The Colombian artisanal mining sector: Formalization is a heavy burden

Article *in* The Extractive Industries and Society · November 2018

DOI: 10.1016/j.exis.2018.11.001

CITATION
1

READS
221

2 authors:

Marcello M. Veiga
University of British Columbia - Vancouver
110 PUBLICATIONS **2,873** CITATIONS

SEE PROFILE

Bruce Marshall
University of British Columbia - Vancouver
23 PUBLICATIONS **87** CITATIONS

SEE PROFILE

The Extractive Industries and Society xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

The Extractive Industries and Society

journal homepage: www.elsevier.com/locate/exis

Original article

The Colombian artisanal mining sector: Formalization is a heavy burden

Marcello M. Veiga*, Bruce G. Marshall

Norman B. Keevil Institute of Mining Engineering, University of British Columbia, Vancouver, Canada

ABSTRACT

The Ministry of Mines and Energy (MME) in Colombia has the potential to be the most pro-active government ministry in the world to deal with the problem of formalization of an estimated 300,000 Colombian artisanal miners, extracting gold, diamonds, emeralds, coal, construction minerals, etc. However, currently, the MME has reached the basic stage of formalization of only about 7% of the total registered mining units in the country. In conjunction with the Ministry of the Environment and Sustainable Development, local authorities and even the Army (for the use of explosives), the inherent regulations required for formalization are very difficult to manage for the artisanal miners. As a result, gold production in the country reached 61.8 tonnes in 2016, in which the formal sector only represented 13% of this total, while the informal miners produced 87% of the gold. Furthermore, apart from the Colombian Government missing out on taxes that could be garnered from the informally produced gold, it is clear that there are significant quantities of gold being smuggled out of the country illegally. In 2017, although gold production fell by 35% to a total of 40.1 tonnes, gold exports increased 17% from 48 tonnes in 2016 to 58 tonnes in 2017, which is likely due to illegal mining, mainly from illicit criminal organizations laundering money via gold exports. In order to increase the successful formalization of legitimate artisanal gold miners, major reforms of the legislation are urgently needed, including facilitation of the hurdles required to undergo the process, as well as increased presence on the ground to offer education, training and capital investment for cleaner processing techniques.

1. Introduction

Legislation in many developing countries related to artisanal mining is fraught with confusing definitions. Artisanal mining refers to a rudimentary type of mining and processing used by almost 30 million individuals worldwide to extract minerals from secondary or primary ores, whereas small mining refers only to the size of the operation (Veiga, 1997). Consequently, a small or large mine may operate in a conventional or artisanal fashion. An artisanal mining operation can process over 10,000 tonnes of ore per day, which should not be considered small (Veiga et al., 2014b). Typically, an artisanal miner works based on instinct, the need to feed his family and pay bills. There is no previous "classical" geological exploration, no drilling, proven reserves, ore tonnage establishment or engineering studies undertaken. The concept of survival is constantly the driving force for these miners.

"Informal mining" is another confusing term found in many legislations. This is a broad term that comprises all forms of mining that operate without labor or social protection (Chen, 2007). This term is usually mixed up with "illegal mining", which is usually identified when the activity is conducted deliberately without proper authorization issued by the relevant authorities or by criminals practicing the activity for the purposes of laundering money. Informal mining encompasses a set of deficiencies in environmental management, technical assistance and development, access to information and acceptable working conditions (Hentschel et al., 2002). Few countries have clear regulations or definitions of the activities that are classified as artisanal mining, but almost all relate the term only to the size of the operation and not in relation to the types of mining and processing techniques utilized.

2. Artisanal gold mining in Colombia

In Colombia, 44% of the 1122 municipalities in the country have a tradition in artisanal (informal) mining (Serrano et al., 2015) and 23% of those have artisanal gold mining. This is a result of poverty and lack of employment opportunities in rural areas. Pantoja and Pantoja (2016) stressed that 74% of the Colombian population is living in poverty and there is no evidence that conventional mining, through the return of royalties to the municipalities, is reducing poverty in rural municipalities. In 2013, informal employment in Colombia through all sectors represented 64% of the workforce (ILO, 2014), which continues to grow, due to a large influx of informal immigrants, mainly from Venezuela.

According to the Colombian Ministry of Mines and Energy (MME, 2014), artisanal gold production is occurring in 261 municipalities from 19 departments (out of a total of 32 departments in the country, which are equivalent to states), most of them using rudimentary processes to amalgamate gold. From the 543 units of ore processing investigated by the MME, approximately 70% did not have their legal papers in order.

In Colombia, the term artisanal mining is not contemplated in the

* Corresponding author.
E-mail address: veiga@mining.ubc.ca (M.M. Veiga).

https://doi.org/10.1016/j.exis.2018.11.001
Received 4 May 2018; Received in revised form 28 May 2018; Accepted 2 November 2018

legislation. The Mining Code of 1988 provided a definition of the type of mine based on the volume of material being extracted, the installed capacity for mining and mineral processing, as well as other technical, social and economical aspects. Decree 2636 of 1994 defined another type of miner, "**mineros de hecho**" (miners *de facto*), who are informal miners that work with no mineral title and undertake mining as a traditional economic activity (MME, 2014). In the Mining Code of 2001, the definition of the size of the mines was eliminated, but the definition of the "**barequero**" was expanded. In Article 155, "barequero"[1] was defined as an activity related to non-mechanized alluvial and colluvial mining of precious metals and gemstones. Moreover, Article 156 requires the registration of a "barequero" (panner) at the local city hall and authorization of the local land owner for this type of activity. The Mayor has the authority to resolve any possible conflicts between parties. The informal "barequeros" must keep a distance of 300 m from formal mineral titles owned by third parties.

