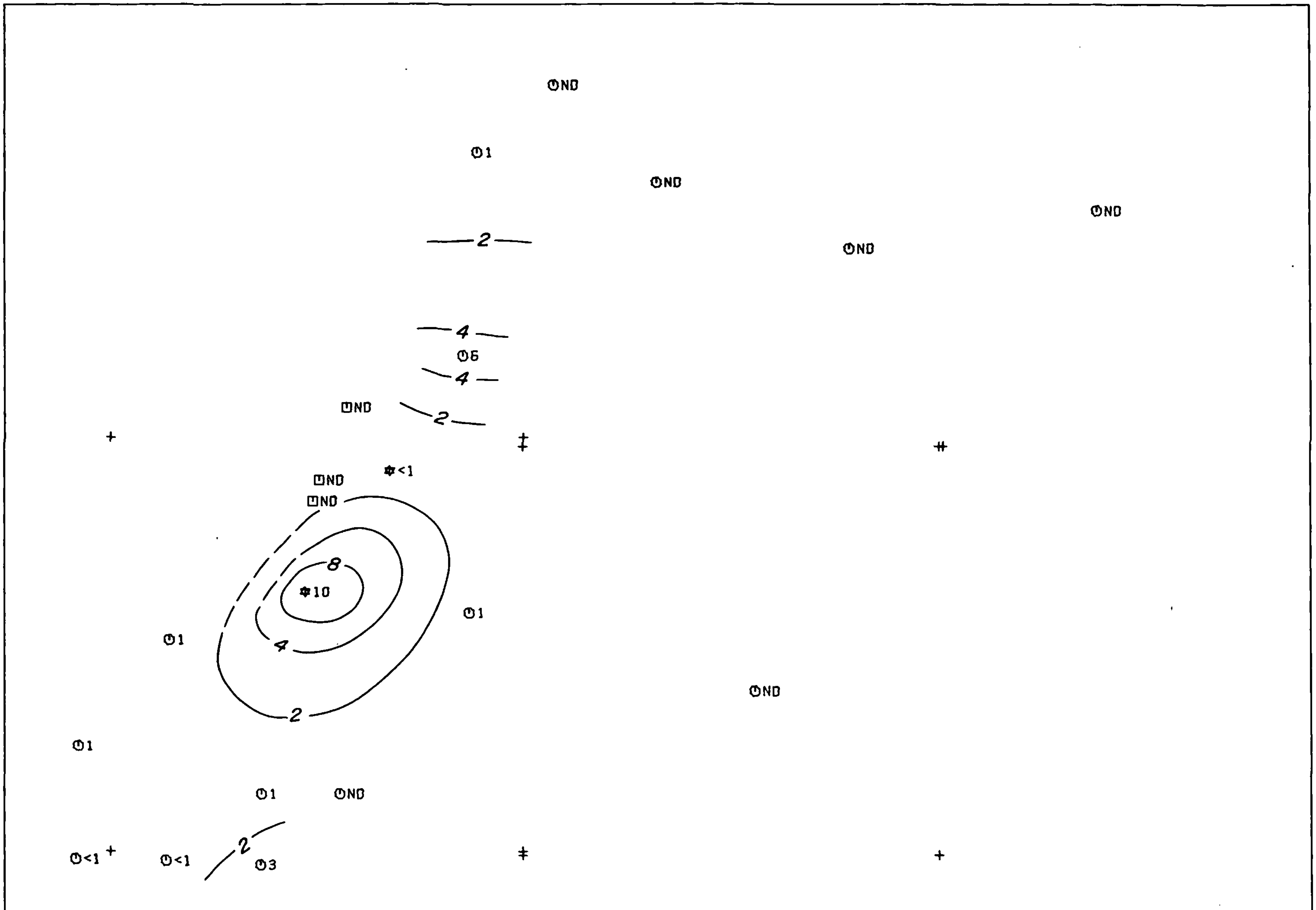


FIGURE: 26 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES



10000 FEET

FIGURE: 26 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

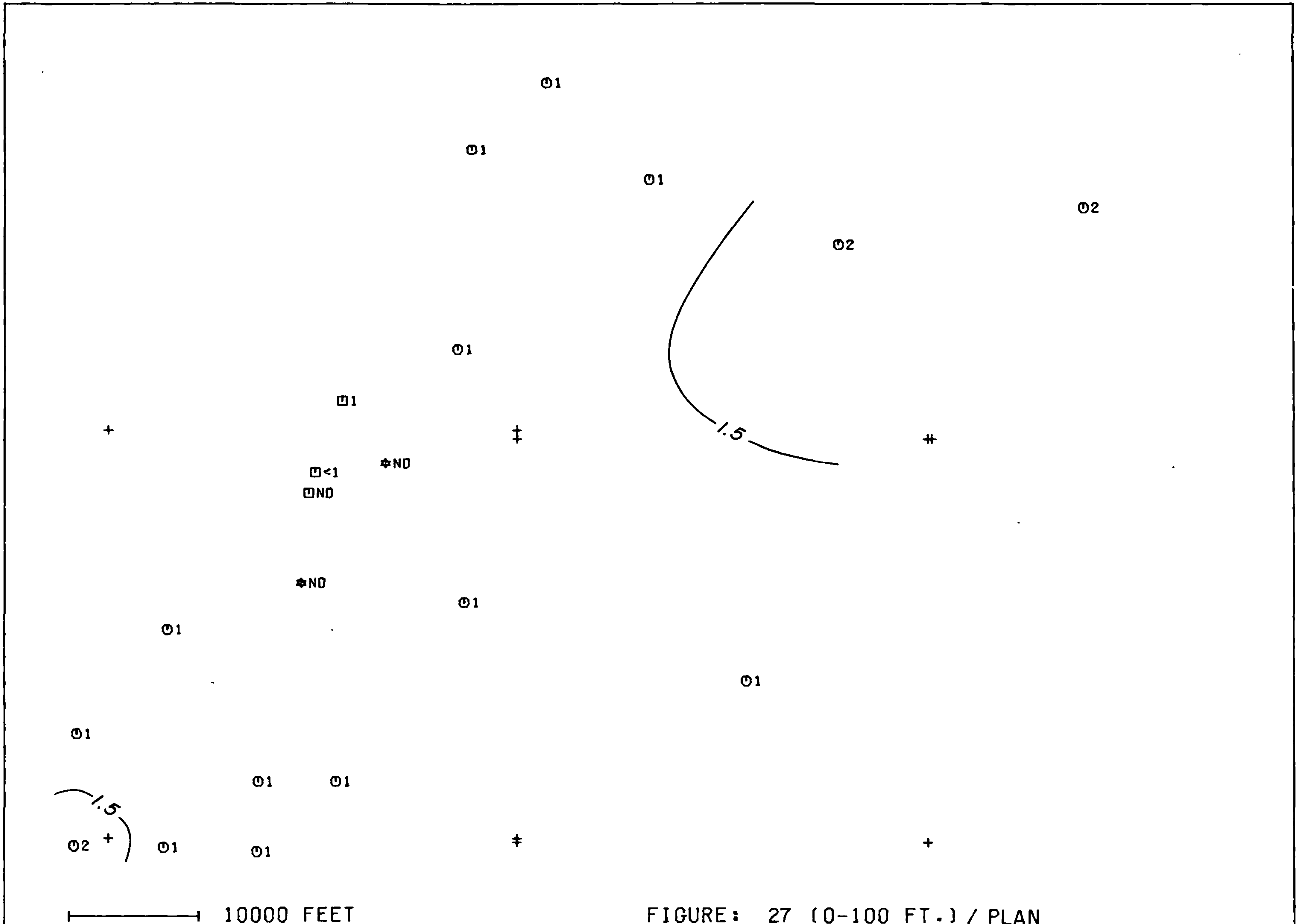
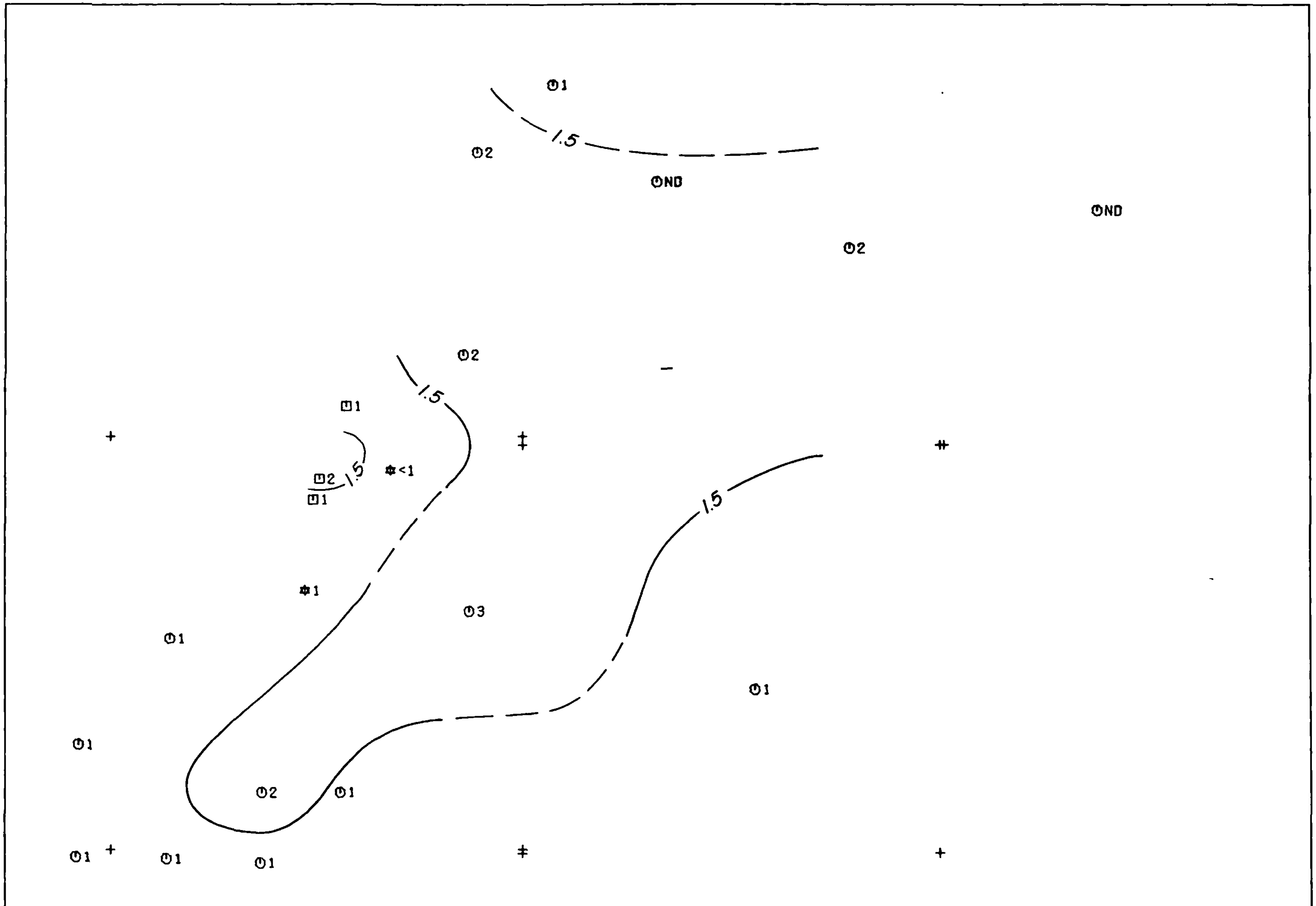


FIGURE: 27 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

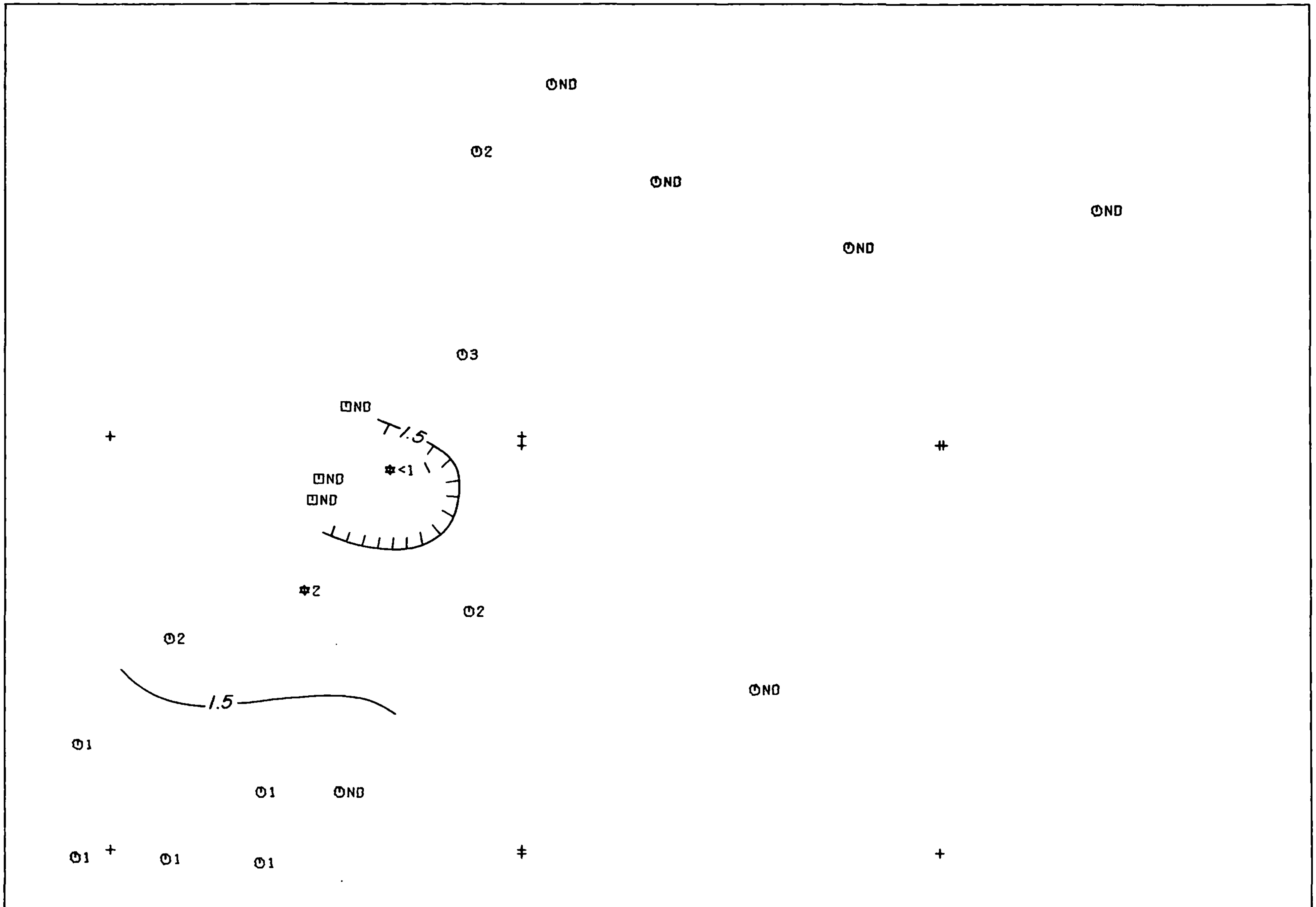


10000 FEET

FIGURE: 27 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES



10000 FEET

FIGURE: 27 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

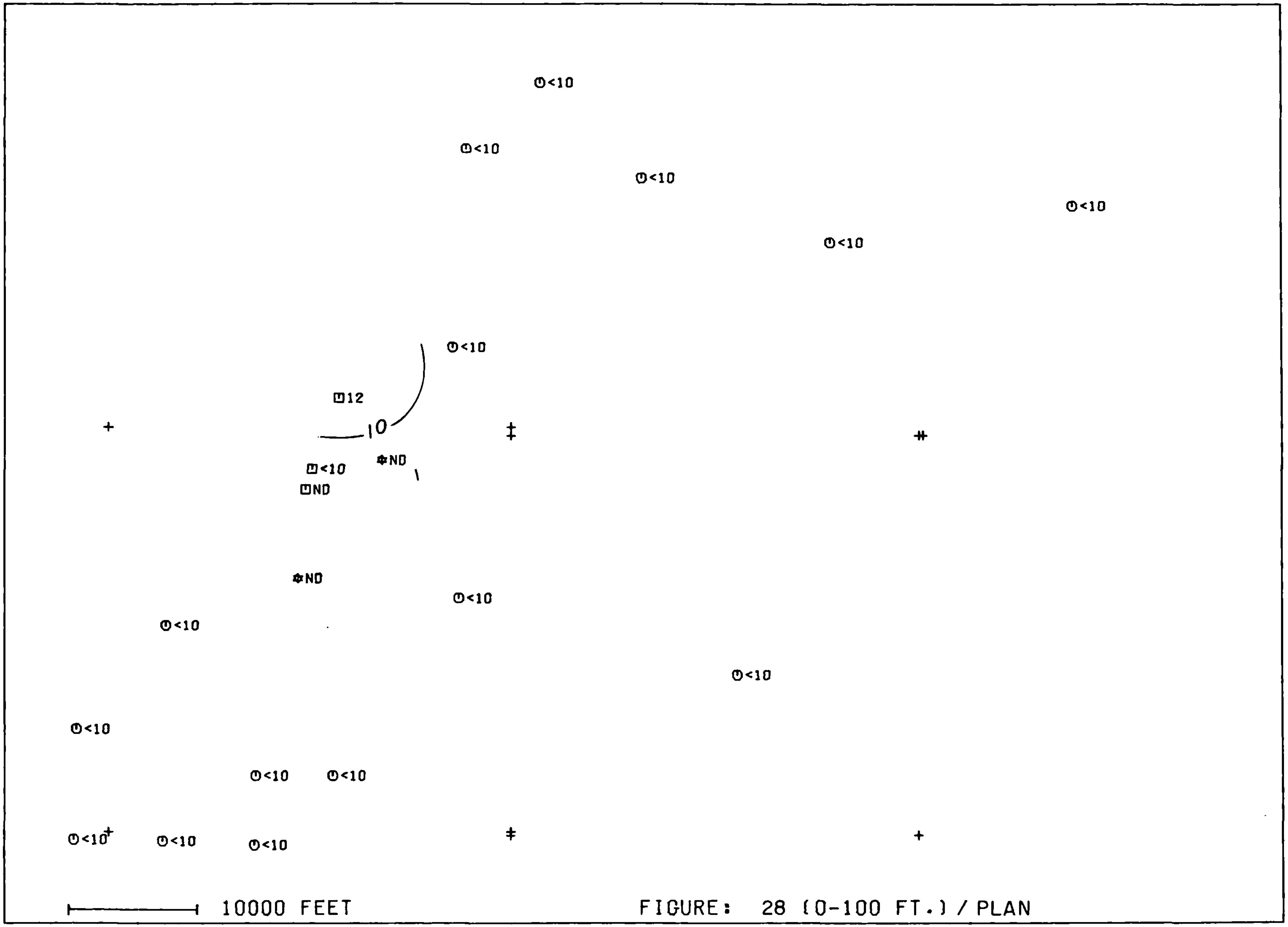
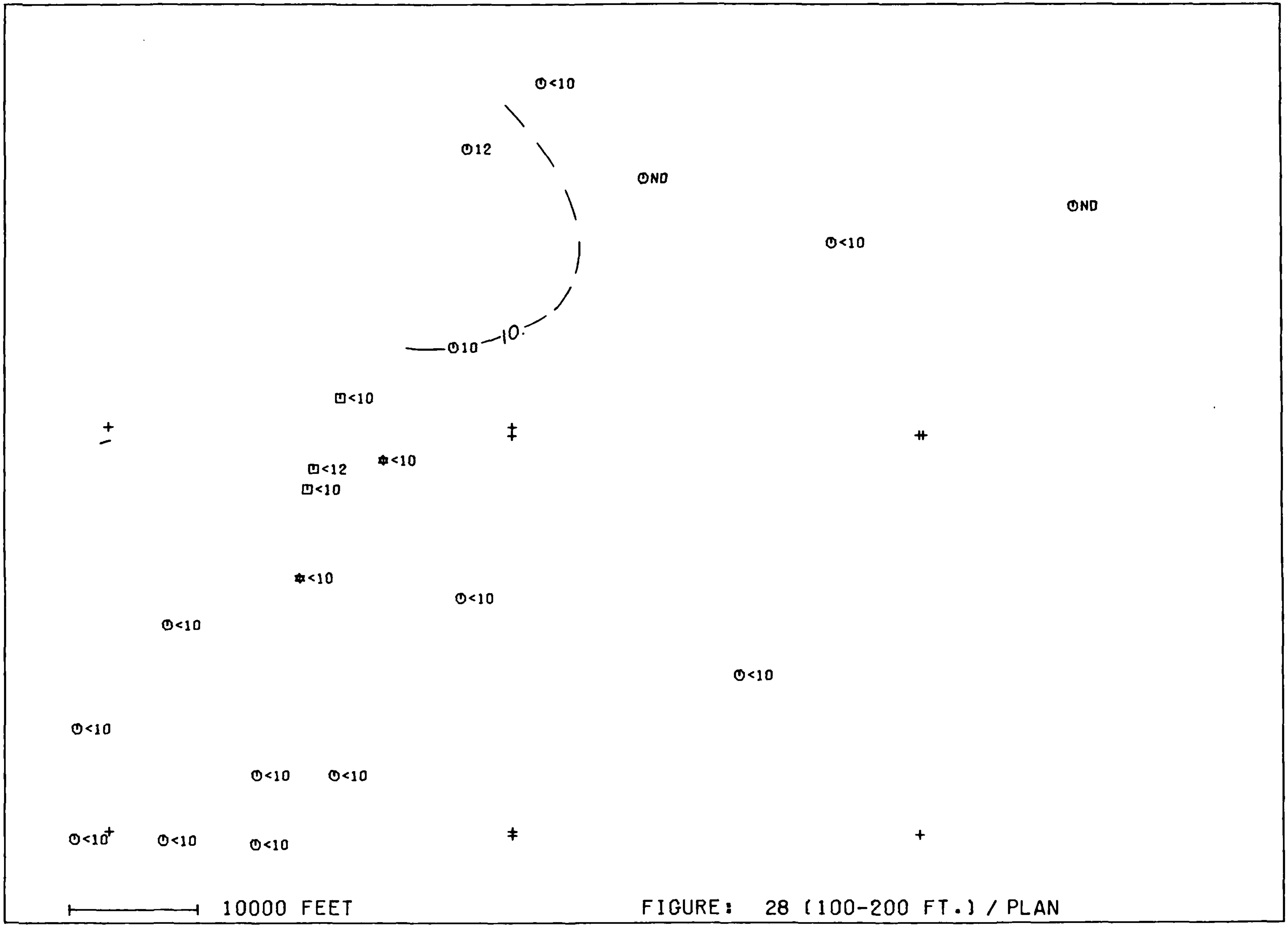


FIGURE: 28 (0-100 FT.) / PLAN

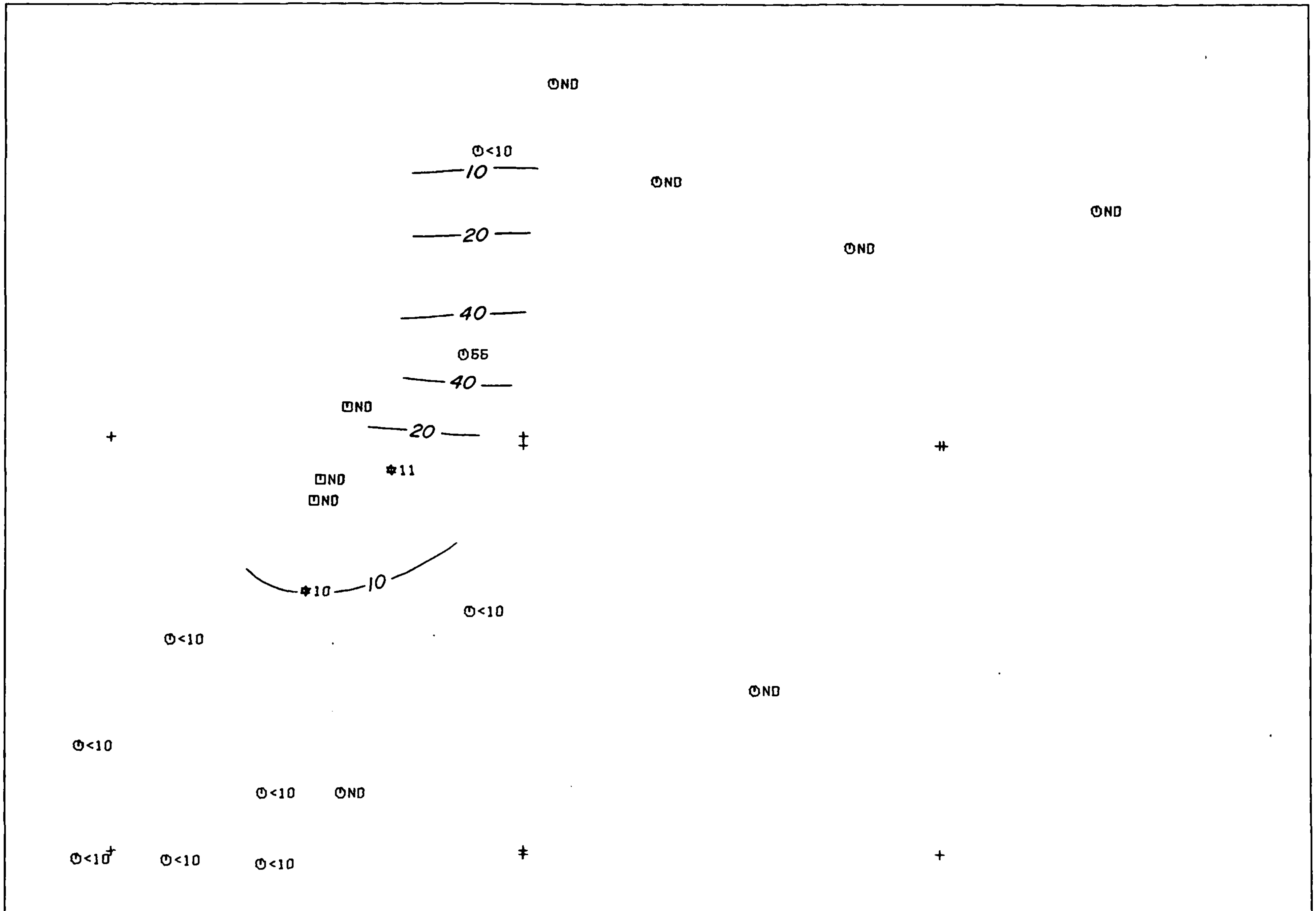
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES



10000 FEET

FIGURE: 28 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

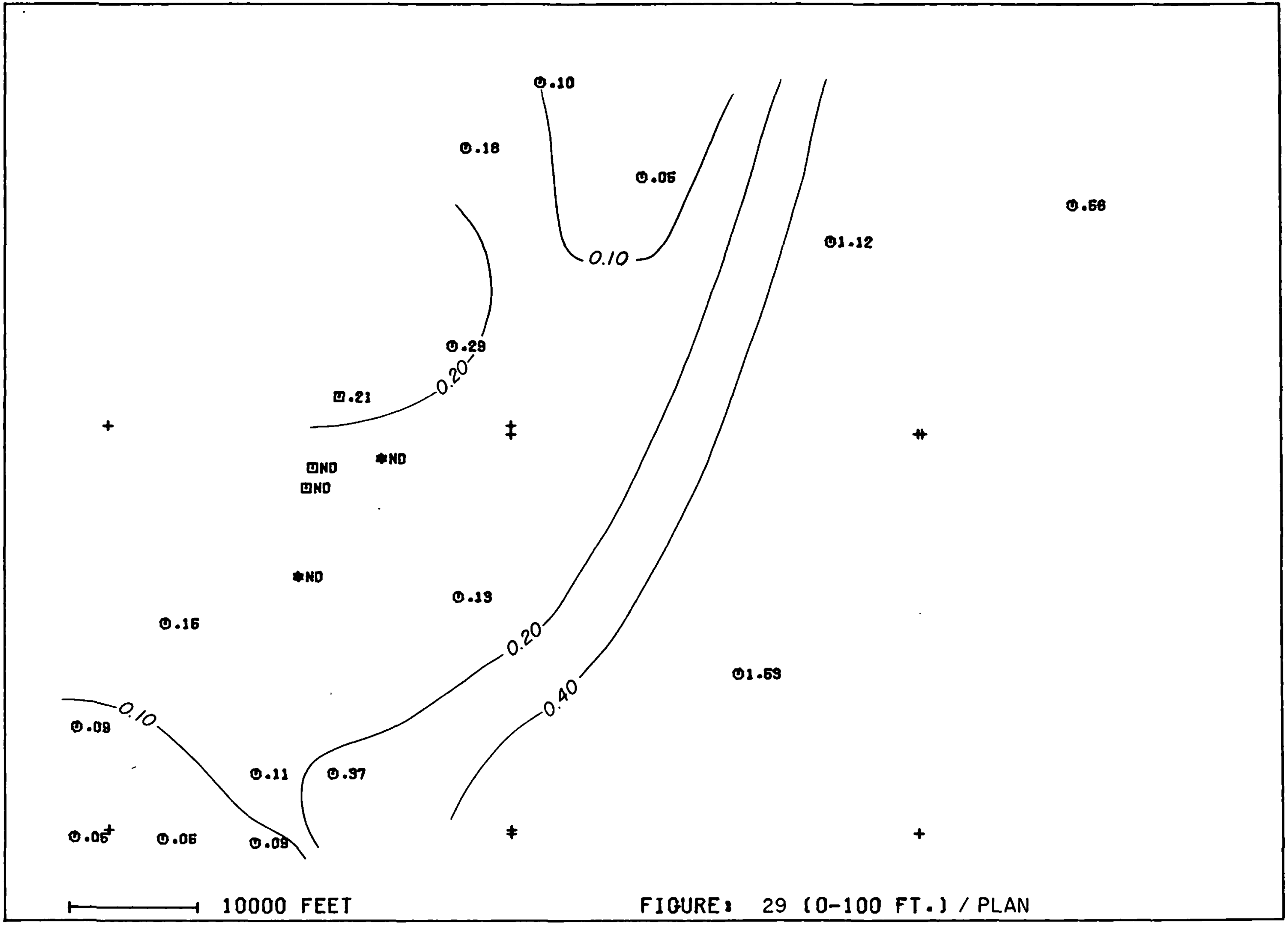


FIGURE: 29 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.3 LESS MAG 0-100 FT.

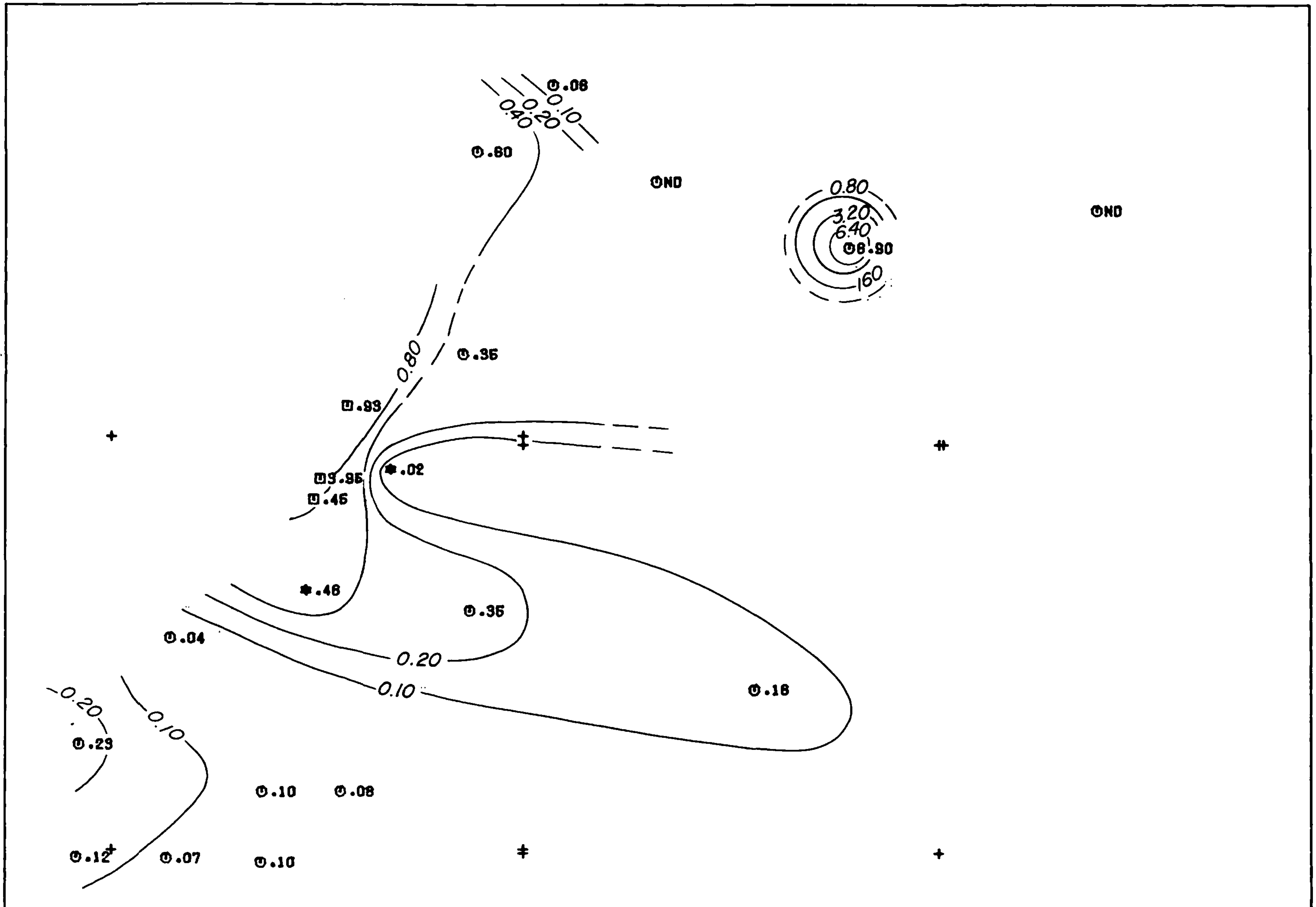
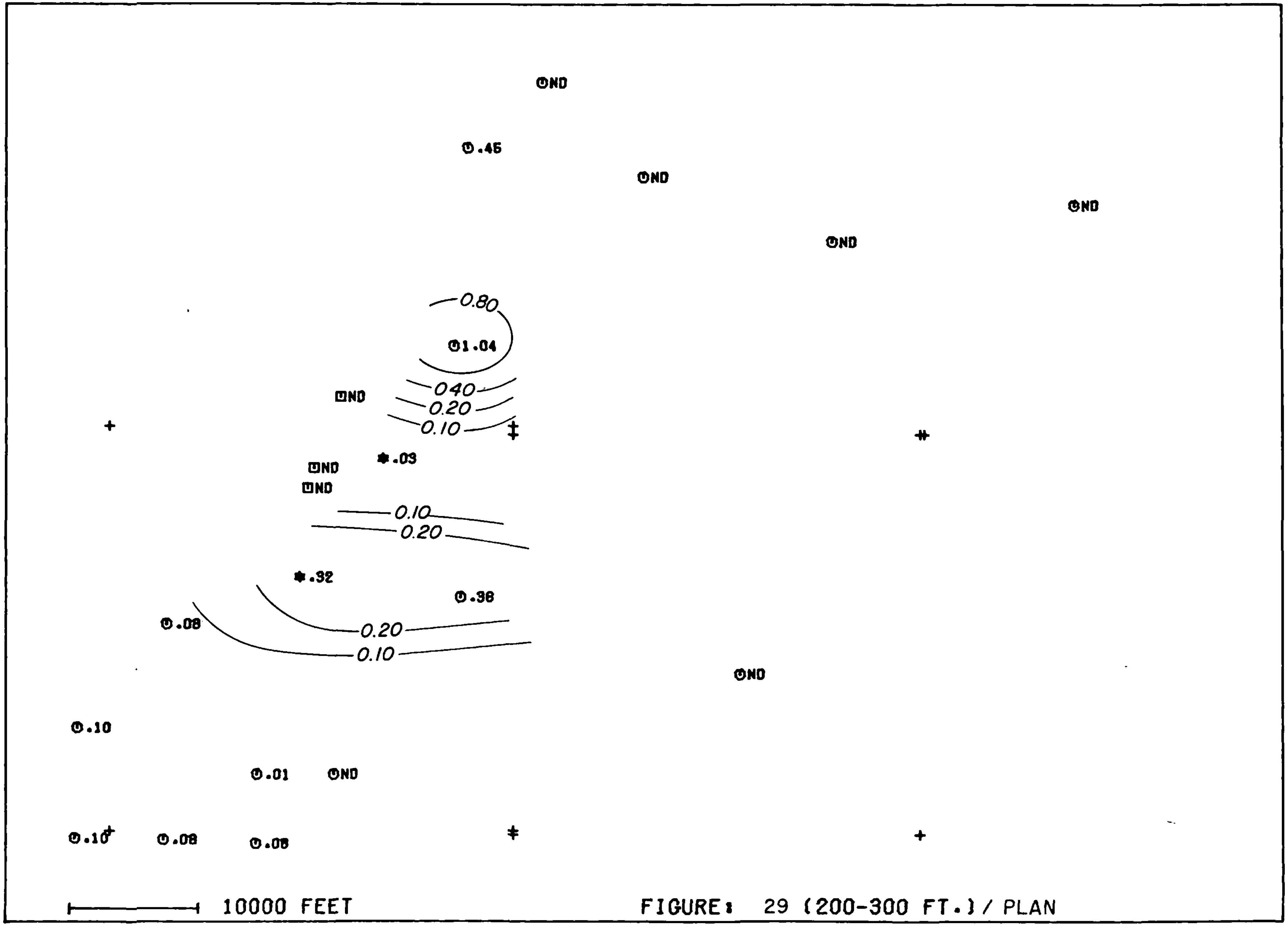


FIGURE: 29 (100-200 FT.) / PLAN

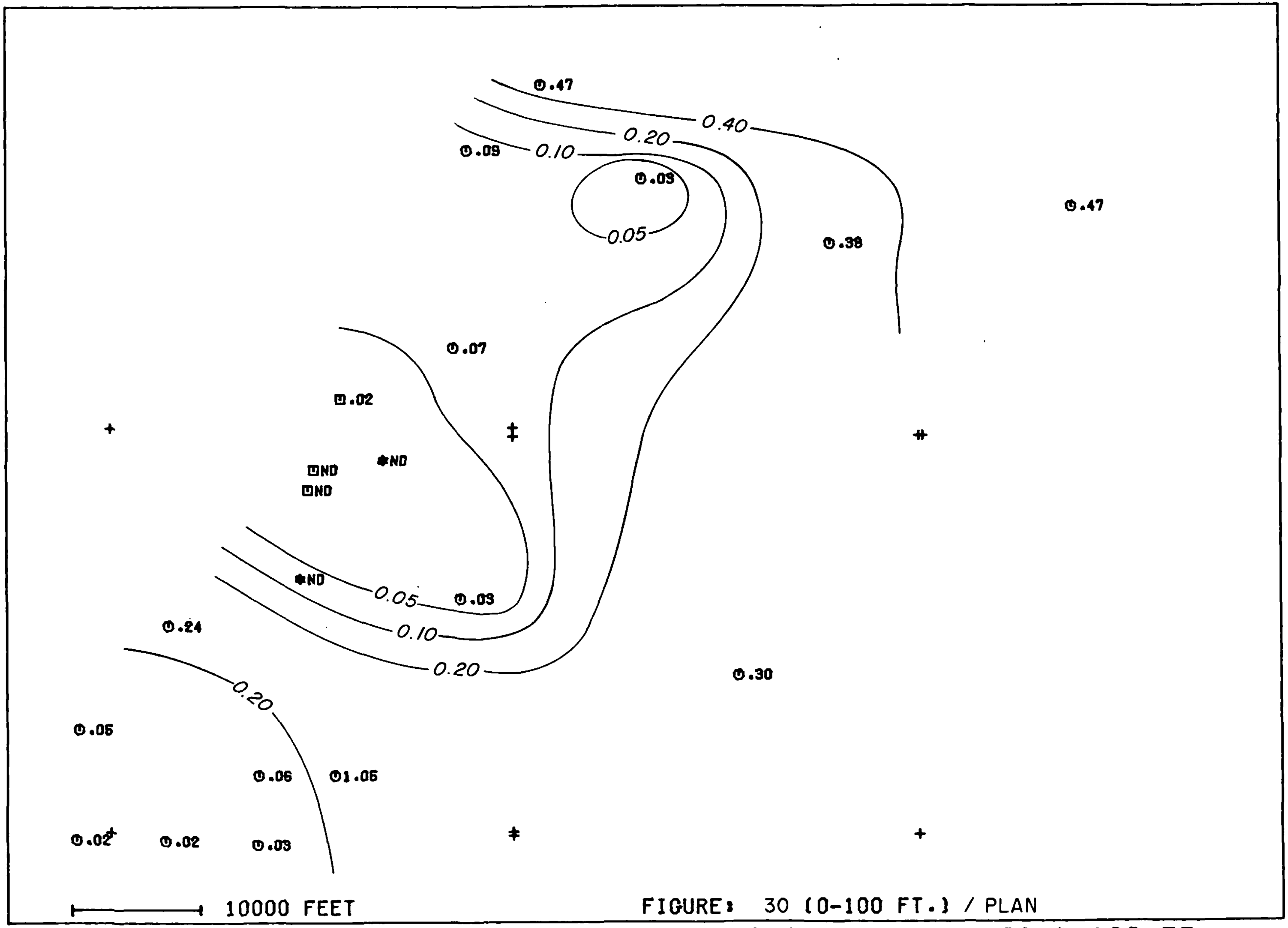
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.3 LESS MAG 100-200 FT.



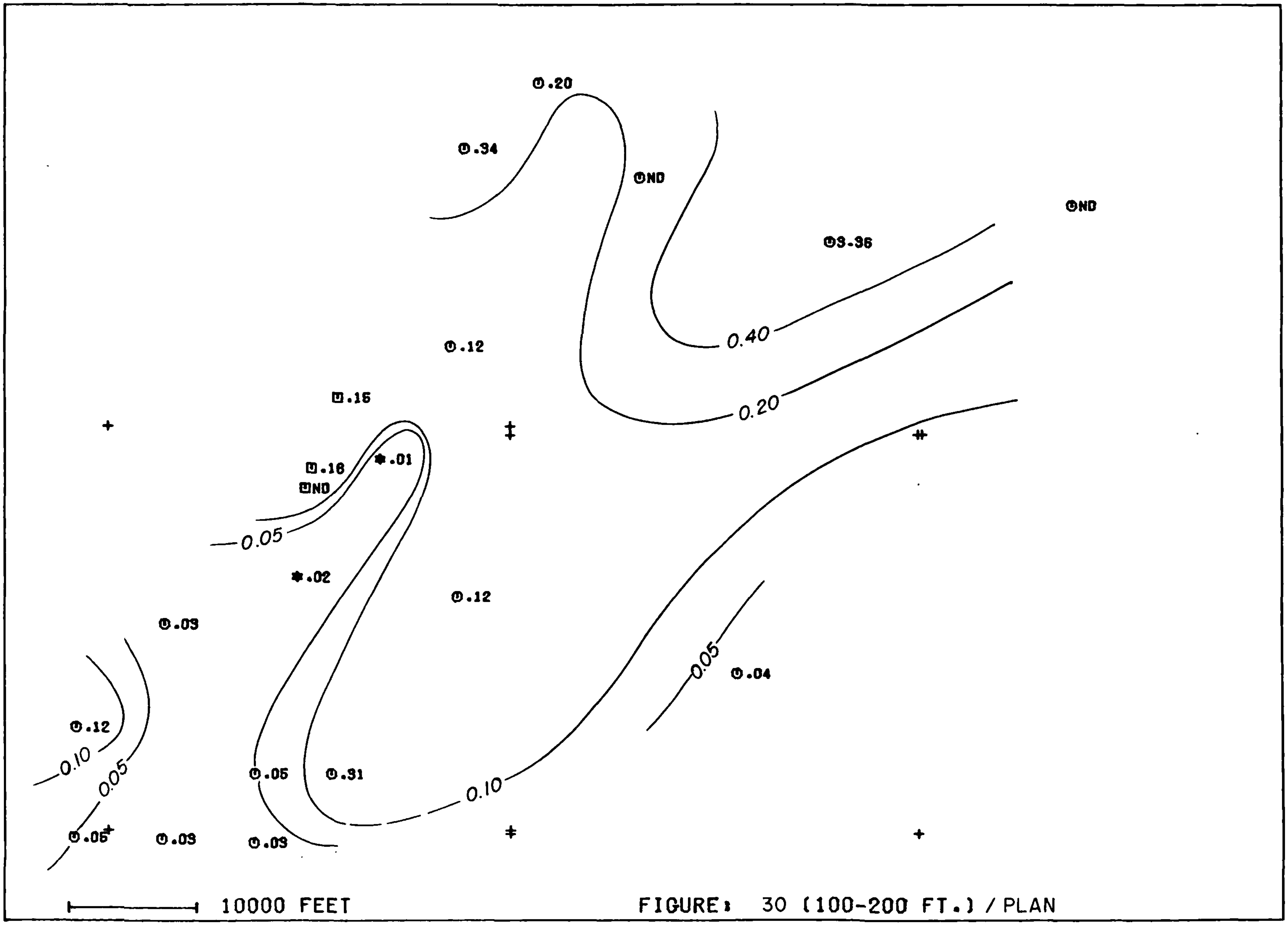
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.3 LESS MAG 200-300 FT.



ROOSEVELT KGRA
BEAVER COUNTY,UTAH

WT % +3.0-3.3 LESS MAG 0-100 FT.



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.0-3.3 LESS MAG 100-200 FT.

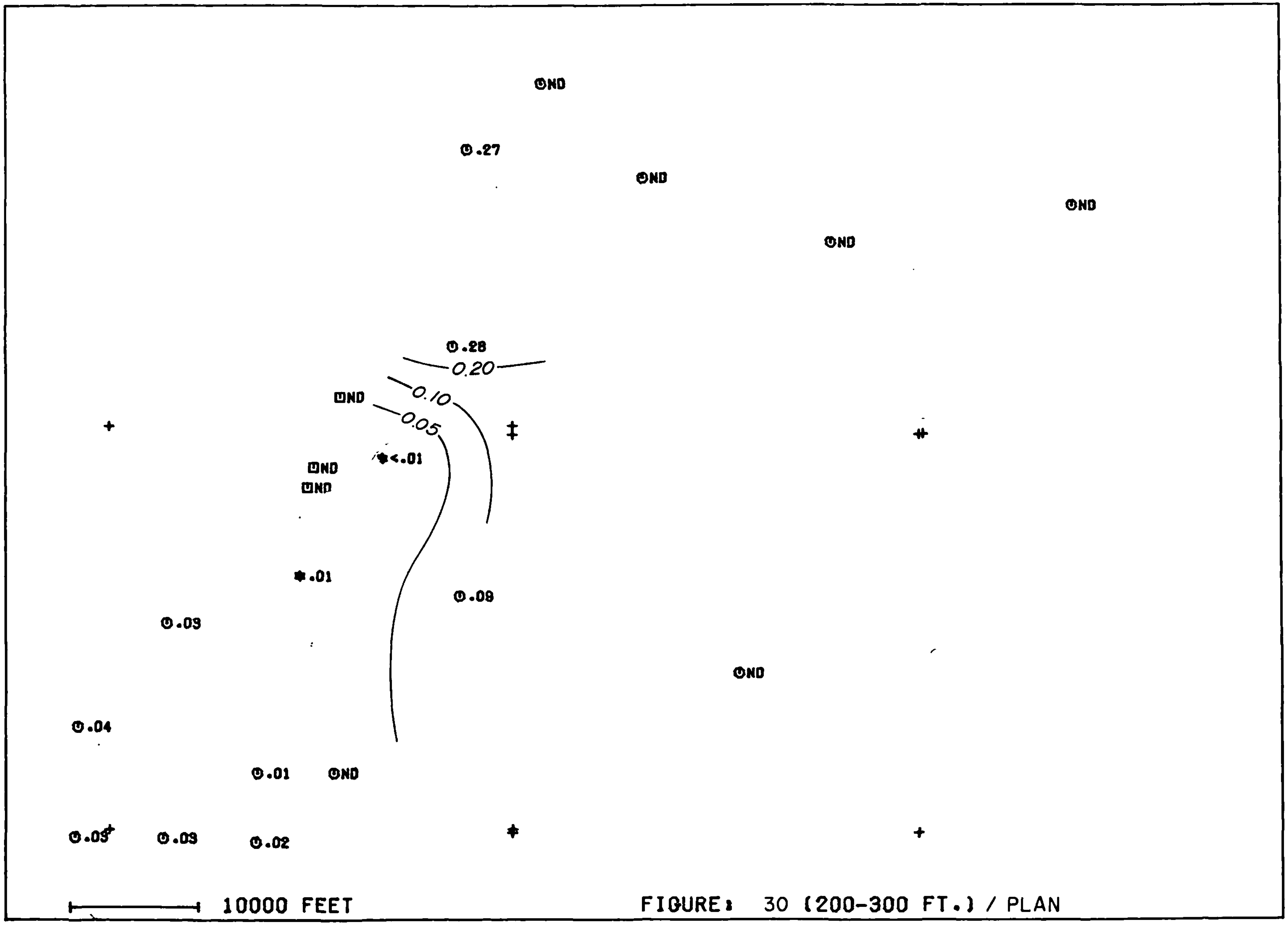


FIGURE: 30 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.0-3.3 LESS MAG 200-300 FT.

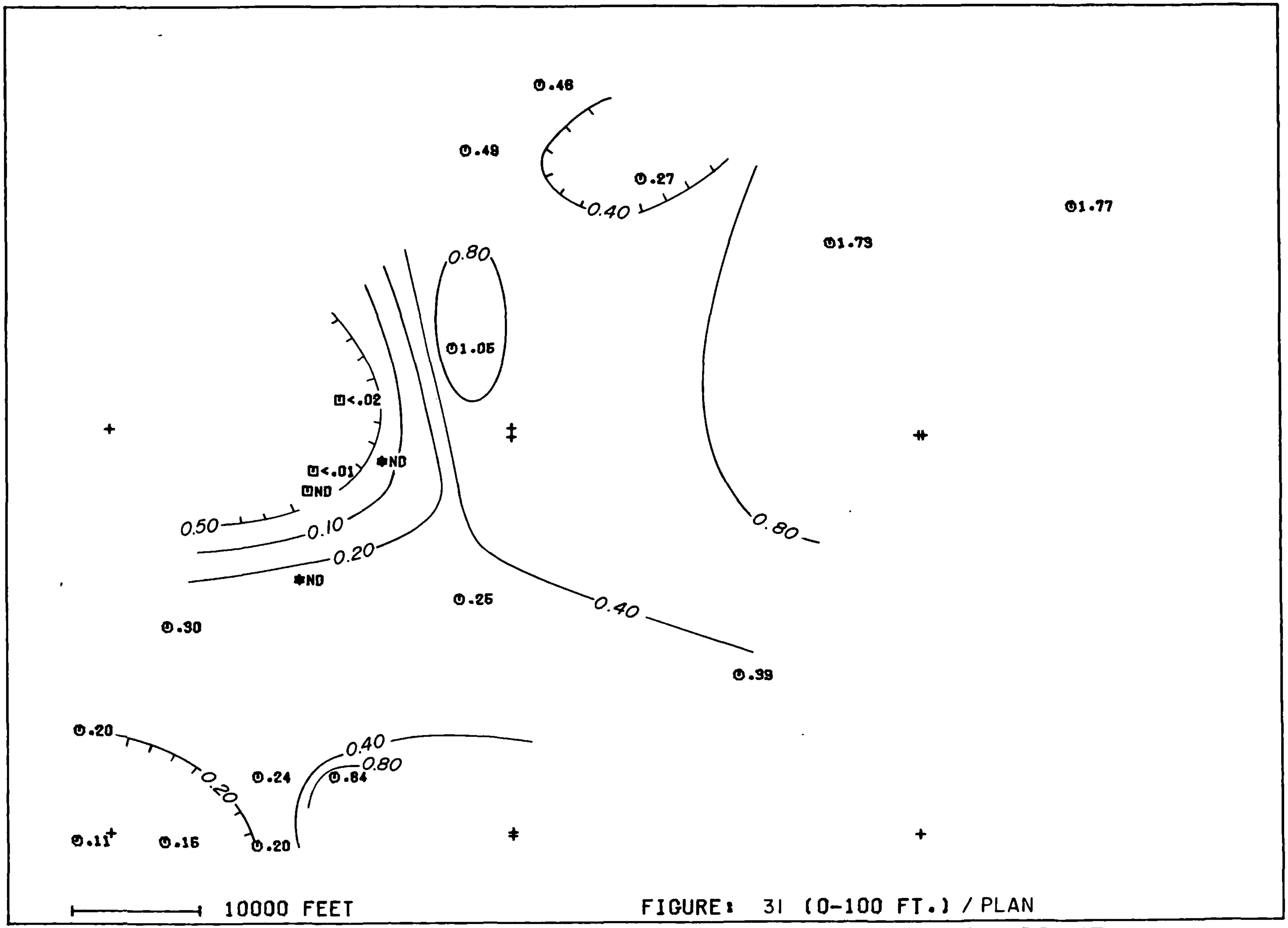
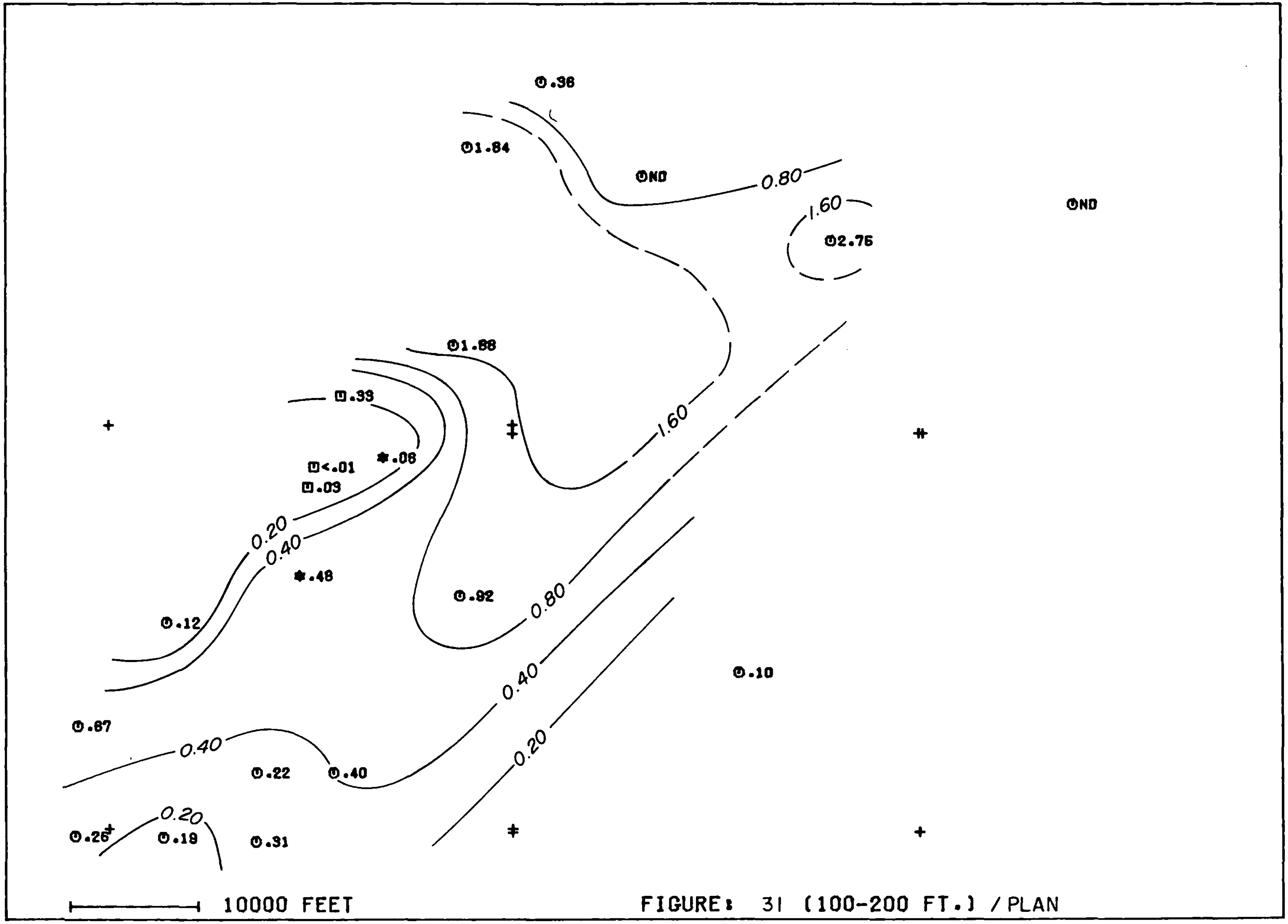


FIGURE: 31 (0-100 FT.) / PLAN

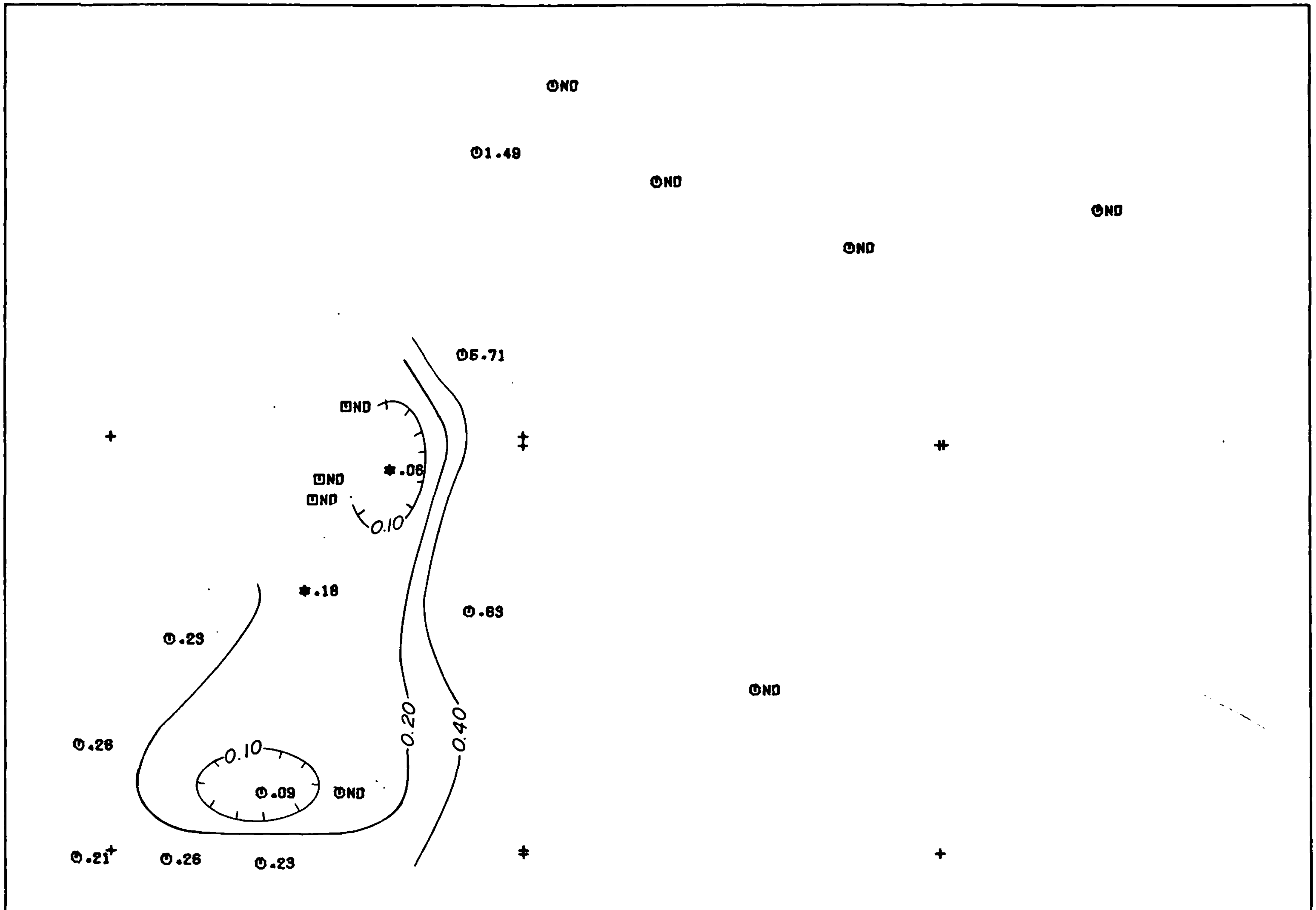
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % MAG FRACTION 0-100 FT.



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % MAG FRACTION 100-200 FT.



10000 FEET

FIGURE: 31 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % MAG FRACTION 200-300 FT.

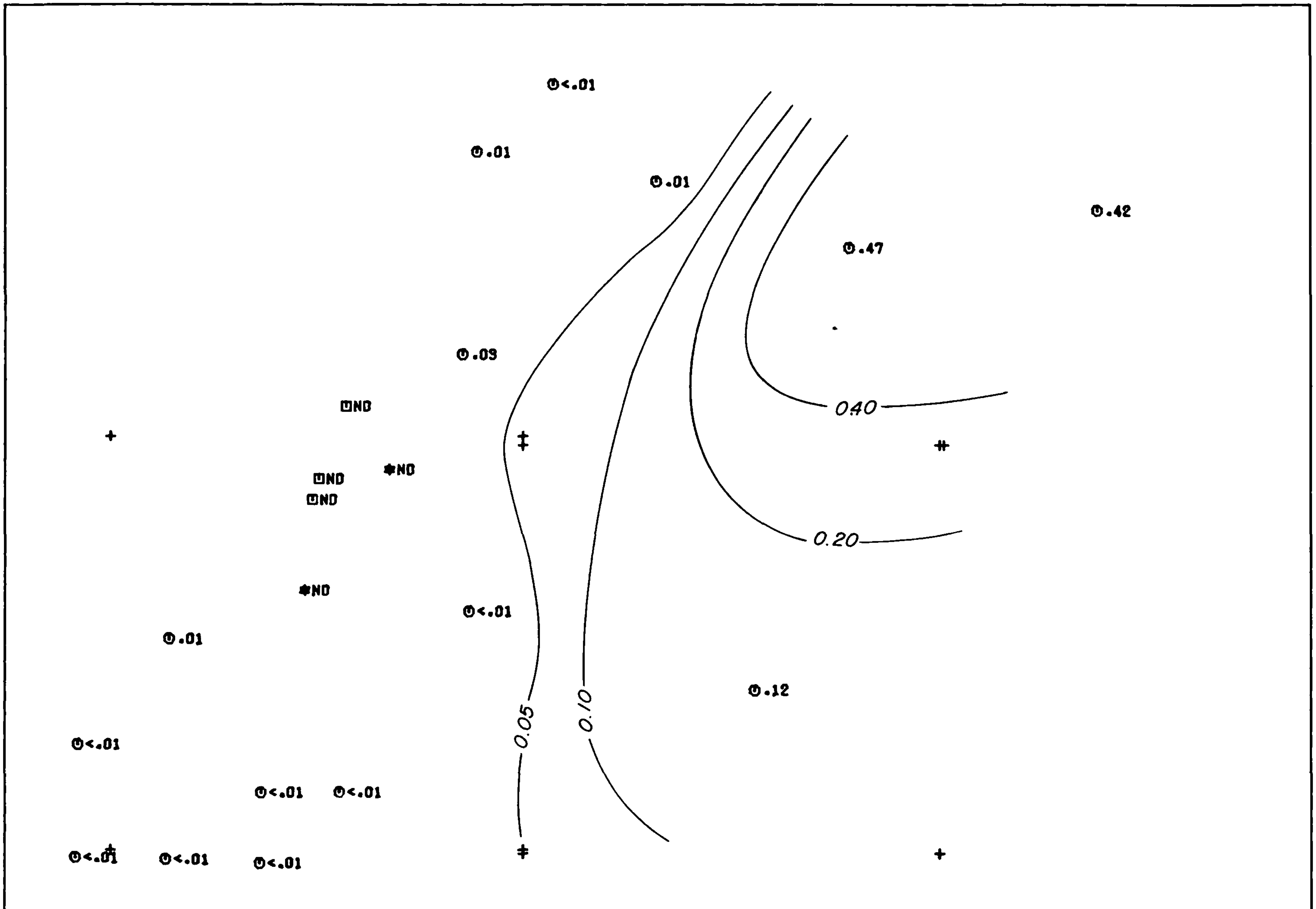


FIGURE: 32 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % HEMATITE 0-100 FT.

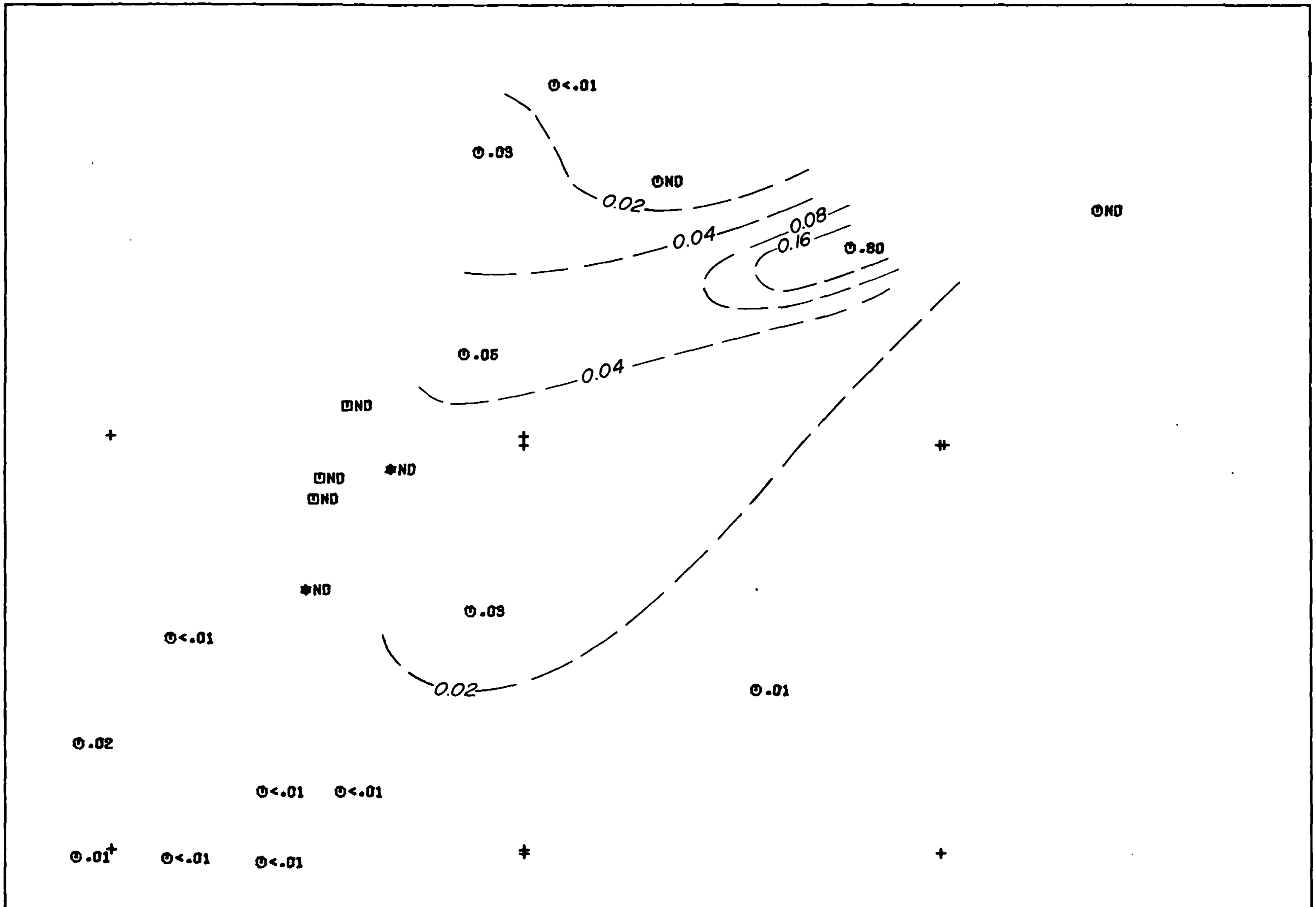


FIGURE: 32 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % HEMATITE 100-200 FT.

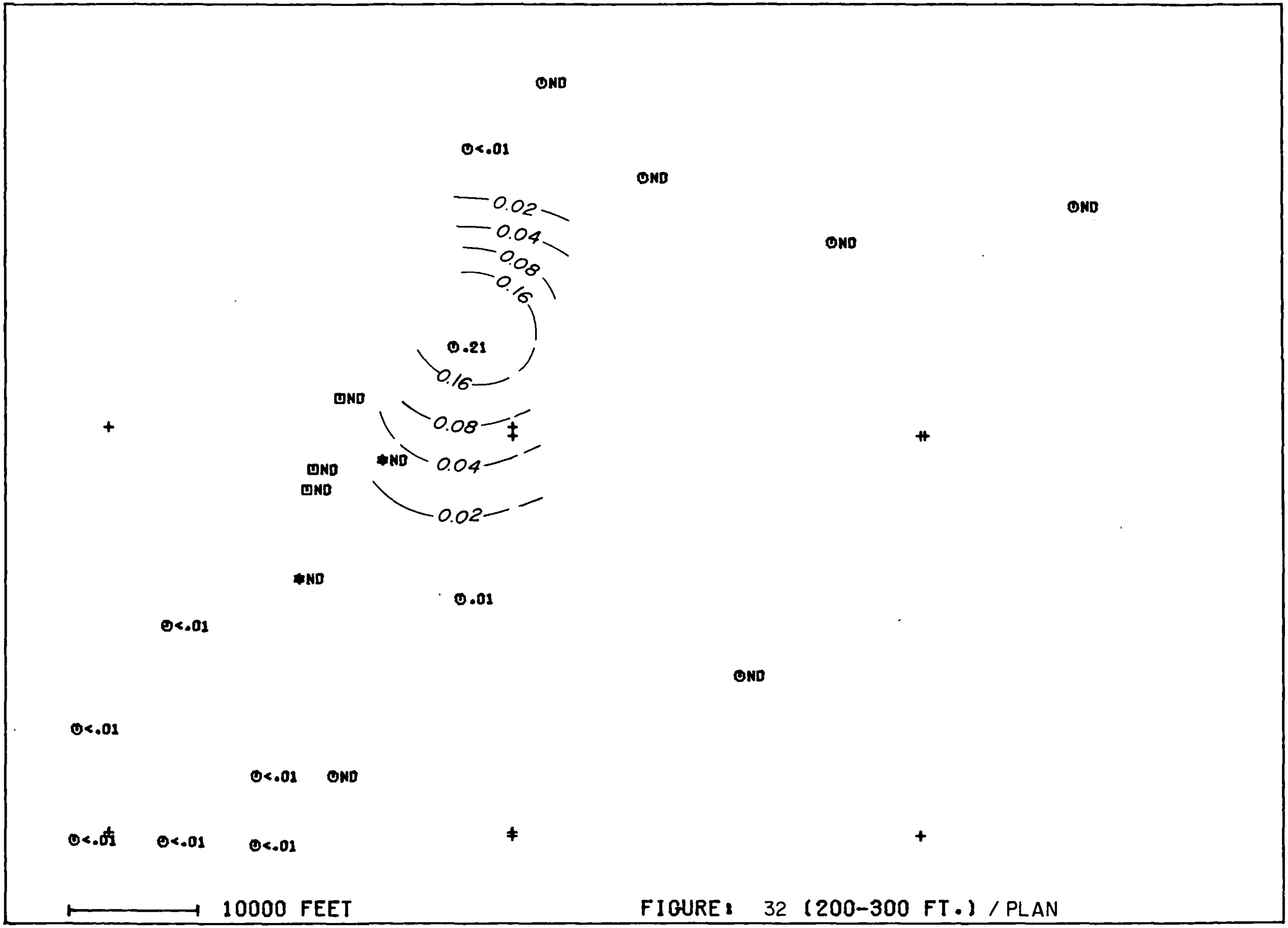


FIGURE: 32 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % HEMATITE 200-300 FT.

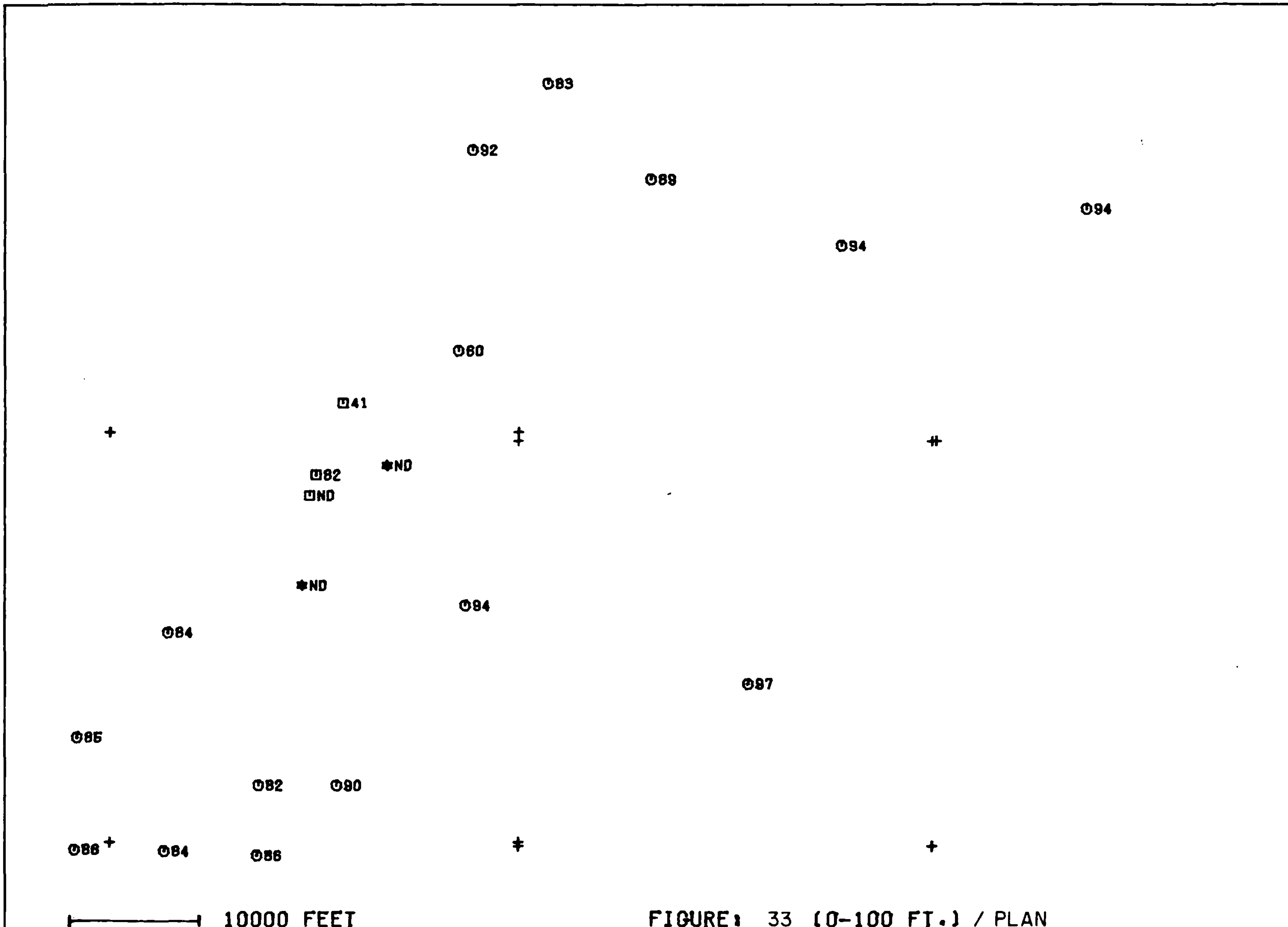


FIGURE: 33 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

VOL % SILICATES IN +3.3 0-100 FT.

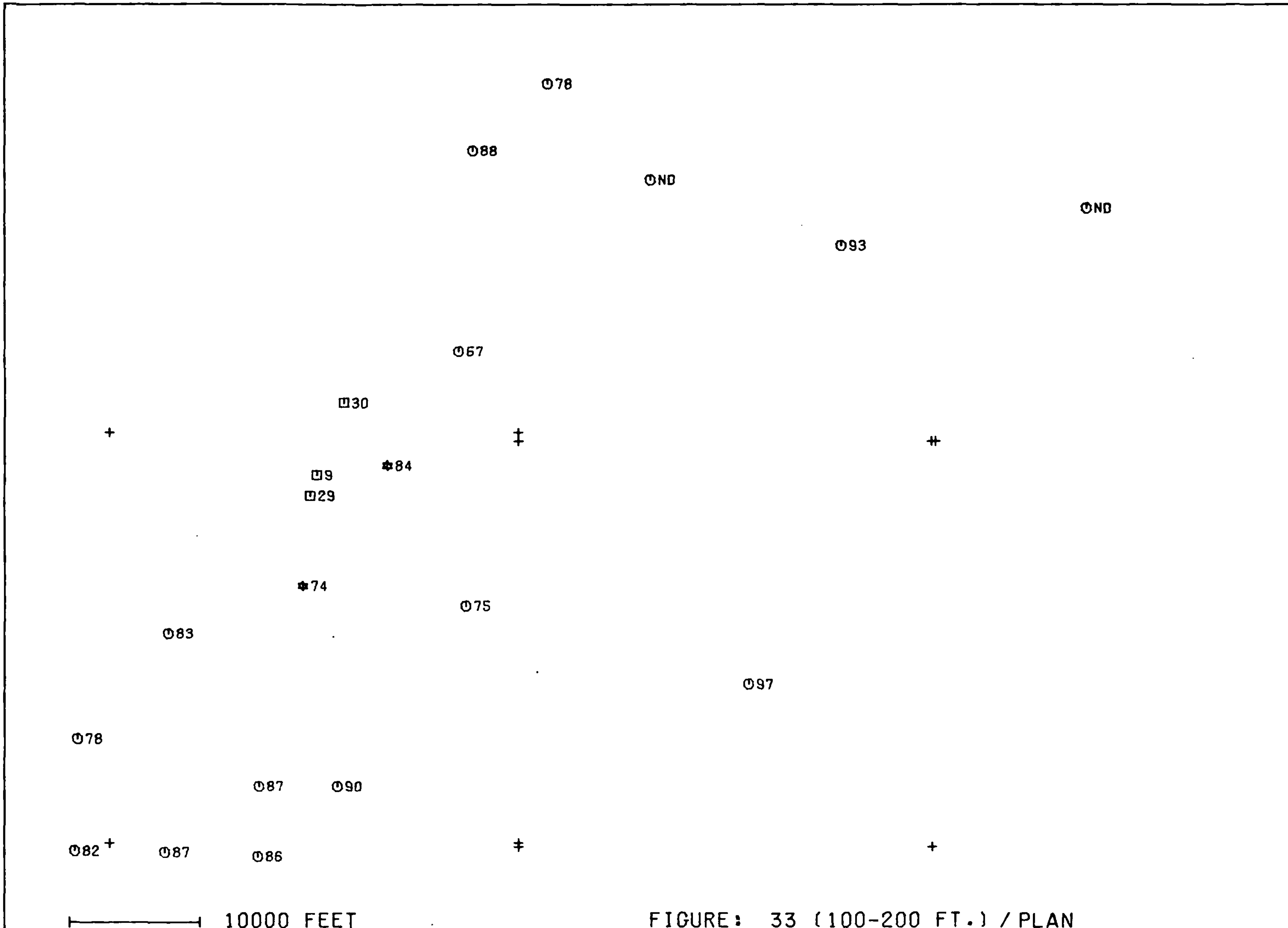
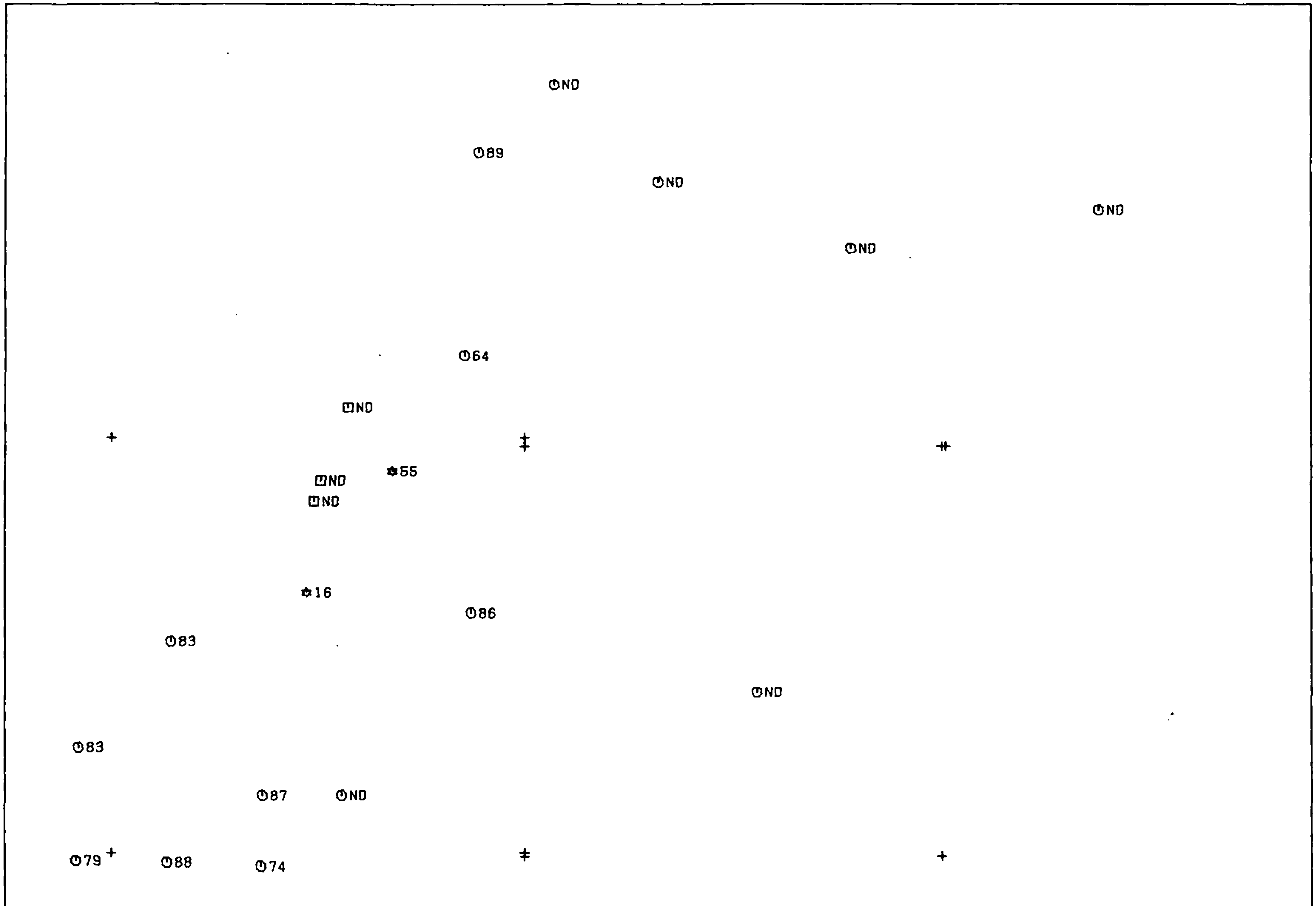


FIGURE: 33 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

VOL % SILICATES IN +3.3 100-200 FT.



10000 FEET

FIGURE: 33 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

VOL % SILICATES IN +3.3 200-300 FT.

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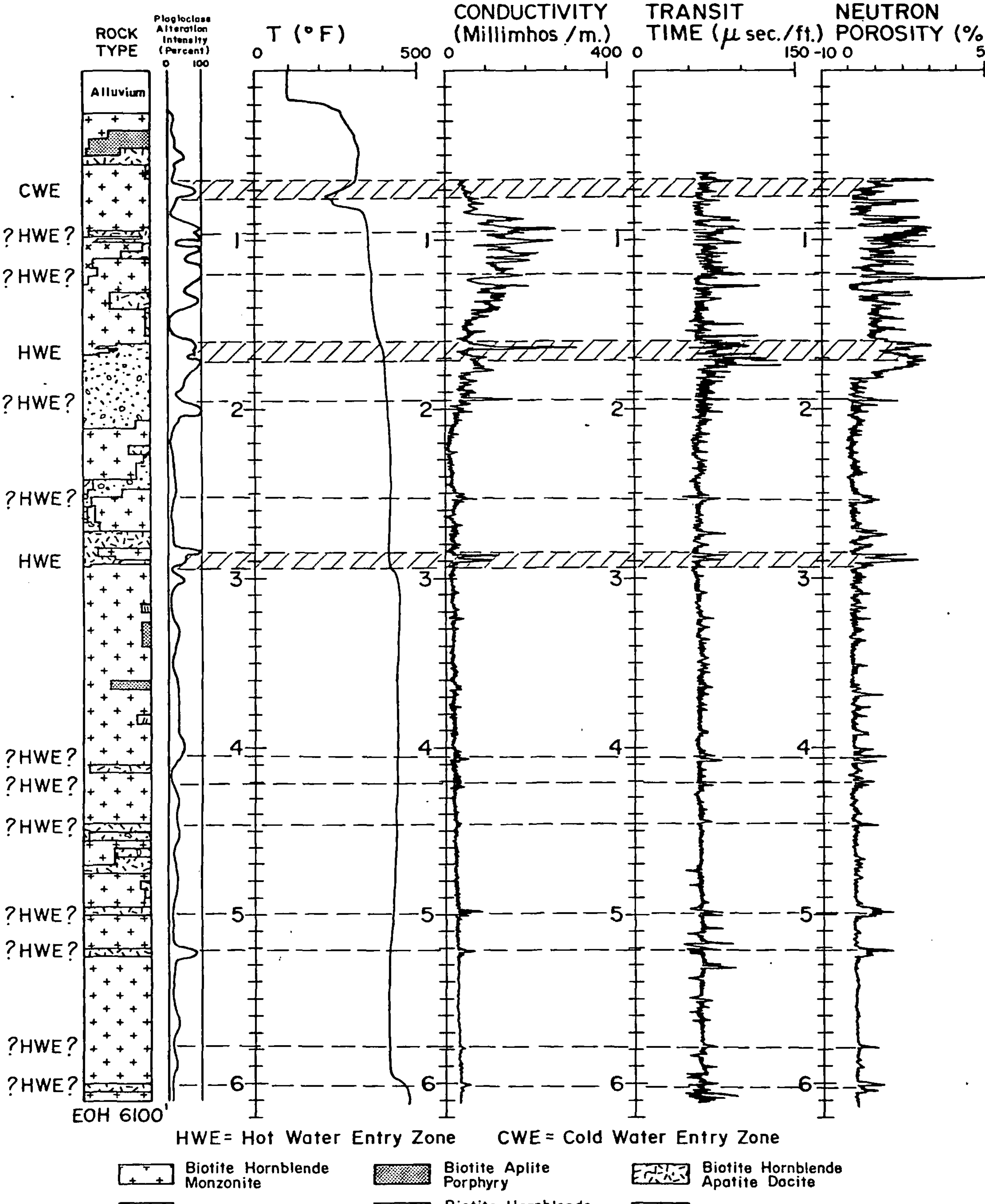
FIGURE 1/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

GENERALIZED GEOLOGY AND SELECTED GEOPHYSICAL LOGS
VERT. SCALE: 800 FT./IN.



Geophysical Logs from Thermal Power Co., Deliverable to DOE/DGE Case Studies Program Contract No. EG-77-C-08-1525.
Geology and Alteration Data after Ballantyne and Parry, 1978.

