GSA Data Repository item 2010082

Appendix DR1. SHRIMP analytical procedures and data interpretation, Figures DR1–DR8 and Tables DR1–DR10

Dating sedimentary rocks using in situ U–Pb geochronology of syn-eruptive zircon in ashfall tuffs <1 mm thick

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SHRIMP U–Pb ZIRCON ANALYSES

Sample preparation

After zircons were identified in polished thin sections (PTS) by optical microscopy, portions of the PTS were removed for SHRIMP analysis. In most cases this was done by core-drilling ~3 mm plugs from the PTS, but for two samples with higher zircon densities longer fragments of the PTS were cut out. The fragments of PTS were cast into normal 25 mm resin mounts. Two of the mounts (BR09-19 and BR09-20) included pre-cast 3 mm discs holding the BR266 Pb/U and U abundance reference standard and a $^{207}Pb/^{206}Pb$ monitor. The other analyses relied on standards in separate mounts that were cleaned and Au-coated with the sample mounts.

U–Pb analyses

The SHRIMP analyses followed routine zircon analytical practise, except for using smaller primary beam diameters (spots) than is common. This necessitates using smaller primary ion currents and correspondingly lower secondary ion count rates. Operating parameters for the three analytical sessions are listed in Table DR1.

All analyses were comprised of seven scans of the mass spectrum. However, to compensate for the modest number of sample grains and the reduced secondary ion count rates, an additional measurement was made on some spots. When these 'repeats' followed immediately after the first analysis the spot was not moved; such analyses are identified by postscript 'b' in the analysis labels. When analysis sites were 'revisited' after intervening analyses the spots had variable overlap with the originals; such analyses are labelled 'x'. No attempt was made to calibrate Pb/U or element abundances for the repeat and revisit analyses (i.e., no repeat analyses were recorded for the standards). Consequently, U, Th, Pb/U and Pb/Th data are not reported for these analyses. The sample ablated during these analyses is obviously immediately adjacent to the volume ablated in the original analyses, and it is assumed to be equally well-preserved. Thus the concordance/discordance measurement from the original analyses was applied to the corresponding repeat and revisited analyses. The Pb isotope data (including the correction for common Pb) in the re-analyses are unaffected.

Results

A numerical summary of the recorded analyses is given in Table DR2. Data were reduced using Squid-2 software (Ludwig, 2009) and plots prepared with Isoplot-3 (Ludwig, 2008).

The following notes apply to all data tables (Tables DR3–DR10):

1. Analysis identification is nnnnX.p-q where nnnn is the mount number, X is the fragment of thin section in the mount, p is the zircon grain within that fragment, and q is the analysis spot within that grain. A postscript 'b' denotes a repeat analysis on the same spot; 'x' is a repeat ('revisit') analysis overlapping the original spot.
2. "f206" is the proportion of ^{206}Pb calculated to be common Pb on the basis of measured ^{204}Pb/^{206}Pb and modelled common Pb composition (Stacey and Kramers, 1975) at the approximate sample age.
3. All listed Pb isotope data are corrected for common Pb, based on measured ^{204}Pb/^{206}Pb.
4. "Disc." is apparent concordance, defined as 100*(1-t[^{206}Pb/^{238}U]/t[^{207}Pb/^{206}Pb]).
5. Listed uncertainties are 1σ and include all components of statistical precision.

The concordia plots (Figs. DR1-DR8) display all first-measurement data. They are plotted as 1σ precision ellipses with the following color code:

Light yellow: 1–2% common ^{206}Pb
Full yellow: >2% common ^{206}Pb
25% grey: >5% but <10% discordant
50% grey: ≥10% discordant
Green: ^{207}Pb/^{206}Pb (age) outlier
[Some analyses qualify for two shadings.]

All ages quoted below are weighted mean ^{207}Pb/^{206}Pb ages, calculated from all the measurements retained for each sample. In doing this, the 'repeat' and 'revisit' measurements are treated as independent analyses, even though they represent volumes of sample contiguous with that of the original analyses and they could be considered to be extensions of the original analyses. It could be argued that the additional data should be combined with the original analyses before weighted means are calculated for the samples, but this makes no significant difference to the final results. However, in most cases the number of discrete spots analysed is appreciably less that the number of measurements used.

REFERENCES CITED

Ludwig, K.R., 2008, Isoplot 3.6; a geochronology toolkit for Microsoft Excel. Berkeley Geochronology Center, 77p.

Ludwig, K.R., 2009, Squid 2; a user's manual. Berkeley Geochronology Center, 100p.

Stacey, J.S., and Kramers, J.D., 1975, Approximation of terrestrial lead isotope evolution by a two-stage model. Earth and Planetary Letters, v. 26, p. 207–221.

U–Pb ZIRCON DATA

Sample WRL-1 684.1 m

(mount BR09-17, discs G–L; mount BR09-20, discs F & G)

8 discs; 12 grains; 18 spots; 26 measurements (Table DR3; Fig. DR1)

Four analyses are discounted on the grounds of discordance and another four have >1% common ^{206}Pb. One other is a distinct (4σ) outlier in ^{207}Pb/^{206}Pb. The remaining 17 have a weighted mean ^{207}Pb/^{206}Pb age of 2632 ± 7 Ma (MSWD = 1.4). If two marginal (2σ) young outliers were also omitted this would become 2635 ± 5 Ma, but the corresponding MSWD (0.8) implies over-culling.

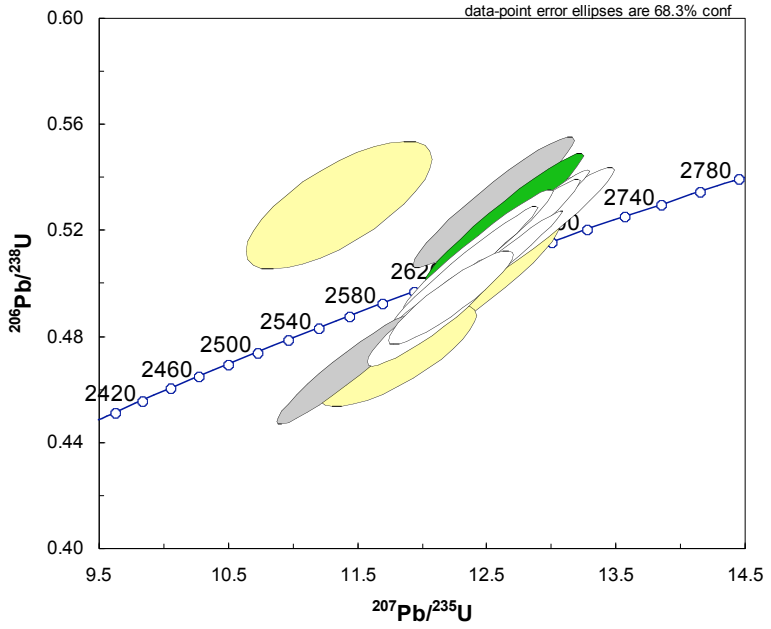

Figure DR1. U–Pb concordia plot for zircons in WRL-1 684.1 m.

