Post-extractive Material Practice: The Case of Quarried Stone

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Abstract

Humans have extracted materials from the earth for millennia, but only recently have our extraction practices had planetary consequences. The scale, intensity, and violence of current practices are theorized as 'extractivism', and as a number of recent publications and exhibitions have made clear, a post-extractive future is urgently needed. How and under what conditions can we address such an imperative? Is it possible to aim toward a pre-modern notion of extraction as a custodial practice of care in relation to earth's resources? Following recent projects to re-introduce load-bearing stone, known loosely as 'The New Stone Age', this argumentative essay explores a post-extractive future through the case of quarried stone. We see it as a poignant case of how we might move from extractivism to a more custodial form of extraction, and show the potential to reduce our need for materials such as steel, concrete, and wood, industries that are driven in large part by extractivist principles. Based on Timothy Morton's notion of ecological thought, we argue for a new way to understand stone extraction as an ecology of interconnections. On the one hand, great potential emerges in the circularity and reversibility of stone construction, along with its extremely long life cycle, and on the other we see a strong potential to recover the historical connections between architecture and the anthropogenic landscapes of stone extraction. In the end, we position the issue of material extraction within its multifaceted entanglements of landscape, construction, socio-cultural and economic contexts.

Keywords

Ecological thought · Extractivism · Post-extraction · Quarried stone

1 Introduction

> The Earth is the very quintessence of the human condition and earthly nature.—Hannah Arendt (1958)

When Hannah Arendt bound the human condition to the Earth, in her seminal book, *The Human Condition* (1958), NASA had not yet released the iconic image of the "Blue Marble", taken from the Apollo 17 mission in 1972. From then onward, humans were no longer an earth-bound entity, creating a classical Cartesian separation between object and subject and challenging both Lovelock's Gaia hypothesis and

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Næss' concept of Deep ecology that Earth is a living system of which we are part, not apart (Lovelock and Whitfield 1982; Naess 1973). By the turn of the century, thousands of satellites circling the earth defined the landscape as a digital field observed and controlled from afar, disabling and reducing tactile human interaction.

Our perspective of the earth as a finite entity should encourage architects to be stewards, but the opposite seems increasingly apparent. As Luke Jones points out in his essay, "The Carbon Tectonic", we have multiplied our rate of material extraction from the earth by more than twenty times during the last century (Jones 2021). Most buildings include elements and materials from all continents, and construction activities are sustained by vast global supply chains (Wigley 2021). This hyper-industrialization of construction materials reduces our understanding of materials' inherent and cultural properties, their whereabouts, and their connection to the environment. Extraction was seen as a technical issue that machinery could solve, and the matter beneath the soil turned into a disposable space at the mercy of human demand. "Seemingly static buildings are actually pieces of mining equipment, actively devouring the planet," writes Mark Wigley, "as buildings rise in one place, a deadly net of holes, gaps, cracks, collapses, deficiencies, floods, and famines appear elsewhere" (Wigley 2021).

Humans have extracted materials from the earth for millennia, but only recently have our extraction practices had planetary consequences. Following the establishment of colonial capitalism in the eighteenth century and its subsequent industrialization throughout the nineteenth century, the scale and exploitative practices have been on a one-way, accelerated expansion. The intensified reliance on large-scale, mineral and cultural exploitation started to receive systematic critique in Latin America in the 1970s under the term *extractivísmo* (Durante et al. 2021; Acosta 2017). More recent scholarship has identified some of the core logic of extractivism: capital intensive, foreign investment aimed primarily toward exportation; little or minimal processing at the site of extraction; maximizing economic benefit at the expense of cultural violence, loss of biodiversity, and ecological degradation. The direct impact of extractivism is rarely seen in the developed world, where we have become accustomed to "cheap architectures" (Grima 2021), as the underlying displacement logic purposely conceals these consequences under the guise of globalized processing and supply chains (Hutton 2020). For architects and consumers, however, materials arrive from 'somewhere else,' or they simply are not considered at all, what Joseph Grima recently described as the problem of "externalities" (Grima 2021).

