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DESCRIPTIVE AND STATISTICAL MODELS FOR ROCKVAL

by

R.J. Newberry, L.E. Burns and G.H. Pessel

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DESCRIPTIVE AND STATISTICAL MODELS FOR ROCKVAL

by
R.J. Newberry,¹ L.E. Burns,² and G.H. Pessel¹

INTRODUCTION

The following deposit models were compiled and devised by using literature listed in the references. These deposit models have been refined over the years and are the set that were used during the Alaska state land selection project in 1991-93. The numbers given are those that will automatically come up in the DGGs ROCKVAL program when that particular model is selected. When running the ROCKVAL program, any number in a deposit model can be modified, but certain numbers, like the cutoff tonnages and the cutoff probability, are based on the original data that the tonnages and grades were built upon.

Terms used for the data sets and their use in the ROCKVAL simulation program are explained below. Model numbers used below refer to the index number in our ROCKVAL program.

TERMINOLOGY

Cutoff probability - the percentage of prospects that are typically large enough to be termed deposits. In this data set, this number is based on the compiled data of grade/tonnage for that model, and unless grade/tonnage data is changed, data is more consistent if this number is not changed.

Deposit - a prospect with a sufficient amount of tonnage to warrant endowment estimation; once a prospect is termed a deposit, the ROCKVAL program generates tonnage and grade data.

Districts vs. areas - Many deposit types occur in clusters; the areas containing clusters are termed districts.

The prospect densities (# deposits/sq mi) and thus distributions are much higher in the districts than for the broad area of lower favorability which generally surrounds the districts. For example, a random 100 sq mi block of Selwyn Basin is likely to have many fewer shale-hosted Pb-Zn prospects

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than is a 100 sq mi area around Macmillan Pass or Faro in Canada. Consequently, several deposit types are described by two models--district and large area--which differ only in the prospect/sq mi distribution.

Drainages - used for prospect density for placer deposits. The prospect density factor entered into the ROCKVAL program was based on the entire area of land that the stream in question drains. Square mileage entered into the program should be this large drainage area; entering only the narrow stream mileage yields a prospect distribution that is too low.

Occurrence probability - for primary commodities, a number from 0 to 1 which reflects the percentage of time that a particular commodity is present in the deposit type; for secondary commodities, a number from 0 to 1 which reflects the percentage of time that a particular element is present in the deposit type only if the P1 primary commodity was simulated as being present.

Prospect - anomalies that would warrant field/laboratory investigation; a proportion of these will be large enough to be deposits.

Prospect densities - This document states what the prospect density is based on, and the parameter to input into the program. The program then automatically generates the prospect distribution.

Regional favorability - a number not included in the data set but generated by the geologists for each particular play. The number reflects the certainty that drillable prospects are present, at least one of which will be large enough to meet the minimum tonnage (cutoff tonnage).

Tonnage cutoff - the minimum tonnage needed for a prospect to be evaluated as a deposit. In this data set, the number is based on the deposits listed in the references, and should not be changed unless the tonnage is changed.

MAFIC-ULTRAMAFIC PLUTONIC DEPOSITS - MODELS 37, 38, 39, AND 43

MODELS 37 (DISTRICTS) AND 38 (LARGE AREAS) PODIFORM CHROMITE DEPOSITS

OTHER NAMES FOR THIS DEPOSIT TYPE - Alpine-type chromite

BRIEF DESCRIPTION - Pod- or sack-like to crudely layered chromite in dunitic parts of ophiolitic complexes

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Acoje, Coto, Zambales, Philippines; Findikli, Turkey; La Caridad, Cuba; Sogham, Iran; Cyprus, Vourinos, Greece; New Caledonia

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Red Mountain (Kenai Peninsula), Bernard Mountain, Misheguk Mountain, Caribou Mountain, Avan

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Semail, Oman

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - (Serpentinized) harzburgite, dunite, wehrlite

TEXTURES - Layered, tectonized, sheared

AGES - Phanerozoic, but Mesozoic-Tertiary are most common

SPECIAL PREREQUISITES - Some ophiolites are better than others for reasons not yet understood

ASSOCIATED DEPOSIT TYPES - Placer PGM

DEPOSIT DESCRIPTION

MINERALOGY - Chromite, ferrichromite, serpentine, olivine, pyroxene

TEXTURES - Nodular, orbicular, layered, gneissic, pull-aparts

ALTERATION - Pervasive serpentinization is common

GEOCHEMICAL SIGNATURE - Cr, Ni

Pb ISOTOPE SIGNATURE - Lead concentrations are miniscule

S ISOTOPE SIGNATURE - ?

NOTES FOR GRADE/TONNAGE MODELS - It is unclear why some ophiolitic complexes have more/larger deposits than others

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" area, that is, ultramafic rocks; "district" model has a higher prospect density than the "large favorable area" model

MODEL 37-38: PODIFORM CHROMITE

MODEL 37 DISTRICT
MODEL 38 LARGE AREAS

Cutoff tonnage (million tons)
Probability that the prospect makes the cutoff tonnage

0.0005
0.25

PROBABILITY	100	95	75	50	25	5	1	0
-------------	-----	----	----	----	----	---	---	---

PROSPECT DENSITY WITHIN 100 SQ MILE AREA

MODEL 37:

No. of prospects	1	6	25	63	200	800	1000	1200
------------------	---	---	----	----	-----	-----	------	------

MODEL 38:

No. of prospects	1	2	6	15	25	37	55	63
------------------	---	---	---	----	----	----	----	----

MILLION TONS OF ORE	0.0005	0.0016	0.0063	0.019	0.08	0.4	5	6.3
---------------------	--------	--------	--------	-------	------	-----	---	-----

11 CHROMIUM GRADE (%Cr₂O₃) 24
Occurrence probability of chromium 0.97

	30	39	45	48	53	56	58
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MODEL 39 GENERIC MAGMATIC SULFIDE

OTHER NAMES FOR THIS DEPOSIT TYPE - Gabbroic magmatic sulfide

BRIEF DESCRIPTION - Massive to disseminated sulfide in small to medium-sized gabbroic intrusions associated with through-going structural zones

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Sally Malay, Carr Boyd, Australia; Rana, Norway; Moxie, Maine; Montcalm, Ontario; Vammala, Finland; Empress, Zimbabwe; Phoenix, Botswana

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Funtier Bay, Yakobi Island

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Bohemia Basin, Mirror Harbor Alaska

GENERAL REFERENCES - Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Composite, irregularly layered, gabbro-norite-troctolite

TEXTURES - Irregular mineralogical and/or compositional layering/zoning

AGES - Archean to Tertiary

SPECIAL PREREQUISITES - Most intrusions are classified as "synorogenic"; there is little evidence for an external source of sulfur

ASSOCIATED-DEPOSIT TYPES - Zoned ultramafic complex PGM

DEPOSIT DESCRIPTION

MINERALOGY - Pyrrhotite, pentlandite, chalcopyrite, magnetite, marcasite

TEXTURES - Disseminated, matrix, vein; older examples highly deformed

ALTERATION - Supergene alteration accompanying sulfide destruction

GEOCHEMICAL SIGNATURE - Cu, Ni, Co, PGE

Pb ISOTOPE SIGNATURE - ?

S ISOTOPE SIGNATURE - $\delta = 3$ permil typical

NOTES FOR GRADE/TONNAGE MODELS - Smaller, and lower PGM concentrations than those associated with rift volcanics and feeder sills

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is the number of square miles of "favorable terrane"--that is, areas with or underlain by favorable (gabbroic) rocks

MODEL39: GENERIC MAGMATIC SULFIDE

	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							0.05 1
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	0	1	1	6	20	40	60	70
MILLION TONS OF ORE	0.05	0.2	0.64	2.1	7	25	35	50
COPPER GRADE (%)	0.05	0.09	0.25	0.47	0.84	1.6	1.8	2
Occurrence probability of copper	1							
NICKEL GRADE (%)	0.13	0.3	0.5	0.77	1.2	1.9	2.5	3.2
Occurrence probability of nickel	1							

5

**MODEL 43: PGM SULFIDE
(CHUGACH/ALASKA RANGE TYPE)**

OTHER NAMES FOR THIS DEPOSIT TYPE - Gabbroic sulfide

BRIEF DESCRIPTION - Magmatic sulfide lenses/masses/disseminations in or adjacent to gabbroic to ultramafic sills and layers

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Acoje (sulfide body), Philippines; Jijal Complex, Pakistan; Illinois River, Oregon; Giant Mascot, E & L, Tofino, British Columbia; Weilgreen, Airways, Yukon

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Chip-Loy, Spirit Mountain, Rainbow Mountain

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Dust Mountain, Sheep Hill Alaska

GENERAL REFERENCES - Laznicka (1985); Foley and others (1989); J. Foley, written comm (1990)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Gabbro, norite, garnet clinopyroxenite, dunite

TEXTURES - Cumulate, sheared

AGES - Mesozoic

SPECIAL PREREQUISITES - Rift-related and/or island arc gabbro?

ASSOCIATED DEPOSIT TYPES - Basalt-hosted and basalt-related Cu

DEPOSIT DESCRIPTION

MINERALOGY - Pyrrhotite, chalcopyrite, pentlandite, magnetite

TEXTURES - Disseminated, massive, veins

ALTERATION - Serpentinization; none directly associated w/ ores

GEOCHEMICAL SIGNATURE - Ni, Cu, Co, PGE

Pb ISOTOPE SIGNATURE - ?

S ISOTOPE SIGNATURE - Limited data suggest +0 to +5 permil

NOTES FOR GRADE/TONNAGE MODELS - There is limited data for this deposit type and the model is not well-constrained

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" mafic/ultramafic rock

MODEL 43: PGM ALASKA/CHUGACH TYPE

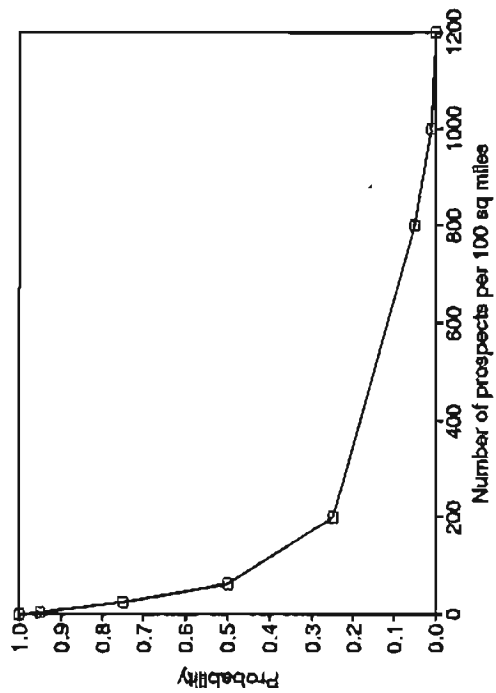
MODEL 43

Cutoff tonnage (million tons)
Probability that the prospect makes the cutoff tonnage

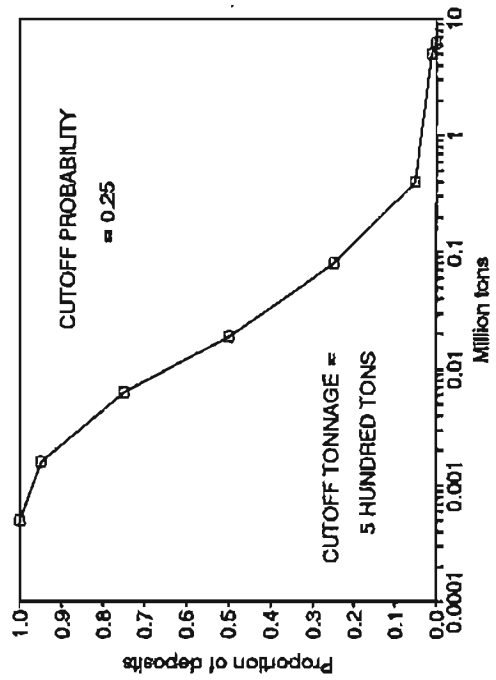
0.0005
0.46

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	0	0	8	19	48	100	140	160
MILLION TONS OF ORE	0.0005	0.001	0.006	0.032	0.25	4	25	50
NICKEL GRADE (%)	0.1	0.15	0.2	0.38	0.6	1.1	1.8	2
Occurrence probability of nickel	0.5							
COPPER GRADE (%)	0.1	0.13	0.25	0.35	0.41	0.52	0.65	0.7
Occurrence probability of copper	0.45							
PLATINUM GRADE (OZ/TON)	0.0015	0.0016	0.003	0.01	0.022	0.04	0.05	0.063
Occurrence probability of platinum	0.8							
PALLADIUM GRADE (OZ/TON)	0.001	0.003	0.01	0.016	0.032	0.1	0.25	0.35
Occurrence probability of palladium	0							

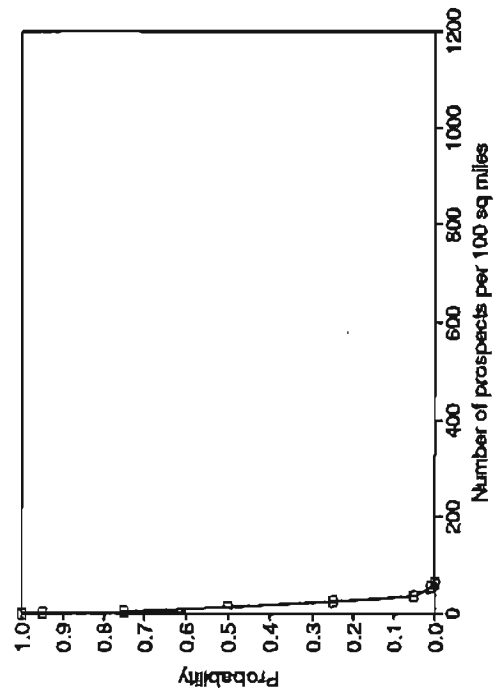
PROSPECT DENSITY - PODIFORM CHROMITE
MODEL 37, DISTRICTS



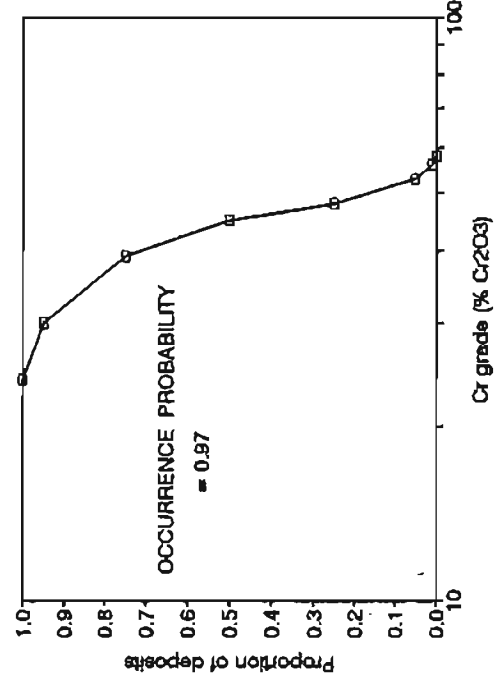
TONNAGE - PODIFORM CHROMITE
MODELS 37-38, DISTRICTS AND AREAS



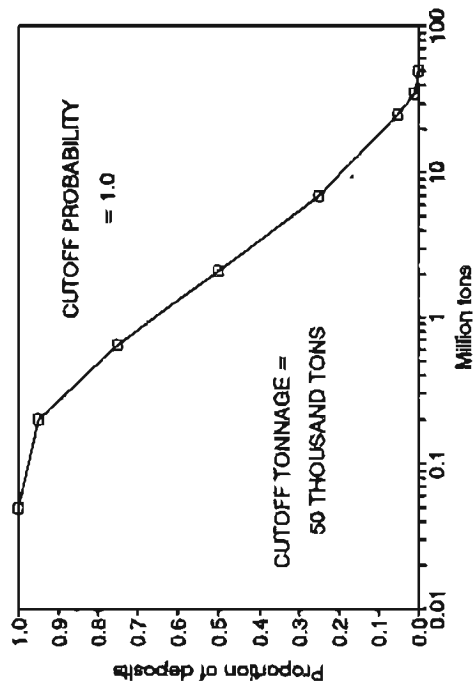
PROSPECT DENSITY - PODIFORM CHROMITE
MODEL 38, AREAS



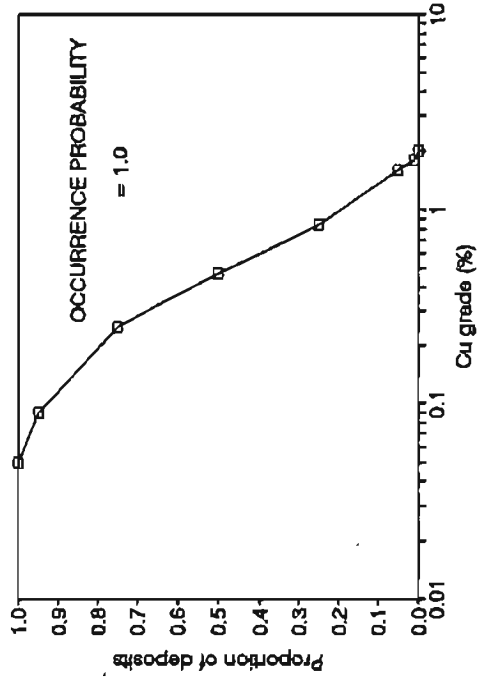
CR GRADE - PODIFORM CHROMITE
MODELS 37-38, DISTRICTS AND AREAS



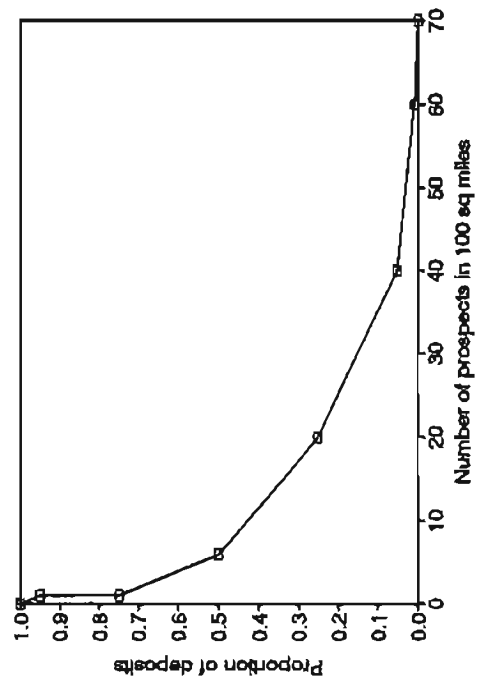
TONNAGE -- MAGMATIC SULFIDE
MODEL 39



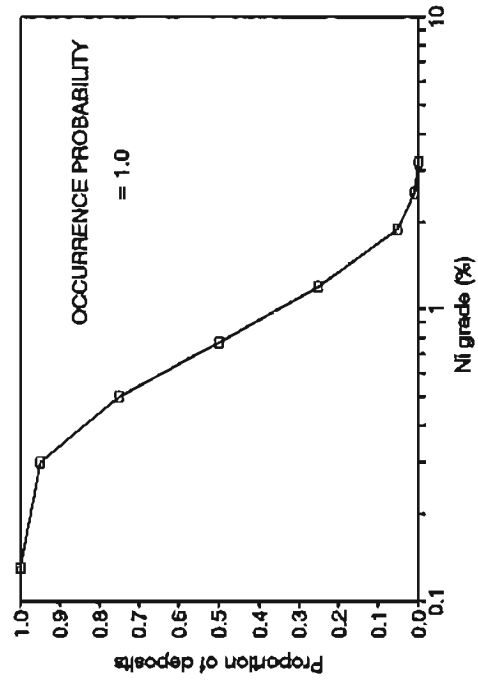
CU GRADE -- MAGMATIC SULFIDE
MODEL 39



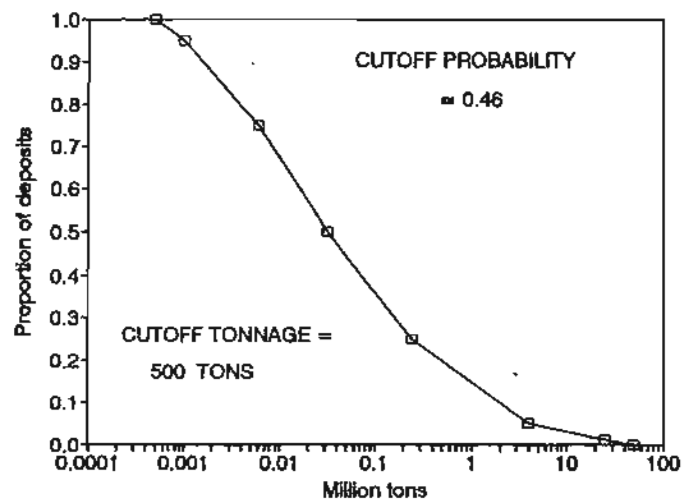
PROSPECT DENSITY -- MAGMATIC SULFIDE
MODEL 39



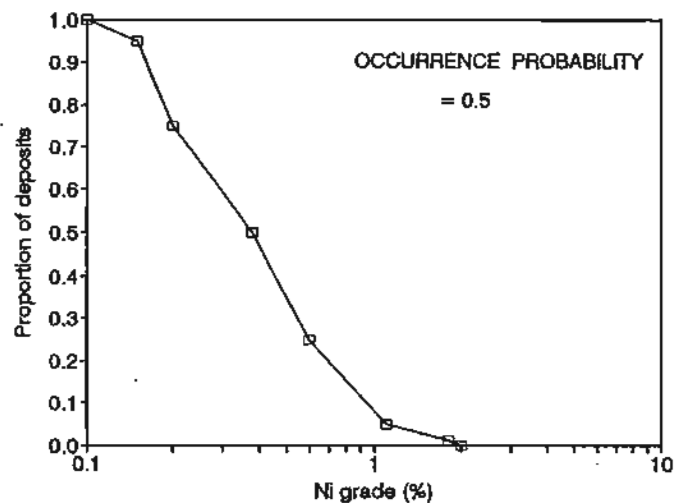
NI GRADE -- MAGMATIC SULFIDE
MODEL 39



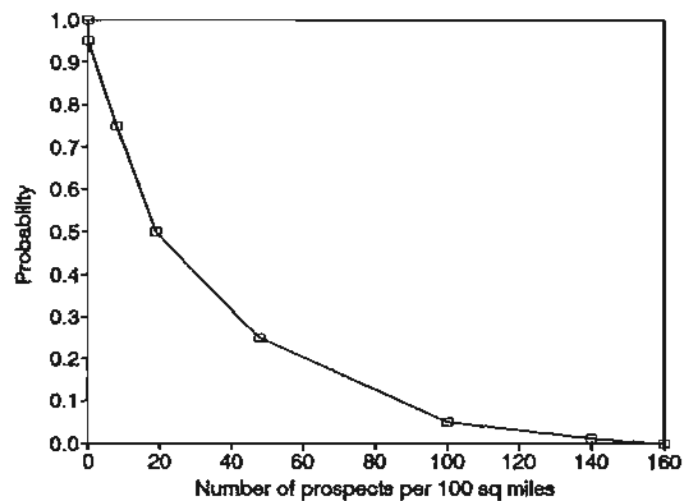
TONNAGE -- CHUGACH-TYPE PGM
MODEL 43



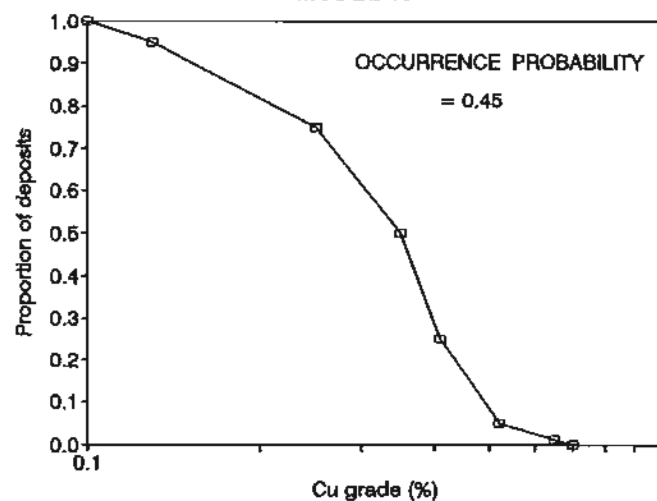
NI GRADE -- CHUGACH-TYPE PGM
MODEL 43



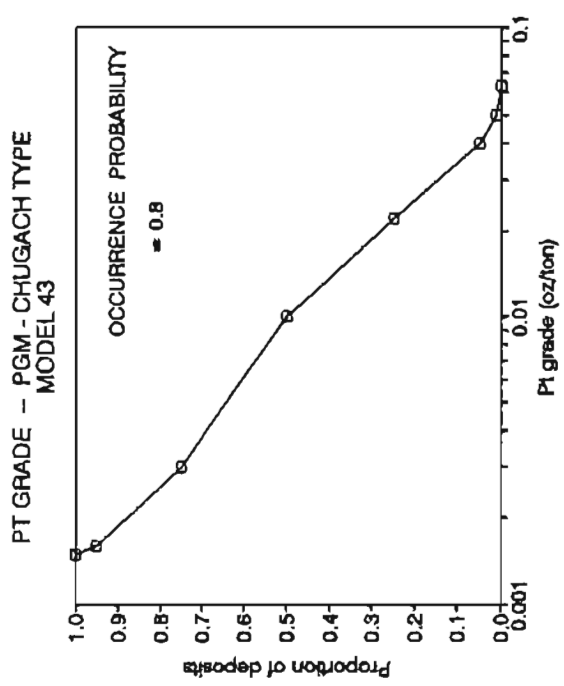
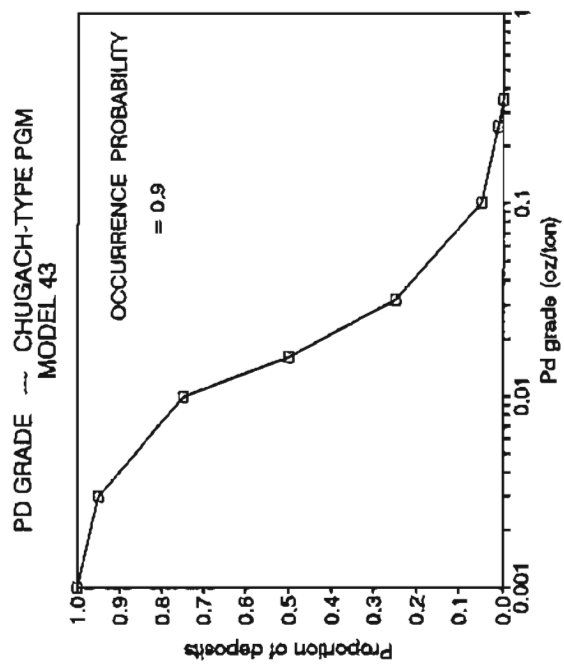
PROSPECT DENSITY -- CHUGACH-TYPE PGM
MODEL 43



CU GRADE -- CHUGACH-TYPE PGM
MODEL 43



6c



PLUTONIC-RELATED VEIN GOLD DEPOSITS - MODELS 1-4 AND 61-64

MODELS 1-4: HIGH GRADE TYPE

OTHER NAMES FOR THIS DEPOSIT TYPE - Au-Ag-Te veins; polymetallic veins; high-sulfide veins.

BRIEF DESCRIPTION - Au-rich vein deposits with a spatial, temporal (and genetic?) relation to felsic plutonic rocks.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Slocan district, Canada; Rossland, British Columbia; La Plata district, Central City, Colorado; Darasun, Kochar, U.S.S.R.; Marysville, Montana.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Fairbanks district; Golden Horn; Snow Gulch.

GENERAL REFERENCES - Laznicka, 1985; Boyle, 1979.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Alkalic and/or nonalkalic plutons and dikes and adjacent country rocks.

TEXTURES - Plutons generally phaneritic.

AGES - All; Cretaceous-Tertiary are most common.

SPECIAL PREREQUISITES - Low oxidation state in pluton; high Cl or CO₂-fluids ?; location near pluton apex?

ASSOCIATED DEPOSIT TYPES - Stockwork gold deposits; Au-rich skarns and replacement bodies.

DEPOSIT DESCRIPTION

MINERALOGY - Au⁰, arsenopyrite, bismuthenite, scheelite, stannite, chalcopyrite, tetrahedrite, sphalerite, galena, pyrrhotite, pyrite, tellurides, quartz, dolomite, tourmaline, white mica.

TEXTURES - Quartz-rich or sulfide-rich veins with strike lengths of 10's - 100's of meters and similar depths.

ALTERATION - White mica.

GEOCHEMICAL SIGNATURE - Au, As, Sb, Te, Bi, Ag, (W, Sn, Mo).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary deposits have ²⁰⁶Pb/²⁰⁴Pb ~ 18.8-19.2; older deposits have less radiogenic ratios.

S ISOTOPE SIGNATURE - Usually 0 ± 5 permil.

NOTES FOR GRADE/TONNAGE MODELS - Grade and tonnage are somewhat correlated; "deposit" definition is somewhat arbitrary, that is, based on historic claims more than single structures.

PROSPECT
NOTES FOR DEPOSIT DENSITY MODEL - There are four different models, built around the observation that higher deposit densities are seen above/adjacent to pluton apex: Model 1 is for stocks < 1 mile in diameter; Model 2 is for plutons 1-2 miles in diameter; Model 3 is for large plutons 2-4 miles in diameter and Model 4 is for batholiths > 8 miles in diameter. Number input into ROCKVAL program is square mileage included with a 4 mile radius around known favorable plutons and a 1 mile radius around favorable dikes.

MODELS 1-4: HIGH-GRADE PLUTONIC GOLD VEINS

MODEL 1: Pluton or dike <2 miles in diameter
 MODEL 2: Pluton 2-4 miles in diameter
 MODEL 3: Pluton 4-8 miles in diameter
 MODEL 4: Pluton >8 miles in diameter

Cutoff tonnage (million tons) 0.01
 Probability that the prospect makes the cutoff tonnage 0.45

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
MODEL 1:								
No. of prospects	10	11	17	33	60	150	190	200
MODEL 2:								
No. of prospects	5	6	9	17	30	75	95	100
MODEL 3:								
No. of prospects	3	3	4	8	15	38	48	50
MODEL 4:								
No. of prospects	1	1	2	4	8	19	24	25
MILLION TONS OF ORE	0.01	0.013	0.023	0.062	0.18	1.2	3.2	3.8
GOLD GRADE (OZ/TON)	0.065	0.07	0.17	0.33	0.5	0.67	0.75	0.8
Occurrence probability of gold	1							

MODELS 61-64: LOWER GRADE TYPE

OTHER NAMES FOR THIS DEPOSIT TYPE - Au-Ag veins; polymetallic veins; high-sulfide veins.

BRIEF DESCRIPTION - Au-bearing vein deposits with a spatial, temporal (and genetic?) relation to felsic plutonic rocks.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Rossland, British Columbia; La Plata district, Central City, Colorado; Darasun, Kochar, U.S.S.R.; Marysville, Montana; Salsigne, France.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Circle, Kantishna, Hyder districts; Blue Lead.

GENERAL REFERENCES - Laznicka, 1985; Boyle, 1979.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Alkalic and/or non-alkalic plutons and dikes and adjacent country rocks.

TEXTURES - Plutons generally phaneritic.

AGES - All; Cretaceous-Tertiary are most common.

SPECIAL PREREQUISITES - Low oxidation state in pluton; high Cl or CO₂-fluids ?; location near pluton apex?

ASSOCIATED DEPOSIT TYPES - Stockwork gold deposits; Au-rich skarns and replacement bodies.

DEPOSIT DESCRIPTION

MINERALOGY - Au⁰, arsenopyrite, bismuthenite, scheelite, stannite, chalcopyrite, tetrahedrite, sphalerite, galena, pyrrhotite, pyrite, tellurides, quartz, dolomite, tourmaline, white mica.

TEXTURES - Quartz-rich or sulfide-rich veins with strike lengths of 10's - 100's of meters and similar depths.

ALTERATION - White mica.

GEOCHEMICAL SIGNATURE - Au, As, Sb, Te, Bi, Ag, (W, Sn, Mo).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary deposits have ²⁰⁶Pb/²⁰⁴Pb ~ 18.8-19.2; older deposits have less radiogenic ratios.

S ISOTOPE SIGNATURE - Usually 0 ± 5 permil.

NOTES FOR GRADE/TONNAGE MODELS - Grade and tonnage are somewhat correlated; "deposit" definition is somewhat arbitrary, that is, based on historic claims more than single structures; Au grade distribution for this model is intermediate between Models 1-4 (higher-Au veins) and Model 6 (gold-byproduct veins).

PROSPECT

NOTES FOR DEPOSIT DENSITY MODEL - There are four different models, built around the observation that higher deposit densities are seen above/adjacent to pluton apex: Model 61 is for stocks <1 mi in diameter; Model 62 is for plutons 1-2 miles in diameter; Model 63 is for large plutons 2-4 miles in diameter and Model 64 is for batholiths, >8 miles in diameter. Number input into ROCKVAL program is square mileage included with a 4 mile radius around known favorable plutons and a 1 mile radius around favorable dikes.

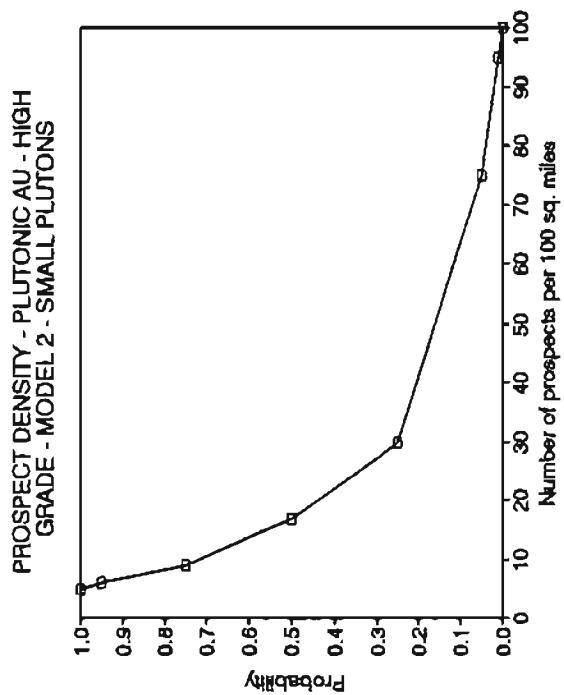
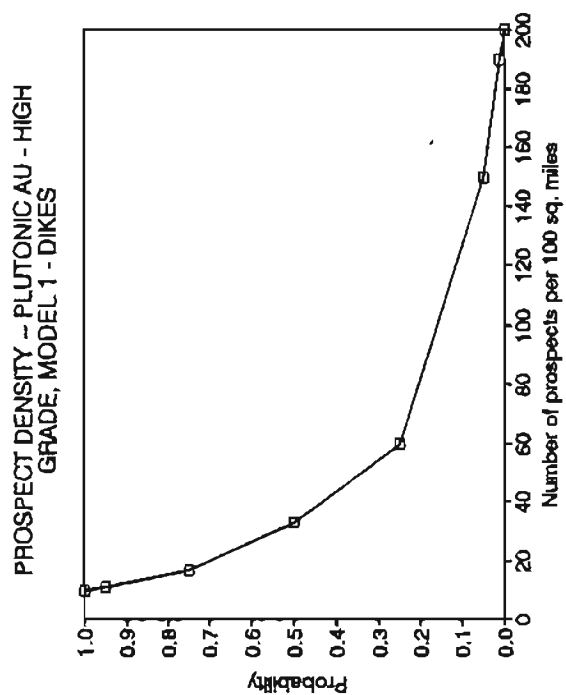
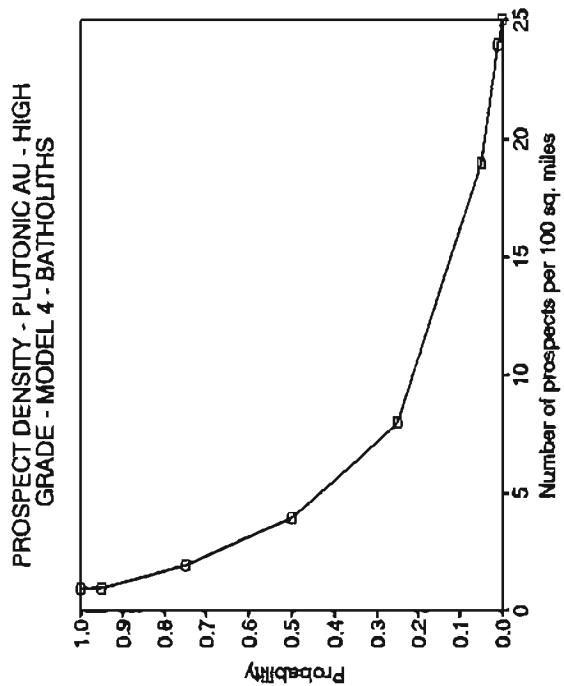
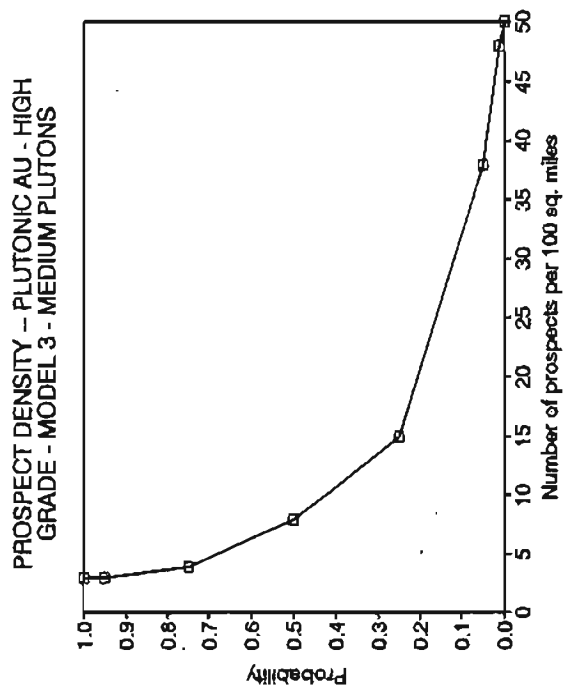
MODEL 61-64: LOWER-GRADE PLUTONIC GOLD-VEIN

MODEL 61 Pluton or dike <2 miles in diameter	Cutoff tonnage (million tons)	0.01
MODEL 62 Pluton 2-4 miles in diameter	Probability that the prospect makes the cutoff tonnage	0.45
MODEL 63 Pluton 4-8 miles in diameter		
MODEL 64 Pluton >8 miles in diameter		

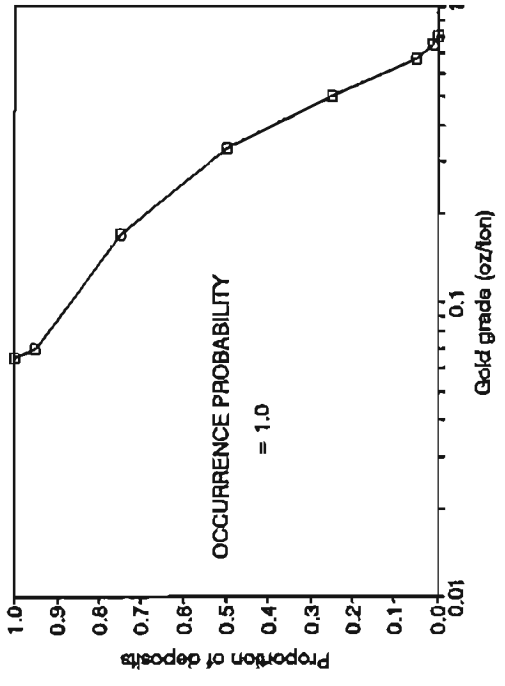
PROBABILITY	100	95	75	50	25	5	1	0
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PROSPECT DENSITY WITHIN 100 SQ MILE AREA

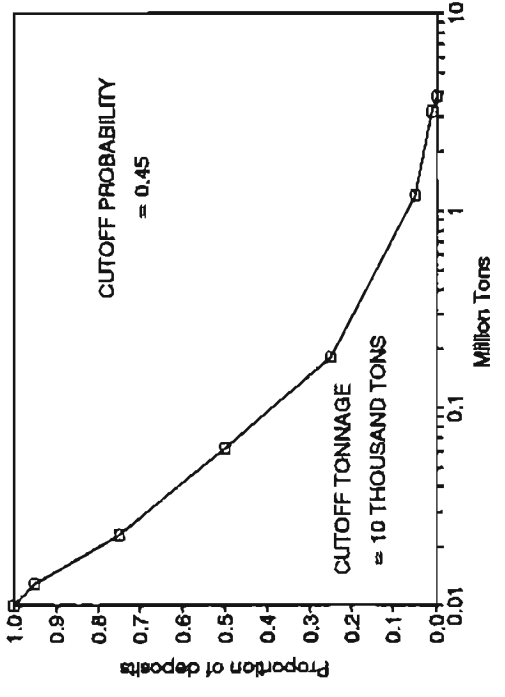
MODEL 61:								
No. of prospects	10	11	17	33	60	150	190	200
MODEL 62:								
No. of prospects	5	6	9	17	30	75	95	100
MODEL 63:								
No. of prospects	3	3	4	8	15	38	48	50
MODEL 64:								
No. of prospects	1	1	2	4	8	19	24	25
MILLION TONS OF ORE	0.01	0.013	0.023	0.062	0.18	1.2	3.2	3.8
GOLD GRADE (OZ/TON)	0.065	0.07	0.08	0.1	0.2	0.25	0.35	0.4
Occurrence probability of gold	1							

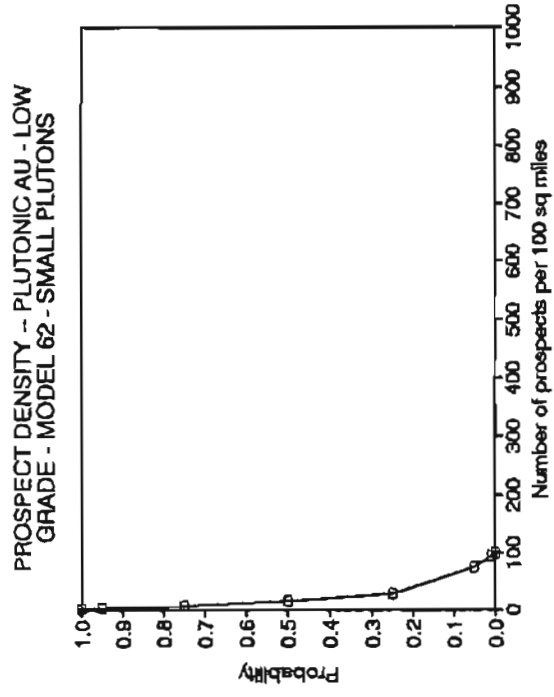
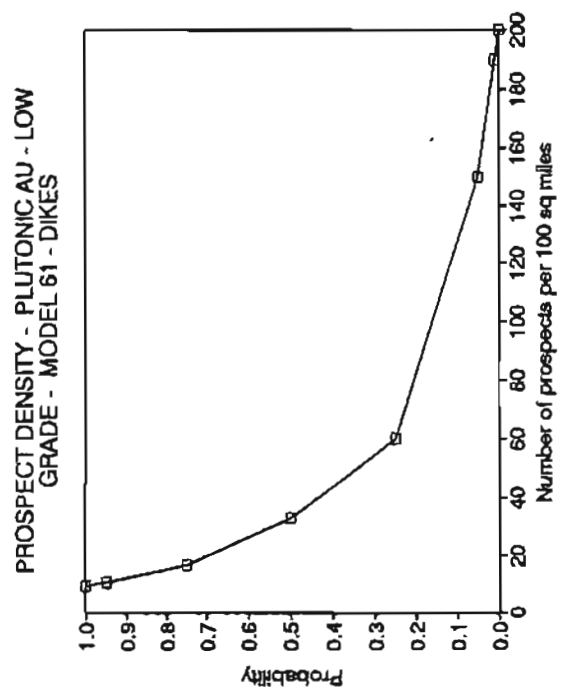
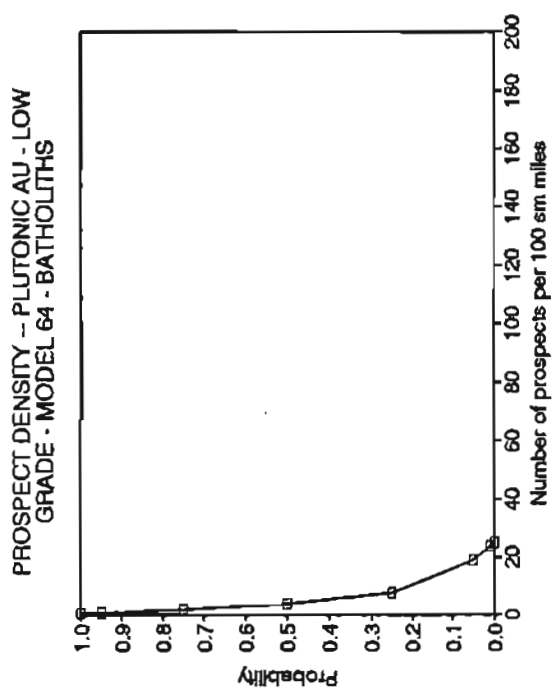
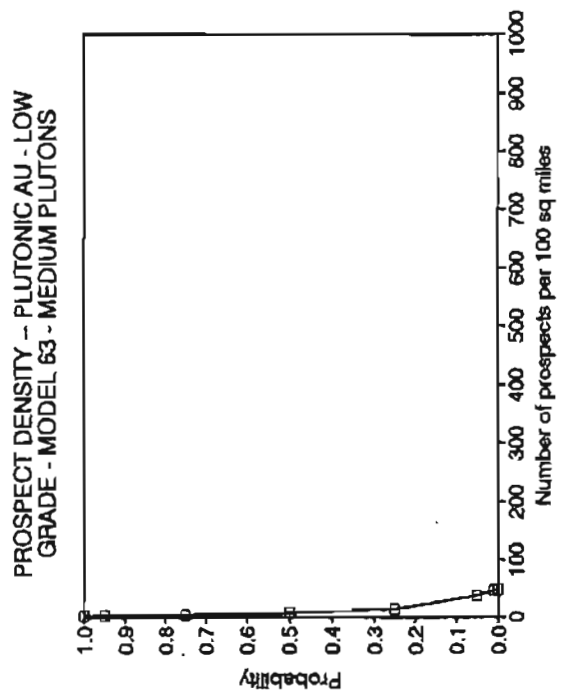


AU GRADE - PLUTONIC GOLD
MODELS 1-4 - HIGH GRADE SYSTEM

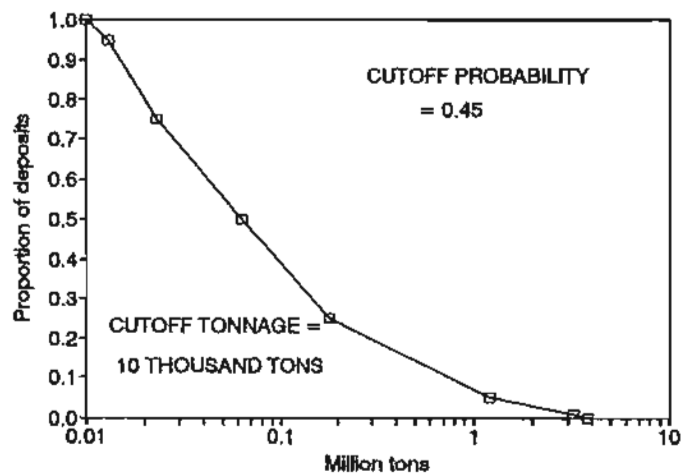


TONNAGE -- PLUTONIC GOLD - HIGH GRADE
MODELS 1-4

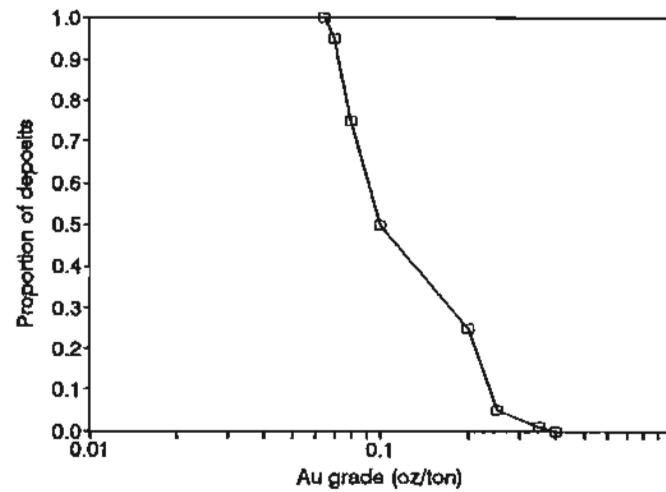




TONNAGE – GOLD PLUTONS - LOW GRADE
MODELS 61-64



AU GRADE – PLUTONIC GOLD - LOW GRADE
MODELS 61-64



MODEL 5: PLUTONIC BULK MINABLE GOLD

OTHER NAMES FOR THIS DEPOSIT TYPE - Porphyry Au; Alkaline Au.

