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Based on the "source-transport" model that relies on biological processes and carbon dioxide depletion for heliumenrichment - taking China Erlian Basin as an example

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Helium gas, as an important strategic gas resource, plays an irreplaceable role in the national economy and high-tech industries. To investigate the causes, distribution patterns, and resource potential evaluation methods of helium gas, this study selected the Erlian Basin in China as a typical area. Gas samples were collected from multiple drilling sites, and gas chromatography, carbon isotopes, helium isotopes, and argon isotopes were analyzed. This study systematically investigated the enrichment degree, formation sources, and accumulation process of helium gas in combination with the geological background of the region. The results showed that the helium content in different secondary structural units of the Erlian Basin varied significantly. Some areas had abundant helium gas, while others were scarce. The formation of helium gas mainly originated from the crustal source, with a small amount coming from the mantle contribution. By analyzing the correlation between helium gas and associated gases and the development of regional Paleozoic granites, it was found that the enrichment of helium gas in the study area was mainly due to the extensive development of high-quality helium source rocks at the base, as well as the consumption and dissolution of carbon dioxide during the migration process and the later replenishment of biogenic nitrogen gas, which together led to the enrichment of helium gas in the shallow reservoirs. Therefore, high helium content gas reservoirs are usually associated with biogenic hydrocarbon gases. Based on this, this study established a favorable mode and two unfavorable modes of helium gas accumulation from the perspective of "source-transport". In addition, by combining the distribution area, rock thickness, formation time, relative abundance of uranium and thorium elements in rocks of the Paleozoic granites in the study area, the resource potential was preliminarily evaluated using the radioactive decay formula of uranium and thorium.



