Customer
Grängesberg Exploration AB
Project
Jan-Matts tailings dam
Mineral Resource Estimate
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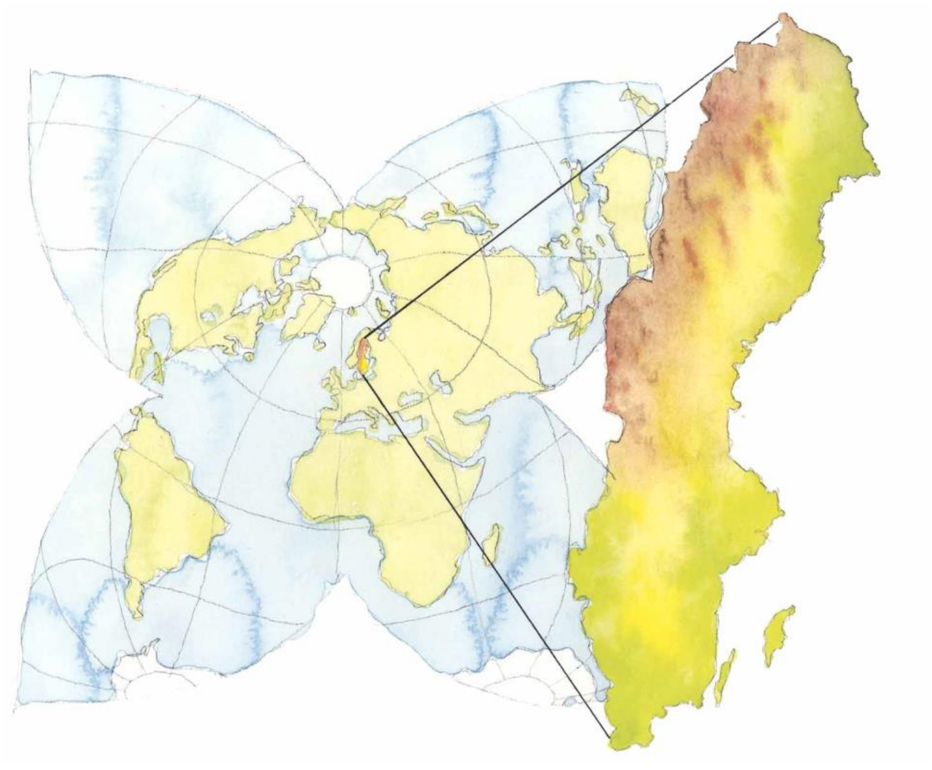
Jan-Matts tailings dam, Grängesberg

Updated

Mineral Resource Estimate

November 2022



Executive summary

On behalf of Grängesberg Exploration AB, GeoVista AB has compiled this independent statement and report over the updated estimation of Mineral Resources for the Jan-Matts tailings dam, found in Grängesberg, Sweden. The mineral resources are reported in accordance with the JORC-code, 2012-edition.

The tailings have been investigated with drilling and sampling in four campaigns, with drillhole collars placed in an approximately 100 * 100 m pattern, with a nominal sample spacing of one sample for every metre of depth in the hole. The fourth campaign was conducted during 2022, and the results have been added to the previous material and is reported here.

The density was determined by drilling and filling a plastic tube with material, this was weighed, dried and weighed again, the volume was measured, thereby allowing the calculation of in-situ density. A total of 4 holes were drilled, for a total of 30 samples.

The volumes of the mineralized material have been determined by a combination of high-resolution terrain models, based on LIDAR data, a sonar survey over the water-covered part of the deposit and the results from the drilling and assaying. All holes from the three most recent campaigns penetrated the bottom of the deposit, into the sub-stratum, which has led to a good estimation of the volume of the deposit.

The grades of P_2O_5 and Fe[1] were estimated by block modelling, using Ordinary Kriging.

The tonnage has been classified as Indicated Mineral Resources, with 3,46 dry Mtonnes containing 5,46 % P_2O_5, compared to the previously estimated 2,79 dry Mtonnes containing 5,44 % P_2O_5 (Lindholm, T., 2021). This corresponds to an increase in dry tonnage of 24% compared to the previous estimate.

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[1] The content of Fe is reported as Fe, however, Fe is present as Fe_2O_3, Fe_3O_4 as well as in other minerals, no speciation has been carried out at this stage.

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1 Summary

1.1 Introduction and property description

On behalf of Grängesberg Exploration AB, GeoVista AB has compiled this independent statement and report over the updated estimate of Mineral Resources for the Jan-Matts tailings dam, located in Grängesberg, Sweden. The mineral resources are reported in accordance with the JORC-code, 2012-edition. The report is accompanied with a completed Table 1, as required by the code.

Grängesberg is located in the Bergslagen region of central Sweden, see Figure 1. Mining of iron ore in Grängesberg was on-going from the 16th century until 1989. The deposit is a magnetite-hematite-apatite iron ore deposit, believed to be a magmatic iron ore, similar to the Kiruna deposit in formation.

The contents of phosphorous in the ore is typically around 1 %, but can locally be higher, the element is principally found in the mineral apatite and as well in monazite, and typically associated with higher contents of rare earth elements.

Work to remove phosphorous from the ore was initiated already in the late 1920's and in 1935 the company installed a flotation plant to recover apatite, and thus improve the product (iron ore concentrate) quality as well as to produce a marketable apatite concentrate.

Over the years, the beneficiation plant was upgraded, and better-quality concentrates were produced with lower contents of phosphorus.

1.2 Mineralization

The mineralization consists of tailings, resulting from the production of iron ore concentrate at the nearby Grängesberg mine. The minerals found in the tailings are typically silicates (potassium feldspar, Na-rich plagioclase, quartz and amphiboles), micas (biotite), iron oxides (magnetite and hematite), apatite, monazite and allanite.

1.3 Drilling, sampling and analyses

The tailings dam has been investigated in four campaigns. The first by 13 drillholes made with a rotating hand-held shovel resulting in 44 samples, with sample depths between 1 and 4,75 m (Berg, 2011). The second by 24 holes using a track mounted drill rig, equipped with a flow through sampler, resulting in a total of 125 samples, with sample depths between 1 and 15 m (Wikström, 2021). The third campaign was directed at determining the in-situ density of the material. Four holes were drilled in the deposit, resulting in 30 samples of 1,2 m length. The samples were aimed at determining the in-situ density of the deposited material. The fourth campaign was again done with the same track mounted rig, resulting in 12 holes in the southern, water covered part of the deposit, for a total 65 samples (Wikström, 2022).

The two latter campaign drillholes always ended in the former lake bottom, to be able to determine the actual depth of deposition in each hole.

The first campaign samples were split and milled at the University of Gothenburg and later sent to ALS Global for assaying. The second and fourth campaign samples were sent whole to the Geological Survey of Finland's mineral processing plant in Outokumpu, GTK Mintec, for sample preparation, assaying and metallurgical testwork. The third campaign samples were transported to the Swedish School of Mining and Metallurgy in Filipstad for determination of density and moisture content (Hellingwerf, 2021b,c).

1.4 Mineral Resources

In total the repository is estimated to contain 3,46 dry Mtonnes of tailings, with an average content of 5,46 % P_2O_5 and 9,69 % Fe_{tot}, the deposit is classified as an indicated category of mineral resources.

Table 1. Mineral resources for the Jan-Matts tailings repository per November 28, 2022.

Category	Tonnage [Mtonnes]	P2O5 [%]	Fe [%]
Indicated	3,46	5,46	9,69

1.5 Metallurgical testwork

Metallurgical testwork, based on composites from the second campaign of sampling, has been performed at GTK Mintec, the results show that the apatite can be recovered to a concentrate with 37,3 % P_2O_5, with a 76,7 % recovery (Arvidson, 2021). A potential for higher recovery was noted. A hematite concentrate can also be produced, however, further testwork to determine the final flowsheet is required.

2 Introduction

2.1 Scope of assignment

The purpose of this report is to present an updated and independent statement on the Mineral Resources in the form of the tailings, as found in the Jan-Matts tailings repository in Grängesberg, Sweden. The principal element of interest is phosphorous, present in the form of apatite and to a lesser extent in monazite. Also, of potential interest is the contents of rare earth elements found in these two products. The possibility to produce a hematite concentrate is also being evaluated.

