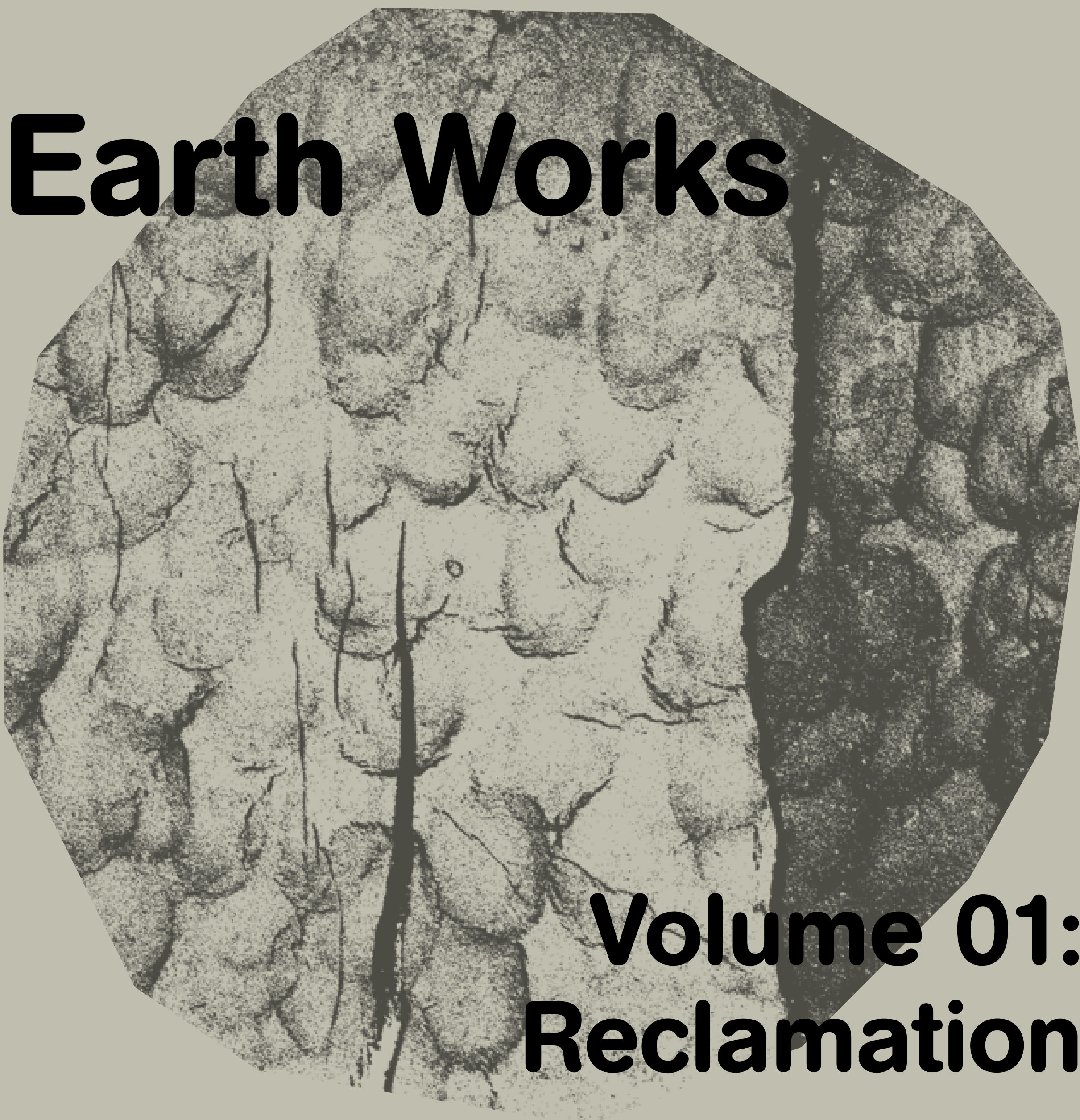
periscope

Earth Works



Volume 01: Reclamation

Spring 2022

Earth Works Volume 01:
Reclamation

Earth Works: Reclamation

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Periscope is a spatial design agency focused on regenerative design and public architecture.

We design and deliver resilient projects that work for people and planet, grounding our interventions within their greater ecological, topographic and social fabric. In valuing meticulous research, technical rigour and plural voices we seek to meet the challenges of our and future generations.

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Most of Perisope's projects are sited in London. And most of our work involves digging.

London rests on layers of seabed clay, deposited 56-34 million years ago through a cycle of sea level fluctuations during the Palaeogene Period. How can we reclaim our relationship with this fundamental earth beneath our feet, and in doing so, use it to reconnect to traditional material crafts?

This Journal is a distillation, synthesis, and reflection on clay reclamation. It serves as a way for us to organise our work; drawing old and new threads through the research. Rather than being a full stop research book, this document serves as a series of observations over the process of clay reclamation and should be read less as a report and more as a series of open thoughts and moments of contemplation over the elements involved.

Deposits of clay form over many years and stratify into distinct sections. The continuation of this research will take a similar form, with different strata that build and layer upon the previous, as we continue to dig into Earthworks.

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01 A Story of Clay

Studio based clay extraction

Processes of material migration and transformation are often overlooked within the construction industry. It is fairly commonplace for London's construction sites to collect bricks from The Netherlands, Spain and France, migrating distances of 2000km at a National annual cost of around £25,000,000[1]. Meanwhile, soils excavated from these construction sites to make way for pile foundations, parking basements and HS2 tunnels are removed and underutilised in several possible ways: as infill on-site or at another site, stored as active or inactive stock, or disposed of in landfill as cover[2]. The management practices of excavated materials are often not clearly defined and under-reported. Materials become treated as commodities rather than processes. With every transaction, matter is wasted.

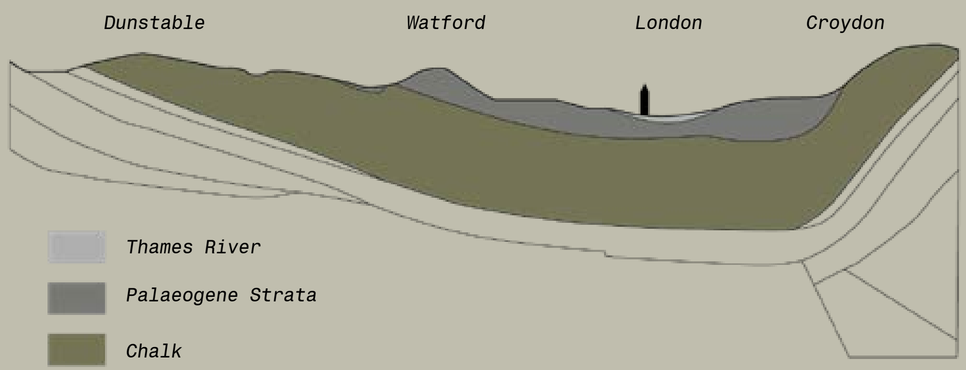
In nature, there is no such thing as waste[3]. Each state that living or mineral matter passes through is part of an ongoing process, each a useful input to a neighbouring organism within a greater ecosystem. A failing of the construction industry is that it rarely acknowledges destruction of natural systems as an inevitable and complementary part of what it does.

Natural ecosystems enact their processes locally. If we are to evolve (or devolve) toward a zero-waste construction process, we should also look locally and operate at a scale relative to our immediate surroundings, and our own body. We should look to the land beneath our feet, and work at a scale relative to our own hands.

Earth Works embarks on a humble and personal journey of material excavation, reclamation, processing, re-insertion and degradation, considering all the by-products along the way and seeing nothing as static, nothing as waste. It looks to directly connect us with earth and to position ourselves as processors of and for the Earth. Within this volume we focus on reclamation of earth.

