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Mineral resource assessment for VMS deposits in Skellefte district, Sweden



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SGU, NGU- December 15, 2020

Study area

Mine in production

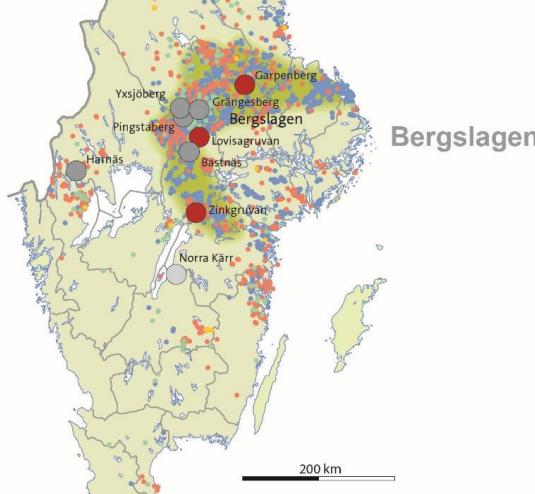
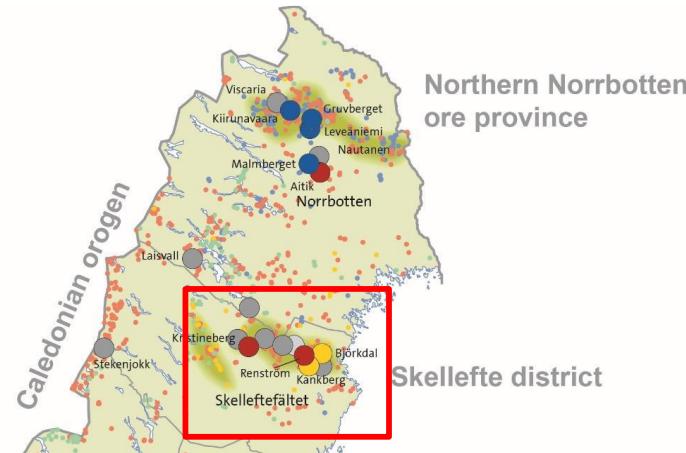
- Iron oxide
- Sulphide
- Precious metal

Not in production

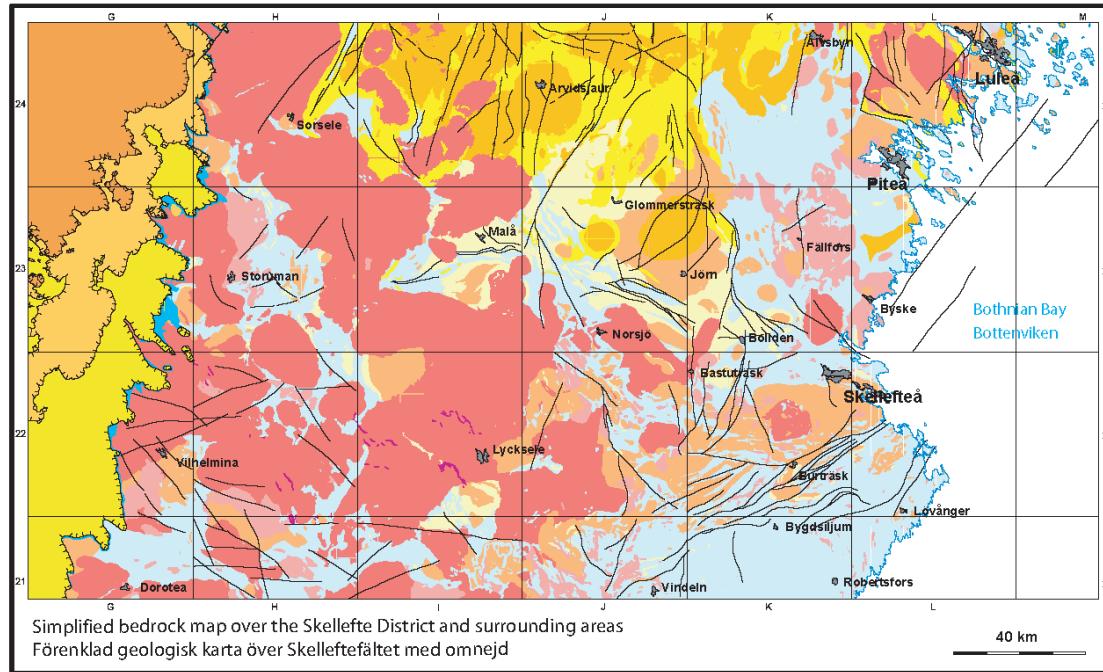
- Closed mine
- Prospect

Type of mineralisation

- Iron oxide
- Other oxides
- Sulphide
- Precious metal



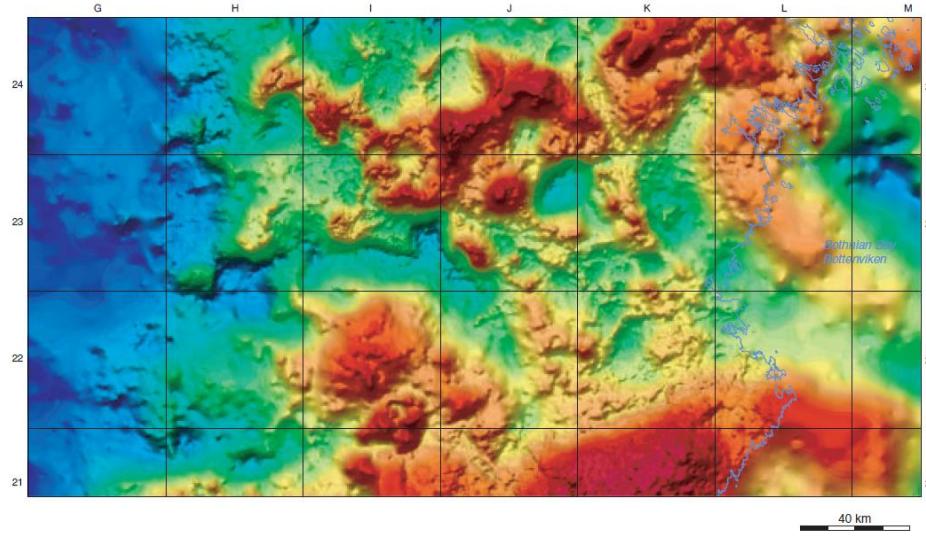
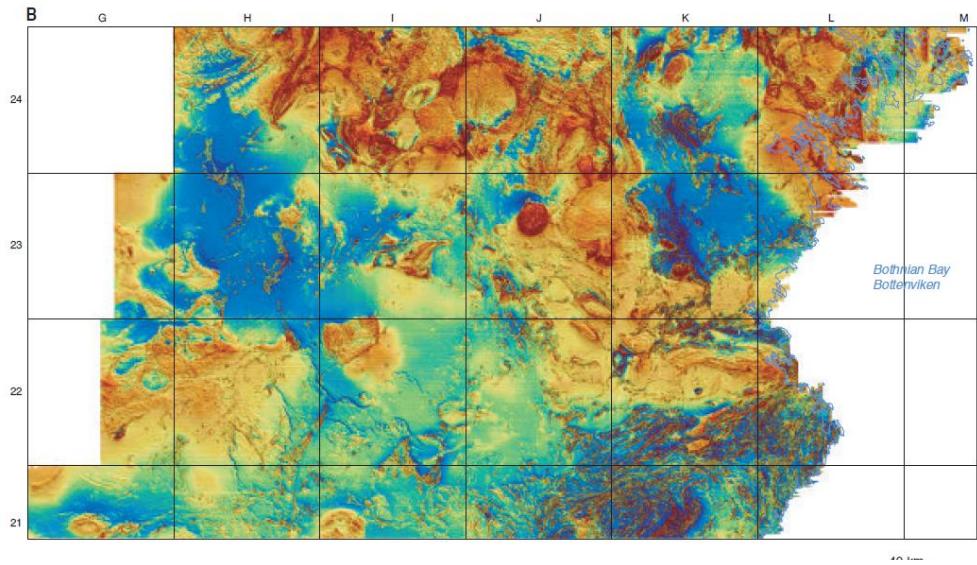
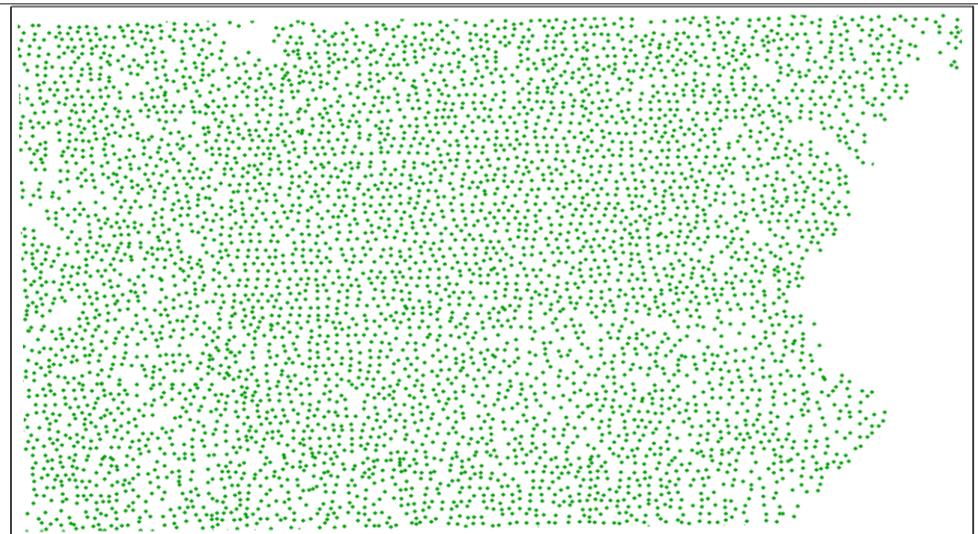
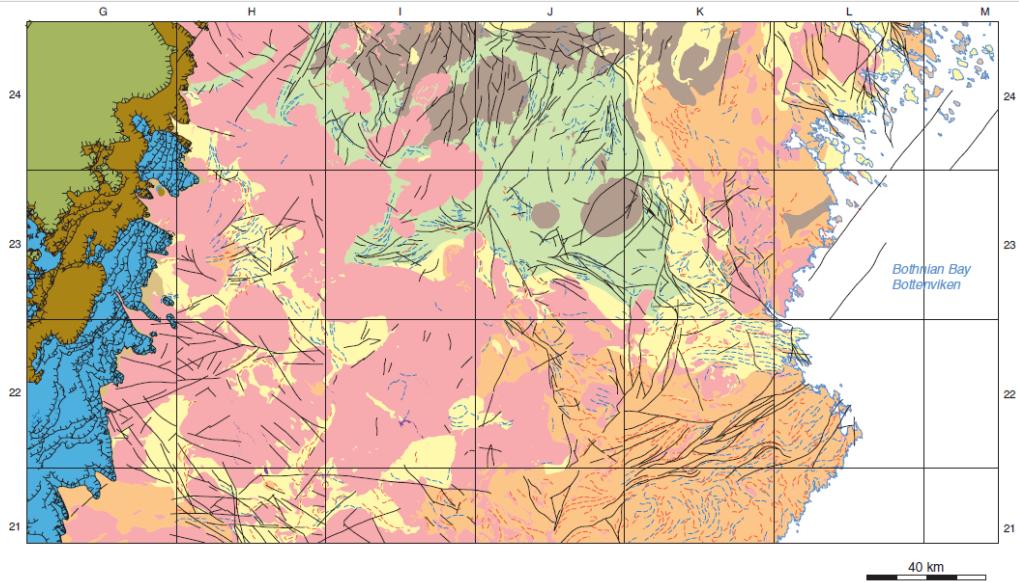
Kathol and Weiherd , 2005 (SGU)



