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Speculating on Nature, Technology and Finance. Geomerce as a Case Study for Research through Design

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Abstract

This paper chronicles and reflects on the processes and the meanings of a project of speculative design that creates a narrative based on the scientific notion of phytomining, the activity of extracting metals from the soil using plants. The paper reflects on the ability of the project of bringing together people from different expertise, as a successful case study of Speculative Design and Research through Practice. Besides the scientific and technical challenges posed by GeoMerce, the authors of this paper reflect on the critical framework that set the basis for such a complex project.

Keywords: multi-/cross-/trans-disciplinary approaches, biologically inspired design, experimentation, data mining

1. Introduction

The authors of this paper relate about a project they worked on in 2015 and that has been exhibited on occasion of several design events. The project, titled GeoMerce, is a design installation that uses speculative design to create a conceptual framework where Science, Finance and Technology intersect to create a scenario in which farmers extract metals from their crops, following metal fluctuations in the financial markets. Research through Design (RtD) is employed in this project as an empirical way to engage with different fields of knowledge and create the context for a dialogue among professionals with different expertise, while progressing towards an output that is engaging and accessible to a broad audience.

The next paragraphs describe the project, and the network of expertises it enabled throughout its process. Finally, the project GeoMerce is analyzed critically in order to unveil its signifying meanings.

2. GeoMerce

2.1 Research through Design as a Methodology

The methodology we use focuses on RtD, a research approach that employs the methods and processes of design practice to generate new knowledge (Zimmerman and Forlizzi, 2014). RtD is also defined as a reflective mode of using design to continuously reinterpret and reframe issues as a result of a critical mode of making and using artefacts (Rittel and Webber, 1973). At the core of this methodology resides the Geomerce installation. Within the research process, Geomerce was simultaneously considered as an object of study and as resources to be deployed. In the first case, we were interested in understanding how design, scientific and technological expertise could converge in the conceptualisation and

realisation of the project. In the second case, Geomerce was used to explore the network brought together by circulating the installation during multiple design events.

2.2 Phytoextraction and Phytomining

GeoMerce was presented for the first time in Milan, during the week of the Salone del Mobile 2015. The key scientific principle that this project is based upon is the one of phytoextraction. Phytoextraction is the ability of plants to absorb metals from the soil through their roots. Some plants are exceptionally efficient at absorbing specific heavy metals such as Zinc, Copper and Nickel from the soil where they grow, and accumulating these metals in their leaves. Those plants are known as hyper-accumulators. The accumulated metals can be extracted by harvesting the plants' leaves and burning the biomass. This process is called phytomining.

2.3 The London Metal Exchange

Starting from this notion, GeoMerce reconsiders the way we commonly think of agriculture and our relationship with the natural environment around us, in favour to finance. In order to understand such shift from agriculture to finance, one needs to understand the way metals are valued and traded in our economies. It is quite common knowledge to think of precious metals as financial assets whose value fluctuates constantly. That is not only true for Silver or Gold, but also for Nickel, Zync, Copper and many others. The London Metal Exchange is an international marketplace where the quotations of all metals are updated every two minutes, following information about supply and demand and the strategies that characterize financial speculations (Moore and Cullen, 1995). That is not much different from the stock market, and metals are in fact not very dissimilar from stock options. Understood this notion about the trade of metals, and keeping in mind what has been described in the previous paragraph about phytoextraction, it becomes easy to understand how fields and crops cultivated with hyper-accumulators can be looked at as fluctuating financial assets, or sources and reservoirs of capitals.

2.4 The Installation

As an installation, GeoMerce renders visible the phytomining process, by tracking it and visualizing it in real-time. The information about the quantities of metals in the plants is combined with the real-time value of the accumulated metals. As a result, the value of the plants varies constantly according to the metals' market value and the plants' accumulation performances. GeoMerce draws a scenario in which agriculture blurs with finance and farming decisions are made according to both financial changes and scientific The installation is composed of five parts, each of them playing a crucial role in conveying the functioning and meaning of the project to the audience (Figure 1). The next paragraphs describe each component of the installation both technically and conceptually.

Figure 1. GeoMerce as exhibited in the ErreCi studios in 2015.

