

# Zoovch Ovoo and Dulaan Uul uranium deposits: application of international reporting standards for mineral resources and ore reserves



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# Areva in Mongolia

## Key dates for uranium exploration

1997

- ▶ **Cogegobi** starts exploration in South-eastern part of Mongolia
  - ◆ Main target: uranium sandstone-hosted deposit type in Upper Cretaceous formations of the Eastern Gobi sedimentary basins

2002

- ▶ **Discovery #1: first mineralized hole on Dulaan Uul deposit**
  - ◆ First typical roll-front uranium deposit found in Mongolia

2009

- ▶ **Discovery #2: first mineralized hole on Zoovch Ovoo deposit**
  - ◆ 25km eastward from Dulaan Uul deposit

2011

- ▶ Successful ISR trial test (ISR pilot) on Dulaan Uul deposit

2015

2016

- ▶ First economical study (feasibility study) for Zoovch Ovoo & Dulaan Uul deposits (feb 2015). Granting of mining licenses (jun 2015). **Mon-Atom** enters in the JV for projects development (2016).

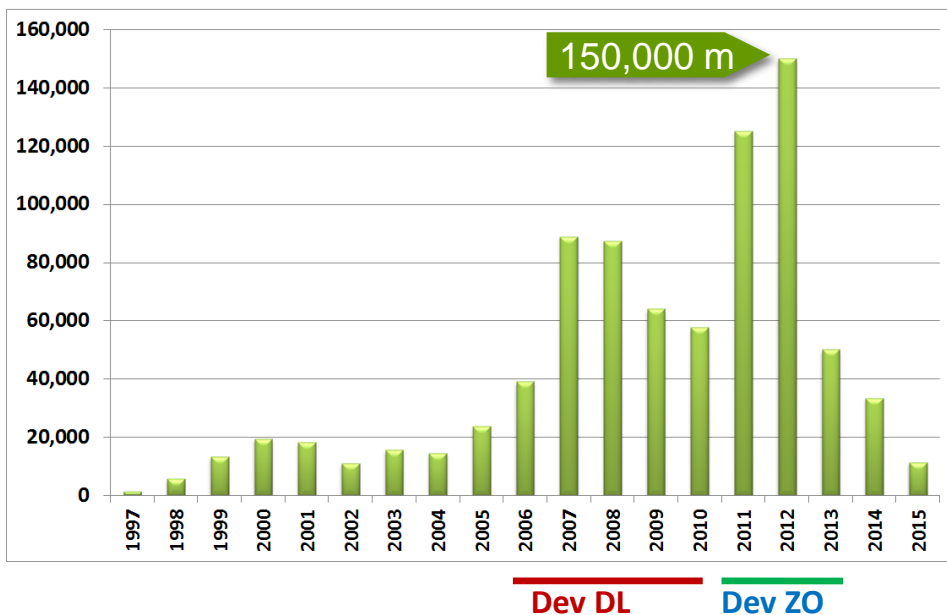


# Areva in Mongolia

## Key figures for uranium exploration



### DRILLING (m)



- ▶ **Substantial take-off in 2006**
  - ◆ After the first resource estimation of Dulaan Uul deposit (in 2005)
- ▶ **2011 - 2012 peak drilling activity**
  - ◆ Zoovch Ovoo intensive drilling
  - ◆ First resource estimation in 2012
- ▶ **1997 - 2015 Total Drilling ≈ 831,000 m, including:**
  - ◆ 430,000 m on Dulaan Uul
  - ◆ 259,500 m on Zoovch Ovoo