1 *Observatory of Economic Complexity*
2 *Sustainable Management of Excavated Soil and Rock in Urban Areas*
3 *David Suzuki*

01



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South East Geology

Deep in the soil, below our made ground, foundations and topsoil, London is underlain by four main geological divisions - forming the Palaeogene strata. The Thanet Sand Formation, the Lambeth Group, the Thames Group and the Bracklesham Group. All compressed into the London Basin - a syncline, or fold, in the chalk layer below.

A chalk layer that grew from the mass death of coccolithophores - Micro-organisms buried in the seabed - during the Late Cretaceous period, between 100 and 65 million years ago.

The initial folding of the London Basin began in the early Palaeogene period during widespread plate tectonic movements. This period is also marked by fluctuating sea levels depositing London Clay into the basin - up to 132 metres thick. The next major geological event happened between 23 and 5.3 million years ago in the mid-Miocene epoch. The same tectonic movements leading to the Alpide belt of mountains caused further folding of the basin - cementing its geological formation.

The unique properties and thickness of this geology helped foster the trajectory of London's metropolis. Its ease of tunnelling allowed for London's underground network connecting the city and it has economic significance for construction.[1]

[1] *London's Geological Heritage. In London's Foundations Protecting the Geodiversity of the Capital,*

01 Early geological map, William Smith, 1815
02 London Basin syncline diagram
03 Geological Strata, data source: William Smith

Clay London

The ancestral Thames, was gradually pushed southwards during the last ice age. Eroding through chalk ridges at Goring and carving through deposited clay, the modern day path of the Thames was formed through present-day London. The Thames left an accumulation of river deposits, over time compacting to form dense, infertile anaerobic soils.

Late-Georgian urbanisation conceived of the London stock brick - a brick that quickly became the vernacular of the city. Made by excavating the city's mud, mixing it with water, debris and domestic waste, brick manufacturing was carried out by hand and fired in kilns on-site, many of which can still be found across London. The variation in colour exposes the differences in mineral strata.

London is built from the clay bed it rests on. In parts sinking into the same clay that it is built with. As the use of vernacular building typologies sees a renewed interest, what will the future relationship between London and clay become?

01

01 George Cruikshank - 'London Going Out of Town' or 'The March of Bricks and Mortar', 1829

The Use of Clay

Clay is an old technology - with the making of bricks going back thousands of years. Throughout history, the popularity of building with materials containing clay rises and falls with trends in the built environment and the latest material sciences.

For us, an exploration into clay is about the connection with the earth beneath our feet through traditional building materials and examining the process of reclamation in the larger material economy of the built environment.

Grymsdyke Farm in Buckinghamshire is a research facility, fabrication workshop and living-working space that pushes contemporary clay-making processes and its intersections between design, making and place. Grymsdyke has hosted several projects that have inspired our own investigations:

Guan Lee's haunting 'Other Room' work and collaborative research with Eleanor Morgan explore the elegant craft and making with clay.

Samantha Oswald's 'Terracotta' Project and Brick research investigated the making of clay modules across their processing stages, producing elegant motifs between digital and hand crafted techniques.

Lydia Johnson's 'Hexacones' project and other projects of hers examine the role of plaster moulds and slip casting in ceramics to create an intricate folly.

01

02

01 Guan Lee - Other Room, 2014
02 Samantha Oswald - Terracotta, 2014
03 Lydia Johnson - Hexacones, 2014

03

The Energy of Earth

Samantha Oswald’s research examines the relationship between the contemporary construction industry and clay bricks. Her work, carried out in part at Grymsdyke Farm, posits a material connection between the physical making of clay bricks and the computational design of their formwork.

Our interest in this work is tied to her in-depth and hands-on exploration of the material processes of clay; from raw clay extraction to its firing into a brick. Looking at her learned process as starting points for how clay reclamation can be used on-site we continue to re-establish the connection between clay and process.

Our research begins with excavated soil. Looking first at the feasibility of extracting clay out of soil site waste prior to its reuse as a construction material.

Samantha Oswald,‘Brick: a story of construction’

01 Mixing clay
02 “Puddling” clay with sand
03 Brick making
04 Brick releasing

01

02

03

04

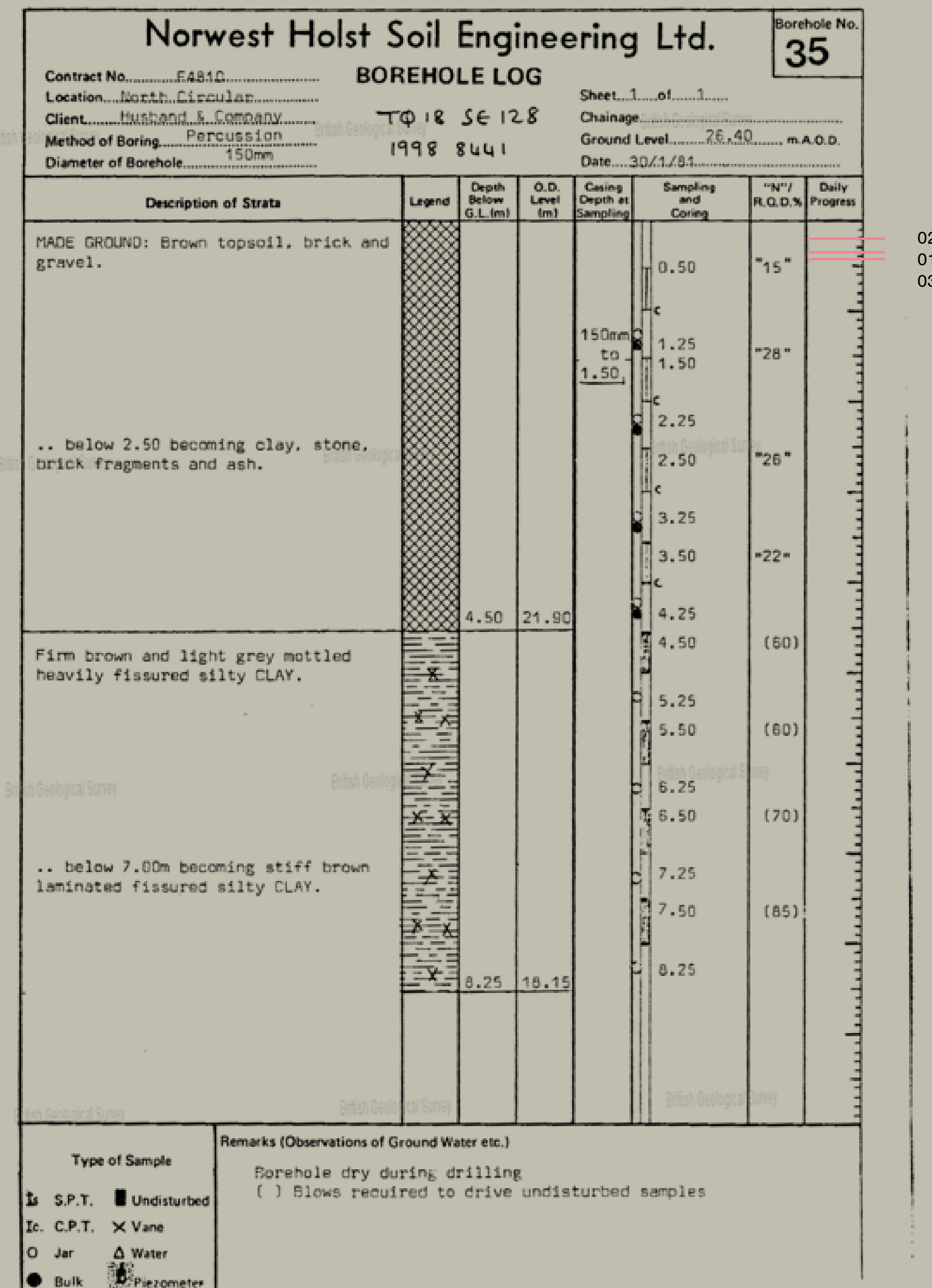
02 Site Works

Investigating collected soil samples and percentages of clay; this section considers a close examination into the specific conditions of the site and material properties that influence. Our story of reclamation begins from samples dug out of alluvium deposits in Brent River Park, our test-bed site. The practice of geology, of earth works, is an inherently site specific endeavour. The material collected and their characteristics moor them to the space where they were collected.

