

Acid Love

Mines, Remediation and Ensembles of the Witwatersrand

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ABSTRACT

Acid mine drainage (AMD) is the result of complex interdependencies between geological, ecological and cultural agencies. Its effects have been disastrous throughout the world, including South Africa's Witwatersrand. Colonial and capitalist attitudes toward the environment have precipitated the contemporary situation; scientific approaches to remediation must be complemented by the development of alternative sensitivities. Sound art may work toward such an end, as proposed via *Acid Love*, an installation produced for the Watershed exhibition in Johannesburg in collaboration with the Centre in Water Research and Development at the University of the Witwatersrand. The piece, inspired by poet and performance scholar Fred Moten's articulation of the term "ensemble," presents AMD as an expression of unreconciled yet interdependent human and nonhuman action.

Visiting Johannesburg in August 2018, I accepted an invitation from photographer Mark Lewis to visit a gold mine called Langlaagte. Here, 132 years earlier, the Australian prospector George Harrison first struck the Witwatersrand gold reef, triggering the largest gold rush in history and the excavation of the most extensive gold deposits in the world. When we arrived, decades after industrial operations had ceased, only a modest unkempt memorial park marked the spot. However, the mine itself was far from abandoned.

Independent miners known as *zama zamas*—Zulu for "those who try to get something from nothing" [1]—still illegally work the tunnels (Fig. 1). Largely young migrants from Mozambique and Zimbabwe, they risk their lives to chip marginal remainders from the original mine walls, sometimes spending months underground. As Mark and I chatted with the men, we asked about the hazards of staying below for so long. One miner mentioned running out of potable water and having to drink seepage in the tunnels. To do so may prove fatal; it is likely to be "acid mine drainage," or AMD, a highly acidic substance contaminated with heavy metals.



Fig. 1. Zama zama miner entering the tunnel at Langlaagte. (© Brian House)

Such a shocking anecdote is indicative of how mining does not simply remove metal from the earth, it reverberates through the geological and ecological processes with which humans are intertwined. Geologists have proposed that we name our current epoch the "Anthropocene," conveying the overall magnitude of the transformations wrought by colonialism and capitalism via extractive industries [2]. But there is additional work to be done if we are to reckon with how something like AMD comes to be, a substance through which complex relationships resonate. Though science provides a means of naming some of those relations, we can cultivate a sensitivity to them through artistic inquiry.

The following account of AMD derives from artistic research. Here, I provide the scientific and conceptual background of this work and describe the resulting sound art installation, *Acid Love*. It is an attempt to regard AMD as an *ensemble*, a term with aesthetic and philosophical overtones that I draw from the writing of theorist and poet Fred Moten. As an ensemble, AMD is not only a dangerous industrial byproduct; it is also an expressive encounter among cultural, biological and geological agencies.

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The Witwatersrand Basin is a largely underground structure of sedimentary deposits laid down three billion years ago. Among the oldest geological formations on Earth, it is the product of an ancient river delta into which swept minerals—

including gold—from a long-vanished mountain range [3]. The basin is exposed to the surface in a broad ridge that rises above the plains and stretches across 300 kilometers of what is now South Africa. This is the Witwatersrand, or “ridge of white waters” in Afrikaans. The “Cradle of Humankind” is here, a complex of limestone caves which contain some of the oldest and most abundant hominin fossils in the world. Three and a half million years ago, these ancient bodies joined gold in geological matrices that would eventually be extracted by miners [4].

In the 17th century, indigenous Khoisan and Bantu-speaking people faced an invasion of Dutch settlers, ancestors of present-day Afrikaners; the British showed up during imperial expansion in the 1800s. Prompted by Harrison’s discovery, mining camps on the Witwatersrand rapidly expanded to form the city of Johannesburg, and its wealth provided the foundation for the modern nation of South Africa. European mining corporations extracted cheap labor from Africans across the continent, and while this created a multiethnic society, colonial structures sedimented into social strata. These characterized 20th century apartheid and persist in the inequities of the present day.

