STATISTICAL ANALYSIS OF STREAM AND PAN CONCENTRATE GEOCHEMICAL SAMPLES FROM THE RICHARDSON MINING DISTRICT, ALASKA

By
P.A. Metz, R.C. Swainbank
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ABSTRACT

The Richardson mining district is located in the south central portion of the Yukon-Tanana Uplands of central Alaska and includes an area of 250 square miles. Placer gold was discovered in the district in 1905 and to date the area has produced approximately 100,000 troy ounces of placer gold and 25,000 troy ounces of silver.

A total of 378 stream sediment and 111 pan concentrate samples were collected during recent 1:40,000 scale geological mapping of the district. The samples were analyzed for Cu, Pb, Zn, Ni, Fe, Mn, Cr, As, Sb, Au, Hg, Ag, and W. Background and anomalous elemental concentrations were determined from concentration - log probability plots.

The stream sediment and pan concentrate sampling indicates six new areas of potential mineralization. Prior to the investigation, there was one known lode mineral occurrence in the district. Although bedrock exposures are poor, inferences can be made from the geochemistry as to possible genetic types of lode mineralization.

Mercury-antimony-tungsten±gold and silver elemental associations are spatially related to mafic gneissic rocks. This association is analogous to the stratabound Hg-Sb-W association of southern Europe and other areas of the circum-Pacific.

Copper-nickel-zinc±gold and silver anomalous are also associated with mafic gneissic rocks. The above association and the low gold fineness values of the adjacent placer deposits suggest a possible syngenetic basemetal sulfide source.

Tin-tungsten-arsenic±gold and silver elemental associations in contact areas of the Birch Lake pluton are suggestive of the Cornubian tin-granite

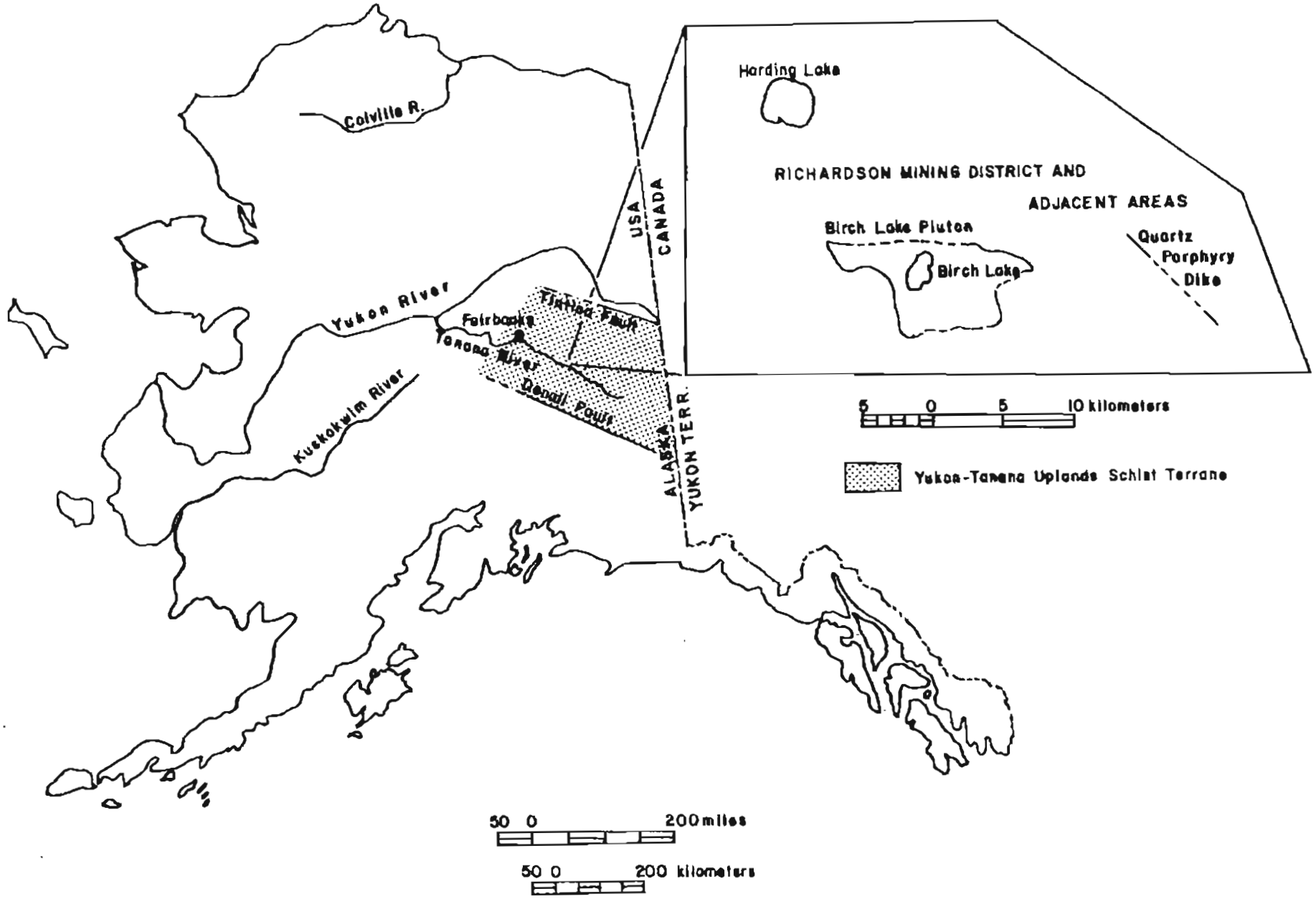
association. The sericitized, greisenized, and kaolinized quartz porphyry dikes slightly younger than the granitic intrusive are very similar to the elvan dike systems of Cornwall, England. The above associations indicate the high potential for precious, base, and transition metal mineralization in the Richardson area.

INTRODUCTION

The Richardson mining district is located in the south central portion of the Yukon-Tanana uplands (see Fig. 1). Placer gold was discovered in the district in 1905 (Prindle, 1913) and to date the area has produced approximately 100,000 ounces of placer gold and 25,000 ounces of silver (Brooks, 1922; Smith, 1930; Capps, 1940; Bundtzen and Reger, 1977). Bundtzen and Reger (1977) conducted limited geological mapping and sampling of the district and concluded that the major lode source of the placer gold mineralization in the district is a structurally controlled quartz-orthoclase porphyry dike. Democrat Gold Lode, the single known lode mineral occurrence in the district is hosted in this altered porphyry dike. Recent geochemical stream sediment and pan concentrate sampling in conjunction with 1:40,000 scale geological mapping (Swainbank et al., 1984) has demonstrated that there are six additional areas of potential lode mineralization in the district. In addition to gold, the elemental associations include Hg-Sb-W±Au-Ag, Cu-Ni-Zn±Au-Ag, Sn-W-As±Au-Ag, and Cr.

BEDROCK GEOLOGY

The bedrock geology of the area adjacent to the Democrat Gold Lode has been described by Bundtzen and Reger (1977). Regional 1:250,000 scale geological mapping of the entire Big Delta quadrangle has been completed by Weber and others (1978) and Foster and others (1979). Plates I and II show the geologic station locations of the recent 1:40,000 scale bedrock geological mapping of the Big Delta B-5 and B-6 quadrangle by Swainbank and others (1984) as well as the location of geochemical samples collected in this investigation.


Colville R.
Yukon River
Kuskokwim River
Fairbanks
Tanana River
Tintina Fault
Denali Fault
USA
CANADA
ALASKA
YUKON TERR.
Harding Lake
RICHARDSON MINING DISTRICT AND
ADJACENT AREAS
Birch Lake Pluton
Birch Lake
Quartz
Porphyry
Dike
5 0 5 10 kilometers
Yukon-Tanana Uplands Schist Terrane
50 0 200 miles
50 0 200 kilometers

The bedrock geology of the Richardson mining district and adjacent areas includes metasedimentary and metaigneous rocks of the Yukon-Tanana Uplands Schist Terrane formerly the Birch Creek Schist (Mertie, 1937; Foster et al., 1973) (see Fig. 2) that have been metamorphosed to greenschist, epidote-amphibolite, and amphibolite facies and have been intruded by Cretaceous and Tertiary (?) plutons and dikes. Due to the poor bedrock exposure in the district, the stream sediment and pan concentrate samples cannot be related generally to individual bedrock units.

GEOCHEMICAL RESULTS

A total of 378 stream sediment and 111 pan concentrate samples were collected. The stream sediment samples were seived and the minus 80 mesh fractions were analyzed by inductively coupled plasma emission spectroscopy for Cu, Pb, Zn, Ni, Fe, Mn, and Cr. Analyses were completed by the Alaska Division of Geological and Geophysical Surveys and are listed in Table 1. Pan concentrate samples were concentrated by elutriation and the minus 100 mesh fractions were analyzed for Ag, W, As, Hg, Au, Sn, and Sb at a commercial laboratory. Silver, mercury, and gold were determined by atomic absorption methods; tungsten and arsenic determinations were completed by colourimetric techniques; and tin and antimony concentrations were measured by X-ray fluorescence. Pan concentrate sample results are listed in Table 2.

Histograms and concentrate-log-probability plots (see Figs. 3-30) were completed for each element and anomalous samples were estimated by the technique described by Lepeltier (1969). Anomalous concentrations are defined as those above the 97.5 probability level. Table 3 is a tabulation of threshold values for all the elements as well as the threshold values of geochemical

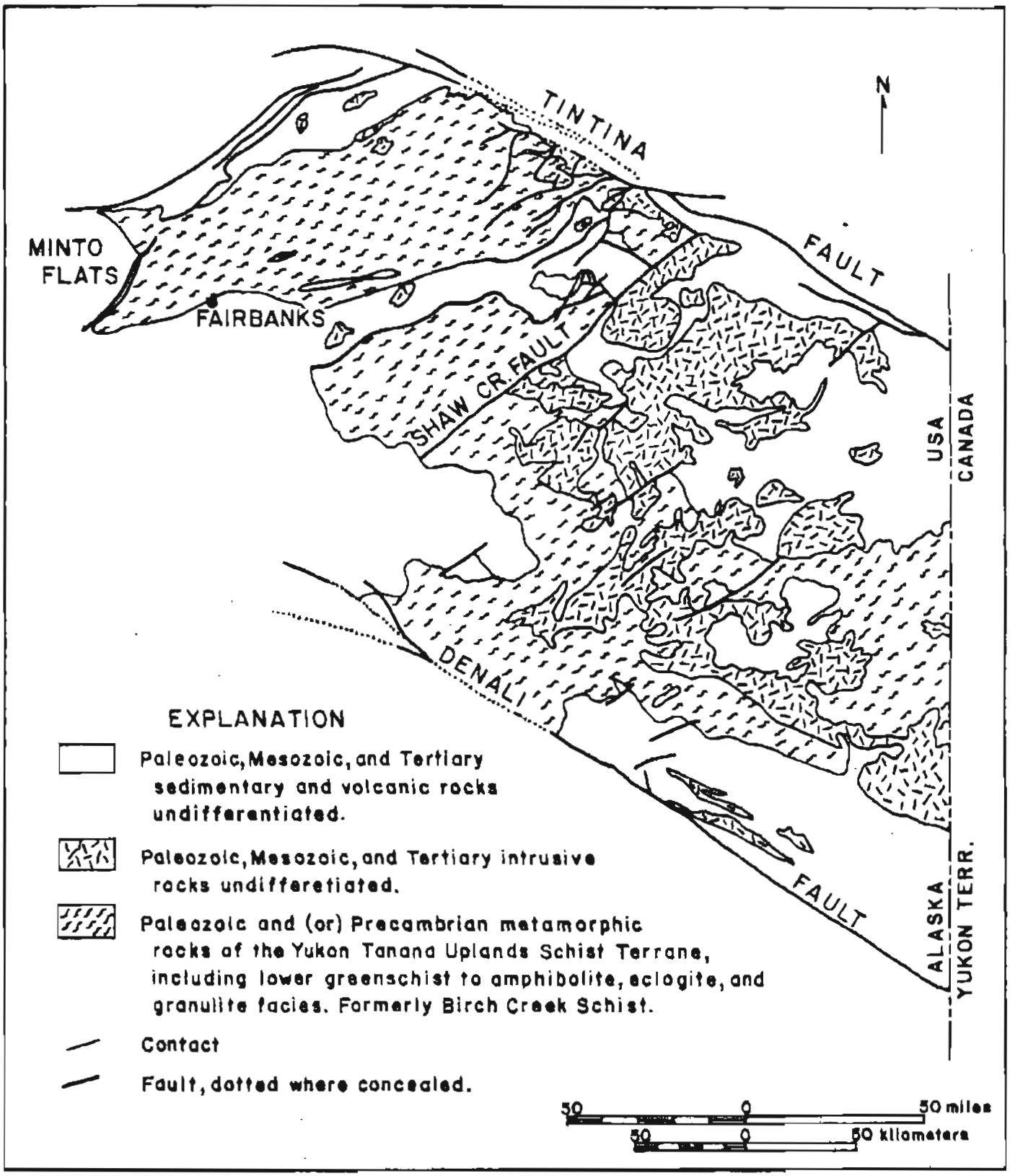

TINTINA
FAULT
N
MINTO
FLATS
FAIRBANKS
SHAW CR. FAULT
USA
CANADA
DENALI
FAULT
ALASKA
YUKON TERR.
EXPLANATION
Paleozoic, Mesozoic, and Tertiary sedimentary and volcanic rocks undifferentiated.
Paleozoic, Mesozoic, and Tertiary intrusive rocks undifferetiated.
Paleozoic and (or) Precambrian metamorphic rocks of the Yukon Tanana Uplands Schist Terrane, including lower greenschist to amphibolite, eclogite, and granulite facies. Formerly Birch Creek Schist.
Contact
Fault, dotted where concealed.
50 0 50 miles
50 0 50 kilometers

Table 1. Stream Sediment Sample Analyses from the Richardson Mining District, Alaska in PPM.

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1004	10	5	35	18	17000	183	24
1006	13	7	44	20	23200	216	20
1011	13	7	39	21	19200	146	20
1012	18	8	49	22	23800	146	20
1016	16	7	48	21	26200	276	18
1018	22	10	55	23	33400	349	24
1019	22	8	51	23	26600	203	23
1021	19	9	46	19	28000	238	17
1027	16	5	47	22	30200	226	17
1028	16	5	48	22	75500	1090	12
1030	18	5	52	24	23500	215	17
1031	16	8	59	29	31300	457	22
1032	18	9	51	18	29500	289	17
1033	20	6	54	27	30400	238	18
1034	16	6	53	24	30800	251	18
1036	16	6	51	22	26500	201	12
1037	16	6	40	21	86500	304	12
1038	16	5	49	21	24200	215	15
1039	18	5	52	27	25900	245	20
1040	14	4	50	24	23500	216	18
1043	36	12	33	20	29200	602	56
1044	16	8	50	21	24100	179	17
1046	15	7	53	21	23800	166	16
1047	23	8	58	28	30900	270	21
1048	18	5	54	26	29000	242	19
1049	16	7	20	10	13000	238	5
1053	19	7	48	23	33900	306	18
1055	24	9	55	25	30700	378	18
1056	21	7	53	25	26800	216	20
1058	14	8	50	22	28100	233	16
1059	20	7	61	27	28700	246	22
1060	17	8	58	27	39000	333	16
1062	15	6	54	23	26100	268	14
1063	14	11	54	19	33500	628	29
1064	23	6	51	26	26600	320	17
1065	19	9	59	28	30900	238	21
1068	17	7	55	26	45400	277	16
1069	18	9	52	24	28900	236	14
1070	18	10	58	26	32800	556	16
1071	19	6	49	24	25000	231	15
1072	13	6	47	20	25000	318	17
1073	16	7	45	27	24200	330	38
1074	14	7	37	23	23100	331	34
1076	16	7	41	24	24100	302	36
1077	17	8	44	24	27100	393	35

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1078	25	13	60	29	30800	546	41
1079	19	10	52	25	30500	509	37
1080	20	8	42	26	27500	380	36
1081	37	5	37	27	21900	190	50
1083	21	9	50	30	36200	1680	37
1085	22	6	45	29	28200	372	38
1085	28	15	66	31	32100	636	40
1086	20	10	42	24	25700	257	33
1088	18	11	32	19	23800	187	29
1089	19	8	35	23	22500	343	32
1090	19	6	38	26	25500	314	34
1092	24	9	47	25	28500	307	33
1092	17	7	36	21	22700	208	26
1095	15	11	58	18	33800	328	30
1098	22	9	45	23	41600	798	32
1099	30	10	12	27	31700	2290	32
1102	21	9	48	21	24800	172	31
1106	27	11	16	24	33800	302	39
1107	17	9	45	20	31900	301	33
1108	20	10	43	20	31400	285	32
1109	24	8	41	22	26100	233	32
1112	19	11	48	20	27500	205	33
1114	14	7	32	20	23900	283	27
1115	16	7	38	22	24700	273	28
1117	19	6	30	17	21600	199	23
1118	22	10	40	20	34200	239	31
1121	35	11	52	26	34700	498	32
1124	18	9	45	19	26700	345	25
1125	18	8	41	18	26300	326	24
1127	22	12	50	21	26700	183	31
1128	17	12	53	21	31900	259	31
1129	21	9	45	20	24900	204	28
1131	10	13	63	21	32200	233	33
1132	22	9	40	20	21500	212	27
1134	17	9	42	19	23000	220	28
1135	17	11	44	18	26200	185	25
1136	21	8	43	20	25900	211	29
1138	33	11	59	30	34700	359	41
1139	18	7	39	20	24700	263	26
1140	16	6	35	20	23200	222	29
1141	14	6	33	20	21800	207	26
1143	16	9	40	19	36600	272	29
1144	14	7	36	19	23200	180	25
1145	13	6	32	18	22500	277	27
1147	16	7	32	17	26500	267	31
1148	12	5	29	18	25300	219	34

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1149	19	6	53	25	24200	360	32
1151	15	7	41	21	23800	258	27
1152	14	7	36	19	23000	303	25
1153	14	8	39	19	24400	361	27
1155	20	9	44	20	31700	365	28
1156	14	7	38	18	34100	447	25
1157	18	7	36	20	23800	325	27
1158	22	6	41	23	36400	347	31
1162	17	7	39	20	29200	386	26
1163	14	7	35	18	25100	349	26
1164	17	7	43	22	26500	235	27
1165	18	7	35	19	25300	251	28
1168	21	9	55	21	29000	325	29
1169	18	10	61	24	35300	470	31
1170	19	7	41	21	24300	256	28
1171	22	8	43	17	21900	516	22
1172	22	12	55	22	51000	498	31
1173	13	11	31	13	106000	659	25
1174	26	10	45	23	32000	328	31
1177	17	7	38	17	28200	231	25
1179	24	6	43	21	25900	214	28
1180	16	8	38	17	25900	275	27
1181	27	10	59	24	28400	289	32
1182	81	12	200	72	51000	606	32
1183	67	9	212	37	65700	1260	29
1185	19	9	56	20	28600	371	26
1186	24	6	39	16	21900	309	23
1188	18	7	42	24	27900	268	27
1189	14	6	34	22	23500	275	27
1190	33	6	47	25	19600	1670	23
1192	42	11	77	32	90800	1500	29
1193	21	10	56	26	28300	609	31
1194	20	8	49	26	24400	583	26
1196	17	10	42	16	25800	302	19
1197	23	10	46	24	28000	345	29
1198	20	9	45	23	31500	690	27
1201	23	9	48	23	26900	376	31
1202	18	10	43	23	26900	314	30
1204	15	8	37	23	36400	594	33
1205	16	7	36	26	31100	567	38
1206	19	8	39	35	28200	299	58
1208	19	10	46	31	27400	519	54
1209	19	8	42	48	28000	332	75
1210	18	8	41	20	34300	339	41
1211	20	9	42	21	34500	328	44
1212	18	8	46	21	27700	363	29

