

HGS Bulletin

Volume 61, Number 5

Houston Geological Society

January 2019

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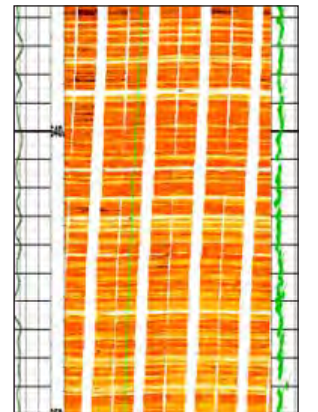
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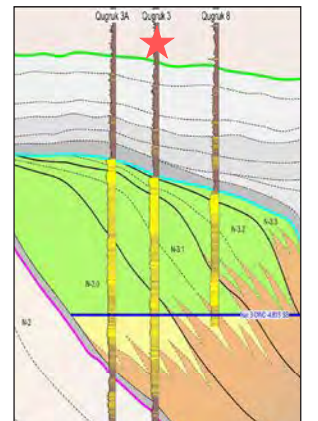
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About the Cover: : 0.5 m by 0.5 m portion of a sand peel from bar deposited along Buffalo Bayou by Hurricane Harvey. Net flow was toward the viewer. The lower ¾ of the peel shows broad planar stratification, changing to shorter wavelength ripples near the top. This is interpreted as deposited during waning flow. The small faults in the upper half of the image probably formed ~ 30-40 days after Harvey while a channel cut across the bar, as Buffalo Bayou adjusted and recovery efforts began.

Fluvial Tapestries: GeoArt of Hurricane Harvey

By Katharine Kendall, Artist; Jerome Kendall, University of New Mexico

Geologists have a unique perspective as the science of geology considers events that occur well beyond the lifespan of humans. Their training hones the skills to read features in the physical world and consider what created those details and when they were formed in scales of millions and billions of years. The details they interpret become visual representations of the time they were formed, so when looking at the landscape geologists see beyond the evidence of humans and life as we know it into the deeper, longer time that creates the infrastructure of the earth itself. We call this "earth time". Earth time chronicles the long-term effects of earth's natural processes and the physical features produced over time scales well beyond what has or will happen in a month, year, decade or century. This awareness and recognition of a deeper earth time combined with human-built landscapes enriches a geologist's assessment of the values and needs of our present human moment.

Today the human time scale dominates our social and political values and choices. We make decisions based on the scale of a human lifetime even as there is an awareness of human history, dating from a few thousand years. In the context of describing the natural world there are terms like 100-year flood and 500-year flood; however, even these terms are too abstract for most people to recognize their value in relation to their own lives. Our contemporary time seems faster with new technology pushing us well beyond physical processes of horsepower and steam power into digital speed through internet cables (when asked 'how fast does Google search' Google returned 4,230,000,000 results in 0.64 seconds as displayed just under the search bar where the search was enacted). This kind of speed and time is what we expect in the contemporary world. It's what the general population can relate to. However, geologists have the ability to describe something

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Harvey impact on Buffalo Bayou level and 211 calls