As a number of recent publications and exhibitions have made clear, a post-extractive future is urgently needed. How and under what conditions can we address such an imperative? Architecture can no longer overlook the impact of where and how materials are exploited (Moe 2020), and the discipline must do more to propose creative alternatives to normative practices of building material extraction (Grima 2021). Is it possible to aim toward a pre-modern notion of extraction as a custodial practice of care in relation to earth's resources? A deeper sensibility is necessary, one that goes beyond simple solutions and focuses on extraction as an ecology of architectural actions and consequences (Morton 2007). This interconnectedness operates within multiple scales and various time perspectives, embedding a diversity of actors and tools to address entangled complexities of extractive processes and materials. The post-extractive approach contributes to UN SDGs, especially goal 12 "Responsible Consumption and Production" by questioning the reliance of the construction sector on natural resources and by advocating for more ecological patterns of architectural production, which have the potential to act against climate change, biodiversity loss, and pollution. Indirectly, it addresses goals 5, 8, 10, and 11 by protecting terrestrial ecosystems and accounting for a broader understanding of socio-economic entanglements.

2 Extraction and Natural Stone

Exploring the ecology of extraction requires a material test case in order to unfold these interconnections. For this, we examine one of architecture's most exploited materials: natural stone. Today, stone is typically quarried in an export economy and used for surface applications such as pavings, building facades, and interior finishes, an ineffective use of resources that leads to a significant amount of generated waste. This atectonic use of materials seems highly inadequate in our epoch of finite resources and multiplying crises. However, a number of architects and engineers have begun experimenting with load-bearing stone, an area of research that has not been seriously pursued since the late nineteenth century. The stone exoskeleton building at 15 Clerkenwell Close in London, by Groupwork, stands as a notable example, as do a number of social housing projects built in and around Paris in recent years (Le Dréan and Kuratli 2022). The latest generation of practitioners often cites the environmental advantages of structural stone: nearly half the embodied energy and one-fourth the carbon footprint of reinforced concrete elements (Webb 2022), the ability to be easily disassembled and reused in perpetuity (Brilliant and Kinney 2016), and its capacity to support biodiversity (Chartier-Dalix 2019). This shift toward exploiting the modular and structural properties of stone, also combined with wood and other materials, is what has recently been dubbed "The New Stone Age," in *Architectural Review* from April 2022 (Webb 2022). These developments point toward a "tectonically simpler architecture based on monolithic and 'literal' materials" (Jones 2021), one that reduces the reach of a building's material supply chains.

The emerging potential of massive stone construction offers a poignant test case for re-imagining architecture's relation with material extraction. There are several reasons for this. To begin, more than most contemporary materials, stone retains its connection with the site of extraction. Larvikite from the Lundhs company, for example, is advertised as "Natural Stone from Norway," accompanied by images depicting the rugged, timeless beauty of the Norwegian landscape. This present-day marketing tool follows a long tradition where the qualities and aesthetic values of stone have been associated with the culture and geology of the extraction site. The architecture of the National Romantic period, for example, relied heavily on the link between geology, culture, and national identity (Ringbom 1987). This also included religious significance, as in the Inca builders, for whom sacred architecture was only achievable through stone quarried from a specific, venerated quarry site (Ogburn 2013). Similarly, the use of the so-called 'Jerusalem Stone,' a limestone quarried today primarily in the West Bank, is throughout the world considered a politically-charged symbol of Jewish identity (Abusaada 2022). Thus, when imagining a post-extractive future, the link between stone and locality seems hard-wired into our collective memory.

The sheer difficulty of extraction and transport meant that architecture often had profound connections with the local landscape and geology. In pre-modern, lithic societies, the local geology was a vehicle for a symbiotic relationship between building culture and landscape (Abu-Jaber et al. 2008). In the Balearic Islands, for instance, a wide-spread geological formation in soft sandstone, known locally as *marès*, supported the development of both monumental and vernacular building culture. At one time, the island of Mallorca hosted over 1500 *marès* quarries, each one supporting an infra-local economic and social community (Mata 2018). The same could be observed in a more contemporary context with the case of Lutetian limestone from the Paris Basin, known also as the 'Paris Stone'. Its pervasive use in the monuments and streets of Paris created a unity between the colors and textures of the city, its regional geology, and its landscape (Barrault et al. 2018).

3 Post-extraction Ecology

These promising trajectories connect to an ecological agenda that considers the broader entanglements of material use, from geology to quarry, from quarry to stone, and the quarry again as a landscape of healing or reuse. The alternatives to extractivism are investigated through an approach to architectural design inspired by principles of ecosystemic plurality and interconnectedness (Tsing 2015; Latour 2018; Ait-Touati et al. 2022) and ecological thought (Morton 2007, 2010) by positioning extractive practices and design actions within the current multi-crisis and engaging with existing environmental, sociocultural, and economic realities indicating evolutionary and post-extractive material strategies.