In the Mining Code of 2001, "**traditional exploitation**" was defined as an activity that had historically been sustaining a community (MME, 2001). In addition, Law 685 of the same Code defined only illicit exploitations and included a definition of artisanal mining only in relation to "barequeros". Clause 68 of Law 685 outlined the technical definitions, which were incorporated by Presidential Decree 2191 on Aug. 4, 2003. Although the Colombian Mining Glossary (MME, 2003) defined different miner types in Colombia, it did not reduce the confusion associated with the terminologies and rights of each type of miner.

Article 21 of Colombian Law 1753 of 2015, from which the National Mining Development Plan of 2017–2018 ha s been based, determined that mining activities were to be classified in terms of subsistence, small, medium and large. Decree 1666 of October 21, 2016 defined subsistence mining as "*a mining activity developed by naturalized persons or groups of people engaged in the opencast extraction of sands and river gravel for the construction industry, clays, precious metals, precious and semiprecious stones, by means and manual tools, without the use of machinery*". In its third paragraph, this Decree authorizes the MME to establish the maximum production volumes of a subsistence mine based on technical studies and statistical data of the activity. Subsistence mining includes the "barequeros", who by way of this definition continue to be considered informal. Although subsistence miners do not require a mineral title, interventions may occur in order to guarantee that the activity is conducted properly, without causing negative impacts to the environment.

Decree 0933 of 2013 defined traditional mining as that which had been practiced before Law 685 of 2001 came into effect, and that included the continuous or discontinuous extraction of mineral deposits owned by the State by Colombian nationals or groups of Colombian nationals or associations without mineral title, but registered in the National Mining Registry. Due to the generally impoverished socio-economic characteristics of this type of miner and the location of deposits being in close proximity to traditional town sites, these activities typically constitute the main source of income for the communities. This type of informal mining is also subject to formalization processes referred to in Articles 31 and 257 of Law 685 of 2001.

The MME, through the Directorate of Formalization (DF), has been working on a project entitled "*The Improvement of the Quality of Life of Subsistence Miners in the National Territory*", which has a timeline of four years (2017–2020) and includes three objectives: (1) implement good practices in mining, which specifically implies sound environmental management; (2) generate initiatives to support employability; and (3) develop productive alternative projects for subsistence miners. In December 2017, the DF reported that a total of 2235 people in 2016 were trained in good mining practices and employability, while 2841 were trained from January 1, 2017 to November 30, 2017.

The lack of distinction between small-scale conventional mining and artisanal mining is usually the source of many legal problems in the large majority of the developing countries, where artisanal mining is a relevant issue. The most pragmatic method for establishing sound legislation with clear parameters is to base the distinction and categorization upon the size of the operation. This would allow the Colombian Government to establish systems of differentiated royalties and income taxation schemes for the operations. When mining operations are defined only by size, the definitions of the technique used by the miners (rudimentary or sophisticated) are redundant and unnecessary. The more a mine produces, the more taxes and royalties it should pay.

This suggested system has the benefit of eliminating the need for mining definitions of artisanal, traditional, small, conventional, etc. For example, if an operation is rudimentary, but extracts and processes large volumes of material per day, the miner or association of miners could pay as much as a conventional, well-established large mine. This would likely provide an incentive to the miner to improve his/her operation. Conversely, if a miner genuinely uses manual processes, then he/she would mine small amounts of material per day and therefore pay little to no tax. This is important, as many artisanal gold mining operators, in knowing that their gold recovery is low (for example below 30%), would simply increase the volume of material they process rather than invest in more sophisticated techniques to increase gold recovery, which is more sustainable. In addition, this would simplify the formalization process. If an artisanal (rudimentary) miner wants to increase production levels, he/she would be required to undertake a more elaborate bureaucratic process that includes training in mining and processing, health and safety, environmental protection, water and tailings management, social impacts, etc. In comparison, the current scenario keeps an artisanal miner permanently characterized as a "barequero", irrespective of the volume of material he/she mines and offering no incentive to change his/her status.

The University of Córdoba (2015) proposed a specific classification of mining types for the purpose of conducting an inventory of the environmental impacts associated with gold processing plants in Colombia. Their four-rank classification is based on the processing capacity of the mined material per unit of time and the type of gold ore (primary and alluvial):

- For primary ores: 1) Subsistence, up to 1 t/day; 2) Small-scale mining, up to 150 t/day; 3) medium-scale mining, up to 300 t/day and; 4) Large-scale mining, greater than 300 t/day.
- For alluvial ores: 1) Subsistence, up to 550 m^3/day; 2) Small-scale mining, up to 2200 m^3/day; 3) Medium-scale mining, up to 5500 m^3/day and; 4) Large-scale mining, greater than 5500 m^3/day.

