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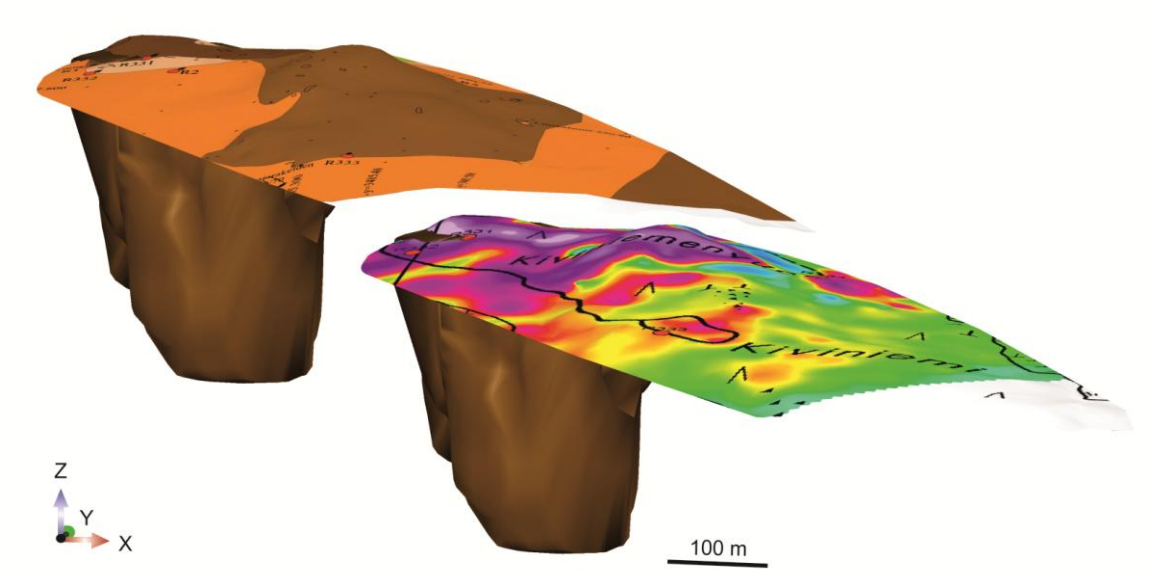
3D modelling and mineral resource estimation of the Kiviniemi Scandium deposit, Eastern Finland

Janne Hokka & Tapio Halkoaho



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GEOLOGIAN TUTKIMUSKESKUS **KUVAILULEHTI**

Päivämäärä / Dnro

Tekijät Janne Hokka & Tapio Halkoaho	Raportin laji Mineraalivarantoarvioraportti
	Toimeksiantaja Geologian tutkimuskeskus
Raportin nimi Rautalammin Kiviniemen skandiumesiintymän 3D-mallinnus- ja resurssiarvioraportti	
Tiivistelmä Tutkimuskohde sijaitsee Itä-Suomen läänissä Rautalammin kunnassa Kiviniemen alueella, karttalehdellä 3224 08 sekä P4333 D2, D4, noin 70 km Kuopiosta lounaaseen. Kiviniemi on asumaton Niiniveteen pistävä, kivikkoinen niemi. Kiviniemen tutkimuskohteelle tehtiin vuosina 2008, 2009 ja 2010 (8.12.2008-16.1.2009 ja 3.5.-3.6.2010) GTK:n toimesta yhdeksän (9) POKA-kairausreikää, yhteispituudeltaan 1251,80 metriä. Rautalammin Kiviniemen ferrodioriitti-intruusio koostuu osista, jotka voidaan erottaa toisistaan raekoon perusteella. Karkearakeisin, rauta- ja skandiumrikkain granaattipitoinen ferrodioriitti sisältää fayaliittia ja se sijaitsee niemen pohjoisosassa dioriittisen yksikön ympäröimänä. Sen reunoilla esiintyy paikoitellen osueina vaaleamman sävyistä leukoferrodioriittia. Käytettävissä olevan tietojen vähäisyys heikentää arvion luotettavuutta. Pääesiintymän homogeenisuus ja säännöllinen muoto kuitenkin auttavat arvion tekemisessä. Lisäksi merkittävä pudotus malmitonneissa tapahtuu vasta välillä 100-150 g/t Sc. Alustavan arvion mukaan Kiviniemen intruusio sisältää 13,4 miljoonaa tonnia kiveä, jonka keskipitoisuus on 162.7 g/t skandiumia, 1726.2 g/t zirkoniumia ja 81 g/t yttriumia. Tässä tuloksessa on käytetty 40 g/t scandiumin cut off- arvoa. Ilman cut off arvoa intruusion kokonaisresurssi on 14.3 miljoonaa tonnia kiveä skandiumin keskipitoisuuden ollessa 154.3 g/t.	
Asiasanat (kohde, menetelmät jne.) Rautalampi, Kiviniemi, 3D-malli, resurssiarvio, fayaliitti ferrodioriitti	
Maantieteellinen alue (maa, lääni, kunta, kylä, esiintymä) Suomi, Itä-Suomen lääni, Rautalampi, Niinivesi, Kiviniemi	
Karttalehdet 3224 08 (KKJ) ja P433 (UTM)	
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GEOLOGICAL SURVEY OF FINLAND **DOCUMENTATION PAGE**

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Authors Janne Hokka & Tapio Halkoaho	Type of report Mineral resource estimation report
	Commissioned by Geological Survey of Finland
Title of report 3D modelling and mineral resource estimation of the Kiviniemi scandium deposit, Eastern Finland	
Abstract The study area of Kiviniemi is located at the municipality of Rautalampi, Eastern Finland Province, about 70 km from the city of Kuopio. The base map sheets are 3224 08 (KKJ) and P4333D (EUREF). During 2008-2010 (8.12.2008-16.1.2009 and 3.5.-3.6.2010) total of 9 drillholes (1251.80 m) were conducted to the Kiviniemi prospect by GTK. The ferrodioritic intrusion of Kiviniemi consists of two parts that can be separated by its grain size. The iron and scandium rich coarse-grained unit of garnet-bearing ferrodiorite situates at the north end of the cape of Kiviniemi surrounded by diorites. Leucoferrodiorite parts are exposed at the contact boundaries. The resource classification is conservative due to the inadequate exploration drilling and should be treated as low certainty. Although, scandium, yttrium and zirconium are following the large homogeneous ferrodioritic unit with an even grade distribution. A dramatic tonnage drop appears not before getting towards 100-150 g/t Sc cut off values. The resource estimation calculated for Kiviniemi intrusion by using 40 g/t Sc cut off value is 13.4 Mt of rock with an average grade of 162.7 g/t scandium, 1726 g/t zirconium and 81 g/t yttrium. The total estimation is 14.3 Mt with an average scandium grade of 154.3 g/t, when no cut off values are applied.	
Keywords Rautalampi, Kiviniemi, 3D model, mineral resource estimation, fayalite ferrodiorite	
Geographical area Finland, Province of Eastern Finland, Rautalampi, Niinivesi, Kiviniemi	
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1 INTRODUCTION

Kiviniemi intrusion is located at the municipality of Rautalampi, Province of Eastern Finland (Figure 1), about 70 km SW from the city of Kuopio and about 350 km NNE of Helsinki. The KKJ base map sheet is 3224 08 and KKJ Zone 3 coordinates are 6967905 (X) and 3485045 (Y), corresponding to the EUREF-FIN geographic coordinates of Latitude 62° 48.886' °N, Longitude 26° 42.202' °E. The UTM map sheet is P4333D.

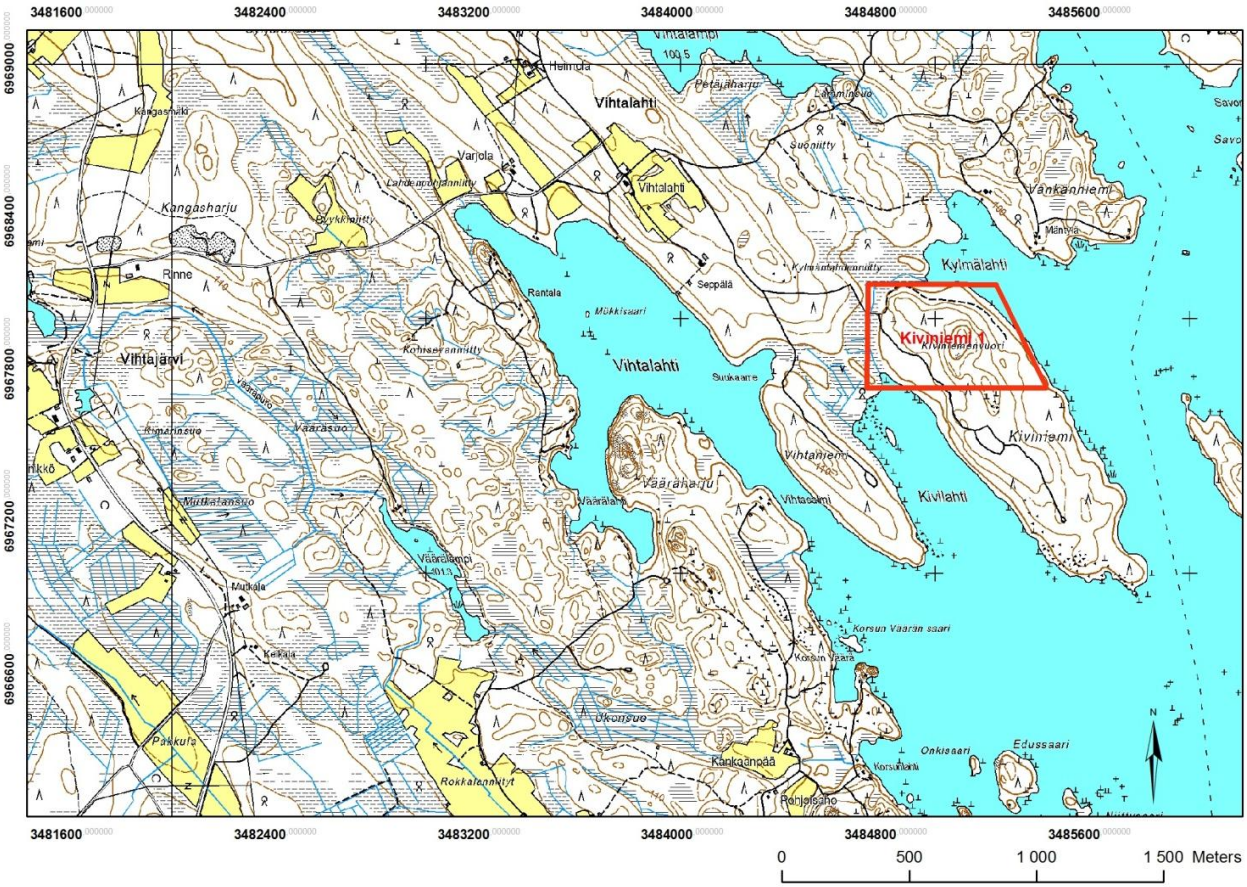


Figure 1. *Location of Kiviniemi claim property*

The Kiviniemi property was covered by a claim (Exploration Licence: Kiviniemi 1) with an area of 24.6 hectares. The claim was rewarded in 13.6.2012 and expired in 13.6.2015 (Halkoaho & Niskanen 2015). The land and surface rights of the Kiviniemi claim area are currently on hold (waiting period).

Kiviniemi property is accessed by 3 – 4 km of gravel road diverging from sealed road 545. The closest village is Rautalampi which is about 30 km south from the claim (road 543-545). Kiviniemi is situated in a cape of lake Niinivesi (Figure 1). The Kiviniemi intrusion is approximately 25 hectares in size and

the highest topographical feature is Kiviniemenvuori, fairly gentle dipping hill that situates at the northern margin of the intrusion.

1.1 Exploration history

The magnetic airborne survey was done in 1986 by GTK and in 2008 GTK commenced in the Kiviniemi area the geophysical ground surveys together with the detail bedrock mapping. The focus was to detect the source for previously found Layman's samples that contained some of nickel and copper. GTK commenced two diamond drilling programs in the Kiviniemi property during 2008 – 2009 and 2010, in total 1251.8 meters. There are several outcrop exposures which have resulted close to 50 bedrock observations in the area. In addition, eight whole rock analyses (XRF) have been made from outcrops of the Kiviniemi intrusion (Figure 2). Bedrock map interpretation from Kiviniemi area (Figure 2) is rather detailed and has been used in enveloping the intrusion.

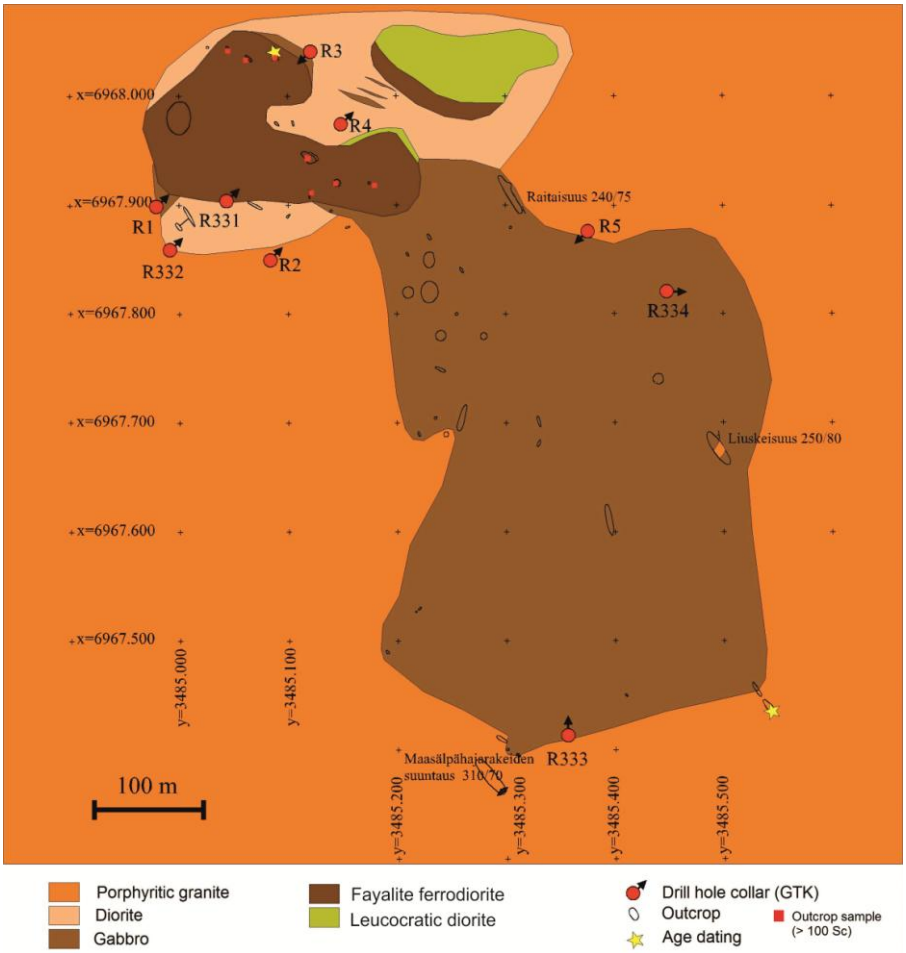


Figure 2. *Bedrock map of the Kiviniemi intrusion. The smaller ferrodiorite intrusion body (NNE) is interpreted by using geophysical and outcrop observation data. The Kiviniemi Sc-deposit is confined to fayalite ferrodiorite (the darkest brown).*

1.2 Drillings and analyses

GTK commenced the first diamond drilling program during 2008 – 2009 which included four drill holes (R331-R334) and a total of 346.50 meters. Second diamond drilling program was commenced in 2010 which included five drill holes (R1-R5) and a total of 905.30 meters covering the northern and southern parts of the intrusion. The average length of drill holes were 139 meters and the maximum vertical extension was to 167 meters. The diamond drill core size used was 46 mm (T56 bit). The distance between the drilling profiles varied from 50 – 200 meters. All drill holes were measured afterwards with GPRS device (< 1 m). No down-hole survey was done from drill holes.

