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The Evolution of Uranium Mineralization in Xiangshan Ore-Field

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1 Introduction

After more than 50 years exploration and development, Xiangshan uranium ore-field is facing the depletion of shallow resource (Li, 2011), where is the next step for deep ore prospecting direction? To Study main ore-controlling facts of uranium deposit and explore the main uranium mineralization process may bring some inspiration for solving this problem.

2 Spatial Distribution of Uranium Deposits in Xiangshan Ore-Field

In Xiangshan ore-field, the deposits are mainly concentrated in the Zou-Shi (Zoujiashan-Shidong) fault zone, with no significant lithologic property for uranium ore-body and typical fault zone ore-controlling. Ore-body occurrence can be roughly divided into two categories: one is controlled by the volcano ring structure, and the other one by NE-trending faults and their secondary faults, that is located in the Zou-Shi fault and its vicinity. Bounded by Hengjian-Furongshan, the ring granite porphyry occurs more frequently on the east side and less on the west side. It is speculated that uranium mineralization in this area, not only is obviously affected by the Zou-Shi fault zone, indirectly related to northwest Red-Basin, but also by differential uplift-erosion in the eastern and western parts. The eastern is more stable and low level of erosion, and the uplift and erosion of the western are also stronger.

3 Differences in the Material Composition of Uranium Deposits

In this area, compositions of uranium ore have significant differences and can be divided into 5 series (Wu et al., 2000; Hu et al., 2010), that are U-Th-REE-Mo-P, U-

REE, U-Mo, U-P and U-Pb-Zn-Ag. 5 series can be classified as two groups, the previous four series as a group, and last series as another group. Ore forming of these both groups are respectively corresponded to the mineralization of volcano-basin and red-basin. In Xiangshan ore-field, uranium ore is mainly as the filling structure. The ore-forming material is derived from the area under their ore-body location, rather than directly from the altered wall rocks on both sides of ore-bodies. There are mainly green-alteration and red-alterations in Xiangshan. Green-alteration is mainly hydromicatization and chloritization. Red-alteration is namely hematitization that is very important to uranium mineralization, or there would be no uranium mineralization without red-alteration. Green-alteration is stronger in the western deposits, but more red-alteration is in the northern deposits.

4 Ages of Igneous Rocks and Mineralization

In Xiangshan, zircon ages of various igneous rocks (U-Pb age) is 132~141.6 Ma (Chen et al., 2012; Yang, 2013). The igneous rocks evolution series (from old to new) are volcano ash flow phase - (rhyodacite and granite porphyry) - (porphyroclastic lava and rhyolite porphyry). U-Pb isochron dating of pitchblende (Sun et al., 2004) shows that the uranium mineralization age of early-stage uranium-hematite type is 115 ± 0.5 Ma (more alkaline alteration in the north-east of Xiangshan) and late-stage uranium-fluorite type is 98 ± 8 Ma (more acidic alteration in the western).

5 Structural Characteristics in Xiangshan Uranium Ore-Field

Since the formation of volcano complex in Xiangshan (142 Ma~), the structures can be divided into 3 systems: The volcano-basin structural system mainly includes the elliptic volcano-basin, sub-volcano rock in ring shape

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distribution and collapse fracture in lava. The structural system of differential uplift and erosion divides the volcano-basin into two parts of the eastern and the western bounded by Hengjian-Furongshan, forming the SN trending faults. The red-basin structural system is characterized by NE-trending basin-controlling faults and mainly as Zou-Shi fault zone.

The effect of red-basin should be particularly emphasized in the study of Xiangshan uranium mineralization. Basin sediments with great thickness can provide a large amount of ore-forming hydrothermal fluid, and massive basin-controlling faults can be deep in the upper and middle crust. The force and thermal from the deep fault will drive the ore-forming fluid into the decompressing space of the Zou-Shi fault belt and the secondary faults, and coupling with phase transformation of water the ore-forming material will deposit to form the uranium ore.

6 Basic Framework of Metallogenic Evolution of Xiangshan Uranium Ore-Field

The framework is that the area has experienced the red-basin superimposed on top of the volcanic-basin on the basis of Precambrian metamorphic basement. In Xiangshan, the evolution of uranium mineralization generally includes 4 stages: the Precambrian basement developmental stage (before 800 Ma), the stage with granite intrusions and localized sedimentation between late Paleozoic and early Mesozoic (401 ~ 200 Ma), the volcano-basin stage (142-132 Ma) and the red-basin stage (100-65Ma). 2/3 of volcano-basin is located in the Middle-Neoproterozoic uplift belt, and the remaining 1/3 is located at the edge of the red-basin or its coverage, which implies there are differences of tectonic evolution and uranium mineralization between the two parts.

7 Conclusions

The ore-field structure and uranium deposits are the results of the geological evolution. Studying on comprehensive aspects (Hu et al., 2007), considering mainly structural feature differences, the geological evolution in Xiangshan ore-field since 142 Ma can be generally divided into 3 stages and the corresponding 3 sets of structures system (mainly fracture): (1) The volcano-basin structural system, the corresponding period is approximately 142 ~ 132 Ma, mainly formed volcanic edifice. (2) The structural system by differential uplift and erosion (Early mineralization stage), which the main activity time was roughly around 120Ma, resulted that the eastern is relatively stable and the western uplift with

strongly weathering and erosion. (3) The red-basin structural system (late mineralization stage), the corresponding period is 100 ~ 65 Ma, formed NE trending Zou-Shi fault zone whose activity border is generally Shazhou-Youfang fracture in the Southeastern.

In Xiangshan uranium ore-field there are early and late main mineralization stages: Early uranium mineralization is mainly resulted from the second stage of the structural system superimposing on the first stage of the structural system. Late uranium mineralization is mainly controlled by the red-basin structural system and can reform the early mineralization or directly form the ore-body. The intensity and scale of late mineralization are more than early mineralization, and there are obvious differences in material composition and physic-chemical conditions in two type mineralization.

Ore-bodies will locate in the intersection of these 3 structural systems which can cause some place with very low pressure, such as the intersection of fractures, the local tensional space caused by the pre-fracture sliding. These are the favorable spaces for prospecting. Taking these studies, with the analysis of ore-controlling theory by water phase transition (Hu et al, 2011), this study suggests that deep in Xiangshan still have the potential of vast uranium reserves.

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