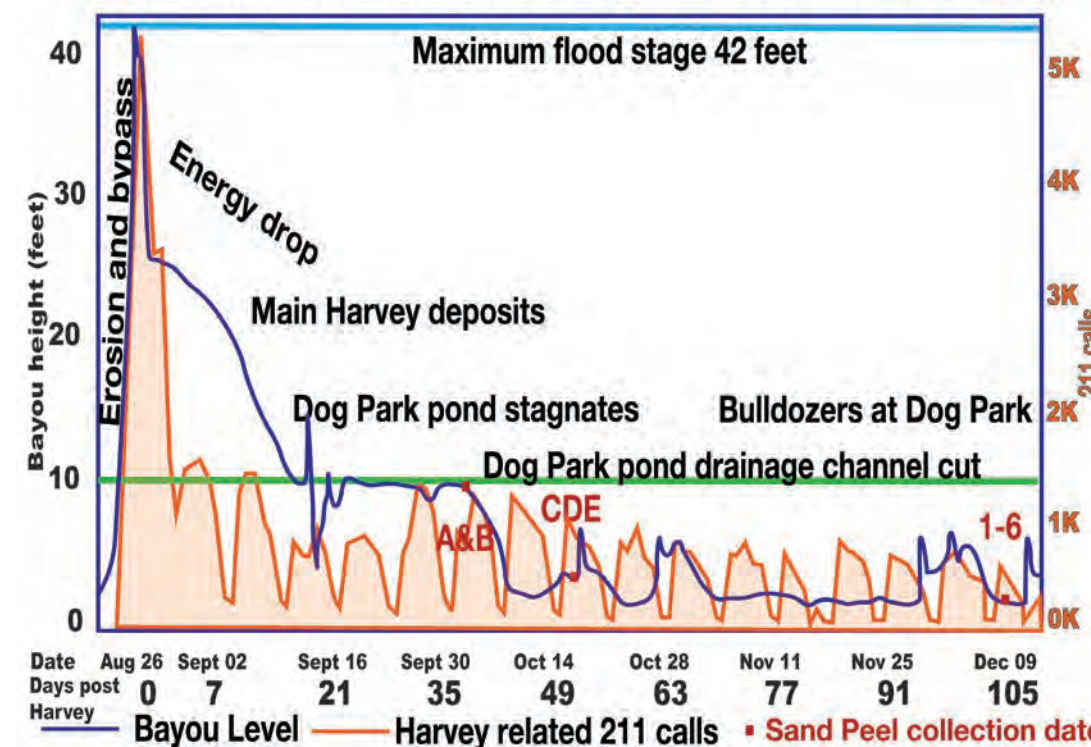


Figure 1. Hurricane Harvey Buffalo Bayou water level and 2-1-1 Calls. The chart plots Buffalo Bayou water level at the Shepard bridge (USGS, 2017) (solid dark blue line in feet elevation scale, on left, location shown as black dot on Figure 2) and United Way 2-1-1 Harvey related telephone call volume (HCDC, 2017) (orange line above light orange color fill with scale in thousands of calls per day on the right; location shown as red dot on Figure 2) over time. The small red squares indicate the dates of sand peel collection. During the first 30 days, calls reached over 5000 per day as the water level peaked, then dropped to below 1000 per day. These calls were dominantly for food and shelter assistance. During this period, at its peak level of 42 feet elevation (dashed horizontal blue line), the bayou eroded older deposits, then deposited most of the sand bars as the water level dropped to 10 feet from its maximum. Approximately 30-40 days post-Harvey, the volume of calls nearly doubled and changed to FEMA registration, housing, and utility assistance. The bayou drops below 10 feet (horizontal green line) and starts to adjust during this period. One adjustment is the cutting of a channel through a new sand bar facilitating the drainage of a pond formed in the dog park. At the 100-day mark, the telephone call level dropped to hundreds per day with more of a focus on financial assistance, while the sand peels record the continued drainage of the dog park and reworking of the deposits by bulldozers during the recovery effort.

