*[****Geological Magazine****]*

[Comparative studies on two phases of Archean TTG magmas from different blocks of the North China Craton: Petrogenesis and constraints on crustal evolution]

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**Supplementary Material**

**Contents of this file**

Text S1

Supplementary Figs. S1 to S9

**Text S1. Results of major and trace elements**

**1. Results of major and trace elements**

*1.a. Trans-North China Orogen*

The SiO2 contents of the 2.5 Ga TTGs in the TNCO range from 61.72-79.98 wt.%, with high Al2O3 (11.06-19.45 wt.%) and Na2O/K2O ratios (average 2.80). Their MgO range from 0.05-4.45 wt.%. Compared with the 2.5 Ga TTGs, the 2.7 Ga TTGs show similar contents of major oxides, with SiO2 contents of 60.83-79.07 wt.%, relatively high Al2O3 contents of 12.14%-19.63 wt.% and Na2O/K2O ratios (average 3.90), and relatively lower MgO of 0.10-3.92 wt.% (average 1.03 wt.%) (Supplementary Table S2). On the Harker diagram (Supplementary Fig. S4), these two phases of TTGs show similar correlations on most elements. For example, MgO, Al2O3, Fe2O3T, TiO2, CaO and P2O5 all display obvious negative correlations with SiO2 for both the 2.5 Ga and 2.7 Ga TTGs (except for the P2O5 of a 2.5 Ga sample). In contrast, these two phases of TTGs show some differences on Na2O and K2O, i.e., the Na2O and K2O of 2.5 Ga TTGs do not show distinct correlations with SiO2, while the 2.7 Ga TTGs display relatively obvious positive correlation between K2O and SiO2 but largely constant Na2O contents with the SiO2 increasing.In addition, both the 2.5 Ga and 2.7 Ga TTGs have high Mg**#** values,with similar ranges of 12.71-63.86 (average 47.78) for 2.5 Ga TTGs and 27.20-62.48 (average 44.70) for 2.7 Ga TTGs (Supplementary Table S2).

The REE and trace elements distribution patterns for 2.5 and 2.7 Ga TTGs from the TNCO are shown in Supplementary Fig. S5. On the chondrite-normalized REE patterns (Supplementary Fig. S5a, c), most of the samples show strong fractionations between LREE and HREE (La/Yb)N=3.82-167 and 4.89-140, respectively), with enrichment of LREE and depletin of HREE. Among them, most samples show relatively flat HREE paterns. Additionally, the 2.5 Ga TTGs in the TNCO show negligible negative Eu anomalies or weak positive Eu anomalies (Eu/Eu\*=0.44-3.41, average 1.13)(Supplementary Fig. S5a; Supplementary Table S2); In contrast, although most of the 2.7 Ga TTGs are characterized by not obvious Eu anomalies, some of them have positive Eu anomalies (Supplementary Fig. S5c; Supplementary Table S2).

On the primitive mantle normalized trace elements diagram (Supplementary Fig. S5b, d), both the two phases (2.5 and 2.7 Ga) of TTGs show enrichment of LILE (Rb, Ba, Sr and Pb) and depletion of HFSE (Nb and Ti) for most of the samples. They have similar trace element concentrations, but the 2.5 Ga TTGs show relatively larger ranges. Moreover, most of the two phases of TTGs both show high Sr (55.0-939 ppm and 132-938 ppm, respectively) and Sr/Y ratios (average 100 and 155, respectively)(Fig. 2a, c; Supplementary Table S2). In contrast, their Cr and Ni show remarkable different contents. Except minor samples, most of the 2.7 Ga TTGs have lower Cr (average 20.6 ppm) and Ni (average 12.0 ppm) concentrations than those of 2.5 Ga TTGs (average 46.7 ppm and 17.6 ppm, respectively) (Supplementary Table S2).

