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Grounding institutions through informal practice: Credibility in artisanal mining of aggregates, Ghana

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ABSTRACT

Artisanal mining is mainly carried out as an informal activity without a mining license, the payment of public fees or compliance with environmental and labour regulations. Although artisanal mining persists in most African countries, efforts by public authorities to formalize such activities have encountered numerous problems. This paper uses the Credibility Thesis to explain the persistence of the artisanal mining of aggregates in the Accra metropolitan area in Ghana. Aggregates are used in the construction of houses, and several artisanal quarries supply the highly fluctuating and unpredictable demand from individual house-owners. We identify complex but relatively stable endogenous ways of organising artisanal production and marketing in five quarries at different stages of consolidation and liquidation: sites are initially exploited but then gradually transformed into waste dumps or new residential areas by landowners as part of an expanding urbanization process. Artisanal miners are evicted, but as demand continues and alternative supplies are not present, new sites are opened, only to go through a similar sequence. However, practices are replicated, and credible (informal) institutions are transferred through time and space due to their functional endurance.

1. Introduction

The topic of this paper is the artisanal mining of aggregates in Accra, the capital of Ghana, an essential and vital component of the expansion of the urban landscape in this metropolitan area. Aggregates, or stones of varying sizes, are mixed with cement and water to form the concrete used in the construction of houses and commercial buildings. Large-scale quarries in the eastern part of the metropolitan Accra area (all except for one located in the Shai Hill area North of Tema) cover the demand for aggregate by road-construction companies and housing-estate developers, but they do not sell to individual house-owners, who are served instead by artisanal quarries. These are scattered around the urban fringe in a pattern that follows a particular geological formation but otherwise changes with the pulse of urban growth.

The term 'artisanal' refers to both the informal nature of the activity and the fact that production is primarily organized by individuals or small groups of people using simple tools (chisels, crowbars, head pans, hammers) to break, carry and crush boulders into smaller stones (aggregates) used in making concrete. 'Artisanal' is somewhat misleading as several hundred people may work at the same quarry site, which may be of considerable territorial extension. However, there are no direct economies of scale linked to these activities, as divisions of labour and product sales take place within the organizational confines of the operations of individual plots.

A salient feature of the artisanal mining of aggregates in the Accra area is that all activities are 'informal': the artisans and operators are not registered as formal businesses, and they exploit resources on plots of land that are not officially recognized as quarries by any public authority, neither the Ministry of Lands and Natural Resources, nor the districts councils in which the sites are located (ILO, 2013). Furthermore, in many cases several actors, like the heads of clans (chiefs), private individuals, religious organizations and public pension funds, claim ownership of the land and are involved in conflicts and struggles over land rights. Thus, artisanal mining takes place in an unstable and insecure regulatory framework under which the operators are periodically evicted by landowners who want to change how the land is used, for instance, for residential areas. However, as some sites are closed down, new sites open up and expand into other areas of the urban fringe. In this way, artisanal aggregate mining is eaten itself up by urban growth, as well as feeding it.

Vehement calls for the formalization of informal small-scale mining activities in Ghana, as in many other African countries (see Hilson and

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Maconachie, 2017), require compliance with the same requirements that are applicable to the large-scale mining sector dominated by transnational companies: the issuing of mining licenses, the payment of fees and observing environmental regulations. However, it is worth examining the actual 'working' institutions of artisanal mining to see if the proposed 'formalization' efforts are aligned with practices in the 'real' world. Is it possible to identify functional and relatively stable institutions that regulate the daily operations of artisanal miners so that production and sales are not interrupted by internal conflict and anarchic conditions? The artisanal mining of aggregates in Accra clearly has a functional role to play as a flexible provider of basic and cheap building materials of adequate quality for individual house-builders. No other wholesale or retail market exists for these products, as the large-scale formal quarries target road-construction companies and housing-estate developers.

In this paper, we show that a notable feature of artisanal mining is the emergence of a highly complex set of common practices and regulatory mechanisms for, among other things, the allocation of plots, the organization of work and 'marketing' among participants. These practices have evolved in different sites for the artisanal production of aggregates. We argue that the relative stability of organizational practices within a continuously challenged and apparently unstable regulatory framework is indicative of the emergence of credible institutions (Ho, 2014; ; 2015, 2016Ho, 2014; 2015, 2016). The endogenous 'rules of the game' have been established over time through a multitude of interactions at the grassroots level and adapted to specific locational and socio-economic features such as the particular nature of ownership and the properties of the resource (e.g. its hardness and flakiness). However, the basic manner in which labour is organized is strikingly similar from site to site, as well as over the period of study (seven years). Surprisingly these institutional 'lessons learned' have not been considered for incorporation into the design of support policies targeting the artisanal sector in Ghana. Instead the proposed elements of the formalization of artisanal mining stem from an exogenous (top-down) institutional design.

The paper is organized in accordance with the argument we are proposing. First, we introduce the debate on the formalization of artisanal mining and explain how the failure to transform its informal nature can be explained by using the explanatory logics of the so-called Credibility Thesis. Second, we outline the methodology and research design used in the study, including our methods of data collection. Third, we describe the characteristics and dynamics, functional as well as spatial, of the five artisanal aggregate quarry sites in the Accra metropolitan area that we have studied. Fourth, the results of the study are reported through a detailed account of the production process, the market and the division of labour that exists between the main actors in the quarry sites. Fifth, we extract the findings on the functionality, endogeneity and credibility of the institutional framework that regulates artisanal activities and describe a recent and potentially devastating external threat to its ability to continue, namely new investments by Chinese companies producing higher quality granitic products at competitive prices. We conclude by placing the findings of our case study in a broader perspective on strategic policy regarding artisanal mining.

2. Formalization and the credibility of artisanal mining

Millions of Africans derive their livelihoods directly or indirectly from the informal artisanal mining of precious or industrial minerals (Hayes, 2008; Hilson and Maconachie, 2017, Table 1). For a number of years now, this phenomenon has been the focus of public debates involving interventions from politicians, public administrators, corporations, NGOs and the media. Formalization has been a recurrent theme in these debates, as artisanal mining mostly takes place as an informal activity without proper registration or the issuing of a license (Chachage, 1995; ILO, 1999; UNECA, 2002). Hence, artisanal miners do not pay any taxes or other fees to the public authorities, and monitoring whether public regulations governing environmental and labour conditions are being complied with is very difficult. Viewed from this perspective, formalization is deemed necessary in order to increase public revenues at both the state (federal) and local levels and to ensure compliance with national laws.

