Available online at www.sciencedirect.com
ScienceDirect
Journal of Asian Earth Sciences 32 (2008) 301–307
Journal of Asian Earth Sciences
www.elsevier.com/locate/jaes

The origin and tectonic setting of ophiolites in China

Paul T. Robinson [a,*], Mei-fu Zhou [b]

[a] *Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia, Canada B3H4J1*
[b] *Department of Earth Sciences, The University of Hong Kong, Pokfulam Road, Hong Kong*

Abstract

Ophiolites are key features for unravelling the geologic history of orogenic belts, especially in China, which was formed by amalgamation of numerous tectonic blocks from Precambrian time to the present. Although much has been learned about ophiolites over the last 30 years, questions remain as to their definition, composition, classification, origin and tectonic significance. Most ophiolites, particularly those in China are incomplete bodies composed of serpentinized peridotite, minor cumulate rocks and sparse pillow lavas. Sheeted dikes are rare in most ophiolites and the structural relationships between the different lithologies are commonly unclear. Such bodies should be considered 'possible' ophiolites unless the lithologies can be clearly linked structurally or compositionally. The former classifications of ophiolites into Cordilleran- or Tethyan-types and Harzburgite- or Lherzolite-types have been superseded by a more process-oriented classification proposed by Dilek (2003) that relates them to different magmatic and tectonic processes. This classification makes it easier to reconstruct paleoenvironments and processes in the geologic record. Although ophiolites were originally interpreted as fragments of normal ocean lithosphere, most such bodies have been shown to contain clear suprasubduction zone geochemical fingerprints. Some ophiolites consist entirely of suprasubduction zone components whereas others are compound bodies formed originally at mid-ocean spreading centers and then modified by later suprasubduction zone melts. Percolation of suprasubduction zone melts through the overlying mantle wedge can produce dunite pods and dikes, commonly associated with podiform chromitites, and may be responsible for the formation of transitional zone dunites. Ophiolite emplacement is thought to require subduction of lower density material beneath the body, a process that is easy to explain in subduction zone environments. Emplacement can occur either during subduction rollback or by final closure of the ocean basin in which the ophiolite formed. Much new work on Chinese ophiolites is currently underway and new interpretations of these bodies are being developed. This Special Issue presents the results of recent studies of ophiolites from most of the major orogenic belts in China.

Keywords: China; Ophiolites; Classification; Lithology; Composition; Emplacement; Tectonic environment

1. Introduction

China's diverse geological character reflects its formation by the amalgamation of numerous tectonic blocks, beginning in the Precambrian and continuing to the present day (Fig. 1). Ophiolites are key features in identifying the suture zones between these blocks, and in delineating the ages and mechanisms of collision. They record evidence of tectonic and magmatic processes occurring in the former ocean basins and provide information on mantle processes, lithosphere accretion and destruction, plate collisions and tectonic environments.

A great deal of work has been carried out on Chinese ophiolites over the past 30 years, much of which is available only in the Chinese literature. Many new data are now being published in English, however, the vast size of the country, the number of ophiolites present, and the challenges of working in remote areas mean that much remains to be done. Beginning with the joint Chinese–French study of Tibetan ophiolites in the early 1980s and the Tibetan geotraverse in 1985, western scientists have become increasing involved in this work. Today, joint projects are being carried out with workers from many different countries.

* Corresponding author. Tel.: +1 902 421 1616.
E-mail address: p.robinson@ns.sympatico.ca (P.T. Robinson).

