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Petrogenesis of the ~2115 Ma Haicheng Mafic Sills in the Eastern North China Craton and Their Implications for An Intra-Continental Rifting

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It is well known that there are widespread igneous events at ~2100 Ma in the Eastern North China Craton; however, their tectonic environments are controversial. They were thought to be either related to an intra-continental rifting or an arc/back-arc along the continental margin. We present here the petrogenesis of the Haicheng mafic sills in the Liaohe rift by revealing the magma source(s) and differentiation processes, and the possibilities of material contributions from a subduction system with details extracted from Wang et al. (2016). Most of the Haicheng mafic sills are E-W-elongated. The thicknesses of the individuals are tens to hundreds of meters and the lengths are hundreds to thousands of meters. They have metamorphosed to amphibolite facies with a mineral assemblage of plagioclase and hornblende, with minor quartz and accessory chlorite, epidote, apatite, ilmenite and magnetite. However, relic gabbro and ophitic textures are well-preserved. SIMS Pb-Pb dating on baddeleyite and zircon from one ~1000 m thick sill both yields average $^{207}\text{Pb}/^{206}\text{Pb}$ ages of ~2115 Ma, representing the timing of crystallization. They are tholeiitic in composition (MgO: 4–9 wt.%; SiO₂: 45–53 wt.%), enriched in light rare earth elements ((La/Yb)_N = 1.7–4.4) and large ion lithophile elements (i.e., Cs, Rb, Sr and K) but depleted in high field strength elements (i.e., Nb, Ta and Ti). These features were unlikely caused by crustal contamination during their emplacement, as there are little variations in Nb/La and Th/Nb. The rocks have experienced significant plagioclase-plus clinopyroxene-dominated fractional crystallization. Their enriched Sr-Nd isotope characteristics ($^{87}\text{Sr}/^{86}\text{Sr}_t = 0.703\text{--}0.705$, $\epsilon_{\text{Nd}t} = -1.9\text{--}0.6$) and trace element patterns

indicate that their source(s) could be the ancient subcontinental lithospheric mantle; and this source is similar to those coeval sills from other parts of the craton. Their arc-like trace element features could be inherited from their source regions formed via a subduction process at the late Archean rather than at the middle-late Paleoproterozoic. These sill swarms are chemically similar and comparable to other sills, e.g., the ~2150 Ma Hengling sills in the Wutai Mts. and the ~2090 Ma Zhanhuang sills in the South Taihang Mts. It seems that the ~2100 Ma sill-dominated igneous rocks were distributed throughout the craton and might have developed in an integrated intra-continental rift system.

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