Comparative study of two standard-free approaches in laser-induced breakdown spectroscopy as applied to the quantitative analysis of aluminum alloy standards under vacuum conditions

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Table 1. List of spectral lines used in the CF-LIBS analysis of Al alloy B8.

Al	I	236.705	Fe	II	262.567	Mn	I	405.893
Al	I	256.798	Fe	II	273.955	Ni	II	230.300
Al	I	265.248	Fe	II	274.320	Ni	II	239.452
Al	I	266.039	Fe	II	274.648	Ni	I	300.249
Al	II	281.619	Fe	II	275.329	Ni	I	341.476
Al	I	305.468	Fe	II	275.573	Ni	I	343.356
Al	I	305.714	Fe	I	296.689	Ni	I	345.847
Al	I	306.429	Fe	I	298.357	Ni	I	346.165
Al	I	306.614	Fe	I	364.784	Ni	I	351.505
Al	II	466.305	Fe	I	371.993	Ni	I	352.454
Al	II	622.618	Fe	I	373.486	Ni	I	361.939
Al	II	623.178	Fe	I	373.713	Si	I	250.690
Al	II	624.336	Fe	I	374.556	Si	I	251.432
Cr	II	283.563	Fe	I	374.948	Si	I	251.611
Cr	II	284.325	Fe	I	375.823	Si	I	251.920
Cr	II	284.984	Fe	I	376.378	Si	I	252.411
Cr	II	297.191	Fe	I	376.719	Si	I	252.851
Cr	II	297.974	Fe	I	382.042	Si	I	288.158
Cr	I	357.869	Fe	I	385.991	Si	II	385.602
Cr	I	359.349	Fe	I	404.581	Si	II	386.259
Cr	I	360.533	Fe	I	406.359	Si	I	390.552
Cr	I	520.604	Fe	I	407.173	Si	II	412.807
Cr	I	520.844	Fe	I	432.576	Si	II	505.598
Cu	II	221.027	Fe	I	438.354	Ti	II	323.452
Cu	II	221.810	Mg	II	279.078	Ti	II	332.294
Cu	II	222.886	Mg	II	279.800	Ti	II	332.946
Cu	II	224.261	Mg	I	285.213	Ti	II	333.520
Cu	II	224.700	Mn	II	259.373	Ti	II	334.034
Cu	II	227.625	Mn	II	260.569	Ti	II	334.941
Cu	II	229.436	Mn	II	261.020	Ti	I	335.464
Cu	II	240.012	Mn	II	293.306	Ti	II	336.121
Cu	I	261.837	Mn	II	293.930	Ti	II	337.280
Cu	I	427.511	Mn	II	294.920	Ti	I	363.546
Cu	I	510.554	Mn	II	344.199	Ti	I	365.350
Fe	II	238.204	Mn	II	348.291	Ti	II	375.930
Fe	II	256.253	Mn	I	356.949	Ti	II	376.132
Fe	II	258.588	Mn	I	380.672	Ti	I	498.173
Fe	II	259.837	Mn	I	403.076	Ti	I	499.107
Fe	II	259.940	Mn	I	403.307	Ti	I	499.951
Fe	II	260.709	Mn	I	403.449	Ti	I	500.721
Fe	II	261.187	Mn	I	403.573	Ti	I	501.424
Fe	II	261.382	Mn	I	404.136			

Table 2. List of spectral lines used in the CF-LIBS analysis of Al alloy D33.

