Appendix 1 – Details of molecular interference correction routine

LA-MC-ICP-MS analyses using molecular interference corrections incorporate measurement of Yb-Lu-Hf isotopes (10 integrations per block), Hf-oxide isotopes (1 integration per block) and Gd-Dy-Er-Yb isotopes (1 integration per block). Mass bias is corrected using an exponential mass bias relationship. Gd and Dy are assumed to have the same mass bias as Yb.

The influence of oxide interferences is corrected using an iterative approach with the following steps:

1. Interpolate Gd and Dy intensites for each Yb-Lu-Hf integration by assuming the measured Gd/Yb and Dy/Yb ratios are consistent throughout the duration of the block and calculating against the measured ^{171}Yb intensity in each integration.
2. Calculate HfO formation rate from sequential measurement of ^{180}Hf and ^{196}HfO masses. This value is extrapolated to the intervening integrations. GdO and DyO formation rates are calculated from this value using the measured relative GdO and DyO formation rates (determined at beginning of analytical session).

All following steps are done for each integration.

3. Calculate Yb mass bias factor (f_{Yb}) using measured ^{171}Yb/^{173}Yb ratio.
4. Calculate ^{155}Gd and ^{157}Gd intensities ($^{155}Gd_a$ and $^{157}Gd_a$) using measured ^{160}(Gd+Dy) and f_{Yb}. (Assumes ^{160}Dy is minimal for the purpose of this step)
5. Calculate intensity of $^{171}GdO_a$ and $^{173}GdO_a$ using calculated $^{155}Gd_a$ and $^{157}Gd_a$ and oxide formation rates.
6. Calculate $^{171}Yb_a$ and $^{173}Yb_a$ by subtracting $^{171}GdO_a$ and $^{173}GdO_a$ from measured ^{171}Yb and ^{173}Yb. Calculate new Yb mass bias factor (f_{Yba}) using $^{171}Yb_a$/$^{173}Yb_a$.
7. Calculate ^{160}Dy using measured ^{162}Dy and f_{Yba} and subtract from measured ^{160}(Gd+Dy) to obtain $^{160}Gd_a$. This step assumes ^{162}Er is a negligible interference on ^{162}Dy.
8. Calculate $^{155}Gd_b$ and $^{157}Gd_b$ intensities using $^{160}Gd_a$ and f_{Yba}.
9. Calculate $^{171}GdO_b$ and $^{173}GdO_b$ and subtract from measured Yb to produce $^{171}Yb_b$ and $^{173}Yb_b$. Recalculate Yb mass bias factor (f_{Ybb}) from the new Yb values. Steps 7 to 9 are repeated to

produce $^{160}Gd_b$, $^{171}Yb_c$, $^{171}Yb_c$, Yb mass bias factor and $^{160}Dy_a$ which are used in subsequent calculations.

This represents an iterative process to remove the GdO interferences on Yb allowing for an accurate calculation of Yb mass bias and ^{160}Dy and ^{160}Gd.

10. Calculate ^{176}GdO, ^{176}DyO, ^{177}DyO, ^{178}DyO, ^{179}DyO and ^{180}DyO and remove from the respective Yb and Hf masses.

Remaining mass bias and isobaric interference corrections are undertaken using normal calculation procedures.

The influence of Tb oxide on Lu is considered to be negligible and does not appear to impact upon oxide corrected data in natural zircon analyses.

