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**The Development of Noble Gases Abundance Measuring and Isotopes Analyzing  
Technology in Hydrocarbon Geology**

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Noble gas is a kind of gas carrying inactive chemical properties, low abundances and specific genetic origins related to nuclear reactions. It has been considered as important tracer indicating the related geological processes. In recent 20 years, the noble gases gradually become one of the most important hotspots and frontiers in geosciences, especially on earth origin, formation, evolution, mineral formation and origination<sup>[1-9]</sup>. The noble gases in hydrocarbon contain a lot of geological information referring to oil and gas, so they play an important role in hydrocarbon reservoir forming and can make great tracing effects on hydrocarbon genesis, hydrocarbon-source correlation, hydrocarbon migration and hydrocarbon reservoir formation<sup>[10-12]</sup>. Because of relatively late studying and less work, up to now, noble gases researching extension and depth on hydrocarbon are far from enough. Furthermore, because of extremely low abundances in geological samples, the pretreatment which is used to purify, extract, enrich and separate noble gases is an important prerequisite for high precise and accurate isotope analysis. So, creating a set of noble gas isotope mass spectrometer and its sampling system, carrying out noble gas abundances measuring and isotopes analyzing on natural gas, solid rock liquid and inclusion samples of hydrocarbon geology, promoting noble gases isotope application in main hydrocarbon bearing basins are of great extensive developing potentials and prospects. The researches on noble gas are of great theoretical and realistic significances for developing hydrocarbon geology.

In order to settle the problems existing in noble gas researches of hydrocarbon geology, one set key equipment of noble gas isotopic mass spectrometer and its sampling system is created in Research Institute of Petroleum Exploration and Development-Langfang. The noble gas sampling system includes 4 parts such as noble gas sampling instrument in natural gas, solid rock, inclusion and liquid samples. The sampling system has our own master intellectual property. All the sampling instruments are self-designed and manufactured by domestic factory. The Noblesse Mass Spectrometer is the best advanced instrument for noble gas analysis and is bought from NU Instrument Company Limited.

Through working hard on sampling system function development, the sampling methods and flow processes of natural gas, rock sample, inclusion and liquid sample are created, and the noble gases sampling technology series for different sample types are formed. According to needs of noble gases abundance measuring processes and steps, using the program language of Quantstar-32bit software, the abundance measure controlling and data handling program for noble gas are created, and the noble gas abundance measuring technology are formed. At last, based on completely understanding working principle, mastering operations of mass spectrometer, and combining the separating function of sampling system, the parameters files for noble gas isotope analyzing are built, and the isotope analyzing technologies for He, Ne, Ar, Kr, Xe are completely formed.



**Fig.1 The noble gas sampling system and its isotope mass spectrometer**

By using air as sample to test the created noble gas abundance measuring and isotope analyzing technologies, the satisfied experimental results are gotten. (1) Firstly, the sensitivity of sampling system to He, Ne, Ar, K, Xe are respectively 3.95%, 3.48%, 2.02%, 1.89%, 3.21% in 6 times experiments, it shows great stability for sampling system; (2) Secondly, using the average sensitivity value of 6 times as system sensitivity, and taking air as sample to measure the noble gas abundances, the measured value of He, Ne, Ar, K, Xe in air are separately  $5.5275 \times 10^{-6}$ ,  $1.7842 \times 10^{-5}$ ,  $9.2007 \times 10^{-3}$ ,  $1.1113 \times 10^{-6}$ ,  $8.2696 \times 10^{-6}$ , the relative deviation of each noble gas to the general acknowledged accepted value is 5.46%, 1.86%, 1.49%, 2.52%, 4.95%, so the experimental results show the sampling system has great accuracy in noble gas abundance measuring; (3) Finally, the created isotope analyzing technologies are used to testing noble gas isotope in air sample, Taking Ne, Ar and Xe for example: 1) Ne:  $^{21}\text{Ne}/^{22}\text{Ne}=0.0277$  (the acknowledged value in air is 0.0290),  $^{20}\text{Ne}/^{22}\text{Ne}=9.542$  (9.80), the relative deviation separately is 4.48% , 2.64%; 2) Ar:  $^{40}\text{Ar}/^{36}\text{Ar}=304.4$  (295.5),  $^{38}\text{Ar}/^{36}\text{Ar}=0.1879$  (0.1880), the relative deviation separately is 3.01%, 0.1%; 3) Xe:  $^{124}\text{Xe}/^{130}\text{Xe}=0.0240$  (0.0234),  $^{128}\text{Xe}/^{130}\text{Xe}=4.799$ (4.715),  $^{131}\text{Xe}/^{130}\text{Xe}=5.388$ (5.213),  $^{132}\text{Xe}/^{130}\text{Xe}=6.411$  (6.607),  $^{134}\text{Xe}/^{130}\text{Xe}=2.534$  (2.563),  $^{136}\text{Xe}/^{130}\text{Xe}=2.149$ (2.176), the relative deviation separately is 2.69%, 1.78%, 3.35%,

2.97%, 1.14% and 1.25%. The measured values are generally close to the acknowledged values, so it shows the created noble gases isotope analyzing files are useful and the isotope analyses are high precise and accurate.

The sampling system is the only one with the most fully functions and our own master intellectual property in domestic, and working together with the noble gas isotope mass spectrometer; many analytical work such as noble gas sampling, component abundance measuring and He, Ne, Ar, Kr, Xe isotope analyzing on hydrocarbon geologic sample referring to natural gas, oil, formation water, source rock, reservoir rock and inclusion sample can be completely achieved. It can meet the extensive needs for noble gases researches in hydrocarbon geochemistry and geology. One sample can supply more than 20 geochemical data, of which the isotope of Ne, Kr and Xe can fill the emptiness in domestic. The general function and technical level of this equipment is in the leading position. It will provide a good and high technical platform for hydrocarbon geochemistry and geology researches, and can supply effective technology support for such as national major project, national "973" project and some other kinds of science and technology projects.

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