Annales de la Société Géologique de Belgique, T. 102 - 1979, pp. 531 - 536

METALLOGENIC ASPECTS OF THE SHABAN COPPERBELT, ZAIRE

by

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(2 figures and 1 table)

RESUME.- On sait que trois horizons stratigraphiques Katangiens relevant de l'arc lufilien du Shaba portent des minéralisations :

1) Le groupe des Mines renferme des minerais cupro-cobaltifères de grande extension; on pourrait y lier génétiquement des dépôts uranifères tels Shinkolobwe en évoquant la remobilisation du contenu métallique d'argiles riches en matière organique.
2) Le groupe Mwashya renferme dans un contexte volcano-sédimentaire (type Shituru) des dépôts cuprifères qu'accompagnent divers autres métaux. On pourrait penser à une liaison génétique entre ces dépôts et les concentrations ferrifères du sud-copperbelt.
3) Le Kundelungu inférieur renferme les dépôts polymétalliques du type Kipushi ainsi que des minéralisations ferrifères. L'examen des métaux présents en trace au sein de ce dernier type de minéralisation suggère une relation avec les dépôts du copperbelt et/ou avec ceux du type Kipushi.

ABSTRACT.- The Katangan strata of the Lufilian arc in Shaba contain metalliferous deposits at three principal stratigraphic horizons :

1) The Mines Group contains widespread copper-cobalt ores, and may have given rise to Shinkolobwe-type uranium ores by remobilization of metals from organic-rich shales.
2) The Mwashya strata host copper deposits characterized by a complex array of other ore metals within a volcano-sedimentary environment (Shituru-type mineralization). Iron deposits south of the copperbelt may be distal affiliates of the Shituru ore.
3) Lower Kundelungu beds contain polymetallic Kipushi-type ore and iron deposits. Trace metals in at least one of the iron deposits suggest genetic links to the Mines Group copper-cobalt ores and/or to Kipushi-type ores.

INTRODUCTION

The Katangan strata of Shaba (Zaire) are host to several important ores within the lufilian arc : extensive stratiform copper-cobalt ores (e.g., those of the Kamoto mining district); uranium ores (e.g., the famous Shinkolobwe deposit); and polymetallic base-metal deposits (e.g., the Kipushi orebody). These same strata have also been reported repeatedly (e.g., OOSTERBOSCH, 1963; DEMESMACKER *et al.*, 1963; FRANCOIS, 1974) to contain several other spatially and geochemically-related metal assemblages of regional metallogenic significance. Unfortunately, little attention seems to have been given as yet to the regional association of both major and minor metals within the Katangan. A synthesis of available published data on these metals and their distributions in Shaba suggests that distinctive metallogenic events may be traced in a north-south direction across the Lufilian arc.

GEOLOGIC CONTEXT AND DISTRIBUTION OF THE STRATIFORM COPPER-COBALT MINERALIZATION

No complete sequence of Lower Katangan (Roan Supergroup) strata (Table 1) has yet been recognized in the Shaban copperbelt of Zaire. The lowermost sediments (RAT Group = R.1) are composed of fine-grained sandstones and pelites of various reddish hues

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Table 1.- Stratigraphic nomenclature of the Katangan System (BARTHOLOME et al., 1973).

Supergroup	Group		Subdivision	
Kundelungu Supergroup	Upper			
	Lower			
Roan Supergroup	Mwashya Group	= R.4		
	Dipeta Group	= R.3		
	Mines Group	= R.2	R.2.3	= CMN
			R.2.2	= SD (Upper Ore Horizon at base)
			R.2.1.3	= RSC
			R.2.1.2	= RSF + D. Strat. (Lower Ore Horizon)
			R.2.1.1	= RAT grises
	RAT Group	= R.1		

attributed to a hematitic pigment (i.e., oxidizing conditions). The top of this unit is marked by an erosional surface overlain by the well-known Mines Group.

