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The Implication Of Quarry Exploitation On Socio-Economic Infrastructure Provision In The West Region Of Cameroon

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Abstract: ***This article reviews the question of the exploitation of mineral resources such as granite, sand, basalts, laterites and volcanic ash etc. in the quarries of the West Region of Cameroon. It sheds light on the quarrying process: from the regulatory and institutional framework to the techniques of extracting subsoil materials. To attain the above objective, the study made used of primary and secondary data. Secondary data was collected through the internet and libraries of the Department of Geography of the University of Yaounde 1, the National Institute of Cartography, the Regional Delegation of Mines, Industry and Technological Development of the West Region and the French Institute of Research. Primary was obtained through direct observation; interviews focus group discussions and with the use of a GPS for waypoints of quarries and the use of the topographic map of the West Region. It appears that the exploitation of quarries is a process that presents different modes taking into account the topography. Each mode of exploitation (artisanal or industrial) corresponds to an appropriate device, with different techniques adapted to the nature of the resource. Indeed, their openings and their exploitation in numbers and in large quantities is important in the construction of sports infrastructures, housing and in civil engineering works in Bafoussam, Bandjoun, Foumban Batie, Dschang and others towns including private residences. The biophysical environment in relation to development, urbanization and socio-economic changes is a corollary of quarry exploitation. For nearly three decades, the rise of urbanization combined with population growth has led all of crystalline West Region of Cameroon to the digging of sand and gravel pits for building and road construction.***

I. BACKGROUND AND STUDT AREA

Mining is any operation whose activities consist in extracting and concentrating mineral substances using manual methods and processes that are not very mechanized, as is the case in quarries of the West Region of Cameroon. Industrial mining, on the other hand, is one whose mining processes are modern and mechanized. There are many articles in the written literature on sandpits, such as those by Goubier and Well (1994) sandpits and the environment south of the Mancelle agglomeration. The West Region of Cameroon has known for more than 30 years a vertiginous evolution of the exploitation of quarries. This is linked to its urbanization which is characterized by the modernization of housing, construction of administrative structures. The new administrative measures which have splited a division of 1160km² into 3 divisions play their full weight in the multiplication of quarries. The quality of the exploited material is added to these factors to increase the spatial scope of the exploitation activity. This aspect is flattering insofar as these quarries contribute to the supply of material for the construction of infrastructures, buildings, housing, and sports equipment. In 2017, the quarries in the region enabled the construction of roads (217 km) in the project to open up agricultural production basins in the Western region.

Mining is an activity that has many environmental and social impacts. It can therefore present many risks if it is not regulated. In Cameroon, it is governed by Law No. 2016/17 of December 14, 2016 on the mining code. It governs the recognition, research, exploitation, possession, transport, transformation and marketing of mineral substances.

Quarry operators must, before investing in the field, have an environmental compliance certificate, which certifies that the interested parties have carried out an environmental impact

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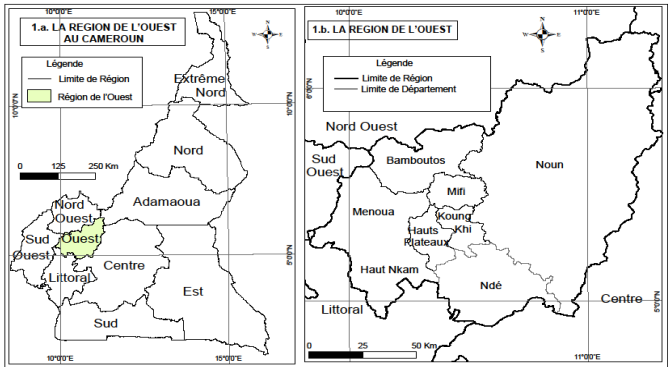
study beforehand, together with methods for restoring the sites after extraction. For those who already exploit the said resources, they are required to carry out environmental audits to present the state of their activities. This is not always the case. This is clearly the thorny problem of the illegal exploitation of these resources.

