

MB 2019-06

Rapport du contrat de géochronologie MERN (2014-2015)

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Rapport du contrat de géochronologie MERN (2014-2015)

Cornelia Roffeis

MB 2019-06

Avertissement

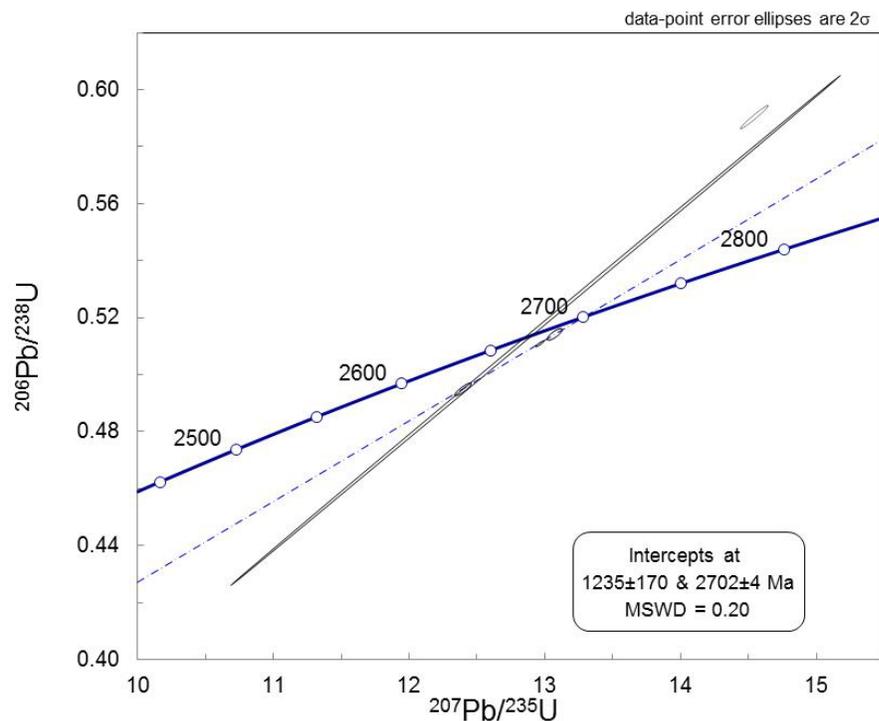
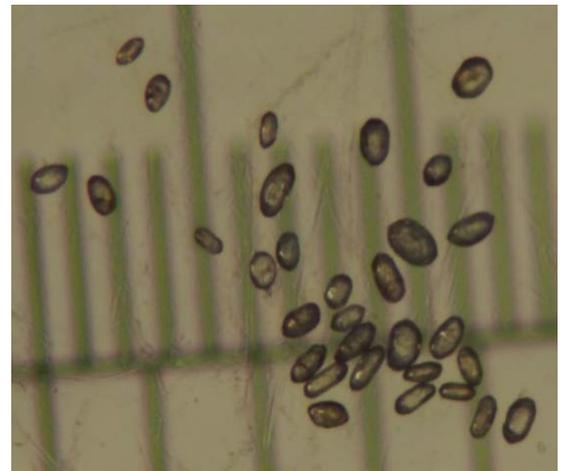
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Sample 14FT3141 Orthogneissic tonalite

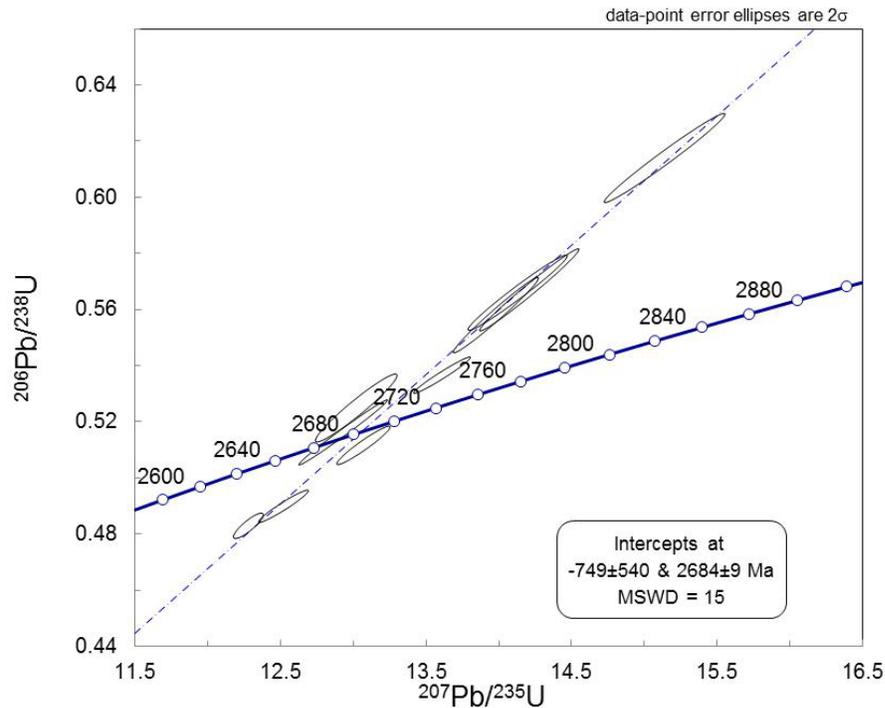
Location: Grenville parautochton

NAD 83 Zone UTM 18N E: 590273 N: 5543734

The rock contains a lot of zircons, with a variety of sizes, shapes and colors. Most grains are prismatic with some degree of rounding; fewer round to ovals shaped grains are observed as well as large prismatic, metamict grains. In some zircons a core-rim structure is observed. The general appearance points towards a metamorphic overprint of magmatic zircons. Single grain analyses of 5 zircons plot discordant, one grain plots reversely discordant and is omitted in the calculations. The remaining 4 data points form a Discordia line with an upper intercept at 2702 ± 4 Ma and a lower intercept at 1235 ± 170 Ma which might correspond to the Grenvillian orogeny, however, the metamorphic overprint is not as pronounced as expected in the isotopic composition of the zircons; the lower intercept is therefore not as well defined as the upper one.



Laser data give a younger age of formation than the one obtained with ID-TIMS. There is no clear distinction between core and rim measurements, supporting the observation that the metamorphic overprint is not very pronounced. Most data points are reversely discordant. The upper intercept plots at 2684 ± 9 Ma.



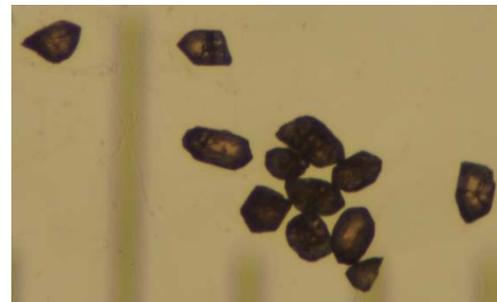
Conclusion: The age of formation is 2702 ± 4 Ma, a weak metamorphic overprint happened in the Grenvillian.