Drill holes P433_2010_R1, P433_2010_R2, P433_2010_R3, and P433_2010_R4 was used in grade estimation study (Appendix 1.1.). No assay data was available from drill hole 3224_2008_R331 and it was excluded from domain model. However, lithological data was used in global model to envelope intrusion boundaries.

All drill holes were logged and photographed at GTK's core logging facility. The core was sampled as half core and the average sample length was 1.3 meters. The core was systematically analysed at Labtium Oy. Various methods were tested to get the optimal results: X-ray fluorescence (XRF) (method code 175X), ICP-MS (method code 308M) and fusion with sodium peroxide (method code 724P). The most reliable results were obtained with sodium peroxide.

GTK metallurgical research laboratory at Outokumpu carried out a primary metallurgical test work from Kiviniemi in 2010 (drill core samples R331-R332 and surface samples). Scandium occurs mainly in the internal structure of iron-rich silicates, such as amphibole (40 %) and pyroxene (59 %), which needs to be enriched and leached with a particular method. In primary testing the most potential separation method of scandium was magnetic separation with ~346 ppm of Sc concentrate with ~72 % of recovery. Acid solution of hydrogen fluoride and hydrochloric/sulphuric acid dissolves scandium at best results. Neither the quantity of acid or recovery of scandium from acid solution has been studied. Some problems may be encountered in leaching due to large quantities of masses and acids needed to be processed in further processing (Korhonen *et al.* 2010). The wet chemistry study group in the University of Eastern Finland have been continuing the testing of scandium recovery from acidic solutions with a patented metal chelator method (Ahven 2016).

1.3 Geological setting

Kiviniemi intrusion is located in the northeastern part of the Central Finland Granitoid Complex, near the arc-type rocks of the Savo Belt. The composition of intrusion is mafic and it's surrounded by porphyritic granite. Kiviniemi intrusion was formed in the post-tectonic stage of Svecofennian orogeny (1880 – 1860 Ma). The U-Pb date of garnet-bearing fayalite ferrodiorite is 1857±2 Ma and the age of surrounding porphyritic granite is 1859±9 Ma (Ahven 2012).

The Kiviniemi intrusion consists of five rock types: coarse-grained (garnet-bearing) fayalite ferrodiorite, leucoferrodiorite, medium- and fine-grained ferrodiorite, diorite and granite. The main host rock for enriched scandium, yttrium and zirconium is the coarse-grained fayalite ferrodiorite. The surface extension of the main Sc-mineralized block is around 2.5 hectares and it's extending the vertical depth down to at least 167 meters (Figure 3). The Kiviniemi Sc-deposit is subdivided into two

ferrodioritic intrusion blocks. The smaller block is situated approximately 100 meters NE of the main block, but there is no surface outcrops (Figure 2). Geometrically blocks are rather homogeneous, deeply dipping packages.

Table 1. *Drill holes in Kiviniemi property.*

Hole-ID	Year	Company	X	Y	X (Euref)	Y (Euref)	Z	Azimuth	Dip	Length
3224_2008_R331	2008	GTK	3485045	6967905	6964985	484880	110	45	-45	102.1
3224_2008_R332	2008	GTK	3484993	6967860	6964940	484828	104	45	-45	93.8
3224_2008_R333	2008	GTK	3485356	6967416	6964497	485191	113	360	-45	60.3
3224_2009_R334	2009	GTK	3485450	6967820	6964900	485285	103	90	-45	90.3
P433_2010_R1	2010	GTK	3484980	6967900	6964980	484815	105	45	-45	253.2
P433_2010_R2	2010	GTK	3485085	6967850	6964930	484920	109	45	-45	254.5
P433_2010_R3	2010	GTK	3485120	6968040	6965120	484955	99	225	-45	173.6
P433_2010_R4	2010	GTK	3485150	6967975	6965055	484985	108	45	-45	131.5
P433_2010_R5	2010	GTK	3485375	6967875	6964955	485210	108	225	-45	92.5
total										**1251.8**

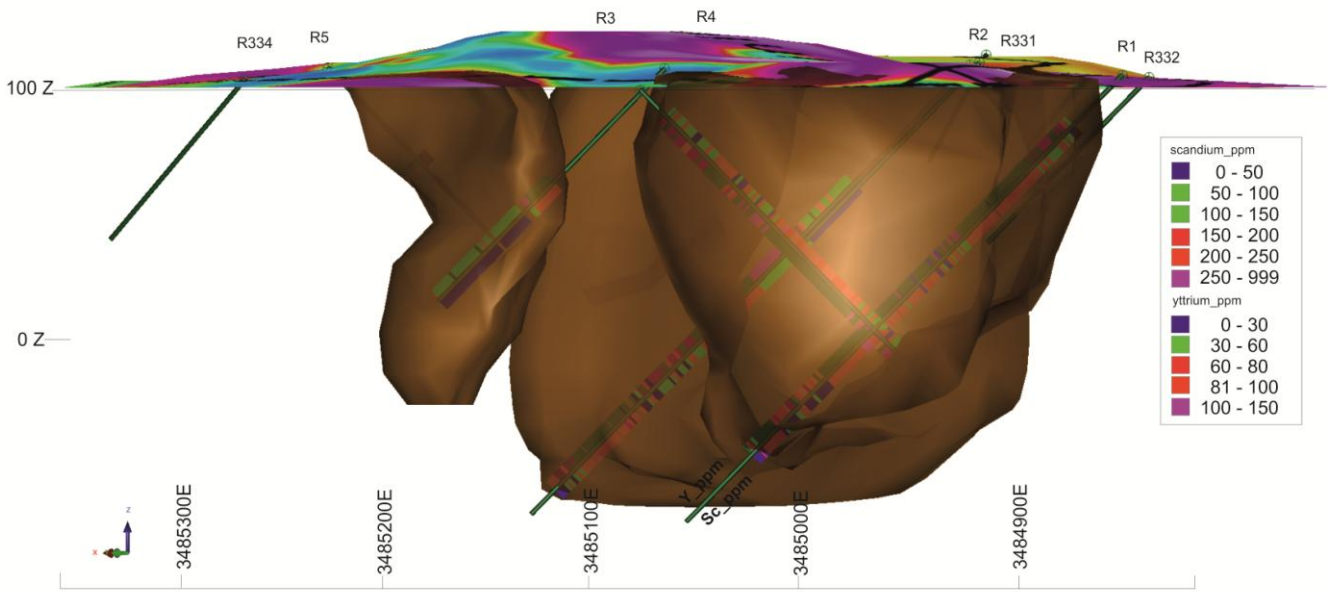


Figure 3. *Fayalite ferrodiorite part of the Kiviniemi intrusion. The dimensions are approximately 200 x 150 x 167 meters. Digital Elevation Model (DEM) shows the topography of Kiviniemi area. Magnetic map is draped over the elevation model surface. Drill holes (green) shows grade distribution of scandium and yttrium in the deposit.*

2 3D MODELLING AND MINERAL RESOURCE ASSESSMENT

2.1 Data Collection

Data is stored in Microsoft access database. Database was updated and checked to ensure no major discrepancies existed in the data, and used for grade estimation study. Database comprises a total of nine drill holes which is stored in collar and survey data along with lithology, assay, and susceptibility data in own tables.

2.2 Topography

The work consisted of creating 3D digital elevation model (DEM) covering the Kiviniemi intrusion. The National Land Survey of Finland's (NLS) Airborne Laser scanning data were used as primary data source (Figure 4).

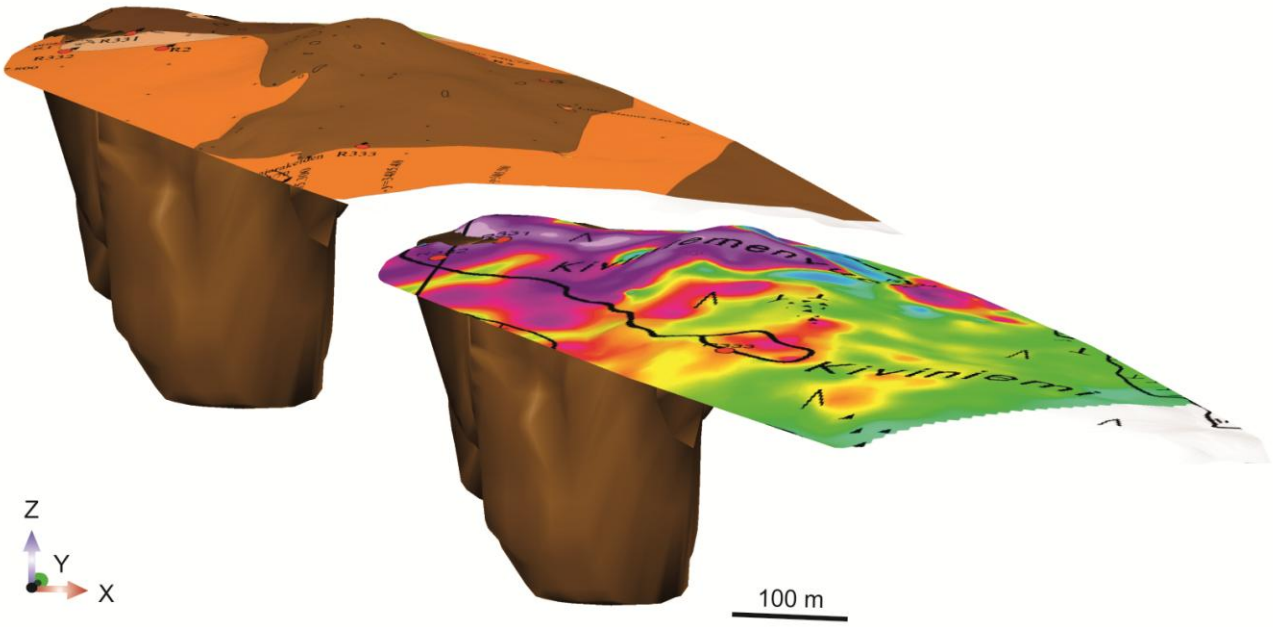


Figure 4. *DEM-model from Kiviniemi area. Bedrock and magnetic maps draped over the elevation model. The brown coloured solid represent the intrusion boundaries. Slight vertical exaggeration is used to emphasize the changes in topography.*

2.3 Compositing data and statistical analysis

A total of 443 samples were analysed (fusion with sodium peroxide, Labtium Oy method code 724P) from five drill holes (P433_2010_R1- P433_2010_R5, see Appendix 1.1.). The mean sample length was 1.3 meters (Figure 5) and assay data was composited to the nearest half meter. The compositing process was controlled using domain boundaries, restarting at each change in domain.

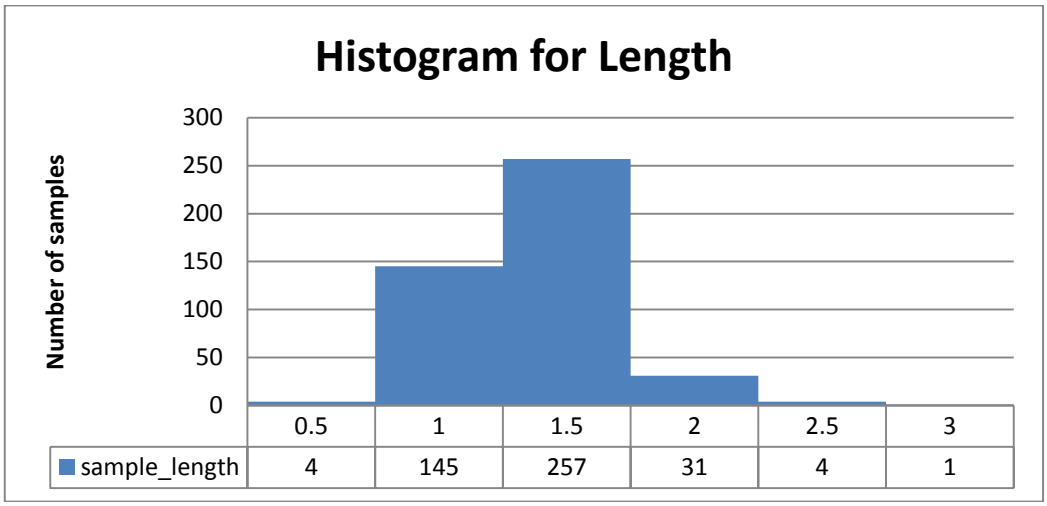


Figure 5. *Histogram shows the average sample length and propotion of assay data. The drill hole assays were composited to 1.5 meters in GEOVIA Surpac mining software.*

Validation checks were done on composites to ensure that metal was not lost in transition. The sample data was checked before and after compositing to ensure that the total length was equal and no metal had been affected. The mean grade in the sample data was compared against the mean grade in the model (Table 2). This was done for each of the domains and elements separately. Domain 201 shows a -10 % difference to the mean of composite data. Acceptable limit can be kept around (10 % difference). No topcut or declustering was applied.

A total of 374 one and a half meter composite samples are in the Kiviniemi. Statistical investigation was done to understand the data behaviour. The composited scandium data shows bimodal distribution with at least two distinctive grade populations (Figure 6).