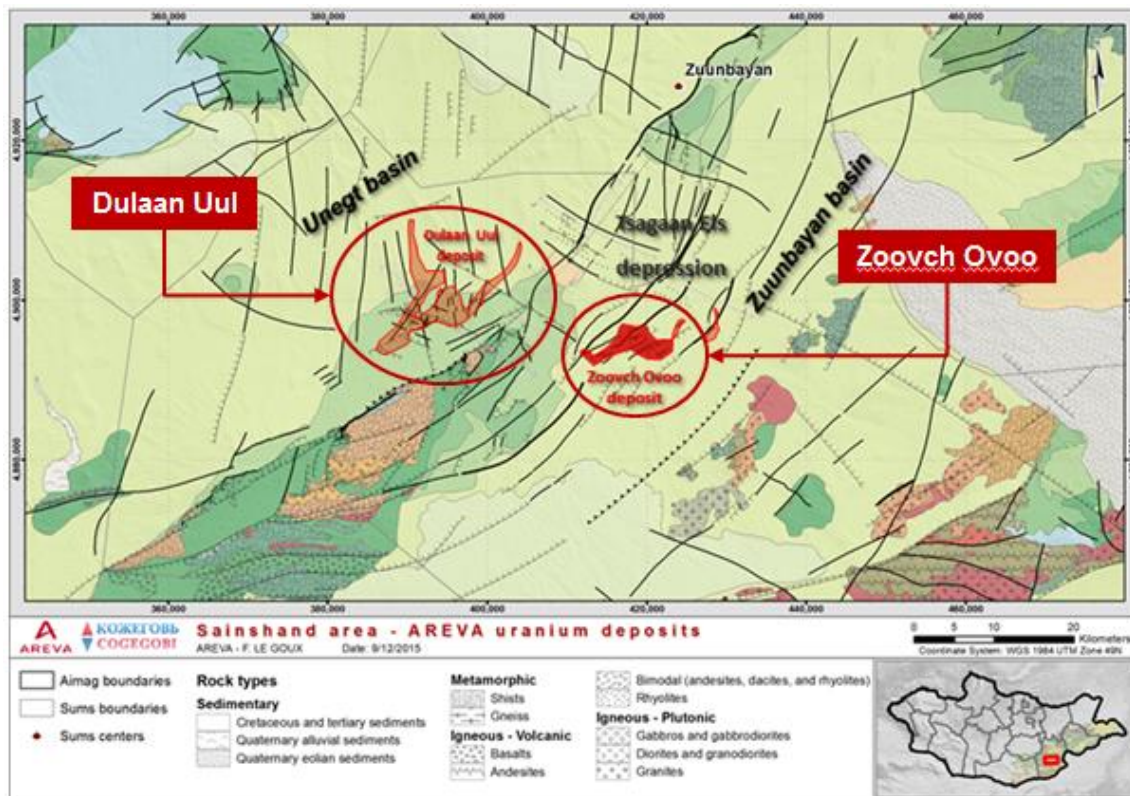
# Geology of the deposits

## ► Dulaan Uul deposit:

- ◆ 40 km long redox front
- ◆ Mineralized roll front ~ 20 km
- ◆ Average grade 220 eUppm
- ◆ Ribbon-like orebodies

