Zircon as an unique window for the tectonic evolution of UHP metamorphic terrane: Mineral inclusions and U-Pb SHRIMP age

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Zircons from Sulu-Dabie UHP rocks, including outcrop and cores from drill holes contain abundant mineral inclusions of protolith, prograde, UHP and retrograde minerals in different domains. Systematic studies on inclusions in zircons indicate that the Sulu-Dabie UHP terrane extends for > 2000 km and is about 50 km wide with 5 km in depth at least, probably the largest UHP terrane recognized thus far. Igneous mineral inclusions are common in the inherited zircon cores. In contrast, quartz eclogite-facies inclusions occur in prograde domains, coesite eclogite-facies inclusions are preserved in UHP domains, and amphibolite-facies inclusions are enclosed in outmost retrograde rims. Parageneses and compositions of inclusion minerals preserved in distinct zircon domains constrain prograde metamorphism at 570-690 °C and 1.7-2.1 GPa, and UHP metamorphism at 750-850 °C and 3.4-4.0 GPa, following by rapid decompression to amphibolite-facies retrograde metamorphism at 550-650 °C and 0.7-1.05 GPa. U-Pb SHRIMP analyses of the zoned zircons show four meaningful ages of the Sulu-Dabie metamorphic evolution: (1) Neoproterozoic protolith ages (800-750 Ma); (2) 246-244 Ma for early-stage prograde metamorphism; (3) 234-225 Ma for UHP metamorphism; (4) 215-208 Ma for late-stage retrogression. This indicates that Neoproterozoic voluminous bimodal igneous rocks in response to the breakup of Rodinia supercontinent, together with various sedimentary rocks, and minor ultramafic rocks, were subjected to coeval Triassic subduction to mantle depths and exhumation during the collision between the Yangtz and Sino-Korean cratons. The related subduction and exhumation rates for the Sulu-Dabie UHP rocks would be up to 4.7-9.3 km Myr^{-1} and 5.0-11.3 km Myr^{-1}, respectively. The zonal distribution of mineral inclusions and the preservation of index UHP minerals such as coesite imply that zircon is the best mineral container for each metamorphic stage. Similar conclusions have been documented elsewhere for other UHP terranes.

The constraint of abyssal crustal and mantle structures to abiogenetic gas in Songliao basin

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The features of abyssal crust and mantle structures and geologic process. We have found that the alkane carbon isotope $\delta^{13}C$ of natural gas in more than 30 wells around Xujia area in the Songliao Basin, with abiogenetic characteristics [1, 2]. Studies revealed that abiogenetic gas was constrained by abyssal crustal and mantle structures. It was found that Low velocity-High conductivity layers developed in upper and lower middle crusts, and we infer that both layers are composed of mantle fluid, which is closely related to abiogenetic gas, indicated by the polyspectrum characteristics of deep seismic reflection analysis. Under Xujia fault depression, where abiogenetic gas was found, thermal diapirs developed, which was the result of abyssal crustal and mantle geological processes. The resulted pressure (P) and temperature (T) made Fe group elements segregate out and accelerated the Fischer-Tropsch synthesis [3]. The lithosphere structures [4] and deep faults are major controlling factors for migration and distribution of abiogenetic gas. Most of the abiogenetic gas pay wells are distributed along the deep faults constructing an intricate conducting system for abiogenetic gas migration, and thick volcanic layer together with weathered basement formatted reservoir bed at the bottom of Xujia fault depression.

Specific crustal and mantle structures and intricate abyssal geological processes formatted a delicate abiogenetic gas generation, migration, accumulation match around Xujia fault depression in Songliao Basin.

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