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BELOW GROUND. HISTORY AND FUTURES OF THE UNDERGROUND FRONTIER

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Underground projects are getting the green light these days, all over the world – also in Switzerland. In December 2021, the Swiss parliament approved the legislative framework for the comprehensive logistics system *Cargo Sous Terrain* (CST), a vast scheme to put the country's small-scale freight transport underground, which has the backing of companies in the transport, logistics, retail, finance, insurance, telecommunications, and energy sectors. By the year 2045, an almost 500 km-long tunnel system is to be created between Geneva and St Gallen, in which fully automated (unmanned) vehicles on electromagnetic induction tracks will whizz goods around, 24/7. Once spit out of the earth again at so-called hubs, the goods will be propelled to their destination via "efficient dispersion" and "environmentally friendly vehicles" (bicycles and electric cars).[1] The project is to be powered 100 % by renewable energy sources. The declared ambition of the project with the hefty price tag of 30 billion Swiss Francs is: to avert the menace of total gridlock on road and rail; to reduce noise pollution; and to cut CO2 emissions.

Perforating, blowing up or scraping away at the earth's crust in order to lay hands on the raw materials concealed in it has been common practice for centuries, worldwide.[2] From the silver mines of Potosí in the early modern period, to the coalmines and oilfields of fossil capitalism in the 19th and 20th centuries, to the lithium mines now foreseen in 21st-century Spain, the lithosphere's mineral and fossil resources have long been factors in capitalist expansion, and still are to this day. The subterranean realm was a major stimulus to colonial and imperial expansion.[3] Despite the imminent climate tipping points, the run on underground raw materials shows no sign of slowing down; indeed, it is now burrowing deeper than ever and with gathering speed. From the turn of the millennium to 2010, global crude oil production increased from 80 to 90 million barrels per day.[4] Prospecting for gold, copper, lithium, or other metals is on the rise, as are the capital sums being directed towards extractivist

industries. The value of (diamond, uranium, and metal) mining companies grew from 80 billion in 1995 to 462 billion in 2008.[5]

Planning, coordinating, and executing subterranean expansion projects such as the *Cargo Sous Terrain* logistics system or, in fact any undertaking for mineral and geo-resource extraction or the underground storage of waste, is impossible without a digitally accessible, uniformly described database. In 2021, the Swiss Federal Council therefore gave the go-ahead to the "Digitisation of the Geological Underground" scheme, in which the Federal Office of Topography plays a pivotal role.[6] The future mobilisation and valorisation of the underground is thus closely bound up with investment in the technoscientific penetration of the subterranean realm and its transformation into ever more detailed datasets.

The Structure of the Living Book

In view of the great promise now emerging from as well as in the depths of the earth, we consider it a matter of urgency to examine the adamant penetration, appropriation, and valorisation of the underground realm with analytical nuance and from multidisciplinary perspectives. In compiling the contributions and sources in this Living Book, we set ourselves several goals. Firstly, we provide access to classical cultural-historical studies on the subterranean sphere as well as to recent texts from various disciplines that advocate volumetric thinking when considering the underground (Section 1). Secondly and most importantly, the Living Book focuses on the past, present, and prospective futures of the so-called *underground frontier*. This key concept, which can be used to bring together and historicise contemporary discourses and practices regarding the underground realm as well as the logic of its economic exploitation, is outlined in more detail below, as is the volumetric approach. Whether in industrial mining, geological surveying and mapping, or mechanised tunnelling, as the sources compiled in Section 2 show, the accelerated development of the subterranean realm from the second half of the 19th century onwards cemented the underground's status as a fount of fascination with, as well as a point of crystallisation of, the modern era; and it sparked imaginings of better futures located in the mechanised underground. Of course, cities also did in fact grow ever deeper in the late 19th century, owing to the construction of underground infrastructures. This "big dig" in the metropolises was accompanied by a vertical social stratification; and among the bourgeoisie, it sowed the seeds of a fear of clandestine subterranean threats (Section 3). The Living Book also brings together papers that address the accelerating appropriation of the underground as a zone for protection and security in the 20th century (Section 4). It traces the enduring bunker fantasies in culture and their materialization that continue to resonate to this day. As the sources of the interdisciplinary journal *Underground Space* compiled in Section 5 subsequently reveal,

staking out the underground as a sustainable and comprehensive resource began as early as the second half of the 20th century or, to be more precise, in the 1970s. Engineers and architects – all of them men – were the first to refer to "inner space" as a "frontier" at this time. A direct link can be drawn from the 1970s to the narratives and promises made by today's underground urbanists, who speak of the underground realm as "the next" or, alternatively, "the new frontier";[7] and yet they fail to develop a nuanced understanding of the term or to illuminate either the drawbacks of the process of frontier-making or the factors thereby often overlooked. Similar omissions can be noted in popular debates about projects and projections associated with the underground realm (Section 6). Our introduction concludes with a brief survey of the problems that thereby ensue.

Before getting into further details of the individual sections and the corresponding online resources, we would first like to elaborate on the conceptual framework of this Living Book – in particular, the concept of the underground frontier and the volumetric perspective on the underground.