The typical Mines Group strata (R.2) are composed of post-Kibaran pre-Lufilian shallow-water sediments of Upper Proterozoic age (between approximately 890 and 1300 m.y. according to CAHEN, 1974). The R.2 unit begins with a basal footwall conglomerate (RAT grises) which gives way conformably upward to the chiefly greyish (reducing conditions) beds of the mineralized zones (the D. Strat. and RSF beds of the lower ore horizon, and the lower SD beds of the upper ore horizon). The occurrence of copper-cobalt ores at the transition from hematitic to organic-rich sulfide-bearing beds in the Shaban copperbelt is a feature shared with many other stratiform copper deposits (e.g., the Kupferschiefer; White Pine, Michigan).
Several detailed studies on the nature and origin of the Mines Group ore (e.g., BARTHOLOME, 1962, 1974; BARTHOLOME *et al.*, 1973) show that the mineralization is due to an early, post-sedimentary influx of ore metals upon originally organic-rich pyritic sediments.

Subsequent deformation broadly attributed to the Lufilian orogeny (see CAHEN, 1974, for greater details) produced a multitude of east-west trending folds and thrust faults parallel and sub-parallel to the Lufilian arc. According to classic tectonic interpretations, the lower Roan strata have been thrust northward over younger Kundelungu beds and have been simultaneously broken up into a mega-breccia in which breccia blocks are commonly the dimension of major orebodies. According to GRUJENSCHI (1978), the breccias represent a sedimentary mélange, a Katangan wildflysch derived from previously folded Mines Group strata transported and redeposited in a more northerly post-Mines Group geosyncline. Interpretations of this nature may lead to important additional metallogenic revisions in the future.

Studies of the unmetamorphosed Katangan sediments have resulted in the delineation of numerous "facies" within the Mines Group (FRANCOIS, 1974). These facies, composed principally of several representative mineralized sections across the Lufilian arc, occupy adjacent and partially overlapping arcuate zones parallel to the well-defined copperbelt. In a north-south profile, FRANCOIS observes gradual increases and decreases in the thicknesses of Mines Group subunits and eventual pinch-outs of some beds. Copper-cobalt mineralization varies in thickness, in grade and in Cu/Co ratios from facies to facies (fig. 1) :

1. **Musonoi-Kalumbwe facies** : These facies exhibit the classic Mines Group stratigraphy such as seen in the Kamoto mining district. Two distinctive ore horizons, each 10-15 metres thick, are separated

