



Original article

‘Zama Zama’ and leftovers: The recycling of ore in abandoned gold mines in South Africa

Esther Makhetha

Institute for Economic Research on Innovation, Tshwane University of Technology (TUT), South Africa



ARTICLE INFO

Keywords:

Abandoned commercial gold mines
Artisanal and small-scale mining
Leftovers
Recycling
Reworking
Scavenging
Zama

ABSTRACT

Despite increased restrictions and security measures imposed on abandoned gold mines by the South African government amidst recent deaths and the ongoing debate about the place of ‘illegal mining’, unlicensed miners, known as ‘zama zamas’ continue to insert themselves into the economy by engaging in practices of scavenging, recycling and reworking of leftover gold ore. Increasingly, abandoned gold mines exemplify the physical ruins that articulate the collapse of the regional mining industry despite the resurgence of the extractive industries in other African countries. While a growing body of literature deals with such miners, their working practices have not been approached from the perspective of recycling/reworking: a practice that is growing and which reveals aspects of the contemporary form that capitalism is taking. In South Africa recycling or reworking of gold bearing ore in abandoned commercial mines is a growing practice. The extraction of residual gold ore from the ruins of capital-intensive enterprises is carried out informally and, according to the state, illegally. This paper explores how, in response to the retrenchment of mine workers from South African mines and the ensuing high unemployment in the country and sub region, ordinary people have inserted themselves into the economy to rework the gold ore that has been left by large scale gold mining companies. It documents how ‘illegal’ miners extract and rework gold bearing ore in the ruins of commercial mines and how recycling becomes an integral part of their livelihood and trade. Finally, the paper draws on extant literature and the author’s ethnographic observations of artisanal and small-scale miners, known as zama zamas, and uses innovation as a lens.

1. Introduction

Until quite recently, many countries in southern Africa served as a labour reserve economy for the South African mining industry. However, changing socio-economic conditions in South Africa have meant that the demand for migrant labour from neighbouring countries (largely men) has diminished significantly, leading to an unprecedented scale of retrenchment. As was documented elsewhere, most ex-miners, upon returning to their homes, are faced with the stark reality of unemployment and a lack of sources of livelihood (Makhetha, 2017). As a result, they have adapted the skills they acquired while employed in the formal mining industry and returned to South Africa to scavenge, rework and recycle leftover gold ore in abandoned gold mines (Mhlongo and Akintola, 2021). Most of these miners are from South Africa’s immediate neighbours of Lesotho, Mozambique and Zimbabwe.

Also involved in reworking abandoned gold mines are unemployed South Africans. As of the first quarter of 2022, the unemployment rate in South Africa was 63.9% for those aged 15–24, and 42.1% for those aged 25–34, while the overall national rate was reported to be 34.5% (Stats

SA, 2022). This shows that young adults/youth are the most affected by unemployment, hence the involvement of large numbers of this age group in unregulated mining activities.

As is the case in the formal mines, teams of informal miners, commonly known as zama zamas, are generally composed of people from the same locations or who speak the same language (Thornton, 2014). The practices of scavenging and recycling ore or mine waste are central to their livelihoods, and for some this could be ‘a platform for wealth creation’ (Hilson and Hu, 2002: 107). Unregulated artisanal and small-scale mining activities are often carried out in abandoned commercial mines (ruins of commercial mines) or close to commercial mining sites (Mhlongo and Akintola, 2021). The South African government calls zama zamas ‘illegal miners’, but the researcher refers to them as unlicensed miners or unregulated miners. The commercial mines involved in this study are those that were abandoned due to financial and economic problems, social conflicts and political instability.

Unlicensed artisanal and small-scale mining is also common in other countries, including Ghana and Zimbabwe. In Zimbabwe these miners are known as *makorokoza* (which means panners) or *magweja*. In Ghana,

E-mail address: makhethael@tut.ac.za.