Appendix 2 - Data for analysis of Yb-doped JMC475 Hf isotope standard solution

	^{176}(Hf+Yb)/^{177}Hf MB	2 S.E.	^{173}Yb/^{177}Hf MB	2 S.E.	Hf fract	2 S.E.	Yb fract	2 S.E.	^{176}Yb/^{177}Hf	2 S.E.	^{178}Hf/^{177}Hf	2 S.E.	^{176}Hf/^{177}Hf	2 S.E.
Session 1														
JMC475 Hf	0.282171	4.6E-06	0.000032	2.6E-06	1.6163	3.2E-03	-	-	0.000027	2.6E-06	1.467273	9.3E-06	0.282145	4.2E-06
JMC475 Hf	0.282169	4.2E-06	0.000024	1.8E-06	1.6546	1.7E-03	-	-	0.000020	1.7E-06	1.467265	9.4E-06	0.282150	4.0E-06
JMC475 Hf	0.282166	4.9E-06	0.000016	1.8E-06	1.6530	2.0E-03	-	-	0.000012	1.4E-06	1.467259	1.1E-05	0.282156	4.9E-06
JMC475+5ppb Yb	0.334996	3.8E-05	0.066556	4.7E-05	1.7039	1.7E-03	1.7110	3.1E-03	0.052340	4.3E-05	1.467259	9.4E-06	0.282160	5.3E-06
JMC475+5ppb Yb	0.335143	2.4E-05	0.066739	3.0E-05	1.7122	1.1E-03	1.7116	3.0E-03	0.052466	2.3E-05	1.467274	8.7E-06	0.282168	5.3E-06
JMC475+5ppb Yb	0.335187	2.3E-05	0.066800	2.8E-05	1.7211	1.1E-03	1.7282	3.3E-03	0.052518	2.2E-05	1.467257	8.5E-06	0.282156	5.4E-06
JMC475+10ppb Yb	0.387125	1.2E-04	0.132215	1.5E-04	1.7193	2.0E-03	1.7258	2.6E-03	0.103963	1.2E-04	1.467257	9.9E-06	0.282160	6.3E-06
JMC475+10ppb Yb	0.386409	5.4E-05	0.131311	6.8E-05	1.7105	1.1E-03	1.7194	2.2E-03	0.103253	5.4E-05	1.467263	9.1E-06	0.282156	6.4E-06
JMC475+10ppb Yb	0.386406	5.6E-05	0.131310	7.0E-05	1.7149	1.1E-03	1.7224	2.2E-03	0.103233	5.7E-05	1.467270	9.8E-06	0.282156	6.2E-06
JMC475+20ppb Yb	0.496776	3.8E-04	0.270338	4.7E-04	1.7389	2.8E-03	1.7467	2.9E-03	0.213174	1.2E-04	1.467261	1.1E-05	0.282151	9.1E-06
JMC475+20ppb Yb	0.497457	1.3E-04	0.271189	1.6E-04	1.7485	1.2E-03	1.7551	1.7E-03	0.212573	3.8E-04	1.467261	1.2E-05	0.282161	8.5E-06
JMC475+20ppb Yb	0.498179	9.0E-05	0.272109	1.1E-04	1.7558	9.6E-04	1.7626	1.4E-03	0.213888	8.8E-05	1.467260	1.1E-05	0.282152	7.8E-06
Session 2														
JMC475 Hf	0.282188	4.8E-06	0.000043	4.0E-06	1.7575	2.3E-03	-	-	0.000043	1.1E-05	1.467265	1.1E-05	0.282156	3.8E-06
JMC475 Hf	0.282177	4.6E-06	0.000035	2.7E-06	1.7758	1.4E-03	-	-	0.000028	2.6E-06	1.467251	1.1E-05	0.282152	4.4E-06
JMC475 Hf	0.282184	5.5E-06	0.000037	3.7E-06	1.7785	1.5E-03	-	-	0.000035	7.4E-06	1.467248	1.1E-05	0.282157	4.1E-06
JMC475+5ppb Yb	0.333697	3.3E-05	0.064920	4.1E-05	1.7104	1.5E-03	1.7227	3.3E-03	0.051064	3.9E-05	1.467274	9.2E-06	0.282154	5.2E-06
JMC475+5ppb Yb	0.333808	2.4E-05	0.065059	3.0E-05	1.7206	1.0E-03	1.7321	3.4E-03	0.051153	2.4E-05	1.467274	9.3E-06	0.282155	5.6E-06
JMC475+5ppb Yb	0.333602	2.9E-05	0.064801	3.4E-05	1.7234	1.4E-03	1.7290	3.3E-03	0.050940	3.1E-05	1.467272	9.0E-06	0.282164	5.2E-06
JMC475+10ppb Yb	0.383718	5.5E-05	0.127921	6.9E-05	1.7198	1.3E-03	1.7277	2.1E-03	0.100593	5.9E-05	1.467270	8.7E-06	0.282161	6.0E-06
JMC475+10ppb Yb	0.383529	4.4E-05	0.127680	5.6E-05	1.7196	1.2E-03	1.7252	2.2E-03	0.100380	4.4E-05	1.467269	8.9E-06	0.282166	6.8E-06
JMC475+10ppb Yb	0.383744	8.1E-05	0.127956	1.0E-04	1.7251	1.7E-03	1.7302	2.7E-03	0.100593	8.0E-05	1.467261	9.7E-06	0.282163	6.9E-06
JMC475+20ppb Yb	0.491670	1.4E-04	0.263897	1.7E-04	1.7272	2.1E-03	1.7341	2.3E-03	0.207749	2.6E-04	1.467277	8.8E-06	0.282163	7.7E-06
JMC475+20ppb Yb	0.492624	7.8E-05	0.265107	9.8E-05	1.7322	1.1E-03	1.7373	1.6E-03	0.208406	7.6E-05	1.467286	9.3E-06	0.282163	8.7E-06