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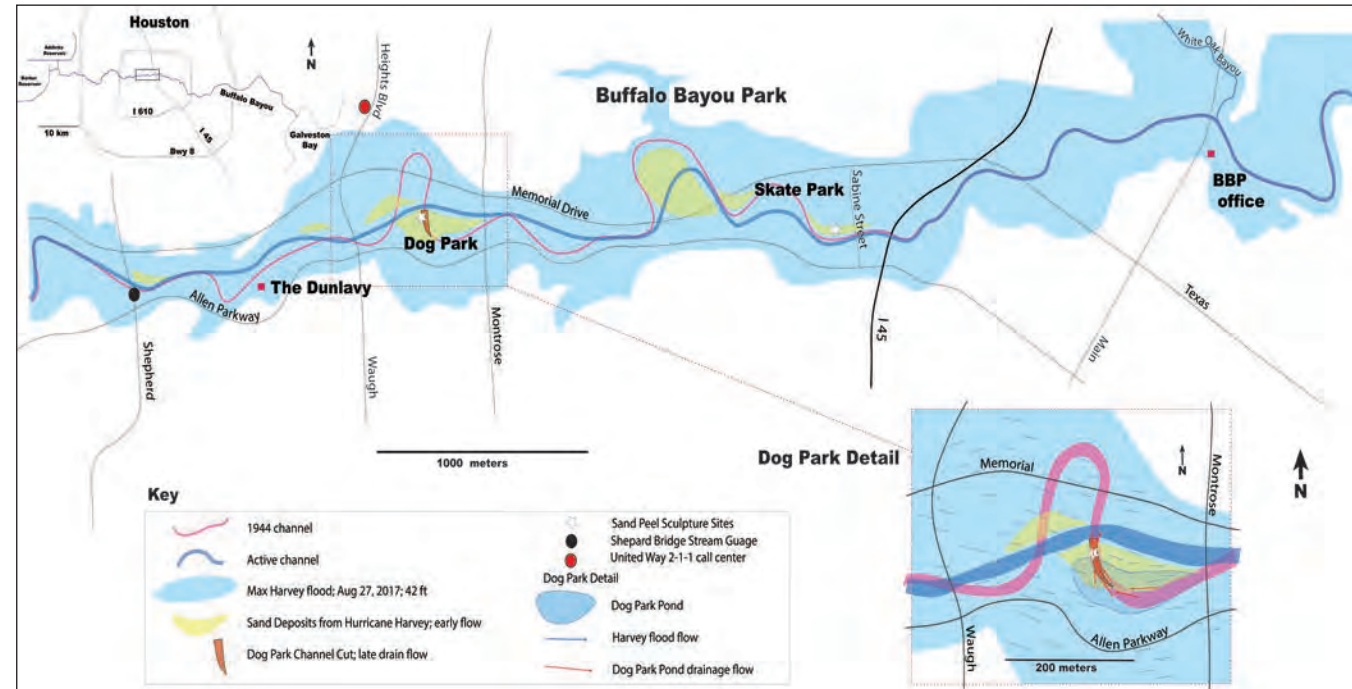


Figure 2. Map of the Hurricane Harvey flood waters in Buffalo Bayou Park. The upper left is a location map showing Buffalo Bayou and major highways. The dark blue line is the current active channel, the red line is the 1944 channel and the blue polygon is the maximum extent of flooding (Harris County Flood Control District, 2017). The light green areas mark the extent of ~3-13 feet (1-4 m) sand bar deposits. Note the correlation between sand bar deposits and the places where the bayou has been artificially straightened. Over 600 million pounds of sand, enough to fill NRG stadium 11 feet deep, were removed during the recovery efforts (BBP, 2017). The detail of the dog park area in the lower right shows a sand bar that is later cut by a channel (orange polygon) draining a pond that formed in the dog park. The blue arrows show the net flow direction of the bayou during flood while the red arrows represent the net flow as the bayou adjusted when the water level dropped below ~10 feet (~3 m), draining the dog park.

different that is vital to humans' relationships to the natural world around them, especially as that world changes in its own time scale with melting glaciers and rising oceans. We need a way to consider both human time and earth time to understand and adapt to our rapidly changing world.

In August 2017 Hurricane Harvey made landfall on the gulf coast of Texas. Many areas received more than 40 inches (~1,000 mm) of rain as the system slowly meandered over eastern Texas and adjacent waters, causing unprecedented flooding over a four-day period. Harvey was the wettest tropical cyclone on record in the United States (Roth, 2018), with peak accumulation of 60.58 in (1,539 mm), in Nederland, Texas. Record water levels occurred at every bridge crossing along Buffalo Bayou (Figure 1). The Harris County Flood Control District recorded one out of every ten buildings in Harris County flooded during Hurricane Harvey (Lindner and Fitzgerald, 2017). Floodwaters carried sediment as it swept downstream towards the Gulf, utilizing the bayou system to channel and move floodwaters out to the Gulf of Mexico. In Buffalo Bayou alone the storm deposited over 600 million pounds of sand, enough sand to fill NRG stadium 11 feet deep according to Buffalo Bayou Partnership (BBP, 2017). These deposits created a prime opportunity for local geologist Jerry Kendall and his daughter and