1367-9120/$ - see front matter
doi:10.1016/j.jseaes.2007.11.014

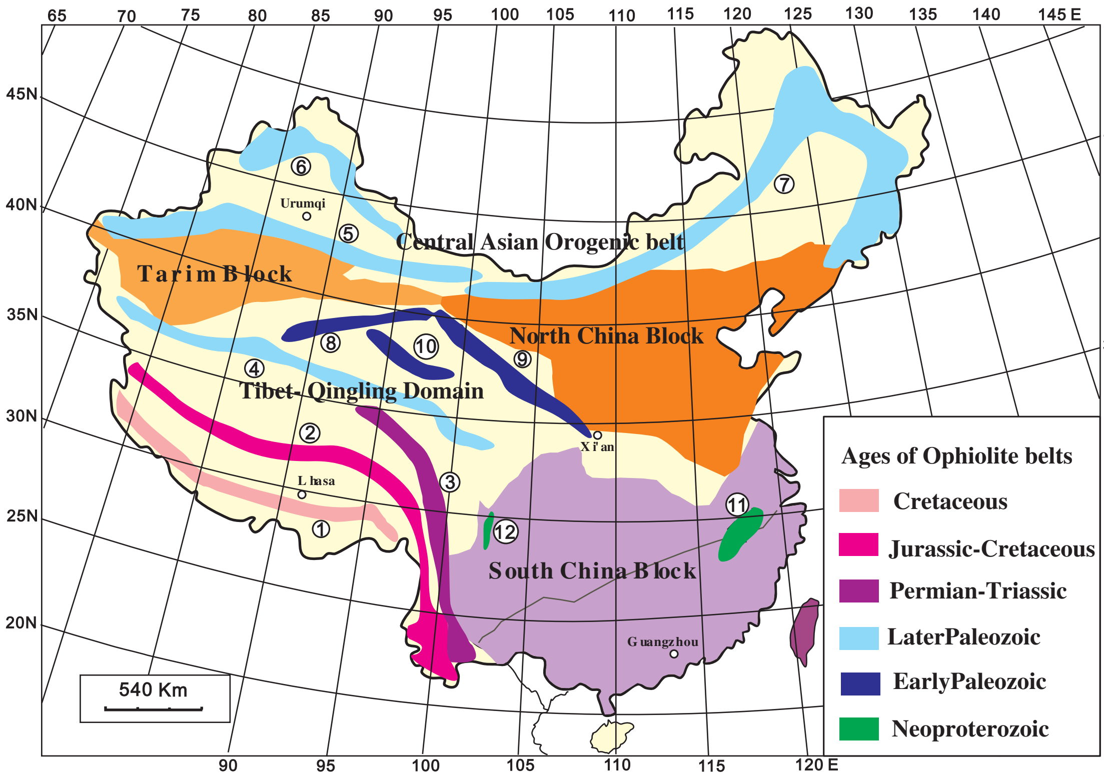

Fig. 1. Map showing the distribution and age of the major ophiolite belts in China (after Bai, 1986). Ophiolite belts: 1 – Yarlung-Zangbo, 2 – Bangong Lake-Lujiang, 3 – Jinshajiang-Ailaoshan, 4 – Kunlun, 5 – Tianshan, 6 – Junggar, 7 – Inner Mongolia-Hingganling, 8 – Altun, 9 – Qilian-Qinling, 10 – North Qaidam, 11 – Jiangnan, 12 – Shimian.

Ideas on ophiolite genesis and emplacement have changed significantly since the pioneering studies of Gass (1968), Moores and Vine (1971), and are still evolving. It is now generally accepted that ophiolites are formed or assembled in suprasubduction zones (SSZ), a view supported by increasingly abundant discoveries of boninites and other arc-like volcanic assemblages in such bodies (Alabaster et al., 1982; Robinson et al., 1983; Pearce et al., 1984; Robinson and Malpas, 1990; Stern and Bloomer, 1992; Shervais, 2001; Pearce, 2003). This interpretation has moved the formation of ophiolites from constructive plate boundaries to collisional zones, thus completely changing their tectonic significance. For example, the clear evidence of extensional tectonics in some ophiolites reflects spreading in suprasubduction zone environments due to slab rollback rather than spreading at a mid-ocean ridge (Flower and Dilek, 2003; Dilek and Flower, 2003). Recognizing that ophiolites form in suprasubduction zone environments also greatly simplifies the problems of obduction because subduction allows the emplacement of less dense material beneath oceanic slabs. Another major step in our interpretation of ophiolites derives from our ability to obtain precise ages of ophiolite formation and emplacement with SHRIMP zircon U/Pb and Ar/Ar techniques.

However, despite these advances a number of important questions remain regarding the definition, structure, composition, origin and tectonic significance of ophiolites. Here, we briefly discuss some of these problems and emphasize how our understanding of ophiolites has evolved over time.

2. Definition of ophiolites

One of the most critical questions remaining is what precisely defines an ophiolite. The 1972 Penrose Conference definition (Anon., 1972) has been used for many years but because it is based heavily on the well-exposed and intact Troodos ophiolite it has several limitations. These limitations become readily apparent when attempting to identify highly deformed and disrupted bodies of mafic and ultramafic rock, particularly when they are very old and poorly exposed. The problem of determining whether or not a particular body is an ophiolite is well illustrated by the Dongwanzi and Aoyougou complexes of northern China. Based on the presence of typical ophiolite lithologies, such as peridotites, gabbros and mafic lavas, these bodies have been proposed to be Precambrian ophiolites (Kusky et al., 2001; Zhaochong et al., 2003; Polat et al., 2006) However, the structural and age relationships among the different components are not clear, leaving the origin of such complexes unresolved (e.g., Zhai et al., 2002; Zhang et al., this volume).

Sheeted dikes have long been considered a key component of ophiolites because they record formation in extensional environments, previously thought to be mid-ocean