FIGURE 2/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE:
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

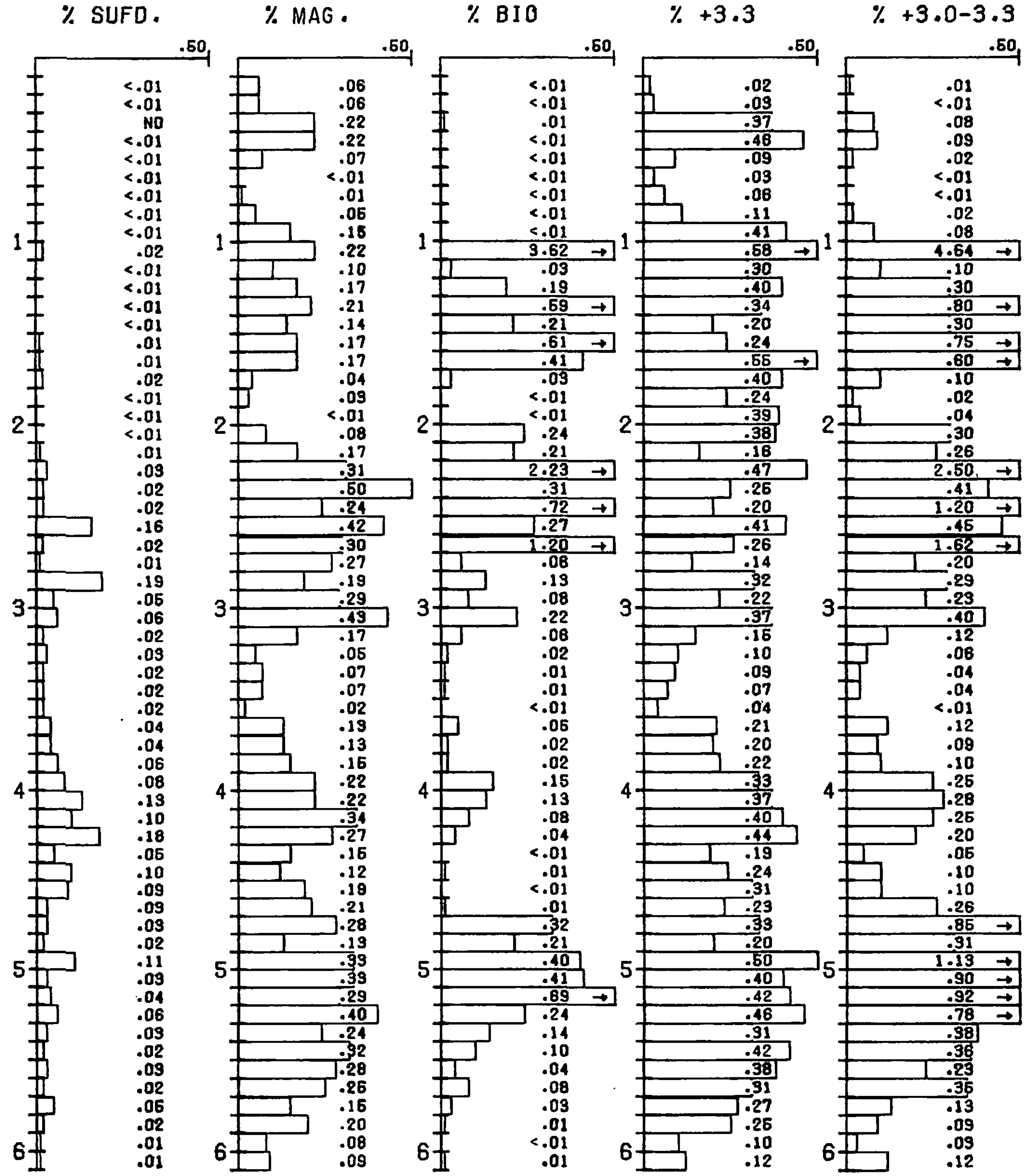


FIGURE 3/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

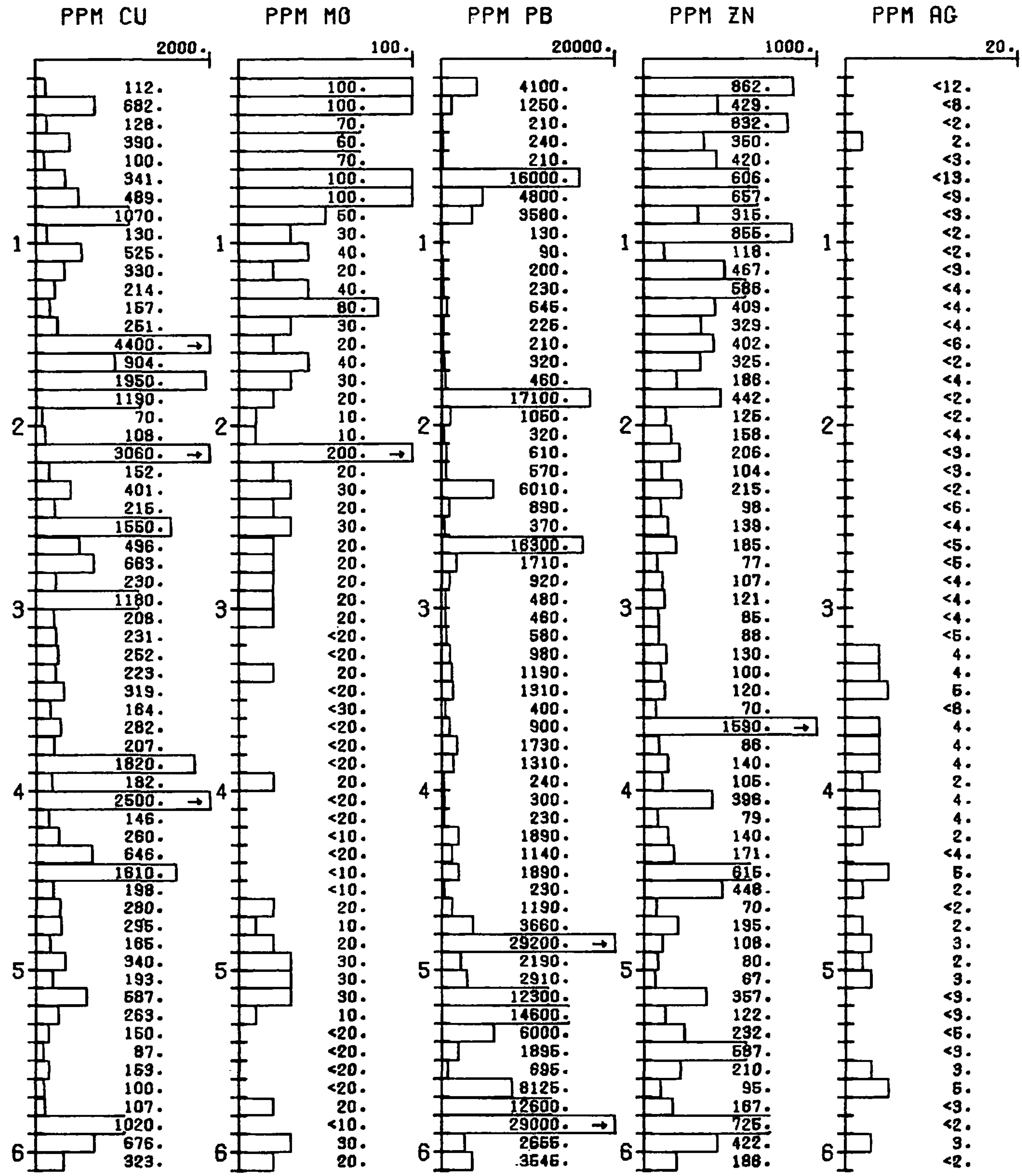


FIGURE 4/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

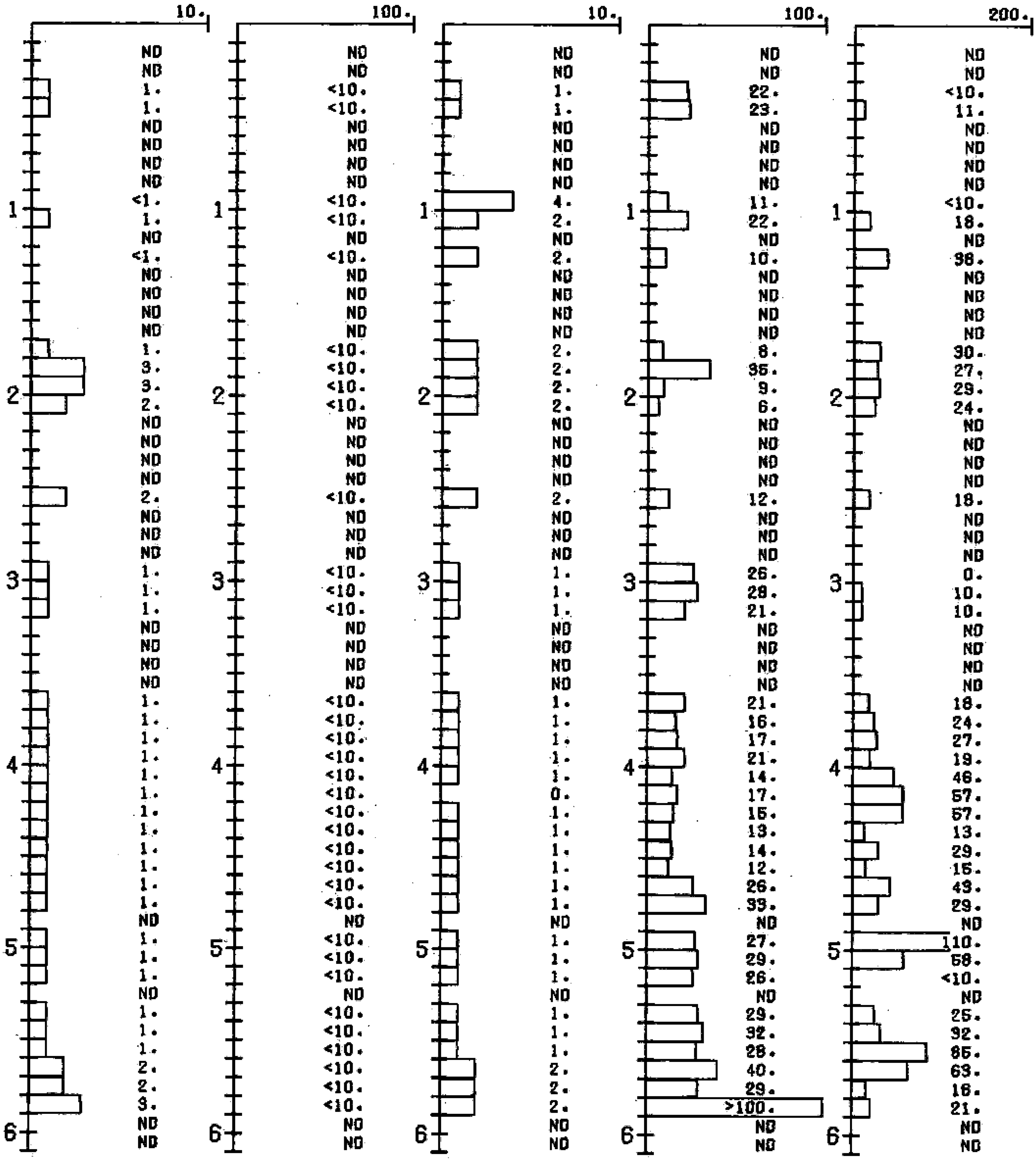
Depth	PPM MN (scale 50000.)	PPM CO (scale 200.)	PPM NI (scale 500.)	% FE (scale 100.0)	PPM AS (scale 800.)
	17000.	100.	350.	12.6	<250.
	48600.	35.	240.	25.9	<170.
	44000.	50.	70.	25.7	<50.
	25800.	70.	90.	29.5	<60.
	44700.	110.	110.	24.9	<70.
	11900.	<50.	250.	47.6	<250.
	71500. →	<30.	200.	34.6	<160.
	20400.	45.	80.	31.9	<60.
	39000.	20.	80.	33.0	<50.
1	5700.	70.	120.	30.8	<50.
	8440.	35.	120.	47.9	265.
	11400.	45.	110.	41.5	570.
	5590.	15.	120.	39.8	315.
	5870.	45.	110.	37.4	285.
	4965.	45.	140.	42.6	235.
	3295.	30.	100.	53.2	280.
	1110.	15.	90.	61.8	70.
	6800.	20.	70.	58.5	<50.
	1000.	20.	60.	68.5	<50.
2	1365.	15.	90.	69.2	<75.
	2395.	55.	80.	36.5	<55.
	3630.	30.	90.	25.2	<55.
	1865.	80.	90.	29.1	<55.
	2950.	50.	150.	34.3	<120.
	1145.	245. →	360.	36.4	320.
	1655.	80.	200.	27.6	<95.
	1535.	65.	220.	15.6	<110.
	945.	295. →	530. →	39.8	410.
	1790.	150.	130.	20.7	210.
3	2460.	90.	150.	18.6	<75.
	3000.	100.	180.	24.5	<125.
	1515.	160.	160.	32.2	<70.
	2750.	105.	130.	30.1	<75.
	2700.	105.	140.	27.8	<90.
	2100.	60.	190.	25.8	<155.
	6110.	70.	130.	19.7	<70.
	4145.	100.	130.	25.2	70.
	4600.	80.	120.	24.6	65.
	4400.	70.	90.	23.4	100.
4	4165.	135.	130.	31.0	210.
	5140.	100.	90.	20.8	<70.
	5700.	60.	90.	21.9	175.
	7035.	55.	100.	24.3	<70.
	1900.	80.	120.	22.0	125.
	4825.	50.	90.	18.5	75.
	6125.	60.	140.	16.1	<50.
	4125.	60.	150.	12.2	<50.
	7375.	75.	110.	17.0	<65.
	2100.	180.	210.	20.4	150.
5	5635.	80.	130.	16.4	<65.
	6000.	70.	150.	19.2	<65.
	9010.	110.	160.	19.6	55.
	13800.	<20.	140.	19.2	<90.
	14400.	10.	110.	20.7	<65.
	11900.	30.	130.	19.0	<65.
	9365.	<20.	180.	16.9	<90.
	10000.	50.	110.	26.1	665.
	9975.	40.	90.	21.8	50.
6	12200.	40.	130.	24.4	155.
	10900.	60.	130.	21.7	100.

FIGURE 5/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)



PPM BI	PPM TE	PPM IN	PPM SN	PPM W
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
1.	<10.	1.	22.	<10.
1.	<10.	1.	23.	11.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	4.	11.	<10.
1.	<10.	2.	22.	18.
ND	ND	ND	ND	ND
<1.	<10.	2.	10.	38.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
1.	<10.	2.	8.	30.
3.	<10.	2.	35.	27.
3.	<10.	2.	9.	29.
2.	<10.	2.	6.	24.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
2.	<10.	2.	12.	18.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
1.	<10.	1.	26.	0.
1.	<10.	1.	28.	10.
1.	<10.	1.	21.	10.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
1.	<10.	1.	21.	18.
1.	<10.	1.	16.	24.
1.	<10.	1.	17.	27.
1.	<10.	1.	21.	19.
1.	<10.	1.	14.	46.
1.	<10.	0.	17.	57.
1.	<10.	1.	15.	57.
1.	<10.	1.	13.	13.
1.	<10.	1.	14.	29.
1.	<10.	1.	12.	15.
1.	<10.	1.	26.	43.
1.	<10.	1.	39.	29.
ND	ND	ND	ND	ND
1.	<10.	1.	27.	110.
1.	<10.	1.	29.	58.
1.	<10.	1.	26.	<10.
ND	ND	ND	ND	ND
1.	<10.	1.	29.	25.
1.	<10.	1.	32.	32.
1.	<10.	1.	28.	85.
2.	<10.	2.	40.	63.
2.	<10.	2.	29.	16.
3.	<10.	2.	>100.	21.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND

FIGURE 6/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

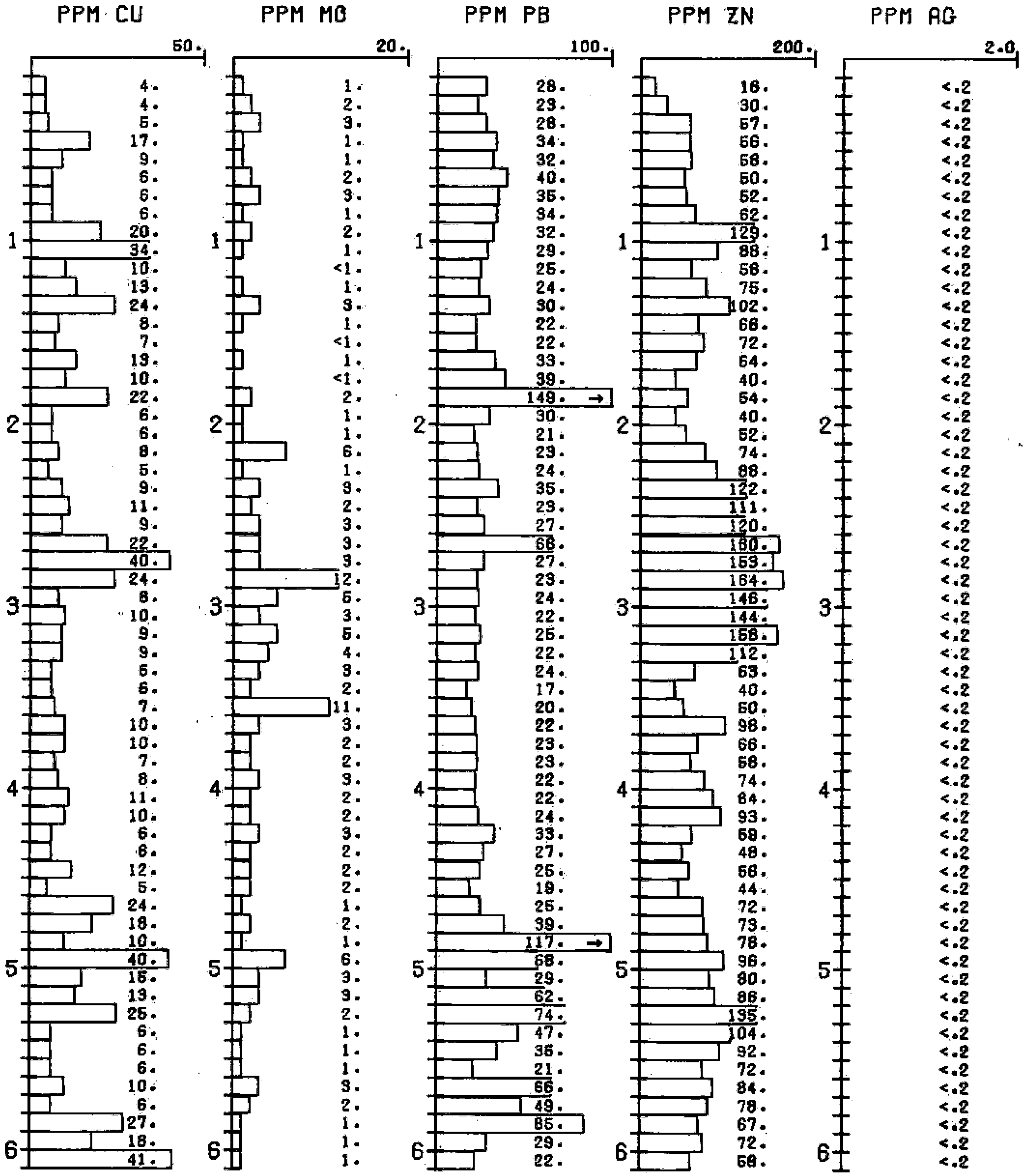


FIGURE 7/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

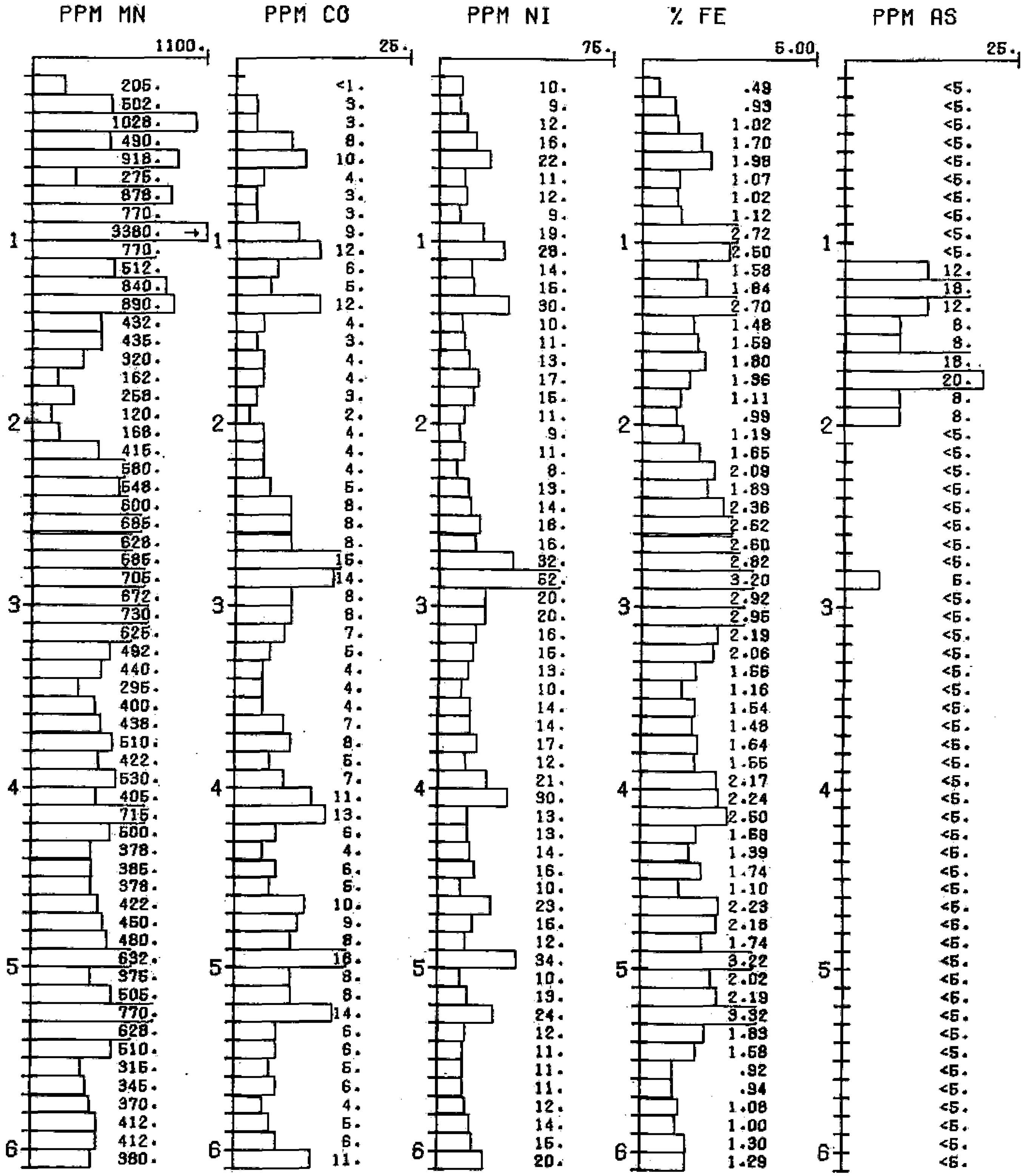


FIGURE 8/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

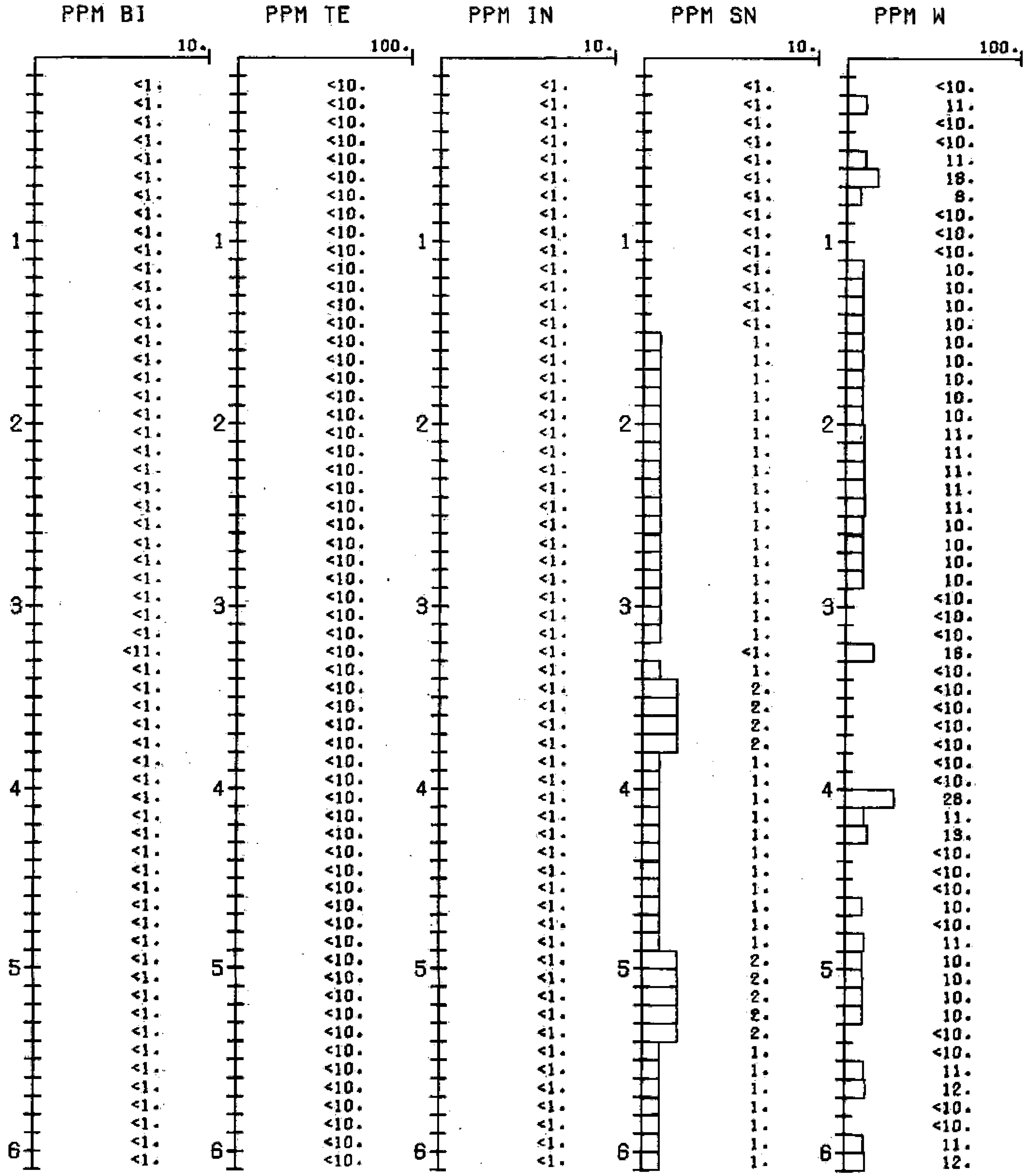


FIGURE 9/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

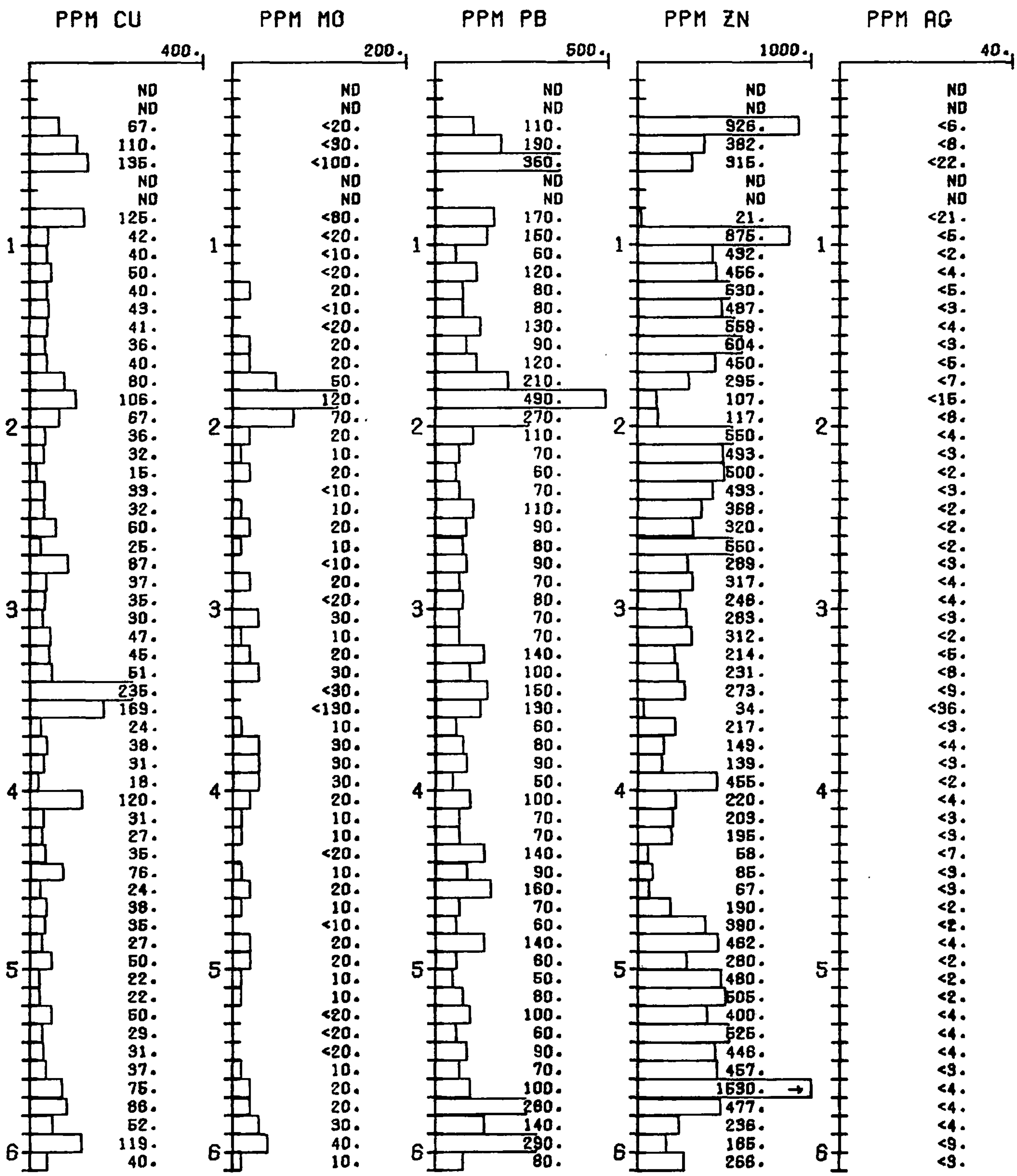
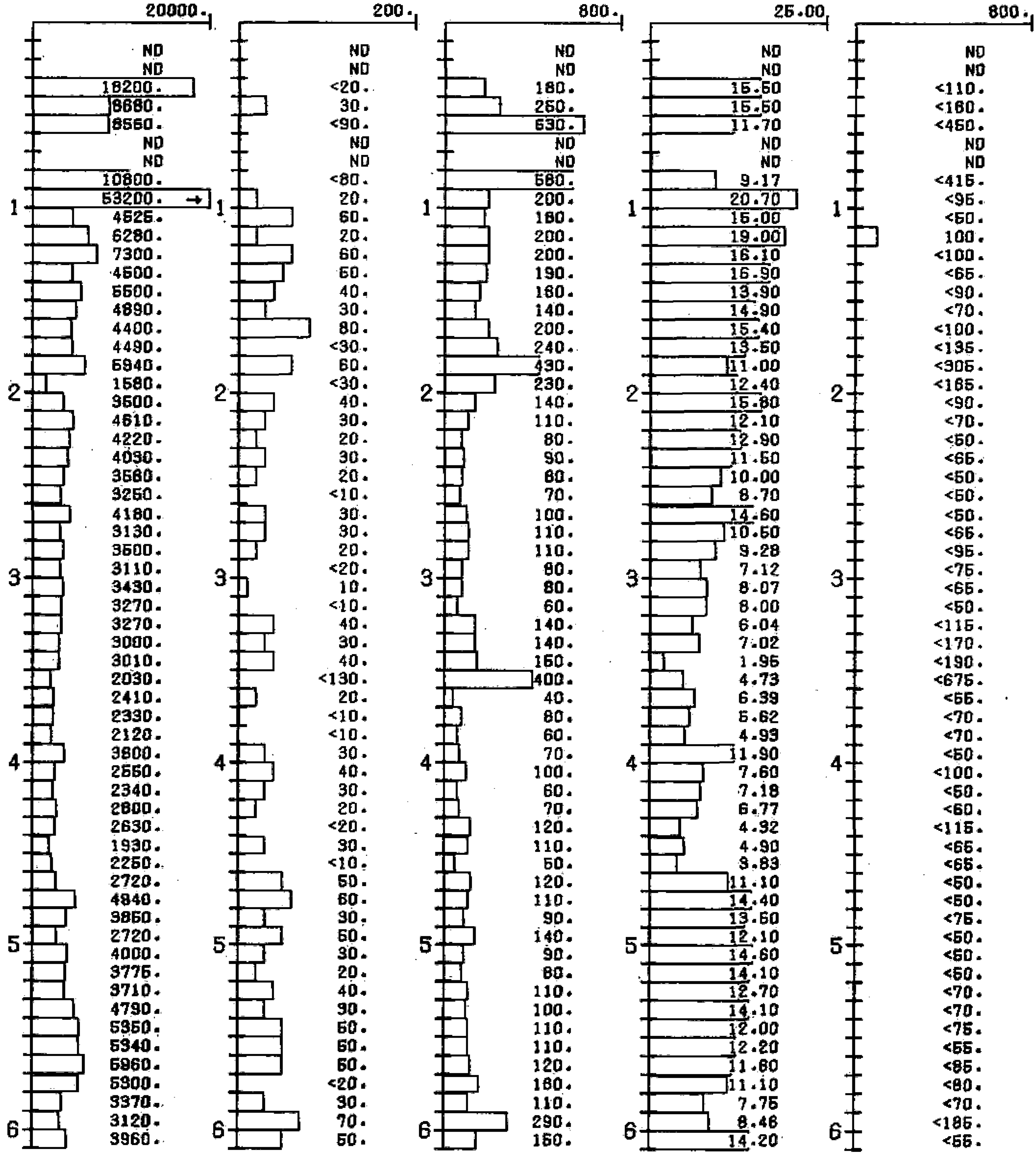


FIGURE 10/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)



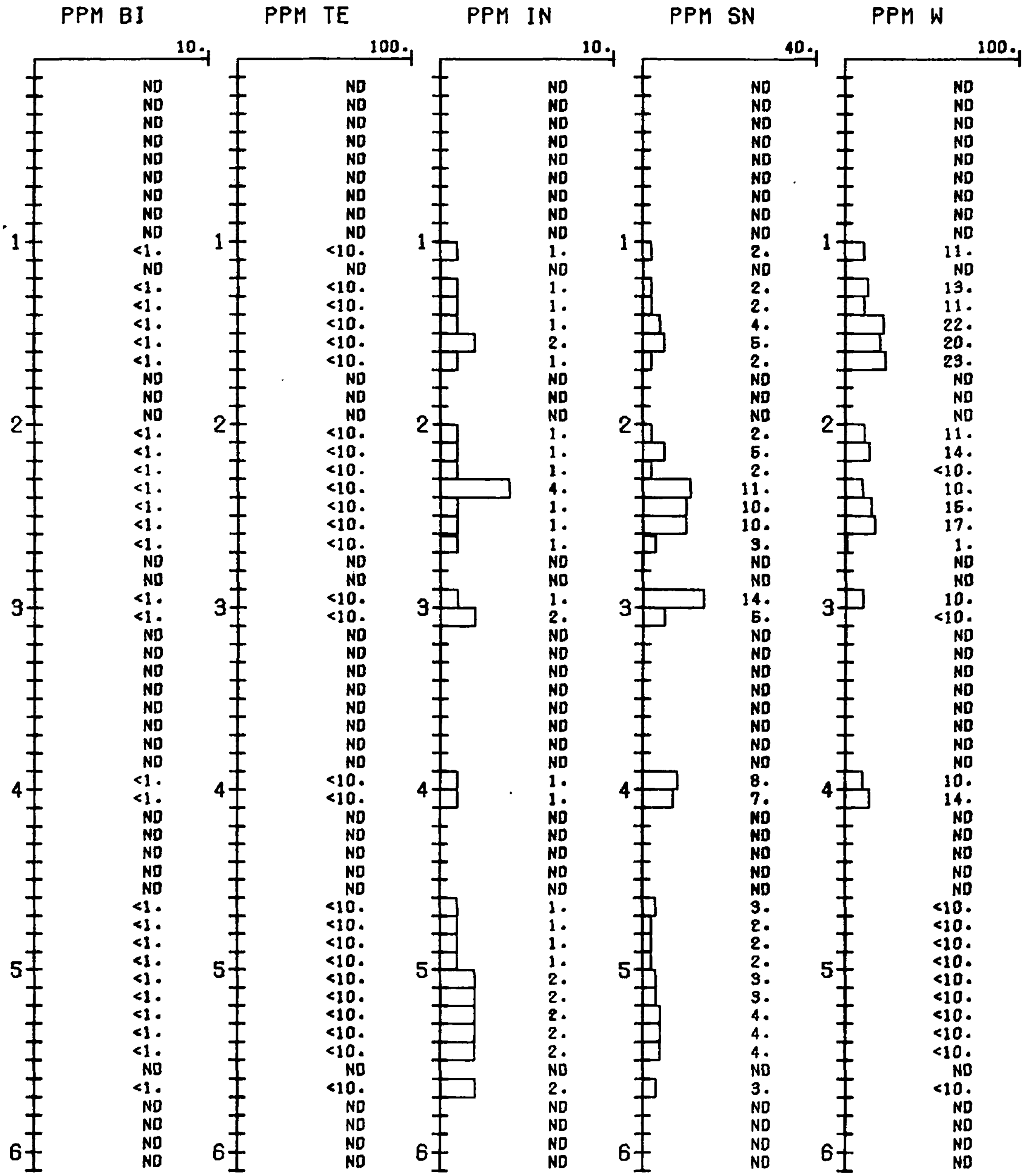
PPM MN	PPM CO	PPM NI	% FE	PPM AS
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
18200.	<20.	180.	15.50	<110.
8680.	30.	250.	15.50	<160.
8560.	<90.	630.	11.70	<450.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
10800.	<80.	580.	9.17	<415.
53200. →	20.	200.	20.70	<95.
4525.	60.	180.	15.00	<50.
6280.	20.	200.	19.00	100.
7300.	60.	200.	16.10	<100.
4500.	50.	190.	16.90	<65.
5500.	40.	160.	13.90	<90.
4890.	30.	140.	14.90	<70.
4400.	80.	200.	15.40	<100.
4490.	<30.	240.	13.50	<135.
5940.	60.	430.	11.00	<305.
1580.	<30.	230.	12.40	<165.
3500.	40.	140.	15.80	<90.
4610.	30.	110.	12.10	<70.
4220.	20.	80.	12.90	<50.
4030.	30.	90.	11.50	<65.
3580.	20.	80.	10.00	<50.
3250.	<10.	70.	8.70	<50.
4180.	30.	100.	14.60	<50.
3130.	30.	110.	10.50	<55.
3500.	20.	110.	9.28	<95.
3110.	<20.	80.	7.12	<75.
3430.	10.	80.	8.07	<65.
3270.	<10.	60.	8.00	<50.
3270.	40.	140.	6.04	<115.
3000.	30.	140.	7.02	<170.
3010.	40.	150.	1.95	<190.
2030.	<130.	400.	4.73	<675.
2410.	20.	40.	6.39	<55.
2330.	<10.	80.	5.62	<70.
2120.	<10.	60.	4.93	<70.
3800.	30.	70.	11.90	<50.
2550.	40.	100.	7.60	<100.
2340.	30.	60.	7.18	<50.
2800.	20.	70.	6.77	<60.
2630.	<20.	120.	4.92	<115.
1930.	30.	110.	4.90	<65.
2250.	<10.	50.	3.83	<65.
2720.	50.	120.	11.10	<50.
4840.	60.	110.	14.40	<50.
3850.	30.	90.	13.50	<75.
2720.	50.	140.	12.10	<50.
4000.	30.	90.	14.60	<50.
3775.	20.	80.	14.10	<50.
3710.	40.	110.	12.70	<70.
4790.	30.	100.	14.10	<70.
5350.	50.	110.	12.00	<75.
5340.	50.	110.	12.20	<55.
5960.	50.	120.	11.80	<85.
5300.	<20.	160.	11.10	<80.
3370.	30.	110.	7.75	<70.
3120.	70.	290.	8.46	<185.
3960.	50.	150.	14.20	<55.

FIGURE 11/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)



PPM BI	PPM TE	PPM IN	PPM SN	PPM W
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	2.	11.
ND	ND	ND	ND	ND
<1.	<10.	1.	2.	13.
<1.	<10.	1.	2.	11.
<1.	<10.	1.	4.	22.
<1.	<10.	2.	5.	20.
<1.	<10.	1.	2.	23.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	2.	11.
<1.	<10.	1.	5.	14.
<1.	<10.	1.	2.	<10.
<1.	<10.	4.	11.	10.
<1.	<10.	1.	10.	15.
<1.	<10.	1.	10.	17.
<1.	<10.	1.	3.	1.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	14.	10.
<1.	<10.	2.	5.	<10.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	8.	10.
<1.	<10.	1.	7.	14.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
<1.	<10.	1.	3.	<10.
<1.	<10.	1.	2.	<10.
<1.	<10.	1.	2.	<10.
<1.	<10.	1.	2.	<10.
<1.	<10.	2.	3.	<10.
<1.	<10.	2.	3.	<10.
<1.	<10.	2.	4.	<10.
<1.	<10.	2.	4.	<10.
<1.	<10.	2.	4.	<10.
ND	ND	ND	ND	ND
<1.	<10.	2.	3.	<10.
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND
ND	ND	ND	ND	ND

FIGURE 12/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

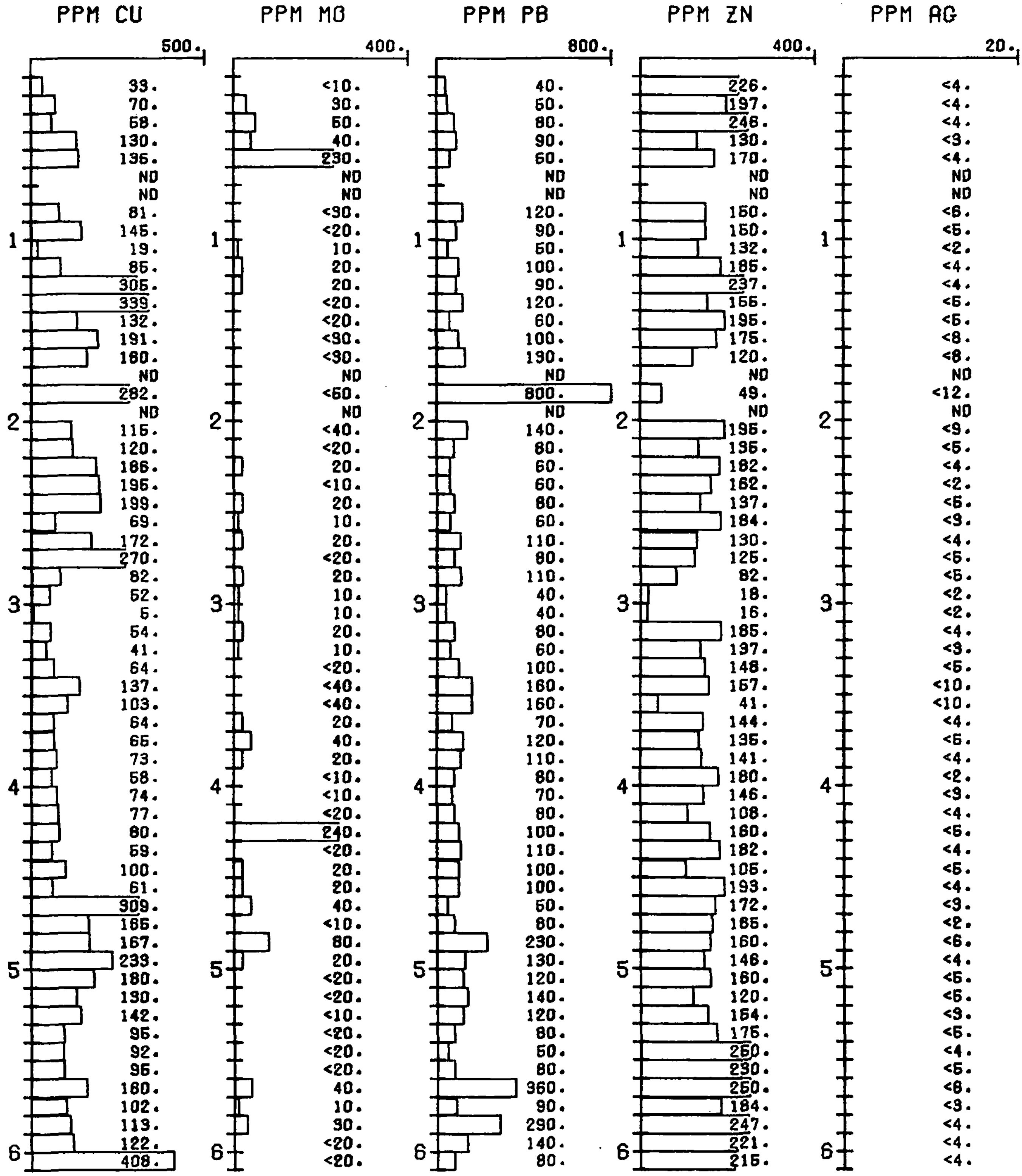


FIGURE 13/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

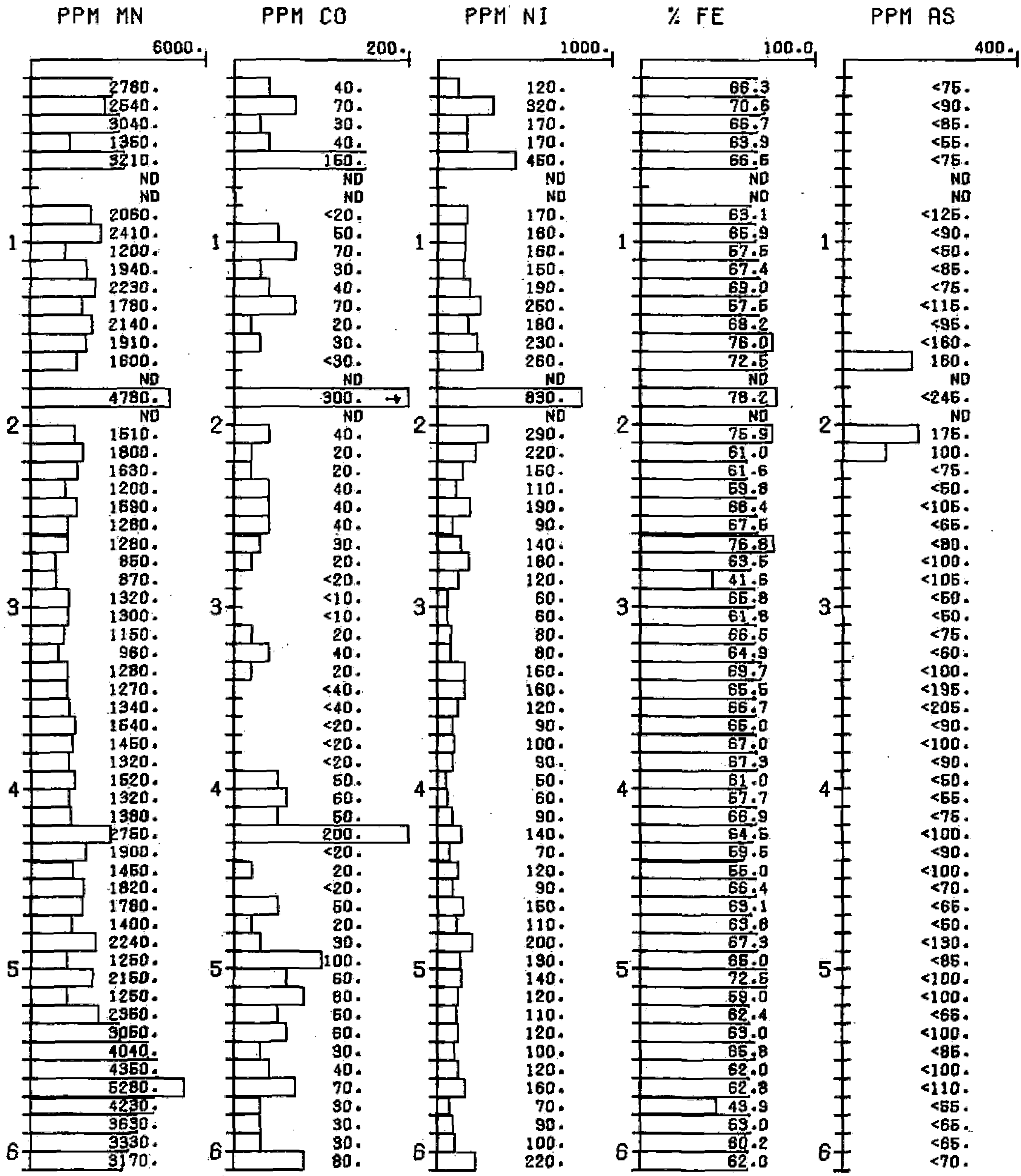


FIGURE 14/14-2

DH 14-2

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 800.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

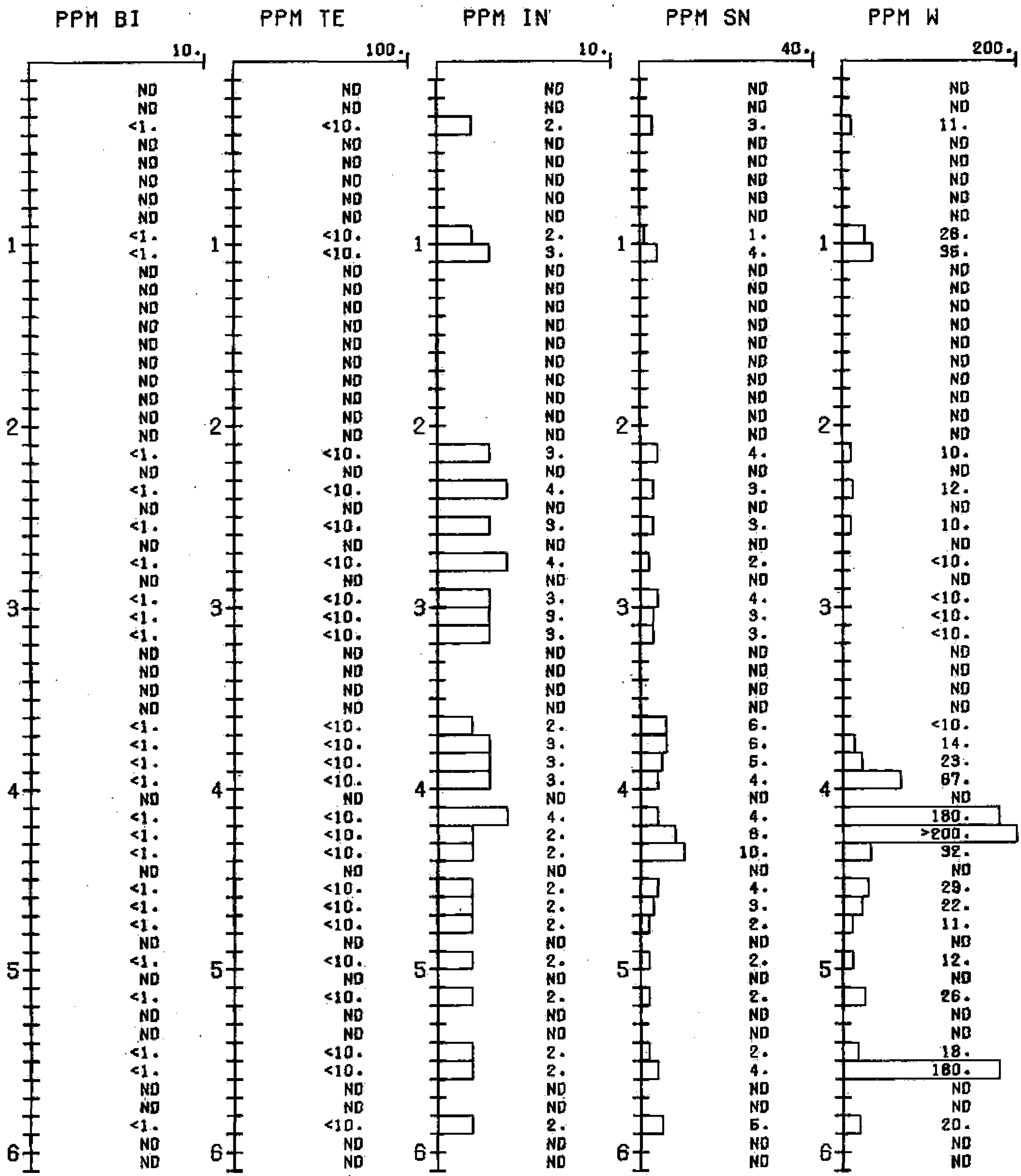
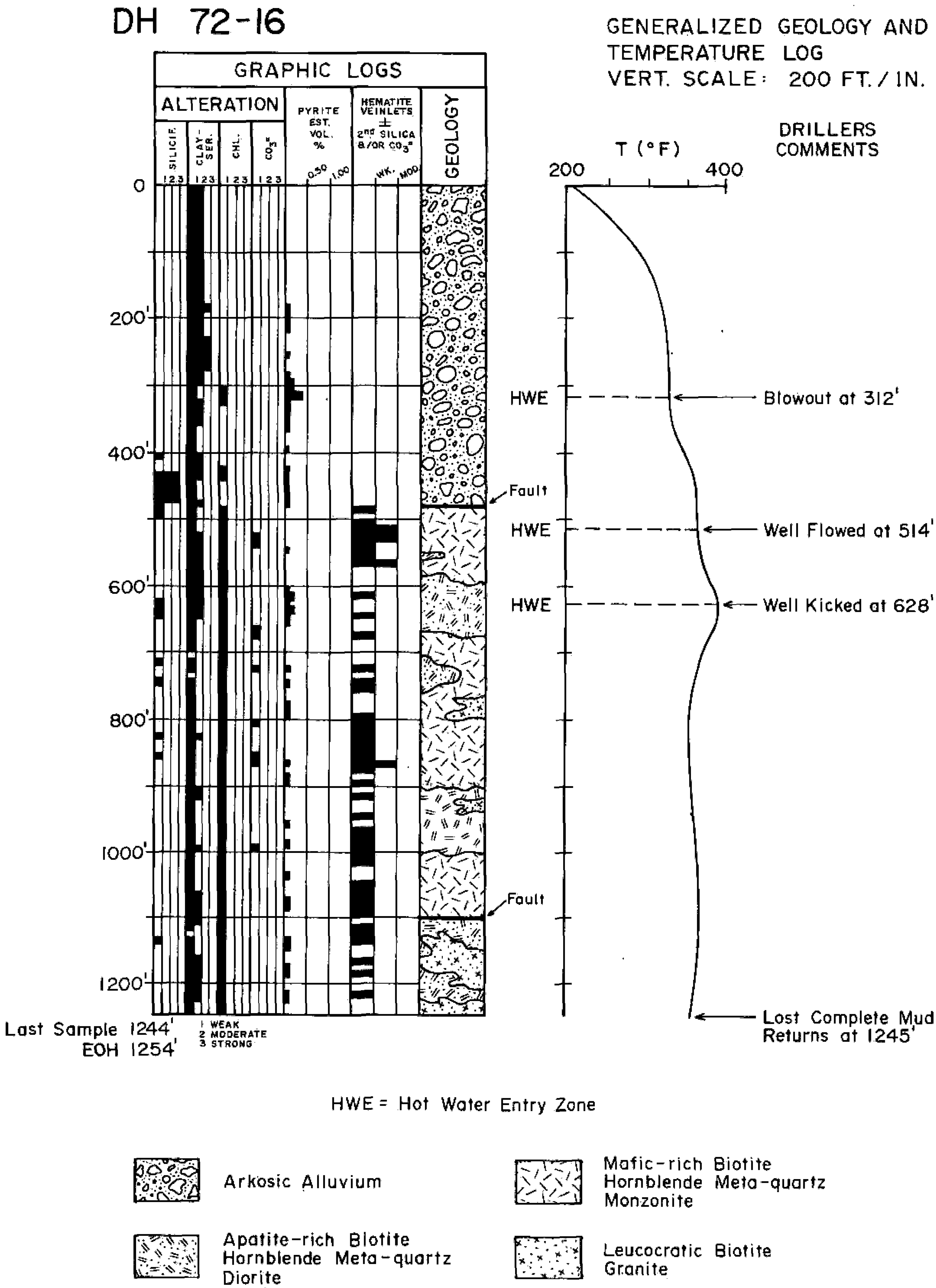


FIGURE 1/72-16

GENERALIZED GEOLOGY AND TEMPERATURE LOG
VERT. SCALE: 200 FT./IN.



Geology and Alteration Data after Moore and Hulen, 1978.

Temperature Log from Thermal Power Co., Deliverable to DOE/DGE Case Studies Program Contract No. EG-77-C-08-1525

FIGURE 2/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE:
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

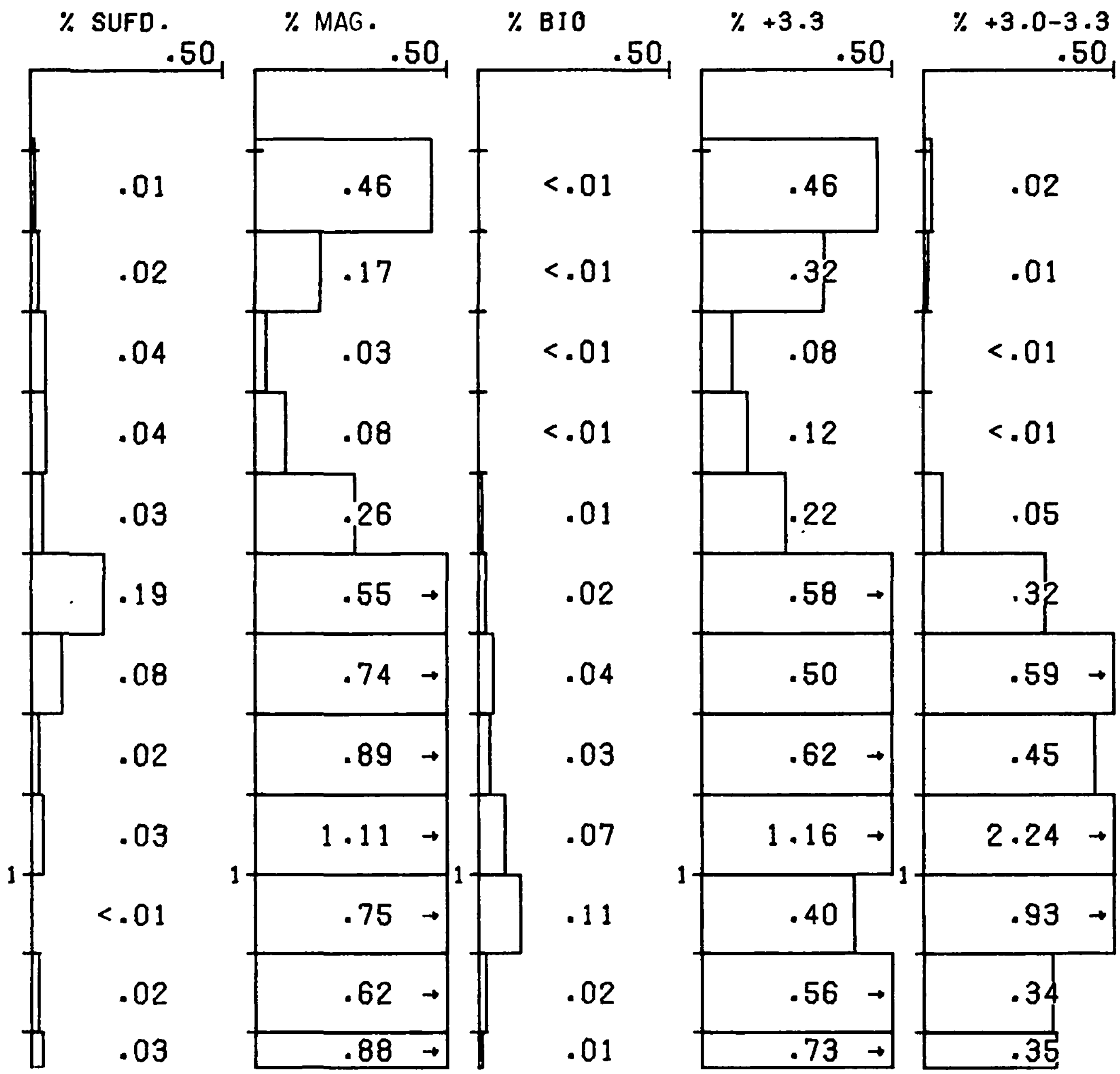


FIGURE 3/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

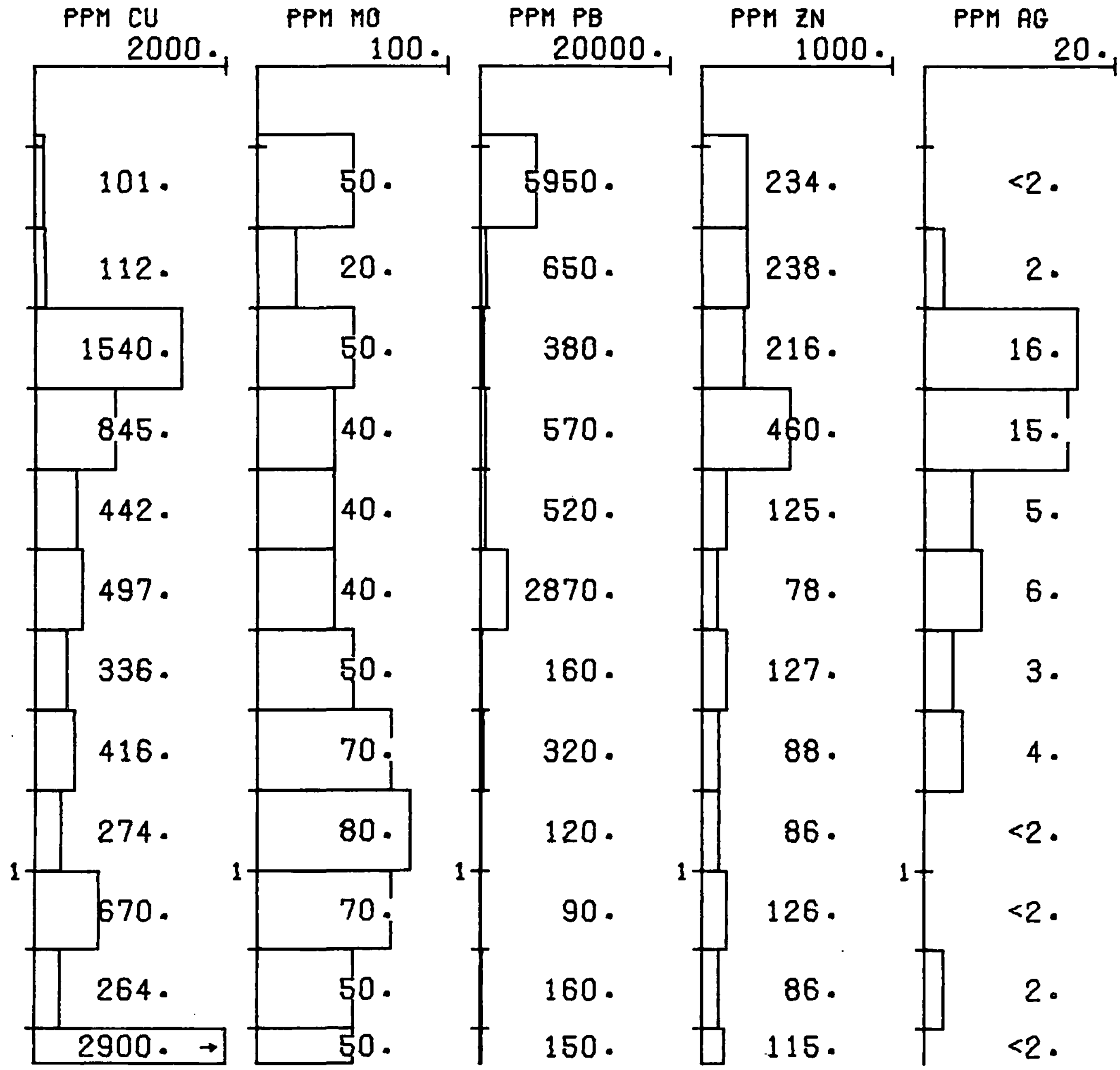


FIGURE 4/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

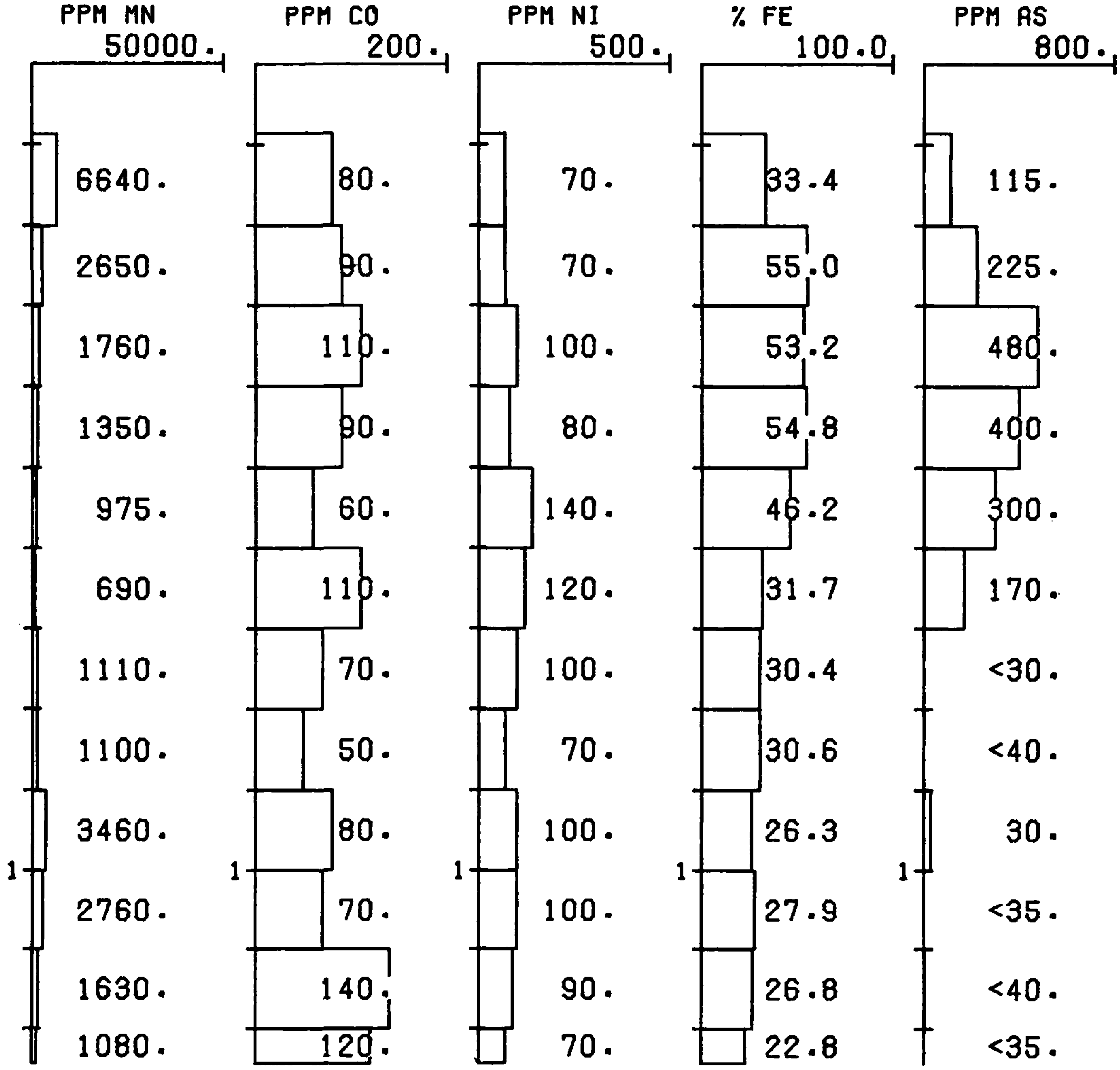


FIGURE 5/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

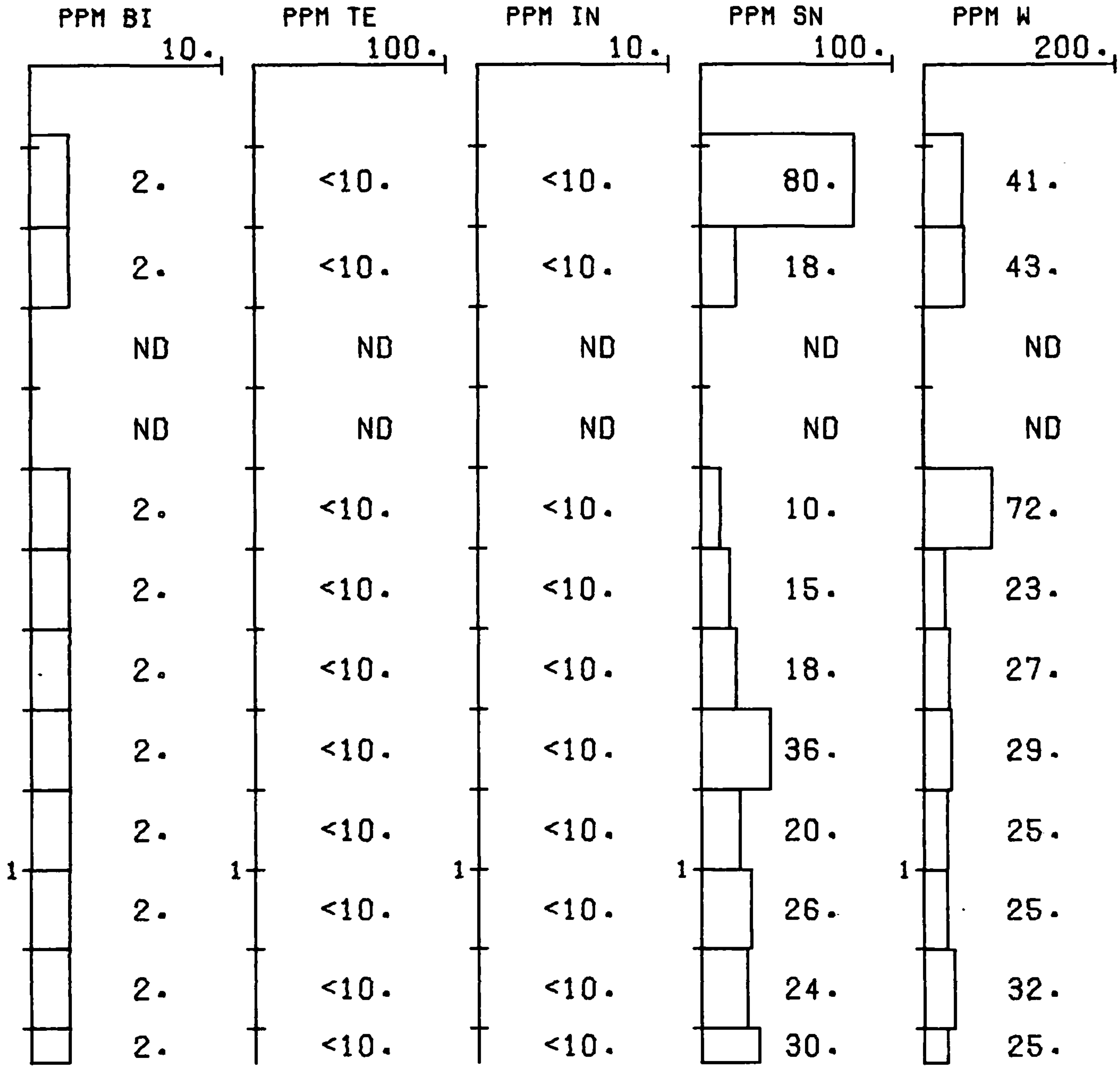


FIGURE 6/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

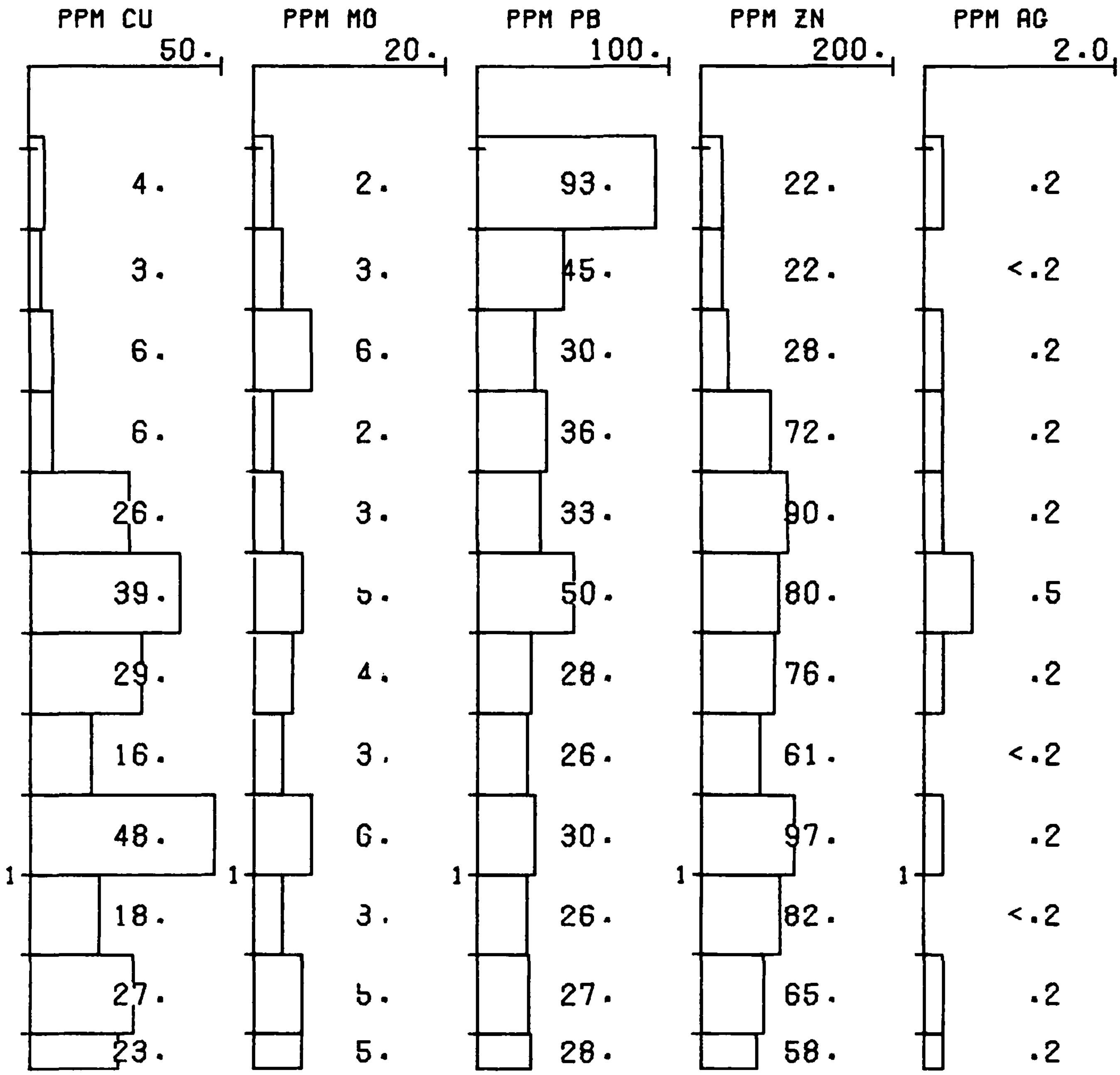


FIGURE 7/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

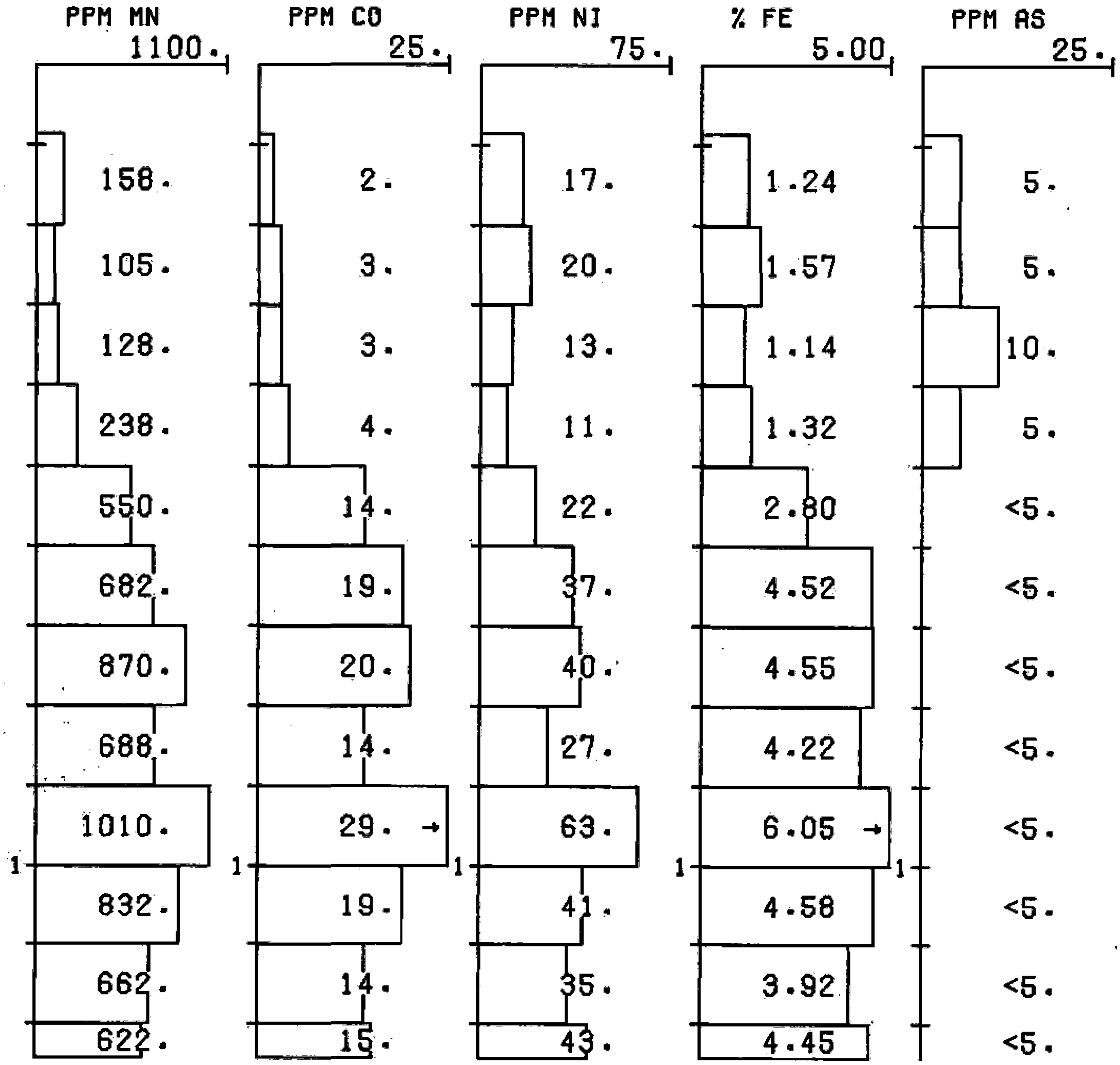


FIGURE 8/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

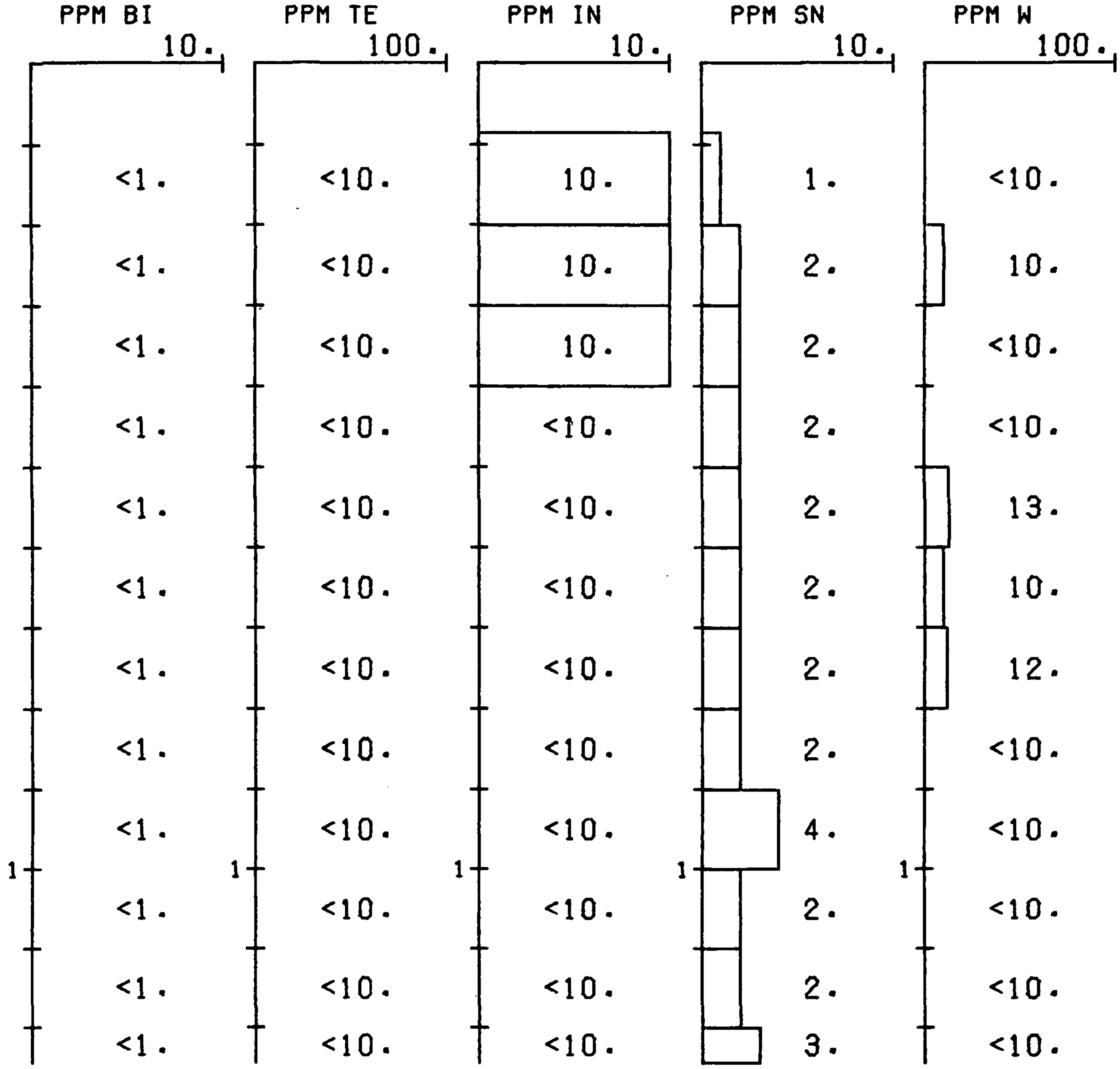


FIGURE 9/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

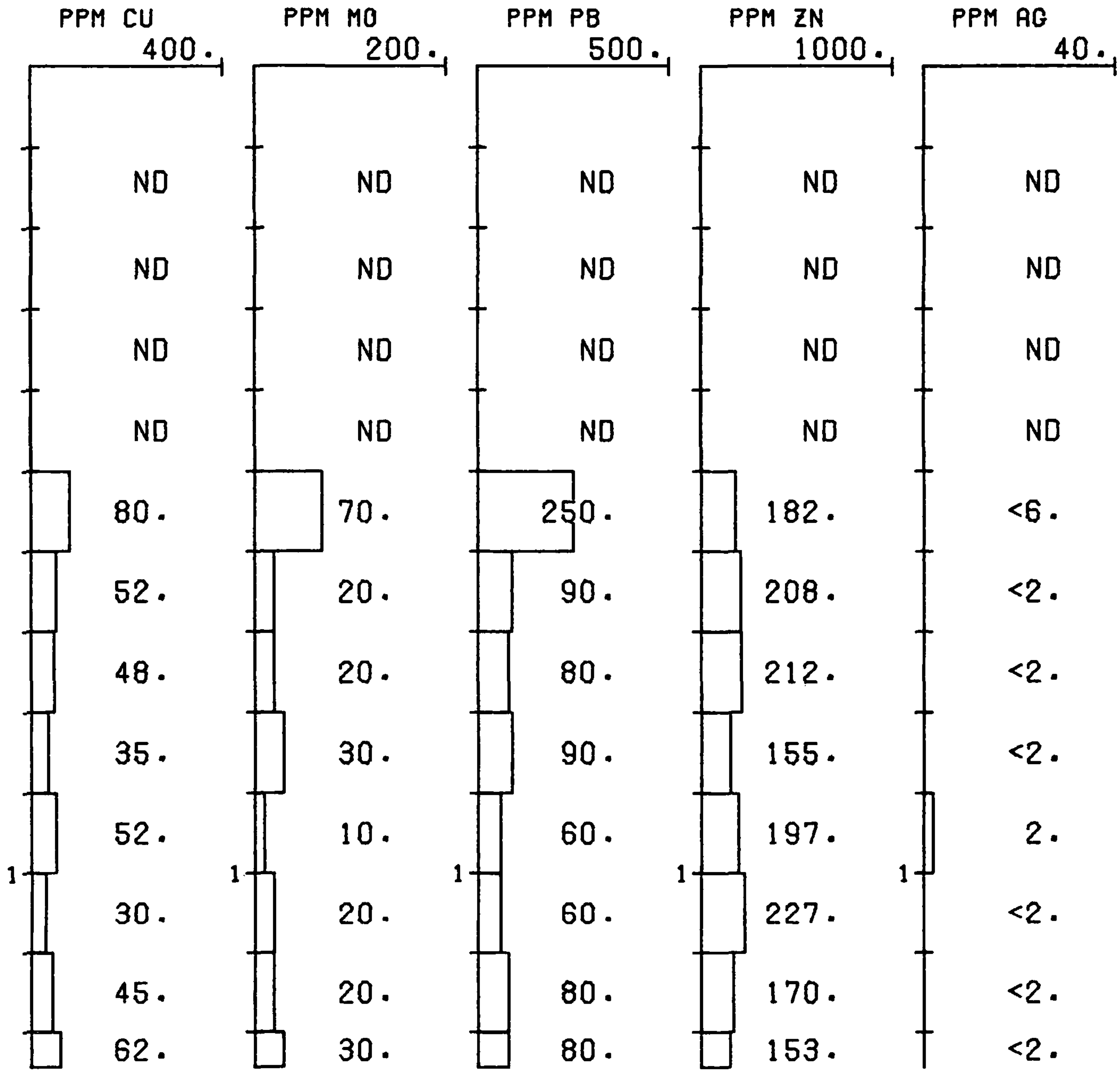


FIGURE 10/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

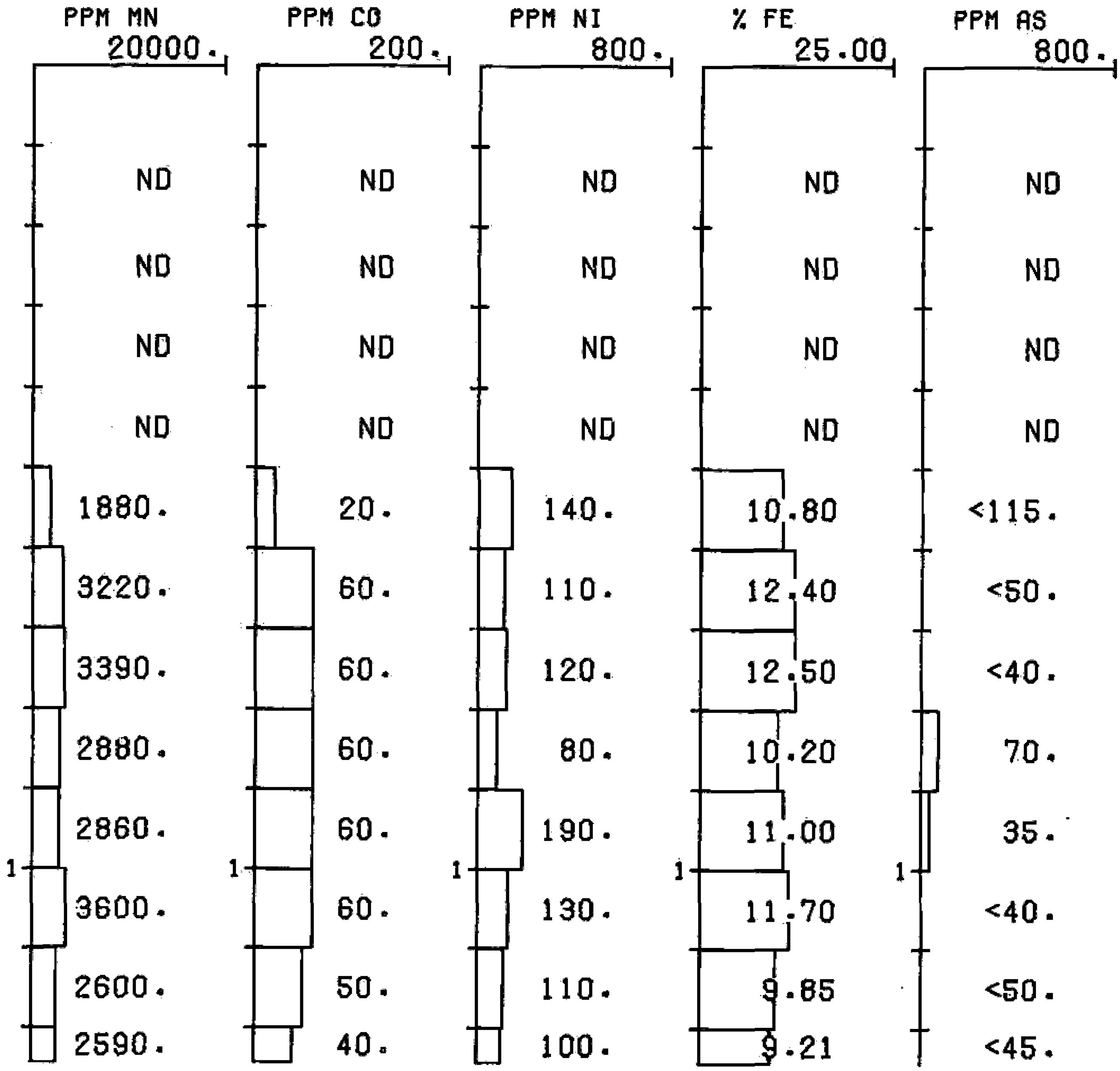


FIGURE 11 72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

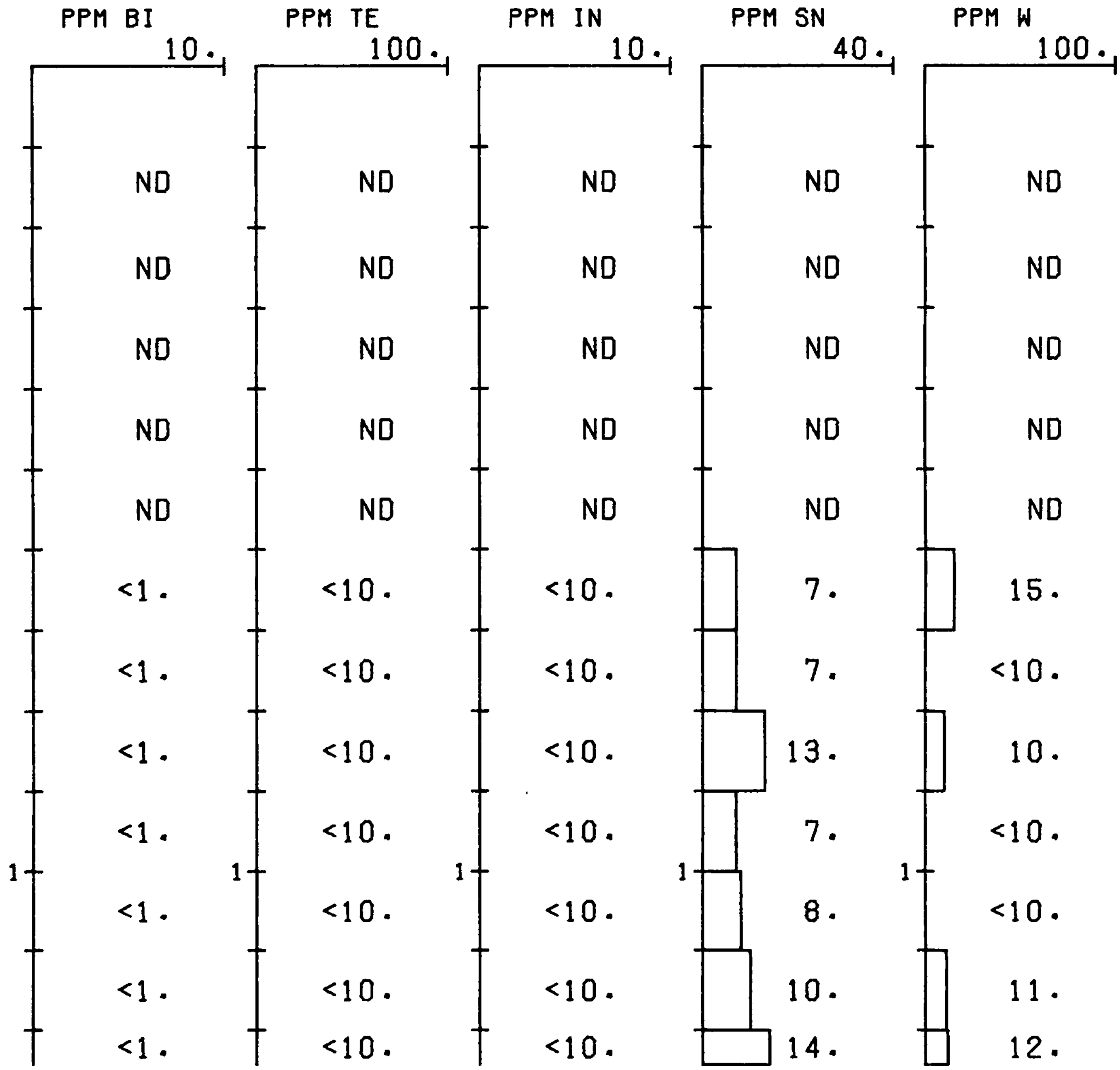


FIGURE 12/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

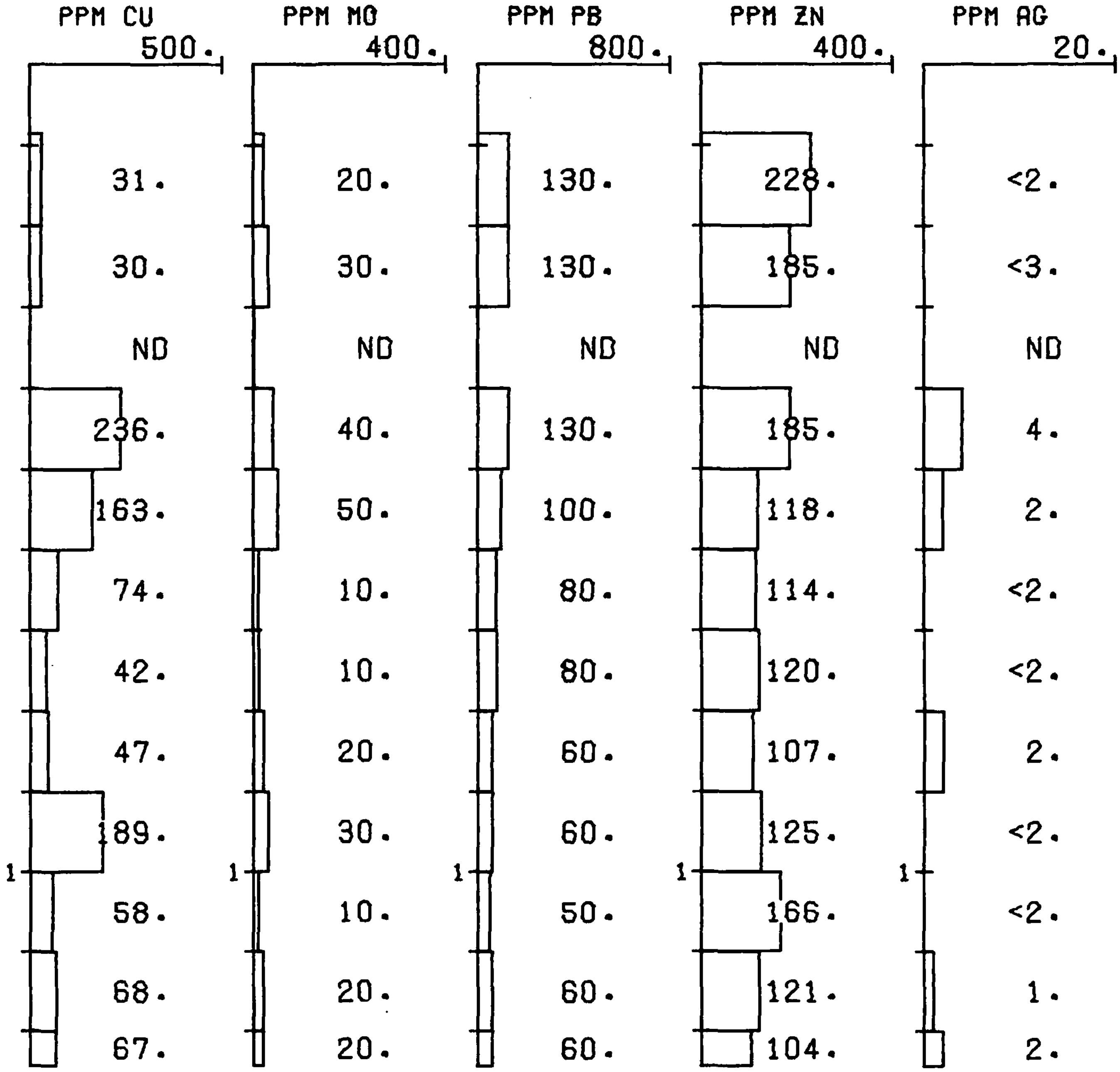


FIGURE 13/72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

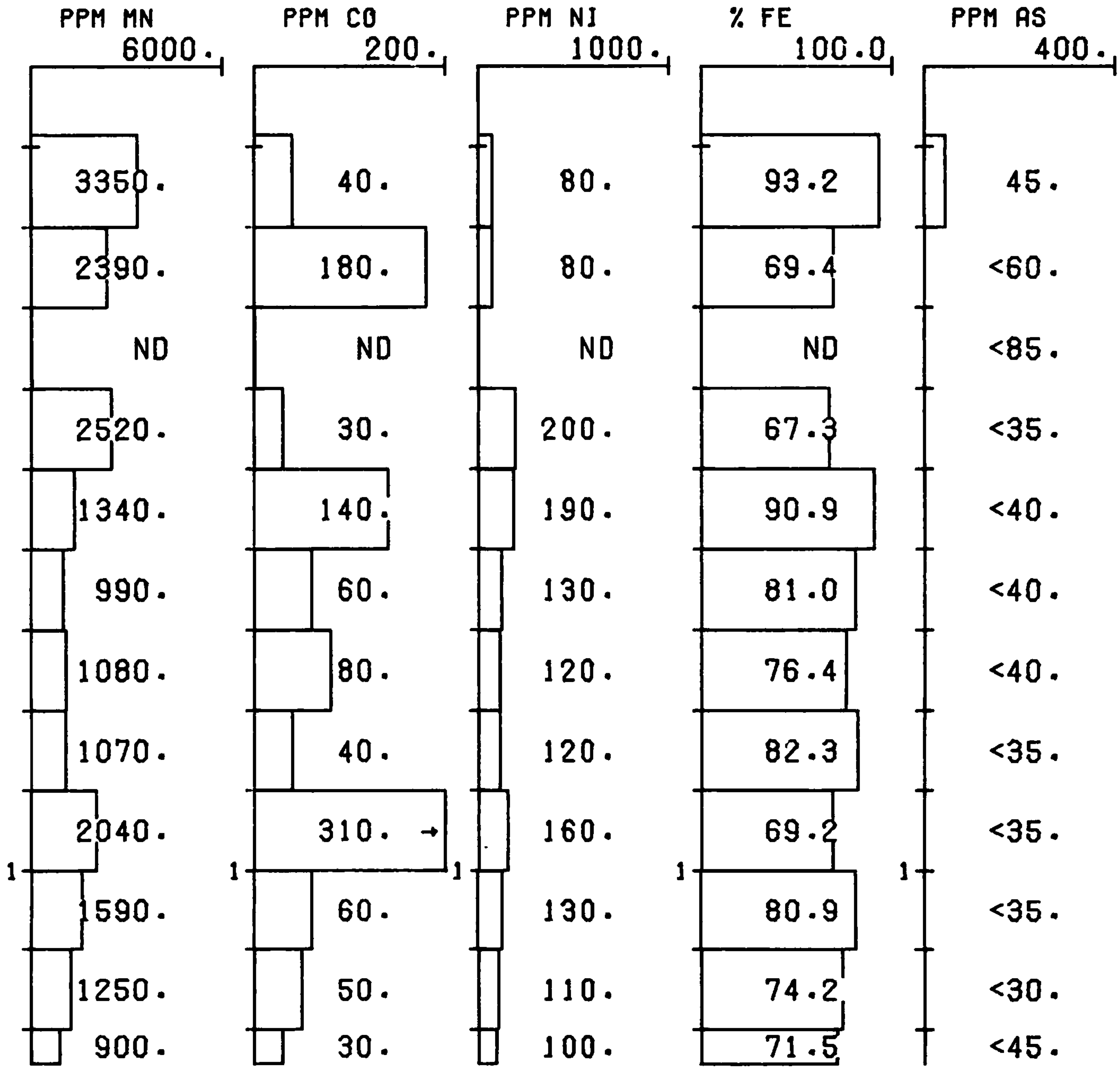


FIGURE 14 /72-16

DH 72-16

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 200.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

