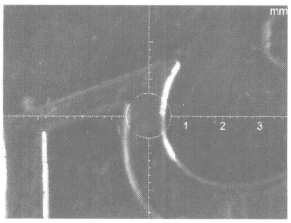
X-Ray fluorescence analysis of a series of German East Africa 20-Heller coins

A collection of well preserved 20-Heller coins could be analized August 2015 at the Dutch branch office of Helmut Fischer Gmbh in Eindhoven.
For this purpose a non-standard program was installed on the testing apparatus, which is standardly programmed for analyzing precious metals.
Both the H = Heller side and the D = DOA side of the coins were tested. Some less well preserved coins from an other collection (pages J & V0) as well as some reference items were mostly tested one side only.
Reference for shorthand symbols for chemical elements https://en.wikipedia.org/wiki/List_of_elements

HELMUT FISCHER GmbH
Industriestrasse 21
71069 Sindelfingen

Fischerscope® XRAY XAN 220
Product: 12 / Munten Afrika **Dir.:** Fischer **Block:** 1
Application: 20 / CuZnSnNiFePbAgAsCoSbBiCd



Calibration: Standard free

n	Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	94.05	4.903	0.986	0.056	0.032	0.013	0.000	0.002	-	-	0.020	-
2	93.95	4.973	0.984	0.058	0.029	0.015	-	0.000	-	-	0.014	-

Measuring time 30 sec
Operator: JN 50 eurocent
Date: 11-8-2015 Time: 10:21:45

Test results for 50 eurocents 2014

As no calibration of this program was possible, other coins and some copper pieces were analyzed to see if anything strange happened. The uncirculated Dutch 50 eurocents piece first analyzed, given composition 89% copper, 5% zinc, 1% tin, 5% aluminium, showed that zinc and tin were adequately rendered and that the aluminium did not influence results for other elements.
Equally Dutch 5 cents pieces 1955 and 1980, composition 95 +/- 2%, tin 4 +/- 1%, rest zinc did well.

Two pieces of copper were analyzed:
1

Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
99.95	0.018	-	-	0.009	0.014	0.005	-	-	-	0.020	0.005

Copper Cu-DHP (Cu-DHP) 22 mm tube (kme.com/en/sanco), electrical conductivity measured 47,9-48,2 MS/m, prescribed composition more than 99,9% copper, 0,015-0.04% phosphor
2.

Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
99.97	0.024	-	-	-	0.011	0.008	0.003	-	-	0.018	0.001

Copper calibration element for an electrical conductivity measuring instrument, inscribed 58,36 MS/m.
As it is very improbable there is any zinc in these pieces, around 0,02% zinc may be regarded as a misinterpretation. Nearly all results in the series show around 0,02% bismuth, which will also be a misreading.

Results for a piece of 2,5 mm2 electrical wire were not printed, but a handwritten note states Cu 99.98%, Pb 0.019, Bi 0,017. Zinc seems to be missing here.

A series of copper coins testing around 0.28% tin also showed some amounts of zinc. Some of these analysis could be compared with earlier analysis from a well respected institution.

Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
99.39	0.182	0.319	0.008	0.077	0.018	0.002	-	-	-	0.018	0.004
99.40	0.212	0.319	0.007	0.038	0.023	0.006	-	-	-	0.014	0.004
97.47	<0.0073	0.3092	0.0112	0.1325	<0.0017	<0.0010	0.0015	0.0318	0.0015	<0.0020	<0.0010
97.95	<0.0074	0.3511	<0.0074	0.0451	<0.0017	0,0053	0.0012	0.0337	0.0026	<0.0019	<0.0010

Other results of this last analysis were Mg 0.0751-0.034, Al 0.2753-0.2035, Si 0.5116-0,2235, P >0.1111->0.1001, S 0.0207-0.0146, Ti 0.0258-0.0249, V 0.0101-0.0075 etc.
Three other tests of low-tin-bearing coins, by the same the institution, showed simular results, confirming that the reading of tin content, by the program used in Eindhoven, was correct, but that the results for zinc must have been triggered by something else. As all low-tin-bearing copper coins rendered a simular amount of zinc, this something else must be a component of the alloy of all these coins.
Elements like Al, Si, P & S are major elements of the dirt in our environment and may be regarded as external pollution of the coins. The machine in Eindhoven was not equiped to measure these elements.

Two other items were analized to get an impression of the quality of the material available on the market around 1916.

Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
68.90	30.73	0.039	0.015	0.061	0.280	0.009	-	-	-	0.021	0.005
69.39	30.24	0.035	0.013	0.060	0.247	0.018	-	0.000	-	0.028	0.018

German Southeast Africa, native pass Swakopmund, produced 1907.

Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
0.030	99.71	-	0.002	0.051	0.199	0.005	0.009	-	-	0.015	0.013
0.022	99.71	-	-	0.033	0.227	-	0.016	-	-	0.024	0.011

Germany, emergency coinage, Iserlohn 10 pfennig 1917.

As an extra a German East Africa 15 Rupien 1916 could be analyzed using a standard program for gold.

Au [%]	Ag [%]	Pt [%]	Pd [%]	Cu [%]	Zn [%]	Sn [%]	Pb [%]	Fe [%]	Cr [%]	Ni [%]	Mo [%]	Co [%]	Rh [%]	In [%]	W [%]	Mn [%]	Cd [%]	Bi [%]	Ir [%]
75.14	11.19	0.033	0.004	13.71	0.002	-	0.004	-	-	0.004	-	-	-	-	0.011	0.011	-	0.012	-
75.37	11.09	-	0.004	13.49	-	-	0.013	0.011	-	-	-	0.003	0.003	0.002	0.070	-	-	0.042	-

The results show that refining in the Sekenke mine itself had resulted in a very fine mixture of gold and silver and that a very pure copper must have been used in Tabora to obtain an alloy with 75% gold. Wikipedia mentions an average ratio of 6 to 1 for gold and silver in the ore of the Sekenke mine.

