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Analysis of helium enrichment and accumulation elements in petroleum-bearing basins

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Helium is one of scarce strategic ore resources, and used widely in many high-tech industries and key technological fields due to the unique physical and chemical properties. Helium is a valuable associated component of petroleum resources, whose abundance changes considerably in diverse natural gas pools, most of natural gas pools are featured with relatively low helium content. Almost all known helium-including or -rich gas fields at present are discovered accidentally during the petroleum exploration processes, the researches associated with key elements of helium enrichment and accumulation are much lacking, seriously restricting the exploration deployment and target optimization regarding helium resources. In this work, according to the statistics results of helium geochemical parameters from hundreds of natural gas samples as well as the analysis of typical natural gas pools around the globe, key elements of helium enrichment and accumulation are discussed. In general, the regions where there are strong supply of helium sources, long accumulation time, moderate tectonic movements, and good preservation conditions, has high helium content in natural gas pools, like Hugoton-Panhandle gas field in the United States, Weiyuan gas field of Sichuan Basin and Dongsheng gas field in China. Older granite and metamorphic rocks in the basement provide valuable helium flux, in addition, uranium and thorium-rich source rocks within the source-reservoir system also provide a significant supply for helium flux. Moderates tectonic movements not only produce a considerable number of faults and fractures that provide effective migration paths for helium-rich fluids, but also lead to the rapid uplift of the strata and subsequently cause the decrease of reservoir pressure, which contribute to the release of helium within helium-rich fluids. Natural gas pools are the places where helium can long-term co-exists with other gaseous components such as CH_4, N_2 and CO_2, because helium diffusion coefficient tends to become very small in the relative low abundance due to the filling of other gaseous components. This seems to demonstrate why no pure helium pool in the natural has been found at present. Overlying gypsum salt and thick mudstone layers are regarded as effective caprocks that preserve the large-scale loss of helium.