BRIEF DESCRIPTION - Felsic plutonic rock (alkaline or not) with spatially, temporally, and genetically (?) related Au \pm sulfide-quartz stockworks/breccias.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Zortman-Landusky, Montana; Ortiz, New Mexico; Gold Hill, Colorado; Berezovsk, U.S.S.R.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Fort Knox, Vinasale, Ester Dome, Golden Zone, Chicken Mountain., Democrat.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Laznicka, 1985; Rytuba and Cox, 1991.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Felsic plutons and dikes.

TEXTURES - Generally aphanitic.

AGES - Mostly Cretaceous-Tertiary, can be older?

SPECIAL PREREQUISITES - Low oxidation state?; high Cl-CO₂ fluids?

ASSOCIATED DEPOSIT TYPES - Au veins, skarns, replacements.

DEPOSIT DESCRIPTION

MINERALOGY - Au⁰, bismuthinite, tellurides, arsenopyrite, pyrite, pyrrhotite, chalcopyrite, stibnite, molybdenite, quartz, calcite.

TEXTURES - Vein stockwork and breccia pipes.

ALTERATION - Sericite, albite, carbonate, K-feldspar, chlorite.

GEOCHEMICAL SIGNATURE - Au, Te, Bi, As, (Ag, W, Cu).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have ²⁰⁶Pb/²⁰⁴Pb of 18.8 to 19.2.

S ISOTOPE SIGNATURE - Generally 0 \pm 3 permil.

NOTES FOR GRADE/TONNAGE MODELS - Too few examples for statistically robust curves.

NOTES FOR ^{PERSPECT} ~~DEPOSIT~~ DENSITY MODEL - Too few examples for high-reliability curves; recommend individual evaluation of results.

MODEL 5: PLUTONIC BULK MINEABLE GOLD

MODEL 5

Cutoff tonnage (million tons)

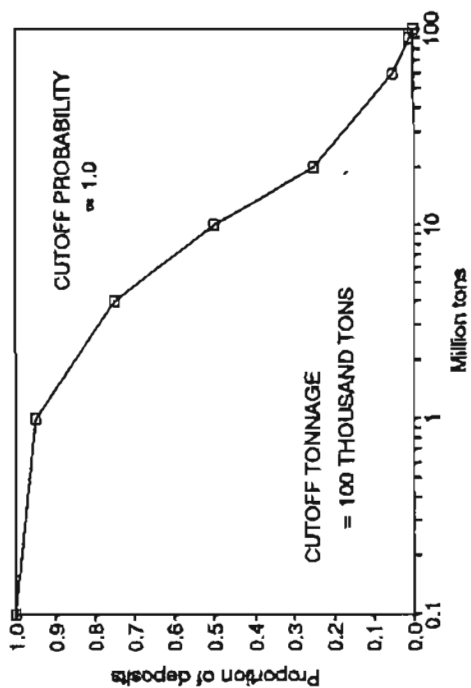
0.1

Probability that the prospect makes the cutoff tonnage

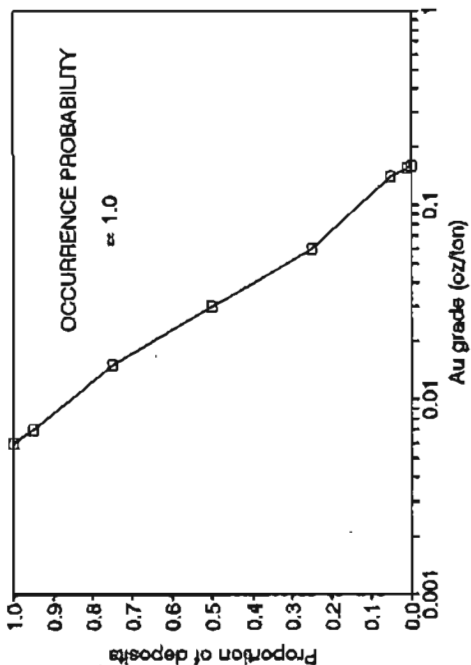
1

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	0	0	0	1	1	3	3	7
MILLION TONS OF ORE	0.1	1	4	10	20	60	90	100
GOLD GRADE(OZ/TON)	0.006	0.007	0.015	0.03	0.06	0.14	0.155	0.16
Occurrence probability of gold	1							

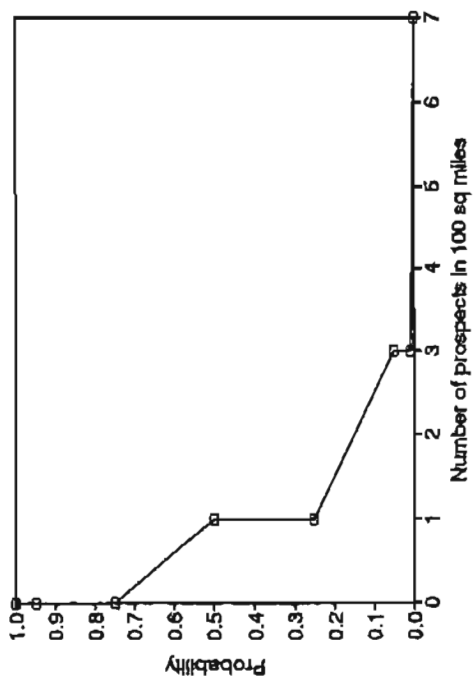
TONNAGE-PLUTONIC BULK MINEABLE GOLD
#5



AU GRADE-PLUTONIC BULK MINEABLE GOLD
#5



PROSPECT DENSITY-PLU. BULK MINEABLE AU
#5



MODEL 6: PLUTONIC-RELATED, POLYMETALLIC VEINS

OTHER NAMES FOR THIS DEPOSIT TYPE - Ag-Pb-Zn veins; polymetallic veins; high-sulfide veins.

BRIEF DESCRIPTION - Ag-, base metal-rich vein deposits with a spatial (and genetic?) relation to felsic hypabyssal plutons.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Slocan, British Columbia; Mammoth, Arizona, Marysville, Montana, Zeehan, Tasmania.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Broken Shovel, Perseverance, Quartz Creek, Bonanza Hills.

GENERAL REFERENCES - Laznicka, 1985; Boyle, 1979.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Typically nonalkalic plutons and dikes and adjacent country rocks.

TEXTURES - Plutons phaneritic to porphyritic.

AGES - All; Cretaceous-Tertiary are most common.

SPECIAL PREREQUISITES - High Cl-fluids ?; location near pluton apex?

ASSOCIATED DEPOSIT TYPES - Replacement bodies; porphyry Cu deposits.

DEPOSIT DESCRIPTION

MINERALOGY - Pyrite, sphalerite, galena, chalcopyrite, tetrahedrite, electrum, arsenopyrite, argentite, hematite, quartz, ankerite, chlorite, rhodochrosite, barite, fluorite.

TEXTURES - Typically sulfide-rich veins with strike lengths of 10's - 100's of meters and similar depths

ALTERATION - Propylitic, silicification.

GEOCHEMICAL SIGNATURE - Ag, Zn, Pb, Cu, As, Mn, Ba (Au, Mo); zoning common.

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary deposits have $^{206}\text{Pb}/^{204}\text{Pb} = 18.8-19.2$; older deposits have less radiogenic ratios.

S ISOTOPE SIGNATURE - Usually 0 ± 5 permil.

NOTES FOR GRADE/TONNAGE MODELS - "Deposit" definition is somewhat arbitrary, that is, based on historic claims more than single structures.

PROSPECT
NOTES FOR DEPOSIT DENSITY MODEL - Based on square miles of "favorable" area, generally a 4 mile radius around known favorable plutons and a 1 mile radius around favorable dikes. Input parameter is square mileage.

MODEL 6: POLYMETALLIC VEINS

MODEL 6

Cutoff tonnage (million tons)

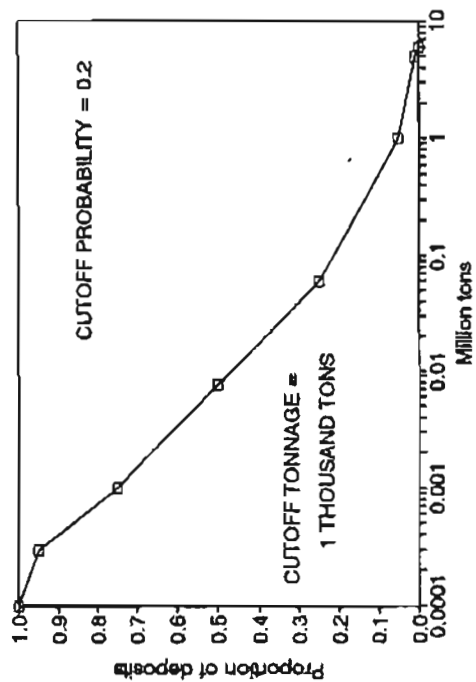
0.0001

Probability that the prospect makes the cutoff tonnage

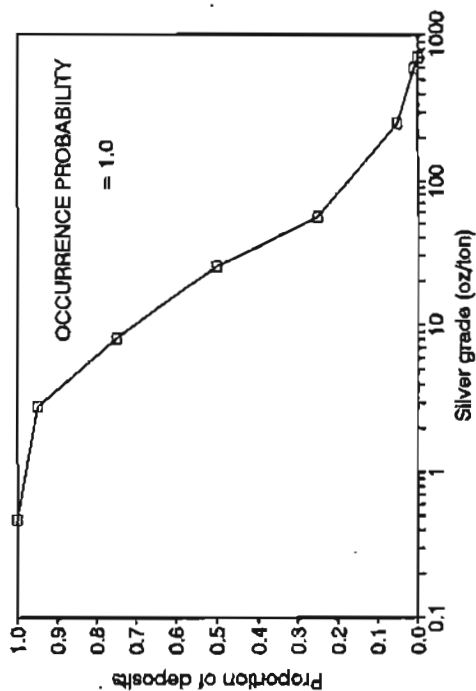
0.2

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	3	4	5	7	9	11	12	12
MILLION TONS OF ORE	0.0001	0.0003	0.001	0.0076	0.06	1	5	6
SILVER GRADE (OZ/TON)	0.47	2.8	8.1	25.5	56	250	600	700
Occurrence probability of silver	1							
GOLD GRADE(OZ/TON)	0.0006	0.001	0.002	0.03	0.19	0.64	1.2	1.6
Occurrence probability of gold	1							
ZINC GRADE (%)	0.4	0.7	1	2.1	6	12	15	17
Occurrence probability of zinc	1							
LEAD GRADE (%)	0.45	1.45	5	10	18	41	47	50
Occurrence probability of lead	1							

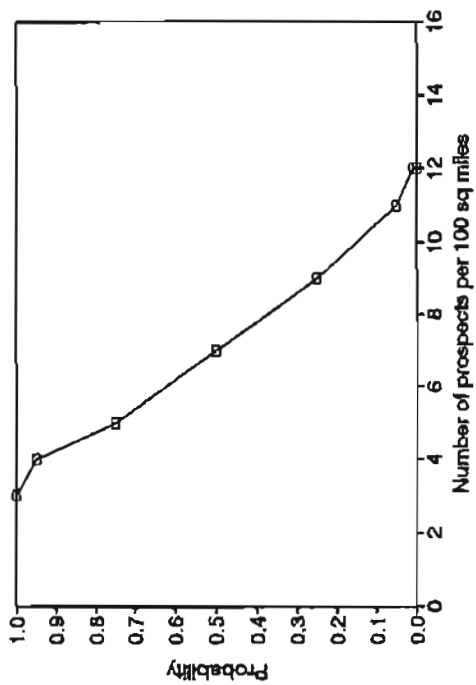
TONNAGE-POLYMETALLIC VEINS
#6



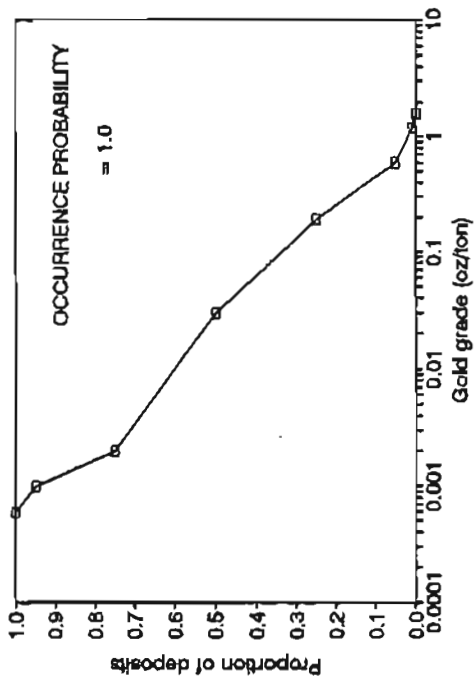
AG GRADE-POLYMETALLIC VEINS
#6

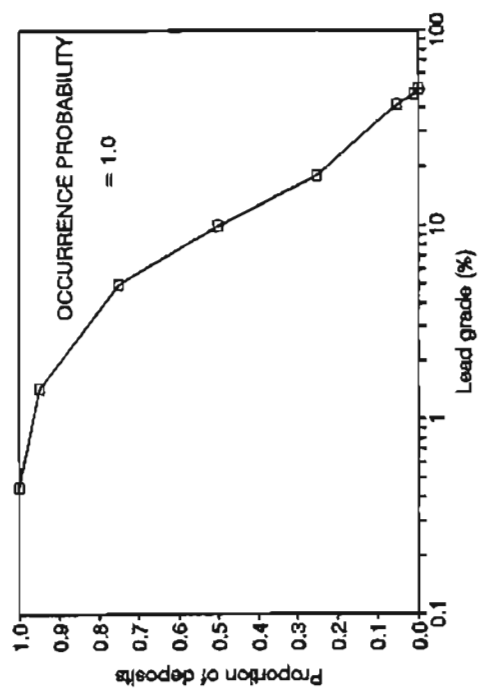
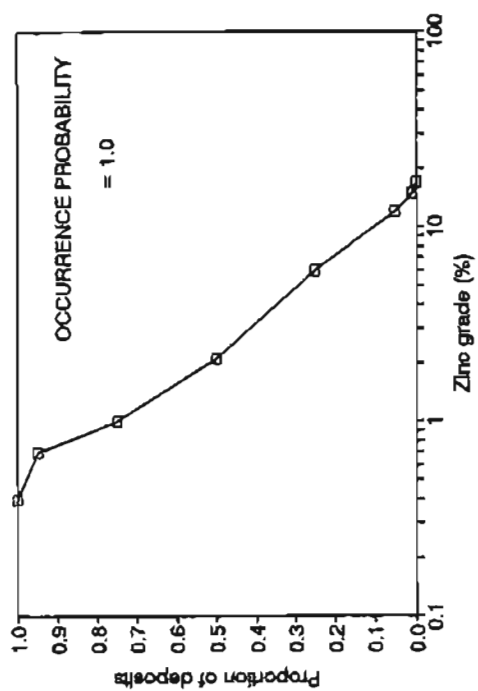


PROSPECT DENSITY-POLYMETALLIC VEINS
#6



AU GRADE-POLYMETALLIC VEINS
#6



PB GRADE--POLYMETALLIC VEINS
#6ZN GRADE--POLYMETALLIC VEINS
#6

SKARN DEPOSITS - MODELS 7, 8, 9, 10, 11, 12, 13, 14, 21, and 22

MODELS 7 GOLD \pm COPPER SKARNS (MINOR CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Gold skarns; gold replacements.

BRIEF DESCRIPTION - Gold-rich skarn \pm replacement deposits spatially associated with felsic plutonic rocks in low-carbonate environments.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Tillicum, British Columbia; Brown's Creek, Australia; Klondyke, Montana.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - It. Alarm, Partin Creek, Paint River.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Meinert, 1989.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Felsic plutonic rocks; minor carbonate rocks in predominantly (meta-) volcanic stratigraphy.

TEXTURES - Plutons generally phaneritic.

AGES - Mostly Cretaceous-Tertiary, but as old as Devonian known.

SPECIAL PREREQUISITES - Carbonate rocks; low-oxidation state plutons.

ASSOCIATED DEPOSIT TYPES - Au-rich veins and stockworks.

DEPOSIT DESCRIPTION

MINERALOGY - Au⁰, arsenopyrite, bornite, pyrite, chalcopyrite, pyrrhotite, bismuthenite, tellurides, garnet, pyroxene, scapolite, wollastonite, actinolite, tourmaline, chlorite, quartz.

TEXTURES - Massive, vein, stratiform, disseminated.

ALTERATION - Epidote-chlorite-sericite-carbonate in pluton and nearby metavolcanic rocks.

GEOCHEMICAL SIGNATURE - Au, Ag, Bi, Te, Cu, As, Sb.

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have ²⁰⁶Pb/²⁰⁴Pb ca. 18.7 to 19.3.

S ISOTOPE SIGNATURE - Generally 0 \pm 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is for skarns in thin/minor carbonate stratigraphic settings.

NOTES FOR DEPOSIT DENSITY MODEL - Input parameter is the number of miles of plutonic-carbonate contact; consider the proportion of carbonate in the stratigraphy in calculating miles.

MODEL 8 GOLD ± COPPER SKARNS (ABUNDANT CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Gold skarns; gold replacements.

BRIEF DESCRIPTION - Gold-rich skarn ± replacement deposits spatially associated with felsic plutonic rocks.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Hedley, British Columbia; Red Dome, Australia; Fortitude, Nevada; Veselyi, U.S.S.R.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Nixon Fork; Liberty Bell; Nabesna; Zackley; Jumbo.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Meinert, 1989.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Felsic plutonic rocks; carbonate rocks.

TEXTURES - Plutons generally phaneritic.

AGES - Mostly Cretaceous-Tertiary, but as old as Devonian known.

SPECIAL PREREQUISITES - Carbonate rocks; low-oxidation state plutons.

ASSOCIATED DEPOSIT TYPES - Au-rich veins and stockworks.

DEPOSIT DESCRIPTION

MINERALOGY - Au⁰, arsenopyrite, bornite, pyrite, chalcopyrite, pyrrhotite, bismuthenite, tellurides, garnet, pyroxene, scapolite, wollastonite, actinolite, tourmaline, chlorite, quartz.

TEXTURES - Massive, vein, stratiform, disseminated.

ALTERATION - Epidote-chlorite-sericite-carbonate in pluton and nearby metavolcanic rocks (if any).

GEOCHEMICAL SIGNATURE - Au, Ag, Bi, Te, Cu, As, Sb.

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have ²⁰⁶Pb/²⁰⁴Pb ca. 18.7 to 19.3.

S ISOTOPE SIGNATURE - Generally 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is for skarns in thick carbonate stratigraphic settings.

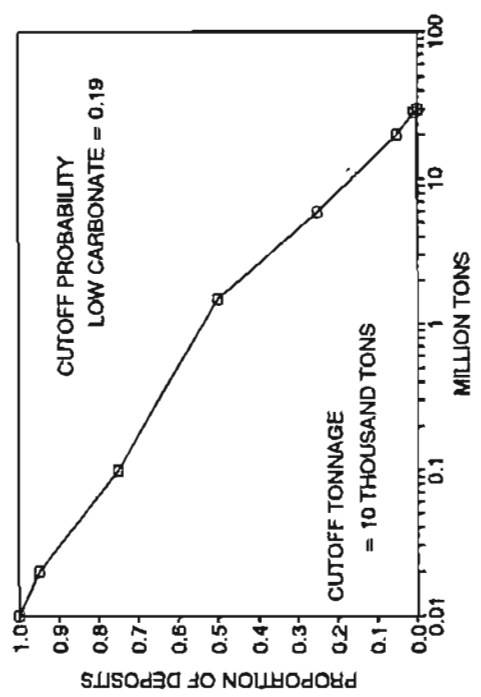
NOTES FOR DEPOSIT DENSITY MODEL - Input parameter is the number of miles of plutonic-carbonate contact.

PROSPECT

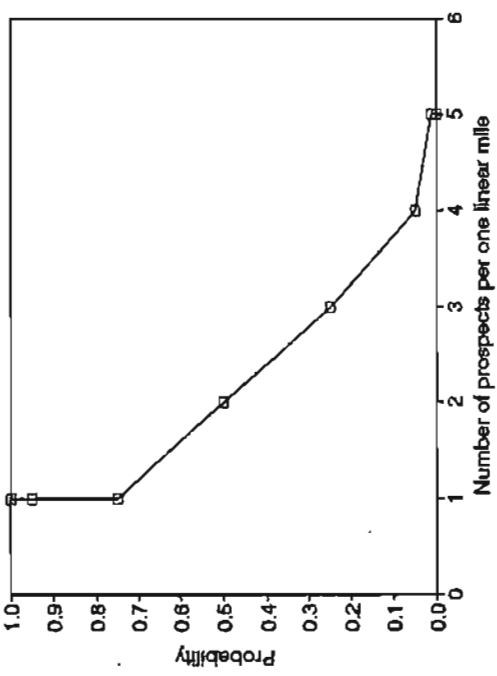
MODEL 7-8: GOLD-COPPER SKARNS

MODEL 7 (MINOR CARBONATE)	Cutoff tonnage (million tons)							0.01
MODEL 8 (ABUNDANT CARBONATE)	Probability that the prospect makes the cutoff tonnage (Model 7)							0.19
	Probability that the prospect makes the cutoff tonnage (Model 8)							0.4
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY ALONG 1 LINEAR MILE OF CARBONATE/PLUTON CONTACT								
No. of prospects	1	1	1	2	3	4	5	5
MILLION TONS OF ORE (Model 7)	0.01	0.02	0.1	1.5	6	20	28	30
MILLION TONS OF ORE (Model 8)	0.03	0.05	0.1	1.5	6	20	28	30
GOLD GRADE (OZ/TON)	0.003	0.01	0.04	0.11	0.23	0.63	1	1.2
Occurrence probability of gold	1							
SILVER GRADE (OZ/TON)	0.03	0.06	0.28	0.63	3	9	11	12
Occurrence probability of silver	1							
COPPER GRADE (%)	0.1	0.14	0.45	1.5	3	4.2	7	8
Occurrence probability of copper	1							

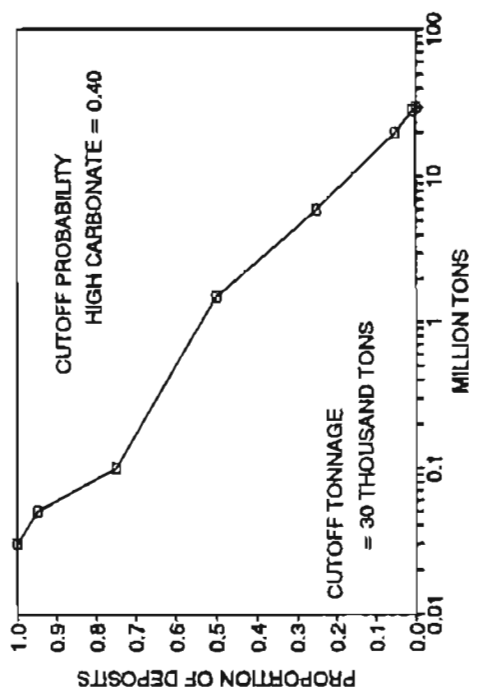
TONNAGE--AU-CU SKARNS
MODEL 7



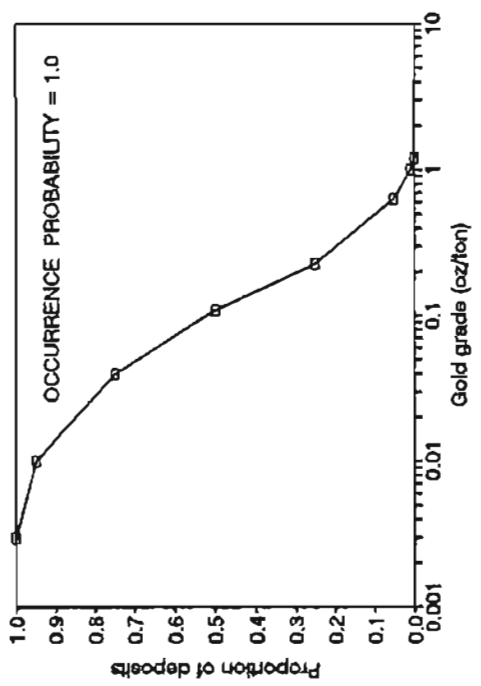
PROSPECT DENSITY--AU-CU SKARNS
MODEL 7 AND 8

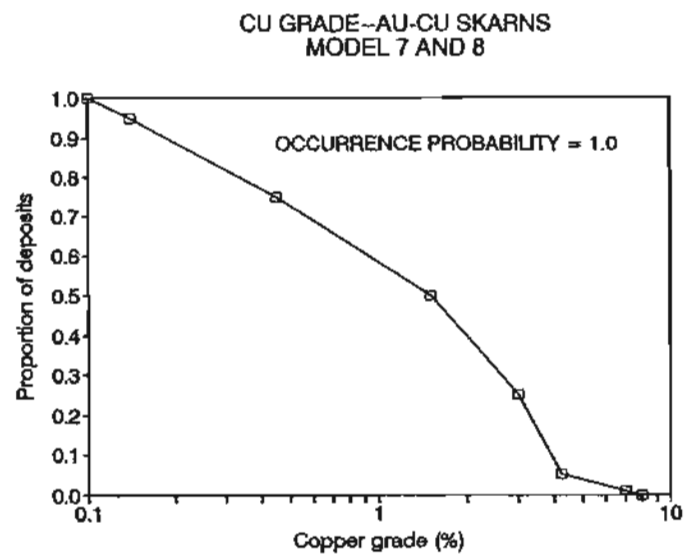
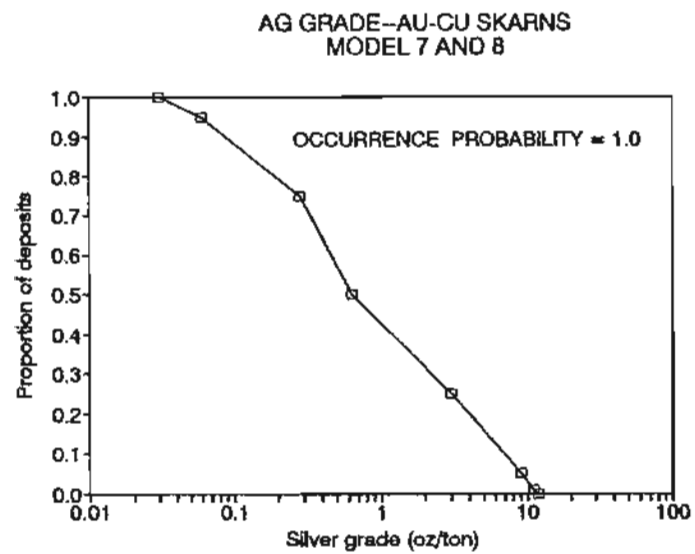


TONNAGE--AU-CU SKARNS
MODEL 8



AU GRADE--AU-CU SKARNS
MODEL 7 AND 8





MODEL 9 IRON ± GOLD SKARNS (MINOR CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Iron skarns; magnetite skarns.

BRIEF DESCRIPTION - Magnetite-rich skarn ± replacement deposits spatially associated with felsic plutonic rocks.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Tasu, Benson Lake, Texada Island, British Columbia.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Poorman, Maine, Rainey Creek, Iron King.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Einaudi and others. (1981).

GEOLOGIC ENVIRONMENT

ROCK TYPES - Felsic plutonic rocks; dominantly volcanic stratigraphy with minor/thin carbonate beds.

TEXTURES - Plutons generally phaneritic.

AGES - Mostly Cretaceous-Tertiary, but as old as Devonian known.

SPECIAL PREREQUISITES - Carbonate rocks: low-sulfidation state plutons.

ASSOCIATED DEPOSIT TYPES - Minor Au-Cu-rich veins and stockworks.

DEPOSIT DESCRIPTION

MINERALOGY - Magnetite, hematite, Au⁰, chalcopyrite, pyrite, pyrrhotite, garnet, pyroxene, scapolite, actinolite, chlorite, serpentine.

TEXTURES - Massive, vein, stratiform, disseminated.

ALTERATION - Epidote-chlorite-sericite-carbonate in pluton and nearby metavolcanic rocks.

GEOCHEMICAL SIGNATURE - Fe, Cu, Co, Au.

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have ²⁰⁶Pb/²⁰⁴Pb ca. 18.7 to 19.3.

S ISOTOPE SIGNATURE - Generally 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is for skarns in thin/rare carbonate stratigraphic settings.

~~DEPOSIT~~ ^{PRESPECT}

NOTES FOR ~~DEPOSIT~~ DENSITY MODEL - Input parameter is the number of miles of plutonic-carbonate contact; adjust latter for proportion of carbonate rocks in the stratigraphy.

19

MODEL 10
IRON ± GOLD SKARNS (ABUNDANT CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Iron skarns; magnetite skarns.

BRIEF DESCRIPTION - Magnetite-rich skarn ± replacement deposits spatially associated with felsic plutonic rocks.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Cornwall, Larap, Pennsylvania; Eagle Mountain, Shasta, California.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Mount Andrew, Magnetite Cliff, North Bradfield River, Medfra.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Einaudi and others (1981).

GEOLOGIC ENVIRONMENT

ROCK TYPES - Felsic plutonic rocks; abundant/thick carbonate beds.

TEXTURES - Plutons generally phaneritic.

AGES - Mostly Cretaceous-Tertiary, but as old as Devonian known.

SPECIAL PREREQUISITES - Carbonate rocks; low-sulfidation state plutons.

ASSOCIATED DEPOSIT TYPES - Minor Au-Cu-rich veins and stockworks.

DEPOSIT DESCRIPTION

MINERALOGY - Magnetite, hematite, Au⁰, chalcopyrite, pyrite, pyrrhotite, garnet, pyroxene, scapolite, actinolite, chlorite, serpentine.

TEXTURES - Massive, vein, stratiform, disseminated.

ALTERATION - Epidote-chlorite-sericite-carbonate in pluton and nearby metavolcanic rocks (if any).

GEOCHEMICAL SIGNATURE - Fe, Cu, Co, Au.

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have $^{206}\text{Pb}/^{204}\text{Pb}$ ca. 18.7 to 19.3.

S ISOTOPE SIGNATURE - Generally 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is for skarns in thick carbonate stratigraphic settings.

NOTES FOR DEPOSIT DENSITY MODEL - Input parameter is the number of miles of plutonic-carbonate contact.

PROSPECT

MODEL 9-10: IRON-GOLD-COPPER SKARNS

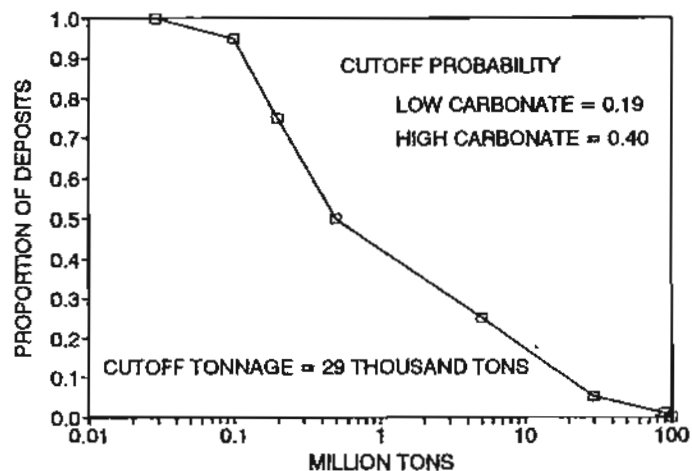
MODEL 9 (MINOR CARBONATE)
MODEL 10 (ABUNDANT CARBONATE)

Cutoff tonnage (million tons)
Probability that the prospect makes the cutoff tonnage (Model 9) 0.029
Probability that the prospect makes the cutoff tonnage (Model 10) 0.19
0.4

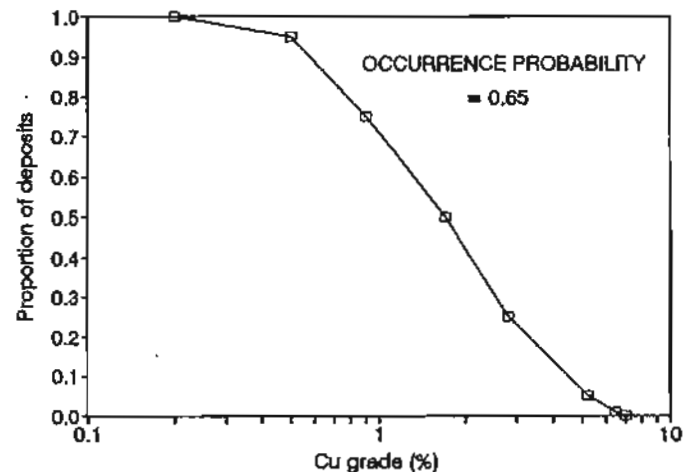
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY ALONG 1 LINEAR MILE OF CARBONATE/PLUTON CONTACT								
No. of prospects	1	1	1	2	3	4	5	5
MILLION TONS OF ORE	0.029	0.1	0.2	0.5	5	30	90	100
COPPER GRADE (%)	0.2	0.5	0.9	1.7	2.8	5.2	6.5	7.0
Occurrence probability of copper	0.65							
IRON GRADE (%)	15	33	42	48	50	55	59	61
Occurrence probability of iron	0.75							
COBALT GRADE (%)	0.001	0.002	0.006	0.013	0.028	0.072	0.12	0.13
Occurrence probability of cobalt	1							
NICKEL GRADE (%)	0.0003	0.0005	0.003	0.007	0.019	0.05	0.09	0.1
Occurrence probability of nickel	1							
GOLD GRADE (OZ/TON)	0.002	0.003	0.01	0.032	0.064	0.535	3	3.38
Occurrence probability of gold	0.5							
SILVER GRADE (OZ/TON)	0.01	0.027	0.067	0.308	0.739	4.56	9	10.9
Occurrence probability of silver	0.5							

Handwritten notes:
The above data are based on the assumption that the prospect is a skarn.
The above data are based on the assumption that the prospect is a skarn.

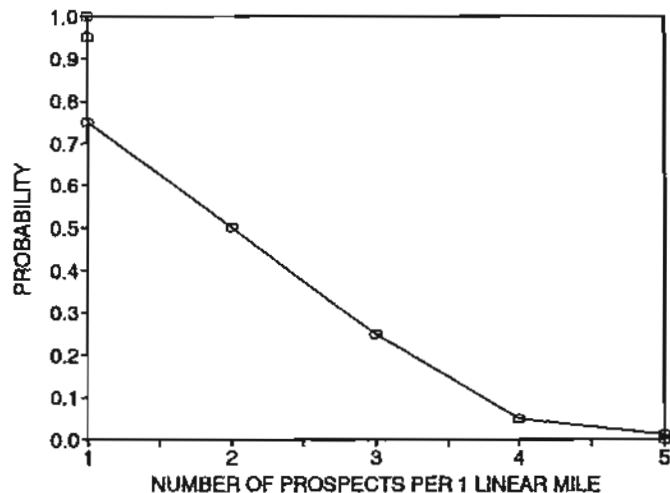
TONNAGE -- FE-AU-CU SKARNS
MODELS 9 AND 10



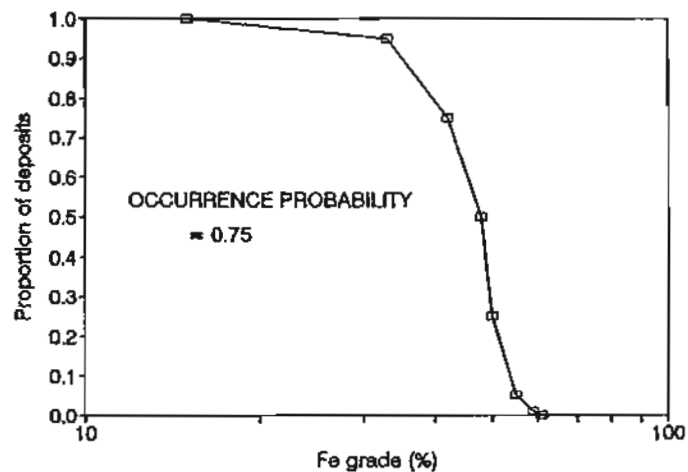
CU GRADE -- FE-AU-CU SKARNS
MODELS 9 AND 10



PROSPECT DENSITY -- FE-AU-CU SKARNS
MODELS 9 AND 10



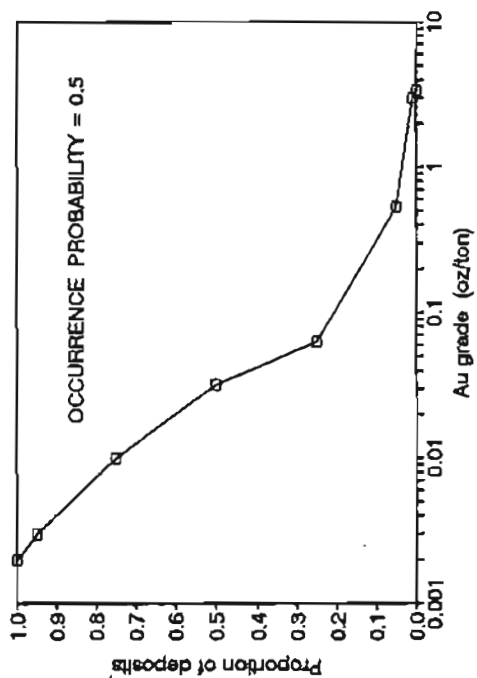
FE GRADE -- FE-AU-CU SKARNS
MODELS 9 AND 10



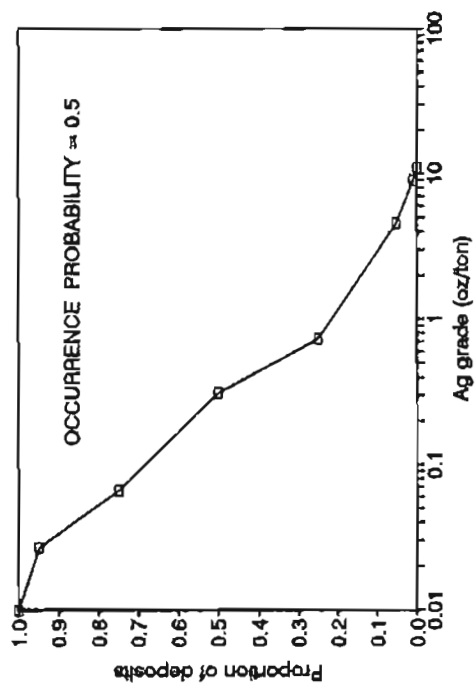
209

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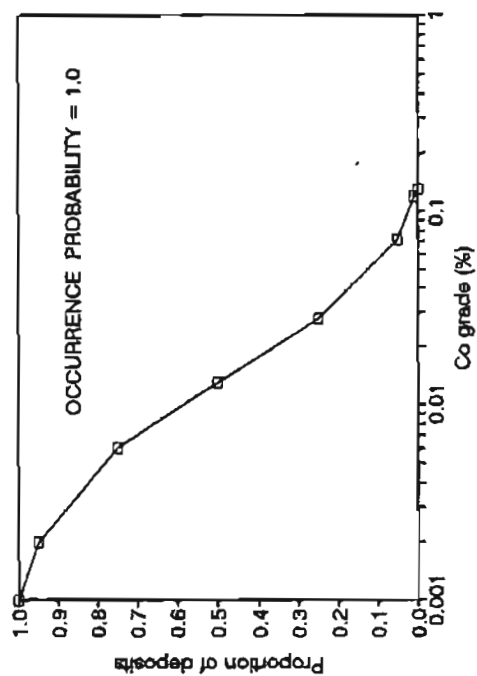
AU GRADE -- FE-AU-CU SKARNS
MODELS 9 AND 10



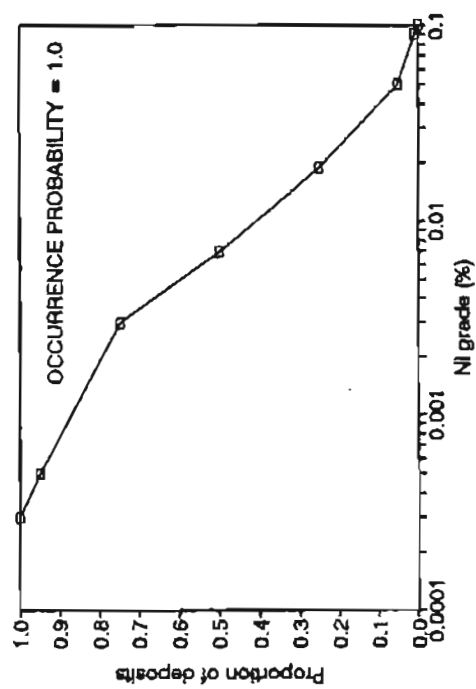
AG GRADE -- FE-AU-CU SKARNS
MODELS 9 AND 10



CO GRADE -- FE-AU-CU SKARNS
MODELS 9 AND 10



NI GRADE -- FE-AU-CU SKARNS
MODELS 9 AND 10



MODEL 11 TUNGSTEN \pm GOLD SKARNS (MINOR CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Scheelite skarns; volcanogenic W.