Another argument is that the formalization of artisanal mining activities is necessary to avoid the miners themselves losing income and property (mine facilities, mining equipment, stock, etc.) if activities are closed down or property destroyed due to their forced removal from the land (Hilson, 2002; Hinton, 2005; Kampani, 2003). Furthermore, formalization is seen as a precondition for financial support, as mining installations and user rights may constitute collateral for formal institutional credit. Here the emphasis is on securing access and user rights for license-holders through the inclusion of these rights in new regulatory mechanisms and mining laws. In some countries, the new legal framework provides for the formal allocation of land for artisanal mining and the establishment of public centres with advisory services (Campbell, 2009; for Tanzania see URT, 2010; for Ghana, see Minerals Commission, 2009). However, numerous obstacles have been identified to the implementation of new formal frameworks for artisanal mining, including the relatively high costs to be paid for licenses (often including bribes to officials), long and complicated administrative procedures, and problems in the demarcation and registration of mining land (Fisher, 2007; Hilson et al., 2007; Spiegel, 2009).

From a different perspective, other observers have criticized the legal frameworks for failing to deal with the incorporation of and concern for those who work for the plot-holders, namely the 'employees' or workers. These men and women are generally much poorer and depend solely on artisanal mining for their livelihoods. They work under various exploitative conditions: no fixed payments, no agreed hours of work, the carrying out of dangerous tasks without protective measures, and modest returns due to their weak bargaining position. Whether they come from the local community or migrants from other regions, they are virtually absent from the legislative frameworks that govern artisanal mining (Luning, 2008; Werthmann, 2003).

This indicates that artisanal mining is not harmonious or free from internal conflicts – informality is not the same as the absence of distributional conflicts over production surpluses. It is not easy to grasp the scope and nature of exploitation in artisanal mining, as relations between different actors are nested in a complex system of exploitative relationships that encompass other actors than workers and 'employers'. For instance, landowners or providers of informal finance may siphon off the production surplus to the detriment of both workers and employers (plot-holders). Alternatively employers and workers may develop 'egalitarian' systems to divide the surplus between them in situations that are characterized by high risk and uncertainty for both parties. It may also be the case that a kind of apprenticeship system develops, the workers of today being the plot-holders of tomorrow, so that some of the prevailing inequalities are reduced or disappear over time. This question relates to a broader discussion of whether artisanal mining is an activity driven by poverty (i.e. Africans are forced to work in informal artisanal mining because they have no income-generating alternative), or whether increasing numbers of young people and middle-aged individuals are actively pursuing a career in artisanal mining because it offers opportunities to earn a personal income and perhaps also to escape from restrictive patriarchal obligations (Hilson and Banchirigah, 2009; J & nsson and Bryceson, 2009; Maconachie, 2011).

Despite the allegedly insecure and unstable conditions at the macro-level due to the informality of artisanal mining and the potentially conflict-ridden nature of the internal relationships among the participants at the micro-level, artisanal mining operations are not haphazard and ad hoc but take place using repeated daily routines (Jaques et al., 2006; J & nsson and Fold, 2009; Luning, 2006). Another argument is that artisanal mining fulfils obvious social needs in that it produces

Table 1
Characteristics of the five artisanal quarry sites.

ASM	Kwabenia E	Ofankor	Omanjor	Oblogo	New Botionor
Start year	1998	1999	1992	1980s	2000
Ownership	Family	Chief + family	Private company	Chief	Pension Fund
Mining license	no	No	yes	no	no
Total no. of workers and plot-holders	120	300	350–700	25	100
Entry fee (GHC) (paid by new plot-holders)	no	No	20–40	20	50
Landlord fee (GHC/SA)	3	1	7	2	1
Price for chippings (GHC/SA)	120–150	120–140	150–160	90–180	65–90
Daily income for crushing (GHC)	8	6	6	6	5

Notes: 1) Daily income is estimated on the basis of data on the work accord and the average number of hours spent to meet production targets. 2) GHC: 1.465 US$ (September 2009). 3) SA: Single-axle truck.

goods that are in high demand from low- or middle-income buyers and thus ensures an income for the poorer social groups who are involved in such operations. Actually, the artisanal mining of so-called industrial minerals such as aggregates or salt is a brilliant example of the fuzzy boundary between the formal and informal sectors (Guha-Khasnobis and Ostrom, 2006; Hilson and McQuilken, 2014): products produced 'informally' enter the 'formal' economy and satisfy a demand that is recognized by the public authorities, who do not interfere in the interaction between the two 'sectors' of the economy.

This resonates well with the so-called Credibility Thesis (see e.g. Ho, 2014, 2016). The scope and content of the spontaneously ordered 'rules of the game' are endogenous in the sense that they have been developed, tested and accepted over time by the participants, artisanal employers as well as employees (workers). These practices serve to structure and organize the space of production in a particular location, or even in a wider region over which artisanal activities are dispersed. In other words, practices become institutions by becoming established and possibly revised over time as 'A set of rules that endogenously shapes and is shaped by actors' (Ho, 2016, p. 1129). In this understanding, local conceptions of 'how to do' things of a certain nature turn into institutional knowledge that can be disseminated over space and time through people; institutions need not be re-invented over and over again.

These practices are adopted and repeated because the participants involved accept them and value their functional attributes. Institutions are considered credible if they serve a functional purpose over a protracted period of time. By outlining the structure and dynamics of durable and functional institutions, the reasons why formalization efforts have succeeded or failed can be assessed. Viewed in this way, the persistence of 'informality' in artisanal mining indicates why the proposed formal institutions are not adopted – they are simply considered inferior in functionality compared to the informal institutions, which have been thoroughly tested 'on the ground':

> ….*institutions that exist and persist fulfill a function, and are credible; otherwise they would have fallen into disuse or shifted into other types*. (Ho, 2016, p. 1126)

This is not to suggest that the Credibility Thesis is necessarily against formalization. However, what it posits is that it is the forms of institutions that follow their time- and space-determined functions and not vice versa. It is necessary to understand the existing functions of institutions as they have been shaped and have evolved through a multitude of actors' interactions. If one neglects such evolutionary trajectories, any attempt to design and implement new institutions, regardless of the form they take, is bound to be unsuccessful. This is why formalization efforts often fail.

In this regard, it is also important to realize that Credibility Theory does not suggest that a 'fully credible institution' would also be free from conflict. Instead, credibility assumes that distributional conflict is part and parcel of any arrangement of property rights, as already noted in the case of artisanal mining. Thus, the critical issue is this: if informal arrangements persist in artisanal mining, what is their institutional function as this has emerged endogenously through actors' interactions, bargaining and conflicts? To understand this function, Credibility Theory argues that we need

> *an Archaeology of Institutions – in other words, an approach by which the change of institutions is meticulously recorded, interpreted and studied through the collection of data from every possible source, regardless of whether that is socio-economic, historical, ethno-anthropological, geographical, psychological or legal-political.* (Ho, 2016, p. 1126)

The next section outlines the research design and methods of data collection that were used in our study of the consistency and uniformity of organizational practices in five different artisanal quarry sites in Accra. Credibility is born and nurtured by revealed functionality and mutual acceptance by the actors involved, but it cannot easily be identified. Hence, what is needed is an institutional interpretation of enduring practices in the daily work and division of labour.