Sample WRL-1 699.3 m

(mount BR09-19, discs A–D & K)

5 discs; 7 grains; 11 spots; 19 measurements (Table DR4; Fig. DR2)

Three analyses are highly discordant and are not considered. Four others (two spots) are >5% discordant and one has >1% common ^{206}Pb. The remaining 11 have a weighted mean ^{207}Pb/^{206}Pb age of 2654 ± 14 Ma (MSWD = 0.61). The average ^{207}Pb/^{206}Pb age for the four slightly discordant points is higher than this, implying that Pb loss is entirely recent and that ^{207}Pb/^{206}Pb has been preserved. If these four, and the analysis with 1.3% common Pb, are included the weighted mean age becomes 2657 ± 13 Ma (MSWD = 0.81). We use the latter result.

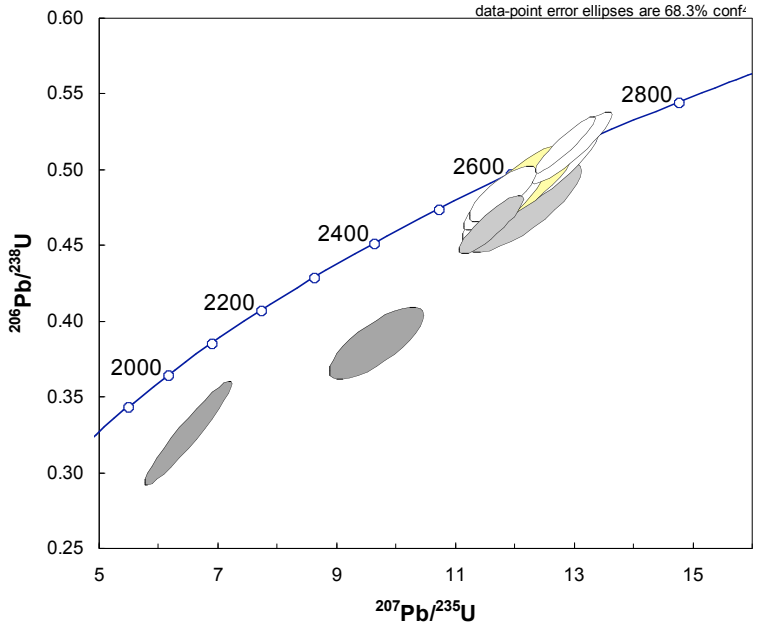

Figure DR2. U–Pb concordia plot for zircons in WRL-1 699.3 m.

Sample DDH186 176.15 m

(mount BR09-15, fragments A & B)

2 fragments; 15 grains; 15 spots; 28 measurements (Table DR5; Fig. DR3).

No rejections were required in this data set. The weighted mean $^{207}Pb/^{206}Pb$ age is 2664 ± 7 Ma (MSWD = 0.85).

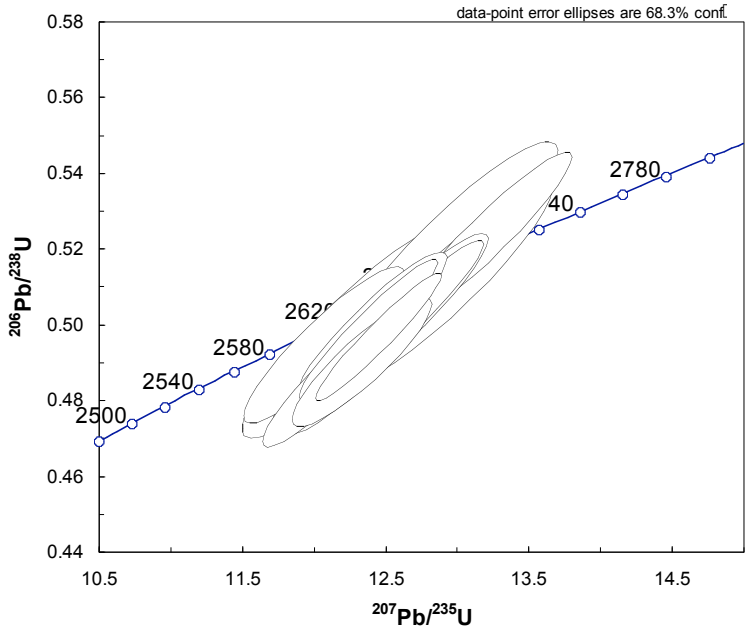

Figure DR3. U–Pb concordia plot for zircons in DDH186 176.15 m.

Sample DDH186 203.5 m

(mount BR09-20, discs I, J, L & M)

4 discs; 7 grains; 8 spots; 11 measurements (Table DR6; Fig. DR4).

Only four of these analyses satisfy the combined criteria of <1% common ^{206}Pb and ≤5% discordance. These give a weighted mean $^{207}Pb/^{206}Pb$ age of 2680 ± 14 Ma (MSWD = 0.89), the good precision resulting from the relatively high U contents (~400 ppm). Including four more with <1.3% common Pb and either minor reverse discordance or no discordance would give 2676 ± 11 Ma (MSWD = 0.79). We have used the latter, although in light of the apparent metamictisation of these grains and the small number of analyses, a more conservative result of 2680 ± 15 Ma can also be used.