BRIEF DESCRIPTION - Scheelite-bearing calc-silicate rocks spatially and genetically related to granitic intrusions.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Black Rock, Garnet Dike, Round Valley, California; Tungsten Jim, Idaho.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Gilmore Dome, upper Salcha River, Table Mountain (Circle Quadrangle).

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Laznicka, 1985; Einaudi and others, 1981.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Thin and/or rare marble beds in shale/schist-dominated stratigraphy; granodiorite-granite intrusion.

TEXTURES - Granitic rocks are holocrystalline and porphyritic.

AGES - 90-60 Ma most common, but older examples are known.

SPECIAL PREREQUISITES - Moderately fractionated intrusions emplaced at 1-2 kb into stratigraphy with thin/rare marble beds.

ASSOCIATED DEPOSIT TYPES - Gold veins and gold placers.

DEPOSIT DESCRIPTION

MINERALOGY - Scheelite (\gg wolframite), molybdenite, pyrite, magnetite, pyrrhotite, chalcopyrite, garnet, pyroxene, hornblende, biotite, calcite.

TEXTURES - Striform $>$ vein.

ALTERATION - Pyroxene-plagioclase "endoskarn" \pm secondary muscovite or biotite in hornfels and intrusion; metamorphic calc-silicates.

GEOCHEMICAL SIGNATURE - W, Mo, Cu, (Sn, Bi, Au, Zn, As, F).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have Pb^{206}/Pb^{204} ca. 18.8 to 19.3.

S ISOTOPE SIGNATURE - Typically 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is designed for areas with minor amounts of carbonate rock in the stratigraphic section.

NOTES FOR DEPOSIT DENSITY MODEL - Prospect abundances are based on number of miles of intrusion-carbonate contact, so consider what fraction of the stratigraphy consists of carbonate rocks.

MODEL 12 TUNGSTEN ± GOLD SKARNS (ABUNDANT CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Scheelite skarns; volcanogenic W.

BRIEF DESCRIPTION - Scheelite-bearing calc-silicate rocks spatially and genetically related to granitic intrusions.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - MacTung, Northwest Territory; Pine Creek, California; Mill City, Tem Piute, Nevada; Salau, France; Tyzny-Auz, U.S.S.R.; King Island, Australia.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - None.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Laznicka, 1985; Einaudi and others, 1981.

V. J. A. K. (1987)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Thick marble beds; granodiorite-granite intrusion.

TEXTURES - Granitic rocks are holocrystalline and porphyritic.

AGES - 90-60 Ma most common, but older examples are known.

SPECIAL PREREQUISITES - Moderately fractionated intrusions emplaced at 1-2 kb into stratigraphy with thick marble beds.

ASSOCIATED DEPOSIT TYPES - Gold veins and gold placers.

DEPOSIT DESCRIPTION

MINERALOGY - Scheelite (>> wolframite), molybdenite, pyrite, magnetite, pyrrhotite, chalcopyrite, garnet, pyroxene, hornblende, biotite, calcite.

TEXTURES - Stratiform > vein.

ALTERATION - Pyroxene-plagioclase "endoskarn" ± secondary muscovite or biotite in hornfels and intrusion; metamorphic calc-silicates.

GEOCHEMICAL SIGNATURE - W, Mo, Cu, (Sn, Bi, Au, Zn, As, F).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have Pb^{206}/Pb^{204} ca. 18.8 to 19.3.

S ISOTOPE SIGNATURE - Typically 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is designed for areas with abundant carbonate rocks in the stratigraphic section.

NOTES FOR DEPOSIT DENSITY MODEL - Prospect abundances based on number of miles of intrusion-carbonate contact.

PROSPECT

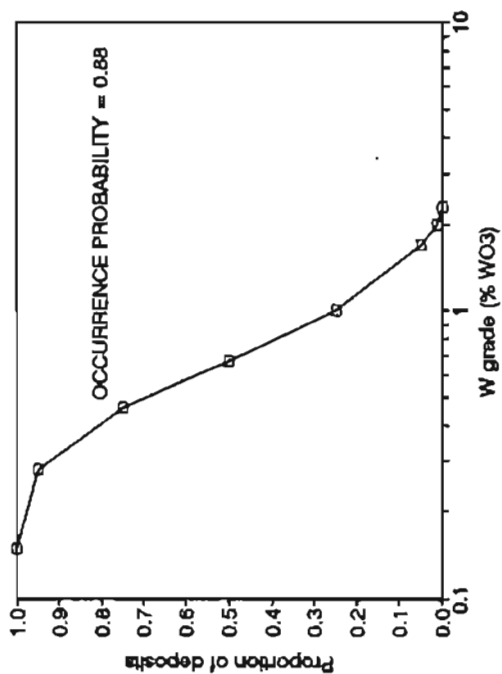
MODEL 11-12: TUNGSTEN-GOLD SKARNS

MODEL 11 (MINOR-CARBONATE)
MODEL 12 (ABUNDANT-CARBONATE)

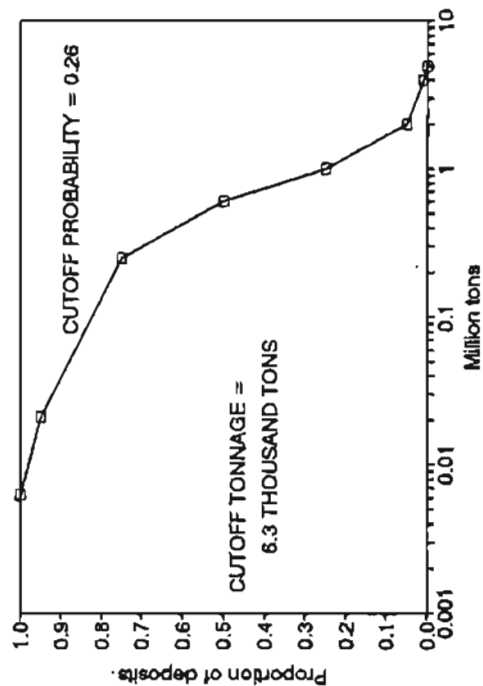
Cutoff tonnage (million tons)
Probability that the prospect makes the cutoff tonnage (Model 11) 0.0063
Probability that the prospect makes the cutoff tonnage (Model 12) 0.26
0.36

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY ALONG 1 LINEAR MILE OF CARBONATE/PLUTON CONTACT								
No. of prospects	1	1	1	2	3	4	5	5
MILLION TONS OF ORE (Model 11)	0.0063	0.021	0.25	0.6	1	2	4	5
MILLION TONS OF ORE (Model 12)	0.0063	0.021	0.28	1.1	5	42	80	90
TUNGSTEN GRADE (% WO ₃)	0.15	0.28	0.46	0.67	1	1.7	2	2.3
Occurrence probability of tungsten	0.88							
GOLD GRADE (OZ/TON)	0.003	0.005	0.008	0.01	0.03	0.05	0.15	0.2
Occurrence probability of gold	0.9							

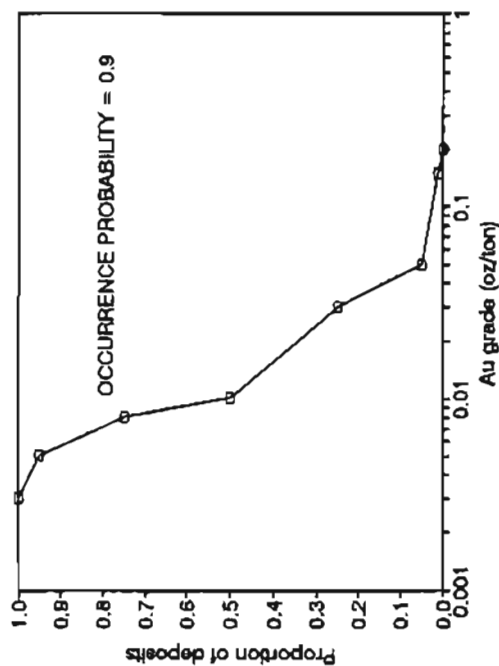
W GRADE - W-AU SKARNS
MODELS 11 AND 12



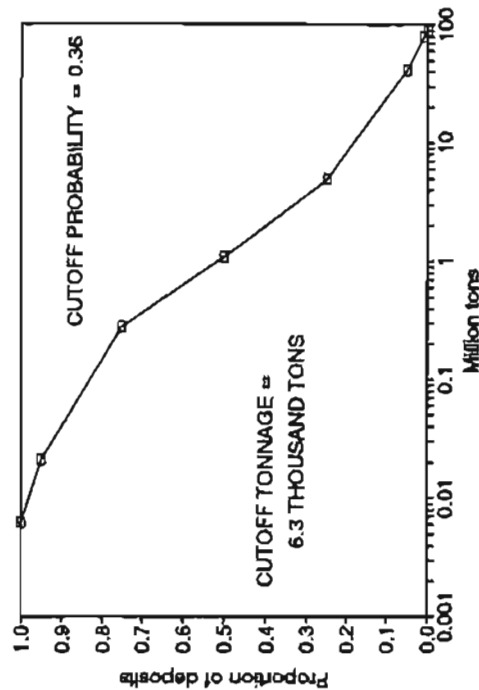
TONNAGE - W-AU SKARNS
MODEL 11 - MINOR CARBONATE

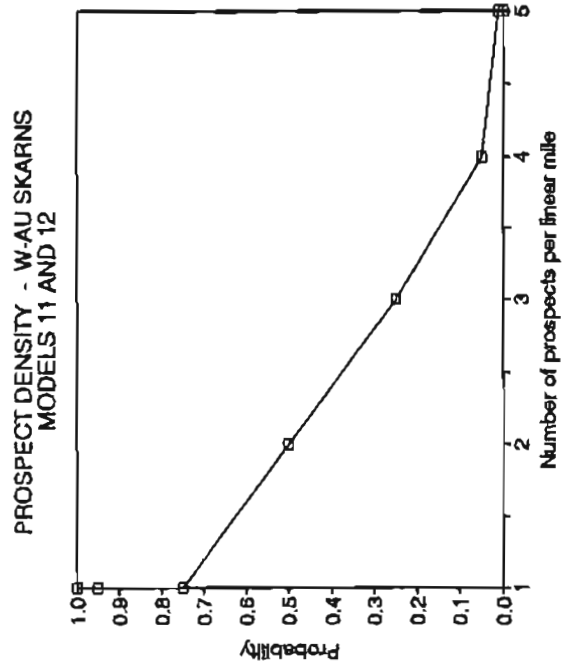


AU GRADE - W-AU SKARNS
MODELS 11 AND 12



TONNAGE - W-AU SKARNS
MODEL 12 - ABUNDANT CARBONATE





MODEL 13 LEAD-ZINC SKARNS (MINOR CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Sphalerite skarns.

BRIEF DESCRIPTION - Sphalerite-galena (silver)-bearing calc-silicate rocks spatially and genetically related to granitic intrusions (rare/thin carbonate beds).

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - South Mountain, Idaho; Chichibu, Japan; Woodlawn, Utah.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Stoneboy Creek, Mount Eielson.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Laznicka, 1985; Einaudi and others, 1981.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Thin/rare marble beds; granodiorite-granite dikes; faults.

TEXTURES - Granitic rocks are commonly porphyritic and dikes.

AGES - <60 Ma most common, but older examples are known.

SPECIAL PREREQUISITES - Abundant faults (high > and/or thrust); plutonic dikes; schist-dominated stratigraphy with thin marble beds.

ASSOCIATED DEPOSIT TYPES - Silver-rich veins; base metal replacements.

DEPOSIT DESCRIPTION

MINERALOGY - Pyrite, sphalerite, galena, magnetite, pyrrhotite, chalcopyrite, garnet, Fe-Mn pyroxene, actinolite, calcite.

TEXTURES - Vein/discordant and stratiform bodies are common.

ALTERATION - Epidote-garnet "endoskarn" ± secondary chlorite, actinolite in hornfels and intrusion.

GEOCHEMICAL SIGNATURE - Zn, Pb, Cu, Mn, Ag (As, F).

Pb ISOTOPE SIGNATURE - Tertiary examples have Pb^{206}/Pb^{204} ca. 18.8 to 19.3.

S ISOTOPE SIGNATURE - Typically 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - Input parameter is designed for areas with minor carbonate rocks in the stratigraphic section.

NOTES FOR DEPOSIT DENSITY MODEL - Input parameter is the number of miles of dike swarm (not individual dikes) and carbonate rock contact.

110 : 50 —

MODEL 14
LEAD-ZINC SKARNS (ABUNDANT CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Sphalerite skarns.

BRIEF DESCRIPTION - Sphalerite-galena (silver)-bearing calc-silicate rocks spatially and genetically related to granitic intrusions (thick/and carbonate beds).

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - El Mochito, Honduras; Ban Ban, Australia; Groundhog, Hannover, New Mexico.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Tin Creek, Jim-Montana, Bowser Creek.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Laznicka, 1985; Einaudi and others, 1981.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Thick marble beds; granodiorite-granite dikes; faults.

TEXTURES - Granitic rocks are commonly porphyritic and dikes.

AGES - <60 Ma most common, but older examples are known.

SPECIAL PREREQUISITES - Abundant faults (high angle and/or thrust); plutonic dikes; stratigraphy with thick marble beds.

ASSOCIATED DEPOSIT TYPES - Silver-rich veins; base metal replacements.

DEPOSIT DESCRIPTION

MINERALOGY - Pyrite, sphalerite, galena, magnetite, pyrrhotite, chalcopyrite, garnet, Fe-Mn pyroxene, actinolite, calcite.

TEXTURES - Vein/discordant and stratiform bodies are common.

ALTERATION - Epidote-garnet "endoskarn" ± secondary chlorite, actinolite in hornfels and intrusion.

GEOCHEMICAL SIGNATURE - Zn, Pb, Cu, Mn, Ag (As, F).

Pb ISOTOPE SIGNATURE - Tertiary examples have Pb^{206}/Pb^{204} ca. 18.8 to 19.3.

S ISOTOPE SIGNATURE - Typically 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is designed for areas with abundant carbonate rocks in the stratigraphic section.

NOTES FOR DEPOSIT DENSITY MODEL - Input parameter is the number of miles of dike swarm (not individual dikes) and carbonate contact.

PROSPECT

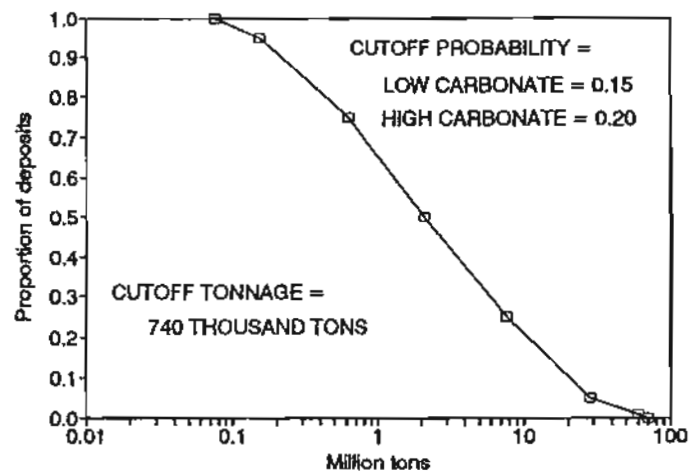
MODEL 13-14: LEAD-ZINC SKARNS

MODEL 13 PB/ZN SKARNS (MINOR CARBONATE)
MODEL 14 PB/ZN SKARNS (ABUNDANT CARBONATE)

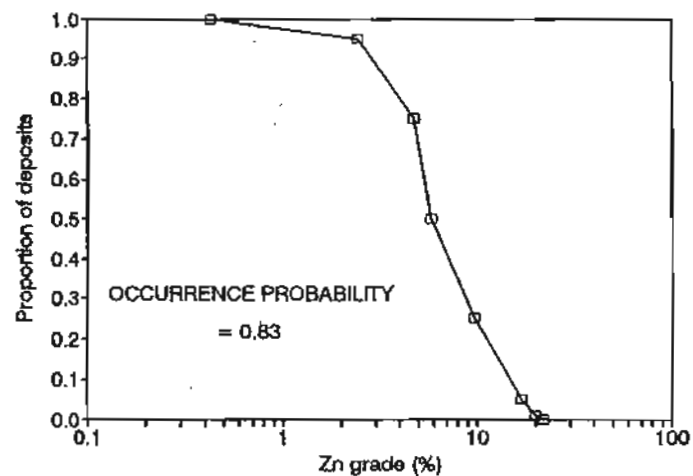
Cutoff tonnage (million tons) 0.074
Probability that the prospect makes the cutoff tonnage (Model 13) 0.15
Probability that the prospect makes the cutoff tonnage (Model 14) 0.2

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY ALONG 1 LINEAR MILE OF CARBONATE/PLUTON CONTACT								
No. of prospects	1	1	1	2	3	4	5	5
MILLION TONS OF ORE	0.074	0.15	0.62	2.1	7.6	28	60	70
ZINC GRADE (%)	0.43	2.4	4.7	5.8	9.72	17	20	22
Occurrence probability of zinc	0.83							
LEAD GRADE (%)	0.01	0.09	0.8	2.6	5	13	16	17
Occurrence probability of lead	1							
COPPER GRADE (%)	0.006	0.01	0.1	0.25	0.5	1.8	1.95	2
Occurrence probability of copper	1							
SILVER GRADE (OZ/TON)	0.064	0.208	1.41	3.4	5.4	17	20	21.8
Occurrence probability of silver	1							
GOLD GRADE (OZ/TON)	0.0009	0.0013	0.0027	0.004	0.007	0.011	0.012	0.013
Occurrence probability of gold	1							

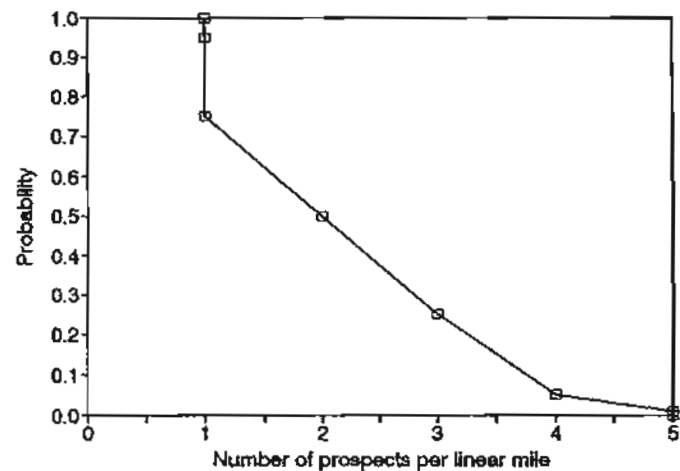
TONNAGE -- LEAD-ZINC SKARN
MODELS 13 AND 14



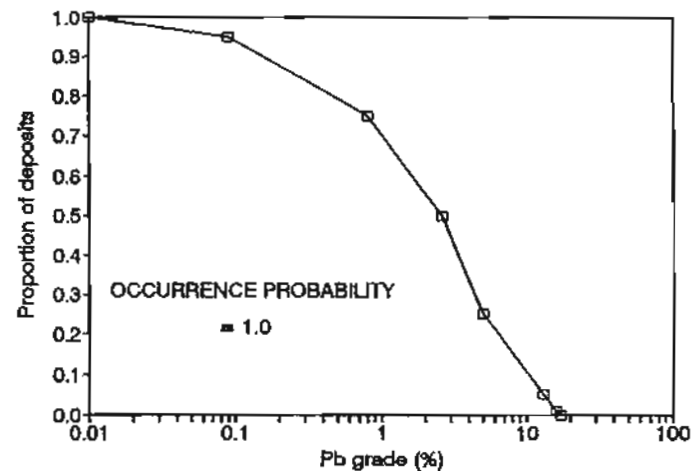
ZN GRADE -- LEAD-ZINC SKARN
MODELS 13 AND 14



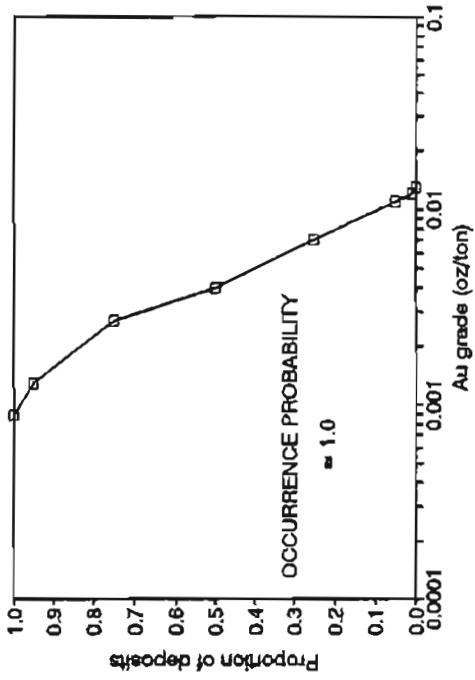
PROSPECT DENSITY -- LEAD-ZINC SKARN
MODELS 13 AND 14



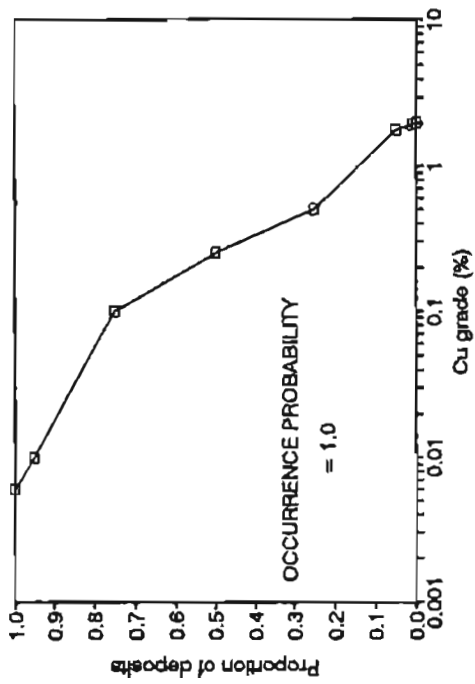
PB GRADE -- LEAD-ZINC SKARN
MODELS 13 AND 14



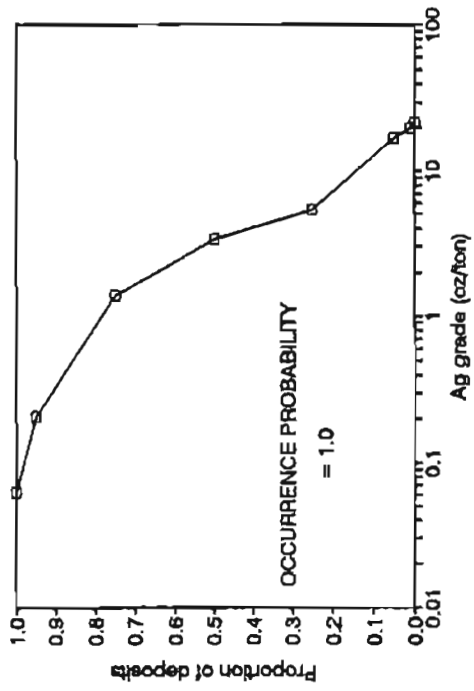
AU GRADE -- LEAD-ZINC SKARN
MODELS 13 AND 14



CU GRADE -- LEAD-ZINC SKARN
MODELS 13 AND 14



AG GRADE -- LEAD-ZINC SKARN
MODELS 13 AND 14



MODEL 21 TIN SKARNS (MINOR CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Tin replacement; exhalative tin.

BRIEF DESCRIPTION - Tin-rich skarn \pm veins and replacement deposits spatially associated with highly-evolved granite.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Seagull Batholith, British Columbia; Dartmoor, England; Mitate, Kuga, Japan.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Groundhog Basin.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Ear Mountain, Alaska.

GENERAL REFERENCES - Einaudi and others (1981); Kwak (1987).

GEOLOGIC ENVIRONMENT

ROCK TYPES - Highly evolved granite; rare/thin carbonate beds.

TEXTURES - Seriate, porphyritic, and equigranular.

AGES - Mostly Phanerozoic.

SPECIAL PREREQUISITES - Rare carbonate rocks in schist-dominant sequence; low-oxidation state, highly evolved, F-rich granite.

ASSOCIATED DEPOSIT TYPES - Sn-rich veins and stockworks.

DEPOSIT DESCRIPTION

MINERALOGY - Cassiterite, muscovite, topaz, scheelite, fluorite, pyrite, sphalerite, andradite, idocrase, tourmaline, chlorite, hornblende.

TEXTURES - Massive, vein, stratiform, disseminated.

ALTERATION - Muscovite-chlorite-fluorite greisen in granite.

GEOCHEMICAL SIGNATURE - Sn, W, F, Be, B, Zn, Rb, Li (Cu, Pb, Ag, Cs).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have $^{206}\text{Pb}/^{204}\text{Pb}$ ca. 18.7 to 19.3.

S ISOTOPE SIGNATURE - Generally 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is for skarns in thin/rare carbonate stratigraphic settings.

NOTES FOR DEPOSIT DENSITY MODEL - Input parameter is the number of miles of granite-carbonate contact; adjust for percentage of carbonate in section.

Model 21

MODEL 22 TIN SKARNS (ABUNDANT CARBONATE)

OTHER NAMES FOR THIS DEPOSIT TYPE - Tin replacement; exhalative tin.

BRIEF DESCRIPTION - Tin-rich skarn \pm veins and replacement deposits spatially associated with highly-evolved granite.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Moina, Rennison-Bell, Tasmania; Dachang, Shizhuayuan, China.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Lost River.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Cape Mountain, Alaska.

GENERAL REFERENCES - Einaudi and others (1981); Kwak (1987).

GEOLOGIC ENVIRONMENT

ROCK TYPES - Highly evolved granite; abundant/thick carbonate beds.

TEXTURES - Seriate, porphyritic, and equigranular.

AGES - Mostly Phanerozoic.

SPECIAL PREREQUISITES - Carbonate rocks; low-oxidation state, highly evolved, F-rich granite.

ASSOCIATED DEPOSIT TYPES - Sn-rich veins and stockworks.

DEPOSIT DESCRIPTION

MINERALOGY - Cassiterite, muscovite, topaz, scheelite, fluorite, pyrite, sphalerite, andradite, idocrase, tourmaline, chlorite, hornblende.

TEXTURES - Massive, vein, stratiform, disseminated, "wriggllite."

ALTERATION - Muscovite-chlorite-fluorite greisen in granite.

GEOCHEMICAL SIGNATURE - Sn, W, F, Be, B, Zn, Rb, Li (Cu, Pb, Ag, Cs).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have $^{206}\text{Pb}/^{204}\text{Pb}$ ca. 18.7 to 19.3.

S ISOTOPE SIGNATURE - Generally 0 ± 5 per mil.

NOTES FOR GRADE/TONNAGE MODELS - This model is for skarns in thick carbonate stratigraphic settings.

NOTES FOR DEPOSIT DENSITY MODEL - Input parameter is the number of miles of granite-carbonate contact.

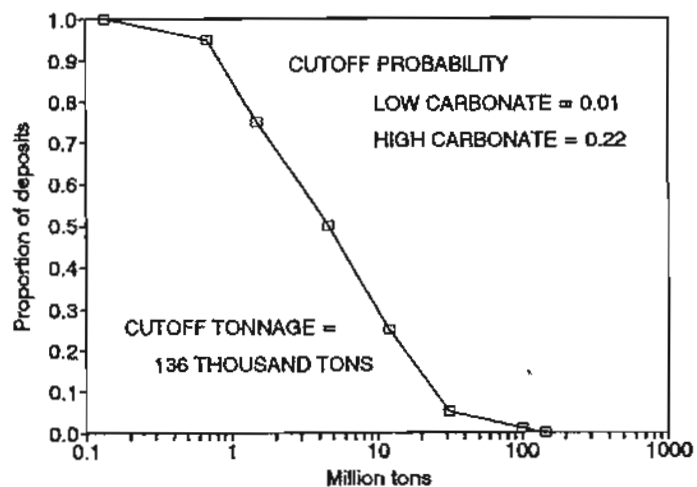
PROJECT

MODEL 21-22: TIN SKARNS

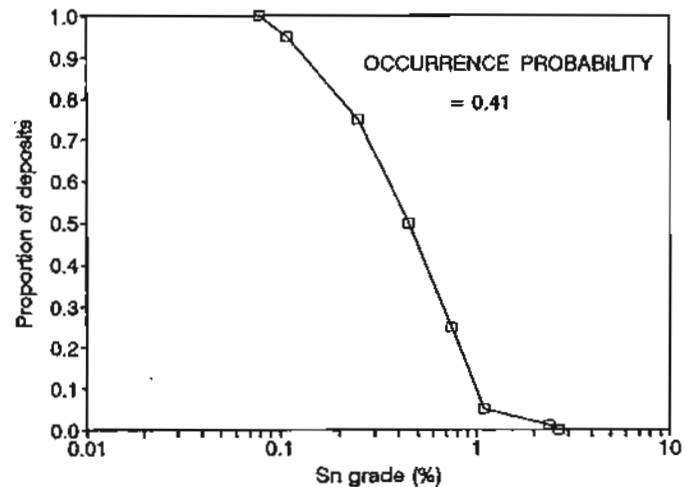
MODEL 21 SN SKARNS (MINOR-CARBONATE)	Cutoff tonnage (million tons)	0.136
MODEL 22 SN SKARNS (ABUNDANT-CARBONATE)	Probability that the prospect makes the cutoff tonnage (Model 21)	0.01
	Probability that the prospect makes the cutoff tonnage (Model 22)	0.22

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY ALONG 1 LINEAR MILE OF CARBONATE/PLUTON CONTACT								
No. of prospects	1	1	1	2	3	4	5	5
MILLION TONS OF ORE	0.136	0.69	1.5	4.6	12	31	100	145
TIN GRADE (%)	0.08	0.11	0.25	0.45	0.75	1.1	2.4	2.7
Occurrence probability of tin	0.41							
SILVER GRADE (OZ/TON)	0.0064	0.0077	0.019	0.091	0.477	4.35	8.5	9.74
Occurrence probability of silver	1							
TUNGSTEN GRADE (% WO ₃)	0.0002	0.0003	0.002	0.005	0.03	0.14	0.45	0.5
Occurrence probability of tungsten	0.7							
LEAD GRADE (%)	0.0005	0.0009	0.005	0.02	0.1	0.7	0.85	0.9
Occurrence probability of lead	0.5							
ZINC GRADE (%)	0.003	0.004	0.032	0.071	0.12	0.63	0.69	0.71
Occurrence probability of zinc	0.5							

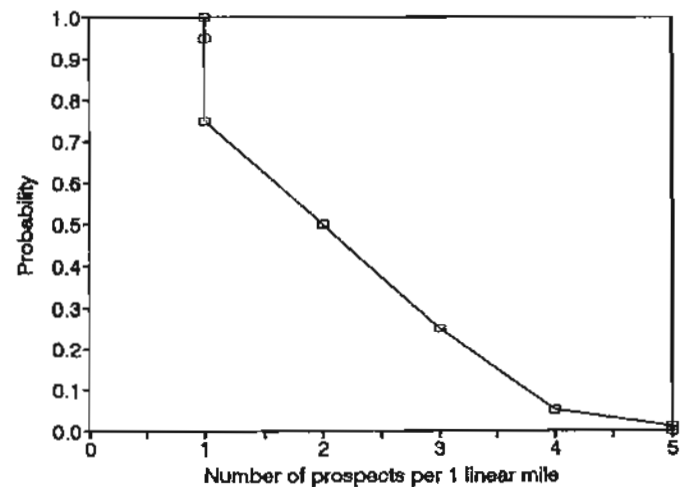
TONNAGE – TIN SKARNS
MODELS 21 AND 22



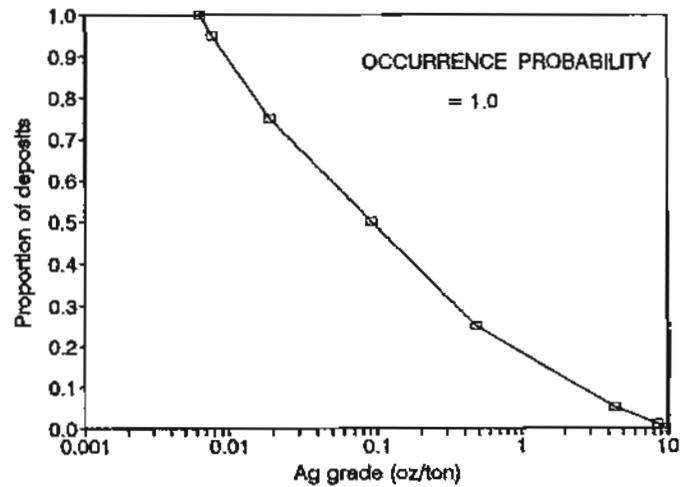
SN GRADE – TIN SKARNS
MODELS 21 AND 22



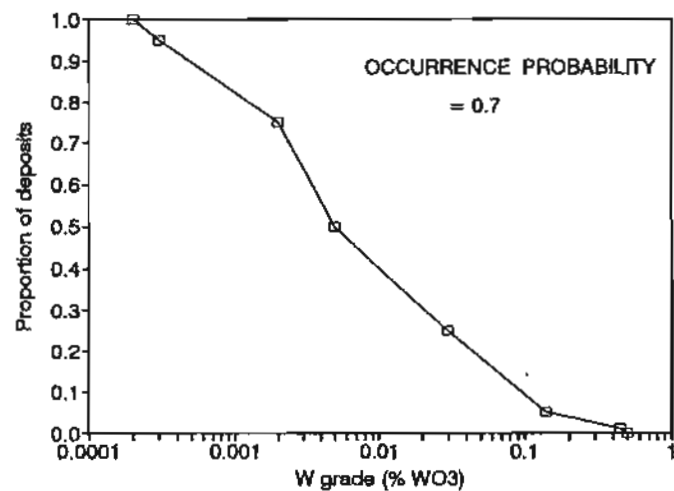
PROSPECT DENSITY – TIN SKARNS
MODELS 21 AND 22



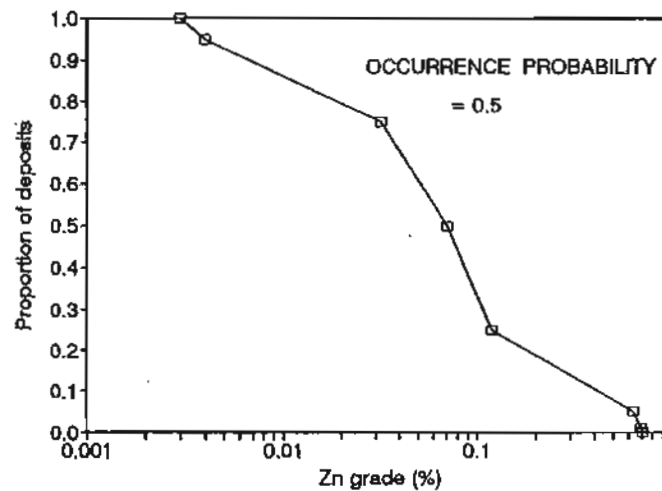
AG GRADE – TIN SKARNS
MODELS 21 AND 22



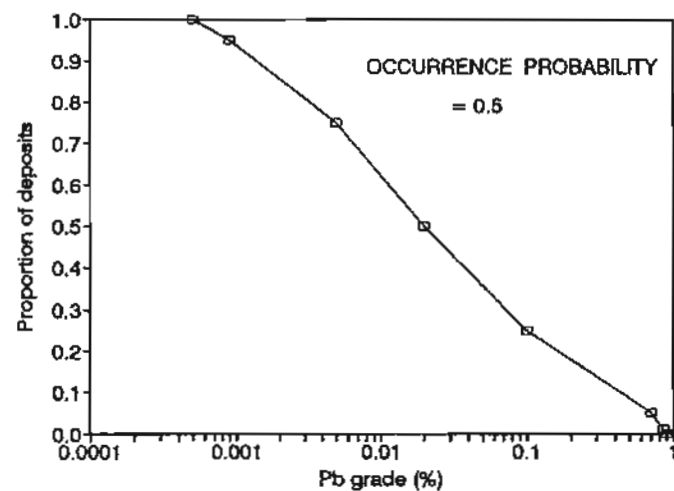
W GRADE -- TIN SKARNS
MODELS 21 AND 22



ZN GRADE -- TIN SKARNS
MODEL 21 AND 22



PB GRADE -- TIN SKARNS
MODELS 21 AND 22



TIN DEPOSITS (BESIDES SKARNS) - MODELS 15, 16, 65, 66, 17, 18, 19, AND 20

MODELS 15 (DISTRICTS) AND 16 (LARGE AREAS) GRANITE TIN GREISENS, PALEOZOIC MODEL

OTHER NAMES FOR THIS DEPOSIT TYPE - Tin greisen.

BRIEF DESCRIPTION - Muscovite \pm topaz \pm tourmaline-altered granite with veins/stockwork of cassiterite-quartz-muscovite \pm wolframite.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Anchor Mine, Australia; Erzebirge, Czechoslovakia; East Kempville, Nova Scotia.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - None.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Laznicka, 1985; Taylor, 1979.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Highly fractionated, Rb-F-rich, reduced granite.

TEXTURES - Seriate, porphyritic, and fine-grained equigranular common.

AGES - Mostly Paleozoic to Precambrian.

SPECIAL PREREQUISITES - Low oxidation state; high F-Cl-fluids; extreme fractionation.

ASSOCIATED DEPOSIT TYPES - Sn skarns, veins, replacements.

DEPOSIT DESCRIPTION

MINERALOGY - Cassiterite, wolframite, pyrite, chalcopyrite, sphalerite, arsenopyrite, quartz, muscovite, topaz, fluorite, chlorite, tourmaline.

TEXTURES - Vein stockwork and breccia pipes.

ALTERATION - Sericite, albite, K-feldspar, chlorite, tourmaline, topaz.

GEOCHEMICAL SIGNATURE - Sn, W, As, Bi, F, Rb, Li, Be, B, Nb, Cs, U, Th, Ta (Cu, Pb, Zn).

Pb ISOTOPE SIGNATURE - Paleozoic examples have $^{206}\text{Pb}/^{204}\text{Pb}$ of 17.5 to 18.5.

S ISOTOPE SIGNATURE - Generally -10 to 5 permil.

NOTES FOR GRADE/TONNAGE MODELS - Paleozoic deposits seem to be larger than Cretaceous-Tertiary deposits.

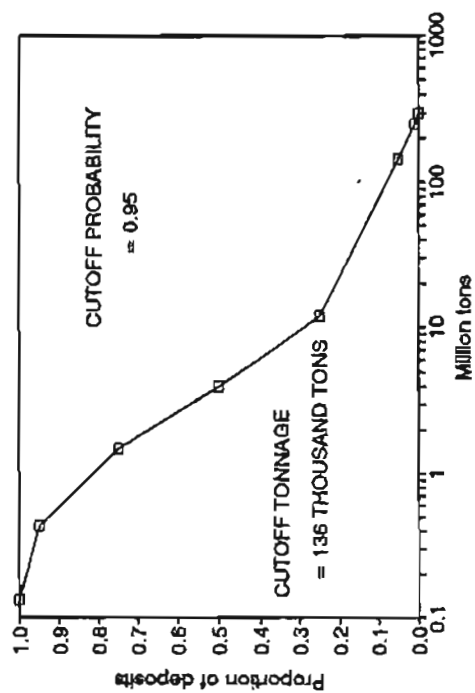
NOTES FOR DEPOSIT-DENSITY MODEL - Based on square miles of "favorable" area, includes a 4 mile radius around favorable plutons; "district" model has a higher deposit density than the "large favorable area" model.