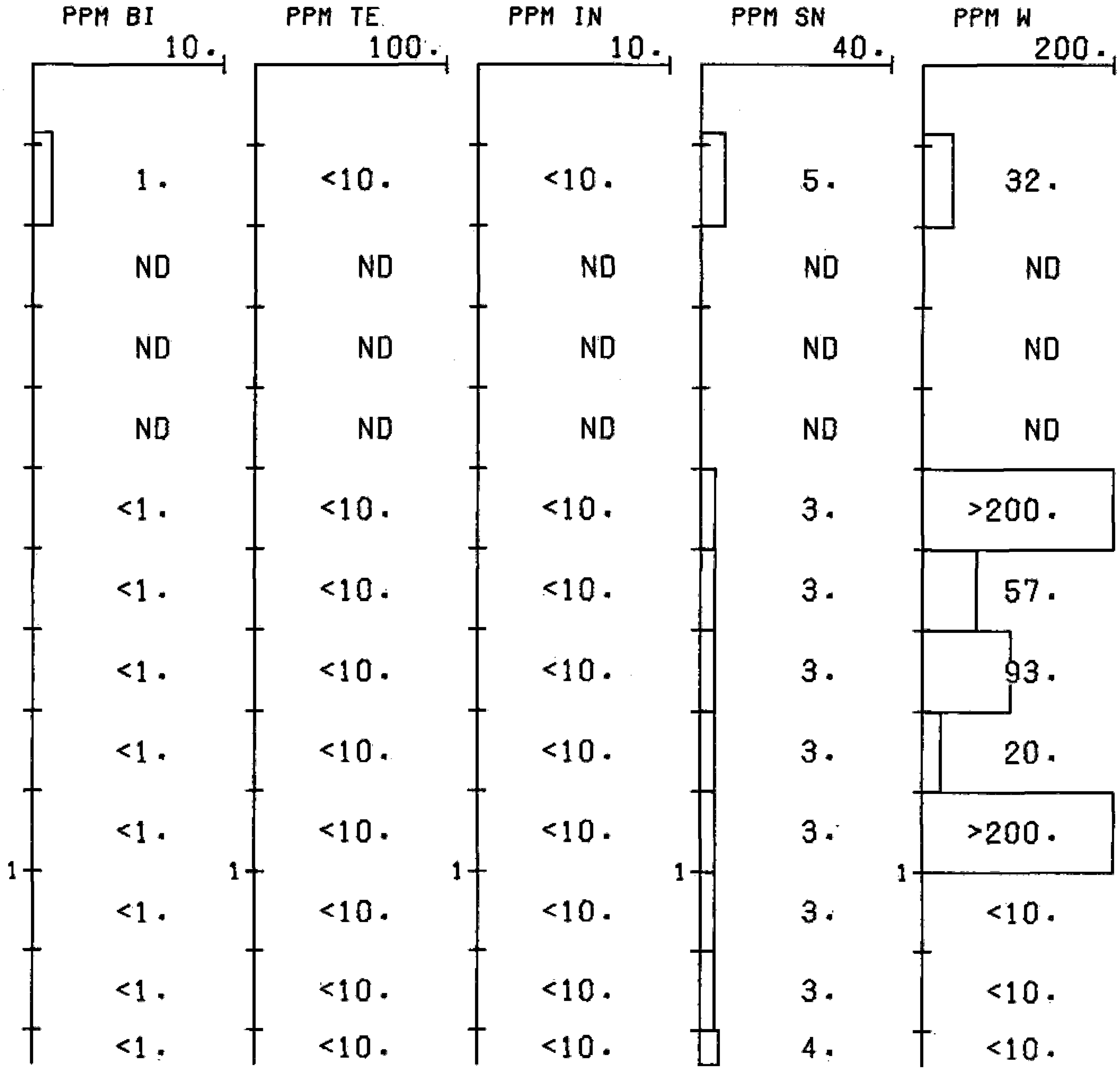
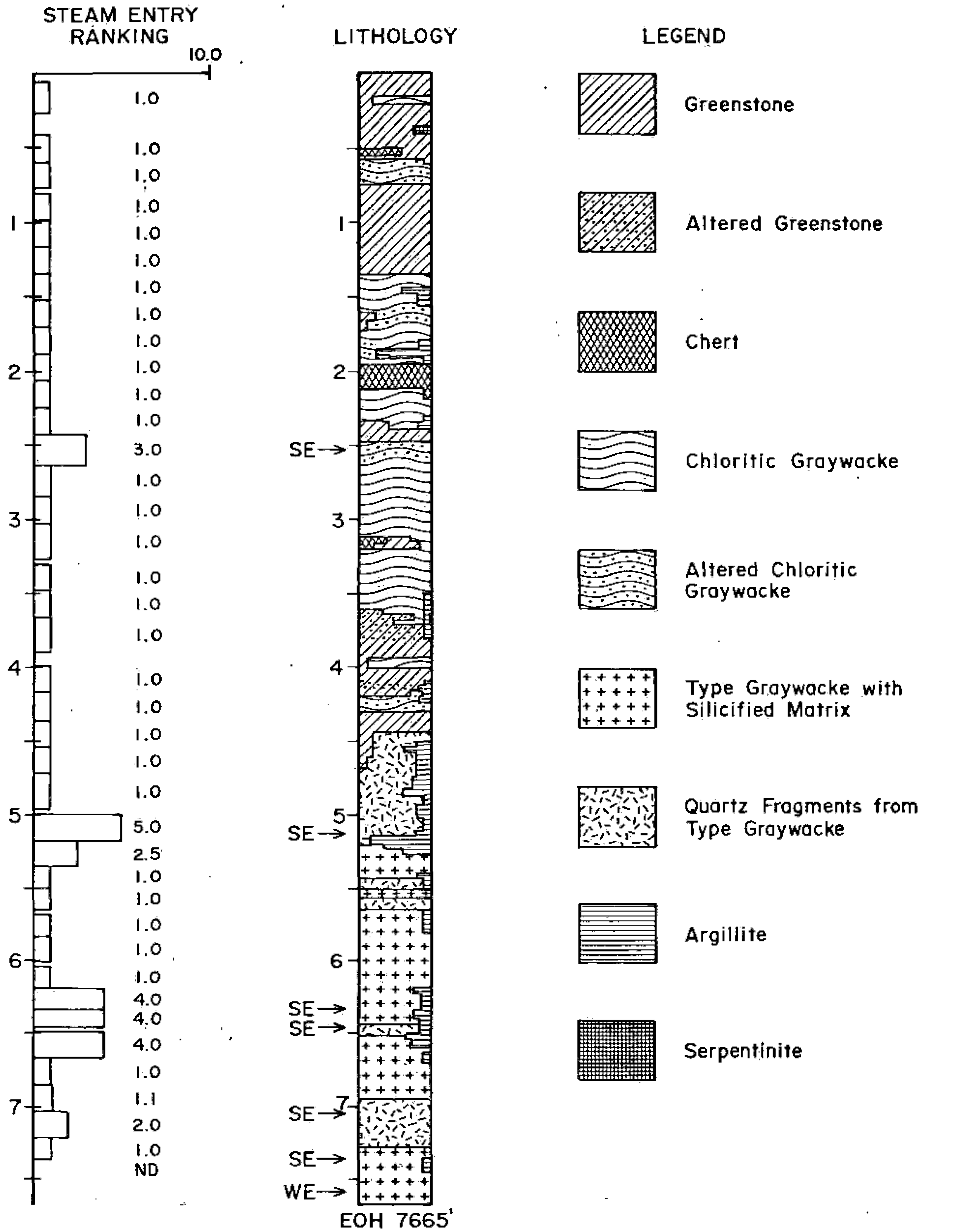


FIGURE 1/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

GENERALIZED GEOLOGY AND STEAM ENTRY RANKING
VERT. SCALE: 1000 FT./IN.



SE= Steam Entry WE= Water Entry

1.0 = No steam entry within or close to sample interval

2.0 thru 5.0 = Steam entries (SE) within or close to sample interval. Relative importance of SE indicated by ranking.

Geology modified from preliminary geologic log by Mary Twichell (Aminoil U.S.A. Inc.).

FIGURE 2/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE:
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

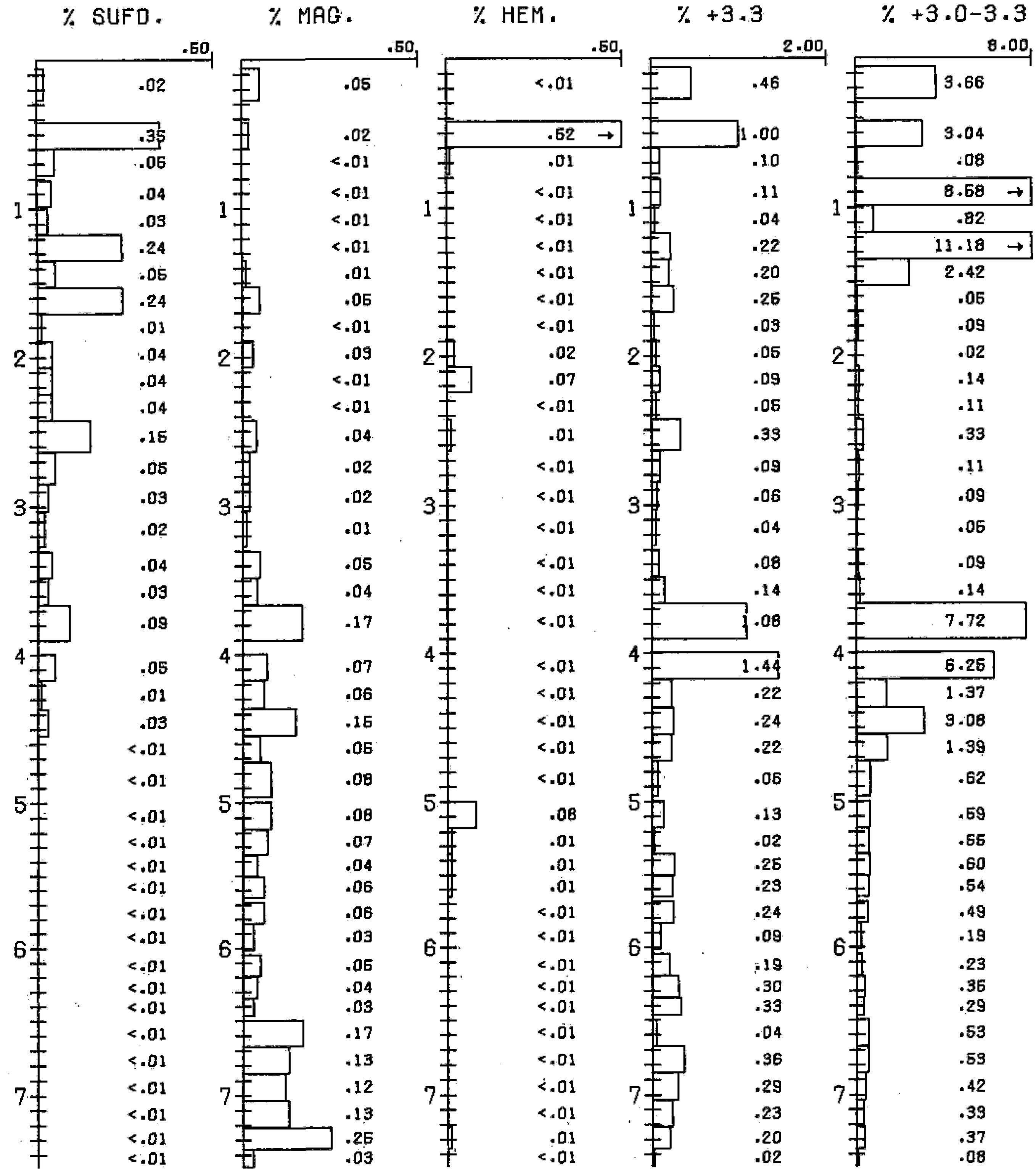


FIGURE 3/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

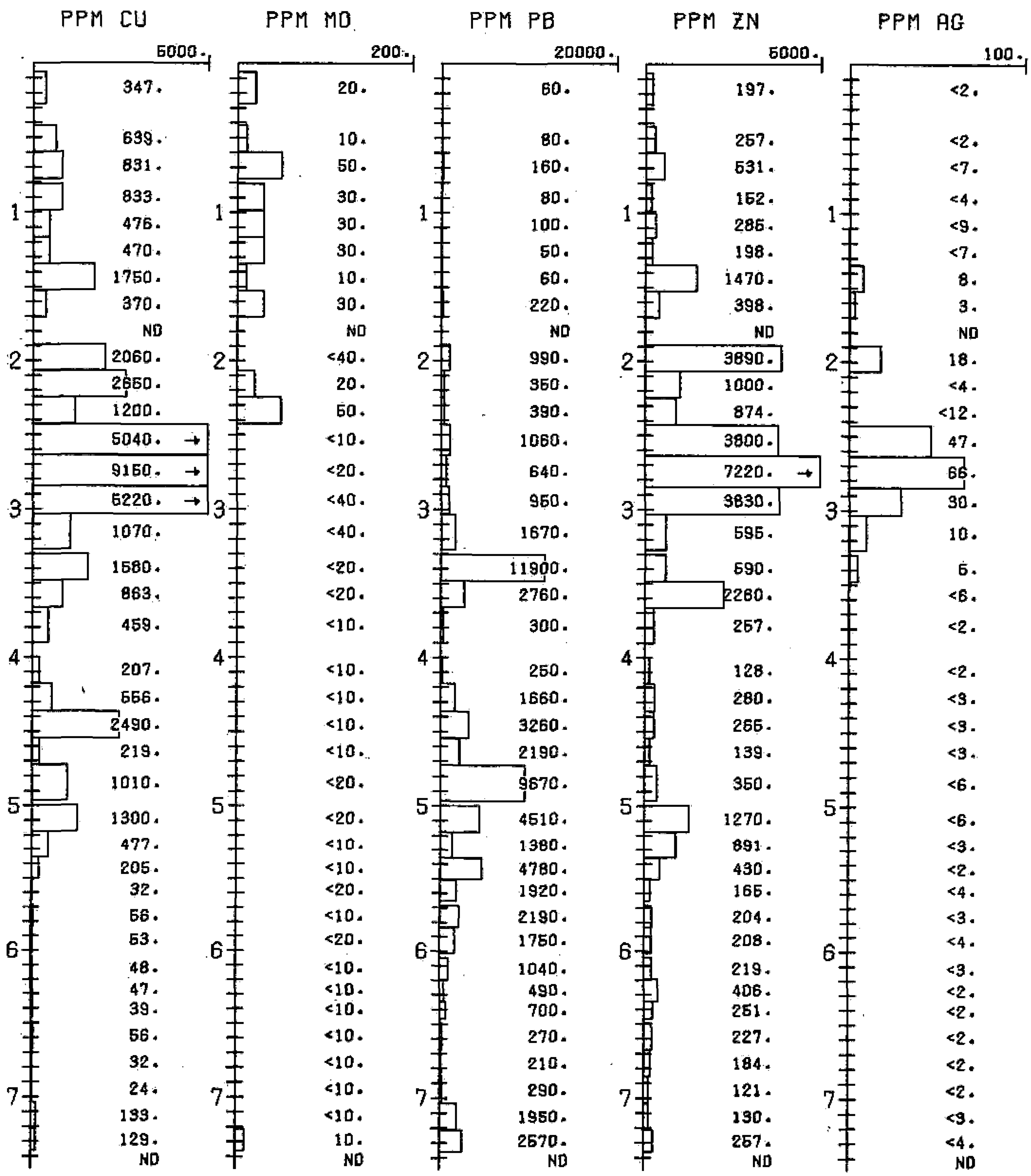


FIGURE 4/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

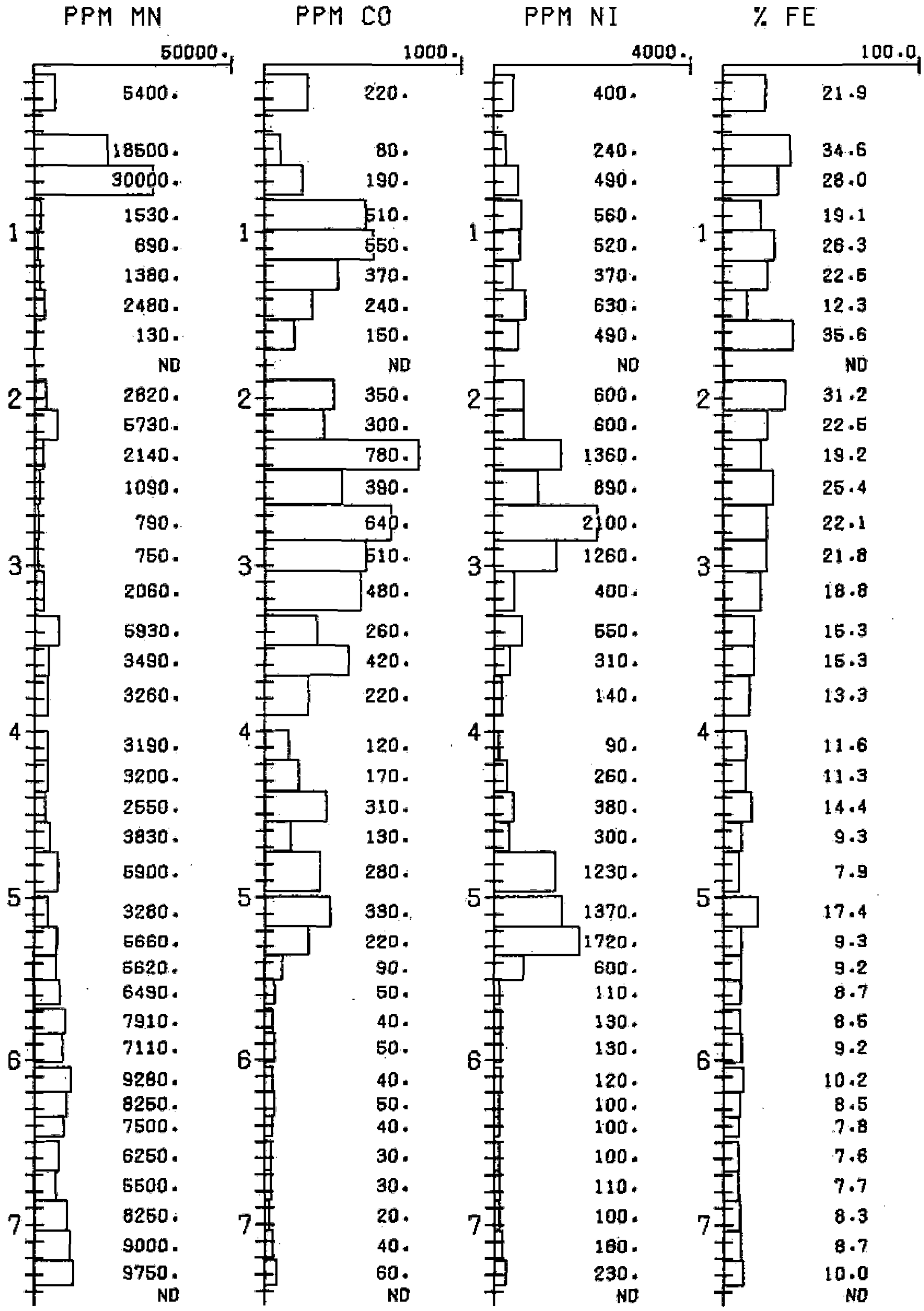


FIGURE 5/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

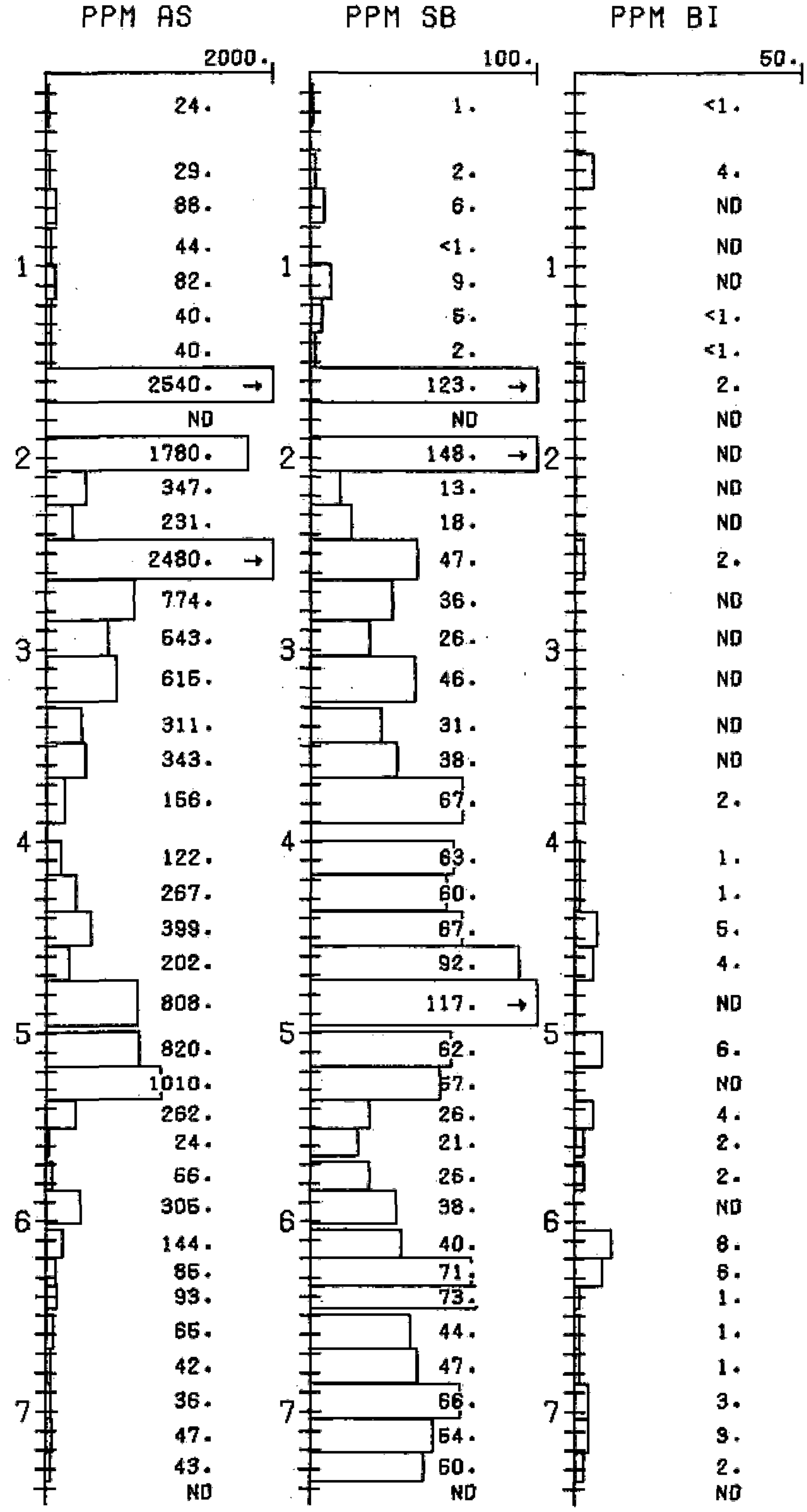


FIGURE 6/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

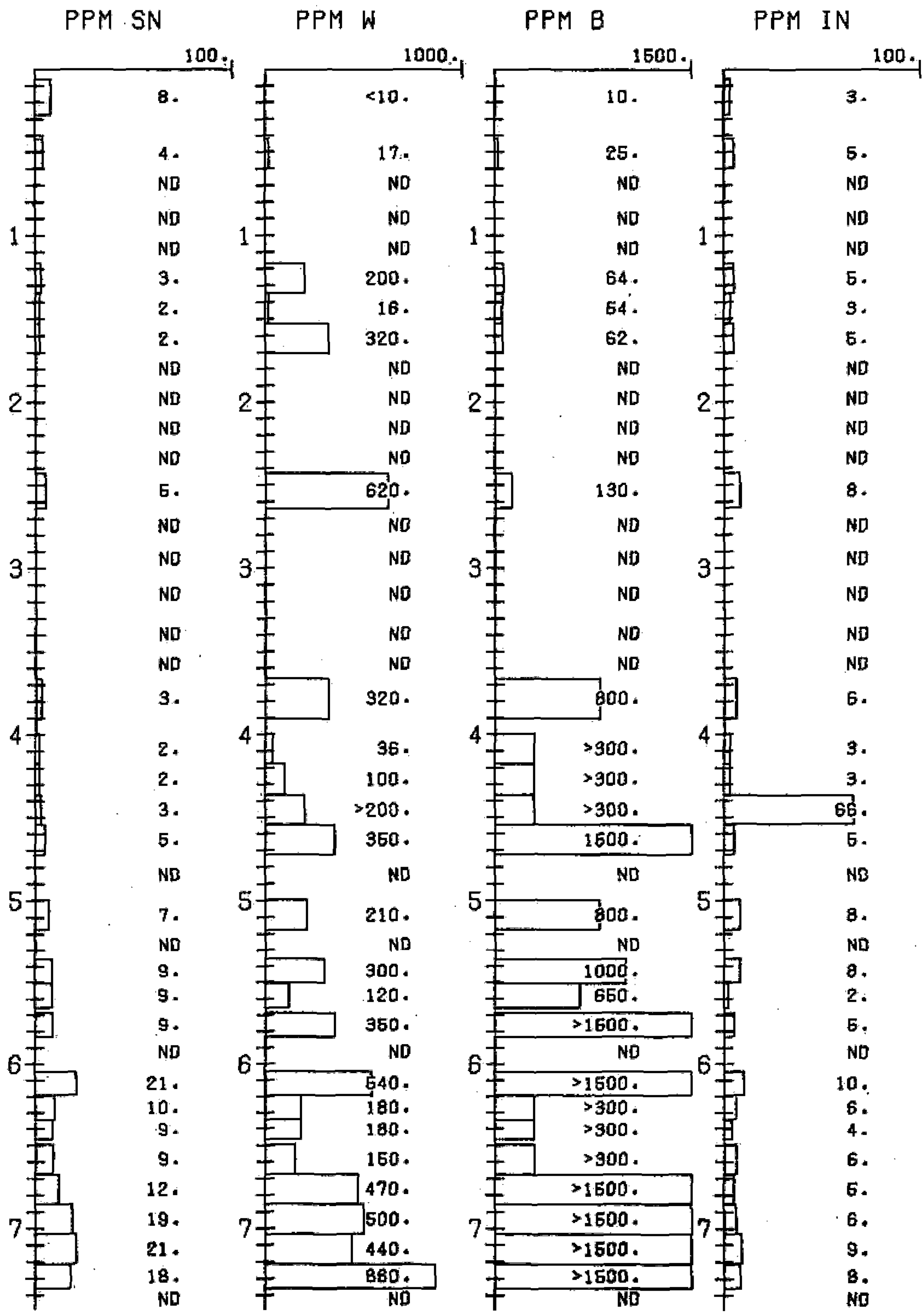


FIGURE 7/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

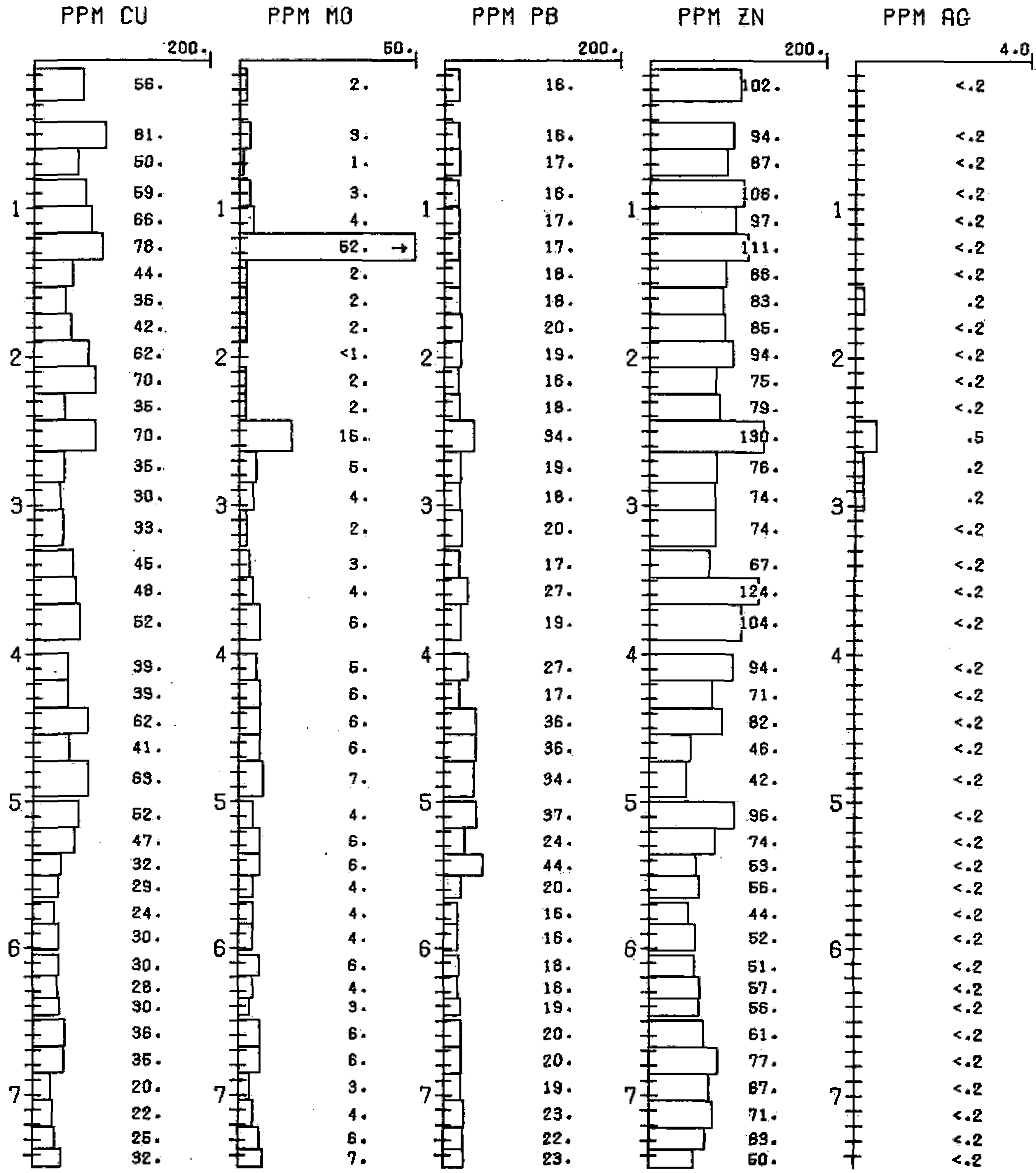


FIGURE 8/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

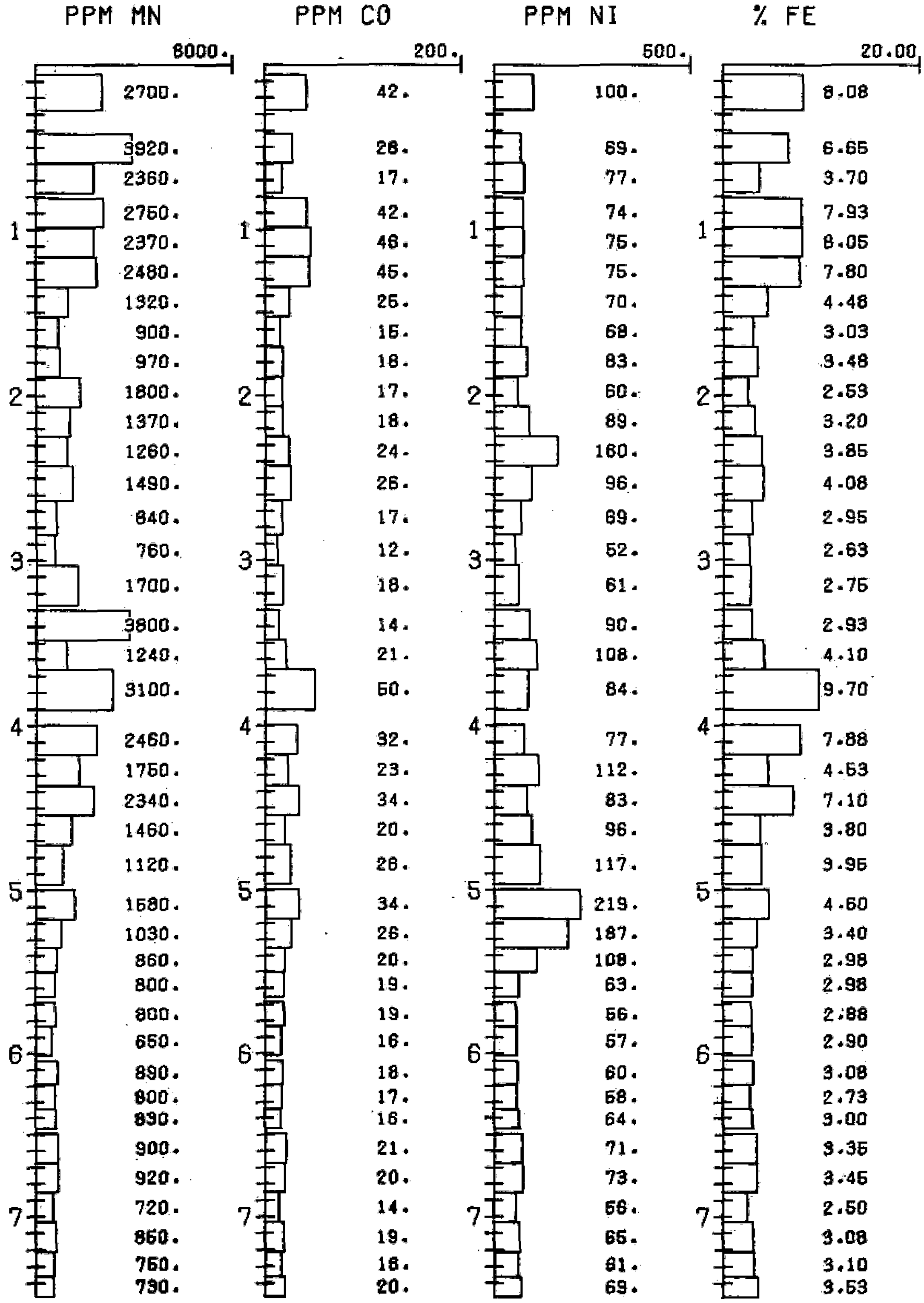


FIGURE 9/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

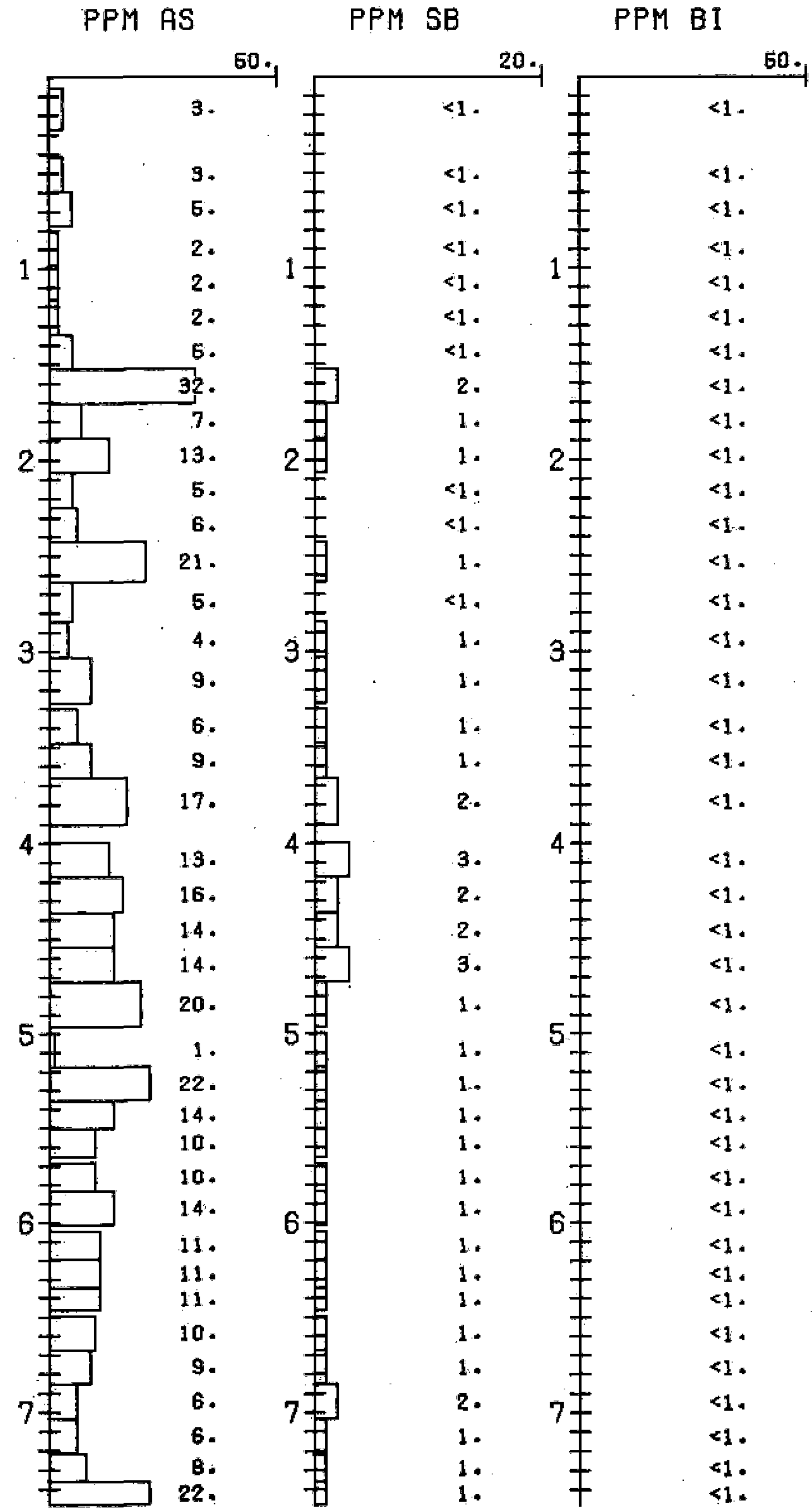


FIGURE 10/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

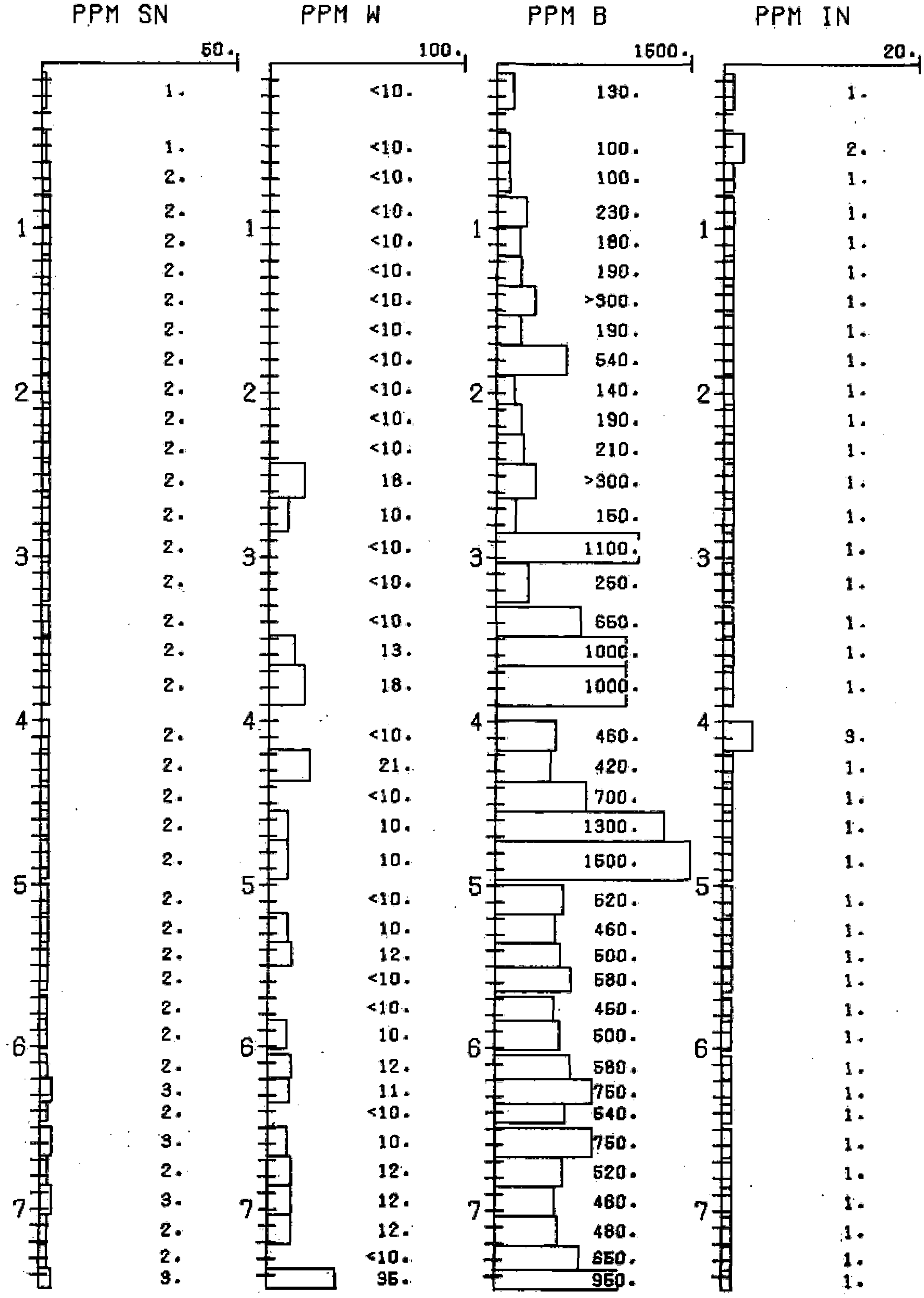


FIGURE 11/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

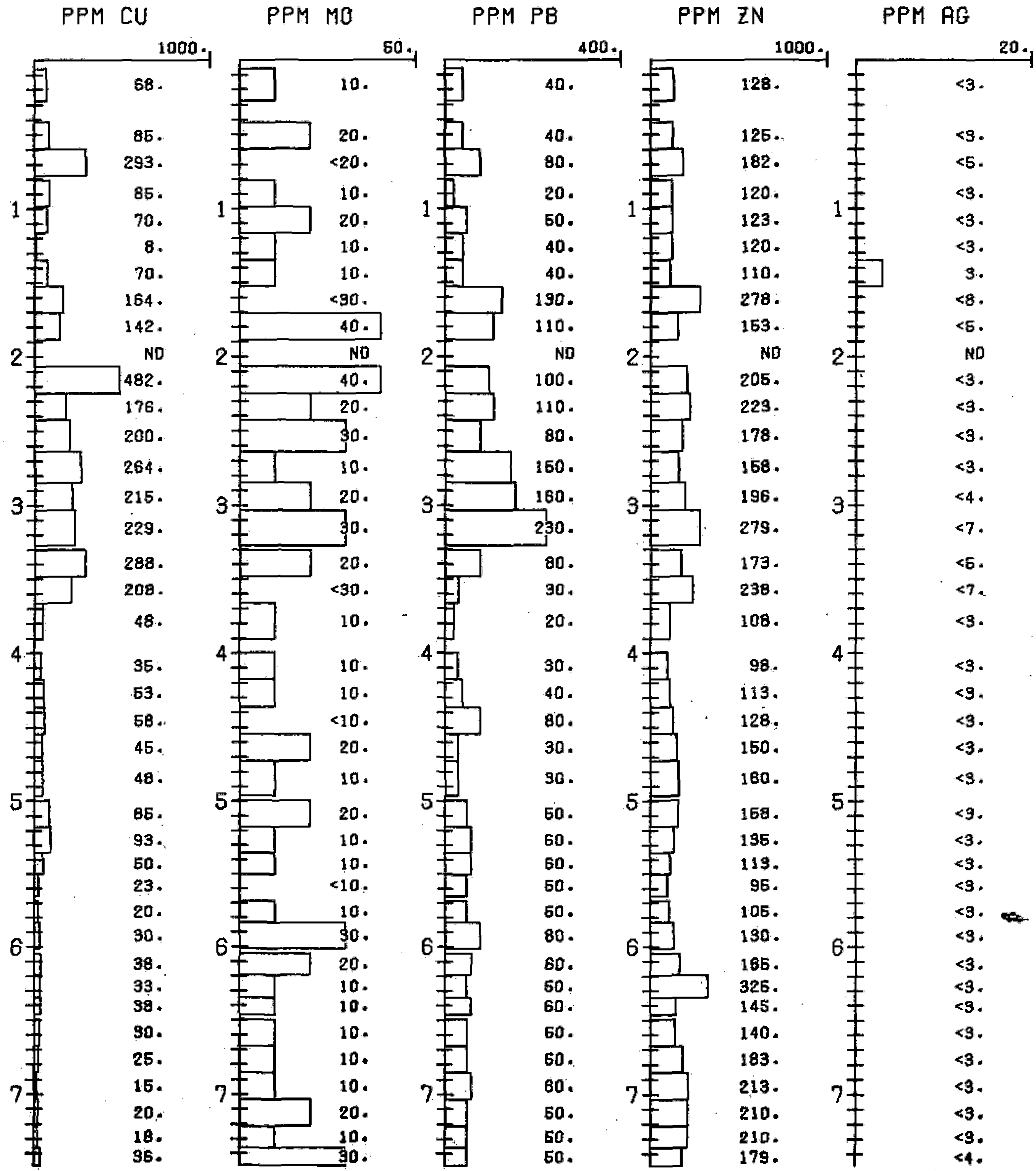


FIGURE 12/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

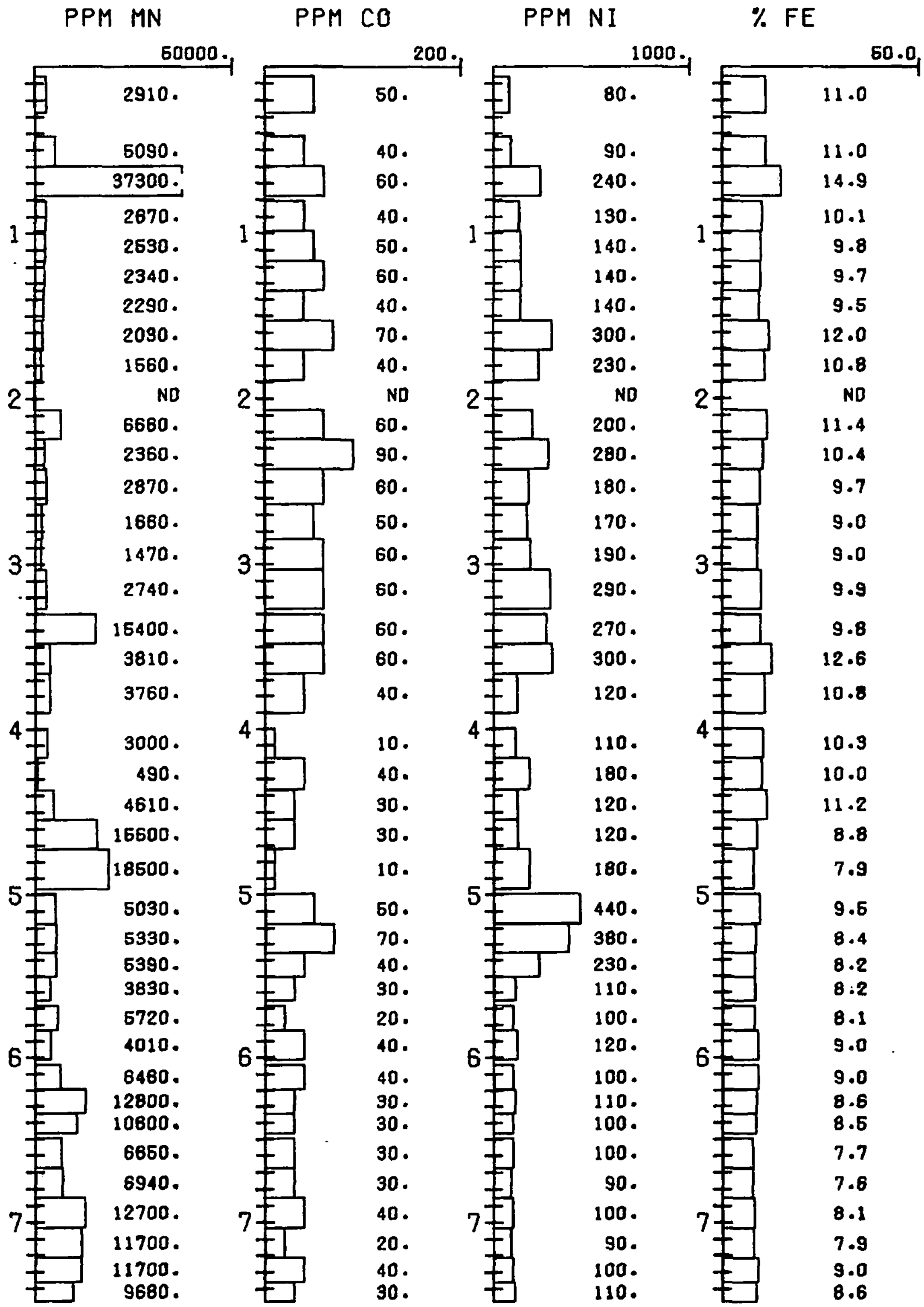


FIGURE 13/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

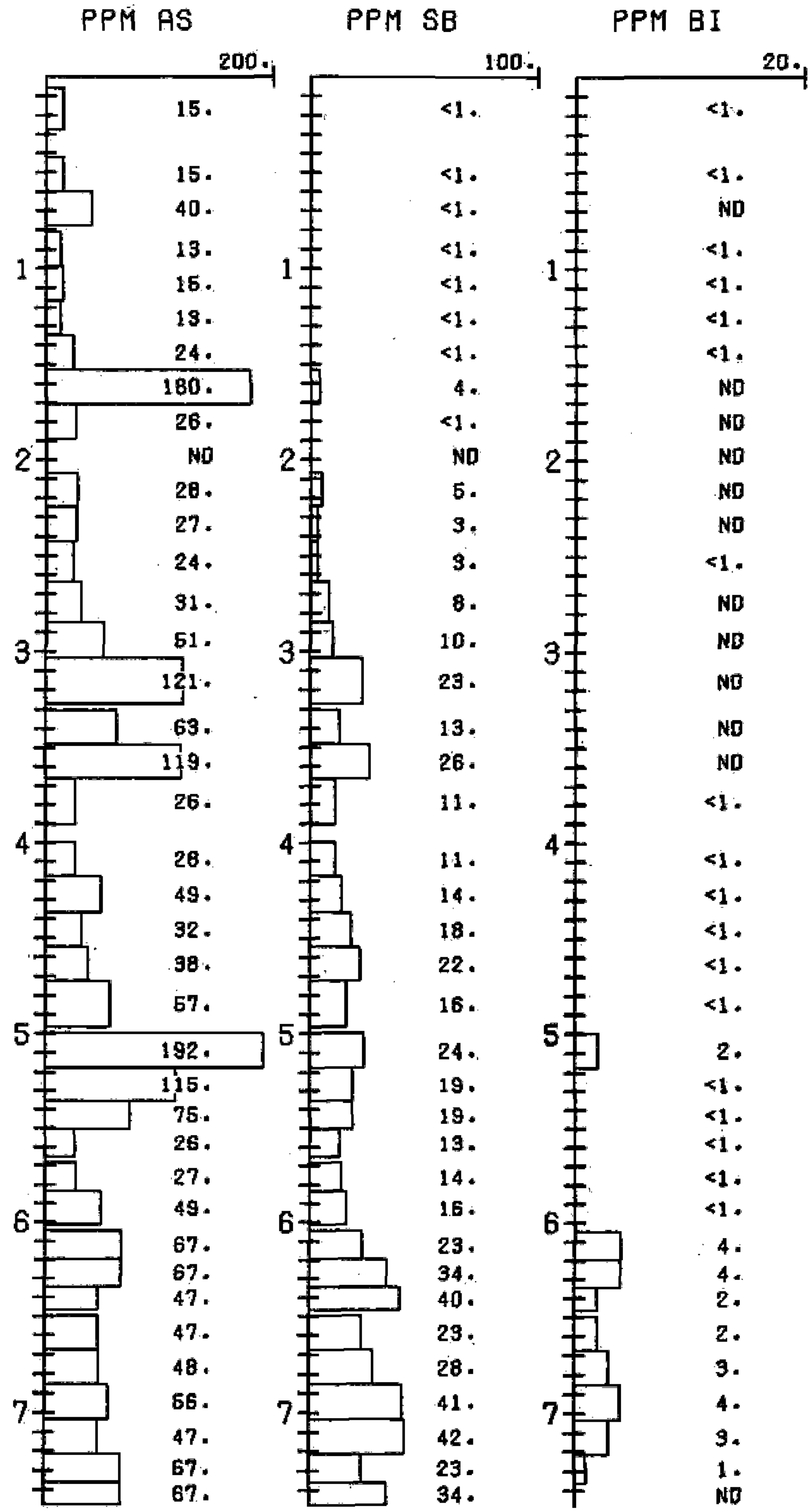


FIGURE 14/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

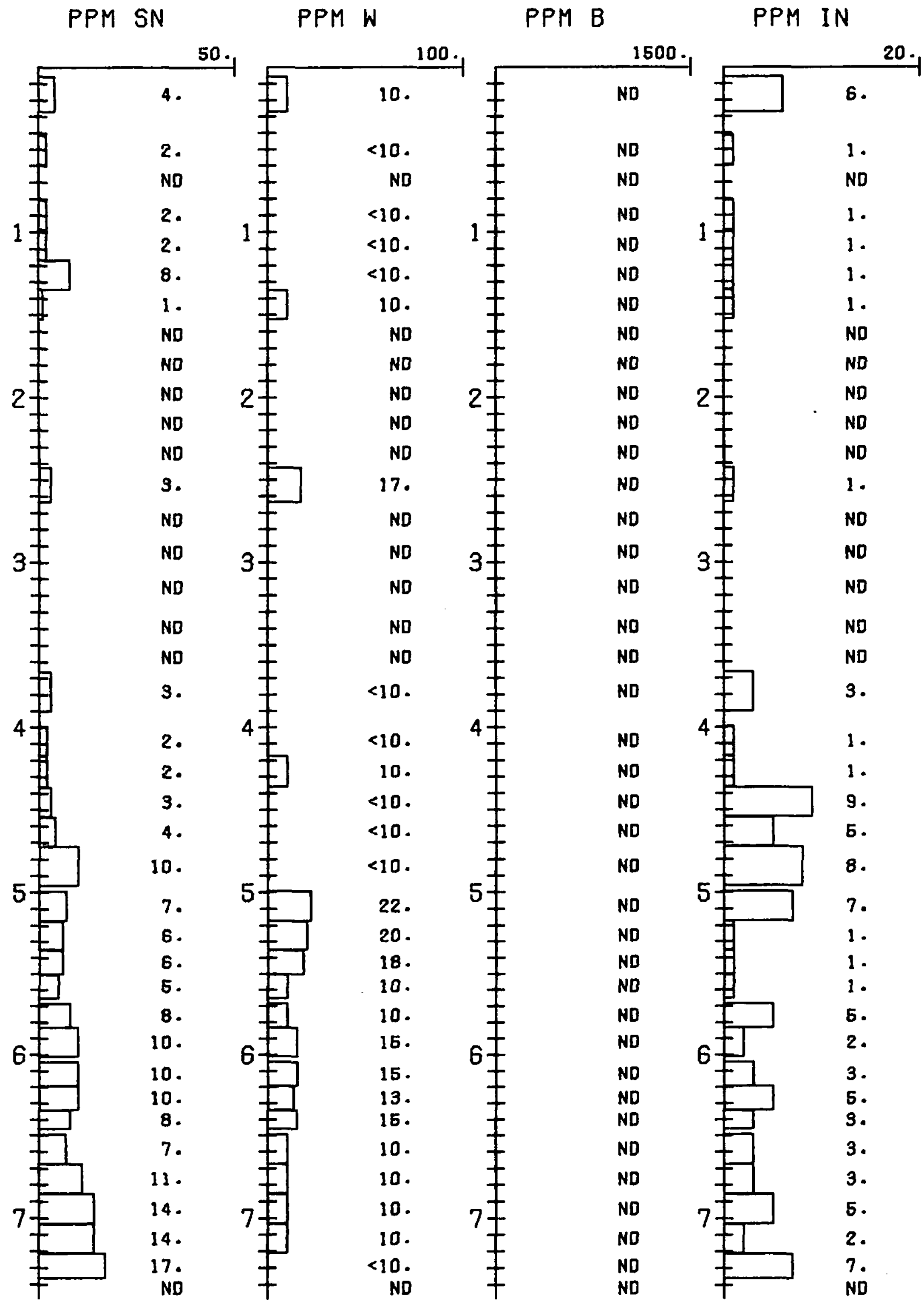


FIGURE 15/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

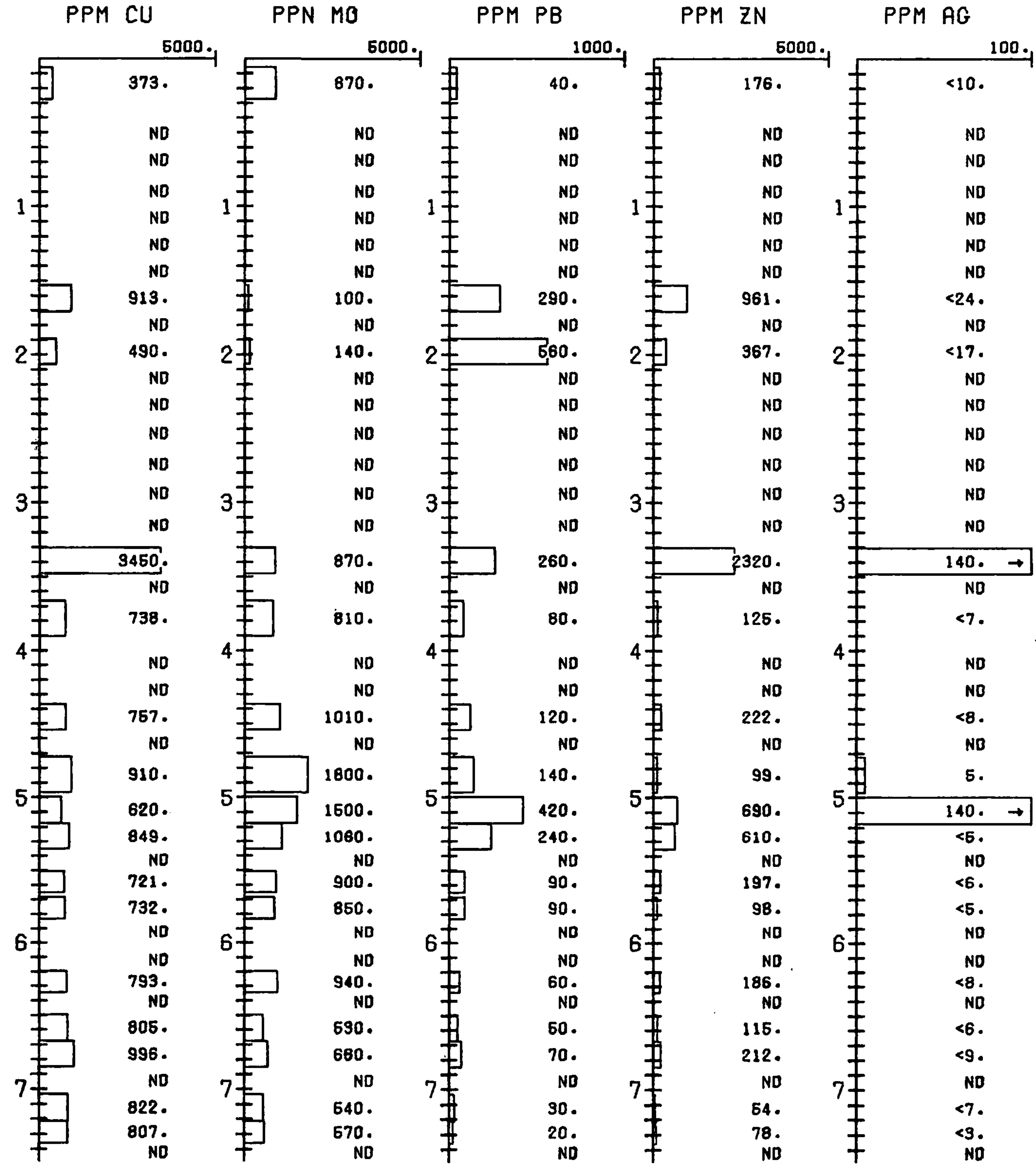


FIGURE 16/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

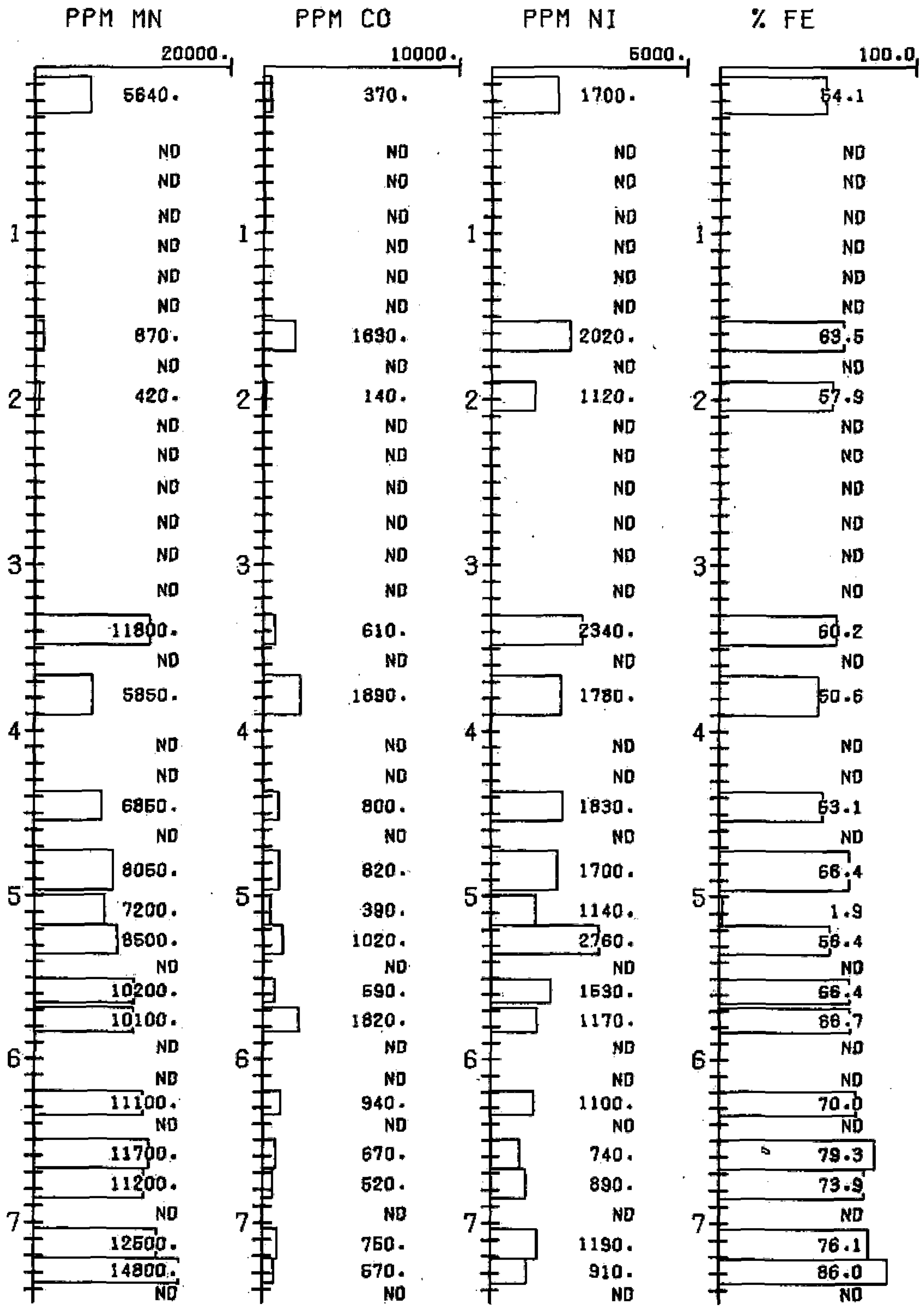


FIGURE 17/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

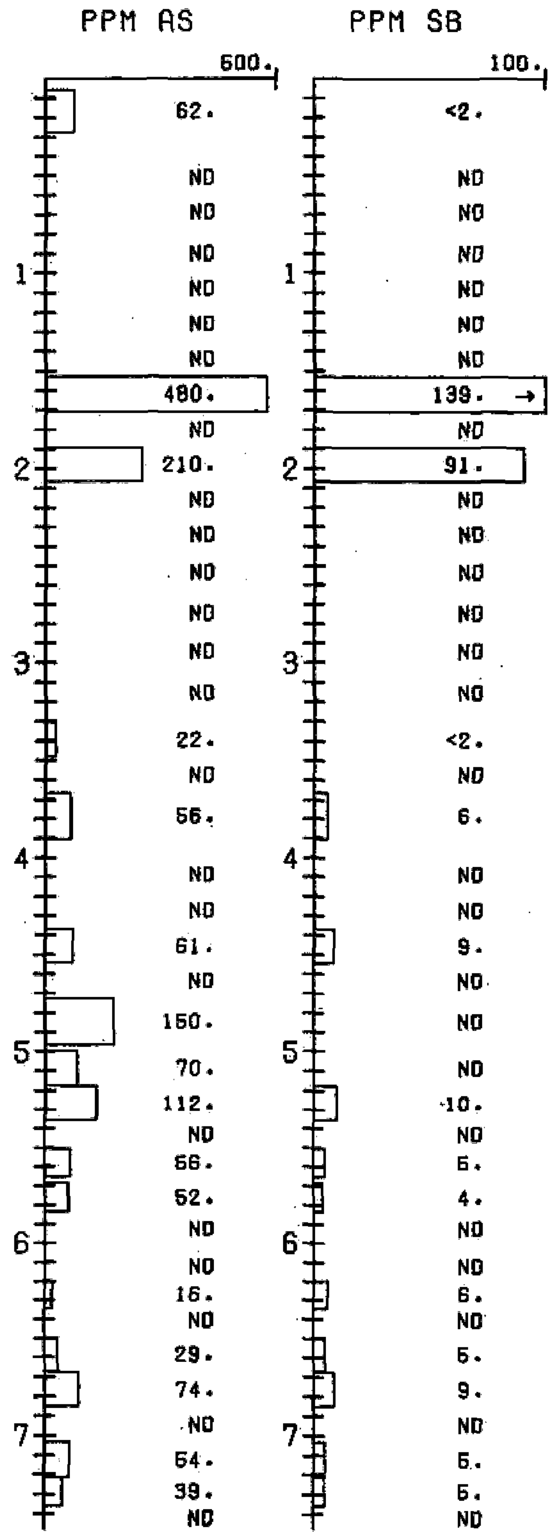
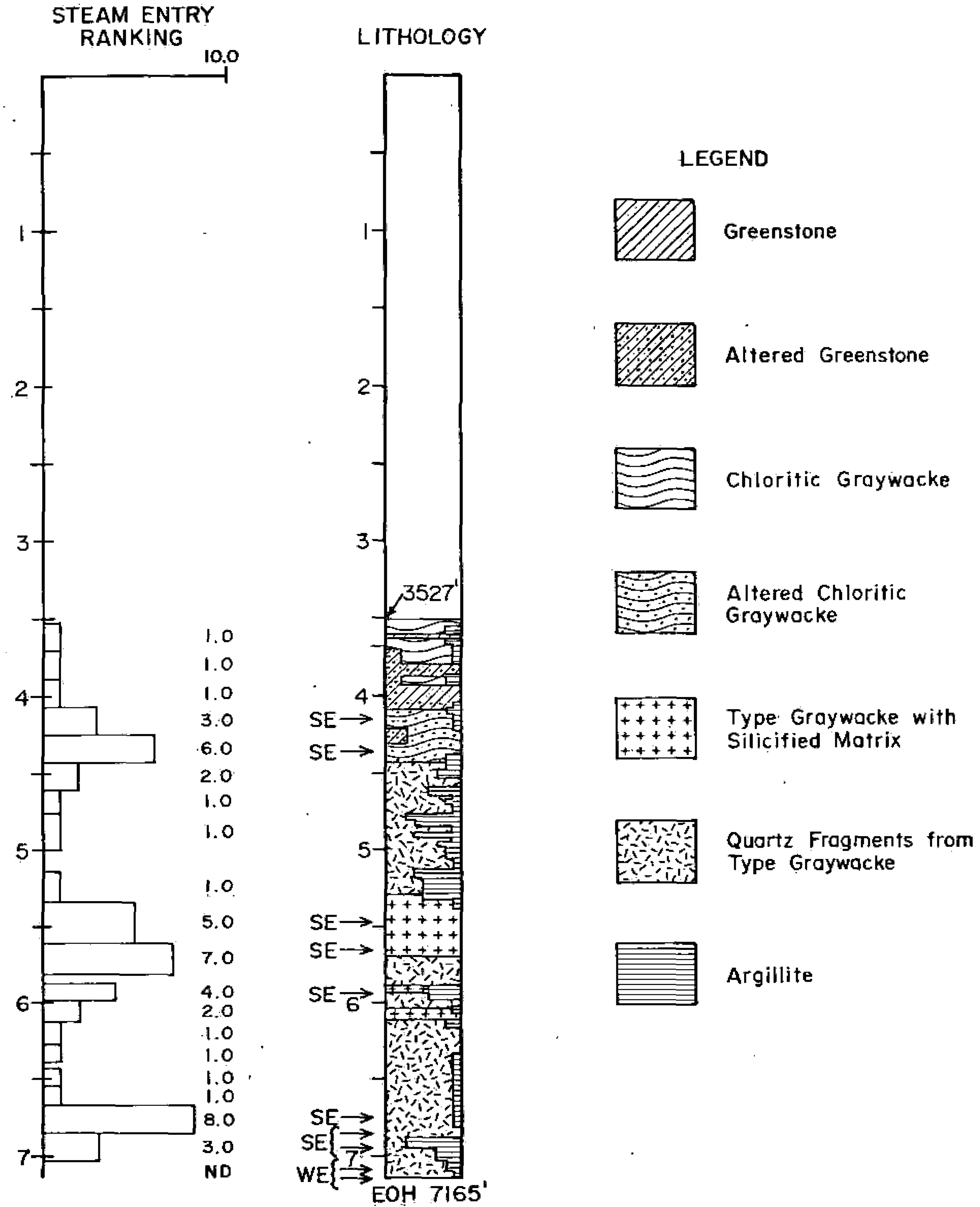


FIGURE 1/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

GENERALIZED GEOLOGY AND
STEAM ENTRY RANKING
VERT. SCALE: 1000 FT. / IN.



SE= Steam Entry WE= Water Entry

1.0 = No steam entry within or close to sample interval

2.0 thru 8.0 = Steam entries (SE) within or close to sample interval. Relative importance of SE indicated by ranking.

Geology modified from preliminary geologic log by Mary Twichell (Aminoil U.S.A. Inc.).