3. Methodology and data

According to Ho (2014, 2015, 2016), it is not possible to identify credible institutions by simply asking the representatives of the different social groups that are part and parcel of it. Ideally, institutions and institutional change need to be studied over time, for instance, by repeating a study at certain intervals of time over a pre-determined period, preferably tracing the institution back to its initial establishment and examining its development and possible consolidation. If this is not possible for whatever reason – problems of consistent data collection, limited financial capacity or simply pragmatic concerns – the institution can be examined simultaneously at different sites. In this case, each site represents a different stage in the institution's development (Ho, 2016, pp. 1131–1133) and thus displays the specific conditions prevailing at that particular stage of development.

Identifying and mapping 'institutional archaeology' (Ho, 2016), as outlined above, is a challenging task. It requires an intricate knowledge of the socio-economic contexts of the different loci for study in order to align them with the appearance and content of the institution in each particular phase. As a number of 'external' factors may influence both the institutions and the conditions over time, the object of study will differ from what was purposefully anticipated. Scale also needs to be taken into account: is it legitimate to conclude that a credible institution at one scale (e.g. the local level) is credible on another scale (e.g. the regional or national level), that is, how can the external validity of the findings be ensured?

This study deals with these methodological challenges by taking a combined approach to time and space. Our aim is to examine the practices and division of labour in five different sites of artisanal aggregate mining in Accra over a relatively limited period (seven years). Hence, the study does not, in the above methodological sense, seek to replace time with space, but rather examines whether the same institution at almost the same stage of 'development' has identical

contents and appearances in different locations over time. The ambition is to extract commonalities in the organizational practices of the five quarry sites while fleshing out the differences where appropriate. The issue of scale is handled pragmatically, as each site constitutes an individual case study, which, taken with others, strengthens the external validity of our data and findings. The initial purpose of the selection of sites was to include the biggest and most important of the operating quarries, but during the research process it turned out that each of the five sites had experienced a different historical development, which, taken together, indicates the different territorial trajectories of artisanal mining sites (see Section 4 for details).

The analysis is primarily based on data collected in a detailed baseline study implemented in the latter part of 2009. Data were collected through semi-structured interviews with both plot-holders and workers from five selected quarry sites. Key facts about the sites are listed in Table 1.

Neither plot-holders nor workers are registered, so it is not possible to establish a complete list for the random sampling of respondents from either of the two groups. Instead purposive sampling was conducted at each site based on an equal gender ratio, but stratified by representative age groups, different locations in the site (centre, periphery) and type of pit (hillside, a hole in the ground). At each of the five sites, 24 plot-holders and 24 workers were interviewed, totalling 120 plot-holders and 96 workers. Artisanal aggregate mining at one of the sites (Oblogo) was closed down during the data collection period, so in this case only data on plot-holders were obtained. Plot-holders were asked about their backgrounds (ethnic, educational, residential), organization of production (including the hiring and management of workers), types of products and customers. Workers were asked about their backgrounds, experience, tasks and working conditions. Besides serving the purpose of understanding the nature and relationship between the key actors, triangulation of data from the two groups of respondents served to strengthen reliability. Descriptive statistics were used to compare production practices and division of labour at the five sites, but no statistical analysis was carried out due to possible bias in the sampling method.

After the initial baseline study in 2009, data on possible changes in the organizational development of and practices in the quarry sites were collected during follow-up studies in 2012, 2013, 2014 and 2016. During this period, each of the five sites was visited in one or two days, and a handful of randomly selected respondents among workers and plot-holders were probed about the same issues as those raised in the baseline study in order to identify any new organizational practices. The visits also included visual observation of work practices and interviews with key informants (caretakers, foremen) and local authorities, such as representatives of district assembly administrations. Other data sources included various digital maps and Google Maps (web-based), the latter being used to identify the location of the former and emerging sites for artisanal aggregate production. The following section briefly outlines the context of the study, that is, the location and history of the artisanal mining sites.

4. Research location: artisanal mining sites in Accra

The particular geology of the Accra metropolitan area sets the conditions for the location and spread of artisanal aggregate sites. The sites examined in this study are located at blows of the Voltaic Togo Series, a band of sedimentary rock (quartzite) that stretches in a north-easterly direction from the coastal area about twenty kilometres west of the urban centre and gradually turns eastwards along the Akwapim Range (Fig. 1).

Roughly, this corresponds to the fringe of the present-day Accra metropolitan area. Former and recent sites for the artisanal mining of aggregates are distinguishable, and different types were included in the study. This section presents the five sites and groups them into three categories (underlined names refer to the actual study sites).

1) *Sites abandoned and used as landfills*

A number of sites have been abandoned and are now used as landfills for household waste. These sites are located on the plateau east of Weija village in the area near Lake Weija, one of the most important water reservoirs for Accra. These sites were among the first to be used for aggregate production, partly because historically the area has been exploited for gravel and quartzite aggregates to feed the initial construction of local primary and secondary roads, as well as the main coast road leading westwards to Cape Coast and the Ivorian border.

At Oblogo (Janman-Sarbah), a quarry further north on the escarpment, plot-holders were told to leave the site in 2009 so that Zoomlion, a Ghanaian waste-management company with undisclosed connections with a well-known Chinese company of the same name, could start preparations for the landfilling operation, including improving the access road. In early 2010 the site was turned into a new landfill after a prolonged dispute over rights of ownership between the leaders of the villages of Gbawe and Weija. However, the capacity of this site had already reached its limits by 2012 when the waste dump was closed; it has now been completely covered with soil and fenced in, and landscape recovery has started.

2) *Sites undergoing transformation into residential areas*

Most of the artisanal mining sites are in the process of being transformed into new residential areas. When this happens, the majority of the artisanal miners are evicted by the landowner, although some operations are allowed to continue in designated areas where housing plots are to be sold in a later phase of the development. Some of the sites undergoing this process of transformation are found in the hilly area just west of the Densu Delta Protected Area, which divides Accra metropolitan area from the new residential area spreading out around Kasoa.

