We present an overview of the internal structure of the ophiolite massifs along the Yarlung-Zangbo Suture Zone (YZSZ) in southern Tibet with a focus on the geochemical character and tectonic evolution of the Ocean Island Basalt (OIB) and mafic alkaline rock assemblages associated with these ophiolites. The Jurassic – early Cretaceous lavas, massive diabase and gabbroic rocks are either tectonically intercalated with the early Cretaceous, subduction-influenced ophiolitic units, or occur as thrust sheets or blocks with an early Cretaceous mélangé and in a Jurassic-Cretaceous flysch unit structurally beneath these ophiolites. They display uniform chondrite-normalized REE patterns with light rare earth element (LREE) enrichment and heavy rare earth element (HREE) depletion, no obvious Eu anomalies or negative Nb, Ta and Ti anomalies, and primitive mantle normalized trace element patterns with significant large-ion lithophile element (LILE) enrichment, similar to those of modern OIB and the Hawaiian alkaline basalts. These mafic alkaline rock assemblages represent OIB- and Plume-type (P-type) oceanic crustal rocks (with no subduction influence) that formed from magmas produced by partial melting of plume–metasomatized asthenospheric mantle source during the early stages of the opening of a Neotethyan seaway between Proto-India and Eurasia. Subsequent consumption of this OIB–P-type mid-ocean ridge (MOR) oceanic lithosphere at an intraoceanic subduction zone produced the ~130-120 Ma forearc to backarc, SSZ oceanic crust within the same Neotethys. The evolutionary history of the YZSZ ophiolites thus reflects a poly-phase melt history and different mantle melt sources. The final tectonic juxtaposition of the older OIB- and P-type oceanic crustal rocks with SSZ-type oceanic lithosphere fragments took place as the northern passive continental margin of Proto-India collided with and underplated the intraoceanic subduction-accretion system in the late Cretaceous. The YZSZ displays a complete Wilson cycle record of the rift-drift, seafloor spreading and subduction zone tectonic evolution of the Mesozoic Neotethys.

Introduction

The geochemistry and geochronology of the YZSZ ophiolites have been studied extensively during the last twenty years, producing a vast database on the geochemical affinities of different ophiolites and the timing of oceanic crust formation prior to the India – Asia collision (Aitchison et al., 2000; Wang et al., 2000; Yin and Harrison, 2000; Dilek and Newcomb, 2003; Dupuis et al., 2005; Sun et al., 2005; Zhang et al., 2005; Zhou et al., 2005; Guilmette et al., 2008, 2009; Bédard et al., 2009; Dai et al., 2011a, b, 2012; Hébert et al., 2012; Liu et al., 2013; Chan et al., 2015; Xu et al., 2015a). Yet, the interpretations of the tectonic settings of ophiolite genesis, the igneous – metamorphic ages and emplacement mechanisms of ophiolites, and the subduction zone numbers and polarities involved in the evolution of Neotethys are highly diverse and still poorly constrained. The lack of systematic field-based structural work along the YZSZ and of the documentation of the internal structure and stratigraphy of the ophiolite massifs and mélangé units is partly responsible for this problem.

In this paper we overview and document the geological occurrence and the geochemical characteristics of a special group of mafic rocks, which are spatially and temporally associated with the ophiolite units.
along the 2500-km-long YZSZ. Largely overlooked in the literature, the early Jurassic-early Cretaceous OIB-type and alkaline mafic rocks are tectonically interleaved with the ophiolite massifs, as well as occurring extensively in the mélangé formations within the YZSZ and in the Jurassic-Cretaceous flysch deposits structurally beneath the YSZS. They are hence part of the rift-drift, seafloor spreading and subduction zone tectonic evolution of the Neotethyan oceanic lithosphere, evolved between India and Eurasia during the Mesozoic.

In the first part of the paper we summarize the spatial distribution and the internal structure of the discrete ophiolite complexes and the associated OIB-type mafic rocks from west to east along the YZSZ. Using some of the most reliable discriminant diagrams, we discuss, based on the extant data, the geochemistry and geochemical characteristics of these OIB-type mafic rocks. We then present an internally coherent tectonic model, synthesizing the structure, petrology, geochemistry and geochronology of the YZSZ ophiolites and the OIB-type rocks associated with them. This paper is intended to stimulate further research and discussions on the YZSZ ophiolites and on the significance of the existence of mafic OIB-type and alkaline oceanic rocks in suture zones in general.

Regional Geology of the Yarlung-Zangbo Suture Zone

The crust of the Tibetan Plateau is made of a series of oceanic and continental terranes bounded by the A’nelmaqin–Kunlun, Jinhajiagiang (JSZ), Bangong–Nujiang (BNSZ), Shuanghu–Dingqing, and Yarlung-Zangbo (YZSZ) suture zones (Fig. 1; Yin and Harrison, 2000; Zhang and Tang, 2009; Xu et al., 2015b). The Yarlung-Zangbo Suture Zone (YZSZ) in the southernmost part of the Tibetan Plateau is the youngest among these suture zones, and has been widely accepted to represent the India–Asia continental collision front with the remnants of the Neotethyan oceanic lithosphere exposed discontinuously along it (e.g., Allègre et al., 1984; Aitchison et al., 2000; Dupuis et al., 2005; Bédard et al., 2009; Zhang et al., 2010; Hébert et al., 2012). These Neotethyan ophiolites occur along two sub-parallel belts within the suture zone: the northern belt includes ophiolite complexes with upper mantle peridotites, gabbros, dikes, sills, extrusive sequences and pelagic-hemipelagic sedimentary rocks, whereas the southern belt consists mainly of peridotite massifs overlain by volcanic-sedimentary rocks. A discontinuous belt of a mélangé unit, containing ophiolitic material, deep marine sedimentary rocks, and high-grade metamorphic rocks structurally underlies the ophiolites within the YZSZ (Guilmette et al., 2008; Liu et al., 2015; Xu et al., 2015a).

A Mesozoic flysch unit, containing blocks of Upper Permian limestone, lower Triassic pelagic limestone, late Cretaceous calcschist, turbiditic rocks, serpentinite, gabbros, massive diabase, and pillow–massive lavas structurally underlies the YZSZ in the south (Xu et al., 2015a, and the references therein). High-grade metamorphic rocks with highly deformed granitoid intrusions make up the Tethyan Himalaya Sequence structurally beneath the Mesozoic flysch unit (Fig. 1). This Tethyan Himalaya Sequence consists mainly of Proterozoic to Eocene siliciclastic and carbonate sedimentary rocks, interbedded with Paleozoic and Mesozoic volcanic rocks (Yin, 2006), collectively forming the passive margin units of Greater India.