Sample 14FL2127 Orthomylonite

Location: East of Grenville

NAD 83 Zone UTM 18N E: 584778 N: 5562296

The zircon content in this sample is not very high; in addition grains are small. Most are colored, either pinkish or yellowish, indicating a quite high U content. Cracks and metamictisation are common, but no metamorphic rounding is observed. Most grains are prismatic, some are irregularly shaped.



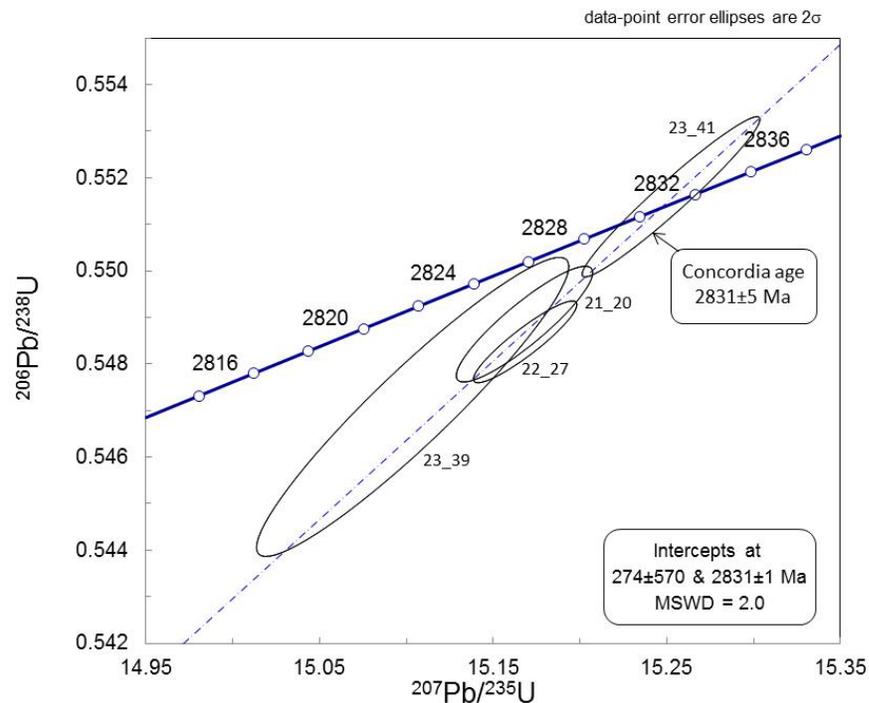
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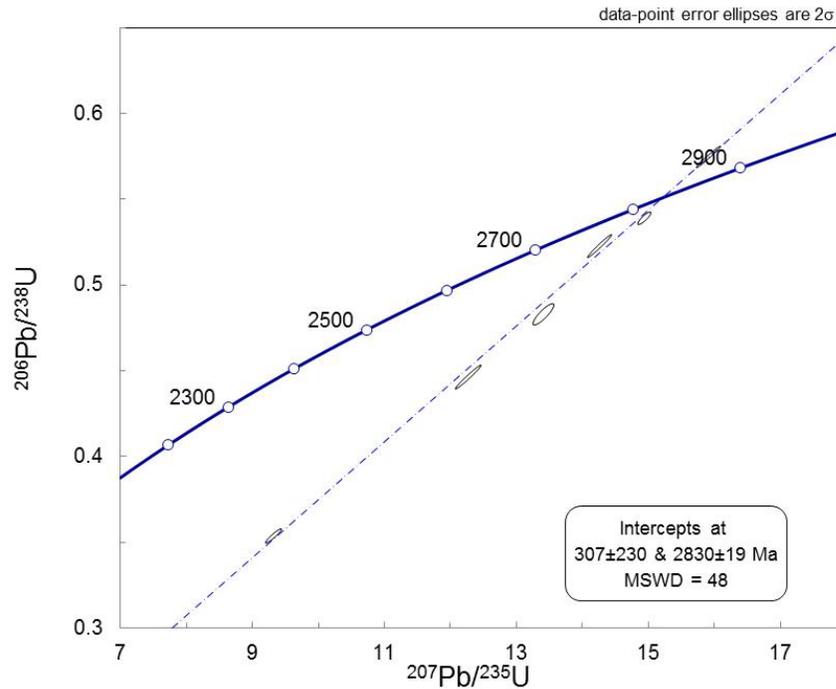
Juin 2015



All grains were treated with chemical abrasion. Due to the very small size of the grains for some analyses fractions of 2 or 3 grains were used. In total seven fractions were analyzed; they all plot close to Concordia, one data point, 23_41, plots concordant. It reveals a Concordia age of 2831 ± 5 Ma. Three analyses have large errors stemming from analytical problems and are omitted. The remaining analyses form a Discordia line with an upper intercept at 2831 ± 1 Ma which is considered the age of formation.



Laser ablation data scatters and gives too low ages for the $^{206}\text{Pb}/^{238}\text{U}$ ratio, however, reveals nearly the same upper intercept age on a Concordia diagram as with TIMS, but with a higher error.



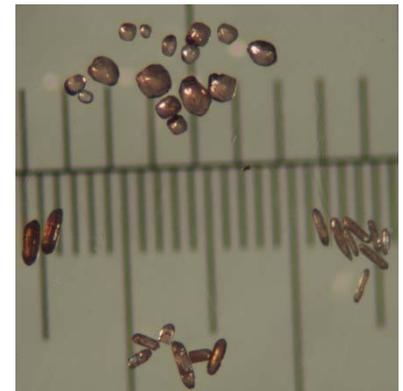
Conclusion: Age of formation is 2831 ± 1 Ma, no strong metamorphic overprint is detected.

Sample 14YD5004 Migmatite

Location: Opatica Subprovince

NAD 83 Zone UTM 18N E: 547162 N: 5576854

Zircons are quite abundant within this sample. One can clearly differentiate between magmatic and metamorphic grains. The magmatic ones are prismatic with different lengths and aspect ratios and are metamict (brown to slightly pinkish). Most magmatic grains show metamorphic rounding at the tip. The metamorphic zircons are clear, nearly colorless and round. Irregularly shaped but clear zircons appear to be related to the round grains and have probably also formed metamorphically. All zircon types occur in different sizes. Nine single grain zircons and 2 titanite fractions were analysed. Titanite was used to obtain the metamorphic age, and can be grouped into pinkish and yellowish grains. Both types are very clear and don't have visible on-growths. They were therefore not abraded.



