Geoscience Frontiers xxx (2017) 1–18

HOSTED BY

ELSEVIER

Contents lists available at ScienceDirect

China University of Geosciences (Beijing)

Geoscience Frontiers

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

Focus paper

# Neoarchean granite-greenstone belts and related ore mineralization in the North China Craton: An overview

Li Tang[a,b,*], M. Santosh[a,c]

[a] School of Earth Sciences and Resources, China University of Geosciences Beijing, 29 Xueyuan Road, Beijing 100083, China
[b] Graduate School of Life and Environmental Sciences, University of Tsukuba, Ibaraki 305-8572, Japan
[c] Centre for Tectonics, Exploration and Research, University of Adelaide, Adelaide SA 5005, Australia

ARTICLE INFO

*Article history:*
Received 12 January 2017
Received in revised form
30 March 2017
Accepted 5 April 2017
Available online xxx

*Keywords:*
North China Craton
Granite greenstone belt
Neoarchean
Plate and plume tectonics
Metallogeny

ABSTRACT

Tectonic processes involving amalgamations of microblocks along zones of ocean closure represented by granite-greenstone belts (GGB) were fundamental in building the Earth's early continents. The crustal growth and cratonization of the North China Craton (NCC) are correlated to the amalgamation of microblocks welded by 2.75–2.6 Ga and ∼2.5 Ga GGBs. The lithological assemblages in the GGBs are broadly represented by volcano-sedimentary sequences, subduction-collision related granitoids and bimodal volcanic rocks (basalt and dacite) interlayered with minor komatiites and calc-alkalic volcanic rocks (basalt, andesite and felsic rock). The geochemical features of meta-basalts in the major GGBs of the NCC display affinity with N-MORB, E-MORB, OIB and calc-alkaline basalt, suggesting that the microblocks were separated by oceanic realm. The granitoid rocks display arc signature with enrichment of LILE (K, Rb, Sr, Ba) and LREE, and depletion of HFSE (Nb, Ta, Th, U, Ti) and HREE, and fall in the VAG field. The major mineralization includes Neoarchean BIF-type iron and VMS-type Cu-Zb deposits and these, together with the associated supracrustal rocks possibly formed in back-arc basins or arc-related oceanic slab subduction setting with or without input from mantle plumes. The 2.75–2.60 Ga TTG rocks, komatiites, meta-basalts and metasedimentary rocks in the Yanlingguan GGB are correlated to the upwelling mantle plume with eruption close to the continental margin within an ocean basin. The volcano-sedimentary rocks and granitoid rocks in the late Neoarchean GGBs display formation ages of 2.60–2.48 Ga, followed by metamorphism at 2.52–2.47 Ga, corresponding to a typical modern-style subduction-collision system operating at the dawn of Proterozoic. The late Neoarchean komatiite (Dongwufenzi GGB), sanukitoid (Dongwufenzi GGB and Western Shandong GGB), BIF (Zunhua GGB) and VMS deposit (Hongtoushan-Qingyuan-Helong GGB) have closer connection to a combined process of oceanic slab subduction and mantle plume. The Neoarchean cratonization of the NCC appears to have involved two stages of tectonic process along the 2.75–2.6 Ga GGB and ∼2.5 Ga GGBs, the former involve plume–arc interaction process, and the latter involving oceanic lithospheric subduction, with or without arc-plume interaction.



## 1. Introduction

Archean granite-greenstone belts are important components of ancient cratons and are composed of elongate slivers of volcano-sedimentary sequences and tonalite–trondhjemite–granodiorite (TTG) suites ranging in age from Eoarchean (>3.6 Ga) to end of Neoarchean (∼2.5 Ga) (Anhaeusser, 2014; Furnes et al., 2014; Manikyamba et al., 2015). They record both vertical and lateral accretionary tectonics, building continents in the early Earth (Van Kranendonk et al., 2004, and references therein; Santosh, 2013). Several workers have argued that Phanerozoic-style plate tectonics operated in the Archean, such as in the Abitibi and Wawa greenstone belts of Superior Province in Canada, Agnew–Wiluna greenstone belt of Yilgarn Craton in Western Australia, and Isua and Ivisaartoq greenstone belts of Greenland, among others (Kerrich et al., 1998; Hollings and Kerrich, 2000; de Joux et al., 2014). In contrast, others believe that granite–greenstone terranes are

