UNFC progress in mining waste

Ronald Arvidsson, Economic geology, Geological Survey of Sweden

FutuRaM

Future availability of secondary raw materials

20240424

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

EU Framework Programmes

Funded by the European Union

SGU Geological Survey of Sweden

Mining Waste data and UNFC

Mining Waste Data – GSEU/Futuram

Examples – Sweden, Finland, Balkans, France, database for Europe (cooperation Futuram and GSEU)

Cases investigated for UNFC - Futuram

Large tailings – Sweden
Håkansboda – Sweden – industrial case
National case – Sweden - strategic
Otanmäki – Finland – industrial case
Salau – France
Bor – Balkans

C

MinW Datab

Mining Waste Data - Futuram

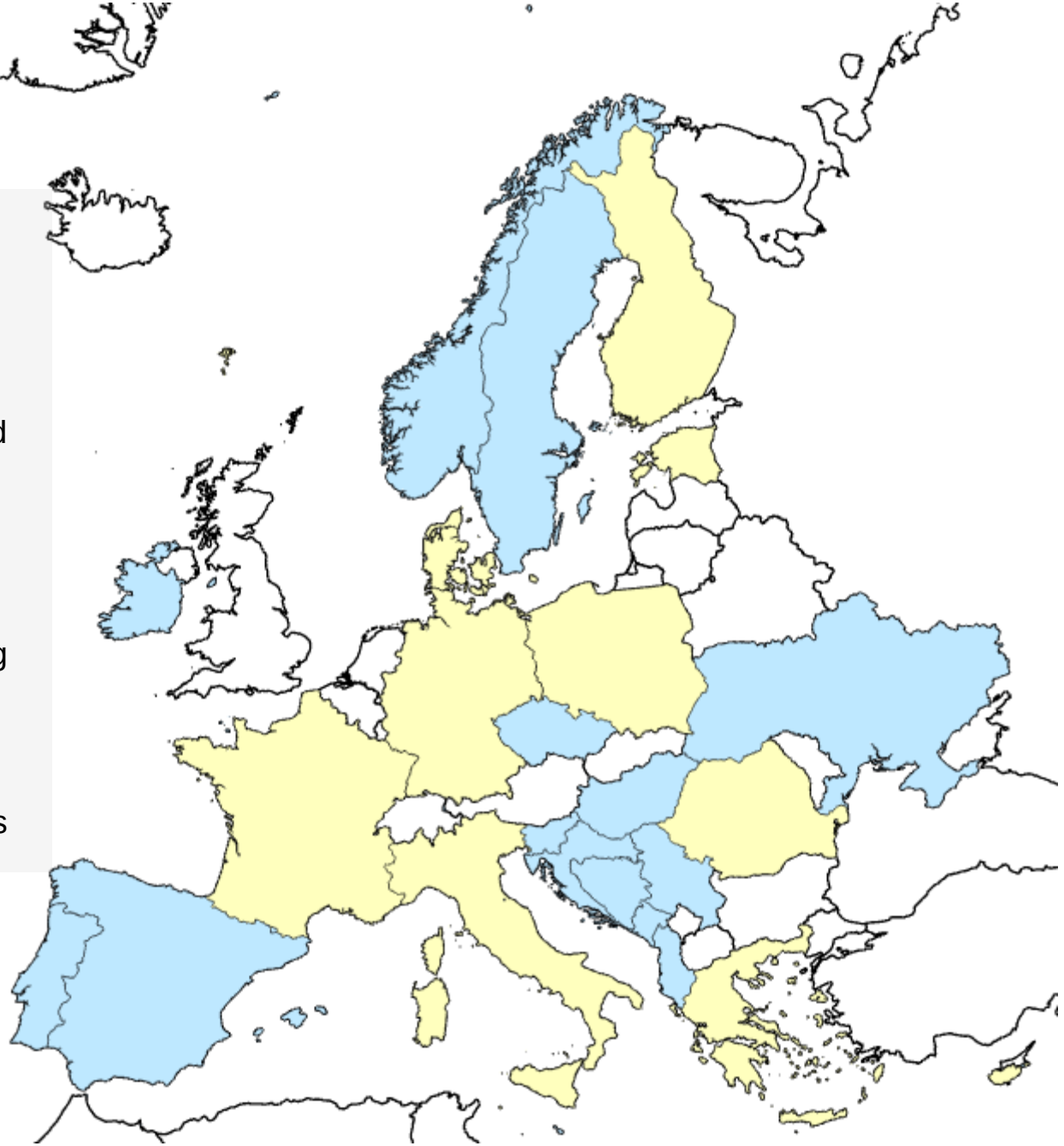
Europe (cooperation Futuram and GSEU)

From 12 to 21 (number of incoming)

In addition Switzerland (no mining waste), NM, Kosovo, Ukraine

SIx workshops – all of Europe invited

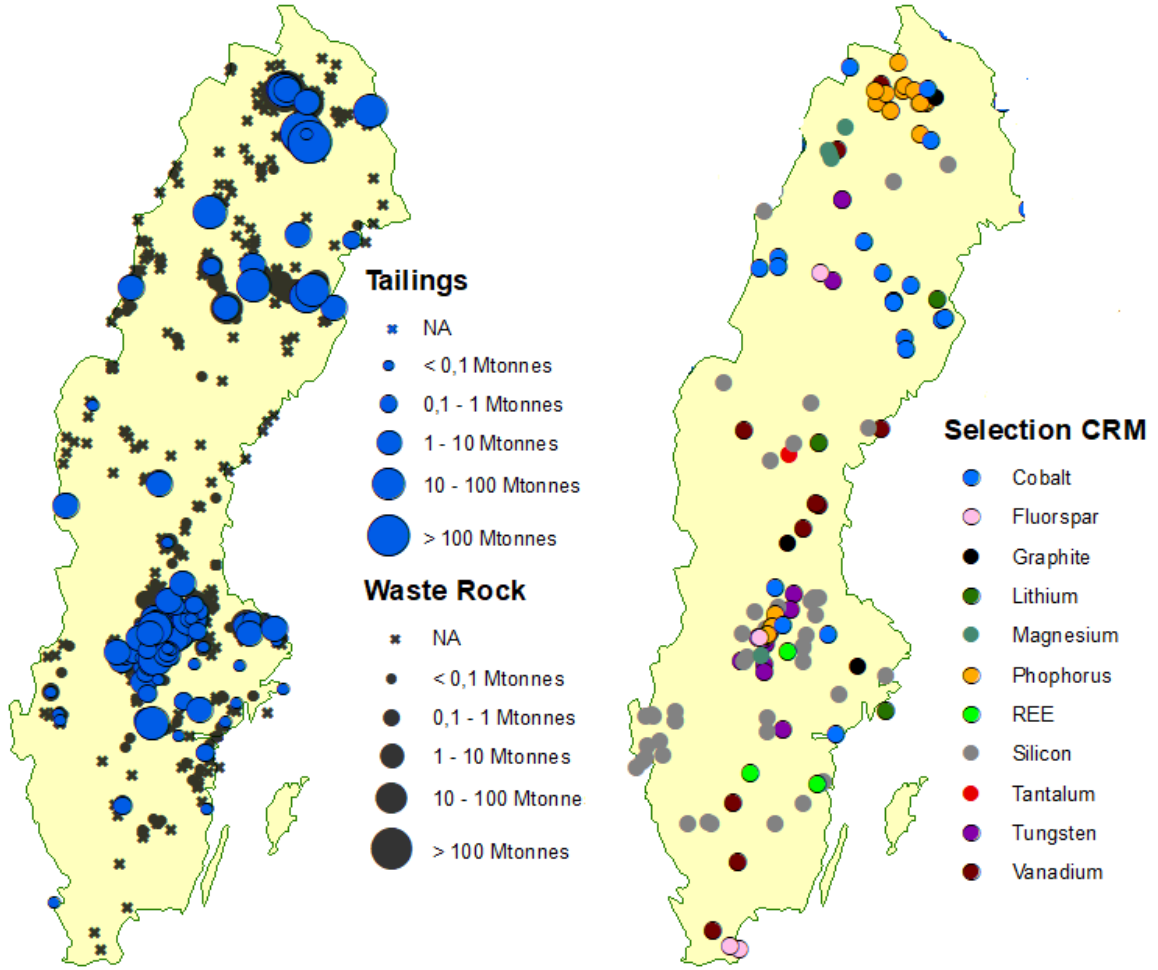
One more planned with stragglers



CRMs in Swedish Mining Waste

Mission from the government development of UNFC and characterization of mining waste