A. LOCATION OF THE WEST REGION

The West Region of Cameroon is located between the 5th and 7th degree of North latitude and between the 8th and 12th degree of East longitude. It is bordered to the North by the North-West Region, to the South by the Littoral, to the West by the South-West and to the East by the Center Region. Figure 1 is the location map of the West Region.



Source: National Institute of Cartography, 2009

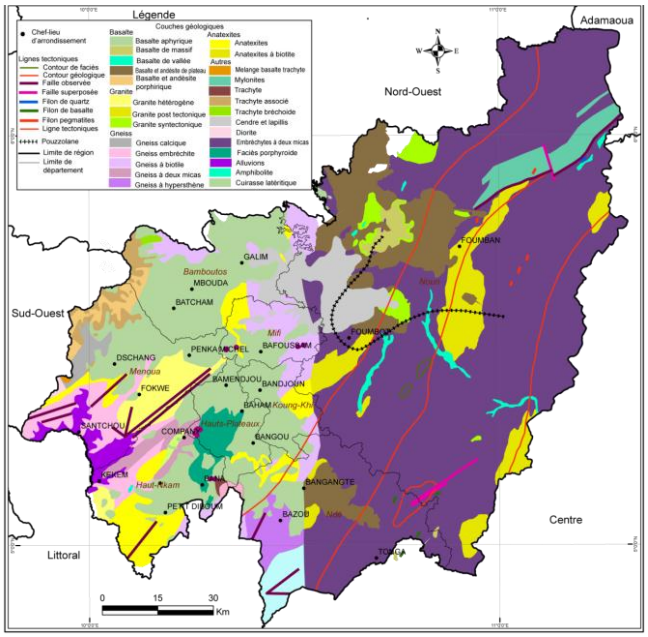
Figure 1: The location of the West Region in Cameroon

II. MATERIAL AND METHODOLOGY

To carry out this work, we effected field visits after consulting the documents on the issue. Surveys of quarry workers and owners as well as administrative and traditional authorities, then support staff from the Regional Delegation of Mines, Industry and Technological Development for the West Region. We surveyed the land to obtain the geographic coordinates of the various operating sites using GPS. The shots were taken in the quarries using the digital camera. We completed the information by interpreting aerial photographs of the study area. We also relied on the topographic map of Bafoussam at 1/50000 to highlight the nature and diversity of the materials exploited in the quarries of the highlands of the West Region of Cameroon.

III. RESULTS

The West Region is full of significant mining potentials distributed in eight Divisions. To better understand the extent of the phenomenon of environmental degradation following the extraction of mining resources, the geological map of the Region gives more exposure to the activity and makes it possible to observe the actual presence of the resources exploited. See Figure 2.



Source: National Institute of Cartography, 2009

Figure 2: The Geological map of the West Region of Cameroon

The map evidences basaltic rocks, granitic and sand deposits amongst others as seen on the key.

A. MINING IN THE STUDY AREA

In the West region, there are two types of mining, namely artisanal mining and industrial mining.

a. INDUSTRIAL MINING

Depending on the materials used in the work or the degree of mechanization, the staff employed and the quantities of materials produced defines the industrial mining activities. We have three industrial quarries in the region, namely: the quarry of the KETCH Company located in Lafé in the Baleng Sub-division; the Ezer construction quarry in Foumban in the Noun Division and finally the RAZEL quarry located in Foréké-Dschang.

Extraction And Loading Equipment

These comprise the following: Site stripping and preparation equipment (bulldozer), Drilling equipment (TAMROCK), Extraction equipment (extractive shovel), Loading equipment (wheel loader), and Transport equipment (dumper truck).

Stages Of Industrial Exploitation

The stages of operation are numerous and coherent, they include among others the following:

Soil Stripping

These are the operations of destruction of the plant cover and all the thickness of alterite that covers the rock. This work

is carried out using a mechanical shovel and the excavated materials are transported by dump trucks to a drop-off point provided for this purpose within the quarry. Photo 1 gives a better illustration of this step.