JMC475+20ppb Yb	0.492219	7.7E-05	0.264593	9.7E-05	1.7299	9.3E-04	1.7403	1.4E-03	0.208013	7.8E-05	1.467271	8.6E-06	0.282147	7.4E-06
JMC475+20ppb Yb	0.496776	3.8E-04	0.270338	4.7E-04	1.7389	2.8E-03	1.7467	2.9E-03	0.212573	3.8E-04	1.467261	1.2E-05	0.282151	9.1E-06
JMC475+20ppb Yb	0.497457	1.3E-04	0.271189	1.6E-04	1.7485	1.2E-03	1.7551	1.7E-03	0.213174	1.2E-04	1.467261	1.1E-05	0.282161	8.5E-06
JMC475+20ppb Yb	0.498179	9.0E-05	0.272109	1.1E-04	1.7558	9.6E-04	1.7626	1.4E-03	0.213888	8.8E-05	1.467260	1.1E-05	0.282152	7.8E-06
JMC475+50ppb Yb	0.857628	3.5E-04	0.724851	4.4E-04	1.7306	1.2E-03	1.7376	1.2E-03	0.569846	3.4E-04	1.467254	8.5E-06	0.282164	1.2E-05
JMC475+50ppb Yb	0.856854	2.6E-04	0.723878	3.3E-04	1.7402	1.0E-03	1.7475	1.2E-03	0.569053	2.6E-04	1.467266	9.0E-06	0.282160	1.3E-05
JMC475+50ppb Yb	0.853070	5.9E-04	0.719101	7.4E-04	1.7355	2.3E-03	1.7431	2.1E-03	0.565511	6.3E-04	1.467269	9.1E-06	0.282166	1.0E-05
JMC475+50ppb Yb	0.853341	3.2E-04	0.719447	4.1E-04	1.7398	1.2E-03	1.7475	1.2E-03	0.565573	3.2E-04	1.467267	9.4E-06	0.282163	1.3E-05
JMC475+50ppb Yb	0.852095	2.2E-04	0.717866	2.8E-04	1.7372	1.1E-03	1.7454	1.1E-03	0.564315	2.3E-04	1.467272	9.6E-06	0.282166	1.2E-05
JMC475+50ppb Yb	0.853019	3.4E-04	0.719041	4.3E-04	1.7405	1.3E-03	1.7494	1.4E-03	0.565338	3.7E-04	1.467279	9.6E-06	0.282150	1.2E-05
Session 3														
JMC475 Hf	0.282175	4.7E-06	0.000028	2.1E-06	1.6110	3.0E-03	-	-	0.000024	2.7E-06	1.467277	1.1E-05	0.282153	3.9E-06
JMC475 Hf	0.282168	4.0E-06	0.000027	1.6E-06	1.6092	1.7E-03	-	-	0.000022	1.6E-06	1.467265	9.4E-06	0.282148	4.1E-06
JMC475 Hf	0.282171	4.6E-06	0.000026	2.3E-06	1.6030	1.9E-03	-	-	0.000022	2.5E-06	1.467278	1.1E-05	0.282152	4.2E-06
JMC475+5ppb Yb	0.332035	4.6E-05	0.062812	5.8E-05	1.4712	7.0E-03	1.5023	7.4E-03	0.049480	4.6E-05	1.467267	1.2E-05	0.282149	5.7E-06
JMC475+5ppb Yb	0.331727	2.7E-05	0.062428	3.4E-05	1.4085	2.2E-03	1.4335	3.6E-03	0.049182	2.9E-05	1.467255	1.4E-05	0.282151	5.0E-06
JMC475+5ppb Yb	0.331440	2.6E-05	0.062068	3.1E-05	1.3994	2.0E-03	1.4344	3.5E-03	0.048907	2.5E-05	1.467269	1.4E-05	0.282146	5.5E-06
JMC475+10ppb Yb	0.378388	5.2E-05	0.121185	6.5E-05	1.4492	2.0E-03	1.4764	2.8E-03	0.095448	5.2E-05	1.467257	1.3E-05	0.282146	7.2E-06
JMC475+10ppb Yb	0.378105	3.7E-05	0.120824	4.7E-05	1.4662	2.0E-03	1.4958	2.7E-03	0.095168	4.1E-05	1.467269	1.3E-05	0.282144	5.7E-06
JMC475+10ppb Yb	0.377877	4.4E-05	0.120535	5.5E-05	1.4640	2.0E-03	1.4931	2.6E-03	0.094938	4.2E-05	1.467270	1.3E-05	0.282148	6.5E-06
JMC475+20ppb Yb	0.489814	1.9E-04	0.261524	2.4E-04	1.6329	2.4E-03	1.6494	2.4E-03	0.205775	1.9E-04	1.467269	9.3E-06	0.282157	8.0E-06
JMC475+20ppb Yb	0.489243	1.3E-04	0.260808	1.6E-04	1.6312	1.8E-03	1.6481	2.1E-03	0.205186	1.2E-04	1.467266	8.8E-06	0.282153	8.2E-06
JMC475+20ppb Yb	0.488508	1.1E-04	0.259885	1.4E-04	1.6260	1.9E-03	1.6432	2.5E-03	0.204443	1.2E-04	1.467273	2.3E-05	0.282149	1.3E-05
JMC475+50ppb Yb	0.844302	3.9E-04	0.707981	4.9E-04	1.6510	1.9E-03	1.6665	1.7E-03	0.556916	3.8E-04	1.467266	9.8E-06	0.282150	1.3E-05
JMC475+50ppb Yb	0.841788	4.0E-04	0.704809	5.1E-04	1.6419	2.5E-03	1.6586	2.6E-03	0.554879	5.7E-04	1.467270	9.1E-06	0.282143	1.4E-05
JMC475+50ppb Yb	0.840420	3.0E-04	0.703079	3.8E-04	1.6332	1.6E-03	1.6504	1.6E-03	0.553091	3.0E-04	1.467263	9.0E-06	0.282144	1.4E-05

