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Brunswick Harbor, Georgia
Vibracore Samples
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1. SUMMARY

This work is in support of monitoring efforts of nearshore-placed dredged material from the Brunswick Harbor, Georgia navigation channel by the US Army Corps of Engineers (USACE) and Evans-Hamilton, Inc. (EHI) project number 6000.34. See website: http://www.frf.usace.army.mil/brunswick/ for more information about the project.

The lab work in this report was performed by the Virginia Institute of Marine Science (VIMS), College of William and Mary, under the direction of Grace Cartwright. Thirty-two Vibracore sediment sub-samples were received by VIMS on May 20, 2003. These were selected sub-samples from seven vibracores collected by EHI and USACE personnel. The sediment samples were analyzed for percent by weight for clay, silt, sand and gravel using wet sieve and pipette methods. The sand portion was sieved into four fractions:
63-500 microns, 500-850 microns, 850-1400 microns and 1.4 -2.0 mm. The same samples were also analyzed for grain-size volume distribution and D50 grain-size for mud (5 to <63 microns) and sand (63 to <500 microns) using a Laser In-Situ Scattering Transmissometer (LISST 100).

Table 1. Sediment Sub-sample Identification

SAMPLE ID	VIBRACORE	DEPTH	SAMPLE ID	VIBRACORE	DEPTH
VC01A	VC01	0.0 - 0.1	**VC04C**	VC04	1.3 - 1.7
VC01B	VC01	0.1 - 0.5	**VC04D**	VC04	3.3 - 3.85
VC01C	VC01	0.9 - 1.25			
VC01D	VC01	1.25 -1.45	**VC05A**	VC05	0.1 - 0.3
			VC05B	VC05	1.1 - 1.5
VC02A	VC02	0.0 - 0.1	**VC05C**	VC05	1.5 - 1.8
VC02B	VC02	0.1 -0.3	**VC05D**	VC05	1.8 - 2.35
VC02C	VC02	2.1 - 2.3			
VC02D	VC02	2.3 - 2.5	**VC06A**	VC06	0.0 - 0.05
VC02E	VC02	3.1 - 3.3	**VC06B**	VC06	0.3 - 0.7
VC02F	VC02	3.9 -4.1	**VC06C**	VC06	1.1 - 1.45
			VC06D	VC06	1.6 - 1.9
VC03A	VC03	0.1 - 0.5	**VC06E**	VC06	3.1 - 3.5
VC03B	VC03	1.3 - 1.8			
VC03C	VC03	1.8 - 2.25	**VC07A**	VC07	0.1 - 0.5
VC03D	VC03	2.25 - 2.5	**VC07B**	VC07	0.9 - 1.2
VC03E	VC03	2.6 - 2.85	**VC07C**	VC07	1.2 - 1.5
			VC07D	VC07	1.5 - 1.7
VC04A	VC04	0.1 - 0.5			
VC04B	VC04	0.5 - 0.9			

2. METHODS

The samples, delivered via Fed-Ex, were received May 20, 2003. Identification information for each of the sub-samples is listed in Table 1.

2.1 Percent grain-size distribution by weight

Wet sieve methods were used to determine the percent fractions of mud (<63 microns), percent sand as four fractions (63 -500 microns, 500-850 microns, 850-1400 microns and 1.4 -2.0 mm) and gravel (>2 mm) for an aliquot of each sub-sample from each of the seven vibracores. Ten millimeters of stock mesophosphate solution (0.3 g sodium carbonate and 51 g sodium mesophosphate solution/L de-ionized water) was added to each aliquot and put in a sonicator to prevent flocculation during the size separation process. Pipette analyses were used to separate the mud into clay and silt fractions. Percent by weight was determined for each fraction of the total weight of the aliquot.

2.2 Percent grain-size distribution by volume

The sand fraction (63-500 microns) and the mud fraction from the previous section were used to determine the volume grain-size distribution of these fractions. For the mud distribution, from 4 to 85 ml of the mud fraction, depending on the concentration of the mud generated for the pipette analysis in the section above, was brought to a total of 90 ml with a 10% solution of the stock sodium mesophosphate solution. For the sand distribution, enough sand was added to 90 ml of the 10% sodium mesophosphate solution to give a good response from the LISST. Each solution was placed in a stirring chamber within the laser path length of the LISST and at least 100 seconds of data were collected at 1 Hz. The LISST records grain-size distribution ranging from 5 to 500 microns in 32 bins. An average for each of these bins was calculated.

For the mud distribution, the averaged response of the first 17 bins, corresponding to the 5 to 63 microns grain-size, were added together to get a total mud response. The response of each of these bins was then divided by the total mud response and multiplied by 100 to give a logarithmically spaced percent volume grain-size distribution for the mud fraction. The D50 mud grain-size is the bin-size that corresponds to 50 percent of the cumulative response of these 17 bins.

For the sand distribution, the averaged response for bins 18 to 32, corresponding to the 63 to 500 microns range, were added together to get a total sand response and multiplied by 100 to give a logarithmically spaced percent volume grain-size distribution for the sand fraction. The D50 sand grain-size is the bin size that corresponds to 50 percent of the cumulative response of these 15 bins.

Table 2. Percent Grain-size distribution by weight

SAMPLE ID	CLAY% (<20 micron)	SILT% (20 - 63 micron)	SAND % (63 - 500 micron)	(500 - 850 micron)	(850 - 1400 micron)	(1.4 - 2.0 mm)	GRAVEL% >2.0 mm
VC01A	0.00	1.57	59.95	23.57	11.67	2.79	0.45
VC01B	0.08	1.26	63.92	21.60	10.19	2.16	0.79
VC01C	0.19	0.92	40.36	32.70	17.66	4.90	3.26
VC01D	6.53	2.90	48.29	14.15	8.90	5.04	14.19
VC02A	1.05	10.88	87.09	0.52	0.46	0.00	0.00
VC02B	1.64	9.90	86.77	0.60	0.51	0.57	0.00
VC02C	9.61	6.52	79.34	1.24	1.46	0.91	0.92
VC02D	4.16	3.82	83.23	4.12	2.53	1.01	1.12
VC02E	4.74	3.09	91.32	0.28	0.44	0.13	0.00
VC02F	3.23	2.52	92.69	0.97	0.41	0.17	0.00
VC03A	0.32	0.46	76.92	14.93	4.94	1.21	1.22
VC03B	0.53	0.50	54.42	24.17	12.37	4.72	3.29
VC03C	33.21	11.68	32.29	11.04	7.66	2.92	1.21
VC03D	13.33	6.01	60.04	8.03	5.04	2.69	4.85
VC03E	1.66	1.20	81.19	8.26	4.79	1.34	1.57
VC04A	1.32	0.68	39.66	31.16	17.35	4.80	5.04
VC04B	1.79	0.99	35.93	30.23	21.58	5.23	4.25
VC04C	27.53	10.37	18.03	8.33	9.29	6.42	20.04
VC04D	40.53	16.01	20.08	4.79	5.87	4.21	8.51
VC05A	7.42	3.98	71.95	5.10	5.59	4.76	1.20
VC05B	1.48	1.41	73.44	9.13	5.84	2.59	6.12
VC05C	19.30	12.10	48.62	4.68	4.21	3.13	7.96
VC05D	2.10	1.01	91.45	2.77	1.58	0.83	0.26
VC06A	3.40	9.46	86.59	0.26	0.29	0.00	0.00
VC06B	1.23	0.66	93.55	1.89	1.26	0.48	0.93
VC06C	0.95	2.08	87.64	3.13	2.65	1.86	1.69
VC06D	5.01	1.80	84.66	1.79	2.15	1.39	3.20
VC06E	3.13	1.21	92.91	1.24	0.96	0.55	0.00
VC07A	0.62	0.51	56.75	23.20	12.93	2.89	3.10
VC07B	0.45	0.11	47.58	27.03	15.66	4.47	4.70
VC07C	3.85	3.63	70.77	12.89	7.21	1.65	0.00
VC07D	1.41	0.74	84.56	9.52	2.93	0.51	0.34