Source : Field work (2013)

Figure 3 : Photo showing part of the stripped industrial quarry in Dschang

This photo shows the stripped part of the quarry in Dschang being prepared for drilling. This is the reason why we observe chains fixed higher up on the site on a machine intended to carry out the drilling in order to prepare for the mining stage.

Drilling

It consists of drilling vertical holes of about 10 cm in diameter in the rock according to a well-defined spacing (the "mesh"). In the case of the RAZEL CAM quarry in Foréké-Dschang, for example, an average of one hundred holes with a depth varying between 10m and 14m in depth and 10cm in diameter are dug on average twice a week according to a plan of precise drills.

Figure 4: Photo showing drilling in the quarry of Razel-Cam Source: Field work (2013)

In this image, the drilling is by putting in place the holes by means of the wire in which the explosives will be placed as well as the detonators preparing the blasting.

Mining

Drill holes are filled with explosives. The successive explosion of the holes coarsely fragments (< 800 mm) the rock and knocks it down. These explosives consist of different products including dynamite, nitrate and electric detonators. These are the elements, the nature and power of which are adapted to the operation and therefore arranged according to a very precise logic. At the bottom of the hole, the detonator is placed. At 6m the ammonium nitrate placed, then, in the center of the dynamite, the electric detonators are connected and regulated using micro-delays. At the top, the stuffing is made with the earth previously dug. Using a trigger, the firing of mines is affected. Mine blasts can break up a rock that is too hard or too compact. There are two mine blasts: major blasts and minor blasts. The principle in the first case is to generate a shock wave which cracks the rock. This period is followed by a fairly significant release of gas which will rush into the cracks and break down the rock by the collapse of the fragments. This process is repeated in minor firings on the fragments of rocks that are too large until the smallest dimensions called rubble are obtained. Slaughtering and block shooting are operations carried out using several chemical constituents and mechanical materials. Inside each drilled hole with a depth varying between 12m and 14m, products are added according to a very precise combination. These include: dynamite, ammonium nitrate, electric detonator, connection detonator, non-electric detonator and earth for tamping.

Scalping

Optional, the materials advanced on rails are separated by approximately 200 mm. The little ones pass through. Fine materials are often unsuitable for the noble uses of aggregates as scalping eliminates them like clays.

Crushing

In primary crushing, the coarse materials are broken by a direct mechanical action, for example the closing of two vertical jaws or the violent projection on a metal screen. We generally seek to obtain materials ranging from 0 to 250 mm.

Screening

Primary screening: after primary crushing, the materials are sent by belt conveyors to a series of vibrating grids. The size of the holes in the grids makes it possible to sort the materials. Those small enough to be marketed are placed in storage.

Pre-stocking: optional, the stocking and recovery of the others go to secondary grinding. Materials for further processing provide flexibility in plant operation. The primary part can thus operate separately from the rest of the installation.

Secondary crushing

Materials that are too large are broken by often indirect mechanical action using attribution where gyratory vertical conical crushers are common whereby the sizes of the largest are reduced to 50 mm. Secondary screening follows the same principle as above, but largest materials pass through the secondary crusher, the others go either to tertiary crushing or to marketable stocks. In tertiary crushing, the aim is to obtain materials less than 14 mm in diameter.

Tertiary Screening

Several screens in series end up separating the aggregates into increasingly fine "cuts".