Al	I	232.156	Fe	II	261.187	Fe	I	404.581	Ni	I	300.249
Al	I	256.798	Fe	II	261.382	Fe	I	406.359	Ni	I	300.363
Al	I	265.248	Fe	II	261.762	Fe	I	407.173	Ni	I	301.200
Al	I	266.039	Fe	II	262.167	Fe	I	427.175	Ni	I	313.411
Al	II	281.619	Fe	II	262.567	Fe	I	430.790	Ni	I	339.105
Al	I	305.007	Fe	II	262.829	Fe	I	432.576	Ni	I	339.299
Al	I	305.468	Fe	II	272.754	Fe	I	438.354	Ni	I	341.476
Al	I	305.714	Fe	II	273.697	Fe	I	440.475	Ni	I	342.371
Al	I	306.429	Fe	II	273.955	Mg	II	279.078	Ni	I	343.356
Al	I	306.614	Fe	I	274.240	Mg	II	279.553	Ni	I	343.728
Al	II	466.305	Fe	II	274.320	Mg	II	279.800	Ni	I	344.626
Al	II	622.621	Fe	II	274.648	Mg	II	280.270	Ni	I	345.289
Al	II	623.175	Fe	II	274.932	Mg	I	285.213	Ni	I	345.847
Al	II	624.337	Fe	II	275.329	Mn	II	259.373	Ni	I	346.165
Cr	II	297.974	Fe	II	275.573	Mn	II	260.569	Ni	I	349.296
Cr	II	342.273	Fe	I	296.689	Mn	II	261.814	Ni	I	351.505
Cr	I	427.480	Fe	I	297.313	Mn	I	280.106	Ni	I	352.454
Cu	II	224.261	Fe	I	298.357	Mn	II	293.305	Ni	I	356.637
Cu	II	224.700	Fe	II	298.482	Mn	II	293.931	Si	I	250.690
Cu	II	227.625	Fe	I	299.442	Mn	II	294.921	Si	I	251.432
Cu	I	296.116	Fe	I	300.094	Mn	II	344.199	Si	I	251.611
Cu	I	301.084	Fe	I	300.814	Mn	II	346.032	Si	I	251.920
Cu	I	510.554	Fe	I	300.956	Mn	I	403.076	Si	I	252.411
Fe	II	233.131	Fe	I	302.063	Mn	I	403.307	Si	I	252.851
Fe	II	233.280	Fe	I	346.586	Mn	I	403.449	Si	I	288.158
Fe	II	233.801	Fe	I	349.057	Mn	I	403.573	Si	I	298.764
Fe	II	234.349	Fe	I	351.381	Mn	I	404.136	Si	II	385.367
Fe	II	234.428	Fe	I	356.537	Mn	I	404.876	Si	II	385.602
Fe	II	234.830	Fe	I	357.009	Mn	I	405.554	Si	II	386.259
Fe	II	238.204	Fe	I	358.119	Ni	II	220.672	Si	I	390.552
Fe	II	238.863	Fe	I	361.876	Ni	II	221.648	Si	II	412.807
Fe	II	239.563	Fe	I	363.146	Ni	II	222.296	Ti	II	323.452
Fe	II	239.924	Fe	I	364.784	Ni	II	225.385	Ti	II	323.658
Fe	II	240.489	Fe	I	368.745	Ni	II	226.446	Ti	II	323.904
Fe	II	240.666	Fe	I	371.993	Ni	II	227.021	Ti	II	323.966
Fe	II	241.052	Fe	I	373.486	Ni	II	227.877	Ti	II	334.941
Fe	II	241.107	Fe	I	373.713	Ni	II	229.655	Ti	II	336.122
Fe	II	241.331	Fe	I	374.556	Ni	II	229.714	Ti	II	338.376
Fe	II	243.930	Fe	I	374.826	Ni	II	230.300	Ti	II	338.785
Fe	II	256.253	Fe	I	374.948	Ni	II	231.604	Ti	II	339.458
Fe	II	256.348	Fe	I	375.823	Ni	I	232.003	Ti	II	350.490
Fe	II	258.588	Fe	I	376.378	Ni	II	233.458	Ti	I	363.546
Fe	II	259.154	Fe	I	382.042	Ni	II	239.452	Ti	I	364.268
Fe	II	259.837	Fe	I	382.588	Ni	II	241.613	Ti	II	368.520
Fe	II	259.940	Fe	I	382.782	Ni	II	243.789	Ti	II	376.132
Fe	II	260.709	Fe	I	385.991	Ni	I	298.165			

Table 3. List of spectral lines used in the CF-LIBS analysis of Al alloy S4.