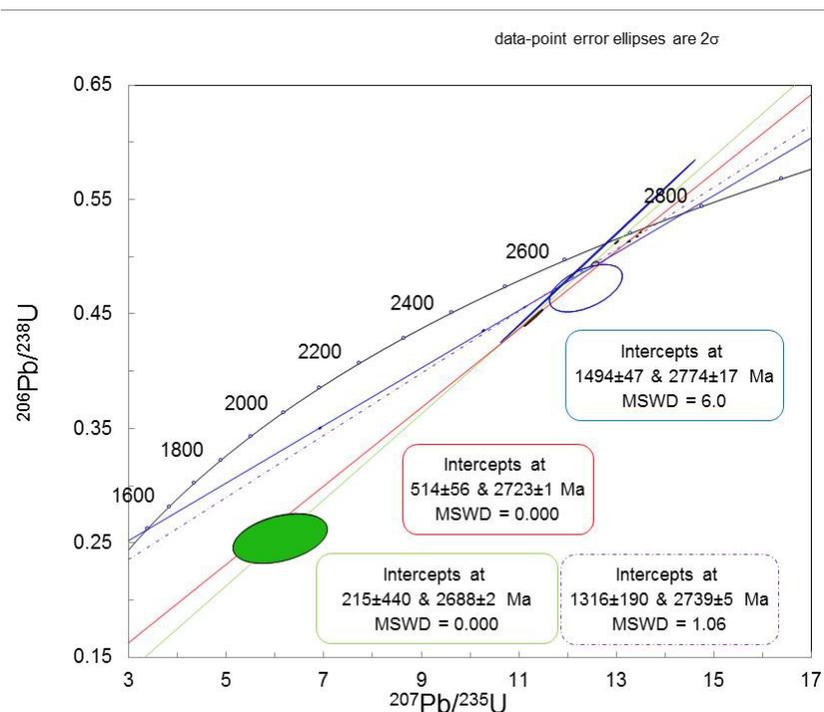
Analyses 18_39, 18_41 and 21_30 represent prismatic grains with only slight metamorphic rounding, 18_38 and 18_40 represent tips of magmatic grains and 18_35 and 18_36 represent metamorphic grains. There is a

chemical distinction between magmatic and metamorphic grains. The magmatic grains are higher in U and Pb and have a lower U/Th ration compared to the metamorphic grains.

On a Concordia diagram the data points scatter. Grouped based on appearance 4 Discordia lines emerge. The oldest age, 2774 ± 17 Ma, is an upper intercept formed by air abraded (except 21_30), magmatic looking grains (18_38, 18_39, 18_40, 18_41, 21_30). (blue line on the diagram). The metamorphic grains, also air abraded (18_35, 18_36), form a Discordia line with an upper intercept at 2723 ± 1 Ma. This age very well defined with one grain, 18_36, plotting very close to Concordia and is considered the metamorphic age (red line on diagram). Some chemically abraded metamorphic grains (21_21, 21_28, 21_30, 21_32) form an upper intercept between the intrusive and the metamorphic age, 2739 ± 5 Ma. It is the question if that represents an earlier metamorphic event or if it is the result of mixing ages due to inheritance. (purple dashed line on the diagram). Two fractions of differently colored titanite grains form a Discordia line with an upper intercept at 2688 ± 2 Ma, well constrained by an analysis of yellowish grains close to Concordia.

Conclusion

The most clearly metamorphic looking grain (18_36) lies close to Concordia and strongly supports the Discordia line with an upper intercept at 2723 Ma. This event is considered the first metamorphic event. The titanite upper intercept age of 2688 Ma, well constrained by an analysis close to Concordia, is considered either a second metamorphic event or a part of the protracted metamorphic path. The oldest age of 2774 Ma is regarded as the intrusive age. The lower intercepts are not well constrained, most likely due to several metamorphic overprints.



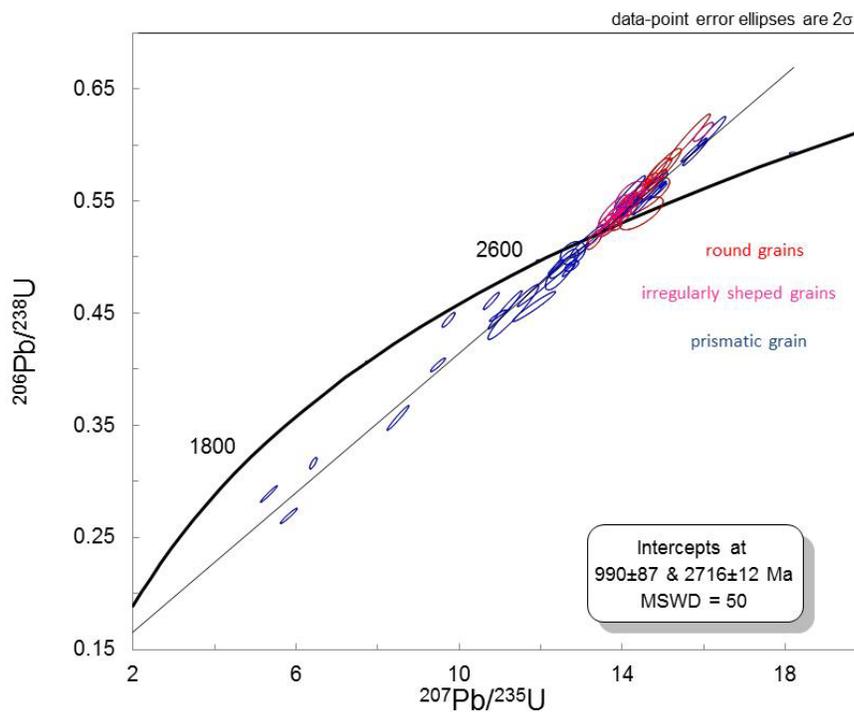
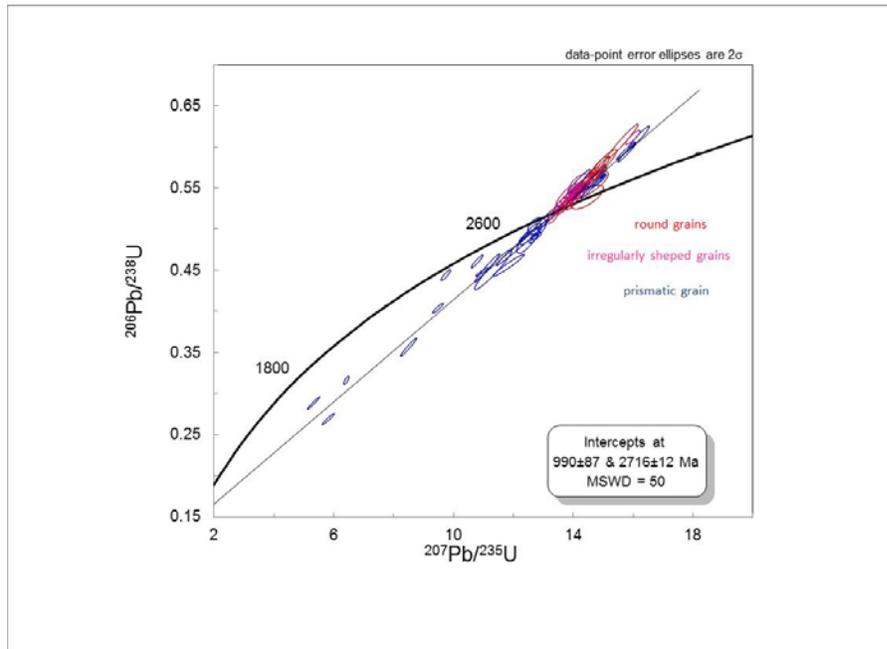
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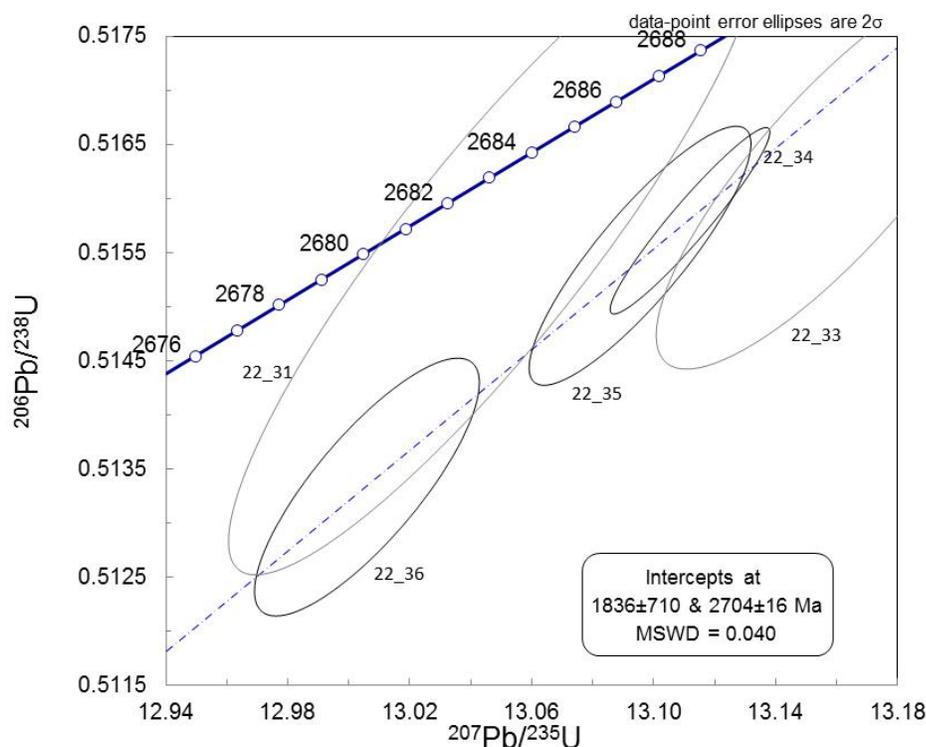
Laser ICPMS didn't detect the difference between magmatic and metamorphic grains. The ages are in general younger than the age of formation obtained with ID-TIMS, and scatter around the older metamorphic age. The upper intercept lies at 2716 ± 12 Ma (MSWD = 50).



