EXTRACTION OF YELLOWCAKE FROM NIOBIUM-TANTALUM LEACHING TAILING AND BERYLLIUM ORE THROUGH COMPREHENSIVE UTILIZATION MEANS

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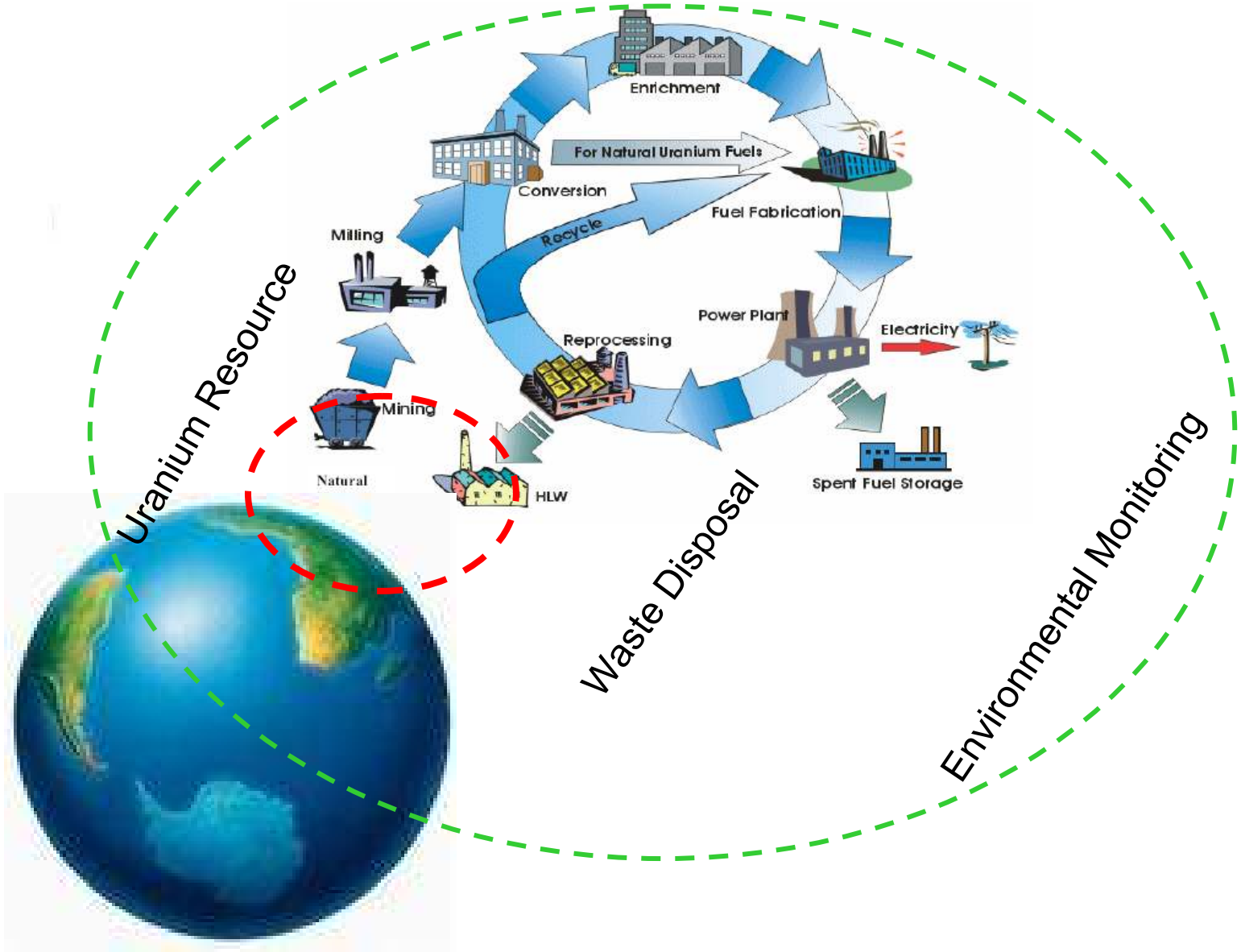


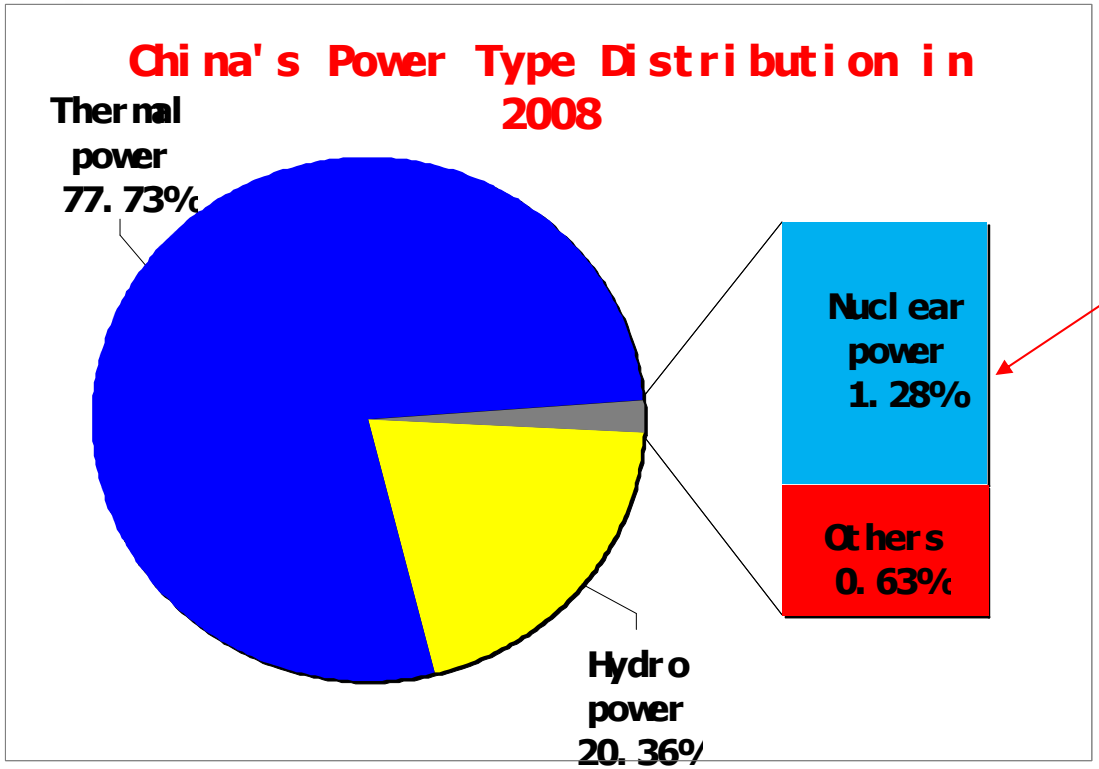
The Role of BRIUG, CNNC

Contents:

- Introduction
- Experiment
- Results and discussion
- Conclusion

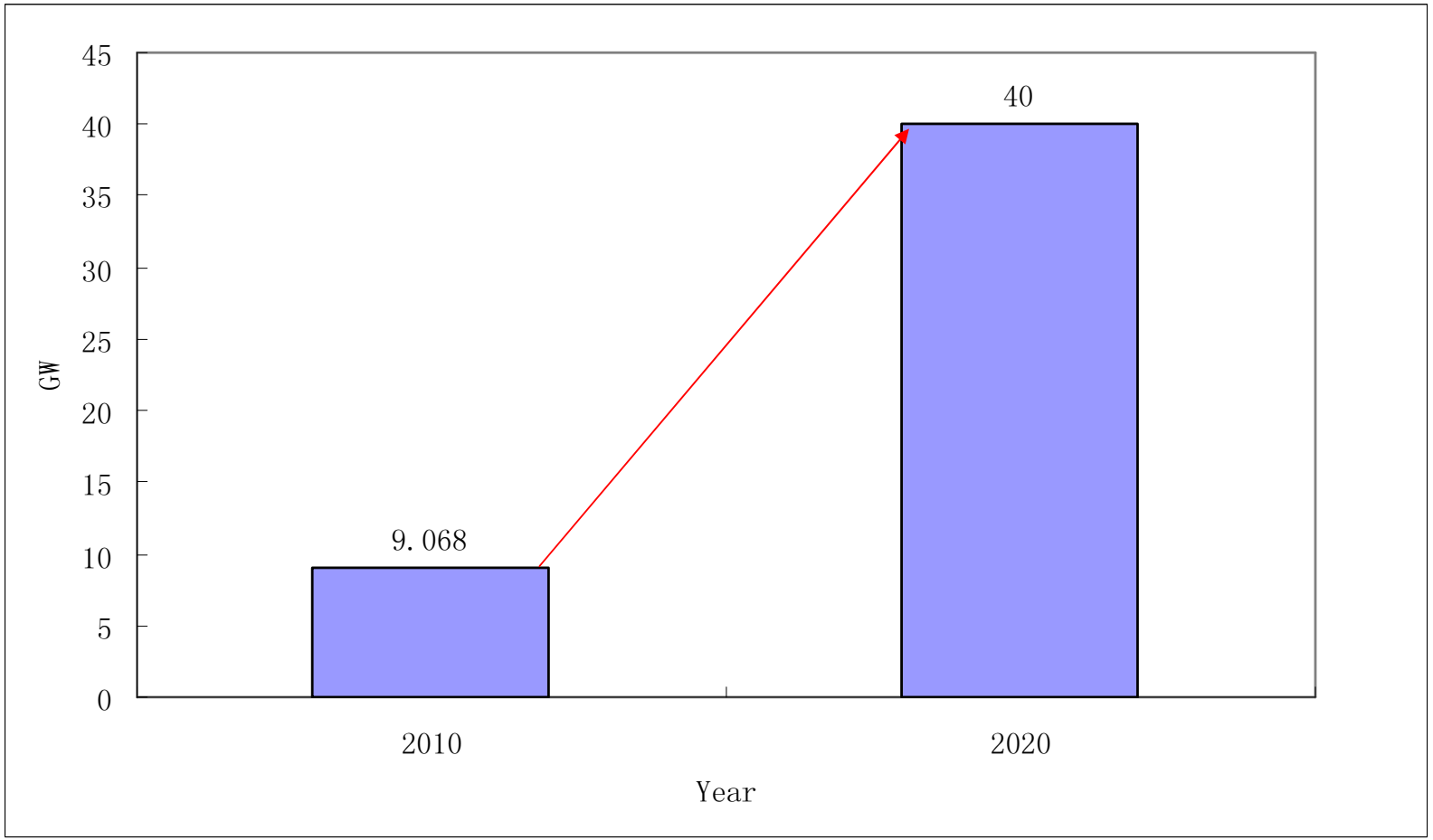
Introduction

China's economic growth has lead to raising energy demand, where development of nuclear power is one of the priorities.