- Closed mining sites with no operator
- Some data >1000 sites
- Tailings and Waste Rock – about 200 Mt
- About 70 sites waste sites sampled and characterised
- 24 tailings – drill and surface sampling and modeling
- Analysis covered all CRM and basemetals
  - tonnage
  - composition (mineralogy, elements, commodities…)



Assessment of waste sites – by geological survey

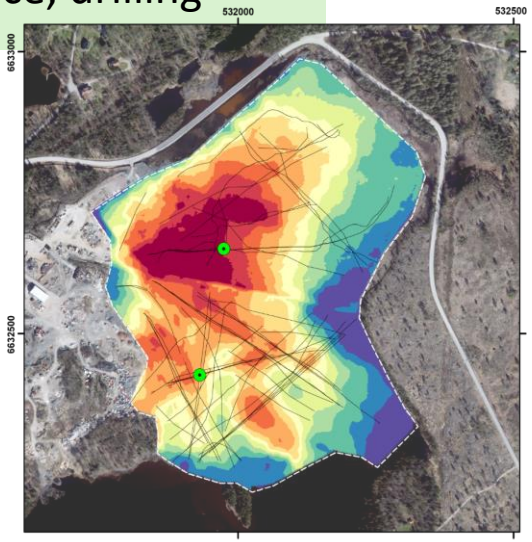
What parameters – G-axis - tailings

- Extent often easily found
- Tonnage – often known through reported from processing plants
- Grade – needs sampled and analysed
- Mineralogy – needs determined

Tailings – case Sweden

Sampling protocoll

- Hand drill and shovel
- Drill rig – auger – every m
- Analysis – standard protocols, most of the periodic table
- Mineralogy
- Tonnage from processing – out of flotation
- Volume – geophysics and observed surface, drilling

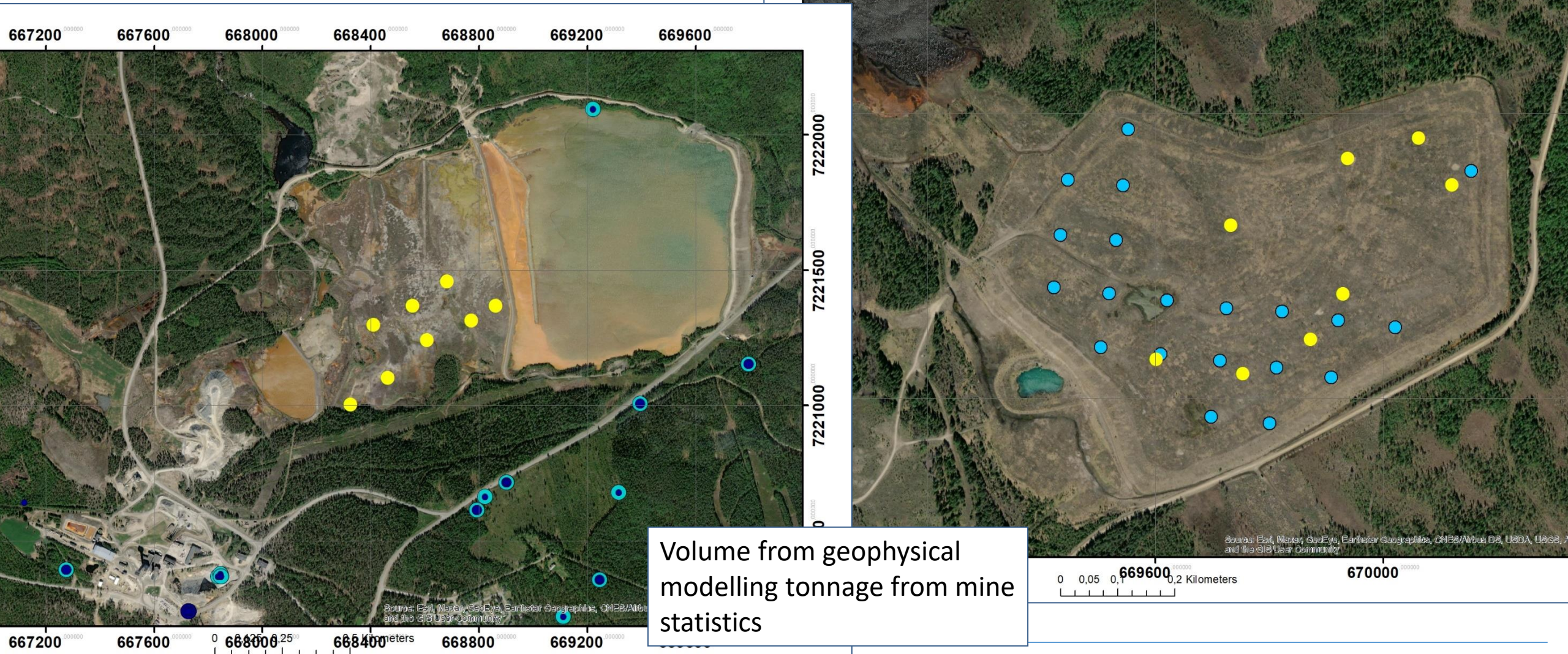


Waste rock – case Sweden

Sampling protocoll

- Hand sampling
- Random 30 samples bottom, centre, top
- Analysis – standard protocols, most of the periodic table
- Mineralogy
- Tonnage from estimate of volume or reported from mine

Large tailings Sweden – example drilling Kristineberg and Adak



Volume from geophysical modelling tonnage from mine statistics

Tailings

Type of objects – increasing ranking

1. Only known tonnage
2. Add surface sampling
3. Add surface and few drill holes
4. Add drill holes – dense to semidense
5. Industrial cases