New Botianor dominates the northern part of the hilly area, while older sites (Old Botianor and Aplaku) in the southern part are located on two opposite slopes of a valley; activities at both of the older sites have more or less stopped, as most of the area is now used for housing. New Botianor was closed in 2011 because the owners, a pension fund for public servants (the Social Security and National Insurance Trust or SSNIT), wanted to develop a long-planned estate project. The police evicted the miners and occasionally patrol the area. Bulldozers have levelled some parts of the land, and roads have been established within the area planned for housing. Nevertheless, illicit quarrying activities continued for some time, mostly during the night. In 2016, a relatively small group was working during the day in more remote parts of the site, based on a temporary agreement that could be ended any time at the owner's discretion.

Other sites that are experiencing the same process of transformation are located northeast of the sites mentioned above. Ofankor is a quite concentrated area just east of the main road leading towards Nsawam. The hilly landscape has been extensively mined since the early 1990s, and the resulting 'hole' is wide and deep compared to the original surface, resulting in a fairly steep and winding access road. This was probably one of the biggest sites in terms of the number of active miners and the volume of aggregates being mined. The southernmost part of the site, previously known as 'John Teye', was the first area to be closed to miners, and recently the western parts near the main road were closed because the landowners, a Lutheran church group, wanted to sell surplus land as housing plots while maintaining the top area for their own buildings. A substantial number of miners have since left, but activities are still continuing in the central part of the site, and the miners have also obtained permission to work on the eastern part, which is controlled by another landowner.

Kwabenya, further northeast, is probably the most territorially extended site, stretching over a number of hilltops that surround a valley near Kwabenya village, now a dense suburban area. An equally large area east of the present site was previously used as a quarry site, but the slopes have now been taken over by residential houses and roads. The Kwabenya area was planned to become the location for a huge waste

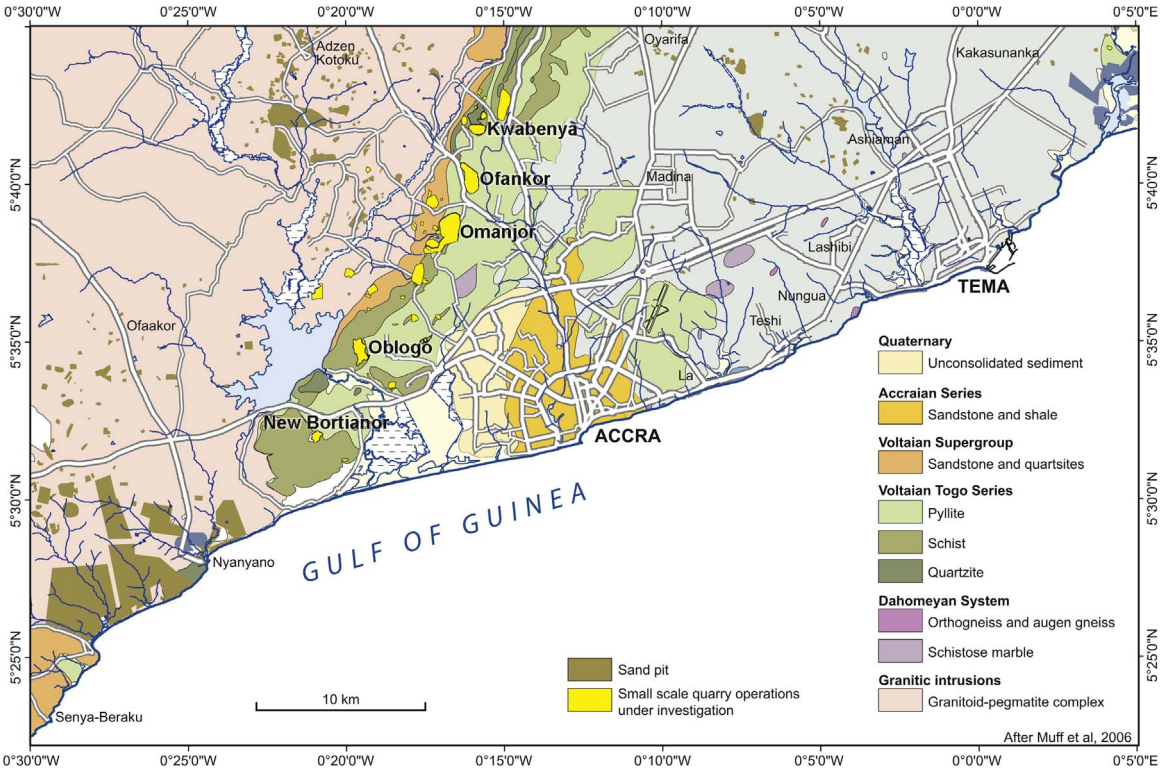

Fig. 1. Geology of Accra and the five artisanal aggregate sites.

dump financially supported by the World Bank. However, it never materialized due to a well-organized local community that vigorously fought the plans to establish a waste dump in what was already a heavily settled area (for details, see Oteng-Ababio, 2011). The physical structure is quite different from that at Ofankor: until recently miners were spread out over an extensive area, and many of the operations were quite remotely located, particularly in the southern and western parts, while there still are a number of concentrated sites of activity in the northern part. In 2011, the miners in the southern and western parts were told to leave, as the landowners wanted to develop the land into a residential zone. After some dispute, the miners withdrew, though some were allowed to continue their activities on an unexploited slope in the eastern part. However, the miners face a major problem in having to remove the topsoil from the steep hillside.

3) *Sites under 'formal' management*

Omanjor is a 'formal' site that has a registered license from the Ministry of Mines, which makes it a relatively unique case, although all its production is of the same informal nature as in the other quarry sites. For instance, workers are not formally employed, and production is organized in similar ways. This site is located on a couple of hilltops on the same north-eastern line between New Botianor and Kwabenya, just beside the road that 'shortcuts' the Nsawam road with the Kwame Nkrumah motorway. In a sense this is an example of a site at an earlier phase than the previously mentioned sites, but most of it was actually closed to miners several years ago, when the land was turned into a residential area. However, the site is managed differently from the others, as it is controlled by a local family, together with some of their business partners. All the plot-holders have to pay a fee to the owners by collecting a formal receipt for weigh-bill payments for each outgoing load of aggregates. A caretaker records each truck that leaves the site and collects the money on behalf of the owners.

Summing up, the artisanal mining of aggregates takes place under highly unstable conditions with no formal regulation of its activities. The miners sometimes encroach on a site without the permission of the landowners, but in other cases they operate with the consent of the owners subject to certain conditions. Despite the inherently unstable nature of artisanal aggregate mining due to the changing land-use preferences of the owners, relative operational stability is obtained over prolonged periods of several years. During these periods, up to several hundred miners – or even thousands in the biggest quarries – work side by side, seemingly without any serious or violent conflicts among them. This is not to suggest the existence of a fully harmonious state of affairs, but it does indicate that informal activities have matured into practices and regular ways of 'doing things' that are broadly accepted by the actors involved. In other words, functional institutions have been consolidated from below – no public authority has been involved in setting up rules of the game. The next section describes in detail the organization of activities at the five quarry sites and the differences between them.