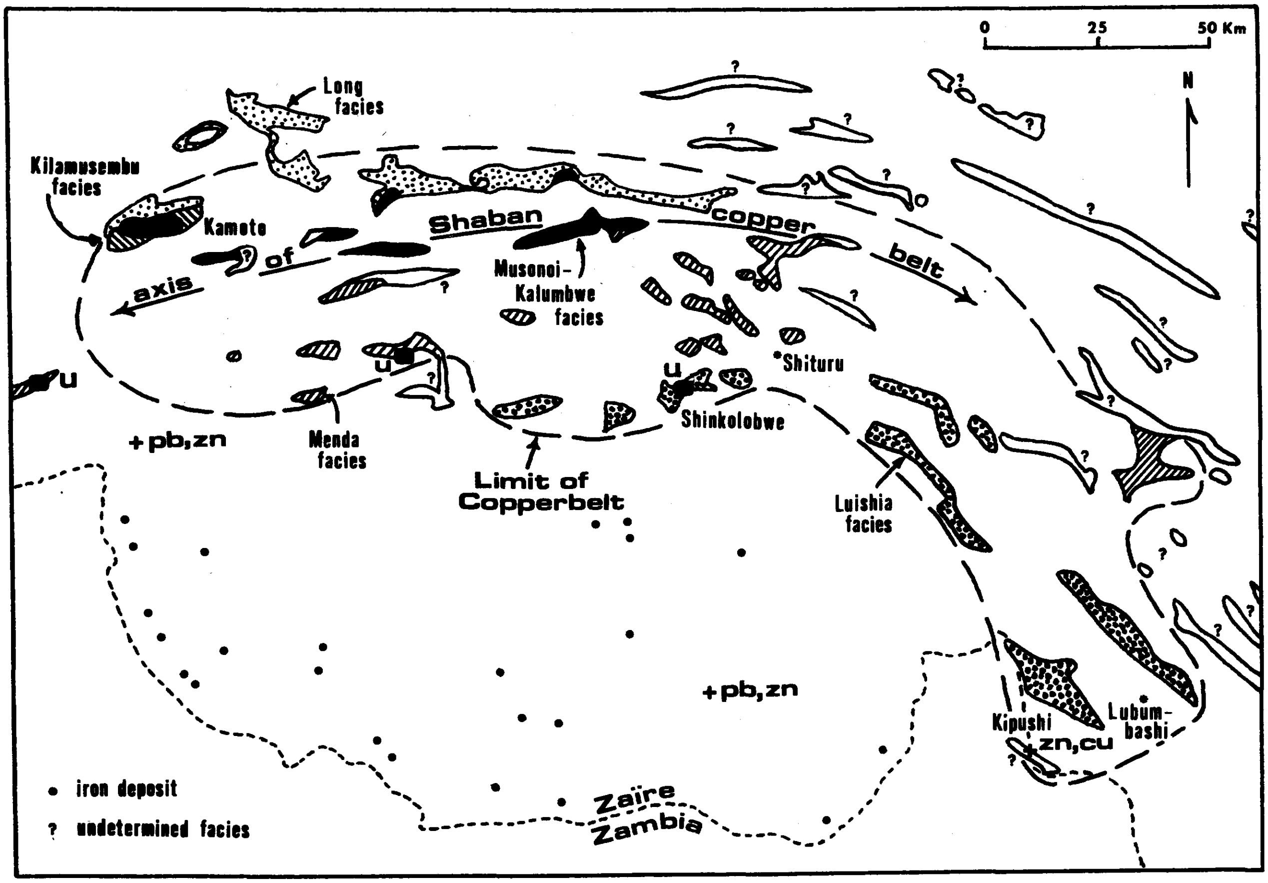

Figure 1.- Facies of the Mines Group (R.2) after FRANCOIS (1974), and location of known mineralization in the Lufilian arc of Shaba according to DEMESMACKER et al. (1963).

by a poorly-mineralized 15-20 metre thickness of massive siliceous dolomite (RSC). In general, the upper ore horizon is cupriferous and cobaltiferous, while the lower ore horizon is cobalt-poor. These facies form a narrow arcuate zone enclosing the major mines of the Shaban copperbelt. Other facies of lesser economic interest occupy broad parallel zones to the immediate north and south of the Musonoi-Kalumbwe facies and give appreciable breadth to the copperbelt as illustrated in figure 1.

2. **Kilamusembu facies** : The upper ore horizon of this northern facies is found to be cobalt-rich and copper-poor, while the lower horizon is both copper and cobalt-rich.

3. **Long facies** : In this most northerly facies, the upper "ore" horizon is unmineralized and the lower horizon contains only minor amounts of copper.

Thus, northward from the Musonoi-Kalumbwe zone, the upper ore horizon becomes progressively more weakly mineralized until it is entirely sterile. Cobalt seems to be preferentially concentrated toward the top of the cupriferous zone of the Musonoi-Kalumbwe and Kilamusembu facies, and pinches out with copper in a northerly direction.

The southern portions of the Lufilian arc are characterized by the Menda and Luishia facies :

4. **Menda facies** : Where mineralized, the upper horizon is cupriferous while the lower is cupro-cobaltiferous (contrasting with copper-cobalt in the upper and copper only in the lower ore horizons to the north). In some cases, the Menda facies is poorly-mineralized or even sterile.

5. **Luishia facies** : The Mines Group strata are commonly poorly-mineralized, or well-mineralized only in the basal beds of the lower ore horizon.

From these brief descriptions, it can be seen that copper-cobalt mineralization decreases markedly to the south as well as to the south of the central Musonoi-Kalumbwe facies.

OTHER OCCURRENCES OF COPPER

Copper is found in more restrictive settings and minor abundaces levels above the lower Roan stratiform ores. Impregnations, fracture coatings and veinlets of malachite occur in altered rocks believed to belong to grabbroic horizons of the Dipeta (R.3) Group, and sparse dissemination of chalcopyrite have been seen in nearby exposures of underlying unaltered dolomitic beds (FRANCOIS, 1974).

The Mwashya (R.4) Group has been mined for stratiform copper in dolomites and dolomitic shales associated with a chloritized pyroclastic unit at Shituru (LEFEBVRE, 1973, 1974). Other deposits in the Mwashya (one near the Kamoto district) contain important quantities of cobalt as well as copper.

