

## **Evaluation of the Adit No. 28 Underground Geological Sampling (control re-sampling) on the +2293 m horizon of the Kutessay-II rare-earth deposit**

In order to confirm the results of historic geological sampling and, consequently, validate the historical reserves estimation, a control geological re-sampling of mine workings was recently conducted. The re-sampling was carried out on minerals obtained at the level of +2293 m of the drift No. 28 along the Central and Northern deposits of the Kutessay II rare earth mine. This initial sampling was carried out on January 1, 1992 (S. Isaev, 1992) during a supplementary exploration of deep horizons of Kutessay II.

The results of total rare earth oxides ( $\Sigma TR_2O_3$ ) of the re-sampling of cross-cuts No. 3, 4, 7, 8 of drift No. 28, were included in the historical “*Report on Supplementary Exploration of Deep Levels of the Kutessay II Rare-Earth Deposit with Reserves Estimation as of 1 January 1992*” (S.I. Isaev, T. Beregovaya). The results of the control re-sampling of the same mine workings, was conducted by Stans Energy KG LLC in 2010, and these samplings were used for comparative analysis.

The grades results of total rare earth oxides provided in the reports of 1992 and 2010 are given in Appendix 1.

In 1992, a total of 1844 samples, including 1018 channel and 826 core samples, were taken in the process of making the drift No. 28 at the level of +2293 m. Control geological re-sampling of the drill-hole core cannot be conducted in view of its absence (it was liquidated). Drilling of new underground test pits and duplicating the old ones will require considerable time, organizational and labor costs. Considering the above issues, it was decided to conduct an analysis of reliability of grades of total rare earth oxides (TREO) based only on channel samples.

According to the “*Guidelines for Application of Classification of Reserves and Geological Resources of Solid Minerals. Niobium, Tantalum Ores and Rare Earth Elements,*” Moscow 2007, the volume of control sampling in each grade category must be sufficient for statistical processing of results and well-founded conclusions regarding the absence or presence of inherent mistakes. In the case of a significant number of samples being analyzed, 6% of their total should be sent for control analysis. If the number of samples from each separate grade category is lower, then the quantity of control analyses must correspond to the recommendations of Soviet Union standard 41-08-214-82 (Table 1).

Table 1. Volume of Control Samples Depending on the Number of Samples in a Set

Volume of analyzed set, number of samples	Volume of control samples	
	Number of samples	% of the set
2 to 15	all	100
16 to 25	5	25
26 to 50	8	21
51 to 90	13	18
91 to 150	20	17
151 to 280	32	15
231 to 500	50	14
501 to 1200	80	10
1201 to 3200	125	6

The distribution of total rare earth oxides ( $\Sigma\text{TR}_2\text{O}_3$ ) within the channel samples of the 1992 report by grade category at the level of +2293 m of the drift No. 28 is given in Table 2.

Table 2 Distribution of Total Rare Earth Oxides ( $\Sigma\text{TR}_2\text{O}_3$ ) in Channel Samples

No. of interval	Class of grades, %	Quantity of samples	% of total quantity of samples
1	2.0 and more	3	0.29
2	1.0-1.9	30	2.95
3	0.50-0.99	119	11.69
4	0.20-0.49	416	40.86
5	0.10-0.19	253	24.85
6	<0.10	197	19.35
Total		1018	100

Out of the total number of channel samples (1018):

- 821 samples were selected from the outline of the deposit with the grade of TREO from 0.1% and higher, at the level of the drift No. 28 during the exploration;
- Where upon, 788 samples or 96% of them fall into three grade categories of 0.10-0.99%.

Cross-cuts Nos. 3, 4, 7, 8 of the drift No. 28 that pass through quartz-chlorite metasomatites, make up 50.7% of the historical commercial resource at the drift level. These Cross-cuts were selected for control re-sampling. Considering that there were 170 channel samples taken from earlier cross-cuts Nos. 3, 4, 7, and 8, the number of samples for control re-sampling was made to be 170 as well.

Thus, 16.7% of 1018 channel samples or 9.2% of the total number of earlier samples - which were taken from the exploration level - were subjected to re-sampling; this corresponds to recommendations of the Soviet Union standard 41-08-214-82.

## **Control Sampling Procedure**

In accordance with the “*Guidelines for Application ...*” Moscow, 2007, the control re-sampling in 2010 was conducted in a form of continuous line without gaps, i.e. uninterruptedly, in the same manner as during the prospecting works. The cross-section of the control samples, the length, weight and location of the sampling line itself are all the same as those in the historic sampling.

1. Prior to sampling, the mine working was thoroughly surveyed, cleared from cutter breaks and documented by a qualified geologist using historic documentation of tunneling and sampling of the drift No. 28. At the same time, the geologist marked the geological boundaries of historical mineral types along the sampling line, identified contacts and described the mode of occurrence of rocks, tectonic disturbances and other geological parameters. The layout of the previously conducted sampling was being restored wherever possible.
2. In 2010, Stans selected the control channel samples using the restored layout along the old line of sampling with the same intervals as our predecessors had used. The samples were selected using the continuous horizontal channel method cross-cutting the thickness of two delineated zones – north and central. The channel is 1.5 m long deviating 0.5 m to either side depending on the type of host rock, 0.05 m wide, and 0.03 m deep. The original mass of 1.5 m long channel sample varies from 6.0 to 7.0 kg, depending on the mineral type or grade, as well as on the content of minerals (lead, zinc) within them.
3. The control sampling was conducted under the supervision of an expert geologist to avoid violations of the sampling procedure (such as the unevenness of the channel cross section or the depth of the tear sample, the loss of chipped pieces as a result of their scattering, contamination and sample material dilution, etc.). Each individual sample received a code, in order to avoid the marking of samples by an unauthorized person.

