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SUMMARY GEOCHEMICAL MAPS OF THE JOPLIN 1° x 2° QUADRANGLE, KANSAS AND MISSOURI

By

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INTRODUCTION

This map is the first in a folio of maps of the Joplin 1°X2° quadrangle, Kansas and Missouri, prepared under the Conterminous United States Mineral Assessment Program. Additional maps showing various other geologic aspects of the Joplin quadrangle will be published as U.S. Geological Survey Miscellaneous Field Studies Maps bearing the same serial number with different letter suffixes (MF-2125-B, -C, and so on).

Geochemical studies of the Joplin 1°X2° quadrangle, Kansas and Missouri, are a part of a joint multidisciplinary study by the U.S. Geological Survey, the Kansas Geological Survey, and the Division of Geology and Land Survey, Missouri Department of Natural Resources. The objective of the joint study is to assess the mineral resource potential of the quadrangle by integrated geologic, geochemical, and geophysical investigations.

MINING ACTIVITY

The northern half of the world-class Tri-State Zinc District is in the southeastern part of the quadrangle, in southeastern Kansas and southwestern Missouri (fig. 1). The Picher field, in the western part of the Tri-State Zinc District, was the most productive mining area in the district. The Picher field straddles the quadrangle border (Kansas-Oklahoma State line) a few miles west of the Missouri State line. The Galena, Kans., area and the Joplin and Webb City, Mo., mining areas are also parts of the Tri-State District (McKnight and Fischer, 1970). Mining activity in these areas ceased in 1970 with the closing of the Swalley mine just west of Baxter Springs in Cherokee County, Kans. There are several additional small zinc-lead mines, prospects, and occurrences in southeastern Kansas and southwestern Missouri, but none of these is currently active.

GEOCHEMICAL STUDY

The subsurface geochemical study of the Joplin quadrangle follows the procedures, methodology, and concepts developed for the mineral resource assessments of the Rolla and Springfield (Missouri) and Harrison (Missouri and Arkansas) 1°X2° quadrangles (Erickson and others, 1978, 1979, 1985, and 1988a). Those studies indicated that spectrographic analyses of insoluble residue leached by dilute

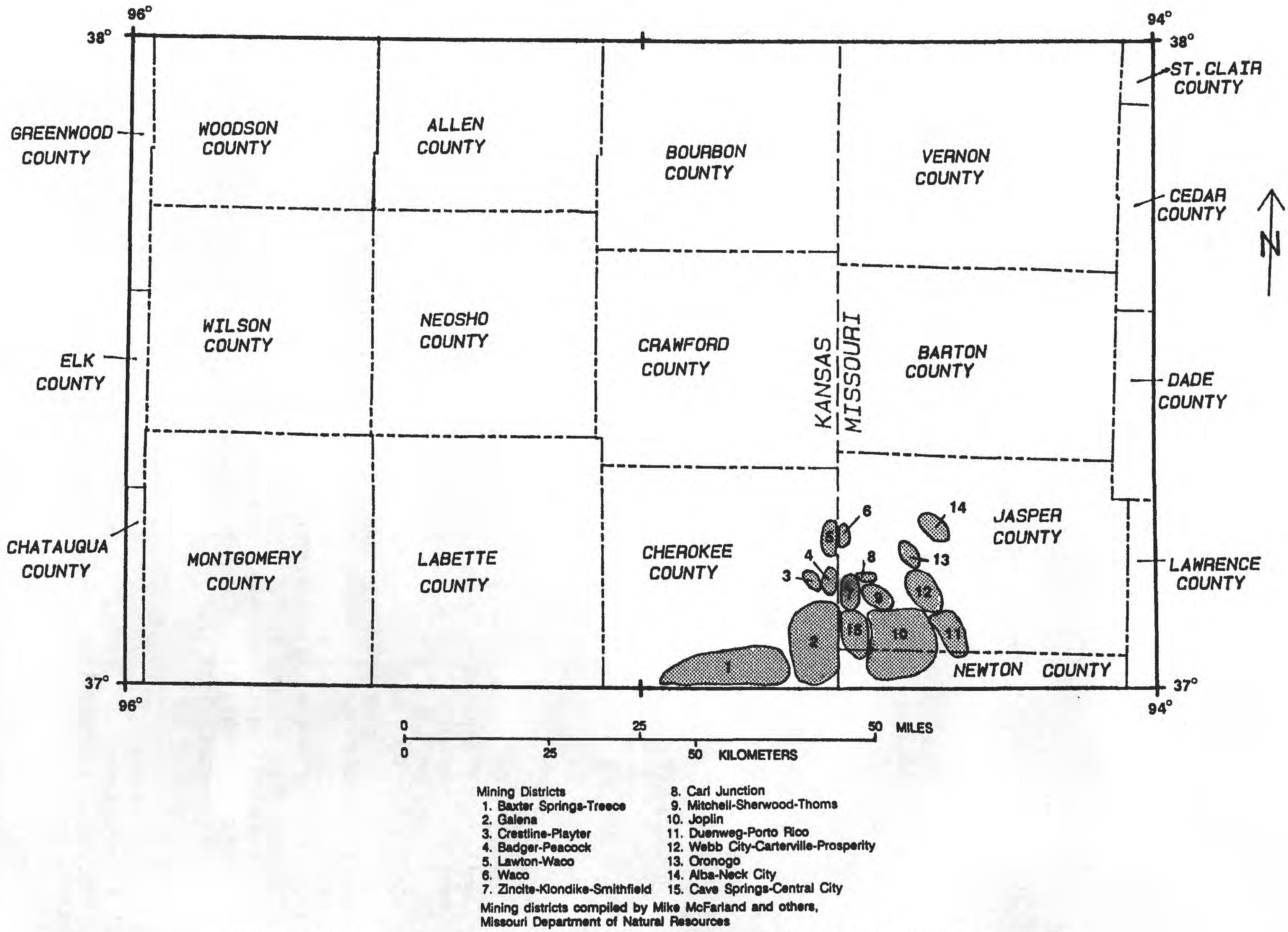

Figure 1.--Map showing mining districts in the Joplin 1°X2° quadrangle.

Table 1. List of drill holes for which samples were analyzed in the Joplin 1° x 2° quadrangle, Kansas and Missouri

Drillhole No.	Kansas/Missouri log number or well name	County state	Location: section, township, and range
J1	(KS) #1 ELk	Elk, KS	4-29S-12E
J2	(KS) #1SWD Clinesmith	Wilson, KS	4-27S-15E
J3	(KS) #1 King	Cherokee, KS	4-35S-22E
J4	(KS) #9A L.F. Kepley	Neosho, KS	2-27S-18E
J5	(KS) #1 Altendorf	Montgomery, KS	2-33S-16E
J6	(KS) #1 Wort	Labett, KS	17-31S-21E
J7	(KS) N.E. Greathouse	Wilson, KS	4-28S-14E
J8	(KS) #10 Springer	Montgomery, KS	28-32S-14E
J9	(KS) #4 Fee	Greenwood, KS	25-26S-12E
J10	(KS) #1 Neely	Neosho, KS	34-30S-18E
J11	(KS) #1 Solomon	Woodson, KS	29-26S-17E
J12	(KS) #2 R.C. Wetzel	Montgomery, KS	23-33S-13E
J13	(KS) #1-33 Fee	Greenwood, KS	33-27S-13E
J14	(KS) #1 Uitts	Montgomery, KS	18-32S-16E
J15	(KS) #1 Showers	Wilson, KS	16-30S-15E
J16	(KS) #10 Lauber "A"	Woodson, KS	19-26S-15E
J17	(KS) #1 J. Dowling	Crawford, KS	8-28S-22E
J19	(KS) #1 Beal	Montgomery, KS	12-33S-14E
J20	(KS) #1 Stevenson	Bourbon, KS	16-26S-24E
J22	(KS) #1 E. Kimbell	Woodson, KS	19-24S-14E
J23	(KS) #1 Rich	Woodson, KS	1-24S-15E
J24	(KS) #41-26 G. Crocker	Montgomery, KS	26-34S-13E
J25	(KS) #SWD1 W. Goff	Montgomery, KS	33-32S-13E
J26	(KS) #1 Carra	Chataqua, KS	27-34S-13E
J27	(KS) #3 C.R. Coombs	Neosho, KS	30-28S-21E
J28	(KS) #1 Forkner	Cherokee, KS	17-33S-23E
J29	(KS) #1 Harley	Cherokee, KS	30-31S-22E
J30	(KS) #1 J. Gobl	Cherokee, KS	20-28S-25E
J31	(KS) #1 Ecco Ranch	Woodson, KS	33-26S-15E
J32	(KS) Clinesmith 3-4	Wilson, KS	4-27S-15E
J33	(KS) #1 Clark	Cherokee, KS	13-33S-21E
J34	(KS) #3 Coleman	Montgomery, KS	4-33S-17E
J35	(KS) #1 Newbold	Woodson, KS	29-25S-16E
J36	(KS) #1 Corbin	Elk, KS	29-31S-13E
J37	(KS) #1 Eagle	Woodson, KS	19-26S-16E
J38	(KS) #1 Leavell	Allen, KS	10-24S-19E
J39	(KS) #1 C.R. Burney	Bourbon, KS	22-25S-25E
J40	(KS) #8 Harris	Woodson, KS	8-24S-17E
J41	(KS) #1 Wright	Woodson, KS	3-25S-17E
J42	(KS) #2 R.B. Smith	Neosho, KS	32-29S-20E
J43	(KS) #1 Marvin	Cherokee, KS	31-32S-24E
J44	(KS) #1 McCdm	Crawford, KS	36-30S-22E
J45	(KS) #1 Geier	Crawford, KS	28-30S-23E
J46	(KS) #1 Beachner	Neosho, KS	3-30S-21E
J47	(KS) #1 Naylor	Crawford, KS	17-31S-24E

Table 1--continued

J48	(KS) #2 Regis	Crawford, KS	8-31S-24E
J49	(KS) #1 Hartley	Cherokee, KS	3-34S-23E
J53	(KS) #1 Lovell	Crawford, KS	14-31S-23E
J54	(KS) #1 Westevelt	Crawford, KS	3-31S-23E
J55	(KS) #1 Prewett	Cherokee, KS	28-31S-23E
J56	(KS) #1 Baker	Labette, KS	11-31S-20E
J57	(KS) #1 KL 2-1 Gray	Neosho, KS	34-30S-21E
J58	(KS) #1 Hebb	Elk. KS	33-28S-12E
J59	(KS) #31 Manwarren	Greenwood, KS	1-27S-12E
J60	(KS) #1 Oakes	Greenwood, KS	30-27S-12E
J61	(KS) #1 Gillam	Montgomery, KS	4-35S-15E
J62	(KS) #14 Engstom	Greenwood, KS	10-27S-13E
J63	(KS) #1JPKS 7-A1 Conrad	Cherokee, KS	24-34S-21E
J64	(KS) #5 Baxter Springs	Cherokee, KS	36-34S-24E
J65	(KS) #1 Hall	Montgomery, KS	17-34S-16S
J66	(KS) #4 Baxter Springs	Cherokee, KS	1-35S-24E
J67	(KS) # Jordan D	Allen, KS	29-26S-20E
J68	(KS) #4 Beggs	Allen, KS	5-26S-21E
J69	(KS) #1 Willis	Neosho, KS	7-28S-18E
J70	(KS) #1 Franklin	Wilson, KS	12-28S-16E
J71	(KS) Water Dept District #3	Cherokee, KS	17-34S-24E
J72	(KS) #1 Wells	Montgomery, KS	7-34S-15E
J73	(KS) #1 Reed	Labette, KS	7-34S-21E
J74	(KS) #1 Atleberry	Labette, KS	22-32S-19E
J75	(KS) #1 Nelson	Bourbon, KS	11-24S-22E
J76	(KS) #1 J. Hess	Allen, KS	31-25S-20E
J78	(KS) #23-8 Plummer	Montgomery, KS	8-31S-17E
J79	(KS) #5 Bruenger I	Allen, KS	7-26S-19E
J100	(MO) #26768	Jasper, MO	26-28N-32W
J101	(MO) #21407, #22146	Ottawa, OK	20-29N-23E
J102	(MO) #22563	Ottawa, OK	1-29N-23E
J103	(MO) #2302	Ottawa, OK	13-29N-22E
J104	(MO) #4595	Ottawa, OK	19-29N-23E
J105	(MO) #22145	Cherokee, KS	12-35S-23E
J106	(MO) #23239	Cherokee, KS	12-35S-23E
J107	(MO) #23238, #21406	Cherokee, KS	11-35S-23E
J108	(MO) #28309	Cherokee, KS	13-34S-25E
J109	(MO) #28470	Labette, KS	22-31S-20E
J110	(MO) #12606	Bourbon, KS	20-24S-25E
J111	(KS) Wilbur P-34	Cherokee, KS	14-35S-23E
J112	(MO) #28032	Barton, MO	20-31N-30W
J113	(MO) #28016	Vernon, MO	16-37N-32W
J114	(MO) #28479	Vernon, MO	23-35N-33
J115	(MO) #28244	Jasper, MO	16-29N-32
J116	(MO) #28302	Jasper, MO	4-29N-33
J117	(MO) #28617, #25045	Jasper, MO	17-30N-33
J118	(MO) #27903	Barton, MO	21-31N-32
J119	(MO) #27378	Crawford, KS	26-29N-25E
J120	(MO) #12632	Jasper, MO	1-27N-32W
J121	(MO) #20387	Barton, MO	35-31N-29W

Table 1--continued

J122	(MO) #27052	Barton, MO	6-31N-32W
J124	(MO) #25107	Barton, MO	27-32N-30W
J125	(MO) #25178	Barton, MO	17-32N-31W
J126	(MO) #25231	Barton, MO	20-31N-33W
J127	(MO) #22948	Vernon, MO	15-36N-30W
J128	(MO) #22030	Vernon, MO	5-35N-31W
J129	(MO) #27071	Jasper, MO	24-30N-31W
J130	(MO) #26999	Crawford, KS	28-30S-25E
J131	(MO) #23538	Vernon, MO	35-34N-31W
J132	(MO) #23564	Vernon, MO	5-34N-32W
J133	(MO) #24170	Lawrence, MO	9-27N-28W
J134	(MO) #27087	Cedar, MO	28-36N-28W
J135	(MO) #28327	Cedar, MO	15-33N-28W
J136	(MO) #28390	Dade, MO	29-30N-28W
PM-1	(KS) #PM-1	Cherokee, KS	13-33S-21E
PM-5	(KS) #PM-5	Cherokee, KS	30-32S-22E
PM-9	(KS) #PM-9	Cherokee, KS	18-32S-23E
PM-10	(KS) #PM-10	Cherokee, KS	22-31S-22E
S-45	(MO) #28298, #19161	Jasper, MO	2-28N-31W
DH-89	(MO) #27471	Vernon, MO	6-34N-29W

hydrochloric acid from samples of carbonate rocks revealed regional patterns of distribution and abundance of metals in the subsurface that were important to the resource assessment.

Composite insoluble residue samples from 116 drill holes were selected for this study (representing about 6,800 samples; see table 1). Unfortunately, few drill holes penetrate from the surface to Precambrian basement rocks. Therefore, our geochemical study is constrained by the distribution of drill holes and by sample materials available. Forty-nine holes, chiefly in the west half of the quadrangle, penetrate Pennsylvanian rocks; 99 holes penetrate Mississippian rocks; 81 holes penetrate Cambrian-Ordovician rocks; and only 25 holes penetrate Precambrian basement or basal sandstone. We use the term "Cambrian-Ordovician" because, in Kansas, the Lower Ordovician (Canadian Series) and the Upper Cambrian carbonate strata are combined and commonly referred to as the Arbuckle Group. Thus, Cambrian-Ordovician contacts usually are not shown on Kansas stratigraphic logs and the chiefly carbonate section between a basal sandstone (Lamotte or Reagan Sandstone) and the top of the Cotter Dolomite of Early Ordovician age is called the Arbuckle Group. In the Missouri part of the quadrangle, this stratigraphic section commonly is subdivided into Cambrian and Ordovician formations. Because it is not feasible for us to confidently pick the Ordovician-Cambrian contacts in Kansas and because two-thirds of the quadrangle is in Kansas, we have elected to compile geochemical maps for the combined Upper Cambrian-Lower Ordovician carbonate section of the entire quadrangle. Thus, many of the drill holes shown on the Cambrian-Ordovician map (map E) may not actually penetrate strata of Cambrian age. However, the geochemical bar graphs for each drill hole (see Appendix) show subdivisions of this section where they are available to us from the Kansas and Missouri Geological Surveys.

Most of the insoluble residue samples from the Kansas part of the quadrangle were prepared from splits of cuttings from oil test holes archived at the sample library in Wichita, Kans. Very little material was available for many of these drill holes, and many samples were composited, so a single sample may represent as much as 100 ft of section. Another complicating factor is that cuttings commonly contained caved rock fragments from higher in the hole. This problem is particularly bothersome for drill holes that collar in Pennsylvanian shale because the shale caves easily and becomes part of almost every sample taken from below the shale. Nevertheless, with proper awareness of these factors, manual removal of as much extraneous rock material as possible, and thorough binocular examination of the lithology and mineralogy of the residues, useful information on geochemical patterns of distribution and abundance of metals can be obtained from the analysis of the residues. The samples analyzed from drill holes in Missouri are splits of insoluble residues archived in the sample library of the Missouri Geological Survey. These insoluble residues were obtained from drill core and, therefore, the samples were not contaminated by rock from above. Most of these samples are contiguous composites of 10- to 20-ft intervals.

Each composite insoluble residue sample was analyzed for 31 elements by a semiquantitative six-step direct-current-arc optical-emission spectrographic method (Grimes and Marranzino, 1968). The results of these analyses were plotted on the maps in anomalous metal feet (AMF). AMF is a reporting unit derived by normalizing the ratio of a reported anomalous metal content to the threshold of anomalous metal content, multiplied by the length of the sample interval in feet. The thresholds of anomalous metal contents of insoluble residues were established by inspection of the data (in parts per million): As, 200; Zn, 200; Pb, 100; Cu, 100; Ni, 70; Mo, 70: Co, 30; and Ag, 1. Thus, reported values of 500 ppm Pb and 3 ppm Ag for a 10-foot interval normalize to 50 AMF of Pb and 30 AMF of Ag. The AMF can be summed for an entire drill hole, or for each geologic system, or for each formation, or for individual metals. The geochemical maps for each geologic system show only those drill holes that penetrate at least 100 ft of the geologic system portrayed.

The geochemical anomalies shown on the maps are bases on simple form lines drawn to call attention to clusters of similar AMF values. The shapes of the anomalies are not significant and are not meant to imply a continuum of AMF values between the widely spaced drill holes. The significance of anomalies in single drill holes is not known. Undoubtedly, new drilling and more closely spaced holes would reveal many barren areas within postulated trends, change the inferred orientation of trends, or reveal other areas of anomalous metal content not detected in this study. Nevertheless, the geochemical patterns generated by form lines are useful because they permit comparison, integration, and interpretation of geochemical patterns with lithologic, structural, and geophysical trends.

This pamphlet includes bar graphs showing the stratigraphic distribution and abundance of metals in insoluble residue, in parts per million, for selected drill holes and a table showing metal content of insoluble residue samples, in anomalous metal feet, from each drill hole (table 2). Only values equal to or greater than the minimum anomalous value are shown in the bar graphs. The formation boundaries used on the bar graphs were determined by the Kansas and Missouri Geological Surveys.

RESULTS

The summary geochemical map (map A), compiled on a generalized geologic, structure, and aeromagnetic base, shows the total metal content (Ag + As + Co + Cu + Mo + Ni + Pb + Zn), in AMF, for all the stratigraphic units penetrated in each drill hole. Other geochemical maps are compiled for zinc in Pennsylvanian strata (map B), zinc (map C) and nickel + cobalt (map D) in Mississippian strata, and for total metals (Ag, As, Co, Cu, Ni, Pb, and Zn) in Cambrian-Ordovician strata (map E).

Ore-related elements are much less abundant in residue samples of the Paleozoic carbonate units in the Joplin quadrangle than they are in the adjacent Springfield (Missouri) and Harrison (Missouri and Arkansas) quadrangles (Erickson and others, 1985 and 1988a). Most of the geochemical maps show only broad low-level anomalies that have no clear association with geologic, structural, or geophysical features. However, many of the patterns trend northeast, approximately parallel to the regional strike of sedimentary units in the quadrangle. Only 25 of the 116 drill holes studied penetrate to Precambrian basement, and only 37 of the 81 drill holes shown on the Cambrian-Ordovician map penetrate strata known to be Cambrian in age. Thus, the concept that Cambrian strata are the principal aquifers for metal transport in the Ozark region (Erickson and others, 1988b) cannot be clearly demonstrated in the Joplin quadrangle--except in the Tri-State Zinc District, where several drill holes penetrate to Precambrian basement. Nevertheless, broad low-level geochemical anomalies are present, and they must be interpreted in order to help assess the mineral resource potential of the Joplin quadrangle.

The summary map (map A) shows two broad anomalous areas that enclose drill holes containing 1,000 or more AMF combined metals. The western area is chiefly the result of anomalous amounts of zinc in Pennsylvanian strata and anomalous amounts of Cu, Pb, Zn, Ag, Ni, As, and Mo in Cambrian-Ordovician strata. The southeastern area is part of the Tri-State Zinc District and reflects anomalous amounts of zinc in Mississippian strata and a zinc-lead-rich base-metal suite in Cambrian-Ordovician strata.

Map B (zinc in Pennsylvanian rocks) shows two prominent, narrow northeast-trending patterns across the western part of the quadrangle. The separation of these two form-line trends may be illusory: no analytical data are available between them in the western part of the area. The "hottest" part of the northernmost pattern appears to center just west of the quadrangle (map B, drill holes J1, J58, J59, and J60). Although the integrity of the cuttings is poor, both trends appear to be hosted chiefly by limestone of the Kansas City and Lansing Groups. Some zinc probably occurs in the Pennsylvanian black-shale units, however, binocular microscopic examination confirms that samples having the highest zinc content in this study, as much as 2,000 ppm, are from sphalerite in limestone. Elevated concentrations of Ni, V, Mo, Cr, and Zn are common in black shales of Pennsylvanian and Devonian age in the Joplin quadrangle. We believe that these elements are intrinsic to the black shales--not parts of an epigenetic metal suite. No attempt is made, in this study, to assess the mineral resource potential of black shale.

Map C (zinc in Mississippian rocks) shows, as expected, an anomalous concentration of zinc in residue samples from the Tri-State area. The northeast quadrant of the quadrangle is covered by 100-400 ft of Pennsylvanian strata and, surprisingly, all drill holes in the northeast quadrant show greater than 100 AMF zinc in the underlying Mississippian strata. Most Mississippian zinc deposits and occurrences are structurally controlled and commonly do not exhibit large lateral halos. Thus, this broad, consistent pattern suggests that the area has significant potential for concealed zinc deposits beneath relatively thin Pennsylvanian cover--particularly those areas of faulting or brecciation. The low-level zinc anomaly near the western border of the quadrangle is concealed by more than 1,500 ft of Pennsylvanian strata. However, the overlying Pennsylvanian strata in this area also contain anomalous amounts of zinc (map C, drill holes J1, J58, J59, and J60). Because of the thick overlying section of Pennsylvanian strata, this area is less favorable than the anomalous area in the northeast quadrant for concealed zinc deposits hosted by Mississippian strata.

Map D (nickel and cobalt) shows three low-level anomalies in Mississippian strata. Qualitative spectrographic analysis of selected hand-picked grains show that the nickel and cobalt in these areas occurs chiefly in millerite and pyrite and commonly correlates well with other base metals. Most of the nickel and cobalt in the south-central anomalous area occurs near the base of the Mississippian section at, or just above, the unconformity between Mississippian and CambrianOrdovician rocks (Appendix, J108, PM-1, PM-10). The intense nickel and cobalt anomaly at drill hole J2, in the northwestern part of the quadrangle, is principally due to nickel related to mica peridotite (lamproite) dikes and sills that intrude Mississippian and Pennsylvanian rocks in the Silver City dome (fig. 1). Drill holes J31, J32, and J37, northeast of J2, also cut dikes and sills in Pennsylvanian strata, and the nickel content of residue samples is high. Fragments of serpentinite and phlogopite are common in samples from all of these drill holes. The low-level anomaly in the northeastern part of the quadrangle occurs within the broad zinc anomaly in Mississippian rocks (map C), but we see no direct correlation of high nickel values with high zinc values.

Map E (Ag, As, Co, Cu, Ni, Pb, Zn) in Cambrian and Ordovician rocks shows two principal areas of anomalous metal content. The roughly northeast trending pattern in the southeastern part of the quadrangle is similar to the pattern of zinc anomalies in Mississippian rocks (map C) and, we believe, is related to fluid movement in Cambrian-Ordovician strata below the Mississippian-hosted Tri-State District. Considering the southeast anomalous area as a whole, zinc and lead are the most abundant metals in the combined metal suite, most of the zinc occurs in the Ordovician part of the section, and most of the lead and other metals occur in the Cambrian part. This distribution and abundance is well documented in the bar graphs for drill holes J106 and J111 (Appendix). The results from these holes are a part of the evidence that Cambrian strata were the principal aquifers for metal-bearing brines throughout the Ozark region, as concluded by Erickson and others (1988b). They reported that residue samples from Cambrian carbonate rocks, regionally, are commonly rich in lead and contain an extensive suite of other metals (Zn, Cu, Ag, As, Mo, Ni, Co), and that samples from each successively higher geologic system are increasingly rich in zinc and the presence of anomalous amounts of other metals is less common. Residue from samples of Mississippian and Pennsylvanian rocks tends to be overwhelmingly rich in zinc, and anomalous concentrations of other metals are relatively rare. Erickson and others (1988b) also postulated that mineral districts such as the Tri-State could form in post-Cambrian strata where geologic structures intersect and tap the Cambrian aquifers. Whether or not the Cambrian-Ordovician section below the Tri-State has significant mineral resource potential for lead and zinc cannot be assessed by the geochemical data for the subsurface alone. The presence or absence of other important factors, such as rapid facies changes, shale windows, or Precambrian knobs, must also be demonstrated. However, clearly, metal-bearing fluids have traversed the Cambrian-Ordovician section in this area.

The broad anomaly shown by residue samples from Cambrian-Ordovician rocks in the western part of the quadrangle is caused chiefly by anomalous amounts of copper, lead, and zinc. Drill holes J14, J15, and J34 (map E) penetrate to basement, and the Cambrian-Ordovician section is chiefly crystalline dolomite with a clean basal sandstone in some places. Shale, siltstone, and glauconitic sandstone, common in the lower part of the Cambrian section in the Ozark region to the east, are uncommon here. Particularly intriguing is the observation that the Cambrian-Ordovician section is much thinner here than in the eastern part of the quadrangle and that thicknesses are variable and appear to change rapidly. For example, the entire Cambrian-Ordovician section in drill hole J34 is only 375 ft thick. In J15, to the west, the section is 902 ft thick. Our sparse data points suggest the presence of small, shallow basins between Precambrian knobs and local pinchouts of Cambrian-Ordovician sediments against knobs. Further, several faults are present in and near the most intense part of the geochemical anomaly. Thus, the area shown on map E as >1000 AMF enclosing drill holes J10, J14, J15, and J34 may have significant mineral resource potential. Note that drill holes J5, J74, and J78, just outside of the anomaly, penetrated only 200 ft or less of Cambrian-Ordovician section (Appendix, table 2). Deeper penetration in these areas might reveal additional areas that are strongly anomalous in amounts of metals in residue samples from Cambrian-Ordovician rocks.

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APPENDIX--TABULAR AND GRAPHICAL DRILL-HOLE DATA

The stratigraphic distributions of anomalous contents of selected metals, in parts per million, in insoluble residue samples of carbonate rocks from each drill hole analyzed in this study are shown in the following bar graphs. These bar graphs enable the user to refer to a specific drill hole shown on the geochemical maps to determine stratigraphic position, metal suite, and relative abundance of each metal, and intensity, continuity, thickness, and depth from the surface of the geochemically anomalous zones. Metal contents less than the minimum anomalous contents are not graphed. Cobalt, nickel, copper, and molybdenum are omitted in some bar graphs. The reader is directed to table 2 for a complete list of values for each element.

