

Mbalm Iron Ore Project, Northern edge of the Congo Craton, Southeast Cameroon.

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Abstract

The Mbalm iron ore deposit, southeastern Cameroon is located to the northern edge of the Congo craton, a region previously unexplored for iron ore mineralisation. This paper presents the geological setting as baseline information to this potential economical world class iron-ore deposit region. Exploration works by various companies in this region to date have focused on Archean-Proterozoic itabirite host rocks of the Congo craton and indicates the potential for a world class iron ore region with high grade (>60% Fe) iron ore deposit. The protolith of the high-grade hematite rock is an itabirite (BIF) rock. The Mbalm deposit is delimited by a series of NE-SW to N-S trending faults that truncated a roughly E-W-striking isoclinal fold structure. Key exploration tools in the region have been the reinterpretation of regional aerogeophysical surveys, geological field reconnaissance, and drilling to depth.

Introduction

Although sedimentary iron-ore deposits range in age from the Archean to the Tertiary, the most important in terms of tonnage mined are those derived from banded iron-formations (BIFs). There are many sites in the world where unenriched BIF (taconite, itabirite) is mined; however, the vast majority of high-grade iron-ore deposits containing between 60 to 70 wt% Fe in which quartz is almost absent mined today are hosted by Precambrian BIFs. The geologic processes responsible for transformation of iron formation into giant iron orebodies of almost monomineralic hematite have been described from many parts of the world such as in Australia (Hamersley district: Taylor et al., 2001; Lascelles, 2002, and Lascelles, 2006), Brazil (Serra dos Carajas: Dalstra and Guedes, 2004; Quadrilatero Ferrifero and Aguas Claras: Spier et al., 2003, 2005, Rosiere and Rios, 2004 and Buekes et al., 2008), India (Noamundi: Beukes et al., 2008) and South Africa (Thabazimbi: Dalstra and Guedes, 2004; Buekes et al., 2008) but little or nothing is found in the literature about the iron ore potential of the Congo craton which outcrop in Cameroon, Congo and Gabon owned to the fact that no mine has been developed in this area.

Previous studies in this area have focused on the tectonic evolution of the area (Toteu et al., 1994, Ngako et al., 2004, Toteu et al., 2006, Ngako et al., 2008, Milesi et al., 2006, Suh et al., 2008), with little or no attention to the economic potential of this world class iron ore deposit. This paper presents the geological setting of the Mbalm iron ore deposit within the clusters of deposits of the Congo craton as baseline information into the potential world class iron ore province.

Local Geology

The Mbalm Iron ore deposits are located in the South eastern part of Cameroon near the frontier with the Republic of Congo. They are typical supergene hematite enrichments from an Archean BIF protore which have been recrystallised to ferruginous quartzite. The massive hematite deposits of the Mbalm region form part of the Mbalm Series, an Archean greenstone belt composed of chlorite sericite or amphibolite schists, pyroxene-bearing amphibolites and serpentinites. The Mbalm Greenstone Belt occurs on the northern margin of the Congo Craton (Fig. 1) which has been age-dated at 2,850 Ma. Similar greenstone terrains with BIF within the Congo Craton are also known from the High Ivindo in Gabon and Nabeba in the Congo.

The Mbalm Series represents metamorphosed pelitic and minor psammitic rocks, BIF, mafic volcanics, intrusive rocks and serpentinite. The metamorphic grade is unknown and the mineral paragenesis is not compatible suggesting possibly an amphibolite facies metamorphism overprinted by a lower grade sericite and chlorite bearing greenschist event.

Unconformably overlying the Archean rocks in the Project area are flat dipping, metamorphosed and deformed sandstones, conglomerates and shales of the Lower Dja Series. These rocks represent fluvial, deltaic and shallow marine sedimentary rocks that have been correlated with the Franceville Series in Gabon and dated at about 2,150 million years. In the Mbalm area the discontinuity between the Archean rocks and overlying Lower Dja Series is marked by a conglomerate horizon. This unit is an important host rock for uranium mineralisation in the Franceville Basin.



Figure 3: Itabirites of Mbalm Iron Ore Project are typically gray-brown to dark grey in colour, show pronounced bands and or laminations of iron oxides and silica, and have been tightly folded with subvertical plunge of the fold axis.