Artisanal Mining

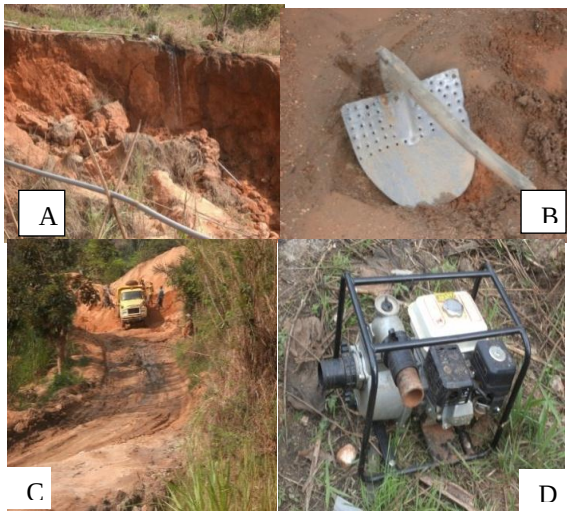
Artisanal mining is dependent on the exploitation techniques and the type of material utilized by the population or stakeholders implicated in the process.

The Exploitation Of Sand By Digging The Slopes Of Hills

The granitic arenas in this case are obtained by excavating the sections of the slopes of the hills of the different localities. It is also the form most practiced in the West region of Cameroon. It goes back according to the surveys carried out with the traditional leaders of the locality, informed operators as well as some administrative authorities dating back to the 1980s. This form of exploitation has often led to the disappearance of the important peaks of many localities in the region (Batié, Bamougoum, Bangou, Bandjoun). This is all the more so since it is a mixture of quartz, feldspar, iron and magnesium which is much in demand in the composition of concrete.

The Material Used

Operators use a range of varied equipment for this purpose, which changes according to the mode of operation and specialization. In these quarries, wheelbarrows are used to transport the sand from the drains to the exposure points. The shovels are used to stir, wash the mixture made up of earth and sand and also to remove the sand from the drains in contact with water and finally to load the trucks. The crowbars and pickaxes have the role of digging and bringing the mixture down the drains. The pipes allow the water to be channeled from the streams to the sandpit. The forks observed in the sand pits make it possible to hold the pipes immobile and to direct these pipes towards the parts of the sand pit to be excavated. Water is of paramount importance and a limiting factor in this activity because it cleans the sand. Perforated hoes are used to pick up sand while letting water flow. Figure 5 shows the phenomenon being practiced.



Source: Field work (2017)

Figure 5: Plate showing equipment used for sand extraction

A: Water channeling pipe towards the quarry in Bamougoum

B: A perforated hoe in the Balingang quarry in Menoua

C: A truck being loaded in a quarry in Bamougoum

D: A motor pump for water supply in the Balingang quarry

Photo A above shows the water channeling pipe towards the sand pit supported by stakes on the ground. Photo B shows the perforated hoe used to extract water from the sand in the drains and in the retention tanks built for this purpose. Photo C shows the loaders on either side of the truck loading the truck. Behind them is a large pile of sand. View D gives a motor pump in the sandpit located in the Balingang district in the Menoua Division. This generator is used to supply the pit with water if the pit and the water course are located in opposite directions.

Exploitation Of Sand By Digging And Sieving

In this case, the operators use a lot of equipment. These are precisely the shovels that allow the organic matter that covers the upper part to be stripped and that must carry out the digging. It is also used to collect sand and load it. The wheelbarrow which ensures the movement of the sands as well as the blocks which cannot be the subject of the sieving in the distant corners of the quarry and the mixture towards the zone where the sieve is located. Tridents and pickaxes are used to dig the hill. Figure 6 illustrates the materials used in this quarry.

Source: Field work (2017)

Figure 6: Plate showing Materials used for sand extraction in Baleng

A: Sieving of the materials exploited in the quarry at Baleng

B: The sandblasters at work in the quarry at Baleng

On photo A we see a wheelbarrow loaded with particles that could not pass through the mesh of the sieve and the sieve in question. Photo B shows two piles of sand, a sieve. Behind the sieve are two sandblasters at work.