Brent River's edge condition

Key

01 Sample_0001_A-01
02 Sample_0002_A-01
03 Sample_0003_A-01
04 Borehole TQ18SE128



Norwest Holst Soil Engineering Ltd.

Borehole No. 35

BOREHOLE LOG

Contract No. F4810
Location North Circular
Client Husband & Company
Method of Boring Percussion
Diameter of Borehole 150mm

TQ 18 SE 128
1998 8441

Sheet 1 of 1
Chainage
Ground Level 26.40 m.A.O.D.
Date 30/1/81

Description of Strata	Legend	Depth Below G.L.(m)	O.D. Level (m)	Casing Depth at Sampling	Sampling and Coring	"N"/ R.Q.D.%	Daily Progress
MADE GROUND: Brown topsoil, brick and gravel.					0.50	"15"	
				150mm to 1.50	1.25		
					1.50	"28"	
					2.25		
.. below 2.50 becoming clay, stone, brick fragments and ash.					2.50	"26"	
					3.25		
					3.50	"22"	
					4.25		
		4.50	21.90		4.50	(60)	
Firm brown and light grey mottled heavily fissured silty CLAY.					5.25		
					5.50	(60)	
					6.25		
					6.50	(70)	
.. below 7.00m becoming stiff brown laminated fissured silty CLAY.					7.25		
					7.50	(85)	
		8.25	18.15		8.25		

Type of Sample: S.P.T. / C.P.T. / Jar / Bulk / Undisturbed / Vane / Water / Piezometer

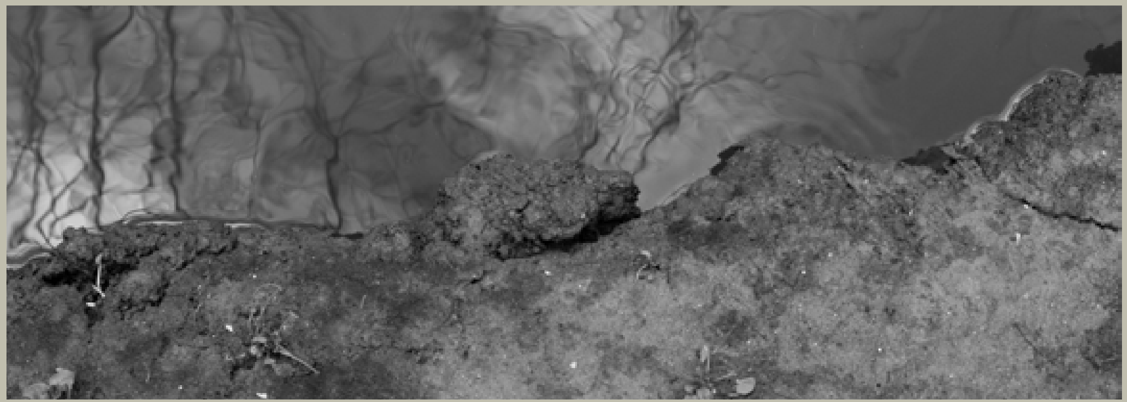
Remarks (Observations of Ground Water etc.)

Borehole dry during drilling
( ) Blows required to drive undisturbed samples

River Edge Erosion

Edges are a marker of separation, the zone between materials, states or forces with differing characteristics. The edge thus becomes a transitional area that shifts and moves when acted on. The eroding riverbank is a mark of this transitional edge between earth and water.

The power of moving water forms and reforms the river's edge. With each seasonal flooding removing old material and depositing new matter into the rivers bank. A direct exchange of earthen particles. Systems of roots and decaying organic material become revealed and washed away by the changing river.



Edge erosion reveals built up strata of geological deposition, and the history of material movement through the river. Brent river is filled with alluvium deposits - Layers of loose sand, gravel, silt, clay, and other matter from upstream deposited by the river. These are the deposits we dug into to reclaim clay.

Digging through Earth

Before clay can be reclaimed from the soil, an exchange with the earth must first occur - exerted labour for soil collection. Digging in a site, at the scale of the individual through the scale of construction, are acts of alteration and exploration of a site's geological archive.

These layers of naturally deposited geology track backwards through previous seasons, weather patterns, organic growth and death, flooding and countless other events that influence the earth's layering.

Our samples take the past few years of deposited alluvium. The soil was taken just below the surface that artefact the recent rains of mid-January 2022 to the seasonal rising of the river.

Eroding the Surface

When the surface becomes weathered a revealing of the earth occurs. Dirt, mud, and earth poke through the vegetation they normally support. This slow act can be a product of the same actions that originally deposited the geological layers: Seasonal weather, flooding; or mechanical processes: the person on a leisurely walk, the children playing 'it' in the park, or the dog digging a hole.

This engagement with the surface mediates our connection to geological material. These sites of revealed mud and dirt present a place to get stuck into the earth. To engage more closely with the geology supporting our daily experience. Sites that connect our experience to the natural processes occurring between elements from above and below the mud.

Soil Samples

Extracted Large Matter

Sample_0001_A-01

Collection Depth: 55mm
Materials: soil (sand, silt, clay), roots, organic matter

Field Notes:
Collected outside the river bank. The soil clumps together into larger granules of material and smear and compress when pressed between fingers.

Sample_0002_A-01

Collection Depth: 400mm
Materials: roots, twigs, soil (sand, silt, clay), pebbles

Field Notes:
Collected on the river bank close to the water’s edge. This sample is tied together with tightly interwoven large and small root systems. The inorganic material clumps to and is held in place by the roots that run around them.

