Geoscience Frontiers 5 (2014) 525–536

Contents lists available at ScienceDirect

China University of Geosciences (Beijing)

Geoscience Frontiers

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

Research paper

How many sutures in the southern Central Asian Orogenic Belt: Insights from East Xinjiang–West Gansu (NW China)?

Wenjiao Xiao [a,b,*], Chunming Han [a,b], Wei Liu [b], Bo Wan [b], Ji'en Zhang [b], Songjian Ao [b], Zhiyong Zhang [b], Dongfang Song [b], Zhonghua Tian [b], Jun Luo [b]

[a] Xinjiang Research Center for Mineral Resources, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China
[b] State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China

ARTICLE INFO

Article history:
Received 27 February 2014
Received in revised form
30 March 2014
Accepted 2 April 2014
Available online 21 April 2014

Keywords:
Major suture
Paleogeographic separation
Accretionary complex
Intra-oceanic arc
Southern CAOB

ABSTRACT

How ophiolitic mélanges can be defined as sutures is controversial with regard to accretionary orogenesis and continental growth. The Chinese Altay, East Junggar, Tianshan, and Beishan belts of the southern Central Asian Orogenic Belt (CAOB) in Northwest China, offer a special natural laboratory to resolve this puzzle. In the Chinese Altay, the Erqis unit consists of ophiolitic mélanges and coherent assemblages, forming a Paleozoic accretionary complex. At least two ophiolitic mélanges (Armantai, and Kelameili) in East Junggar, characterized by imbricated ophiolitic mélanges, Nb-enriched basalts, adakitic rocks and volcanic rocks, belong to a Devonian–Carboniferous intra-oceanic island arc with some Paleozoic ophiolites, superimposed by Permian arc volcanism. In the Tianshan, ophiolitic mélanges like Kanggurtag, North Tianshan, and South Tianshan occur as part of some Paleozoic accretionary complexes related to amalgamation of arc terranes. In the Beishan there are also several ophiolitic mélanges, including the Hongshishan, Xingxingxia–Shibangjing, Hongliuhe–Xichangjing, and Liuyuan ophiolitic units. Most ophiolitic mélanges in the study area are characterized by ultramafic, mafic and other components, which are juxtaposed, or even emplaced as lenses and knockers in a matrix of some coherent units. The tectonic settings of various components are different, and some adjacent units in the same mélange show contrasting different tectonic settings. The formation ages of these various components are in a wide spectrum, varying from Neoproterozoic to Permian. Therefore we cannot assume that these ophiolitic mélanges always form in linear sutures as a result of the closure of specific oceans. Often the ophiolitic components formed either as the substrate of intra-oceanic arcs, or were accreted as lenses or knockers in subduction-accretion complexes. Using published age and paleogeographic constraints, we propose the presence of (1) a major early Paleozoic tectonic boundary that separates the Chinese Altay–East Junggar multiple subduction systems of the southern Siberian active margin from those of the northern Tarim; and (2) a major Permian suture zone that separates the Tianshan–Beishan from the northern active margin of the Tarim Craton. These new observations and interpretations have broad implications for the architecture and crustal growth of central Asia and other ancient orogens as well.

1. Introduction

Sutures are the tectonic boundaries between adjoined plates, and have been used to describe the amalgamation history of orogens. Ophiolites and/or ophiolitic mélanges are commonly found in sutures, because they represent the remains of accreted fragments of vanished oceans and of material that were deposited in the subducted trenches. Therefore, ophiolites and/or mélanges found in the field are usually regarded as sutures, which represent the vanished oceans between blocks (Dewey, 1977; Smith, 1988; Xiao and Tang, 1991; Şengör, 1992; Dewey, 2005).

* Corresponding author. Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing 100029, China. Tel.: +86 10 8299 8524; fax: +86 10 6201 0846.
E-mail address: wj-xiao@mail.igcas.ac.cn (W. Xiao).

Peer-review under responsibility of China University of Geosciences (Beijing)

Production and hosting by Elsevier

1674-9871/$ – see front matter © 2014, China University of Geosciences (Beijing) and Peking University. Production and hosting by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.gsf.2014.04.002

However, a question arises as to whether all ophiolites and/or ophiolitic mélanges found in the field are all sutures. This question is related to the fundamental architecture of different types of orogens. Continent-continent collision orogens typically have well definable sutures, which may contain distinct ophiolites and/or ophiolitic mélanges, although some may be transported by post-collisional thrusts onto a foreland far from its mother suture. In accretionary orogens the situation is less clear. Although one can imagine that the Nankai Trough off Japan will one day become a suture, it is questionable whether the boundary between every accreted adjacent island arc can be called a suture, particularly when many of those boundaries have undergone extension during oceanward trench migration (Şengör, 2004). In consequence, the position of sutures and of accreted tectonic boundaries in many orogens remains controversial, and this can affect the understanding of the ambient tectonic evolution (Alps: Jolivet et al., 2003; Ratschbacher et al., 2004; the Himalayas: Chang et al., 1986; Dewey et al., 1988; Yin and Harrison, 2000; Aitchison et al., 2001; the Central Asian Orogenic Belt (CAOB): Şengör, 1992, 2004; Şengör and Natal'in, 1996a,b; Xiao et al., 2003).

The East Xinjiang–West Gansu area of the CAOB or Altaids (Şengör and Okurogullari, 1991; Şengör et al., 1993; Carroll et al., 1995; Seltmann et al., 2001; Yakubchuk et al., 2001; Jahn et al., 2004; Xiao et al., 2010; Bazhenov et al., 2012; Choulet et al., 2012; Kröner et al., 2014) contains many ophiolitic mélanges, the components of which are varied and often controversial, and thus provide useful constraints and points for discussion of the questions at hand.