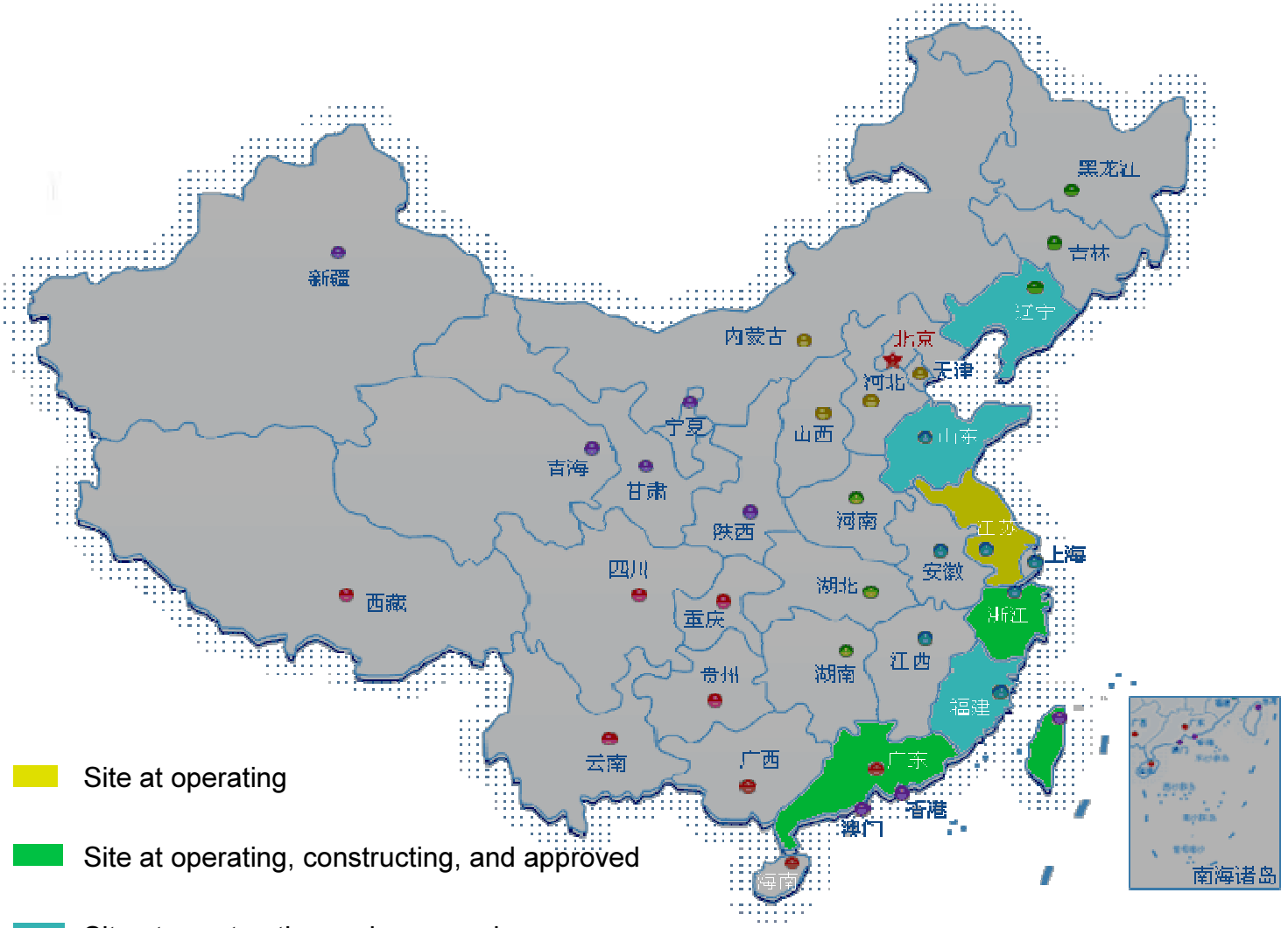


Average worldwide 16%

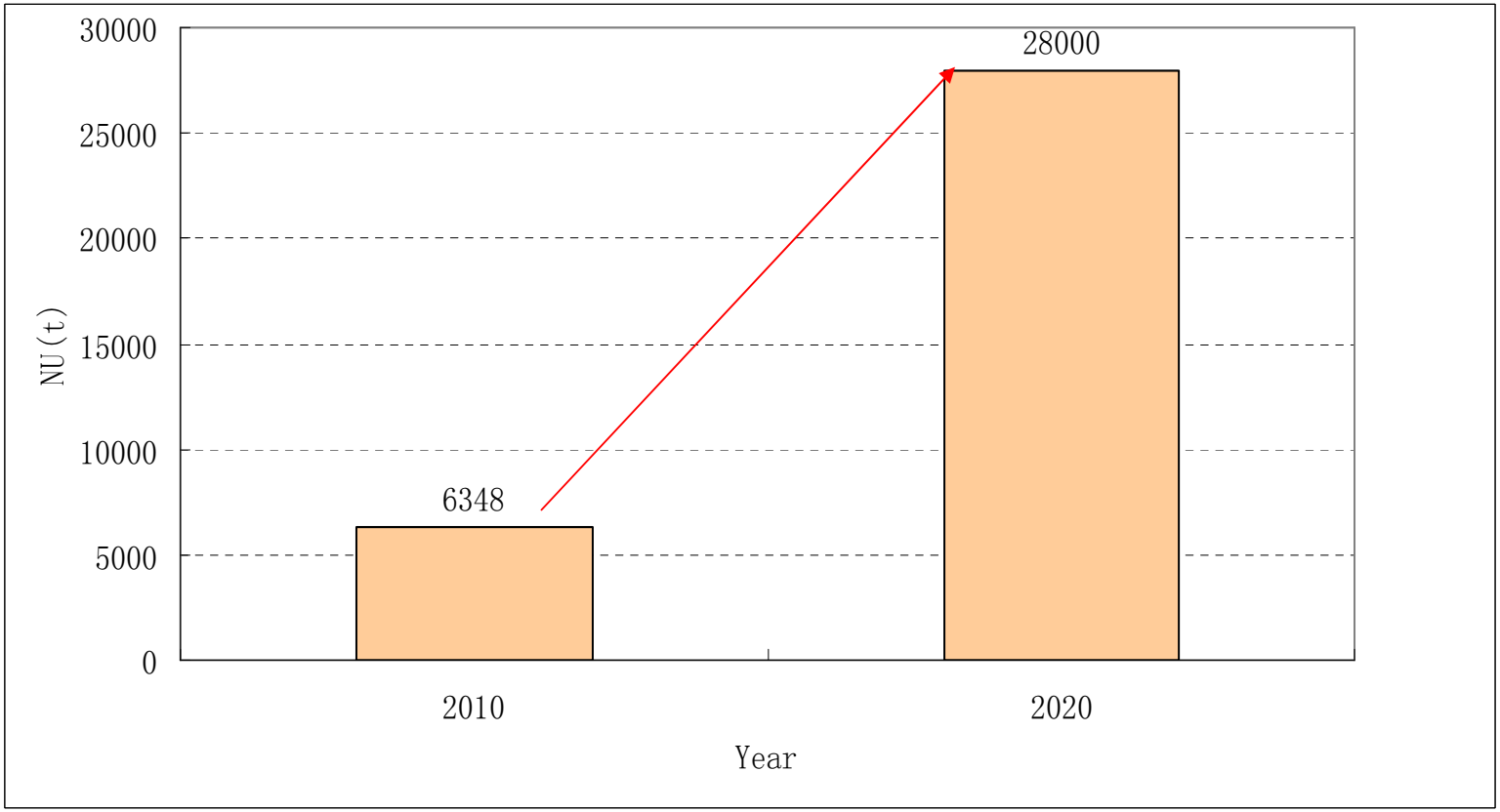
By 2020, the capacity of nuclear power will reach 40GW or more



