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RESOURCE MODELING AND QUANTIFICATION OF POZZOLANA DEPOSIT IN NJOMBE PENJA, LITTORAL REGION CAMEROON USING SURPAC 6.5.1

[1]*Ndah Euodia Musi, [2]*Ndimungiang Bechan Lika, [3]*Zoum Fon Alain, [4]Azinwi Primus Tamfuh

[1] M.Eng. in mining and mineral engineering, Department of Mining and Mineral Engineering, NAHPI, University of Bamenda, Cameroon, PO Box 39, Bambili.*
[2, 3] M.Sc. in mining and mineral engineering, Department of Mining and Mineral Engineering, NAHPI, University of Bamenda, Cameroon, PO Box 39, Bambili.*
[4] Associate Professor, Department of Mining and Mineral Engineering, NAHPI, University of Bamenda, Cameroon, PO Box 39, Bambili.

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Pozzolana deposit, Solid model, Surpac 6.5.1, Njombe Penja, Cameroon.

ABSTRACT
The increase in the construction of structures in Cameroon has led to an increase in the demand for aggregate. Sand is increasingly being limited and other aggregates are used to meet the rising demand in the construction industry. They include but not limited to basalt, gneiss, granite and pozzolana. Making an estimate of the quantity of a pozzolana deposit is as essential as it is to other industrial minerals, as it foretells the life of the deposit if to be exploited, and gives a cost and profit estimate of the business. Therefore, this paper sorts the use of Specialised Computer Software in mining (Surpac 6.5.1) to model a pozzolana deposit which will enable us to estimate the volume and tonnage of pozzolana in our study area. GPS coordinates were collected round the foot of the pozolanna cone, this process was repeated at different heights till the peak of the cone was reached. These coordinates were downloaded from the GPS with the aid of Garmin Base-Camp, exported, cleaned and an excel workbook consisting of collar and survey data generated. These data were then imported into Surpac 6.5.1 where a solid model, volume and tonnage estimate of the pozolanna were achieved. Results showed that the total area occupied by this deposit was 321600m^2 with a total volume of 608520m^3 and a tonnage of 419,878.75 tons.

INTRODUCTION
The process of resource estimation is used to define a mineral resource in three dimensions, with the ultimate aim of determining both the size (typically reported in tons) and grade (generally expressed as the metal or mineral content in wt. % or g/t) of the resource. Resource estimation is specifically concerned with determining the size and quality of a mineral resource with a view to commercial exploitation. A 3D ore deposit model (or block model as they are known) is used to show the extent of the deposit below the surface but also the distribution of metal or mineral within the deposit (i.e. zones of high and low-grade) [1].

Computers are of tremendous value in enabling more to be rapidly done with available data than is possible by manual means; this does not necessarily follow, though, all computer-derived estimates are better. With increasing amounts of information and consideration of other factors, such as economic, social and environmental aspects, a mineral resource may be upgraded to a mineral reserve [2]. In resource estimation the amount of sampling required depends on the complexity of the deposit [1]. The true value of a mineral deposit is not known until the shape, size and other critical characteristics are determined. Before the use of modeling software like Surpac, orebody shape and size determination was a very complicated, time-consuming and error-prone task. Technological advancement in this area has provided more reliable computational methods capable of developing models more accurate to true representation in relatively shorter timeframes. Nonetheless, the basis for accurate modeling still remains dependent on the quality of the data and a good understanding and interpretation by the modeler [3].

The methods used for resource estimation are usually expensive; needing sophisticated equipment and experts, and time consuming. In local quarries where there is limited knowledge on resource estimation, increasing cost resulting from shallow data on the size and characteristic of the deposit is expected. The use of conventional methods of resource estimation through drillhole data or that obtained from seismic survey are expensive and may render local exploitation of industrial deposits such as pozolanna unprofitable.