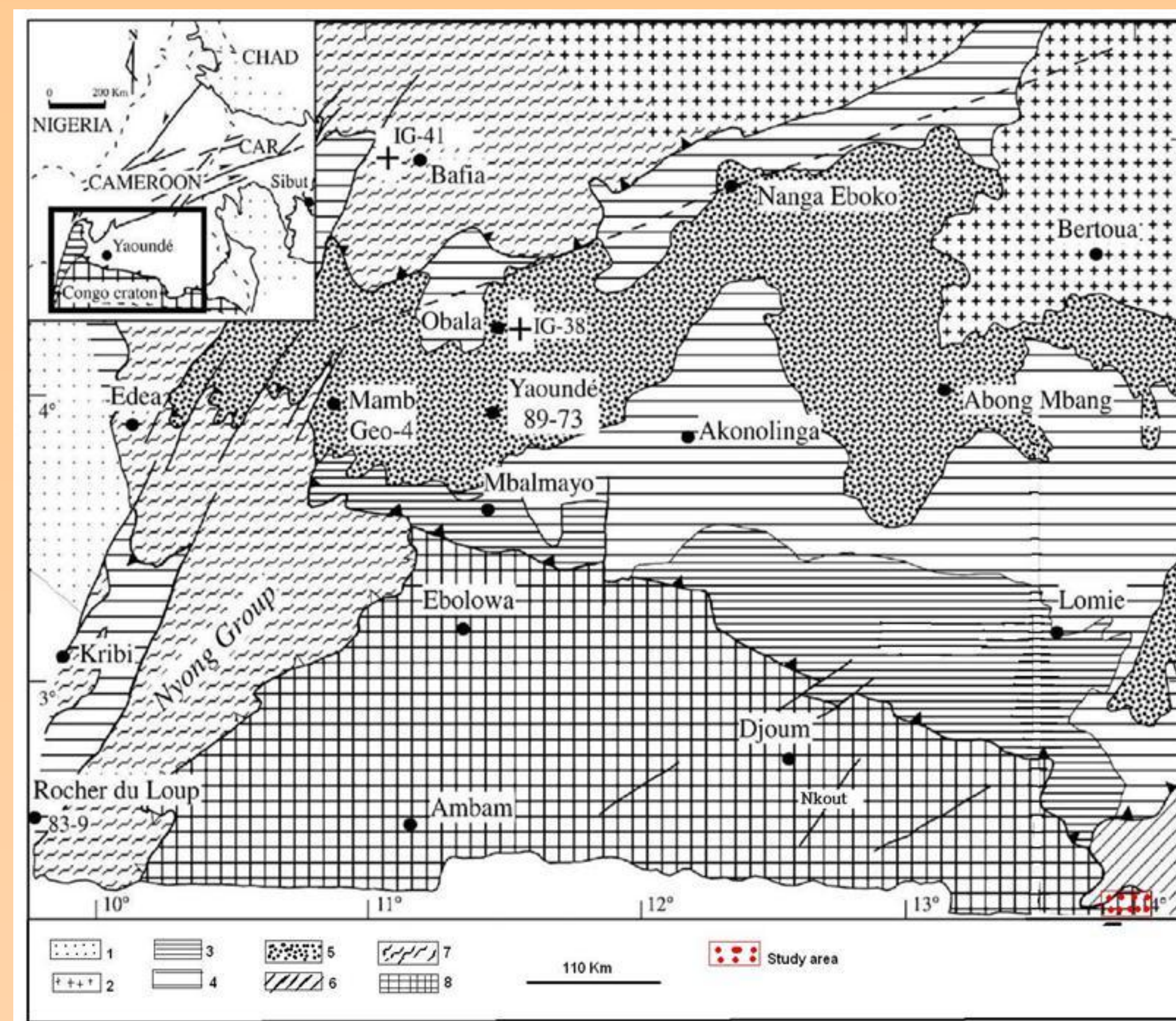


Figure 1: Geological Sketch map of the southern Cameroon (modified from Toteu et al. 2006) showing the study area. (1) Coastal Cenozoic basin, (2) Pan-African granitoids; Yaounde Group with (3) Low-grade schists, (4) medium-grade schists, (5) high-grade gneisses and granulites, (6) schisto-doleritic complex, (7) high-grade Paleoproterozoic or assumed gneisses (Nyong and Bafia Group), (8) Archean Congo craton. Insert: Location of the studied area in the central African fold belt (white).

