

# Petrography and the Need to Establish Optimum Blasting Parameters for Rocks in Akamkpa-Oban Mining Area, Southeastern Nigeria

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## ABSTRACT

The study area is in the basement complex of southeastern Nigeria. There are over twenty-eight quarries in Akamkpa-Oban mining district. The area is a major mining district which supplies aggregates and dimension stone in the south-south and southeastern Nigeria. The rock types identified are granite, pegmatite, dolerite and migmatite. The photomicrograph of the rocks shows quartz, feldspar, mica and accessories.

Although most of the quarries which are mainly designed for crushed rock aggregates have been abandoned due to the down turn in the economy and low to moderate rock strength. The quarries have been obtaining very high percentage of rock boulders (85% – 95%) after blasting, as compared with 5% maximum for a standard and effective blast operation round. Field investigations indicates that the boulders range in size from (1.5m - 2.5m). In this paper, we suggest reasons to reduce the oversize, rock strength analysis, with field tested parameters for effective fragmentation and operations cost reduction in this mining area.

(Keywords: petrography, rock boulders, blasting, tested parameters, fragmentation, Akamkpa-Oban)

## INTRODUCTION

The Akamkpa area has been a center for large scale mining activities for over three decades. It can be accessed through Odukpani-Akamkpa road and Calabar-Oban road, the elevation is about 173m. The vegetation is thick and has been reason for less geological activity particularly at the boundary between the Republic of Cameroon and eastern part of the area.

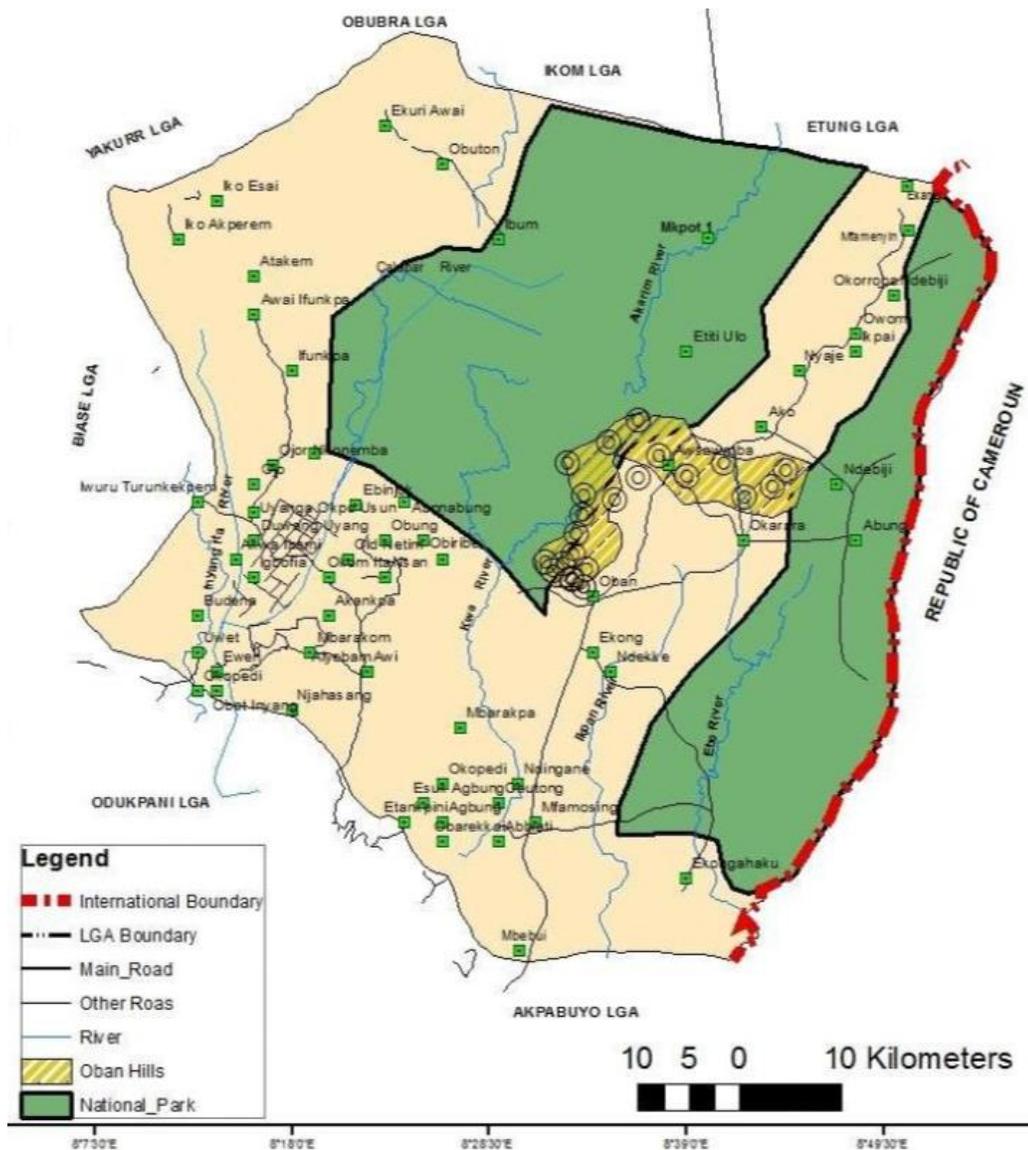
The rock types identified in the area are granite, granodiorite, pegmatite, dolerite, migmatite schist and gneiss. The granite-pegmatite and dolerite were found at Nsan area, migmatite and pegmatite were observed at Old Netim Cossel quarry, Jinack quarry and also at Hitec quarry at Akamkpa area, while granodiorite was found at Igbofia area. There are several small water springs which were running down from the rocks with some points having a waterfall feature.