Appendix 2 (Cont.)- Data for analysis of Yb-doped JMC475 Hf isotope standard solution

	^{176}(Hf+Yb)/^{177}Hf MB	2 S.E.	^{173}Yb/^{177}Hf MB	2 S.E.	Hf fract	2 S.E.	Yb fract	2 S.E.	^{176}Yb/^{177}Hf	2 S.E.	^{178}Hf/^{177}Hf	2 S.E.	^{176}Hf/^{177}Hf	2 S.E.
Session 4 - X-cones														
JMC475 Hf	0.282156	3.2E-06	0.000006	8.4E-07	1.0676	3.0E-02	-	-	0.000005	7.7E-07	1.467188	2.7E-05	0.282154	3.2E-06
JMC475 Hf	0.282152	3.1E-06	0.000006	8.4E-07	1.2174	3.1E-03	-	-	0.000005	9.5E-07	1.467186	1.7E-05	0.282150	3.1E-06
JMC475 Hf	0.282188	8.8E-06	0.000052	6.7E-06	1.0989	7.4E-03	-	-	0.000049	1.2E-05	1.467199	1.4E-05	0.282146	4.1E-06
JMC475+10ppb Yb	0.410635	1.6E-04	0.161868	2.0E-04	1.1674	2.3E-03	1.1637	2.3E-03	0.127693	1.9E-04	1.467200	1.3E-05	0.282152	4.6E-06
JMC475+10ppb Yb	0.411476	1.5E-04	0.162945	1.9E-04	1.1726	1.9E-03	1.1675	2.0E-03	0.128414	1.6E-04	1.467202	1.1E-05	0.282157	4.7E-06
JMC475+10ppb Yb	0.411398	2.7E-04	0.162828	3.4E-04	1.1672	4.2E-03	1.1634	3.7E-03	0.128391	3.7E-04	1.467167	4.1E-05	0.282154	8.5E-06
JMC475+20ppb Yb	0.554691	5.3E-04	0.343370	6.6E-04	1.2002	2.3E-03	1.1921	2.1E-03	0.270524	5.4E-04	1.467200	1.3E-05	0.282160	6.2E-06
JMC475+20ppb Yb	0.552370	5.4E-04	0.340440	6.8E-04	1.1868	3.1E-03	1.1804	2.8E-03	0.268475	6.5E-04	1.467210	2.4E-05	0.282159	7.3E-06
JMC475+20ppb Yb	0.552003	8.4E-04	0.339976	1.1E-03	1.1855	4.3E-03	1.1795	4.0E-03	0.268149	9.0E-04	1.467211	1.9E-05	0.282155	9.1E-06
JMC475+50ppb Yb	0.992708	1.3E-03	0.895162	1.7E-03	1.1578	3.7E-03	1.1550	3.2E-03	0.705771	1.6E-03	1.467202	1.7E-05	0.282157	2.1E-05
JMC475+50ppb Yb	0.993774	1.2E-03	0.896480	1.5E-03	1.1588	3.2E-03	1.1562	2.8E-03	0.707048	1.4E-03	1.467199	1.1E-05	0.282170	1.0E-05
JMC475+50ppb Yb	0.986610	1.2E-03	0.887443	1.6E-03	1.1364	4.3E-03	1.1357	3.9E-03	0.699154	1.6E-03	1.467207	1.1E-05	0.282157	1.2E-05