Grängesberg Exploration AB has requested that GeoVista AB perform an independent review and updated estimation of the Mineral Resource for apatite within the material in the dam.

The definitions of measured, indicated and inferred Mineral Resources as used by the author, correspond to those found in the Joint Ore Reserves Committee (JORC) Code, 2012 edition.

The report is based on information made available up to October 8, 2022. The estimate is based on the volumes of the tailings as surveyed during February and March of 2021, the sampling in February of 2022, and the chemical assays from the same surveys. In addition, assays from samples collected and assayed during a survey 2011 were added to firm up sampling density in the central parts of the deposit. GeoVista is not aware of any material changes having occurred regarding the Mineral Resources after this date.

3 Property description and location

The town Grängesberg is located in the Bergslagen district of central Sweden, approximately 200 km west-northwest of Stockholm, see Figure 1. The town was an important iron ore producer from the16th century until mining ceased in 1989. The access to the area is good, with paved roads and railway.

The deposit is a magnetite-hematite-apatite iron ore deposit, believed to me a magmatic iron ore, similar to the Kiruna deposit in formation.

The contents of phosphorous in the ore is typically around 1 %, but can locally be higher, the element is found in apatite as well as in monazite and typically associated with higher contents of rare earth elements (Hellingwerf, 2021a).

Work to remove phosphor from the ore was initiated already in in the late 1920's and in 1935 the company installed a flotation plant to recover apatite, and thus improve the product (iron ore concentrate) quality as well as to produce a marketable apatite contrate.

Over the years, the beneficiation plant was upgraded, and better-quality concentrates were produced with lower contents phosphorus.

Figure 1: Grängesberg location map.

4 Description of the deposit

The mineralization consists of tailings, resulting from the production of iron ore concentrate at the nearby Grängesberg mine. The minerals found in the tailings are typically silicates (potassium feldspar, sodium-rich plagioclase (Hellingwerf, 2022), quartz and amphiboles), micas (biotite), iron oxides (magnetite and hematite), apatite, monazite and allanite (Hellingwerf 2021a). The tailings dam is located just outside the industrial area of the former mine, see Figure 2.

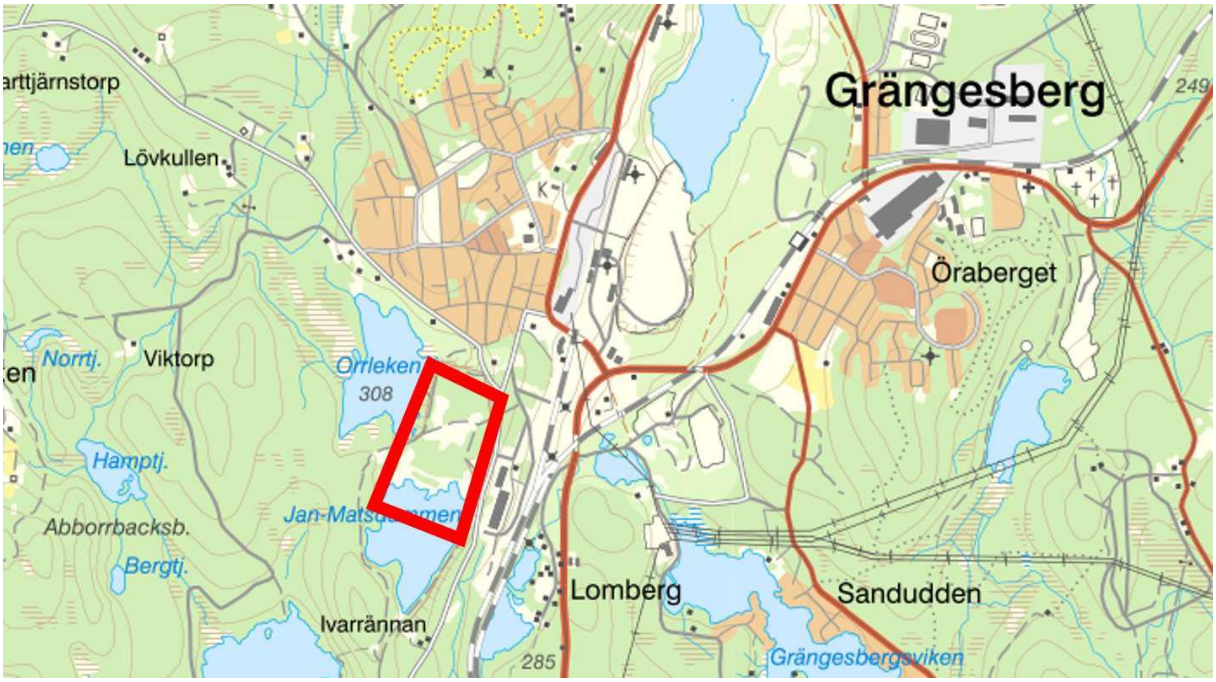

Figure 2. Location map of the Jan-Matts tailings dam (outlined in red) south west of Grängesberg.

The deposition of material took place between the years 1950 and 1970 according to available production data.

5 Exploration work

5.1 Sampling

Three campaigns of sampling for determination of grade distribution were carried out. In addition, one campaign of sampling for determination of in-situ densities and contents of moisture was carried out. The sample locations are shown in Figure 3.

The first campaign was done by an M.Sc. student for his thesis (Berg, 2011). The samples were collected by pressing a rotating shovel down into the material and a sample was taken for every 1m interval from surface and downwards. The deepest located sample was taken from a depth of 4,75m. A total of 13 stations were sampled for a total of 45 samples. The resulting samples weighed between 1 and 2 kg.

Samples were directly placed into Ziplock plastic bags and sealed and transported to the laboratory of Göteborg University, for sample preparation and mineralogical studies.

The second and fourth campaigns were done by technical consultant Thyréns, using a track mounted drillrig (Wikström, 2021 and Wikström 2022). The rig was equipped with a window sampler (flow though) with an inner diameter of 65 mm, see Figure 4. The resulting samples weighed between 0,25 and 6,4 kg, with an average of 4,25 kg.

All holes were drilled in vertical orientation. The nominal sample length was 1 m, and in practice this varied between 0,3 to 1,0 m, with the odd sample lengths appearing at the end of the holes. The distance between drill hole collars is, on average, 100 m. All holes were drilled through the bottom of the deposit, and the sampled material was logged.

