Precambrian Research 204–205 (2012) 12–39

Contents lists available at SciVerse ScienceDirect

Precambrian Research

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

Revised Eburnean geodynamic evolution of the gold-rich southern Ashanti Belt, Ghana, with new field and geophysical evidence of pre-Tarkwaian deformations

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ARTICLE INFO

Article history:
Received 8 June 2011
Received in revised form 6 January 2012
Accepted 17 January 2012
Available online 14 February 2012

Keywords:
Birimian
Eburnean
Paleoproterozoic
Ghana
Mineralisation

ABSTRACT

Integration of regional geophysical datasets and detailed field observations provide new insights into the paleoproterozoic structural evolution of southwestern Ghana. The study area is dominated by three metavolcanic and metasedimentary packages known as the Sefwi Group, the Kumasi Group (Birimian) and the Tarkwa Group (Tarkwaian) that were intruded by abundant TTG granitoids during the Eoeburnean and Eburnean phases of an event termed the "Eburnean Orogeny". This study identifies an Eoeburnean (pre-Tarkwaian) deformation event (D1) that produced significant deformation in the Sefwi Group metavolcanics. D1 is associated with N-S shortening manifested as regional scale folding in the southern Ashanti Belt. D1 synorogenic granitoids were intruded between 2187 Ma and 2158 Ma under greenschist metamorphic condition. Syn-D1 gold mineralisation associated with quartz veining could be the original source of Tarkwaian paleo-placers and/or remobilised gold concentrations along major shear zones.

D2 represents an extensional phase associated with the Kumasi Group sedimentation (2154–2125 Ma) which could be related to activation of major structures such as the Ashanti Fault as low angle detachments that controlled the deposition of the Kumasi Group and the opening of the Kumasi and Akyem Basin. The Tarkwa Group (2107–2097 Ma) unconformably overlies the Birimian Supergroups and was deposited in response to D3 shortening. D3 resulted in the inversion of syn-D2 detachments faults within the Ashanti Belt. NW-SE D3 shortening produced regional scale folding within the Birimian and the Tarkwaian metasediments. D4 deformation corresponds with sinistral reactivation of D3 thrust faults, and is locally associated with macro-scale folding at Obuasi and Wassa gold mines. By the end of D4, the regional scale architecture was built and was only slightly modified by the two last events. D5 postdates the Eburnean metamorphic peak and corresponds to open recumbent folds associated with a subhorizontal crenulation cleavage. D6 is present as a subvertical crenulation cleavage and reverse faults associated with NE-SW shortening.

1. Introduction

The Ashanti greenstone belt in the Western Region of Ghana hosts numerous hydrothermal gold deposits (e.g. Obuasi, 60 Moz) and older placer deposits (e.g. Tarkwa, 41 Moz) that were created and deformed during the Eburnean orogeny (Bonhomme, 1962). The presence of massive gold placers that predate all known hydrothermal deposits, suggests an early phase of gold mineralisation and subsequent deformation in the Ashanti Belt. Characterising this early event is essential for understanding the tectonic evolution and geological context for gold mineralisation in the south-west Ghana. This region is composed primarily of paleoproterozoic metavolcanic and metasedimentary rocks that are divided into the Birimian Supergroup (Sefwi and Kumasi Groups) and the Tarkwa Group, that are both intruded by abundant granitoids (Fig. 1).

Allibone et al. (2002a) separated the Paleoproterozoic Eburnean orogeny into two distinct phases known as Eburnean I and II. Their Eburnean I event predates the deposition of Tarkwaian sediments and is associated with a major period of magmatism and metamorphism in the Sefwi Group basement. Their Eburnean II event is associated with significant post-Tarkwaian deformation

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doi:10.1016/j.precamres.2012.01.003