Sample_0002_A-02

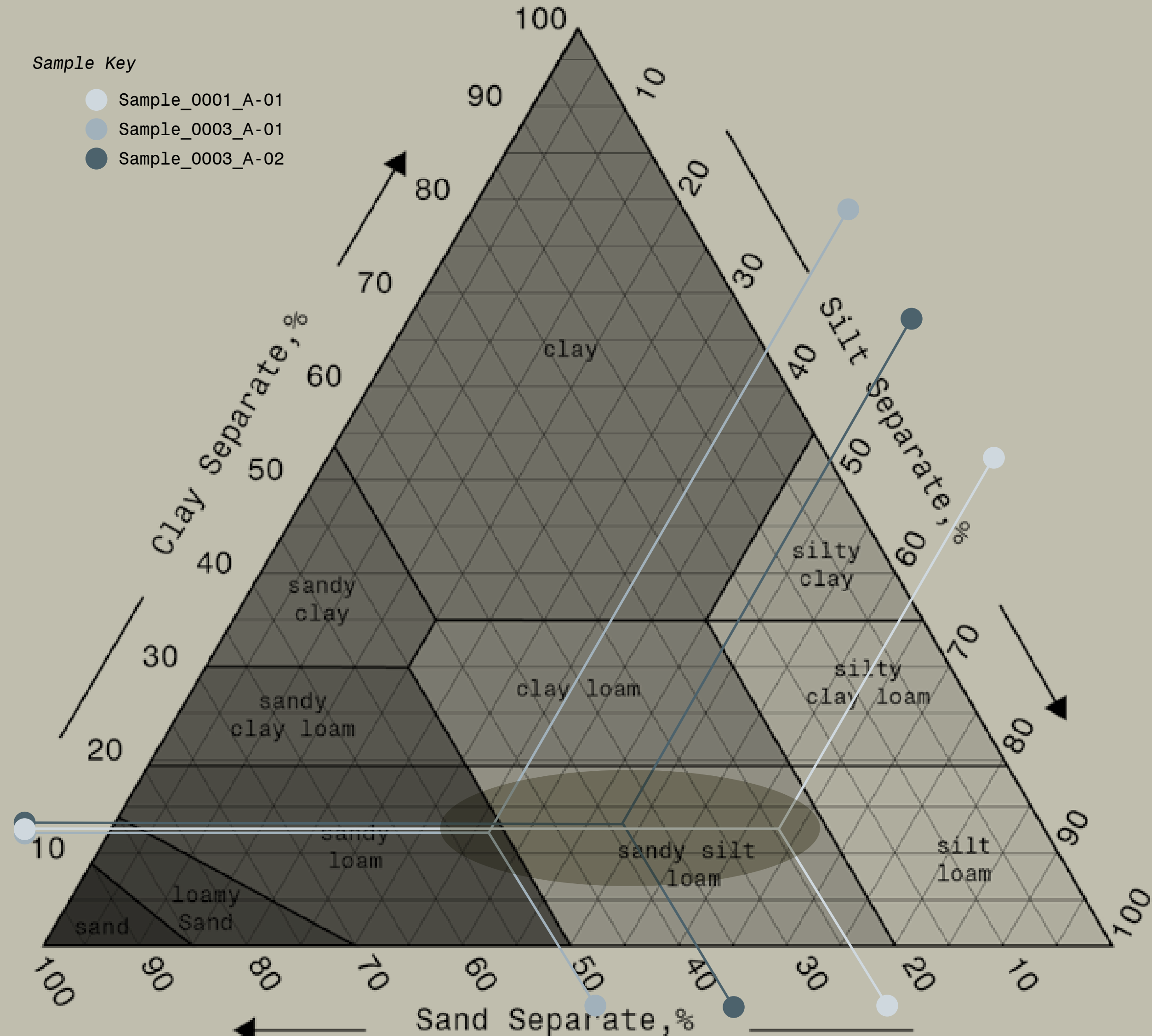
Collection Depth:180mm
Materials: leaves, soil (sand, silt, clay), roots, twigs, rocks

Field Notes:
Collected on the river bank close to the water’s edge. Reading from left to right the soil sample maintains its vertical strata of material layers. The sample appears to be held together through layers of decaying leaves and root systems that run through the inorganic material.

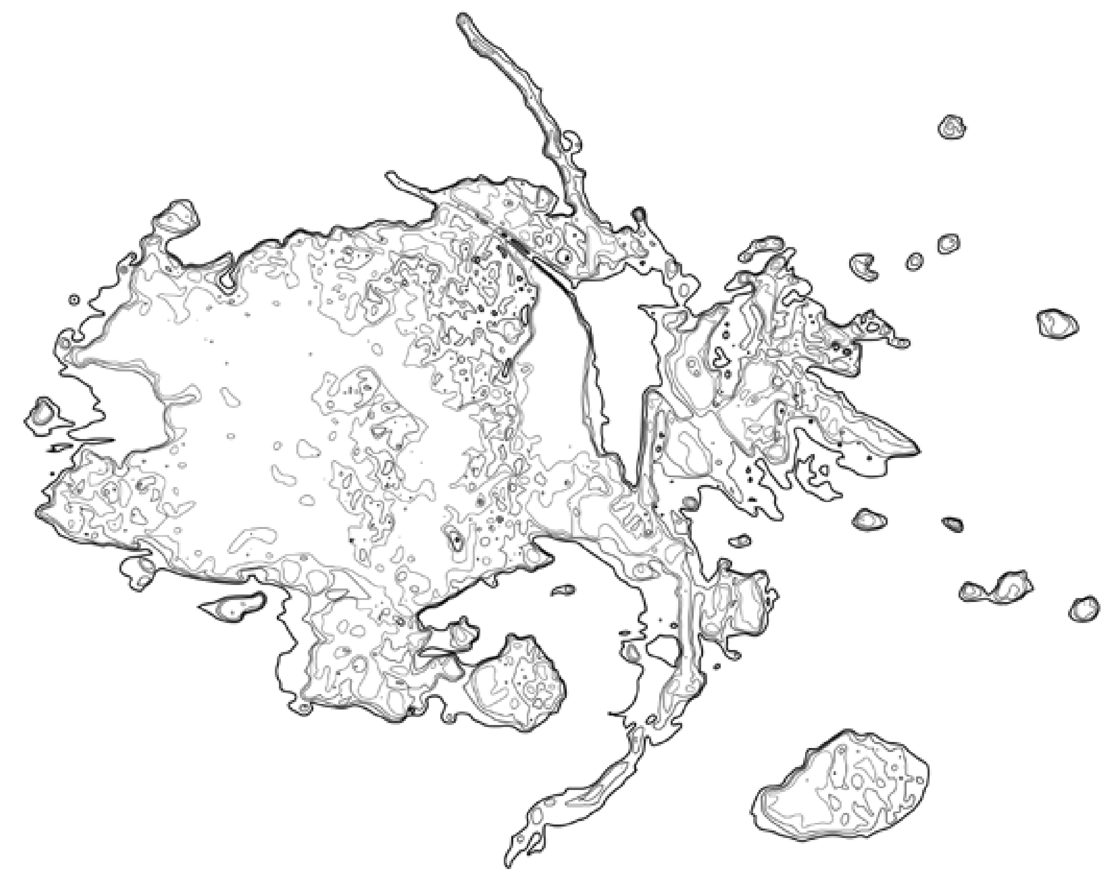
Sample_0003_A-01

Collection Depth: 380mm
Materials: soil (sand, silt, clay), roots, large pockets of sand

Field Notes:
Collected on the river bank. The soil at the surface of this collection was waterlogged and saturated. The predominant material chances from a soil mixture to pockets of sand at 350mm below the surface.



Soil Texture Triangle



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Soil Texture

Soil texture triangles are used to quickly categorize soil type based on the relative content of its component particles - sand (2.0-0.05mm), silt (0.05-0.002mm), and clay (Less than 0.002mm)

The analysis of our samples collected, separated through water suspension, indicate that it falls into the silt loam soil texture. (12-13% clay, 24-51% sand, 37-62% silt)

01 Sample_0002_A-01

1

01 Sample_0002_A-02

Clay

Clay is in a dynamic relationship between its material composition and water content. This state of flux gives the clay a type of local precision - material differences that are relative to each different sampling of clay. Creating a need for physical engagement and a learning curve with each type of clay.

Clay is one of the three main particulates in soil composition. With particles that are smaller than sand and silt grains (less than 2 microns) and an electrically charged mineral surface clay particles are attracted to other clay particles. The water involved exists in two states - adsorbed water (water adhered to the surface of the clay particles) and chemically bound water (water that is only removed in the kiln firing process). This slippage between water and charged clay particles lends itself to clay's plasticity. Clay as a material requests an active hand in learning how to work with it. The plasticity of clay offers back an orchestrated choreography of energy exchanges between clay, water, and the craftsman.

03 Lab Works

Lab Works is a reflection on the iterations and improvements developed in extracting clay from the soil samples. Musing on the role of gravity in the design and process, kiln shrinkage, the marks and stains created by the processing.

Clay distillation

Iteration 01

Soil, in its raw form, contains particles that vary in size by up to 1000 times. With this concept in mind, the initial test in reclaiming clay particles relies on a model of wet processing soil. The working theory is that clay will stay in suspension while the sand and silt will sink to the bottom of the water, and the suspended clay can be poured off.

It proved successful in extracting workable clay. However, there was still a noticeable amount of organic matter and silt remaining.

Iteration 02

To address this, a second batch is first powdered through a metal mesh, removing larger aggregates while creating consistent soil size. Allowing the mixture to separate more easily in the water. The soil is then broken up in the water, poured off and allowed to settle a second time, before being poured off and filtered through a cotton cloth.

This improvement produced a smoother clay with less silt but was still unsuccessful in removing decaying organic matter.