5. Results: production, market and division of labour in the artisanal mining of aggregates

In this section, we provide a detailed description of the organizational practices of artisanal mining on these sites. The purpose is to demonstrate the endogenous nature, main features and complexity of the prevailing institutional structure. This will be done by reviewing i) the production process, ii) the market and iii) the division of labour between plot-holders and workers.

5.1. The production process

Based on field observations, the basic processes of artisanal aggregate mining can be divided into the following successive steps. First, the topsoil or overburden has to be removed from an area with exploitable rocks. This is mostly carried out at an early phase by road construction companies using heavy machinery; after the gravel has been removed, the site is left open for aggregate production. Second, depending on the hardness of the specific site, holes for dynamite have to be drilled in the rock that is selected for aggregate production so blasting can take place. Third, the rock has to be broken free of the ground as boulders and carried to crushing sites. Fourth, the boulders

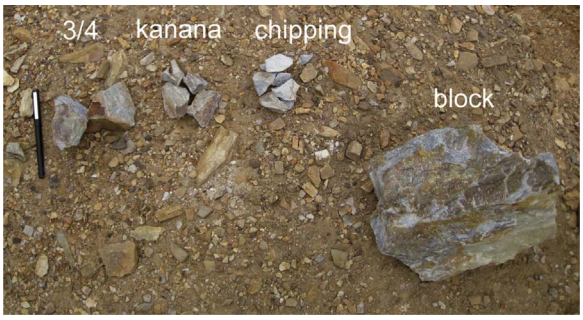

Fig. 2. The products from artisanal mining of aggregates.

are crushed into finer pieces and sorted into different sizes (see below). Fifth, the aggregate product is loaded into head-pans, carried to a truck and transported to the customer. Apart from the drilling equipment, which is usually operated by specialized blasting teams, the tools used in aggregate production are simple: iron crowbars to break off the chunks of rock, hammers and chisels to transform the chunks into different end-products and steel pans, or occasionally wheelbarrows, to transport the finished products.

The production process results in five different stone product types (Fig. 2), although they are not always available at the same site. The types used for concrete for proper construction purposes come in three different sizes. The largest is the 'three-quarter' ('3/4'), used for floors, followed by the 'kanana' (about half the size) and the 'chipping' (the smallest size), the latter two normally being used for wall construction. As a general rule, the price per unit weight is higher for the smaller types due the greater amount of labour (crushing) that needs to go into the product. However, probably due to different local 'standards', there are differences from site to site as to how the products are categorized. For example, a kanana at one site would be defined as a chipping at another site, and so on. Thus, in relative terms all the sites have price margins that correspond to the relative size of the aggregate piece, but there are differences in both size and price across the metropolitan area. From a customer's point of view, these price differentials have to be compared with transportation costs in order to decide the site for the optimal purchase. A relatively rare type is the 'flat', a quite large and flat piece mostly used for decorative purposes on the lower part of a house façade, as garden structures or on walls fencing off the plot from streets and neighbours. Another rather specialized product type is the 'block', a lumpy piece of rock that is used in the construction of sanitary installations.

Even though the rock type is basically the same at all the sites, qualities such as hardness and flakiness differ between them, thereby causing some specialization and differences in quality. To some extent, however, this difference is modified by the skills and strategies of individual operators, who may want to exploit 'niches' in the local market. Product portfolios vary not only between sites but also within them, as some sites are characterized by a greater degree of diversity than others.

5.2. The market

Production closely follows demand (insignificant volumes are produced for stock) and is highly seasonal: from October to February demand is higher and production therefore greater, while demand significantly slows down in June to August. This seasonality is closely related to fluctuations in construction activities, as it is easier to work on construction sites in the dry season. In the rainy season from April to July, construction of houses slows down and the demand for aggregates decreases, while the opposite happens in the dry season from November to March. Furthermore, many of the prospective house-owners belong to the diaspora in the US or the EU. They return to Ghana at Christmas and want to oversee the purchase of building materials personally in order to avoid being cheated and to ensure that their money is being spent efficiently. Production roughly halves in the low (rainy) season. This is a remarkably consistent picture in all the sites, even though the absolute level of production (volume measured as single-axle trucks per week) differs significantly between the sites due to variations in the scale of production and the efficiency and quality of the rock.

Customers include a mixed group of private individual builders, developers, contractors and wholesalers, but individual customers are the most important group. These individual customers mostly deal directly with the plot-holder, agree on price and volume, and organize a truck to transport the aggregates to the building site. Developers and contractors are also important, although purchases are limited somewhat by the lack of sufficient volumes of consistent quality. Hence, contractors who buy artisanal products are not big companies involved in large-scale housing schemes, but rather smaller companies hired by private clients to carry out the whole or parts of the construction of a single house. Wholesalers are very rare customers, as this kind of business is virtually non-existent. Hence, the structure of supply and demand for these kinds of building materials leaves a market niche for the artisanal mining of aggregates, an activity that fulfils an important function.

The destination of products, that is, the geographical range of the market, falls mostly within the administrative districts of the quarry. The importance of the 'local area' depends on the scope of construction activity in the immediate vicinity of the site. For example, in Ofankor, the plot-holders consider the local area to be more important than in the other sites because it is located near to one of the rapidly booming parts of the metropolitan area (Amasaman). The location of customers is reflected in the pattern of transportation: trucks mainly only operate locally. Customers prefer to use trucks parked overnight at the particular quarry site or at truck stations nearby so that the transportation costs are minimized; quality concerns and personal relations with truck owners and drivers are less important than price. Also, transactions with plot-holders are easier for local truck owners and drivers, as the parties know each other from previous deals.

5.3. Division of labour: plot-holders

Each quarry site is run by numerous independent plot-holders, who lease the right to mine the aggregates at a certain location (plot) from the landowners. In some places, plot-holders have to make an initial down payment to those who own or control the land in order to obtain a plot and the permission to produce aggregates. The payment varies and has increased over recent years due to the scarcity of available plots in the best known and most attractive sites. In addition, plot-holders pay a fee to the landowner as compensation for exploiting the resource, usually an amount per single-axle truck of aggregates that is sold (see Table 1). The fee varies quite substantially between the sites, though not within each site. The lowest fee (in 2009) was paid in Ofankor (which is family-owned) and in New Botianor (owned by the SSNIT pension fund). However, the fee in New Botianor is not paid to SSNIT but sometimes to a family or a local chief who claims to be the real owner of the land, although he is constantly challenged by another stool (i.e. chief) over ownership. The highest fee is paid in Omanjor, the most 'formal' site. This payment includes a waybill that trucks are obliged to pay for transporting aggregates on roads in Ghana. The waybill is issued by the Department of Mines and is paid initially by the caretaker (acting on behalf of the family who owns the land), who signs and hands over the waybill to the truck driver once the plot-holder has paid the fee.