artist Kate Kendall to create sand peels in their own backyard with the intention of combining their skills to create both science and art objects that would tell a distinctive story of Hurricane Harvey and its effects on Houston, TX.

From October 2017 to June 2018 a team of artists and geologists led by Kate Kendall and Jerry Kendall, working in communication with the Buffalo Bayou Partnership (BBP) and the University of Houston Department of Earth and Atmospheric Sciences, collected 12 sand peels from sediment deposits left by Hurricane Harvey in Buffalo Bayou Park (Figure 2). Taken from two locations near the Johnny Steele Dog Park and the Lee and Joe Jamail Skatepark, the sand peels capture and preserve the sedimentary structures and layers deposited during the flood. These layers are interpreted to indicate the directions of water/sediment flow, the time of maximum flow and floodwaters, the time(s) of adjustment, and the recovery efforts on the part of the Buffalo Bayou Partnership stabilization crew (Figures 3, 4, and 5). The sedimentary structures are the result of the evolving energy levels and sediment load carried by Buffalo Bayou as rainfall was unleashed by Hurricane Harvey. These can be dated in approximate time when compared to the stream gauge at the Shepherd bridge (Figure 1).

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Figure 3. Sand peel sculpture of the waning flood



Figure 3a. Interpreted sand peel sculpture of the waning flood. Flood: The sand on clay contact near the base of the sand peel records erosion at the peak of Harvey flooding early on the morning of August 27th (blue line). The approximately 24-inch-thick broadly layered fine sand above the erosional base records the initial deposits from waning flow of Buffalo Bayou during the next ~20 days. In the upper right corner of the sculpture, above an erosional surface, are shorter wavelength bed forms and ripple marks interpreted to result from reduced flow rates. This phase deposited a sand bar up to ~12 feet (3.5m) thick. The flow direction of the bayou is towards the viewer. All the sand peel sculptures are shown as mirror images so the orientations are as they appeared in the outcrops. The red arrows indicate the net flow direction. Up arrow is for flow away from the viewer and a down arrow is toward the viewer.



Figure 4. Sand peel sculpture of the flood and adjustment phase
Photo Credit: Don Yurewicz



Figure 5. Sand peel sculpture of the flood, adjustment and recovery phase
Photo credit: Don Yurewicz

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A special feature of these sand peels is existing in both earth time and human time. It is rare in the geologic community that a rock or a sediment deposit can be pinpointed to a specific and exact time of creation on any human time scale. The sediments deposited during Hurricane Harvey can be correlated to specific points in earth and human times using data from the Shepherd bridge stream gauge. The main sand peel extraction site at the dog park is the United Way 211 Call Center where human events are being recorded, a few hundred meters downstream from the Shepherd bridge stream gauge. Figure 1 shows the Buffalo Bayou water level at the Shepherd bridge (USGS, 2017) and the United Way 2-1-1 Harvey related telephone call volume to Houston Community Data Connections (HCDC, 2017) for approximately 100 days following Hurricane Harvey. The sand peels (white stars on Figure 2), stream gauge (black dot on Figure 2) and 2-1-1 call center (red dot on Figure 2) capture the bayou's geologic record, water level, and human impact of Hurricane Harvey at essentially the same location. The records of 2-1-1 calls closely correlate with the flood gauge water levels, with the highest volume of calls during the peak flood water levels and a corresponding drop in calls when water levels receded. 2-1-1 also tracks the needs of each caller: Harvey calls related first to instant needs of food and shelter and transitioned after 30 days to basic immediate needs of living expenses with a spike when rent was due. After 90 days, most calls were related to recovery needs of employment assistance and home repair. The data sets from the stream gauge, the 2-1-1 calls and the sand peels are used to create a timeline that contains both human and geologic time elements and supports the interpretations.

