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The volcano-sedimentary succession of Upper Permian in Wuli area, central Qinghai-Tibetan Plateau: Sedimentology, geochemistry and paleogeography

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Detailed observations on cores and thin sections well documented a volcano-sedimentary succession from Well TK2, which is located in Wuli area, central Qinghai-Tibetan Plateau. The TK2 volcano-sedimentary succession reflects an active sedimentary-tectonic setting in the north margin of North Qiangtang-Chamdo terrane in the late Permian epoch. Based on the observation and recognition on lithology and mineralogy, the components of TK2 succession are mainly volcanic and volcaniclastic rocks and four main lithofacies are recognized, including massive volcanic lithofacies (LF1), pyroclastic tuff lithofacies (LF2), tuffaceous sandstone lithofacies (LF3) and mudstone lithofacies (LF4). LF1 is characterized by felsic components, massive structure and porphyrotopic structure with local flow structure, which indicates submarine intrusive domes or extrusion-fed lavas that formed by magma ascents via faults or dykes. Meanwhile, its eruption style may reflect a relative high pressure compensation level (PCL) that mainly determined by water depth, which implies a deep-water environment. LF2 is composed of volcanic lapilli or ash and featured with massive structure, parallel bedding and various deformed laminations including convolve structure, slide deformation, ball-and-pillow structure, etc.. LF2 indicates the sedimentation of initial or reworked explosive products not far away from volcano centers, reflecting the proximal accumulation of volcano eruption-fed clasts or their resedimentation as debris flows. In addition, the submarine volcano eruptions may induced earthquakes that facilitate the resedimentation of unconsolidated sediments. LF3 contains abundant pyroclastic components and is commonly massive with rip-up mudstone clasts or usually interbedded with LF4. In addition, typical flute casts, scour structures and graded beddings in thin-interbedded layers of sandstone and mudstone are commonly observed, which also represents the sedimentation of debris flows or turbidity flows in a relative deep-water environment. LF4 indicates suspension deposits of distal turbidity sediments in deeper-water setting, which is mainly tuffaceous and ordinary mudstone, commonly interbedded with thin pyroclastic layers. Geochemically, the felsic volcanic rocks belong to tholeiitic to calc-alkaline series, exhibiting characteristics of right-leaning rare earth element (REE) patterns with conspicuous Eu negative anomalies, enrichments in large ion lithophile elements (LILEs) and depletions in high field-strength elements (HFSEs), which reflect an island arc environment that corresponds to the late-Permian subduction of slabs. The TK2 volcanic-sedimentary succession reveals a submarine volcano-dominated depositional model and proves the existence of a deeper water environment, at least in a restricted zone of Wuli area. However, the traditional sedimentary and paleogeographic knowledges are mostly about coal-forming transitional facies in stable environment. Therefore, the proposing of a deep-water volcano-sedimentary model will provide a further comprehension of paleogeography in southern Qinghai at late-Permian, which will also supplement the previous cognition of stable ocean-land transitional environments and provide a new sight to the paleogeographic framework of late-Permian in North Qiangtang-Chamdo terrane.