10-25-87

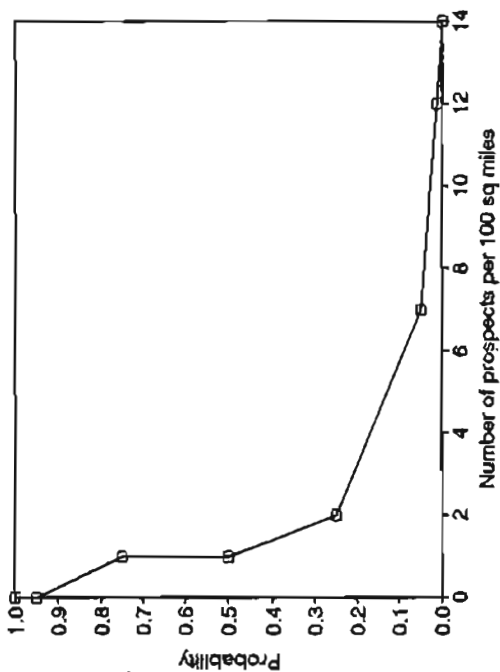
MODEL 15-16: GRANITE TIN GREISENS, PALEOZOIC MODEL

MODEL 15 DISTRICTS MODEL 16 LARGE AREAS	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage										0.136 0.95
	100	95	75	50	25	5	1	0			
PROSPECT DENSITY WITHIN 100 SQ MILE AREA											
MODEL 15:											
No. of prospects	1	2	3	3	3	7	12	14			
MODEL 16:											
No. of prospects	0	0	1	1	2	7	12	14			
MILLION TONS OF ORE	0.136	0.44	1.5	4	12	145	250	300			
TIN GRADE (%)	0.067	0.11	0.23	0.28	0.35	0.52	1	1.2			
Occurrence probability of tin	1										
TANTALUM GRADE (%)	0.005	0.008	0.009	0.015	0.029	0.04	0.044	0.045			
Occurrence probability of tantalum	0.5										
BERYLLIUM GRADE (%)	0.005	0.01	0.015	0.02	0.1	0.3	0.45	0.5			
Occurrence probability of beryllium	0.2										
FLUORINE GRADE (%)	5	7	9	12	17	23	24.5	25			
Occurrence probability of fluorine	0.5										
SILVER GRADE (OZ/TON)	0.024	0.031	0.063	0.156	0.38	0.56	0.6	0.63			
Occurrence probability of silver	0.8										
TUNGSTEN GRADE (% WO ₃)	0.1	0.12	0.17	0.2	0.3	0.4	0.43	0.45			
Occurrence probability of tungsten	0.2										

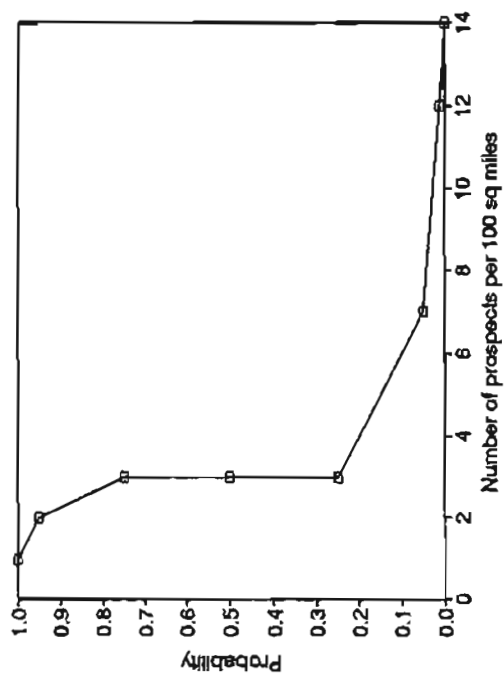
TIN GREISEN PLUTONS-DISTRICTS AND AREAS
TONNAGE - MODELS 15 AND 16



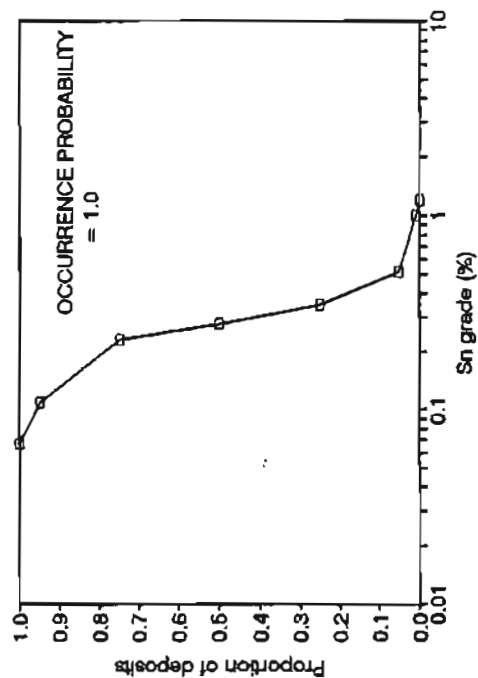
TIN PLUTONS - STRONG SYSTEMS
PROSPECT DENSITY - MODEL 16



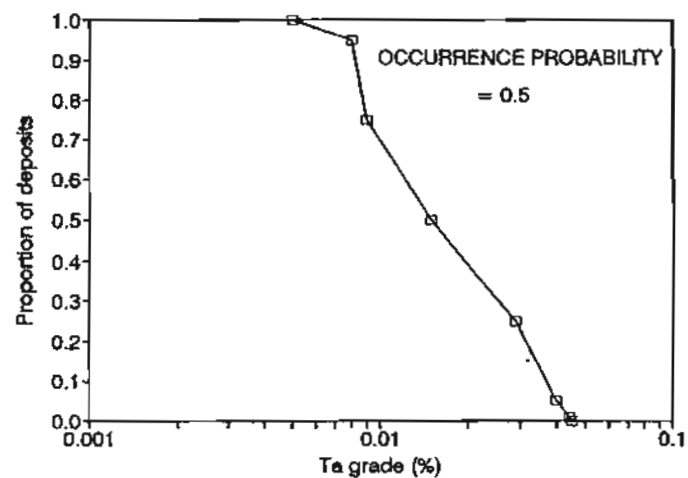
TIN PLUTONS - STRONG SYSTEMS
PROSPECT DENSITY - MODEL 15



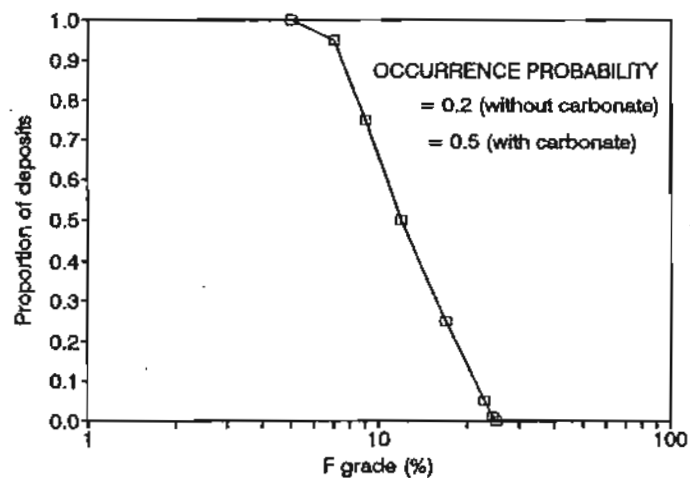
TIN PLUTONS - STRONG SYSTEMS
SN GRADE - MODELS 15 AND 16



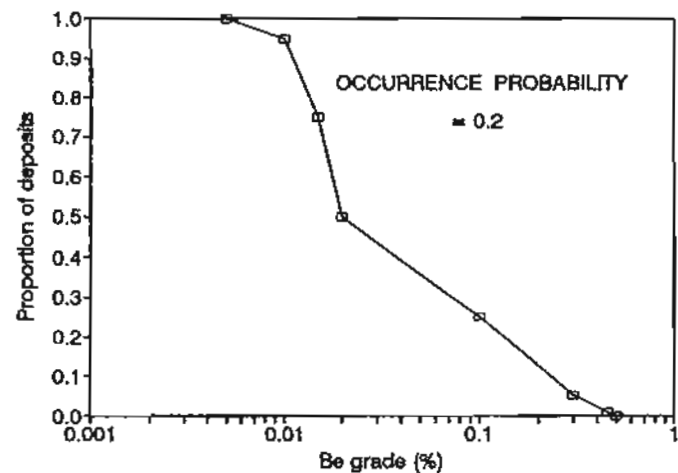
TIN PLUTONS - STRONG SYSTEMS
TA GRADE - MODELS 15 AND 16



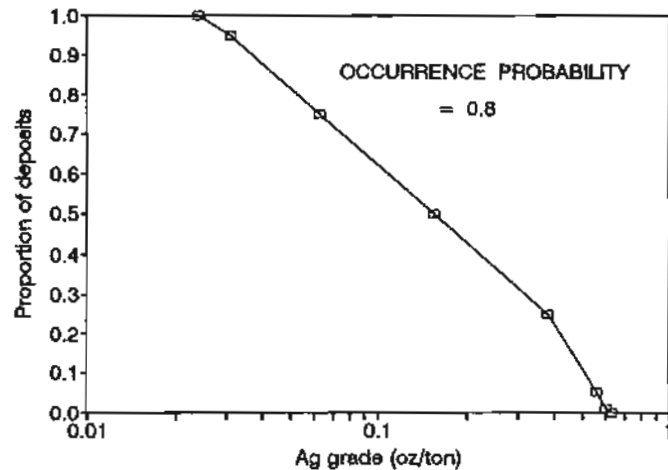
TIN PLUTONS - STRONG SYSTEMS
F GRADE - MODELS 15 AND 16



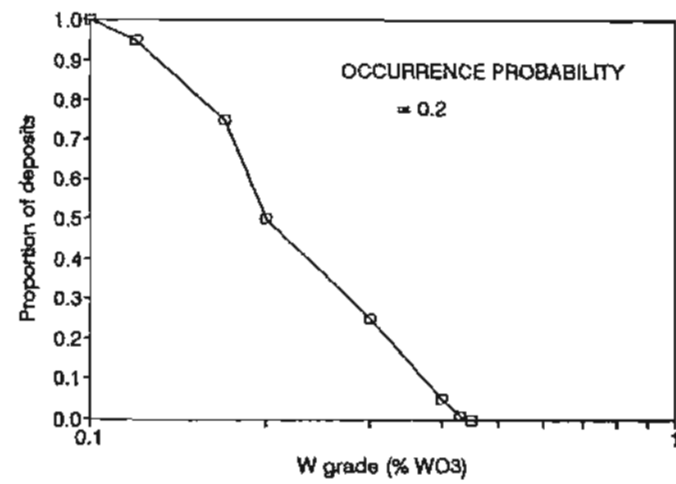
TIN PLUTONS - STRONG SYSTEMS
BE GRADE - MODELS 15 AND 16



TIN GREISEN PLUTONS-DISTRICTS AND AREAS
AG GRADE - MODELS 15 AND 16



TIN PLUTONS - STRONG SYSTEMS
W GRADE - MODELS 15 AND 16



MODELS 65 (DISTRICTS) AND 66 (LARGE AREAS) GRANITE TIN GREISENS, MESOZOIC MODEL

OTHER NAMES FOR THIS DEPOSIT TYPE - Tin greisen.

BRIEF DESCRIPTION - Muscovite \pm topaz \pm tourmaline-altered granite with veins/stockwork of cassiterite-quartz-muscovite \pm wolframite.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Khapcheranga, Kavaleroovo, Russia.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Lost River, Coal Creek, Kougarok.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Ohio Creek, Lime Peak, Alaska.

GENERAL REFERENCES - Laznicka, 1985; Taylor, 1979.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Highly fractionated, Rb-, F-rich, reduced granite.

TEXTURES - Seriate, porphyritic, and fine-grained equigranular common.

AGES - Mesozoic-Tertiary granites; wallrocks are any age.

SPECIAL PREREQUISITES - Low oxidation state; high F-Cl-fluids; extreme fractionation.

ASSOCIATED DEPOSIT TYPES - Sn skarns, veins, replacements.

DEPOSIT DESCRIPTION

MINERALOGY - Cassiterite, wolframite, pyrite, chalcopyrite, sphalerite, arsenopyrite, quartz, muscovite, topaz, fluorite, chlorite, tourmaline.

TEXTURES - Vein stockwork and breccia pipes.

ALTERATION - Sericite, albite, K-feldspar, chlorite, tourmaline, topaz.

GEOCHEMICAL SIGNATURE - Sn, W, As, Bi, F, Rb, Li, Be, B, Nb, Cs, U, Th (Cu, Pb, Zn).

Pb ISOTOPE SIGNATURE - $^{206}\text{Pb}/^{204}\text{Pb} = 18.8$ to 19.5 .

S ISOTOPE SIGNATURE - Generally -10 to 5 permil.

NOTES FOR GRADE/TONNAGE MODELS - Cretaceous-Tertiary deposits seem to be smaller than Paleozoic.

NOTES FOR DEPOSIT DENSITY MODEL - Based on square miles of "favorable" area, includes a 4 mile radius around favorable plutons; "district" model has a higher deposit density than the "large favorable area" model.

RESPECT

MODEL 65-66: GRANITE TIN GREISENS, MESOZOIC MODEL

MODEL 65 DISTRICTS MODEL 66 LARGE AREAS	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage									
	100	95	75	50	25	5	1	0.136	0.5	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA										
MODEL 65: No. of prospects	1	2	3	3	3	7	12	14		
MODEL 66: No. of prospects	0	0	1	1	2	7	12	14		
MILLION TONS OF ORE	0.136	0.44	1.5	4	12	145	250	300		
TIN GRADE (%) Occurrence probability of tin	0.067 0.8	0.11	0.23	0.28	0.35	0.52	1	1.2		
NIOBIUM GRADE (%) Occurrence probability of niobium	0.005 0.5	0.008	0.009	0.015	0.029	0.04	0.044	0.045		
BERYLLIUM GRADE (%) Occurrence probability of beryllium	0.005 0.3	0.01	0.015	0.02	0.1	0.3	0.45	0.5		
FLUORINE GRADE (%) Occurrence probability of fluorine Occurrence probability of fluorine	5 0.05 (without carbonate) 0.2 (with carbonate)	7	9	12	17	23	24.5	25		
SILVER GRADE (OZ/TON) Occurrence probability of silver	0.024 0.7	0.031	0.063	0.156	0.38	0.56	0.6	0.63		

~~(Model 65)~~

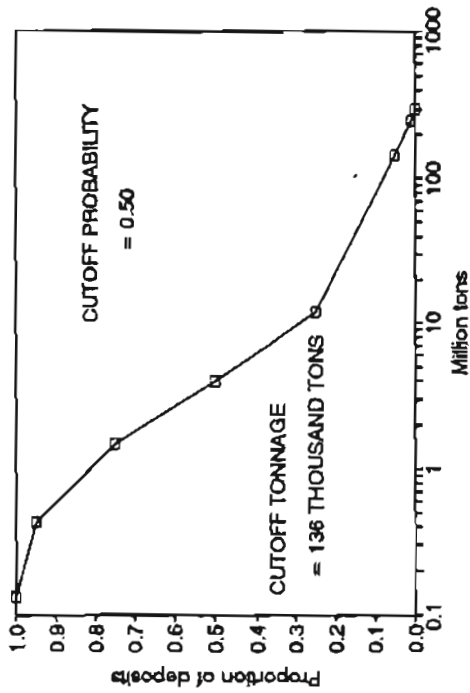
TUNGSTEN GRADE (%WO ₃)	0.11	0.12	0.17	0.2	0.3	0.4	0.43	0.45
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~~(Model 66)~~

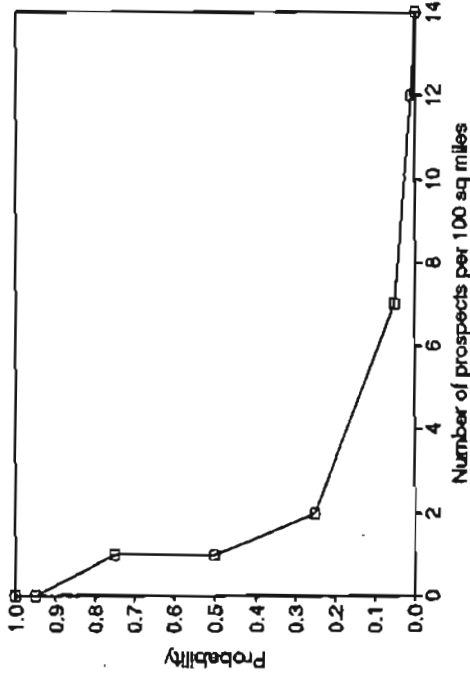
TUNGSTEN GRADE (%WO ₃)	0.112	0.12	0.17	0.2	0.3	0.4	0.43	0.45
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Occurrence probability of tungsten	0.1							
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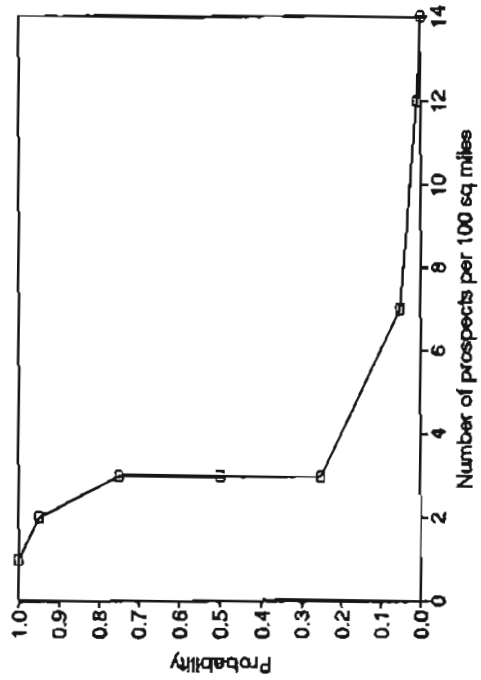
TIN GREISEN PLUTONS-DISTRICTS AND AREAS
TONNAGE - MODELS 65 AND 66



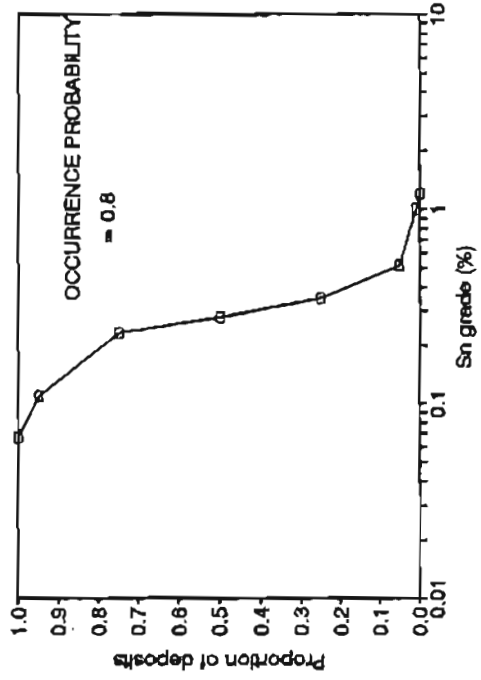
TIN PLUTONS - ALASKAN SYSTEMS
PROSPECT DENSITY - MODEL 66



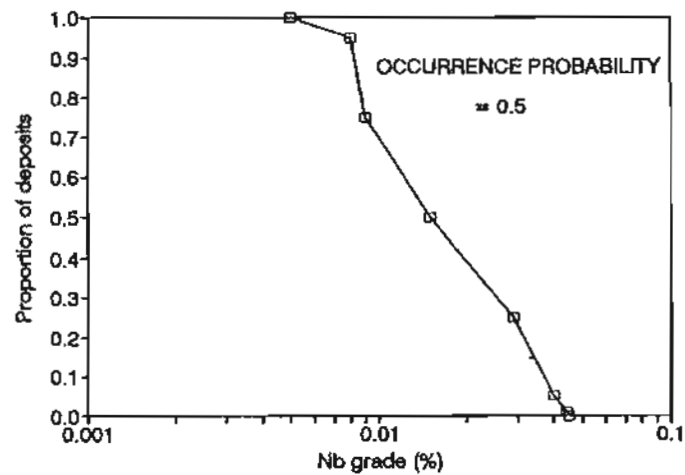
TIN PLUTONS - ALASKAN SYSTEMS
PROSPECT DENSITY - MODEL 65



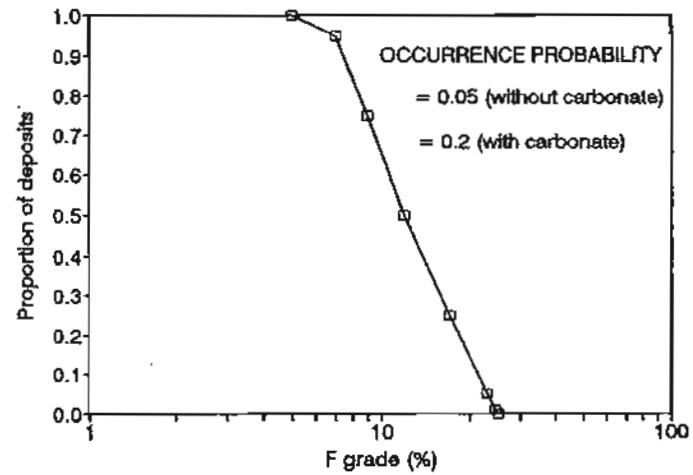
TIN PLUTONS - ALASKAN SYSTEMS
SN GRADE - MODELS 65 AND 66



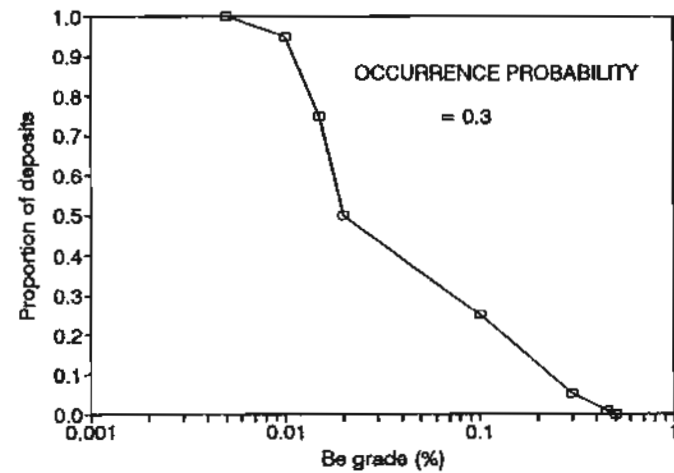
TIN PLUTONS - ALASKAN SYSTEMS
NB GRADE - MODELS 65 AND 66



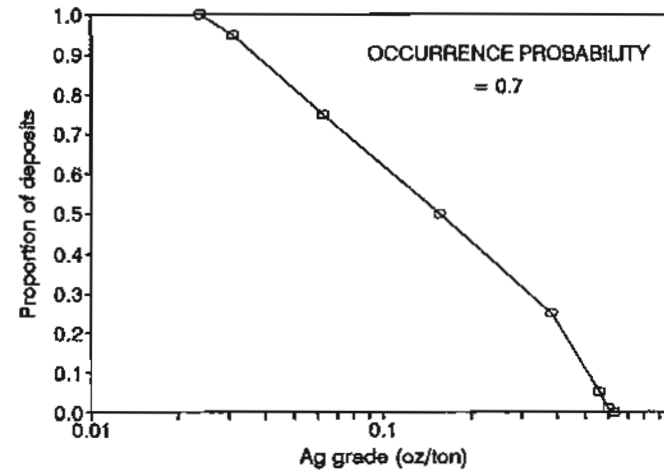
TIN PLUTONS - ALASKAN SYSTEMS
F GRADE - MODELS 65 AND 66



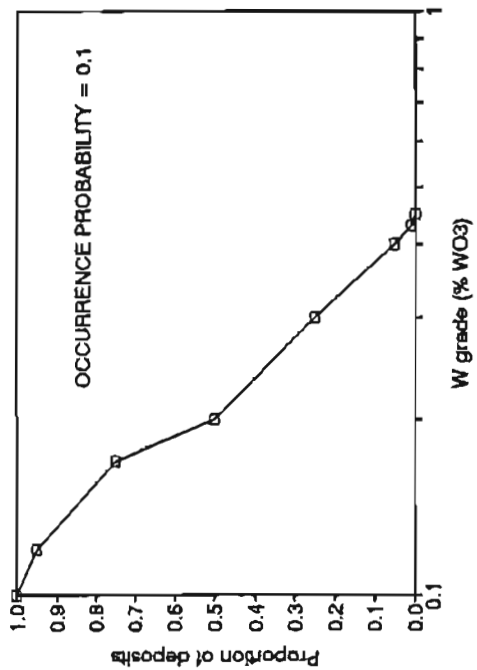
TIN PLUTONS - ALASKAN SYSTEMS
BE GRADE - MODELS 65 AND 66



TIN PLUTONS - ALASKAN SYSTEMS
AG GRADE - MODELS 65 AND 66



TIN PLUTONS - ALASKAN SYSTEMS
W GRADE - MODELS 65 AND 66



MODELS 17 (DISTRICTS) AND 18 (LARGE AREAS) SUBVOLCANIC TIN GREISENS

OTHER NAMES FOR THIS DEPOSIT TYPE - Porphyry tin.

BRIEF DESCRIPTION - Muscovite \pm tourmaline \pm topaz - altered rhyolite porphyry with veins/stockwork of cassiterite-quartz-muscovite \pm wolframite.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Potosi, Choirelque, Oruro, Tatasi, Bolivia; Mount Pleasant, New Brunswick.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Win. Won (Cloudy Mountains).

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Laznicka, 1985; Taylor, 1979; Grant and others (1980).

GEOLOGIC ENVIRONMENT

ROCK TYPES - Rhyolitic volcanics and related rhyolite porphyry stocks.

TEXTURES - Extremely altered quartz porphyry.

AGES - Mesozoic-Tertiary are most common.

SPECIAL PREREQUISITES - Low oxidation state?; high F-Cl-fluids; extreme fractionation?

ASSOCIATED DEPOSIT TYPES - Sn veins, replacements.

DEPOSIT DESCRIPTION

MINERALOGY - Cassiterite, pyrite, chalcopyrite, sphalerite, stannite, arsenopyrite, quartz, muscovite, topaz, fluorite, chlorite, tourmaline.

TEXTURES - Vein stockwork and breccia pipes.

ALTERATION - Sericite, chlorite, tourmaline.

GEOCHEMICAL SIGNATURE - Sn, As, B, Ag, U (Cu, Pb, Zn, Sb).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have $^{206}\text{Pb}/^{204}\text{Pb} = 18.8$ to 19.5.

S ISOTOPE SIGNATURE - ?

NOTES FOR GRADE/TONNAGE MODELS - It is unclear why some are richer in silver than others.

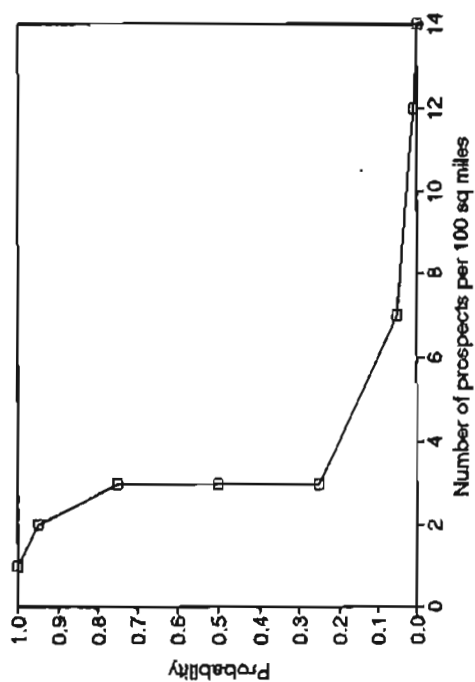
NOTES FOR DEPOSIT DENSITY MODEL - Based on square miles of "favorable" area, including favorable volcanic rocks (covering? stocks); "district" model has a higher deposit density than the "large favorable area" model.

PROJECT

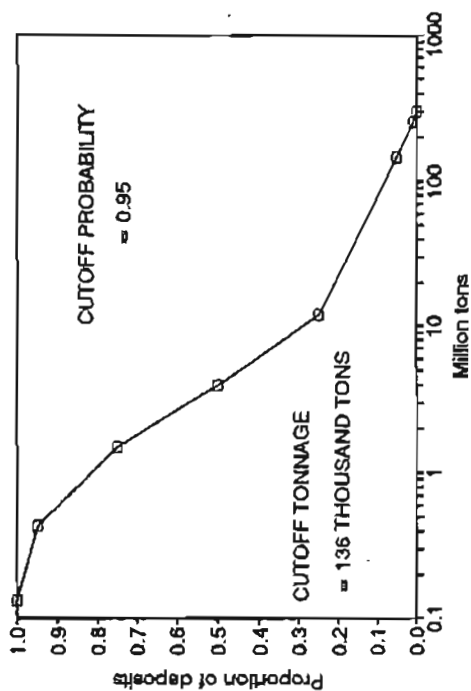
MODEL 17-18: SUBVOLCANIC TIN GREISEN

MODEL 17 DISTRICTS MODEL 18 LARGE AREAS	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							0.136 0.95
	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
MODEL 17:								
No. of prospects	1	2	3	3	3	7	12	14
MODEL 18:								
No. of prospects	0	0	1	1	2	7	12	14
MILLION TONS OF ORE	0.136	0.44	1.5	4	12	145	250	300
TIN GRADE (%) Occurrence probability of tin	0.067 1	0.11	0.23	0.28	0.35	0.52	1	1.2
TANTALUM GRADE (%) Occurrence probability of tantalum	0.005 0.5	0.008	0.009	0.015	0.029	0.04	0.044	0.045
BERYLLIUM GRADE (%) Occurrence probability of beryllium	0.005 0.2	0.01	0.015	0.02	0.1	0.3	0.45	0.5
FLUORINE GRADE (%) Occurrence probability of fluorine	5 0.5	7	9	12	17	23	24.5	25
SILVER GRADE (OZ/TON) Occurrence probability of silver	5 0.7	7	20	70	130	180	650	720
TUNGSTEN GRADE (% WO ₃) Occurrence probability of tungsten	0.1 0.5	0.12	0.17	0.2	0.3	0.4	0.43	0.45

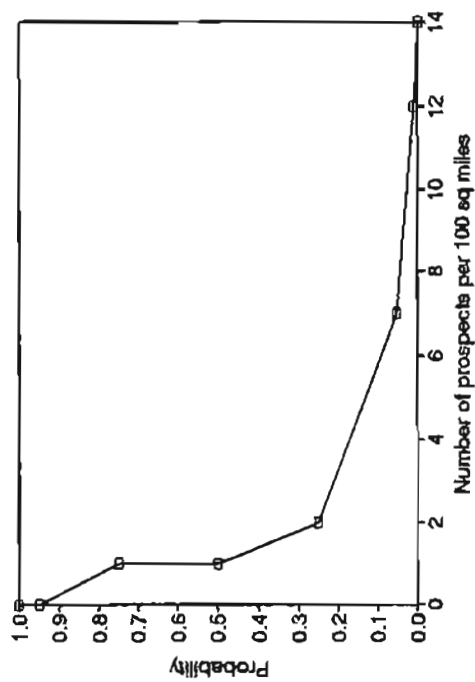
PROSPECT DENSITY - VOLCANIC TIN SYSTEMS
MODEL 17



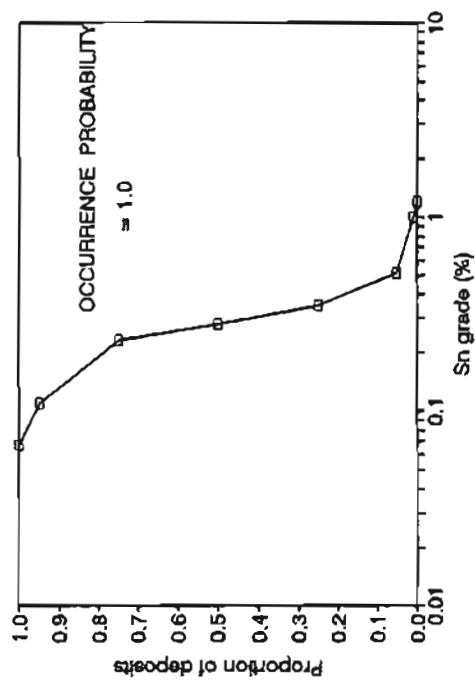
TONNAGE - VOLCANIC TIN SYSTEMS
MODELS 17 AND 18



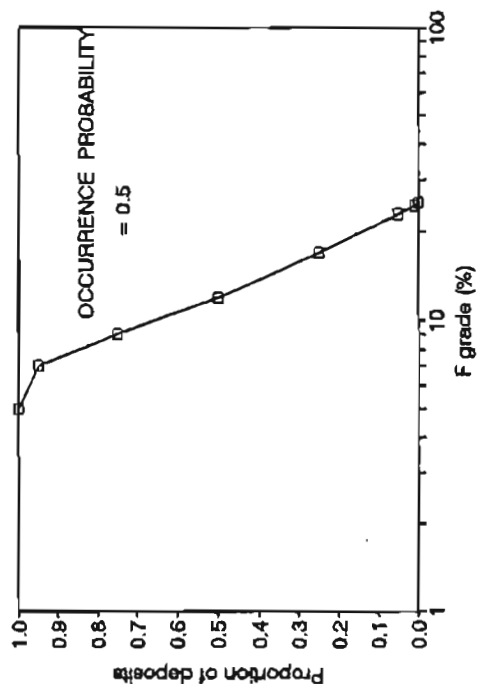
PROSPECT DENSITY - VOLCANIC TIN SYSTEMS
MODEL 18



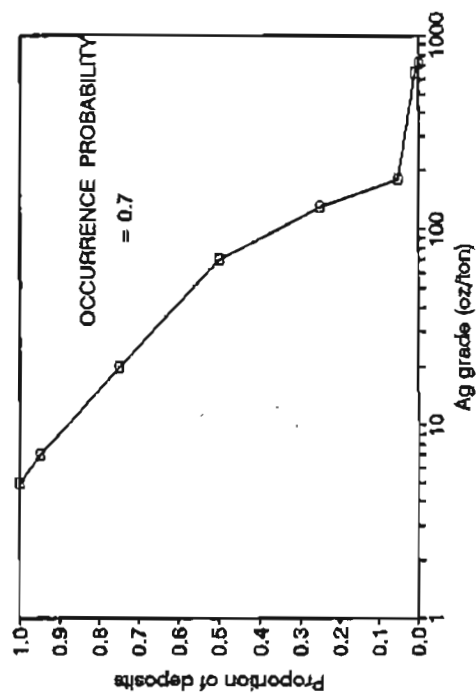
SN GRADE - VOLCANIC TIN SYSTEMS
MODELS 17 AND 18



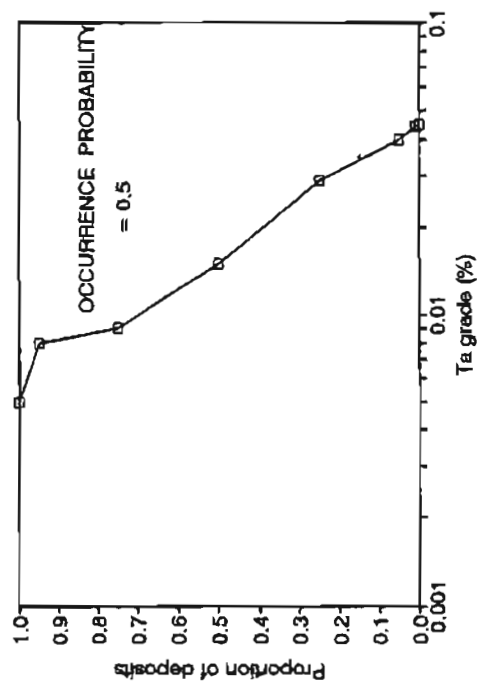
F GRADE -- VOLCANIC TIN SYSTEMS
MODELS 17 AND 18



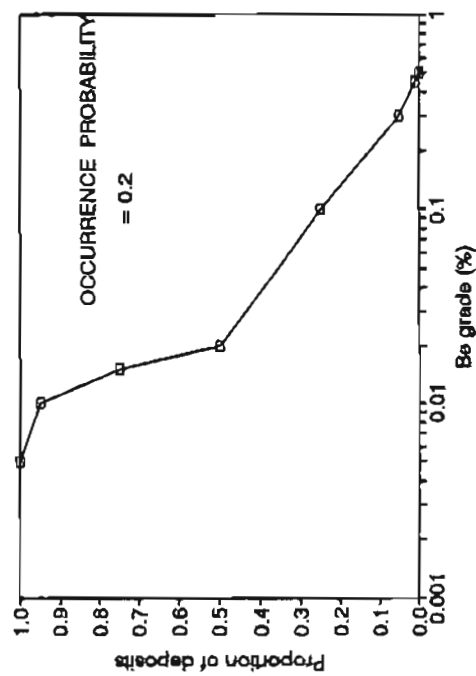
AG GRADE -- VOLCANIC TIN SYSTEMS
MODELS 17 AND 18



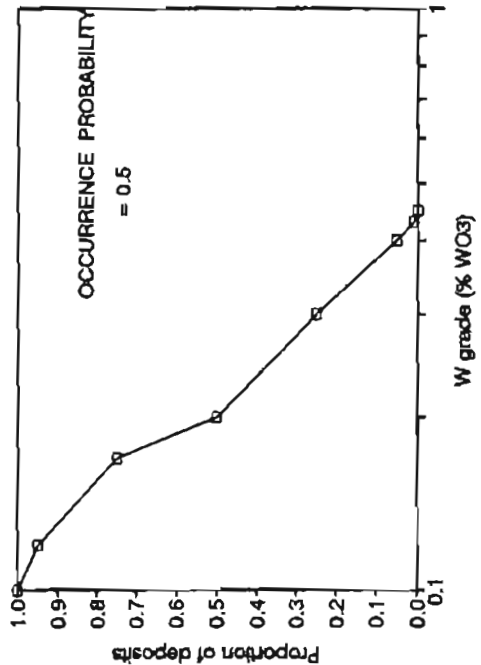
TA GRADE -- VOLCANIC TIN SYSTEMS
MODELS 17 AND 18



BE GRADE -- VOLCANIC TIN SYSTEMS
MODELS 17 AND 18



W GRADE - VOLCANIC TIN SYSTEMS
MODELS 17 AND 18



37
46

MODELS 19 (DISTRICTS) AND 20 (LARGE AREAS) GRANITE TIN VEINS

OTHER NAMES FOR THIS DEPOSIT TYPE - Cornish tin lodes; polymetallic veins.

BRIEF DESCRIPTION - Through-going quartz-cassiterite-wolframite-sulfide veins in or near granite.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Cornwall, England; Herberton, Australia; Krupka, Czechoslovakia; Pahang, Malay.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE -

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Ready Cash, Potato Mountain, Groundhog Basin.

GENERAL REFERENCES - Laznicka, 1985; Taylor, 1979.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Highly fractionated F-Rb-rich granite; schist.

TEXTURES - Seriate, porphyritic, and equigranular.

AGES - Phanerozoic are most common.

SPECIAL PREREQUISITES - Low oxidation state?; high F-Cl-fluids; extreme fractionation?, high sulfidation state?; major structures?

ASSOCIATED DEPOSIT TYPES - Sn replacements, skarns, greisens.

DEPOSIT DESCRIPTION

MINERALOGY - Cassiterite, pyrite, chalcopyrite, sphalerite, stannite, arsenopyrite, quartz, muscovite, topaz, fluorite, chlorite, tourmaline.

TEXTURES - Large, multiple stage veins.

ALTERATION - Sericite, chlorite, silicification, tourmaline, hematite.

GEOCHEMICAL SIGNATURE - Sn, As, B, F, W, Cu, Zn (U, Rb, Li, Mo, Nb).

Pb ISOTOPE SIGNATURE - Cretaceous-Tertiary examples have $^{206}\text{Pb}/^{204}\text{Pb} = 18.8$ to 19.5 ; Paleozoic examples have $^{206}\text{Pb}/^{204}\text{Pb} = 17.5$ - 18.5 .

S ISOTOPE SIGNATURE - Generally -10 to +5 permil.

NOTES FOR GRADE/TONNAGE MODELS - Deposit definition based on historic mining.

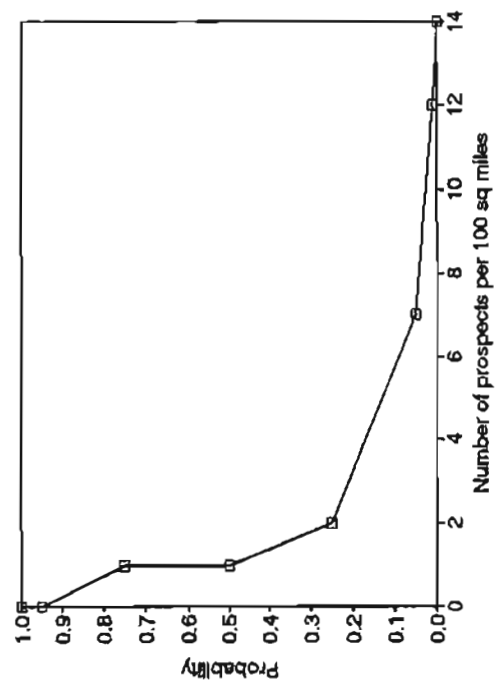
NOTES FOR DEPOSIT DENSITY MODEL - Based on square miles of "favorable" area, including a 4 mile radius around favorable plutons; "district" model has a higher deposit density than the "large favorable area" model.

district

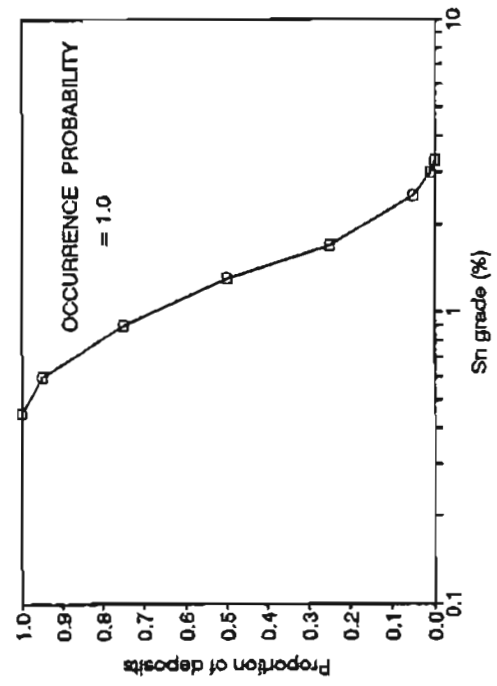
MODEL 19-20: GRANITE TIN VEINS

MODEL 19 DISTRICT MODEL 20 LARGE AREA	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							0.001 0.7
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
MODEL 19:								
No. of prospects	1	2	3	3	3	7	12	14
MODEL 20:								
No. of prospects	0	0	1	1	2	7	12	14
MILLION TONS OF ORE	0.001	0.007	0.03	0.24	1	5	12	13
TIN GRADE (%)	0.45	0.6	0.9	1.3	1.7	2.5	3	3.3
Occurrence probability of tin	1							
TUNGSTEN GRADE (% WO ₃)	0.32	0.4	0.72	0.9	1.2	1.5	1.6	1.8
Occurrence probability of tungsten	0.3							
COPPER GRADE (%)	0.1	0.12	0.18	0.32	0.58	1.5	2	2.7
Occurrence probability of copper	0.1							
SILVER GRADE (OZ/TON)	1	2	3	6	10	13.5	14.4	15
Occurrence probability of silver	0.9							
NIOBIUM GRADE (%)	0.005	0.008	0.01	0.05	0.1	0.2	0.3	0.4
Occurrence probability of niobium	0.5							

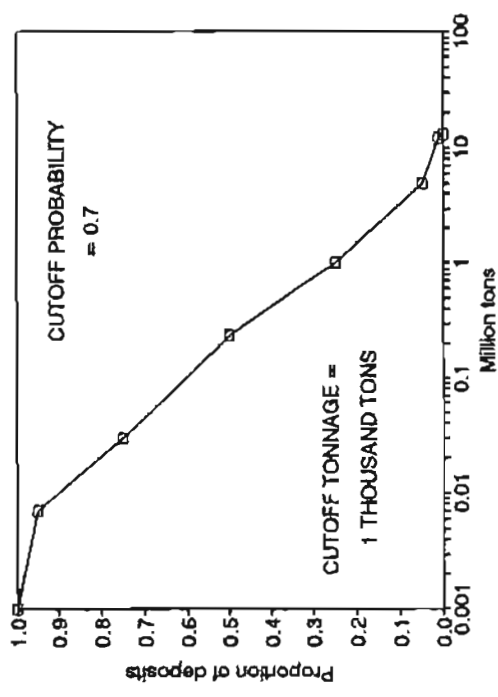
PROSPECT DENSITY -- TIN VEINS
MODEL 20, LARGE AREAS



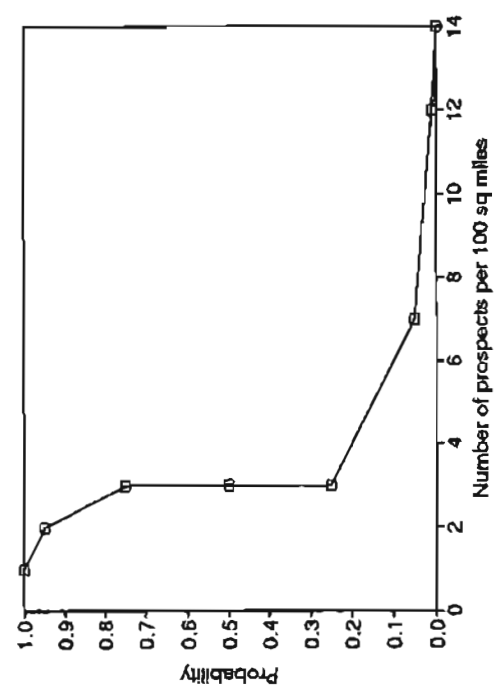
SN GRADE -- TIN VEINS
MODELS 19 AND 20, DISTRICTS AND AREAS



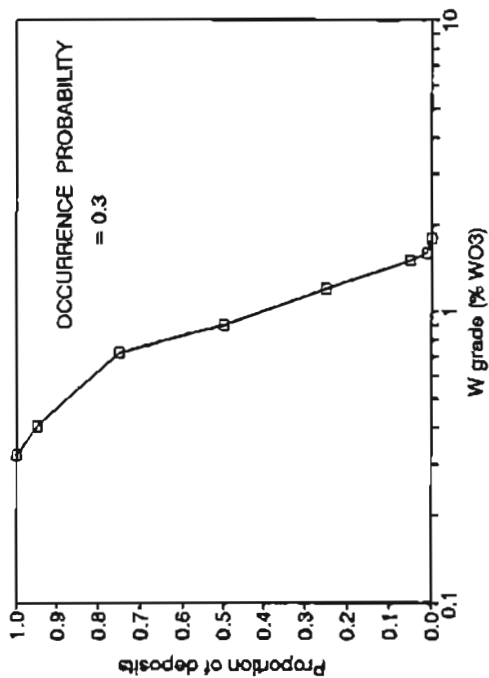
TONNAGE -- TIN VEINS
MODELS 19 AND 20, DISTRICTS AND AREAS



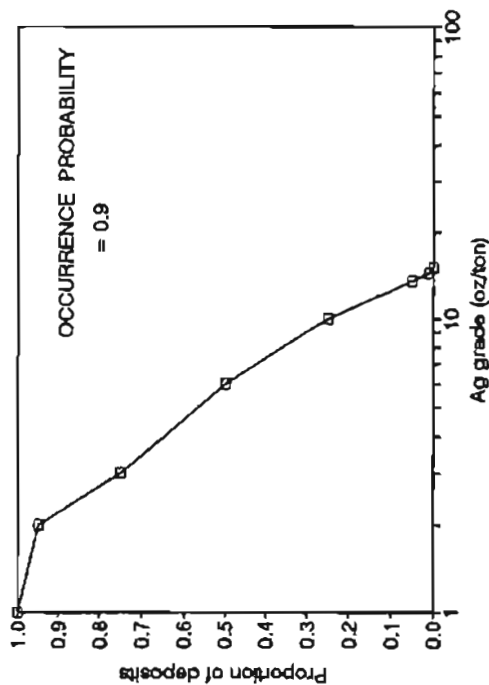
PROSPECT DENSITY -- TIN VEINS
MODEL 19, DISTRICTS



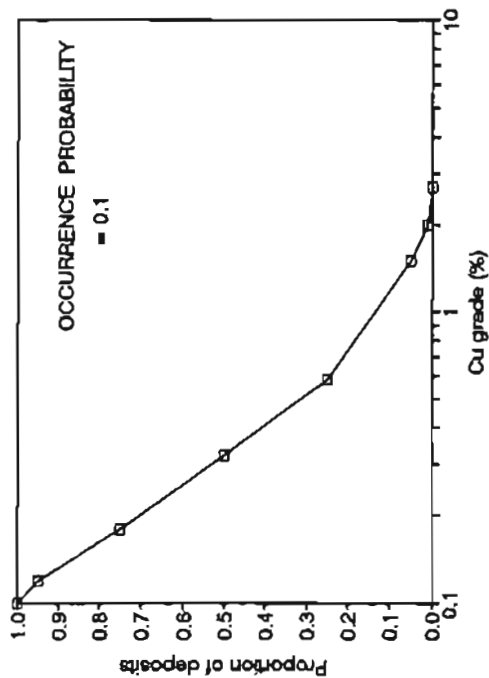
W GRADE -- TIN VEINS
MODELS 19 AND 20, DISTRICTS AND AREAS



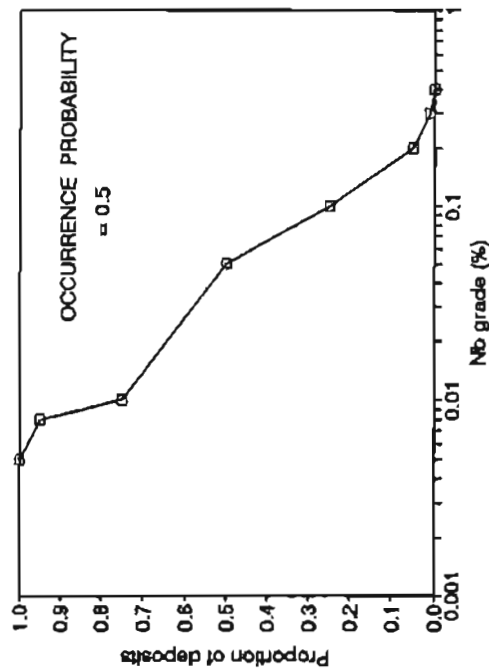
AG GRADE -- TIN VEINS
MODELS 19 AND 20, DISTRICTS AND AREAS



CU GRADE -- TIN VEINS
MODELS 19 AND 20, DISTRICTS AND AREAS



NB GRADE -- TIN VEINS
MODELS 19 AND 20, DISTRICTS AND AREAS



PORPHYRY DEPOSITS - MODELS 44, 68, 45, AND 46

MODEL 44 PORPHYRY COPPER—SOUTH AMERICAN MODEL (HUGE, OXIDIZED)

OTHER NAMES FOR THIS DEPOSIT TYPE - Large porphyry Cu

BRIEF DESCRIPTION - Quartz-pyrite-chalcopyrite vein/veinlet stockwork in altered porphyritic granodiorite-granite and adjacent country rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - El Salvador, Chuquicamata, El Abra, Rio Blanco, Mocha, Braden, Chile; Toquepala, Quellaveco, Cuajone, Santa Rosa, Peru; El Pachon, Argentina; Cananea, La Caridad, Mexico; Cerro Colorado, Panama

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - None presently known?

