The Living Trace. Mineral Aesthetics

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The Living Trace. Mineral Aesthetics focuses on the footprint left by human activity and mining industry, their evolution, and the reusing of waste in the current moment of energy transition plans and Sustainable Development Goals. The aim is to address the intersection between architecture, history, art, science, and technology to study the development of extractive techniques, the transformation of the territory, and proposals of social and scientific alternatives for possible futures, which involves collaboration with diverse local and international scientists, and professionals from different fields, such as art, architecture, engineering, and journalism. Hence, this paper raises the theme of the contemporary sublime as an updated version of the current climate crisis concerning the sublime of Romanticism, always based on an intersection between social strata and geological strata.

During the 18th century, the feeling of danger or loss of control that humans experienced towards the immensity and majesty of nature has now been transformed into a feeling of fear and discomfort related to the consequences that we have caused in our environment, and that make the Earth a place where many species, including humans, are at risk of not surviving depending on their geography or the so-called sacrifice zones. The pleasure we used to take in admiring nature is now overwhelmed by environmental stress beyond the scale of our control. Now, what characterizes our era - The Anthropocene - is a crisis of the human scale: confronted with the slow catastrophe caused by the chain of its actions, the human species is literally disoriented, that is, bereft of its spatial coordinates, both minuscule and oversized.[1]

In the present, the contemplation of the footprint that human beings leave on the Earth's surface can be both beautiful and perverse. The marks that workers imprint in the strata, the stone, or in the soil when extracting the natural resources necessary for the development of societies is a record of the exploitation, not only of nature but also of invisible human bodies, creators of stories but not participants of history and who dedicate their vital energy in the production of these voids. The voids are witnesses of the evolution of our society, our land use and the transformation of nature. Those immense scars on the extraction surfaces, as can be seen in these images, are marks resulting from the use of different tools used to cut, carve the stone or dig in the rock. Some of them are still visible after more than two thousand years.

Fig. 1 and 2

Fig. 1 and 2. Author: Elena Lavellés. Photographs of the quarries of Tusculum. The city of Tusculum was one of the largest and oldest in Italy. In its quarries you can still see the marks of the tools left more than two thousand years ago by the workers when extracting the stone blocks.

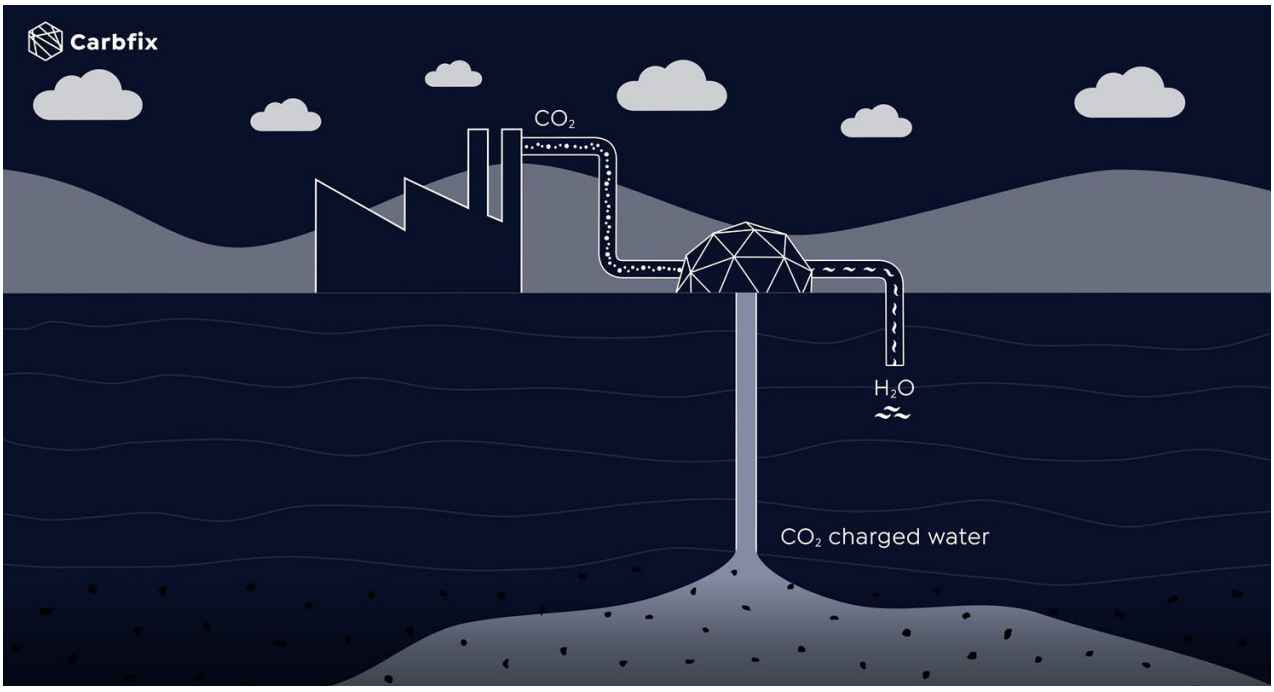
1 Nicolas Bourriaud, *Planet B. Climate Change and The New Sublime* (Turín: Ermes Graphics, 2022), 18.