Early mining in the Witwatersrand used mercury to liquify gold and separate it from the ore. However, pyrite prevents the necessary chemical reaction, and it is an abundant mineral at lower depths. Consequently, miners developed a more advanced cyanide-based technique, which requires pulverizing the ore into a fine dust [5]. As a result, mountainous dumps accumulated around Johannesburg, resulting in over six billion tons of tailings [6]. These dumps remain rich in minerals and have been reworked multiple times to extract metals such as radioactive uranium as they have become valuable on the global market.

Pyrite (“fool’s gold”) remains plentiful in the tailings and has reoccurring significance (Fig.2). When exposed to water and oxygen, pyrite undergoes a chemical transformation through which it separates into iron and sulfate, releasing acidifying hydrogen ions. This acid, in turn, dissolves the surrounding rock, exposing more pyrite and forming a chemical feedback loop through which water seeping through the tailings becomes acid mine drainage (AMD) [7]. This richly hued orangish liquid, laden with heavy metals leached from the rock, finds its way down into old mining tunnels and into the groundwater (Fig.3).



Fig. 2. Gold ore from the Witwatersrand. (Photo: James St. John. © James St. John. Licensed under CC-by-2.0 <https://creativecommons.org/licenses/by/2.0/>. image cropped from original: <https://www.flickr.com/photos/jsjgeology/14696801316/>)



Fig. 3. Acid mine drainage. (© Brian House)

One form of life, however, not only benefits from AMD but is essential to its formation. The oxidizing agent *Acidithiobacillus ferrooxidans*, a species of bacteria that thrives in highly acidic environments, vastly accelerates the chemical feedback process [11]. Thus a collaboration between humans and these extremophiles converts inert rock into such a reactive substance.

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The very term “environment” privileges human agency and suggests a passivity that *A. ferrooxidans*, among others, proves to be untrue. Colonial and capitalist enterprises have ignored their inescapable entanglements in part through the philosophical fallacy that (white) culture is separate and superior to nature; contemporary humanities scholarship has introduced a host of alternatives in an attempt to remediate Western discourse. These include “naturecultures” from Donna Haraway [12], “actor-networks” from Bruno Latour [13], “vibrant matter” from Jane Bennett [14], “the mesh” from Timothy Morton [15], and “assemblages” used by Anna Tsing [16], Manuel DeLanda [17], and others by way of Gilles Deleuze and Felix Guattari [18]. Despite their sometimes conflicting philosophical commitments, these concepts all share a sense of human and nonhuman interdependence.

I propose that the term “ensemble,” as developed in the work of Fred Moten [19], might also apply. An orchestral musician is subsumed into the collective by the demands of a conductor and score; in jazz, however, an ensemble emerges only through individuals’ improvisatory and potentially agonistic interaction with each other. Black culture in general works similarly, according to Moten, as it is not of a singular or even determinate origin. This formulation breaks with Western philosophical traditions that would privilege a universally applied perspective. For Moten, “an ensemble tone [...] is not structured by or around the presence/absence of singularity or totality, the tone is not iterative but generative” [20].

Though Moten does not explicitly address geology or ecology, Moten’s understanding of ensemble can also undo the colonial idea that would have a passive environment subject to human (i.e., European) control. Instead, Harrison’s strike at Langlaagte sounds together with microscopic lifeforms

commingled with ancient rock, an ensemble joined by the zama zamas. AMD cannot be addressed just as a dangerous substance to be contained; it is an expression of contemporary dynamics encountering historical conditions in complex and difficult ways.

The sonic quality here is particularly powerful. Marisol De la Cadena, for example, inverts the term “Anthropocene” to be “anthropo-not-seen,” naming the consequences when much remains invisible to the dominant Western view [21]. Or as Anna Tsing argues, we must develop an appreciation for “the multiple temporal rhythms and trajectories of the assemblage” [22]. Ensemble is a more direct way of expressing this, one that sidesteps a commitment to scientific models (“network,” “mesh”) or an affinity with European art (“assemblage”) in favor of referencing Black aesthetics that have long performed epistemological resistance. Though I do not claim these aesthetics for my own work, I am inspired to explore how thinking through ensembles might provoke novel practices within my own discourse.