Underground Frontier and Volumetric Turn – An Analytical Gaze into the Depths

According to the architect Godofredo Pereira, the current trend towards abstracting the earth into discrete datasets has been constitutive of what he calls the "underground frontier"[8] – science and technology having become the motor of a subterranean expansion of capitalist accumulation. From the diachronic perspective, however, the current deepening and acceleration of the techno-sciences' grip on the underground realm can be seen as part of a longer history of frontier formation. The environmental historian and geographer Jason W. Moore points out that, in capitalism, frontier-making – which is to say, the on-going process of frontier formation – is a fundamental spatial factor that contributes to unleashing the epochal potential of continuous accumulation.[9]

To cite the economic historian Andrea Komlosy, frontiers can thus be read as "shifting border spaces",[10] in which the radically future-oriented temporal logic of capitalist economic activity and its expansionist drive are made manifest. Advocates of a global take on history have seconded this view, designating the 600-year history of capitalism as one of shifting "commodity frontiers"[11] – horizontally conceived, for the most part – at which raw materials, energy, labour, knowledge, and land have been (and continue to be) fed into the commodity-producing global economy. As Jason W. Moore emphasises, this frontier-making as a process of commodification is always bound up with spatial control and geographical knowledge, for these are essential to the appropriation of natural resources and unpaid labour.[12]

The underground frontier, like any other, brings forth its own specific pioneers.[13] The current pioneers of the subterranean realm, such as representatives of construction and engineering groups, are promoting its development as a promising business model. They only rarely talk about their own interests, but rather, they speak all the more emphatic of the "tremendous opportunities" lying dormant beneath the earth's surface.[14] To attract capital flows, they attempt to prestructure the "fictional expectations"[15] of investors with success stories. As human geographer Maria de Lourdes Melo Zurita argues, they conceive of the underground in a quasi, neo-colonial gesture as a *sub terra nullius* or empty space that is just waiting to be awoken from its slumber and exploited.[16]

The underground frontier is now more than merely a place where valuable resources can be found, as Godofredo Pereira stresses: it has become in its entirety a comprehensive resource of capitalist expansion.[17] That this resource holds the promise of solutions, in particular to the challenges facing global metropolises, was spelled out by Jenny Yan, President of the *International Tunnelling Association*, at a conference of experts in 2020. In her view, underground structures are the key to megacity issues such as land scarcity, environmental pollution, traffic congestion, and natural disasters.[18] In fact, cities like Hong Kong[19] or Singapore[20] have long since presented plans for a – in the words of those in charge – "sustainable development" of their underground terrain. Appropriation of the latter in Singapore is progressing, for example, within the framework of a subterranean *Science City*, a cargo tunnel linking the city centre with the container ports and a gigantic underground oil bunker.[21] To fully exploit its underground "strategic resource", the city-state relies on the 3D technology under development in the framework of the "digital underground" project at the *Singapore ETH Centre*, a research facility of *ETH Zurich* (the Swiss Federal Institute of Technology) and the *Singapore National Research Foundation*.[22] Likewise, a conference convened in Singapore in autumn 2023 by the *Associated Research Centers for the Urban Underground Space* (ACUUS) explored the new opportunities afforded by using underground space. Its title was both programme and promise, as it underscored the fact that the pioneers of urban underground development have long since polished up their PR, as in: welcome to "Underground Space – the Next Frontier"![23]

The conceptualisation of frontier-making as a three-dimensional expansionist drive builds on a perception of the underground not as an autonomous or clearly delineated sphere but rather as one to be examined from a volumetric perspective. As the geographer Stuart Elden pointed out, territories or entities such as cities must be understood as complex and dynamic spaces; the world consists not only in a surface, but must be thought of in three-dimensional configurations that can be defined as volumes. Studies of volumetric urbanism (cf. McNeill), vertical transportation systems, oceanic depths, arctic ice or ephemeral territories like islands highlight the intricate interplay and intermingling of realms above and below ground,

emphasizing thus multiple layers and mobile entities and challenging notions of radically separate spheres.[24] Projects such as *Cargo Sous Terrain* illustrate the significance of this entanglement between surface and subsurface realms. The purpose of the new tunnels and hubs near urban centres is, after all, to foster movement and connectivity: the underground and the "aboveground" are to become ever more closely linked. The same can be said of mines, tunnels, and underground transport infrastructures. Thus, the world of volumes must always also be understood as a dynamic, fluid world, in which goods, people, and ideas never cease to flow. In essence, this means saying goodbye to the idea of stable surfaces and embracing three-dimensional mobilities instead. The underground frontier itself is thus to be imagined as an expanding, three-dimensional configuration, in which people, material flows, technologies, and the accumulated knowledge of means of spatial control are interconnected in overlapping layers.