The northern boundary of the YZSZ is a complex, tectonic zone with ophiolitic and mélangé units structurally overlying the Xigaze forearc basin sequence (XG in Figure 1) and/or the Gangdese magmatic terrane (GMT in Figure 1) along N-vergent backthrusts.
The Xigaze forearc basin sequence includes Cretaceous clastic units interbedded with marly carbonate layers (Einsele et al., 1994; Wang et al., 1999, 2012). The Gangdese magmatic terrane consists of late Jurassic to Paleogene calc-alkaline granitoids and andesitic-dacitic-rhyolitic volcanic–volcaniclastic sequences that collectively make up an Andean-type magmatic arc formed above a N-dipping subduction zone beneath the southern margin of Asia (Chung et al., 2005; Chu et al., 2006; Wen et al., 2008a, b; Ji et al., 2009).

YZSZ ophiolites and associated OIB-type rocks

The Yarlung-Zangbo ophiolites crop out along the Yarlung-Zangbo River, and the main massifs include from west to east the Yungbwa, Xiugugabu, Dangqiong, Zhonga, Saga, Sangsang, Jiding, Xigaze, Zedong-Luobusa and the Eastern Himalayan Syntaxis ophiolites (Fig. 2). Recent geochronological and biostratigraphic studies in these ophiolites have revealed crystallization, deposition and metamorphic ages ranging from the middle Jurassic to the early Cretaceous; however, most of the igneous ages of the ophiolites are clustered at 130–120 Ma (Table 1; McDermid et al., 2002; Zhou, 2002; Malpas et al., 2003; Miller et al., 2003; Ziaibev et al., 2003; Wang et al., 2006; Wei et al., 2006a, b; Zhong et al., 2006; Chan et al., 2007; Guilmette et al., 2008, 2009; Li et al., 2008, 2009; Xia et al., 2008b; Dai et al., 2012). Petrological and geochemical studies of various crustal units (lavas, dikes, sills and gabbros) of the YZSZ ophiolites have indicated multi-stage melting episodes in different tectonic settings during their magmatic accretion and evolution, encompassing mid-ocean ridge, and backarc to forearc supra-subduction zone environments (Table 1; McDermid et al., 2002; Hébert et al., 2003; Xia et al., 2003; Dubois-Côté et al., 2005; Zhou et al., 2005; Bédard et al., 2009; Guilmette et al., 2008, 2009; Geng et al., 2010; Dai et al., 2011a, b; Bezard et al., 2011; Liu et al., 2010, 2012; Hébert et al., 2012; Dai et al., 2011b, 2013; Dilek and Furnes, 2014; Liu et al., 2015; Xu et al., 2015a). The Jurassic-Cretaceous mélangé unit structurally beneath the YZSZ ophiolites includes coherent blocks of alkaline lavas, gabbros and dikes, and these lithologies are also tectonically interleaved with the ophiolitic units and their volcanic-sedimentary sequences.

In this section we describe the internal structure and stratigraphy of some of the discrete YZSZ ophiolite massifs and the alkaline rock suites spatially associated with them from west to east along the YZSZ. The geographic distribution of the investigated ophiolite massifs is shown in Figure 2. Table 1 summarizes the details of the extant age data from the YZSZ ophiolites and the data sources. The geochemistry of these alkaline rock suites is discussed in the following section.

Dongbo ophiolite

The Neo-tethyan ophiolites in the westernmost part of the YZSZ occur in two sub-parallel belts (Fig. 2), separated by the Zhongba–Zhada crustal block (Liu et al., 2015; Xu et al., 2015a). The northern sub-belt largely displays a mélange character, whereas the southern sub-belt consists of discontinuous exposures of ophiolites with mafic-ultramafic and volcanic-sedimentary sequences. The Dongbo and
The Xiugugabu massif

The Xiugugabu ophiolite also occurs in the southern sub-belt in the western YZSZ (Fig. 2) and tectonically overlies the same early Cretaceous mélangé to the south as the Dongbo massif. It is composed of harzburgite and clinopyroxene (cpx)-harzburgite intruded by amphibole-bearing micro-gabbro and micro-gabbronitrite sills (Bezard et al., 2011). These sill intrusions and their host harzburgites show ductile deformation structures and mylonitic foliation of high-temperature origin. A massive diabase unit stratigraphically overlain by silstone and hylolastic volcanic rocks is faulted against the peridotites in the north. Diabasic rocks have tholeiitic basalt compositions with Mg#s of 0.60-0.63 that are distinctly different from those of the sill intrusions (Mg#s of 0.74-0.86), and show OIB (ocean island basalt) geochemical affinities with a slight crustal contamination fingerprint (Bezard et al., 2011). The Cr#s of the spinel-bearing harzburgites and the cpx-harzburgites vary between 0.20 and 0.80. Bezard et al. (2011) inferred that these upper mantle peridotites might have undergone less than 25% partial melting beneath a mid-ocean ridge spreading center, followed by a refertilization process in a supra-subduction zone setting. Sm-Nd whole-rock and U-Pb zircon dating of micro-gabbro sill rocks in the peridotites has revealed the crystallization ages of 126.2±9.1 Ma and 122.3±2.4 Ma, respectively, for the Xiugugabu massif (Fig. 2; Wei et al., 2006b; Xu et al., 2008).