The rock exposure at Nsan and Akamkpa are very massive and could be mined at the present rate for over twenty-five years while the Old Netim migmatite are moderately large. The Nsan and Old Netim area is in the Precambrian Basement of Oban massif in southeastern Nigeria (Ekwueme, 1990, 2003) and Egesi and Tse (2011).

Figure 1 is the location map of the Akamkpa Local Government Area (LGA) showing the study area. The area surrounded by Yakurr LGA in the northwest, Obubra and Ikom LGAs in the north, Etung LGA in the northeast, Biase LGA in the west, Odukpani and Akpabuyo LGAs in the south and the Republic of Cameroon in the East. It is one of the largest LGA in Cross River State, Nigeria.

## Geological Setting

The Oban massif and Obudu Plateau is the prolongation of the Bamenda massif of Cameroon into southeastern Nigeria. The thick equatorial rain forest vegetation and lack of access roads have made geological study in the area difficult (Ekwueme, 1987). At Nsan mining pit the dolerite intrusion at the quarry site is a dyke about 4.29m long while the width varies from 1.10m to 1.30m.



**Figure 1:** Map of Akamkpa LGA showing Nsan and Old Netim at the Southwestern Part of the Area (Goggle map, 2019).

The rock is dark and fine grained, the exposure was not observed at any other point visited on the mined out surfaces. The minerals in hand specimen are oxides of iron like ilmenite and plagioclase. The pegmatite is a complex type, coarse grained to very coarse grained it occurs as both dyke and sill in several places. The leucocratic minerals are feldspar, quartz and muscovite while melanocratic minerals are biotite and rare earth elements REEs.

The pegmatite is granite pegmatite and varies in size from 58cm to 72cm in width, while the length is 12.5m in the East-West direction. The overburden lateritic deposit which support vegetation was removed from 0.5m to 1.0m in different sides of the quarry. Ekwueme (2003), reported that Iwuru and Ayiebam pegmatites are granitic, undeformed and contain predominantly quartz, feldspar, tourmaline and muscovite.

He also added that at Kwa Falls in the eastern part of the Oban massif, pegmatites were closely associated with migmatitic schists and gneisses, and suggested that it could be products of partial melting under amphibolites facies metamorphic conditions. However, Ferré et al., (1995), in contrast with Ekwueme(1990), observed there is indication that metamorphism reached grades higher than upper amphibolites facies, with the formation of abundant metatexites and diatexites. They added that all the metamorphic rocks are coarse grained (grain size commonly, 0.5 – 1cm).

The minerals orthopyroxene and mesoperthite, observed in leptynites and associated leucosomes are typical minerals of the granulites facies, characteristic of deep-seated regional metamorphism, suggesting peak temperatures well above 650°C Ferré et al. (1996).

