ABSTRACT

Title of Document:	WHAT DOES THE MINE HAVE TO TELL US? ART AS A RECLAMATION STREATEGY IN THE POST-MINED LANDSCAPE OF THE OLDEST KNOWN MINE IN THE WORLD, NGWENYA MINE SWAZILAND
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Swaziland's Ngwenya Mines, the oldest known mine in the world, has been a source of ochre for cultural use for over 43,000 years. Until the 20th Century, extraction at Ngwenya Mine left an imperceptible mark on the landscape until industrial technology enabled new mining practices that have dramatically and irrevocably altered this landscape.

The intent of this thesis is to further the development of mine reclamation models and ultimately benefit similar sites around the world. By building on current mine reclamation strategies where Land Art is a mediator between ecology and industry, this thesis focuses on the important story Ngwenya Mine can tell. With no intervention, the conclusion will be an untreated landscape with limited potential. With creative design responses, a story of cultural and ecological integrity can persist into the future.

WHAT DOES THE MINE HAVE TO TELL US? ART AS A RECLAMATION STREATEGY IN THE POST-MINED LANDSCAPE OF THE OLDEST KNOWN MINE IN THE WORLD, NGWENYA MINE SWAZILAND

By

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Preface

The mineral products of the earth affect almost every aspect of modern civilization. Ngwenya Mine, one piece of the national wealth of Swaziland, Kingdom of King Mswati III in southern Africa, is the world's oldest known mine where evidence of the long history of mineral use is intact. Over time, the iron ore and other valuable minerals at Ngwenya Mine will be extracted and exhausted leaving behind a degraded and fragile landscape that can never be returned to pre-mined conditions. The pattern likely to unfold at Ngwenya Mine will be repeated at mines around the world and the impacts of large-scale surface mining will have repercussions on a global scale.

Mining, probably the oldest form of human industrial activity will continue as long as resources are found on Earth. Technological advances in mining have enabled extraction to exponentially expand in speed and scale. The marks and materials left in landscapes after contemporary mining projects cease require stabilization treatments at minimum and more complex strategies if the landscapes are to realize new productive uses.

Reclamation interventions allow post-mined lands to express the potential inherently within them and offer new cultural, economic, and ecological value. Landscape art and landscape architecture are especially capable of responding to, critiquing, mediating and healing post-mined areas. A creative reclamation plan for Ngwenya Mine will bring forward the universal importance of this place, respond to subsequent ecological needs, and take advantage of existing conditions by connecting to and enhancing infrastructure that Swaziland already has in place.

Acknowledgements

With deep gratitude I thank my entire committee, without them this project would not have happened. I would also like to thank the Maryland Chapter of PEO International for their support and encouragement. In Swaziland, Wiseman Dlamini, Bob Forrester and Dane Armstrong were outstanding in their willingness to help by providing information and critiques throughout the process. Swaziland's YEBO! Gallery and YEBO! ArtReach also offered much inspiration. Strijdom van der Merwe was gracious and generous with time and information that deeply informed this project. AMD & ART collaborators Stacy Levy and Dr. T. Allan Comp were both very giving of time and insight. Smithsonian Gardens and the National Museum for African Art were great places to be and talk with horticulturists, scholars and artists about the ideas within this project.

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Chapter 1: Background

Living and working in the Appalachian region of the United States, a coal-rich but low-wealth swath of the country, instilled a profound desire to participate in resolving the problems embedded in the practice of mining. In 2006, while studying environmental policy and planning at Ohio University I visited Kayford Mountain, West Virginia, with the environmental group Sierra Club. Kayford Mountain was the only intact mountain surrounded by others that had been mined by mountain top removal in order to access the coal seams under the Earth. Larry Gibson's family cemetery was on Kayford Mountain; the Gibson family's decision not to sell the land was the only thing protecting it. After telling us his story, Gibson plainly asked, "Now that you've seen this, what are you going to do?"

I continued to study the impacts mining have on the environment and on local communities and joined with local watershed groups to explore these things first hand. In 2006, employed by the Voinovich School of Leadership and Public Affairs at Ohio University, a think-tank development group focused on rural development, I worked on Southeastern Ohio's Raccoon Creek Watershed's Management Plan addressing acid mine draining from the 21,550 acres of surface coal mines and 25,610 acres of underground mines in the watershed. The strategies employed focused on treating the substance itself and little on the aesthetic or cultural possibilities.

I moved on to work with the Central Appalachian Network, a multi-state network that builds healthy regional economies by promoting economic justice through ecologically sustainable practices in rural communities. Since at least 1987 when the United Nations' defined sustainable development as that which "meets the needs of the

present without compromising the ability of future generations to meet their own needs"[1], efforts to craft and test development models addressing cultural, economic, and environmental leverage points have been underway. The Network developed models of sustainable economic development that could be replicated or adapted across the Appalachian region. The models included the development of agriculture value chains to grant market access to small farmers by establishing aggregation centers and distribution paths as well as working with local and state policy makers to enable schools and other institutions to more easily procure locally grown food.

Through the study of landscape architecture, I was drawn to the increasing practice of repurposing postindustrial sites into publicly accessible, artfully conceived civic spaces, envisioned within a framework of sustainability. While official models are not necessarily being developed, the evolution of renewal projects has arrived at a set of common practices that often engage community participation to generate places that interpret and celebrate industrial heritage and local culture, include ecological restoration efforts, and act as drivers of economic development.

The thesis is motivated by the extreme environmental and social impacts of industrial mining. Like many industries, mining provides a great benefit to civilization but rarely provides a plan for the post-industrial or post-mined place left behind. At Ngwenya Mine, the story of mining is vividly told through the existing landscape but is inconclusive. This thesis is an exploration into the opportunities associated with the inherent value of Ngwenya Mine and possible strategies to bring the story to a conclusion that makes Ngwenya a model for similar mines around the world.

[1] United Nations. http://sustainabledevelopment.un.org (retrieved May 9, 2013)

Chapter 2: Introduction

The manmade landscape is where societies can read their priorities. Mining, public art, preservation, and reclamation are some of the ways we express our philosophical attitudes about our world, reading the choices we make in the landscape tells us who we are.

To explore solutions to the global problems and issues associated with post-mined lands, this paper focuses on the landscape of Swaziland's Ngwenya Mine and ways emerging models from the field of mine reclamation could be applied. Ngwenya Mine, the oldest known mine in the world, offers a unique opportunity to follow the path of mineral mining. At Ngwenya Mines we can understand the cultural roots of mining from the Early, Middle and Late Stone Ages, through the evolution of metallurgy during the Metal Ages, ending at the ability of contemporary mining to extract the materials that have advanced civilization further than ever before. However, the story does not have to end there; processes of reclamation can conclude the story in a way that allows post-mined lands to have new value and new life.

To become acquainted with this project it is important to get a sense of place, become familiar with the materials of this mine in particular, understand the legacy of mining both locally in Swaziland and globally, and understand the benefits and problems associated with contemporary mining.

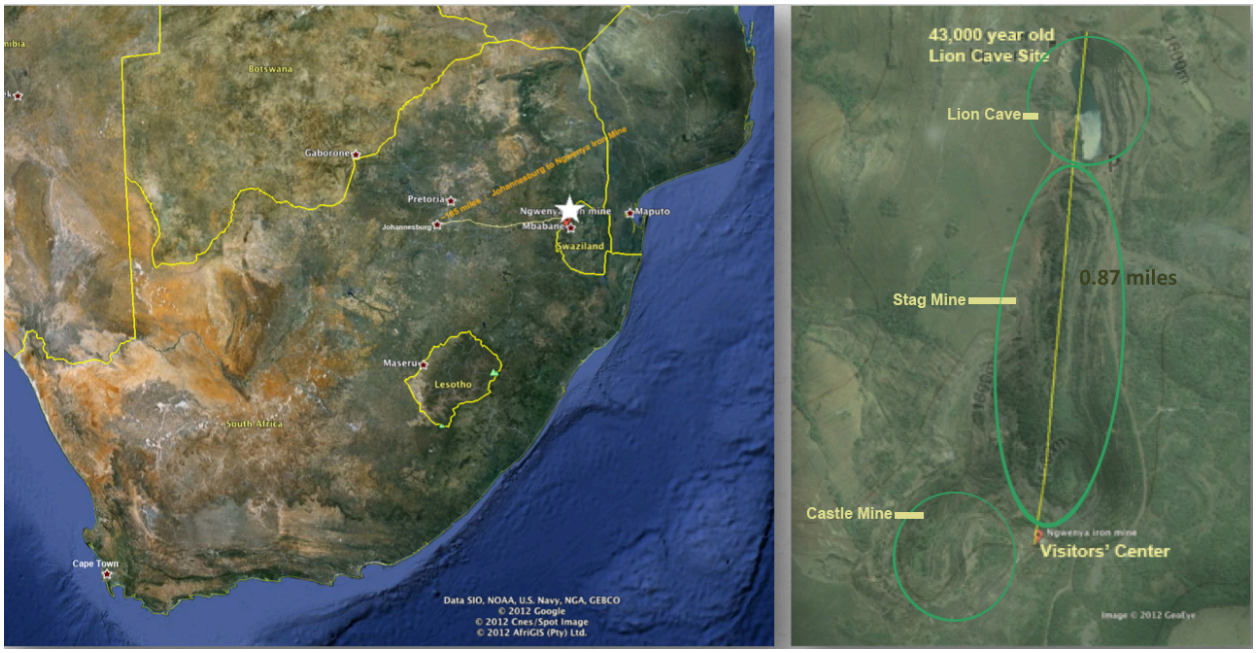

Figure 1: Map A) Southern Africa from Google Earth (left) and B) Ngwenya Mine from Google Earth (right)

Section 1: The Place

The focus area of this paper is Ngwenya Mine in the Kingdom of Swaziland in southern Africa. Ngwenya Mine is about seventeen miles from Mbabane, Swaziland's largest city and the national capital. 1.4 million people live in Swaziland; about twenty percent live in Mbabane. Most Swazis are indigenous Africans with only about three percent of the population being European or of European descent.[2]

Swaziland is a small country with a north to south length of about 120 miles and east to west breadth of no greater than 90 miles. The landscape is diverse with an altitude change of over 1800 meters between the mountains and the lowland plateau. Ngwenya Mine is in the northwest of the country, in the mountainous Highveld, located in the Malolotja Natural Reserve.

[2] CIA website. https://www.cia.gov/library/publications/the-world-factbook/geos/wz.html Retrieved May 9, 2013

To the east, Swaziland shares a border with Mozambique and South Africa on the west, north and south. On paved roadways, Ngwenya Mine is 70 miles from the eastern border with Mozambique and another 55 miles across Mozambique to the Indian Ocean. The Swaziland border with South Africa is less than three miles from Ngwenya Mine.

South Africa is an important economic trade partner supplying 90% of imports and receiving 60% of goods exported by Swaziland.[3] The main exports are sugar, wood pulp and minerals.[4] Mining has historically been an important sector in the Swazi economy but is now waning. Between the 1940s and 1960s, asbestos was the government's main source of revenue[5] but by 2010, only one mine remained active.[6]

In 1964, commercial iron ore mining began at Ngwenya Mine. The mine site is composed of three distinct mines, from north to south, the Lion Cave, Stag Mine, and Castle Mine (see Map 1B).[7] Lion Cave is where the earliest miners, the San people, mined for ochre, a common name for hematite, a reddish orange mineral used around the world in cultural practices, over 100,000 years ago.

The Ngwenya Mine Site is culturally and environmentally significant. It is located within the Malolotja Nature Reserve, an 18,000 acre reserve declared in 1982, and home to many endemic and endangered flora and fauna.[8] In 2008, the Swaziland National Trust Commission and Swaziland National Museum submitted Lion Cave to the United Nations Educational, Scientific and Cultural Organization (UNESCO), for consideration

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[3] CIA website
[4] Action for Southern Africa Constitution (ACTSA) Country profile. http://www.actsa.org/Pictures/UpImages/Swaziland/Civil_Society_Swaziland.pdf, Retrieved May 9, 2013
[5] Script from Ngwenya Mine Visitor Center Interpreter. Obtained in August 2012.
[6] USGS 2010 Minerals Yearbook. Lesotho and Swaziland. http://minerals.usgs.gov/minerals/pubs/country/2011/myb3-2011-lt-wz.pdf retrieved May 9, 2013
[7] Partners in Progress: The Opening of Swaziland' Railway and Iron Ore Mine, Produced by the Public Relations Department, Angle American Corporation of South Africa, Limited. November 5th, 1964, page 9.
[8] Swaziland National Trust Commission. http://www.sntc.org.sz/reserves/mal.html. Retrieved May 9, 2013

as a World Heritage Site. UNESCO began the procedures of authenticating the mine and justifying its outstanding universal value. A small museum and visitor center was built and interpreters were trained to guide visitors through the ecological and historic stories within the site. UNESCO has slowed the process of inducting Ngwenya Mine; today it remains on the tentative list of world heritage nominations.[9]

Section 2: Overview of Hematite Mining in Swaziland

Archeological studies of two important cave sites in Swaziland and nearby South Africa, Lion Cave and Border Cave indicate that at least 100,000 years ago, ochre was transported about 60 miles across the country and handmade into crayons or pencils to serve as a medium to create ornamental drawings or paintings either on stone or as body paint.[10] At Lion Cave in particular, thousands of primitive mining tools have been found and proven to be at least 43,000 years old.[11] Mining for ochre is suspected to have carried on at Lion Cave until an unknown time when a five to ten ton boulder fell from the hill above and blocked the cave's entrance.[12] In the 1940s, British Colonialists, who had assumed control of Swaziland at the beginning of the twentieth century, surveyed the country to record an inventory of resources to attract investors. During this inventory, Lion Cave was rediscovered.[13] Within ten years, the British mining company Anglo-American Corporation, attracted by the iron ore deposits on the Ngwenya Mine site, established the Swaziland Iron Ore Development Company.[14] Between the mid1960s

[9] UNESCO. http://whc.unesco.org/en/tentativelists/5421, retrieved May 9, 2013
[10] Raymond Dart, Debt of Paleontology to Hematite, page 207
[11] Dart, Debt of Paleontology, page 207.
[12] Raymond Dart and Peter Beaumont, Evidence of Iron Ore Mining in Southern African in the Middle Stone Age, page 127
[13] Partners in Progress, page 5
[14] Partners in Progress, page 5

and late 1970s almost 30 million tons[15] of high-grade iron ore was extracted from Ngwenya Mine, hauled by truck across the country and through Mozambique to the port at Maputo where the ore boarded ships bound for Japan (Map of iron route from Visitors' Center Museum).[16] Between the 1970s and 2010s, Swaziland's mining industry went into decline. In 2012, Indian firm V.M. Salgaocar & Bro. Pvt. Ltd was granted a seven-year lease at the Ngwenya Mine site to reprocess, or re-mine, the iron ore tailings left by the Anglo-American mining forty years before.[17] Today, a reprocessing plant is on site, separating the viable iron ore from the waste materials distributed around the Ngwenya Mine.

Section 3: The Material

Hematite is a hard and heavy oxide mineral (Fe_2O_3) with a high iron content of 70%. Iron richness and abundance make it the most important iron ore available. There are many differently named types of hematite; one is specularite, also found at Ngwenya Mine, a glittery, gunmetal colored type of hematite.[18]

The complete history of mining can be found within an exploration of hematite used culturally as ochre and industrially as iron ore. The world's first miners, going back 100,000 years[19] sought out ochre for various ceremonial purposes, most commonly for burial practices.[20] Eventually, advances in technology led to the Iron Age when the spread

[15] Script from Ngwenya Mine Visitor Center Interpreter. Obtained in August 2012.
[16] Partners in Progress, page 5
[17] V.M Salgaocar website: http://www.vmsalgaocar.com/vision.php. Retrieved March 26, 2013. V.M. Salgaocar & Bro. Pvt. Ltd. Company Profile: "enlightened vision" is "to be a dominant iron ore exporter and to establish Hotels of international standards" and the Salgaocar "steadfast mission" is "to contribute to the local economy through sustained and judicious development of mineral resources in an eco-friendly manner"
[18] Encyclopedia Britannica, Hematite entry. http://www.britannica.com/EBchecked/topic/260704/hematite. Retrieved, March 18, 2013.
[19] Dart, Debt of Paleontology, page 207
[20] Raymond Dart, The Birth of Symbology, page 22

of metalworking across southern Africa followed the migration of the Bantu people who were crafting tools to farm and hunt.[21] Between then and now, the entire structure of modern civilization was built upon iron.

[21] Knapp, Arthur Bernard, Vincent C. Pigott, and Eugenia W. Herbert. 1998. Social approaches to an industrial past : The archaeology and anthropology of mining. Page 139

Chapter Two: Mining

Section 1: The Practice of Mining

Mining, at its most basic, is understood as the process of extracting minerals of value from the earth's crust for the benefit of mankind.[22] Understanding what motivated our ancestors to gouge the Earth's surface and dig in search of something valuable to their lives will illuminate the special importance of Ngwenya Mine. As the following story unfolds, it is easy to imagine those experiencing it understanding their world to be the most modern possible. Understanding the complex history makes it easier for contemporary societies to accept that it is still possible to add value to our quality of life.

A thread that connects our most ancient ancestors with today's modern civilization is the reliance on the Earth for materials that shape our lives. Shelter, food, tools, and ornament have been sourced from the Earth since the beginning of time. During the Paleolithic or Old Stone Age, the very first miners were in search of flint, silica, which reliably fractures into sharp-edges. The miners, *Homo neanderthalensis,* mining between 80,000 to 30,000 years ago, used whole stones as a primary tool until they discovered the sharp-edge fracturing qualities of flint which led to more sophisticated but still crude flint tools.

The act of collecting the Earth's materials eventually broke the surface and discoveries of flint, clay, colorful stones, copper and other mineral materials allowed civilizations to progress toward higher qualities of life and more complex social

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[22] Gregory, Cedric Errol. 2001. *A concise history of mining*. Lisse, Netherlands; Exton, PA: A.A. Balkema, page XV

arrangements. Flint is found in deposits and in fallen rocks that line stream beds, one theory is that actual mining for flint began when it was discovered that newly excavated flint was easier to craft into tools making it preferable to that found in streams.[232425] Another theory is that during the Neolithic period, when supplies of surface flint were exhausted, prospecting for flint deposits began.[26] Regardless, about 35,000 years ago, *Homo sapiens* reached Europe and "flourished in an environment of excellent flint deposits and an abundance of caves" demonstrating the important role minerals and ultimately mineral mining had in stimulating early human evolution and progress.[27]

Dramatic progress in metal mining is linked to the emergence of crafted metal implements about 8,000 years ago in Turkey. This coincides with the commencement of the Copper Age. Copper use underwent much experimentation, from hardening it by hammering, to annealing it or making it more malleable with fire, and finally smelting to manipulate it into a relatively strong substance capable of being sharpened though quickly becoming dull.[28]

There is evidence that smelting was independently developed in sub-Saharan Africa, southeast Asia, northern China, and western Europe, most likely in all cases associated with advances in pottery firing.[29] As technology advanced, temperatures around 900 degrees Celsius could be reached and maintained which expanded the

[23] Gregory, A Concise History, page 4
[24] Jellicoe, Geoffrey, and Susan Jellicoe. 1975. The landscape of man: shaping the environment from prehistory to the present day. New York: Viking Press. Page 11
[25] Dart, the Debt of Paleontology. Page 208
[26] Dart, the Debt of Paleontology. Page 208
[27] Gregory, A Concise History, page 4
[28] Gregory, A Concise History, page 12

[29] Martin Lynch, Martin,. 2002. Mining in world history. London: Reaktion Books. page 9

opportunities for smelting. Eventually, the process of alloying or mixing materials like tin with copper, advanced to get a sum greater than the parts and bronze was created.