Although this classification seems adequate, it could be improved by implementing a continuum curve instead of fixed categories. This way, mine classification based on daily tonnage would have a consistent relationship with the taxes applied to the operations. Currently, the Colombian Government is considering a review of the Mining Glossary, but there is no evidence that the definition of artisanal mining will be simplified.

3. Gold production in Colombia

In 2013, Colombia officially produced 55.75 tonnes of gold (America Economia, 2014), of which artisanal gold miners were responsible for 72% of this production or approximately 40 tonnes of gold (Guiza, 2013). In 2014, the gold mining sector in Colombia officially produced approximately 57 tonnes, while in 2015 the total reached 59.2 tonnes (Boletín Estadístico de Minas y Energia, 2012–2016). In 2016, gold production was 61.8 tonnes (MME, 2017), of which the

[1] Definition of "barequero", according to the MME (2003) Mining Glossary: "*The barequero is understood to be the activity that is focused on washing sand by manual means without any help of machinery or mechanical means and in order to separate and collect precious metals contained in said sands*".

formal sector only represented 13%, while the informal miners produced 87% of the gold (VerdadeAbierta.com, 2017). In February 2017, Carlos Cante, the Vice-minister of Mines, declared that only 18% of gold production in Colombia came from legal companies (HSB Noticias, 2017).

In 2017, Colombia officially produced a total of 40.1 tonnes of gold, which was a 35% decrease from the year before (ANM, 2018). However, while gold production fell by more than 20 tonnes, the National Administrative Department of Statistics reported that gold exports in 2017 increased by 10 tonnes, from 48 tonnes in 2016 to 58 tonnes in 2017 (DANE, 2018), which translated into an additional US $245 million. For the Colombian Mining Association (ACM), this discrepancy between gold production and the volume reported is due to three possible factors: a lag in exports; a lag in inventories; and illegal production (Periódico Portafolio, 2018). Although the ACM explained that the lags in exports and inventories could be based on a number of reasons, including the inability to dispatch product during the fiscal year of 2016, withholding due to market price variances, need to liquidate old stock first, warehousing issues, selling dates agreed to with buyers, and contract agreements, such a large discrepancy seems implausible to account for by these measures. Therefore, the more likely explanation is due to a combination of informal artisanal mining and the actions of illicit criminal organizations that are involved in money laundering via gold exports.

Considering that such a large percentage of gold in Colombia comes from informal sources, it is important to understand the main characteristics of this kind of production. After mining the ore, most artisanal miners take the material to processing centers, locally known as “entables”, which are independent plants run by individuals who charge the artisanal miners a nominal fee (usually US $5/tonne) for gold extraction of their ores. The main process used in Colombian “entables” is amalgamation of the whole ore using “cocos”, which are small ball mills. This practice represents the main cause of mercury losses in the country, as whole ore amalgamation only recovers 50–70% of the original mercury entering the process (Garcia et al., 2015; Cordy et al., 2011). Furthermore, this process is extremely inefficient in terms of gold recovery, resulting in returns to the artisanal miners of only 20–30% of the total gold in the ores. The processing centers keep the Hg-contaminated tailings as “payment” for the amalgamation services and extract the residual gold using cyanide. In turn, this causes the dangerous formation of mercury cyanide complexes in the tailings, which are then dumped untreated into local drainages (Veiga et al., 2014a). In a project for the MME, the Universidad de Córdoba (2016) identified 1590 basic gold processing plants “entables”) in 261 municipalities of 19 Colombian departments, whereby 243 were using both amalgamation and cyanidation.

In 2015, the University of Córdoba determined that there were 1058 gold mineral titles distributed throughout 21 departments, of which Antioquia had the largest number, with a total of 435. In succession, Bolívar had 183 titles, Caldas 142, Tolima 59, Santander 50, Nariño 41, and Chocó with 40 titles (University of Córdoba, 2015).

There has been a discrepancy between the official number of artisanal gold miners in Colombia established by the Mining Census of 2011 (MME. 2011) of approximately 50,000, the University of Córdoba (2014) with 68,000, and the number estimated by Cordy et al. (2011) of around 200,000, which was based on non-official information from miners and local governments. It is important to point out that this higher number was also estimated by the Secretary of Mines of Antioquia. Officially, in 2014, the Department of Antioquia produced almost half of the gold in the country (49.3%) or approximately 28 tonnes (Fig. 1), followed by Chocó with almost 20% and Nariño with around 9% (ANM, 2015). In the Department of Antioquia, there were 1526 gold mines, in which 186 possessed legal mineral titles (12.5%). Furthermore, it was estimated that there were a total of 15,000 to 30,000 gold miners, with most of them located in the Lower Cauca River and in the northeast region of Antioquia, where gold has been mined since pre-

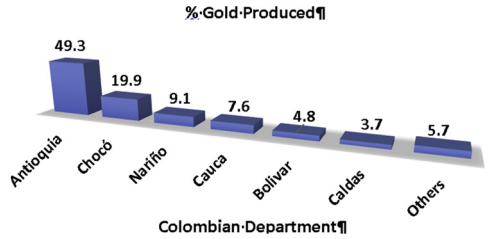

Fig. 1. Gold production by Colombian departments, 2014. (Source ANM, 2015).

colonial times (MME, 2011).