The stratigraphic boundaries on the bar graphs are those shown on the stratigraphic log of each drill hole on file either with the Division of Geology and Land Survey, Missouri Department of Natural Resources, or the Kansas Geological Survey. Stratigraphic abbreviations are explained at the top of table 2.

The vertical axis is depth from the surface (in feet); total depth (T.D.) is given for each hole. Values that equal the upper bound on the element scale are represented by a solid bar for that sample interval. Values that exceed the upper bound of the scale are represented by a break in the solid bar. The symbol M* represents undifferentiated Mississippian-age rocks including the Chattanooga shale unit.

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri

[IP, Pennsylvanian; M, Mississippian; MDc, Chattanooga Shale; €O, Cambrian-Ordovician; Oc, Cotter Formation; Oj, Jefferson City Formation; Or, Roubidoux Formation; Og, Gasconade Dolomite; Ogg, Gunter Sandstone; €e, Eminence Dolomite; €dd, Derby-Doerun Dolomite (as used by Missouri Geological Survey); €d, Davis Formation; €l, Lamotte Sandstone; €pb, post-Bonneterre Cambrian; €r, Reagan Sandstone; p€, Precambrian; TD, total depth; >, greater than; *, value from one sample; ppm, parts per million]

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J1	IP	260	1450	200	0	10	650	445	1600	200	4005	7110	
	M	1710	320	30	0	0	10	125	105	0	320	590	
	MDc	2030	10	0	0	0	0	50	10	0	0	60	
	€O	2040	360	0	0	0	95	240	75	50	0	460	
	TD	2400		230	0	10	755	860	1790	250	4325	8220	
J2	IP	900	440	35	35	435	90	50	2530	45	460	3680	
	M	1340	410	0	0	265	70	175	2905	20	115	3550	
	MDc	1750	170	0	0	60	0	65	1020	0	25	1170	
	TD	1920		35	35	760	160	290	6455	65	600	8400	
J3	IP	100	150	0	0	0	0	0	45	0	50	95	Driller's log says bottoms in "red granite" but it may be rhyolite.
	M	250	260	10	0	0	0	80	55	10	25	180	
	MDc	510	40	0	0	0	10	30	20	0	0	60	
	€O	550	340	80	0	0	60	165	60	80	25	470	
	p€	890	213	0	0	0	0	0	0	40	0	40	
	TD	1103		90	0	0	70	275	180	130	100	845	
J4	IP	693	387	70	0	0	95	130	140	30	50	515	
	M	1080	260	20	0	0	240	75	150	10	100	595	
	MDc	1340	60	0	0	0	10	80	10	0	0	100	
	€O	1400	70	0	0	0	10	90	10	0	0	110	
	TD	1470		90	0	0	355	375	310	40	150	1320	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J5	ℙ	150	890	220	0	0	90	290	590	55	1265	2510	
	M	1040	300	10	0	0	10	45	60	0	235	360	
	€O	1340	200	0	0	0	0	360	0	0	10	370	
	TD	1540		230	0	0	100	695	650	55	1510	3240	
J6	M	498	302	0	0	0	0	0	60	0	0	60	Bottoms in €l.
	MDc	800	6	0	0	0	0	0	30	0	0	20	
	€O	806	1074	60	40	60	170	200	30	95	95	750	
	TD	1880		60	40	60	170	200	120	95	95	830	
J7	ℙ	450	910	205	0	60	485	445	850	40	845	2930	
	M	1360	290	0	0	20	30	0	200	0	20	270	
	MDc	1650	20	0	0	20	0	100	20	0	0	140	
	€O	1670	20	0	0	0	0	0	10	0	0	10	
	TD	1690		205	0	100	515	545	1080	40	865	3350	
J8	M	1600	26	0	0	0	0	0	0	0	0	0	Bottoms in pink granite.
	€O	1626	482	0	0	35	95	510	70	20	60	790	
	p€	2108	24	0	0	0	0	0	0	10	0	10	
	TD	2132		0	0	35	95	510	70	30	60	800	
J9	€O	1984	506	0	0	0	70	130	0	0	25	225	Bottoms in pink granite.
	p€	2490	147	0	0	200	25	0	15	0	0	240	
	TD	2637		0	0	200	95	130	15	0	25	465	
J10	M	1170	140	0	0	50	0	0	110	0	90	250	
	€O	1310	890	240	0	130	1150	120	740	1830	210	4420	
	TD	2200		240	0	180	1150	120	850	1830	300	4670	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J11	P	500	760	40	0	60	100	180	520	0	640	1540	Bottoms in pink granite.
	M	1260	320	0	0	0	600	80	120	0	60	860	
	MDc	1580	40	0	0	0	60	0	0	0	0	60	
	€O	1620	732	0	40	320	140	260	0	60	0	820	
	p€	2352	148	0	0	0	0	0	0	0	0	0	
	TD	2500		40	40	380	900	520	640	60	700	3280	
J12 •	P	400	1220	380	0	40	205	340	575	400	805	2745	Poor-quality samples.
	M	1620	280	0	0	0	0	60	40	280	180	560	
	MDc	1900	40	0	0	0	0	120	0	0	0	120	
	€O	1940	175	0	0	0	0	300	0	60	40	400	
	TD	2115		380	0	40	205	820	615	740	1025	3825	
J13	P	240	1200	120	0	240	120	460	840	0	380	2160	Sample interval 2325 to 2585 in granite not analyzed.
	M	1440	205	0	0	0	0	0	30	0	0	30	
	MDc	1645	45	0	0	40	0	200	40	0	0	280	
	€O	1690	590	80	0	0	0	0	0	0	400	480	
	p€	2280	45	0	0	0	0	0	0	0	0	0	
	TD	2587		200	0	280	120	660	910	0	780	2950	
J14	€O	1406	902	145	100	0	840	205	10	90	65	1455	Only four scattered samples available from 1406 to 1970 depth. High Ba and Sr (>1%) in lower part of €O; bottoms in pink biotite granite.
	p€	2308	155	0	0	0	0	0	0	0	0	0	
	TD	2463		145	100	0	840	205	10	90	65	1455	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J15	€O	2109	396	340	40	50	340	580	190	255	200	1995	Bottoms in pink biotite granite.
	TD	2505		340	40	50	340	580	190	255	200	1955	
J16	€O	1920	728	30	0	80	290	180	0	60	90	730	Very high Sr (1-10%) from 2140 to 2230; bottoms in biotite granite.
	p€	2648	7	0	0	0	0	0	0	0	0	0	
	TD	2655		30	0	80	290	180	0	60	90	730	
J17	€O	1360	499	220	275	0	150	390	0	310	0	1345	Only 11 poor-quality samples available
	TD	1859											
J19	M	1407	239	0	0	0	0	0	0	0	0	0	Sample intervals range from 30 to 100 ft. Bottoms in pink biotite granite.
	MDc	1646	38	0	0	10	0	50	0	0	0	60	
	€O	1684	847	0	0	0	0	150	0	90	0	240	
	p€	2531	8	0	0	0	0	0	0	0	0	0	
	TD	2539		0	0	10	0	200	0	90	0	300	
J20	P	35	440	70	0	150	50	200	340	40	345	1195	Sample intervals 10-60 ft.
	M	475	415	0	0	0	0	0	0	0	0	0	
	MDc	890	20	10	0	20	0	0	40	0	20	80	
	€O	910	775	100	100	60	115	145	50	110	765	1445	
	TD	1685		180	100	230	165	345	430	150	1130	2720	
J22	M	1675	325	0	0	45	0	840	25	0	210	1120	Only six samples available. One sample, 1740 to 1800 ft, contained 700 ppm Zn.
	MDc	2000	80	0	0	0	0	0	0	0	0	0	
	€O	2080	30	0	0	0	0	45	0	0	0	45	
	TD	2110		0	0	45	0	885	25	0	210	1165	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J23	P	1440	20	0	0	0	0	0	0	0	0	0	Sample intervals 20-50 ft; only 14 samples available.
	M	1460	340	0	0	30	135	40	20	0	0	225	
	MDc	1800	41	0	0	10	60	110	0	0	0	180	
	€O	1841	29	0	0	0	0	30	0	0	0	30	
	TD	1870		0	0	40	195	180	20	0	0	435	
J24	P	1000	500	240	0	0	160	520	220	0	0	1140	Sample intervals 40-100 ft; bottoms in pink granite.
	M	1500	260	0	0	0	90	160	0	6	0	250	
	€O	1760	690	0	0	50	440	840	100	0	0	1430	
	p€	2450	150	0	0	150	0	0	0	0	0	150	
	TD	2600		240	0	200	690	1520	320	6	0	2970	
J25	P	1050	593	400	0	0	120	400	460	0	240	1620	Sample intervals 20-120 ft; most AMF values are from single, thick-interval samples.
	M	1643	297	0	0	0	0	0	0	0	275	275	
	MDc	1940	90	0	0	0	0	450	0	0	0	450	
	€O	2030	270	0	0	0	0	680	0	0	175	855	
	TD	2300		400	0	0	120	1530	460	0	690	3200	
J26	P	1590	28	0	0	0	0	0	0	0	0		Sample intervals 10-100 ft; bottoms in pink granite.
	M	1618	192	0	0	0	90	0	0	0	0	90	
	MDc	1810	70	0	0	0	0	350	105	0	0	455	
	€O	1880	925	0	0	180	0	375	60	350	0	965	
	p€	2805	3	0	0	0	0	0	0	5	0	5	
	TD	2808		0	0	180	90	725	165	355	0	1515	
J27	M	695	305	0	0	0	30	0	20	0	0	50	Sample intervals 20-40 ft.
	€O	1000	665	0	0	0	0	120	60	0	0	180	
	TD	1665		0	0	0	30	120	80	0	0	230	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J28	IP	40	276	0	0	0	0	0	0	0	0	0	Sample intervals 10-30 ft.
	M	316	369	0	0	0	0	0	90	30	70	190	
	ꞒO	685	1177	0	0	0	20	185	0	0	0	205	
	TD	1862		0	0	0	20	185	90	30	70	395	
J29	ꞒO	850	983	145	0	0	360	410	120	265	70	1370	Sample intervals 10-100 ft; bottoms in pink granite.
	pꞒ	1833	19	0	0	0	0	0	0	0	0	0	
	TD	1852	—	145	0	0	360	410	120	265	70	1370	
J30	IP	350	10	0	0	0	0	0	0	0	0	0	Bottoms in pink granite.
	M	360	305	0	0	0	0	0	0	0	105	105	
	MDc	665	55	0	0	0	0	0	0	0	0	0	
	ꞒO	720	1122	0	0	0	0	50	0	0	75	125	
	pꞒ	1842	20	0	0	0	0	0	0	0	0	0	
	TD	1862		0	0	0	0	50	0	0	180	230	
J31	IP	0	1100	80	0	195	80	480	1255	20	105	2215	Ni and Co values are derived from fragments of mica peridotite in the cuttings.
	TD	1100											
J32	IP	500	880	220	0	0	435	395	605	1270	685	3610	Barium >5000 ppm in interval 590 to 630 ft; traces of mica peridotite in cuttings.
	TD	1380											

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J33	IP	10	394	0	0	0	0	0	75	0	0	75	Sample intervals 30-50 ft.
	M	404	334	0	0	0	0	60	140	0	0	200	
	€O	738	1168	0	0	0	35	100	0	60	0	195	
	p€	1906	11	0	0	0	0	0	0	0	0	0	
	TD	1927		0	0	0	35	160	215	60	0	470	
J34	IP	200	629	0	0	230	60	240	785	260	580	2155	Sample intervals 40-60 ft; bottoms in pink granite.
	M	829	296	0	0	0	0	0	0	0	60	60	
	MDc	1125	35	0	0	0	0	0	0	0	0	0	
	€O	1160	375	0	0	0	1230	870	0	460	585	3145	
	p€	1535	27	0	0	0	200	0	0	0	0	200	
	TD	1562		0	0	230	1490	1110	785	720	1225	5560	
J35	M	1277	322	0	0	20	30	100	125	75	290	640	Bottoms in pink granite.
	MDc	1599	19	0	0	0	0	200	0	0	0	200	
	€O	1618	782	60	0	0	85	310	15	85	65	620	
	p€	2400	47	0	0	0	0	50	0	10	0	50	
	TD	2447		60	0	20	115	660	140	170	355	1520	
J36	IP	90	1430	170	0	120	40	560	480	0	350	1720	
	M	1520	260	0	0	0	0	0	0	0	150	150	
	MDc	1780	30	0	0	0	0	120	0	0	0	120	
	€O	1810	50	0	0	0	0	20	0	0	50	70	
	TD	1860		170	0	120	40	700	480	0	550	2060	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J37	P	1151	189	0	0	262	0	0	1010	60	160	1492	Mica peridotite chips in the top 200 ft of P; Ba >5000 ppm, 1151 to 1169 ft.
	M	1340	195	0	0	0	0	0	0	0	0	0	
	MDc	1535	15	0	0	0	0	0	0	0	0		
	ЄO	1550	90	0	0	0	0	165	0	0	50	215	
	TD	1640		0	0	262	0	165	1010	60	210	1707	
J38	P	180	850	155	0	0	35	510	220	0	1580	2345	Sample intervals 30-40 ft.
	M	1030	294	0	0	0	0	0	40	0	105	145	
	MDc	1324	28	0	0	0	0	90	30	0	0	120	
	ЄO	1352	33	0	0	0	0	0	0	0	0	0	
	TD	1385		155	0	0	35	600	290	0	1685	2610	
J39	ЄO	1170	630	0	100	0	70	210	0	0	0	380	No samples available 1860 to 1945; pЄ probably metamorphic rock.
	pЄ	1800	175	0	0	0	0	0	0	0	0	0	
	TD	1975		0	100	0	70	210	0	0	0	380	
J40	M	1170	245	0	0	0	0	0	0	0	0	0	Only three samples available; two samples are M (1170 to 1350 ft); no sample (1350 to 1400 ft); bottom sample (1400 to 1470 ft) probably pЄ quartzite. Implies M directly on pЄ.
	pЄ	1415	55	0	0	0	0	0	0	0	0	0	
	TD	1470		0	0	0	0	0	0	0	0	-	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J41	M	1200	330	0	0	0	0	0	80	0	30	110	
	MDc	1530	20	0	0	0	0	100	30	0	0	130	
	€O	1550	180	0	0	0	0	0	0	0	0	0	
	TD	1730		0	0	0	0	100	110	0	30	240	
J42	P	10	790	105	0	60	197	205	220	80	450	1317	
	M	800	315	0	0	10	0	0	255	0	25	290	
	TD	1115		105	0	70	197	205	475	80	475	1607	
J43	P	10	270	0	0	25	0	0	80	15	75	195	
	M	280	340	0	0	40	0	0	225	0	10	275	
	€O	620	40	0	0	0	0	0	0	0	0	0	
	TD	660		0	0	65	0	0	305	15	85	470	
J44	P	280	200	7	0	0	0	0	20	0	35	62	
	M	480	230	0	0	0	0	0	0	0	10	10	
	TD	710		7	0	0	0	0	20	0	45	72	
J45	P	10	436	30	0	0	45	55	145	0	145	420	
	M	446	339	0	0	0	0	30	15	0	60	105	
	TD	785		30	0	0	45	85	160	0	205	525	
J46	P	640	2	0	0	0	0	0	0	0	0	0	
	M	642	348	0	0	0	0	20	120	0	0	140	
	TD	990		0	0	0	0	20	120	0	0	140	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J47	ℙ	25	245	15	0	0	0	0	85	125	260	485	
	M	270	230	0	0	0	0	0	0	0	0	0	
	TD	500		15	0	0	0	0	85	125	260	485	
J48	ℙ	20	360	0	0	0	0	20	135	0	310	465	
	M	380	208	0	0	0	0	0	0	0	25	25	
	TD	588		0	0	0	0	20	135	0	335	490	
J49	ℙ	20	232	10	0	0	10	10	150	0	95	275	
	M	252	208	0	0	0	0	0	10	890	75	965	
	TD	460		10	0	0	10	10	160	890	170	1240	
J53	ℙ	5	451	10	0	0	35	100	335	0	295	777	
	M	456	384	0	0	0	0	0	75	0	85	160	
	TD	840		10	0	0	35	100	410	0	380	937	
J54	ℙ	20	430	35	0	50	45	40	100	0	115	395	
	M	450	370	0	0	0	0	0	40	0	0	40	
	€O	820	235	0	0	0	0	0	0	0	0	0	
	TD	840		35	0	50	45	40	140	0	115	435	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J55	P	370	10	0	0	0	0	0	0	0	0	0	
	M	380	380	0	0	15	0	10	140	0	10	175	
	€O	760	15	0	0	0	0	0	0	0	0	0	
	TD	775		0	0	15	0	10	140	0	10	175	
J56	P	20	580	55	0	20	55	95	230	10	355	820	
	M	600	300	0	0	10	25	35	75	0	35	180	
	MDc	900	10	0	0	15	10	0	0	0	0	25	
	€O	910	15	0	0	10	0	0	10	0	10	30	
	TD	925		55	0	55	90	130	315	10	400	1055	
J57	P	480	20	0	0	0	0	0	5	0	0	5	
	M	500	195	0	0	0	30	15	10	0	60	115	
	TD	695		0	0	0	30	15	15	0	60	120	
J58	P	700	990	0	0	110	1155	45	620	30	1220	3180	Irregular sample intervals 10-40 ft.
	M	1690	240	0	0	0	0	0	10	0	180	190	
	MDc	1930	40	0	0	15	0	45	0	0	0	60	
	€O	1970	15	0	0	0	0	45	0	0	0	45	
	TD	1985		0	0	125	1155	135	630	30	1400	3475	
J59	P	450	1135	0	0	250	530	250	725	370	1350	3475	Irregular sample intervals 30-60 ft.
	M	1585	235	20	0	0	0	0	0	0	20	40	
	MDc	1820	30	0	0	20	0	115	0	0	0	135	
	€O	1850	210	0	0	0	0	40	50	0	0	90	
	TD	2060		20	0	270	530	405	775	370	1370	3740	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J60	P	100	1723	20	0	350	420	160	565	2000	1355	4870	2,000 AMF Pb from a single sample interval, 1470-1490 ft.
	M	1823	287	0	0	20	80	0	110	0	300	510	
	MDc	2110	50	0	0	20	0	30	50	0	0	100	
	€O	2160	37	0	0	35	0	30	20	30	0	115	
	TD	2197		20	0	425	500	220	745	2030	1655	5595	
J61	P	1010	345	0	0	30	0	0	70	0	35	135	
	M	1355	225	0	0	0	0	0	10	0	55	65	
	MDc	1580	127	0	0	20	0	100	60	0	25	205	
	€O	1707	6	0	0	25	0	25	10	0	0	60	
	TD	1713		0	0	75	0	125	150	0	115	465	
J62	P	350	1225	110	0	60	435	260	715	150	670	2400	
	M	1575	228	0	0	0	0	0	30	0	0	30	
	MDc	1803	53	0	0	0	0	30	0	0	0	30	
	€O	1856	149	0	0	0	0	0	0	0	75	75	
	TD	2005		110	0	60	435	290	745	150	745	2535	
J63	P	100	180	0	0	75	0	0	155	0	50	280	
	M	280	420	0	0	0	0	0	30	0	0	30	
	€O	700	770	0	0	0	0	200	0	0	0	200	
	TD	1470		0	0	75	0	200	185	0	50	510	
J64	€O	505	589	0	0	0	0	30	0	0	300	330	
	TD	1094		0	0	0	0	30	0	0	300	330	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J65	P	200	1040	80	0	80	0	120	200	0	310	790	Sample intervals 20-40 ft.
	M	1240	260	0	0	40	0	60	40	0	60	200	
	MDc	1500	60	0	0	20	0	120	0	0	20	160	
	€O	1560	20	0	0	20	0	30	0	0	0	50	
	TD	1580		80	0	160	0	330	240	0	390	1200	
J66	€O	1050	237	0	0	0	0	55	0	0	25	80	
	TD	1287											
J67	P	500	400	40	0	0	40	120	150	0	160	510	Sample intervals 20-40 ft.
	M	900	390	0	0	0	0	80	40	0	40	160	
	MDc	1290	10	0	0	0	0	0	0	0	0	0	
	€O	1300	400	0	0	0	80	0	0	0	0	80	
	TD	1700		40	0	0	120	200	190	0	200	750	
J68	P	500	365	20	0	0	80	90	180	0	170	540	
	M	865	345	0	0	0	100	0	25	0	125	250	
	MDc	1210	20	0	0	0	0	20	20	0	20	60	
	€O	1230	45	0	0	0	0	0	0	0	0	0	
	TD	1275		20	0	0	180	110	225	0	315	850	
J69	P	703	345	0	0	0	0	0	35	0	0	35	Sample intervals 20-30 ft.
	M	1048	312	0	0	0	45	45	0	0	0	90	
	MDc	1360	24	0	0	0	0	25	0	0	0	25	
	TD	1384		0	0	0	45	70	35	0	0	150	
J70	P	120	1150	120	0	150	400	410	385	0	695	2160	Sample intervals 40-100 ft.
	M	1270	50	0	0	0	0	0	0	0	0	0	
	TD	1320		120	0	150	400	410	385	0	695	2160	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J71	ЄO	640	390	10	0	10	0	270	10	0	0	300	Sample intervals 10-20 ft.
	Td	1030											
J72	ℙ	900	570	20	0	0	80	160	220	0	505	985	Sample intervals 20-40 ft.
	M	1470	290	0	0	0	0	0	0	0	190	190	
	MDc	1760	10	0	0	0	0	30	0	0	0	30	
	TD	1770		20	0	0	80	190	220	0	695	1205	
J73	ℙ	415	10	0	0	0	0	0	0	0	50	50	Sample intervals 10-30 ft.
	M	435	314	0	0	4	6	0	20	0	0	30	
	MDc	749	3	0	0	10	20	15	15	0	50	110	
	ЄO	752	313	0	0	0	0	0	0	0	0	0	
	TD	1065		0	0	14	26	15	35	0	100	190	
J74	M	765	275	30	0	30	30	60	45	0	20	215	Sample intervals 10-40 ft.
	ЄO	1040	175	0	0	0	20	0	0	0	0	20	
	TD	1215		30	0	30	50	60	45	0	20	235	
J75	M	890	210	0	0	0	60	0	0	0	270	330	About 20-ft sample intervals.
	MDc	1100	20	0	0	0	0	30	0	0	0	30	
	ЄO	1120	15	0	0	0	0	15	0	0	0	15	
	TD	1135		0	0	0	60	45	0	0	270	375	
J76	ℙ	300	800	0	0	0	0	0	0	0	0	0	Sample intervals 60-250 ft; only five samples available.
	TD	1100											

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J78	P	500	640	50	0	140	80	230	405	0	200	1105	Sample intervals 30-60 ft.
	M	1140	270	0	0	30	0	0	30	0	40	100	
	€O	1410	101	0	0	0	0	0	0	0	0	0	
	TD	1511		50	0	170	80	230	435	0	240	1205	
J79	P	580	435	0	0	0	0	50	75	0	50	175	Sample intervals 50-70 ft.
	TD	1015											
J100	M	20	390	0	0	0	0	0	145	0	435	580	
	€O	410	1060	0	30	0	20	55	10	240	410	765	
	TD	1470		0	30	0	20	55	155	240	845	1345	
J101	M	60	360	0	0	10	0	0	35	15	485	545	Golden Hawk core, Picher field.
	€O	420	1270	30	0	0	30	90	0	85	25	260	
	TD	1690		30	0	10	30	90	35	100	510	805	
J102	M	250	120	0	0	20	0	25	15	0	25	85	Anna Beaver drill-hole, Picher field.
	€O	370	941	0	0	0	80	10	0	215	1195	1500	
	TD	1311		0	0	20	80	35	15	215	1220	1585	
J103	P	100	45	--	0	15	0	0	20	0	15	50	Bird Dog drillhole, Picher field; Cambrian section not present.
	M	145	275	0	0	0	15	0	0	50	95	160	
	€O	420	786	0	0	0	280	410	0	15	1830	2535	
	TD	1206		0	0	15	295	410	20	65	1940	2745	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J104	IP	300	5	0	0	0	0	0	0	0	0		John Beaver drill-
	M	305	145	0	0	0	0	0	0	0	15	15	hole, Picher field.
	ꞒO	450	1320	60	25	0	25	615	55	155	1205	2140	
	TD	1770		60	25	0	25	615	55	155	1220	2155	
J105	M	440	377	0	0	0	0	0	10	1740	405	2155	Kansas Exchange,
	ꞒO	817	1139	290	80	20	155	720	120	195	20	1600	Picher field,
	pꞒ	1956	74	0	0	0	0	0	0	0	0	0	Cambrian section cored; bottoms in
	TD	2030		290	80	20	155	720	130	1935	425	3755	maroon rhyolite.
J106	IP	90	30	0	0	0	0	10	0	0	0	10	Webber drillhole,
	M	120	360	0	0	10	35	0	35	0	485	565	Picher field,
	ꞒO	480	1183	620	520	40	1715	1495	150	325	10	4875	Cambrian section cored.
	TD	1663		620	520	50	1750	1505	185	325	495	5450	
J107	M	120	315	0	0	10	0	20	20	280	1305	1635	King Brand drill-
	ꞒO	435	1279	110	35	10	20	355	15	140	375	1060	hole, Picher field;
	pꞒ	1714	136	not analyzed									Cambrian section cored; bottoms in
	TD	1850		110	35	20	20	375	35	420	1680	2695	maroon rhyolite.
J108	M	0	345	0	0	85	25	35	1515	70	385	2115	Visible millerite
	ꞒO	345	915	15	15	140	15	1360	115	925	435	3020	and sphalerite in Mississippian.
	TD	1260		15	15	225	40	1395	1630	995	820	5135	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J109	M	670	240	0	0	55	0	0	85	120	65	325	
	€O	910	906	0	10	0	55	170	0	190	70	495	
	TD	1816		0	10	55	55	170	85	310	135	820	
J110	M	460	420	0	0	0	10	15	20	0	315	360	
	MDc	840	7	0	0	0	0	0	0	0	0	0	
	€O	847	206	0	0	0	0	15	10	0	70	95	
	TD	1053		0	0	0	10	30	30	0	385	455	
J111	IP	100	42	0	0	0	0	0	20	0	0	20	Wilbur drillhole, Picher field. Cambrian Section cored.
	M	142	340	0	0	0	0	0	0	0	855	855	
	€O	474	1307	445	230	25	230	985	195	370	45	2525	
	p€	1789	87	0	0	25	0	0	95	0	10	130	
	TD	1876		445	230	50	230	985	310	370	910	3530	
J112	M	20	460	0	0	45	0	0	25	0	700	770	Bottoms in Oj.
	€O	480	145	0	0	0	20	0	0	0	0	20	
	TD	625		0	0	45	20	0	25	0	700	790	
J113	M	230	380	0	0	0	0	0	50	0	310	360	Sample intervals 10-20 ft; bottoms in Oj.
	€O	610	85	0	0	0	0	0	0	0	0	0	
	TD	695		0	0	0	0	0	50	0	310	360	
J114	M	240	320	0	0	70	0	0	40	0	110	190	Bottoms in Or; 20-ft sample intervals.
	€O	560	340	0	0	0	30	0	0	0	40	70	
	TD	900		0	0	70	30	0	40	0	150	260	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J115	M	10	390	0	0	0	0	0	40	0	520	560	Sample interval 20 ft; bottoms in Og.
	€O	400	720	10	25	10	50	100	60	0	400	655	
	TD	1120		10	25	10	50	100	100	0	920	1215	
J116	M	65	495	0	0	0	0	0	75	0	10	85	Sample intervals 20-40 ft; bottoms in €e.
	€O	560	658	0	0	0	0	305	20	0	0	325	
	TD	1218		0	0	0	0	305	95	0	10	410	
J117	M	100	335	0	0	10	0	0	10	0	0	20	Sample intervals 10-20 ft; bottoms in €dd.
	€O	435	1045	0	0	35	70	95	65	20	810	1095	
	TD	1480		0	0	45	70	95	75	20	810	1115	
J118	M	130	490	0	0	20	0	0	20	0	15	55	Sample interval 20 ft; bottoms in Og.
	€O	490	610	0	0		0	30	0	0	0	30	
	TD	1100		0	0	20	0	30	20	0	15	85	
J119	M	445	255	0	0	0	0	0	30	0	300	330	Sample intervals 10-20 ft; bottoms in Or.
	€O	700	265	0	0	0	0	0	0	0	0	0	
	TD	965		0	0	0	0	0	30	0	300	330	
J120	M	10	260	0	0	0	0	0	220	140	370	730	Sample interval 20 ft; bottoms in €dd.
	€O	270	1132	0	0	0	90	30	0	0	300	420	
	TD	1402		0	0	0	90	30	220	140	670	1150	
J121	M	30	310	0	0	0	0	0	30	0	*1250	1280	*From one sample; sample intervals 5-30 ft; bottoms in €e.
	€O	340	760	0	0	0	0	0	0	0	0	0	
	TD	1100		0	0	0	0	0	30	0	1250	1280	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J122	M	165	355	0	0	0	30	0	35	0	15	80	Sample intervals 10-20 ft; bottoms in Og.
	€O	520	530	0	0	0	0	0	0	0	0	0	
	TD	1050		0	0	0	30	0	35	0	15	80	
J124	ℙ	30	130	0	0	20	0	0	45	0	0	65	*Most of AMF comes from one sample; sample intervals 20-30 ft; bottoms in Og
	M	160	255	0	0	15	0	0	85	0	120	220	
	€O	415	525	0	0	0	*250	0	0	0	70	320	
	TD	940		0	0	35	250	0	130	0	190	605	
J125	M	140	340	0	0	15	160	0	195	0	280	650	Irregular, 5- to 20-ft intervals; bottoms in Og.
	MDc	480	5	0	0	15	5	0	20	0	0	40	
	€O	485	410	0	0	0	0	0	0	0	0	0	
	TD	895		0	0	30	165	0	215	0	280	690	
J126	ℙ	10	195	0	0	95	0	0	125	0	110	330	Sample intervals 10-20 ft; bottoms in Og.
	M	205	390	0	0	30	0	0	20	0	0	50	
	€O	595	222	0	0	0	20	0	20	0	50	90	
	TD	817		0	0	125	20	0	165	0	160	470	
J127	M	220	400	20	0	0	0	30	60	0	445	555	Sample interval 20 ft; bottoms in Or.
	€O	620	220	0	0	0	40	0	0	0	0	40	
	TD	840		20	0	0	40	30	60	0	445	595	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