The first true metal tools and weapons were made of bronze during what accumulated into a major epoch in the development of humankind, the Bronze Age between 3200 and 1200 BC. Following bronze tin, copper, silver and lead were exploited. The next major step was iron, a more abundant, harder and stronger material than bronze. The Iron Age was experienced at different speeds around the world but ranged from 1300 BC to 500 AD.

Iron was in use long before however; its manipulation and full exploitation was limited by the point at which it becomes molten, 1400 degrees Celsius. Before smelting technology was capable of reaching that point, rendering iron useful was extremely labor intensive.[30] Eventually, around 680 BC the invention of metal coinage replaced bartering which added a layer of value to mineral mining.[31] Between around 500 AD, and now, the entire structure of modern civilization was built upon iron**.**

By the Industrial Revolution's mid1700s through the early to mid1800s, various mining technologies had been explored, practiced and replaced. Various underground and surface mining practices propelled transitions from agricultural societies to industrial ones especially in Europe and the United States.[32] Today mining has expanded to supply materials for automobiles, electronics and almost every other aspect of our lives.

The modern world's needs for more materials, especially minerals, is already bringing the future into focus through advanced and sophisticated technologies like metal

[30] Lynch, Mining in World History, page 11
[31] Gregory, A Concise History, page 28
[32] Gregory, A Concise History, page 58

recycling and mining processes that extract very fine grains of available minerals from their sources.

Section 2: The Importance of Iron Mining

The importance of iron mining in particular and its nuanced history within the evolution of civilization helps elevate the true importance of Ngwenya Mine. In the article, The Birth of Symbology, Raymond Dart, an Australian anthropologist and scholar on southern Africa, explains and emphasizes that importance when he writes, "By means of its dominating agency in the diffusion of the myths, rites and mysteries of ancient metallurgy and alchemy, it has played parts of such continuity and expanding diversity as to have rendered it unique amongst all minerals in moulding mankind's existence then and today."[33] This story is especially important to sub-Saharan Africa, as much of the landscape is exposed low-grade iron.[34]

Section 3: Opencast Mining

Ngwenya Mine is an opencast or open pit surface mine that was mined from the top down. Opencast mining greatly disturbs the surface and the use of large-scale machinery that subsequently reduces the number of miners required. The mine is dug by creating a series of benches, berms, and haul roads that are cut gradually to minimize the slope of the pit-walls as the pit grows deeper. The slope between benches, berms or roads can vary but is commonly 45 degrees. Opencast mining extracts the mineral and large quantities of overburden, materials of no value like soil and other minerals, while the mine is being developed. The overburden waste piles can be used to regrade the surface, a reclamation

[33] Dart, Birth of Symbology, page 25
[34] Knapp, Social Approaches to an Industrial Past, page 139

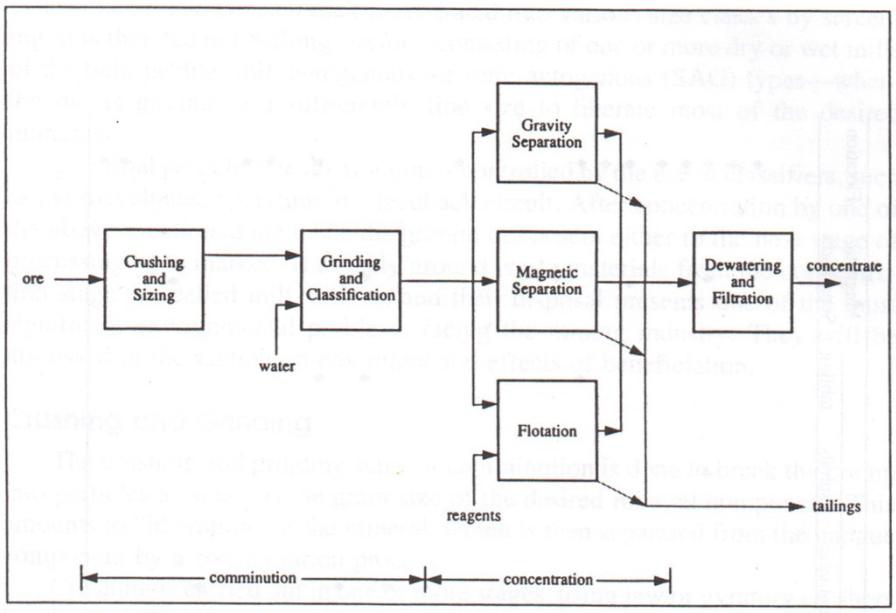
strategy. However, during extraction, waste rock, dust, mine drainage and ore oxidation are all threats to the local environment.

Figure 2: Historic photograph of Anglo-American Mining operation commencement in the 1960s. Used with the permission of Bob Forrester.

Following extraction, beneficiation (see Image ---[35]) is a process by which undesired constituents are removed, usually on the mine site so transportation costs are dedicated to high value ore. Beneficiation is a three-step process: preparation through crushing or grinding, concentration to separate the ore from the waste, and finally dewatering of the concentrate. The concentration processes include gravity separation,

[35] Ripley, Earle A., Robert E. Redmann , Adèle A. Crowder, and Earle A. Ripley . 1996. *Environmental effects of mining*. Delray Beach, Fla.: St. Lucie Press. Page 25

flotation, and magnetic and electrostatic separation. The remainders, generally left on site, are the mine tailings.



Simplified flow-chart of the beneficiation stage of mining, in which an ore is comminuted and separated into its desired (concentrate) and gangue (tailings) fractions.

Figure 3: Simple diagram of the beneficiation process.

Section 4: Mining and Community

No one "culture of mining" can be associated with the act of mining at any time in history or anywhere, including sub-Saharan Africa. Mining cultures were naturally shaped by the societies mining rather than the act itself. However, with a few exceptions, there is evidence of two closely related characteristics of mining patterns across much of the sub-Saharan region. The first is that mining camps were often temporary and driven by seasonal changes and the second is that miners were laborers, often providing the labor for other activities, sometimes farmers and cattle raisers who, during the dry season, would migrate to areas rich in iron ore and mine for the season.[36]

[36] Knapp, Social approaches to an industrial past , page 140-41

Migration continues to be a result of mining today. Current anthropological research on mining in general and Africa in particular has collected evidence that migration to mine areas occurs more frequently and for longer periods of time in African countries than in Europe and Asia. This is important because trends in migration, like distance of migration and length of time away from home, impact the social fabrics of local communities. Migration of this sort often attracts one gender away from rural communities and the absence of large numbers of males or females, especially when a mass exodus within a short period of time happens, impacts the "traditional values and authority patterns" of a community.[37]

Other important impacts around mines and many other newly industrial areas are felt in the agriculture sector providing the miners' food supply. If farms are not already in the area, they often accompany the industrial activity that brings with it a social dynamic. An example around a South African mining industry, which did have pre-existing local farms farmed by African producers suddenly became much more lucrative. Within a few years, white Afrikaner farmers, backed by the state, displaced native producers.[38]

In these transitions forced upon a place by new industry, are basic examples of the competing modes of production, the precapitalist and the capitalist. Conflict, unequal exchange, and organizations following labor groups emerge changing the local lifestyle as these new social and economic patterns take hold and replace preexisting patterns.[39]

Section 5: Iron Mining and the Environment

The reality is that mining in general has advanced so quickly that the full scope of environmental issues associated with mining practice remains unknown. Today, as the

[37] Godoy, R. 1985. "Mining: Anthropological Perspectives". *Annual Review of Anthropology.*14: 199-217. Page 206
[38] Godoy, page 208
[39] Godoy, page 209.

effects become more clear, awareness, concern and comprehension of the problems is increasing globally.[40]

What is known is that while iron ore mining does not cause the levels of pollution as does mining for other materials like coal can, it is still a significant disturbance on the landscape. During extraction, the impacts of iron ore mining are localized involving the disturbance of the surface, production of waste material and the release of particulate matter into air and water. A disturbed surface often means there is less space available for wildlife habitat, agriculture, and recreation.[41] Iron mine waste materials do create a great risk for environmental contamination, with especially high potential for groundwater acidification. The storage and treatment of waste is critical and is one of the most difficult things for the mining industry to accomplish. The metal content in the waste materials can result in chemical reactions with other elements in the environment that need treatment well into the future. In this image from the northern gorge near Lion Cave, note the water discoloration between rusty and aqua, this is a chemical reaction between water and iron.

[40] Ripley, redman, crowder, page vii
[41] Arbogast, B. F., Daniel H. Knepper, and William H. Langer. 2000. *The human factor in mining reclamation*. Denver, Colo: U.S. Geological Survey. Page 1

Figure 4: Photograph of the pond near Lion Cave. Photo taken by and used with permission of Greg Marinovich.

Chapter 3: Mining at Ngwenya Mine, Swaziland

Section 1: Introduction to Mining in Swaziland

Swaziland's national economy was changed forever because of mineral development. This chapter will explore the current conditions and status of mining and mineral activity at the Ngwenya Mine site from present day back to the historic cultural uses that motivated the exploitation of ochre on this site over 100,000 years ago. A description of the site's current conditions and constituent pieces will begin to illuminate the physical character of the place. An understanding of the uses of the site and how they have changed over its lifetime will explain the effects of different uses on different user communities. Simultaneously, a political reality of Swaziland, including its history, is at play on the state of Ngwenya Mine.

Mine reclamation is an emerging phenomenon. Policy and practice are in the early stages of being developed around the world. This chapter will conclude with an exploration into aspects of the policy model in place in the United States. Finally, an examination of two mine reclamation projects demonstrates the evolution of mine reclamation. One project, AMD and Art, demonstrates how mine reclamation policy has been creatively applied in the United States and another project at a DeBeers diamond mine in Namaqualand, South Africa demonstrates how mining reclamation is beginning to be assumed by mining companies themselves.

Section 2: Today at Ngwenya Mine

Figure 5: Diagram of Mining History and Zones

In 2012, Salgaocar Swaziland (PTY) LTD, a subsidiary of V.M. Salgaocar & Bro. Pvt. Ltd based in Goa, India, began processing iron ore mine tailings at the Ngwenya Mine

Site.[42] Salgaocar was granted a seven-year lease at Ngwenya in 2012. This is significant because Swaziland's once robust mining industry had been in decline and the outlook was grim. The 2010 United States Geological Survey report on the state of Swaziland's mining industry and resources projected little change in the downward path due to the low levels of exportation and the high levels of HIV/AIDS[43]. The report listed the minerals of economic importance as coal, diamond, gold, kaolin and silica, all with declining commodity rates between 2006 and 2010, and listed only one official mine in the country, Maloma Mine of Maloma Colliery Ltd., a coal mining operation in the eastern part of the country. The report suggests that the importance of mining in 2010 Swaziland was minimal and that information and reporting about the state of the industry was not readily available. Neither Ngwenya Mines nor iron ore were mentioned in the report. [44]

Swaziland's greatest challenge is indeed the high prevalence of HIV infection; the World Health Organization identifies it as the rate highest in the world. This impacts every aspect of Swazi civic live, work absenteeism, health care infrastructure, educational attainment, emotional well-being, family structures, and the amounts of public attention, funds and resources available for other needs.[45] This crisis directly explains why further exploitation of natural resources and any other source of income may be pursued by the Swazi state. That aside, the local response to the Salgaocar project was not enthusiastic.

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[42] V.M Salgaocar website: http://www.vmsalgaocar.com/vision.php. Retrieved March 26, 2013. V.M. Salgaocar & Bro. Pvt. Ltd. Company Profile: "enlightened vision" is "to be a dominant iron ore exporter and to establish Hotels of international standards" and the Salgaocar "steadfast mission" is "to contribute to the local economy through sustained and judicious development of mineral resources in an eco-friendly manner"

[43] USGS 2010 Minerals Yearbook. Lesotho and Swaziland.

[44] USGS 2010 Minerals Yearbook. Lesotho and Swaziland.

[45] World Health Organization (http://apps.who.int/ghodata/?vid=18900&theme=country) Retrieved May 9, 2013

The media captured the local response and an information dossier on the Salgaocar Ngwenya Iron Ore project was created to record the situation.

Section 3: The Salgaocar Project

In 2011 Salgaocar Swaziland was granted a lease to process tailings from an iron ore mining project executed by Anglo-American Corporation (see next section) that terminated in 1977. The project is described by Salgaocar and the Swaziland Ministry of Natural Resources & Energy as a "rehabilitation" project and as a sustainable development project with components addressing the social, environmental and economic capital needs of Swaziland. The Ministry of Natural Resources & Energy, describes the project as follows[46]:

> "Salgaocar Africa Resources identified an opportunity to rehabilitate the dumps that were left by Anglo-American Corporation in 1977; a basis for sustainable development in Social, Environment and Economic Capital- a balance in the Triple Bottom Line Principle. Having realized the improper management of the environs due to improper disposal of mine wastes at the closed Ngwenya Iron Ore Mine, Salgaocar indicated its intention to reclaim the mine dumps at the old mine by lodging a mining licence [*sic*] application to the Commissioner of Mines. The Minerals Management Board appraised Salgaocar's proposal based on the requirements of the Mines and Minerals Act 4 of 2011. Salgaocar Swaziland Pty Ltd was successfully granted the Mining Lease in June 2011 by INgwenyama on behalf of the Swazi nation. The basis for this decision was the Triple Bottom Line Principle of Sustainable development which formulates the provisions of Mines and Minerals Act 4 of 2011."

As required by Swaziland's mining policy, Salgaocar produced an Environmental Impact Assessment (EIA) and Comprehensive Mitigation Plan before processing began. The EIA, dated August 2011 included an attached cover letter dated July 2011, and was

[46] The Swaziland Ministry of Natural Resourced & Energy: http://www.gov.sz/index.php?option=com_content&view=article&catid=84:natural-resources-a-energy&id=845:ngwenya-mine&Itemid=232 Retrieved May 9, 2013

submitted to the Swaziland Environment Authority.[47] Within the document, the phases of the processing plan are identified as follows: widening access roads, bringing in equipment, setting up offices, removing wattle trees which have overgrown the dumps, excavating the site, employing a beneficiation process, and transporting the final material to the Maputo port. Salgaocar estimates that 223 trips will be made daily by a fleet of 56 trucks carrying 32 tons of material.[48] To determine the value of iron ore that will be removed from the site, the iron ore market price tables in Appendix --- suggest that the material leaving daily is valued at approximately $1,105,000USD.[49] The closure plan following the "rehabilitation" project is to level the site, apply topsoil and revegetate the site with endemic plants.[50]

Figure 6 (above right): Infrastructure installed between August 2012 and January 2013. Illustrative of the speed at which the operation has been installed.

[47] Environmental Impact Assessment of Salgaocar Mining at Ngwenya Mines. page 1-2
[48] EIA, Page ii
[49] Iron Ore Monthly Price. http://www.indexmundi.com/commodities/?commodity=iron-ore. Retrieved March 29, 2013
[50] Environmental Impact Assessment, page 3.

Between August 2012 and January 2013, significant infrastructure (see images: electricity, water lines) was installed on the Ngwenya Mine site. Several soil samples (see images) were also taken which suggests that further mining is being considered beyond the processing of tailings for which the 2011 lease was granted.

Fines Mining and Melting (PTY), a South African company, built three processing plants at Ngwenya Mine in order to implement the complete beneficiation process. The enormous quantities of water used in the beneficiation process are being siphoned from the pond, next to Lion Cavern in the northern pit and transported for use in the beneficiation plant, at least a mile in distance.[51]

Section 4: Public Response to the Salgaocar Project

Public discussion about the Salgaocar Project at Ngwenya Mine is rare. Perhaps, as in many cultures this is because conflict is avoided or perhaps the priorities for public interest are absorbed in solving issues faced by developing countries. While in Swaziland, reactions to questions about the mine were that it is not discussed, that it is a taboo subject. "Swaziland's Ngwenya mine extracts its ore and exacts its price", an article in the South African weekly *Mail & Guardian* newspaper describes talking with a park guide at the mine and he becomes "quiet. As is almost everyone in Swaziland" about the topic.[52] Of the public responses, the loudest voices are those from the environmental and art communities.

Environmental groups challenging the EIA's predictions about air, soil and water quality are recorded in the Ngwenya Dossier and bring attention to the fact that the EIA's rehabilitation plan is "restricted to half a page"; excludes details of the industrial

[51] Email with Isak Dippenaar, metallurgist, Fines Mining

[52] Bowles, Nellie, August 31, 2012. http://mg.co.za/article/2012-08-31-00-swazilands-ngwenya-mine-extracts-its-ore-and-exacts-its-price

reprocessing factory (size, noise, chemical presence); fails to incorporate the Swaziland National Trust Commission requirements of heritage and game animal site treatments; [53] and omits details about iron ore tailings treatment; dust mitigation; and stockpile management.[54]

Swaziland's art community has also made Ngwenya Mine its subject. YEBO! Contemporary Art Gallery in Mantenga, Swaziland has hosted at least two exhibitions with pieces inspired by and critiquing the capitalist culture that has commoditized nature's resources at Ngwenya Mine. *Exhibition #15 – Swaziland Now Part II* showed the work of Ray Berman and Dane Armstrong. Berman's paintings were described as abstractions of the trail of ochre, symbolizing blood, that spans between the mine and India, its current destination. Armstrong's piece, "I'm $till Waiting", the hand with shirt cuff, comments on the impacts capitalism and commoditization of natural resources have had on Swazi cultural fabric, those who have adopted capitalism are not only able to profit from the culturally priceless ochre, but are ready to ask for more. *Exhibition #17 – Kaleidoscope*[55] in which Katlin Sandvik's "iCorrput" responds to the iPad "gifts" Salgaocar gave to government ministers as the lease deal was being brokered, the Bowles

[53] Comments on the Rehabilitation of Ngwenya Mine EIA. http://ngwenyadossier.wikispaces.com/file/view/Comments+on+the+Rehabilitation+of+Ngwenya+Mine+EIA.pdf/282336972/Comments%20on%20the%20Rehabilitation%20of%20Ngwenya%20Mine%20EIA.pdf retreived March 29, 2013

[54] Comments on revised EIA. http://ngwenyadossier.wikispaces.com/Comments+on+revised+EIA. Retrieved March 29, 2013

[55] YEBO! Gallery Swaziland http://yeboswaziland.com; retrieved March 29, 2013

article explained this as bribery.[56]

Figure 7: Dane Armstrong, I'm $till Waiting, YEBO! Gallery Swaziland. Photo by Sarah Watling, permission to use image of artwork granted by artist Dane Armstrong.

Public art is a component of this thesis, motivated by the ability of public art to generate public discussion. The goal of this project is not to cause controversy but to fuel a conversation that is already underway and bring it into the public realm. This thesis proposes a more thorough address of the social, environmental and economic issues that could be incorporated into the Salgaocar closure plan at the end of their lease or when the

[56] Bowles, Nellie, August 31, 2012. http://mg.co.za/article/2012-08-31-00-swazilands-ngwenya-mine-extracts-its-ore-and-exacts-its-price

last mineral resources are removed from the site and no further financial interests are available.

Section 5: The Anglo-American Project

The Salgaocar project is possible because of a commercial mining project executed by Anglo-American Corporation, a British mining company. In the 1940s, as part of a national economic development plan in preparation for granting independence to Swaziland in 1968[57], British Colonists took an inventory of Swaziland at large including arable land, natural resources, and other features and existing conditions that may have been attractive to investors in search of business opportunities in the country. [58] In 1946, 47 million tons of ore containing 62% iron were proven present at Ngwenya Mine with the probability of an additional 15 million tons on site. Nearby, north of Ngwenya, another 280 million tons of low-grade ore containing 48.7% were estimated. In addition to this large mineral deposit, Lion Cave was also discovered behind a huge five to ten ton boulder believed to have fallen from the hill above. Within the Lion Cave were mining tools and charcoal which, based on carbon dating, proved that 43,000 years ago, mining was underway at Ngwenya mine. [59]

[57] Interview with Bob Forrester, anthropologist, author, museum designer, at Ngwenya Mine on January 8, 2013.
[58] Partners in Progress, page 5
[59] Dart and Beaumon, 1969, Evidence of Iron Ore Mining in Southern African in the Middle Stone Age, page 127

Figure 8: Top: Photo from "Partners in Progress" the PR brochure released by Anglo America. This image is of Ngwenya Mine before mining began.

