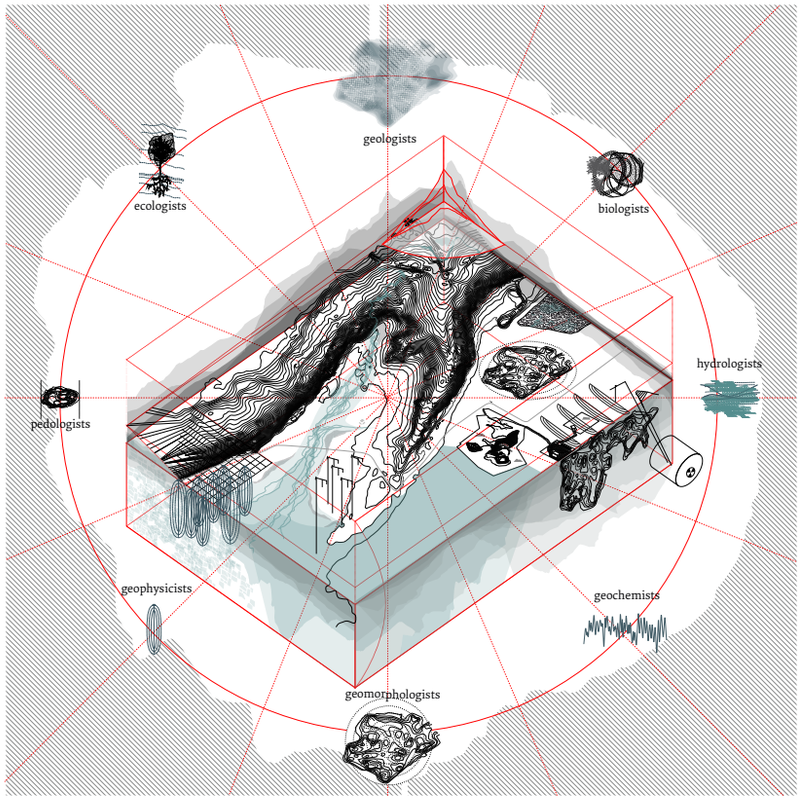
THE CRITICAL ZONE

The Critical Zone: Observatory Space

Alexandra Arènes

Earth's "critical zone" is the thin surface layer of the planet that extends from the tree canopy to deep rock. It is where water, soil, and organisms interact to make the planet habitable. The zone is threatened by what has come to be called the "Anthropocene." To monitor landscapes undergoing severe environmental disturbance and to better understand how they behave and what threatens their habitability, a network of earth scientists established critical zone observatories (CZOs) around the world. [1] Observatories are not physical buildings but areas of physical space (watershed, forest, field, mountain, etc.) monitored for scientific study. And scientists from several earth science disciplines are developing instruments to understand how Gaia (to use Bruno Latour's and Isabelle Stengers's preferred term for the planet and its entanglements) responds to human activities.[2]



Axonometric diagram showing the locations of various observatories and the scientific disciplines studying the compartments of the critical zone. Drawing by the author based on fieldwork.

1 There are international and national networks. For more information : https://www.czen.org/about, https://www.ozcar-ri.org

2 Bruno Latour, *Facing Gaia: Eight Lectures on the New Climatic Regime* **(Cambridge, UK: Polity, 2017); and Isabelle Stengers,** *In Catastrophic Times: The Coming Barbarism* **(Ann Arbor, MI: Open Humanities Press and Meson Press, 2015), DOI: 10.14619/016.**

An installation by Alexandra Arènes and Soheil Hajmirbaba, Atelier SOC (Société d'Objets Cartographiques), in the exhibition *Critical Zones: Observatories for Earthly Politics*, 2020/2021, ZKM | Center for Art and Media Karlsruhe, Germany, curated by Peter Weibel and Bruno Latour.