3. RESULTS

Table 1 identifies each of the sediment sub-samples received. There are seven vibracores labeled VC01 to VC07. Each vibracore has at least 4 sub-samples labeled A-D. VC03 and VC06 have 5 sub-samples each, labeled A-E and VC02 has 6 sub-samples, labeled A-F. Each sub-sample is a portion of the vibracore measured by depth, documented in Table 1.

3.1 Percent grain-size distribution by weight

Table 2 lists the percent grain-size distribution by weight for each of the vibracore sub-samples received. The mud portion is represented by two fractions: clay (<20 microns) and silt (20 – 63 microns). The sand portion is represented by five fractions: 63 – 500 microns, 500 – 850 microns, 850 – 1400 microns, and 1.4 – 2 mm. The last portion labeled "gravel" is actually all material that is greater than 2 mm and includes shell fragments, bigger pieces of quartz, etc.

Figures 1.1 – 1.7 show that the sand fraction, 63-500 micron, is the largest fraction represented in the vibracores accounting for over 50% of the sediment in most of the sub-samples. That fraction accounts for over 79% of sediment in all the sub-samples in VC02 (Figure 1.2) and over 84% of sediment in the VC06 sub-samples (Figure 1.6). The next largest fractions in these two vibracores are the clay and silt fractions. Over 9% of the sediment is in the clay fraction in VC02C (2.1-2.3 meter depth) and in the silt fraction in VC02A (0.0-0.1 meter), VC02B(0.1-0.3 meter), VC06A(0.0-0.05 meter).

VC01 (Figure 1.1) has between 40 – 64% of the sediment in the 63-500 micron sand fraction. In this vibracore the next largest fraction of sediment is the 500-800 micron sand fraction accounting for as much as 33% of the sediment in VC01C (0.9-1.25 meter) and as little as 14% in VC01D (1.25-1.45 meter) , which also has over 6% in the clay fraction.

The top two depths and the bottom depth in VC03, A (0.1-0.5 meter), B (1.3-1.8 meter) and E (2.6-2.85 meter), have most of their sediment in the three finest grain-size sand fractions: 63-500 micron, 500-850 micron and 850-1400 micron. A has 77, 15 and 5 percent, respectively, B has 54, 24 and 12 percent, respectively and E has 81, 8 and 5 percent, respectively. C (1.8-2.25 meter) shifts to almost as much clay (33%) and silt (12%) as sand: 63-500 micron (32%) and 500-850 micron (11%). In D (2.25-2.5 meter) a notable amount of the sub-sample is accounted for in the clay (13%), and silt (6%) fractions as well.

Vibracore VC04 follows a similar pattern in its top two sub-samples, with A (0.1-0.5 meter) and B (0.5-0.9 meter) accounting for most of their sediment in the three finest grain-size sand fractions: 63-500 micron, 500-850 micron and 850-1400 micron. A has 40, 31 and 17 percent, respectively and B has36, 30 and 22 percent, respectively. C (1.3-1.7 meter) and D (3.3-3.85 meter) have less than 20 percent in the 63-500 micron fraction and less than 9 percent in the next two coarser sand grain-size fractions. A significant

amount of their sediment is in the clay and silt fractions: 28 and 10 percent, respectively, for C, and 41 and 16 percent, respectively, for D. C also has over 20 percent of its sediment in the >2 mm fraction.

Vibracore VC05 has the highest concentration of 63-500 micron grain-size sand in sub-sample D (1.85-2.35 meter) at 91 percent. Sub-samples A (0.1-0.3) and B (1.1-1.5) are similar with slightly more than 70 percent each. Sub-sample C (1.5-1.8) has the least amount of the fraction accounting for only 49 percent of its sediment. C has the least amount of the finest sand fraction also has the greatest concentration of clay and silt at 19 and 12 percent, respectively. A differs from B by having more clay and silt, A having 7 and 4 percent, respectively, as compared to 1.5 each in B.

In Vibracore VC07, sub-sample C (1.2-1.5 meter) is the depth where the greatest amount of clay and silt is observed at 3.8 and 3.6 percent, respectively. Most of the sediment is observed in the three finest grain-size sand fractions. A (0.1-0.5 meter) and B (0.9 -1.2) are similar in composition. A has 57, 23, and 13 percent for the 63-500 micron, 500-850 micron and the 850-1400 micron fractions, respectively. Similarly, B has 48, 27 and 16 percent, respectively. C increases in the finest sand fraction and decreases in the next two fractions with 71, 13 and 7 percent, respectively. D continues to increase concentration in the finest sand fraction and decreases in the next two fractions with 85, 10 and 3 percent, respectively.

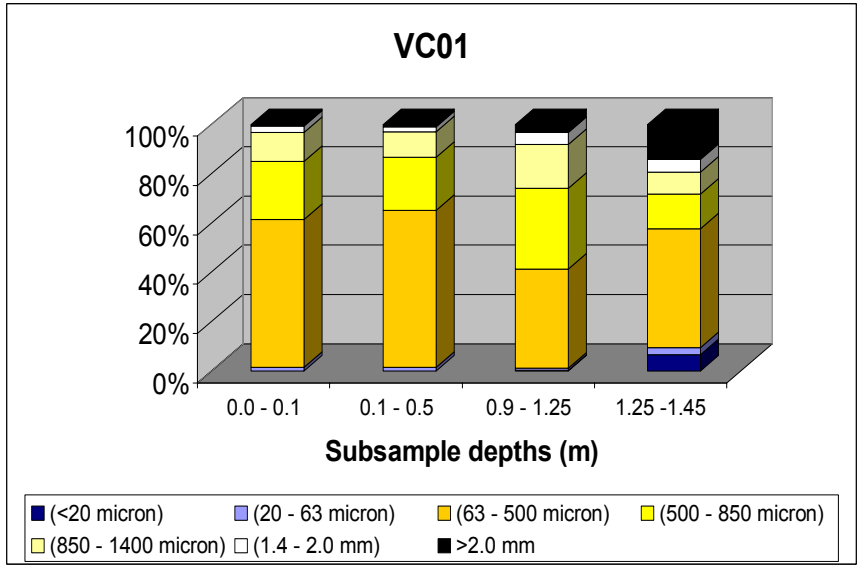
3.2 Percent grain-size distribution by volume

