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Editorial

Editorial for the Special Issue "Formation and Evolution of the Continental Crust in North China Craton during Precambrian"

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The North China Craton (NCC) preserves ancient rocks dating back to ca. 3.8 Ga, and has witnessed multiple magmatic–metamorphic events during the Archean–Proterozoic era [1–3]. This critical period may have marked the transformation of the geodynamic regime on early Earth. As a result, the NCC serves as an ideal natural laboratory for deciphering the growth and evolution of continental crust, the onset of plate tectonics, and the architecture of the Archean geodynamic regime. To better understand the geological evolution of the NCC during Precambrian, we collected 11 contributions for this Special Issue.

A significant component within the NCC is the Khondalite Belt, a major Paleoproterozoic orogenic belt. In this Special Issue, three contributions focus on the tectonic evolution of the Khondalite Belt, examining it from the perspectives of magmatism and deformation. Zhu et al. [4] proposed that the Sanchakou gabbro in the Khondalite Belt formed during the late Paleoproterozoic, based on zircon U-Pb dating. A comprehensive analysis of elemental and Hf-O-Sr-Nd isotopes further revealed a complex process involving assimilation and fractional crystallization within a post-collision tectonic environment. Qiao et al. [5] provided geochronological constraints for the Paleoproterozoic gneiss domes in the Qianlishan region. They identified two phases of deformation during the late Paleoproterozoic: D1 deformation, characterized by isoclinal folds and penetrative transposed foliations/gneissosities, occurring at ~1.95 Ga; and D2 deformation, featuring doubly plunging upright folds, formed between 1.93 and 1.90 Ga. The authors suggested that the collision between the Yinshan and Ordos Blocks led to the formation of the Qilishan gneiss domes. Qiao et al. [6] presented time and structural constraints for the Qianlishan ductile shear zones within the Khondalite Belt. The zircon U-Pb dating of mylonites is indicative of the metamorphic ages of 1.90–1.88 Ga, interpreted as the activity timing of Qianlishan ductile shear zones. Notably, their findings revealed three phases of deformation during Orosirian, suggesting that the Khondalite Belt underwent an orogenesis lasting over 100 Ma.

In this Special Issue, three contributions specifically focused on the Paleoproterozoic granitic dykes, felsic metavolcanic rocks, and meta-sedimentary rocks within the Jiao–Liao–Ji Belt. Zhao et al. [7] investigated newly identified late Paleoproterozoic granitic dykes from the Liaodong Peninsula. Zircon U-Pb dating indicated crystallization ages of 1859–1852 Ma for these dykes. Geochemical and zircon Hf isotopic analyses suggested that these granitic dykes formed through the partial melting of early Paleoproterozoic granitoids and meta-sedimentary rocks in a post-collisional environment. Cheng et al. [8] conducted systematic analyses of zircon geochronology, geochemistry, and zircon Hf isotope on the 2.2–2.1 Ga felsic metavolcanic rocks from the Li'eryu Formation in the Liaodong Peninsula. They proposed that these metavolcanic rocks originated from the partial melting of Archean TTG rocks, with some contributions from lower crustal materials. Additionally,

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they suggested an intra-continental rift setting for the Jiao–Liao–Ji Belt during 2.2–2.1 Ga. Gao et al. [9] reported new detrital zircon ages for the Paleoproterozoic Langzishan and Li'eryu Formations within the Jiao–Liao–Ji Belt. The geochronological results indicated deposition ages of 2136 Ma for Langzishan and 1974 Ma for Li'eryu. Combining those findings with previous magmatic studies, they proposed a back-arc basin environment for these sedimentary rocks.

Two contributions explore the affinity between the NCC and the Alxa Block based on magmatism and metamorphism. Niu et al. [10] conducted systematic zircon geochronological analyses, revealing magmatic activities at ~2.84, ~2.76, ~2.54, and ~2.49 Ga within the Alxa Block, previously considered part of the NCC. Geochemical and zircon Hf isotopic data suggest a distinct crustal evolutionary history for the Alxa Block during the Archean. Zhou et al. [11] used zircon U-Pb dating, mineral geochemistry, detailed petrological observations, and phase equilibrium modeling to constrain the P–T conditions of amphibolites in the Diebusige and Bayanwulashan complexes of the Alxa Block. These amphibolites experienced amphibolite–facies metamorphism at temperatures ranging from 800 to 910 °C and pressures of 7.0–10.8 kbar during 1901–1817 Ma. A post-collision extensional setting played a critical role in this metamorphic event.

In this Special Issue, researchers also discussed three key aspects: the oldest fuchsite quartzite from the eastern Hebei, the oldest clastic strata of the Xiong'er Group, and newly identified Paleoproterozoic mafic igneous rocks in the northern Liaoning. Zhao et al. [12] presented new zircon ages for the oldest fuchsite quartzite found in the Lulong area of the eastern Hebei terrane. Numerous 3.8–3.4 Ga detrital zircons were identified, suggesting a depositional age of 3.3–3.1 Ga for this fuchsite quartzite. Zircon Hf isotopes further implied significant crustal growth during the Eoarchean–Paleoarchean in the NCC. Zhang et al. [13] reported new detrital zircon ages for the earliest clastic strata of the Xiong'er Group from the southern margin of the NCC. Zircon U-Pb dating revealed four distinct age groups: 1905–1925, 2154–2295, 2529–2536, and 2713–2720 Ma, indicating a provenance link to the NCC basement. They proposed that these sedimentary rocks of the Dagushi Formtion formed through continuous crust fracturing. Chen et al. [14] identified four stages (~2.21, ~2.15, ~2.06, and ~2.02 Ga) of mafic magmatism in northern Liaoning. These mafic rocks constrain their surrounding strata to be Paleoproterozoic rather than Neoproterozoic. These mafic rocks likely formed in island arc or oceanic island environments associated with the oceanic subduction and extension during the Paleoproterozoic.