## **Sample Processing and Analysis**

1. Sample processing was conducted according to the following scheme.

Samples were processed using the generally accepted formula  $Q=Kd^2$  with the coefficient “K”=0.4-0.5. Average initial weight of a channel sample (size – 1.5 m x 0.05 m x 0.03 m) is 6.3 kg (6.0-6.7 kg); diameter of pieces is under 50 mm. A sample was crushed in a jaw crusher to make the bits 1 mm small; then the sample was blended the second time and reduced according to the Jones divider to make each portion 400 g. This portion was then blended one more time; a

100 g portion was taken from it for further grinding to 0.074 mm (analytical portion). The remaining part of the sample was used as a duplicate.

After the processing of each sample, the work zone of the crusher was cleaned using compressed air, and the glasses of the grinder were cleaned using inert material (quartz sand).

2. Information Research Centre LLC carried out a laboratory analysis of samples for rare earth elements and yttrium. The main method of the analysis was the X-ray fluorescence method with the use of QUANT'X spectrometer.

3. External monitoring of analyses was conducted in accordance with the All-Union standard 41-08-214-82 at an independent organization that is appropriately certified to conduct such work. The samples for external monitoring were sent to the Central Scientific Research Laboratory (CSRL) of Kara-Balta Ore Mining Complex OJSC and analyzed by the ICP method.

### **Statistical Processing of Results**

Out of 170 samples selected in 2010, 149 samples were quartz-chlorite metasomatite with sulfide mineralization, which constitutes 87.7% of the total number of samples selected; followed by brecciated amphibole schists – 17 samples (~10%); then, pink chloritic granophyres – 3 samples (~1.7%), and diorite-porphyry from dike – 1 sample (~0.6%). Information Research Centre LLC defined grades of Y, La, Ce and Nd in each sample using the X-ray fluorescence method.

The rare earth oxides  $Y_2O_3$ ,  $La_2O_3$ ,  $Ce_2O_3$ ,  $Nd_2O_3$  were defined using a computational method, and their conversion coefficients are shown in Appendix 2.

According to the “*Report on Estimation of Reserves of the Kutessay-II Rare Earth and Polymetallic Deposit as of 1 January (1959)*” by V.N. Doroshenko and A.D. Karchenko, it appears that a certain zoning is observed when it comes to distribution of rare earth elements in the deposit. The yttrium group elements prevail at the upper part of the deposit and cerium group elements prevail in the lower part, i.e. the correlation of rare earth elements in samples is not a stable and constant value.

The “*Report on Additional Exploration of Deep Horizons of the Kutessay-II Rare-Earth Deposit with Reserve Estimation as of 1 January (1992)*” shows that the grade of the sum of lanthanum, cerium, neodymium and yttrium for the deposit as a whole made up 79.3%; and considering the conversion into oxides, it equates to 80.1%.

Therefore, considering the aforementioned, the total sum of all rare earth oxides in the Kutessay II deposit in 2010 was calculated based on the fact that these 4 elements make up 80.1% of the total grade of rare earth elements according to the historic data.

Figure 1 shows the results of distribution of total rare earth oxides of 1992 and 2010.

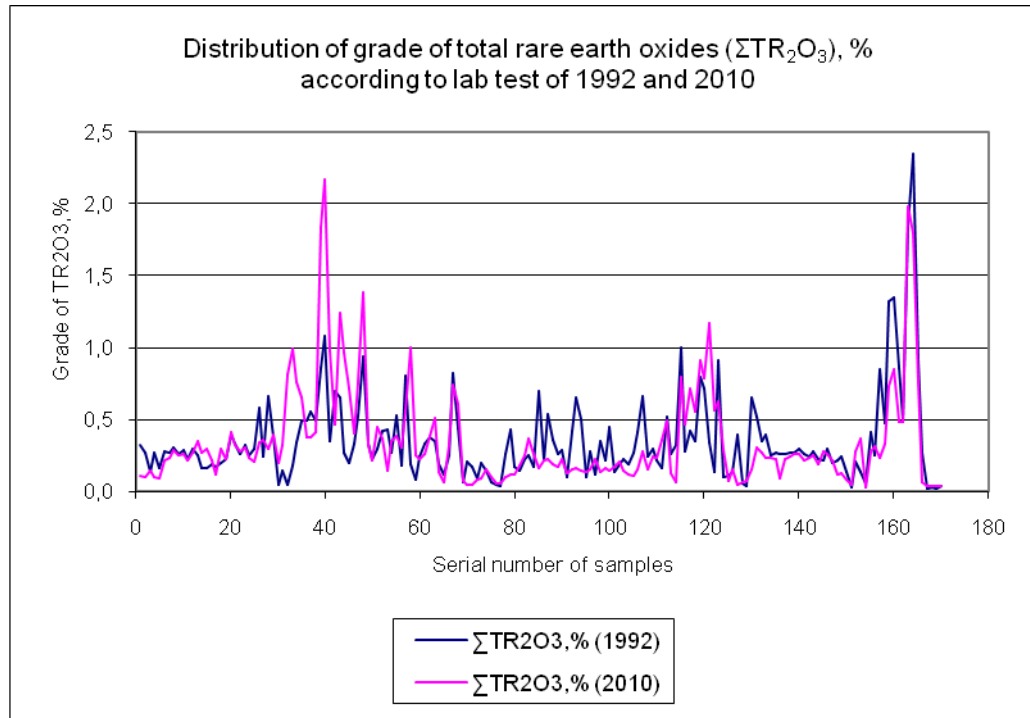


Figure 1

The sample analysis results that were previously carried out show a somewhat averaged (smoothed) graph of distribution, while the 2010 sample analysis results are represented by more sudden drops. The increased grades in samples **A28R0720040**, equal to 2.172% (serial number 40); **A28R0720048**, equal to 1.384% (serial number 48); **A28R0720121**, equal to 1.168% (serial number 121); and the decreased grades in the interval of samples from 70 to 110 are explained by more a sensitive analytic base at the present time.