Tailings

Provtagningsobjekt	Tailings (ton)	Be	Bi	Co	Ga	Ge	Hf	In	Li	Nb	P	PGM	REE+Y	Sb	Sc	Sr	Ta	Ti	V	W	Fe	Ni	Cu	Pb	Zn	Ag	Au
Adak	5 400 000	0.19	7.61	158.00	16.20	0.20	0.25	0.71	10.23	0.32	582.00	<0,006	102.00	19.05	18.00	78.10	0.40	3300.00	74.00	13.00	9.92	13.00	1874	54.00	458.00	1.48	0.19
Blaiksjön	okänt	0.79	0.43	18.00	10.70	0.15	3.70	0.16	61.60	9.40	600.00	<0,006	189.00	4.64	16.00	153.00	0.70	3730.00	193.00	5.00	5.10	102.00	72.00	1084.00	3185.00	2.01	0.04
Blötberget Glaningen	300 000	3.04	0.52	20.10	15.05	0.58	4.59	0.10	27.87	10.79	9900.00	<0,006	1240.00	0.35	9.30	32.33	1.14	1105.00	294.10	18.64	13.31	38.50	5.22	9.24	56.00	0.04	0.02
Blötberget Norberget	4 400 000	1.78	0.32	9.75	15.20	0.43	4.13	0.06	15.00	11.04	6310.00	<0,006	1180.00	0.68	8.23	64.60	1.58	693.00	214.58	13.14	10.62	23.58	8.43	7.76	42.70	0.08	0.02
Bäckegruvan	5 300 000	3.43	54.05	321.22	12.78	2.09	3.76	3.28	23.07	10.25	115.24	0.01	1080.00	0.95	3.98	33.98	0.76	547.68	5.73	52.43	12.55	4.49	1191.17	4.60	34.15	0.45	0.07
Grängesberg Hötjärnen	8 400 000	6.69	0.37	19.95	23.76	1.12	2.41	0.23	97.73	15.27	9650.00	<0,006	1940.00	1.60	13.13	34.11	3.24	1300.00	551.86	18.46	22.80	37.50	5.38	6.44	136.85	0.01	0.00
Grängesberg Jan-Matsdamme	2 550 000	4.85	0.56	14.67	19.60	0.88	3.05	0.09	114.29	21.42	22900.00	<0,006	1850.00	0.87	11.86	52.98	4.15	980.00	368.26	26.48	15.04	24.38	7.79	7.70	65.95	0.01	0.00
Grängesberg Svandammen	3 120 000	1.35	0.27	12.67	16.03	0.39	3.75	0.06	50.31	22.82	9330.00	<0,006	901.88	0.58	15.30	72.27	3.64	1290.00	129.85	9.42	7.37	21.48	4.63	9.03	45.19	0.02	0.01
Idkerberget	50 200	0.71	0.47	31.43	23.20	0.60	3.64	0.05	21.61	12.13	14300.00	<0,006	1140.00	0.22	16.14	159.43	0.73	4680.00	336.29	4.86	12.83	37.71	26.63	14.57	74.00	0.03	0.00
Intrånget	2 650 000	2.19	48.50	37.78	12.16	1.46	2.26	1.93	7.80	4.71	387.89	<0,006	203.51	0.21	10.67	83.71	0.17	1490.00	54.56	68.44	11.45	20.33	1524.89	202.44	978.33	1.56	0.13
Kalvsbäcken	280 000	0.49	1.11	6.02	9.47	0.19	2.28	0.15	8.32	5.10	80.00	<0,006	107.82	33.93	4.50	29.67	0.22	709.39	26.83	26.83	10.10	7.50	670.33	4833.33	7366.67	43.63	0.06
Kaveltorp	500 000	2.90	21.53	3.46	12.04	0.56	1.50	0.15	11.32	5.16	93.51	<0,006	106.55	4.10	1.74	18.55	0.53	206.67	10.00	58.36	4.94	3.47	1215.19	7658.10	9213.33	6.32	0.07
Källfallet	940 000	7.63	21.50	23.23	31.97	1.24	4.84	0.38	10.29	11.60	113.29	<0,006	2680.00	0.16	3.29	9.31	0.71	503.80	5.31	83.40	13.34	11.77	313.22	4.64	10.44	0.06	0.03
Laisvall	60 000 000	0.23	0.03	1.06	1.13	0.05	0.45	0.09	4.27	0.18	131.67	<0,006	60.59	1.25	0.86	78.53	<0,01	87.50	4.94	0.23	0.68	3.94	5.94	3847.22	1034.00	<0,01	<0,001
Långnäs	800 000	0.40	30.97	26.55	7.55	0.94	1.08	2.02	2.57	2.77	145.46	<0,006	101.83	1.12	4.17	52.12	0.18	719.38	24.33	44.17	15.15	6.17	245.33	200.00	546.33	2.18	0.13
Lövås	285 000	0.45	2.93	43.20	9.62	0.32	1.63	0.18	2.72	3.28	276.37	<0,006	99.02	36.40	7.33	59.44	0.17	1070.00	48.44	7.11	12.82	8.56	307.33	4884.44	7991.11	10.49	0.03
Nyberget	1 400 000	0.55	13.63	12.33	8.43	0.62	0.97	1.32	1.50	2.51	138.19	<0,006	252.00	0.21	2.33	28.45	0.10	369.68	11.25	17.50	9.80	3.17	96.15	12.67	99.67	0.04	0.00
Stollberg	2 800 000	1.78	2.53	3.48	18.75	0.33	2.21	0.82	5.30	5.31	217.42	<0,006	187.14	14.20	2.73	26.02	0.58	384.82	13.16	22.15	10.68	4.61	158.55	3061.86	4857.50	8.87	0.02
Svärdsjö	okänt	0.67	2.71	8.40	8.80	0.22	4.40	0.61	5.55	6.30	283.64	<0,006	255.33	4.97	5.50	27.15	0.30	989.15	18.50	8.50	9.79	8.00	744.50	3132.00	6802.00	20.49	0.05
Vassbogruvan	4 430 000	0.07	0.03	2.25	1.38	<0,05	7.86	0.04	0.65	2.74	191.33	<0,006	54.49	1.23	1.15	156.01	0.30	1230.00	7.92	1.20	0.59	1.83	14.23	3175.38	458.00	1.49	0.00
Vintjärn	3 250 000	0.81	2.55	11.11	9.16	0.12	5.91	1.63	10.91	9.86	529.89	<0,006	235.94	<0,05	6.57	24.76	0.63	1340.00	12.57	3.71	9.88	15.71	98.00	15.29	248.00	0.05	0.02
Viscaria	12 000 000	0.49	5.16	141.44	9.81	0.29	0.56	0.66	26.46	0.08	1530.00	<0,006	360.19	0.58	9.25	49.35	0.01	2010.00	154.28	0.67	10.40	124.00	2999.44	142.17	2730.50	0.95	0.05
Yxsjöberg Morkulltjärnen	2 200 000	129.12	472.84	25.02	22.77	2.89	2.23	3.66	5.77	5.94	181.15	<0,006	163.71	0.42	5.94	34.11	0.31	742.08	37.36	897.45	13.38	10.36	467.68	4.96	275.23	0.28	0.13
Average concentration	121 055 200	7.41768	30.027	41.35226	13.72	0.6799	2.93	0.8	22.8323	7.7807	3390.741236	0.000265206	630.0432783	5.55295	7.737487	59.04243	0.8929	1281.658333	112.9185	60.92033	10.545	23.1332	524.175971	1407.47	2030.82	4.3697	0.046464
Tonnage		897.949	3634.9	5005.906	1660.8	82.306	355	96.7	2763.97	941.9	410466.8584	0.001166907	76270.01506	672.213	936.663	7147.393	2E-05	155151.4058	13669.37	7374.723	1E+07	2800.39	63454.227	170382	245842	528.97	5.624728