Upper Allochthon Övre skollberggrund	Svecokarelian intrusive rocks, c. 1.88–1.86 Ga (Arvidsjaur and Vägfors groups) Svecofenniska terrestiska vulkaniter, ca. 1.88–1.86 Ga (Arvidsjaur- och Vägforsgruppen)
Middle Allochthon Mellersta skollberggrund	Svecokarelian intrusive rocks, c. 1.96–1.86 Ga (Jörn GI suite, Knaften) Tidigsvekokarelska intrusivbergarter, ca 1.96–1.86 Ga (Jörn GI-sviten, Knaften)
Lower Allochthon Undre skollberggrund	Svecofenniska marine volcanic rocks, c. 1.96–1.86 Ga (Bothnian Super-group, Skellefte Group) Svecofenniska marina vulkaniter, ca. 1.96–1.86 Ga (Bottniska supergruppen, Skelleftegruppen)
Sedimentary cover (Neoproterozoic - lower Palaeozoic) Sedimentär pålagring (Neoproterozoikum - undre Paleozoikum)	Svecofennian sedimentary rocks, c. 1.96–1.86 Ga (Bothnian Super group, Skellefte, Arvidsjaur and Vägfors groups) Svecofenniska sedimentära bergarter, ca. 1.96–1.86 Ga (Bottniska supergruppen, Skellefte, Arvidsjaur och Vägforsgruppen)
Dolerite Diabas	Karelian rocks Karelska bergarter
Late to post Svecokarelian intrusive and supracrustal rocks, c. 1.82–1.76 Ga (TIB) Sen-till postsvecokarelska intrusiv- och ytbergarter, ca 1.82–1.76 Ga (TMB)	Archean rocks Arkeiska bergarter
Deformation zone, unspecified Deformationszon, ospecifierad	Base of Lower, Middle and Upper Allochthons Bas för undre, mellersta och övre skollberggrund
Late to post Svecokarelian intrusive rocks, c. 1.82–1.78 Ga (Skellefte-Härnö suite) Sen-till postsvecokarelska intrusiv- och ytbergarter, ca 1.82–1.78 Ga (Skellefte - Härnösvitens)	
Early Svecokarelian intrusive rocks, c. 1.88–1.86 Ga (Perthite monzonite suite) Tidigsvekokarelska intrusivbergarter, ca 1.88–1.86 Ga (Perititonitnsvitens)	

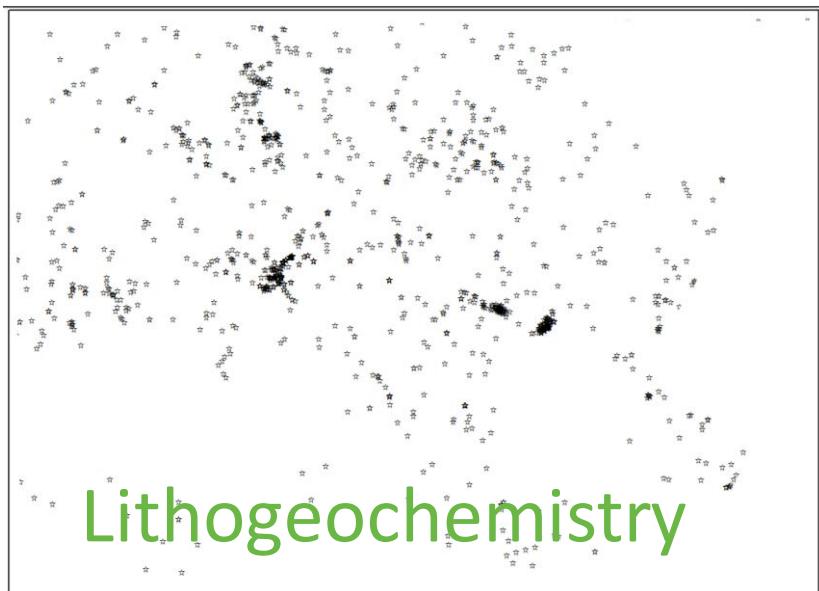
Supported by:

Data



Source of data (SGU)

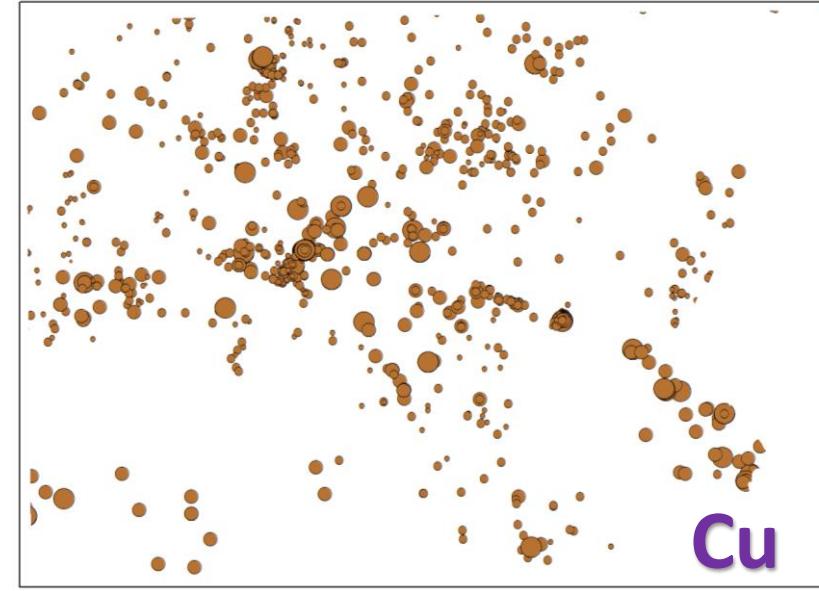
Supported by: eit RawMaterials
Connecting matters