| Table 1. Summary of the existing geochronological – biostratigraphic data from the Yarlung-Zangbo suture zone ophiolites and OIB-type rocks and key for the references used in Figure 1. |
|-----------------------------------------------|-------------------------------|-------------------------------|
| **Locality**                             | **Dating method**              | **References**               |
| Sapi–Shergol mélange                       | K–Ar in hornblende in amphibolite | Honnegger et al. (1982)       |
| Dras                                       | 40Ar/39Ar in hornblende in amphibolite | Honnegger et al. (1982)       |
| Spongantang                                | 40Ar/39Ar in amphibolite in basaltic andesite | Reuber et al. (1989)         |
| Spong arc                                  | 40Ar/39Ar in amphibolite in basaltic andesite | Reuber et al. (1987)         |
| Niarc                                      | U–Pb in zircon in andesite | Reuber et al. (1987)         |
| Dongbo                                     | U–Pb in zircon in pyroxenite and gabbro | Ahmad et al. (2008)          |
| Kiorar                                     | U–Pb in zircon in cumulate gabbro | Kojima et al. (2001)         |
| Yungbwa                                    | U–Pb in zircon in amphibolite | Miller et al. (2003)         |
| Dangxiong                                  | U–Pb Zircon in gabbro | Chan et al. (2007)           |
| Xiugugabu                                  | U–Pb in zircon in micro-gabbro | Chan et al. (2007)           |
| Naiju                                      | Sm–Nd in micro-gabbro | Wei et al. (2006b)           |
| Zhongba                                    | U–Pb in zircon in diabase | Xu et al. (2008)             |
| Buma                                       | U–Pb in zircon in amphibolite | Dai et al. (2011b)           |
| Xigaze                                     | U–Pb in whole rock basalt, diabase and gabbro | Dai et al. (2012)            |
| Qamei, Baigang, Lhazexian,                 | U–Pb in zircon in pegmatitic gabbro | Guilmette et al. (2009)      |
| Beilie, Xiadamei, Zisong,                  | Radiolaire | Hébert et al. (2012)         |
| (Pazuoz, Dayu)                             | U–Pb in zircon in amphibolite | Guilmette et al. (2009)      |
| Quanqang                                   | U–Pb in zircon in amphibolite | Zhou et al. (2002)           |
| Bainang                                    | U–Pb in zircon in amphibolite | Han et al. (2007)            |
| Dazhouchu                                  | U–Pb in zircon in quartz-diorite | Shi et al. (2003)            |
| Zedang                                     | Radiolaire | Mcdermid et al. (2002)       |
| Luobusa                                    | Radiolaire | Mcdermid et al. (2002)       |
| Eastern Syntaxis                           | 40Ar/39Ar in clinopyroxene in ultramafic rock | Dong et al. (2015)           |

The Dongba ophiolite consists of a volcanic-sedimentary sequence, gabbros, and peridotites with dolerite and pyroxenite dikes. Its volcanic-sedimentary sequence rests directly on the serpentinitized peridotites and includes basaltic lavas, volcaniclastic rocks, tuffaceous layers, limestone, red radiolarian chert, and silty shale–sandstone intercalations. Peridotites are composed of harzburgite and dunite with minor lherzolite. Cr-spinels of the Dongbo lherzolite have Cr# [Cr/(Cr+Al)] of 0.2–0.3, whereas Cr# of the harzburgite range from 0.2 to 0.75. U–Pb zircon dating of pyroxenite and gabbro dikes in the harzburgites by LA-ICP-MS has yielded crystallization ages of 130±5.5 Ma and 128±1.1 Ma, respectively, for the Dongbo ophiolite (Fig. 2; Xiong et al., 2011).
Zhongba massif

The Zhongba massif occurs west of the 84°E Longitude along the YZSZ (Fig. 2). It makes up a large thrust-sheet within the early Cretaceous mélangé, and is tectonically underlain by large blocks of massive diabase and pillow lava rocks. The mélange also includes blocks of chert, limestone and massive basalt.

The Zhongba massif is composed entirely of harzburgites with minor dunite. The Cr-spinels in the harzburgites have Cr# of 0.36–0.56 and Mg#s ranging from 0.57 to 0.72 (Dai et al., 2011b). These highly depleted harzburgites show variable relative enrichment in the most incompatible trace elements, characteristic of subduction-influenced mantle wedge peridotides beneath forearc settings (Parkinson and Pearce, 1998). Diabasic rocks and pillow basalts tectonically below the Zhongba thrust sheet exhibit trace element patterns that are similar to those of the average OIB, Hawaiian alkaline basalts, and OIB-type rocks documented from the other Neotethyan ophiolites along the west-central YZSZ. Zircon U-Pb dating of a diabasic rock sample has yielded a crystallization age of 125.7±0.9 Ma (Dai et al., 2012), which is consistent with the reported igneous ages of crustal rocks from the other YZSZ ophiolites (Table 1).

Saga massif

The Saga massif occurs just east of the 85°E Longitude and forms a ~25-km-long thrust sheet, tectonically overlying the early Cretaceous ophiolitic mélangé to the south (Fig. 2). The mélange contains blocks of lherzolitic, dunitic peridotites and garnet- and cpx-bearing amphibolites in a serpentinite matrix (Bédard et al., 2009; Guilmette et al., 2012). Structurally below this mélange in the south bearing amphibolites in a serpentinite matrix (Bédard et al., 2009; Coté et al., 2005; Dilek et al., 2008; Dilek and Furnes, 2009; Bao et al., 2013). The whole-rock compositions indicate their residual, highly refractory nature, which reflect 15% to 24% partial melting. The U-shaped REE patterns of some of the Xigaze harzburgites suggest their reaction-interaction with boninitic melts in a mantle wedge, as also reported from other Neotethyan ophiolites (Dilek and Thy, 1998, 2009; Dubois-Côté et al., 2005; Dilek et al., 2008; Dilek and Furnes, 2009; Bao et al., 2013; Dai et al., 2013).

The majority of doleritic and gabbro dike–sill intrusions and lavas show LREE depletion similar to N-MORB patterns, and enrichment in LILE and Pb and negative Nb–Ta anomalies, suggesting minor subduction influence in their melt evolution. Some dikes and lavas, on the other hand, display distinctive U-shaped boninitic patterns on N-MORB normalized trace element diagrams. Blocks of mafic lavas and gabbros in the Triassic flysch sequence beneath the ophiolitic mélangé of the Xigaze ophiolite have strong OIB geochemical signatures, indicating their origin from within-plate alkaline magmas (Dupuis et al., 2005; Hébert et al., 2012). U-Pb zircon dating of doleritic dikes in the mantle peridotites of the Dazhuqu and Deji sub-masses has revealed crystallization ages of 126.1±1.3 Ma and 124.9±1.1 Ma, respectively; a dolerite sill

The Sangsang massif occurs mainly of tectonized peridotites over lain to the north by a thin sliver (<1km) of gabbro, massive diabase and pillow lavas. The Sangsang peridotites are composed of harzburgite and cpx-harzburgite with spinels having Cr#s of 0.30–0.60, typical of abyssal or forearc mantle peridotites (Bédard et al., 2012). Their trace element characteristics suggest partial melting degrees of 17–30%, higher than those estimated for the peridotides in the Saga massif. Massive diabase and pillow lavas above the peridotides are enriched in incompatible elements, typical of OIB lavas. Alkaline volcanic rocks occurring as blocks in the ophiolitic mélange beneath the Sangsang massif also display OIB affinities (Hébert et al., 2012). The U-Pb SHRIMP dating of zircons from diabasic rocks has revealed a crystallization age of 125.23 Ma (Xia et al., 2008b).