In 2020, for the exhibition *Critical Zones: Observatories for Earthly Politics*, the Atelier SOC (Société d'Objets Cartographiques) reconstructed a watershed inside the ZKM | Zentrum für Kunst und Medien (Center for Art and Media) in Karlsruhe, Germany. After a long investigation of the Strengbach observatory in the Vosges forest—located in eastern France on the border with Germany and comprising eighty hectares of steep slopes assailed by acid rain and forest death—we redesigned the components of the observatory in the atrium of the museum. None of the traditional features of a landscape—trees, slopes, topography, river—were represented. Instead, we reconstructed the network of instruments that scientists use to understand the responses of this specific watershed to environmental disturbances. Thanks to this infrastructure of instruments, the landscape appears in a different way. The trees, river, and soil examined by the scientists' instruments, both high-tech and low-tech, in the critical zone challenge traditional scales, agencies, and temporalities. The research infrastructure of the CZOs, which locates laboratories in vulnerable landscapes, troubles our understanding of the earth. Our installation aimed to give the public an opportunity to experience an encounter with these new technologically advanced optical instruments by navigating from one instrument station to another, following rivers, soils, and trees with a new gaze. Artistic mediation and documentation are mixed with the images produced by scientists to develop a dialogue that fosters ways of becoming sensitive to the movements of the earth. The installation is conceived as a model of the watershed brought back into an architectural space. On the occasion of this exhibition, a series of micro-architectures spatialized a landscape populated by instruments. This chapter offers a photographic tour through the installation, providing insights into this new way of observing and mapping landscapes.

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When entering the museum hall, you discover scattered objects hanging from beams, fixed to posts, on the ground or above your head. Covering the surface of the hall, an articulated steel structure levitates between two and four meters off the ground. You are invited to wander beneath the structure. At the entrance to the installation, a massive sand and concrete model reproduces the topography of the observatory's watershed. From the vantage of the entrance, you can see the reduced model of the watershed in the foreground and the suspended structure in the background. They have the same shape and follow the same landscape undulations. The two models represent the topography of the watershed in two different ways. The first, made of concrete, corresponds to the classic topographical model. The second, composed of suspended lines, reconstructs the topography revealed by the geophones that scientists use to probe the ground. The technical instrument cuts sections through the watershed from one side to the other, following lines called "geophones." These record the propagation of vibrations in the ground at depth and thus allow scientists to "see" the subsurface, its porosity, its granularity, its humidity, its fractures. The soil contains a deep and rich world. But the soil is not a solid mass; it is full of holes, voids that allow for the passage of life. Like a scientist, you are invited to probe the depths of the watershed by collecting stories as you move from one station to the next, reconstructing the landscape of the critical zone.

The entrance showing the concrete model and the hanging structure. Installation view of *Critical Zones: Observatories for Earthly Politics*, **2020/2021, © ZKM | Zentrum für Kunst und Medien, Karlsruhe,**

Photograph: Tobias Wootton.

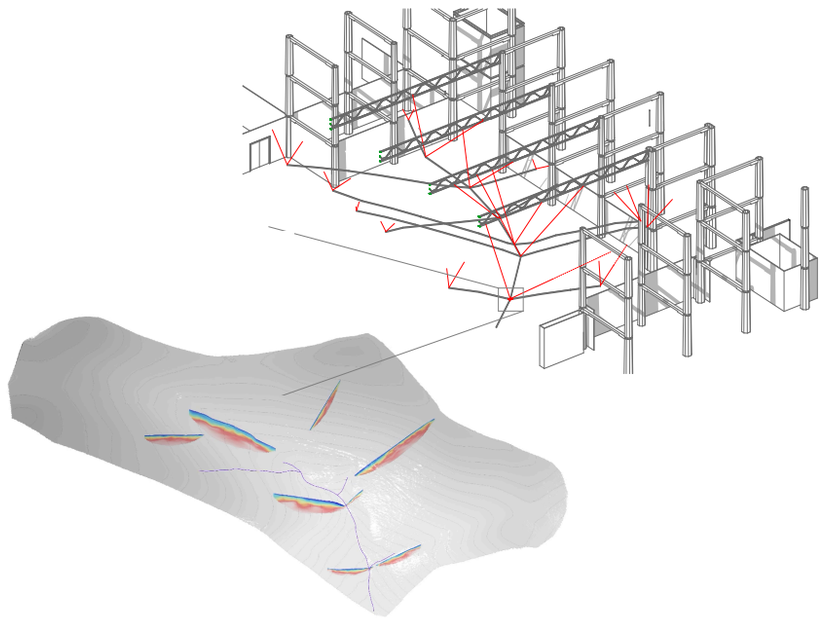
Critical Zone Observatory Space Location: ZKM, Karlsruhe, Germany

Watershed scale: 1:40

Altitude: from 0 to 5 meters

Instrument stations: 8; geophysics profiles: 6

Monitoring: atmosphere, trees, soil, rocks, groundwater



The geophysics station (station 05). Left image: reconstitution of the depth of the watershed with geophysics technique. Image: Sylvain Pasquet, scientist at the Institut de Physique du Globe de Paris (Paris Institute of Earth Physics). Right image: reconstitution of the geophysics lines in the space of the museum.

