



## BESSHI MASSIVE SULPHIDE

G04

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Modified for Yukon by A. Fonseca and G. Bradshaw

Refer to preface for general references and formatting significance.

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### ***IDENTIFICATION***

SYNONYMS: Besshi type, Kieslager.

COMMODITIES (*BYPRODUCTS*): Cu, Zn, Pb, Ag (*Au, Co, Sn, Mo, Cd*).

EXAMPLES (**Yukon**): **Hart River (116A 009)**, **Fyre Lake (105G 034)**;  
(British Columbia - *Canada/International*): Goldstream (082M141), Standard (082M090),  
Montgomery (082M085), True Blue (082F002), Granduc (?) (104B021), Windy Craggy  
(114P020); *Greens Creek (Alaska, USA)*, *Besshi (Japan)*.

### ***GEOLOGICAL CHARACTERISTICS***

**CAPSULE DESCRIPTION:** Deposits typically comprise thin sheets of massive to well layered pyrrhotite, chalcopyrite, sphalerite, pyrite and minor galena within interlayered, terrigenous clastic rocks and calcalkaline basaltic to andesitic tuffs and flows.

**TECTONIC SETTINGS:** Oceanic extensional environments, such as back-arc basins, oceanic ridges close to continental margins, or rift basins in the early stages of continental separation.

**DEPOSITIONAL ENVIRONMENT / GEOLOGICAL SETTING:** Terrigenous clastic rocks associated with marine volcanic rocks and sometimes carbonate rocks; these may overlie platformal carbonate or clastic rocks.

**AGE OF MINERALIZATION:** Any age. In British Columbia, most deposits are Cambrian, Late Triassic and less commonly Mississippian-Permian in age. **The Fyre Lake deposit of the Finlayson Lake District is late Devonian. The Hart River deposit is Proterozoic.**

**HOST/ASSOCIATED ROCK TYPES:** Clastic sedimentary and marine volcanic rocks; basaltic tuffs and flows, shale and siltstone, commonly calcareous; less commonly chert and Fe formations. Possibly ultramafic rocks and metagabbro in sequence.

**DEPOSIT FORM:** Typically a concordant sheet of massive sulphides up to a few metres thick and up to kilometres in strike length and down dip; can be stacked lenses.

**TEXTURE/STRUCTURE:** Massive to well-layered, fine to medium-grained sulphide minerals; gneissic sulphide textures common in metamorphosed and deformed deposits; *durchbewegung* textures; associated stringer ore is uncommon. Crosscutting pyrite, chalcopyrite and/or sphalerite veins with chlorite, quartz and carbonate are common.

**ORE MINERALOGY [Principal and *subordinate*]:** Pyrite, pyrrhotite, chalcopyrite, sphalerite, *cobaltite*, *magnetite*, *galena*, *bornite*, *tetrahedrite*, *cubanite*, *stannite*, *molybdenite*, *arsenopyrite*, *marcasite*.

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GANGUE MINERALOGY (Principal and *subordinate*): Quartz, calcite, ankerite, siderite, albite, tourmaline, *graphite*, *biotite*.

ALTERATION MINERALOGY: Similar to gangue mineralogy - quartz, chlorite, calcite, siderite, ankerite, pyrite, sericite, *graphite*.

ORE CONTROLS: Difficult to recognize; early (syndepositional) faults and mafic volcanic centres.

GENETIC MODEL: Seafloor deposition of sulphide mounds in back-arc basins, or several other tectonic settings, contemporaneous with volcanism.

ASSOCIATED DEPOSIT TYPES: Cu, Zn veins.

### ***EXPLORATION GUIDES***

GEOCHEMICAL SIGNATURE: Cu, Zn, Ag, Co/Ni>1; Mn halos, Mg enrichment.

GEOPHYSICAL SIGNATURE: Sulphide lenses commonly show either an electromagnetic or induced polarization signature depending on the style of mineralization and presence of conductive sulphides.

OTHER EXPLORATION GUIDES: Mafic volcanic rocks (tholeiitic, less commonly alkalic) associated with clastic rocks; Mn-rich garnets in metamorphosed exhalative horizons, possible structures, such as faults; possible association with ultramafic rocks.