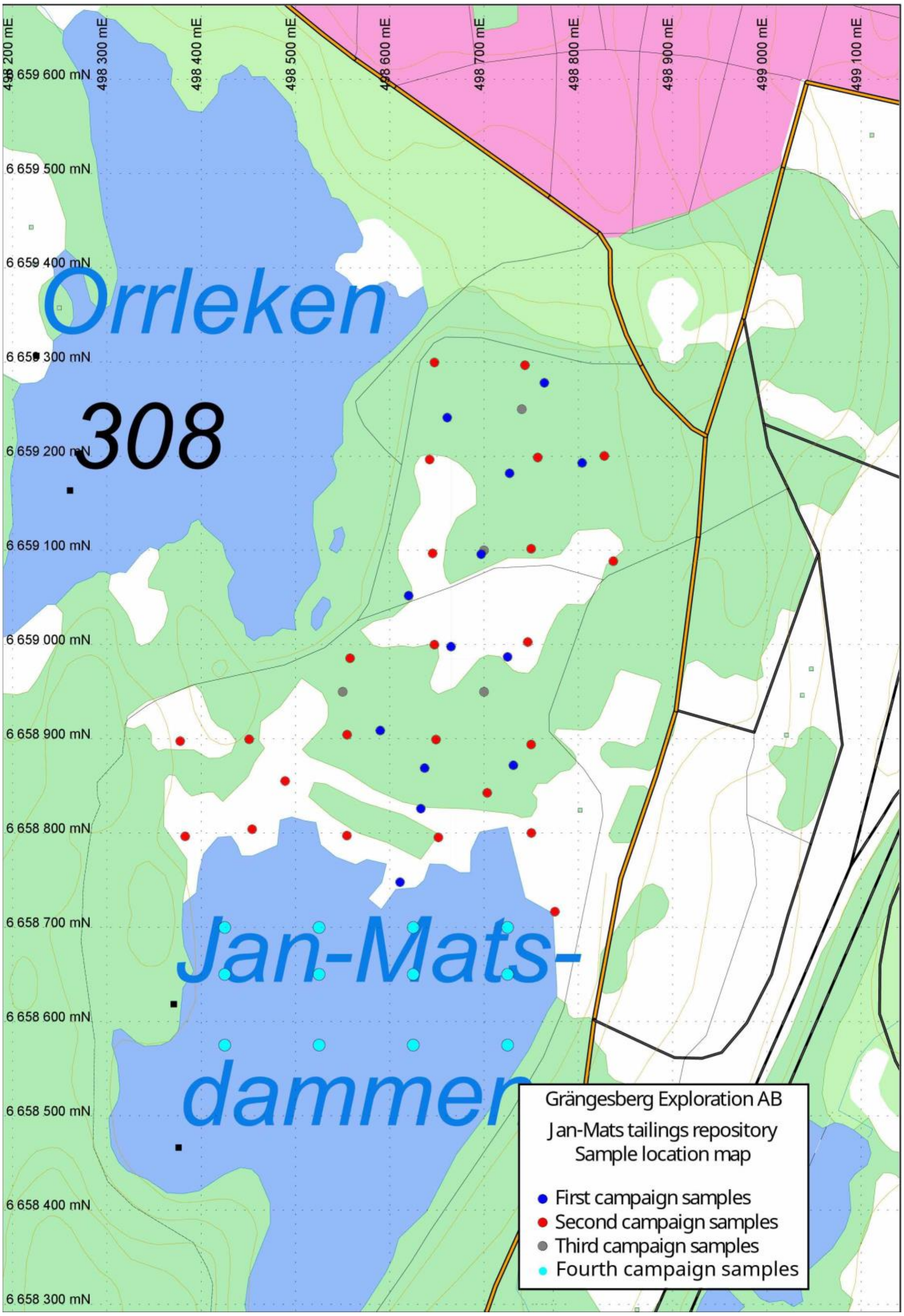

Figure 3. Sample location map.

Figure 4. Drill rig and window sampler.

The samples were collected whole in a bucket, by Tyréns' field technician, and directly poured into sturdy plastic bags. No splitting or duplicate sampling was carried out in the field and the sample represents all the material collected from that metre drilled. All sample bags were marked with hole number and depth from and depth to already in the field. After each day of sampling, the samples were collected and stored in a locked room at the old process plant.

After completion of each sampling campaign, all samples were transported to the Geological Survey of Finland's, GTK Mintec's, sample preparation facility in Outokumpu, Finland, where they were submitted for sample preparation.

All drill hole collars have been surveyed and recorded, using RTK-GPS, with an estimated accuracy of +/- 5-10 mm in easting and northing and +/- 10 mm in elevation. Of the surveyed hole positions, 9 lacks elevation coordinate due to dense forestry.

The third campaign of sampling was done by technical consultant Envix, to determine the in-situ density of the deposit.

A Sonar survey was carried out by technical consultant Norconsult, covering the part of the dam that is water covered to determine the shape of "toe" of the tailings deposit, see Figure 5.

All surveys were done using the Swedish National grid, SWEREF99TM, which is basically the same as UTM zone 33.

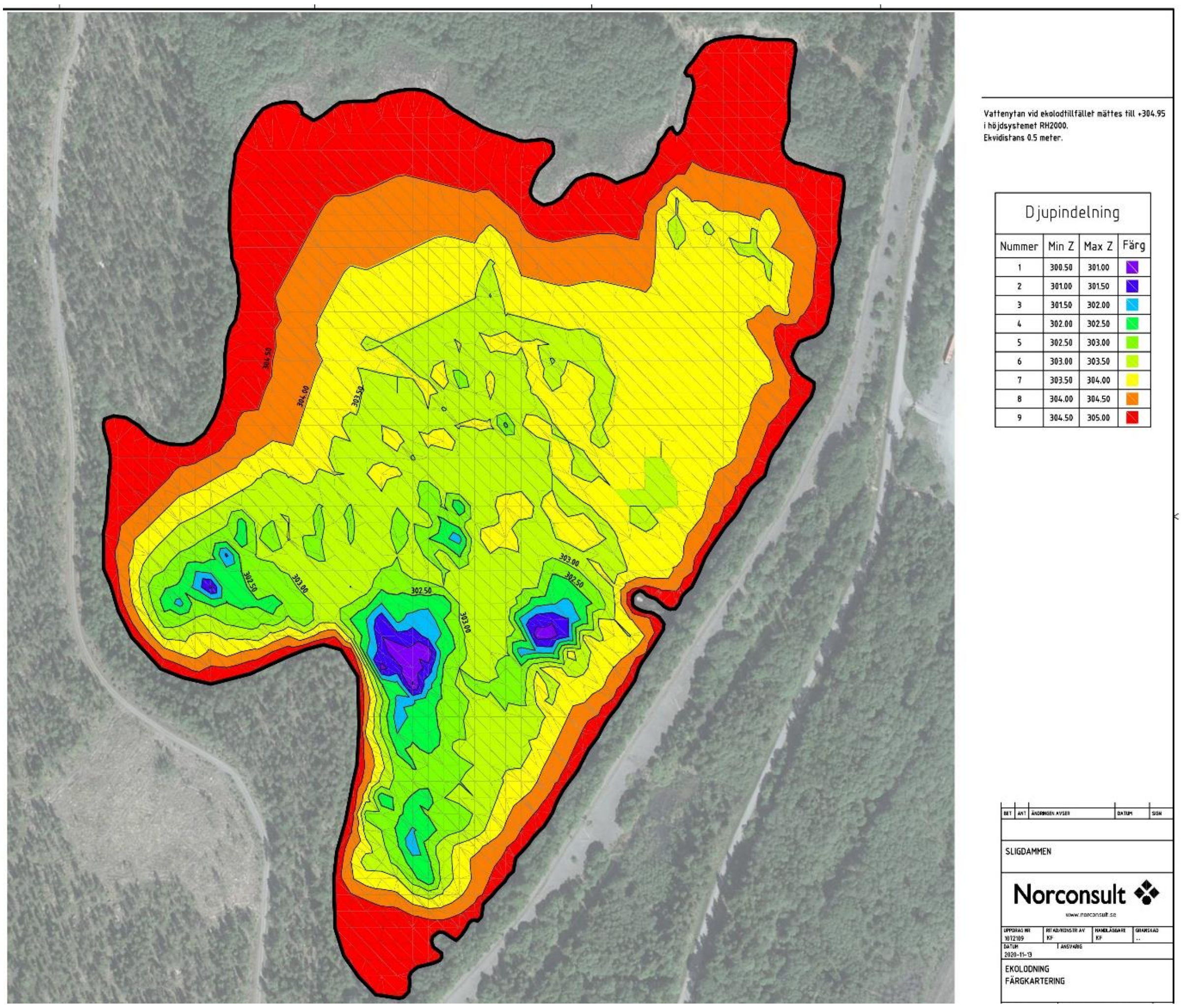

Figure 5. Results from Sonar survey on the water covered part of the dam.

5.2 Bulk density

The bulk density has been determined in a third campaign by drilling down and filling a plastic tube with material. The contents (samples) have been weighed as sampled (wet) and after drying (Hellingwerf, 2021). A clear tendency of increased density with depth can be observed. This is also expected since material located at depth should be more compressed and consolidated.

A total of 4 density stations were investigated, with samples every 1,2 m down to a maximum depth of 10,8 m. A total of 30 density samples were taken. The dry densities vary between 1,68 and 2,18 tonnes/m^3. The results are shown in Figure 6.