At the same time, we do not only extract, we also accumulate. The creation of garbage is an unequivocal sign of a human presence. Our species faced its first garbage crisis when human beings became sedentary animals, and, at the moment, landfills have become what the Australian archaeologist Rowland Fletcher calls the largest monuments that any society builds for itself MVSes —Monstrous Visual Symbols,[2] huge monuments that are witnesses and represent our human activity, which produces industrial waste, contamination, trash management. Garbage mirrors our reality, and its analysis provides possibilities to create alternative ways of consumption, storage, recycling, and manufacturing new materials based on waste use.

Would we ourselves recognize our story when it is told, or will our garbage tell tales about us that we as yet do not suspect?[3]

In this regard, I started to work on possible uses of industrial waste where art and science intertwine. The project *Fixed Carbon. Carbon Sequestration* expands my previous research on this topic and explores how CO2 emissions resulting from coal combustion in the industry and power plants can be injected underground. Experts in an effort to fight against the worst climate change impacts, believe that billions of tons of CO2 can be captured and stored underground. This is how a new project, CarbFix, begins in Iceland in 2012 in which scientists from that region injected hundreds of tons of water and carbon dioxide more than 2000 meters deep into layers of porous basaltic rock. In this way, it has been possible to generate an alternative to store part of the carbon dioxide emitted by power plants and industries and turn carbon dioxide into stone.

Trees and vegetation are not the only forms of carbon drawdown from the atmosphere. Vast quantities of carbon are naturally stored in rocks. Carbfix imitates and accelerates these natural processes, where carbon dioxide is dissolved in water and interacts with reactive rock formations, such as basalts, to form stable minerals providing a permanent and safe carbon sink. The Carbfix process captures and permanently removes CO2. The technology provides a complete carbon capture and injection solution, as CO2 dissolved in water – a sparkling water of sorts – is injected into the subsurface where it reacts with favorable rock formations to form solid carbonate minerals via natural processes in about two years. For the Carbfix technology to work, one needs to meet three requirements: favorable rocks, water, and a source of carbon dioxide.[4]



How CarbFix process works

2 William Rathje and Cullen Murphy, Rubbish! The Archaeology of Garbage (New York: Harper Collins Publishers, 1992),10-82

3 Ibid

4 CarbFix “How it works.” Accessed June 15th, 2023. https://www.carbfix.com/how-it-works.

According to this project, I was interested in exploring these experiments using a combination of artistic and scientific languages. For this purpose, I collaborated with Dr. María Lourdes Fernández Díaz, a professor of Geology at the Complutense University of Madrid, to emulate these kinds of processes in the laboratories as a feasible alternative to capture CO2 emissions, which resulted in a CO2 sequestration by mineral carbonation processes under hydrothermal conditions. This produced a formation of new minerals from the combination of two already existent rocks, olivine (Fe,Mg)2SiO4 and plagioclase (Ca,Na)(Al,Si)3O8, and CO2 that grew in the form of what can be observed in detail in the image captured by an electron microscope.