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2.4.1 The Extraction Units

The first part consists of 3 hydroponic systems provided of aluminium legs, a glass bowl for a hydroponic medium, two sensors and an LED light to keep the plants alive. Those units are designed to metaphorically work as a mining apparatus. As such, they feature an ore to mine – the water solution – and a technology that does the extraction – the plants themselves (Wood and Samson, 1998). The ore consists of a water solution that contains the metal, whose amount was determined on the basis of previous laboratory works (Visioli et al., 2012). Seven plants, arranged in circular array on the top of a Corian plate, work as a living extraction technology. That number corresponds to the average distribution of hyper-accumulators on 1/4 square meter of land and was used as a parameter to program the processor to which the hydroponic systems are connected. Last, each bowl embeds also a series of technical elements: a water oxygenator, a second glass vessel – which compensates for the evaporation of hydroponic medium, and a pair of Ion Selective Electrodes (ISE). The latter, in particular, are fundamental to operate GeoMerce and centralize the role of hyper-accumulating plants in its design (Figure 2).

Figure 2. One of the three extraction units, featuring the ion selective electrodes immersed in the liquid ore.

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In order to read the signals from the electrodes, those are connected to a potentiometer and a central processor, both positioned outside the hydroponic systems. With the electrodes plugged in and the potentiometer powered on, the hydroponic system can communicate with the processing unit. The potentiometer was programmed to receive a signal from the sensors at time intervals of two minutes, and send the information to a computer. Programmed to work at specific time intervals, the technological assembly 'sensors-potentiometer-computer' is used as a method to obtain real-time feedbacks about the activity of the hyper-accumulator plants. This allowed us to use the sensors as an enabling technology, capable of including plants into the setup of GeoMerce.

2.4.2 The Brain

The data related to the quantity of metals in the plants provided by the Extraction Units is transmitted to the second part of the installation, which is referred to as The Brain. The Brain is a device that on one hand receives the information about the extracting performances of each plant, and on the other hand is connected to the London Exchange Market so to receive updates about the always fluctuating value of the collected metals. The Brain features a screen displaying the fluctuations of the collected metals on The London Metal Exchange (Figure 3). It also serves another, important function: it combines the data provided by the Extraction Units and the London Metal Exchange in order to provide what arguably can be considered the real-time value of the hyper-accumulating flora. Digital theorist Roy Ascott (2000) provided a rationale for conceptualizing The Brain's functions, in particular his notion of "Moistmedia" (Ascott, 2000), upon which we built to craft a crossover between biological and digital data. We conceptualised The Brain as a bio-digital processing unit, which could simultaneously collect the 'wet' bio-feedbacks of hyper-accumulators and the 'dry' algorithms of digital finance, merging them together to generate what Ascott defines a "moist" domain. To write The Brain's program, we worked on the convergence of the three types of data. First, those extracted from the changes in the hydroponic medium, as a result of the plants' extraction tasks. Second, those gathered from the financial market of metal commodities. Third, a combination of the two sources. The resulting figure represents the – speculative – amount of metal collected from a group of plants in one square meter of soil. That value is then multiplied by 1.000 (one hectare of land) and the result is multiplied again by the metal's average value. The series of numbers and figures that results from those operations are the 'moist' figures of GeoMerce.