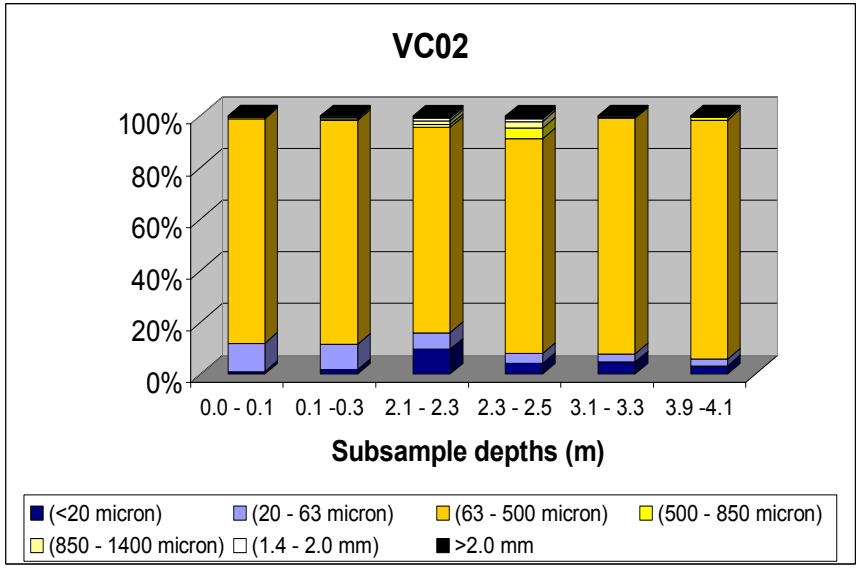
Figures 2.1-2.32 show two graphs for each vibracore sub-sample. The **A** graph of each pair is the percent grain-size distribution calculated from the LISST volume distribution of the mud fraction. In each bar graph, the first peak represents the clay portion of the mud and the second peak is the silt portion. If the clay peak is proportionally greater than the silt peak, then the mud D50 grain-size will be in the clay region, represented by a red line and listed in Table 3 and in Figures 3.1-3.7. Conversely, when the silt peak is greater, the mud D50 is larger.

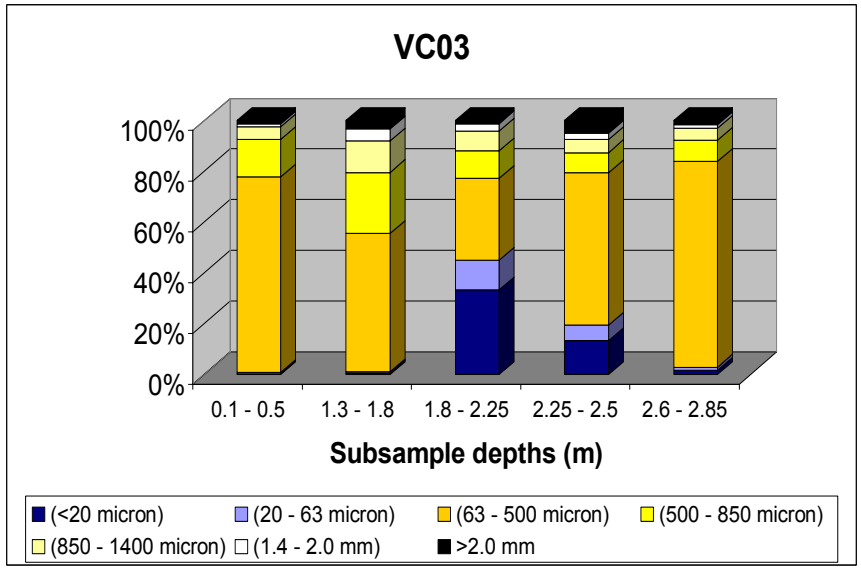
The **B** graph of each pair in Figures 2.1-2.32 is the percent grain-size distribution of the sand fraction from 63-500 microns. The limitation of this method is seen when this fraction is not a majority of the sediment greater than 63 microns because it give an erroneously low D50 represented by the red line in the graph and listed in Table 3 and in Figures 3.1-3.7.

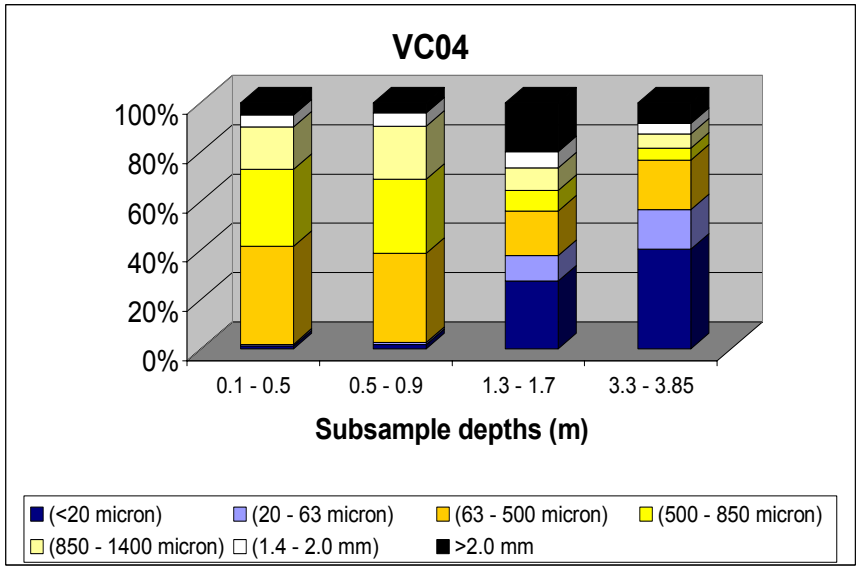
Acknowledgments

This report would not be possible without the excellent advice and support from my co-author Carl Friedrichs and the expert technical assistance provided by Carol Pollard and Kate Mansfield.