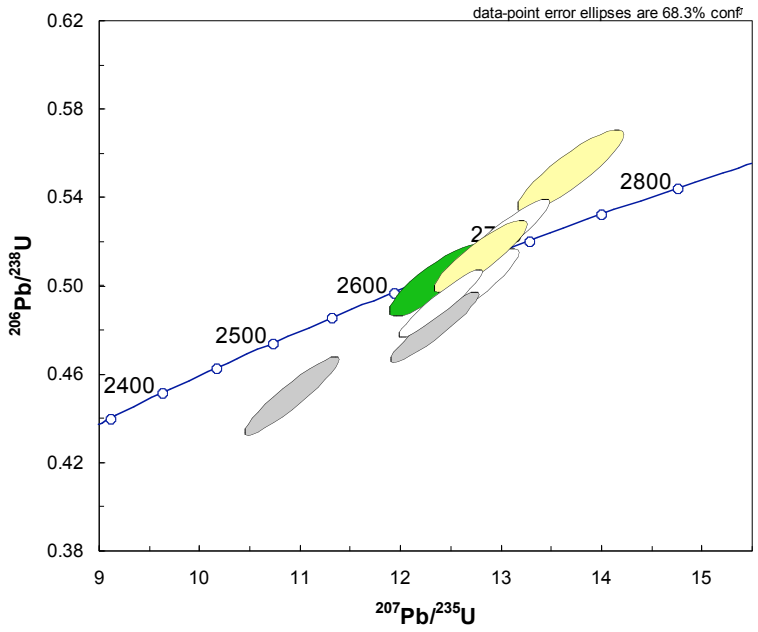

Figure DR4. U–Pb concordia plot for zircons in DDH186 203.5 m.

Sample FVG-1 734.0 m

(mount BR09-19, discs F–J; mount BR09-20, disc B)

6 discs; 9 grains; 10 spots; 18 measurements (Table DR7; Fig. DR5)

Five analyses are disregarded due to high discordance and three others have ≥1% common ^{206}Pb. One spot (two analyses) is moderately reversely discordant. Since true reverse discordance is uncommon and these data are just 1σ discordant, they have been retained. The low count rates (due to low U and low primary ion beam current) results in relatively poor precision for the individual analyses so, despite the good grouping of the 10 retained analyses, their weighted mean age ^{207}Pb/^{206}Pb has a relatively large uncertainty: 2600 ± 25 Ma (MSWD = 0.63) .

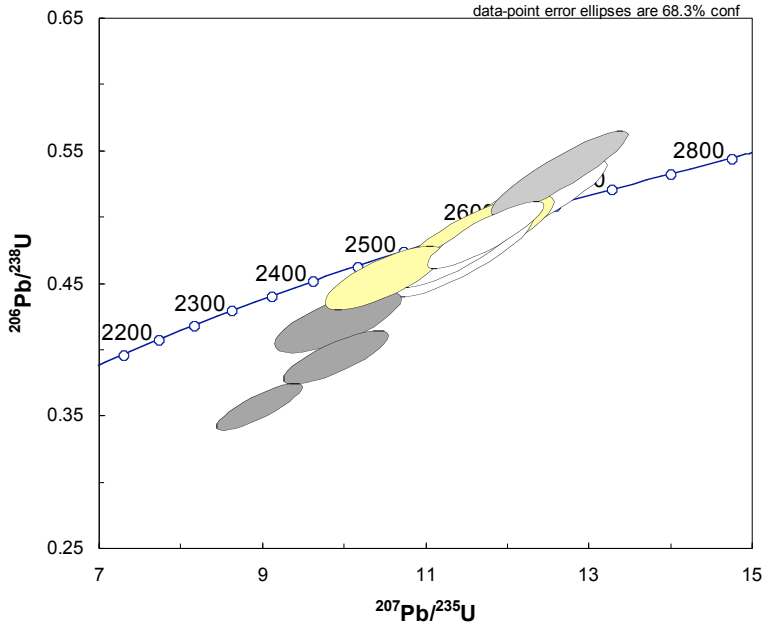

Figure DR5. U–Pb concordia plot for zircons in FVG-1 734.0 m.

Sample FVG-1 767.15 m
(mount BR09-15, fragments C & D)

2 fragments; 11 grains; 15 spots; 24 measurements (Table DR8; Fig. DR6)

Four analyses were disregarded for chronology due to >5% discordance or >1% common ^{206}Pb. The remaining 20 are tightly grouped, with a weighted mean $^{207}Pb/^{206}Pb$ age of 2662 ± 7 Ma (MSWD = 0.66), which can, to be conservative, be expanded to ± 10 Ma.

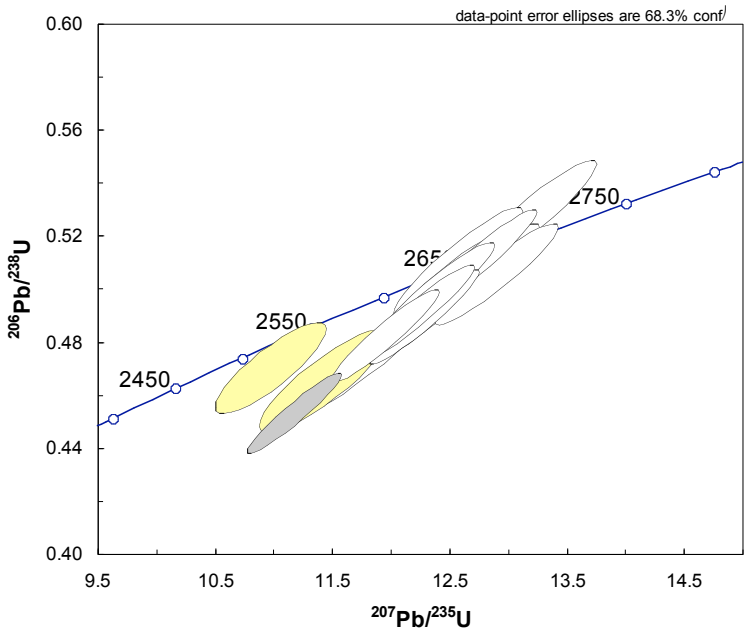

Figure DR6. U–Pb concordia plot for zircons in FVG-1 767.15 m.

Sample RHDH2A 254.6 m

(mount BR09-16, discs A–E)

5 discs; 14 grains; 18 spots; 29 measurements (Table DR9, Figure DR7)

Five analyses are >10% discordant and therefore not considered for chronology. There are seven analyses that are 5%–10% discordant. Since radiogenic Pb loss is dominantly recent (i.e., the $^{207}Pb/^{206}Pb$ for these analyses are entirely consistent with the main group), it could be argued that these should be added to the main $^{207}Pb/^{206}Pb$ data group, but we have not done so and it would make no change to the final result. One >3σ outlier in $^{207}Pb/^{206}Pb$ was also disregarded, though the reason for its disparity is not apparent. The main group, of 16 analyses, gives a weighted mean $^{207}Pb/^{206}Pb$ age of 2636 ± 10 Ma (rounded up; MSWD = 0.93).