Sample 14FT3008 Granite

Location: Dubergergranite, East of Grenville
NAD 83 Zone UTM 18N E: 582147 N: 5543089

The zircons in this sample appear magmatic, no metamorphic rounding is observed. The grains are clear to slightly yellowish but no strong metamictisation is observed. They are all prismatic with different aspect ratios. Five single grains were analysed, they are chemically comparable in terms of U and Pb content, and Th/U ratio. All analyses plot slightly discordant. **Analysis 22_31 is omitted in the calculation since the measurement was faulty.** Analyses 22_36, 22_35, 22_34 and 22_33 form a Discordia line with an upper intercept at 2713 ± 33 Ma. Without the poor measurement 22_33 the upper intercept lies at 2704 ± 16 Ma, which is considered the age of formation.



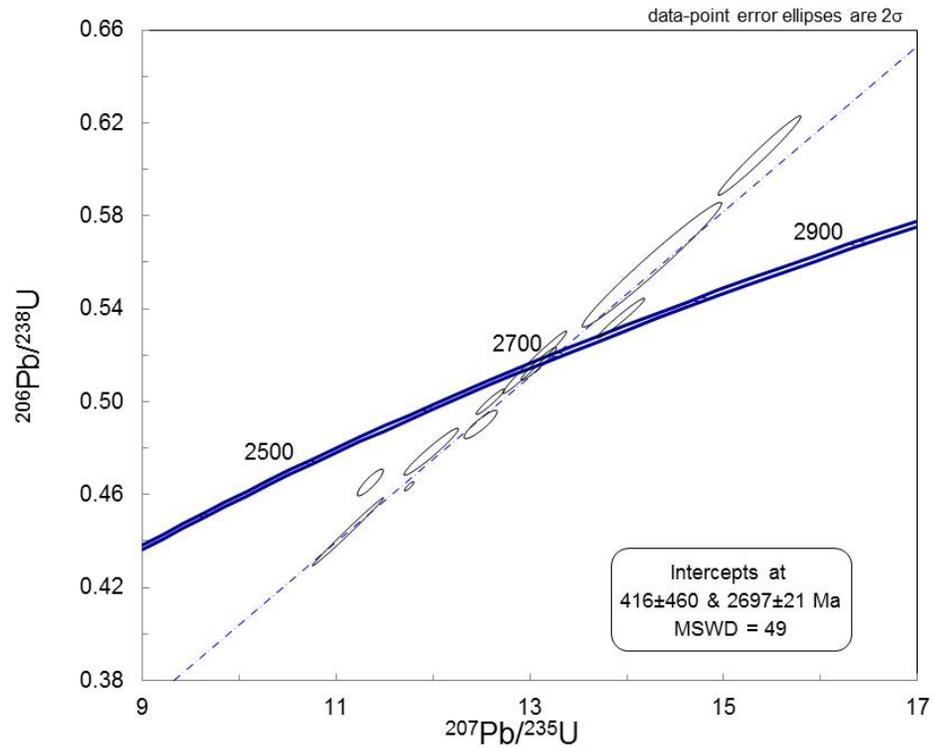
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Laser data confirms that there is no core-rim structure in the zircons. An upper intercept reveals 2697 ± 21 Ma, which supports the TIMS age.

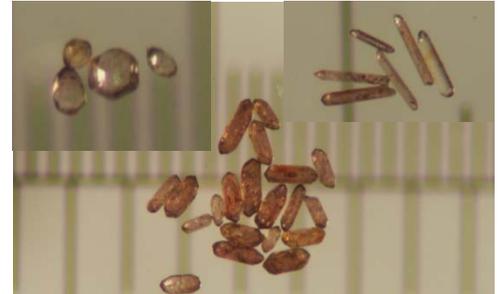


Conclusion: age of formation is 2704 ± 16 Ma.

