



Review

A weathered skarn-type mineralization in Ivory Coast: The Ity gold deposit



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ABSTRACT

Although the Ity deposit is the oldest operating mine in Ivory Coast, very few studies exist on this deposit. It is situated in Western Ivory Coast, some 700 km northwest of Abidjan. The mine is presently operated and mined by SMI (*Société des mines d'Ity* – Society of Ity Mines), and has produced one million ounces of gold since its opening in 1991. All mined ore bodies are hosted in laterite and clay formations. The gold deposits in the Ity area form a cluster of mining operations of various sizes (Flotouo, Zia, Mont Ity), hosted in a Birimian volcano-sedimentary belt. The mineralization is mostly located at the contact between a granodiorite–tonalite intrusive body and sediments. Primary gold mineralization occurs in the form of veinlets and, mostly, skarn at the contact between the granitic intrusion and limestone. Calc-silicate minerals such as diopside and andradite dominate the skarn. However, the economic gold mineralization at Ity is associated with the saprolitic zone (50–120 m thick), and consists of several mineralized lenses of clayey and ferruginous material (“*Terres noires*”), and of sedimentary breccia layers. A thick laterite horizon (a minimum of 10 m) overlies the saprolite and covers the land throughout the region; it is mineralized in the deposit area. This contribution provides a summary of the geological and mineralogical relationships at the Ity deposit, presents new data on skarn-type gold mineralization, and summarizes its history, from the first findings, through exploration and mining assessment.

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1. Introduction

Gold deposits of various types have been recognized in the Paleoproterozoic greenstone belts of the West African Craton. They are mainly orogenic gold deposits (e.g., Béziat et al., 2008 for Burkina

Faso; Oberthür et al., 1994; Allibone et al., 2002; Feybesse et al., 2006 for Ghana; Lawrence et al., 2013 for Mali) but also modified Cu–Au porphyry (e.g., at Gaoua, Siebenaller et al., submitted for publication) or intrusion-related gold (e.g., at Morila, McFarlane et al., 2011; Hammond et al., 2011) and paleoplacers (e.g., at Damang, Pigois et al.,

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2003; see also Milési et al., 1989 for a review). Ivory Coast hosts numerous gold deposits and workings including those at Ity, the Afema gold district (Kadio et al., 2010), the Agbaou deposit within the Oume–Fetekro greenstone belt in the Bonikro and Angovia districts (Milési et al., 1989), and the Tongon deposit from the Senoufo greenstone belt (Greyling et al., 2013). At Ity, like in the Bonikro district, gold is extracted from the supergene mineralization. This is a relatively classic scenario in West Africa, where a vertical succession of alteration profiles described as saprolite grade into a lateritic horizon, both hosting supergene gold from primary, often hidden mineralisation hosted in volcano-sedimentary units (Milesi et al., 1989; Bamba et al., 2002). However, the original aspect of this deposit is the presence of primary mineralization in skarn developed around granitoid intrusions, which are still unexploited.

This is a review article contributing to the West African minerals Atlas Monograph, presenting the state-of-the-art of what is known about the Ity deposit. It is based on available data, such as published papers and technical reports (Billa, 1998; Eulry, 1999; Monthel et al., 2002; Amireault, 2006; Camus et al., 2008), as well as on original data from the skarn-type mineralization.

2. Exploration history

In the 1950s, discovery of copper and gold in placers near the village of Ity attracted the attention of the French mining authorities (*Bureau Minier de la France d'Outre Mer*). The *Division Fédérale des Mines et de la Géologie* began exploring the area in 1955. Pit and drift explorations led to the discovery of gold mineralization, which was later estimated by BRGM (French geological survey – *Bureau de Recherches Géologiques et Minières*) to contain 11.5 tons of ore resources grading at 16.7 g/t Au (BRGM, 1971). However, all attempts to extract gold economically failed due to metallurgical problems, such as the fineness of the gold and the rheology of the clay ore.

In the 1980s, BRGM continued exploration and in 1990s the Société des Mines d'Ity (SMI) was incorporated into the project. A suitable ore process was designed and successfully implemented. Construction of the first open-pit mine, Flotouo, began on the same year, and the first gold ingot was poured in January 1991. A few years later, mining began at Zia (the northeastern extension of Flotouo). BRGM created COMINOR (Compagnie Minière Or), in order to receive some of the assets from La Source during the separation between BRGM and Normandy-Poseidon Mining Group; this included SMI as well as other Ivory Coast exploration properties and other assets in various countries. In September 2002, Ivory Coast was practically split in half by civil unrest. The mine, which was strategically located at the contact between the opposing factions, was attacked and looted on November 30, 2002, and the site

was abandoned from December of that year to June 2003. During the mine closure, COMINOR completely rebuilt and updated the geological database, and developed a new mine plan. At present, the SMI capital stock is distributed as follows: 45.9% to COMINOR, which has been recently replaced by La Mancha; 44.1% to SODEMI; and 10% to the Ivory Coast government.