Anglo-American, attracted by the hematite deposit on the Ngwenya Mine site established the Swaziland Iron Ore Development Company in 1957.[60] In 1964 the company obtained at 21-year lease, with the option to extend an additional 21 years, on Ngwenya Mine. During the 21-year lease, the company was to pay a nominal $700 in rent annually and a small mineral tax of 2.5% of the value of the ore mined. Anglo-American Corporation, in collaboration with De Beers Consolidated Mines, lent the Swazi government $11-14,000,000USD to construct the Swaziland Railway using Anglo-American's labor force. As the first railway in the country, it came with enormous social and economic benefits to Swaziland that are still felt today, this map shows the 201 kilometer[61] railway from west to east with the gray area being out of service but the continuous black line showing the significant portion of the railway still in operation.[6263]

Also in preparation for mining, the Anglo-American project brought infrastructure like electricity, 50 homes and a small school for miners and their families. During the mining period, 1964-1977, 800 Swazis helped mine 28 million tons of high-grade ore, small scale by world mine standards, which were then exported to Japan, where the manufacture of inexpensive automobiles created a great demand for steel. Exact statistics on earning by Anglo-American and by the Swazi state are undocumented[64] but in today's market would be valued between $210,000,000-224,000,000USD. Of note, in January 2013, the interpreter at the Ngwenya Mine site pointed out that Anglo-American's

[60] Partners in Progress, page 5

[61] Anhaeusser, Carl R. The History of Mining in the Barberton Greenstone Belt, South Africa, With an Emphasis on Gold 1868-2012. Page 21.

[62] De Kun, N. 1965. *The mineral resources of Africa*. Amsterdam: Elsevier Pub. Co. page 203

[64] Script from Ngwenya Mine Visitor Center Interpreter. Obtained in August 2012.

opencast mining operation intentionally preserved Lion Cave for its historic and cultural values, sacrificing at least one ton of iron to leave it untouched.[65]

There are three important aspects of the Anglo-American project that are part of the inspiration for this thesis. The first is that while the extents of the benefits of Anglo-American's efforts may be debatable, without question, Swaziland benefited from the infrastructure and short term economic gain that came from the project. The second is that Anglo-American recognized the universal value of Lion Cave as the oldest known mine in the world and made sure it was preserved. The last is the speed and scale of the project; the rate at which it was implemented and terminated and the amount of material that was excavated over such a brief period of time. In public relations materials prepared by Anglo-American, the speed at which the project was able to move is commended:

> "An impressive aspect of Swaziland's latest economic advance is the speed at which it has taken place. The designs and builders of the railway, the mine and the ore-loading terminal at Lourenço Marques have all succeeded at meeting difficult schedules on time. Indeed, the entire project has been a notable example of co-operation between administrators, businessmen and engineers of many different nationalities."[66]

[65] Conversation with Wiseman Dlamini, Naturalist and Interpreter, January 4, 2013 at Lion Cave.
[66] Partners in Progress: The Opening of Swaziland' Railway and Iron Ore Mine, Produced by the Public Relations Department, Anglo-American Corporation of South Africa, Limited. November 5th, 1964

When the iron ore at Ngwenya Mine was first being exploited to feed industrial needs, ideas around environmental reclamation had not developed. Within 13 years, almost 30 million tons of iron ore were extracted and no rehabilitation efforts were undertaken before the Anglo-American Corporation donated the mine to the Swaziland National Trust Commission.[67] Perhaps unbeknownst to anyone at the time, the condition of Ngwenya Mine in 1977 made it an environmental liability.

Figure 9: Post Mining impacts include water pollution in the top image and waste piles in the lower images.

[67] Swaziland's Ministry of Natural Resources and Energy http://www.gov.sz/index.php?option=com_content&view=article&catid=84:natural-resources-a-energy&id=845:ngwenya-mine&Itemid=232. Retrieved February 7, 2013

The environmental impacts that have been revealed since then include significant water pollution from the newly exposed mineral material, the disruption on the landscape that spans almost a mile and goes 300' deep, the loss of native and endemic plant and animal habitat to alien species like the wattle tree. The middle gorge, Stag Mine, has a drainage pipe that outlets into a river. The northern gorge near Lion Cave collects rainwater that is discolored from the chemical reaction between iron ore and water. The tailings dumps, in the process of being re-mined by Salgaocar, remained exposed to the elements and undoubtedly polluted the soil and water nearby.

The elements of speed and scale achieved by the Anglo-American Corporation are even more dramatic when situated within the entire history of the Ngwenya Mine site. In 1968, during Anglo-American's tenure at Ngwenya Mine, Swaziland was granted independence from the British Colonists who held control of the country since 1902.

Section 6: Colonialism in Swaziland

The first whites, the Boers and the British came to Swaziland in the 1800s. They were farmers, traders, hunters, and missionaries who arrived during King Mswati II's reign (1840-1868)[68]. Because of relatively friendly relationships between the whites and Swazi, land concessions were granted to the Boers, who were interested in farming, and the British, whose interests were mining and trade. The whites quickly gained and held concessions on all of Swaziland, which ultimately led to the subjection of the Swazi. The Boers and British joined in exerting control over the Swazi as the "White Committee".

[68] Kuper, Hilda. Page 2. 1952 The Swazi, Ethnographic survey of Africa, edited by Darll Forde. Southern African Part I.

The Committee dissolved, the Anglo-Boer War erupted and concluded and in 1902 Britain assumed "reluctant control" of Swaziland.[69]

[69] Kuper, Hilda. Page 6.

Chapter 5: Ochre's Cultural History in the Ngwenya Mine region

Section 1: Ochre and the Bantu People

When the whites arrived, they found an area settled by Swazis who were descended from the Bantu people. The Bantu began migrating from central Africa to what is now Mozambique in the 15th century and by 1750, what is now Swaziland had been taken from the San people by the Bantu.[70] Contemporary Swazi are decedents of the Bantu people.

The Bantu people who occupied this area and whose ancestors are the Swazis, used and still use ochre as a medium with the ancestral world which offers guidance through decision-making, problem solving, illness, and the location of game animals and rainmaking. Today's Swazis mainly use ochre for marriage purposes. During the kugcotshiswa libovu ceremony, the face of the bride is anointed with ochre providing the groom's ancestors the opportunity to approve and accept her.[71]

Section 2: Ochre and the San People:

The majority of the Lion Cave's story of ochre use belongs to the San people**.** The San lived in Swaziland since prehistory and were pushed out by the encroachment of the Bantu who completely overtook Swaziland by 1750.

Ochre was an ingredient in the paint mixtures used by the San in southern Africa to create cave paintings across the region, many still visible and legible today. Wadley, Willis and Lombard explain that the antibacterial properties of ochre have been exploited by the San in tanning, softening and coloring leather which also continues today in San

[70] Knapp, page 139
[71] Swazi Culture An Annotated Bibliography http://www.h-net.org/~africa/sources/SwaziBib.html

communities in Botswana and Namibia.[72] Evidence of the use of ochre in an adhesive mixture used in hafting, the process of attaching a handle to a tool, was found in another South African mine from the Early Stone Age that proves a relatively sophisticated technical knowledge.[73]

Section 3: Ochre and Cultures around the World

In the Greek language, one of the oldest recorded languages in world history; "haima" is translated as blood and in Greek culture, red ochre is known as "hematite", blood-like or bloodstone. Further emphasizing the strength of the symbolic connection civilizations made with hematite, Raymond Dart, the Australian anthropologist and scholar on southern Africa suggested that, "perhaps it was inevitable that iron ore should play a preponderant role in human cultural history, because the principal metallic elemental and colouring constituent of all vertebrate blood is iron."[74]

One of the most culturally valuable, important practices in societies across time and space is the preparation of their dead for final rest or for a departure from the mortal world. Dart argues that the correlation or symbology of red ochre as a "surrogate for blood appears to have been universal"[75] as evidenced by the presence of ochre in funerary remains around the world, in "burials from the Red Lady of Paviland in far western Europe to Choukoutien in far eastern Asia, in diverse rituals throughout Africa, Australia and the Americans to the Cape of Good Hope, Tasmania and the Tierra del Fuego".[76]

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[72] Wadley, L., B. Williamson, and M. Lombard. 2004. Ochre in hafting in middle stone age southern Africa: A practical role. *Antiquity -Oxford-* 78 (301): 661-75, page 662

[73] Wadley, Williamson, Lombard, page 673
[74] Dart, the Birth of Symbology, page 25
[75] Dart, The Birth of Symbology, page 21
[76] Dart, The Birth of Symbology, page 22

Dart, who studied primitive groups around the globe, explains that in most groups, immortality was a part of the life-cycle belief system and that ochre was used as a symbol of blood to ensure the transition between the mortal and immortal world.

"One of the earliest clues we have to the mining activities of the ancients is associated with their funerary habits. Primitive man believed in immortality. It was understood that blood was the essence of life, and to restore life after death it was necessary to provide adequate replacement of the bodily blood lost in death. This need was provided by the custom of burying the body in a mass grave of red ochre powder with lumps of red stones scattered around the grave."[77]

Section 4: Ochre's Historic Uses Near the Ngwenya Mine Site

In the mid-1960s, "samples of charcoal from hearth levels in an undisturbed haematite quarry floor" were recovered from the Lion Cave and underwent a radiocarbon dating process at Yale University.[78] At that time, carbon dating methodology was capable of registering around 43,000 years of age. Later *Carbon 14* dating suggests that mining may extend back 70,000-80,000 years.[79] Other evidence from Dart's work led him to suggest that "*Homo sapiens* has been engaged in the mining of haematite for ritual purposes for an unknown period, but apparently extending in all probability far beyond 100,000 B.P."[80] At Ngwenya Mines mining hammers and grooved heavy-duty stones, were found[81] and "tens of thousands of implements belonging to the Middle Stone Age have also been found in the area".[82]

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[77] Gregory. Page 4
[78] Dart, Raymond A. The Debt of Palaeontology to Haematite. Journal of the Palaeontological Society of India. Vol. 20, 1977 pp. 205-210.
[79] Anhaeusser, History of Mining in Barberton, page 20
[80] Dart, page 208. The debt of Paleontology to Haematite.
[81] Wadley, Williamson, Lombard, page 661
[82] Anhaeusser, History of Mining in Barberton, page 20

Little though, is published in academic literature about historic uses of ochre near the Ngwenya Mine site in particular or in Swaziland in general. Suppositions are made based on studies of the San culture and later, on Bantu cultural uses. In an article in the South African Archaeological Bulletin, Ian Watts explores pragmatic and symbolic hypotheses about ochre uses based on their composition and assemblage with varieties of hematite. For instance, hematite varieties high in specularite, a "glittery, micaceous expression of hematite",[83] as are the assemblages at Ngwenya Mine, are poor candidates for hide-preservation and hafting due to mineral composition. Therefore, uses of hematite of similar quality to that at Ngwenya Mine were almost certainly limited to symbolism and ritual based on the "visually salient properties of redness and brilliance and (were) used accordingly as pigments".[84]

Dart's scholarship on the Border Cave and Ngwenya Mine (Map ---) sites supports this theory of symbolic use. As mentioned one theme of Dart's research focus was the global historic uses of red ochre. In 1972, red hematite pencils, implying ritual uses such as body-painting,[85] were found at Border Cave, as were the skeletal remains of the earliest dated "modern Homo sapiens known from that period in Africa" by radiometric dating that exceeded over 48,350 years.[86] The hematite pencils were unearthed below two meters of consolidated stratification below the skeletal remains which is "suggestive of a date of 100,000 or more years for the initiation of its use as a habitation".[87] These findings prove that mining for hematite reaches back at least 100,000

[83] Watts, Ian. Page 4, Ochre in the Middle Stone Age of Southern Africa: Ritualized display of Hide Preservative?
[84] Lewis-Williams, Pearce, page 23, San Spirituality.
[85] Wadley, Williamson and Lombard, Ochre in hafting in Middle Stone Age southern Africa: a practical role. Page 661
[86] Dart, Debt of Paleontology, page 207
[87] Dart, Debt of Paleontology, page 207

years. Dart suggests that the source of hematite was about 60 miles to the west at Ngwenya Mine in which case, Ngwenya Mine was mined much earlier than can be scientifically proven and more importantly, was part of a social landscape across Swaziland.[88]

Figure 10: San Rock Art. This is a photograph of a replica on display in the Ngwenya Mine Visitor Center. Photo by Sarah Watling

The documentation of early mortuary sites has not been associated with the Ngwenya Mine area though the aforementioned skeletal remains found at Border Cave provide evidence of ochre use in the area by early San people, likely originating from Ngwenya Mine. Rock art paintings are present in Swaziland. The durable qualities of the paint are attributed to materials like ochre and charcoal that were used as pigment. The

[88] Dunbar, Knight and Power, The Evolution of Culture, page 119.

pigments were blended in differing combinations with melted animal fat like eland or ostrich; a form of amino acid, possibly egg whites or the blood of an ox or eland; and juice from *asclepia gibba*, a plant material.[89]

The subject matter of the Swaziland rock paintings, attributed exclusively to the San people,[90] are relatively advanced depicting animals, people, hunting parties, battle scenes and dances. Paintings are found across the country but are most frequent in the western Highveld, where Ngwenya Mine is also located. These paintings are shamanic, inspired by the experiences of the shaman with the ancestral world. Two exemplary examples of Swaziland's rock painting sites are the Nsangwini and the Sandlane. The Nsangwini site found in 1958 is one of the most unusual with two dark red winged figures preserved with very clear detail believed to be a depiction of rain making. The Sandlane site represents a trance or initiation dance and exhibits two animal figures with are not yet understood within the body of San mythology research.[91]

The San used ochre for rainmaking, which especially called for ochre naturally mixed with specularite and is in abundance at the Ngwenya Mine site. Ochre also symbolized eland blood; the revered eland was able to transmit strength and power, expressed in rock paintings featuring meticulous depictions of eland.[92]

Chapter 6: The Ngwenya Mine Site Character

Section 1: The Lion Cave and Evidence of Mine History

The Lion Cave is one of two ancient mines on the Ngwenya Mine site. The other is Banda Cave, located about two kilometers away. Both Lion Cave and Banda Cave are made up

[89] Lewis-Williams, The Rock Art of Southern Africa, page 24-25.
[90] Lewis-Willams, The Rock Art of Southern Africa, page 36.
[91] Swaziland National Trust Commission. http://www.sntc.org.sz/cultural/rockart.asp, retrieved March 10, 2013
[92] Lewis-Williams, The Rock Art of Southern Africa, page 41

of three mined cavities with a consistent configuration. The left cavern is the deepest, the middle is the tallest, and the right cavern has a medium depth and height. Both Lion and Banda Caves are oriented to face the west, which maximized access to the light of the afternoon sun.

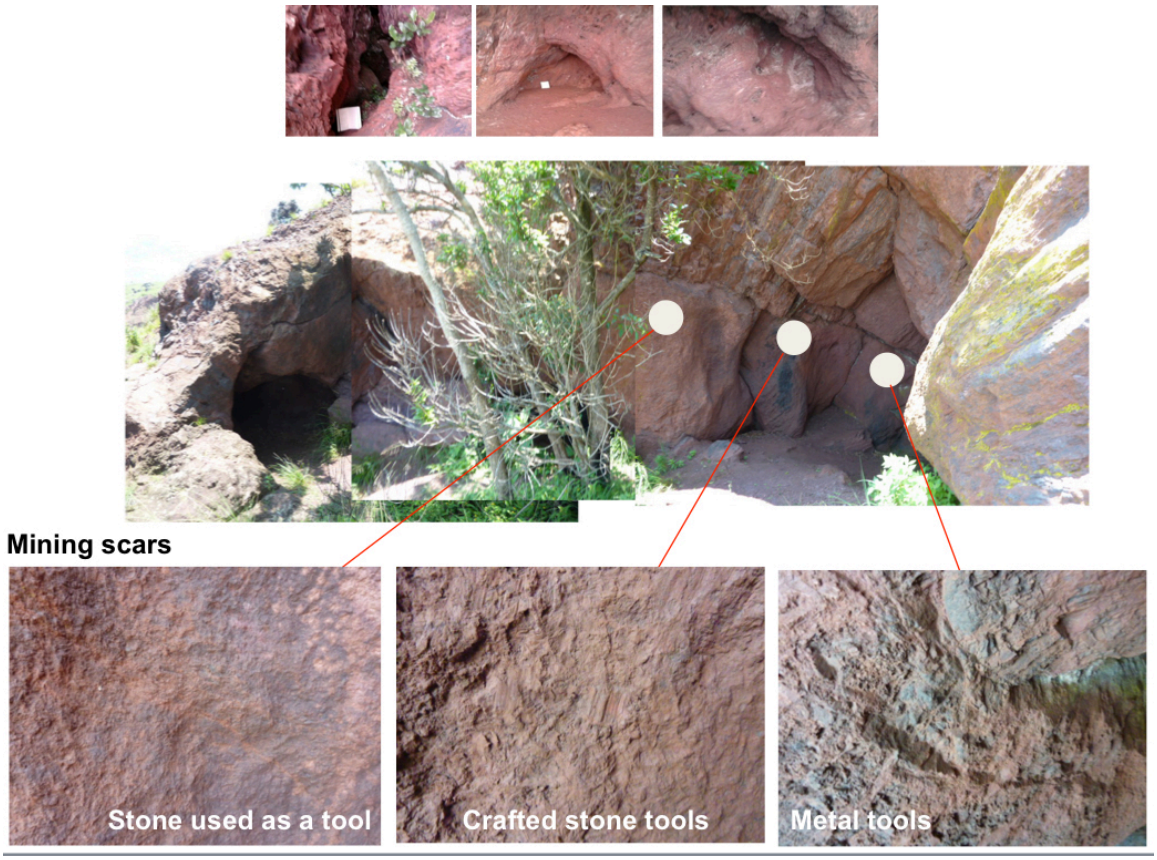

Figure 11: The Lion Cavern. This image illustrates the three cavern configuration and evidence of the long history of mining through different tool uses. Photographs by Sarah Watling

Lion Cave is on the face and at the southern end of a small hematite cliff that is 500 feet high. The three caverns have a "maximum width of 25 feet, a maximum depth of 30 feet and a maximum height of 20 feet". Over the course of the primitive mining

period, “it is estimated that at least 50 tons of specularite-rich haematite were removed from this site, 2/3 of this amount during Middle Stone Age times.”[93]

At the Lion Cave, along a contiguous two-meter stretch of the cave wall, the use of three ancient tools is evident in rock scars, which indicate that Lion Cave was mined with a variety of tools that included natural stone, crafted stone tools, and metal. Less than 100 feet away, an open cast mine began operations in the mid-1960s. The variety of techniques used over a long period of time tells a very complete story of mining, possibly one of the most visibly evident stories in the world.