Drawing: SOC.

Critical Zone Observatory

Location: Strengbach, Vosges forest, France

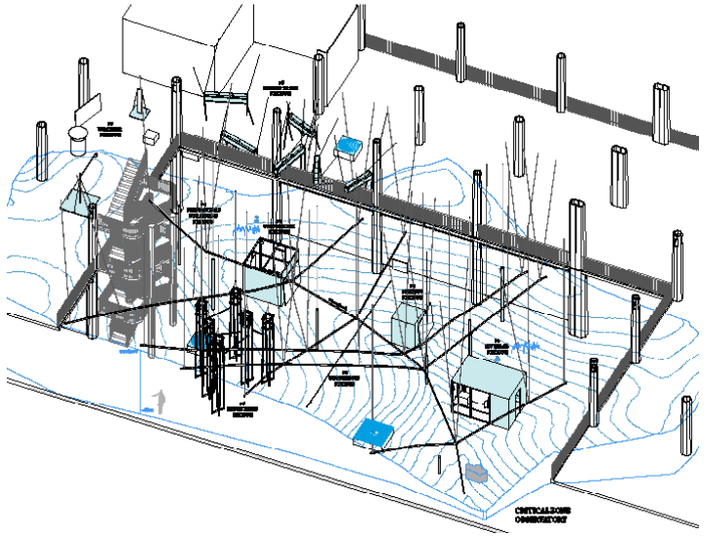
Watershed scale: 1:1 = 80 hectares

Altitude: from 880 to 1,080 meters

Instrument stations: 8; geophysics profiles: 6

Monitoring: atmosphere, trees, soil, rocks, groundwater

Moving through the exhibition, you traverse a model of the watershed of the Vosges forest observatory. The watershed is scaled down to a factor of forty so that it can be accommodated by the museum and on the atrium levels. Respecting this scale, each station is placed at the same altitude and longitude as its actual observatory in the forest. In contrast, the instruments on display maintain their original scale. In effect, different spatial and temporal scales are presented simultaneously, from instruments showing geological events over millions of years to instruments showing chemical events taking place in a river every twenty minutes.



Axonometric drawing of the installation showing the stations. Drawing: SOC.

Grasping the Incommensurability of the Earth

Equipped with a field guide, which reports the data collected by each station, and a map, you can experience a field visit to a CZO, passing from one instrument station to another, observing the work of the scientists through short films projected onto the architecture of the stations. Each station reveals a hidden aspect of the landscape, thanks to the specific instruments imported into the museum.

Riverlab (Station 01)

Listening to the chemical symphony of the river (the microscale composition of the river).

The Riverlab is a tiny field laboratory. Inside, a machine records the chemical variations of the river as river water passes over its circuits in real time. The ten chemical elements measured by the station exhibit different behaviors depending on the time of day, the season, and whether the river is flooding. Using data gathered from the site, a composer generated music that can be listened to in the "potamosensory"[3] space of the museum. Each chemical element becomes a musical instrument that plays its own score and whose rhythm may or may not match that of the other elements.

Inside the installation, ground floor, Riverlab on the left (station 01). Photograph: Tobias Wootton.

3 Potamosensory is a term invented by the geochemists I have interviewed. Potamology means the study of rivers. Potamosensory means to become sensitive to a river's behavior. A specific space in the installation has been designed where visitors can hear and feel the variations of the chemical contents of the Strengbach river through a musical composition specifically created with data derived from the river.

Gravimetry (Station 03)

Echoing the coastal tides (macroscale of the earth).

This machine records the signal from the water table at depth, but it is so sensitive that it also records other signals, such as the force of gravity of the tides breaking on the sea coast hundreds of miles away, like echoes rippling through the continental forest.