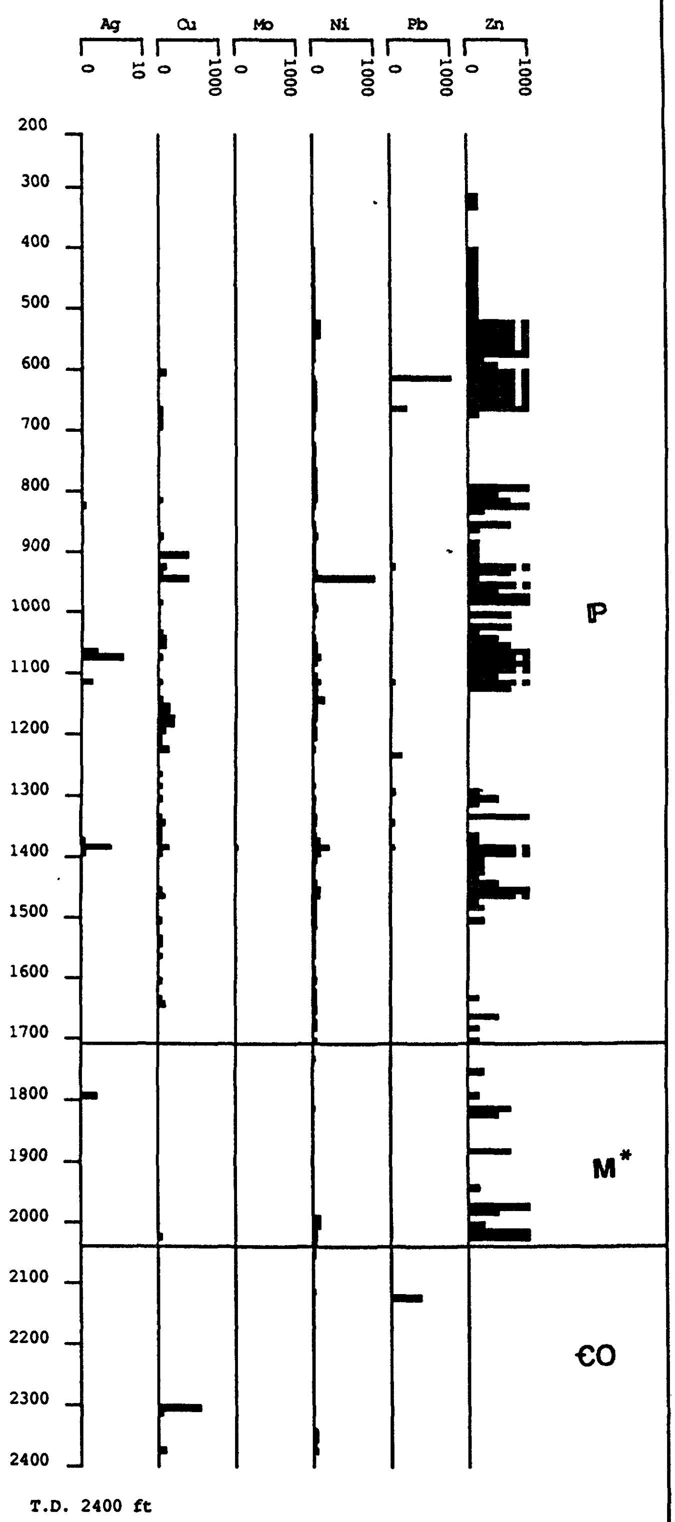
Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J128	M	110	380	0	0	80	140	20	90	0	275	705	Sample interval 20 ft; bottoms in €e.
	€O	490	605	0	0	0	0	0	0	0	0	0	
	TD	1095		0	0	80	140	20	90	0	275	705	
J129	M	15	335	0	0	0	0	0	0	0	0	0	Sample interval 20 ft; bottoms in €d; one sample in Og has 2000 AMF Mo.
	€O	350	1153	65	30	115	220	2710	100	65	45	3350	
	TD	1503		65	30	115	220	2710	100	65	45	3350	
J130	P	150	20	0	0	0	0	0	0	0	0	0	Sample intervals 10-20 ft; bottoms in Og.
	M	170	380	0	0	0	0	0	0	0	0	0	
	MDc	550	50	0	0	0	0	0	0	0	0	0	
	€O	600	450	0	20	0	0	300	0	0	0	320	
	TD	1050		0	20	0	0	300	0	0	0	320	
131	M	190	415	0	0	85	120	0	140	0	140	485	Sample interval 20 ft; bottoms in Or.
	€O	605	325	0	0	160	0	0	20	60	140	380	
	TD	930		0	0	245	120	0	160	60	280	865	
J132	P	15	195	0	0	180	0	0	45	0	20	245	About 20-ft sample intervals; bottoms in Or.
	M	210	440	0	0	20	20	0	40	0	260	340	
	€O	650	135	0	0	0	0	0	0	0	0	0	
	TD	785		0	0	200	20	0	85	0	280	585	
J133	M	30	290	0	0	0	0	0	0	20	0	20	Sample intervals 5-30 ft; bottoms in Or.
	€O	320	547	10	0	0	25	15	15	20	75	160	
	TD	337		10	0	0	25	15	15	40	75	130	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

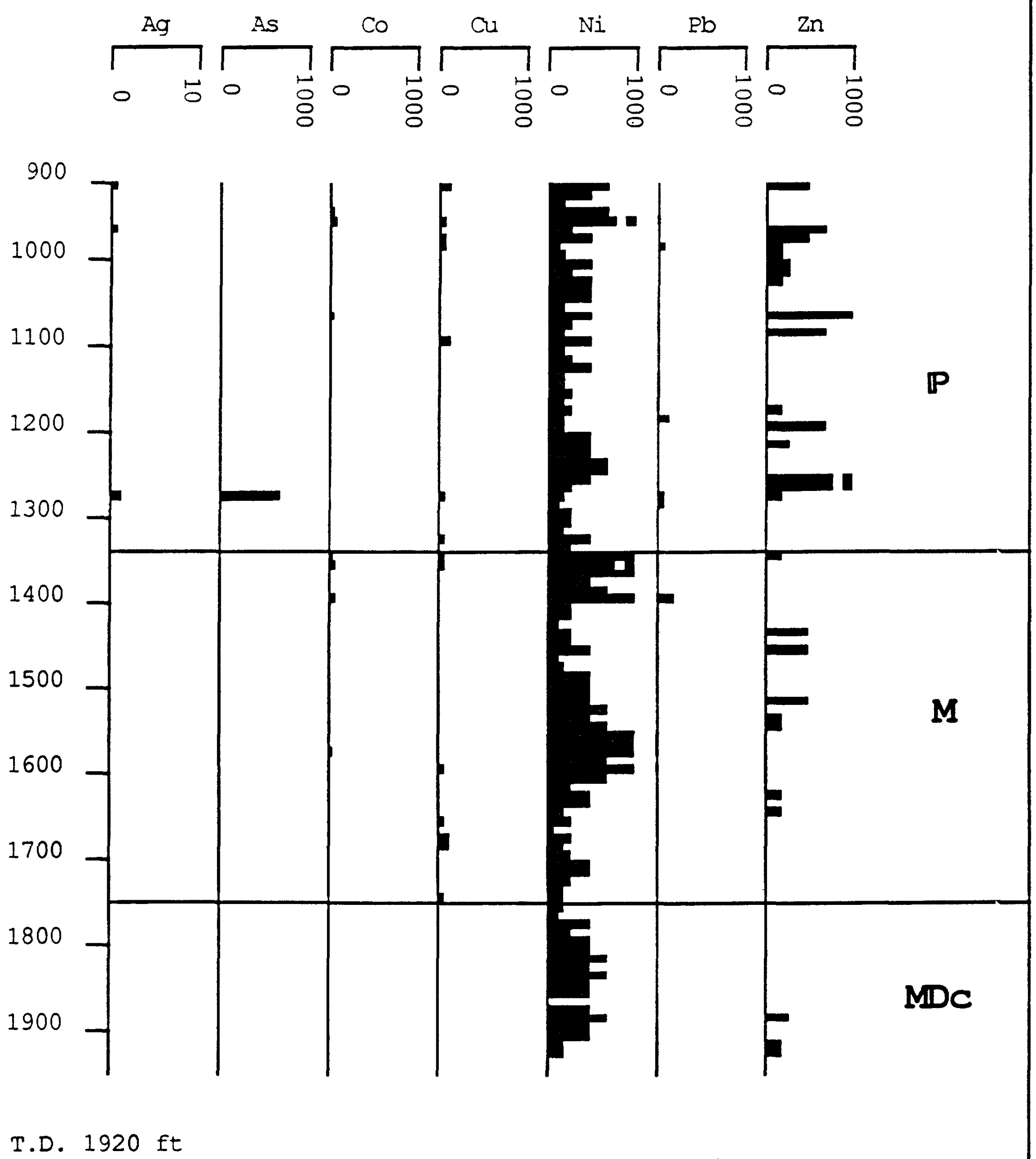
Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
J134	M	20	505	0	0	0	0	0	0	20	245	265	Sample intervals 15-20 ft; bottoms in Og.
	€O	525	460	0	0	0	0	0	0	0	0	0	
	TD	985		0	0	0	0	0	0	20	245	265	
J135	M	95	440	0	0	30	15	0	60	0	170	275	Sample intervals 12-20 ft; bottoms in €e.
	€O	535	680	0	0	0	135	0	0	0	0	135	
	TD	1215		0	0	30	150	0	60	0	170	410	
J136	M	30	290	0	0	0	0	0	0	0	0	0	Sample intervals 15-20 ft; bottoms in €e.
	€O	320	780	30	0	62	35	0	0	0	100	227	
	TD	1100		30	0	62	35	0	0	0	100	227	
PM-1	P	398	10	0	0	0	0	0	10	0	0	10	*Most of AMF comes from one sample; corehole; bottoms in Ordovician.
	M	408	354	80	25	115	95	*2270	*775	45	15	3420	
	€O	762	269	30	0	0	45	45	10	0	*75	205	
	TD	1031		110	25	115	140	2315	795	45	90	3635	
PM-5	P	437	102	0	0	0	0	0	0	0	0	0	Corehole; bottoms in Ordovician.
	M	539	237	50	20	0	40	920	130	55	20	1235	
	€O	776	225	30	45	0	80	150	30	10	10	355	
	TD	1001		80	65	0	120	1070	160	65	30	1590	
PM-9	P	384	10	0	0	0	0	0	0	0	0	0	Corehole; bottoms in Ordovician.
	M	394	354	25	0	10	20	0	215	25	35	330	
	€O	748	242	0	0	0	30	10	10	0	0	50	
	TD	990		25	0	10	50	10	225	25	35	380	

Table 2.--Metal contents (in anomalous metal feet, AMF) of insoluble residue samples from drill holes in the Joplin 1°X2° quadrangle, Kansas and Missouri--Continued

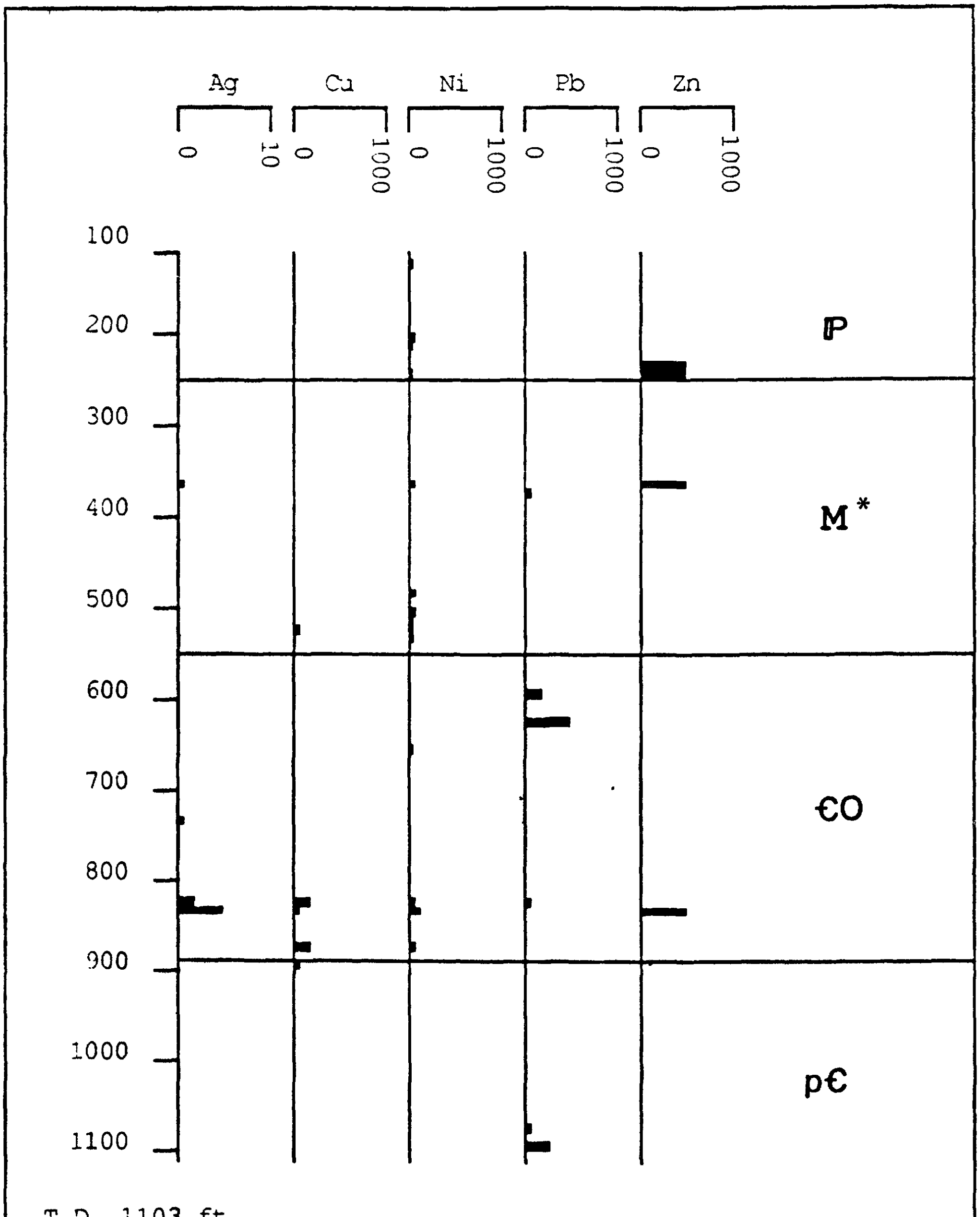
Drill hole No.	Unit	Top of sampled interval from surface	Thickness penetrated	Ag	As	Co	Cu	Mo	Ni	Pb	Zn	Total	Comments
PM-10	M	385	330	0	0	160	10	50	640	10	0	870	Corehole; bottoms in Ordovician.
	€O	715	272	0	0	0	10	0	0	0	0	10	
	TD	987		0	0	160	20	50	640	10	0	880	
S-45	M	15	355	0	15	0	0	0	10	0	60	85	Sample intervals 10-20 ft.
	€O	370	1430	195	785	110	630	1275	355	290	120	3760	
	p€	1800	25	0	0	0	0	0	0	0	0	0	
	TD	1825		195	800	110	630	1275	365	290	180	3845	
DH-89	€O	1070	755	265	30	90	315	200	170	145	0	1215	Corehole; sample intervals 10-20 ft; bottoms in pink granite. Interval analyzed 1070-1590 ft.
	p€	1825	49	not analyzed									
	TD	1874		265	30	90	315	200	170	145	0	1215	



