Activity report on the project "*Microplastic concentration in sediments and waters of Matagorda and San Antonio Bays: Initial assessment and mitigation plans*"

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Period: April 1st 2023 to June 30th 2023 – Continuation of laboratory microplastics separation, open new cores, work on the sediment grainsize analysis and started to determine total organic content (TOC).

During the quarter of April to June 2023, we continued the work on separation of microplastics from sediments by opening more sediment cores collected. We started to analyze grainsize and total organic carbon in the sampled sediments collected in previous field campaigns. For understanding the microplastics accumulation and dynamics in bay sediment is key to analyze the grainsize of the sediment and the total organic content (TOC) in the sediment. If we are able to establish some rules of what type (grainsize, TOC content) the plastics might concentrate we will be able to improve the prediction of microplastics occurrence. The initial hypothesis was that microplastic content will be higher (1) in finer-grained sediments and (2) in organic-rich deposits, which may pertain to overlapping material densities (ca. 0.9-1.5 g/cc).

The grainsize and TOC analysis are ongoing, where so far, we analyzed 63 shallow bed samples to produce distribution maps. Grainsize analysis was performed using the Mastersizer 3000, which uses laser diffraction to measure the particle size distribution of materials (*Malvern Panalytical*, 2023). Here, we compared microplastic concentrations from grab samples to values related to percent sand on cumulative curve distribution at D10, D50, and D90 grainsizes (that is sediment sizes at 10%, 50%, and 90%). The bay sediment ranges from clay (most D10 values are around 10 microns) to fine sand (D90 values at 125-250 microns) (see Figure 1A). Our observations that the bay is dominated by silt-size sediments seem unchanged since it was extensively mapped in the late 1970s. The distribution of the samples varies with some samples showing a unimodal distribution with a peak in the clay-silt range and other samples having a peak in the fine sand range. Interesting to note is that many samples have bi-modal distribution (like sample G_47 in Figure 1B) suggesting different sediment transport and deposition processes. The distribution of the predominant grainsize (i.e., silt) also is roughly similar to the last comprehensive survey (Figure 3A) (e.g., Mud; McGowen, 1979).

The results show the Matagorda Bay sediment is dynamic (with different grainsize distribution modes in different locations), but the grainsize range, dominated by silt is similar. However, if any association with microplastic can be done then we also know the prevalent areas for microplastic accumulations.