The plots are located near access roads, in more distant places in the interior or on the margins of the site, from which it is necessary to transport the aggregates to a loading place at the roadside. Each quarry has a standard ('official') plot size, but plots actually vary widely within each site. The average plot size is lowest in Ofankor and New Botianor, partly reflecting the availability of quality rock for the production of aggregates, but also indicating the different levels of competition for

plots. In a few cases plot-holders have purchased (or leased for a fee) the user rights from others, while some simply acquired more plots through subsequent allocations from the landowners. Some of these plot-holders were able to organize production and marketing with a view to economies of scale through an extended division of labour and high volume sales to construction companies; this was particularly the case in Omanjor.

Almost all plot-holders work on their plots and manage production and sales on a full time basis, but some also work part-time. For instance, some of the plot-holders increase their incomes and secure financing to continue their own aggregate production by taking up temporary positions as workers with other plot-holders. Part-time work is relatively low in Ofankor but far higher in New Botianor: at the former site plots are highly attractive and may be re-allocated to those who are willing to work them more efficiently, while less commitment is evident in New Botianor, where access to the city centre and alternative income-generating activities are much easier to come by.

Male plot-holders are involved in all the tasks (breaking, crushing, loading and transporting), while female plot-holders mostly do the breaking and crushing jobs; only a few women also do loading and transporting, though this pattern too differs between sites (Table 2).

However, it is specialized teams that usually carry out drilling and blasting, although some plot-holders also do drilling if specialized equipment is not needed. In sites and locations within them where the rock is more fragile, it may not be necessary to carry out blasting, but if the rock is solid and lacks weathering cleavages this cannot be avoided. In Ofankor and Omanjor, drilling and blasting are widely used – for instance, about two thirds of the plot-holders in Ofankor rely on drilling and blasting – whereas in New Botianor, Kwabenya and Oblogo only a handful paid for drilling and blasting. The depth of the hole depends on the rock structure and existing alignments. A manually drilled hole is usually paid at a fixed price and is not deeper than twelve hands (about three feet). For deeper holes, mechanical equipment is necessary, and the costs are far higher. Blasting is usually carried out at a fixed time, mostly by the end of the working day.

5.4. Division of labour: workers

A common reason for starting out as a worker is an unsatisfactory or unsustainable situation in one's former occupation, like a low salary, few customers, a need to supplement household income or the closure of a former workplace. In that sense, the main reason can be seen as a push process whereby individuals engage in aggregate mining due to hardships in their former situations, including personal tragedies or household break-ups.

Actually, it is a common practice for plot-holders to hire workers throughout the year, although the scope varies from site to site, and some plot-holders mostly work alone or rely on unpaid family members, including children. Hiring of workers is widespread in Omanjor and Ofankor, where practically all plot-holders did so, but less common in Kwabenya and more sporadic in New Botianor, with fewer plot-holders hiring workers and doing so in smaller numbers than at the other sites. These variations between sites occur in both in the high (dry) and low (rainy) seasons; in the latter case, the number of hired workers is substantially reduced (see Section 6). In general, more women than men are hired in the peak season, but more women are also laid off in the low season, hence acting as a labour buffer to some extent.

Plot-holders prefer to hire workers of about thirty to forty years of age and generally do not hire above this age. Only a handful of the 120 plot-holders admitted that they (rarely) employed children – almost everybody claimed to abstain completely from hiring children (here defined as below ten years).[1] The most important quality parameter for workers is experience of similar work in other quarries and not physical strength. However, somewhat surprisingly, fewer than twenty percent have experience of previous work in aggregate production, and very few have worked in two sites or more before starting at the present one. This is a different pattern than that which characterizes the artisanal mining of precious minerals such as gold. Here workers often pursue individual 'careers' by moving from site to site, building up experience and skills with the aim of increasing income by taking on responsibility as plot-holders (see, for instance, J & nsson and Bryceson (2009) for Tanzania). In contrast, aggregate mining is carried out by people living permanently in the vicinity of the quarry, and workers do not move far away, as remuneration and prospective profits are low.

Most workers are not hired by the same plot-holder every day, although about a third of workers reported stable employment with one plot-holder in Ofankor and Omanjor, possibly because of the more 'workplace-like' organization of these two sites. Particularly in Ofankor, but also in Omanjor and Oblogo, plot-holders hire workers from labour groups operating at the site; only a very few rely on personal relations. A more mixed picture is found in Kwabenya and New Botianor, where hiring acquaintances is more common and labour groups are of far less importance. Interestingly, family-based relations are not very significant at any of these sites; only a few plot-holders at each site select workers from within the family, mostly in Omanjor. Usually the workers simply stroll around the site and ask the plot-holders for work.

Practices related to the duration of the 'employment' vary considerably, both internally and between the sites. In Ofankor and Oblogo, nearly all plot-holders hire workers on a daily basis. In Kwabenya the pattern is less clear, but most plot-holders hire workers in 'shifts', that is, for as long as they have the cash to pay them and expect to receive orders in the future. In New Botianor and Omanjor the picture is pretty mixed, but there is a greater propensity for plot-holders to hire workers for longer periods.

Some workers do only part-time working for reasons of convenience or because they are not able to get work for the whole day. The majority of workers actually find it difficult to get assignments over prolonged periods of time, although a third of them claimed that it is easy. A common reason for the difficulty is the lack of workable rocks due to stoppages in blasting or loosening on previous days. This is caused by a general lack of 'working capital' among the plot-holders, so only a very few are hired for continuous periods, let alone as permanent workers; plot-holders tend to rely on their own labour during these periods. The lack of continuity in employment conditions is also caused by short-term fluctuations in demand. In New Botianor, workers observed that there were too many workers looking for assignments. In Omanjor, however, most workers claim that it is easy to find work, corresponding closely to the statements of plot-holders at this site that adequate labour supply is a major concern.

Table 2
Gender division of labour among plot-holders.