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Ensembles of AMD in different parts of the world are interrelated even as they are situated in local conditions; my prior work with AMD in Colorado [23] was the basis for an invitation to participate in Watershed at the University of the Witwatersrand in August and September 2018. I chose to develop a new piece in collaboration with the students and faculty at the Centre in Water Research and Development (CIWaRD). Their research takes on the necessity of neutralizing the AMD that is held in containment pools near mines; extracting valuable substances in the process is also of interest. These potentially include “rare earth metals,” which thanks to the rapid development of the global electronics industry are in increasing demand [24]. Hence, “remediation” is not only a remedy of past industrial negligence; it also perpetuates the viability of extractive industries within the digital media economy.

The most straightforward way to treat AMD is to add lime, calcite, dolomite or slag—alkaline substances that will counteract the acid and dampen the chemical feedback. This approach does not address metals in the water that still possess reactive qualities, however, and it may only slow, but not prevent, the process that will produce AMD [25]. Consequently, CIWaRD is developing more effective approaches that work with nonhuman organisms. These include “bioreactors,” containers in which decomposing plant matter sustains miniature ecologies. As it flows through a sequence of bioreactors, AMD undergoes multiple physical and biological processes such as dilution, filtration, sedimentation, hydrolysis and ion exchange. The ensemble effect is potable water [26, 27].

A significant agent in bioreactor remediation is another species of bacteria. This is *Desulfovibrio vulgaris*, Acidithiobacillus’ anaerobic foil, which typically lives in aquatic environments (Fig.4). Instead of generating sulfates,

these bacteria “breathe” them in a respiratory process known as “dissimilatory sulfate reduction” which forms recoverable metal sulfides [28]. In other contexts, *D. vulgaris* has an antagonistic relationship with humans, infecting the body and corroding metal structures. But here, it produces an unlikely harmony in the ensemble of AMD as a “sustainable” means of extracting metals.

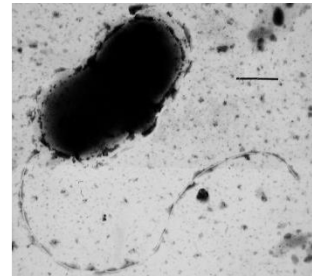


Fig. 4. *Desulfovibrio vulgaris*. (Photo: Graham Bradley. Public Domain.)

Bioreactors have yet to be deployed on an industrial scale in the Witwatersrand, but CIWaRD has an experimental operation at an undisclosed mine site in Mpumalanga Province which I visited with master’s candidate Tamlyn Naidu (Fig.5). The AMD pools themselves are strangely beautiful; disused mining equipment and a crust of chemical precipitate line the shores. Sensors at the site collect data on the acidity and metal concentration in large, interconnected containers. During my visit, the sensors showed that the process was working but not yet to the necessary degree.



Fig. 5. Bioreactor undergoing maintenance by Tamlyn Naidu. (© Brian House)

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I decided to include AMD itself in the Watershed exhibition. As plentiful as AMD is in the Witwatersrand, to present it in an art space in the center of the city would set up a different sort of encounter. The artwork would not be about containing AMD within the restricted areas of the mine site or laboratory, nor would it be comfortable with how people on the city’s periphery are acquainted with contaminated water in a way that those in privileged areas are not. And rather than represent these dynamics in some overdetermined way, the

work would make AMD available directly and leave it open to multiple interpretations.

A site for the installation was arranged through the Fak’ugesi Digital Innovation Festival, which also featured the work. Fak’ugesi partners with the Tshimologong Precinct, a Silicon Valley-style startup incubator in the central neighborhood of Braamfontein. In prior decades, the building was a legendary nightclub. It featured a small pool, now a courtyard visible from the street, through which the artwork could engage with the public (and manage a possible AMD spill). It also juxtaposed the piece with the nascent digital economy which relies on extractive industries for its hardware.

