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Oral Presentations:

T0 – Opening Session

113 Nuclear energy and sustainable development: Assuring a solid foundation

Keynote address, **M.A. McMurphy**, France

Poster Presentations:

T3 – Uranium Exploration & Geology

38 A special kind of sandstone type uranium deposit in North Eastern Ordos basin, China

Z. Li, Anping, C.X. Fangi, Y. Jiano, Y. Sun, Y. Xia, K. Zhang, China

39 The latest study on development of metallogenic mechanism of Baimianshi uranium field, Jiangxi Province, China

H. Fan , D. He, F. Wang, China

40 Application of multi-source remote sensing information in uranium exploration

Y. Zhao, D. Liu, China

41 Latest progress of seismic survey method in hydrothermal uranium deposits exploration in China

G. Xu, H. Liu, D. Zhao, B. Zhu, China

42 Research on geological modeling and integrated prognosis technologies for uranium deposit

Y. Cai, China

118 Geological setting of the Langer Heinrich Uranium mine, Namibia

E. Becker, K. Kärner**,** Australia

T4 – Uranium mining & Processing

119 Optimization of technological processes at uranium ore mining and milling in Ukraine

O. Sorokin, Ukraine

Nuclear energy and sustainable development: Assuring a solid foundation

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The financial crisis is having a pronounced impact on industries worldwide. While it is clear that electricity generators are not immune, it is equally clear that the affect of the financial crisis on the global growth of nuclear energy will be limited. Although some projects may be deferred or called into question, global demand for clean energy is growing and worldwide increase in nuclear generation is inevitable.

For example, rather than reducing its ambitious development program, China now indicates that its objective is to increase nuclear capacity from 40 000 MWe to 75 000 MWe! India, in spite of economic slowdown, is still adhering to its target of increasing the share of nuclear generation to 9% in the next 25 years. Additionally, the United Arab Emirates has announced its intention to build 5 000 MWe of installed capacity by 2020, and several other countries – especially in the Middle East and East Asia – are considering aggressive programs. These programs come on top of announced expansion in the Americas and Europe.

As the growth of nuclear generation is necessary and inevitable for sustainable economic development, the logical corollary is the development of the requisite supporting infrastructure to fuel the continuation and expansion of nuclear generation. This presentation will address the current status and challenges regarding infrastructure development, especially regarding the foundation block for fuel assurance: uranium supply.

A special kind of sandstone type uranium deposit in North Eastern Ordos basin, China

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The Dongsheng sandstone type uranium deposit is a large one discovered in recent years in northeastern Ordos basin, China. It is a special kind of sandstone type uranium deposit, different from other ordinary sandstone type deposits because of its unique signatures. It is generally controlled by a transitional zone between greenish and grayish sandstones, both of those two kinds of sandstones now indicate reduced geochemical environments.

The greenish color of the paleo-oxidized sandstones mainly results from chloritization and epidotization related to oil and gas secondary reduction processes. The deposit genetically is different from ordinary sandstone uranium deposits, which is of more complex origin, undergoing not only paleo-oxidization mineralization process, but also oil-gas fluid and hydrothermal reworking processes. It is spatially related to Jurassic Zhiluo Formation with braided paleochannel systems.

The uranium mineralization zone with higher grade usually exists in the branching area of the distributary channels of main braided streams, whose sandstone heterogeneity shows a transfer sedimentary facies from the braided stream sedimentary system to the braided delta sedimentary system. Statistical results show that medium-grained and fine-grained sandstones are the most favorable rock types for uranium mineralization. The metallogenic superposition model for this kind of uranium deposit has been put forward, and exploration indications summarized.

The latest study on development of metallogenic mechanism of Baimianshi uranium field, Jiangxi Province, China

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It has been considerd that deposits in Baimianshi uranium field have similar features and ore-forming type, it is the syngenetic sedimentation that caused some U-bearing minerals to concentrate, and as a result of the enrichment in the late lithogenetic stage the deposit formed which is separate genesis to sandstone type and volcanic hydrothermal sub-type. This paper takes Huangnihu deposit in Baimianshi field as an example, and regards Baimianshi field as hydrothermal type according to research on intergrowth assemblage, fluid inclusions, U-Pb isotopic dating and Nd-Sr isotopic tracing.

Ore minerals are mainly uraninite, brannerite, coffinite, etc, while the assistant gangue minerals are mainly galena, hematite, marcasite, blende, etc. The materials for uranium mineralization are mainly crust-derived rocks. Continuous extraction of uranium from the upper crust and basement granite by mantle-derived fluids with little of ore-forming elements may be responsible for the remobilization and transformation of uranium.

Mixing of ore-enriched fluid with groundwater in some enclosed places overlain by basalt leads to the precipitation of ore-forming materials from the mixed fluid. There are three episodes of uranium mineralization: The first one is 160.4±0.5Ma, related to double-peak type volcanism, with basalt lithogenetic age of 172.8±7.7Ma and rhyolite lithogenetic age of 164.8±0.57Ma (from Chen Peirong, etc., 1999). The second one is 128±0.8Ma, related to Yanshanian Magmatic activities, for example, Danguanzhang rock mass and sveral phases of complements. The third one is about 100Ma, related to sub-volcanic rocks and dykes, namely quartz porphyry (99Ma) and diabase (105Ma).

The above achievements will play an important part in the guidance of future prospecting in the deeper in that area..

Application of multi-source remote sensing information in uranium exploration

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Uranium exploration needs new technology. Remote sensing technology include multi-band image, hyper-spectral image, radar etc. are developed rapidly, provide important means and information for uranium exploration. In this paper, a new technology, optical-energy integration was developed, both advantage of optical remote sensing and radioactivity energy spectrum are utilize.