*1.b. Eastern Block*

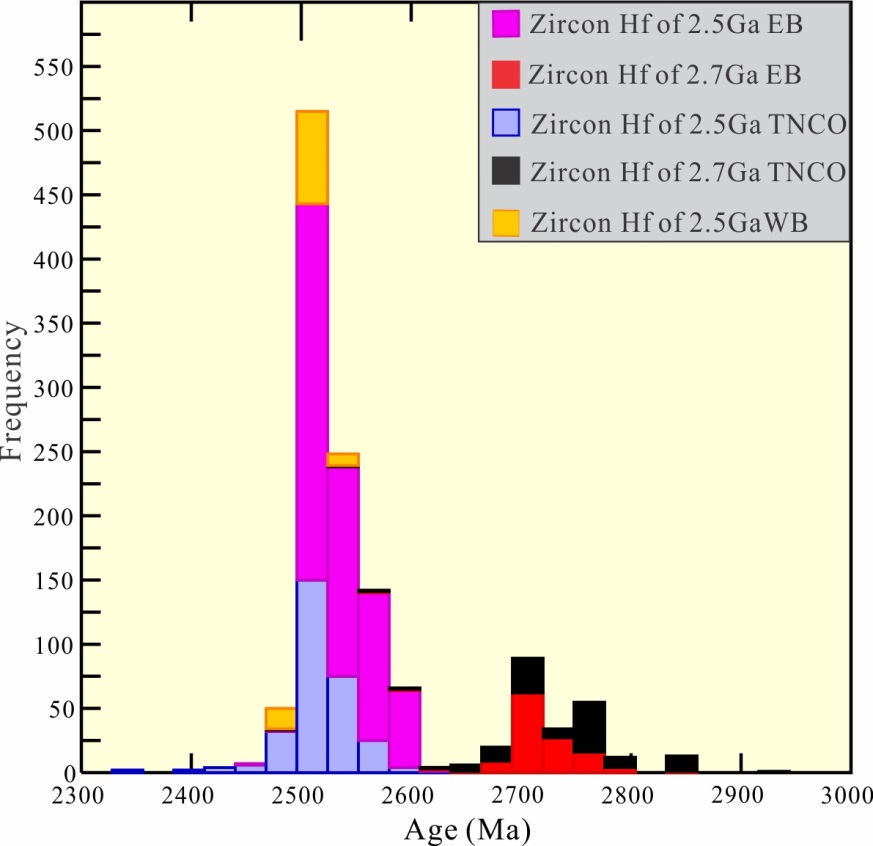
Most of the 2.5 Ga TTGs show SiO2 contents ranging from 60.64-78.68 wt.% and high Al2O3 contents (11.45-21.47 wt.%, average 15.46 wt.%) and Na2O/K2O ratios (2.92 on average), indicating most of them belong to high-Al TTG suite (Barker, 1979). In addition, they show relatively high MgO (average 1.65 wt.%) contents and Mg# (47.06 on average) (Supplementary Table S1 and Fig. S6), very similar to those of many worldwide TTGs at ~2.5 Ga (e.g., Condie, 2005; Martin and Moyen, 2002), but slightly higher than those of Archean average high-Al TTGs (Condie, 1981). On the other hand, the 2.7 Ga TTGs do not show remarkable differences with those of 2.5 Ga TTGs. The 2.7 Ga TTGs show SiO2 contents of 61.09-76.79 wt.%, MgO contents of 0.38-3.60 wt.%, Al2O3 contents of 11.30-17.53 wt.%, indicating that most of them belong to high-Al TTGs while minor belong to low-Al TTGs (Barker, 1979). Similarly, K2O and Na2O of both 2.5 Ga and 2.7 Ga TTGs in the EB do not show good correlations with SiO2, while other major elements (MgO, Fe2O3T, CaO, TiO2, Al2O3, CaO and P2O5) display obvious negative correlations with SiO2 (Supplementary Fig. S6).

Most of the 2.5 Ga TTGs have relatively high REE contents (17.8-329 ppm, average 121 ppm) (Supplementary Table S1), highly fractionated REE patterns ((La/Yb)N =2.73-189, average 33.4) and positive or negligible negative Eu anomalies (Eu/Eu\* = 1.44 on average) (Supplementary Fig. S7a), show close affinity with Archean average high-Al TTG (Condie, 1981). In the primitive mantle normalized trace elements diagram (Supplementary Fig. S7b), they are enriched in LILE (Ba, Sr and Pb) but depleted in HFSE (Nb, Ta and Ti). In addition, like many worldwide TTGs at ~2.5 Ga (e.g., Condie, 2005; Martin and Moyen, 2002), the 2.5 Ga TTGs in the EB mostly show relatively high Sr (141-1431 ppm, 598 ppm on average), Cr (2.04-502 ppm, average 114 ppm) and Ni (2.00-205 ppm, average 28.3 ppm) contents and Sr/Y ratios (average 115) (Fig. 3; Supplementary Table S1). Most of 2.7 Ga TTGs in the EB show similar features to those of the 2.5 Ga TTGs on the chondrite-normalized REE pattern diagram and primitive mantle normalized trace elements diagram (Supplementary Fig. S7c, d), but also have other distinct trace element characteristics. Compared with the 2.5 Ga TTGs, the 2.7 Ga TTGs show lower Sr (135-522 ppm, average 289 ppm), Cr (0.50-25.0 ppm, average 14.9 ppm) and Ni (0.72-25.0 ppm, average 12.6 ppm) contents and Sr/Y(average 47.2) and (La/Yb)N ratios (8.36-108, average 27.0) (Fig. 3; Supplementary Table S1). However, they have similar MgO (0.38-3.60 wt.%, average 1.39 wt.%) and Mg# (26.16-83.14, average 43.71) with the 2.5 Ga TTGs in the EB, but generally show lower values (Supplementary Table S1).