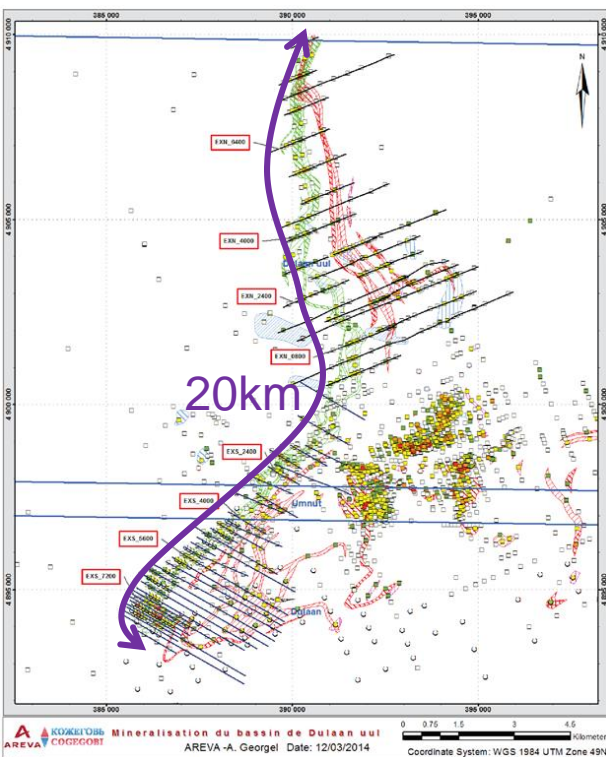
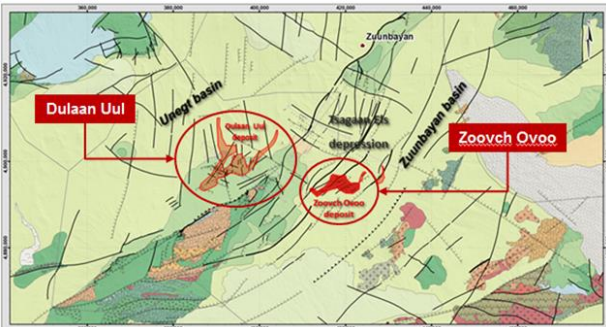
## ► Zoovch Ovoo deposit:

- ◆ 15km long redox front
- ◆ Mineralized roll front ~ 10 km
- ◆ Average grade 230 eUppm
- ◆ Sub-tabular orebodies





# Geology of the deposits

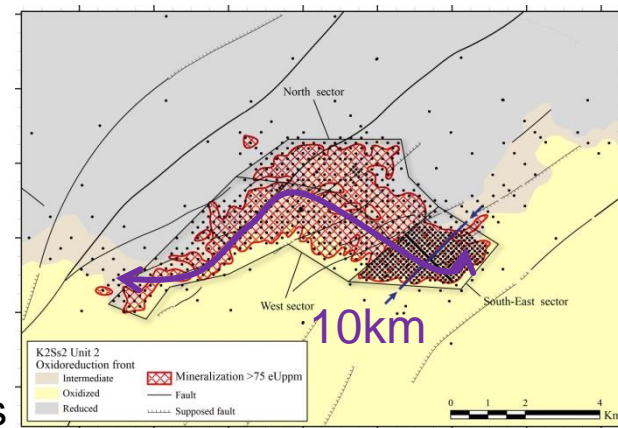


## ▶ Dulaan Uul deposit:

- ◆ Mineralized roll front ~ 20 km
- ◆ Average grade 220 eUppm
- ◆ Narrow ribbon-like orebodies with locally tabular orebodies

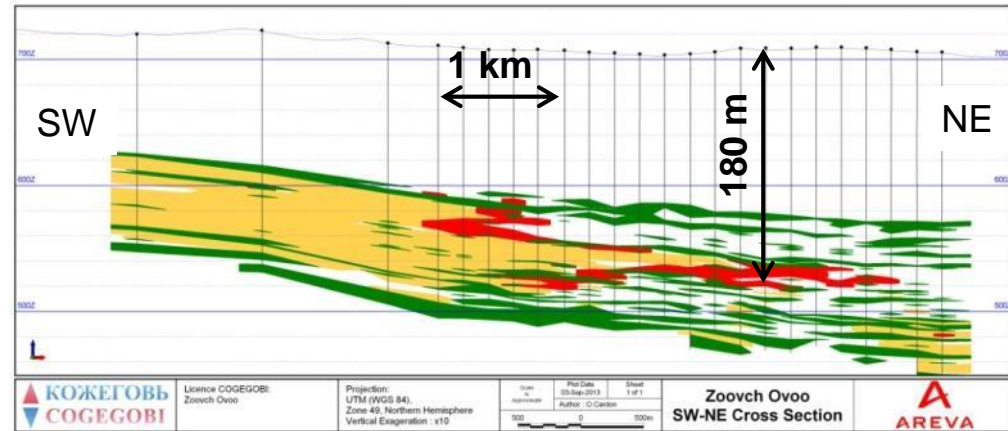
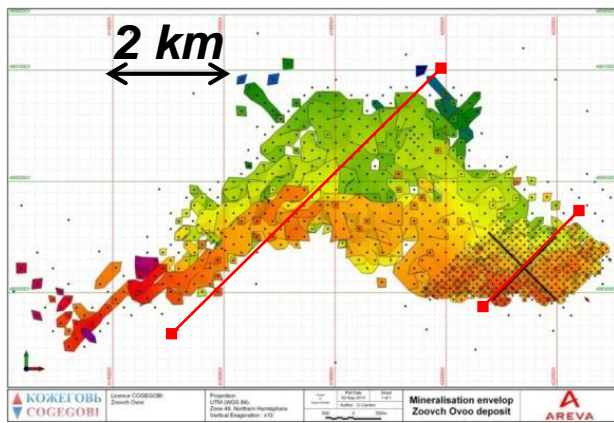
## ▶ Zoovch Ovoo deposit:

- ◆ Mineralized roll front ~ 10 km
- ◆ Average grade 230 eUppm
- ◆ Massive sub-tabular orebodies



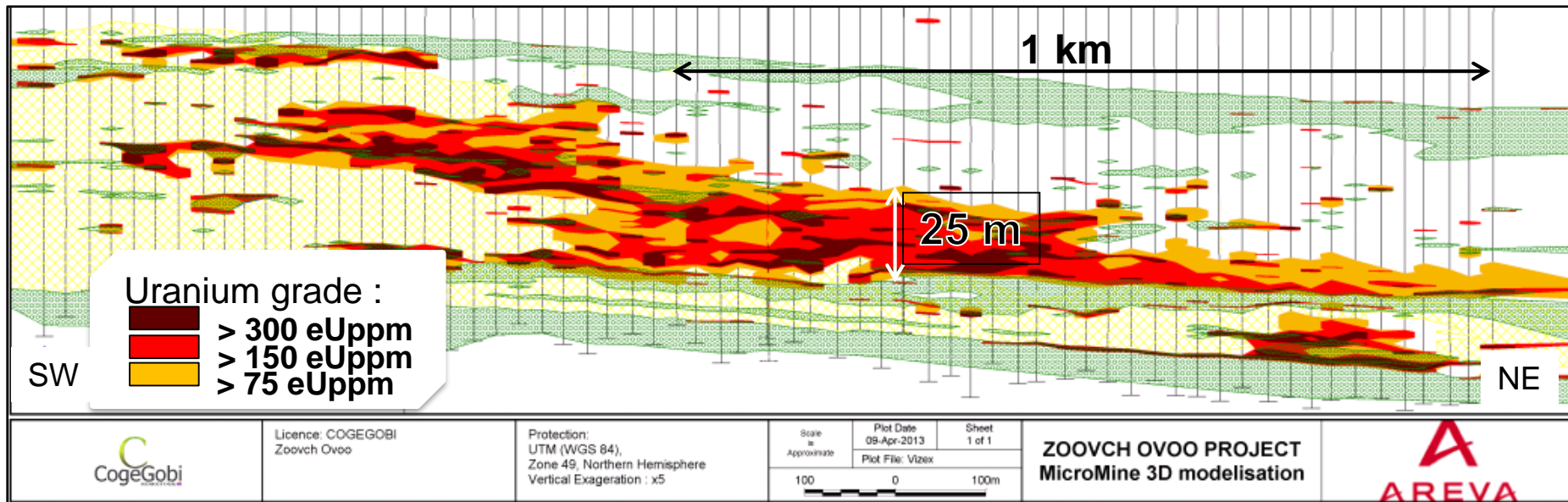


# Zoovch Ovoo deposit



► Mineralization @ 75 eUppm cut-off

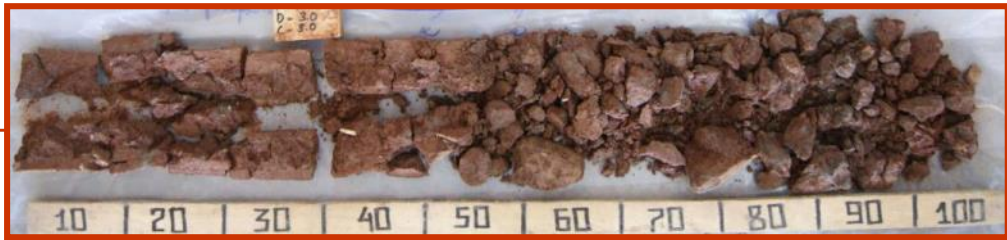
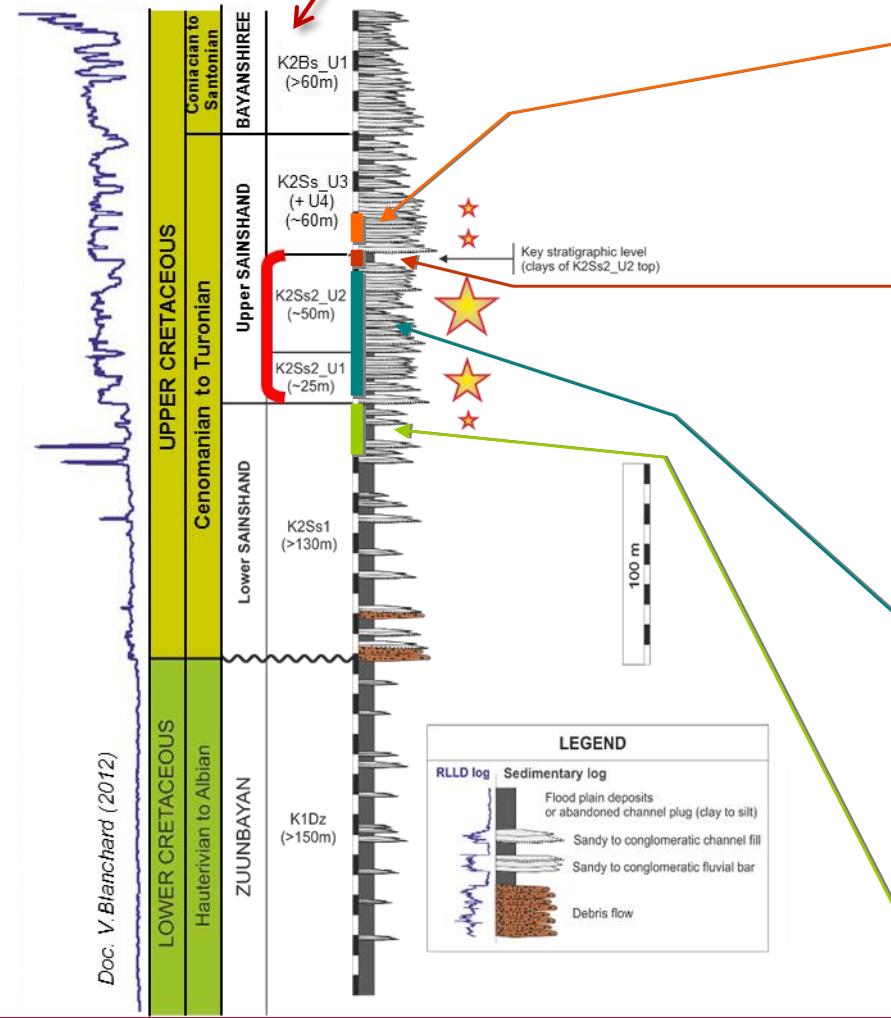
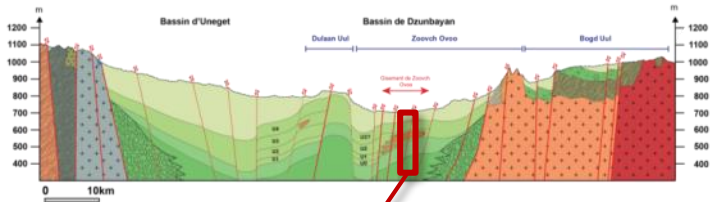
◆ Drilling spacing: 200m