Along with geologic interpretations, these sand peels are designed as art objects with specific features that highlight aspects of their creation and potential poetic analyses of the natural and human processes that created them. The process of collecting the peels is both artistic and scientific and the sand peel sculptures present not only their geology but also their production process, which is painterly and specific and relies both on technique and chance. Each peel is unique in both its geology (structure, location and time) and also in its process of extraction as each location had specific moisture and permeability variations, each time of extraction had specific weather conditions and each pass with the brush to apply the liquid polymer had a unique stroke and penetration, all of which give each sand peel its own shape, texture and relief. After using a fixative to strengthen their integrity, each of the 12 resulting sand peels taken from Buffalo Bayou was cut to a unique shape to highlight the stratification and/or the shape of the original peel as it was pulled from its site. These shapes were then traced and cut to create custom mounting boards for each peel. This technique leaves little to no edge to frame the peels and allows them to float frameless as a finished pieces of art. Any holes in the original peels were also cut out of the mounting boards, preserving the gaps where the polymer did not impregnate the sediment and evidence of the variability in the collection process. Custom brackets made of



Figure 4a. Interpreted sand peel sculpture of the flood and adjustment phase
Flood: The irregular sand on clay contact near the base of the sand peel records erosion at the peak of Harvey flooding early on the morning of August 27th (blue line). The approximately 6-inch-thick layer of finely structured sand records the waning flow of Buffalo Bayou during the next 20 or so days. This flood phase deposited thick a sand bar but only a thin remnant remains (blue to green line). The flow direction is away from the viewer.
Adjustment: Approximately 45 days after Harvey, Buffalo Bayou dropped 10 feet (~3m), receding back to its channel, and water began to drain from a pond formed at the dog park. After ~ October 5th, the rapidly draining pond partially eroded the sand bar, then deposited the sand in the upper 4/5ths of the sculpture (above green line). This peel also captures an additional event from a thunderstorm in November that refilled the dog park pond and deposited a new layer of mud (dashed green line). This later drainage of the pond again deposited additional sand and debris in the upper 1/5th of the tapestry. For the adjustment period, (above green line) the flow direction is from right to left.



Figure 5a. Interpreted sand peel sculpture of the flood, adjustment and recovery phase
Flood: The irregular sand on clay contact near the base of the sand peel records erosion at the peak of Harvey flooding early on the morning of August 27th (blue line). The approximately 10-inch-thick layer of finely structured sand records the waning flow of Buffalo Bayou during the next 20 or so days. This flood phase deposited a thick sand bar but only thin remnant remains (blue to green line). The flow direction is away from the viewer.
Adjustment: Approximately 45 days after Harvey, Buffalo Bayou dropped 10 feet (~3m), receding back to its channel and water began to drain from a pond formed at the dog park. The episodic draining pond partially eroded the sand bar then deposited the sand in the middle 1/3 of the sculpture (between green and red lines). The base of this segment is rich in organics. Flow was from right to left. The contorted and vertical beds are interpreted to record collapse of the channel cut wall as the channel cut and filled the bar.
Recovery: The unstructured sands above the red line were pushed into the channel cut by bulldozers grading the sands during the sand removal process. Over 600 million pounds of sand were removed during the recovery efforts (BBP, 2017).

reclaimed oak panels from Harvey debris were secured to the back of each mounting board to hang the finished peels on a wall with approximately an inch of space between the wall and the back of the mounting board. The backs of the boards are painted in either a blue or green glossy paint. This paint reflects a hue of blue or green on the wall behind the peel which shifts in saturation and brightness as the viewer moves around the finished, hanging sand peel sculpture. This subtle color glow also complements and magnifies the natural yellows and oranges in the captured sediment. These visual cues of color, outline and texture can be read and interpreted as the stratification but in an aesthetic context. They tell the story of the sand peel creation process: the variables of the location and timing of collection, the context of flooding water and the hands of the makers, all of which recognize the specificity of each object.