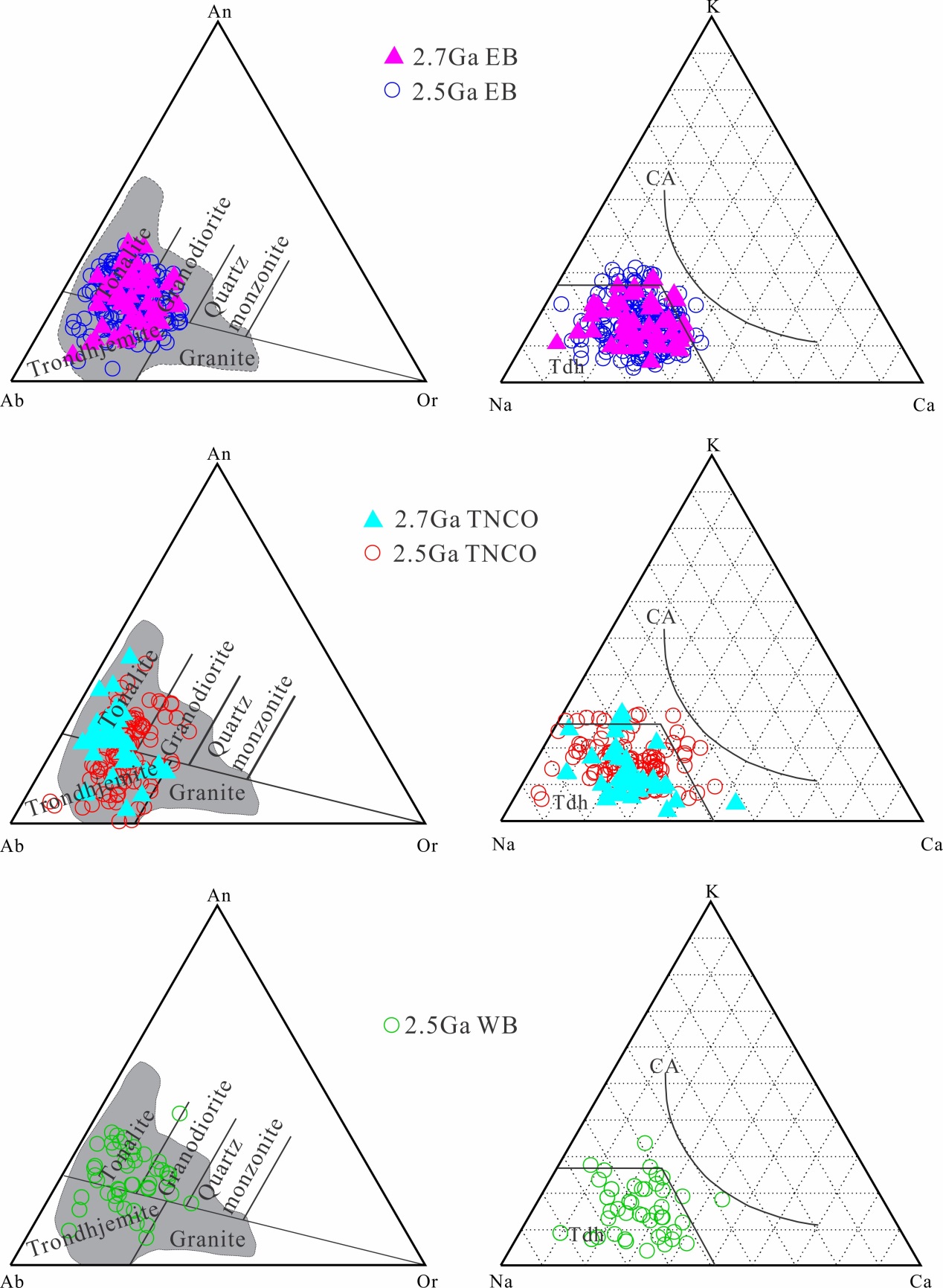
*1.c. Western Block*

Up to now, only 2.5 Ga TTG data were available. Compared with the TTGs from TNCO or EB, the TTGs from the WB show SiO2 contents of 60.36-73.91 wt.%, Al2O3 contents of 11.50-19.32 wt.%, average Na2O/K2O ratios of 3.36, and MgO contents of 0.46-3.74 wt. %. Similar to the TTGs from TNCO and EB, on the Harker diagram, MgO, Fe2O3T, CaO, TiO2, Al2O3, CaO and P2O5 show negative correlations with SiO2, while K2O and Na2O do not show any correlation with SiO2 (Supplementary Fig. S8).