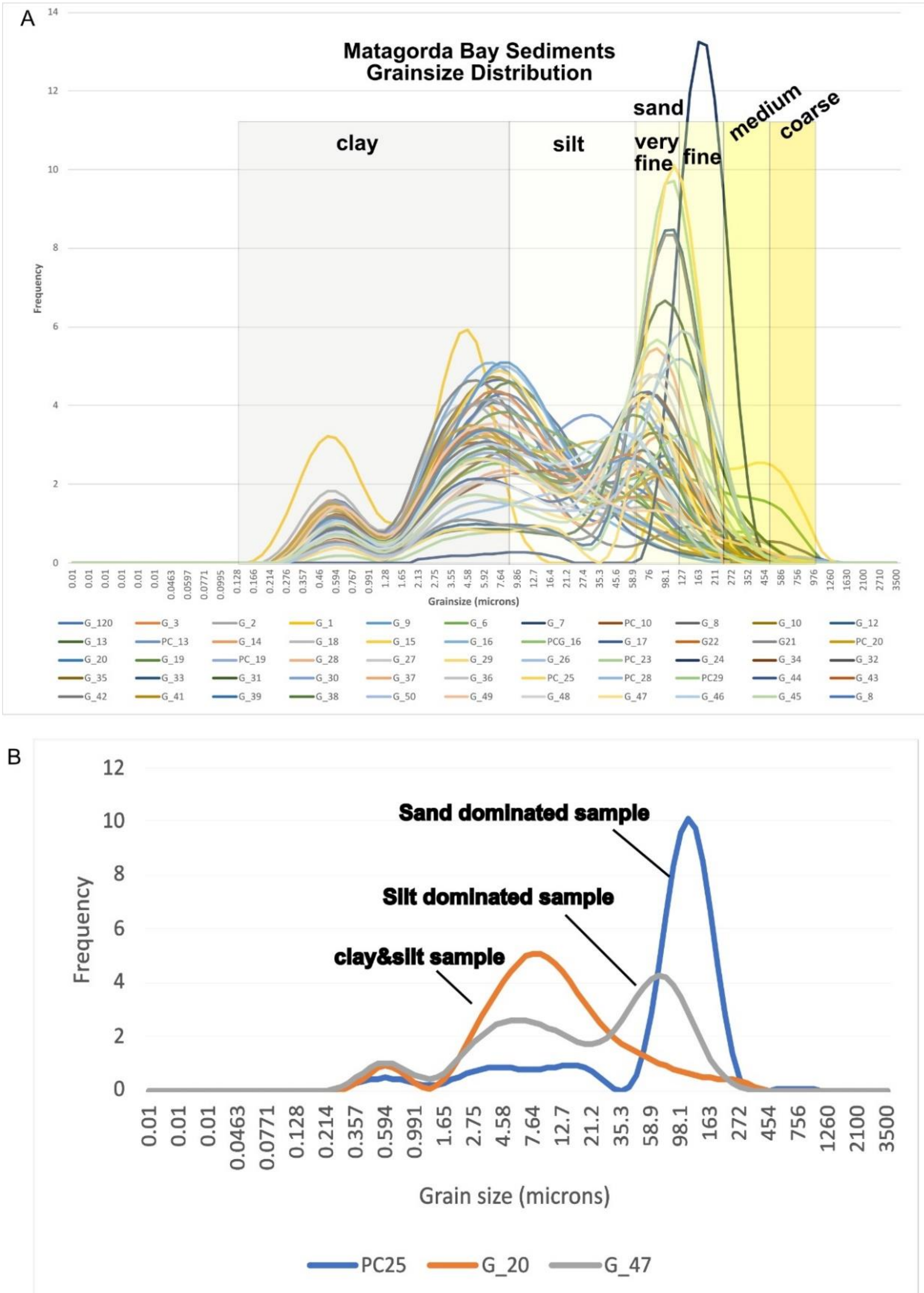

Figure 1. A – Multi-sample grainsize distribution. Notice the range is from clays to silt to very fine sands. However, the grainsize distribution between samples varies. B – Samples with different distribution modes. Note some samples have unimodal distribution with a peak in clay-silt range and other samples have a pick in fine sand range.