In 2014, according to the University of Córdoba (2015), the majority of gold production in Colombia came from eight Antioquian municipalities: Segovia (4.48 tonnes), El Bagre (4.44 tonnes), Tarazá (3.80 tonnes), Remedios (2.88 tonnes), Caucasia (2.58 tonnes), Maceo (2.42 tonnes), Cáceres (2.41 tonnes) and Zaragoza (1.53 tonnes). In other departments, the municipalities of Nóvita (2.11 tonnes) and Istmina (1.85 tonnes) in Chocó Department showed high production, while the municipality of Marmato in Caldas Department produced 1.61 tonnes, and Santa Rosa Del Sur (1.43 tonnes) and Simití (1.39 tonnes) were standouts for Bolivar Department (Fig. 1). The rest of the municipalities produced between 0.5 and 1 tonnes each.

4. Formalization process in Colombia

The formalization approach has been attempted by the majority of governments in developing countries that face problems with informal artisanal mining. Chen (2007) suggested that informal employment comprises 50 to 75% of non-agricultural employment in developing countries. In Colombia, the International Labour Organization estimated that informal employment amounted to 68% in 2009 and 64% in 2013, which dipped only slightly to 62.5% in 2009 and 59% in 2013 when the agricultural sector was removed from the calculations (ILO, 2014).

In metropolitan areas in Colombia informality is also high, as a recent government report in September 2017 showed that informal employment had reached 48.7% in 23 cities (DANE, 2017). In comparison, the Universidad de Rosario estimated that informal employment in Colombia had reached 65% of total employment in 2017 (El Colombiano, 2017). Informality in Colombia is apparently increasing, due to high levels of unemployment in the country (~9.5%) and the migration of 25,000 Venezuelans per day into the country (Semana, 2017). Colombia is not prepared for this large migration of people from neighboring Venezuela, which adds to a growing total of over 1.2 million illegal and legal Venezuelans already in the country (El Empleo, 2017). Furthermore, the authors have personally observed many Venezuelans working in informal artisanal mining operations in Colombia.

The increasing unemployment rate in developing and emerging countries like Colombia, as well as the strong price of gold hovering around US $40/g, is driving 16 million artisanal gold miners worldwide to work informally and look for more gold deposits (Seccatore et al., 2014). The increasing number of informal artisanal miners in developing countries is a consequence of poor resource policies in rural areas of the globe. Although governments in developing countries want to introduce formalization of the mining sector as a way to control pollution and gain taxes, this does not work with artisanal miners who do not understand the benefits of a legal mining title and the reasons for paying taxes. Furthermore, many formalized miners from different Latin American countries interviewed in the field believe that if they have legal documents, then they have the right to pollute.

In Colombia, the Ministry of Mines and Energy (MME) has the potential to be the most pro-active government ministry in the world to deal with the problem of formalization of an estimated 300,000 Colombian artisanal miners, extracting gold, diamonds, emeralds, coal,

construction minerals, etc. However, currently, the MME has reached the basic stage of formalization of only about 7% of the total registered mining units in the country. Moreover, as in most countries, formalization by the MME does not imply that full legality has been acquired, since permits from other government ministries like the Ministry of the Environment and Sustainable Development (MADS) must also be obtained. According to Guiza and Aristizabal (2013), 95% out of a total of 4134 Gold Mining Production Units (UPM) in the country in 2011 did not possess any environmental permits.

This lack of integration between the MME and MADS has also been a problem in other countries as well. For example, in the "Reserva Garimpeira do Tapajós" (Tapajós Artisanal Mining Reserve) in the Amazonian region of Brazil, all artisanal miners have mining licences issued by the Brazilian Ministry of Mines and Energy. However, in 2010, as 99.3% of them did not have the proper environmental permits, the vast majority simply ignored Law 97.507/89 that states: "*no artisanal mining site is allowed to use mercury (Hg) or cyanide (CN) without a previous permit issued by the environmental authority. Environmental crimes are punishable with both fines and prison terms*" (Sousa et al., 2011).

Besides the need for environmental permits, formalization also poses other demands for artisanal miners to operate legally. In August 2013, the Government of Colombia proposed implementation of a new law in which only artisanal miners with at least 2 years of experience in the mining sector would be eligible for legalization (El País, 2013). The Program for Formalization of Traditional Mining in Colombia, which was based on Law 1320 of 2010 and Decree 933 of 2013, established criteria pertaining to the miners' legalization and implementation of better practices. In July 2013, 8125 requests for formalization were filed by the Ministry, in which 39% were rejected for not following the right procedures, resulting in only one title being issued (MME, 2014).

Unfortunately, most governments do not usually have the technical capacity to deal with unregulated artisanal miners. While the formalization approach has relative merit in dealing with small, medium and large artisanal mining operations, it cannot work with micro-miners ("barequeros"), who are the millions of miners who pan the river banks to produce a few grams of gold per day. This activity is usually driven by poverty and subsistence. Therefore, what is the incentive for the "barequero" to be formalized? The possibility for this type of miner to be awarded a mining title is almost nonexistent and there is strong likelihood that they will always be viewed by society as being both illegal and as invaders of the land. As a matter of fact, Colombian society used to call any informal miners "illegal". In a society where close to 70% of the labor force in all sectors is considered informal, it is surprising that only miners are relegated with this connotation of illegality.

