



Some Things are not held together by Glue: Chunambo and other ‘Sticky Matter’ in Subtropical Macao, China

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Abstract

This article uses adhesives or what I am calling here ‘sticky matter,’ to illustrate multispecies relationships in Macao, a subtropical coastal region in South China. It focuses primarily on a traditional rammed earth material known as *chunambo* in Macao and other former Portuguese colonies. Composed of oyster shell, straw, rice, local soils and sand chemically bounded together by slacked lime, this precursor to modern day concrete has a unique combination of porosity and structural integrity that makes it particularly adaptable to tropical climates and a contrast to contemporary building practices which are often designed to create sealed interior environments. Discussions of porosity within New Materialism, Urban Studies and Chinese aesthetics will be used to think stickiness alongside questions of material integrity in the face of sea level rise, erosion and anthropogenic forces. Much like limestone sediments formed over the course of thousands of years at the bottom of ancient tropical sea beds, *chunambo* invites speculation about material permanence in the face of climate futures and a changing urban environment.

Keywords: land reclamation, porosity, chunambo, concrete, urban development, New Materialism, matter, tropical climate, Macao, China

Sticky Matter

Some things are not held together by glue; they are held together by friction, tension and other sometimes competing and invisible forces. In her work Anna Tsing offers a critique of the imagined seamless flows of global capitalism. Instead of supply chain fantasies, she recounts the friction and “sticky materiality of practical encounters” that bind people, places and aspirations together (Tsing, 2005, p. 1). Her work was on Indonesian deforestation, but we can take Tsing’s ‘sticky materiality’ literally and look to study materials that are especially adhesive, materials whose main function is to hold things together. Such materials can be used to trace not just material connections but also connections between people, multispecies environs and global networks.

Taking a cue from New Materialism and its renewed attention to materiality and unexpected relationships between people and things, this article will use limestone, marine calcification and its various uses in rammed earth construction, whitewashing and modern-day concrete to consider material, cultural and ecological relationships in the former Portuguese enclave of Macao. This key nexus in the history of maritime trade between Europe, Asia and the U.S. offers a unique opportunity to study differing attitudes towards the tropics and urban development. This also has to do with how heat, humidity and other environmental factors have been historically dealt with by both the Chinese and Portuguese communities as they built relationships between themselves and this subtropical coastal environment. Composite materials and the ‘sticky matter’ that binds them together can help re-frame this history as well as concurrent discourses around urban development and the environment in general. In Macao, it can be used to think about flows of people, capital and goods. Given the large-scale land reclamation projects ongoing in Macao, it can also help consider how new islands and their coasts are designed to deal with the subtropical storms and climate that so inform this casino capital of Asia.

In chemistry, adhesion is the holding together of two separate materials while cohesion is the force that connects similar molecules. Within a certain distance, molecules are held together by so-called *Van der Waals* forces named after the Dutch scientist Johannes Diderik van der Waals who while experimenting with gases in 1873 first theorized their existence. This scientific property of cohesion can be clearly seen in the surface tension that holds liquids together. Adhesion can be seen across nature with forces holding disparate materials together from the sticky properties of a gecko’s foot to the grasp of lichens and fungi on hard surfaces. In marine environments corals, anemones and shellfish cluster and grow together, forming a network of multispecies bonds. Oysters are a particularly notable example of adhesion with their cement-like

secretions enabling them to adhere to rocks and each other. Their bond is stronger and more rigid than the malleable attachment of mussels and other bi-values. Over time, this great diversity of calcium rich shells, corals, silica and other biomass die and filter down to the benthic depths of the sea, where they amass, eventually forming limestone and other sedimentary rock.

To think adhesion in the world, in the world of the tropics more specifically, is to think about materials that have been valued for their ability to resist being dissolved in humidity and heat, it is to consider materials that hold things together while still letting air and water pass through them. Limestone in the tropics shows signs of wind and rain erosion, weather wearing away its surface and passing through it. Counterintuitively, this very permeability has also historically been part of its strength and aesthetic appeal.