Al	I	226.910	Fe	II	239.562	Fe	I	374.826	Mn	I	405.554
Al	I	236.705	Fe	II	239.924	Fe	I	374.948	Ni	I	300.249
Al	I	237.312	Fe	II	240.488	Fe	I	375.823	Ni	I	336.957
Al	I	237.840	Fe	II	240.666	Fe	I	376.378	Ni	I	338.057
Al	I	256.798	Fe	II	241.052	Fe	I	376.554	Ni	I	339.299
Al	I	257.510	Fe	II	241.331	Fe	I	376.719	Ni	I	341.476
Al	I	265.248	Fe	II	249.326	Fe	I	382.042	Ni	I	344.626
Al	I	266.039	Fe	II	256.253	Fe	I	385.991	Ni	I	345.847
Al	I	305.007	Fe	II	256.348	Fe	I	388.628	Ni	I	346.165
Al	I	305.468	Fe	II	258.588	Fe	I	404.581	Ni	I	351.505
Al	I	305.714	Fe	II	259.837	Fe	I	406.359	Ni	I	352.454
Al	I	306.429	Fe	II	259.940	Fe	I	407.173	Si	I	250.690
Al	I	306.614	Fe	II	260.709	Fe	I	427.175	Si	I	251.432
Al	II	466.305	Fe	II	261.187	Fe	I	430.790	Si	I	251.611
Al	II	622.621	Fe	II	261.382	Fe	I	432.576	Si	I	251.920
Al	II	623.175	Fe	II	261.762	Fe	I	438.354	Si	I	252.411
Al	II	624.337	Fe	II	262.567	Fe	I	440.475	Si	I	252.851
Cr	II	283.563	Fe	II	262.829	Fe	I	441.512	Si	I	288.158
Cr	II	284.325	Fe	II	271.441	Mg	I	277.669	Si	II	385.602
Cr	II	284.984	Fe	I	271.902	Mg	I	277.827	Si	I	390.552
Cr	II	285.568	Fe	II	272.754	Mg	I	278.142	Si	II	412.807
Cr	I	300.089	Fe	II	273.697	Mg	I	278.297	Ti	II	323.452
Cr	II	313.206	Fe	II	273.955	Mg	II	279.078	Ti	II	323.657
Cr	I	360.533	Fe	II	274.320	Mg	II	279.553	Ti	II	323.904
Cr	I	425.433	Fe	II	274.648	Mg	II	279.800	Ti	II	324.199
Cr	I	427.480	Fe	II	275.329	Mg	II	280.270	Ti	II	332.294
Cr	I	428.972	Fe	II	275.574	Mg	I	285.213	Ti	II	334.941
Cu	II	221.027	Fe	II	278.369	Mg	II	292.863	Ti	II	336.121
Cu	II	221.810	Fe	I	296.689	Mg	II	293.651	Ti	II	337.280
Cu	II	222.886	Fe	I	297.313	Mn	II	257.610	Ti	II	338.376
Cu	II	224.261	Fe	I	298.357	Mn	II	259.373	Ti	II	338.784
Cu	II	224.700	Fe	I	299.442	Mn	II	260.569	Ti	II	339.458
Cu	II	227.625	Fe	I	302.063	Mn	II	261.020	Ti	I	363.546
Cu	II	229.436	Fe	I	344.060	Mn	I	280.106	Ti	I	364.268
Cu	II	240.333	Fe	I	346.586	Mn	II	293.306	Ti	I	365.350
Cu	I	276.637	Fe	I	356.537	Mn	II	293.930	Ti	II	368.520
Cu	I	296.116	Fe	I	357.009	Mn	II	294.920	Ti	II	375.930
Cu	I	327.396	Fe	I	360.885	Mn	II	344.199	Zn	II	250.199
Cu	I	510.554	Fe	I	361.876	Mn	II	346.033	Zn	II	255.795
Fe	II	233.131	Fe	I	363.146	Mn	I	380.672	Zn	I	328.233
Fe	II	233.280	Fe	I	364.784	Mn	I	403.076	Zn	I	330.258
Fe	II	233.801	Fe	I	371.993	Mn	I	403.307	Zn	I	334.502
Fe	II	234.349	Fe	I	372.761	Mn	I	403.449	Zn	I	468.014
Fe	II	234.830	Fe	I	373.486	Mn	I	403.573	Zn	I	472.215
Fe	II	238.204	Fe	I	373.713	Mn	I	404.136	Zn	I	481.053
Fe	II	238.863	Fe	I	374.556	Mn	I	404.876	Zn	II	491.162

Table 4. List of spectral lines used in the CF-LIBS analysis of Al alloy SM10.