Iteration 02
Weight of soil: 749g
Weight of sand: 379g - 51%
Weight of silt: 278g - 37%
Weight of clay: 92g - 12%
Iteration 01
Weight of soil: 1180g
Weight of sand: 292g - 24%
Weight of silt:736g - 62%
Weight of clay: 152g - 13%

Iteration 03

The next target became to remove organic material and further isolate impurities. Based on a technical paper examining the effects of alkali solutions for kaolin clay purification, a mixture of sodium carbonate was added. This became a third settling stage after the majority of sand and silt had been removed. In principle the alkali solution causes impurities to clump together and fall out of suspension sooner than finer particles. In practice, this process has left the smoothest raw clay. But there always remains room for improvement.


Iteration 03
Weight of soil: 331g
Weight of sand: 130g - 39%
Weight of silt: 160g - 48%
Weight of clay: 41g - 13%

Reclamation Process

Equipment:
3 buckets, metal sieve, cotton drill fabric, string,

Matter:
Water, Soil, Soda Crystals

Steps:
1 Collect and dry the sample from the site.
2 Powder the soil through a fine metal sieve removing large debris as you go.
3 Combine a ratio of 1 part soil to 4 parts water in a bucket big enough to allow for mixing.
4 Agitate and mix the liquid, making sure to break up the clumps of soil.
5 Allow the water mixture to begin settling - larger particles of sand and rocks will fall out of suspension immediately; Silt and fine sand should fall out of suspension between 5-10 minutes; Clay should remain in suspension for an hour+.
6 After 10 minutes slowly pour off the clay-water mixture, through a metal sieve, into a bucket. Stop pouring just before the sand and silt begin to flow out.
7 Re-agitate the clay water and repeat steps 5 and 6.
8 Mix Soda Crystals and water and add to the clay water mixture.
9 After 20 minutes pour off the clay water suspension into a clean bucket and allow it to completely fall out of suspension. (3-24+ hours)
10 Carefully pour off the clear water sitting on top of the settled clay.
11 Pour the liquid clay into a cotton fabric set inside a bucket to filter out the remaining water.
12 Remove and dry the clay to an appropriate consistency and knead the clay together.

Gravity and Matter

Gravity, as a constant, seems to challenge the designer. Some systems gain stability through their relationship with gravity, while others collapse if an element falls out of sync. Take for example the keystone - the final brick laid in an arch system. When the keystone is in sync with the other bricks, material gravity brings order and strength to the system. Misalign and remove the keystone and the arch is at challenge with gravity and the system collapses.

When gravity is placed in this spectrum, between stressor and order, moments of intervention open up. This process of clay reclamation is one of those interventions. It relies on the effects gravity has on the matter to sort elements of the soil.

A mixture of particulates suspended in water, our clay reclamation relies on how this particulate matter responds to gravity in suspension.

Bureau of Standards Technological Paper No.51

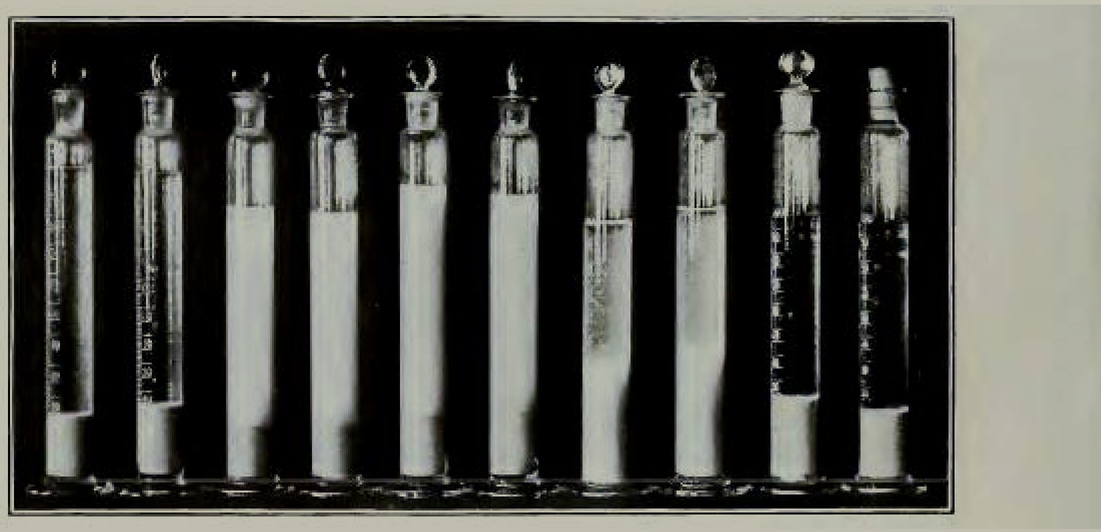
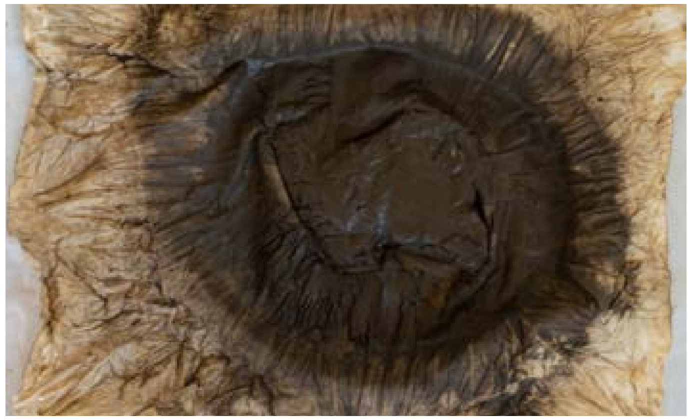


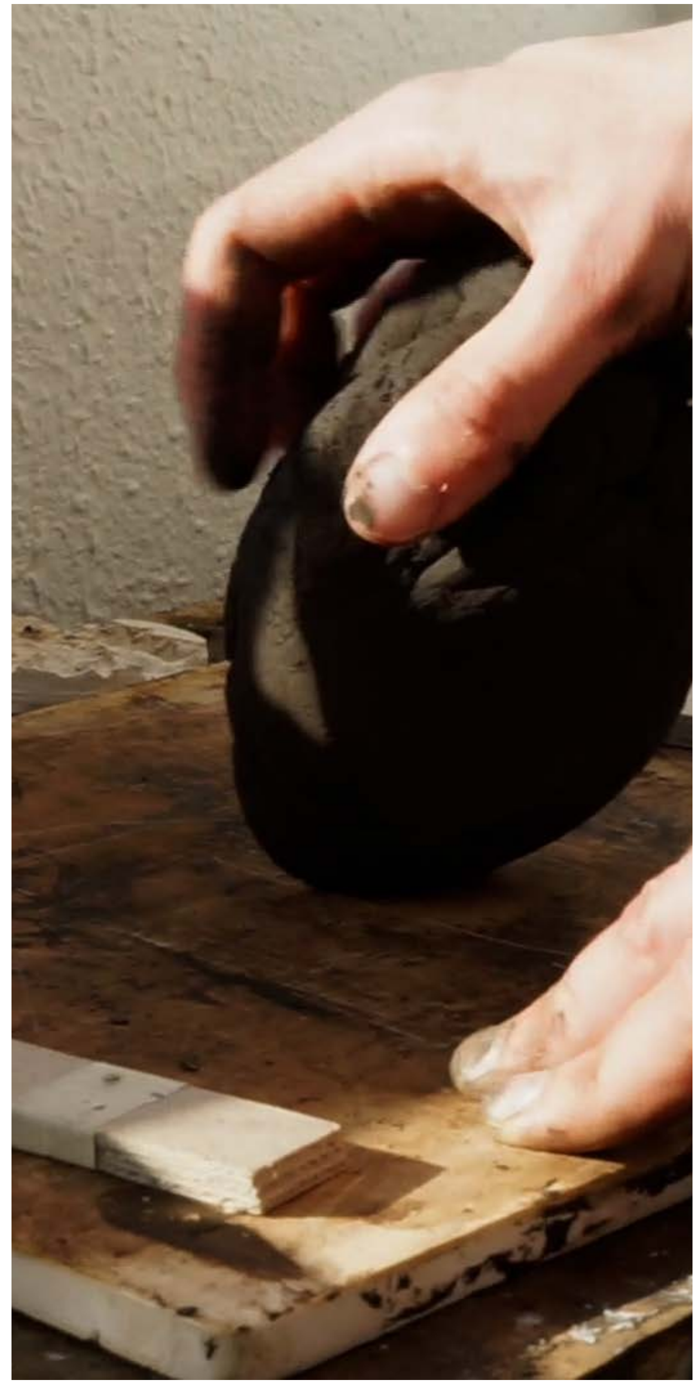
Fig. 1.——Effect of increasing amounts of NaOH in bringing about deflocculation and reflocculation

