No great unconformity found between Xiamaling and Longshan formations in the North China Craton

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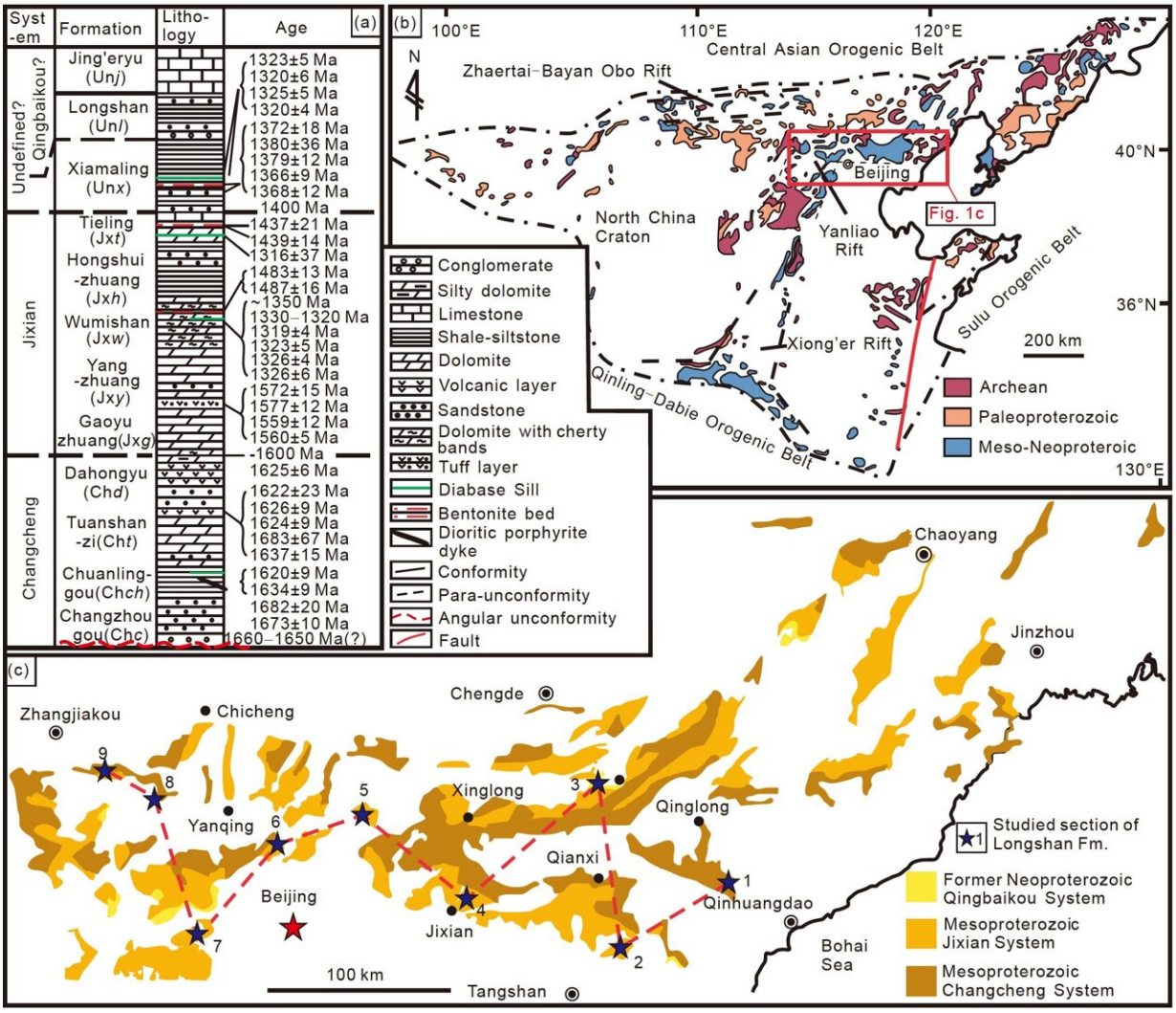