In Old Netim, at Cossel quarry and Jinack quarry sites the rocks are migmatites and pegmatites. The overburden removed from the surface of the migmatites ranges from 1.0m to 2.5m in places. The surface of the migmatites has been extensively weathered. The rocks are migmatitic schist and pegmatite. The schist indicates two colours, light-coloured and dark-coloured types which is evidence of presence of quartz and feldspar in the leucocratic rock while the melanocratic one has biotite and hornblende. In hand specimen, the grains are granular with the texture medium to coarse grained. The migmatite have been dissected by quartzo-feldspathic veins and dykes which indicates migmatitic characteristics.

## METHODOLOGY

Field mapping and petrographic analysis of the rocks were made. The mining method at both quarries is open cast. The mined out face has reached four benches at Nsan area. The bench height ranges from 4.5 to 6.5m meters. The first bench height at the entrance of the mining pit is the highest at 6.5m while the other three which are more in sequence ranges from the top 4.5m, 5.0m to 6.0m, respectively. There is only one bench height at Cossel quarry site which is more than 6.5m. The holes are being drill on the surfaces after the removal of the overburden materials, for the introduction the blasting materials dynamite or Ammonium Nitrate Fuel Oil (ANFO).

## RESULTS AND DISCUSSION

The blasted boulders of rocks are more than 1.5m in several places and will require re-blasting before moving them to primary crusher for crushing Figure 2. A good rock fragmentation must provide fragment sizes in the neighborhood of 20cm, fragments in the neighborhood of 1m are considered as boulders Rock boulders must not constitute more than 5% of the total material blasted in one round (Tomakov, 1994).

If the rocks are poorly blasted, it has ripple effect on cost of loading and haulage. The problems ranges from loading operations which causes dynamic load on haulage vehicles both at the points of loading, haulage routes and dumping activities. The result of this blasting operation is that bucket of the loading equipment cannot be filled, which will lead to a fall in the productivity of the loading equipment. The application of secondary blasting to reduce the size of boulders, the blasting becomes more expensive than would have been if the primary blasting were optimum (Nwosu et al., in press).

The granite is the most extensive of the rock types at Nsan area. They are light colored with minerals like quartz, feldspar and biotite in hand specimen, in a few places features of subtle migmatization are present and displays schistose and gneissose characteristics. The migmatitic features are less pronounced and subtle and requires experience to identify (Figure 2).

The maximum height allowable in order to avoid bad fragmentation, that is, creation of boulders is known as bench height. If the bench heights is very less than the recommended maximum, it may lead to over-blasting, fly rocks and dust which may not be economical to the quarry operations. In addition, it can increase cost per unit of production since access roads have to be created each time from one bench to another as the productivity of drilling, loading and haulage equipment may be reduced. However, it is better to over-blast than to operate with increased bench heights leading to bad fragmentation of the rocks. Thus, lower bench height is more economical provided the maximum allowable bench heights are not exceeded (Adeev and Baron, 1986).



**Figure 2:** Field Photograph showing Granite Boulders more than 1m at Nsan Quarry.



**Figure 3:** Field Photograph showing Fractures which have been Induced by the Blasting Vibrations at the Background and 1m and above Blasted Boulders at Nsan.



**Figure 4:** Field Photograph showing Migmatite Schist more 1m Blasted Boulder at Cossel Quarry, Old Netim Area.

In the Auchi-Igarra and Okene-Lokoja mineral districts Nwosu et al., (2019), observed that over-estimated bench heights compared to diameter of the blast-hole is the major factor affecting bad fragmentation of rocks. They stated that it is important and economical for the quarries to operate with field tested parameters within the recommended bench heights and diameter of the blast-hole.

**Table 1:** Average Rock Strength for Each Quarry Established by Total Quality Nigeria Limited at Effurun Delta State Nigeria (Nwosu et al., 2019)

| QUARRY   | TYPE OF ROCK | ROCK STRENGTH (MPA) | ROCK CLASS FACTOR | SWELL FACTOR |
|----------|--------------|---------------------|-------------------|--------------|
| QUARRY 1 | GRANITE      | 23                  | 5                 | 1.2          |
| QUARRY 2 | MARBLE       | 16                  | 4                 | 1.12         |
| QUARRY 3 | GRANITE      | 24                  | 5                 | 1.2          |
| QUARRY 4 | MARBLE       | 20                  | 4                 | 1.12         |
| QUARRY 5 | GNEISS       | 36                  | 7                 | 1.25         |
| QUARRY 6 | MARBLE       | 16                  | 4                 | 1.12         |
| QUARRY 7 | GRANITE      | 26                  | 5                 | 1.2          |
| QUARRY 8 | MARBLE       | 16                  | 4                 | 1.12         |