<https://doi.org/10.1016/j.exis.2023.101272>

Received 29 November 2022; Received in revised form 15 May 2023; Accepted 15 May 2023

Available online 2 June 2023

2214-790X/© 2023 Elsevier Ltd. All rights reserved.

unlicensed mining is called *galamsey* (Madimu, 2022). In the literature on informal mining, the practice has been reviewed primarily from the perspective of livelihood, and also of criminality. Perspectives that have not been explored sociologically are those of mines as sites for reworking and waste recycling, and mines as ruins. Likewise, the concept of innovation as a lens for analysis has not been widely used. This paper, therefore, contributes to scholarly knowledge on mines as ruins, and as sites for reworking to extract leftover gold ore, and cites for recycling waste in southern Africa.

Greater awareness of this section of the economy is significant simply as an exploration of southern African people's attempts to survive economically against all odds, and also as a gauge of shifting economic realities within the region and globally. Waste in general is increasingly becoming a sought-after commodity, with global value chains for waste recycling beginning to mirror production and trade in other commodities. In the case of mining waste, existing research shows that recycling and re-use is largely driven by practical applications and financial returns (Lottermoser, 2011). Moreover, the increasing demand for mineral and energy resources by a growing world population is making the recovery of waste through re-use, recycling, and energy recovery increasingly attractive to business (Lottermoser, 2011).

Section 2, which follows, discusses the contextual features and methods of the study, highlighting the research method. It examines the concept of innovation, and stresses the importance of using this concept as a lens to re-examine the concepts of mines and ruins, recycling and waste. Section 3 focuses on South African mining legislation and its relationship with zama activities. Section 4 provides a brief overview of the abandoned mines in South Africa. Section 5 considers mining innovation as a technical/non-technical concept. It examines a central issue for zama miners; namely, the efficiency of the techniques and tools used to recycle/rework leftover gold ore. In addition, the section focuses on miners' knowledge and technical skills, and the relationship with mining innovation. The paper concludes with an overview of the most recent innovation/technological development and suggests a potential future direction for anthropological research on mining innovation, recycling, and reworking of leftover gold ore in abandoned mines.

2. Contextual features and methods of the study

The article draws from the extant literature and the researcher's ethnographic observations. Since the study is using innovation as a lens for analysis, it is imperative to examine the term. Innovation is often likened to research and development (R&D) and involves elements such as intensive technological breakthroughs, and patentable inventions, amongst others (De Beer et al., 2016). It is also defined as follows: 'a way to improve people's lives by transforming knowledge into new or improved ways of doing things in a place where, or by people for whom, they have not been used before' (De Beer et al., 2016 citing Kraemer-Mbula and Wamae, 2010).

In mining, innovation can be both technical and non-technical. Mining innovation is often associated with mobility, adaptation to different places, or adaption to a new period in time, as well as to contingent circumstances. In this paper we are referring to innovations adopted by informal miners, zama zamas in the abandoned commercial mines (ruins of commercial mines) in South Africa. 'Often these innovations are linked to the presence of migrants – free and unfree labourers who, while travelling, bring with them knowledge, tools, and experiences' (D'Angelo, 2022: 169). In this context, zama zamas from the southern African region, as well as the local miners, bring along knowledge, tools, and experience as they scavenge, recycle and rework leftover gold ore in ways that are adapted to the new circumstances, and which do not have the advantage of the lifting mechanisms, extraction machinery, protective devices and other advantages that would be used in a large-scale commercial mining. The following section reviews South African mining legislation and its relationship with zama activities.

3. Legislation

Artisanal and small-scale mining (ASM) predates large-scale mining in South Africa; however, the colonial government did not recognise it as a legitimate activity. It was formally introduced in 1994 as a recognised form of economic activity as part of the socio-economic development agenda of the democratic government (Ledwaba, 2017; Madimu, 2022). In an attempt to reform the mining sector, the local government tier was mandated to integrate ASM into the economy. The government's focus was to include the section of the population described as 'Historically Disadvantaged Black South Africans' in the mining sector in a bid to redress historical injustice. The post-1994 period was marked by a decline in industrial mining and manufacturing, which amplified an unemployment crisis and a trend towards precarious work, including informal mining (Ledwaba, 2017; Madimu, 2022). The post-1994 government also introduced several pieces of legislation. These include the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA), the Mining Charter of 2018, and the National Environmental Management Act, National Environmental Management Act (NEMA) no 8 of 2004.