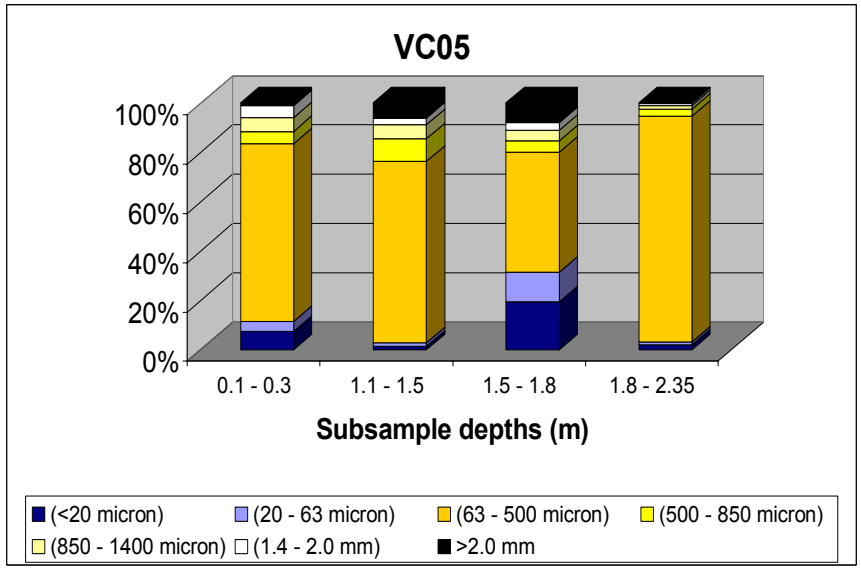


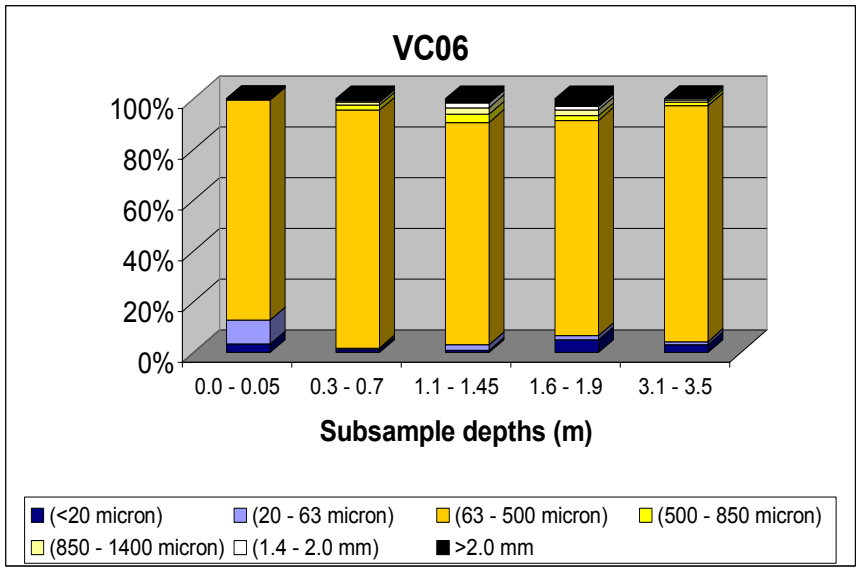


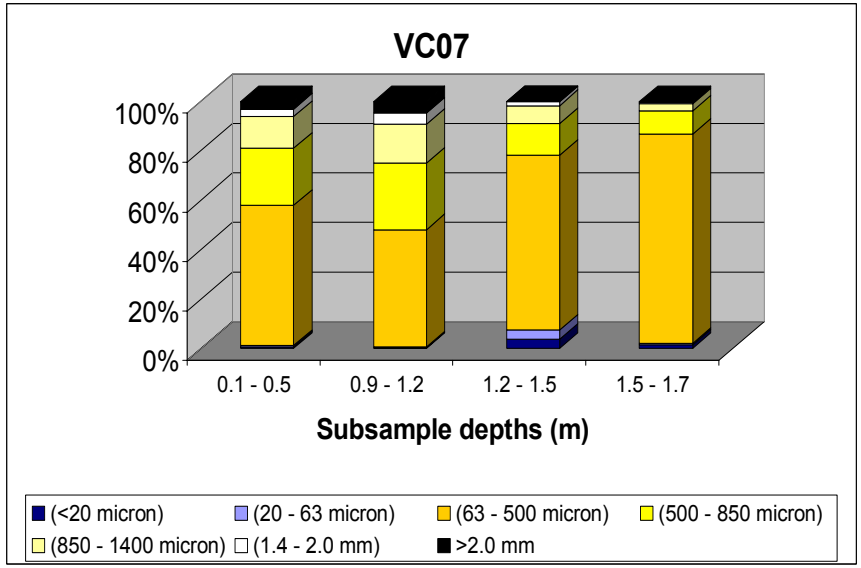




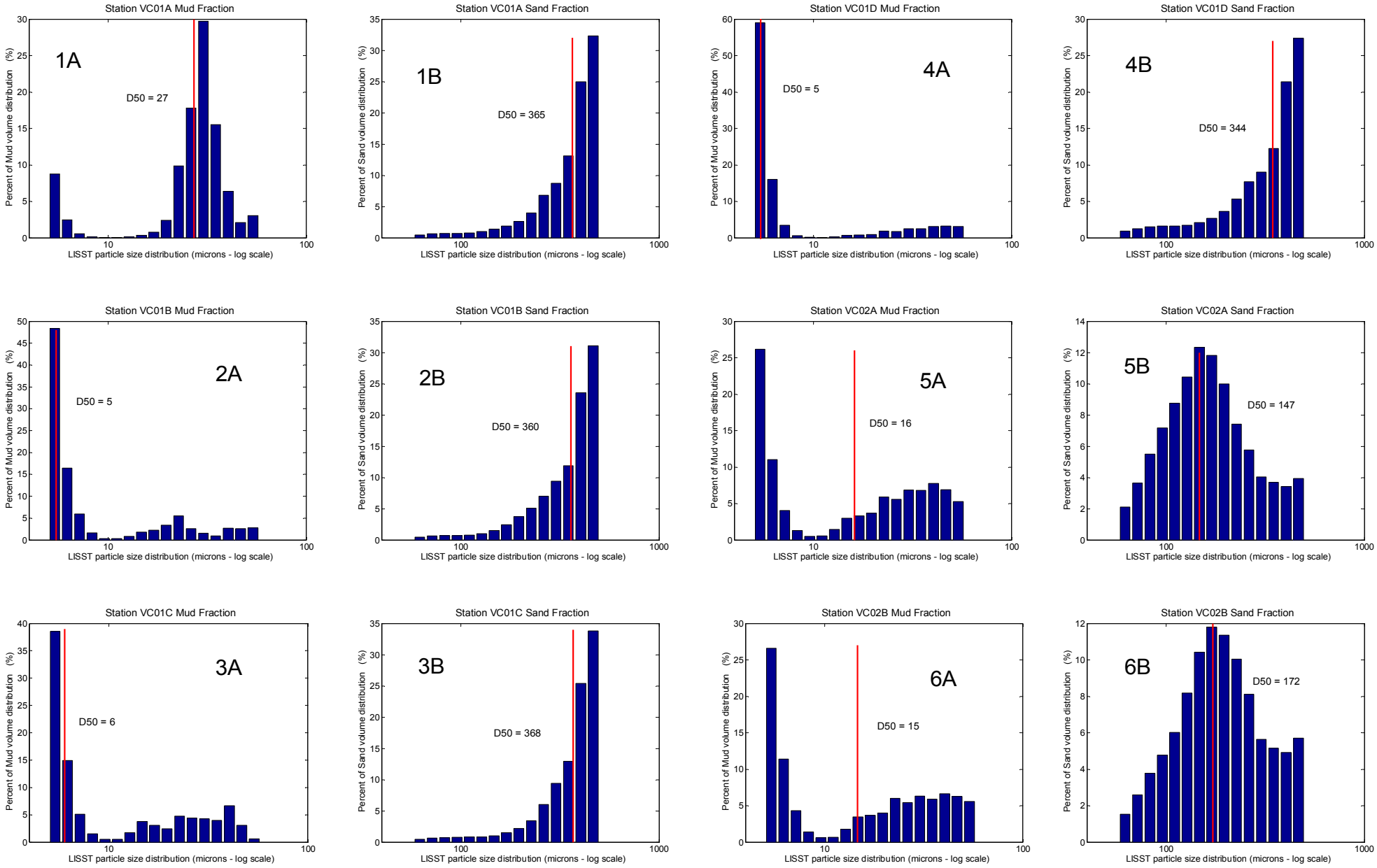
Figures 1.1 – 1.4. Percent distribution by weight of each fraction for clay to >2.0mm of the vibracore sub-samples.