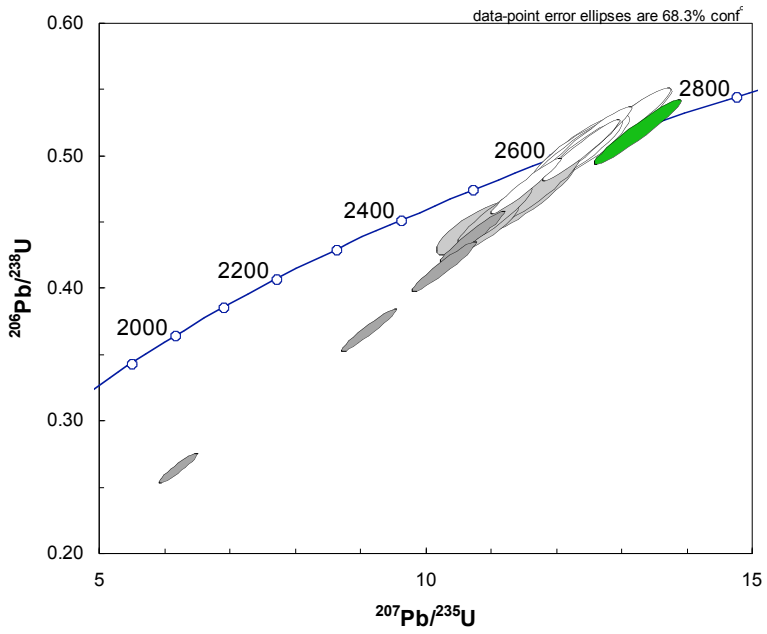

Figure DR7. U–Pb concordia plot for zircons in RHDH2A 254.6 m.

Sample RHDH2A 268.8 m

(mount BR09-16, discs G–J)

4 discs; 7 grains; 17 spots; 21 measurements (Table DR10; Fig. DR8)

These data form a single, coherent group (Fig. DR2) with only two showing >5% (and >1σ) discordance. However, there is significant spread in $^{207}Pb/^{206}Pb$, the entire data set having MSWD = 2.0, increasing to 2.1 when the discordant points are omitted. There is no identifiable reason for the scatter. In particular, almost the full range of $^{207}Pb/^{206}Pb$ is seen within single grains, including the six spots on the largest grain, 0916J.1. The values show no correlation with position within the grain.

The weighted mean $^{207}Pb/^{206}Pb$ age for the main group is 2643 ± 13 Ma.

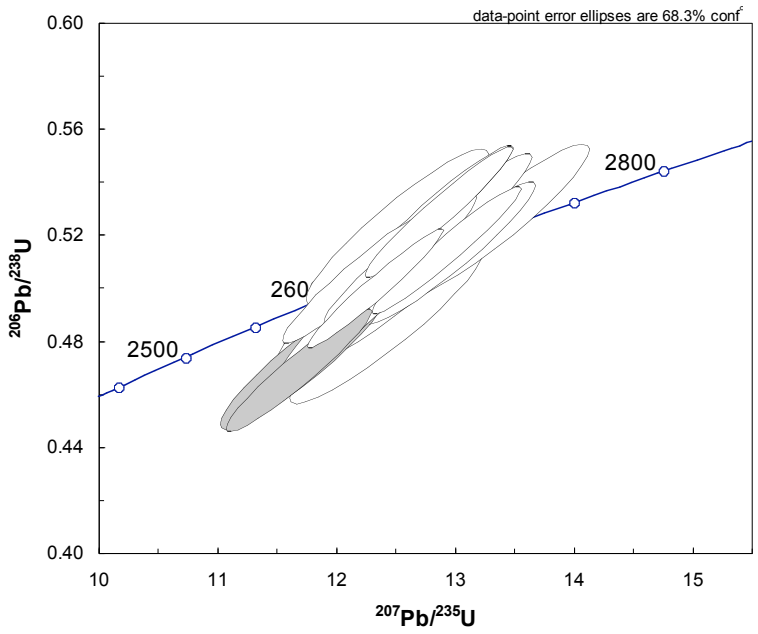

Figure DR8. U–Pb concordia plot for zircons in RHDH2A 268.8 m.

TABLE DR1. ANALYTICAL SESSIONS AND SHRIMP OPERATING PARAMETERS

Session	Date	Mounts	Samples	Kohler aperture (μm)	Spot size (μm)	O_2^- primary (nA)	M/ΔM (1%)	# Pb/U Stds	Pb/U External precision (1σ; %)
1	23/06/09	09-15	DDH186 176.15 m, FVG-1 767.15 m	50	10x12	0.36	4975	9 of 11	1.9
2	01/07/09	09-16, 09-17	RHDH2A 254.6 m, WRL-1 684.1 m, RHDH2A 268.8 m	50	10x12	0.43	5000	18 of 21	2.7
3	14/07/09	09-19, 09-20	WRL-1 699.3 m, FVG-1 734.0 m, DDH186 203.5 m, WRL-1 684.1 m	30	~8	0.18	4900	16 of 16	1.6

TABLE DR2. ANALYSIS SUMMARY

Sample	Tuff thickness (~mm)	# PTS used	Grains analysed	Total spots	Total meas.	Disc. & Common Pb	outliers	Used grains	Used spots	Used meas.	$^{207}Pb/^{206}Pb$ age (Ma)	±
WRL-1 684.1 m	0.5	4	12	18	26	8	1	9	12	17	2632	7
WRL-1 699.3 m	0.8	2	7	11	19	3	0	5	9	16	2657	13
DDH186 176.15 m	<3	1	15	15	28	0	0	15	15	28	2664	7
DDH186 203.5 m	0.6	1	7	8	11	2	1	5	5	8	2676	11
FVG-1 734.0 m	0.3	1	9	10	18	8	0	5	6	10	2600	25
FVG-1 767.15 m	0.8	1	11	15	24	4	0	9	12	20	2662	7
RHDH2A 254.6 m	0.3	1	14	18	29	12	1	9	9	16	2636	10
RHDH2A 268.8 m	3	1	7	17	21	2	0	7	15	19	2643	13
Total			82	112	176	39	3	61	83	134		

"Used" is the number used in the age determination.