In theory, while governments believe that formalization of artisanal miners is a step towards cleaner production, formalization is inherently a process, which does not necessarily guarantee that more environmentally responsible processing techniques will be adopted and implemented. Although formalization can result in ownership of mineral titles, which then provides transferable capital to the miners (Siegel and Veiga, 2009), the reality is that there are few available areas in Colombia to be delegated to artisanal miners. Therefore, the first step in formalization must involve education, which is similar to taking a course to study for a driver's license. Although a driver preparation course with associated reading materials can educate and prepare someone for the written exam, extensive practice driving is required in order to have a chance of passing the road test in the presence of a qualified examiner, who will fail candidates for the smallest infractions. If the infrastructure and preparation for formalization of artisanal miners was as thorough as the motor vehicle branches of most countries, the Ministry of Mines and Energy would have garnered more success by way of this process.

As available mineral titles are scarce, one viable way to formalize groups of artisanal miners is through the approval of sub-contracts to miner associations via a type of co-existence with the owners of mineral titles, which allows greater potential to secure the adequate investments for implementation of clean processing techniques and receive the necessary environmental permits to operate. In addition, these miner associations would have the capacity to provide education and training for their operators, who would be considered artisanal miners if working independently. Although there are currently 27 sub-contracts that have been granted to mining corporations to conduct formalization of artisanal miners on their concessions, this only represents a small fraction of the hundreds of thousands of artisanal gold miners in Colombia (Rochlin and Fernández de Soto, 2017; Rochlin, 2018). Therefore, co-existence arrangements between miner associations/cooperatives and the owners of mineral titles is something that the governments need to be promoting more, as it provides a vehicle for conflict resolution on mining concessions, allows for investments in more advanced mining and processing equipment, and pays for pensions and other social benefits, as well as serving as a profit-sharing agreement between the interested parties. Furthermore, it is much easier for the government to be able to monitor and enforce regulations with a company or association that is already registered with the authorities, as opposed to trying to control thousands of unregistered artisanal miners spread out over a vast area.

In Colombia, the "Oro Legal Project", sponsored by USAID since 2015, has investigated problems with the formalization of artisanal miners and detected some bottlenecks. Despite the good will and flexibility of the MME, MADS has implemented a difficult and cumbersome process. According to the representative of the Oro Legal Project, there are 380 steps for an informal miner to go through in order to have his/her legal title approved by the MADS. Furthermore, not all miners can fulfill the legal requirements for formalization, as some of them are extracting and processing ores within the boundaries of national parks or other protected areas.

One of the main barriers to formalization is caused by disputes between owners of mineral titles (individuals or mining companies) and artisanal miners. Although the artisanal miners are often the ones who discovered the deposits and started working them first, they are typically deemed to be invading the land, as they don't possess the mineral titles and the necessary permits to operate. Consequently, the mineral titles are usually assigned to a third party that has the capacity and wherewithal to deal with the legal and administrative mechanisms required to formally register a property, which the artisanal miners generally lack. While mining companies are often keen to establish dialogue or even implement co-existence arrangements with artisanal miners working on their concessions, many individuals with mineral titles have never been to the site and only have the titles in order to speculate with large conventional mining companies. As mentioned above, a viable co-existence strategy between mining corporations and artisanal miners via sub-contracts or another type of mutually-beneficial agreement is something that the Colombian Government needs to promote more and further expand, as the lack of areas for the artisanal miners to work is one of the major hurdles to successful formalization.

Another barrier to mining development and the implementation of formalization initiatives is the slow and unwieldy authorization process currently in place to purchase explosives. In Antioquia Department, it has been observed that various formalized mining operations were halted for at least 3 months while they awaited authorization by the local Secretary of Mines and the Army to purchase explosives. Miners must obtain these authorizations every time they want to buy ANFO explosives (a widely used bulk industrial explosive), as well as being required to attend a full-day course every year given by the Army.

From 2009–2011, the Government of Colombia conducted a nationwide Mining Census (MME, 2011) in 23 Departments, whereby it was concluded that there were 14,357 Mining Production Units (UPM), in which 63% did not have a mineral title and 75.7% did not have any type of environmental permit. The size of the UPMs was calculated based on the number of employees, where only 1% (208) of the UPMs were considered large, with more than 70 employees, while

approximately 26% (3748) were classified as medium-sized with 6–70 employees, and 72% (10,401) were deemed small, with up to 5 employees. The small and medium-sized UPMs numbered 314,000 workers. Approximately 47% of the UPMs were mining non-metallic construction minerals (60% illegal/informal operations), 20% coal (40% illegal/informal UPMs), 2% emeralds (84% illegal/informal UPMs) and 31% were gold and silver (85% illegal/informal UPMs). The Mining Census also identified that 10 departments had more than 80% informality (MME, 2011).

The Colombian Program of Mining Formalization, which is administered by the Directorate of Formalization (DF) of the Ministry of Mines and Energy (MME), has as its fundamental objective the legalization of small-scale and subsistence miners. In order to accomplish this goal, the DF works with miners to provide orientation on how to obtain a mining title and environmental permits, as well as learning how to work in a formal business environment. This program works within two action lines. The first focuses on the miners with legal Mining Production Units (UPM), assisting them on how to implement sound cleaner practices. The second action line is focused on supporting those miners that have been traditionally working with mining, but are informal.