After Lewerentz et al 2023

Waste Rock

Object	Tonnage	Be	Bi	Co	Ga	Ge	Hf	In	Li	Nb	P	PGM	REE+Y	Sb	Sc	Sr	Ta	Ti	V	W	Fe	Ni	Cu	Pb	Zn	Ag	Au
Baggetorpsgruvan	94183	0.3	48.8	8.1	16.0	0.2	4.8	0.1	13.3	10.5	209.5	0.006	158.1	0.2	8.9	108.4	1.0	1762.5	45.9	342.5	2.5	9.5	142.8	6.9	49.1	0.33	0.003
Basttjärnsfältet	257174	0.91	3.1327	7.8	14.8	0.276	3.914	0.2093	9.66	6.6313	125.1	<0,006	114.34	0.242	2.1133	18.42	0.4533	477.33	9.5	9.9067	13.681	2.9333	163.53	114.89	210.53	0.4407	0.0041
Bjurfors gruvfält	30863	0.1	10	61	21.6	0.196	5.1	2.583	11.6	6.15	104	<0,006	152.7	2.29	6.8	27.6	0.5	1535	33	1.9	11.597	2	6465	36	1992	2.54	0.037
Blötbergsfältet	4213605	1.0167	0.1153	12.6	16.18	0.2967	4.68	0.0477	13.687	11.493	2650.4	<0,006	592.32	0.706	5.3333	62.16	1.6467	814.67	261	11.933	15.697	21.4	5.7333	6.7333	28.867	0.01	0.002
Bäckegruvan	okänt	1.7	104.5	286.1	13.7	1.0	3.9	3.3	20.0	11.0	66.9	0.006	768.0	0.2	3.6	12.7	0.8	597.5	6.7	39.6	24.7	5.4	4705.3	5.2	17.7	1.5	0.1
Grängesberg mining district	5500000	1.7208	0.1569	18.181	19.199	0.3301	4.5125	0.0414	28.623	10.677	4020	<0,006	510.22	0.3404	9.9108	80.333	3.445	1834.1	242.5	15.631	10.322	19.85	9.4688	7.6938	36.55	0.0112	0.0033
Gruvberget	122000	0.52	6.84	26	12.2	0.13	2.6	0.246	20.0	6.1	387	<0,006	103	26.5	9	51	0.3	1958.0	68	4	7	14	2141	9519	23550	26.96	0.14
Guttusjögruvan	140000	0.13	0.04	3	2.3	0.05	29.7	0.027	1.0	12.7	143	<0,006	143	1.55	3	39	0.9	5378.6	26	1	1	2	12	11300	140	2	0.001
Hällefors silvergruvor	94000	0.8133	0.5833	7.4	14.956	0.0933	3.4444	3.5673	6.7474	8.7722	188.2	<0,006	150.49	49.394	2.3944	32.589	0.5278	150.49	35.25	2	10.37	7.75	113.06	9665.2	13520	31.621	0.0559
Idkerbergets gruva	okänt	0.75	0.06	25	20.0	0.24	3.0	0.024	10.3	11.9	3380	<0,006	293	0.19	24	319	1.0	6323.7	419	3	15.597	48	20	63	181	0.25	0.002
Kalvsbäcksgruvan	140000	0.55	3.15	8	15.1	0.14	3.6	1.198	8.1	7.0	118	<0,006	175	29.27	6	22	0.4	839.2	23	6	9	7	1409	12600	37410	51.49	0.052
Kaveltorps gruvor	233000	2.5988	131.15	5.225	19.631	0.3413	3.3625	0.4402	25.631	12.506	109.1	<0,006	222.04	2.9238	2.7625	13.325	1.9688	314.38	9.875	26.875	6.2369	4.25	2681.6	15600	22390	15.594	0.1557
Kittelgruvan	okänt	4.4	339.6	370.9	44.9	1.8	3.6	2.5	11.9	10.4	98.9	<0,006	8200.8	0.2	3.2	5.3	0.7	603.5	14.0	9.4	12.5	43.1	1806.6	23.2	18.9	0.67	0.24
Källfallsgruvan	1070000	7.16	5.41	14.94	32.45	0.57	4.21	0.23	11.18	11.56	48.77	0.01	1226.63	0.13	3.24	6.15	0.81	486.64	5.24	34.53	13.33	7.59	203.71	3.25	8.82	0.045	0.011
Ljusnarsbergs gruvor	122000	2.2288	60.7	13.188	14.106	0.435	3.8438	0.5306	38.513	10.225	106.37	<0,006	180.34	0.2675	3.1667	8.0313	1.3625	310.67	6.3077	42.25	19.063	2.3333	2513.9	1569.9	2403.4	3.2113	0.0444
Lainejaur	61000	0.1395	0.6158	308.42	14.547	0.2074	2.0737	0.0887	16.168	0.0721	539.73	0.0137	76.807	14.795	18.526	197.03	0.1278	3454.9	88.316	<1	9.1337	2933.9	2775.3	27.632	174.89	1.7768	0.1613
Laver	133000	0.1794	1.4906	9.3125	19.594	1.0375	3.8569	0.5878	16.25	7.1213	180.01	<0,006	143.34	0.8475	4.8125	188.28	0.625	985.4	25.313	2.5563	3.1781	12.438	4456.3	137.5	706	12.944	0.0479
Lövåsfältet	55000	0.44	102.40	31	9.5	0.25	1.4	0.103	2.1	3.6	218	<0,006	79	8.73	10	67	0.2	1158.8	53	6	20	9	415	6217	7320	8.76	0.035
Malmkärrafältet	83000	20.0	7.6	7.3	104.1	1.8	2.1	0.2	9.7	6.5	96.0	0.006	5486.2	0.3	3.6	10.6	0.5	311.7	5.8	200.4	22.5	23.3	161.5	20.8	51.5	0.041	0.004
Sköttgruve- Mossgruvefälten	1310000	1.024	0.804	9.6	18.547	0.1533	4.184	0.1588	17.3	17.03	325.85	<0,006	194.68	0.0873	4.7467	54.047	2.4	830.67	58.733	9.1133	6.4876	8.6667	28.2	16.253	53.267	0.0293	0.0023
Nya Bastnäs	okänt	9.0	100.6	201.6	28.8	2.0	2.7	1.3	8.2	7.1	163.6	0.006	8107.0	2.3	2.6	16.2	0.5	554.5	12.6	19.7	24.2	35.0	1180.8	3.4	19.6	0.219	0.057
Yxsjöbergsfältet	644000	45.308	118.35	21.941	19.718	0.6518	4.2059	0.7956	8.7235	10.047	349.12	0.0056	210.38	0.1635	9.8529	46.529	0.6176	1414.1	100	692.12	6.9774	24.118	262.71	3.5294	98.529	0.0794	0.0385
Morbergsfältet	560000	5.4	17.4	28.2	22.8	0.5	5.5	0.6	7.6	15.6	72.7	0.006	870.8	0.1	3.6	4.3	1.0	587.5	8.4	20.6	12.2	6.9	748.5	3.3	11.5	0.069	0.030
Pahtohavare		0.5653	0.046	105.03	12.873	0.2187	0.218	0.1139	24.547	0.0891	624.67	0.0096	135.41	0.1107	21.053	17.833	<0,1	2568.7	242.8	<1	10.097	119.33	5150.4	11.636	31.867	0.8	0.1943
Skytt- och Näverbergsgruvan	171000	0.67	5.49	38	14.4	0.74	2.0	0.464	3.7	5.0	480	<0,006	131	117.9	4	22.0	0.3	983.0	22	7	8	9	4777	33600	89190	140.03	0.533
Ställbergs- Haggruvefälten	5500000	2.0213	4.048	9.6	13.18	0.1567	3.192	0.4211	5.2133	6.8327	174.56	<0,006	127.19	0.1853	3.0667	33.76	0.3267	679.33	22.5	3.1	12.2	8.1429	131.27	5.26	45.067	0.0433	0.0061
Svärdsjö gruva	210000	0.24	40.1	14	11.4	0.22	1.4	0.580	2.7	3.7	87	<0,006	77	2.24	5	23	0.3	899.1	28	2	8	21	6960	4050	17900	19.90	0.358
Tomtebo gruva	76000	0.50	33.14	68	13.1	0.15	1.9	0.951	8.9	3.6	61	<0,006	79	3.2	2	12	0.3	551.4	54	3	12	2	3856	1579	1476	16.02	0.505
Stora Utterviksgruvan	4500	0.9	32.7	37.5	12.5	0.2	2.5	0.2	14.9	6.6	698.2	0.006	154.3	8.4	5.8	54.3	0.6	1040.9	32.0	1.4	8.4	16.9	953.4	762.5	6519.6	3.7	0.015
Venafältet	13800	0.7	129.8	155.6	20.6	0.2	4.4	0.4	24.3	9.4	546.0	0.006	181.5	34.5	14.2	90.0	0.7	2515.2	90.6	1.3	4.3	20.0	2895.8	161.8	1695.1	3.121	0.007
Viscaria	5267743	0.2512	0.5265	70.647	18.235	<0,05	2.2647	0.1672	39.429	0.1333	627.65	0.0084	106.09	0.2624	34.118	0.6529	0.2294	2340	290.41	<1	9.8746	110.06	1775.5	104.53	1014.9	0.8867	<0,001
Wigströmsgruvan	214750	29.068	29.409	5.125	25.544	0.9506	5.0938	0.365	30.206	17.744	136.38	<0,006	204.58	0.515	4.3875	21.438	1.9625	805.63	25.467	507	5.6001	2.5833	15.313	18.031	196.38	0.0475	0.0094
Getbacks- och Rödbergsfälten	573869	1.8	0.7	8.4	16.1	0.7	2.6	0.5	3.1	6.8	136.7	0.006	456.9	1.9	4.5	39.0	0.4	739.4	20.5	45.1	20.0	7.3	138.3	2.5	36.3	0.033	0.002
Östanmossen	okänt	10.3	3.4	10.5	17.1	1.0	0.9	0.6	1.50	2.3	66.9	0.006	1573.3	0.5	1.2	15.9	0.2	131.9	5.0	84.1	21.8	7.1	194.3	2.0	25.7	0.025	0.006
Average		4.5122	39.5	59.067	20.283	0.5051	4.0196	0.6947	13.965	8.1381	509.99	0.0029	923.07	9.1623	7.3653	50.567	0.798	1351.1	70.276	63.36	11.69	105.14	1743.2	3154.3	6721.2	10.152	0.0852