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1214	22	9	46	23	29400	382	31
1215	22	8	43	24	30100	377	35
1216	18	7	42	24	28400	317	34
1217	22	8	41	23	27100	343	28
1219	23	8	70	30	32600	518	45
1220	19	9	62	29	29300	509	37
1221	19	11	64	32	31800	498	41
1222	20	18	66	34	32500	527	42
1223	27	7	67	34	34900	464	48
1229	34	4	63	58	31500	480	53
1230	24	9	69	37	32300	429	53
1231	22	7	63	34	30800	393	48
1236	21	7	68	29	30600	459	36
1238	21	8	42	26	27600	267	34
1239	18	7	40	27	27500	267	33
1241	23	17	59	19	28500	382	29
1242	23	14	50	22	30500	333	31
1243	24	10	48	26	33100	339	42
1244	19	10	40	22	28800	286	32
1245	18	10	38	21	28800	273	36
1247	31	17	53	22	32900	395	33
1248	19	12	48	18	32600	377	28
1249	16	9	43	18	24900	209	23
1251	18	13	55	20	30200	520	30
1252	15	12	48	17	30500	614	24
1255	16	10	45	17	38500	252	26
1256	15	9	41	16	35900	316	24
1258	19	14	37	17	27400	851	21
1259	15	11	40	18	22100	236	24
1261	15	10	38	16	33300	286	24
1263	17	14	40	17	26500	480	26
1264	15	11	37	17	25200	467	25
1265	18	11	48	29	28200	222	46
1266	13	9	42	25	24200	200	41
1268	20	9	47	28	26400	309	45
1269	15	10	46	29	23800	317	47
1270	15	8	44	28	28600	388	43
1272	17	7	43	27	25400	214	42
1273	18	8	42	25	26200	208	38
1274	15	8	37	24	25800	234	37
1275	16	8	46	25	28600	228	38
1277	20	9	51	25	44000	256	41
1278	19	7	50	24	30400	223	40
1279	21	11	53	26	47900	288	41
1280	20	25	56	27	33800	560	42
1283	14	7	48	21	29300	298	33

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1285	15	7	56	23	26600	226	32
1286	18	9	50	21	31900	380	34
1286A	17	9	56	24	48300	1080	34
1287A	15	8	44	19	28100	209	32
1287B	18	6	45	22	24400	231	33
1287C	14	4	31	20	22700	223	30
1289	17	7	45	23	23300	270	35
1290	15	8	38	20	23400	247	35
1291	23	9	44	21	24200	216	32
1292	16	9	42	21	26600	219	32
1294	16	9	36	18	24400	252	30
1295	13	7	38	18	23300	173	31
1297	14	7	39	17	22400	174	27
1298	15	7	42	17	24800	178	24
1299	15	8	40	17	23600	164	27
1301	17	9	46	18	28600	163	30
1302	11	9	34	14	34900	222	25
1303	13	9	37	14	24600	251	26
1304	14	9	38	14	22200	161	24
1305	15	9	43	16	24000	170	25
1307	11	9	45	16	41100	496	25
1308	9	8	41	15	26700	193	26
1310	16	11	51	18	30400	181	29
1312	21	8	42	17	21500	165	26
1314	18	9	61	19	29800	232	30
1315	17	8	41	15	23600	190	24
1317	12	9	52	26	20700	329	44
1319	8	8	47	21	19000	190	38
1320	7	8	45	22	19000	281	37
1321A	22	10	63	28	27300	378	41
1321B	13	10	64	27	24100	220	43
1323	14	10	65	30	44600	321	43
1324	13	11	63	31	77200	1900	45
1325	8	7	56	26	24500	285	36
1327	19	11	55	<10	31400	230	40
1328	13	8	59	28	22400	255	35
1330	16	11	73	31	28100	262	38
1331	9	7	55	26	25600	318	32
1332	10	9	61	27	26500	576	30
1333	13	9	64	29	27500	450	32
1335	17	8	61	29	28900	236	32
1336	26	10	64	39	28800	324	36
1337	20	10	60	31	28400	258	33
1338	12	8	63	29	23200	277	27
1342	11	11	40	26	21800	290	55
1345	15	15	55	26	39500	350	45

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1346	10	9	49	24	26800	302	40
1347	13	10	55	26	29500	722	41
1348	10	9	50	23	26200	600	40
1350	12	8	51	24	29800	328	38
1351	14	9	56	26	33300	585	39
1352	10	8	49	23	23200	310	36
1353	11	7	50	22	24000	397	35
1356	42	12	176	53	44900	715	47
1357	37	10	151	47	38300	630	45
1358	10	8	52	24	27100	418	40
1359	19	9	62	23	24000	237	38
1360	8	7	48	21	23200	236	37
1361	11	8	54	23	25400	302	41
1362	10	8	56	24	24700	386	39
1363	15	7	62	27	26900	605	43
1365	12	9	52	23	25300	334	39
1366	19	14	130	34	38700	2870	47
1367	20	12	48	26	29200	340	49
1368	11	18	59	25	27800	282	44
1369	12	13	75	28	34600	341	44
1370	10	13	67	26	37500	239	45
1371	7	6	39	22	19500	196	35
1372	7	7	40	22	21100	237	34
1374	9	8	44	27	21000	230	44
1375	8	6	43	23	21000	225	34
1376	9	6	39	24	20500	230	35
1377	12	7	36	27	24000	203	36
1379	8	7	43	23	22000	222	35
1380	11	8	55	25	27500	265	59
1381	12	10	65	28	32600	374	43
1382	14	9	54	32	28800	271	38
1385	17	13	52	18	21600	416	32
1386	16	14	52	18	21000	488	29
1387	23	13	42	31	33600	237	41
1388	17	10	62	38	31800	374	42
1389	23	15	47	35	29600	213	42
1390	20	12	61	35	33400	435	42
1391	22	11	56	36	32400	380	42
1392	16	10	50	32	28600	284	38
1393	16	10	53	32	28400	271	39
1395	17	10	50	32	29400	324	39
1396	16	9	47	30	28600	310	38
1398	14	8	46	29	27500	293	36
1400	11	8	40	25	26700	465	34
1402	16	11	56	21	36200	710	31
1403	17	14	43	27	30300	357	38

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1404	16	10	48	29	29100	330	34
1405	17	9	52	30	30900	273	36
1408	41	10	45	159	30800	349	302
1410	15	9	46	26	28100	272	36
1411	18	11	51	30	27200	314	34
1413	27	13	64	39	32700	403	42
1414	26	13	60	33	34000	548	38
1415A	47	14	47	33	33900	324	38
1415B	23	11	58	30	30800	567	33
1416	22	12	55	29	30400	198	37
1417	13	8	37	21	24900	177	29
1418	12	9	47	16	22000	165	23
1420	19	13	58	25	37600	342	32
1422	16	11	53	23	28700	312	28
1424	19	13	56	27	23900	219	30
1425	7	7	39	11	18600	158	21
1426	8	8	37	12	20700	192	20
1428	10	9	44	15	22800	208	28
1429	9	8	42	15	20800	176	25
1430	11	9	43	15	19300	159	23
1431	12	9	49	18	23700	325	26
1433A	24	13	74	34	30800	437	32
1433B	11	7	39	17	21000	222	26
1434A	13	7	50	23	22100	259	26
1434B	8	9	38	13	16600	157	19
1436A	14	7	34	16	21000	217	27
1436B	6	7	30	11	12700	114	15
1441	6	8	40	15	17500	164	22
1443	7	8	32	12	14000	129	17
1444	6	7	35	19	15800	143	20
1445	9	9	42	16	21800	190	26
1446	17	7	51	26	30000	302	32
1447	25	10	58	28	29800	342	31
1449	25	11	55	29	32700	376	32
1450	17	8	40	23	27600	231	32
1451	32	11	49	31	33800	299	38
1452	57	17	90	46	40800	556	35
1453	46	13	76	50	36000	675	30
1454	33	11	61	34	28800	321	27
1455	20	10	76	33	27300	304	24
1456	25	13	57	28	28100	278	29
1458	29	12	79	37	32600	528	31
1461	16	8	45	22	26000	216	26
1465	12	7	34	18	24500	183	22
1468	20	8	78	22	79800	656	27
1470	16	8	52	20	47900	694	26

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1471	16	7	43	21	27800	349	24
1472	19	9	45	22	29000	300	31
1474	17	10	51	20	32400	461	27
1475	19	7	41	30	26100	252	29
1476	32	16	44	29	37200	399	31
1477	29	18	55	27	38800	194	36
1478	20	10	54	23	37400	273	27
1479	24	9	53	28	42500	447	32
1481	23	8	61	22	28900	316	29
1482	23	7	54	21	26500	473	26
1484	25	11	61	27	32400	304	34
1486	28	12	63	27	36100	336	35
1493	23	9	56	24	61400	1440	30
1494	18	10	52	25	25000	241	27
1496	14	10	40	21	22400	203	22
1497	13	7	42	22	22700	192	23
1502	17	8	36	24	28300	275	29
1503	17	8	36	25	28800	273	30
1506	18	9	44	34	34100	340	40
1508A	20	9	45	34	33100	338	38
1508B	14	6	37	22	26000	279	27
1509A	17	5	36	26	27800	315	30
1509B	20	8	46	32	32600	338	36
1510	14	6	40	24	32500	929	27
1511	15	7	37	23	27700	350	26
1512	15	4	38	22	28600	465	22
1516	15	5	33	21	25600	245	24
1517	16	6	46	29	52300	5290	21
1518	20	9	51	29	58400	2660	25
1519	14	6	38	19	22700	202	17
1525	14	12	50	19	26500	354	22
1527	10	5	31	18	23700	291	21
1529	14	6	43	22	28100	366	24
1530	14	6	45	25	33500	1580	28
1531	12	6	40	20	27900	444	25
1532	15	6	45	23	32900	624	26
1534	16	7	43	24	36700	1230	28
1535	12	7	36	19	31800	349	18
1536	15	8	44	22	39600	668	22
1537	14	7	41	21	51100	702	20
1538	20	9	48	25	26600	345	22
1540	28	11	53	31	31800	488	23
1541A	20	10	41	25	26900	426	21
1541B	19	12	49	28	31200	573	24
1542	17	12	40	26	28900	707	23
1546	15	8	39	23	24300	256	22

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1551	36	11	48	54	25500	502	24
1552	26	13	68	45	29200	378	27
1553	29	13	59	49	27000	516	22
1556	17	13	69	30	27000	1030	24
1557	12	12	56	27	26300	718	21
1560	14	18	61	28	26200	703	21
1561	12	12	53	25	25500	814	21
1563	15	20	61	23	41400	1270	24
1564	9	10	34	19	19300	396	17
1565	10	20	43	16	20900	281	15
1566	9	10	33	21	20200	378	19
1567	15	14	49	29	21600	325	19
1568	18	16	49	30	23200	350	19
1569	20	16	51	32	23400	393	18
1571	13	9	29	20	24000	269	16
1572	9	8	24	18	19700	193	15
1574	11	14	36	21	18400	226	15
1576	9	9	22	16	14700	141	12
1577	6	10	12	<10	25600	207	<10
1578	41	10	13	19	48300	52	24
1579	10	10	32	21	20200	575	13
1580	11	10	36	25	27000	816	17
1581	11	9	30	21	22700	397	16
1582	14	11	47	27	27800	435	18
1583	12	10	35	25	23900	354	17
1585	11	9	33	21	21700	587	16
1586	11	8	32	22	23800	887	15
1587	10	6	29	24	23600	1210	16
1588	7	8	20	19	17000	186	13
1590	9	7	27	24	26700	411	15
1592	7	9	20	20	17200	308	12
1593	3	11	8	<10	11900	1070	<10
1594	3	8	<5	<10	7480	384	<10
1599	2	7	<5	<10	3870	24	<10
1600	2	6	<5	<10	3430	20	<10
1601	2	6	<5	<10	3930	30	<10
1603	<1	5	<5	<10	<500	<10	<10
1604	<1	4	<5	<10	<500	<10	<10
1605	7	5	28	25	25300	279	20
1606	2	6	<5	<10	2550	<10	<10
1607	2	5	<5	<10	3560	25	<10
1608	2	4	<5	<10	4090	25	<10
1609	2	7	<5	<10	3170	13	<10
1610	2	6	<5	<10	5750	56	<10
1613	5	5	11	14	11900	138	<10
1614	4	6	12	<10	17200	292	<10

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1615	7	7	22	32	18200	222	31
1617	8	7	29	28	20200	263	28
1618	7	5	20	27	17500	239	25
1619	9	6	24	30	21800	346	27
1620	13	7	29	34	23800	523	31
1622	14	7	35	40	24000	544	33
1623	17	7	40	49	27900	515	34
1624	13	17	53	35	29200	318	32
1626	14	8	34	32	20900	218	30
1628	13	7	28	33	19300	190	26
1629	11	4	28	36	30100	602	29
1630	12	5	36	37	27500	454	33
1631	10	5	28	34	19400	374	26
1633	12	8	36	39	23000	285	32
1634	9	7	25	30	18900	218	25
1635	24	6	85	77	50400	734	59
1636	9	6	22	34	19600	224	26
1638	17	7	22	41	24700	301	33
1639	9	7	25	37	21400	233	32
1640	10	6	25	38	20300	232	28
1641	9	7	25	38	21600	234	34
1643	8	8	23	26	18500	184	22
1644	11	7	29	33	30000	618	29
1645	10	8	26	25	17600	176	25
1647	11	8	28	29	20600	301	23
1649	12	7	27	33	29200	589	27
1650	10	8	32	30	27000	549	30
1651	13	10	31	31	23200	301	30
1652	24	10	78	59	47500	657	53
1653	9	8	25	26	25800	296	25
1654	11	6	27	30	26200	519	28
1655	11	5	28	34	23700	404	28
1660	11	6	30	39	33800	1010	35
1662	12	4	42	39	32600	369	35
1663	17	4	55	54	47500	467	57
1664	35	6	92	64	47500	719	52
1668	8	3	26	26	24300	252	21
1669	14	5	32	35	24000	300	27
1670	14	5	36	39	33300	369	29
1672	11	4	25	28	21400	312	24
1674	11	3	31	31	25300	268	26
1675	9	5	32	31	26600	250	30
1677	13	5	28	34	24200	241	29
1680	9	4	25	26	21800	386	23
1681	8	3	23	25	21400	309	24
1682	9	4	25	25	21300	356	21

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1684	11	4	38	36	49700	573	35
1685	10	3	31	29	27000	1110	25
1687	8	3	23	22	18500	201	19
1689	13	6	37	24	22200	400	21
1691	17	7	71	27	24300	656	23
1692	13	6	38	22	21700	435	19
1693	12	7	36	22	21300	338	19
1695	10	5	37	18	20200	229	25
1696	9	7	41	15	19600	270	26
1697	11	5	40	18	22100	211	28
1703	8	3	36	17	41200	558	27
1704	18	7	60	25	36600	2220	34
1705	7	5	40	14	19860	247	24
1706	19	9	58	21	23700	486	27
1707	18	9	65	23	26200	502	32
1709	9	7	58	20	23000	397	30
1710	12	15	67	21	22200	600	30
1711	13	16	65	23	24100	460	33
1712	13	15	57	22	23600	327	32
1713	12	12	44	18	18000	387	25
1714	10	8	46	18	20200	302	28
1715	7	9	38	13	20900	404	22
1718	18	15	61	29	22700	372	36
1719	16	11	58	25	23900	563	35
1720	10	9	49	23	21500	345	36
1721	12	11	52	23	20900	376	33
1723	13	8	44	20	23800	298	30
1725	7	4	43	15	19100	218	26
1726	9	9	43	16	70600	416	33
1727	7	4	40	12	17800	146	24
1728	8	4	46	16	20200	395	25
1729	12	4	52	17	24300	238	42
1730	19	5	40	15	22200	299	25
1731	13	12	35	14	20000	236	27
1732	15	2	40	16	21700	503	24
1733	9	7	35	13	17200	252	22
1734	11	13	45	14	22700	405	27
1735	11	12	50	14	22500	417	26
1736	9	10	45	13	20800	376	23
1737	8	10	41	13	18300	363	22
1738	9	10	35	13	17800	207	22
1740	9	11	45	13	18600	291	22
1741	5	9	41	11	17500	227	18
1742	4	9	33	<10	14100	174	14
1744	9	9	41	14	18100	243	25
1745	12	7	46	18	21500	197	29

Table 1. (cont'd)

FIELD NUMBER	Cu	Pb	Zn	Ni	Fe	Mn	Cr
1746	8	9	37	19	19000	225	27
1747	17	11	58	20	26100	422	36
1747A	11	12	39	11	21400	318	24
1748	10	9	47	13	20300	355	21
1749	13	11	51	17	22100	346	28
1750	7	7	35	12	17200	196	21
1752	11	8	35	14	19200	222	23
1753	18	7	82	30	40500	379	51
2088	15	11	49	18	22100	270	26
2089	15	10	50	21	24900	359	28
2090	16	8	52	22	26200	377	29

Table 2. Pan Concentrate Sample Analyses from the Richardson Mining District, Alaska.