	Kwabenya E		Ofankor		Omanjor		Oblogo		New Bortionor	
	M	F	M	F	M	F	M	F	M	F
Breaking	11	7	12	5	12	3	13	5	14	10
Transport	0	0	11	5	4	4	13	1	2	2
Crushing	12	12	13	11	11	12	14	9	13	11
Loading	5	0	10	0	2	0	8	0	6	0
Drilling	0	0	0	0	1	0	0	0	0	0
Part-time	6	3	2	1	5	1	3	3	7	4
Work in other plots	8	6	5	2	5	7	7	9	4	4
Total	12	12	13	11	12	12	14	10	15	10

Note: 1) Tasks do not add up to the total number of respondents; plot-holders were asked to list their main tasks.

[1] This study did not address child labour issues, and it is not possible to verify the statements of plot-holders. However, there are strong indications of the widespread use of child labour in artisanal quarries in Ghana. See ILO (2013), Thorsen (2012), and Lund et al. (2008).

There is also a gendered division of labour among workers. Female workers are predominantly engaged in crushing, although some also transport bulky rocks from the plot to the crushing site and aggregate products from there to a sales hub for finished products. Very few women are involved in breaking: men, who also carry out other tasks such as drilling and crushing, carry this out. There seems to be no further specialization since workers are involved in several tasks, simply carrying out what is necessary to finish production of the particular batch.

However, few male workers load the final products into trucks in addition to doing the other tasks. Instead specialized teams of six to seven young men will do the loading for a single-axle truck, while nine to ten will load a double-axle truck. The loaders wait at the entrance(s) to the site, where they offer their services to arriving trucks. One worker stands in the truck bucket and spreads out the products, another fills the head pans with a shovel, and the rest of the team carry the pans from hive to truck. The person packaging the truck earns more than the loaders; he may act as a middleman and charge the plot-holder for arranging the contact with the truck driver, while also being a kind of boss for the gang of loaders. The loading teams are hired by the truck-drivers but paid by the plot-holders, who also organize the loading while the driver is resting.

6. Consolidation of endogenous institutions, and exogenous threats to their endurance

Having described the organizational practices and details of the division of labour in the five artisanal quarry sites, this section elaborates on the function, endogeneity and credibility of the institution. We show that, despite the labile conditions, the informal activities in the quarry sites have been going on over a prolonged period of time as an important element in the process of urban growth. We argue that, during this period, endogenous rules for participation in these activities have been established. This is indicative of the functional roles of artisanal mining, while also providing evidence of a consolidated yet flexible endogenous institution − in essence supporting the Credibility Thesis (explained in Section 2). We end the section by revealing some recent findings concerning the future erosion of the functionality of the institution through the entry of new actors, namely Chinese quarry companies offering higher quality products at competitive prices.

The rapid, comprehensive and unplanned growth of metropolitan Accra has resulted in immense infrastructural and social problems. Devastating housing conditions and slum areas in both old inner-city areas and new peri-urban areas are discernible indications of this process. A contrasting aspect of the process is the development of huge private houses in prospective high- or higher middle-income areas. Here buildings may be in very different stages of completion, but the sheer size and architecture of structures and houses indicate the owner's financial capacity, even though most of the surrounding physical and functional infrastructure may be in a rather sad state. Somewhat peculiar mixes of 'monster houses', more modest self-contained houses and contractor projects consisting of uniform houses are found in other parts of the city. A common feature of these new areas is the gradual expansion over time of both buildings and space: buildings and structures are initially placed in a seemingly random pattern, with empty sites in between, and constructed in uncoordinated phases according to fluctuations in the owner's financial capacity or personal concerns.

This cyclical nature of both the completion of houses and the broader spatial expansion of the built environment due to the financial situations of individuals and national economies translates into a highly fluctuating demand for building materials. Moreover, price and flexibility rather than quality are of the essence for customers as long as the basic quality requirements for aggregate properties (hardness, flakiness, size) are fulfilled by suppliers. This market opportunity is exploited by Accra's artisanal miners, who can adapt their production to the fluctuating market, individual preferences and the limited volumes of transactions. The large-scale quarrying companies, which are primarily located in the Shai Hill area east of the capital, produce high-quality granitic aggregates and are not interested in this segment of the market for building materials. Their products are more highly priced, and they target high-volume transactions with road-construction companies and housing-estate developers, rather than sales of small volumes to unstable customers.

Hence, the artisanal quarry sites have an important functional role, having responded to the demand for aggregates from individual house-owners for more than three decades starting in the 1980s. The oldest site, at Oblogo, was established in the 1980s, as were a number of other sites in this area, like Mallam and McCarthy Hill, which have been used as waste dumps for more than a decade; they are located on the escarpment bordering the Weija delta plains towards the east. Household waste has been dumped virtually up to the edge, and garbage is still exposed and visible. The dumping of waste started after the building of the adjacent residential areas, although the residents have complained to the local authorities and media about obnoxious smells and other inconveniences (Oteng-Ababio, 2011). In another site nearby – Anyaa, near the so-called Fanmilk Junction – artisanal mining activities have by and large ceased, and parts of the site have been used for dumping waste.

In contrast to these abandoned sites and the sites that are gradually being transformed into residential areas, like those examined in this study, artisanal operations have been started up in new sites located closer to the zones of rapid urban growth in the west and north of the metropolitan area. These sites are 'discovered' by miners after road-construction companies (now often Chinese companies) have removed the topsoil so that the quartzite below is accessible without using heavy machinery. The new sites are found in relatively remote areas 'beyond' the urban fringe, where residential housing is more sporadic and land use is dominated by agriculture. There seems to be a marked geographical shift in artisanal aggregate activities towards the northeast of the Accra metropolitan area, as there are very few accessible, new quartzite deposits found northwest of the hilly ridge mentioned above. There are exceptions in the western area, however, for instance, a site called Hebron (or Darkokrom) north of the Akwapim Range a couple of kilometres away from the Nsawam road. But this is a lonely exception: the boom areas for new artisanal quarries are located towards Dodowa town in the east. Deposits are now gradually being developed and exploited as far away as the foothills of the eastern slope of the Akwapim Range.

Despite the unstable formal regulatory conditions and the resulting spatial 'fluidity' of artisanal quarrying, the organization of work has turned into a set of discernible practices, rules and 'ways of doing things' both over time and across space. These differ somewhat in content from site to site, as they may be adapted to particular features at the site of operation or fixed due to the preferences of the owner or his caretaker. They also regulate artisanal activities in terms of entry, operations and sales.[2]

In some cases the prospective plot-holder has to agree to pay an entry fee. Even though the costs incurred are relatively low, they may be prohibitive for many, who then have the option of entering as workers. However, 'running costs' in the form of a fee paid to the landowner for the use right to exploit the resource is common at all five sites. The fees are paid for each single-axle truckload of products sold and are relatively low compared to the average price of the products, even though they add to the plot-holder's costs of production. The substantial differences in total plot size allow more entrepreneurial individuals to scale up production by acquiring more plots and hiring more workers, thus ensuring a higher level of aggregate production and fee income for the landowner. The low fee may indicate that some

[2] See Table 1 (Section 3) for data referred to in this section.

landowners actually consider artisanal mining activities to be a very cheap way to level a hilly surface, that is, the initial phase of land preparation for future building purposes.