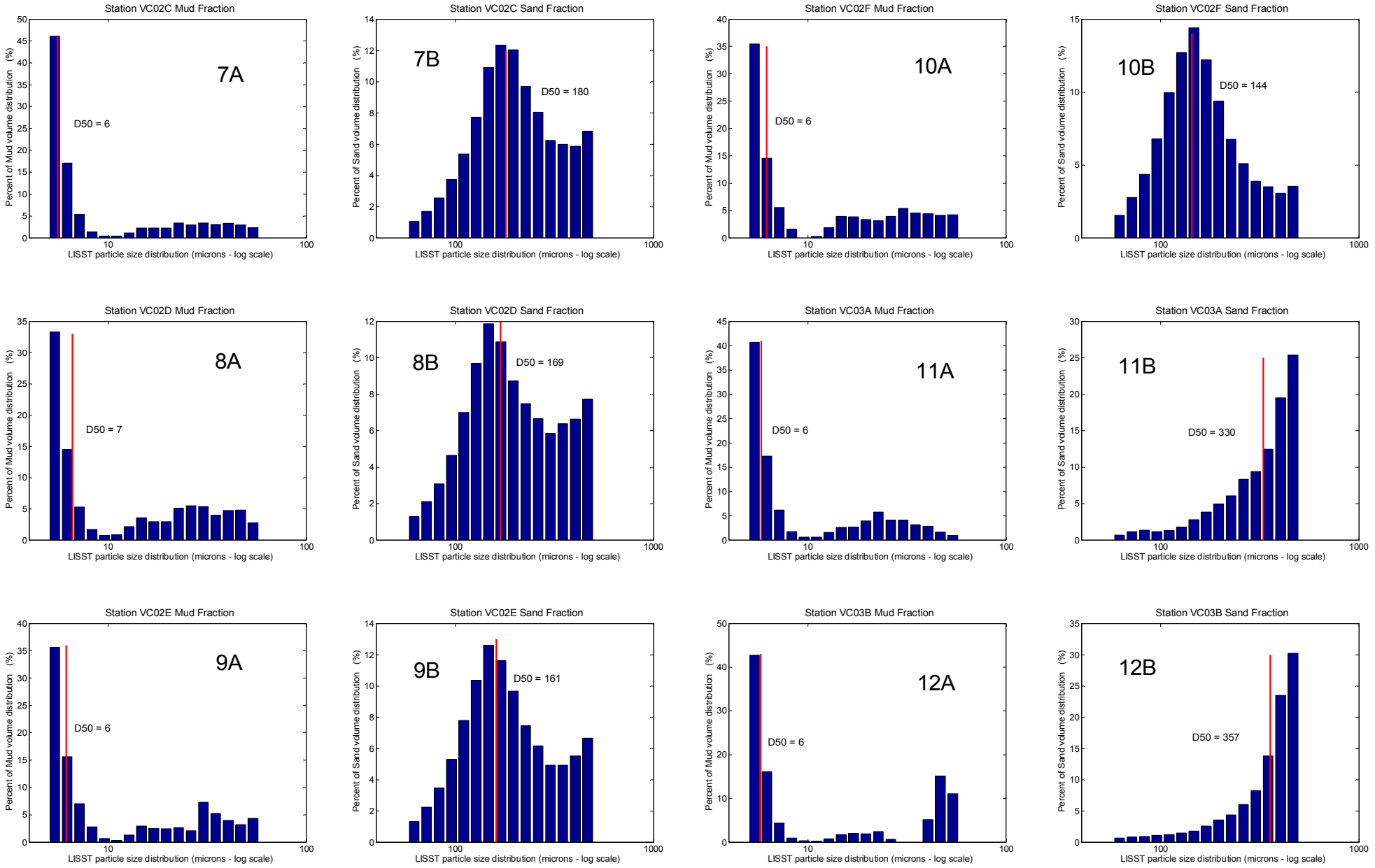




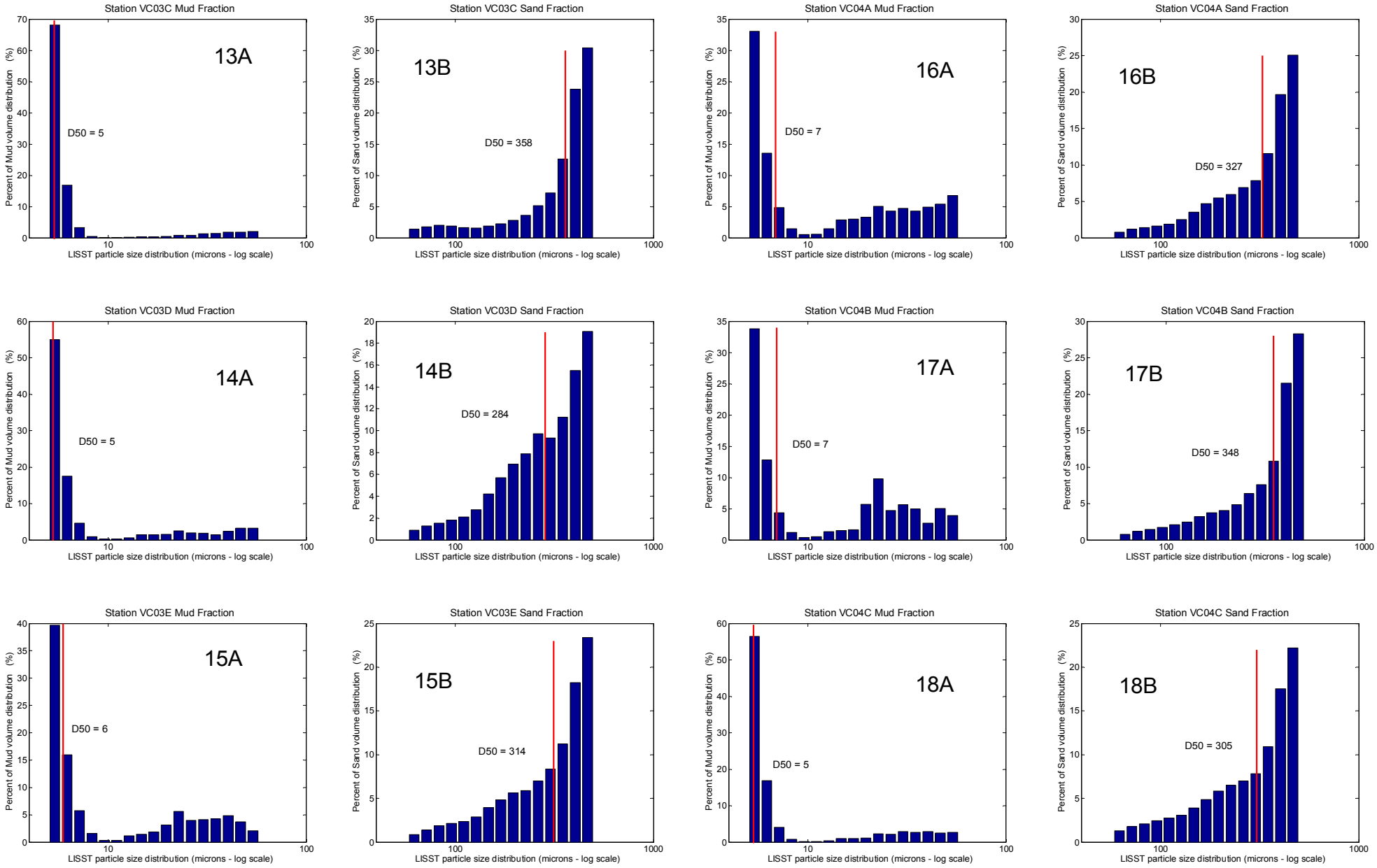
Figures 1.5 – 1.7. Percent distribution by weight of each fraction for clay to >2.0mm of the vibracore sub-samples.



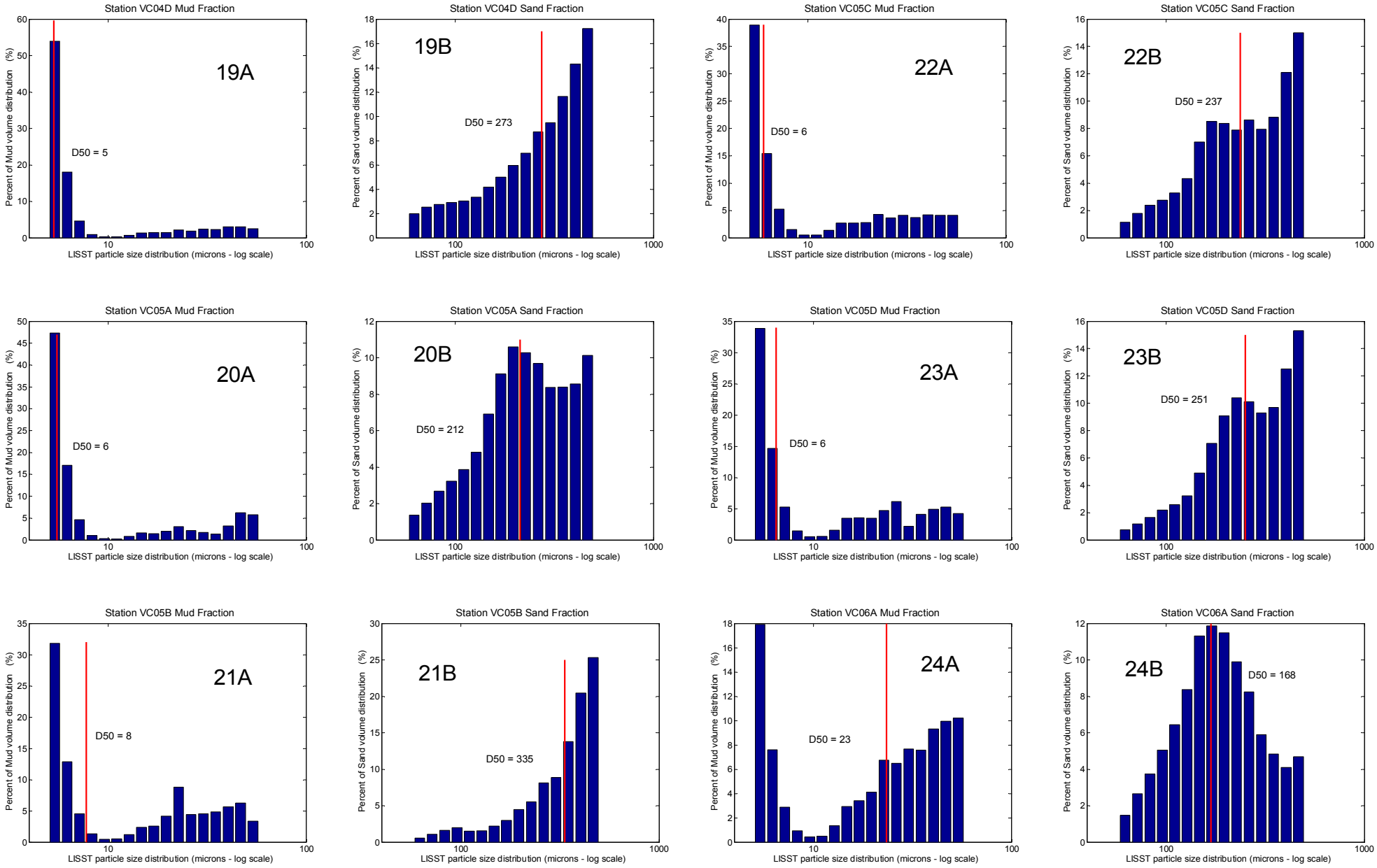
Figures 2.1 – 2.6. LISST percent grain-size distributions by volume for Vibracore VC01 sub-samples A-D and Vibracore VC02 sub-samples A-B. The A graph is the distribution of the mud fraction and the B graph is the distribution for the sand fraction. The red line on each graph is the D50 grain size for that fraction.