Appendix 3 - Data for laser ablation analysis of Yb and JMC475 Hf doped glass beads

	^{176}(Hf+Yb)/^{177}Hf MB		^{173}Yb/^{177}Hf MB		Hf fract		Yb fract		^{176}Yb/^{177}Hf		^{176}Lu/^{177}Hf	
Analysis No.		2 S.E.		2 S.E.		2 S.E.		2 S.E.		2 S.E.		2 S.E.
GB_CA1	1.121468	1.1E-04	1.05756	1.5E-04	0.7969	3.1E-03	0.7891	3.2E-03	8.36E-01	1.3E-04	6.25E-07	1.9E-07
GB_CA2	1.103419	1.7E-04	1.03465	2.2E-04	0.7231	3.0E-03	0.7250	4.1E-03	8.18E-01	2.1E-04	5.22E-07	1.0E-07
GB_CA3	1.097736	2.3E-04	1.02746	3.0E-04	0.7047	3.0E-03	0.7079	4.2E-03	8.12E-01	2.4E-04	3.80E-07	1.1E-07
GB_CA4	1.085635	2.0E-04	1.01215	2.7E-04	0.6896	3.0E-03	0.6885	4.3E-03	8.00E-01	2.2E-04	4.43E-07	1.2E-07
GB_CA5	1.086636	1.4E-04	1.01363	2.0E-04	0.6930	2.9E-03	0.6929	4.0E-03	8.01E-01	1.8E-04	3.83E-07	1.2E-07
GB_CA6	1.070023	9.8E-04	0.99290	1.2E-03	0.7059	4.0E-03	0.7005	6.0E-03	7.85E-01	9.9E-04	3.92E-07	1.8E-07
GB_CB1	-	-	-	-	0.7166	4.2E-03	-	-	1.29E-05	1.0E-05	-4.06E-07	3.4E-07
GB_CB2	-	-	-	-	0.7434	4.5E-03	-	-	3.21E-06	1.1E-05	-2.89E-07	3.8E-07
GB_CB3	-	-	-	-	0.7449	4.5E-03	-	-	-8.96E-06	1.1E-05	2.00E-08	3.9E-07
GB_CB4	-	-	-	-	0.7665	4.8E-03	-	-	4.29E-06	1.2E-05	-6.48E-07	3.9E-07
GB_CB5	-	-	-	-	0.7681	4.5E-03	-	-	-1.37E-05	1.2E-05	3.48E-07	3.5E-07
GB_CB6	-	-	-	-	0.9388	3.8E-03	-	-	-7.42E-07	6.2E-06	-7.26E-08	2.2E-07
GB_CB7	-	-	-	-	0.9173	3.6E-03	-	-	1.12E-05	6.4E-06	-1.80E-07	2.0E-07
GB_CB8	-	-	-	-	0.9133	4.1E-03	-	-	-3.09E-06	8.3E-06	1.39E-07	2.7E-07
GB_CC1	0.420556	5.3E-05	0.17439	6.7E-05	0.7692	3.2E-03	0.7723	8.5E-03	1.38E-01	6.0E-05	6.03E-08	2.0E-07
GB_CC2	0.420470	3.9E-05	0.17431	5.0E-05	0.7656	3.7E-03	0.7537	8.7E-03	1.38E-01	4.7E-05	-6.48E-08	1.9E-07
GB_CC3	0.418744	5.0E-05	0.17207	6.2E-05	0.8076	3.2E-03	0.7926	8.3E-03	1.36E-01	6.1E-05	7.04E-07	2.0E-07
GB_CC4	0.419522	4.4E-05	0.17305	5.5E-05	0.7894	3.6E-03	0.7716	8.7E-03	1.37E-01	5.2E-05	-3.39E-08	1.9E-07
GB_CC5	0.418917	4.5E-05	0.17232	5.6E-05	0.8033	3.3E-03	0.7850	8.7E-03	1.36E-01	5.3E-05	3.92E-07	2.0E-07
GB_CC6	0.428162	5.2E-05	0.18395	6.7E-05	0.8762	2.4E-03	0.8683	5.7E-03	1.45E-01	5.7E-05	2.68E-07	1.1E-07
GB_CD1	0.322416	1.9E-05	0.05071	1.9E-05	0.8090	3.3E-03	0.7991	1.8E-02	4.01E-02	2.2E-05	1.05E-06	1.8E-07
GB_CD2	0.322409	2.0E-05	0.05071	2.3E-05	0.8183	3.3E-03	0.8041	1.8E-02	4.01E-02	2.5E-05	1.23E-06	1.8E-07
GB_CD3	0.322260	1.9E-05	0.05052	1.9E-05	0.8271	3.5E-03	0.8182	1.9E-02	3.99E-02	2.3E-05	1.04E-06	1.7E-07
GB_CD4	0.321920	1.5E-05	0.05011	1.6E-05	0.8498	3.7E-03	0.8405	1.9E-02	3.96E-02	2.2E-05	9.16E-07	1.5E-07
GB_CD5	0.322090	3.1E-05	0.05032	3.6E-05	0.8470	3.2E-03	0.8532	1.9E-02	3.98E-02	3.7E-05	8.74E-07	1.6E-07
GB_CD6	0.325564	1.3E-05	0.05468	1.4E-05	0.8718	2.6E-03	0.8637	9.7E-03	4.32E-02	1.5E-05	1.09E-06	7.6E-08
GB_CD7	0.325670	1.2E-05	0.05481	1.3E-05	0.8740	2.7E-03	0.8741	1.0E-02	4.33E-02	1.5E-05	1.18E-06	7.9E-08
GB_CD8	0.326241	4.4E-05	0.05555	5.7E-05	0.8870	2.5E-03	0.8698	9.8E-03	4.39E-02	4.5E-05	1.07E-06	8.0E-08
GB_CE1	0.309514	1.7E-05	0.03442	1.3E-05	0.8571	3.6E-03	0.8441	3.6E-02	2.72E-02	2.4E-05	5.14E-07	2.2E-07
GB_CE2	0.312720	1.3E-05	0.03851	1.3E-05	0.8698	2.7E-03	0.8596	1.7E-02	3.04E-02	1.6E-05	5.25E-07	1.1E-07
GB_CE3	0.312570	1.3E-05	0.03832	1.1E-05	0.8707	3.0E-03	0.8772	1.5E-02	3.03E-02	1.3E-05	6.16E-07	1.0E-07
GB_CE4	0.312546	1.5E-05	0.03828	1.6E-05	0.8719	2.8E-03	0.8279	1.5E-02	3.02E-02	1.6E-05	5.78E-07	1.0E-07
GB_CE5	0.312576	1.4E-05	0.03832	1.3E-05	0.8774	3.0E-03	0.8532	1.5E-02	3.03E-02	1.5E-05	5.48E-07	1.0E-07
GB_CF1	0.385051	3.3E-05	0.12962	4.2E-05	0.8541	3.0E-03	0.8533	7.6E-03	1.02E-01	3.7E-05	2.59E-07	1.1E-07
GB_CF2	0.385090	3.5E-05	0.12968	4.5E-05	0.8689	2.7E-03	0.8712	6.5E-03	1.02E-01	4.0E-05	2.12E-07	1.0E-07
GB_CF3	0.384415	1.6E-05	0.12884	2.1E-05	0.8613	2.8E-03	0.8602	6.6E-03	1.02E-01	2.4E-05	2.68E-07	9.9E-08
GB_CF4	0.384394	4.3E-05	0.12880	5.1E-05	0.8683	2.5E-03	0.8619	6.6E-03	1.02E-01	4.7E-05	2.22E-07	9.4E-08
GB_CF5	0.384519	2.2E-05	0.12899	3.0E-05	0.8766	3.1E-03	0.8726	7.7E-03	1.02E-01	3.1E-05	1.52E-07	9.9E-08