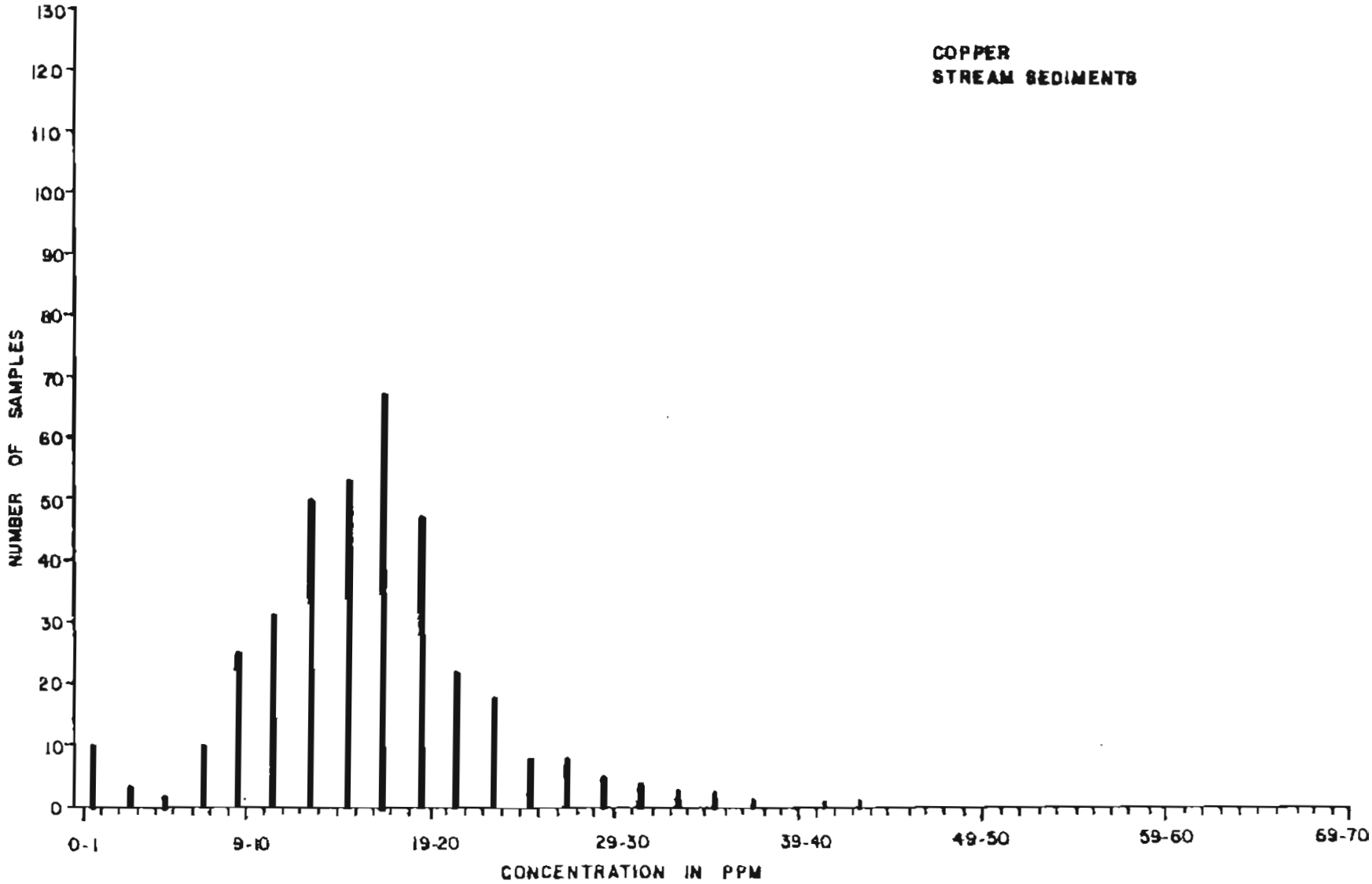
Field Number	Ag PPM	W PPM	As PPM	Hg PPB	Au PPB	Sn PPM	Sb PPM
C 1005	0.2	2	50	50	5	<5	110
C 1013	0.2	3	550	45	75	<5	935
C 1017	0.2	2	11	160	<5	<5	40
C 1020	1.5	48	140	60	15	<5	335
C 1029	0.2	2	8	280	<5	<5	29
C 1035	0.2	6	25	20	<5	<5	165
C 1045	0.2	3	11	80	85	<5	17
C 1050	0.2	2	13	15	<5	<5	64
C 1057	0.2	2	6	30	15	<5	15
C 1061	0.2	2	8	35	<5	<5	41
C 1066	0.2	3	6	280	<5	<5	18
C 1082	0.2	11	7	375	<5	20	65
C 1087	0.2	7	6	15	<5	<5	12
C 1091	0.2	6	5	40	<5	<5	33
C 1113	0.2	8	6	40	20	<5	12
C 1130	0.2	2	11	180	<10	<5	82
C 1133	0.2	2	7	55	25	9	25
C 1137	0.2	2	7	60	15	9	24
C 1142	0.2	2	6	30	<5	<5	15
C 1146	0.2	3	5	20	5	<5	25
C 1150	0.2	2	6	20	<5	<5	15
C 1154	0.4	2	8	70	10	<5	20
C 1166	0.2	2	4	25	<5	8	6
C 1178	0.2	2	6	30	<5	<5	19
C 1200	0.2	12	34	80	65	47	120
C 1203	0.2	12	18	20	1200	36	15
C 1207	0.2	2	6	10	<5	<5	6
C 1213	1.8	2	13	105	9465	13	17
C 1218	0.2	33	7	25	260	34	4
C 1232	0.2	2	33	30	560	14	15
C 1237	0.4	2	22	45	3370	16	50
C 1240	0.2	2	7	30	50	53	8
C 1246	0.7	2	11	20	2660	78	10
C 1250	0.2	2	7	1850	25	<5	10
C 1253	1.3	6	16	10	65	6	10
C 1262	0.2	4	5	115	20	9	12
C 1267	0.2	3	6	35	10	<5	3
C 1271	0.2	8	11	25	30	<5	18

Table 2. (cont'd)

Field Number	Ag PPM	W PPM	As PPM	Hg PPB	Au PPB	Sn PPM	Sb PPM
C 1276	0.2	2	5	35	25	<5	4
C 1281	0.2	105	6	60	115	<5	14
C 1284	0.2	2	7	25	<5	<5	5
C 1288	0.2	22	5	20	25	6	14
C 1288A	0.2	7	5	30	170	<5	6
C 1288B	0.2	85	5	20	<5	<5	3
C 1293	0.2	2	8	90	50	<5	12
C 1296	0.2	2	5	40	285	15	21
C 1326	0.2	6	5	35	10	<5	10
C 1334	0.2	45	27	45	155	10	6
C 1344	0.2	2	11	15	<5	<5	58
C 1349	0.2	11	8	20	10	<5	4
C 1354	0.2	93	14	10	5	<5	9
C 1364	0.5	205	21	10	345	<5	7
C 1373	0.2	28	7	10	<5	<5	6
C 1378	0.2	650	8	20	20	6	7
C 1383	0.2	2	6	310	<5	<5	4
C 1391	1.7	35	14	160	10	<5	17
C 1397	0.2	2	11	40	<5	<5	10
C 1399	0.2	12	15	60	20	<5	22
C 1401	0.2	6	17	800	<5	<5	8
C 1407	0.2	2	11	45	5	<5	13
C 1409	0.2	2	12	40	<5	10	9
C 1412	0.2	9	35	30	5	<5	22
C 1419	0.2	33	7	150	60	<5	8
C 1427	0.2	2	7	50	<5	7	6
C 1432	0.2	2	7	50	25	<5	14
C 1435	1.7	3	11	165	4850	<5	25
C 1442	0.2	35	6	50	50	9	3
C 1448	0.2	18	11	30	75	20	10
C 1455	0.2	12	7	190	60	<5	8
C 1456	0.2	9	8	30	5	6	15
C 1466	0.2	2	13	80	100	<5	7
C 1473	0.2	8	7	10	70	9	3
C 1480	0.2	10	550	30	45	6	10
C 1495	0.2	17	15	400	10	<5	10
C 1507	0.2	2	15	10	10	<5	5
C 1513	0.2	45	20	200	<5	<5	14
C 1526	0.5	33	47	90	235	<5	9

Table 2. (cont'd)

Field Number	Ag PPM	W PPM	As PPM	Hg PPB	Au PPB	Sn PPM	Sb PPM
C 1528	0.2	2	6	30	<5	<5	5
C 1533	5.1	33	5	20	>10,000	<5	5
C 1537	0.2	13	6	50	<5	10	72
C 1539	0.2	23	11	20	450	<5	6
C 1543	0.2	14	5	20	5	<5	14
C 1555	2.7	19	5	365	>10,000	10	8
C 1558	0.2	25	7	40	45	7	7
C 1562	0.2	3	8	55	85	8	8
C 1570	0.2	6	11	40	15	<5	6
C 1575	0.2	3	7	25	20	<5	17
C 1584	0.2	14	15	30	5	<5	4
C 1591	0.2	2	6	25	90	<5	3
C 1602	0.2	16	7	80	5	<5	3
C 1611	0.2	19	6	60	10	<5	9
C 1616	0.2	19	4	40	395	<5	7
C 1621	0.2	2	13	45	<5	<5	9
C 1625	0.2	14	7	40	305	<5	2
C 1637	0.2	2	6	35	<5	<5	5
C 1642	0.2	2	7	35	20	<5	9
C 1656	0.2	2	6	30	<5	<5	<2
C 1661	0.4	2	6	50	<5	<5	7
C 1673	0.2	2	11	20	<5	<5	11
C 1679	0.2	2	6	15	<5	<5	<2
C 1690	0.2	195	22	45	115	8	20
C 1698	0.2	1690	7	45	440	<5	10
C 1702	0.2	205	4	35	20	<5	10
C 1708	0.2	700	6	40	10	21	15
C 1715	0.2	23	8	30	<5	7	3
C 1716	0.2	630	5	205	<5	6	14
C 1722	1.4	9	7	20	60	<5	9
C 1724	0.2	8	11	35	10	7	9
C 1739	0.2	585	4	40	15	8	5
C 1743	0.2	>2000	3	255	240	<5	8
C 1751	0.2	33	6	10	10	<5	8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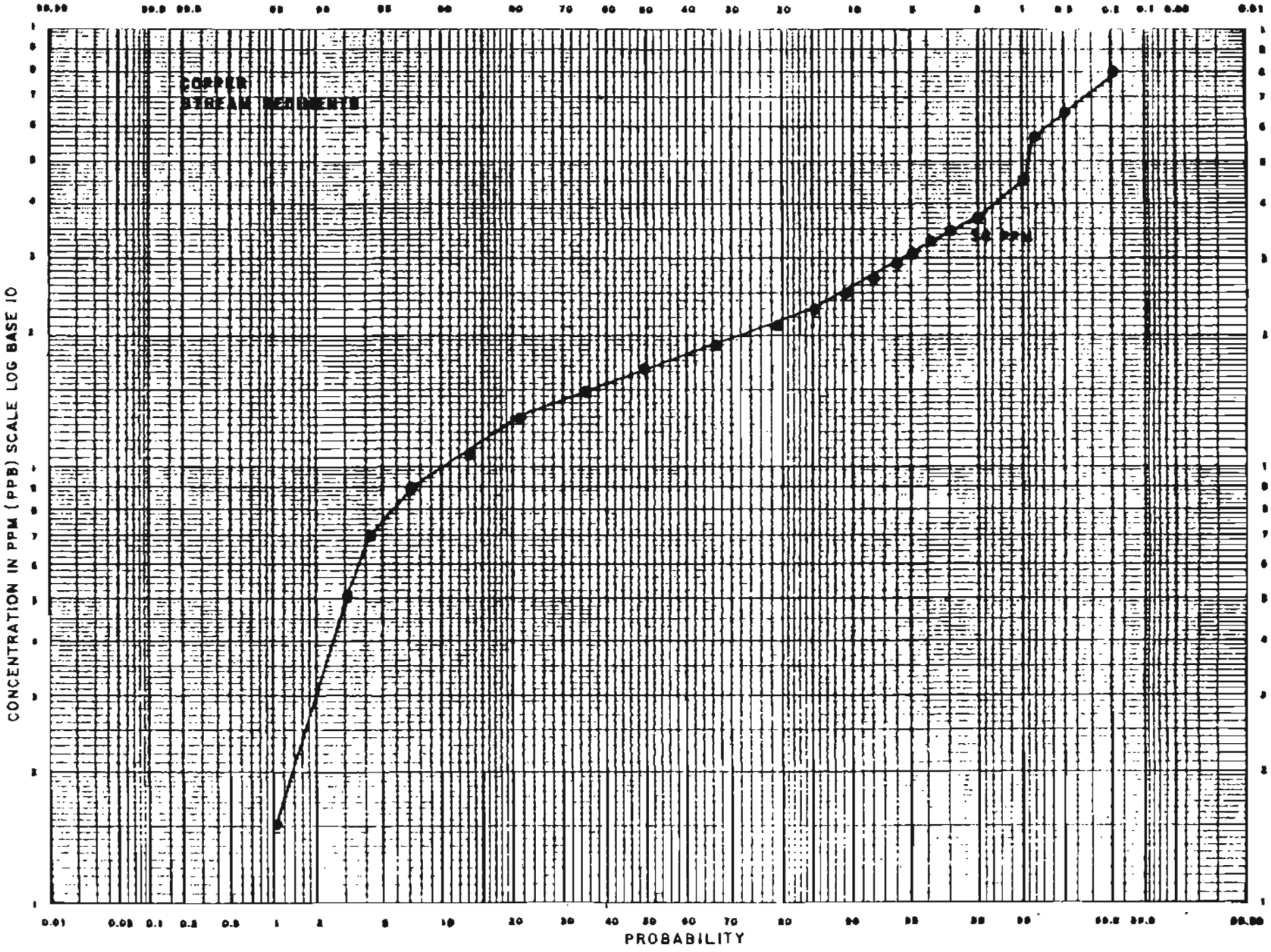
CONCENTRATION IN PPM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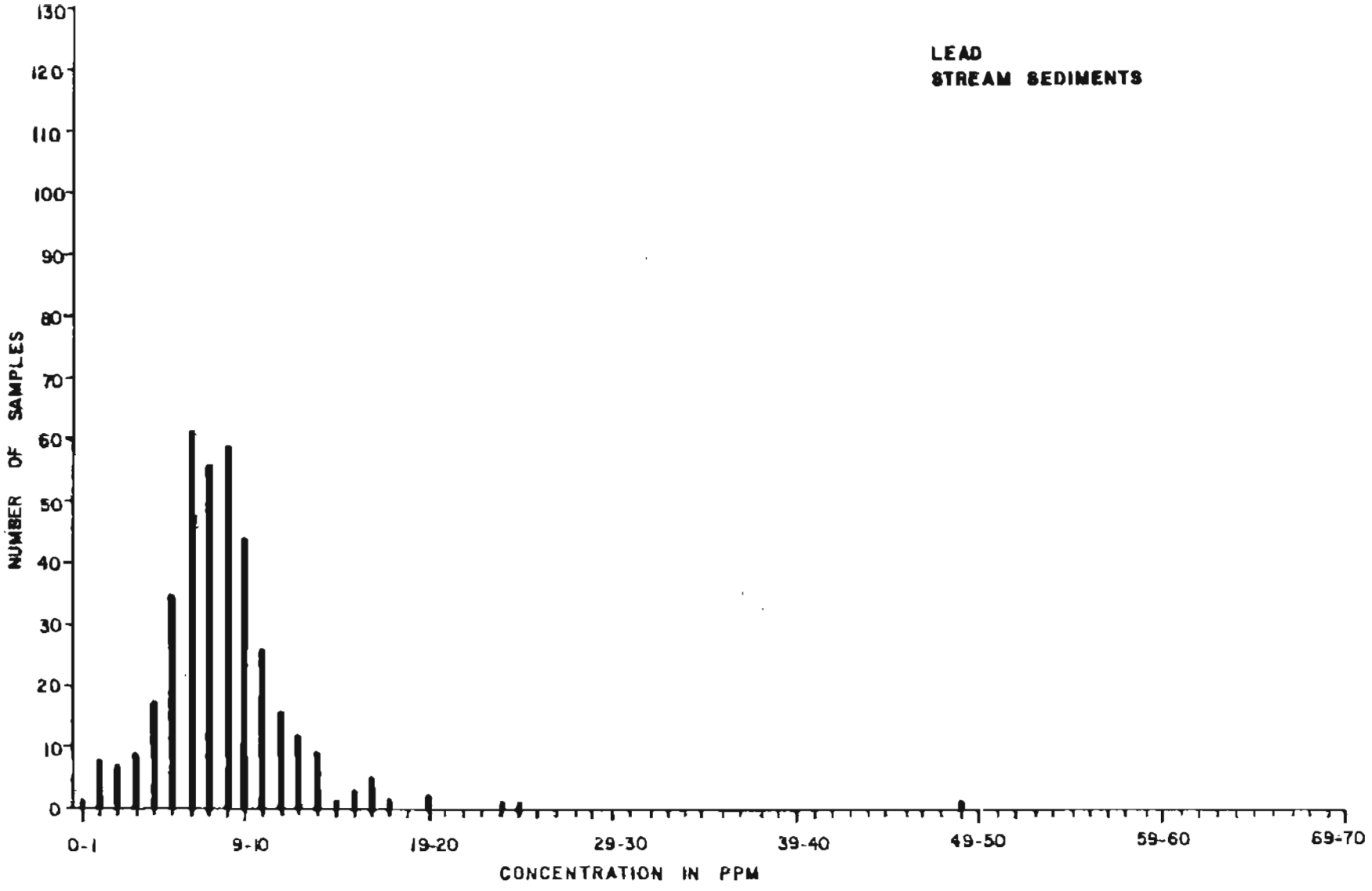
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY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STREAM SEDIMENTS
NUMBER OF SAMPLES
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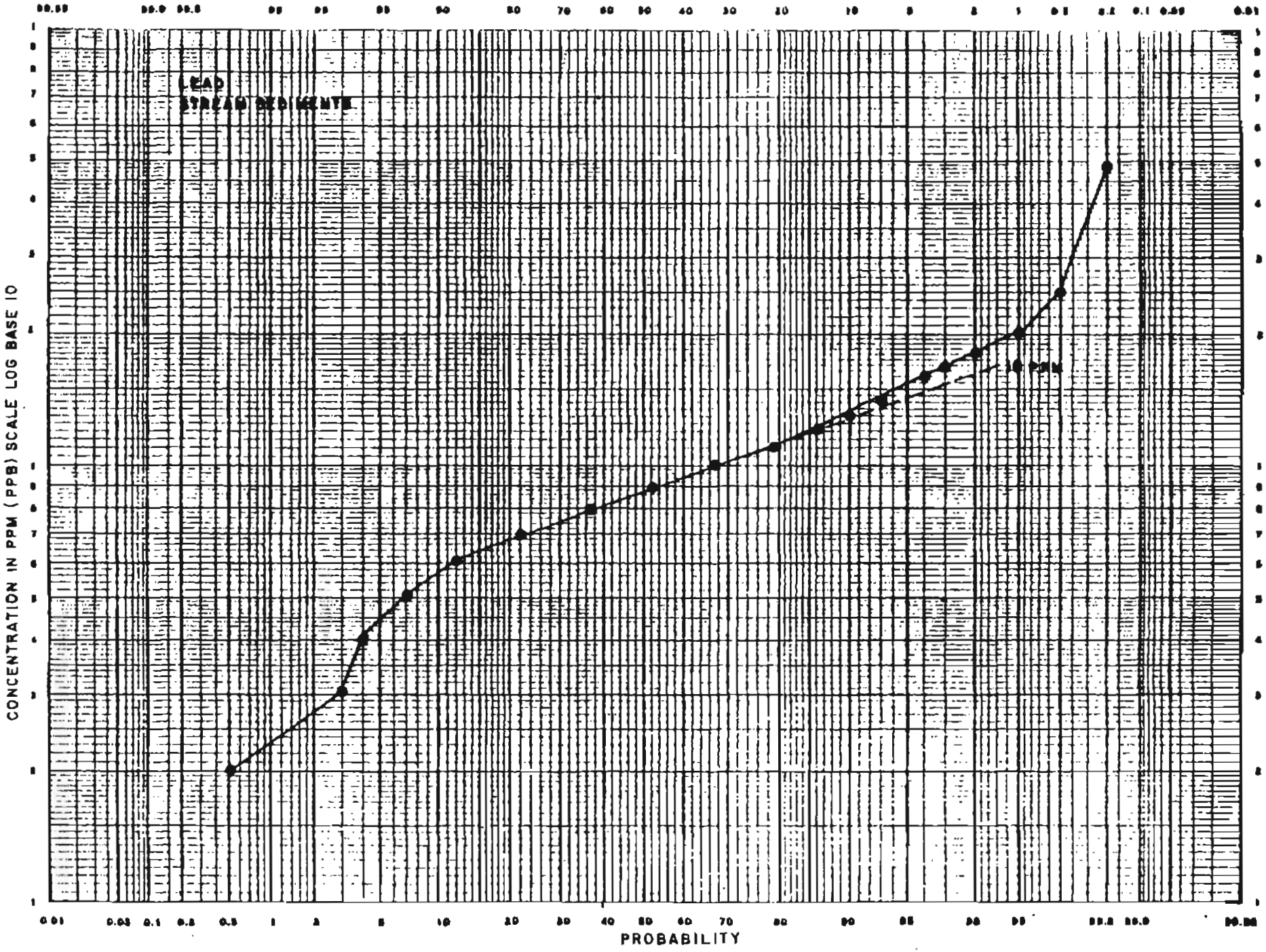
19-20
29-30
39-40
49-50
59-60
69-70
CONCENTRATION IN PPM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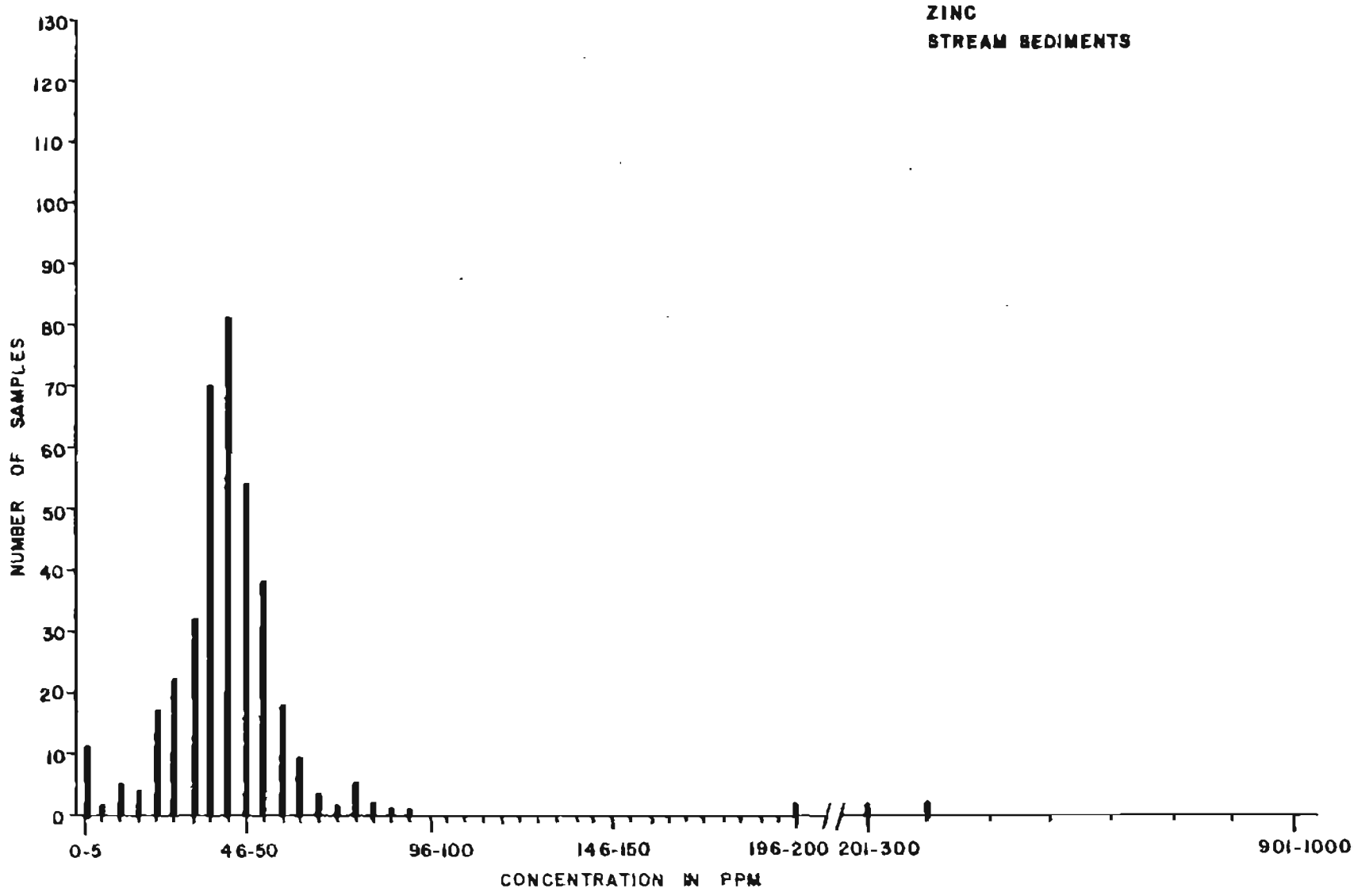
STREAM SEDIMENTS
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY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STREAM SEDIMENTS
NUMBER OF SAMPLES
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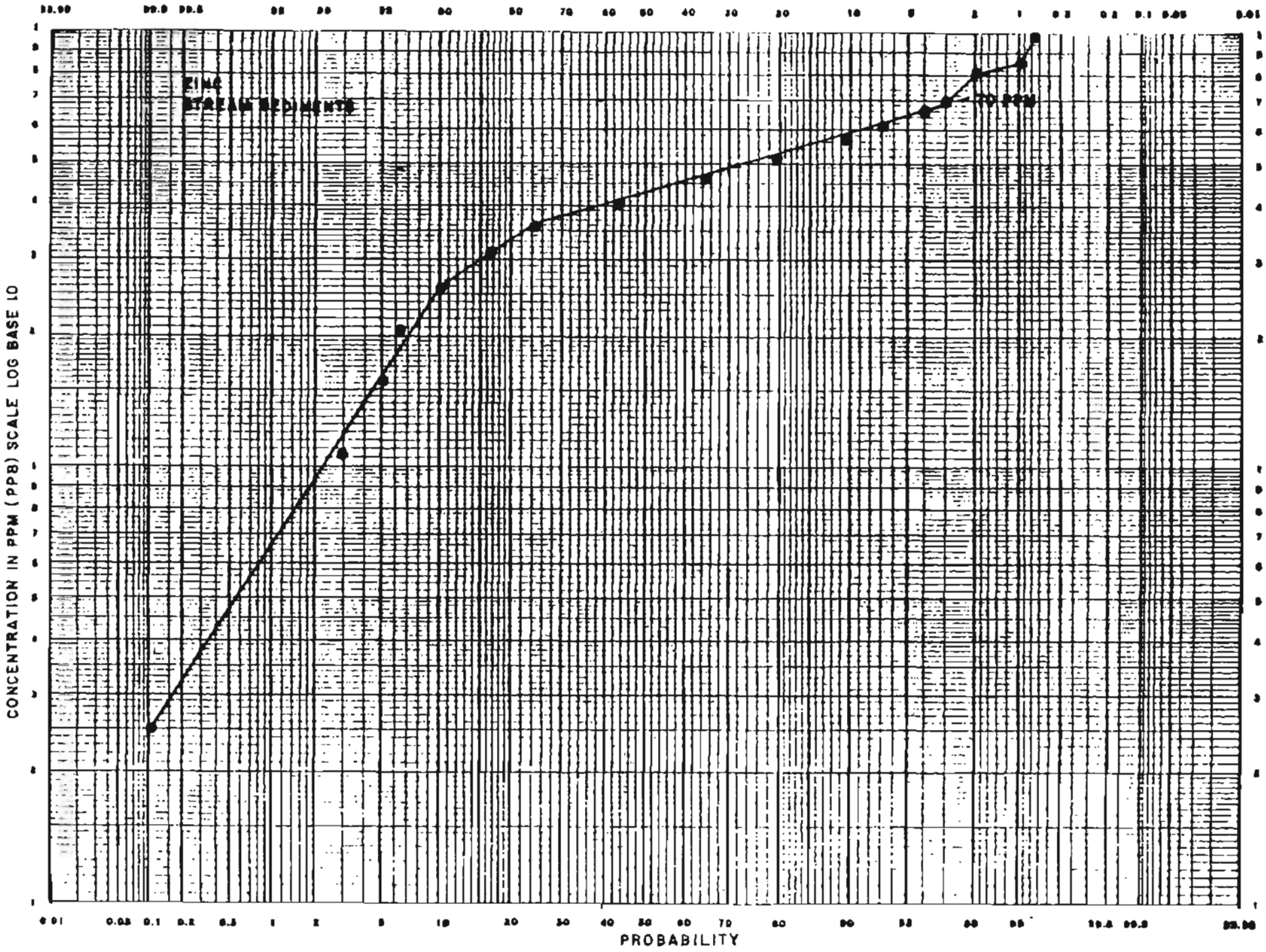
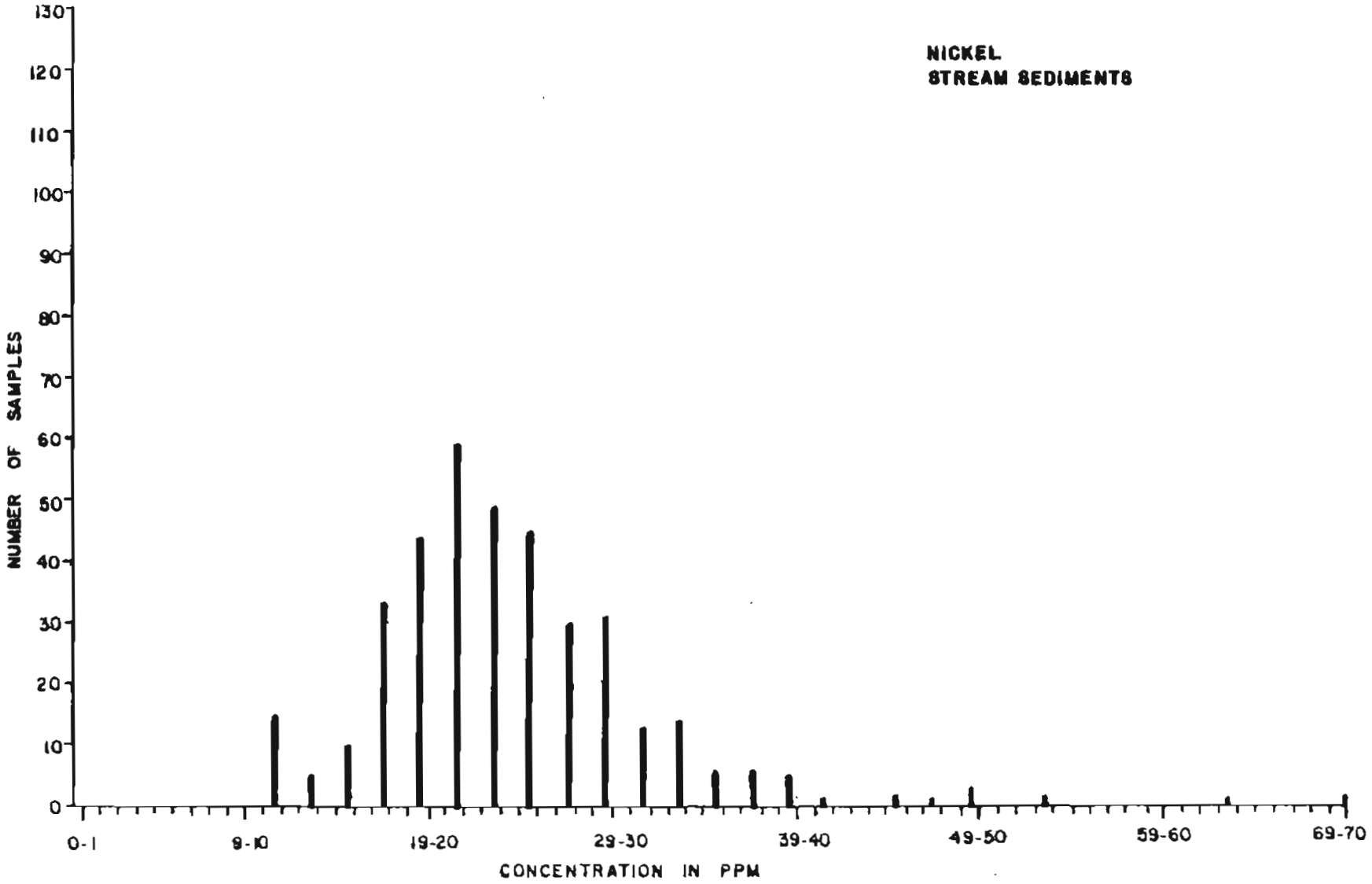
146-150
196-200
201-300
901-1000
CONCENTRATION IN PPM


