Uranium Exploration
- Nigeria and Canada

SPEAKER: GEORGE TSANG
MA, MSC, CPG, M AUSIMM, CMA, PHD CANDIDATE

LOCATION: ROOM 702, JD MALL, 233 NATHAN ROAD, KOWLOON

DATE: 18, MARCH, 2016
TIME: 7:00 PM- 9:00 PM
URANIUM RESOURCES

Uranium Resources (RAR - $130/kg U)

World Total = 3524900 t

(c) WISE Uranium Project

$t =$ metric tonne  -  NA = Data not available
10- China – 166,100 tonnes / 3% of world reserve
9- United States – 207,400 tonnes / 4% of world reserve
8- Namibia – 261,000 tonnes / 5% of world reserve
7- Brazil – 276,700 tonnes / 5% of world reserve
6- South Africa – 279,100 tonnes / 5% of world reserve
5- Niger – 421,000 tonnes / 8% of world reserve
4- Canada – 468,700 tonnes / 9% of world reserve
3- Russia – 487,200 tonnes / 9% of world reserve
2- Kazakhstan – 629,000 tonnes / 12% of world reserve
1- Australia – 1,661,000 tonnes / 31% of world reserve
More than half of the world's uranium production comes from just 10 mines.
Canada, the second biggest uranium producer in the world, hosts the world's biggest - the McArthur River uranium mine;
Olympic Dam mine- Australia, the second biggest;
Ranger uranium mine- Australia, the world's third largest;
Arlit- Niger; the fourth largest;
Tortkuduk uranium mine-Kazakhstan, the fifth;
Rossing uranium mine, Namibia, the sixth;
Budenovskoye 2, Kazakhstan, the seventh;
Kraznokamensk, Russia, the eighth;
Langer Heinrich uranium mine, Namibia, the ninth;
South Inkai – Kazakhstan, the tenth
TOP 10 URANIUM PRODUCING COUNTRIES 2014

  Kazakhstan has been the world's leading producer of uranium since 2009, when it produced almost 28 percent of the global total.
- 2. Canada - Mine production: 9,134 tonnes
- 3. Australia - Mine production: 5,001 tonnes
- 5. Namibia - Mine production: 3,255 tonnes
- 6. Russia - Mine production: 2,990 tonnes
- 7. Uzbekistan - Mine production: 2,400 tonnes
- 8. United States - Mine production: 1,919 tonnes
- 10. Ukraine - Mine production: 926 tonnes
CONSUMPTION OF URANIUM FUEL OF CHINA

- China will construct 6~ 8 nuclear power plants per year starting 2016;
- The power capacity of 2020 is 3 times of 2014, China is expected to have at least 110 nuclear power plant in 2030 which is more than USA;
- 50% U fuel is imported.
China was considered as the U-deficiency country, but it changes when Da Ying U-mine (大营铀矿) was found in 2012, it is upgraded to the largest U mine in China, and the 14th largest in the world, it is a world class U mine.

Ordos basin- low grade U is always associated with coal.
WHERE IS THE U-DEPOSIT?
THE CHARACTERISTICS OF DEPOSITS

- Minerals exist in groups (成群出现);
- Focus in belts (成带集中)

Whenever you find an elephant in the forest, it should not be the only one!
THE FIRST GEOLOGICAL TEAM OF CHINA FOR URANIUM- NO. 309 TEAM JIN YIN Zhai, HUNAN
URANIUM CAPITAL OF CHINA - XIANGSHAN

- It was discovered by Team 261 (P.O. Box 78);
- The team has found 29 U mines in China.
USE OF AIRBORNE GAMMA-RAY SPECTROMETRY FOR ENVIRONMENTAL ASSESSMENT OF THE MINE RICH IN RADIOACTIVE MINERALS, CHINA

WU Qifan*, FENG Youcai1,2, ZHAO Shunping1,3, LIU Guifang1,4, XIONG Shengqing5, TSANG Hin-yuen6