This focus on adhesion and sticky matter also draws from new materialist approaches which involve a borrowing of scientific concepts and terminology from one discipline and application of them in new ways to another discipline. Such unconventional usage works to complicate or otherwise blur previously assumed boundaries between things and their environment. So, too, in this article, the aim is to use adhesion to think through environmental issues that are not typically discussed in such terms. Posthumanist literature also looks to the language of biology and ecology to avoid humancentric narratives. A focus on adhesion in the environment similarly provides a means to avoid humancentric stories about the forces at play in Macao. Materials in both these emergent bodies of scholarship are understood as part of networks and interactions, not just distinct or isolated objects. Given this emphasis, what might we make of things that are particularly sticky, that have a capacity to hold things together? Cement, glue and other adhesives have played an important role in building and architecture as well as bookbinding, boat-building and painting. What would the world be without these binding agents? If we look at such 'sticky matter' with an eye to its origins we might be able to find connections and multispecies relationships that typically go overlooked when considering our own place in the world.

Another common aspect of New Materialism that informs this article is the frequent use of fiction and speculative methodologies. Skiveren notes that this tendency is sometimes overshadowed by the very novelty of the materials about which any one author might be writing (Skiveren, 2020, p. 188). So here too I would like to tell a few stories that extend out from the porous materials of chunambo and limestone into speculation about the flow of goods, people and materials in the coastal waters of Macao. Speculation through the composite material chunambo can lead to new ways of thinking the current development of this Special Administrative Region of China where large scale land reclamation projects have regularly transformed its very

boundaries. This archipelago, comprised of an interesting mixture of littoral coastal zones and human-made borders provides a perfect setting for this kind of speculation.

Telling these material stories in Macao, also requires expressing feelings of endangerment and precarity that impact its residents as much as the wind, water and weather that affect its shores. Recently, these have shifted from historic concerns about rival colonial powers and pirates to the threats of climate change and the economic impact of the pandemic. Oysters, limpets and other life hanging on to the edge of Macao's coastal waters might be able to teach us lessons about ways of surviving in tropical climates, ways to hold on while tides incessantly come ashore. Chunambo, limestone and other composite materials can also be thought, not as just given materials with certain properties, but also as encapsulations or calcifications of ecological relationships. So, with these attunements in mind, I will attempt to tell a multiscalar story that jumps from tidal pools to the ramparts of fortress walls, from global economies to the history of maritime trade. Everything might not stick together perfectly, but hopefully even when things fall apart, the holes that remain will still be of interest.

Concrete Prehistories

Concrete is a quintessential modernist material. It is there in Gropius' Bauhaus, in Corbusier and in Kahn. It is there in brutalist architecture, parking garages and vacation condos. And in the greater Pearl River Delta region it would now be near impossible to imagine the subsequent development of Hong Kong, Macao and Guangzhou without cement. Skyscrapers, housing complexes, and infrastructure are all dependent on this one composite material. So, it is remarkable to recall that the very first cement factory in East Asia was established on Ilha Verde in Macao in 1886 by Englishman Creasy Ewens. This factory produced Portland cement comprised of limestone from Guangdong and mud from Macao's Inner Harbour that was used in Australia, Japan and much of the rest of Asia (Costa, n.d., para. 28).

The adhesive powers of the oyster and slacked lime (Calcium hydroxide) in chunambo, and the slow calcification of sedimentary rock are precursors to the layers of concrete and building materials that human activity has been amassing on the planet. Cement and its aggregate form, concrete, comprise so much infrastructure and architecture that they are now ubiquitous. It can be all too easy to take the material for granted, and thus overlook its impact on the environment. Simonetti and Ingold, in their writing on ice and concrete, argue that concrete has become the 'most obvious candidate for marking the origin of the Anthropocene' (2018, p. 27). They add that it also symbolizes an imagined mastery of geological deep time and modernist myths of permanence.

Given the prevalence of concrete and these accompanying fictions of permanence and stability, it is clear that there is much to be gained in returning to concrete's predecessors. Concrete and its precursors are not just mined or found, they are actively made. They involve a practice of bringing things together, a ritual alchemy of binding. Traditional rammed earth, found in various forms around the globe, binds together different local materials. Chunambo, tabby, taipa, pise en terre and other forms of rammed earth construction make use of burned limestone, oysters, coral and other marine shells to make a binding agent called slacked lime that holds together various other materials just as cement does in concrete. These earlier construction materials and their differing cultural uses can provide new ways of thinking about stone and material adhesion in terms of permeability and porosity as well as in terms of integrity and permanence.

