Preliminary Evaluation of Available Data from LA-2

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The following partial, preliminary summary is intended to gather my thoughts and to help generate discussion, particularly as concerns remaining significant uncertainties that should be targeted in next (final?) round of sampling in LA-2. All thoughts welcome.

Sample sites and geomorphic units in LA-2 presented on FIMAD plot 105389 (contact Marcia Jones, 5-2807, for copy). I have Excel spreadsheets with particle size data for samples, Am-241, Cs-137, Pu-239,240, Sr-90 values, preliminary calculations of contaminant inventories, and notes on each sample. Contact me for copies of the spreadsheets.

General Notes on Particle Size Variations (Texture) of Sampled Deposits

Texturally, the sampled sediments in LA-2 range from sand (<10% silt+clay) to silt loam (mixtures of sand, silt, and clay, with up to 73% silt and clay in the LA-2 samples). Intermediate textures (loamy sand, sandy loam, and loam) are also present. Sampled active channel deposits in LA-2 are classified as sand, representing the bedload of Los Alamos Canyon in floods, and are dominated by medium to very coarse sand size particles (0.25-2 mm). Overbank sediments deposited on the c2, c2b, c3, and f1 surfaces vary greatly in particle size, with median grain size ranging from silt to medium sand, reflecting significant variations in the energy of the associated floodwaters; the most common textures of these deposits are sandy loams and loamy sands, although they also include sands, silt loams, and loams.

Preliminary Interpretation of Am-241, Cs-137, Pu-239+240, and Sr-90 in LA-2

Concentrations of radionuclides in LA-2 vary as a function of particle size, age (geomorphic unit and stratigraphic layer), and sediment source (Upper Los Alamos Canyon vs. DP Canyon). Recognized contaminants in LA-2 are dominated by releases into DP Canyon, although contributions from upstream in Los Alamos Canyon are also present.

° Channel deposits (sands) generally have lower concentrations of radionuclides than temporally-related finer-grained overbank deposits.

° Relative amounts of different radionuclides vary between geomorphic units of different age and between stratigraphic layers within a given unit. Peak concentrations of Cs-137 and Sr-90 are associated with the relatively old c3 unit, both buried floodplain deposits and overlying channel deposits. Buried floodplain deposits in the next younger c2b unit indicate a decrease in Cs-137 and Sr-90 and an increase in Am-241. Buried floodplain deposits in the younger c2 unit contain maximum Am-241 concentrations and slightly lower Cs-137 values. The uppermost (youngest) stratigraphic unit in both c2 and c2b have lower concentrations of Am and Cs (and Sr?) (although it is a relatively coarse sandy layer, which could be the main cause of lower concentrations in this layer).

° Distributions of Pu-239+240 are incompletely known because it was not obtained in the limited suite samples (because of its relatively low concentrations in the full suite samples, at most ~1/4 mesa top SALs). The highest concentration obtained is in a c3 layer with the highest Cs and Sr, suggesting that they may be collocated. However, layers with high Am have not been analyzed for Pu, and a collocation of Am and Pu is possible.

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° Both Sr-90 and Pu-239+240 are recognized in Los Alamos Canyon above the confluence with DP Canyon. Sr-90 in c2 upstream of DP Canyon can be similar to values downstream, indicating significant mixing of Sr from these two sources. Pu upstream of DP Canyon can also be similar to values downstream, both in c1 and c2 units, suggesting significant mixing from 2 sources, although data are limited at present.

° The largest inventory of all the above radionuclides are contained within fine-grained overbank layers within the c2 unit of Los Alamos Canyon, downstream of DP Canyon. About 20-30% of the Cs-137 and Sr-90 in LA-2 are contained within the c3 unit. ?

Possible Issues to Address in Next Round of Limited-Suite Sampling in LA-2

1) Collocation of Pu-239,240 and Am-241 in c2b layer with highest Am-241?

2) Pu-239,240 concentrations in c2 upstream of DP Canyon?

3) Additional evaluation of variability in c2, where the largest inventory is located?

4) Additional evaluation of floodplains, including sites possibly affected by floods prior to release of Cs-137 from DP Canyon.

5) Resampling of subset of prior sample sites where range of Cs, Sr, and Am obtained, to further test collocation of contaminants. Analyze for everything that was recognized above background?