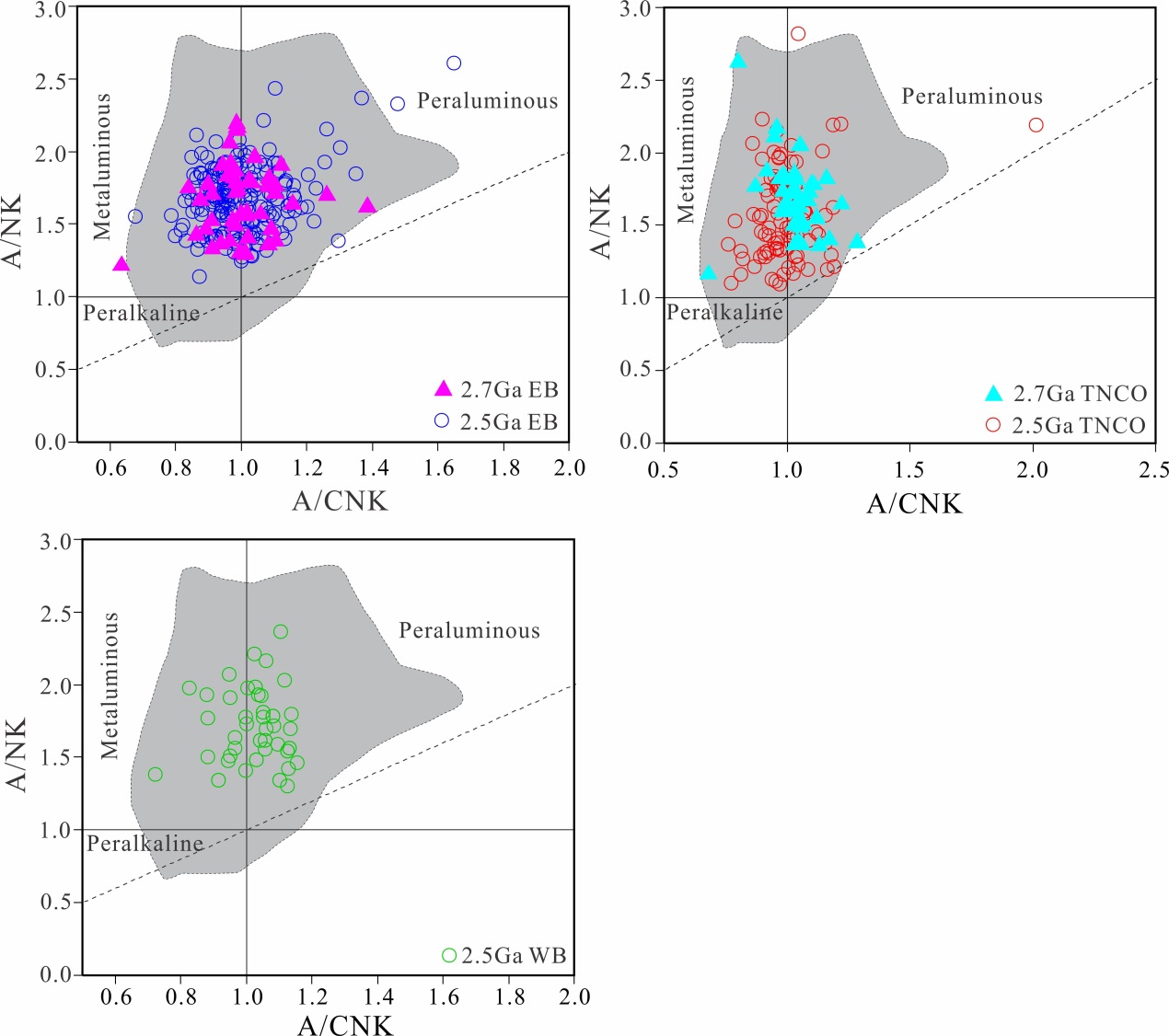
The 2.5 Ga TTGs from the WB display similar patterns with those from the TNCO and EB on the chondrite-normalized REE pattern diagram: enriched in LREE, depleted in HREE, highly fractionated between LREE and HREE ((La/Yb)N=1.72-116), no Eu anomalies or weak positive/negative Eu anomalies (Eu/Eu\*=0.61-6.66) (Supplementary Fig. S9a; Supplementary Table S3). On the primitive mantle normalized trace elements diagram (Supplementary Fig. S9b), 2.5 Ga TTGs from the WB are characterized by enrichment of LILE (Rb, Ba and Sr) and depletion of HFSE (Nb, Ta and Ti). They also show high Sr and Sr/Y values, ranging from 294-1054 ppm and 16.4-327, respectively (Fig. 4; Supplementary Table S3). Compatible elements Cr and Ni vary from 4.00-419 ppm and 3.70-88.3 ppm, respectively (Supplementary Table S3).



