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Models for Helium Exploration

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Summary The number of helium exploration models has been growing over the past few years. Helium models can be divided into two groups: 1) focused on structure-stratigraphy-tectonics and 2) the type of host gas. The sources of helium are 1) uranium or thorium rich granites in the lower crust or upper mantle; 2) some unknown quantity of the element trapped in the Earth during its formation and 3) minor release from Li and other elements. The source of helium for a specific accumulation cannot be clearly identified. Isotopes help give an idea. Present drilling technology cannot reach these sources in the subsurface so they cannot be quantified. At present there are about eight general structure-stratigraphic-tectonic helium models for exploration. The most common model is a structure with three or four-way closure. Helium is typically found in a reservoir that lies immediately below the first effective seal in stratigraphic column to slow the element's leakage to the surface. Examples are Harley Dome, Grand County, Utah; North and South Pars, Qatar and Iran; and Mankota Trend, Southwestern Saskatchewan, Canada. Another model for helium exploration is the stratigraphic trap such as the Otis-Albert Field in Russell County, Kansas which produces from Cambrian sandstone, pinches out against a lateral seal, and the top seal is low permeable and nonporous Pennsylvanian strata. The Texas Panhandle -Hugoton, Oklahoma and Texas, USA represents a hydrodynamic trap model for helium with large areal extent, under pressured, and carbonate or sandstone reservoirs that are overlain by normally pressured salts and anhydrites that form a temporary seal. The complexity of the geologic strata and structure of the East Africa Rift System in Tanzania and the Mid-Continent Rift in Kansas USA features is another model. A fractured troctolite/anorthosite gabbro with 10%+ helium and carbon dioxide as the host gas has been identified along the northern part of the Mid-Continent Rift, USA in Minnesota. Regional homogenous reservoirs with local closures or thickening, reservoir pressure near atmospheric are another model type. An example of this model is the Lyons sandstone in Las Animas County, Colorado, USA. The Virgina Field in South Africa is a model characterized by uranium and gold rich Precambrian conglomerates as a source, the Vredefort crater and accumulation in the shallow sandstone reservoir (the Karoo Supergroup). Recent, hydrogen exploration has also uncovered another model for helium in a variety of geologic settings such as igneous strata interbedded with sediments such as in Mali and Australia respectively. Host gases associated with helium can be categorized into a separate group of models as well. These models are defined by the dominate gas species or host gas which are: 1) natural gas, 2) carbon dioxide, 3) nitrogen, and 4) hydrogen. Accumulations where there is no one gas species acting as the host are not that common but still can be found. More model types are likely to be discovered as more helium accumulations are being found in more diverse geologic and tectonic settings.

Theory / Method / Workflow

Results, Observations, Conclusions

Novel/Additive Information

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