6) Analyze particle size separates of select samples for select radionuclides (Cs, Sr, Am, ± Pu?), to evaluate concentrations in respirable fractions (clay-size particles, <2 microns)? Perhaps also analyze concentrations in silt+clay fraction and one or more sand size fractions in one or more samples?

7) Other outstanding issues??? [illegible]

Los Alamos Canyon, Reach LA-2

Field Site #	Sample ID No	Request No	Geomorphic Unit	Sample Depth (in)	Sample Depth (cm)	Am-241 (pCi/g)	Cs-137 (pCi/g)	Sr-90 (pCi/g)	Pu-239+240 (pCi/g)	Lab Texture	Median Particle Size	Gravel	Coarse-Med Sand	Fine Sand	Silt	Clay
LA2-9	04LA-96-0141	2104	c1 (up LA Cyn)	0--3	0-8	0.034	<0.12	0.66	0.211	s	cs	1.5	99.27	0.49	0	0.23
LA2-61	04LA-96-0147	2104	c1 (down LA Cyn)	0--4	0-10	0.278	2.12	1.04	0.22	s	cs	0	94.3	4.73	0.97	0
LA2-4	04LA-96-0140	2104	c2b (DP Cyn)	0--3	0-8	3.35	87.82	9.87	4.15	gls	fs	22.9	35.49	42.23	19.28	3
LA2-12	04LA-96-0215	2833	c2 (up LA Cyn)	0--5	0-13	BDL	0.33	2.4	NM	sl	vfs	2.4	14.3	43.9	35.8	6
LA2-12	04LA-96-0216	2833	c2 (up LA Cyn)	8--11	20-28	BDL	0.38	3.3	NM	sl	fs	4.6	39	29.8	25.8	5.5
LA2-12	04LA-96-0217	2833	c2 (up LA Cyn)	16--20	41-51	BDL	0.32	3.7	NM	gls	cs	38.6	73.7	9.2	12	5.2
LA2-12	04LA-96-0218	2833	c2 (up LA Cyn)	24--28	61-71	BDL	0.28	3.1	NM	gls	ms	63.9	65.3	14.7	13	7
LA2-S7																
LA2-48	04LA-96-0143	2104	c2 (down LA Cyn)	0--6	0-15	1.13	5.77	2.21	0.632	s	ms	8.8	56.12	34.95	7.73	1.2
LA2-48	04LA-96-0225	2833	c2 (down LA Cyn)	7--10	18-25	8.3	13	5.8	NM	sl	fs	5.1	23.2	42.8	27.4	6.6
LA2-48	04LA-96-0226	2833	c2 (down LA Cyn)	14--17	36-43	17	21	6.9	NM	sil	cmsi	6.2	10	33.2	51.1	5.7
LA2-48	04LA-96-0227	2833	c2 (down LA Cyn)	19--22	48-56	2.5	9.2	4.1	NM	sl	vfs	6.2	22.2	40.6	29.6	7.6
LA2-S17																
LA2-62	04LA-96-0146	2104	c2 (down LA Cyn)	0--3	0-8	0.95	4.76	1.91	0.54	ls	ms	11.2	62.72	27.15	8.83	1.3
LA2-62	04LA-96-0205	2833	c2 (down LA Cyn)	8--12	20-30	28	25	NM	NM	l	vfs	5.2	21.7	28.3	43	7
LA2-62	04LA-96-0206	2833	c2 (down LA Cyn)	16--19	41-48	21	20	3.3	NM	sl	vfs	1.8	18.7	38.3	36.8	6.2
LA2-62	04LA-96-0207	2833	c2 (down LA Cyn)	21--25	53-64	2.3	5.7	4	NM	gs	cs	57	77.6	10.3	7.5	4.5
LA2-S11																
LA2-54A	04LA-96-0144	2104	c2b (down LA Cyn)	0--6	0-15	1.15	5.52	1.86	0.653	s	ms	14.4	56.88	34.52	7.5	1.1
LA2-54	04LA-96-0211	2833	c2b (down LA Cyn)	8--12	20-30	7	13	NM	NM	ls	fs	7.2	33.7	41.2	19.5	5.5
LA2-54	04LA-96-0212	2833	c2b (down LA Cyn)	15--19	38-48	9.4	38	NM	NM	sl	fs	4.5	32.7	28.2	30.2	8.9
LA2-54B	04LA-96-0145	2104	c2b (down LA Cyn)	25--29	64-74	1.3	34.53	1.27	NM	ls	fs	3.6	39.68	39.74	16.77	3.8
LA2-S4																
LA2-30	04LA-96-0148	2104	c3 ("garden plot")	0--6	0-15	0.348	27.85	3.93	0.95	s	cs	4.8	94.97	4.11	0.92	0
LA2-30-31	04LA-96-0220	2833	c3 ("garden plot")	6--9	15-23	BDL	25	13	NM	s	cs	11.4	83.3	8.6	3.2	5.2
LA2-30-31	04LA-96-0221	2833	c3 ("garden plot")	13--18	33-46	BDL	39	9.3	NM	s	cs	15.2	89.5	5.4	1.8	4
LA2-31	04LA-96-0149	2104	c3 ("garden plot")	26--32	66-81	1.59	192.31	39.56	5.41	sl	ms	8.9	51.32	13.47	27.41	7.8
LA2-30-31	04LA-96-0222	2833	c3 ("garden plot")	29--32	74-81	BDL	230	36	NM	gsil	cmsi	30.3	11.7	15.4	56.9	16
LA2-30-31	04LA-96-0223	2833	c3 ("garden plot")	35--39	89-99	1.6 U	170	17	NM	s	cs	15.2	88.4	4.5	3.1	4
LA2-30-31	04LA-96-0224	2833	c3 ("garden plot")	45--48	114-122	0.6	18	6	NM	s	ms	18	76.7	14.7	5.3	3.3
LA2-30-31	04LA-96-0229	2833	c3 ("garden plot")	50--58	127-147	BDL	8	4.9	NM	gs	cs	48.4	79.6	11	5.5	3.9
LA2-10	04LA-96-0142	2104	f1 (up LA Cyn)	0--3	0-8	0.043	1.6	0.77	1.31	ls	fs	9	32.45	41.48	23.27	2.8