Section 2: Visitors Center

There is a small Visitors Center at the southern rim of the Stag gorge. In 2005, with support from the European Union, a museum opened. The exhibits include the geology of Swaziland, the complete story of mining including smelting and a steam engine, as well as symbolic flint weapons created by the San. For a brief period the museum was also suited as a somewhat successful restaurant, the Pick and Shovel, however the generation of income was not permitted under the grant so the restaurant was closed.[94]

Figure 12: Visitors Center Museum Installations. Photographs by Sarah Watling

[93] Dart and Beaumont, 1969, page 128
[94] Interview with Bob Forrester

Chapter 7: Mine Reclamation

Section 1: Swaziland Mine Reclamation Policy

Swaziland's national policy around mining has a short history. In 1958, five years before Swaziland was granted independence from Great Britain, Swaziland's Mining Act was created to govern the mining and mineral industries. In 2002, Swaziland's Mining Act was reviewed but not updated until 2011. In 2002, Mbendi, an independent South African company that provides business research on Africa, described Swaziland's minerals policy and legislation as follows: "There is a fundamental distinction in the constitutional law of Swaziland between the State and its Government on the one hand and on the other the 'Swazi Nation' and the King (the Ngwenyama). By constitution minerals are vested in the Ngwenyama in trust for the Swazi Nation. The Ngwenyama grants mineral rights after consultation with a Minerals Committee. This committee is appointed by the Ngwenyama on advice by his advisors in accordance with the Swazi law and custom. The conditions and terms of mineral rights issues are negotiated and approved by the Ngwenyama."[9596]

Examples of the application of Swaziland's Mining Act happened in 2002 and again in 2011. The background on the 2002 case began in 1972 when the National Trust Commission Act, Section 20(2)[97] gave authority to the Commission to allow or prohibit activities for scientific or other benefits within Swaziland's protected areas. In 2002, the authority of the Swaziland National Trust Commission was successful at halting the

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[95] Coakely, George. Page 27.1, The Mineral Industry of Swaziland

[96] Mbendi Minerals Legislation Overview of Swaziland. http://www.mbendi.com/land/af/sw/p0005.htm. Retrieved February 10, 2013.

[97] Swaziland National Trust Commission, http://www.sntc.org.sz/discuss/eiacomments.html. "Under the section on legislation the National Trust Commission Act of 1972 is mentioned. Specifically Section 20(2) is referred to on page 69 of the report which states that notwithstanding subsection (1), the Commission (i.e the Swaziland National Trust Commission) may, for scientific purposes or the improvement of the park or reserve or for other good and sufficient reason, authorize any person to do any act prohibited by this section.:

development of a mining operation in the Malolotja Reserve by a Taiwanese company based on this provision.[98]

The 2011 example was facilitated by an update to the Mining Act. A revision to the Mining Policy was passed permitting the re-mining or processing of mine tailings to extract remaining elements of value in protected areas like Malolotja Reserve, where Ngwenya Mine is located. The 2011 Mining Act came about suddenly and dictated that the investor earns 50% of the profits, the government earns 25% of the profits, and the King earns 25% of the profits. Within the Mining act, rehabilitation and mine closure plans are addressed as follows: the plans shall "(a) be in the prescribed form; or (b) if no form is prescribed, be in a form approved for the purpose by the Commissioner."[99] At present, there are no "prescribed forms" for the rehabilitation and mine closure of Ngwenya Mine. The Environmental Impact Assessment prepared for processing of tailings at Ngwenya Mine describes the processing itself as "rehabilitation" of the current site conditions.[100]

In summary, Swaziland's mining regulation policies were initiated before Swaziland was granted freedom so national Swazi ownership of the policy is debatable. There has been little evidence of policy implementation since its inception even though mining has been an important part of Swaziland's economic history. The policy does declare that actions within the bounds of natural reserves like Malolotja Reserve are

[98] Swaziland National Trust Commission, http://www.sntc.org.sz/discuss/eiacomments.html, retrieved on March 18, 2013.
[99] http://www.gov.sz/images/stories/mining/mines%20%20minerals%20act-%202011-swaziland.pdf
[100] Page 29, Proposed reprocessing of Ngwenya Iron Ore Mine Dumps, Environmental Impact Assessment and comprehensive Mitigation Plan. http://ngwenyadossier.wikispaces.com/file/view/Environment+Impact+Assessment+Doc.pdf/283584592/Environment%20Impact%20Assessment%20Doc.pdf, retreived March 8, 2013.

prohibited. In 2011, that prohibition was quickly lifted, mining policy was adjusted and permission to continue removing iron ore from the Ngwenya Mine site was granted.

Section 2: United States Mine Reclamation Policy

Mining governance and reclamation issues and problems are not unique to Swaziland. They are international problems gaining attention as the need to solve the problems left behind becomes clearer. Around the world, mining proposals have rarely included closure or reclamation plans following the mining process. Post-mined lands have historically been abandoned, left to release pollutants and remain unsightly marks on the landscape. However, newly created laws and regulations are being set around the world regarding the treatment of these lands.

The United States' Surface Mining Control and Reclamation Act (SMCRA) of 1977 was drafted in response to the environmental issues emerging from abandoned mines. SMCRA, assigning responsibility to the mine operator, sets general standards which "require the operation at a minimum to restore the land affected to a condition capable of supporting the uses which it was capable of supporting prior to any mining, or higher or better uses of which there is reasonable likelihood, so long as such use or uses do not present any actual or probably hazard to public health or safety…"[101] Section 508 outlines that operators are also required to restore the original contour of the land, avoid acid mine drainage and prevent erosion to minimize impacts to nearby waters, reclaim the land in a timely manner, and establish appropriate vegetation that will cover the disturbed area.[102]

[101] SMCRA, Section 515 – Enviornmental Proteticton Performance Standards (30 U.S.C 1265) (b) General standards, number (2). http://www.osmre.gov/topic/SMCRA/SMCRA.pdf. Retrieved March 20, 2013.
[102] SMCRA, Section 508 – Reclamation Plan requirements (30 U.S.C 1258)

Section 3: Mine Reclamation Design Responses

In Ripley, Redman, and Crowder's book, Environmental Effects of Mining, some traditional and advanced responses to environmental effects like surface disturbances and waste dumps; hydrospheric effluents; and atmospheric dust emissions of mining are explored. The salient solutions informing this design proposal at Ngwenya Mines include greater use of waste material for mine backfilling, settling ponds, lime neutralization, and road surfacing.[103]

Geomorphic reclamation is a new technique implemented at McKinley Mine, northwest of Gallup, New Mexico and within the Navajo Nation. Geomorphic reclamation recreates pre-mining topography and stream channels. This technique incorporates high drainage density, complex slope shapes with concaved lower slopes and sinuous drainages mimicking the natural topography. The USGS produced a compilation of case studies on North American mine reclamation projects for human use, potential uses to explore at Ngwenya Mines are in this table[104]:

Land Use	**Wet Site**	**Dry Site**
Conservation	Fish spawning Aquatic/water flow habitat Riparian or wetland habitat Beach or stream restoration Threatened/endangered species	Native plant revegetation Wildlife habitat Historical Nature Center Threatened/endangered species
Recreation	Swimming Fishing	Botanical garden Golf course Casino Hiking, biking, horse trails Motorcycle tracks Public parks Hunting and camping Athletic fields
Public Facilities	Sculptural	College extension campus Amphitheater

[103] Ripley, Redman, Crowder. Page 22, Table 1.2
[104] USGS, page 9

		Sculptural Permanent easement for utilities and highways
Commercial/Industrial	Academic research	Academic research Light manufacturing Office, housing, shopping
Residential	Sewage treatment Water quality improvement	Housing
Recycling	Ground water recharge Wastewater recharge	Agriculture (pasture, crops) Forestry Composting Methane production
Storage	Water supply Flood control Inert fill material	Livestock shelter Equipment Food Cemetery Sanitary landfill

Chapter 8: Land Art

Section 1: Land Art as a Story Telling Strategy in Ngwenya Mine

The Ngwenya Mine site has a powerful narrative about its history, culture, and environment. Some threads of the narrative are the profound examples of how industrious the human being is in the landscape and how significantly culture manifests around color and material and symbology; the history of the act of mining interlaced with the long path civilization has taken to become deeply reliant on the Earth's minerals; and evidence of how powerful technology can be and the importance of long-term thinking when using technology in landscapes that are not completely understood.

Today, visitors can understand the narrative through the Museum in the Visitors' Center and trained interpreters who guide tours of the Lion Cave. Visitor engagement depends on these things to go beyond the surface of an aesthetically dramatic landscape with a history summarized in a single sign on site (Image ---).

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Figure 13: Ngwenya Mine from southern gorge. Photograph by Sarah Watling

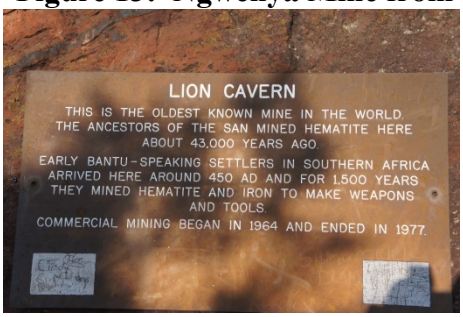

Figure 14: Ngwenya Mine signage.

The purpose of proposing an art installation, in combination with enhanced interpretation and remediative ecological treatments is to add an experiential layer that is dependent on the visitor. In Ecological Aesthetics: Art in Environmental Design, Theory, and Practice, Johen Bobert writes, "A place has to be found in people's minds for a new kind of thinking, for a new understanding of what fundamentally determines our existence."[105] Bobert goes on to say that art "has to create the images, give us the language that will make it possible to conceptualize the present state of affairs, and then lead us to mutually desirable visions of a future we could experience. "[106] In other words, art's ability to

[105] Bobert, Johen. Prigann, Herman, Heike Strelow, and Vera David. 2004. *Ecological aesthetics: art in environmental design : theory and practice*. Basel: Birkhäuser. Page 7
[106] Bobert, Johen. Page 8

provoke the beholder to pause, think, learn and act[107] is the right addition to transform this place toward the next chapter of what its mined landscape could become.

Section 2: Overview of the Land Art Genre

To understand the role of art in the environment, this thesis explored the Land Art tradition, a very specific art movement which emerged in the United States in the late sixties in which landscape and the work of art are inextricably linked."[108] In the book *Land and Environmental Art,* Jeffrey Kastner clarifies Land Art as "an imperfect hyponym for a slippery and widely interconnected band of conceptual kinship".[109] Kastner's point is that defining and separating Land Art from other labels like earth art, nature art, and environmental art is a difficult task.

The history of landscape being a material and medium for art is lengthy. Examples go far back in time to works like the 2000 year old Serpent Mounds in southern Ohio and the Nazca geoglyphs in southern Peru. More recently, genres have represented landscape through painting and photography. But Land Art was born when artists decided to move beyond the relatively small square canvas and beyond merely 'representing' images of the land.

Land Art began in the 1960s when North American artists began creating work, often in remote parts of the American West[110], which came to be understood in at least

[107] Nato Thompson, Living as form, Socially engaged art from 1991-2011.

[108] Weilacher, Udo. 1996. Between landscape architecture and Land Art. Basel; Boston: Birkhäuser.Page 11

[109] Kastner, Jeffrey, and Brian Wallis. 1998. *Land and environmental art*. London: Phaidon Press.

[110] Boettger, Suzaan. 2002. *Earthworks: Art and the landscape of the sixties*. Berkeley: University of California Press. Page 1

two ways. One is as a counterpoint to the commercialization of consumable art objects placed on display, for sale in museums and galleries. Another is as a commentary or response to the reality of nature's fragility, examples of which unfolded quickly as industrial production raged forward driven by North American ideas like planned obsolescence and moves toward the perfection of mechanization.[111]

[111] Beardsley, John. 1998. *Earthworks and Beyond*.

Figure 15: Spiral Jetty by Robert Smithson. Images used with permission of Robert Smithson Estate and James Cohan Gallery.

By using land, the Earth, as canvas and medium, a new distinct movement was defined.[112] Representations of nature or the nature of a place also changed as works of Land Art were usually imagined as site specific and referential instead of replicas of the natural world in which they were situated.[113]

John Beardsley begins *Earthworks and Beyond*[114] with four presumptions about the origins and inspiration of Land Art. They are that human relationships to landscape are one of the most significant expressions of culture and in "many respects equal in importance to the relationship to the sacred"; that the history of form building like the Serpent Mounds and Nazca is foundational both in realized form and in attitude; that the definition of sculpture and art evolved and broadened to include new ideas of time and space; and that North Americans, even Land Artists, are ambivalent toward nature, at once exploiting and protecting it. Even through these conflicted approaches and deliveries, most Land Art falls under the ideal of creating a sense of place.[115][116][117]

While many artists do not want to be linked to any movement[118], art history recognizes a group of Land Artists including Walter De Maria, Agnes Denes, Michael Heizer, Nancy Holt, Robert Morris, Richard Serra, Robert Smithson and many others. Smithson arguably created the most well-known Land Artwork, Spiral Jetty, in Utah's Great Salt Lake in 1970. Smithson, simultaneously an active artist and theorist, is

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[112] Kastner, Wallace
[113] Hogue, Martin. 2004. The Site as Project: Lessons from Land Art and Conceptual Art. Journal of Architectural Education, pp. 54-61
[114] Beardsley, John. 1998. *Earthworks and Beyond*.
[115] Carlson, Allen. 1986. Is Environmental Art an Aesthetic Affront to Nature? Canadian Journal of Philosophy, Vol.16, No. 4. Pages 635-650.
[116] Doubleday, Nancy, A. Fiona D. Mackenzzie, Simon Dalby. 2004. Reimagining sustainable cultures: constitutions, land and art. The Canadian Geograper. 48, no 4.
[117] Hogue, Martin. 2004. The Site as Project: Lessons from Land Art and Conceptual Art. Journal of Architectural Education, pp. 54-61
[118] Kastner page 13

described as "the acknowledged polemicist for the budding Earth Art movement"[119] and as putting "into practice what others only speculated about…"[120] Smithson raised many important issues, like the potential for Land Art to create a new way for industry and ecology to relate to one another, and his early death has left many of them "perpetually open".[121]

An evolution of the Land Art toward Reclamation Art is visible in Smithson's body of work. Two pieces in 1969, *Asphalt Rundown,* a free-flowing splash of asphalt slowly oozing down a hillside in Rome, the Eternal City (pictured here);[122] and *Concrete Pour,* poured concrete from a Ready Mixer into Lake Michigan from a ravine where "trucks came at the end of each day to discard unused concrete"[123] were clearly not expressing the message of reclamation.

Near Smithson's death, in 1973, the issue of reclaiming or recycling of post-mined lands with art was coalescing in his writing and work.

Figure 16: Top image, Asphalt Rundown by Robert Smithson. Middle image, Spiral Hill by Robert Smithson. Lower image, Broken Circle by Robert Smithson. Images used with permission of Robert Smithson Estate.

[119] Kastenr Wallace, page 24
[120] Flam, Jack. Smithson, the Collected Writings p xxv
[121] Flam, p. xxiv
[122] Hobbs, Robert. Robert Smithson Sculpture, page 176
[123] Hobbs, Robert. Robert Smithson Sculpture, page 179

Smithson suggestions that art as a method of reclamation would not only be pragmatic in the landscape at the moment but could evolve the differences in ideologies and the relationship between "the ecologist and the industrialist" in order to move beyond the paralysis each camp felt toward the other.[124] Smithson wrote,

> "Across the country there are many mining areas, disused quarries and polluted lakes and rivers. One practical solution for the utilization of such devastated places would be land and water re-cycling in terms of "earth art."…Economics, when abstracted from the world, is blind to natural processes. Art can become a resource, that mediates between the ecologist and the industrialist. Ecology and industry are not one-way streets, rather they should be cross-roads. Art can help to provide the needed dialectic between them. A lesson can be learned from the Indian cliff dwellings and earthworks mounds. Here we see nature and necessity in consort."[125]

Smithson's ideas, around repurposing what are now known as postindustrial landscapes to help civilization take its next step in evolving, were radical. At the time, ecology and industry were two civic poles and the tension between them was limiting the possibility for anything new to happen. Smithson was proposing a new way of thinking where civilization appreciates and supports ecology and industry equally and in so doing, allowing movement between polarities.

Section 3: Land Art as a Reclamation Strategy

In 1971, Smithson specifically created "reclamation" art works with Broken Circle and Spiral Hill, (pictured above), built at a closed sand quarry in Emmen, Holland. In 1972, Smithson began approaching mining corporations as an experienced land reclamation

[124] Untitled, 1971. In Nancy Holt, ed., The Writings of Robert Smithson, p. 220.
[125] Untitled, 1971. In Nancy Holt, ed., The Writings of Robert Smithson, p. 220.

artist.[126] However, the majority of American Land Artists, or Reclamation Artists from the early 1970s, while some were interested in the ecology and aesthetic problems left behind in postindustrial landscapes, their applications of "reclamation" did not mean reintegrating the place back into the environmental and human ecological cycles. Their aims were toward changing the way people thought and less about transforming a landscape in a way that realized its potential for future use.[127]

Subsection 1: What is reclamation?

Robert Morris writes that Bill S.425, Senate's 1973 bill to regulate surface mining, defines *reclamation* as "the process of restoring a mined area affected by a mining operation to its original or other similarly appropriate condition, considering past and possible future uses of the area and the surrounding topography and taking into account environmental, economic, and social conditions"[128] In 2013, mine reclamation is defined by the U.S. Environmental Protection Agency as "restoration of mined land to original contour, use, or condition. Also describes the return of land to alternative uses that may, under certain circumstances, be different from those prior to mining."[129] The Oxford English Dictionary offers several definitions of "reclamation" including: to make reusable, to recycle by removing impurities; to make fit for cultivation or habitation; to claim again; to demand the restoration or return of, esp. by legal means; and to reassert a legal right to".[130]

For clarity, *reclamation* differs from *restoration*, the "return of an ecosystem to a close approximation of its condition prior to disturbance" and *remediation*, the "cleanup or

[126] Hobbs, Robert. Robert Smithson Sculpture, page 208
[127] Strelow, Ecological Aesthetics, page 12
[128] Morris, Robert. Notes on Art as/and Land Reclamation page 88
[129] US EPA website http://iaspub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do;jsessionid=gnydRSQP1GYbKmZ9PyVPwl1mMjH3Wt2VymTTM2gTSv4ZT92LHXQP!1257315459?search=
[130] Oxford English Dictionary, retrieved February 4, 2013, http://www.oed.com/view/Entry/159603?redirectedFrom=reclamation#eid

other methods used to remove or contain a toxic spill or hazardous materials from a hazardous waste site".[131] Reclamation, at its simplest, is the process by which land becomes reusable to people once again.

Section 4: Approaches to Reclamation of Postindustrial Landscapes

Postindustrial Landscapes, in general, are where civilization has made its greatest physical mark; scars in these landscapes are "powerful symbols of industrial reality" which often inspired the early Land Artists to emphasize this industrial power.[132] Not all Land Artists, especially the earliest, were concerned with reclamation, Michael Heizer for instance was interested in making art regardless of the site, sometimes referring to a site's history rather than its ecology and said outright, "I don't support reclamation art sculpture projects" even though his projects were acts of reclamation as it was being understood at the time.[133]

Robert Morris's work and writing focused on economy and ecology to challenge the common belief that technology will solve all problems for all people even though it is the source of many of those same problems.[134] Morris's *Untitled: Johnson Pit #30* is described as a work that "masterfully makes us reflect on the denatured character of the place. Paradoxically, the work transforms the site while it also preserves its history. This reclamation artwork turns the immolation of nature into beauty-while putting that same immolation on view".[135] While the beauty of Smithson's *Spiral Jetty* is apparent and

[131] US EPA sites
[132] Ecological aesthetics page 155
[133] Dreher, Thomas. Robert Smithson, Land Reclamation and the Sublime
[134] Morris, Robert Notes…page 96

[135] Heyd, Thomas. 2007. Reflections on reclamation through art. *Ethics, Place &; Environment* 10 (3): 339-45.

understood, Morris focused on the aesthetic writing, "it would perhaps be a misguided assumption to suppose that artists hired to work in industrially blasted landscapes would necessarily and invariable choose to convert such sites into idyllic and reassuring places, thereby redeeming those who wasted the landscape in the first place".[136]

This intent, of designing the reclaimed landscape to more permanently or dramatically reflect what has led to the need for reclamation in the first place, may have contributed to a scholarly discussion that volleyed for fifteen years. In 1983 Donald Crawford wrote about environmental art as an affront to nature as many critics described several Land Art installations as unappealing, even offensive. In 1986, Allen Carlson agrees that many installations deeply alter the site and are an affront to any observer but since 'nature' itself cannot experience an affront, Crawford is missing the point and holding up the man versus nature paradigm.[137]

Section 5: Land Art Evolution

Driving all of this is the need to fill public space needs, to clean and reuse contaminated sites, to celebrate the past and represent collective memory, and heal emotionally and ecologically from industrial degradation.