Also electrical conductivity of both sides of the coins could be measured. These data are, for the main collection, presented on the last pages, together with weight and density of the coins.

Many thanks go to Johan Nieuwlands and Bas van Heijst of Helmut Fischer Netherlands for giving the opportunity to use their equipment. http://www.helmut-fischer.nl/nl/nl/home

J724a HA4b-DA10a XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HA4b-DA10a	99.39	0.182	0.319	0.008	0.077	0.018	0.002	-	-	-	0.018	0.004
2		99.40	0.212	0.319	0.007	0.038	0.023	0.006	-	-	-	0.014	0.004
3	HA4b-DA10a	99.84	0.067	-	0.006	0.058	0.019	0.008	0.004	-	-	0.016	0.008
4		99.90	0.043	-	0.004	0.051	0.013	0.003	0.009	-	-	0.020	-
5	HA4b-DA10a	99.44	0.019	0.011	0.035	0.015	0.101	0.013	0.343	-	0.003	0.027	0.000
6		99.53	0.025	0.017	0.027	0.017	0.067	0.017	0.291	-	-	0.015	-
7	HA4b-DA10a	99.71	0.018	-	0.023	0.007	0.047	0.005	0.190	-	0.007	0.030	-
8		99.67	0.021	-	0.024	0.008	0.027	0.022	0.224	-	0.008	0.025	-
9	HA4b-DA10a	99.56	0.032	-	0.033	0.077	0.062	0.019	0.232	-	-	0.020	0.003
10		99.57	0.090	-	0.026	0.081	0.051	0.002	0.183	-	-	0.018	-
11	HA4b-DA10a	99.72	0.032	-	-	0.179	0.022	0.045	0.009	-	-	0.017	0.014
12		99.76	0.092	-	0.009	0.112	0.013	0.040	0.013	-	-	0.013	-
13	HA4b-DA10a	99.44	0.157	-	0.003	0.005	0.030	0.056	0.320	-	-	0.018	0.003
14		99.46	0.077	-	0.001	0.029	0.016	0.077	0.340	-	-	0.013	0.005
15	HA4b-DA10a	99.25	0.016	-	0.015	0.007	0.052	0.034	0.615	-	-	0.049	-
16		99.41	0.024	-	0.023	0.016	0.054	0.024	0.442	-	-	0.039	-
17	HA4b-DA10a	99.57	0.337	-	0.020	0.020	0.069	0.006	-	-	-	0.016	0.004
18		99.37	0.144	0.001	0.007	0.119	0.316	0.007	0.026	-	-	0.017	-
19	HA4b-DA10a	99.50	0.020	-	0.031	0.011	0.055	0.024	0.327	-	0.011	0.037	0.006
20		99.37	0.012	-	0.028	0.005	0.104	0.025	0.408	0.000	0.008	0.048	0.002
21	HA4b-DA10a	99.16	0.019	-	0.043	0.013	0.155	0.028	0.477	-	0.007	0.099	0.011
22		99.04	0.018	-	0.040	0.017	0.212	0.023	0.544	-	0.004	0.107	0.008

J724b LL - HA(C)1-DA XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HA(C)1a-DA1a	68.77	30.79	0.024	0.091	0.048	0.216	0.029	-	-	0.014	0.022	0.007
2		69.69	29.90	0.027	0.089	0.040	0.202	0.024	-	-	0.010	0.026	-
3	HA(C)1a-DA1a	69.91	29.55	0.024	0.092	0.112	0.247	0.031	0.012	-	0.005	0.024	-
4		73.53	26.01	0.005	0.104	0.112	0.187	0.022	-	-	0.008	0.024	-
5	HA(C)1a-DA1a	70.15	29.36	0.016	0.095	0.059	0.252	0.020	0.004	-	0.016	0.034	0.007
6		70.14	29.31	0.027	0.097	0.054	0.299	0.018	0.019	-	0.006	0.030	0.014
7	HA(C)1b-DA3b	68.83	30.73	0.047	0.088	0.055	0.245	0.014	-	-	0.000	0.012	0.005
8		68.28	31.23	0.037	0.091	0.060	0.253	0.017	-	-	0.013	0.023	0.007
9	HA(C)1d-DA2a	67.21	32.03	0.028	0.083	0.082	0.459	0.021	0.025	-	0.031	0.031	0.004
10		68.71	30.78	0.029	0.095	0.052	0.252	0.029	0.003	-	0.007	0.030	0.009
11	HA(C)1c-DA6a	74.57	25.34	-	-	0.052	0.038	-	0.013	-	-	0.019	0.008
12		75.25	24.66	-	0.009	0.048	0.021	0.014	0.009	-	0.001	0.016	-
13	HA(C)1c-DA6a	70.77	28.67	0.003	0.093	0.138	0.267	0.021	0.009	-	0.008	0.023	-
14		70.90	28.71	0.010	0.081	0.075	0.177	0.015	-	-	0.004	0.021	0.018
15	HA(C)1c-DA6a	75.46	24.37	-	0.090	0.040	0.024	0.018	0.005	-	-	0.018	0.013
16		75.84	23.99	-	0.084	0.030	0.023	0.020	0.008	-	-	0.026	0.001

