Journal of Asian Earth Sciences 127 (2016) 300–313

Contents lists available at ScienceDirect

Journal of Asian Earth Sciences

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

Full length Article

Early Paleozoic oceanic inliers and reconstruction of accretionary tectonics in the Middle Gobi region, Mongolia: Evidence from SHRIMP zircon U-Pb dating and geochemistry

Mingshuai Zhu [a,*], Laicheng Miao [a], Munkhtsengel Baatar [b], Fochin Zhang [a], Chimedtseren Anaad [b], Shunhu Yang [a,c], Xingbo Li [a,c]

[a] Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China
[b] Mongolian University of Science and Technology, Ulaanbaatar 120646, Mongolia
[c] University of Chinese Academy of Sciences, Beijing 100049, China

ARTICLE INFO

Article history:
Received 18 December 2015
Received in revised form 15 June 2016
Accepted 21 June 2016
Available online 29 June 2016

Keywords:
Middle Gobi
Namdain hundy ophiolite
SHRIMP
Early Paleozoic

ABSTRACT

The ophiolites that occur as inliers among the Late Paleozoic formations in the Middle Gobi area are crucial for understanding the tectonic evolution of South Mongolia. In this paper, we conducted detailed studies on the Namdain hundy ophiolite to provide some constraints on the Early Paleozoic evolution of the Middle Gobi region in Mongolia. The ophiolite mainly consists of ultramafic rocks (carbonatation), plagiogranite, metagabbro, basalt and chert. The metagabbro and plagiogranite from Namdain hundy ophiolite yielded SHRIMP zircon U-Pb ages of 528 ± 7 Ma and 519 ± 5 Ma, respectively. Though most of the volcanic rocks of this ophiolite show supra-subduction zone (SSZ) affinity, samples with OIB and N-MORB geochemical features were also identified, indicating genesis in a forearc setting. The granodiorite intruding into the Namdain hundy ophiolite yielded a SHRIMP zircon U-Pb age of 491 ± 3 Ma, which constrained the upper age limit of ophiolite emplacement. This granodiorite shows adakitic geochemical affinity, attesting to the existence of Cambrian paleo - subduction in South Mongolia. Based on the available data so far, we suggest the Middle Gobi area comprises of the Manlay accretion complex, the island arc and the Biluutiin ovoo back-arc basin. The spatial configuration of these three tectonic belts suggests that the polarity of the paleo-ocean subduction was from south to north in the Early Paleozoic, forming a trench-arc-basin system south of the Central Mongolia microcontinent.

1. Introduction

Mongolia occupies the central position within the CAOB and therefore can provide important constraints on the tectonic evolution of the CAOB as well as the extension of tectonic belts. Over the last few years, studies on the Southeast Mongolia are mainly focused on the evolution of the Devonian and Carboniferous arc and the related mineral deposits (Blight et al., 2010; Wainwright et al., 2011), with few studies dealing with the Early Paleozoic tectonic evolution. Concerning the tectonic evolution of the Middle Gobi area, there are mainly three models: (1) accretionary wedge which grew to the south of Tuva-Mongolia microcontinent from the Ordovician to the Early Carboniferous with Upper Silurian to Lower Carboniferous magmatic arc (Şengör et al., 1993); (2) forearc/backarc basin terrane in the northern part and Middle-Late Paleozoic island arc terrane in the southern part (Badarch et al., 2002; Windley et al., 2007); (3) Middle-Late Ordovician active margin with Late Ordovician-Silurian accretionary wedge during the Early Paleozoic and peri - continental arc with back-arc basin during the Middle-Late Paleozoic (Wilhem et al., 2012). Actually, the Early Paleozoic tectonic evolution of the Middle Gobi area in these models is not well constrained though some geochemical and geochronological data have been reported for the ophiolites and coeval island arc (Zhu et al., 2014a,b). Further studies for the dismembered ophiolite fragments in the Middle Gobi (Fig. 1) could help us better understand the Early Paleozoic architecture of the orogen in this area and solve the controversies on the former models.