Over time, Land Art reclamation projects have moved beyond aesthetic treatments, beautiful or not, to ones where culture, history, industry and nature are all involved.[138] Mined lands are often connected closely to communities who experience pollution resulting from active or spent mines. In, "Creative and Green: Art, Ecology, and Community", Sarah Graddy argues that if citizens are not involved in remediation

[136] From Heyd, but notes as Morris, 1979, p. 16 quoted in Beardsley, 1984, p. 94
[137] [137] Carlson, Allen. 1986. Is Environmental Art an Aesthetic Affront to Nature? Canadian Journal of Philosophy, Vol.16, No. 4. Pages 635-650
[138] Prigann, Ecological Aesthetics, Page 156

efforts, it is unlikely that they will either be aware of them or help to prevent such exploitation of local resources in the future.[139] When a mine is spent, the "reclaimed land will have to last forever and meet all the demands that future generations may put upon it."[140] Furthermore, "real mine closure means creating new lands that are not merely sustainable, but self-sustaining…defined in terms of economic after-use, but if it is not – and in many places the after-use value of reclaimed lands can be very small – then it must be defined in terms of natural control…which can be very small."[141]

To fully explore its potential, Land Art has readily become interdisciplinary; it has become wedded to ecology, engineering, education, landscape architecture, history, sociology, economics, health, fine art, and the communities within which it is situated.[142] James Corner writes, "landscape ecology and design can invent alternative forms of relationships between people, place and cosmos so that landscape architectural projects become more about invention and programs rather than merely corrective measures of restoration."[143] Beyond representation of disciplinary interests, many of these projects build "ethical questions into landscape design, from exploring systemic thinking, analyzing the links between ecology and aesthetics via critical consideration of practices in their own disciplines, to examining the socio-political prerequisites of an ecological aesthetic."[144]

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[139] Graddy, Sarah E. Creative and Green: Art, Ecology, and Community
[140] Haigh, Martin J. Land Reclamation and Deep Ecology: in search of a more meaningful physical geography
[141] Haigh, Martin J. Land Reclamation and Deep Ecology: in search of a more meaningful physical geography
[142] Strelow, Ecological Aesthetics, page 12-13
[143] James Corner from Ecology and Landscapes as agents of creativity from Lourdes and Panagopoulos' Sustainable reclamation of industrial areas in urban landscapes page 793
[144] Strelow, Ecological Aesthetics, page 13-14

Paul Klite composed a survey of Earth Art, reclamation and specific mine reclamation projects in 1985, these artists have all produced work on post mined lands.[145]: Herbert Bayer, Stan Dolega, John Roloff, Richard Fleischner, Gary Dwyer, Michelle Stuart, Dennis Oppenheim, Nancy Holt, Alan Sonfist, Agnes Denes, Sam Judd, Charles Ross, James Turrell, Ismu Noguchi, Michael Heizer, Athena Tacha, Zigi Ben-Haim, Walter De Maria, Lloyd Hamrol, Christo and Jean Claude, Mary Miss, Robert Irwin, Buster Simpson. Key Land Artists working on mined lands included Robert Smithson (Spiral Jetty; an oil mining area in Utah's Great Salt Lake; Broken Circle – sand quarry in Emmen, Holland[146]), Harriet Feigenbaum's Serpentine Vineyard and Valley of 8,000 Pines at the Storrs Pit strip-mine in Pennsylvania; and Robert Morris' Johnson Pit #30. Other more contemporary projects on post-mined lands are Herman Prigann's Lost River – Earth Wave, 1998-1999, Goitsche opencast mine, near Bitterfeld, Germany[147], Herman Prigann's Yellow Ramp, 1993-1995, opencast mine near Cottbus, Germany, Martha Schwartz's McLeod Tailings, Geraldton, Canada[148]; Charles Jencks' Northumberlandia; Strijdom van der Merwe's am/pm Shadow Lines; and Stacy Levy and Julie Bargmann's work on AMD & ART Park in Vintondale, Pennsylvania.

Section 6: Precedent examples of Mine Reclamation:

Two noteworthy examples of mine reclamation that are applications of the sustainability model approach addressing social, economic, and cultural issues simultaneously are Strijdom van der Merwe's *am/pm Shadow Lines* in South Africa and AMD & Art Park in Vintondale, Pennsylvania. The two projects are similar in that they were implemented

[145] Klite, page 9-42
[146] Doss, 1995
[147] Page 148 – Ecological Aesthetics
[148] http://www.marthaschwartz.com/projects/reclamation_tailings.php

through collaborations and they each have a cultural, economic, and ecological component.

Subsection 1: am/pm Shadow Lines

Strijdom van der Merwe's project is a Land Art installation at the DeBeers Namaqua Diamond Mine Company in Northern Cape, South Africa. This project's explicit goals were to rreintroduce indigenous plants onto mined dunes; establish abalone farming in the large holes created near the ocean; and use the mining equipment already available onsite to create a large-scale work of land art.

This project began in 2010, in Koingnass, Northern Cape, South Africa. DeBeers Consolidated Mines, in partnership with Conservation International South Africa, and Public Eye, an organization which initiates public art projects, supported the creation and installation of a three faceted intervention: a Land Artwork by South African artist Strijdom van der Merwe; the planning and implementation of a R32 (US$4.6 million) 150 ton mariculture abalone project in partnership with a leading seafood brand, staffed mainly by locals; and a R50 (US$7.1 million) environmental rehabilitation project focused on native revegetation[149].

[149] DeBeers Group Report to Society 2007. https://www.debeersgroup.com/ImageVaultFiles/id_1006/cf_5/DB_Group_RtS07.PDF

Figure 17: Images of the DeBeers Diamond Mine in Namaqualand Swaziland. Photographs by Sarah Watling

The Land Art installation was described in a press release by Conservation International South Africa as "the first of hundreds of Land Art installations which will transform the Namaqualand landscape while drawing a new audience to this area".[150] Namaqualand is northwest of Cape Town, about five hours driving, and receives visitors in August and September, the South African spring, when millions of succulent wildflowers bloom in the Succulent Karoo, what is normally a dramatic and barren looking landscape. A Land Art collection to complement this landscape would add to an already unique visual experience.

am/pm Shadow Lines is composed of alluvial diggings and mine tailings dumps and was created with earthmoving mining equipment already on site. The artist was intentional about using the materials and tools of the site as well as responding to the mining disturbed landscape. The piece is a 100 meter wide circle of two meter high ridges in contrasting position. The ridges cast shadows changing throughout the day and seasons and are best viewed in early morning or afternoon.

Figure 18: am/pm Shadow Lines by Strijdom van der Merwe. Photograph by Sarah Watling

[150] Conservation International South Africa Press Release, April 20, 2010.

The artwork is powerful, clearly taking cues from the surrounding waste rock piles. The forms used, the circle and lines, are ordered perfectly, the uniform heaps of waste material clearly show the hand of the artist but are clearly referential to the heaps and trails left by tumbling waste rock in the post mined landscape as well. Few people are able to visit the piece due to its remoteness and its protected location on DeBeers' property.

The strength of the vision to incorporate the three aspects, art, environment and economics into this project is difficult to read. The three projects, am/pm Shadow Lines, the mariculture project, and the native revegetation project each have strengths but are not especially strengthened by the relationships between them. The artist explained that DeBeers is concerned about projects that generate money and uplift the community but may not be convinced that the emotional, educational or aesthetic value of art in the landscape makes a difference in peoples' lives which is why the entire collection of pieces proposed has not yet been realized several years after the project began.[151] This thesis has been most inspired by DeBeers' interest in implementing a "pilot project" such as this, in van der Merwe's words, "at least we have made a beginning that is appreciated by many people and many other mining companies have taken notice of De Beers. These things take time to develop and *am/pm Shadow Lines* is a quiet pilot project that lead the way for more to come."[152]

[151] Personal email with the artist, February 14, 2013.
[152] Personal email with the artist, February 14, 2013.

Figure 19: AMD & ART in Vintondale Pennsylvania. Images used with permission of project artist Stacy Levy.

Subsection 2: AMD & ART

AMD & Art is a Public Park in Vintondale, Pennsylvania. It was created through a collaborative community based reclamation partnership between the Vintondale Community, artist Stacy Levy, landscape architect Julie Bargmann, hydrogeologist Robert Deason, historian T. Allan Comp, and many others. The project both treats the acid mine drainage (AMD) water and shows the process through a series of gardens, thoughtful plantings and constructed wetlands. The purpose of this project is to be a model of renewal and has three aspects: to blend history and science; illuminate the healing accessibility and delight of innovative design; and to come from the energy of community engagement.[153]

Vintondale is a small town of about 200 households in western Pennsylvania, about 10% of who live below the US poverty line. There is a legacy of coal mining in the area and as is often the case, the departure of the coal industry had a powerful mark on the community and its economy.

The project was initiated by Dr. T. Allan Comp, a historian with the Office of Surface Mining in Washington D.C. The idea behind AMD and Art is that "art could somehow play a part in environmental reclamation".[154] A collaboration between "historians, hydrogeologist, landscape designers, artists, retired miners, community activities, AmeriCorps volunteers, Navy Seabees, politicians, schoolteachers, and students came together" as the project evolved. [155]

The vision for AMD and Art was a new paradigm by seeing the problem as an opportunity "to create an economic – even a spiritual –asset, a chance for

[153] AMD and Art website. http://www.amdandart.org/projectindex.html
[154] Maksymowicz, Virginia. The new earthwork, page 83
[155] Maksymowicz, Virginia. The new earthwork, page 83

transformation". The method of doing that was to ask "new questions" to find "new answers".[156]

The elements of the park are a trail system, a steam and ponds, wildflowers, athletic fields, and a pavilion. The deeper elements are the way the story and the process of healing are being told through art. *The Great Map* is a large ceramic mosaic based on historic maps of the area, the word "Hope" is translated into the 26 languages spoken by the immigrant miners, the *Clean Slate* is a reflective art piece, and *Testing the Waters* is a passive treatment system that de-acidifies the water; also called the *Litmus Garden*.

Artist Stacy Levy, the artist on the team for *Testing the Waters* provided an interview on February 15, 2013. She explained the project's overarching goals as trying to solve the acid mine draining, truly an engineering problem, with a sequential and passive system that had to be legible to visitors so the reclamation message could be absorbed. The project relied on site-specific materials like mine tailings to create opportunities for visitors to find prospect points from which to observe the entire system.

While describing the Litmus Garden and the array of wetlands, Levy said, "The design of the water treatment wetlands brings the massive scale of the mining operation back to the site with raised plinths of soil demarcating the footprints of the original mine buildings"[157]. In this way, blending history and memory with contemporary responses of reclamation. In response to the questions, "Why is art important?" Levy explained that in AMD and Art, art and science were equal partners but that art it is a bridge between a skilled thing like engineering and nature, the visual component drawing visitors in to witness what happened to make our civilization grow. Levy also pointed out that art

[156] Maksymowicz, Virginia. The new earthwork, page 83
[157] http://www.stacylevy.com/installations/amd_and_art.php

loves the materials of reclamation, like the "yellow-boy", a yellow sediment from acid mine drainage, the color is still inspiring even though it is such a toxin.

On March 25, 2013, at the United States Office of the Interior, Department of Surface Mining in Washington, D.C., Dr. T. Allan Comp spoke about the project and described it as a long-term experiment, the testing of a replicable model where engaging the arts and sciences creates a sum much greater than the parts. The art layers of AMD and Art, Comp explained are not about decoration; they feature the most significant parts of the mining story. Comp explained the importance of subtle interpretation that allows visitors to engage and arrive at conclusions on her or his own. In Comp's opinion, a challenge is keeping the spirit of the project going and one way to do that and expand the reach of the project is through the website, www.amdandart.org, which today maintains high traffic and serves as a resource where the ideas from the project are catalogued and available. The project was completed after ten years in 2005. The 35-acre coalfield turned park was given to the community at a community celebration.

The strengths of this project are: the collaborative framework within which it was implemented; the extent to which community involvement was incorporated; and the focus on legibility, allowing the story of the place and the science, to be read in the landscape with subtle interpretive elements and clear indicators that design is at work. As a model or pilot, AMD & Art is very successful because of its replicability. Unfortunately, little information has been captured about the success of the remediation efforts.

Chapter 9: Methodology

This thesis began with an interest in why designers are transitioning postindustrial places into public spaces around the world and retaining some, often much, of the original character of the site. A literature review was prepared on postindustrial sites in transition to public spaces. This led to learnings about landscapes and memory, emotion, healing, repurposing, celebrating and many other things that enhance civic life.

Thesis projects are appropriate venues for extreme explorations into a subject or topic so thinking about the oldest human industry of all pointed toward mining. From there, research showed that the Ngwenya Mine in Swaziland was the oldest known mine in the world. Research about its mining past and present made it an appropriate place through which a statement about the treatment of postindustrial places could be made, an understanding of current and innovative mine reclamation practice could be developed, and finally a set of recommendations could be drafted that may actually impact this or other mines as the field of mine reclamation takes form.

Section 1: Site selection

Visiting the site proved it to be richer than any other. The entire story of mining is visible from the Early Stone Age through today; the current and past uses of the site contribute deeply to the cultural fabric of the local communities; and the need for reclamation is immense. To select this site, other mine considered were a coal mine in southeastern Ohio and generally, the gold mines in Johannesburg, South Africa to build upon research presented at the International Federation of Landscape Architects in 2012. Ultimately, Ngwenya Mine was chosen because of the incredible history, the dramatic landscape, and the opportunity to respond to the lack of a comprehensive closure strategy following the

re-processing of mine tailings underway now. Ngwenya Mine also fit the following criteria that guided the search, these criteria surfaced in the literature on landscape architecture and mine reclamation.

- Societal value – How great is the importance of the use of the site to the community or visitor?
- Potential for reuse - Does the site have the character and ability to support a new use as proposed?
- Historical importance – Does the site offer something unique to the community or user's understanding of the past?
- Ecology - Are the natural ecological conditions of the site capable of sustaining visitor use and are those conditions safe for visitor use?
- Size – Is the size of the site manageable within the time constraints of this project?
- Readiness – Is the site ready for development? Are there supporting organizations interested in the project? Is the place politically stable?
- Narrative - Does the site have a story to tell?
- Interventions - To what extent are the ecological conditions in need of remediation and is landscape architecture an appropriate discipline to address the issues or are they severe enough to warrant significant scientific research and experimentation to identify appropriate interventions for remediation?

Following site selection, I explored to the genre of Land Art to begin to understand how artists had used land and landscape to create meaningful works in response to industry and the growing number of postindustrial sites which were being left untreated. From the Land Artists, I became acquainted with creative precedents and gained a vocabulary of aesthetic, materials, site specificity, scale, and an understanding of the experiential potential bound to artwork of this kind.

The Land Art genre's limited scope addressing the technical environmental issues that are more clearly understood today led me to the models of sustainability where culture, environment and economics are addressed simultaneously. The two precedent projects, am/pm Shadow Lines and AMD & Art are examples of sustainability models which explicitly incorporate art as part of a multifaceted strategy to reclaim a mined landscape. From am/pm Shadow Lines, I was inspired by the clarity of the referential relationship

between the art and the landscape and from AMD & Art, I was inspired by the notion of legibility and equality of art and science.

Section 2: Site analysis

This data informs an understanding the site developed through explorations into a variety of characteristics from the national level to site specific. This site analysis records observations, facts, and characteristics of a site to inform and inspire design movement. Exploration of past, present and projected conditions of the environment, economy, and cultures of a place are all relevant and found here. Within this section is information on forestry, protected natural areas, geography, geology, topography, hydrology, climate, wildlife (flora, fauna: birds and animals), history, Swaziland's royal lineage, ethnicity, economy, politics, demographics, infrastructure, education, health, current uses of the Ngwenya Mine site, visitor registration book analysis, and finally opportunities and challenges presented to the intent to design. From the site analysis, a set of opportunities and challenges emerged which will be addressed in the design. This section begins with opportunities and challenges and ends with the remaining referential data collected about the site.

Section 3: Opportunities

Tourism - Ngwenya Mine site is extremely unique; the entire story of mining is present in one location**.** The site was under UNESCO World Heritage Site consideration that could be revisited, it is a very easy trip (by private car or luxury bus) between Johannesburg and the Ngwenya Mine site, it is also situated near Kruger National Park that receives an extraordinary number of visitors. Birding in this part of the world is an excellent tourist attraction. Furthermore, an analysis of visitors on record at the Ngwenya Mine museum

indicates that the highest proportions of visitors are Swazis followed by South Africans. A significant number of school groups also visit Ngwenya Mine.

Visible remnants of early primitive mining tool use – The Lion Cave offers a clear and comprehensive record of ochre mining through the ages in a few square feet of stone that are subsequently about 200 feet from the open cast mine. This is a tremendous asset to tell the story of mining. The examples of stone use, stone tool use, and metal tool use illustrate a natural evolution of humankind over at least 40,000 years. This record is dramatically contrasted against the open cast mine that extracted a volume filling a 300-foot deep, mile long mark on the landscape. The story is undeniably evident.

The Arts – The outlets for public art in Swaziland include the National Museum,[158] focused on Swazi cultural and natural history, and several independent galleries where expression through art is growing. Galleries include YEBO! House on Fire, Indinglizi Art & Craft Gallery, and Gallery.com.[159] Many women's cooperatives initiated by Western NGOs and development agencies are in the area and make a very diverse range of crafts made from the local materials (recycled glass, magazines, sisal baskets and rugs) available.

In January 2013, the U.S. Embassy Swaziland asked its social media followers, "Do you think artists should address national issues in their poetry, music, paintings, etc.? What is the role of art in society?" This question and the responses, some of which are here, support the conclusion that an art installation with cultural significance is an appropriate component of the Ngwenya Mine reclamation solution proposed in this thesis. The following are some of the posts shared:

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[158] http://www.sntc.org.sz/cultural/museum.html retreived March 29, 2013

[159][159] http://yeboswaziland.com/; http://www.house-on-fire.com/ ; http://www.swaziplace.com/indinglizi/main.html

- I think that art's place in society is that it lifts our spirit up. Life without art is sad.
- My take is that at times their art reflects their expression on a particular issue.to the extent that freedom of expression is one of the treasured freedoms, art therefore could play the role if expression.
- Artists are so influential in the society. It is their responsibility to contribute in the various aspects of our lives. They have power to influence others and talk about trivial issues and bring them into limelight.
- ....in as much as we can lie to ourselves that freedom of expression exist but that only in books, political expression thru art can lead to artists prisoned, banned from media, alienated by their ppl and exiled. Especially if that artist views does not praise the rules of the ruler. The art is made to become a useless tool, they destroy ur image, ur integrity and value in society. such that few ppl would associate themselves with ur art for many reasons. History of artistic political emancipation has shown us poets held in prisons without charge or trial for as long as his masters see fit to rot the artist in solitary confinements....but beside that art is the best way to address political issues and social justice.....we poets lie to tell the truth....
- We have the right to contribute, part of our responsibility is to showcase what any other person would be afraid to say.. My paintings say a lot about things we see on a daily basis, why then should it not contain politics cause we live in a political world...
- Art brings about social order
- As much as the artist is better positioned to voice their agency, I do not think that it is particularly fair to task them with political voice per se. As David mentioned earlier on, an artist is a person just like all of us. Back in the post-colonial era, writers like Chinua Achebe felt that it was the role of the writer to "decolonize the African mind." Of late, contemporary artists have forwarded the case for "art for art's sake." In this light, the artist is free to say what she wants to say and not say what she does not want to say. She/he has just as much voice as all of us, perhaps more access to a microphone by virtue of having their work open for public consumption. The problem with tasking the artist with political and social voice is that we can pass the buck and feel like we have some select members of society whose role it is to speak up. The fact of the matter is that we should all realize that it is our role to speak up, whether it be by art or other means. It is great to have art around, even better when that art can speak to a larger course, but best that art exists alongside our own active agency

Section 4: Challenges

HIV – The World Health Organization sites Swaziland with the highest prevalence of HIV infection in the world, 38.8% of the population are HIV+. This impacts work absenteeism, health care infrastructure, emotional well-being, family structures and

orphans, funds available for other needs. HIV/AIDS was declared a national disaster in 1999. 23% of people in need receive Antiretroviral Therapy.[160]

Drought – Drought is a natural hazard with the potential to increase with global climate changes. Preventative strategies could be implemented such as reforestation, management of existing water sources through strategies such as riparianization and the elimination, limitation, and/or containment of eminent water pollutants.