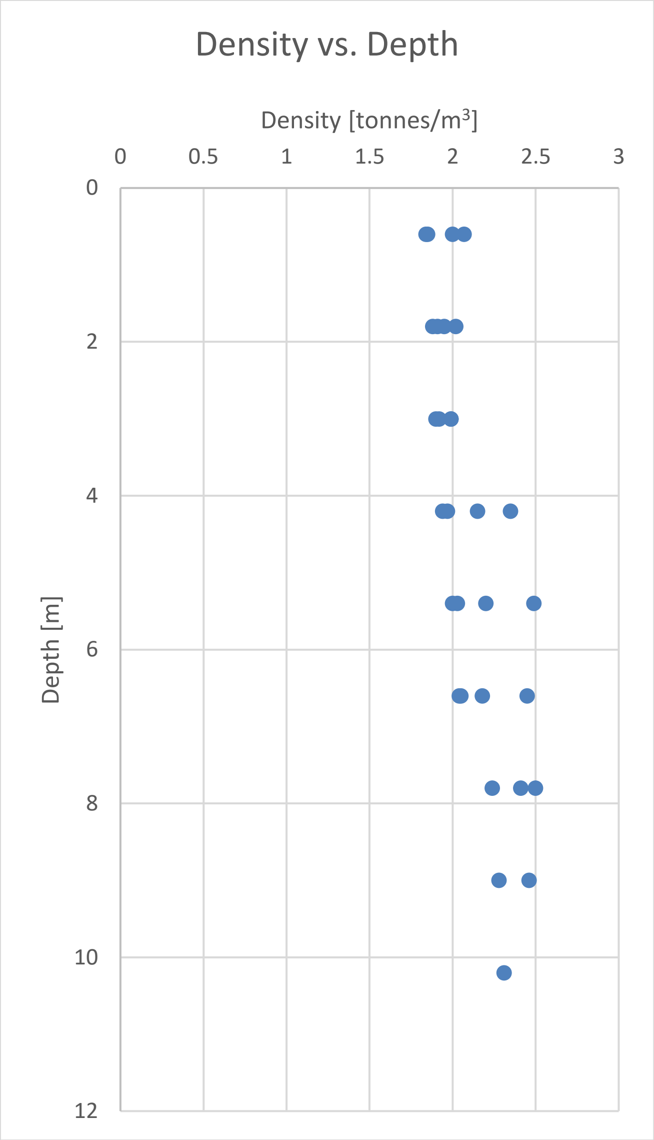

Figure 6. Results of density determinations.

The resulting function between depth and bulk density was determined to be:

Density = 1,84 + 0,07 * Depth

5.3 Solids contents

The content of solids has been determined by weighing all samples from the second and third campaigns wet (as sampled) and dry (after drying in oven). The result is that solid contents vary between 60,5 % and 99,3 %, with an average of 84,7 %.

There does not appear to be an obvious relation between sampling depth and contents of moisture, see Figure 7.

The contents of dry solids have thus been assumed to be 84,7 % in the estimation of dry tonnage.

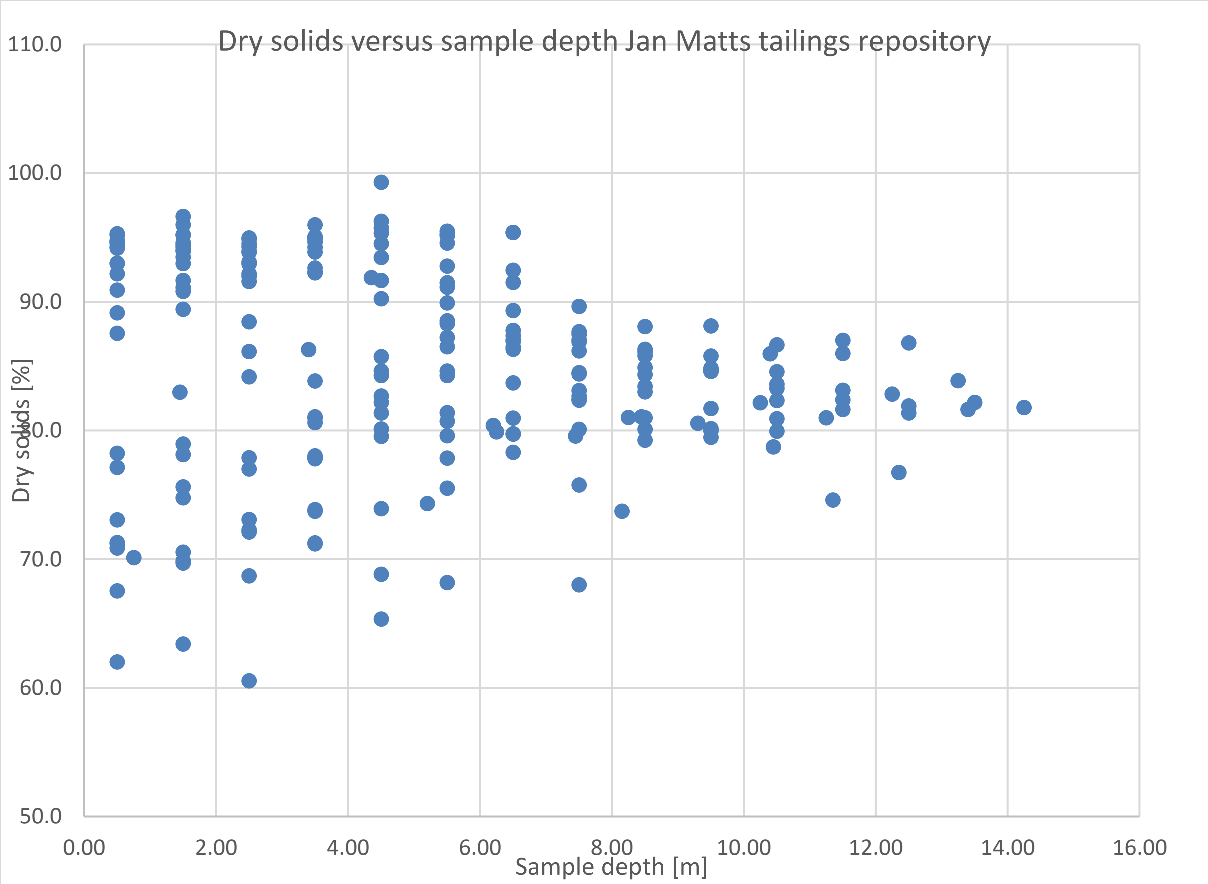

Figure 7. Dry solids versus sample depth Jan Matts tailings repository.

The third campaign of sampling, where all samples have been taken under the water table of the lake, show a similar pattern but with an average of 27,4 % moisture.

5.4 Sample preparation and assaying

The first campaign samples were weighed wet and after drying, then split in two by coning and halfing. One half was stored for reference, the other half was milled for 15 seconds in a Rock Labs Jumbo swing mill. From this, 80-100 grammes were split out and milled until 85 % was below 75 µm in size. The swing mill was carefully cleaned with tissue paper in between every sample. The final sub-sample was then sent to ALS Global for assaying. All samples were assayed with the accredited methods ME-ICP06 for Al_2O_3, BaO, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SiO_2, SrO and TiO_2 and with ME-MS81 for Ag, Ba, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Ga, Gd, Hf, Ho, La, Lu, Mo, Nb, Nd, Ni, Pb, Pr, Rb, Sm, Sn, Sr, Ta, Tb, Th, Tl, Tm, U, V, W, Y, Yb, Zn and Zr.

The second and third campaign samples were weighed on receipt at the laboratory in Outokumpu, dried in an oven and weighed again to determine the amount of moisture.

After drying a 1 kg subsample was split out by way of a rotary splitter.

The samples were milled, and two 100 g ampoules were split out and one each sent to CRS Laboratories, Outokumpu and Eurofins Labtium Oy, Kuopio, respectively for assay.

The assay method used at CRS Laboratories is XRF-181X-O for SiO_2, TiO_2, Al_2O_3, Cr_2O_3, V_2O_5, FeO, MnO, MgO, CaO, Rb_2O, SrO, BaO, Na_2O, K_2O, Zr_2O, P_2O_5, Cu, Ni, Co, Zn, Pb, Ag, S, As, Sb, Bi, Te, Y, Nb, Mo, Sn, W, Cl, Th, U, Cs, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta and Br and phosphorous colorimetric assays, method AD-SP-P04.