The aim of these three Acts of Parliament was to correct the injustices of the past by providing or improving socio-economic opportunities to historically disadvantaged South Africans, as well as enabling a sustainable environment for mining communities (Bester and Groenewald, 2021). In line with this aim, the main purpose of the Mineral and Petroleum Resources Development Act was to establish and promote South Africa's artisanal and small-scale mining sector. However, the primary focus of the MPRDA is on small-scale mining, which does not necessarily mean artisanal mining (Bester and Groenewald, 2021). The expectation had been that artisanal mining would be given due attention, since this form of economic activity was within the reach of South Africans who had been historically disadvantaged and who did not necessarily have the means to enter the commercial mining sector. As a result of the neglect of the artisanal mining sector within the formal economy many people turned to informal mining activities through recycling and reworking leftover gold ore in the abandoned mines.

3.1. Mineral and petroleum resources development act 28 of 2002

The MPRDA was enacted to provide equitable access to and sustainable development of the nation's mineral and petroleum resources. The Act established that mineral resources are the common heritage of all South Africans with the State as a custodian. As part of its custodial role, the State is tasked with granting mining licences (Ubink and Pickering, 2020), including in the area of artisanal and small-scale mining, known as ASM. However, the acquisition of permits by small-scale miners is an often insurmountable challenge for an ex-miner or other citizen seeking a legitimate means of livelihood, due to the high financial cost of acquiring them. Only a limited number of small-scale miners have managed to obtain permits since the implementation of the MPRDA Act (Madimu, 2022) and all others seeking a living in this way make a living as small-scale miners operating outside the regulatory framework.

Moreover, the MPRDA states that no person may start mining activities without prior approval from the environmental authorities. The multitude of permits that a small-scale miner must acquire includes reconnaissance permission; a prospecting or mining right or the permission to remove; a mining right or mining permit; and a retention technical co-operation permit, or reconnaissance permit (Ndlazi, 2021). Compliance with the stipulations of this legislation is well beyond the means of the majority of prospective miners, which means that only established mining companies with the necessary financial, administrative, and technical wherewithal can realistically obtain a licence (Ndlazi, 2021). For an unemployed young person or migrant worker, complying with these requirements is difficult, if not impossible. These legislative barriers and the bureaucratic processes involved not only

discourage, but simply exclude the majority of miners from accessing minerals; which, as already said, leads to their turning to unregulated mining including recycling and reworking leftover gold ore in abandoned mines.

To reiterate, as much as the MPRDA was established to accommodate both artisanal and small-scale mining, in effect the legislation only addresses commercial mining and small-scale mining (Bester, 2023), and not artisanal mining specifically. So it is little wonder that many people who live in traditional communities located near the mining sites scavenge for the leftover gold ore in the abandoned mines as some form of livelihood.

In May 2021, the South African government, through the Department of Mineral Resources and Energy (DMRE), released the draft ASM policy for public comment (Bester, 2023; Sitefane, 2021). This draft was available for implementation in March 2022 (Bester, 2023; DMRE, 2022; Sitefane, 2021). However, at the time of writing, May 2023, it had not yet been implemented. The MPRDA is still the main legislation for the mining sector in South Africa (Bester, 2023). According to the draft ASM policy, the miners are limited to surface operations only, which means the legislation, when it is effected, will not allow informal miners to operate underground (Sitefane, 2021), when in reality these miners are already doing so.

Given that there are informal mines working underground, one would have expected that the government, through this draft policy, would have included underground operations. As Hilson and Hu (2022) argue, most governments fail to see how their efforts to promote the growth of capital-intensive mineral exploration and extraction, together with the setting up of licensing schemes that are unrealistic for ASM, have in effect been complicit in obliging those seeking a livelihood in mining to informally; something which they routinely condemn (Hilson and Hu, 2022). Host governments in the sub-Saharan Africa including the southern African region have largely resisted calls for ASM to become more of a centrepiece of the region's rural poverty alleviation and development strategy (Hilson and Hu, 2022: 107).