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Oxidized, calc-alkalic diorite to monzogranite

TEXTURES - Porphyry, porphyritic, and aplitic

AGES - Mesozoic and Tertiary

SPECIAL PREREQUISITES - High oxidation state; low to moderate fractionation; intrusion at about 1-2 km below surface

ASSOCIATED DEPOSIT TYPES - Cu skarns; placer Au

DEPOSIT DESCRIPTION

MINERALOGY - Chalcopyrite, pyrite, chalcocite, molybdenite, biotite, quartz, Cretaceous-feldspar, anhydrite, sericite, clays

TEXTURES - Vein/veinlet stockwork

ALTERATION - Cretaceous-feldspar \pm biotite; propylitic; sericitic

GEOCHEMICAL SIGNATURE - Cu, Mo, Ag, Au (Zn, Pb, Mn, Te, Ba)

Pb ISOTOPE SIGNATURE - $^{206}\text{Pb}/^{204}\text{Pb}$ typically 18.8 to 19.3

S ISOTOPE SIGNATURE - Generally -5 to +5 permil

NOTES FOR GRADE/TONNAGE MODELS - This deposit model is built around the deposits of South and Central America, which are characteristically larger than deposits in North America and most other districts in the world. It represents the "maximum possible" metal potential from a porphyry Cu prospect.

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" area, that is, porphyry-textured granitic rocks, including a 1 mile radius around favorable plutons and areas thought to be underlain by favorable plutons.

MODEL 68 PORPHYRY COPPER-MOLYBDENUM, MODERATE-SIZED, OXIDIZED

OTHER NAMES FOR THIS DEPOSIT TYPE - Porphyry Cu-Mo

BRIEF DESCRIPTION - Quartz-pyrite-chalcopyrite vein/veinlet stockwork in altered porphyritic granodiorite-granite and adjacent country rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Casino, Yukon; Highland Valley, British Columbia; Ely, Yerington, Nevada; Ajo, San Manuel, Ray, Esperanza, Arizona; Tyrone, Inspiration, New Mexico; Gaspé, Quebec

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Orange Hill, Bond Creek, Taurus, Pyramid, Bee Creek, Baultoff

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Ivanof, Mallard Duck Bay, Rex

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Oxidized, calc-alkalic diorite to monzogranite

TEXTURES - Porphyry, porphyritic, and aplitic

AGES - Mesozoic and Tertiary most common, older examples known

SPECIAL PREREQUISITES - High oxidation state; low to moderate fractionation; intrusion at about 1-3 km below surface

ASSOCIATED DEPOSIT TYPES - Cu skarns

DEPOSIT DESCRIPTION

MINERALOGY - Chalcopyrite, pyrite, chalcocite, molybdenite, biotite, quartz, K-feldspar, anhydrite, sericite, clays

TEXTURES - Vein/veinlet stockwork

ALTERATION - Cretaceous-feldspar \pm biotite; propylitic; sericitic

GEOCHEMICAL SIGNATURE - Cu, Mo, Ag (Zn, Pb, Mn, Ba)

Pb ISOTOPE SIGNATURE - $^{206}\text{Pb}/^{204}\text{Pb}$ typically 18.8 to 19.3

S ISOTOPE SIGNATURE - Generally -5 to +5 permil

NOTES FOR GRADE/TONNAGE MODELS - This deposit model is built around the deposits outside of South and Central America. It represents the "most likely" metal potential for a porphyry Cu prospect in Alaska.

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" area, that is, porphyry-textured granitic rocks, including a 1 mile radius around favorable plutons and areas thought to be underlain by favorable plutons.

MODEL 44-68: PORPHYRY COPPER/PORPHYRY COPPER-MOLYBDENUM

MODEL 44 HUGE OX, CALC-ALK

MODEL 68 OX, CALC-ALK, ALASKAN-SIZED

Cutoff tonnage (million tons) (Model 44)

20

Cutoff tonnage (million tons) (Model 68)

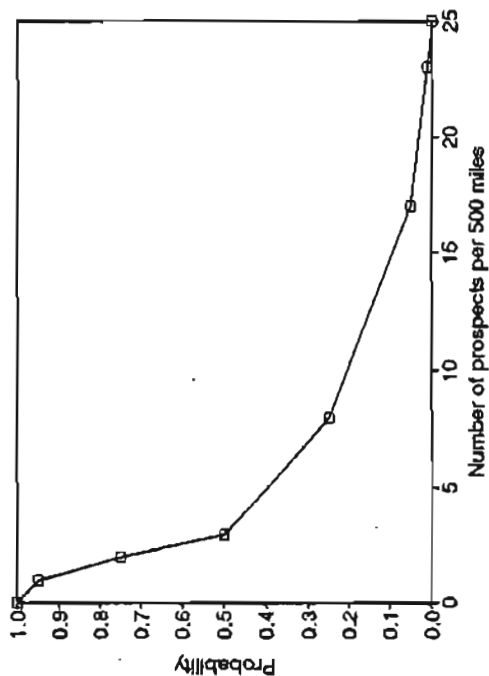
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Probability that the prospect makes the cutoff tonnage

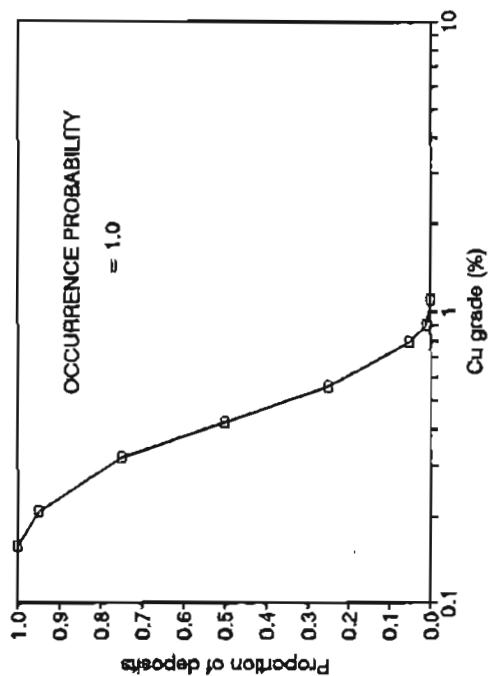
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PROBABILITY	100	95	75	50	25	5	1	0
(MODEL 44 and 68) PROSPECT DENSITY WITHIN 500 SQ MILE AREA								
No. of prospects	0	1	2	3	8	17	23	25
MILLION TONS OF ORE (Model 44) 20		80	250	500	1200	2000	4000	5000
MILLION TONS OF ORE (Model 68) 10		50	150	250	300	500	750	1000
COPPER GRADE (%)	0.16	0.21	0.32	0.42	0.56	0.79	0.9	1.1
Occurrence probability of copper	1							
MOLYBDENUM GRADE (%)	0.0028	0.0056	0.011	0.016	0.022	0.04	0.05	0.065
Occurrence probability of molybdenum	1							
GOLD GRADE (OZ/TON)	0.0001	0.00012	0.0002	0.0004	0.0008	0.0015	0.002	0.0024
Occurrence probability of gold	1 (Model 44)							
Occurrence probability of gold	0.3 (Model 68)							
SILVER GRADE (OZ/TON)	0.003	0.0076	0.019	0.036	0.067	0.16	0.21	0.27
Occurrence probability of silver	1							

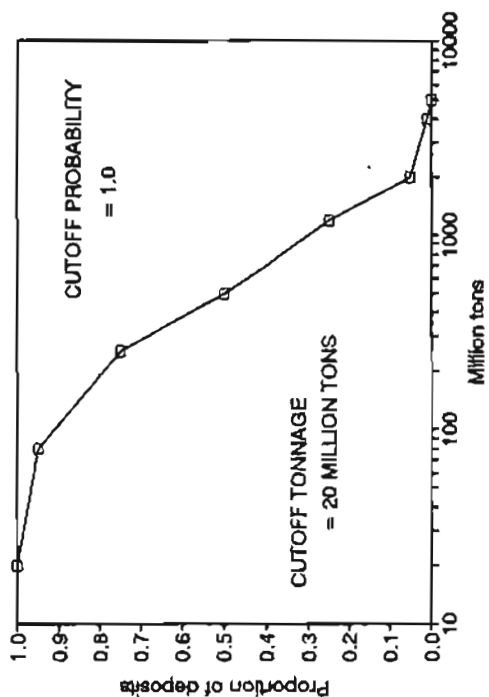
PROSPECT DENSITY -- PORPHYRY CU-MO, OX.
MODELS 44 AND 68



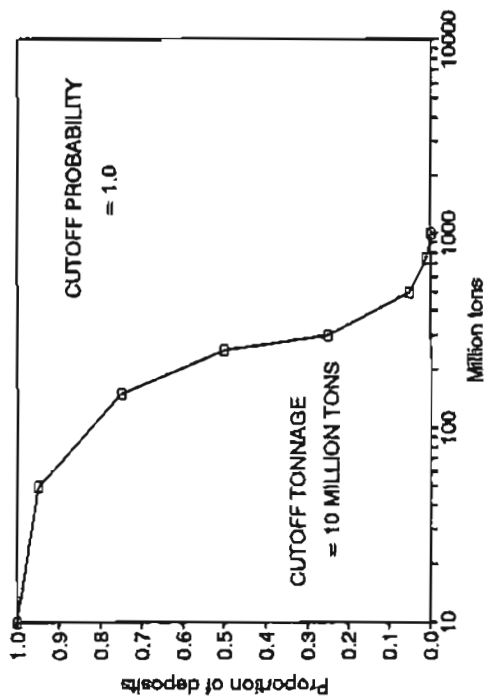
CU GRADE -- PORPHYRY CU-MO, OXIDIZED
MODELS 44 AND 68



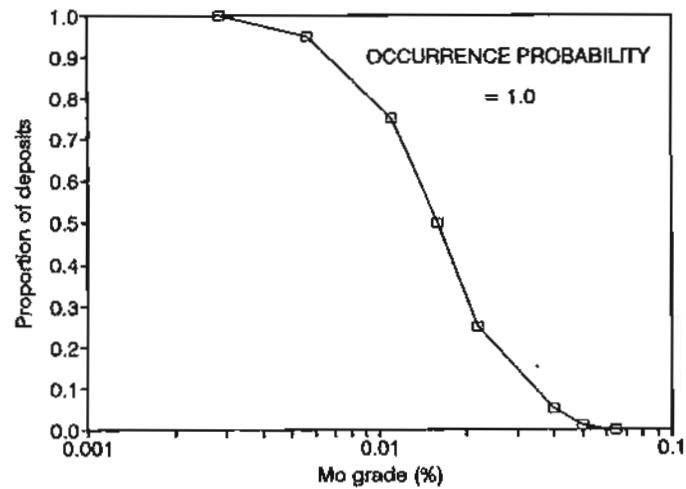
TONNAGE -- PORPHYRY CU-MO, OXIDIZED
MODEL 44, SOUTH AMERICAN



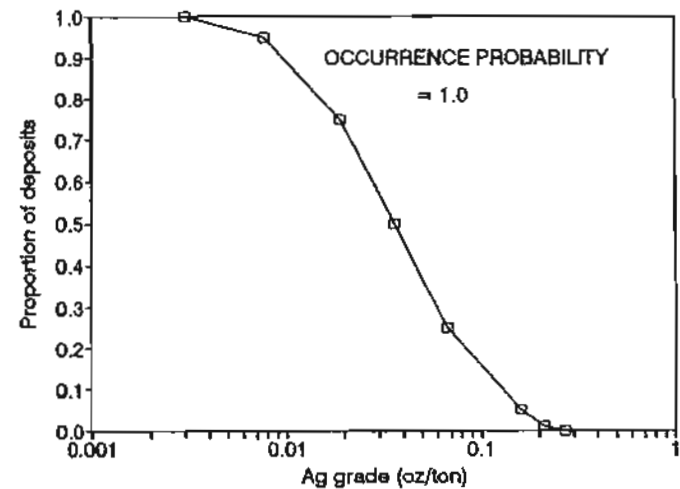
TONNAGE -- PORPHYRY CU-MO, OXIDIZED
MODEL 68, ALASKAN TYPE



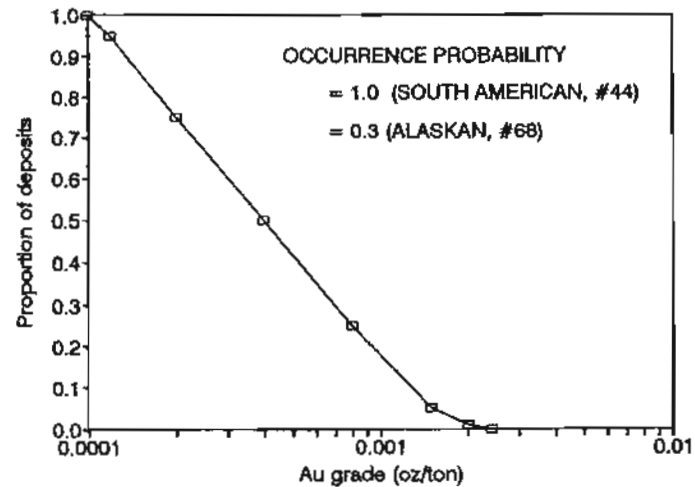
MO GRADE -- PORPHYRY CU-MO, OXIDIZED
MODELS 44 AND 68



AG GRADE -- PORPHYRY CU-MO, OXIDIZED
MODELS 44 AND 68



AU GRADE -- PORPHYRY CU-MO, OXIDIZED
MODELS 44 AND 68



MODEL 45 PORPHYRY COPPER-GOLD DEPOSITS

OTHER NAMES FOR THIS DEPOSIT TYPE - Alkalic porphyry Cu

BRIEF DESCRIPTION - Quartz-pyrite-chalcopyrite vein/veinlet stockwork in altered porphyritic granodiorite-granite and adjacent country rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Ok Tedi, Frieda, Papua New Guinea; Mamut, Sabah, Malaysia; Saint Tomas, Philippines; Copper Canyon, Nevada; Bingham, Utah; La Plata, Colorado; Dos Pobres, Arizona; Copper Mountain, Afton, Lorraine, Galore Creek, British Columbia

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Pebble Cu, Golden Zone

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Silver King, Margerie Glacier, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Reduced, alkalic to alkali-calcic, diorite to monzogranite

TEXTURES - Porphyry, porphyritic, and aplitic

AGES - Mesozoic and Tertiary most common

SPECIAL PREREQUISITES - Low oxidation state and/or alkalic magma series; low to moderate fractionation; intrusion at about 1-2 km below surface

ASSOCIATED DEPOSIT TYPES - Cu-Au skarns; Au-As veins; placer Au

DEPOSIT DESCRIPTION

MINERALOGY - Chalcopyrite, pyrite, bornite, magnetite, arsenopyrite, (molybdenite), biotite, quartz, Cretaceous-feldspar, sericite, clays

TEXTURES - Vein/veinlet stockwork

ALTERATION - Cretaceous-feldspar \pm biotite; propylitic; sericitic

GEOCHEMICAL SIGNATURE - Cu, Ag, Au, As (Mo, Zn, Pb, Mn, Te)

Pb ISOTOPE SIGNATURE - $^{206}\text{Pb}/^{204}\text{Pb}$ typically 18.8 to 19.3

S ISOTOPE SIGNATURE - Generally -5 to +5 permil

NOTES FOR GRADE/TONNAGE MODELS - This deposit model is built from deposits with high average Au contents (most higher than 0.2 ppm) which are characteristically associated with alkalic and/or reduced plutons. These contain low primary magnetite contents, but high mt + bn + Au in the core of the potassic zone.

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" area, that is, porphyry-textured reduced/alkalic granitic rocks, including a 1 mile radius around favorable plutons and areas thought to be underlain by favorable plutons.

MODEL 45: PORPHYRY COPPER-GOLD DEPOSITS

MODEL 45 REDUCED, ALASKAN-SIZED

Cutoff tonnage (million tons)
Probability that the prospect makes the cutoff tonnage

0.9
1

PROBABILITY 100 95 75 50 25 5 1 0

(MODEL 45) PROSPECT DENSITY WITHIN 500 SQ MILE AREA

No. of prospects 0 1 2 3 6 18 23 25

MILLION TONS OF ORE

0.9 16 58 105 230 600 900 1300

COPPER GRADE (%)

0.24 0.32 0.45 0.5 0.63 0.9 1 1.4

Occurrence probability of copper

GOLD GRADE (OZ/TON)

0.0036 0.0048 0.009 0.012 0.017 0.024 0.03 0.04

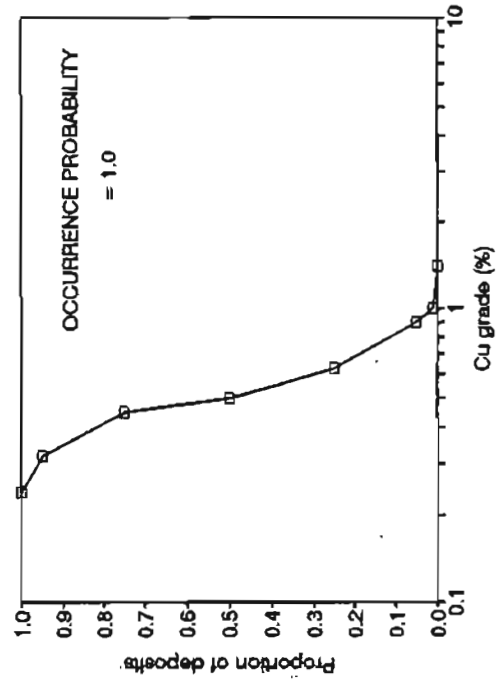
Occurrence probability of gold

SILVER GRADE (OZ/TON)

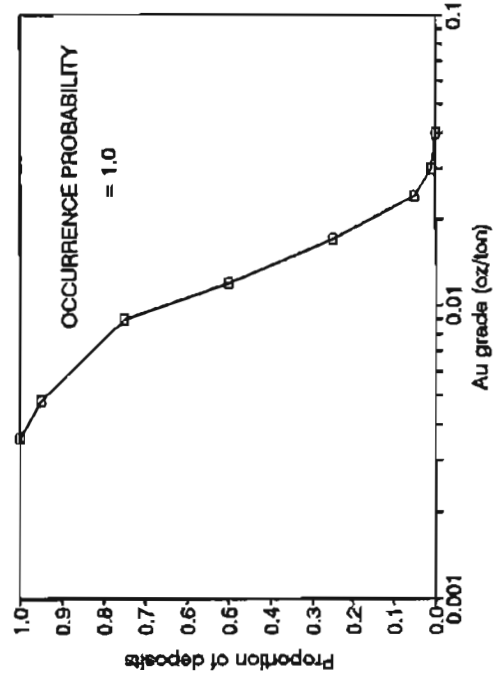
0.012 0.019 0.03 0.064 0.1 0.23 0.3 0.38

Occurrence probability of silver

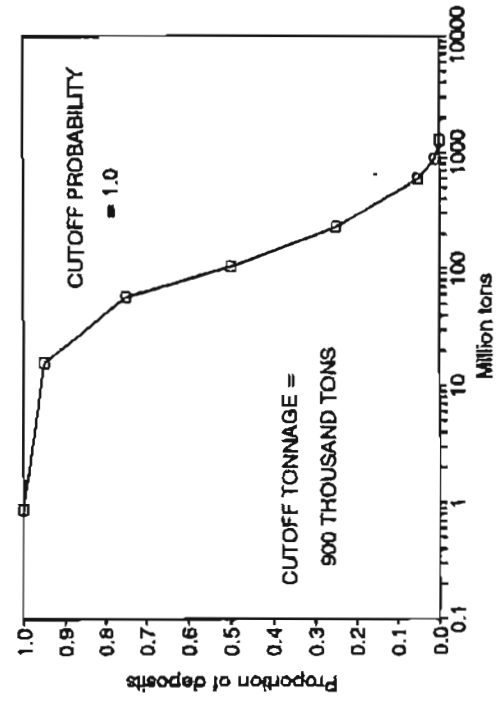
CU GRADE -- PORPHYRY CU-MO, REDUCED
MODEL 45



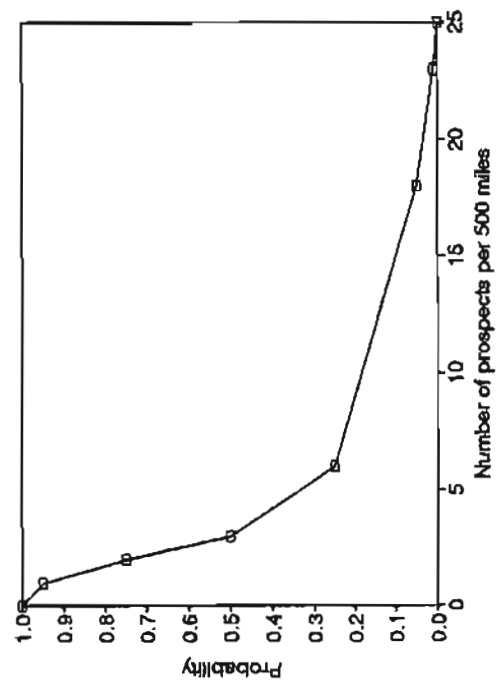
AU GRADE -- PORPHYRY CU-MO, REDUCED
MODEL 45

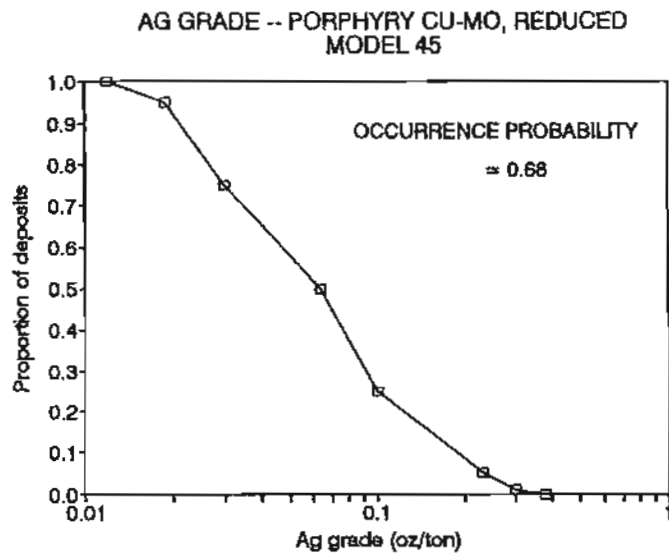


TONNAGE -- PORPHYRY CU-MO, REDUCED
MODEL 45



PROSPECT DENSITY -- PORPHYRY CU-MO, REDU.
MODEL 45





MODEL 46 LOW-FLUORINE PORPHYRY MOLYBDENUM

OTHER NAMES FOR THIS DEPOSIT TYPE - Granodiorite Mo; BC-type porphyry Mo; calc-alkaline Mo

BRIEF DESCRIPTION - Quartz-molybdenite vein/veinlet stockwork in granodiorite-granite and adjacent country rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Adnac, Bell, Ajax, Endako, British Columbia; Hall, Pine Nut, Buckingham, Nevada; Thompson Creek, Idaho; Red Mountain, Yukon; Mount Tolman, Washington

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Quartz Hill, Miss Molly

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Nunatak, Windy Creek, McLeod, Mike Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Low-F, high-magnetite, granodiorite and monzogranite

TEXTURES - Porphyry, porphyritic, and aplitic

AGES - Mesozoic and Tertiary

SPECIAL PREREQUISITES - High oxidation state; moderate fractionation; F typically less than 1,000 ppm in little-altered rocks

ASSOCIATED DEPOSIT TYPES - Mo veins and Mo skarns

DEPOSIT DESCRIPTION

MINERALOGY - Molybdenite, pyrite, scheelite, fluorite, chalcopyrite, biotite, quartz, K-feldspar, muscovite, clays

TEXTURES - Vein/veinlet stockwork

ALTERATION - Cretaceous-feldspar \pm biotite; silicification; propylitic; sericitic

GEOCHEMICAL SIGNATURE - Mo, Cu, W, F (Zn, Ag, Pb)

Pb ISOTOPE SIGNATURE - $^{206}\text{Pb}/^{204}\text{Pb}$ typically 18.8 to 19.3

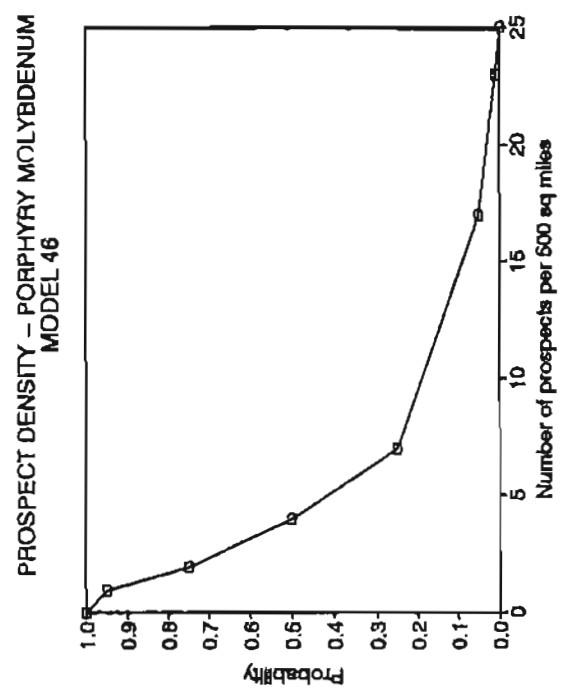
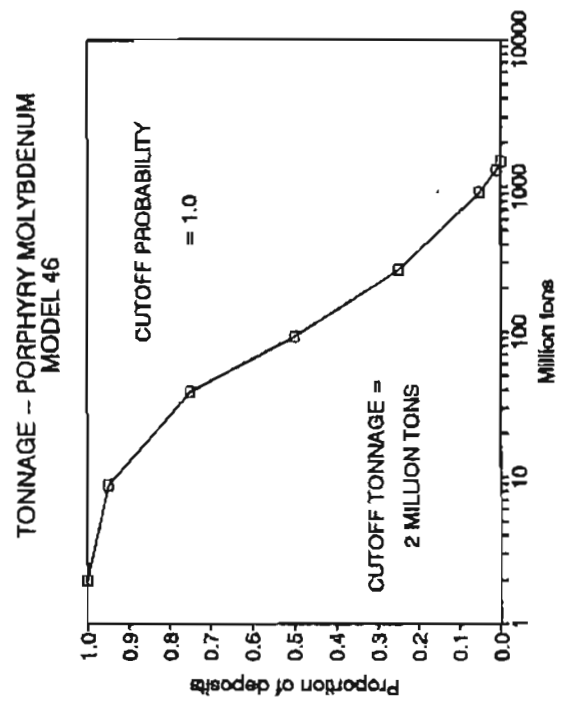
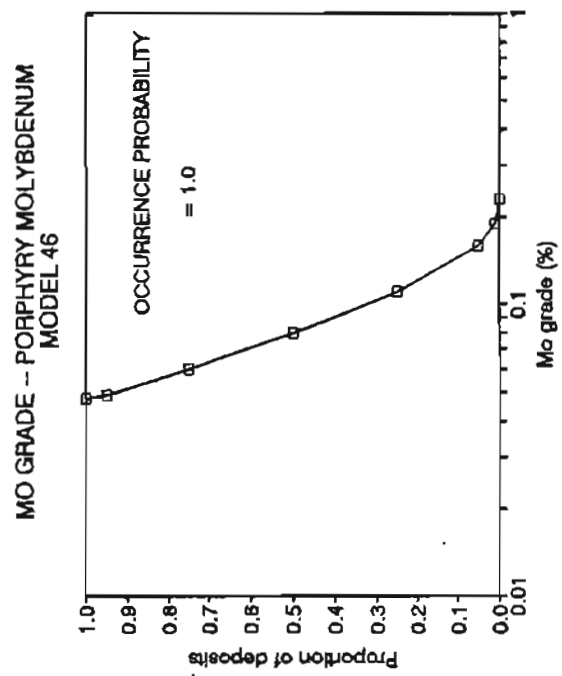
S ISOTOPE SIGNATURE - Generally -5 to +5 permil

NOTES FOR GRADE/TONNAGE MODELS - This deposit model is broadly similar to high-F porphyry Mo (not included herein), but associated igneous rocks of this group are less fractionated (lower F, Rb, Nb, Y, etc.) and grades/tonnages are lower than those of the high-F group.

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" area, that is, appropriate composition granitic rocks, including a 1 mile radius around favorable plutons.

MODEL 46: PORPHYRY MOLYBDENUM

		Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							
MODEL 46		100	95	75	50	25	5	1	2 1
(MODEL 46) PROSPECT DENSITY WITHIN 500 SQ MILE AREA									
No. of prospects		0	1	2	4	7	17	23	25
MILLION TONS OF ORE		2	9	39	94	268	921	1300	1500
MOLYBDENUM GRADE (%)		0.048	0.049	0.06	0.08	0.11	0.16	0.19	0.23
Occurrence probability of molybdenum 1									



URANIUM DEPOSITS - MODELS 23, 24, 67, AND 34

MODEL 23 GRANITE-HOSTED, LARGE TONNAGE URANIUM

OTHER NAMES FOR THIS DEPOSIT TYPE - Granite uranium; felsic plutonic uranium

BRIEF DESCRIPTION - Uraninite stockworks and/or disseminations in highly-evolved, sometimes alkalic, typically two-mica granite

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Rossing, Southwest Africa; Limousin, Morvan, France; Urgeirica, Portugal; Millet Brook, Nova Scotia; Khorgos, Kazakstan; Freiberg, Germany

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Bokan Mountain, Roy Creek (Mt. Prindle)

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Eagle Creek, Wheeler Creek, Zane Hills Alaska

GENERAL REFERENCES - Rich and others (19?)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Highly evolved, oxidized (?) granite

TEXTURES - Seriate, porphyritic, and equigranular

AGES - Mostly Phanerozoic, especially late Paleozoic, Cretaceous, and Tertiary

SPECIAL PREREQUISITES - High oxidation state, highly evolved, F-, CO₂- rich granite

ASSOCIATED DEPOSIT TYPES - U-REE-rich veins

DEPOSIT DESCRIPTION

MINERALOGY - Pitchblende, torbernite, chalcopyrite, quartz, feldspars, ankerite, chlorite, pyrite, clay, tourmaline, fluorite

TEXTURES - Vein, stockworks

ALTERATION - Albite, ~~Cretaceous~~ feldspar, muscovite, chlorite, carbonate, hematite

GEOCHEMICAL SIGNATURE - U, REE, Mn, F, CO₂ (Cu, Sn, W, Pb)

Pb ISOTOPE SIGNATURE - Very radiogenic, due to high U/Pb ratios in ore

S ISOTOPE SIGNATURE - Generally 0 ± 5 per mil

NOTES FOR GRADE/TONNAGE MODELS - This model is for low grade/large tonnage deposits: stockworks, not individual veins

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is the number of square miles of "favorable terrane"--that is, areas with or underlain by favorable granitic rocks

MODEL 23: GRANITE-HOSTED, LARGE TONNAGE URANIUM

MODEL 23

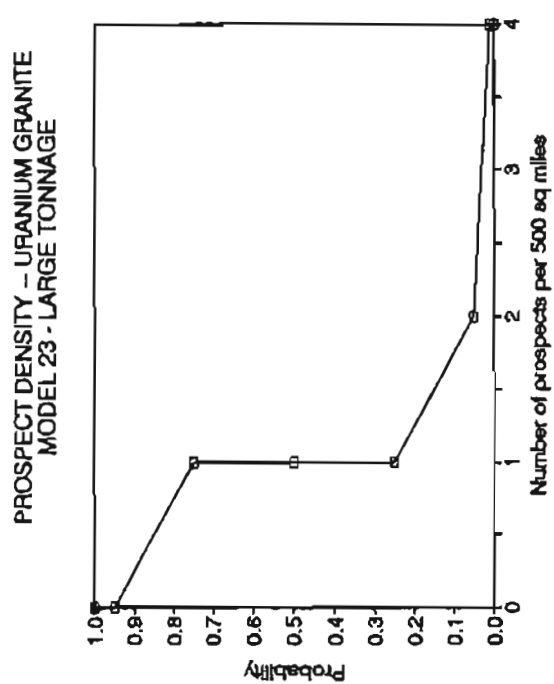
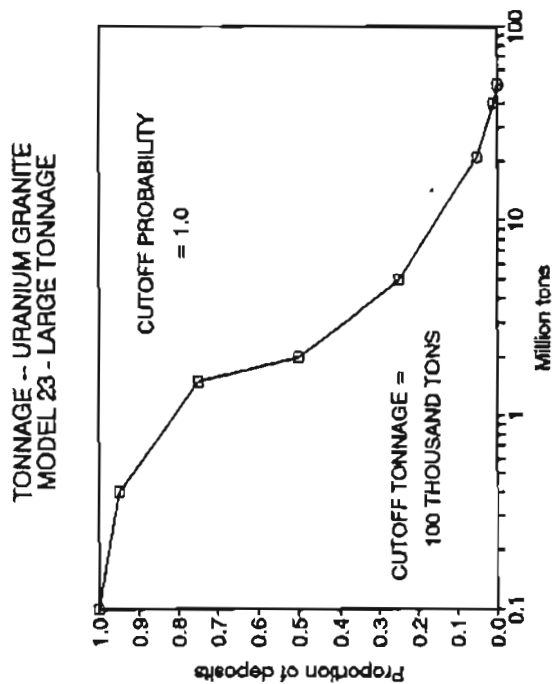
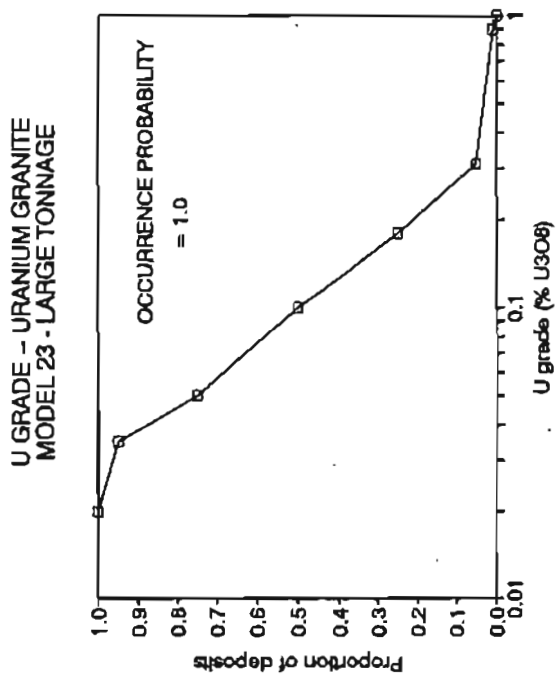
Cutoff tonnage (million tons)

0.1

Probability that the prospect makes the cutoff tonnage

1

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 500 SQ MILE AREA								
No. of prospects	0	0	1	1	1	2	4	4
MILLION TONS OF ORE	0.1	0.4	1.5	2	5	21	40	50
URANIUM GRADE (% U_3O_8)	0.02	0.035	0.05	0.1	0.18	0.31	0.9	1
Occurrence probability of uranium	1							



MODEL 24 U-REE VEINS, LARGE TONNAGE

OTHER NAMES FOR THIS DEPOSIT TYPE - Vein uranium; felsic plutonic uranium

BRIEF DESCRIPTION - Uraninite/pitchblende veins in or near highly-evolved, typically alkalalic granite and/or granite pegmatite

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Schwartzwalder, Central City, Caribou, Colorado; Marysville, Utah; Stanley, Idaho; Central Lake, Malawi; Jachymov, Horni Slavkov, Czechoslovakia

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Salmon Bay, William Henry Bay

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Selawik Hills, Alaska

GENERAL REFERENCES - Rich and others (197)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Evolved, alkalalic, oxidized granite and/or pegmatite and subjacent metamorphic rocks

TEXTURES - Seriate, porphyritic, and equigranular

AGES - Mostly Phanerozoic, especially late Paleozoic, Cretaceous, and Tertiary

SPECIAL PREREQUISITES - High oxidation state, highly evolved, U-, F-, CO₂- alkali-rich granite; Major through-going faults/fissures

ASSOCIATED DEPOSIT TYPES - U-REE-skarns; sediment-hosted U

DEPOSIT DESCRIPTION

MINERALOGY - Pitchblende, torbernite, chalcopyrite, quartz, feldspars, ankerite, chlorite, pyrite, clay, fluorite

TEXTURES - Vein

ALTERATION - Albite, Cretaceous-feldspar, muscovite, chlorite, carbonate, hematite

GEOCHEMICAL SIGNATURE - U, REE, Mn, F, CO₂ (Cu, Pb)

Pb ISOTOPE SIGNATURE - Very radiogenic, due to high U/Pb ratios in ore

S ISOTOPE SIGNATURE - Variable

NOTES FOR GRADE/TONNAGE MODELS - This model is for high grade/low tonnage - veins and is particularly appropriate for strongly alkalalic granites

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is the square miles of "favorable terrane"—that is, areas with or underlain by favorable granitic rocks

MODEL 67
U-REE VEINS, SMALL TONNAGE

OTHER NAMES FOR THIS DEPOSIT TYPE - Vein uranium; felsic plutonic uranium

BRIEF DESCRIPTION - Uraninite/pitchblende veins in or near highly-evolved, typically two-mica true granite

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Marshall Pass, Colorado; Lakeview, Oregon; Midnite Mine, Washington; Vendee, France; Cornwall, England; Mary Kathleen, Queensland

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Salmon Bay, William Henry Bay

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Reese River, Nevada

GENERAL REFERENCES - Rich and others (197)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Evolved, oxidized granite and subjacent metamorphic rocks

TEXTURES - Seriate, porphyritic, and equigranular

AGES - Mostly Phanerozoic, especially late Paleozoic, Cretaceous, and Tertiary

SPECIAL PREREQUISITES - High oxidation state, highly evolved, U-, F-, CO₂- rich granite; Major through-going faults/fissures

ASSOCIATED DEPOSIT TYPES - U-REE-skarns; sediment-hosted U

DEPOSIT DESCRIPTION

MINERALOGY - Pitchblende, torbernite, chalcopyrite, quartz, feldspars, ankerite, chlorite, pyrite, clay, fluorite

TEXTURES - Vein

ALTERATION - Albite, Cretaceous-feldspar, muscovite, chlorite, carbonate, hematite

GEOCHEMICAL SIGNATURE - U, REE, Mn, F, CO₂ (Cu, Pb)

Pb ISOTOPE SIGNATURE - Very radiogenic, due to high U/Pb ratios in ore

S ISOTOPE SIGNATURE - Variable

NOTES FOR GRADE/TONNAGE MODELS - This model is for high grade/very low tonnage veins, especially those associated with true granite; it may be a more realistic model for most prospects than #24

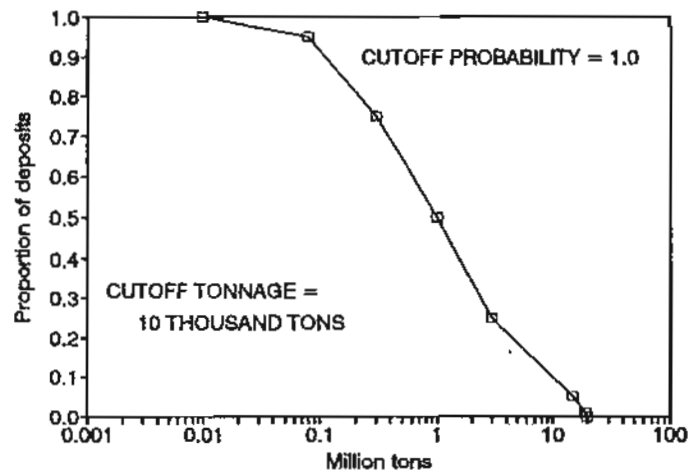
NOTES FOR PROSPECT DENSITY MODEL - Input parameter is the square miles of "favorable terrane"—that is, areas with or underlain by favorable granitic rocks

Model 24-67: Uranium-REE Veins

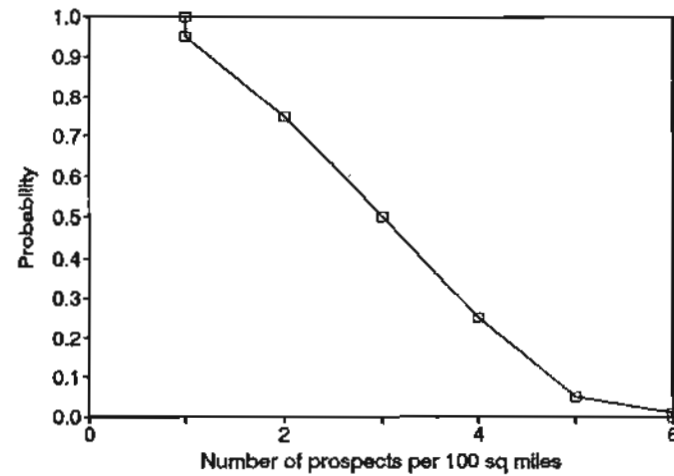
MODEL 24 LARGE TONNAGE	Cutoff tonnage (million tons) (Model 24)							0.01
MODEL 67 SMALL TONNAGE	Cutoff tonnage (million tons) (Model 67)							0.001
	Probability that the prospect makes the cutoff tonnage							1
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	1	1	2	3	4	5	6	6
MILLION TONS OF ORE (Model 24)	0.01	0.08	0.3	1	3	15	19	20
MILLION TONS OF ORE (Model 67)	0.001	0.08	0.15	0.3	0.45	0.6	0.7	1
URANIUM GRADE (% U_3O_8)	0.02	0.035	0.08	0.13	0.22	0.5	0.65	0.7
Occurrence probability of uranium	1							
REE GRADE (% total rare earths)	0.006	0.03	0.1	0.3	0.7	3	4	5
Occurrence probability of rare earths	1							

50

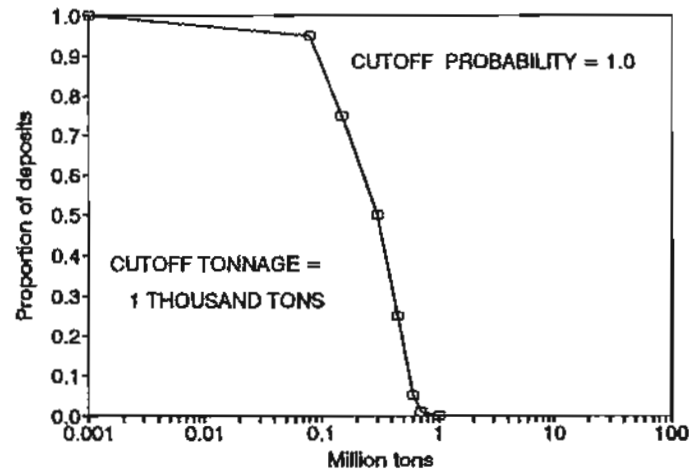
TONNAGE – U-REE VEINS
MODEL 24, WORLDWIDE SYSTEM



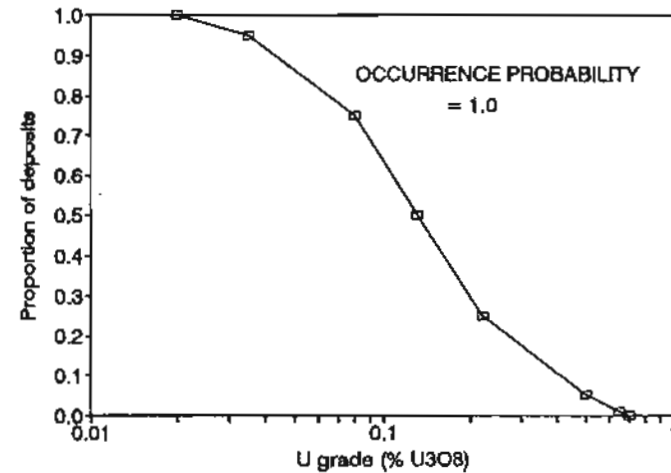
PROSPECT DENSITY – U-REE VEINS
MODELS 24 AND 67

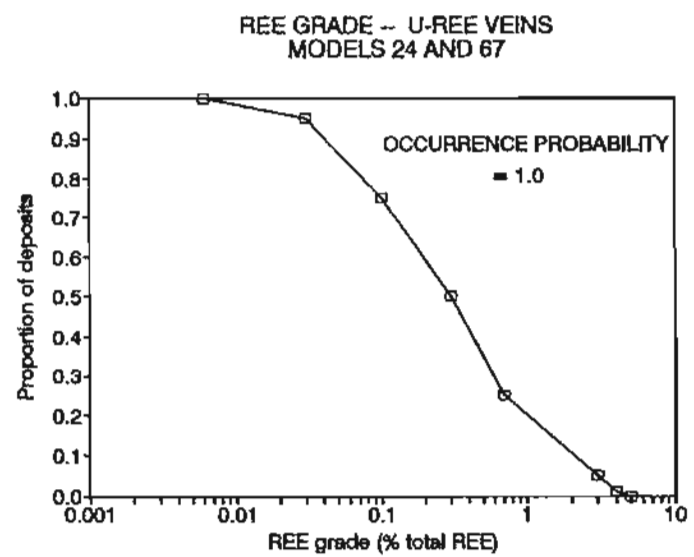


TONNAGE – U-REE VEINS
MODEL 67, ALASKAN SYSTEM



U GRADE – U-REE VEINS
MODELS 24 AND 67





MODEL 34 SEDIMENT-HOSTED URANIUM DEPOSITS

OTHER NAMES FOR THIS DEPOSIT TYPE - Sandstone uranium, roll-front U, trend U.