Al	I	226.910	Fe	II	234.349	Fe	I	357.009	Mn	II	293.930
Al	I	236.705	Fe	II	234.428	Fe	I	358.119	Mn	II	294.920
Al	I	237.207	Fe	II	234.830	Fe	I	360.668	Mn	II	344.199
Al	I	237.312	Fe	II	238.204	Fe	I	360.885	Mn	II	346.033
Al	I	265.248	Fe	II	238.863	Fe	I	361.876	Mn	I	380.672
Al	I	266.039	Fe	II	239.562	Fe	I	363.146	Mn	I	403.076
Al	II	281.619	Fe	II	239.924	Fe	I	364.784	Mn	I	403.307
Al	I	305.007	Fe	II	240.488	Fe	I	371.993	Mn	I	403.449
Al	I	305.468	Fe	II	240.666	Fe	I	372.761	Mn	I	403.573
Al	I	305.714	Fe	II	241.052	Fe	I	373.486	Mn	I	404.136
Al	I	306.429	Fe	II	241.107	Fe	I	373.713	Mn	I	404.876
Al	I	306.614	Fe	II	241.331	Fe	I	374.556	Mn	I	405.554
Al	II	466.305	Fe	I	252.284	Fe	I	374.826	Ni	II	221.648
Al	II	622.621	Fe	II	256.253	Fe	I	374.948	Ni	I	300.249
Al	II	623.175	Fe	II	256.348	Fe	I	375.823	Ni	I	344.626
Al	II	624.337	Fe	II	258.588	Fe	I	376.378	Si	I	250.690
Cr	II	283.563	Fe	II	259.154	Fe	I	376.554	Si	I	251.432
Cr	II	284.325	Fe	II	259.837	Fe	I	376.719	Si	I	251.611
Cr	II	284.984	Fe	II	259.940	Fe	I	381.584	Si	I	251.920
Cr	II	285.568	Fe	II	260.709	Fe	I	382.042	Si	I	252.411
Cr	II	297.974	Fe	II	261.187	Fe	I	385.991	Si	I	252.851
Cr	I	300.089	Fe	II	261.382	Fe	I	404.581	Si	I	288.158
Cr	II	313.206	Fe	II	261.762	Fe	I	406.359	Si	II	385.602
Cr	I	357.869	Fe	II	262.567	Fe	I	407.173	Si	II	386.259
Cr	I	359.349	Fe	II	262.829	Fe	I	427.175	Si	I	390.552
Cr	I	360.533	Fe	II	271.441	Fe	I	430.790	Si	II	412.807
Cr	I	425.433	Fe	I	271.902	Fe	I	432.576	Ti	II	323.452
Cr	I	427.480	Fe	II	272.754	Fe	I	438.354	Ti	II	323.657
Cr	I	428.972	Fe	II	273.697	Fe	I	440.475	Ti	II	323.904
Cu	II	221.027	Fe	II	273.955	Fe	I	441.512	Ti	II	324.199
Cu	II	221.810	Fe	II	274.320	Mg	I	277.669	Ti	II	336.121
Cu	II	222.886	Fe	II	274.648	Mg	I	277.827	Ti	II	337.280
Cu	II	224.261	Fe	II	275.329	Mg	I	278.142	Ti	II	338.376
Cu	II	224.700	Fe	II	275.574	Mg	I	278.297	Ti	II	368.520
Cu	II	227.625	Fe	II	278.369	Mg	II	279.078	Ti	II	375.930
Cu	II	229.436	Fe	I	294.787	Mg	II	279.800	Ti	II	376.132
Cu	II	240.012	Fe	I	298.357	Mg	II	280.270	Zn	II	250.199
Cu	I	330.795	Fe	I	299.442	Mg	II	292.863	Zn	II	255.795
Cu	I	465.112	Fe	I	302.063	Mg	II	293.651	Zn	I	328.233
Cu	I	510.554	Fe	I	305.908	Mn	II	259.373	Zn	I	334.502
Fe	II	233.131	Fe	I	344.060	Mn	II	260.569	Zn	I	472.215
Fe	II	233.280	Fe	I	346.586	Mn	II	261.020	Zn	I	481.053
Fe	II	233.801	Fe	I	356.537	Mn	II	293.306			