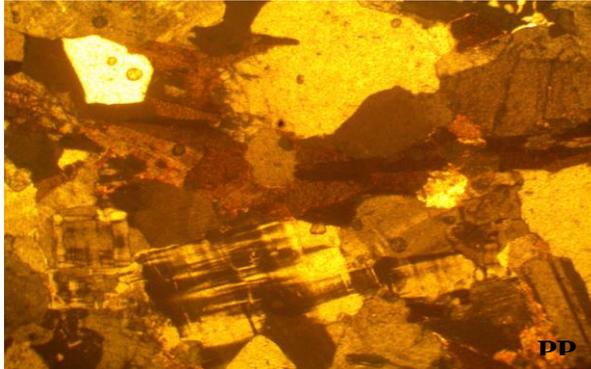
**Figure 5:** Field Photograph Showing Blasted Rocks with the Recommended Parameters.



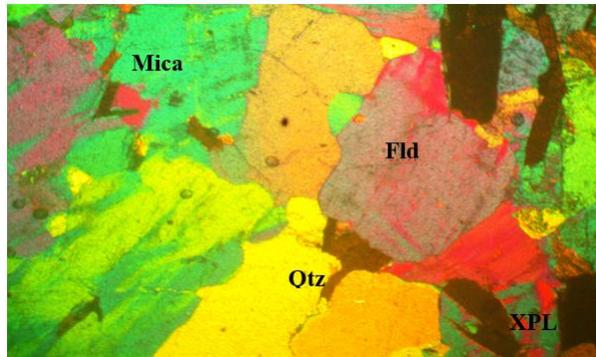
**Figure 6:** Field Photograph of Blasted Rock with Recommended Parameters.



**Figure 7:** Field Photograph of Pegmatite at the Quarry.

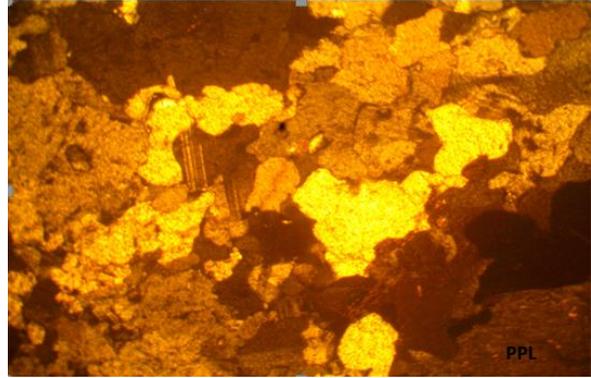


A.

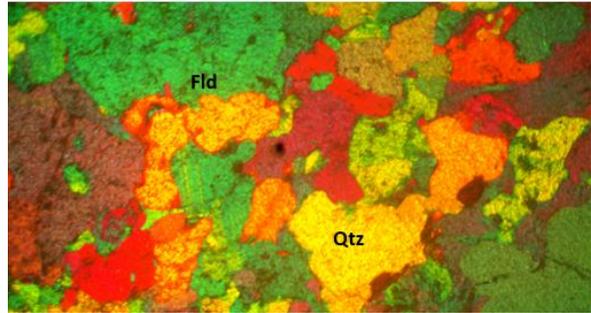


B.

**Figure 8 A and B:** Photomicrograph Showing Some Mineral Quartz, Feldspar and Mica.



A.



B.

**Figure 9 A and B:** Photomicrograph of Granite Showing Some Minerals Quartz, Feldspar and Biotite.

## CONCLUSION

The field investigations in Akamkpa and Oban mining district shows that bad fragmentation is a major factor affecting quarries in the area. Although few quarries commented on dust and flying rocks, when blasting is made with very low bench heights. Based on our field tested parameters in southwest and central parts of Nigeria, we recommend that the maximum bench height allowable and diameter of the blast-hole, reasonable estimated burden and spacing for the blast-hole and adequate charge quantity and firing sequence per hole, will give an effective and economical blast operation round in the area.

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## SUGGESTED CITATION

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