[4] established various methods to estimate sand and gravel deposits and in one of the methods, they used geological blocks. As of now, there is little or no information on the estimation of pozzolana deposits. So, this research will attempt to carryout an estimation of pozzolana deposit through an adaptive method from the estimation of sand and gravel. Pozolanna, sand and gravel are loose deposits occurring on the surface and as such possess similar characteristics. This adaptive method takes into consideration the nature of occurrence and geometry (cone-like) of the deposit.

Description of the Study Area

The study area is located between 4° 40’ 00" N to 4° 42’ 30" N and 9° 40’ 00" E to 9° 40’ 30" E. Njombe Penja is located in the Moungo Division, Littoral Region; 74 km from Douala (Economic Capital of Cameroon and headquarter of the Littoral Region) and 33 km from Nkongsamba (figure 1). It covers an area of 430 km^2 and is bounded to the North by Loum, to the West by Mbonbo, to the North-West by Tombel, to the South by Mbanga and South and West by Yabassi in Nkam Division. The municipality is subdivided into 14 villages.

The climate is equatorial, strongly influenced by the tropical monsoon climate. This climate is characterized by four seasons in a year; two rainy seasons accounting for 80% of annual precipitation and two dry seasons. Average annual rainfall of 2.699mm. The temperature is influenced by the proximity to the sea, about 50km from Douala and the chain of hills and mountains that surround it with an average temperature between 19 ° and 25°C. The soils are of volcanic origin, black in texture, made up of a mixture of quartz and very loose clay and suitable for agriculture [5].

Its relief is characterised by high mountains, hills and plateaus. Respectively, the area has peaks of 2250m^2 for Mount Manengouba and 2070m^2 for Mount Koupé. There are two large rivers (Makombe, Mbété) and a few streams which crisscross the villages and whose flow vary according to the seasons. These streams are used as a source of drinking water and in the practice of market gardening.

Materials and Methods

An adaptive method was used to collect field data where basic mathematical calculation of depth from geographic coordinates gotten through a Garmin 78 GPS device. The accuracy of the GPS device was 3m for each geographic coordinate collected. The assumptions made in this work include: (1) Pozzolana deposit was considered to be in a cone-like shape; (2) The composition of pozzolana was assumed to be uniform; (3) Every marked point (GPS waypoint) was considered as a drill hole. To be able to create successful bases for the calculation of depth as opposed to the conventional method of getting depth through drill holes, the deposit was divided into 3 sections for mapping of waypoints (location), the base, the middle and the top, and the location of each point was taken along these lines as shown in figure 2.

The GPS coordinates (data) were downloaded from a Garmin 78 GPS device using Garmin BaseCamp into a PC. The data was cleaned. A GPS geometric geoid computed in a small part of the target area showed that the absolute accuracy of this local geoid model is 14cm. After a four-parameter fitting to the GPS reference surface, this absolute accuracy reduced to 11cm (0.011m) [6]. This information was used to correct the acquired height from the field using the formula $H = h – N$; where h is the GPS geometrical heights, H is the Orthometric heights and N the Geoid undulations. The depth of each drill hole at level L2 was obtained by subtracting the elevation at the refrence line (L1) from the elevation at L2. This was same for L3 and L4. The data generated was rearrange into collar and survey files and saved as comma delimited (csv) files to be used for modelling on Surpac 6.5.1. Volume and Tonnage estimation were derived from the model generated on Surpac 6.5.1.

