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Geological setting of the Wassa gold deposit, SW Ghana

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ABSTRACT

Including past production, current indicated and inferred resources, Wassa is a 5 Moz poly-deformed early-orogenic gold deposit located on the eastern flank of the Ashanti Belt, in southwest Ghana. It is hosted by metamorphosed volcanic, intrusive and sedimentary rocks of the Sefwi Group (ca. 2260–2160 Ma). Early mineralization has an Eoeburnean age (2164 ± 22 Ma, Re–Os on pyrite) and is characterized by quartz veins, by a carbonate alteration of the host rocks, and by deformed gold-bearing pyrite. Remobilization of this gold occurred during the late stages of the Eburnean Orogeny (~2.1 Ga) and is associated with quartz-carbonate veins with visible gold and euhedral pyrites.

1. Exploration history

The Wassa deposit is a multi-million ounce (Moz) low-grade orogenic gold system. Historical production is over 1 Moz of gold and current indicated resources are around 2.9 Moz (average grade of 2.06 g/t, Golden Star Resources Ltd, 2014). Wassa has been an artisanal mining area since the early 20th century. From 1994 to 1997, Wassa Mineral Resources Ltd, Moydow Resources Ltd and Glencar Mining Ltd developed a joint exploration drilling program and started industrial mining in 1998. Production stopped in 2001 and the property was sold to Golden Star Resources Ltd. After a short exploration phase in 2002 and 2003 (MacCandlish, 2003; Bourassa, 2003), mining operations restarted in 2005 and are still active with an average production of 150 koz per year. The mining schedule has been extended up to 2026 (Oldcorn et al., 2012).

2. Regional geological overview/introduction

The deposit is located on the eastern flank of the gold-rich Ashanti greenstone belt, in southwest Ghana (Fig. 1, modified after Milesi et al., 2004 and Perrouty et al., 2012). The Ashanti Belt is composed of three stratigraphic units: the Sefwi Group (>2160 Ma), the Kumasi Group (2154–2125 Ma), and the Tarkwa Group (2017–2097 Ma, Perrouty et al., 2012). These groups have been intruded by multiple generations of granitoids during the Eburnean Orogeny (~2.1 Ga, Bonhomme, 1962). The Wassa mineralized system is hosted by the Sefwi Group and is located 3 km east of the Tarkwa Basin and 2 km south and west of the Akyem Basin (Fig. 1).

The structural evolution of the Ashanti Belt is extensively described by Allibone et al. (2002a); Feybesse et al. (2006) and Perrouty et al. (2012). Six major deformation events have been identified. The D1 deformation event of Perrouty et al. (2012) corresponds to a regional scale folding of the Sefwi Group rocks, contemporaneous with an Eoeburnean magmatic phase. D2 is a possible regional-scale extension with the deposition of the Kumasi Group sediments in both the Kumasi Basin and the Akyem Basin, as proposed by Feybesse et al. (2006). D3 and D4 affected the Sefwi, Kumasi and Tarkwa groups and are characterized by NW–SE shortening (D3), developing kilometric-scale folds

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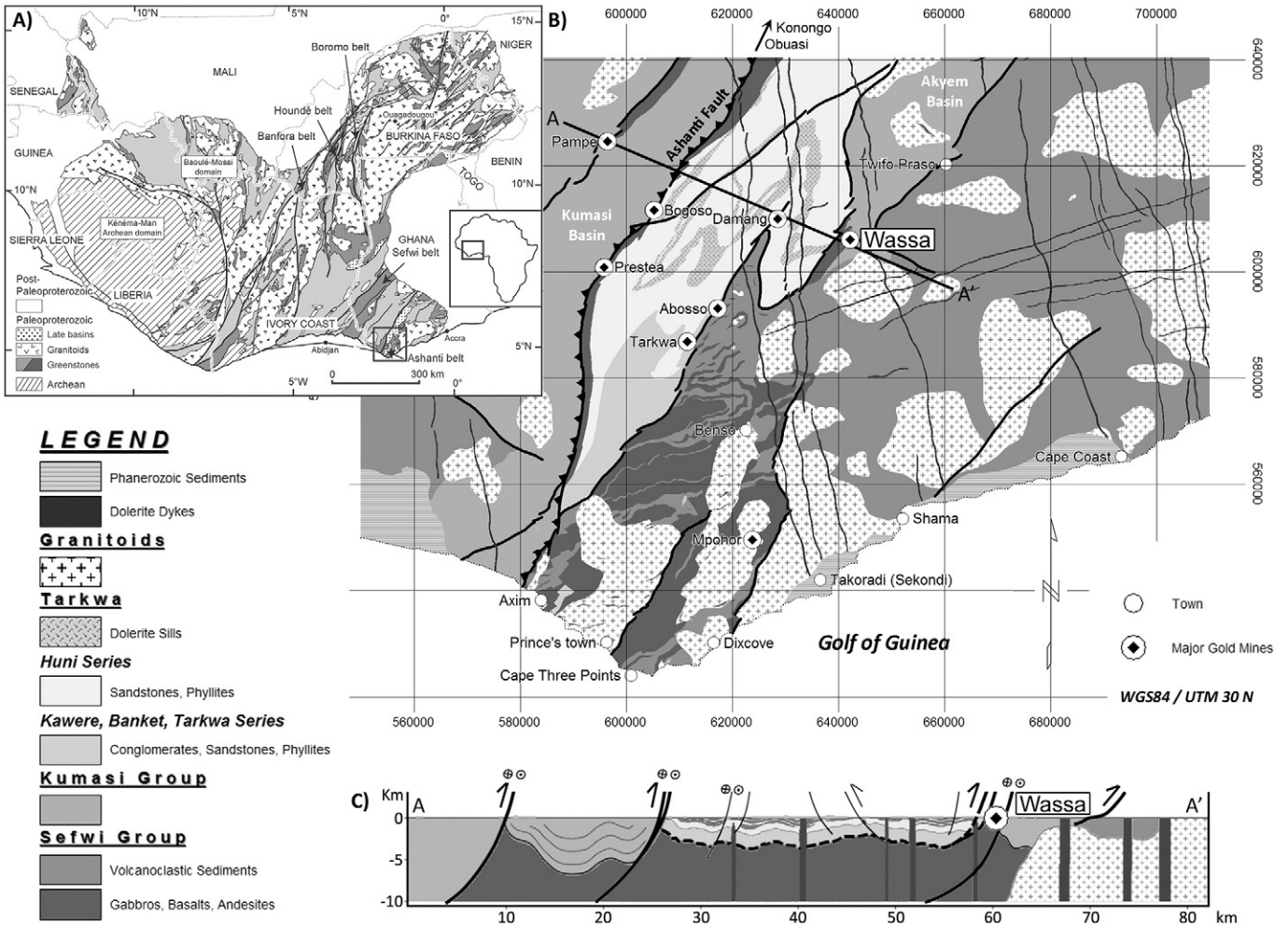