That the volumetric turn throws into question power relations that are inscribed both in the surveillance and control of airspace and in the perforation and exploitation of the underground is evident from studies of volumetric sovereignty. For example, the social anthropologist Frank Billé pointed out that the reach of the state is increasingly oriented to subterranean regions and that agents of the state are penetrating these ever more deeply.[25] Moreover, asymmetries of power in society are closely intertwined both with vertical urban infrastructures and vertical metaphors. As Stephen Graham has shown in relation to urban space, social hierarchies manifest and reproduce themselves in the vertical plane. Thus, while skyscrapers since their invention in the late 19th century have symbolised the power, masculinity, and upwardly mobile competitiveness of economic elites,[26] social inequalities are also increasingly apparent in the opposite direction. The top one percent of the world's population is planning to survive "the end of the world" in luxurious bunkers, the so-called "billionaire bunkers" created in recent years in the bowels of the earth.[27]

The vertical attributions "top" and "bottom", "upper" and "lower", "above" and "below" are thus deeply anchored in the collective subconscious and serve to hierarchise social relations. "Upper class", "the underclass", "to be on top of a thing" or "to go under" are just a few examples of the very many such pervasive terms. As Graham notes, no serious academic engagement with humans' expansion into the underground realm can afford to ignore that vertical spatial metaphors may subtly idealise power and wealth and thus legitimise inequalities.[28]

Now, after these introductory remarks on the volumetric turn and the notion of the underground frontier, we turn our attention to the second half of the 19th century, a heyday of mass industrialisation and accelerated technological progress, when the underground came to be perforated by ever more shafts and tunnels.

Subterranean Technical Wonder Worlds and Visions of the Future in the 19th Century

The subterranean sphere underwent immense development owing to capitalist mining and metallurgy, to tunnel construction powered by efficient blasting technology and mechanised drilling machines (e.g., construction of the Gotthard railway tunnel, 1872–82), and to large-scale scientific projects, such as geological mapping or palaeontological excavations. Those alive to see this regarded the underground realm as a locus of modernity. The burgeoning interest in the underground in the 19th century was also related to the fateful reorientation of early industrial production, as described by the human geographer Andreas Malm, shifting away from water-driven towards fossil fuel supply.[29] While the early entrepreneurs reliant on hydroelectric power were still tied to the waterways, steam engines and fossil fuels allowed them to overcome these dependencies. The new energy sources, first coal, later oil, had to be brought up from the depths. This not only had devastating health consequences for the miners and their communities. It also released into the atmosphere the vast quantities of CO2 that had been safely fixed underground for millions of years. This marked the start of two centuries of industrial capitalist accumulation, a process that has meanwhile come to pose an acute threat to the sustainability of the planetary ecosystem.

The philosopher of technology Lewis Mumford described the mines as artificial terrains from which organic life had been largely banished. In consequence, he conceived of the underground realm as a lifeless, mechanised object permeated by artificial light and ventilation and equipped with lifting and transport machines – the mine as a metaphor of the fully mechanised environment.[30] That this mechanised realm as well as the miners working in it and the subterranean raw materials they extracted exerted great fascination on the public at the time, is attested by the popularity of a whole string of books about the underground "wonder worlds", among them, Louis Simonin's *Les Merveilles du Monde Souterraine* (1872) and William H. Davenport's *Beneath the Surface* (1876). Probably the most monumental popular work on the underground was *The Underground World. A Mirror of Life Below the Surface*, a one-thousand-page tome penned by the American journalist and author Thomas W. Knox and published in 1877.[31] In it, Knox dealt with mines and quarries in various regions of the world, and also devoted himself to the maritime underground, caves, volcanoes, and underground animal habitats. And that was not all, for he also went on to cover underground spaces of archaeological and cultural interest, including catacombs in various cities. That he addressed not only the spatial but also the symbolic dimensions of places below ground in his explorations and research is underscored by his preoccupation with criminal machinations, with the demi-monde, opium dens, thieves, and subterranean mysteries.

While Knox's mines proved striking owing to their multi-layered phenomenology, mines of the same period in literary fiction were fast becoming the locus of a better life or, indeed, of a better future. For example, in his novel *Les Indes-Noires* (published in 1877, and then in English the following year under the title *Black India*), Jules Verne conjured an underground technological environment that enabled a withdrawal from civilisation and history. In a former coal mine in the town of New Aberfoyle, a group of free individuals applies science and technology in order to escape the conventional rules of ownership and nationhood, and so form an ideal community (cf. also Williams).

Under the City – Urban Infrastructures and Social Stratification around 1900

The literary scholar David Pike has shown that underground urban landscapes replaced mines and caverns as the main site of subterranean capitalist expansion by the end of the 19th century.[32] What took shape in this period was an increasingly essential support system for major cities, namely various interlinked underground infrastructures. Sewerage, drainage and drinking water systems, steam pipes, underground train tunnels, telegram and telephone lines, rail tracks and pneumatic post installations were invented or expanded, and progressively became the vital fundaments of the *networked city*. And not only the world metropolises of that time, such as Paris, London, and Berlin, ranked among the vertically expanding and interconnected hotspots of the industrial era. Patently less sophisticated cities, such as Zurich, or prime examples of "sprawling" cities, such as Los Angeles (cf. Hansen), likewise grew in depth (and height). There, too, the never-ending "big dig"[33] offering views of torn-up streets and pipes extending many metres below the pavements was part and parcel of everyday public life. The vertical dimensions of newly erected buildings such as the Warenhaus Jelmoli, which opened its doors in Zurich in 1899 as one of the first ever department stores in Switzerland, proved nothing less than sensational. The basement and cellar extended seven metres below street level; from there, the building rose to the "giddy heights" of the fourth floor and attic.[34] The effortless movement of people and goods was assured by passenger lifts, goods lifts, spiral chutes, and conveyor belts that ran vertically and diagonally through the building, making of the department store a huge volumetric motion machine. Yet this vertically and horizontally networked shopper's paradise (re)produced unequal mobilities. The lift going up was reserved for customers with money to spend, while the sales assistants had to take the stairs and the lower classes had to stay away altogether from the marvellous three-dimensional consumerism cathedral.