The history of concrete and cement, seen through a European lens, is most often traced back to a Greco-Roman origin. In truth, the use of slacked lime to bind shells, sand and other materials together has multiple origins in both Europe and Asia. There is a long history of the use of such composite materials in India, China and South Asia. Vasco de Gama encountered what was called *chunam* on his arrival in India and soon after "variants of these recipes were quickly adopted throughout Portuguese settlements stretching from Mozambique to Brazil and Macau" (Guedes, 2018, p. 299).

Figure 1. Photo of oysters in Coloane, Macao.



Rocks in intertidal zone covered in oysters (Photo by author, 2022).

Rather than give a precise origin to any one rammed material, the credit for their binding properties perhaps should go to oysters. The lowly oyster taught our ancestors a few things about how to build your way back out of the muck. Oysters produce their own shells through calcification and make an adhesive that allows them to adhere to rocks in even the most turbulent tides. They attach themselves to rocks, piers and each other using their own adhesive. The chemical structure of the ‘biomineralized adhesive material’ responsible for the oyster’s impressive hold and reef building capacity was only recently identified (Burkett et al., 2010). The oyster and other shellfish’s ability to build and adhere were, however, recognized much earlier. Chinese mythology viewed the *shen* or ‘clam-monster’ as responsible for mirages of whole islands seen at sea (Hodges, 2021). In myth, they were seen as primordial subaquatic world builders.

Each variant of rammed earth is also a record of local resources, part of the vernacular architecture of a place. In Macao, *chunam* or *chunambo*, as it is locally known, consists of clay, sand, rice straw, rocks, and oyster shells, all materials readily available. The city’s first wall, was built in 1569 out of *chunambo* (Figure 2). Initially designed to keep Portuguese and Chinese communities separate, this city wall later served as defense against rival European powers angling for a share of Chinese trade. The thick *chunambo* walls of Macao helped hold out against the Dutch invasion of Macao in 1622; and as any worthy tourist guide book will tell you, the walls that once supported the iconic facade of the St. Paul ruins were also made of *chunambo*.

Figure 2. Photo of old city wall in Macao.



Section of city wall in Macao made of *chunambo* (Photo by author, 2022).

Macao's fortresses were made of this same organic mixture of locally sourced materials as their combined thickness and structural integrity proved resilient against enemy canon fire. Spanish forts in Florida were similarly built of coquina, a naturally occurring form of limestone composed predominately of shells. Walls built of such composite materials, whether human-made or naturally occurring, had strength because they could give but not break, unlike stone walls held together by mortar which were more readily destroyed by incoming cannon fire. The invention of canons changed defensive architectures:

The perfection of making canons brought to an end the medieval defensive system, since high stone walls could easily be destroyed. The new defensive design acquired a lower profile, but larger in size and weight to better resist the impacts of the cannon balls" (Pinheiro, Yagi & Korenaga, 2005, p. 290).

In Macao the traditional site of the lime kilns needed for the manufacture of the slacked lime used in chunambo was in a region fittingly called Chunambeiro. It was located just outside of the Fortaleza de São Tiago da Barra along the Praia Grande water front. The high heat it takes to make slacked lime and the exothermic reaction this new material goes through when combined with water make it a volatile material and process. It is almost alchemical in its transformative powers. It is interesting to note that this same site is where Portuguese cannon-maker Manuel Tavares Bocarro had his forge. Cannons and the binding agent of slacked lime burned and forged nearby are part of a paired history of long-range military weapons and defensive architectures. One can imagine on a hot and humid day, the labour involved in feeding these two fires; one used to make a binding agent to build walls and the other to make a means of destroying said walls.