Ophiolitic fragments in accretionary orogens contain important evidence of magmatic and tectonic processes experienced by the ocean floor during its transport from ridge to trench and subsequent accretion (e.g. Dilek et al., 2000; Dilek and Robinson, 2003;

* Corresponding author at: No. 19, Beitucheng Western Road, Chaoyang District, Beijing 100029, China.
E-mail address: shuaimingzhu@163.com (M. Zhu).

http://dx.doi.org/10.1016/j.jseaes.2016.06.018
1367-9120/

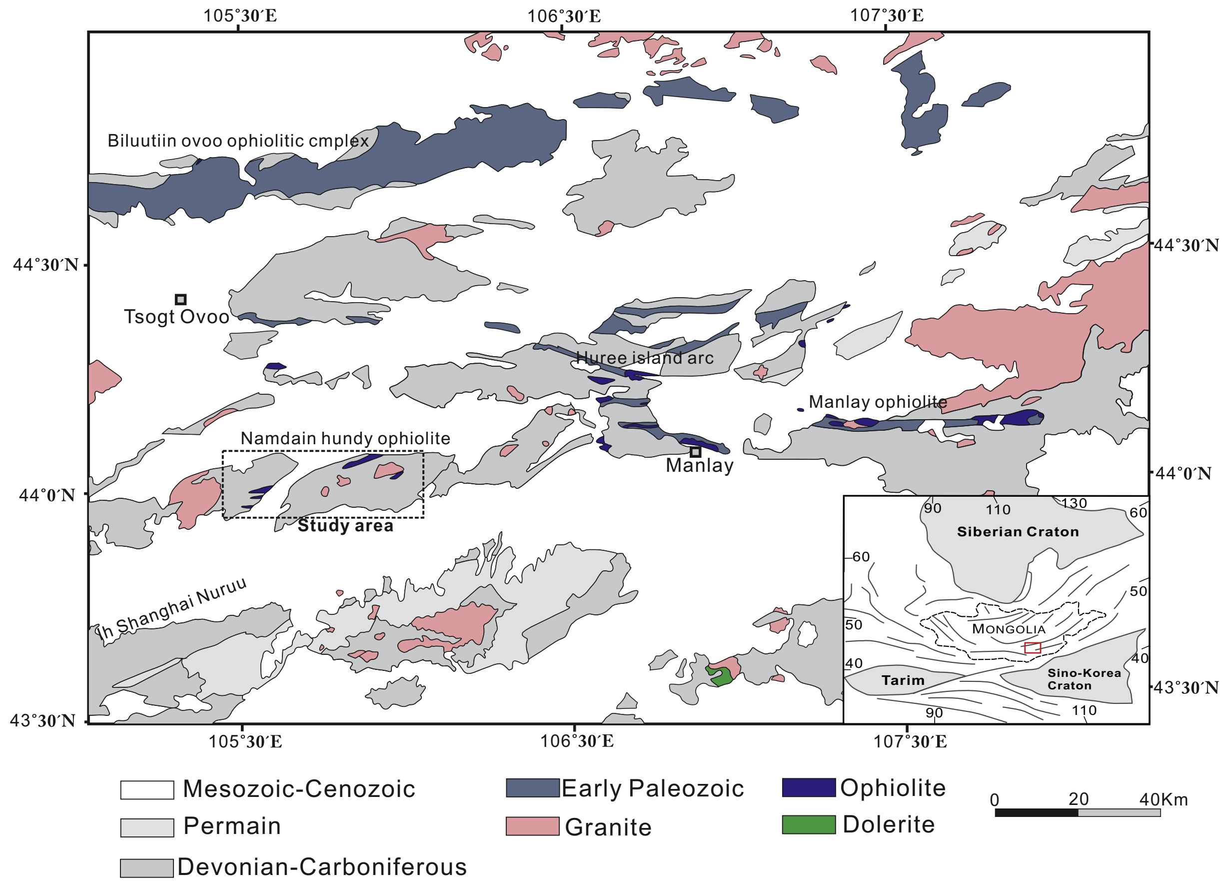

Fig. 1. Simplified geological map of Middle Gobi area, South Mongolia (compiled from Geological Map of The Central and Eastern Mongolia with a 1:500000 scale (Jamyandorj et al., 1990). Inset showing the location of the study area in the Central Asian Orogenic Belt (modified from Badarch et al. (2002)).