The artworks that I finally produced were inspired by these outcomes and show the internal structure of these formations, which shapes how we see the rock from the outside. The visualization of bigger structures organized inside in a very complex and microscopical form gives us an analogy with the importance of inner formations to understand how bigger structures work: political, economic, social, etc.

A year later, in 2020, I started to work on an international project titled *Expanded Stratigraphy. From Geology to Social Fabric* part of the exhibition *Overview Effect*, which took place at MoCAB (Belgrade). This project has two parts and involved my collaboration with different institutions in Serbia and Spain.

The first part of this project is fieldwork-based and the main references are two coal mines: Senjski Rudnik, the oldest underground coal mine still active in the country, and the one that marks the beginning of the Industrial Revolution in Serbia. The second mine is Kolubara: one of the biggest coal mines in Europe, and very important due to workers' struggles demanding social justice and better labor conditions.

These two mines show the capacity of human beings to transform their territory through the exploitation of natural resources and their derivative industries and are examples of social resistance and solidarity in the face of these processes. In these mines, we can observe the geological strata coexisting and interacting with social strata. The coal miners reveal how solidarity is a key element in their everyday life and work since they constantly coexist with extreme circumstances. Therefore, these labor conditions tell us about how mine communities survive in a mutual state of caring in the face of danger.

The second part of the project is based on lab work. After being extracted from the mine, the coal is burnt for the energy it produces, releasing CO2 and creating fly ash, a fine gray powder consisting mostly of spherical, glassy particles that are produced as a byproduct in coal-fired power stations. This waste is being used in studies of new materials for construction, such as cement at the Institute Mihajlo Pupin, the University of Belgrade, and also in Spain, in CSIC – The Spanish National Research Council, both collaborators in this project.

Fly ash is recognized as an environmentally friendly material because, as a byproduct, it has a low level of embodied energy, which is the measure of how much energy is consumed in producing and shipping a building material. The use of fly ash as an ingredient in cement avoids producing more CO2, something that happens in the manufacture of Portland cement.

These three sculptures (Fig. 3) have been created using cement formed from fly ash and slag — the waste resulted from a kind of industrial steel process. In this manner, we are also developing sustainable artworks out of industrial waste, avoiding new production and material consumption. Furthermore, we are giving an alternative use to coal byproducts as a symbol of new possibilities of thinking about waste use in different fields beyond just the industrial one.

In this sense, art is another means to develop potential uses of waste through architecture and engineering. These fields allow variable scales in terms of social impact through analysis of community needs, design research, and citizen participation. *All the Footprints the Footprint. Energy Aesthetics* is a project started as a lab aiming at the design of a prototype for sustainable and social purposes and to design new architectural languages for a sustainable built environment based on equality and the intersection between disciplines. The final design focuses on the construction of communitarian architectures made out of recycled human and industrial waste, thereby preserving our natural resources, and reducing CO2 emissions.

Fig. 3

Elena Lavellés. *Open pit I, II y III* // Sand, fly ash, byproducts // 15x15x15 cm

All the Footprints the Footprint. Energy Aesthetics takes as a symbol the footprint left in the landscape by the extractive industries of natural resources, such as coal or iron -which are used by humans to generate energy or produce materials in the form of cement or steel-. This project proposes the reusing of large amounts of waste—industrial and urban, instead of the consumption of natural resources.

