Ore Geology Reviews 78 (2016) 631–638

Contents lists available at ScienceDirect

Ore Geology Reviews

journal homepage: www.elsevier.com/locate/oregeorev

The Youga gold deposit, Burkina Faso

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ARTICLE INFO

Article history:
Received 25 May 2015
Received in revised form 6 November 2015
Accepted 10 November 2015
Available online 11 November 2015

Keywords:
Gold mineralization
West Africa
Paleoproterozoic
Burkina Faso
Youga deposit

ABSTRACT

The Youga gold deposits are located in southern Burkina Faso, close to the border with Ghana and classified as epigenetic mesothermal orogenic type gold deposits. They are hosted within or adjacent to Tarkwaian-type metasediments of the Youga Basin, composed of a succession of arkosic sandstones, conglomerates and subordinate chlorite schists. The Youga deposits are characterized by two distinct styles of mineralization; the moderately to weakly silicified host rock with quartz stockwork veining and pyrite as the predominant sulphide which generally grades between 0.5 and 2 g/t and the intensely silicified arkose with abundant quartz veins and more diverse sulphides (pyrite, arsenopyrite, chalcopyrite, pyrrhotite and galena) which generally grades >3 g/t. The alteration paragenesis associated with the mineralized vein stockwork is characterized by quartz, ankerite, albite, chlorite and pyrite. The first mineralization episode occurred under brittle-ductile conditions during the $D1_Y$ deformation event characterized by E–W trending penetrative to discrete structures. Gold is concentrated in zones affected by irregular fracturing, quartz veining and occasional brecciation. Reworking of these structures during $D2_Y$, by N–S to NE-trending sub-vertical shear zones, lead to further economic concentration of gold found in eight individual deposits, all localized in or immediately adjacent to Tarkwaian-type sediments (Main, East, West Zone 1, 2, and 3, A2NE, NTV and Zergoré). Absolute age of mineralization is unknown as well as that of the host sediments; however stratigraphic and structural craton-wide correlations suggest that the mineralization occurred after 2110 Ma if not much later. Commercial production was achieved at the Youga Gold Mine in 2008 and as of December 31st, 2014 has produced 537,621 oz of gold.

1. Introduction and exploration history

The Youga gold deposits are located in southern Burkina Faso, close to the border with Ghana, in the northernmost part of the Bole-Nangodi greenstone belt. Gold in the Youga deposit is concentrated in the Tarkwaian-type meta-sediments of the Youga Basin. Gold deposits in Tarkwaian-type detrital sediments are known from other places of the West African craton, the most important being represented by Tarkwa and Damang in southern Ghana (Junner et al., 1942; Sestini, 1973; Milési et al., 1989; Milési et al., 1991; Eisenlohr, 1992; Hirdes and Nunoo, 1994; Pigois et al., 2003; White et al., 2014, 2015). Two types of mineralization were documented in the Tarkwaian-type sediments: paleoplacers (Tarkwa) and structurally controlled hydrothermal orogenic gold deposits (Damang). To date, no published study exists on the detrital sediment hosted Youga gold deposit.

Gold was first reported near the Youga village in 1938 by Van Aubel (Ashanti Goldfields Company Ltd., 2003). However, this report does not distinguish clearly if local artisanal miners were exploiting the gold bearing quartz-veins in silicified shear zones. The deposits were discovered using regional 500 m × 500 m soil geochemistry by Incanore Resources Ltd. in 1994 (Incanore Resources Ltd., 1995). The property changed hands a number of times over the next few years until 2003, when Etruscan Resources Inc. ("Etruscan") acquired the Youga exploitation permit and developed the Youga Gold Mine, which achieved commercial production in 2008. Between 2009 and 2010 Endeavour Mining Corporation ("Endeavour") acquired Etruscan. As of December 31st, 2014 the Youga Gold Mine has produced 537,621 oz of gold.

Geochemical data, used in conjunction with the available geophysical surveys and geological mapping, has been effective in the delineation of significant gold mineralization targets within the project area. This methodology continues to provide drill targets, however, given that the deposits are clearly structurally controlled, a better understanding of these controls may lead to the discovery of additional "blind" deposits. In this paper we present the current understanding of the Youga deposits.

2. Regional geological overview

2.1. Regional geology

Southern Burkina Faso is located within the eastern portion of the Paleoproterozoic terranes (Fig. 1) of the southern West African