J724b - HA2-4-DA XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HA3n-DA8c	66.02	33.63	0.008	0.033	0.144	0.083	0.017	0.023	-	-	0.029	0.017
2		65.47	34.26	0.009	0.036	0.101	0.088	0.014	0.011	-	-	0.023	0.016
3	HA3c-DA6b	66.40	33.11	-	0.089	0.147	0.243	0.014	-	-	-	0.018	0.022
4		65.81	33.75	-	0.090	0.079	0.260	0.007	0.006	-	0.008	0.020	0.002
5	HA3i-DA9f	74.45	25.36	-	0.029	0.125	0.029	-	0.005	-	-	0.021	0.005
6		75.67	24.18	-	0.028	0.101	0.014	-	0.009	0.000	-	0.024	0.001
7	HA4a-DA8a (H)	75.67	24.13	-	0.027	0.106	0.037	0.013	0.008	-	-	0.017	0.011
8	(D)	72.31	27.46	-	0.025	0.123	0.061	0.005	0.011	-	-	0.029	0.017
9	(H)	69.17	30.70	-	0.014	0.040	0.048	0.005	0.007	-	-	0.022	0.021
10	(D)	72.61	27.23	-	0.019	0.070	0.050	0.014	0.007	-	-	0.019	0.017
11	HA4a-DA8a	74.00	25.97	-	0.005	0.012	0.024	0.001	0.004	-	-	0.016	0.005
12		74.39	25.59	-	-	0.019	0.010	0.002	0.004	-	-	0.019	0.003
13	HA2b-DA2a	69.25	30.37	0.014	0.093	0.068	0.172	0.026	-	-	-	0.021	0.016
14		69.58	30.06	-	0.096	0.074	0.163	0.023	-	-	0.001	0.019	-
15	HA3a-DA4c	70.84	28.49	0.019	0.103	0.102	0.399	0.017	-	-	0.014	0.021	0.000
16		69.55	29.73	0.034	0.102	0.213	0.302	0.023	0.012	-	0.013	0.022	0.007
17	HA2b-DA2a	68.81	30.61	0.030	0.091	0.177	0.207	0.031	0.012	-	0.002	0.028	0.008
18		67.96	31.43	0.028	0.101	0.122	0.294	0.023	-	-	0.028	0.023	-
19	HA3e-DA7a	69.42	30.21	0.014	0.080	0.056	0.158	0.014	0.002	-	0.010	0.028	0.006
20		68.20	31.31	0.028	0.085	0.063	0.238	0.031	0.006	-	0.015	0.021	0.011
21	HA3m-DA6e	76.33	23.47	-	0.079	0.013	0.117	0.001	-	0.001	-	0.019	0.011
22		75.13	24.65	-	0.089	0.023	0.137	0.006	-	-	-	0.016	0.009
23	HA4c-DA11a	69.43	30.24	-	0.030	0.050	0.247	0.011	-	-	-	0.015	0.032
24		68.97	30.78	-	0.020	0.054	0.161	0.012	0.002	-	-	0.017	0.025
25	HA4c-DA11a	68.73	31.03	-	0.023	0.019	0.155	0.011	-	0.001	-	0.022	0.033
26		69.71	29.99	-	0.018	0.029	0.234	0.004	-	-	-	0.024	0.030
27	HA2a-DA1b	68.24	31.11	0.032	0.078	0.094	0.377	0.018	-	0.001	0.017	0.029	0.013
28		67.99	31.36	0.037	0.087	0.069	0.386	0.020	0.014	0.001	0.012	0.017	0.004

J725a - HB5z-DA9c

XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HB5z-DA9c	99.37	0.202	0.282	0.013	0.081	0.030	0.008	0.012	-	-	0.012	0.002
2		99.33	0.244	0.283	0.004	0.085	0.040	0.019	0.005	-	-	0.009	0.002
3	HB5z-DA9c	99.46	0.142	0.284	0.018	0.075	0.025	0.001	0.003	-	-	0.013	-
4		99.40	0.152	0.300	0.014	0.083	0.024	0.008	0.011	-	-	0.025	-
6	HB5z-DA9c	99.47	0.138	0.294	0.006	0.058	0.018	0.008	0.008	-	-	0.014	-
7		99.50	0.169	0.280	0.004	0.037	0.009	-	0.012	-	-	0.004	0.007

J725(b) - HB-DA

XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HB5z-DA9c	84.64	14.98	-	0.012	0.015	0.330	0.019	-	0.000	-	0.026	0.005
2		89.00	10.56	-	0.009	0.016	0.352	0.029	0.010	0.000	-	0.022	0.007

J725b - HB-DA

XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HB5z-DA9c	67.43	31.77	-	0.045	0.115	0.591	0.027	-	0.001	-	0.031	0.008
2		66.59	32.74	-	0.040	0.127	0.471	0.016	0.021	-	-	0.034	0.021
3	HB5z-DA9c	68.93	30.80	-	0.029	0.046	0.161	0.004	-	-	-	0.018	0.036
4		68.59	31.10	-	0.030	0.029	0.210	0.015	-	-	-	0.024	0.037
5	HB5y-DA8b H red	69.99	29.73	-	0.020	0.068	0.073	0.016	0.102	-	-	0.021	0.018
6	H-side yellow	63.36	36.10	-	0.025	0.079	0.284	0.009	0.130	-	-	0.025	0.017
7	D-side red(?)	62.67	36.83	-	0.020	0.072	0.224	0.018	0.155	-	0.005	0.023	0.018
8	(?)D-side yellow	73.58	26.17	-	0.019	0.042	0.094	0.024	0.074	-	-	0.016	0.012
9	HB3c-DA3a	70.04	29.45	0.028	0.096	0.074	0.257	0.017	-	-	0.005	0.019	0.013
10		68.99	30.52	0.029	0.094	0.064	0.240	0.024	0.008	0.004	0.001	0.026	0.004
11	HB3c-DA3a	68.81	30.60	0.030	0.098	0.143	0.285	0.025	0.005	-	-	0.013	-
12		69.06	30.40	0.005	0.086	0.070	0.300	0.017	0.025	0.001	0.007	0.029	0.008
13	HB3d-DA6a	64.83	34.74	-	0.083	0.070	0.222	0.006	0.007	-	-	0.032	0.032
14		63.66	35.89	-	0.083	0.112	0.233	0.016	0.015	-	-	0.018	0.010
15	HB5y-DA8b	68.17	31.52	-	0.032	0.025	0.208	0.016	-	-	-	0.028	0.036
16		70.60	29.13	-	0.030	0.034	0.204	0.006	-	-	-	0.026	0.035
17	HB5y-DA8b	68.88	30.89	-	0.035	0.039	0.158	0.010	-	-	-	0.016	0.026
18		68.16	31.59	-	0.045	0.037	0.164	0.008	-	-	-	0.022	0.019
19	HB4c-DA11c	71.17	28.58	-	0.026	0.046	0.108	0.011	-	0.006	-	0.022	0.042
20		68.31	31.30	-	0.027	0.053	0.244	0.010	-	0.007	0.006	0.028	0.042
21	HB3c-DA3a	68.60	30.92	0.015	0.090	0.082	0.237	0.023	0.007	-	-	0.036	-
22		69.51	29.98	0.032	0.087	0.091	0.225	0.043	-	-	0.005	0.023	0.004
23	HB3d-DA6a	64.62	34.98	-	0.085	0.063	0.227	0.007	0.012	-	-	0.024	0.012
24		64.24	35.27	-	0.088	0.091	0.249	0.009	0.030	-	-	0.024	0.023