Xigaze ophiolite

The Xigaze ophiolite occurs between the 88°E and 89°30’E Longitudes in the central part of the YZSZ (Fig. 2) and includes the Dazhuqu, Deji, Quanrang, Luqu and Jiding massifs. It is the biggest and most complete ophiolite complex along the entire YZSZ. It tectonically overlies the early Cretaceous ophiolitic mélangé to the south along an originally S-vergent thrust fault; however, the late Triassic-early Jurassic flysch sequence south of the YZSZ, the ophiolitic mélangé and the Xigaze ophiolite are all imbricated along N-vergent backthrusts, and rest structurally above the late Cretaceous and younger clastic rock sequences of the Xigaze Group in the north (Xu et al., 2015a).

In general, the Xigaze ophiolite consists of upper mantle peridotites, ultramafic cumulates, doleritic and gabbroic dike–sill intrusions in the peridotites, thin (<300 m) gabbro–gabbro-norite rocks in some massifs, and an extrusive sequence composed of pillow and massive lavas and tuffaceous volcaniclastic rocks, which are intercalated with radiolarian chert deposits near the top of the extrusive sequence. Siliceous mudstone, chert, radiolarite and fine-grained clastic rocks make up a sedimentary cover of the ophiolite.

The upper mantle units comprise harzburgite, cpx-harzburgite and lherzolite with minor occurrences of dunite and chromitites. The Mg# of these peridotites is in the range of 90.0–92.8, and the Cr# of spinels is in the range of 79 to 81 (Bao et al., 2013; Dai et al., 2013). The whole-rock compositions indicate their residual, highly refractory nature, which reflect 15% to 24% partial melting. The U-shaped REE patterns of some of the Xigaze harzburgites suggest their reaction-interaction with boninitic melts in a mantle wedge, as also reported from other Neotethyan ophiolites (Dilek and Thy, 1998, 2009; Dubois-Côté et al., 2005; Dilek et al., 2008; Dilek and Furnes, 2009; Bao et al., 2013; Dai et al., 2013).

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The late Triassic flysch unit is composed of shale, siltstone-sandstone, flysch rocks in its upper and mylonitic peridotites in its lower parts. The Paleogene Liuqu Conglomerate in the north (Xu et al., 2015a). The Zedang shear zone, which puts the ophiolitic peridotites on top of the NLZT represents a steeply south-dipping, 200- to 300-m-thick, ductile intrusion in the Deji sub-massif has given a weighted zircon U-Pb age of 127 Ma to 124 Ma for its late-stage mafic and felsic intrusive rocks. There are no age data available from the alkaline rocks, but their close spatial association with ophiolitic peridotites within the flysch near Renbu suggests that they are not significantly older than the early Cretaceous ages of the YZSZ ophiolites.

**Luobusa-Lang County ophiolites**

The Luobusa–Lang County ophiolite belt (Fig. 2) is situated in the eastern end of the YZSZ between 92° and 93° of longitudes, and includes the Kangjinla, Luobusa and Baozhigou massifs to the east, the Sangri, Chenbaxiang and Gongbar massifs in the center, and the Zedang massif to the west. This entire ophiolite belt is bounded by two regional, south-dipping, ductile to ductile–brittle thrust faults, the South Luobusa–Zedang thrust (SLZT) and the North Luobusa–Zedang thrust (NLZT) (Liang et al., 2011; Xu et al., 2015b). A highly deformed late Triassic flysch sequence is thrust over the ophiolite belt along the E-W-striking and steeply south-dipping SLZT. The NLZT represents a steeply south-dipping, 200- to 300-m-thick, ductile shear zone, which puts the ophiolitic peridotites on top of the Paleogene Liuqu Conglomerate in the north (Xu et al., 2015a).

In the Kangjinla–Luobusa area, the SLZT consists of mylonitic flysch rocks in its upper and mylonitic peridotites in its lower parts. The late Triassic flysch unit is composed of shale, siltstone–sandstone, and blocks of marble and quartz listwanite. The Luobusa ophiolite in this area constitutes a 40- to 50-km-long and up to ~ 4-km-wide mafic-ultramafic slab that is thrust northward onto the Gangdese batholith and the Cenozoic terrestrial strata (Yang et al., 2015b). However, an ophiolitic mélangé composed of blocks of pillow lavas, volcanic breccia, chert, marble, shale, isotropic gabbro and pyroxenite in a highly sheared serpentinite matrix underlies the ophiolite along its northern margin. Serpentinitized peridotites in the mélangé are transitional upward into a 300-m-thick dunite unit, which is overlain by cpx-harzburgites with chromitite bands and pods (Yang et al., 2015b). Structurally upward in the Luobusa ophiolite and overlying the cpx-harzburgites are depleted harzburgites with lenses and pods of chromitite enveloped by dunite (Huang et al., 1981; Zhou et al., 1996, 2002, 2005, 2014; Malpas et al., 2003; Hébert et al., 2003; Robinson et al., 2004; Shi et al., 2007; Yamamoto et al., 2007, 2009; Yang et al., 2007, 2014; Xu et al., 2011, 2014; Xiong et al., 2014).

A detailed account of the petrology and geochemistry of the Luobusa peridotites and crustal units is presented by Yang et al. (2015–this issue). The highly depleted upper harzburgites and the less-depleted cpx-bearing lower harzburgites represent the residues of high-degrees and low-degrees of melting, respectively (Bao et al., 2014). All these peridotite types display variously depleted, U-shaped REE patterns, characteristic of those mantle wedge peridotites beneath forearc settings (Parkinson and Pearce, 1998).

The Sangri, Chenbaxiang and Gongbar massifs in the center of the Luobusa–Lang County ophiolite belt are highly dismembered by numerous thrust faults, and occur as blocks in meters to tens of meters in size within an Upper Jurassic to Lower Cretaceous volcanic–sedimentary sequence. The late Triassic flysch unit to the south tectonically rests on this volcanic-sedimentary sequence along the SLZT. Further west, the Zedang massif occurs as a S-dipping thrust sheet sandwiched between the late Triassic flysch to the south and the late Cretaceous andesitic volcanic rocks of the Gangdese magmatic terrane to the north (Xu et al., 2015a). The ophiolite contains peridotites, podiform chromitites, gabbro, dolerite dikes and volcanic rocks, which are in places tectonically intercalated with middle-late Cretaceous sandstone, phyllite and radiolarite. The Zedang peridotites are composed of cpx-harzburgite, harzburgite with minor lherzolite and dunite (Bao et al., 2014). Volcanic rocks with MORB, island arc tholeiite (IAT) and boninitic geochemical affinities and REE patterns coexist within the Zedang extrusive rock suites (Bao et al., 2014).