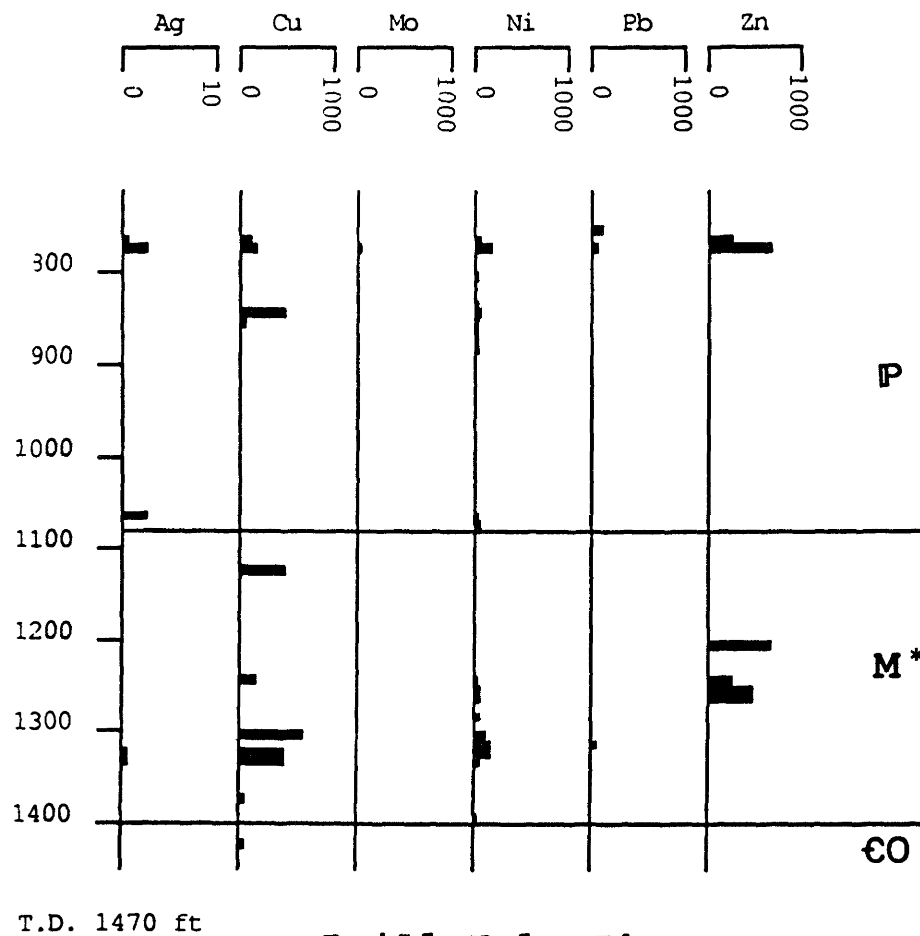
Drill Hole J1



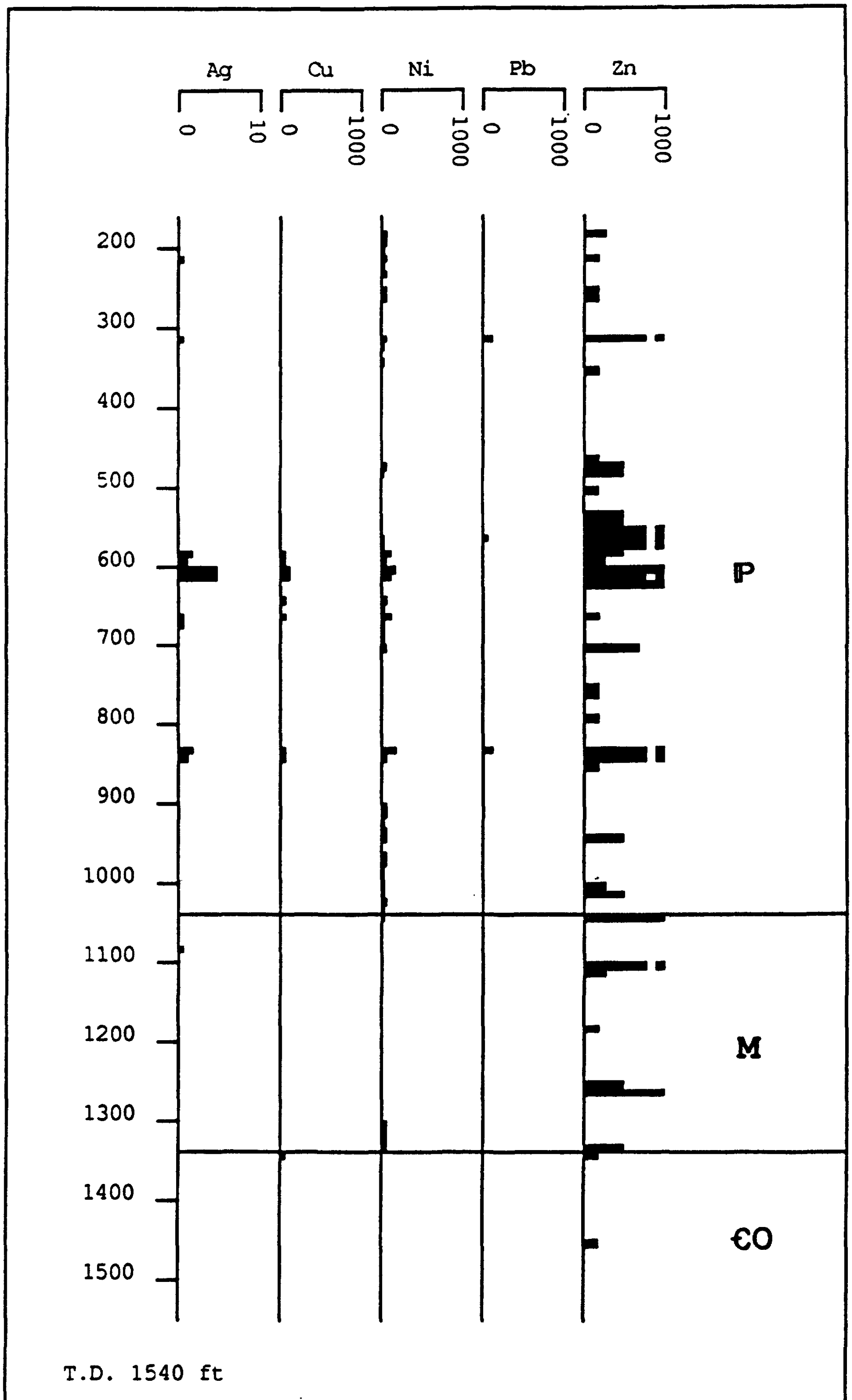
Drill Hole J2



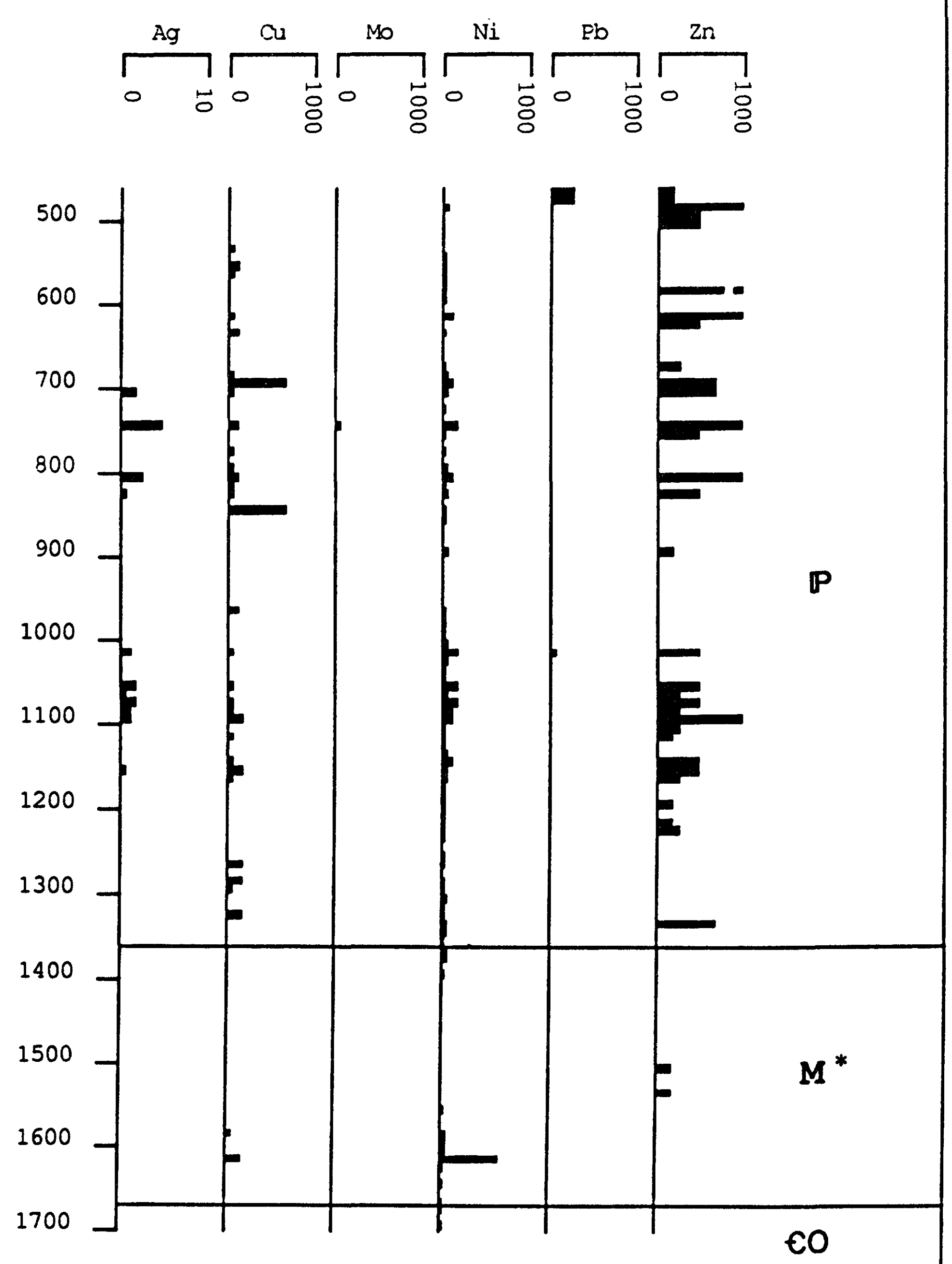
Drill Hole J3



Drill Hole J4

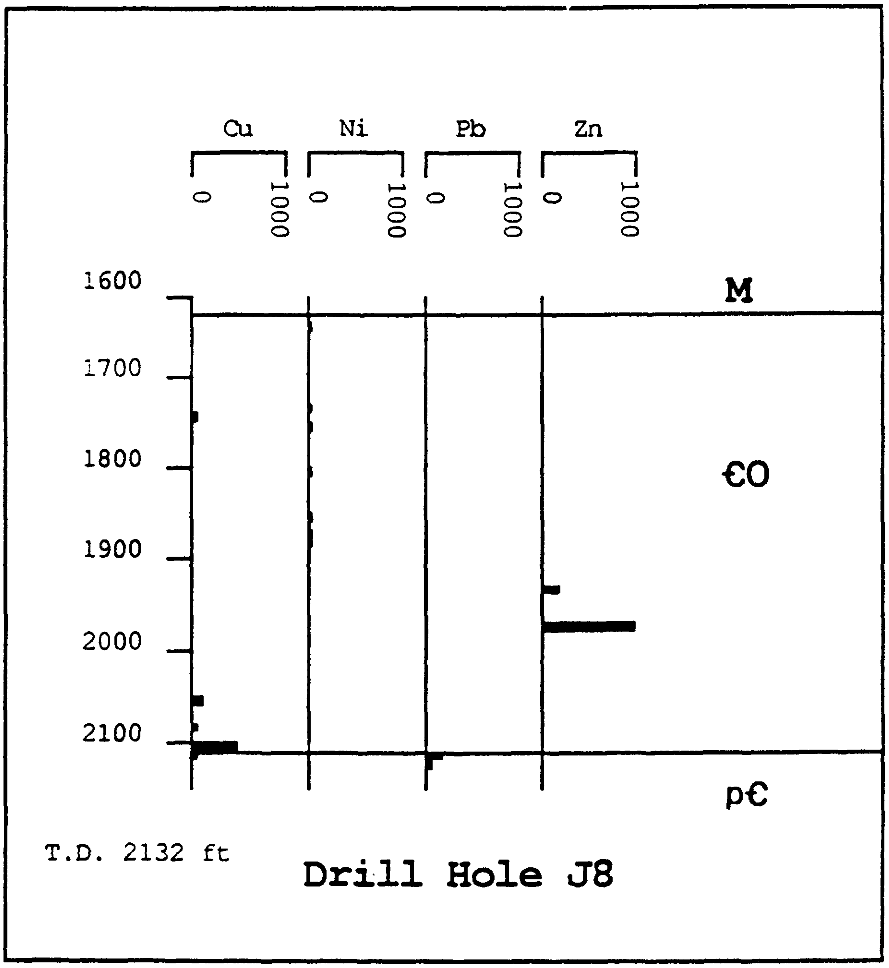


Drill Hole J5

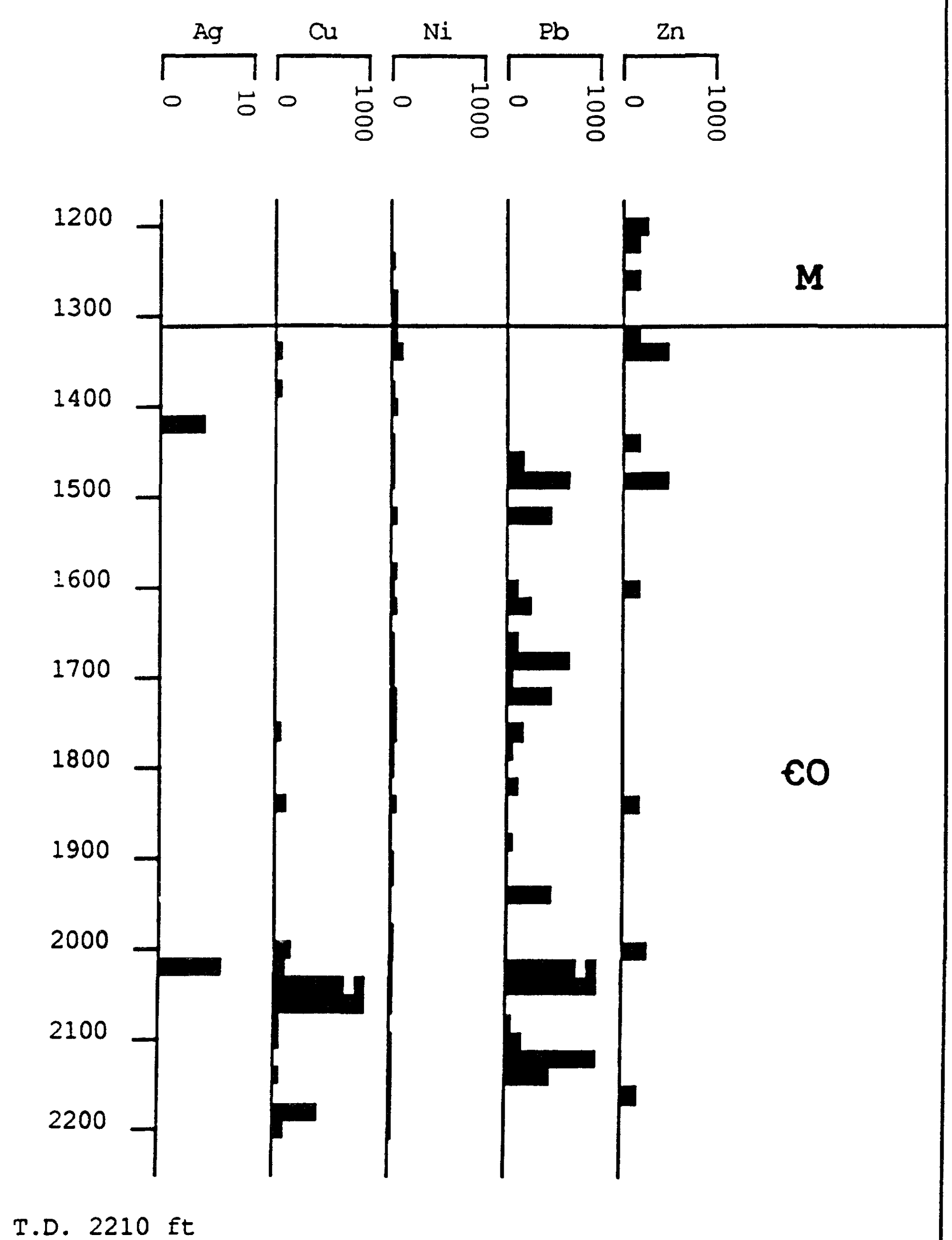


T.D. 1695 ft

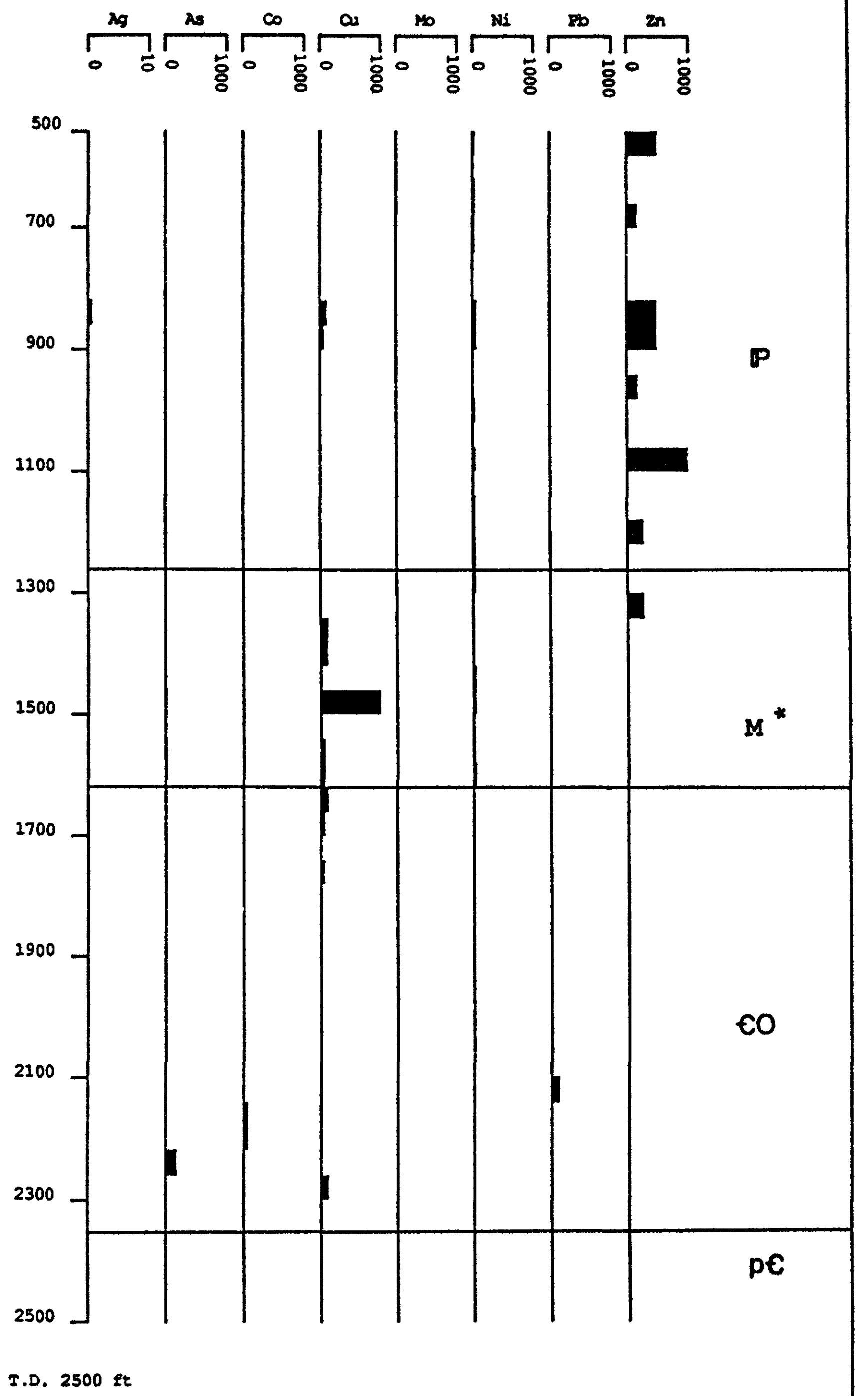
Drill Hole J7



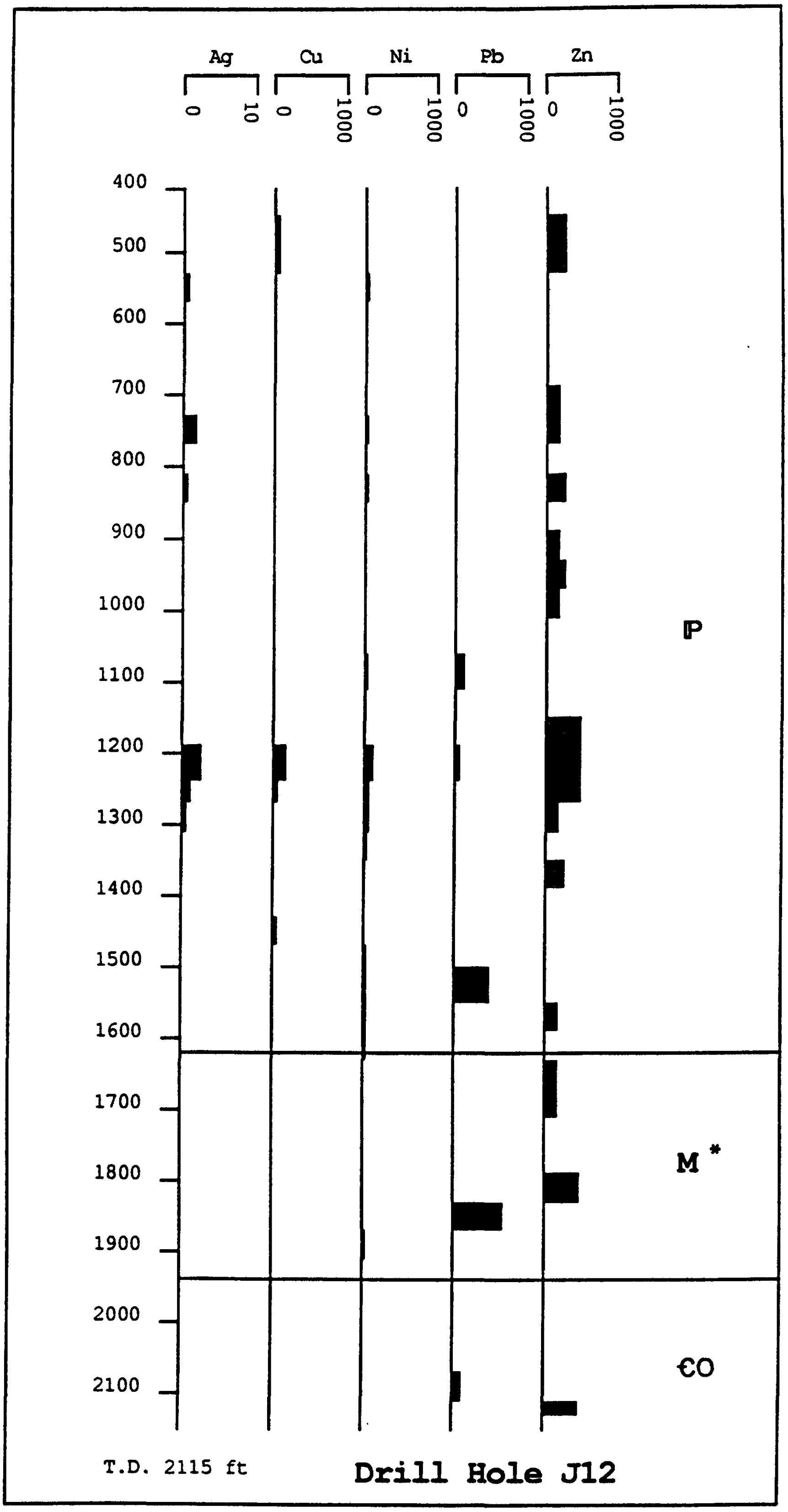
Cu
Ni
Pb
Zn
0
1000
1600
1700
1800
1900
2000
2100
M
€O
p€
T.D. 2132 ft
Drill Hole J8

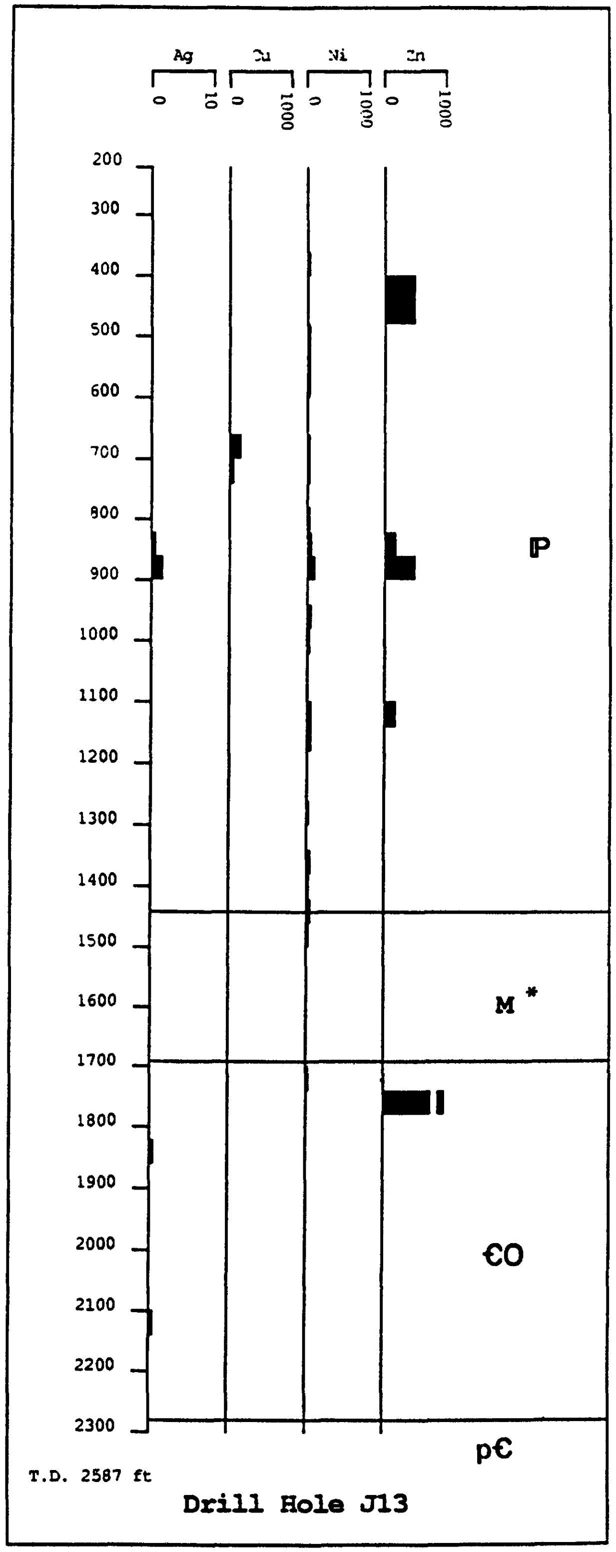


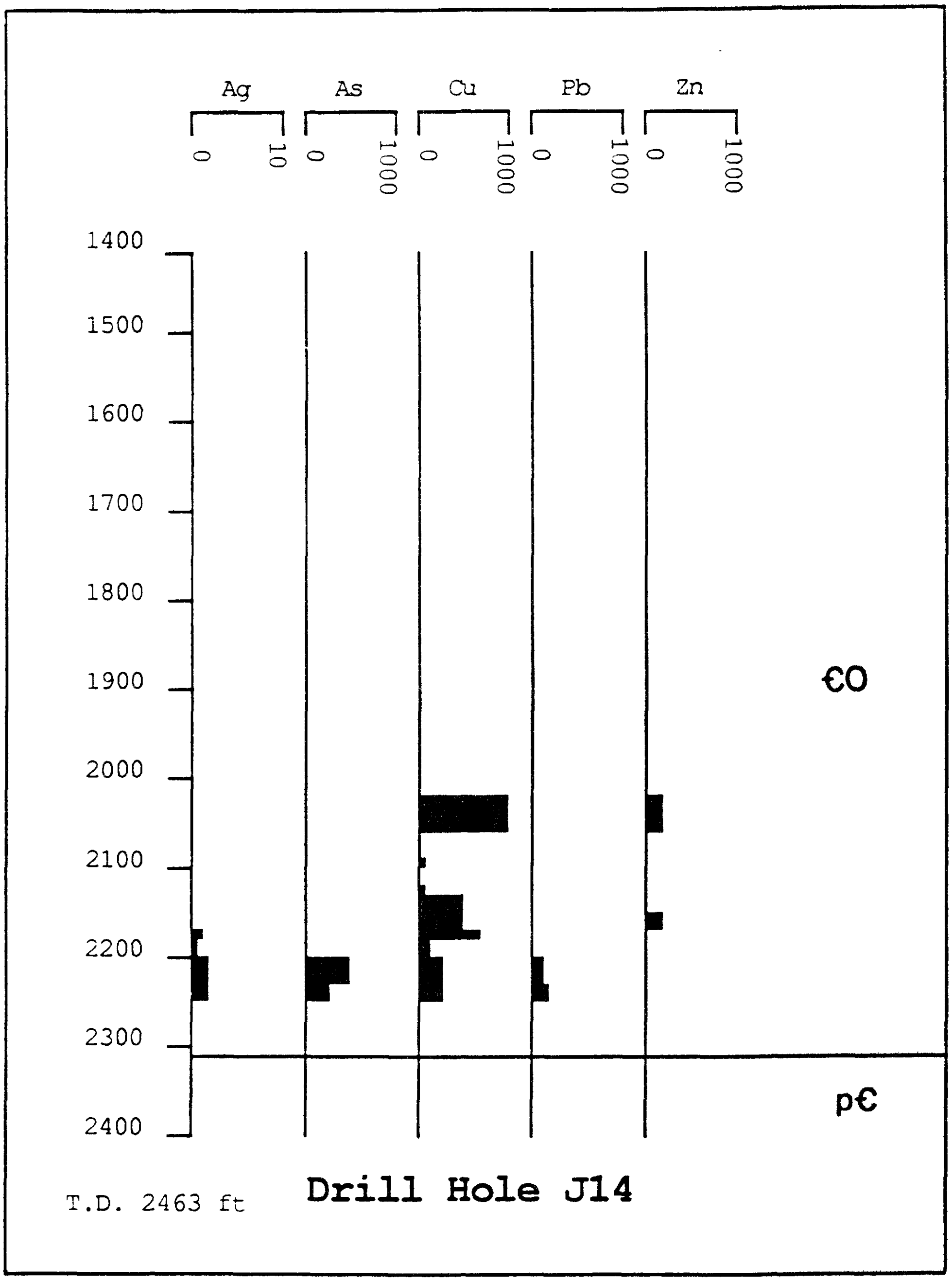
Drill Hole J10



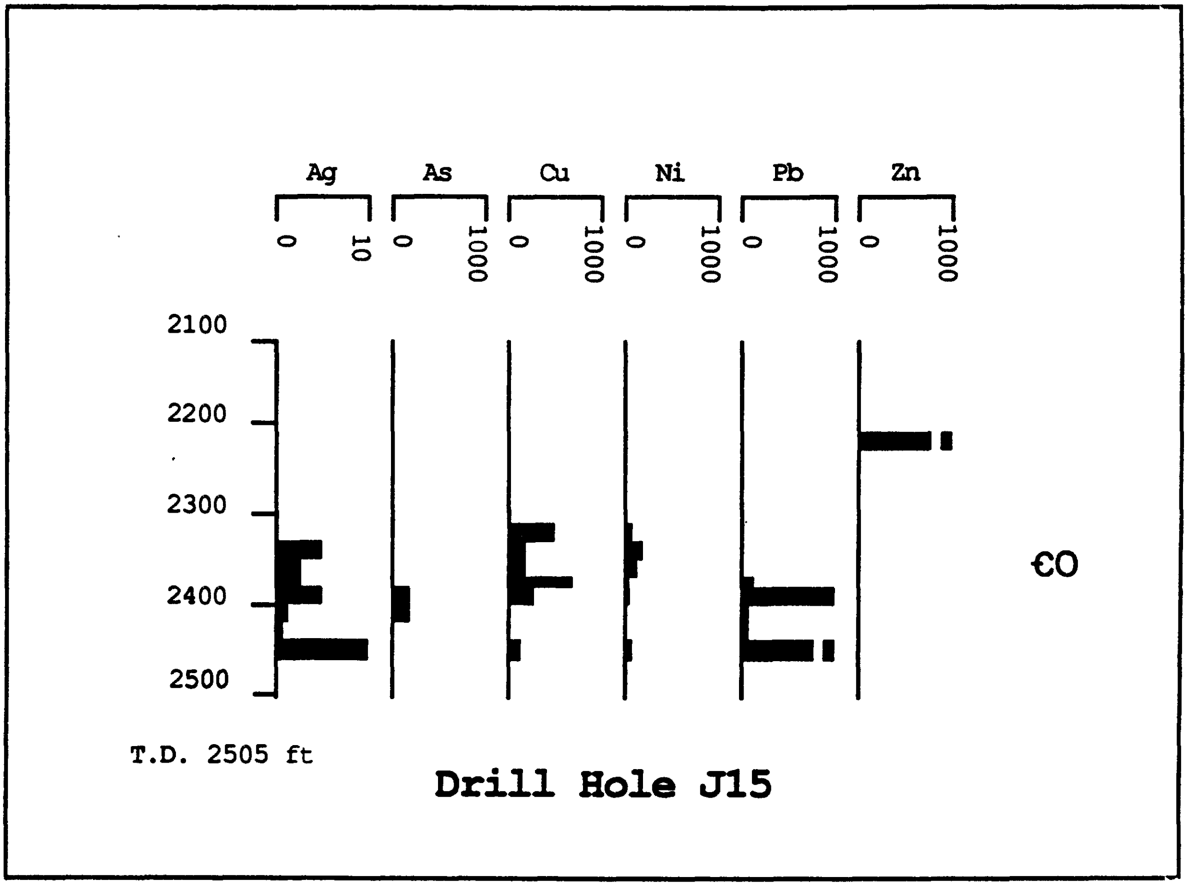
Drill Hole J11

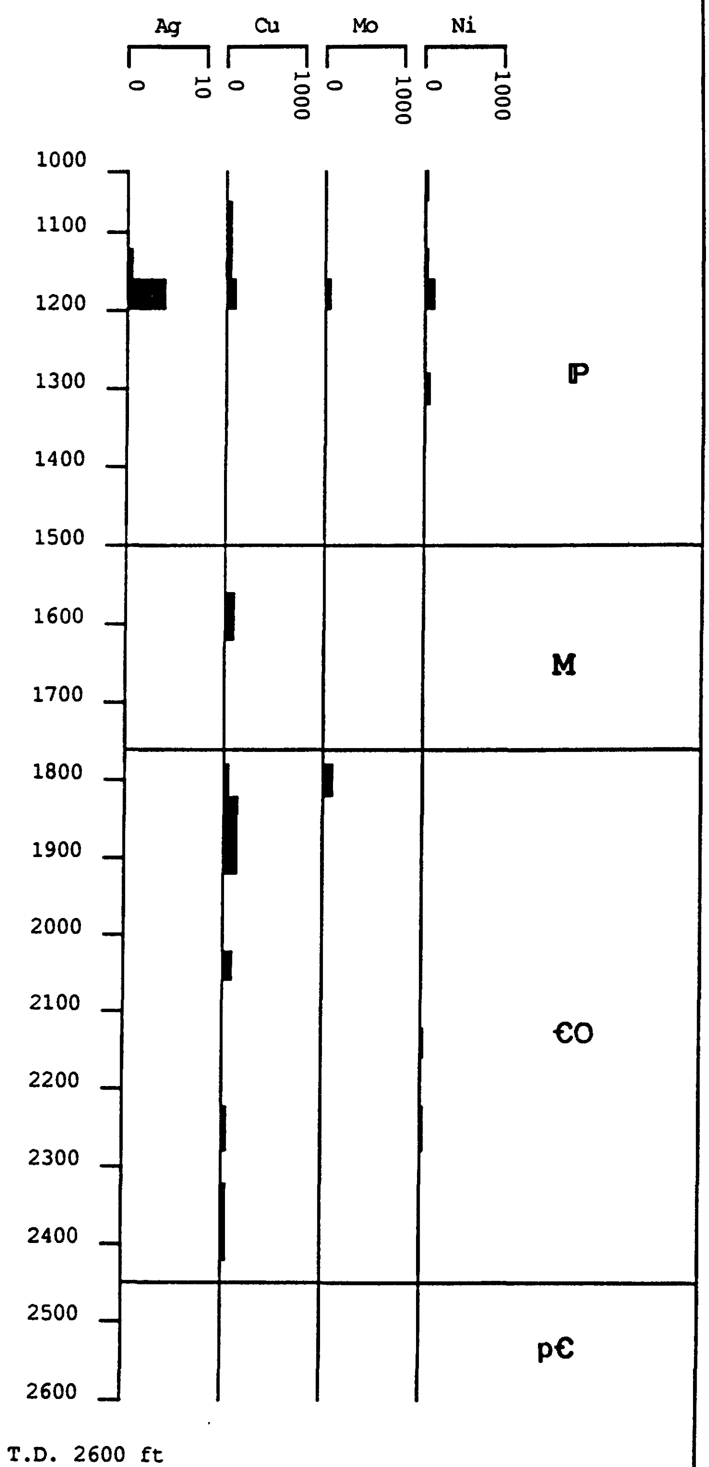

Ag
Cu
Ni
Pb
Zn
0
10
0
1000
0
1000
0
1000
0
1000
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
IP
M *
€O
T.D. 2115 ft
Drill Hole J12