B. EXPLOITATION OF BASALT AND GRANITE

This form of quarrying in the West Region of Cameroon is the most practiced and occupies 75% of the quarries found in the region. It does not require significant investments in materials and sometimes begins with family levies for the satisfaction of their own needs in the construction of housing

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very often under the inattentive gaze of the authorities in charge.

a. THE MATERIAL USED

The exploitation, although artisanal, is not as manual as one might think, it requires a minimum of equipment. Thus, in these quarries during work, the following materials are observed: The baramine which allows to reach the depths of the rock through the various cracks; The hammer, once the baramine has been pushed into the slot, the rock is tapped to isolate the block or the desired vein until the block is unhooked and the block falls into the pit. The hammer, which in turn allows the rock to be crushed into rubble, giving it the required shapes and also facilitates transport to the exhibition area. Unlike the crowbar, the chisel makes it possible to open cracks in the rock with the help of the hammer. The machete which is used for clearing before stripping. The pickaxe is used to dig the blocks of rock in the quarries where the basalts are isolated from each other and separated by the earth. The wheelbarrow, like the buckets, ensures the movement of the earth towards the parts already exploited or to carry the mud that comes out of the pits during the rainy season. The board below presents the materials used in the quarries.

Source: Field work (2017)

Figure 7: Plate showing Materials used for basalt mining

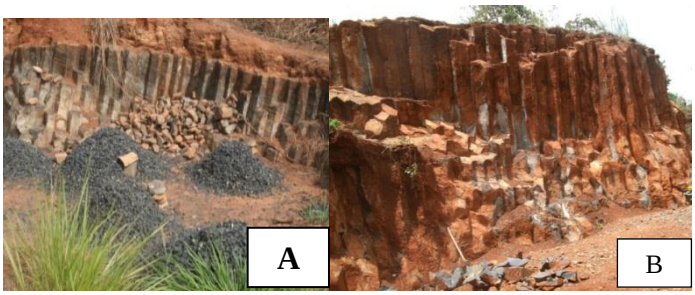
A and B: A bucket for transporting basalts of reduced dimensions and the range of materials used in the exploitation of basalt in the artisanal quarries of Toket in Bafoussam

b. THE STAGES OF ARTISANAL MINING OF BASALTS AND GRANITES IN QUARRIES

These stages include stripping rock dislocation, crushing and transportation amongst others.

Stripping

Stripping is the step that consists of clearing the layer of organic matter that covers the rock material before any mining activity. This stage is also observed in the exploitation of sand quarries in our study area. Figure 8 shows the part of the stripped quarry.



Source: Field work (2017)

Figure 8: Plate showing Stripping of alterites in a back in the Mifi

A: Stripping of alterites on the rocks in the Toket quarry

B: Stripped quarry in Kamkop village

In the two photos in Figure 8, the upper part of the rock material is well stripped as the extraction continues.

The opening of the pit on the face of the block of rock to be extracted

This is the stage of opening a pit in the direction of career development. This pit is of capital importance insofar as it is in this one that the blocks will be lodged by appeal to the vacuum and also it is in these pits that the operators position themselves to better observe the cracks of the rock. It is still in these pits that the crushing of stones takes place as evident on Figure 9

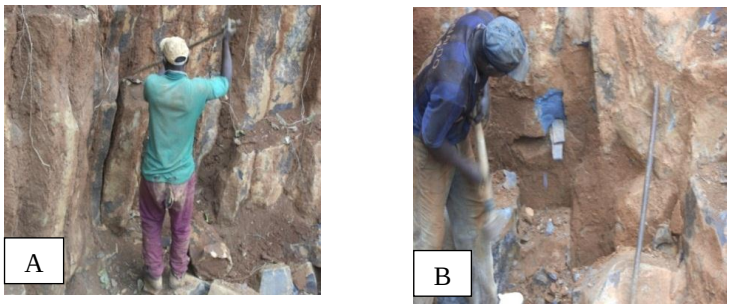
Source: Field work (2017)

Figure 9: Photo showing the basalt mining holes in the Toket quarry

The view shows a series of three open holes in the Toket slope, the starting point of mining. At the lowest level of the photo, is a miner waiting to enter the pit to crush and take out the rocks. To the northwest of the photo, there is a worker transforming the particles that cannot be made into gravel.