Eurofins Labtium Oy used ICP-OES and ICP-MS, methods 304P and 304M to determine the elements Al, As, Ba, Be, Ca, Cr, Cu, Fe, K, La, Li, Mg, Mn, Na, Ni, P, Rb, S, Sr, Ti, V, Y, Zn, Zr and Ag, Bi, Cd, Ce, Co, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, In, Lu, Mo, Nb, Nd, Pb, Pr, Re, Sb, Sc, Se, Sm, Sn, Ta, Tb, Te, Th, Tl, Tm, U, W and Yb respectively.

5.5 Quality assurance

As mentioned earlier, no field duplicates were split out, neither were certified standards or blanks inserted into the assay batches by the company, which instead relied on the internal standards and blanks inserted by the respective laboratories.

CRS Laboratories used the certified standards GPO-13 and GPO-15, from Geostats Pty Ltd.

Eurofins Labtium in Kuopio consistently used the standards Oreas GBMS304-6, Oreas 153B and Natural Resources Canada SY-4, thereby permitting plots of the repeat performance for the assays of the elements of interest.

The relatively low variation in grade of P_2O_5 between samples in combination with the behaviour of the control samples leads to the author's opinion that the assays are of sufficient quality for the estimation of Mineral Resources.

6 Estimated Mineral Resources

The Mineral Resource of the deposit is estimated by M. Sc. Thomas Lindholm, GeoVista AB. Mr Lindholm is a Fellow of the Australasian Institute of Mining and Metallurgy and has sufficient experience that is relevant to the style of mineralization and type of deposit under consideration and to the activity which he is undertaking to qualify as Competent Person as defined in the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves.

6.1 Tenement

The Swedish Minerals Act does not define extraction waste as concession minerals unless they are located within an otherwise valid mining concession. The waste is instead the property of the landowner Grängesberg Exploration AB holds a 10-year agreement with the landowner that gives the company exclusive right to extract the extraction waste stored in the Jan-Matts repository.

There are no known impediments to obtain the necessary permits to extract the tailings, nor to put the planned production facility in operation.

6.2 Economic viability

GRANGEX has developed a processing method, based on re-grinding of the tailings followed by flotation to recover an apatite concentrate.

A scoping study has been developed showing the economic viability of the project. Processing 560 000 tonnes of tailings per year would result in the recovery of 95 000 tonnes of apatite concentrate, containing approximately 37 % of P_2O_5 (Lindholm 2021).

Highlights from the scoping study can be found in Table 2.

Table 2. Scoping Study Highlights.

Scoping Study Highlights	
Annual Production	95 000 tonnes P_2O_5-concentrate
Life of Plant (LOP)	5 years
Life of Plant Revenue	650 million SEK
Pre-tax NPV (8% discount rate)	170 million SEK
Average Net Operating Cost per ton of recovered P_2O_5	675 SEK/tonne
Total initial capital costs	120 million SEK
Payback of capital costs	<2 years

The process flowsheet has been developed by GRANGEX, based on testwork by an independent metallurgical laboratory, GTK Mintec, a high-level version of the flow sheet can be found in Figure 8.

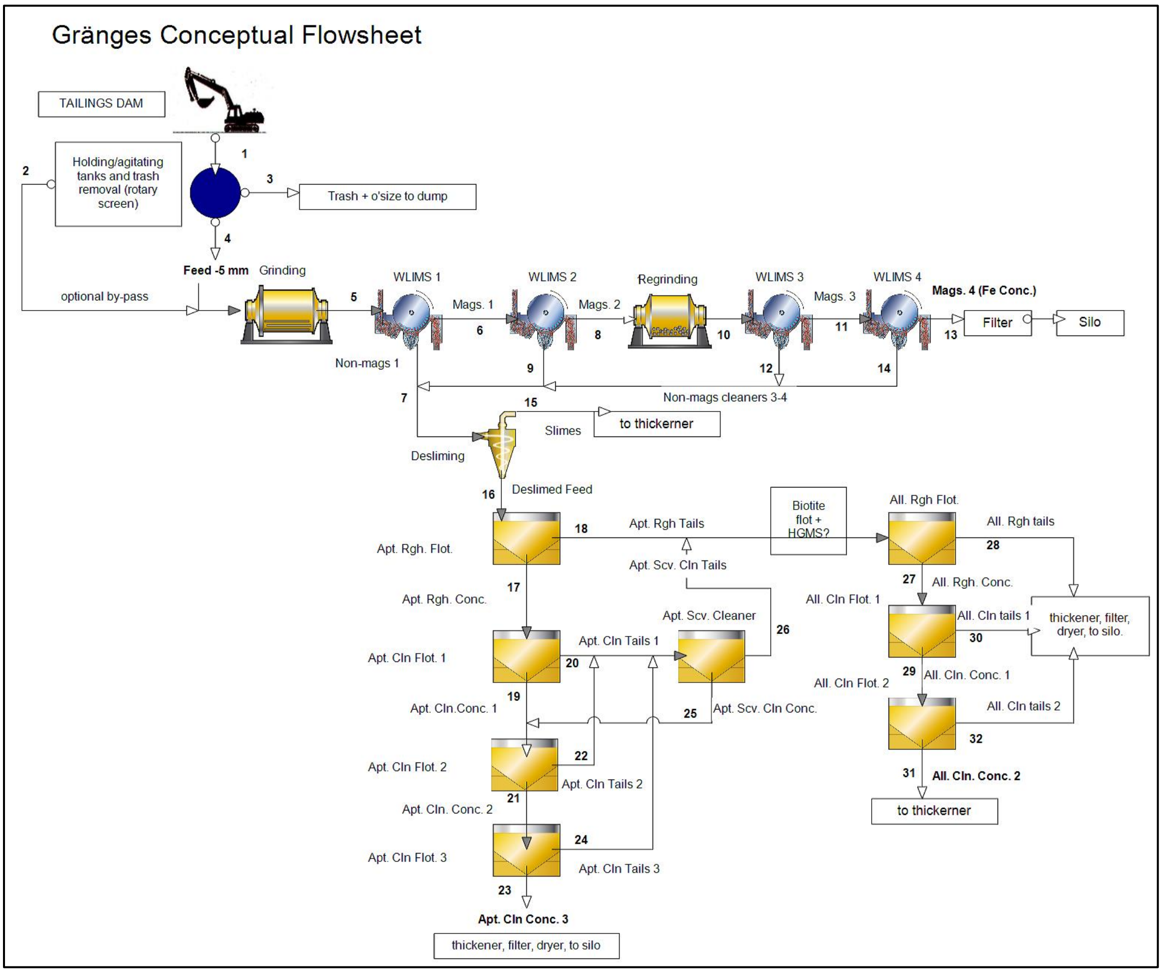

Figure 8. Conceptual flowsheet for the Jan-Matts tailings.

The scoping study was based on the previously reported mineral resources (2,79 dry Mtonnes @ 5,44 % P_2O_5), the current estimate of 3,46 dry Mtonnes @ 5,46 % P_2O_5, is bound to improve the results.

6.3 Modelling

The volumes of mineralized material have been determined by a combination of a high-resolution terrain model (LIDAR), a sonar survey over the water covered part of the deposit and the results from the drilling. All holes from the second and third campaigns penetrated into the sub-stratum and the volumetric model can thus be considered to give a fair representation of the deposit. The modelling principle is illustrated in a cross-section in Figure 9.

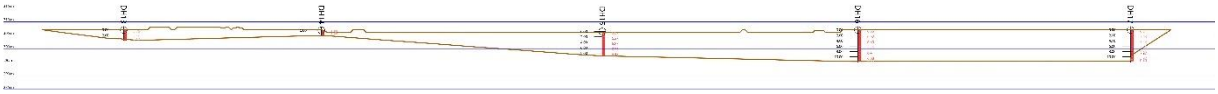

Figure 9. Cross-section showing drillholes and modelled bottom.

The finished model encloses a volume of 1,93 million m^3, an isometric rendering is shown in Figure 10.