* Corresponding author. School of Earth Sciences and Resources, China University of Geosciences Beijing, 29 Xueyuan Road, Beijing 100083, China.
*E-mail addresses:* ltang@cugb.edu.cn, tangli199005@126.com (L. Tang).
Peer-review under responsibility of China University of Geosciences (Beijing).

http://dx.doi.org/10.1016/j.gsf.2017.04.002
1674-9871/

Please cite this article in press as: Tang, L., Santosh, M., Neoarchean granite-greenstone belts and related ore mineralization in the North China Craton: An overview, Geoscience Frontiers (2017), http://dx.doi.org/10.1016/j.gsf.2017.04.002

products of vertical tectonics related to mantle plume (Hamilton, 1998; Van Kranendonk et al., 2007). A combined plume–arc interaction model has also been proposed to explain the coexisting komatiites and arc-related rocks in Archean GGBs such as in the Sumozero-Kenozero GGB of Baltic Shield (Puchtel et al., 1999) and Hutti GGB of Dharwar Craton in India (Manikyamba et al., 2009).

As the major ancient cratonic nuclei in eastern Eurasia, the NCC is characterized by multi-stage Neoarchean crustal growth with tectonothermal events of 2.8–2.7 Ga juvenile addition followed by another strong tectono-magmatic event with extensive reworking at ~2.5 Ga (Wan et al., 2011; Peng et al., 2013a; Wang et al., 2015; Tang et al., 2016a). Zhai and Santosh (2011) emphasized a micro-block model for the cratonization of the NCC involving the subduction-collision of seven ancient microblocks through closure of the intervening oceans as represented by major GGBs (Fig. 1). The GGBs comprise volcano-sedimentary sequences and TTG suites with ages of 2.75–2.6 Ga and 2.6–2.5 Ga (Peng et al., 2015; Deng et al., 2016; Ren et al., 2016). In recent years, several studies have focused on the petrology, geochemistry and geochronology of the various GGBs in the NCC. However, the geodynamic setting and mechanisms of the late Neoarchean tectono-magmatic event related to the formation of the ~2.5 Ga GGBs still remain controversial, involving subduction-accretion process (Zhai and Santosh, 2011; Guo et al., 2016; Tang et al., 2016a) or mantle plume (Geng et al., 2006; Zhao and Zhai, 2013; Zhu et al., 2015).

In this paper, we compile the salient features of the major GGBs in the NCC including their lithological assemblages, geochemical features, and geochronological and metallogenic characteristics. The objective of this overview is to provide further insights into understanding the Neoarchean cratonization, tectonic processes, crustal growth, and mineralization in the NCC as part of the global construction of continents in the early Earth.

## 2. Geological background and tectonic framework of the North China Craton

The NCC is tectonically bordered by the Qinling-Dabie Orogenic Belt to the south, the Central Asian Orogenic Belt to the north, the Qilian Orogen to the west and the Sulu HP–UHP metamorphic belt to the east (Fig. 1). The craton occupies over 300,000 km$^2$, and is mainly composed of Archean–Paleoproterozoic metamorphic basement rocks and Mesoproterozoic to Cenozoic cover sequences (e.g. Zhao et al., 2005, 2012; Zhai and Santosh, 2011; Zhao and Zhai, 2013; Santosh et al., 2015; Tang et al., 2016b). Archean basement rocks are widely distributed in many areas of the NCC (Fig. 1), including Eoarchean (3.85–3.6 Ga, Liu et al., 1992, 2008), Paleo-Mesoarchean (3.6–2.8 Ga, Wu et al., 2008) and Neoarchean (2.8–2.5 Ga, Wan et al., 2011) TTG gneisses, amphibolites, paragneisses, quartzites, banded iron formations (BIF) and leptynites.

Two diverse models have been proposed for the tectonic framework of the NCC: (1) the Paleoproterozoic continent-continent collision model (e.g. Zhao et al., 2001, 2005, 2012; Trap et al., 2012), and (2) the Neoarchean micro-block amalgamation model (e.g. Zhai and Santosh, 2011; Santosh et al., 2016; Tang et al., 2016; Yang et al., 2016). In first model, the NCC is considered to be composed of two large crustal blocks: the Western Block and Eastern Block which collided along the Trans-North China Orogen (TNCO) at 1.96–1.85 Ga (Zhao and Zhai, 2013; Tang et al., 2015, 2017; Yang and Santosh, 2015; Qian and Wei, 2016; Zhang et al., 2016a). The Western Block can be further sub-divided into the Yinshan Block, Ordos Block and the intervening Inner Mongolia Suture Zone (also known as the Khondalite Belt, Santosh, 2010). The Jiao-Liao-Ji Belt within the Eastern Block represents a 2.2–1.9 Ga rift-subduction-collision belt between the Longgang and Langrim blocks (e.g. Li and Zhao, 2007).