### ***ECONOMIC FACTORS***

GRADE AND TONNAGE: Highly variable in size. B.C. deposits range in size from less than 1 Mt to more than 113 Mt. For example, Goldstream has a total resource (reserves and production) of 1.8Mt containing 4.81 % Cu, 3.08 % Zn and 20.6 g/t Ag and Windy Craggy has reserves in excess of 113.0 Mt containing 1.9 % Cu, 3.9 g/t Ag and 0.08% Co. The type-locality Besshi deposits average 0.22 Mt, containing 1.5% Cu, 2-9 g/t Ag, and 0.4-2% Zn (Cox and Singer, 1986).

IMPORTANCE: Significant sources of Cu, Zn and Ag that can be found in sedimentary sequences that have not been thoroughly explored for this type of target.

### ***SELECTED BIBLIOGRAPHY***

- Abbott, G., 1997. Geology of the Upper Hart River Area, eastern Ogilvie Mountains, Yukon Territory (116A/10, 11). Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, Bulletin 9, 92 p.**
- Blanchflower, D., Deighton, J. and Foreman, I., 1997. The Fyre Lake Deposit: a new copper-cobalt-gold VMS discovery. In: Yukon Exploration and Geology 1996, Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 46-52.**
- Cox, D.P. and Singer, D.A., Editors, 1986. Mineral Deposit Models; *U.S. Geological Survey*, Bulletin 1693, 379 pages.
- Höy, T., 1991. Volcanogenic Massive Sulphide Deposits in British Columbia; *in Ore Deposits, Tectonics and Metallogeny in the Canadian Cordillera*, McMillan, W.J., Coordinator, *B. C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1991-4, pages 89-123.
- Franklin, J.M., Lydon, J.W. and Sangster, D.M., 1981. Volcanic-associated Massive Sulfide Deposits; *Economic Geology*, 75th Anniversary Volume, pages 485-627.
- Hutchinson, R.W., 1980. Massive Base Metal Sulphide Deposits as Guides to Tectonic Evolution; *in The Continental Crust and its Mineral Deposits*, Strangway, D.W., Editor, *Geological Association of Canada*, Special Paper 20, pages 659-684.
- Fox, J.S., 1984. Besshi-type Volcanogenic Sulphide Deposits - a Review; *Canadian Institute of Mining and Metallurgy*, Bulletin, Volume 77, pages 57-68.

**Sebert, C., Hunt, J.A. and Foreman, I.J., 2004. Geology and lithogeochemistry of the Fyre Lake copper-cobalt-gold sulphide-magnetite deposit, southeastern Yukon. Yukon Geological Survey, Open File 2004-17, 46 p.**