The construction of new infrastructures put a strain on city dwellers in everyday life but it fascinated them nonetheless. Underground train tracks, sewage systems, and the like were markers of cultural progress, and people considered them bold, bright, hygienically clean, as

well as rationalised and controllable (cf. Gandy).[35] However, the general pride in underground technological progress was also fused with deep-seated dreads engrained in myths and religion. According to Hartmut Böhme, these fears had been rooted since antiquity in perceptions of the underworld as a dark and uncanny, dangerous and abysmal place, the realm of angst and death.

As the prolific critic, writer, and editor Wendy Lesser points out in her work of cultural studies *The Life Below the Ground* (1987), there was a strong physical-material component to the underground in the second half of the 19th century; but at the same time, it evoked powerful figurative associations and thus became a particularly intense metaphor, one that fuelled subterranean utopias in fiction as well as fear among the "cultured" classes of the "gaping abysses" in society. In Victor Hugo's work, for example, the urban underground – or more specifically, the sewers – was a rich cultural medium that came to symbolise the menaces lurking on the margins of society. (In his novel, *Les Miserables*, the police chase an insurgent through the Parisian sewers.)[36]

It was not only in fiction, however, that penniless and at times shady characters populated the underbelly of major cities as the living personification of the criminal or rebellious elements so feared by the bourgeoisie. The sub-proletariat dwelled in meagre cellars while the have-nots and homeless were pushed under bridges or into the tunnels of the convoluted sewers. Also those who carried out essential work in the sewage systems of metropolises like Paris and formed unions to protect their interests were (seen as) "a threat from below" to the vertical social structure of bourgeois class society.[37] The extent to which cities were vertically stratified by class around 1900 is illustrated by *Durch die Wiener Quartiere des Elends und Verbrechens*, a report on the miserable state of the poor and crime-ridden districts of Vienna penned by the journalist and writer Emil Kläger and published in 1908. Kläger gained the trust of certain spokespersons among the Viennese sub-proletariat, adopted their jargon, and dressed as they did. On his expeditions, he would accompany the so-called *Strotter*, namely vagabonds and rag-pickers who made a pittance by gleaning from the sewers objects they might be able to sell. To anyone familiar with their passages and chambers, the labyrinthine sewers also offered safe refuge from cold weather or possibly even the long arm of the law. Not least, as Haewon Hwang points out, the bourgeoisie associated the urban underground with prostitution, defining the "fallen woman" through her literary placement in the sewer as a discarded product of the surface world.[38] David Pike posits that the sewers are probably the most conflictual subterranean space in the city, inasmuch as metaphor and materiality are fused in them, along with the aforementioned significant ties to mythical and religious traditions regarding the life-altering passage into the underworld.[39]

Safe Spaces? Trenches and Bunkers from the First World War to the Cold War

During the First World War, a new type of underground character joined the ranks of the have-nots, prostitutes, and hoodlums: the soldier in the trenches. Trench warfare in all its horror became the very epitome and *lieu de mémoire* of the First World War.[40] The trench systems of defence shored up by wood, concrete, or metal developed into worlds of their own, complete with hospitals, sleeping quarters, and command posts, and were appropriated by the soldiers by means of graffiti and other markers. Precisely because the trenches feature so prominently in the commemoration and iconography of the "Great War", it has largely remained unknown that the First World War was also fought as a war of mines and tunnels. Matt Leonhard shows how both German and French tunnel troops launched highly dangerous and lethal attacks by tunnelling deep below the enemy trenches in order to set explosives there and blow them sky high.

Given the growing trend to aerial warfare from the 1930s on, then the start of the Second World War, then the onset of the Cold War, the colonisation and appropriation of the underground realm as a zone of protection and security steadily intensified. Military personnel, political elites, state authorities, and also the civilian population increasingly affected by the "Total War" were to be protected from the incendiary and explosive bombs dropped from above as well as from the qualitatively new and, in comparison to conventional weapons, far more devastating threat, the atomic bomb. Even while national differences were pronounced and state measures for the protection of the civilian population during the Cold War were focused in many places on dispersion and evacuation,[41] rather than on nationwide, state-sponsored shelter construction, it is important to note that there are nonetheless conceptual continuities between the nuclear shelters of the Cold War and the air-raid shelters of the interwar period or the Second World War. As Peter Bennesved argues with regard to Sweden, the rupture that the Cold War and the atomic bomb supposedly represented for civil defence efforts and shelter construction must thus be put into perspective.[42] Also, as Peter Bennesved and Silvia Berger Ziauddin have each demonstrated, there is ample evidence of transnational knowledge transfer in the field of civil defence construction in Europe, from the interwar period through to the Cold War era.[43]