Fig. 1. A) Geology of the West African Craton (modified after Milesi et al., 2004). B) Map and C) section of the southern Ashanti Belt (modified after Perrouty et al., 2012). The Wassa deposit (longitude 1.720 W; latitude 5.490 N) is located 150 km west of Accra, 37 km northeast of the Tarkwa Mine, 14 km east of the Damang Mine. It is hosted by Sefwi Group rocks, east of the Tarkwa Basin.

and thrust faults, followed by a NNW–SSE shortening (D4), associated with sinistral shear zones that sometimes reactivate the D3 thrust faults such as the Ashanti Fault (Fig. 1). Late D5 and D6 events are minor shortening phases with crenulation cleavages, open folds, and rare NW–SE faults. D1w, D2w, D3w, and D4w are the major deformational events observed in the Wassa mine and correspond respectively to the D1, D3, D4, and D5 regional events (Perrouty et al., 2015).

3. Geometric and kinematic controls

Mineralization at Wassa is hosted by highly strained rocks that have been deformed by at least four phases of folding. The first deformation event (D1w) developed isoclinal F1w folds and a S1w foliation marked by chlorite, mica, carbonate and gold-bearing pyrite. D2w and D3w deformation events (characterized by tight folds and by crenulation cleavages) contribute to the structural complexity of the deposit and to the overall distribution of the mineralization. The late D4w deformation event (characterized by recumbent open to tight folds and by a crenulation cleavage) partially controls the distribution of the late quartz carbonate veins and therefore the late gold remobilization.

4. Host rocks

The Wassa deposit is hosted by a sequence of meta-volcanic (basaltic to andesitic protoliths) flows intercalated with meta-sedimentary rocks (greywacke, magnetite-rich argillite and rare black shale layers) and by meta-intrusive rocks (diorite, felsic porphyry). Absolute ages of volcanic and volcano-sedimentary rocks are unknown. Mineralized intrusive (felsic porphyry) rocks are dated at 2192.7 ± 4.6 Ma (U/Pb SHRIMP on zircon, Parra-Avila et al., 2015). These lithologies belong to the Sefwi Group, represent the oldest known stratigraphic sequence in southwest Ghana (Perrouty et al., 2012), and host numerous gold occurrences and a few deposits (Perrouty et al., 2014).

Fig. 2 shows drill core photographs of the main lithologies. Metasomatized felsic volcanic, mafic volcanic, and sedimentary rocks display chlorite–quartz–calcite–ankerite assemblages. Metasomatized dioritic dykes show similar mineral assemblages with mm-scale ankerite porphyroblasts and rare muscovite. Felsic porphyry dykes are composed of plagioclase feldspar–quartz–muscovite, and contains trace of calcite and ankerite. Sulfides, mostly pyrite, are present in variable amounts in all of these lithologies (Perrouty et al., 2015).

5. Timing of mineralization

The first (and main) gold mineralization event (M1w) is associated with pyrite minerals that have been formed during the first deformation event (D1w): these pyrites host tiny gold particles and have been aligned and stretched along the S1w fabric (Fig. 3). The first deformation event (D1w) at Wassa correlates with the first folding