SHIP SHOAL BLOCK 88 DREDGE PIT INFILL REPORT

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LSU GEOLOGY AND GEOGPHYSICS UROP FINAL REPORT

I. Abstract

The Gulf coast of Louisiana has been shaped for thousands of years by deltaic cycles that have left large shoals of sand within the Gulf of Mexico. Dredging these shoals for their sand has been a business that has only grown as the need for sand has increased not only in the United States but globally[1]. This dredging has left open pits within the Gulfs Shoals that are infilled from the infilled from the Mississippi River and Atchafalaya River, that deposit their contents into the Gulf of Mexico. Cores Taken from Ship Shoal, Block 88 located to the east of the Atchafalaya and west of the Mississippi, have been analyzed for Grain size, Beryllium 7 decay, and x-rayed for future identification of sediment packages for sourcing and depositional environment. With this a future of if these are renewable sources of necessary sand will be able to be able to be identified.

II. Study Area

Ship shoal was formed by the Maringouin Delta complex that was the main delta of the Mississippi River from 7500 YRS BP to 5000 YRS BP.[1] Shoals are a geologic formation that happens after a barrier island has been eroded down until the island is no longer above the water's surface. Ship Shoal is located on the continental shelf of Louisiana and measures 50 km long, 5 to 12 km wide, and at its highest point is submerged 8 meters below the water surface (Fig. 1). The shoal is situated roughly 90 km away from the Atchafalaya River Delta and 140 km away from the Mississippi Delta's main river channel. The sand within ship shoal is high quality coarse sand that is overlain with modern day deltaic deposits of silt and fine sand.[1]

III. Purpose

Dredging on the coast of Louisiana has been happening for well over a century in order to meet demands of good building sand, and to help restore coastal marshes that are being actively eroded[2]. Ship Shoal has seen active dredging in the past decade and is being looked at as a renewable source of sand, however what happens to these pits that are left opened is currently being investigated. These pits fill in with different material that is deposited into the Guld of Mexico by the Atchafalaya basin and the Mississippi River. Deposition can be affected by seasonal variations in river output and may be seen within the pits refill as well as storm occurrences in the Gulf, both Seasonal Storms and high intensity hurricanes. Coring these pits can reveal different sediment packages that can used to identify where the source of the package comes from. Using this a hypothesis can be formed that due to recent increase in storm activity over the years before the cores were extracted, larger packages of sediment can be found within the cores that can be characterized as new types of packages.

IV. Methods

Grain size

A Multi-Coring apparatus was used to collect cores within and outside of Block 88: 3 were collected inside, BL20-1, BL20-2, BL20-3, and 2 were collected outside, BL20-4, BL20-5 (Fig 1). At the collection site, each core was cut into 2 cm slices and were placed into Whirlpacks to be processed back at LSU Geology Department. For grain size preparation at

LSU, subsamples were taken whereby roughly 2-grams of wet sample were placed into glass test tubes and then 2ml of peroxide added. Samples were then placed into a hot bath at 50c for 5 hours to completely remove all organic material within the subsamples. Subsamples were then filtered through a 850-µm sieve to remove any large organic fibers remaining, then mixed with ~ 15ml sodium metaphosphate before being vortexed. Finally, samples were poured into a Beckman-Coulter Laser Diffraction Particle Size Analyzer (LDPSA) with an Aqueous Liquid Module (ALM), which allows measurement of material from 0.0017 µm to 2000 µm.

X-ray

At each coring location plexiglass X-ray trays (60cm x 8cm x 2 cm) were inserted into all five cores in the field and taken back to the Louisiana State University Coastal Studies Institute where they were put into an X-ray machine. Raw digital images had the color inverted in ImageJ for easier identification of sand packages. These images were then saved as a JPGs.

Beryllium-7 dating

The radioisotope Beryllium-7 (^{7}Be) was used to calculate the sedimentation rates within the Block 88 dredge pit. Beryllium-7 is a naturally occurring radioisotope that occurs from cosmic impacts on Nitrogen atoms that then fall to earth and stick to fine grained sediment particles[3]. Thus, any particle less than 64 µm can be charged with Beryllium-7 molecules[3]. Once these particles are deposited and settle to the bottom of a body of water they begin to decay and break down with a half-life of 52 days. For this study, the 2 cm-thick samples were dried after grain size sampling, and subsequently ground using a mortar and pestle into a powder (as fine as possible). These samples were then placed in a sealed petri dish before being placed in either Canberra REGe or BEGe germanium detectors, where the samples were run for 24 hours to measure the amount of Beryllium-7 that is within the samples (gamma peak for ^{7}Be is 470 keV).