The civilian shelter infrastructures that emerged from the 1930s onwards ranged from makeshift spaces in underground railway stations to simple air-raid shelters and the, preferably half embedded, Anderson "tin-shed" type, to high bunkers in cities, to standardised concrete shelters (which can still be found in every cellar in Switzerland, for example, and in Albania, where pillbox bunkers dot the landscape, cf. also Pike Talk); and finally, to elaborate high-security underground bunkers for the state authorities and ruling elites.[44]

Particularly instructive, with a view to the interconnections of top and bottom, above and below, brought into focus in this Living Book, is Ian Klinke's work on Marienthal, the German government bunker built during the Cold War.[45] Klinke not only highlights a material continuity between the government bunker and another extraordinary space of modernity, the concentration camp, but also points to a specific biopolitical interdependence of these two spaces. While the underground bunker served the bureaucratic elites as an architectural membrane, sealing off their "lebensraum" from the hostile world above them – specifically, from all the space beyond the bunker limits in which the other citizens of Germany were potentially exposed to annihilation (by the nuclear holocaust) – the concentration camp held the Other, the personification of the hostile world, firmly within its bounds and, thus, through its genocidal logic, "purified" the "lebensraum" beyond those bounds. The underground government bunker thus reversed the exterminatory logic of the above-ground camp.

Another form of the interdependence of above and below is illustrated by the studies of Joe Masco and Silvia Berger Ziauddin with regard to the nuclear bunkers of the Cold War. Thus, the subterranean civil defence spaces that materialised throughout Switzerland and the fallout shelters[46] that predominantly appeared as *imaginary spaces* in the USA served to mirror and reinforce ideas of the above-ground order, which included family and gender orders as well as stratifications according to class and race.[47] If, like Silvia Berger Ziauddin, one analyses the bunker as a heterotopic space that is in constant reconfiguration over time, one is struck by its effectiveness, in the late 1970s and early '80s, as a nucleus of ambiguity and difference, one which promoted the transcendence of traditional above-ground orders and the emergence of new ones. Thus, the Manichean patterns of thought and interpretation of the Cold War in Switzerland were increasingly distorted and undermined by subterranean bunker tactics of the "New Left" and punks, by imaginings of the shelter by critical writers and filmmakers, as well as by the bunker practices and bunker imagery of the new peace and anti-civil-defence movement around 1980.

The huge impact of bunker fantasies on film, literature, music and other cultural productions in the USA in both the 1960s and the 1980s is impressively demonstrated by David Pike in his latest publication.[48] According to Pike, existential threats other than the nuclear apocalypse – the climate crisis, for example – are currently contributing to the mutation of bunker fantasies and influencing our cultural life, and will continue to do so. The ethnographer Bradley Garret shows where this journey may lead. He studied people involved in the rapidly growing global "prepper" movement (so named because of the *preparations* made to avert or mitigate future threats). Among other things, preppers buy up military and civil defence facilities left over from the Cold War and convert them into so-called "doomsday bunkers". These they regard as offering protection not only against a nuclear or conventional military attack, but also against a whole phalanx of modern-day risks. In addition to man-made threats such as the

global climate crisis, the energy or financial crises, many preppers fear the gathering speed of technological progress, including recent developments in artificial intelligence, genetic manipulation and surveillance systems, and too, not least, potential pandemics. Today, as Garrett points out, *prepping* is a multibillion-dollar industry and media event, with catastrophes being conjured up left, right and centre, on the entire political spectrum.[49]

Subterranean Consumerist Realms and Human Habitats – A New Frontier in the Face of the Limits to Growth Above Ground

While the subterranean realm was repeatedly reactivated as a (temporary) zone of protection and security throughout the 20th century, it was the century's second half that witnessed cardinal changes regarding the subterranean sphere of cities. First of all, given the strong economic growth that began in the Global North after the Second World War, the 1950s and '60s saw a momentous increase in the purchasing power of broad sections of the population as well as the launch of the motorised society. In response to the growing congestion of above-ground roads by public transport, cars, and pedestrians, plans laid as early as the 1920s to separate and steer these mobility flows were dusted off and adopted. The city was now reconfigured as a multi-level entity comprising different layers of height and depth. The world beneath the urban dwellers' feet was given a fundamentally new function: it became a sphere of consumerism, a place to linger and spend leisure time in subterranean shopping worlds or so-called underground cities and thus – as the urban planner Jacques Besner emphasises – was "humanised", as it were. Unlike around the year 1900, this lively realm was inhabited no longer merely by the homeless, unemployed underclass, but by consumers with spending power. Montreal's *Underground City* – also known as RÉSO or the Ville intérieure – was the prototype of this development in the 1960s. The network of arcades, shops, restaurants, underground stations, office buildings, museums, conference centres, and public squares was built as an interconnected city in several phases, beginning in 1962,[50] and ultimately covered an area of more than 12 square kilometres. The city's inhabitants can stay on the move there without ever stepping outside, which they undoubtedly find advantageous, given the freezing winter weather. But it wasn't only cities with harsh climates that jumped on the bandwagon with projects such as Helsinki's *Underground*[51] or Toronto's *The PATH*. Zurich's *Shopville*, initiated in 1967 and opened in 1970, was likewise built with the aim of quickly disentangling motorised and pedestrian traffic flows and opening up the underground as an inhabited layer of the city.[52]