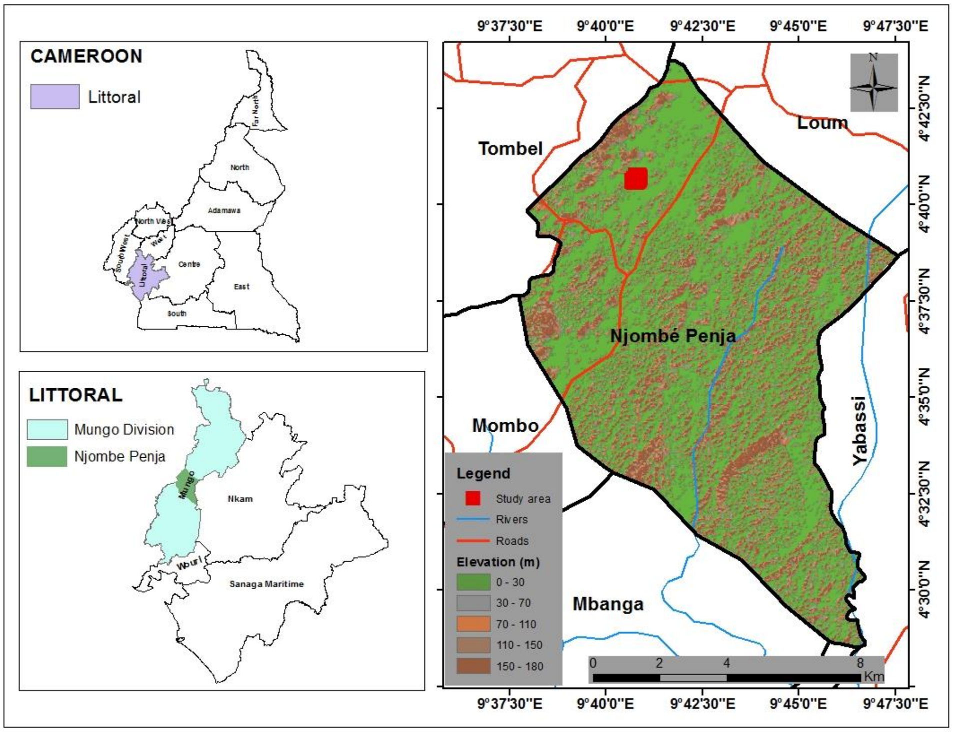

Figure 1: Study Area Map

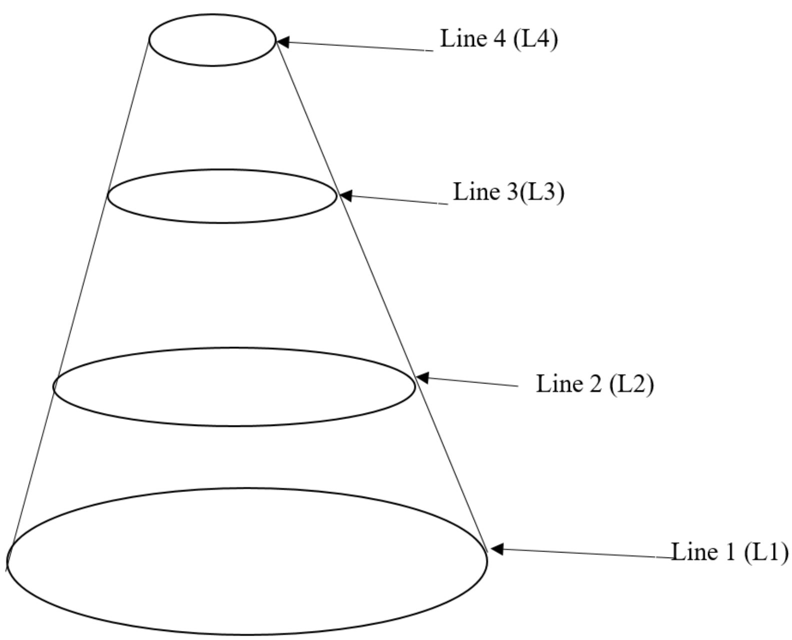

Figure 2: Imaginary Cone of Pozzolana Deposit

RESULTS AND DISCUSSIONS

Results from field observation revealed the presence of a cone-like pozzolana deposit with uniform colour and size distribution, and very little overburden. Two tables (collar and survey) were generated from from field data. The collar table consisted of Hole ID, Northerns, Easterns, Reduced Level, and TDepth (Table 1). The "drillhole" depth ranged betwen 2 m – 121 m. The survey table composed of Hole ID, SDepth, Azimuth and Dip (Table 2). The dip of all "drillholes" was 90^0 whereas the azimuth was 0^0.