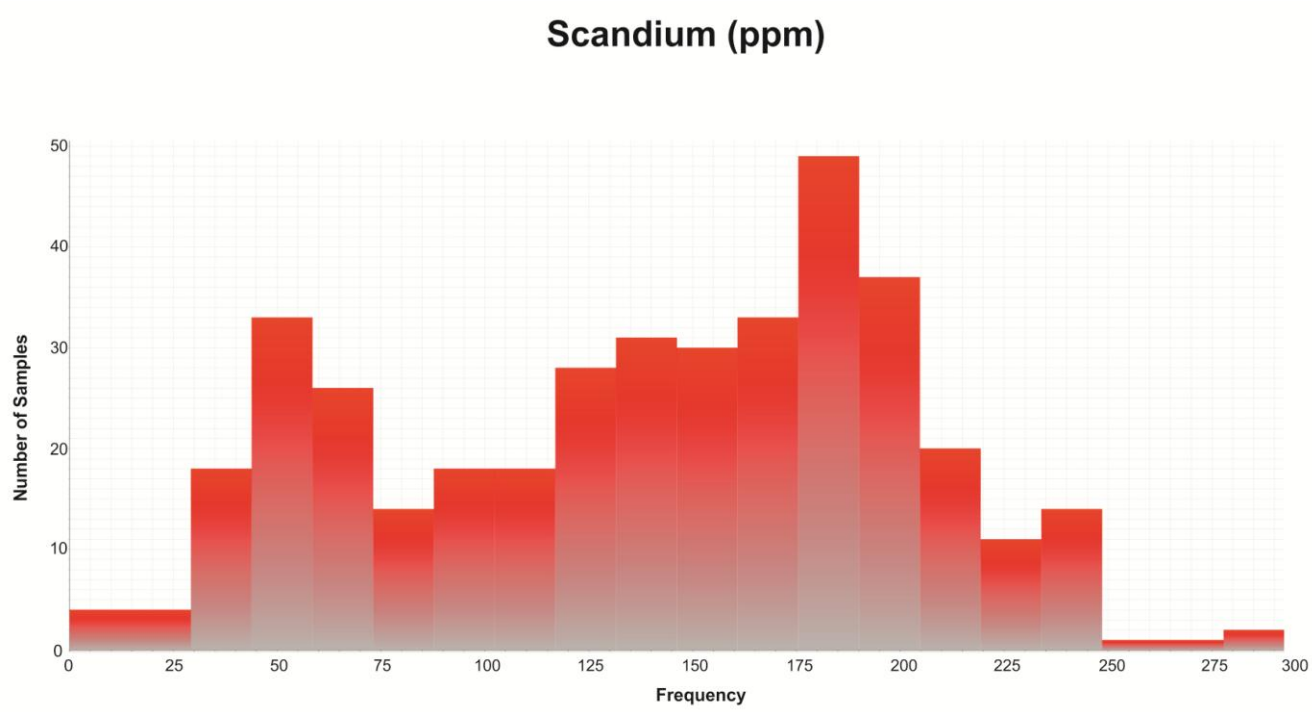


Figure 6. *Histogram of scandium (ppm) shows a bimodal distribution which is an indication of mixed populations.*

2.4 Domaining

The geological characteristics used to define the estimation domains at Kiviniemi included lithological control and scandium grade. Interpreted strings were linked together to create 3D solids (wireframes) and modified if necessary to create realistic geological shapes. The three-dimension domain solids were constructed using GEOVIA Surpac mining software.

The criteria for the domains are:

1. *Global domain* consists of an interpretation of the total volume of the deposit. Solid was modelled to envelope the deposit boundaries from available surface mapping and drill hole data. All the individual domains were included in this model.
2. *Individual Domains* consist (Figure 7) of three domains (codes: 101, 201, 301) and three sub-domains (codes: 102, 103, 202). Lenses were modelled as cross-sections using lithology and scandium grade to distinguish the main populations and classifying them into high grade, low grade and medium grade domains. High grade and low grade domains included several lenses which were subdivided into sub-domains.

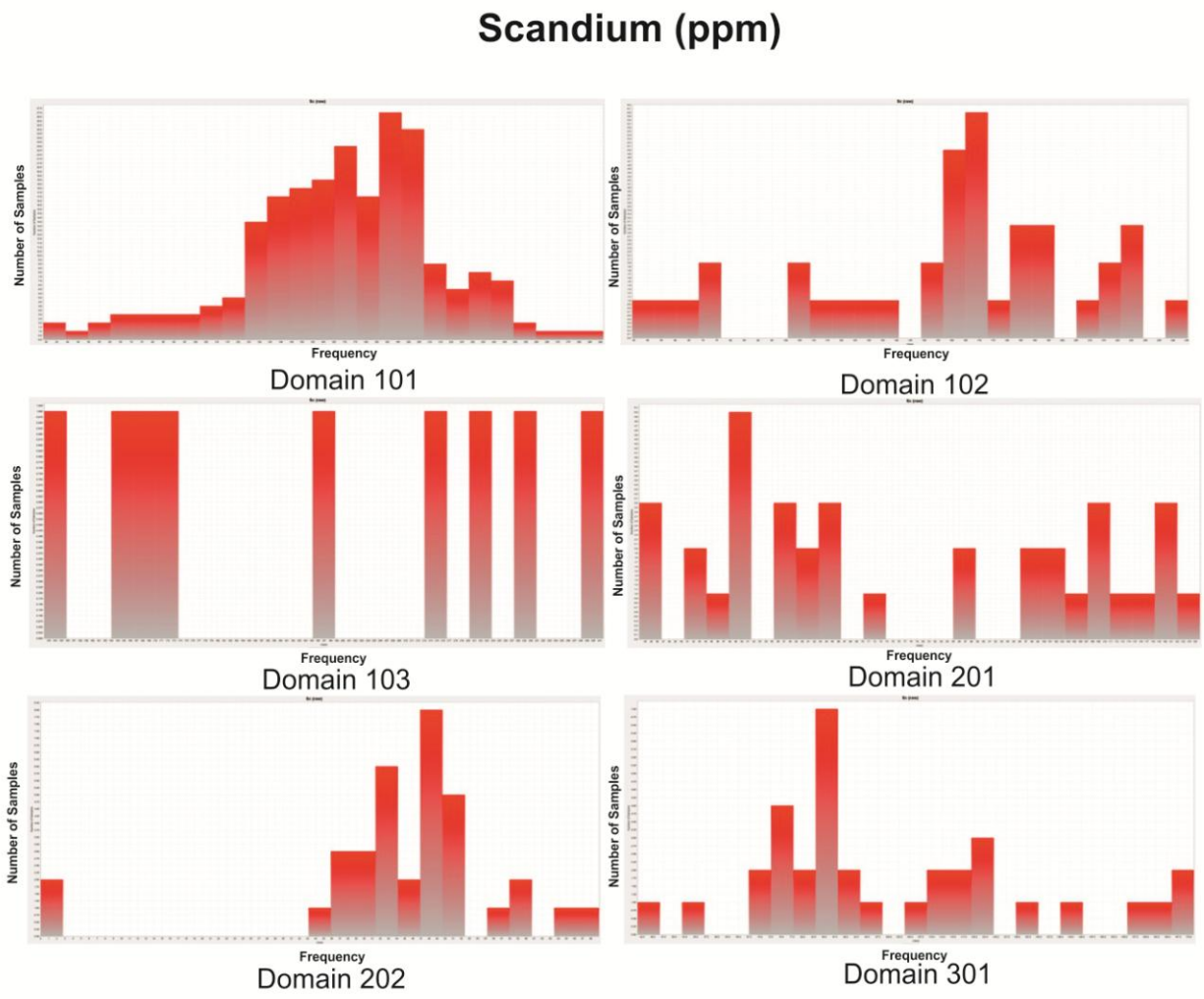


Figure 7. *Scandium grade population in each domain (Table 2). The main domain 101 (top left) shows negatively skewed (-0.515) normal distributed grade population.*

Table 2. *Statistical comparison of scandium, yttrium and zirconium in all domains. The Coefficient of Variation (CV) is generally low which indicates no need for topcut. Table also shows the grade variation of global domain and individual domains for each element.*

Sc	Samples	Minimum	Maximum	Mean	CV	Model difference	Global model difference
all	**373**	**0**	**291.24**	**142.15**	**0.29**	**4.83**	**14.37**
domain 101	221	28.66	291.24	169.65	0.26	0.91	
domain 102	38	44.44	245.33	158.09	0.31	0.80	
domain 103	9	152.27	241.64	195.93	0.16	-0.22	
domain 201	36	33.02	125.75	76.86	0.39	-10.48	
domain 202	35	0	68.99	44.78	0.30	1.60	
domain 301	34	41.43	171.25	100.65	0.31	3.97	
Y	Samples	Minimum	Maximum	Mean	CV	Model difference	Global model difference
all	**373**	**0**	**231.43**	**84.15**	**0.21**	**-1.66**	**-5.71**
domain 101	221	44.47	168.00	81.52	0.21	-3.72	
domain 102	38	58.33	96.76	82.39	0.12	-1.42	
domain 103	9	64.57	77.00	71.54	0.06	0.11	
domain 201	36	89.15	154.39	103.02	0.13	1.58	
domain 202	35	0	144.54	70.57	0.35	1.42	
domain 301	34	51.47	231.43	100.51	0.29	2.78	
Zr	Samples	Minimum	Maximum	Mean	CV	Model difference	Global model difference
all	**373**	**3.05**	**5683.20**	**1743.80**	**0.58**	**0.11**	**-2.55**
domain 101	221	290.17	5683.20	1675.76	0.70	3.18	
domain 102	38	1143.40	4874.92	2765.31	0.44	5.65	
domain 103	9	1110.32	5658.07	3065.36	0.42	-0.64	
domain 201	36	592.09	3186.22	1833.19	0.33	-4.43	
domain 202	35	3.05	3478.80	1451.50	0.42	3.41	
domain 301	34	359.11	1720.66	900.76	0.37	3.03	

Multi-variate data analysis was done to provide a quick assessment of whether there were obvious relationships between the elements and whether these realationships are positive or negative. Absolute correlation coefficient greater that 0.6 is kept as signal of a strong correlation (Table 3).

Table 3. *Multi-variate analysis shows strong correlation with scandium and zirconium in most of the domains (red). Scandium also correlates well with yttrium in domain 202 (blue).*

domain		Sc	Y	Zr	domain		Sc	Y	Zr
101					**102**				
	Sc	1	0.0711	0.515		**Sc**	1	0.4416	0.6512
	Y	0.0711	1	0.3158		**Y**	0.4416	1	0.2091
	Zr	0.515	0.3158	1		**Zr**	0.6512	0.2091	1
103					**201**				
	Sc	1	0.3102	0.6818		**Sc**	1	-0.4135	0.6358
	Y	0.3102	1	-0.0402		**Y**	-0.4135	1	-0.3723
	Zr	0.6818	-0.0402	1		**Zr**	0.6358	-0.3723	1
202					**301**				
	Sc	1	0.8298	0.6933		**Sc**	1	0.2377	0.1413
	Y	0.8298	1	0.7398		**Y**	0.2377	1	0.0076
	Zr	0.6933	0.7398	1		**Zr**	0.1413	0.0076	1

2.5 Inverse distance estimation

2.5.1 Background/Block Model

A block model was built using Gemocom Surpac softaware. The volume model (describing the geometry of domains) was based on 20 meters (X) x 20 meters (Y) x 20 meters (Z) sized parent cells, and was sub-celled to 5 meters (X) x 5 meters (Y) x 5 meters (Z) blocks at the domain boundaries (Table 4 and Figure 8). The parental cell size was chosen to represent half the drill spacing.

Table 4. *Kiviniemi Block Model Parameters*

BLOCK MODEL PARAMETERS	Y	X	Z
Minimum Coordinates	6967855	3484950	-100
Maximum Coordinates	6968075	3485290	160
User Block Size	20	20	20
Min. Block Size	5	5	5
Rotation	0	0	0
Total Blocks	25965		
Storage Efficiency %	83.31		

The empty block model was coded using the main geological features. Blocks above topography DTM were flagged as air and blocks inside the deposit were flagged as mineralised rock and outside the deposit boundary flagged as barren rock (footwall and hangingwall rocks). Each domain was coded using the solid wireframes. Only eleven gravity measurements were taken from drill holes. The average gravity of three samples taken from fayalite ferrodiorite 3.16 g/cm^3 were assigned to all mineralised rocks and used in resource estimation.

Several commonly used validation checks were performed to ensure the quality of the model. Checks included volumes, composites and metal, sample data versus model data comparison and visual checks (Appendices 1.2 and 1.4.).

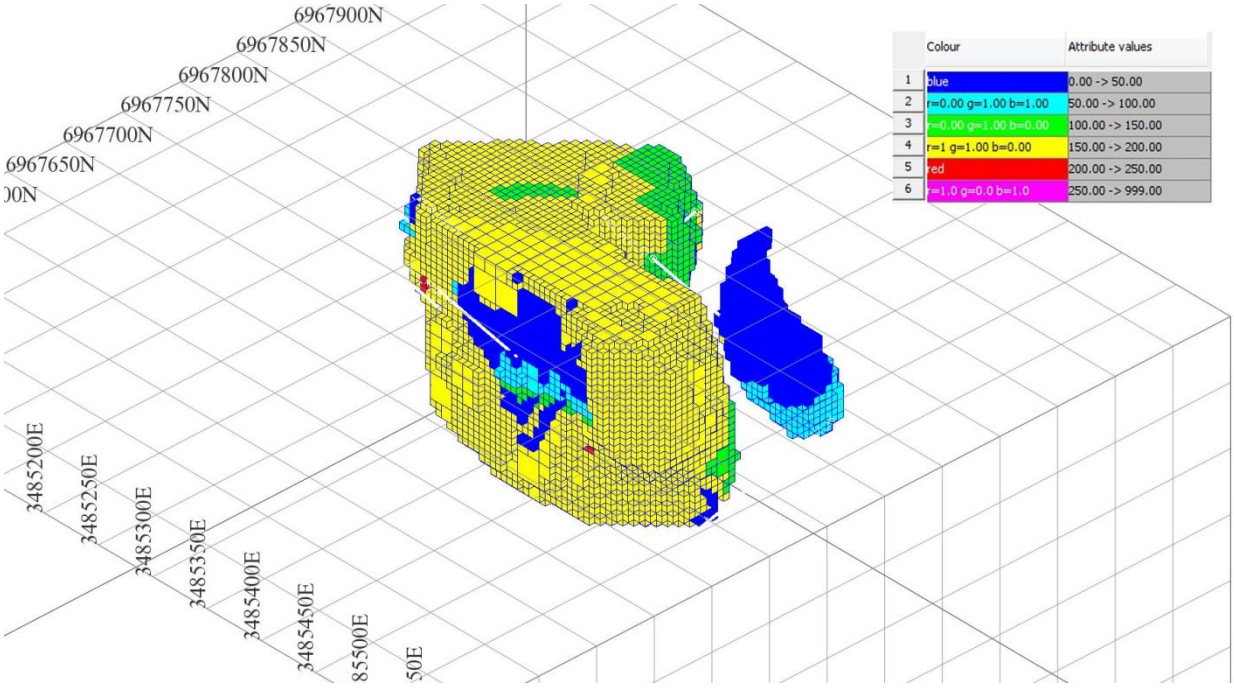


Figure 8. *Block model of Kiviniemi deposits (global domain). Colour coding represents the scandium grade.*

Inverse distance method was used to interpolate the average grades for each block (see Appendices 1.3. and 1.5.). Drill core assays were weighted using inverse of the square of a distance (ID2). Due to the sparse drilling, grade continuity of deposit resulted poor variograms. The trend of deposit is considered to be roughly in SE direction and dipping around -60 degrees (Table 5).