In this paper we aim to present the results of our field, structural and geochemical/isotopic studies made over many years and integrated with relevant published data. First, we describe some newly discovered mélanges and accretionary complexes that include ophiolitic fragments, integrated with some recent SHRIMP zircon ages for some ophiolitic fragments and with recently published high-resolution isotopic age data, in order to constrain the temporal development of the ophiolitic fragments and sutures. Combined with published geochemical, structural, geochronological, and geophysical data (Wang et al., 2003a), we interpret the key subduction-accretion complexes in terms of their tectonic settings and paleogeographic significance. We discuss the evolution of the major sutures of this part of the orogen in terms of the long-lived subduction-accretion events from the Cambrian to Permian, and we place this in the context of the crustal growth of the southern CAOB.

2. Regional geology

The CAOB, one of the world's largest accretionary orogens, was largely formed by subduction and accretion of juvenile material from the Neoproterozoic through the end-Paleozoic (Mossakovsky et al., 1993; Şengör et al., 1993; Allen et al., 1995; Long et al., 2007; Xiao et al., 2008, 2010; Geng et al., 2011; Cai et al., 2012a).

The East Xinjiang–West Gansu area links the southern CAOB in Mongolia to the east with Kazakhstan in the west (Figs. 1 and 2); this is a remote area near the Chinese–Mongolian border with excellent exposures of arc rocks and ophiolites, which mark the sites of consumption of the Paleo-Asian Ocean and accretion to the southern active margin of Siberia in the late Paleozoic (Xiao et al., 2004b; Windley et al., 2007). The Chinese Altay, the northernmost belt, is connected northwards to the Siberian active margin in Kazakhstan and Russia (Buslov et al., 2001; Dobretsov et al., 2004; Safonova et al., 2004; Dobretsov et al., 2006; Long et al., 2007, 2008;

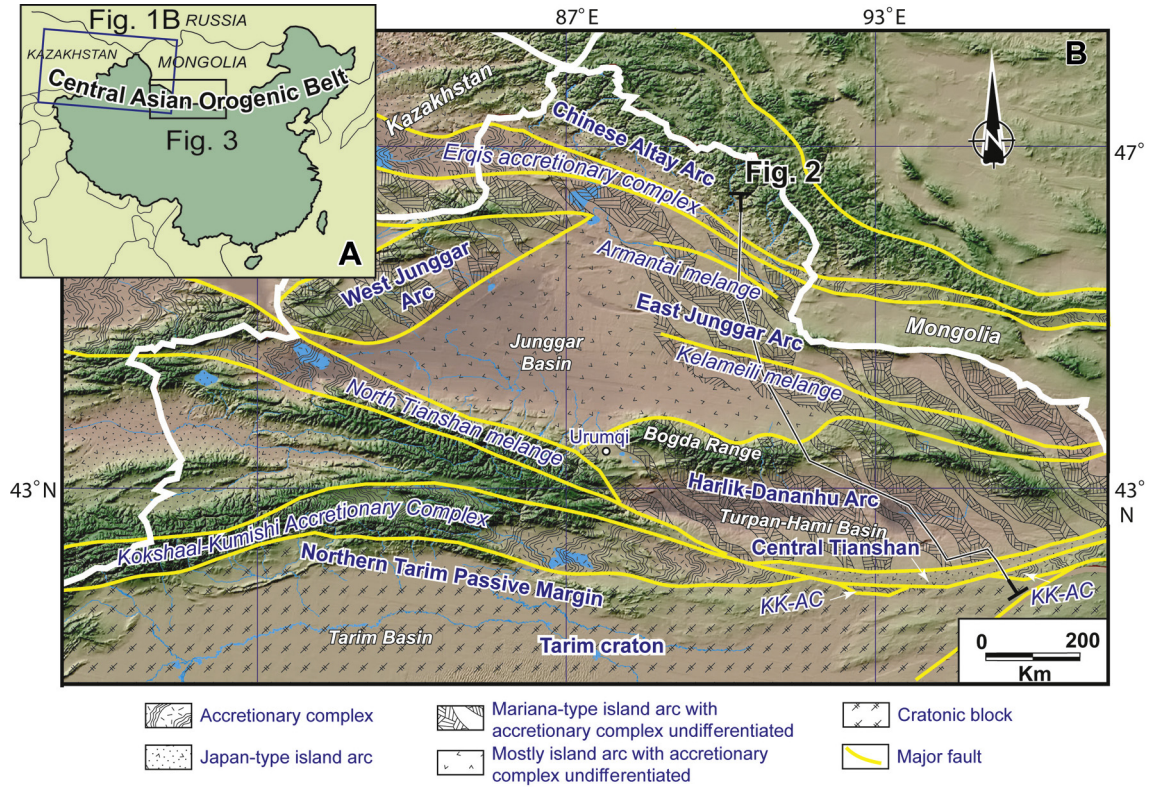

Figure 1. (A) Schematic map showing the tectonic position of Northern Xinjiang in the southernmost part of the CAOB. Figs. 1B and 3 are outlined. (B) Schematic tectonic map showing the Chinese Altay–East Junggar orogenic collage (East Xinjiang–West Gansu area) (Xiao et al., 2004a,b, 2008; Xiao and Santosh, 2014). KK-AC = Kokshaal-Kumishi accretionary complex.