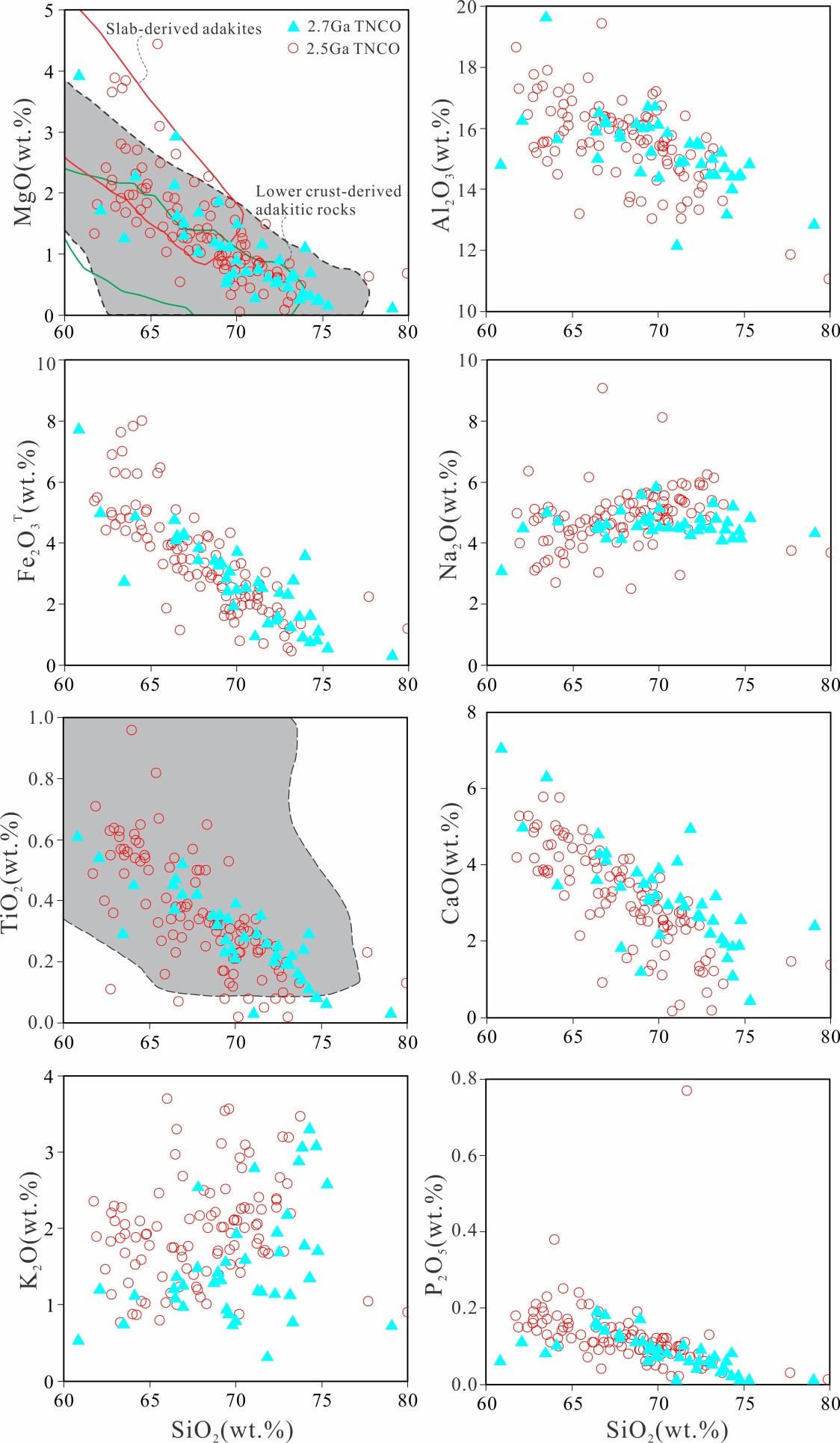
Supplementary Fig.S1 Histograms for the magmatic ages of zircon Hf isotopic data of TTGs from the three blocks in the NCC.



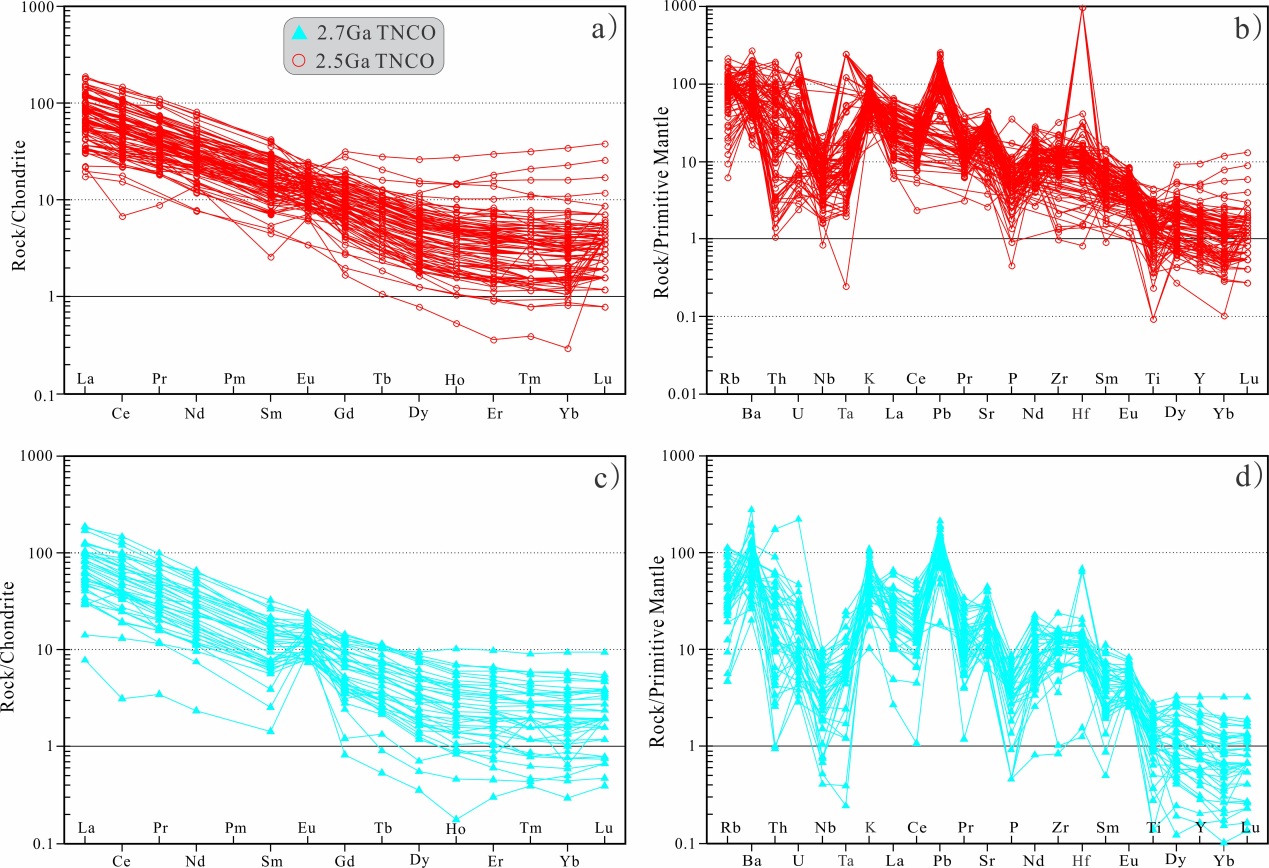
Supplementary Fig.S2 Normative An–Ab–Or diagram and K-Na-Ca diagram for TTG gneisses from the NCC. The grey fields represent experimental compositions of metabasalt melts at 1-4 GPa (Data from Sen and Dunn (1994), Rapp and Watson (1995), Rapp et al. (1999, 2002, 2003), Skjerlie and Patiño-Douce (2002) and references therein).