The airborne measuring system consisted of a spectrometer (NaI (Tl) detector and 256-channel analyzer (GR-820)), radar altimeter and barometer, the GPS. Spectra were measured at a range of heights –1.8, 2.1, 2.4, 2.7 and 3.0 km above the water. Data were recorded for ten minutes accumulation time at each height.
OTHER PROSPECTING METHODS

- Observation of outcrops
- Chemical analysis of samples
- Testing of radon
- Study of regional geology and environment
- Fungshui prospecting (By George Tsang)
- Including plant anomalous
GEOLOGICAL MAP OF NIGERIA

CENOZOIC
- Alluvial, sands, gravels, clays, mangrove swamps, pebbles
- Sands, clays, shales, sandstones, lignites, grits
- Volcanics (basalts, tachytes, rhyolites)
- Neogene ('- Paleogene)
- Cenozoic, undifferentiated

MESOZOIC
- Sands, clays, coals, shales, sandstones, mudstones, limestones, siltstones, ironstones, grits
- Basic and intermediate intrusions
- Granites, syenites, gabbros, rhyolites
- Mostly Cretaceous

PALEOZOIC - PROTEROZOIC
- Molasse, schists, quartzites
- Older granites, undifferentiated
- Basement complex, undifferentiated
- (Ordovician?) - Neoproterozoic
Some Uranium occurrences have been located in Cross River, Bauchi, Adamawa, Taraba, Plateau and Kano States. Small bodies of granite containing Pyroclore which contains 3.3% Uranium oxide, 3.3% Thorium oxide and 41.1% Niobium and Tantalum oxides were found by the Atomic Energy Division of the Geological Survey of Great Britain in the Liruei Hills in Kano State and in the Kigo Hills near Dorowa on the Jos Plateau in 1947. Recent studies are indicating that Uranium deposits may occur at depths in those areas of occurrences, particularly in Taraba State.
MAP SHOWING OCCURRENCE OF TA & U
NIGERIA URANIUM EXPLORATION TEAM
PROJECT AREA
THE SITE
WORKING
U-TA-NB MINE
ZR WAREHOUSE
China has the second biggest resource of thorium, next to India.

Thorium can be converted to U233 which is a fuel and weapon;

77% of thorium oxide in China is found in Baiyun Obo (2009);

Advantages of using thorium over uranium- less radioactive pollution (50%), higher energy, more resource.
MAIN PIT OF URANIUM DEPOSIT
# URANIUM MINERALS

## Primary uranium minerals

<table>
<thead>
<tr>
<th>Name</th>
<th>Chemical Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>uraninite or pitchblende</td>
<td>UO₂</td>
</tr>
<tr>
<td>coffinite</td>
<td>U(SiO₄)₁₋ₓ(OH)₄ₓ</td>
</tr>
<tr>
<td>brannerite</td>
<td>UTi₂O₆</td>
</tr>
<tr>
<td>davidite</td>
<td>(REE)(Y, U)(Ti, Fe³⁺)₂₀O₃₈</td>
</tr>
<tr>
<td>thucholite</td>
<td>Uranium-bearing pyrobitumen</td>
</tr>
</tbody>
</table>