Rammed Earth Islands

The namesake of the island of Taipa in Macao comes from the Portuguese word for rammed earth, *taipa*. Today, Taipa forms a continuous landmass with the once separate island of Coloane. The section of reclaimed land that now connects them is called Cotai, an amalgam of Coloane and Taipa. It is more commonly referred to as the Cotai Strip, in an homage to the Vegas Strip, as it houses most of Macao's casino industry which exploded after the internationalization of gaming licenses in 2002 (Simpson, 2018). These megaresort complexes sit on a foundation of reclaimed land that is itself a form of rammed earth, only rather than the manual techniques of traditional chunambo, this version forms via machine driven vibration and other natural and artificial methods for large scale land compaction.

Figure 3. 'Sea City Clam Tower' 4k frame from digital video



Land reclamation project in Macao New Urban Zone C (Photo by author, 2022).

In fact, the majority of Macao's population now lives on reclaimed land. Current plans are also underway to extend the landmass of Macao through new land reclamation that involves the construction of five artificial islands known as the Macao New Urban Zone project (Hodges, 2019). In contrast to the locally sourced materials of chunambo, much of the sand and earth material used for these new projects has been shipped in from elsewhere, with delays caused by a global shortage of sand. Sand is a finite resource that in many cases needs to be imported from other regions and countries. Singapore famously has imported much of its sand for its own reclamation projects from top sand exporting countries like Cambodia and emerging sources like Myanmar (Lamb, Marschke & Rigg, 2019; Lundberg & Peer 2020). This creates environmental impacts at two sites, both the site of extraction and the deposit. It is important here to see sand not just as an increasingly valuable commodity, but also as a habitat – a home that is itself comprised of the material remains of once living shells, coral and other marine life.

The scarcity of this most common of materials makes the global scale of development strikingly apparent. If we are already running out of sand, how will future states and coastal communities handle any kind of sea level rise? What can chunambo teach us about all this? Is the lesson that we should build up defensive walls to hold the sea at bay, or is it that we need to think more about permeability, about impermanence and locally sourced materials?

Here we can take a detour to remember the destruction of the Pruitt-Igoe housing complex in Saint Louis, Missouri, as a now infamous inflection point in the history of modern architecture when the speed and efficiency of modernist design was confronted with its rapid obsolescence. The complex's first tenants arrived in 1954 and it was completed in 1956, only to be demolished in 1972, a process that lasted until 1976. What does this short lifespan of a modernist housing complex mean for future developments? A new materialist approach might ask not so much what it means, whether it was a good project or not, but instead might ask what has happened to its matter. Where did it go? What happened to its rubble and waste? Is it still there just compounded into a base for a new project or has it been shipped off to a new site to provide material for some other purpose?

If we extend this roughly twenty-year life span of the Pruitt-Igoe housing complex into the deep time of speculative fiction we can imagine the casinos and hotels of the Cotai strip in the future being reclaimed by the sea, their lobbies and gaming tables providing nooks and crannies for marine life. And if we imagine in the opposite direction, we can discover that the whole region had already been underwater. These imaginary time travel flights of fancy, much like the real life Pruitt-Igoe case, bring into question any assumption of material permanence.

As Macao has developed through successive waves of land reclamation it has also created new shores, such that most of its coastline is now a result of human decisions and not natural processes. The beaches and rocky granite coasts typical of less developed outlying islands in the region are not common in Macao. This distinction between a natural and artificial shoreline is complicated by the fact that every littoral zone is nonetheless inhabited by aquatic life. Significant to Macao's waters are the oysters that are native to the region and played an early role in land reclamation through the creation and management of oyster farms. Oysters native to Macao's waters, and those intentionally cultivated, both offer alternative ways of thinking about porosity and coastal management.

Oyster beds have historically played a significant part as living breakwaters and artificial reefs. Even discarded oyster heaps can form into artificial islands bound together by new populations of living oysters. These mounds can significantly impact the flow of coastal waters. Experiments in intentionally reestablishing such natural barriers have taken place in Bangladesh and New York (Shah et al., 2019). Both places have suffered recent catastrophic effects of so-called super storms. In Macao, typhoon Hato in 2017, and Mangkhut in 2018, created large scale flooding in the historic Inner Harbour of Macao. This was compounded as the storm surge pushed over flood walls but was then not able to drain back into the harbour. Paradoxically, the very impermeability of the flood wall resulted in severe flooding.