The Lang County ophiolite is 70-km-long and constitutes the eastern extension of the Luobusa ophiolite. It includes upper mantle peridotites composed of harzburgite and dunite, and minor occurrences of meta-gabbro, meta-basalts, pillow basalts, dolerite sills and dikes. Basaltic lavas display E-MORB and OIB geochemical affinities.

The Luobusa cpx-harzburgites are crosscut by numerous gabbroic dikes. U/Pb zircon dating of one of these dike rocks has revealed a crystallization age of 148±4.5 Ma (Chan et al., 2007), which is considered as the minimum age of the ophiolite. U–Pb zircon dating of basaltic rocks from the Lang County ophiolite has yielded crystallization ages of 145.7±2.5 Ma and 147.8±3.3 Ma (Zhang et al., 2011). However, gabbroic rocks from the same ophiolite have provided U–Pb zircon ages of 191.4±3.7 Ma (Zhang et al., 2011). These limited age data from the Luobusa-Lang County ophiolites indicate much older magmatic ages from the eastern part of the YZSZ, suggesting that the Neotethyan oceanic lithosphere formation in this part of southern Tibet might have extended further back into the early Jurassic in the east.

**Eastern Syntaxis ophiolites (ESO)**

These ophiolites are situated at the extreme eastern end of the YZSZ where the Tethyan suture zone makes a sharp hairpin turn to the south between 95° and 96° of longitude and encounters the N-S-oriented, dextral Sagaing Fault (Fig. 1), which separates the Burma microplate in the west from the Sundaland to the east. Ophiolitic lithologies, composed of boninitic dolerite, arc tholeiite, back-arc basalt, amphibolite, and alkaline mafic rocks, occur as dismembered and metamorphosed blocks within a ~N-S-trending mélangé zone (Geng et al., 2010; Hébert et al., 2012; Ghose et al., 2014; Fareeduddin and Dilek, 2015). Geochronological data from the Eastern Syntaxis ophiolites in China are nearly non-existent. 40Ar/39Ar dating of clinopyroxene separates from an ultramafic rock has revealed a cooling age of 200±4 Ma (Geng et al., 2006). This age is consistent with the U/Pb zircon age of 191.4±3.7 Ma, obtained from the Lang County ophiolite directly to the north (Yang et al., 2011). However, gabbroic rocks from the same ophiolite have provided U–Pb zircon ages of 191.4±3.7 Ma (Zhang et al., 2011). These limited age data from the Luobusa-Lang County ophiolites indicate much older magmatic ages from the eastern part of the YZSZ, suggesting that the Neotethyan oceanic lithosphere formation in this part of southern Tibet might have extended further back into the early Jurassic in the east.

**Geochemistry of the OIB-type and alkaline rocks**

We have examined the extant geochemical data available in the literature from all alkaline rocks associated with the YZSZ ophiolites as described above, and have screened the major element analyses in order to avoid those samples with high LOI (loss on ignition) values.
We have selected only those samples with <5 wt.% LOI for the least altered samples analyzed, and have then compiled the high-quality data from more than 60 rock samples, including lavas, massive diabase, and gabbros with OIB affinities. A list of the most representative rock samples used in this study and their compositional names together with the ophiolite location and the data sources (references) is given in Table 2. We present the compiled trace element and REE data in Table 3.

The chondrite normalized REE patterns and the primitive mantle normalized trace element spider diagrams are shown in Figures 3 and 4, respectively. The average trends of modern OIB, E-MORB, N-MORB and Hawaiian alkali basalts are also shown on these plots for comparison (after Sun and McDonough, 1989; Garcia et al., 1995; Hofmann and Jochum, 1996; Xu et al., 2007). All the OIB-like rocks associated with the YZSZ ophiolites display uniform chondrite normalized REE patterns with LREE enrichment and HREE depletion, and with no obvious Eu anomalies. Most of the evaluated samples resemble modern OIB (Sun and McDonough, 1989) and the Hawaiian alkali basalts, although few show patterns similar to those of E-MORB and N-MORBs (Fig. 3). In the primitive mantle normalized spidergrams (Fig. 4), the examined rocks display trends that are similar to those reported for the Hawaiian alkali basalts and for the average OIB. There are no obvious negative Nb, Ta, and Ti anomalies.

Rocks produced from subduction-influenced magmas can be easily distinguished from OIB-type alkine rocks on the V–Ti/1000 discrimination diagram of Shervais (1982). The individual V-Ti diagrams from all examined ophiolites along the YZSZ show that the OIB rock suites plot largely in the alkaline field (Fig. 5), although some rock samples straddle the MORB – Alkaline boundary as well as plotting in the MORB field. On the Th/Yb versus Nb/Yb discrimination diagram (Fig. 6) of Pearce (2008), the majority of the examined rock suites plot closer to the OIB domain within the mantle array, and overlap significantly with the Hawaiian alkaline basalt field shown in the upper right-corner (Key diagram). On the Nb-Zr-Y ternary discrimination diagram, most of the OIB-type rocks from the YZSZ fall in the within-plate alkaline and tholeiitic basalt fields, while few samples plot in the E-MORB field (Fig. 7; Meschede, 1986).

We also applied the binary diagrams of Saccani (2015), which utilize absolute measures of Th and Nb, normalized to the N-MORB composition of Sun and McDonough (1989), to find out whether the examined rock suites show any subduction zone influence or evidence for crustal contamination, and to better identify their MORB affinities (Fig. 8). Elemental ratios of the examined samples range from E-MORB to P-MORB (plume-type MORBs; Dilek and Furnes, 2011, 2014; Pearce, 2008; Saccani, 2015) and to those in alkaline basalts (Fig. 8A), showing a continuous compositional variation from the less enriched to the more enriched rocks. These rocks exhibit multi-element patterns significantly enriched in LILE compared to HFSE and HREE. The overall geochemistry of the majority of the samples resembles that of alkaline basalts generated in within-plate ocean island settings (Fig. 8A). In terms of their tectonic fingerprint, these alkaline samples from the YZSZ overlap with subduction unrelated rifted margin and ocean-continent transition zone (OCT) rocks (Fig. 8B; Saccani et al., 2015). Only a very few of them may show slight chemical influence of lower crustal contamination in their melt evolution. We hence infer that the YZSZ alkaline rocks were generated from partial melting of a MORB-type asthenospheric source enriched in LREE by an OIB type component (plume-type component).