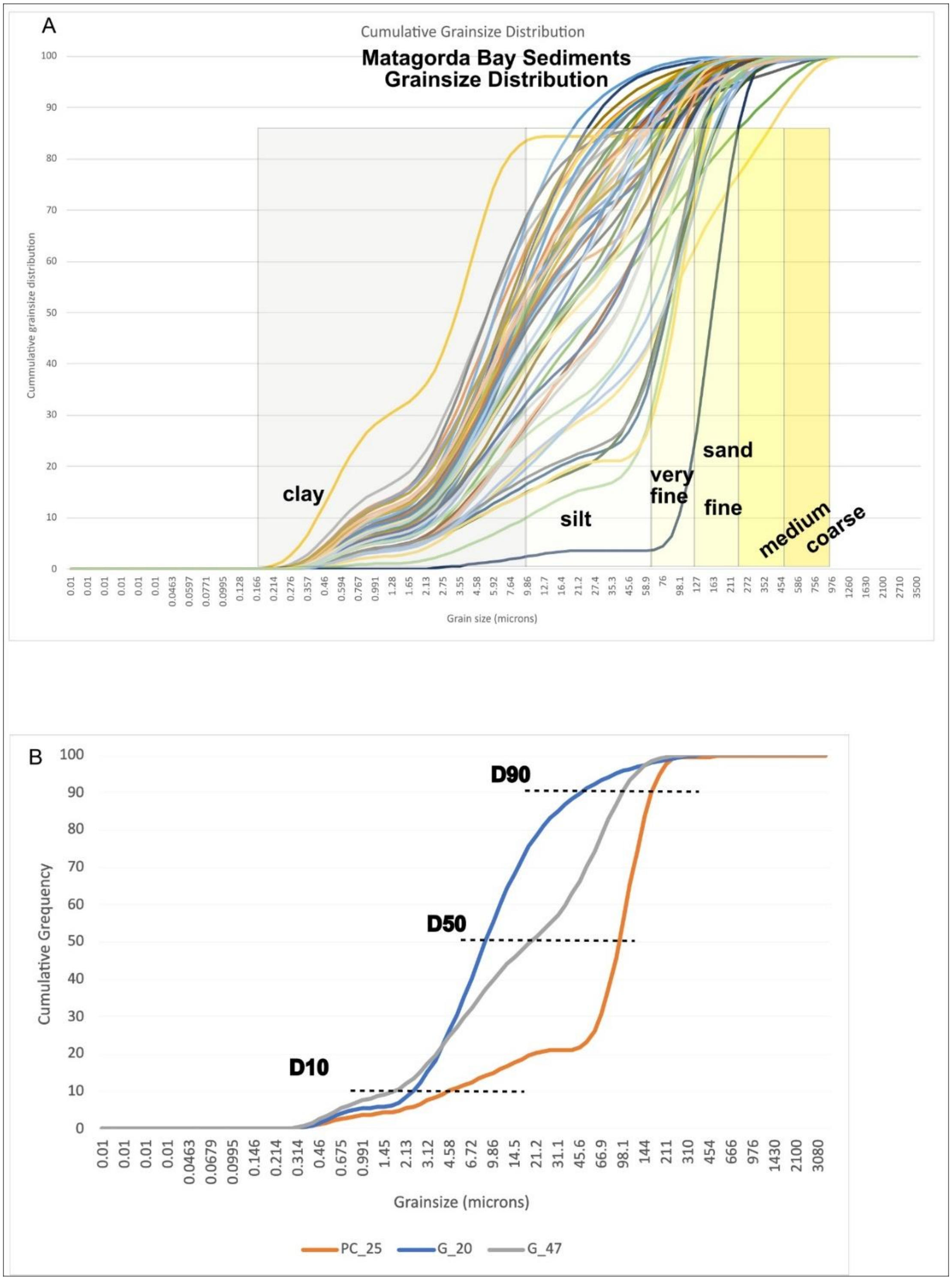

Figure 2. Cumulative distribution graphs of the same samples from Figure 1. A – Multi-sample grainsize distribution. Notice the range is from clays to silt to very fine sands. However, the grainsize distribution between samples varies. B – Samples with different distribution modes. Note some samples have unimodal distribution with a peak in clay-silt range and other samples have a pick in fine sand range. The steepest curve location indicates the higher frequency grainsize range.

Our initial results indicate higher microplastics concentrations within silt-dominated bay areas (Figure 4). Ongoing work with TOC will also help inform us of changes in bed content and may indicate a pattern with microplastic concentration.

While there are still samples to process, and might not represent the final finding, at this point it seems grainsize is a poor prediction for microplastic content in this silt-dominated depositional environment. The total microplastic concentration versus the grainsize distribution shows a relatively poor correlation with the highest microplastic concentration in fine sediments (Figure 5A). However, there are fine grainsize samples that have low microplastic concentrations (Figure 5A). If the microplastics are separated by type (fibers and fragments) and plotted against D10, D50 or D90 distributions the correlation is still low (Figure 5B).

In contrast, when we compare relative concentrations of microplastic in the sediment versus in the water column, initial results indicate approximately 1,000- times more plastic resides in the bay sediment. The relatively low microplastic counts in Texas bays compared to other studied systems are hypothesized as being consequences of: 1) short residence times for bay water due to rapid exchange with the Gulf of Mexico; 2) remobilization and outflow of surface sediment during wind events; and 3) relatively high, sediment-accumulation rates in Texas bay systems.