A concrete design that balances between porosity and retention was developed in the 1950's by a French team working out of the Laboratoire dauphinois d'hydraulique de Grenoble. They developed the tetrapod, a cement structure with four legs designed to deflect water around it while serving en masse as a form of artificial breakwater. Such tetrapods are commonly used in Japan, the Maldives, and any number of other communities looking to stay land erosion. In Macao, much press and community concern was directed at the tetrapods that surrounded a section of the Macao-Hong Kong-Zhuhai bridge in 2018. Prior to opening the bridge, it appeared from aerial photos that a mass of the tetrapods had become dislodged and were sinking away from their planned protective position. Officials assured that this was all to be expected. The new reclaimed lands of Macao are built with this in mind, using a combination of retaining walls and surrounding beds of stone with porous gaps between them to deflect the sea. Whatever their immediate effectiveness we still need to think about a geological time and speculative future. How will these materials hold up and how much longer can we keep making them given the limitations of the raw materials involved in their construction?

Limewash and other Sealants

The problems presented by coastal flooding, super storms and sea level rise are certainly no trivial matter. The high-water marks still found on some buildings in the Inner Harbour district of Macao are a reminder of this. Sand bags and hastily erected barriers used to guard against incoming waters were not always effective. So too, tape crosses placed on windows to help prevent against shattering glass in the high winds of typhoons are still visible throughout town. They remain like a talisman to ward off future storms. And even where homeowners and shopkeepers have tried to remove these taped crosses, the sticky adhesive often still remains leaving behind a ghost image of past storms and a reminder of persistent fears.

These smaller scale examples of adhesion are another route into concerns about bodily safety and material integrity and permeance in the tropics. As we have already seen, there are a variety of different local and imported practices used to hold things together in subtropical Macao. There was already a local tradition of rammed earth construction in South China prior to the arrival of the Portuguese but the Portuguese brought with them the indigenous practices of other coastal communities using clam, coral and other shells to make slacked lime (Guedes, 2018). To this aggregate of clay, straw, slacked lime and shells, local recipes added sticky rice or glutinous rice to make a material that was simultaneously solid and porous. In discussing the restoration of a chunambo wall in Macao, Heritage Conservation expert Kin Hong Ip explains, "Once compaction finished, a paste-like mixture containing slaked lime, soil and fine sand was rubbed on the surface of the finished wall to create a smooth wall 'skin'. This 'skin'

acts as a natural protective layer against atmospheric pollutants and storm waters, but remains permeable to the interior and exterior moisture movement” (Kin, 2015, p. 10). Depending on proportions and additives, the surface could be made waterproof while also being sufficiently permeable to prevent water becoming trapped in the walls themselves. This is a problem that has accompanied the use of modern finishes and materials, such as latex and oil paint. In the world of historical preservation this trapped water is a well-known enemy of older stone walls and timber; with rot, mold and decay all possible results of water being trapped in historic architecture that has been topped with more impenetrable coatings.

In addition to its use in chunambo and other forms of rammed earth construction, slacked lime from burned oysters was also an essential element in boat building. A mixture of tung oil, hemp and slacked lime played a key role in the design of Chinese Junk boats in the coastal communities of Fujian and South China. It was used to seal bulkheads creating buoyancy even when individual sections flooded with sea water. Marco Polo remarked on this innovation stating that “they take some lime and some chopped hemp, and these they knead together with a certain wood-oil; and when the three are thoroughly amalgamated, they hold like any glue. And with this mixture they do paint their ships” (Polo, Yule & Cordier, 1993, p.251). Today, shipping boats are not sealed with such an organic mixture, but they do employ a similar bulkhead design. An unintended consequence of this is that ballast water from boats is responsible for the transfer of invasive species and microorganisms into marine environments. A strong seal can be both an asset and a weakness.