The current Directorate of Formalization (DF) provided accompaniment and comprehensive technical assistance to 1694 Mining Production Units (UPMs) in 2016 and 1546 UPMs in 2017. In December 2017, according to the Director of the DF, the basic stage of formalization had been reached for 1012 UPMs, which represents approximately 7% of the total UPMs of all types of minerals in the country (14,357 UPMs), which are fully[2] or on the way to be formalized. This seems to be a remarkable success, since in Latin America probably less than 1% of artisanal mining operations have been formalized (Marshall and Veiga, 2017). A further 10,425 UPMs were identified and characterized, of which 2020 are now in the process to be formalized. All formalized units receive permanent technical support from the DF, as well as assistance to obtain financial credit from banks.

In order to comply with Law 1658 of 2013, a project was initiated in 2016 that focused on the "*Theoretical and practical training for the reduction or elimination of mercury in gold beneficiation processes in the national territory*", where 14,083 “barequeros” received training in technical, economic, environmental, social and legal aspects of mining. According to the DF, this project has managed to eliminate 28.4 tonnes of mercury per year. Interventions were carried out at 51 legal beneficiation plants or “entables” (with mining titles and environmental permits), benefiting 512 small miners.

Despite all of the legal restrictions, artisanal mining continues to increase in Colombia and other developing countries, particularly in remote areas, where law enforcement is non-existent and the majority of artisanal miners are located (Hilson, 2002). In 2012, the Government of Colombia, under Decree No. 2235, passed a law allowing the destruction of all types of heavy equipment, such as excavators being used in illegal/informal mining operations.

The absence of government authorities in remote artisanal mining areas is also a major part of the problem (Hilson and Vieira, 2007). The authorities should not only enforce the law, but also provide orientation to the informal miners on how to legalize, as well as disseminating information regarding better mining and processing practices. Without training, miners do not know why and how to obtain legal mineral titles (McDaniels et al., 2010) or how to improve their gold extraction methods. Good examples of successful formalization are rare.

5. Conclusion and recommendations

Efforts by the Ministry of Mines and Energy (MME) in Colombia have not been followed by other authorities in the country and the formalization of artisanal gold miners is still moving slowly. Although the formalization process does not guarantee that the miners will operate in a cleaner way, it at least allows them to be registered in a national database, receive instruction on best practices and have access to a mineral title, which are discernible benefits.

Without training, capital and law enforcement, artisanal miners will not change their polluting techniques. The artisanal miners have resisted changing their practices, based on the belief that any modification will lead to a reduction in their gold production (Hinton et al., 2003). The Colombian MME recognizes that there are deficiencies in the enforcement and control of artisanal mining operations. In their plans, they have put forth an optimistic projection that the Colombian mining industry will be totally formalized in terms of legal, social, economic, technical, environmental and fiscal aspects by 2040 (Gobierno de Colombia, 2014). However, this cannot be accomplished without a strong governmental presence in the field and adequate training and education programs for the artisanal miners. To date, the presence of government representatives in the field discussing legal and technical issues with artisanal miners has been rarely observed.

Another important issue involves the political nature of formalization initiatives in the AGM sector, whereby national executing agencies responsible for improvements in the mining industry end up appointing personnel who have inadequate expertise for implementing technical solutions in the field (Hilson et al., 2018). One of the major problems to eliminate mercury use in Colombia, as well as in other developing countries with AGM, is that governments need to realize that formalization does not guarantee that cleaner processing techniques will necessarily be implemented. A recent investigation by the authors of 71 formalized small-scale gold processing plants in Colombia revealed that a large majority were still using mercury even after Law 1658 had come into force in July 2018, which prohibits the use of mercury in the AGM sector.

Due to governmental shortcomings, one way to fill the void is through the assistance offered by non-governmental organizations, such as Oro Verde, Fair Trade International (FLO), COMUNICA Project, Better Gold Initiative, Partnerships for International Research and Education (PIRE), and the Alliance for Responsible Mining (ARM), which have implemented capacity-building initiatives in ASGM communities, promoted the use of mercury-free processing techniques and compliance with regulations, as well as the assembly of financial and ethical gold supply chains (Sippl, 2015). Although the results of some pilot projects have been promising, the non-state market-based regulatory approaches are difficult to sustain, as they often lack accountability and fail to reform the worst offenders and assist those most in need (Jaffe, 2007; Borck and Cary, 2009). Ultimately, if not tied in with broad-based collaborations agreed upon by multiple stakeholders, including governments, companies, NGOs and community leaders, the market is an ineffective tool to solve the problems it helped to create (Lipschutz, 2005).

Without education and training, formalization initiatives are not sustainable and only perpetuate inefficient mining and processing methods that includes the harmful use of mercury. The pollution and legal problems will only begin to be resolved upon implementation of a tailor-made formalization process that includes reduction of the bureaucratic process, education, training and capital investment, as well as adequate consultation of miners and their communities *a priori*. In order to turn informal artisanal miners into responsible small-scale miners, one needs to understand their motivations and capacity to adopt better practices, apply alternative processes and engage in other economic activities, as mining is clearly not sustainable.

