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Late Permian–Middle Triassic Backarc Basin Development in West Qinling, China

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The Upper Permian–early Middle Triassic strata of the northern West Qinling area, northeastern Tibetan Plateau, are composed of various sediment gravity flow deposits. Detailed sedimentary facies analysis indicates these strata were deposited in three successive deep-marine environments. The Upper Permian–Lower Triassic strata of the Maomaolong Formation and the lowest part of the Longwuhe Formation define a NW-SE trending proximal slope environment. Facies of the Lower Triassic strata composing the middle and upper Longwuhe Formation are consistent with deposition in a base-of-slope apron environment. Whereas facies of the Anisian age Gulangdi Formation are more closely associated with a base-of-slope fan depositional environment. These lithofacies and spatial-temporal changes in paleocurrent data from these strata suggest the opening of a continental margin backarc basin system during Late Permian to early Middle Triassic time in the northern West Qinling. U-Pb zircon ages for geochemically varied igneous rocks with diabasic through granitic compositions intruded into these deep-marine strata are in the range of 244–230 Ma. These observations are consistent with extensional backarc basin development and rifting between the Permian–Triassic eastern Kunlun arc and North China Block during the continent-continent collision and underthrusting of the South China Block northward beneath Erlangping-Qinling terranes of the North China Block. Deep-marine sedimentation ended in the northern West Qinling by the Ladinian stage, but started in the southern West Qinling and Songpan-Ganzi complex to the south. We attribute these observations to southward directed rollback of Paleo-Tethys oceanic lithosphere, continued attenuation of the West Qinling on the upper plate, local post-rift isostatic compensation in the northern West Qinling area, and continued opening of a backarc basin in the southern West Qinling and Songpan-Ganzi complex. Rollback and backarc basin development during Late Permian to early Middle Triassic time in the West Qinling area explains: the truncated map pattern of the eastern Kunlun arc, the age difference of deep-marine sediment gravity flow deposits between the upper Permian–early Middle Triassic northern West Qinling and the late Middle Triassic–Upper Triassic southern West Qinling and Songpan-Ganzi complex to the south, and the discontinuous trace of ophiolitic rocks associated with the Mianlue-Anyimaqen-Kunlun suture.

Key words: West Qinling, Paleo-Tethys, Triassic, deep-marine sedimentation, sedimentary architecture, backarc rift basin, rollback tectonics