Table 5. *Kiviniemi Search Parameters*

SEARCH PARAMETERS		
Surpac	ZXY	
First axis		105
Second axis		0
Third axis		-59.6
ANISOTROPY FACTORS		
Semi_major axis		2
Minor axis		1
OTHER INTERPOLATION PARAMETERS		
Max search distance of major axis		200
Max vertical search distance		200
Maximum number of samples		15
Minimum number of samples		3

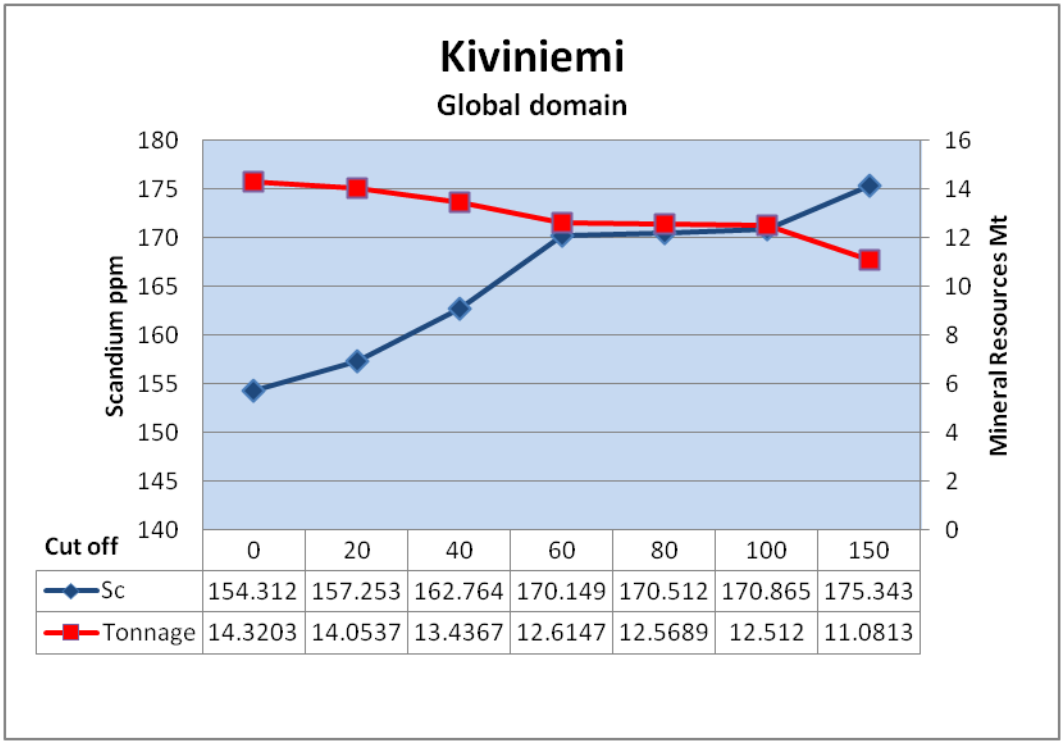
Table 6. *Table showing volumes, tonnages and grades for individual domains. Global domain is only an indication of exploration potential and should be treated as very low certainty***.**

Kiviniemi Scandium deposit			Method: Inverse distance		
Indivividual Domains	**volume**	**tonnage**	**Sc_ppm**	**Y_ppm**	**Zr_ppm**
domain 101	865500	2734980	171.279	78.602	1732.973
domain 102	53500	169060	159.345	81.228	2921.466
domain 103	5875	18565	195.51	71.614	3045.803
domain 201	159375	503625	68.806	104.641	1751.99
domain 202	52375	165505	45.498	71.57	1500.932
domain 301	51750	163530	104.653	103.302	928.076
Total	**1188375**	**3755265**	**148.67**	**82.94**	**1750.24**

Global Domain	**volume**	**tonnage**	**Sc_ppm**	**Y_ppm**	**Zr_ppm**
intrusion	**4531750**	**14320330**	**154.312**	**78.488**	**1679.783**

Table 7. *Table showing inferred resources and their main grades with different cut off values. Global domain is only an indication of exploration potential, not categorised as inferred resource, and should be treated as very low certainty*.

Individual Domains				
cut off (Sc ppm)	Tonnage	Sc	Y	Zr
0	3.7	149.1	82.8	1748.6
20	3.7	149.1	82.8	1748.6
40	3.7	150.1	83.0	1751.3
60	3.3	163.4	81.1	1791.4
80	3.2	164.8	80.7	1790.8
100	3.2	166.1	80.3	1787.5
150	2.1	182.9	78.7	2099.3
Global Domain				
cut off (Sc ppm)	Tonnage	Sc	Y	Zr
0	14.3	154.3	78.5	1679.8
20	14.1	157.3	80.0	1711.8
40	13.4	162.8	81.0	1726.2
60	12.6	170.1	80.5	1745.0
80	12.6	170.5	80.4	1744.7
100	12.5	170.9	80.3	1743.6
150	11.1	175.3	80.2	1830.3



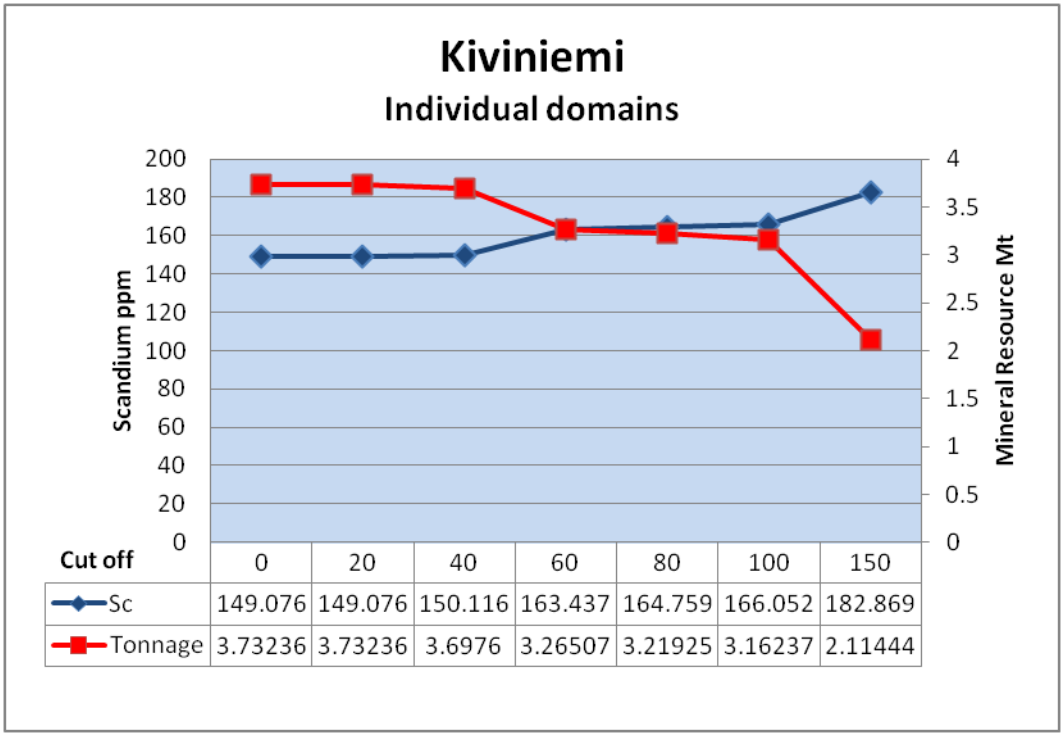


Figure 9. *Mineral resource curves by block modelling as function of cut off grade. A dramatic tonnage drop appears not before getting towards 100-150 g/t Sc cut off values.*

3 DISCUSSION

There are 1-5 drill hole intersections at the modelled sections and the distance between each section is 30-200 meters. Due to the scattered sample grid the resource classification is categorised as ore potential category rather than considering it as inferred resource estimate. Although, the scandium seems to have a fairly good continuity, more drilling and sampling is required to obtain more accurate resource assessment. Nevertheless, the dramatic tonnage drop appears not before getting towards 100-150 g/t Sc cut off values (Figure 9, Tables 6 and 7).

The dimensions of the two Kiviniemi intrusions are still only been partly explored. The main intrusion is open in all directions and same applies to the smaller intrusion. The global domain model estimation gives a good scale of size of the intrusion and its vast potential. Scandium grade is fairly homogeneous and increases the confidence on estimation the global resources.

Further exploration drilling is needed to increase the confidence on resource estimation. The infill drilling should be targeted between the drill hole profiles so that at least 50 m spacing is achieved. This would require approximately 500-700 meters of diamond drilling.

4 CONCLUSION

The assessment and related investigations are following the international standards. The resource classification is conservative due to the inadequate exploration drilling and should be treated as low certainty. Although, scandium, yttrium and zirconium are following the large homogeneous ferrodioritic unit with an even grade distribution, only few additional drill holes would improve the estimation substantially. The global domain should not be considered as resource category, rather an exploration potential measurement.

The resource estimation calculated for Kiviniemi intrusion by using 40 g/t Sc cut off value is 13.4 Mt of rock with an average grade of 162.7 g/t scandium, 1726 g/t zirconium and 81 g/t yttrium. The total estimation is 14.3 Mt with an average scandium grade of 154.3 g/t, when no cut off values are applied.

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6 APPENDIX

Appendix 1.1. *Drill hole assay data of Kiviniemi*

Appendix 1.2. *Cross-section of domain boundaries*

Appendix 1.3. *The solid model of Kivinemi intrusion*

Appendix 1.4. *Visual validation of individual domains*

Appendix 1.5. *Blockmodel of Kiviniemi intrusion with different cut off grade*

APPENDIX 1.1. DRILL HOLE ASSAY DATA OF KIVINIEMI

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R1	28.3	29.8	1.5	59	99	1090	
P433_2010_R1	29.8	30.8	1	72	114	1220	
P433_2010_R1	30.8	31.8	1	73	113	861	
P433_2010_R1	31.8	33	1.2	131	84	299	
P433_2010_R1	33	34	1	133	114	856	
P433_2010_R1	34	35	1	175	175	846	
P433_2010_R1	35	36	1	146	136	892	
P433_2010_R1	36	37	1	168	111	693	
P433_2010_R1	37	38	1	153	93	492	
P433_2010_R1	38	39	1	167	96	461	
P433_2010_R1	39	40	1	135	109	605	
P433_2010_R1	40	41	1	144	93	667	
P433_2010_R1	41	42	1	134	89	528	
P433_2010_R1	42	43	1	131	86	445	
P433_2010_R1	43	44	1	123	84	496	
P433_2010_R1	44	45	1	141	95	783	
P433_2010_R1	45	46	1	164	93	652	
P433_2010_R1	46	47	1	171	97	670	
P433_2010_R1	47	48	1	148	84	682	
P433_2010_R1	48	49	1	181	103	772	
P433_2010_R1	49	50	1	166	96	486	
P433_2010_R1	50	51	1	149	86	1080	
P433_2010_R1	51	52	1	158	92	1150	
P433_2010_R1	52	53	1	179	102	1130	
P433_2010_R1	53	54	1	168	99	1380	
P433_2010_R1	54	55	1	156	86	1370	
P433_2010_R1	55	56	1	186	93	1230	
P433_2010_R1	56	57	1	204	103	1120	
P433_2010_R1	57	57.9	0.9	208	120	723	
P433_2010_R1	57.9	59	1.1	214	105	2200	
P433_2010_R1	59	60	1	174	89	2810	
P433_2010_R1	60	61	1	163	86	2790	
P433_2010_R1	61	62	1	175	90	2690	
P433_2010_R1	62	63	1	186	96	3240	
P433_2010_R1	63	64	1	184	93	3000	
P433_2010_R1	64	65	1	171	94	2840	
P433_2010_R1	65	66	1	207	99	3740	
P433_2010_R1	66	67	1	210	96	3400	
P433_2010_R1	67	68	1	185	76	2010	
P433_2010_R1	68	69	1	222	94	1780	
P433_2010_R1	69	70	1	190	78	2060	
P433_2010_R1	70	71	1	192	78	2180	
P433_2010_R1	71	72	1	191	92	2820	
P433_2010_R1	72	73	1	221	114	3070	
P433_2010_R1	73	74	1	187	85	2160	
P433_2010_R1	74	75.3	1.3	181	79	2430	
P433_2010_R1	75.3	75.6	0.3	27	66	365	
P433_2010_R1	75.6	77.1	1.5	167	71	2210	
P433_2010_R1	77.1	78	0.9	187	75	2420	

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R1	78	79	1	247	86	3370	
P433_2010_R1	79	80	1	246	90	3970	
P433_2010_R1	80	81	1	242	94	3760	
P433_2010_R1	81	82	1	183	83	2070	
P433_2010_R1	82	83	1	201	101	3250	
P433_2010_R1	83	84	1	215	83	2240	
P433_2010_R1	84	85	1	210	79	1230	
P433_2010_R1	85	86	1	216	92	2240	
P433_2010_R1	86	87	1	183	80	2490	
P433_2010_R1	87	88	1	227	80	1920	
P433_2010_R1	88	89	1	183	72	2300	
P433_2010_R1	89	90	1	174	85	2170	
P433_2010_R1	90	91	1	190	81	2520	
P433_2010_R1	91	92.5	1.5	185	78	2180	
P433_2010_R1	92.5	95.5	3	149	64	1660	
P433_2010_R1	95.5	96.5	1	173	64	1390	
P433_2010_R1	96.5	97.7	1.2	109	50	1200	
P433_2010_R1	97.7	98.1	0.4	0	23	177	
P433_2010_R1	98.1	99.4	1.3	193	74	1230	
P433_2010_R1	99.4	100.4	1	175	75	1400	
P433_2010_R1	100.4	101.4	1	132	70	1930	
P433_2010_R1	101.4	102.4	1	175	74	2050	
P433_2010_R1	102.4	103.4	1	173	70	2030	
P433_2010_R1	103.4	105.4	2	22	61	565	
P433_2010_R1	105.4	106.6	1.2	129	70	1260	
P433_2010_R1	106.6	108.1	1.5	163	75	1470	
P433_2010_R1	108.1	109.9	1.8	27	110	1200	
P433_2010_R1	109.9	111.1	1.2	185	76	1340	
P433_2010_R1	111.1	112.3	1.2	195	61	1350	
P433_2010_R1	112.3	113.5	1.2	183	60	1500	
P433_2010_R1	113.5	114.7	1.2	204	107	2700	
P433_2010_R1	114.7	115.7	1	247	120	3100	
P433_2010_R1	115.7	116.7	1	205	68	1960	
P433_2010_R1	116.7	117.7	1	177	65	1850	
P433_2010_R1	117.7	119.1	1.4	29	106	575	
P433_2010_R1	119.1	120	0.9	171	66	1910	
P433_2010_R1	120	121	1	197	71	722	
P433_2010_R1	121	122	1	165	59	595	
P433_2010_R1	122	123	1	196	59	616	
P433_2010_R1	123	124	1	196	66	1110	
P433_2010_R1	124	125	1	176	56	736	
P433_2010_R1	125	126	1	178	56	558	
P433_2010_R1	126	127	1	187	58	697	
P433_2010_R1	127	128	1	149	54	628	
P433_2010_R1	128	129	1	171	68	1190	
P433_2010_R1	129	130	1	194	66	1540	
P433_2010_R1	130	131	1	179	58	670	
P433_2010_R1	131	132	1	185	61	697	
P433_2010_R1	132	133	1	200	59	1540	

