Geochemical and mineralogical constraints on the petrogenesis of Xiangshuigou felsic peralkaline complex

YU-SHENG ZHU*, JIN-HUI YANG, HAO WANG, LEI, XU, RUI LI, YA-DONG WU

State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, 100029, China
(*correspondence: Zhuyusheng@mail.iggcas.ac.cn)

The source and petrogenesis of felsic alkaline to peralkaline rocks are always enigmatic because of their highly evolved geochemical composition and the lack of coeval mafic rocks. Minerals crystalized from alkaline magma often show zonation and can record the compositional variation of the evolving magma. Here, we use in situ mineral composition and whole-rock geochemistry to reveal the source and magmatic evolution of Xiangshuigou complex, which is located within the alkaline magmatic belt in the northern North China Craton. The complex mainly consists of evolved alkali syenite and nepheline syenite (agpaitic) without accompanied mafic rocks. Zircon and eudialyte U-Pb dating give similar ages of 216-225 Ma for these rocks. Their whole-rock Sr-Nd-Hf isotopes are consistent and enriched, consistent with other alkaline rocks of the magmatic belt, establishing that different rocks in the complex are cogenetic and derived from an enriched lithospheric mantle. Major and trace element analyses show that these rocks have low CaO, Sr with negative Eu anomalies, similar to the Ca (Sr)-depleted type of evolved alkaline rocks of the Ilímaussaq complex, which indicates extensively fractionation of plagioclase. However, the cores of clinopyroxene found in these rocks show high CaO, Sr without the Eu anomalies. Modeled melt composition based on them are more similar to those of Ca (Sr)-rich type of alkaline rocks, which evolve from nephelinitic parental melts and did not crystalize large amounts of plagioclase. This is supported by the relatively higher Sr and weaker Eu anomalies of the early alkali syenites than the late nepheline syenites. These evidences indicate that the parental magma of the Xiangshuigou complex are more likely to be nephelinite derived from enriched lithospheric mantle and experienced in shallow level the fractionation of feldspar and clinopyroxene to generate the alkali syenites and nepheline syenites. It is thus suggested that mineral composition could provide more information about the primary magma and should be combined with whole-rock geochemistry to reveal the petrogenesis of highly evolved alkaline rocks.