A.V. Bleininger ‘Use of Sodium Salts in the Purification of Clays and in the Casting Process’

Tipping Point

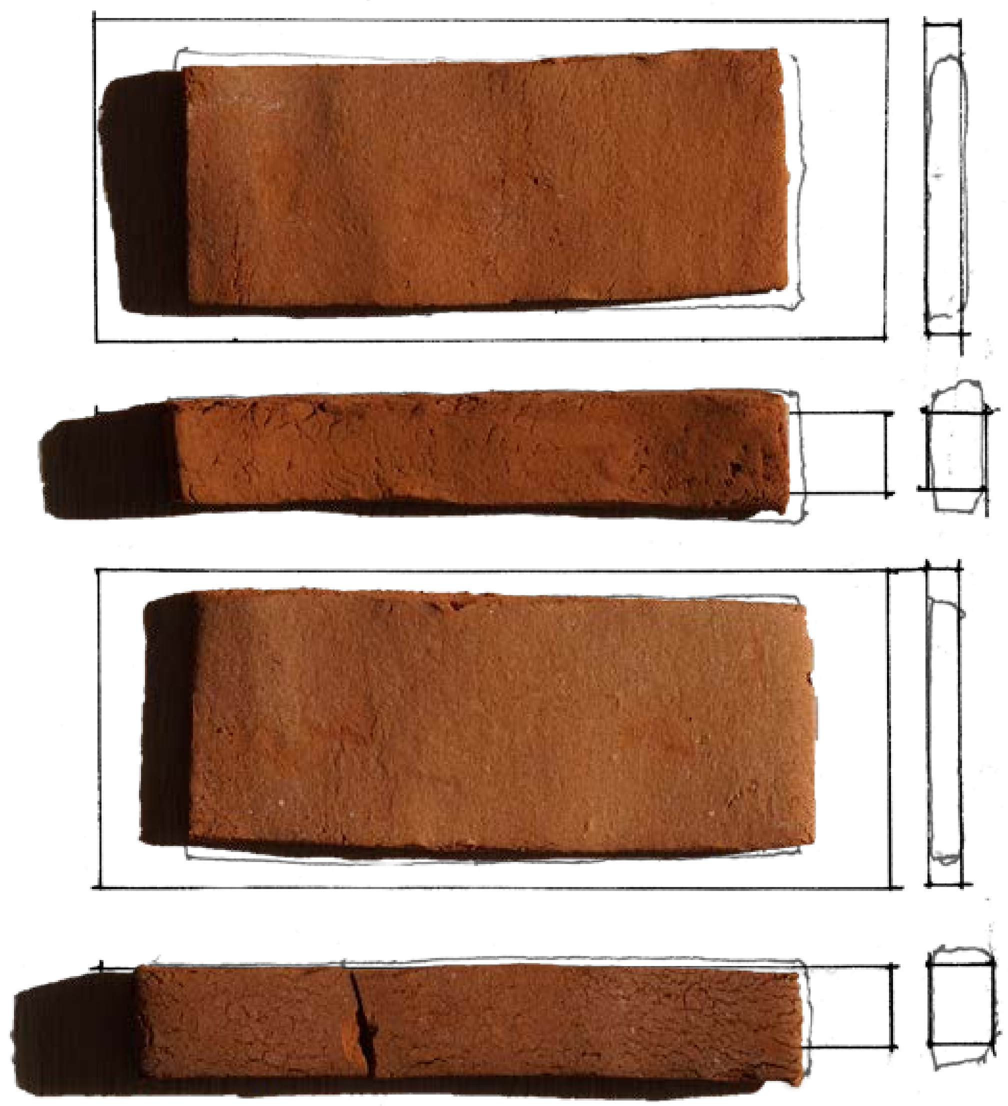
The cotton filter is tied and suspended over a bucket collecting excess water. Once it leaves its liquefied state, the clay becomes a cohesive ball. It is then removed from the fabric and spread out on a board to finish drying before being kneaded out.

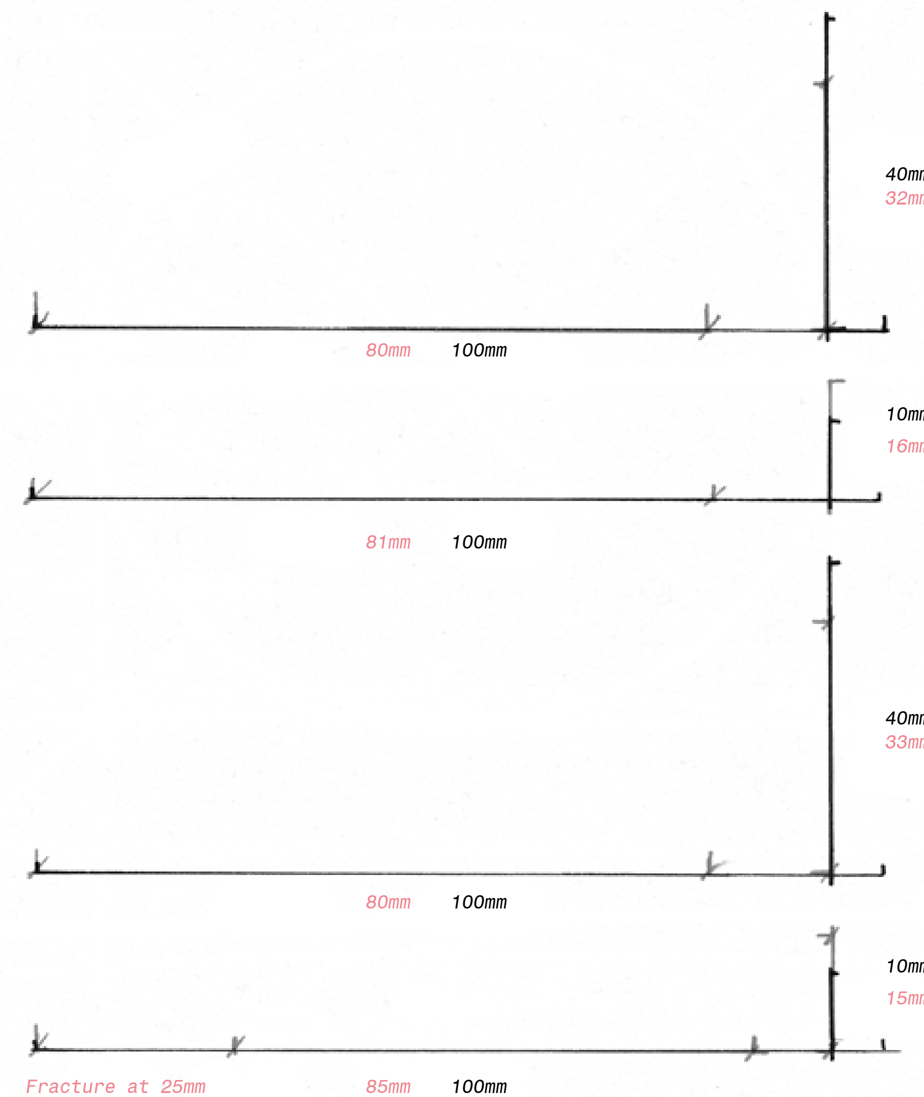




Clay Kneading

As the clay comes together in the cloth it reaches a stage where it can be spread out onto a surface to encourage even drying. As more water is evaporated out of the clay a balance is struck between kneading, scraping, and flipping.