BRIEF DESCRIPTION; SUPPOSED GENESIS - Pitchblende, U-silicates, and U-organics in sandstone. Two main varieties: organic-rich U-V "trend ores" in oxidized and U-V-Mo (\pm Cu-Ag) oxide-rich in reduced at redox front. Both thought to represent diagenetic fluid movement and reaction; first is reduced fluid into oxidized host, second is oxidized fluid into reduced host. U source is probably siliceous volcanic or plutonic rocks; by-product metals are determined by chemistry of the transporting fluid.

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Grants district, New Mexico, Uravan, Rifle Creek, Colorado, Shirley Basin, Wyoming.

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Death Valley (Seward Peninsula), Port Camden, southeastern Alaska.

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA -

GENERAL REFERENCES - Laznicka, 1985; Childers, Bailey, 1979.

GEOLOGIC ENVIRONMENT

ROCK TYPES - Continental-derived sandstone.

TEXTURES - Disseminated mineralization.

AGES - Devonian to Tertiary.

SPECIAL PREREQUISITES - (1) climate change, resulting in diagenetic fluids replacing pore fluids of contrasting chemistry, (2) felsic (volcanic or plutonic) U source, and (3) sandstone aquifers confined by shale units

ASSOCIATED DEPOSIT TYPES - Sandstone-hosted V, Cu-Ag, Mo?

DEPOSIT DESCRIPTION

MINERALOGY - Uraninite, coffinite, organo-uranics, secondary U-V minerals chlorite, quartz, pyrite.

TEXTURES - Disseminated and replacement (organics).

ALTERATION - Roll-front: at redox front; trend: secondary quartz, chlorite.

GEOCHEMICAL SIGNATURE - U, V, Mo, Se, (Cu, Ag).

Pb ISOTOPE SIGNATURE - Highly variable due to high-U ore.

S ISOTOPE SIGNATURE - Typically wide range in values, +20 to -20.

NOTES FOR GRADE/TONNAGE MODELS - (1) deposits are commonly broken out by claims, not paleo-aquifers; district-deposit distinction often fuzzy and (2) grade and tonnage are relatively independent.

PROSPECT

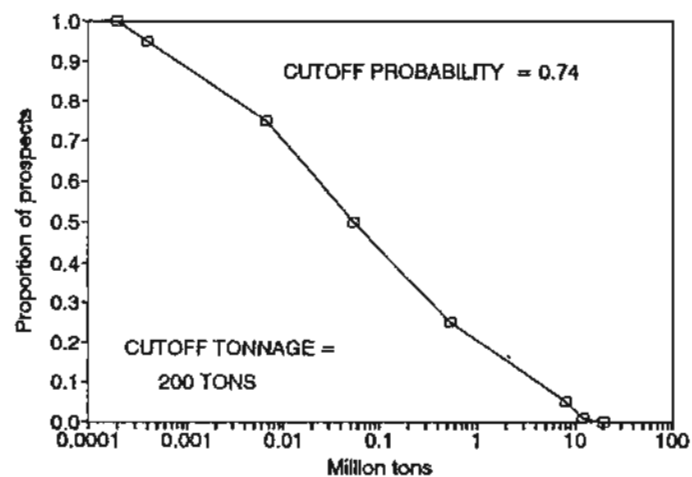
(11)

NOTES FOR ~~DEPOSIT~~ DENSITY MODEL - See above; an area can be described as many small or 1 large (disjointed) deposit.

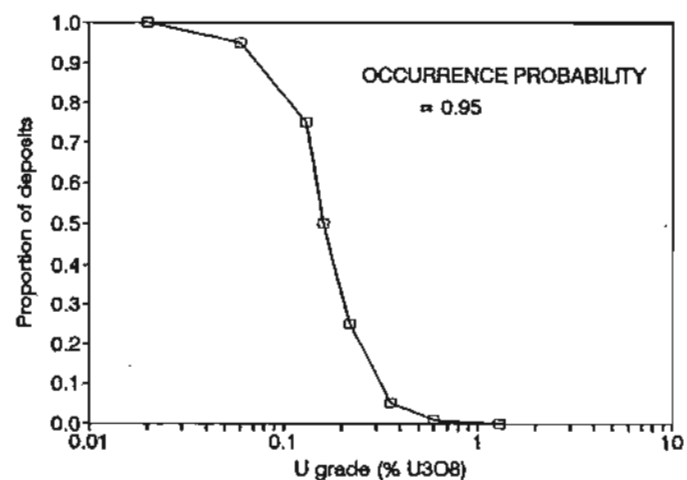
MODEL 34: SEDIMENT-HOSTED URANIUM DEPOSITS

MODEL 34 SED HOSTED		Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage						0.0002 0.74
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	0	0	0	1	2	5	6	8
MILLION TONS OF ORE	0.0002	0.0004	0.0066	0.054	0.54	8	12	20
URANIUM GRADE (% U_3O_8)	0.02	0.06	0.13	0.16	0.22	0.36	0.6	1.3
Occurrence probability of uranium	0.95							

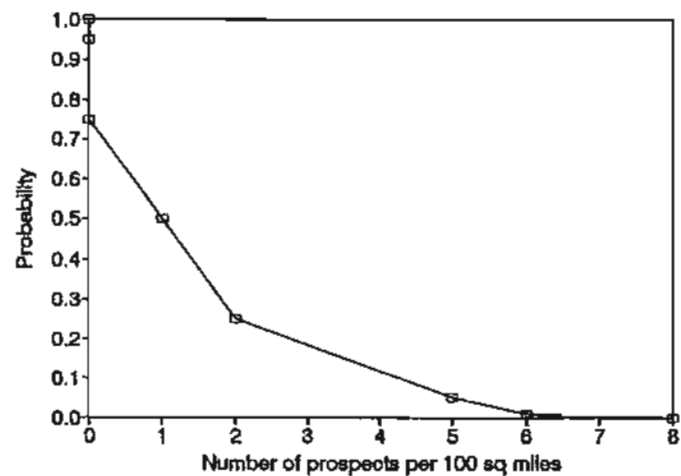
TONNAGE -- SEDIMENT-HOSTED URANIUM
MODEL 34



U GRADE -- SEDIMENT-HOSTED URANIUM
MODEL 34



PROSPECT DENSITY -- SED.-HOSTED URANIUM
MODEL 34



530

SUBMARINE VOLCANOGENIC DEPOSITS

MODEL 25 PIEDMONT-TYPE STRATABOUND GOLD

OTHER NAMES FOR THIS DEPOSIT TYPE - Submarine volcanogenic gold

BRIEF DESCRIPTION - Stratabound pyrite-rich, base metal-poor, gold lenses and veins associated with altered volcanic and submarine sedimentary rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Haile, Howie, Ridgeway, Brewer, South Carolina; Virginia Au-pyrite belt, Virginia; Oage, Akeshi, Kasuga, Japan; Pueblo Viejo, Dominican Republic

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Spruce Peak occurrence (Kantishna Hills)

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Robbins district, North Carolina

GENERAL REFERENCES - Worthington and Kiff (1970)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Highly sericite-pyrite altered volcanic rocks

TEXTURES - Schistose, veined, laminated

AGES - Phanerozoic, especially early-mid Paleozoic and Tertiary

SPECIAL PREREQUISITES - Bimodal volcanism is typically present; deposits are localized in the transition between volcanic and sedimentary rocks; intense shearing accompanying greenschist-amphibolite metamorphism may be important

ASSOCIATED DEPOSIT TYPES - Volcanogenic massive sulfides

DEPOSIT DESCRIPTION

MINERALOGY - Gold, pyrite, arsenopyrite, quartz, sericite, pyrophyllite

TEXTURES - Stratiform, laminated, disseminated, vein

ALTERATION - Sericite, pyrophyllite, Cretaceous-feldspar, quartz, pyrite

GEOCHEMICAL SIGNATURE - Au, As, Sb, Cu (Mo)

Pb ISOTOPE SIGNATURE - Carolina slate belt has typical lower Paleozoic values

S ISOTOPE SIGNATURE - Variable, not much data

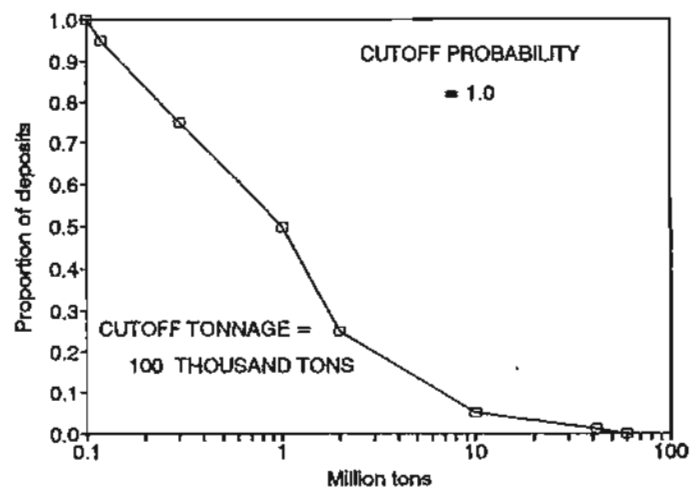
NOTES FOR GRADE/TONNAGE MODELS - Although these deposits appear to resemble Archean "Homestake-type" stratabound Au, they are all much smaller than the Archean types.

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is linear miles of "favorable terrane"—that is, areas with or underlain by favorable altered bimodal volcanic and nearby sedimentary rocks

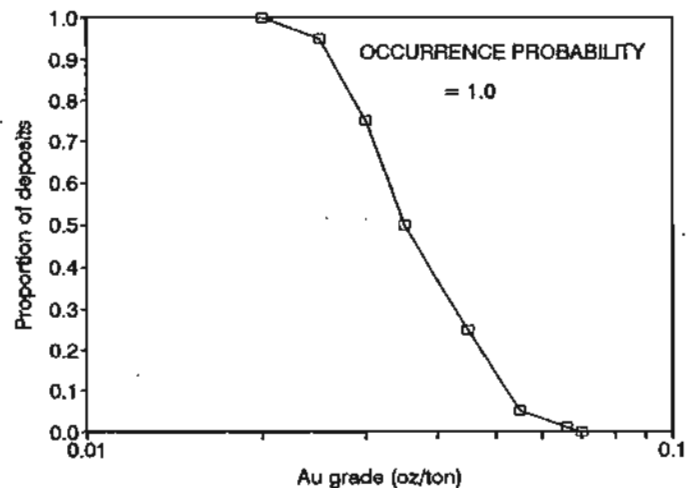
MODEL 25: PIEDMONT TYPE - STRATABOUND GOLD (PALEOZOIC)

MODEL 25 PIEDMONT MOD.		Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							0.1 f
PROBABILITY		100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 LINEAR BELT									
No. of prospects	4	4		6	9	15	42	48	50
MILLION TONS OF ORE	0.1	0.12		0.3	1	2	10	42	60
GOLD GRADE (OZ/TON)	0.02	0.025		0.03	0.035	0.045	0.055	0.066	0.07
Occurrence probability of gold	1								

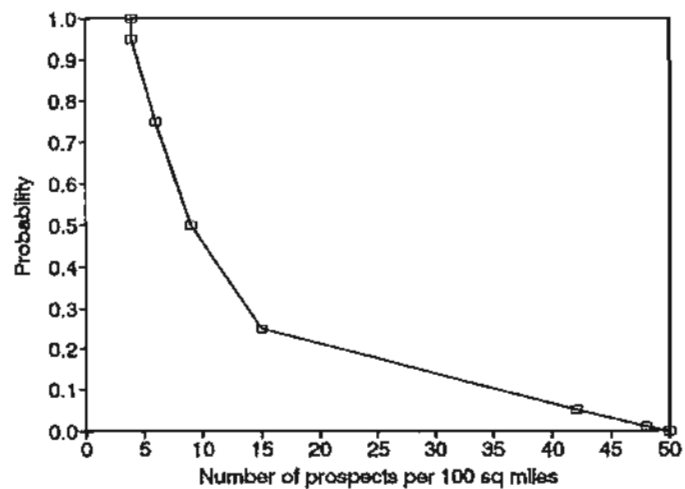
TONNAGE - STRATABOUND AU, PIEDMONT TYPE
MODEL 25



AU GRADE--STRATABOUND AU, PIEDMONT TYPE
MODEL 25



PROSPECT DENSITY -- STRATABOUND AU,
PIEDMONT TYPE, MODEL 25



55a

MODEL 26 ARCHEAN-TYPE VOLCANOGENIC PRECIOUS METAL SULFIDE

OTHER NAMES FOR THIS DEPOSIT TYPE - Homestake Au, volcanogenic gold, Fe-formation gold

BRIEF DESCRIPTION - Stratabound pyrite-rich, base metal-poor, gold lenses and veins associated with altered Archean volcanic and submarine sedimentary rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Homestake, South Dakota; Agnico Eagle, Quebec; Passagem, Brazil; Vubachikwe, Zimbabwe; Hemlo, Canada (?)

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - None currently known

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA

GENERAL REFERENCES - Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Regionally metamorphosed, carbonate-sericite altered, felsic and mafic volcanic and sedimentary rocks; oxide, sulfide, and/or carbonate iron-formation

TEXTURES - Schistose, veined, laminated

AGES - Archean

SPECIAL PREREQUISITES - Deposits are localized in the transition between volcanic and sedimentary rocks; intense shearing accompanying greenschist-amphibolite metamorphism is common

ASSOCIATED DEPOSIT TYPES - Volcanogenic massive sulfides; Algoma-type Fe

DEPOSIT DESCRIPTION

MINERALOGY - Gold, pyrite, arsenopyrite, quartz, sericite, carbonate

TEXTURES - Stratiform, laminated, disseminated, vein

ALTERATION - Sericite, carbonate, chlorite, tourmaline

GEOCHEMICAL SIGNATURE - Au, As, Sb, B, (Cu, Pb, Zn, Ag)

Pb ISOTOPE SIGNATURE - ???

S ISOTOPE SIGNATURE - Variable, not much data

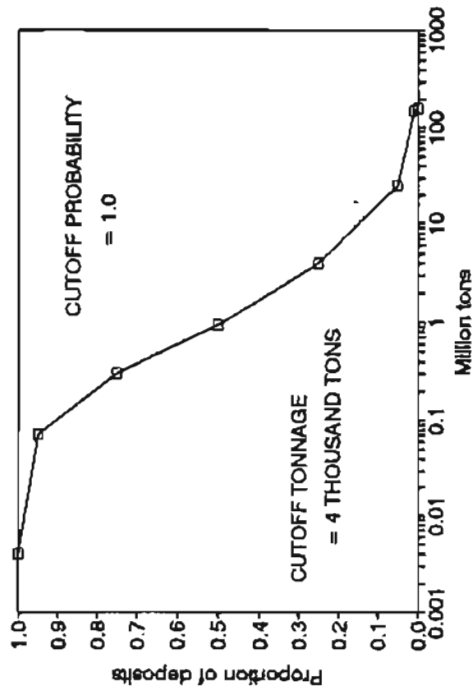
NOTES FOR GRADE/TONNAGE MODELS - Although these deposits appear to resemble Phanerozoic stratabound Au, they are characteristically much larger than the younger types.

NOTES FOR PROSPECT DENSITY MODEL - Input parameter of linear miles of "favorable terrane"—that is, areas with or underlain by favorable altered and nearby sedimentary rocks

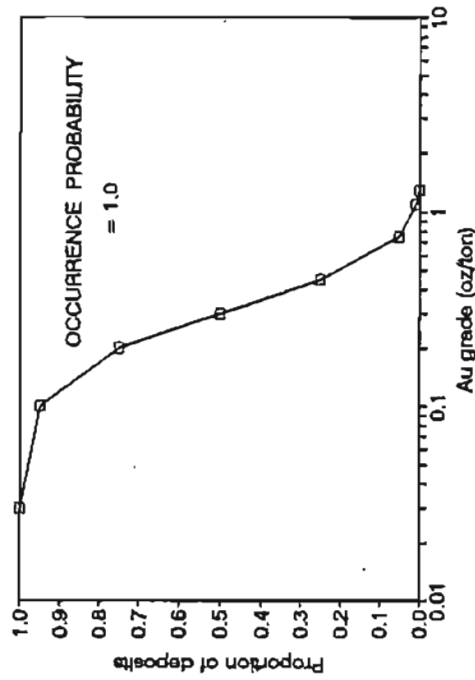
MODEL 26: VOLCANOGENIC PRECIOUS METAL SULFIDE, ARCHEAN MODEL

MODEL 26	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							0.004 1
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 500 SQ MILE AREA								
No. of prospects	0	1	2	2	9	28	35	40
MILLION TONS OF ORE	0.004	0.07	0.3	0.94	4	25	150	160
GOLD GRADE (OZ/TON) Occurrence probability of gold	0.03 1	0.1	0.2	0.3	0.45	0.75	1.1	1.3
SILVER GRADE (OZ/TON) Occurrence probability of silver	0.005 1	0.006	0.018	0.05	0.1	0.5	0.8	1.5

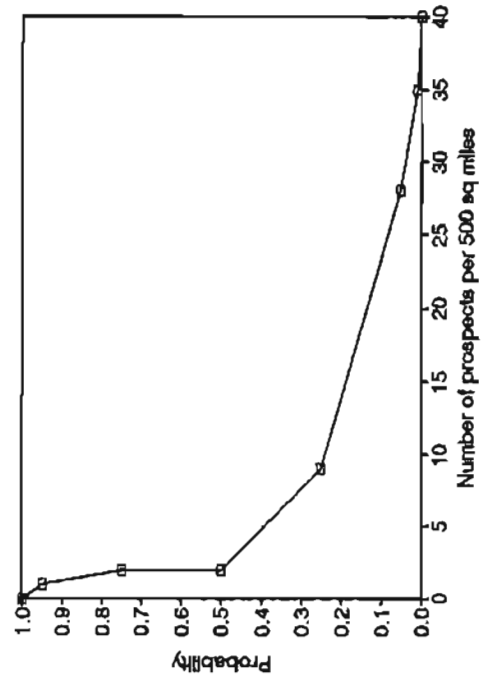
TONNAGE -- VPMS
MODEL 26



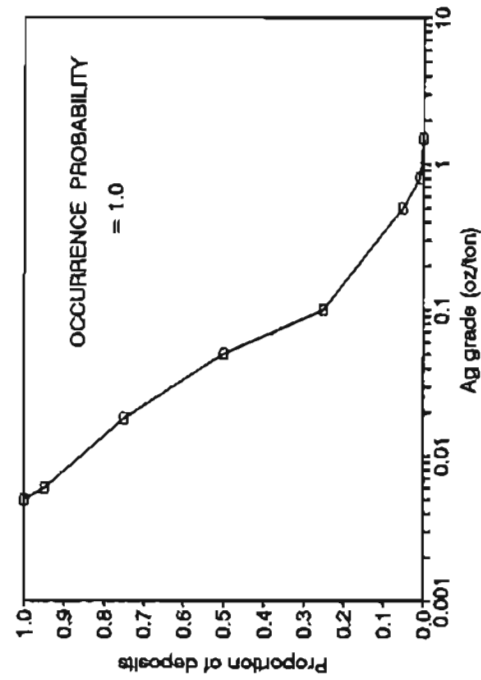
AU GRADE -- VPMS
MODEL 26



PROSPECT DENSITY -- VPMS
MODEL 26



AG GRADE -- VPMS
MODEL 26



MODEL 40
POLYMETALIC VOLCANOGENIC MASSIVE SULFIDE,
PHANEROZOIC, CALC-ALKALIC (NON-RIFT)

OTHER NAMES FOR THIS DEPOSIT TYPE - Kuroko type VMS; volcanogenic massive sulfide

BRIEF DESCRIPTION - Stratabound, stratiform massive sulfide underlain by alteration and veining, present near interface between submarine volcanics and sed

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Foothills Copper Belt, California; Kuroko district, Japan; Buchans, Newfoundland; Undu, Vanua Levu, Fiji; Samar Island, Philippines; Que River, Tasmania

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Red Mountain (Alaska Range), Khayyam, Niblack

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Anderson Mountain, Sheep Creek, Hayes Glacier, Orange Point, Helen S., Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Greatly to little-metamorphosed and variably altered/veined: rhyolite, dacite, andesite, basalt, mudstone, and chert

TEXTURES - Pyroclastic, breccia, vein, flow, laminated, all with variable schistose to gneissic overprint

AGES - Phanerozoic (older VMS deposits are not included in this model)

SPECIAL PREREQUISITES - Calc-alkalic volcanism in a deep marine setting; submarine caldera?; anoxic basin?; subvolcanic intrusions?

ASSOCIATED DEPOSIT TYPES - Volcanogenic Mn and Fe

DEPOSIT DESCRIPTION

MINERALOGY - Pyrite, chalcopyrite, sphalerite, galena, barite, magnetite, tetrahedrite, pyrrhotite, gold, anhydrite, bornite, quartz, carbonate, sericite, chlorite, tourmaline (and metamorphic equivalents of all)

TEXTURES - Stratiform, massive to thinly laminated; veined, stockworks

ALTERATION - Sericite, quartz, chlorite, clay (and metamorphosed versions)

GEOCHEMICAL SIGNATURE - Cu, Zn, Pb, Ag, Au, As, Ba, Mn, Se

Pb ISOTOPE SIGNATURE - Varies with age of deposits and basement, older deposits are less radiogenic, younger deposits more radiogenic

S ISOTOPE SIGNATURE - Varies with age of deposit, most values of $\delta^{34}\text{S}$ are from -10 to +25 permil; single deposits usually show little variation

NOTES FOR GRADE/TONNAGE MODELS - Archean and Proterozoic deposits are low in Pb and not included here; "rift"-related deposits are typically larger and flatter than this group

NOTES FOR PROSPECT DENSITY MODEL - Input parameter square miles of "favorable terrane"--that is, areas with or underlain by mixed submarine calc-alkalic volcanic/volcaniclastic and sedimentary rocks

MODEL 41 POLYMETALIC VOLCANOGENIC MASSIVE SULFIDE, PHANEROZOIC, BIMODAL (RIFT) TYPE

OTHER NAMES FOR THIS DEPOSIT TYPE - Kuroko type VMS; volcanogenic massive sulfide

BRIEF DESCRIPTION - Stratabound, stratiform massive sulfide underlain by alteration and veining, present near interface between submarine volcanics and sediments

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Rio Tinto, Cerro Colorado, Tharsis, La Zarza, Spain; Madenkoy, Turkey; Aljustrel, Louisa, Portugal; Stekenjokk, Sweden; Butte Lake, Kutchuk Creek, British Columbia; Bathurst district, New Brunswick; Shasta district, California

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Arctic Camp, Greens Creek, Delta district

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Smucker, BT, Sun, Michigan Creek, Mt Henry Clay, Pyrolo, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Greatly to little-metamorphosed and variably altered/veined: rhyolite, basalt, mudstone, and chert

TEXTURES - Pyroclastic, breccia, vein, flow, laminated, all with variable schistose to gneissic overprint

AGES - Phanerozoic (older VMS deposits are not included in this model)

SPECIAL PREREQUISITES - Bi-modal volcanism in a deep marine setting (rifting?); anoxic basin?; subvolcanic intrusions?

ASSOCIATED DEPOSIT TYPES - Volcanogenic Mn and Fe

DEPOSIT DESCRIPTION

MINERALOGY - Pyrite, chalcopyrite, sphalerite, galena, barite, magnetite, tetrahedrite, pyrrhotite, gold, anhydrite, bornite, quartz, carbonate, sericite, chlorite, tourmaline (and metamorphic equivalents of all)

TEXTURES - Stratiform, massive to thinly laminated; veined, stockworks

ALTERATION - Sericite, quartz, chlorite, clay (and metamorphosed versions)

GEOCHEMICAL SIGNATURE - Cu, Zn, Pb, Ag, Au, As, Ba, Mn, Se

Pb ISOTOPE SIGNATURE - Varies with age of deposits and basement; older deposits are less radiogenic, younger deposits more radiogenic

S ISOTOPE SIGNATURE - Varies with age of deposit, most values of $\delta^{34}\text{S}$ are from -10 to +25 permil; single deposits usually show little variation

NOTES FOR GRADE/TONNAGE MODELS - Archean and Proterozoic deposits are low in Pb and not included here; deposits associated with calc-alkalic volcanism are typically smaller and more mushroom-shaped than deposits of this group

NOTES FOR PROSPECT DENSITY MODEL - Input parameter square miles of "favorable terrane"—that is, areas with or underlain by mixed submarine bimodal volcanic/volcaniclastic and sedimentary rocks

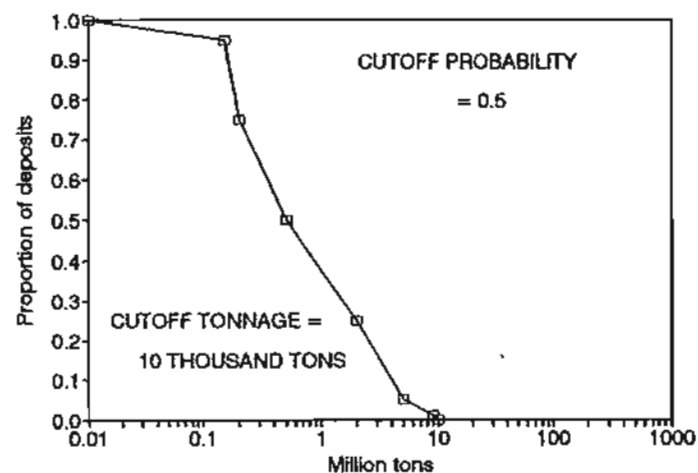
MODEL 40-41: POLY METAL VMS

MODEL 40 NON-RIFT
MODEL 41 RIFT RELATED

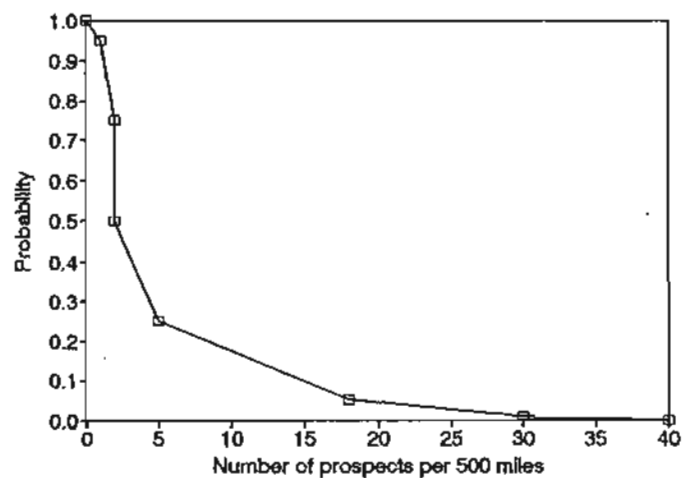
Cutoff tonnage (million tons) (Model 40) 0.01
Cutoff tonnage (million tons) (Model 41) 0.1
Probability that the prospect makes the cutoff tonnage 0.5

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 500 SQ MILE AREA								
No. of prospects	0	1	2	2	5	18	30	40
MILLION TONS OF ORE (Model 40)	0.01	0.15	0.2	0.5	2	5	9	10
MILLION TONS OF ORE (Model 41)	0.1	0.3	0.8	3	6	40	150	200
ZINC GRADE (%)	1	1.5	3	5.5	9	15	18	19
Occurrence probability of zinc	1							
COPPER GRADE (%)	0.5	0.75	1	2.9	4.8	6.5	6.9	7
Occurrence probability of copper	0.9							
LEAD GRADE (%)	0.2	0.5	1	2.5	4	7	7.8	8
Occurrence probability of lead	1							
SILVER GRADE (OZ/TON)	0.5	0.8	1	3	7	10	11.5	12
Occurrence probability of silver	0.5							
GOLD GRADE (OZ/TON)	0.001	0.003	0.01	0.03	0.06	0.13	0.25	0.3
Occurrence probability of gold	0.6							

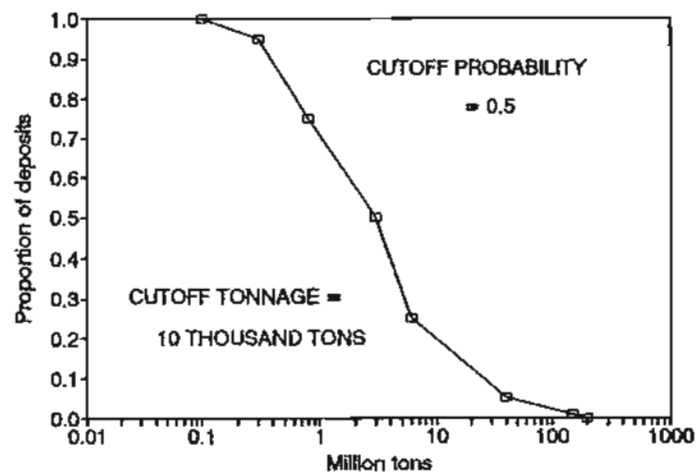
TONNAGE - VOLCANOGENIC MASSIVE SULFIDE
MODEL 40 - NON-RIFT



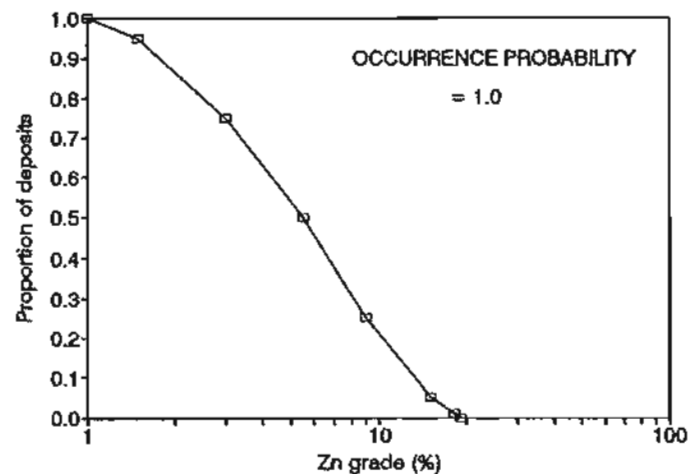
PROSPECT DENSITY - VOLC. MASSIVE SULFIDE
MODELS 40&41: RIFT- AND NON-RIFT-RELATED



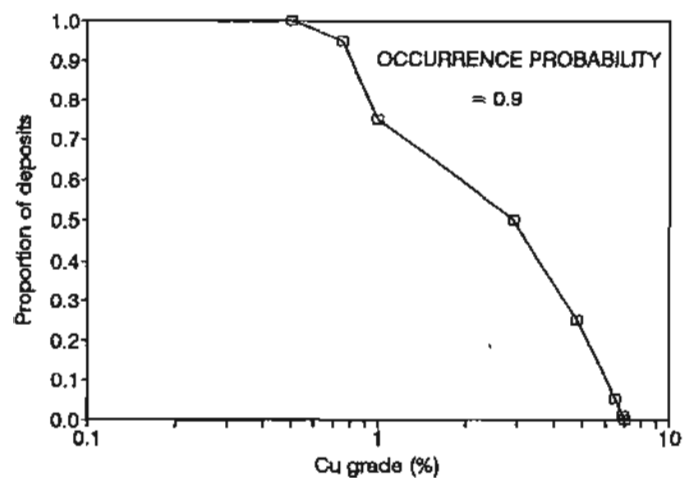
TONNAGE - VOLCANOGENIC MASSIVE SULFIDE
MODEL 41 - RIFT-RELATED



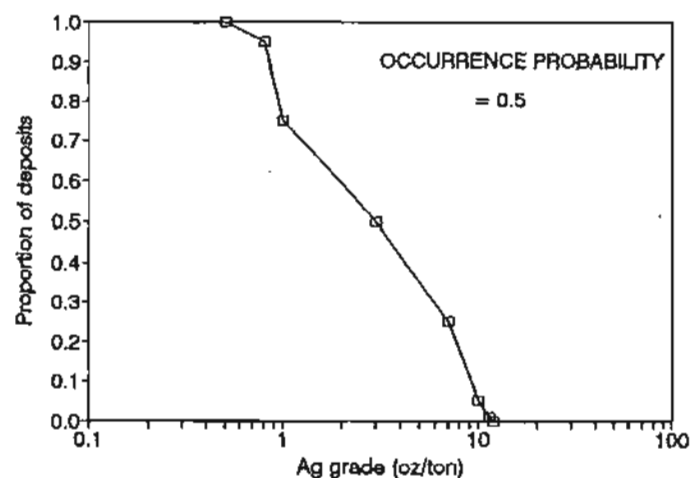
ZN GRADE - VOLCANOGENIC MASSIVE SULFIDE
MODELS 40&41: RIFT- AND NON-RIFT-RELATED



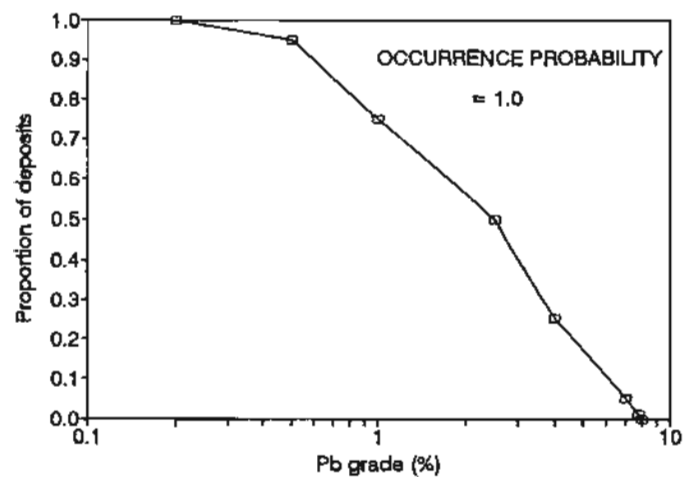
CU GRADE--VOLCANOGENIC MASSIVE SULFIDE
MODEL 40&41:RIFT- AND NON-RIFT-RELATED



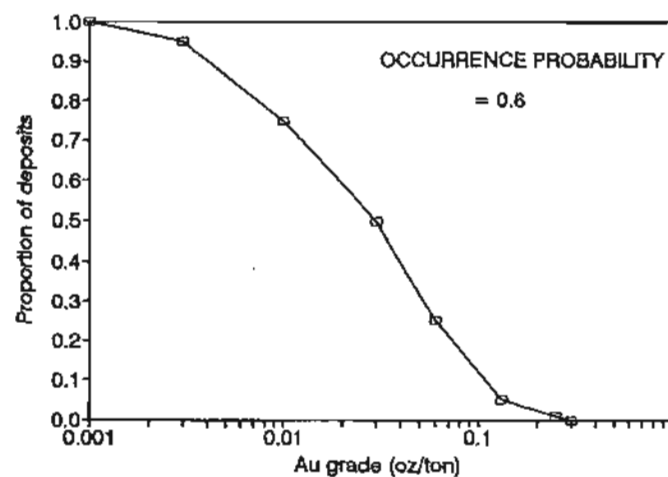
AG GRADE--VOLCANOGENIC MASSIVE SULFIDE
MODELS 40&41:RIFT- AND NON-RIFT-RELATED



PB GRADE--VOLCANOGENIC MASSIVE SULFIDE
MODELS 40&41:RIFT- AND NON-RIFT-RELATED



AU GRADE--VOLCANOGENIC MASSIVE SULFIDE
MODELS 40&41:RIFT- AND NON-RIFT-RELATED



MODEL 50 BESSHI MASSIVE SULFIDE

OTHER NAMES FOR THIS DEPOSIT TYPE - Besshi type, Kieslager ores

BRIEF DESCRIPTION - Stratabound, stratiform thin sheets of massive to laminated sulfides in thinly-laminated marine sedimentary rocks with mafic tuffs, flows, and sills; deposits are inevitably metamorphosed and folded

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Besshi, Shirataki, Sazare, Motoyasu, Japan; Lokken, Joma, Norway; Kraslice, Czechoslovakia Republic; Kieslager, Austria; Raul, Peru

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Midas, Latouche, Beatson, Ellamar

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Shellebarger Pass, Findalgo, Schlosser, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Greatly to little-metamorphosed: mudstone and sandstone; basaltic to andesitic tuff, breccia, and flow rocks; Mn-rich chert

TEXTURES - Thinly laminated, schistose to gneissic

AGES - Predominantly Paleozoic and Mesozoic

SPECIAL PREREQUISITES - Basaltic volcanism in a sediment-rich setting; anoxic basin?; rifting?; permeable sediments?

ASSOCIATED DEPOSIT TYPES ?

DEPOSIT DESCRIPTION

MINERALOGY - Pyrrhotite, pyrite, chalcopyrite, sphalerite, magnetite, tetrahedrite, quartz, carbonate, albite, sericite, chlorite, tourmaline

TEXTURES - Stratiform, massive to thinly laminated; rare veins/veinlets

ALTERATION - Chloritization

GEOCHEMICAL SIGNATURE - Cu, Zn, Co, Ag, Ni, Cr (Au, As)

Pb ISOTOPE SIGNATURE - Varies with age of deposits and basement

S ISOTOPE SIGNATURE - Varies with age of deposit, $\delta^{34}\text{S}$ of -10 to +25 permil have been recorded; major variations are common in a single deposit

NOTES FOR GRADE/TONNAGE MODELS - Most of the data is from Besshi type deposits of Japan.