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R1	133	134	1	187	72	1790	
P433_2010_R1	134	135	1	181	66	1910	
P433_2010_R1	135	136	1	195	65	1130	
P433_2010_R1	136	137	1	188	63	1660	
P433_2010_R1	137	138	1	204	64	2150	
P433_2010_R1	138	139	1	191	58	1870	
P433_2010_R1	139	140	1	208	57	1310	
P433_2010_R1	140	141	1	211	71	1800	
P433_2010_R1	141	142	1	197	65	1200	
P433_2010_R1	142	143.5	1.5	200	62	1940	
P433_2010_R1	143.5	145.7	2.2	21	62	263	
P433_2010_R1	145.7	147	1.3	244	75	1350	
P433_2010_R1	147	148.3	1.3	231	71	3450	
P433_2010_R1	148.3	149.4	1.1	293	88	985	
P433_2010_R1	149.4	150.5	1.1	291	90	1270	
P433_2010_R1	150.5	151.6	1.1	277	99	1020	
P433_2010_R1	151.6	152.8	1.2	258	97	1860	
P433_2010_R1	152.8	154	1.2	226	89	2730	
P433_2010_R1	154	155	1	233	91	2970	
P433_2010_R1	155	156	1	247	98	3870	
P433_2010_R1	156	157	1	231	97	3170	
P433_2010_R1	157	158	1	237	96	3970	
P433_2010_R1	158	159	1	233	97	4900	
P433_2010_R1	159	160	1	229	97	5320	
P433_2010_R1	160	161	1	229	99	4290	
P433_2010_R1	161	162	1	217	92	4760	
P433_2010_R1	162	163	1	204	84	2200	
P433_2010_R1	163	164	1	169	74	3240	
P433_2010_R1	164	165	1	185	101	1570	
P433_2010_R1	165	166	1	203	79	2440	
P433_2010_R1	166	167	1	196	83	1480	
P433_2010_R1	167	168	1	169	106	1600	
P433_2010_R1	168	169	1	178	73	1310	
P433_2010_R1	169	170	1	217	93	1500	
P433_2010_R1	170	171	1	208	89	1120	
P433_2010_R1	171	172.2	1.2	171	84	1750	
P433_2010_R1	172.2	173.7	1.5	74	119	978	
P433_2010_R1	173.7	175.2	1.5	80	105	1010	
P433_2010_R1	175.2	176.7	1.5	73	103	899	
P433_2010_R1	176.7	178.2	1.5	91	94	1040	
P433_2010_R1	178.2	179.7	1.5	71	105	1050	
P433_2010_R1	179.7	181.2	1.5	105	103	1020	
P433_2010_R1	181.2	182.7	1.5	74	110	851	
P433_2010_R1	182.7	184.2	1.5	75	111	997	
P433_2010_R1	184.2	185.8	1.6	82	111	903	
P433_2010_R1	185.8	186.8	1	165	79	2220	
P433_2010_R1	186.8	187.8	1	158	76	1350	
P433_2010_R1	187.8	188.8	1	175	81	1770	
P433_2010_R1	188.8	189.7	0.9	135	69	1660	

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R1	189.7	191.2	1.5	122	106	1030	
P433_2010_R1	191.2	192.7	1.5	76	104	762	
P433_2010_R1	192.7	194.2	1.5	89	88	802	
P433_2010_R1	194.2	195.7	1.5	83	98	890	
P433_2010_R1	195.7	197.2	1.5	84	116	1000	
P433_2010_R1	197.2	198.5	1.3	102	119	974	
P433_2010_R1	198.5	199.7	1.2	95	123	1050	
P433_2010_R1	199.7	201	1.3	244	101	2360	
P433_2010_R1	201	202	1	157	80	2370	
P433_2010_R1	202	203	1	186	75	1720	
P433_2010_R1	203	204	1	193	99	1820	
P433_2010_R1	204	205	1	191	96	1760	
P433_2010_R1	205	206	1	173	85	1860	
P433_2010_R1	206	207	1	152	86	1540	
P433_2010_R1	207	208	1	151	76	2030	
P433_2010_R1	208	209	1	202	92	1760	
P433_2010_R1	209	210	1	178	77	1310	
P433_2010_R1	210	211.3	1.3	58	89	1510	
P433_2010_R1	211.3	212	0.7	180	82	1230	
P433_2010_R1	212	213	1	92	66	1080	
P433_2010_R1	213	214	1	65	103	1790	
P433_2010_R1	214	215.5	1.5	60	92	1590	
P433_2010_R2	67	67.9	0.9	33	92	1190	
P433_2010_R2	67.9	68.4	0.5	32	88	1070	
P433_2010_R2	68.4	70.15	1.75	37	95	2110	
P433_2010_R2	70.15	71.5	1.35	34	93	1210	
P433_2010_R2	71.5	73	1.5	45	108	1010	
P433_2010_R2	73	74.5	1.5	52	121	1180	
P433_2010_R2	74.5	76	1.5	45	105	2080	
P433_2010_R2	76	77.5	1.5	49	100	1220	
P433_2010_R2	77.5	79	1.5	61	116	1110	
P433_2010_R2	79	80.5	1.5	48	106	1800	
P433_2010_R2	80.5	82	1.5	48	107	1570	
P433_2010_R2	82	83.5	1.5	68	129	1730	
P433_2010_R2	83.5	85	1.5	61	102	1330	
P433_2010_R2	85	85.8	0.8	59	96	1470	
P433_2010_R2	85.8	87.8	2	48	95	1450	
P433_2010_R2	87.8	89	1.2	30	96	1250	
P433_2010_R2	89	90.1	1.1	37	86	1120	
P433_2010_R2	90.1	91.5	1.4	59	158	1710	
P433_2010_R2	91.5	93	1.5	58	148	1580	
P433_2010_R2	93	94.9	1.9	65	118	1470	
P433_2010_R2	94.9	96	1.1	82	91	2090	
P433_2010_R2	96	97	1	100	89	2340	
P433_2010_R2	97	98	1	108	90	2210	
P433_2010_R2	98	99	1	109	94	2850	
P433_2010_R2	99	100.5	1.5	112	99	2440	
P433_2010_R2	100.5	102	1.5	102	97	2520	
P433_2010_R2	102	103.5	1.5	103	106	2750	

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R2	103.5	105	1.5	86	94	2590	
P433_2010_R2	105	106.5	1.5	90	90	3310	
P433_2010_R2	106.5	108	1.5	123	102	2860	
P433_2010_R2	108	109.5	1.5	108	94	1870	
P433_2010_R2	109.5	111	1.5	119	91	2070	
P433_2010_R2	111	112.5	1.5	121	94	1920	
P433_2010_R2	112.5	114.4	1.9	117	93	2230	
P433_2010_R2	114.4	116.4	2	114	89	2790	
P433_2010_R2	116.4	118	1.6	133	90	1680	
P433_2010_R2	118	119	1	102	106	1490	
P433_2010_R2	119	120.8	1.8	139	82	1620	
P433_2010_R2	120.8	122.4	1.6	130	85	1120	
P433_2010_R2	122.4	123.7	1.3	148	94	1430	
P433_2010_R2	123.7	125	1.3	233	92	2570	
P433_2010_R2	125	126.5	1.5	199	86	2160	
P433_2010_R2	126.5	128	1.5	171	80	2180	
P433_2010_R2	128	129.5	1.5	165	80	2750	
P433_2010_R2	129.5	131	1.5	175	69	1940	
P433_2010_R2	131	132.5	1.5	200	80	4430	
P433_2010_R2	132.5	134	1.5	208	72	3020	
P433_2010_R2	134	135.5	1.5	198	76	2360	
P433_2010_R2	135.5	137	1.5	138	71	2660	
P433_2010_R2	137	138.5	1.5	169	63	2520	
P433_2010_R2	138.5	140	1.5	212	79	3480	
P433_2010_R2	140	142	2	195	73	3880	
P433_2010_R2	142	143.5	1.5	217	94	5290	
P433_2010_R2	143.5	145	1.5	229	102	5100	
P433_2010_R2	145	146.5	1.5	239	108	6070	
P433_2010_R2	146.5	148	1.5	208	130	5250	
P433_2010_R2	148	149.5	1.5	219	111	3120	
P433_2010_R2	149.5	151.2	1.7	246	106	921	
P433_2010_R2	151.2	153.2	2	193	96	684	
P433_2010_R2	153.2	154.5	1.3	197	81	484	
P433_2010_R2	154.5	156	1.5	213	84	655	
P433_2010_R2	156	157.5	1.5	168	78	366	
P433_2010_R2	157.5	159	1.5	110	82	359	
P433_2010_R2	159	160.5	1.5	137	86	600	
P433_2010_R2	160.5	162	1.5	119	63	493	
P433_2010_R2	162	163.5	1.5	170	107	452	
P433_2010_R2	163.5	165	1.5	150	58	265	
P433_2010_R2	165	166.5	1.5	140	71	542	
P433_2010_R2	166.5	168	1.5	82	51	618	
P433_2010_R2	168	169.5	1.5	110	56	346	
P433_2010_R2	169.5	171	1.5	122	88	473	
P433_2010_R2	171	172.3	1.3	96	87	647	
P433_2010_R2	172.3	172.9	0.6	0	91	689	
P433_2010_R2	172.9	174.2	1.3	200	255	507	
P433_2010_R2	174.2	175.4	1.2	126	89	537	
P433_2010_R2	175.4	176.5	1.1	30	40	278	

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R2	176.5	178	1.5	122	65	669	
P433_2010_R2	178	179.5	1.5	138	73	550	
P433_2010_R2	179.5	181	1.5	102	123	594	
P433_2010_R2	181	182.2	1.2	121	87	545	
P433_2010_R2	182.2	183.9	1.7	26	124	682	
P433_2010_R2	183.9	185.5	1.6	97	115	673	
P433_2010_R2	185.5	187.5	2	181	114	861	
P433_2010_R2	187.5	188.7	1.2	116	118	1410	
P433_2010_R2	188.7	190.3	1.6	50	112	1670	
P433_2010_R2	190.3	191.9	1.6	26	31	666	
P433_2010_R2	191.9	193.5	1.6	195	73	3120	
P433_2010_R2	193.5	195.6	2.1	0	54	560	
P433_2010_R2	195.6	197	1.4	217	90	2630	
P433_2010_R2	197	198.1	1.1	200	107	3990	
P433_2010_R2	198.1	198.8	0.7	21	51	459	
P433_2010_R2	198.8	200.3	1.5	219	83	3910	
P433_2010_R2	200.3	201.8	1.5	250	95	4850	
P433_2010_R2	201.8	203.5	1.7	217	84	4580	
P433_2010_R2	203.5	204.7	1.2	176	78	3510	
P433_2010_R2	204.7	206	1.3	152	82	3520	
P433_2010_R2	206	206.6	0.6	0	43	384	
P433_2010_R2	206.6	208.1	1.5	179	74	4210	
P433_2010_R2	208.1	209.6	1.5	175	73	3690	
P433_2010_R2	209.6	210.8	1.2	154	75	3710	
P433_2010_R2	210.8	212	1.2	150	80	3890	
P433_2010_R2	212	213.5	1.5	185	81	3950	
P433_2010_R2	213.5	215	1.5	221	87	5000	
P433_2010_R2	215	216.5	1.5	187	93	4330	
P433_2010_R2	216.5	218	1.5	229	98	4840	
P433_2010_R2	218	219.4	1.4	178	84	3550	
P433_2010_R2	219.4	220.4	1	199	91	3640	
P433_2010_R2	220.4	221	0.6	0	13	126	
P433_2010_R2	221	222.5	1.5	156	84	3870	
P433_2010_R2	222.5	224	1.5	159	83	3680	
P433_2010_R2	224	225.5	1.5	166	90	3930	
P433_2010_R2	225.5	227	1.5	170	85	1490	
P433_2010_R2	227	228.5	1.5	136	86	1240	
P433_2010_R2	228.5	230	1.5	152	83	1460	
P433_2010_R2	230	231.5	1.5	105	83	1360	
P433_2010_R2	231.5	233	1.5	75	109	2220	
P433_2010_R2	233	234.5	1.5	114	104	1810	
P433_2010_R2	234.5	235.5	1	162	108	4400	
P433_2010_R2	235.5	236.8	1.3	118	72	1190	
P433_2010_R2	236.8	238	1.2	66	51	1320	
P433_2010_R2	238	239.5	1.5	66	53	1570	
P433_2010_R2	239.5	241	1.5	67	54	1640	
P433_2010_R3	14.5	16.1	1.6	129	168	5220	
P433_2010_R3	16.1	16.45	0.35	0	81	217	
P433_2010_R3	16.45	17.3	0.85	145	163	6760	