The 1970s marked a second turning point. It was largely propelled by the realisation of the finite nature of both space on the earth's surface and other planetary resources. The report "The Limits to Growth", which was published by the *Club of Rome* in 1972 and received

worldwide media attention, posited that, were the paradigm of constant economic growth to be upheld and the pace of industrialisation, environmental protection, energy consumption, and global population growth to continue unabated, the absolute limits to growth on earth would be reached within one hundred years.[53] Beginning with the European Year of Nature Conservation in 1970, a holistic view of nature conservation also gained traction. Without wishing to downplay the precursors of the ecology movement, one can concur with Joachim Radkau in seeing the period around 1970 as an ecological turning point. It helped lend momentum to those modern, heterogeneously composed environmental protection movements in the Western world that were demanding a responsible approach to natural resources and environmental issues of relevance to people's quality of life.[54]

It was against the backdrop of this conservationist thrust and insight into the planetary limits to growth that the underground realm was now described for the first time ever – by those who organised themselves in the mid-1970s in the newly founded *International Tunnelling Association* and the interdisciplinary *American Underground Space Association* – as a "vast, virtually untapped resource"[55] and as a potential solution to a multitude of pressing above-ground problems. Thus Charles Fairhurst, President of the *American Underground Space Association* and Senior Editor of its magazine *Underground Space*, addressed underground locations in his introduction to the first ever issue, published in 1976, in response to the urgent dual demand of his day: not to further exploit "nature" and, instead, to live harmoniously with it: "Underground locations seem, in fact, to respond to the call that man should attempt to live in harmony with nature, and not to seek always to conquer and destroy it".[56] True to the neo-Malthusian tradition, Fairhurst regarded underground buildings as a means to relieve the pressure on the – owing to population growth – increasingly scarce space above ground. In the same issue, the Swedish architect Birger Jansson asked whether, in view of the finite nature of planetary resources, the expansion of "lebensraum" (sic!) into outer space was the only answer, or whether the subterranean world of "terraspace" should not be tapped instead.[57] Advocates of the new "environmentally-friendly" use and planning of the underground realm characteristically began using the metaphor of the "new frontier" or the "new Noah's ark"[58] – which was a novel departure. In this way, they presented themselves on the one hand both as pioneers and as the saviours of humanity, but on the other hand they also underlined the supposedly inexhaustible potential of the underground and their own capacity to act on behalf of frontier-making. At the same time, the articles in *Underground Space* demonstrate that this process had continually shifted spatially: from the technology-intensive fin-de-siècle expansion of aviation, to space travel from the mid-20th century on, to the underground realm from the 1970s onwards.[59]

As Gavin Warnock emphasised in his programmatic article "New Frontiers of Inner Space" in 1978, underground space was to play a role in the future with regard to almost all of man's

industrial, commercial and residential needs.[60] In these texts, written for the most part by engineers, little remains of the mythical or religious connotations still invoked by the underworld in the 19th century. Now, the rallying call was: downwards exploration and growth. To the 1970s mindset, the underground realm looked like unadulterated potency, in the sense of a sheer infinite resource to be comprehensively tapped. As Warnock says: "[the] trends are clear: there are stimulating new frontiers of inner space. They call for vigorous exploration. They provide an unaccustomed but excellent way to grow".[61]

Sustainability, Resilience, Naturalness, and Beauty: Projects and Projections of the Present and Future

Today, those pioneers of urban underground development briefly mentioned here at the start are taking up the 1970s narratives – of the frontier, firstly, and of the underground realm as a sustainable resource ripe for comprehensive development – as well as demands for long-term planning and comprehensive subterranean "surveys" and "datamaps", such as were already expressed at that time (cf. Fairhurst). The best example of this is the book *Underground Cities. New Frontiers in Urban Living* (2020), which was funded by AECOM, a consortium of infrastructure consultancies active in the Americas and the Asia-Pacific and Middle East regions. In it, the underground is promoted as an "integral layer of the sustainable city", and the subterranean expansion of cities as a legitimate means to make urban zones resilient to uncertain and disruptive futures.[62] The move into the depths seems inevitable and is rhetorically linked to "overpopulation", rapid urbanisation, and the escalation of environmental problems – just as it was in the 1970s. One cardinal anchor point of the legitimizing strategy of the underground pioneers is now, of course, climate change. Accompanied as this is by heatwaves, drought, intense rainfall and other increasingly extreme weather events, and the subsequent rise in sea levels, it will force cities to "adapt". In order to develop a "resilient city", claims Will Symons of the AECOM consortium, "[cities] must start putting people – and all their manifest needs – at the heart of their underground infrastructure".[63]

In a decisive reversal of the late-19th-century perceptions of the urban underground as a primarily technical, artificial space, today's pioneers see it as an Eldorado, as a place that holds the promise of sustainability and resilience, but above all, of vitality, air, and green spaces. According to Pamela Johnston, the underground realm should be a space "that not only leaves more room for nature on the surface but enfolds the element of nature within itself".[64] Unpacking this element of nature requires a "shift in mindset". The underground realm itself must be interpreted as a living environment and arena with its own atmosphere and aesthetics; an arena in which to stand, sit, linger, and watch; a place to talk, listen, and

play sports and games: “In short: a beautiful space, inhabited by people who are there by choice and not simply because they need to work”.[65]

The *Lowline* project in New York City attempts to make a reality of the “beautiful space” imagined by Johnston, by setting its sights on a green wonderland in a former tram terminal beneath Delancey Street on Manhattan’s Lower East Side. So far realised only on paper and as a laboratory experiment by those in charge of the project, the densely planted realm dotted with ponds is increasingly a fusion of above-ground and below-ground dreamworlds. Media representations of the *Lowline* accordingly evoke a flourishing and transcendental futuristic habitat.[66] The metaphors of evil, darkness, and threat still associated with the subterranean realm in the late 19th century is completely absent from these modern imaginaries.