With regard to the issuing of the ASM permit in South Africa, there is no time limit stipulated. Once it is granted, the draft ASM policy does not specify the duration of the permit (Sitefane, 2021). This draft ASM policy appeared after the South African government issued mining permits to unlicensed artisanal diamond miners in Kimberley, Northern Cape Province, in 2018. It was an indication that the government had realised the important contribution of unlicensed mining activities in job creation and the improvement of livelihoods. This realisation led the government and Kimberley Ekapa Mining Joint Venture to issue more mining permits to unlicensed artisanal diamond miners in Kimberley in 2018 (Bester and Groenewald 2021; Madimu, 2022). This move was regarded as something positive for the unlicensed artisanal diamond miners who had before been considered 'illegal' (Bester and Groenewald, 2021). The big question now is whether this concession will be extended to zama zamas reworking leftover gold ore in the abandoned underground mines.

The structural challenges that face artisanal and small-scale miners are primarily a lack of access to the following: the formalised mining industry, finance, support from the government and education (Ndlazi, 2021). Such structural deprivations, compounded by the unregulated nature of ASM, which often takes place in abandoned mines, leads those dependant on this form of livelihood to engage in haphazard mining and mineral processing as well as illegal trading, with negative health, social and environmental consequences (Ndlazi, 2021). To compound the challenge, some miners from commercial mining companies participate in zama mining activities by reworking and recycling leftover gold ore as a way to avoid being involved in the labour strikes, which are popular in the commercial mining sector (Nhlengetwa and Hein, 2015). However, for most miners working in the commercial mining sector, poor health and safety issues in the artisanal mining sector, deter them from joining zama mining operations (Harvey, 2016).

3.2. National environmental management act

The National Environmental Management Act (NEMA) no 8 of 2004 is relevant and important legislation for the mining sector in South Africa. Section 28 of the Act speaks about duty care and remediation of environmental damage (NEMA no 8 of 2004). This is significant for environmental degradation, which is often associated with ASM. The Section states that reasonable measures must be put in place to avoid environmental degradation and to stop any environmental hazards from happening (NEMA no 8 of 2004). These measures are to be taken by the people who are causing, have already caused, or are about to cause pollution or degradation of the environment. These reasonable measures must be taken to prevent pollution or degradation from occurring, continuing, or recurring, or harm to the environment (NEMA no 8 of 2004).

The Section further states that miners and prospective miners need to investigate, assess, as well as check and communicate the possible effect of mining activities on the environment. As a result, there must be practical ways to rehabilitate the land to its original state before mining took place; since miners and prospective miners are or were responsible for environmental hazards that include pollution or ecological degradation due to prospecting or mining operations, they must rehabilitate the land.

This simply means that before mining commences, the mining company is expected to conduct an environmental impact assessment (EIA), taking into consideration the preparation for the mine's closure, as well as the effect of mining on communities close to the mines (Bester and Groenewald, 2021). In cases where these two major factors governing the proper closure of a gold mine are not taken into consideration the effect has been and is likely to continue to be an increase in the number of miners participating in unregulated scavenging and recycling leftover gold ore in the mines which do not have proper closure. Currently zama miners are able to access such mines, which they do in order engage with the economy by reworking the residual gold ore.

The literature (see Bansah et al., 2016; Hilson, 2016; Yu and Zahidi, 2023) speaks extensively about the environmental hazards associated with commercial, ASM and zama mining activities. In as much as there is an increase in the importance of ASM to rural livelihoods, artisanal mining is known for its poor record in terms exacerbating environmental degradation (Hilson, 2016), and its use of child labour (Maconachie and Hilson, 2016; Hilson, 2010). Scholars (Gunson and Veiga, 2004; Kambani, 2003; Hilson, 2016) argue that artisanal mining causes environmental damage despite the relatively small scale of its operations. It is important to note that there are also some environmental concerns with regard to chemical pollution (for example, cyanide and mercury pollution), noise pollution, and pollution of rivers in the commercial mining (Baah-Ennumh, 2012; Hilson and McQuilken, 2014). These environmental concerns are also popular in zama mining operations in abandoned mines.