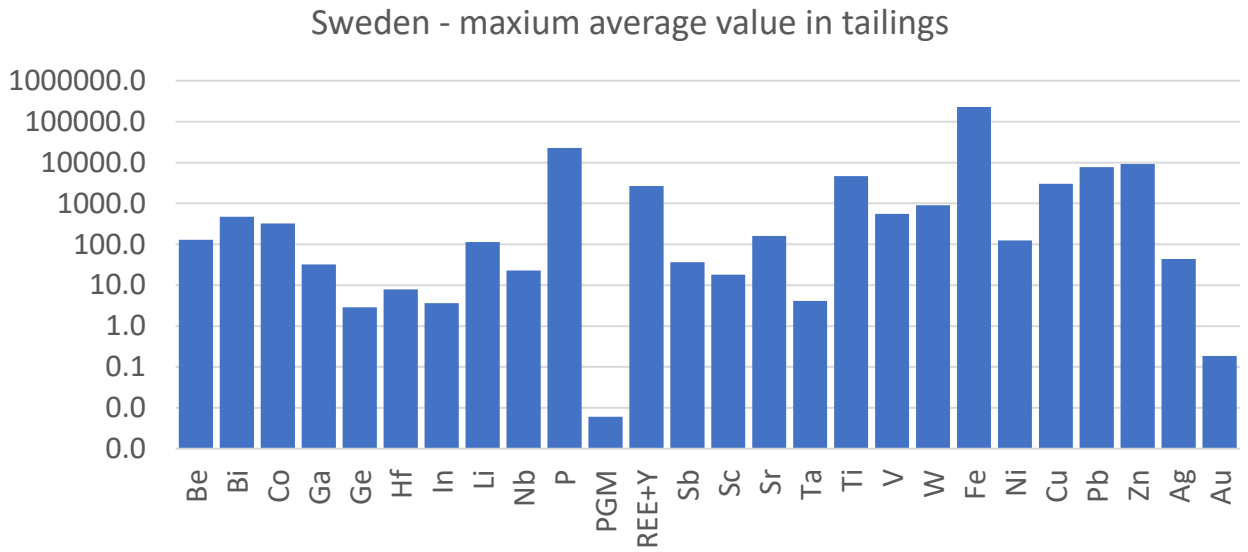
After Lewerentz et al 2023

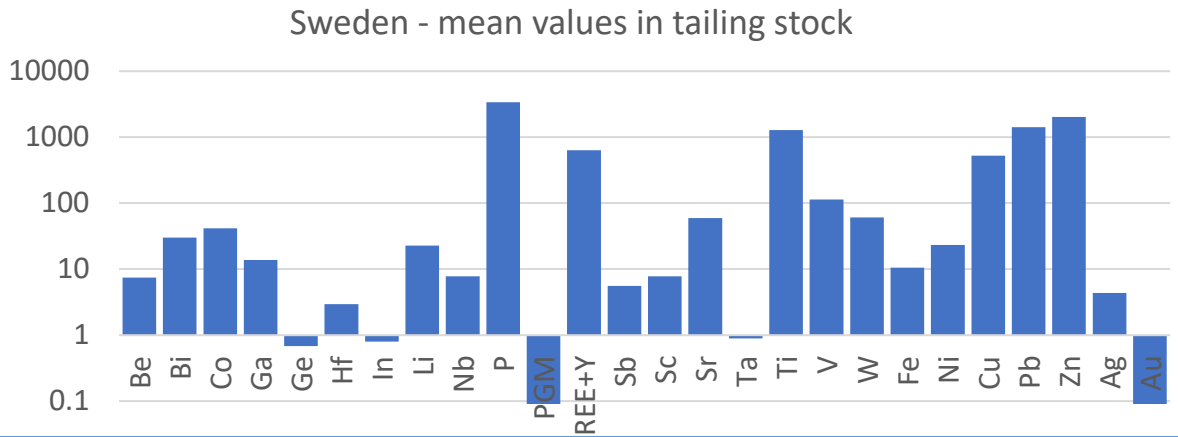
How to evaluate grade in mining waste stock?

Comparison maximum values with mean for stock

=> stock must be evaluated at site level

=> Use UNFC





UNFC

Viable projects – industry

Non-viable projects - surveys

Total Products	Class		Sub-class	Categories E	F	G[a]	
Known Sources	Viable Projects *Estimates associated with Viable Projects are defined in many classification systems as Reserves, but there are some material differences between the specific definitions that are applied within different industries and hence the term is not used here.* [c]		On Production	1	1.1	1, 2, (3)	operating continuously operating intermittently
			Approved for Development	1	1.2	1, 2, 3	under development
			Justified for Development	1	1.3	1, 2, 3	pending approval
	Potentially Viable Projects *Not all Potentially Viable Projects will be developed*		Development Pending	2[b]	2.1	1, 2, 3	feasibility evaluation of the ore deposit
			Development On Hold	2	2.2	1, 2, 3	care and maintenance retention
	Non-Viable Projects *Non-Viable Projects include those that are at an early stage of evaluation in addition to those that are considered unlikely to become Viable developments within the Foreseeable Future.* [c]		Development Unclarified	3.2	2.2	1, 2, 3	resource assessment (geological interpretation, approximate calculation of the resource)
			Development Not Viable	3.3	2.3	1, 2, 3	closed abandoned historic
	Remaining Products not developed from identified Projects *Remaining Products not developed from identified Projects or Prospective Projects may become developable in the future as technological or environmental-socio-economic conditions change. Some or all these estimates may never be developed due to physical and/or environmental-socio-economic constraints.* [c]			3.3	4	1, 2, 3	
Potential Sources	Prospective Projects			3.2	3.1	4	subsurface exploration
				3.2	3.2	4	detailed surface exploration
				3.2	3.3	4	regional reconnaissance
	Remaining Products not developed from Prospective Projects			3.3	4.1	4	
				3.3	4.2	4	
				3.3	4.3	4	

UNFC CRM and 2RM– National Case Sweden

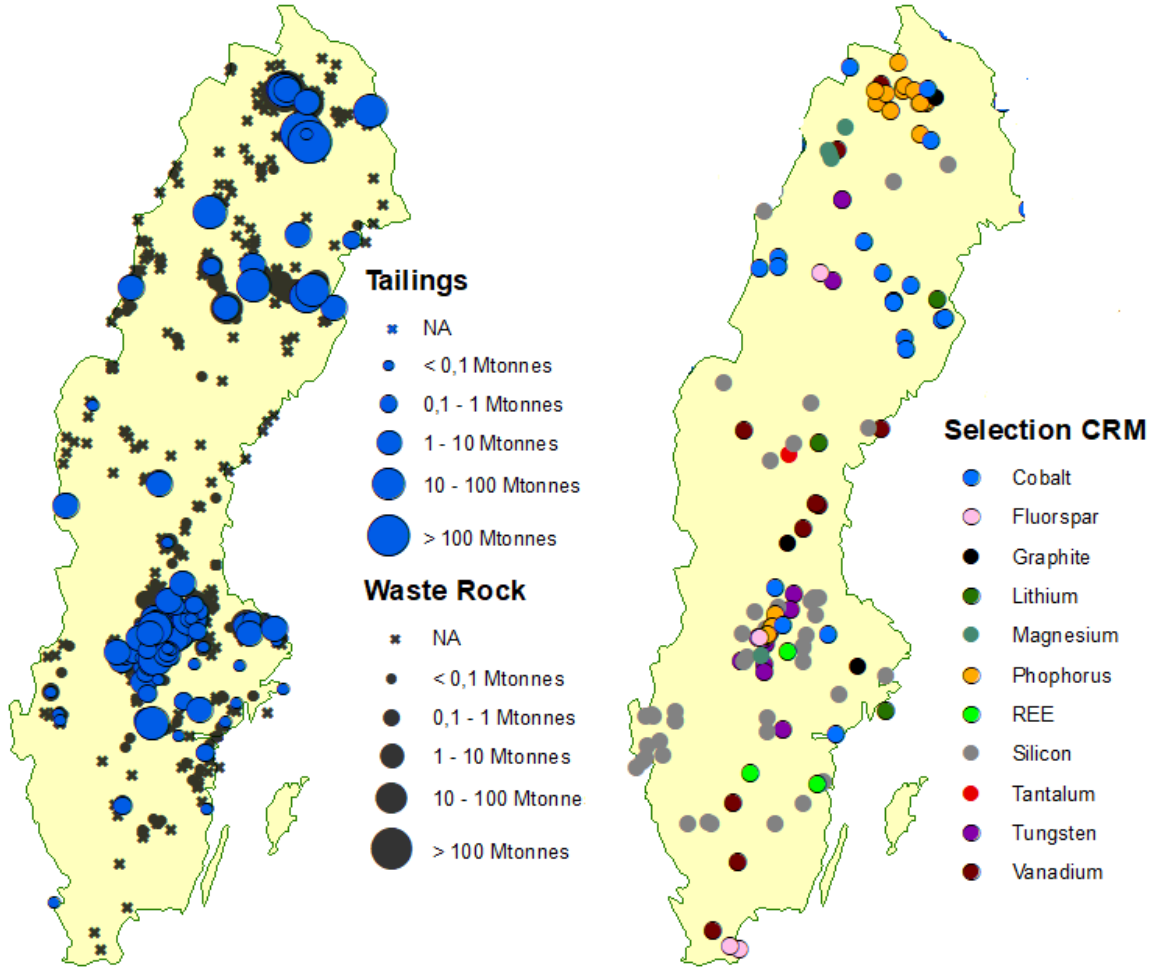
Mission from the government development of UNFC and characterization of mining waste – closed mine sites