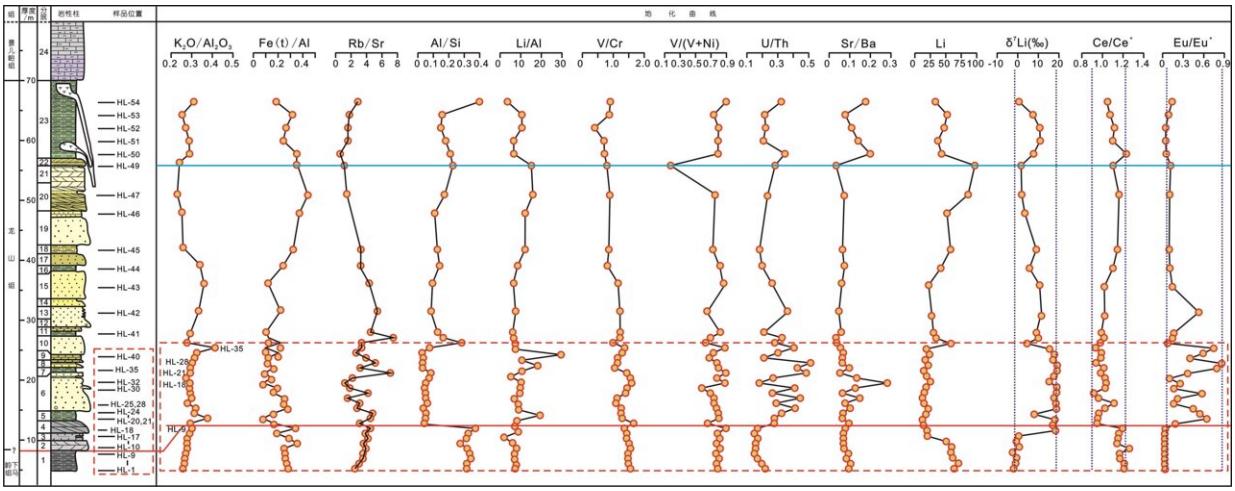
(a) Stratigraphy and age of the Meso-Neoproterozoic in the Yanshan-Liaoning

area; (b) regional geological sketch and location of the study area; (c) figure denoting enlarged section from the study area denoted by red box. From east to west, the sections are: 1, Liujiang section, Qinhuangdao, Hebei Province (Teng and Sun, 1999; Xu, 2015); 2, Zhaozhuang section, Tangshan, Hebei Province (Chen, 1981); 3, Kuancheng section, Hebei Province (measured section); 4, Jixian section, Tianjin (Tian et al., 1990); 5, Miyun section, Beijing (measured section); 6, Longshan section, Changping, Beijing (Qi et al., 1999; Zhang et al., 2020); 7, Xishan section, Beijing (Qiao, 1976; Zhang C et al., 2017); 8, Zhaojiashan (and Liangjiazhuang) section, Huailai, Hebei Province (measured section); 9, Xiahuayuan section, Xuanhua, Hebei Province (Song and Zhang, 1983). Credit: Science China Press

Recently, the journal *Science China Earth Sciences* published research by Professor Hongwei Kuang, Dr. Nan Peng and Professor Yongqing Liu from the Institute of Geology, Chinese Academy of Geological Sciences.

Based on multidisciplinary evidence from the sedimentary sequences and the continuity, the youngest detrital zircon age spectra, and geochemical indicators of the transition between the Xiamaling and the Longshan formations proved there probably not "a great sedimentary hiatus" or " a great unconformity" for more than 300 Ma between the Xiamaling and the overlying Longshan Formation in the North China Craton.

The researchers argue that the Xiamaling Formation and the Longshan-Jingeryu formations might be deposited continuously in the late Mesoproterozoic. On this basis, the paleogeography of the Xiamaling-Longshan-Jingeryu formations in Yanliao area of the North China Craton has been reconstructed.