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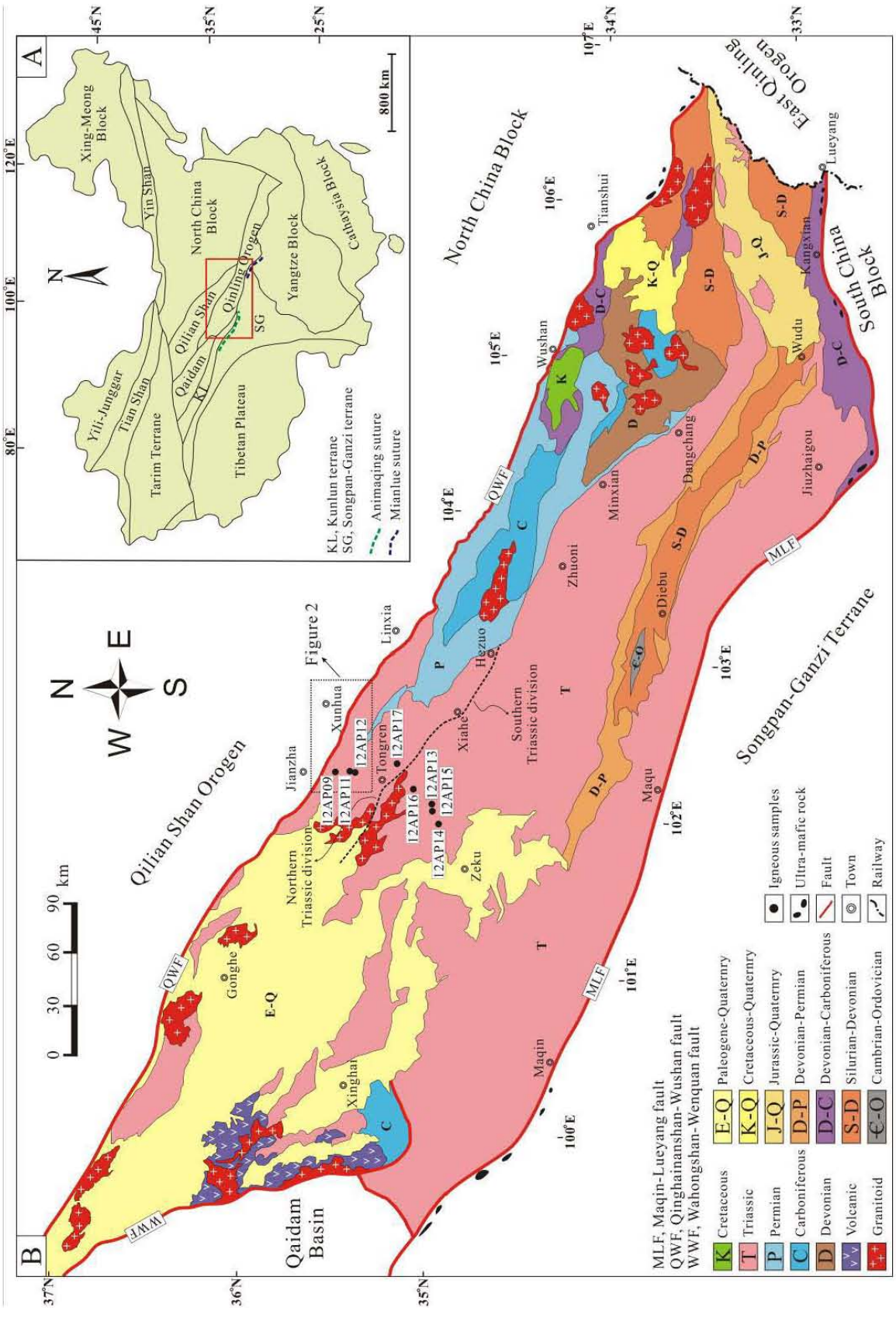

Fig. 1. (A) Subdivision of main tectonic units of China. (B) Geological map of the West Qinling.
The rectangle box in Figure 1A represents the local enlarged areas in Figure 1B, and rectangle box in Figure 1B outlines studied area in the northern West Qinling. Dotted line along the town of Tongren, Xiahe, Hezuo is the boundary between the northern and southern division of West Qinling Triassic depositions. Sedimentary differences between these two divisions are show in Figure 2

