Geoscience Frontiers 6 (2015) 861–873

HOSTED BY

Contents lists available at ScienceDirect

China University of Geosciences (Beijing)

Geoscience Frontiers

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

Research paper

Correlations between the North China Craton and the Indian Shield: Constraints from regional metallogeny

Caifeng Li [a,b], Dongyue Chen [a,b,*], Jianping Chen [a,b], Xizhen Chen [c], Xingchen Yang [d], M.A. Aboelnour [a,b]

[a] School of Earth Sciences and Resources, China University of Geosciences (Beijing), Beijing 100083, China
[b] Institute of High and New Techniques Applied to Land Resources, China University of Geosciences (Beijing), Beijing 100083, China
[c] Institute of Water Resources and Hydropower, Wuhan University, Wuhan 430072, China
[d] Institute of Geomechanics, Chinese Academy of Geological Sciences, Beijing 100081, China

ARTICLE INFO

Article history:
Received 25 June 2014
Received in revised form
4 March 2015
Accepted 14 March 2015
Available online 16 April 2015

Keywords:
North China Craton
Indian shield
Metallogeny
Archaean
Correlations
Mesoproterozoic

ABSTRACT

The correlation between the North China Craton (NCC) and the Indian Shield (IND) has been a hot topic in recent years. On the basis of ore deposit databases, the NCC and IND have shown broad similarity in metallogenesis from the middle Archaean to the Mesoproterozoic. The two blocks both have three major metallogenic systems: (1) the Archaean BIF metallogenic system; (2) the Paleoproterozoic Cu-Pb-Zn metallogenic system; and (3) the Mesoproterozoic Fe-Pb-Zn system. In the north margin of the NCC and the west margin of the IND, the Archaean BIF-Au-Cu-Pb-Zn deposits had the same petrogenesis and host rocks, the Paleoproterozoic Cu-Pb-Zn deposits were controlled by active belts, and the Mesoproterozoic Fe-Pb-Zn deposits were mainly related to multi-stage rifting. Matching regional mineralization patterns and geological features has established the continental assembly referred to as "NCWI", an acronym for the north margin of the NCC (NC) and the west margin of the IND (WI) during the middle Archaean to the Mesoproterozoic. In this assembly, the available geological and metallogenic data from the Eastern Block and active belts of NC fit those from the Dharwar craton and the Aravalli–Delhi–Vindhyan belt of WI, respectively. Moreover, the depositional model and environment of Paleoproterozoic metasedimentary manganese deposits in NCWI implied that the assembly may be located at low latitudes, where the conditions were favorable for dissolving ice and precipitating manganese deposits.

1. Introduction

The early Precambrian connection of the North China Craton (NCC) with other cratonic blocks has been a subject of debate in the past decade (Wilde et al., 2002; Hou et al., 2008a). Qian (1997) and Wilde et al. (2002) believed that the NCC and the Baltic Shield may have once been connected in terms of age, lithologies, and configurations of the Archaean and Palaeoproterozoic active belts. However, the main cratonization time or amalgamation time of the micro-continental blocks of the Baltic Shield was between 2.8 and 2.6 Ga, whereas the growth and stabilization of the granite–greenstone belt was from 2.7 to 2.6 Ga (Amelin et al., 1995; Artemieva, 2006; Hou et al., 2008b). These values are significantly different from those of the NCC, in which the cratonization of micro-continental blocks began at 2.6 to 2.5 Ga and was finally completed at ~1.85 Ga (Zhao et al., 2002, 2005; Kusky et al., 2007; Zhai, 2010). In addition, the palaeomagnetic studies by Elming (1994, 2001) suggested that the Ukrainian Shield did not separate from Fennoscandia until 1.3 Ga. This result contradicts the previous belief that the NCC was adjacent to the Baltic Shield.

Alternatively, Li et al. (1996), Condie (2002), and Wang (2010) proposed that the NCC was once connected to Siberia during the Palaeo- and the Mesoproterozoic based on similarities of Palaeo- to Mesoproterozoic stratigraphy between North China and Siberia. Additionally, some paleomagnetic data appear to support this North China-Siberia connection (Halls et al., 2000; Zhang et al., 2000). However, it remains unknown whether or not this

* Corresponding author. Tel.: +86 13717921943.
E-mail address: chendongyue0108@163.com (D. Chen).
Peer-review under responsibility of China University of Geosciences (Beijing).

http://dx.doi.org/10.1016/j.gsf.2015.03.004

connection can be extrapolated to the Archaean, because there are some striking differences in tectonic evolution during the Archaean between the two continental blocks. For example, the Aldan Shield in Siberia first reached stabilization at ~3.1–2.9 Ga, and the micro-continental blocks of the Anabar Shield were amalgamated at 2.6 to 2.5 Ga (Nutman et al., 1992; Rosen et al., 2006). These data are significantly different from those of the NCC during the Archaean.

Zhao et al. (2003a) made a comparison of sedimentary sequence, isotopic geochronology, lithology, tectonics and geochemistry between the NCC and the IND. He suggested that the eastern Block (EB) of the NCC and South Block (SB) of the IND were once connected. A possible fit was proposed for the reconstruction of the EB and SB. In this reconstruction, the northern margin of the EB was placed adjacent to the western margin of the SB, with the Trans-North China Orogen (TNCO) and the Western Block representing the continuations, respectively, of the central Indian Tectonic Zone (CITZ) and the North Indian Block. Hou et al. (2008a) argued that the NCC, IND and Laurentia were part of Columbia prior to its extension and break up on the basis of the ca. 1.85–1.75 Ga giant radiating dyke swarm and Large Igneous Provinces (LIPs). Zhao et al. (2011) thought that the present south margin of the NCC represented an active continental margin in Columbia and was likely to face an open ocean, whereas its north margin was connected to a large landmass based on subduction-related accretion at the NCC margins.