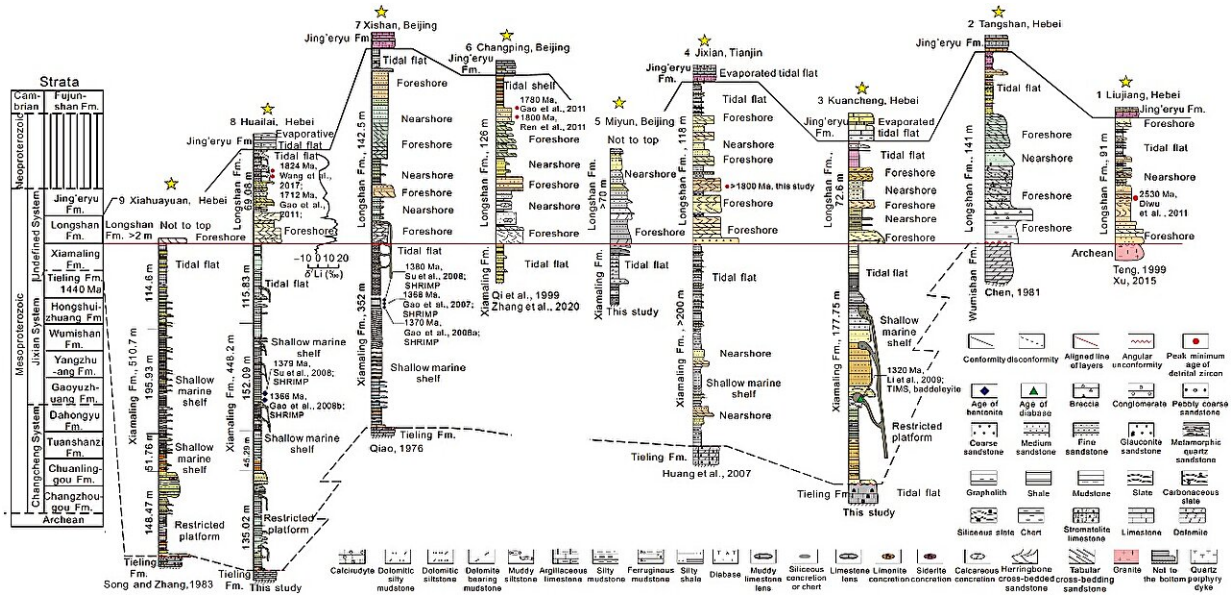


The ratios of major and trace elements of siliceous sediments that have significant response to geological characteristics such as provenance, continental weathering degree, paleoclimate, redox environment, such as Al2O3, Na2O/Al2O3, Sr/Ba, Rb/Sr, FeO/Fe2O3, as well as the CIA, chemical index of weathering (CIW), and plagioclase alteration index (PIA) were selected. Li isotope, Li and geochemical indices content indicate that chemical weathering of the transition between the Xiamaling Formation and the Longshan Formation weakened, and no weathering crust existence. Credit: Science China Press

Field geological records show that the pebbly sandstone at the bottom of the Longshan Formation does not have the properties of basal conglomerate. The Xiamaling and the Longshan formations are composed of multiple normal sedimentary cycles with coarse to fine sandstone/mudstone of different thicknesses. In ascending order, they develop a continuous clastic rock sedimentary sequence composed of a shallow sea, shore, and tidal flats from the Xiamaling Formation-Longshan Formation-Jing'eryu Formation.

The youngest detrital zircon age peaks of the Longshan Formation and the Jing'eryu Formation are both older than 1.6 Ga, lacking provenance

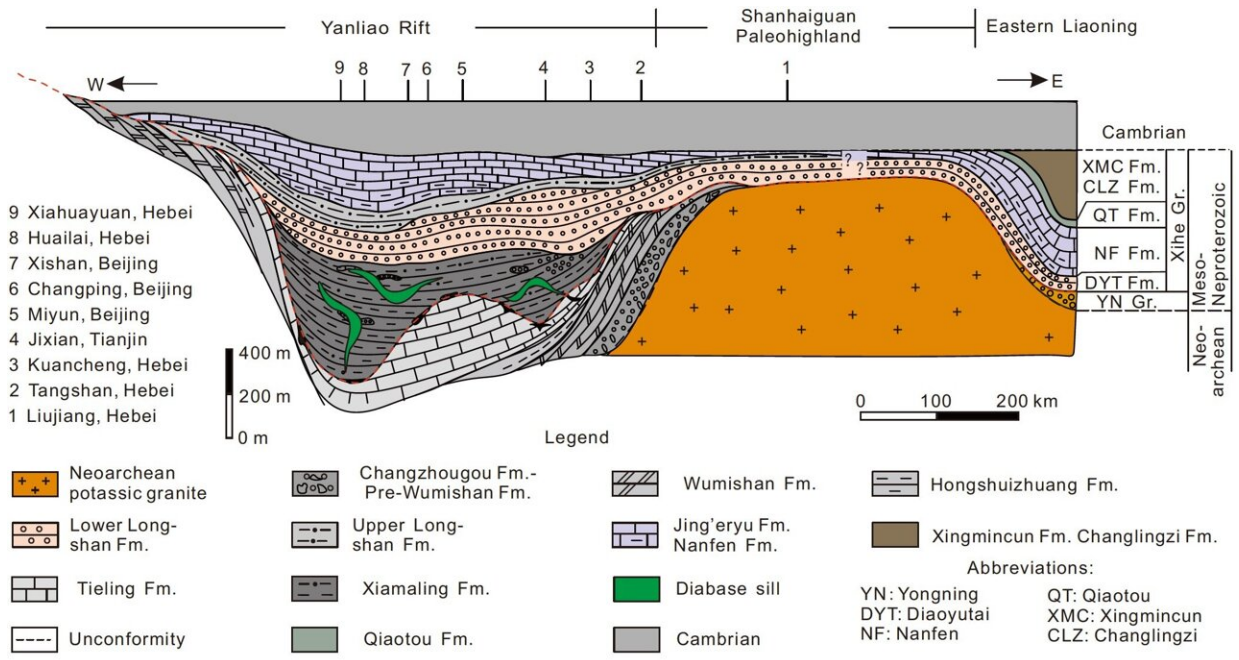
information for the volcanic magmatic events prior to deposition of the Longshan Formation. This is highly consistent with the detrital zircon age spectra of the underlying Mesoproterozoic sedimentary rocks, which indicates that they share the same provenance, which further indicates that the Xiamaling Formation and its lower strata are not the provenance of the Longshan Formation.