V. Results

Grain size Results

Cores BL20-1, BL20-2, BL20-3 were taken within the Block 88 dredge pit. BL20-1 is composed predominately of fine to coarse silt, with thin ~1 cm laminations of fine sand to coarse sand, and one large ~2 cm thick bed of fine to coarse sand (Fig. 2). BL20-2 displays thin beds, >1cm - ~2cm,of coarse-grained sand under a large bed of silt, with a final large bed of coarse silt to fine sand before the end of the core (Fig. 3). BL20-3 is composed predominately of coarse-grained silt to fine grained sand, with large beds (1-2 cm), of fine to medium grained sand. The top few centimeters are predominately fine-grained silt until it abruptly transitions into a large bed of fine to medium sand. This is followed by interbedded layers of fine-grained silt and fine-grained sand until an abrupt large bed of fine-grained sand (Fig. 4). Cores BL20-4 and BL20-5 were taken outside the pit and showed coarse-grained sand, in the .5mm to 1mm range, cores very uniform no variation in size or type.

Cores BL20-1 and BL20-3 share a similar large, grained package, >1cm in thickness, that are similar in composition being almost entirely composed of fine sand with very little variation. In BL20-1 the package occurs at a depth of 20 cm, and in BL20-3 the package occurs at a depth of 28 cm. BL20-3 has a coarser grained silt to fine sand near this depth that encompasses 18 cm to 24 cm in depth. All cores within the pit had the same material present at the top of core: the first 2 cm was composed of very fine-grained silt, to coarse clay, as seen as mud in the field.

X-ray Results

Using color-inverted X-ray images revealed better detail of the grain size variations and bedding with the cores. Within core BL20-1 the top surface is composed mostly of the fine-grained silt then rapidly coarsens into a thin bed of coarser material before an abrupt switch to a thin <1 cm coarse lamination (Fig. 5). This is followed by a section in interbedded coarse and fine silt beds. A large 4 cm bed of silt is under the interbedded layers that slowly coarsens from fine silt to coarse silt fine sand into a thin, <2cm, interbedded section. Another large 3.5cm, bed of silt is present directly under the 2nd interbedded section that coarsens downward into a thin ~2cm section of coarse-grained silt and fine-grained sand with very small >1cm laminations of fine-to coarse silt and fine to coarse sand. The Rest of the Core exhibits an intermixing of fine- and coarse-grained sediment from fine silt to coarse sand. This core exhibited the most fining upward sequences as compared to BL20-2 and BL20-3.

Core BL20-3 differs heavily from BL20-1 with its inclusion of shell fragments into the sandy beds (Fig 6). The top few centimeters of BL20-3 have a large bed of coarse clay to fine sand, from 100 µm to ~4 µm to with very thin, >1cm, laminations of coarse-grained silt, ~50 µm to fine grained sand. Abruptly changes to a large, ~4cm, bed of coarse-grained silt and fined grained sand that has small collections of shells within. The shells are arranged together across the core and can be called their own bed within the core, although they were too large to appear in the grain size results due to the processing of grainsize preparation preventing anything larger than 850 microns from entering the machine. Under the coarse bed that contains shells there is another interbedded layer of thin >1cm beds of fine grained and coarse-grained beds along with larger ~2 cm beds of coarse- and fine-grained material. Under these interbedded layers another large bed of coarse-grained material with another thin bed layer of shells near the bottom of this specific coarse-grained bed. This layer of shells includes shells from different organism, as a clear gastropod shell and a clam shell are visible. Under this bed there is shifting of the beds around that may be due to degradation of the core before X-ray processing or from the processing of putting the X-ray tray into the core. These beds do show mixing of the fine- and coarse-grained material as there is no distinct layers but pockets of material that form small wisps within the end of the core. The bottom of the core itself has a coarse silt to find sand lamination before the core itself stops.