ZINC
STREAM SEDIMENTS
70 PPM
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


NICKEL
STREAM SEDIMENTS
NUMBER OF SAMPLES
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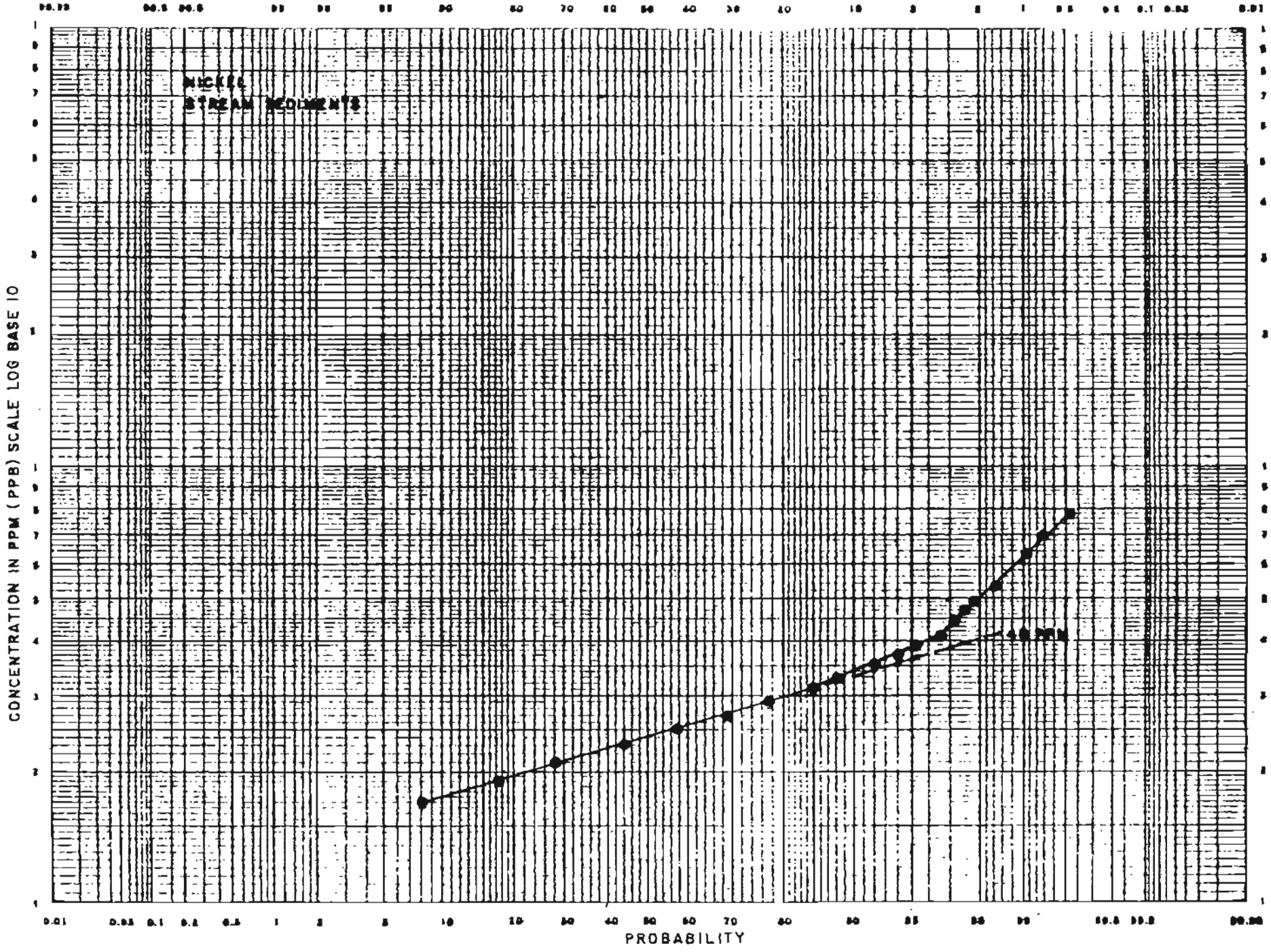
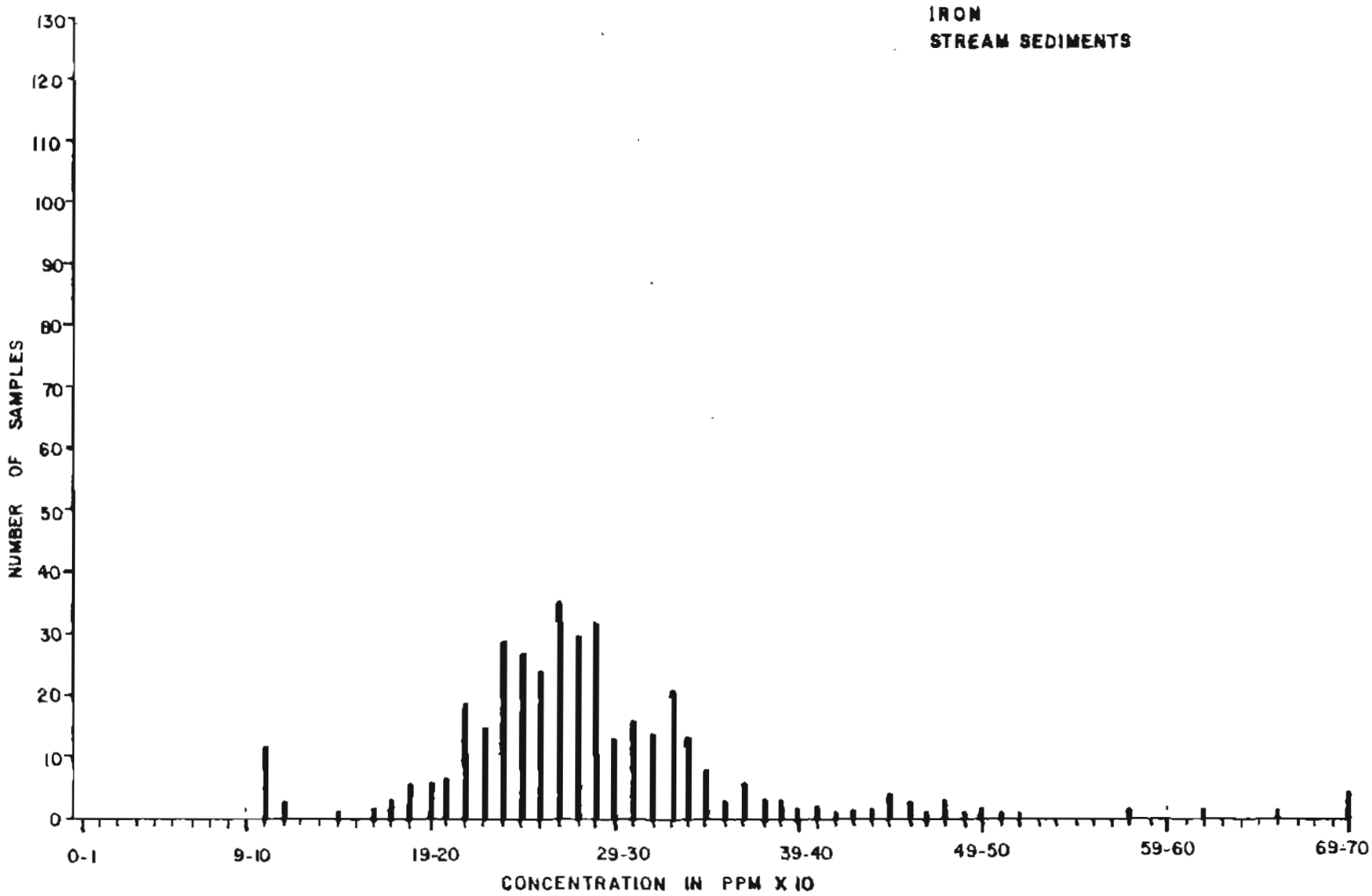
0-1
9-10
19-20
29-30
39-40
49-50
59-60
69-70
CONCENTRATION IN PPM