The labs at Wits furnished a set of old glass containers, and Ph.D. candidate Nicholas Burman and I filled these with ~100 liters of AMD from the Mpumalanga site. Although we took the requisite safety precautions, the nature of the endeavor meant that I became familiar with how the substance feels on skin and in the nose, and a distinctly metallic impression wafted from my work clothes for days afterward. To situate the containers in the space, I constructed a loose brick platform, which became part of the ensemble. The ubiquitous building material of Johannesburg, these bricks related the AMD to the conditions through which the city came to be.

In addition, Burman, Naidu and I decided that the installation itself could undergo remediation by adding slag to the containers (Fig.6). The process would cause a change to the color of the acid over the course of the exhibition as metals in the AMD precipitated to the bottom, and this would complete the first stage of processing for a bioreactor to which the result could then be added after the exhibition. On a small scale, the installation would demonstrate some of the more optimistic ways in which humans interact with AMD.



Fig. 6. Adding slag to the installation. Photo: (Fak’ugesi Digital Innovation Festival, used with permission)

Finally, because AMD “sounds” through the complex and irreconcilable processes in which it participates, I wanted it to be experienced at Tshimologong as a substance in flux. I did this by having the ensemble produce actual sound. While remediation would take place over a number of weeks, audible vibration would evidence the liveness of the process. And by resonating in the space with visitors’ bodies, the

4 House, Acid Love (abstracted in Leonardo Vol. 54, No. 5 [2021]).

sound would demonstrate the pervasiveness of the ensemble. Furthermore, the speakers and electronics in the installation would reference how consumer goods are implicated in an extractive global economy and are critical for cultural expression (sourcing them in Johannesburg’s second-hand markets underscored this intention).

In the resulting design, the sound is derived directly from the AMD. Since its high concentration of metals means the substance is conductive, AMD can be incorporated into an electrical circuit. I used a set of small microcontrollers to measure the resistance across each of the containers and generate pulse waves at corresponding frequencies; driving speakers with these signals produces sound that constantly shifts with the ongoing chemical interactions. The atonal mix also includes “beat frequencies”—acoustic phenomena in which sound waves interact to produce additional audible pulsations. In addition, one microcontroller works differently; its frequency is derived from Naidu’s dataset at the mine source, incorporating dynamics from CIWaRD’s bioreactor into the sound itself.



Fig. 7. Brian House, Acid Love, 2018. Installation at Tshimologong Precinct, Johannesburg featuring AMD and audio electronics. Photo: Brian House

The title, *Acid Love*, was inspired by the acidophile *A. ferrooxidans* as well as the former nightclub setting (Fig.7). The intent is not to make light of the negative impact of acid mine drainage—and socioeconomic forces responsible for it—on the lives of so many South Africans. Rather, it points to the difficult intimacy with which humans and nonhumans are materially entwined in the Witwatersrand. Or, to follow Moten’s critique of Freud, love is not simply the desire to return to some prior and unrecoverable unity between self and other (or between human nature). Rather, we can tune in to an endless unfolding encounter, “the ensemblic, improvisational nature of this sound of love, the human animality of its instruments” [29].

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Acid Love demonstrates how a resonant substance like AMD is an access point through which to engage with an otherwise intractable scale of interdependencies. Its aesthetic

expressivity is important in that regard. The color, smell, conductivity and toxicity of AMD make it available to the “ensemble of the senses” [30] in a way that can be approached as art. The questions that immediately follow ask what it is and how it came to be. The work is, therefore, a means of participating in, rather than representing, the ensemble of AMD. In the form of the installation, I have tried to to

emphasize such an ambivalent encounter. Visitors can walk around *Acid Love* and investigate it from any angle, even while they are bathed in the sound which calls into question whether the AMD is safely contained. It is not. And cultivating sensitivities not predicated on the divide between human and environment is necessary for its remediation.

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