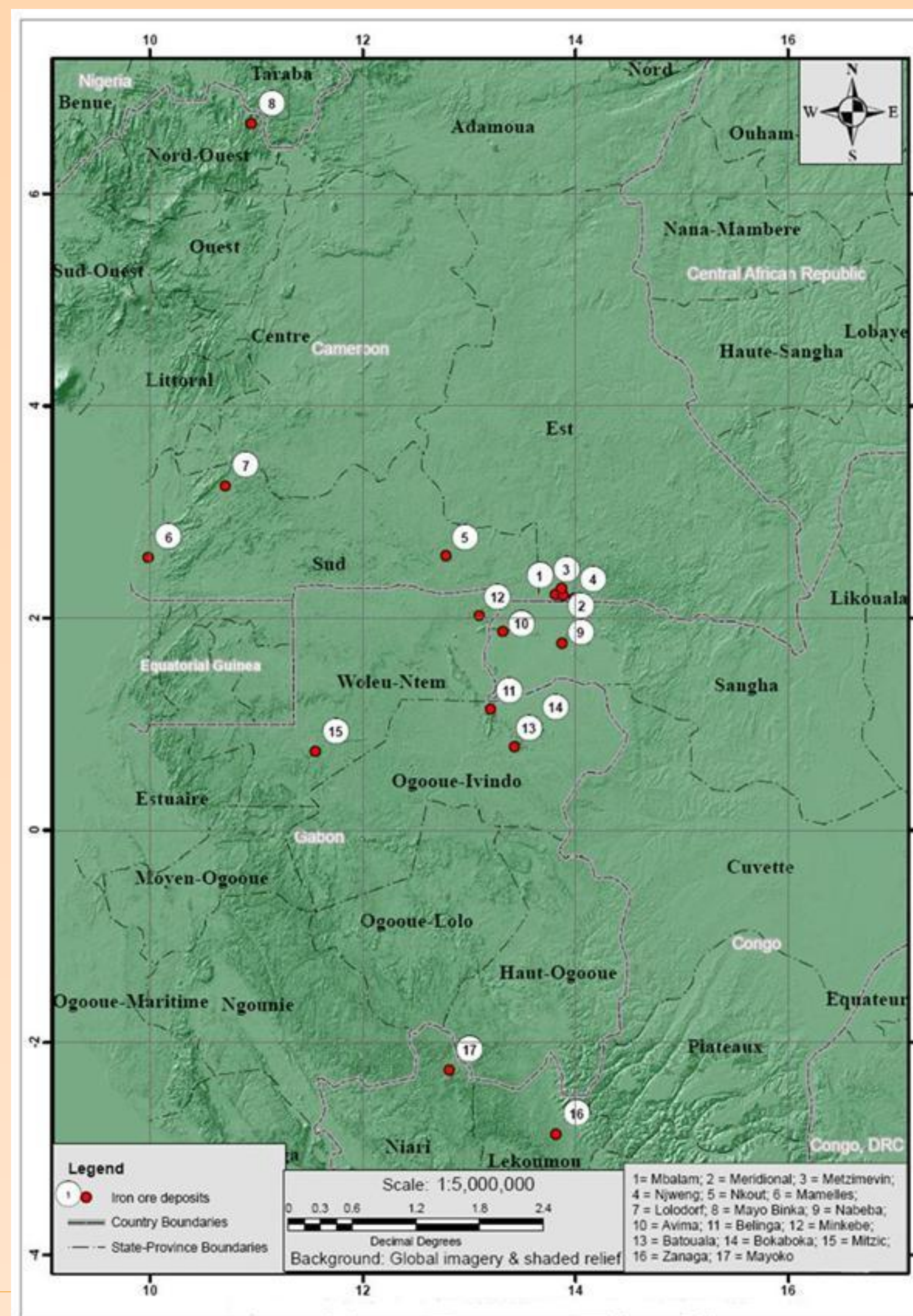


Figure 2: Location of the Mbalm Iron Ore with the know BIF clusters (Iron Ore distribution) in the Congo craton.



Figure 4: High grade enriched soft laminated (biscuity) supergene ore (DSO) at Mbalm. DSOs are limited or related to a very well defined plateau with deep soil and areas of laterite development.

Regional Exploration and Economic Implication

The cluster of known BIF deposits on the Archean Congo Craton in Cameroon, Congo Republic and Gabon are shown in Figure 2. In 1976 and 1984, the UNDP undertook limited reconnaissance exploration work over Mbalm area and were successful in locating massive hematite deposits. The four hematite occurrences discovered at Mbalm are located at Mbarga, Metzmevin, Njeng and Meridional (fig. 2). Although the UNDP undertook this study, very little geological information concerning the deposit, its mineral chemistry is available in the literature.

The itabirite of Mbalm vary in character along strike with generally very steep dips. The itabirite equally shows great variation in the thickness of alternating quartz-rich and Fe-rich layering and in overall Fe content. The variations are due in part to primary depositional features and partly to the intense deformation and metamorphism. The layering varies from sub-mm fine laminations to cm scale. Where the layering is very fine scale it shows great structural complexity and its own its character to strong shearing and transposition (figure 3). A distinctive itabirite characterised by magnetite, amphibole and carbonate with cm-scale banding is also found within the project area.