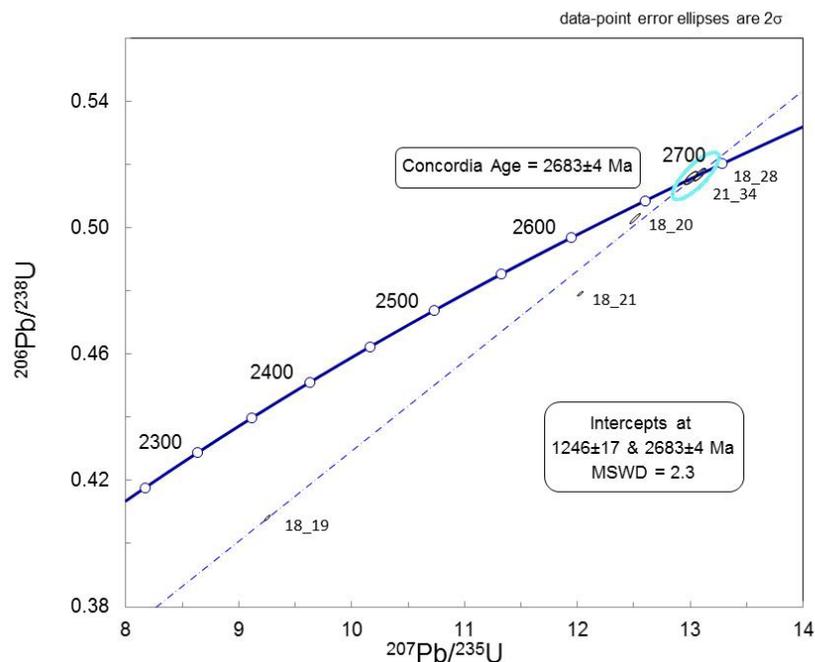
Sample 14JM5021 Tonnancourt granite

UTM Nad 83 E 358591 N: 5416936

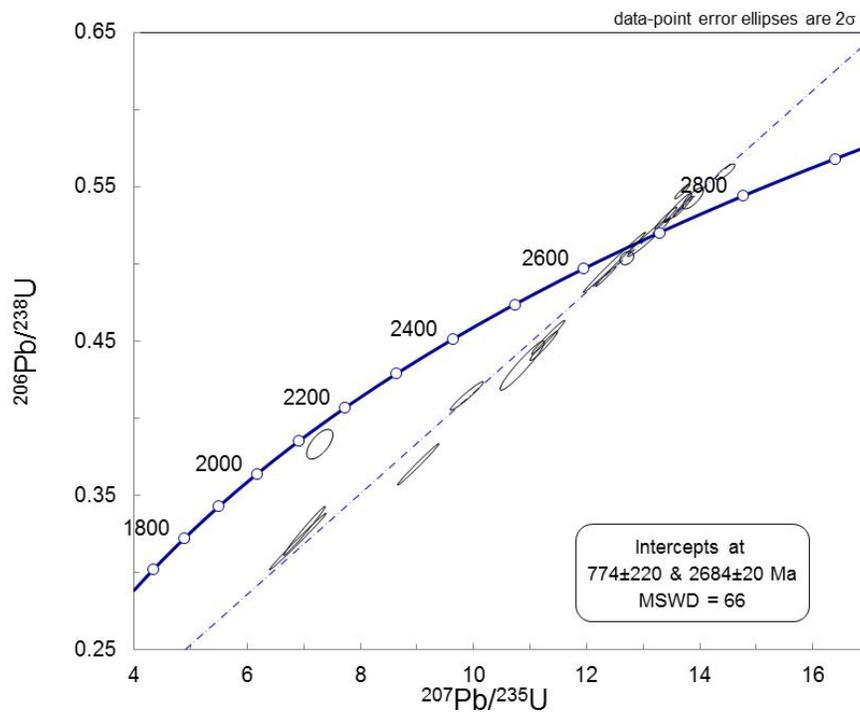
The sample reveals a lot of zircons which all appear to be of magmatic origin; no metamorphic rounding is observed. The grains are prismatic with varying aspect ratios, ranging from short prismatic to long, thin needles. Many grains show signs of metamictisation (yellow to brown in color), but also clear grains occur.



Five single grains were analysed, three metamict grains were treated with air abrasion (18_19, 18_20, 18_21) and two clear grains were treated with chemical abrasion (18_28, 21_34). The air abraded grains plot discordant whereas the chemically abraded grains plot concordant. It seems like chemical abrasion managed to remove the areas affected by Pb loss better. Grains treated with chemical abrasion are distinctively lower in U and Pb compared to the air abraded grains. The chemically abraded grains form a Concordia age at 2683 ± 4 Ma, the assumed age of formation. The discordant grains don't fall on a single Discordia line, but scatter. This might indicate several events causing Pb loss. The most meaningful Discordia line in terms of regional geology would be one formed by the concordant data points and grain nr 18_19, a needle shaped grain, high in U and low in common Pb. It gives a lower intercept age of 1246 ± 17 Ma, which might be related to the Grenvillian event.



Laser data suggests that there is no difference between core and rim analyses. A combined age from all laser data points reveals nearly the same age as ID-TIMS analyses, 2684 ± 20 Ma.



Conclusion: The intrusive age of the rock is 2683 ± 4 Ma a slight metamorphic overprint is detected in the Grenvillian.

Sample 14FT3038, Tonalite

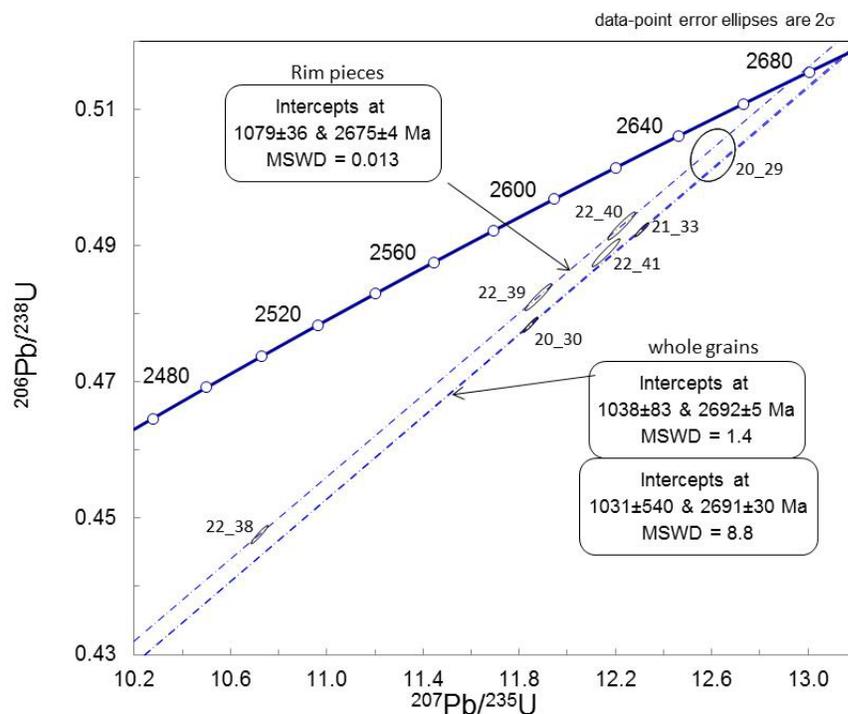
Location: Laganiere Complex

NAD 83 Zone UTM 18N E: 602523 N: 5561729

Zircon is very abundant in this sample; most grains are prismatic with different aspect ratios. Slight rounding is common, metamictisation is not pronounced. In many grains a core-rim structure is visible. Prismatic whole grains and pieces of the outermost rim – broken off from the core after chemical abrasion - were analyzed separately. Analyses 22_38, 22_39 and 22_40 stem from rim pieces most likely not containing any core. Analyses 20_29, 21_33, 22_41 and 20_30 stem from prismatic whole grains.



