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DISCUSSION

Comment on "Timing and nature of the Xinlin–Xiguitu Ocean: constraints from ophiolitic gabbros in the northern Great Xing'an Range, eastern Central Asian Orogenic Belt" by Feng et al. (2016)

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Abstract We disagree the transitional supra-subduction zone model of Feng et al. (Int J Earth Sci (Geol Rundsch) 105:491–505, 2016) for the tectonic setting of Jifeng ophiolite suite in NE China. Existence of the komatiite in the Jifeng ophiolite indicates an oceanic plateau environment for this ophiolite suite within the so-called Xinlin–Xiguitu ocean.

Keywords Ophiolitic mélange · Komatiite · Geochemistry · Oceanic plateau · Great Xing'an Range · NE China

Introduction

The Central Asian Orogenic Belt (CAOB) between the Siberian, Russian cratons and the Tarim–North China cratons represents a complex collage of numerous continental lithospheric and oceanic fragments and accretionary wedges (e.g., Xiao et al. 2010; Zhou et al. 2011). In the eastern part of the CAOB, the Great Xing'an Range has been intensely overprinted by the magmatism produced by subduction of the Mongol–Okhotsk oceanic ridge during the Late Mesozoic (Zhang 2014). Moreover, this huge range could even have been impacted by the North China–South China collision during the Latest Permian to the Triassic (Zhang 1997, 2004).

There are many puzzles about the tectonic reconstruction of the Great Xing'an Range. For example, how and when was the Great Xing'an Range amalgamated by the Erguna, Xing'an and Songnen continental blocks? What is the nature of the Proto-Tethyan branches that separated these continental blocks? How did these oceanic branches evolve before they got closed? Clearly, all these questions are fundamental to understanding the tectonic evolution of the CAOB and eastern Asia.

As a significant progress, Feng et al. (2016) reported the chronology, geochemistry and Lu–Hf isotopes of the gabbros from the Jifeng ophiolitic mélange (ultramafic rocks, meta-basalts and gabbros) along the so-called Xinlin–Xiguitu suture zone that separated the Erguna block to the west and Xing'an block to the east. According to Feng et al. (2016), these gabbros were crystallized at about 647 Ma and geochemically display a transitional supra-subduction zone (SSZ)-type characteristic (indistinctive rare-earth elemental fractionation, $[La/Yb]_{\text{NORMALIZED TO CHONDRITE}} = 1.97–2.98$; negative Nb anomalies relative to Th). Therefore, Feng et al. (2016) concluded that the oceanic crust represented by the Jifeng ophiolitic mélange developed in an environment of intra-oceanic subduction.

However, I note that komatiites have been well documented in the Jifeng ophiolitic mélange by many workers (e.g., Zhao et al. 1996; Hu et al. 2001, 2003; Li et al. 2002; Feng 2015) that was studied by Feng et al. (2016). It is generally believed that such high-MgO lavas with higher melting temperatures in excess of 1600 °C are typically related to mantle plume upwelling and can hardly be generated by intra-oceanic subduction (e.g., Arndt and Nisbet 1982; Kerr et al. 1998; Arndt et al. 2008; Kerr 2014; Lu et al. 2016). The Jifeng gabbros with enriched mid-oceanic ridge basalt (E-MORB) signature (Feng et al. 2016) could have been formed in the same thermomagmatic event as the

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high-MgO lavas by mantle plume upwelling (see Kerr et al. 1998, 2000; Lu et al. 2016). Therefore, I disagree that the oceanic crust represented by the Jifeng ophiolitic mélange was produced in a transitional supra-subduction zone environment as suggested by Feng et al. (2016).

An overview of the komatiites in the Jifeng ophiolitic mélange

Field investigations reveal that there exist numerous blocks of komatiites in the Jifeng ophiolitic mélange that was studied by Feng et al. (2016), with the largest block up to 4 km long and 400 m wide (e.g., Zhao et al. 1996; Hu et al. 2001, 2003). These komatiites have characteristic spinifex texture defined by extremely acicular olivine phenocrysts (e.g., Zhao et al. 1996; Hu et al. 2001, 2003; Li et al. 2002; Feng 2015). The phenocrysts observed in these Jifeng komatiites include forsteritic olivine (Fo > 90), calcic, chromian pyroxene and chromite (Hu et al. 2001; Li et al. 2002). The sheaves of olivine phenocrysts have lengths of 0.8–2.6 mm. These phenocrysts show random orientation or preferred arrangement, and the acicular bundles of olivine or pyroxenes are set in a matrix of devitrified glass (Hu et al. 2001; Li et al. 2002).