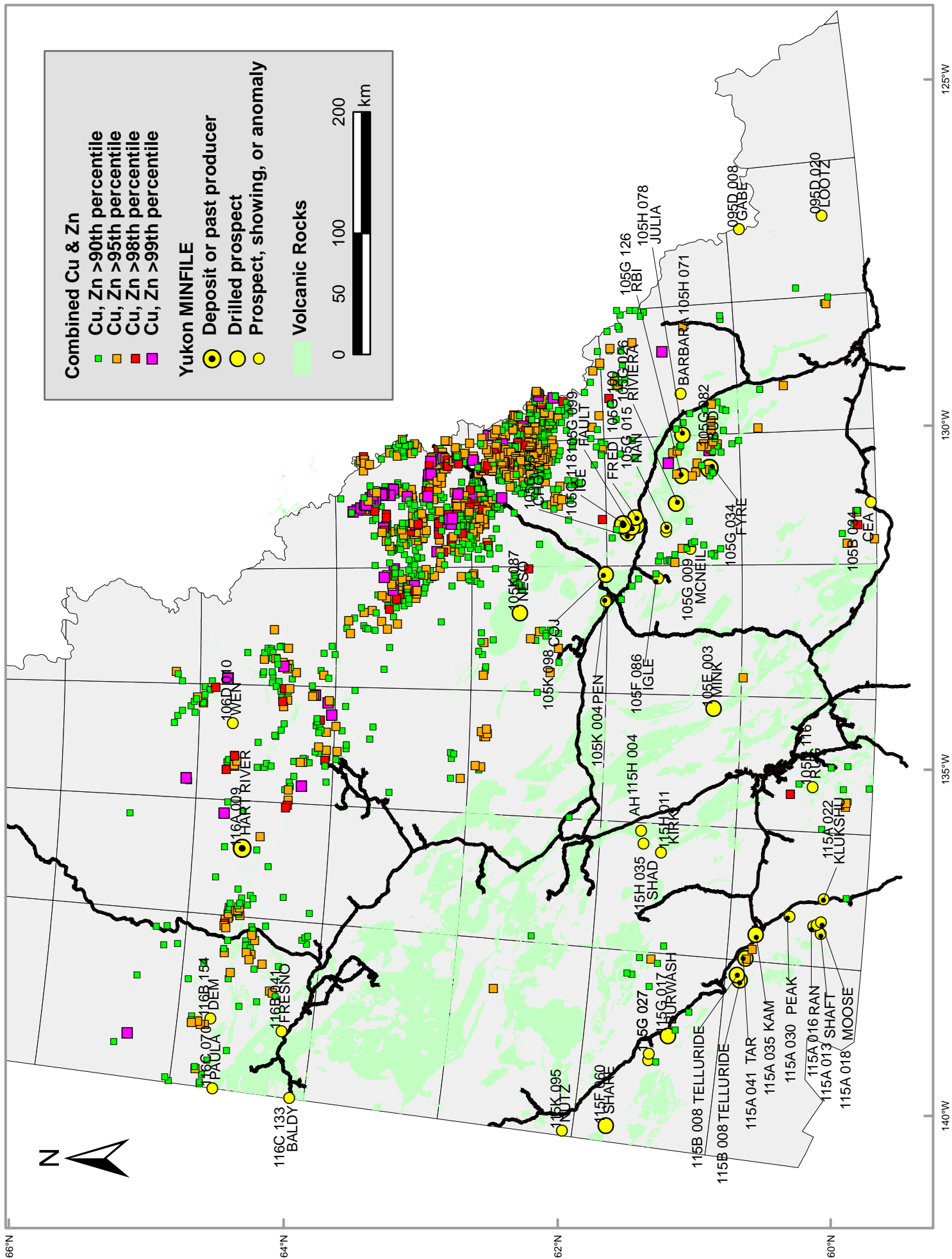
Slack, J.F. (in press). Descriptive and Grade-Tonnage Models for Besshi-type Massive Sulphide Deposits. *In: Mineral Deposit Modeling*, Kirkham, R.V., Sinclair, W.D., Thorpe, R.I. and Duke, J.M., Editors, *Geological Association of Canada*, Special Paper 40, pages 343-371.

## G04 - Besshi massive sulphide - world deposits

<b>deposit</b>	<b>country</b>	<b>tonnes</b>	<b>Au</b>	<b>Ag</b>	<b>Cu</b>	<b>Zn</b>
GOLDSTREAM	CNBC	22 000			3.5	2.15
GRANDUC	CNBC	26 000 000	0	8	1.44	0
WINDY CRAGGY	CNBC	297 000 000	0.2	4	1.38	0
GREENS CREEK	CNBC	2 997 960	4.8	555.42	0	11.9
BESSHI	JAPN	30 000 000	0.2	6.6	2.45	0.3
ICE	CNYK	4 561 863			1.48	
FYRE	CNYK	15 400 000	0.73		2.1	
HART RIVER	CNYK	523 454	1.37	50	1.45	3.65

## Yukon MINFILE

<b>MINFILE</b>	<b>NAMES</b>	<b>STATUS</b>
105G 034	KONA, FYRE	DEPOSIT
116A 009	HART RIVER, MARK	DEPOSIT
105G 026	RIVIERA	DRILLED PROSPECT
105G 126	RBI	DRILLED PROSPECT
105H 078	JULIA	DRILLED PROSPECT
115G 017	BURWASH	DRILLED PROSPECT
105G 100	HARRIS, EAGLE	PROSPECT
105G 009	MCNEIL	SHOWING
106D 010	WEN	SHOWING
115G 026	MUSKETEER	SHOWING
115H 004	AH	SHOWING
115H 011	KIRK	SHOWING
115H 035	SHAD	SHOWING
116B 041	FRESNO	SHOWING
116C 133	BALDY	SHOWING
105G 015	NAN	ANOMALY



125°W

130°W

135°W

140°W

Map of Yukon showing volcanic rocks, Cu-Zn geochemistry and mineral occurrences that are similar to the Besshi deposit model