Portland cement is the most widely used binder for cement and concrete manufacture. More than 4 billion tons of cement are produced annually, representing approximately 8% of global CO2 emissions. Today, as incredible as it may seem, concrete is the second most consumed input in the world after water and the use of raw construction materials will double by 2060. By then, steel, concrete, and cement will be the main contributors to greenhouse gas emissions. This research presents technical options to reduce the emissions associated with cement production involving different disciplines.

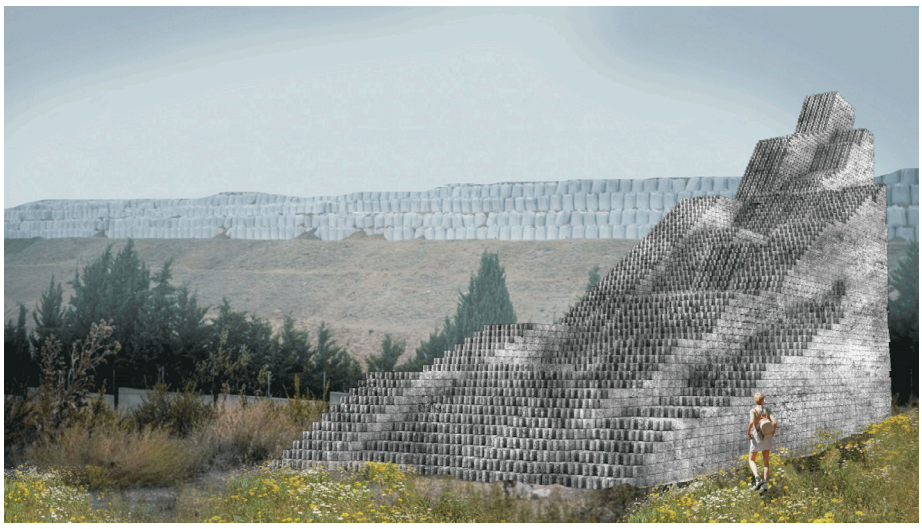
We propose a prototype made out of ashes that come from the incineration of urban solid waste. This piece is a modular construction element and its organic interlocking design reduces material and labor use, highlighting the importance of using efficient materials from an insulating and structural point of view. For its manufacture, we have worked in collaboration with The Eduardo Torroja Institute of Construction Sciences of the CSIC (Spanish National Research Council). Their research teams have already developed cement substitutes based on ash from different sources and wastes.

The Eduardo Torroja Institute's labs. All the project's team working in manufacturing the prototype designed at Medialab Matadero.

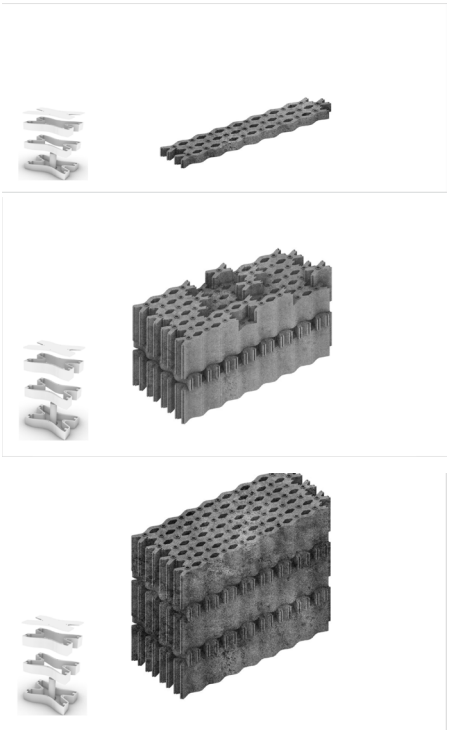
We searched for possible locations where we could find these kinds of ashes and created a mapping of Urban Solid Waste landfills in Spain. We focused our practice on Valdemingómez and the people who live in its slums: the Cañada Real Galiana in Madrid, due to its inequality, urban and contamination issues. This represents a scalable prototype for other landfill areas in the process of landscape recovery, social transformation processes, and constructive reusing.

