Protoliths and ∼440-Ma ultrahigh-pressure metamorphism of eclogite and gneiss in the north Qaidam orogen, NE Tibet: implications for deep subduction of the Qaidam Basin

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The Qaidam basin preserves a denser, stronger and seismically faster lower crust with a shallower Moho than other Tibetan terranes. Its northern part is widely believed to have undergone an early Paleozoic continental subduction down to >100 km. What kind of basement can result in such deep subduction and unusual geophysical features? U-Pb ages, trace-element and Hf-isotope compositions of zircon in eclogite and gneiss from the oldest strata of the North Qaidam orogen were analysed, to probe the nature of basement and its link with continental deep subduction. Gneissic zircons yield a wide age spectrum from 2016 to 430 Ma. Their wide range of εHf(t) (+16.0 to -17.5) suggests additions of depleted-mantle (DM) components at 0.8 Ga into an evolved basement as old as 2.5 Ga. Eclogitic zircons show mostly early Silurian ages (∼442 Ma) with minor Neoproterozoic ages (∼785 Ma). Mineral inclusions, trace-element patterns and Hf isotopes reveal that the ∼440-Ma zircons were formed during UHP eclogite-facies metamorphism and recrystallized in ∼785 Ma igneous precursors. Variations of εHf(t) from +14.2 to -19.2 indicate basaltic protoliths for the eclogites involving large-scale intracontinental mixing between DM-derived magmas and ancient materials at 1.0–0.8 Ga. This magmatism and coeval igneous events in the gneisses probably endowed the Qaidam basement with a denser and stronger framework, which was a prerequisite for deep subduction and its present geophysical properties.