### Table 2. Summary of the extant geochemical data for the OIB-type mafic rocks from the YZSZ.

| Sample  | Rock type   | Location     | Reference         |
|---------|-------------|--------------|-------------------|
| 11L36-1 | Basalt      | Dongbo       | Liu et al. (2013) |
| 11L36-2 | Basalt      | Dongbo       | Liu et al. (2013) |
| 11L36-4 | Basalt      | Dongbo       | Liu et al. (2013) |
| 11L36-5 | Basalt      | Dongbo       | Liu et al. (2013) |
| 11L37-1 | Basalt      | Dongbo       | Liu et al. (2013) |
| 11L37-4 | Basalt      | Dongbo       | Liu et al. (2013) |
| 11L37-7 | Basalt      | Dongbo       | Liu et al. (2013) |
| 11L37-8 | Basalt      | Dongbo       | Liu et al. (2013) |
| 09-ZH-56A | Diabase   | Xiugugubu    | Bezzard et al. (2011) |
| 09-ZH-57 | Diabase     | Xiugugubu    | Bezzard et al. (2011) |
| 09-ZH-58 | Diabase     | Xiugugubu    | Bezzard et al. (2011) |
| ZEOS-5-01 | Pillow basalt | Zhongba     | Dai et al. (2012) |
| ZEOS-5-03 | Pillow basalt | Zhongba     | Dai et al. (2012) |
| ZEOS-5-05 | Pillow basalt | Zhongba     | Dai et al. (2012) |
| ZEOS-5-08 | Pillow basalt | Zhongba     | Dai et al. (2012) |
| ZEOS-6-03 | Basalt      | Zhongba      | Dai et al. (2012) |
| ZEOS-4-03 | Diabase      | Zhongba      | Dai et al. (2012) |
| ZEOS-4-04 | Diabase      | Zhongba      | Dai et al. (2012) |
| ZEOS-4-05 | Diabase      | Zhongba      | Dai et al. (2012) |
| ZEOS-4-05R | Diabase    | Zhongba      | Dai et al. (2012) |
| 06-SA-10C | Altered diabase | Saga        | Bédard et al. (2009) |
| 06-SA-16 | Brecciated diabase | Saga      | Bédard et al. (2009) |
| 07-SG-14 | Hematized basalt | Sangsang  | Bédard et al. (2009) |
| 07-SG-17A | Hematized basalt | Sangsang  | Bédard et al. (2009) |
| 07-SG-53 | Basalt       | Sangsang     | Bédard et al. (2009) |
| 07-SG-61 | Sandstone    | Sangsang     | Bédard et al. (2009) |
| 07-SG-63A | Gabbro      | Sangsang     | Bédard et al. (2009) |
| RB49    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB50    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB55    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB56    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB58    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB61    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB63    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB70    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB73    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB74    | Basalt      | Rembu        | Xia et al. (2008a) |
| RB141   | Basalt      | Rembu        | Xia et al. (2008a) |
| RB143   | Basalt      | Rembu        | Xia et al. (2008a) |
| RB145   | Basalt      | Rembu        | Xia et al. (2008a) |
| RB146   | Basalt      | Rembu        | Xia et al. (2008a) |
| RB147   | Basalt      | Rembu        | Xia et al. (2008a) |
| RB151   | Basalt      | Rembu        | Xia et al. (2008a) |
| Lz-18   | Basalt      | Cuolashan    | Zhu et al. (2008) |
| Lz-19   | Basalt      | Cuolashan    | Zhu et al. (2008) |
| Lz-21   | Basalt      | Cuolashan    | Zhu et al. (2008) |
| Lz-23   | Basalt      | Cuolashan    | Zhu et al. (2008) |
| SG-16   | Basalt      | Sangdanlin   | Zhu et al. (2008) |
| W-8     | Basalt      | Sangdanlin   | Zhu et al. (2008) |
| LX03-1  | Metabasalt  | Lang county  | Zhang et al. (2011) |
| LX03-3  | Metabasalt  | Lang county  | Zhang et al. (2011) |
| LX03-5  | Metabasalt  | Lang county  | Zhang et al. (2011) |
| M-68    | Metabasalt  | Eastern Syntaxis | Geng et al. (2010) |
| M-114   | Metabasalt  | Eastern Syntaxis | Geng et al. (2010) |
| M-124   | Metabasalt  | Eastern Syntaxis | Geng et al. (2010) |
| M-125   | Metabasalt  | Eastern Syntaxis | Geng et al. (2010) |
| M-149   | Metabasalt  | Eastern Syntaxis | Geng et al. (2010) |
| M-153   | Metabasalt  | Eastern Syntaxis | Geng et al. (2010) |
| M-18    | Metabasalt  | Eastern Syntaxis | Geng et al. (2010) |
| L-21    | Metabasalt  | Eastern Syntaxis | Geng et al. (2010) |

**Tectonic evolution of the YZSZ ophiolites and the OIB-type rocks**

The YZSZ ophiolites display major variations in their magmatic and metamorphic ages, geochemical affinities and melt evolution patterns. However, almost all the ophiolite massifs and the early
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Table 3. Selected trace element contents and ratios for the OIB-type rock assemblages from the YZSZ and typical OIB in the world for comparison. Key to the numbering system for the data: 1-Sun and McDonough (1989); 2-Wilson (1989); 3-Liu et al. (2013); 4-Bezard et al. (2011); 5-Dai et al. (2012); 6-Bédard et al. (2009); 7-Xia et al. (2008a); 8-Zhu et al. (2008); 9-Zhang et al. (2011); 10-Geng et al. (2010).