Characters of lithology can be classified very well, and uranium mineralized target strata can be identified, some alteration information can be extracted from the new image. So, the optical-energy integration technology is an effect method in the uranium exploration.

Latest progress of seismic survey method in hydrothermal uranium deposits exploration in China

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Since 1950s, many non-seismic geophysical survey techniques, such as radioactive geophysical survey method, induced polarization (IP), high resolution magnetic survey method, AMT and CSAMT have been applied and have played a very important role in exploration for hydrothermal uranium deposits in China. However, up to the early stage of 21st century, seismic survey method has been hardly utilized in hydrothermal uranium deposits exploration. It is mainly due to the more complicated geological settings where hydrothermal uranium deposits occur than oil field, gas field or coal field does.

These complicated geological settings involve many cases, for example, uranium ore form is complicated and its dimension is small, lithology composition is various, wave impedance difference between the medium on each side of the interface is small, ground surface conditions are rough and there are lots of high-energy interference waves.

Since 2007, based on studies of hydrothermal uranium ore formation mechanism and ground surface characteristics in uranium ore field, seismic work group of BRIUG has carried out a lot of systemic tentative work on excitation type of seismic source, layout of geophones, data analysis and processing techniques, and has obtained obvious success in detection of ore-control factors, such as basement or faults with big angle of inclination. We are sure that seismic survey method developed by BRIUG will become one of the most important techniques for hydrothermal uranium deposits exploration within several years.

Research on geological modeling and integrated prognosis technologies for uranium deposit

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Due to continuously rapid development of China's national economy, the demand on energy is increasing urgently, therefore, nuclear power beccome one of the necessary to the sustainable development of China's future energy. With more and more effort on uranium exploration, undiscovered uranium mineralization near surface and in subsurface is getting less, and it is more and more difficult to find U deposit directly by traditional surface survey.

To meet the higher demand in the evaluation and prognosis of U resources, this paper introduces detailedly and systematically the uranium geological modeling and the prognosis technologies through integrated geological data. Guided by geodynamics, metallogenic dynamics and U metallogenetic theory, the geotectonic, geophysical, geochemical and remote sensing data of the known U deposits has been studied to summarize the prognosis factors and build geological models of U deposits.

The model and prognosis factors are then transformed into evaluation and prognosis model in GIS. With GIS we can, estimate U resource amount in analogy districts in the outlined U metallogenetic prognosis zone. All the above study have resulted in an integrate set of operating method and technical flow for U resource potential evaluation.

Geological setting of the Langer Heinrich uranium mine, Namibia

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The Langer Heinrich Uranium Mine is located in the central Namib Desert, Namibia, some 90 km east of the coastal town Swakopmund.

Geologically, the Namib Desert lies within the Late Proterozoic Damara orogenic belt consisting of metamorphic sedimentary and volcanic rocks. Different stages of syn- to post-tectonic granites and alaskites have intruded into the Damara rocks, some of them containing naturally high amounts of uranium, e.g. Rössing and Ida Dome alaskites.

Rift-related uplift initiated by the break-up of Gondwana in Late Jurassic and related surface denudation of Proterozoic rock units were accompanied by the retreat of the Great Escarpment, which is one of the most prominent morphological features in Namibia and divides e.g. the Namib Desert from the Khomas Hochland plateau. Continuous erosion of the high elevated plateaus and the resulting eastern movement of the Great Escarpment during the Cenozoic led to the deposition of fluvial and alluvial deposits west of the Escarpment.

These Cenozoic sediments are host to surficial uranium mineralization throughout the Namib Desert including the Langer Heinrich ore body. The Langer Heinrich ore body occurs over 15 km length and strikes east-west along a palaeo-channel, located between the Langer Heinrich Mountain in the north and the Schieferberge to the south. The host rocks are composed of calcretized conglomerates, grits, and minor sands and silts. The bedding is lenticular with meter-thick fining upward sequences being common. Vertical as well as lateral facies changes are rapid.

Carnotite is the main ore mineral and has been precipitated from groundwater, with uranium being derived from granites and pegmatites exposed in the vicinity of the Langer Heinrich palaeo-channel. The near-surface mineralisation is between 1m to 30m thick and 50m to 1,100m wide depending on the width of the palaeo-valley.

At a 250 ppm U_3O_8 cut off grade the current resource contains 127.1 Mt@0.06% U_3O_8 containing 74 415 t U_3O_8 (164 Mlb U_3O_8) including an ore reserve of 50.6 Mt@0.06% U_3O_8 (65.84 Mlb U_3O_8). Mining operations started in August 2006. The mine has achieved nameplate production in December 2007 and is now in the process of increasing capacity from the original 2.6 Mlb U_3O_8/annum to 3.7 Mlb U_3O_8/annum.

Optimization of technological processes at uranium ore mining and milling in Ukraine

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Uranium industry of Ukraine is 60 years old. It partly satisfies needs of Ukrainian NPPs; however, the raw materials base of the uranium industry in Ukraine allows covering the requirements of the NPPs fully. The raw materials base has special features comparatively with other countries of the world. The industrial uranium resources of Ukraine are large-scale but the ores, as a whole, are related to low-grade ones by uranium content.

The main industrial type of uranium deposits in Ukraine is metasomatite and the ores occur as hard rocks. Monometallic nature of the ores stipulates possibility of high-quality uranium concentrate output with very low content of detrimental impurities. Mining and processing technologies are different from the foreign ones.

The Ukrainian government approved a number of programs aimed at increasing uranium production up to the level, which can satisfy the requirements of the nuclear power plants, modernization of technology (heap leaching, in situ leaching, in-place leaching) and also liquidation of negative environmental consequences of uranium mining and processing activities.