Limewash or whitewash also played a part in the management of public health during the bubonic plague outbreak in 1894 in Hong Kong. So-called *whitewash brigades* went door-to-door covering the homes of infected persons with whitewash. Limewash acts as a kind of antifungal and antibacterial disinfectant. This historical precedent brings to mind the teams of white suited workers spraying homes with disinfectant in the more recent campaign to prevent COVID-19 in China. In the case of Hong Kong’s earlier 19th century outbreak, the colonial government forced invasion into the Chinese neighborhoods of Hong Kong. This intrusion and the subsequent use of non-traditional burial treatments of the deceased led to a backlash in the Chinese community – a backlash that resulted in a lasting change in the policies of the British colonial government regarding public health (Buchillet, 2010). In neighboring Macao, the numbers of infected were not nearly so severe. This disparity led to further speculation on the reason for this, some theorized it was due to Macao’s favorable climate while others even speculated that it was because of the large number of cats in the colony that kept down the rat population along with the plague carrying fleas associated with them (2010, p. 80). Limewash has also been used as a preventative measure against pests and insects. Limewash painted on fruit trees and other susceptible varieties of plants works as a physical barrier and a kind of natural pesticide.

This odd mixture of permeability and preventative barrier is a key part of chunambo and other uses of slacked lime. It is able to both repel and accept, to let water through and evaporate. This is in contrast to some other sealants and finishes that can function to effectively trap water inside of a structure creating an attractive environment for mold and other microorganisms.

Porous Cities

“As porous as this stone is the architecture” (Benjamin, 1978, p.165)

To think about cohesion and adhesion is also to consider a material’s porosity. Porosity is the measure of how much empty space there is in any given material and how much might pass through it. Thinking about a material in these terms has proven productive for a number of scholars and disciplines. Discussion of porosity proliferated in Urban Studies after Walter Benjamin and Asja Lacis used it in their essay on the city of Naples. They saw the courtyards, alleyways and common spaces of this southern Italian city as openings where human activity was allowed to take place. As they put it, “Porosity results not only from the indolence of the Southern artisan, but also, above all, from the passion for improvisation, which demands that space and opportunity be at any price preserved” (Benjamin, 1978, pp. 166-67). Porosity at this scale of the urban environment provides open space for living and an atmosphere of potential.

Tim Simpson has applied this concept of porosity to Macao, pointing to it as one of the defining legacies of the Portuguese influence (Palmer & Simpson, 2014, p.25). The labyrinth of smaller streets in the older sections of town create a pedestrian friendly environment where the activities of shop owners and residents often spill out into the street. These same qualities are also part of the city’s appeal to tourists. During the height of the city’s pre-pandemic boom, however, throngs of tourists crowded these same streets detrimentally impacting the idle atmosphere they had come to experience.

In writing about the Macau New Urban Zone land reclamation project, Sheng, Tang and Grydehoj focus on what they term the ‘urban fragmentation’ of Macao – a concept not dissimilar to porosity. This fragmentation, they point out, has led to a variety of inequalities. They argue “Macao’s historically contingent growth has led to the development of highly distinct urban fragments, which has occasioned spatial inequalities in environmental health” (Sheng, Tang & Grydehoj, 2017, p. 207). In Macao, as in many other cities, air quality and economic inequality are linked. These new large-scale land reclamation projects are particularly interesting as they represent

the local government's attempts to address such issues while also perhaps unintentionally magnifying the fragmentation that Shang, Tang and Grydehoj have noted. We can, and should ask here, what 'sticky matter' and an attunement to multispecies relationships might add to such discussions on urban fragmentation and porosity.

A tentative answer might lie in rethinking the relationship between economy and ecology. Gibson-Graham, Hill and Law have called for 'community economies' that position human economies within more-than-human ecologies. This is a critique of a traditional understanding of economics that treats nature primarily as a source of wealth and resource extraction. They emphasize the need for "ethical negotiations between human and non-human economies in ecologies of more than human communities" (Gibson-Graham, Hill & Law 2016, p. 6). Thinking in these terms the land reclamation projects taking place in Macao are doing more than just providing needed housing to the human population of the city, they are also creating a new habitat for the non-human residents of the city. This extends from endangered pink dolphins native to the surrounding waters, to migratory birds, fish and even microbial life sure to find a place for itself on these new shores.