However, the statistical parameters of sample analyses are similar; their distribution is shown in Table 3.

Table 3. Statistical Parameters of Distribution of Total Rare Earth Oxides ( $\Sigma TR_2O_3$ ) in Channel Samples

Statistical parameters	$\Sigma TR_2O_3$ , %, 1992	$\Sigma TR_2O_3$ , %, 2010
Sum	60.04	68.12
Mean	0.35	0.40
Minimum	0.02	0.04
Maximum	2.4	2.5

Median	0.3	0.3
Standard deviation	0.3	0.4
Sample variance	0.1	0.2

Minimum grades of  $\Sigma\text{TR}_2\text{O}_3$  in the interval of less than 0.1%; maximum grades in the interval of more than 2%; median, standard deviation and sample variance are identical; average grades in the interval of grades of 0.2%-0.49% are represented by a maximum quantity of analyzed samples and are shown in Table 4.

Table 4 Distribution of Total Rare Earth Oxides ( $\Sigma\text{TR}_2\text{O}_3$ ) by Classes

No. of interval	Class of grades, %	Quantity of samples		% of total quantity of samples		Sum		Mean	
		1992 report	2010	1992 report	2010	1992 report	2010	1992 report	2010
1	2.0 and more	1	1	0.59	0.59	2.35	2.17	2.35	2.17
2	1.0-1.9	5	7	2.94	4.12	6.60	10.42	1.32	1.48
3	0.50-0.99	25	22	14.71	12.94	17.43	16.43	0.70	0.74
4	0.20-0.49	93	80	54.71	47.06	28.29	23.84	0.30	0.29
5	0.10-0.19	30	36	17.65	21.18	4.57	5.15	0.15	0.14
6	<0.10	16	24	9.41	14.12	0.80	1.52	0.05	0.06
<b>Total</b>		<b>170</b>	<b>170</b>	<b>100</b>	<b>100</b>	<b>60.04</b>	<b>59.53</b>		
<b>Mean</b>								<b>0.35</b>	<b>0.35</b>

Figure 2 shows the tendency of distribution of the quantity of samples by intervals of grades.

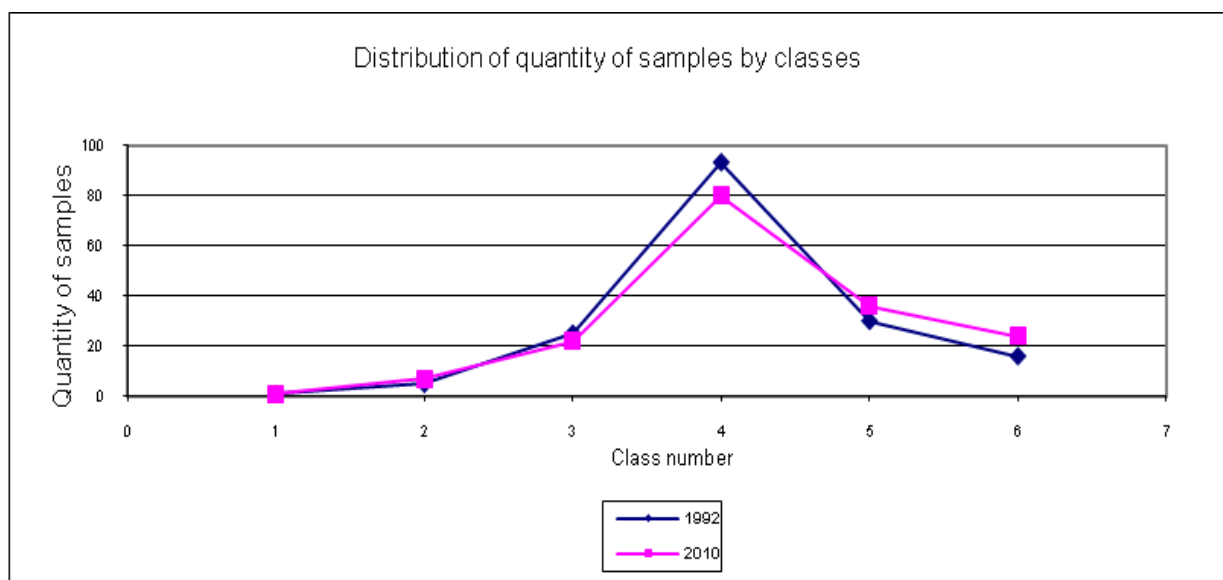


Figure 2

Table 4 also shows that average grades of total rare earth oxides ( $\Sigma\text{TR}_2\text{O}_3$ ) in channel samples of the 1992 report and the 2010 control re-sampling are comparable and have practically the same line of distribution that is depicted in Figure 3.