In conclusion, this Special Issue significantly contributes to our understanding of the Archean and Paleoproterozoic evolution of the NCC. However, further investigations into magmatism, sedimentary processes, metamorphism, and structural analyses remain essential.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Wan, Y.; Dong, C.; Xie, H.; Wilde, S.A.; Liu, S.; Li, P.; Ma, M.; Li, Y.; Wang, Y.; Wang, K.; et al. Hadean to early Mesoarchean rocks and zircons in the North China Craton: A review. *Earth-Sci. Rev.* **2023**, *243*, 104489. [CrossRef]
2. Liu, J.; Palin, R.M.; Mitchell, R.N.; Liu, Z.; Zhang, J.; Li, Z.; Cheng, C.; Zhang, H. Archaean multi-stage magmatic underplating drove formation of continental nuclei in the North China Craton. *Nat. Commun.* **2024**, *15*, 6231. [CrossRef] [PubMed]
3. Zhao, G.; Cawood, P.A.; Li, S.; Wilde, S.A.; Sun, M.; Zhang, J.; He, Y.; Yin, C. Amalgamation of the North China Craton: Key issues and discussion. *Precambrian Res.* **2012**, *222–223*, 55–76. [CrossRef]
4. Zhu, W.P.; Tian, W.; Wang, B.; Zhang, Y.H.; Wei, C.J. Paleoproterozoic Crust–Mantle Interaction in the Khondalite Belt, North China Craton: Constraints from Geochronology, Elements, and Hf-O-Sr-Nd Isotopes of the Layered Complex in the Jining Terrane. *Minerals* **2023**, *13*, 426. [CrossRef]
5. Qiao, H.; Deng, P.; Li, J. Geochronological Constraints on the Origin of the Paleoproterozoic Qianlishan Gneiss Domes in the Khondalite Belt of the North China Craton and Their Tectonic implications. *Minerals* **2023**, *13*, 1361. [CrossRef]
6. Qiao, H.; Liu, M.; Dai, C. Timing and Tectonic Implications of the Development of the Orosirian Qianlishan Ductile Shear Zones in the Khondalite Belt, North China Craton. *Minerals* **2024**, *14*, 561. [CrossRef]
7. Zhao, Y.; Lyu, J.; Han, X.; Lin, S.; Zhang, P.; Yang, X.; Chen, C. Geochronology and Geological Implications of Paleoproterozoic Post-Collisional Monzogranitic Dykes in the Ne Jiao-Liao-Ji Belt, North China Craton. *Minerals* **2023**, *13*, 928. [CrossRef]

8. Cheng, C.; Liu, J.; Zhang, J.; Zhang, H.; Chen, Y.; Wang, X.; Li, Z.; Yu, H. Petrogenesis of the Early Paleoproterozoic Felsic Metavolcanic Rocks from the Liaodong Peninsula, NE China: Implications for the Tectonic Evolution of the Jiao-Liao-Ji Belt, North China Craton. *Minerals* **2023**, *13*, 1168. [CrossRef]
9. Gao, J.; Li, W.; Liu, Y.; Zhao, Y.; Liu, T.; Wen, Q. Detrital Zircon LA-ICP-MS U-Pb Ages of the North Liaohe Group from the Lianshanguan Area, NE China: Implications for the Tectonic Evolution of the Paleoproterozoic Jiao-Liao-Ji Belt. *Minerals* **2023**, *13*, 708. [CrossRef]
10. Niu, P.; Qu, J.; Zhang, J.; Zhang, B.; Zhao, H. Archean Crustal Evolution of the Alxa Block, Western North China Craton: Constraints from Zircon U-Pb Ages and the Hf Isotopic Composition. *Minerals* **2023**, *13*, 685. [CrossRef]
11. Zhou, F.; Gou, L.; Xu, X.; Tian, Z. Metamorphic Ages and PT Conditions of Amphibolites in the Diebusige and Bayanwulashan Complexes of the Alxa Block, North China Craton. *Minerals* **2023**, *13*, 1426. [CrossRef]
12. Zhao, C.; Zhang, J.; Wang, X.; Zhang, C.; Chen, G.; Zhang, S.; Guo, M. Tracing the Early Crustal Evolution of the North China Craton: New Constraints from the Geochronology and Hf Isotopes of Fuchsite Quartzite in the Lulong Area, Eastern Hebei Province. *Minerals* **2023**, *13*, 1174. [CrossRef]
13. Zhang, Y.; Zhang, G.; Sun, F. The Earliest Clastic Sediments of the Xiong'er Group: Implications for the Early Mesoproterozoic Sediment Source System of the Southern North China Craton. *Minerals* **2023**, *13*, 971. [CrossRef]
14. Chen, J.; Tian, Y.; Gao, Z.; Li, B.; Zhao, C.; Li, W.; Zhang, C.; Wang, Y. Geochronology and Geochemistry of Paleoproterozoic Mafic Rocks in Northern Liaoning and Their Geological Significance. *Minerals* **2024**, *14*, 717. [CrossRef]