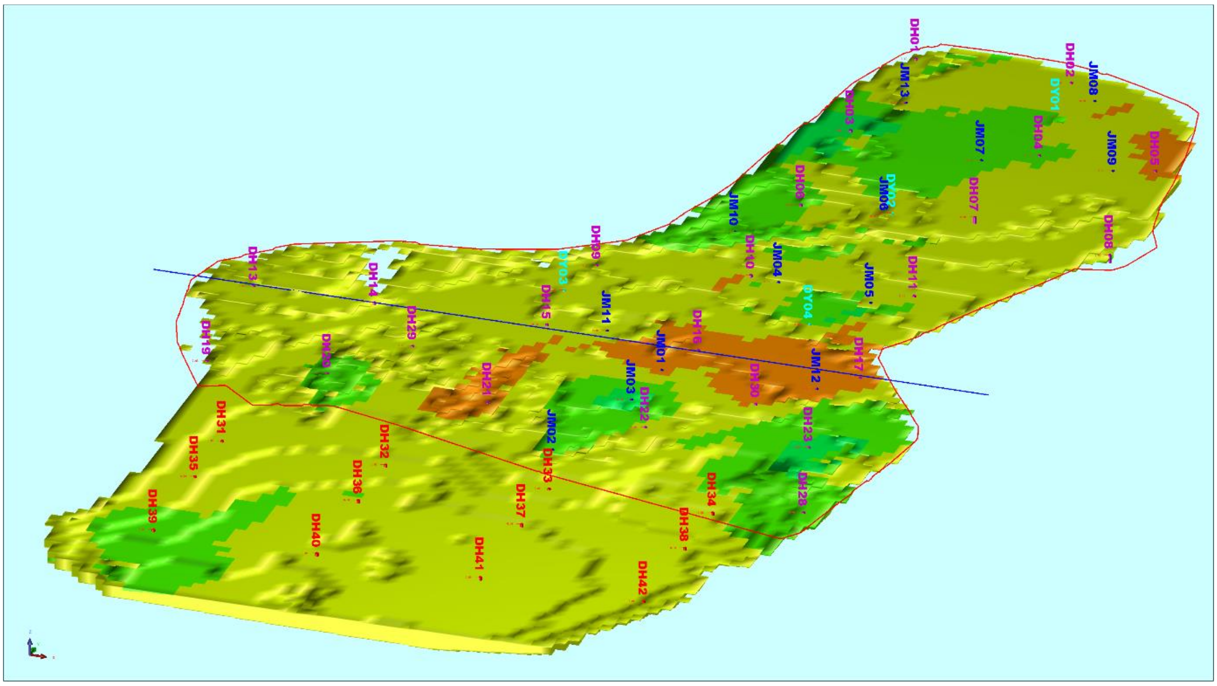

Figure 10. Isometric rendering of the Jan-Matts tailings repository, red outline shows extent of previously reported model. Blue line marks position of section in Figure 9. Drillhole collars are: blue=first campaign, purple=second, red=third, cyan=density determination.

6.4 Composites

Compositing is the first process in the estimation of grades. The composites were calculated to 1 m nominal length, using Surpac's "best fit" function. This resulted in composites that vary in length between 0,75 m and 1,08 m, with an average length of 0,94 m.

Top-cutting of composited values was not considered appropriate, given the smooth distribution of data.

6.5 Cut-off grade

No economic cut-off grade has been defined. Most likely, the material deposited in the repository can't be extracted selectively, a cut-off is thus not meaningful unless lower grade material is found at the very bottom, which does not appear to be the case.

6.6 Block modelling

A basic statistical study of the composited assays indicates a distribution close to normal, fit for grade interpolation by kriging. A stacked histogram in Figure 11 illustrates this.

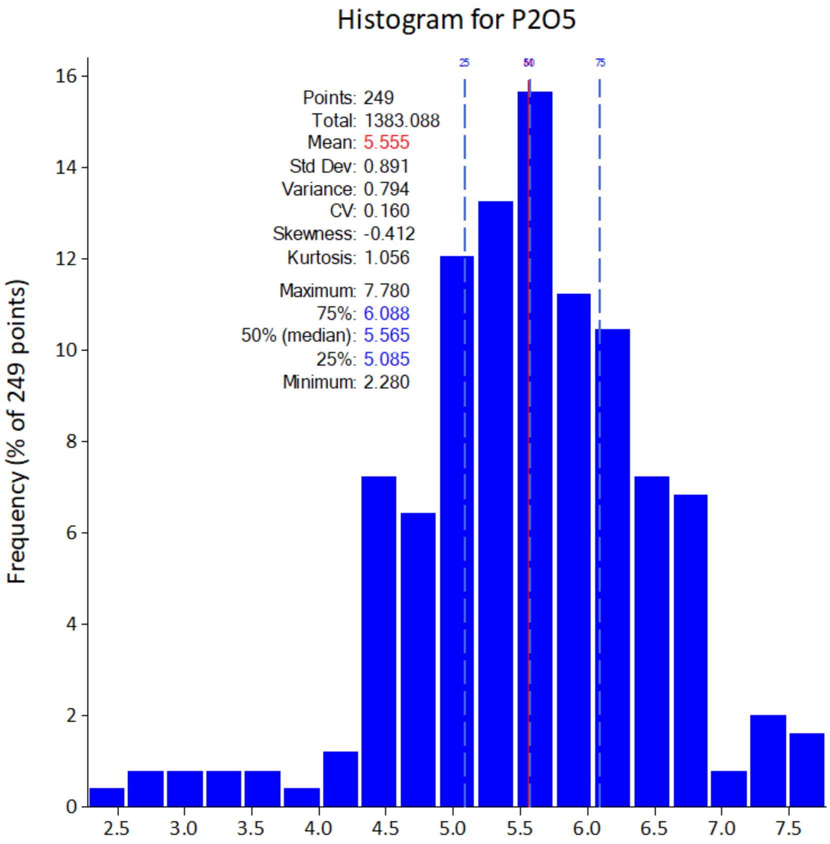

Figure 11. Histogram of Composites for P2O5.

The deposit has thus been modelled as one single domain.

Variography studies of the composites show good grade continuity along as well as across the deposit, with ranges of well over 100 m, as indicated in Figure 12.

