

Intensive volcanic eruptions recorded in black shales within the Xiamaling Formation in the North China Craton

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The Xiamaling Formation in the Yanliao rift zone in the northern North China Craton (NCC) consists of shale and mudstone and was deposited in a tectonically quiet marine basin. Black shales are very common at the middle part of the Xiamaling Formation and are 100–300 m thick. Tuff (or K-bentonite beds) with TIMS and SHRIMP zircon U-Pb ages of 1384 ± 1 Ma to 1366 ± 9 Ma with a peak age of 1384 Ma and a weighted mean age of 1383 ± 2 Ma have been identified from the black shales within the middle part of the Xiamaling Formation^[1–3]. The Xiamaling Formation in the NCC and the Velkerri Formation in North Australian Craton were most likely deposited in the same basin of Nuna/Columbia supercontinent^[4–5].

Our investigations show that the frequency and thickness of tuff beds are increasing from lower part of black shales to the middle part, and then disappear quickly. Specially, four thick tuff layers with thickness of 3–5 cm have been identified from middle part of the Xiamaling black shales (Figure 1). These four thick tuff beds are distributed over a large area that is *ca.* 400 km long from Lingyuan in east to Xiahuayuan in west and represent the most extremely intensive explosive volcanic eruptions during deposition of the black shales. Our new zircon CA-ID-TIMS U-Pb dating of tuffs from Lingyuan and Chengde obtained two weighted mean $^{206}\text{Pb}/^{238}\text{U}$ ages of 1382.1 ± 1.3 Ma and 1380.0 ± 1.1 Ma, respectively, indicating extremely intensive volcanic eruptions at 1382–1380 Ma. Large areal extent of four thick tuff layers in Xiamaling black shales in the NCC most likely recorded some extremely intensive explosive volcanic eruptions during a short period in Earth's history.

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[1] Gao et al. (2007) *Geol Bull China* **26**, 249–255. [2] Su et al. (2008) *Gondwana Res* **14**, 543–553. [3] Zhang et al. (2015) *PNAS* **112**, 1406–1413. [4] Zhang et al. (2018) *Geology* **46**, 963–966. [5] Mitchell et al. (2021) *Geology* **49**, 25–29.

