Geological characteristics and ore-controlling structure of a Uranium deposit in Wulan County, Qinghai Province

Wei Li *, Qing Chen
No.203 Research Institute of Nuclear Industry, Xianyang, Shaanxi, China

1  General geology

The uranium deposit is located in the northeastern margin of the Qaidam basin and belongs to the eastern margin of the remnant belt of the northern margin of the Qaidam basin, and to the southern margin of the Tuomuerrite ophiolite melange zone. The exposure strata in the area are the Dakendaban group of lower Proterozoic and the Tanjianshan group of Ordovician-Silurian. The Tanjianshan group of Ordovician-Silurian is a set of greenschist facies metamorphic rocks and it is the main ore-bearing strata in the area. Its lithology is mainly green schist, partly hornblende schist, small amount of palimpsest medium-base volcanic rocks, volcanic clastic rocks interbedded with mica-quartz schist, marble, etc. The structure is dominated by the NW-SE direction ductile-brittle fracture, followed by the NE fracture. The NW-SE trending fault is characterized by first ductile and later brittle, tensile after compressive, and is the main ore-controlling and ore-bearing structure in the region. Magmatic activity is strong, resulting in a large number of Valex gray-white medium-coarse grain granodiorite, which is the main rock of uranium deposits. The veins are developed from basic to acidic, and the felsic and syenitic veins are closely related to the later uranium enrichment and provide the main ore-forming fluids.

2  Deposit characteristics

2.1  Deposit scale

The deposit is about 9 km long and 25–170 m wide. The mineralized zones are distributed in the northwest and controlled by the NW-trending faults. They can be divided into east, middle and west sections. The eastern section is 3200 m long and 50–120 m wide. The gamma ray intensity is (65–115)×10^{-6} and the maximum is 450×10^{-6}. The uranium ore bodies have been found in deep. The western section is 4200 m long and 10–20 m wide. The gamma ray intensity is (85–140)×10^{-6} and the
maximum is $320 \times 10^{-6}$. The middle section is nearly 2100 m long and 20–170 m wide. It is composed of many abnormal bands. The gamma ray intensity is $(120–650) \times 10^{-6}$ and the maximum is $2500 \times 10^{-6}$. A number of uranium ore bodies have been discovered in this section.

### 2.2 Geological characteristic of orebody

In the middle section, there are 6 industrial grade uranium orebodies and 5 low-grade uranium orebodies. The length of the orebodies is 123–400 m, the thickness is 0.88–20.07 m and the grade is 0.035%–0.251%. The ore bodies are located in the Tanjianshan group of Ordovician-Silurian. The ore-hosting rocks are plagioclase amphibole schist intercalated with amphibolite, epidote schist, actinolite schist and epidote chlorite schist. The ore-bearing rocks are mylonitic plagioclase amphibole schist, tectonic breccia and cataclasite. The ore body is in parallel with the NW-trending fault structure and tends to northeast with angle of 58°–70°. The ore bodies shape as vein, irregular shapes and lenticular and have the expansion, contraction, thinning-out recurrence and branching phenomenon. The alteration of wall rocks mainly includes silicification, chloritization, hematitization, carbonatization, potash feldspathization and pyritization. The silicification, pyritization, carbonation and potash feldspathization are most closely related with mineralization.

### 2.3 Ore characteristics

#### 2.3.1 Ore types

The ore is mainly plagioclase amphibole schist (mylonitization and cataclasitization) in which the felsic vein is densely distributed, disseminated pyritized tectonic breccia, pale red pyritized orthorhombic granite.

#### 2.3.2 Texture and structure

Ores are mostly granular, microscopic, lamellar crystal structure and mylonitic structure, fragmentation structure, sheet and gneissic structure.

#### 2.3.3 Mineral assemblage

In the plagioclase amphibole schist ore, the useful minerals are mendeleevite, uraninite, uranothorite and thoruraninite and the rock-forming minerals are hornblende, plagioclase, biotite, calcite, a small amount of pyrite and so on. The useful mineral is uraninite and the rock-forming minerals are actinolite, albite, epidote, calcite, pyrite and so on in the tectonic breccia ore. The useful minerals are uranothorite and thoruraninite and the rock-forming minerals are potash feldspar (90%, mainly microcline, orthoclase secondarily), plagioclase, biotite and trace limonite in the orthorhombic granite ore.

#### 2.3.4 Chemical composition

#### 2.3.4.1 Constant element feature

In the uranium ore, the content of SiO$_2$ is 42.09%–44.74%, the content of Al$_2$O$_3$ is 13.62%–14.39%, MgO content is 9.38%–11.39%, CaO content is 12.58%–15.25%, Na$_2$O content is 1.17%–2.29%, K$_2$O content is 1.09%–1.75%, and has the characteristics of low TiO$_2$, FeO, K$_2$O, MgO and high CaO. Therefore, the original rock should be basalt.

#### 2.3.4.2 Associated element characteristics

Uranium ores associated with some important elements such as Th, Nb, light rare
earth, Ni, Cu, Au, etc, which the contents of Nb, Ce, La, Th can reach industrial grades. Ce, La, Th and U are positively correlated, but the linear relationship is not obvious (correlation coefficient $\gamma <0.4$, $\alpha <13^\circ$). U is positively correlated with Nb, the correlation coefficient $\gamma=0.9028$, $\alpha=45^\circ 11'$, basically a linear relationship, that is, the Nb content increases with the increase of U content.

### 2.3.4.3 REE characteristics

The REE distribution type curve is the right type, rich light rare earth, $\Sigma Ce > \Sigma Y$. It is depleted in Eu, and Ce is not significantly abnormal, indicating that the deposit is formed in a reductive environment, which is consistent with the physical and chemical environment required for uranium precipitation and enrichment, and also with the development of a large number of pyrite and other reducing substances in mineralized rocks. The total amount of rare earth elements is proportional to the degree of uranium mineralization, that is, the greater the uranium mineralization intensity, the greater the amount of rare earth elements. Granodiorite body, ortho-granite, wall rock, anomaly, mineralization and industrial rock have the same REE distribution pattern, indicating that diorite, syenite vein and surrounding rock may provide some material source for uranium mineralization.

### 2.3.5 The form of uranium

Uranium minerals are mainly distributed in a band, extending in a vein, which corresponds exactly to the felsite in the hand specimen, indicating that the uranium minerals are present in the felsic veins and controlled by the postmagmatic hydrothermal. Uranium exist as mendeleevite, uraninute, uranothorite and thoruraninite.

### 3 Study on ore-controlling structure

#### 3.1 Characteristics of ore-controlling structure

The structural deformation of this ore deposit has obvious ductile-brittle transition and superposition, that is, the ductile shear deformation is dominant in the early stage, and later the ductile shear deformation is transformed into brittle deformation due to the decrease of deformation temperature and pressure condition. The rock brittle fracture and form a large number of veins, and along with the formation of mineralization in this area.

#### 3.2 Ore-controlling tectonic evolution process

The ore-controlling structure in the uranium deposit has undergone the preparation phase of ore-forming material, activation—migration—preconcentration stage of ore-forming material, metallogenic material accumulation—metallogenesis stage and later stage of ore body destruction, and finally forms the present characteristics that the ductile-brittle fracture structure controls uranium mineralization.

### References