TABLE DR3. SHRIMP U-Pb FOR ZIRCON IN TUFF LAYER FROM DRILL-HOLE WRL-1 684.1 m

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	Disc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)	Sess.
0917G.1-1	445	436	1.01	0.11	0.1766	0.0011	0.507	0.015	12.35	0.37	0.1376	0.0042	-1	2621	10	2
0917G.1-1b				0.09	0.1784	0.0008								2638	8	2
0917G.1-2	341	286	0.87	0.44	0.1792	0.0022	0.504	0.017	12.45	0.44	0.1288	0.0048	+1	2646	21	2
0917H.1-1b				0.33	0.1771	0.0018								2626	17	2
0917H.1-2	140	79	0.58	0.14	0.1776	0.0014	0.516	0.015	12.64	0.39	0.1401	0.0049	-2	2630	13	2
0917I.2-2	134	62	0.48	0.19	0.1762	0.0014	0.512	0.015	12.44	0.39	0.1441	0.0053	-2	2617	13	2
0917I.3-1	166	231	1.44	0.20	0.1783	0.0013	0.488	0.014	11.99	0.36	0.0547	0.0022	+3	2638	13	2
0917I.4-1	100	41	0.42	-0.04	0.1796	0.0016	0.520	0.016	12.87	0.42	0.1440	0.0057	-2	2649	15	2
0917I.4-1b				0.14	0.1777	0.0017								2632	16	2
0917I.4-2	73	31	0.43	0.00	0.1770	0.0018	0.516	0.017	12.58	0.42	0.1393	0.0058	-2	2625	17	2
0917K.1-1	337	183	0.56	0.12	0.1799	0.0009	0.506	0.014	12.55	0.36	0.1442	0.0044	+0	2652	8	2
0917K.1-1b				0.09	0.1775	0.0008								2630	8	2
0917L.2-1	226	251	1.15	0.13	0.1775	0.0010	0.519	0.016	12.70	0.40	0.1433	0.0048	-2	2630	10	2
0920G.1-1	235	120	0.53	0.05	0.1797	0.0019	0.488	0.012	12.08	0.33	0.1372	0.0078	+3	2651	18	3
0920G.1-2	286	148	0.53	0.27	0.1792	0.0019	0.495	0.012	12.23	0.32	0.1298	0.0061	+2	2646	18	3
Marginal outliers																
0917H.1-1	99	42	0.43	0.06	0.1748	0.0015	0.525	0.016	12.64	0.41	0.1377	0.0053	-4	2604	14	2
0917L.2-1b			1.06	0.19	0.1748	0.0012								2604	12	2
Strong outlier																
0917I.3-1b			1.48	0.61	0.1711	0.0017								2568	16	2
>5% discordant																
0917J.2-1	91	48	0.55	0.39	0.1716	0.0018	0.531	0.017	12.56	0.41	0.1362	0.0068	-7	2573	17	2
0917J.2-1b				0.49	0.1719	0.0019								2577	18	2
0917I.2-1	177	136	0.79	0.26	0.1771	0.0017	0.468	0.014	11.42	0.36	0.1208	0.0060	+6	2626	16	2
0917I.2-1b				0.32	0.1771	0.0019								2626	17	2
>1% common ^{206}Pb																
0917L.1-1	235	204	0.90	1.06	0.1809	0.0021	0.497	0.017	12.40	0.44	0.1441	0.0054	+2	2661	19	2
0917L.1-1b				1.18	0.1736	0.0018								2593	17	2
0917L.2-2	116	156	1.39	1.22	0.1557	0.0045	0.530	0.016	11.36	0.47	0.1648	0.0083	-14	2409	49	2
0920F.1-1	235	241	1.06	1.85	0.1813	0.0037	0.473	0.013	11.82	0.40	0.1068	0.0060	+6	2665	34	3

TABLE DR4. SHRIMP U-Pb DATA FOR ZIRCON IN TUFF LAYER FROM DRILL-HOLE WRL-1 699.3 m

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	Disc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)	Sess.
0919A.1-2	275	171	0.64	0.04	0.1804	0.0017	0.517	0.013	12.86	0.33	0.1443	0.0046	-1	2656	15	3
0919A.1-2b				0.09	0.1797	0.0018								2650	17	3
0919B.1-1	122	106	0.89	0.08	0.1828	0.0025	0.515	0.016	12.98	0.44	0.1464	0.0059	+0	2679	22	3
0919B.1-1b				0.57	0.1760	0.0037								2615	35	3
0919C.1-1	185	119	0.67	0.89	0.1767	0.0029	0.480	0.013	11.70	0.37	0.1256	0.0060	+4	2622	27	3
0919C.1-1x				0.78	0.1818	0.0030								2670	27	3
0919D.1-1x				0.54	0.1791	0.0046								2645	43	3
0919D.2-1	215	190	0.91	0.97	0.1769	0.0035	0.484	0.012	11.81	0.38	0.1220	0.0049	+3	2624	33	3
0919K.1-1	93	37	0.41	0.38	0.1829	0.0037	0.501	0.018	12.64	0.52	0.1385	0.0103	+2	2680	33	3
0919K.1-2	106	52	0.51	0.32	0.1797	0.0033	0.477	0.016	11.81	0.45	0.1187	0.0074	+5	2650	30	3
0919K.1-2x				0.00	0.1820	0.0029								2671	26	3
>1% common ^{206}Pb																
0919D.1-1	95	52	0.56	1.32	0.1799	0.0047	0.492	0.017	12.19	0.53	0.1312	0.0110	+3	2652	44	3
>5% discordant																
0919A.1-1	174	111	0.66	0.51	0.1816	0.0027	0.464	0.013	11.62	0.36	0.1232	0.0059	+8	2668	25	3
0919A.1-1b				0.00	0.1830	0.0022								2680	20	3
0919B.1-2	50	29	0.61	0.36	0.1849	0.0061	0.476	0.020	12.13	0.65	0.1229	0.0092	+7	2698	55	3
0919B.1-2x				0.23	0.1715	0.0045								2572	44	3
Highly discordant																
0919B.1-3	157	177	1.17	1.07	0.1455	0.0032	0.325	0.023	6.53	0.48	0.0741	0.0065	+21	2293	38	3
0919B.2-1	54	39	0.75	1.53	0.1824	0.0063	0.385	0.016	9.69	0.52	0.0928	0.0093	+21	2674	57	3
0919B.2-1x				2.17	0.1812	0.0081								2664	74	3