Erosion – Erosion is a natural process that has shaped the landscape of Swaziland. As mentioned in the Geology section, harder rock formations have provided mountain ranges while softer stone bodies have crafted the softly rolling hills. Erosion also results from the actions of civilization. Agriculture, timber harvesting, grazing, human settlement and other activities interfere with the natural vegetation patterns often resulting in soil exposure which is then susceptible to weather events like rain and wind. Strategies to address erosion involve thoughtful land use planning and reforestation**.**

[160] World Health Organization: http://apps.who.int/ghodata/?vid=18900&theme=country. Retrieved March 29, 2013

Chapter 10: Conclusions and Design:

Section 1: Introduction

As discussed throughout this paper, the motivation of this thesis is to engage in the experimentation and model building that is emerging to address the social, environmental and economic issues that have arisen as technology and industry have been used to develop modern civilization. The need for more creative solutions to help landscapes transition from industrial to postindustrial places has inspired the development of this design.

Mining, as an industrial activity, has an extremely long history and, when implemented with modern technology, is one of the most aggressive forms of industriousness. For these reasons, it is a suitable candidate to help humankind recognize that the current perceptions of the scope, scale and lifecycles of an industrial activity must be expanded to include remediation of these postindustrial landscapes.

Experimentation and model development toward this end is underway. Methods to treat soil, air, and water quality in postindustrial places are being tested and incorporated with social and economic development issues common in places that were once productive. The design for Ngwenya Mine, which has provided cultural resources for at least 100,000 years and industrial resources for the last fifty years, is based on mine reclamation models that recognize and address social, cultural and economic issues as equals.

Section 2: Process

In August 2012 and January 2013 I was able to visit Swaziland's Ngwenya Mine. During those visits, I observed the conditions of the site and how they changed; I visited

studios, galleries and art market places; and talked with people along the way. Following those trips, I continued the research process by staying in correspondence with a Naturalist Interpreter, an Anthropologist/Archeologist, Artists, and a Forester, all local Swazis who had a personal and/or professional connection with Ngwenya Mine. The site visits and subsequent research provided a sense of the current uses and issues at the Ngwenya Mine site as well as a collection of local users design ideas which all influenced this design proposal.

A secondary part of the process was an exploration into the Land Art genre, a source of some of the earliest mine reclamation strategies addressing cultural issues through public art installations. Land Art offers theory and several examples of aesthetic vocabulary that influenced this proposal. The genre itself is rather specific in its definition but a path of examples clearly influenced by the core Land Artists, continuously in practice today, also influenced this proposal. Two specific examples, am/pm Shadow Lines and AMD & Art are detailed in the precedent section of this paper and are summarized in this section.

The third part of the process was to begin to understand mining and mine reclamation. This important human activity has been a commonality or a universal activity amongst human groups for thousands of years and often for the same purposes, to provide materials for culturally defining practices like burial and marriage and to provide materials with which implements are crafted that ease and advance life quality. Over the last three hundred years, the evolution of mining has accelerated to such an extent that a corollary activity emerged, mine reclamation. By the 1970s, policy and regulatory frameworks were being developed to help places with mining activity protect the

environment from the negative impacts that mining has. Today, most countries have some guidelines in place about the exploitation of the Earth's mineral resources. Mine reclamation practices are also evolving and more sophisticated strategies are being implemented to find real solutions to the results of mining activities.

Because the issues around mining are complex and site specific, this proposal is focused on experiential cultural preservation and experimental environmental remediation and public education. The strategies are designed to honor the cultural story of this place in particular; to meet the need for real-time responses to environmental problems not yet understood; and to inform and engage the visitors of the purposes and processes of mine reclamation. It builds upon existing best management practices like public art, waste containment, and education through interpretation; it attempts to stabilize the most hazardous conditions until they may be addressed by more effective mine reclamation practice; and imagines a methodology to test phytoremediation, one of the newest reclamation practices in the field while also offering legibility of the process as a learning opportunity

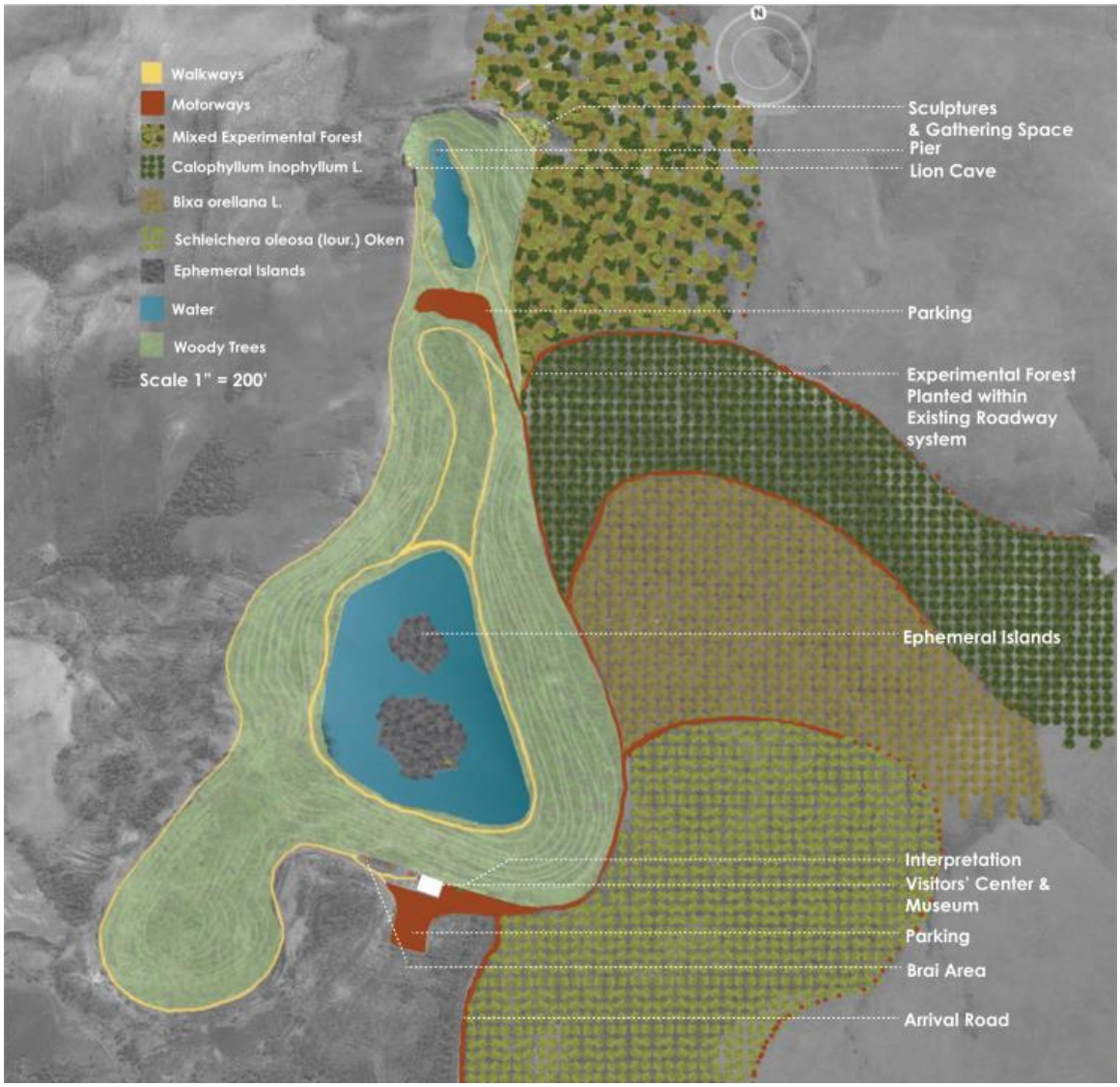
Section 3: Design Schemes

Subsection 1: Story Telling**:**

The major inspiration of the Ngwenya Mine site is the completeness of the mining story. The site has been verified as the oldest known mine in the world and scholarly conclusions have been drawn which suggest it has been the visited for the collection of ochre for at least 100,000 years. Upon the walls of the mine are clear markings of the use of stone as a tool, actual stone tools, and metal tools, visible in these images. A few feet away, is the northern gorge which has filled with water and become a pond where the terracing or benching technique of the commercial mining that happened at Ngwenya

Mine in the 1960s and 70s is visible. Currently, tailings piles are spread across the eastern edge of the north and south gorges. The piles along the northern edge form unique shapes, ovals and tear drops, while the southern piles are more amorphous.

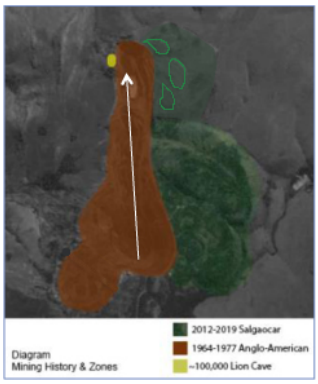
The earliest miners used this place to gather materials important to their lives. At



the same time, the remnants of the recent miners, also gathering materials important to their lives and on behalf of consumers around the world, are also visible. Because reprocessing of the tailings piles began in 2012 and will continue until 2018, it is an opportune moment to imagine a more elaborate conclusion to the story than the one that

can be inferred from the proposed closure plan following reprocessing. The plan simply involves leveling the site, adding topsoil and planting native vegetation.

The research for this thesis explored mine reclamation best practices at open cast mines, iron mines, and mines in general. From that research a set of interventions that are most appropriate based on site conditions and the desires of local stakeholders is proposed as a more strategic conclusion to the mining processes at Ngwenya Mine.



Subsection 2: Preservation & Experimentation**:**
The site layout includes a natural divide between the northern gorge and the two southern gorges. Because of this existing division, the design program focuses on experiential cultural preservation in the northern gorge and experimental environmental remediation and public education in the southern gorges. This section illustrates the 'saddle' that exists between the north and south.

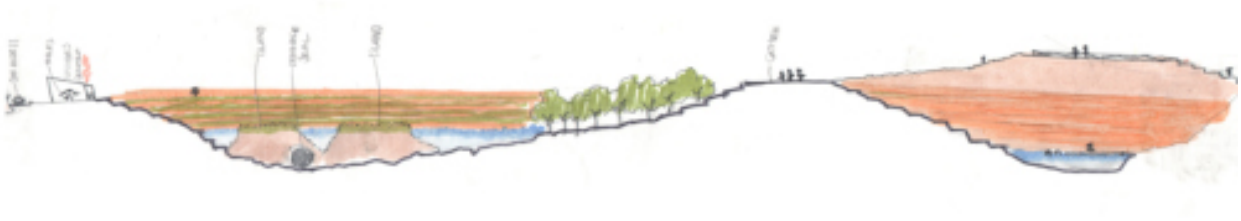


Figure 20: Section Sketch illustrating the saddle that divides the site, the drainage pipe in the southern gorge and the ephemeral island concept.

Subsection 3: Experiential Cultural Preservation in the Northern Gorge**:**
As mentioned, Ngwenya Mine offers a very complete story of mining. Evidence of the evolution of mining tools from simple stone to industrial technology are all present in the northern gorge. The story also becomes nuanced because here, it is possible to see a tailings pile, the waste materials from the Anglo-American era of mining. It is also evident that the water quality has been impacted. The teal color of the water is suggestive of a chemical reaction between iron and the oxygen in the water.

Design Features: The existing path to observe the Lion Cave is modest but appropriate so no changes are suggested to this feature. The three design elements are a landform to serve as an exaggerated plinth; three figures made of steel and based upon the San rock

paintings found in the region and across southern Africa; and a pier upon which small groups can gather in the pond.

Figure 21: Figural Sculptures Visibility Diagram

Figure 22: Landform Plinth is established on the footprint on an existing tailings pile, outlined in orange here.

I. Landform Plinth: The landform is inspired by the interesting shapes of the existing tailings piles, outlined in IMAGE ## in orange. These piles are normally 15 feet tall as is the landform plinth. The footprint of the plinth is a teardrop to reference its current shape but its size is at half-scale. The smaller size is based on the assumption that Salgaocar will reprocess all of these tailings and remove about 30% of the existing materials. This plinth will remain, as an indicator of scale, the height and dramatic size will provoke an imagining of the amount of waste that remains after intensive earth moving to obtain the materials within. The plinth is accessible from a steel staircase on the southern end that

is found at the juncture of existing paths.

Figure 23: Figural Sculptures as seen from the Platform at Lion Cave. Original photograph by Sarah Watling

II. Three-Figures: These three figures, each 25 feet tall, are inspired by the scale of a mine that is 300 feet deep and almost a mile long. The monumental scale is larger than life which is inspired by the lore around the San paintings of the region.

Figure 24: Figural Sculptures as visible from Visitors Center (looking north). Original photograph by Sarah Watling

The San rock art paintings are famous across southern Africa. Anthropologists theorize that the paintings represent San life and beliefs. Scenes often feature groups captured in motion and pointing towards cracks on the stone walls upon which they are painted. This was explained by the interpretive guide at Ngwenya Mine as a representation of the groups entering into the ancestral world, a place larger than life through the crack in the stone.

Figure 25: Figural Sculptures in relationship to Lion Cavern and the pond. Original photograph by Sarah Watling

The figural forms remind us that we are linked both to the earliest miners and the miners of today. They are made of steel and placed upon the plinth, which has been stabilized with a common mine, reclamation vegetation treatment. These figures are visible from the Visitors' Center and from the landing to the Lion Cave across the pond. They are facing south where the design interventions include experimentation and the future of this reclaimed mine.

III. The Pier: The pond emerged during the Anglo-American mining era. Today, groups of up to 12 people are granted free permits to collect the water that offers divine properties to the collectors. The pier adds specialness to the occasion of collecting water and provides a place where small groups can gather. The pier is one hundred feet long with a platform that is thirty feet across. The length allows visitors to experience the

Figure 26: The Pier in the southern gorge. Original Photography taken and used with permission of Greg Marinovich.

gorge in a dramatic way taking them out into the water and over one hundred and twenty feet below grade to be surrounded by terraces from the mining operations.

Figure 27: The Pier in relationship with the Figural Sculptures. Original photography by Sarah Watling

The interpretation of the sacredness of this pond is balanced with the practical ways it is used. For instance, during the January visit, swimmers were observed in the pond. Also, once weekly, the local police force practices aquatic rescue operations in the pond and the pier would serve as a useful space for those exercises as well.

The quality of water in the pond could be problematic. The best available data is from the Environmental Impact Assessment prepared by Salgaocar which determined that the water showed acceptable levels of heavy metals but high levels of organic materials making it non-potable. The accuracy of this specific data is questionable as the entire report was prepared within a few weeks. Therefore, opportunities for water quality testing from the pier exist and implementation of such tests could raise awareness around the impacts of mining on water quality as well as about how the water should or should not be used by humans. Furthermore, data collected during the three phases of this proposal would provide important information regarding the efficacy of the vegetative

stabilization strategy described in the next section on Experimental Environmental Remediation and Public Education.

Subsection 4: Experimental Environmental Remediation and Public Education in the Southern Gorge

Today, the story of mining is incomplete. The rehabilitation project performed by Salgaocar will certainly remove a portion of the heavy metals from the site but their proposal to level the site, replace the topsoil and replant with native vegetation would be an incomplete rehabilitation of this place. To further the rehabilitation or reclamation process and subsequently the "story" Ngwenya Mine tells, this proposal includes three additional design features in the southern section. The first is a pair of ephemeral islands; the second is a set of four legible phytoremediation experimental forests; and finally is an interpretive sign inspired by the "Makhonjwa Barberton Mountain Geotrail – A journey to the beginning of time" project which is underway.

Because of Salgaocar's current lease that extends until 2018, this proposal is presented in three phases. The majority of the experimental environmental remediation and public education interventions are part of the final phase three. The phasing plan description follows the next section on design features.

Design Features:

Ephemeral Islands: As Salgaocar concludes their preprocessing activities; piles of waste materials will be left on site. As mentioned, the current closure plan proposes leveling those remaining tailings piles, covering them with topsoil and planting the areas with native vegetation. Containment of waste materials is a viable strategy and covering with topsoil is one method. However, the nature of the metals and materials in question suggest a more robust strategy would be more appropriate. Furthermore, because of the

topography of the Ngwenya Mine site, being one of the highest points in the area, a more a containment strategy should insure that waste materials do not flow downhill and enter the water supply during precipitation events. One of the most effective containment options of current mine reclamation practice is to hold materials underwater so they do not contaminate the air, soil or inadvertently enter streams or other water bodies.

Figure 28: Study Diagram of how Salgaocar could become involved with the containment of the remaining waste rock.

To engage Salgaocar in the reclamation process, this thesis proposes that Salgaocar use their equipment to transport the waste materials generated through reprocessing to the bottom of the Stag gorge. Historic photographs indicate that two peninsular landforms are accessible via roads created and used by Anglo-American. Reutilizing those roads, the waste materials can be deposited here during phase I and in preparation for storage and containment.

At the bottom of this gorge, is a drainage pipe that is currently contaminating a nearby stream. During phase I, the pipe will be lines with limestone which is at effective treatment of acidic mine waste water. The efficacy of limestone treatment is limited to moving water so it will only be implemented in this drainage scenario and not as a treatment for the existing pond which is static.

In phase III, following the conclusion of Salgaocar's lease, the drainage pipe will be sealed in order to contain the polluted water. As mentioned in the site analysis section, Swaziland and this area in the highlands experiences a dramatic wet (January) and dry seasons (June). In June when water levels are low, these two islands of waste materials will emerge from the water (top image) offering visible clues to the polluting waste material containment efforts while in the wet season, they will be completely underwater (bottom image).

Figure 29: Ephemeral Islands during dry season (above) and rainy season when they will be submerged (below). Original photography by Sarah Watling

Experimental Forest: Phytoremediation, the use of vegetation to absorb and metabolize heavy metals and other contaminates is on the cutting edge of land reclamation in general and some recent studies have demonstrated that it is effective in mine reclamation scenarios. A study conducted in India by Chaturvedi, Dhal, and Rama Reddy explored the phytoremediation potential of three species on iron ore tailings in conditions similar to those found at Ngwenya Mine. Their study concluded that Calophyllum inophyllum

L., a tree native to Swaziland's neighboring Mozambique was the most effective species at taking up heavy metals.[161]

Because mine reclamation is so dependent on site specific conditions, this proposal is for a thirty year experiment in forestry. Four test plots are proposed, one stand for each of the three species and one mixed stand to determine if any of the three species is more capable of surviving in these conditions and if any one species is more effective at taking up heavy metals from the soil.

The experiment design will be dependent on the participation of a research entity such as a university or other interested forestry advocacy group. Regular monitoring and evaluation will be needed to determine impacts on water quality and quantity in neighboring water bodies as well as soil testing to determine the impacts, if any, of the vegetation on the levels of heavy metal content in the soil.