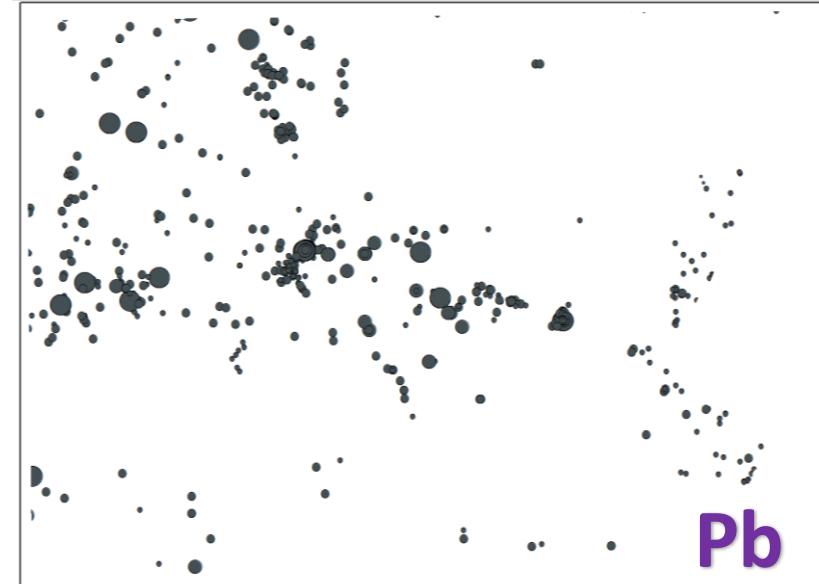
Lithogeochimistry



Zn

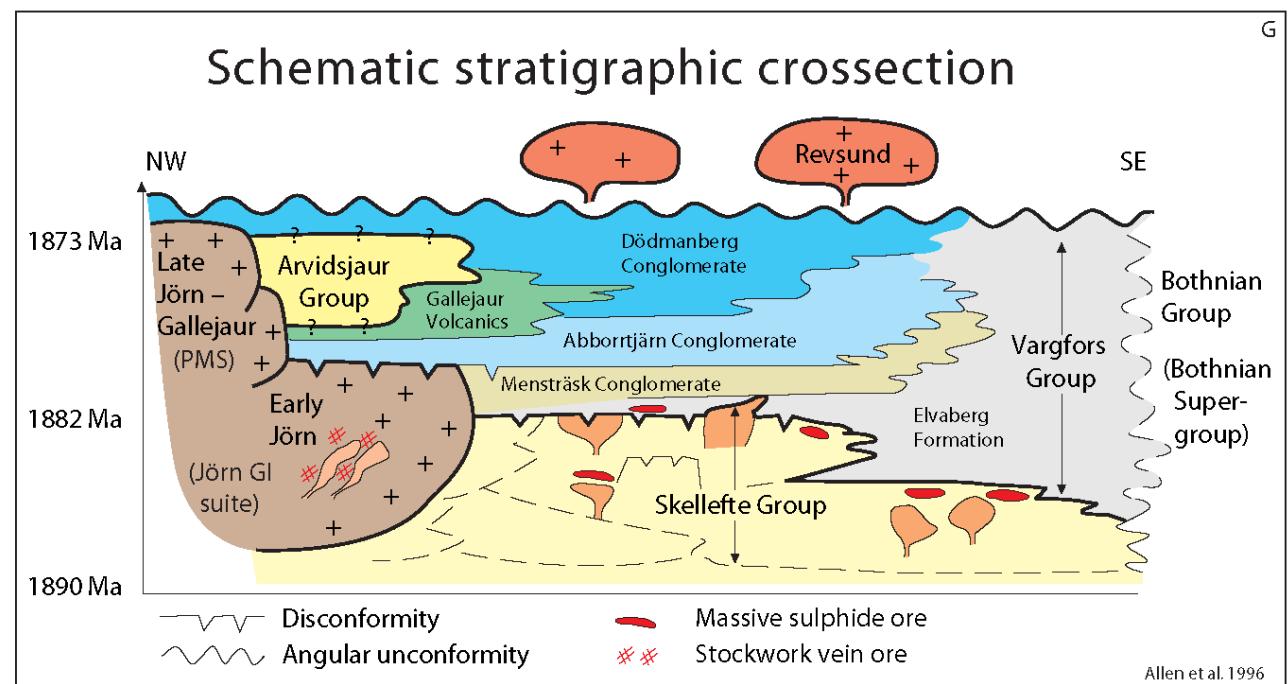
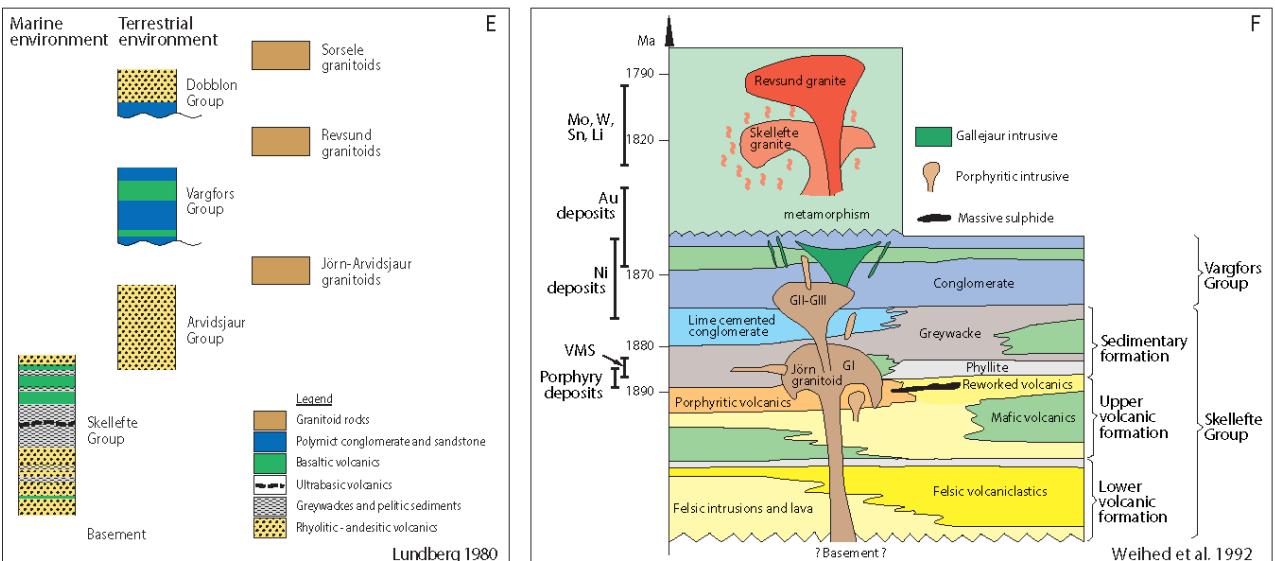