NICKEL
STREAM SEDIMENTS
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY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NUMBER OF SAMPLES
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29-30
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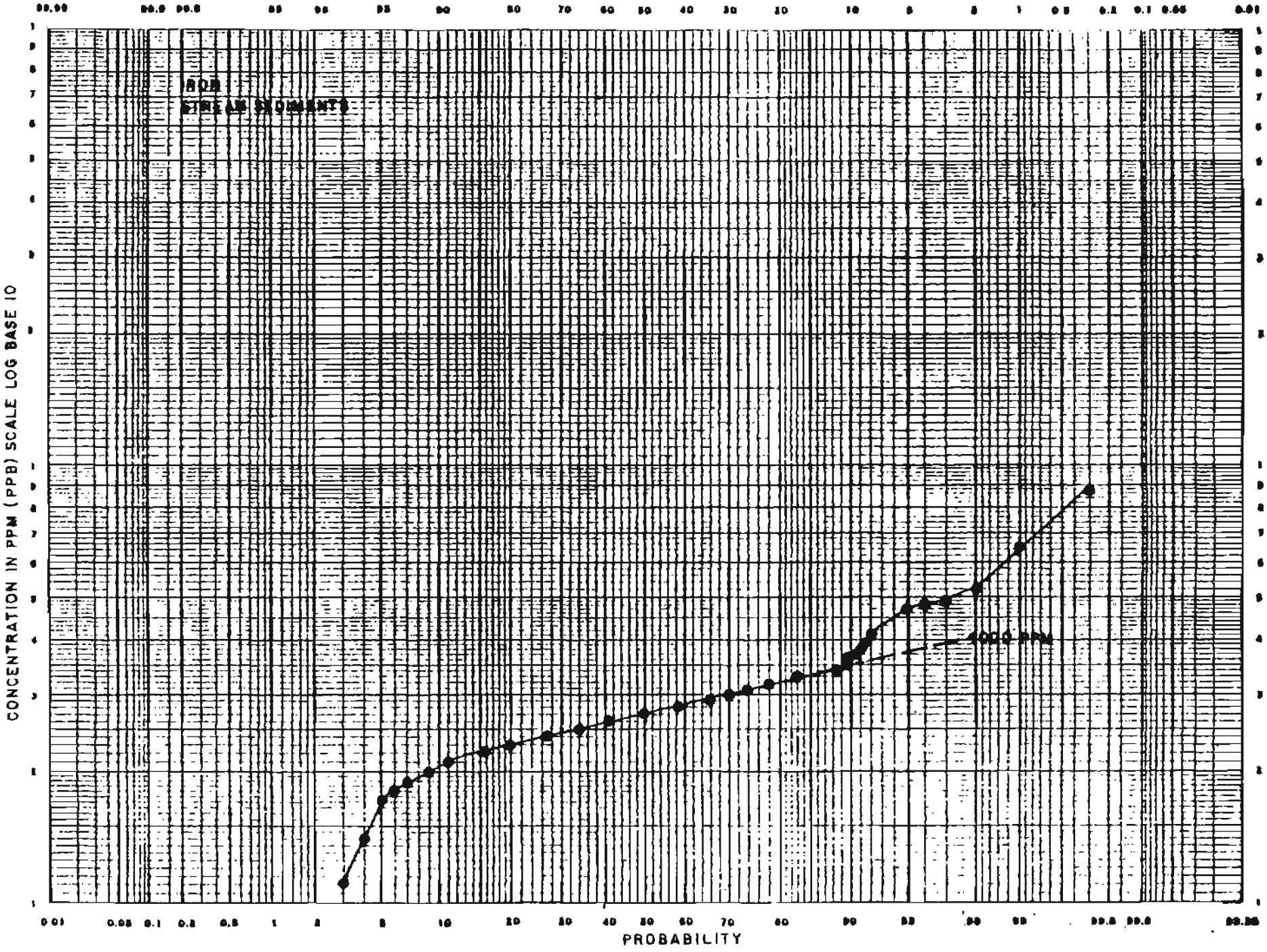
49-50
59-60
69-70
CONCENTRATION IN PPM X 10


BOD
STREAM SEDIMENTS
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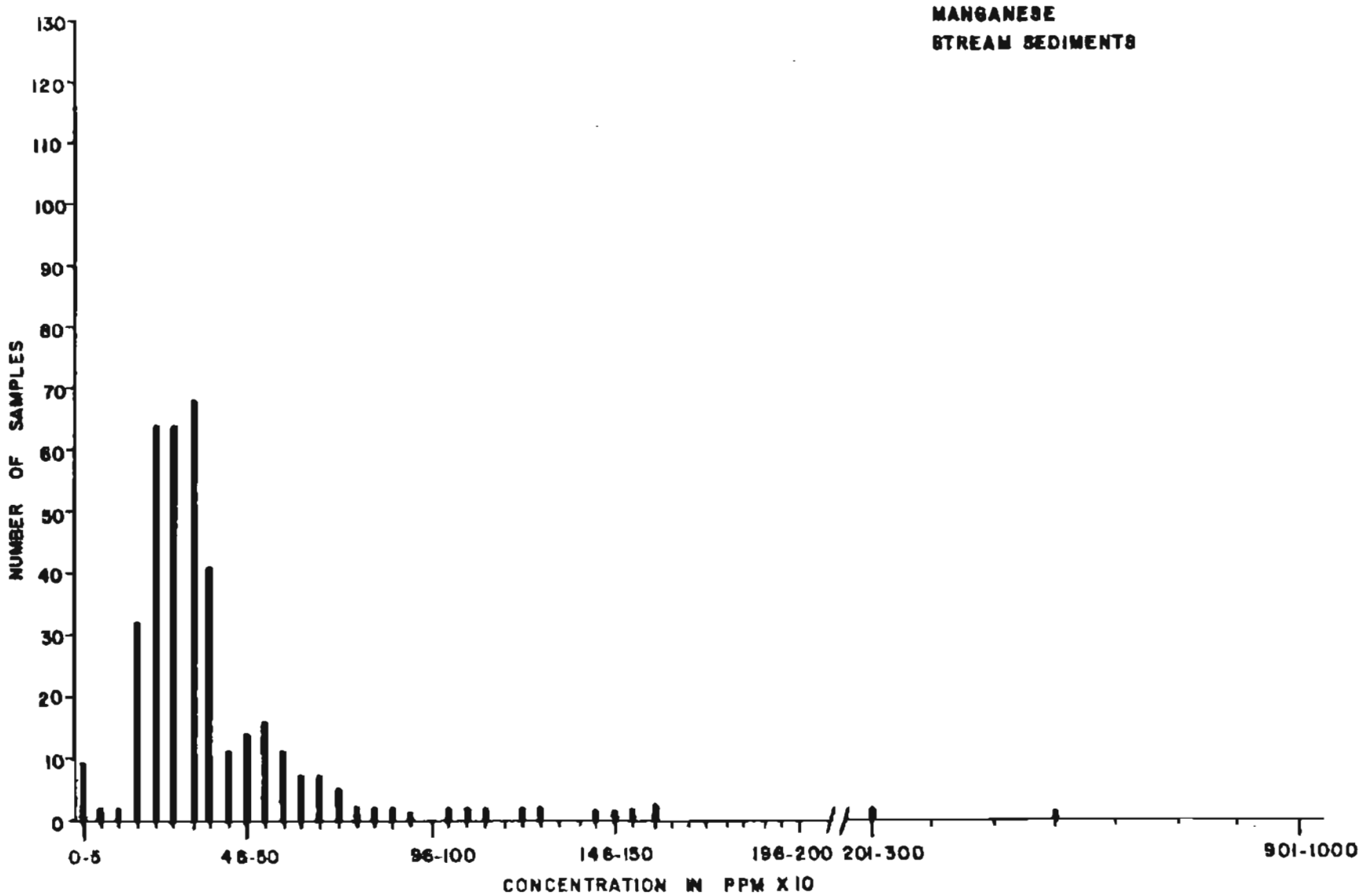
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


MANGANESE
STREAM SEDIMENTS
NUMBER OF SAMPLES
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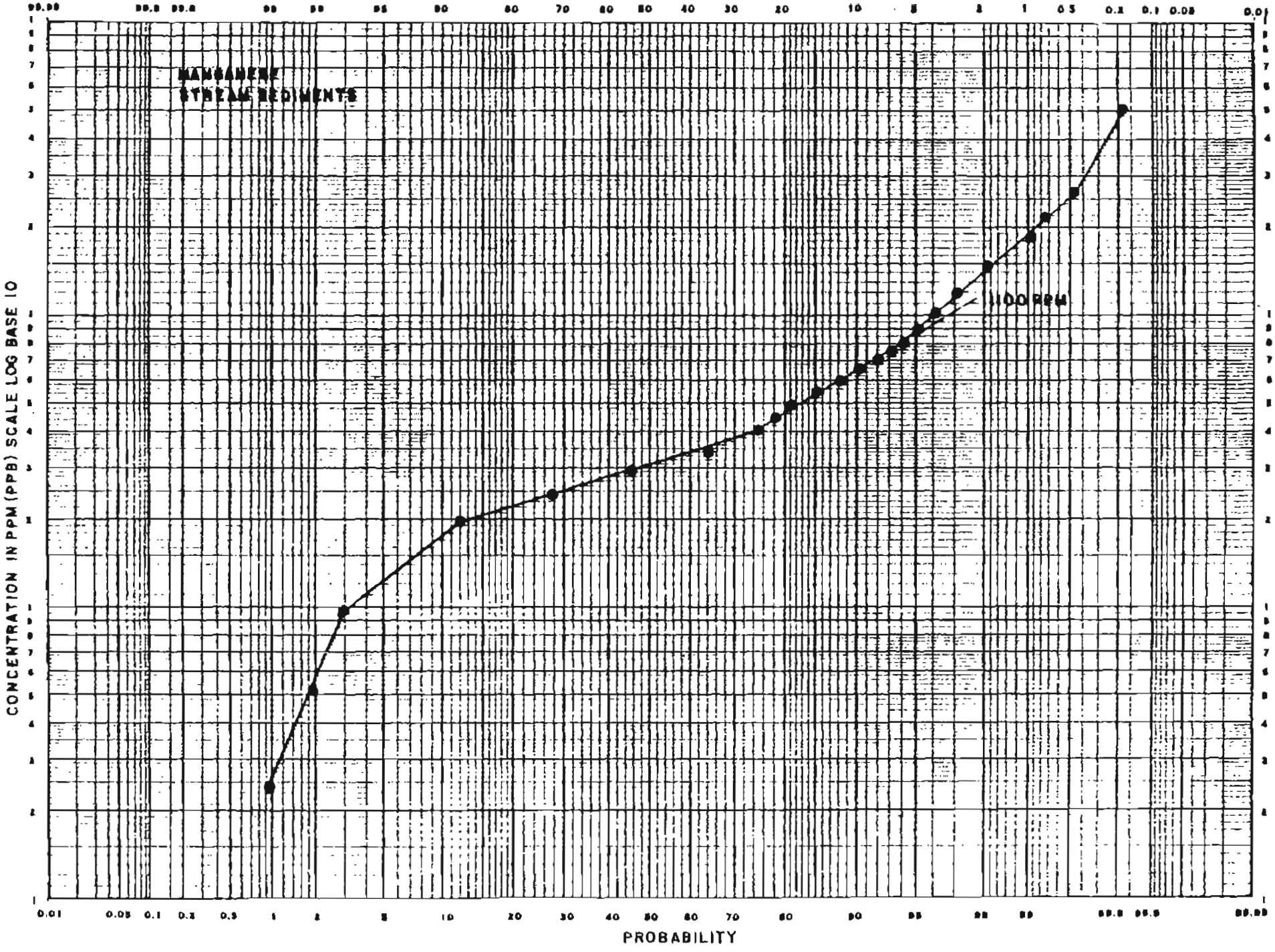
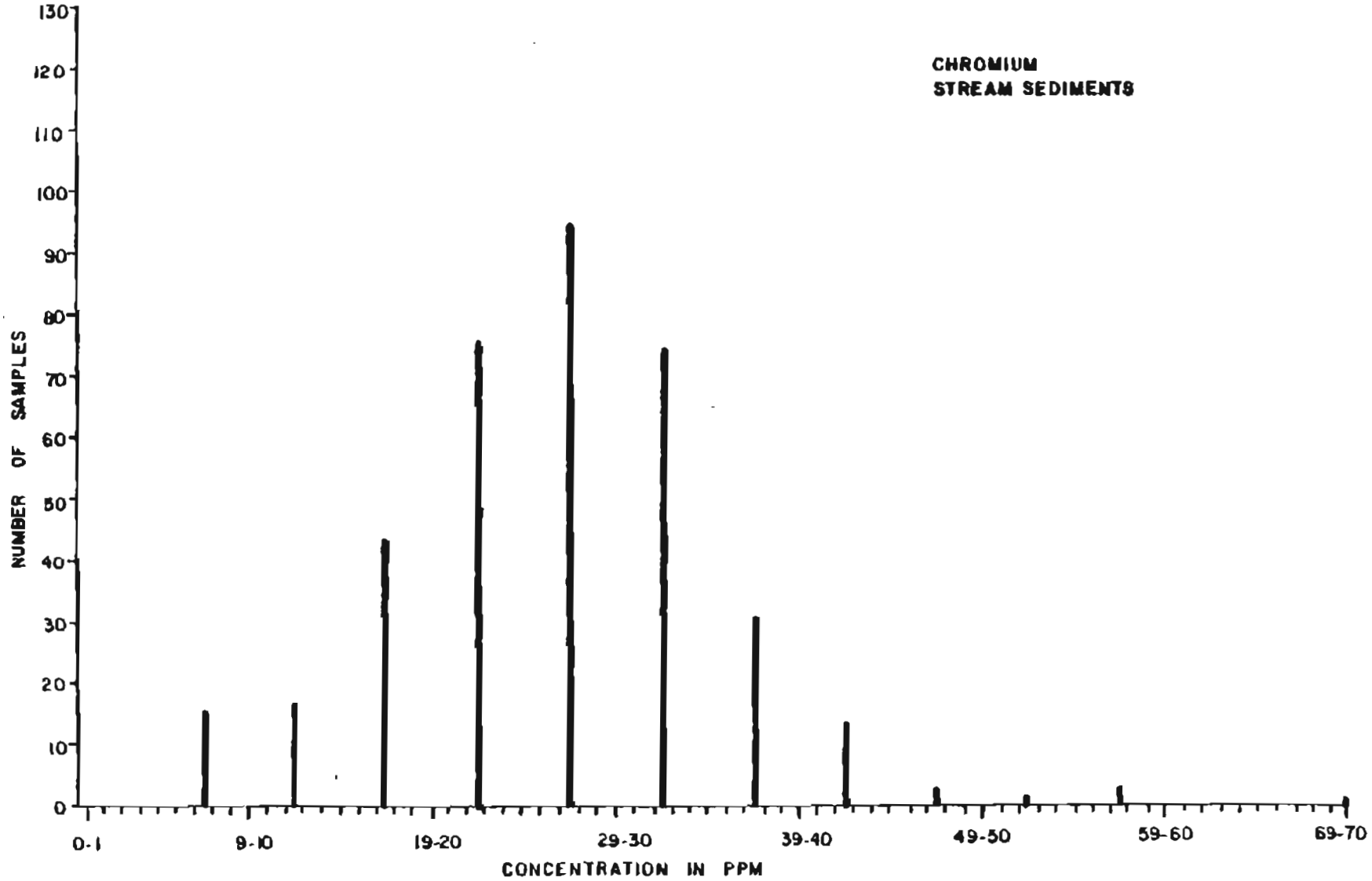
201-300
901-1000
CONCENTRATION IN PPM X 10


MANGANESE
STREAM SEDIMENTS
1100 PPM
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


CHROMIUM
STREAM SEDIMENTS
NUMBER OF SAMPLES
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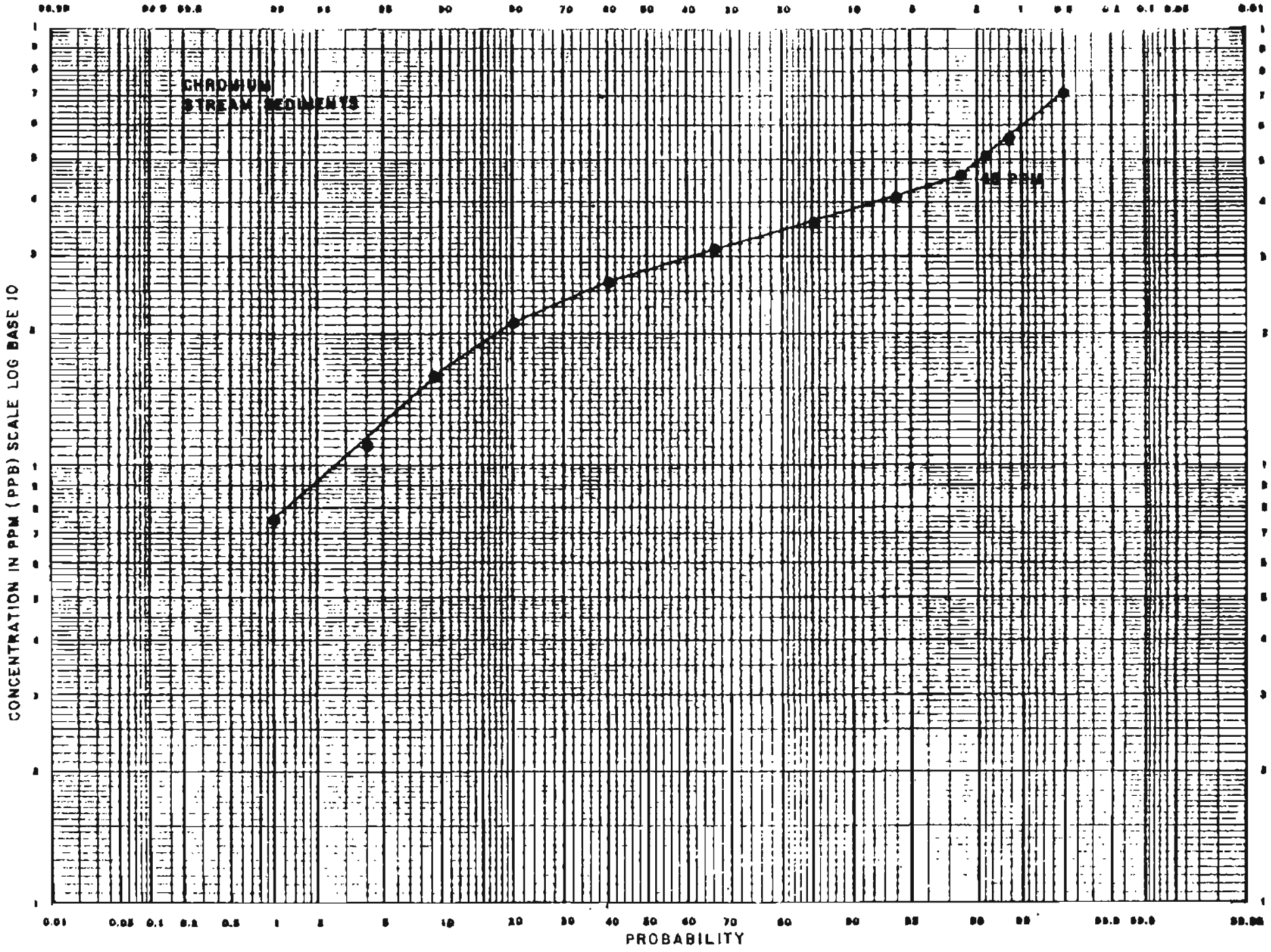
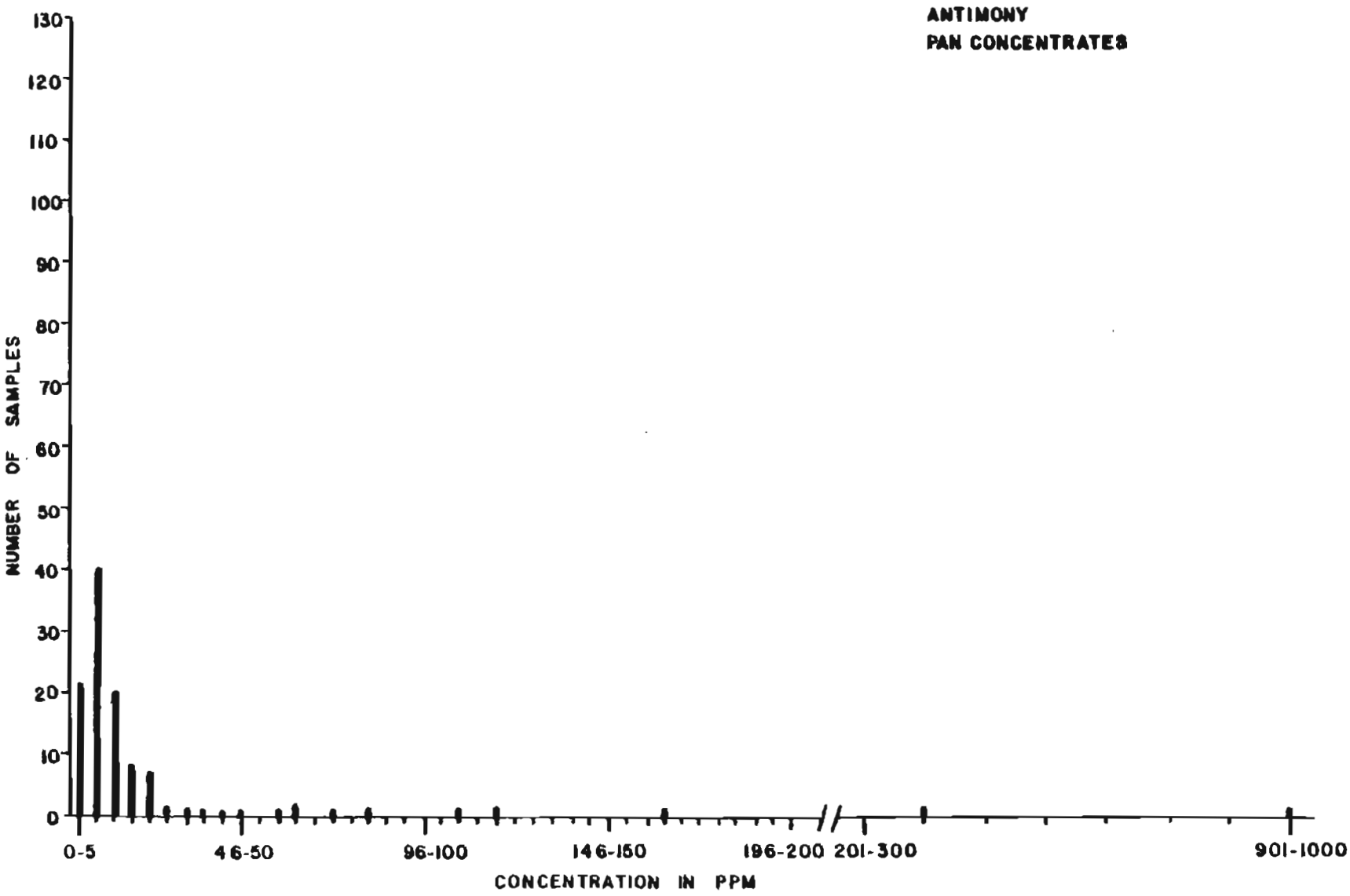
59-60
69-70
CONCENTRATION IN PPM


