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Regional gravity analysis of Burkina Faso: Implications for the location of metallic ore deposits

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Abstract

Gravity data were analyzed in conjunction with available geological data to determine the origin of observed gravity anomalies and their possible relationship to metallic ore deposits. The gravity data analysis included the construction of a Bouguer gravity anomaly, isostatic residual gravity anomaly and enhanced horizontal gravity gradient maps, and two and one-half dimensional gravity models. The isostatic residual gravity anomaly field could be broken down into five distinct regions based on anomaly amplitude, trend and wavelength. The analysis of these regions showed that both the Birimian and granitoid provinces consist mainly of a series of short wavelength gravity maxima and minima with a few large scale anomalies which suggests that the subsurface geology is more complicated than is currently known. Two gravity models roughly oriented north-south also implied this complicated subsurface geology and showed that most source bodies have depths up to 5 km. The known base metal deposits occur on the edge of small-scale gravity maxima within the Birimian province with the exceptions of the deposits within the Bouroum-Yalogo belt which occur next to a large amplitude gravity maximum related to an ultramafic complex.

Keywords: Bouguer gravity; Burkina Faso; Ore deposits; West Africa craton

1. Introduction

Burkina Faso is mainly composed of metamorphic and igneous lithologies of Precambrian age (Fig. 1) (Sattran and Wenmenga, 2002; Schwartz, 2006) that lie on the eastern edge of the West African craton. Despite having been relatively tectonically inactive since the Precambrian, Burkina Faso had an active Precambrian history that includes varying degrees of metamorphic events, the formation of one or more island arcs, accretion of these island arcs during the Eburnean orogeny and the intrusion of multiple episodes of granitoid bodies (Sattran and Wenmenga, 2002). Despite extensive studies of these events (see the references within Sattran and Wenmenga, 2002), there still remains controversy on the exact tectonic origin of the rock units within Burkina Faso (Debat et al., 2003; Hein et al., 2004). This can be partially explained by the lack of geophysical studies which would aid in determining the subsurface geological features and their relationship to the above tectonic events. To date there have been no known seismic studies and only local qualitative interpretations of the gravity and magnetic data (Hastings, 1983; Hein et al., 2004). The most detailed studies in the region surrounding Burkina Faso have been gravity analyses determining the nature of the Pan African orogenic belt (Bayer and Lesquer, 1978; Tidjani et al., 1993).

Burkina Faso is well-endowed with metallic ore deposits (Bourges et al., 1998; Sattran and Wenmenga, 2002; Schwartz and Melcher, 2003) as it contains several gold, lead and zinc deposits located mainly within Birimian lithologic units (Schwartz, 2006). This is consistent with regional metallogenic studies within the Lower Proterozoic units of the West African craton (Umeji, 1983; Milési et al., 1992) that have shown the region contains numerous economic and subeconomic deposits of gold, zinc, lead and manganese.