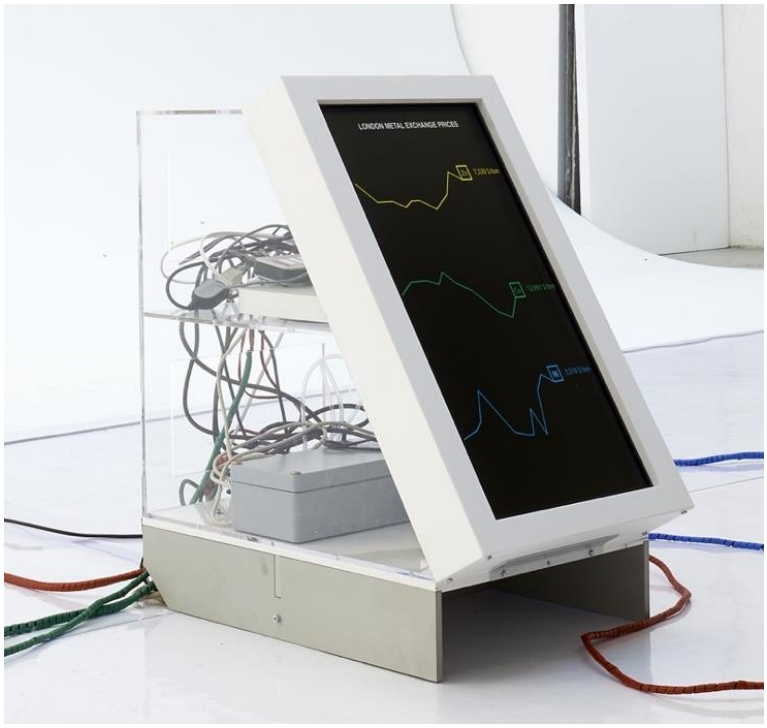

Figure 3. The brain unit assembled and cabled.

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2.4.3 The Circular Plotters

The result of the data regarding the quantity of metals extracted by the hyper-accumulators combined with the real-time value of the extracted metals is then transmitted to three circular plotting units (Figure 4). The installation features three of these Circular Plotters drafting graphs on round sheet of papers. Each of the three Circular Plotters is programmed to produce one printed artifact per day, which referred to nine hours of daily operation (09:00 – 18:00). The vertical lines drawn on the external area of the print refer to data concerning individual plant performances at time intervals of two minutes. The segmented line refers to the financial trend of the extracted metal; every change in that segment refers to value variations in the market, at time intervals of two minutes. The numbers printed between the two green circles express the speculative yearly value (in U.S. dollars per metric ton) of a hectare of contaminated soil, assuming this was cultivated using hyper-accumulators.

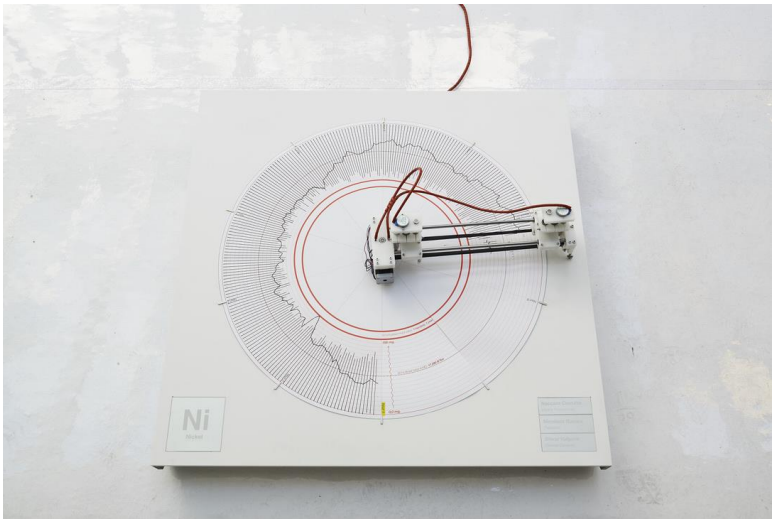

Figure 4. One of the three circular plotters tracing graphs about the copper extraction

2.4.4 The Lenses

Not all the components of GeoMerce are active or moving. While conceptualising the installation, we felt the need to mediate actual scientific content, to strengthen the perception of GeoMerce's process as believable evidence. This applied particularly to the perception of the scale at which those processes take place. How small is really a metal molecule? How much metal can a plant accumulate and where does it physically end up? These questions led us to design some objects inspired by the laboratory work of scientists and comprising a series of hanging elements inside which we exhibited the foliar organs of hyper-accumulators. Through a specially designed protocol involving a progressive chemical 'clearing', these leaves were made transparent, retaining at the same time the entirety of their vascular system. The leaves are then cast into clear resin, together with fragments and powder of the metals that they are able to extract. The final design recalls the visual archetype of a magnifying lens, as an invitation for the viewer to come closer and look through the objects (Figure 5). Plants represented in the lenses include both hyper-accumulators and metal-tolerant species such as Arabidopsis Halleri, Noccaea Caerulescens, Niccotiana Rustica and Silene Vulgaris.