Rock dislocation

The strike is one of the complex phases of extractive activity. It is here that the operator uses all his senses to identify the cracks after an in-depth study of the structure of the basalts. Thus, using the chisel and the crowbar, he isolates the basalt seam and propels it into the pit. He sends the chisel into the crack to create the passage for the crowbar which is a little longer and which allows him to tip the basalt vein into the void. If he has difficulty fixing the chisel in the crack, he uses the hammer for this purpose. Figure 10 shows the process



Source: Field work (2017)

Figure 10: Plate showing the breaking of rocks in the Toket quarry in Bafoussam

A: Positioning of the baramine in the rock of the toket quarry in Bafoussam,

B: Breakdown in the tocket quarry in Bafoussam

On photo A, he is still in action to unhook the vein of the basalt by means of baramin.

On photo B, the quarryman is seen dividing the rock seam using two flat pieces of iron and the mace in order to reduce the size and weight of the rock to be unhooked.

Crushing of basalt veins into rubble

This step constitutes the last phase of the extractive activity because it concerns the sizing of the rock. This is the operation that consists of giving the unhooked vein the required size that can be transported by the operator of the pit to the place of exposure. This is where the hammers come into play for splitting, especially due to the fact that it is almost difficult to transport a whole vein from the extraction point to the loading point. Figure 11 is a glaring xample.

Source: Field work (2017)

Figure 11: Plate showing Crushing phases of basalt veins

A and B: A crushing phase of the basalt vein within the Tocket quarry in Bafoussam

On the two photos above, we observe our workers, with a hammer, crushing the blocks of basalt according to the desired dimensions and ready to be transported for exhibition.

The transport of rubble for the exhibition area

After the crushing phase, comes the stage of moving the rubble to the point of exposure in the quarry. This is done using hands for the less well-off and using wheelbarrows for those who have a little means. In this regard, we can observe the photo below.

Source: Field work (2017)

Figure 12: Plate showing transport of fragmented basalts

A: Transport of rubble from a quarry in Bafoussam

B: Transport by wheelbarrow of rubble within a quarry in Bamougoum in Bafoussam III

We observe through these photos the process of transport of the rubble by the workers for exhibition. On the first view, it is done manually while on the second photo, it is done by means of the wheelbarrow. The worker here is busy transporting the pieces of crushed rock into rubble for display and sale.

Grinding and sieving

Unlike many traditional craft quarries abounding in the West Region of Cameroon, a few techniques are being developed that bring them closer to so-called industrial quarries. This technique consists of observing the steps described above and crushing using mallets and hammers and sifting in Bandjoun like what the CMC company did, although this is anarchic exploitation because no regulations are followed. This is made possible by using sieves with meshes conforming to the requested dimensions, the quantities of gravel are interesting. The photographic board below shows us this activity.

Source: Field work (2017)

Figure 12: Plate showing gravel exposure and gravel screening

A: Exhibition of quarry products in the Peté quarry in Bandjoun

B: A sieving phase of the crushed basalts using macettes in the Peté quarry in Bandjoun

On image A, we observe the piles of basalts transformed into gravel of different dimensions from the rocky block located in the background of the photo. In photo B, we see two young men sifting by hand giving the requested dimensions to their gravel. Behind these two little boys is a worker resting next to the pool of water from the rainwater.