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is square miles of "favorable terrane"--that is, areas with or underlain by mixed submarine clastic and mafic volcanic/volcaniclastic rocks

MODEL 50: BESHI TYPE VMS

MODEL 50

Cutoff tonnage (million tons)

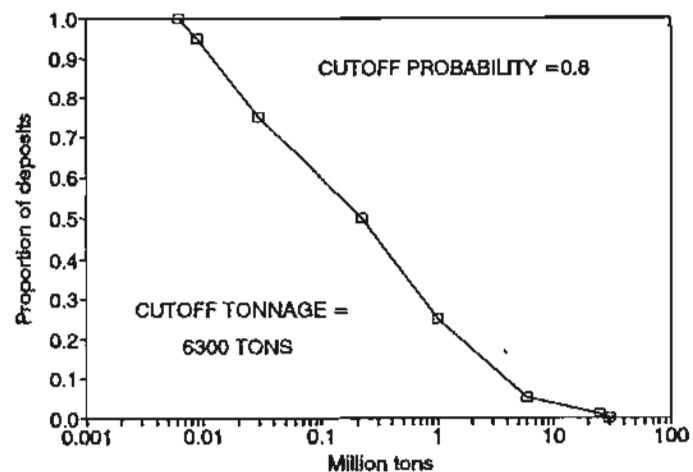
0.0063

Probability that the prospect makes the cutoff tonnage

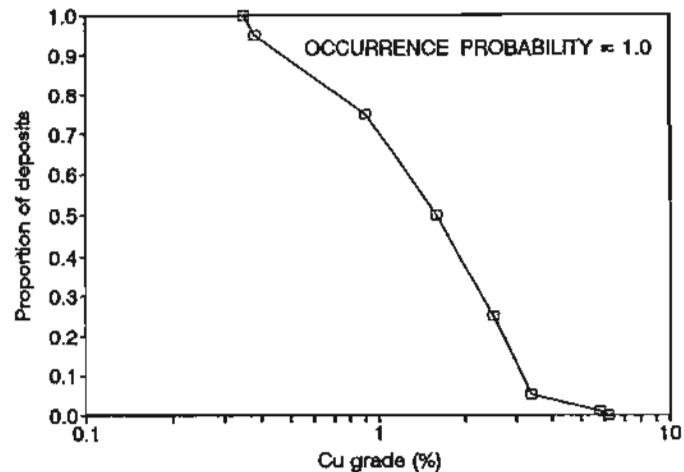
0.8

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 500 SQ MILE AREA								
No. of prospects	0	1	2	2	5	18	35	40
MILLION TONS OF ORE	0.0063	0.009	0.03	0.22	1	6	25	30
P/ COPPER GRADE (%)	0.35	0.38	0.9	1.6	2.5	3.4	5.8	6.2
Occurrence probability of copper	1							
P ZINC GRADE (%)	0.25	0.28	0.36	0.52	0.74	0.95	1.2	1.6
Occurrence probability of zinc	0.8							
P SILVER GRADE (OZ/TON)	0.07	0.085	0.12	0.19	0.29	0.59	1.8	2.21
Occurrence probability of silver	0.7							
P GOLD GRADE (OZ/TON)	0.002	0.003	0.006	0.012	0.022	0.053	0.065	0.074
Occurrence probability of gold	0.8							
P COBALT GRADE (%)	0.03	0.04	0.08	0.1	0.12	0.16	0.19	0.2
Occurrence probability of cobalt	0.8							

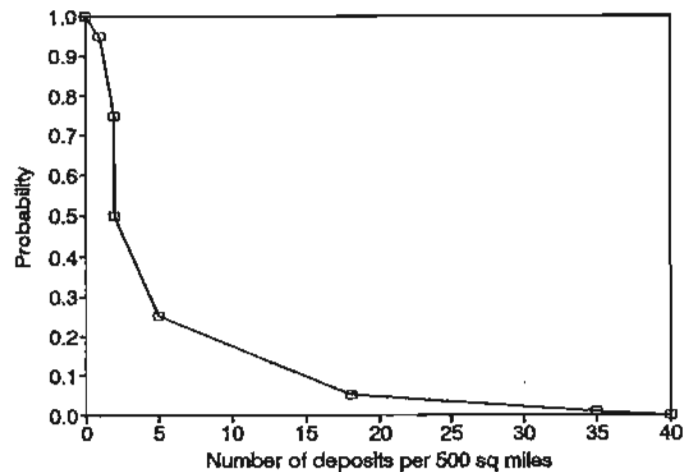
TONNAGE -- BESSHI MASSIVE SULFIDE
MODEL 50



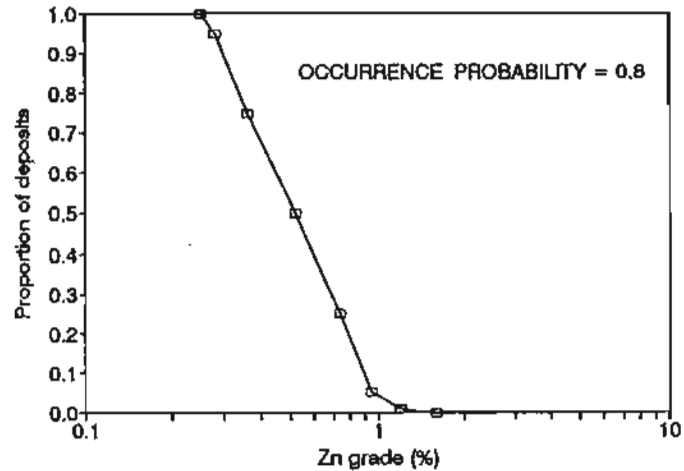
CU GRADE -- BESSHI MASSIVE SULFIDE
MODEL 50



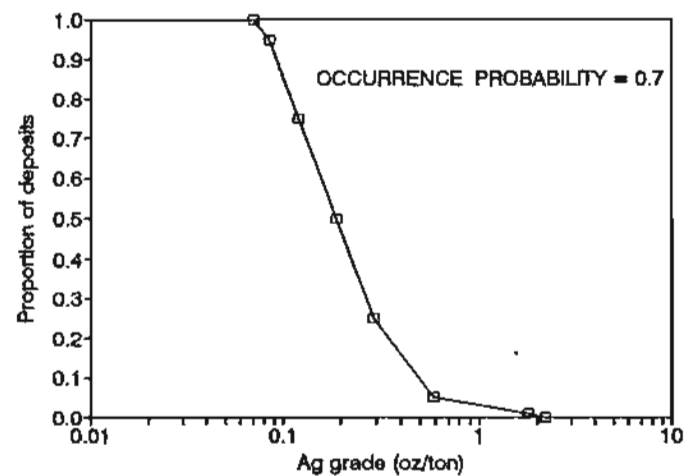
PROSPECT DENSITY-BESSHI MASSIVE SULFIDE
MODEL 50



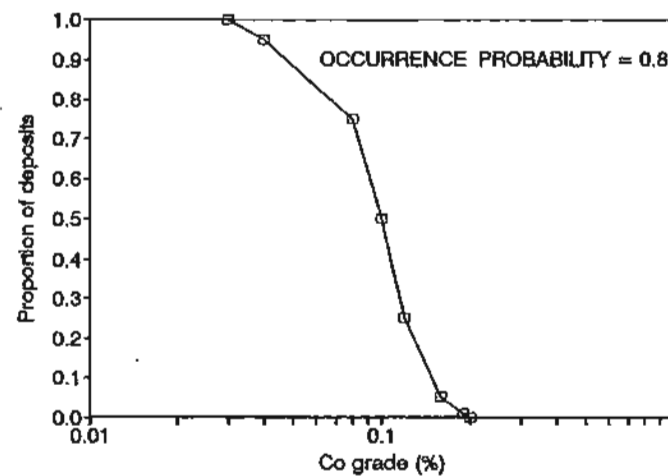
ZN GRADE -- BESSHI MASSIVE SULFIDE
MODEL 50



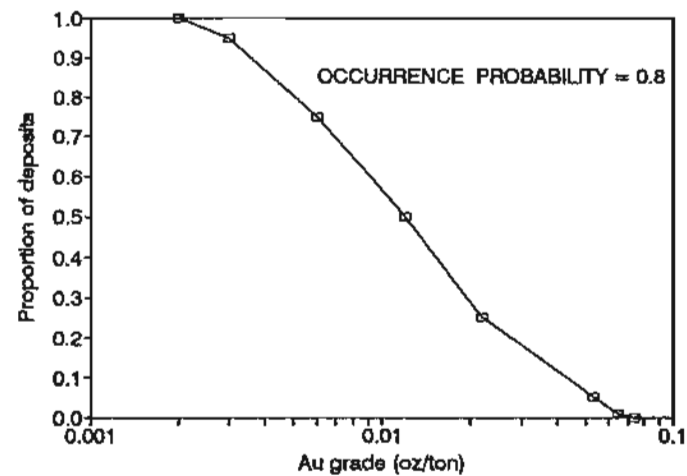
AG GRADE -- BESSHI MASSIVE SULFIDE
MODEL 50



CO GRADE -- BESSHI MASSIVE SULFIDE
MODEL 50



AU GRADE -- BESSHI MASSIVE SULFIDE
MODEL 50



EPITHERMAL DEPOSITS - MODELS 27, 28, AND 42

MODEL 27 SEDIMENT-HOSTED EPITHERMAL GOLD

OTHER NAMES FOR THIS DEPOSIT TYPE - Carlin-type Au, epithermal Au

BRIEF DESCRIPTION - Stratabound to stratiform, very fine-grained, gold and sulfides disseminated in carbonaceous calcareous rocks and associated jasperoids

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Carlin, Getchell, Rain, Prebble, Nevada; Mercur, Utah; Tolman, Idaho; Cinola, Graham Island, British Columbia

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Mex claims, Clearwater Mountains (?)

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Thin-bedded, silty, carbonaceous, dolomitic limestone and calc-shale; felsic dikes

TEXTURES - Porphyritic

AGES - Any, but most known deposits are Tertiary or late Cretaceous

SPECIAL PREREQUISITES - Thrusting?; nearby reduced plutons?; regional-scale fluid collection and movement?; carbonaceous host and source?

ASSOCIATED DEPOSIT TYPES - Placer Au; Sb-Ba veins; Au-bearing skarn

DEPOSIT DESCRIPTION

MINERALOGY - Gold, pyrite, arsenopyrite, realgar, orpiment, barite, cinnabar, quartz, sericite, carbonate, organic matter

TEXTURES - Stratiform-laminated to massive silicification; disseminated sulfides; rare veins

ALTERATION - Silica, clay, carbonate, alunite

GEOCHEMICAL SIGNATURE - Au, As, Hg, W, Sb, Tl

Pb ISOTOPE SIGNATURE - Limited data suggests Tertiary deposits have $^{206}\text{Pb}/^{204}\text{Pb}$ of about 18.5-19

S ISOTOPE SIGNATURE - Limited data for Great Basin suggests $\delta^{34}\text{S}$ of 0 to +10 permil is typical of sulfides; +30 permil is typical for barite

NOTES FOR GRADE/TONNAGE MODELS - Most data is for the Great Basin of the Western United States.

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is square miles of "favorable terrane"--that is, areas with or underlain by carbonaceous calcareous rocks in the vicinity of major faults and volcanic or plutonic rocks

MODEL 27: CARBONATE-HOSTED SILVER-GOLD

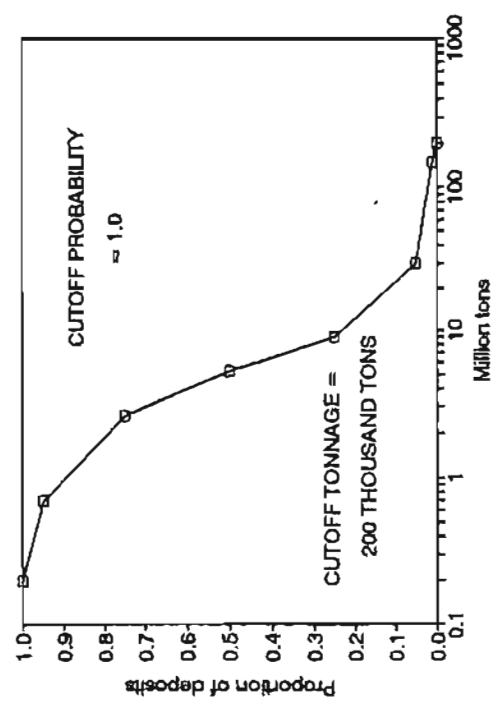
MODEL 27 SILVER GOLD

Cutoff tonnage (million tons)
Probability that the prospect makes the cutoff tonnage

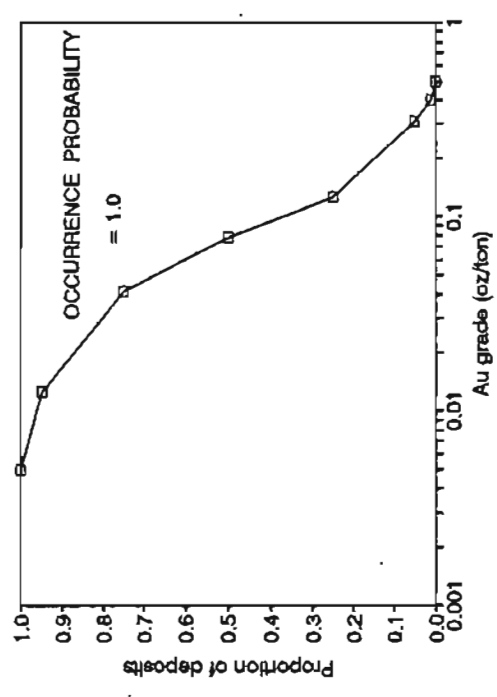
0.2
1

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	1	1	1	1	2	3	3	4
MILLION TONS OF ORE	0.2	0.7	2.6	5.3	9	30	150	200
GOLD GRADE (OZ/TON)	0.005	0.0125	0.041	0.078	0.125	0.31	0.4	0.5
Occurrence probability of gold	1							
SILVER GRADE (OZ/TON)	0.03	0.05	0.1	0.2	0.5	3	6	7
Occurrence probability of silver	1							

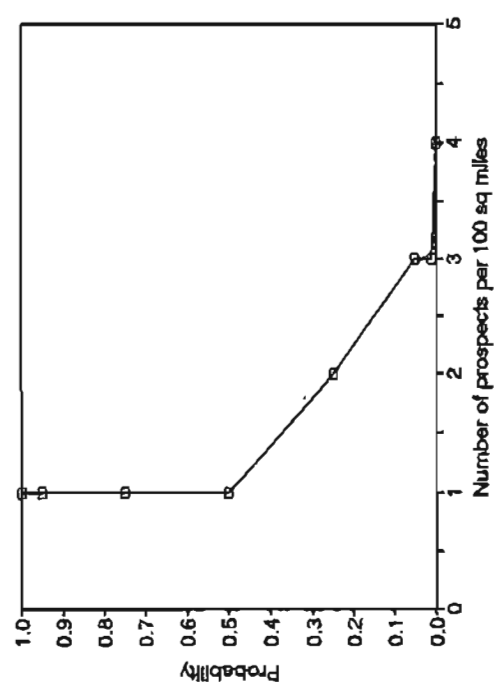
TONNAGE -- CARBONATE GOLD SILVER
MODEL 27



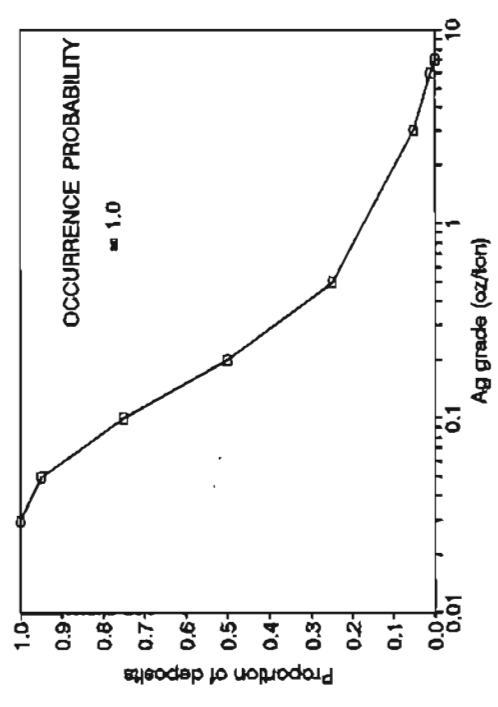
AU GRADE -- CARBONATE GOLD SILVER
MODEL 27



PROSPECT DENSITY--CARBONATE GOLD SILVER
MODEL 27



AG GRADE -- CARBONATE GOLD SILVER
MODEL 27



MODEL 28 HOT SPRINGS MERCURY

OTHER NAMES FOR THIS DEPOSIT TYPE - Epithermal Hg

BRIEF DESCRIPTION - Cinnabar, mercury, and pyrite in siliceous sinter and in volcaniclastic rocks below hot springs, associated with mafic dikes

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - McDermitt, Steamboat Springs, Nevada; Glass Butte, Opalite, Oregon; Manhattan, Sulphur Bank, California; Almaden, Spain; Santa Barbara, Peru

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Cinnabar Creek, Red Devil, DeCoursey Mountain

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - White Mountain, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Graywacke, shale; andesite-basalt dikes, sills, flows, tuffs, breccia; siliceous sinter

TEXTURES - Layered, porphyritic, breccia

AGES - Any, but most known deposits are Tertiary or late Cretaceous

SPECIAL PREREQUISITES - Bimodal or alkalic volcanism is most typical; organic-rich graywacke basement?; high-angle faults

ASSOCIATED DEPOSIT TYPES - Placer Au; Sb veins; epithermal Au

DEPOSIT DESCRIPTION

MINERALOGY - Marcasite, cinnabar, mercury, pyrite, sulfur, clay, carbonate, quartz, chalcedony, chlorite

TEXTURES - Disseminated, fracture-coatings

ALTERATION - Silica, clay, propylitic

GEOCHEMICAL SIGNATURE - Hg, Sb, As (Au)

Pb ISOTOPE SIGNATURE - $^{206}\text{Pb}/^{204}\text{Pb}$ is about 19 for Tertiary examples

S ISOTOPE SIGNATURE - ??

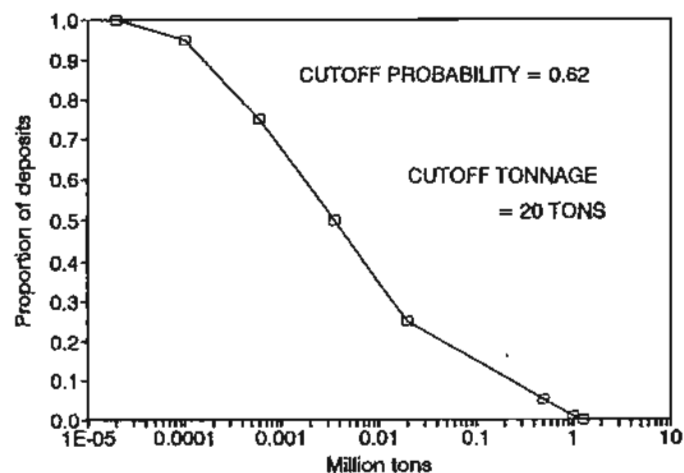
NOTES FOR GRADE/TONNAGE MODELS - Most of the data is from the Western United States. This model combines sinter and "below-sinter" deposits.

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is square miles of "favorable terrane"—that is, areas with or underlain by greywacke w/basalt-andesite dikes near major fault zones

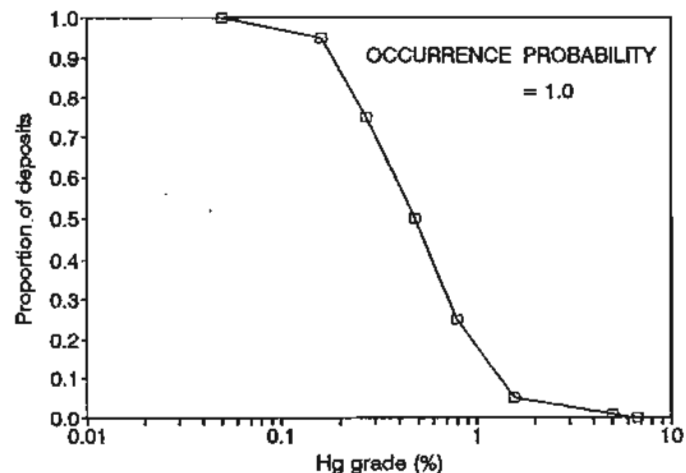
MODEL 28: HG HOT SPRING RELATED

MODEL 28	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							0.00002 0.62
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	0	0	0	1	1	5	7	8
MILLION TONS OF ORE	0.00002	0.0001	0.0006	0.0035	0.02	0.5	1	1.3
MERCURY GRADE (%)	0.05	0.16	0.27	0.48	0.79	1.56	5	6.7
Occurrence probability of mercury	1							
ANTIMONY GRADE (%)	1	1.5	2.4	3.6	5.9	8	9.5	10
Occurrence probability of antimony	1							
GOLD GRADE (OZ/TON)	0.003	0.005	0.02	0.05	0.2	0.5	2	2.5
Occurrence probability of gold	1							

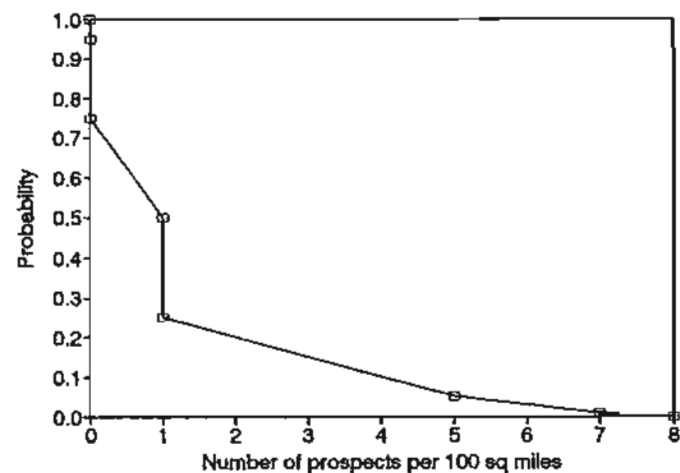
TONNAGE – HG-HOT SPRING RELATED
MODEL 28



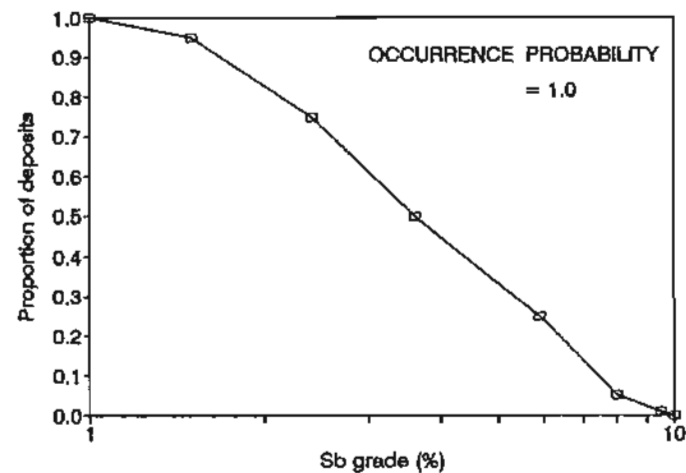
HG GRADE – HG-HOT SPRING RELATED
MODEL 28



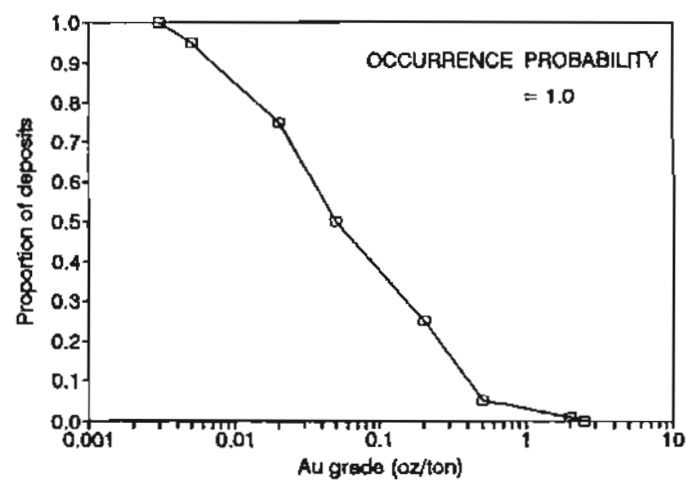
PROSPECT DENSITY – HG-HOT SPRING RELATED
MODEL 28



SB GRADE – HG-HOT SPRING RELATED
MODEL 28



AU GRADE - HG-HOT SPRING RELATED
MODEL 28



67

MODEL 42 GENERIC VOLCANIC-HOSTED EPITHERMAL GOLD

OTHER NAMES FOR THIS DEPOSIT TYPE - Epithermal Au, Comstock type, hot spring Au

BRIEF DESCRIPTION - Stratabound, stratiform to vein-breccia, fine- to coarse-grained, gold and sulfides in volcanic rocks and silica-rich hot springs deposits

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Round Mountain, Comstock, Tonopah, Nevada; McLaughlin, Bodie, California; Delamar, Idaho; Oatman, Arizona; Mongollon, New Mexico; Creede, Colorado; Hauraki, New Zealand; Sado, Japan; Republic, Washington; Tayoltita, Pachuca, Zacatecas, Mexico

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Apollo, Shumagin

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Canoe Bay, Aquila, San Diego Bay, Kuy, Fog Lake, Taylor Mountains, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Rhyolite, andesite, dacite, rhyodacite; hypabyssal domes and stocks; felsic dikes

TEXTURES - Porphyritic, breccia

AGES - Any? but most known deposits are Tertiary or late Cretaceous

SPECIAL PREREQUISITES - Bimodal or alkalic volcanism is most typical; caldera formation is common;

ASSOCIATED DEPOSIT TYPES - Placer Au; hot-spring Hg; polymetallic veins

DEPOSIT DESCRIPTION

MINERALOGY - Gold, pyrite, barite, + arsenopyrite, realgar, orpiment, cinnabar, chalcopyrite, tellurides, fluorite, hematite; quartz, sericite, adularia, carbonate, chlorite, chalcedony, kaolinite, clays

TEXTURES - Banded veins, open-space fillings, stockworks, breccias, comb structure, crustification, lamellar quartz

ALTERATION - Silica, clay, alunite, adularia, propylitic

GEOCHEMICAL SIGNATURE - Au, As, Hg, Sb, Tl, Ag (Pb, Zn, Cu, Te, W)

Pb ISOTOPE SIGNATURE - Tertiary deposits have $^{206}\text{Pb}/^{204}\text{Pb}$ of about 18-19; values apparently depend on nature and age of basement rocks

S ISOTOPE SIGNATURE - Limited data for Great Basin suggests $\delta^{34}\text{S}$ of 0 to +5 permil is typical of sulfides; +30 permil is typical for barite

NOTES FOR GRADE/TONNAGE MODELS - Most of the data is from the Great Basin of the Western United States. This model combines a variety of volcanic-hosted, epithermal deposits, including acid-sulfate, adularia-quartz, hot springs, and Sado types.

PROSPECT

NOTES FOR ~~DEPOSIT~~ DENSITY MODEL - Input parameter is square miles of "favorable terrane" --that is, areas with or underlain by altered subaerial volcanic rocks, especially in caldera settings

MODEL 42: VOLCANIC HOSTED EPITHERMAL

MODEL 42

Cutoff tonnage (million tons)

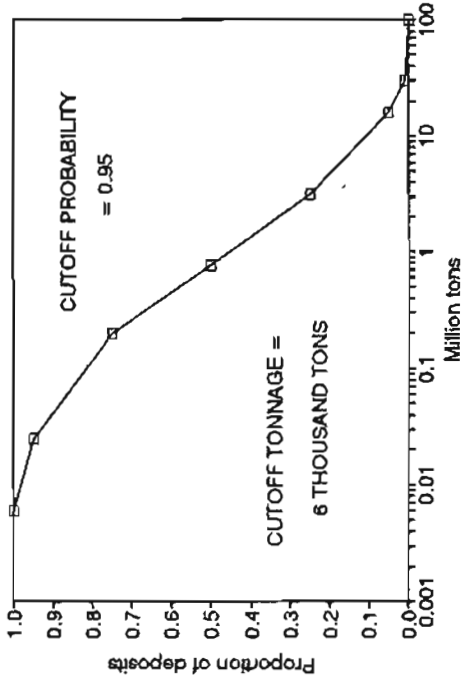
0.006

Probability that the prospect makes the cutoff tonnage

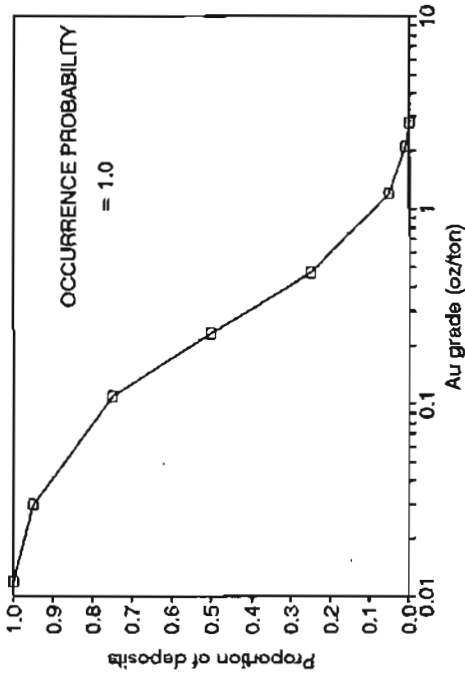
0.95

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 500 SQ MILE AREA								
No. of prospects	0	0	1	2	3	13	15	25
MILLION TONS OF ORE	0.006	0.025	0.2	0.77	3.2	16	30	100
GOLD GRADE (OZ/TON)	0.012	0.03	0.11	0.23	0.47	1.2	2.1	2.8
Occurrence probability of gold	1							
SILVER GRADE (OZ/TON)	0.02	0.19	0.96	3.3	13.5	54	76	150
Occurrence probability of silver	1							

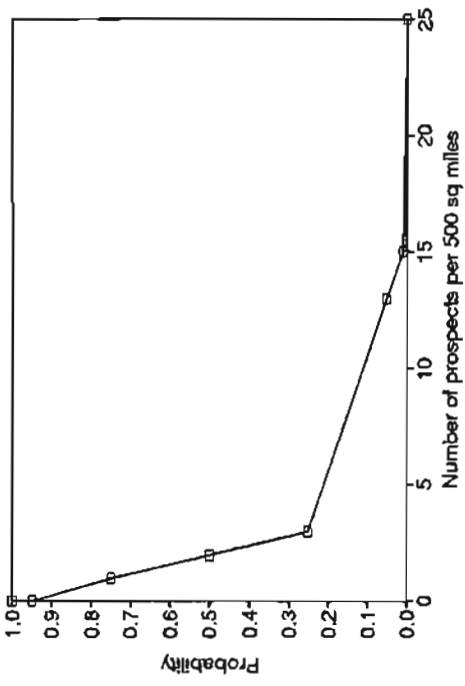
TONNAGE -- VOLCANIC-EPITHERMAL SYSTEMS
MODEL 42



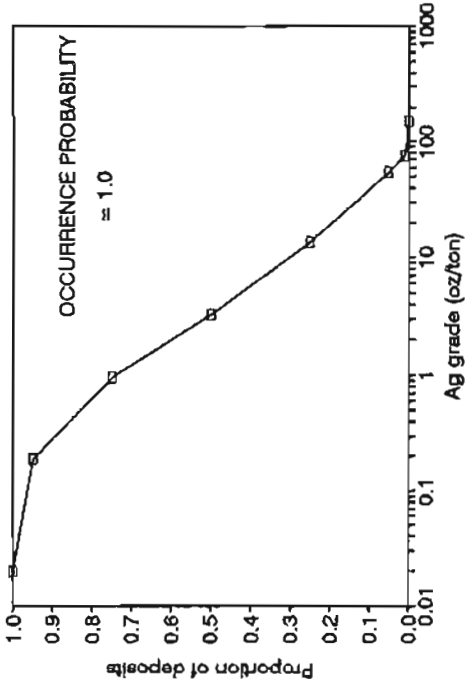
AU GRADE -- VOLCANIC-EPITHERMAL SYSTEMS
MODEL 42



PROSPECT DENSITY--VOL-EPITHERMAL SYS.
MODEL 42



AG GRADE -- VOLCANIC-EPITHERMAL SYSTEMS
MODEL 42



SEDIMENT-HOSTED STRATIFORM LEAD-ZINC - MODELS 29 AND 30

MODELS 29 (DISTRICTS) AND 30 (LARGE AREAS)

OTHER NAMES FOR THIS DEPOSIT TYPE - Shale-hosted Pb-Zn; sedex deposits

BRIEF DESCRIPTION - Stratiform tabular lenses of sulfide and sulfate minerals thinly interbedded with marine sedimentary rocks and underlain by veins

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Sullivan, Cirque, British Columbia; Howards Pass, McMillan, Faro, Yukon; Meggan, Rammelsberg, Germany; Broken Hill, McArthur, Mt Isa, Australia

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Red Dog, Lik

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Drenchwater, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Thick sequences of carbonaceous marine sediments, including shales, carbonates, and siltstones, with local slump breccias

TEXTURES - Breccias, conglomerates, and veins common under ores

AGES - Middle Proterozoic and Cambrian to Carboniferous

SPECIAL PREREQUISITES - Rifted (pull-apart) basin? euxinic event? minor basaltic volcanism?

ASSOCIATED DEPOSIT TYPES - Stratiform sediment-hosted barite

DEPOSIT DESCRIPTION

MINERALOGY - Pyrite, pyrrhotite, sphalerite, galena, barite, marcasite, chalcopyrite, quartz, ferroan dolomite, muscovite

TEXTURES - Thinly laminated sulfides, underlain by veins

ALTERATION - Sericite, albite, chlorite, carbonate (tourmaline)

GEOCHEMICAL SIGNATURE - Pb, Zn, Ba, Ag, Mn, Cu, NH₃

Pb ISOTOPE SIGNATURE - Varies with age: Proterozoic deposits have ²⁰⁶Pb/²⁰⁴Pb of 16 to 17; Paleozoic deposits have ²⁰⁶Pb/²⁰⁴Pb of 18 to 19

S ISOTOPE SIGNATURE - Varies tremendously between deposits (+25 to -25 permil); usual variations of ca. 10-15 permil within a deposit

NOTES FOR GRADE/TONNAGE MODELS

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is square miles of "favorable" area, that is, area with - "favorable" stratigraphy/geochemistry; the "district" model has a higher prospect density than the "large favorable area" model

MODEL 29-30: LEAD-ZINC SEDEX

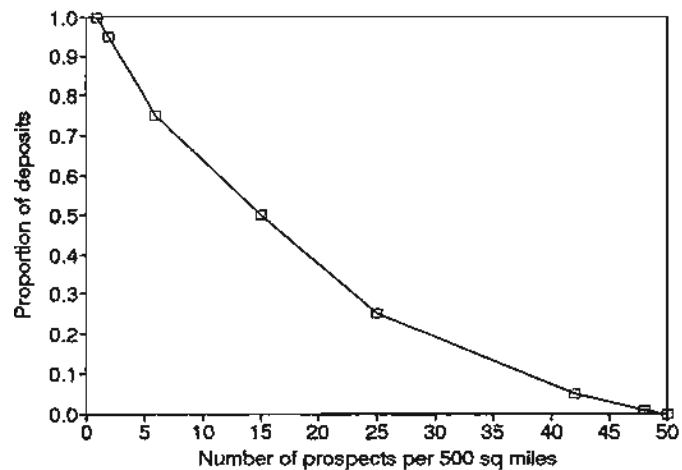
MODEL 29 DISTRICTS
MODEL 30 LARGE AREAS

Cutoff tonnage (million tons)
Probability that the prospect makes the cutoff tonnage

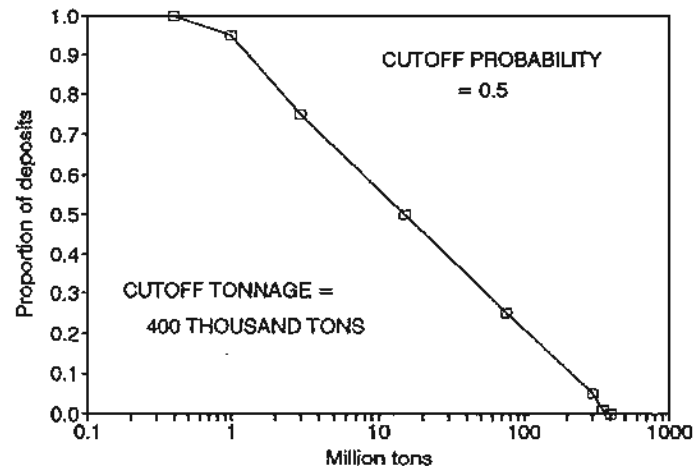
0.4
0.5

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 500 SQ MILE AREA								
MODEL 29:								
No. of prospects	1	2	6	15	25	42	48	50
MODEL 30:								
No. of prospects	1	1	2	2	3	4	5	7
MILLION TONS OF ORE	0.4	1	3	15	75	300	350	400
ZINC GRADE (%)	1.3	2.5	5	8	12	19	21	22
Occurrence probability of zinc	1							
LEAD GRADE (%)	0.3	0.85	2.8	4.4	6.5	10	11.5	12
Occurrence probability of lead	1							
SILVER GRADE (OZ/TON)	0.1	0.2	1	2	3	7	8	9
Occurrence probability of silver	0.85							

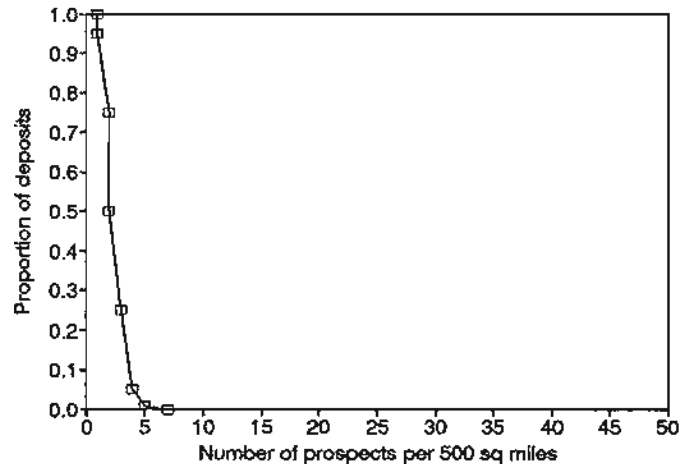
PROSPECT DENSITY – LEAD-ZINC SEDEX
MODEL 29, DISTRICTS



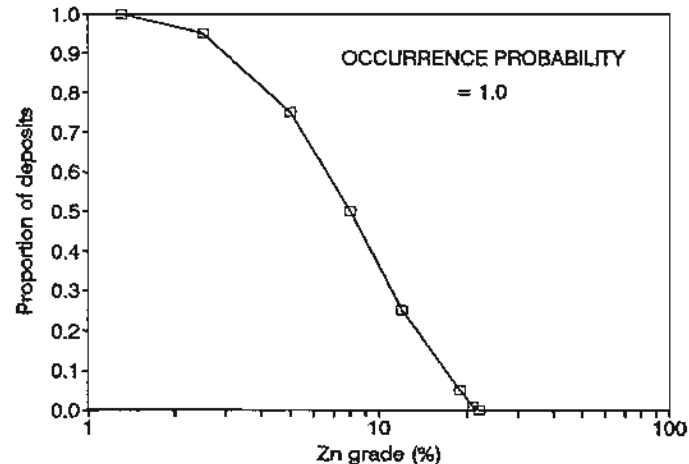
TONNAGE – LEAD-ZINC SEDEX
MODELS 29 AND 30, DISTRICTS AND AREAS



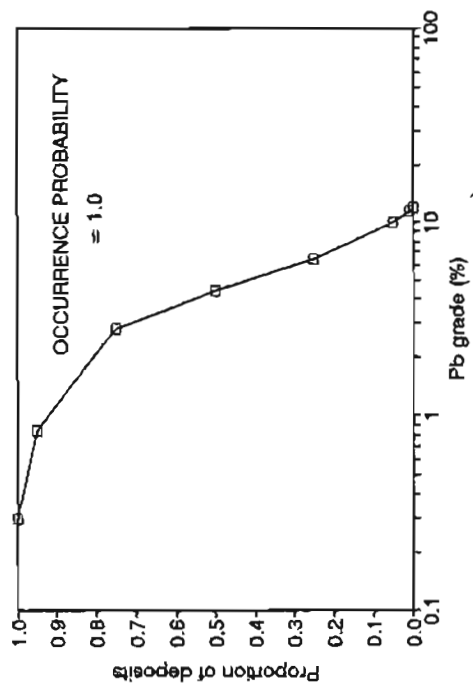
PROSPECT DENSITY – LEAD-ZINC SEDEX
MODEL 30, AREAS



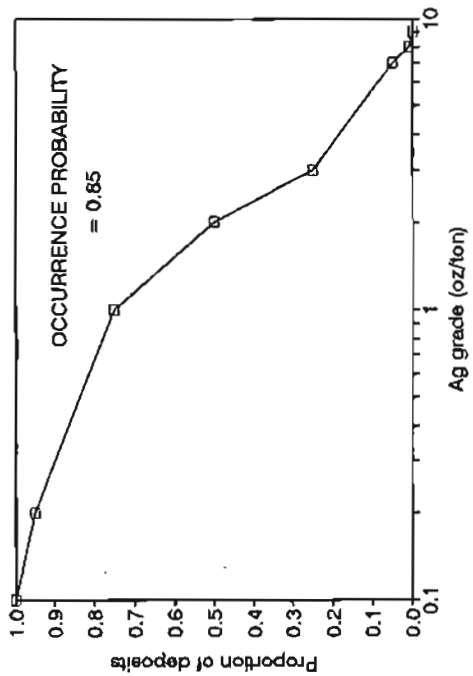
ZN GRADE – LEAD-ZINC SEDEX
MODELS 29 AND 30, DISTRICTS AND AREAS



PB GRADE -- LEAD-ZINC SEDEX
MODELS 29 AND 30, DISTRICTS AND AREAS



AG GRADE -- LEAD-ZINC SEDEX
MODELS 29 AND 30, DISTRICTS AND AREAS



METAMORPHIC DEPOSITS - MODELS 31, 32, 47, AND 48

MODELS 31 METAMORPHIC GOLD DEPOSITS, "BELT" TYPE

OTHER NAMES FOR THIS DEPOSIT TYPE - Low-sulfide Au-quartz veins, mesothermal quartz veins

BRIEF DESCRIPTION - Gold-bearing, persistent quartz veins in regionally metamorphosed terranes; groups of deposits occur in elongate structural belts

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Mother Lode, Grass Valley, California; Piedmont gold belt, North and South Carolina; Bridge River district, British Columbia; Otago Schist belt, New Zealand

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Alaska-Juneau, Treadwell, Kensington, Jualin, Sumdum Chief, Willow, Big Hurrah, Chandalar district, Cliff, Chichagoff, Nuka Bay, Lucky Strike

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Monarch, Jewel, Goldstream, Gold Standard, Apex, Nome, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Regionally metamorphosed rocks, typically complex packages of volcanic, plutonic, and sedimentary types

TEXTURES - Schistose to gneissic, veined

AGES - Archean to Tertiary

SPECIAL PREREQUISITES - Major structural zones; abundant compressional and extensional structures; competency contrasts; greenschist to amphibolite metamorphism; inverted metamorphic belt?