The presence of transparent leaves embedded in resin provided visual representations to the otherwise invisible effects of these plants' physiological mechanisms. Such process could not be enabled by the animation, in that it necessitated quasi-scientific artefacts that could be empirically experienceable. Moreover, these elements did not just account for the process of metal uptake but also connected temporally distant events. The metal outside the leaves recalls the by-product of previous industrial activities that altered the environment. The presence of transparent leaves saturated of minerals, on the one hand, recalls the process of physiological adaptation of these plants after decades of environmental pollution; on the other, it brings us into a speculative future dimension, accounting for hypothetic processes that are not-yet-here. This part of the exhibition helps visitors understand where the metal is accumulated and makes a direct relation between the plants and the metals.

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Figure 5. The lenses hanging in the exhibition.

2.4.5 The GeoStory

The last part of the installation is an audio-visual animation projected on a circular horizontal surface of Corian carved as a landscape. This surface represents a plot of land and the video projected onto it is a narrated animation that describes the fictional story. The storyboard was designed using graphics inspired by Google Maps, which we used to animate into the past, present and a possible future of a fictional industrial area (Figure 6). Beginning from a factory that polluted air and soil, we represented a hypothetical scenario in which local people started growing plants to reclaim polluted land, while extracting valuable metals.

Figure 6. The GeoStory video projected on the milled corian surface representing a landscape in the installation

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Because plants accumulate metals in the form of molecules, our video wants to represent the size of the micro, the ionic, which is normally invisible to the naked eye. Starting from a fuming chimney, the animation draws the path of some metal molecules, until they penetrate the ground, slowly reaching a plant's roots and then its foliar organs. The video moves then to represent fields as financial assets, whose productiveness is half dependent on plants and half from financial trends. The animation approaches the theme of environmental contamination, but without the urge of necessarily proposing solutions to that problem. Instead, with the idea in mind of projecting an open-ended future of collaboration between people and plants. The idea of designing an open-ended scenario, rather than a predictive or a prescriptive one, appeared to us as an opportunity to keep the project open to individual interpretations of what the future under question could be or look like. This was done in the perspective of pushing the viewers to independently reflect about the possible implications of the project. This animation, which we call GeoStory, helps also to inform visitors in a linear and accessible way about phytoextraction, the London Metal Exchange and how such information is assembled in the project.

3. GeoMerce as a Network

3.1 Design of GeoMerce

GeoMerce's design process was made possible thanks to the convergence of conceptual, scientific and technological knowledge. This synthesis was achieved through several interactions between designers, scientists and technology producers, within places that extended beyond the traditional design studio, including – for instance, labs and greenhouses located within science departments. The activities included workshops and conversations with biologists and agronomists, laboratory experiments, walks and sampling done on a contaminated site in Italy. During those activities, it was essential to comprehend the different expectations of the actors involved, that is, the objectives that motivated their engagement and participation to the process and find a way to align these through Geomerce.

One issues we encountered, for instance, was of a technological kind, and concerned the difficulty of finding sensors to be used for monitoring the activity of hyper-accumulators in real time. One lab workshop evidenced the diversity in expectations between us, the scientific institution we collaborated with, and a technology producer, concerning the development of a sensors-based monitoring device in the area of phytomining research. Plant scientists, for instance, are used to work with plant cuts and tissues, but rarely with living samples. The development of such a technology was seen from the collaborating scientists as an opportunity to explore new research protocols to work with those plants. The technology producer looked at the production of the sensors as a way to promote the company reputation in the field of bespoken devices. In an interview, the CEO claimed that "the project is not, and will never become a project where the huge money lies […] but it is a very 'pressish' project" (Gatto, 2020), thus revealing that investing in GeoMerce would guarantee them returns in terms of visibility and reputation.

The development of GeoMerce showed that design can engage with challenges that are multi-faceted and multi-scalar, thus requiring expertise from different domains and actors (Irwin, 2015). Here, as argued by O'Brien et al (2013), "linear models of research and knowledge transfer have been challenged, with suggestions [for approaches] that recognizes the need to engage stakeholders [and] frame problems […] widely and more collaboratively". The interdisciplinary research upon which GeoMerce is based demonstrated that transfer of knowledge between disciplines and practices is possible and desirable, and that the network that becomes formed is regulated by expectations and objectives that needs to be accounted for, in view of granting and maintaining participation of all stakeholders.