Piezometers and Core Samples (Station 04)

Archiving the weathering of rocks.

Columns extract soil from deep underground, exposing previously unsuspected pockets of water at depths of nearly 120 meters. The water triggers chemical reactions in the rocks, perhaps even enabling the presence of organisms. The boundaries of the critical zone extend intensively into the depths.

Geoseismic (Station 05)

Probing the depths.

Lines of geophones placed momentarily on the surface of the watershed probe the composition of the ground up to 150 meters. Vibrations are triggered on the soil, and their propagation is monitored, allowing the rock's qualities to be assessed.

Beech Trees (Station 06)

Cosmic beings.

Trees are sentinels of the environment. Large parts of the forest are monitored to understand whether they exhibit resilience after storms, acid rain, parasite invasions, and the impacts of the forest industry.

Inside the installation, ground floor, the beech trees station (06). Photograph: Tobias Wootton.

Weather Station (Station 07)

Tracing connectedness.

Multiple devices record variations in the lower atmosphere, the direction of the winds, and the components they transport. Sulfur emissions from industrial activity in Asia can reach the Vosges forest in less than twenty days.

Inside the installation, first floor, the weather station (07). Photograph: Tobias Wootton.

Spruce Trees (Station 08)

Harvesting pollutants from the rain.

Large rectangular gutters placed under the trees collect rainwater to analyze its pollutants, including sulfur, which acidifies the soil and is responsible for the death of trees.

Inside the installation, first floor, the spruce trees station (08). Photograph: Tobias Wootton.

he spaces between the CZO's stations invite you to reconstruct the shape of the forest—its trees, its water, its soil—in a complex way, where imagination mixes with scientific data and where micro- and macro-worlds intertwine to create a living environment. The space between the stations is left open to the affordances of exploration. "Staying with the trouble" is a prerequisite to approaching the complexity of the earth, because "all knowledge, human and non-human, is now stammering, and the question asked in each zone is how to share a concerned perplexity, how to not dream of a solution but to learn, as Donna Haraway puts, to stay with the trouble."[4] You must physically pass and repass the various mediums, arts, and scientific demonstrations, which are sometimes so intermixed it is hard to discern the influence of the one or the other, artistic practice or scientific practice. You must venture questions, suffer disorientation, and get lost while searching for signs and traces if you are to cultivate a curiosity toward the earth. Indeed, "the answer of what earthly sciences could be has nothing to do with a conversion, a new general understanding of what the Earth demands from us. This is also not a new perspective, because the Earth won't let itself be watched. It is there, folded many ways, entangling all scales not only space but also of time. And efforts to simplify it have further increased complications."[5]

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The installation is an artifact, so we are not really in the territory itself alongside its problems, its inhabitants, and its political complexities. What we can grasp in a museum are fragments that come from the territory; fragments of practices; fragments of time, of live data, of live movements, or of something that has already happened; fragments of instruments that are here at the same scale as there, questioning the scalability of laboratory instruments and of the entities that they record and that they cannot render totally generic. This is also why critical-zone science cannot be practiced exclusively in the

4 Isabelle Stengers, "The Earth Won't Let Itself Be Watched," in *Critical Zones: The Science and Politics of Landing on Earth*, ed. Bruno Latour and Peter Weibel, 228–35 (Cambridge, MA: MIT Press, 2020), 233.

5 Stengers, "The Earth Won't Let Itself Be Watched," 232.

laboratory; it must be performed in the field because the earth is not scalable. The installation stages this tension between the possibility and impossibility of scalability. The geography is scaled, but the instruments are not, and these instruments in turn magnify tiny elements.