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R3	17.3	18.3	1	158	110	3360	
P433_2010_R3	18.3	19.5	1.2	186	99	2180	
P433_2010_R3	19.5	21	1.5	145	82	1660	
P433_2010_R3	21	22.5	1.5	138	87	1380	
P433_2010_R3	22.5	24	1.5	159	86	1260	
P433_2010_R3	24	25.5	1.5	142	75	870	
P433_2010_R3	25.5	27	1.5	145	72	585	
P433_2010_R3	27	28.5	1.5	145	90	723	
P433_2010_R3	28.5	30	1.5	65	82	690	
P433_2010_R3	30	31.5	1.5	72	47	560	
P433_2010_R3	31.5	33	1.5	127	89	776	
P433_2010_R3	33	34.5	1.5	140	68	559	
P433_2010_R3	34.5	36	1.5	140	75	812	
P433_2010_R3	36	37.6	1.6	176	82	536	
P433_2010_R3	37.6	39.4	1.8	124	70	795	
P433_2010_R3	39.4	41.3	1.9	140	85	811	
P433_2010_R3	41.3	43	1.7	190	93	655	
P433_2010_R3	43	44.5	1.5	166	83	701	
P433_2010_R3	44.5	46	1.5	172	81	641	
P433_2010_R3	46	47.5	1.5	150	70	570	
P433_2010_R3	47.5	49	1.5	170	75	527	
P433_2010_R3	49	50.5	1.5	212	90	606	
P433_2010_R3	50.5	52	1.5	151	74	612	
P433_2010_R3	52	53.5	1.5	94	56	707	
P433_2010_R3	53.5	55	1.5	120	65	509	
P433_2010_R3	55	56.5	1.5	76	61	789	
P433_2010_R3	56.5	58	1.5	90	72	773	
P433_2010_R3	58	59.5	1.5	178	96	873	
P433_2010_R3	59.5	61	1.5	171	74	386	
P433_2010_R3	61	62.5	1.5	122	66	582	
P433_2010_R3	62.5	64	1.5	151	78	558	
P433_2010_R3	64	65.2	1.2	148	83	873	
P433_2010_R3	65.2	66.6	1.4	30	87	731	
P433_2010_R3	66.6	68	1.4	168	76	493	
P433_2010_R3	68	69.5	1.5	145	63	395	
P433_2010_R3	69.5	71	1.5	123	52	301	
P433_2010_R3	71	72.5	1.5	131	85	438	
P433_2010_R3	72.5	73.8	1.3	99	68	641	
P433_2010_R3	73.8	75	1.2	242	70	1190	
P433_2010_R3	75	76.5	1.5	129	41	682	
P433_2010_R3	76.5	78	1.5	200	54	902	
P433_2010_R3	78	79.5	1.5	179	55	1310	
P433_2010_R3	79.5	81	1.5	194	84	1810	
P433_2010_R3	81	82.5	1.5	287	70	1170	
P433_2010_R3	82.5	84	1.5	237	76	1830	
P433_2010_R3	84	85.5	1.5	216	65	2000	
P433_2010_R3	85.5	87	1.5	189	60	1460	
P433_2010_R3	87	88.5	1.5	177	51	858	
P433_2010_R3	88.5	90	1.5	205	66	1490	

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R3	90	91.5	1.5	201	66	1390	
P433_2010_R3	91.5	93	1.5	176	58	1850	
P433_2010_R3	93	94.5	1.5	163	53	2030	
P433_2010_R3	94.5	96	1.5	183	57	1510	
P433_2010_R3	96	97.5	1.5	194	69	2740	
P433_2010_R3	97.5	99	1.5	153	52	1190	
P433_2010_R3	99	100.5	1.5	166	52	1390	
P433_2010_R3	100.5	102	1.5	201	61	3600	
P433_2010_R3	102	103.5	1.5	228	63	1630	
P433_2010_R3	103.5	105	1.5	176	65	3270	
P433_2010_R3	105	106.5	1.5	194	57	2270	
P433_2010_R3	106.5	108	1.5	187	103	3180	
P433_2010_R3	108	109.5	1.5	184	80	2600	
P433_2010_R3	109.5	111	1.5	249	95	5070	
P433_2010_R3	111	112.5	1.5	235	91	4010	
P433_2010_R3	112.5	114	1.5	242	90	5010	
P433_2010_R3	114	115.5	1.5	242	83	4410	
P433_2010_R3	115.5	117	1.5	197	79	2870	
P433_2010_R3	117	118.5	1.5	181	80	1960	
P433_2010_R3	118.5	120	1.5	189	84	1960	
P433_2010_R3	120	121.5	1.5	204	79	1100	
P433_2010_R3	121.5	123	1.5	178	77	1430	
P433_2010_R3	123	124.5	1.5	157	73	1590	
P433_2010_R3	124.5	126	1.5	141	69	1770	
P433_2010_R3	126	127.5	1.5	157	76	1450	
P433_2010_R3	127.5	128.8	1.3	186	94	2250	
P433_2010_R3	128.8	130.1	1.3	0	60	196	
P433_2010_R3	130.1	131.5	1.4	146	82	1640	
P433_2010_R3	131.5	133	1.5	152	83	1360	
P433_2010_R3	133	134.5	1.5	143	81	1610	
P433_2010_R3	134.5	136	1.5	139	81	777	
P433_2010_R3	136	137.5	1.5	133	88	431	
P433_2010_R3	137.5	139.2	1.7	130	94	844	
P433_2010_R3	139.2	141.4	2.2	69	110	1210	
P433_2010_R3	141.4	142.7	1.3	63	100	1210	
P433_2010_R3	142.7	144.2	1.5	170	103	825	
P433_2010_R3	144.2	145.6	1.4	124	94	700	
P433_2010_R3	145.6	146.8	1.2	106	77	543	
P433_2010_R3	146.8	148.5	1.7	145	85	470	
P433_2010_R3	148.5	150	1.5	165	92	289	
P433_2010_R3	150	151.5	1.5	174	96	346	
P433_2010_R3	151.5	152.6	1.1	154	89	339	
P433_2010_R3	152.6	154.2	1.6	127	84	479	
P433_2010_R3	154.2	155.7	1.5	68	97	1370	
P433_2010_R3	155.7	157.2	1.5	69	104	1420	
P433_2010_R4	62.5	63.7	1.2	0	39	117	
P433_2010_R4	63.7	64.3	0.6	0	25	337	
P433_2010_R4	64.3	65.5	1.2	154	76	769	
P433_2010_R4	65.5	67.1	1.6	229	64	3490	

HOLE-ID	From m	To m	Length m	sc_ppm	y_ppm	zr_ppm	Appendix 1.1
P433_2010_R4	67.1	68.1	1	239	77	5790	
P433_2010_R4	68.1	69.1	1	245	77	5490	
P433_2010_R4	69.1	70.45	1.35	208	70	3650	
P433_2010_R4	70.45	72.5	2.05	167	64	3690	
P433_2010_R4	72.5	74	1.5	165	72	2290	
P433_2010_R4	74	75.5	1.5	218	79	2240	
P433_2010_R4	75.5	77	1.5	225	74	2240	
P433_2010_R4	77	78.3	1.3	135	75	1840	
P433_2010_R4	78.3	79.6	1.3	111	89	2530	
P433_2010_R4	79.6	80.85	1.25	0	0	63	
P433_2010_R4	80.85	82.1	1.25	0	0	0	
P433_2010_R4	82.1	83.5	1.4	46	66	1370	
P433_2010_R4	83.5	85	1.5	44	64	1240	
P433_2010_R4	85	86.6	1.6	36	52	1100	
P433_2010_R4	86.6	88	1.4	41	65	1270	
P433_2010_R4	88	89.5	1.5	40	80	1580	
P433_2010_R4	89.5	91	1.5	51	94	2510	
P433_2010_R4	91	92.5	1.5	37	77	2090	
P433_2010_R4	92.5	94	1.5	43	60	1430	
P433_2010_R4	94	95.5	1.5	46	64	1480	
P433_2010_R4	95.5	97	1.5	41	54	1210	
P433_2010_R4	97	98.5	1.5	0	11	0	
P433_2010_R4	98.5	100	1.5	43	83	1780	
P433_2010_R4	100	101.5	1.5	52	83	3480	
P433_2010_R4	101.5	103	1.5	69	92	2220	
P433_2010_R4	103	104.5	1.5	57	99	1930	
P433_2010_R4	104.5	106	1.5	60	112	2450	
P433_2010_R4	106	107.5	1.5	34	78	1070	
P433_2010_R4	107.5	109	1.5	37	54	1070	
P433_2010_R4	109	110.5	1.5	49	68	1300	
P433_2010_R4	110.5	112	1.5	47	69	1510	
P433_2010_R4	112	113.5	1.5	47	68	1270	
P433_2010_R4	113.5	115	1.5	50	71	1320	
P433_2010_R4	115	116.5	1.5	48	69	1630	
P433_2010_R4	116.5	118	1.5	47	64	1180	
P433_2010_R4	118	119.5	1.5	50	72	1380	
P433_2010_R4	119.5	121	1.5	60	76	1260	
P433_2010_R4	121	122.5	1.5	49	72	1220	
P433_2010_R4	122.5	124	1.5	48	72	1260	
P433_2010_R4	124	125.5	1.5	44	68	1140	
P433_2010_R4	125.5	127	1.5	48	77	1400	
P433_2010_R4	127	128.5	1.5	52	79	1330	
P433_2010_R4	128.5	129.5	1	43	81	1430	
P433_2010_R4	129.5	130.7	1.2	49	85	1400	
P433_2010_R4	130.7	131.5	0.8	81	198	2440	
P433_2010_R5	51	52	1	60	124	1270	
P433_2010_R5	52	53	1	67	136	1330	
P433_2010_R5	53	54	1	59	118	1320	
P433_2010_R5	54	55	1	62	124	1360	
P433_2010_R5	55	56	1	64	126	1350	
P433_2010_R5	56	57	1	69	122	1120	