Table 5. List of spectral lines used in the CF-LIBS analysis of Al alloy V14.

Al	I	231.249	Fe	II	241.052	Fe	I	382.043	Ni	I	349.296
Al	I	232.156	Fe	II	241.107	Fe	I	382.588	Ni	I	351.505
Al	I	236.705	Fe	II	241.331	Fe	I	382.782	Ni	I	352.454
Al	I	237.312	Fe	II	242.836	Fe	I	383.422	Ni	I	356.637
Al	I	256.798	Fe	II	243.930	Fe	I	385.991	Ni	I	361.939
Al	I	265.248	Fe	I	247.977	Fe	I	407.173	Si	I	221.089
Al	I	266.039	Fe	I	248.814	Fe	I	427.175	Si	I	243.515
Al	II	281.619	Fe	II	249.326	Fe	I	430.790	Si	I	250.690
Al	I	305.007	Fe	I	251.083	Fe	I	432.576	Si	I	251.432
Al	I	305.468	Fe	I	252.743	Fe	I	438.354	Si	I	251.611
Al	I	305.714	Fe	II	256.253	Fe	I	440.475	Si	I	251.920
Al	I	306.429	Fe	II	256.348	Mg	II	279.078	Si	I	252.411
Al	I	306.614	Fe	II	258.588	Mg	II	279.553	Si	I	252.851
Al	II	466.305	Fe	II	259.837	Mg	II	279.800	Si	I	288.158
Cr	II	266.602	Fe	II	259.940	Mg	II	280.270	Si	II	385.367
Cr	II	267.181	Fe	II	260.709	Mg	I	285.213	Si	II	385.602
Cr	II	283.563	Fe	II	261.187	Mn	II	257.610	Si	II	386.260
Cr	II	284.325	Fe	II	261.382	Mn	II	259.373	Si	I	390.552
Cr	II	284.984	Fe	II	261.762	Mn	II	260.569	Si	II	412.805
Cr	II	285.568	Fe	II	262.567	Mn	II	261.020	Ti	II	323.452
Cr	II	297.974	Fe	II	262.829	Mn	II	261.814	Ti	II	323.658
Cr	II	313.206	Fe	II	266.466	Mn	I	280.106	Ti	II	323.904
Cr	I	357.869	Fe	II	272.754	Mn	II	293.306	Ti	II	324.199
Cr	I	359.349	Fe	II	273.697	Mn	II	293.931	Ti	II	328.766
Cr	I	360.533	Fe	II	273.955	Mn	II	294.921	Ti	II	332.294
Cr	I	425.433	Fe	II	274.320	Mn	II	344.199	Ti	II	333.520
Cr	I	427.480	Fe	II	274.648	Mn	II	346.032	Ti	II	334.036
Cr	I	428.972	Fe	II	274.932	Mn	II	347.413	Ti	II	334.941
Cu	II	221.027	Fe	II	275.329	Mn	II	348.868	Ti	II	336.122
Cu	II	221.810	Fe	II	275.573	Mn	II	349.584	Ti	II	337.280
Cu	II	222.886	Fe	I	295.394	Mn	II	349.753	Ti	II	338.377
Cu	II	224.261	Fe	I	298.357	Mn	I	403.076	Ti	II	338.785
Cu	II	224.700	Fe	II	298.482	Mn	I	403.307	Ti	II	339.458
Cu	II	227.625	Fe	II	298.554	Mn	I	403.449	Ti	II	344.431
Cu	II	229.436	Fe	I	356.537	Mn	I	403.573	Ti	II	350.490
Cu	I	296.116	Fe	I	357.009	Mn	I	404.136	Ti	I	363.546
Cu	I	510.554	Fe	I	358.119	Ni	II	220.672	Ti	I	364.268
Cu	I	578.213	Fe	I	360.885	Ni	II	221.648	Ti	I	365.350
Fe	II	233.131	Fe	I	361.876	Ni	II	227.877	Ti	II	368.520
Fe	II	233.280	Fe	I	363.146	Ni	II	230.300	Ti	II	374.164
Fe	II	233.801	Fe	I	364.784	Ni	II	231.604	Ti	II	375.930
Fe	II	234.349	Fe	I	371.993	Ni	II	239.452	Ti	II	376.132
Fe	II	234.428	Fe	I	373.486	Ni	II	241.613	Ti	II	454.962
Fe	II	234.830	Fe	I	373.713	Ni	I	313.411	Ti	II	457.198
Fe	II	236.483	Fe	I	374.556	Ni	I	338.057	Ti	I	498.173
Fe	II	238.204	Fe	I	374.826	Ni	I	339.299	Ti	I	499.107
Fe	II	238.863	Fe	I	374.948	Ni	I	341.476	Ti	I	499.951
Fe	II	239.563	Fe	I	375.823	Ni	I	343.356	Ti	I	500.721
Fe	II	239.924	Fe	I	376.378	Ni	I	344.626			
Fe	II	240.489	Fe	I	376.719	Ni	I	345.847			
Fe	II	240.666	Fe	I	381.584	Ni	I	346.165			