Water pollution is another form of environmental hazard that is caused by ASM or zama mining operations. Water becomes polluted by direct and indirect dumping of tailings and effluents into the body of water; poorly built tailings dams, acid rock drainage, river siltation, and damage in alluvial areas (Baah-Ennumh, 2012; Aryee et al., 2003; Hilson, 2016; Hilson and Pardie, 2006). In addition, land degradation due to zama activities causes environmental problems. This degradation is the result of the continuous pitting and trenching of land by miners with no subsequent rehabilitation; and also deforesting of the land while searching for ore (Hilson, 2002; Hilson and McQuilken, 2014). It is important to note that environmental hazards are also associated with commercial mining operations, which often affect an extensive area of land (Tibbett, 2009). The land affected by mining operations is important in many ways: for farming, as a source of water or a wetland, as a wildlife habitat, or for other environmental or social purposes. The following section explores the abandoned mines, and how the zama zamas rework the leftover gold in these mines.

4. Abandoned mines in South Africa

Abandoned mines are found in countries that have a long history of mining including South Africa, Australia, Canada, Namibia, Chile, the United Kingdom and the United States of America (Mhlongo and Sigxashe, 2021). In the context of South Africa, these mines are referred to as 'derelict and ownerless mines' (D&O), and the country has more than 6 000 such mines. As far as can be ascertained these mines do not have closure certificates, furthermore, there has been no rehabilitation, and no legal avenues can be pursued in cases where there is a need for someone to assume responsibility (Mhlongo and Akintola, 2021; Olalde, 2016; Sesele et al., 2021). As a result, this provides a conducive environment for zama miners (Bester and Groenewald, 2021) to rework and recycle the left-over gold ore in those mines.

Interestingly, unregistered mining by zama zamas is also taking place in some mines that are still operational (Bester and Groenewald, 2021). Zama-zama miners also work on the mine tailings, which are situated close to the informal settlements.

The South African areas where abandoned gold mines are located include Barberton, Benoni, Vlakfontein, Modderfontein, Blyvooruitzich, Roodeport and Welkom (Olalde, 2016; Thornton, 2014). Identifying mining areas operated by zama miners is not always easy for people who are not familiar with this form of mining, which consists of recycling and reworking of the gold ore by inside the abandoned mine (Thornton, 2014).

In addition, zama miners are very mobile (Bester and Groenewald, 2021); often they follow leftover gold ore to rework and recycle for the market. They work in unsafe and unhealthy places (Bester and Groenewald, 2021) as was the case in the abandoned Langlaagte mine in Johannesburg, where the bodies of the unregulated miners were retrieved from underground in 2016 (Enca, 2016).

Furthermore, these areas are very close to communities, which for many decades have been neglected by the lack of government service delivery. In fact, communities in these areas have poor service delivery and a high unemployment rate. This often causes conflict between them and the zama zamas over limited resources (Thornton, 2014). The zama zamas often compete amongst themselves for gold ore, which frequently degenerates into conflicts that at times spill over into the neighbouring communities (E. Makhetha, 2020). Clashes also occur between the zama miners on the one hand and the police and commercial mine security officials on the other hand. Commercial mining companies often use security forces to solve conflicts, and this frequently contributes to the poor relationship between the two sectors (Bester, 2023).

Women miners involved in zama mining activities are often affected by abuse from the South African police (Bester, 2023). Police officials often put pressure on women miners to offer them sexual favours to avoid arrest. Police take advantage of women miners because these miners do not know their rights and are not necessarily familiar with laws governing gender-based violations in South Africa (Bester, 2023). The following section discusses extraction methods and innovation that zama miners employ while reworking and recycling leftover gold ore.

4.1. Innovation, skills and experience brought by zama miners

Working as efficiently as possible is crucial for the survival of zama miners. In their extraction methods they need to be as efficient and as innovative as possible, using the best technology they can. This need for efficiency and innovation is most pressing in cases where the deposits are highly depleted and difficult to access, as is the case in most abandoned mines where zama zamas work.

Zama zamas often work in groups, which typically range from five to fifteen, although some may be bigger. The larger groups are more likely to be affected by internal conflict, which often hinders or delays their mining activities (Thornton, 2014). These groups are composed of miners from different ethnicities, national, or linguistic backgrounds. As mentioned earlier, this diversity is a mirror image of those that operate

in commercial mining, where miners are from different ethnic groups, and linguistic and national backgrounds. Zama zamas usually work underground and their shifts often last up to a week or more inside the mines (Thornton, 2014, also see Munakamwe, 2018).