Two Discordia lines can be plotted, one formed by rim pieces, one by whole grains. Data points 22_39, 22_40 and 22_41 were calculated with default fractionation values, since the measured values seemed to have been disturbed. The rim analyses Discordia gives an upper intercept age at 2675 ± 4 Ma, the upper intercept for prismatic grains lies at 2691 ± 30 Ma. This age is the presumed age of formation. The high error stems from the poor fit of analysis 22_41, a grain which shows magnificently lower values in U and Pb content compared to the other prismatic grains. Without this data point the age of formation is 2692 ± 5 Ma.



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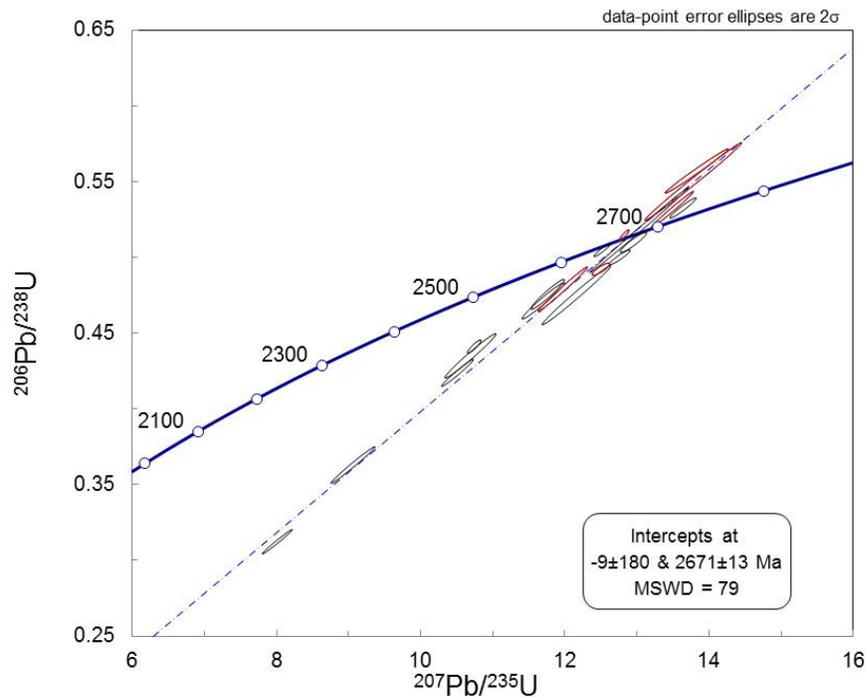
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The metamorphic event responsible for the formation of the rim occurred at 2675 ± 4 Ma. The lower intercept varies between 1079 and 1031 Ma and is not well established. However, it indicates later Pb loss at a Grenvillian time.

Laser data reveals younger ages for both, core and rim analyses. The data scatters and doesn't reveal two clearly different Discordia lines but rather shows that the core data (red) plots less discordant compared to the rim data. The upper intercept lies at 2671 ± 13 Ma.



Conclusion:

The rock was formed at 2692 ± 5 Ma and experienced a first metamorphic event at 2675 ± 4 Ma. A later event, probably Grenvillian, caused further Pb loss.