Weathered Stones

Bodies and materials, like cities, can be thought of less in terms of their rigid boundaries and more in terms of their porosity and fluid connections. Both Astrida Neimanis' focus on *fluidity*, and Nancy Tuana's concept of *viscous porosity*, each emphasize ways to avoid static categories, fixed notions of things in isolation (Neimanis, 2011; Tuana, 2008). In writing through the tragedy of Hurricane Katrina in New Orleans, Tuana makes a call to abandon "all traces of ontological divides between nature and culture" (2008, p. 209). In this last section I would like to provide some examples from Chinese aesthetics that can serve as a parallel to these contemporary ecological concerns. In these traditions of Chinese poetry and painting we can find a shared valuation of human and non-human relationships and a sense of material porosity and impermanence.

Long before its appearance in contemporary Urban Studies, porosity was valued in Chinese aesthetics. In the tradition of *Gongshi* or 'spirit stones' natural stones are collected and placed on wooden pedestals to be admired and contemplated. Another common term for them is 'portable mountains,' which, like penzai or bonzai, function to bring a miniature version of landscapes into the home or garden. Contemplation of such collected stones was meant to connect one back to a larger natural world and the forces that shaped the stone.

In an often recounted anecdote, Mi Fu, a famous collector of such stones, is said to have bypassed a line up of greeting dignitaries preferring to address, instead, a nearby *gongshi* as “Elder Brother Rock.” In this way he treated the stone as more worthy of respect and admiration than his human peers. This peculiar scene has since been a subject of a number of paintings (Figure 4). Mi Fu also later wrote a treatise on *gongshi* in which he stressed the aesthetic values of thinness (瘦 *shòu*), openness (透 *tòu*), perforations (漏 *lòu*), and wrinkling (皺 *zhòu*).

Figure 4. ‘Mi Fu Bowing to a Rock’ by Guo Xu, painted in 1503



This scene depicts Mi Fu paying his respects to a *Gongshi* stone.

These prized qualities are quite different than the aesthetic categories found in a western tradition of art criticism. Winckelman’s neoclassical appreciation of the Belvedere Torso provides a good example of this contrast. In his fawning account of the broken marble torso of Hercules, he values it for its craftsmanship, its flowing lines and solidity. Winckelman compares the muscular contours of the Belvedere Torso to “a landscape discovered from the summit of the mountains, a landscape over which nature has poured out the manifold richness of its beauties” (Winckelmann, 2013, p. xvi). Unlike the porous natural limestone prized by Chinese scholars like Mi Fu, marble was valued in this neoclassical tradition for its malleability. It could be sculpted relatively easily and yet was still sufficiently firm enough to hold detail. Marble was also favored because it exhibited some of the same subsurface scattering of light found in human skin making figures sculpted from it appear to have an anthropomorphic life of their own. Mi Fu’s aesthetic categories, on the other hand, relate to a stone’s natural asymmetries, holes, surface irregularities and imperfections. The erosion and weathering of *gongshi* are their strength, while for Winckelman the

broken sculpture's value is in the story it tells of its former glory, of the hand of the artist that could still be read within it.

Both aesthetic traditions, in one way or the other, draw attention to the passage of time. The weathering of the natural stone and the hand of the sculptor both leave a record of duration. In his poem, 'Tai Lake Rocks,' from 843, Bai Juyi emphasizes the weathering of stone by water and wind.

Emerald green mists and several autumn colors
 Large waves left ten thousand ancient marks
 Scraped and whittled to produce flat shards of green jade
 If sliced into pieces, they become like the offspring of bluish-green clouds.

Wind erosion leads to their holes and crags
 Moss penetrates or covers to guard their openings
 Specific younger versions of several mountain peaks
 Are like the grandchildren of Mt. Hua.¹

Bai Juyi refers to these stones as offspring of Mt Hua, one of the famous mountains of China; but in truth, such Tai Lake Rocks or Taihu stones were famously from Lake Tai which is close to Dongting Mountain in Suzhou. Such rocks were found naturally on the shores of Tai Lake but others were also intentionally manufactured, submerged in the lake where water could work to smooth the marks of man-made modifications. Whether embellished or not, the goal was to create a stone that appeared natural and provoked contemplation of geological changes, of the slow weathering.