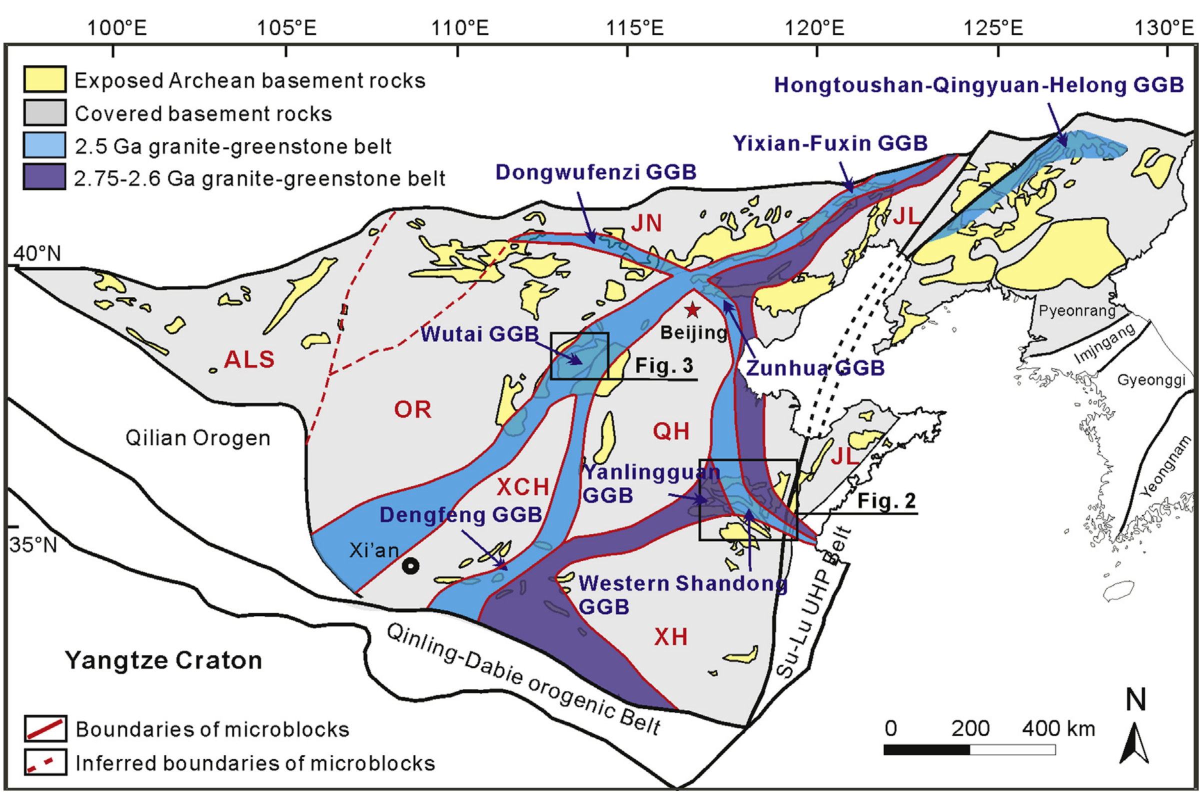


**Figure 1.** Updated subdivision of the North China Craton (modified after Zhai and Santosh, 2011; Zhao and Zhai, 2013) showing the major microblocks, granite-greenstone belts and Neoarchean basement rocks. Abbreviations: GGB, granite-greenstone belt; JL, Jiaoliao Block; QH, Qianhuai Block; OR, Ordos Block; JN, Jining Block; XCH, Xuchang Block; XH, Xuhuai Block; ALS, Alashan Block.

Please cite this article in press as: Tang, L., Santosh, M., Neoarchean granite-greenstone belts and related ore mineralization in the North China Craton: An overview, Geoscience Frontiers (2017), http://dx.doi.org/10.1016/j.gsf.2017.04.002