Interpretive Signage: During the site visit in January 2013, Dr. Christoph Heubeck was also visiting the Ngwenya Mine Visitors' Center. Dr. Heubeck, a Professor of Geologist at the Freie Universitaet in Berlin Germany and an expert in the Barberton Greenstone belt within which Ngwenya Mine is located, was exploring the site as a potential addition to the Barberton Makhonjwa Geotrail, (BMG) a self-guided tour to various geologically significant sights in the vicinity. The BMG has an established route with interpretive stations in South Africa and plans to expand into Swaziland and incorporate Ngwenya Mine into the trial at some point. The BMG has interpretive signage and this proposal includes an interpretive panel that is to be placed at the Visitors' Center and that is modeled after the BMG's panel design. The sign explains the geology, the history of

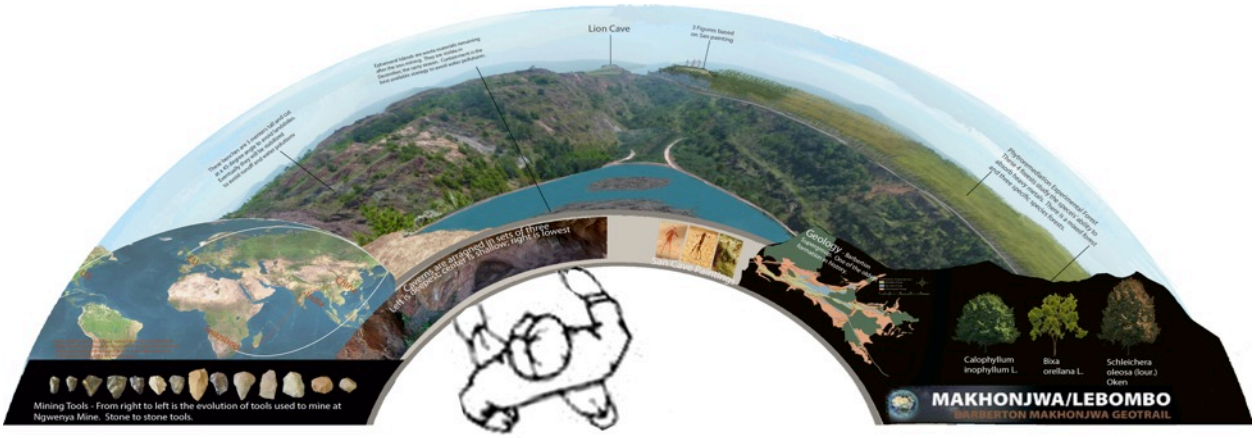
[161] Chaturvedi, Dhal, and Rama Reddy. Page 117. International Journal of Mining, Reclamation and Environment.

mining at Ngwenya Mine, the inspiration of the three sculptural figures, the routes around the world the iron ore from Ngwenya Mine have travelled during the Anglo-American and Salgaocar mining eras, the experimental forest and other significant features of the site.

In response to a request for design guidelines for the panels used on the BMG, the designer shared the following explanation that I followed in the preparation of the panel prepared for this proposal.

> We used semicircular panels for the view sites for several reasons. The primary one is that the views are immensely wide -- 180 degrees plus. It enables us to roughly align features on the panel with the same feature in the landscape. We think that makes it easier for people to identify the features. We wouldn't consider using them in another context with a much narrower view plane. The other reason is that we would like the panels to appeal aesthetically to the main audience — casual/interested tourist/day-tripper. A curved panel is something a little different from the usual vertically mounted rectangle.
>
> We don't have a framework/template. We typed in the info along curves on each individual panel. The theme of the trail is geology but we have used the view panels to tie in some cultural history and biodiversity. These are both important in the context of status as a World Heritage Site.

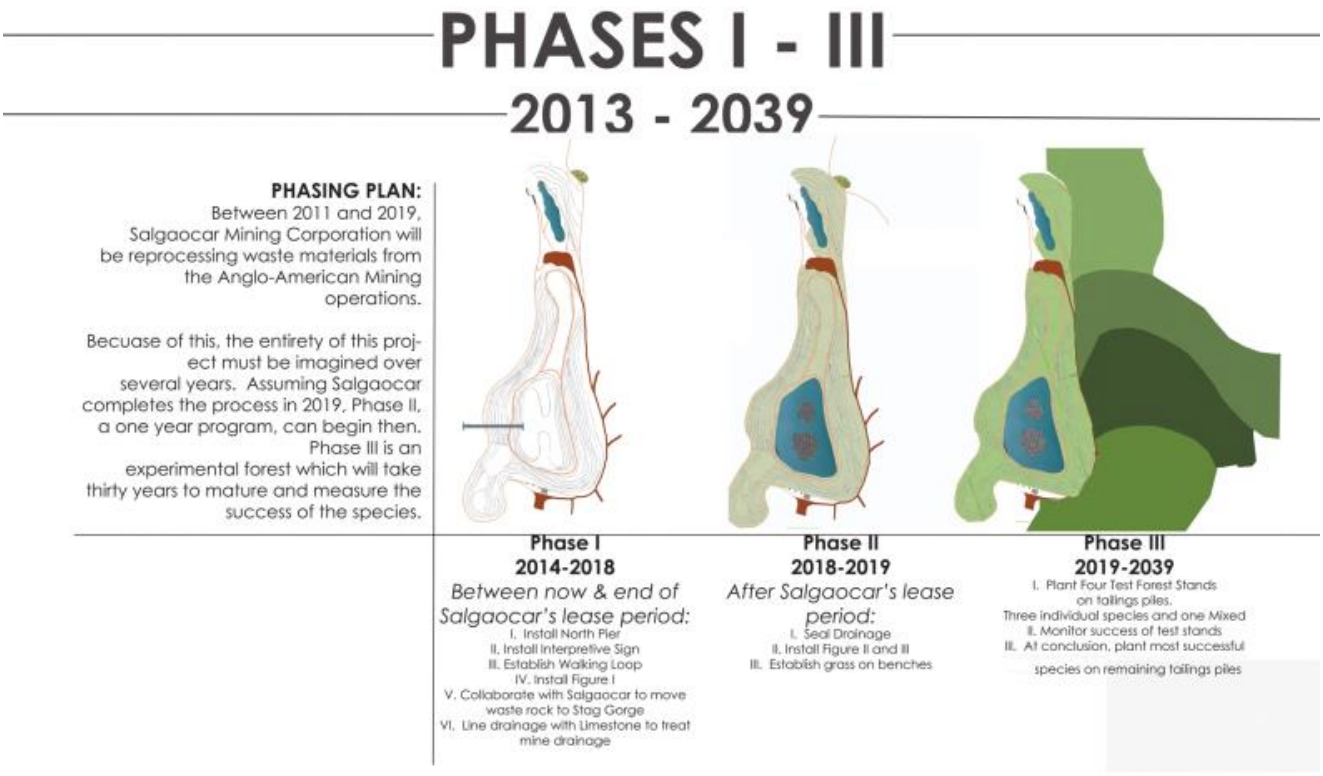
Figure 30: Interpretive Panel based on Makhonjwa/Lebombo GeoTrail signage. Original photography by Sarah Watling



Section 4: Phasing Diagrams and Interventions

Because of the Salgaocar operation, this project must be imagined in phases.

This diagram suggests a phasing plan to implement the program over 26 years.



Appendix 1: Supplementary Site Analysis

The Arts – Historic: the San people inhabited ancient Swaziland. Because the San were the first miners there and because the conceptual nature of landscape is a series of eras nested overtime, understanding San art history is important to inform this project. David Lewis-Williams is a South African scholar of cognitive archeology at the University of the Witwatersrand in Johannesburg where Raymond Dart, the aforementioned anthropologist and anatomist also worked, dedicated much focus to the rock art of southern Africa and to the cognitive origins of art in general. In a 1987 paper delivered as part of the twenty-fifth Raymond Dart Lecture series, Lewis-Williams discusses two methods of rock artistry, paintings and engravings. The engravings found in the central plateau depict geometric forms like grids, circles, and undulated lines, rare themes in the paintings in the mountainous areas especially those of the Maluti and Drakensberg range, which runs along the western edge of Swaziland.

Recent scholarship on art in small-scale societies, like the San groups, makes it clear that this art has very specific, complex purposes and meanings.[162] San art is shamanic, depicting the practice of medicine men and women hallucinating and entering trance states to perform acts like understanding and curing illness, making rain, moving antelope herds and embarking on vision quests. This is important to understand because this was part of life for the earliest ochre users at Ngwenya Mine. The shamanic states were entered not through hallucinogens but through hyperventilation, rhythmic movement and music, and intense concentration. The transition to a hallucinated state goes through three phases: first is *entropic phenomena* where rapidly changing visions of geometric forms (i.e. dots, spirals, grids, zigzags, U-shapes, honeycombs) are created in the optic

[162] Lewis-Williams, paper, page 2

nerve or cortex and experienced with the eyes open or closed; from entropic phenomena the brain tries to recognize or decode these images while the shaman is hoping or expecting to see something from the spirit world; finally, the sensation of being in a vortex or having tunnel vision where upon the 'walls' of the tunnel the entropic phenomena, with the psychic power of the shaman, become iconic images that create emotional experiences enforcing the perception of reality.[163] These are important design inspirations for this project.

While no San paintings have been found at the Ngwenya Mine site, it is easy to imagine the painters here. The durable paints used were created from eland blood, haematite and ochres, charcoal or specularite, all of which were present or part of the Ngwenya landscape.[164] Like many of the rock paintings found around the world, the San paintings were painted one on top of the other, this repetition supports ideas about ritual and that the paintings have a greater purpose than art for its sake. The paintings in the eastern part of southern Africa frequently feature groups of hunters and dancers and the eland. The lack of variety in subject matter also supports the notion that there is a deeper meaning to these images.[165] The Jellicoes describe the importance of ancient rock paintings in general, "The design is complex in time as well as space, for one animal has later been drawn over another with a respect for the past. Considered as a whole, the cave paintings are the first and still the most pure of all the intuitive arts of landscape design".[166]

[163] Lewis-Williams, page 13
[164] Lewis-Williams, Imprint of Man, page 24
[165] Lewis-Williams, Imprint of Man, page 41.
[166] Jellicoe, Geoffrey, and Susan Jellicoe. 1975. *The landscape of man: shaping the environment from prehistory to the present day*. New York: Viking Press. Page 15

Forestry: In the last century, the increase in Swaziland's population has put intense pressure on indigenous vegetation. Add increasing poverty[167], drought and low awareness of the importance of natural resource management and limited government agency resources to implement management plans and the pressure is exacerbated.[168] In a paper for the United Nations Food and Agriculture Organization, Futhi Felicity Magagula reported on historical and current forestry conditions and offered scenarios going forward. Magagula's work identifies Swaziland's semitropical indigenous vegetation patterns as grasslands in the highlands; and wooded grassland, bushland and woodland in the lowlands.[169] Swaziland's indigenous forest covers are undifferentiated Afromontane vegetation in the northwest where Ngwenya Mine is located, undifferentiated woodland in the eastern half of the country; and a mosaic of Afromontane scrub forest, scrub woodland and secondary grassland in the western quarter.[170] Some, but very little natural evergreen forest is also present in the western high altitudes and in small patches on the eastern boundary.[171] While the value of indigenous forests is great, reforestation plans have not been implemented.[172] As the pressures from civilization increase, secondary vegetation patterns are emerging which are generally represented by invasive alien species.[173] Secondary forests are categorized as post extraction as is the case at Ngwenya Mine, post fire, post abandonment and post grazing.[174] As human needs grow, even secondary forests

[167] The Swaziland Environmental Authority, Ministry of Tourism and Environmental Affairs. 2009. Swaziland's Fourth National Report to the Convention on Biological Diversity.
[168] Magagula, Futhi Felicity. Ministry of Agriculture and Co-operatives: Forestry Section. 2002. Country paper: Swaziland, Tropical Secondary Forest Management in Africa, Reality and perspectives. Prepared for the Food and Agriculture Organization of the United Nations. Page 1 and 10.
[169] Magagula, Futhi Felicity. Page 2.
[170] Magagula. Page 3.
[171] Magagula. Page 2.
[172] Magagula. Page 2.
[173] Magagula. Page 7.
[174] Magagula. Page 1.

are transitioning to other land uses like agriculture (18% of total land use), communal grazing land (50%), ranching (19%), firewood extraction and housing.[175]

Protected Areas: In 1972 Swaziland established the Swaziland National Trust Commission (SNTC) as superintendents of conservation and preservation programming, both public and private. By 1992, land being conserved or preserved accounted for almost four percent of the country's land area.[176] Nationwide, Swaziland has 20 endemic plant species with the highest richness (see list in *Flora* section) residing in the montane grasslands in and around Malolotja Nature Reserve, declared a conservation area in 1980, where Ngwenya Mine is located.[177] Malotoja Nature Reserve is described as a mountain wilderness spanning 18,000 hectares. As is the case around the world, the relationship between economic development and preservation is a difficult one. In the best case, a protected area is able to produce economic gains and contribute to a country's well-being as South Africa's Kruger National Park does just north of Swaziland. Like many other protected areas, Swaziland's are in jeopardy because they are not producing enough revenue or jobs. The threat is growing as the population grows by 3.5% annually.[178]

Geography: Ngwenya Mine, situated within the Malolotja Nature Reserve in northwestern Swaziland, is northwest of Mbabane, the Swaziland capital. Landlocked, Swaziland is bordered on the east by Mozambique and on the north, west, and south by South Africa. On paved roadways, Ngwenya Mine is around six kilometers from the Swaziland border with South Africa. Ngwenya Mine is around 110 kilometers from the eastern Swaziland border with Mozambique and another 90 kilometers across

[175] Magagula. Page 2.
[176] Hackel page 61.
[177] The Swaziland Environmental Authority, Ministry of Tourism and Environmental Affairs.
[178] Hackel and Carruthers, page 63

Mozambique to the Indian Ocean. Swaziland's total area is 17,364 square kilometers (of which 160 square kilometers are water) which is slightly smaller than New Jersey.[179] The largest city in the country is the capital, Mbabane with a population of 74,000.[180] In 2010, 21% of Swazis lived in Mbabane. Swaziland is seven hours ahead of Washington, DC during Standard Time or UTC+2.

Geology: The region's geologic formation was through a process of volcanic activity. The Barberton Greenstone Belt, which extends through the western edge of Swaziland, is composed of three groups, the Onverwacht Group, the Fig Tree Group and the Moodies Group.[181] Within the Onverwacht Group, lies the unique iron deposit that spurred Ngwenya Mine. Here, ironstones and quartzites are plentiful and resistant to erosion, the high peaks of Ngwenya Mountain, Silotfwane Mountain and the Mgwayiza Range are all examples of the durable ironstones and quartzites which have stood up to natural erosion.[182] Soapstones, a softer rock, are also abundant and are visible in the rolling hills across the landscape.[183] Iron deposits of the Fig Tree shales (fact check) are the only ones with economic value. A eight kilometer wide belt extends along the northwestern border of Swaziland, within which is the Ngwenya zone which extends 1980 meters reaching about 100 meters at the widest point.[184] The Barberton Greenstone Belt has been gold mined continuously since beginning in 1886. As mining technology evolves and becomes more efficient, the limits of extractive processes allow mining to push further into the earth. Because of these technological advances and because of new discoveries of other

[179] Central Intelligence Agency, the World Factbook. Retrieved February 11, 2013. https://www.cia.gov/library/publications/the-world-factbook/geos/wz.html
[180] CIA
[181] Ward, J.H.W. 1995. Geology and metallogeny of the Barberton greenstone belt: a survey. Journal of African Earth Sciences, Vol. 21.
[182] SNTC
[183] SNTC
[184] De Kun, Mineral Resources of Africa, page 274

minerals in the Barberton Greenstone Belt, mining will continue here "well into the foreseeable future."[185]

Topography: This region is situated along Southern Africa's Great Escarpment[186] near the *Drakensberg Mountain Range*. The highest point is in Emlembe at 1,862 meters and the lowest in the Great Usutu River and 21 meters.[187] The altitude ranges almost 1,800 meters creating four physiographic regions: Highveld, Hilly Middleveld, Lowveld, and Lubombo Plateau.[188] The Malolotja Nature Reserve is within the ecotone between the Highveld and the Middleveld.[189] The Lowveld is a swath running north to south and the lowest region, the Lubombo Plateau, runs along the east.[190] The Lowveld is also where remnants of Swaziland's big game habitat are found.[191] In places like the Malolotja Nature Reserve and other mountainous areas, the landscape is dramatic, providing spectacular vistas over the aforementioned rolling hills. The landscape in Swaziland is comprised of savannahs, mountains, and rain forests, this diversity is notable in a country of this size.

Climate: Swaziland is about 300 kilometers south of the Tropic of Capricorn in a subtropical climate. The seasons are the reverse of those in the Northern Hemisphere with December being mid-summer and June mid-winter. Rain falls mostly during the summer months, often in the form of thunderstorms. Winter is the dry season. Annual rainfall is highest on the Highveld in the West, between 1,000 and 2,000 mm (39.4 and 78.7 in) depending on the year. Less rain falls in the east with the Lowveld recording 500 to 900 mm (19.7 to 35.4 in) per year. Variations in temperature are related to the altitude of the different regions. The Highveld temperature is temperate while the Lowveld may record temperatures around 40 degrees

[185] Anhaeusser, page 1
[186] Swaziland National Trust Commission. http://sntc.org.sz/reserves/malgeol.html
[187] CIA
[188] Magagula
[189] sntc
[190] Magagula
[191] Hackel and Carruthers page 64

centigrade or 104 degrees Fahrenheit in summer. The average temperatures in Mbabane, the capital: spring from September – October is 18 °C (64.4 °F); summer from November – March is 20 °C (68 °F); fall from April – May is 17 °C (62.6 °F); and winter from June – August is 13 °C (55.4 °F). David Lewis-Williams, the anthropologist, discusses the seasonal movement of San camps and suggests that in September to January, when summer rains attracted migratory antelope herds to the higher grasslands, San groups moved to higher areas as well, these higher areas are where many rock cave paintings are found.[192]

Wildlife[193]: Flora: Within the diverse landscapes of native and secondary vegetation described earlier, exist plants endemic to Swaziland. The following is a provisional and working list of endemic plants[194]: Eragrostis comptonii; Eragrostis sp. nov; Kniphofia umbrina; Aloe keithii; Dierama elatum; Disa intermedia Linder; Crassula vaginata Eckl. & Zeyh. subsp. minuta Toelken; Lotononis spicata Compton; Euphorbia keithii R.A. Dyer; Cassipourea swaziensis Compton; Erica swaziensis E.H.G. Oliver; Ceropegia sp. (Kemp 662,1300); Syncolostemon comptonii Codd; Orthosiphon vernalis Codd; Selago swaziensis Rolfe; Streptocarpus davyi S. Moore; Eumorphia swaziensis Compton; and Senecio mlilwanensis Compton.

Fauna: Birds - The Swaziland National Trust Commission says that due to the countries diverse landscapes, Swaziland provides habitat sufficient to register greater bird species diversity "in a smaller area than the Kruger National Park, which is world renowned as a birding locality". This strongly suggests a case for preserving bird habitat and promoting this facet of Swaziland to attract birding visitors. The following table lists some examples

[192] Lewis-Williams, The Imprint of Man, page 16

[193] Swaziland's Twentieth Century Wildlife Preservation Efforts: The Present as a Continuation of the Past Jeffrey D. Hackel and E. Jane Carruthers *Environmental History Review* , Vol. 17, No. 3 (Autumn, 1993), pp. 61-84

[194] SNTC. Swaziland's Threatened and Endemic Flora. Retrieved February 1, 2013. http://www.sntc.org.sz/biodiversity/endemics.html

of bird species that are globally threatened and/or threatened within southern Africa which are able to find refuge and grassland habitat specifically within the Malolotja Reserve:[195]

Globally Threatened:

1. Blue Swallow Hirundo atrocaerulea
2. Blue Crane Grus paradise
3. Ground woodpecker Geocopaptes olivaceous
4. Buffstreaked Chat Oenanthe bifasciata
5. Southern Bald Ibis Geronticus calvus

Threatened within Southern Africa:

1. Stanley's Bustard *Neotis denhami*
2. Striped Flufftail *Sarothrura affinis*
3. Broadtailed Warbler *Schoenicola brevirostris*

Fauna: Animals[196] - The Natural History Society of Swaziland (NHSS), formed in 1978 "to provide a meeting ground for all people interested in fostering a broader & deeper understanding and appreciation of the Natural History of Swaziland".[197] Between 1990 and 2010, the NHSS performed a game count in Malolotja Nature Reserve and recorded the presence of the following 19 game animals: baboon, chacma, Blesbok; rock dassie, grey duiker, red duiker, eland, red hartebeest, impala, blackbacked jackal, klipspringer, mongoose, vervet monkey, Oribi, common reedbuck, mountain reedbuck, grey rhebok, black warthog wildebeest, blue wildebeest, Burchells' zebra.