Table 6. List of spectral lines used in the CF-LIBS analysis of Al alloy Z8.

Al	I	231.906	Cu	I	296.116	Fe	II	261.187
Al	I	232.156	Cu	I	301.084	Fe	II	261.382
Al	I	256.798	Cu	I	319.410	Fe	II	261.762
Al	I	265.248	Cu	I	328.271	Fe	II	262.167
Al	I	266.039	Cu	I	329.054	Fe	II	262.567
Al	II	281.619	Cu	I	333.784	Fe	II	262.829
Al	I	305.007	Cu	I	465.112	Fe	II	266.466
Al	I	305.468	Cu	I	510.554	Fe	II	271.441
Al	I	305.714	Cu	I	529.252	Fe	I	272.090
Al	I	306.429	Cu	I	578.213	Fe	II	272.754
Al	I	306.614	Fe	II	233.131	Fe	II	273.697
Al	II	622.621	Fe	II	233.280	Fe	II	273.955
Al	II	623.175	Fe	II	233.801	Fe	II	274.320
Al	II	624.337	Fe	II	234.349	Fe	II	274.648
Cr	II	276.259	Fe	II	234.428	Fe	II	274.932
Cr	II	282.238	Fe	II	234.830	Fe	II	275.329
Cr	II	283.563	Fe	II	238.204	Fe	II	275.573
Cr	II	284.001	Fe	II	238.863	Fe	II	278.369
Cr	II	284.325	Fe	II	239.563	Fe	I	294.787
Cr	II	284.984	Fe	II	239.924	Fe	I	296.689
Cr	II	285.568	Fe	II	240.489	Fe	I	297.313
Cr	II	285.890	Fe	II	240.666	Fe	I	299.442
Cr	II	286.257	Fe	II	241.052	Fe	I	299.951
Cr	II	297.190	Fe	II	241.107	Fe	I	300.094
Cr	II	311.865	Fe	II	241.331	Fe	I	300.814
Cr	II	312.036	Fe	II	243.930	Fe	I	341.313
Cr	II	312.869	Fe	I	247.977	Fe	I	356.537
Cr	II	313.206	Fe	I	248.327	Fe	I	358.119
Cr	II	313.668	Fe	I	248.814	Fe	I	360.885
Cr	I	357.869	Fe	II	249.326	Fe	I	361.876
Cr	I	359.349	Fe	I	251.083	Fe	I	363.146
Cr	I	360.533	Fe	I	252.284	Fe	I	364.784
Cr	I	425.433	Fe	I	252.743	Fe	I	375.823
Cr	I	427.480	Fe	II	253.363	Fe	I	376.378
Cr	I	428.972	Fe	II	253.442	Fe	I	376.719
Cu	II	221.027	Fe	I	253.560	Fe	I	381.584
Cu	II	221.810	Fe	II	253.820	Fe	I	382.042
Cu	II	222.886	Fe	II	253.899	Fe	I	385.991
Cu	II	224.261	Fe	II	256.253	Fe	I	404.581
Cu	II	224.700	Fe	II	256.348	Fe	I	406.359
Cu	II	227.625	Fe	II	258.588	Fe	I	407.173
Cu	II	229.436	Fe	II	259.154	Fe	I	427.175
Cu	II	260.027	Fe	II	259.837	Fe	I	430.790
Cu	I	282.437	Fe	II	260.709	Fe	I	432.576