The CZO is a device that plays with measures, models, and scales without announcing the rules or fixing them once and for all. It is somewhat like the fable of Alice in Wonderland. As in the depths of the critical zone, Alice falls into an underworld full of surprising effects, including strange scaling phenomena that are beyond her control and that dramatically alter her body. In the same way, the Anthropocene and the COVID-19 virus cause our bodies to change scale in unexpected ways that are, to say the least, elusive, since we cannot control them. Every time Alice wants to regain control of her scale (by trying to scale herself to the world around her), she fails, and, more dramatically, she makes the situation worse. You will find yourself, like Alice, in a kind of underworld called the "critical zone." You must not try to control the scales but let yourself be guided, dive into the folds of the earth. Test an instrument (or a potion?) so that your mind becomes tiny and can explore the microcosm. A few minutes later, expand again to grasp the terrestrial scale of human habitation. As in Alice's adventure, we do not move from one scale to another smoothly, as in Charles Eames and Ray Eames's short film *The Power of Ten*, but we are projected into each world, each scale of the entity we follow, grasping a fragment of each terrestrial monad through the scope of a chthonic hole.

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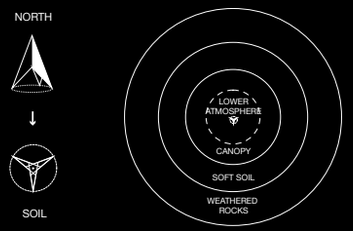
Soil Map, Down to Earth

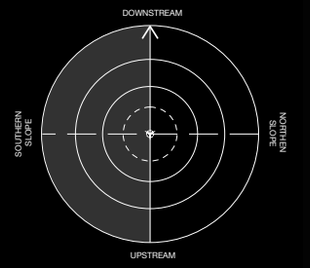
View of the installation from the first floor. Photograph: Tobias Wootton.

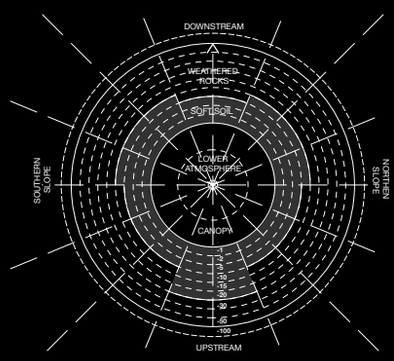
You can also explore a map of the observatory in the middle of the installation. The map is a kind of toposcope (orientation map) that produces an inversion of the conventional repertoire of cartography. It has no north, no latitude or longitude references, and no scales. Or rather, different scales coexist on the map. The map directs us to the ground. The gaze is reversed: we do not map the surface of the earth from above (i.e., from a vantage point) but instead map the depth of the ground from below (i.e., from the inside). The map is a cross-section of the critical zone—a circular cross-section where the depths of the rocks encompass the thin, fragile layers of fertile soil and its organisms. In the center, the sulfur-laden atmosphere threatens the soil with acid rain. What is released into the atmosphere on the other side of the world does not escape into infinite space (the universe) but is trapped in the protective layer of the earth and thus falls back down upon us. Pollution remains in the atmosphere. The blue elements denote the instruments of the observatory. The map visualizes what we see through their lenses: the composition of the soil, the movements of water, the turbulence of the atmosphere, the microscopic world, and so on. The soil map shows that even the soil is not stable but composed of a watery and viscous consistency. The depths are not a solid infrastructure; there is no stable surface on which we can unquestionably build more and more. If we can no longer consider the depths as a guarantee of stability, then the idea that the ground is a fixed surface (covered by roads, squares, building slabs) disappears like a modernist infrastructural chimera. What, then, is infrastructure?