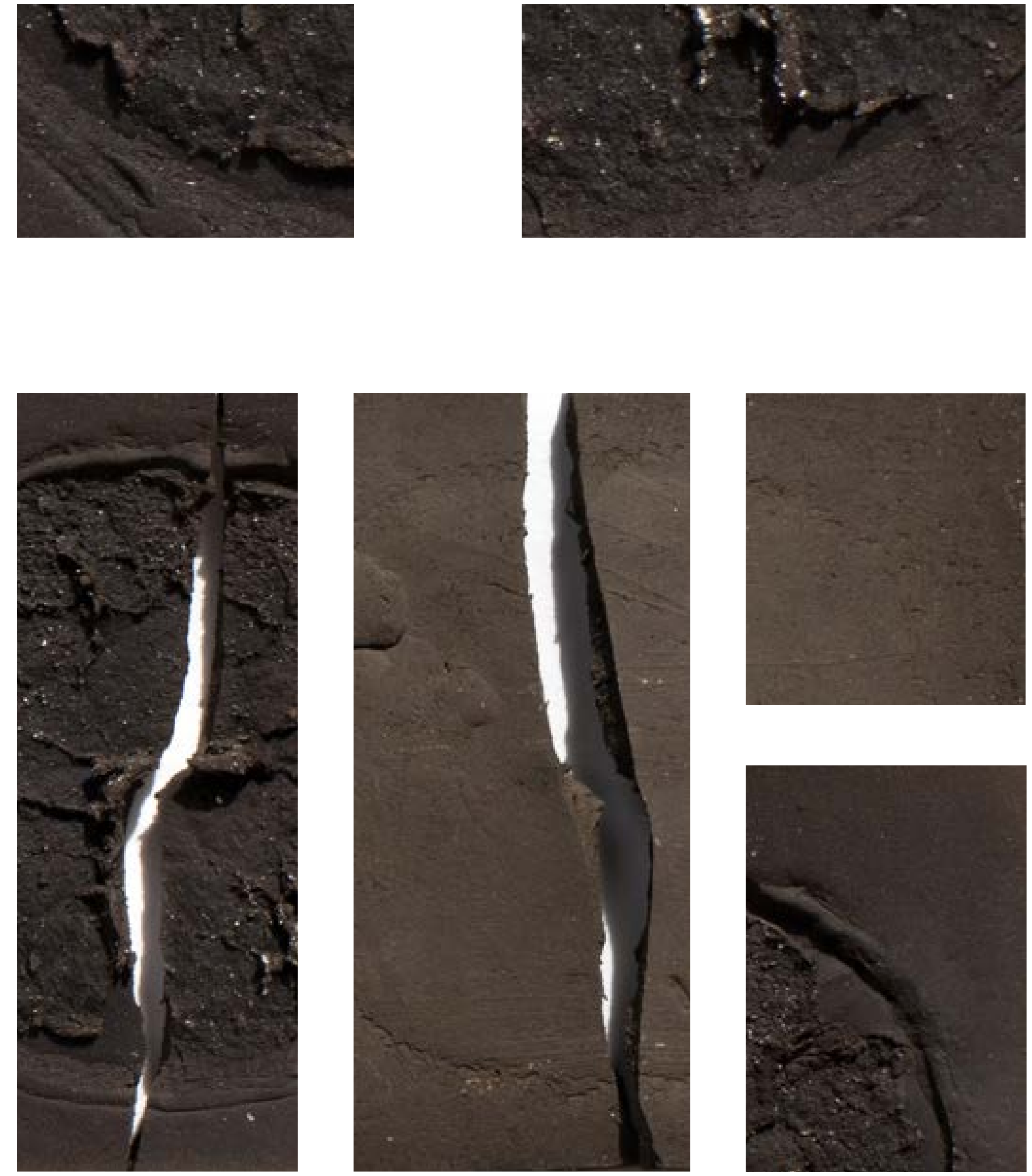
Kiln Shrinkage

Clay shrinks several times throughout its firing. Initially, the still-wet clay shrinks as its adsorbed water evaporates off - bringing the clay particles closer together. A great deal of stress is created in the clay body as it goes through this drying phase - coming from uneven density in the clay particles. A second shrinkage happens from the partial glassification of clay particles during the vitrification phase.

This shrinkage comes from the diminishing size of clay particles as their molecular arrangement changes. Clay shrinkage is unpredictable to the untrained practitioner and requires sacrificial tests while the characteristics of the clay body are learned. Our reclaimed clay body experienced an overall shrinkage of about 20%.

Material Marks

Slight variants in process, material, thickness, drying, etc., lead to marks, cracks, material impurities and warps in the fired clay. Clay is a material of variance, this means that its precision is not the same as precision in steel or wood, which maintain their own material properties. Thus, clay should be approached through its unpredictability - not through a means to force error-free precision at the cost of time and energy.



This is not to say that clay is unrefined as a working material and can only produce imperfect artefacts. With practice, the marks created in the clay test pieces and initial attempts can be read like a material notation. Allowing the study marks, stresses, and material cross-section to inform specific improvements in the process.







The Earthworks Reclamation cabinet is a synthesis of the developed parts and their constituents, taking you through the eight main stages of clay reclamation. Functioning as both a quick guide and an educational curiosity, this display encourages examination of each step to understand the slow yet fundamental change of states of matter.

04 Artefacts

The handmade artefact presents a way to test the scale and usability of reclaimed clay in the production of unique objects. This section considers the process of making tiles with local textures using our studio as a site.

Latex relief taken of concrete aggregate

Textures

Surface textures develop from overlays of marks, dirt, and material characteristics. Notating a history of change, surface textures peer into the palimpsest of past tools, dropped materials, and dirt collected through use.

The latex relief is a copier of texture. A material that presents back the surface and dirt that it is painted onto. As the latex dries and is removed it lifts with it the top surface of dirt and grime that has gathered on the surface. Imbuing the latex not only with formal characteristics but also a layer of material residue.

01 Polystyrene Foam

02 Ficus Lyrata Leaf

03 Large Concrete Agregate

04 Kinetic Sand

05 Oak Floorboards

06 Silicone Moulds

07 Honeycomb Cardboard

08 Algae Sand

09 Small Concrete Aggregate

10 Painted Brick Wall

To make a stamp for the clay tiles, the latex relief is cast into a series of plaster discs. These discs take on the same formal characteristics as the surfaces they duplicate but in a unified material. Normalising the surface texture data pickup up by the latex and producing an object with a single characteristic: form.

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Making Tiles

The tiles were produced and left to dry over the course of a day. In part, the beginning of the day was spent developing the best method of producing uniform tile shapes. Testing moulds, flattening methods, and stamping of the clay. A larger percentage of the day was learning its properties; its plasticity, refining its water content and learning how it reacts to shaping. The last few hours of the day were spent making the final tiles.

4

5

6

Steps:
1 Knead the clay into consistency.
2 Roll the clay flat with stop blocks at the desired tile thickness.
3 Place the template onto the clay and with a utility knife cut away the excess clay.
4 Press the stamp into the clay; cutting off the excess material around the edges of the tile once again.
5 Clean up the smooth face and edges with a finger dipped in water.
6 Remove the tile and place it to dry slowly, lightly covered by a plastic sheet.

