Subterranean Matters is a collaborative artistic research and VR experience made by Baris Pekcagliyan, Paulina Greta, Warja Rybakova and Nayeli Vega under the “Stretching Senses School” as a response to the exhibition “Stretching Materialities”, curated by the Object Space Agency of the Cluster of Excellence “Matters of Activity” at Humboldt University in Berlin.

The research underpinning this VR piece is revolving around the exploration of time, memory, and human impact on the land, through stones with the point of view of a non-human perspective.

![Image of rocks and stones with labels and arrows indicating connections between human body, lime in Berlin's water, and human skeleton.]

Limestone from the Matters of Activity Exhibition collection
HUMAN IMPACT

TIME

MEMORY
Our research started with exploring stones and soil in the exhibition collection. One of the things that caught our attention was how limestone is common between stones, and anthropogenic soils gave us an idea about how rocks and lands contain the memory in a way that we humans do not easily see with our bare senses. We decided to stay local since geology is really connected with where we stand physically. We started to research Berlin-Brandenburg’s land, soil, and rocks. During our research, we came across the Rüdersdorf limestone mine in Berlin. This mine has a very important place in Berlin’s history since most of the important buildings in Berlin have limestone as the main material, as well most houses in Berlin are made with limestone that comes from this mine, moreover, Berlin’s water has very high amount of lime. As we deepen our research, we also realized that %99 of the caves in the world are made of limestone which was humanity’s home for many years. Last but not least, we realized our bones, and the structure of our body is made by limestone, the same material that surrounds us everywhere invisibly.

The project is an attempt to capture a lifetime journey of limestone observing it from a micro to a macro level (microscopic, human-eye, satellite), with the intention to
develop an experiential framework in order to strengthen our bonds with the limestone and stone matter.

The project consists of 3 different levels in a VR installation, and 3D printings on a physical level, supporting the VR experience with a tactile feeling.

Eager to explore more out of our modes of perceiving, we parted from the common way of seeing rocks as stable. We found that what seems to be static only behaves so because of our own perception, and its specific scale. In reality, the stones are constantly moving, changing, degrading, and growing.

During the VR experience we explored time and memory and tried to display how rocks, stones, and land can tell us stories through their own perception of time, or to be more precise, through the trace of recordings of data over time. Since it is not possible to access these processes with our bare senses, technology enables us to display what we can't perceive otherwise. With this experience we want to extend and stretch our human perception of rock's growing and excavation phases.

The experience, moreover, deepens the bidirectional impact that humans and stones have on each other. The human impact on the land through territory exploitation for building purposes leads to a final connection with lime.
We find it actually invisibly connected to our lives: in our everyday contact with it in our home, present in the walls surrounding us, and in the water we drink.
The Use of Immersive Technology

Subterranean Matters uses technology to create scenes and interactions inspired by physical reality. In the first level, environment is created by VR sculpting and texturing according to references from micro-images. In the second level, environment created by 3D scans by using Lidar scanning, photogrammetry, and macro photogrammetry to capture details from little stones. Moreover, 2D textures we captured from a physical limestone cave and 2D textures we captured from Rüdelsdorf mine are used to create maps for PBR materials, and by using tessellation procedural walls are created. Also the hands in second level, created by VR sculpting, rigged, and textured by the same material from the cave. In the third level, we use Houdini VFX to create procedural buildings, and explorable environment are textured with the photographs and data we collect about the effect of human impact.
3D SCANNING
FIRST LEVEL: MICROSCOPIC LANDSCAPES

FIRST LEVEL

The first level is meant to explore the micro structure of the limestone and to give an insight in the microscopic world where time is slow and invisible to the human eye.