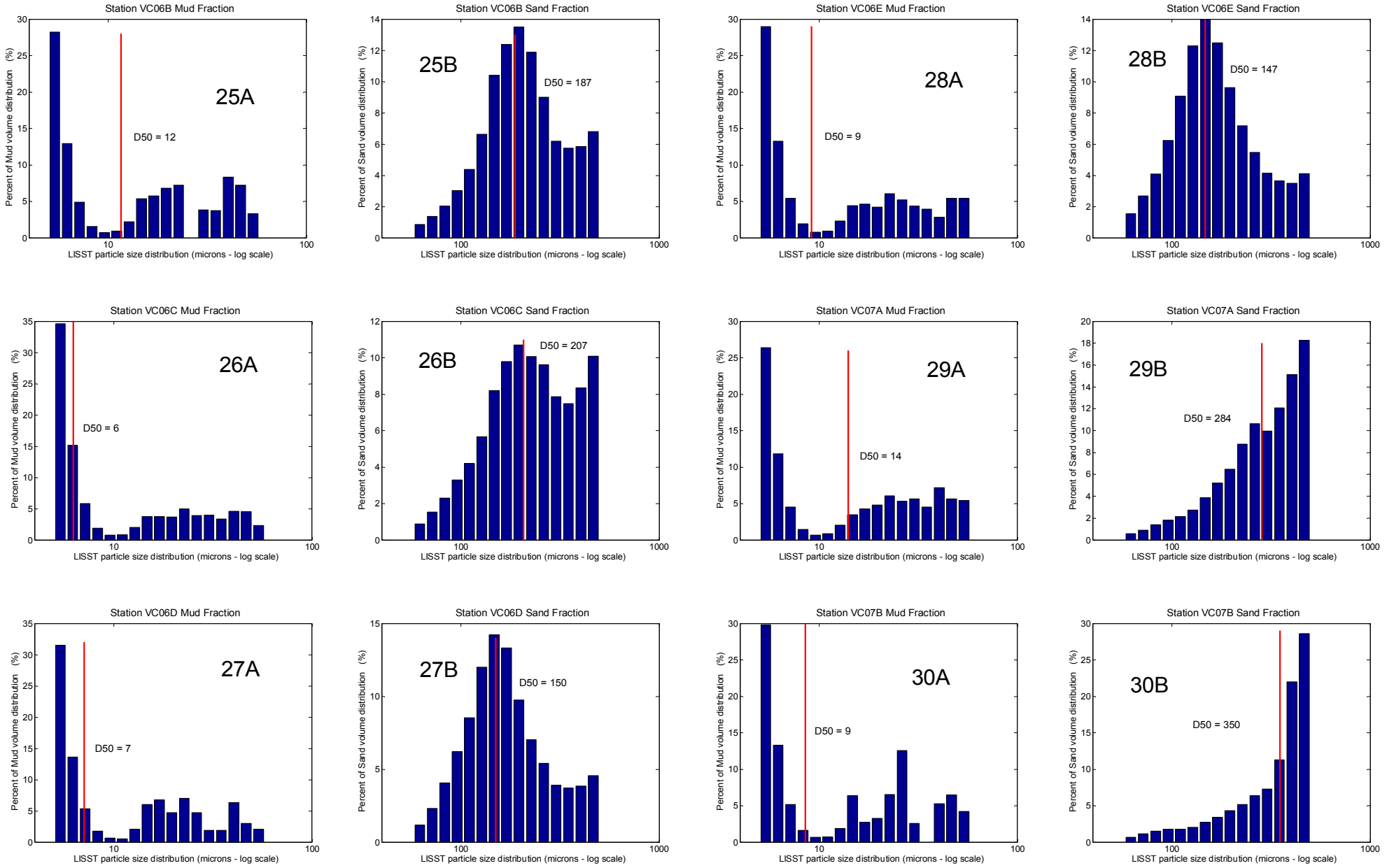
Figures 2.7 – 2.12. LISST percent grain-size distributions by volume for Vibracore VC02 sub-samples C-F and Vibracore VC03 sub-samples A-B. The A graph is the distribution of the mud fraction and the B graph is the distribution for the sand fraction. The red line on each graph is the D50 grain size for that fraction.



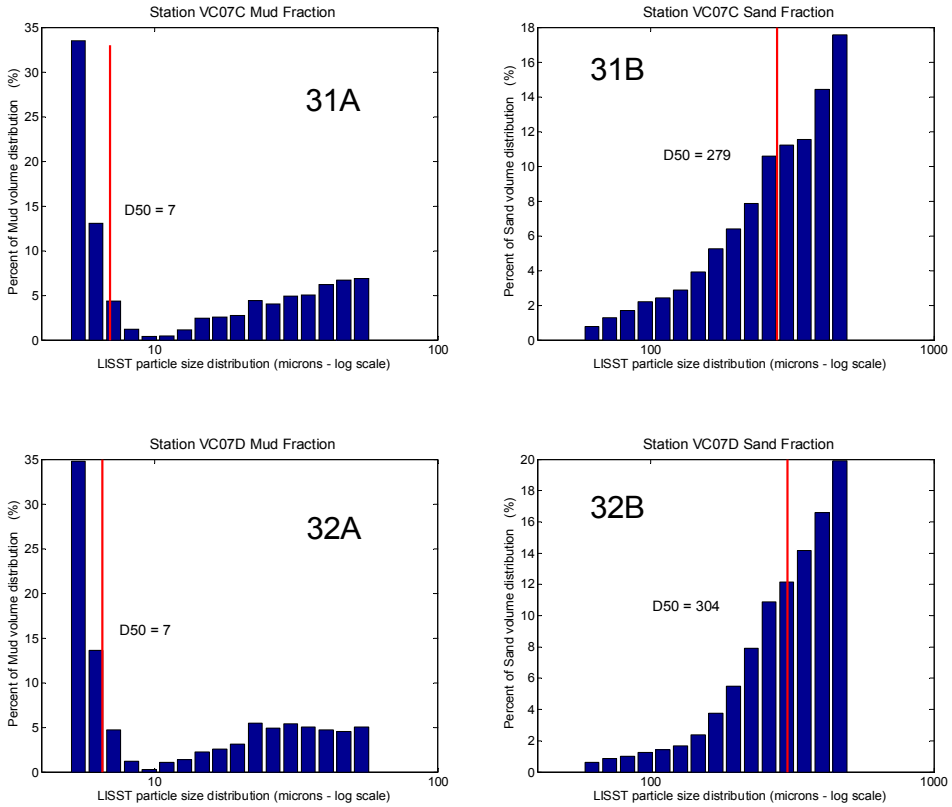
Figures 2.13 – 2.18. LISST percent grain-size distributions by volume for Vibracore VC03 sub-samples C-E and Vibracore VC04 sub-samples A-C. The A graph is the distribution of the mud fraction and the B graph is the distribution for the sand fraction. The red line on each graph is the D50 grain size for that fraction.



Figures 2.19 – 2.24. LISST percent grain-size distributions by volume for Vibracore VC04 sub-sample D, Vibracore VC05 sub-samples A-D and Vibracore VC06 sub-sample A. The A graph is the distribution of the mud fraction and the B graph is the distribution for the sand fraction. The red line on each graph is the D50 grain size for that fraction.



