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Metallogenic portfolio of the West Africa craton

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ABSTRACT

The West African Craton hosts major resources of gold, iron ore, aluminium ore, diamonds, phosphates and manganese. This portfolio of ore deposits is linked to the formation of Archean–Paleoproterozoic greenstone belts, Jurassic rifting and extended periods of Mesozoic to Cenozoic weathering and erosion. We give a brief overview of the temporal and spatial distribution patterns of West African ore deposits with emphasis on the main commodity types. The oldest ore forming processes generated major resources in iron ore and gold in the Kénéma–Man and Reguibat Shields during the Neo-Archean. The majority of gold, porphyry copper, lead–zinc and sedimentary manganese deposits formed during the Paleoproterozoic, dominantly within the Baoulé-Mossi domain. At the same time diamond-bearing kimberlites developed in Ghana. Another distinct diamond event has been recognized in the Mesozoic of the Kénéma–Man shield. Isolated occurrences of IOCG's as well as copper–gold and gold formed in Pan-African/Variscan belts. During the Neoproterozoic, the majority of mineralization consists of sedimentary iron ore and phosphate deposits located within intracratonic basins. During the Phanerozoic aluminium ore, phosphates and mineral sands concentrated along the margins of the coastal and intracratonic basins.

1. Introduction

Over the last two decades, the West Africa Craton (WAC) has increasingly become a focus for exploration and development of gold, iron ore, diamonds, aluminium ore, phosphate, and uranium resources (Fig. 1). Herein we provide a brief overview of the mineral deposits, their styles and character, and distribution across the WAC. For a comprehensive database of West African Mineral deposits we refer to Markwitz et al. (2015).

The main commodities include (1) gold as orogenic, intrusion-related, skarn-hosted, porphyry-hosted, paleoplacer, and within iron-oxide copper–gold (IOCG) deposits; (2) iron ore as sedimentary-BIF, skarn-hosted, lateritic duricrusts, and intrusion-related deposits; (3) aluminium ore as lateritic bauxite; (4) diamonds as kimberlites pipes and placers; (5) nickel–cobalt–PGE and VMS; (6) sedimentary phosphate, and (7) sedimentary manganese deposits (Fig. 1).

Here we give an overview of the most significant deposits, and provide background information on deposits described by the authors of this special volume.

2. Regional background

The WAC consists of the Reguibat Shield in the north and Kénéma–Man Shield (and Kédougou-Kéniéba, Kayes and Ansongo inliers) in the south. It is made up of Archean rocks separated from Paleoproterozoic rocks by major shear zones (Fig. 1). The shields are separated by the intracratonic Meso-Proterozoic to Palaeozoic Taoudeni basin and surrounded by Pan-African (750–550 Ma) and Variscan (~330 Ma) orogenic belts. They are flanked by coastal basins that formed during Mesozoic to Cenozoic Atlantic paleo-rift formation.

Three major tectono-thermal events are widely accepted for the WAC: (1) the 3.5–2.9 Ga Pre-Leonean and Leonean Orogeny (Morel, 1979; Potrel et al., 1996; Kouamelan et al., 1997; Thiéblemont et al., 2001); (2) the 2.9–2.8 Ga Liberian Orogeny (Thiéblemont et al., 2001; Egal et al., 2002) and (3) the ~2.19–2.15 Ga Pre-Eburnean (Tangaean) event (Allibone et al., 2002; Hein, 2010 and others) and 2.15–~1.8 Ga Eburnean Orogeny (Caen-Vachette, 1986; Feybesse et al., 2006). The Eburnean Orogeny is associated with significant gold mineralisation in volcanic, volcano-sedimentary and sedimentary rocks of the Birimian Supergroup (Milési et al., 1989; Béziat et al., 2008). The emplacement of kimberlite bodies took place probably during the Paleoproterozoic (Hastings, 1982) although the main event occurred in the Early Cretaceous during the break-up of Gondwana (Bardet and Vachette, 1966; Rombouts, 1987; Chirico et al., 2010a, 2010b, 2014).