J726a - HA4d-DB3b XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HA4d-DB3b	99.39	0.155	0.286	0.004	0.115	0.023	0.004	0.003	-	-	0.028	-
2		99.41	0.133	0.279	0.000	0.122	0.013	0.016	0.007	-	-	0.024	0.009
3	HA4d-DB3b	99.07	0.222	0.289	0.006	0.370	0.027	0.010	0.013	-	-	0.017	0.001
4		99.05	0.219	0.286	0.000	0.263	0.176	0.000	0.031	-	-	0.019	0.009
5	HA4d-DB3b	99.43	0.162	0.300	0.001	0.068	0.021	0.001	0.009	-	0.001	0.022	-
6		99.45	0.158	0.276	0.004	0.073	0.029	0.004	0.016	-	-	0.016	0.002
7	HA4d-DB3b	99.42	0.143	0.273	0.001	0.123	0.031	0.011	-	-	-	0.019	0.002
8		99.45	0.155	0.289	-	0.072	0.018	0.002	0.004	-	-	0.022	0.001
9	HA4d-DB3b	99.24	0.013	-	0.046	0.009	0.124	0.018	0.465	-	0.015	0.085	0.011
10		99.16	0.023	-	0.034	0.003	0.166	0.025	0.501	-	0.019	0.096	-

J726a2 - HA4d-DB3b XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HA4d-DB3b	99.43	0.159	0.308	0.019	0.056	0.015	0.008	0.008	-	-	0.019	-
2		99.45	0.154	0.287	0.013	0.055	0.017	0.008	0.004	-	0.001	0.013	0.002
3	HA4d-DB3b	99.45	0.152	0.219	0.008	0.129	0.031	0.004	-	-	-	0.015	-
4		99.45	0.129	0.272	0.002	0.103	0.025	0.005	0.003	-	-	0.015	0.009

J726b LL - HA(C)1-2d-DB XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HA2d-DB3w	69.24	30.23	0.016	0.096	0.070	0.303	0.016	0.000	-	0.000	0.029	0.004
2		69.62	29.87	0.017	0.095	0.089	0.254	0.028	0.006	-	0.005	0.027	0.003
3	HA(C)1c-DB3v	77.15	22.84	-	0.005	0.013	0.014	0.005	0.001	-	-	0.015	0.004
4		76.66	23.31	-	0.008	0.014	0.010	0.013	0.002	-	-	0.016	0.007
5	HA(C)1c-DB3v	74.46	25.41	-	0.077	0.020	0.036	0.011	0.013	-	-	0.022	0.003
6		73.56	26.30	-	0.078	0.037	0.021	0.006	0.006	-	-	0.028	0.002
7	HA(C)1c-DB3v	84.19	15.78	-	0.003	0.016	0.011	0.006	0.013	-	-	0.015	0.003
8		75.85	24.11	-	0.000	0.015	0.010	0.012	0.007	-	-	0.027	-
9	HA(C)1c-DB3v	70.14	29.38	0.024	0.100	0.056	0.224	0.026	0.007	-	0.012	0.019	0.017
10		70.65	28.92	0.030	0.109	0.056	0.179	0.023	0.013	-	0.019	0.023	-
11	HA(C)1c-DB3v	67.94	31.62	0.022	0.075	0.080	0.223	0.010	-	-	0.006	0.020	0.003
12		72.12	27.36	0.021	0.073	0.058	0.286	0.028	0.005	-	0.026	0.024	0.010

J726b - HA2-4-DB XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HA4d-DB3b	67.91	31.65	-	0.030	0.086	0.252	0.036	-	0.001	-	0.024	0.028
2		67.85	31.71	-	0.033	0.055	0.310	0.023	-	0.002	-	0.031	0.027
3	HA4d-DB3b	66.95	32.61	0.002	0.030	0.153	0.193	0.018	0.011	-	-	0.022	0.029
4		68.49	31.21	-	0.032	0.060	0.179	0.003	-	-	-	0.021	0.026
5	HA3w-DB3v	75.63	24.26	-	0.059	0.026	0.019	0.015	0.016	-	-	0.021	0.013
6		75.74	24.08	-	0.063	0.065	0.035	0.016	0.010	-	-	0.017	0.003
7	HA4d-DB3b	67.66	32.04	0.003	0.022	0.053	0.176	0.007	-	-	0.003	0.020	0.022
8		64.69	34.91	-	0.029	0.044	0.279	0.015	-	-	0.006	0.022	0.024
9	HA3w-DB3v	74.73	25.22	-	0.003	0.033	0.021	0.008	-	-	-	0.021	-
10		74.93	25.01	-	0.007	0.031	0.014	0.013	0.004	0.000	-	0.017	0.007
13	red spot (D)	95.62	4.344	-	0.006	0.014	0.014	0.010	0.002	-	-	0.014	0.003
11	HA4d-DB3b	68.44	31.21	-	0.023	0.025	0.258	0.035	-	-	0.004	0.019	0.021
12		67.91	31.67	0.002	0.026	0.033	0.321	0.019	-	-	-	0.031	0.027