Since opening, the site has produced nearly one million ounces of gold from mineralization in laterites and clay ore; from 2011 to 2014 the mine has produced 37, 54, 82 and 75 Koz Au for each year, respectively (www.lamancha.com). Presently, the mine consists of three open pits: Flotouo, Zia and Mount-Ity; only the latter is still exploited, the two other pits being filled with waste. Several drilling campaigns (DDH) were organized in order to extend the geological knowledge to the northeast of Mt-Ity. At present, the ore is treated by heap leaching by cyanide; gold is recovered as gilt on active carbon, and ingots are poured on site. The main features of the Ity deposit are summarised on Table 1.

3. Regional geological overview

The southern part of the West African Shield, known as the Leo–Man Craton, comprises the Archean Kenema–Man domain to the west and the Paleoproterozoic Baoulé–Mossi domain to the east, separated by the transcurrent Sassandra fault (Bessoles, 1977; Milési et al., 1989; Boher et al., 1992; Kouamelan, 1996) (Fig. 1a). The Ity gold deposit is located ca. 100 km west of this fault. The basement units belong to the Kenema–Man domain, also known as “gneissic basement” in the mine area, which, south of the Danane–Man fault, consists of intensely deformed migmatites, gneisses and banded iron formations (BIF) that were metamorphosed to granulite facies (Kouamelan, 1996; Pitra et al., 2010). An Archean protolith was suggested for the migmatitic and charnockitic gneisses from the Logoualé area, on the basis of whole-rock Nd model ages and U/Pb ages on zircons from gneisses and granites (dated around 2.8 Ga, Kouamelan et al., 1997).

Paleoproterozoic formations in West Africa (referred to as the Birimian, after the Birim River in Ghana, cf., Yacé, 1984) correspond to a period of accretion during the Eburnean orogeny at ca. 2170–2130 Ma (e.g., Boher et al., 1992; Feybesse et al., 2006). Rocks of this age form the geology in the Ity area and include a volcano-sedimentary belt oriented NE–SW and 10 to 15 km in width, plus several granitoid intrusions (Feybesse et al., 1990; Guerrot, 1996; Kouamelan, 1996). This sequence is classically interpreted as a nappe remnant, locally named Toulépleu–Ity klippe, which forms the centre of a syncline that affected the Kenema–Man terrane (Fig. 1). In its centre, outcrops the Guiamapleu granitoid (named Toulépleu massif by Kouamelan et al., 1997), dated at 2104 Ma by whole-rock Nd model and U/Pb ages on zircons (Kouamelan et al., 1997), indicating that it had intruded into the Birimian rocks (Delor et al., 1994). In the Ity area, the Birimian units of the Toulépleu–Ity klippe belong to a stratigraphic succession known as the Ity sequence, which consists of banded amphibolite and ultramafic rocks overlain by fine-grained sediments, composed mostly of intercalated limestone, plus, locally, jasperoids and black schist. The Toulépleu conglomerate rests unconformably over the Ity sequence; it is probably of Tarkwaian age, i.e., it formed mostly at the same time as the D1 episode and was infilled as a foreland basin during D2 tectonism (Feybesse et al., 2006; see below). The youngest units that intruded the Ity sequence are felsic sub-volcanic rocks (Fig. 2).

Feybesse et al. (1990; see also Milési and Feybesse, 1993) identified two main phases of Eburnean syn-metamorphic ductile deformation (D1 and D2) and an episode of brittle deformation in the Toulépleu–Ity unit: D1 was recognised by a metamorphic foliation, S1, that affected only the basal Birimian metabasalts and metasediments. The S1 foliation was later partially transposed parallel to bedding, an episode that also boudinaged and frayed the earlier mineralised bodies. D2 affected all rock units and is essentially a transcurrent and folding phase (P2). Locally, an axial-plane crenulation cleavage (S2) is also found in syn-

Table 1
General information on the Ity deposit (Markwitz et al., 2015).

Deposit name	Ity
Commodity of exploitation	Au (Cu)
Location	Western Ivory Coast
Longitude [dec degrees]	6°53'N
Latitude [dec. degrees]	8°07'W.
Geographic location	The project is situated in Western Ivory Coast at 700 km northwest of Abidjan.
Geological location	West African Craton; Leo–Man Shield; Baoulé–Mossi Domain
Deposit status	Active mine since 1991
Deposit type	Saprolitic zone hosted; skarn hosted
Current owner	COMINOR, La Mancha (45.9%)
Average grade	3.45 g/t
Tonnage	296,100 oz measured and indicated resource; 83,540 oz proven and probable reserves (December 2010)
Past production	16,860 oz in 2011; 24,000 oz in 2010; >1,000,000 oz overall

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