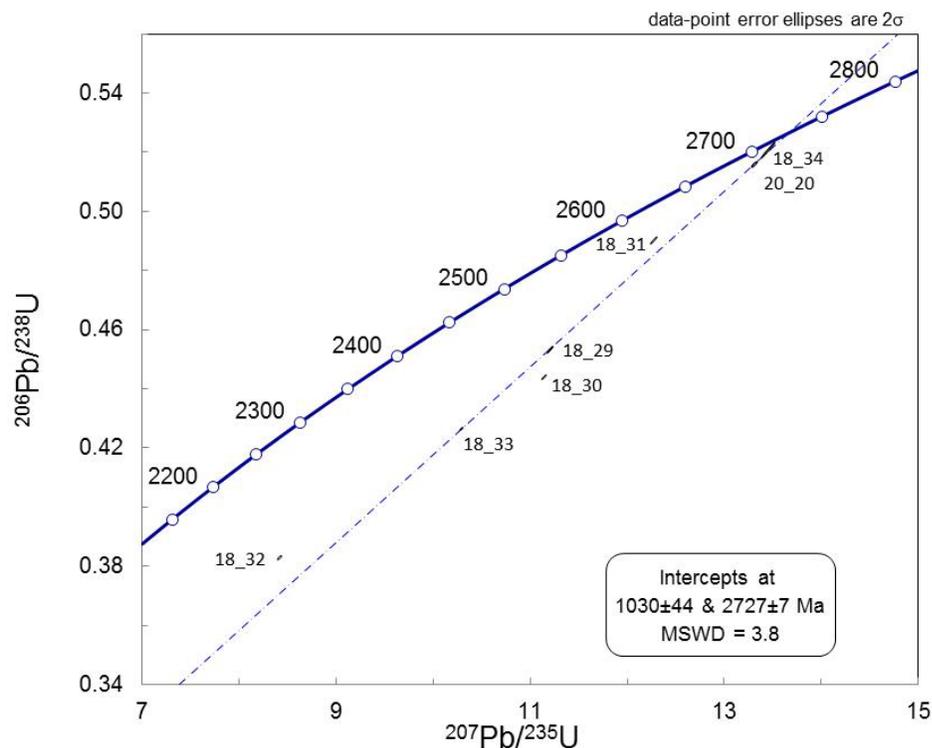
Sample 14HH1206 Holmes tonalite

Location: UTM Nad 83 E: 374793 N: 5425352

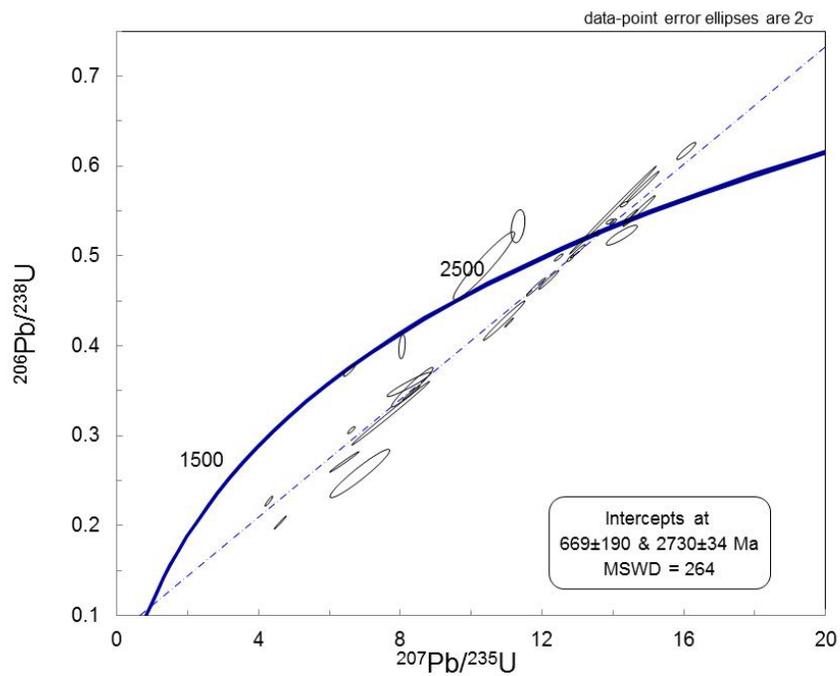
The sample reveals many zircons which are generally prismatic with variable aspect ratios. The most common shape is short prismatic (1:2 – 1:3) but also long and narrow needles occur. Metamictisation ranges from slightly yellowish to brown. No rounding is visible.



All analyses are discordant. However, they don't plot on the same Discordia line but scatter. The best analyses are 18_34 and 20_20, which represent long prismatic grains, treated with chemical abrasion. They plot just slightly underneath Concordia and therefore constrain the upper intercept very well. A Discordia line can be formed with these grains plus two short prismatic grains (18_29 and 18_33). The upper intercept lies at 2727 ± 7 Ma, the presumed age of formation. The lower intercept lies at 1030 ± 44 Ma which could indicate a Grenvillian influence. Grains 18_31, 18_32, 18_30 don't plot on the same Discordia line but scatter. That might indicate several events that caused Pb loss.



Laser ICPMS measurements show no difference between the different zircon shapes or core and rim analyses. In general the data is more scattered. An upper intercept age gives 2730 ± 34 Ma.



Conclusion

The age of formation is best revealed but an upper intercept age from 4 ID-TIMS analyses and lies at 2727 Ma.

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Tableau récapitulatif (voir fichier Excel avec les diagrammes Concordia associés):