Cawood et al., 2009). Therefore, studies on ophiolites cannot only provide good constraints on the tectonic evolution of the orogenic belts, but also provide essential information about the nature of the oceanic lithospheric mantle, oceanic magma processes, and mechanisms of continental growth in accretionary and collisional belts (e.g. Dilek, 2003; Whattam, 2009; Jian et al., 2010a,b). This paper presents new results of geochronological and geochemical analyses for the Namdain hundy ophiolite complex in the Middle Gobi region of Mongolia with aims to: (1) determine the age and origin of the ophiolite; (2) probe into the basement of Devonian - Carboniferous arcs in the South Mongolia; (3) reconstruct the Early Paleozoic accretionary tectonics of the Middle Gobi region.

2. Geological setting

According to Badarch et al. (2002), the study area is dominated by two island-arc terranes, the Gurvansaykhan in the south and Mandalovoo in the north. These two terranes are interpreted to originally belong to one contiguous island-arc, but dextral strike-slip faults separated them to their current positions (Blight et al., 2008). They have similar components and mainly consist of deformed Ordovician to Carboniferous volcanic and sedimentary rocks. Specifically, Ordovician and Silurian formations comprise sandstone, argillite, limestone, chert and volcanoclastic rocks (Lamb and Badarch, 1997). Devonian and Early-Middle Carboniferous formations consist of conglomerate, sandstone, shallow-marine fossil-rich limestone, felsic tuff, pillow basalt, andesite, volcanoclastic rocks and chert (Badarch et al., 2002). Geochemical data from pillow lavas indicate that the basalts were erupted in a subduction setting (Lamb and Badarch, 2001). Many porphyry copper deposits, such as Tsagaan Suvarga and Oyu Tolgoi, are related to arc formations of this time. Late Carboniferous and Permian system is characterized by a bimodal volcanic suite, accompanying peralkaline granites in the study area and the whole southern Mongolia (Yarmolyuk et al., 2008). The structure of this area is complex and dominated by imbricate thrust sheets, dismembered blocks, melanges, and high strain zones (Badarch et al., 2002). There are many small outcrops of dismembered ophiolites distributed in southern Mongolia (Fig. 1), and some age and geochemical data have been reported for them (Zhu et al., 2014a,b). The Manly ophiolite shows a supra-subduction zone (SSZ) feature and formed during Cambrian (ca. 509 Ma) in the south (Zhu et al., 2014a). The Billuutiin ovoo ophiolite has SSZ affinity and also formed during Cambrian (ca. 525 Ma) in the north (Zhu et al., 2014b). Between these two ophiolites, a remanent volcanic arc (Huree arc; ca. 487 Ma) was recognized in this region (Zhu et al., 2014a). However, some of the ophiolites still lack systematic studies and thus the Early Paleozoic tectonic evolution of this region remains to be constrained. In this paper, detailed studies were conducted on the Namdain hundy ophiolitic complex, which occurs nearly at the same latitude of the Manlay ophiolite (Zhu et al., 2014a).

According to our field observation, the Namdain hundy ophiolitic complex mainly has two outcrops along its strike (Fig. 2). The eastern part consists of ultramafic rocks, gabbro, plagiogranite, basalt, tuff sandstone and chert. The ultramafic rocks suffered strong carbonation dipping to the south (Fig. 3a). The gabbro, occurring as lenses in tuff sandstone, is north to the ultramafic rocks. The tuff sandstone, with a thickness of ~50 m, crops out further north dipping to the south (~50°). The plagiogranite occur