BL20-2 due to its small amount recorded do not offer as much information as the cores before it (Fig. 7). The top section of the core is a large, ~2.5 cm thick deposit of fine-grained silt to coarse clay, that abruptly transitions to a thin, ~1 cm thick lamination of coarse-silt to fine sand. Under this thin bed there is an inter mixing of fine- and coarse-grained material with one very thin distinct bed of coarse-grained silt to fine grained sand. This then abruptly transitions into a not entirely stable bed of coarse-grained material that has some interchange of fine-grained material within it before transitioning into a thin, <2cm, bed of finer grained silt. The bottom, <2 cm thick section of the core is composed of coarse-grained material.

Cores BL20-4 and BL20-5 were taken outside of the pit and both show the same medium sand make-up except the top <2 cm of BL20-4 core which shows the medium sand being intermixed with coarser grained silt (Fig. 8). Core BL20-5 has a large burrow that runs the whole extent of the core from an unknown sea organism (Fig. 9). Core BL20-5 lacks the intermixed layer that BL20-4 has at the top layers.

^{7}Be dating results

Cores BL20-1, BL20-2, BL20-3 were all taken within the dredge pit. Core BL20-1 showed a max ^{7}Be activity of 3.60± 0.2 dpm/g at a depth of 2 cm, with an exponential decay (Fig. 10). At a depth of 10-12 cm, the activity increases to 3.15±0.09 dpm/g, then goes to 0 dpm/g at 14 cm. Core BL20-2 showed a ^{7}Be activity of 3.062±0.2031 dpm/g, then an exponential increase to 3.58± 0.16 at a depth of 6-8 cm, then activity drops down to 2.001 dpm/g±0.1601 at a depth of 8-10 cm before dropping to 0 dpm/g at 10-12 cm (Fig. 11). Core Bl20-3 shows an increase in ^{7}Be activity from 3.37±0.18 to 2.68±0.16 from 0-2 cm to 2-4 cm, then from 4-6 cm the activity drops to 3.0801±0.1026 dpm/g, then increases to 3.22±.10 dpm/g from 6-8 cm, drops to 1.92 ± 0.074 dpm/g from 8-10 cm. From 10-12 cm there is a shorter decay fom to 1.84± 0.075 dpm/g from 10-12cm, activity drops to 0 dpm/g after 12cm (Fig. 9). Cores BL20-4 and BL20-5 showed no ^{7}Be activity outside of the dredge pit (Fig. 12).

VI. Conclusion

With these results so far, future grain size packages will be able to be identified from what is seen within the grain size, and x-ray images. Further using the Be7 decay the deposition rate of individual packages can be identified and where the sediment could have been sourced from. With this better conclusion to what happens to these open pits as time goes on can be formed. The overall impact these pits have on the environment itself is not able to be fully deciphered with the current information from this study, but being able to distinguish that this dredge pit cannot be used as a renewable resource as once thought is important.

Citations

1. Aurora Torres, Mark U. Simoni, Jakob K. Keiding, Daniel B. Müller, Sophus O.S.E. zu Ermgassen, Jianguo Liu, Jochen A.G. Jaeger, Marten Winter, Eric F. Lambin, Sustainability of the global sand system in the Anthropocene, One Earth, Volume 4, Issue 5, 2021, Pages 639-650, ISSN 2590-3322,

2. Khalil, Syed & Finkl, Charles & Roberts, Harry & Raynie, Richard. (2010). New Approaches to Sediment Management on the Inner Continental Shelf Offshore Coastal Louisiana. Journal of Coastal Research. 26. 591-604. 10.2112/10A-00004.1.

3. Suedel, B.C., McQueen, A.D., Wilkens, J.L., Saltus, C.L., Bourne, S.G., Gailani, J.Z., King, J.K. and Corbino, J.M. (2021), Beneficial use of dredged sediment as a sustainable practice for restoring coastal marsh habitat. Integr Environ Assess Manag

4. Baskaran, M.; Coleman, C.H., and Santschi, P.H., 1993. Atmospheric depositional fluxes of 7Be and 210Pb at Galveston and College Station, Texas. Journal of Geophysical Research: Atmospheres, 98(D11), 20555-20571.

Figures

Figure 1. Study area of Block 88 dredge pit off the coast of Louisiana and core location within the pit.