APPENDIX 1.2. CROSS-SECTION OF DOMAIN BOUNDARIES

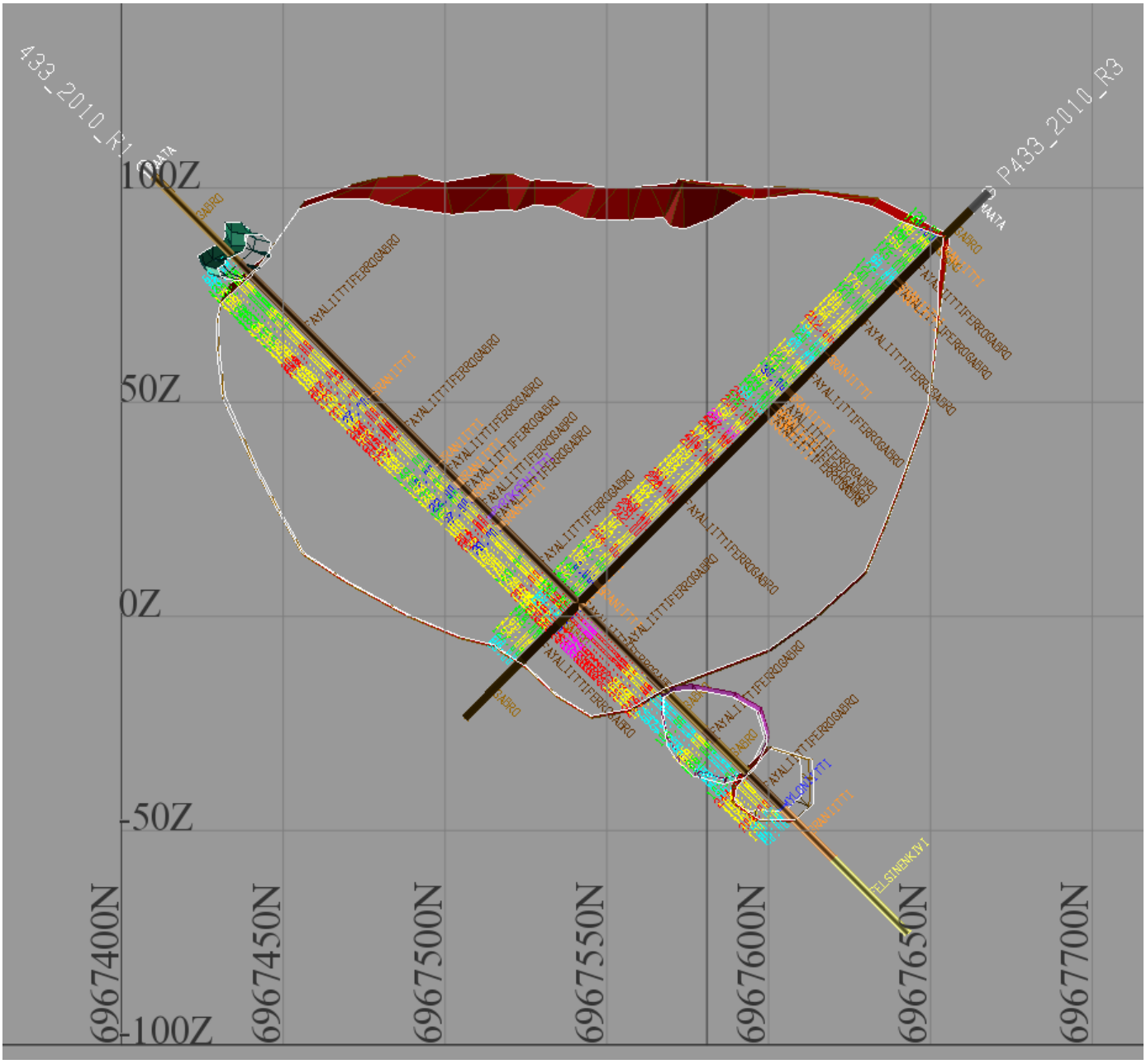

Figure 1.2.1. *Cross-section of domain boundaries*

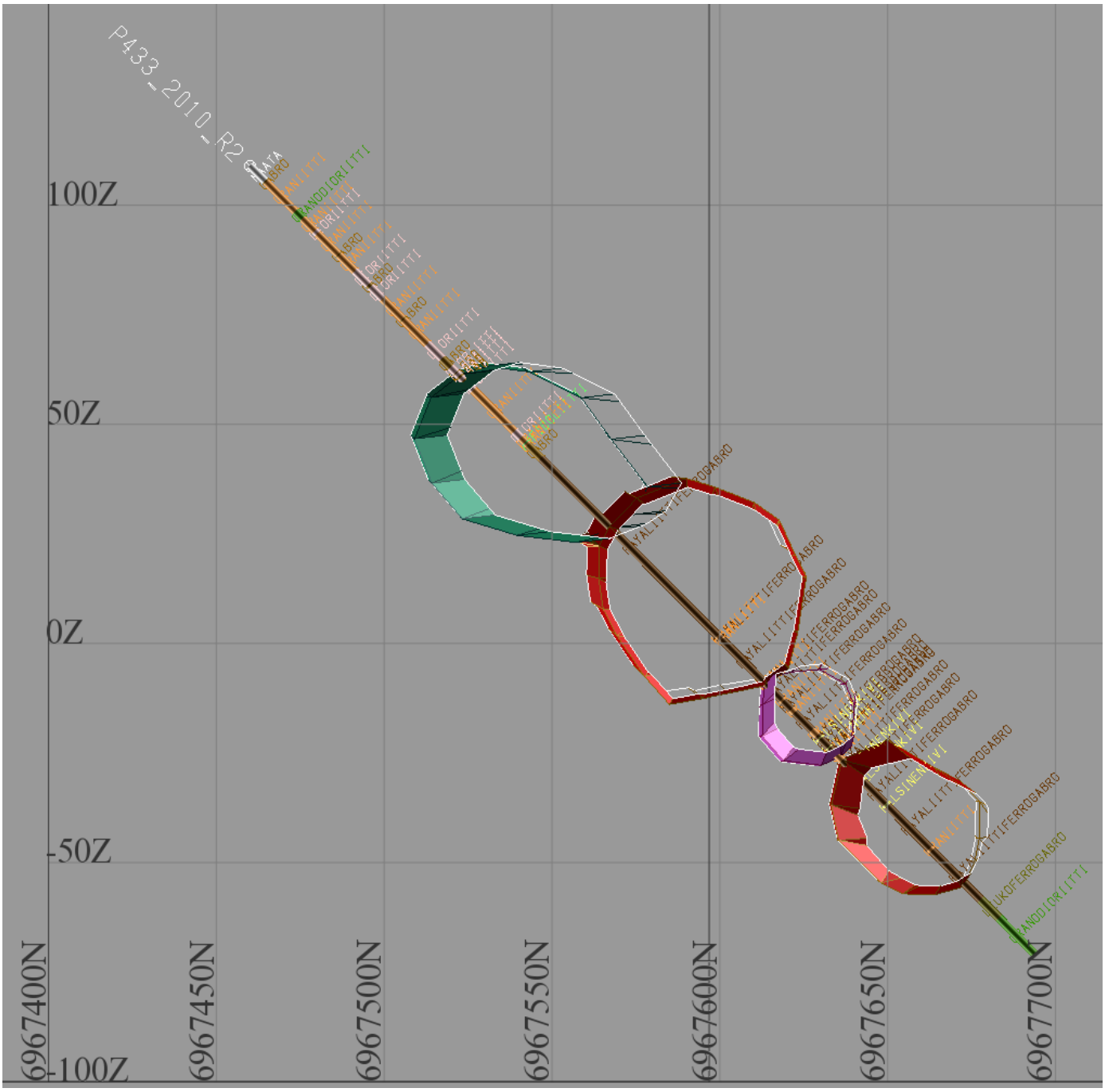

Figure 1.2.2. *Cross-section of individual domain boundaries.*

APPENDIX 1.3. THE SOLID MODEL OF KIVINEMI INTRUSION

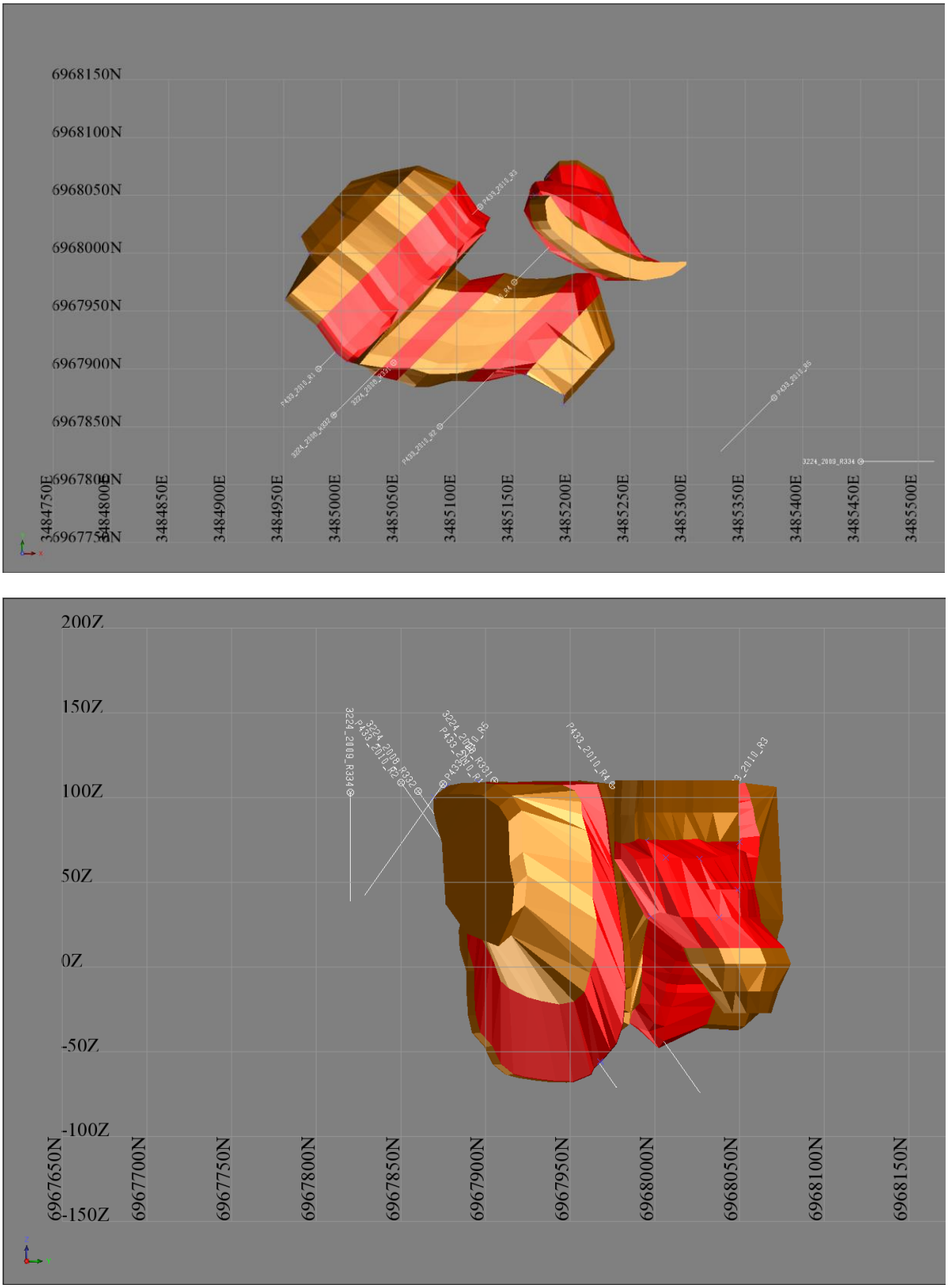

Figure 13.1. *The solid model of the main intrusion and smaller NE block. Red areas are drill hole intersections with higher confidence and brown areas interpretation.*

APPENDIX 1.4. VISUAL VALIDATION OF INDIVIDUAL DOMAINS

	Colour	Attribute values
1	blue	0.00 -> 50.00
2	r=0.00 g=1.00 b=1.00	50.00 -> 100.00
3	r=0.00 g=1.00 b=0.00	100.00 -> 150.00
4	r=1 g=1.00 b=0.00	150.00 -> 200.00
5	red	200.00 -> 250.00
6	r=1.0 g=0.0 b=1.0	250.00 -> 999.00

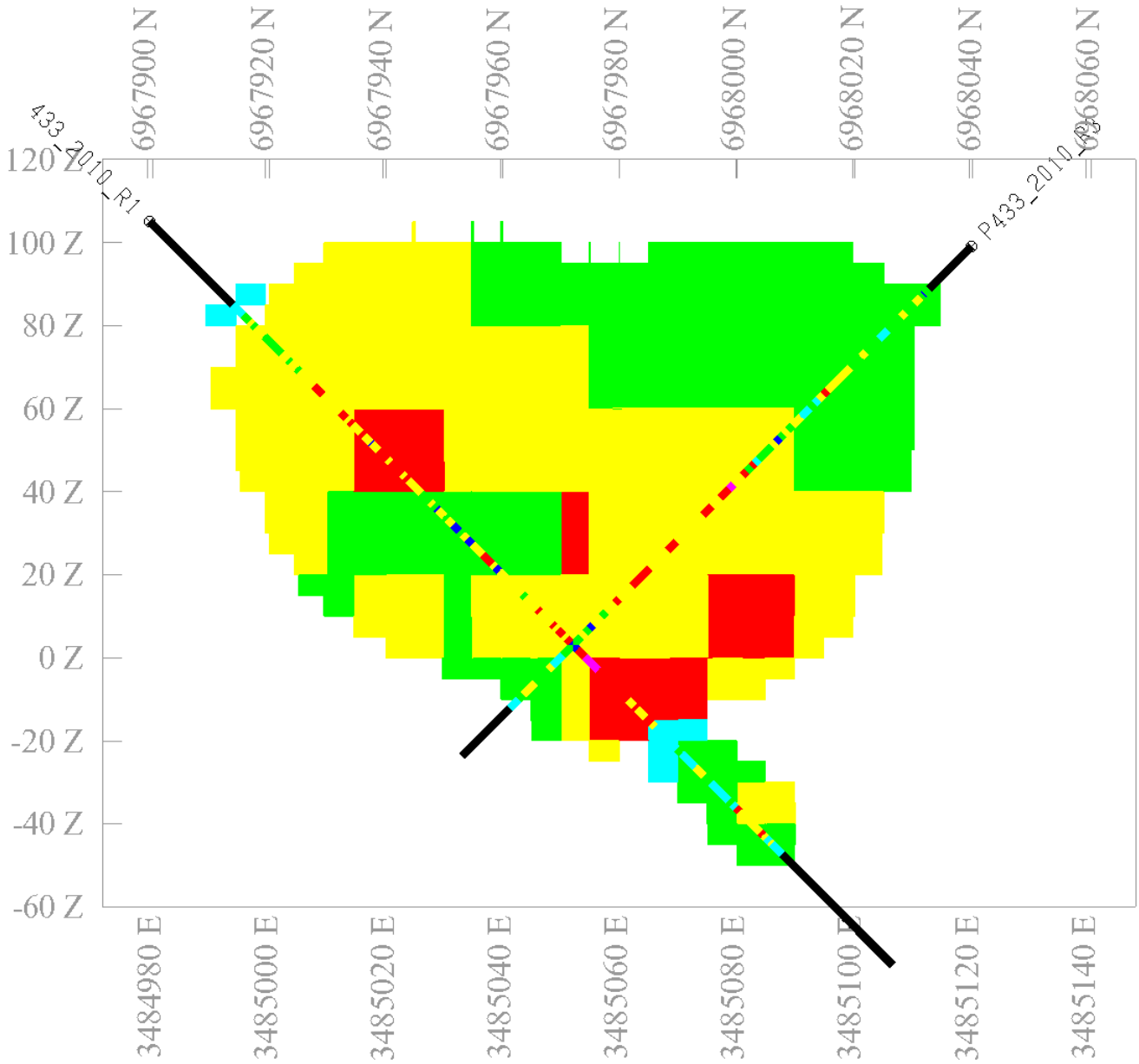

Figure 1.4.1. *Visual validation of individual domains. The colour coding is presented in the table above.*