Clay before firing
Clay after firing

01 Polystyrene Foam

02 Ficus Lyrata Leaf

03 Large Concrete Agregate

04 Kinetic Sand

05 Oak Floorboards

06 Silicone Moulds

07 Algae Sand

08 Small Concrete Aggregate

09 Painted Brick Wall

05 By-Products

Dismantling the lab

This section contemplates the by-products produced in the choreography of reclaiming clay. Stains, marks, and remnants occupy the space of exploration. It is an examination of the dance between material, mess and equipment over time.

Lab Setup

The lab became a temporary place of experimentation with the messiness of reclamation. A temporary space defined by the edges of the plastic sheeting that protected the wooden floor beneath.

Under constant surveillance by the cameras, microphones and lights, three worlds coexisted in this room. Step onto the plastic and you were in the world of the earth - covered in dirt, water, and mud. Just outside the plastic border was the world of large 1:100 scale urban design model making - mixing sand, trees, and buildings while forming and reforming landscapes.

Filling the air between the two worlds of making were the words of design meetings, weekly catch ups, and video calls. The meeting space occupied the third world of this floor. Less defined in its borders, the sonic landscape of design mixed with the sounds of mixing, scraping, and making, energised the room.

All of these spaces overlaid themselves. Questions in one world were promptly asked and answered by inhabitants of a different world. Design making and conversation were all brought together in this lab.

1

Cloth filter setup

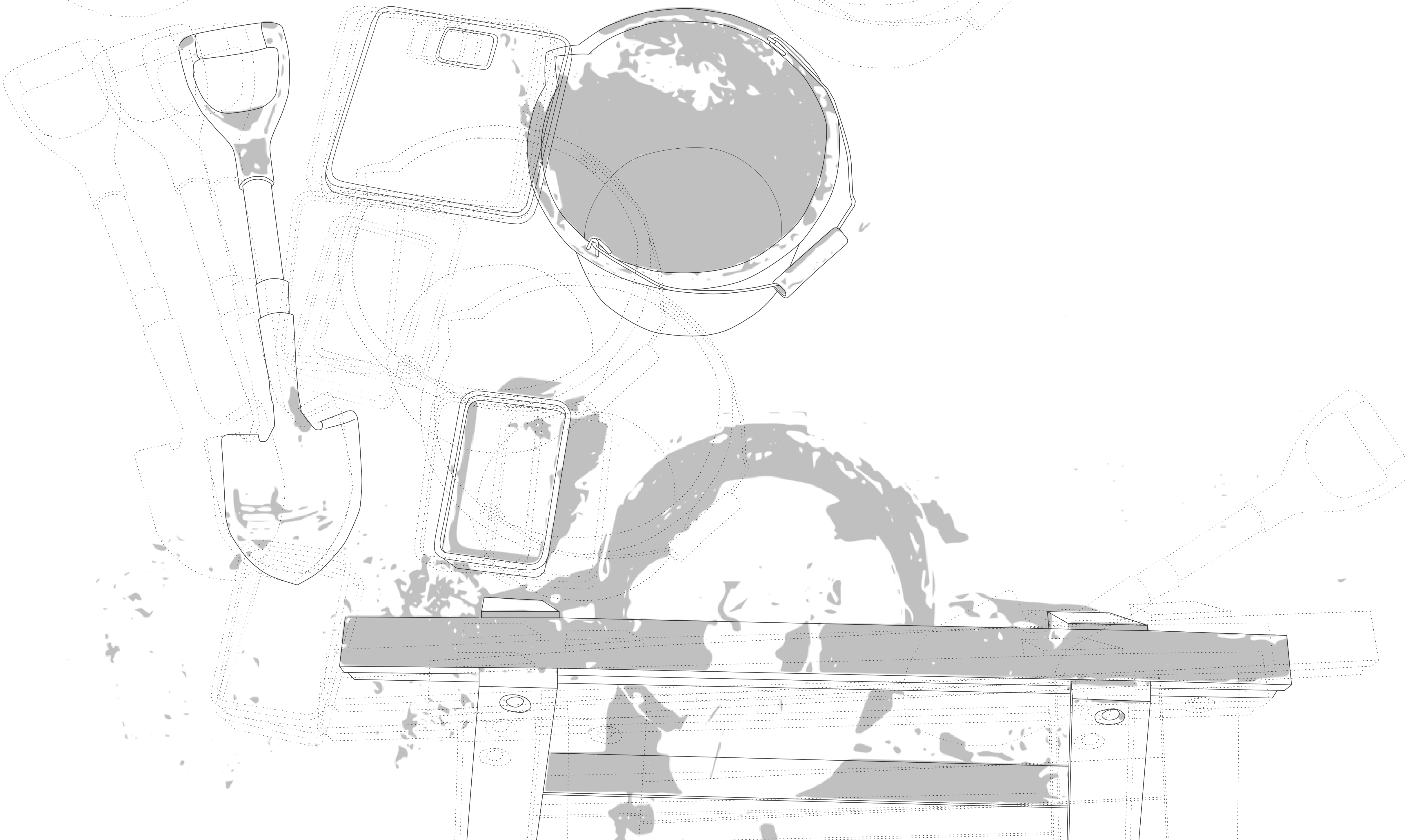
Clay is an ancient material. This means that it necessitates only a few essential supplies to gather clay from soil - a space to hold the soil and water to wash and separate the soil.

The equipment gathered was an ad-hoc process based on the needs of the moment. There were general supplies that were initially bought or borrowed- but the supply language followed the language of the exploration process.

The resultant staining of the cotton reveals the seeping path of clay and water through the filter; while the patterning notates how the filter was tied and suspended.

The plastic sheet used as floor protection became a collector of choreographic traces and marks of the process. Stains from the containers alongside mud smears and footprints reveal the dance around reclaiming clay by hand. These two trails show the relief of the board that the soil was powdered on. While older mud stains underneath occupy the scape of previous iterations. The earth extraction process created its own compressed geological strata.


MICRO SHOVEL
ROUND



Material Movement over Time

Looking from the middle outward you don’t notice the extent to which elements are in play - moving, being used, and making marks. It is only on reflection that you notice the extent of built-up of stains, traces and remnants that have been following you. Faint footprints that note the several times you stepped through the muddy water, piles of silt and sand that were set aside for data collection but were promptly left as the process charged forward, and equipment all within reach but just out of the way.

The seamless flow of equipment and material becomes revelatory notation to understand the space a process occupies in hindsight.

06 Digging Deeper

Drying Filter Cloth

Earth Works: Volume 01 focused on connecting us back to the earth beneath our feet. It serves as a feasibility study into the reclamation of usable clay out of site excavated soil.

It is a fairly straightforward process to reclaim workable clay from soil, though requires an investment of time. The resultant clay at the end of Volume 01 is usable but contains inconsistencies, and requires a secondary non-shrinking material to stabilise it and allow a level of control over its properties. The inconsistencies form part of its character and charm, yet to deliver an effective construction material usable at scale, or in a range of built scenarios, greater control of output will be needed.

Concluding Volume 01 has left us with a series of questions:

1 How can we refine the processing to allow a greater control of the clay properties?
2 If earth works is a part of a larger tectonic, what other material/biological/ecological systems does it also engage with? And how does one engage the other?
3 What would a regenerative form of earth works reclamation look like? How can the processes of borrowing a site's material improve the local ecological systems?
4 The process creates sand, silt and water as by-products of the reclamation, how can these materials become a positive part of the process?

Earth Works: Volume 02 will dig into the characterization of reclaimed clay bodies, building a clay taxonomy from several sites around London, to obtain a better understanding of natural clay mineralogy and develop more controllable clay body recipes suitable for specific construction applications. The expanded field of test-sites will interrogate site specificity and variation across London.

Volume 02 will stage a series of conversational site walks with multi-disciplinary professionals, building relationships between ceramics, soils, construction and community.

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