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Cenozoic evolution of Qaidam basin controlled by the transition of two epochs basin-forming dynamics systems in the northern Tibetan plateau

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Cenozoic basin-froming dynamics of Qaidam basin, in which Cenozoic occupies more than 90% of sediments, has been an open question. Transversal wave velocity structure of Qaidam basin and its nearby region imaged from ambient noise and earthquake data reveal the low velocity layer uplifting from south to north in middle crust, under which the lower crust and upper mantle lithosphere are obviously deflected toward the eastern Kunlun orogenic belt in the south and Qilian orogenic belt in the north. These deformation features in lithosphere reflect that the deep dynamics process of Qaidam basin is similar with the type foreland basin. But Cenozoic Qaidam basin is located in a narrow and semi-closed tectonic environment, structural displacement from the southwest Qaidam has achieved, even exceeded, the north-south width of basin, which disabled the development of stable craton and wedge deposition form of a typical foreland basin.

Our basin-scale AMS study in seven locations of Qaidam basin reveal that the palaeo-stress orientation of middle to late Eocene Xiaganchaigou Formation is N-S direction, while that of early to middle Miocene Xiayoushashan Formation is NE-SW direction. Moreover, the early N-S compression is more intense in the northern Qaidam basin than that in the western Qaidam basin, while the late NE-SW compression, which dominates the modern NW-SE trending fold axial traces, is more intense in the southwestern Qaidam basin than that in the northern Qaidam basin. So we infer that Cenozoic structural deformation of Qaidam basin maybe dominated by two epochs basin-forming dynamics systems. The transition of these two epochs systems also dominated the Cenozoic basin evolution pattern from open state to closed state. The kinematic properties and pattern of late basin-forming dynamics system with NE-SW compression since Miocene can also be verified from the distinctive topography in southwestern Qaidam basin, where there are a series of arched mountains between the eastern Kunlun and Qimantage orogenic belts. This distinctive topography can be satisfactorily explained using the following model: once the newborn eastern Kunlun strike-slip fault with straight shape and E-W direction developing, it will be pushed northward into arch shapes, so the arched mountains will gradually accumulate the displacements of its southern arched mountains. This model is consistent with the orderly arrangement of Cenozoic basin structures in space and time, and reveals an important structural transfer mechanism, which is characterized by the structural displacement transmission along detachments in Qaidam basin.