U-Th-Pb isotopic data

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Sample	Nr	Properties (a)	Wt. mg (b)	Compositional Parameters						Radiogenic Isotope Ratios						Isotopic Ages						
				Pb ppm (c)	U ppm (c)	Th U (d)	Pb* (pg) (e)	Pbc (pg) (e)	206Pb/204Pb (f)	207Pb/235U (g)	% err (h)	206Pb/238U (g)	% err (h)	corr. coef. (i)	207Pb/206Pb (g)	% err (h)	207Pb/235U (i)	± (h)	206Pb/238U (i)	± (h)	207Pb/206Pb (i)	± (h)
14JM5021																						
18_19		long prism, air	0.001	281.2	624	0.335	277.4	3.78	4185	9.254200	0.213	0.408153	0.174	0.876	0.164443	0.104	2363.5	2.0	2206.5	3.3	2501.9	1.7
18_20		short prism, large, yellow, air	0.002	194.3	346	0.301	378.2	10.41	2062	12.510477	0.304	0.502875	0.264	0.945	0.180432	0.102	2643.5	2.9	2626.1	5.7	2656.8	1.7
18_21		short prism, large, yellow, air	0.004	171.2	322	0.314	675.1	9.71	3905	12.024989	0.169	0.479086	0.123	0.894	0.182041	0.081	2606.4	1.6	2523.3	5.6	2671.6	1.3
18_28		very short prism	0.001	21.4	25	2.313	20.2	1.16	714	13.082096	0.334	0.516770	0.314	0.823	0.183603	0.193	2685.6	3.1	2685.5	6.9	2685.7	3.2
21_34		2gr, small, drop shape	0.001	13.9	22	0.440	12.7	1.15	640	13.006543	0.365	0.515695	0.323	0.763	0.182923	0.240	2680.1	3.4	2680.9	7.1	2679.6	4.0
14YD5004																						
18_35		met, round, clear, air	0.002	35.6	70	0.385	69.5	1.62	2438	11.301132	1.36734	0.44678	1.35727	0.99174	0.18346	0.17538	2548.3	12.8	2380.9	27.0	2684.4	2.9
18_36		met, pinkish, clear, air	0.015	21.8	37	0.466	324.7	1.94	9309	13.493418	0.13166	0.52172	0.09496	0.92685	0.18758	0.05635	2714.8	1.2	2706.5	2.1	2721.0	0.9
18_39		prism, air	0.001	310.2	625	0.228	304.9	5.31	3322	11.120243	0.16429	0.45598	0.12674	0.89	0.17687	0.0774	2533.3	1.5	2421.8	2.6	2623.8	1.3
18_40		tip, air	0.001	124.5	270	0.292	100.4	24.13	256	6.9217133	0.28154	0.35034	0.18624	0.55955	0.14329	0.2351	2101.4	2.5	1986.2	3.1	2267.4	4.1
18_41		short prism, air	0.001	90.3	186	0.194	85.8	4.56	1117	10.270159	0.19867	0.4355	0.14594	0.73897	0.17103	0.13385	2459.4	1.8	2330.5	2.9	2567.8	2.2
alt18_38		tip, air	0.001	338.1	649	0.040	336.2	1.99	10401	12.621238	12.9118	0.50496	12.9106	0.99997	0.18128	0.10235	2651.8	121.5	2635.1	279.2	2664.6	1.7
21_21		round	0.013	22.3	38	0.461	286.8	3.26	4831	13.413067	0.12457	0.51796	0.08612	0.89786	0.18796	0.06058	2709.9	1.2	2690.5	1.9	2724.4	1.0
21_28		round	0.016	8.5	13	0.439	119.6	16.11	419	13.260719	0.15934	0.51378	0.11344	0.69078	0.18719	0.11527	2698.4	1.5	2672.7	2.5	2717.7	1.9
21_30		long prism	0.001	3.0	2	0.149	1.1	1.83	56	12.374554	4.93641	0.4725	3.59351	0.51257	0.18994	4.36994	2633.2	46.4	2494.5	74.3	2741.7	71.9
21_32		round	0.005	18.0	21	0.489	58.7	31.14	118	12.566288	0.42222	0.49432	0.3087	0.34599	0.18437	0.42622	2647.7	4.0	2589.3	6.6	2692.6	7.1
21_33		titanite, pinkish	0.092	0.0	0	0.160	0.5	3.32	28	6.098514	12.8721	0.25391	7.00068	0.3757	0.1742	12.1239	1990.0	112.3	1458.6	91.4	2598.4	202.1
21_54		titanite, yellow	0.057	15.2	25	0.568	830.8	36.49	1219	13.004009	0.27485	0.51306	0.2502	0.95256	0.18383	0.08445	2679.9	2.6	2669.7	5.5	2687.7	1.4
14FL2127																						
21_20		tip	0.001	82.8	123	0.658	80.2	2.62	1624	15.168028	0.21188	0.54886	0.18521	0.89203	0.20043	0.09584	2825.8	2.0	2820.4	4.2	2829.7	1.6
22_27		3gr, irreg shape	0.001	152.7	231	0.674	151.1	1.60	5007	15.168415	0.16084	0.54848	0.13096	0.91312	0.20058	0.06747	2825.9	1.5	2818.8	3.0	2830.9	1.1
21_19b		prism	0.001	272.7	420	0.619	269.6	3.17	4500	14.981282	0.5023	0.54453	0.45537	0.93993	0.19954	0.17228	2814.1	4.8	2802.4	10.3	2822.4	2.8
23_39		irreg shape, small	0.001	431.9	665	0.639	430.8	1.12	20533	15.103613	0.48683	0.54708	0.47983	0.94000	0.20023	0.01100	2821.8	4.6	2813.0	10.9	2828.1	2.8
23_40		5gr, tips, very small	0.004	123.1	187	0.634	485.6	6.70	3782	15.116006	0.10153	0.54795	1.00662	0.99597	0.20008	0.09113	2822.6	9.7	2816.6	23.0	2826.8	1.5
23_41		small, prism	0.001	160.3	241	0.699	159.1	1.19	7014	15.252472	0.27472	0.55159	0.25528	0.9671	0.20055	0.07066	2831.1	2.6	2831.8	5.9	2830.7	1.2
23_38b		2gr, irreg	0.004	183.8	280	0.636	734.1	1.18	33217	15.312334	7.62726	0.55463	7.62475	0.9998	0.20023	0.15075	2834.9	72.7	2844.4	175.4	2828.1	2.5
14FT3008																						
22_30		prism	0.001	30.1	55	0.156	26.6	3.50	462	11.701718	5.880	0.458677	5.865	0.850	0.185030	0.119	2580.8	55.0	2433.7	118.9	2698.5	1.9
22_33		tip	0.001	75.4	125	0.209	68.7	6.67	609	13.158849	0.360	0.516234	0.287	0.829	0.184871	0.202	2691.1	3.4	2683.2	6.3	2697.1	3.3
22_34		long prism	0.001	142.1	261	0.122	141.0	1.09	7813	13.111935	0.163	0.515794	0.137	0.951	0.184370	0.054	2687.7	1.5	2681.3	3.0	2692.6	0.9
22_35		prism	0.001	66.1	115	0.160	62.8	3.35	1117	13.095551	0.227	0.515470	0.190	0.866	0.184255	0.114	2686.6	2.1	2679.9	4.2	2691.5	1.9
22_36		tip	0.001	64.3	115	0.138	62.0	2.31	1618	13.005959	0.232	0.513332	0.190	0.809	0.183757	0.136	2680.1	2.2	2670.8	4.2	2687.1	2.3
22_31b		prism	0.001	65.8	118	0.109	63.7	2.06	1877	13.047283	0.543	0.515530	0.477	0.898	0.183554	0.239	2683.1	5.1	2680.2	10.5	2685.2	4.0
14FT3038																						
20_29		prism	0.001	88.5	72	0.385	40.1	48.39	63	12.604606	0.600	0.503268	0.626	0.221	0.181647	0.765	2650.6	5.6	2627.8	13.5	2668.0	12.7
20_30		prism	0.002	189.9	361	0.175	365.3	14.43	1480	11.846557	0.211	0.478395	0.188	0.959	0.179599	0.061	2592.3	2.0	2520.3	3.9	2649.2	1.0
21_33		prism	0.001	264.5	500	0.207	262.5	1.97	7875	12.309564	0.191	0.492335	0.168	0.953	0.181335	0.060	2628.3	1.8	2580.8	3.6	2665.1	1.0
22_38		long pieces, rim	0.001	154.8	322	0.201	153.0	1.78	5109	10.702091	0.268	0.447618	0.247	0.962	0.173699	0.074	2499.2	2.5	2384.7	4.9	2593.6	1.2
22_40b		irreg pieces	0.003	232.2	435	0.276	695.3	1.39	29176	12.225107	0.385	0.492887	0.340	0.957	0.179889	0.115	2621.8	3.6	2583.2	7.2	2651.8	1.9
22_39b		pieces, rim	0.001	217.6	419	0.214	215.4	2.20	5776	11.879291	0.381	0.482447	0.336	0.959	0.178583	0.112	2594.9	3.6	2537.9	7.0	2639.8	1.9
22_41b		prism	0.001	79.9	151	0.196	78.5	1.40	3345	12.160394	0.389	0.488954	0.344	0.959	0.180376	0.114	2616.9	3.7	2566.1	7.3	2656.3	1.9
14FT3141																						
22_19		prism	0.001	43.4	69	0.148	42.5	0.92	2785	14.542842	0.578	0.590389	0.570	0.978	0.178653	0.120	2785.8	5.5	2991.0	13.6	2640.4	2.0
22_20		long prism	0.002	46.9	82	0.370	92.5	1.23	4293	12.963259	0.196	0.510845	0.168	0.929	0.184045	0.074	2677.0	1.8	2660.2	3.7	2689.7	1.2
22_21		round	0.001	23.7	42	0.201	22.1	1.62	825	12.396734	0.403	0.494486	0.370	0.888	0.181692	0.185	2634.9	3.8	2591.6	7.9	2668.4	3.1
22_28		round	0.001	24.0	41	0.153	22.1	1.89	715	13.072203	0.346	0.514106	0.326	0.809	0.184414	0.209	2684.9	3.3	2674.1	7.1	2693.0	3.4
22_29b		round	0.001	31.4	53	0.157	28.8	2.69	650	12.931639	14.181	0.515514	14.180	1.000	0.181933	0.117	2674.7	133.7	2680.1	310.9	2670.6	1.9
14HH1206																						
18_29		short prism, flat tip	0.001	192.0	388	0.252	189.5	2.50	4399	11.203283	0.223	0.453214	0.202	0.960	0.179284	0.064	2540.2	2.1	2409.5	4.1	2646.3	1.1
18_30		short prism	0.001	190.8	378	0.389	187.6	3.23	3241	11.141598	0.173	0.443937	0.144	0.941	0.182022	0.061	2535.0	1.6	2368.2	2.9	2671.4	1.0
18_31		long prism, some incl	0.002	706.7	1031	1.507	1402.8	10.61	5846	12.												