ASSOCIATED DEPOSIT TYPES - Placer Au; volcanogenic massive sulfides

DEPOSIT DESCRIPTION

MINERALOGY - Gold, pyrrhotite, pyrite, chalcopyrite, sphalerite, galena, scheelite, stibnite, quartz, carbonate, sericite, chlorite, tourmaline

TEXTURES - Veins, stockworks, saddle reefs, ribbon quartz, shearing

ALTERATION - Sericite, quartz, chlorite, carbonate, albite

GEOCHEMICAL SIGNATURE - Au, As, Ag, Cu, Zn, Pb

Pb ISOTOPE SIGNATURE - Varies considerably with age of deposit and age/character of basement

S ISOTOPE SIGNATURE - Varies with deposit host rocks. most values of $\delta^{34}\text{S}$ are from -20 to +10 permil; plutonic-hosted deposits have $\delta^{34}\text{S}$ of 0 ± 5 permil; there is little variation within a single deposit

NOTES FOR GRADE/TONNAGE MODELS - Deposits within a mile of each other have been lumped together for tonnage estimation

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is linear miles of "favorable belt"--that is, a major structural zone with abundant quartz veining and evidence of metamorphism/fluid movement

MODEL 32 METAMORPHIC GOLD DEPOSITS, "AREA" TYPE

OTHER NAMES FOR THIS DEPOSIT TYPE - Low-sulfide Au-quartz veins, mesothermal quartz veins

BRIEF DESCRIPTION - Gold-bearing, persistent quartz veins in regionally metamorphosed terranes; deposits occur in an irregularly defined area

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Klamath Mountains, California; Meguma goldfields, Nova Scotia; Ballarat Goldfield, Victoria, Australia; Yana-Kolyma, Russia

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Nome district

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Bluff, Sukakpak Mountain, Purdy, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Regionally metamorphosed rocks, typically complex packages of volcanic, plutonic, and sedimentary types

TEXTURES - Schistose to gneissic, veined

AGES - Archean to Tertiary

SPECIAL PREREQUISITES - Abundant compressional and extensional structures; competency contrasts; greenschist to amphibolite metamorphism

ASSOCIATED DEPOSIT TYPES - Placer Au; volcanogenic massive sulfides

DEPOSIT DESCRIPTION

MINERALOGY - Gold, pyrrhotite, pyrite, chalcocopyrite, sphalerite, galena, scheelite, stibnite, quartz, carbonate, sericite, chlorite, tourmaline

TEXTURES - Veins, stockworks, saddle reefs, ribbon quartz, shearing

ALTERATION - Sericite, quartz, chlorite, carbonate, albite

GEOCHEMICAL SIGNATURE - Au, As, Ag, Pb, Zn, Cu

Pb ISOTOPE SIGNATURE - Varies considerably with age of deposit and age/character of basement

S ISOTOPE SIGNATURE - Varies with deposit host rocks, most values of $\delta^{34}\text{S}$ are from -20 to +10 permil; plutonic-hosted deposits have $\delta^{34}\text{S}$ of 0 ± 5 permil; there is little variation within a single deposit

NOTES FOR GRADE/TONNAGE MODELS - Deposits within a mile of each other have been lumped together for tonnage estimation

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is square miles of "favorable area"—that is., an area with abundant quartz veining and evidence of metamorphism/fluid movement

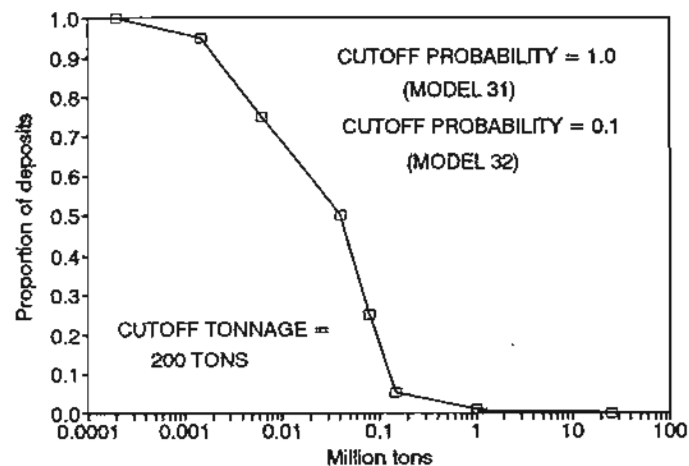
MODEL 31-32: METAMORPHIC GOLD VEINS

MODEL 31 BELT DEPOSITS
MODEL 32 AREA DEPOSITS

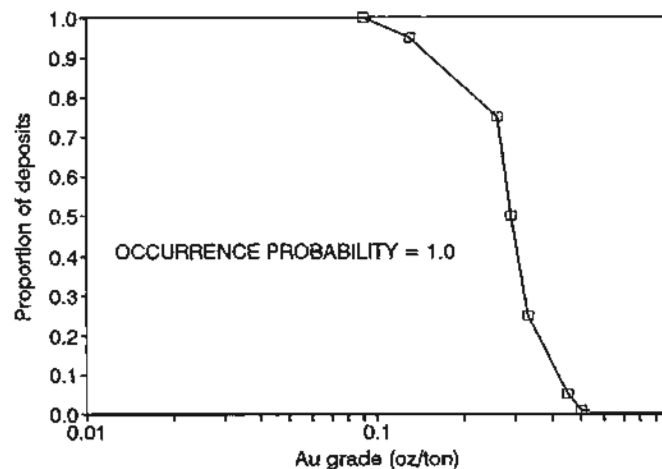
Cutoff tonnage (million tons) 0.0002
Probability that the prospect makes the cutoff tonnage (Model 31) 1
Probability that the prospect makes the cutoff tonnage (Model 32) 0.1

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN BELT 25 MILES LONG								
No. of prospects	1	3	8	25	45	95	106	113
MILLION TONS OF ORE	0.0002	0.0015	0.0063	0.041	0.08	0.15	1	25
P1 GOLD GRADE (OZ/TON)	0.09	0.13	0.26	0.29	0.33	0.45	0.5	1
Occurrence probability of gold	1							
P SILVER GRADE (OZ/TON)	0.1	0.11	0.13	0.16	0.29	0.64	0.8	1
Occurrence probability of silver	0.1							

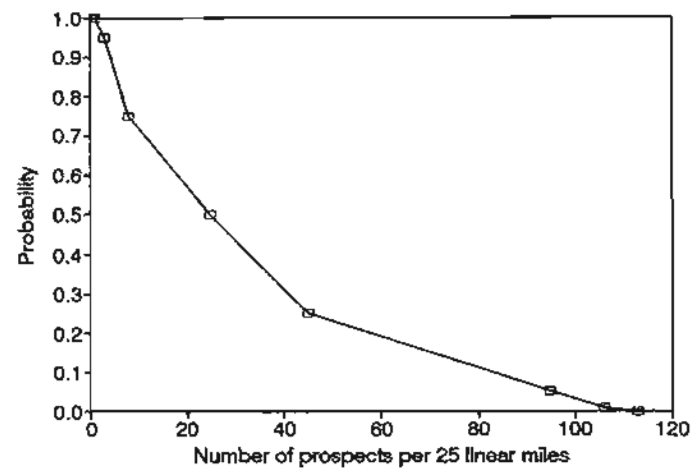
TONNAGE -- METAMORPHIC GOLD
MODELS 31 AND 32



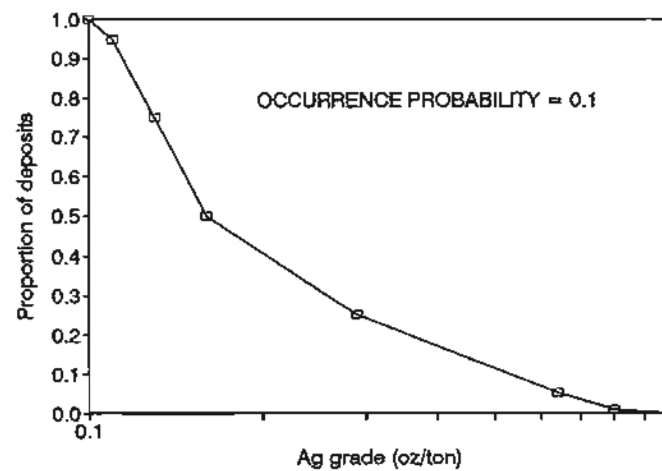
AU GRADE -- METAMORPHIC GOLD
MODELS 31 AND 32



PROSPECT DENSITY -- METAMORPHIC GOLD
MODELS 31 AND 32



AG GRADE -- METAMORPHIC GOLD
MODELS 31 AND 32



MODEL 47 SEDIMENT-HOSTED, BASALT-ASSOCIATED COPPER

OTHER NAMES FOR THIS DEPOSIT TYPE - Basaltic Cu

BRIEF DESCRIPTION - Stratabound, but discordant, Cu-rich sulfide bodies, layers, and veins in carbonate and carbonate-bearing rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Boleo district, Mexico; White Pine, Michigan; Sustut, British Columbia

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Kennicott, Bonanza, Jumbo, Regal, Green Butte, Binocular, Denali

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Nelson, Westover, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Limestone or calcareous sediment, subaerial basalt, red-bed sandstone and conglomerate

TEXTURES - Amygdules and flow-tops in basalts

AGES - Proterozoic, Mesozoic, and Tertiary deposits known

SPECIAL PREREQUISITES - Subaerial, rift-related basalt with overlying carbonaceous and/or calcareous sediment; mild regional metamorphism

ASSOCIATED DEPOSIT TYPES - Basalt-hosted Cu

DEPOSIT DESCRIPTION

MINERALOGY - Chalcocite, bornite, chalcopyrite, pyrite, dolomite.

TEXTURES - Layered or massive, minor veins

ALTERATION - Regional zeolite-facies propylitization; hematite

GEOCHEMICAL SIGNATURE - Cu, Ag (Se)

Pb ISOTOPE SIGNATURE - Mesozoic deposits have $^{206}\text{Pb}/^{204}\text{Pb}$ of 18.5-19

S ISOTOPE SIGNATURE - Limited data suggest +5 to +15 permil

NOTES FOR GRADE/TONNAGE MODELS - Data mostly from North American deposits

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles, derived from linear miles of sediment-basalt contact times 1/2 mile

MODEL 47: SED-HOSTED COPPER

MODEL 47 BASALT ASSOC.

Cutoff tonnage (million tons)

0.0001

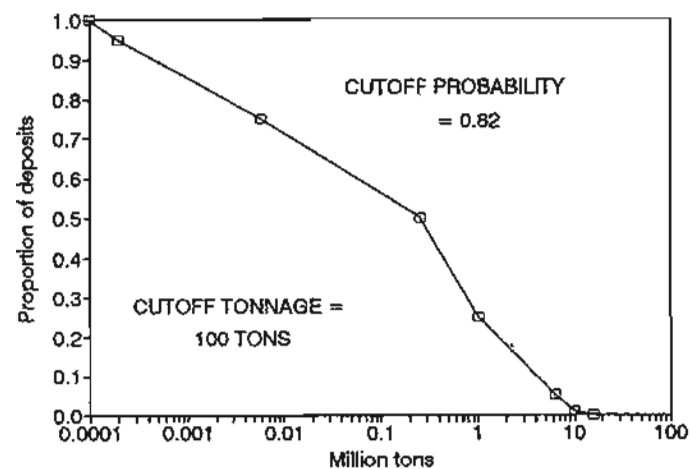
Probability that the prospect makes the cutoff tonnage

0.82

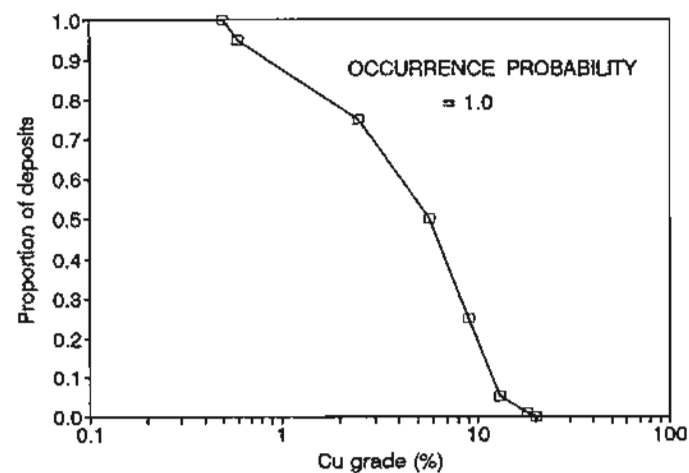
PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	1	2	6	20	40	80	140	160
MILLION TONS OF ORE	0.0001	0.0002	0.006	0.25	1	6.3	10	16
COPPER GRADE (%)	0.5	0.6	2.5	5.7	9	13	18	20
Occurrence probability of copper	1							
SILVER GRADE (OZ/TON)	0.05	0.15	0.4	0.7	0.8	2	3	5
Occurrence probability of silver	1							

0.8

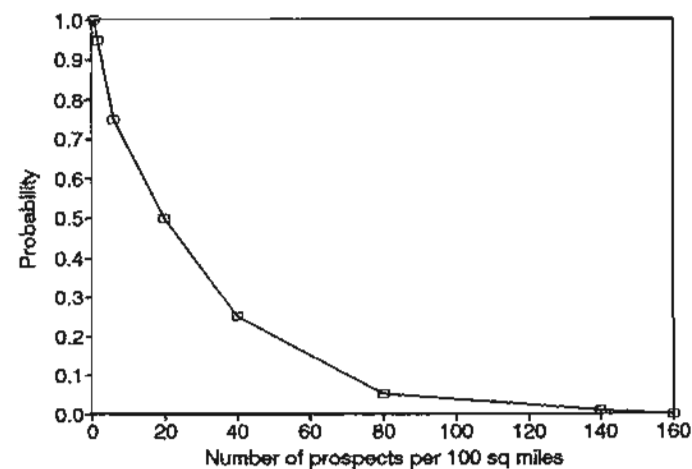
TONNAGE -- SEDIMENT-HOSTED COPPER
MODEL 47



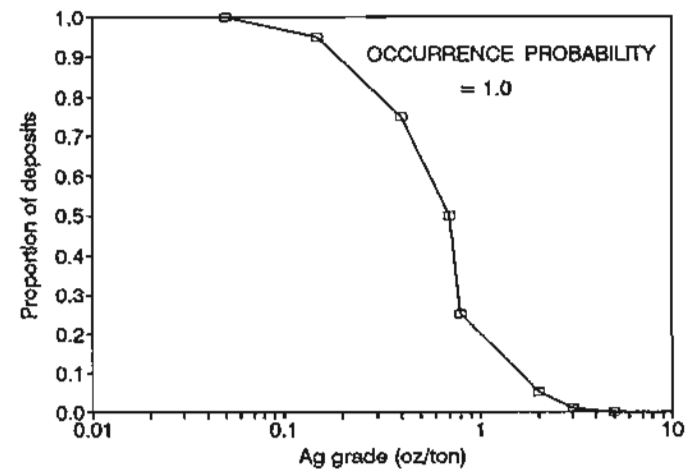
CU GRADE -- SEDIMENT-HOSTED COPPER
MODEL 47



PROSPECT DENSITY -- SEDIMENT-HOSTED
COPPER -- MODEL 47



AG GRADE -- SEDIMENT-HOSTED COPPER
MODEL 47



MODEL 48 BASALT-HOSTED COPPER

OTHER NAMES FOR THIS DEPOSIT TYPE - Basaltic Cu; Cu-Ag vein

BRIEF DESCRIPTION - Stratabound, but discordant, native Cu and Cu-rich sulfide bodies, layers, and veins in subaerial, rift-related basalt

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Keweenaw, Calumet, Michigan; Redstone, Northwest Territories; Tokrau, Kazakhstan; Buena Esperanza, Chile; White River, Yukon

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Kathleen-Margaret, Erickson, Nikolai

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA - Nugget Creek, Nelson, Baker Peak, Alaska

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Subaerial, rift-related basalt

TEXTURES - Amygdules and flow-tops in basalts

AGES - Proterozoic, Mesozoic, and Tertiary deposits known

SPECIAL PREREQUISITES - Subaerial, rift-related basalt; mild regional metamorphism

ASSOCIATED DEPOSIT TYPES - Sediment-hosted, basalt-related Cu

DEPOSIT DESCRIPTION

MINERALOGY - Native Cu, Ag, chalcocite, bornite, chalcopyrite, pyrite, epidote, quartz, calcite, chlorite, albite

TEXTURES - Disseminated, massive, veins

ALTERATION - Regional propylitization; hematite

GEOCHEMICAL SIGNATURE - Cu, Ag (Se)

Pb ISOTOPE SIGNATURE - Mesozoic deposits have $^{206}\text{Pb}/^{204}\text{Pb}$ of 18.5-19

S ISOTOPE SIGNATURE - Limited data suggest +0 to +5 permil

NOTES FOR GRADE/TONNAGE MODELS - Data mostly from North American deposits; Proterozoic deposits are apparently much larger than Mesozoic examples and consequently, the upper end of the tonnage distribution may be inapplicable to Alaskan prospects

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" basaltic rock

MODEL 48: BASALT-HOSTED COPPER

MODEL 48

Cutoff tonnage (million tons)

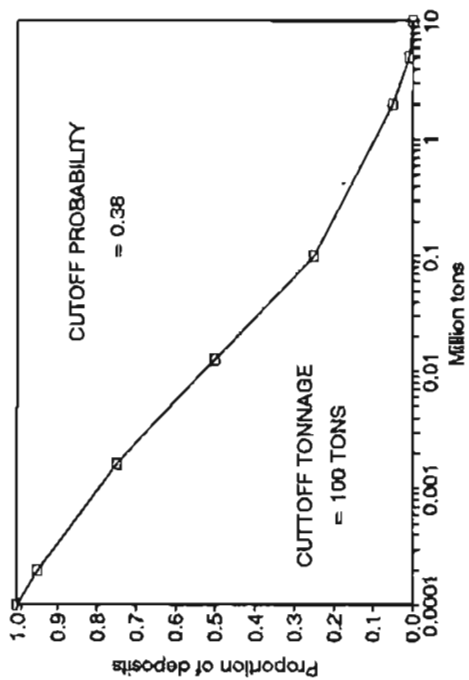
0.0001

Probability that the prospect makes the cutoff tonnage

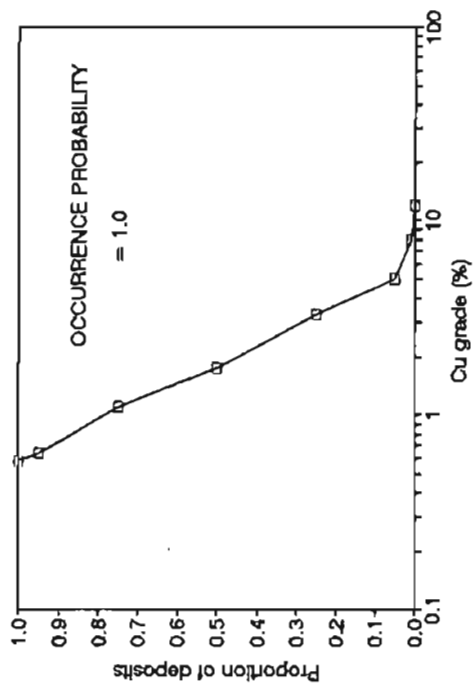
0.38

PROBABILITY	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	1	2	6	20	40	80	140	160
MILLION TONS OF ORE	0.0001	0.0002	0.0016	0.0126	0.1	2	5	10
COPPER GRADE (%)	0.58	0.63	1.1	1.75	3.3	5	8	12
Occurrence probability of copper	1							
SILVER GRADE (OZ/TON)	0.05	0.1	0.25	0.52	1.2	3.5	5	6
Occurrence probability of silver	1							

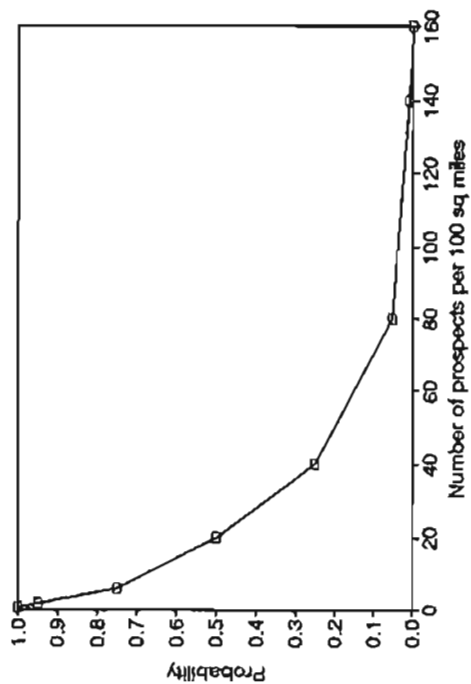
TONNAGE -- BASALT-HOSTED NI-CU
MODEL 48



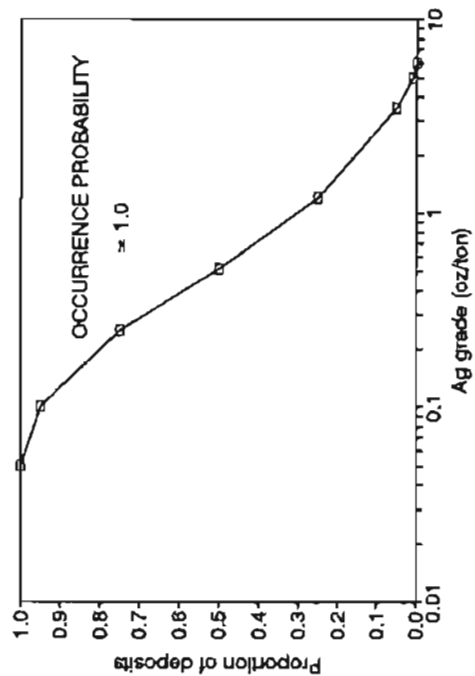
CU GRADE -- BASALT-HOSTED NI-CU
MODEL 48



PROSPECT DENSITY -- BASALT-HOSTED NI-CU
MODEL 48



AG GRADE -- BASALT-HOSTED NI-CU
MODEL 48



PLACER GOLD \pm PGE - MODELS 33, 69, AND 49

MODEL 33 PLACER GOLD (LARGE STREAMS AND RIVERS)

OTHER NAMES FOR THIS DEPOSIT TYPE

BRIEF DESCRIPTION - Native gold grains and nuggets in gravel

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Victoria, Australia; Lena Basin, Russia; Yuba-American River, California; Klondike, Yukon

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Fairbanks, Valdez Creek, Hammond River, Flat, Chistochina

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Alluvial gravel and conglomerate

TEXTURES - Clastic

AGES - Cenozoic

SPECIAL PREREQUISITES - Lode Au source

ASSOCIATED DEPOSIT TYPES - Almost any Au-bearing lode deposit

DEPOSIT DESCRIPTION

MINERALOGY - Au-Ag alloys, magnetite, chromite, garnet, quartz

TEXTURES - Flattened nuggets

ALTERATION - None

GEOCHEMICAL SIGNATURE - Au, As, Ag, Hg, Zr, Ti, PGE, Cr

Pb ISOTOPE SIGNATURE - ?

S ISOTOPE SIGNATURE - ?

NOTES FOR GRADE/TONNAGE MODELS - This model is for areas where large stream/river placers are geomorphologically possible

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is square miles of area drained by "favorable" drainages, that is, those with known or suspected Au-lode sources

MODEL 69 PLACER GOLD (SMALL STREAMS AND GULCHES)

OTHER NAMES FOR THIS DEPOSIT TYPE - Small gold placers

BRIEF DESCRIPTION - Native gold grains and nuggets in gravel

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Helena, Montana; Deadwood, South Dakota; Morobe, New Guinea; Nelson, New Zealand; Boulder, Colorado; Adelong Creek, New South Wales

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Livengood, Circle, Hope, Noatak, Kantishna, Willow Creek, Gold Creek

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Alluvial gravel and conglomerate

TEXTURES - Clastic

AGES - Cenozoic

SPECIAL PREREQUISITES - Lode Au source

ASSOCIATED DEPOSIT TYPES - Almost any Au-bearing lode deposit

DEPOSIT DESCRIPTION

MINERALOGY - Au-Ag alloys, magnetite, chromite, garnet, quartz

TEXTURES - Flattened nuggets

ALTERATION - None

GEOCHEMICAL SIGNATURE - Au, As, Ag, Hg, Zr, Ti, PGE, Cr

Pb ISOTOPE SIGNATURE - ?

S ISOTOPE SIGNATURE - ?

NOTES FOR GRADE/TONNAGE MODELS - This model is for areas where only small streams and gulches are geomorphologically possible

NOTES FOR PROSPECT DENSITY MODEL - Input parameter is square miles of area drained by "favorable" drainages, that is, those with known or suspected Au-lode sources

MODEL 33-69: GOLD PLACERS

MODEL 33 LARGE STREAMS
MODEL 69 SMALL STREAMS

PROBABILITY	100	95	75	50	25	5	1	0.0011
								1

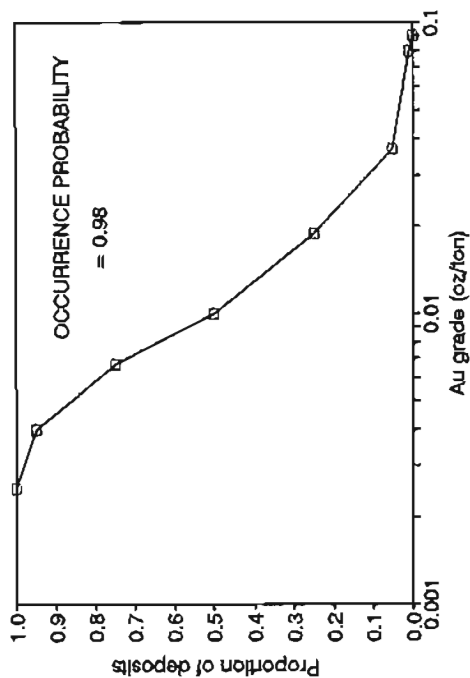
PROSPECT DENSITY WITHIN 100 SQ MILE AREA

No. of prospects	0	0	1	2	5	8	10	11
MILLION TONS OF ORE (Model 33)	0.0011	0.0014	0.14	2.1	4.2	11	15	28
MILLION TONS OF ORE (Model 69)	0.0011	0.0014	0.014	0.14	0.25	0.5	1	5
GOLD GRADE (OZ/TON)	0.0025	0.004	0.0067	0.01	0.019	0.037	0.08	0.09
Occurrence probability of gold	0.98							
SILVER GRADE (OZ/TON)	0.0004	0.0005	0.002	0.0042	0.0104	0.042	0.06	0.072
Occurrence probability of silver	1							

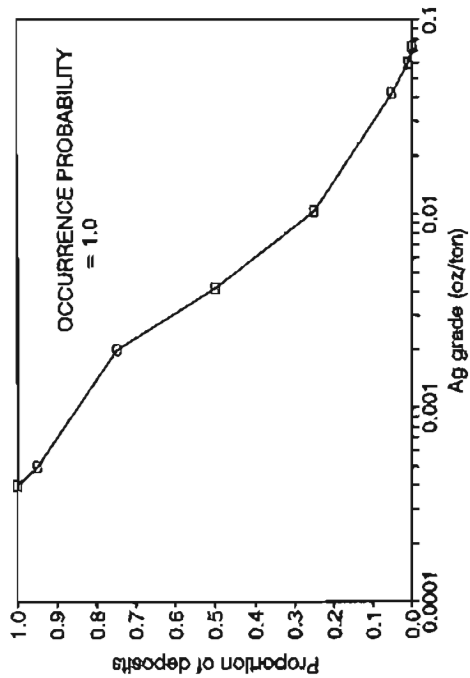
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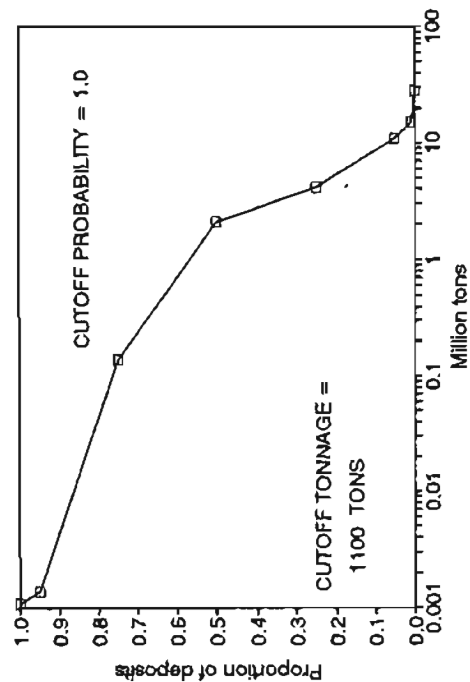
AU GRADE -- AU PLACER
MODELS 33 AND 69



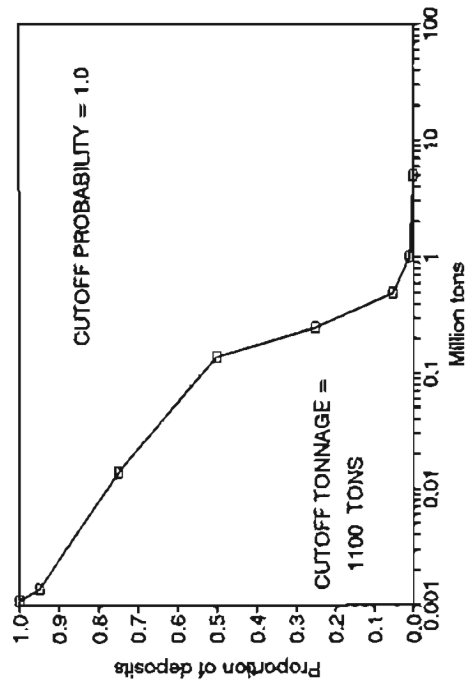
AG GRADE -- AU PLACER
MODELS 33 AND 69

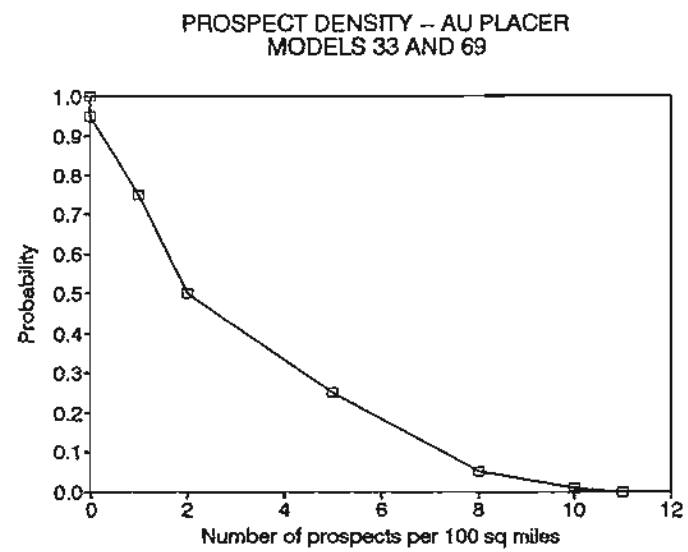


TONNAGE -- AU PLACER
MODEL 33, LARGE STREAM



TONNAGE -- AU PLACER
MODEL 69, SMALL STREAM





MODEL 49 PLACER GOLD-PLATINUM

OTHER NAMES FOR THIS DEPOSIT TYPE - Placer PGE-Au

BRIEF DESCRIPTION - Pt-group alloys and native gold grains and nuggets in gravel downstream from ultramafic/mafic rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Tulameen, British Columbia; central Urals, Russia; Choco, Columbia

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Goodnews Bay

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Alluvial gravel and conglomerate; ultramafic/mafic rocks

TEXTURES - Clastic

AGES - Tertiary to Holocene

SPECIAL PREREQUISITES - Mafic/ultramafic source rock

ASSOCIATED DEPOSIT TYPES - PGE's in Alaska-type zoned complexes

DEPOSIT DESCRIPTION

MINERALOGY - Pt-Fe, Pt-Ir, Os-Ir, and Au-Ag alloys, magnetite, chromite

TEXTURES - Flattened nuggets

ALTERATION - None

GEOCHEMICAL SIGNATURE - Au, As, Ag, PGE, Cr

Pb ISOTOPE SIGNATURE ?

S ISOTOPE SIGNATURE ?

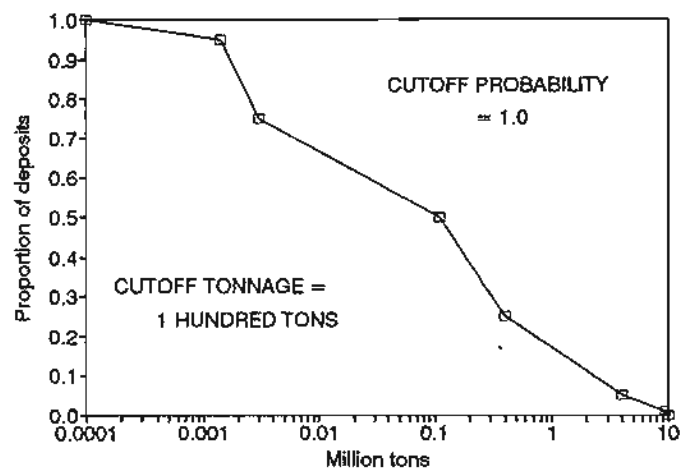
NOTES FOR GRADE/TONNAGE MODELS - Most of the data is from the Urals

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" drainages, that is, those with mafic/ultramafic rock sources

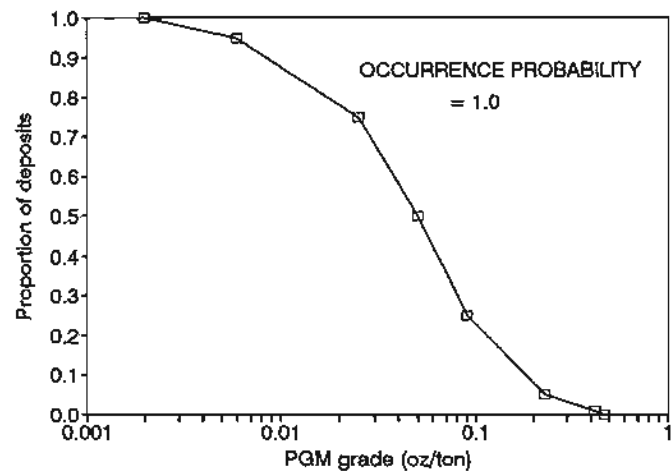
MODEL 49: PLACER GOLD-PGM

MODEL 49	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							
PROBABILITY	100	95	75	50	25	5	1	0.0001
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
No. of prospects	0	0	1	2	5	9	11	11
MILLION TONS OF ORE	0.0001	0.0014	0.003	0.11	0.4	4	9.5	10
PLATINUM GRADE (OZ/TON) Occurrence probability of platinum	0.002 1	0.006	0.025	0.05	0.09	0.23	0.42	0.47
GOLD GRADE (OZ/TON) Occurrence probability of gold	0.00001 0.5	0.00003	0.0003	0.0007	0.003	0.005	0.07	0.074

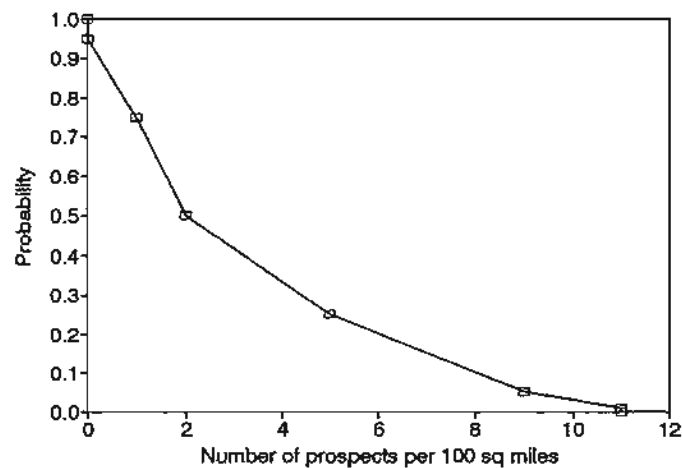
TONNAGE -- PGM PLACER +/- AU
MODEL 49



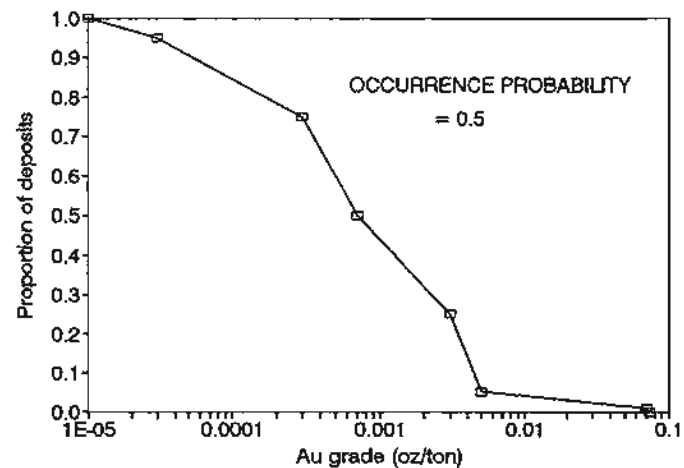
PGM GRADE -- PGM PLACER +/- AU
MODEL 49



PROSPECT DENSITY -- PGM PLACER +/- AU
MODEL 49



AU GRADE -- PGM PLACER +/- AU
MODEL 49



MODELS 35 (DISTRICTS) AND 36 (LARGE AREAS) CARBONATE-HOSTED BASE METAL DEPOSITS

OTHER NAMES FOR THIS DEPOSIT TYPE - Mississippi Valley type deposits; Alpine Pb-Zn

BRIEF DESCRIPTION - Stratabound galena-sphalerite-pyrite-rich sulfide bodies, layers, and veins in carbonate rocks

WORLD-WIDE DEPOSITS USED IN GRADE/TONNAGE COMPILATION - Viburnum, Missouri; Jefferson City, Tennessee; Pine Point, Northwest Territories; Metalline, Washington; Monarch-Kicking Horse, British Columbia; Upper Silesia, Poland

ALASKAN EXAMPLES OF THIS DEPOSIT TYPE - Reef Ridge

KNOWN DEPOSITS LACKING GRADE/TONNAGE DATA

GENERAL REFERENCES - Laznicka (1985); Cox and Singer (1986)

GEOLOGIC ENVIRONMENT

ROCK TYPES - Dolomite and limestone

TEXTURES - Calcarenites, stromatolitic reefs, solution collapse breccias, reef breccias, lesser micrite

AGES - Proterozoic to Triassic; lower Paleozoic most common

SPECIAL PREREQUISITES - Extensive development of primary and/or secondary porosity; underlying (sandstone?) aquifer; fluid migration (e.g., large-scale collision) event important?

ASSOCIATED DEPOSIT TYPES - ?

DEPOSIT DESCRIPTION

MINERALOGY - Pyrite, sphalerite, galena, marcasite, chalcopyrite, barite, quartz, dolomite, calcite, fluorite

TEXTURES - Open-space filling: vuggy, colloform, layered, banded; also, veins, breccias

ALTERATION - Regional and local dolomitization; silicification

GEOCHEMICAL SIGNATURE - Pb, Zn, Cu (Ag)

Pb ISOTOPE SIGNATURE - Varies remendously between deposits: $^{206}\text{Pb}/^{204}\text{Pb}$ 18 to 24; individual deposits also show major variations

S ISOTOPE SIGNATURE - Varies remendously both within and between deposits (+35 to -35 permil)

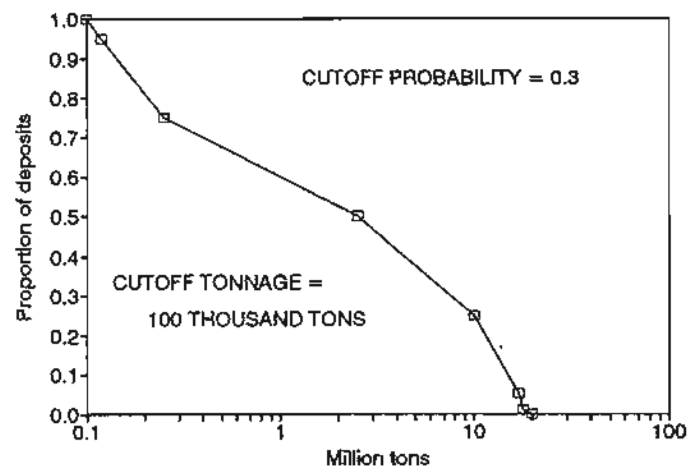
NOTES FOR GRADE/TONNAGE MODELS - Data mostly from North American deposits

NOTES FOR PROSPECT DENSITY MODEL - Based on square miles of "favorable" area, that is, area with "favorable" stratigraphy/geochemistry; "district" model has a higher prospect density than the "large favorable area" model

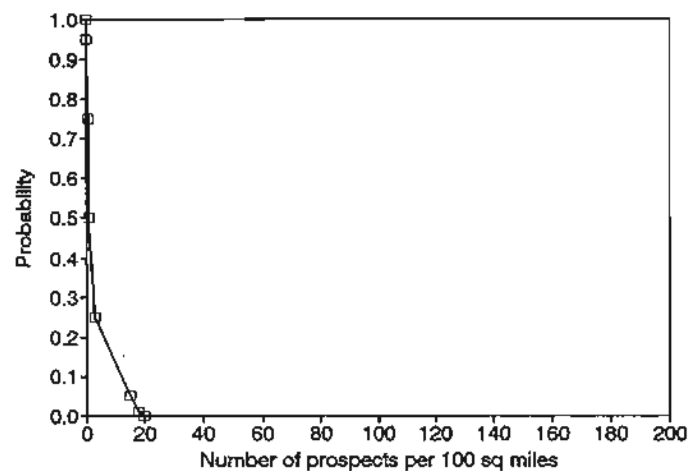
MODEL 35-36: CARBONATE-HOSTED BASE METAL

MODEL 35 DISTRICT MODEL 36 AREAS	Cutoff tonnage (million tons) Probability that the prospect makes the cutoff tonnage							0.1 0.3
	100	95	75	50	25	5	1	0
PROSPECT DENSITY WITHIN 100 SQ MILE AREA								
MODEL 35: No. of prospects	2	3	6	14	25	150	180	200
MODEL 36: No. of prospects	0	0	1	1	3	15	18	20
MILLION TONS OF ORE	0.1	0.12	0.25	2.5	10	17	18	20
P1 LEAD GRADE (%) Occurrence probability of lead	0.05 0.9	0.12	0.35	2	4.5	8.2	9	10
P ZINC GRADE (%) Occurrence probability of zinc	0.17 1	0.2	2.5	6	10	15	22	25
P COPPER GRADE (%) Occurrence probability of copper	1 0.1	1.5	2	2.9	4	6	10	12
S SILVER GRADE (OZ/TON) Occurrence probability of silver	0.7 1	0.7	0.7	0.7	1	3	3.5	4

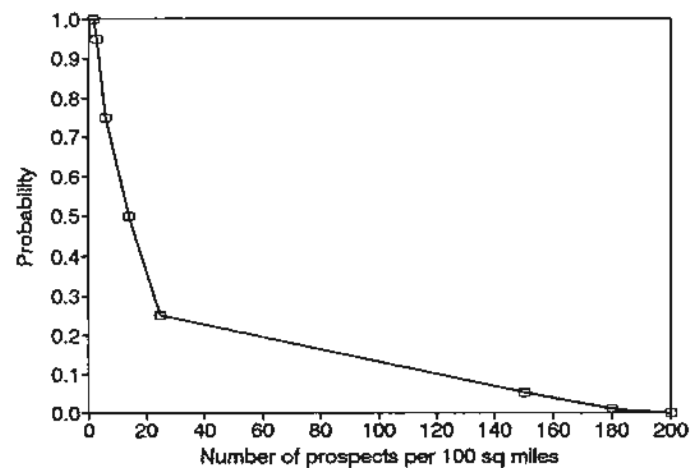
TONNAGE -- CARBONATE-HOSTED BASE METAL
MODELS 35 AND 36



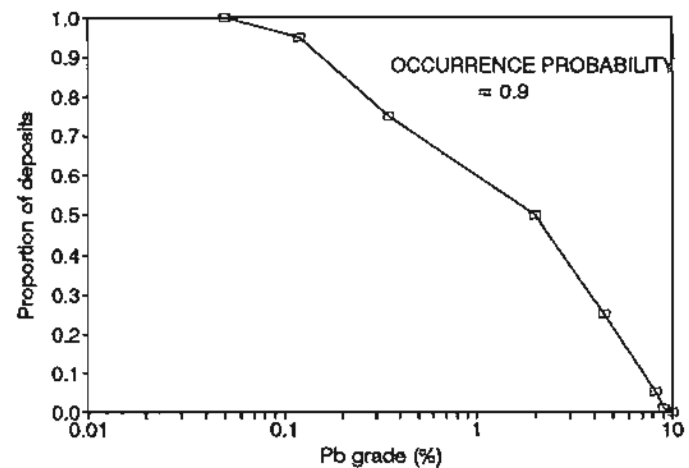
PROSPECT DENSITY -- CARBONATE-HOSTED
BASE METAL, MODEL 36 - AREAS



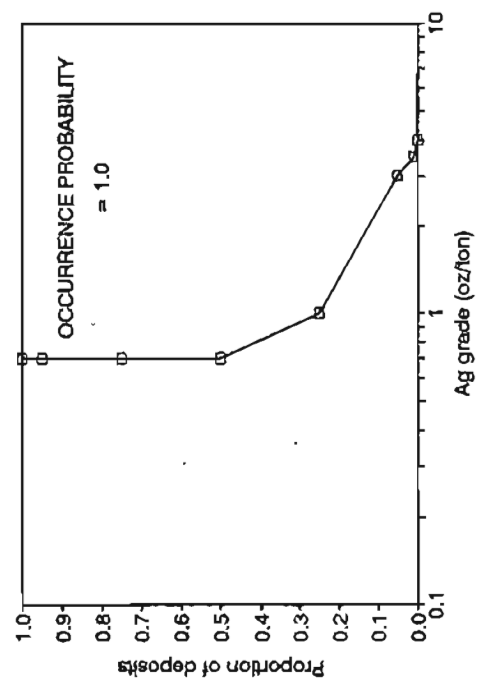
PROSPECT DENSITY -- CARBONATE-HOSTED
BASE METAL, MODEL 35 - DISTRICTS



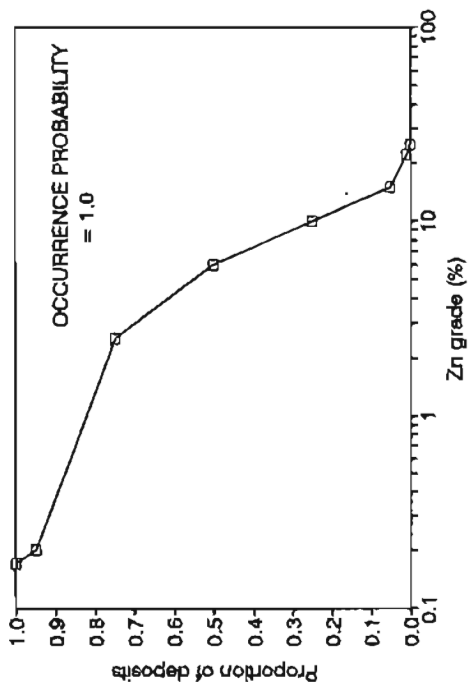
PB GRADE -- CARBONATE-HOSTED BASE METAL
MODELS 35 AND 36



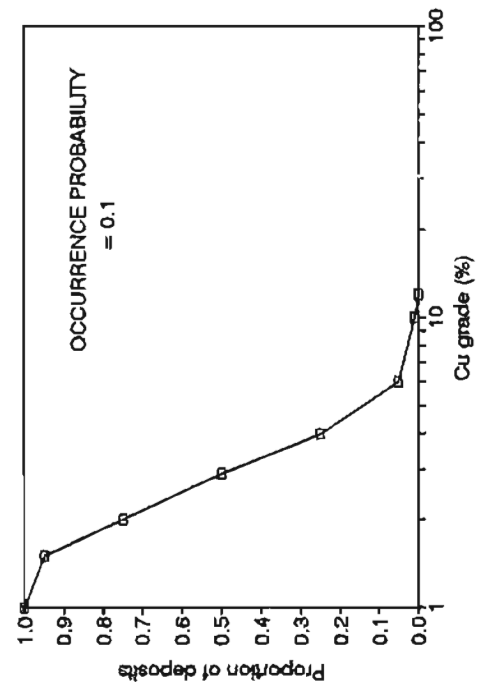
AG GRADE -- CARBONATE-HOSTED BASE METAL
MODELS 35 AND 36



ZN GRADE -- CARBONATE-HOSTED BASE METAL
MODELS 35 AND 36



CU GRADE -- CARBONATE-HOSTED BASE METAL
MODELS 35 AND 36



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