CHROMIUM
STREAM SEDIMENTS
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


ANTIMONY
PAN CONCENTRATES
NUMBER OF SAMPLES
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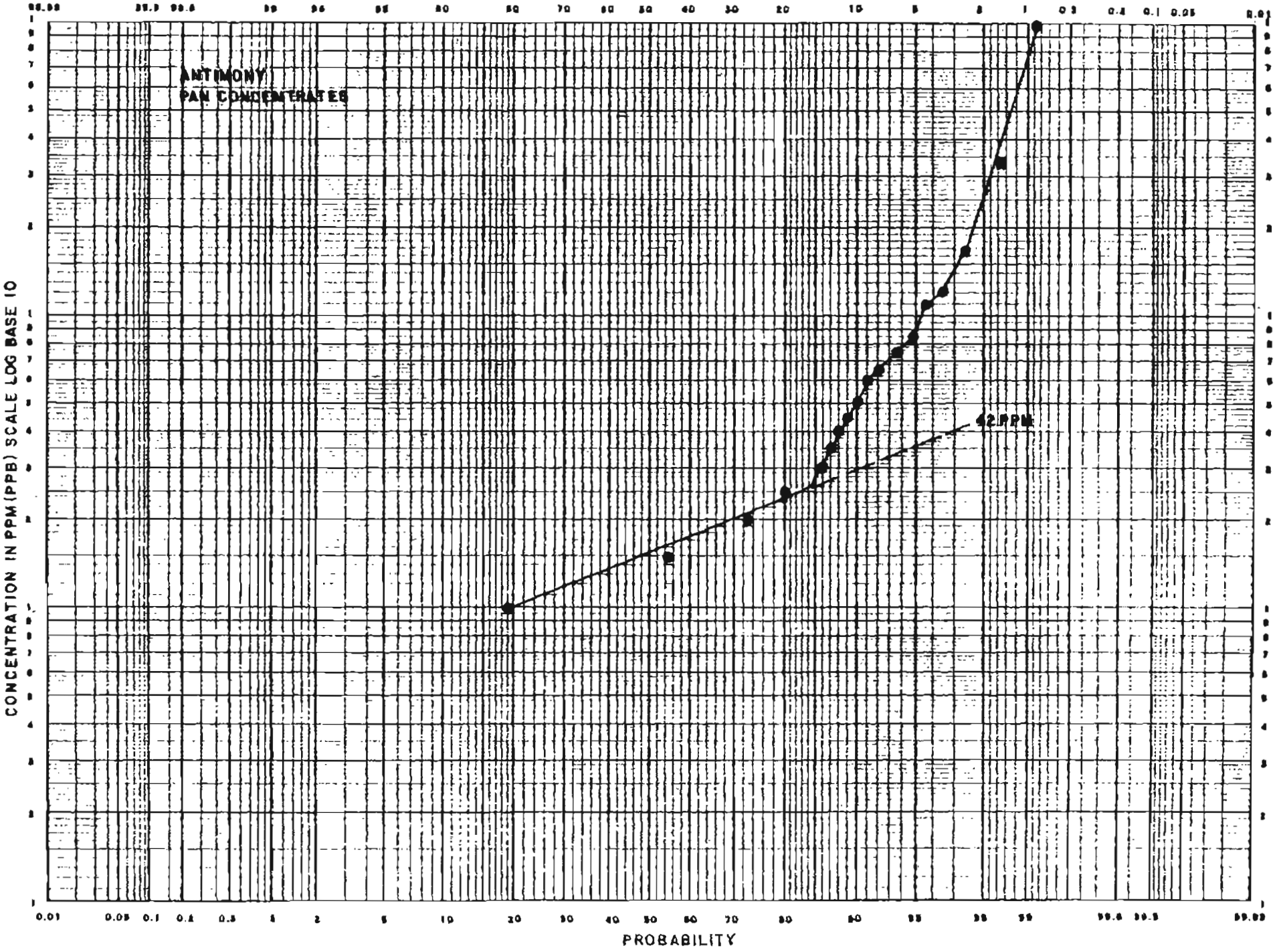
146-150
196-200
201-300
901-1000
CONCENTRATION IN PPM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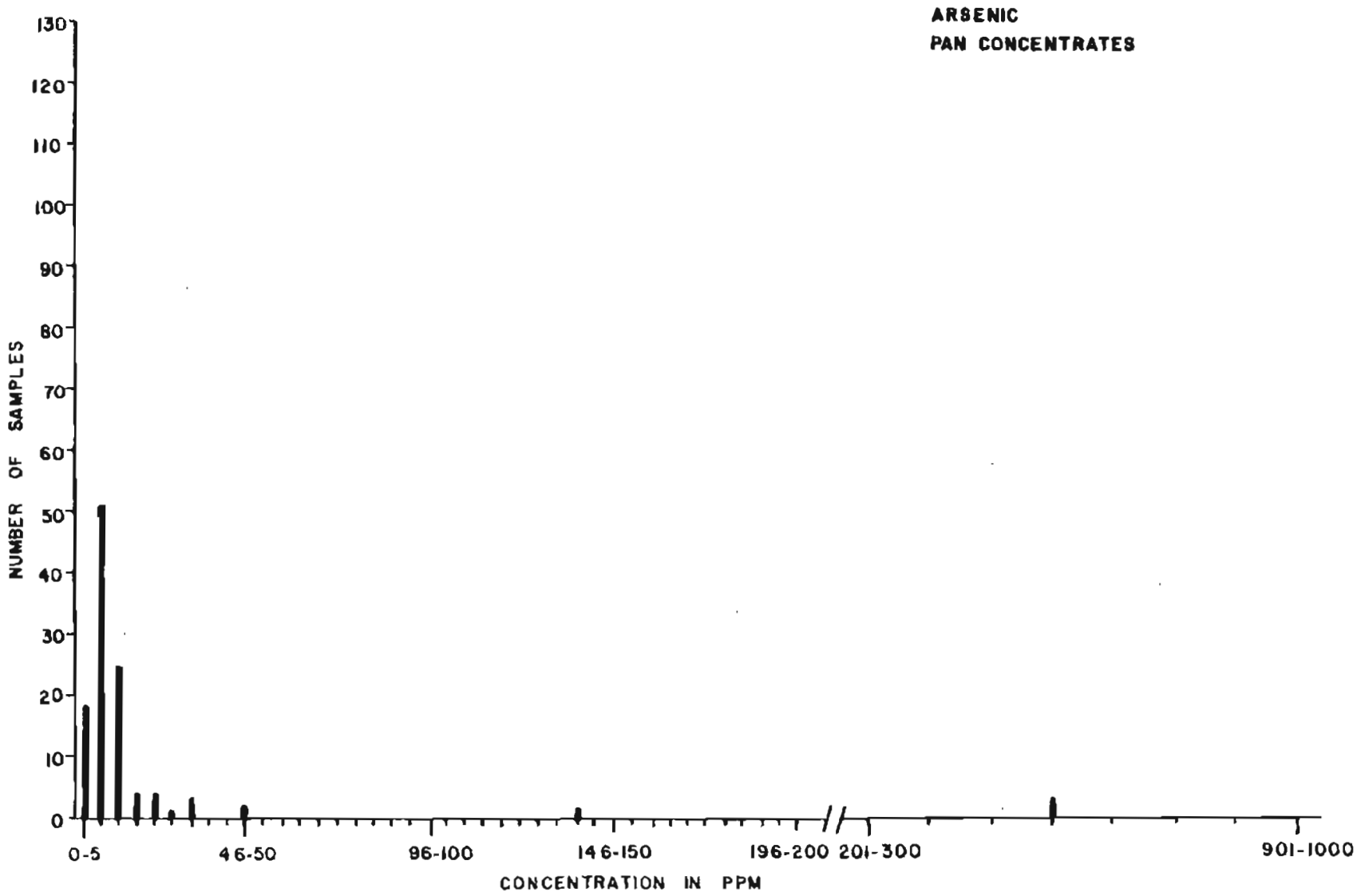
PAN CONCENTRATES
42 PPM
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


ARSENIC
PAN CONCENTRATES
NUMBER OF SAMPLES
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80
70
60
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0
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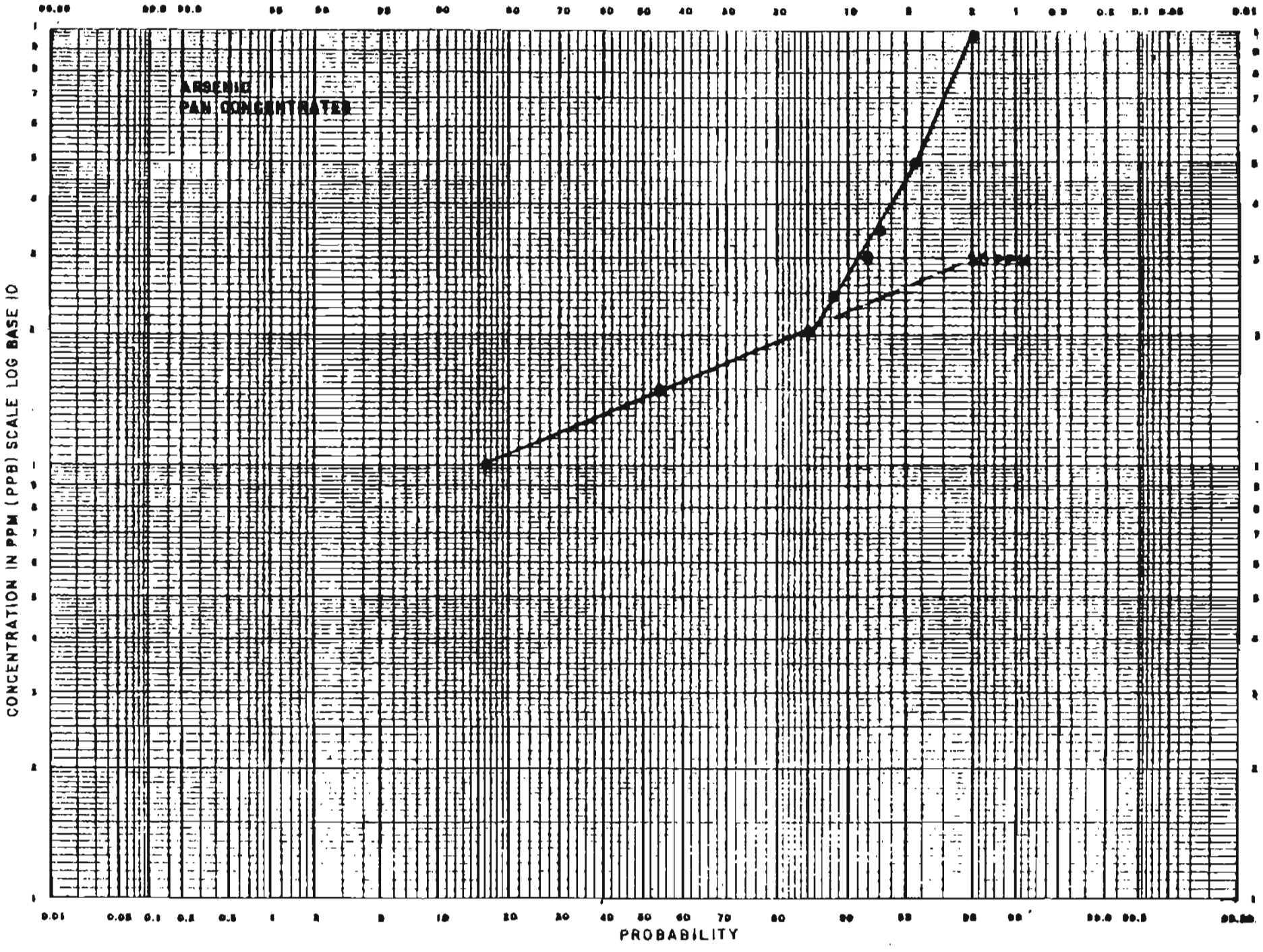
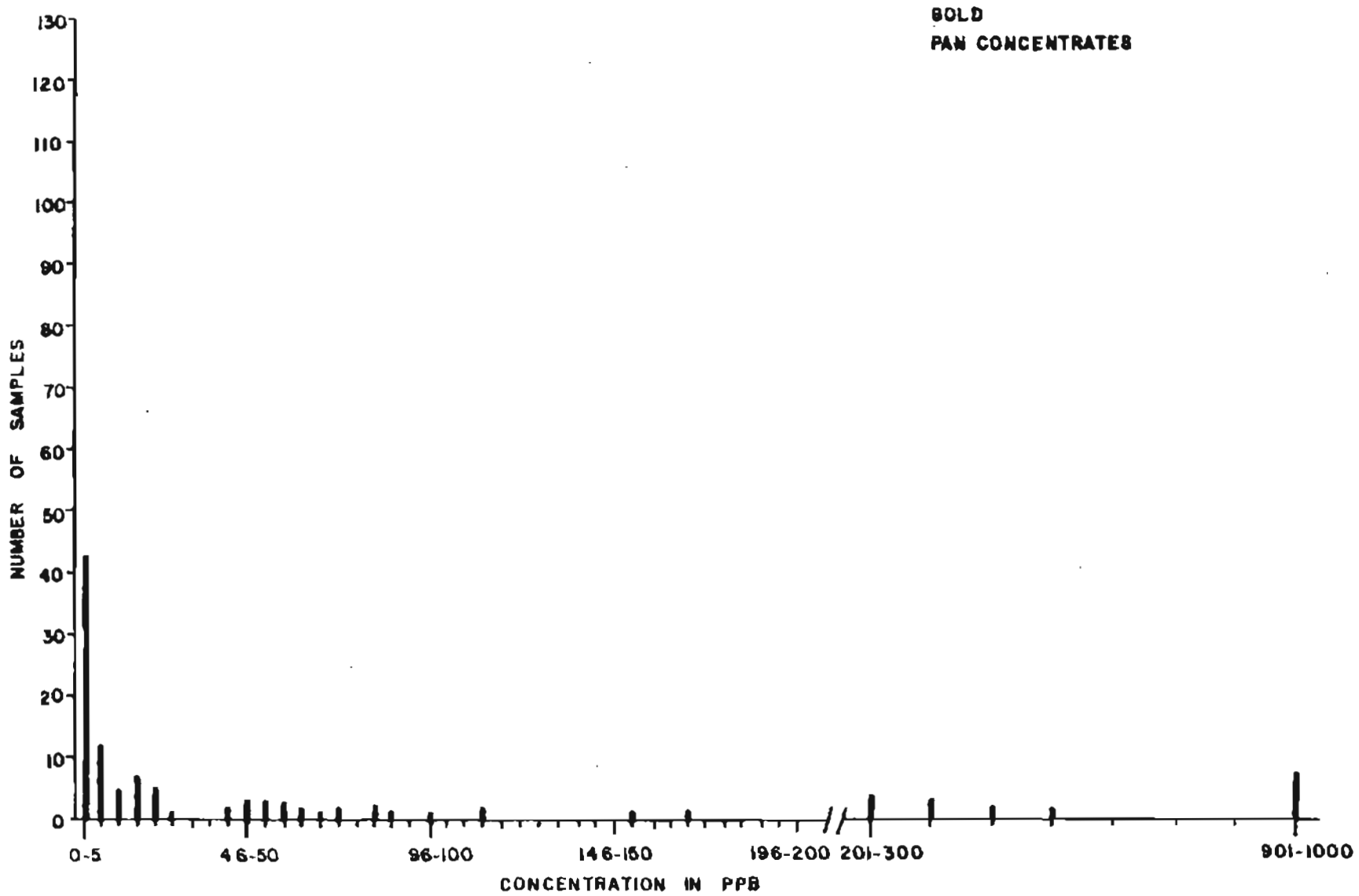
46-50
96-100
146-150
196-200
201-300
901-1000
CONCENTRATION IN PPM