## Secondary uranium minerals

<table>
<thead>
<tr>
<th>Name</th>
<th>Chemical Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>autunite</td>
<td>Ca(UO₂)₂(PO₄)₂ x 8-12 H₂O</td>
</tr>
<tr>
<td>carnotite</td>
<td>K₂(UO₂)₂(VO₄)₂ x 1-3 H₂O</td>
</tr>
<tr>
<td>gummite</td>
<td>Gum like amorphous mixture of various uranium minerals</td>
</tr>
<tr>
<td>saleeite</td>
<td>Mg(UO₂)₂(PO₄)₂ x 10 H₂O</td>
</tr>
<tr>
<td>torbernite</td>
<td>Cu(UO₂)₂(PO₄)₂ x 12 H₂O</td>
</tr>
<tr>
<td>tyuyamunite</td>
<td>Ca(UO₂)₂(VO₄)₂ x 5-8 H₂O</td>
</tr>
<tr>
<td>uranocircite</td>
<td>Ba(UO₂)₂(PO₄)₂ x 8-10 H₂O</td>
</tr>
<tr>
<td>uranophane</td>
<td>Ca(UO₂)₂(HSiO₄)₂ x 5 H₂O</td>
</tr>
<tr>
<td>zeunerite</td>
<td>Cu(UO₂)₂(AsO₄)₂ x 8-10 H₂O</td>
</tr>
</tbody>
</table>
URANIUM ORES- MAINLY URANINITE/ PITCHBLENDE
AUTUNITE ON FRACTURE WALL
<table>
<thead>
<tr>
<th>铀同位素</th>
<th>丰度</th>
<th>半衰期</th>
<th>衰变类型</th>
<th>衰变能</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-233</td>
<td>人造</td>
<td>$1.592 \times 10^5$ 年</td>
<td>$\alpha$</td>
<td>4.908 MeV</td>
</tr>
<tr>
<td>U-234</td>
<td>0.0054%</td>
<td>$2.455 \times 10^5$ 年</td>
<td>$\alpha$</td>
<td>4.858 MeV</td>
</tr>
<tr>
<td>U-235</td>
<td>0.7204%</td>
<td>$7.04 \times 10^8$ 年</td>
<td>$\alpha$</td>
<td>4.679 MeV</td>
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<tr>
<td>U-236</td>
<td>人造</td>
<td>$2.342 \times 10^7$ 年</td>
<td>$\alpha$</td>
<td>4.573 MeV</td>
</tr>
<tr>
<td>U-237</td>
<td>人造</td>
<td>6.75 天</td>
<td>$\beta^-$</td>
<td>0.519 MeV</td>
</tr>
<tr>
<td>U-238</td>
<td>99.2742%</td>
<td>$4.468 \times 10^9$ 年</td>
<td>$\alpha$</td>
<td>4.270 MeV</td>
</tr>
<tr>
<td>U-239</td>
<td>人造</td>
<td>23.45 分钟</td>
<td>$\beta^-$</td>
<td>1.262 MeV</td>
</tr>
</tbody>
</table>
Two veins are found in the site which is located in a W-E direction hill, the height of the hill is about 15~20m, plantation is stripped, length of W-E is 150 meters, N-S is 20~30m, the country rock is composed of felsic granite with fractured rock body.

sketch map of geology around uranium veins
1—granite, 2—uranium vein, 3—silicified vein
SE-N profiles for radioactive survey

W-E profiles for radioactive survey
CHECKING OUTCROP WITH DOSIMETER

Can we use this to conduct the U exploration?
SILICIFIED RADIOACTIVE VEIN
GEOLOGICAL ACTIVITIES IN THE AREA

Exposure of granite with vein that is showing displacement

The granite (right of pen) and micro-granite (under and to left of pen) contact
THE EXCAVATION PITS
TRENCHES
WASTE DUMPS
DATA COLLECTED FROM THE SITE