More and more NPPs are at operation, construction and preparation



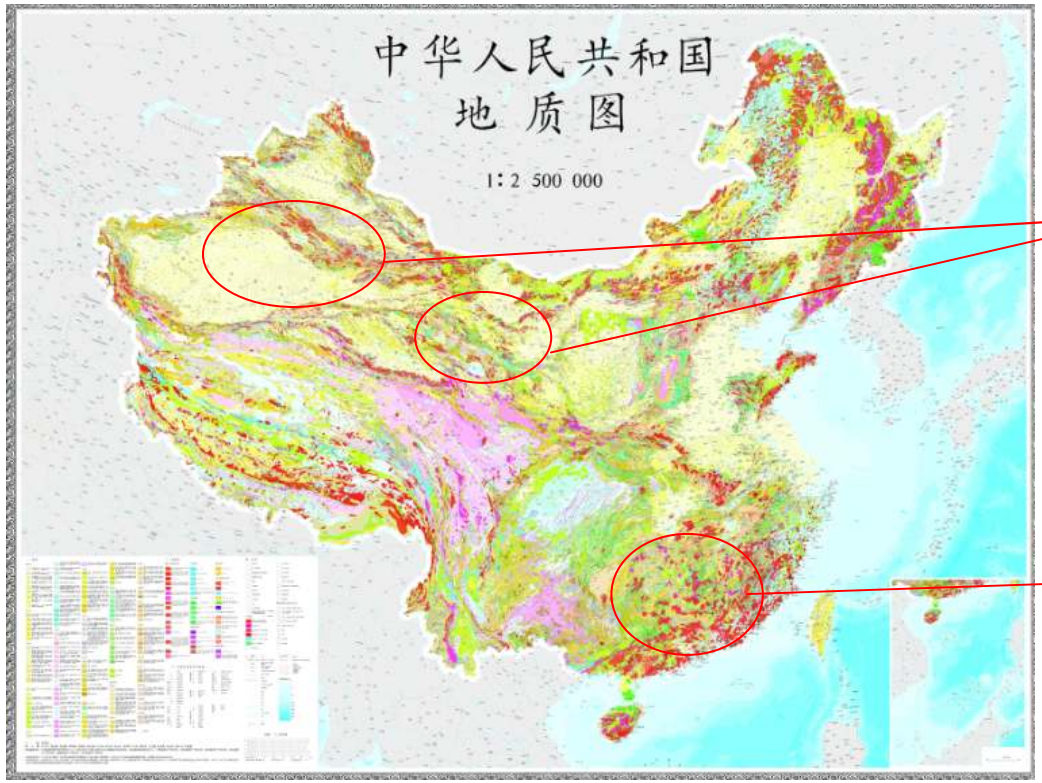
Development of NPPs is resulting in the significant uranium demand.



Increasing uranium demand needs diversity of uranium supply

- Economic grade uranium ores;
- Low grade uranium ores;
- Uranium as a by-product from other mining and milling activities.

Increasing uranium demand needs diversity of uranium supply

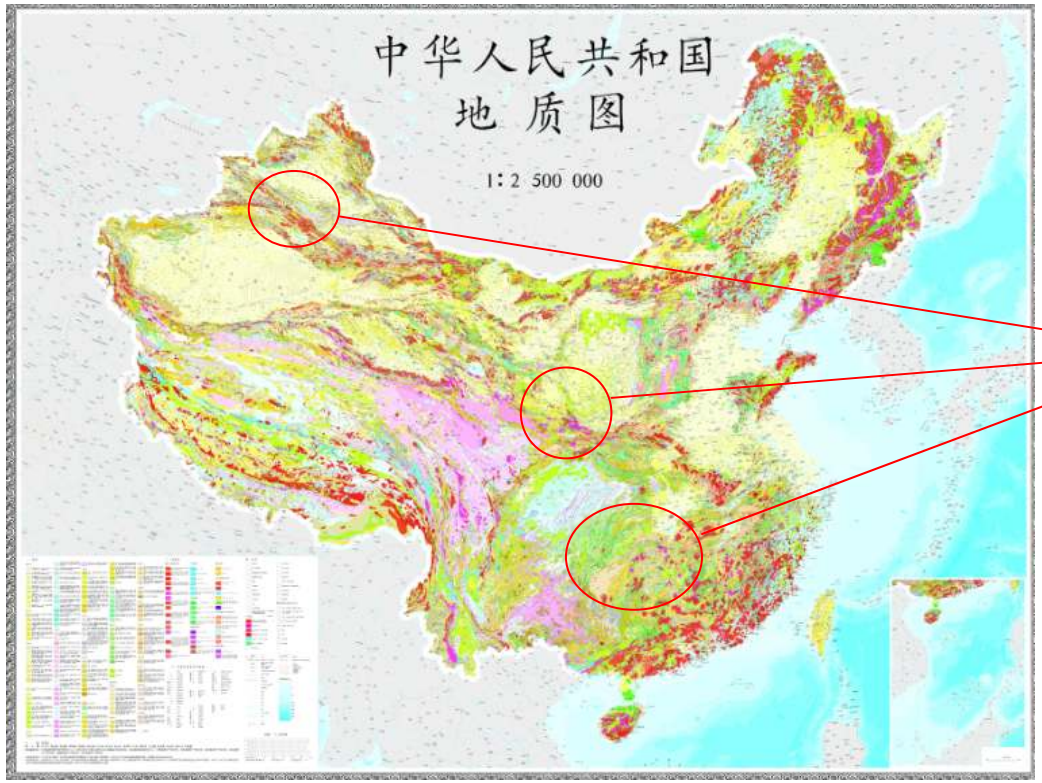


Sandstone type uranium deposits areas

Igneous , hydrothermal uranium deposits areas

Primary uranium supply in China

Increasing uranium demand needs diversity of uranium supply

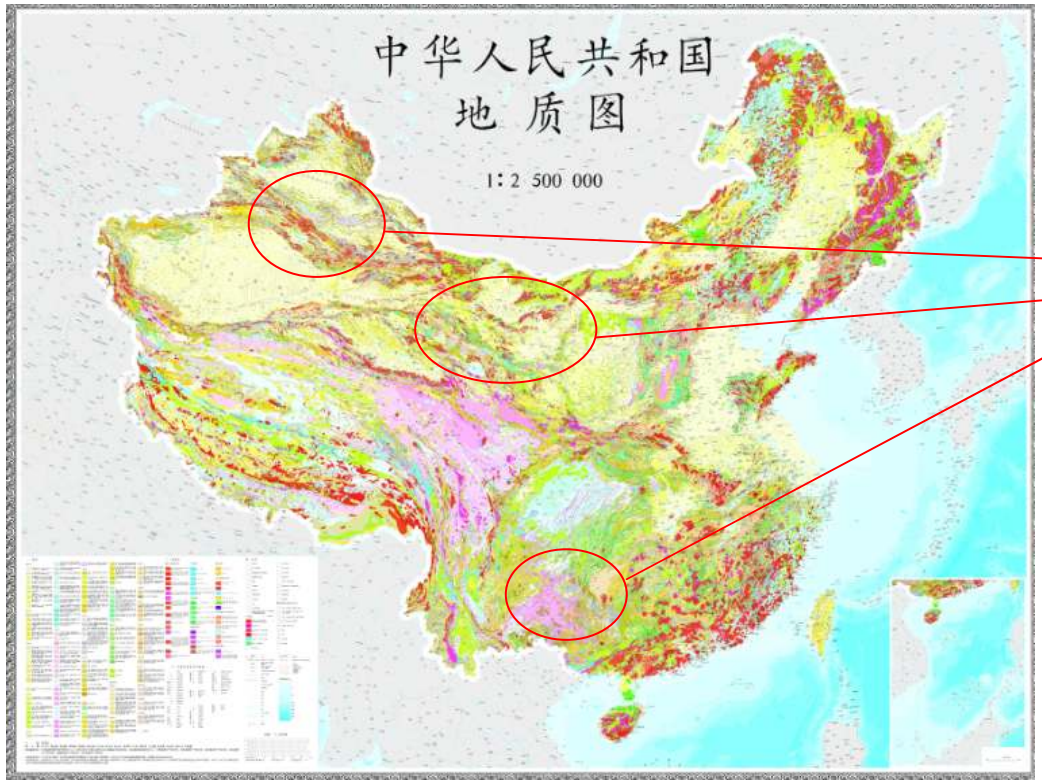


Low grade uranium deposits areas (Shanxi, Hunan,..)

U: 0.01%-0.05%

Low grade uranium deposits have been explored

Increasing uranium demand needs diversity of uranium supply



Uranium as by-product from other mining and milling (P-ores, Be-ores, Nb-Ta-ores, Lanthanides-ores,..)

Uranium in non-uranium ores has been attended.