Ag
Cu
Ni
Zn
0
10
1000
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
P
M *
€O
p€
T.D. 2587 ft
Drill Hole J13

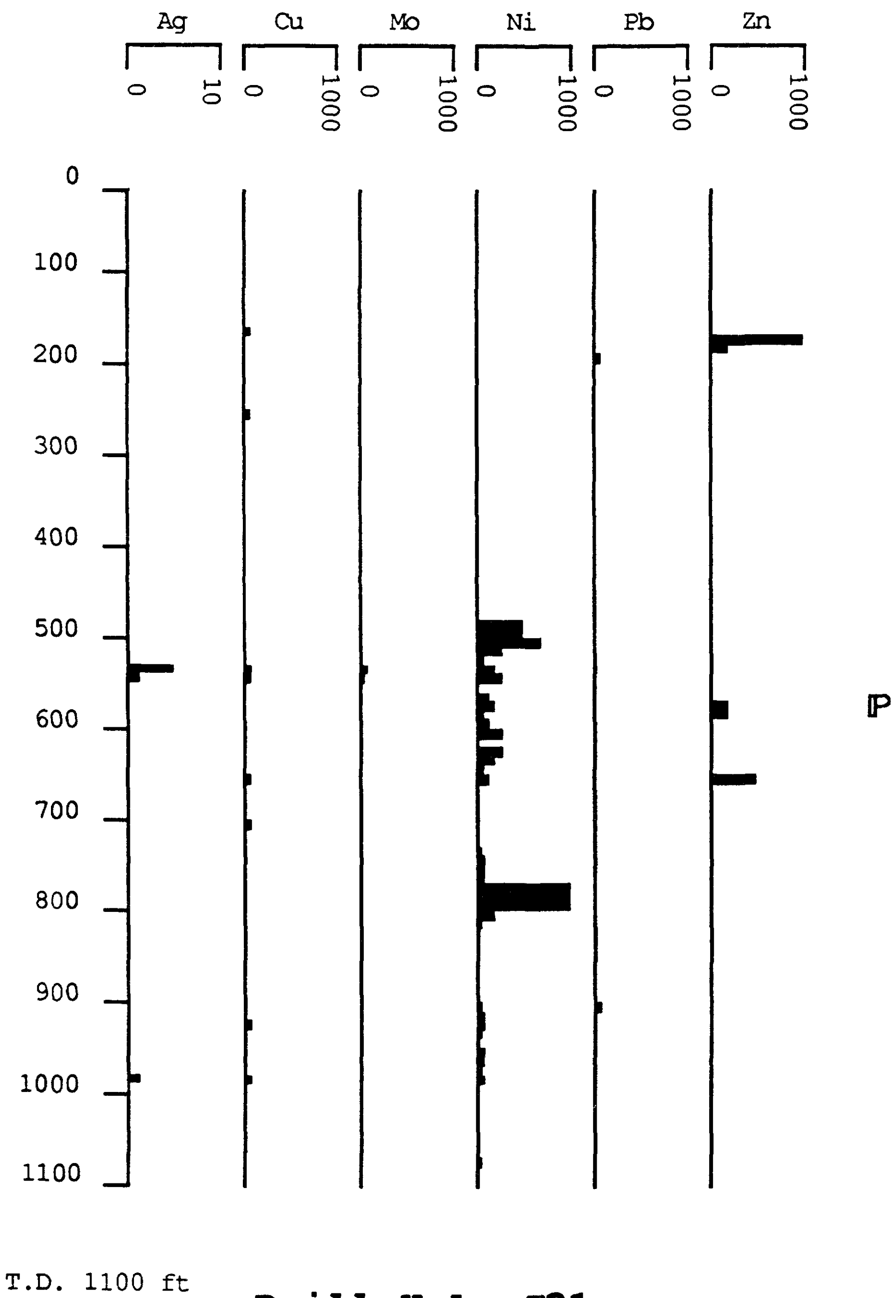


Drill Hole J14

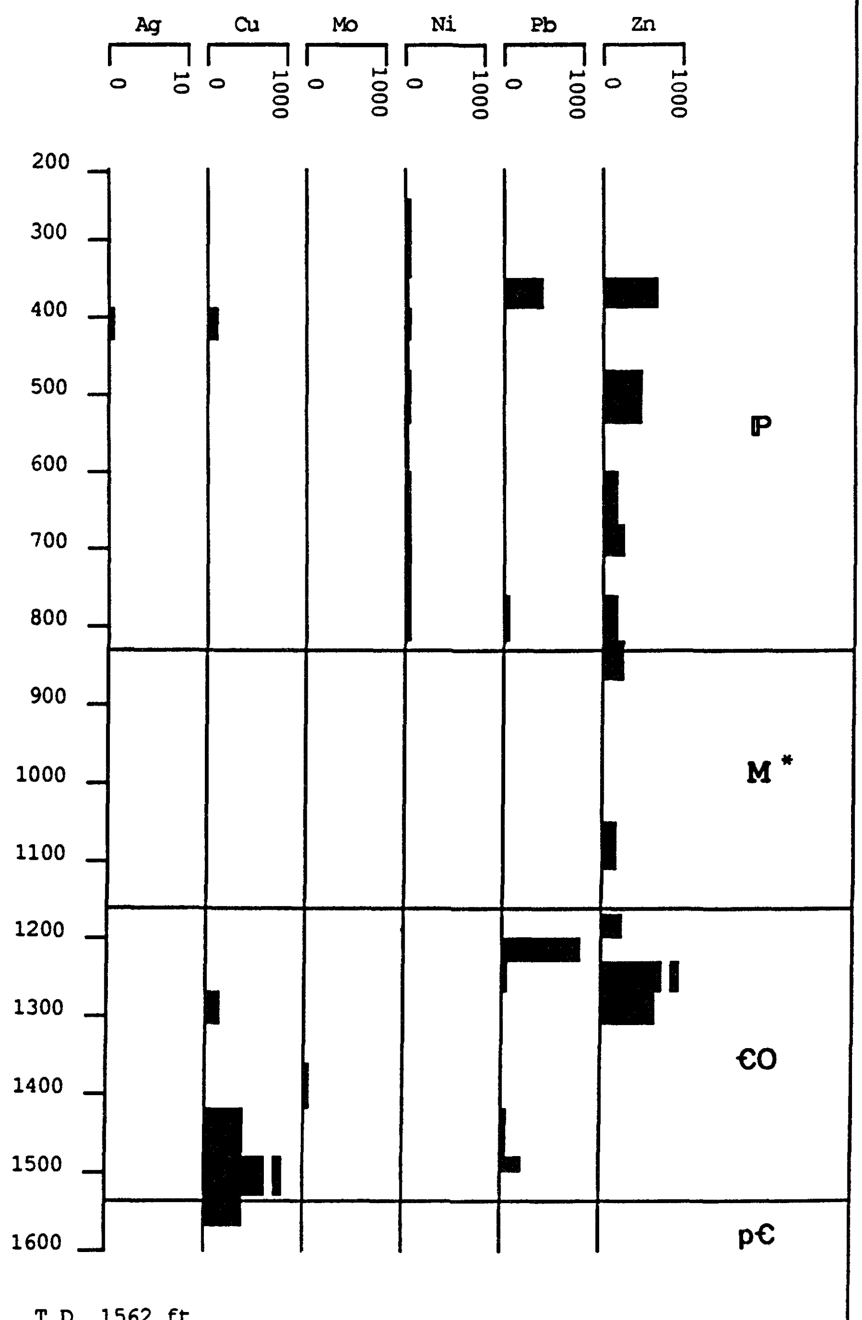

Ag
As
Cu
Ni
Pb
Zn
0
10
0
1000
2100
2200
2300
2400
2500
€O
T.D. 2505 ft
Drill Hole J15