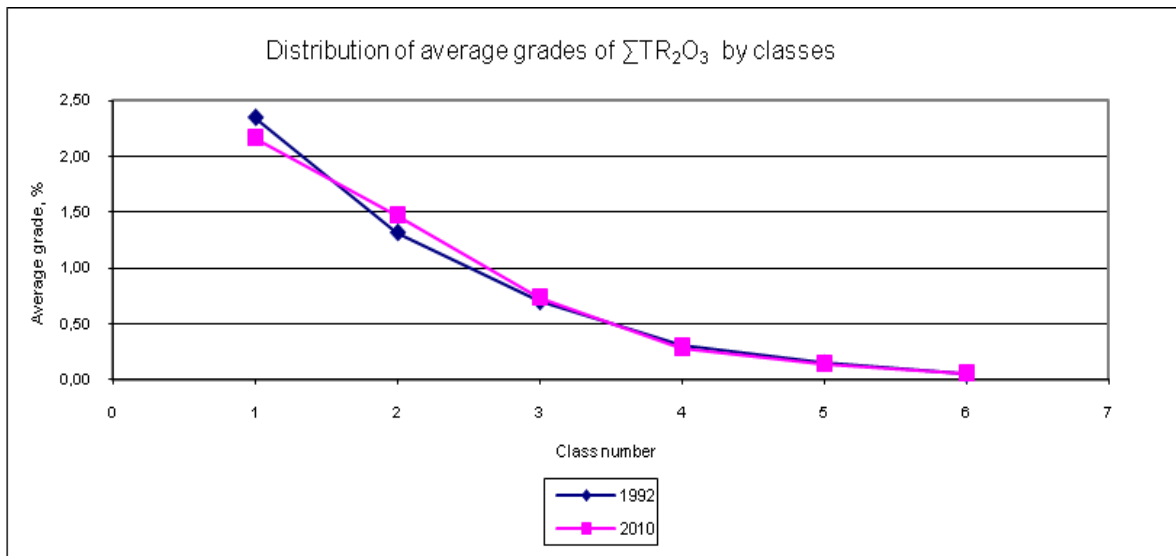


Figure 3

The statistical processing of analysis results was carried out with consideration of the following tasks:

1.1. Comparing the results of control sample analyses conducted in two independent laboratories, in accordance with the Soviet Union standard 41-08-214-82

The samples taken in 2010 from the drift No. 28 on the horizon of +2293 m were analyzed in Information Research Centre LLC and the Central Scientific Research Lab of Karabalta Mining Works (CSRL). The X-ray fluorescence and ICP analysis methods were used accordingly. Detection limits of both methods are high enough; for La, Ce, Nd they are 0.008% and for Y they are 0.001%. The comparative analysis conducted showed good convergence of the results from the two independent laboratories, which confirms the presence of higher grades of rare earth elements in this area.

1.2. Comparing the results of the 2010 control sampling (re-sampling) and the data of the primary sampling using the method of geological control of analytical work

According to the *Manual for Internal, External and Arbitral Geological Quality Control of Analyses of Prospecting Samples of Solid Noncombustible Minerals Carried Out in the Laboratories of the Ministry of Geology of the USSR, Moscow (1982)*, a geological control was conducted on grades of total rare earth oxides ( $\Sigma TR_2O_3$ ):

- Absolute systematic discrepancy is calculated as follows:

$$Da = \frac{\sum_{i=1}^m (Ci0 - Cik)}{m}, \text{ where}$$

$Ci0$  – grade of component in the  $i^{th}$  sample, determined in 1992;

$C_{ik}$  – grade of component in the  $i^{th}$  sample, determined in 2010;

$m$  – quantity of check samples;

$i = 1, 2, \dots, m$

$$Da = -0.003\%$$

- Then, relative systematic discrepancy is calculated:

$$Dr = \frac{Da * 100}{C_{\bar{n}\bar{\theta}0}}, \text{ where}$$

$C_{cp0}$  – average grade;

hence

$$Dr = 0.85\%$$

- Systematic discrepancy significance evaluation is calculated by means of t-criteria (Student distribution)

$$t_{ex} = \frac{IDaI * \sqrt{m}}{Sd}, \text{ where}$$

$Sd$  – sample standard deviation;

$$t_{ex} = 0.15$$

According to the “Manual...the Ministry of Geology of the USSR, Moscow (1982)” Appendix 5, for the significance level, 0.05/95% confidence probability ( $m = 170$ ) is

$$t_{teor} = 1.96,$$

hence

$$t_{ex} < t_{teor};$$

$$0.15 < 1.96$$

Therefore, the *systematic discrepancy is not significant*, and it denotes good reproducibility of analyses.

## Conclusions

The results of the geological sampling (control re-sampling) of Central and Northern deposits at the drift No. 28 on the horizon of +2293 m of the Kutessay II rare earth deposit allow us to make the following basic conclusions:

- In order to evaluate the reliability of the historic geological sampling at the drift No. 28 (orts Nos. 3, 4, 7, 8) on the horizon of +2293 m of the Kutessay II deposit, 170 samples were taken and analyzed in 2010. This represents 9.2% of the total quantity of samples (1844 samples) selected here earlier (the 1992 report).
- Statistical parameters of  $\sum TR_2O_3$  distribution in channel samples from different years have good convergence, as well as the common pattern of distribution by grades. The maximum quantity of samples within the interval of 0.20-0.49% from the 1992 report made up 54.7%, and in 2010 it makes up 45.29% of the total quantity of samples. The minimum quantity of samples in the class of grades more than 2% makes up 0.59% (in one sample); average grades are comparable and equal to 0.35%.
- The comparison of analyses of the same samples conducted at two independent laboratories showed good convergence of the results, which allowed to perform geological control of the analytical work, proving non-significant systematic discrepancy ( $t_{ex}=0.15 < t_{teor}=1.96$ ) and, consequently, good reproducibility of analyses.

The above mentioned confirms good convergence of grades of rare earth elements in control geological samples selected in 2010 on the horizon of the drift No. 28, with the results from analogous samples taken at the same drift, and within the same intervals included in Kutessay II reserve estimation in the *Report on Addition Exploration of Deep Horizons ... as of 1 January (1992)* (S.I. Isaev, T. Beregovaya).

Thus, the control geological re-sampling proved the presence of historical commercial rare earth mineralization in the Kutessay II rare earth deposit in the Kyrgyz Republic.