Innovative techniques to develop low grade uranium ores

- **Microbial heap leaching;**
- **In-site fragmentation leaching;**
- **Integrated technology for black shale;**
- **Extraction uranium from other mining and milling activities;**
- **……**

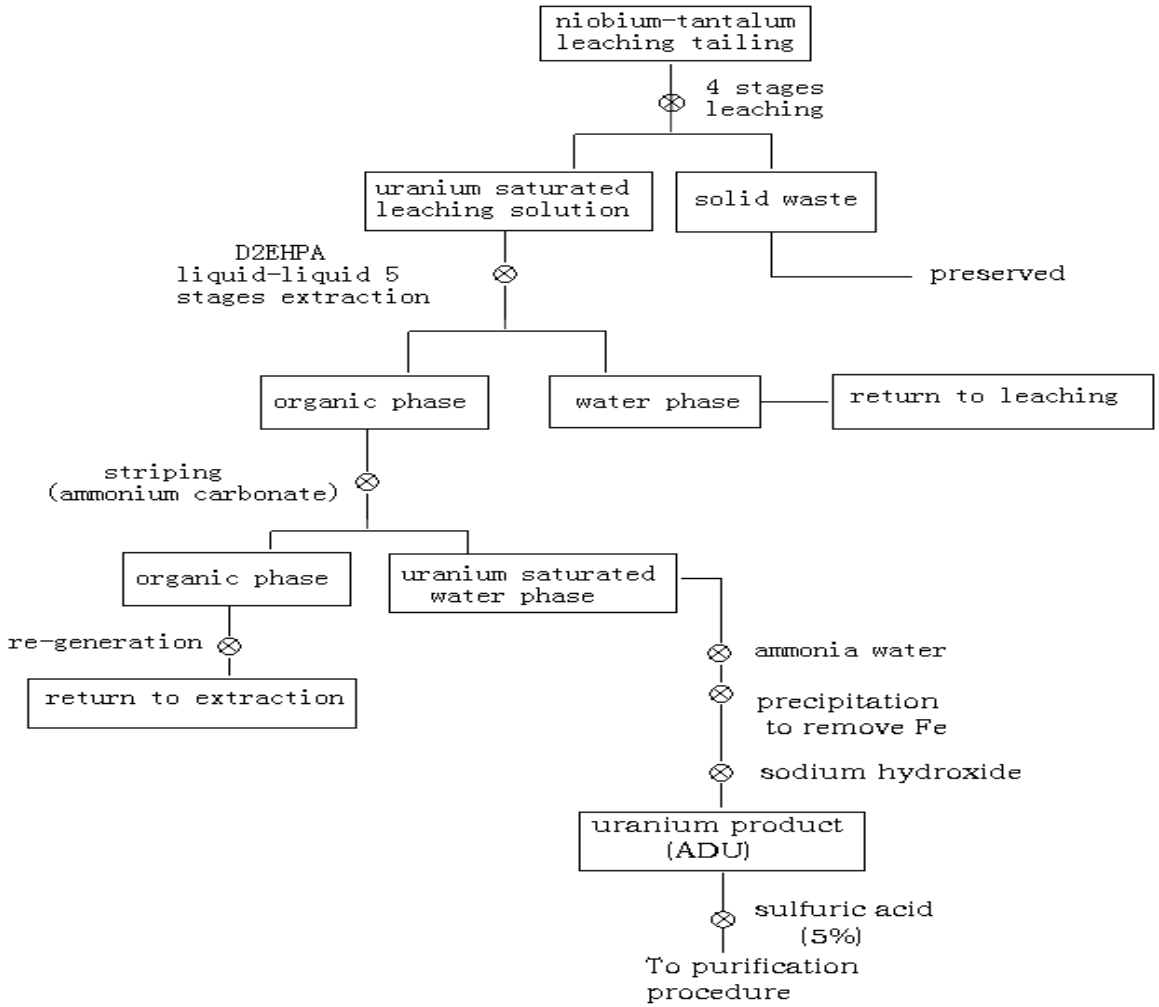
Experiment

Materials and Instruments

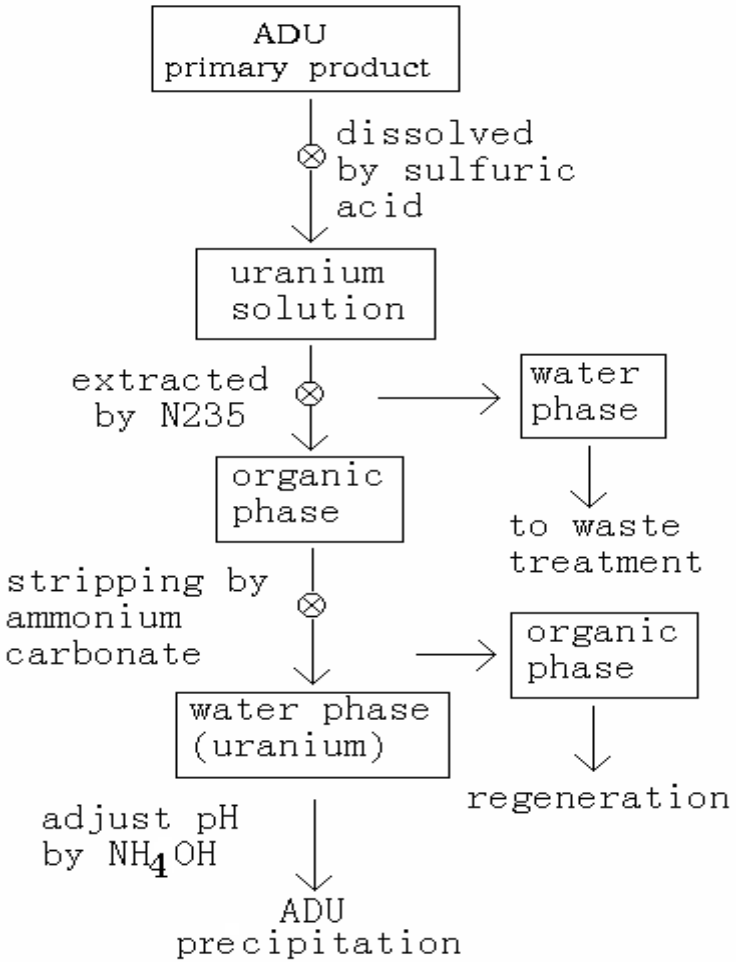
- Niobium-tantalum leaching tailing ;
- Beryllium ore;
- Inorganic reagents : sulphuric acid, ammonia, ammonium carbonate, ammonium sulphate, sodium hydroxide, calcium oxide ;
- Organic reagents: di(2-ethylhexly)phosphoric acid (D2EHPA) , trialkyl amine (N235), 200# sulfonated kerosene, octanol, ethanol, and strong base type anion exchange resin (D201, 60~80 mesh)
- Glassware
- ICP-OES, ICP-MS and XRF

Procedure for extraction of uranium (1)

Extraction of uranium from niobium-tantalum leaching tailing

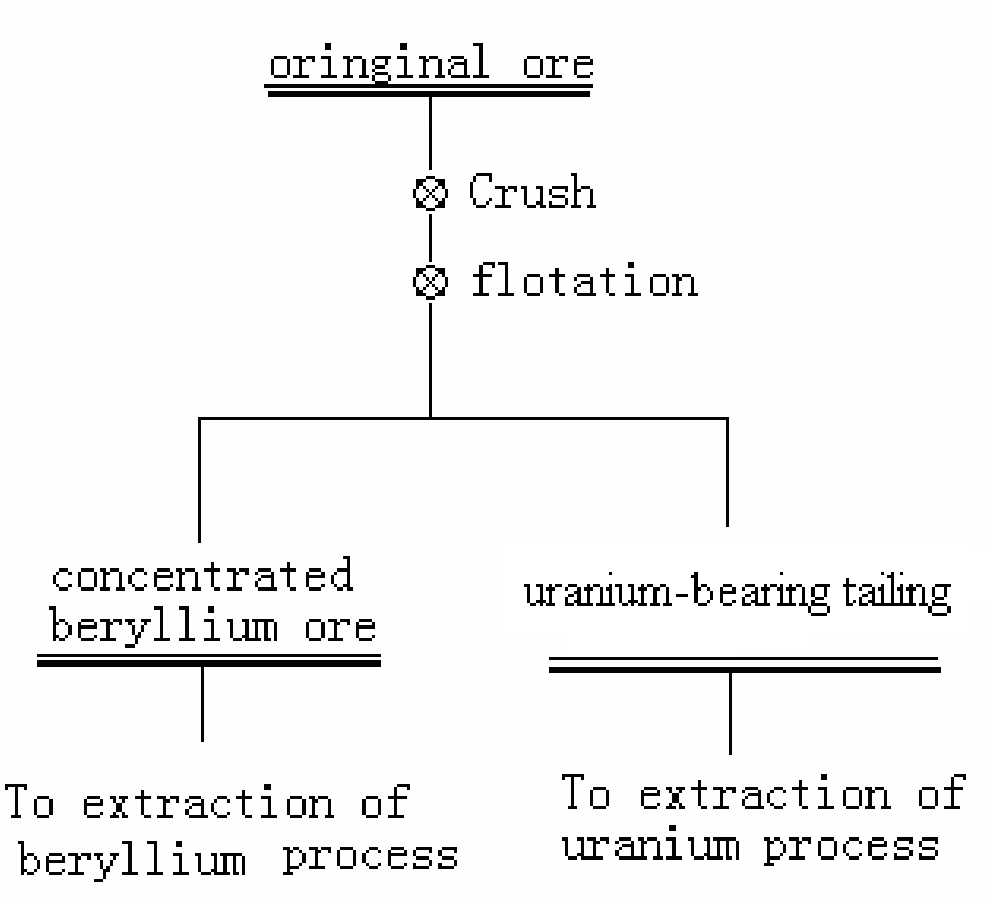


Procedure for extraction of uranium (1)
Extraction of uranium from niobium-tantalum leaching tailing
Purification of uranium product