Cu

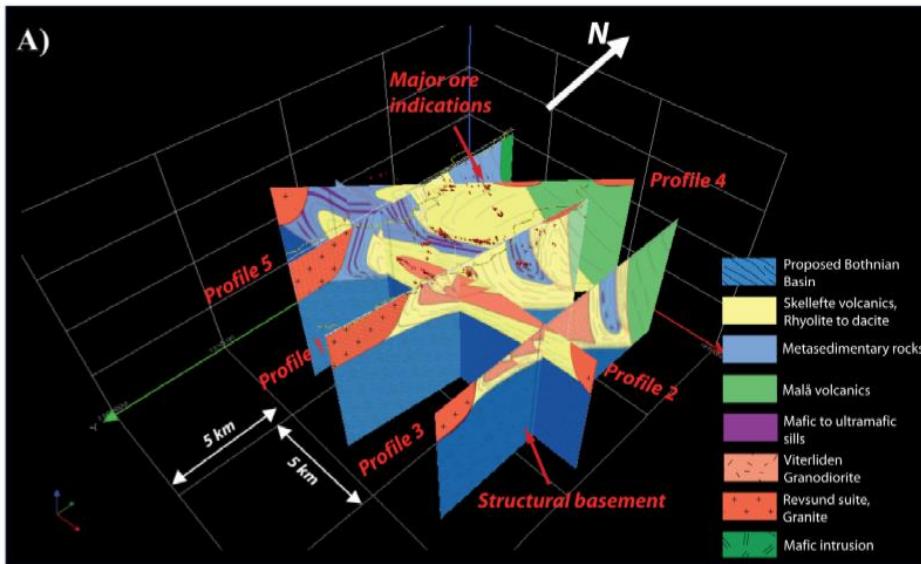


Pb

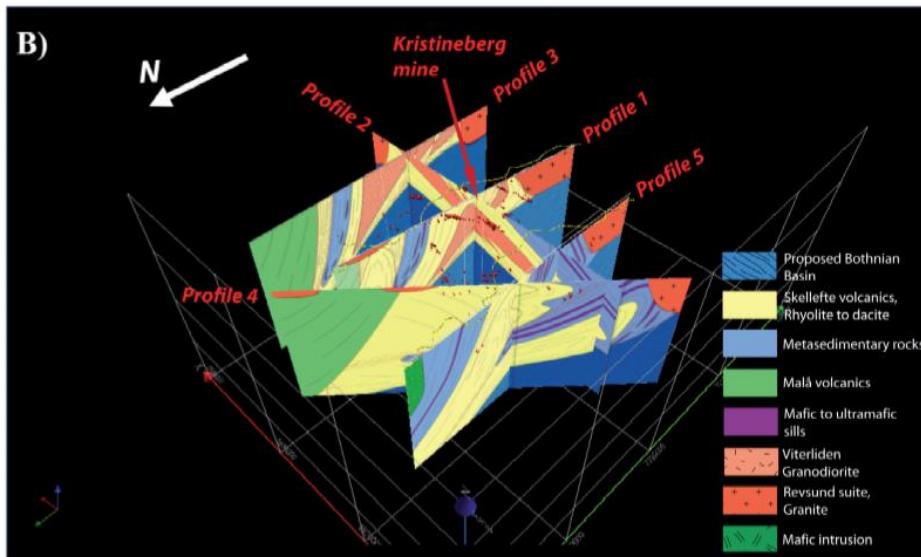
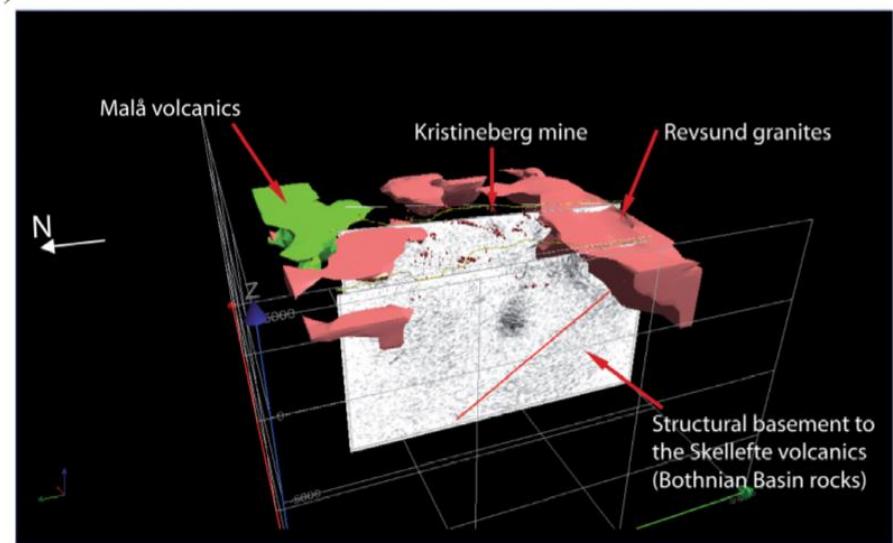
Kathol and Weiher , 2005 (SGU)
Chevalier 1999
Årebäck et al. (2005)
Barrett et al. (2005)
Allen , 2007
Malehmir, 2007
Bauer et al. (2011)
Bauer et al. (2013)
Dehghannejad et al. (2012)
Tavakoli et al. (2012)
Skyttä et al. (2010, 2011,2013).



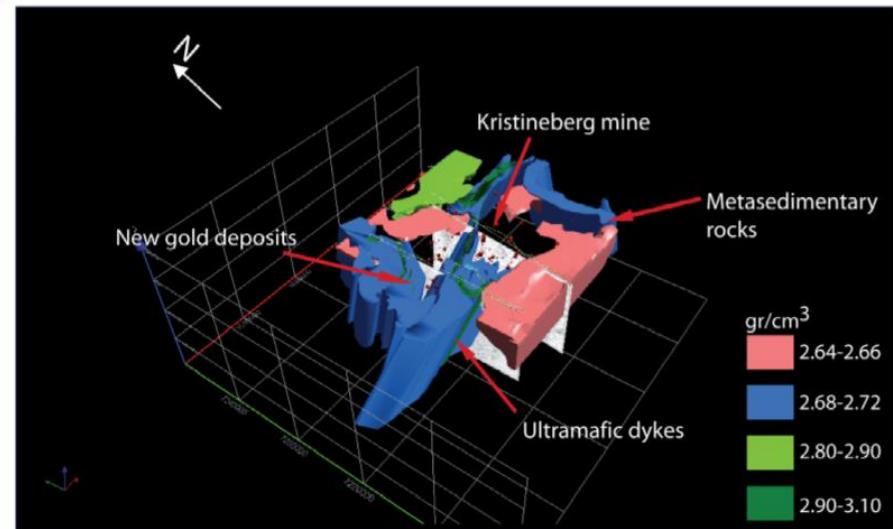
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A)



B)



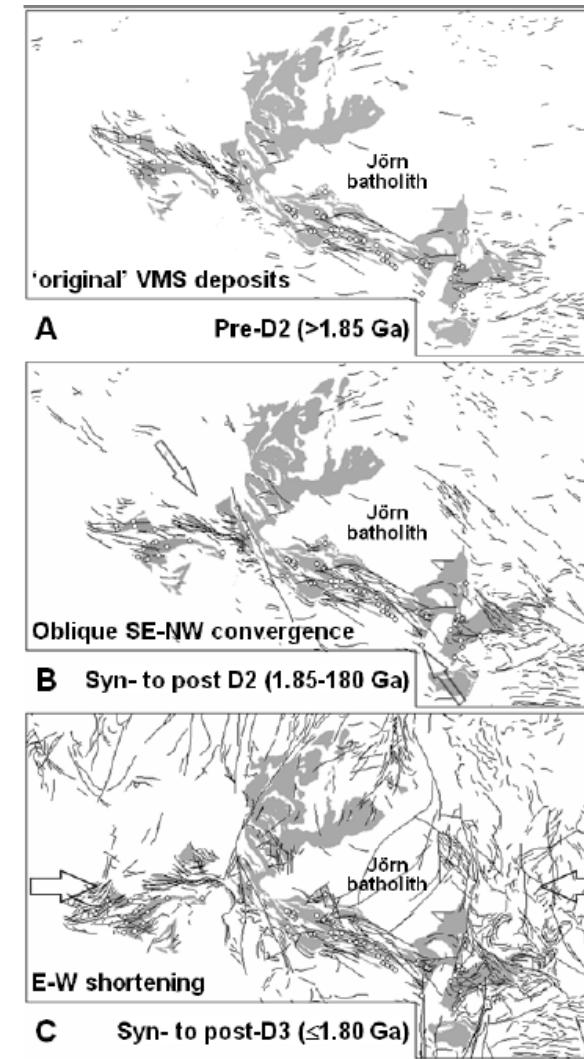
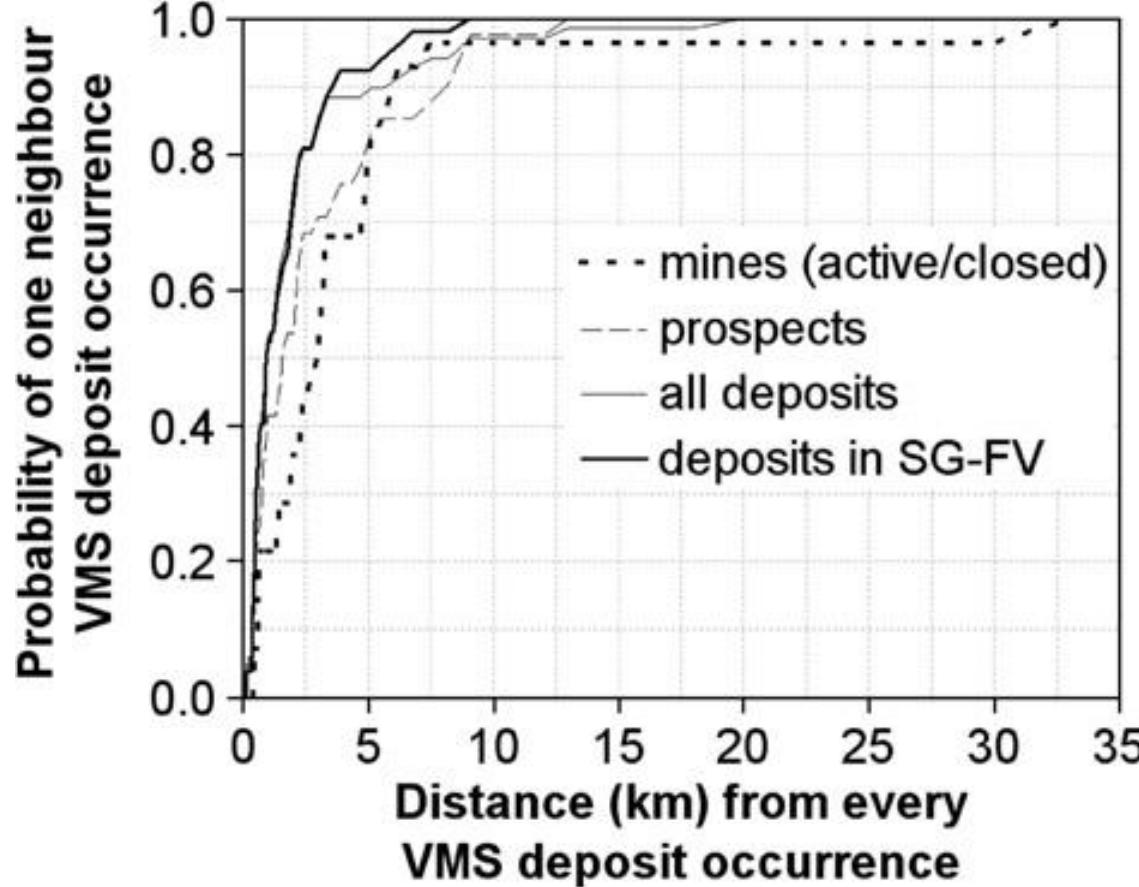
Malehmir, 2007