Notes

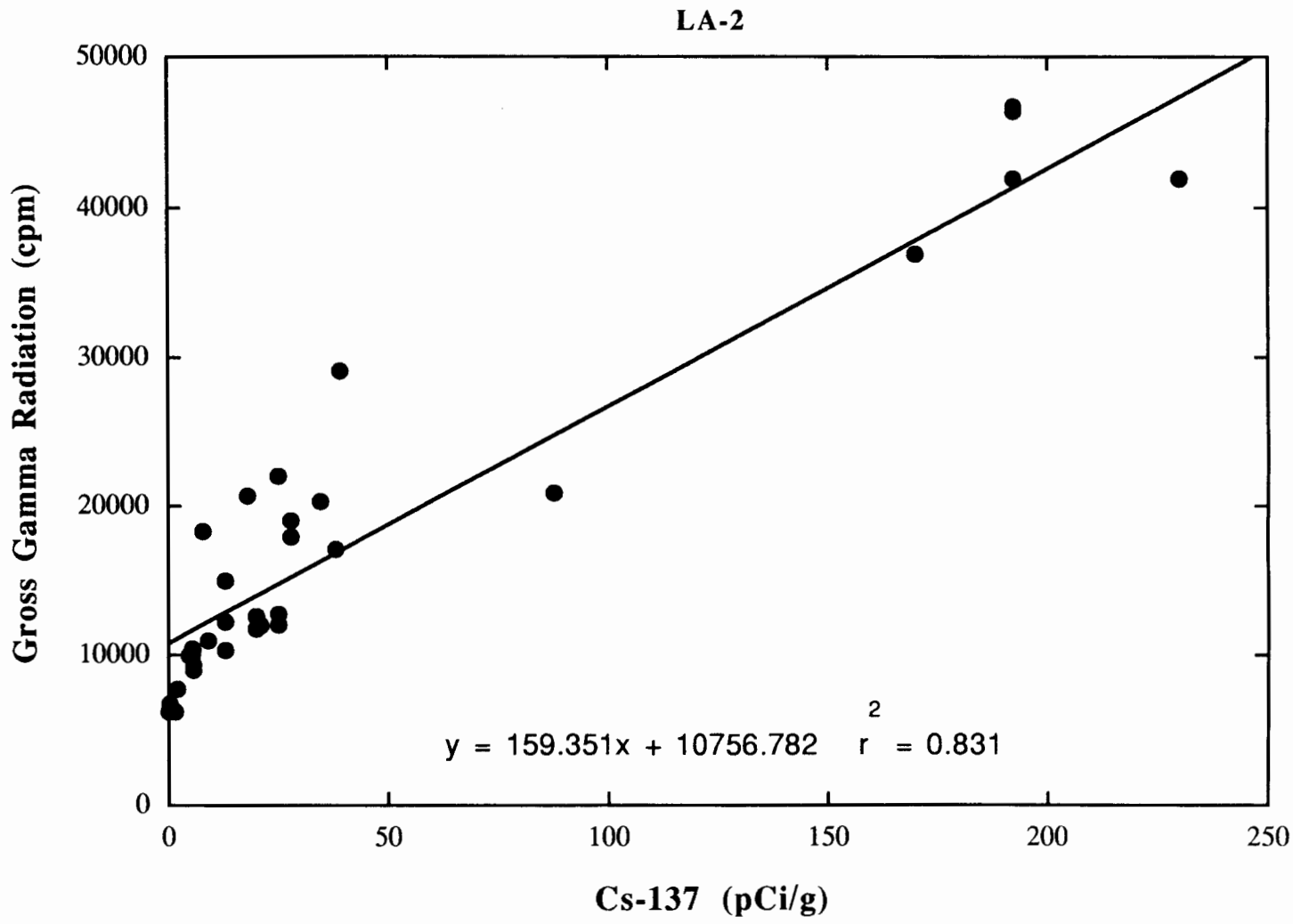
BDL = below detection limit. NM = not measured.