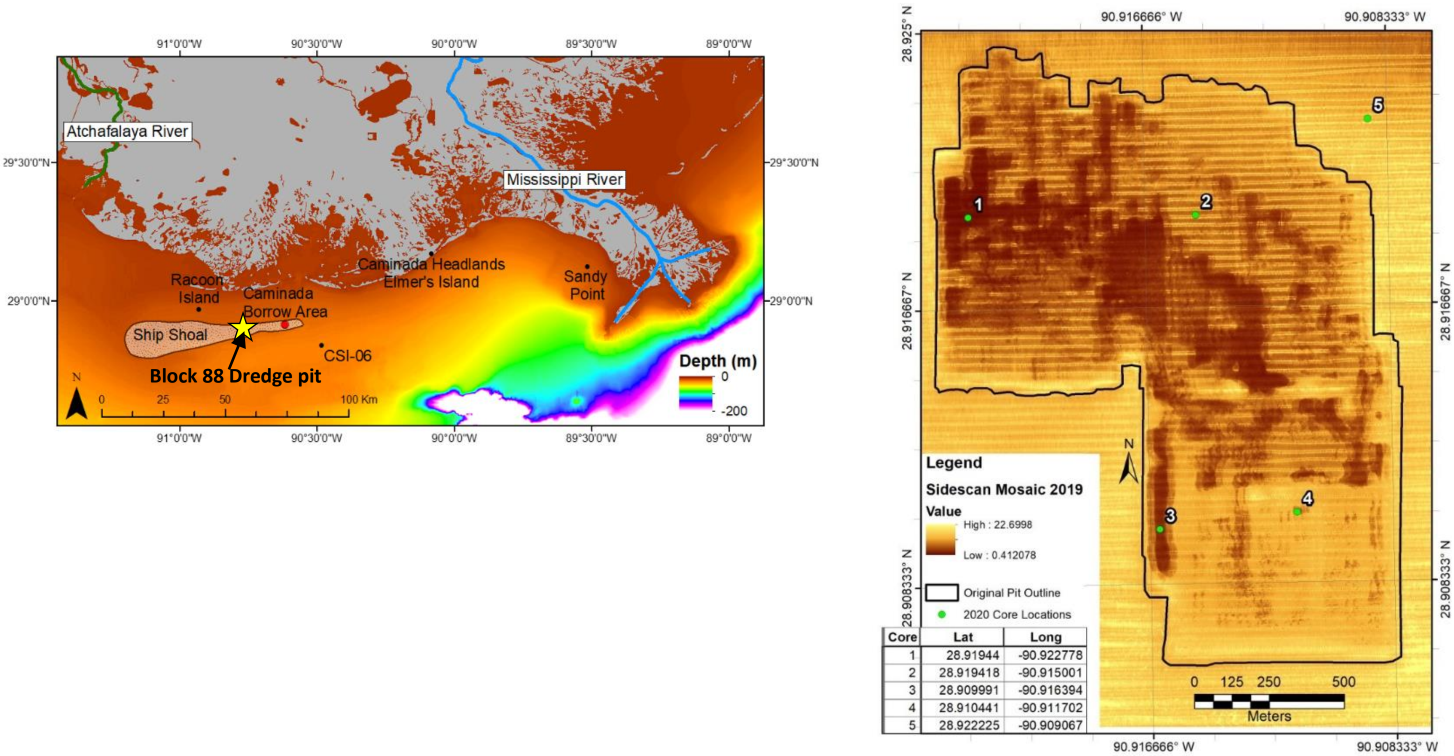

Figure 2. Grain size data for core BL20-1

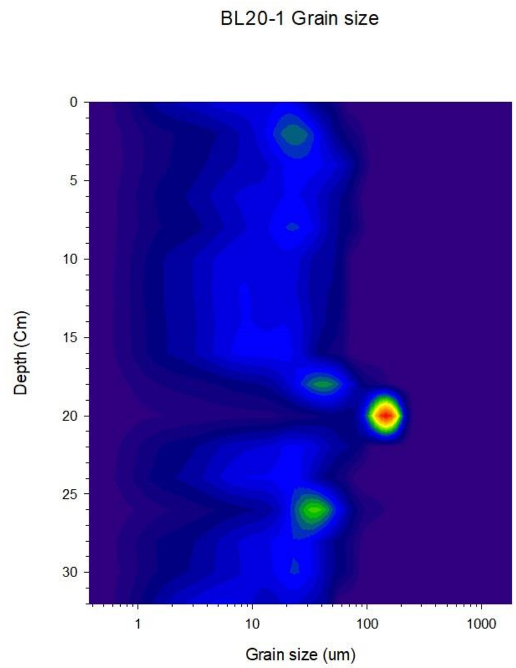

Figure 2. Grain size data for core BL20-2