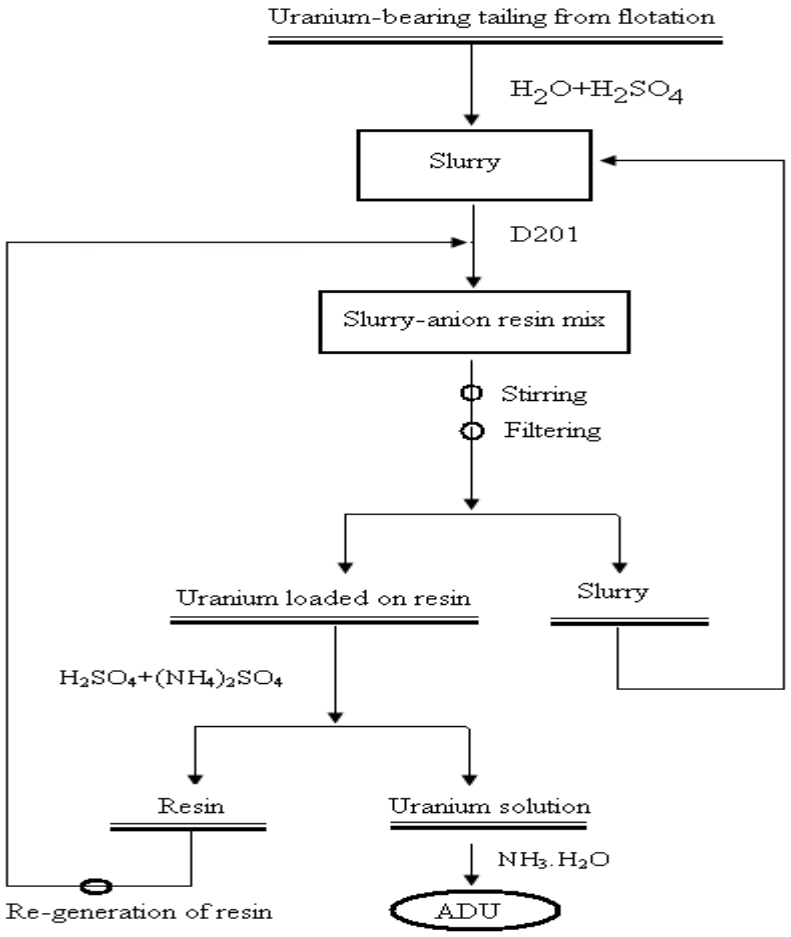
Procedure for extraction of uranium (2)

Extraction of uranium from beryllium ore



Procedure for extraction of uranium (2)

Extraction of uranium from beryllium ore



Results and Discussion

Results and Discussion (1)

Niobium-tantalum leaching tailing

Table 1. The results of elements in niobium-tantalum leaching tailing by XRF and ICP-MS

Element	Content (μ g/g)	Element	Content (μ g/g)	Element	Content (μ g/g)
As	409	Ho	83	Sm	340
Ba	1177	In	18	Sn	5564
Be	51	La	975	Sr	406
Bi	1614	Li	260	Ta	13555
Cd	147	Lu	56	Tb	65
Ce	2348	Mn	37333	Th	1326
Co	70	Mo	18	Ti	8910
Cr	932	Nb	7163	Tl	13
Cs	82	Nd	1004	Tm	51
Cu	272	Ni	65	U	3864
Dy	387	Pb	2351	V	45

Results and Discussion (1)

Niobium-tantalum leaching tailing

Table 1. The results of elements in niobium-tantalum leaching tailing by XRF and ICP-MS

Element	Content (μ g/g)	Element	Content (μ g/g)	Element	Content (μ g/g)
Er	263	Pr	286	W	389
Eu	8	Rb	107	Yb	387
Ga	148	Re	0.0	Y	1595
Gd	295	Sb	14	Zn	1712
Ge	81	Sc	150	Zr	6914
Hf	864	Se	43		

Results and Discussion (1)

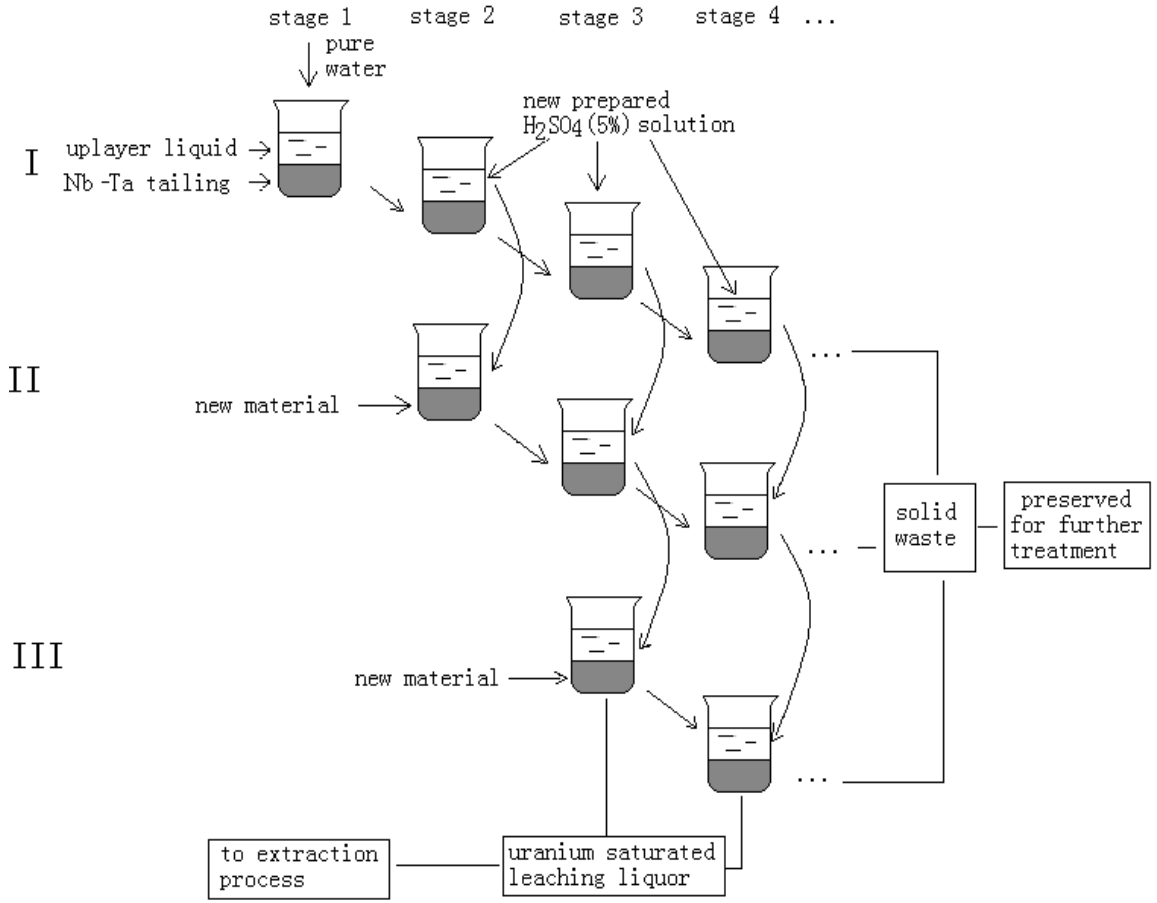
Leaching Uranium from Niobium-tantalum leaching tailing

Table 2. The results of uranium in leaching solution (ppm)

Time/temp	Room temp		50 ℃		100 ℃	
	U	recovery %	U	recovery %	U	recovery %
5 h	291	13.5	519	24	886	35.5
24 h	685	32	835	3838	1342	62.4
48 h	1177	55	1791	83.3	1943	90.4
72 h	1563	73	1880	87.5	2234	>95

Results and Discussion (1)

Leaching Uranium from Niobium-tantalum leaching tailing



Results and Discussion (1)

Leaching Uranium from Niobium-tantalum leaching tailing

Table 3. The concentration of uranium in leaching solution at each step

Gradient (step)	Step1 (Pure water)	Step2	Step3	Step4	Step5	Total recovery
Concentration of uranium (ug/mL)	1038	665	254	190	80	80.2 %

Step2 to step5: 5%H_2SO_4

Results and Discussion (1)