Percentages of sand, silt, & clay size fractions calculated from < 2mm fraction.

Lab Texture: l=loam; ls=loamy sand; sl=sandy loam; s=sand; sil=silt loam; gs=gravelly sand; gsil=gravelly silt loam; gls=gravelly loamy sand (g indicates >20% gravel)

Median Particle Size: refers to <2mm fraction (fraction submitted for chemical analysis) cmsi=coarse to medium silt; cs=coarse sand; fs=fine sand; ms=medium sand; vfs=very fine sand

Summary of LA-2 Depth Sections								
				Maximum				
			Gross	Gross	Depth of			
			Gamma	Gamma	Maximum			
	Fixed		Radiation	Radiation	Gamma		Cs-137	Cs-137
	Point	Geomorphic	Surface	At Depth	Radiation	Sampled	Surface	Maximum
Section	Site	Unit	(cpm)	(cpm)	(cm)	Sections	(pCi/g)	(pCi/g)
LA2-S1	17	c3	27982	23118	20			
LA2-S2	19	c2	11347	11794	40			
LA2-S3	26	c2	10389	10325	20			
LA2-S4	30	c3	17871	46701	70	*	27.85	230
LA2-S5	47	c3	23976	38599	70			
LA2-S6	43	c2b	14528	21068	40			
LA2-S7	48	c2	9283	11956	40	*	5.77	21
LA2-S8	49	c2	9374	12352	60			
LA2-S9	51	c2	9597	10330	40			
LA2-S10	52	c2	9919	11821	40			
LA2-S11	54	c2b	10394	20259	70	*	5.52	38
LA2-S12	55	c2	9242	12507	40			
LA2-S13	56	c2	9839	12897	50			
LA2-S14	58	c2	10852	11970	30			
LA2-S15	59	c2	10340	10678	30			
LA2-S16	60	c2	10400	11547	30			
LA2-S17	62	c2	9932	12718	30	*	4.76	25
LA2-S18	37	c2	10472	10959	20			
Notes								
All depth sections measured downstream of DP Canyon.								
Gross gamma radiation measured at surface and every 10 cm with 2" detector.								