[2] This means that the UPMs count with mineral titles, environmental permit, pay royalties and social insurance for their employees

References

America Economia, 2014. Produccion De Carbon, Oro Y Níquel Cayo En Colombia Durante 2013. http://www.americaeconomia.com/negocios-industrias/produccion-

de-carbon-oro-y-niquel-cayo-en-colombia-durante-2013.
ANM Agencia Nacional de Mineria, 2015. Producción de minas y canteras 2014. https://www.anm.gov.co/?q=Produccion-minas-canteras-2014.
ANM Agencia Nacional de Mineria, 2018. Así se movieron las cifras de producción de minerales en 2017. https://www.anm.gov.co/?q=asi-se-movieron-las-cifras-de-produccion-de-minerales-en-2017.
Borck, J.C., Cary, C., 2009. Voluntary environmental programs: assessing their effectiveness. Annu. Rev. Environ. Resour. 34, 305–324.
Chen, M.A., 2007. Rethinking the Informal Economy: Linkages with the Formal Economy and the Formal Regulatory Environment. Research Paper, 46. UN/DESA. United Nations Department of Economic and Social Affairs, pp. 14p. http://www.un.org/esa/desa/papers/2007/wp46_2007.pdf.
Cordy, P., Veiga, M.M., Salih, I., Al-Saadi, S., Console, S., Garcia, O., Mesa, L.A., Velásquez-López, P.C., Roeser, M., 2011. Mercury contamination from artisanal gold mining in Antioquia, Colombia: the world's highest per capita mercury pollution. Sci. Total Environ. 410, 154–160.
DANE Departamento Administrativo Nacional de Estadística, 2018. Exportaciones.
DANE Departamento Administrativo Nacional de Estadísticas, 2017. Empleo informal y seguridad social. http://www.dane.gov.co/index.php/estadisticas-por-tema/mercado-laboral/empleo-informal-y-seguridad-social.
El Colombiano, 2017. El 65% de los trabajadores en Colombia son informales, dice U. del Rosario. http://www.elcolombiano.com/negocios/economia/informalidad-laboral-en-colombia-XC6422264.
El Empleo, 2017. Los venezolanos que vienen a buscar trabajo en Colombia no te van a quitar tu empleo. http://www.elempleo.com/co/noticias/tendencias-laborales/los-venezolanos-que-vienen-buscar-trabajo-en-colombia-no-te-van-quitar.
El País, 2013. Gobierno sólo legalizará a mineros artesanales con tradición. http://www.elpais.com.co/elpais/colombia/noticias/gobierno-tiene-dos-puntos-cedera-ante-mineros.
Garcia, O., Veiga, M.M., Cordy, P., Suescún, O.E., Molina, J.M., Roeser, M., 2015. Artisanal gold mining in Antioquia, Colombia: a successful case of mercury reduction. J. Clean. Prod. 90, 244–252.
Gobierno de Colombia, 2014. Política nacional para la formalización de la Minería en Colombia. Ministerio de Minas y Energía. https://www.minminas.gov.co/documents/10180/581708/DocumentoPoliticaVersionFinal.pdf/9fd087db-7849-4728-92ff-6e426acccf9c.
Guiza, L., 2013. La pequeña minería en Colombia: una actividad no tan pequeña. Dyna 80 (181), 109–117.
Guiza, L., Aristizabal, J.D., 2013. Mercury and gold mining in Colombia: a failed State. Universitas Scientiarum 18 (1), 33–49.
Hentschel, T., Hruschka, F., Priester, M., 2002. Global Report on Artisanal & Small-scale Mining. Report to MMSD/IIED. International Institute of Environment and Development, pp. 67p. http://pubs.iied.org/pdfs/G00723.pdf.
Hilson, G., 2002. Small-scale mining and its socioeconomic impact in developing countries. Nat. Resour. Forum 26 (1), 3–13.
Hilson, G., Vieira, R., 2007. Challenges with minimizing mercury pollution in the small-scale gold mining sector: experiences from the Guianas. Int. J. Environ. Health Res. 17 (6), 429–441.
Hilson, G., Zolnikov, T.R., Ramirez-Ortiz, D., Kumah, C., 2018. Formalizing artisanal gold mining under the Minamata convention: previewing the challenge in Sub-Saharan Africa. Environ. Sci. Policy 85, 123–131.
Hinton, J.J., Veiga, M.M., Veiga, A.T.C., 2003. Clean artisanal gold mining: a utopian approach? J. Clean. Prod. 11 (2), 99–115.
HSB Noticias, 2017. Sólo el 18% de la producción de oro del país proviene de la minería legal. http://hsbnoticias.com/noticias/nacional/solo-el-18-de-la-produccion-de-oro-del-pais-proviene-de-la-m-278826.
ILO, International Labour Organization, 2014. FORLAC: Trends in Informal Employment in Colombia. pp. 2009–2013. http://www.ilo.org/wcmsp5/groups/public/—americas/—ro-lima/documents/publication/wcms_245885.pdf.
Jaffe, D., 2007. Brewing Justice. University of California Press.
Lipschutz, R.D., 2005. Power, politics and global civil society. Millenn. - J. Int. Stud. 33 (3), 747–769.
Marshall, B.G., Veiga, M.M., 2017. Formalization of artisanal miners: stop the train, we need to get off!. Extr. Ind. Soc. 4, 300–303.