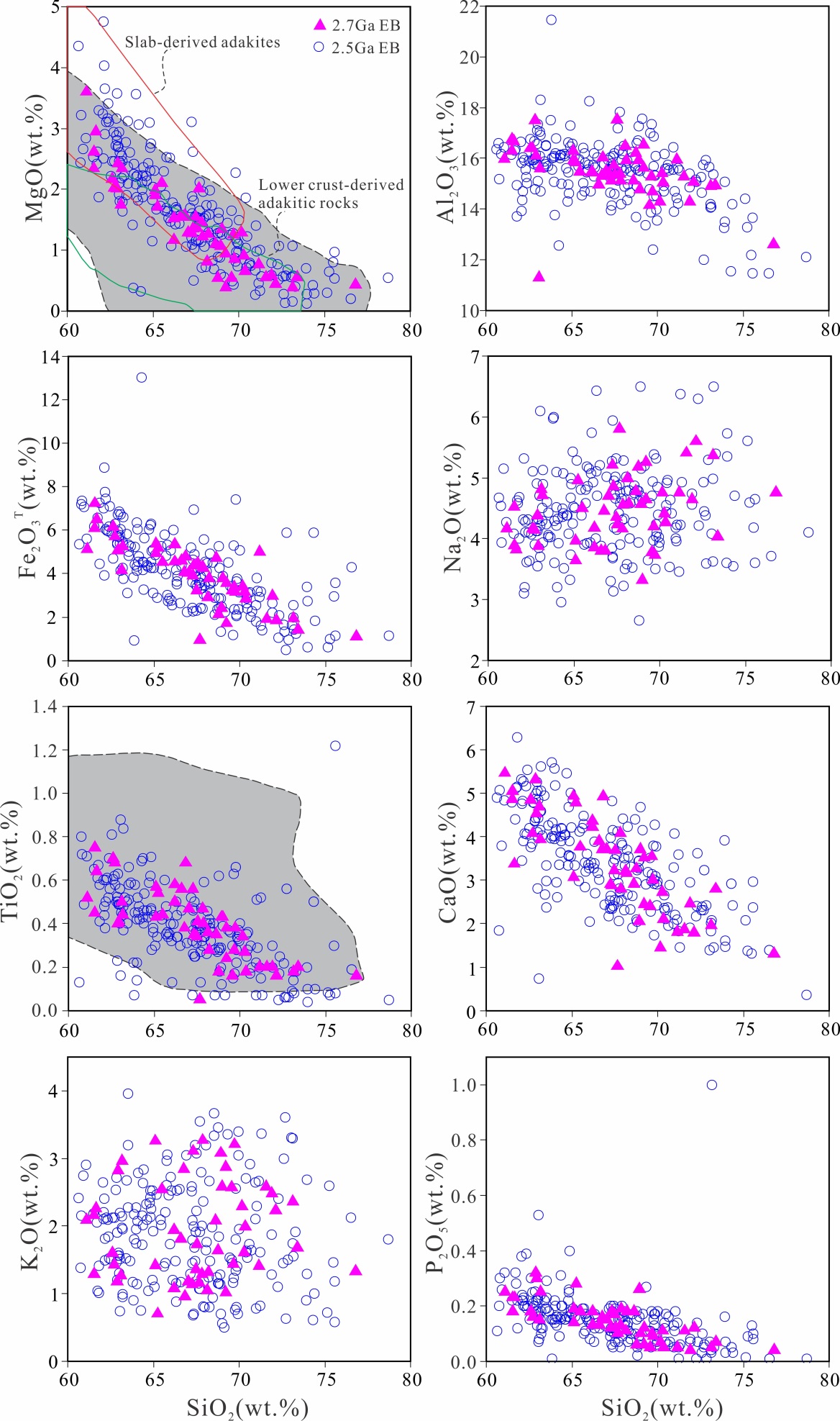
Supplementary Fig.S3 A/NK vs A/CNK diagram for TTG gneisses from the NCC. The grey fields are the same as those in Fig. S2. Note that samples with remarkably high A/NK or A/CNK values are not shown.