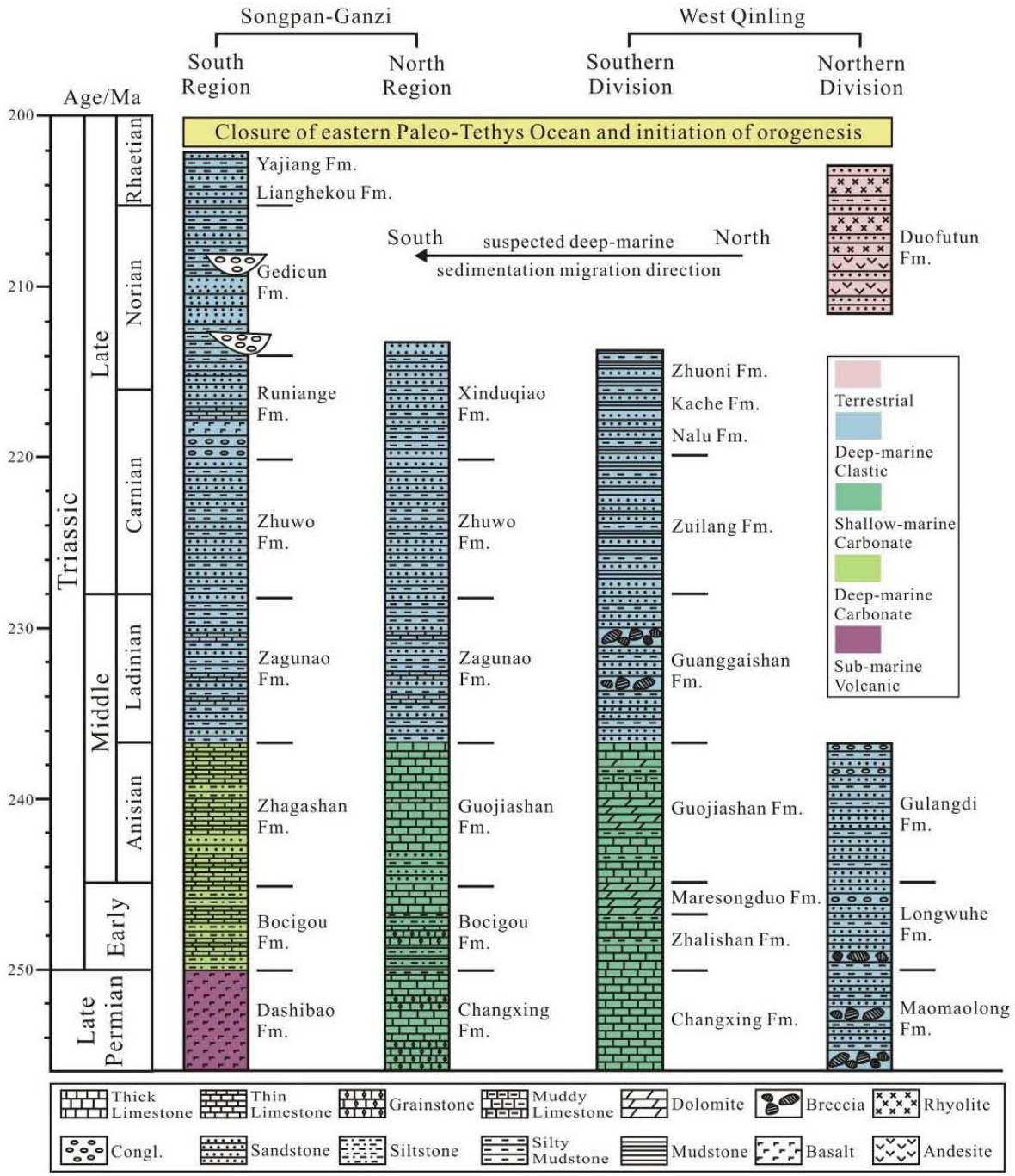

Fig. 2. Late Permian-Late Triassic lithostratigraphy of the West Qinling and Songpan-Ganzi complex (Modified from Meng et al., 2007).

In the northern division of West Qinling, the Late Permian to early Middle Triassic strata are dominated by deep-marine slumps and sediment gravity flow deposits; while, no further marine deposition since Ladinian Stage. In the southern division of West Qinling, the Late Permian to early Middle Triassic are mainly shallow marine carbonate deposition; from late Middle Triassic Ladinian Stage, deep-marine slumps and sediment gravity flow deposits appeared, and continued to the Late Triassic Norian Stage. The lithostratigraphy of the northern Songpan-Ganzi is nearly identical to the southern division of West Qinling. The southern Songpan-Ganzi is a little different with the northern Sonpan-Ganzi, with a longer deep marine sediment gravity flow deposition until to the Late Triassic Rhaetian Stage. This temporal and spatial differences of lithostratigraphy between the northern division of West Qinling, the southern division of West Qinling and northern Songpan-Ganzi, and the southern Sonpan-Ganzi is interpreted here as a result of the southward directed rollback of Paleo-Tethys oceanic lithosphere, which created a gradually southward opening rift basin. See Figure 3 for tectonic interpretation.