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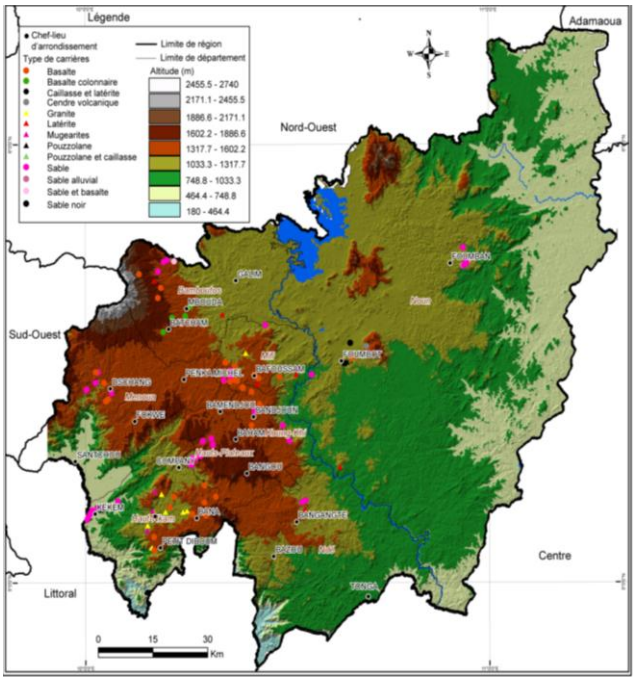
C. DISTRIBUTION OF QUARRIES IN THE WEST REGION OF CAMEROON

Until 2018 in the Region, there were 191quarries, with a high concentration in the Haut-Kam, MIFI, Menoua and the Bamboutos Divisions. The different quarries in the region are presented in Figure 13.

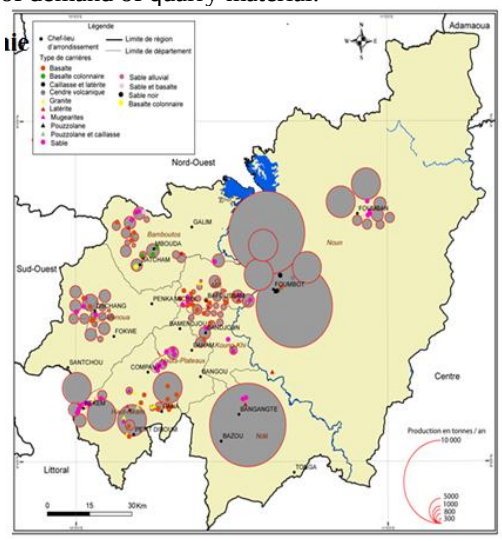


Source: Extract from the topographic map of Bafoussam at 1/50000 and .DEM image data. INC. 2009 draft UTM WGS 84.

Figure 13: Distribution of quarries in the West-Cameroon region

D. IMPORTANCE OF THE MATERIALS USED IN THE CONSTRUCTION OF INFRASTRUCTURES

Volcanic rocks are of great importance in infrastructure construction and civil engineering works. This is shown by Figure 14 – illustrating the importance, diversity and the influence of demand of quarry material.



Source: Adapted from the topographic map of Bafoussam 1/50000 AND DEM Image of NIC 2009 UTM WGS 84 Projection

Figure 14: Quarry production map of the West Region of Cameroon

As seen on Figure 14, the production of quarries is important, diversified and influenced by the forces of demand and supply. It was observed that Bangante and Foumban had more production than any other area due to numerous disenclavement of big production basins.

a. POZZOLANS

Pozzolan is extracted from basalt rocks. This pozzolan mixed with quicklime gives the bitumen which is used in road construction works. Pozzolana by its sonic property, absorbs sounds and is used in the construction of buildings, tunnels, nightclubs and dams. It still has a water absorption property, hence its usefulness in the construction of basketball, volleyball and tennis stadia and field tracks. It resists because it increases the strength of the concrete as the years pass and causes the concrete to harden quickly in water. This is why it is very important in the construction of bridges, buildings and tunnels. Pozzolan from quarries in the Noun Division mixed with volcanic ash, black sand or white sand gives good quality concrete blocks.

b. GRANITES

Granites and gneisses are used as gravel and rubble in the construction of roads, houses, buildings, bridges and tunnels.