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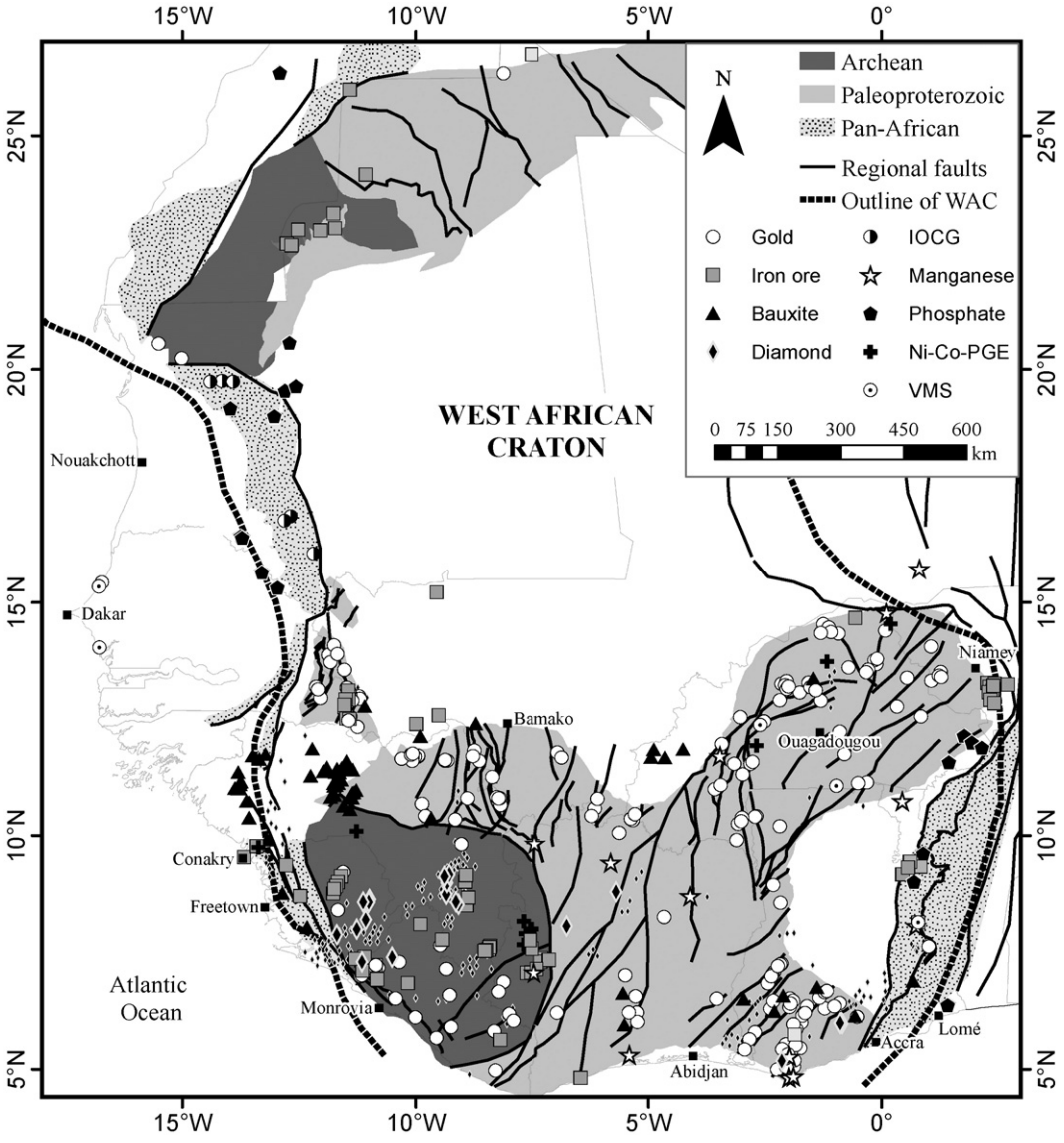

Fig. 1. Overview map of the West African Craton highlighting main commodities.

The Kénéma–Man Shield in the Man domain, the Baoulé-Mossi domain and the Kédougou-Kéniéba Inlier (KKI) host world-class deposits of gold, important diamond and iron ore concentrations, and manganese, uranium, lead–zinc, aluminium ore, and phosphate mineralisation. The majority of gold deposits formed during the Eburnean Orogeny, but there are a number of deposits in Ghana, Burkina Faso and Mali that formed before the Eburnean Orogeny during a period of oceanic arc–backarc formation (Tshibubudze et al., 2009; De Kock et al., 2012), as well as during erosion in the Neoproterozoic and Cretaceous (Hein et al., 2015; Masurel et al., submitted for publication).

In contrast, the Reguibat Shield has potential as a primary source of diamonds (Kahoui et al., 2008), and gold and copper in the Paleoproterozoic Yetti sub-domain, while Archean rocks host world-class iron ore and gold deposits (Heron et al., 2016 — this volume).

During the Pan-African Orogeny, chromite, zinc and platinum in layered mafic intrusions were emplaced, for example, in the Rokelides and Mauritanides. The post Pan-African history included development of deposits in copper–gold (e.g., Akjoujt and Indice 78 in Mauritania), mineral sands, iron ore (e.g., Nioro in Mali and Sassandra in Cote d'Ivoire), aluminium ore (e.g., Bidikoum and Sangaredi in Guinea), chromite, nickel–cobalt, diamonds (e.g., Mano River in Liberia or Koidu Pipe in Sierra Leone) and gold (e.g., Yatela in Mali) (Markwitz et al., 2015; and references therein).

Large magmatic complexes that intruded during the Cretaceous are associated with platinum mineralisation in layered intrusions in Sierra Leone and Liberia (Freetown Inlier; Beckinsale et al., 1977; Chalokwu, 2001), and nickel–copper mineralisation in the Mount Kakoulima complex of southern Guinea (Konate and Pan, 2013).

From the Cretaceous to Tertiary a protracted period of erosion and weathering resulted in development of iron, manganese and aluminium ore resources in lateritic duricrusts across the WAC, as well as oolitic ironstones, and zinc and copper gossans. Aluminium ore resources formed during the Cretaceous and Cenozoic, and phosphate deposits were developed on continental shelves. Undeformed and flat-lying Tertiary phosphates in Togo and southern Burkina Faso also formed at this time (Markwitz et al., 2015).

3. Mineralization

The spatial distribution of mineral deposits is strongly linked to geological regions (Fig. 2A), tectonic events, and deposit types. The location of deposits described below can be identified in Fig. 2B.