TABLE DR5. SHRIMP U-Pb DATA FOR ZIRCON IN TUFF LAYER FROM DRILL-HOLE DDH186 176.15 m

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	Disc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)	Sess.
0915A.1-1	86	68	0.82	0.19	0.1806	0.0021	0.493	0.014	12.29	0.38	0.1354	0.0050	+3	2659	19	1
0915A.1-1b				0.06	0.1796	0.0022								2649	20	1
0915A.2-1	115	151	1.35	0.11	0.1829	0.0016	0.502	0.013	12.67	0.34	0.1344	0.0047	+2	2679	14	1
0915A.2-1b				0.09	0.1796	0.0019								2649	18	1
0915A.3-1	44	23	0.54	-0.12	0.1787	0.0031	0.498	0.019	12.28	0.51	0.1346	0.0079	+1	2641	29	1
0915A.3-1b				0.28	0.1810	0.0037								2662	34	1
0915A.4-1	309	299	1.00	0.12	0.1818	0.0012	0.497	0.011	12.45	0.29	0.1370	0.0035	+3	2670	11	1
0915A.4-1b				0.20	0.1793	0.0013								2646	12	1
0915A.5-1	158	149	0.98	0.08	0.1801	0.0014	0.499	0.012	12.38	0.32	0.1334	0.0039	+2	2654	13	1
0915A.5-1b				0.22	0.1782	0.0017								2636	15	1
0915A.6-1	132	100	0.79	0.32	0.1824	0.0020	0.504	0.013	12.67	0.36	0.1347	0.0047	+2	2675	18	1
0915A.6-1b				0.09	0.1835	0.0018								2684	17	1
0915A.7-1	139	108	0.80	0.20	0.1812	0.0019	0.487	0.013	12.16	0.34	0.1245	0.0051	+4	2664	17	1
0915A.7-1b				0.47	0.1828	0.0023								2678	21	1
0915A.9-1	218	195	0.92	0.08	0.1826	0.0022	0.490	0.011	12.34	0.32	0.1361	0.0037	+4	2677	20	1
0915A.9-1b				0.00	0.1830	0.0012								2680	11	1
0915A.10-1	101	84	0.85	0.35	0.1772	0.0023	0.495	0.014	12.08	0.37	0.1255	0.0048	+1	2626	21	1
0915A.11-1	96	72	0.78	0.29	0.1824	0.0022	0.492	0.014	12.36	0.38	0.1272	0.0060	+4	2675	20	1
0915A.11-1b				0.88	0.1777	0.0031								2632	29	1
0915A.12-1	147	147	1.03	0.45	0.1802	0.0019	0.500	0.013	12.42	0.35	0.1316	0.0042	+2	2655	18	1
0915A.13-1	178	195	1.13	0.23	0.1818	0.0014	0.504	0.015	12.63	0.39	0.1355	0.0045	+1	2669	13	1
0915A.13-1b				0.20	0.1810	0.0023								2662	21	1
0915B.1-1	52	36	0.71	0.18	0.1805	0.0028	0.520	0.019	12.95	0.50	0.1441	0.0070	-2	2658	26	1
0915B.1-1b				0.17	0.1793	0.0026								2646	24	1
0915B.2-1	52	37	0.74	0.00	0.1840	0.0024	0.511	0.017	12.96	0.47	0.1428	0.0065	+1	2690	21	1
0915B.2-1b				0.18	0.1810	0.0028								2662	26	1
0915B.3-1	105	88	0.87	-0.08	0.1832	0.0018	0.524	0.014	13.23	0.39	0.1479	0.0050	-1	2682	16	1
0915B.3-1b				0.04	0.1820	0.0018								2671	16	1

TABLE DR6. SHRIMP U-Pb DATA FOR ZIRCON IN TUFF LAYER FROM DRILL-HOLE DDH186 203.5 m

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	Disc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)	Sess.
0920I.1-1	451	284	0.65	0.62	0.1807	0.0017	0.523	0.011	13.02	0.30	0.1390	0.0054	-2	2659	15	3
0920J.1-1	574	382	0.69	0.12	0.1828	0.0014	0.492	0.010	12.40	0.28	0.1356	0.0038	+4	2678	12	3
0920J.1-1x				0.04	0.1839	0.0013								2689	12	3
0920M.2-1	274	130	0.49	0.64	0.1841	0.0022	0.499	0.012	12.68	0.33	0.1587	0.0063	+3	2690	20	3
>1% common ^{206}Pb																
0920I.1-1x				1.26	0.1844	0.0027								2693	24	3
0920J.2-1	532	461	0.90	1.15	0.1809	0.0020	0.513	0.011	12.80	0.30	0.1531	0.0044	-0	2661	18	3
0920L.1-1	383	200	0.54	1.17	0.1799	0.0022	0.552	0.012	13.70	0.35	0.1841	0.0077	-7	2652	20	3
0920L.1-1x				0.34	0.1829	0.0033								2679	29	3
>1% common ^{206}Pb and 2σ outlier (in $^{207}Pb/^{206}Pb$)																
0920L.2-1	543	431	0.82	1.48	0.1784	0.0023	0.503	0.011	12.36	0.31	0.1457	0.0050	+0	2638	21	3
>5% discordant																
0920L.2-2	494	531	1.11	0.65	0.1761	0.0018	0.450	0.012	10.93	0.31	0.0975	0.0032	+8	2617	17	3
0920M.1-1	402	218	0.56	0.09	0.1860	0.0016	0.481	0.011	12.35	0.29	0.1380	0.0042	+6	2707	14	3