FIGURE 2/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE:
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

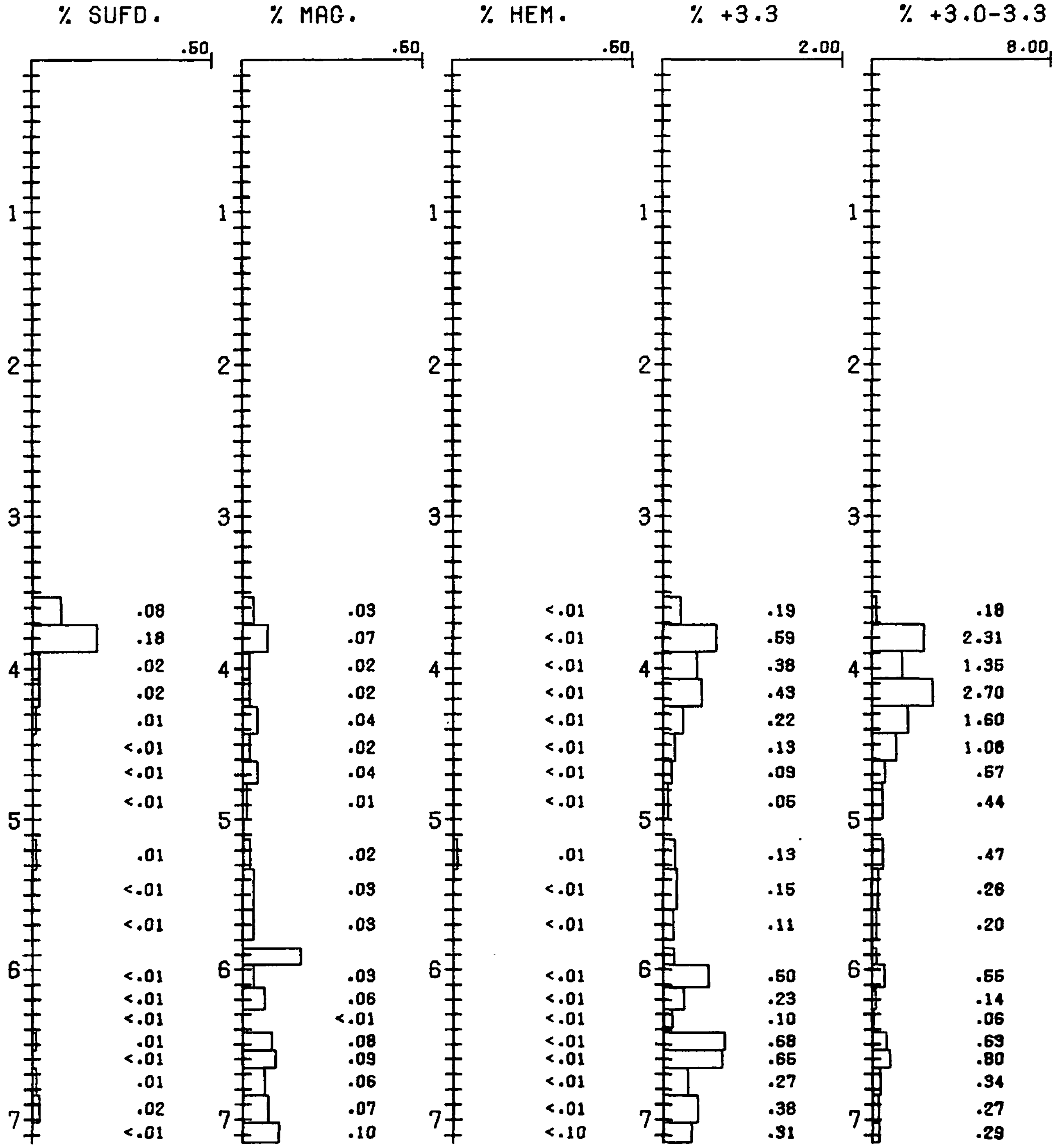


FIGURE 3/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

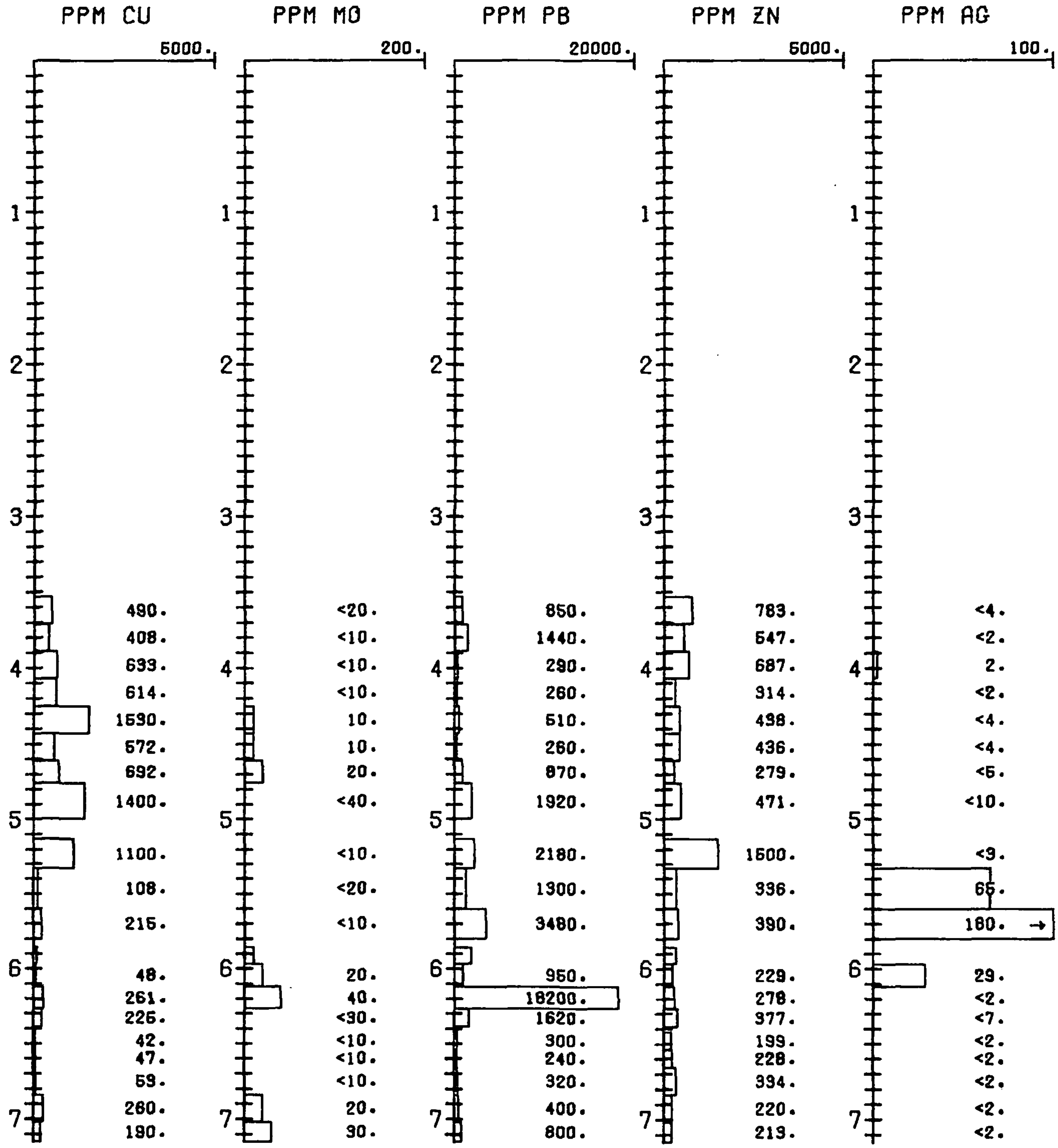


FIGURE 4/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

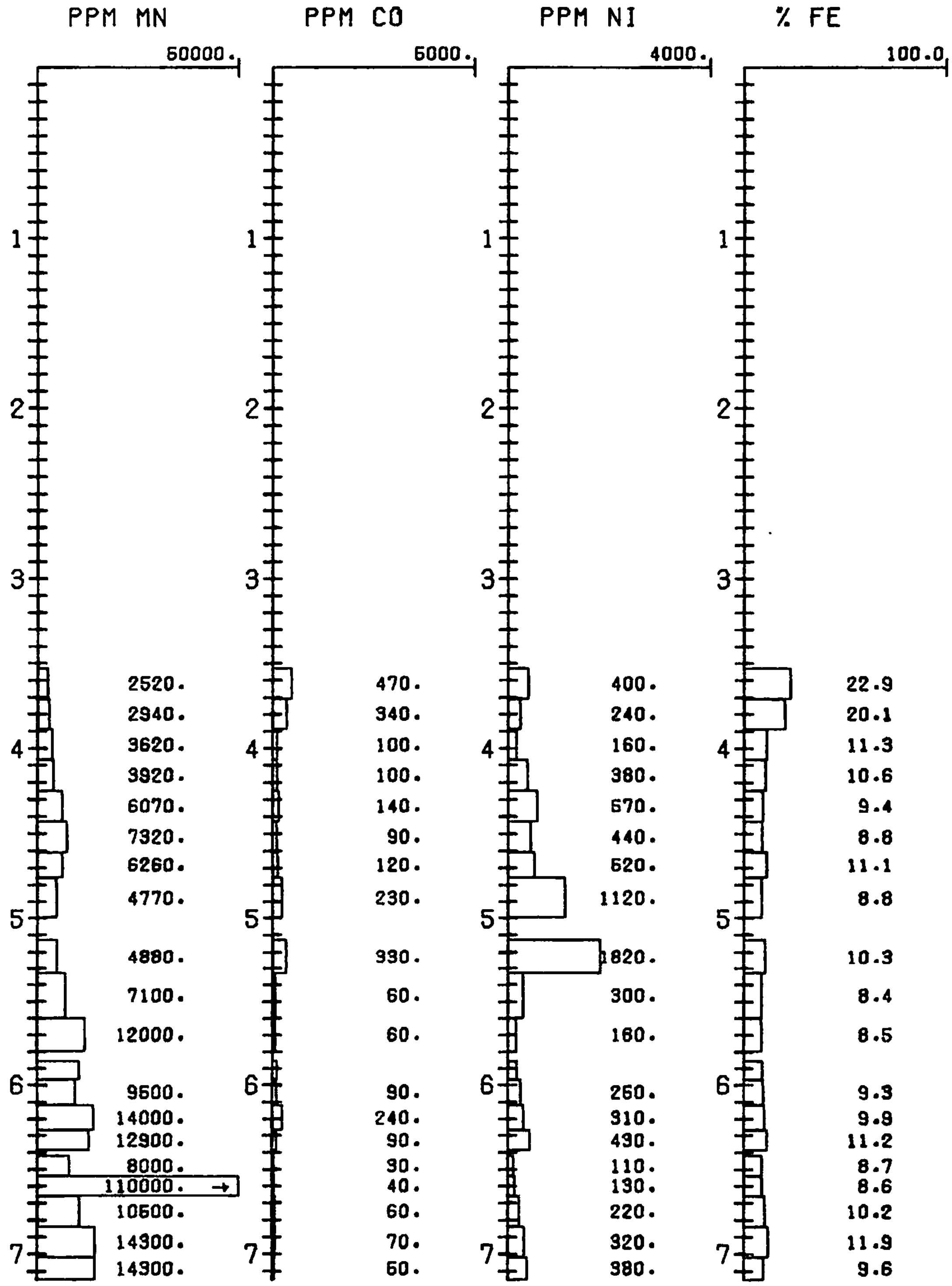


FIGURE 5/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

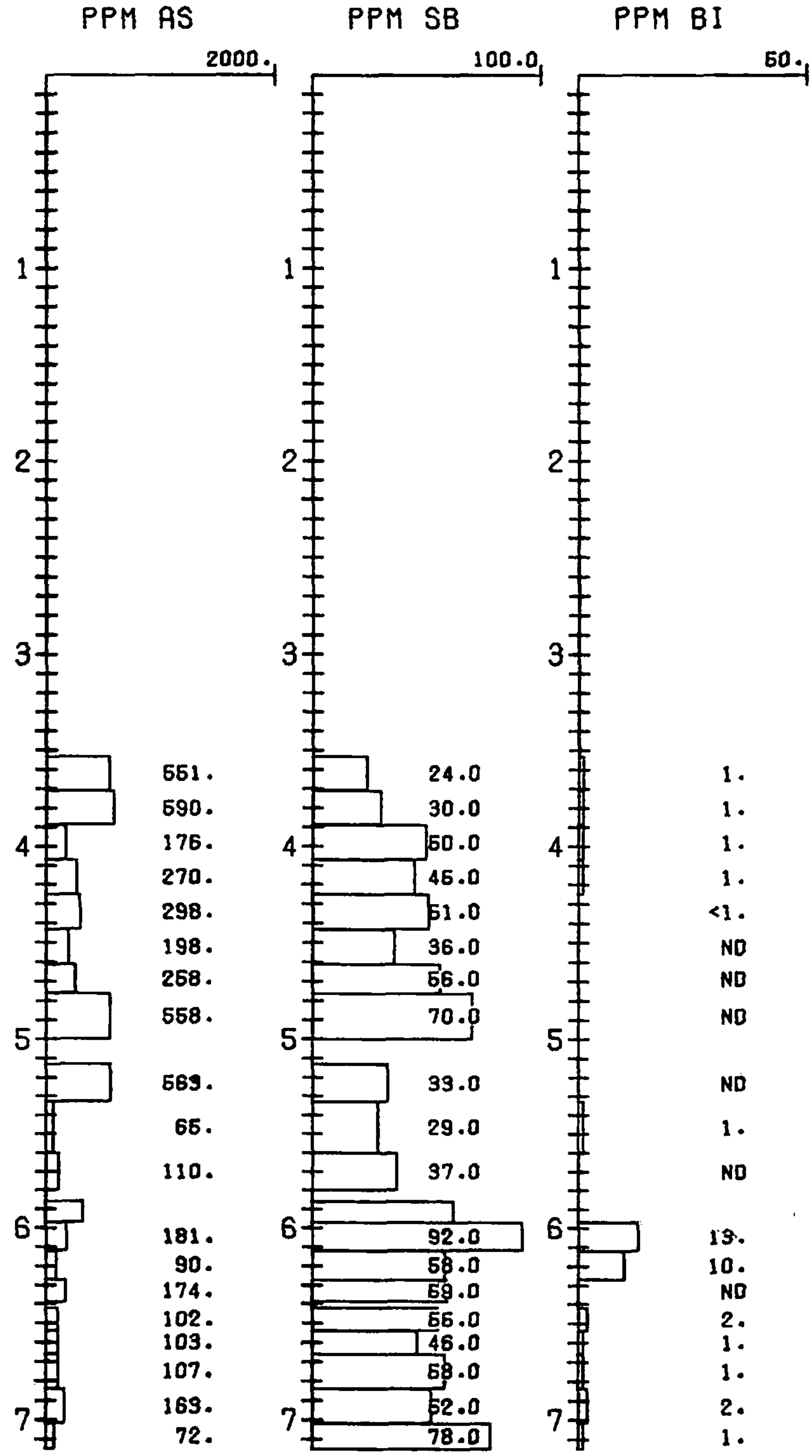


FIGURE 6/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

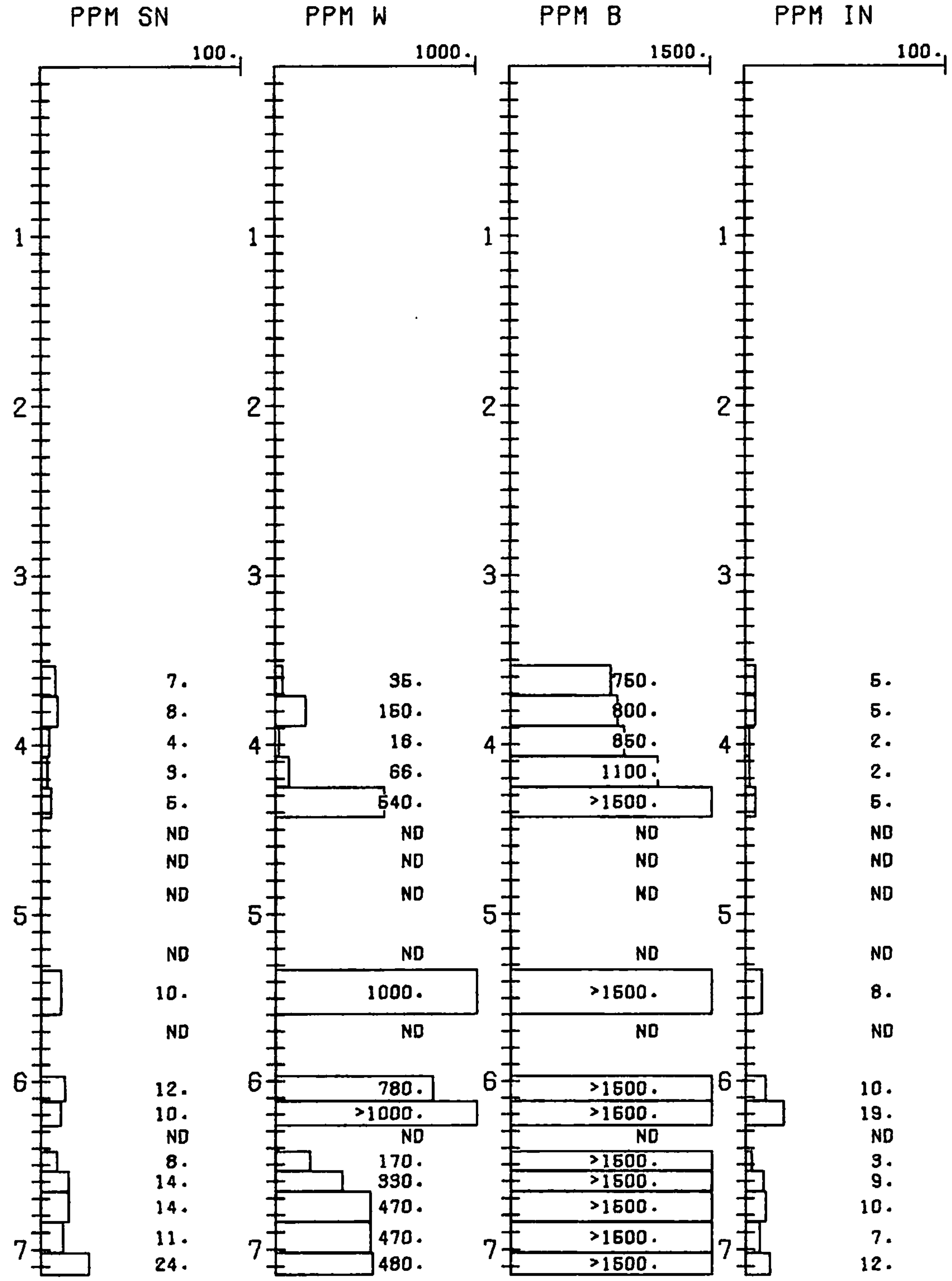


FIGURE 7/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

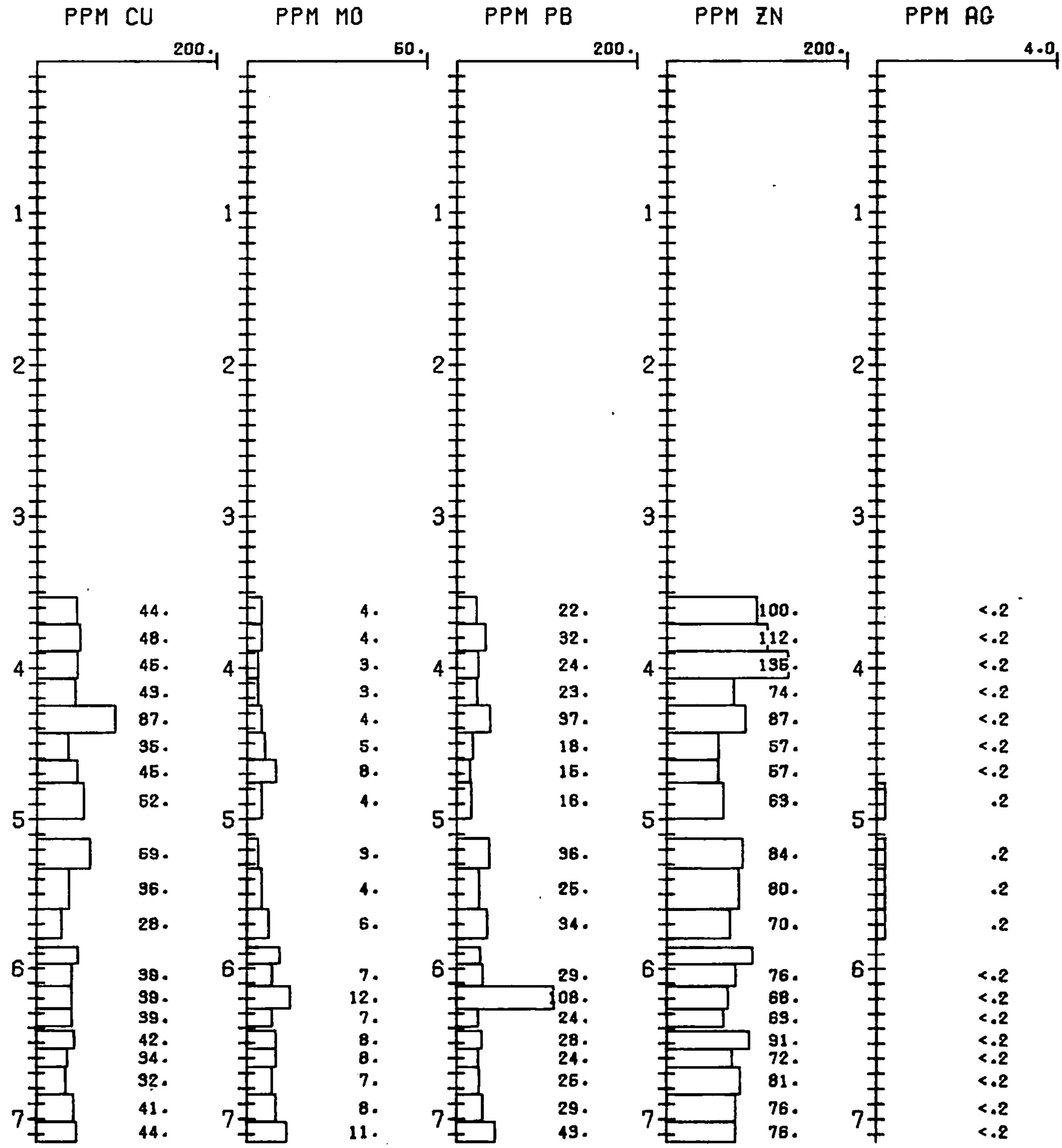


FIGURE 8/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

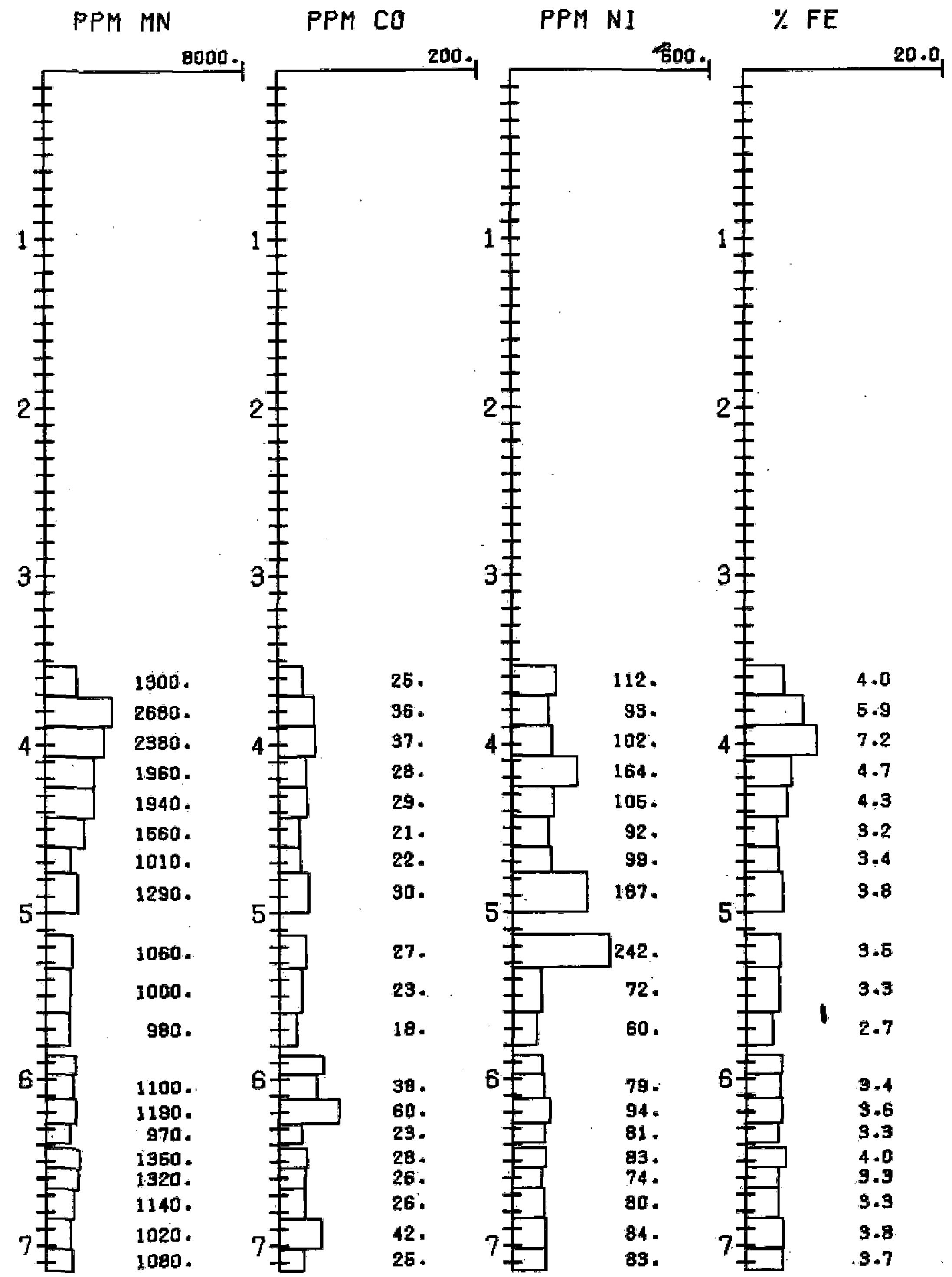


FIGURE 9/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

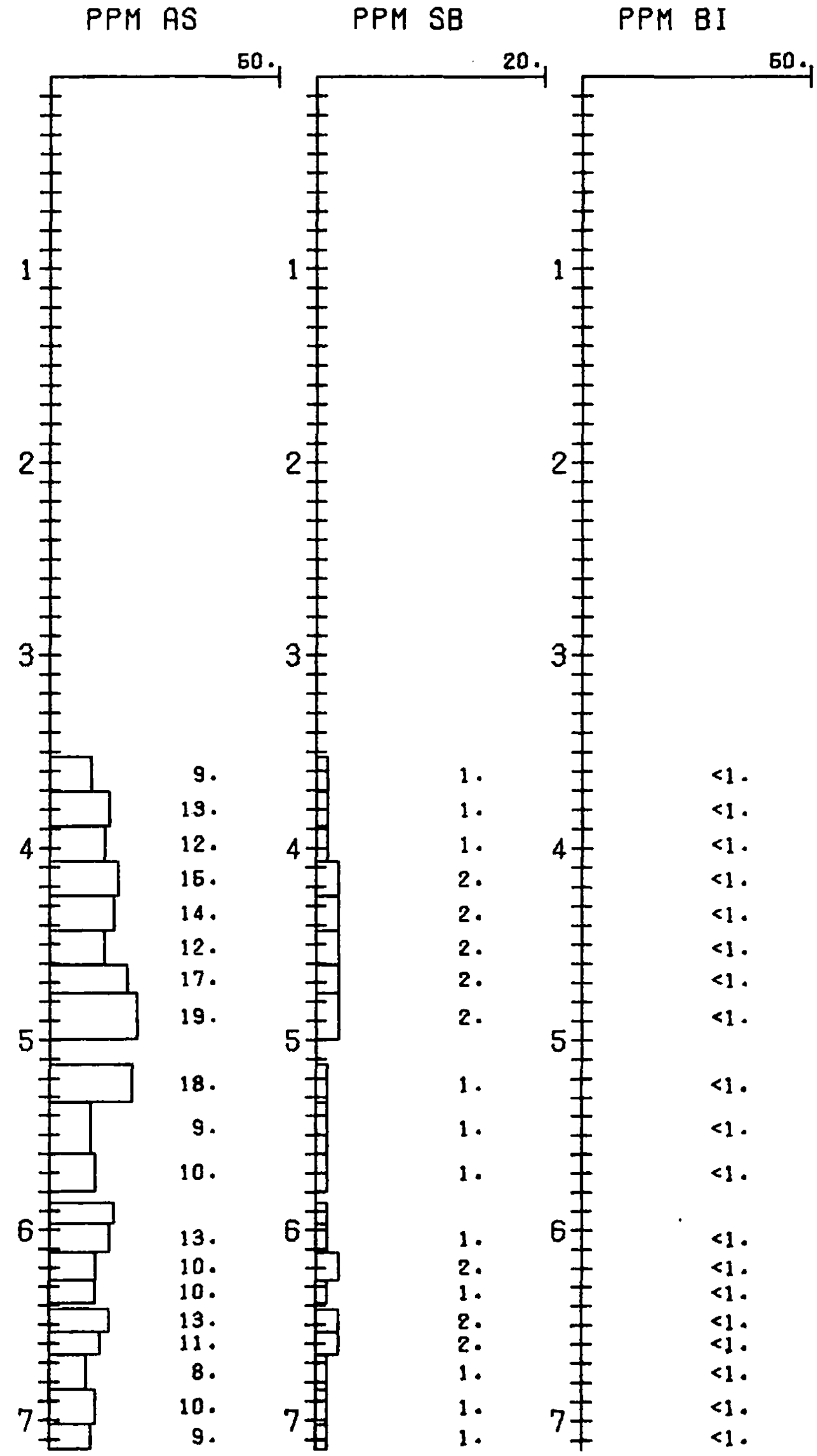


FIGURE 10/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: WHOLE ROCK
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

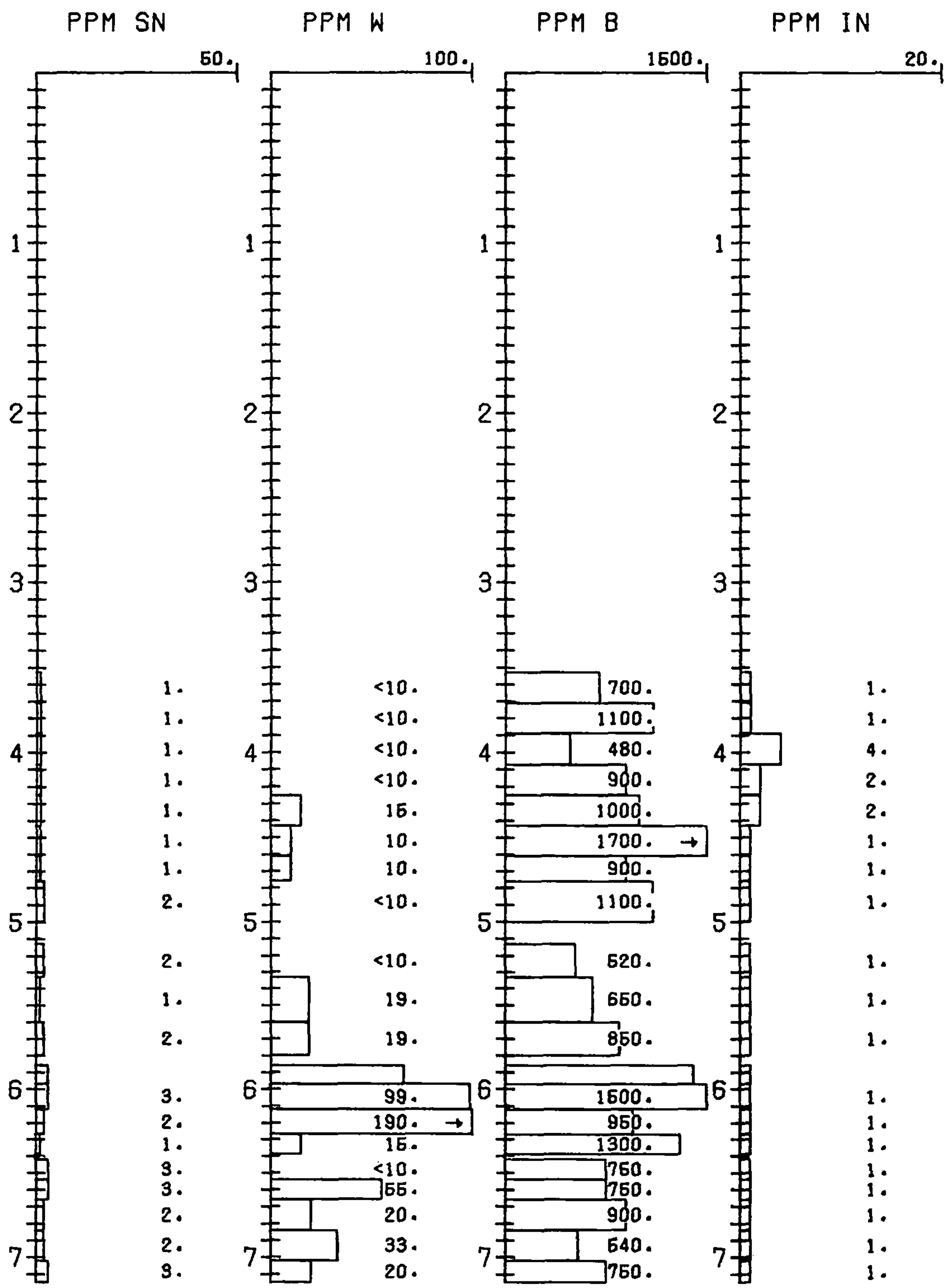


FIGURE 11/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

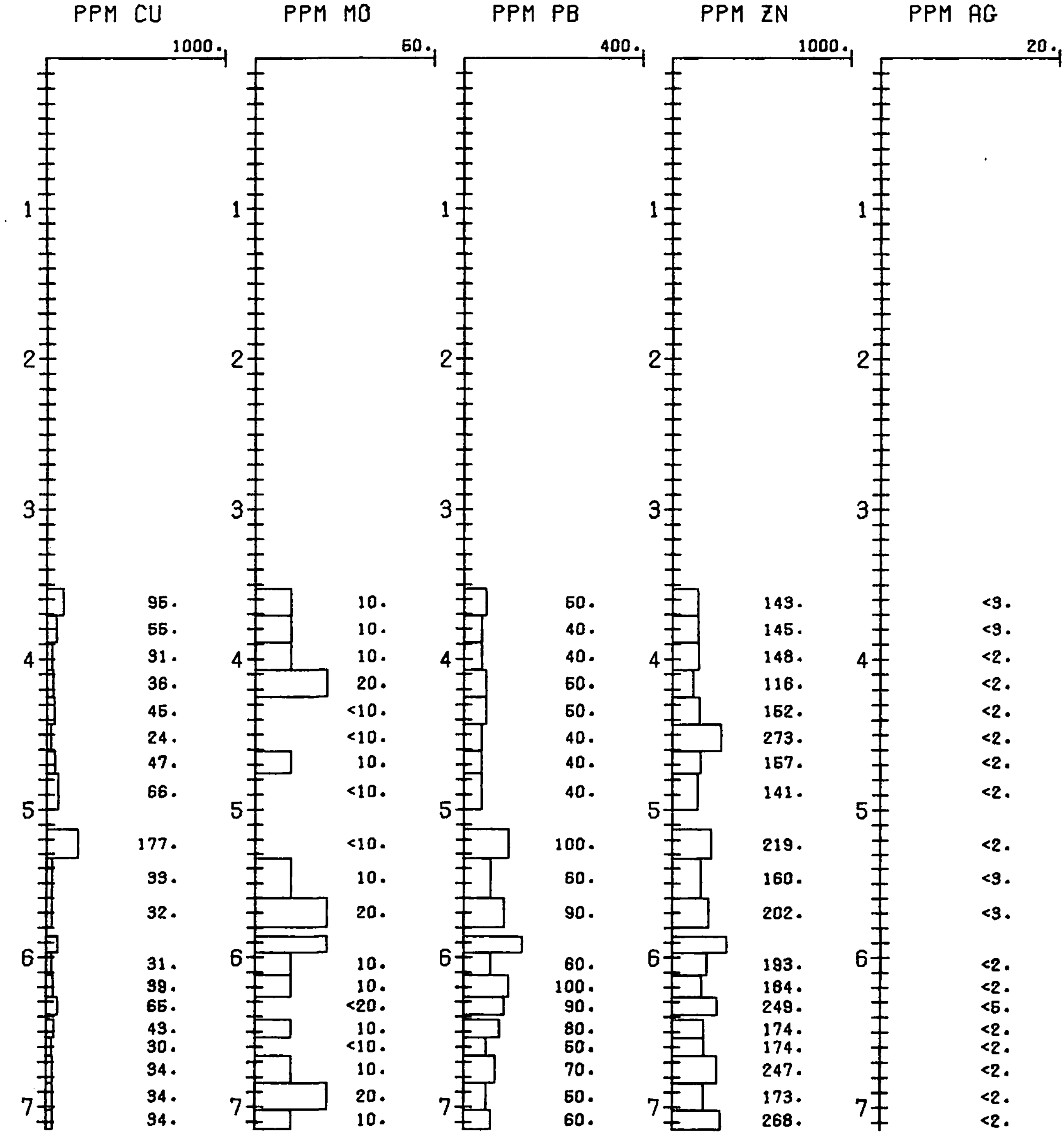


FIGURE 12/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

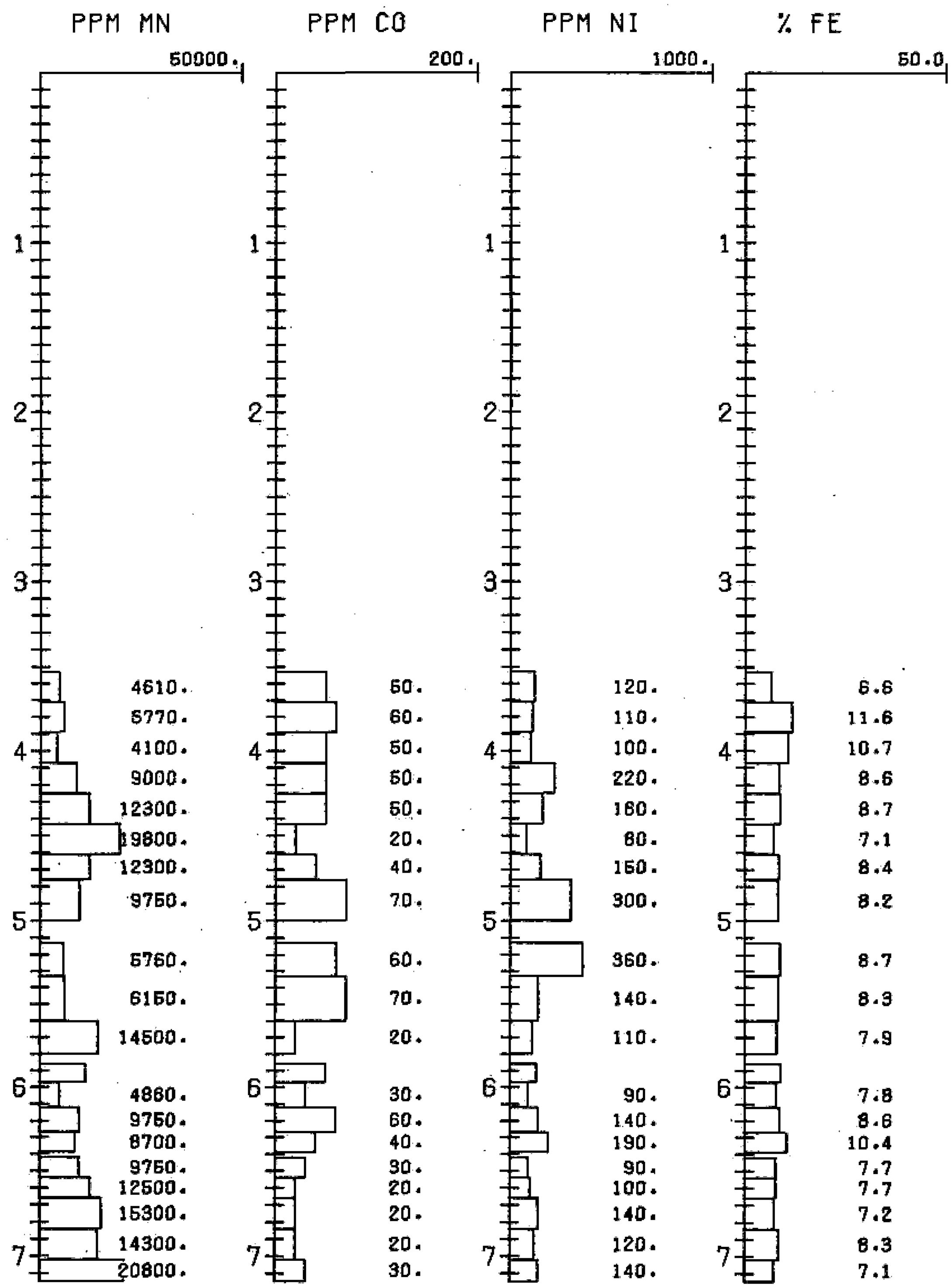


FIGURE 13/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

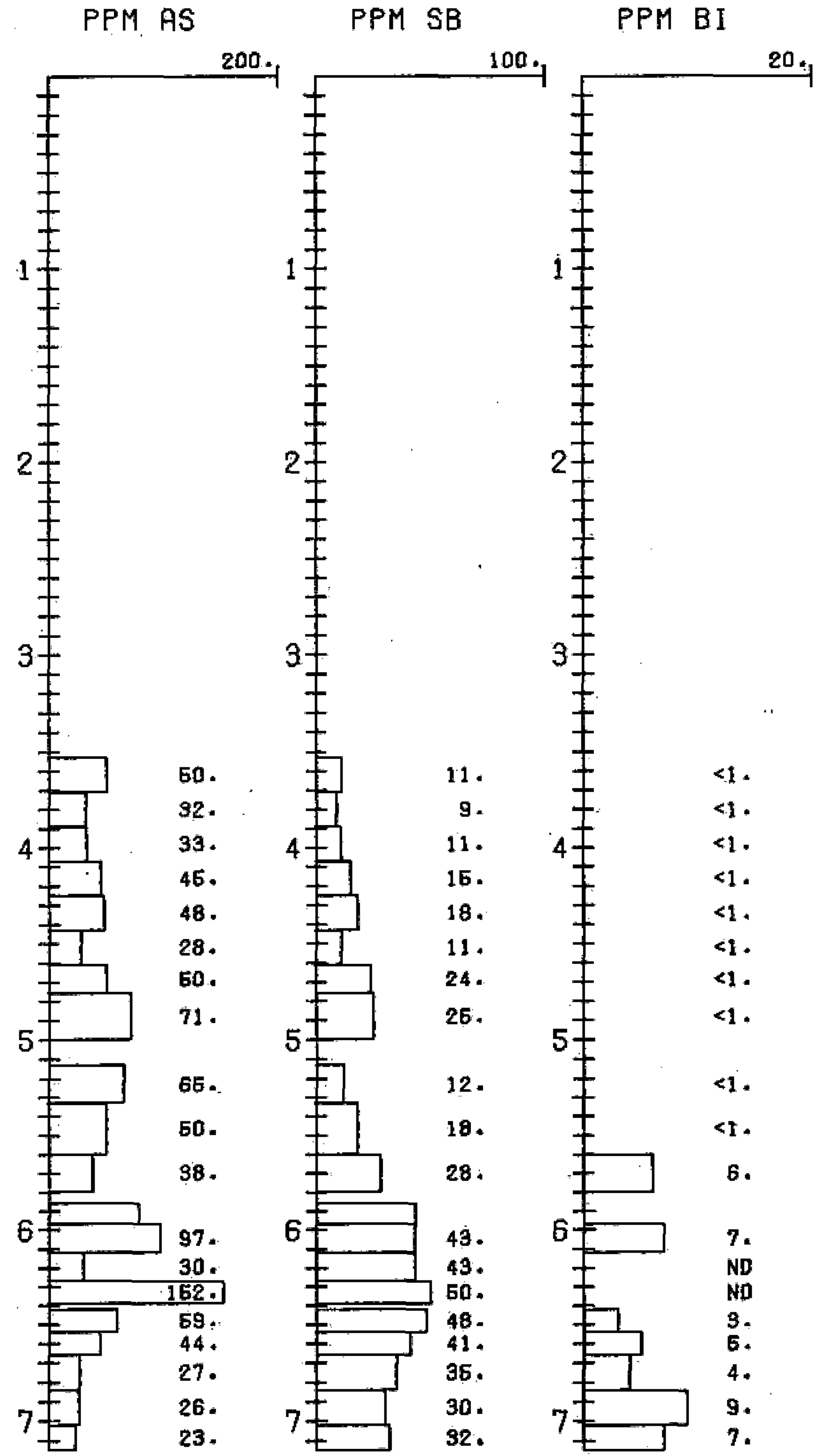


FIGURE 14/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: +3.0-3.3 H.L. CONC.
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

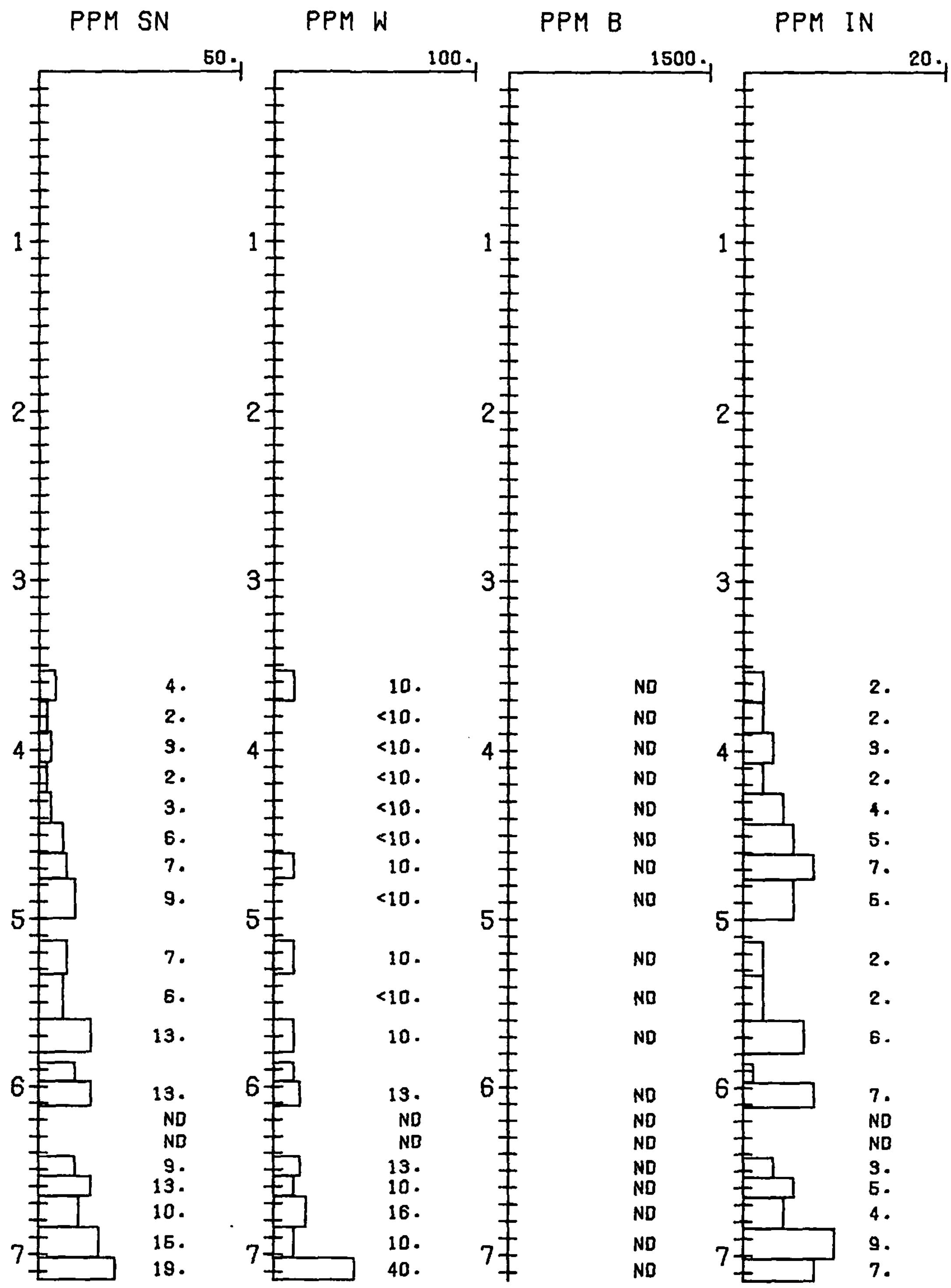


FIGURE 15/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

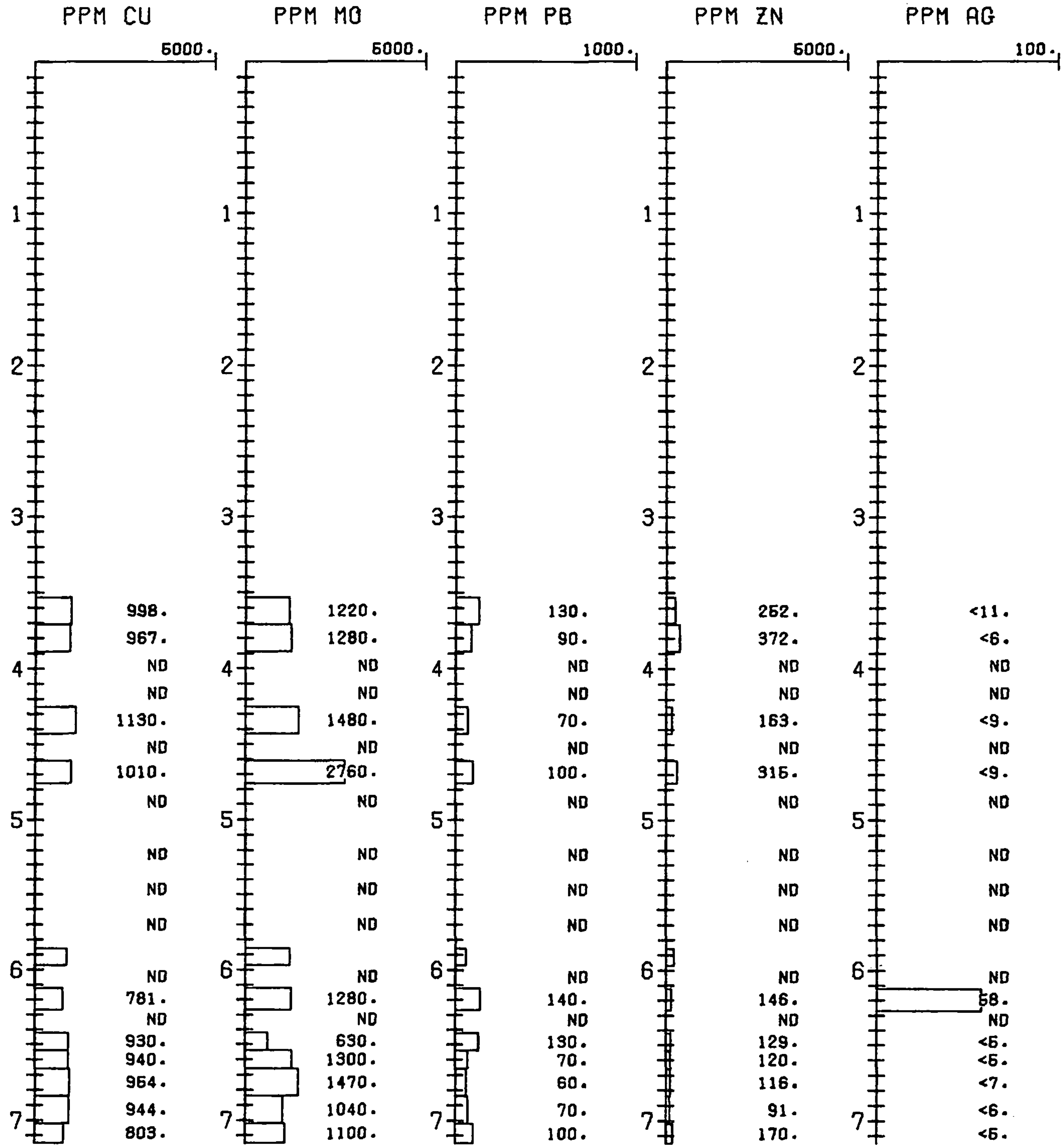


FIGURE 16/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)

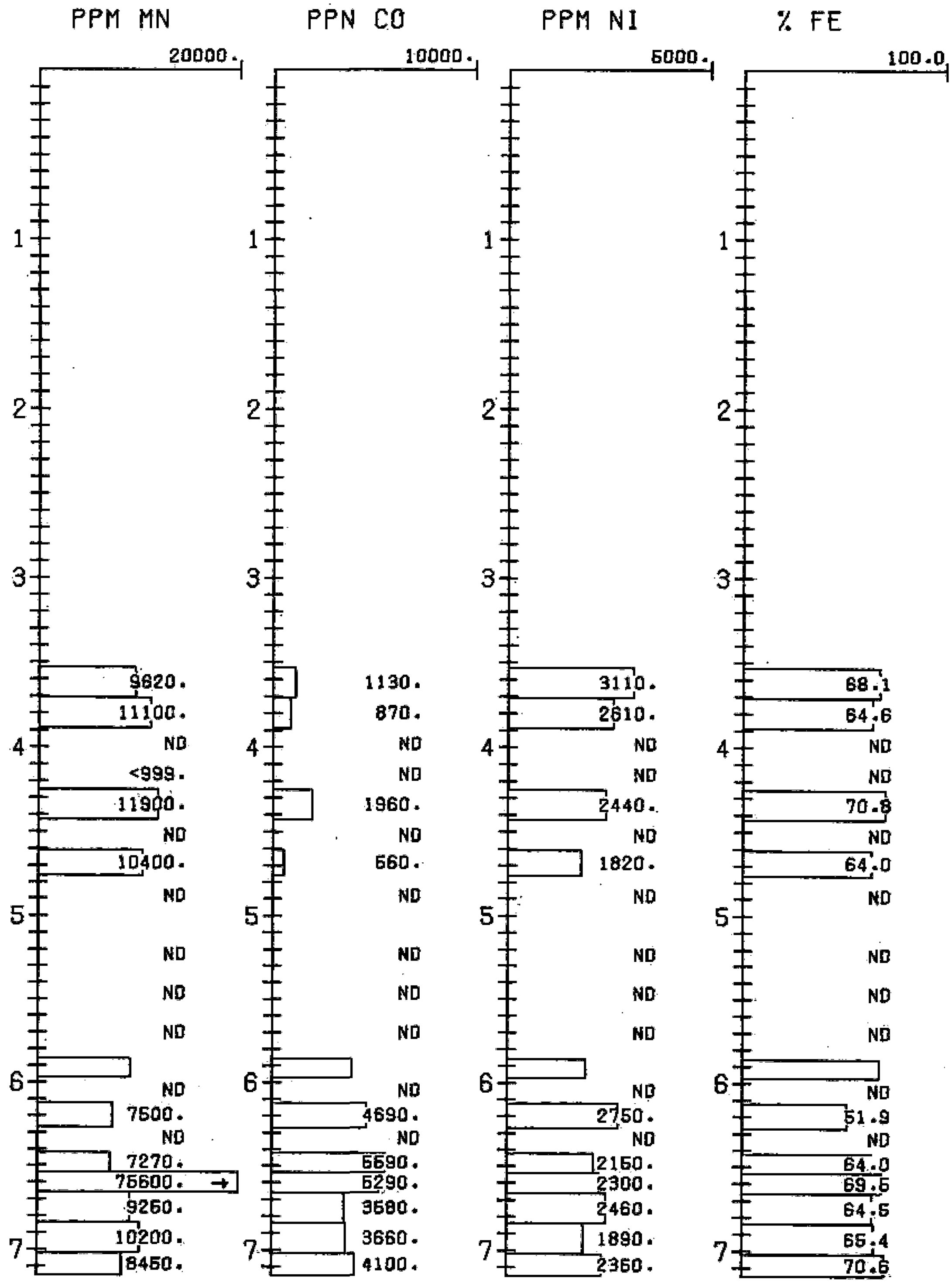
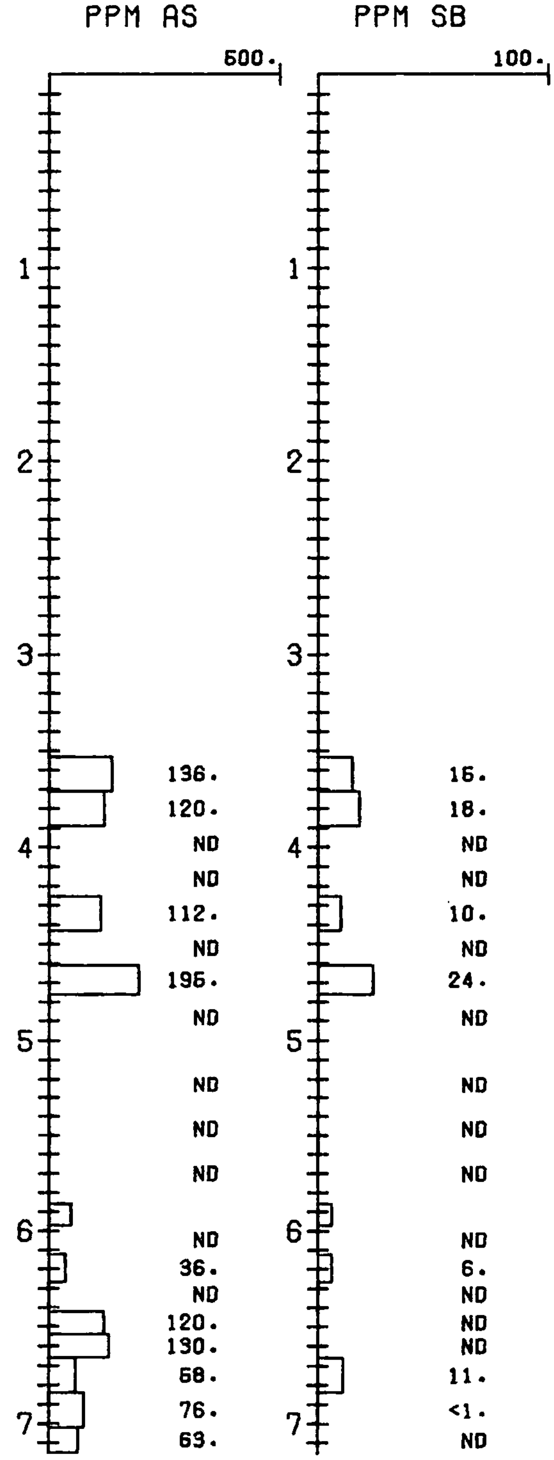


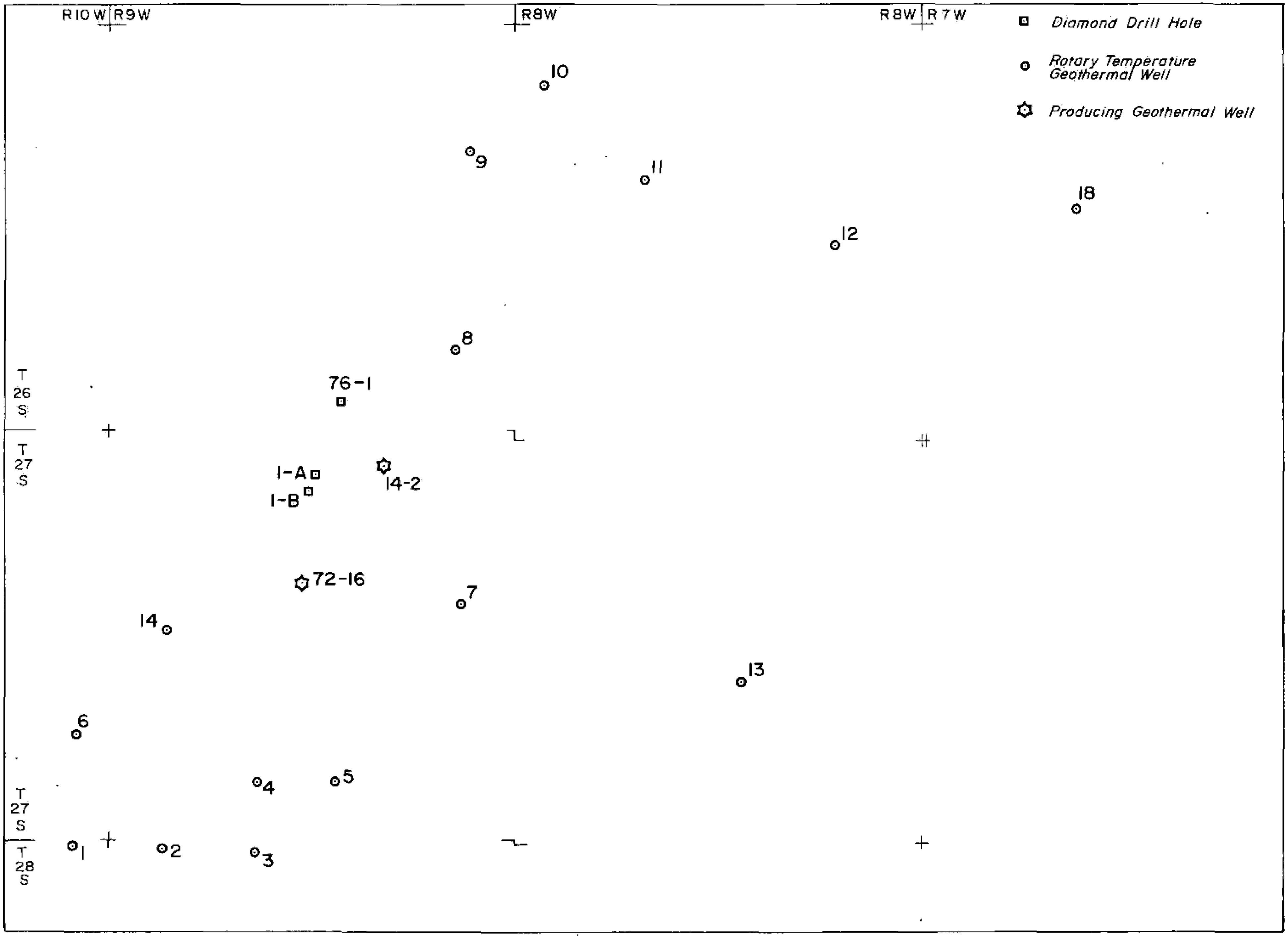
FIGURE 17/G-1R

DH G-1R

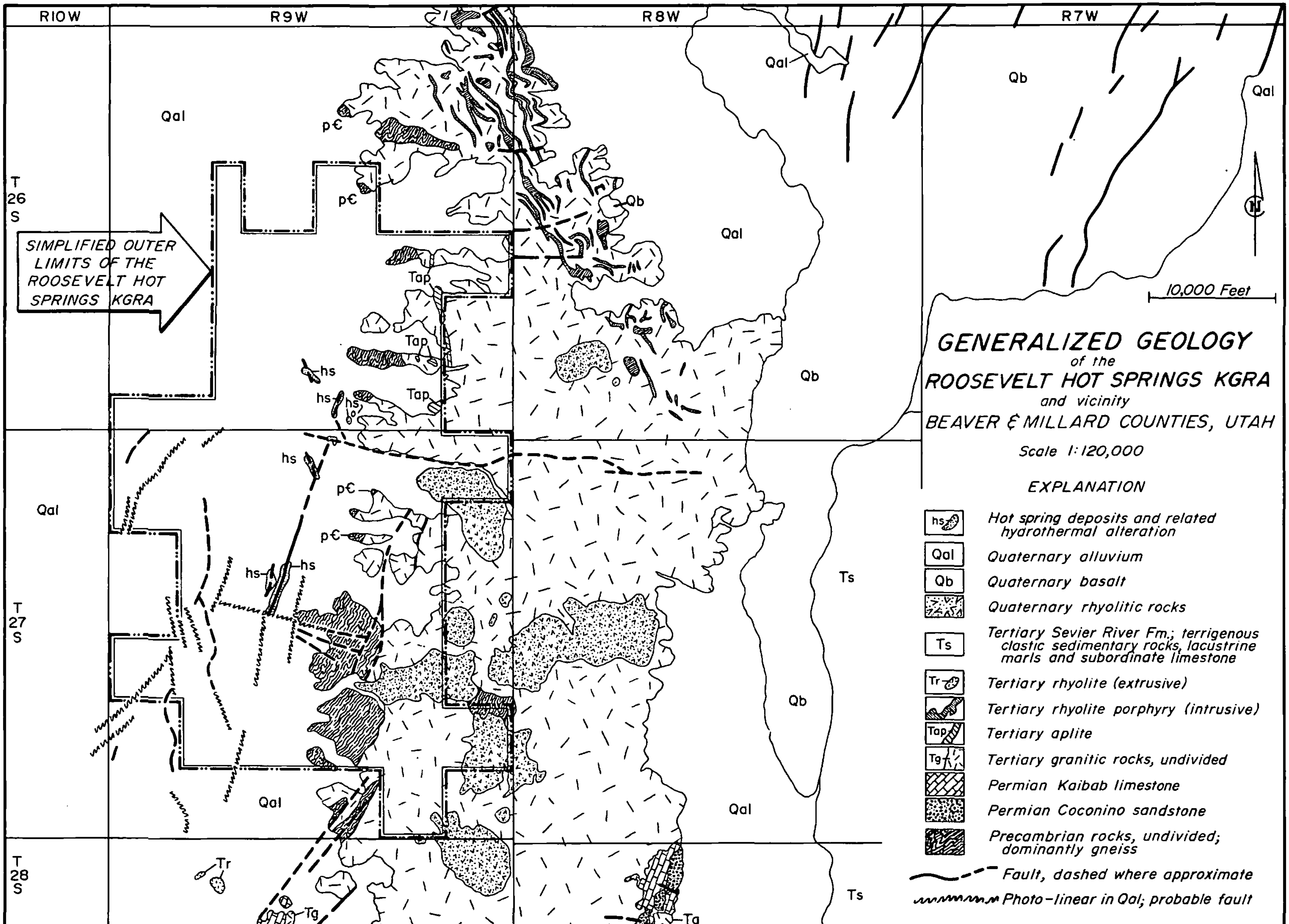
GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

SAMPLE TYPE: MAGNETICS
VERT. SCALE: 1000.0 FT./IN.
(DEPTH SHOWN IN KILOFEET)



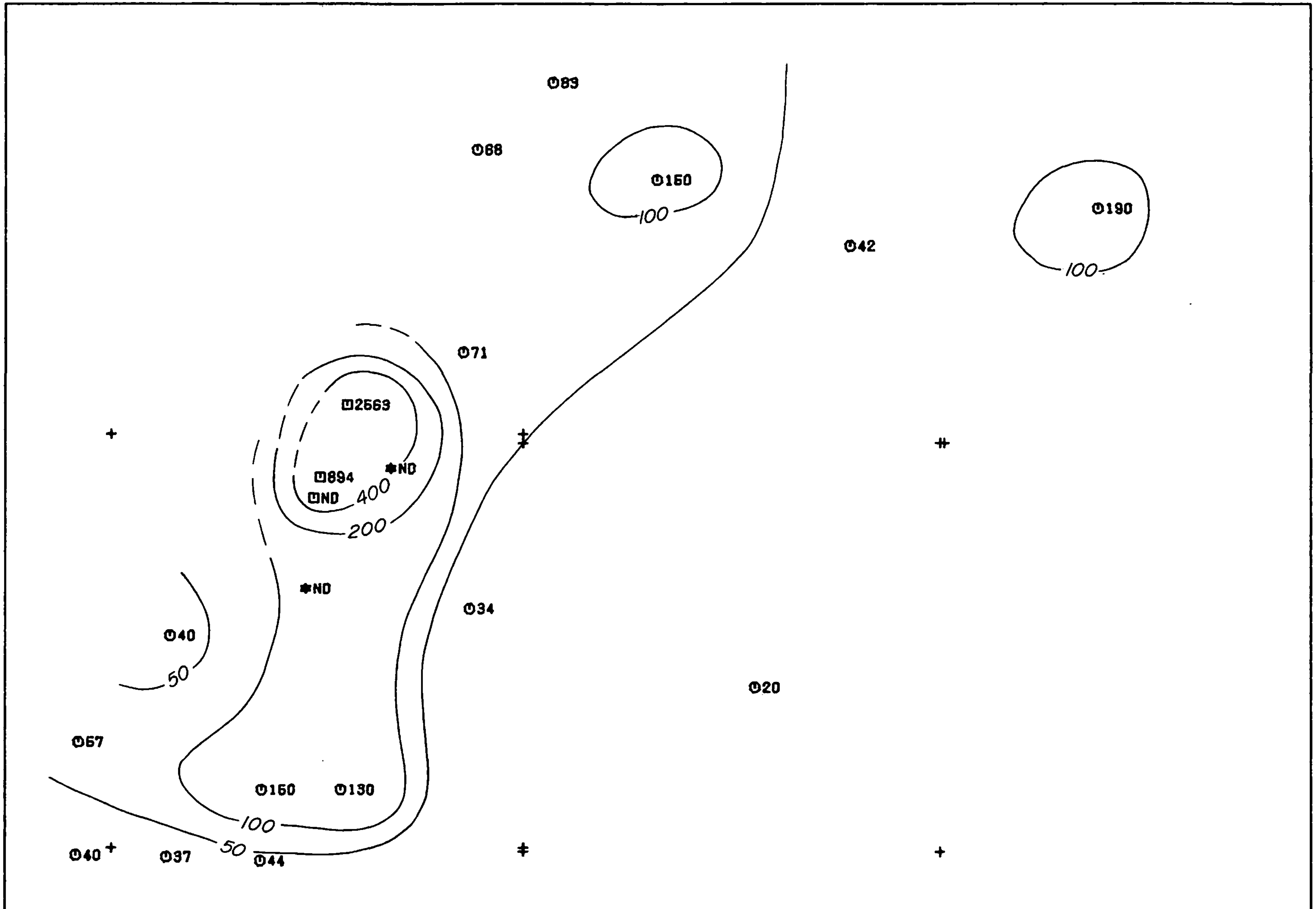


OVERLAY TO FIGURE 1/PLAN



Geology modified by J. B. HULEN from Liese, 1957; Hintze, 1963, 1975; Evans et al, 1977

FIGURE 1/PLAN



10000 FEET

FIGURE: 2 (0-100 FT) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

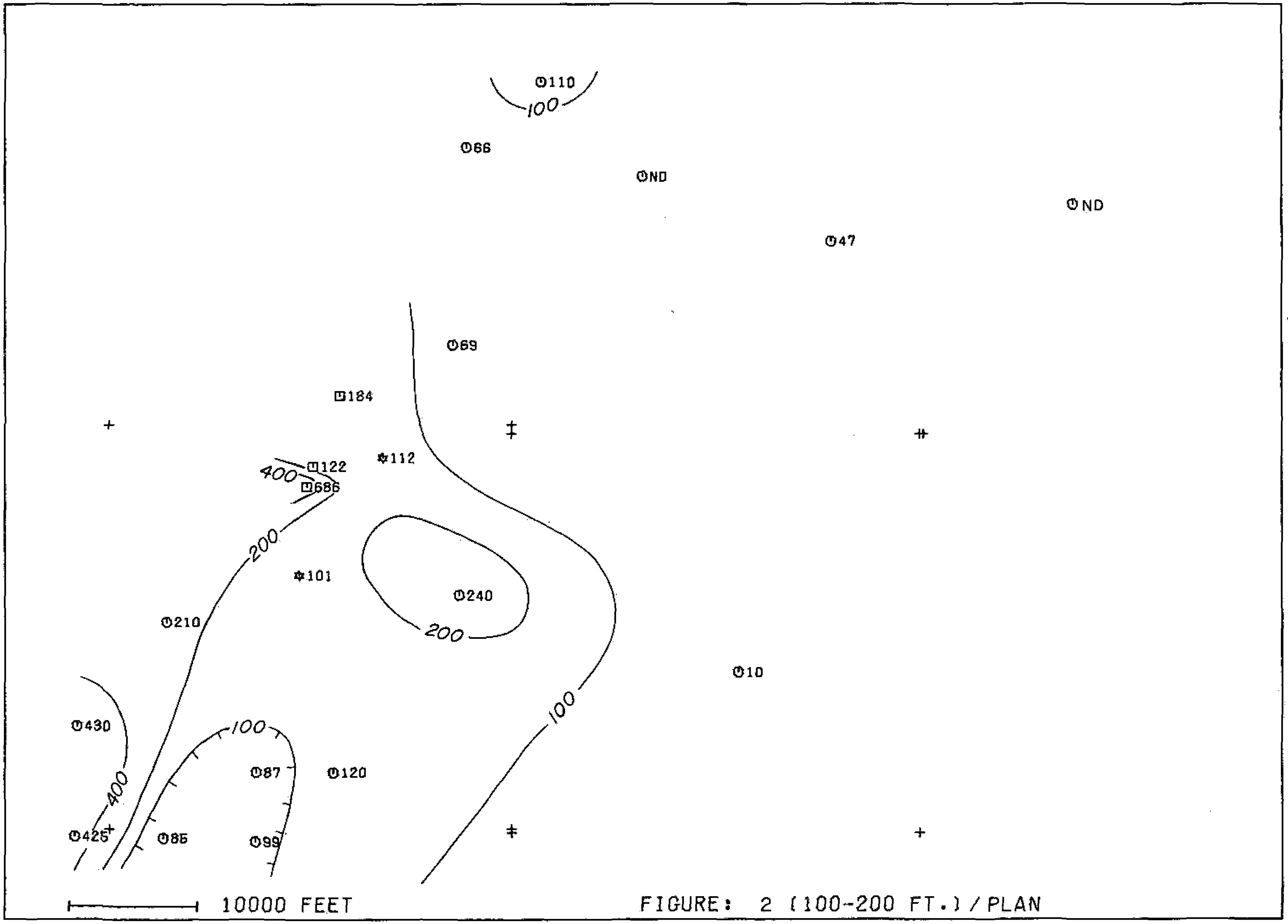
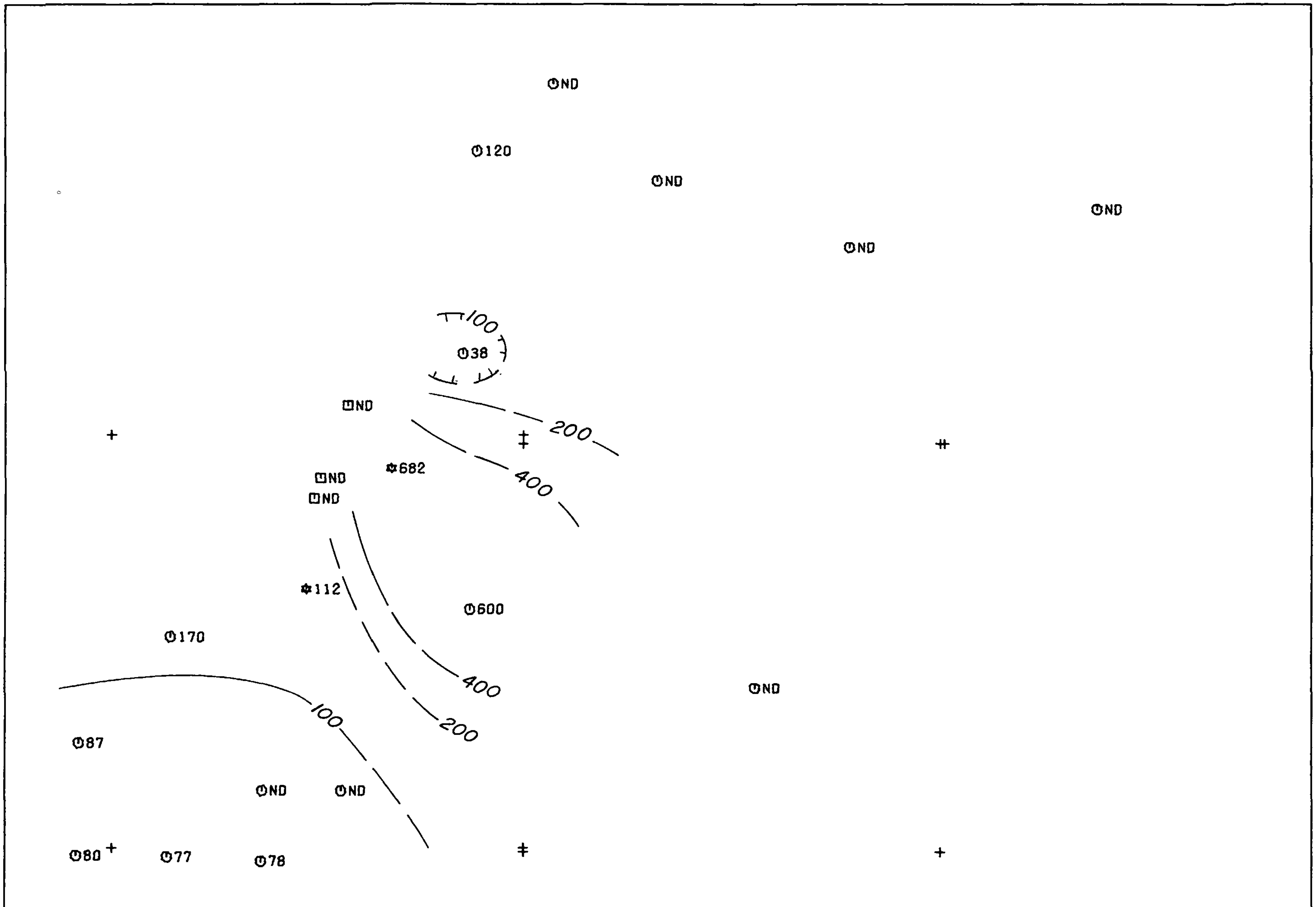


FIGURE: 2 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 2 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

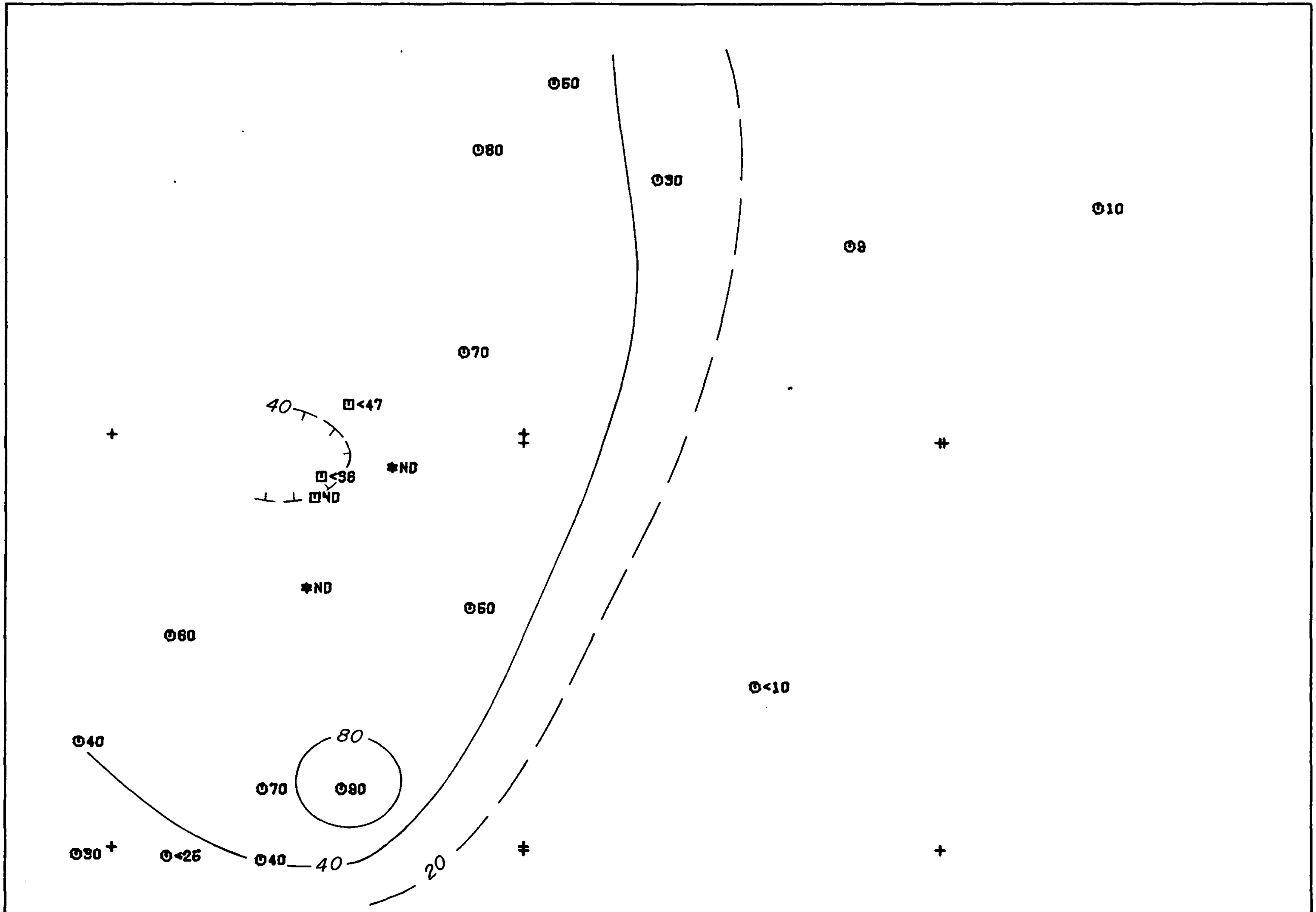
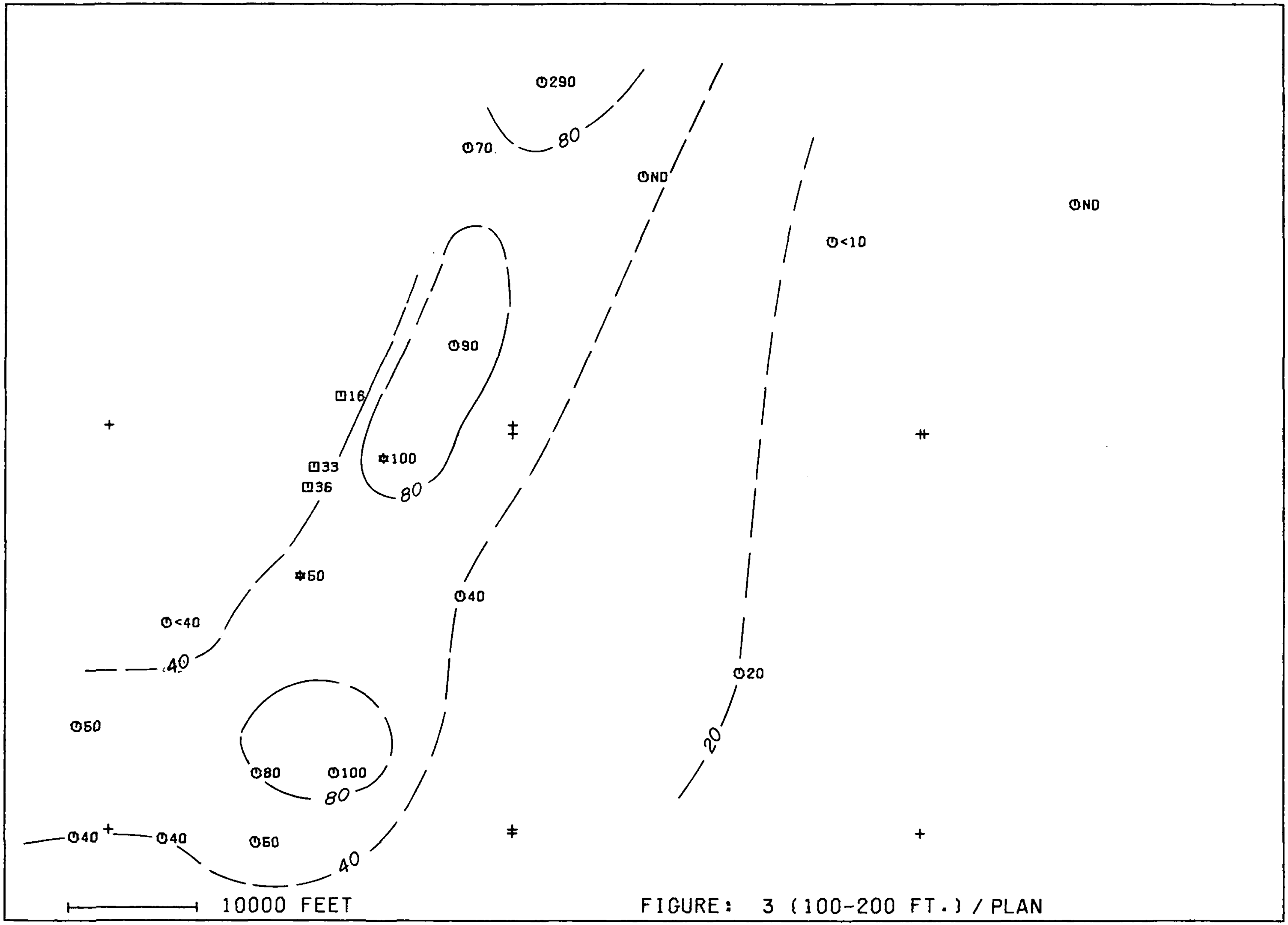


FIGURE: 3 (0-100 FT.) / PLAN

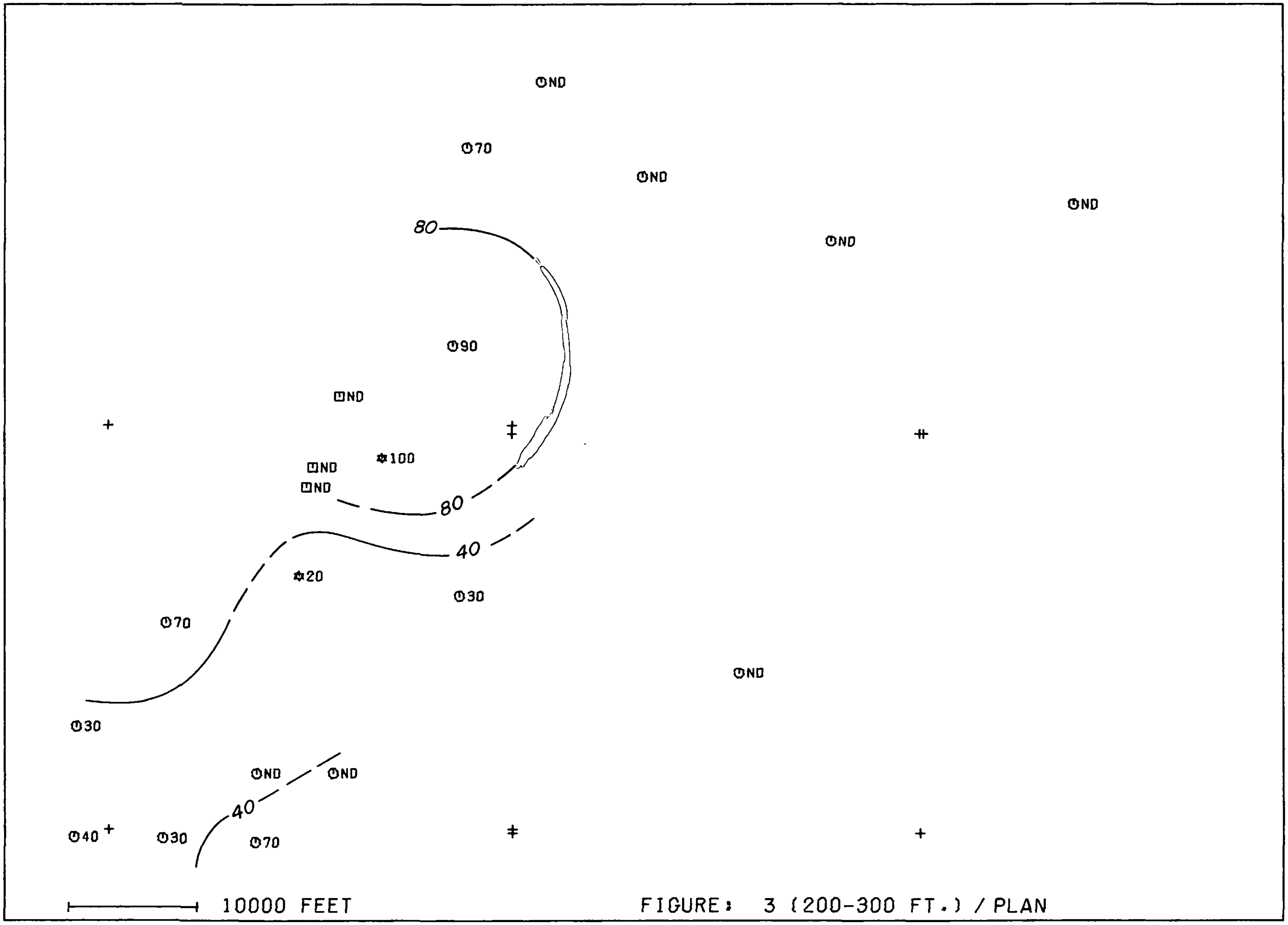
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



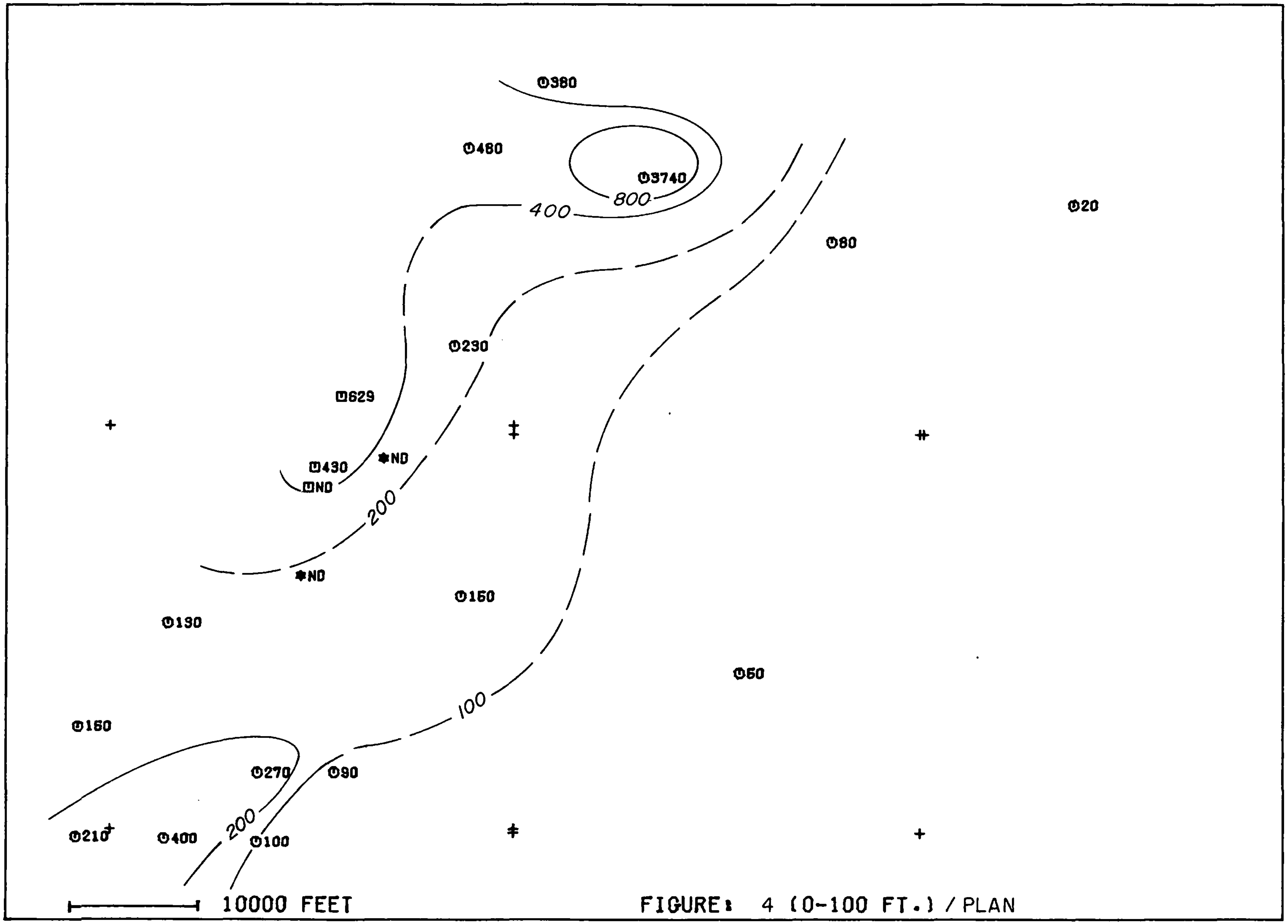
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



