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地热水溶型和天然气伴生型氦气来源特征对比 ——以渭河盆地和鄂尔多斯盆地北部为例

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摘要:氦气是一种稀有惰性气体,在军工、航天、医学等多个领域发挥着不可替代的作用,但中国可供利用的氦气资源稀缺,目前尚未发现独立成藏的氦气资源,已知的氦气赋存形式主要包括天然气伴生型和地热水伴生型2种。鄂尔多斯盆地北部杭锦旗地区和渭河盆地作为2种类型氦气资源的典型盆地,以此为研究对象,通过开展两地氦气同位素质谱分析、岩石放射性元素分析等方法,对采集的研究区伴生气、岩心和周边潜在的氦气源岩样品进行化验分析。结果表明,鄂尔多斯盆地北部杭锦旗地区氦气为典型的壳源成因氦气,渭河盆地在宝鸡—咸阳断裂、秦岭山前断裂等沟通基底的深大断裂附近,幔源成因氦气体积分数占比较高(最高达到6.959%)。渭河盆地和鄂尔多斯盆地同属华北板块西南缘,盆地基底组成均包括太古界—元古界变质岩—花岗岩系,构成了地区氦气形成的主要源岩,而渭河盆地氦气的主要源岩还包括周缘燕山期富铀花岗岩和盆地深部同时期隐伏花岗岩体。两地基底沉积岩系因U、Th元素质量分数较低或脱附气氦气量低于基底变质岩系,均不能作为主要氦气源岩。两地氦气的形成、运移、聚集整个过程均受源岩和断裂控制,与深大断裂带的展布密切相关。依据以上结论,可为两地氦气资源下一步的勘探开发提供一定参考。

关键词:渭河盆地;鄂尔多斯盆地北部;氦气;伴生资源;来源对比

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Comparison of helium source characteristics between geothermal water-dissolved type and natural gas-associated type: A case study of Weihe Basin and northern Ordos Basin

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Abstract: Helium is a rare inert gas with indispensable applications in defense, aerospace, and medicine. However, helium resources available for use in China are extremely limited. To date, no independently accumulated helium resources have been found. Helium is primarily found in two forms: natural gas-associated and geothermal water-dissolved. This study focused on two typical basins—the Hangjinqi area in the northern Ordos Basin and the Weihe Basin—to investigate the genesis of helium. Helium isotope mass spectrometry analysis, rock radioactive element analysis and other methods were conducted to test the associated gas, core samples and potential helium source rock in the surrounding areas of the study area. The results show that helium in the Hangjinqi area in the northern Ordos Basin is typically crust-derived. While in Weihe Basin, high volume fractions of mantle-derived helium (up to 6.959%) were detected near deep-seated faults penetrating the basement, such as the Baoji-Xianyang fault and the Piedmont Fault of the Qinling Mountains. Both basins are located on the southwestern margin of the North China Plate and share a basement composed mainly of Archean-Proterozoic metamorphic-granite complexes, which serve as the main source rocks of helium formation. In addition, the main source rocks for helium gas in the Weihe

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