LA-2
Gross Gamma Radiation (cpm)
50000
40000
30000
20000
10000
0
0
50
100
150
200
250
Cs-137 (pCi/g)
y = 159.351x + 10756.782
r2 = 0.831

Preliminary Am-241, Cs-137, Pu-239/240, Sr-90 Inventory, Reach LA-2

Unit	Location	Section	Area (m2)	Estimated Average Thickness (m)	Estimated Thickness Range (m)	Estimated Volume (m3)	Length (m)	Unit Vol. (m3/m)	Est. Gravel (%)	Est. Portion Non-gravel	Est. Range Non-gravel	Density (g/cm3)	notes on concentrations	Measured Range in Am-241 (pCi/g) (n=*)
c1	Up LA Cyn	0-max	348	0.5	0.2-0.8	174	195	0.89	50	0.5	0.2-0.8	1.25	LA2-9 sample	0.034 (1)
c2	Up LA Cyn	upper	482	0.65		313	195	1.61	5	0.95	0.9-1.0	1.25	LA2-12 section	BDL (4)
		lower	482	0.5	0.2-0.8	241	195	1.24	50	0.5	0.2-0.8	1.25	LA2-12 section	NM
f1	Up LA Cyn	upper	2386	0.2	0.1-0.3	477	195	2.45	5	0.95	0.9-1.0	1.25	LA2-10 sample	0.043 (1)
c1	Lower DP	0-max	213	0.5	0.2-0.8	107	70	1.52	50	0.5	0.2-0.8	1.25	DPS-4 data, 1986-1995 av.	NM
c2	Lower DP	upper	323	0.65		210	70	3.00	5	0.95	0.9-1.0	1.25	assumed same as c2, LA Cyn	NM
		lower	323	0.5	0.2-0.8	162	70	2.31	50	0.5	0.2-0.8	1.25	assumed same as c2, LA Cyn	NM
c2b	Lower DP	upper	109	0.65		71	70	1.01	5	0.95	0.9-1.0	1.25	LA2-4	3.35 (1)
		lower	109	0.5	0.2-0.8	54	70	0.78	50	0.5	0.2-0.8	1.25	assumed same as c2, LA Cyn	NM
c1	Down LA Cyn	0-max	1317	0.5	0.2-0.8	659	700	0.94	50	0.5	0.2-0.8	1.25	LA2-61 sample	0.278 (1)
c2	Down LA Cyn	upper	3191	0.15	0.05-0.25	479	700	0.68	5	0.95	0.9-1.0	1.25	av. LA2-48, 54a, 62 sfc.	0.95-1.15 (3)
		middle	3191	0.5	0.1-0.9	1596	700	2.28	5	0.95	0.9-1.0	1.25	av. LA2-48, 62 depth	2.5-28 (5)
		lower	3191	0.5	0.2-0.8	1596	700	2.28	50	0.5	0.2-0.8	1.25	LA2-62 basal gravelly sand	2.3 (1)
c2b	Down LA Cyn	upper	222	0.15	0.05-0.25	33	700	0.05	5	0.95	0.9-1.0	1.25	av. LA2-48, 54a, 62 sfc.	0.95-1.15 (3)
		middle	222	0.5	0.1-0.9	111	700	0.16	5	0.95	0.9-1.0	1.25	LA2-54 depth	1.3-9.4 (3)
		lower	222	0.5	0.2-0.8	111	700	0.16	50	0.5	0.2-0.8	1.25	assumed same as c2 basal sands	NM
f1	Down LA Cyn	upper	1234	0.2	0.1-0.3	247	700	0.35	5	0.95	0.9-1.0	1.25	assumed same as c2 depth	NM
f1b	Down LA Cyn	upper	174	0.2	0.1-0.3	35	35	1.00	0	0.95	0.9-1.0	1.25	assumed same as c2b depth	NM
c3-1	Down LA Cyn	0-0.2 m	125	0.2	0.1-0.3	25	32	0.78	10	0.9	0.85-0.95	1.25	av. LA2-30 & 31 sfc	BDL-0.348 (3)
		0.2-0.4 m	125	0.2	0.1-0.3	25	32	0.78	0	0.95	0.9-1.0	1.25	assumed c2 values	NM
c3-2	Down LA Cyn	0-0.6 m	190	0.6	0.4-0.8	114	20	5.69	10	0.9	0.85-0.95	1.25	av. LA2-30 & 31 sfc	BDL-0.348 (3)
		0.6-0.8 m	190	0.2	0.1-0.3	38	20	1.90	20	0.8	0.7-0.9	1.25	LA2-31	BDL-1.59 (2)
		0.8-1.5 m	190	0.7	0.5-0.9	133	20	6.64	50	0.5	0.2-0.8	1.25	av. of 35-58" depth samples	BDL-1.6 (3)

equations: Inventory (uCi) = concentration (pCi/g) * density (g/cm3) * portion non-gravel * volume (m3)