As these ambitious projects and action plans show, the ground beneath our feet now exerts an almost magical attraction on stakeholders in politics, business, and science. These projects and the future valorisation of the underground realm are also met with euphoria in public debates and media reports (srf programme *Einstein*); rarely do they provoke any criticism or reflection. The focus is on how efficiently and holistically the underground realm can be techno-scientifically permeated and surveyed, legally regulated, and subject to the organisational planning apt to facilitate future uses (Hochparterre).

Potential of the Underground Realm? A Call for Critical Reflection

The credo of today’s underground frontier is: inexhaustible potential, sustainability, resilience, naturalness, beauty. But what is possibly being overlooked among these sublime promises? And what is being blanked out?

At the underground frontier, the predominant logic of capitalist valorisation, which makes *not* exploiting a resource appear to be an irrational idea, in tandem with the techno-scientific culture of recording and quantifying the underground realm for data processing purposes, which, as we have seen, generally goes hand in hand with frontier-making and its attendant expansive dynamics, stands in the way of any pause for thought or critical (self-)reflection. Yet the urgency of pausing and of opening up a space for questions is evident from a multidisciplinary, historically informed analysis of the “vertical obsession” and current hype about the underground realm’s potential as the “next frontier”. As the process of appropriation and utilization that we have outlined above shows, the underground realm since the late 19th century has been subjected to drilling to ever greater depths and a variable extent, at a consistently accelerating pace and with increasing technological finesse; and this has mirrored and propelled processes of social stratification in the vertical plane as

well as metaphorically charged hopes for the future of certain sectors of the global demographic.

As for the metaphor of *the frontier*, it is necessary, first of all, to take a closer look at its use and function. This figure of speech, which has been used by engineers since the 1970s, implies that we are dealing with a supposedly virgin empty space and thus ignores the fact that the fascination with the underground is – as we have shown – by no means a new phenomenon, given that subterranean space has long since been the object of exploration, permeation, multiple misalignment and use. Moreover, the notion of a frontier abstracts from the actual subsoil with its material cycles in the deep biosphere as well as in the upper layers of the soil (cf. Wenzel); and this makes it difficult to address the subsoil's limited capacity for regeneration. Today's underground pioneers see the underground realm as a resource of the capitalist profit machine – as a container for urban infrastructures, as a space for urban and military expansion, as a supplier of raw materials, and as a waste dump. In many ways, however, this threatens the very foundation in which human life is rooted. If, as some underground pioneers emphasise, the underground realm too is our "environment", then we need to think about how to protect it, just as we do above-ground spaces and the air that we breathe. But who effectively protects the underground realm, and how? Which lobby does it have?

In the discourses of today's underground pioneers, it is also not mentioned who benefits from underground projects. In fact, underground urbanism is strongly driven "from above". Underground construction consists in large-scale projects that require high capital investment and are increasingly dominated by the private sector. The demand for a return on investment is therefore high, and this drives the expansion of underground space as a means of meeting commodified needs. As Bradley Garrett, Maria de Lourdes Melo Zurita, and Kurt Iveson recently warned, large parts of the publicly controlled urban underground have already been transferred into private hands.[67] This trend to privatisation is making it increasingly difficult for the use of the underground realm in the public interest.

The question of who will have access to subterranean spaces and resources must therefore be put. As hindsight shows, processes of subterranean appropriation promote social inequality. Malls, science cities, or urban parks in the underground realm ultimately address specific strata of the population; they are open to consumers with spending power as well as to highly qualified workers in the knowledge economy. Numerous projects of underground urbanism, such as the billionaire bunkers, epitomise processes of gentrification that reinforce social inequity in the urban environment. Seldom is any mention made here, of who is developing the underground realm, or of what working conditions prevail there, or to what extent the participation rights of specific groups are thereby affected or violated, even. How to give voice to the concerns of the people affected? Who can object to the use of the

underground realm? As Maria de Lourdes Melo Zurita has suggested, a new politics of the urban underground is needed, to counter the prevailing extractivist and utilitarian practices. She proposes to reimagine underground spaces as common property or *commons*, the use of which would consequentally have to be negotiated in public debate.[68]

In addition to these questions around the lack of governance and the reproduction of social inequalities, the promise of "sustainability" itself needs more careful consideration. The slogan today seems clear: transferring everything downwards and going underground will assure us a simple "sustainability fix" on the surface. Yet the matter remains of how far the discourse on "sustainability" stems from a genuine concern for the environment or rather is a means of paying lip-service to it while actually pursuing new strategies of accumulation and neutralising ecological resistance from the outset.[69] The shift to the underground realm also by no means implies that production and consumption patterns above ground would be structured sustainably. There are other blind spots, too. For example, with the underground logistics system *Cargo Sous Terrain*, it can be assumed that traffic in areas around the hubs will likely become heavier, not less. When it comes to the modes of transportation used for the fine distribution of goods (such as bicycles or small electric vehicles), it is also important to examine to what extent they further contribute to precarious working conditions for gig workers, such as bicycle couriers. Such social factors appear to be overlooked in the talk of sustainability.