The distinction between being an employer and an employee is not cast in stone: many of the plot-holders are hired by other plot-holders for shorter periods. The hybrid status of the plot-holders is indicative of the highly flexible labour market that is able at short notice to scale up or downsize production by both the plot-holders themselves (according to the distribution of orders) and at the site level by hiring workers. The latter are mostly hired on a daily basis and according to 'anonymous' labour market dynamics, where individual labour is supplied to those who demand it and are willing to pay. Our data and estimates indicate an almost similar level of daily income for workers across the sites, and there are no indications of gender inequality in terms of payments for the same task. There is, however, a marked difference in the tasks that men and women carry out, as it is mainly men who do the heavier tasks. Also, certain tasks are carried out by specialized 'teams' with their own organization (drillers, loaders) independently of the plot-holders.

Transactions between plot-holders and customers follow fairly similar patterns in the five sites, although prices vary considerably both over the year and between sites, and possibly also within sites due to the respective bargaining positions of the actual buyer and seller. The data on sales prices may be considered somewhat unreliable, as plot-holders were hesitant to specify their prices and stated that each deal was unique. At all events, there seems to be a relatively transparent 'market' for artisanal aggregates in the Accra metropolitan area, taking into account the differences in product quality and transport costs.

Summing up, practices in artisanal mining have been endogenously established and developed to create a stable, albeit dynamically adaptable institutional environment for these informal activities. No public or formal private institution has been involved in the design and implementation of the regulatory structures; these have being consolidated over time and space by those who participate in these activities. Dissemination of institutional knowledge from older quarry sites to newer ones has most likely been embedded in individuals who have moved to the latter to start up operations. In essence, credible institutional arrangements for the regulation of artisanal quarrying activities have been consolidated, while also being sufficiently flexible to be adapted to different local conditions in terms of land ownership, resource quality, skill levels among participants and remoteness. Our study did not reveal any serious conflicts among the plot-holders or workers within the quarry sites, and to our knowledge none have been reported by other sources. This is not the same as claiming a complete harmonious state of affairs in the quarries, but quarrels between parties are apparently solved before developing into serious conflicts. Obviously, there are conflicts with landowners and/or public authorities, but these come from 'outside' and do not originate in the internal institutions that regulate the artisanal mining itself.

Knowledge may also have been acquired by landowners or caretakers who simply emulated what was happening in other places and opened up land sites for artisanal quarries or turned a 'blind eye' to what was happening on the ground. Actually, as Hilson and Maconachie (2017) have recently argued, one important reason why artisanal quarrying activities are tolerated for such extended periods of time could be the many vested interests that benefit from its informal structures. Whether or not there is some kind of elite control of the artisanal sector by politicians or regulators cannot be decided on the basis of our data, but one indication that there might be is that, although aggregate sites are closed down for one reason or another, they continue to re-appear in new locations.

However, recently a more profound external threat to the institutional stability of artisanal aggregate mining in the Accra area has entered the scene, namely the entry of formally registered Chinese quarrying companies that have started operations even further outside the metropolitan area. These companies are located in areas with access to granite deposits similar to those being exploited by the long-time established quarries in the Shai Hill area. Some have actually started businesses in the Shai Hill area by taking over licensed quarries or reviving abandoned ones. Others have moved to the area between Kasoa and Winneba (on the coast road towards the Ivorian border) or the area around the city of Nsawam (on the road towards Kumasi). The Chinese companies deploy cheap and low-quality equipment and are not able to produce the same diverse portfolio of products as their more established competitors. However, their crushed products are indisputably of better quality that those produced by the artisanal miners due to the much harder nature of granite compared to quarzitic sediments. Moreover, the Chinese prices are competitive, and transport costs are less because double-axle trucks are used and the access roads are of good quality. This new exogenous factor, which is de-stabilizing artisanal aggregate mining in the Accra area, is clearly felt by the artisanal miners: at all five sites complaints were voiced about this new competition, which has already eroded artisanal mining operations and is severely threatening their continued existence.

7. Conclusion

It is necessary to understand the nature and durability of the local institutions that regulate 'informal' activities and their possible variation between different sites. If the institution demonstrates a relatively stable configuration over time and space, it is credible: it constitutes a regulatory framework that is perceived as functional and is acceptable to both the participants involved and society in general, albeit not necessarily expressing an egalitarian or socially harmonious compromise between them. The complex organization of the production process and marketing of aggregate products described in the empirical cases in this paper clearly support the Credibility Thesis, although the evolutionary aspect is not fully covered by the period of study (only seven years), despite the proxy approach adopted by incorporating quarry sites at different 'phases' of their development.

Besides endogenously regulating the artisanal mining of aggregates, institutional functionality has two other dimensions. On the one hand, it fills an employment gap for lower-income social groups that have only modest chances of finding alternative sources of income. On the other hand, it provides cheap products that fit the prevailing ('formal') demand patterns for building materials, which fluctuate according to individual resources and macro-economic business cycles. In this sense, artisanal mining has endogenously evolved and adapted to its own environment. Formalization efforts that do not take this endogenously grown fabric into account are therefore likely to fail.

Ideally the institutional 'lessons learned' from cases like those examined in this study will be incorporated into the design of support policies targeting the informal artisanal sector and aiming to exploit its economic and social impacts on the poorer strata of the population. Important components could, for instance, include low financial barriers to entry, the possibility for modular acquisition and the cession of small plots over a given period, flexibility in plot-holder and worker functions, and low fees for resource exploitation to legitimate landowners, including the state and local authorities. Variations and similarities in existing practices need to be carefully examined and reflected in support policies so that they can accommodate a flexible approach. If credible institutions are not used as a point of departure, it will be impossible to ensure that production is taking place in accordance with environmental regulations or that basic workers' rights in terms of, for example, health, safety measures, working time or child labour are being observed. However, even under ideal conditions, with support policies being adapted to credible institutions, economic realities may be encountered that are hard or impossible to handle. As in the present case, the entry of highly efficient competitors using a different technology and organizational practices is challenging the functionality of the material base of the credible institution. Thus, support policies are not sufficient in themselves but need to be included in strategic considerations regarding development in a broader perspective, such as the

modalities of metropolitan expansion.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.landusepol.2017.06.022.

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