## Results of grades of total rare earth oxides of 1992 and 2010

Sr. No.	Cross-cut No.	Sample code, 1992	Sample code, 2010	Sampling FRO M, m	Sampling TO m	Sampling interval, m	Rock	Mineral type	$\Sigma$ TR <sub>2</sub> O <sub>3</sub> ,% 1992	$\Sigma$ TR <sub>2</sub> O <sub>3</sub> ,% 2010
1	Ort7	56737	A28R0720001	0.0	1.5	1.5	metasomatite	quartz-chlorite	0.320	0.107
2	Ort7	56738	A28R0720002	1.5	3.0	1.5	metasomatite	quartz-chlorite	0.270	0.102
3	Ort7	56739	A28R0720003	3.0	4.5	1.5	metasomatite	quartz-chlorite	0.140	0.145
4	Ort7	56740	A28R0720004	4.5	6.0	1.5	metasomatite	quartz-chlorite	0.270	0.106
5	Ort7	56741	A28R0720005	6.0	7.5	1.5	metasomatite	quartz-chlorite	0.160	0.090
6	Ort7	56742	A28R0720006	7.5	9.0	1.5	metasomatite	quartz-chlorite	0.280	0.218
7	Ort7	56743	A28R0720007	9.0	10.5	1.5	metasomatite	quartz-chlorite	0.270	0.233
8	Ort7	56744	A28R0720008	10.5	12.0	1.5	metasomatite	quartz-chlorite	0.310	0.288
9	Ort7	56745	A28R0720009	12.0	13.5	1.5	metasomatite	quartz-chlorite	0.260	0.252
10	Ort7	56746	A28R0720010	13.5	15.0	1.5	metasomatite	quartz-chlorite	0.290	0.261
11	Ort7	56747	A28R0720011	15.0	16.5	1.5	metasomatite	quartz-chlorite	0.230	0.219
12	Ort7	56748	A28R0720012	16.5	18.0	1.5	metasomatite	quartz-chlorite	0.300	0.271
13	Ort7	56749	A28R0720013	18.0	19.5	1.5	metasomatite	quartz-chlorite	0.250	0.355
14	Ort7	56750	A28R0720014	19.5	20.5	1.0	metasomatite	quartz-chlorite	0.160	0.269
15	Ort7	56751	A28R0720015	21.2	22.5	1.3	metasomatite	quartz-chlorite	0.160	0.298
16	Ort7	56752	A28R0720016	22.5	24.0	1.5	metasomatite	quartz-chlorite	0.190	0.220
17	Ort7	56753	A28R0720017	24.0	25.5	1.5	metasomatite	quartz-chlorite	0.170	0.122
18	Ort7	56754	A28R0720018	25.5	27.0	1.5	metasomatite	quartz-chlorite	0.200	0.299
19	Ort7	56755	A28R0720019	27.0	28.5	1.5	metasomatite	quartz-chlorite	0.230	0.231
20	Ort7	56756	A28R0720020	28.5	30.0	1.5	metasomatite	quartz-chlorite	0.400	0.414
21	Ort7	56757	A28R0720021	30.0	31.5	1.5	metasomatite	quartz-chlorite	0.330	0.325
22	Ort7	56758	A28R0720022	31.5	33.0	1.5	metasomatite	quartz-chlorite	0.260	0.276
23	Ort7	56759	A28R0720023	33.0	34.5	1.5	metasomatite	quartz-chlorite	0.320	0.307
24	Ort7	56760	A28R0720024	34.5	36.0	1.5	metasomatite	quartz-chlorite	0.250	0.233
25	Ort7	56761	A28R0720025	36.0	37.5	1.5	metasomatite	quartz-chlorite	0.300	0.212
26	Ort7	56762	A28R0720026	37.5	39.5	2.0	granophyre	chloritized	0.580	0.345
27	Ort7	56763	A28R0720027	39.5	41.0	1.5	granophyre	chloritized	0.240	0.357
28	Ort7	56764	A28R0720028	41.0	42.5	1.5	granophyre	chloritized	0.660	0.299
29	Ort7	56765	A28R0720029	42.5	44.5	2.0	metasomatite	quartz-chlorite	0.380	0.392
30	Ort7	56766	A28R0720030	44.5	46.0	1.5	metasomatite	quartz-chlorite	0.050	0.203
31	Ort7	56767	A28R0720031	46.0	47.5	1.5	metasomatite	quartz-chlorite	0.150	0.323
32	Ort7	56768	A28R0720032	47.5	49.0	1.5	metasomatite	quartz-chlorite	0.050	0.819
33	Ort7	56769	A28R0720033	49.0	50.5	1.5	metasomatite	quartz-chlorite	0.180	0.995
34	Ort7	56770	A28R0720034	50.5	52.0	1.5	metasomatite	quartz-chlorite	0.340	0.765
35	Ort7	56771	A28R0720035	52.0	53.5	1.5	metasomatite	quartz-chlorite	0.490	0.657
36	Ort7	56772	A28R0720036	53.5	55.0	1.5	metasomatite	quartz-chlorite	0.490	0.379
37	Ort7	56773	A28R0720037	55.0	56.5	1.5	metasomatite	quartz-chlorite	0.560	0.376
38	Ort7	56774	A28R0720038	56.5	58.0	1.5	metasomatite	quartz-chlorite	0.490	0.417
39	Ort7	56775	A28R0720039	58.0	59.5	1.5	metasomatite	quartz-chlorite	0.860	1.844
40	Ort7	56776	A28R0720040	59.5	61.0	1.5	metasomatite	quartz-chlorite	1.080	2.172
41	Ort7	56901	A28R0720041	61.0	62.5	1.5	metasomatite	quartz-chlorite	0.350	0.974
42	Ort7	56902	A28R0720042	62.5	64.0	1.5	metasomatite	quartz-chlorite	0.700	0.465
43	Ort7	56903	A28R0720043	64.0	65.5	1.5	metasomatite	quartz-chlorite	0.650	1.245
44	Ort7	56904	A28R0720044	65.5	67.0	1.5	metasomatite	quartz-chlorite	0.270	0.969
45	Ort7	56905	A28R0720045	67.0	68.5	1.5	metasomatite	quartz-chlorite	0.200	0.721
46	Ort7	56906	A28R0720046	68.5	70.0	1.5	metasomatite	quartz-chlorite	0.330	0.401
47	Ort7	56907	A28R0720047	70.0	71.5	1.5	metasomatite	quartz-chlorite	0.530	0.765