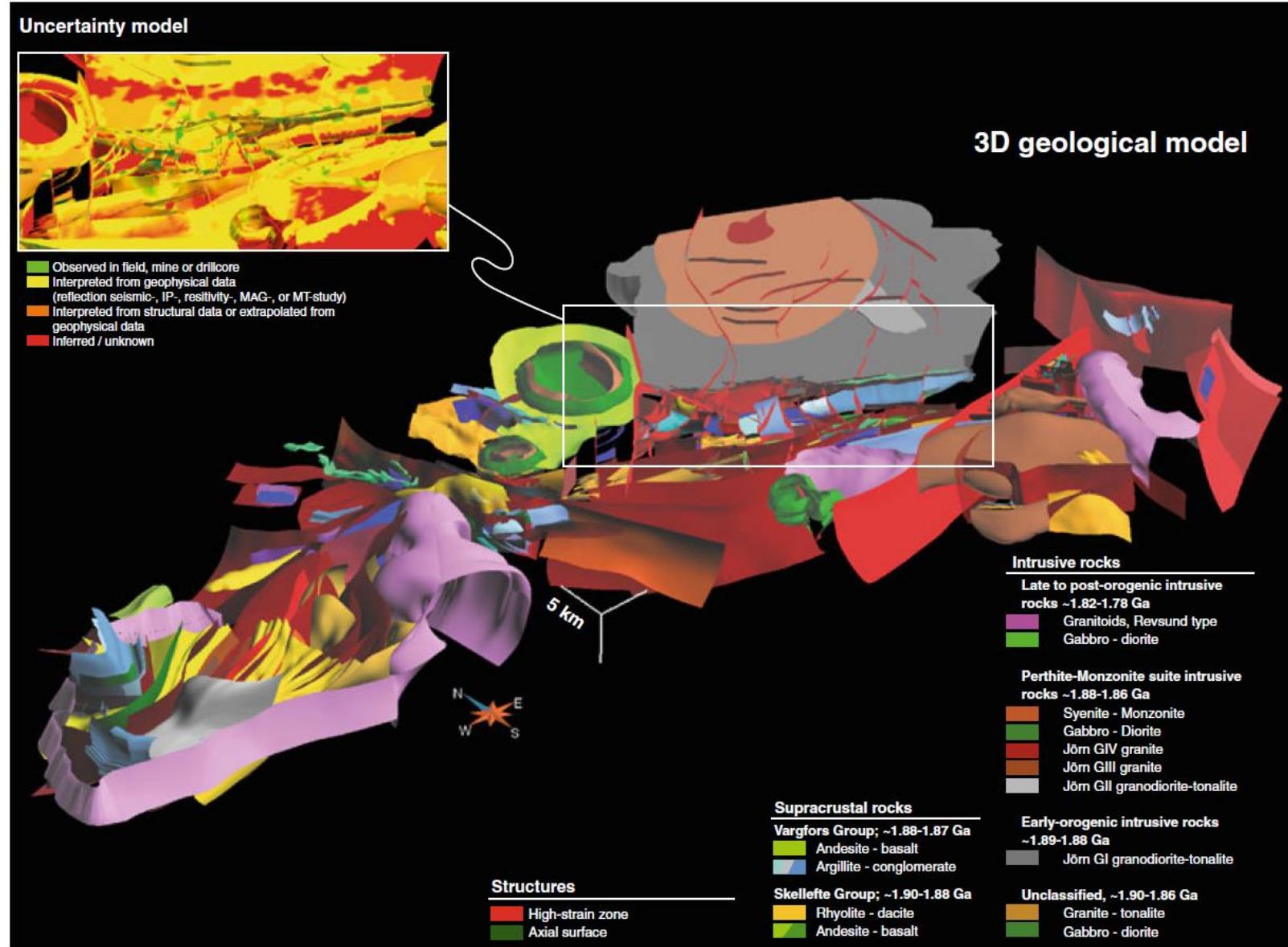
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What means the three conspicuous WNW-trending belts of Fry points?

in the sense that there are no obvious features or patterns in the geological map that readily explain their even spacing and en echelon formation