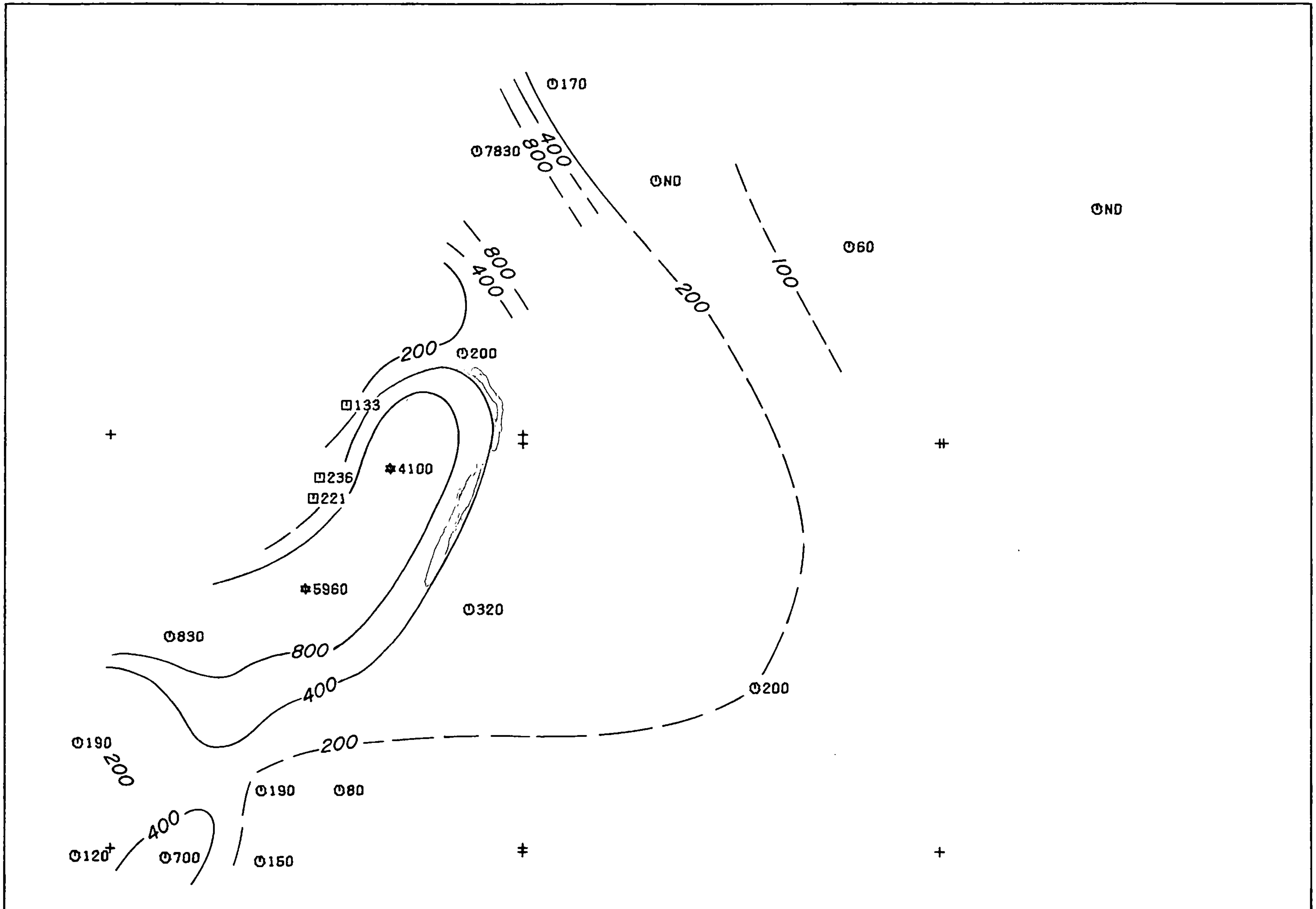
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

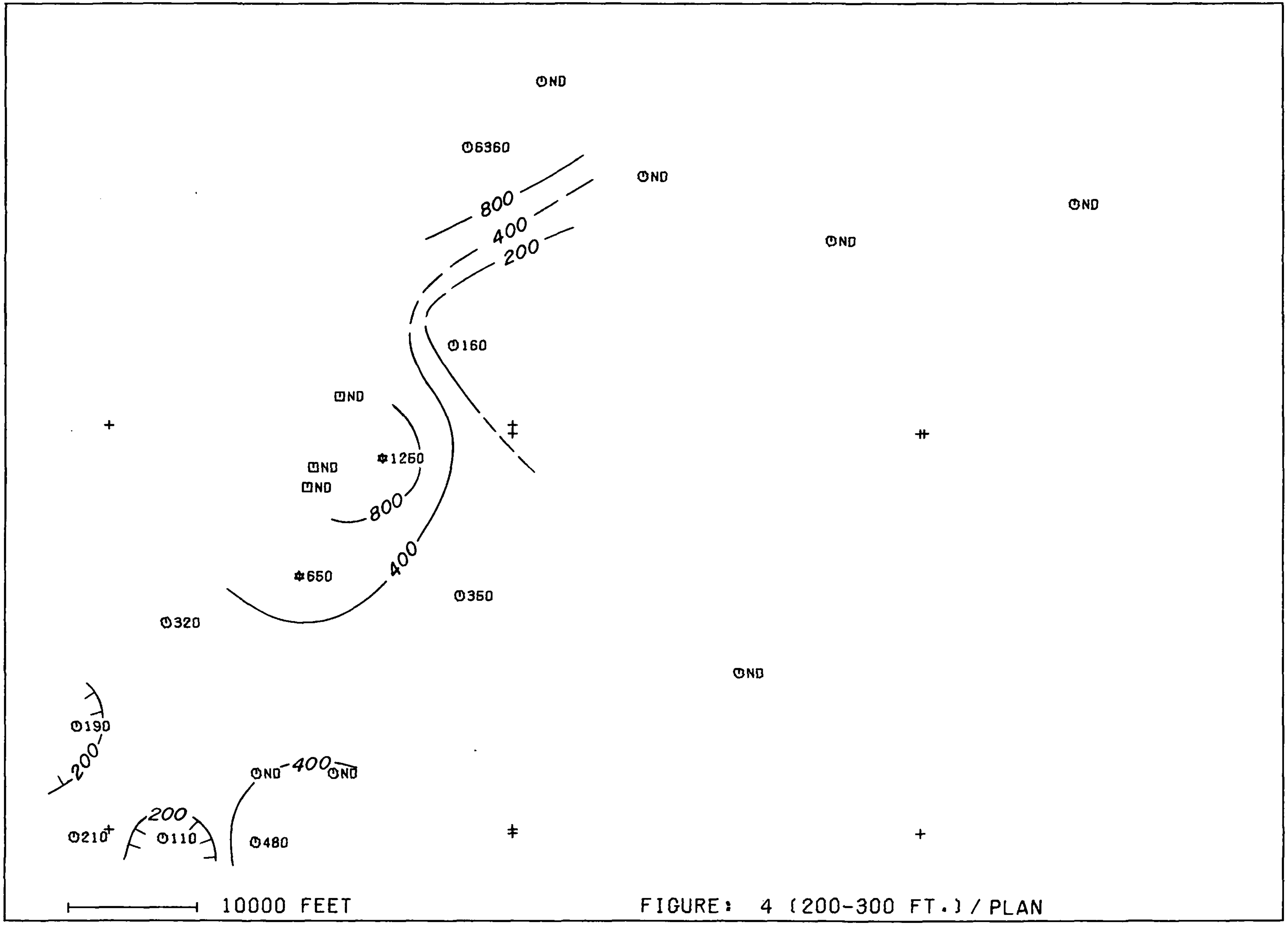


FIGURE: 4 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

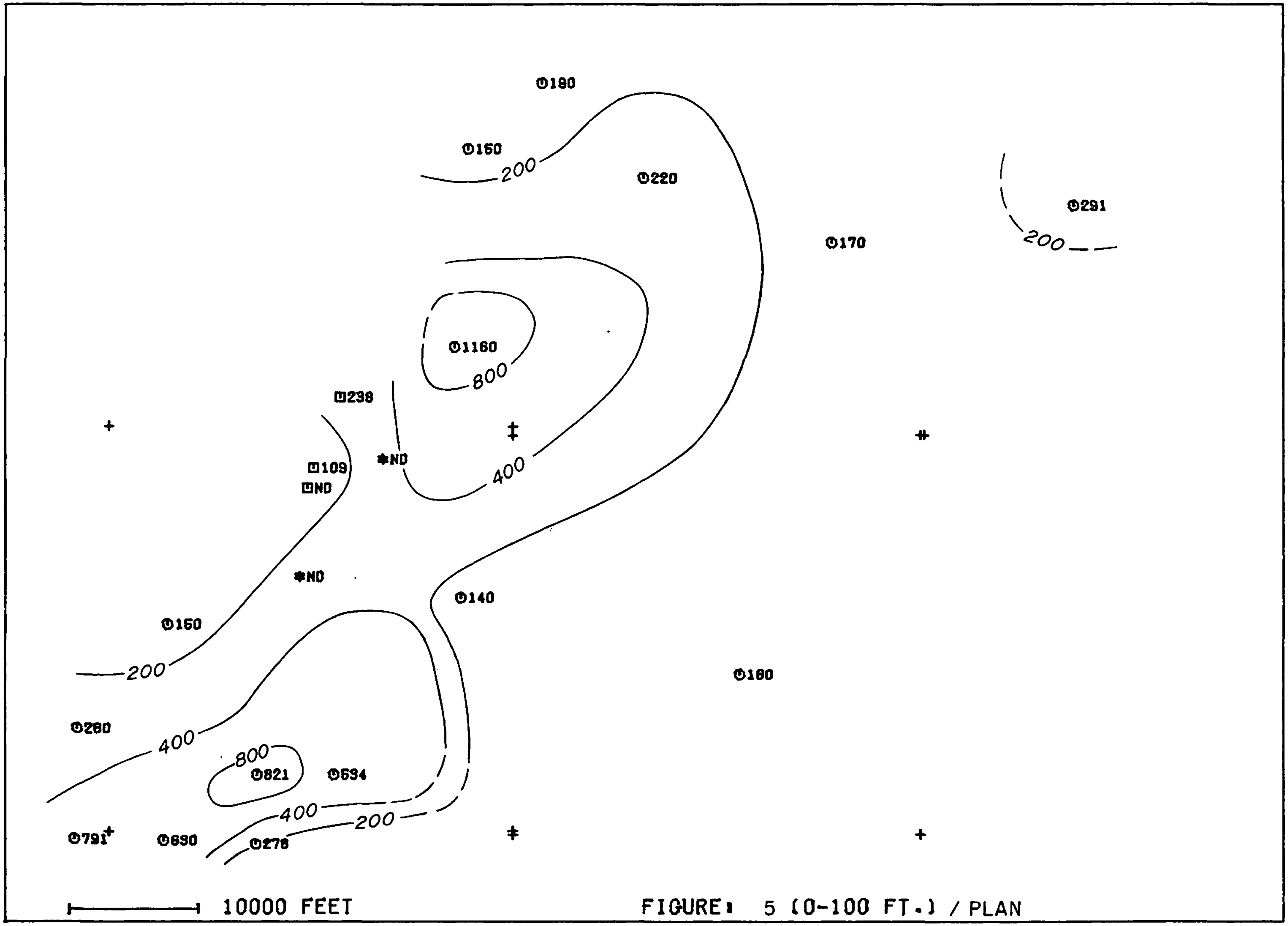
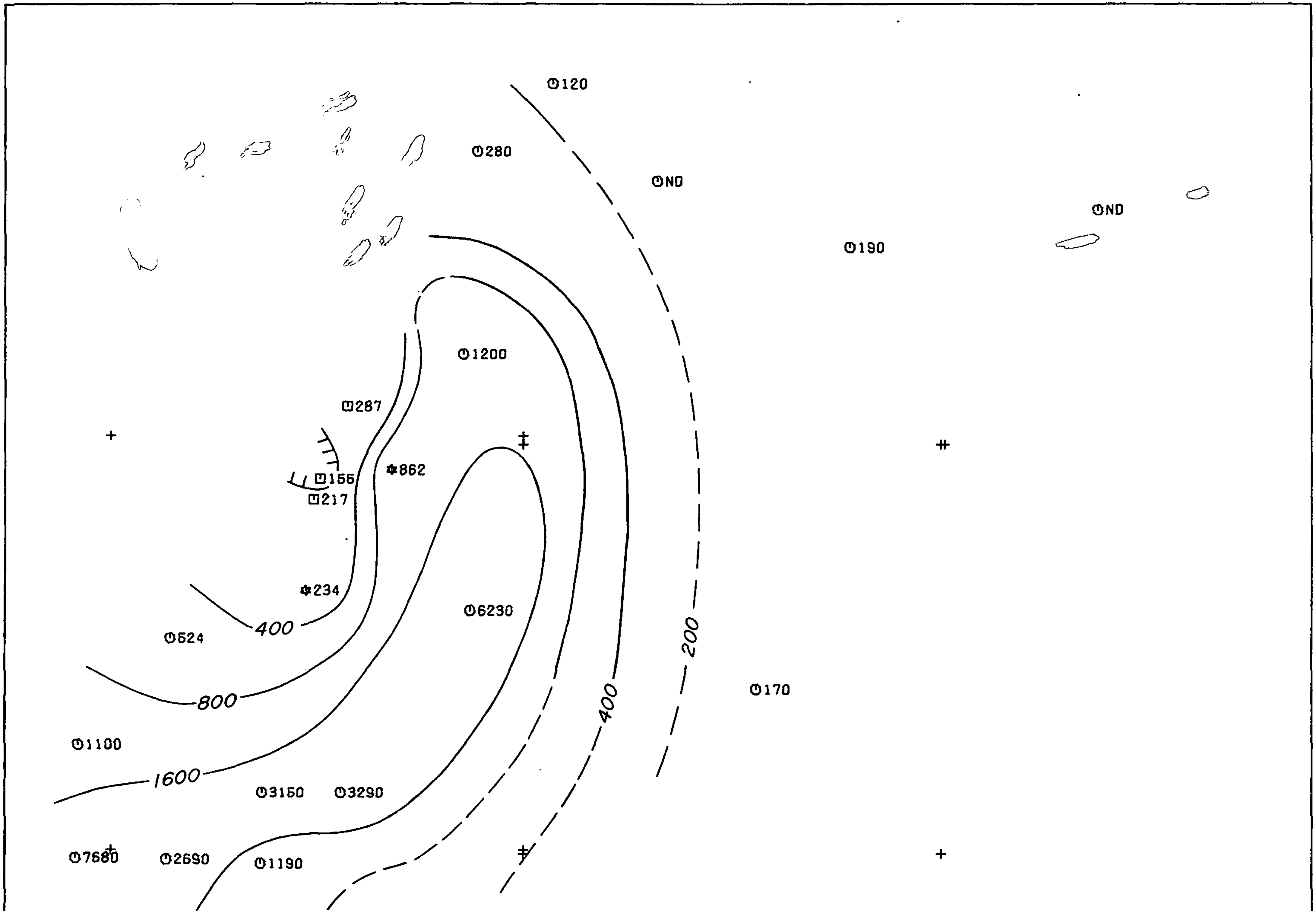


FIGURE: 5 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 5 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

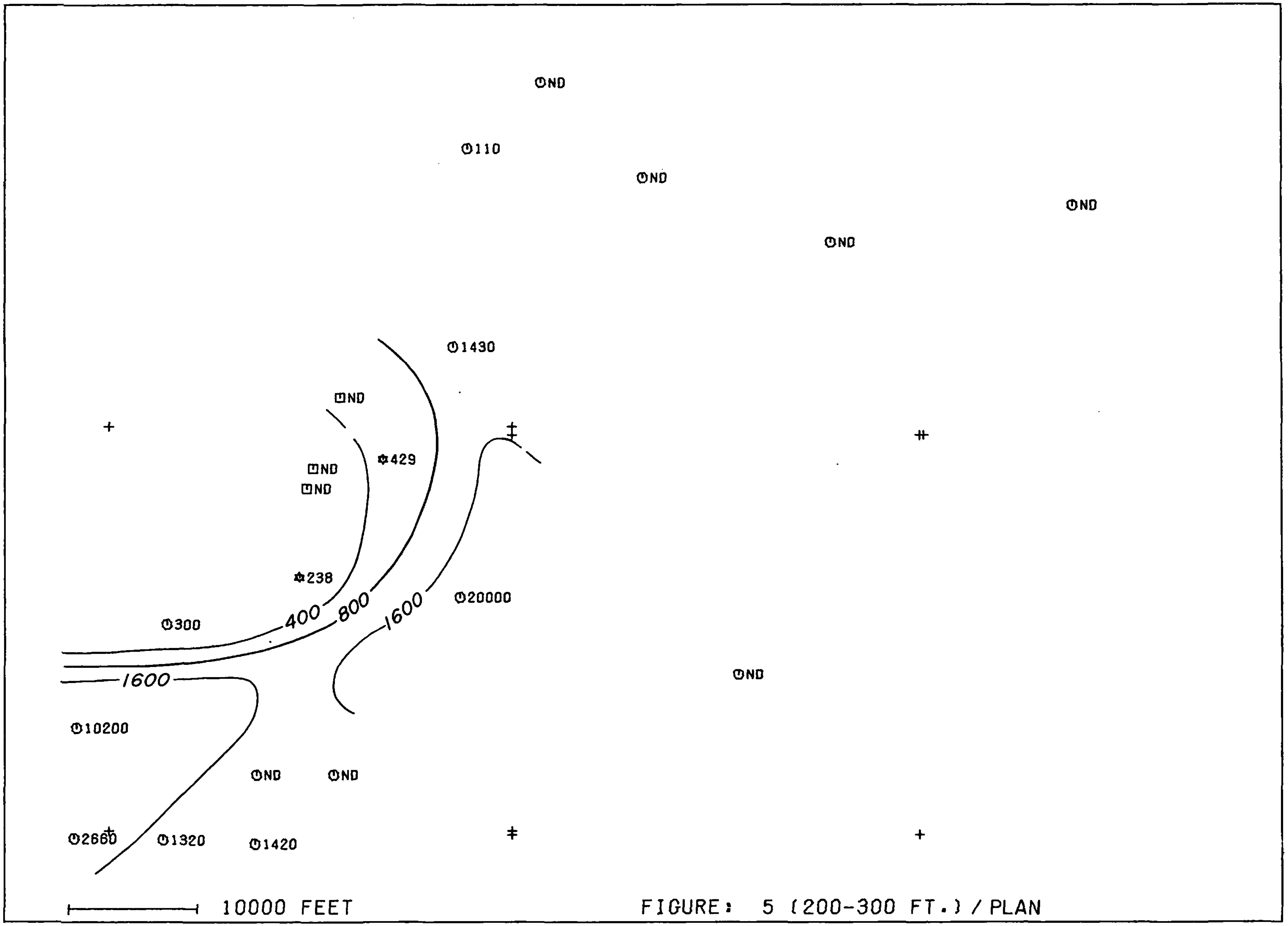


FIGURE: 5 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

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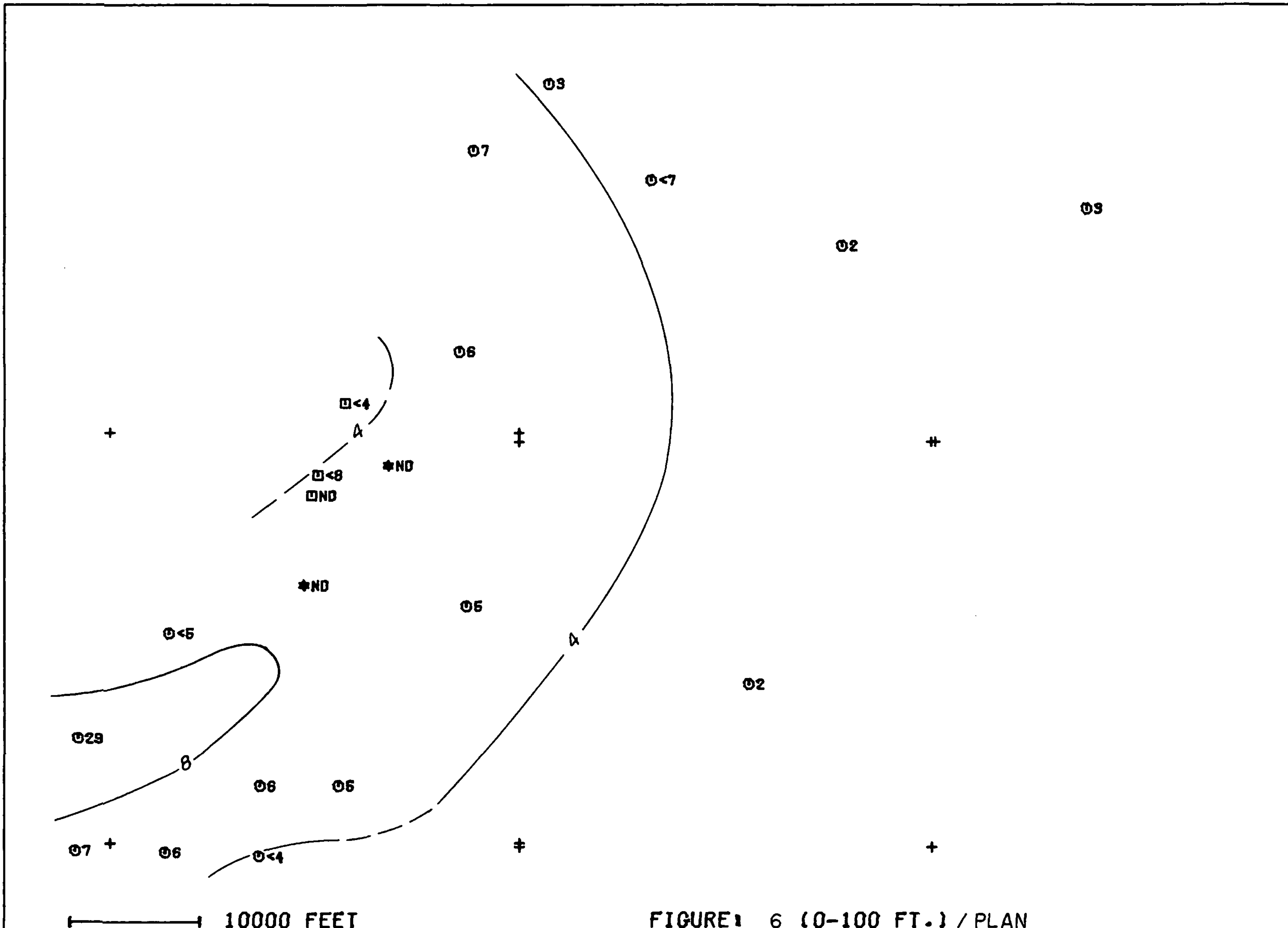
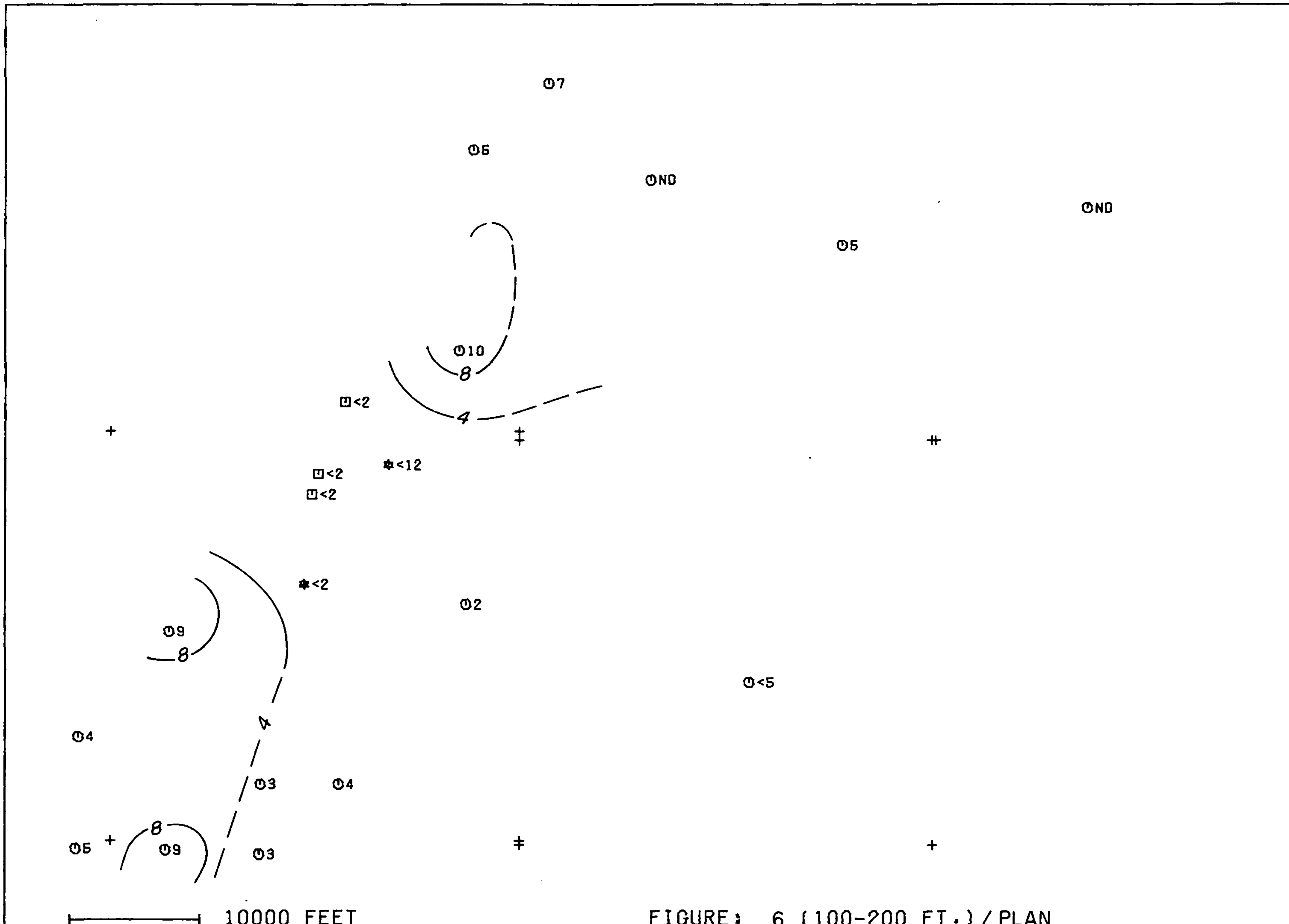


FIGURE: 6 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 6 (100-200 FT.)/PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

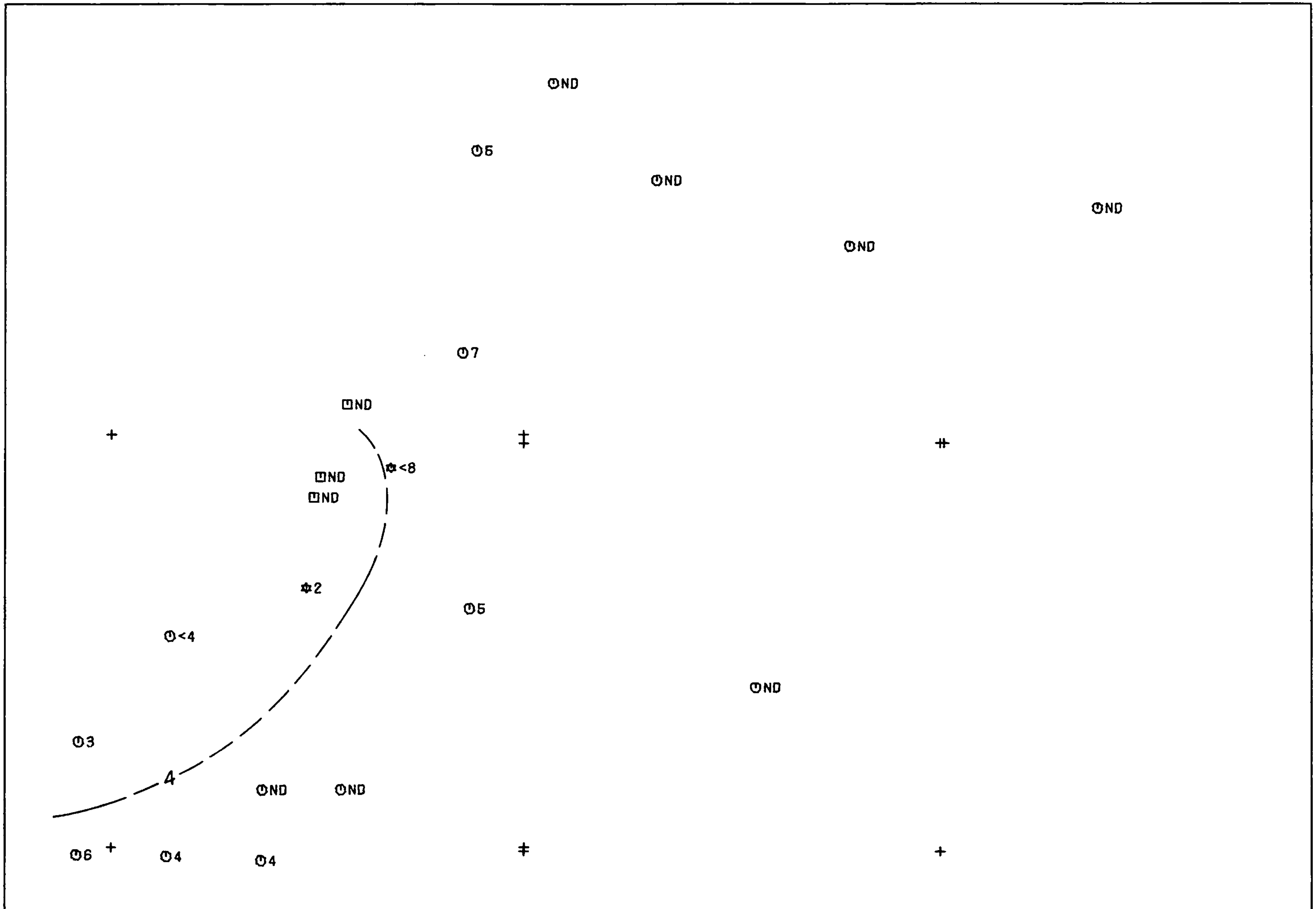


FIGURE: 6 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

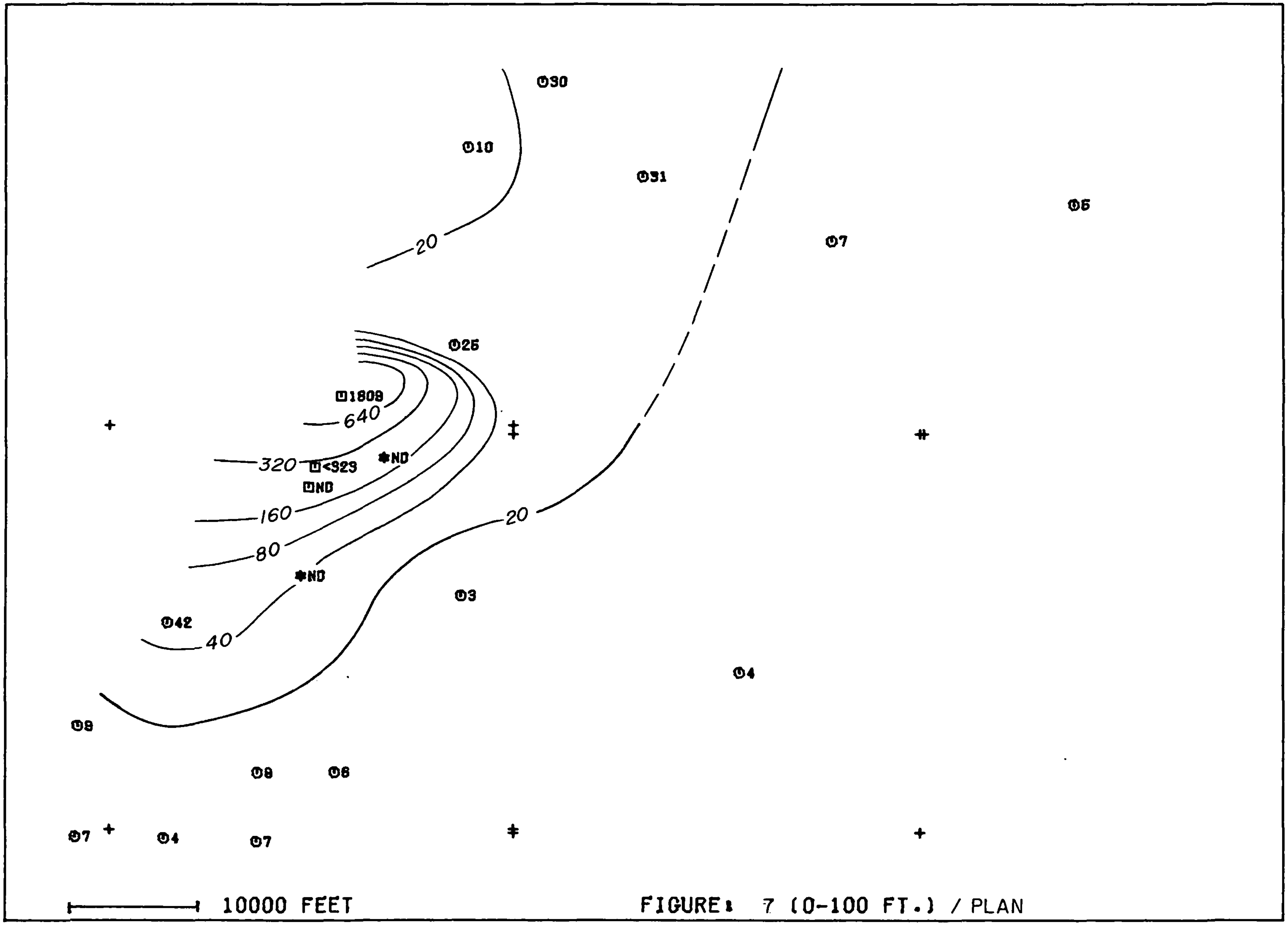
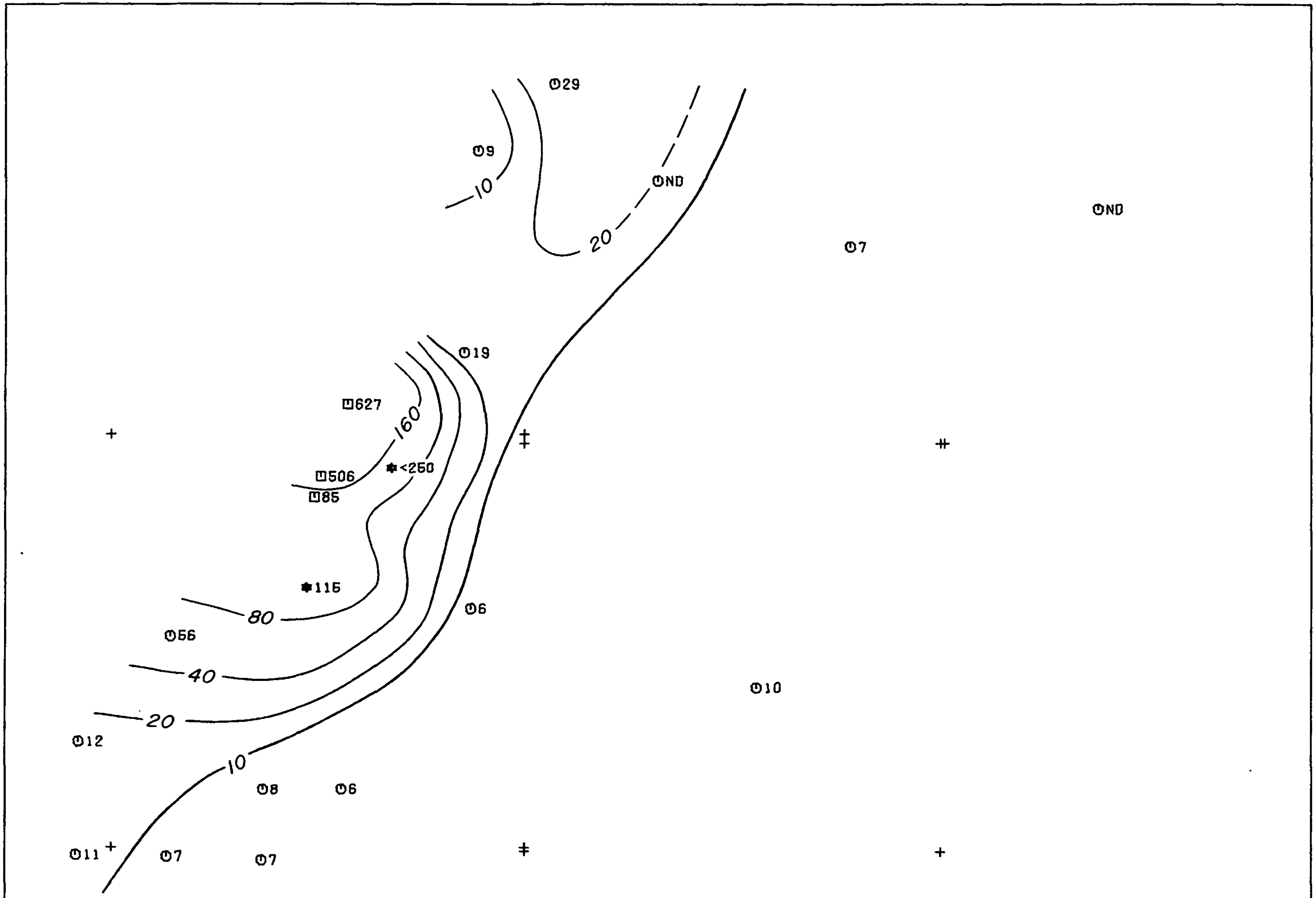


FIGURE: 7 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: COLOR

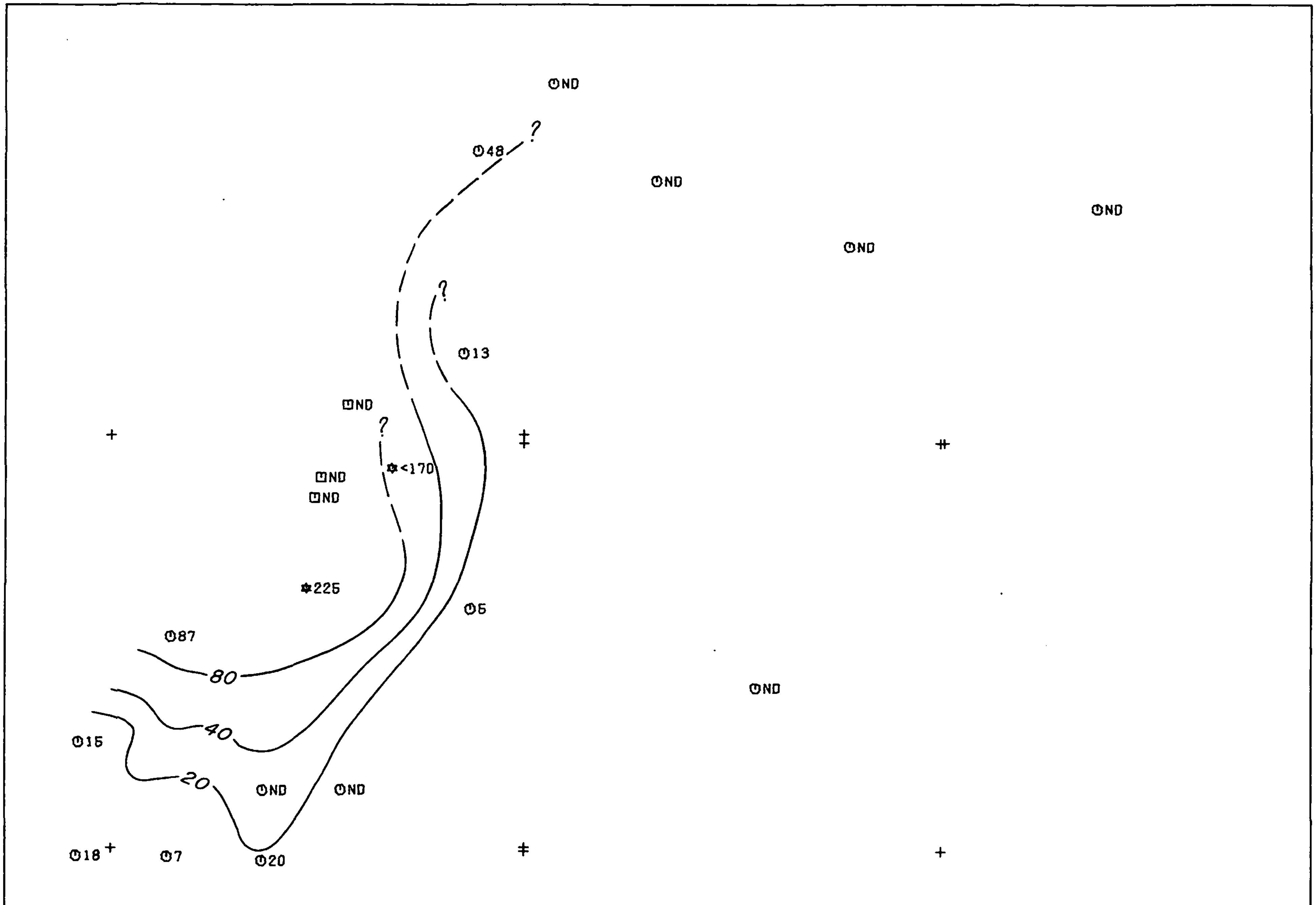


10000 FEET

FIGURE: 7 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: COLOR



10000 FEET

FIGURE: 7 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: COLOR

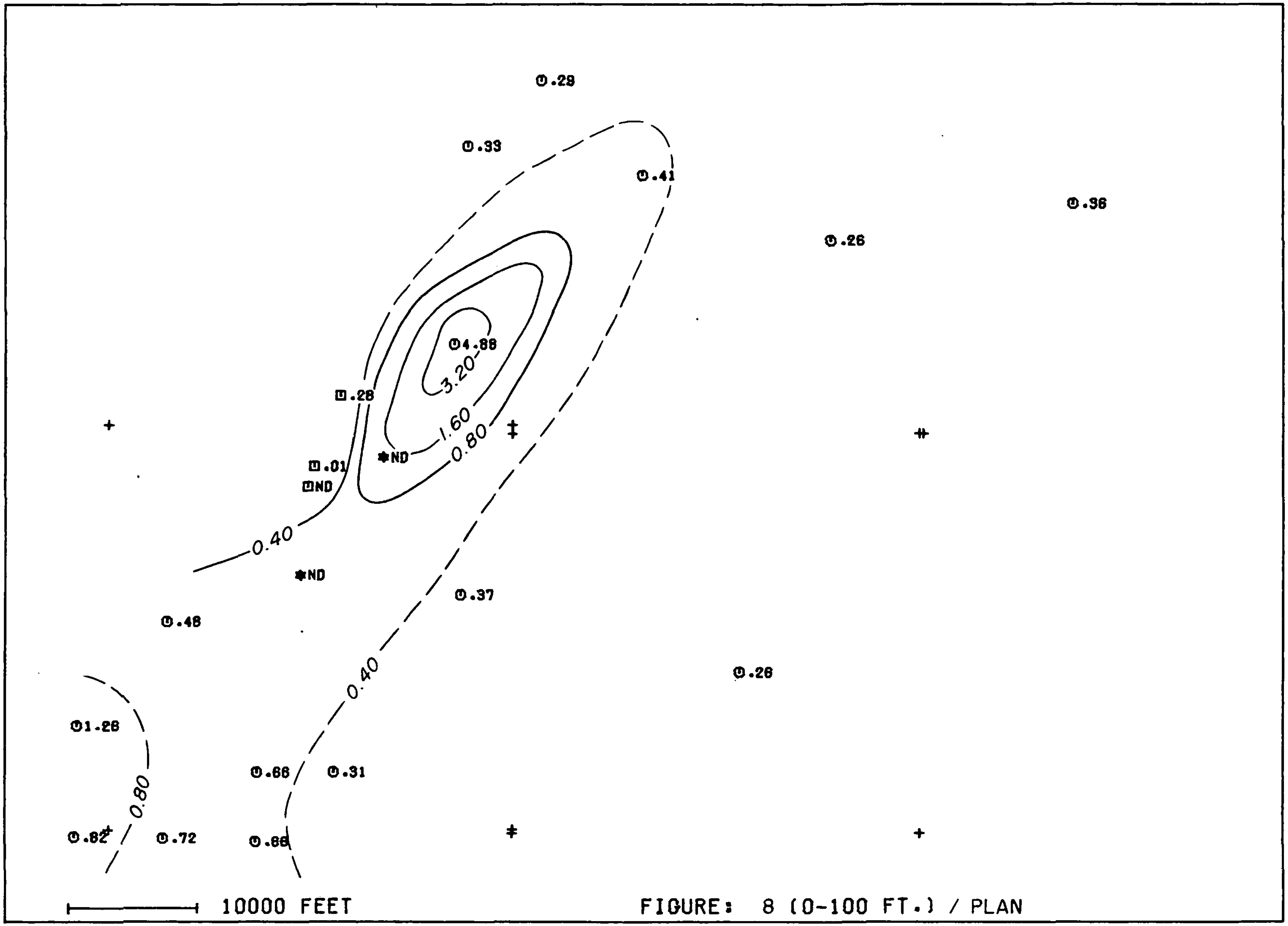


FIGURE: 8 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

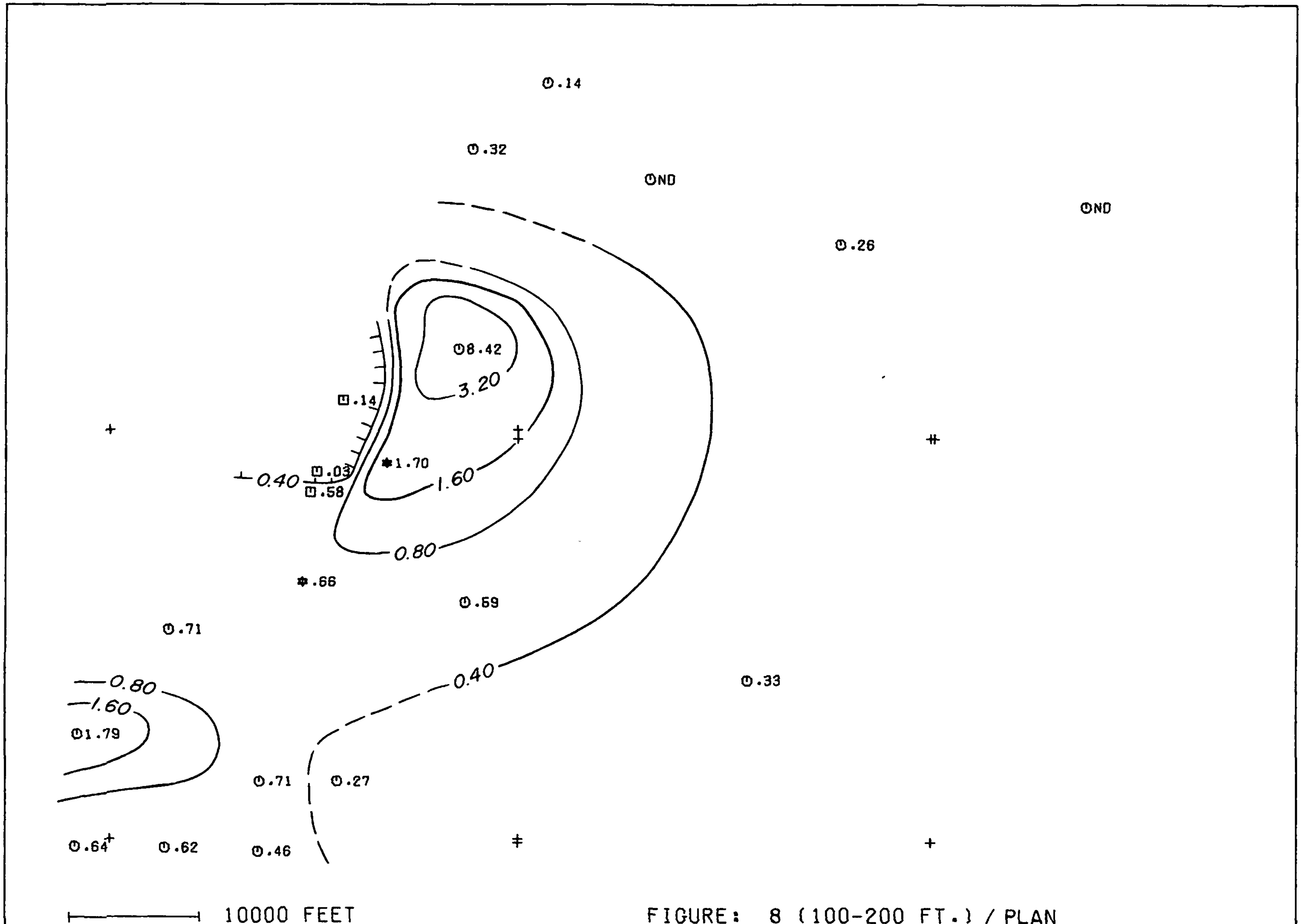


FIGURE: 8 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

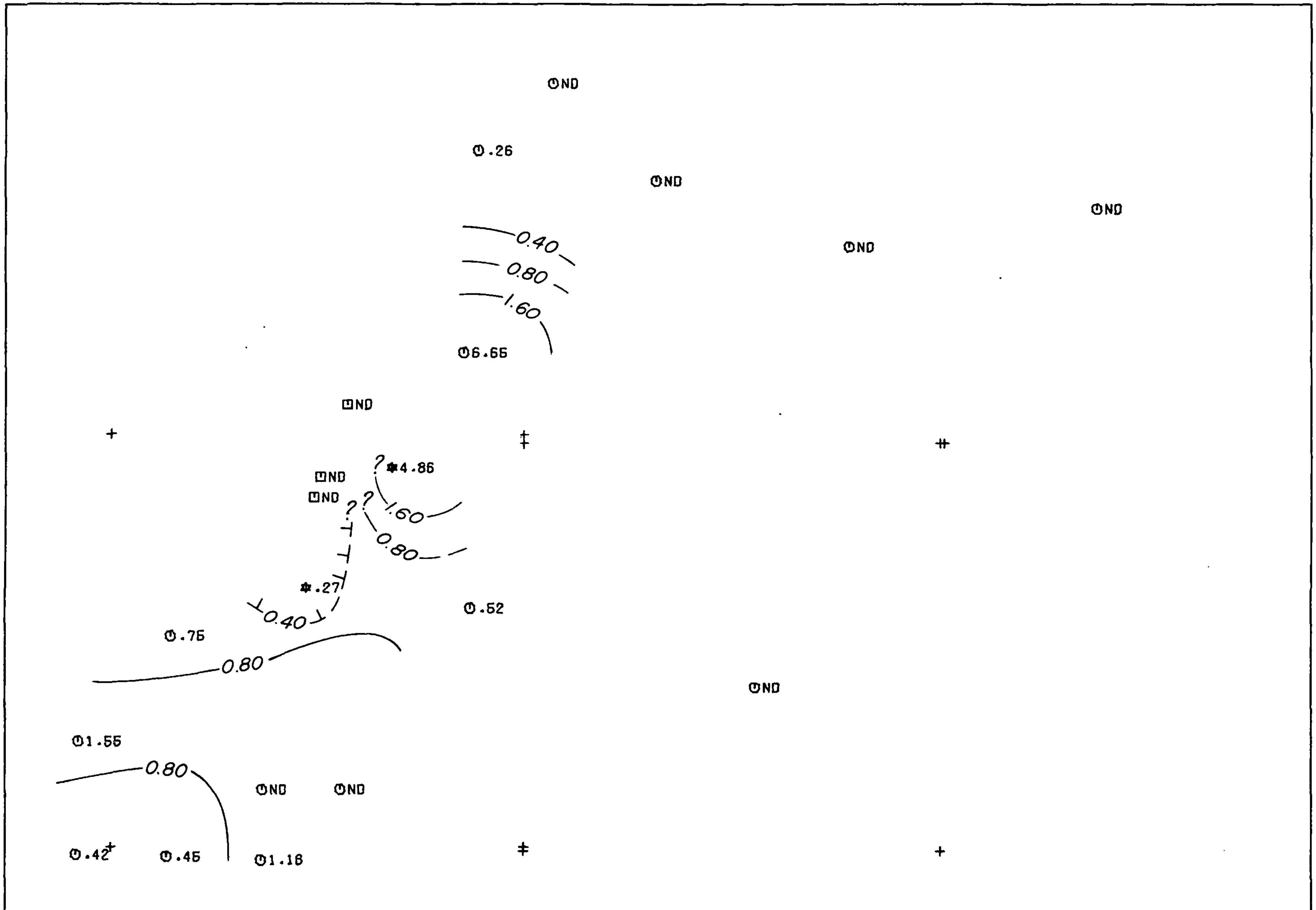
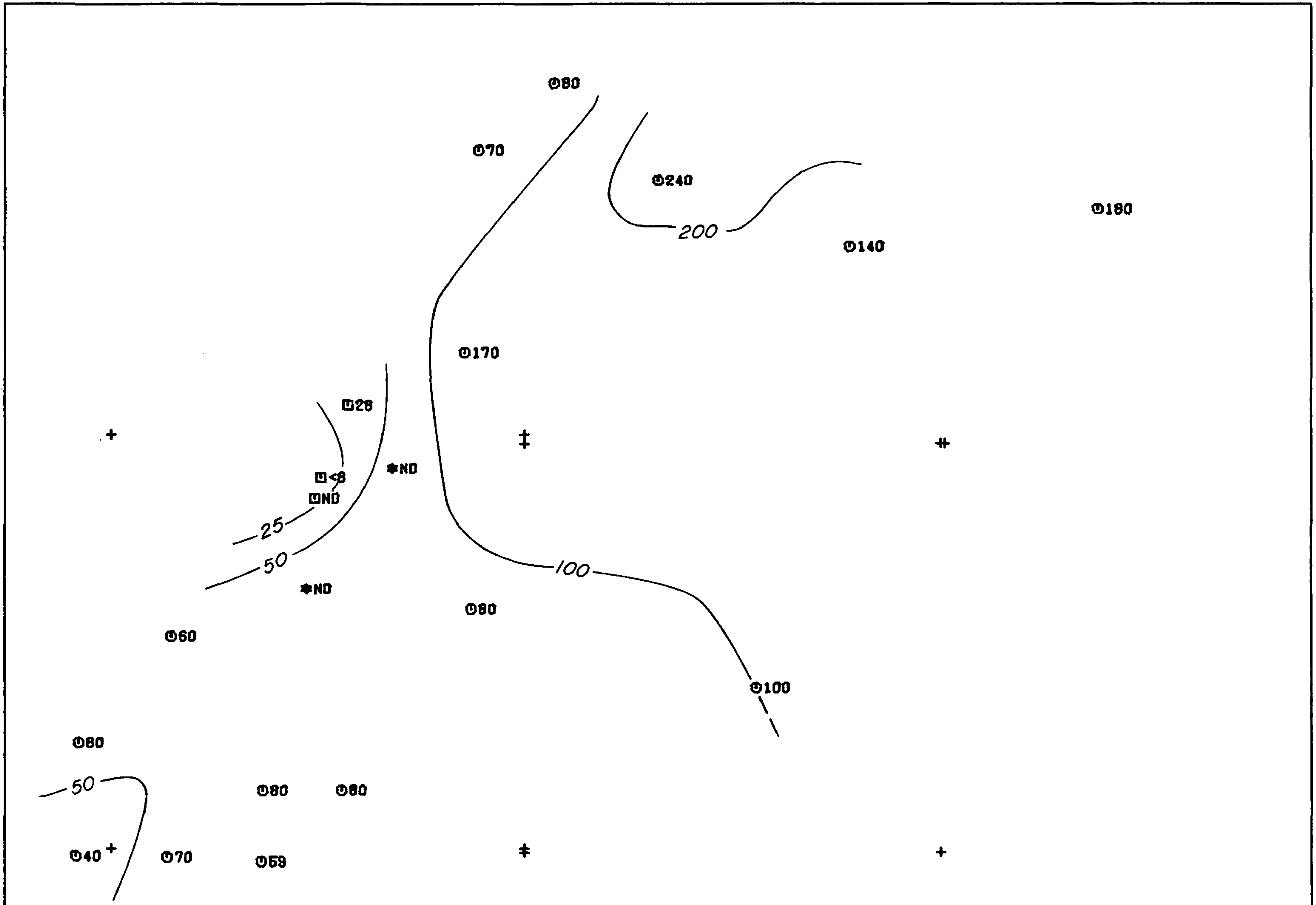


FIGURE: 8 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 9 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

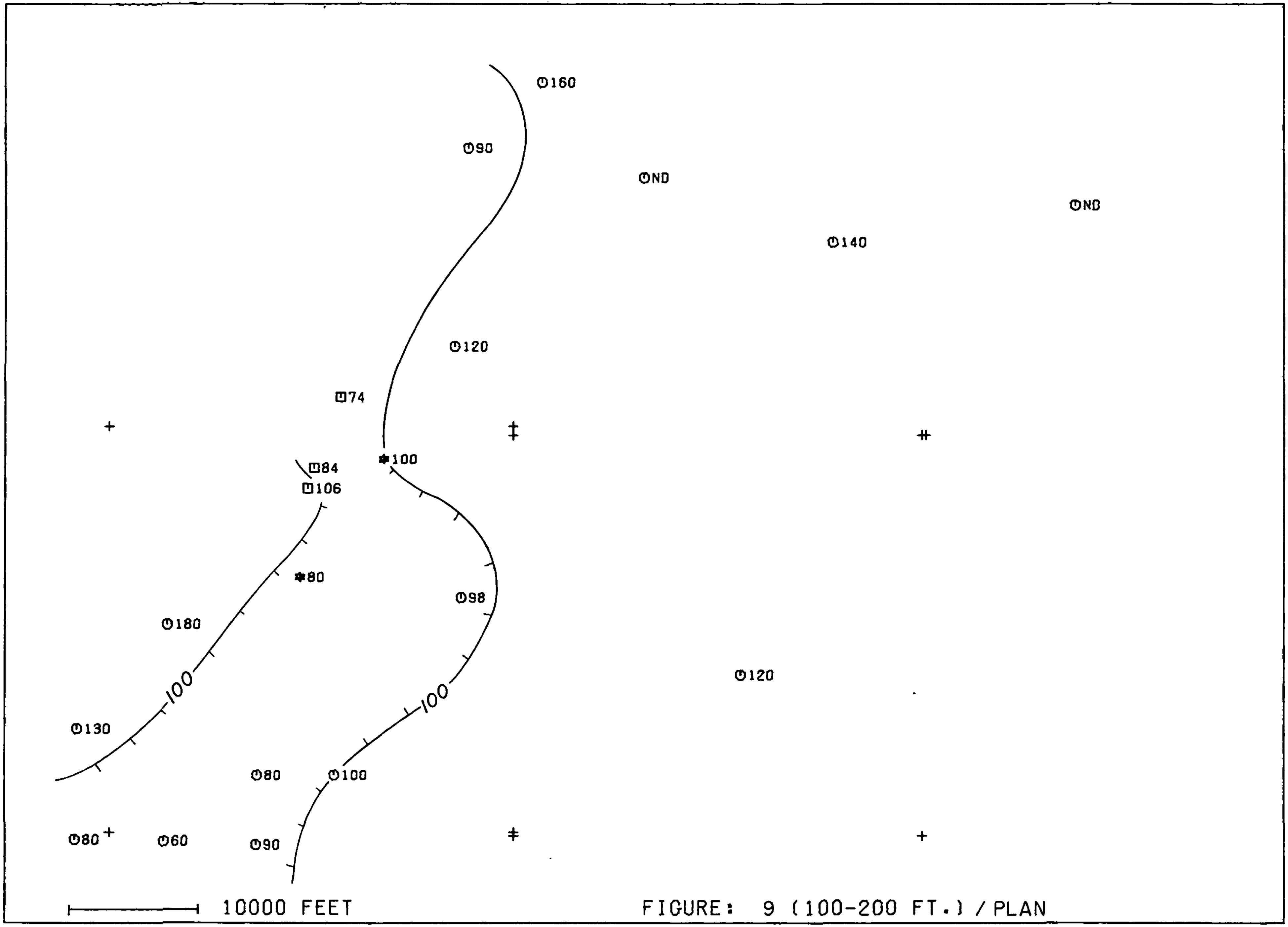


FIGURE: 9 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

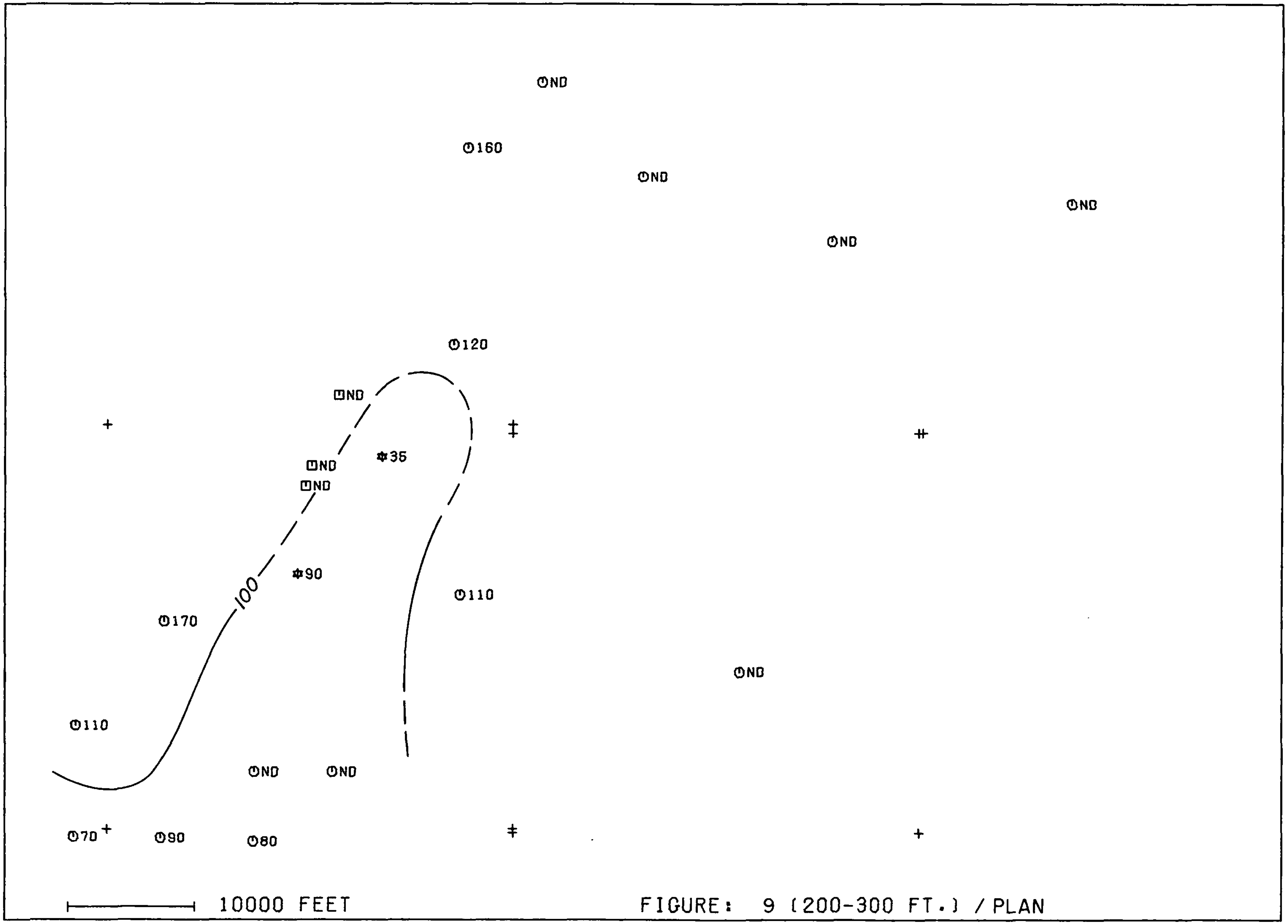
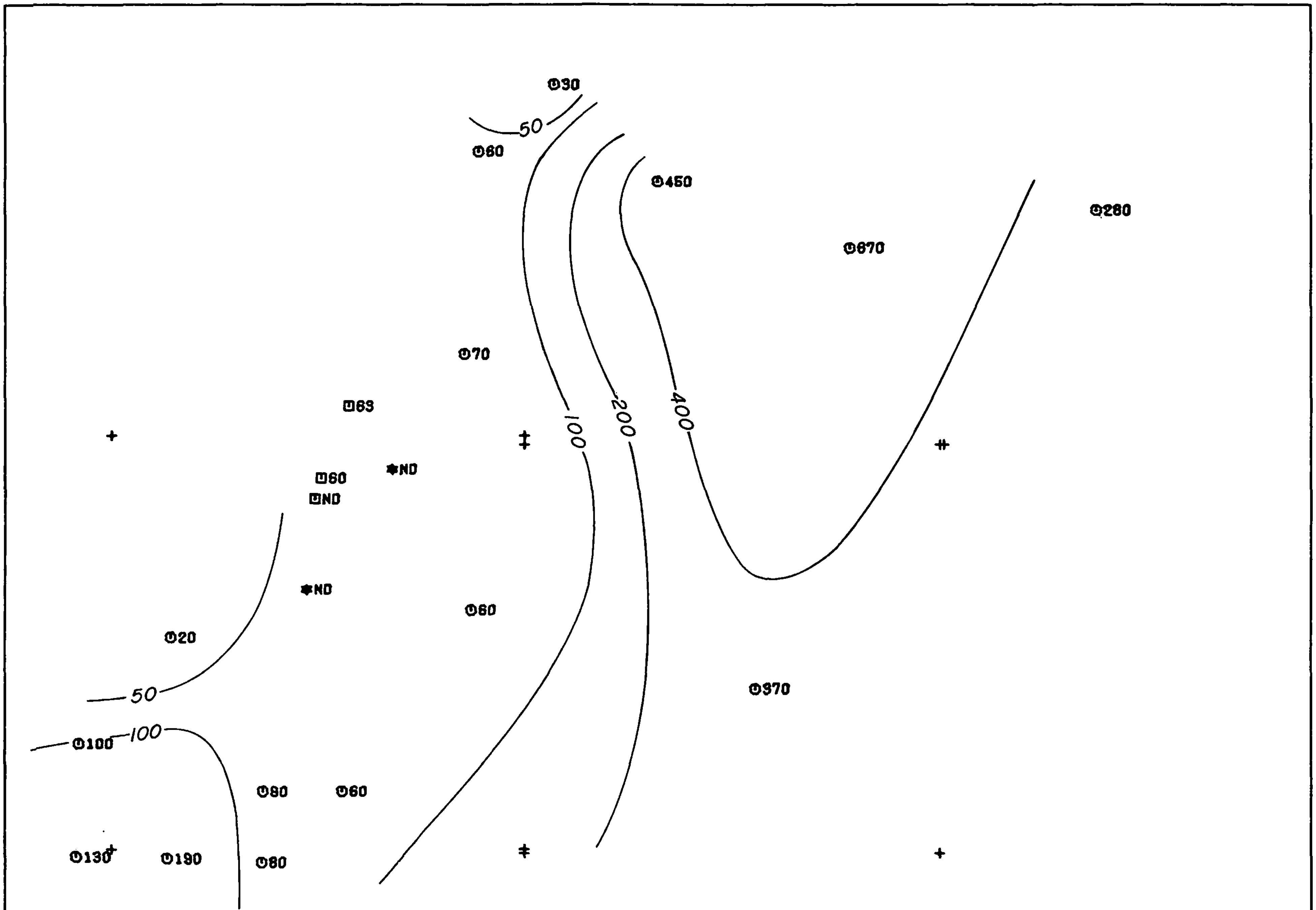


FIGURE: 9 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

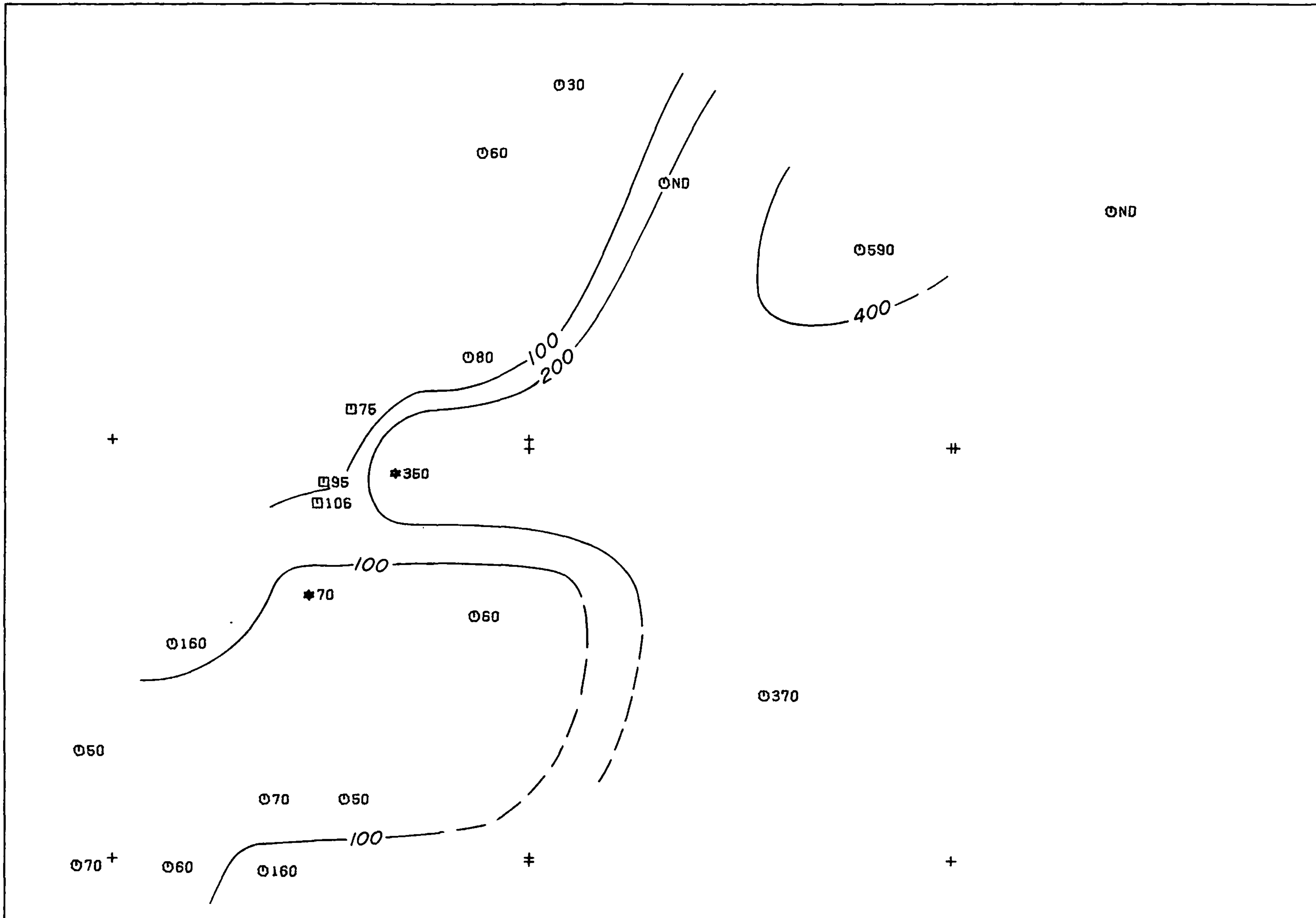


10000 FEET

FIGURE: 10 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 10 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

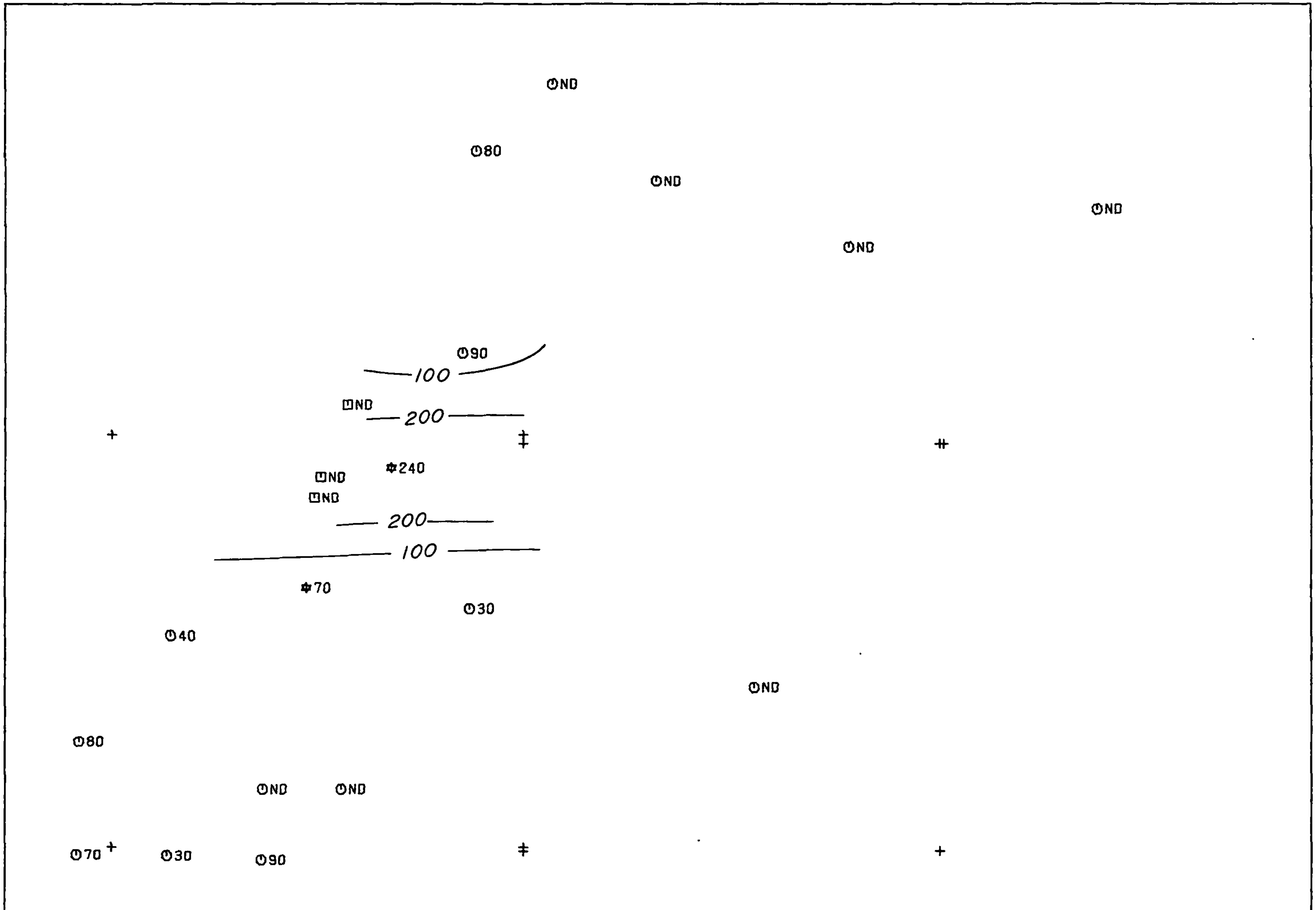
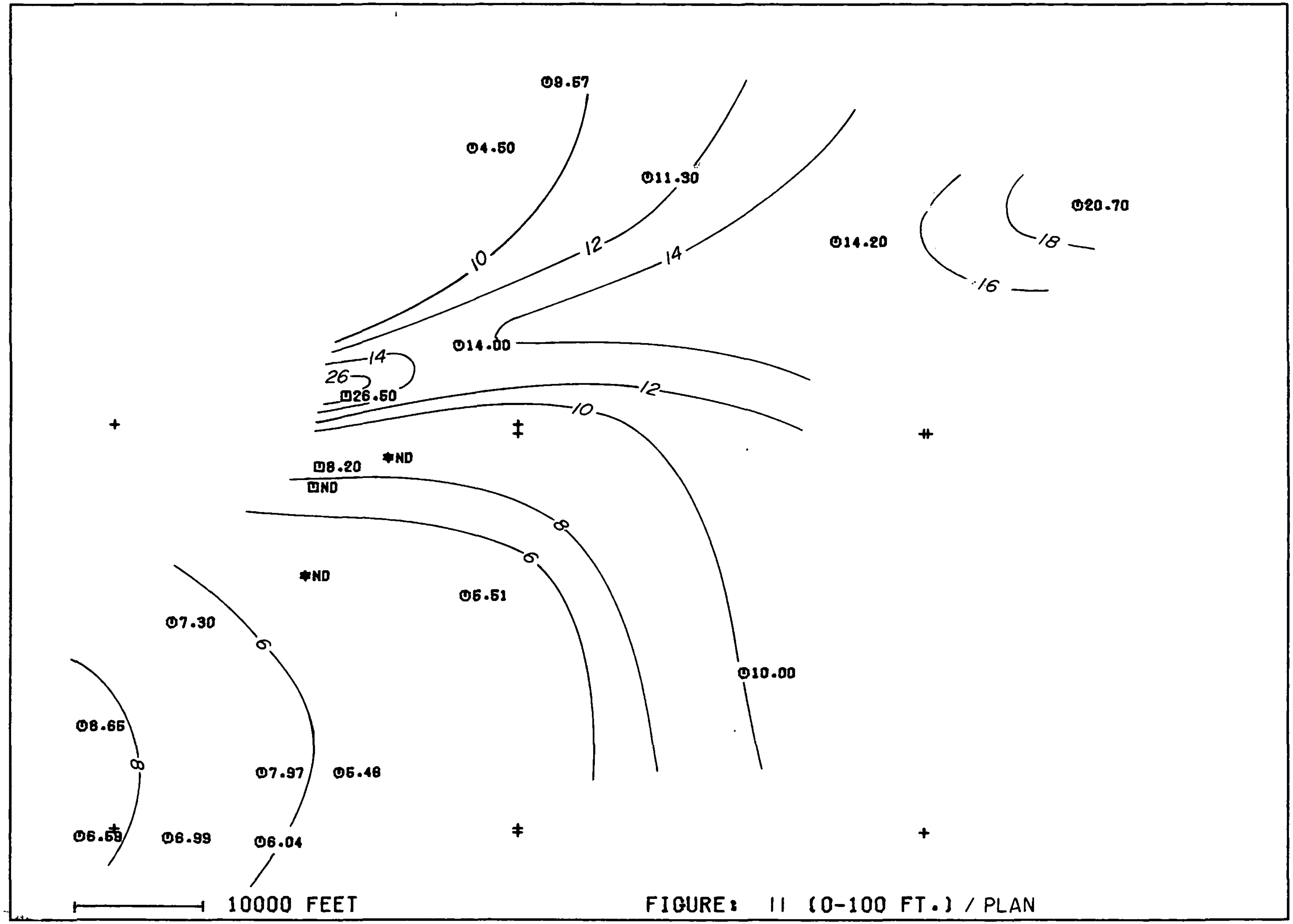


FIGURE: 10 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

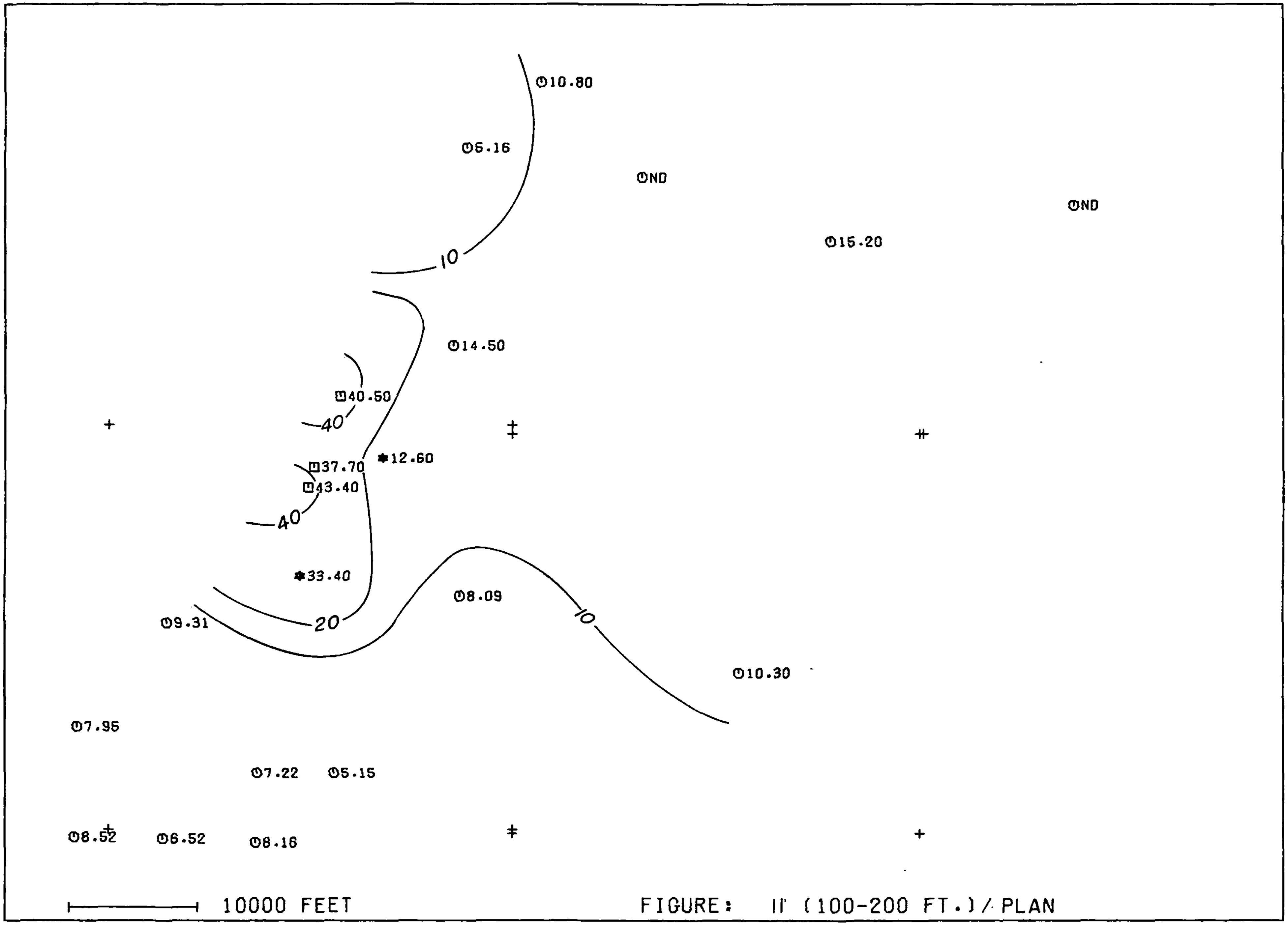
NICKEL (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