The depositional environment and stratigraphic evolution of the Xiamaling Formation to the Longshan Formation, are represented by coarse-fine normal cycle deposits of different grades and thicknesses. Although the middle sedimentary stage of the Xiamaling Formation is dominated by fine-grained sediments in shallow shelf or a relatively euxinic environment, sandstones with different thicknesses are observed. The sedimentary successions and evolution processes from the Xiamaling Formation to the Longshan Formation indicates that the Xiamaling-Longshan formations is the sedimentary product from the peak period of rift extension or continental breakup (Mitchell et al., 2021; Zhang S H et al., 2022). Here, the rift basin changes from deep and narrow to shallow and wide, which is continuous (in time) and expansive (in space). Credit: Science China Press

From the top of the Xiamaling Formation to the lower part of the Longshan Formation, the δ^7Li displays a rising trend, while Li content decreased. CIA and other series of weathering indices decreased, K_2O/Al_2O_3 decreased, Na_2O/ Al_2O_3 increased, and FeO/Fe_2O_3 decreased.

Li/Al, V/Cr, and V/(V+Ni) demonstrated a slight increase or decrease in the interface. The ratios of Ce/Ce*, Eu/Eu*, Rb/Sr, and U/Th showed a pronounced change at transition interface. Ce/Ce* is positive, Eu/Eu* is negative, Rb/Sr and Al/Si indicated a pronounced decrease, with an increase of U/Th. These geochemical indices confirm that there is no weathering crust between Xiamaling Formation and Longshan Formation, and that the intensity of continental weathering gradually weakens.



Accompanied by the global scale Columbia supercontinent rifting peak around 1.4 Ga in the Mesoproterozoic, strong crustal extension occurred from the western part of Yanshan Mountain to the northern part of Taihang Mountain

with the formation of the Large Igneous Province. This formed a narrow and deep aulacogen basin extending over 500 km from east to west and 120 km wide, with the deepest rift located in northwestern Hebei. The largest rifting area in the basin is from Changping to Huailai and Xuanhua in the west, with a thick accumulation of grayish-green and black illite shales and carbonaceous shales. Meanwhile, to the east of Changping, the water depth becomes shallow, and siltstones and sandstones are dominant. In the middle stage, mudstones and shales with intercalated sandstones in a shallow shelf environment are dominant, and in the late stage, mudstones and siltstones in a tidal flat with thin interbeds of calcareous nodules have predominantly developed. This indicates sedimentary evolution and a sediments infilling response from the initial strong subsidence of the rift valley, to the drift of rift valley in the middle and late stages. Therefore, the area with the largest stratigraphic thickness in the west Beijing-Zhangjiakou area has become the sedimentation and sub sidence center of the rift basin and the deep-water basin area (Liu and Zheng, 1994). From west to east, the transition from a narrow and deep basin center to an open and shallow sea on the shoulder of the rift valley has been recorded (Song and Zhang, 1983). At the end of the deposition of the Longshan-Jing'eryu formations, the east Liaoning rift valley maybe have started rifting. Thus, the paleogeographic pattern started to shift from the high in the east (Shanhaiguan-east Liaoning) and low in the west (Yanliao) of the Longshan-Jing'eryu stage to the high in the west (Yanliao) and low in east (Shanhaiguan-east Liaoning) of the Diaoyutai-Nanfen stage. The Diaoyutai-Nanfen formations may be contemporaneous with or slightly later than the Longshan-Jing'eryu formations. After that, Yanliao areas uplifted, and deposition did not occur in the Jiao-Liao-XuHuai areas. Credit: Science China Press

Although the existence of large unconformity between the Xiamaling and Longshan formations needs more precise multidisciplinary evidence, especially the geochronological data, at present, this "great unconformity" has not been supported by basin evolution, sedimentary infilling, sedimentary and tectonic environment and geochemistry, etc.

Therefore, this study suggested that the Longshan and Jingeryu formations should be regarded as conformable or continuous sedimentary products with Xiamaling Formation, and together placed at the upper part of the "Undefined System." Meanwhile, this study provides new evidence for further revealing the evolution process of the North China Craton and the global paleogeography, paleoenvironment and paleotectonic evolution during the late Mesoproterozoic.

More information: Hongwei Kuang et al, Is there a great unconformity between Xiamaling and Longshan formations in the North China Craton?, *Science China Earth Sciences* (2023). DOI: 10.1007/s11430-022-1034-9

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