| Element | MORB | Hawaii | Saga | Zhongba | Saga | Saga | Saga | Saga | Saga | Saga |
|---------|------|--------|------|---------|------|------|------|------|------|------|
| Ba (ppm) | 6.3-57 | 248-1357 | 341-1357 | 35 | 301 | 280 | 115 | 28 | 153 | 115 |
| Rb (ppm) | 0.56-5.04 | 0.5-0.9 | 0.9-1.1 | 3 | 0.5 | 48 | 8 | 8 | 7 | 4 |
| Zr (ppm) | 73-90 | 280-340 | 102-340 | 3 | 3 | 15 | 1 | 2 | 1 | 1 |
| Hf (ppm) | 2.03-2.05 | 2.7-3.5 | 3.0-3.5 | 1.87 | 2.7 | 15 | 1 | 2 | 1 | 1 |
| La (ppm) | 2.5-6.3 | 37 | 7.58 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| Ce (ppm) | 7.5-15 | 35 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| Ce/Nb | 1.81-3.22 | 0.73 | 2.09 | 1.54 | 2.52 | 1.54 | 1.15 | 1.72 | 1.35 | 1.27 |
| Hf/Nb | 0.24-1.23 | 0.16 | 0.19 | 0.08 | 0.18 | 0.13 | 0.13 | 0.15 | 0.09 | 0.11 |
| Zr/Nb | 8.8-31.8 | 5.83 | 6.76 | 5.04 | 5.04 | 5.04 | 5.04 | 5.04 | 5.04 | 5.04 |
| Ba/Nb | 2.7-6.9 | 7.3 | 8.82 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 |
| La/Nb | 0.76-1.07 | 0.77 | 0.8 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 |
| Ba/Th | 52.5-95 | 87.5 | 117.25 | 62.19 | 62.19 | 62.19 | 62.19 | 62.19 | 62.19 | 62.19 |
| Ba/La | 2.52-9.05 | 9.46 | 8.95 | 8.95 | 8.95 | 8.95 | 8.95 | 8.95 | 8.95 | 8.95 |

Cretaceous ophiolitic mélangé units within the YZSZ are spatially and temporally associated with OIB-type rock associations, as documented in this study and in some previous studies (Dupuis et al., 2005; Zhang et al., 2005; Xia et al., 2008a; Zhu et al., 2008; Bezard et al., 2011). Geochemical features of these OIB-type extrusive and intrusive rocks are consistent with plume-influenced melt evolution of their magmas.

The YZSZ ophiolitic peridotites appear to have experienced two-stage melt evolution and depletion events. The cpx-rich harzburgites in these peridotites are analogous to the upper mantle peridotites produced after low-degree melt extraction at a mid-ocean ridge setting. The second stage re-melting of these already depleted upper mantle peridotites (residues of the first stage MOR melting) created a higher-degree depleted mantle residue, after they became trapped in a mantle wedge above an intraoceanic subduction zone (Zhou et al., 1996, 2005; Huot et al., 2002; Dilek and Robinson, 2003, and references therein; Chen and Xia, 2008; Liu et al., 2010; Bezard et al., 2011; Dai et al., 2011b; Xu et al., 2015a). This second episode of melting of the already depleted mantle was responsible for the production of island arc tholeiite to boninitic melts enriched in light REE (due to the contribution from the subducting slab) (Dilek and Furnes, 2009; Dilek and Thy, 2009).

On the basis of these petrological – geochemical observations and interpretations, we have developed a tectonic model for the magmatic evolution of the YZSZ ophiolites and the associated OIB-type rock associations, following the model suggested by Xu et al. (2015a). In this refined model the oldest Neotethyan ophiolites (>180 – 140 Ma) that are currently exposed in the easternmost part of the YZSZ are inferred to have formed in a plume-proximal seafloor spreading system (Dilek and Furnes, 2011, 2014) within a Neotethyan seaway, which evolved between Proto-India and Eurasia (Fig. 9A). The oceanic lithosphere that formed during the rift-drift and seafloor spreading stages of the evolution of this Neotethyan seaway contains mafic rock associations produced by E-MORB, P-MORB and OIB-type melts, and fragments of these mafic rock assemblages widely occur within the Triassic across Jurassic-Cretaceous flysch units, the early Cretaceous ophiolitic mélangé, and ophiolite complexes along the YZSZ. The role of plume magmatism and plume-metasomatized mantle chemistry in the petrogenetic evolution of rift-drift generated magmatic rocks exposed in suture zones is well documented in the literature (Dilek, 2003; Buiter and Torsvik, 2014).

In addition to the occurrence of P-type and OIB-type ophiolite lithologies along the entire length of the YZSZ, there is another independent line of evidence for the potential involvement of a regional plume or mantle updraft event in the early history of Neotethys in southern Tibet. The peridotites and chromitite bodies in the Loubusa ophiolite contain in-situ diamonds and other ultrahigh-pressure (UHP) mineral inclusions (Yamamato et al., 2009; Yang et al., 2014, 2015a, 2015b., and references therein), suggesting that they might have initially originated under very high-temperature and high-pressure conditions. The P-T estimates of the UHP mineral assemblages suggest that the chromite formation might have initially begun within or near the mantle transition zone (Yang et al., 2015b, and references therein). The early, high-temperature deformation fabrics in the podiform chromitites and peridotites containing UHP inclusions appear to have developed during their ascent from the lower to the upper mantle by a regional-scale, plume-originated updraft (Fig. 9A; Yang et al., 2014). The upwelling OIB melt might have also contained methane fluids originated in the lower mantle, and these
Figure 3. Chondrite-normalized REE diagrams for the OIB-type mafic rocks from the ophiolite massifs investigated in this study. Chondrite normalizing values, and the N-MORB, E-MORB, and OIB trends are from Sun and McDonough (1989). Data for the Hawaii alkaline basalt field are from Garcia et al. (1995), Hofmann and Jochum (1996), and Xu et al. (2007). Map symbols are the same as in Figure 1. Data sources for the chemical compositions of the OIB-type rocks from different ophiolite massifs are listed in Table 2.

Figure 4. Primitive-mantle-normalized spider diagrams for the OIB-type mafic rocks from the ophiolite massifs investigated in this study. Primitive mantle values, and the N-MORB, E-MORB, and OIB trends are from Sun and McDonough (1989). Data for the Hawaii alkaline basalt field are from Garcia et al. (1995), Hofmann and Jochum (1996), and Xu et al. (2007). Map symbols are the same as in Figure 1. Data sources for the chemical compositions of the OIB-type rocks from different ophiolite massifs are listed in Table 2.
Figure 5. Ti/1000 (ppm) versus V (ppm) diagram (modified after Shervais, 1982) for the OIB-type mafic rocks from the ophiolite massifs investigated in this study. Map symbols are the same as in Figure 1. Data sources for the chemical compositions of the OIB-type rocks from different ophiolite massifs are listed in Table 2.