TABLE DR7. SHRIMP U-Pb DATA FOR ZIRCON IN TUFF LAYER FROM DRILL-HOLE FVG-1 734.0 m

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	Disc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)	Sess.
0919F.1-1x				0.73	0.1713	0.0039								2571	38	3
0919I.1-1	51	24	0.49	-0.21	0.1767	0.0043	0.471	0.020	11.47	0.57	0.1314	0.0104	+5	2623	40	3
0919I.1-1x				0.22	0.1728	0.0064								2585	61	3
0919I.1-2	57	27	0.49	0.38	0.1745	0.0044	0.511	0.022	12.28	0.62	0.1281	0.0111	-2	2601	42	3
0919I.1-2b				0.42	0.1718	0.0046								2576	45	3
0919I.2-1	88	45	0.53	0.29	0.1750	0.0036	0.473	0.017	11.41	0.48	0.1289	0.0084	+4	2606	35	3
0919I.3-1	91	51	0.58	0.53	0.1751	0.0035	0.486	0.017	11.74	0.47	0.1164	0.0076	+2	2607	33	3
0919I.3-1x				0.51	0.1724	0.0037								2581	36	3
Reverse discordant																
0919J.1-1	64	33	0.53	0.00	0.1719	0.0031	0.534	0.021	12.65	0.56	0.1437	0.0086	-7	2576	30	3
0919J.1-1x				0.32	0.1816	0.0040								2667	36	3
≥1% common ^{206}Pb																
0919F.1-1	96	82	0.89	1.62	0.1676	0.0049	0.454	0.016	10.50	0.48	0.0965	0.0072	+5	2534	49	3
0919G.1-1	59	30	0.53	1.26	0.1738	0.0053	0.487	0.020	11.68	0.60	0.1270	0.0126	+1	2594	51	3
0919I.2-1x				0.99	0.1642	0.0049								2499	50	3
>10% discordant																
0919F.2-1	83	96	1.18	2.17	0.1711	0.0061	0.421	0.016	9.93	0.51	0.0701	0.0062	+12	2568	60	3
0919H.1-1	111	158	1.47	0.40	0.1826	0.0038	0.356	0.012	8.97	0.35	0.0559	0.0029	+27	2677	34	3
0919H.1-1x				1.12	0.1719	0.0055								2577	53	3
0920B.1-1	92	125	1.40	1.11	0.1825	0.0046	0.394	0.013	9.91	0.42	0.0668	0.0042	+20	2676	42	3
0920B.1-1x				2.05	0.1793	0.0059								2647	54	3

TABLE DR8. SHRIMP U-Pb DATA FOR ZIRCON IN TUFF LAYER FROM DRILL-HOLE FVG-1 767.15 m

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	Disc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)	Sess.
0915C.2-1	181	120	0.68	0.39	0.1852	0.0018	0.506	0.013	12.91	0.35	0.1221	0.0045	+2	2700	16	1
0915C.3-1	111	51	0.48	0.17	0.1808	0.0019	0.502	0.013	12.51	0.36	0.1448	0.0058	+1	2660	18	1
0915C.3-1b				0.33	0.1780	0.0021								2634	20	1
0915C.3-2	165	91	0.57	0.08	0.1811	0.0015	0.511	0.013	12.75	0.33	0.1383	0.0044	+0	2663	14	1
0915C.4-1	160	78	0.50	0.10	0.1823	0.0017	0.498	0.016	12.51	0.42	0.1379	0.0055	+3	2674	15	1
0915C.4-1b				0.04	0.1801	0.0017								2654	16	1
0915C.4-2	121	67	0.58	0.38	0.1829	0.0020	0.505	0.013	12.73	0.36	0.1351	0.0072	+2	2679	18	1
0915C.5-1	181	109	0.62	0.11	0.1799	0.0015	0.482	0.012	11.96	0.30	0.1243	0.0039	+4	2652	14	1
0915C.5-1b				0.26	0.1809	0.0017								2661	16	1
0915C.6-1	147	67	0.47	0.12	0.1809	0.0018	0.479	0.016	11.94	0.42	0.1293	0.0056	+5	2661	17	1
0915C.6-1b				-0.09	0.1797	0.0018								2650	17	1
0915C.9-1	109	40	0.38	0.05	0.1815	0.0019	0.527	0.015	13.18	0.39	0.1430	0.0059	-2	2666	17	1
0915C.9-1b				0.15	0.1811	0.0021								2663	19	1
0915C.9-2	119	52	0.45	0.21	0.1788	0.0019	0.510	0.014	12.57	0.36	0.1363	0.0057	-1	2642	18	1
0915D.1-1	184	114	0.64	0.05	0.1822	0.0014	0.489	0.012	12.30	0.31	0.1288	0.0039	+4	2673	13	1
0915D.1-1b				0.07	0.1807	0.0016								2659	15	1
0915D.2-1	178	107	0.62	0.13	0.1808	0.0015	0.491	0.012	12.24	0.31	0.1323	0.0041	+3	2660	14	1
0915D.2-1b				0.12	0.1808	0.0016								2660	15	1
0915D.3-1	151	90	0.61	0.29	0.1802	0.0017	0.499	0.012	12.39	0.33	0.1326	0.0045	+2	2655	15	1
0915D.3-1b				0.23	0.1816	0.0017								2667	16	1
>5% discordant or >1% common ^{206}Pb																
0915C.8-1	247	285	1.19	0.08	0.1791	0.0013	0.453	0.010	11.18	0.26	0.0800	0.0023	+9	2644	12	1
0915C.8-1b				0.17	0.1777	0.0014	0.423	0.009	10.36	0.25	0.0807	0.0024		2632	13	1
0915C.1-2	118	92	0.81	0.98	0.1783	0.0028	0.465	0.013	11.43	0.37	0.0728	0.0052	+7	2637	26	1
0915C.1-1	218	184	0.87	1.44	0.1696	0.0025	0.470	0.011	10.99	0.31	0.0858	0.0039	+3	2554	24	1