J 727a HB-DB

XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HB5a-DB3d	99.96	0.034	-	0.004	0.025	0.007	0.003	0.010	-	-	0.022	-
2		99.92	0.028	-	0.009	0.040	0.011	0.014	0.004	-	-	0.017	-
3	HB5a-DB3c	99.78	0.028	-	0.013	0.105	0.049	0.010	0.016	-	-	0.020	0.001
4		99.84	0.024	-	0.020	0.095	0.020	0.007	0.009	-	-	0.010	0.005
5	HB5f-DB3h	99.83	0.150	-	0.001	-	0.020	0.005	0.004	-	-	0.022	0.003
6		99.79	0.158	-	0.008	0.024	0.020	0.002	0.005	-	-	0.023	0.002
7	HB5d-DB3g	99.59	0.018	-	0.183	0.016	0.177	0.031	0.012	-	-	0.027	-
8		99.61	0.033	-	0.192	0.034	0.108	0.029	0.002	-	-	0.025	0.012
9	HB5k-DB3k	99.31	0.393	0.227	0.004	0.039	0.015	0.003	0.006	-	-	0.016	-
10		99.29	0.331	0.283	0.009	0.046	0.027	0.006	-	-	-	0.017	0.017
11	HB5n-DB3n	99.62	0.017	-	0.000	0.038	0.016	0.037	0.274	-	-	0.013	0.004
12		99.70	0.033	-	0.007	0.045	0.010	0.026	0.196	-	-	0.015	-
13	HB5e-DB3g	99.05	0.200	-	0.066	0.119	0.116	0.082	0.350	-	-	0.080	-
14		99.64	0.053	-	0.007	0.030	0.067	0.020	0.169	-	0.003	0.019	-
15	HB5d-DB3g	99.64	0.018	-	0.192	-	0.133	0.031	0.017	-	-	0.016	-
16		99.66	0.010	-	0.155	0.010	0.107	0.026	0.026	-	0.003	0.021	-

J 727b - HB-DB

XRF H-side - D-side

nr		Cu[%]	Zn[%]	Sn[%]	Ni[%]	Fe[%]	Pb[%]	Ag[%]	As[%]	Co[%]	Sb[%]	Bi[%]	Cd[%]
1	HB1z-DB1z	76.71	22.44	0.036	0.097	0.270	0.362	0.045	0.007	-	0.007	0.022	0.003
2		76.24	22.69	0.041	0.094	0.320	0.547	0.036	-	-	0.027	0.018	0.003
3	HB5l-DB5l	99.25	0.030	-	0.071	0.060	0.025	0.016	0.534	-	0.033	0.016	-
4	J727a	98.50	0.108	-	0.063	0.095	0.035	0.019	1.124	-	0.036	0.022	0.007
5	HB4c-DB3b	66.76	32.97	0.004	0.022	0.026	0.159	0.010	-	-	0.001	0.024	0.036
6		67.13	32.63	0.003	0.031	0.036	0.134	0.016	-	0.003	-	0.019	0.033
7	Hb2j-DB2p	70.34	29.02	0.034	0.105	0.072	0.351	0.027	0.000	-	0.025	0.024	0.008
8		69.38	29.95	0.020	0.103	0.056	0.409	0.026	0.006	0.003	0.015	0.020	0.008
9	HB2d-DB2f	77.54	21.68	0.076	0.102	0.033	0.470	0.029	0.014	-	0.023	0.024	0.002
10		79.16	20.05	0.049	0.098	0.042	0.497	0.016	0.047	-	0.022	0.026	-
11	HB2g-DB2i	70.77	28.54	0.024	0.105	0.088	0.382	0.020	0.012	0.003	0.016	0.029	0.006
12		69.04	30.42	0.036	0.085	0.101	0.219	0.038	0.021	-	0.019	0.035	0.007
13	HB2i?-DB2o	69.93	29.42	0.008	0.104	0.080	0.382	0.026	0.013	-	0.023	0.026	-
14		68.82	30.57	0.032	0.094	0.128	0.304	0.025	0.001	-	0.002	0.021	0.007
15	HB2b-DB2d	70.57	28.80	0.023	0.095	0.220	0.231	0.021	-	-	0.021	0.017	0.008
16		70.97	28.58	0.024	0.095	0.052	0.250	0.013	-	-	0.006	0.033	0.005
17	HB2j-DB2p	71.38	28.20	0.005	0.101	0.082	0.168	0.021	0.005	-	0.009	0.023	0.012
18		70.85	28.57	0.044	0.099	0.095	0.289	0.021	-	0.001	-	0.030	0.006
19	HB2b-DB2d	70.93	28.41	0.038	0.102	0.067	0.349	0.033	0.013	-	0.020	0.024	0.008
20		72.14	27.22	0.029	0.092	0.050	0.371	0.042	0.008	0.002	0.022	0.025	0.003
21	HB2d-DB2f	69.89	29.60	0.059	0.098	0.042	0.225	0.019	0.004	-	0.020	0.023	0.018
22		72.03	27.49	0.037	0.105	0.074	0.189	0.022	0.008	0.004	0.003	0.028	0.009