ARSENIC
PAN CONCENTRATES
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


BOLD
PAN CONCENTRATES
NUMBER OF SAMPLES
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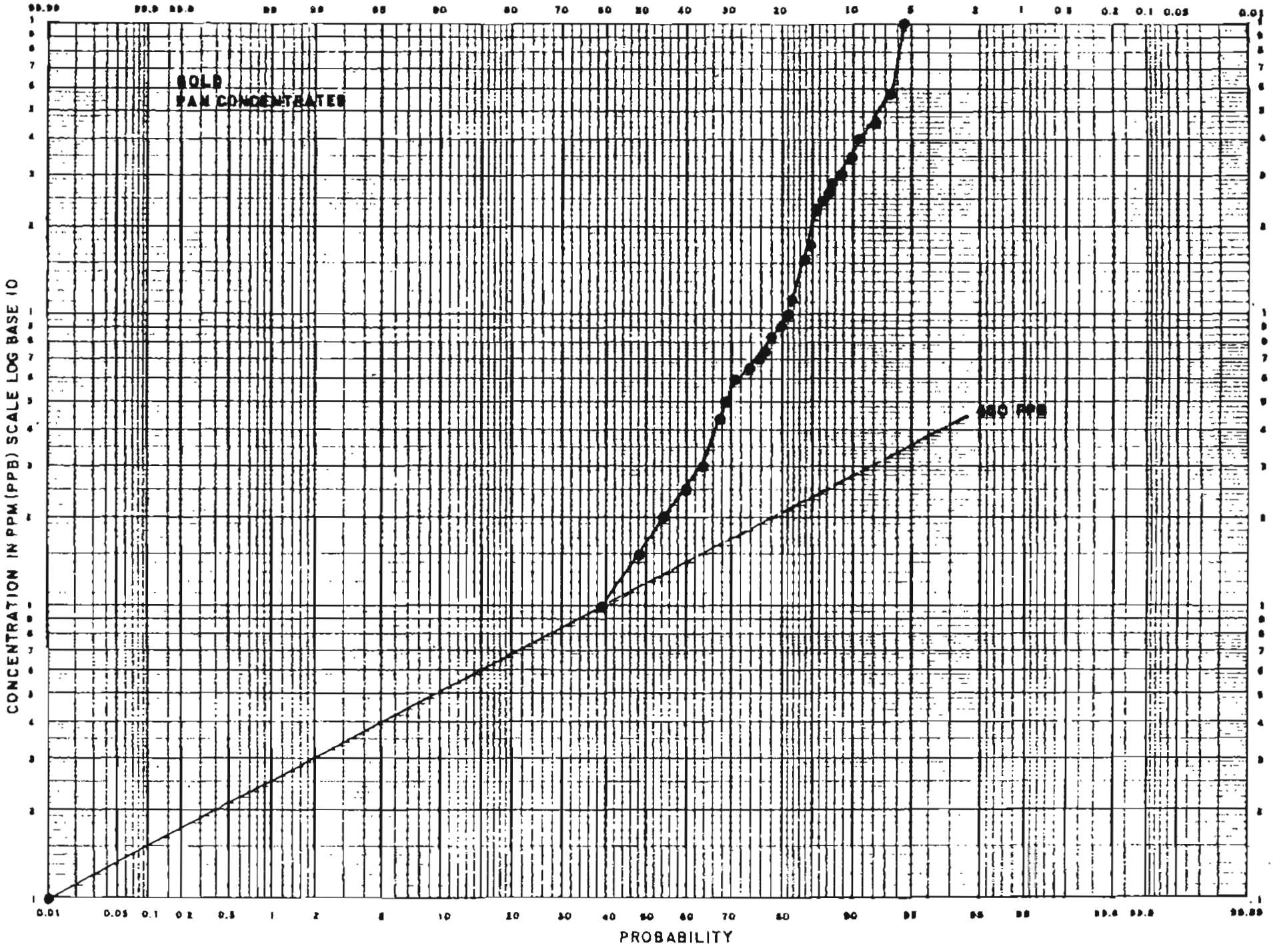
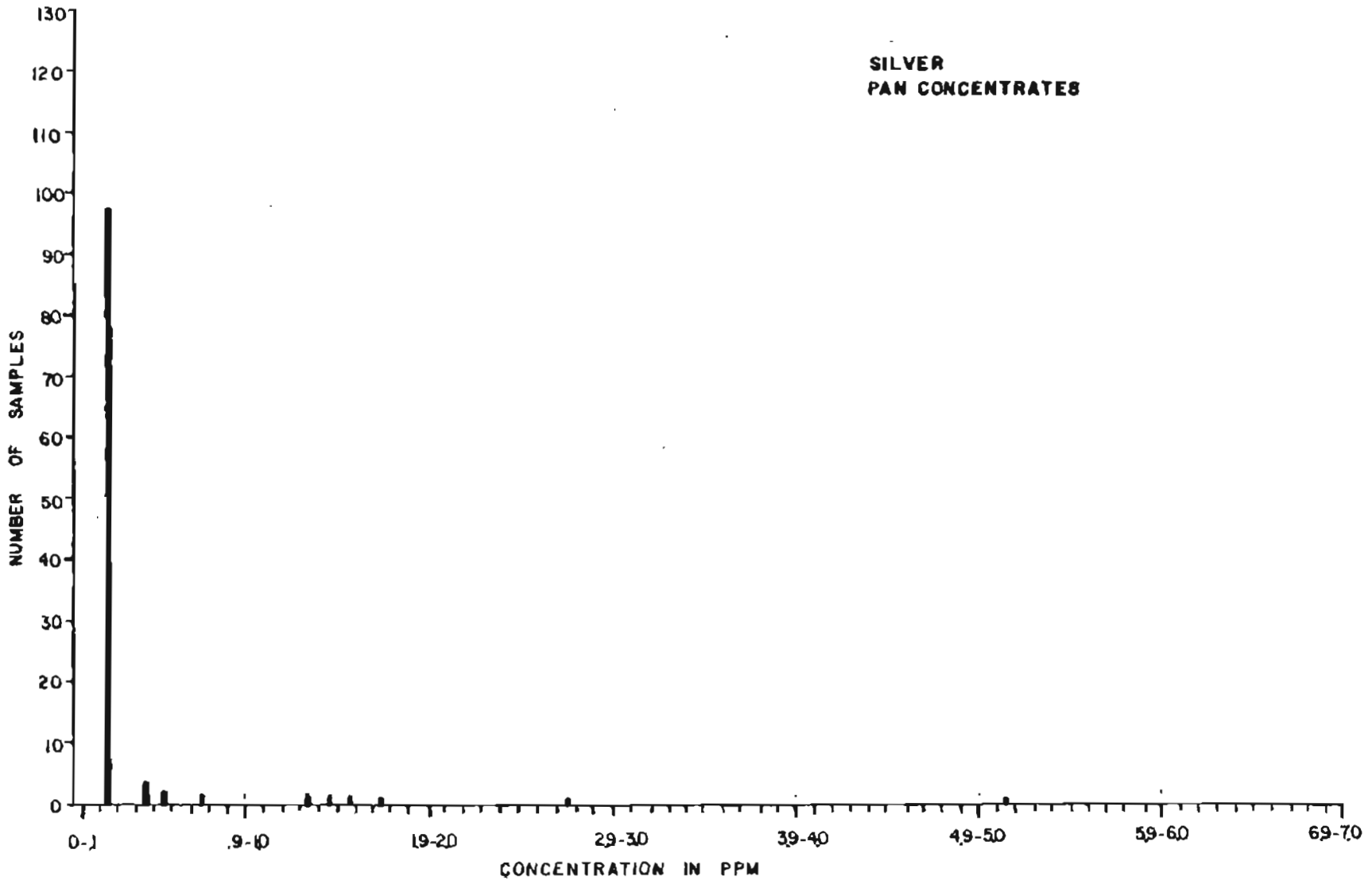
46-50
96-100
146-150
196-200
201-300
901-1000
CONCENTRATION IN PPB


GOLD
PAN CONCENTRATES
480 PPB
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


SILVER
PAN CONCENTRATES
NUMBER OF SAMPLES
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120
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0
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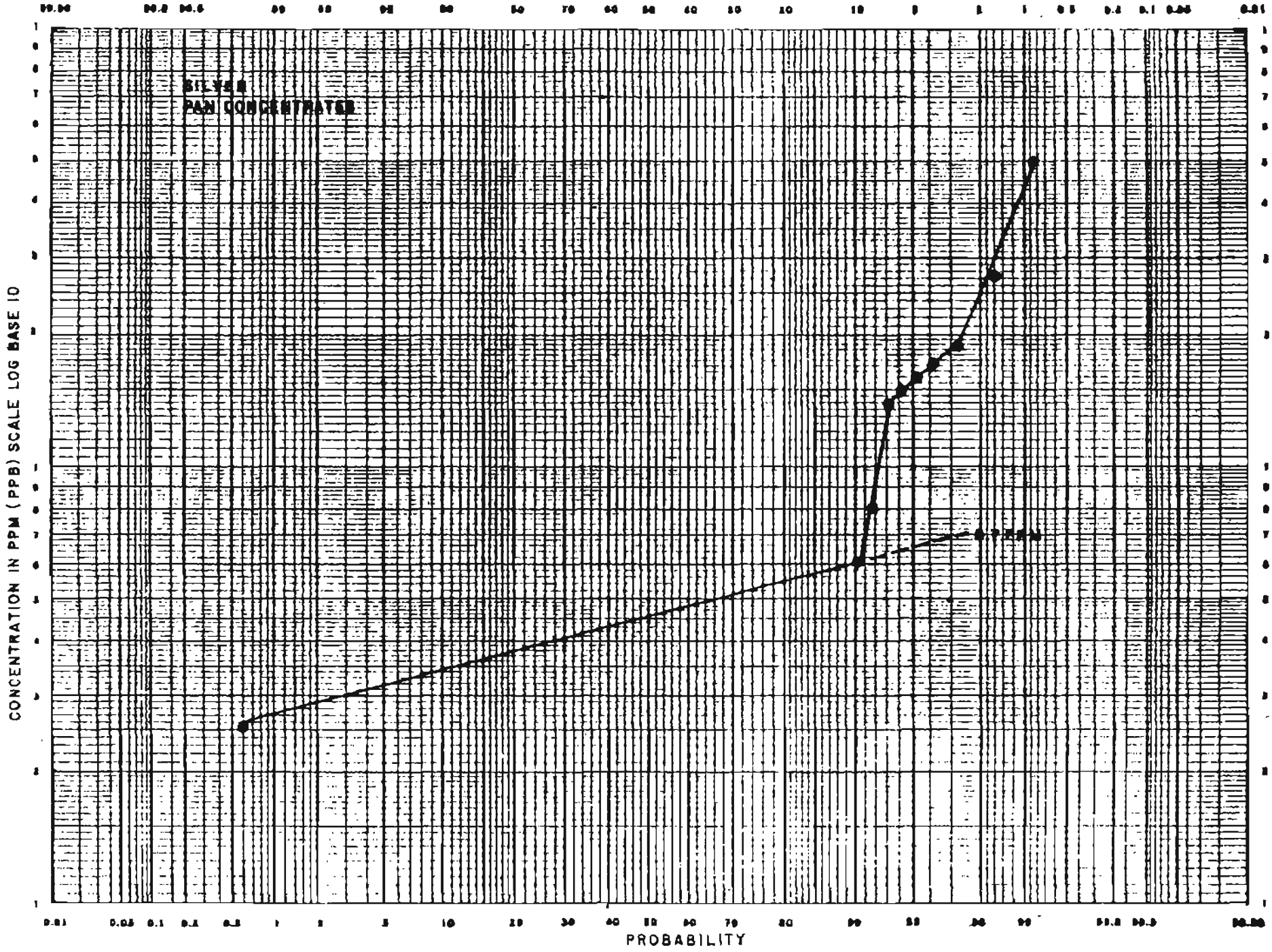
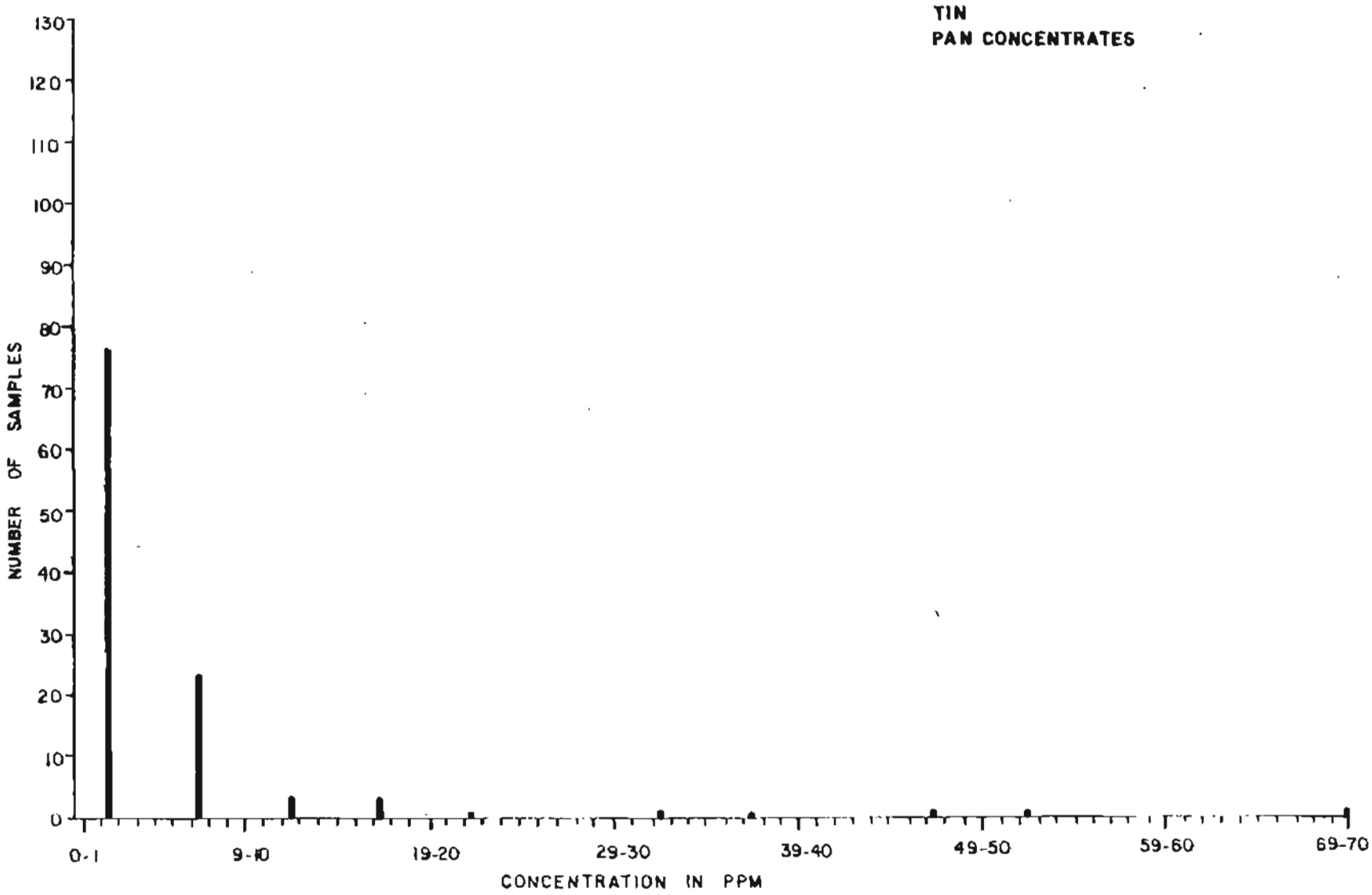
1.9-2.0
2.9-3.0
3.9-4.0
4.9-5.0
5.9-6.0
6.9-7.0
CONCENTRATION IN PPM


SILVER
PAN CONCENTRATES
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


TIN
PAN CONCENTRATES
NUMBER OF SAMPLES
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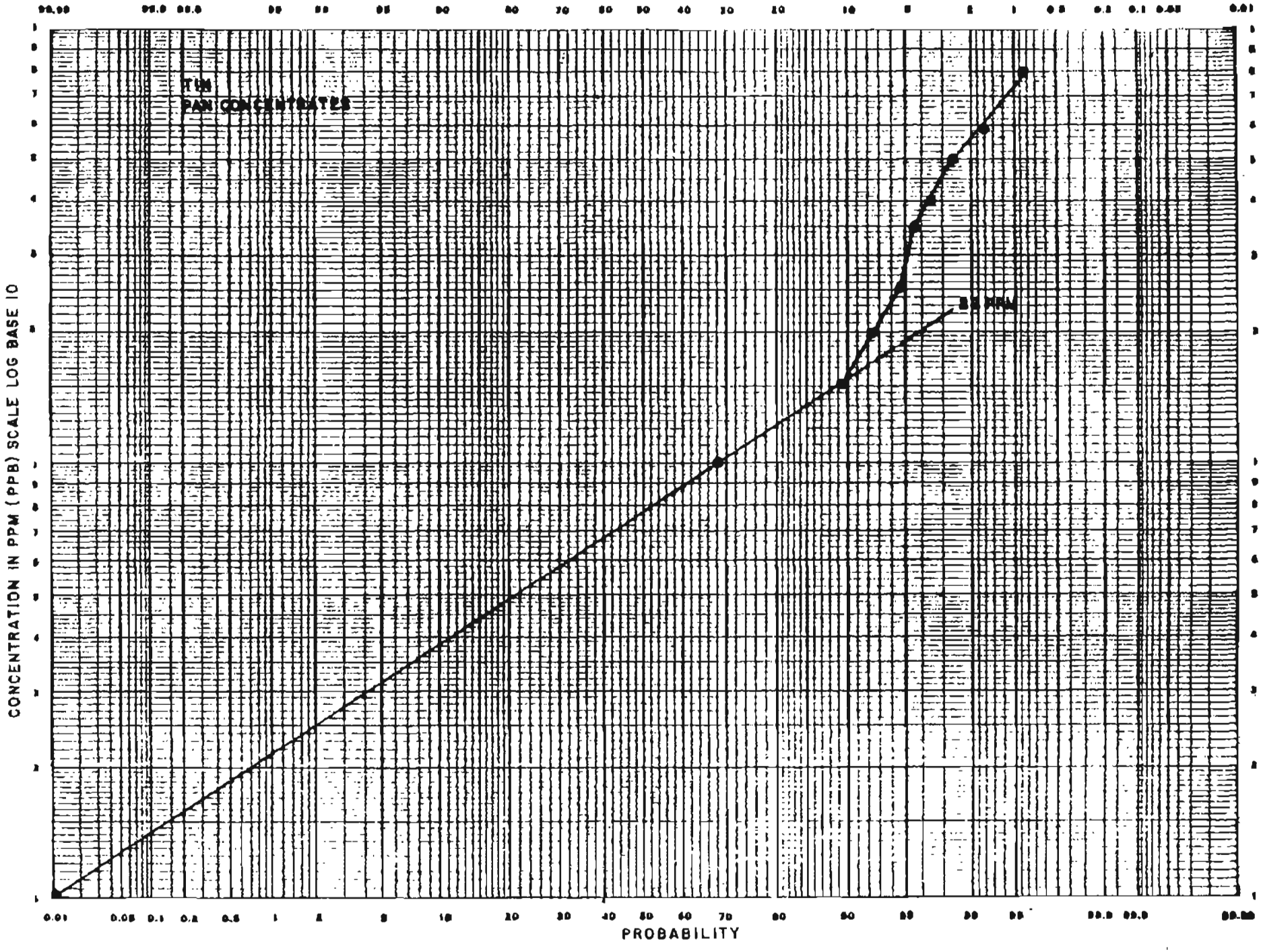
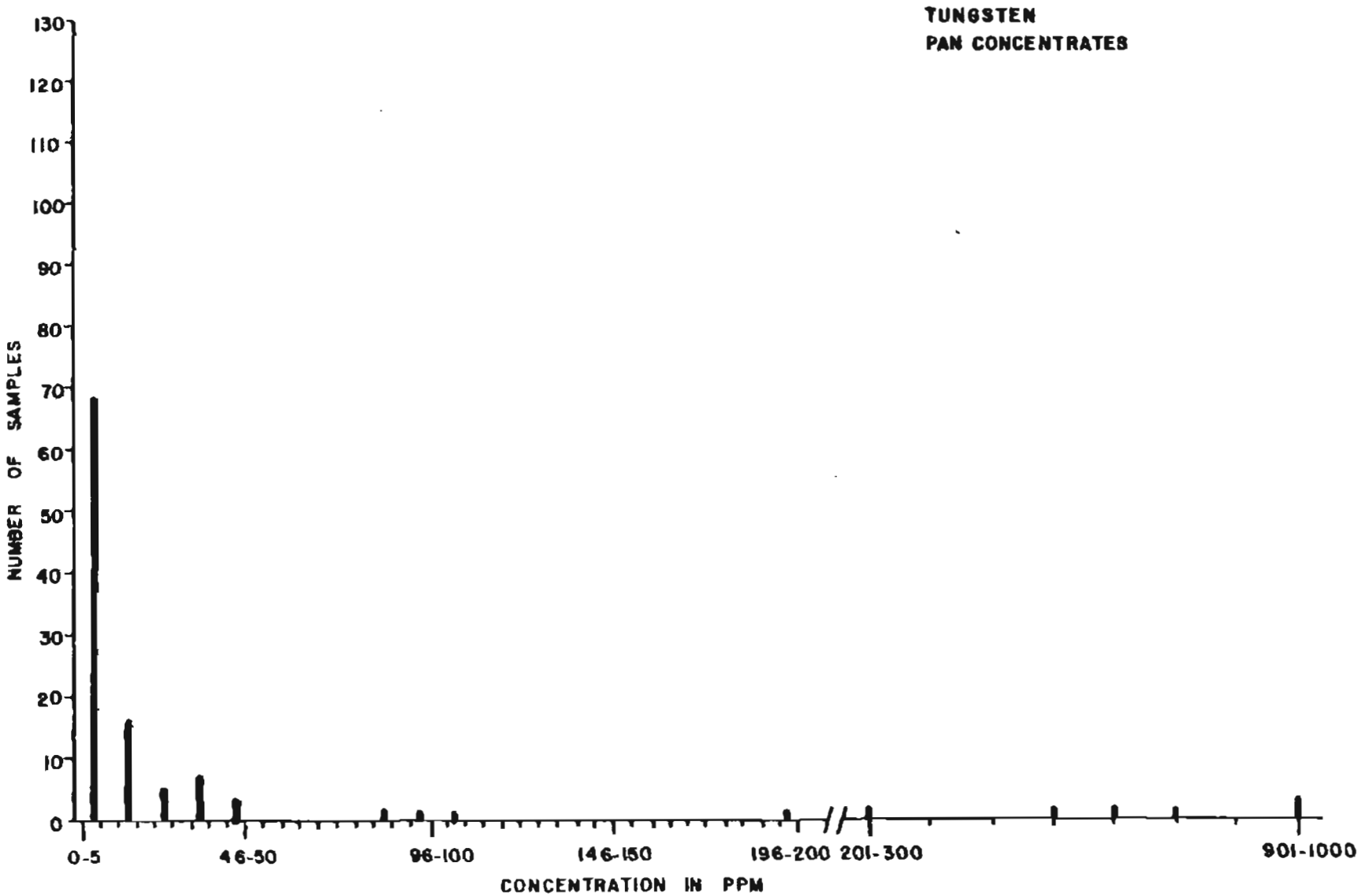
0-1
9-10
19-20
29-30
39-40
49-50
59-60
69-70
CONCENTRATION IN PPM