<table>
<thead>
<tr>
<th>Y</th>
<th>X</th>
<th>X-r</th>
<th>U(ppm*100)</th>
<th>Th(ppm*100)</th>
<th>K(%*100)</th>
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<tbody>
<tr>
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<td>107.75</td>
<td>20073</td>
<td>1160</td>
<td>494</td>
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<tr>
<td>8.98027778</td>
<td>11.60666667</td>
<td>91.65</td>
<td>12417</td>
<td>2030</td>
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<tr>
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<td>402</td>
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<tr>
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<td>样品单位</td>
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<td>项目</td>
<td>测试结果(μg/g)</td>
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</tr>
<tr>
<td>------</td>
<td>----------</td>
<td>----------</td>
<td>------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Li</td>
<td>Be</td>
<td>Sc</td>
</tr>
<tr>
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<td>15287</td>
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<td>11.0</td>
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<tr>
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<td>9.24</td>
<td>1.56</td>
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<tr>
<td>4</td>
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<td>4</td>
<td>336</td>
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<thead>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Zr</td>
<td>Nb</td>
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<td>Gd</td>
<td>Tb</td>
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<td>1</td>
<td>4.07</td>
<td>0.522</td>
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<tr>
<td>2</td>
<td>15288</td>
<td>2</td>
<td>4.69</td>
<td>0.591</td>
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<tr>
<td>3</td>
<td>15289</td>
<td>3</td>
<td>2.97</td>
<td>0.403</td>
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<tr>
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<td>15290</td>
<td>4</td>
<td>77.5</td>
<td>42.0</td>
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<th>项目</th>
<th>测试结果(μg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Th</td>
<td>U</td>
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<td>15289</td>
<td>3</td>
<td>42.7</td>
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<tr>
<td>4</td>
<td>15290</td>
<td>4</td>
<td>22484</td>
<td>3056</td>
</tr>
</tbody>
</table>

意见与解释：As、Se、Sn、Ge仅供参考。
SHORT CONCLUSION

①U content in the surface is 0.03%--0.12%;
②Uranite is found along the two veins, the distance between the two veins is about 50m, it is expected the veins would combine together in the deeper level as the spectrometers shown, it indicates the prospect is optimistic;
③The grade of mineral is high which means economic;
④Water is sufficient in the surrounding which provides a good condition for beneficiation.
AZELIK, A U MINE OWNED BY CHINESE IN NIGER

- The first overseas U-mine invested by Chinese.
- Azelik is operated by a joint partnership called Somina, with ownership split between the China National Nuclear Corporation (CNNC), which owns 37%, the Niger government, which owns 33%, and a second Chinese investor. A Korean investor holds a 5% stake as well.
- The Chinese proposed to invest USD300 million according to the report of Reuters, but it is said the mine has not produced any U metal up to 2015.
LOCATION OF THE U MINES IN NIGER
WELCOME TO CANADA
The speaker has signed a confidential disclosure agreement with the client, some of the content of Canada exploration are deleted, however, the readers can get the complete information from the public document of Hong Kong Stock Exchange News and google search:

LOCATION OF THE CANADIAN SITE

Patterson Lake South Property
Northern Saskatchewan, Canada
Location Map
THE HIGHEST GRADE OF URANIUM DEPOSIT

- Kazakhstan
- Namibia
- Australia
- Niger
- Canada

100m Composite Mineralization Includes 38.49% U3O8 Over 10.5m.

57.6 wt% U3O8
STOPOVER- VANCOUVER, KELOWNA, CALGARY
DEPART FOR THE URANIUM SITE
THE BEAUTIFUL LAKES
HIGH DOSE OF THE CORE
SITE OF THE U-VEINS
It is the most significant uranium metallogenic district in Canada, it covers an area of greater than 85000 sq.meters in Northern Saskatchewan and north-eastern Alberta. Age - 1760 ~ 1500 Ma.
The highest grade uranium deposits are found in the Athabasca Basin in Canada, including the two largest high grade uranium deposits in the world, Cigar Lake with 217 million pounds (99,000 t) $U_3O_8$ at an average grade of 18% and McArthur River with 324 million pounds (147,000 t) $U_3O_8$ at an average grade of 17%. Additionally, another high grade discovery is in the development stage at Patterson Lake (Triple R deposit).
Modern yellowcake typically contains 70% to 90% triuranium octoxide ($\text{U}_3\text{O}_8$) by weight. Other oxides such as uranium dioxide ($\text{UO}_2$) and uranium trioxide ($\text{UO}_3$) exist.
THANK YOU!