Importing the collar and survey files into Surpac 6.5.1 and displaying "drillhole" data revealed the "drillholes" as shown on figure 5. Also, a solid model was generated from collar and survey files, revealing the shape and orientation of the pozzolana deposit (figure 6) as well as the area, volume and tonnage (figure 7).

TABLE 1: Collar File

Hole	Northern	Eastern	RL	TDepth/m
H1	575272.1	517024.1	447.871	6
H2	575308.9	517047.7	458.8522	13
H3	575361.4	517133.8	464.939	21
H4	575365	517119.2	457.0965	13
H5	575325.3	517048.9	444.5239	7
H6	575341.1	517068.5	435.4099	13
H7	575203.4	516965.1	428.4336	9
H9	575411.2	516840.8	425.33	34
H10	575369.4	516841.3	419.9124	23
H11	575354.6	516841.4	417.824	27
H12	575339.6	516847.1	414.8649	21
H13	575310.3	516854.4	414.1246	16
H14	575422.8	516840.3	425.4154	36
H15	575267.5	516876.1	419.1024	37
H59	575576.5	517094.4	488.163	113
H60	575573	517067	490.4925	112
H61	575553.8	517032.7	489.1131	104
H62	575518.9	516988.6	484.6124	111
H63	575506.3	516979.1	490.3127	114
H64	575453	516943	484.3295	107
H65	575445.8	516913.4	470.5803	90
H66	575467.8	516954.2	486.618	105
H67	575402.9	516993.4	491.8782	49
H68	575425.5	516998.7	496.2356	50
H69	575368.8	516963.5	482.0501	69
H70	575381.9	516957.7	482.5081	92
H71	575437.8	516938.1	484.4151	87
H72	575424.7	516936.6	484.1144	95
H73	575409.8	516945.8	483.9617	85
H74	575397	516952.7	483.3211	106
H75	575446	516973.4	497.574	121
H76	575446	516963.5	492.4509	110