To extract gold ore in abandoned mines, zama zamas use rudimentary tools, as is quite normal for artisanal miners elsewhere. These tools include picks, shovels, hammers, fuses, chisels of various kinds, electricity generators, copper cables, simple head torches, and drills (Mhlongo and Akintola, 2021; Munakamwe, 2017).

According to Munakamwe (2017), the zama zamas also use relatively innovative equipment, such as Nokia phones, which use powerful lenses to 'scan' for gold-rich rocks underground (Munakamwe, 2017).

Furthermore, some zama zamas use large machinery, including generators, especially in places where they have discovered or detected large concentrations of gold. These large types of machinery often cause underground accidents, particularly rock falls (Munakamwe, 2017). In such cases, copper cables are used to convey miners in and out of the loose surface. Paradoxically, these cables are not stable enough to step on because of the potential that they have to cause further rock fall accidents. Moreover, zama zamas stated that copper cables are the worst form of conveyance because any slight mistake leads to instant death as they are unstable (Munakamwe, 2017).

A further hazard in this form of mining is the use of mercury by zama zamas for processing gold in the final stages. They buy it from the miners working in commercial mines (Munakamwe, 2017).

For zama miners, success often depends on their 'knowledge of geology', which enables them to identify underground rocks rich in gold (Thornton, 2014). Success also depends on their technical knowledge in extracting, processing, and reworking the leftover gold ore in circumstances that are different from that of the commercial mines. Thornton (2014) argues that zama zamas' local knowledge of mining forms part of the global market as well as the global mining sector. This local knowledge is also attributed to the historical roots of mining in southern Africa.

Zama zamas acquire their mining skills from their colleagues or elders (Nhlengetwa and Hein, 2015), or from the skills they have acquired in commercial mines (Munakamwe, 2017) and which they have repurposed in the different circumstances of an abandoned mine. In their working groups, the miners generally have a leader, who is the person with the most knowledge, experience and expertise (Nhlengetwa and Hein, 2015); as a result, this enables easy transfer of knowledge in the context of the abandoned mines.

To do their work zama miners need to play a number of roles. The tasks include the following activities, which are generally done underground: breaking rocks, putting broken rocks into bags, crushing the rocks (something that women often do) and processing leftover gold ore underground (Munakamwe, 2017, 2018; Nhlengetwa and Hein, 2015). As mentioned earlier, the various zama mining groups, most of whom are men, are often based along ethnic lines (Munakamwe, 2017, 2018; Nhlengetwa and Hein, 2015), which makes for easy communication amongst miners. This is certainly the case in the Durban Deep mine in the Roodepoort area where the zama groups are speakers of Sesotho, Shona, Zulu language/s from Lesotho, Mozambique, South Africa and Zimbabwe.

In general, the geological knowledge, capacity for innovation, and technical knowledge in the recycling and reworking of leftover gold ore of zama miners in one location, such as Durban Deep, is the same or similar to the knowhow and skills of zama miners in other locations and other countries such as Lesotho.

A study of small scale artisanal diamond mining and rural livelihood diversification in Lesotho (Makhetha, 2017) observed that the geological knowledge, innovation, and technical knowledge of unlicensed miners in South African miners is connected to the same skill and knowledge set that is held by retrenched or former Basotho miners who worked in South African commercial mines. Likewise, unlicensed artisanal diamond miners in the highlands area of Lesotho get their skills

through working with those who formerly worked in South Africa, as well as from other miners with local knowledge of extracting diamonds in the highlands of Lesotho.

5. Conclusion

The operations of zama miners in South Africa highlight and demonstrate the link between the ruins of mines, scavenging, recycling, leftover gold ore, and innovative mining approaches and techniques. The techniques that zama-zama miners use for processing leftover ore and extracting valuable minerals are innovative in the mining context. Thornton (2014) argues that there is still plenty to learn about how zama zamas learned about mining techniques, geological knowledge, technical knowledge of extraction and processing of gold ore, as well as their innovative ways of identifying rocks that are rich in gold. However, Nhlengetwa and Hein (2015) contend that zama miners acquire their mining skills from their colleagues, other zama miners, or elders, as well as the leader of their particular group.