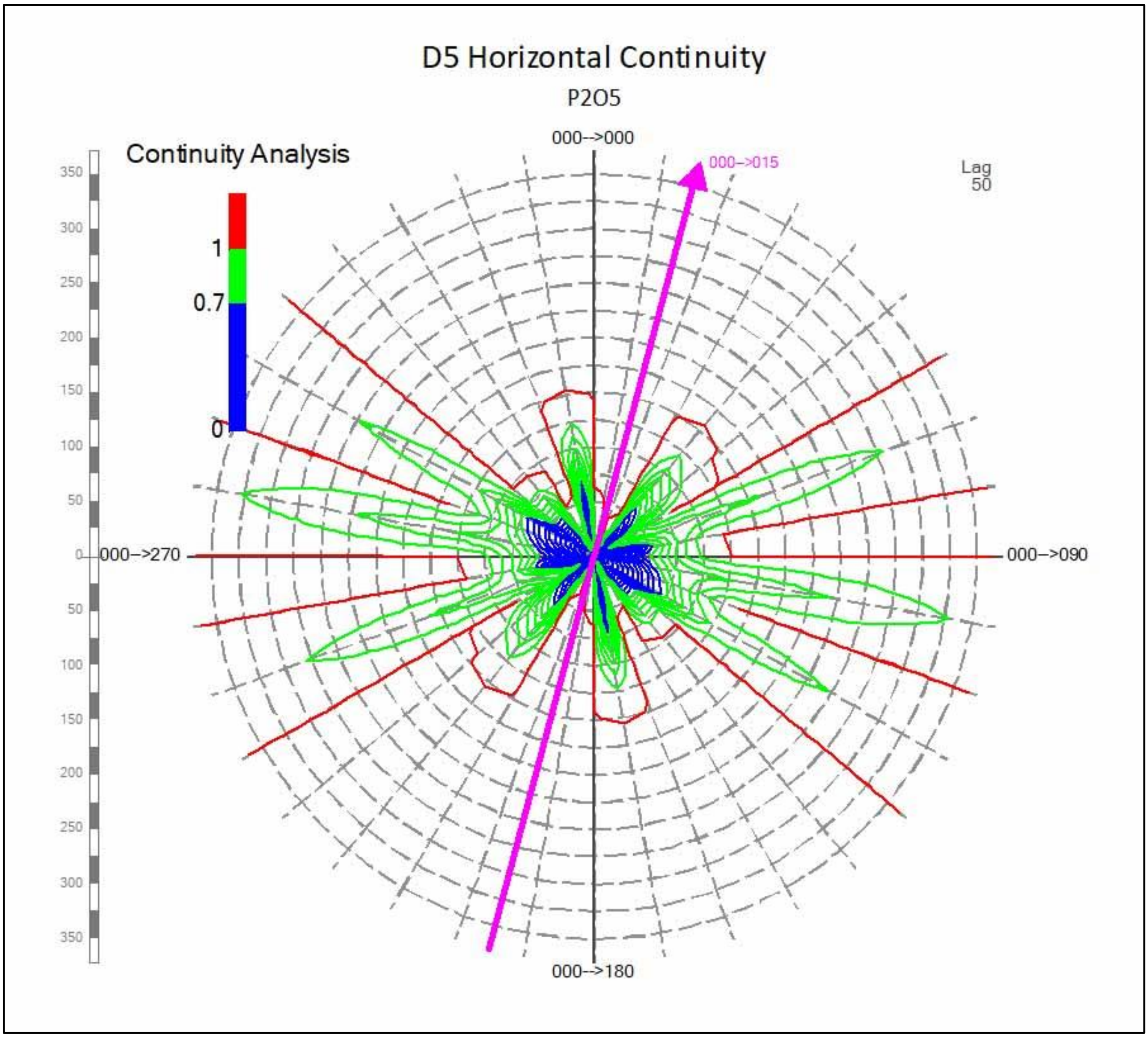

Figure 12. Horizontal continuity for P_2O_5.

Downhole variography as shown in Figure 13 indicates that there is virtually no nugget effect.

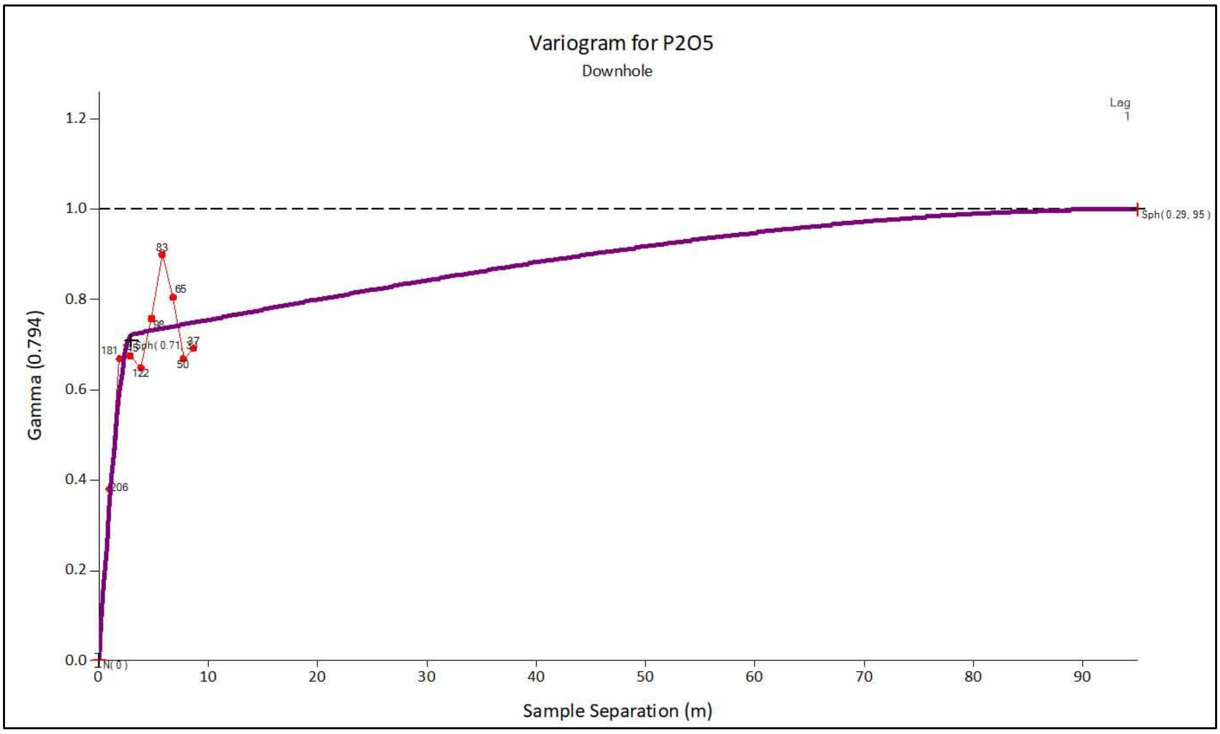

Figure 13. Downhole variogram for P_2O_5.

Grade estimation for the deposit has been populated into a block model. The block sizes are, X=25 m, Y= 25 m and Z=2 m, using a sub-blocking factor of ¼ to better fit the geometry of the heaps.

The elemental grades of P_2O_5 and Fe were interpolated using Ordinary kriging whilst the density was calculated based on the depth, as discussed in section 5.2. The search ellipse was oriented with the major axis along the main strike of the deposit, as indicated by the variography and flat lying.

The search parameters for interpolation by way of Ordinary Kriging are presented in Table 3

Table 3. Search parameters for Ordinary Kriging.

	Search radii		No. of samples		Min. no. of holes
Pass	Major/Semimajor	Minor	Minimum	Maximum	
1	75	6	8	20	4
2	150	8	8	20	4

Block models were developed for P_2O_5, Fe, and density.

The basic statistics for blocks compare well with those of the composited values, see Table 4.

Table 4. Basic statistics of blocks compared to composited P_2O_5.

	BM	Comps
Mean	5.44	5.51
Median	5.43	5.55
Geometric Mean	5.41	5.44
Variance	0.29	0.72
Standard Deviation	0.54	0.85
Coefficient of variation	0.10	0.15

A plot, shown in Figure 14, comparing the percentiles for composite values with block values show a slight bias, with some overestimation of low-grade material and some underestimation of higher grade. This bias implies an overall underestimation of grade, but is it not considered significant.

The block model has also been visually checked for accuracy by comparing the block values with those of nearby assayed samples from the drilling. The results show good correlation.

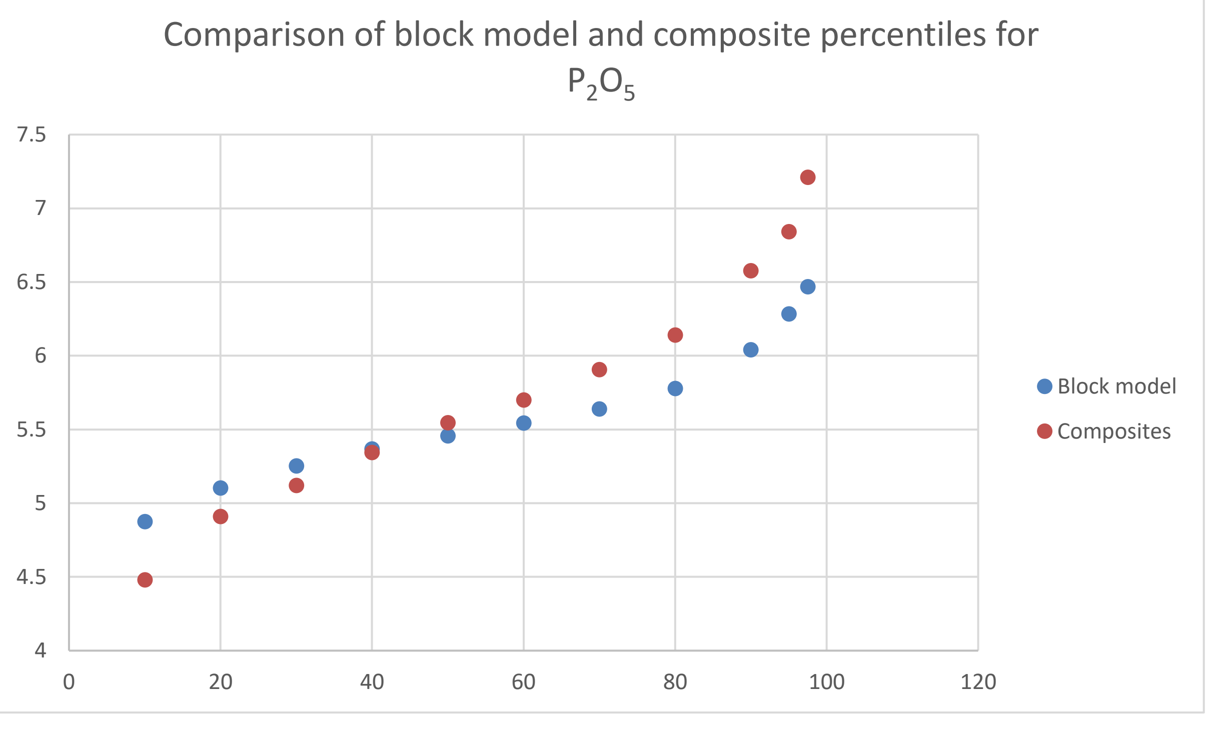

Figure 14. Comparison of percentiles for block model and composites for P2O5.