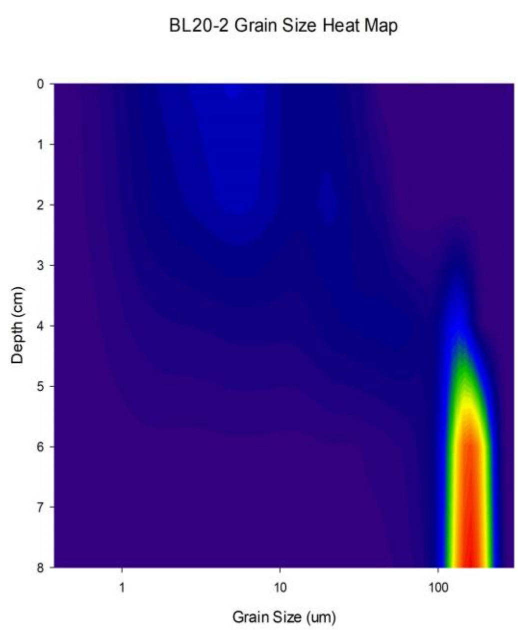

Figure 4. Grain size data for core BL20-3

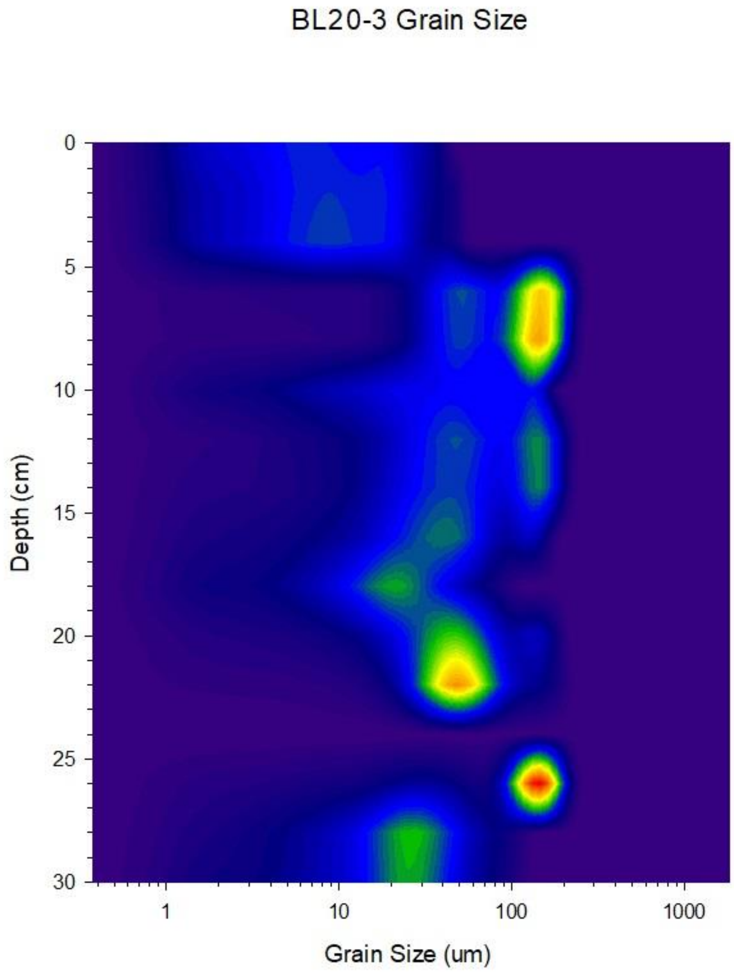

Figure 5. X-ray image for core BL20-1. Lighter colors are coarser grain size.