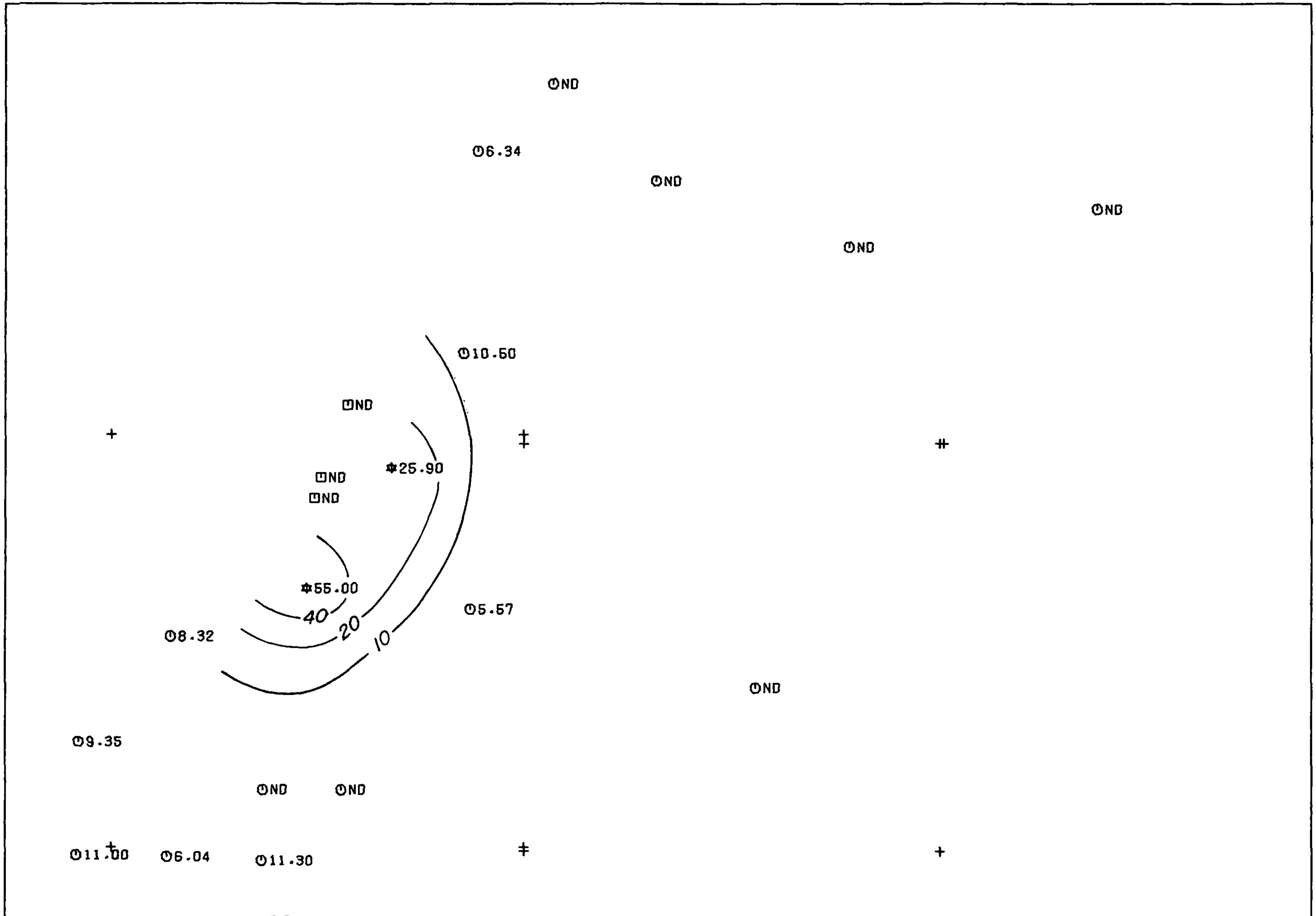
FIGURE: 11 (0-100 FT.) / PLAN

IRON (%) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS

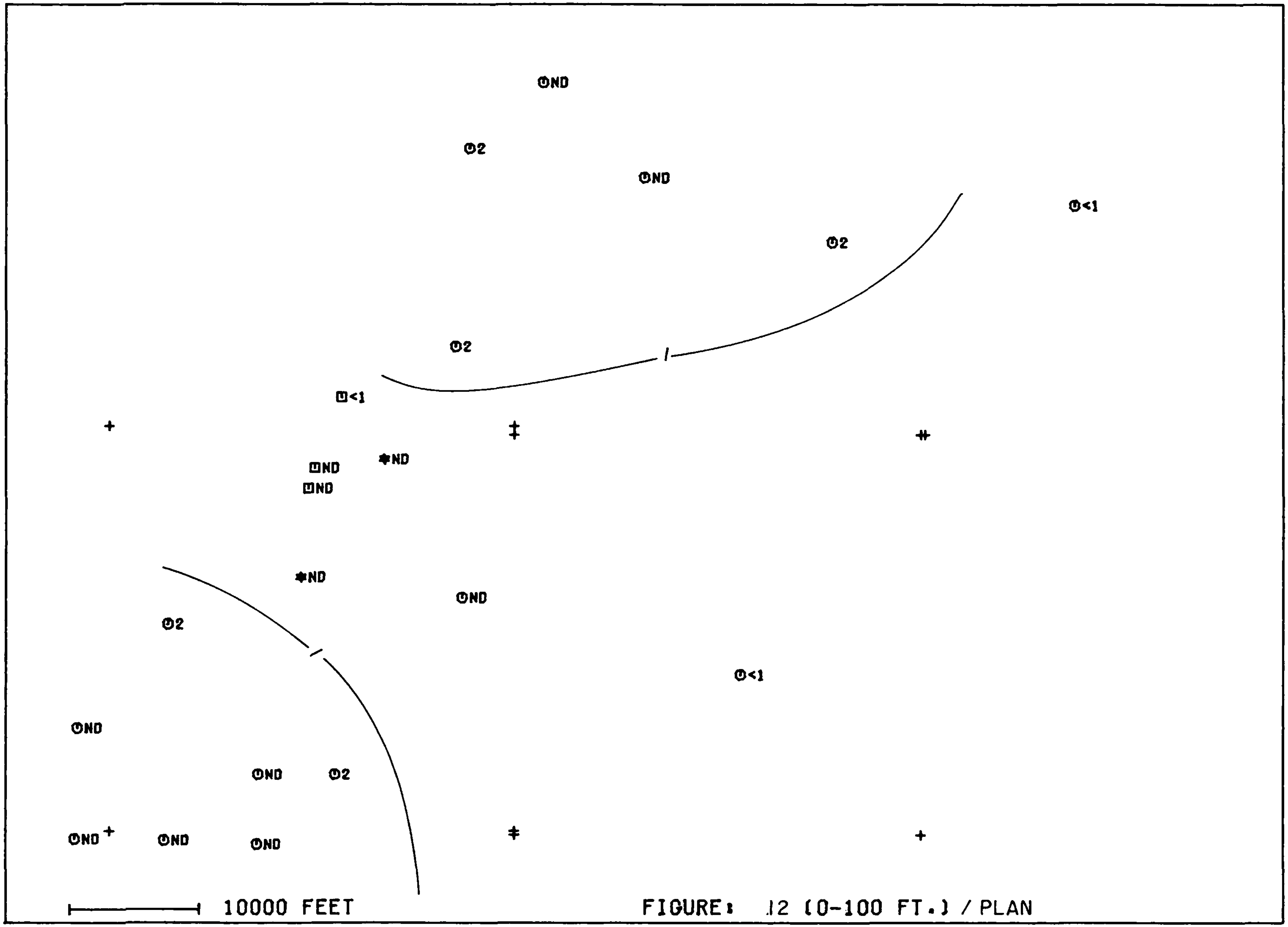


10000 FEET

FIGURE: 11 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

BISMUTH (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

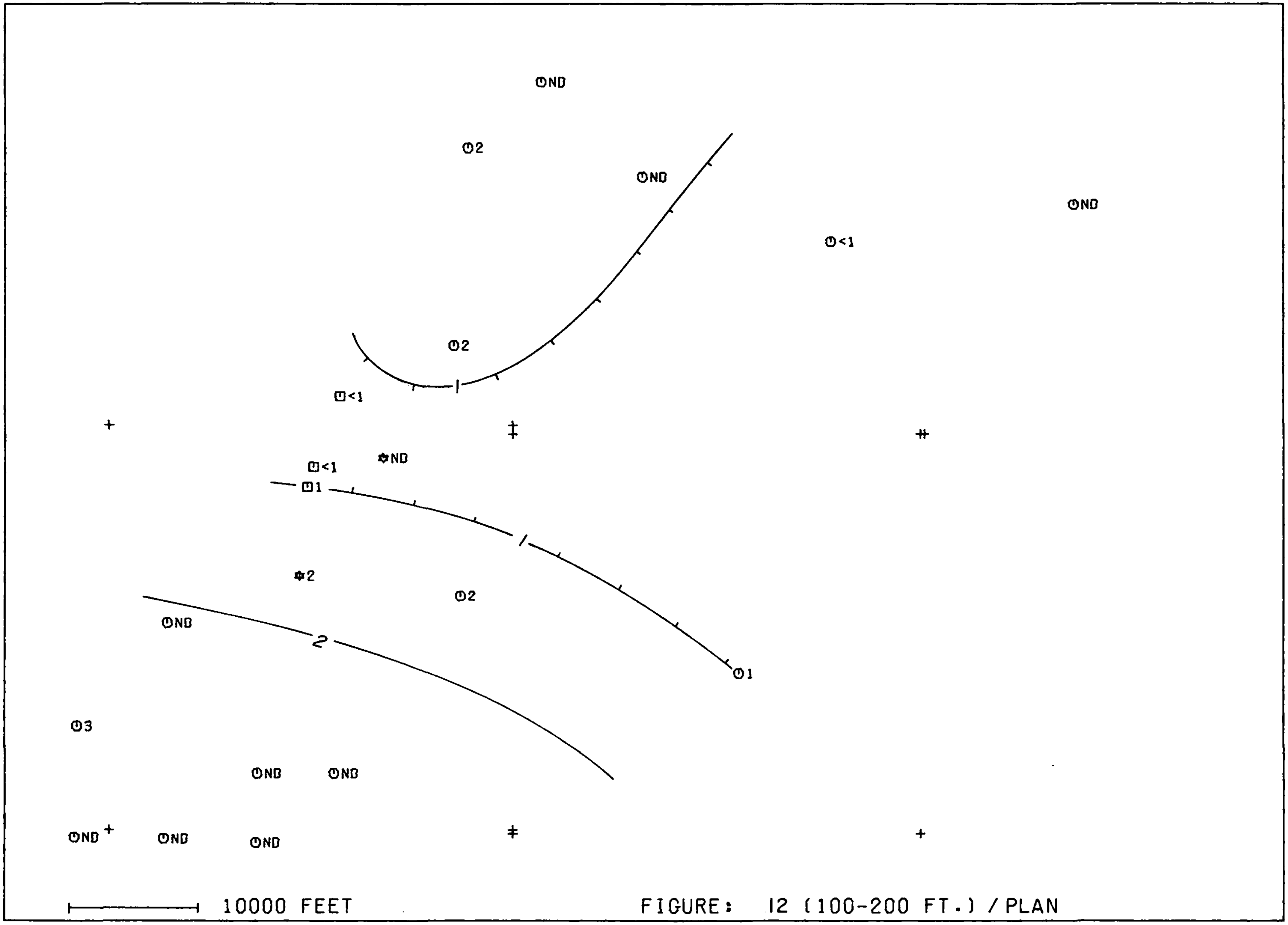
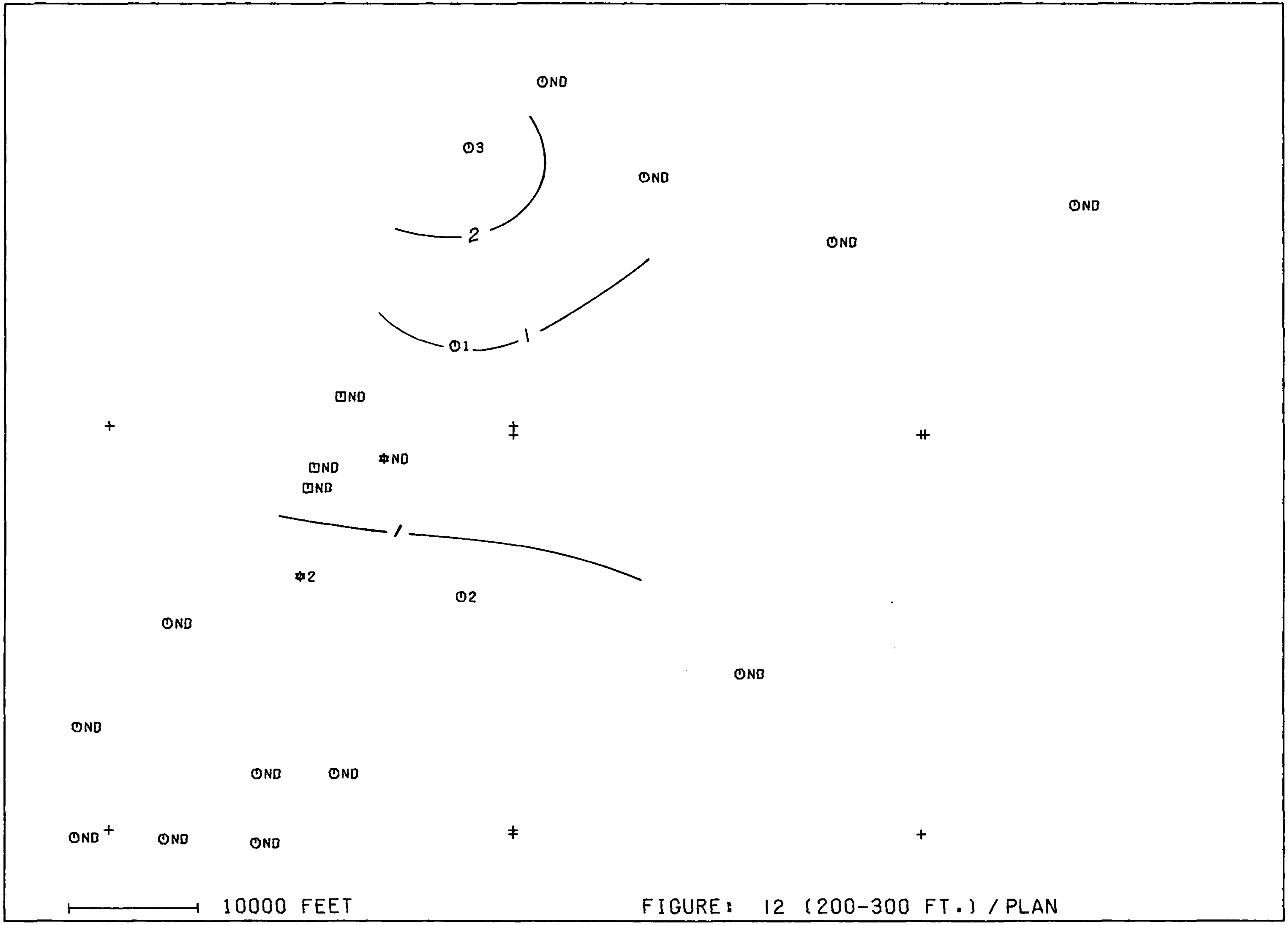


FIGURE: 12 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

BISMUTH (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

BISMUTH (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

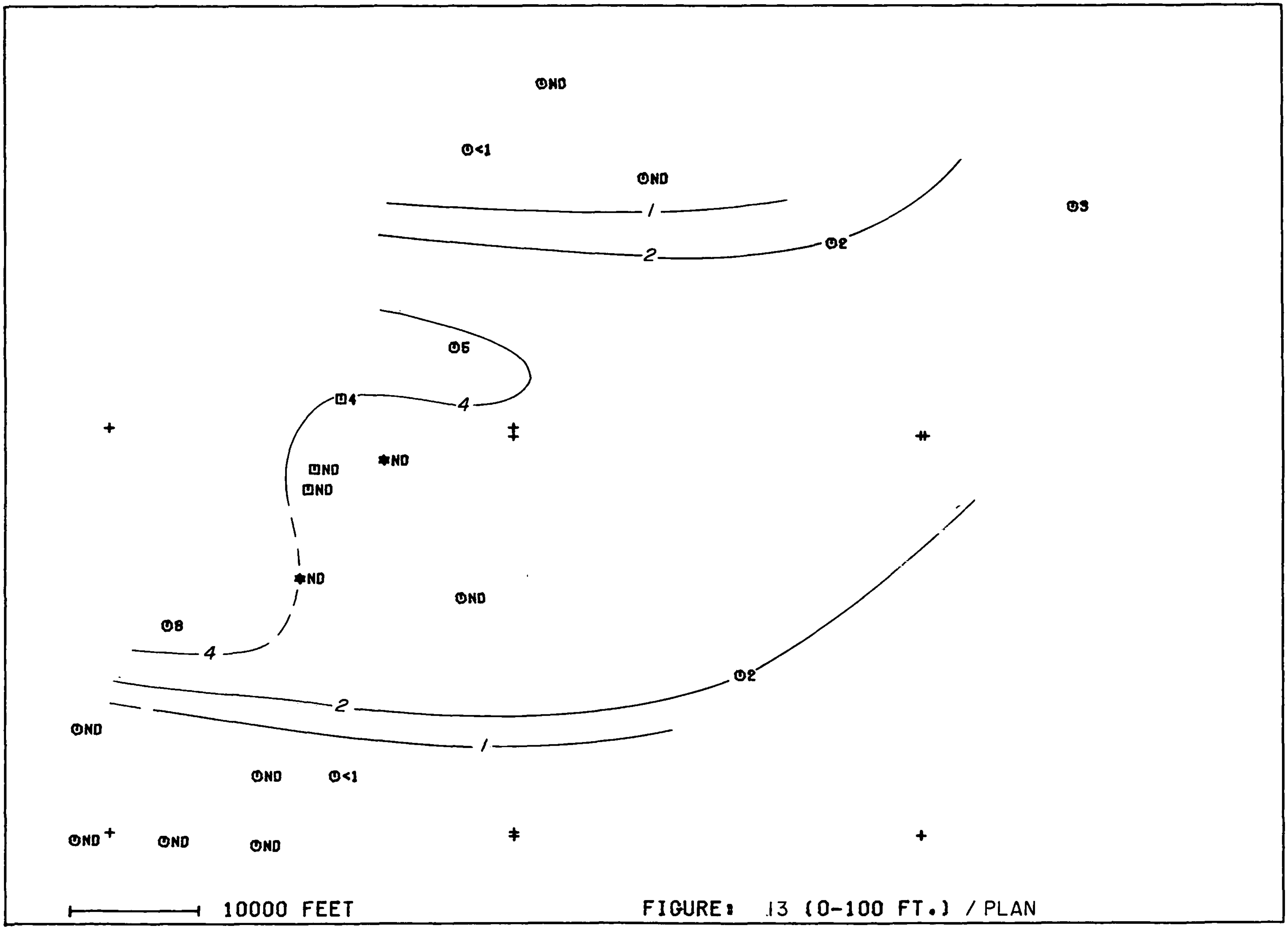
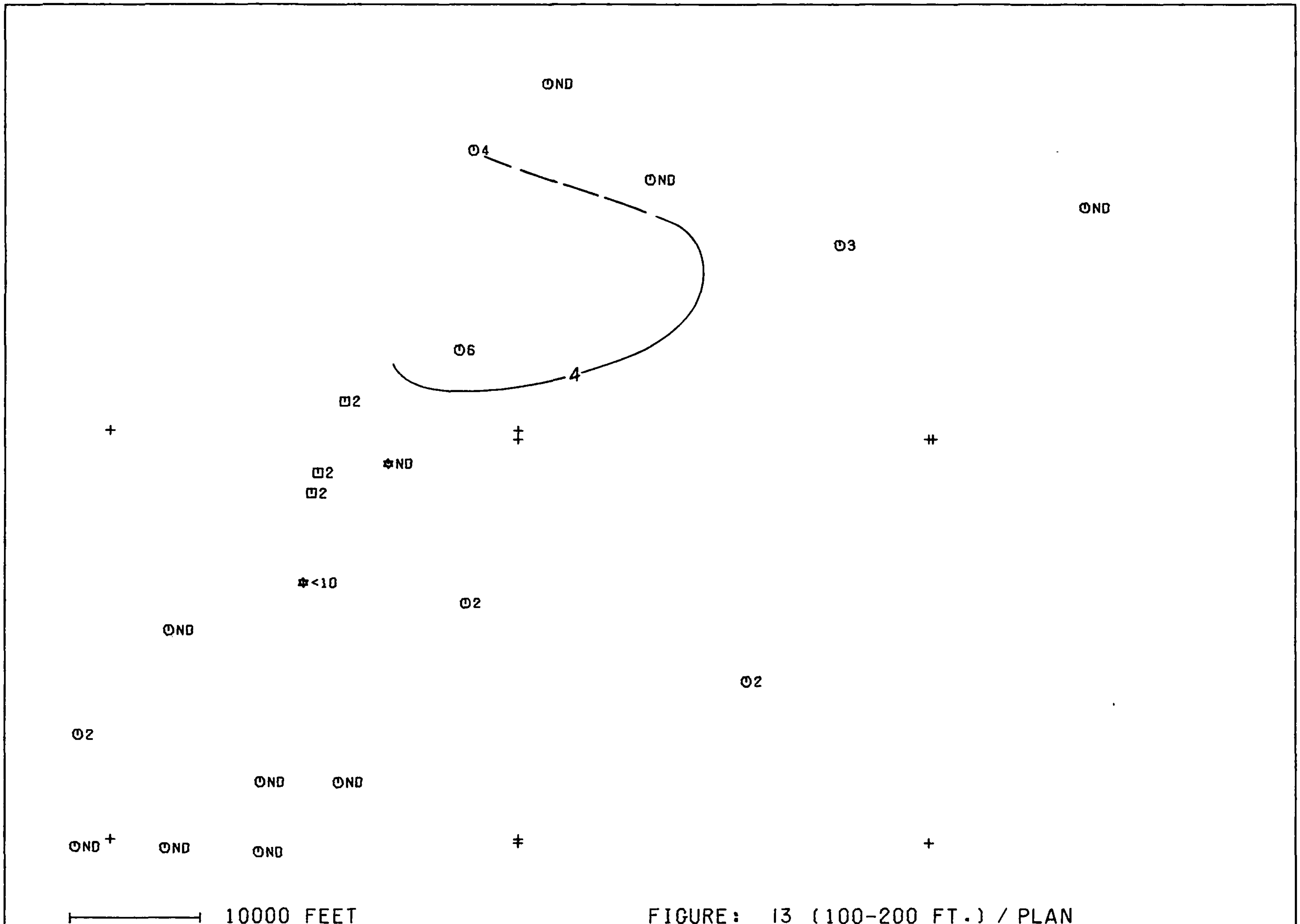


FIGURE: 13 (0-100 FT.) / PLAN

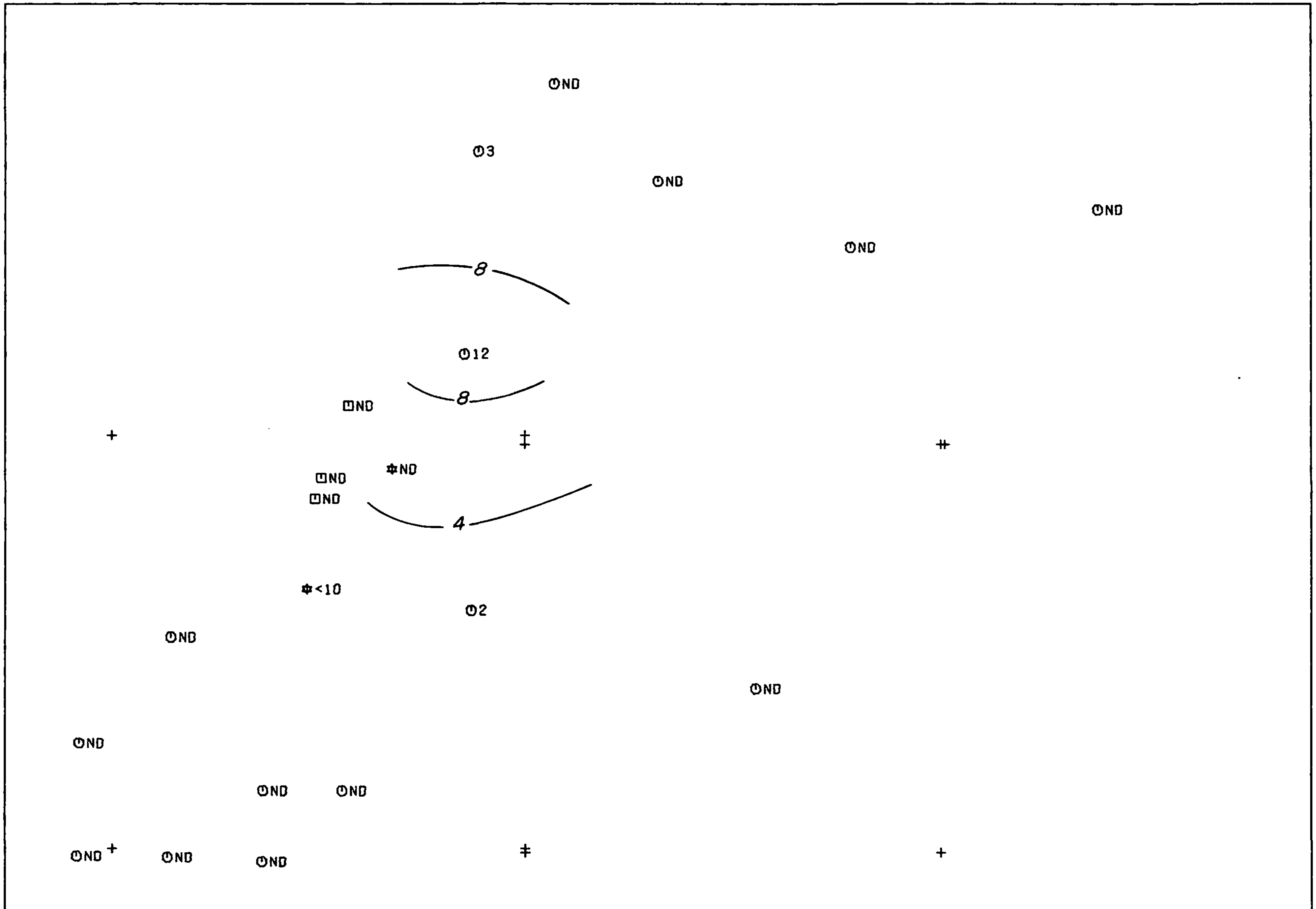
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

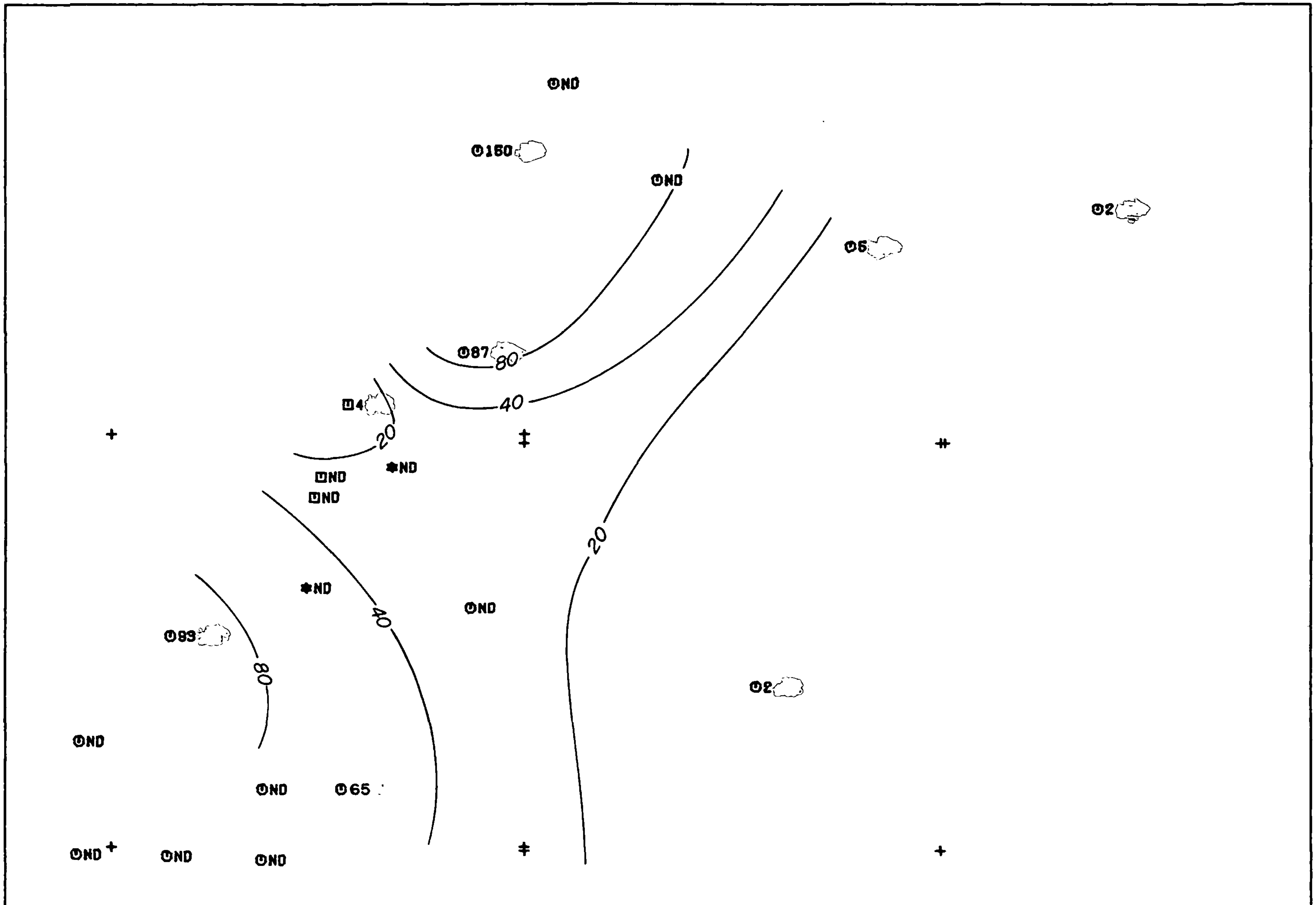


10000 FEET

FIGURE: 13 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

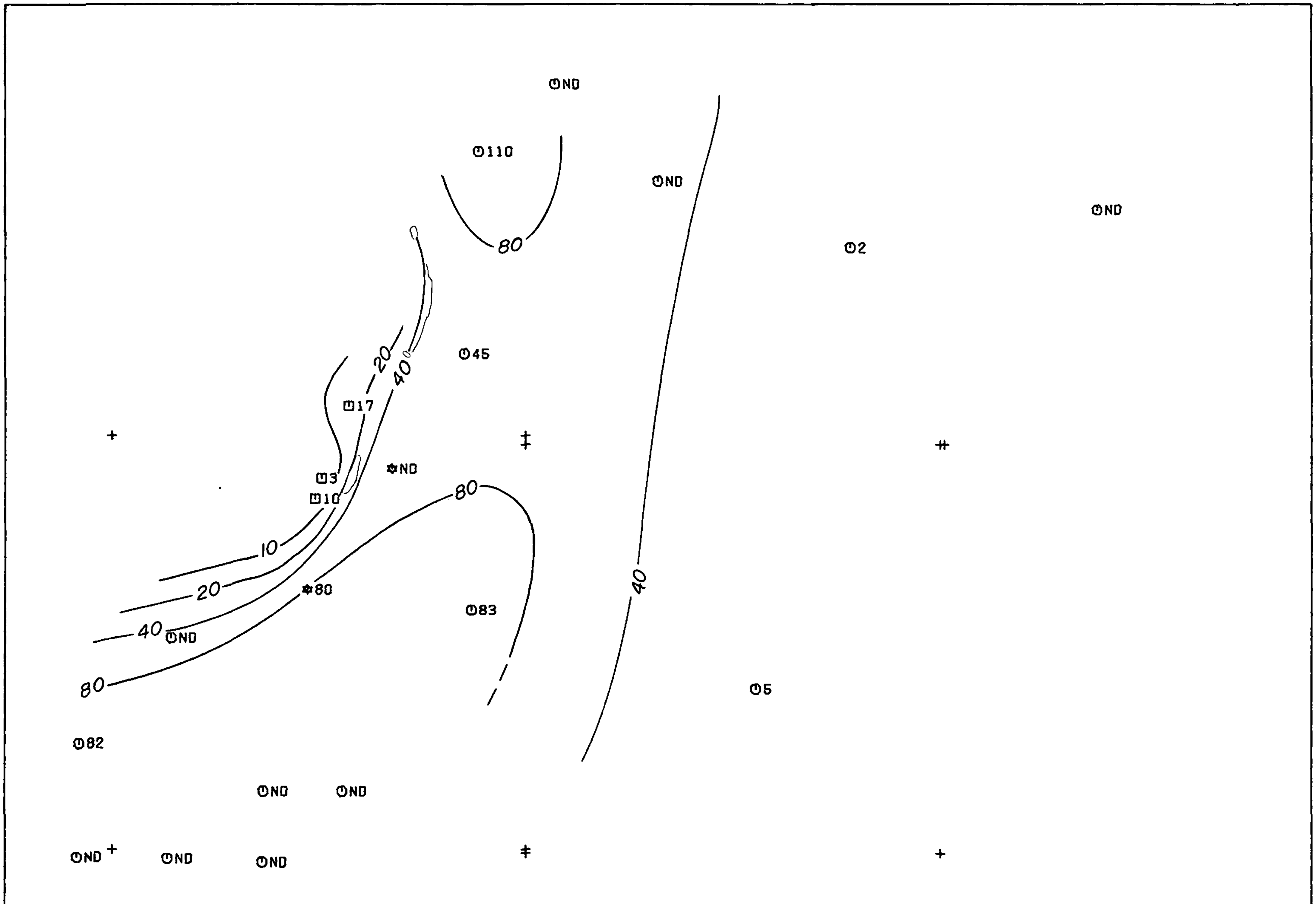


10000 FEET

FIGURE: 14 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES



10000 FEET

FIGURE: 14 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

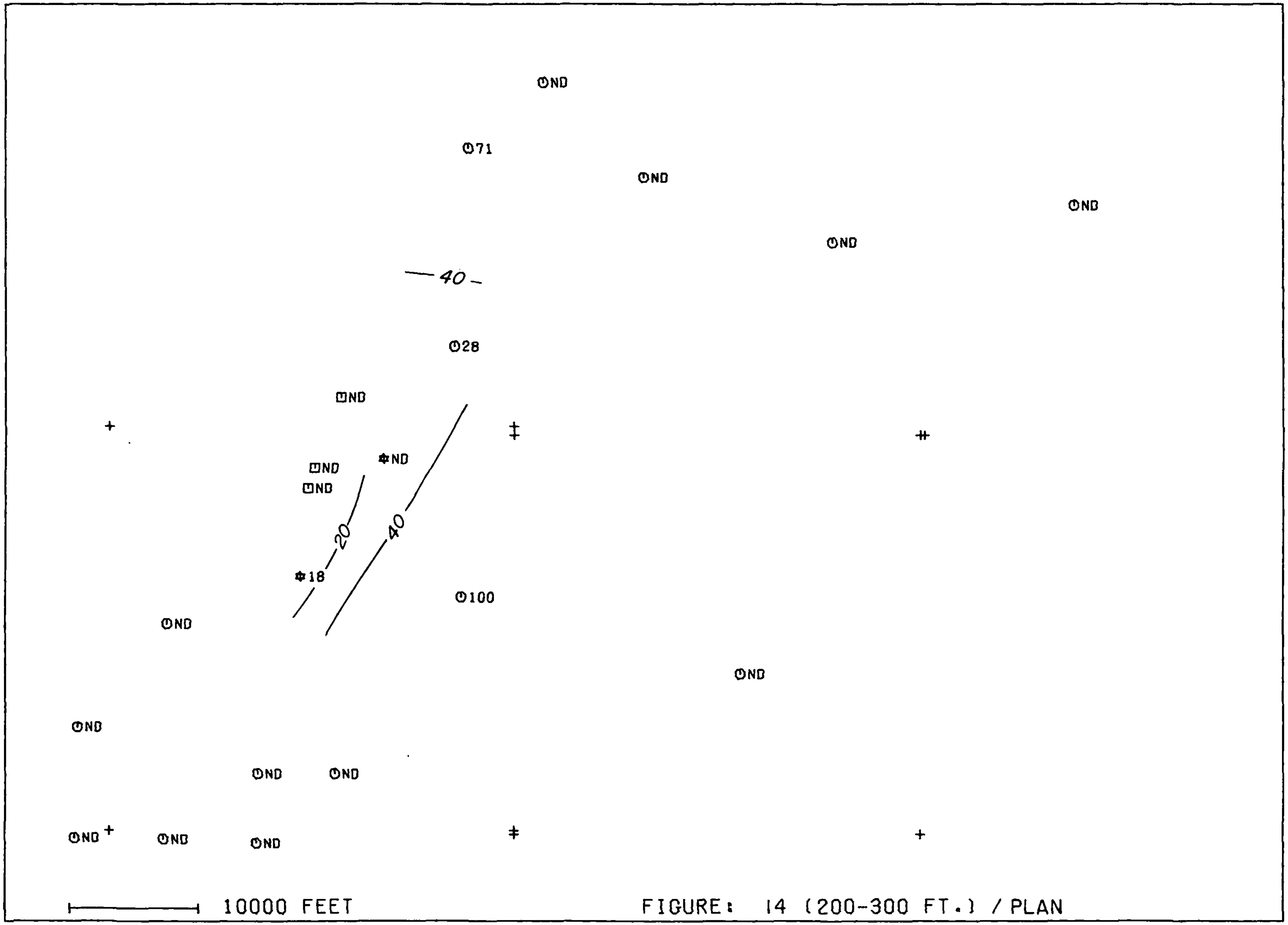
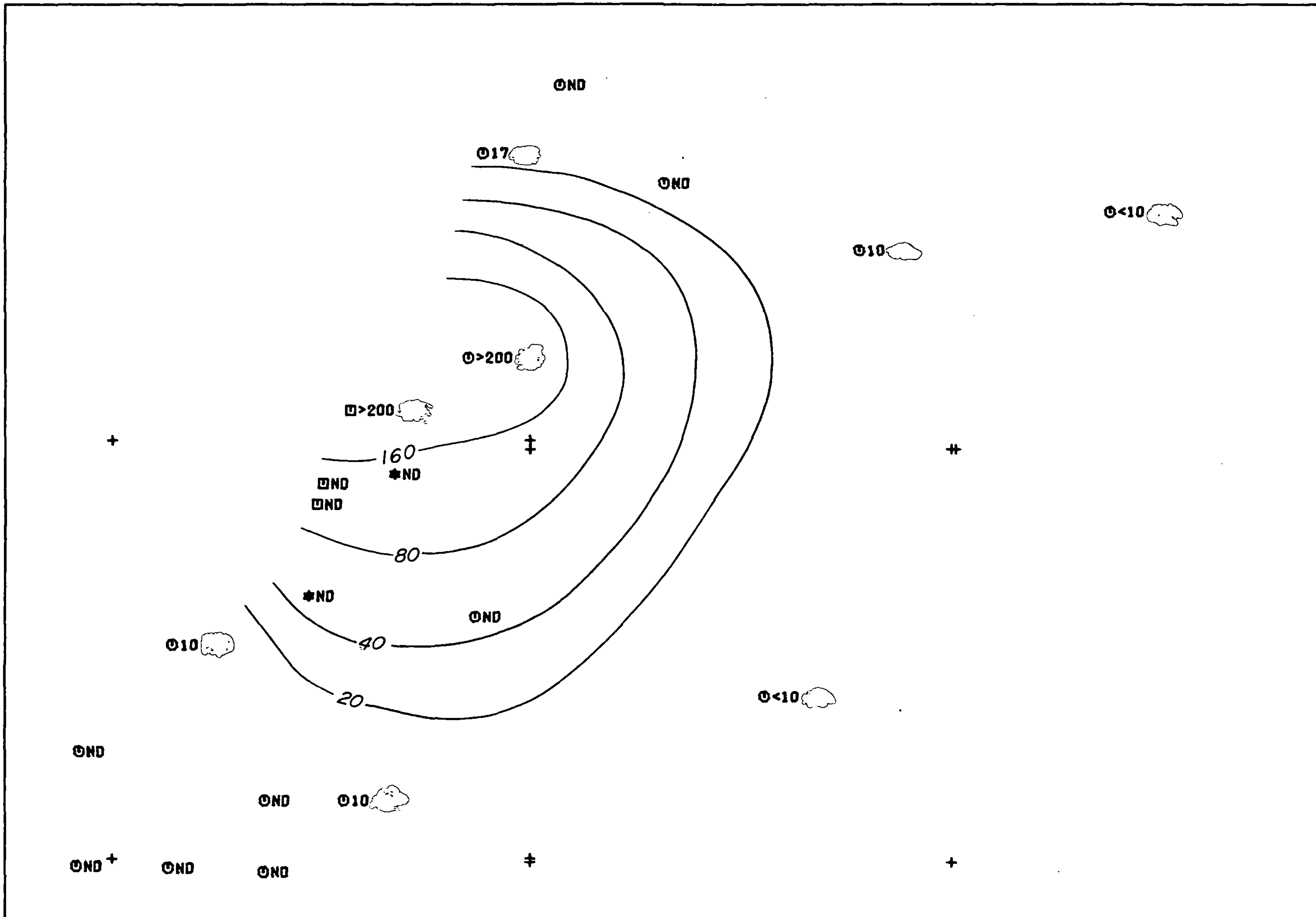


FIGURE: 14 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES



10000 FEET

FIGURE: 15 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 0-100 FT.
SAMPLE TYPE: +3.3 LESS MAG
ANALYTICAL METHOD: OES

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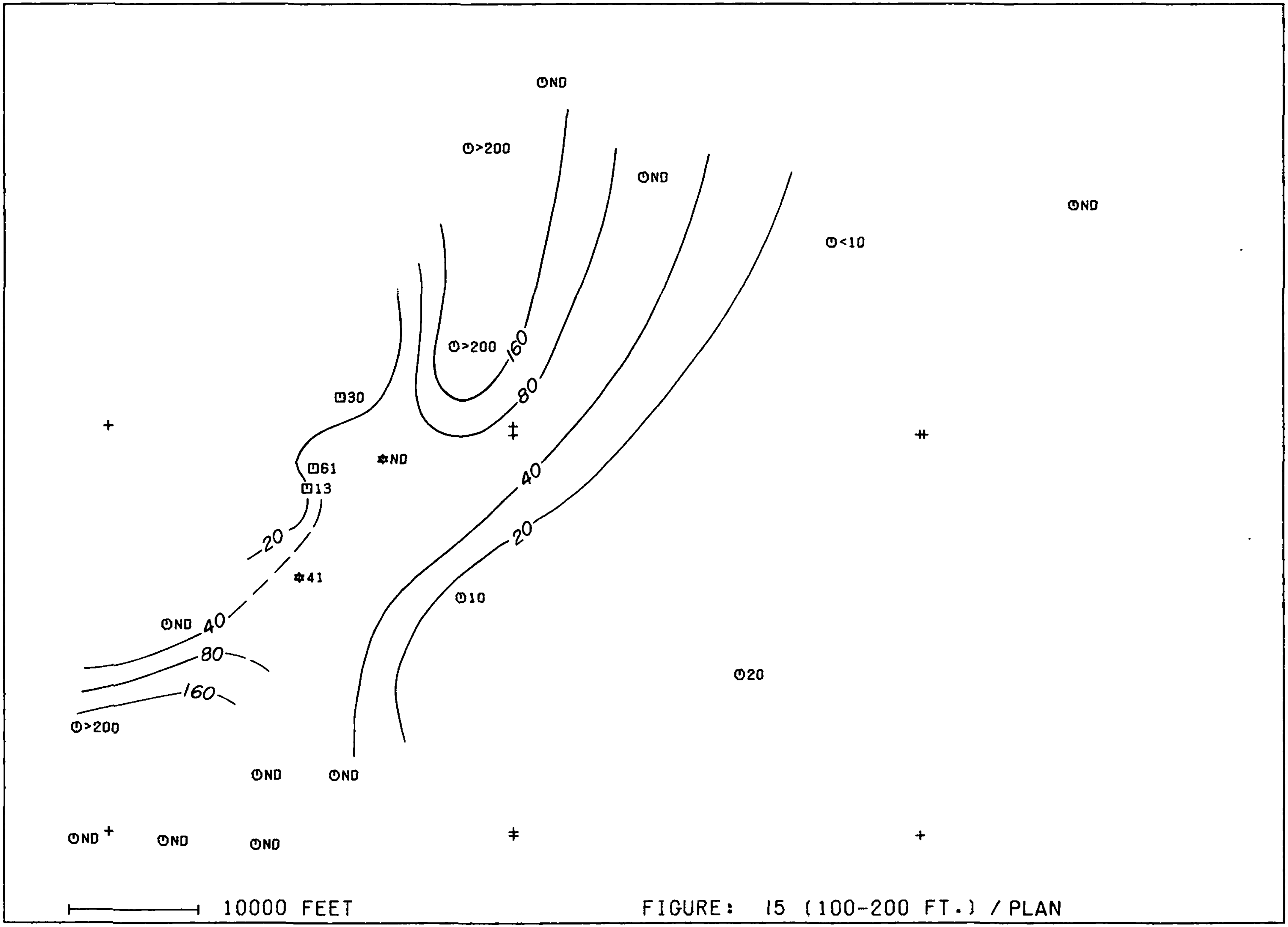


FIGURE: 15 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 100-200 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

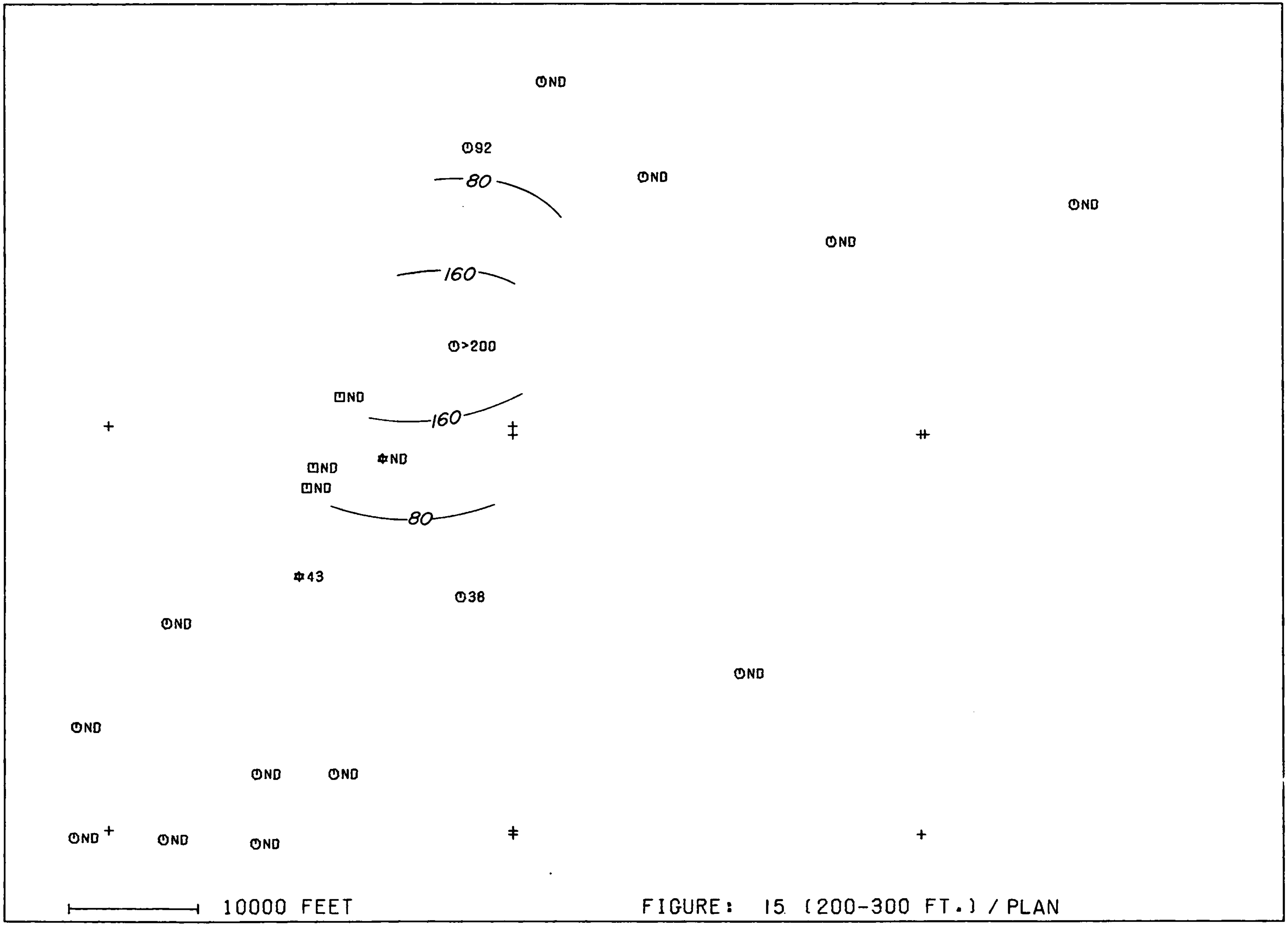


FIGURE: 15 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 200-300 FT.
SAMPLE TYPE: +3.3 LESS MAG.
ANALYTICAL METHOD: OES

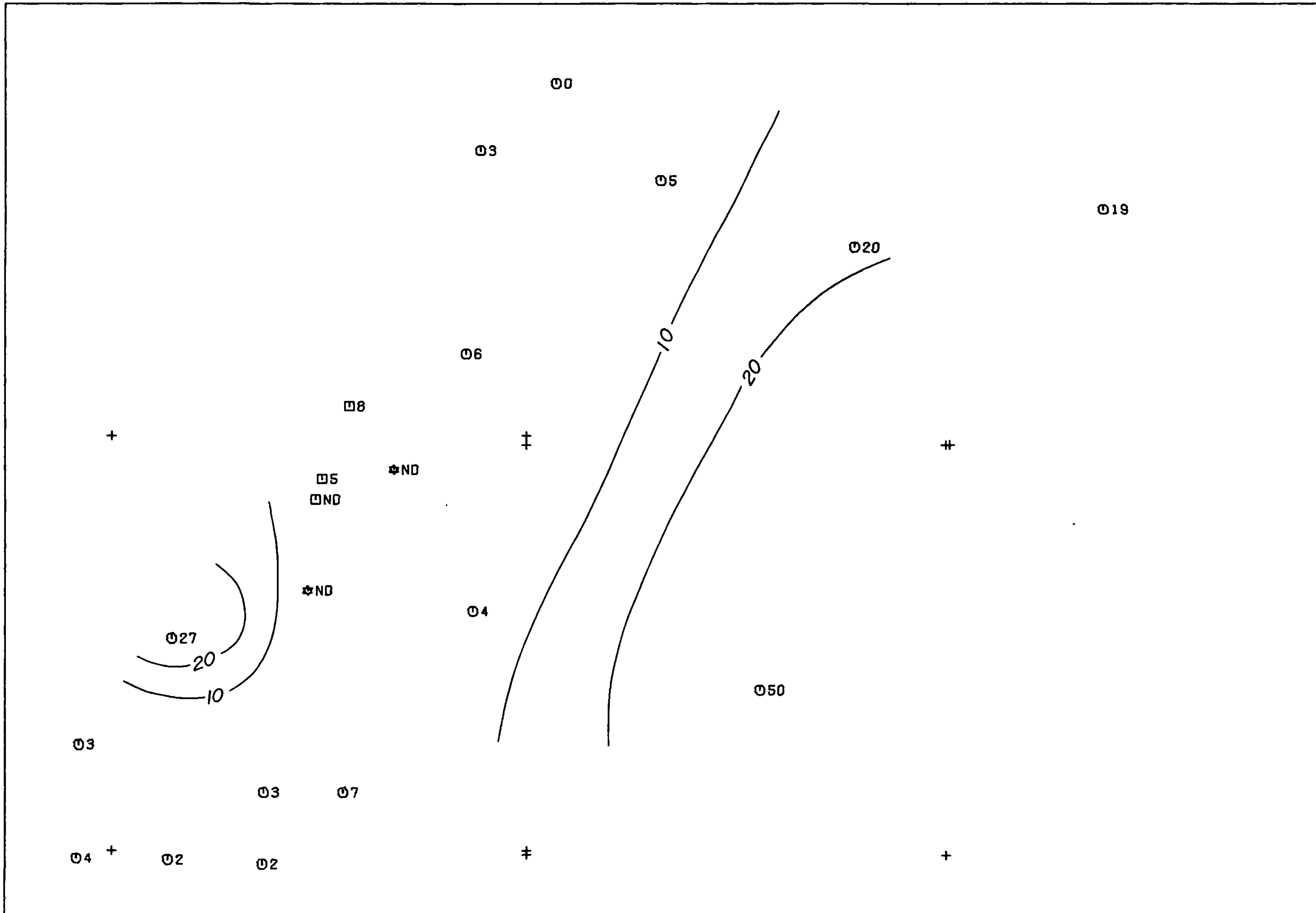
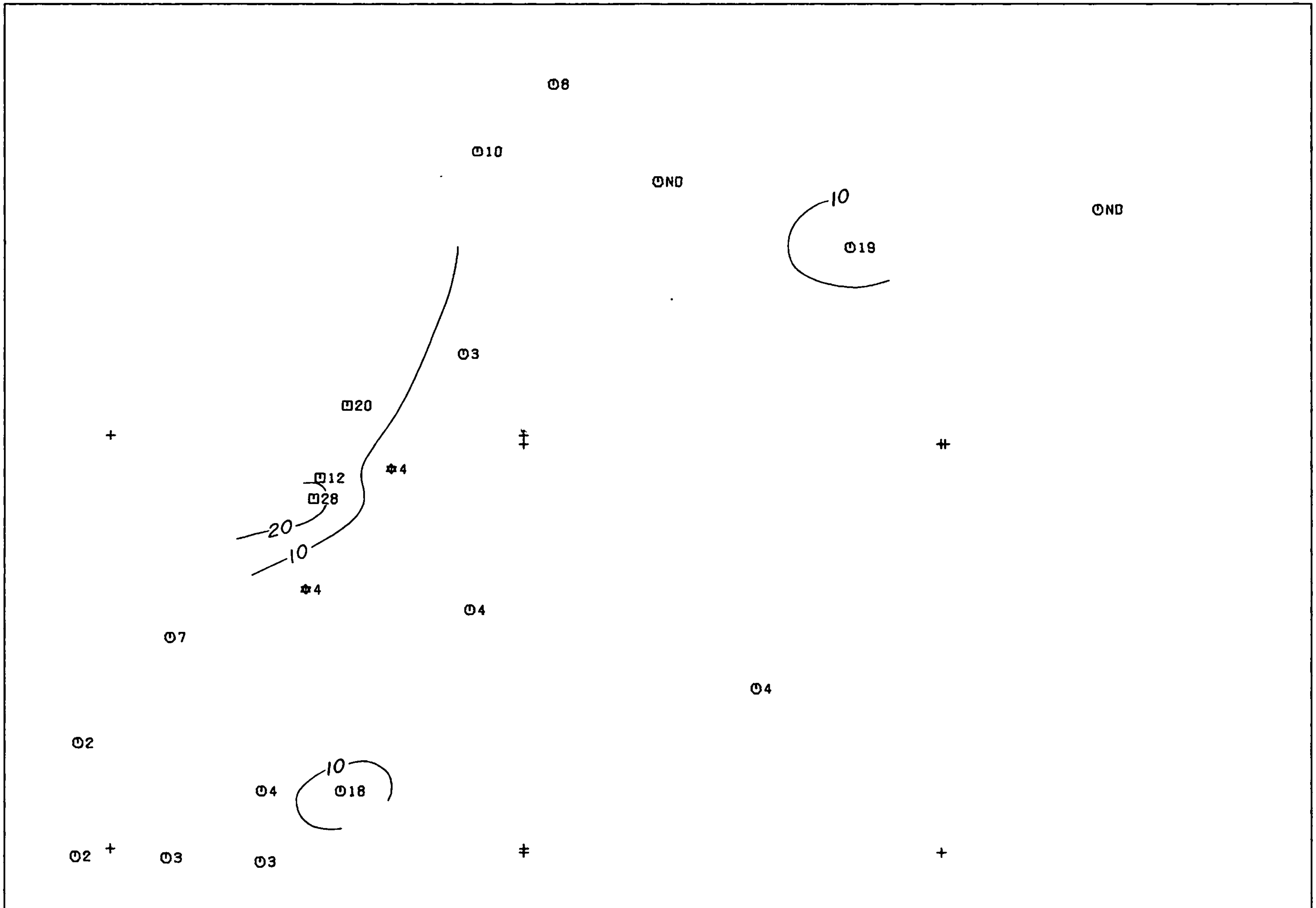


FIGURE: 16 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

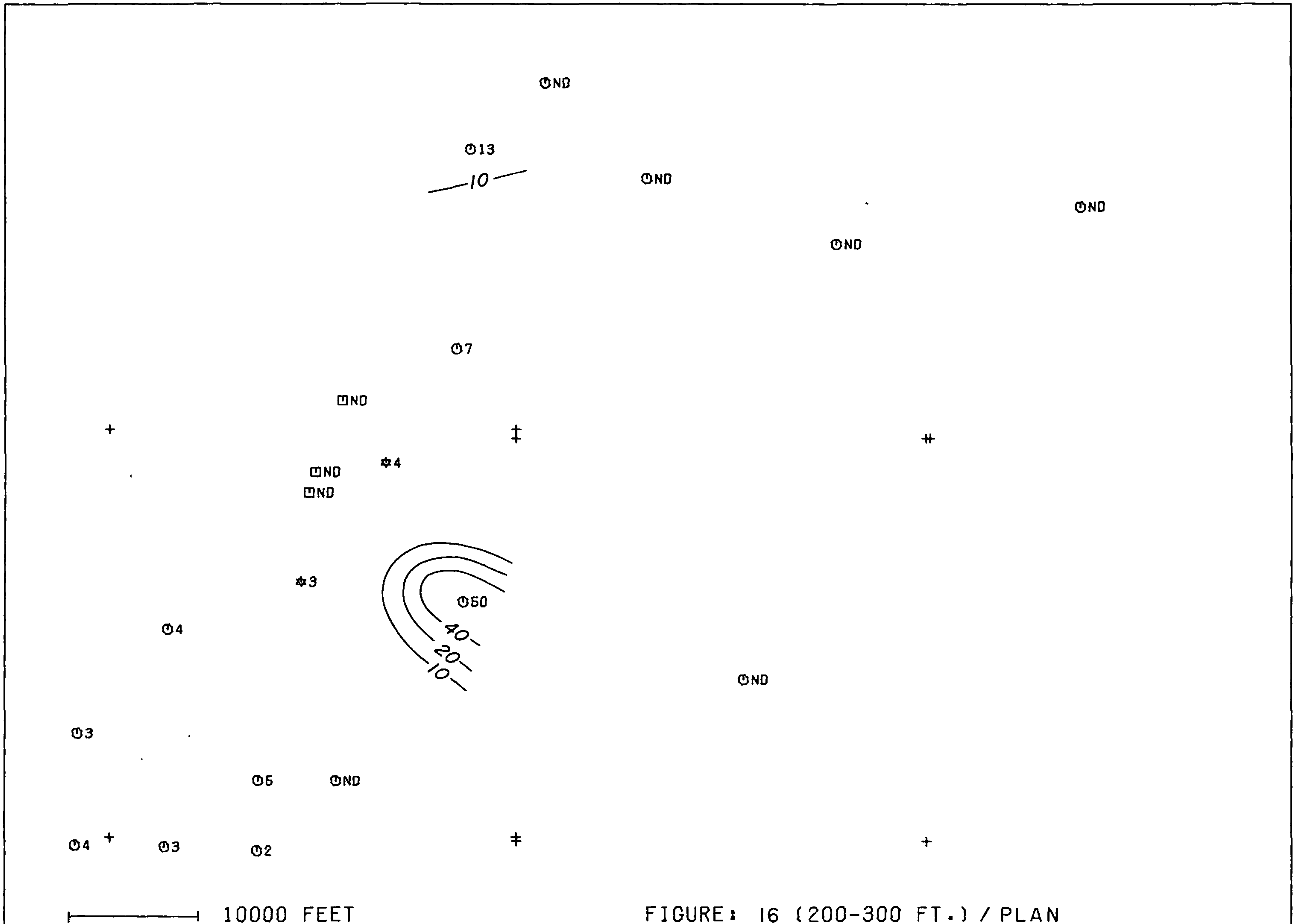


10000 FEET

FIGURE: 16 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COPPER (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

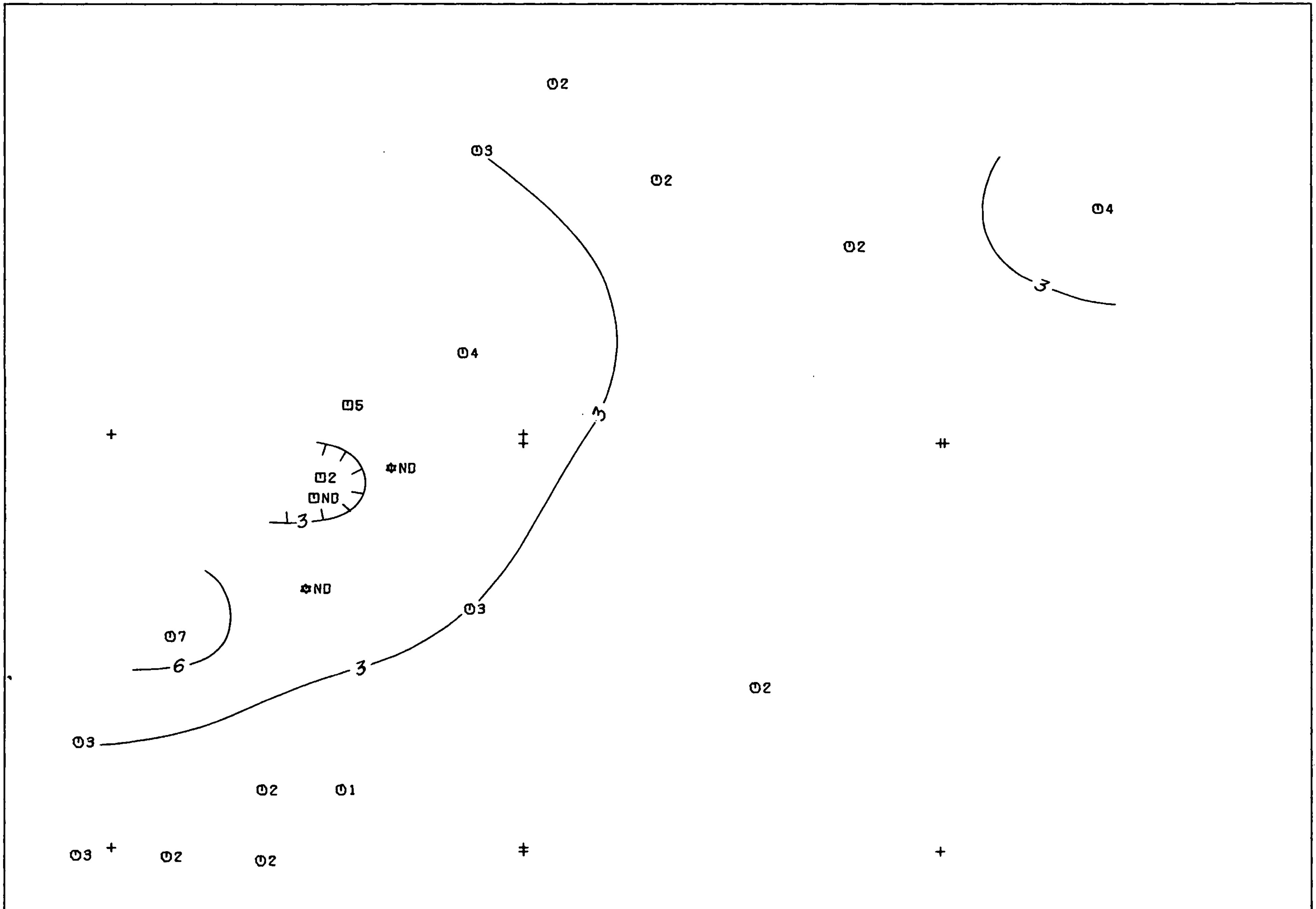


FIGURE: 17 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

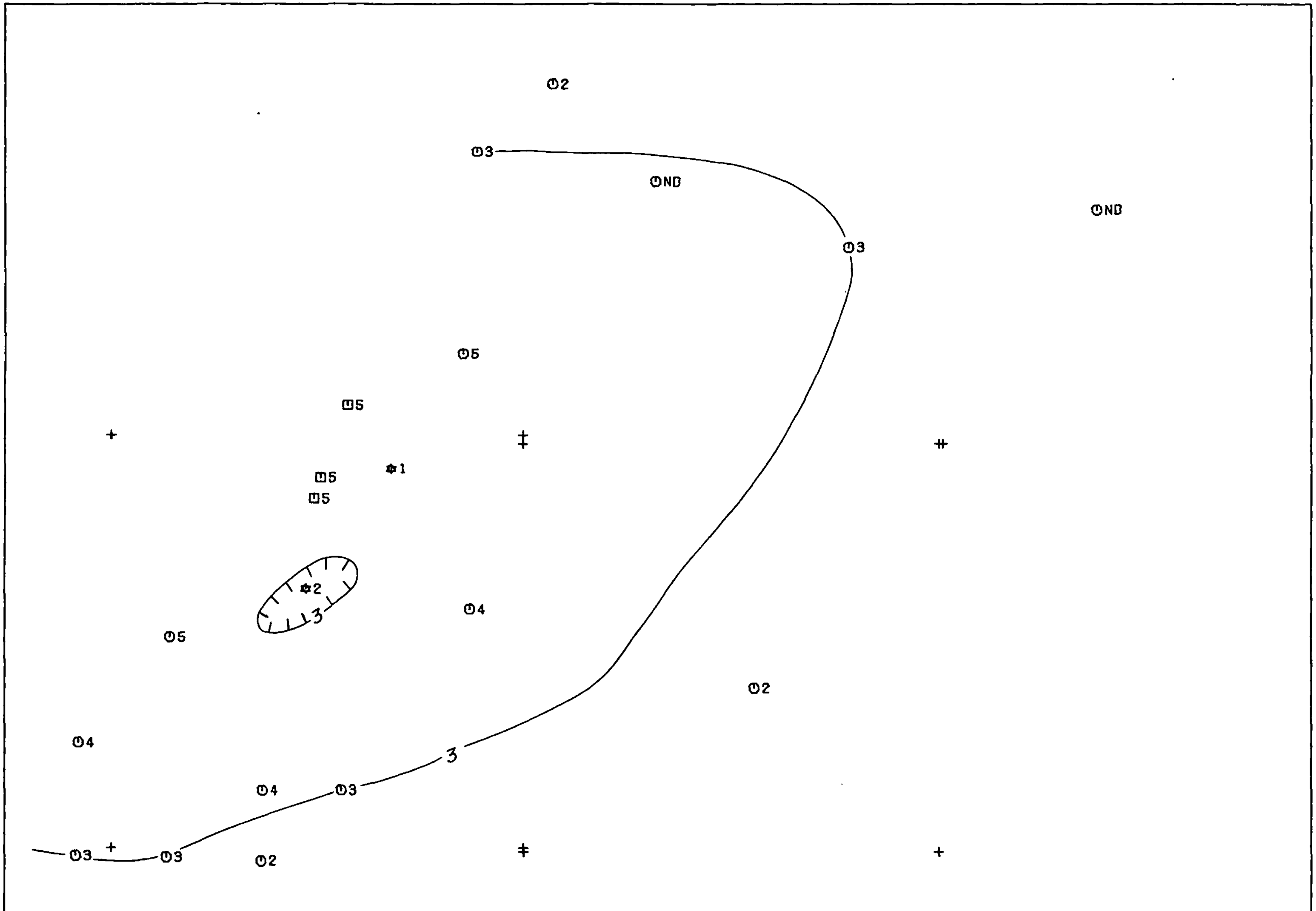


FIGURE: 17 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

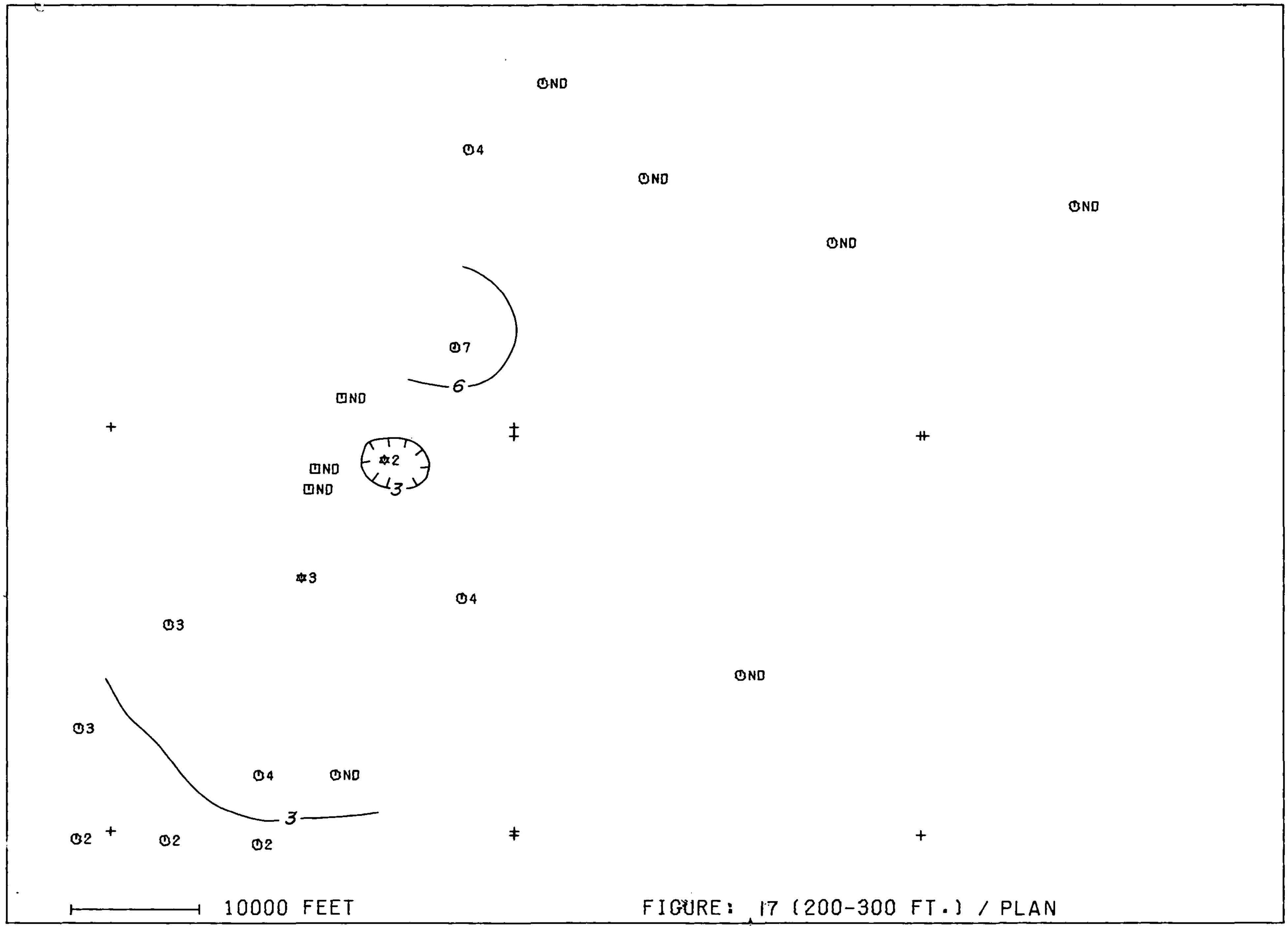
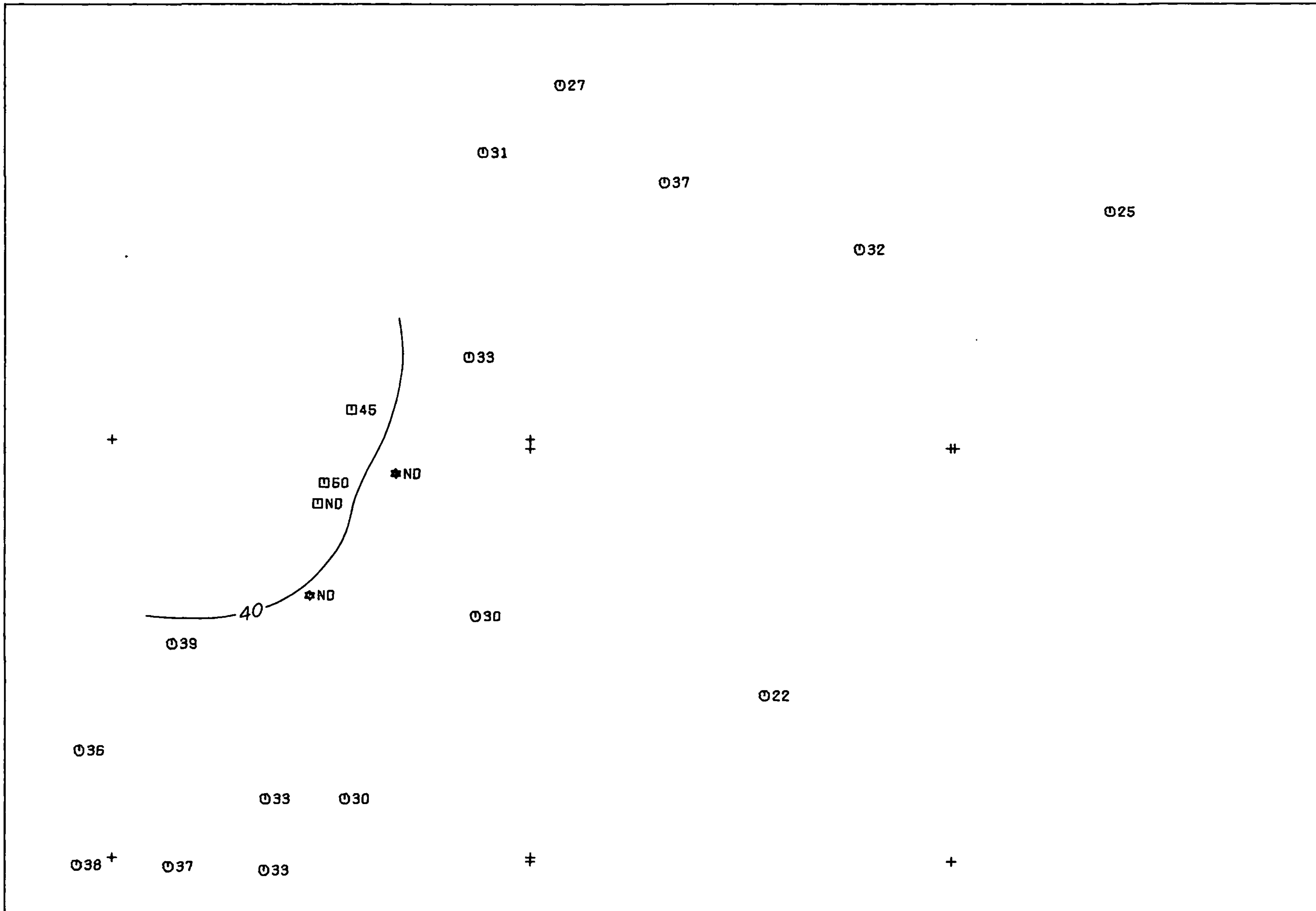


FIGURE: 17 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MOLYBDENUM (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 18 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

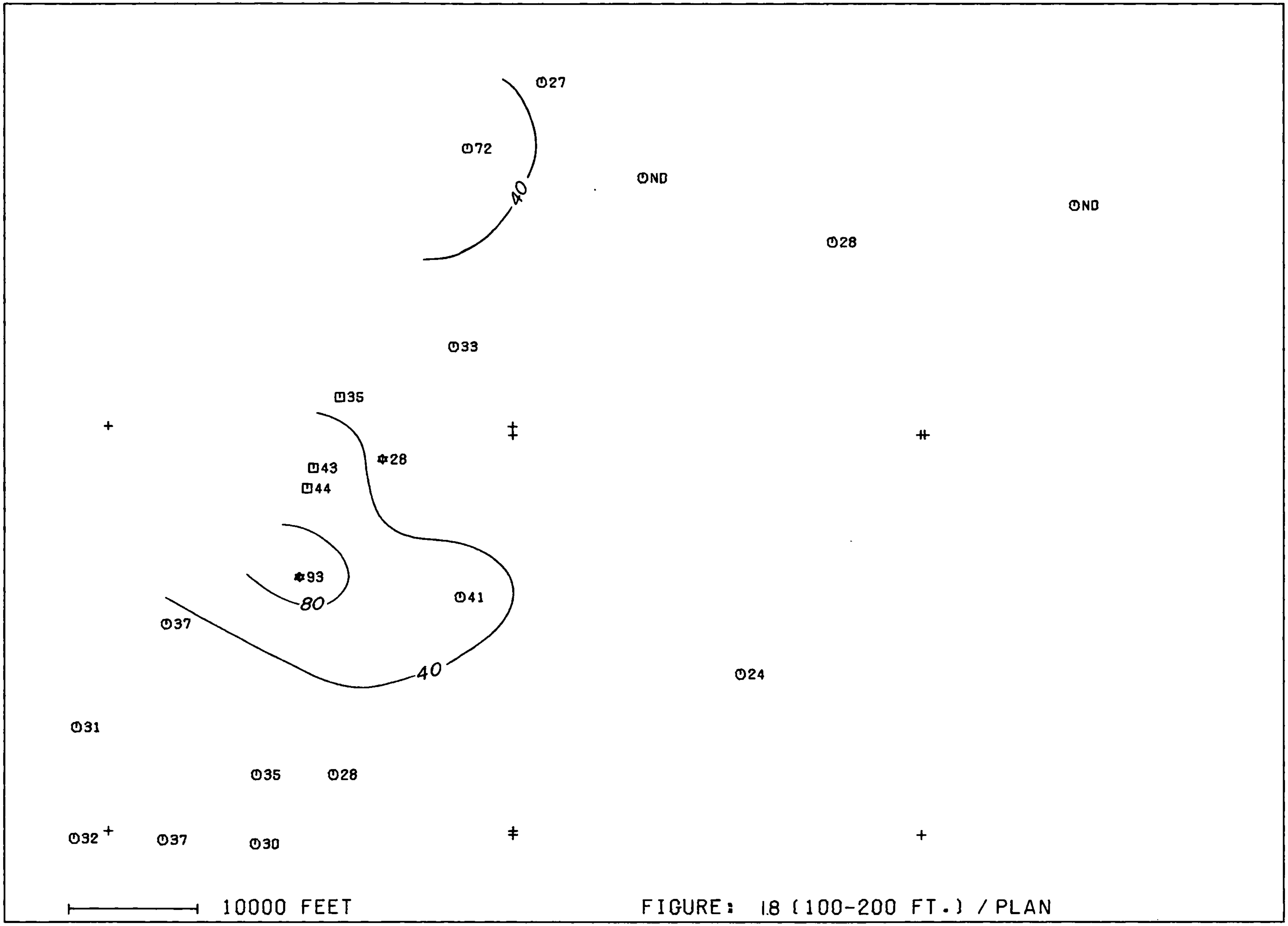


FIGURE: 18 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

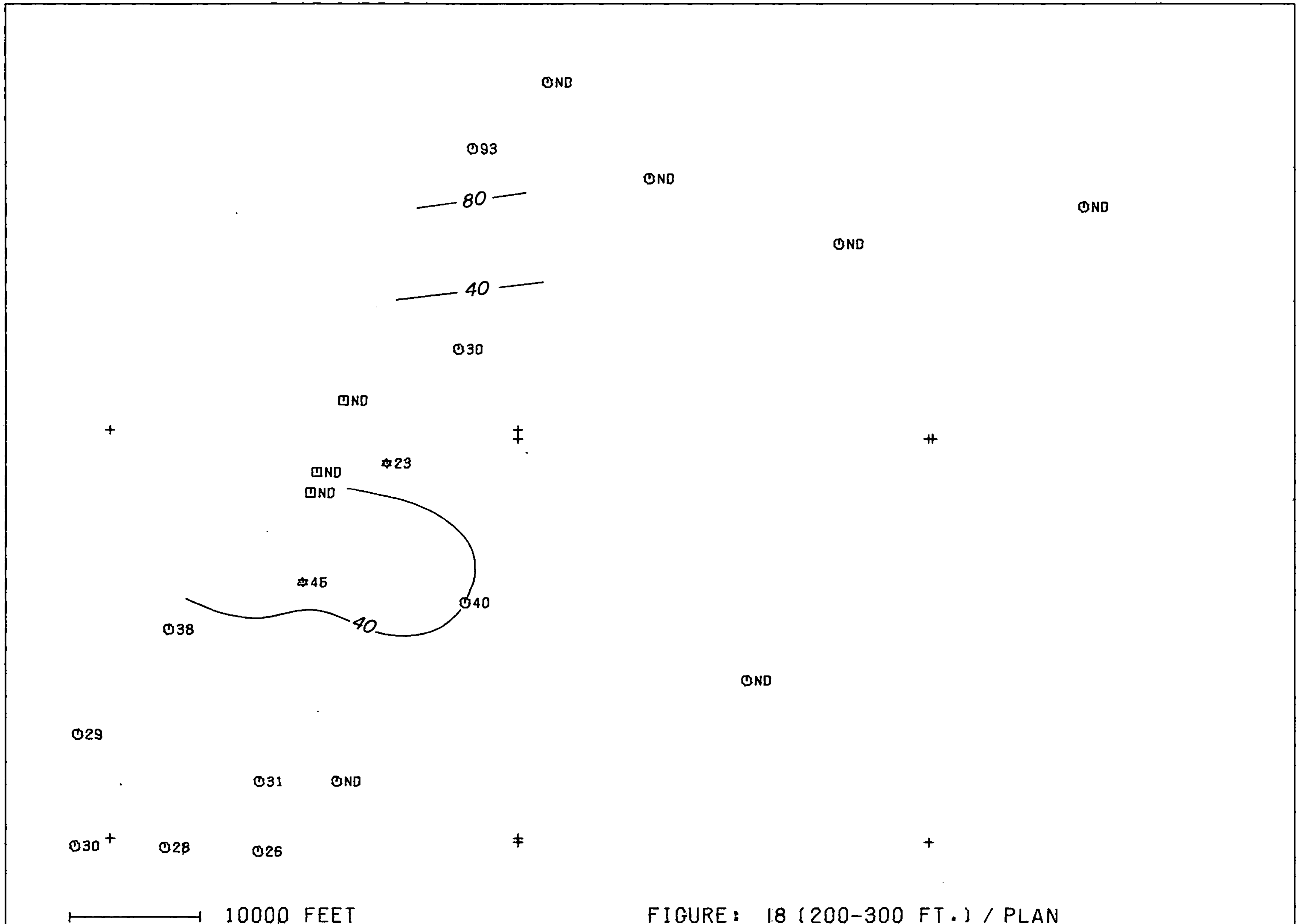


FIGURE: 18 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

LEAD (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

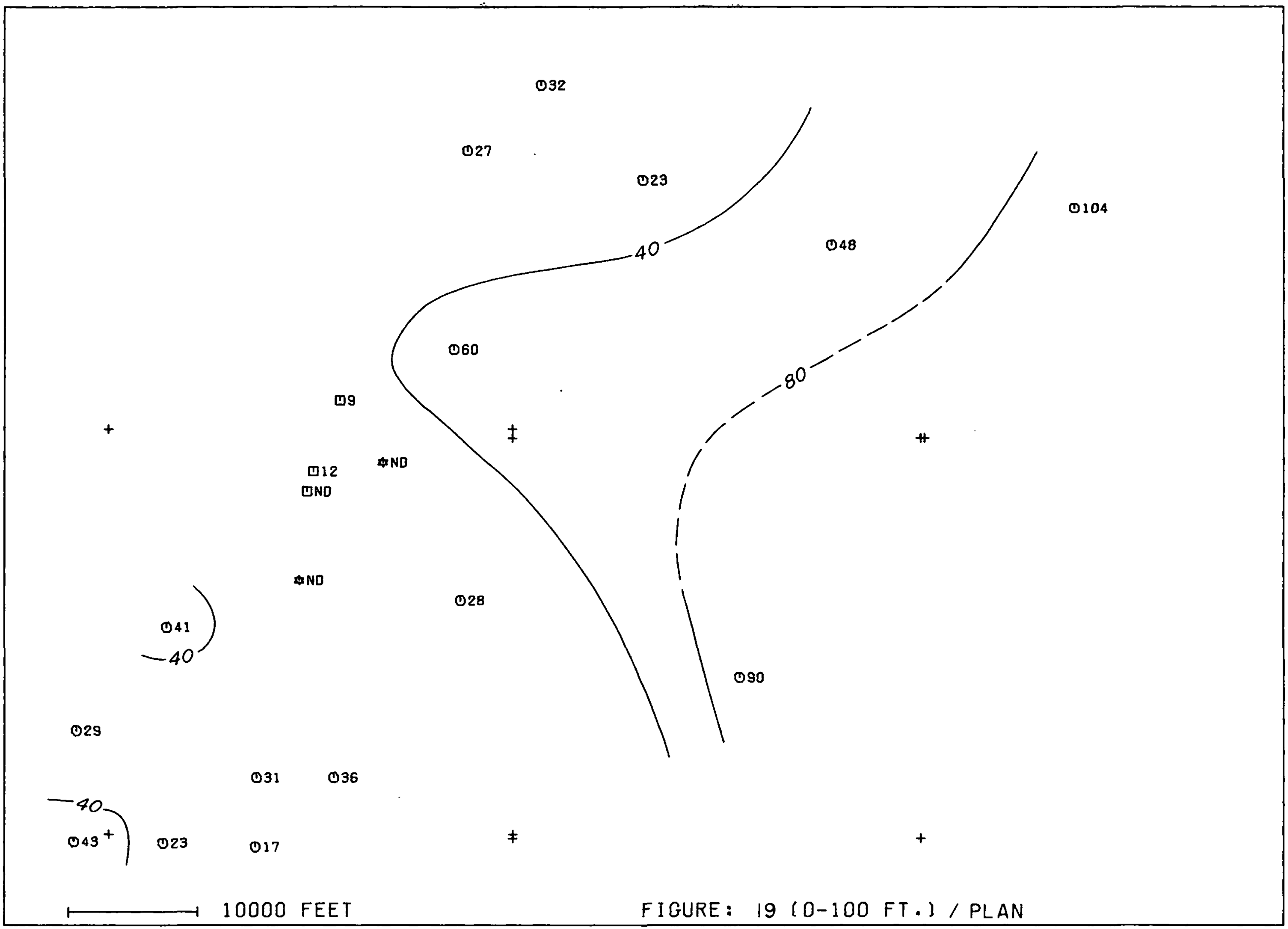
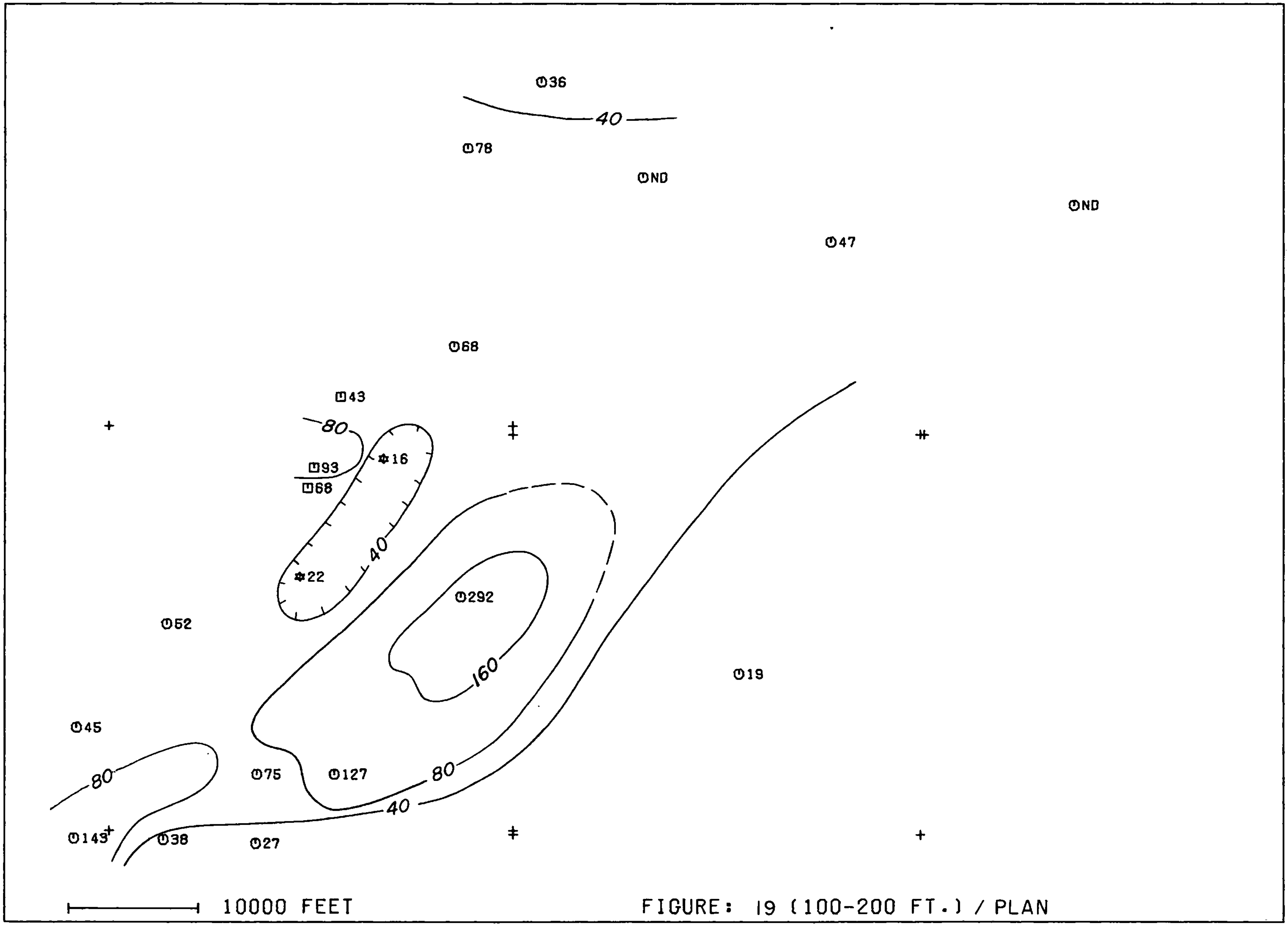