SOIL MAP - NEW COORDINATES

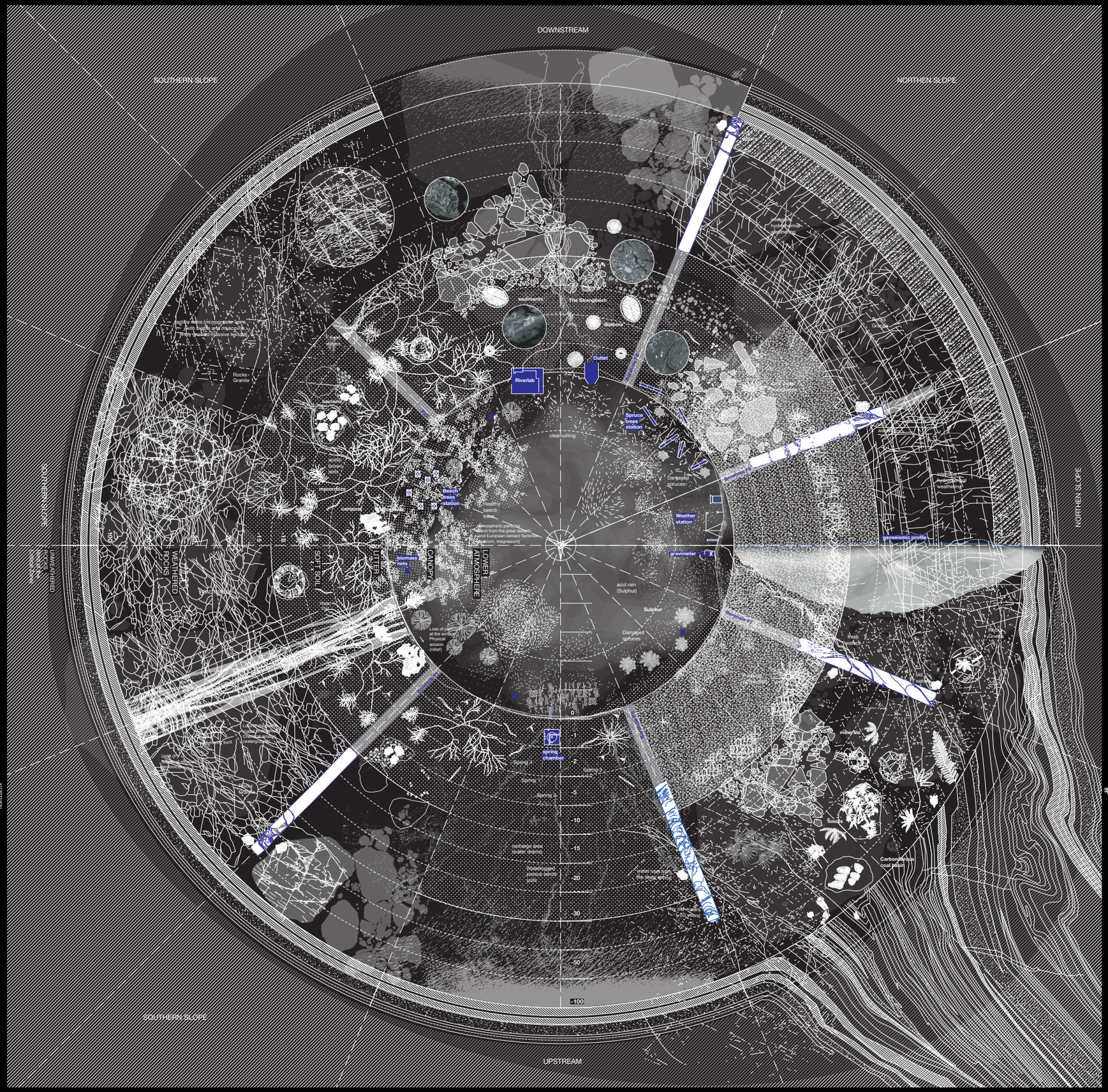


SOIL MAP - CZO STRENGBACH

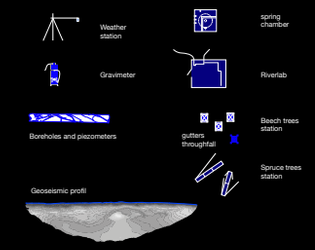




Soil map of the Strengbach Critical Zone Observatory. By the author.

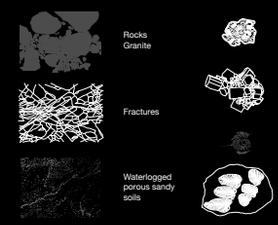


THE INSTRUMENTS OF THE CRITICAL ZONE OBSERVATORY

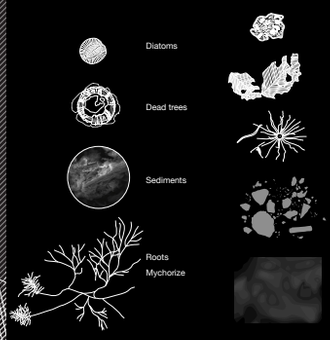


SOIL MAP OF THE STRENGBACH CRITICAL ZONE OBSERVATORY

WEATHERED ROCKS



SOFT SOIL / LITTER



CANOPY / LOWER ATMOSPHERE