When exposed to wind and rain, large formations of limestone can also show signs of erosion and disintegration as in the form of Karst mountains. Such unique limestone formations can be found in tropical and subtropical South China and Vietnam as well as in Southern France and the Balkans. Over time, water-eroded caves form and collapse leaving behind unique limestone mountain peaks also called mogotes. Their unique sheer faces make them favored subjects in Chinese landscape paintings known as *shan shui*, a genre that literally translates to 'mountain and water.' In this tradition, karst mountain peaks are often shown jutting out through clouds and mist. These relatively rare geological formations have also recently become synonymous with a certain subgenre of science fiction that imagines a tropical future with islands of karst mountains emerging out of the sea into the sky. A prime example of this is the Avatar series of films which re-purposed the ZhangJiaJie National Forest Park in China's Hunan Province to represent a distant alien paradise full of such karst formations. In their introduction to a recent journal special issue entitled 'Tropical

¹ Bai Juyi, Tai Lake Rocks: <https://www.learnancientchinese poetry.org/2017/02/24/bai-juyi-tai-lake-rocks/>

Landscapes: nature-culture entanglements', the authors show how this trend of using tropicity in speculative fiction, and the Avatar series specifically, is tied to a longer history of western exotification of a tropical other (Lundberg, Regis & Agbonifo, 2022).

In considering the popularity of karst landscapes in traditional Chinese painting and in recent science fiction, it is interesting to remember that much of North America was once under a shallow tropical sea as it was, at the time, positioned closer to the equator. This slippage and migration of earth's tectonic plates draws into question the clear boundaries of the tropics. The tropics are not just a question of where but also when. Where might the tropics be in the future under a warming planet?

Cities and stones can be thought of in terms of duration, porosity and weathering. These concepts complicate a simple division between inside and out. When considering traditional composite materials like chunambo and modern materials like concrete, we should consider their porosity, how they do or do not allow for air and water to flow through them. We also need to remember their impermanence and consider how they will age, transform and hold up over time.

Conclusion: Material Linkages

What does it mean to adhere, to hold things together that might not otherwise stick together on their own? Material linkages hold together trade routes and colonial ambitions. They bind history together and empower us to ward off future storms. To think colonialism and the current era of capitalism involves thinking about certain key materials which bond together global networks. It involves thinking how materials like sugar and tobacco linked together a global network of colonial exploitation and slavery. Slacked-lime is another one of these key, but overlooked, elements. It helped hold forts and boats together, not to mention also playing an essential role in refining sugarcane along with a whole host of other industrial and agricultural applications. Lime kilns could be found everywhere in the coastal economy of maritime trade centers. Now concrete is another of these materials that has become ubiquitous and has so informed how cities and infrastructure are imagined. The origin of the source materials used to make concrete, the cement, sand and other aggregates, are hidden behind a veil of modernity.

Porosity, permeability and sustainability are all qualities that made chunambo and other rammed earth construction techniques popular throughout the tropical regions of South East Asia as well as Portuguese colonies in Africa and South America. The material qualities of these structures made them effective against extreme heat and humidity. These approaches to managing the flow of air and water from inside to out differ from strategies of sealing the interior off from the outside. Air conditioning,

cement and modern insulation materials largely seek to create an isolated interior with its own atmospheric qualities and temperature. These vernacular architectural traditions, by contrast, offer alternative ways of thinking about permanence, porosity and adhesion. The use of slacked lime from burned shells, limestone and other calcium rich material remind us of the organic origin of sedimentary rocks like limestone. The adhesive properties of chunambo can challenge still circulating myths about modernism and the resilience of concrete structures especially in tropical climates.

And in the end, as we contemplate chunambo and materiality in the tropics, we are left with questions. Could a return to rammed earth techniques using locally sourced materials avoid some of the supply chain problems facing development today as in the case of sand used for land reclamation and building projects? Could a more porous coast line avoid or at least help alleviate the flooding and sea level rise that threaten coastal communities? And most importantly, might we learn from the oyster how to make our own ties that bind us to things and empower us to face questions of climate change and to brave future tides?

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