McDaniels, J., Chouinard, R., Veiga, M.M., 2010. Appraising the Global Mercury Project: an adaptive management approach to combating mercury pollution in small-scale gold mining. Int. J. Environ. Pollut. 41 (3/4), 242–258.
MME, 2001. Ministerio de Minas y Energia. Mining Code: Law 685 of 2001.
MME, 2003. Mineral Glossary. Ministerio de Minas y Energia. http://www.minminas.gov.co/minminas/minas.jsp?cargaHome=3&id_categoria=111&id_subcategoria=251.
MME, 2011. Censo Minero. Ministerio de Minas y Energia. https://www.minminas.gov.co/censominero.
MME, 2014. Política Nacional para la Formalización de la Minería en Colombia. Ministerio de Minas y Energia, pp. 110. https://www.minminas.gov.co/documents/10180/581708/DocumentoPoliticaVersionFinal.pdf/9fd087db-7849-4728-92ff-6e426acccf9c.
MME, 2017. Producción National de Minerales. Ministerio de Minas y Energia. https://www.minminas.gov.co/documents/10180/23907914/ANEXO-MEMORIAS_Mineria.pdf/0d96bc03-36a4-482e-92aa-ed5444a366c3.
Pantoja, F.H., Pantoja, S.D., 2016. Problemas y desafíos de la minería de oro artesanal y en pequeña escala en Colombia. Revista de la Facultad de Ciencias Económica. Universidad de Nariño 24 (2), 147–160.
Periódico Portafolio, 2018. Colombia exportó el año pasado más oro del que produjo. http://mineros.com.co/es/component/content/article/20-noticias/741-colombia-exporto-el-ano-pasado-mas-oro-del-que-produjo.
Rochlin, J., 2018. Informal gold miners, security and development in Colombia: charting the way forward. Extr. Ind. Soc In Press.
Rochlin, J., Fernández de Soto, A., 2017. Interview with the Vice-Ministro para asuntos internacionales. Ministerio de Defensa, Gobierno de Colombia (28 June, Bogotá).
Seccatore, J., Veiga, M.M., Origliasso, C., Marin, T., Tomi, G., 2014. An estimation of the artisanal small-scale production of gold in the world. Sci. Total Environ. 496, 662–667.
Semana, 2017. El impacto del éxodo de venezolanos. May 8, 2017. http://www.semana.com/nacion/articulo/venezolanos-cruzan-la-frontera-en-busca-de-libertad-comida-y-salud/535377.
Serrano, A.M., Martínez, M.S., Fonseca, L.A., 2015. Diagnóstico y caracterización de la mineria ilegal en el Municipio de Sogamoso, hacia la construcción de estrategias para la sustitución de la minería ilegal. Revista de la Facultad de Ciencias Económicas y Administrativas. Universidad de Nariño 18 (1), 104–119.
Siegel, S., Veiga, M.M., 2009. Artisanal and small-scale mining as an extralegal economy: de Soto and the redefinition of "formalization". Resour. Policy 34, 51–56.
Sippl, K., 2015. Private and civil society governors of mercury pollution from artisanal and small-scale gold mining: a network analytic approach. Extr. Ind. Soc. 2, 198–208.
Sousa, R., Veiga, M.M., Van Zyl, D., Telmer, K., Spiegel, S., Selder, J., 2011. Policies and regulations for Brazil's artisanal gold mining sector: analysis and recommendations. J. Clean. Prod. 19, 742–750.
Universidad de Córdoba, 2016. Identificación y Caracterización de las Unidades Básicas De Beneficio Aurífero en 261 Municipios. Resumen Ejecutivo. http://www1.upme.gov.co/simco/Cifras-Sectoriales/EstudiosPublicaciones/Identificacion_Caracterizacion_Unidades_Basicas.pdf.
University of Córdoba, 2015. Incidencia Real de la Mineria del Carbon, del Oro y del Uso del Mercurio en la Calidad Ambiental con Enfasis Especial en el Recurso Hidrico - Diseño de Herramientas para la Planeacion Sectorial. pp. 663. http://www.upme.gov.co/SeccionMineria_sp/Incidencia_real_de_la_mineria_sobre_recurso_hidrico.pdf.
University of Córdoba, 2014. Estudio de la cadena del mercurio en Colombia con enfasis en la actividad minera de oro. Tomo 3. Report to MME. pp. 253. https://www.mesadedialogopermanente.org/wp-content/uploads/2015/07/Cadena_Mercurio-Tomo-III-Prod-6-7-8-y-9.pdf.
Veiga, M.M., 1997. Introducing New Technologies for Abatement of Global Mercury Pollution in Latin America. Published by UNIDO/UBC/CETEM, Rio de Janeiro, pp. 94 ///C:/Users/veiga/Downloads/introducing-new-technologies-for-abatement-of-global-mercury-pollution-in-latin-america%20(1).pdf.
Veiga, M.M., Angeloci, G., Hitch, M., Velasquez-López, P.C., 2014a. Processing centers in artisanal gold mining. J. Clean. Prod. 64, 535–544.
Veiga, M.M., Angeloci-Santos, G., Meech, J.A., 2014b. Review of barriers to reduce mercury use in artisanal gold mining. Extr. Ind. Soc. 1 (2), 351–361.
VerdadeAbierta.com, 2017. 'Barequeros' y 'chatarreros', entre criminales y la DIAN. Mar, vol. 16 2017. https://verdadabierta.com/barequeros-y-chatarreros-entre-criminales-y-la-dian/.