Those strategies employ five attributes of hyperobjects, defined as "things that are massively distributed in time and space relative to humans" (Morton 2013). They include *viscosity, nonlocality, temporal undulation, phasing, and interobjectivity* (Morton 2013), which act as lenses to explore post-extractive material practices. Viscosity and nonlocality, by questioning the perception of distance and proximity, reveal the limitations of approaches that focus only on immediate contexts and local markets. Temporal undulation argues that surrounding objects are also distributed in time which shows the necessity to explore different temporal frames for extraction and design practices. Phasing, by stating that we are experiencing only fractions of the entities, directs us to questions of scale and tools to address ungraspable material complexities. Finally, interobjectivity leads beyond anthropocentric and local approaches that indicate fundamental repositioning of extraction and reversible design processes that favor multispecies coexistence and community building.

Everything known and unknown is interconnected (Morton 2018). Thus, a post-extractive building and design approach values *multiplying viewpoints* over a *single vision* (Latour 2018) and employment of *the art of noticing*, understood as simultaneous noticing, observing, documenting, and tracing of multiple phenomena that manifest *the patchiness of the world* (Tsing 2015). This viewpoint means that design choices are embedded in multi-scalar and multi-local entanglements (Ait-Touati et al. 2022). The ambiguity of distances and scales in times of globalization influences the invisibility of environmental and socio-economic associations embedded in material substance and construction processes. Currently, available advanced tools and technologies operate with more and more data enabling optimization of environmental and economic impacts, although this optimization still operates within the system where resources are perceived as commodified entities.

The post-extractive approach investigates the consequences of design actions on sites of material extraction, production, supply, and construction by asking "how can we fundamentally transform supply chains that are built on the exploitation of cheap work and cheap nature …?" (Malterre-Barthes 2021). This approach necessitates multidimensional perspectives, transdisciplinary collaboration, diverse scales of exploration, and multifaceted architectural responses that consider ecosystemic entanglements. The scope of analysis needs to be a multifocal perspective that includes the changes in the extractive landscapes (quarry), the reservoir of finite resources (stone), embedded environmental impacts (embodied carbon), and modifications of socio-cultural structure (local communities).

How to track those impacts when the materials are extracted all over the world, shipped, and constructed in distant locations? It is easy to advocate for using locally extracted resources as it happens, for example, with *marès* stone in Mallorca (Fig. 1). For years, this sandstone, which rarely if ever leaves the island, has been extracted from adjacent quarries in standardized blocks with dimensions that mirror the modular system of architectural elements that construct Mallorcan villages and cities (Inyesta and Sunyer 1997). The case of *marès* shows that stone can be used effectively, avoiding unnecessary waste during extraction and at the end-of-life as material durability and repetitive modularity enables reuse (Fig. 2). Moreover, Mallorcan stone shows

Fig.1. The scale of extraction of marès in quarries in Mallorca: 1–2., 4 Petra, 3. Bank of marés in Petra, 5. Can Picafort. *Source* U. Kozminska