We understand the project as an eco-socio-cultural prototype. The final goal is to create a monument out of the large quantities of ash found in the area in bad storage conditions that end up blowing in the wind and spreading. Therefore, we consider it necessary to work with the vulnerable population living in the area, valuing their knowledge in self-construction to co-design the project and to respond to their needs in a specific way. If all the ash poorly stored there were used to produce the construction modules of the prototype, it would be possible to build a structure or a huge monument, a Monstrous Visual Symbol, like this every day (Fig. 4), with almost 60,000 bricks immobilizing the ash in the landscape.

Fig. 4

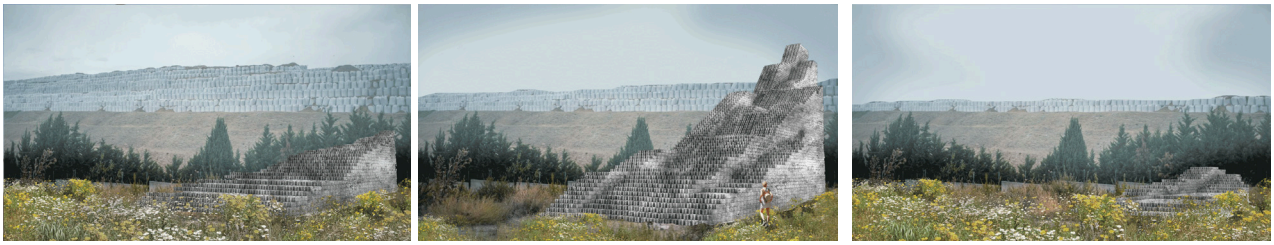


The monument is built by stacking bricks that form a solid massif, an ephemeral architecture on the landscape of the urban landfill itself. This large volume serves as a warehouse to which citizens from the participatory processes, or the surrounding area, have access. As they are collected, the large volume fades away until it disappears. This MVS activates and makes environmental issues visible, but it is also a device to create citizen culture and social participation. It works as an interconnection of knowledge, needs, and search for collective solutions.



Valdemingómez is a place where urban planning and public and private spaces have not reached appropriate levels, therefore it offers the possibility of working with local associations to identify their needs through participatory processes, such as meeting agoras, individual and collective infrastructures, ovens, and self-construction modules workshops among other activities.

The sequence of the monument's construction and deconstruction is due to people's interventions. This space is meant to be used as a local convention and gathering space to encourage meetings about the current situation in the area, workshops to produce one's own bricks out of the ash, and dialogue about the current urban waste storage situation.



Sequence of the monument construction and deconstruction due to people interventions. This space is meant to be used as a local intervention and gathering space to develop meetings about the current situation in the area, workshops to produce your own bricks out of the ashes, and talks about the current urban waste storage situation. (Modelling develope with Rinhoceros, stacking with Grasshopper and photomontage with Photoshop)

This tentative prototype was developed during The Metabolic Sublime Lab at Matadero Madrid between January 25th - February 10th, 2023, and the following stages of the project will be developed during 2023 and 2024 with the support of Medialab Matadero, Daniel and Nina Carasso Foundation, and The Eduardo Torroja Institute of Construction Sciences of the CSIC (Spanish National Research Council). Our team is integrated by professionals from different fields, such as architecture (Manuela Sancho and Raquel Gómez), civil engineering (Uriel Sterin), creativity and art (Mónica Gutiérrez-Basurama and Elena Lavellés), and investigative journalism specializing in sustainability (Brenda Chávez).

Can constructive logic be transformed by new materials?
Can the same productive model that generates dysfunctions reinvent itself on the same logic?
What happens when this impact becomes visible?
Should we think beyond this?
To whom does this ash belong and who should be responsible for it?
The monument is a space for visibility, reflection, speculation, open dialogue, free exchange of ideas, collective learning, and for questioning our way of inhabiting our planet.

Can we reach a future in which this monument will not be necessary?

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