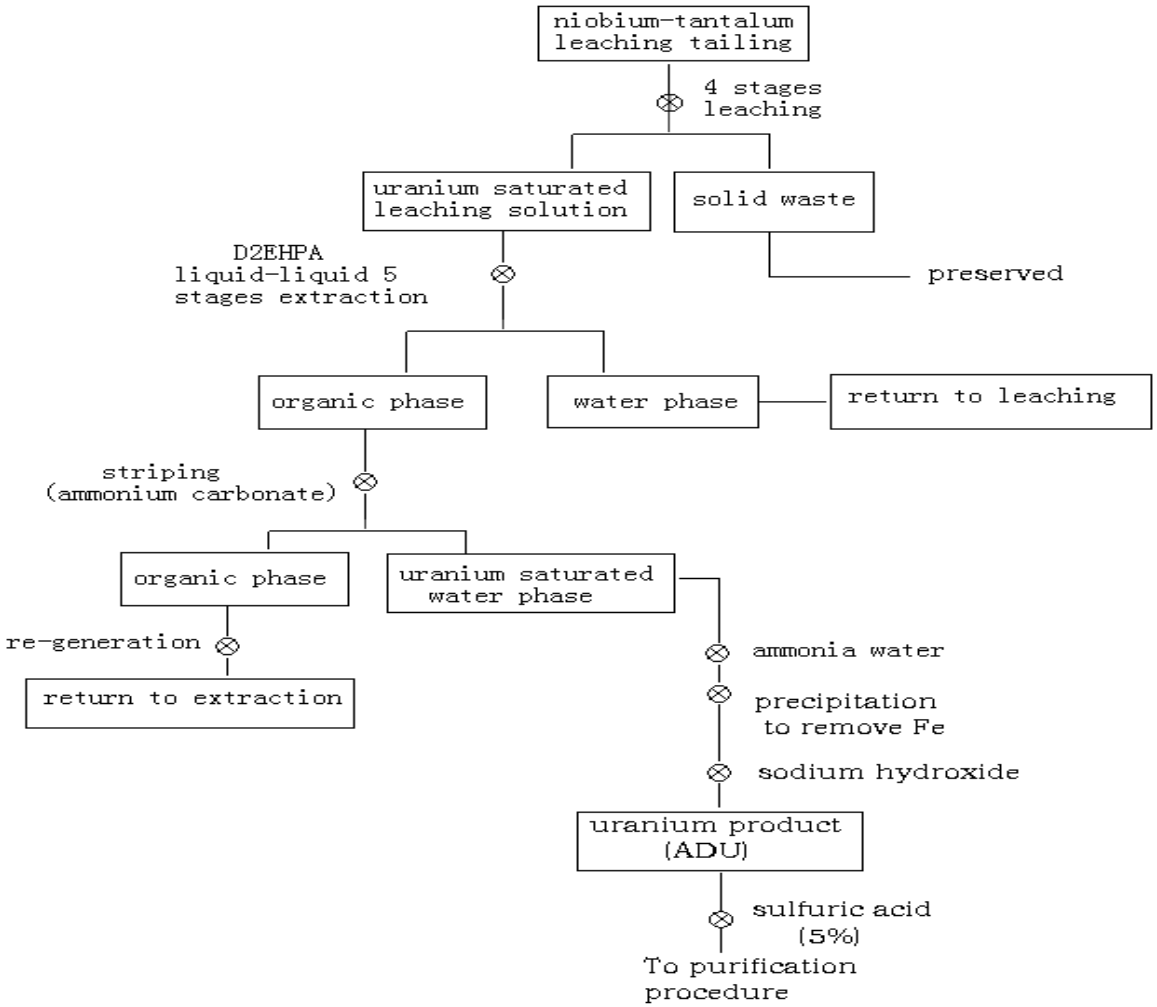
Leaching Uranium from Niobium-tantalum leaching tailing

Table 4. The major elements in leaching solution (mg/L)

U	Zr	Fe	Nb	Hf	Mn	Ta	Ti	Th
1153	737	9001	353	115	3163	623	410	102

Results and Discussion (1)

Extraction of uranium from niobium-tantalum leaching tailing



Results and Discussion (1)

Optimized Extraction Conditions Using D2EPHA Technique

- Leached solution: 5%H_2SO_4, U> 1 g/L;
- O/W: 1/5;
- Contact time: 5~10min;
- Phase separation time: 30min;
- Extraction stages: 5;
- Saturated organic phase：U>5g/L;
- Extraction raffinate: U <0.005 g/L;
- Impurities wash: 5% H_2SO_4, 2 stages;
- Back extraction solution: 10% ammonium carbonate;
- O/W: 2/1;
- Back extraction time: 10min;
- Back extraction separation time: 30min;
- Back extraction stages: 3;
- Elements in water phase: U>10g/L and impurities Zr, Th, Fe;
- Extractant regeneration: wash organic phase with 5% H_2SO_4.

Results and Discussion (1)
Extraction of uranium from leaching solution

Table 5 The performance of extraction by D2EHPA

Element	Original concentration (mg/L)	Concentration in extraction raffinate at first state (mg/L)	Recovery of element through one state (%)	Concentration in extraction raffinate at third state (mg/L)	Recovery of element through there states (%)
U	1139	141	87.6	66	94.2
Zr	1094	719	34.3	514	53
Hf	175	86	51	51	71
Nb	304	308	<5	295	3
Ta	241	253	<5	224	7.1
Ti	408	403	1.2	351	14
Fe	11870	10300	13.2	9150	23
Th	120	87.4	28	53	56

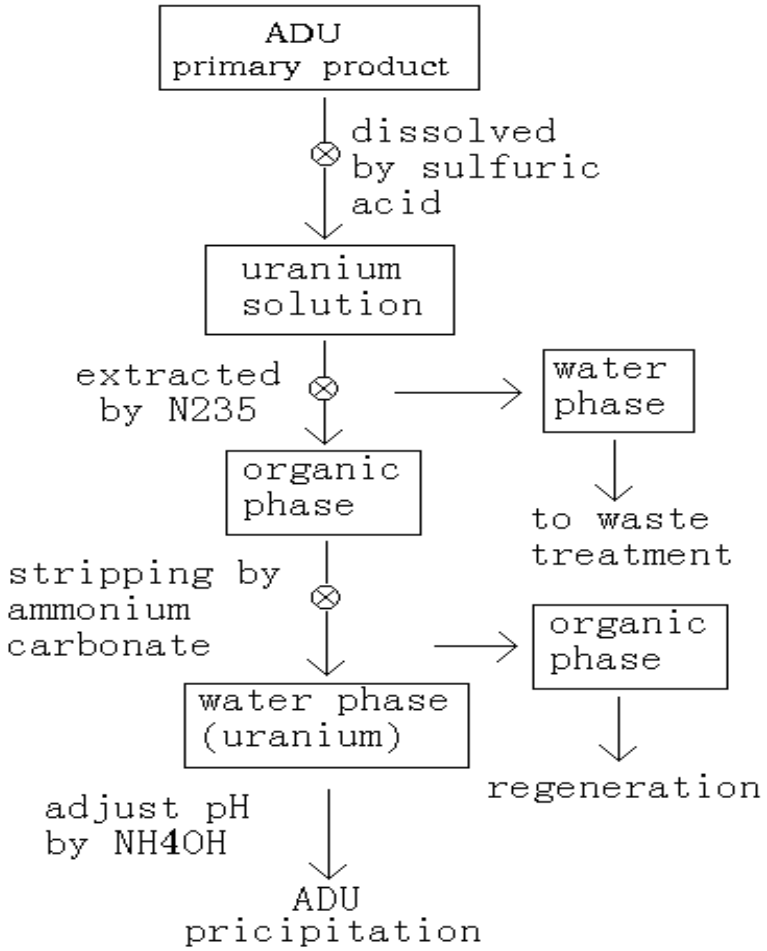
Results and Discussion (1)
Extraction of uranium from leaching solution

Table 6 Back extraction of uranium by ammonium carbonate 10%

Element	U	Th	Nb	Ta	Zr	Hf	Ti	Fe
Concentration at 1st Back extraction (mg/L)	4055	490	-	3	543	75	21	35
Concentration at 2nd Back extraction (mg/L)	1128	219	79	84	1827	362	48	272

Results and Discussion (1)

Purification of uranium product



Results and Discussion (1)

Purification of uranium product

Table 7 Impurities in ADU after purification

Element	Standard required (%)	Measured in ADU (%)
V	<0.05	0.04
P	<0.20	0.05
Mo	<0.10	0.03
Fe	<0.50	0.0
Ca	<0.50	0.0
Na	<0.50	0.12
K	<0.20	0.04
Ti	<0.02	0.09
Zr	<0.05	0.03
Si	<0.20	0.10
Mg	<0.30	0.0
Th	<0.50	0.0
Nb	-	0.008
Ta	-	0.03

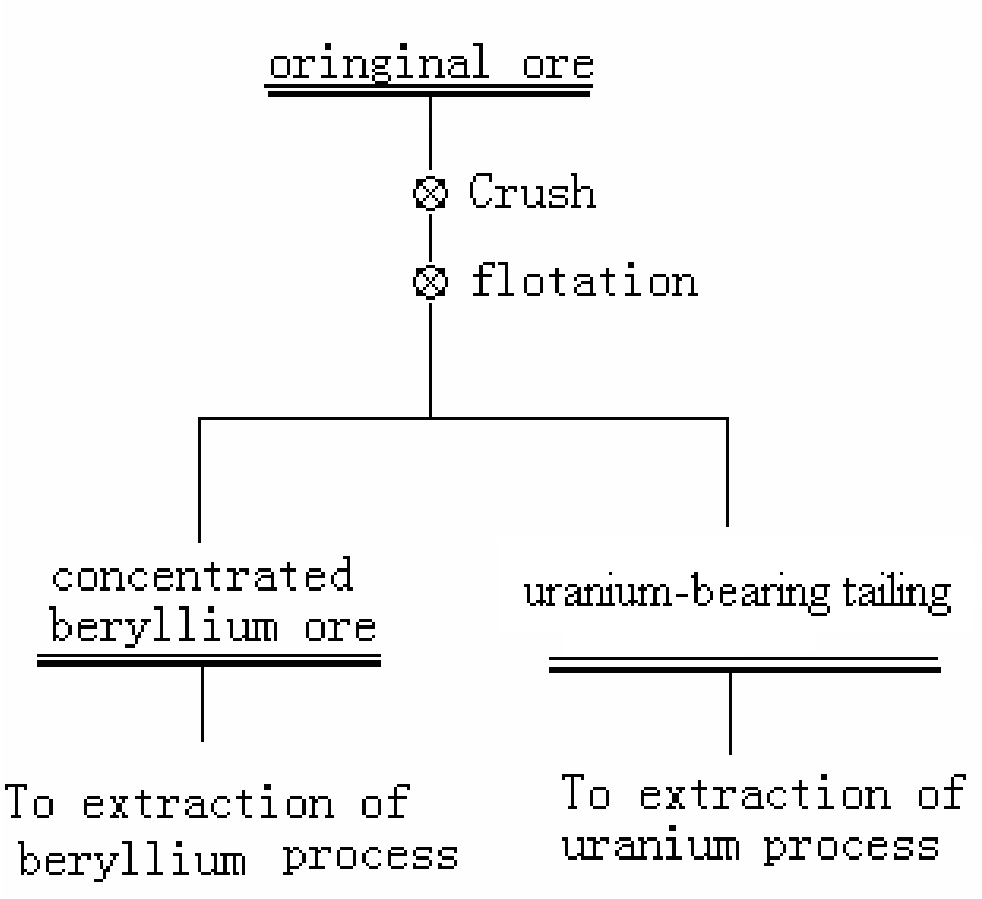
Results and Discussion (2)