Ethnicity: Swaziland is fairly homogenous and most people are of Bantu descent. There are both Zulu and white populations but both are small. Vail explains, "Ethnicity is not a natural cultural residue but a consciously crafted ideological creation."[198] Vail argues that Swazi socioeconomic class overshadows ethnicity since, different from surrounding

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[195] Parker, Vincent. Priorities for conservation of avifauna in Swaziland. SNTC.
[196] Natural History Society of Swaziland. Malolotja Nature Reserve Game Counts, 1990-2010. Retrieved February 11, 2013: http://www.naturalhistorysociety.org.sz/attachments/NHSS%20Malolotja%20Game%20Counts%201990%20to%202010.pdf
[197] Natural History Society of Swaziland. Retrieved February 8, 2013. http://www.naturalhistorysociety.org.sz/
[198] Vail in Grinker…, page 100

nations, ethnic unity and identity keeping was not as necessary for Swazis as for other groups who participated more aggressively in migration during the early stages of gold mining.

Economy[199]: South Africa provides 90% of goods imported to Swaziland and receives 60% of Swazi exports. Their currencies, the South African Rand and the Swazi Lilangeni are of equal value. Approximately 40% of the population is unemployed, 70% subsist on agriculture and 69% live below the poverty line. In 2006-07, Swaziland suffered a drought that required emergency food aid for 25% of the population. Swaziland heavily depends on customs duties from the Southern African Customs Union (SACU) that decreased by 62% between 2009 and 2010. Sugar is the main export earner and is closely linked with the European market. In 2007, sugar prices declined by 17% but in 2012, the European Union made a grant of $25,000,000 six-year project grant for sugarcane production and to increase the sector's efficiency.[200] Other exports are soft drink concentrates, cotton, yarn, textiles, citrus and canned fruit. Mining, once a large contributor to the national economy, is currently in decline. Current strategies for economic development focus on attracting foreign direct investments. In 2011, Swaziland sought support from the International Monetary Fund and from the African Development Bank but failed to meet requisites for funding such as reforming the wage bill for Swaziland's bureaucracy that is 18% of the 2011 GDP of $6.231 billion.

About 90% of energy consumption in rural households is from firewood from wattle jungles (*Acacia mearnsii).*[201] Charcoal, derived from the wattle jungles (*Acacia*

[199] CIA website
[200] The Africa Report, Swaziland Profile, page 119
[201] Magagula. Page 9

mearnsii), is exported to South Africa.[202] Economic forecasts suggest that environmental factors like overgrazing, soil depletion flooding and drought will impact forestry putting additional burden on the economic structure.

Politics – Swaziland is governed by monarchy, which is hereditary. The monarch appoints the prime minister who is a sitting member of the elected members of the House of Assembly. The prime minister recommends cabinet membership that is confirmed by the monarch. The House of Assembly is composed 65 members serving five-year terms, the monarch appoints 10 and 55 are elected by popular vote. The legislative branch is a bicameral Parliament composed of a Senate of 30 members serving five-year terms. The monarch appoints 20 members and the House of Assembly elects 10 members. The monarch appoints judges for both the Supreme and High Courts. Active political associations are the African United Democratic Party, Imbokodvo National Movement, Ngwane National Liberatory Congress and the People's United Democratic Movement. Swaziland joined the United Nations in September 1968.[203] Of note, the People's United Democratic Movement (PUDEMO) illegally formed in 1983 during the transition between King Sobhuza and the current King Mswati III. PUDEMO formed to create a multi-party democracy, encourage economic freedom and social progress. PUDEMO continues to operate illegally and varying degrees of severe punishment fall upon its leaders when PUDEMO and the monarchy clash.[204]

Demographics: This demographic data was collected by the United States Central Intelligence Agency and the United Nations. In 2012, the population of Swaziland was

[202] Magagula, page 9
[203] United National Country Profile, Swaziland
[204] ACTSA.org, Civil Society in Swaziland.
http://www.actsa.org/Pictures/UpImages/Swaziland/Civil_Society_Swaziland.pdf

1,386,914 people, 97% of whom are native African and 3% are European or of European descent, and is growing at 1.2-1.4% annually. The life expectancy at birth is 49.7 years though 83 per 1000 live births suffer an under-five mortality rate.[205] The following table captures age distribution:[206]

Age in years	Percent of Population	Female individuals	Male individuals
0-14	37.4-38.8	256,095	261,961
15-64	59%	409,798	408,278
65+	3.7%	30,017	20,765

Language: English and siSwati are both official languages with English being used for government and business. Zulu, Tsonga and Afrikaans are also used in Swaziland[207].

Religion: 40% of Swazis subscribe to Zionism, a blend of Christianity and indigenous ancestral worship. 20% subscribe to Roman Catholicism, 10% are Muslim and various other religions compose the remaining 30% (Anglican, Baha'i, Methodist, Mormon, Jewish).[208]

Health: The San and Bantu people both lived in shamanic cultures reliant on medicine people who today are considered traditional healers. Traditional healers and western medicine met in 1894 when traditional healing, thought of as witch doctoring by white settlers, became illegal. In the mid-1940s, legislative movement was made to recognize traditional healers but never went into effect. King Sobhuza II envisioned a system combining the best of traditional and western medicine. In the early 1980s, research on traditional medicine was proposed as was organizing and recognizing traditional

[205] ACTSA, Country Profile Swaziland
[206] ACTSA, Country Profile Swaziland
[207] ACTSA. Country Profile Swaziland
[208] CIA website

healers.[209] By the mid-1980s, the presence of HIV/AIDS changed the discussion and by the early 1990s, traditional healers were being trained in HIV/AIDS and STD prevention.[210] In the early 2000s, barriers to controlling the spread of HIV/AIDS were largely cultural (culture mores influence sexual behavior; sanctioned gender-based power dynamics; and religious and cultural taboos).[211] Between then and now, little research appears to have been done on the relationship between traditional medicine as treatment of HIV/AIDS however western and Swaziland governmental medicals professions are adapting their approaches to reach more traditional healers as the crisis continues to grow.[212] In 2009, 25.9% of adults were HIV positive, 180,000 people were living with HIV/AIDS.[213]

Visitors on Record: Between 2004 and 2013, 7,290 visitors registered in the visitor log at the Ngwenya Mine Visitors Center and Museum. Two visitor registries are available side by side with no differentiation in purpose. The vast majority of visitors are Swazi (3406 total) and South African (1771 total). Between 2004 and 2013, 4243 adults and 3047 children visited Ngwenya Mine. (See Appendix --- for graphs).

Hydrology: Drought is a natural hazard in Swaziland. Of Swaziland's total area, only about 0.9% is water. 60% of the population does not have access to an improved water source.[214] Landlocked, Swaziland's water comes from surface waters, groundwater and atmospheric moisture. "The Komati, Lomati, and Usutu rivers originate in South Africa

[209] Green and Makhubu, page 1071
[210] Green, Bongi, and Dupree, abstract
[211] Tobias, abstract
[212] Levers, page 87
[213] CIA website
[214] ACTSA – Action for Southern Africa. Country Profile, Swaziland. September 2011. Retrieved February 11, 2013. http://www.actsa.org/Pictures/UpImages/pdfs/Swaziland%20Country%20Profile%20September%202011.pdf

while the rest of the rivers originate within Swaziland. The four major tributaries of the Great Usutu river basin which has an area of about 12,000km2, originate in the Republic of South Africa (RSA), combine to form the Great Usutu river…and discharge into RSA and eventually into Mozambique".[215] The drainage basins are: Lomati, Komati, Usutu, Mbuluzi, Mgwavuma, Pongola, and Lubombo. A 1992 report[216] on a groundwater survey conducted by the Swaziland Department of Geological Surveys and Mines, between 1981 and 1986 and in partnership with the Canadian International Development Agency, identified several hydrogeologic units in the water-bearing subsurface strata. Of the units, the most productive are all located in the Highveld area, one of which is the Greenstone Belt mentioned in the Geology section within which is the Malolotja Nature Reserve and Ngwenya Mine. The report describes ground water flow systems as mostly shallow which supply characteristic springs, seeps and vlei or intermittent ponds.[217] Groundwater recharge is estimated at between 0.5 and 15% of average annual rainfall.[218] Very little of the potential groundwater resource has been realized and the Middle and Highvelds, where Ngwenya Mine is located, offer the best opportunities for groundwater exploitation.[219]

Jonathan Matondo's analysis of a modeling project to predict the impacts of the combination of population increase and climate change in Swaziland concludes with the following statement, "What can be concluded here is that stream flows will be low during the winter months and the population increase will cause water shortages during the winter months. Therefore, optimal water resources management will be crucial. Adaptation

[215] Matondo, Msibi, page 426
[216] Government of Swaziland, Department of Geological Surveys and Mines and Canadian International Development Agency. Groundwater Resources of Swaziland. Prepared by Piteau Associates Engineering LTD. North Vancouver, B.C., Canada. December 1992. Executive Summary.
[217] SNTC Geology, Soils and Hydrology.
[218] Government of Swaziland, Groundwater Resources of Swaziland.
[219] Government of Swaziland, Groundwater Resources of Swaziland.

options have been suggested and range from modification of the existing infrastructure to water demand management."[220] From this analysis, Matondo proposes a set of adaptation strategies available in the following table.[221]

Modification of the Existing Infrastructure:

1. Supply adaptation (installing canal lining, changing location of water intakes, using closed conduits instead of open channels, integrating separate reservoirs into a single system, using artificial recharge to reduce evaporation)
2. Possible modification if there are increased flows due to climate change (raising dam wall height, increased canal size, removing sediment from reservoirs for more storage)
3. Construction of new infrastructure (reservoirs, hyproplants, delivery systems, inter-basin transfers)
4. Alternative management of existing water supply systems (change operating rules, use conjunctive surface/groundwater supply, change priority of releases, physically integrate reservoir operation system, coordinate supply/demand)

Demand Adaptation:

Conservation and Improved Efficiency

5. Domestic (low-flow toilets, low-flow showers, re-use of cooking water, more efficient appliance use, leak repair, commercial car washing where recycling takes place, rainwater collection for non-potable uses)
6. Agricultural (night time irrigation, lining canals, closed conduits, improvement in measurement to find losses and supply water efficiently, drainage re-use, use of wastewater effluent, better control and management of supply network)
7. Industrial (re-use of acceptable water quality, recycling)

Technological Change

8. Domestic (water efficient toilets, water efficient appliances, landscape changes, dual supply systems, recycled water for non-potable uses)
9. Agricultural (low water use crops, high value per water use crops, drip, micro-spray, low-energy, precision application irrigation systems, salt tolerant crops that can use drain water, drainage water mixing stations)
10. Industrial (dry cleaning technologies, closed cycled and/or air cooling, plant design with reuse and recycling of water imbedded, shift the type of products manufactured)
11. Energy (additional reservoirs and hydropower stations, low head run of river hydropower, more efficient hydropower turbines)

Market/price driven transfers to other activities

12. Using water price to shift water use between sectors

[220] Matondo, page 431
[221] Matondo, page 434

Land Use Management

13. Land use is the major factor that affects the runoff in a stream. Therefore, there is a need for the implementation of good land use practices in the country in order to conserve the water resource. This will require the change of attitudes of the people in animal herding and land husbandry principles and strategies. This is very important for the conservation of the water resource for the present and future generations.

Promoting Regional Partnership – almost all rivers in Swaziland are international rivers. Therefore, there is the need to establish partnership the utilization of international waters.

Swaziland's Royal Lineage: The maintenance of royal power in Swaziland is rooted in a respect for tradition, actively created by the monarchy.[222] This is a summary of the royal family in Swaziland:

- Mswati II: ruled between 1840 and his death in 1889. The greatest gains in Swazi territory were made during his reign.
- King Mbandzeni: ruled between 1874 to 1889 and granted land concessions to white settlers for mineral, grazing, timber exploitation rights. Hackel and Carruthers explain how these concessions translated into extreme power, held by a few hundred white settlers over the entire Swazi population. In addition to land use, concessions included exclusive authorities over printing, lottery administration, and revenue collection, essentially issuing political complete authority of Swaziland. [223]
- King Ngwenyama Sobhuza II (1899-1982) reined his entire life, arguably holding the longest reign of any monarch in history at the time of his death. Sobhuza was the son of Bhunu and Lomawa Ndwandwe from whom he was given the name, Nkhotfotjeni or stone lizard as his father was "living among stones like a lizard

[222] Twentieth-Century Swaziland, Review of When the Sleeping Grass Awakens
[223] Hackel and Carruthers, page 64

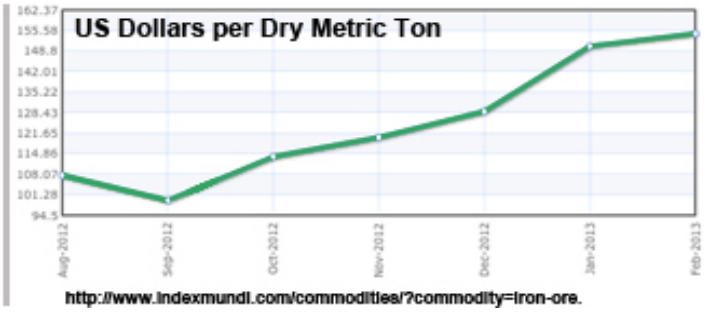
because war was threatening" with the Boers.[224] Months following Bhunu's death, Nkhotfotjeni was chosen as King and readdressed, Sobhuza II. The first national school in Swaziland, Zombodze Primary School, was built for him. During his childhood through young adulthood, his grandmother, Gwamile or the Queen Regent Labotsibeni served as the royal leader (Follow up on Jonathan Crush: "QRL was highly skilled in the deployment of inventive strategies during Sobhuza's minority and needs credited for her formative influence"). Following his education, he assumed the Kingship in 1921. Under his leadership, Swaziland joined the United Nations and received independence from Britain. Following his death, the illegal and controversial People's United Democratic Movement emerged during the transition to a new King (see Politics for more on PUDEMO).

- King Mswati III - On April 25, 1986, King Mswati III assumed the kingship; he is 44 years old now.

[224] Swaziland National Trust website, retrieved February 16, 2013, http://www.sntc.org.sz/cultural/sobhuza.html

Appendix 2: Value of Iron Ore

These tables illustrate the market changes in the value of iron ore; from which it can be extrapolated that 223 trips carrying 32 tons of iron daily will be valued at approximately $1,105,000 USD. [225][226]



[225] Iron Ore Monthly Price. http://www.indexmundi.com/commodities/?commodity=iron-ore. Retrieved March 29, 2013.
[226] Retrieved March 30, 2013.

Appendix 3: Analysis of Visitor Country of Origin and Adult/Child Comparison between 2004 and 2013.

These tables illustrate the nationality of visitors between 2004 and December 2012 and the distribution of adults and children visiting per year between 2004 and December 2012. It is included here to demonstrate who uses the space and how. Swazis and South African visitors are the main audience and a significant number of youth also visit. Not illustrated here are the clusters of children in the registration book which suggests that they are visiting as part of a school or youth group. For this reason, the design called heavily on the local history of the San paintings and included significant environmental education and interpretation to take advantage of the existing audiences.

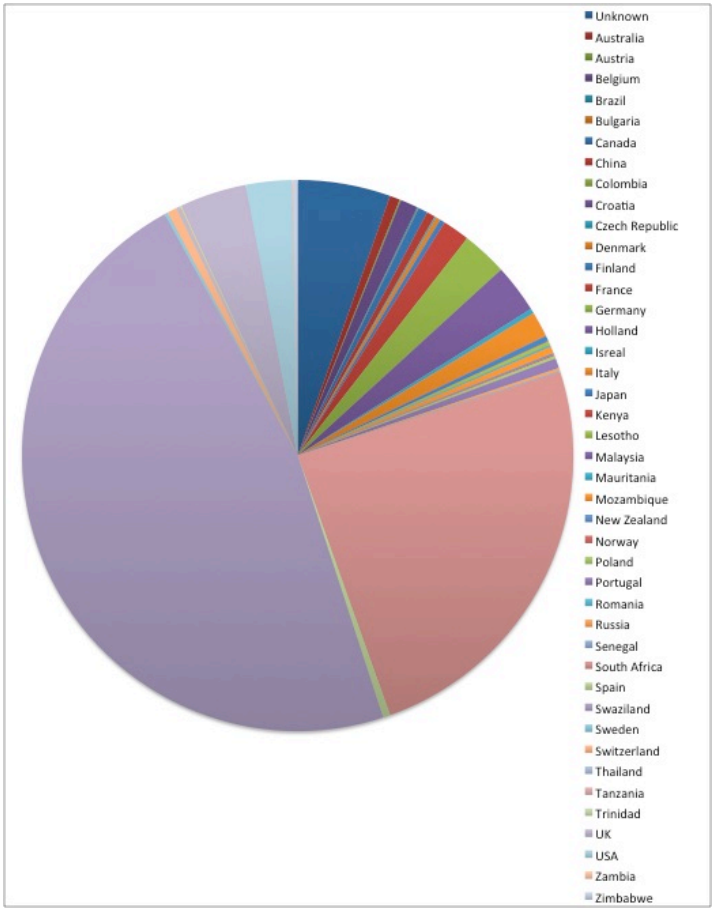


Figure 31: Illustrates the country of origin of visitors compiled from the visitors' registration book between 2004 and 2012.

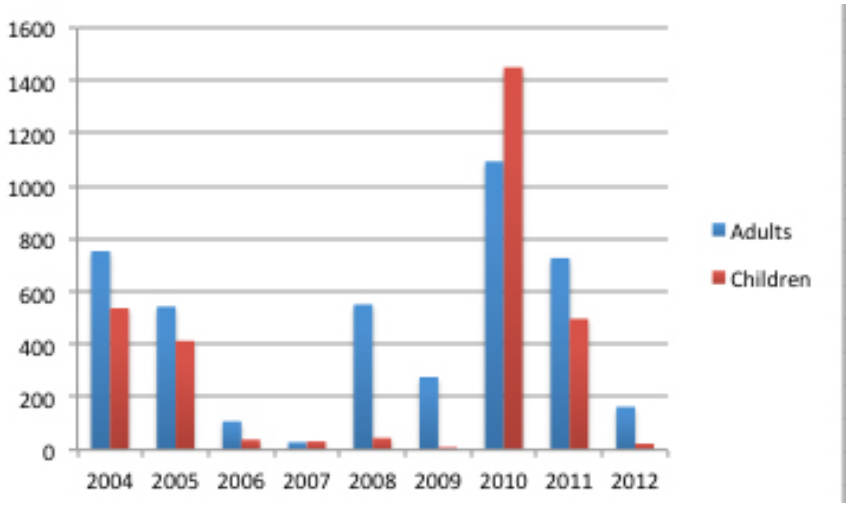


Figure 32: Illustrates the distribution of adults and children visiting Ngwenya Mine, per year, from 2004 and 2012.

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