High grade enriched soft laminated (biscuity) supergene ore (Fig.4) at Mbalm are limited or related to a very well defined plateau with deep soil and areas of laterite development. This relationship of soft enriched ores to plateaus is seen in other know iron ore cluster in the Congo craton e.g. Nabeba in Congo, Avima and Belinga in Gabon, and an origin related to supergene enrichment on those surfaces is the most likely.

Enrichment of iron ore in this area follows the principal NE-SW structural corridor which can extend for more than 8km. The hard hematite is a late epigenetic type of mineralisation which forms flat-lying to gently north dipping veins up to 10m thick or more that follow low angle brittle south-verging thrust faults. Folds are tight to isoclinal that have been refolded by a later generation folds. One other common type of structure is ladder veining in hematite bands.

Sundance Resources Ltd confirmed extensive supergene mineralisation from surface to drill depths averaging around 50m and inferred mineral resource of direct shipment ore (DSO) quality hematite at the Mbarga and Mbarga South Deposits to a tune total 220 million tonnes at an average grade of 60.1% Fe with 0.09% P.

Contiguous and across the frontier to the south in the Congo Republic are a number of known BIF occurrences at Avima, Nabeba, Badongo and Letioukba (Fig.2). High grade at +62.9% Fe with low P of 0.02% are known from Nabeba, located about 60 km from Mbalm. Kumba Resources Ltd announced deposits in Gabon with +60% Fe with slightly high P at 0.11%, although low P zones are known. The Zanaga (Fig.2) deposit has quoted grade of 50% Fe and 0.03% P and Mayoko has grades of 56.2% Fe with P at 0.24%.

Selected References

- Beukes N.J., Mukhopadhyay J. and Gutzmer J. (2008): Genesis of high-grade iron ores of the Archean iron ore group around Noamundi, India. *Economic Geology* 103, 365 – 386.
- Dalstra Hilke and Guedes Sergio (2004): Giant hydrothermal hematite deposits with Mg-Fe metasomatism: a comparison of the Carajas, Hamersley, and other iron ores. *Economic Geology* 99, 1793 – 1800.
- Lerouge C., Cocherie A., Toteu S.F., Penaye J., Milesi J.P., Tchameni R., Nsifa E.N., Mark Fanning C., and Delouie E. (2006): Shrimp U-Pb zircon age evidence for Paleoproterozoic sedimentation and 2.05 Ga syntectonic plutonism in the Nyong Group, South-Western Cameroon: consequences for the Eburnean – Transamazonian belt of NE Brazil and Central Africa. *Journal of African Earth Sciences* 44, 413 – 427.
- Milesi, J.P., Toteu, S.F., Deschamps, Y., Feybesse, J.L., Lerouge, C., Cocherie, A., Penaye, J., Tchameni, R., Moloto-A-Kenguemba, G., Kampunzu, H.A.B., Nicol, N., Duguey, E., Leistel, J.M., Saint-Martin, M., Ralay, F., Heinry, C., Bouchot, V., Doumngang Mbaigane, J.C., Kanda Kula, V., Chene, F., Monthel, J., Boutin, P., and Caliteux, J. (2006): An overview of the geology and major ore deposits of Central Africa: Explanatory note for the 1:4,000,000 map "Geology and major ore deposits of Central Africa". *Journal of African Earth sc.*, 44, pp. 571-595
- Suh C.E., Cabral A.R., Shemang E.M., Mbinkar L., and Mboudou G.G.M. (2008): Two contrasting iron deposits in the Precambrian mineral belt of Cameroon, West Africa. *Exploration and Mining Geology* 17 (3-4), 197 – 207.
- Toteu S.F., Penaye J., Van Schmus W.R., and Michard A. (1994): Preliminary U-Pb and Sm-Nd geochronologic data on the North-Central Cameroon: contribution of an Archean and paleo-Proterozoic crust to the edification of an active domain of the Pan-African orogeny. *C.R. Acad. Sci. Paris*, 319 serie II, 1519 – 1524.
- Toteu S.F., Van Schmus W.R., Penaye J., and Njobe J.B. (1994): U-Pb and Sm-Nd evidence for Eburnean and Pan-African high-grade metamorphism in cratonic rocks of southern Cameroon. *Precambrian Research* 67, 321 – 347.
- Toteu S.F., Fouateu R.Y., Penaye J., Tchakounte J., Mouangue A.C.S., Van Schmus W.R., Delouie E., and Stendal H. (2006): U-Pb dating of plutonic rocks involved in the nappe tectonic in southern Cameroon: consequence for the Pan African orogenic evolution of the central African fold belt. *Journal of African Earth Sciences* 44, 479 – 493.

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