Data from external sources | Copper coins | Brass coins

Number	Die combination	Weight	Density	Conductivity	Copper %	Zinc %	Tin %	Lead %	Other %	
724a										
E 724a 1-2					97,47	0.007	0,309		Total 97,786	
	A4b-A10a	12,09	8,943	42,2-45,4	99,4-99,4	0,18-0,21	0,32-0,32	0,02-0,02	As 0-0, Fe 0,08-0,04	
E 724a 3-4					89,54	0,007	0,001		Total 89,548	
	A4b-A10a	**13,24**	8,891	38,1-36,3	99,8-99,9	0,07-0,04	0-0	0,02-0,01	As 0,00-0,01, Fe 0,06-0,05	
E 724a 5-6	A4b-A10a	11,85	8,908	27,2-26,9	99,4-99,5	0,02-00,3	0,01-0,02	0,10-0,07	**As 0,34-0,29,**	
E 724a 7-8	A4b-A10a	11,60	8,906	32,2-32,3	99,7-99,7	0,02-0,02	0-0	0,05-0,03	**As 0,19-0,22**	
E 724a 9-10	A4b-A10a	11,69	8,8994	30,1-33,8	99,6-99,6	0,03-0,09	0-0	0,06-0,05	**As 0,23-0,18**, Fe 0,08-0,08	
E 724a 11-12	A4b-A10a	10,09	8,8504	55,4-56	99,7-99,8	0,03-0,09	0-0	0,02-0,01	As 0,01-0,01, Fe 0,18-0,11	
E 724a 13-14	A4b-A10a	11,59	8,8829	28,1-27,1	99,4-99,5	0,16-0,08	0-0	0,03-0,02	**As 0,32-0,34,**	
E 724a 15-16	A4b-A10a	11,47	8,8813	19,5-19,6	99,3-99,4	0,02-0,02	0-0	0,05-0,05	**As 0,61-0,44**, Bi 0,05-0,04	
E 724a 17-18	A4b-A10a	10,13	8,911	38,4-37,8	99,6-99,4	0,34-0,14	0-0,001	0,07-0,32	As 0-0,03, Fe 0,02-0,12	
E 724a 19-20	A4b-A10a	11,59	8,889	24,7-25,1	99,5-99,4	0,02-0,01	0-0	0,06-0,10	**As 0,33-0,41**, Bi 0,04-0,05	
E 724a 21-22	A4b-A10a	11,82	8,873	25,3-23,4	88,2-99,0	0,02-0,02	0-0	0,16-0,21	**As 0,48-0,54**	
724b LL										
E 724b LL 1-2	A1a-A1a	11,88	8,455	13,5-13,8	68,8-69,7	30,8-29,9	0,02-0,03	0,22-0,20	Ni 0,09-0,09, Fe 0,05-0,04	
E 724b LL 3-4	A1a-A1a	11,79	8,3825	13,6-13,0	69,9-73,5	29,6-26,0	0,02-0,01	0,25-0,19	Ni 0,09-0,10, Fe 0,11-0,11	
E 724b LL 5-6	A1a-A1a	11,35	8,4418	12,6-13,5	70,2-70,1	29,4-29,3	0,02-0,03	0,25-0,30	Ni 0,10-0,10, Fe 0,06-0,05	
E 724b LL 7-8	A1b-A3b	11,71	8,452	13,6-13,6	68,8-68,3	30,7-31,2	0,05-0,04	0,25-0,25	Ni 0,09-0,09, Fe 0,06-0,06	
E 724b LL 9-10	A1d-A2a	11,31	8,438	13,5-13,9	67.2-68,7	32,3-30,8	0,03-0,03	0,46-0,25	Ni 0,08-0,10, Fe 0,08-0,05	
E 724b LL 11-12	A1c-A6a	11,16	8,556	15,6-16,6	74,6-75,3	25,3-24,7	0-0	0,04-0,02	Ni 0-0,01, Fe 0,05-0,05	
E 724b LL 13-14	A1c-A6a	10,08	8,3659	12,7-13,1	70,8-70,9	28,7-28,7	0,00-0,01	0,27-0,18	NI 0,09-0,08. Fe 0,14-0,08	
E 724b LL 15-16	A1c-A6a	11,41	8,5489	15,7-16,3	75,5-75,8	24,4-24,0	0-0	0,02-0,02	NI 0,09-0,08. Fe 0,04-0,03	
724b broken L										
E 724b 1-2	A3n-A8c	10,71	8,456	15,1-15,2	66,0-65,5	33,6-34,3	0,01-0,01	0,08-0,09	Fe 0,14-0,10	
E 724b 3-4	A3c-A6b	12,07	8,424	14,2-14,1	66,4-65,8	33,1-33,8	0-0	0,24-0,26	Fe 0,15-0,08, Ni 0,09-0,09	
E 724b 5-6	A3i-A9f	**9,76**	8,570	16,1-16,3	74,5-75,7	25,4-24,2	0-0	0,03-0,01	Fe 0,13-0,10	
E 724b 7-8-9-10					75,7-72,3	24,1-27,5		0,04-0,06	Fe 0,11-0,12	
	A4a-A8a	**8,83**	8,4968	15,9-15,7	69,2-72,6	30,7-27,2	0-0	0,05-0,05	Fe 0,04-0,07	D-Side coloured
E 724b 11-12	A4a-A8a	**7,69**	8,5501	16,7-16,3	74,0-74,4	26,0-25,6	0-0	0,02-0,01		
E 724b 13-14	A2b-A2a	11,71	8,407	12,6-13,4	69,3-69,6	30,4-30,1	0,01-0	0,17-0,16	Fe 0,07-0,07, Ni 0,09-0,10	
E 724b 15-16	A3a-A4c	11,19	8,3852	12,8-13,4	70,8-69,5	28,5-29,7	0,02-0,03	0,40-0,30	Fe 0,10-0,21, Ni 0,10-0,19	
E 724b 17-18	A2b-A2a	11,15	8,4421	12,8-13,3	68,8-68,0	30,6-31,4	0,03-0,03	0,21-0,29	Fe 0,18-0,12, Ni 0,09-0,10	
E 724b 19-20	A3e-A7a	11,53	8,414	12,8-13,3	69,4-68,2	30,2-31,3	0,01-0,03	0,16-0,24	Fe 0,06-0,06, Ni 0,08-0,09	
E 724b 21-22	A3m-A6e	11,74	8,449	14,7-14,8	76,3-75,1	23,5-24,7	0-0	0,12-0,14	Ni 0,08-0,09	
E 724b 23-24	A4c-A11a	11,27	8,453	15,1-15,2	69,4-69,0	30,2-30,8	0-0	0,25-0,16	Fe 0,05-0,05	
E 724b 25-26	A4c-A11a	11,23	8,430	14,7-14,8	68,7-69,7	31,0-30,0	0-0	0,16-0,23		
E 724b 27-28	A2a-A1b	11,15	8,4188	13,6-13,6	68,2-68,0	31,1-31,4	0,03-0,04	0,38-0,39	NI 0,08-0,09, Fe 0,09-0,07	

