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Advances in geophysical methods used for uranium exploration and their applications in China

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INTRODUCTION

Geophysics is one of the most useful technique for uranium exploration. It supports the development of geological theory through the definition of lithological, structural and alteration characteristics of metallogenic environments under evaluation. With the increasing of prospecting depth, the traditional radiometric will no longer be effective for uranium exploration. Despite uranium mineralization is not closely related with the observable gravity, magnetic and impendence anomalies. The application of gravity, magnetic and electromagnetic techniques can survey an area's subsurface geological setting and can be effective in detecting the deeper uranium deposit. [1] The progression and development of geophysical methods in theory, measurement techniques, data processing, computer modelling and inversion have yielded improvements in the field of uranium exploration[1-2].

It is well known that the progress in geophysical methods have contributed to successful field investigations in the area of deeper deposits (including uranium) exploration. Xu et al (2013) has reviewed the latest advance and developing trend of geophysical and geochemical methods and techniques applied in uranium resources exploration in China[2]. Following such work, this paper summarizes the work done by East China University of Technology during the past decade, those works including 3D inversion of magnetic data and 3D EM methods have been carried out in Xiazhuang granite type uranium deposit [3-4], in Xiangshan volcanic type uranium deposits in China. [5] The results indicated that some of the objectives include the mapping of basement structures, rock interface and lithology recognition can be achieved.

APPLICATION ON THE DEEP PROSPECTING OF URANIUM DEPOSITS IN XIAZHUANG

We have performed a case study on the use of magnetic 3D inversion and EM image in Xiazhuang uranium ore field which is granite-related uranium deposit. In this area, the uranium deposits related to diabase are mainly located in the eastern part of the Guidong massive granite body [6-8]. This type of uranium deposits was named intersection-type which is located on the intersection points of diabase dykes swarming with near EW-strike and silicified fault system with NNE-extension. After some new discoveries located in the deeper have been obtained during the mining process, attention was taken to the Xiazhuang uranium ore field.

Integrated geophysical methods including gravity, magnetic and EM were used to delineate the granite rocks and the faults in the deeper. The goal of this study was to test the applicability of the mentioned methods in the exploration of uranium and to predict for deep ore prospecting. In this manner, 8 profiles was assigned for AMT and gravity survey, 20Km2 magnetic surveying along an area on which several some uranium bodies exist in the deeper drill holes.

After surveying those profiles, the acquired data were processed, 2D or 3D inversed and interpreted. The results effectively identifies the granite rocks at large depths and the imaged distribution of these units is consistent with information from local geology. Finally, by integration of the results from the gravity, magnetic and electromagnetic data, three locations were suggested for borehole drilling. And two of them meet uranium around 1000m while one is dry hole. After drilling in those locations, cores were studied and compared with the results obtained from the geophysical methods that resulted in confirmation of the geophysical finding.

Furthermore, this work shows the availability of the geophysical methods to explore the deeper granite-hosted uranium deposit.

APPLICATION ON THE GEOLOGICAL STRUCTURE SURVEY OF XIANSHAN VOLCANIC BASIN

As the third largest volcanic-type uranium ore field in the world, Xiangshan volcanic basin is attracting great research interests and a large amount of industry investment all the time. We have performed a three dimensional geological structure survey and modeling project from 2011. The object of this project is to delineate the volcanic calderas which is still not confirmed over the past 60 years and to investigate the deeper geological structure of the basin. Based on the physical property measurement of around 1400 samples from drill core and along the geological profiles. 3D inversion of regional gravity and magnetic data were conducted and 19 profiles of Magnetotelluric(MT) covered the Xiangshan volcanic basin were carried out. The MT data was inverted using 2D and 3D inversion algorithm developed by our group [9-10]. With the integration of the geophysical survey results and with information from drill holes and local geology, a 3D geological and geophysical model was set up. And we got the following conclusions: Xiangshan volcanic basin has double basements, one is Metamorphic basement and the other is Caledonian granite basement. A low resistivity layer exists between the basement metamorphic rock sand the overlying volcanic-sedimentary rocks was inferred as an unconformity interface. A mushroom shape low resistivity geological body with a radius of around 2km located in Xiangshan mountain peak was inferred as the Ehuling Formation. Seven North-East-strike, four North-West-strike and one North-South-strike faults are delineated based on the geophysical results.

CONCLUSIONS

We implemented integrated geophysical survey for deeper uranium deposits exploration and 3D geological structure survey in south China. Combined with geological and borehole data, we provide support for deeper uranium exploration in those area. We conclude that geophysical methods can get qualified results using in uranium exploration. While the selection of geophysical methods depends on the physical properties of the target and its accompanied rocks, geological setting and the environments. Integration of several geophysical methods and other disciplines is necessary in most case in order to achieve more certain results.

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