UNFC G-axis

- Some data >1000 sites -> less than 70 sites for UNFC
- G4, G3 Tailings and Waste Rock
- G2 A few examples (well determined)

F – axis – few case F2 – few industrial cases 3 industrial cases

E-axis – E3 and E2 hearing with industry and authorities



Example Håkansboda rich in Cu, Zn, Co
Futuram project –Lovisamine (lovisagruvan)

Mined 13th-20th century

Waste Rock

Tonnage estimated

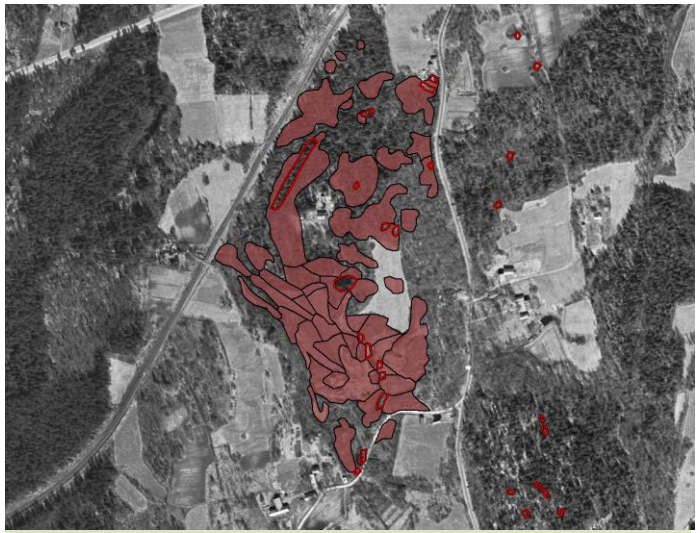
Exploration – sampled 120 sites

Characterization

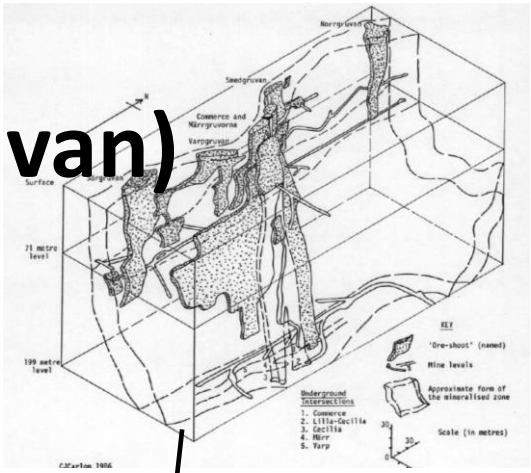
- Geochemistry
- Mineralogy