The underground frontier blanks out the everyday appropriations of the underground realm "from below" and overshadows the diverse possible futures with techno-scientific, commodified visions. Here, the underground realm as an underground frontier features merely as a perpetuation and, perhaps, as an acceleration of all that has gone before – and thus it loses its future.

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[12] Moore, Jason W.: Capitalism in the Web of Life. Ecology and the Accumulation of Capital, London, New York 2015, p. 63.

[13] Courtwright, David T.: Sky as Frontier. Adventure, Aviation, and Empire, College Station 2005, p. 8–12.

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[42] Cf. Bennesved, Peter: Sheltered Society. Civilian Air Raid Shelters in Sweden-From Idea to Materiality, 1918–1940 and Beyond, Malmö 2020.

[43] Cf. Bennesved, Peter: A New Lodestar. Engineers and Architects 1934-1945, in: id.: Sheltered Society. Civilian Air Raid Shelters in Sweden-From Idea to Materiality, 1918-1940 and Beyond, Malmö 2020, p. 267-336; Berger Ziauddin, Silvia: Superpower Underground. Switzerland's Rise to Global Bunker Expertise, in: Technology and Culture 58 (4), 2017, p. 921–954.

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[45] Cf. Klinke, Ian: Cryptic Concrete. A Subterranean Journey Into Cold War Germany, Oxford 2018.

[46] Cf. Rose, Kenneth D.: One Nation Underground. The Fallout Shelter in American Culture, New York 2001. As for the few civilian bunkers materializing in the US cf. Monteyne, David: Fallout Shelter. Designing for Civil Defense in the Cold War, Minneapolis 2011.

[47] Regarding gender order, cf. also Lichtman, Sarah A.: Do-It-Yourself Security. Safety, Gender, and the Home Fallout Shelter in Cold War America, in: Journal of Design History 19 (1), 2006, p. 39–55.

[48] Pike, David L.: Cold War Space and Culture in the 1960s and 1980s. The Bunkered Decades, Oxford 2022.

[49] While preppers distrust the state's preparedness efforts in times of disaster and war, questioning their legitimacy and effectiveness, the existing civil defense systems and public bunkers promoted by the state in Europe have come back into the spotlight for broad public and official debates since the start of Russia's war of aggression against Ukraine in February 2022 and the resurgence of nuclear threats. Cf., eg., Last, John: What Happened to Europe's Public Bunkers?, in: Foreign Policy, 08.05.2022, < https://foreignpolicy.com/2022/05/08/europe-public-bunkers-nuclear-war-russia-ukraine-civil-defense/ >,

accessed: 05.01.2023.

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[51] Cf. Vähääho, Ikka: City of Deep Collaborations, in: Endicott, John; Johnston, Pamela; Lin, Nancy F. (Hg.): Underground Cities. New Frontiers in Urban Living, London 2020, S. 22–41.

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[57] Jansson, Birger: Terraspace – A World to Explore, in: Underground Space 1, 1976, S. 9–18, here p. 9.

[58] Duffaut, Pierre: Past and Future of the Use of Underground Space in France and Europe, in: Underground Space 3, 1980, p. 86–91, here p. 91.

[59] Cf. Courtwright, David T.: Sky as Frontier. Adventure, Aviation, and Empire, College Station 2005, p. 14 and 172.

[60] Warnock, J. Gavin: New Frontiers of Inner Space – Underground, in: Underground Space 3 (1), 1978, p. 1–7, here p. 1.

[61] Ibid., p. 7.

[62] Symons, Will: The Resilient City, in: Endicott, John; Johnston, Pamela; Lin, Nancy F. (Hg.): Underground Cities. New Frontiers in Urban Living, London 2020, S. 62–81, here p. 62.

[63] Ibid., p. 75.

[64] Johnston, Pamela: Homo Subterraneus. Inhabiting the Subsurface, in: Endicott, John; Johnston, Pamela; Lin, Nancy F. (Hg.): Underground Cities. New Frontiers in Urban Living, London 2020, p. 82–91, here p. 84.

[65] Ibid., p. 91.

[66] The Lowline, <http://thelowline.org/about/project/>, accessed: 05.01.2023.

[67] Cf. Garrett, Bradley; Melo Zurita, Maria de Lourdes; Iveson, Kurt: Boring Cities. The Privatisation of Subterranea, in: City. Analysis of Urban Trends, Culture, Theory, Policy, Action 24 (1–2), 2020, p. 276–285.

[68] Melo Zurita, Maria de Lourdes: Core Beliefs. The Underground is Full of Stories and Structures, in: The Architectural Review 1480, April 2021, p. 6–12.

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