TABLE DR9. SHRIMP U-Pb DATA FOR ZIRCON IN TUFF LAYER FROM DRILL-HOLE RHDH2A 254.6 m

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	Disc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)	Sess.
0916A.1-1	110	91	0.85	-0.06	0.1802	0.0021	0.525	0.018	13.05	0.47	0.1402	0.0078	-2	2655	20	2
0916A.1-1b				0.34	0.1810	0.0026								2662	24	2
0916A.2-2	145	92	0.66	0.19	0.1771	0.0018	0.514	0.016	12.54	0.42	0.1420	0.0055	-2	2626	17	2
0916B.1-1	87	66	0.78	0.23	0.1769	0.0023	0.502	0.017	12.25	0.44	0.1330	0.0057	0	2624	21	2
0916B.1-1b				0.07	0.1809	0.0023								2661	21	2
0916C.1-1	193	145	0.78	0.11	0.1755	0.0013	0.477	0.014	11.55	0.35	0.1255	0.0044	4	2611	12	2
0916C.1-1b				0.00	0.1764	0.0013								2620	12	2
0916D.1-1	106	69	0.67	0.19	0.1776	0.0032	0.504	0.016	12.34	0.45	0.1316	0.0052	0	2630	30	2
0916D.4-1	46	35	0.79	-0.15	0.1805	0.0025	0.522	0.019	13.00	0.51	0.1445	0.0068	-2	2657	23	2
0916D.4-1b				0.25	0.1807	0.0028								2660	26	2
0916E.2-1	112	50	0.46	0.31	0.1780	0.0018	0.503	0.016	12.33	0.41	0.1290	0.0057	0	2634	17	2
0916E.2-1b				0.08	0.1785	0.0018								2639	17	2
0916E.3-1	141	93	0.68	-0.06	0.1782	0.0015	0.504	0.016	12.40	0.40	0.1337	0.0061	0	2637	14	2
0916E.3-1b				-0.14	0.1804	0.0017								2657	16	2
0916E.4-1	74	61	0.86	0.10	0.1778	0.0035	0.506	0.017	12.41	0.48	0.1265	0.0051	0	2633	33	2
0916E.4-1b				0.06	0.1785	0.0021								2639	20	2
5%–10% discordant																
0916C.2-1	130	129	1.02	0.65	0.1766	0.0023	0.455	0.014	11.07	0.38	0.0555	0.0029	8	2621	22	2
0916C.2-1b				0.35	0.1781	0.0022								2635	21	2
0916D.1-2	94	57	0.63	0.23	0.1797	0.0021	0.474	0.015	11.75	0.41	0.1223	0.0052	6	2650	19	2
0916D.2-1	90	62	0.71	0.11	0.1805	0.0021	0.469	0.016	11.66	0.41	0.1247	0.0052	7	2657	19	2
0916D.2-1b				-0.31	0.1830	0.0024								2681	22	2
0916D.3-1	180	120	0.69	-0.14	0.1759	0.0041	0.446	0.014	10.81	0.42	0.0986	0.0047	9	2614	39	2
0916D.3-1b				0.11	0.1775	0.0021								2630	19	2
$^{207}Pb/^{206}Pb$ outlier																
0916A.2-1	153	99	0.67	0.04	0.1855	0.0017	0.518	0.016	13.25	0.44	0.1469	0.0055	0	2702	15	2
>10% discordant																
0916B.2-1	233	387	1.71	0.10	0.1802	0.0014	0.368	0.011	9.15	0.28	0.0460	0.0019	24	2655	13	2
0916B.2-2	219	182	0.86	0.14	0.1772	0.0014	0.439	0.013	10.72	0.33	0.1031	0.0035	11	2627	13	2
0916E.1-1	161	278	1.79	0.12	0.1793	0.0016	0.416	0.013	10.29	0.33	0.0375	0.0017	15	2646	15	2
0916E.1-1b				0.12	0.1824	0.0016								2675	14	2
0916E.1-2	161	434	2.78	0.23	0.1710	0.0017	0.264	0.008	6.23	0.19	0.0284	0.0010	41	2568	16	2

TABLE DR10. SHRIMP U-Pb DATA FOR ZIRCON IN TUFF LAYER FROM DRILL-HOLE RHDH2A 268.8 m

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	Disc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)	Sess.
0916G.1-1	47	26	0.57	0.11	0.1809	0.0030	0.501	0.019	12.50	0.53	0.1375	0.0076	2	2661	27	2
0916G.1-1b				0.13	0.1805	0.0033								2657	30	2
0916G.2-2	88	76	0.90	0.12	0.1782	0.0018	0.511	0.016	12.55	0.42	0.1446	0.0054	-1	2636	17	2
0916G.2-3	26	11	0.45	0.00	0.1788	0.0032	0.502	0.022	12.38	0.58	0.1285	0.0083	1	2642	29	2
0916G.3-1	113	77	0.70	0.03	0.1824	0.0015	0.514	0.016	12.93	0.42	0.1271	0.0057	0	2674	14	2
0916G.3-1b				0.10	0.1768	0.0016								2623	15	2
0916H.1-1	41	27	0.67	0.24	0.1735	0.0026	0.523	0.020	12.52	0.51	0.1302	0.0067	-5	2592	25	2
0916H.1-2	45	26	0.60	-0.23	0.1842	0.0026	0.525	0.019	13.34	0.53	0.1469	0.0075	-1	2691	24	2
0916I.1-1	70	36	0.54	0.13	0.1755	0.0019	0.504	0.017	12.20	0.42	0.1358	0.0058	-1	2611	18	2
0916I.1-1b				0.10	0.1767	0.0020								2622	19	2
0916I.1-2	69	29	0.44	0.25	0.1797	0.0022	0.493	0.016	12.21	0.43	0.1319	0.0105	3	2650	20	2
0916I.2-1	61	28	0.48	0.06	0.1790	0.0021	0.524	0.018	12.94	0.47	0.1236	0.0058	-3	2644	19	2
0916I.2-1b				-0.07	0.1835	0.0025								2685	22	2
0916I.2-2	93	77	0.86	0.10	0.1762	0.0017	0.529	0.017	12.85	0.42	0.1358	0.0050	-5	2617	16	2
0916J.1-1	31	15	0.49	0.00	0.1854	0.0030	0.486	0.020	12.43	0.54	0.1410	0.0102	5	2702	27	2
0916J.1-2	57	60	1.08	0.16	0.1792	0.0021	0.500	0.017	12.37	0.44	0.1259	0.0057	1	2646	19	2
0916J.1-3	166	185	1.15	0.02	0.1789	0.0013	0.500	0.015	12.34	0.38	0.1326	0.0045	1	2643	12	2
0916J.1-5	58	46	0.83	-0.06	0.1831	0.0022	0.513	0.018	12.96	0.48	0.1339	0.0057	0	2681	20	2
0916J.1-6	110	108	1.01	-0.03	0.1765	0.0015	0.529	0.016	12.87	0.41	0.1413	0.0051	-4	2620	14	2
>5% discordant																*2*
0916G.2-1	55	35	0.66	0.17	0.1799	0.0027	0.473	0.017	11.73	0.46	0.1198	0.0077	6	2652	25	2
0916J.1-4	83	70	0.86	0.00	0.1808	0.0019	0.469	0.015	11.70	0.40	0.1294	0.0050	7	2660	18	2