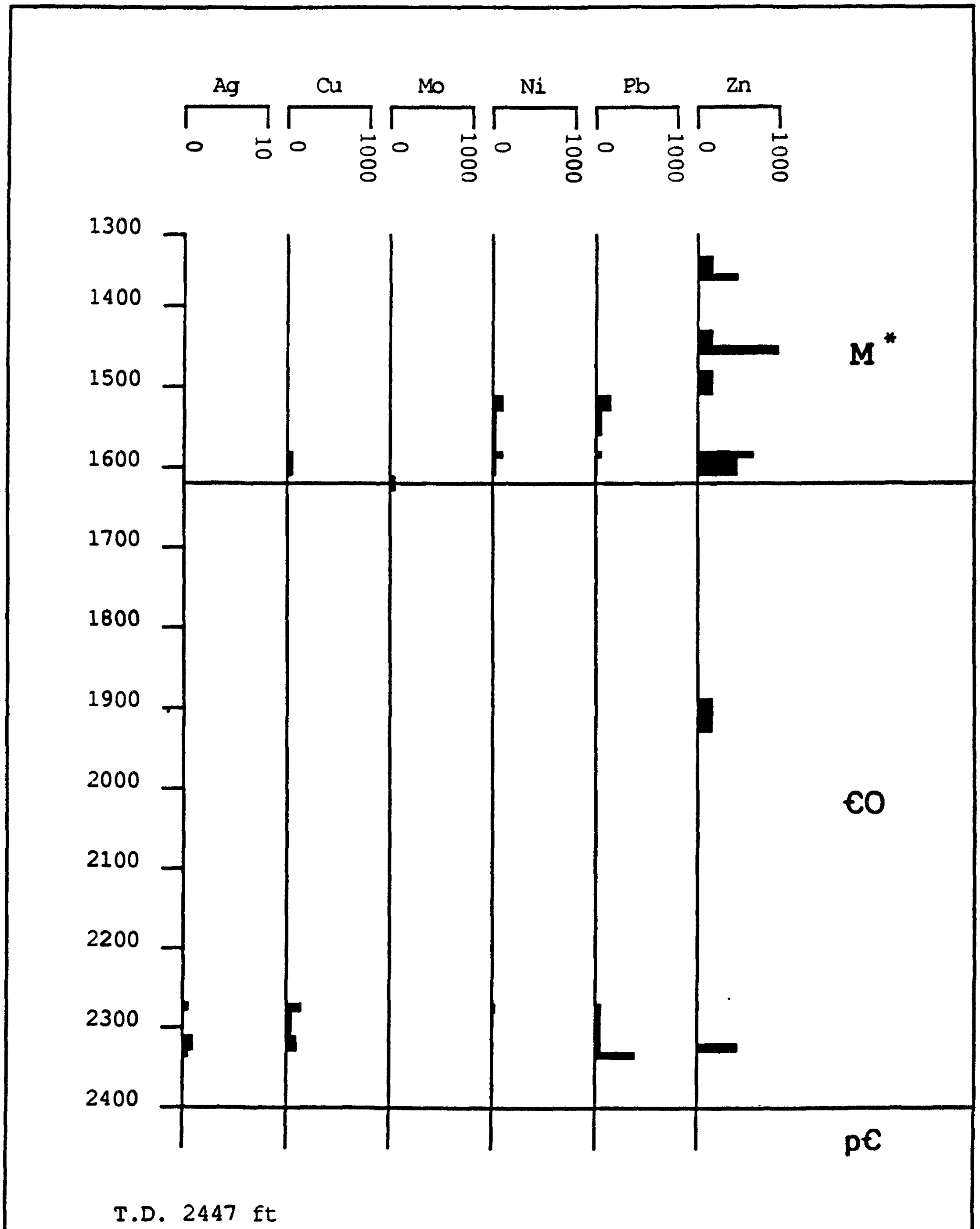
Drill Hole J24



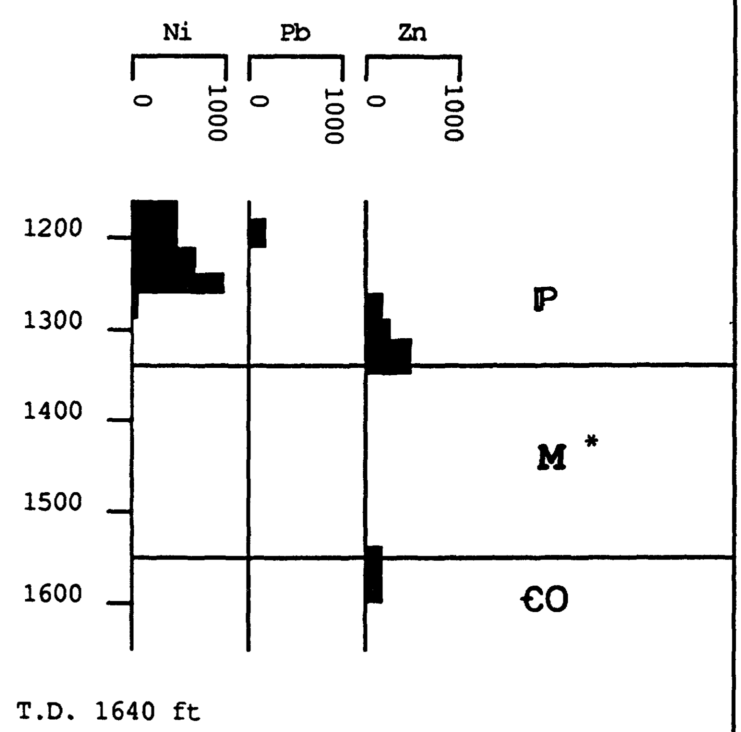
Drill Hole J31



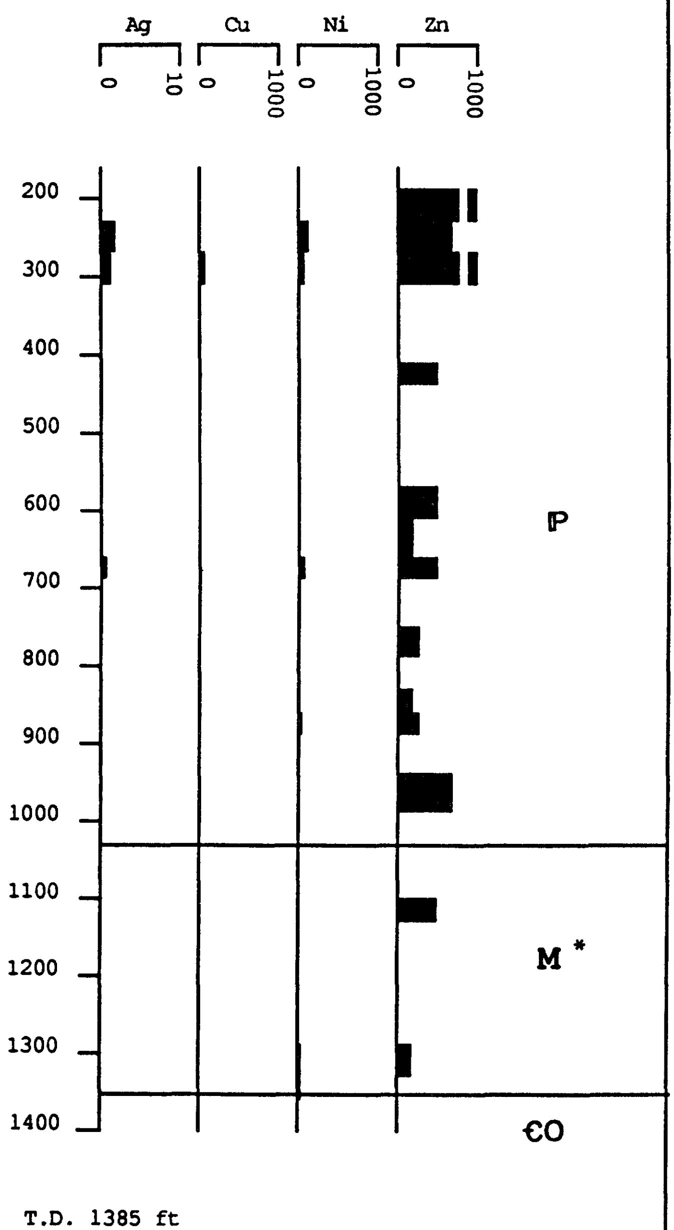
Drill Hole J34



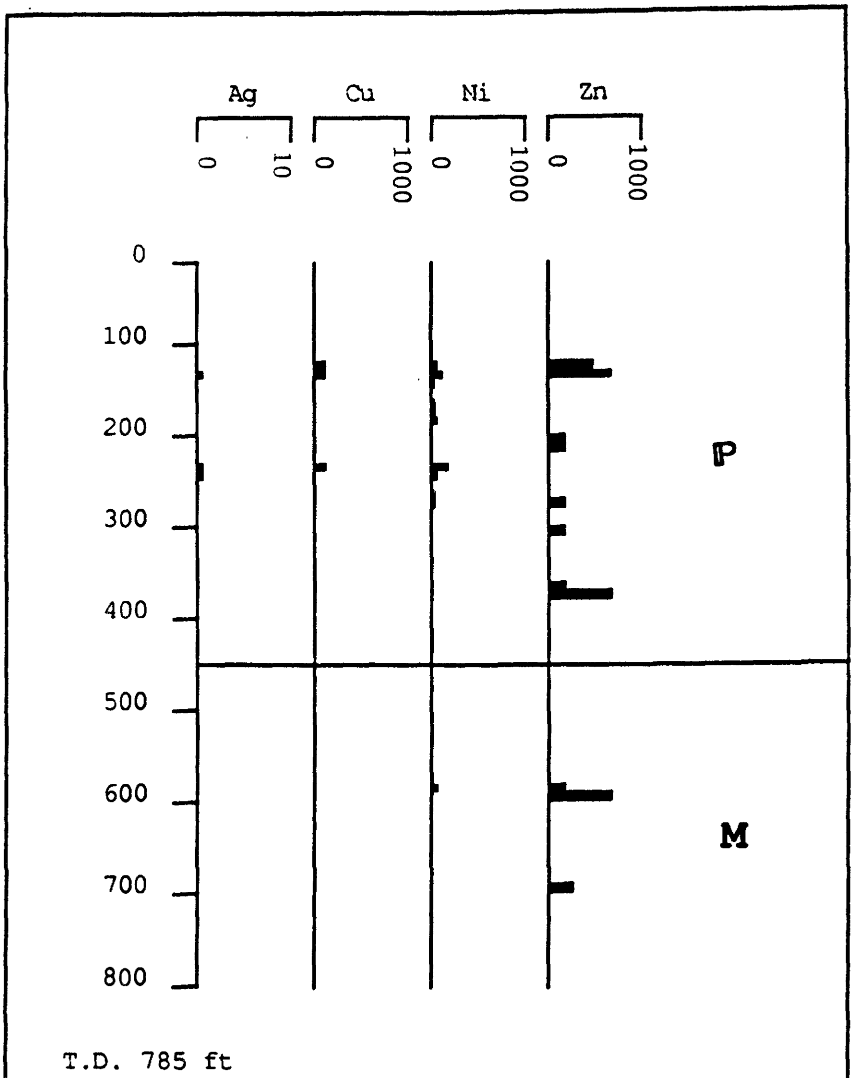
Drill Hole J35



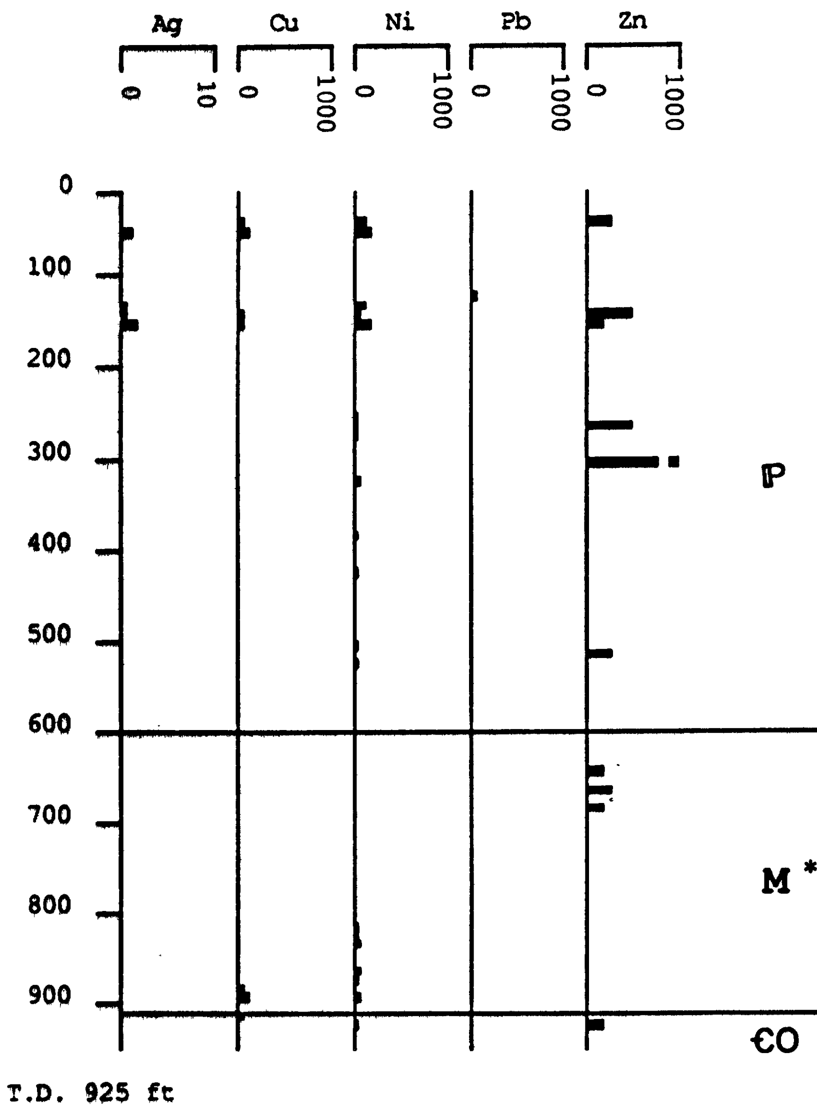
Drill Hole J37



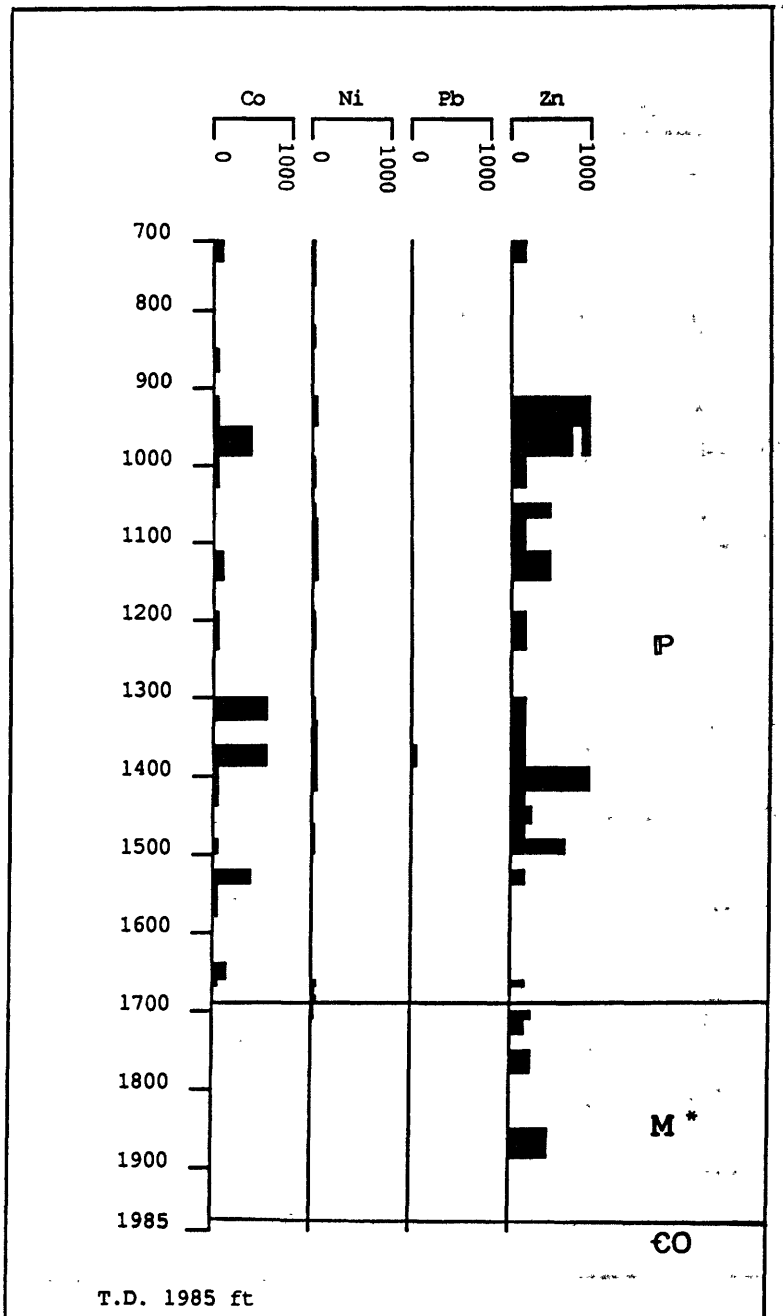
Drill Hole J38



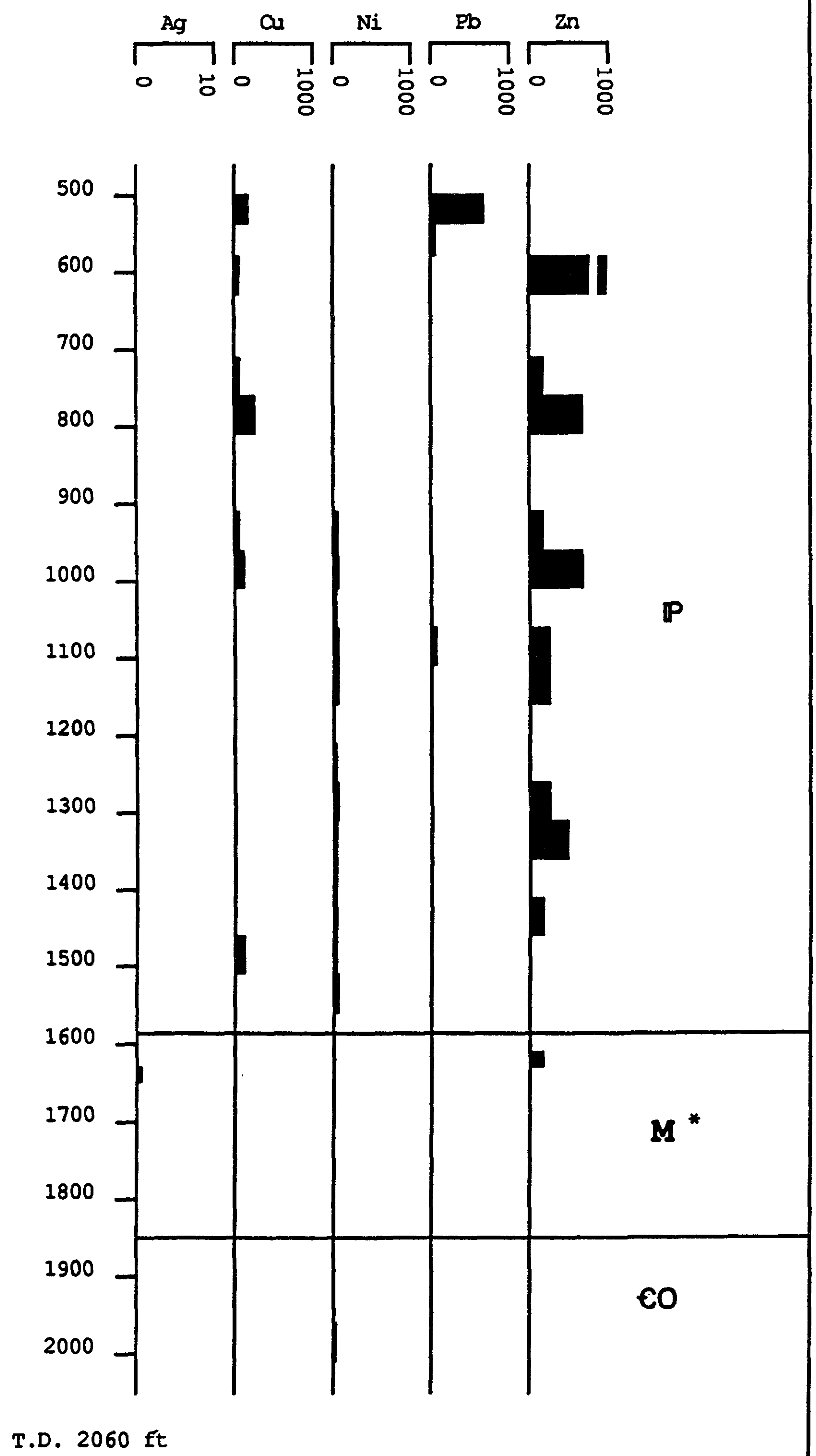
Drill Hole J45



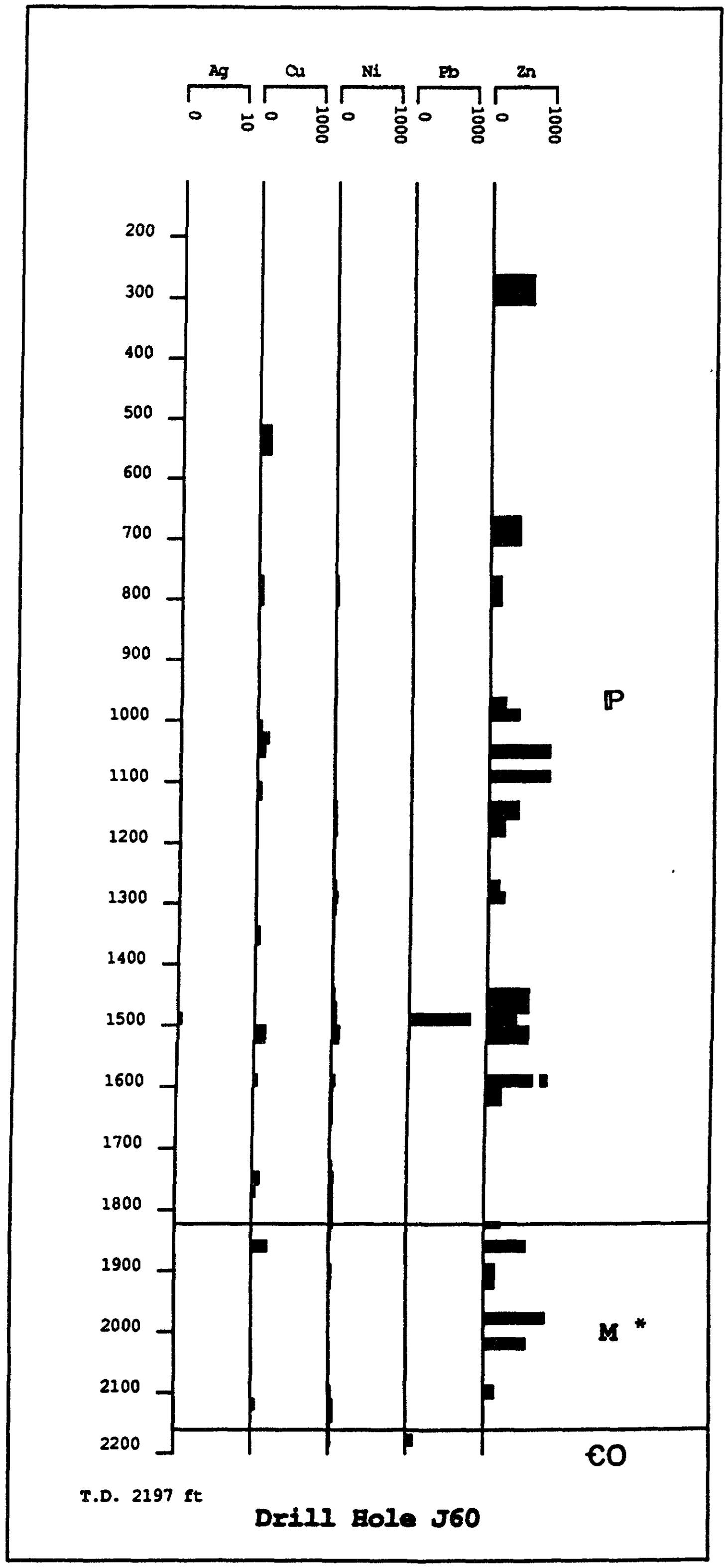
Drill Hole J56

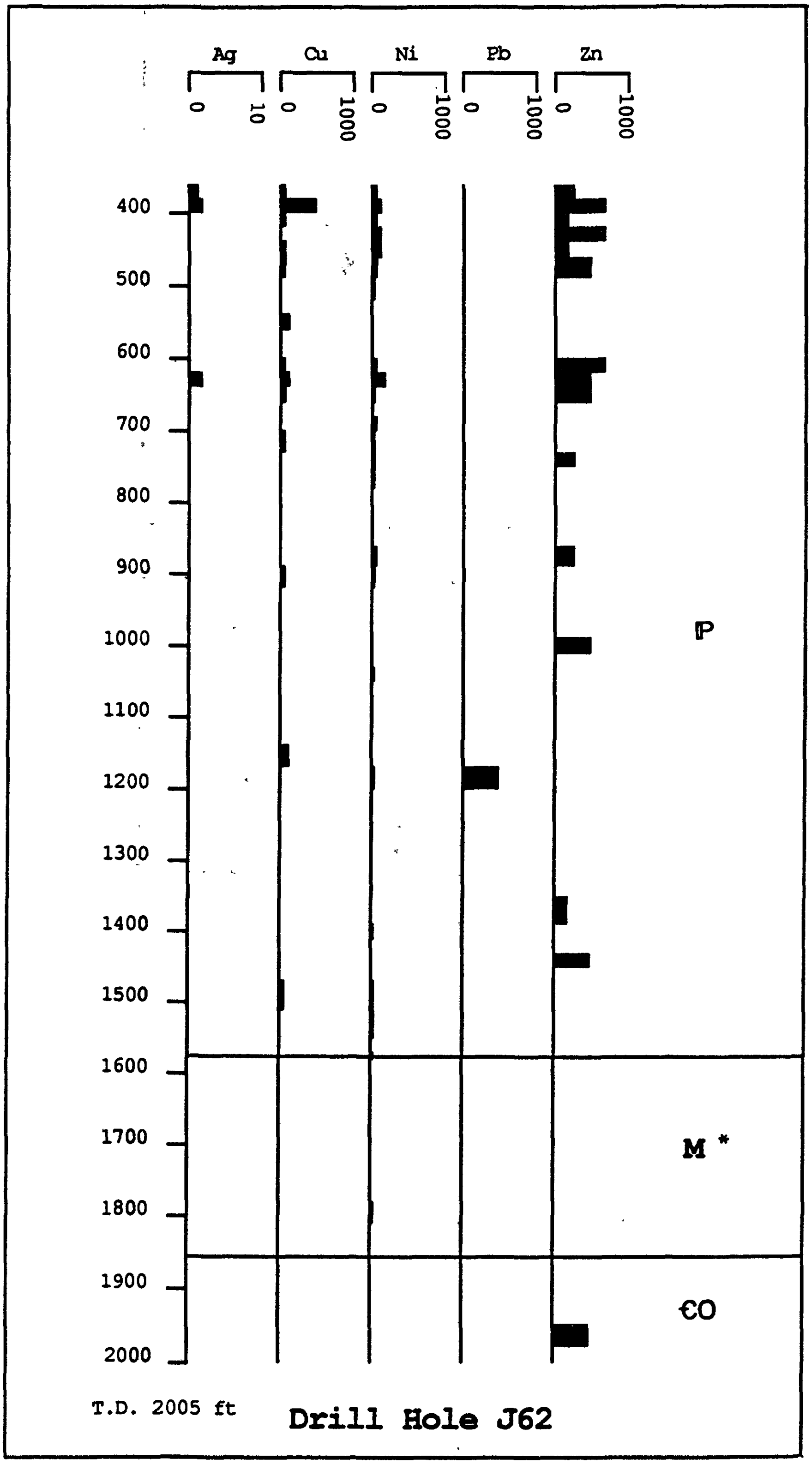


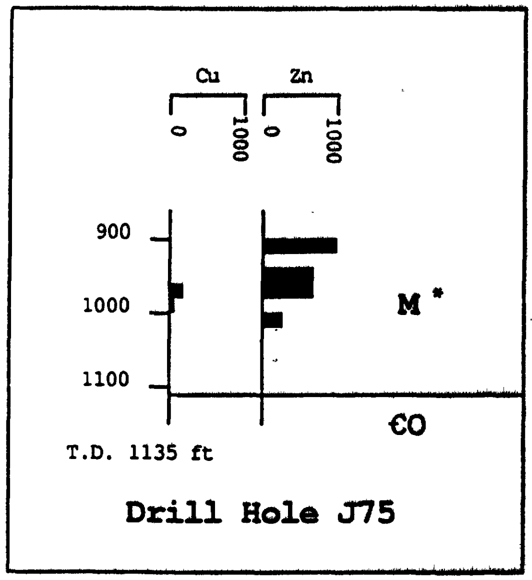
Drill Hole J58



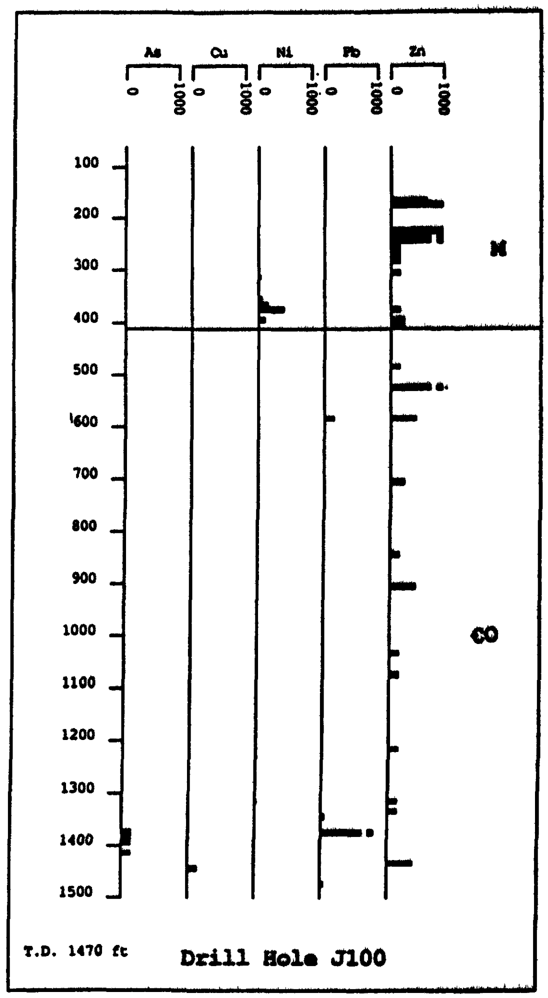
Drill Hole J59


Ag
Cu
Ni
Pb
Zn
0
10
0
1000
0
1000
0
1000
0
1000
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
IP
M *
€O
T.D. 2197 ft
Drill Hole J60

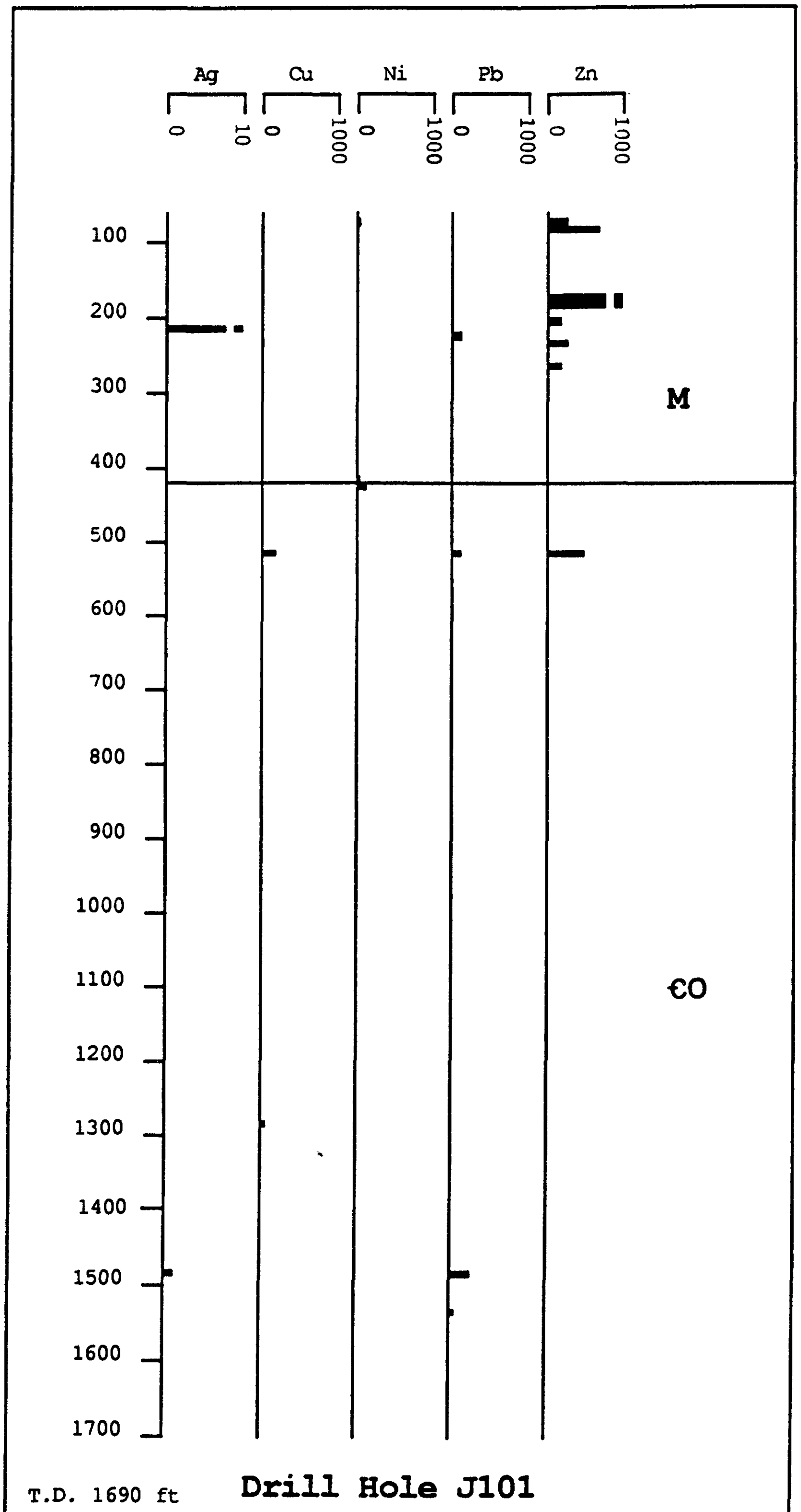

Ag
Cu
Ni
Pb
Zn
0
10
0
1000
0
1000
0
1000
0
1000
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
P
M *
€O
T.D. 2005 ft
Drill Hole J62



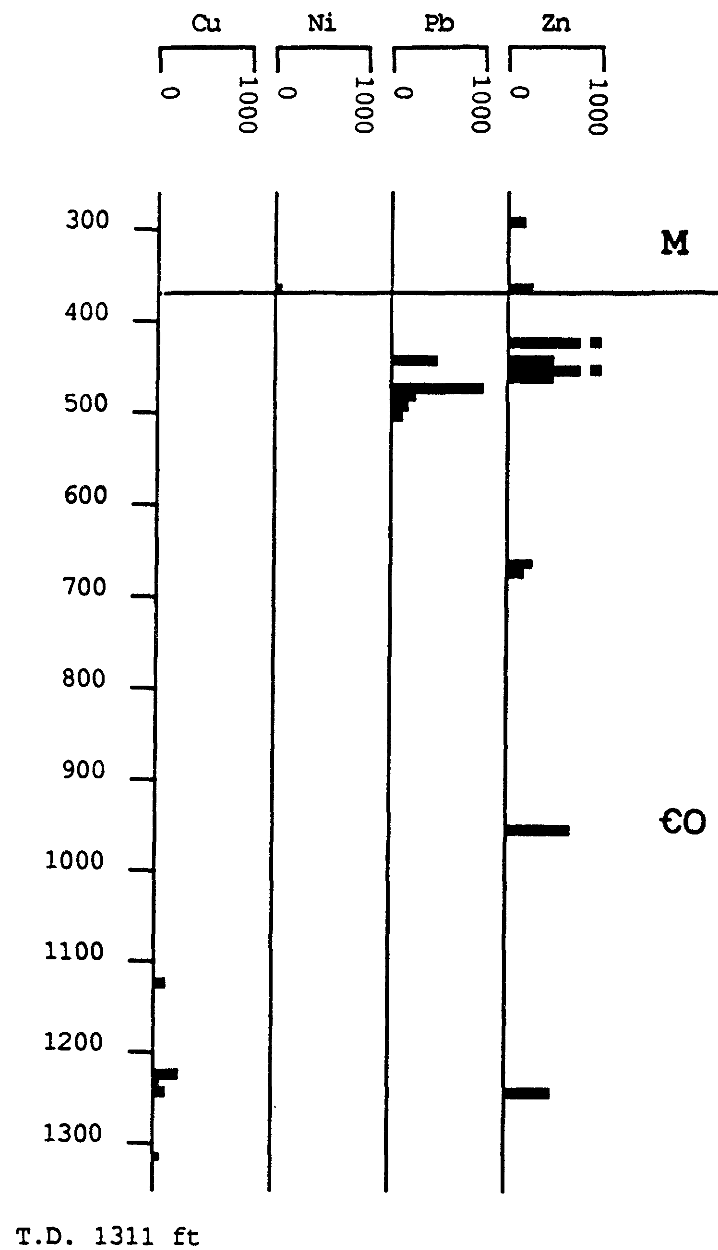
Cu
Zn
0
1000
0
1000
900
1000
1100
M *
€O
T.D. 1135 ft
Drill Hole J75



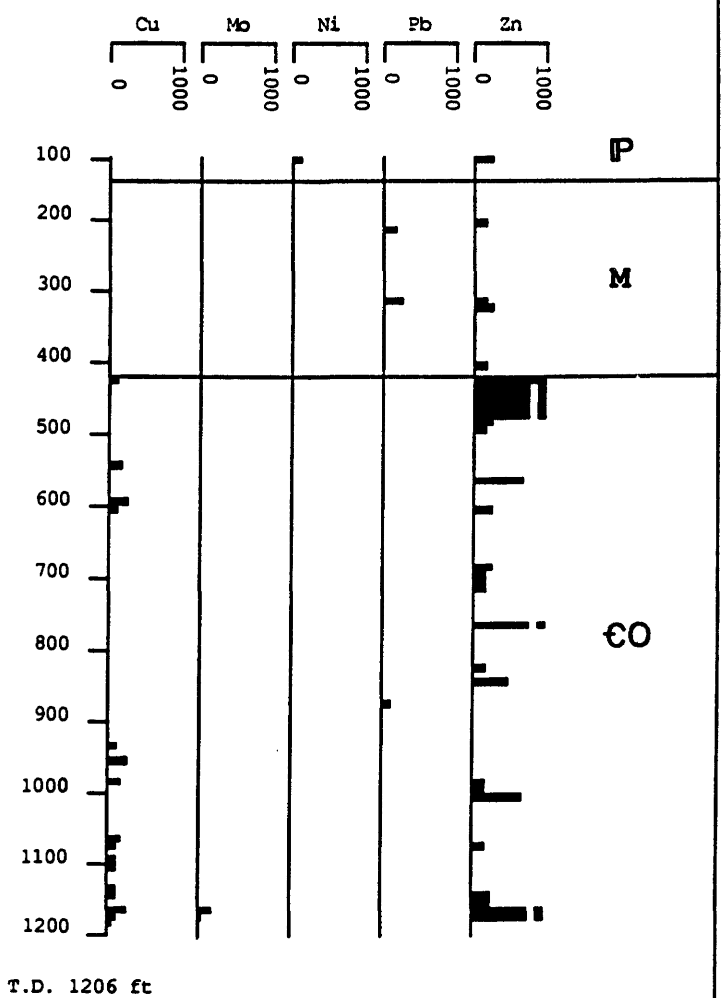
As
Cu
Ni
Pb
Zn
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
M
€O
T.D. 1470 ft
Drill Hole J100