Though the concept of a sand peel comes from a traditional scientific and educational geology background (Moiola, 1969), the mounting and presentation of these sand peels as art objects allows for the coexistence of scientific and artistic interpretation both of the objects and of the context of their creation including their relationships to geologic and human time scales. Science and art share many traits especially in relation to the scientific process and the art making process, where we have a human drive to collect, analyze, and represent the world around us. Both are tools to understand and pass on information about the current, past and future world. Being able to utilize information from the different logics and perspectives of science and aesthetics allows for different points of access to understand the event and the time it represents. The sand peels offer a unique opportunity for both perspectives of the storm as opposed to the more traditional human only narratives of these kinds of events.

To mark the anniversary of the storm Fotofest International presented a show of images from Hurricane Harvey (Fotofest, 2018). Titled SEEING HARVEY: Personal Stories, Public Responses, the exhibition focused "on the widespread and sustained influence this monumental event had on the region's landscape, infrastructure, and communities, and on the resilience and fortitude of those affected" and displayed images from professional photojournalists and artists and from members of the public. Images came from Houston Chronicle photojournalists, Houston area artists, and the general public in response to an open call for submissions through social media and the web. Overwhelming amounts of water, people in their flooded homes, high water in various areas of the affected region, rescue efforts and recovery efforts dominated the representations of the storm. They depicted the human story by people witnessing their human world affected by Harvey in a human time scale with the image captions noting the time and place each image was taken. These images and this sense of time resonate in a human world, but what is their relationship with the natural world and its representation and understanding?

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Figure 6. Image looking down Dog Park channel cut

View looking north out of the Dog Park drainage channel at Buffalo Bayou. The sand peel sculpture site of **Figure 3** is on the left and that of **Figure 4** is on the right. The sand peel sculpture shown in **Figure 4** is ~ 2 feet wide and 4 feet high (0.6 x 1.2m). On the left are primarily sand bar deposits. The blue lines mark the basal erosional surface. On the right are remnants of the sand bar (between the blue and green line). This is overlain by the Dog Park channel cut deposits (between green and red lines). Above this are sands reworked by bulldozers. Across Buffalo Bayou a bridge spans a small tributary that lies in the old (1944) channel. To the right of the bridge at water level are outcrops of Pleistocene red mudstone coastal plain deposits of the Beaumont Formation (USGS 2017).

The sequence of events interpreted is:

1. Pleistocene (2.5-0.0117ma) fluvial deposits were formed on a coastal plain when the coastline was on the order of ~ 60 miles (~100km) south of where it is today (Paine et al., 2012). Paine (2012) estimates shore line retreat rates have been 10 to 40 feet per year (3 to 12m) over the last 16,000 years.
2. In 1944, the viewed segment of natural Buffalo Bayou channel flowed toward the viewer under the present-day bridge and through what is now the Dog Park drainage channel until the bayou was straightened in the 1970s.
3. During the waning flow, Harvey floodwater dropped from 42 feet to ~10 feet and flowed from left to right depositing the thick sand bar and filling the dog park channel.
4. When the bayou dropped below ~ 10 feet (3m) approximately 30 days after Harvey, the pond that formed in the dog park started draining, cutting through the sand bar. The flow was away from the viewer. This channel continued to cut and fill for approximately 60 days.
5. Around 70 days after Harvey bulldozers and trucks began reworking and removing sand from the area.