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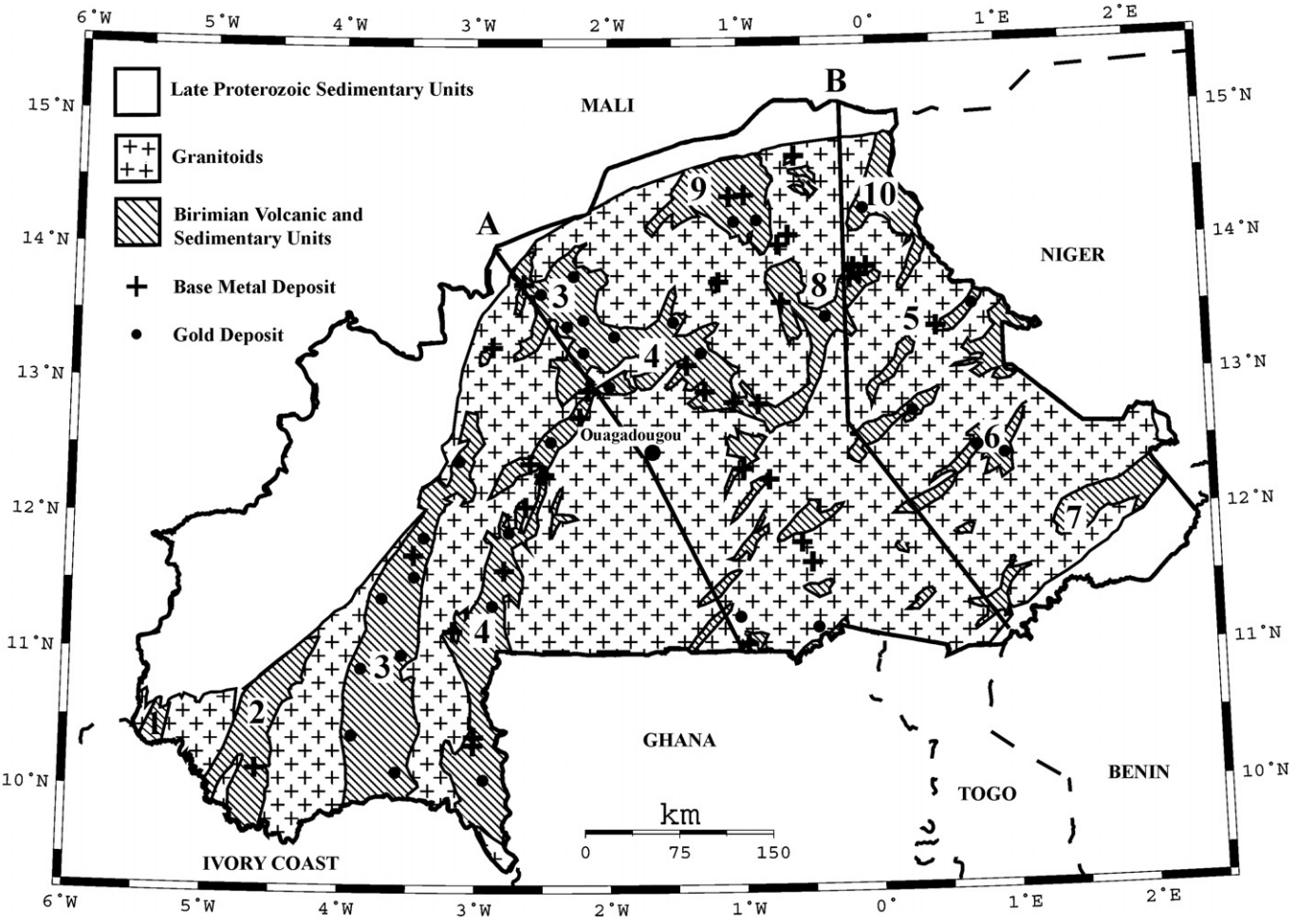

Fig. 1. Geological map of Burkina Faso (adapted after Schwartz, 2006). Base metal locations (+) are from Schwartz (2006) and gold deposits (dots) are from Sattran and Wenmenga (2002). The Birimian province has been broken into ten belts (Sattran and Wenmenga, 2002) as shown by the bolded numbers: 1 – Loumana, 2 – Banfora, 3 – Houndé, 4 – Boromo-Goren, 5 – Manga-Sebba, 6 – Fada N'Gourma, 7 – Diapaga, 8 – Bouroum-Yalogo, 9 – Djibo-Aribinda, 10 – Dori (after Sattran and Wenmenga, 2002). Bold lines are the locations of gravity models A and B.

However when compared to other cratons worldwide, the West African craton contains significantly less iron and volcanogenic mineralization.

In the present study, I will use available gravity data to determine the regional geologic environment and infer if these data can aid in determining the location of metallic ore deposits. This will be accomplished by constructing Bouguer gravity, isostatic residual and horizontal gradient gravity anomaly maps, and two and one-half dimensional (2.5D) gravity models constrained by available geologic mapping.

2. Geological setting

The exposed rocks within Burkina Faso are mostly part of the West African craton with the majority of the lithologies dating from approximately 2.6–1.6 Ga (Abouchami et al., 1990; Boher et al., 1992; Sattran and Wenmenga, 2002). The West African craton is composed of several smaller cratonic regions including the Man shield which comprises most of Burkina Faso (Feybesse and Milési, 1994). The Man shield occupies the southern one-third of the West African craton (Bosseles, 1977) southwest of Burkina Faso (mostly in Liberia, Sierra Leone, Guinea and the Ivory Coast) and there are also Paleoproterozoic rocks of the Birimian/Eburnean province (Hirdes et al., 1996) in Burkina Faso. The Man shield consists of Archean rocks ranging in age from 2.75 to 3.1 Ga.

The Paleoproterozoic rocks of the Birimian province consist of a series of volcanic and sedimentary rocks that occur in terranes that range from narrow sedimentary basins and linear or arcuate volcanic belts that have been intruded by a variety of granitoids (Hirdes et al., 1996; Béziat et al., 2000) (Fig. 1). Workers have grouped these rocks into two stratigraphic units: (1) Lower Birimian of predominantly sedimentary units (mainly flysch-type units) and minor volcanic units and (2) Upper Birimian of a variety of volcanic units (Hein et al., 2004). However, Hirdes et al. (1996) oppose the idea of the volcanic units overlying the sedimentary units as they interpret the Birimian units to be generations of volcanic rocks. Both units have been metamorphosed from greenschist up to amphibolite facies