Table 6. Continued.

Fe	I	438.354	Ni	II	231.604	Ti	II	322.860
Fe	I	440.475	Ni	I	232.003	Ti	II	322.860
Mg	I	277.669	Ni	II	233.458	Ti	II	323.452
Mg	I	277.827	Ni	II	239.452	Ti	II	323.658
Mg	I	278.142	Ni	II	241.613	Ti	II	323.904
Mg	I	278.297	Ni	II	243.789	Ti	II	323.966
Mg	II	279.078	Ni	I	300.249	Ti	II	333.520
Mg	II	279.800	Ni	I	300.363	Ti	II	334.036
Mg	I	285.213	Ni	I	301.200	Ti	I	334.188
Mg	II	292.863	Ni	I	313.411	Ti	II	334.941
Mg	II	293.651	Ni	I	338.057	Ti	II	336.122
Mg	I	382.930	Ni	I	339.105	Ti	II	337.280
Mg	I	383.230	Ni	I	339.299	Ti	II	338.377
Mg	I	383.829	Ni	I	341.476	Ti	II	338.785
Mg	I	516.733	Ni	I	343.356	Ti	II	344.431
Mg	I	517.268	Ni	I	344.626	Ti	II	350.490
Mg	I	518.361	Ni	I	345.847	Ti	II	362.482
Mn	II	257.610	Ni	I	346.165	Ti	I	363.546
Mn	II	259.373	Ni	I	349.296	Ti	II	364.133
Mn	II	260.569	Ni	I	351.505	Ti	I	364.268
Mn	II	261.020	Ni	I	352.454	Ti	I	365.350
Mn	II	261.814	Ni	I	356.637	Ti	II	368.520
Mn	II	293.305	Ni	I	361.939	Ti	II	374.164
Mn	II	293.931	Si	I	250.690	Ti	II	375.930
Mn	II	294.921	Si	I	251.432	Ti	II	376.132
Mn	I	322.809	Si	I	251.611	Ti	II	390.055
Mn	II	344.199	Si	I	251.920	Ti	II	391.347
Mn	II	346.032	Si	I	252.411	Ti	I	398.176
Mn	II	349.584	Si	I	252.851	Ti	I	398.976
Mn	II	349.753	Si	I	288.158	Ti	I	399.864
Mn	I	380.672	Si	II	385.602	Ti	II	429.410
Mn	I	403.076	Si	I	390.552	Ti	II	430.005
Mn	I	403.307	Si	II	412.805	Ti	II	439.503
Mn	I	403.449	Ti	II	315.226	Ti	II	444.379
Mn	I	403.573	Ti	II	315.421	Ti	II	446.850
Mn	I	404.136	Ti	II	315.568	Ti	II	450.127
Mn	I	404.876	Ti	II	316.122	Ti	II	454.962
Ni	II	220.672	Ti	II	316.177	Ti	II	457.198
Ni	II	221.648	Ti	II	316.257	Ti	I	498.173
Ni	II	222.296	Ti	II	316.853	Ti	I	499.107
Ni	II	226.446	Ti	II	319.088	Ti	I	499.951
Ni	II	227.021	Ti	II	320.254	Ti	I	500.721
Ni	II	227.877	Ti	II	321.706			
Ni	II	230.300	Ti	II	322.284			