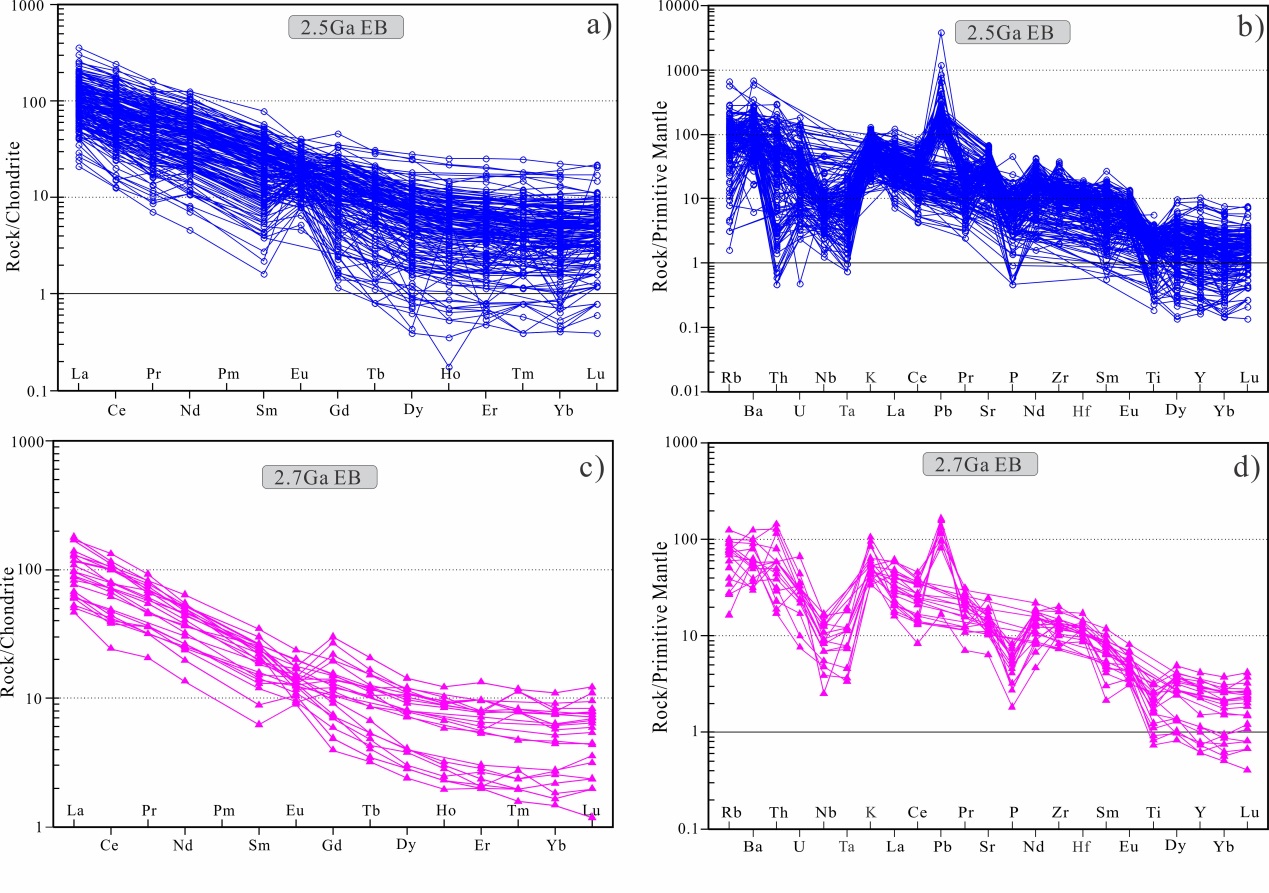
Supplementary Fig.S4 Harker diagrams for selected major elements of the TTG gneisses from the TNCO of the NCC. The grey fields are the same as those in Fig. S2.