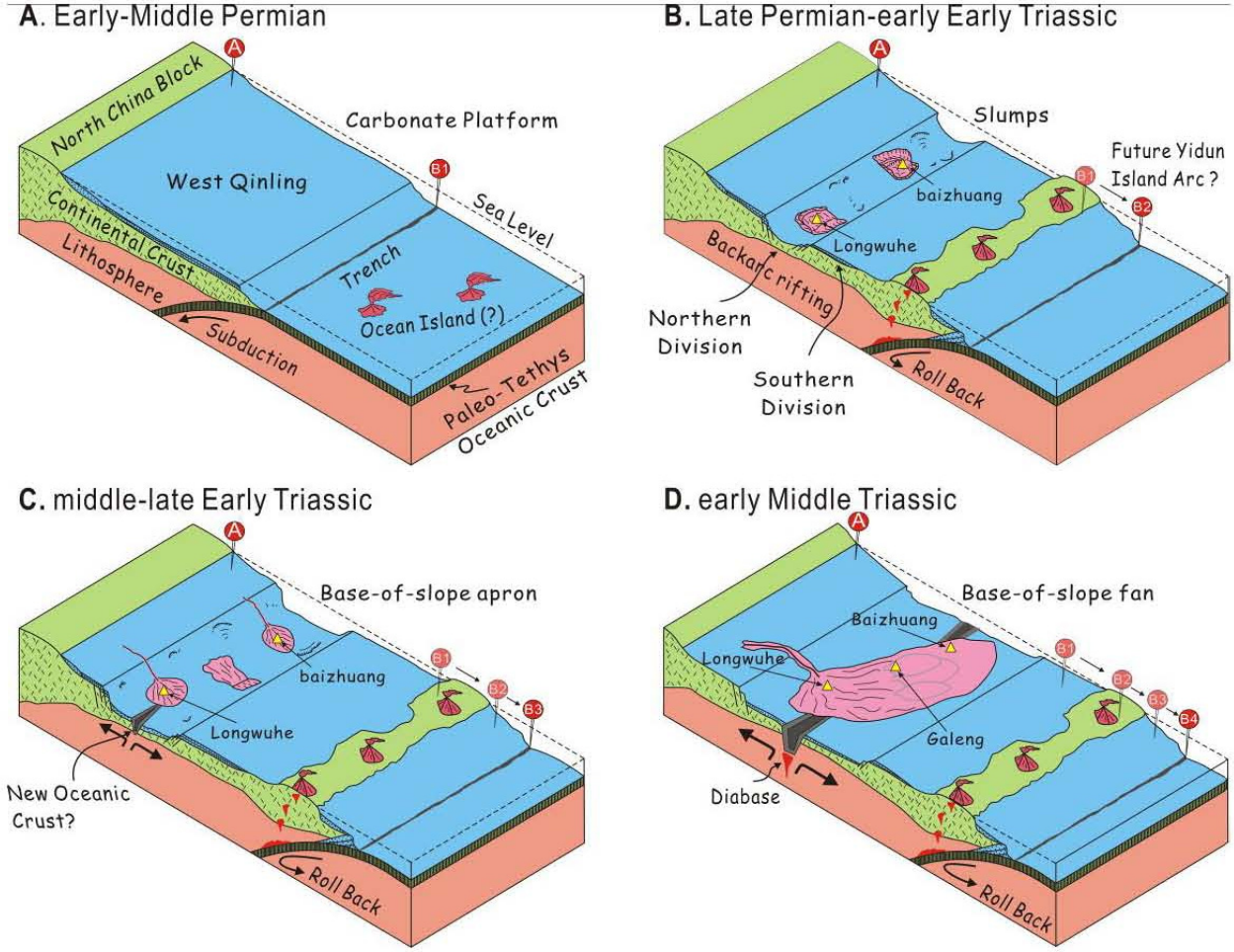

Fig. 3. Tectono-sedimentary evolution model for the Early Permian–early Middle Triassic West Qinling

(A) Early–Middle Permian: The West Qinling, beneath which the Paleo-Tethys oceanic lithosphere subducted, served as the southern passive margin of the North China Block. Shallow marine carbonates were widely developed all over the West Qinling during this time. (B) Late Permian–early Early Triassic: Rollback of the northward subduction created an extensional backarc rifting region on the continental crust of the northern West Qinling. In the rifted basin, sedimentation was dominated by slope slumps and breccias; while, in the southern Qinling, there was still shallow marine carbonate deposition. (C) middle–late Early Triassic: Continued spreading of the rift created new oceanic crust in the northern West Qinling. Slump strata were decreased; base-of-slope apron system developed in the rift basin; shallow marine carbonate deposition continued in the southern division. (D) early Middle Triassic: The rift basin got to its greatest stage. Diabase intruded and base-of-slope fan system formed in the northern division. Although shallow marine carbonate deposition continued in the southern division, the rifting began to migrate to the south shortly after this period. Increased rate of rollback since the Ladinian Stage caused the southward directed migration of rifting, which created the deep-marine sediment gravity flow depositions in the southern West Qinling and Songpan-Ganzi area. The island arc, which previously developed in the southern margin of West Qinling as part of the Eastern Kunlun arc, migrated to the south, becoming the subsequent Yidun arc.