Appendix 3 (Cont.)- Data for laser ablation analysis of Yb and JMC475 Hf doped glass beads

	$^{178}Hf/^{177}Hf$		$^{176}Hf/^{177}Hf$ Uncorrected		Total Hf	^{173}Yb	$^{176}Hf/^{177}Hf$ - Yb-corr.		$^{176}Hf/^{177}Hf$ - Hf-corr.		$^{176}Hf/^{177}Hf$ - Hf-corr.	
Analysis No.		2 S.E.		2 S.E.	(V)	(V)		2 S.E.	H-cone value	2 S.E.	X-cone value	2 S.E.
GB_CA1	1.46729	5.28E-05	0.280823	7.08E-05	6.409	1.231	0.282086	6.9E-05	0.281863	2.67E-05	0.282027	5.34E-05
GB_CA2	1.46731	7.82E-05	0.280909	9.63E-05	12.047	2.269	0.282073	9.0E-05	0.281973	3.40E-05	0.282133	6.79E-05
GB_CA3	1.46729	7.94E-05	0.280895	1.01E-04	12.056	2.256	0.282038	9.6E-05	0.281951	3.53E-05	0.282106	7.04E-05
GB_CA4	1.46728	8.01E-05	0.280990	1.02E-04	10.534	1.943	0.282120	9.5E-05	0.281974	3.40E-05	0.282127	6.79E-05
GB_CA5	1.46730	7.50E-05	0.280969	9.40E-05	10.351	1.912	0.282084	8.9E-05	0.281963	3.31E-05	0.282115	6.61E-05
GB_CA6	1.46732	1.17E-04	0.280909	1.36E-04	8.702	1.578	0.281968	1.2E-04	0.281827	4.39E-05	0.281982	8.79E-05
GB_CB1	1.46728	9.00E-05	0.280979	2.23E-05	3.451	-	-	-	0.282123	2.41E-05	0.282122	2.41E-05
GB_CB2	1.46728	7.99E-05	0.280955	2.54E-05	3.360	-	-	-	0.282139	2.63E-05	0.282139	2.63E-05
GB_CB3	1.46726	7.88E-05	0.280994	2.20E-05	3.313	-	-	-	0.282185	2.42E-05	0.282186	2.42E-05
GB_CB4	1.46730	8.63E-05	0.280914	2.39E-05	3.145	-	-	-	0.282139	2.61E-05	0.282139	2.61E-05
GB_CB5	1.46731	8.49E-05	0.280974	2.35E-05	3.297	-	-	-	0.282200	2.52E-05	0.282199	2.52E-05
GB_CB6	1.46728	8.82E-05	0.280655	1.49E-05	6.120	-	-	-	0.282154	1.59E-05	0.282154	1.59E-05
GB_CB7	1.46726	9.70E-05	0.280694	1.56E-05	5.838	-	-	-	0.282160	1.65E-05	0.282159	1.65E-05
GB_CB8	1.46730	7.34E-05	0.280699	1.95E-05	6.591	-	-	-	0.282158	2.16E-05	0.282159	2.16E-05
GB_CC1	1.46727	7.89E-05	0.280874	3.50E-05	6.226	0.197	0.282106	3.4E-05	0.282091	2.09E-05	0.282119	2.08E-05
GB_CC2	1.46728	8.71E-05	0.280931	3.51E-05	6.548	0.208	0.282158	3.3E-05	0.282107	2.11E-05	0.282134	2.11E-05
GB_CC3	1.46728	7.62E-05	0.280886	3.33E-05	6.031	0.188	0.282180	3.2E-05	0.282121	2.00E-05	0.282148	1.99E-05
GB_CC4	1.46731	8.39E-05	0.280922	3.31E-05	6.373	0.200	0.282182	3.2E-05	0.282121	1.90E-05	0.282147	1.90E-05
GB_CC5	1.46725	7.69E-05	0.280878	3.42E-05	6.250	0.196	0.282162	3.3E-05	0.282099	1.94E-05	0.282125	1.94E-05
GB_CC6	1.46729	6.73E-05	0.280759	2.58E-05	11.714	0.390	0.282160	2.4E-05	0.282119	1.47E-05	0.282148	1.47E-05
GB_CD1	1.46727	8.19E-05	0.280875	2.15E-05	7.346	0.068	0.282170	2.1E-05	0.282155	1.47E-05	0.282163	1.47E-05
GB_CD2	1.46730	8.48E-05	0.280860	2.20E-05	7.727	0.071	0.282168	2.2E-05	0.282150	1.42E-05	0.282157	1.42E-05
GB_CD3	1.46728	8.72E-05	0.280838	2.36E-05	7.420	0.068	0.282156	2.3E-05	0.282147	1.54E-05	0.282155	1.54E-05
GB_CD4	1.46729	9.22E-05	0.280788	2.24E-05	7.357	0.067	0.282148	2.1E-05	0.282135	1.45E-05	0.282143	1.45E-05
GB_CD5	1.46727	8.26E-05	0.280780	2.34E-05	7.518	0.069	0.282133	2.3E-05	0.282132	1.52E-05	0.282140	1.52E-05
GB_CD6	1.46729	8.36E-05	0.280761	1.55E-05	15.554	0.154	0.282153	1.4E-05	0.282144	1.00E-05	0.282152	1.00E-05
GB_CD7	1.46730	8.12E-05	0.280759	1.60E-05	16.359	0.163	0.282156	1.5E-05	0.282149	1.08E-05	0.282158	1.08E-05
GB_CD8	1.46731	8.11E-05	0.280752	1.49E-05	15.345	0.155	0.282169	1.4E-05	0.282150	1.01E-05	0.282159	1.00E-05
GB_CE1	1.46731	8.97E-05	0.280816	2.85E-05	5.134	0.032	0.282193	2.8E-05	0.282180	1.83E-05	0.282186	1.84E-05
GB_CE2	1.46732	7.93E-05	0.280767	1.70E-05	11.123	0.078	0.282159	1.6E-05	0.282149	1.18E-05	0.282155	1.18E-05
GB_CE3	1.46728	8.55E-05	0.280758	1.67E-05	11.581	0.080	0.282148	1.6E-05	0.282149	1.22E-05	0.282155	1.22E-05
GB_CE4	1.46728	8.37E-05	0.280784	1.58E-05	11.381	0.079	0.282180	1.5E-05	0.282149	1.06E-05	0.282155	1.06E-05
GB_CE5	1.46729	8.55E-05	0.280768	1.56E-05	11.860	0.082	0.282170	1.5E-05	0.282152	1.06E-05	0.282157	1.06E-05
GB_CF1	1.46730	8.30E-05	0.280790	2.43E-05	11.692	0.275	0.282153	2.2E-05	0.282139	1.46E-05	0.282160	1.47E-05
GB_CF2	1.46730	8.13E-05	0.280752	2.25E-05	12.505	0.294	0.282142	2.1E-05	0.282133	1.36E-05	0.282154	1.36E-05
GB_CF3	1.46729	8.07E-05	0.280755	2.23E-05	12.266	0.287	0.282129	2.1E-05	0.282114	1.41E-05	0.282134	1.40E-05
GB_CF4	1.46726	7.28E-05	0.280756	2.18E-05	12.533	0.293	0.282144	2.0E-05	0.282118	1.30E-05	0.282137	1.30E-05
GB_CF5	1.46729	9.34E-05	0.280726	2.61E-05	13.052	0.305	0.282131	2.3E-05	0.282108	1.49E-05	0.282128	1.49E-05

Appendix 4 - Data for solution analyses of Gd-Dy-Tb-doped JMC475 Hf isotope standard solution

	$^{176}Hf/^{177}Hf$ [a]		Hf fract [a]		$^{176}Hf/^{177}Hf$ [b]		Hf fract [b]		$^{176}GdO/^{177}Hf$		$^{176}DyO/^{177}Hf$		$^{196}HfO/^{180}Hf$
Analysis No.	Isobaric corr. only (2 S.E.)			2 S.E.	Oxide Corr.	2 S.E.		2 S.E.		2 S.E.		2 S.E.	(%)
JMC475 Hf	0.282151	2.0E-06	1.06760	0.02971	-	-	-	-	-	-	-	-	-
JMC475 Hf	0.282147	1.7E-06	1.21736	0.00313	-	-	-	-	-	-	-	-	-
JMC475 Hf	0.282146	2.1E-06	1.09891	0.00736	-	-	-	-	-	-	-	-	-
Hf-Gd-Dy-Tb_A1	0.282147	4.5E-06	1.11761	0.00588	0.282142	4.5E-06	1.11745	0.00588	8.70E-06	1.20E-07	2.70E-07	3.74E-09	0.0164
Hf-Gd-Dy-Tb_A2	0.282152	4.9E-06	1.11648	0.01426	0.282147	4.9E-06	1.11632	0.01427	8.82E-06	3.31E-07	2.73E-07	1.02E-08	0.0165
Hf-Gd-Dy-Tb_B1	0.282154	4.5E-06	1.13456	0.00387	0.282146	4.6E-06	1.13426	0.00387	1.70E-05	1.56E-07	5.37E-07	4.79E-09	0.0166
Hf-Gd-Dy-Tb_C1	0.282165	3.8E-06	1.13236	0.00355	0.282149	3.8E-06	1.13176	0.00354	3.28E-05	2.55E-07	1.03E-06	7.78E-09	0.0166
Hf-Gd-Dy-Tb_D1	0.282179	4.7E-06	1.14147	0.00374	0.282147	4.7E-06	1.14024	0.00373	6.71E-05	6.14E-07	2.13E-06	1.99E-08	0.0167
Hf-Gd-Dy-Tb_D2	0.282177	4.2E-06	1.13524	0.01227	0.282144	4.5E-06	1.13398	0.01229	6.82E-05	2.41E-06	2.18E-06	8.04E-08	0.0169