48	Ort7	56908	A28R0720048	71.5	73.0	1.5	metasomatite	quartz-chlorite	0.940	1.384
49	Ort7	56909	A28R0720049	73.0	74.5	1.5	metasomatite	quartz-chlorite	0.330	0.326
50	Ort7	56910	A28R0720050	74.5	76.0	1.5	metasomatite	quartz-chlorite	0.230	0.216
51	Ort7	56911	A28R0720051	76.0	77.5	1.5	metasomatite	quartz-chlorite	0.300	0.449
52	Ort7	56912	A28R0720052	77.5	79.0	1.5	metasomatite	quartz-chlorite	0.420	0.369
53	Ort7	56913	A28R0720053	79.0	80.5	1.5	metasomatite	quartz-chlorite	0.430	0.145
54	Ort7	56914	A28R0720054	80.5	82.0	1.5	metasomatite	quartz-chlorite	0.270	0.350
55	Ort7	56915	A28R0720055	82.0	83.5	1.5	metasomatite	quartz-chlorite	0.530	0.382
56	Ort7	56916	A28R0720056	83.5	85.0	1.5	metasomatite	quartz-chlorite	0.180	0.305
57	Ort7	56917	A28R0720057	85.0	86.5	1.5	metasomatite	quartz-chlorite	0.810	0.565
58	Ort7	56918	A28R0720058	86.5	88.0	1.5	metasomatite	quartz-chlorite	0.190	1.004
59	Ort7	56919	A28R0720059	88.0	89.5	1.5	metasomatite	quartz-chlorite	0.080	0.253
60	Ort7	56920	A28R0720060	89.5	91.0	1.5	metasomatite	quartz-chlorite	0.240	0.222
61	Ort7	56921	A28R0720061	91.0	92.5	1.5	metasomatite	quartz-chlorite	0.330	0.262
62	Ort7	56922	A28R0720062	92.5	94.0	1.5	metasomatite	quartz-chlorite	0.380	0.383
63	Ort7	56923	A28R0720063	94.0	95.5	1.5	metasomatite	quartz-chlorite	0.350	0.515
64	Ort7	56924	A28R0720064	95.5	97.0	1.5	metasomatite	quartz-chlorite	0.190	0.136
65	Ort7	56925	A28R0720065	97.0	98.5	1.5	metasomatite	quartz-chlorite	0.120	0.065
66	Ort7	56926	A28R0720066	98.5	100.0	1.5	metasomatite	quartz-chlorite	0.250	0.322
67	Ort7	56927	A28R0720067	100.0	101.5	1.5	metasomatite	quartz-chlorite	0.820	0.746
68	Ort7	56928	A28R0720068	101.5	103.0	1.5	metasomatite	quartz-chlorite	0.440	0.613
69	Ort7	56929	A28R0720069	104.7	106.0	1.3	schist	amphibole	0.070	0.072
70	Ort7	56930	A28R0720070	106.0	107.5	1.5	schist	amphibole	0.210	0.048
71	Ort7	56931	A28R0720071	107.5	109.0	1.5	schist	amphibole	0.170	0.051
72	Ort7	56932	A28R0720072	109.0	110.5	1.5	schist	amphibole	0.090	0.083
73	Ort7	56933	A28R0720073	110.5	112.0	1.5	schist	amphibole	0.200	0.093
74	Ort7	56934	A28R0720074	112.0	113.5	1.5	schist	amphibole	0.150	0.154
75	Ort7	56935	A28R0720075	113.5	115.2	1.7	schist	amphibole	0.070	0.097
76	Ort7	56936	A28R0720076	115.2	117.0	1.8	schist	quartz-chlorite	0.050	0.060
77	Ort7	56937	A28R0720077	117.0	118.8	1.8	schist	quartz-chlorite	0.040	0.057
78	Ort8	56563	A28R0820078	0.0	1.5	1.5	metasomatite	quartz-chlorite	0.260	0.104
79	Ort8	56564	A28R0820079	1.5	3.0	1.5	metasomatite	quartz-chlorite	0.430	0.118
80	Ort8	56565	A28R0820080	3.0	4.5	1.5	metasomatite	quartz-chlorite	0.170	0.120
81	Ort8	56566	A28R0820081	4.5	5.5	1.0	metasomatite	quartz-chlorite	0.150	0.185
82	Ort8	56567	A28R0820082	5.5	6.5	1.0	metasomatite	quartz-chlorite	0.230	0.257
83	Ort8	56568	A28R0820083	6.5	8.0	1.5	metasomatite	quartz-chlorite	0.250	0.368
84	Ort8	56569	A28R0820084	8.0	9.5	1.5	metasomatite	quartz-chlorite	0.170	0.262
85	Ort8	56570	A28R0820085	9.5	11.0	1.5	metasomatite	quartz-chlorite	0.700	0.161
86	Ort8	56571	A28R0820086	11.0	12.5	1.5	metasomatite	quartz-chlorite	0.220	0.216
87	Ort8	56572	A28R0820087	12.5	14.0	1.5	metasomatite	quartz-chlorite	0.540	0.223
88	Ort8	56574	A28R0820088	14.0	15.5	1.5	metasomatite	quartz-chlorite	0.360	0.190
89	Ort8	56575	A28R0820089	15.5	17.0	1.5	metasomatite	quartz-chlorite	0.260	0.174
90	Ort8	56576	A28R0820090	17.0	18.5	1.5	metasomatite	quartz-chlorite	0.290	0.224
91	Ort8	56577	A28R0820091	18.5	20.0	1.5	metasomatite	quartz-chlorite	0.100	0.129
92	Ort8	56578	A28R0820092	20.0	21.0	1.0	metasomatite	quartz-chlorite	0.420	0.159
93	Ort8	56579	A28R0820093	21.0	22.0	1.0	metasomatite	quartz-chlorite	0.650	0.162
94	Ort8	56580	A28R0820094	22.0	23.5	1.5	metasomatite	quartz-chlorite	0.500	0.146
95	Ort8	56581	A28R0820095	23.5	25.0	1.5	metasomatite	quartz-chlorite	0.100	0.135
96	Ort8	56582	A28R0820096	25.0	26.0	1.0	metasomatite	quartz-chlorite	0.280	0.158
97	Ort8	56583	A28R0820097	26.0	27.0	1.0	metasomatite	quartz-chlorite	0.120	0.226
98	Ort8	56584	A28R0820098	27.0	28.5	1.5	metasomatite	quartz-chlorite	0.350	0.135
99	Ort8	56585	A28R0820099	28.5	30.4	1.9	metasomatite	quartz-chlorite	0.220	0.165
100	Ort8	56586	A28R0820100	30.4	31.5	1.1	metasomatite	quartz-chlorite	0.450	0.149
101	Ort8	56587	A28R0820101	31.5	33.0	1.5	metasomatite	quartz-chlorite	0.140	0.169
102	Ort8	56588	A28R0820102	33.0	34.5	1.5	metasomatite	quartz-chlorite	0.190	0.205
103	Ort8	56710	A28R0820103	34.5	36.0	1.5	metasomatite	quartz-chlorite	0.230	0.147
104	Ort8	56711	A28R0820104	36.0	37.5	1.5	metasomatite	quartz-chlorite	0.190	0.122

