Thinning and Accretion of Deep Lithosphere in North China Block

One of the major achievements in the study of deep geodynamics over the past two decades is the finding that the subcontinental lithosphere is not immutable. The instability of the lithosphere may be closely related to the tremendous change in its structure, composition and rheology. The trigger and mechanism of lithospheric destabilization are the key to understanding the generation of intraplate magmatism, ore-forming processes and tectonic evolution. Therefore, along with the development of the research in this direction, the plate tectonic theory can be improved to more successfully cover the tectonics of continental plate.

An award-winning project, "Thinning and accretion of deep lithosphere in North China Block and its adjacent regions", is the quintessence of twenty years' hard efforts by five renowned Earth scientists, including Profs. XU Yigang with the CAS Guangzhou Institute of Geochemistry (GIG), ZHENG Jianping with the China University of Geosciences, FAN Weiming with the CAS Bureau of Science and Technology for Resource and Environment, XU Jifeng and GUO Feng both from the GIG. The North China craton represents one of the most ancient continental nuclei in the world, which shows several reactivation features. Igneous rocks of different ages including crustal and mantle xenoliths create a good opportunity for Prof. XU and his colleagues to investigate into the evolution of the lithosphere beneath this particular region. Over the years, they performed systematic studies on these rocks, which resulted in a series of substantive achievements in the continental lithospheric field.

First of all, Prof. XU and his cooperators noticed the remarkable contrast between the Cenozoic and Paleozoic lithospheric mantles underneath the same North China craton, and this revelation led to the idea that the lithosphere

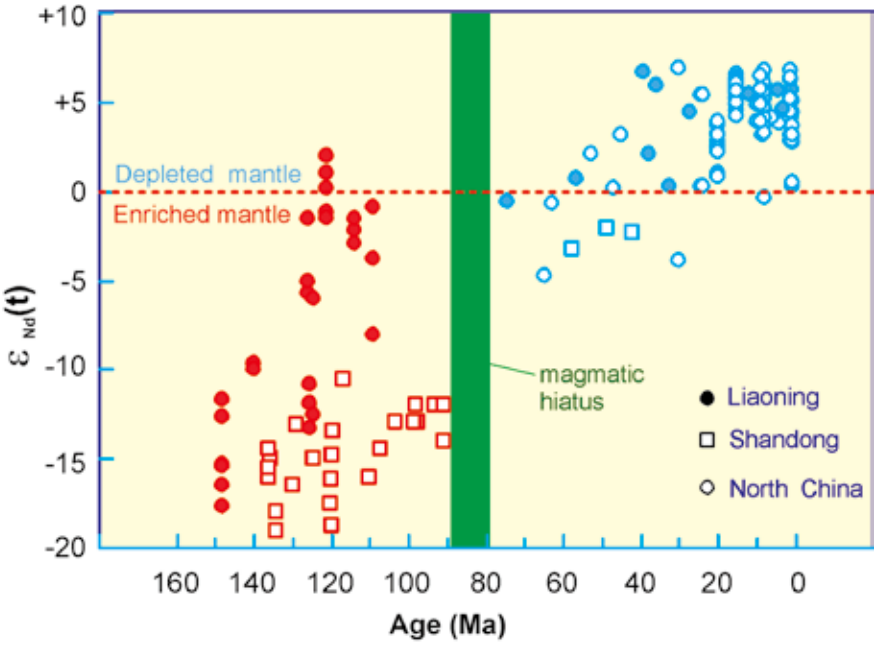

Figure 1: Temporal variation in the Nd isotopic composition of basalts in the North China Craton.