Inventory per unit length (uCi/m) = Inventory (uCi) / Length of unit (m)

Estimated Average Am-241 (pCi/g)	Measured Range in Cs-137 (pCi/g) (n=*)	Estimated Average Cs-137 (pCi/g)	Measured Range in Pu-239,240 (pCi/g) (n=*)	Estimated Average Pu-239/240 (pCi/g)	Measured Range in Sr-90 (pCi/g) (n=*)	Estimated Average Sr-90 (pCi/g)	Stored Am-241 (uCi)	Stored Cs-137 (uCi)	Stored Pu-239 (uCi)	Stored Sr-90 (uCi)	Unit	Location	Section
0.03	<0.12 (1)	0.06	0.211 (1)	0.2	0.66 (1)	0.7	3	7	22	76	c1	Up LA Cyn	0-max
0.04	0.28-0.38 (4)	0.33	NM	1	2.4-3.7 (4)	3.1	15	123	372	1154	c2	Up LA Cyn	upper
0.03	NM	0.06	NM	0.2	NM	0.7	5	9	30	105			lower
0.04	1.6 (1)	1.6	1.31 (1)	1.3	0.539-2.4 (8)	0.8	23	907	737	453	f1	Up LA Cyn	upper
					Total up LA Cyn		**45**	**1045**	**1161**	**1788**			
0.2	NM	2.6	NM	0.2	NM	1.2	13	173	13	80	c1	Lower DP	0-max
15	NM	18	NM	0.6	NM	5	3744	4493	150	1248	c2	Lower DP	upper
2.3	NM	5.7	NM	0.2	NM	4	232	576	20	404			lower
3.4	87.82 (1)	88	4.15 (1)	4.2	9.87 (1)	9.9	285	7389	353	831	c2b	Lower DP	upper
2.3	NM	5.7	NM	0.2	NM	4	78	194	7	136			lower
					Total Lower DP Cyn		**4353**	**12824**	**543**	**2699**			
0.3	2.12 (1)	2.1	0.22 (1)	0.2	1.04 (1)	1	123	864	82	412	c1	Down LA Cyn	0-max
1.1	4.76-5.77 (3)	5.4	0.54-0.653 (3)	0.6	1.86-2.21 (3)	2	625	3069	341	1137	c2	Down LA Cyn	upper
15	9.2-25 (5)	18	NM	0.6	3.3-6.9 (4)	5	28420	34104	1137	9473			middle
2.3	5.7 (1)	5.7	NM	0.2	4 (1)	4	2294	5684	199	3989			lower
1.1	4.76-5.77 (3)	5.4	0.54-0.653 (3)	0.6	1.86-2.21 (3)	2	43	213	24	79	c2b	Down LA Cyn	upper
5.9	13-38 (3)	29	2.32 (1)	2.3	1.27 (1)	1.3	777	3821	303	171			middle
2.3	NM	5.7	NM	0.2	NM	4	160	395	14	277			lower
15	NM	18	NM	0.6	NM	5	4395	5274	176	1465	f1	Down LA Cyn	upper
5.9	NM	29	NM	2.3	NM	1.3	244	1200	95	54	f1b	Down LA Cyn	upper
0.4	25-39 (3)	31	0.95 (1)	1	3.93-13 (3)	9	11	875	28	254	c3-1	Down LA Cyn	0-0.2 m
15	NM	18	NM	0.6	NM	5	447	536	18	149			0.2-0.4 m
0.4	25-39 (3)	31	0.95 (1)	1	3.93-13 (3)	9	51	3967	128	1152	c3-2	Down LA Cyn	0-0.6 m
1.6	192.31-230 (2)	211	5.41 (1)	5.4	36-39.56 (2)	38	61	8001	205	1441			0.6-0.8 m
0.6	8-170 (3)	65	NM	1	4.9-17 (3)	9	50	5392	83	747			0.8-1.5 m
					Total c3		**620**	**18771**	**462**	**3742**			
					Total below DP		**37701**	**73396**	**2833**	**20799**			
					% in c3		**2%**	**26%**	**16%**	**18%**			

SALS?