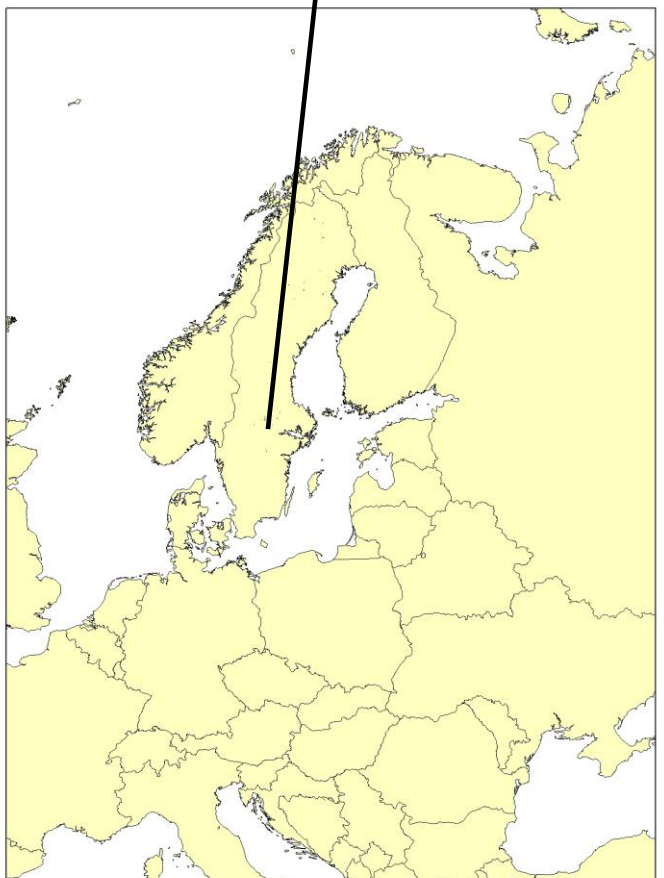
Beneficiation test

Advanced x-ray sorting

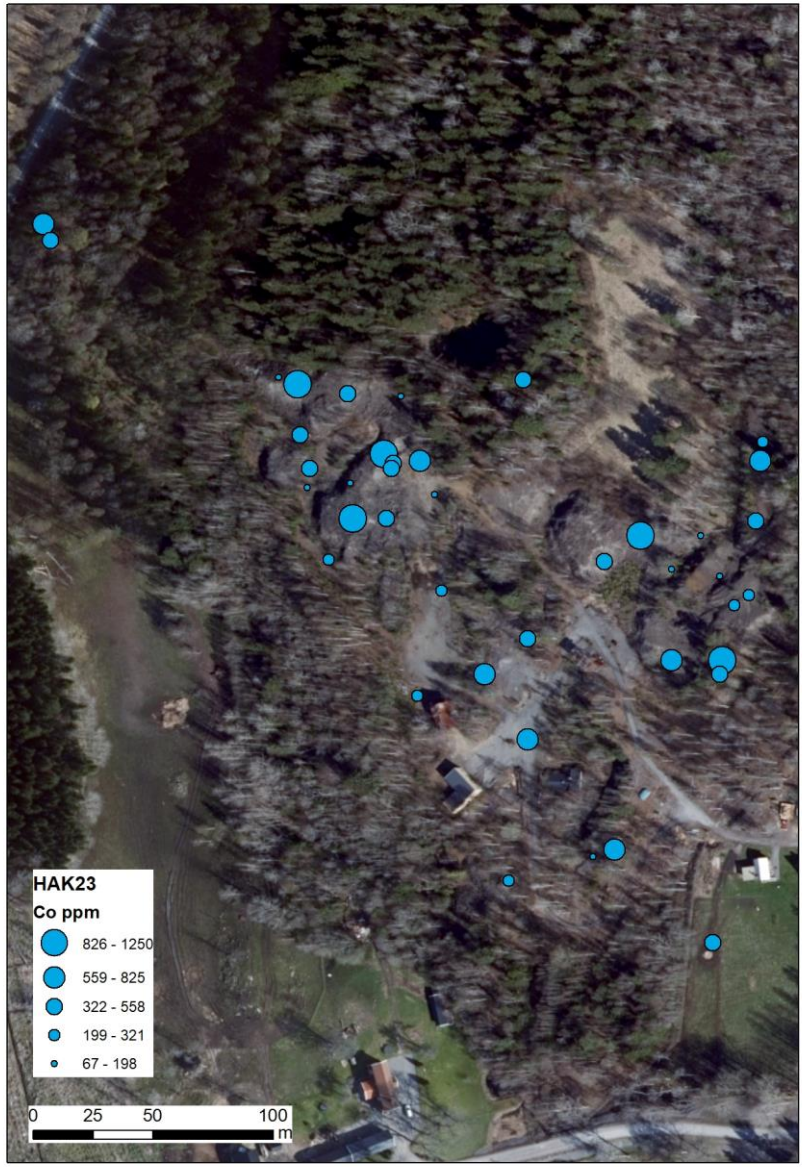


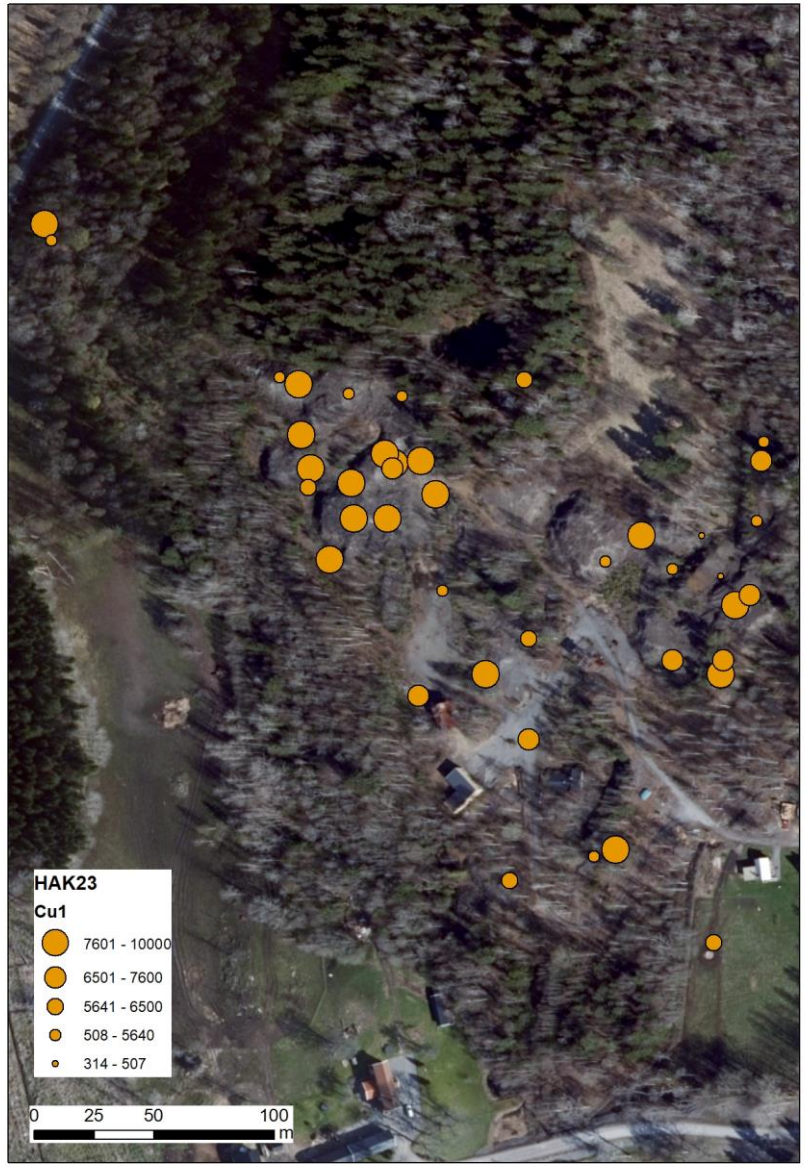
Håkansboda
Mining waste: ~7,87 ha.
~200 000 – 300 000 t

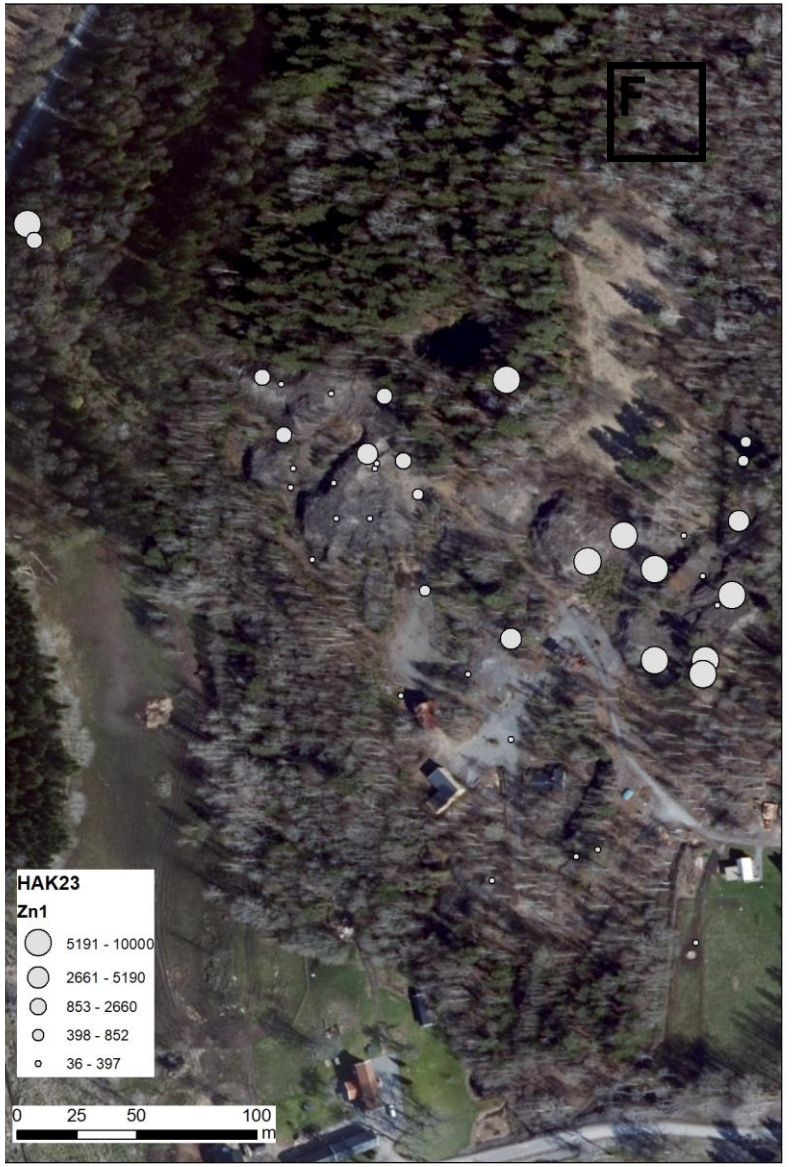




Resource Cu , Co, Zn







Development of UNFC – Håkansboda preliminary results

Conceptual study

- Resources
  - 250 000 tonnes
  - Cu 0.7%
  - Zn 1.2%
  - Co Areas >500 ppm
  - Ag 15 ppm
  - Au .2 ppm
- Beneficiation test – 1st step, but ongoing
- Permitting has not started for excavation/EIA