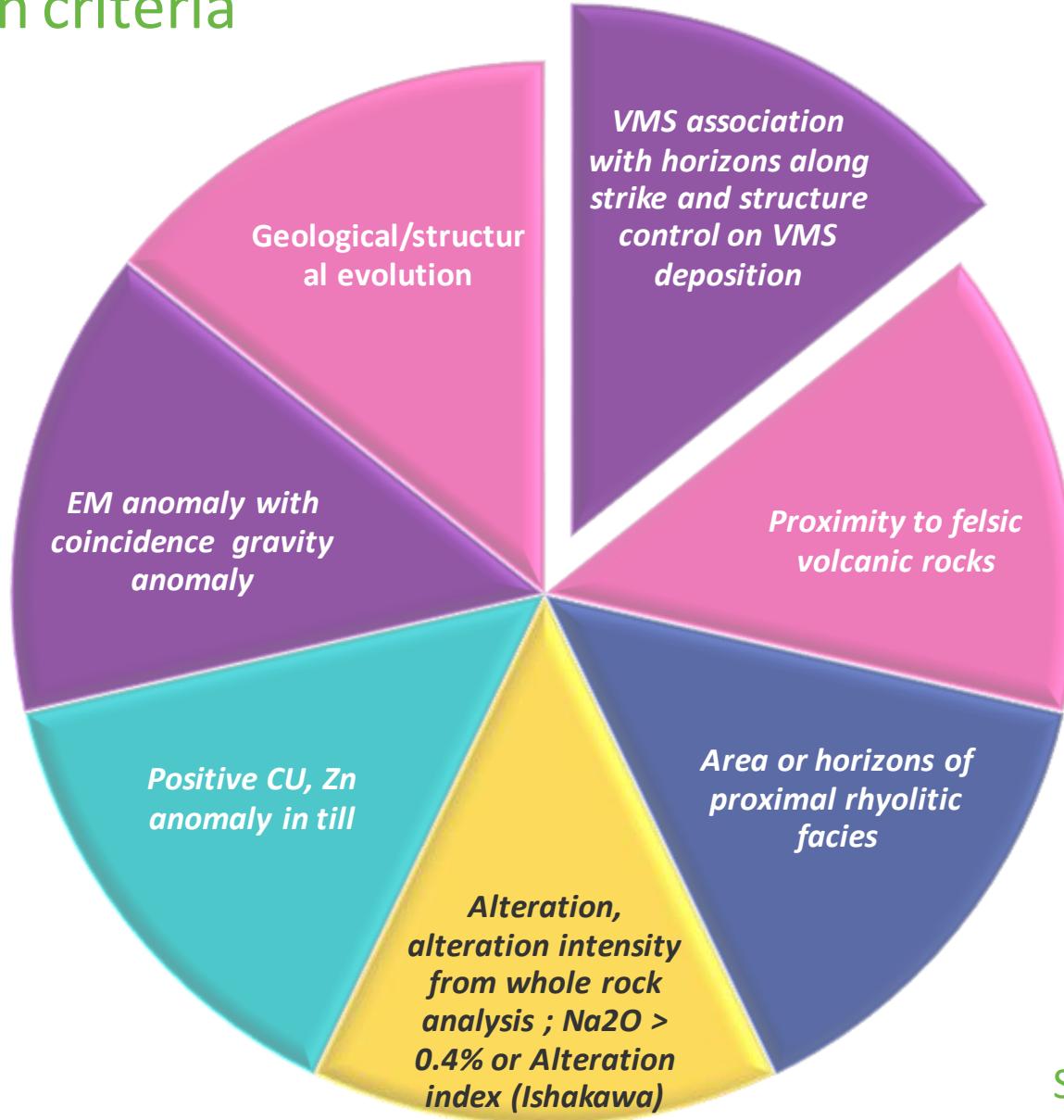




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Exploration criteria



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Mineral system approach (Mappable ingredients)

Source

Proximity to 1.89 rhyolites and basalt (host control)

Proximity to syn-volcanic granitoids as heat source

Transport

Proximity to area of high fault density

NW-SE deformation zones (3.3 km)

Fault associated with low TMI

Trap

Syn-volcanic lithologies with sediments (2.1 km; SG-VG)

Extrusive lithologies associated with TMI slope (-22 to 353 nT)