Appendix 5 - Data for laser ablation analysis of rare earth element doped beads

	$^{176}Hf/^{177}Hf$ [a]		Hf fract [a]		$^{176}Hf/^{177}Hf$ [b]		$^{176}Hf/^{177}Hf$ [b]		$^{176}Hf/^{177}Hf$ [b]		$^{160}Gd/^{177}Hf$		$^{162}Dy/^{177}Hf$		$^{193}HfO/^{177}Hf$
Analysis No.				2 S.E.	Oxide Corr.	2 S.E.		2 S.E.		2 S.E.		2 S.E.		2 S.E.	(%)
Gd-doped beads					Solution rate - 5.06		Laser Rate - 11.28		Laser Rates - 11.40						
GB_Gd2c	0.284318	1.3E-05	0.9466	6.0E-03	0.283361	1.3E-05	0.282181	1.3E-05	0.282158	1.3E-05	0.33665	1.1E-02	-	-	0.128
GB_Gd2d	**0.284210**	**1.6E-05**	**0.8962**	**5.0E-03**	**0.283303**	**1.6E-05**	**0.282184**	**1.6E-05**	**0.282162**	**1.6E-05**	**0.34310**	**1.8E-02**	-	-	**0.121**
GB_Gd2e	0.284242	1.5E-05	0.8902	5.9E-03	0.283277	1.5E-05	0.282092	1.4E-05	0.282069	1.4E-05	0.34704	1.5E-02	-	-	0.128
GB_Gd2f	0.284230	2.0E-05	0.8717	5.4E-03	0.283314	1.8E-05	0.282191	1.8E-05	0.282169	1.8E-05	0.33051	5.8E-03	-	-	0.121
GB_Gd2g	0.284251	1.4E-05	0.8667	4.9E-03	0.283288	1.5E-05	0.282111	1.5E-05	0.282088	1.5E-05	0.35033	1.8E-02	-	-	0.127
GB_Gd3c	0.282199	1.5E-05	0.9341	6.3E-03	0.282178	1.5E-05	0.282153	1.5E-05	0.282152	1.5E-05	0.00702	2.3E-04	-	-	0.124
GB_Gd3d	0.282202	1.5E-05	0.9750	5.1E-03	0.282182	1.5E-05	0.282159	1.5E-05	0.282158	1.5E-05	0.00718	2.6E-04	-	-	0.121
GB_Gd4c	**0.282274**	**1.6E-05**	**0.9870**	**4.8E-03**	**0.282213**	**1.6E-05**	**0.282138**	**1.6E-05**	**0.282137**	**1.6E-05**	**0.02121**	**8.8E-04**	-	-	**0.125**
GB_Gd4d	0.282289	1.9E-05	0.9986	4.4E-03	0.282228	1.9E-05	0.282153	1.9E-05	0.282152	1.9E-05	0.02115	6.2E-04	-	-	0.128
GB_Gd4e	0.282305	1.7E-05	1.0028	5.4E-03	0.282248	1.6E-05	0.282179	1.6E-05	0.282178	1.6E-05	0.02141	6.4E-04	-	-	0.123
GB_Gd4f	0.282284	1.8E-05	0.9924	5.1E-03	0.282229	1.8E-05	0.282161	1.9E-05	0.282160	1.9E-05	0.02093	4.5E-04	-	-	0.119
GB_Gd4g	0.282282	1.7E-05	0.9969	4.7E-03	0.282224	1.7E-05	0.282155	1.7E-05	0.282154	1.7E-05	0.02086	6.1E-04	-	-	0.122
GB_Gd5c	0.282321	1.7E-05	0.9840	4.6E-03	0.282245	1.7E-05	0.282151	1.7E-05	0.282149	1.7E-05	0.02956	5.7E-04	-	-	0.118
GB_Gd5d	0.282331	1.6E-05	0.9908	4.4E-03	0.282252	1.7E-05	0.282153	1.7E-05	0.282151	1.7E-05	0.02977	7.4E-04	-	-	0.119
GB_Gd5e	**0.282322**	**1.7E-05**	**0.9943**	**3.8E-03**	**0.282237**	**1.7E-05**	**0.282134**	**1.7E-05**	**0.282132**	**1.7E-05**	**0.03041**	**7.5E-04**	-	-	**0.124**
GB_Gd5f	0.282337	1.7E-05	0.9858	4.2E-03	0.282258	1.8E-05	0.282161	1.8E-05	0.282159	1.8E-05	0.02936	5.5E-04	-	-	0.118
GB_Gd5g	0.282343	1.9E-05	0.9930	3.9E-03	0.282261	2.0E-05	0.282163	2.0E-05	0.282161	2.0E-05	0.02995	5.5E-04	-	-	0.117
GB_Gd6c	0.282426	1.9E-05	0.9839	4.9E-03	0.282310	2.0E-05	0.282167	2.0E-05	0.282164	2.0E-05	0.04310	1.1E-03	-	-	0.122
GB_Gd6d	0.282399	1.5E-05	0.9775	4.3E-03	0.282292	1.5E-05	0.282159	1.6E-05	0.282157	1.6E-05	0.04157	9.4E-04	-	-	0.115
GB_Gd6e	0.282406	1.5E-05	0.9849	4.9E-03	0.282286	1.5E-05	0.282139	1.5E-05	0.282136	1.5E-05	0.04236	1.0E-03	-	-	0.124
GB_Gd6f	0.282421	1.9E-05	0.9817	5.1E-03	0.282310	1.9E-05	0.282173	2.0E-05	0.282171	2.0E-05	0.04307	1.2E-03	-	-	0.117
GB_Gd6g	**0.282427**	**1.6E-05**	**0.9860**	**4.6E-03**	**0.282313**	**1.6E-05**	**0.282169**	**1.7E-05**	**0.282166**	**1.7E-05**	**0.04355**	**1.5E-03**	-	-	**0.120**
Dy-doped beads															
GB_Dy1a	0.282165	1.3E-05	1.1138	0.0045	-	-	-	-	-	-	-	-	0.08207	5.2E-03	0.169
GB_Dy1b	0.282161	1.5E-05	1.0803	0.00513	-	-	-	-	-	-	-	-	0.07963	5.0E-03	0.151
GB_Dy1c	0.282157	1.6E-05	1.0796	0.00519	-	-	-	-	-	-	-	-	0.08062	3.5E-03	0.158
GB_Dy1d	0.282148	2.1E-05	0.7352	0.00516	-	-	-	-	-	-	-	-	0.08513	6.1E-03	0.163
GB_Dy1e	0.282140	2.1E-05	0.7315	0.00494	-	-	-	-	-	-	-	-	0.08665	4.9E-03	0.174
GB_Dy2a	0.282144	1.3E-05	1.0486	0.0039	-	-	-	-	-	-	-	-	0.05307	1.8E-03	0.156
GB_Dy2b	0.282149	1.4E-05	1.0623	0.00468	-	-	-	-	-	-	-	-	0.05416	2.0E-03	0.158
GB_Dy2c	0.282132	2.5E-05	0.6900	0.00659	-	-	-	-	-	-	-	-	0.05762	2.1E-03	0.218
GB_Dy2d	0.282158	2.1E-05	0.6992	0.00444	-	-	-	-	-	-	-	-	0.05728	3.7E-03	0.151
GB_Dy2e	0.282157	2E-05	0.7278	0.00542	-	-	-	-	-	-	-	-	0.05634	3.1E-03	0.127
GB_Dy2f	0.282157	2E-05	0.7087	0.00503	-	-	-	-	-	-	-	-	0.05519	2.6E-03	0.134
GB_Dy2g	**0.282148**	**2.3E-05**	**0.7324**	**0.00559**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.05473**	**1.8E-03**	**0.124**
GB_Dy6a	0.282158	1.4E-05	0.9625	0.00567	-	-	-	-	-	-	-	-	0.00006	2.6E-05	0.230
GB_Dy7a	0.282158	2E-05	1.0380	0.00551	-	-	-	-	-	-	-	-	0.44027	4.2E-02	0.255
GB_Dy7b	0.282152	1.8E-05	1.0073	0.00615	-	-	-	-	-	-	-	-	0.43316	3.2E-02	0.221
GB_Dy7c	0.282193	2.3E-05	1.0131	0.00726	-	-	-	-	-	-	-	-	0.44861	2.7E-02	0.234
GB_Dy7d	0.282152	1.8E-05	1.0018	0.00521	-	-	-	-	-	-	-	-	0.43566	1.9E-02	0.216