Geochemically, these Jifeng komatiites are characterized by high MgO concentrations (27.90–32.16 wt%) and low contents of SiO_2 (48.94–42.26 wt%), K_2O (<0.2 wt%) and CaO and Na_2O (≤5 wt% combined) (Hu et al. 2001). They are aluminum-undepleted komatiites (AUK) as defined by their high Al_2O_3/TiO_2 ratios (20–94) (Hu et al. 2001). They display flat or right-inclined rare-earth-element (REE) patterns in the chondrite-normalized spider gram ([La/Yb] $_{\text{NORMALIZED TO CHONDRITE}}$, 1.55–5.91), with slight or no Eu anomalies (Eu/Eu*, 0.85–1.09) (Hu et al. 2001).

Genetic environment of the Jifeng ophiolite: Oceanic plateau rather than transitional supra-subduction zone

As pointed out above, the high-MgO komatiites are generally produced by mantle plume upwelling under higher melting temperatures (≧1600 °C) (e.g., Arndt and Nisbet 1982; Kerr et al. 1998; Arndt et al. 2008; Kerr 2014). Geochemically, the Jifeng gabbros studied by Feng et al. (2016) display indistinctive rare-earth elemental fractionation ([La/Yb] $_{\text{NORMALIZED TO CHONDRITE}}$ = 1.97–2.98), which is a diagnostic geochemical characteristic of the magmatic rocks that constitute an oceanic plateau (see Kerr et al. 1998; Kerr 2014; Lu et al. 2016). The trace elemental geochemistry of the gabbros (Feng et al. 2016) is compatible with an origin from oceanic plateau magmatism. Therefore, the Jifeng gabbros could be part of an oceanic plateau as the komatiites. I infer that the oceanic crust represented by the Jifeng ophiolite should have produced in an oceanic plateau environment rather than in a transitional supra-subduction zone environment. Of course, the oceanic plateau could have been slightly contaminated by subduction as revealed by the negative Nb anomalies relative to Th of the Jifeng gabbros (Feng et al. 2016).

Concluding remarks

Therefore, we disagree the transitional SSZ model of Feng et al. (2016) for the tectonic setting of the Jifeng ophiolite because their model is inconsistent with the geologic facts. More likely, the Jifeng ophiolite marks an oceanic plateau environment within the so-called late Precambrian Xinlin–Xiguitu Ocean.

Subduction of topographic ridges, rises or plateaus on the ocean floors is critical in evolution of subduction zone, continental crust growth and mountain building (e.g., Ben-Avraham et al. 1981; Zhang et al. 2014). Missing record of such features was often observed in ophiolites worldwide (e.g., Ben-Avraham et al. 1981; Zhang et al. 2006a, b, 2014; Dilek and Ernst 2008). Besides the fragments of oceanic plateau observed at the Jifeng area, ophiolitic fragments with diagnostic oceanic plateau or oceanic island signature have been reported at several other sites along the so-called Xinlin–Xiguitu suture zone (e.g., Zhong and Fu 2006; Du et al. 2013; Feng 2015; Zhou et al. 2015). Besides, the mafic rocks in the ophiolitic mélange exposed along the Xinlin–Xiguitu suture zone, for example, at Gaxian and Xinlin, geochemically exhibit flat to right-inclined REE patterns (for detail, see Feng 2015), characteristic of the magmatic rocks related to oceanic plateaus (Kerr et al. 1998, 2000; Lu et al. 2016). Therefore, it is essential to evaluate the role of the topographic highs (oceanic plateau or oceanic island) on the late Precambrian Xinlin–Xiguitu Ocean floor in the oceanic subduction and the collision between the Erguna and Xing'an blocks.

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