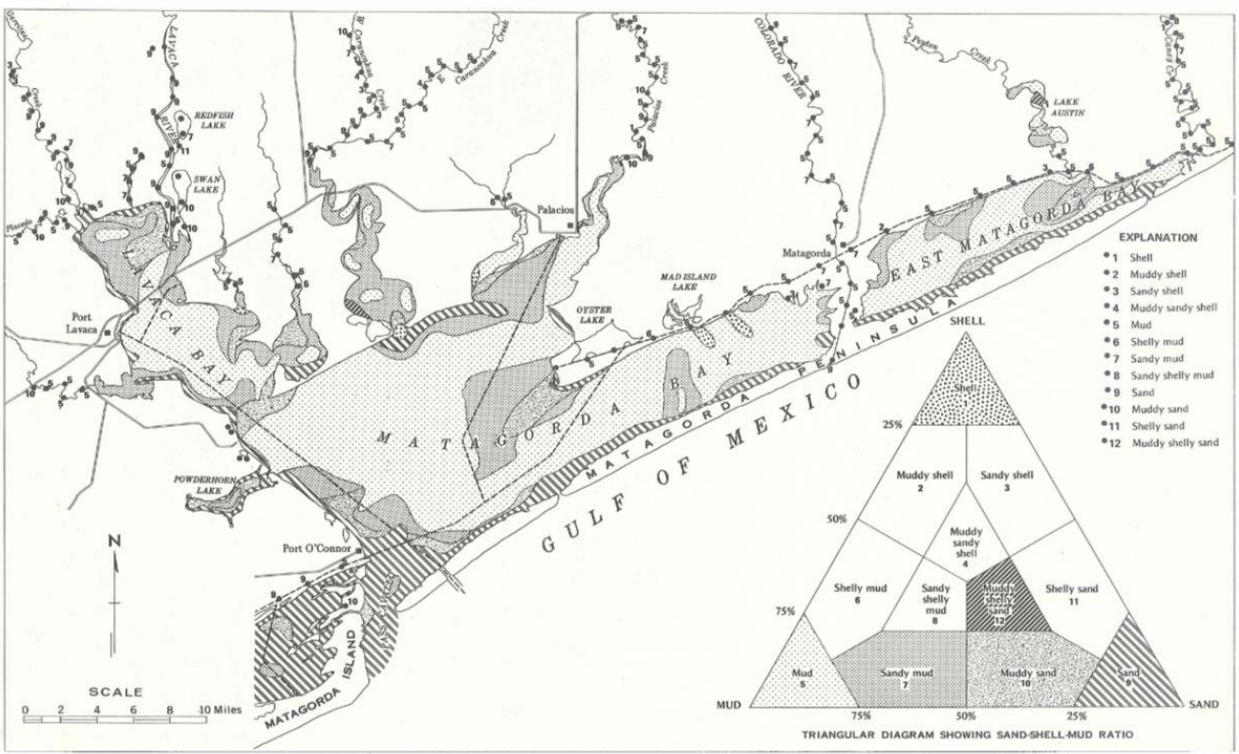

Figure 6. Sediment distribution map.

Figure 3. A – Sediment grainsize distribution map in San Antonio and Matagorda bays (McGowan, 1979).