6.7 Classification

The basis for the classification of the Mineral Resources is the degree of confidence the Competent Person has for the tonnage and grades.

Mineralization may be classified as an Indicated Mineral Resource when the nature, quality, amount and distribution of data are such as to allow confident interpretation of the geological framework and to assume continuity of mineralization.

Mineralization may be classified as a Measured Mineral Resource when the nature, quality, amount and distribution of data are such as to leave no reasonable doubt, in the opinion of the Competent Person determining the Mineral Resource, that the tonnage and grade of the mineralization can be estimated to within close limits, and that any variation from the estimate would be unlikely to significantly affect potential economic viability.

The determination of the volume and grade variations in the tailings dam is considered to be of good quality and is not likely to change significantly, should more sampling through drilling be carried out.

The determination of density shows greater variation, and the tonnage factor to convert block volumes to tonnage is therefore more uncertain.

Based on the above, the material in the dam is classified as Indicated Mineral Resources.

6.8 Resource statement

The dry density for the material has been calculated by removing the influence of the moisture for every sample.

Dry density = Humid density * (1 – (wet weight – dry weight)/wet weight).

All tonnes reported for the Mineral Resource estimate are dry tonnes. The overall tonnage and grade are presented in **Fel! Hittar inte referenskälla.**.

In total the Jan-Matts tailings dam contain 3,46 million tonnes with 5,46 % P_2O_5 and 9,69 % Fe, as shown in Table 5**Fel! Hittar inte referenskälla.**.

Table 5. Mineral Resource tonnes and grade by classification.

Class	**Dry tonnes [Mt]**	**Fe [%]**	**P_2O_5 [%]**
Measured	**--**	**--**	**--**
Indicated	**3,46**	**9,69**	**5,46**
Inferred	**--**	**--**	**--**

Assumptions:

- Thomas Lindholm, of GeoVista AB, Sweden, is a competent person for the Mineral Resource Estimate. The effective date of the estimate is November 29, 2022.
- There are reasonable prospects for eventual economic extraction under assumptions of a P_2O_5 price of US$ 180,00/ ton for a 37% concentrate: employment of truck and shovel material re-handling, and conventional processing consisting of re-milling, flotation and magnetic separation.
- All in processing, re-handling and general and administration costs are an estimated US$ 79,50/ ton of apatite concentrate.
- No mining cut-off has been applied as all material will be processed.
- No allowance has been made for dilution or losses.
- Resource Classification of Indicated based on approximately 100m drill spacing.
- Rounding as required by reporting guidelines may result in apparent summation differences between tonnes, grade and contained metal content.

7 Other deposits in the area

Since the introduction of dephosphorization of the iron ore, tailings have been deposited in several repositories in the Grängesberg area, in addition to the Jan-Matts dam. Hötjärnen and Orrleken being the most prominent, see Figure 15.

Grängesberg Exploration AB has recently initiated a study of their contents and possibility of extraction; however, no systematic sampling has yet been carried out.

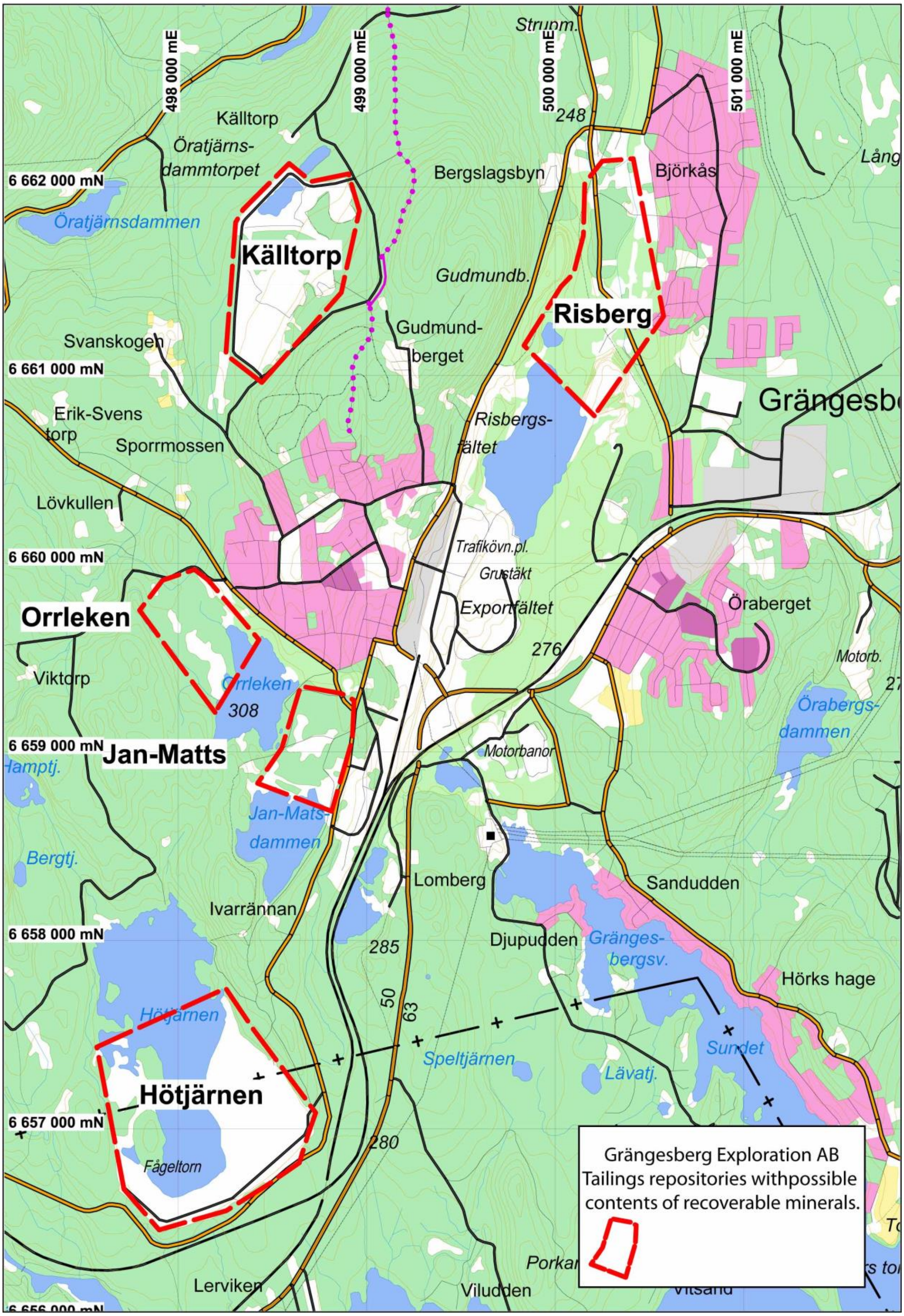

Figure 15. Targets for potential recovery of value minerals.

8 Conclusions

The tonnage and elemental grades of the tailings found in the Jan-Matts tailings repository in Grängesberg has been estimated with sufficient quality for declaration of mineral resources.

If any further work is considered, this should be directed at understanding the variations in density and contents of moisture. The possibility of recovering other value minerals than from phosphorous and iron should also be considered.

9 References

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