Table 8 Contents of major elements in beryllium ore

Element (some expressed as oxide)	Contents (%)	Element (some expressed as oxide)	Contents (%)
Na_2O	4.258	Fe_2O_3	4.234
MgO	0.333	ZnO	0.208
Al_2O_3	16.07	Rb	0.018
SiO_2	68.51	SrO	0.011
P_2O_5	0.021	Y_2O_3	0.127
SO_3	0.037	ZrO_2	0.071
K_2O	4.174	Nb_2O_5	0.007
CaO	1.353	PbO	0.024
TiO_2	0.315	U_3O_8	0.083
MnO_2	0.146	BeO	0.10

Results and Discussion (2)

Pretreatment of beryllium ore



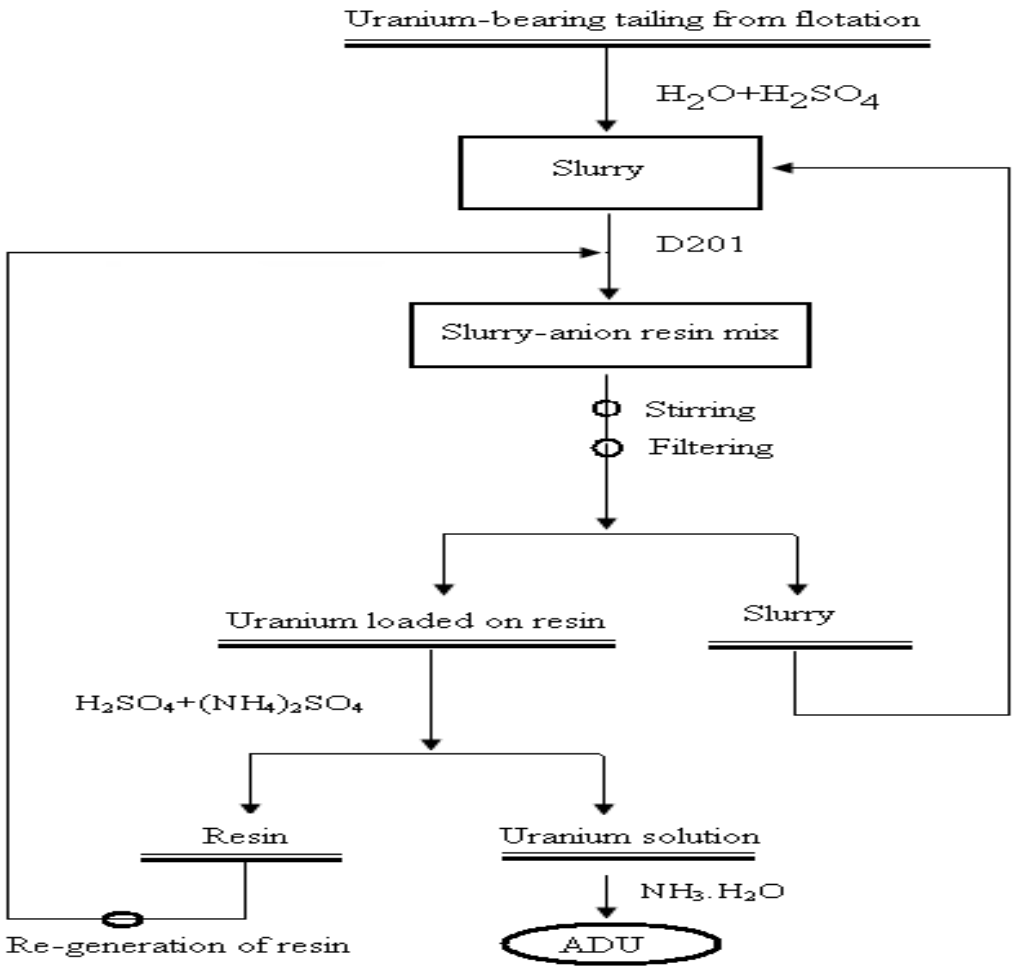
Results and Discussion (2)

Table 9 Distribution of uranium during treatment of beryllium ore

Portion	%
Concentrated beryllium ore	5~8
Flotation tailing	92~95
Flotation liquid	0~0.2

Results and Discussion (2)

Technical scheme for extraction of uranium from beryllium flotation tailing



Results and Discussion(2)

Technical scheme for extraction of uranium from beryllium flotation tailing

Results under optimized leaching condition: sulfuric acid 2~2.5%(v/v), pH 1.0~1.5 and 48~72h leaching time at room temperature

Time /element	Concentrations(mg/L) in leaching solution					Recovery of U (%)
	Al	Ca	Fe	Na	U	
2h	390	695	2865	258.5	428	46
5h	435	810	3150	275	460	49
24h	733	978.5	4750	368.5	584	62
48h	1175	1250	5345	435	735.5	79
72h	1456	1716	8600	658	931	>95

Results and Discussion(2)

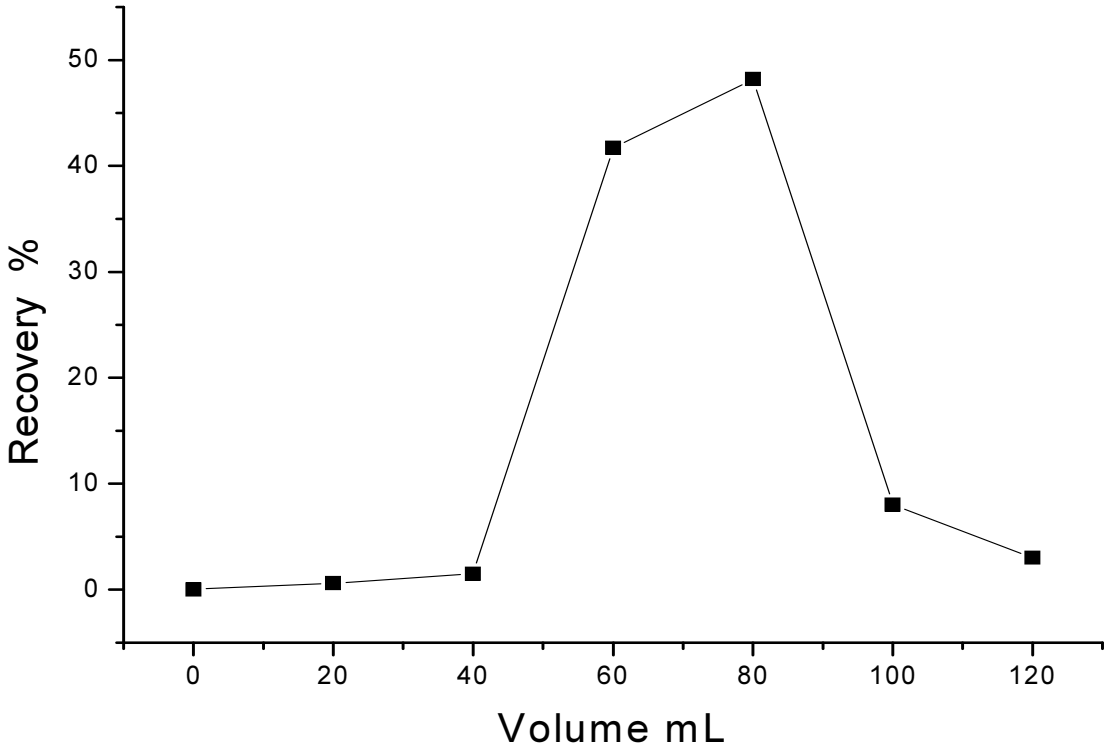
Extraction of uranium from leaching solution

Table 15 Concentration of Al, Fe, U in slurry vs time (mg/L)

Time/Element	Al	Fe	U	R% (U)
0 h	2202	9298	787	-
1 h	1726	6902	135	82.9
2 h	1601	7001	135	82.9
3 h	1603	7011	132	83.0

Results and Discussion(2)

