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GR focus review

A geodynamic perspective of world-class gold deposits in East Asia

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ABSTRACT

The world-class gold-ore districts of South-East Russia and North-East China are located above the frontal and peripheral regions of subducted oceanic lithosphere accumulated as stagnant slabs in the mantle transition zone generated by paleo-Pacific plate subduction. The highly productive ore systems of the Aldan (South Yakutiya), Baley (Transbaikalia), and Zhao-Ye (Jiaodong) metallogenic belts which are widely separated in space, but formed at the same time, are associated with similar mechanisms of huge magma flare-ups in the Middle-Jurassic–Early Cretaceous driven by deep mantle processes. Their common features and crust–mantle interaction signature offer important clues to mantle dynamics rooted along the periphery of the subducted slabs in a mega-convergent zone in East Asia.

Contents

1. Introduction . . . 816
2. Geophysical and geological background . . . 817
   2.1. Features of the deep-seated structure of the region . . . 817
   2.2. Comparative geology of the marginal parts of the North-Asian and Sino-Korean cratons . . . 820
3. Brief characteristics of the large gold-ore districts of East Asia . . . 820
   3.1. Aldan district . . . 820
   3.2. Baley district . . . 822
   3.3. Zhao-Ye district . . . 825
4. Major characteristics of the gold belts . . . 827
   4.1. Common salient features of the large gold-ore districts of East Asia . . . 827
   4.2. Paleotectonic reconstructions (Late Mesozoic–Cenozoic) and seismic tomography data . . . 827
5. Discussion . . . 829
6. Conclusions . . . 831
Acknowledgments . . . 831
References . . . 831

1. Introduction

Large precious metal reserves associated with primary and placer deposits of East Asia have attracted considerable attention in terms of their economic as well as strategic importance (Radkevich, 1969; Zhou et al., 2002; Goldfarb et al., 2007, 2014). The contiguous geological terrains of the Russian Federation and People's Republic of China, with important reserves of gold (Khomich et al., 1998; Romanovsky et al., 2006; Khomich et al., 2010; Goldfarb and Santosh, 2014), form part of the metallogenic mega-belts associated with the Central Asian Orogenic Belt as well as the region influenced by Pacific slab subduction, principally bounded in the north and south by the North-Asian (Siberian) and Sino-Korean Cratons (Fig. 1). The two largest gold-bearing districts (with Au reserves exceeding 1000 tons) — the Aldansky (Russia) and the Zhao-Ye in Jiaodong (China) — are located along the marginal

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domains of the above cratons. The gold mineralization in these areas is mostly hosted within Jurassic–Cretaceous granitoids that show alkaline affinity (e.g., Guo et al., 2013; Yang et al., 2014; Goldfarb and Santosh, 2014; Goldfarb et al., 2014). Another equally large and well-known district with rich gold deposits is Baleisky, in the Russian territory, within the Kerulen–Argunsky 'superterrane' (Khomich, 1972; Khomich and Boriskina, 2007). The different types of gold mineralization in the Baleisky district, similar to those in Aldan, as well as the Jiaodong gold field in China, are also associated with Jurassic–Cretaceous magmatic complexes with typical alkaline features. Several other regions of precious-metal reserves are known in different parts of East Asia (e.g., Khomich and Boriskina, 2010b; Khomich et al., 2013) although the resource potential in these localities are essentially lower than those in the major belts mentioned above.

The aim of our present work is to synthesize the data available on the distribution, salient geological features, and age of the magmatic formations that are associated with the Late Mesozoic large-scale precious-metal mineralization and to evaluate the possible influence of deep-seated geodynamics on the mineralization processes. Our study emphasizes the possible link between these major metallogenic zones and mantle dynamics in a mega convergent regime.

Understanding the role of deep-seated geodynamic processes in the formation and distribution of world-class gold-ore districts requires a comparative analysis of the geological–geophysical features of the largest gold-ore districts of South-East Russia and North-East China, which are localized on the conjugate territory of both countries in East Asia. In order to provide a unified approach for the metallogenic subdivisions, we adopt here the different orders as proposed in Khomich (1986) with the principle of proportionality based on statistical data (Kosygin, 1988). Thus, order III (10^6–10^4 km^2) includes belts, zones, provinces, and areas; order IV (10^4–10^2 km^2) includes ore districts and nodes; and order V (10^2–10^0 km^2) includes ore fields and deposits. We principally base our analysis on the link between the formation and distribution of the large-scale gold mineralization and geodynamics based on recent data and inferences on the deep-seated processes in these regions from combined geological, geophysical and tectonic perspectives during Late Mesozoic–Cenozoic (e.g., Zhao, 2001; Zorin et al., 2006; Maruyama et al., 2007; Zhao et al., 2009; Li and van der Hilst, 2010; Zhao et al., 2010; Guo et al., 2013; Zhao and Tian, 2013; Goldfarb and Santosh, 2014; Yang and Santosh, 2014, among others).