The Kundelungu Supergroup also hosts important amounts of base metals including copper. Polymetallic deposits such as the Kipushi orebody (Zn, Cu, Pb, As, Cd, Bi, Ge, Ga, Mo, W, V, Ag) located within the Lower Kundelungu have been classed as hydrothermal replacement vein deposits. Showings of chalcopyrite-pyrite mineralization have also been observed at numerous locations in association with detrital and dolomitic beds at various levels throughout the Upper and Lower Kundelungu.

In conclusion, copper was obviously emplaced along with both simple and complex assemblages of other metals at a multitude of stratigraphic levels within the Katangan strata. While the nature of the cupriferous deposits varies greatly both laterally and vertically across the Lufilian arc (from stratiform dissemination, to hydrothermal veins, to volcanogenic affiliations), these clearly different types of mineralization show many spatial and stratigraphic affinities to other metals in the Katangan.

METALLOGENICALLY-ASSOCIATED METALS

URANIUM (NICKEL-COBALT)

The lower horizon of copper-cobalt ore is also known for uranium mineralization, especially along the southern edge of the copperbelt and in equivalent facies of the Mines Group further to the south. Nickel, and to a lesser extent copper, cobalt, selenium, cerium and precious metals, commonly accompany uranium. FRANCOIS (1974) suggests that uranium and its associated metals were remobilized and concentrated into economic grades in structural sites such as mylonitized zones.

ZINC (LEAD-COPPER)

As stated earlier, the Kipushi-type ores are considered to have had hydrothermal vein origins. The ultimate source of this mineralization is poorly understood, but it is notable that three deposits of this category occur at the same stratigraphic level (Lower Kundelungu), and they form a linear east-west trend south of the copperbelt (fig. 1).

BARTHOLOME (1974) reports that no sphalerite or galena have been found in the Kamoto ores at the Mines Groum level.

IRON

A number of iron deposits have been located, mostly to the south of the copperbelt (fig. 1). Three conformable lenticular occurrences of iron are known to occur at the same stratigraphic level as the Kipushi-type deposits (Lower Kundelungu). This coincidence suggests that there may be a genetic relationship between such iron deposits and the polymetallic vein ore. One of the iron deposits (Kisanga) contains traces of copper, cobalt, zinc and gold, reinforcing this concept of a genetic link to Kipushi-type mineralization along the Lower Kundelungu.

The Mwashya (R.4) strata contain iron mineralization in the form of stratiform hematitic (possibly taconitic or volcanogenic) deposits along pelitic-dolomitic beds within the copperbelt (e.g., at Shituru : LEFEBVRE, 1973, 1974), and numerous sub-stratiform lenses of hematite and magnetite-bearing siliceous shales to the south of the copperbelt.

METALLOGENIC SIGNIFICANCE OF THE METALS AND THEIR DISTRIBUTIONS

Figure 2 summarizes the principal regional metallogenic features that arise from the above observations. In this very generalized sketch, it can be seen that :

1. Kamoto-type stratiform copper-cobalt ores and vein-type uranium deposits characterized by complex metal assemblages occur at the same stratigraphic level, in the Mines Group (R.2) beds. The widespread stratiform Cu-Co mineralization at the base of the organic-rich Roan sequence is considered to be syn-diagenetic in origin, with sulfur enrichment due to very early deposition of disseminated iron sulfides which were soon replaced in the cupriferous zone by copper-iron and cobaltiferous sulfides (BARTHO-

