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Early Paleozoic polyphase metamorphism and orogenesis in northern Tibet, China

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The Altun-Qilian-Kunlun orogenic system in the northern Tibetan Plateau is considered as the northernmost orogenic collage of the proto-Tethyan domain. Early Paleozoic polyphase tectonothermal events related to the subduction of the proto-Tethyan ocean and subsequent collisional orogeny produced two dominant metamorphic belts: the North Qilian (NQL)-North Altun (NAT) HP/LT metamorphic belt, and north Qaidam (NQD)-south Altun (SAT) UHP metamorphic belt. The NQL-NAT HP/LT metamorphic belt mainly consists of blueschist, eclogite and high-pressure metasedimentary rocks. Eclogites record metamorphic conditions of 420-550 °C and 2.1-2.5 GPa, at 510 to 460 Ma. The HP/LT metamorphic belt is associated with ophiolite, a subduction-accretion complex, and arc magmatic rocks, suggesting that the NQL-NAT is a typical early Paleozoic accretionary orogenic belt. In contrast, the NQD-SAT UHP metamorphic belt is characterized by eclogite and garnet peridotite enclosed within continental orthogneiss and paragneiss. These rocks record UHP metamorphism at $T > 700$ °C and $P > 2.7$ GPa. Geochronology suggests that the UHP metamorphism occurred at 500 to 423 Ma, and eclogite protolith ages of 850 to 750 Ma suggests the protoliths are related to Neoproterozoic continental rifting. Field relationships, petrology and geochronology suggest that the NQD-SAT UHP metamorphic belt resulted from the deep subduction of continental crust. Moreover, in the NQD-SAT UHP metamorphic belt, two types of HP granulites have been recognized. The first type of HP granulite records overprinting of eclogite during exhumation. The second type of HP granulite has a single metamorphic history and similar age to that of UHP eclogite. Penecontemporaneous metamorphic ages but different geothermal gradients between HP granulites and related UHP eclogite define a possible paired metamorphic belt, which may be considered to be a diagnostic characteristic of collisional orogens. High grade metamorphic rocks in the NQD-SAT commonly record Barrovian-type metamorphism, although it remains unclear whether or not all of these rocks have an earlier (U)HP metamorphic history. The low-medium- P Barrovian metamorphism and associated magmatism is about 20-50 Ma later than UHP metamorphism. Newly recognized eclogites in the northern part of the East Kunlun Mountains, to the south of Qaidam basin, have a similar field relationship (enclosed in continental gneiss) and mineral assemblage to the NQD eclogites, and a similar or slightly younger metamorphic age (410-430 Ma). The occurrence of similar continental type eclogites on two sides of the Qaidam basin makes it necessary to reconsider the nature of the Qaidam block. The polyphase metamorphism in northern Tibet can be linked to accretion and collisional orogenesis related to the evolution of Prototethys through the early Paleozoic.