The knowledge and innovation techniques brought by miners who formerly had experience in the commercial mining sector, including the gold and diamond mining sectors, is passed on to other miners who have not ever worked in commercial mining (Makhetha, 2017). There is also indigenous or local knowledge of mining that is circulating amongst the unlicensed miners in the highlands of Lesotho, as well as in the broader southern Africa region.

The circulation of innovation and knowledge in the artisanal and small-scale mining sector is not necessarily an automatic phenomenon; rather, it is a result of social bearers of innovation at the grassroots level (D'Angelo, 2022). Zama zamas can therefore be regarded as 'social bearers of innovation' in the abandoned gold mines.

References

- Aryee, B.N.A., Ntibery, B.K., Atorkui, E., 2003. Trends in the small-scale mining of precious minerals in Ghana: A perspective on its environmental impact. *J. Clean Prod.* 11 (2), 131–140.
- Baah-Ennumh, T.Y., 2012. Sustaining Livelihoods in Artisanal Small-Scale Mining Communities in the Tarkwa-Nsuam Municipality. DPhil Kwame Nkrumah University of Science and Technology.
- Bansah, K.J., Yalley, A.B., Dumakor-Dupey, 2016. The Hazardous Nature of Small-scale Underground Mining in Ghana. *Journal of Sustainable Mining* 15, 8–25.
- Bester, V., Groenewald, L., 2021. Corporate Social Responsibility and Artisanal Mining: towards a Fresh South African Perspective. *Resource Policy* 72, 102124.
- Bester, V., 2023. Towards a Sustainable Artisanal Gold Mining Sector in South Africa: proposed Developmental Initiatives. *J Rural Stud* 97, 375–384.
- D'Angelo, L., 2022. Technology. In: D'Angelo, L., Pijper, R.J. (Eds.), *The Anthropology of Resource Extraction*. Routledge, London, pp. 167–283.
- ENCA. 2016. More Bodies Recovered from Langlaagte Mines. Available: <https://www.enca.com/south-africa/more-bodies-recovered-from-langlaagte-mines> [22 February 2023].
- De Beer, J., Kun, F., Wunsch-Vincent, S., 2016. *Innovation in the Informal Economy*. Cambridge University Press, Cambridge.
- Gunson, A.J., Veiga, M., 2004. Mercury and artisanal mining in China. *National Association of Environmental Professionals* 6, 109–120.
- Harvey, R.G., 2016. Why is Labour Strife so Persistent in South Africa's Mining Industry? *The Extractive Industries and Society* 3, 832–842.
- Hilson, G., 2002. Land use competition between small- and large-scale miners: a case study of Ghana. *Land Use Policy* 19, 149–156.
- Hilson, G., 2010. Child Labour in African Artisanal Mining Communities: experiences from Northern Ghana. *Dev Change* 41 (3), 445–473. <https://doi.org/10.1111/j.1467-7660.2010.01646.x>.
- Hilson, G., 2016. Farming, Small-Scale Mining and Rural Livelihoods in Sub-Saharan Africa: a Critical Overview. *The Extractive Industries and Society* 3 (2), 547–563.
- Hilson, G., Hu, Y., 2022. Changing Priorities, Shifting Narratives: remapping Rural Livelihoods in Africa's Artisanal and Small-scale Mining Sector. *J Rural Stud* 92, 93–108.
- Hilson, G., McQuilken, J., 2014. Four decades of support for artisanal and small-scale mining in sub-Saharan Africa: A critical review. *Extr. Ind. Soc.* 1, 104–118.
- Hilson, G., Pardie, S., 2006. Mercury: An agent of poverty in Ghana's small-scale gold-mining sector? *Res. Policy*. 31, 106–116.
- Kambani, S.M., 2003. Small-scale mining and cleaner production issues in Zambia. *J. Clean. Prod.* 11, 141–146.
- Kraemer-Mbula, E. and Wamae, W., 2010. Innovation and the Development Agenda OECD/IDRC.
- Ledwaba, P.F., 2017. The Status of Artisanal and Small-scale Mining Sector in South Africa: tracking Progress. *J South Afr Inst Min Metall* 117, 1.
