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Geochemistry of Quaternary basaltic lavas from the Nuomin volcanic field, Inner Mongolia: Implications for the origin of potassic volcanic rocks in Northeastern China

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ABSTRACT

The Nuomin volcanic field (NM for short) in northern Greater Xing'An Mountains is dominated by Quaternary monogenetic eruptions, forming lava flows covering an area of about 600 km^2. The lavas range from tephrite and basanite to trachybasalts, with high K_2O contents between 2.6 wt.% and 4.3 wt.%, and K_2O/Na_2O between 0.78 and 1.08. These NM lavas are generally magnesian (Mg# between 0.59 and 0.78) and may contain useful information on the origin of potassic magmas in NE China. The NM lavas are characterized by relatively high $(La/Yb)_N$ (21.6–41.9) and enrichments in large ion lithophile elements (LILEs), but low in high field strength element (HSFE) concentrations. The NM lavas have negative ε_{Nd}(−0.8–−3.0), $^{87}Sr/^{86}Sr$ between 0.704661 and 0.704880, $^{206}Pb/^{204}Pb$ between 17.0 and 17.2, $^{207}Pb/^{204}Pb$ between 15.41 and 15.43, and $^{208}Pb/^{204}Pb$ between 37.0 and 37.3. Their trace element spider diagram and chondrite-normalized rare earth element (REE) diagram are similar to those of Wudalianchi lavas, but are different from the Halaha–Chaoer river lavas in central Greater Xing'An Mountains. Their REE characteristics indicate that the NM lavas originate from garnet stability field. Based on petrological and geochemical data, we propose that the delamination of K-rich lithosphere mantle trigger the Quaternary potassic volcanism in Northeastern China.

1. Introduction

Cenozoic basaltic volcanism occurred over a vast area in the Asian continent, producing diverse volcanic rocks in dispersed volcanic fields. These volcanic rocks can be roughly grouped into potassic and sodic volcanic rocks. Potassic volcanic rocks usually occur in complex tectonic settings and their origin remains enigmatic. Various models are proposed for the formation of intra-continental small-volume potassic volcanism: low degree of partial melting of enriched lithosphere mantle (Zhang et al., 1995); slow upwelling mantle source composed of phlogopite-bearing garnet peridotites (Zou et al., 2003); delamination of the lithospheric mantle and melting of a metasomatically altered sub-continental lithospheric mantle containing phlogopite (Farmer et al., 2002; Hunt et al., 2012); upwelling of a hydrous mantle plume from the mantle transition zone (Kuritani et al., 2013); and the presence of a small-scale thermal anomaly in the upper mantle or localized lithospheric extension.

As for the widespread potassic volcanic rocks in China (Fig. 1), Holocene potassic volcanic rocks in Wudalianchi are the most well known because of their definite historic eruptions between 1719 AD and 1721 AD. In addition to Wudalianchi, Quaternary volcanic fields of Keluo, Erkeshan, Xiaogulihe and Jingbohu also have potassic volcanic rocks (Shao et al., 2009; Zhang et al., 1995). Although previous geochemical studies have revealed some geological information (Kuritani et al., 2013; Zhang et al., 1995; Zou et al., 2003), petrogenesis of potassic rocks is still under debate. The potassic volcanic rocks are mostly characterized by strong enrichment of large ion lithophile elements (LILE) and close association with H_2O-rich minerals such as phlogopite or amphibole (source mineral or phenocryst), indicative of an enriched source. Both deep sub-lithospheric enriched mantle (mantle plume or upwelling mantle triggered by subducted ocean crust or delamination of the lithosphere) and enriched lithospheric mantle are considered as candidates for source of the Wudalianchi potassic volcanic rocks (Kuritani et al., 2013; Zou et al., 2003). In this paper, we report geochemical data for potassic basalts of the Nuomin volcanic field (NM for short) in northern Greater Xing'An Mountains, NE China. Combined with available data of Wudalianchi basalts and Halaha–Chaoer river area basalts, two volcanic fields closest to NM with similar geological settings, we aim to shed new light on the petrogenesis of potassic volcanic rocks in northeastern China.

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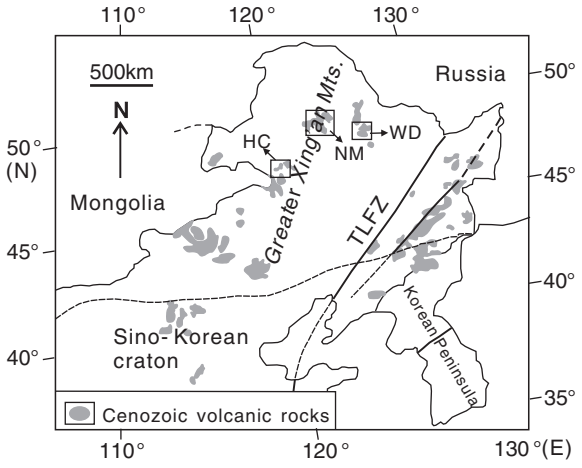

Fig. 1. Distribution of Cenozoic volcanic rocks in Northeastern China. TLFZ stands for Tan-Lu fault zone.