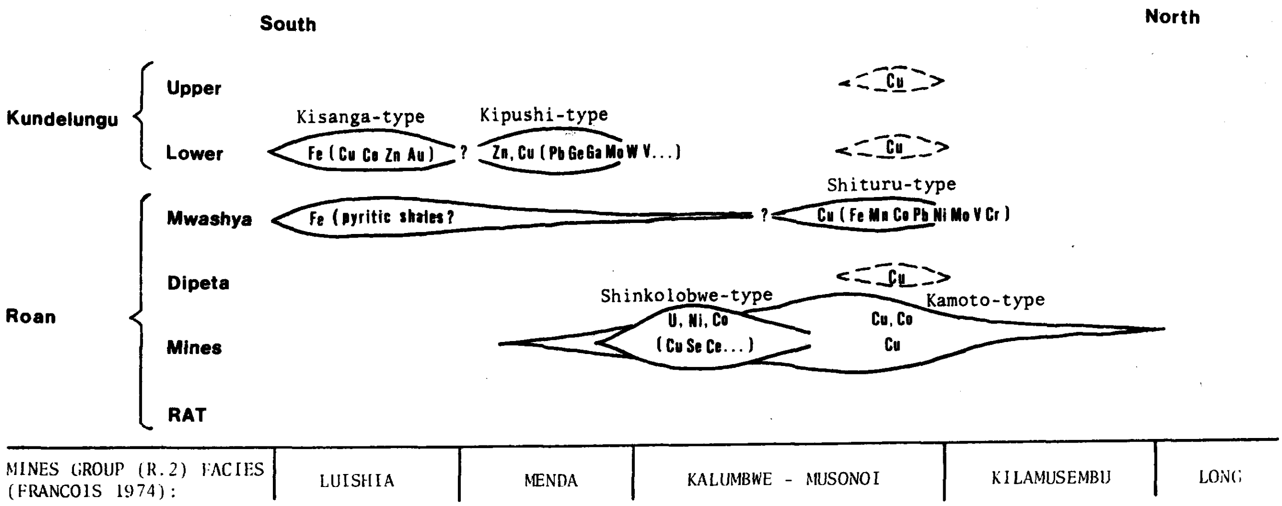

Figure 2.- Stratigraphic location of mineralization across the Lufilian arc with reference to the facies described by FRANCOIS (1974).

LOME, 1974; BROWN, 1978).

The structurally-controlled occurrences of complex uranium vein mineralization (Shinkolobwe-type) in host-rocks at the R.2 horizon suggest a genetic relationship to the Kamoto-type ore. This possible association is supported by the abundance of copper and cobalt in both deposit-types. Furthermore, the complex array of many metals in vein-type uranium deposits has been cited as indicative of ores remobilized from the anomalous traces of similar metals found in organic-rich source-beds (e.g., DAKLKAMP, 1978; DAVIES, 1979), and it would be interesting to apply the same genetic model to be Shaban uranium deposits.

Since the principal uranium deposits occur along the southern margin of the copperbelt proper, it would appear that the R.2 beds were preferentially more enriched in uranium (and perhaps its associated metals) in the Kalumbwe facies than in the copper--cobalt-rich Musonoi facies; or else the remobilization process favored uranium mobility in the Kalumbwe facies.

2. At the Mwashya (R.4) level, there is possible volcanogenic mineralization within the copperbelt at Shituru, **and** many occurrences of iron mineralization associated with R.4 shales south of the copperbelt. The Shituru copper deposit is considered to be syngenetic and volcanogenic in origin (LEFEBVRE, 1974), and its local stratiform iron deposits hosting complex assemblages of ore metals may also have resulted form volcanic activity during sedimentation. Could the sedimentary-hosted iron deposits at the R.4 horizon south of the copperbelt be distal equivalents of the volcanic-affiliated mineralization at Shituru ?

3. Polymetallic Kipushi-type deposits (predominantly zinc-lead-copper mineralization in vein-type configurations) occur at the same stratigraphic level (Lower Kundelungu) as conformable iron deposits containing traces of several ore metals (copper, cobalt, zinc and gold). Again it is intriguing to note the similarities and differences of these two types of mineralization, and to consider a possible genetic link between them. The presence of copper and cobalt in one of the Kundelungu iron deposits suggests first that there is a relationship to the stratigraphically-deeper Mines Group stratiform copper-cobalt ores further north. Recurrences of minor copper mineralization are found at many levels in the Katangan strata including the Lower Kundelungu of the copperbelt facies, and it should not be too surprising to find traces of copperbelt metals in the distant southern facies as well. The polyetallic character of the Kipushi ore and of at least one of the Kundelungu iron deposits also suggests a possible common genesis (hydrothermal and exhalative processes ?) between these mineralizations, and a regional zoning of metals specific to the complex signature of each deposit-type.

The above-mentioned observations and interpretations are clearly based on limited data from both the field and laboratory. Hence, they should be seen as speculations on possible regional metallogenic relationships in the Lufilian arc of Shaba. However, it is hoped that this synthesis of facts and ideas on the copperbelt mineralization will lead to further useful discussions and investigations. Certainly such conceptual hypothesizing was a common and fascinating preoccupation of our late friend Paul BARTHOLOME, and I like so many others now miss his gentle advice and insight in such reviews of regional metallogeny.

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