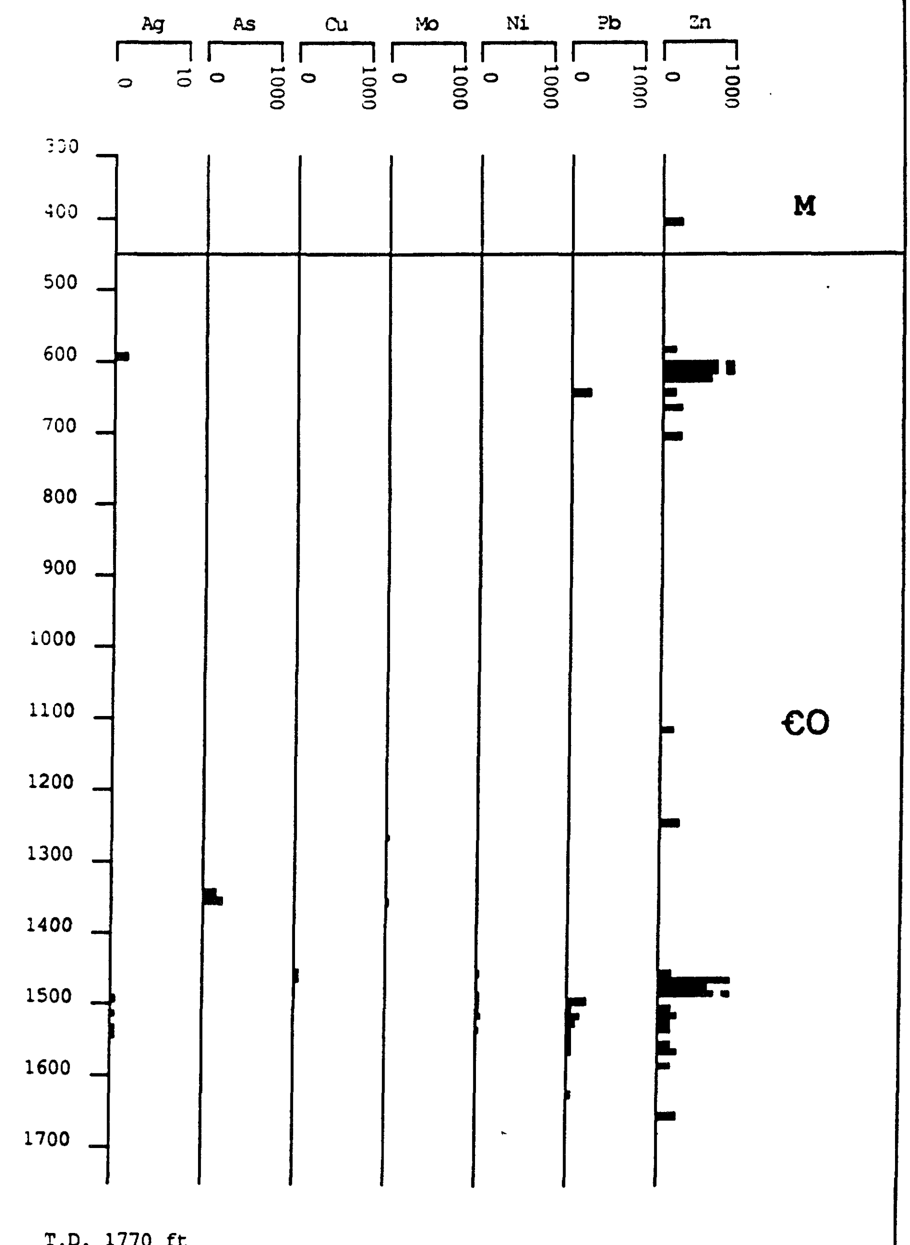
Drill Hole J101



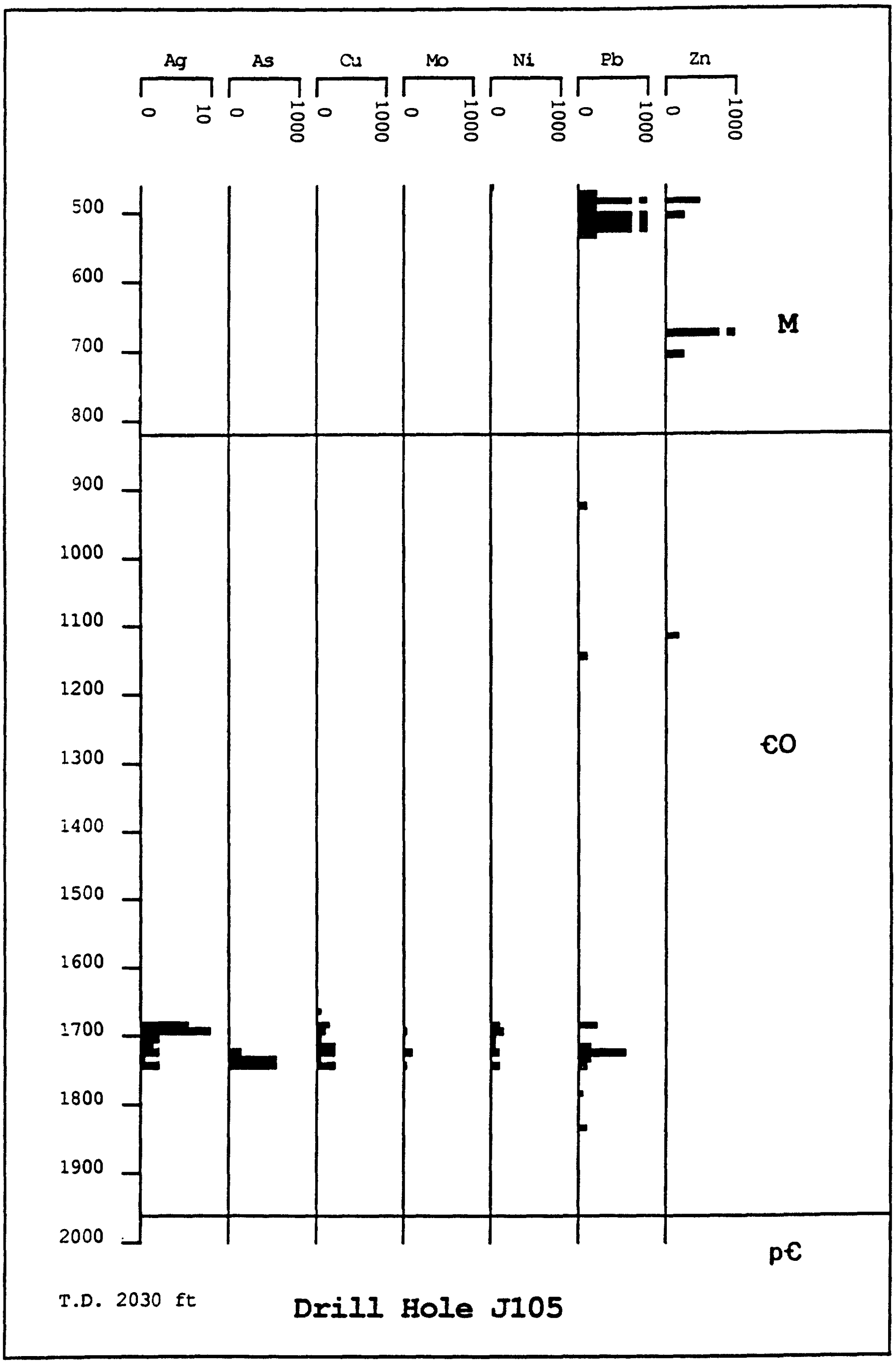
Drill Hole J102



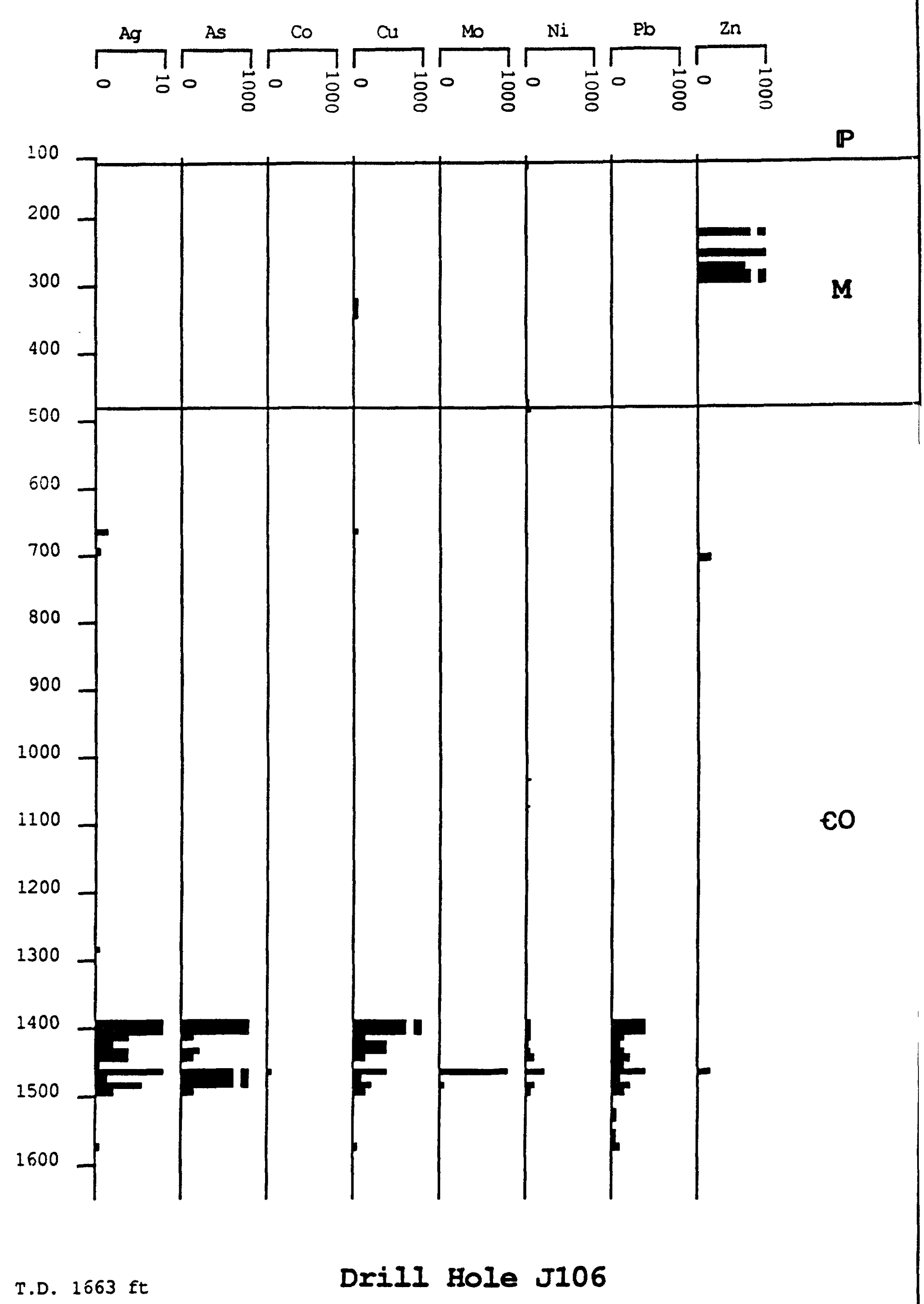
Drill Hole J103



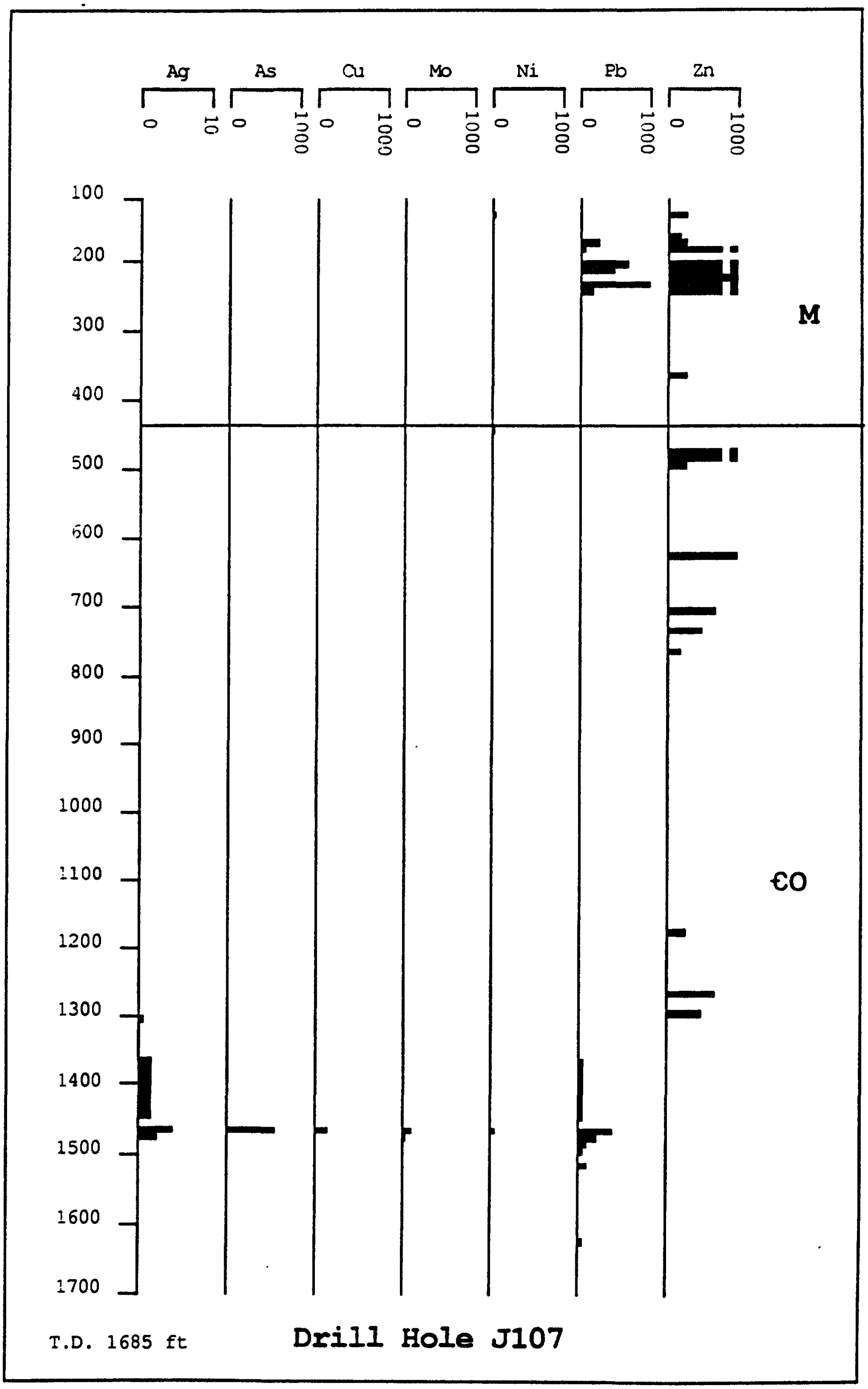
Drill Hole J104

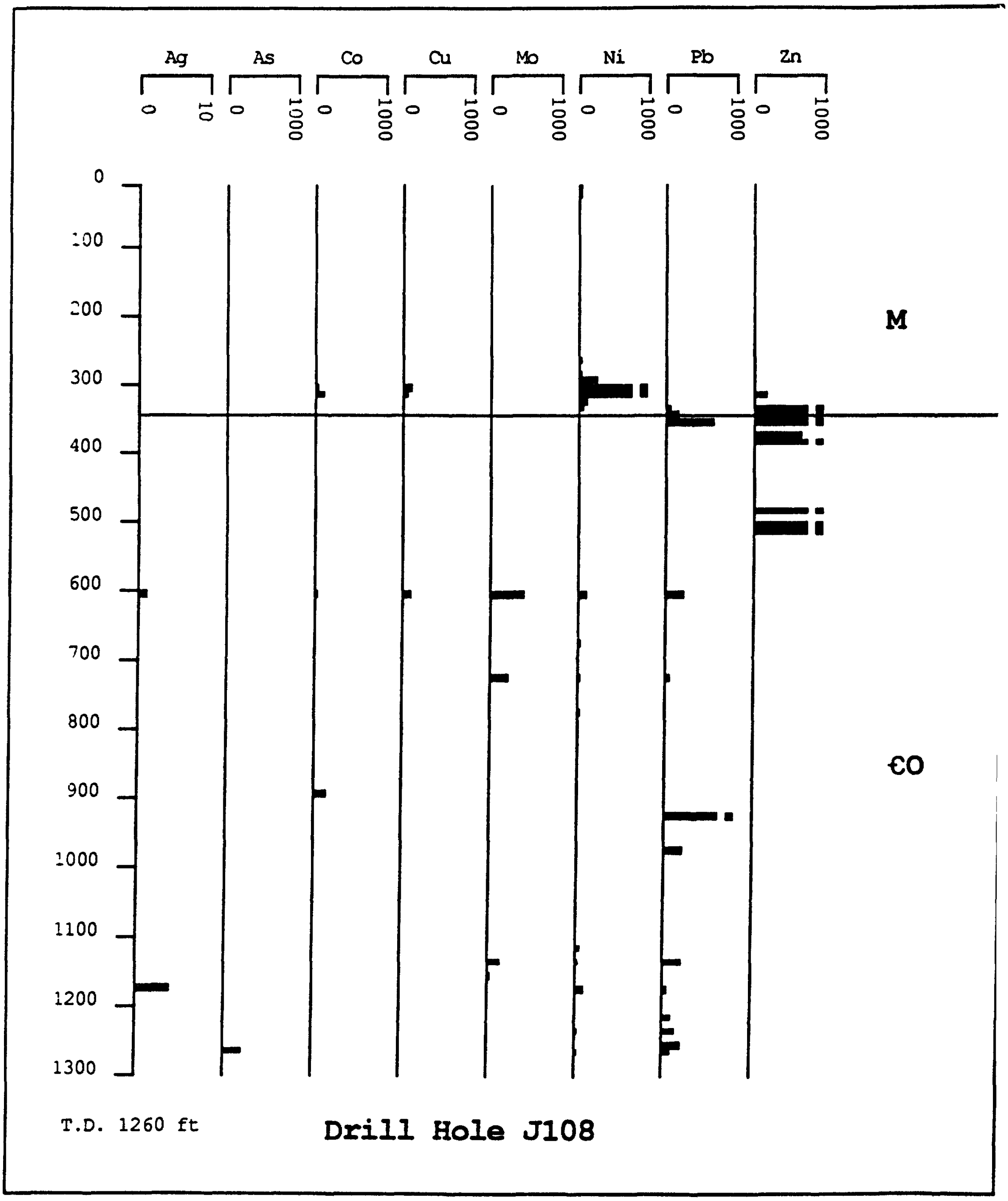


Drill Hole J105

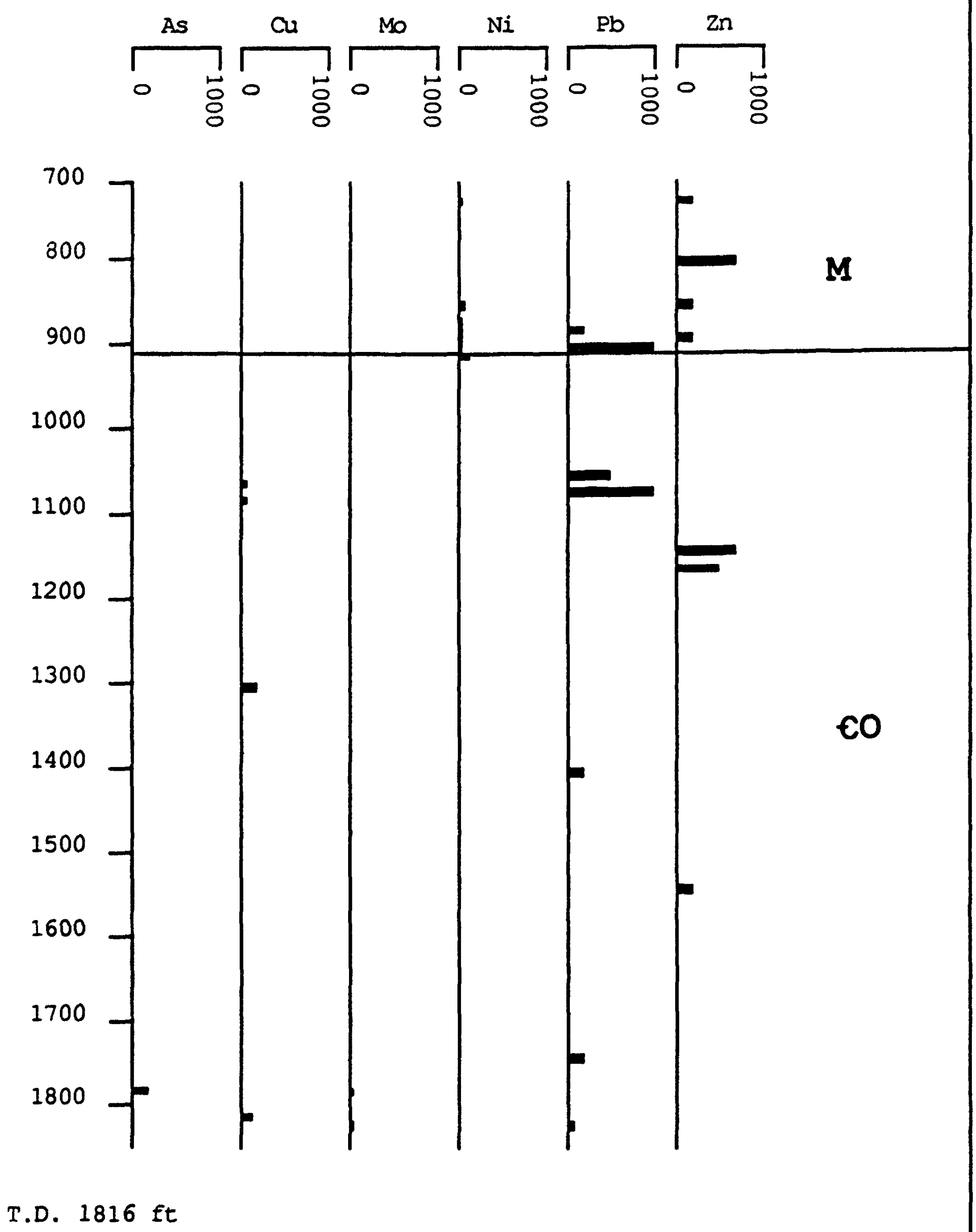


Drill Hole J106

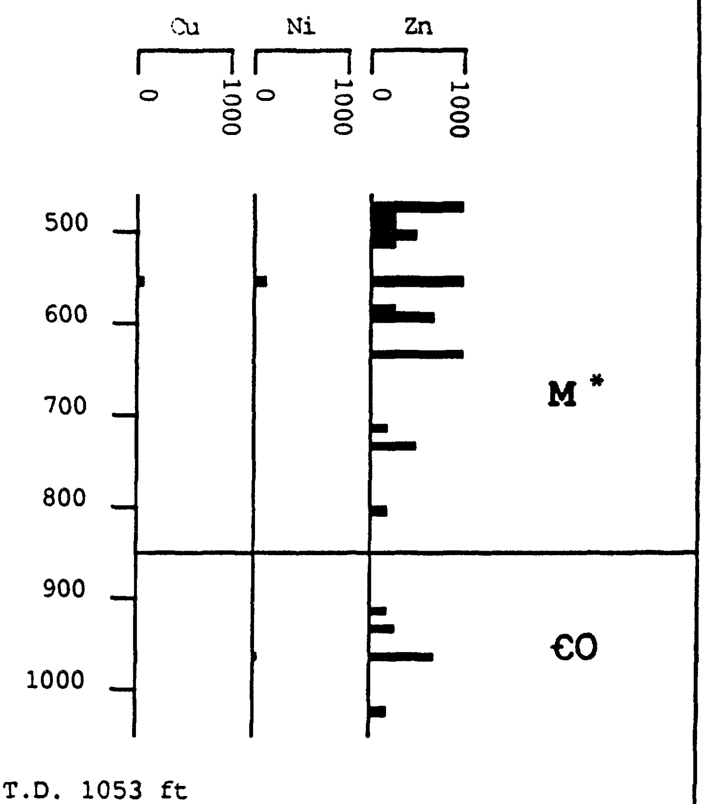

Ag
As
Cu
Mo
Ni
Pb
Zn
0
10
0
1000
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
M
€O
T.D. 1685 ft
Drill Hole J107



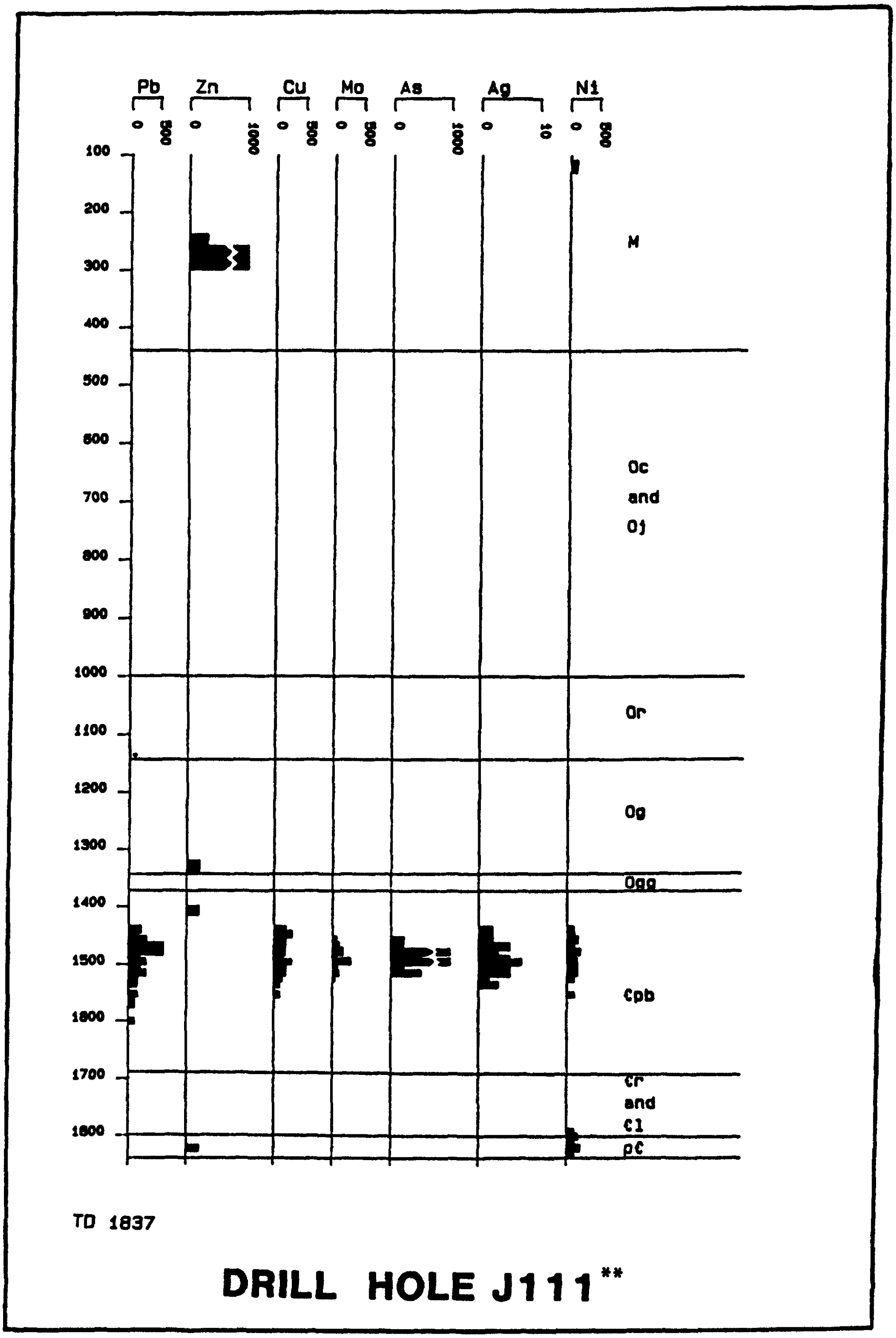
Drill Hole J108



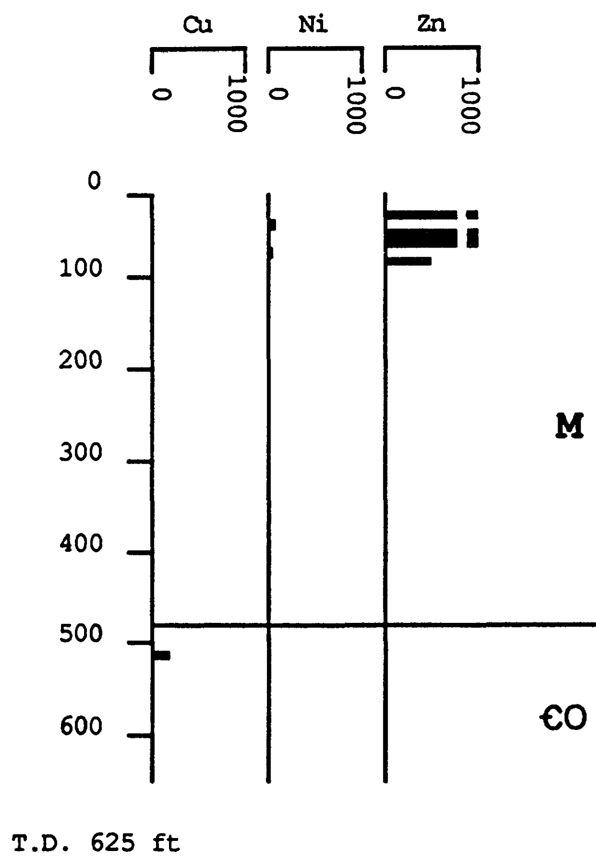
Drill Hole J109



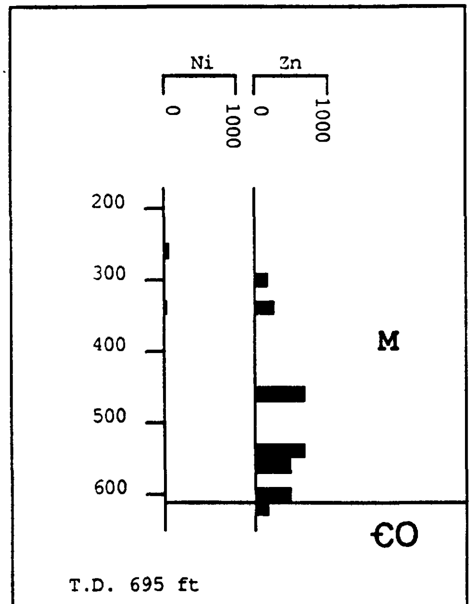
Drill Hole J110



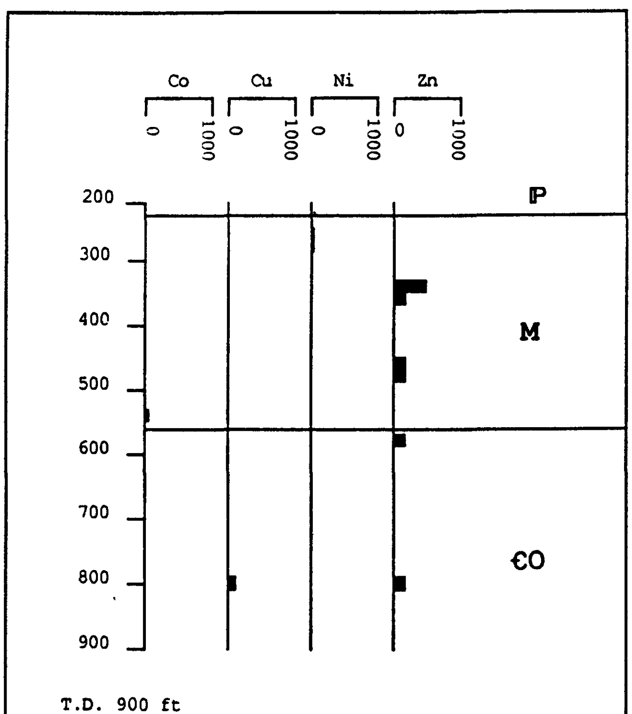
** NOTE - This bar graph represents AMF values not PPM values