FIGURE: 19 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

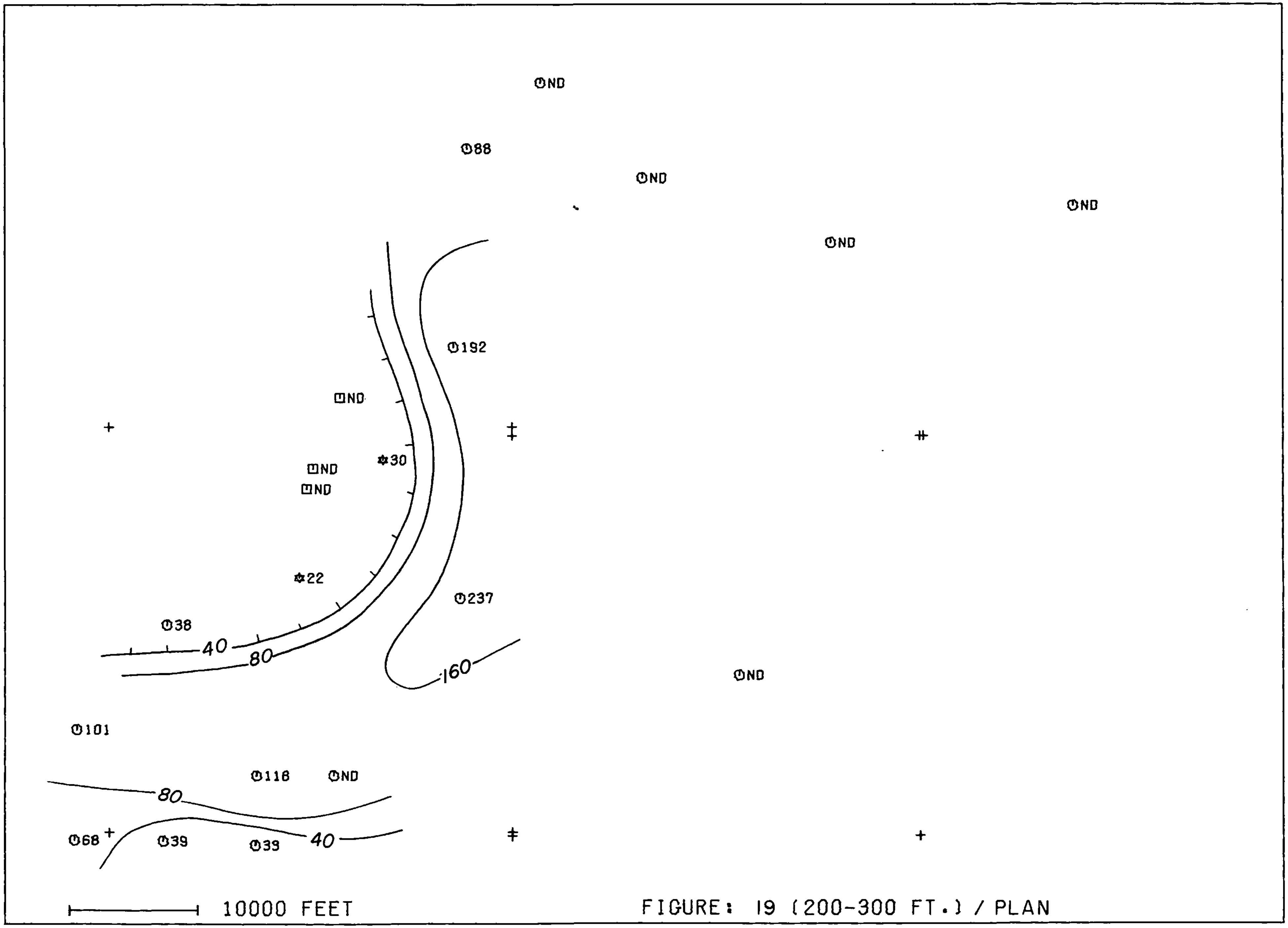
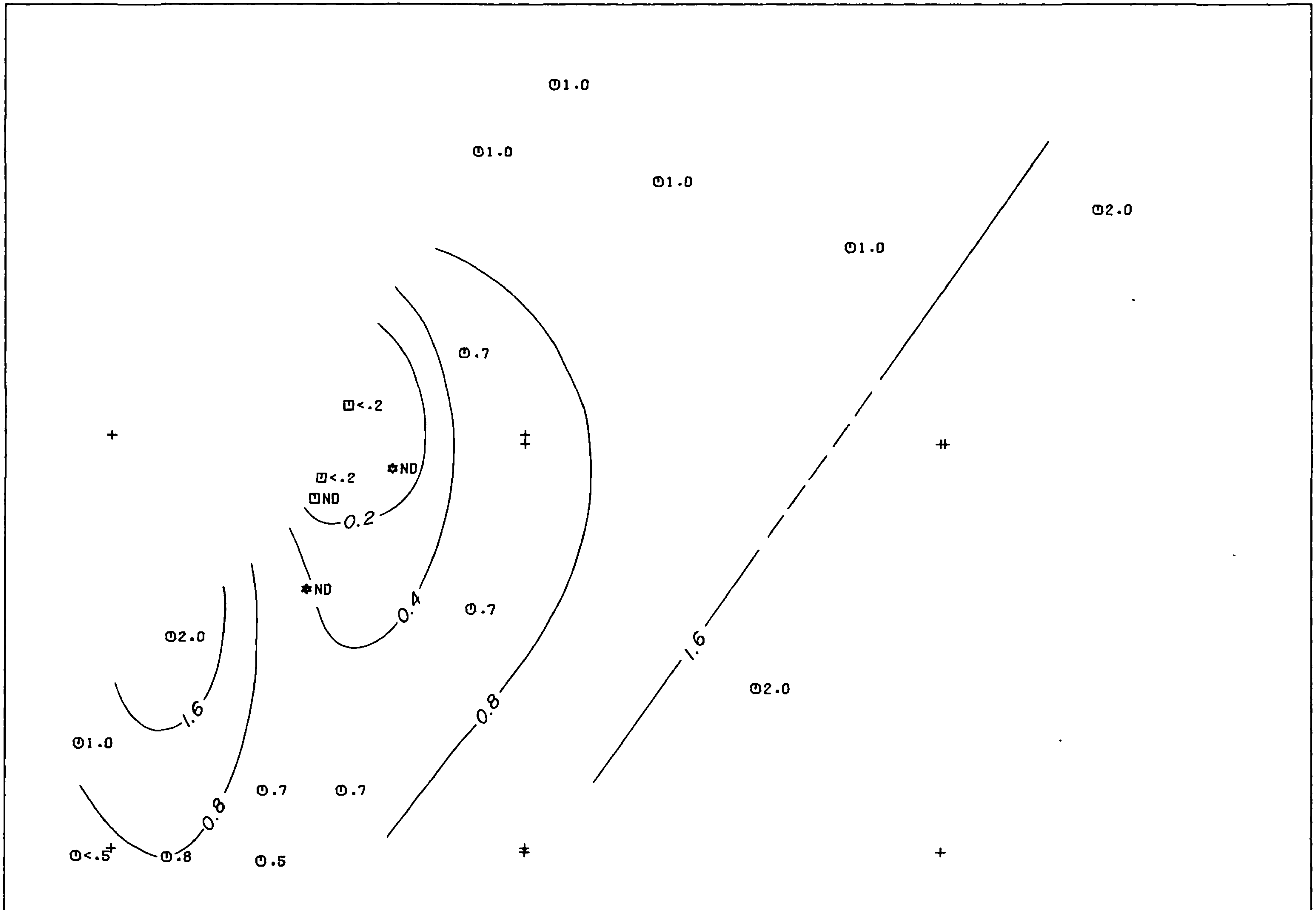


FIGURE: 19 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ZINC (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

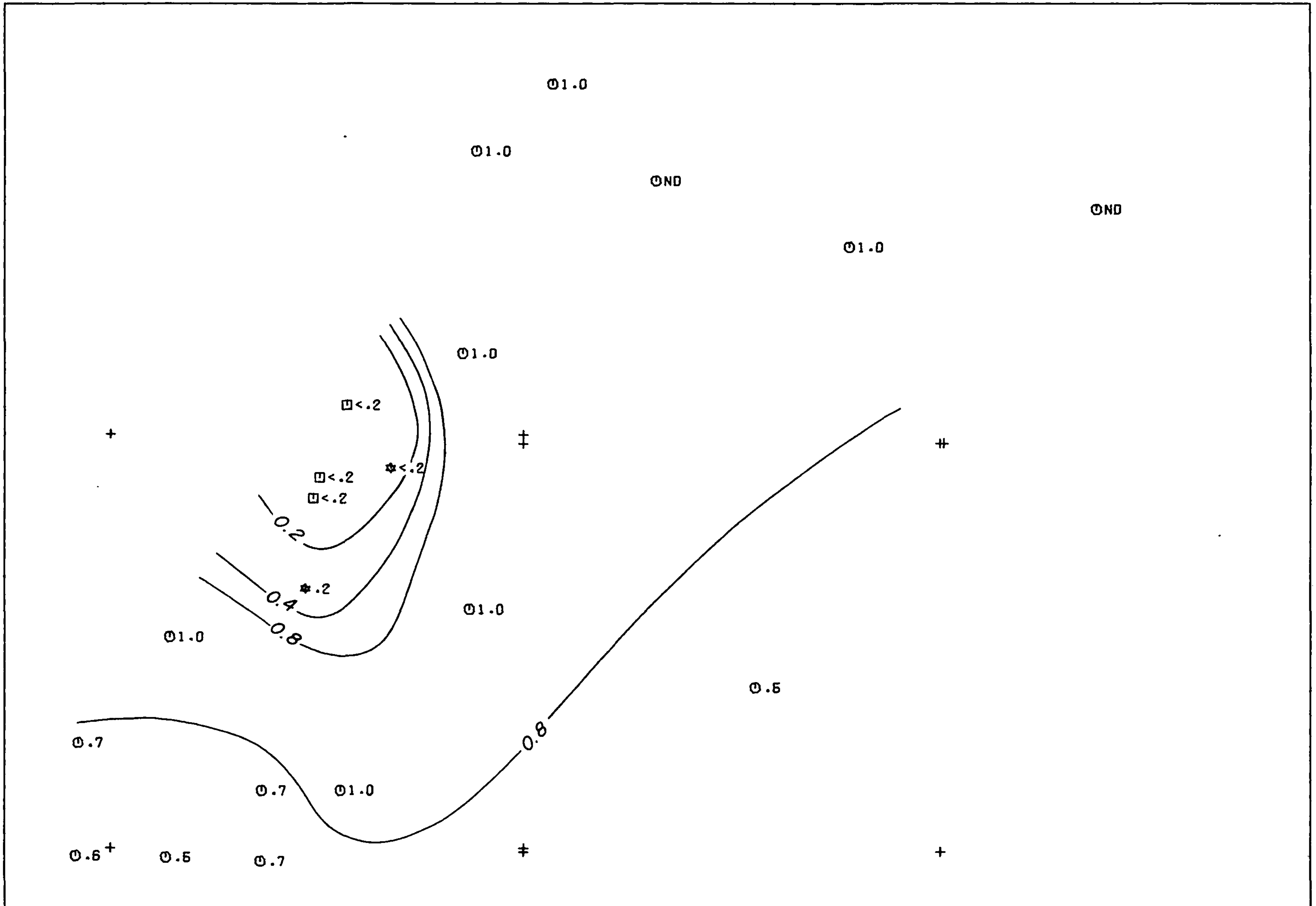


10000 FEET

FIGURE: 20 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

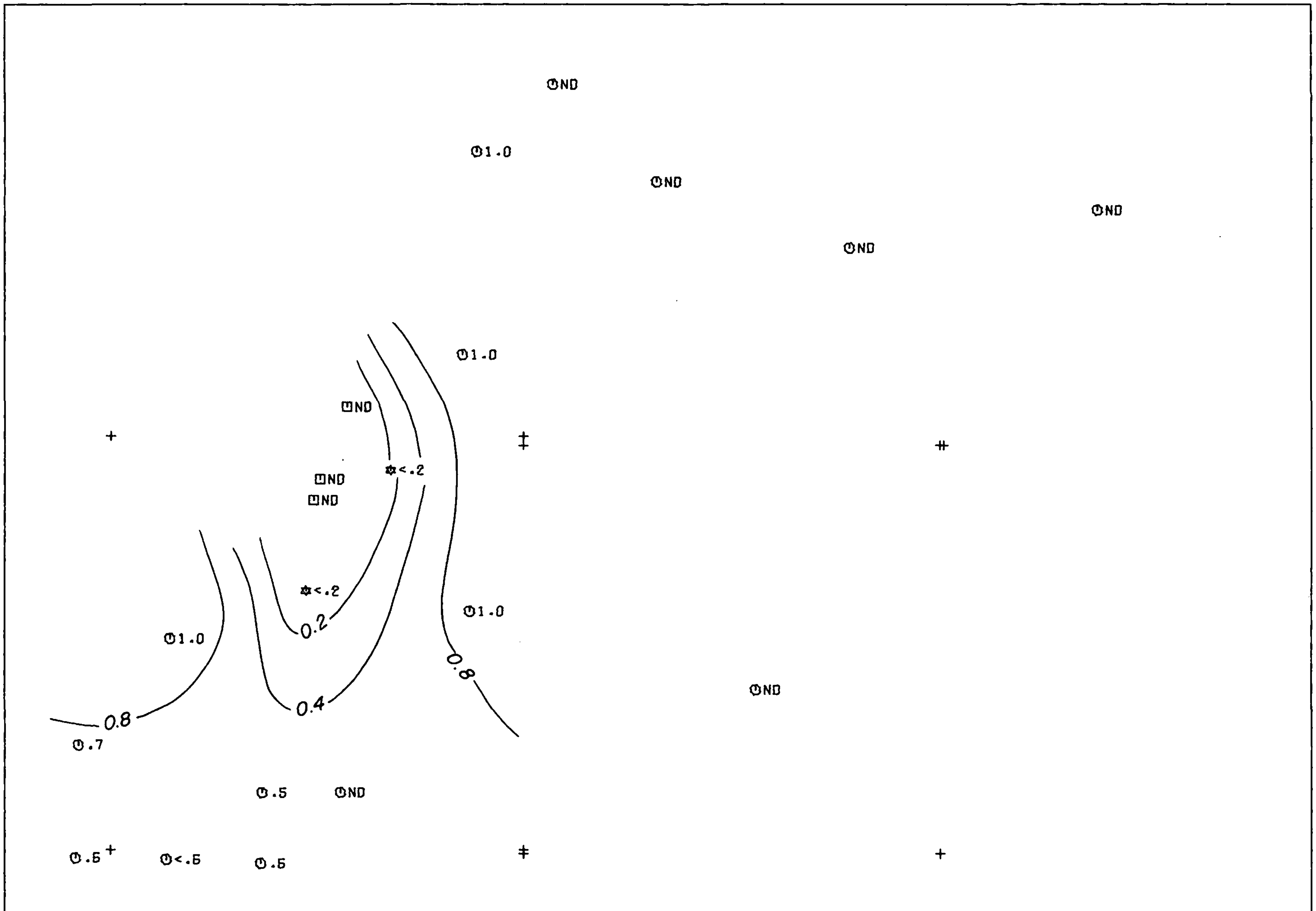


10000 FEET

FIGURE: 20 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

SILVER (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

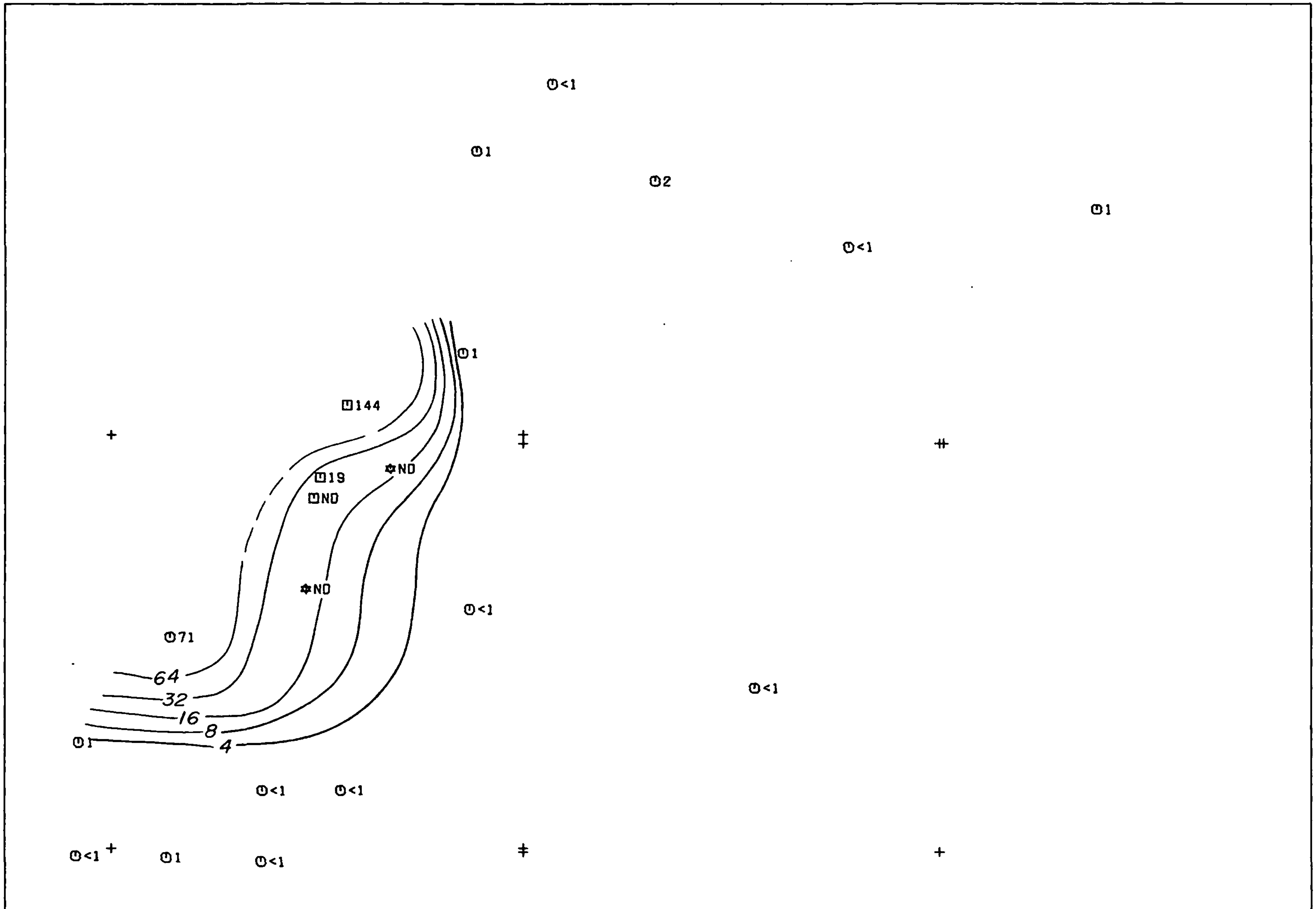


10000 FEET

FIGURE: 20 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY,UTAH

SILVER (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 21 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: COLOR

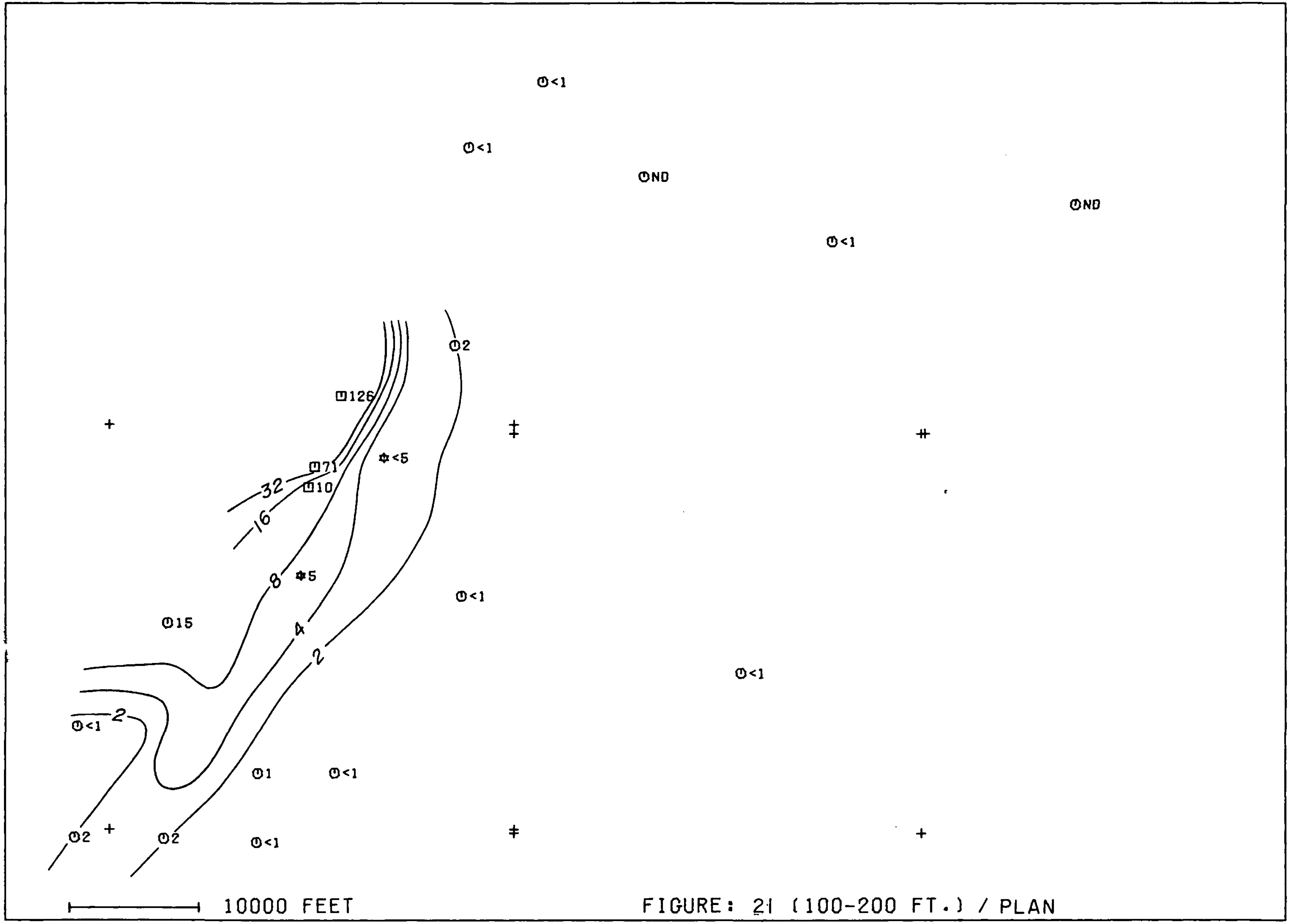
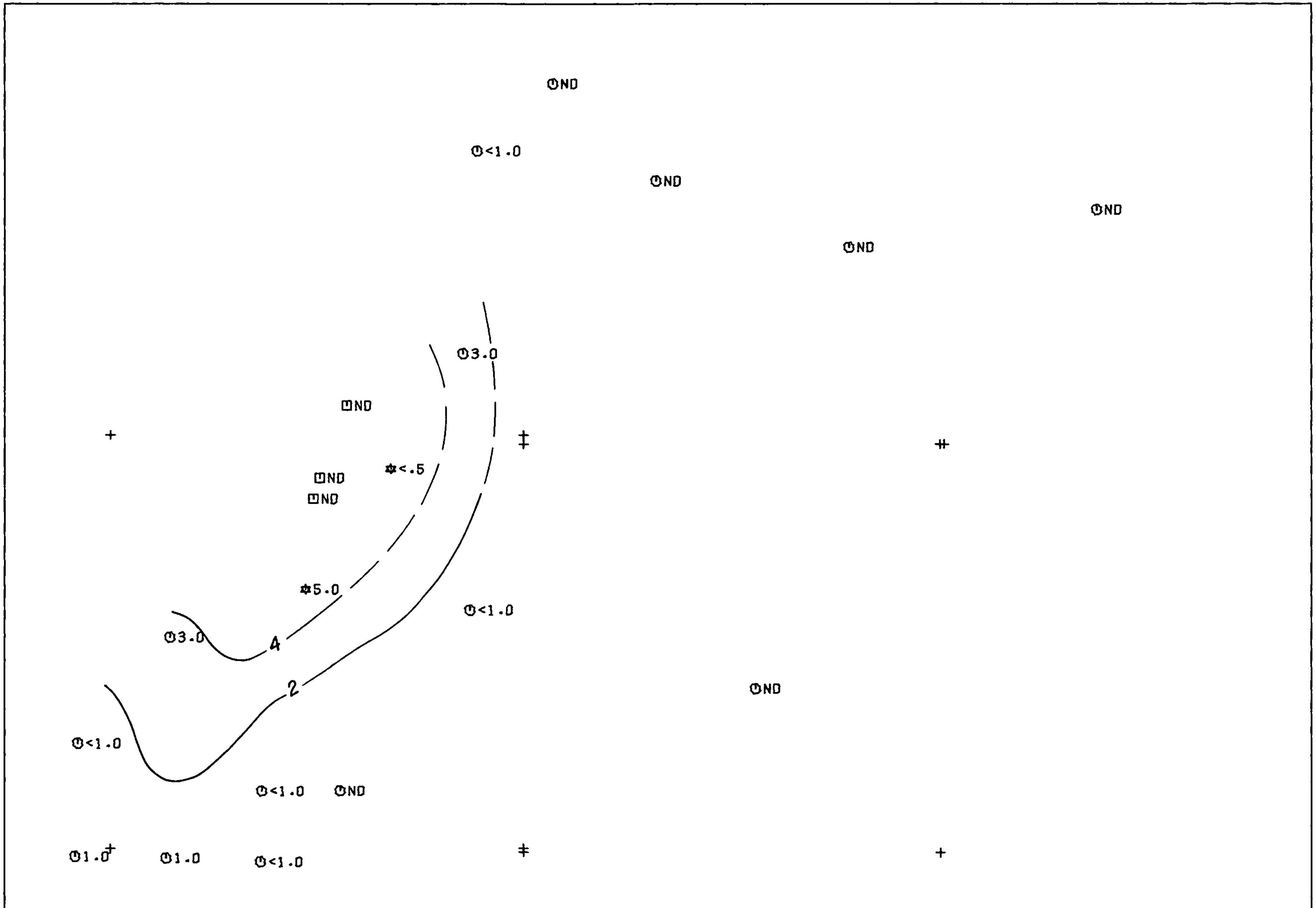


FIGURE: 21 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: COLOR



10000 FEET

FIGURE: 2[illegible] (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

ARSENIC (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: COLOR

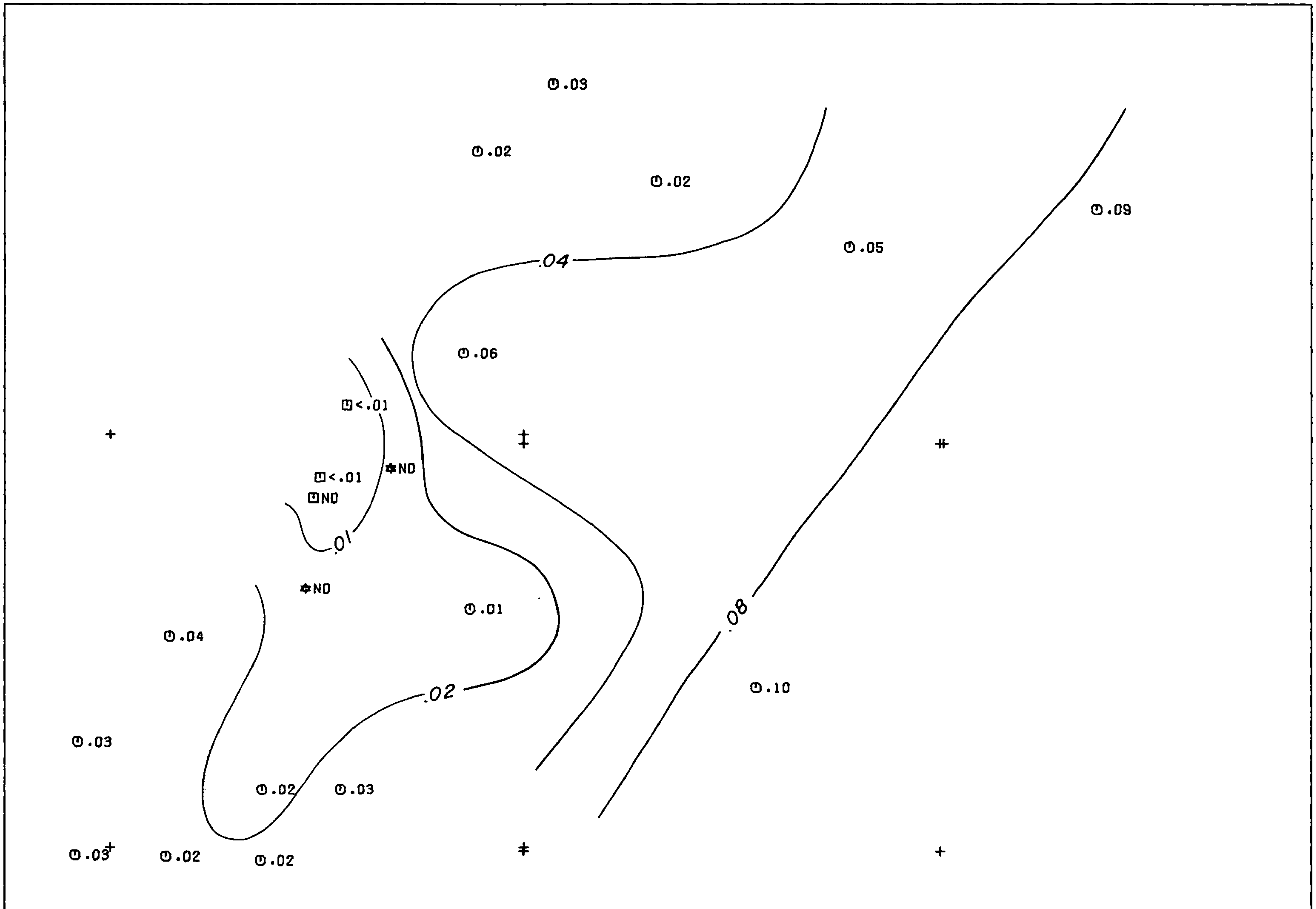
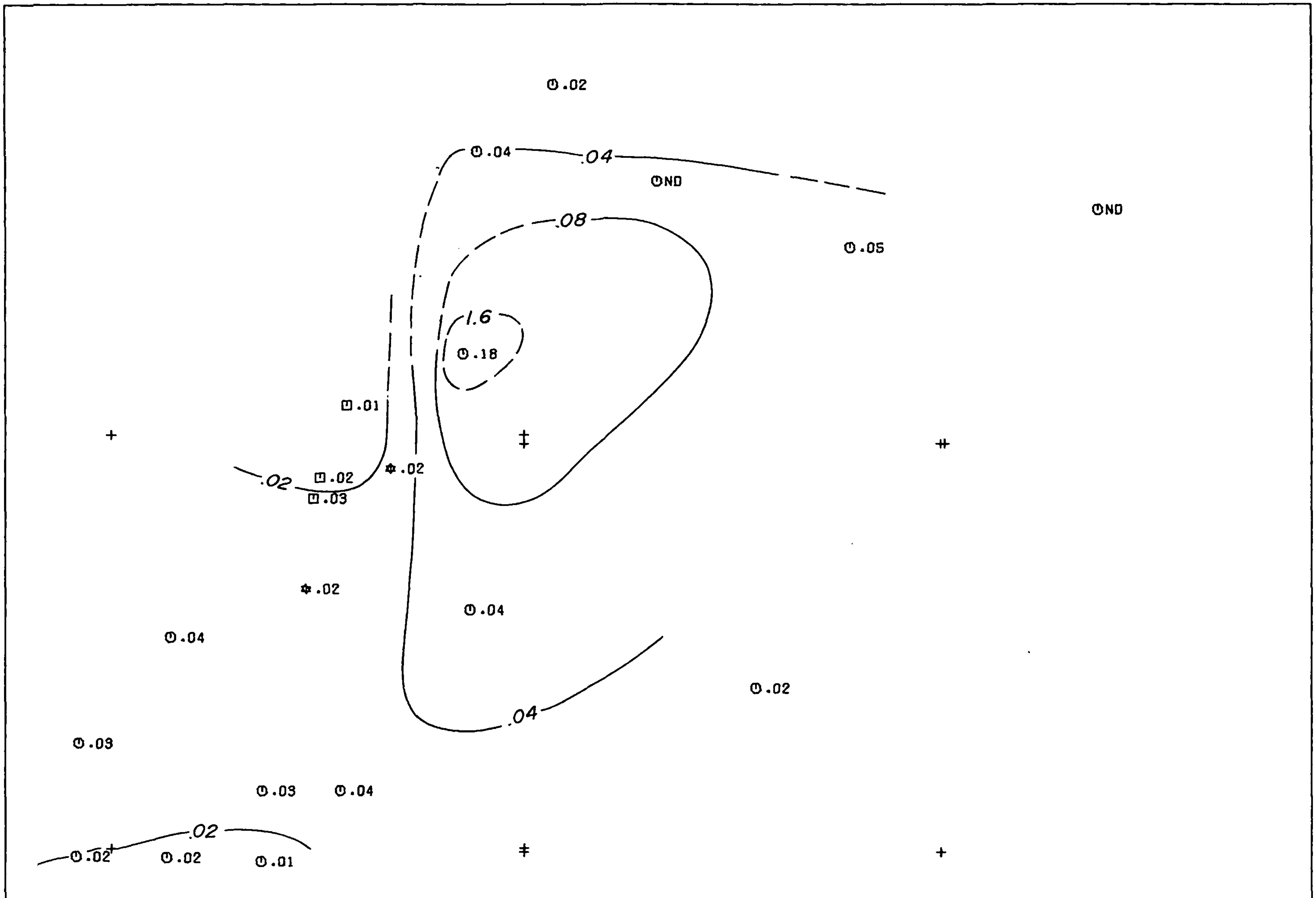


FIGURE: 22 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 22 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

MANGANESE (%) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

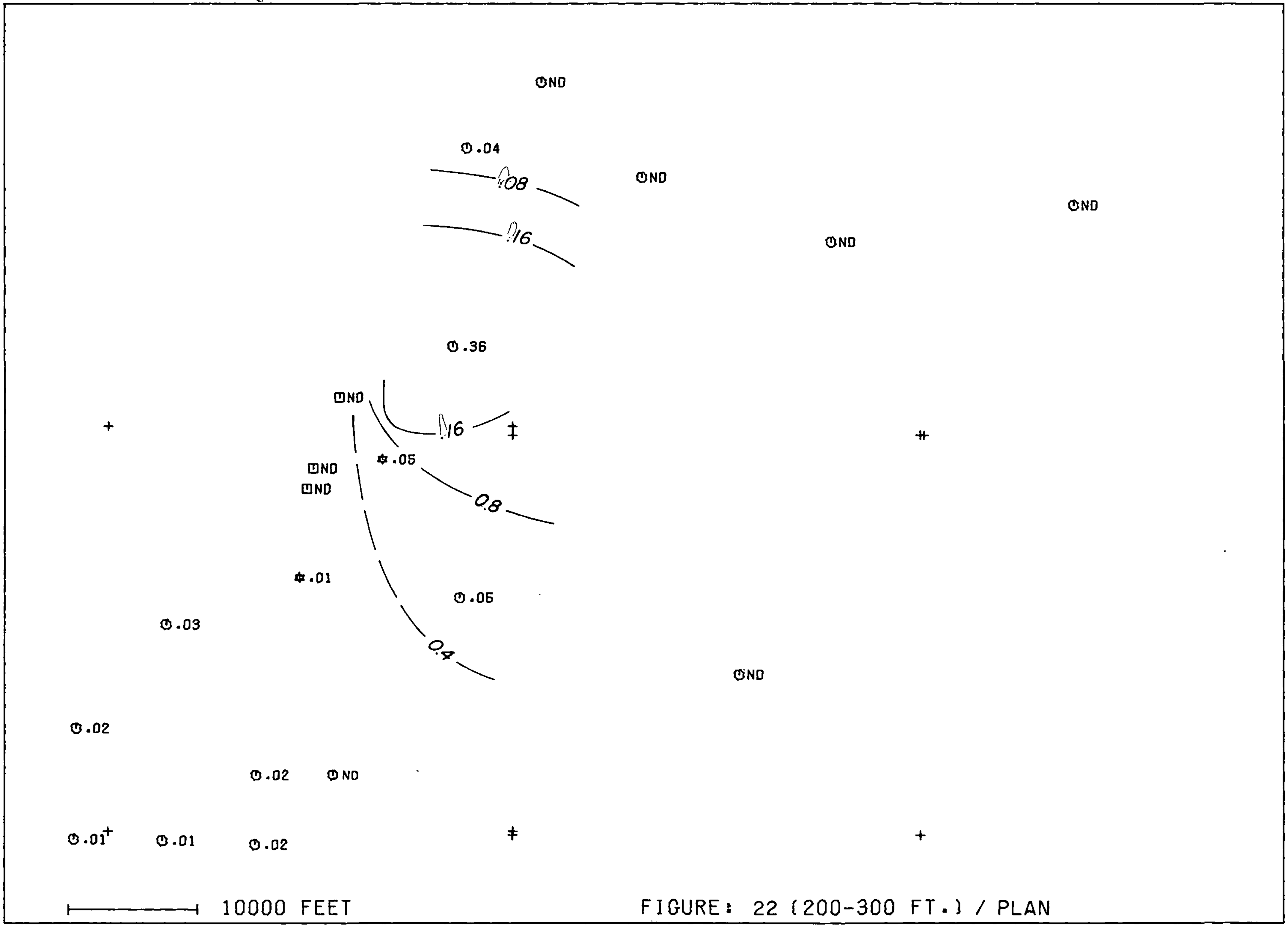


FIGURE: 22 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY,UTAH

MANGANESE (%) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

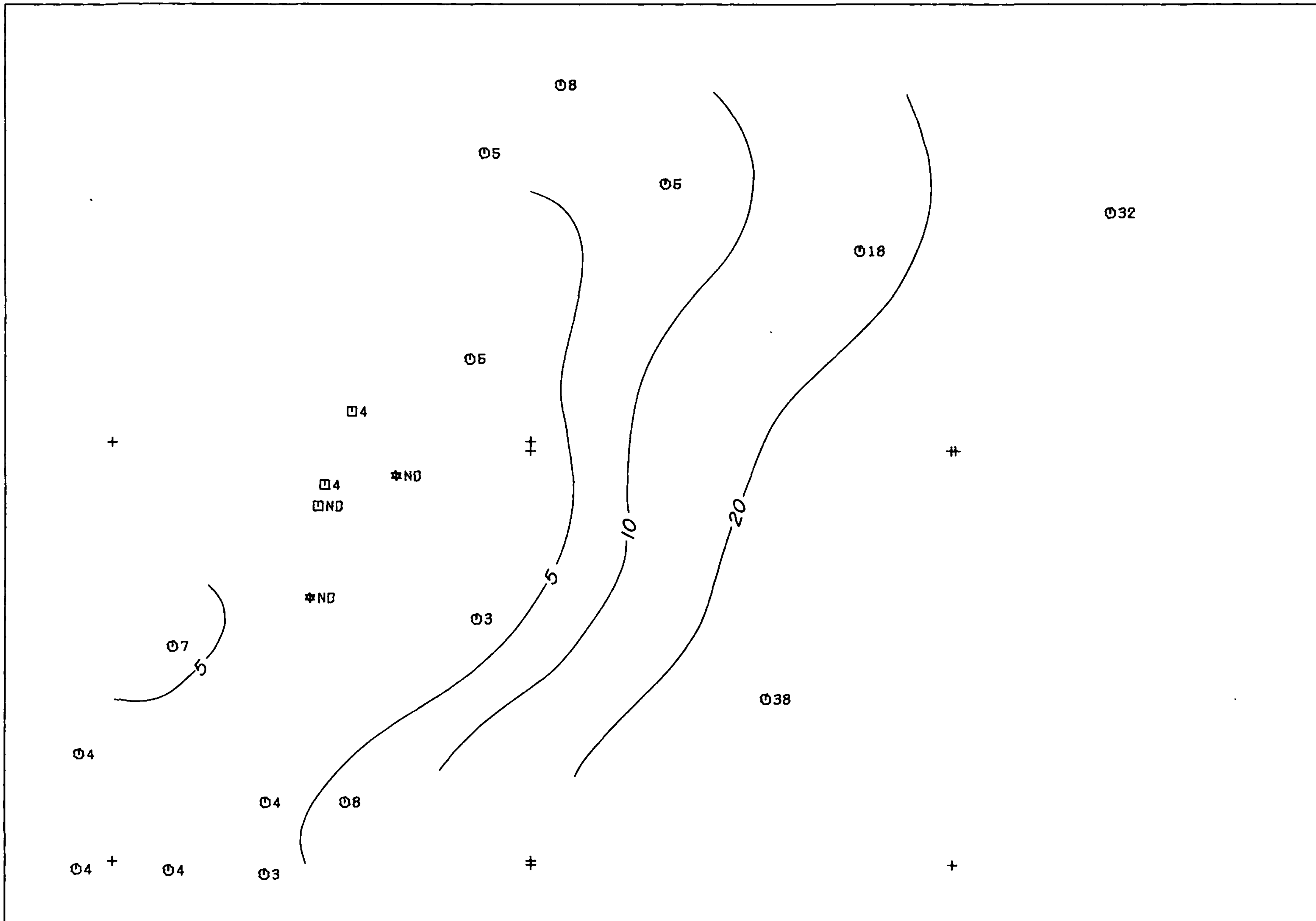


FIGURE: 23 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

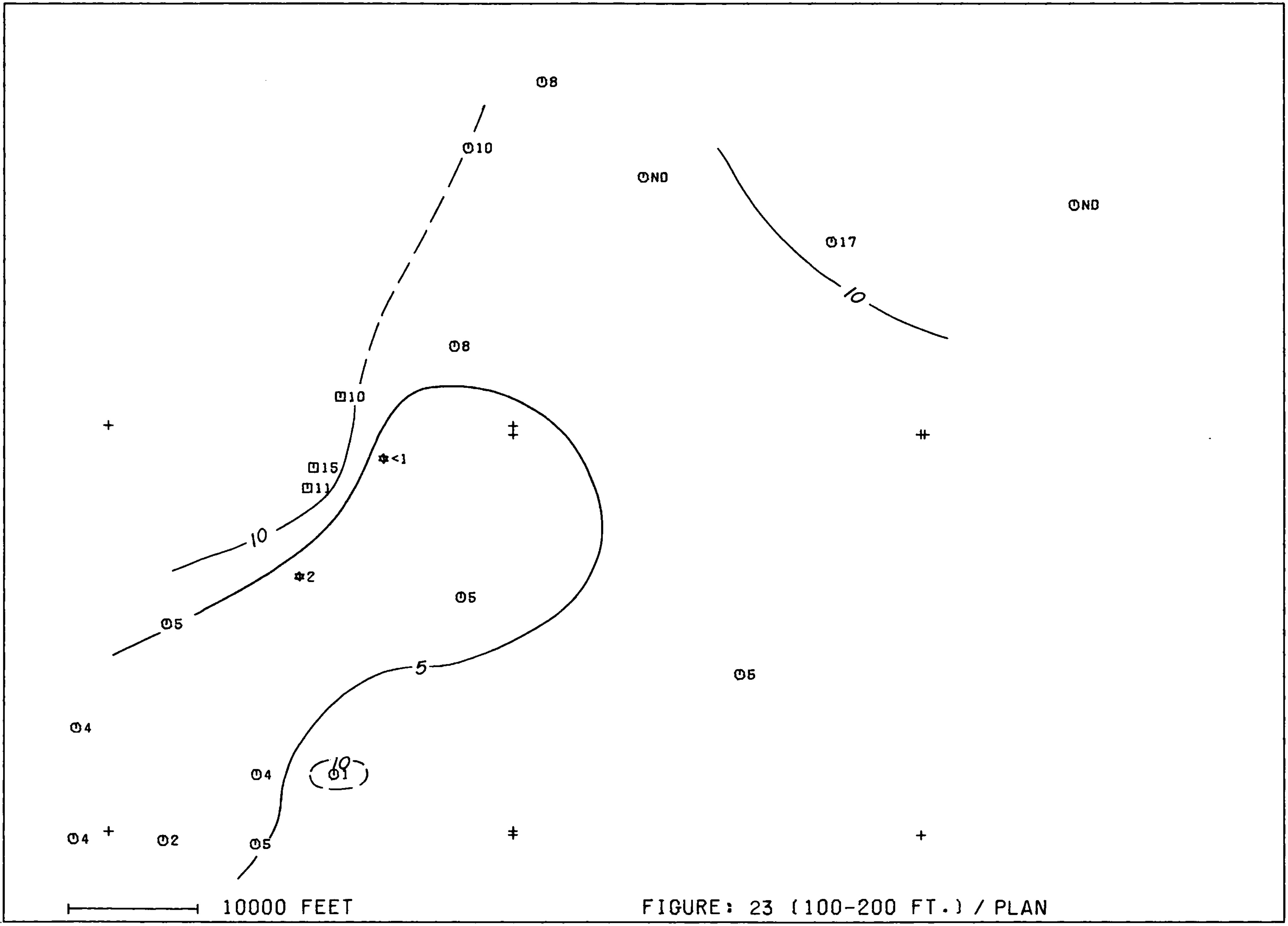
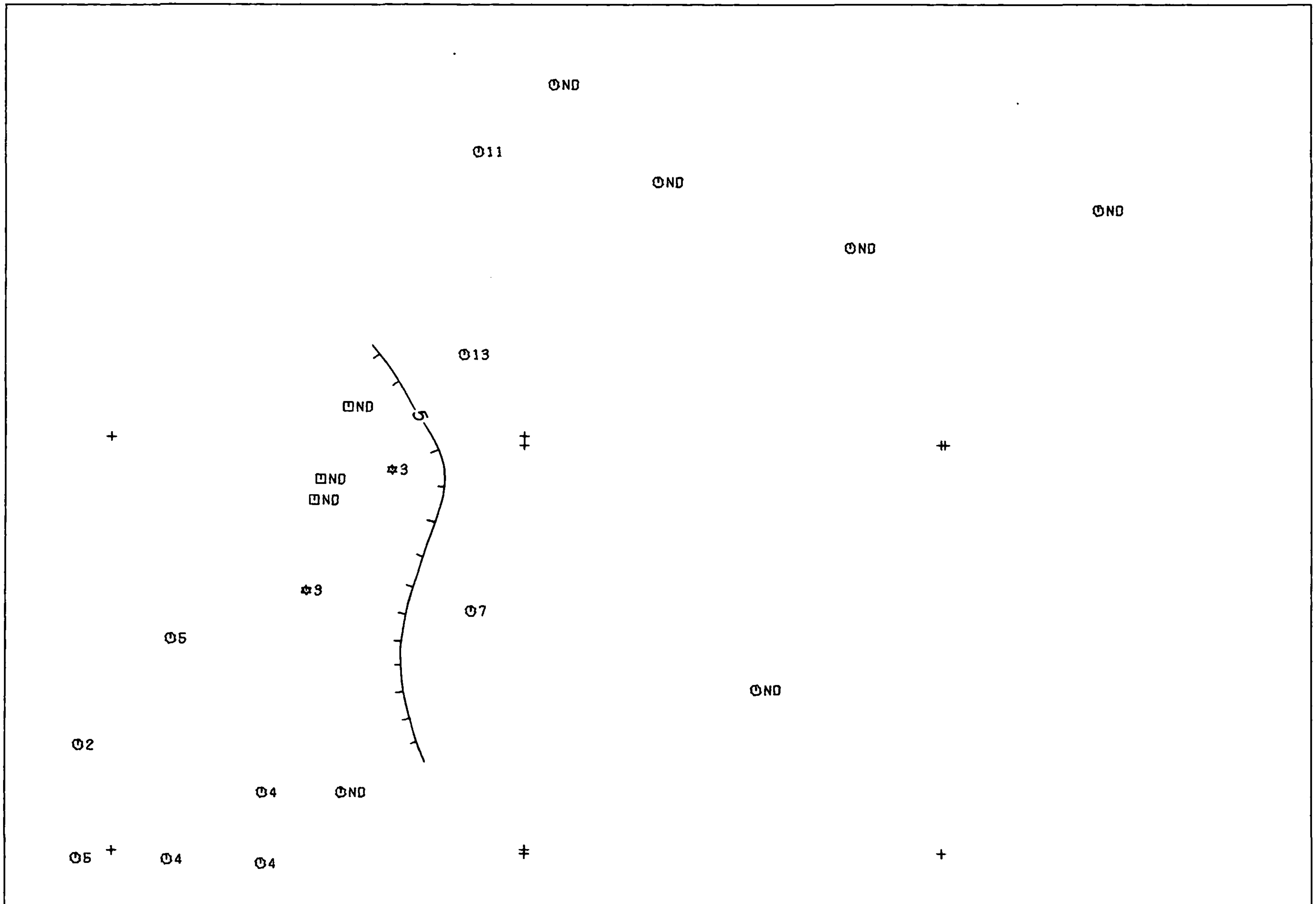


FIGURE: 23 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

COBALT (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

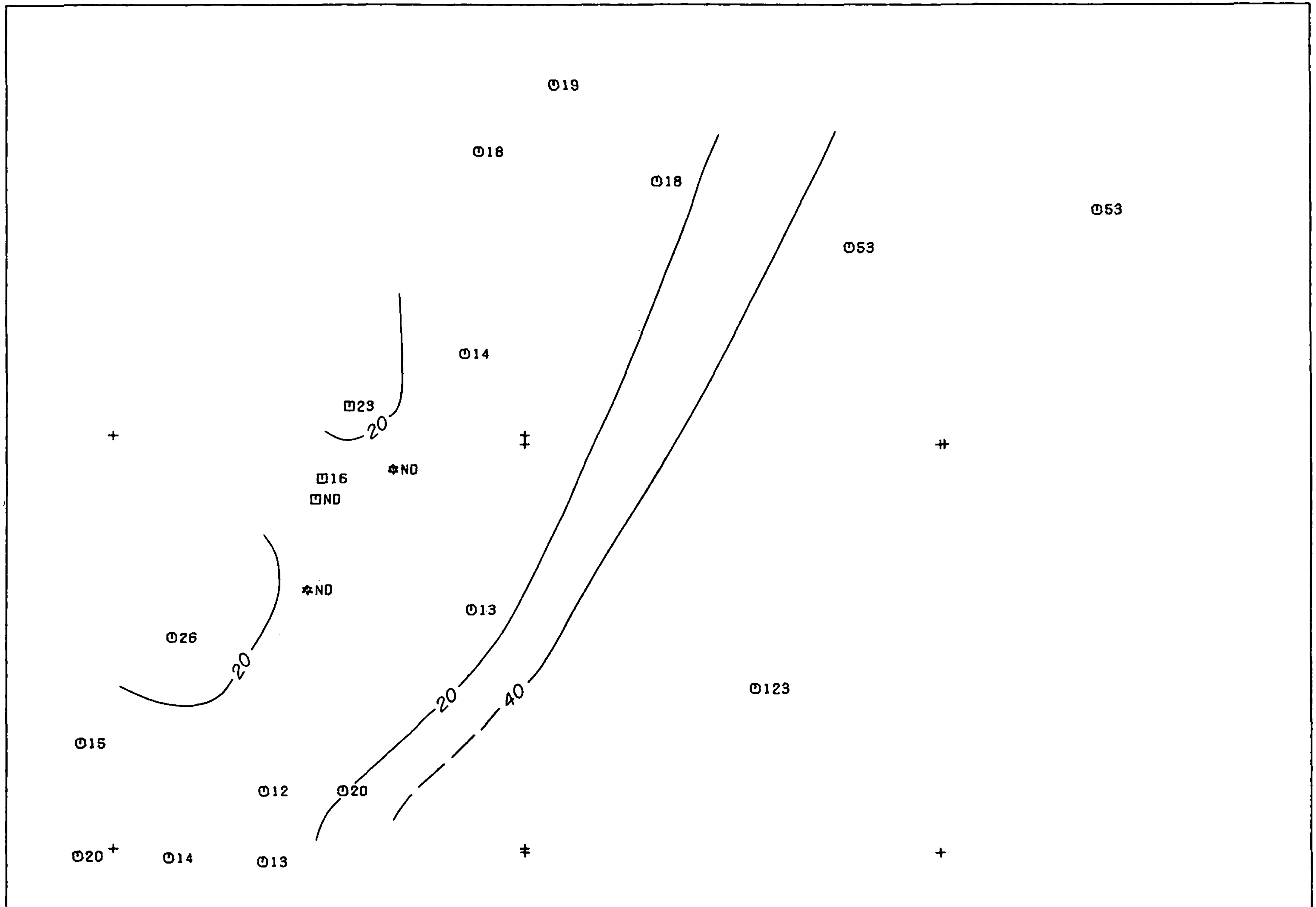


10000 FEET

FIGURE: 23 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY,UTAH

COBALT (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

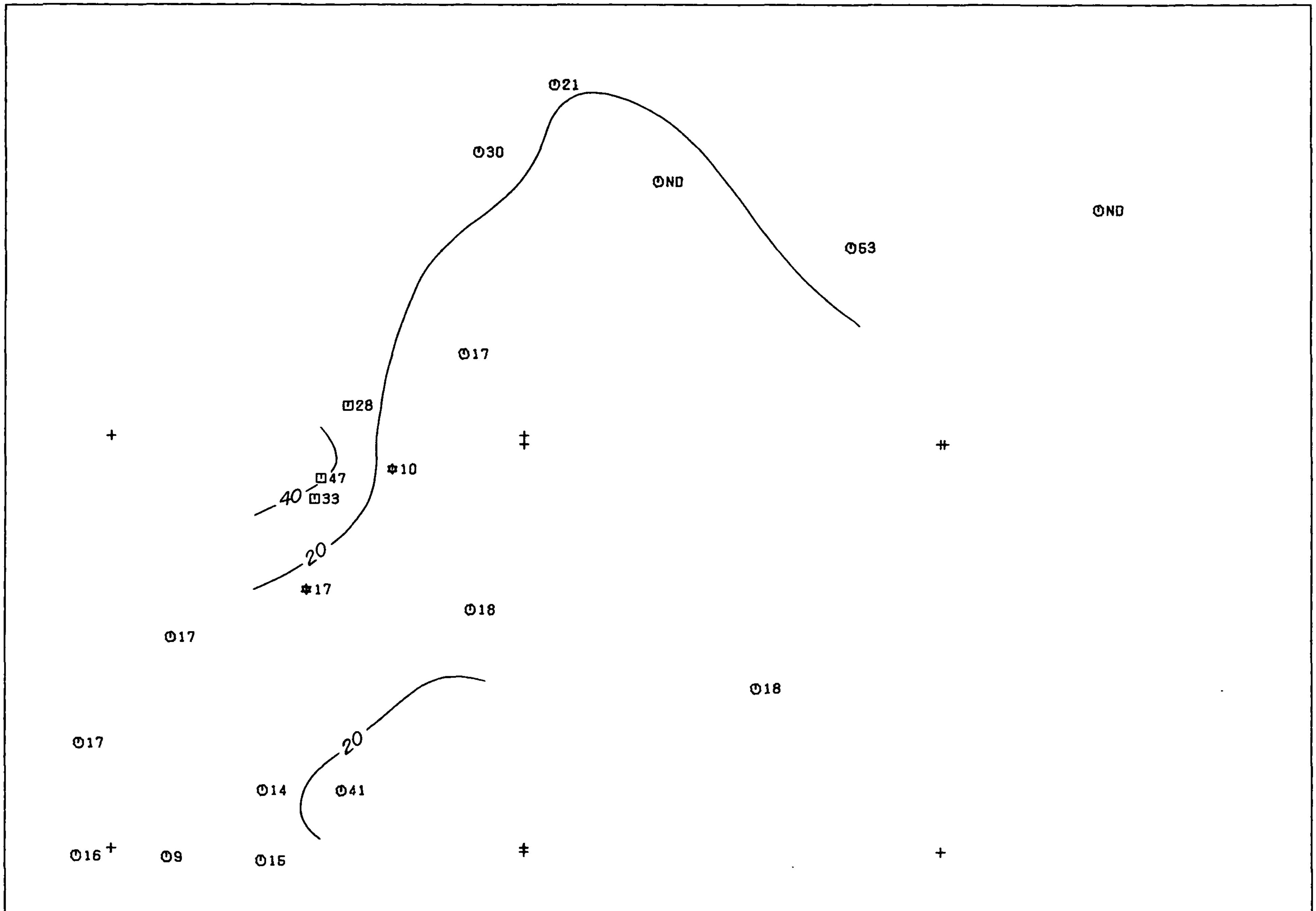


10000 FEET

FIGURE: 24 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 24 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY,UTAH

NICKEL (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

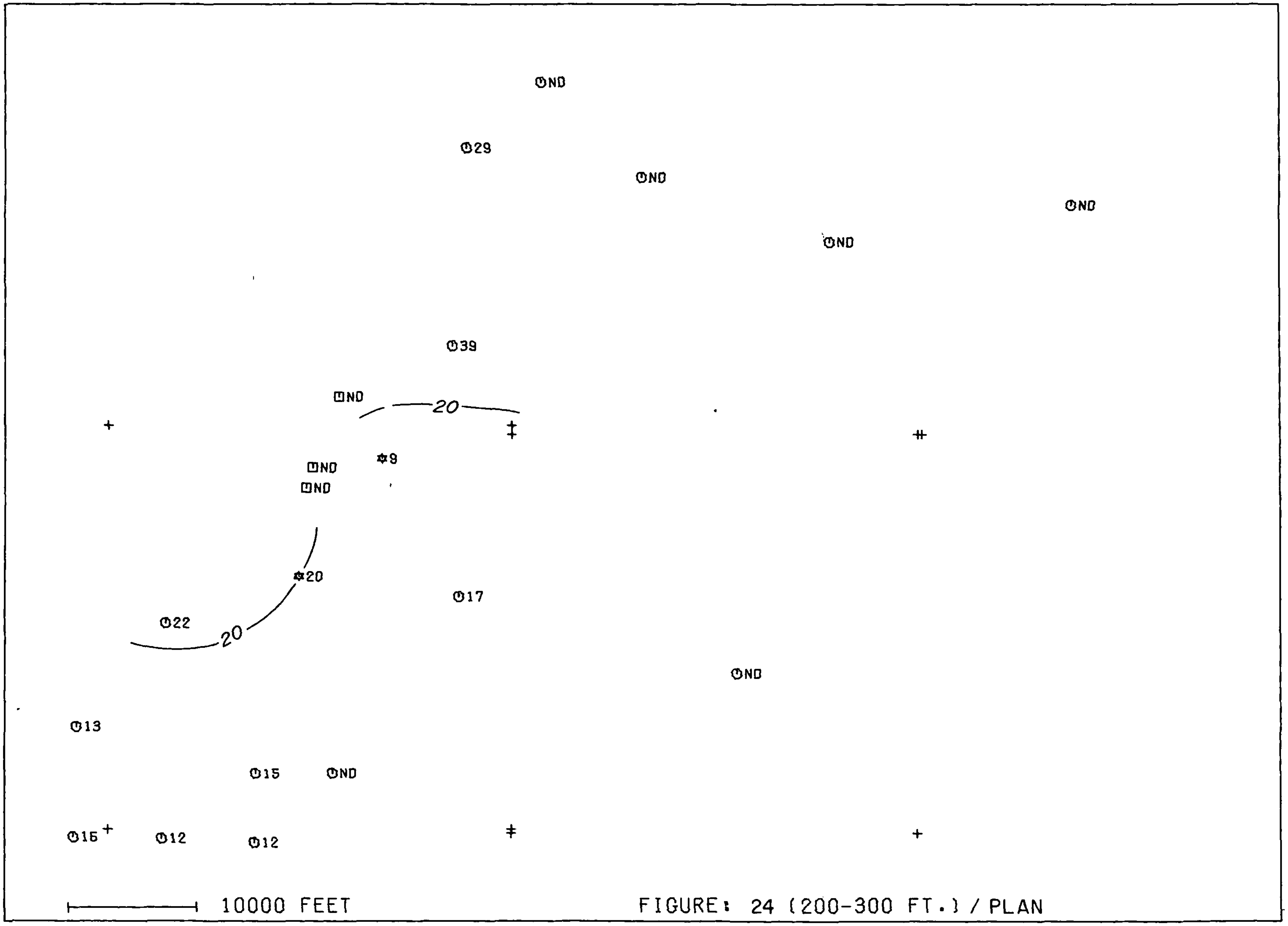
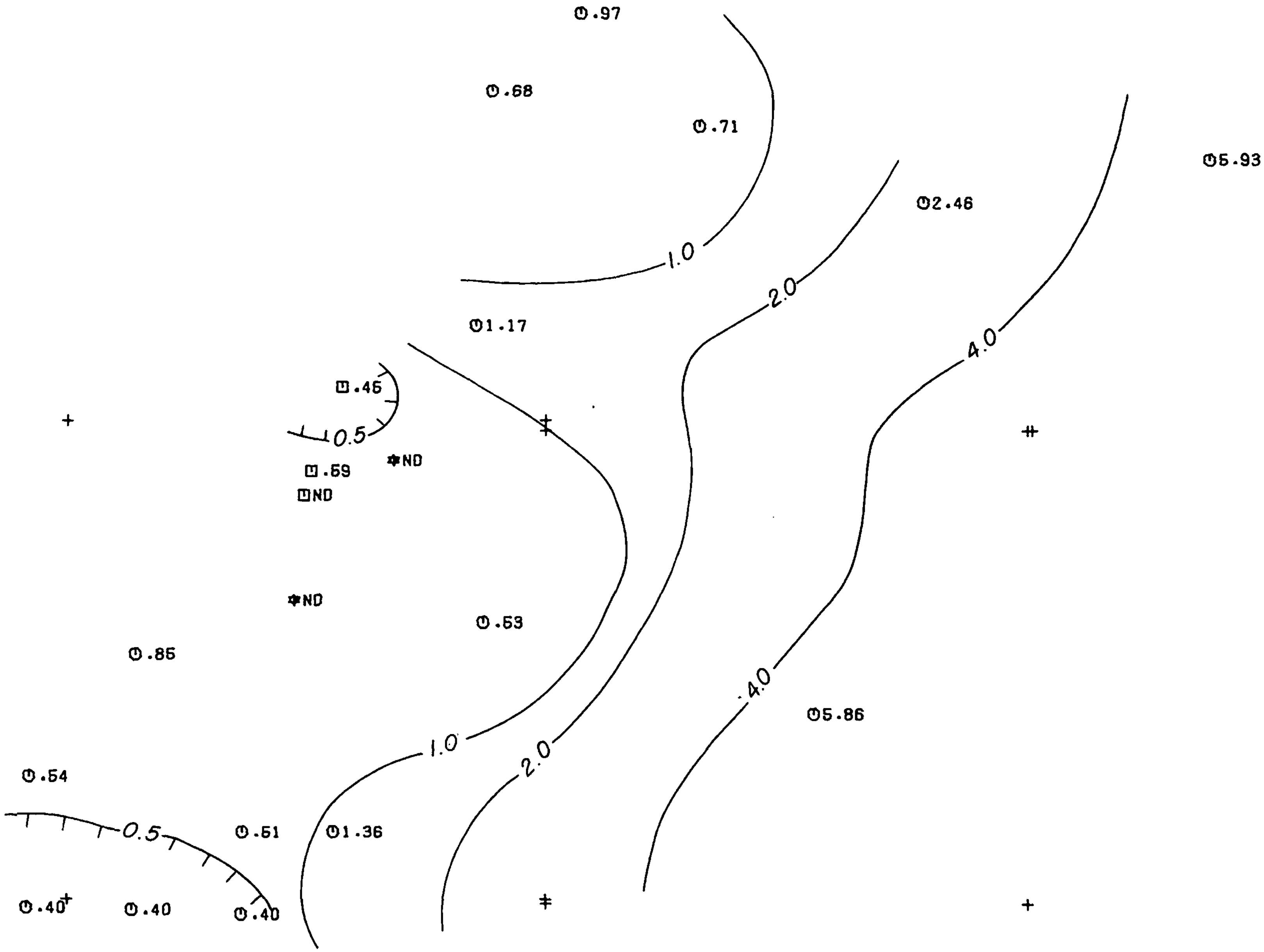


FIGURE: 24 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

NICKEL (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

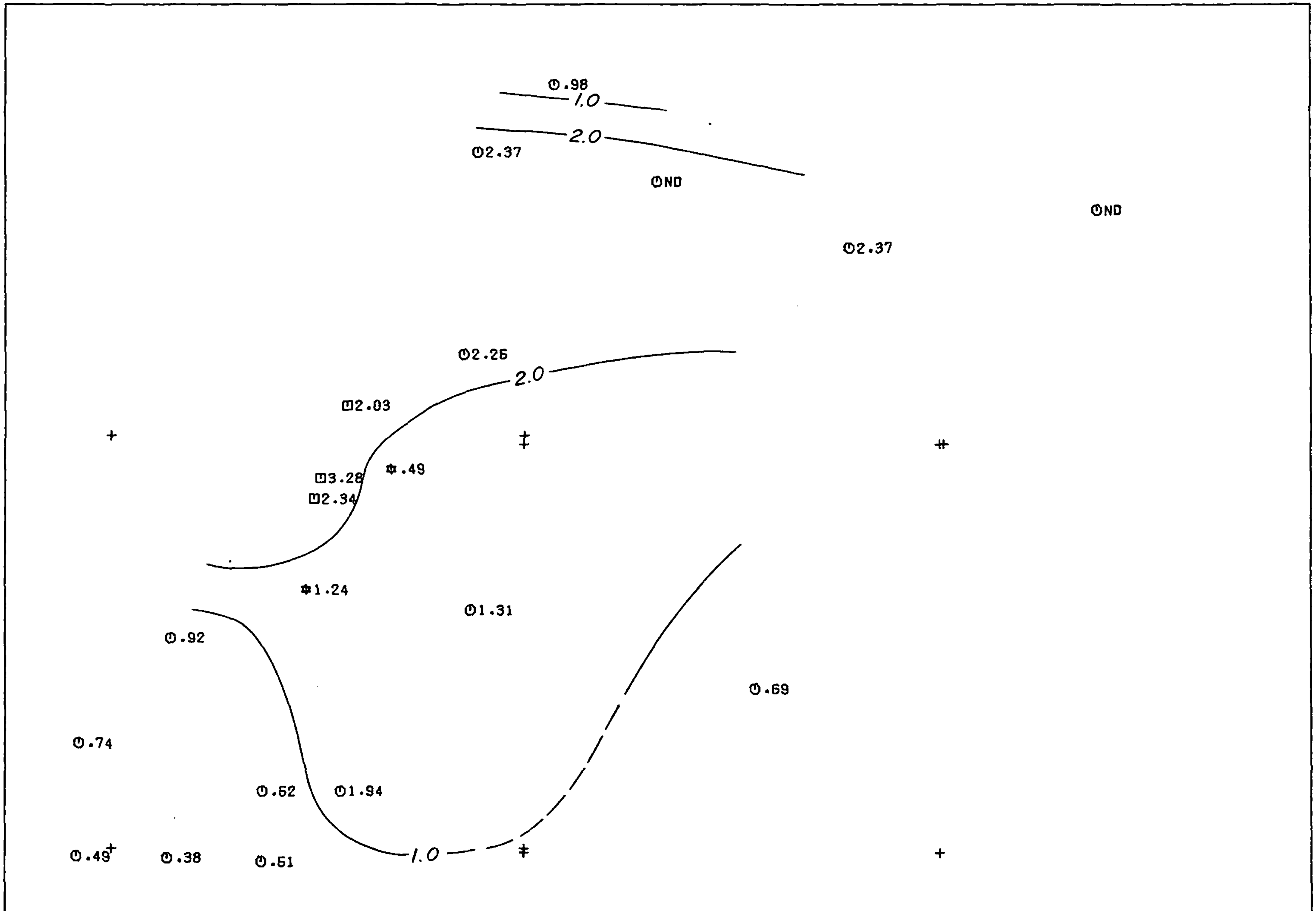


10000 FEET

FIGURE: 25 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS



10000 FEET

FIGURE: 25 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

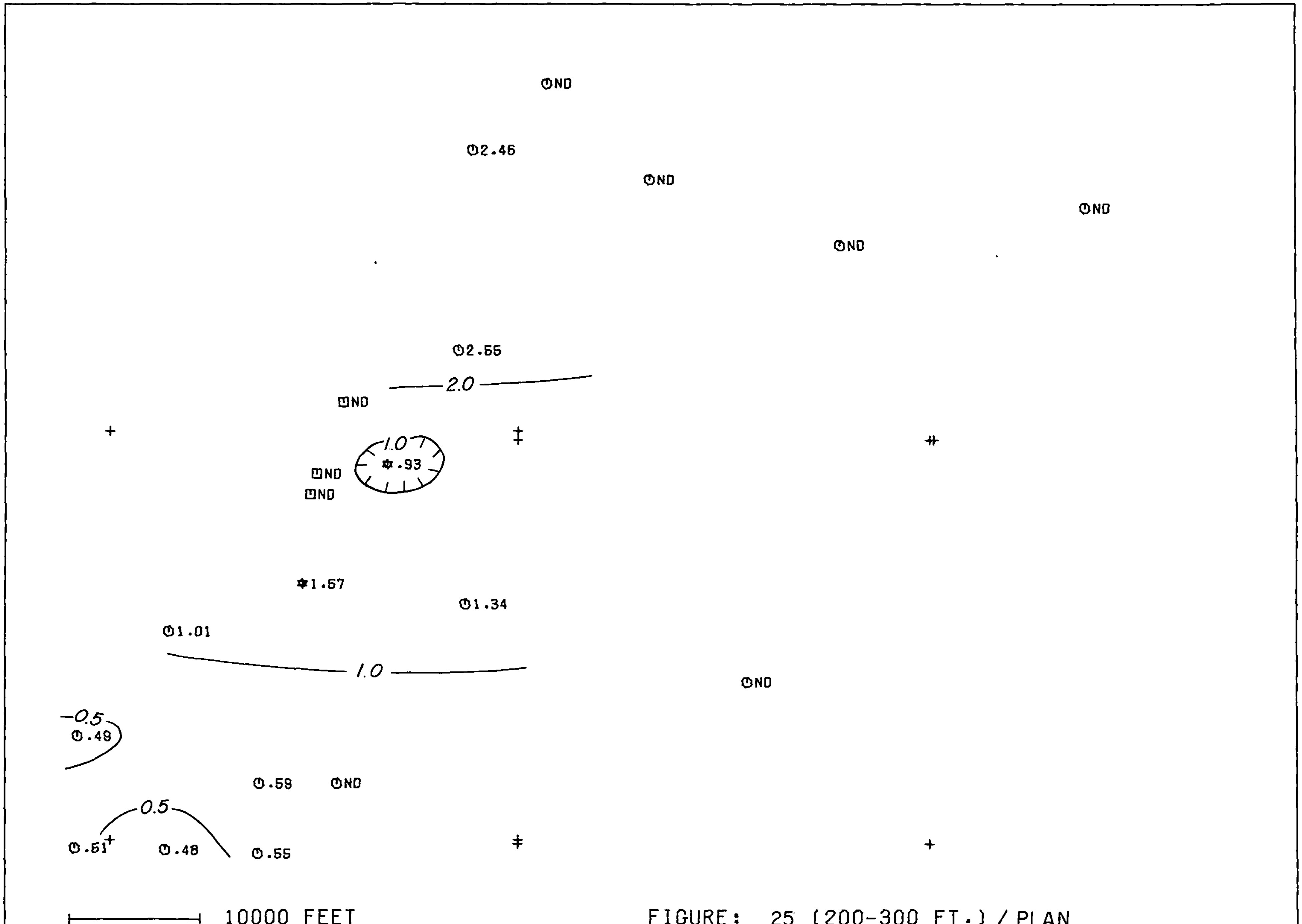


FIGURE: 25 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

IRON (%) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: AAS

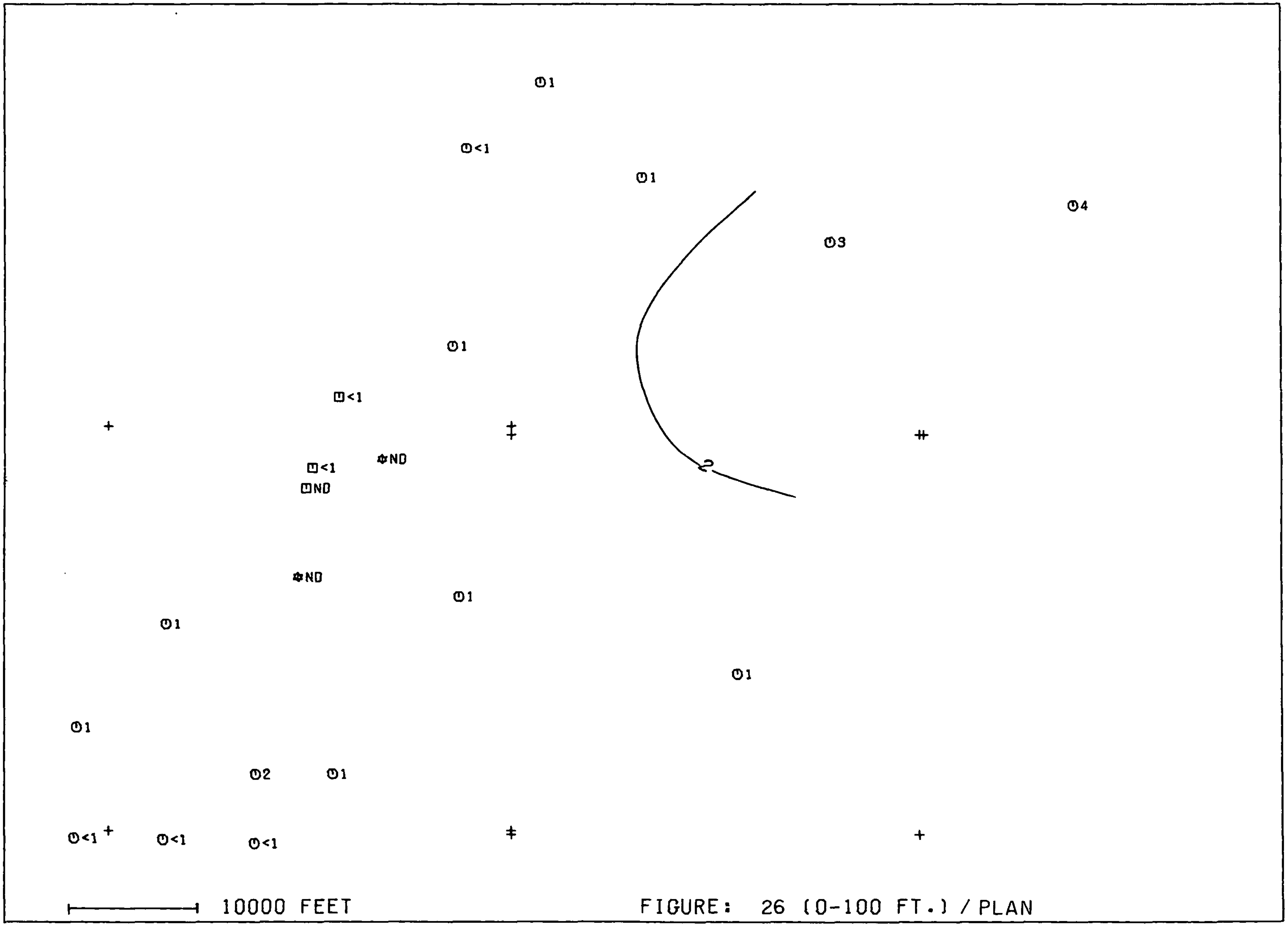
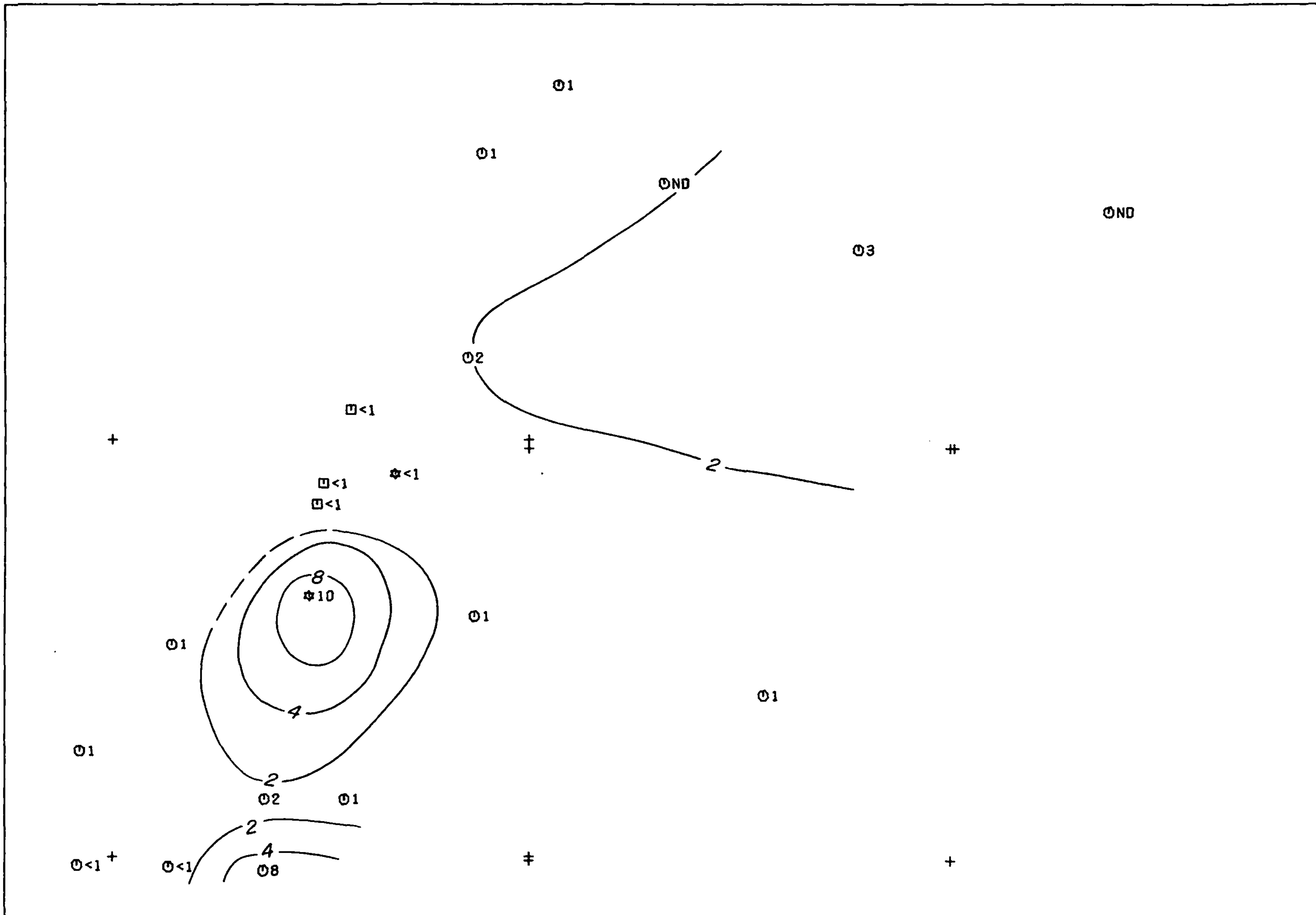


FIGURE: 26 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY,UTAH

INDIUM (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES



10000 FEET

FIGURE: 26 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

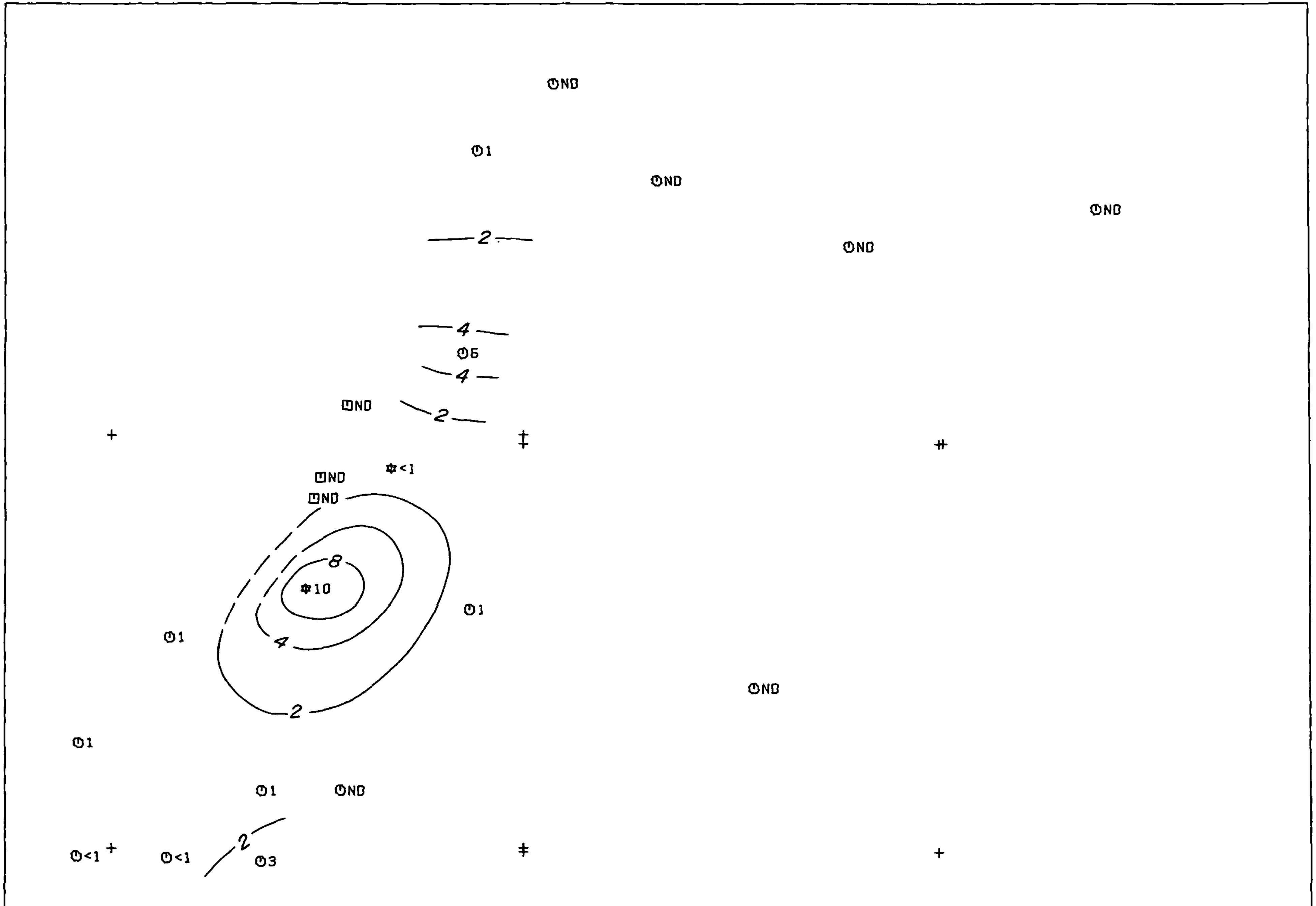


FIGURE: 26 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

INDIUM (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

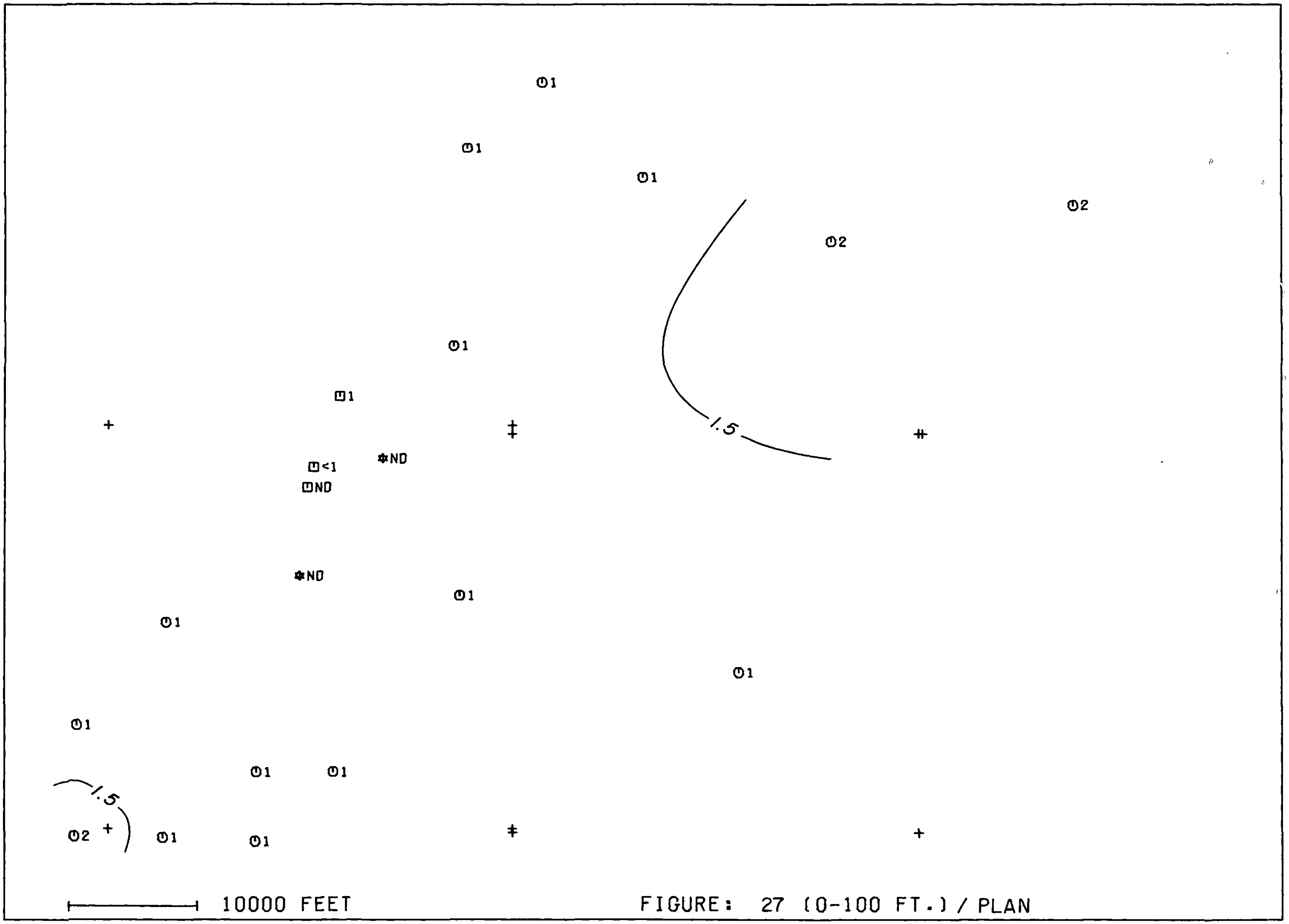
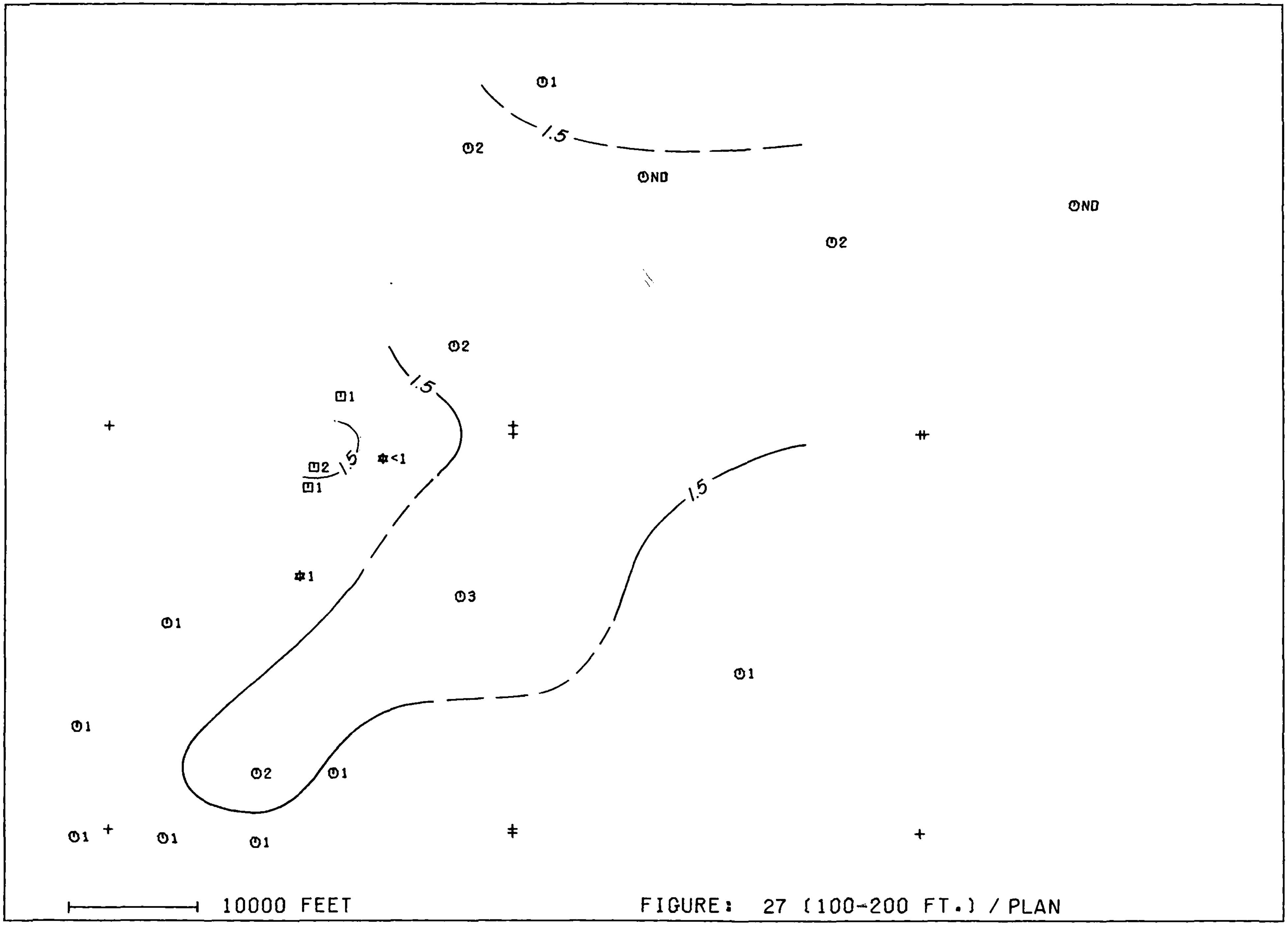