However, most of the aforementioned studies are based on comparisons of geological characteristics, and it is generally accepted that ore deposits are not randomly distributed in time and space and are closely related to geological evolution (Qiu et al., 2014). Zhai (2010) and Zhai and Santosh (2013) argued that the metallogenesis has a high spatiotemporal coupling with major geological and tectonic events in Earth's history. Mao and Zhong (2001) argued that similar geological evolution and metallogenic geological conditions correspond to similar metallogenesis, including similar mineralization types, mineralization characteristics and ore-forming processes. In this paper, we further test and extend Zhao's (2011) hypothesis by comparing the Archaean to Palaeoproterozoic metallogenic systems of the NCC and the IND. Our study reveals that the NCC and the IND show strong metallogenic similarities from the middle Archaean to the Mesoproterozoic. The conclusions verify the tectonic affinity between the NCC and the IND, supporting that the north margin of the NCC and west margin of the IND once connected during the middle Archaean to the Palaeoproterozoic era. In addition, the depositional environment of the Paleoproterozoic metasedimentary manganese deposits of the two blocks implied that the assembly may have been located at low latitudes. In contrast to the NCC, the IND was likely to have been located at lower latitudes, where the conditions were more favorable for dissolving ice after the "Ice Earth" (2.5–2.3 Ga) and precipitating manganese deposits.

2. Geological background

The NCC and the IND are both ancient continental blocks (Fig. 1a). Approximately 90% of the continental crust in the NCC formed in the early Precambrian period. The basement of the NCC consists of variably exposed Archaean to Paleoproterozoic rocks, including tonalite–trondhjemite–granodiorite (TTG) gneisses, granites, charnockites, migmatites, amphibolites, greenschists, pelitic schists, Al-rich gneisses (khondalite), banded iron formations (BIFs), calc-silicate rocks, and marble (e.g., Zhao et al., 1998, 2005; Kusky et al., 2007; Zhai, 2010, 2011; Zhai and Santosh, 2011). The basement is tectonically divisible into the eastern and western Blocks, which are separated by a central zone called the Trans-North China Orogen. This zone is a nearly 1500 km-long orogenic belt that extends from north to south. The Western Block

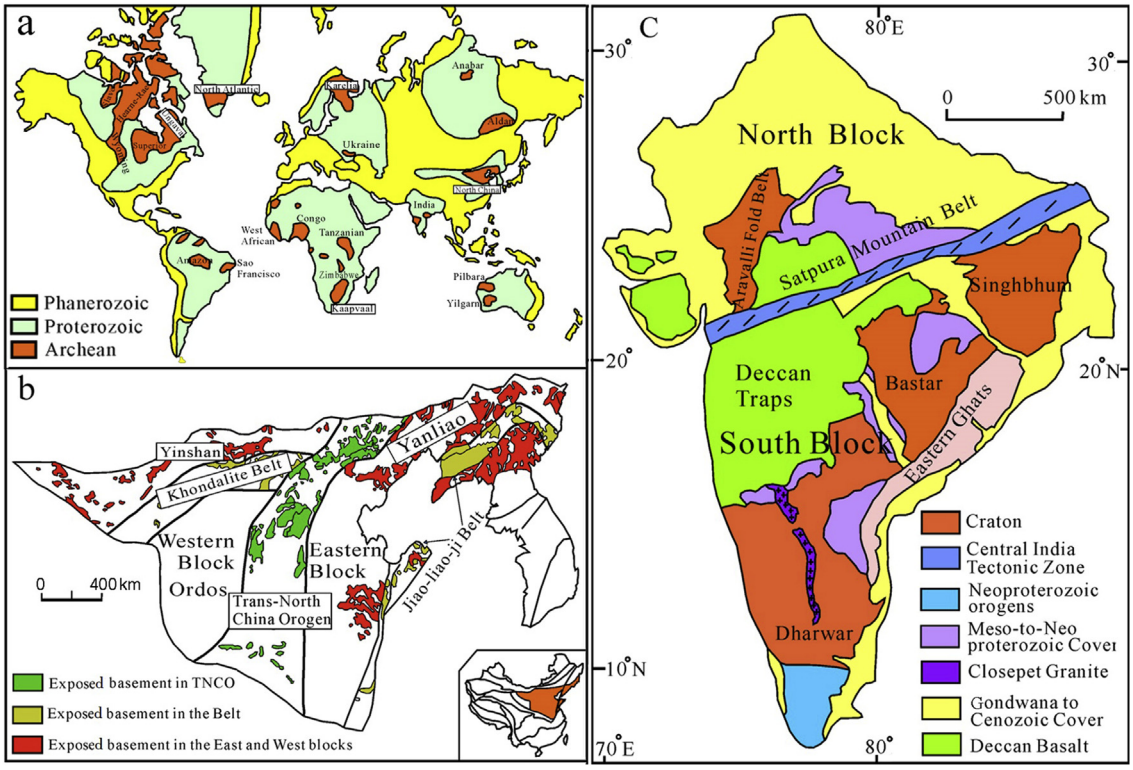

Figure 1. (a) A map of showing the distribution of ancient nuclei and Archaean micro-blocks (revised after Santosh et al., 2009); (b and c) tectonic architecture of the North China Craton and the Indian Shield (b–revised after Kusky et al., 2007; c–revised after Zhao et al., 2002).