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http://dx.doi.org/10.1016/j.oregeorev.2015.11.015
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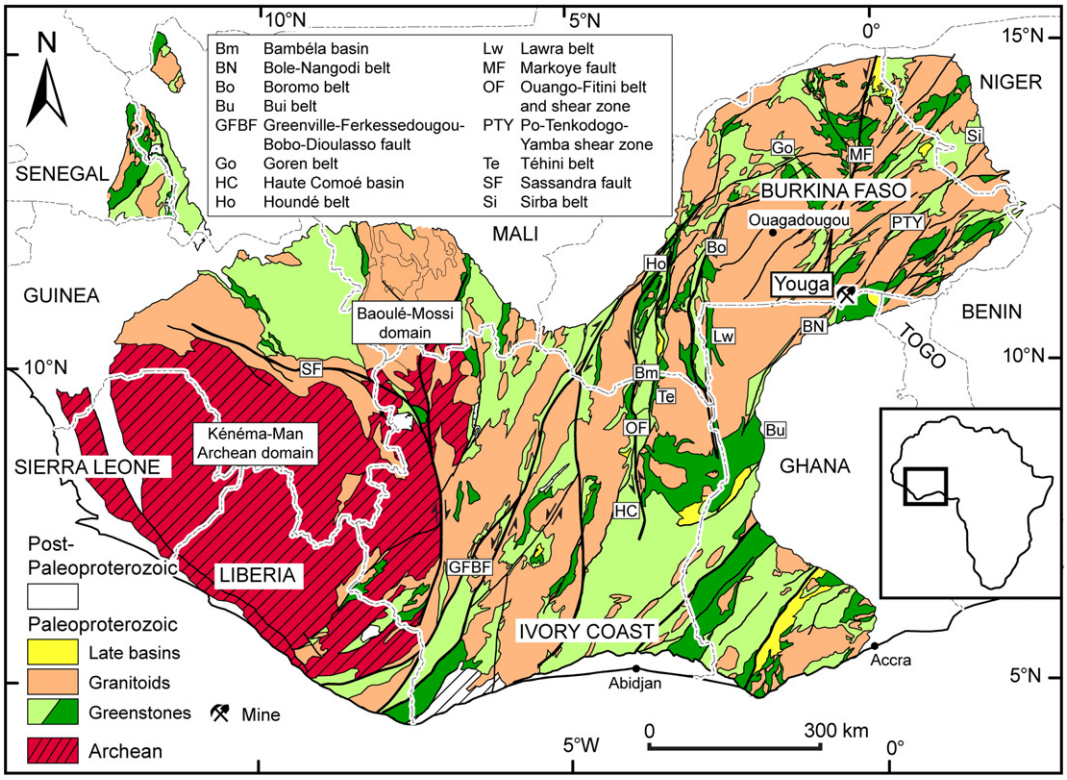

Fig. 1. Location of the Youga deposits in the West African Craton. Simplified geological map of the Leo-Man Craton (modified after the BRGM SIGAfrique map, Milési et al., 2004), with the study area indicated.

Craton (sWAC). The Birimian greenstone belts composed of volcanic and volcano-sedimentary sequences are intercalated with granitoid intrusions, ranging in age from ~2.25 Ma to 2.1 Ma (Castaing et al., 2003; Baratoux et al., 2011; Tshibubudze et al., 2013). Detrital sedimentary units of Tarkwaian-type are interpreted to be the youngest stratigraphic units and can be found across the entire sWAC (Milési et al., 1989; Bossière et al., 1996; Baratoux et al., 2011; Feybesse et al., 2006; Davis et al., 2015). The granite–greenstone terranes and Tarkwaian-type sediments were affected by the polyphase Eburnean Orogeny (Bonhomme, 1962), which operated between ~2150 and 1980 Ma (Feybesse et al., 2006; White et al., 2014; Block et al., 2015b).

The polyphase character of the Eburnean orogeny has been noted by many workers (e.g. Milési et al., 1989; Allibone et al., 2002; Feybesse et al., 2006; Baratoux et al., 2011; Block et al., 2015b). Seven deformation phases were identified in northern Ghana, a study area adjacent to the Youga Basin (Block et al., 2015b). D1 is characterized by N–S shortening, crustal thickening and tectonic burial of supracrustal rocks, which were exhumed during D2 marked by a N–S extension. These structures are overprinted by N–S to NNE-trending foliation and fold axial planes related to E–W shortening under amphibolite facies conditions attributed to D3. D4 and D5 correspond to ENE–WSW and E–W shortening, which lead to the development of localized regional-scale NNW sinistral and NE dextral shear zones. Brittle structures, such as E–W oriented tension gashes and conjugate brittle strike-slip faults crosscutting the previous structures were attributed to D6, which operated under E–W compression. The latest deformation event is characterized by NW-striking sub-vertical crenulation cleavage found only in incompetent highly anisotropic lithologies.

Metamorphic conditions in the eastern sWAC range between greenschist facies and amphibolite–granulite facies transition (Block et al., 2015b; Tshibubudze et al., 2015). Gold mineralization occurs at various stages of the Eburnean Orogeny (see Markwitz et al., 2015 for a review).

Paleoproterozoic greenstones are divided into: light green–intermediate to acid volcanoclastics and volcano-sediments, dark green–mafic to intermediate lavas and volcanic products.

2.2. Local geology

The Youga deposits are located in the Bole-Nangodi volcano-sedimentary belt, a paleoproterozoic Birimian greenstone belt which spans the border between northern Ghana and southern Burkina Faso. The northern extent of the greenstone belt is defined by a major NE-trending crustal structure, known as the Po-Tenkodogo-Yamba shear zone in Burkina Faso (Naba et al., 2004), the Bole-Nangodi shear zone in Ghana (Block et al., 2015b) and locally referred to as the Bole-Bolgatanga shear zone. The belt is bounded by high-grade metamorphic rocks and related intrusions (Block et al., 2015a). Most of the volcanic rocks of the Bole-Nangodi greenstone belt and its north-east extension to Burkina Faso including the Tarkwaian-type sediments of the Youga Basin were metamorphosed under greenschist facies conditions. Local occurrence of blueschist and amphibolite facies conditions was reported further NE in Burkina Faso (Ganne et al., 2012).

At Youga the majority of the deposits are hosted within the Tarkwaian-type detrital sediments, composed of a succession of arkosic sandstones consisting of quartz and feldspar in roughly equal proportions which are surrounded by volcano-sediments and volcanic rocks of mafic to intermediate composition (Fig. 2). The arkoses demonstrate little compositional variation and their grain size varies from fine silt to coarse sand. Bands and lamellae of detrital magnetite do occur, particularly at or near the lower contact of coarse units; otherwise distinctive bedding is not evident.

The arkoses are intercalated with thin subordinate chlorite schists. The chlorite schists have been identified in mapping by various geologists as volcanic horizons, mafic dykes and as fine-grained sediments