Deposition

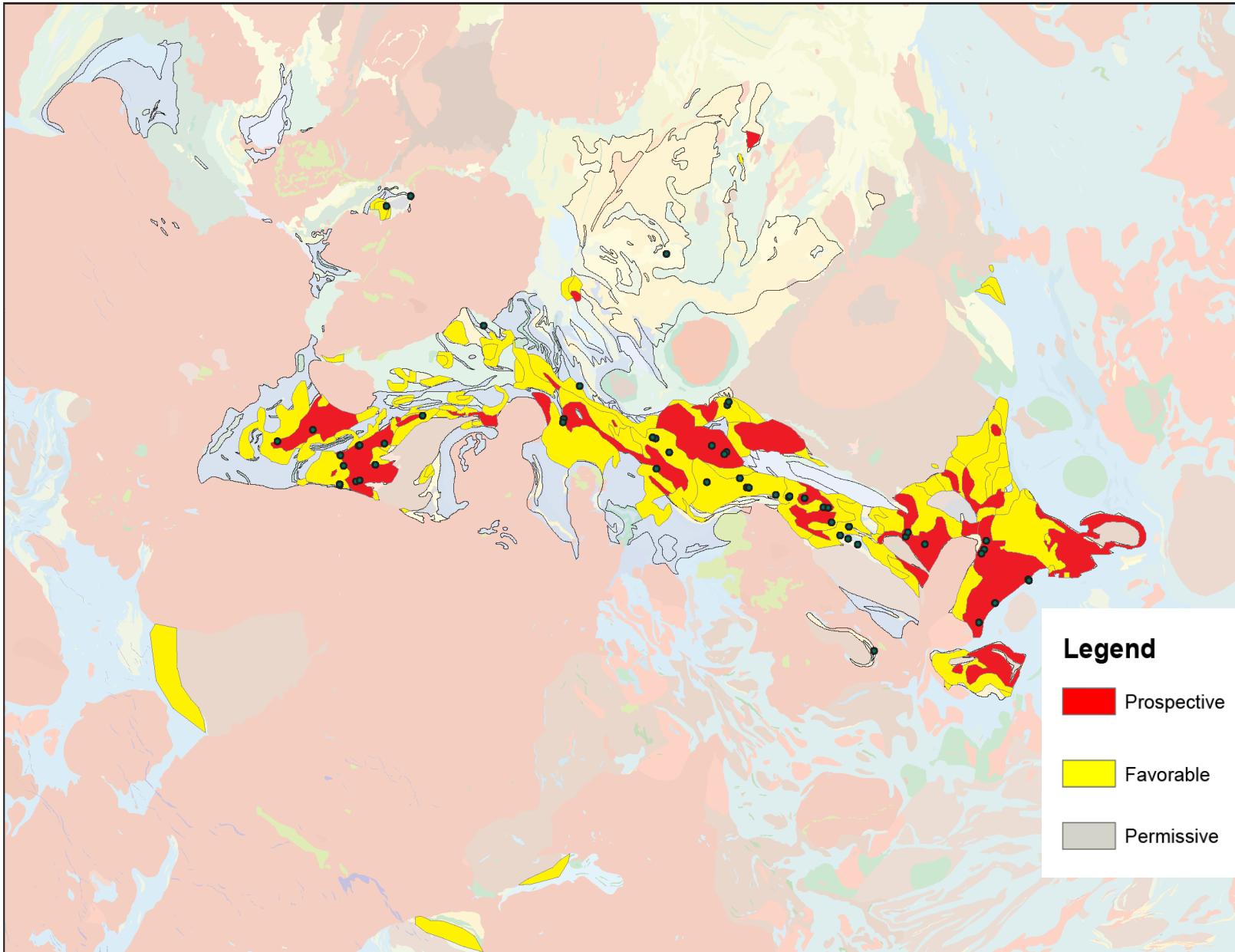
Proximity to -22 to 353 nT TMI

Rocks Bi> 1ppm

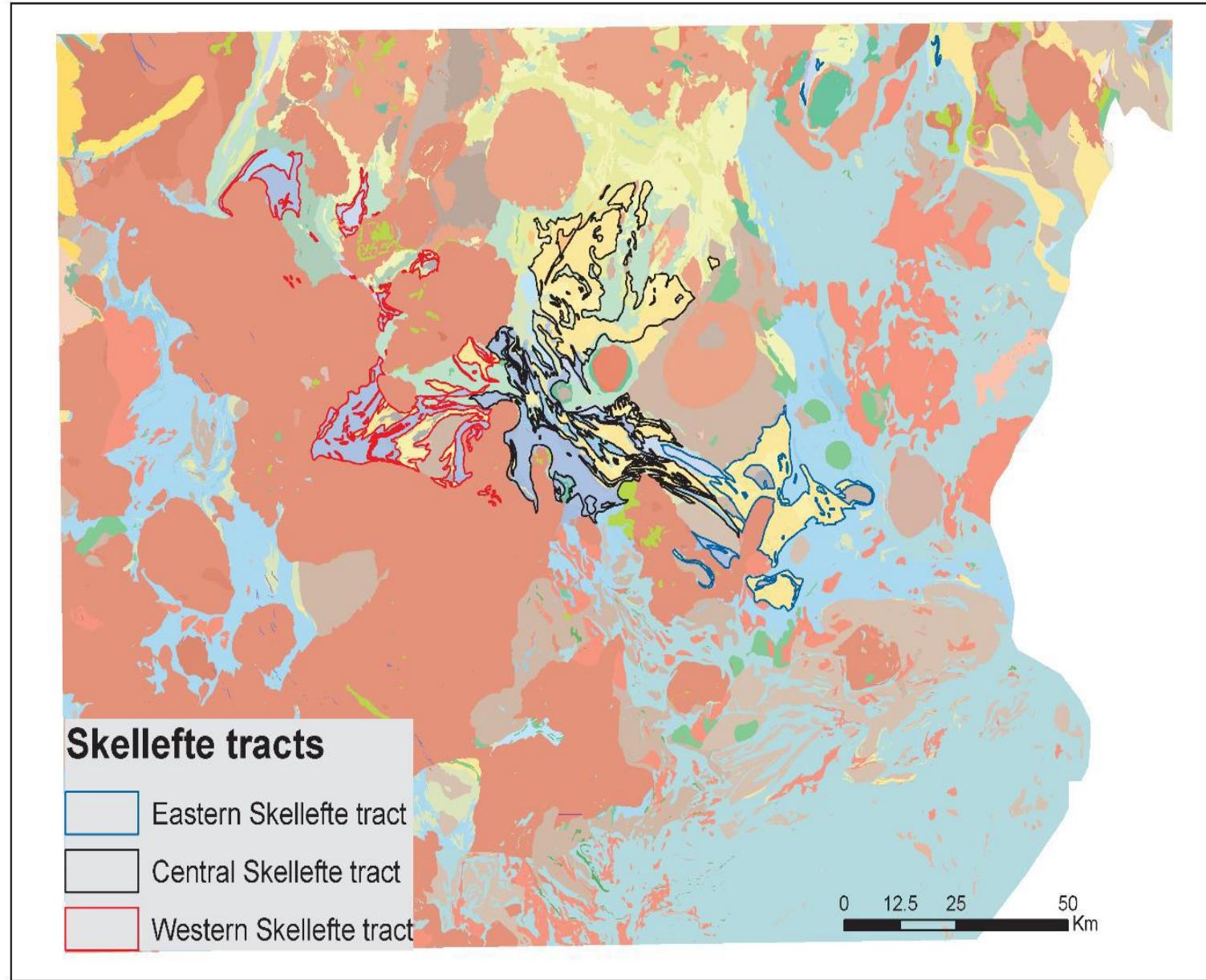
till As \geq 41ppm

Till Cu \geq 38 ppm

Till Zn $>$ 205 ppm

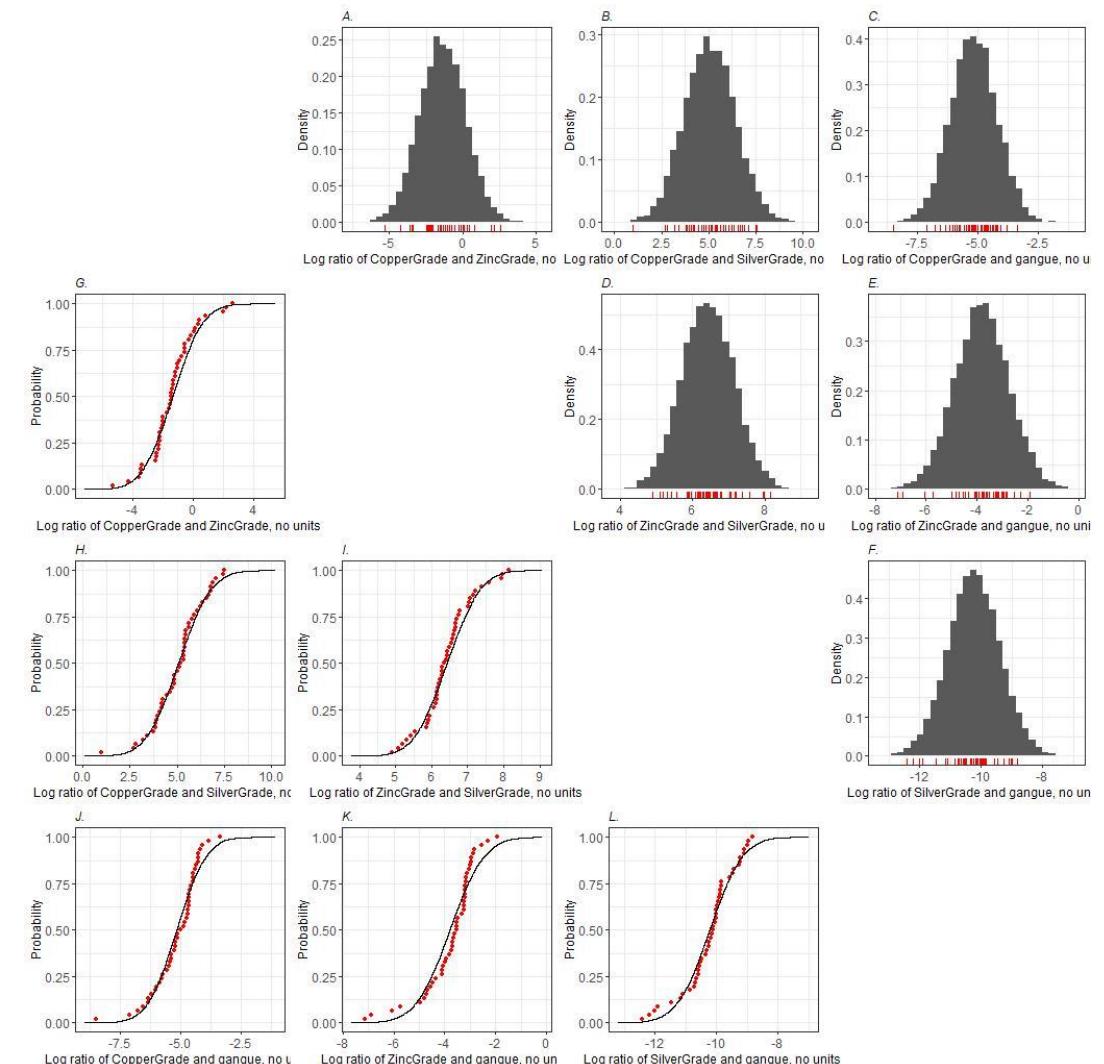
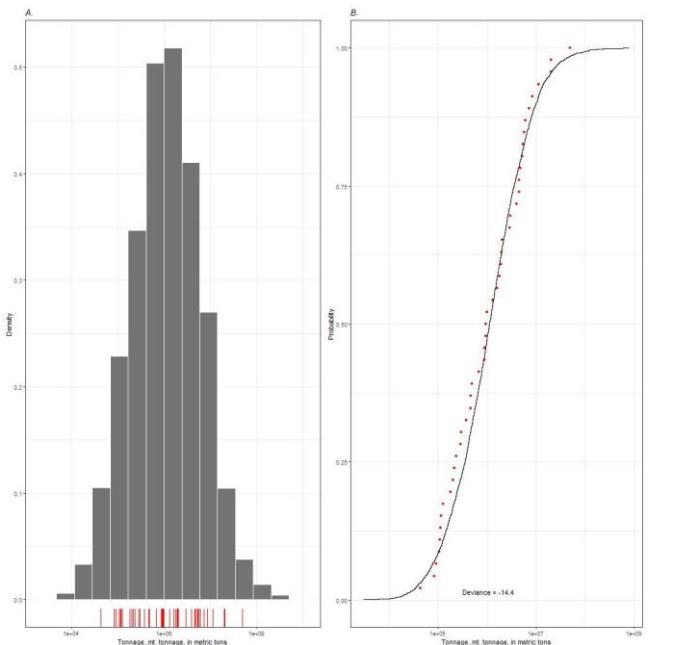


Prospectivity class (% of Skellefte district)	Status of VMS deposits delineated			Number of VMS deposits delineated	
	Active mines	Closed mines	Prospect	Total	Percentage
High (3%)	2	13	21	36	52.94
Mod. high (3%)	1	6	9	16	23.53
Moderate (3%)	0	4	7	11	16.18
Mod low (3%)	0	0	3	3	4.41
Low (3%)	0	1	1	2	2.94
Uncertain (85%)	0	0	0	0	0.00