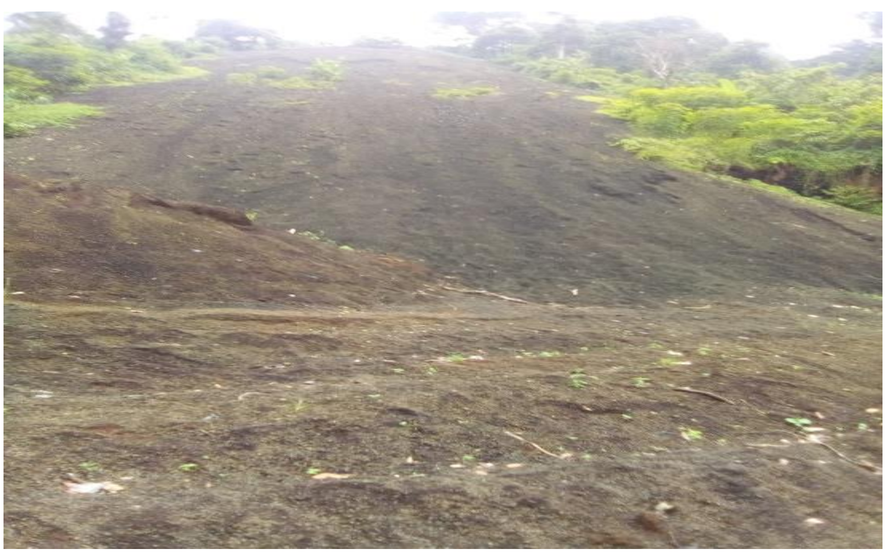

Figure 3: Cone-like Pozzolana Deposit

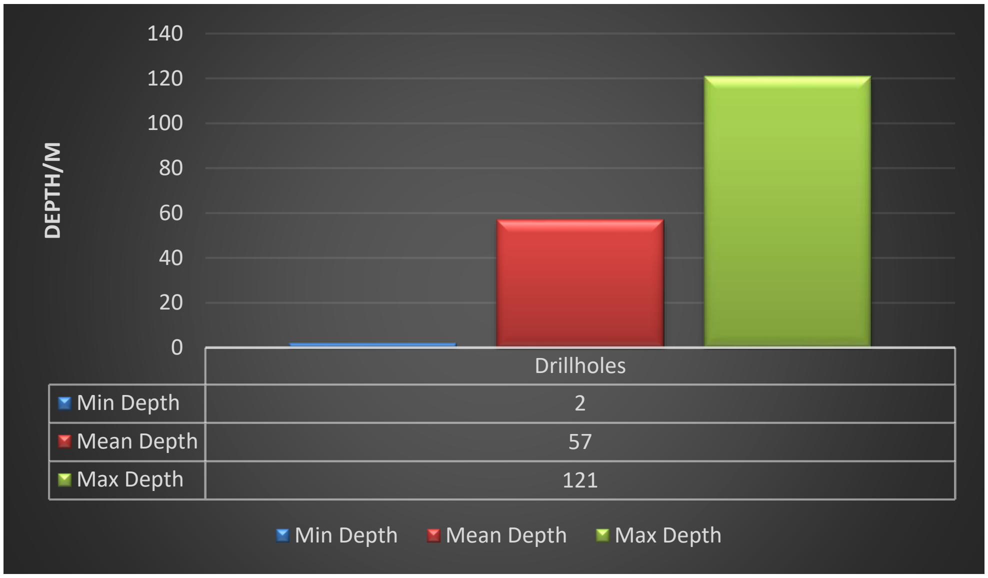

Figure 4: Min, Mean and Max "Drillhole" Depths

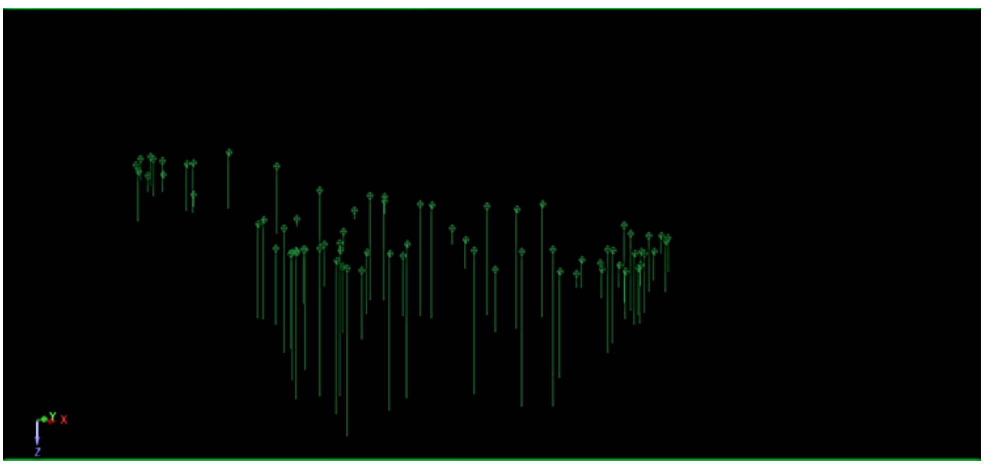

Figure 5: "Drillhole" Display on Surpac 6.5.1

Figure 6: Model of Pozzolana Deposit

Table 2: Survey File

Hole	Sdepth/m	Azim/^{0}	DIP/^{0}

H1	0	0	90
H1	6	0	90
H2	0	0	90
H2	13	0	90
H3	0	0	90
H3	21	0	90
H4	0	0	90
H4	13	0	90
H5	0	0	90
H5	7	0	90
H6	0	0	90
H6	13	0	90
H7	0	0	90
H7	9	0	90
H8	0	0	90
H8	2	0	90
H9	0	0	90
H9	34	0	90
H10	0	0	90
H10	23	0	90
H11	0	0	90
H11	27	0	90
H12	0	0	90
H12	21	0	90
H13	0	0	90
H13	16	0	90
H14	0	0	90