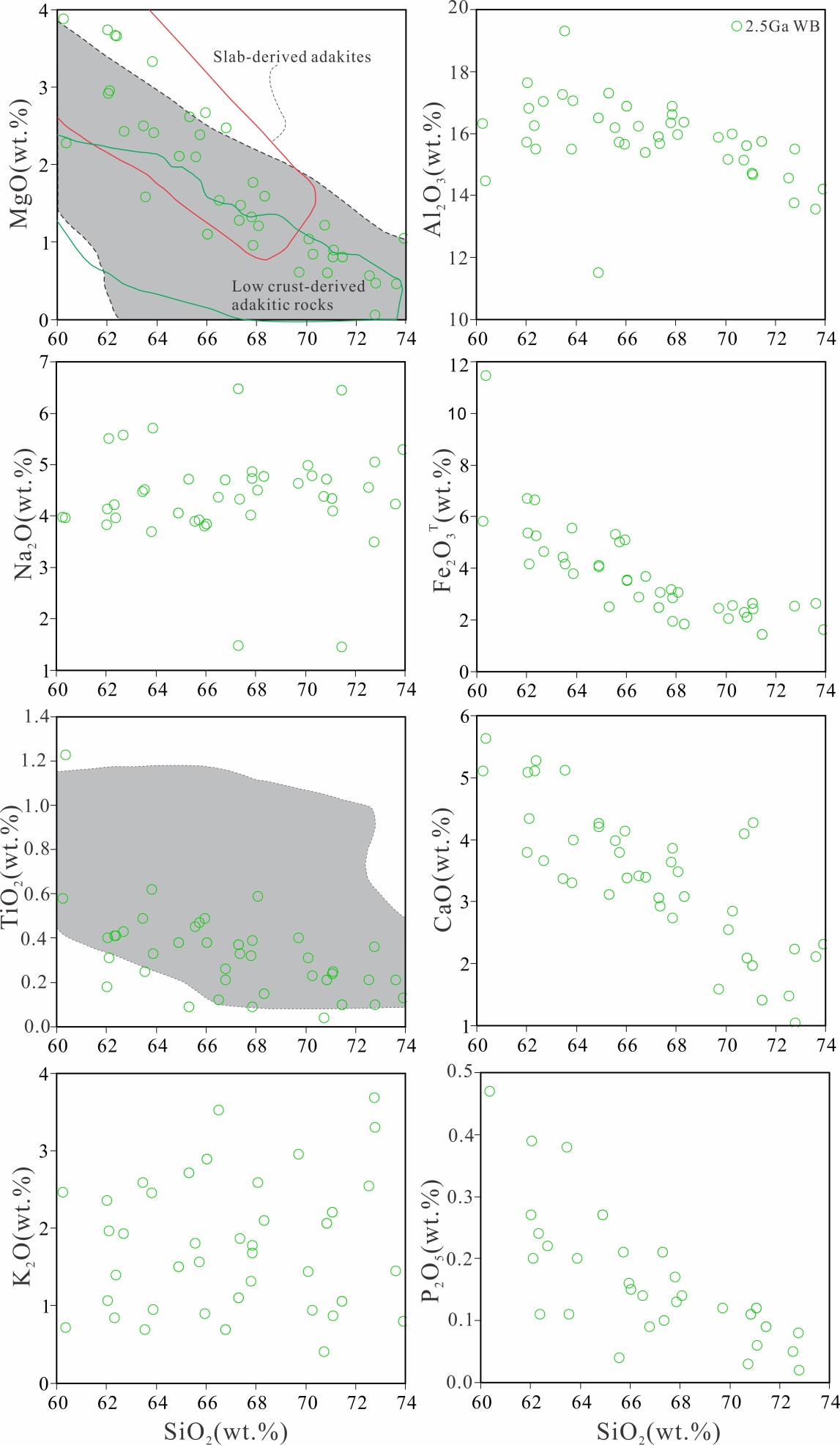
Supplementary Fig. S5 Chondrite-normalized REE patterns and PM-normalized spidergram of the TTG gneisses from the TNCO of the NCC (chondrite and PM normalized values of Sun and McDonough, 1989).



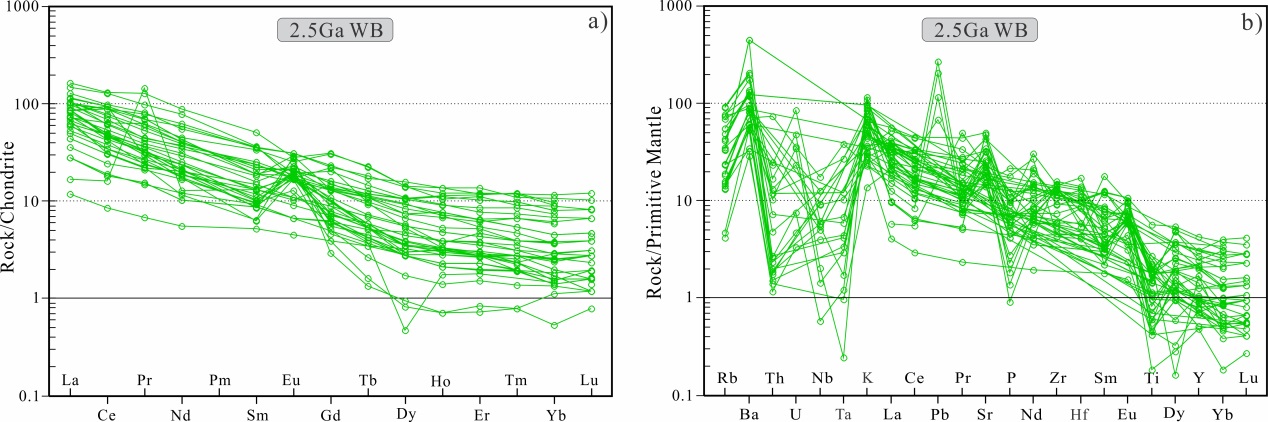
Supplementary Fig.S6 Harker diagrams for selected major elements of the TTG gneisses from the the EB of the NCC. The grey fields are the same as those in Fig. S2.



Supplementary Fig. S7 Chondrite-normalized REE patterns and PM-normalized spidergram of the TTG gneisses from the EB of the NCC (PM and chondrite normalized values of Sun and McDonough, 1989).



Supplementary Fig.S8 Harker diagrams for selected major elements of the TTG gneisses from the WB of the NCC. The grey fields are the same as those in Fig. S2.



Supplementary Fig. S9 Chondrite-normalized REE patterns and PM-normalized spidergram of the TTG gneisses from the WB of the NCC (PM and chondrite normalized values of Sun and McDonough, 1989).