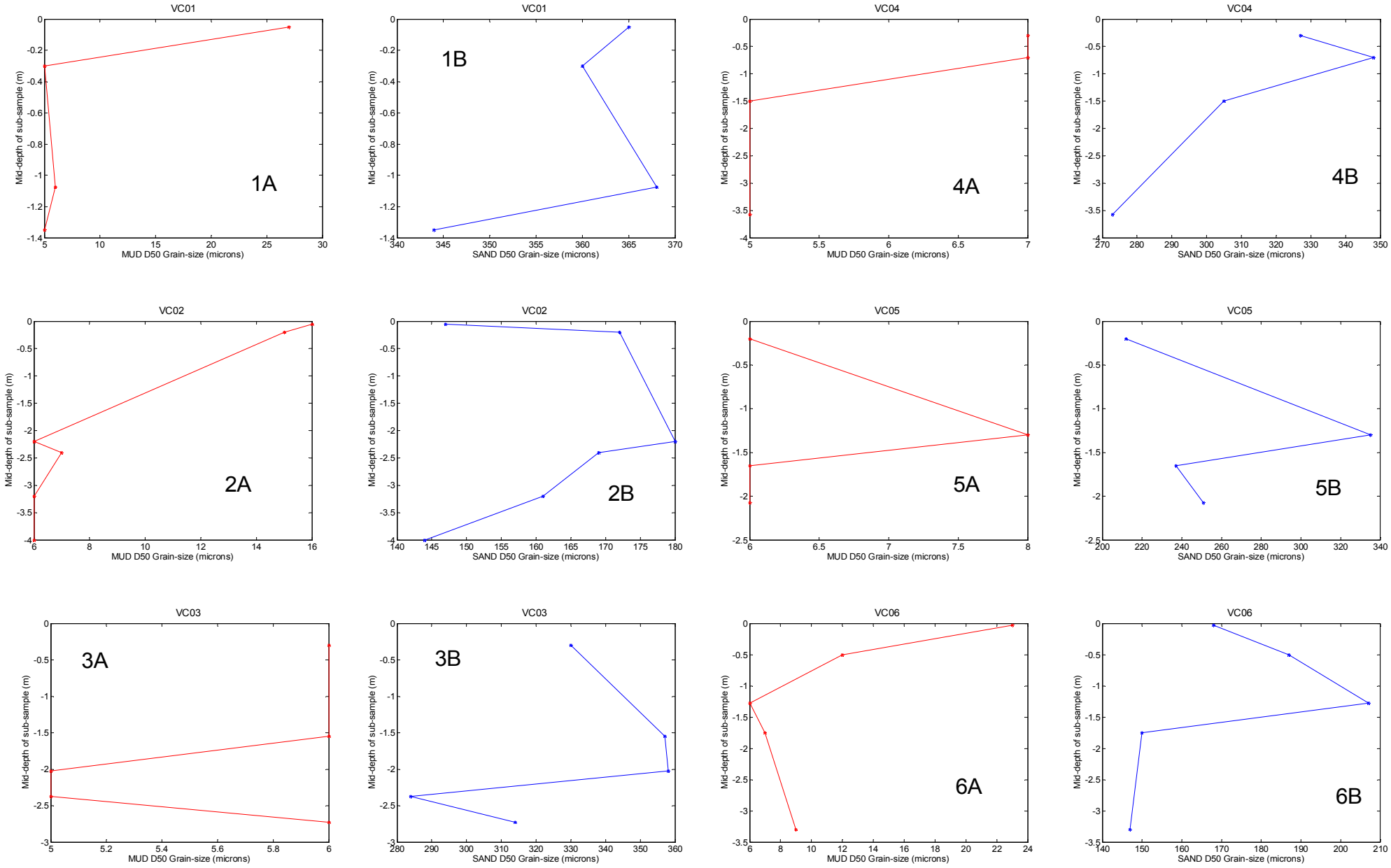
Figures 2.25 – 2.30. LISST percent grain-size distributions by volume for Vibracore VC06 sub-samples B-E and Vibracore VC07 sub-samples A-B. The A graph is the distribution of the mud fraction and the B graph is the distribution for the sand fraction. The red line on each graph is the D50 grain size for that fraction.



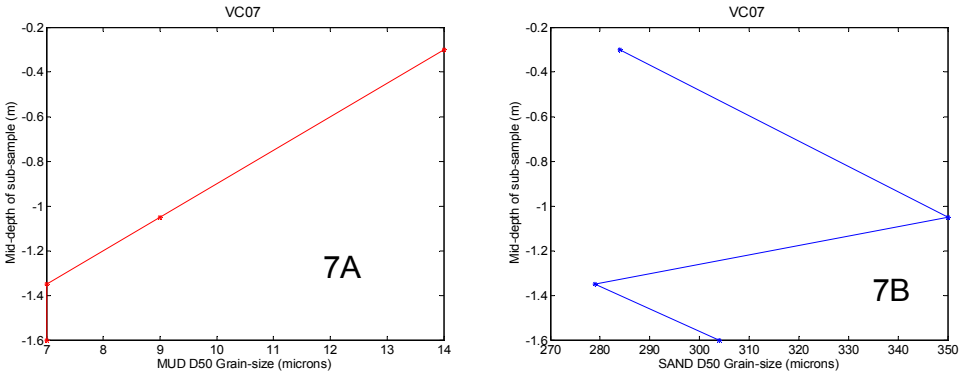
Figures 2.31 – 2.32. LISST percent grain-size distributions by volume for Vibracore VC07 sub-samples C-D. The A graph is the distribution of the mud fraction and the B graph is the distribution for the sand fraction. The red line on each graph is the D50 grain size for that fraction.

Table 3. LISST D50 Grain-sizes

Sample ID	MUD D50	SAND D50
VC01A	27	365
VC01B	5	360
VC01C	6	368
VC01D	5	344
VC02A	16	147
VC02B	15	172
VC02C	6	180
VC02D	7	169
VC02E	6	161
VC02F	6	144
VC03A	6	330
VC03B	6	357
VC03C	5	358
VC03D	5	284
VC03E	6	314
VC04A	7	327
VC04B	7	348
VC04C	5	305
VC04D	5	273
VC05A	6	212
VC05B	8	335
VC05C	6	237
VC05D	6	251
VC06A	23	168
VC06B	12	187
VC06C	6	207
VC06D	7	150
VC06E	9	147
VC07A	14	284
VC07B	9	350
VC07C	7	279
VC07D	7	304



Figures 3.1 – 3.6. LISST D50 Grain-size as a function of depth for Vibracores VC01 - VC06. The A graph is the D50 grain-sizes for the mud fraction and the B graph is the D50 grain-sizes for the sand fraction.



Figures 3.7. LISST D50 Grain-size as a function of depth for Vibracore VC07. The A graph is the D50 grain-sizes for the mud fraction and the B graph is the D50 grain-sizes for the sand fraction.