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Nature of Three Episodes of Magmatism (2181 Ma, 2115 Ma and 1891 Ma) in the Liaohe Rift of North China: Implications for Tectonic Evolution

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To define a tectonic environment switching from rifting to subduction and their respective duration time are usually largely debated. Such case occurs for the Liaohe rift: whether it went through a long subduction from 2100 to 1850 Ma or there were two different events in different tectonic settings? In this study, we investigate two episodes of granites in the Liaohe rift: the 2180 Ma Mafeng monzogranite gneiss and 1890 Ma Qingchengzi trondhjemite gneiss, in addition to a ~2115 Ma mafic sill event. SIMS U-Pb dating on magmatic zircons from two granites yields concordant ages of 2181 ± 6 Ma ($n=20$, MSWD=4.3) and 1891 ± 10 Ma ($n=8$, MSWD=1.8), representively for the monzogranite and trondhjemite. The monzogranites, with high-K calc-alkaline and metaluminous to weak peraluminous characteristics, have high Fe_2O_3^t of 3.70-4.08 wt.%, TiO_2 of 0.29-0.31 wt.%, K_2O of 4.98-5.07 wt.% but low MgO of 0.09-0.12wt.%, Al_2O_3 of 12.09-12.44 wt.%, CaO of 0.55-0.87 wt.%, and are enriched in light rare earth elements (total: 213-346 ppm, La/Yb_N : 5.04-10.57) and elements that are compatible in plagioclase (i.e., Eu, Ba and Sr) but depleted in high field strength elements (i.e., Nb, Ta, P and Ti). They have high $10000 \times \text{Ga/Al}$ ratios of 3.19-3.61, Zr concentrations of 315-441ppm and Zr+Nb+Ce+Y concentrations of 472-656 ppm. These above features indicate that these monzogranites belong to A-type granites. The trondhjemites, with medium-K calc-alkaline and medium peraluminous features, have relatively high Al_2O_3 of 15.51-15.6 wt.%, CaO of 1.80-2.32 wt.%, Na_2O of 5.37-5.4 wt.% but relatively low Fe_2O_3^t of 1.20-1.40 wt.%, TiO_2 of 1.91-2.32 wt.%, K_2O of 1.91-2.32 wt.%,

and are enriched in light rare earth elements (total: 17.6-21.6 ppm, La/Yb_N : 19.14-20.43) and large ion lithospheric elements (i.e., Ba, K and Sr) but depleted in high field strength elements (i.e., Nb, Ta, P, Ti and Y). These characters, combined with high Sr/Y ratios of 327-413, could be comparable with adakites. In the meanwhile, the Liaohe Group and the 2115 Ma Haicheng mafic sills followed the 2180-2140 Ma aluminous A-type granites, suggesting a rift environment while the 1900 Ma regional metamorphism companied with the 1890-1850 Ma trondhjemite, granitic pegmatite, porphyritic granite and alkaline syenite, suggesting a subduction-orogeny process.

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