2. Geophysical and geological background

2.1. Features of the deep-seated structure of the region

The deep lithospheric structure of the area covering the conjugate territories of China and Russia (Fig. 2) can be inferred based on seismic and other geophysical data (e.g., Malyshev, 1993; Chengwei, 1996; Krasnyi et al., 1999; Shatkov and Volsky, 2004; Zhao et al., 2009; Guo et al., 2013). This region is characterized by high seismicity, anomalously high heterogeneity of the crust and mantle, and active rifting processes, and shows the presence of linear systems of the Mesozoic–Cenozoic graben-like depressions with vast areas of basaltic volcanism (Yarmolyuk et al.,

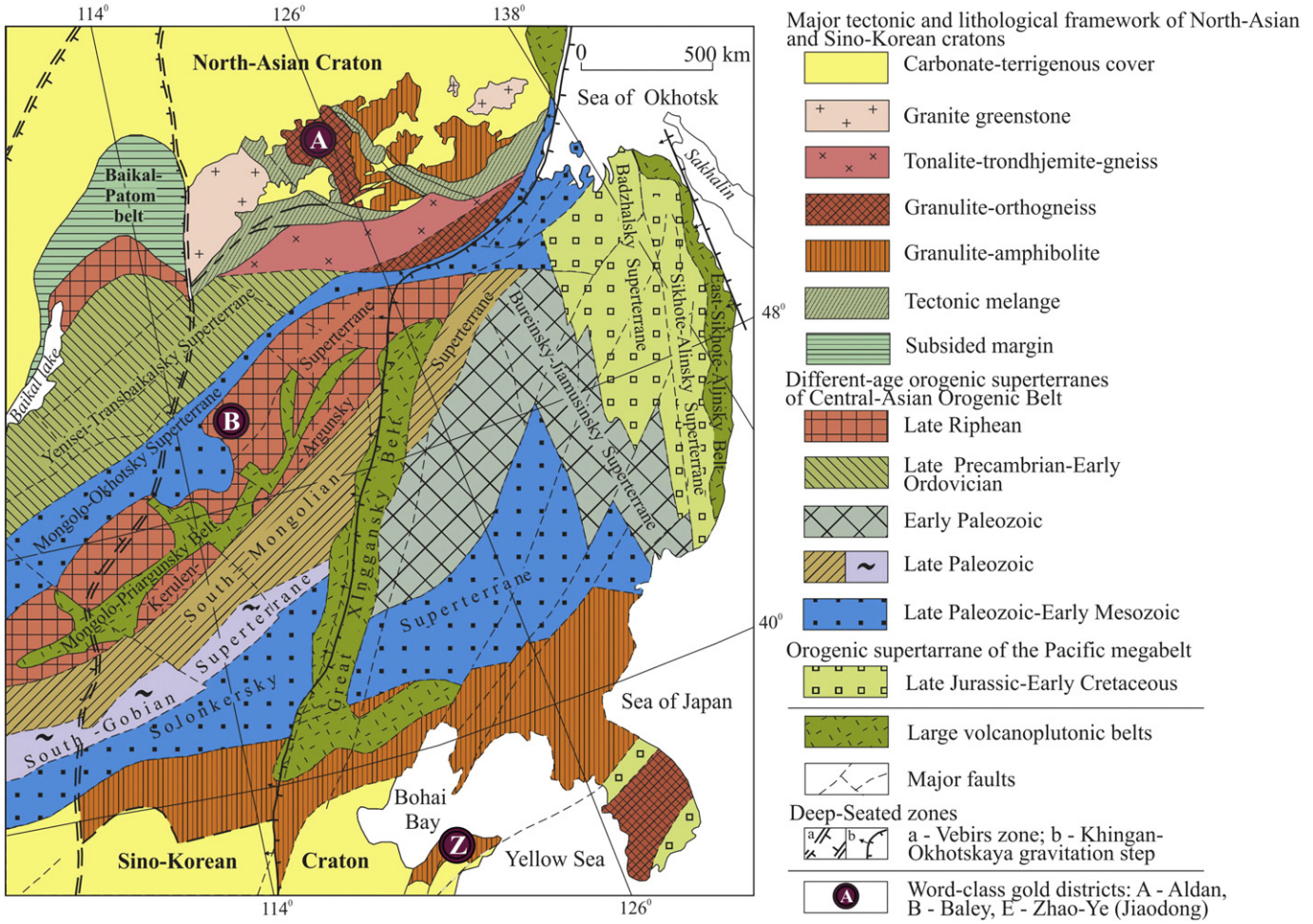

Fig. 1. Tectonic framework of East Asia.
Modified with additions after Parfenov and Kuzmin (2001), Parfenov et al. (2003) and Shatkov and Volsky (2004).