BL20-1 X-ray

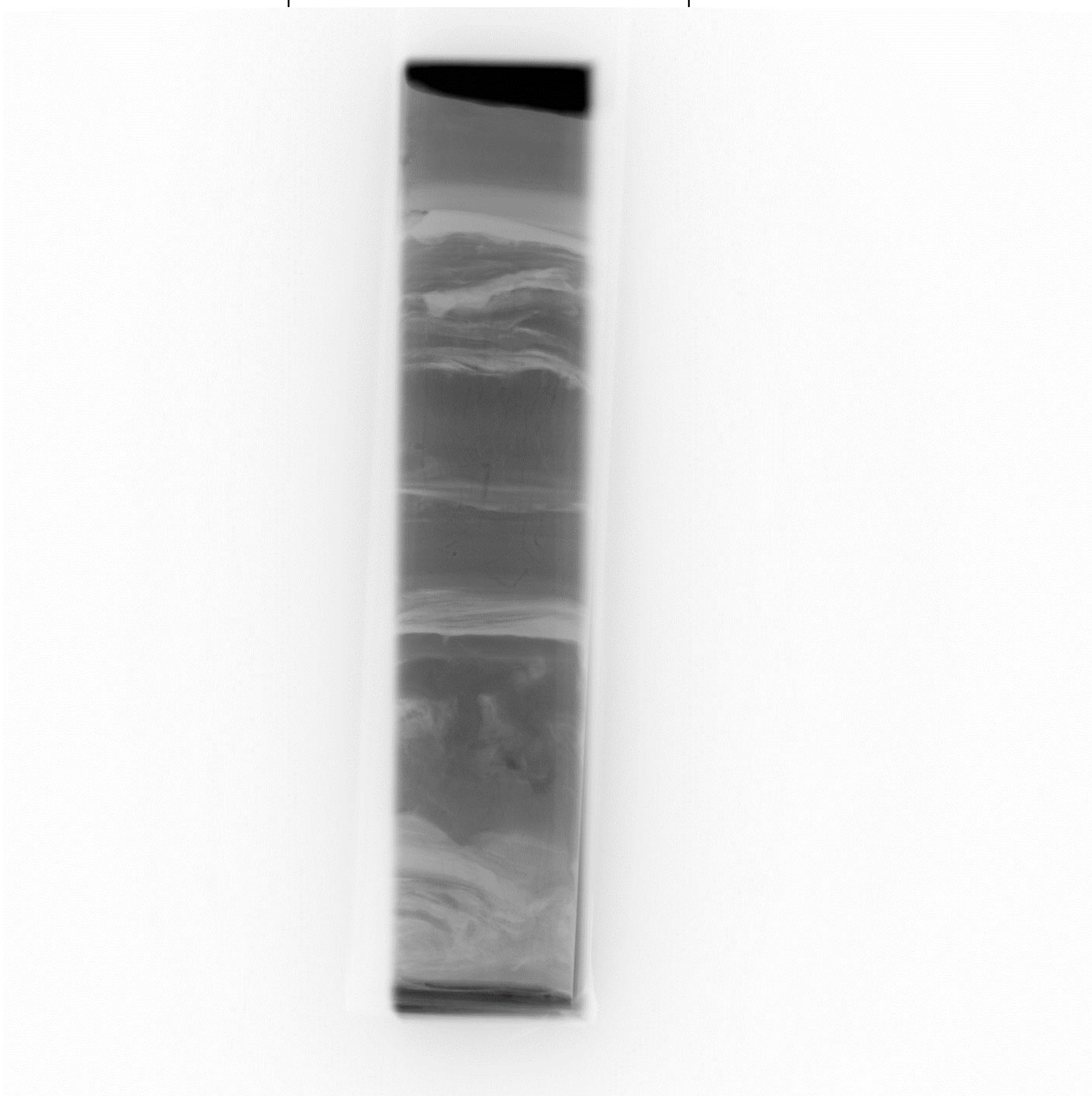

Figure 6. X-ray image for core BL20-3. Lighter colors are coarser grain size.

Figure 7. X-ray image for core BL20-2. Lighter colors are coarser grain size.

BL20-2 X-ray

Figure 8. X-ray image for core BL20-4. Lighter colors are coarser grain size.

BL20-4 X-ray

Figure 9. X-ray image for core BL20-5. Lighter colors are coarser grain size.