- Lottermoser, B.G., 2011. Recycling, Reuse and Rehabilitation on Mines Wastes. *Elements* 7, 405–410.
- Maconachie, R., Hilson, G., 2016. Re-Thinking the Child Labor "Problem" in Rural Sub-Saharan Africa: the Case of Sierra Leone's Half Shovels. *World Dev* 78 (Supplement C), 136–147. <https://doi.org/10.1016/j.worlddev.2015.10.012>.
- Madimu, T., 2022. 'Illegal' Gold Mining and the Everyday in Post-apartheid South Africa. *Rev Afr Polit Econ*. <https://doi.org/10.1080/03056244.2022.2027750>.
- Makhetha, E.L., 2017. Small Scale Artisanal Diamond Mining and Rural Livelihood Diversification in Lesotho. University of Pretoria, South Africa. PhD Thesis.
- Makhetha, E., 2020. Basotho Mineworkers and Zama Zama in Disused Commercial Gold Mines in Gauteng Province, South Africa. In: Nshimbi, C., Moyo, I. (Eds.), *Borders, Mobility, Regional Integration and Development. Advances in African Economic, Social and Political Development*. Springer. https://doi.org/10.1007/978-3-030-42890-7_5. Cham.
- Mhlongo, S.E., Sigxashe, S., 2021. The Criteria for Ranking and Prioritization of Rehabilitation of Abandoned Mines. *Journal of Degraded and Mining Lands Management* 8 (4), 2947–2956.
- Mhlongo, S.E., Akintola, G.O., 2021. Artisanal and Small-scale Mining Activities as Post-mining Land Use in Abandoned Mine Sites: a Case of Giyani and Musina Areas, Limpopo Province of South Africa. *Journal of Degraded and Mining Lands Management* 8 (3), 2815–2827.
- Munakamwe, J., 2017. Zamazama – Livelihood Strategies, Mobilisation, and Resistance in Johannesburg. In: Nhemachena, A., Warikandwa, T.V. (Eds.), *Mining Africa: Law, Environment, Society, and Politics in Historical and Multidisciplinary Perspectives*. Langaa Research & Publishing CIG, South Africa.
- Munakamwe, J., 2018. Emerging Political Subjectivities in a Post Migrant Labour Regime: Mobilisation, Participation, and Representation of Foreign Workers in South Africa (1980-2013). Faculty of Humanities, University of The Witwatersrand, Johannesburg. PhD Thesis.
- Ndlazi, S., 2021. Alone in the Dark': how the Current Mining and Minerals Legal Regime Continues to Fail Artisanal and Small-scale Miners in South Africa. *Law, Democracy & Development* 25.
- Nhlengetwa, K., Hein, K.A.A., 2015. Zama-Zama Mining in the Durban Deep/Roodepoort Area of Johannesburg, South Africa: an Invasive or Alternative Livelihood? *The Extractive Industries and Society* 2, 1–32.
- Ubink, J. Pickering, J. 2020. Shaping legal and institutional pluralism: land rights, access to justice and citizenship in South Africa. *S. Afr. J. Hum. Rights*, 36: 2-3, 178–199.
- Olalde, M. 2016. SA's Failed System of Mine Closure. <https://www.iol.co.za/news/opinion/sas-failed-system-of-mine-closure-7117963>, [accessed 28 October 2021].
- Sesele, K., Marais, L., van Rooyen, D., 2021. Women and Mine Closure: a Case Study of Policy in South Africa. *Resources Policy* 72, 102059.
- Sitefane, M. 2021. 10 Things to Know about the Draft Artisanal and Small-scale Mining Policy 2021. ENSafrica.
- Stats SA. 2022. The Quarterly Labour Force Survey (QLFS). Available at: www.statssa.gov.za.
- Thornton, R., 2014. Zamazama, 'Illegal' Artisanal Miners, Misrepresented by the South African Press and Government. *The Extractive Industries and Society* 1 (2), 129–129.
- Tibbett, S. 2009. A Golden opportunity: Recasting the debate on the economic and development benefits of small-scale and artisanal gold mining. Gred Foundation.
- Yu, H., Zahidi, I., 2023. Environmental Hazards Posed by Mine Dust, and Monitoring Method of Mine Dust Pollution Using Remote Sensing Technologies: an overview. *Science of The Total Environment* 864, 161135.