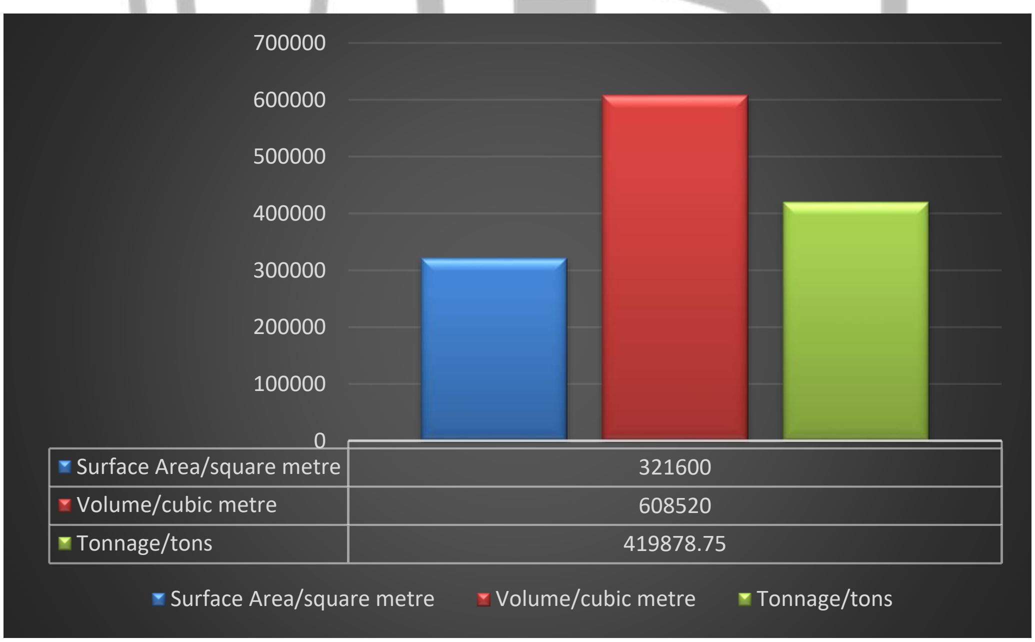

Figure 7: Surface Area, Volume and Tonnage Estimates

"Drillhole" data from Tables 1 and 2 revealed different depths at different locations thereby shedding light on the thickness of the deposit at any given point in time. In all, 76 "drillholes" where considered for the study, with minimum, mean, and maximum depths of 2m, 57m, and 121m respectively (figure 4). Figure 6 revealed shallow depths at the extremities of the model with higher depths about the middle. This confirmed the assumption which considered the deposit to exist in a cone-like shape to be true. The other extreme with higher depths revealed by figure 6 was as a result of the difficulties encountered in obtaining authorization to cover the entire deposit during field work. As a result, only a part of the entire deposit was modelled. From the model, one can clearly see a cone-like shape. The estimated surface area, volume and tonnage as gotten from the model in figure 6 were 321600m^2, 608520m^3 and 419878.75 tons respectively (Figure 7).

Conclusion

This paper sorts the use of Specialised Computer Software in mining (Surpac 6.5.1) to model a pozzolana deposit at Njombe Penja Littoral region of Cameroon, which enabled us to estimate the volume and tonnage of the deposit. The surface area covered by the deposit was 321600m^2, the volume was 608520m^3 and the estimated tonnage was 419,878.75 tons.

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