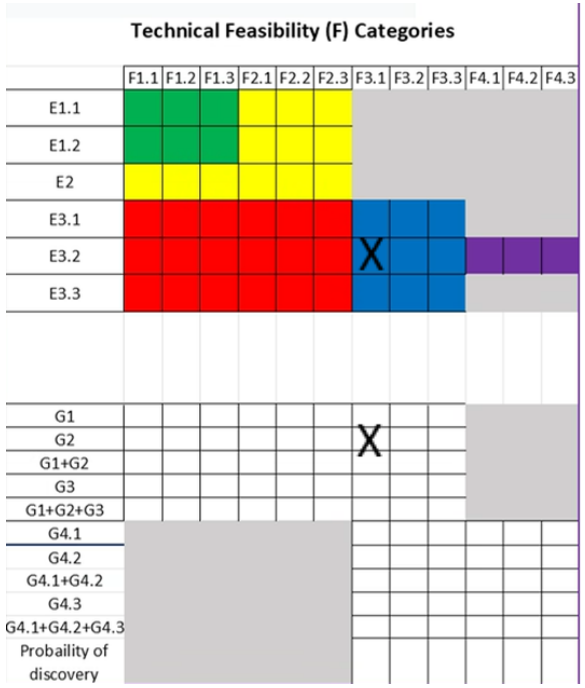
Minimum UNFC Categories	INSPIRE Code Name (Exploration Activity)	INSPIRE Code (Exploration Activity)	INSPIRE Code List Description
E3.2 F2.2 G1,2,3	**resource assessment**	**resourceAssessment**	**The aim of this phase is the delineation of the envelope of an orebody. Logging of cores, sampling of mineralized sections to better understand the distinctive features of the deposit, the physical properties of the ore, and finally to lead to a first (still approximate) calculation of the resource.**
	percussion drilling assessment	percussionDrillingAssessment	The assessment of the resource using percussion drilling, sometimes on a grid with a wide mesh. The aim of this phase is the (still rough) delineation of the envelope of an orebody. Drill logging, sampling of mineralized sections to better understand the distinctive features of the deposit, the physical properties of the ore, and finally to lead to a first (still approximate) calculation of the resource.
	core drilling assessment	coreDrillingAssessment	Drilling of a cylindrical hole with an ad hoc tool to collect a rock sample, or to conduct a physical measurement or a geological observation. By extension, designates also the drill hole, whatever the latter's purpose. Boreholes are drilled by coring. This technique is used to collect undisturbed rock cylinders and allows to confirm/to precise results from percussion drilling.
	geological interpretation	geologicalInterpretation	Compilation and synthesis of all the available geological information to get as precise as possible model of the mineral resource.
	ore beneficiation tests	oreBeneficiationTest	Technique designed to treat run-of-mine material.
	approximate calculation of the resource	approximateResourceCalculation	Rough evaluation of the tonnage and grade essentially based on drill holes information, by correlation and interpolation of intersected mineralized sections.

Development of UNFC – Håkansboda preliminary results

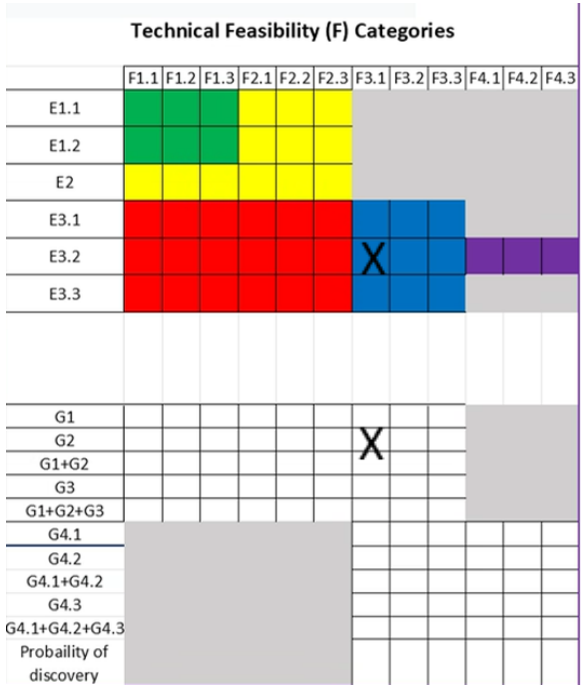
Futuram case – operator Lovisagruvan

- Resources
  - 250 000 tonnes
  - Cu 0.7%
  - Zn 1.2%
  - Co Areas >500 ppm
  - Ag 15 ppm
  - Au .2 ppm
- Beneficiation test – 1st step, but ongoing
- Permitting has not started for recovery/EIA

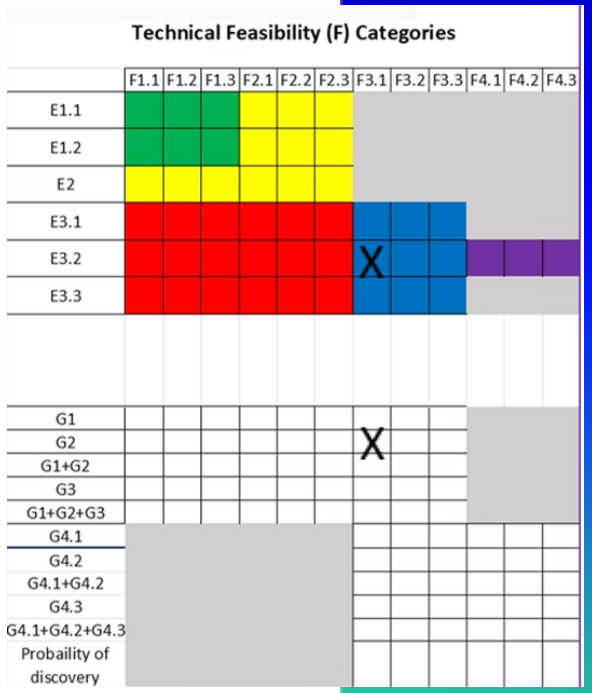
Cu



Zn

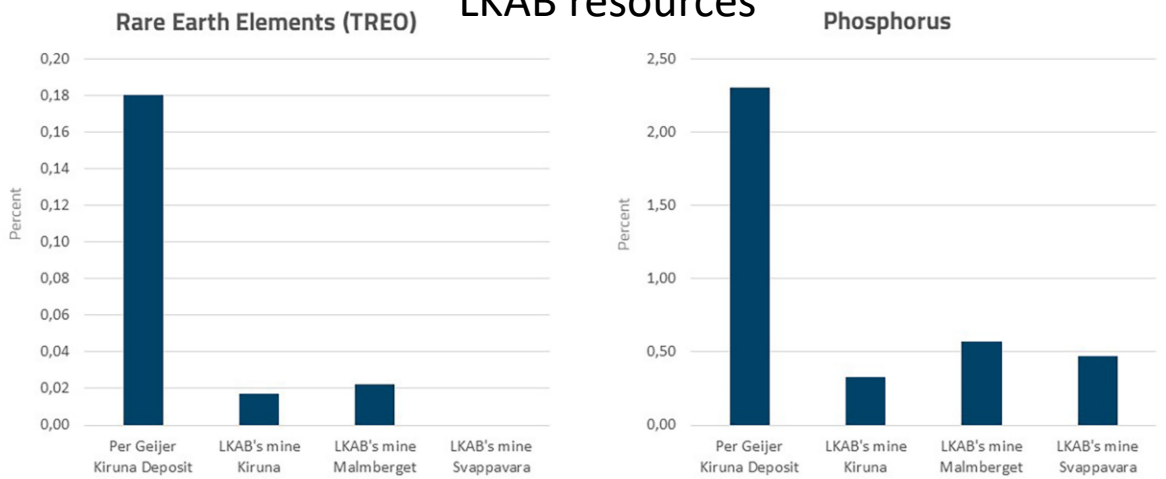


Co



Conclusions

LKAB resources



Source: LKAB 2023-06-12

Mining Waste

Promising for raw materials/CRM

Stock low compared to primary mining

Extraction need combination of other RM maybe with primary

Not all mining waste is viable for recovery

Tonnage can be well determined/known

Grade must be analysed

Permitting must be clear otherwise no extraction/recovery

UNFC highlights permitting differences/hurdles compare to primary

Thank you

"THE VIEWS EXPRESSED ARE THOSE OF Ronald Arvidsson AND/OR SGU AND DO NOT NECESSARILY REFLECT THE VIEWS OF THE UNITED NATIONS."

SGU Geological Survey of Sweden