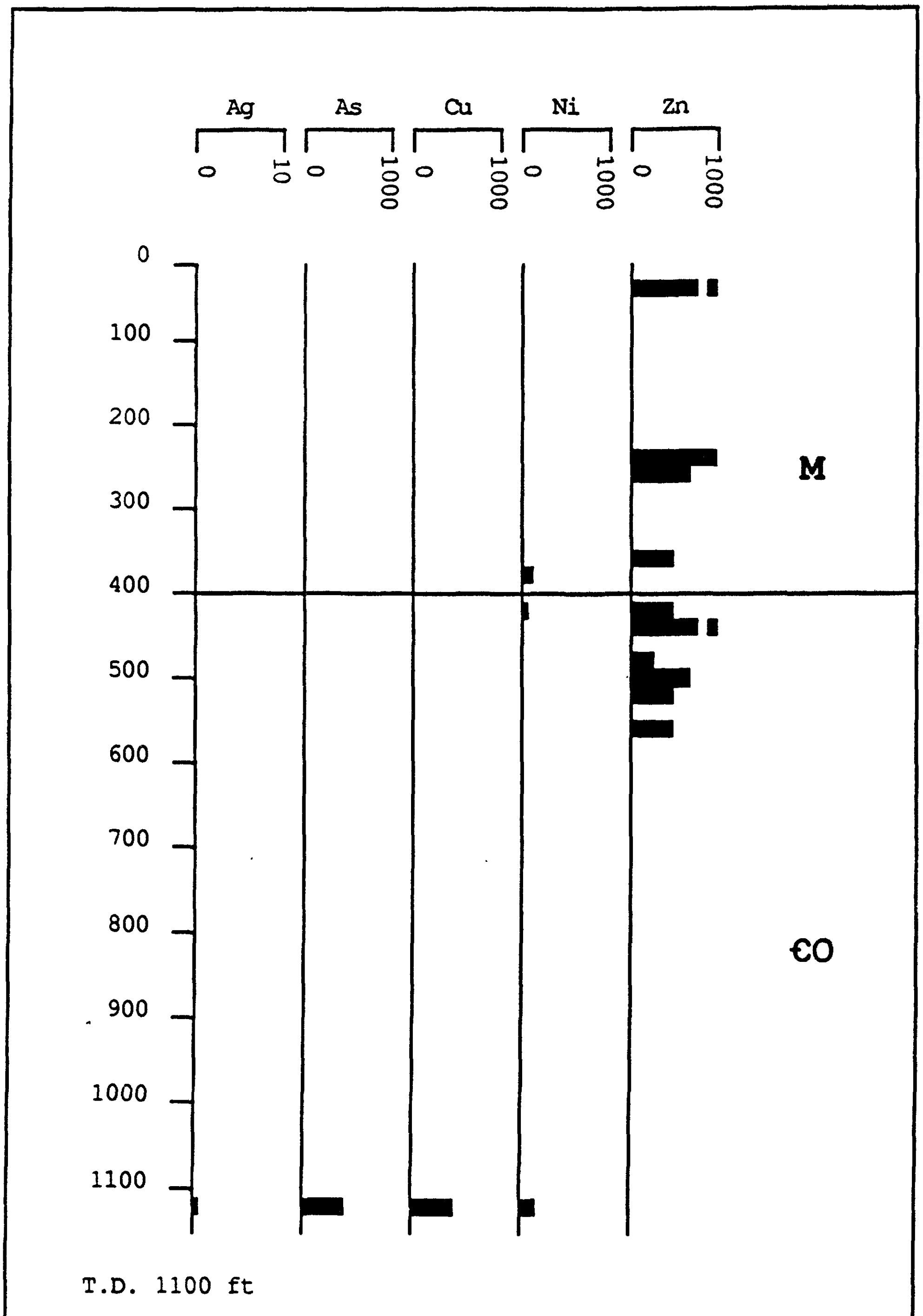
Drill Hole J112



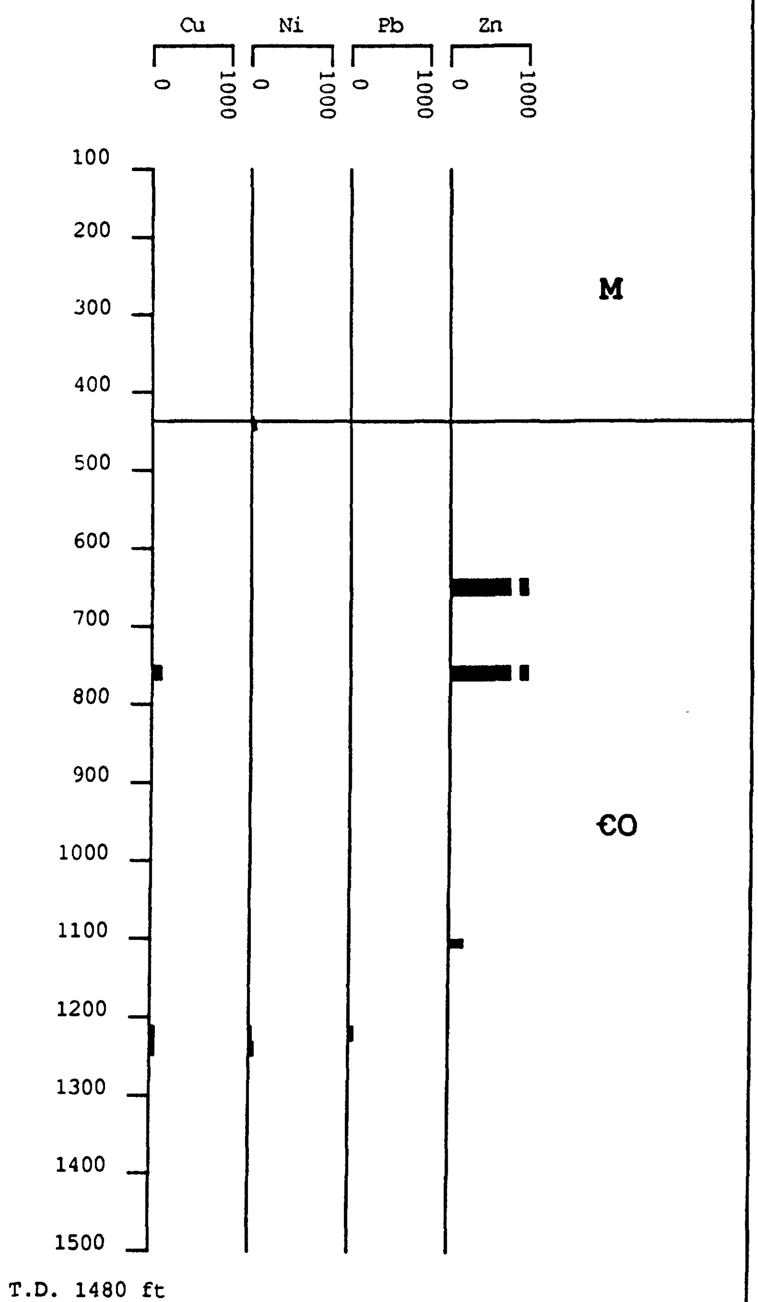
Drill Hole J113



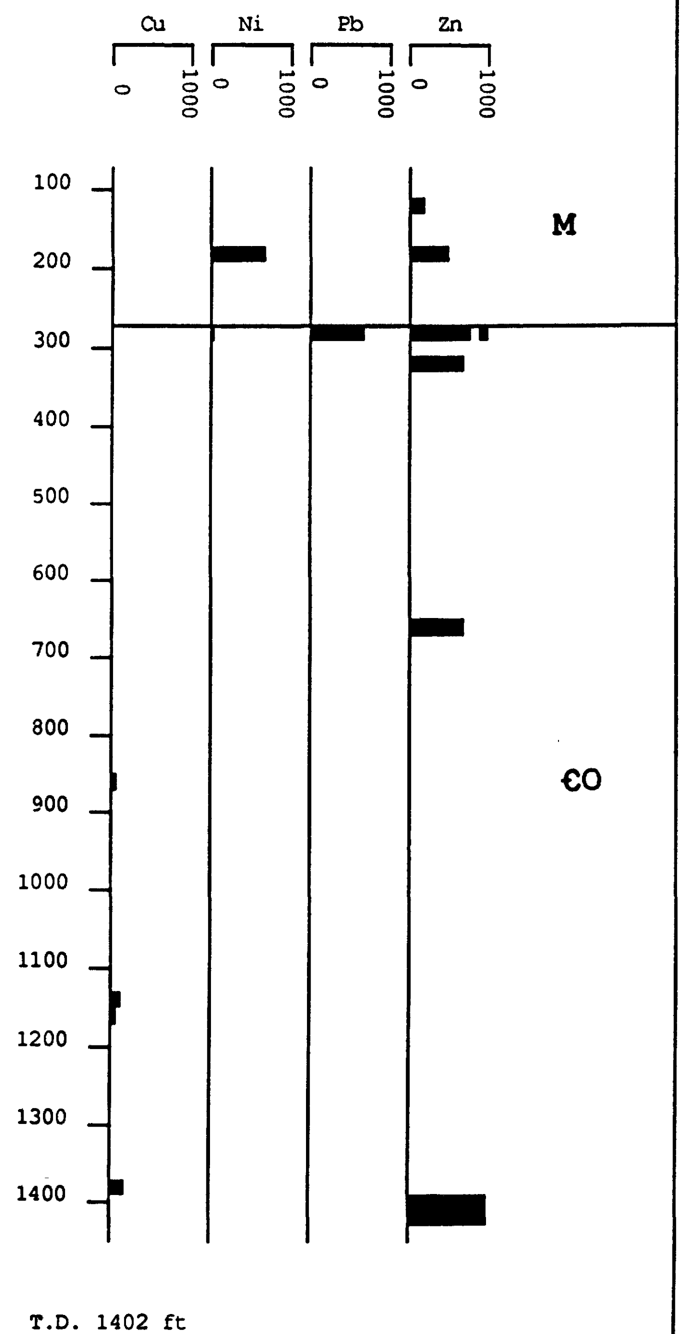
Drill Hole J114



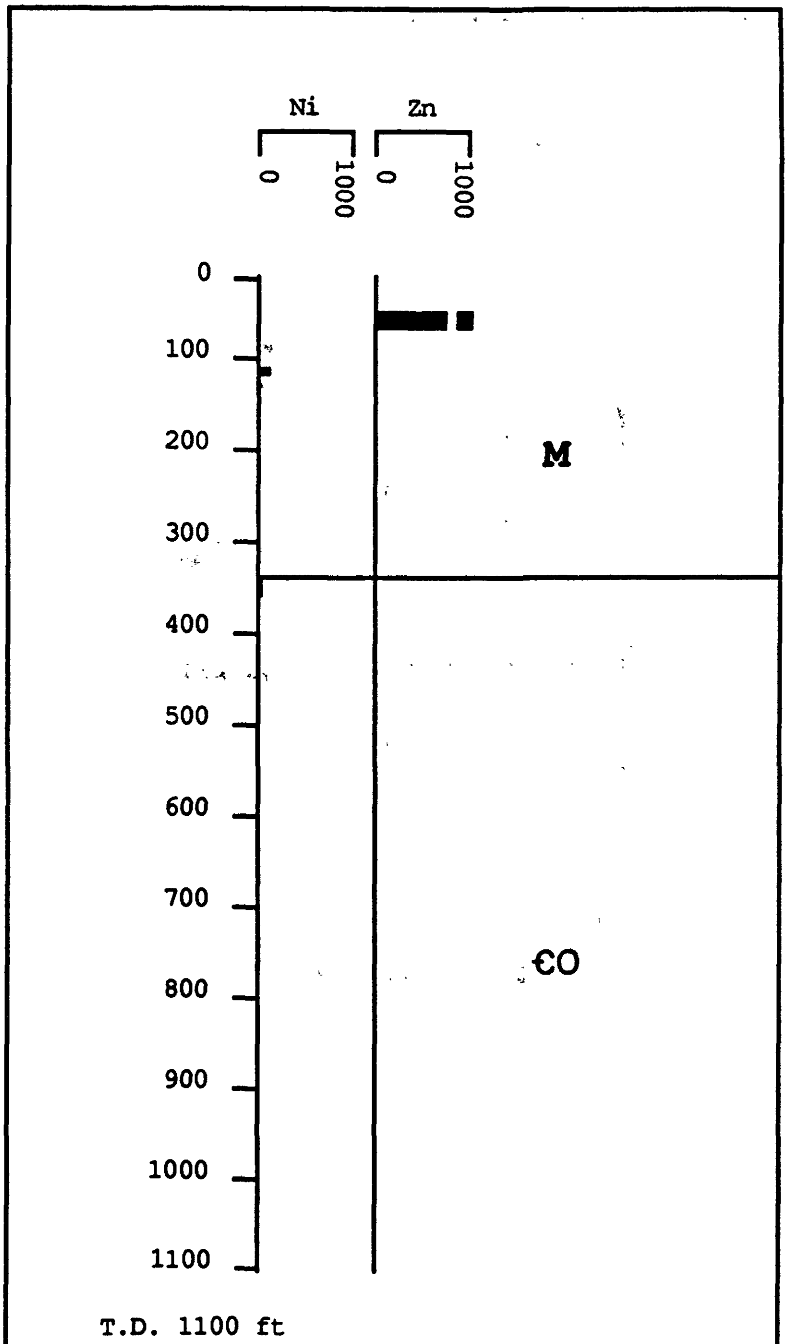
Drill Hole J115



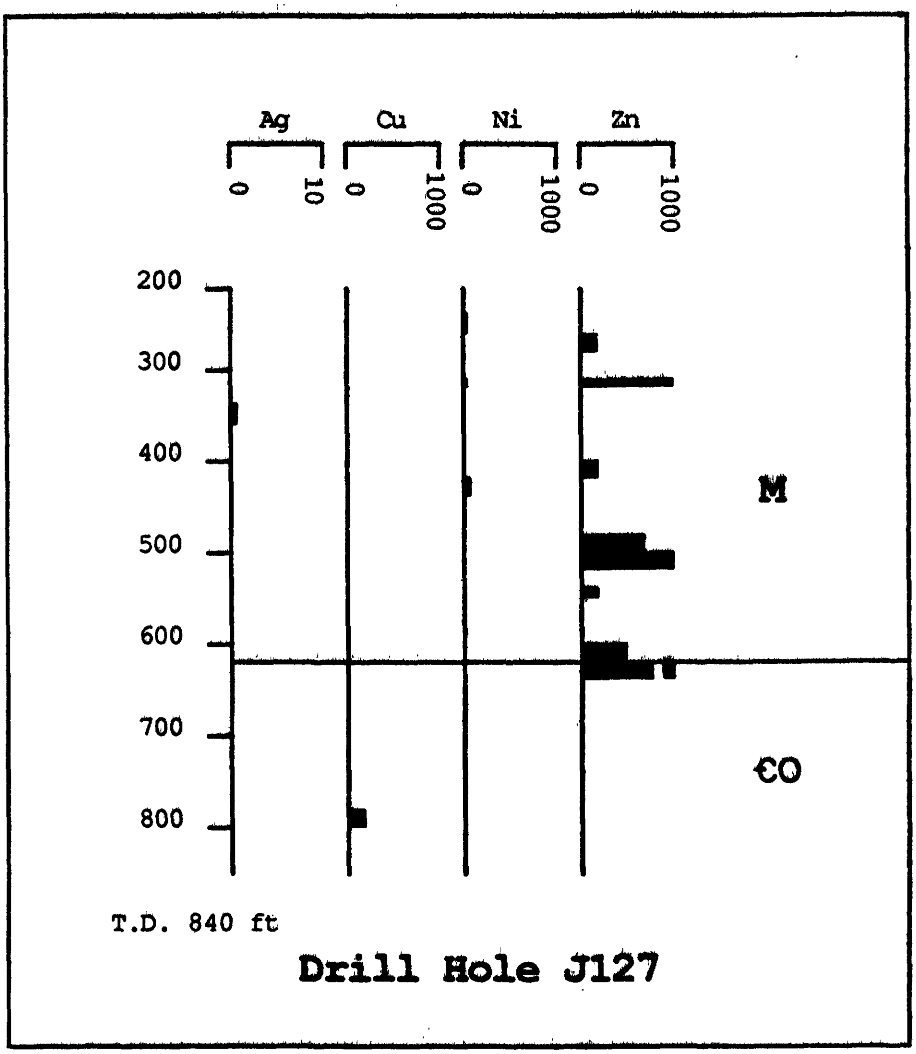
Drill Hole J117

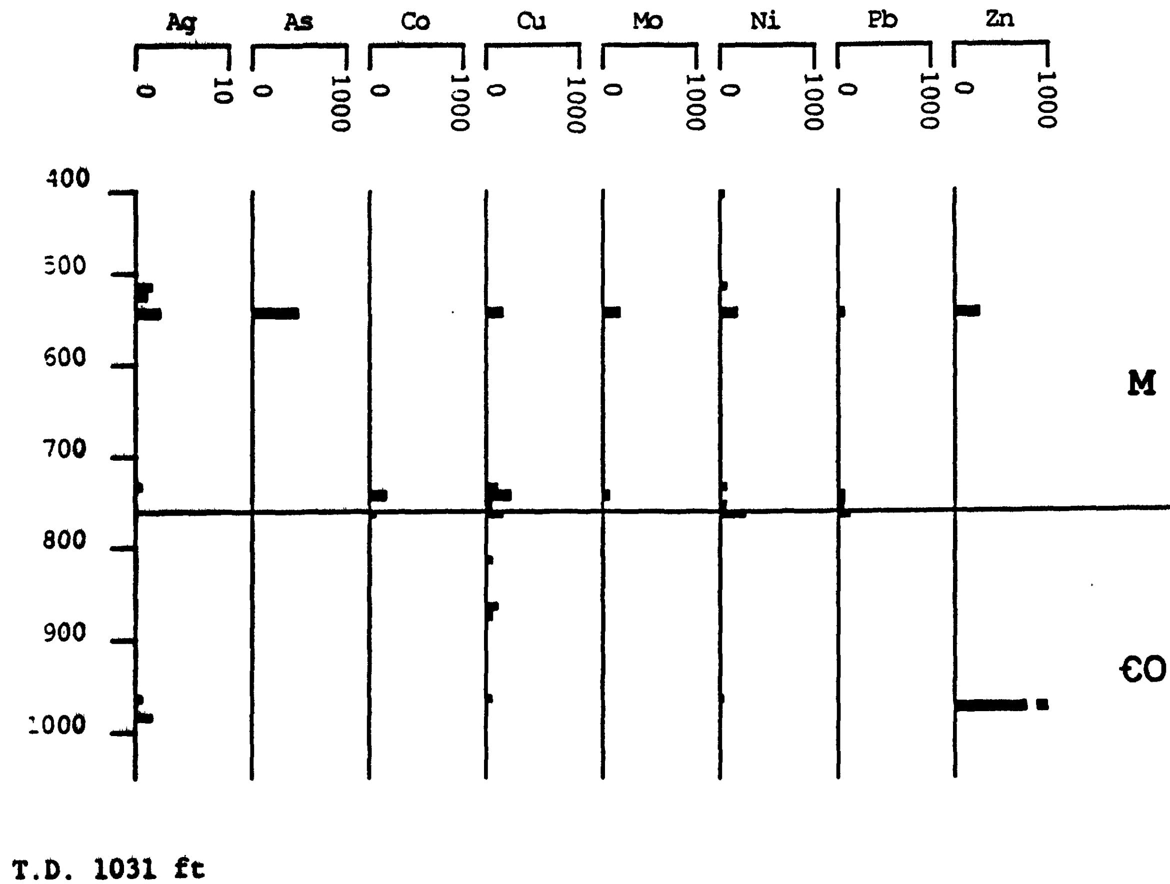


Drill Hole J120

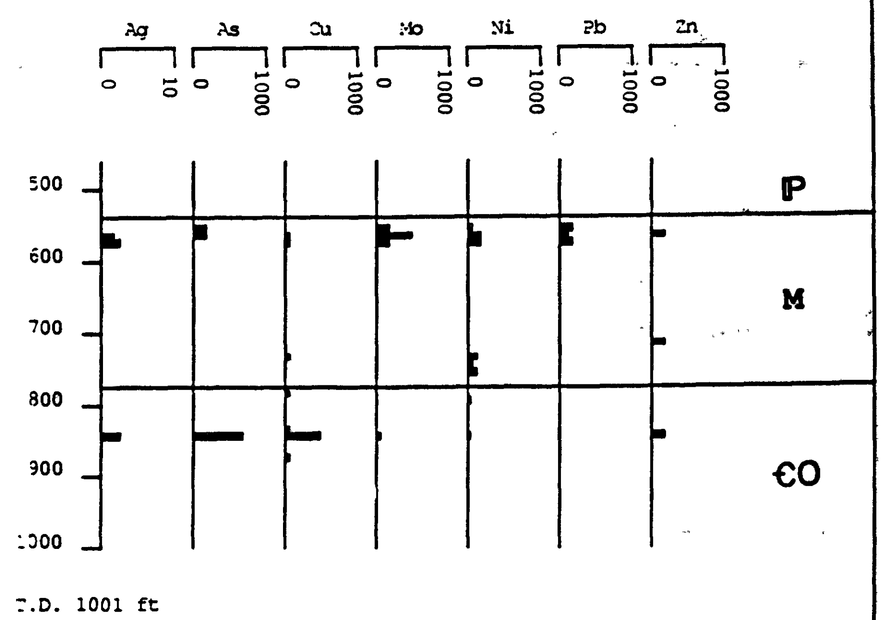


Drill Hole J121

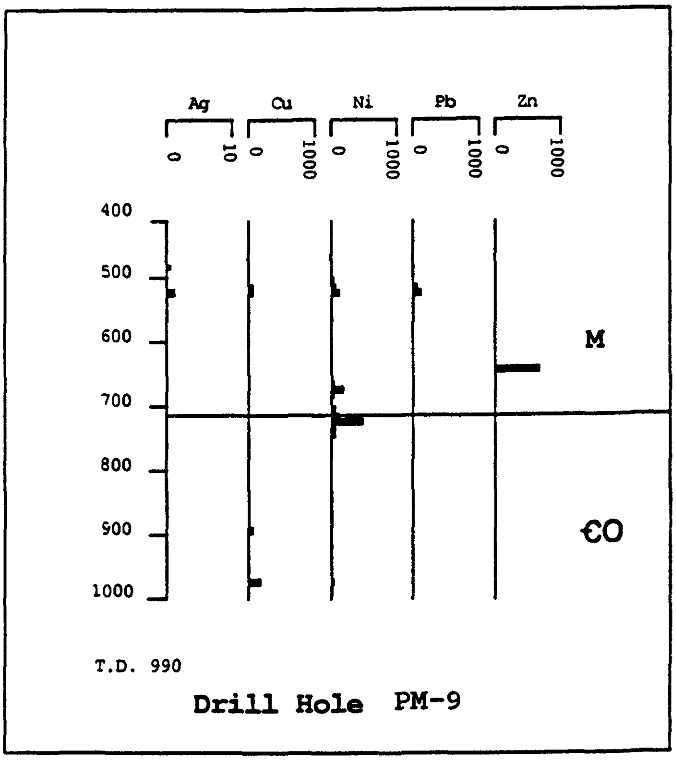

Ag
Cu
Ni
Zn
0
10
0
1000
0
1000
0
1000
200
300
400
500
600
700
800
M
€O
T.D. 840 ft
Drill Hole J127

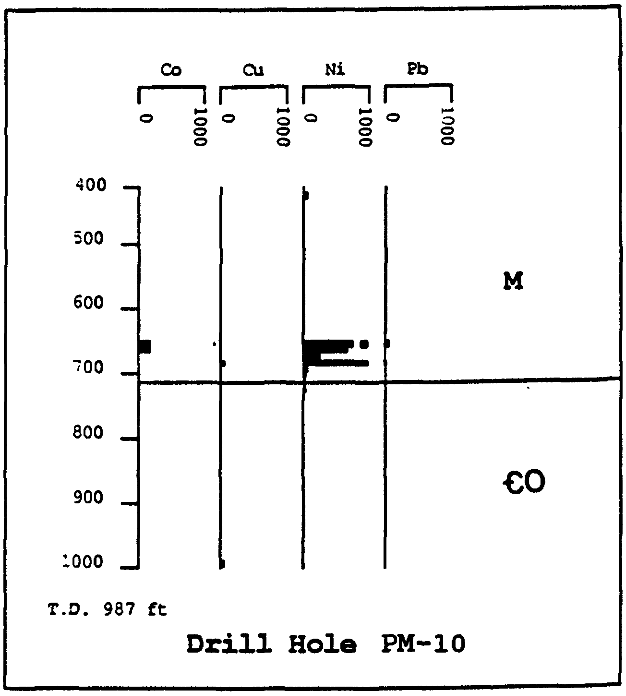


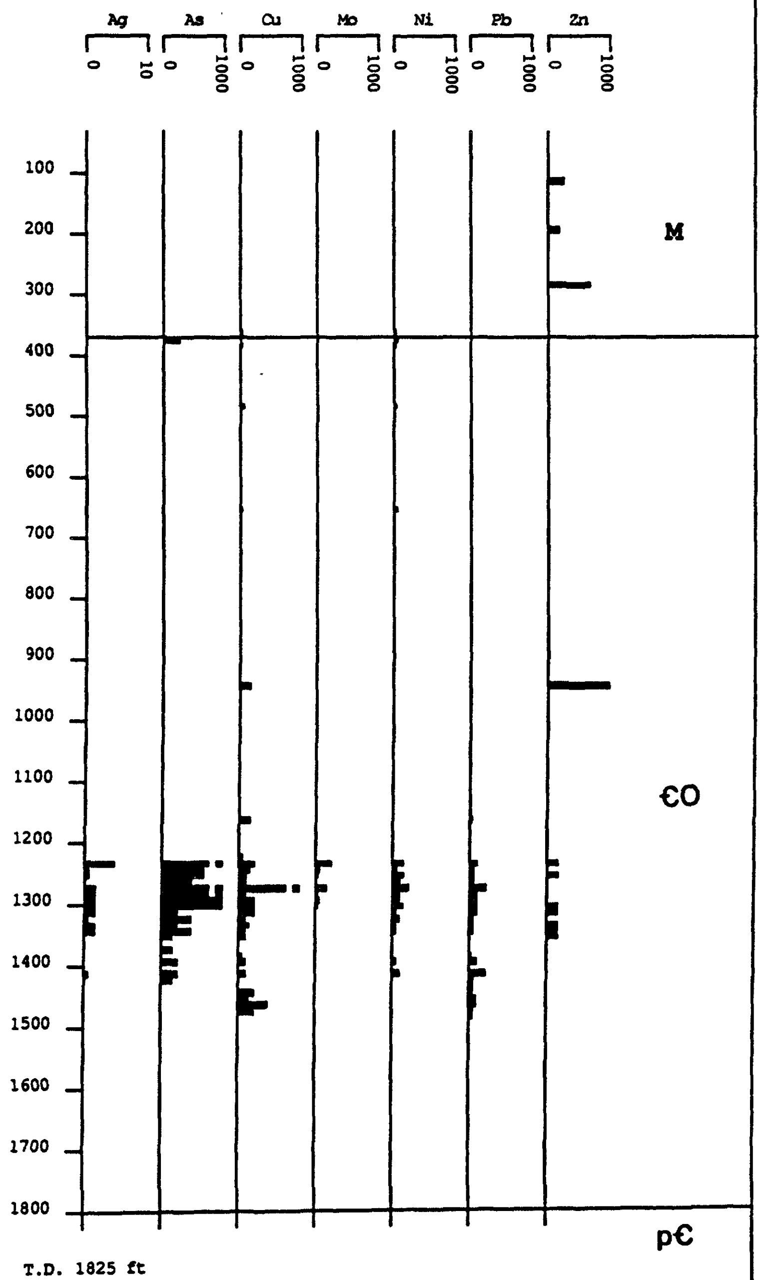
Drill Hole PM - 1



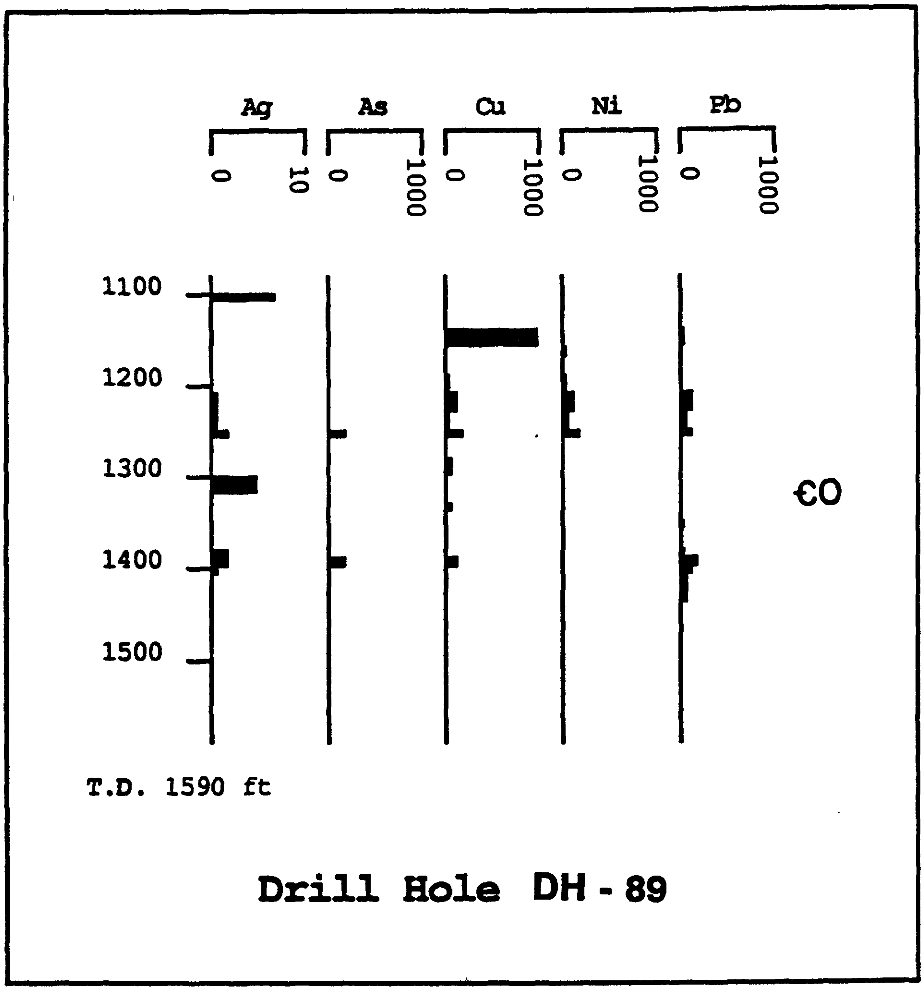
Drill Hole PM-5


Ag Cu Ni Pb Zn
0 10 0 1000 0 1000 0 1000 0 1000
400
500
600
700
800
900
1000
M
€O
T.D. 990
Drill Hole PM-9


Co Cu Ni Pb
0 1000 0 1000 0 1000 0 1000
400
500
600
700
800
900
1000
M
€O
T.D. 987 ft
Drill Hole PM-10



Drill Hole S-45


Ag
As
Cu
Ni
Pb
0
10
0
1000
0
1000
0
1000
0
1000
1100
1200
1300
1400
1500
€O
T.D. 1590 ft
Drill Hole DH - 89