105	Ort8	56712	A28R0820105	37.5	39.0	1.5	metasomatite	quartz-chlorite	0.270	0.111
106	Ort8	56713	A28R0820106	39.0	40.5	1.5	metasomatite	quartz-chlorite	0.410	0.159
107	Ort8	56714	A28R0820107	40.5	42.0	1.5	metasomatite	quartz-chlorite	0.660	0.282
108	Ort8	56715	A28R0820108	42.0	43.5	1.5	metasomatite	quartz-chlorite	0.240	0.157
109	Ort8	56716	A28R0820109	43.5	45.0	1.5	metasomatite	quartz-chlorite	0.300	0.243
110	Ort8	56717	A28R0820110	45.0	46.5	1.5	metasomatite	quartz-chlorite	0.220	0.235
111	Ort8	56718	A28R0820111	46.5	48.0	1.5	metasomatite	quartz-chlorite	0.160	0.356
112	Ort8	56719	A28R0820112	48.0	49.5	1.5	metasomatite	quartz-chlorite	0.520	0.493
113	Ort8	56720	A28R0820113	49.5	51.0	1.5	metasomatite	quartz-chlorite	0.260	0.128
114	Ort8	56721	A28R0820114	51.0	52.5	1.5	diorite-porphry		0.320	0.068
115	Ort8	56722	A28R0820115	52.5	54.0	1.5	metasomatite	quartz-chlorite	1.000	0.798
116	Ort8	56723	A28R0820116	54.0	55.5	1.5	metasomatite	quartz-chlorite	0.280	0.466
117	Ort8	56724	A28R0820117	55.5	57.0	1.5	metasomatite	quartz-chlorite	0.420	0.715
118	Ort8	56725	A28R0820118	57.0	58.5	1.5	metasomatite	quartz-chlorite	0.350	0.557
119	Ort8	56726	A28R0820119	58.5	60.0	1.5	metasomatite	quartz-chlorite	0.800	0.913
120	Ort8	56727	A28R0820120	60.0	61.5	1.5	metasomatite	quartz-chlorite	0.720	0.790
121	Ort8	56728	A28R0820121	61.5	63.0	1.5	metasomatite	quartz-chlorite	0.340	1.168
122	Ort8	56729	A28R0820122	63.0	64.5	1.5	metasomatite	quartz-chlorite	0.140	0.568
123	Ort8	56730	A28R0820123	64.5	66.0	1.5	metasomatite	quartz-chlorite	0.910	0.632
124	Ort8	56731	A28R0820124	66.0	67.5	1.5	metasomatite	quartz-chlorite	0.100	0.292
125	Ort8	56732	A28R0820125	67.5	68.5	1.0	metasomatite	quartz-chlorite	0.110	0.076
126	Ort8	56733	A28R0820126	68.5	69.9	1.4	metasomatite	quartz-chlorite	0.140	0.152
127	Ort8	56734	A28R0820127	69.9	71.5	1.6	schist	amphibole	0.400	0.046
128	Ort8	56735	A28R0820128	71.5	73.0	1.5	schist	amphibole	0.060	0.063
129	Ort8	56736	A28R0820129	73.0	74.5	1.5	schist	amphibole	0.040	0.075
130	Ort8	56573	A28R0820130	13.4	14.5	1.1	schist	amphibole	0.650	0.152
131	Ort4	56501	A28R0420131	0.0	1.5	1.5	metasomatite	quartz-chlorite	0.520	0.309
132	Ort4	56502	A28R0420132	1.5	3.0	1.5	metasomatite	quartz-chlorite	0.350	0.273
133	Ort4	56503	A28R0420133	3.0	4.5	1.5	metasomatite	quartz-chlorite	0.400	0.231
134	Ort4	56504	A28R0420134	4.5	6.0	1.5	metasomatite	quartz-chlorite	0.250	0.233
135	Ort4	56505	A28R0420135	6.0	7.5	1.5	metasomatite	quartz-chlorite	0.270	0.228
136	Ort4	56506	A28R0420136	7.5	9.0	1.5	metasomatite	quartz-chlorite	0.260	0.094
137	Ort4	56507	A28R0420137	9.0	10.5	1.5	metasomatite	quartz-chlorite	0.260	0.224
138	Ort4	56508	A28R0420138	10.5	12.0	1.5	metasomatite	quartz-chlorite	0.270	0.243
139	Ort4	56509	A28R0420139	12.0	13.5	1.5	metasomatite	quartz-chlorite	0.270	0.264
140	Ort4	56510	A28R0420140	13.5	15.0	1.5	metasomatite	quartz-chlorite	0.300	0.261
141	Ort4	56511	A28R0420141	15.0	16.5	1.5	metasomatite	quartz-chlorite	0.260	0.221
142	Ort4	56512	A28R0420142	16.5	18.0	1.5	metasomatite	quartz-chlorite	0.240	0.235
143	Ort4	56513	A28R0420143	18.0	19.5	1.5	metasomatite	quartz-chlorite	0.280	0.249
144	Ort4	56514	A28R0420144	19.5	20.8	1.3	metasomatite	quartz-chlorite	0.230	0.192
145	Ort4	56515	A28R0420145	20.8	22.0	1.2	metasomatite	quartz-chlorite	0.220	0.280
146	Ort4	56516	A28R0420146	22.0	23.0	1.0	metasomatite	quartz-chlorite	0.300	0.263
147	Ort4	56517	A28R0420147	23.0	24.8	1.8	metasomatite	quartz-chlorite	0.200	0.217
148	Ort4	56518	A28R0420148	48.5	50.0	1.5	metasomatite	quartz-chlorite	0.220	0.124
149	Ort4	56519	A28R0420149	50.0	51.4	1.4	metasomatite	quartz-chlorite	0.240	0.125
150	Ort4	56520	A28R0420150	53.0	54.6	1.6	metasomatite	quartz-chlorite	0.140	0.084
151	Ort4	56521	A28R0420151	59.5	61.0	1.5	metasomatite	quartz-chlorite	0.030	0.046
152	Ort4	56522	A28R0420152	61.0	62.5	1.5	metasomatite	quartz-chlorite	0.210	0.282
153	Ort4	56523	A28R0420153	62.5	64.0	1.5	metasomatite	quartz-chlorite	0.140	0.368
154	Ort4	56524	A28R0420154	64.0	65.0	1.0	metasomatite	quartz-chlorite	0.060	0.033
155	Ort3	56454	A28R0320155	0.0	1.5	1.5	metasomatite	quartz-chlorite	0.410	0.280
156	Ort3	56455	A28R0320156	1.5	3.0	1.5	metasomatite	quartz-chlorite	0.250	0.317
157	Ort3	56456	A28R0320157	3.0	4.5	1.5	metasomatite	quartz-chlorite	0.850	0.232
158	Ort3	56457	A28R0320158	4.5	6.0	1.5	metasomatite	quartz-chlorite	0.480	0.331
159	Ort3	56458	A28R0320159	6.0	7.5	1.5	metasomatite	quartz-chlorite	1.320	0.735
160	Ort3	56459	A28R0320160	7.5	9.0	1.5	metasomatite	quartz-chlorite	1.350	0.854
161	Ort3	56460	A28R0320161	9.0	10.5	1.5	metasomatite	quartz-chlorite	0.860	0.483