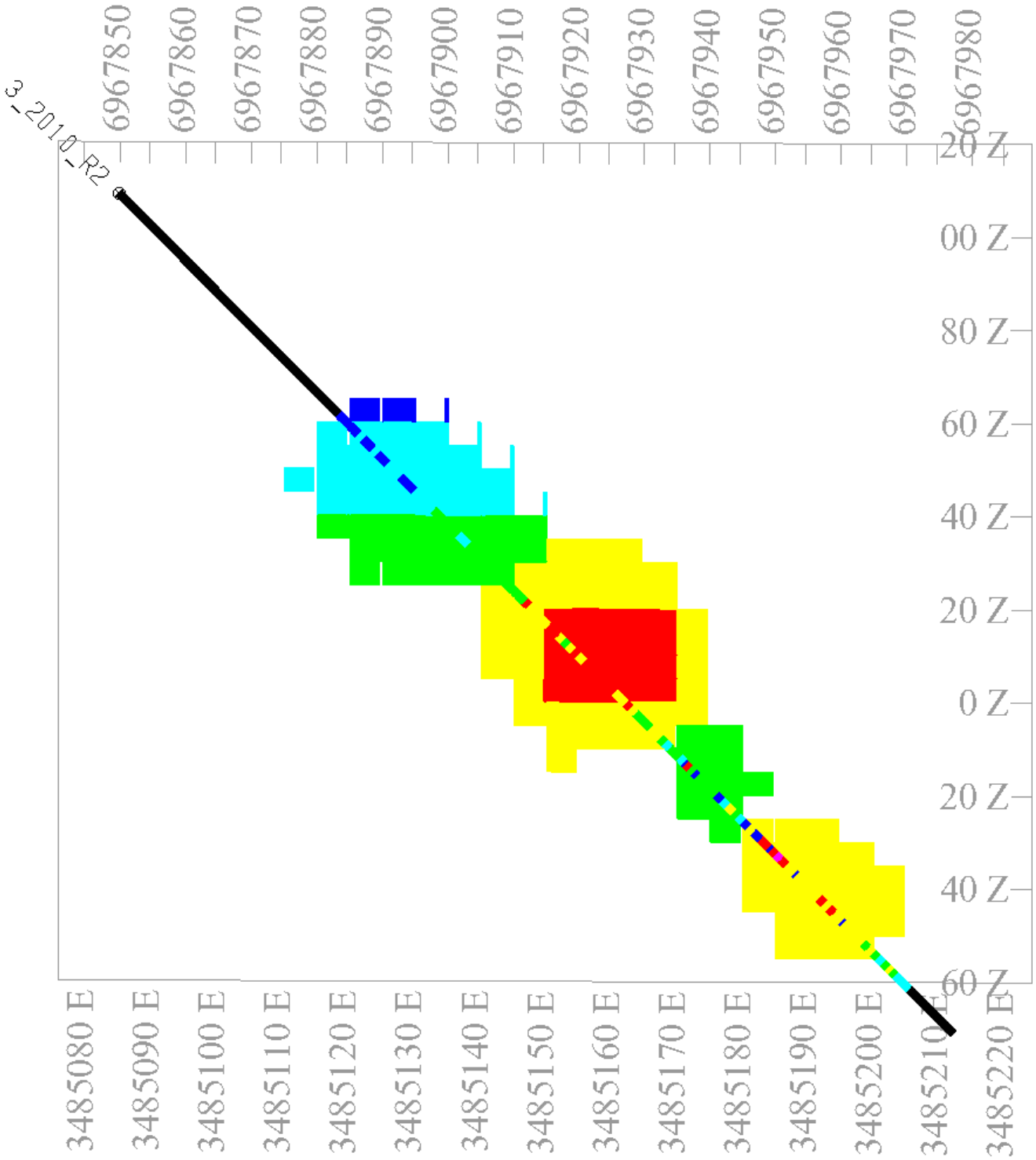

Figure 1.4.2. *Visual validation of individual domains.*

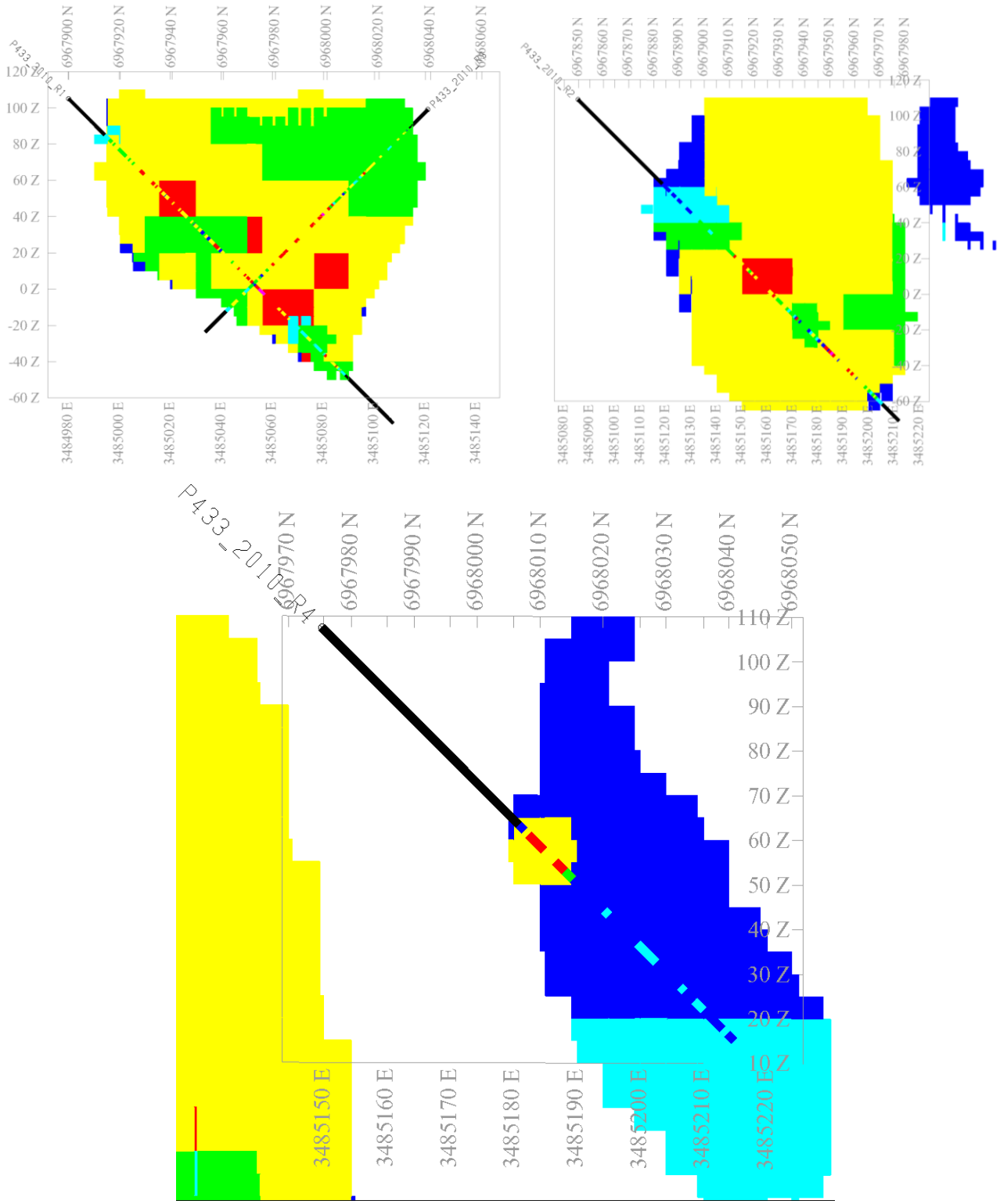

Figure 1.4.3. *Visual validation of global domain.*

APPENDIX 1.5. BLOCKMODEL OF KIVINIEMI INTRUSION WITH DIFFERENT CUT OFF GRADE

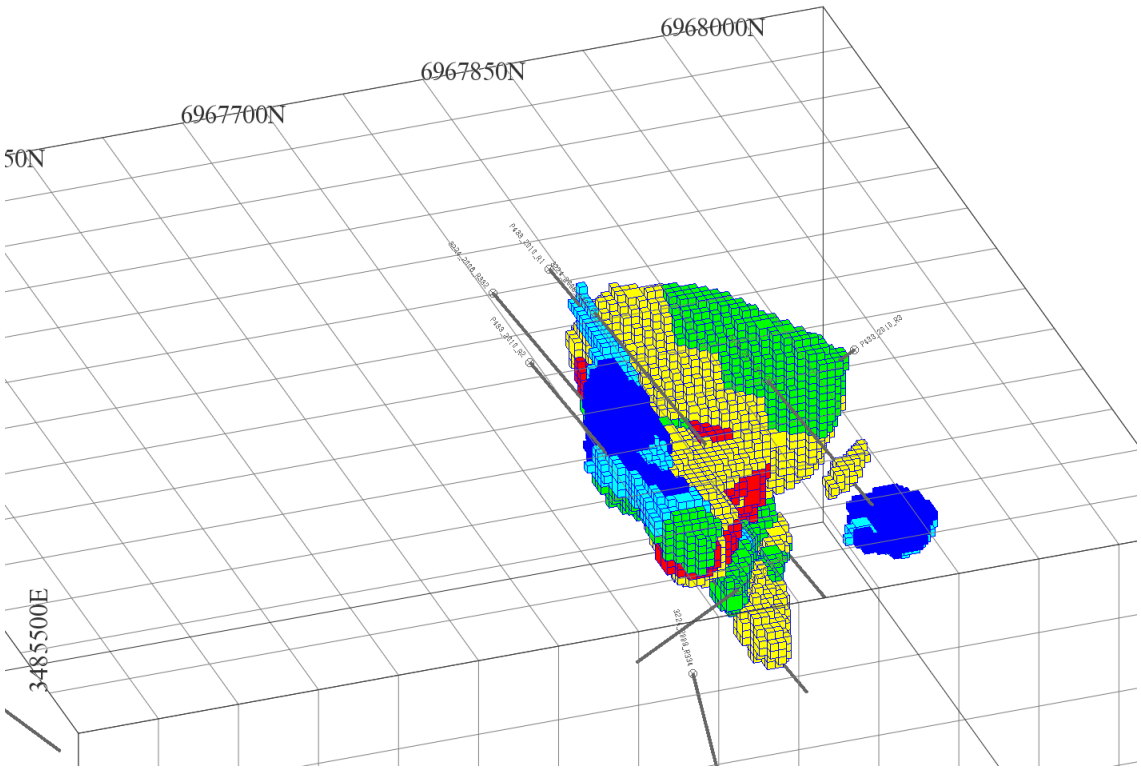

Figure 1.5.1. *Individual domains with 40 ppm Sc cut off.*

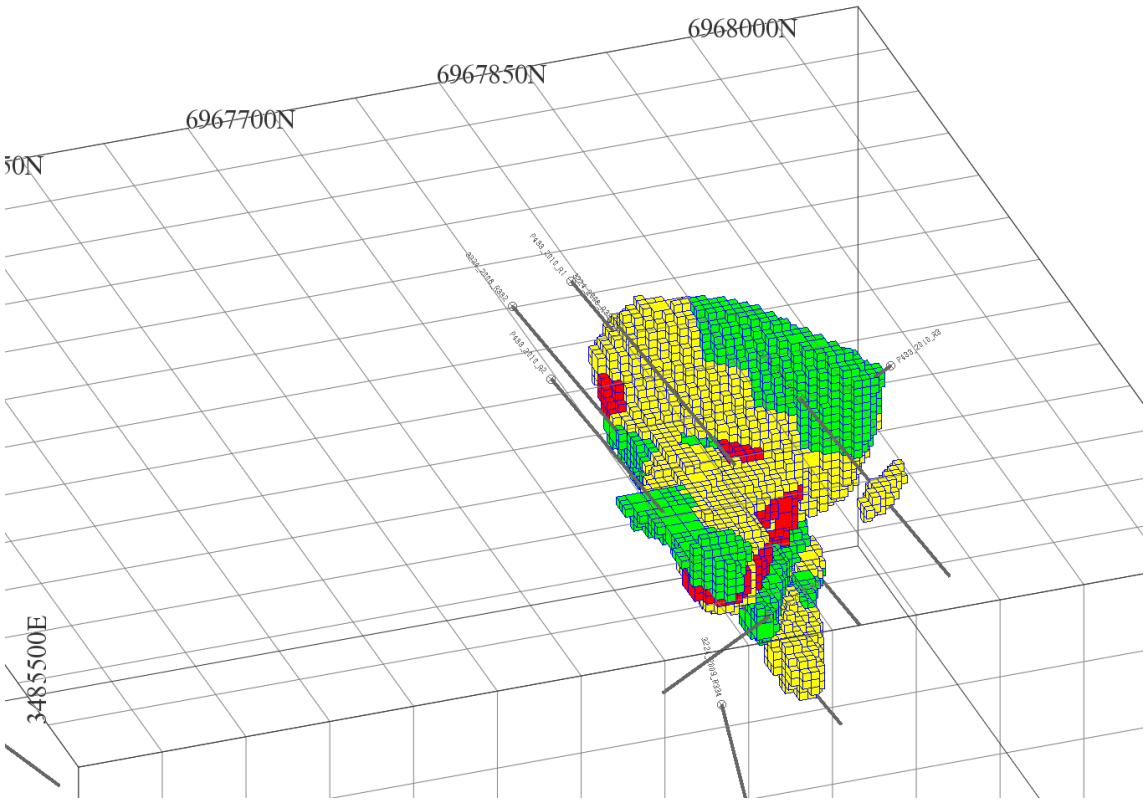

Figure 1.5.2. *Individual domains with 100 ppm Sc cut off.*

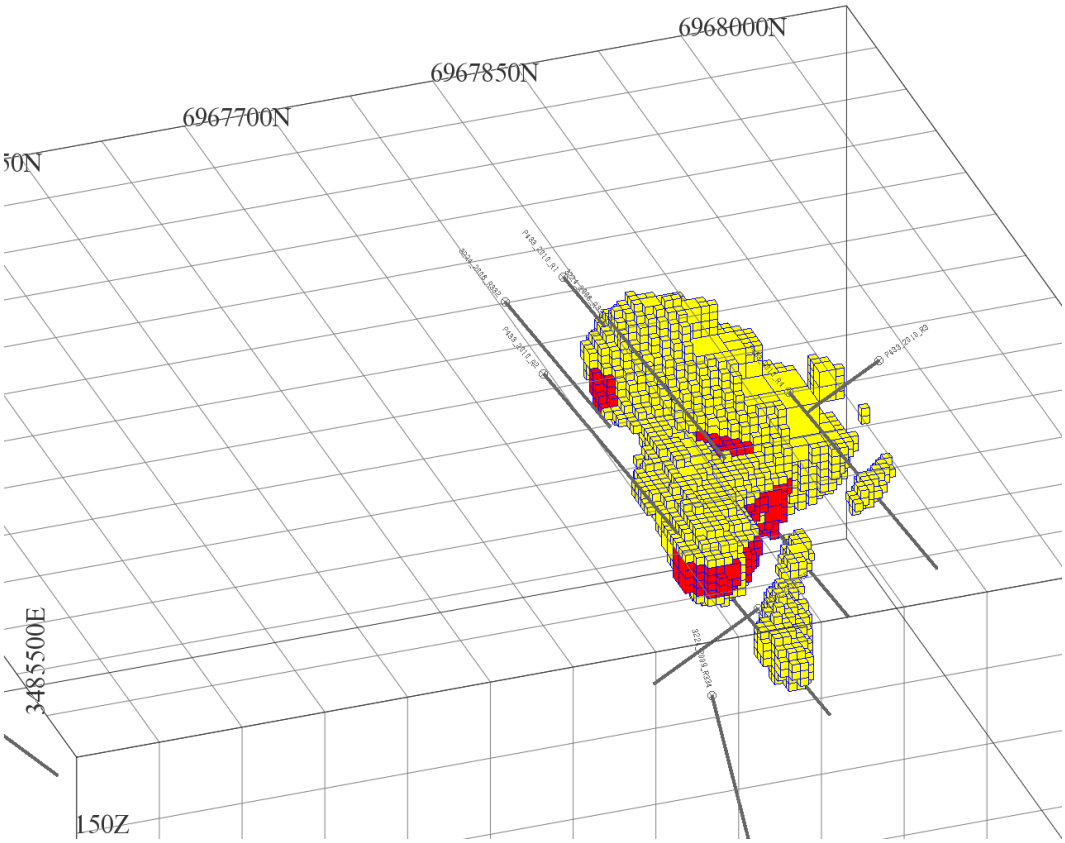

Figure 1.5.3. *Individual domains with 150 ppm Sc cut off.*

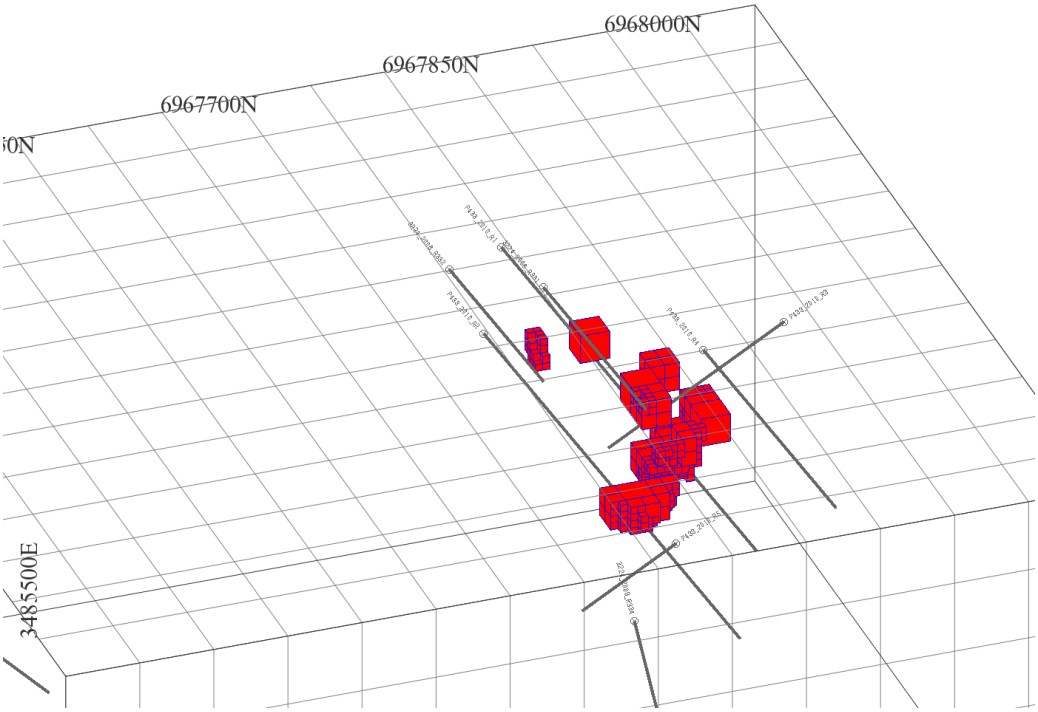

Figure 1.5.4. *Individual domains with 200 ppm Sc cut off.*