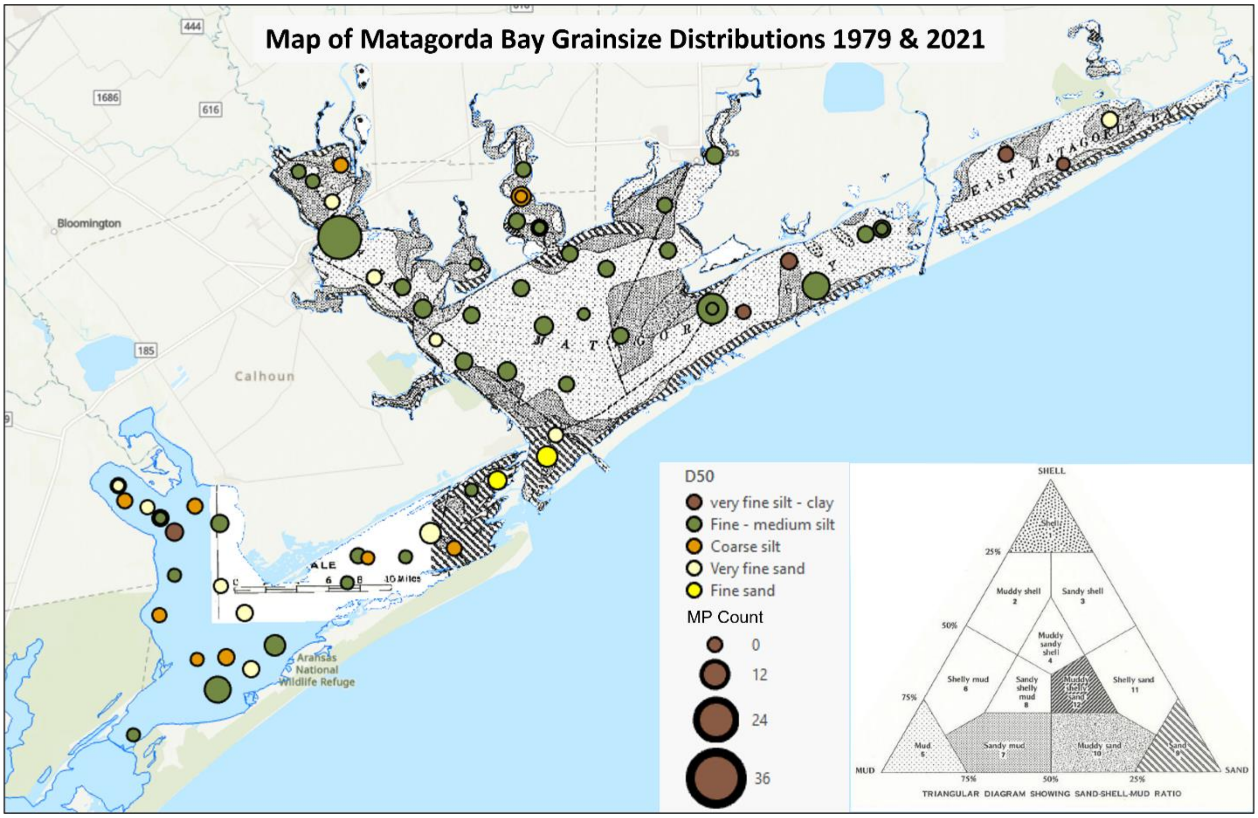

Figure 4. Map of Matagorda Bay grainsize distribution and microplastic concentrations from shallow bed grab (circles, collected in 2021) samples overlain with the sediment distribution map (modified from McGowen, 1979). Map illustrates higher microplastic concentrations proximal to urbanized areas (e.g., Port Lavaca) and in fine to medium silt-dominated bed material.

Total Organic Carbon (TOC) distribution in Matagorda Bay and establishing its level of association with microplastics is important because the organic material might be food for many organisms and the presence/association of microplastics with that might affect the trophic chain. So far, 17 Matagorda Bay grab samples have been analyzed for TOC content (Table 1). We found TOC varying from 0.25% to 12.7% (average ca. 4.6%), where the highest TOC occurs proximal to Lavaca River and Pass Cavallo. Interestingly, these values are significantly higher than the TOC values found in McGowan's (1979) study, where most samples contained less than 0.5% TOC. This stark contrast may be related to the different lab methods used (i.e., Loss on Ignition (this study) versus Wet Combustion (McGowan, 1979). From the limited processed samples, we can say that TOC is not associated with microplastics as there is not a good correlation between the values.

Lastly, as part of promoting awareness of the microplastic problem, the Ph.D. students, William Bailey and Xiangtao Jiang presented initial bay microplastic results at the annual Plastic Pollution Symposium in Houston, where our methods and findings were well received by the community.

Figure 5. Sediment grain size versus microplastic (MP) concentration. A – All microplastics find plotted against D10-D50-D90 values. B – Microplastics concentration separated by type (fiber, fragments) versus grainsize values at D10, D50 and D90.

Site	TOC (g)	TOC (%)
19A	0.25	0.42%
19B	0.13	0.25%
20	1.15	2.08%
21	0.92	1.83%
22	0.47	0.88%
23	6.33	12.58%
24	6.51	12.33%
26	2.53	4.87%
27	0.51	0.99%
28	0.22	0.40%
29	0.14	0.27%
30	2.12	3.95%
31	6.41	12.66%
32	2.48	4.63%
33	3.78	6.83%
34	0.89	1.52%
35	5.74	11.07%

Table 1. Samples analyzed for TOC.

References

McGowen, J. H. (1979). Geochemistry of bottom sediments--Matagorda Bay system, Texas. *Virtual Landscapes of Texas*.