3.2 Circulation of GeoMerce

Taken on its own, GeoMerce is a project that re-imagines agriculture as a speculative network of biological, technological, and economic agents. Being designed to be publicly exhibited, however, GeoMerce also enables conversations and it contextualises its contents. The landing of the project on occasion of different design events and venues provided occasions to connect GeoMerce to different geographical contexts. Circulating the work also helped us to better understand it: not just what it is that

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we had actually designed, but also the scope and implications of the project in relation to different social and cultural settings.

Between 2015 and 2020 GeoMerce was installed at several venues across Europe, mostly on occasion of public design events. Each time, the project remained installed for three to four days, during which it performed, gathered data and printed information. The rationale that followed for all the events focused on the value of GeoMerce in those specific geographical contexts – and the value of the contexts for GeoMerce. In synthesis, GeoMerce proved itself as an activator of new local networks of knowledge. In particular, we were interested in understanding how the actors who populate each context carry different types of expertise, how such expertise can be shared within the network and through what kind of meaning-making mechanisms. Theorist Donna Haraway refers to the result of these processes as "situated knowledges" (Haraway, 1988). Those can be complex and sometimes contradictory but have the advantage of opening to in-depth analysis, shedding light on how knowledge flows across different subjects and disciplines. The strategy we used was based on an inventive method, that is, "following the plant" (Gatto and McCardle, 2019). In doing that, we understood what actors we could collaborate with and how they could inform – and be informed by – GeoMerce. Those included plant scholars, members from local communities, environmental activists, designers, sociologists, and technology producers. We also familiarized with the sites in which those actors live or work, and explored modes of interaction between designers and practitioners in other fields.

4. Critical Discussion

GeoMerce is a complex project offering multiple angles for a critical discussion. The following paragraphs briefly describe some of the insights that working and disseminating GeoMerce has generated.

4.1 Accessibility

The first layer of analysis indicates that GeoMerce can be read as a design-cum-science experiment and comes about as an informative project. While phytoextraction and phytomining are scientific principles that might seem obvious to the scientific community, the general public is mostly unaware about those, and their applications. Design, with its engaging aesthetics, narratives and storytelling is a powerful language to transmit complex information in more accessible ways than the ones commonly employed by scientists. The numerous events in which GeoMerce was exhibited confirmed the fact that the visiting audience easily understands the science and technology upon which the project is based and actively engages with the narrative that these contribute to develop. They also demonstrate that a GeoStory is always a situated story, and that its plot aggregates different publics in relation to the settings of the context in which it is displayed.

4.2 Speculative Design as Catalyst

The project saw the participation of many different experts and professionals. From the biologists offering their expertise on plants and phytomining, to financial advisors suggesting tools and ways to quantify economic value, to scientists developing sensors to track the absorbing performance of plants. Additionally, videomakers, tinkerers and programmers were involved in the realization of this large and complex project. From this project we have learned how a speculative project like GeoMerce serves as a catalyst for people from very diverse backgrounds to come together and develop networks and strategies to exchange information. Considering that this was a project with a relatively low budget, it is safe to state that all parties involved took part in the process for other reasons than monetary ones. Speculative design offers seemingly impossible challenges that trigger the motivation of many professionals (Broms et al., 2017). Furthermore, working on an artistic installation that will be publicly exhibited offers another layer of motivation and excitement that the project can benefit from.

4.3 On Eco-Capitalism

GeoMerce's quality of being accessible, as discussed in the first paragraph 4.1, allows it to function as a catalyst for discussion and to expand the debate beyond the scientific notions that are contained within

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the project. It is clear that GeoMerce also serves as a commentary on our current and future economies and politics. While GeoMerce seems to hint at the possibility of a bright and positive future, it also casts the shadows of a dystopian scenario in which financial profit and actual or speculative monetary value determine every aspect of our world, including Nature and our relationship with it. By reducing Nature to a service provider for the human economics, GeoMerce serves as a trojan horse that first seduces the viewer with the promises of a rising Green or Eco-Capitalism; while on the other hand it reveals the horror of a world where Nature is just another form of financial asset (Sullivan, 2009). This is even clearer in the final part of the GeoStory when the video suggests that the future of GeoMerce might lay in genetic modifications to improve the phytoextraction performances of hyper-accumulator plants. The doubt that should rise in the thoughts of the visitor is whether the improved hyper-accumulators would be owned, patented or traded and by whom. Moreover, the concerns could focus on the soil and the effects that a profit-led intensive phytomining activity could have on the land. Quickly, the debate would spin in a capitalistic vortex that is hard to break, unless capitalistic logics are taken out of the equation.