FIGURE: 27 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

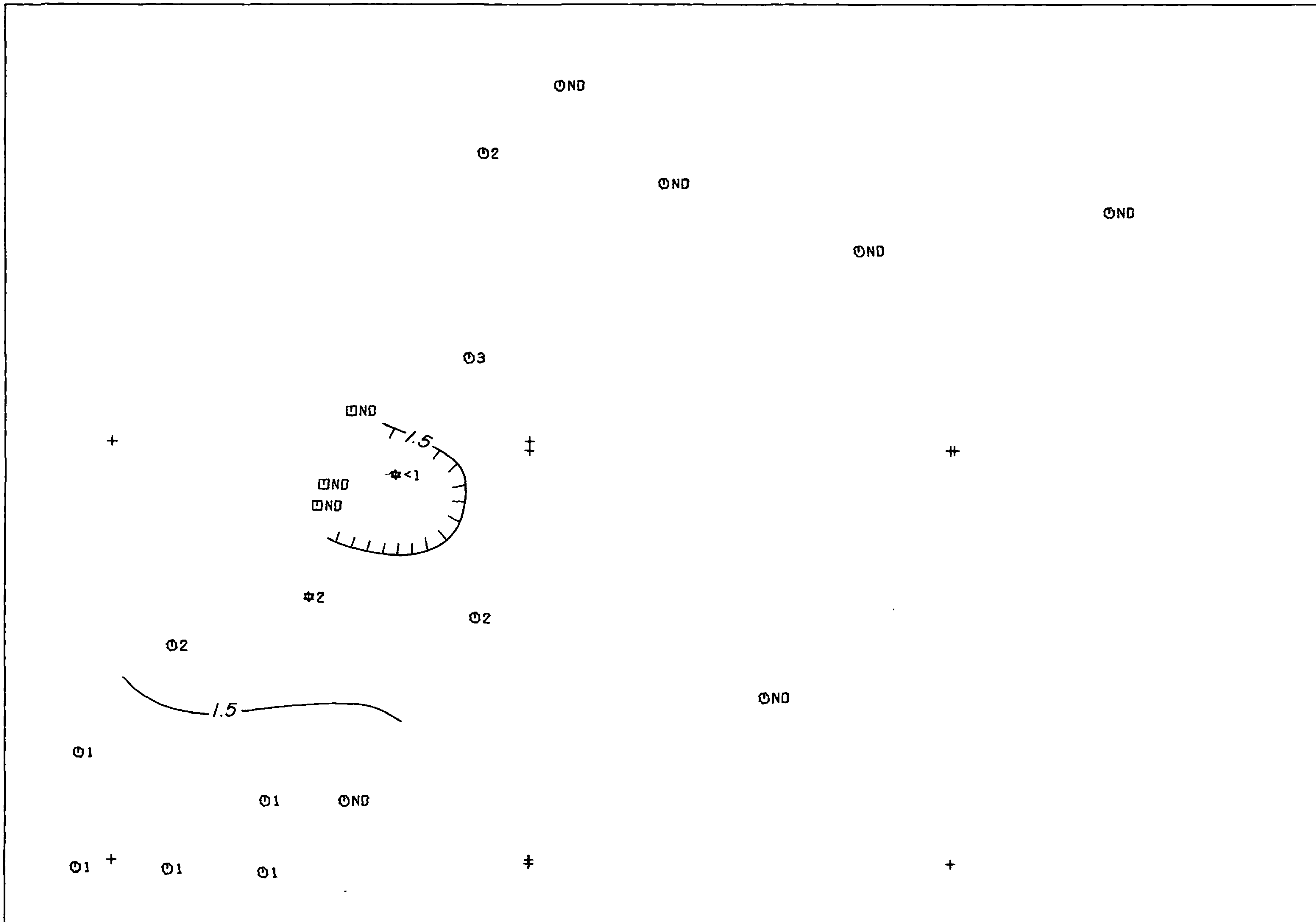
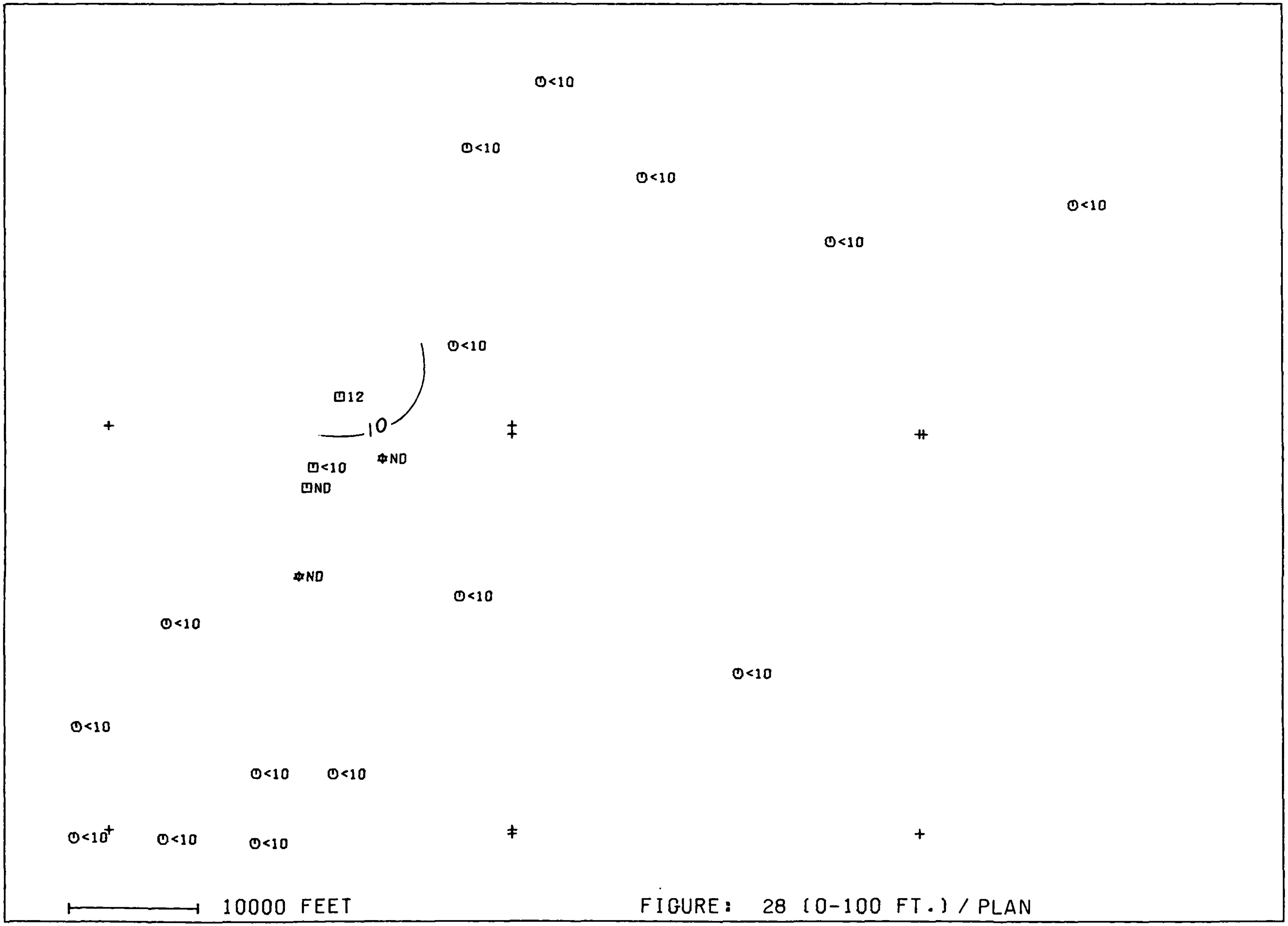


FIGURE: 27 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TIN (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 0-100 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

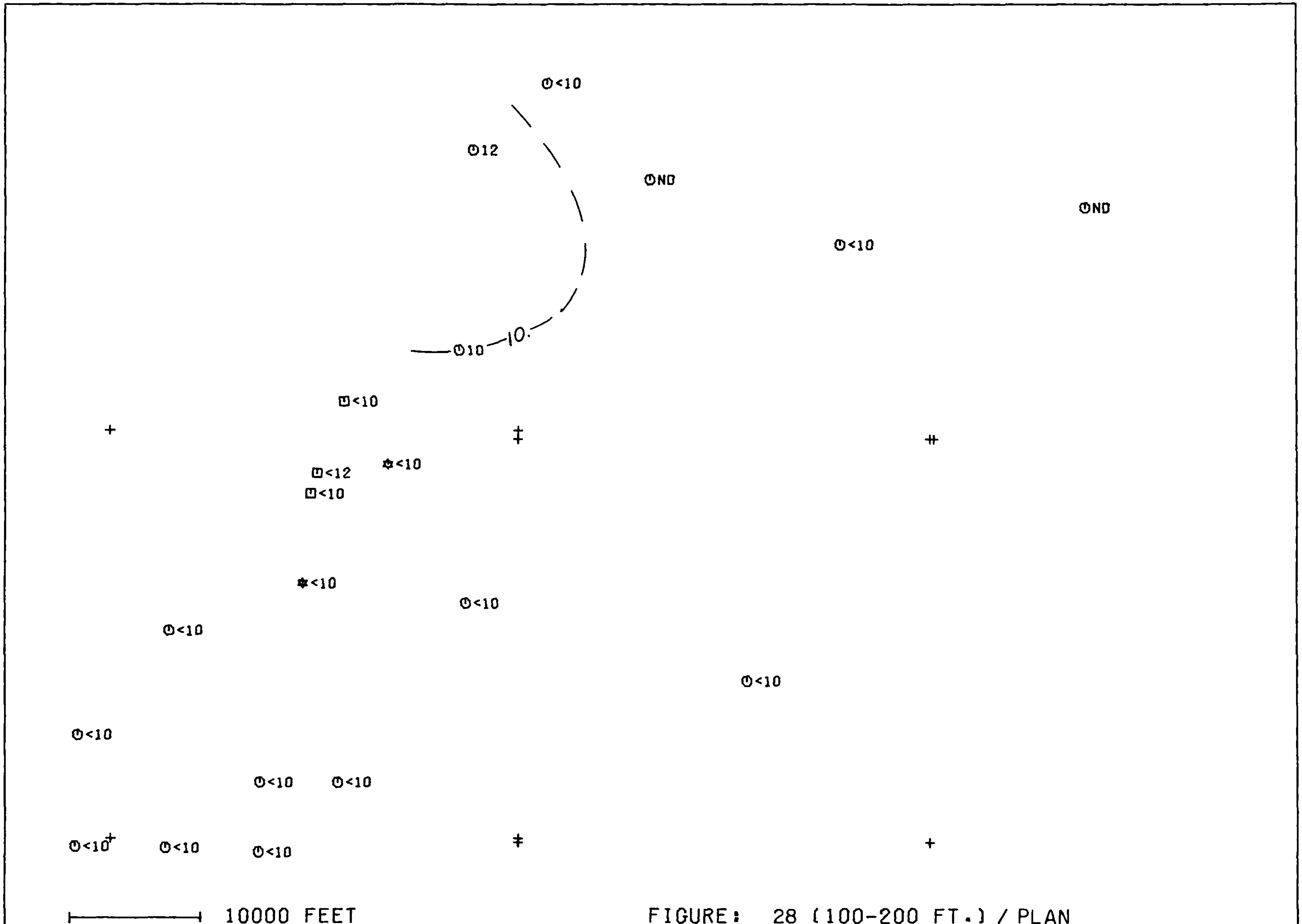
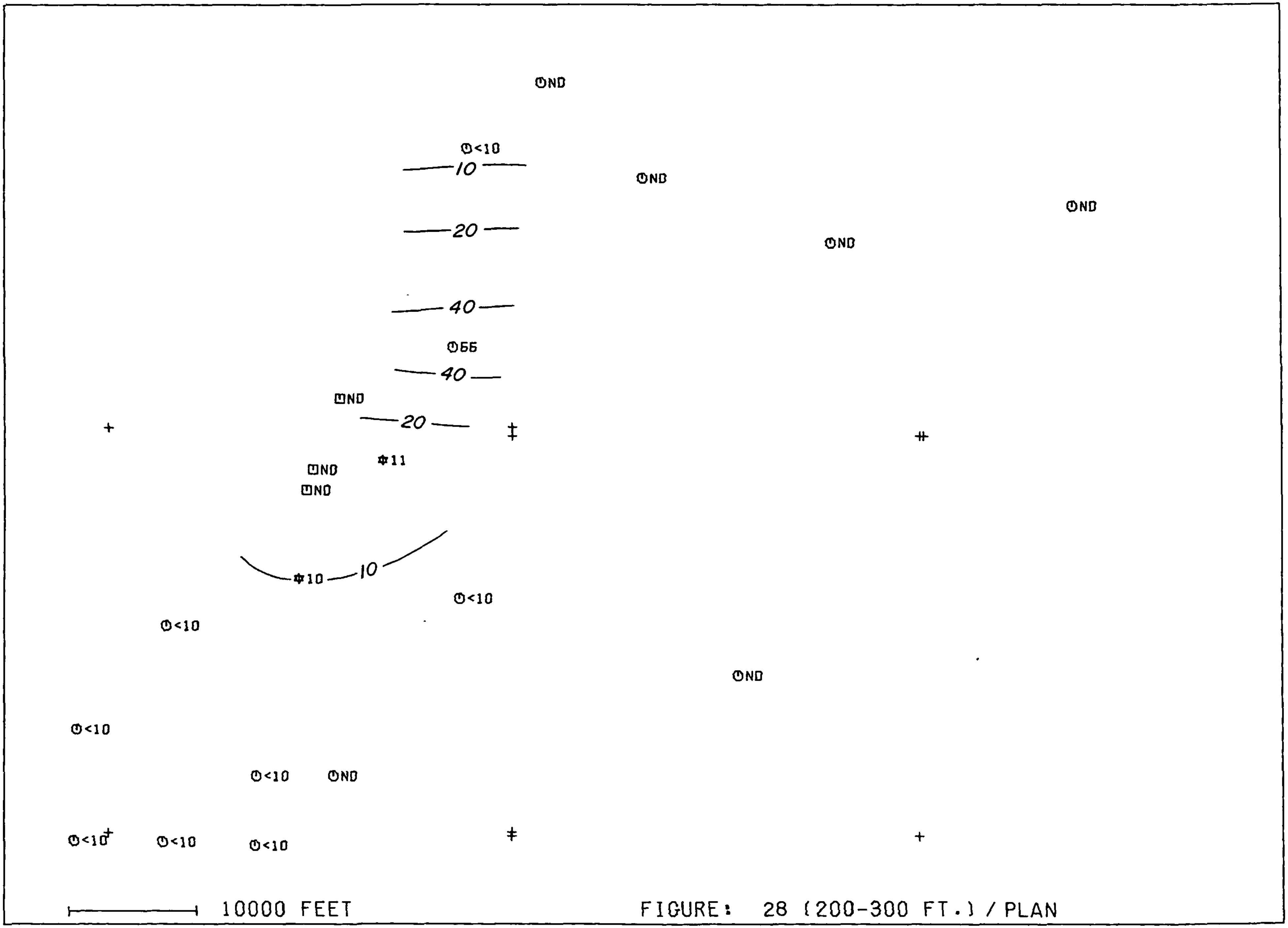


FIGURE: 28 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 100-200 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

TUNGSTEN (PPM) 200-300 FT.
SAMPLE TYPE: WHOLE ROCK
ANALYTICAL METHOD: OES

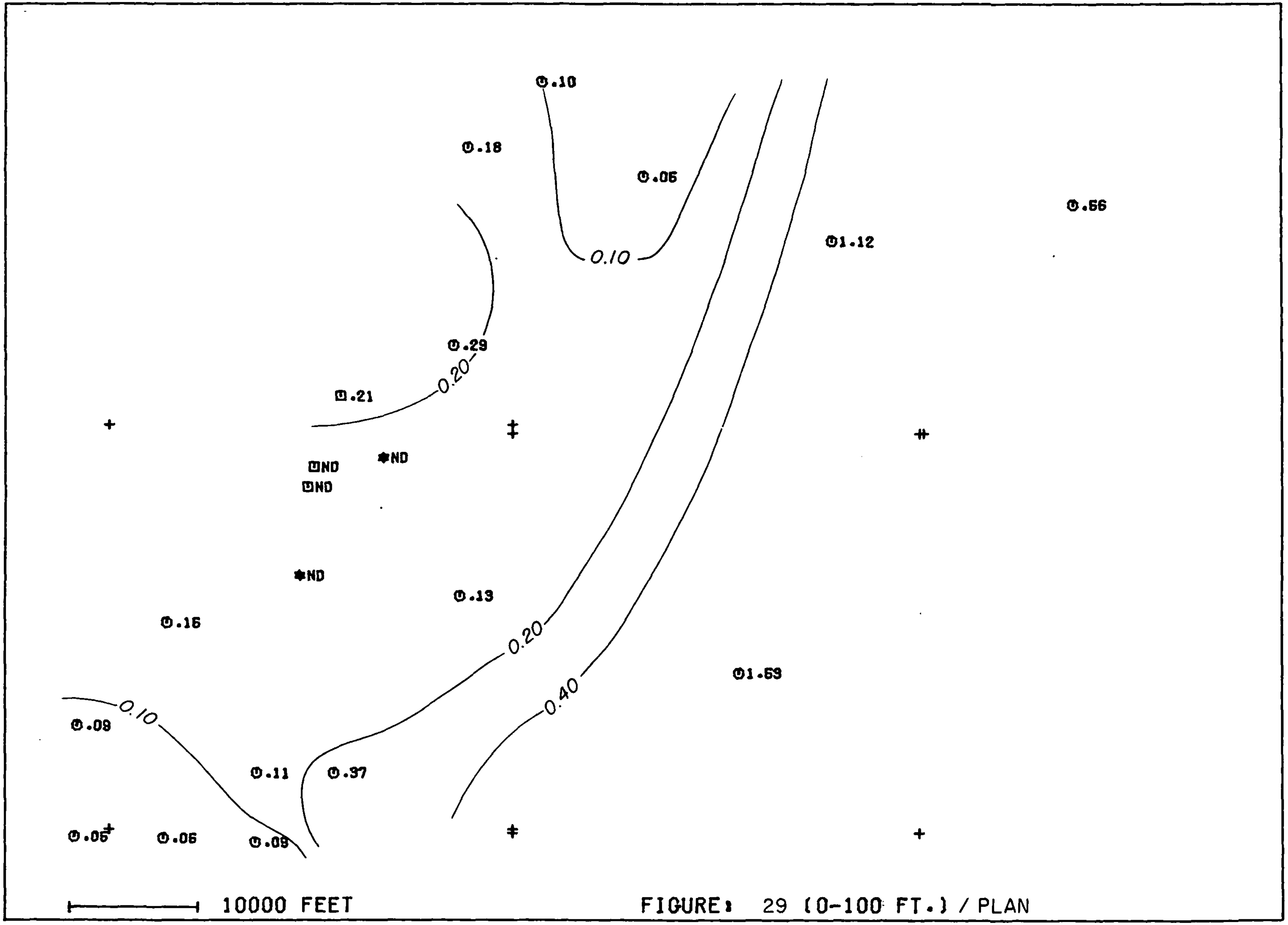
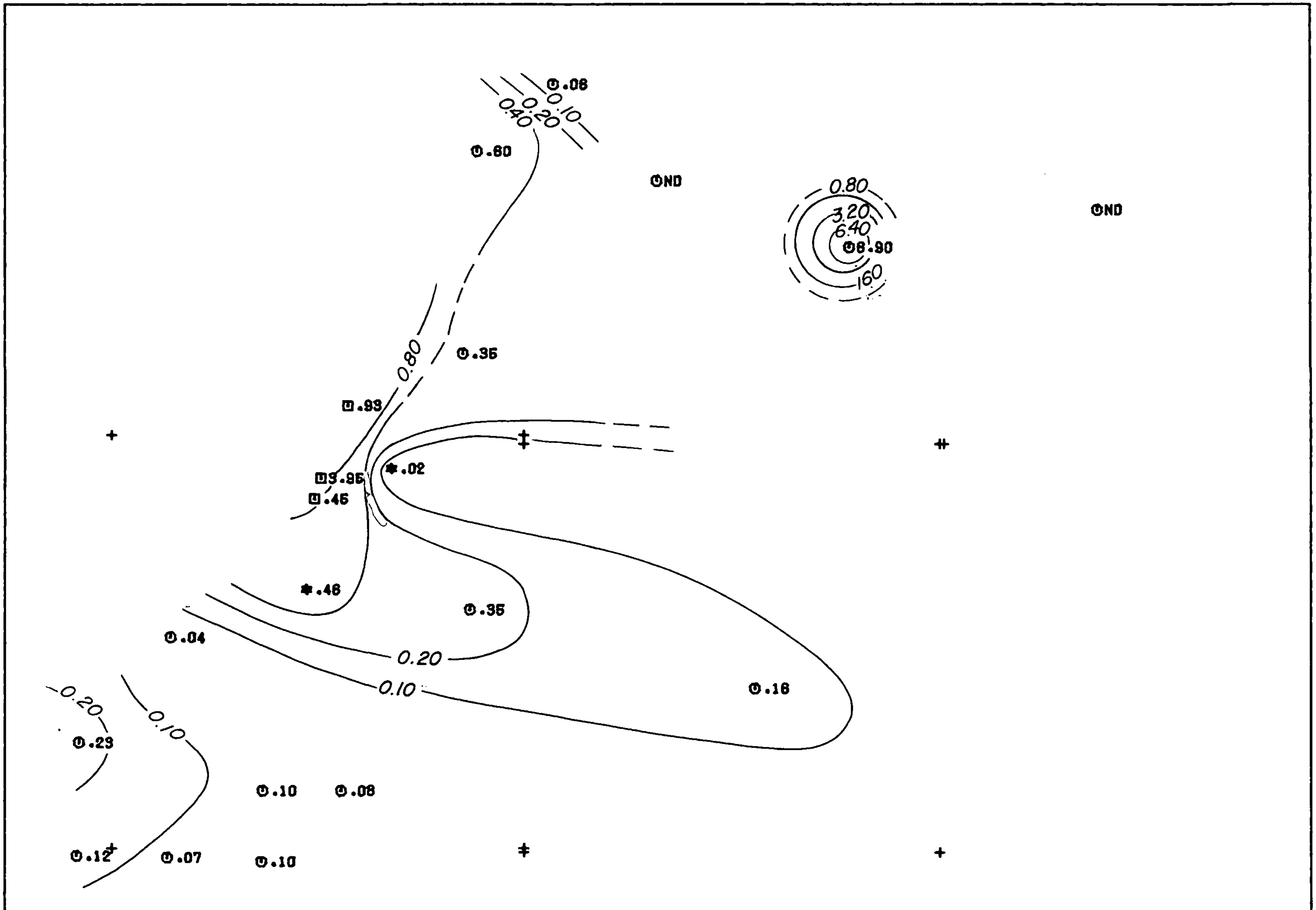


FIGURE: 29 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.3 LESS MAG 0-100 FT.

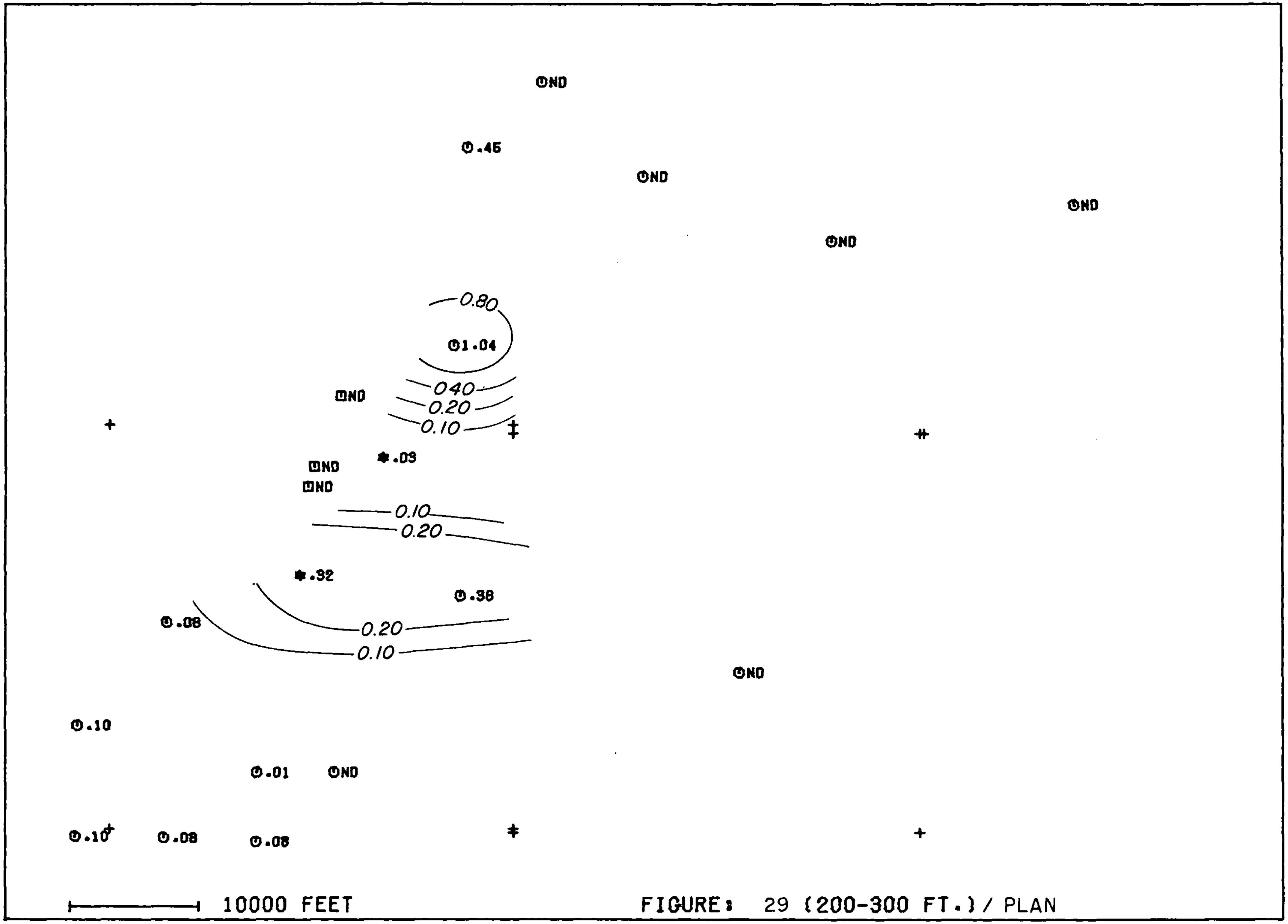


10000 FEET

FIGURE: 29 (100-200 FT.) / PLAN

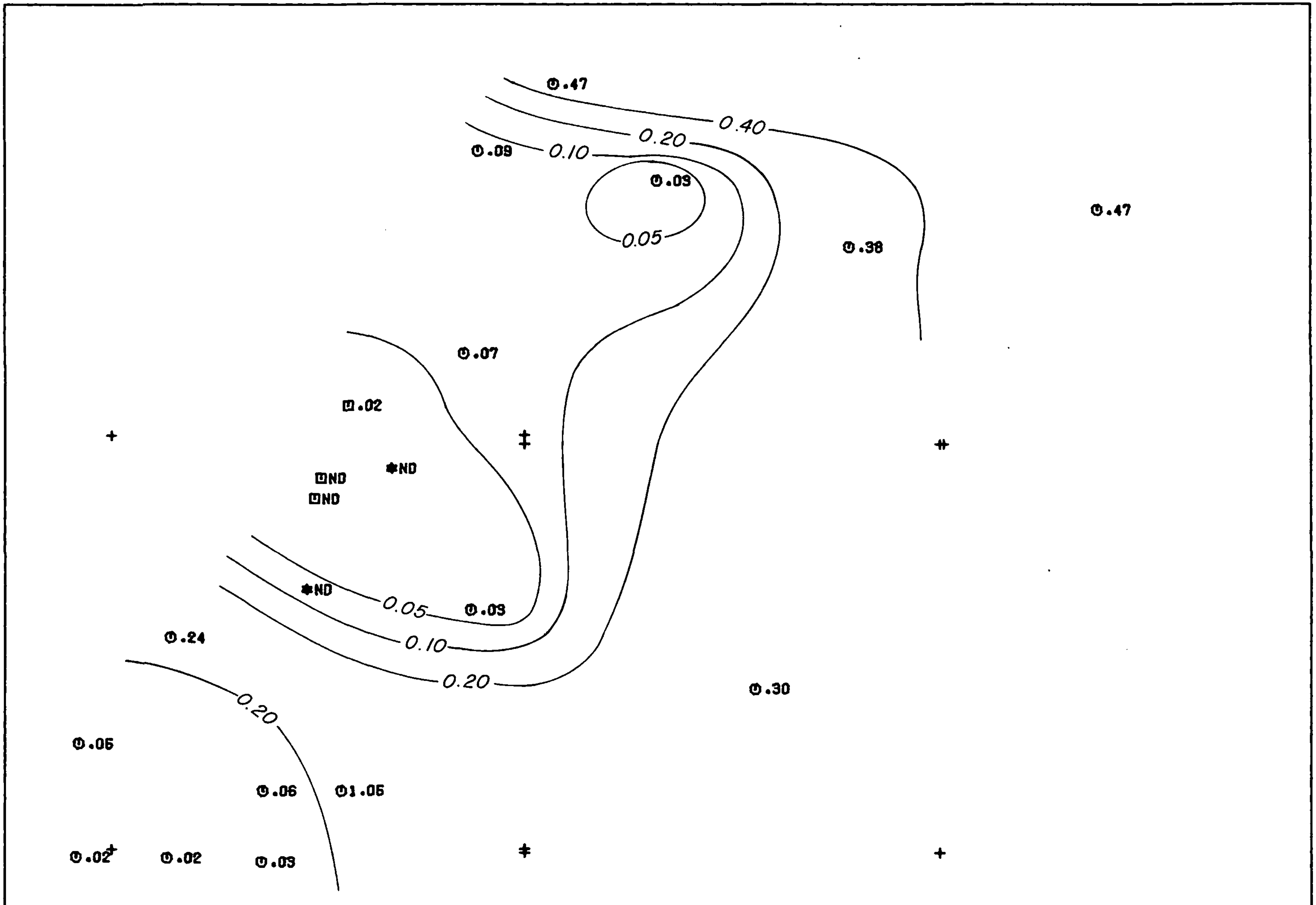
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.3 LESS MAG 100-200 FT.



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.3 LESS MAG 200-300 FT.

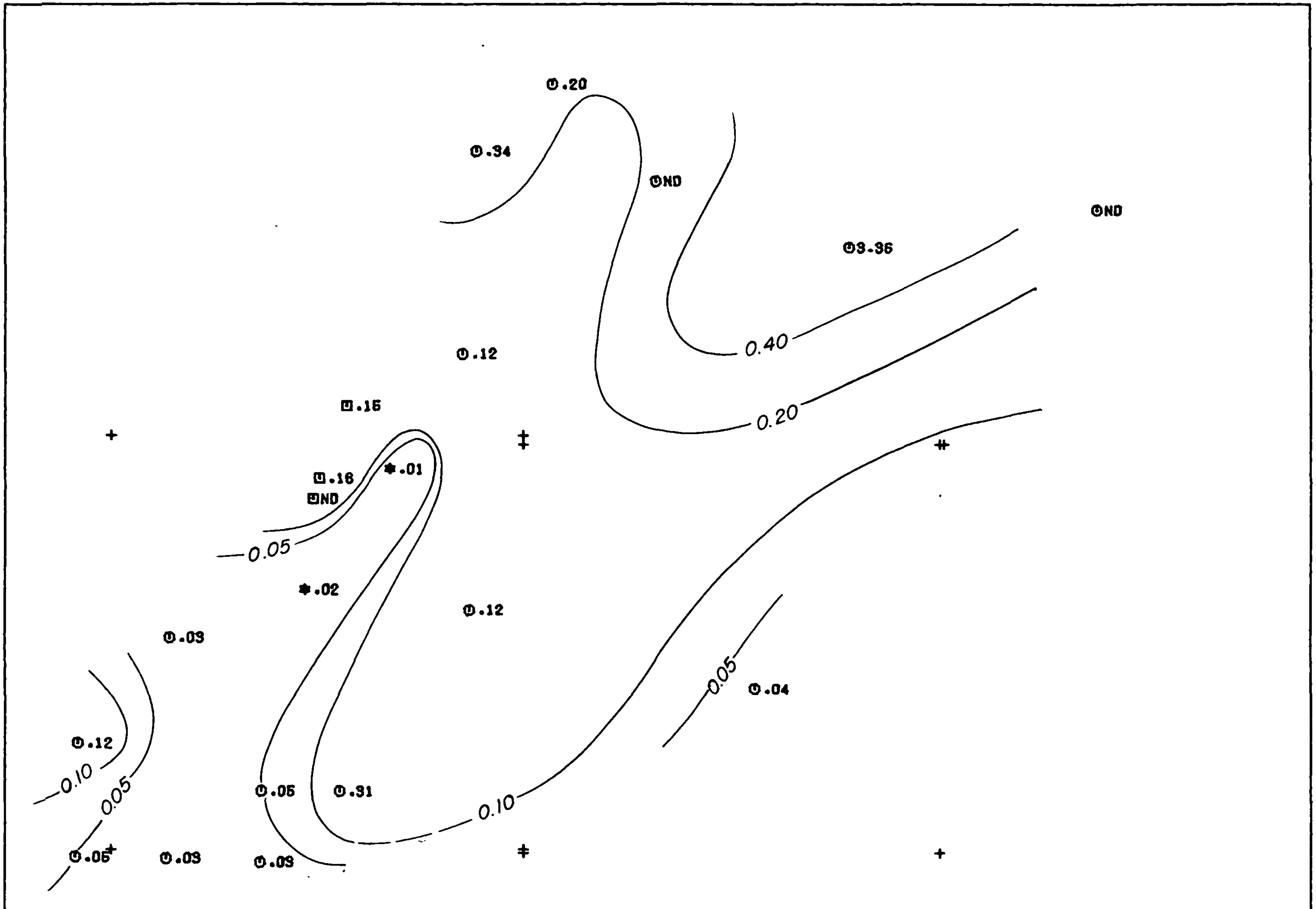


10000 FEET

FIGURE: 30 (0-100 FT.) / PLAN

WT % +3.0-3.3 LESS MAG 0-100 FT.

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

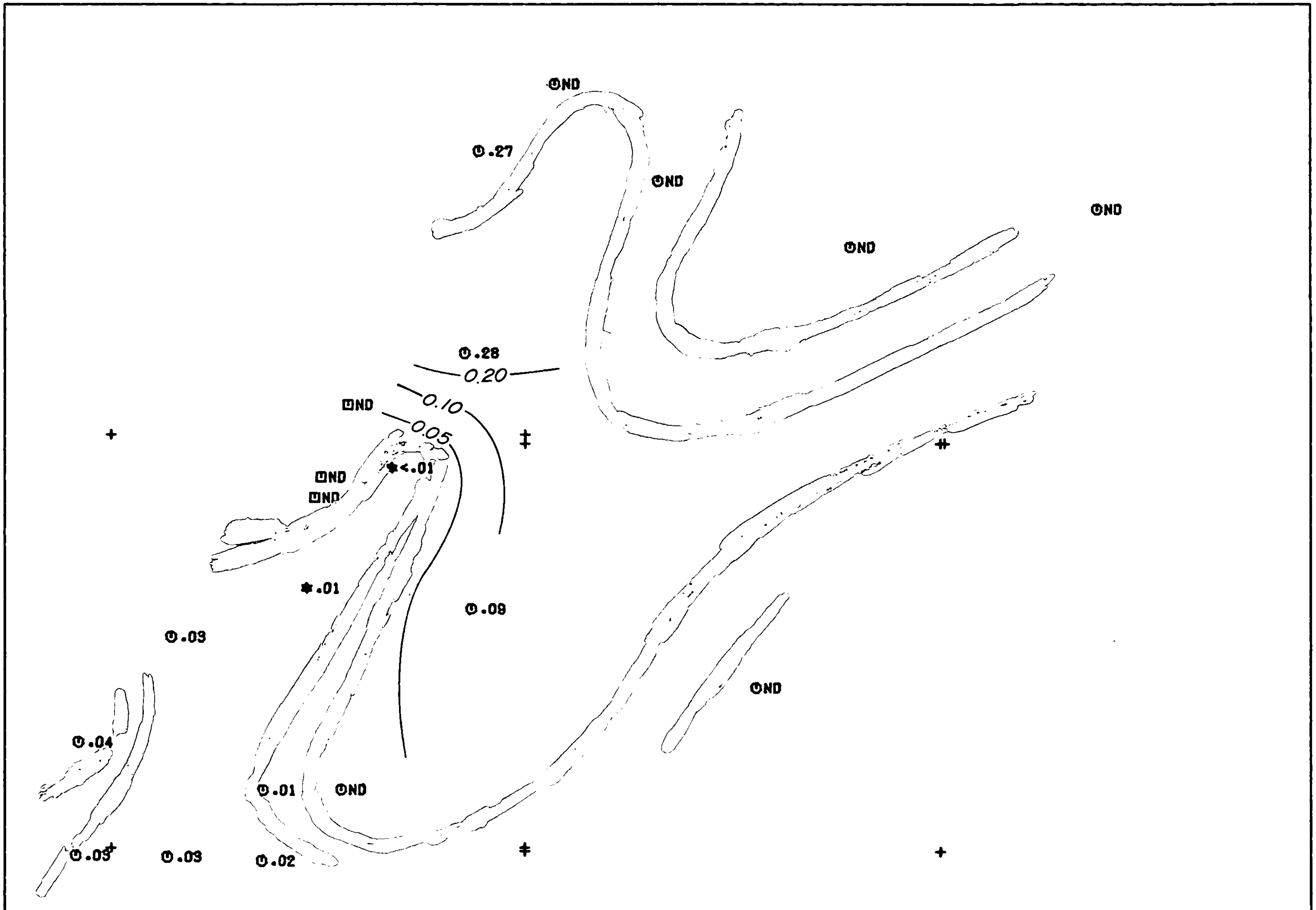


10000 FEET

FIGURE: 30 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.0-3.3 LESS MAG 100-200 FT.

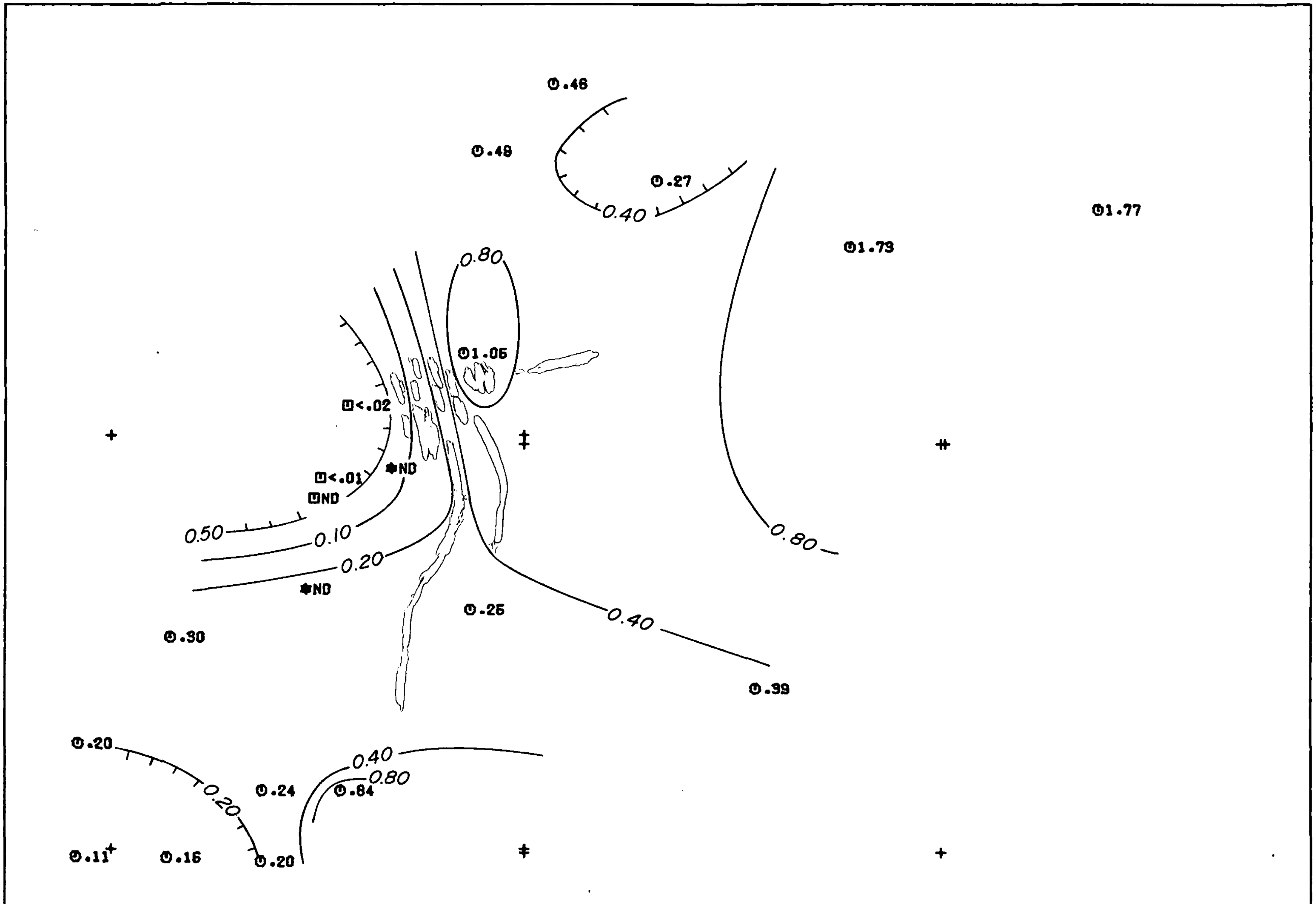


10000 FEET

FIGURE: 30 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % +3.0-3.3 LESS MAG 200-300 FT.



10000 FEET

FIGURE: 31 (0-100 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % MAG FRACTION 0-100 FT.

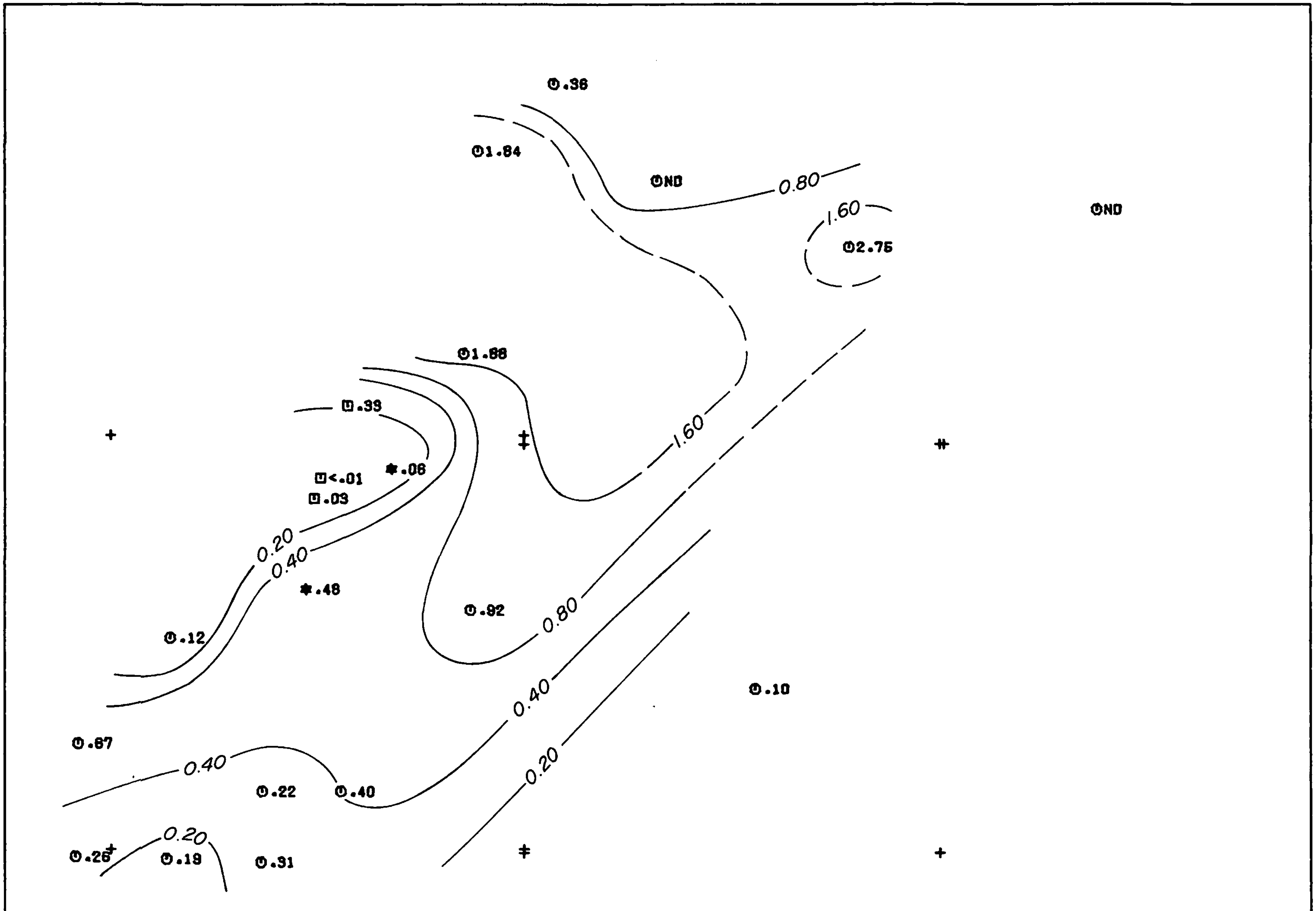
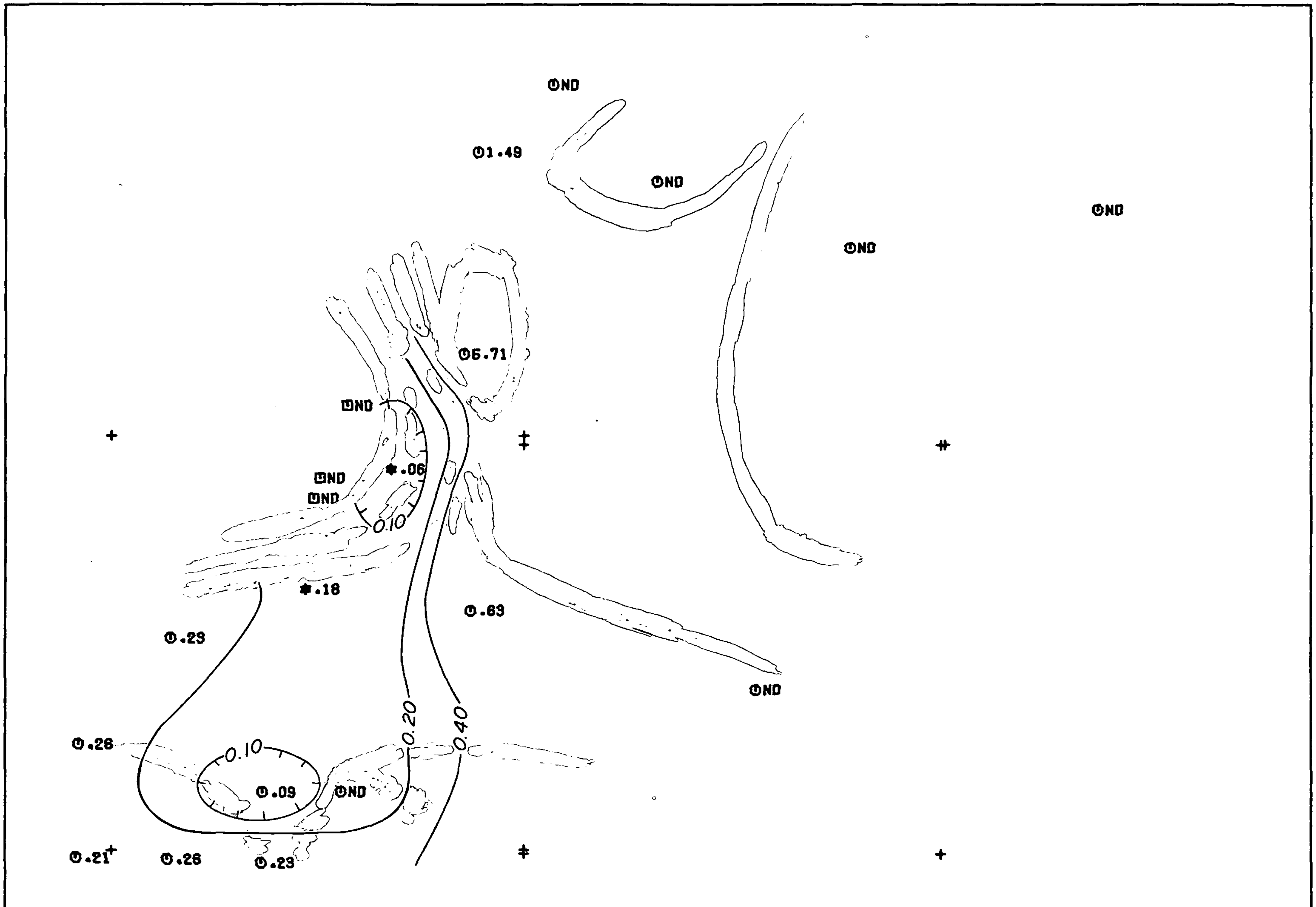


FIGURE: 31 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % MAG FRACTION 100-200 FT.

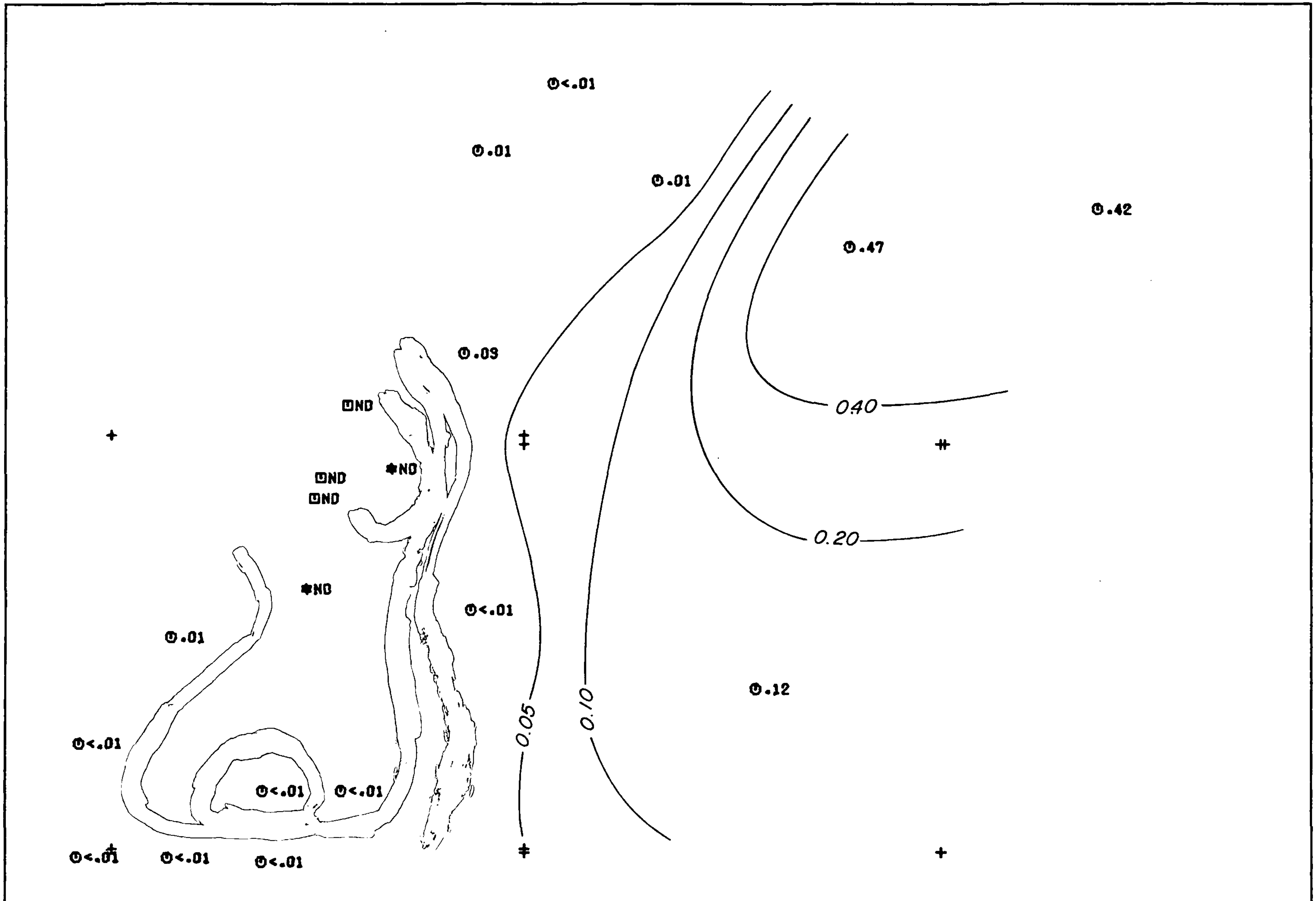


10000 FEET

FIGURE: 31 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % MAG FRACTION 200-300 FT.



10000 FEET

FIGURE: 32 (0-100 FT.) / PLAN

WT % HEMATITE 0-100 FT.

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

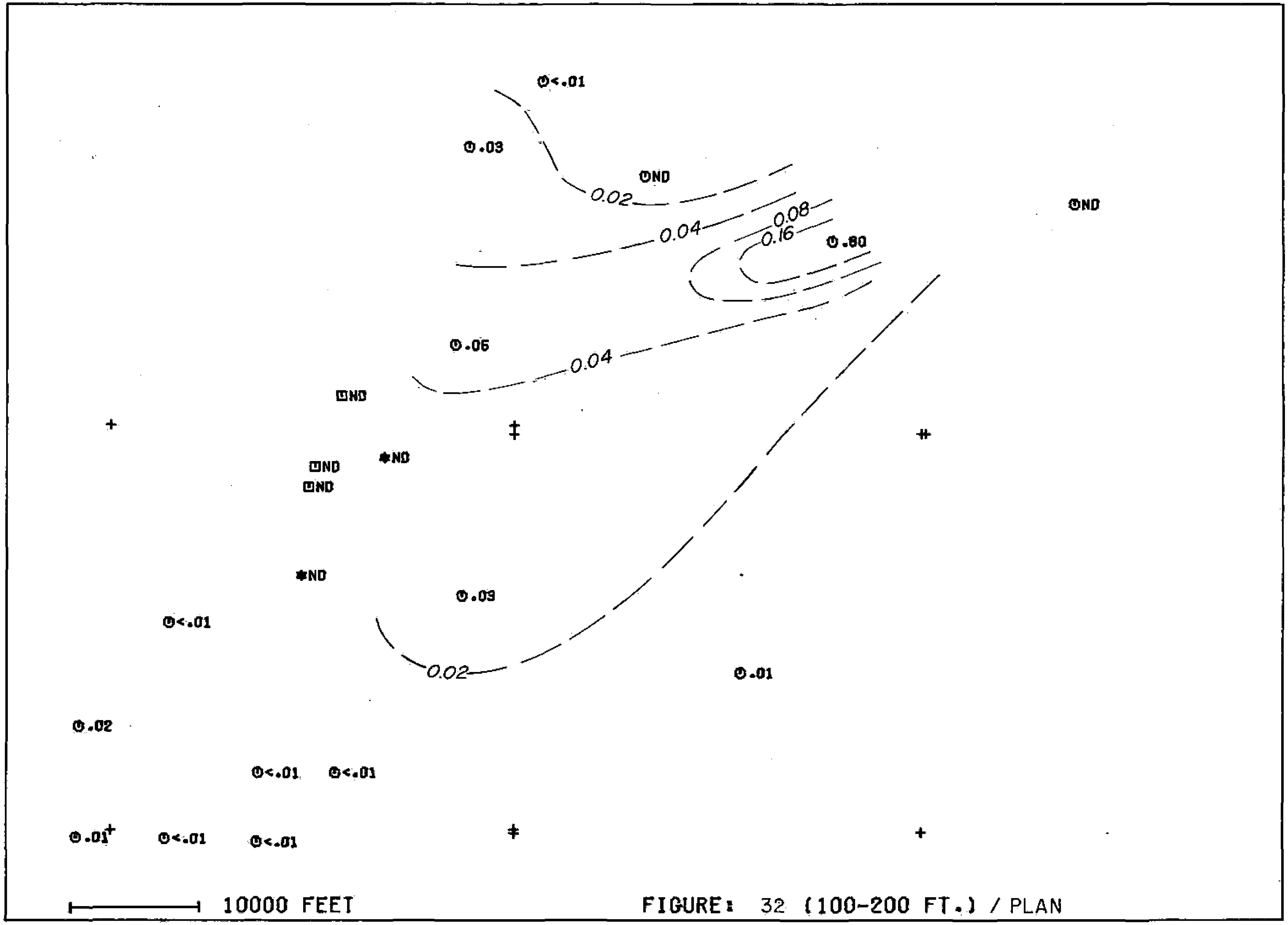
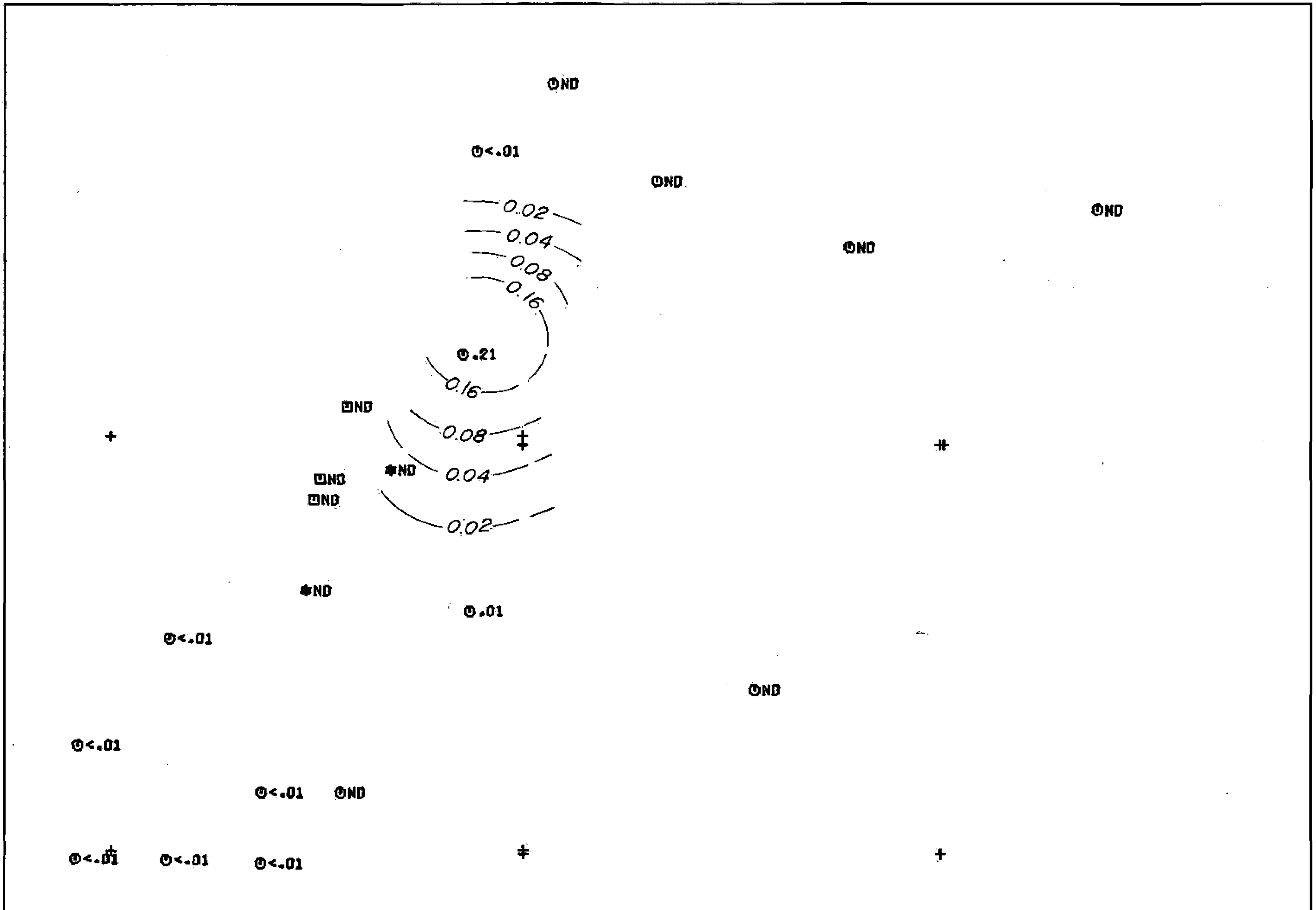


FIGURE: 32 (100-200 FT.) / PLAN

WT % HEMATITE 100-200 FT.

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

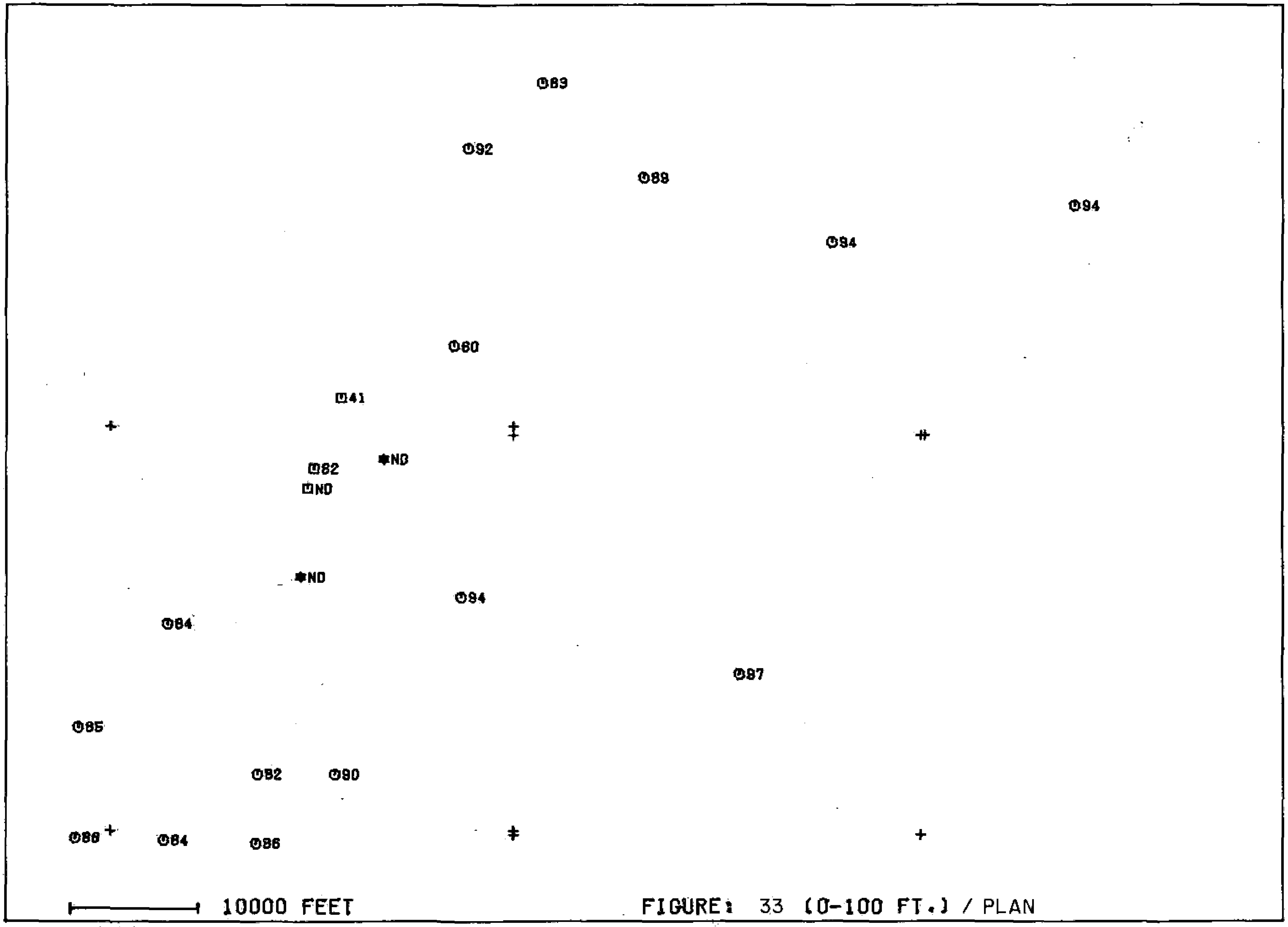


10000 FEET

FIGURE: 32 (200-300 FT.) / PLAN

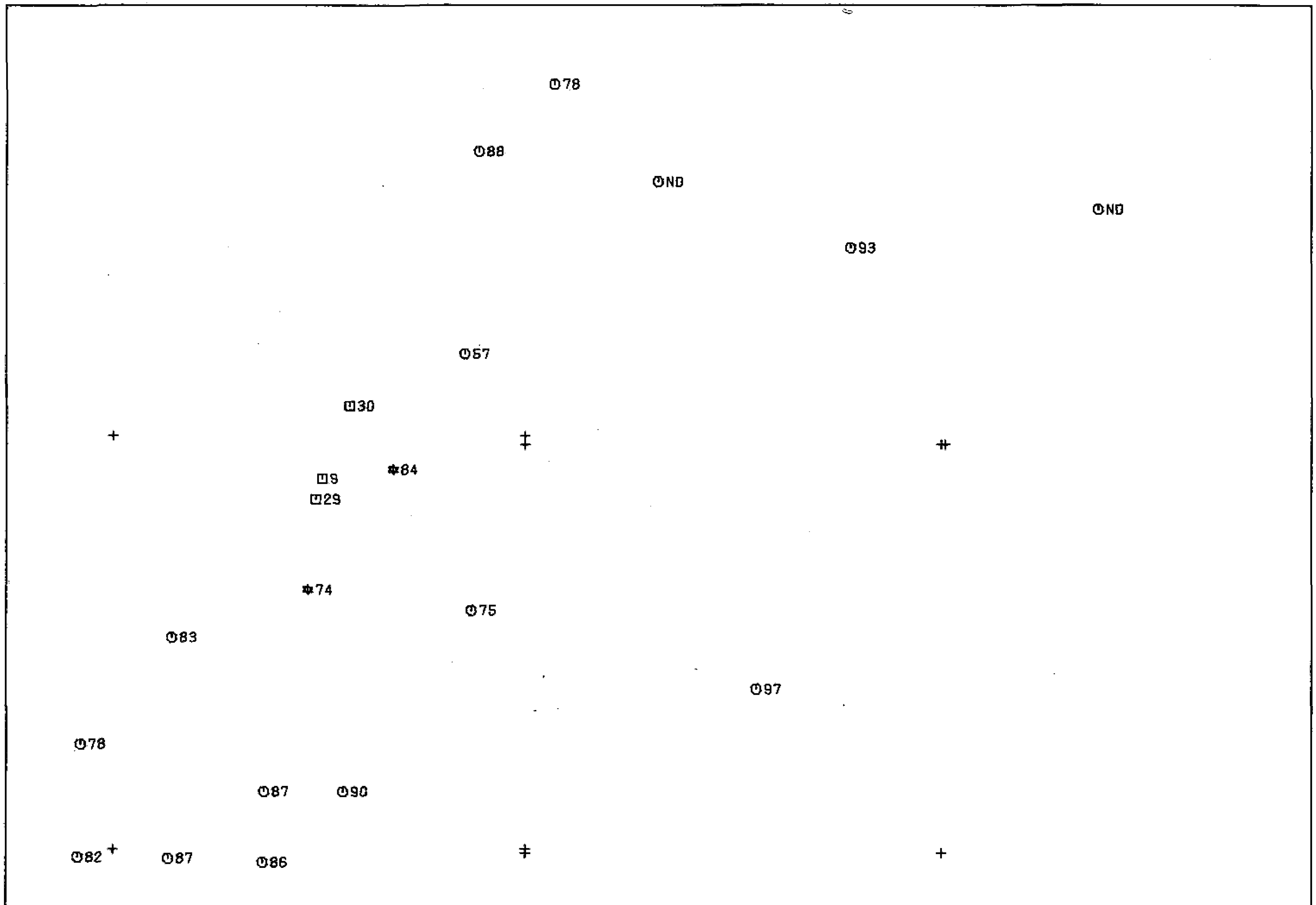
ROOSEVELT KGRA
BEAVER COUNTY, UTAH

WT % HEMATITE 200-300 FT.



ROOSEVELT KGRA
BEAVER COUNTY, UTAH

VOL % SILICATES IN +3.3 0-100 FT.



10000 FEET

FIGURE: 33 (100-200 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY,UTAH

VOL % SILICATES IN +3.3 100-200 FT.

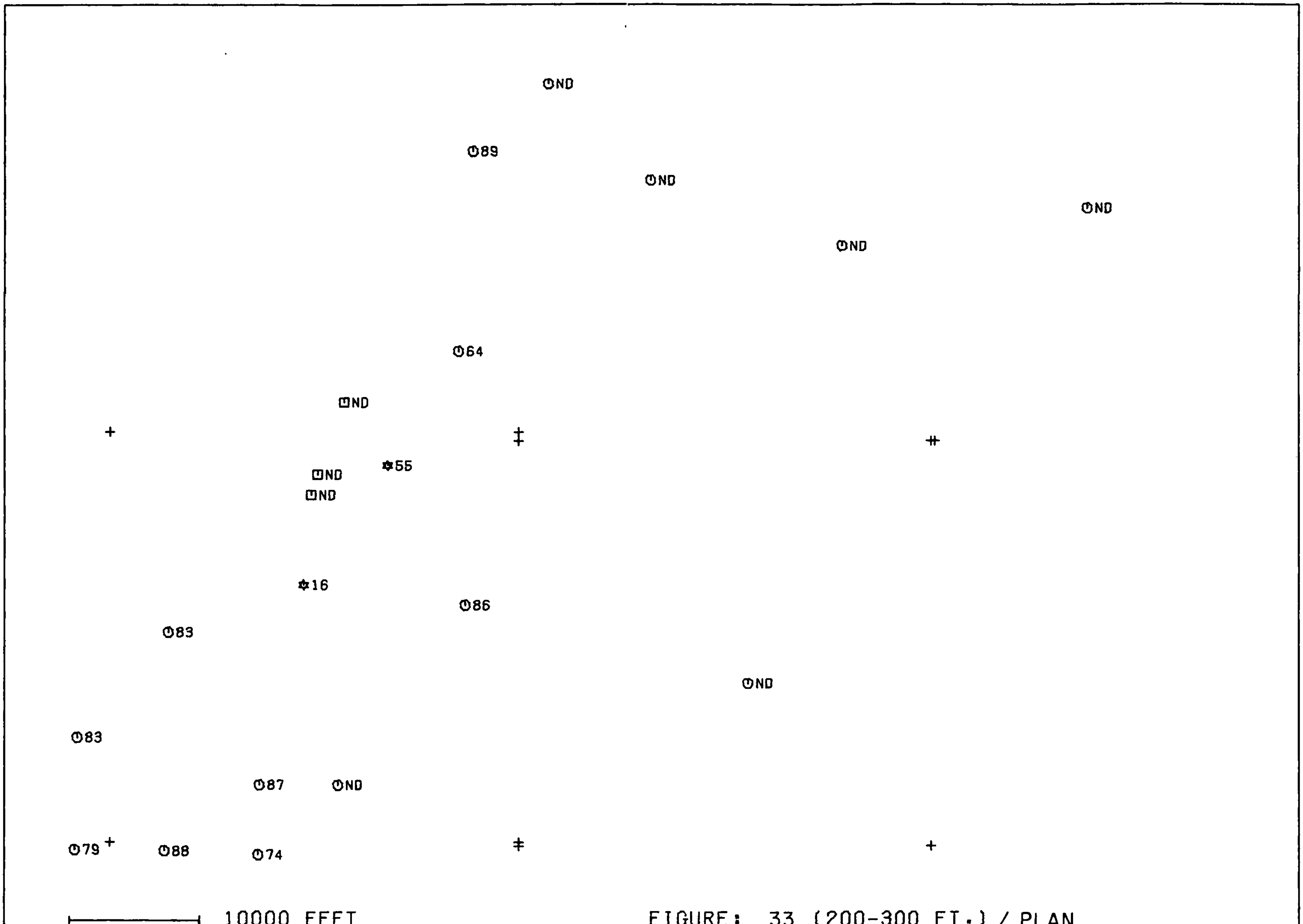


FIGURE: 33 (200-300 FT.) / PLAN

ROOSEVELT KGRA
BEAVER COUNTY, UTAH

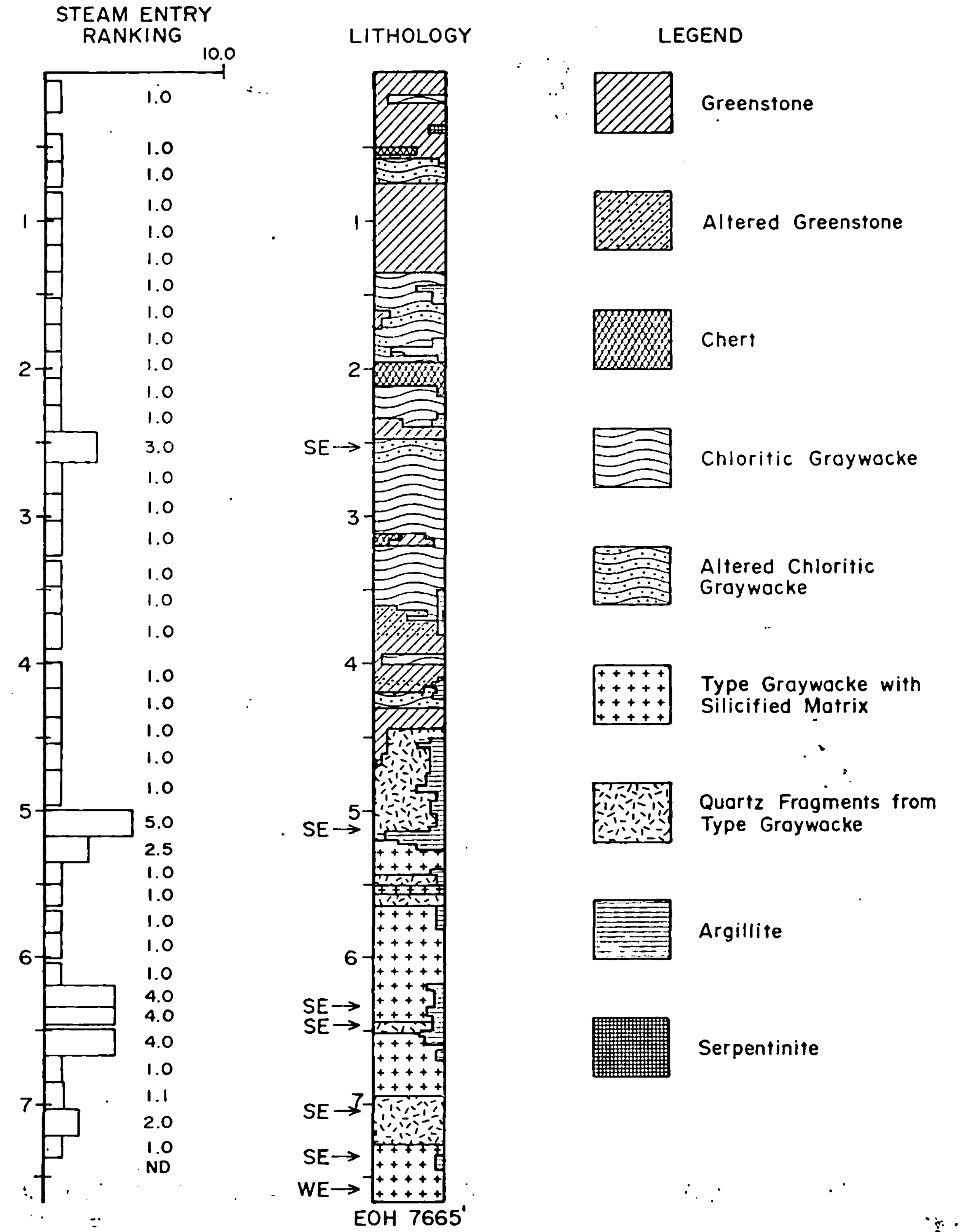
VOL % SILICATES IN +3.3 200-300 FT.

FIGURE 1/G-1

DH G-1

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

GENERALIZED GEOLOGY AND
STEAM ENTRY RANKING
VERT. SCALE: 1000 FT./IN.



SE = Steam Entry   WE = Water Entry

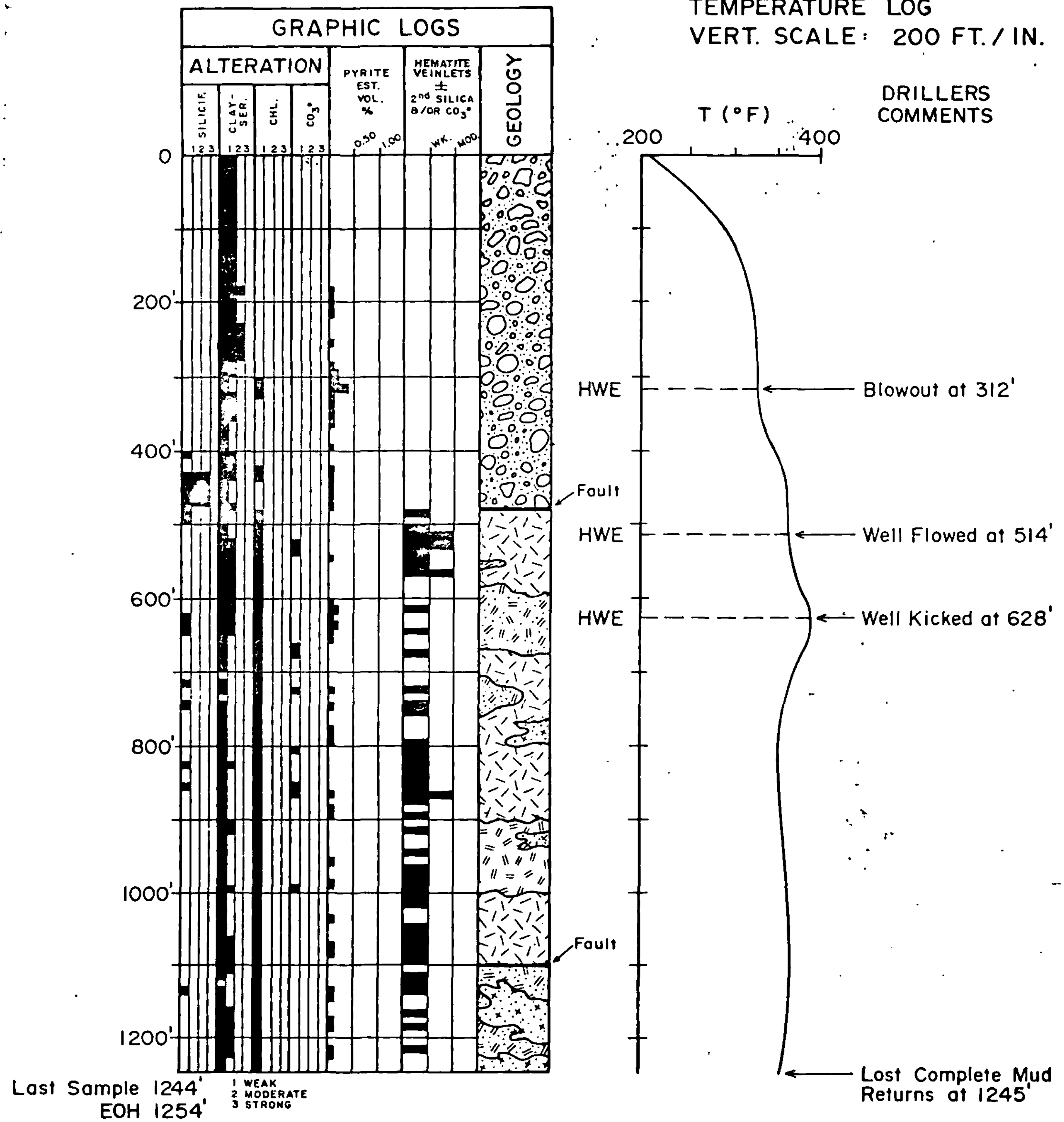
1.0 = No steam entry within or close to sample interval

2.0 thru 5.0 = Steam entries (SE) within or close to sample interval. Relative importance of SE indicated by ranking.

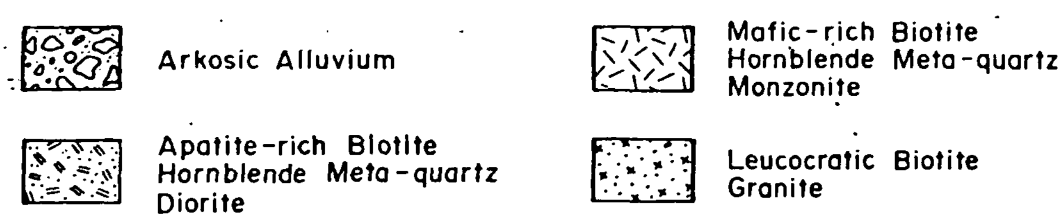
Geology modified from preliminary geologic log by Mary Twichell (Aminoil U.S.A. Inc.).

DH 72-16

GENERALIZED GEOLOGY AND TEMPERATURE LOG
VERT. SCALE: 200 FT./IN.



HWE = Hot Water Entry Zone



Geology and Alteration Data after Moore and Hulen, 1978.

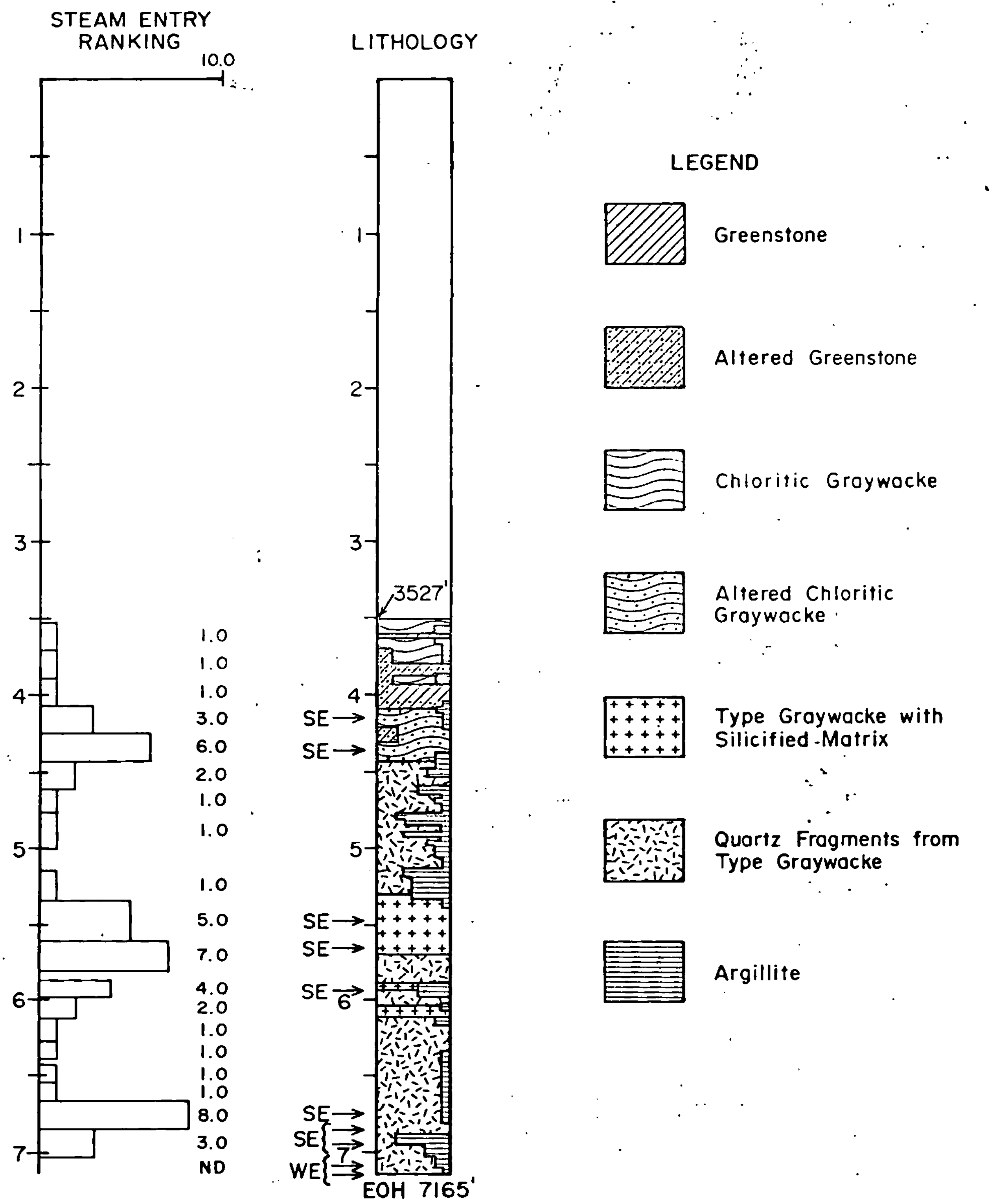
Temperature Log from Thermal Power Co., Deliverable to DOE/DGE Case Studies Program Contract No. EG-77-C-08-1525

FIGURE 1/G-1R

DH G-1R

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

GENERALIZED GEOLOGY AND
STEAM ENTRY RANKING
VERT. SCALE: 1000 FT./IN.



SE= Steam Entry WE= Water Entry

1.0 = No steam entry within or close to sample interval

2.0 thru 8.0 = Steam entries (SE) within or close to sample interval. Relative importance of SE indicated by ranking.

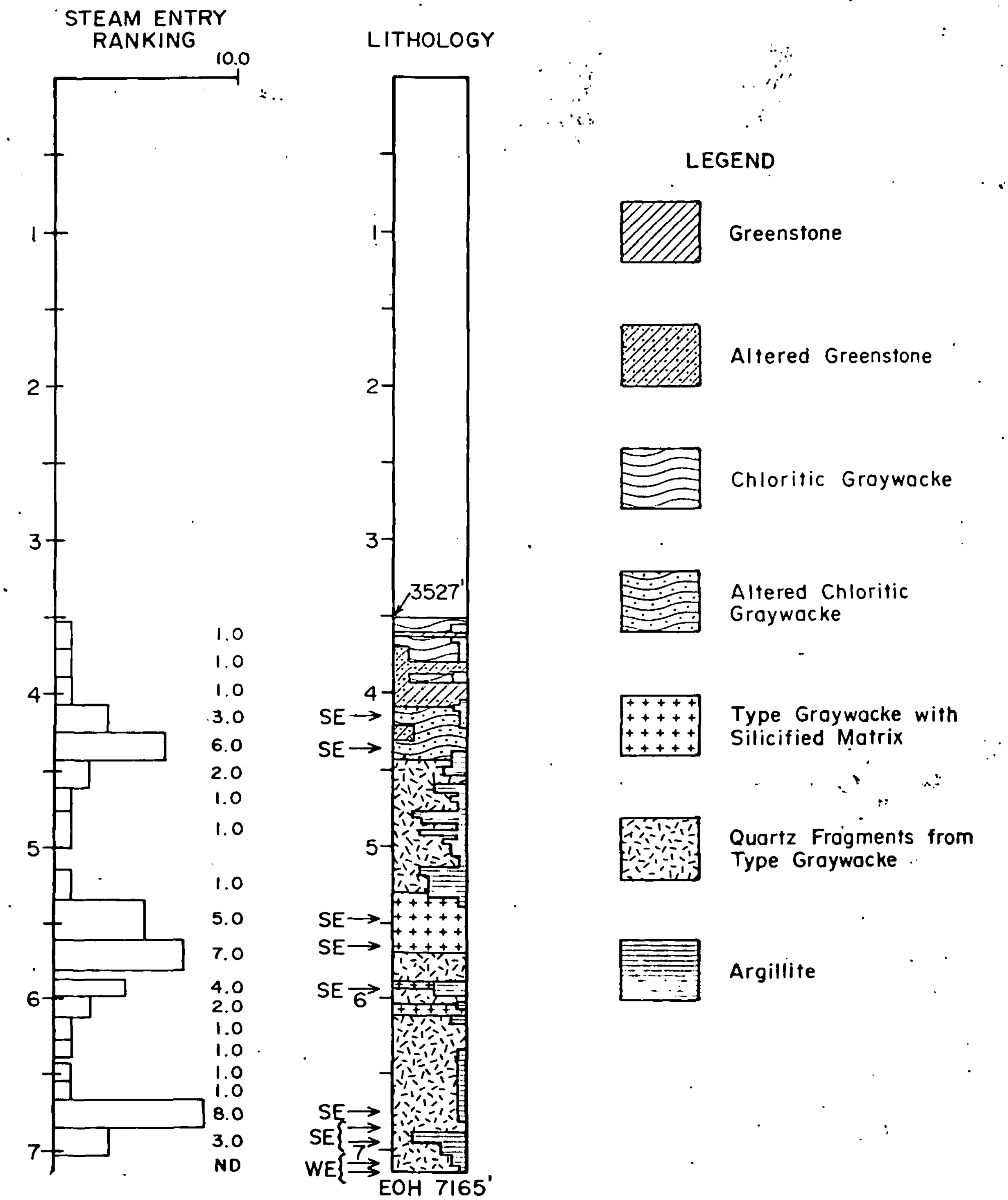
Geology modified from preliminary geologic log by Mary Twichell (Aminoil U.S.A. Inc.).

FIGURE I/G-IR

DH G-IR

GEYSERS KGRA
SONOMA & LAKE COS., CALIF.

GENERALIZED GEOLOGY AND STEAM ENTRY RANKING
VERT. SCALE: 1000 FT./IN.



SE = Steam Entry   WE = Water Entry

1.0 = No steam entry within or close to sample interval

2.0 thru 8.0 = Steam entries (SE) within or close to sample interval. Relative importance of SE indicated by ranking.

Geology modified from preliminary geologic log by Mary Twichell (Aminoil U.S.A. Inc.).