BL20-5 X-ray

Figure 10. Berylium-7 data with depth for core BL20-1

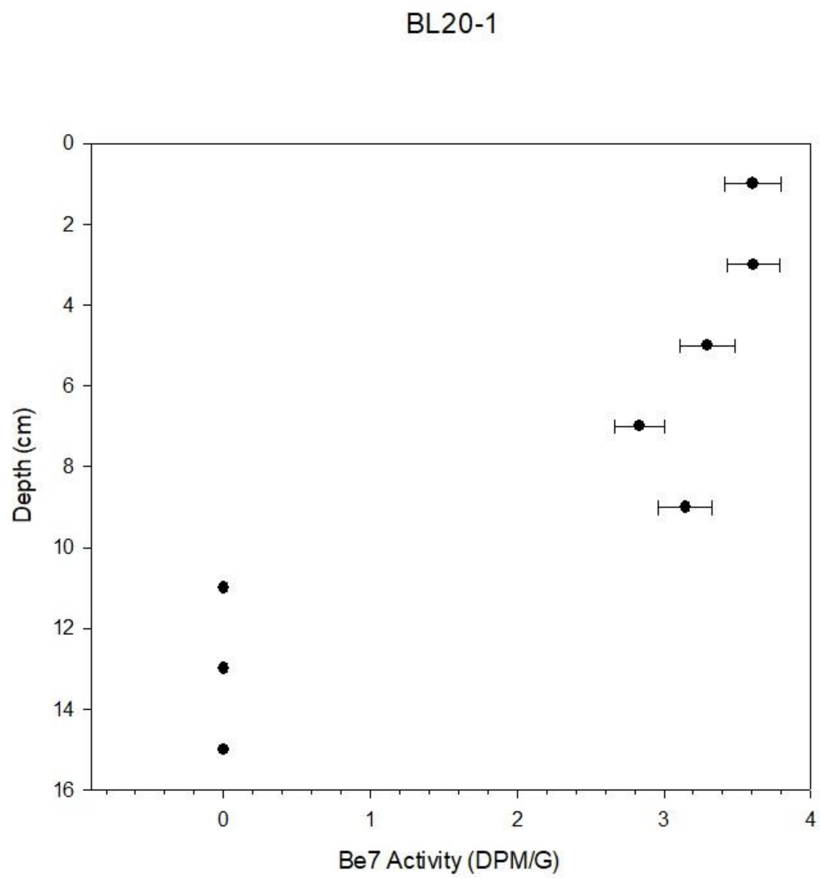

Figure 11. Berylium-7 data with depth for core BL20-2

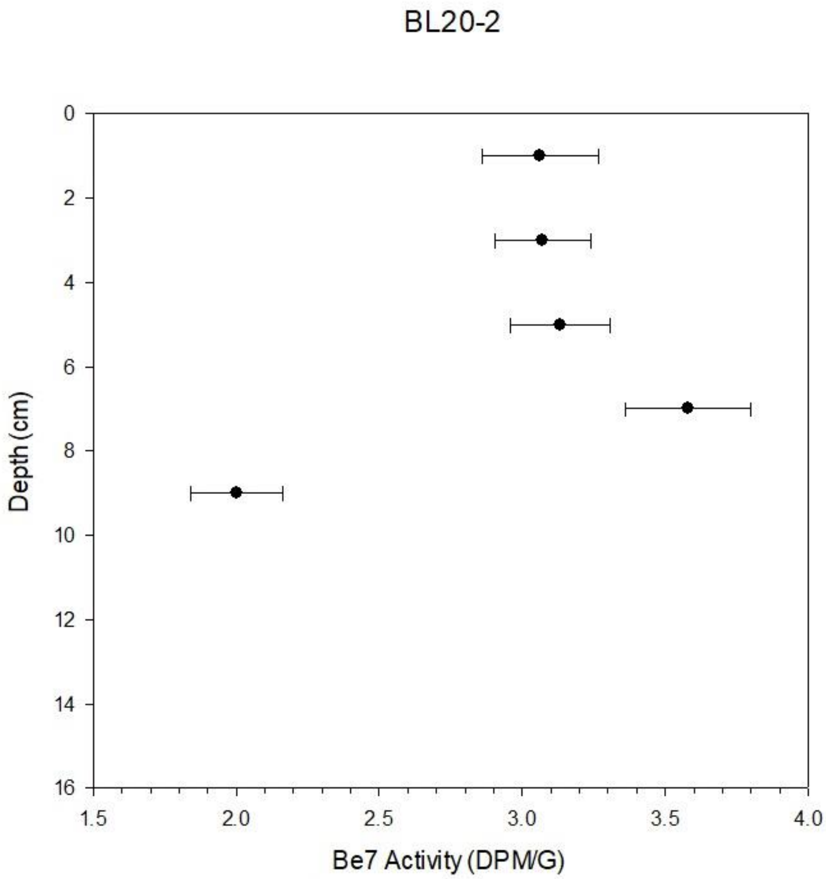

Figure 12. Berylium-7 data with depth for core BL20-3