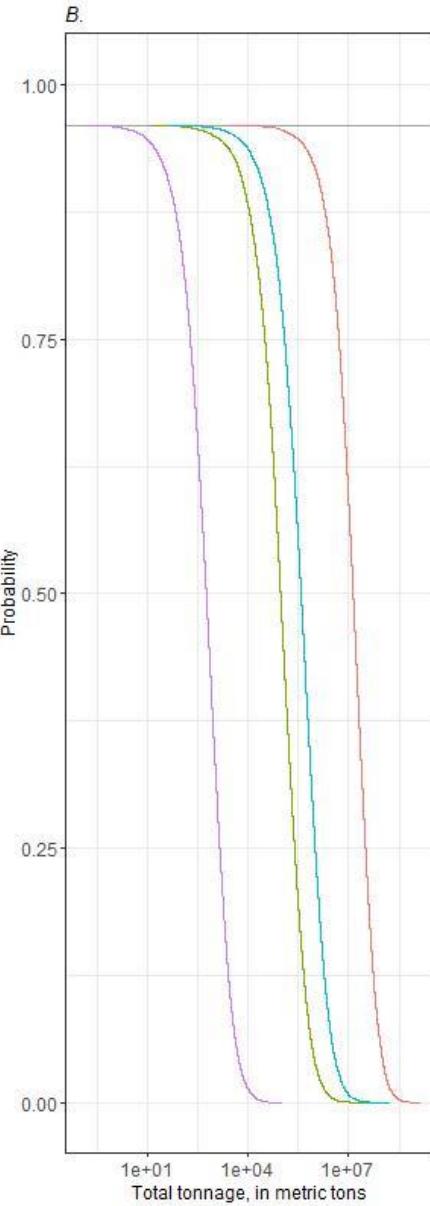
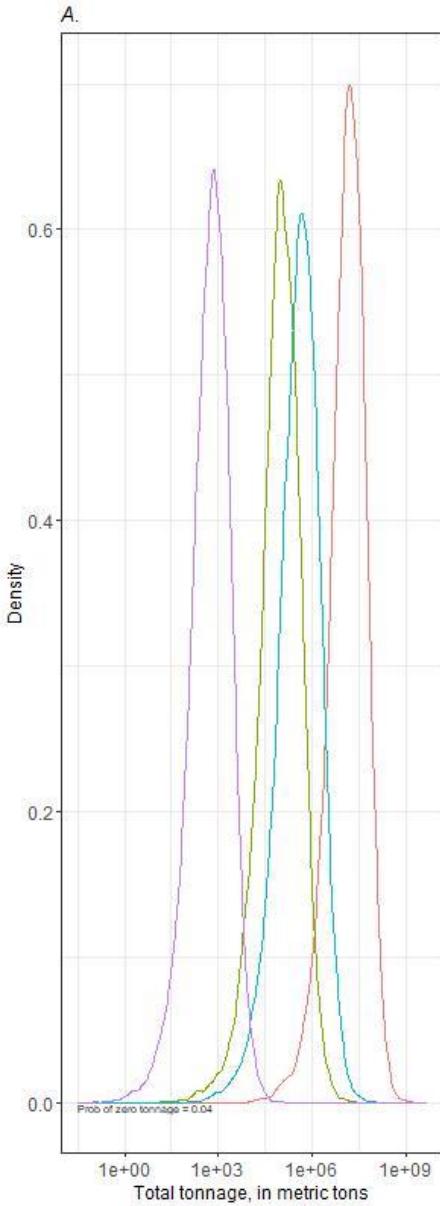


Grade- Tonnage

	Tonnage (Mt)	Cu %	Zn %	Pb %	Au g/t	Ag g/t
Valid N	51	52	51	41	49	50
Mean	3.31	0.80	3.35	0.53	1.51	47.85
Median	0.93	0.70	2.88	0.34	0.68	39.00
Minimum	0.01	0.02	0.08	0.02	0.10	4.00
Maximum	48.56	3.05	14.30	5.00	15.50	235.00
Percentile	0.93	0.70	2.88	0.34	0.68	39.00
Std.Dev.	7.41	0.65	2.78	0.79	2.61	42.15



Monte Carlo simulations of undiscovered resources



Summary of pmf, number of undiscovered deposits

Type	CustomMark3
Mean	5.27833
Variance	12.5909
St. Dev.	3.54836
Mode	2
Smallest N deposits in pmf	0
Largest N deposits in pmf	16
Information entropy	2.56038

Material	At least the indicated amount at the probability of							Mean	P (0)	P(>mean)
	Q_0.05	Q_0.1	Q_0.25	Q_0.5	Q_0.75	Q_0.9	Q_0.95			
Ore (Mt)	0	0.532	3.92	12.7	29.1	57.3	84.2	24.4	0.064	0.300
Cu (kt)		2.58	23.3	84.9	219	487	779	222	0.064	0.247
Zn (kt)		9.8	92.9	342	909	2020	3160	884	0.064	0.257
Ag (t)		16.5	144	508	1290	2660	4180	1180	0.064	0.272

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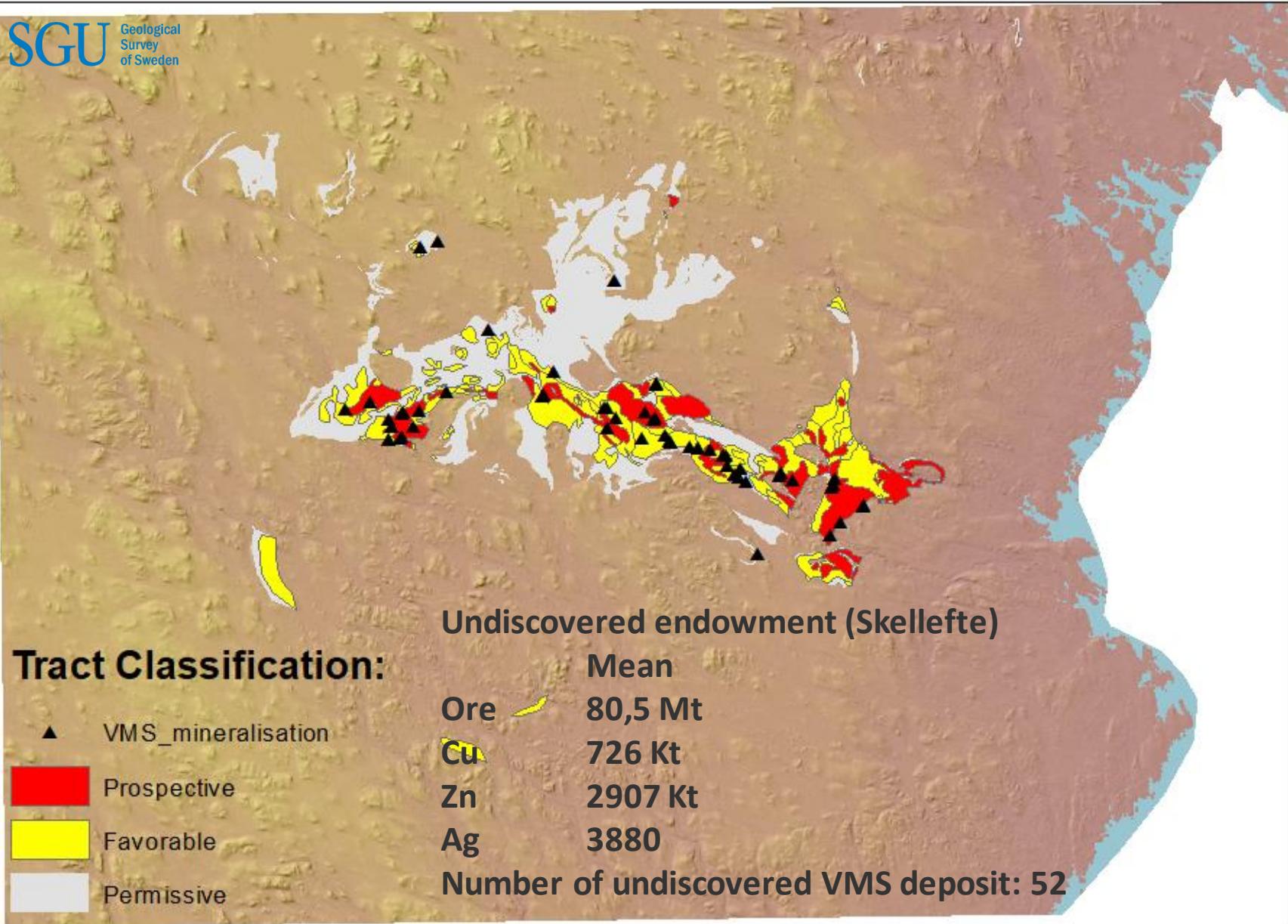
Aggregate of tracts

	West	Central	East	Total
Ore	24400000	31400000	24700000	80500000
Cu (t)	222000	280000	224000	726000
Zn (t)	884000	1130000	893000	2907000
Ag (t)	1180	1510	1190	3880

MPM to QMRA

	One-Level Prediction	Radial –density fractal analysis	This project
	(MaCammon et al., 1994)	(Raines, 2008)	(USGS-MAP Project)
Ore	95 Mt	97 Mt	80.5 Mt
Copper Grade	709 Kt	746 Kt	726 Kt
Zinc Grade	3190 Kt	3389 Kt	2907 Kt
Silver Grade	-----	-----	3880
Number of undiscovered deposit	48	50	52

Carranza, M., Sadeghi, M. (2010). Predictive mapping of prospectivity and quantitative estimation of undiscovered VMS deposit in Skellefte district (Sweden). Ore Geology Review 38, 219-241



We estimated that although the Skellefte district is a well explored area, there is still a substantial undiscovered endowment in the area and has potential to discover several deposits with an average tonnage of more than 1000 kt.

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