TIN
PAN CONCENTRATES
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


TUNGSTEN
PAN CONCENTRATES
NUMBER OF SAMPLES
130
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90
80
70
60
50
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30
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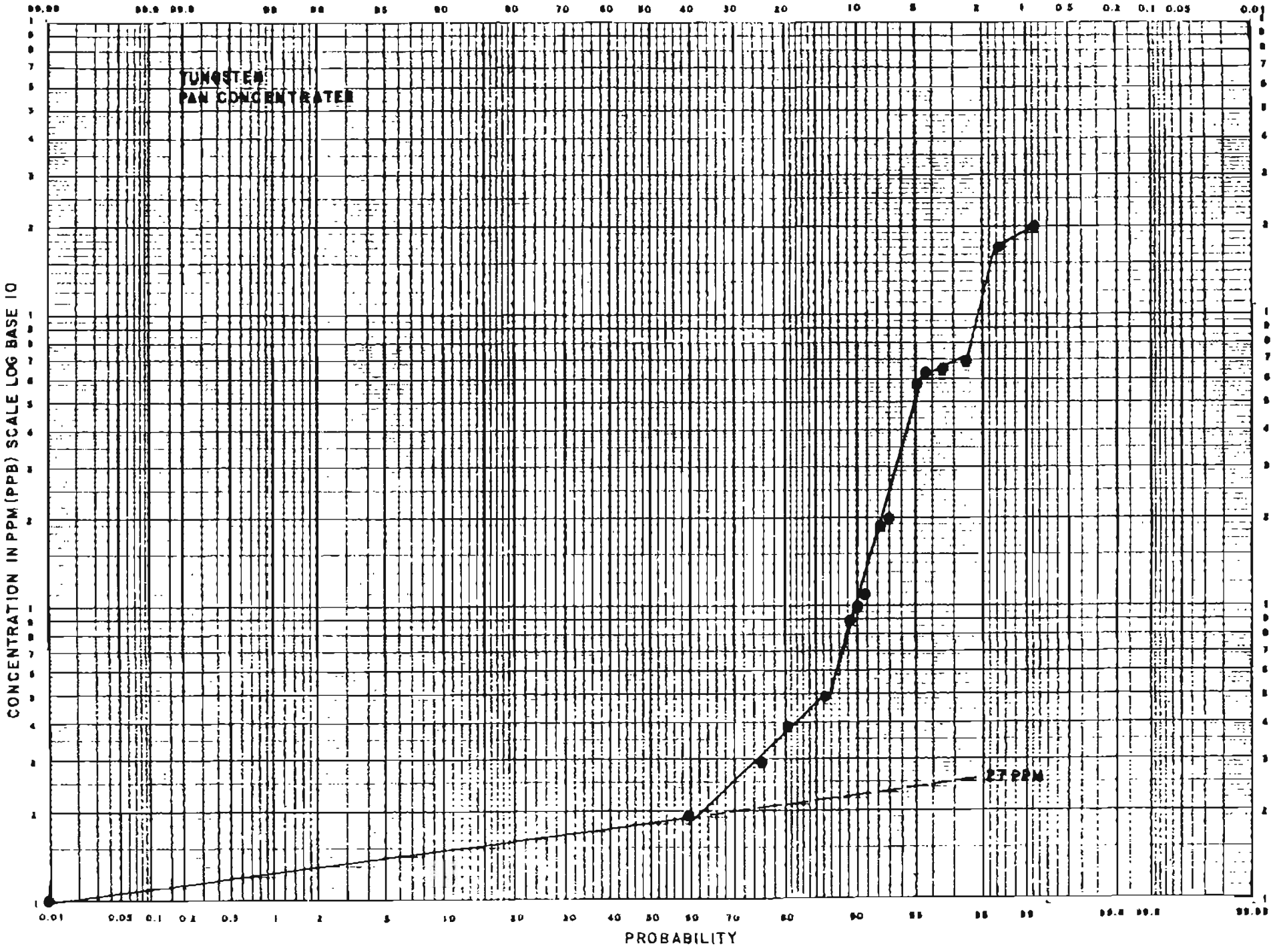
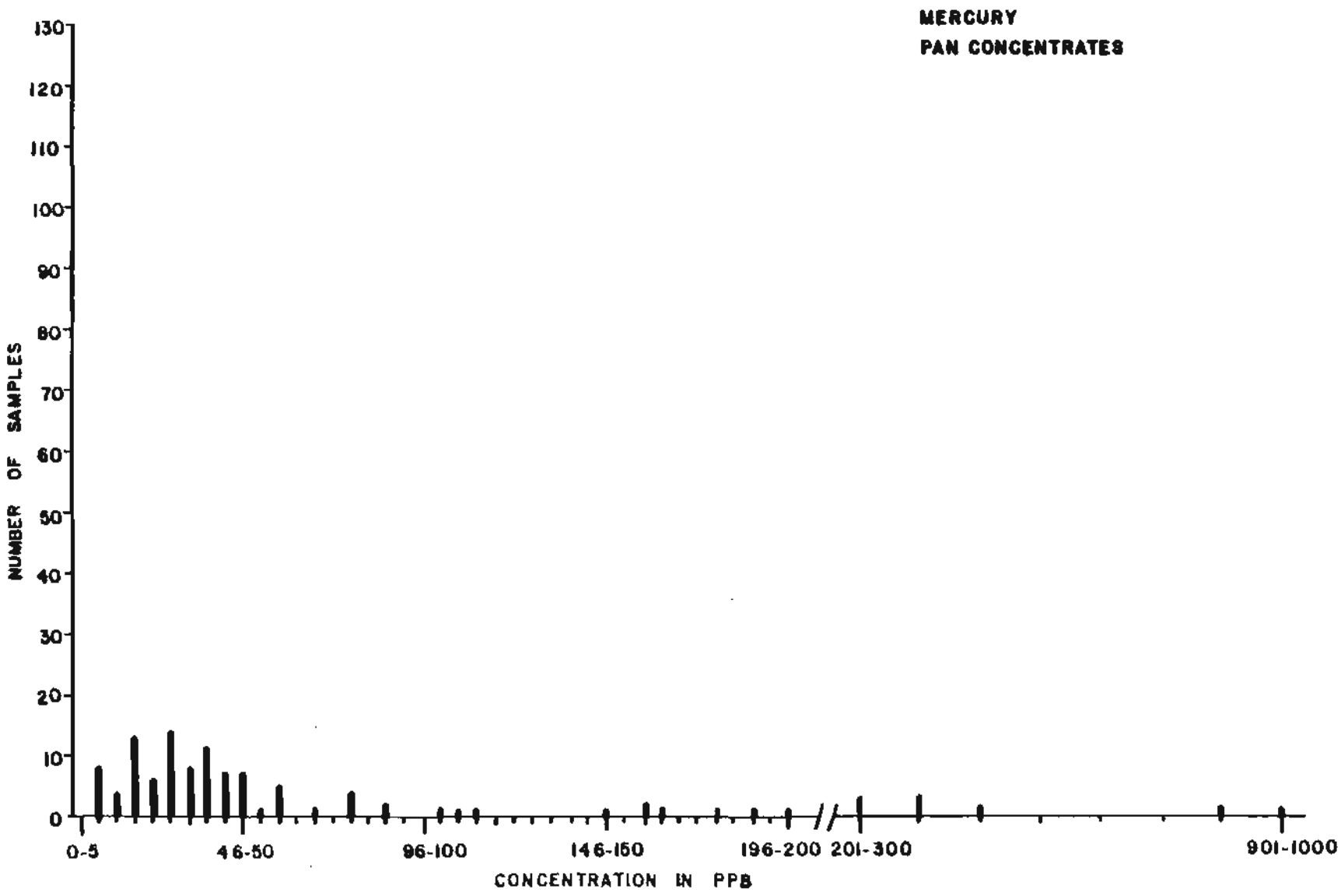
10
0
0-5
46-50
96-100
146-150
196-200
201-300
901-1000
CONCENTRATION IN PPM


TUNGSTEN
PAN CONCENTRATES
27 PPM
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY


MERCURY
PAN CONCENTRATES
NUMBER OF SAMPLES
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0
0-5
46-50
96-100
146-150
196-200
201-300
901-1000
CONCENTRATION IN PPB

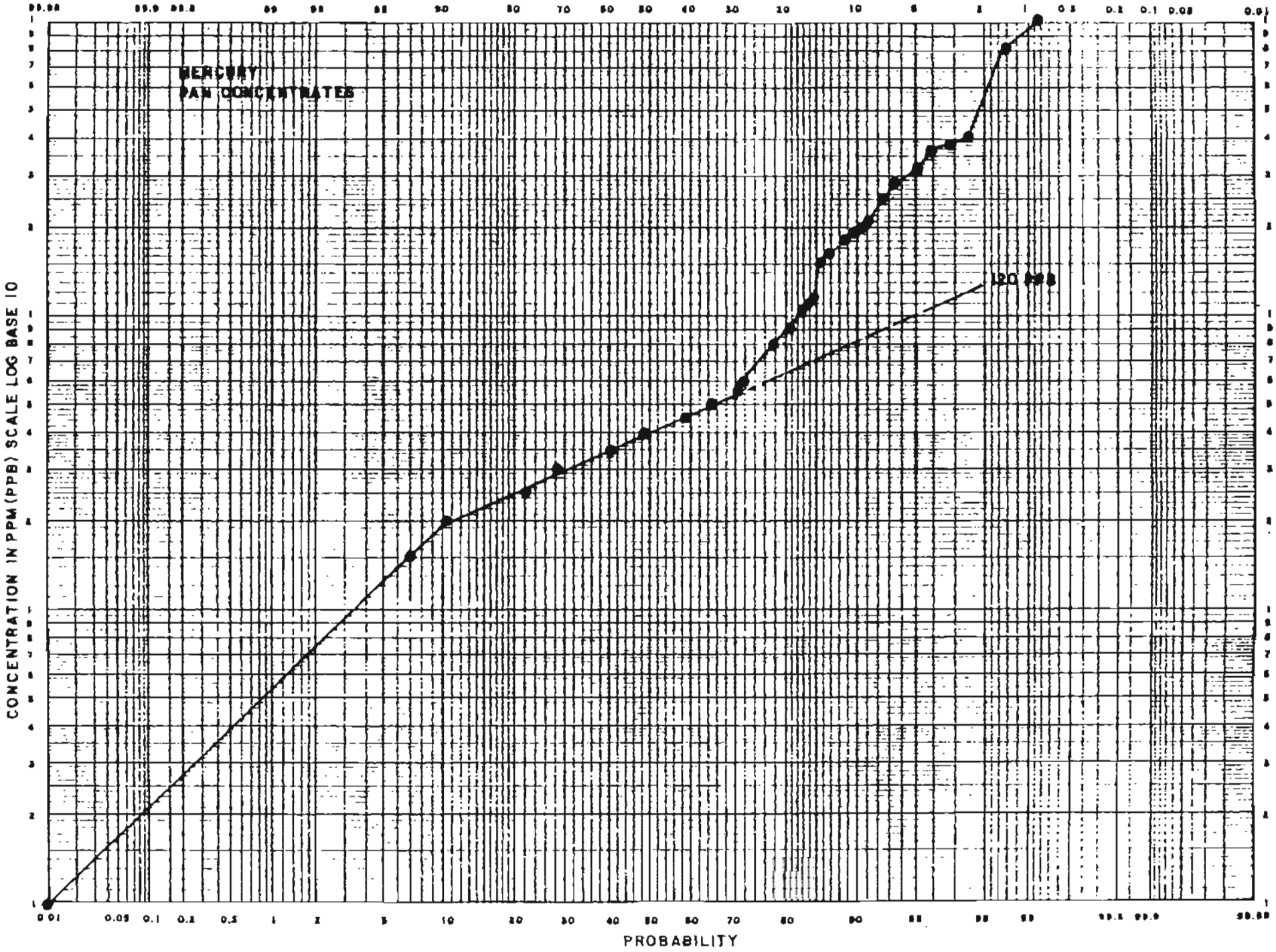
MERCURY
PAN CONCENTRATES
120 PPB
CONCENTRATION IN PPM (PPB) SCALE LOG BASE 10
PROBABILITY

Table 3. Threshold values in PPM for rock, stream sediment, and pan concentrate samples from the Fairbanks (Metz, 1984) and Richardson mining districts.

		FAIRBANKS		RICHARDSON	
Element	Rocks	Stream Sediment	Pan Concentrate	Stream Sediment	Pan Concentrate
Sb	42	—	10	—	42
As	22	52	—	—	30
Cu	180	28	—	36	—
Au	0.5	—	0.45	—	0.450
Pb	48	17	—	18	—
Hg	6	—	—	—	0.120
Ag	1.0	0.5	—	—	0.7
Sn	15	—	10	—	22
W	27	—	19	—	27
Zn	110	74	—	70	—
Ni	—	—	—	40	—
Fe	—	—	—	4000	—
Mn	—	—	—	1100	—
Cr	—	—	—	45	—
	n=812	n=1013	n=159	n=378	n=111

samples from the Fairbanks mining district (Metz, 1984). Threshold values for similar sample types are comparable for the two districts. Samples with one or more element above the estimated threshold are located on Plates III and IV. Plates III and IV also show the locations of the major intrusive rocks in the Richardson district as well as aeromagnetic contours (ADGGS, 1973).

DISCUSSION

The anomalous sample localities shown on Plates III and IV suggest that there are at least six additional areas of lode mineralization in the district. Anomalous areas are defined by more than one sample with one or more anomalous elements. Roman numerals on Plates III and IV depict these anomalous areas.

Area I is located in Sec. 20, T 6 S, R 76, F.M. (Plate III). The major elemental associations include Hg-W±Au-Ag and Cu-Ni-Zn-Fe±Au-Ag. Bedrock in the area is felsic and mafic gneiss, felsic granofels, schistose gneiss, marble, and a small quartz monzonite pluton.

Area II is located in Sec. 31, T 6 S, R 8 E, F.M. (Plate III). The elemental associates and bedrock is the same as in Area I.

Area III is located in Sec. 21, T 6 S, R 5 E, F.M. (Plate IV). The major elemental associations are Hg-Sb and Fe-Mn. Bedrock exposure is poor, however rubble crops indicate the predominance of mafic gneiss with minor schistose gneiss, quartzite, rhyolite porphyry and andesite porphyry.

Area IV is located in Sec. II, T 63, R 5 E, F.M. (Plate IV). The major elemental associations are Hg-Sb-W-As, and Fe-Mn±Cr. Bedrock exposure is poor, however rubble crops indicate the predominance of mafic gneiss, schistose gneiss, quartz-mica-feldspar schist and quartzite.

Area V is located in Sec. 27, T SS, R 6 E, F.M. (Plate IV). The major elemental association is Cr and the predominant bedrock type is amphibole gneiss.

Area VI is located in Sec. 22, T 7 S, R 6 E, F.M. (Plate IV). The major elemental associations are Sn-W-As±Sb-Au-Ag and Cu-Ni-Zn±Fe-Mn-Cr. Bedrock in the area is quartz-mica-feldspar schist, marble, hornfels, skarn, and granite of the Birch Lake pluton.

SUMMARY AND CONCLUSION

Stream sediment and pan concentrate sampling in the Richardson mining district indicates six additional areas of potential lode mineralization. Although bedrock exposures are poor to non-existent, inferrences can be made to possible genetic types of lode mineralization based on the elemental associations and limited petrologic data.

The mercury-antimony-tungsten±gold and silver elemental associations are similar to the metamorphosed syngenetic mineralization in the Fairbanks district (Metz, 1977, 1982 and 1984; Metz and Robinson, 1979 and 1980). Strong silicate and ore petrologic similarities exist between the Fairbanks syngenetic mineralization and the stratabound tungsten model of Maucher (1976).

The copper-nickel-zinc±gold-silver elemental associations in areas of mafic gneiss indicate possible metamorphosed syngenetic basemetal sulfide mineralization. Saunders (1965) suggested that the low fineness values of the placer gold from the district (Smith 1941) is a function of a basemetal sulfide source. The low fineness values for Banner and Buckeye Creeks (Metz

and Hawkins, 1981) and the stream sediment base metal anomalies in this area are further supporting evidence for that hypothesis.

The tin-tungsten-arsenic±gold-silver elemental associations in the contact areas of the Birch Lake pluton are suggestive of the Cornubian tin-granite association. The sericitized, greisenized, and kaolinized quartz porphyry dikes slightly younger than the granitic intrusives are very similar to the elvan dike systems of Cornwall, England. The presence of cassiterite, scheelite, and tourmaline in the placer deposits below the quartz porphyry dike (Wedow et al., 1954; Saunders, 1965) in T 7 S, R 7 E, F.M. (Plate IV) further supports this genetic model.

The chromium anomalies in Area V are associated with amphibolite gneiss. The association suggests a mafic volcanic or ultramafic origin of the gneiss. The economic potential of any chromite mineralization is low, however if the original bedrock source is an ultramafic rock there may be some potential for platinum group metal mineralization.

ACKNOWLEDGEMENTS

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