162	Ort3	56461	A28R0320162	10.5	12.0	1.5	metasomatite	quartz-chlorite	0.490	0.486
163	Ort3	56462	A28R0320163	12.0	13.5	1.5	metasomatite	quartz-chlorite	1.850	1.979
164	Ort3	56463	A28R0320164	13.5	15.0	1.5	metasomatite	quartz-chlorite	2.350	1.796
165	Ort3	56464	A28R0320165	15.0	16.5	1.5	metasomatite	quartz-chlorite	0.910	0.760
166	Ort3	56465	A28R0320166	16.5	17.6	1.1	metasomatite	quartz-chlorite	0.270	0.070
167	Ort3	56466	A28R0320167	21.4	22.4	1.0	schist	amphibole	0.020	0.043
168	Ort3	56467	A28R0320168	28.5	29.5	1.0	schist	amphibole	0.030	0.038
169	Ort3	56468	A28R0320169	29.5	30.5	1.0	schist	amphibole	0.020	0.041
170	Ort3	56469	A28R0320170	30.5	31.3	0.8	schist	amphibole	0.040	0.041

**Conversion factors from elements to oxides****Yttrium**

Atomic weight - 88.9

Y<sub>2</sub>O<sub>3</sub> molecular weight - 225.8

1 molecule of Y<sub>2</sub>O<sub>3</sub> contains 177.8 g Y (88.9•2) and 48 g O.

Conversion factor from element to oxide is:

$$K = \frac{225.8}{177.8} = 1.269966 = 1.270$$

**Lanthanum**

Atomic weight - 139.9

La<sub>2</sub>O<sub>3</sub> molecular weight - 327.8

1 molecule of La<sub>2</sub>O<sub>3</sub> contains 279.8 g La (139.9•2) and 48 g O.

Conversion factor from element to oxide is:

$$K = \frac{327.8}{279.8} = 1.17155 = 1.172$$

**Cerium**

Atomic weight - 140.1

Ce<sub>2</sub>O<sub>3</sub> molecular weight - 328.2

1 molecule of Ce<sub>2</sub>O<sub>3</sub> contains 280.2 g Ce (140.1•2) and 48 g O.

Conversion factor from element to oxide is:

$$K = \frac{328.2}{280.2} = 1.1713 = 1.171$$

**Neodymium**

Atomic weight - 144.2

Nd<sub>2</sub>O<sub>3</sub> molecular weight - 336.4

1 molecule of Nd<sub>2</sub>O<sub>3</sub> contains 288.4 g Nd (144.2•2) and 48 g O.

Conversion factor from element to oxide is:

$$K = \frac{336.4}{288.4} = 1.1664 = 1.166$$