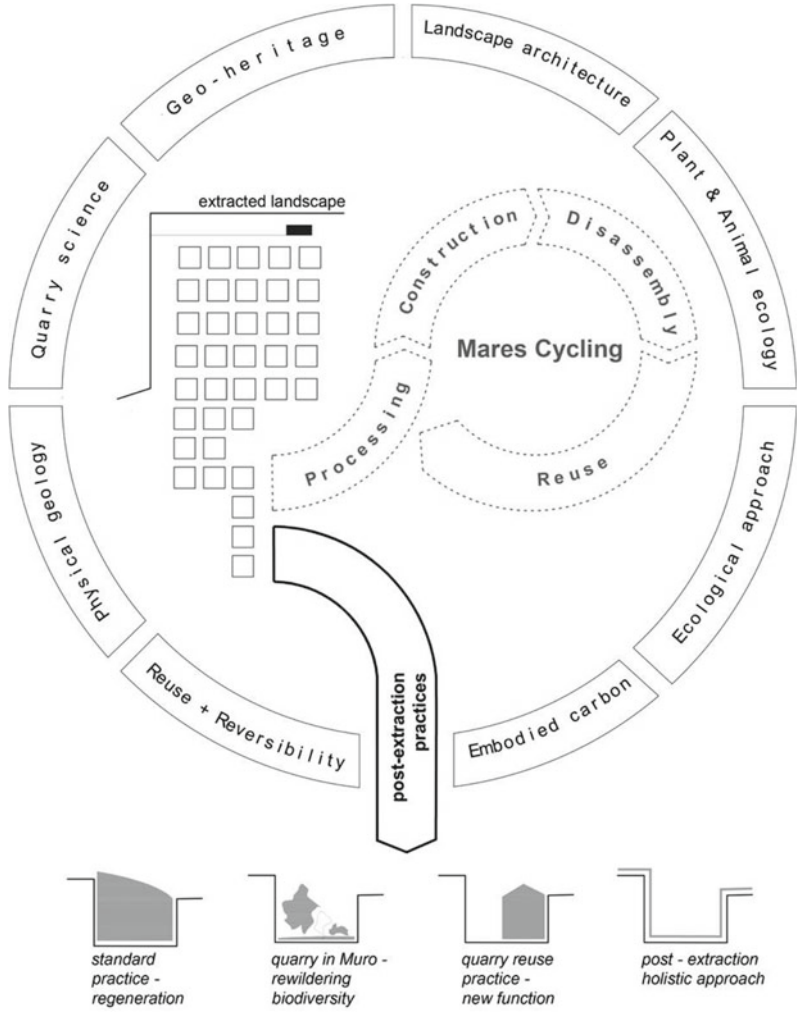

Fig. 2. Diagram of post-extractive approach in marès staone, illustrating the main points of transdisciplinarity, circularity, and multi-focal/mult-scalar perspectives. *Source* N. Gjorgjievski

that the scale of production limited to local markets makes a positive, reciprocal impact on the local environment, landscape, and communities (Matas 2018).

A contrary situation can be observed in the quarry in Larvik, Norway, which exemplifies most extractive practices in stone today. Here, the local stone, known as larvikite, is extracted in large blocks of 15–20 tons to be shipped to processing facilities elsewhere in Europe, where they are usually turned into finished elements. Due to the high reliance on marketable and aesthetic standards, the waste generated during the extraction process in Larvik constitutes approximately 50% of extracted resources. This is actually quite low in relation to the global standard, which can yield up to 70% of waste (Carredu 2019). Optimal carbon trajectories are less obvious as Portuguese, Spanish or Italian facilities score better than the ones located in Norway due to the heavy reliance on sea transport over truck freight. However, the apparent disconnect between the extraction site and architectural element results in relatively inefficient use of the finite resource, not to mention other displaced impacts.

These two examples of diverse extraction and use of stone not only show certain inspiring directions, but also ambiguities embedded in current extractive practices. They bring up the questions of the sustainable scale of extraction, the relation between material production and architectural elements, the contemporary, perhaps carbon-related definition of locality within the global contexts, and tools that can inform ecological design decisions and sustainable use of natural stone.

The discussion concerning the scale of the extraction process does not end here. Ecological thinking makes us "realize that there are lots of different temporality formats" (Morton 2018) and that the consequences of our material choices are spread over time. Therefore, a post-extractive use of resources, stone included, requires that we redefine the temporal frame of an architectural project that equally cares for what is taken as well as left behind. The discussion concerning resources cannot be limited to calculating embodied carbon, but it needs to address the entire life cycle of the material, starting with sites of extraction, processing, production, and construction, followed by anticipation of diverse usage and performance patterns to plan for maintenance, repair, and reuse.

The post-extractive approach considers the changes within the landscape. In the case of natural stone, this means that designers enter a geological time perspective and are to reflect on the life cycle of the quarry that material is sourced from and related changes to its ecosystem. Moreover, it is not only about understanding the current environmental and social impacts, but also foreseeing the future ones. It is about considering the afterlife of the quarry while extracting materials but also taking responsibility for the modified landscape and maybe extracting less and more efficiently. As Mark Wigley argues, there is a need for architecture less complicit with extractive economies, and one that: "must at least return a gift of the architect and take the risk of seeing what might come after architecture" (Wigley 2021).