In the first level, the environment is based on microscopic image references from CaCO3, the main molecule of limestones. CaCO3 is present in the bones of all animals and creates our own skeleton. It is present in the water we drink everyday, especially in Berlin, where water's lime percentage is very high.
On a microscopic level, the perception of time is really different from how we perceive time as humans. Even though we cannot observe these movements with our bare eyes, there are ceaseless growing and excavating movements happening. We conveyed this sense of movement using animations, embedded in a sterile and white environment like animal bones. The environment is carefully sculptured in VR using scientific visual references. The sound design of this level was created by speculating on micro universes, and using references from recordings that records activities in those levels.
SECOND LEVEL: THE CAVE

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In the prehistoric eras, humankind accepted caves as homes and lived in them for a long time. Actually, this time frame is much longer than the time we spent living in the buildings. 99% of the caves in the world are created out of limestone, the same material that we have in our own body's structure.
The entire environment of the cave level is created by either 3D scans or by procedurally created 3D models out of textures that were taken from physical environments.
This level is playing with the idea of Plato's cave and its connection with the arts and the perception of reality. As an analogy to Plato's prison, users can excavate and grow the rocks around them to break the prison, and to explore the cave. The user interacts using hands that are made from the same material as the cave, becoming part of the environment. Time goes very fast during this excavation since with our own perception of time we don't see rocks growing in this way. Textures are the memory of
the rocks, bringing on their surface signs and traces, telling their stories. The users are for the first time able to explore, stretch, grow these textures that usually are only met by sight and touch.
The sound composition is made using many different layers. The main concept was echo, as an inseparable aspect of the caves. To simulate echo, we used an analog delay synthesizer as our main base. On top of that, we added field recordings and sounds created by limestones on a human-scale level. Moreover, we used an anti-radio to record frequencies from the field and from the rocks filtered with a delay processor.

**THIRD LEVEL: HUMAN IMPACT, LAND, INFRASTRUCTURES**

The third level is meant to explore the human manipulation and use of stone matter: the creation of infrastructures, architectures, cities. The exploitation of the natural resources and the subsequent impact on the landscape, leave a trace that can be seen from far with satellites.

In the third level, the environment is based on the macro satellite data showing the maps and the human impact around the Rüdersdorf mine in Brandenburg, Germany. Nowadays, most of Berlin's buildings are created out of limestone, and most of the iconic buildings of the city were made by limestone taken out of Rüdersdorf's mine.
2D TEXTURES TO 3D DIGITAL ASSETS

TEXTURES

The core concept of our project is based on textures and visual materials as matter to use for creating sensory environments.

A visual research was carried out on the rocks and the mine's mechanical structures.

We used textures from Rudelsdorf mine and the limestone cave and created procedural 3D objects to create our environments.

We materialized them using a software and created different maps such as normal map, height map, and ambient occlusion map.
The environment of the level is built procedurally. The textures that cover the deconstructed architectures are all made of maps and photos from the mine. The level mimics the experience of a building site, where the structures and blocks are moving, putting the user in the center of a becoming city.

This level explores data on a macro and satellite scale and presents a time perception that though being observable by the human eye, requires years to display the changes.
The sound design in this level is made by many layers, including construction and excavation sounds from tools that humans use during these processes. Human voices overlap with tools and stones hammered and excavated, depicting ecologies of dependence and exploitation.
3D PRINTING

TACTILE EXPLORATION

Tactile exploration based on different scale-maps.

This part comes as an extension of the VR experience, reconnecting the virtual visual elements with correspondent physical structures.

#scale maps
#extension
#physical fabrication
Visual in the cave

3D PRINTED PROTOTYPES

Subterranean Materials
Visual in the cave

3D PRINTED PROTOTYPES

Subterranean Matters
Wrap-up

Subterranean Matters is an attempt to use technology as a means of an extended exploration of the physical world. Stones were analyzed as materials that have embedded in their surfaces traces of history, growth, and change. These surfaces were scanned, digitalized, and used in this project as textures to build virtual environments to manipulate and live on different sizes and time scales. In this way the VR experience allows users to immerse themselves in what usually would be unobtainable, invisible or perceivable only as a small material surface. The project used real data to build most of the digital elements, from color textures to 3D environments. During our research, we realized that the limestone surrounds us everywhere, in the water we drink, in our bones, and externally in our present shelters and in shelters of our ancestors. The field trip to the Rüdersdorf mine gave further insight into the relation of man with the stone matter as a tool for creating infrastructures. It depicted a state of resource exploitation whose dynamics leave a trace on the land and are seen on satellite maps. Our exploration of memory and time, from a non-human perspective, focused on the processes of material excavation and growth as the main dynamics of registering stories and displaying different timescales. What in the end was created is an experience that stretches the matter through digital techniques, and allows user
interaction with non-human agents, challenging our way of understanding and exploring stones and their dynamics.

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