5. Conclusions and Future Work

At each stage of the GeoMerce project, we have noticed how the processes it generated represents opportunities for an exchange that otherwise would have unlikely happened. During its conception and making phase, the powerful narrative of GeoMerce served as a catalyst to attract experts from various fields. May those professionals be biologists, technologists or financial agents, everyone felt compelled in taking part in the narrative that GeoMerce built. In many ways, GeoMerce proved itself successful in serving as an opportunity and a context to allow a conversation among a diversity of expertises, knowledges and ways of looking at Nature.

After the project was completed and made public, GeoMerce continued its role of a conversation activator. The narrative of GeoMerce invites the audience to think of a future for its story and reflect on the suggested scenarios. Acknowledging a shift in the relationship between humans and Nature, GeoMerce adds technology and economics to its speculative narrative. The result is an implicit criticism to Green Capitalism instilling doubts to the direction our economies seem to be heading towards.

As for the future, GeoMerce sets the foundation for a possible body of work that continues to question the current and future relationships between Nature, Technology, Economics, and Politics. This represents a fertile ground for both collaborations with experts of different fields and for instigating debates on urgent topics such as Anthropocene, Capitalocene, Biopolitics and Geopolitics.

References

Ascott, R., 2000. Edge-Life: Technoetic Structures And Moist Media, in: Ascott, R. (Ed.), Art, Technology, Consciousness: Mind@Large. Intellect, Bristol, UK, pp. 2–6.

Broms, L., Wangel, J., Andersson, C., 2017. Sensing energy: Forming stories through speculative design artefacts. Energy Research & Social Science 31, 194–204.

Gatto, G., 2020. Design as Multispecies Encounter: Plant Participation and Agency In and Through Speculative Design. Loughborough University.

Gatto, G., McCardle, J.R., 2019. Multispecies Design and Ethnographic Practice: Following Other-Than-Humans as a Mode of Exploring Environmental Issues. Sustainability.

Haraway, D., 1988. Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. Feminist Studies 14, 575. https://doi.org/10.2307/3178066

Irwin, T., 2015. Transition Design: A Proposal for a New Area of Design Practice, Study, and Research. null 7, 229–246. https://doi.org/10.1080/17547075.2015.1051829

Moore, M.J., Cullen, U., 1995. Speculative efficiency on the London metal exchange. The Manchester School of Economic & Social Studies 63, 235–256.

O'Brien, L., Marzano, M., White, R.M., 2013. "Participatory interdisciplinarity": Towards the integration of disciplinary diversity with stakeholder engagement for new models of knowledge production. Science and Public Policy 40, 51–61. https://doi.org/10.1093/scipol/scs120

Rittel, H., Webber, M., 1973. Dilemmas in a general theory of planning. Policy Science 4, 155–169.

Sullivan, S., 2009. Green capitalism, and the cultural poverty of constructing nature as service-provider. Radical anthropology 3, 18–27.

https://doi.org/10.1017/pds.2022.213 Published online by Cambridge University Press

Visioli, G., Vincenzi, S., Marmiroli, M., Marmiroli, N., 2012. Correlation between phenotype and proteome in the Ni hyperaccumulator Noccaea caerulescens subsp. caerulescens. Environmental and Experimental Botany 77, 156–164. https://doi.org/10.1016/j.envexpbot.2011.11.016

Wood, S.A., Samson, I.M., 1998. Solubility of Ore Minerals and Complexation of Ore Metals in Hydrothermal Solutions, in: Reviews in Economic Geology. Society of Economic Geologists, pp. 33–80.

Zimmerman, J., Forlizzi, J., 2014. Research Through Design in HCI, in: Olson, J.S., Kellogg, W.A. (Eds.), Ways of Knowing in HCI. Springer Science+Business Media, New York, pp. 167–189. https://doi.org/10.1007/978-1-4939-0378-8

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