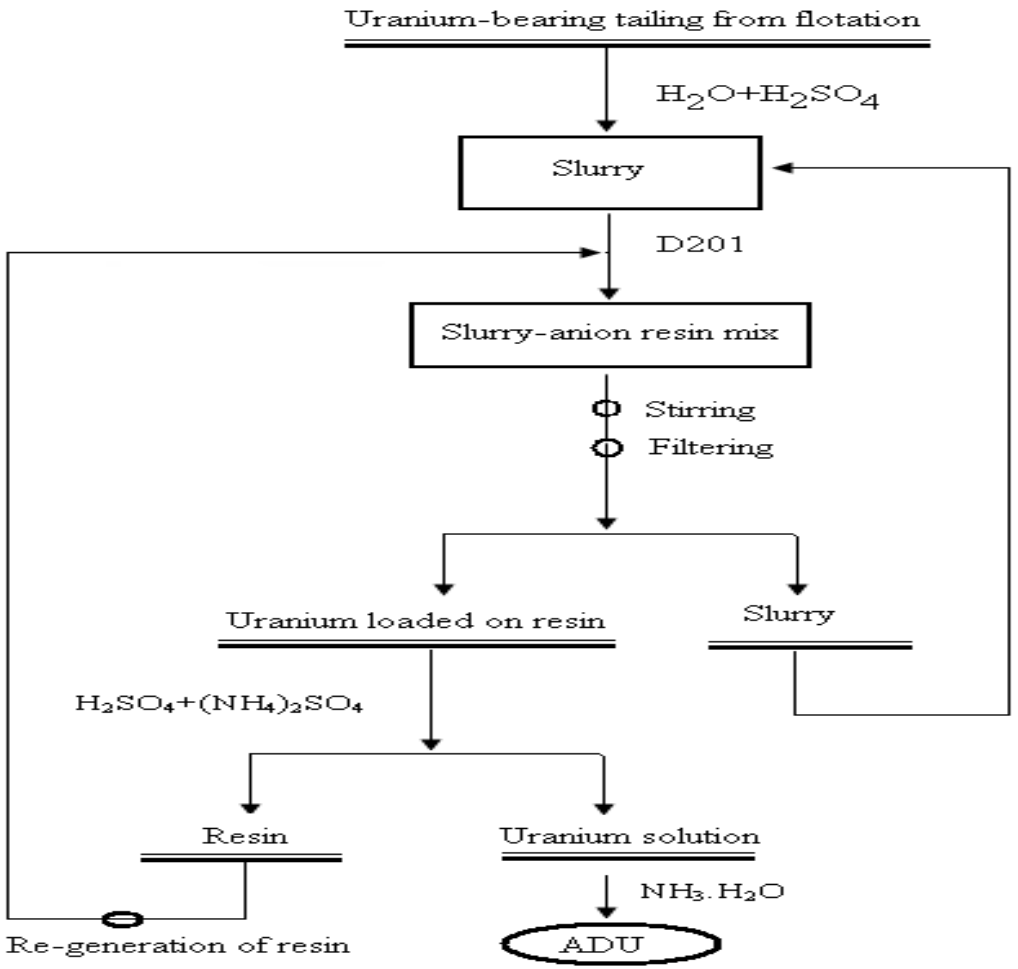
Extraction of uranium from leaching solution



Elution curve of uranium loaded on the resin

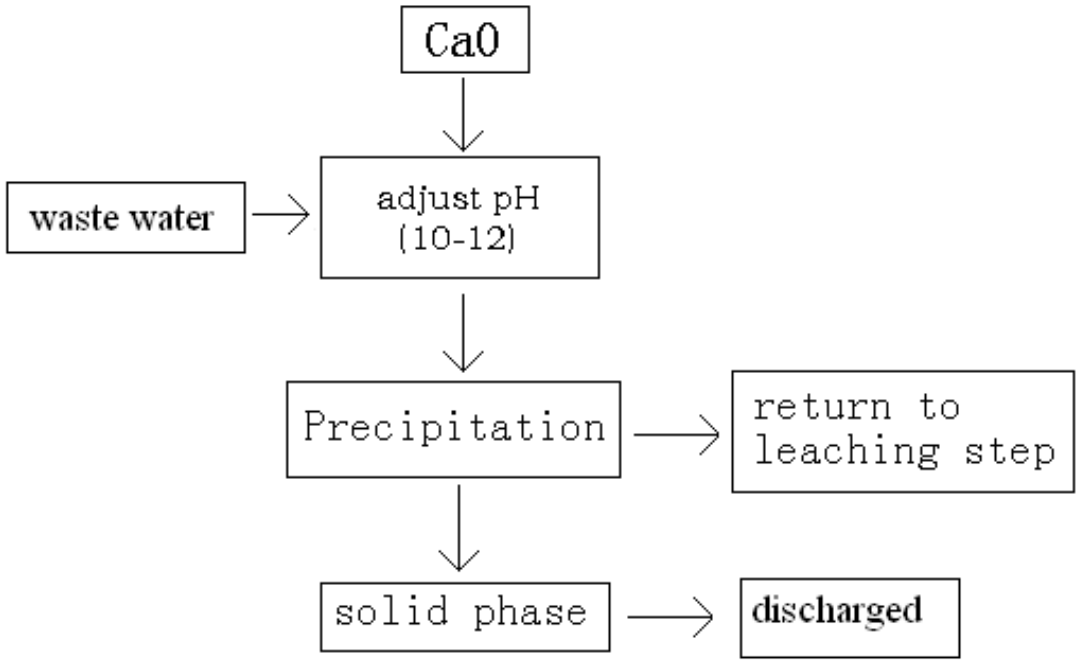
Results and Discussion (2)

ADU produced from eluted uranium solution at final stage



Results and Discussion

Waste water treatment procedure



Conclusion

1) Uranium-bearing ores have been treated by other mining and milling process purpose, and uranium has gone to the tailings, without ore crushing and grinding. This is the key factor to reduce cost for uranium production.

2) Extraction of uranium from the tailings needs specific concentrating techniques due to the difference of tailing composition and speciation of uranium.

3) Solvent liquid-liquid extraction technique (D2EHPA) is suitable for the complicated composition tailing like niobium-tantalum leaching tailing, while anion exchange technique is better for the simple composition tailing such as beryllium ore flotation tailing .

Conclusion

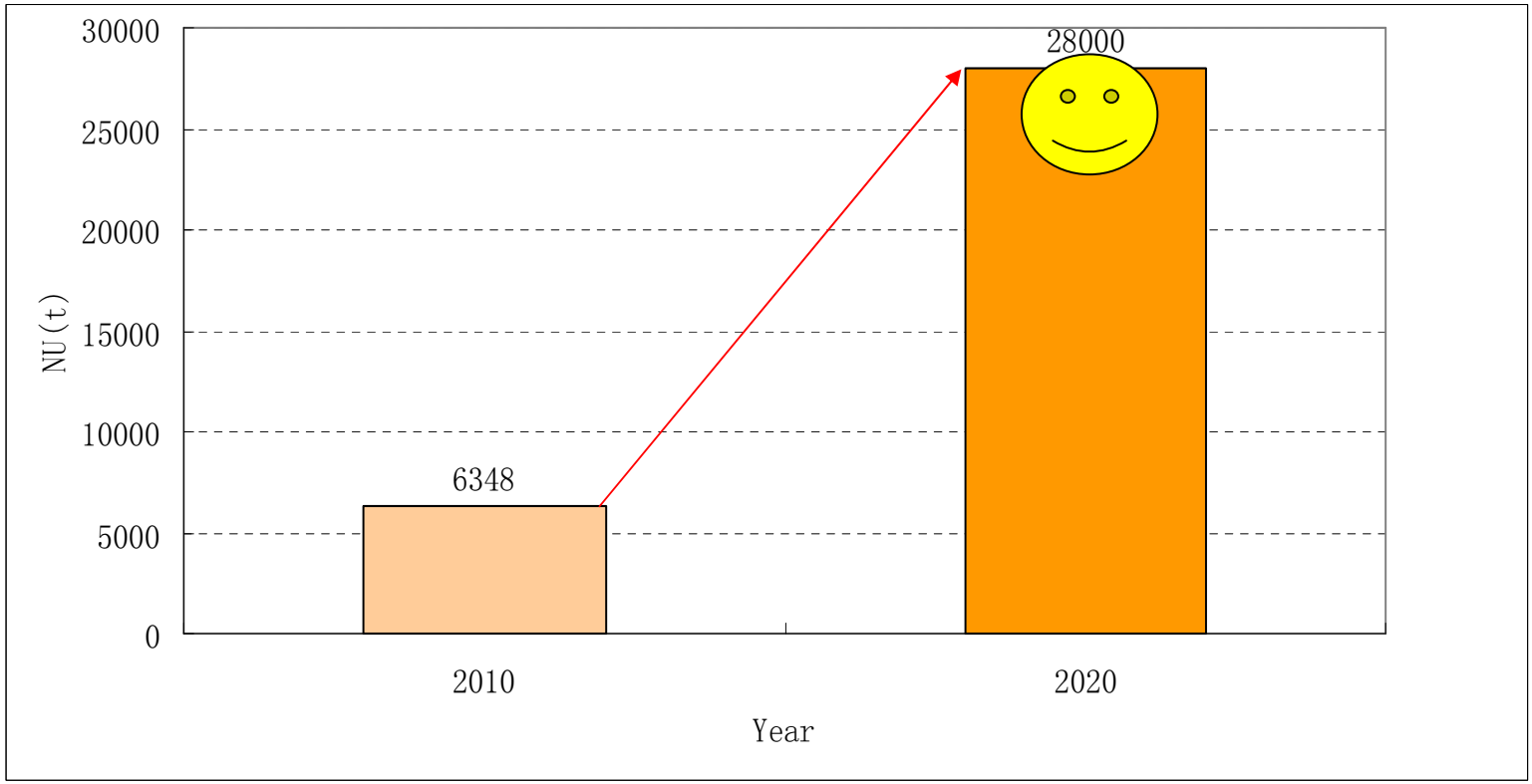
4) Yellowcake product extracted from tailings needs to be purified to meet the standard specification of uranium ore concentrate (UOC) due to more impurities in tailings compared to the traditional UOC process.

5) Integrated techniques or comprehensive utilization means is an approach to deal with low grade uranium ores which contain other valuable elements (Be, Nb, Ta, etc.).

6) The developed techniques are able to upgrade to the industrial application.

Conclusion

Development of low grade uranium resources, like extraction of yellowcake from valuable tailings, may provide a way to increase uranium supply and reduce uranium as a radionuclide waste impact on environment during other milling process.



Thank you for your attention!

Questions & Comments?