How to return this doubtful gift? Existing policies concerning quarry landscape regeneration (Jorba and Vallejo 2010) are often limited to filling in the excavated territories that look the same as they did before extraction. Although quarry pits are often seen as deep scars in the landscape today (Palmer 2014), this visual approach seems to forget that terraforming is a multi-species practice and that extraction transforms chemical and physical soil composition and embedded ecosystems that unfold around the zone of direct interference (Ait-Touati et al. 2022). Therefore, instead of filling up closed quarries, it might be more ecological to employ *techniques of patching* to reestablish ecosystemic continuities (Ait-Touati et al. 2022). This happened, for example, in a closed quarry in Muro, Mallorca where a thin layer of soil covering the pit and some orange seeds created a new natural habitat in place of previous *marés* extraction. Therefore, it may be crucial to look for less anthropocentric approaches which treat extractive ruins as new topographies and allow the territories to create their own "feral dynamics"

that flourish "on infrastructures of human disturbance" (Bubandt and Tsing 2018). Maybe the way forward is about doing less—extracting, controlling and covering up less, and embracing instabilities, including more than human perspectives and developing over time.

Hopefully, the attitude of more mindful and efficient extraction would reduce the amount of generated waste during material extraction and production. Current statistics concerning quarry waste demonstrate that around 50% of extracted material is classified as waste due to irregular shapes. Moreover, present circular approaches to reduce the amount of quarry waste include turning it into aggregates, pebble stone, rubble, sawdust, and stone sludge for agriculture, breakwater, and paving. Thus, due to legislation issues and waste definitions, large, defective blocks are crushed and downcycled despite the fact that their physical–chemical and mechanical properties are often defined as equal to raw material (Carredu 2019). A shift toward more use of structural stone opens the door to significantly reducing waste even further (Webb 2022).

The issue of waste is not limited to quarry waste. The post-extractive approach requires that we reflect on future waste streams to be generated at the end of the life of a designed building. Ideally, we should avoid generating it at all by creating long-lasting buildings that are maintained and repaired to function undisturbedly due to the suitable layered organization of their elements (Brand 1994). However, considering the fact that, on average, a building lasts around 60 years, it is crucial to consider its future disassembly and reuse scenarios, where "in the most optimistic ecological scenario, architecture would be so generous that it would disappear" (Wigley 2021).

Natural stone has the potential to fulfill this ecological agenda by creating new reversible building systems that rely on circular construction (Guldager Jensen 2016) and design for disassembly principles (Crowther 2001) while working with such reversible building actions as, for example, *stacking, resting, overlapping, consoling, spanning, lifting or splitting* (Nielsen 2012). However, more reversible strategies for stone construction require that we embrace its load-bearing capacity and use elements of larger dimensions instead of employing the material only as finishings. This approach starts to appear in architecture, for example, in the aforementioned modular stone system proposed by Groupwork or the biodiversity wall systems by Chartier-Dalix.

Lastly, it is crucial to explore reversible tectonics and landscape approaches in broader systemic contexts investigating the environmental and socio-cultural impacts while rethinking existing economies, business models, and supply chains that construct the new building systems. It is advisable to follow the discourse of Jane Hutton, who advocates for more *solidarity* to avoid colonizing practices and *reciprocity* to create mutual, inter-species obligations for land and resources (Hutton 2021).

4 Conclusion

As the practice of architecture continues to dictate material extraction, it is prudent to question the new potentials of buildings, no longer perceived as disconnected finalities but as catalysts for change. Yet, even the staunchest opponents of resource extraction acknowledge that a moratorium on mining and quarrying would be practically unrealizable. For this reason, we need to look closer at the materials we extract for architecture and take "an approach to the designed environment that takes complete responsibility for itself" (Grima 2021). Such an approach requires that we flatly reject our widespread reliance on site-intensive and extractivist development. To do so, we must look critically at extraction and find ways not only to reduce the demand on earth's resources, but also to use what we take in the best way and to encourage responsible approaches to the disturbed landscapes that employ more plural perspectives and operate within the diversity of species, localities, temporalities, scales, and disciplines. We encourage the visualization of the link between the building and its extracted landscape, highlighting that the design challenge of the future

must not solely address the spatial problem of the building, but the opened landscape as well.

Although only in a nascent state, new research into natural stone offers a poignant case of how we might move from extractivism to a more custodial form of extraction. It shows the potential of reducing our need for materials such as steel, concrete, and wood; industries that are driven in large part by extractivist principles. Furthermore, it is not so challenging to imagine how to reinstate historical connections between architecture and the anthropogenic landscapes of stone extraction. In this way, we position the issue of material extraction within its multi-faceted entanglements of landscape and socio-cultural and economic contexts. Only when those contextual associations are acknowledged and understood, can it be possible to develop post-extractive, reversible, and more circular modes of building with natural resources.

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