2. Geological setting

The Nuomin volcanic field is located in northern Greater Xing'An Mountains, near the town of Nuomin in the Oroqen Autonomous Banner, Hulunbeir City (Fig. 2), with geographical coordinate ranging from 123° 00′E to 124° 15′E in longitude and from 49° 10′N to 50° 00′N in latitude. This region is dominated by Early Cretaceous volcanic rocks, Permian granites and Quaternary strata of alluvial and diluvium deposits. The region is bound by the Halaha river–Chaoer river volcanic field (HC for short) to the south, Greater Xing'An Mountains and Mongolian Plateau to the west, and the Songliao Graben with several potassium volcanic fields, including Wudalianchi, Keluo, and Erkeshan, to the east.

Most young volcanoes in the Greater Xing'An Mountains are located in thick forests. The Nuomin volcanic field was first reported in the 1:1,000,000 scale geological map of *Heilongjiang Province and its adjacent area* (printed by Institute of Geology, Heilongjiang Province, 1980). Preliminary studies on this volcanic field include aerial photo and satellite photo interpretations (Xu et al., 1995), petrological study and K–Ar dating (Fan et al., 2012).

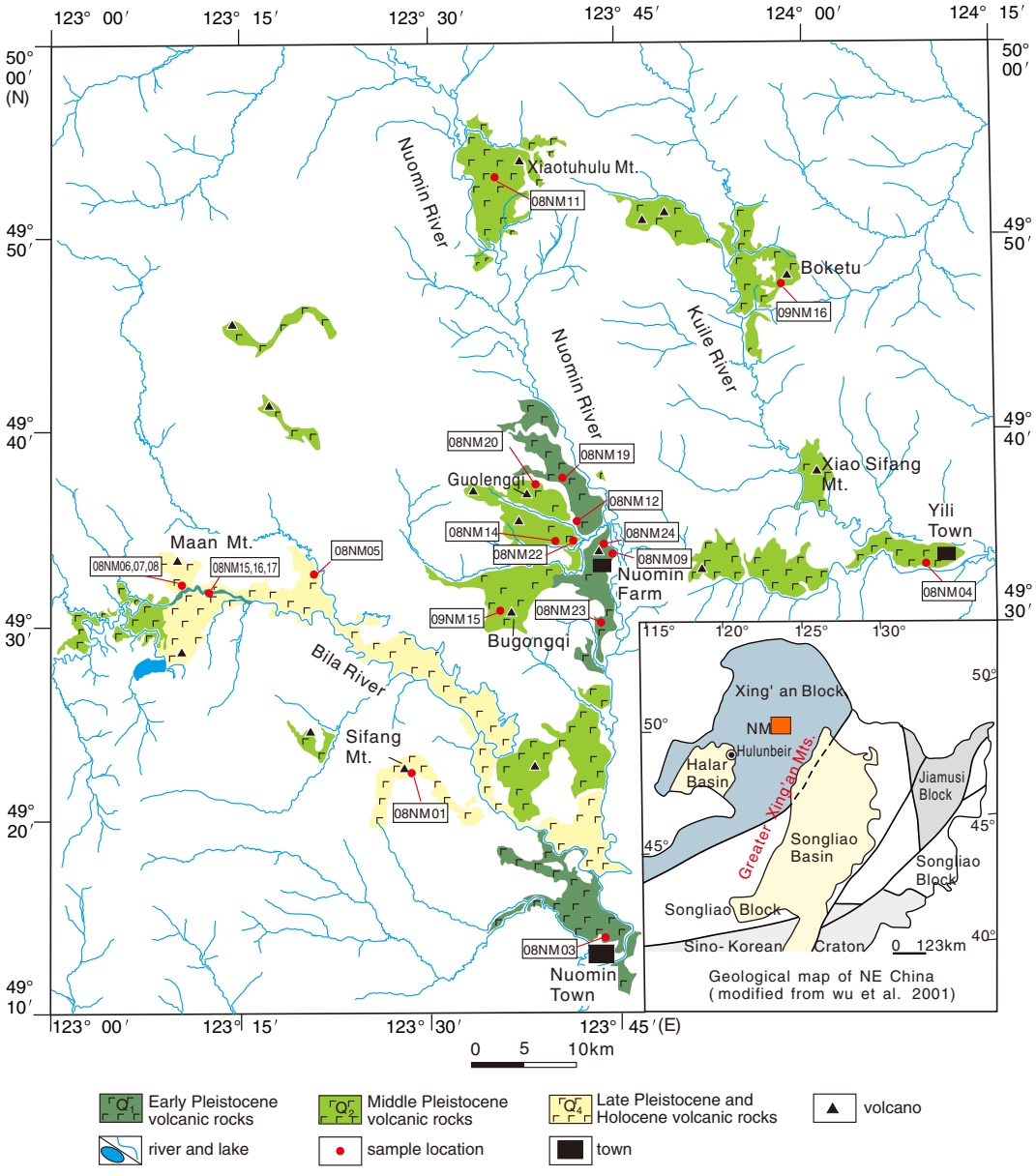

Fig. 2. Distribution of volcanic rocks in the Nuomin volcanic field. The geological map of NE China is modified after Wu et al. (2001).