c. SAND

Sand is used in the composition of concrete and the manufacture of agglomerates for the construction of many structures, particularly in civil engineering works (slabs, slabs, cobblestones, balusters, nozzles, kostras, vaults, prefabricated posts, bases, monuments, curbs for gutters) and many other decorative objects.

d. BASALTS

Basalts are used in construction and in statuary. Basalts, because of their fine and isotropic textures, are also valued as aggregates of high compactness and high mechanical resistance. Some are used for making railway ballast. Rock wool is obtained from basalt or diabase rock analogous to basalt, via a melting process (in a cupola in which fluxes and coke are added to bring it to 1500°c) and extrusion. Also a method of geo-engineering, forced weathering, envisages the spreading of finely ground basalt to fix atmospheric CO2 in agricultural soils.

Source: Field work (2017)

Figure 14: Plate showing use of quarries products in the construction of channels, houses

A and B: view of the ditch at Djunang high school and the barrier at Mbouda

A: View of rainwater drainage at Djunang High School. On the first photo, the block of classrooms on which is inscribed the name of the establishment and then below is a channel which allows water to drain, all showing the usefulness of material obtained from quarrying.

B: This photo shows the use of basalts first as an element of the foundation and then as decorative materials thanks to the mixture of sand and cement for solidification. As seen, these stones are cut into briquettes. Above this barrier is another element of decoration which is from the baluster on both sides of the central portal

Source: Field work (2017)

Figure 15: Plate showing Valorization of quarry products

A and B: A view of a brick factory in Dschang

Photo B shows us, among other things, the castras, the statuette of the hawk, the balusters and some prefabricated posts with their bases and some post heads. Photo A shows the manufacturer of concrete blocks at work in a corner of the market where he is displaying for sale after drying for customers who no longer want to start manufacturing themselves. It is a mixture of sand and cement to arrive at the production of concrete blocks.

No	Project title	Designation of routes	Successful bidder	Length (km	Material used	Major works to be carried out
1	Asphalting in surface dressing	Banganté-Foumbot-Bamedjin-Galim	RAZEL Cam	107	Granite at 20% for the gutters and basalt at 80% for the asphalting	Earthworks, asphalting in surface dressing, double layer, sanitation works
2	Asphalting in surface dressing	1st Baleveng-Balessing - Batcham-2nd Galim Mbouda-Balatchi-Bamesso 3em Mbouda-Ngouaya-Bati	ESER CONTRACTING and INDUSTRY INC. CO	110	Basalt at 20% for gutters and granite at 80% for asphalting	Earthworks, asphalting in surface dressing, double layer, sanitation works

Source: West Regional Delegation of Public Works, March 2017

Table: Asphalting of roads in the major agricultural production basins of Western Cameroon

IV. DISCUSSION

The exploitation of mineral resources in the quarries of the western region is constantly growing; it is all the most important because it feeds the construction of housing, sports and roads infrastructure. This exploitation is also important in the sense that it makes it possible to fight against the problem of silting, which has as its corollary the fight against floods. The exploitation allows the creation of jobs, the fight against unemployment and poverty and the creation of wealth in the construction industry.

V. CONCLUSION

In the final analysis, the exploitation of mining resources such as sand, basalt, granites, pozzolan, and volcanic ash in quarries consists of collecting but above all digging the granite slopes of the region. The exploitation of mining resources process demand proceeds from a process to be followed which goes from the regulatory and institutional framework to the techniques of extraction of materials. It appears that the exploitation of careers is a process that presents different modes considering the topography. Each mode of exploitation (artisanal or industrial) corresponds to an appropriate device, with different techniques adapted to the nature of the resource. The materials exploited in quarries of the West Region Cameroon are of great interest in the region. We have: construction of sports and road infrastructure. The construction of 217 km of road in the project to open up agricultural production basins in the region absorbed a large quantity of materials. The quarries in the region make it possible to fight against unemployment and poverty, they create the wealth used in public works buildings (PTB).

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