[a]Isobaric correction only, [b]Molecular Interference correction

Appendix 5 (cont.) - Data for laser ablation analysis of rare earth element doped beads

	$^{176}Hf/^{177}Hf$ [a]		$^{176}Hf/^{177}Hf$ [b]		$^{176}Hf/^{177}Hf$ [b]		Hf fract [b]		$^{176}Yb/^{177}Hf$		$^{160}Gd/^{177}Hf$		$^{162}Dy/^{177}Hf$		$^{193}HfO/^{177}Hf$
Analysis No.				2 S.E.		2 S.E.		2 S.E.		2 S.E.		2 S.E.		2 S.E.	(%)
Zircon Comp. Glass Bead			Using Laser Rate - 11.28		Using Laser Rates - 11.40										
GB_Dy5a	0.282313	8.5E-05	0.282229	8.5E-05	0.282228	8.5E-05	0.7204	5.7E-03	0.3532	1.3E-04	0.02104	1.2E-03	0.08704	4.8E-03	0.117
GB_Dy5b	0.282224	9.9E-05	0.282143	9.9E-05	0.282142	9.9E-05	0.7397	5.8E-03	0.3512	2.0E-04	0.02147	1.6E-03	0.08896	6.5E-03	0.113
GB_Dy5c	0.282274	8.7E-05	0.282199	8.5E-05	0.282198	8.5E-05	0.7581	6.3E-03	0.3487	1.6E-04	0.02163	1.5E-03	0.08950	6.0E-03	0.107
GB_Dy5d	0.282190	1.2E-04	0.282116	1.2E-04	0.282115	1.2E-04	0.7553	7.8E-03	0.3489	3.0E-04	0.02174	1.3E-03	0.09005	5.2E-03	0.115
GB_Dy5e	0.282287	9.3E-05	0.282113	9.1E-05	0.282111	9.1E-05	1.0866	5.6E-03	0.3993	2.8E-04	0.01981	1.0E-03	0.08615	4.3E-03	0.272
GB_Dy5f	0.282222	9.3E-05	0.282059	9.1E-05	0.282058	9.1E-05	1.0419	4.6E-03	0.3939	1.9E-04	0.01980	1.6E-03	0.08575	6.8E-03	0.249
GB_Dy5g	0.282296	1.0E-04	0.282127	9.8E-05	0.282125	9.8E-05	1.0578	5.1E-03	0.3968	2.4E-04	0.01907	8.9E-04	0.08285	3.9E-03	0.259
Weighted Mean	**0.282263**	**3.5E-05**	**0.282146**	**5.5E-05**	**0.282144**	**5.6E-05**									

[a]Isobaric correction only, [b]Molecular Interference correction