Number	Die combination	Weight	Density	Conductivity	Copper %	Zinc %	Tin %	Lead %	Other %	
725a										
E 725a 1-2					93,58	0,008	0,27		Si 3,48	
	B5z-A9c	12,71	8,939	42,6-43,4	99,4-99,3	0,20-0,24	0,28-0,28	0.03-0.04	Fe 0,08-0,09	
E 725a 3-4	B5z-A9c	12,96	8,9106	44,1-44,1	99,5-99,4	0,14-0,15	0,28-0,30	0,03-0,02	Fe 0,08-0,08	
E 725a 6-7	B5z-A9c	11,61	8,9153	42,8-43,9	99,5-99,5	0,14-0,17	0,29-0,28	0,02-0,01	Fe 0,06-0,04	
725b red										
E 725(b) 1-2	B5z-A9c	10,95	8,1350	14,4-14,5	84,7-89,0	15,0-10,6	0-0	0,33-0,35		
725b										
E 725b 1-2					62,52	34,81	0,003			
	B5z-A9c	11,67	8,436	14,7-14,8	67,4-66,6	31,8-32,7	0-0	0,59-0,47	Fe 0,12-0,13, Ni 0,05-0,04	
E 725b 3-4	B5z-A9c	11,23	8,441	15,0-15,1	68,9-68,6	30,8-31,1	0-0	0,16-0,21		
E 725b 5-6-7-8					70	29,7	0	0,073	Fe 0,07, Ni 0,02, As 0,10	H-Side red
					63,4	36,1	0	0,28	Fe 0,08, Ni 0,03, As 0,13	yellow
					62,7	36,8	0	0,22	Fe 0,07, Ni 0,02, As 0,16	D-Side red
	B5y-A8b Zebra	11,30	8,381	15,9-15,9	73,6	26,2	0	0,09	Fe 0,04, Ni 0,02, As 0,07	yellow
E 725b 9-10	B3c-A3a	11,66	8,438	13,0-13,4	70,0-69,0	29,5-30,5	0,03-0,03	0,26-0,25	Fe 0,07-0,06, Ni 0,10-0,09	
E 725b 11-12	B3c-A3a	11,07	8,4564	13,4-14,2	68,8-69,1	30,6-30,4	0,03-0,00	50,29-0,30	Fe 0,14-0,07, Ni 0,10-0,09	
E 725b 13-14	B3d-A6a	11,26	8,458	14,3-14,4	64,8-63,7	34,7-35,9	0-0	0,22-0,23	Fe 0,07-0,11, Ni 0,08-0,08	
E 725b 15-16	B5y-A8b	11,38	8,448	15,3-15,4	68,2-70,6	31,5-29,1	0-0	0,21-0,20		
E 725b 17-18	B5y-A8b	11,53	8,4323	14,8-14,9	68,9-68,2	30,9-31,6	0-0	0,16-0,16		
E 725b 19-20	B4c-A11c	11,31	8,419	15,1-15,0	71,2-68,3	28,6-31,3	0-0	0,11-0,24		
E 725b 21-22	B3c-A3a	11,68	8,4185	13,3-13,7	68,6-69,5	30,9-30,0	0,02-0,03	0,24-0,23	Fe 0,08-0,09, Ni 0,09-0,09	
E 725b 23-24	B3d-A6a	11,58	8,4391	14,2-14,2	64,6-84,2	35,0-35,3	0-0	0,23-0,25	Fe 0,06-0,09, Ni 0,09-0,09	
726a										
E 726a 1-2	A4d-B3b	11,19	8,9154	42,5-41,7	99,4-99,4	0,16-0,13	0,29-0,28	0,02-0,01	Fe 0,12-0,12	
E 726a 3-4	A4d-B3b	12,65	8,9086	42,7-42,6	99,1-99,1	0,22-0,22	0,29-0,29	0,03-0,18	Fe 0,37-0,26	
E 726a 5-6					95,7-97,95	0,007-0,00	0,351-0,276		Si 0,23-2,25, Ni 0,01	
	A4d-B3b	11,49	8,930	43,3-42,3	99,4-99,5	0,16-0,16	0,30-0,28	0,02-0,03	Fe 0,07-0,07	
E 726a 7-8	A4d-B3b	11,83	8,926	42,3-42,6	99.4-99,5	0,14-0,16	0,27-0,29	0,03-0,02	Fe 0,12-0,07	
E 726a 9-10	A4d-B3b	12,25	8,895	23,9-24,5	99.2-99,2	0,01-0,02	0-0	0,12-0,17	**As 0,47-0,50**, Fe 0,01-0,00	
726a part 2										
E 726a2 1-2	A4d-B3b	11,77	8,906	43,6-41,7	99,4-99,5	0,16-0,15	0,31-0,29	0,02-0,02	Fe 0,06-0,06	
E 726a2 3-4	A4d-B3b	10,79	8,925	44,7-42,7	99,5-99,5	0,15-0,13	0,22-0,28	0,03-0,03	Fe 0,13-0,10	
726b LL										
E 726b LL 1-2	A2d-B3w	11,32	8,384	12,9-13,1	69,2-69,6	30,2-29,9	0,02-0,02	0,30-0,25	Fe 0,07-0,09, Ni 0,10-0,10	
E 726b LL 3-4	A1c-B3v	11,41	8,573	16,1-16,4	77,2-76,7	22,8-23,3	0-0	0,01-0,01		
E 726b LL 5-6	A1c-B3v	11,59	8,5341	16,3-16,3	74,5-73,6	25,4-26,3	0-0	0,04-0,02	Ni 0,08-0,08	
E 726b LL 7-8	A1c-B3v	11,65	8,5132	16,2-16,6	84,2-75,9	15,8-24,1	0-0	0,01-0,01		
E 726b LL 9-10	A1c-B3v	11,25	8,436	13,4-13,5	70,1-70,7	29,4-28,9	0,02-0,03	0,22-0,18	Fe 0,06-0,06, Ni 0,10-0,11	
E 726b LL 11-12	A1c-B3v	10,79	8,467	14,0-14,0	67.9-72,1	31,6-27,4	0,02-0,02	0,22-0,29	Fe 0,08-0,06, Ni 0,08-0,07	
726b broken L										
E 726b 1-2	A4d-B3b	11,08	8,451	14,4-14,2	67,9-67,9	31,7-31,7	0-0	0,25-0,31	Fe 0,09-0,06	
E 726b 3-4	A4d-B3b	11,07	8,441	14,7-15,1	67,0-68,5	32,6-31,2	0,00-0	0,19-0,18	Fe 0,15-0,06	
E 726b 5-6	A3w-B3v	11,20	8,573	15,7-15,1	75,6-75,7	24,3-24,1	0-0	0,02-0,04	Fe 0,06-0,03, Ni 0,06-0,06	
E 726b 7-8	A4d-B3b	11,22	8,4205	14,7-15,2	67,7-64,7	32,0-34,9	0,00-0	0,18-0,28		
E 726b 9-10+13					74,7-74,9	25,2-25,0	0-0	0,02-0,01		
	A3w-B3v	11,60	8,5429	15,9-16,6	95,6	4,3	0	0,01		Red spot
E 726b 11-12	A4d-B3b	10,44	8,443	14,4-14,7	68,4-67,9	31,2-31,7	0,00-0	0,26-0,32		