The sand peel sculptures offer a more complex narrative for the Harvey and its impact on Houston. The sand strata imagery provides both a direct natural narrative and a more abstract view than images of people and their constructed spaces. The abstraction and the consideration of the natural world enable thinking in earth time, the kind of time that is relevant to understand these kinds of events in relation to the past and the future of the city of Houston. A storm like Harvey is not the first and it will not be the last major storm to hit the gulf coast of Texas. These flood events will happen again; it is recorded in the geology of the Gulf. **Figure 6** shows Pleistocene fluvial deposits along Buffalo Bayou where the sand peels were collected. These deposits were formed on a coastal plain when the coastline was approximately 60 miles (100 km) south of where it is today (Paine et al., 2012). Paine estimates shoreline retreat rates have been 10 to 40 ft/year (3 to 12 m/year) over the last 16,000 years. With this understanding of the region, the Houston geologic community has a responsibility to educate other Houston and Gulf Coast communities to understand these two kinds of time and the reality of storms and flooding for the infrastructure

and people of the Houston and the greater Gulf Coast region.

Buffalo Bayou is an ever-evolving fundamental feature of Houston. It always will change and adapt to its surroundings. The bayou responds to both natural and artificial changes imposed on it, eroding in one place and depositing sediment somewhere else, working simultaneously in both human and earth time. Hurricane Harvey is not unique; it was one of thousands of such events that Buffalo Bayou has experienced, and will happen again. The natural record in Buffalo Bayou preserved in the sand peel sculptures documents the Hurricane Harvey flood and recovery and reminds us that we need to be prepared to coexist with an ever-changing coastline. The human time scale is not dominant; it coincides with a natural one, an earth time. Together, considering our cohabitation of the Gulf Coast, we can work to embrace this complexity, make changes and be ready for the next major storm event.

The GeoArt Collaborative, an effort of artists and geologists to raise the appreciation of coastal inhabitants for the dynamic nature

of where they live, is building on the sand peel effort. The sand peel sculptures are planned for exhibition and featured in a field trip at the GCAGS fall 2019 meeting in Houston. These sand peel sculptures are an artistic and scientific collaboration between artist and daughter Kate Kendall, geologist and father Jerry Kendall, and their communities with support from the Buffalo Bayou Partnership and funded in part by the City of Houston through the Houston Arts Alliance. For past exhibitions, information and images of the artwork and future GeoArt events visit <https://www.katekendall.info>. ■

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Biographical Sketches

KATE KENDALL (b. 1985) looks to the natural world as a less determined space than the human world to soften boundaries and complicate, challenge and enrich the viewer's perspective on reality. As a conceptual artist, she uses many different media ranging from sculpture and installation to video, sound and text to help communicate ideas and create experiences. Her goal is to promote new narratives and languages that enable mobility and find ways for us to live with complexity and difference together. Her work mines focused research and personal experiences/history with geology and landscape to consider narrative knots, aiming to expose their construction, stress their complexity and enrich the viewer's perception of their own cultural and political context.

Kate Kendall received her MFA from California Institute of the Arts and her BA from the University of Southern California. She has exhibited in Los Angeles, New Mexico, South Africa and various spaces in Houston including DiverseWorks Art Space, Lawndale and Box13 ArtSpace. She has also worked fabricating and installing public art all around the city of Houston while working for public artist Dixie Friend Gay and completed her own mosaic, the Forget-Me-Not Panel of Smither Park in 2013 for the Orange Show Center for Visionary Art Campus.

JERRY KENDALL is a global expert on the processes of mountain building. He began his geology career in the Arctic doing field exploration and research in Greenland and Svalbard. He has 40 years of experience in outdoor geology instruction in remote areas to varied groups, including Boy Scouts, students and professional geologists. He has worked in academia and industry expanding the limits of knowledge on how multiple earth processes interact to produce mountains and hydrocarbon accumulations. He has a deep passion for understanding the integration of earth systems, how it impacts us, and sharing that understanding with others.

Jerry Kendall has been a resident of Houston Texas for 20 years. He currently advises students at the University of Houston Earth and Atmospheric Science department and is adjunct faculty at the University of New Mexico. He lives directly on Buffalo Bayou and has watched it flow, surge and evolve over the last 20 years. He is interested in how the natural processes of the bayous have integrated with the anthropogenic efforts to coexist with it.