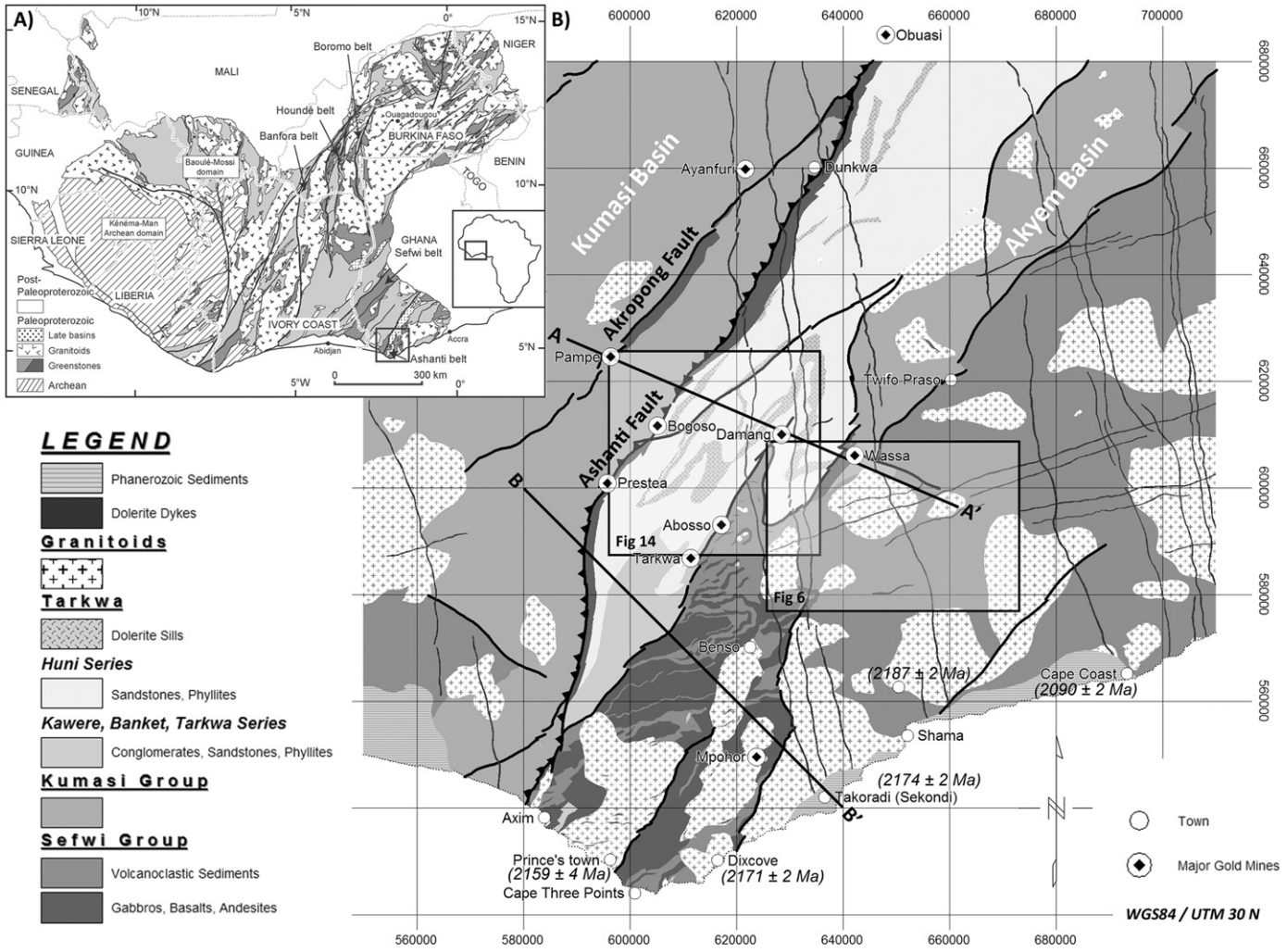

Fig. 1. (A) The West African Craton (modified after Milési et al., 2004, BRGM SIGAfrique) is composed of an Archean nucleus in the southwest bounded by series of paleoproterozoic greenstone belts and voluminous granitoids in the northwest to the east. (B) Simplified geology map of the Ashanti Belt (modified after Agyei Duodu et al., 2009) showing the locations of Figs. 6, 14 and 16.

that affected both the Birimian Supergroup and overlying Tarkwaian sediments. This second phase of the Eburnean orogeny is relatively well known in the study area and is described at the mine scale (Blenkinsop et al., 1994, in Obuasi; Allibone et al., 2002a, in Obuasi and, Allibone et al., 2002b, in Bogoso; Kutu, 2003, in Konongo; Tunks et al., 2004, in Damang) and at a regional scale (Eisenlohr and Hirdes, 1992; Milési et al., 1992; Ledru et al., 1994; Barritt and Kuma, 1998; Feybesse et al., 2006).

Eburnean I events have been described along the West African Craton and called Eoeburnean in northern Ghana (De Kock et al., 2011) or Tangaean in Burkina Faso (Tshibubudze et al., 2009; Hein, 2010), but are relatively poorly resolved in southwestern Ghana. This study presents an integrated interpretation based on new field data, geophysical surveys and previous structural studies and maps (Loh et al., 1999; Agyei Duodu et al., 2009) that provides a new structural context to the Eoeburnean phase and clarifies the subsequent tectonic evolution of the Ashanti greenstone belt.

2. Geological setting

The southern part of the West African Craton, known as the Leo-Man craton, is composed of an Archean nucleus that is tectonically juxtaposed against Paleoproterozoic granitoid-greenstone assemblages to the north and east (Fig. 1). In southwest Ghana, four NE-SW greenstone belts occur, known as the Bui, Sefwi, Ashanti and Kibi-Winneba belts from west to east, respectively. These belts are separated by three sedimentary basins namely the Sunyani, the Kumasi and the Akyem Basins (or Cape Coast Basin, Agyei Duodu et al., 2009). These greenstone belts and dividing sedimentary basins were formed and deformed during the Eburnean orogeny (Bonhomme, 1962).

2.1. Eburnean orogeny

Feybesse et al. (2006) proposed an early Eburnean phase between 2135 Ma and 2100 Ma corresponding to magmatic accretion and plutonism that terminated with development of the Kumasi Basin. The synchronous Eburnean orogeny (2130–1980 Ma) corresponds to thrust tectonism dominated by sinistral transcurrent deformation in the Ashanti Belt. Allibone et al. (2002a) suggests an alternative two phase Eburnean evolution, divided into the Eburnean I (2200–2150 Ma) and Eburnean II (2116–2088 Ma), that are separated by deposition of the Birimian and Tarkwaian units. In northern Ghana De Kock et al. (2011) called these two phases Eoeburnean and Eburnean, respectively. This nomenclature is referred to in the text, based on the correlation with published zircon geochronology (Fig. 2A).