Number	Die combination	Weight	Density	Conductivity	Copper %	Zinc %	Tin %	Lead %	Other %
727a									
E 727a 1-2	B5a-B3d	12,45	8,914	34,6-34,1	100-99,9	0,03-0,03	0-0	0,01-0,01	
E 727a 3-4	B5a-B3c	11,45	8,930	33,4-34,4	99,8-99,8	0,03-0,02	0-0	0,05-0,02	Fe 0,11-0,10
E 727a 5-6	B5f-B3h	12,63	8,9677	33,4-35,5	99,8-99,8	0,15-0,16	0-0	0,02-0,02	
E 727a 7-8	B5d-B3g	11,70	8,8753	50,2-50,4	99,6-99,6	0,02-0,03	0-0	0,18-0,11	Ni 0,18-0,19
E 727a 9-10	B5k-B3k	12,49	8,919	43,8-44,8	99,3-99,3	0,39-0,33	0,23-0,28	0,02-0,03	
E 727a 11-12	B5n-B3n	12,43	8,869	29,6-30,0	99,6-99,7	0,02-0,03	0-0	0,02-0,01	**As 0,27-0,20**
E 727a 13-14	B5e-B3g	11,75	8,876	40,2-36,3	99,1-99,6	0,20-0,05	0-0	0,12-0,07	**As 0,35-0,17**, Fe 0,12-0,03, Ni 0,07-0,01
E 727a 15-16	B5d-B3g	12,77	8,8468	50,7-50,5	99,6-99,7	0,02-0,01	0-0	0,13-0,11	Ni 0,19-0,16
727b									
E 727b 1-2	B1z-B1z	12,60	8,416	10,5-9,9	76,7-76,2	22,4-22,7	0,04-0,04	0,36-0,55	Fe 0,27-0,32, Ni 0,10-0,09
E 727b 3-4 (**727a**)				**10,6-9,4**	99,1-99,3	0,03-0,04	0-0	0,02-0,04	**As 0,36-0,56**, Fe 0,06-0,18, Ni 0,07-0,07
	B5l-B3l	**13,05**	8,851	**Fr 11**	98,5-98,7	0,08-0,11	0-0	0,04-0,07	**As 0,85-1,12**, Fe 0,10-0,18, Ni 0,06-0,08
E 727b 5-6	B4c-B3b	11,34	8,4231	15,5-15,2	66,9-67,1	33,0-32,6	0,00-0,00	0,16-0,13	
E 727b 7-8 M	B2j-B2p	11,61	8,4033	13,3-13,7	70,3-69,4	29,0-30,0	0,03-0,02	0,35-0,41	Fe 0,07-0,06, Ni 0,11-0,10
E 727b 9-10	B2d-B2f	10,54	8,416	12,7-13,4	77,5-79,2	21,7-20,1	0,08-0,05	0,47-0,50	Ni 0,10-0,10
E 727b 11-12	B2g-B2i	11,67	8,336	12,0-12,2	70,8-69,0	28,5-30,4	0,02-0,04	0,38-0,22	Fe 0,09-0,10, Ni 0,11-0,09
E 727b 13-14	B2i?-B2o	11,03	8,4456	13,7-13,7	69,9-68,8	29,4-30,6	0,01-0,03	0,38-0,30	Fe 0,08-0,13, Ni 0,10-0,09
E 727b 15-16	B2b-B2d	11,08	8,1947	12,4-12,3	70,6-71,0	28,8-28,6	0,02-0,02	0,23-0,25	Fe 0,22-0,05, Ni 0,10-0,10
E 727b 17-18	B2j-B2p	11,95	8,3817	13,4-12,8	71,4-70,9	28,2-28,6	0,01-0,04	0,17-0,29	Fe 0,08-0,10, Ni 0,10-0,10
E 727b 19-20	B2b-B2d	11,17	8,358	12,4-12,5	70,9-72,1	28,4-27,2	0,04-0,03	0,35-0,37	Fe 0,07-0,05, Ni 0,10-0,09
E 727b 21-22	B2d-B2f	11,47	8,519	14,0-14,3	69,9-72,0	29,6-27,5	0,06-0,04	0,23-0,19	Fe 0,04-0,07, Ni 0,10-0,11