Figure 6. Th/Yb vs Nb/Yb proxy for the OIB-type mafic rocks from the ophiolite massifs investigated in this study. The MORB-OIB array and the volcanic arc array are from Pearce (2008). Map symbols are the same as in Figure 1. Data sources for the chemical compositions of the OIB-type rocks from different ophiolite massifs are listed in Table 2. The data for the Hawaiian alkaline basalt field are from: Chen et al., 1990; Gaffney et al., 2004; Kimura et al., 2006.
Figure 7. Nb*2–Zr/4–Y triangular diagram for the OIB-type mafic rocks from the ophiolite massifs investigated in this study. Map symbols are the same as in Figure 1. Data sources for the chemical compositions of the OIB-type rocks from different ophiolite massifs are listed in Table 2.

Figure 8: A- N-MORB normalized Th\textsubscript{N} vs. Nb\textsubscript{N} binary discriminant diagram, showing the compositional variations of different mafic rock-types and their tectonic affinities (after Saccani, 2015) and the distribution of the representative OIB-type rocks from the YZSZ. Vectors mark the trends of compositional variations controlled by the main petrogenetic processes. Abbreviations for vectors: SSZ-E: supra-subduction zone enrichment; AFC: assimilation-fractional crystallization; OIB-CE: ocean island-type (plume-type) component enrichment; FC: fractional crystallization. Crosses represent the compositions of typical N-MORB, E-MORB and OIB (after Sun and McDonough, 1989). Key for other symbols: MORB – mid-ocean ridge basalt; G-MORB – garnet-influenced MORB; N-MORB – normal-type MORB; E-MORB – enriched-type MORB; P-MORB – plume-type MORB; AB – alkaline ocean island basalt; IAT – low-Ti, island arc tholeiite; BON – very low-Ti, boninitic basalt; CAB – calc-alkaline basalt; MTB – medium-Ti basalt; D-MORB – depleted-type MORB; BABB – backarc basin basalt. B- Tectonic interpretation of ophiolitic mafic rock types based on Th\textsubscript{N}-Nb\textsubscript{N} systematics, and the distribution of the representative OIB-type rocks from the YZSZ. Backarc A – backarc basin basalts (BABB) characterized by input of subduction or crustal components; Backarc B – BABBs with no input of subduction or crustal components (mature intra-oceanic back arcs); OCTZ – ocean-continent transition zone. See text for further discussion.
fluids might have contributed to the carbon budget in the transition zone and have acted as catalysts for diamond crystallization.

The younger Neotethyan oceanic crust (130–120 Ma) preserved within the YZSZ include mafic-ultramafic rock units that display strong subduction influence in their melt evolution. These subduction-related YZSZ ophiolites formed in forearc to backarc tectonic environments in a suprasubduction zone setting (Hébert et al., 2012; Dai et al., 2013) above a N-dipping, intraoceanic subduction zone during the early Cretaceous (Fig. 9B). The pre-existing oceanic lithosphere that formed via seafloor spreading within the Neotethyan seaway (>170–140 Ma) was consumed at this intraoceanic subduction zone, and the younger SSZ ophiolites (130–120 Ma) were produced through a combination of hydrous melting, corner flow, and slab rollback-driven extensional tectonics in the upper plate. This scenario has been also proposed for the younger (late Cretaceous: 95-92 Ma) Neotethyan ophiolites farther west in the eastern Mediterranean region (Dilek and Flower, 2003; Flower and Dilek, 2003). Tectonic underplating and partial subduction of the northern passive margin of Proto-India beneath the intraoceanic arc system resulted in the telescoping of the SSZ ophiolites and the ophiolitic mélanges within the YZSZ, or they occur as blocks and thrust sheets within the Jurassic-Cretaceous flysch units structurally below and south of the YZSZ. They display LREE enrichment and HREE depletion, no subduction influence in their trace element patterns, and significant enrichment in LILE in comparison to HFSE and HREE. Compositionally, these OIB-type and alkaline rock associations formed from partial melting of a MORB-type asthenospheric source, enriched by plume component, during the rift-drift and seafloor spreading evolution of the Neotethyan oceanic lithosphere during the Jurassic through Cretaceous. The younger (130-120 Ma) oceanic lithosphere evolved in forearc to backarc SSZ settings above a N-dipping subduction zone, which consumed much of the previously formed Neotethyan oceanic crust. The YZSZ ophiolites hence reflect a poly-phase melt history and different mantle melt sources in their evolutionary history. Tectonic juxtaposition of the geochemically and geochronologically diverse Neotethyan ophiolites took place during their emplacement onto the northern passive margin of Proto-India in the lower plate during the late Cretaceous. The existence within the YZSZ and the suture zones in other Tethyan orogenic belts of OIB-type and alkaline mafic rocks shows that oceanic rocks produced during different stages of the Wilson cycle evolution of ocean basins are commonly well preserved in the crustal architecture of the collision zones (Dilek and Sandvol, 2009).

**Conclusions**

A systematic review of the extant geochemical and geochronological data from the YZSZ ophiolites reveals the widespread occurrence of OIB-type and alkaline mafic rock assemblages, which range in age from the earliest Jurassic through early Cretaceous. These rock associations are tectonically intercalated with oceanic rocks both in the ophiolites and ophiolitic mélanges within the YZSZ, or they occur as blocks and thrust sheets within the Jurassic-Cretaceous flysch units structurally below and south of the YZSZ. They display LREE enrichment and HREE depletion, no subduction influence in their trace element patterns, and significant enrichment in LILE in comparison to HFSE and HREE. Compositionally, they resemble modern OIB and the Hawaiian alkaline basalts. Magmas of these OIB-type and alkaline rock associations formed from partial melting of a MORB-type asthenospheric source, enriched by plume component, during the rift-drift and seafloor spreading evolution of the Neotethyan oceanic lithosphere during the Jurassic through Cretaceous. The younger (130-120 Ma) oceanic lithosphere evolved in forearc to backarc SSZ settings above a N-dipping subduction zone, which consumed much of the previously formed Neotethyan oceanic crust. The YZSZ ophiolites hence reflect a poly-phase melt history and different mantle melt sources in their evolutionary history. Tectonic juxtaposition of the geochemically and geochronologically diverse Neotethyan ophiolites took place during their emplacement onto the northern passive margin of Proto-India in the lower plate during the late Cretaceous. The existence within the YZSZ and the suture zones in other Tethyan orogenic belts of OIB-type and alkaline mafic rocks shows that oceanic rocks produced during different stages of the Wilson cycle evolution of ocean basins are commonly well preserved in the crustal architecture of the collision zones (Dilek and Sandvol, 2009).

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