Precambrian Geodynamic Regime of the Liaodong Peninsula, North China Craton

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Abstract: To decipher the geodynamic regime of the Liaodong Peninsula and its vicinity, previous investigators placed great emphasis on the Phanerozoic cover, and not the Precambrian basement. In particular, the Archean basement rocks were often overlooked due to their high-grade metamorphism and multiple deformations. However, there is now emerging a much more comprehensive knowledge of the Archean–Proterozoic history, and these recent studies have deepened our understanding of the Liaodong Peninsula during Precambrian time, as well as the formation and evolution of the North China Craton. To make the Archean–Proterozoic tectonic framework clearer, it is important to examine the major lithotectonic units of the Liaodong Peninsula and to determine their tectonic settings. Here, therefore, we present a comprehensive review of the Neoarchean, Paleoproterozoic and Mesoproterozoic lithotectonic assemblages in the Liaodong Peninsula, and then summarize the Precambrian geodynamic regime.

Our data support an Archean proto-mantle plume model based on the following evidence (Li and Wei, 2017): (1) The large volume of Neoarchean granitoid gneisses with dominantly TTG compositions across the ~800 km wide Eastern Block were emplaced during not a long period, without systematic age or geochemical progression. (2)The late Neoarchean bimodal volcanic assemblages (ultramafic–mafic and dacitic–rhyolitic rocks) over the North China Craton are in contrast with the common unimodal (mainly andesitic) rocks in Phanerozoic magmatic arcs. (3) The depleted basalts in the volcanic assemblages show geochemical characteristics of mixing between oceanic plateau basaltic and arc-related basaltic magmas. That is to say, the rising mantle plume head may govern the genesis of the depleted basalt, suggesting plume–lithosphere interaction. (4) The common occurrences of komatiite and basaltic komatiite within the late Neoarchean greenstone belts in the Eastern Block indicate anomalously high-temperatures, which are too high for subduction zones. (5)The most prominent structural feature is the dome-and-keel structure of the late Neoarchean basement, inconsistent with the linear magmatic arc environment that typifies the Proterozoic and Phanerozoic orogens. What's more, when applied to the North China Craton, the arc model also conflicts with the rarity of lithologies and associations characteristic of active margins, such as ophiolite, andesite, accretionary mélange, molasse, flysch, high-pressure belt and thrust-and-fold belt. Thus, the evidence listed above can hardly support a magmatic arc setting, whereas they have no controversy with the mantle plume model.

Then we synthesize the Paleoproterozoic magmatism, sedimentation, metamorphism and metallogeny against the rift model, and propose a process of arc-continent collision between the northern Longgang and the southern Nangrim Blocks (Li and Chen, 2014). This conclusion is consistent with the observations, including that (i) the 2.0–2.2 Ga magmatism shows a typical sub-alkaline series, rather than a bimodal distribution, sincethe mafic rocks mostly have arc affinities and the acidic–intermediate rocks belong to the calc-alkaline series; (ii) the main source of the 1.9–2.0 Ga sedimentary rocks is the Paleoproterozoic arc materials, indicating a fore-arc or back-arc basin setting; (iii) a couple of big borate deposits occur in the boron-rich volcanic rocks that were formed in convergent continental margins; (iv) the North and South Liaohe Groups show different rock associations and metamorphic histories (P–T paths); and (v) the Nangrim and Longgang Blocks vary in lithological units, geochronology and metamorphic features. Thus, an arc-continent collision tectonic scenario for the Paleoproterozoic Jiao-Liao-Ji Belt are involved: (i) a southward subduction in the period 2.0–2.2 Ga; (ii) sedimentation during the period 1.9–2.0 Ga; (iii) arc-continent collision at ca. 1.9 Ga; and (iv) post-collisional extension at 1.82–1.87 Ga, marking the end of the Paleoproterozoic tectonothermal event.

Mesoproterozoic mafic dike swarms provide evidence of global Mesoproterozoic rifting events associated with the final breakup of the Columbia supercontinent (Li et al., 2016). The majority of the Mesoproterozoic mafic dike swarms in the Liaodong Peninsula and its vicinity are geochemically classified as continental flood basalts, with some being either continental flood basalts or alkali basalts that formed within continental rift settings or have E-MORB compositions. The alkaline rocks have OIB affinities and may have been generated by a low degree of partial melting of a depleted region of the asthenospheric mantle with limited involvement of the lithospheric mantle, a process that is typical of magmatism within rift settings. In addition, the

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mafic dikes and coeval granites within the study area define a bimodal Mesoproterozoic association that provides further evidence of a continental rift environment. A rift environment is also indicated by the presence of a Meso–Neoproterozoic sedimentary sequence that previous studies concluded formed in a rift valley or trough-type depression environment, both of which can be classified as a stable secondary tectonic environment.

In sum, the Precambrian basement in the Liaodong Peninsula witnessed a transformation from Neoarchean plume head–lithosphere interaction mantle source, Paleoproterozoic sub-continental lithospheric mantle source metasomatized by subduction zone fluids/melts, to Mesoproterozoic plume tail–asthenospheric/lithospheric mantle interaction mantle source.

Key words: geodynamic regime, Liaodong Peninsula, Neoarchean, Paleoproterozoic

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