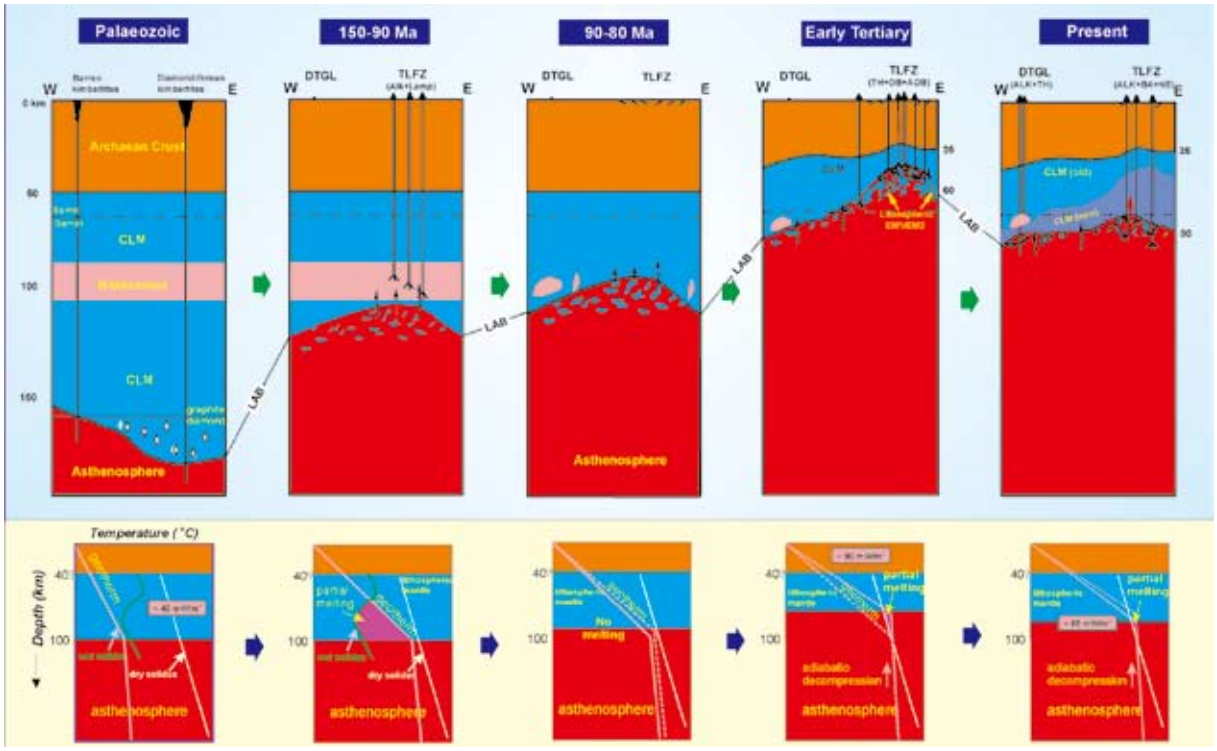

Figure 2: Schematic illustration of the thermo-tectonic evolution of the lithospheric mantle beneath the North China Craton and related magmatism.

beneath this region had experienced dramatic thinning processes. Therefore, they further assessed the oceanic affinity of the Cenozoic lithospheric mantle beneath this region, and demonstrated that lithospheric accretion must have taken place subsequent to the lithospheric thinning processes. This finding contrasts with the traditional view that the lithosphere beneath cratons is stable forever.

After that, the scientists provided reliable evidences to show that the Mesozoic lithospheric mantle beneath the North China landmass is highly heterogeneous in chemical composition, and attributed it to the modification by crustal components recycled into the depth via variable ways during the interactions of the North China craton with its surrounding plates. This has greatly improved the understanding to the mantle heterogeneity.

What's more, they summarized the magma in the North China craton evolved from Mesozoic "isotopically enriched" type, via a magmatic hiatus, to Cenozoic "depleted" type. This temporal variation in magma geochemistry resulted from the changing relationships between thermal gradient and mantle solidus during lithospheric thinning, and change-over of magma sources. The relatively long timescale of magmatism (~100 Ma) suggests that thermal-chemical erosion by convective mantle is one of the main mechanisms of lithospheric thinning.

Also, the scientists identified the coexistence of the new and the old mantles in the present-day lithosphere beneath the North China craton, and highlighted the role of translithospheric weak zones in lithospheric thinning. This finding suggests that the lithospheric thinning has proceeded in a diachronous manner in time and space.

Through these achievements, the prize-winning research group has been recognized as one of the most active groups worldwide in the continental lithosphere field, and the North China craton as the best example in the world for removal of ancient lithosphere by young and hot oceanic-type mantle. Apart from more than a hundred papers published, among which eight representative ones were cited by hundreds of times, the research group successfully organized the International Conference on Continental Volcanism in 2006, which was sponsored by the International Association for Volcanology and Chemistry of Earth's Interior (IAVCEI), and fulfilled the publication of two relevant special issues in *Lithos* and *Episodes*.