► Zoom on South-Eastern area:

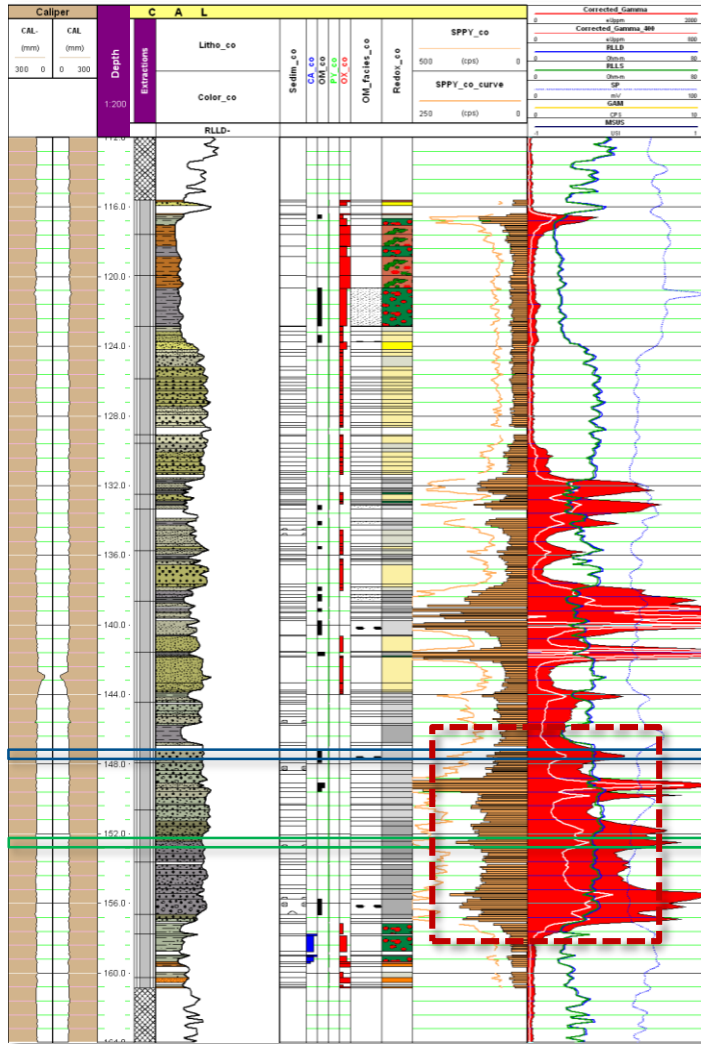
◆ Drilling @ 25m (continuity of mineralization & grade; continuity of impermeable layers)

# Mineralized reservoir



Doc. V Blanchard (2012)

# Zoovch Ovoo deposit



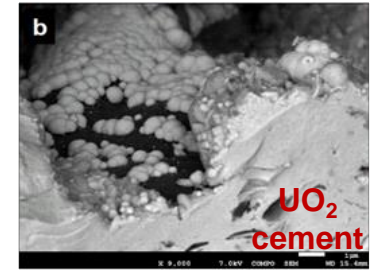
Very coarse sand

Fine to medium sand

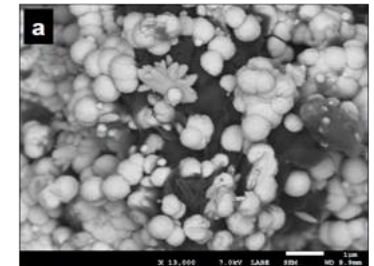


▶ **Common U minerals:**

- ◆ **Uraninite** disseminated or massive in sand matrix (+ in clay microcracks, epigenetic on organic matter fragments)
- ◆ **Coffinite**, phosphocoffinite, disseminated



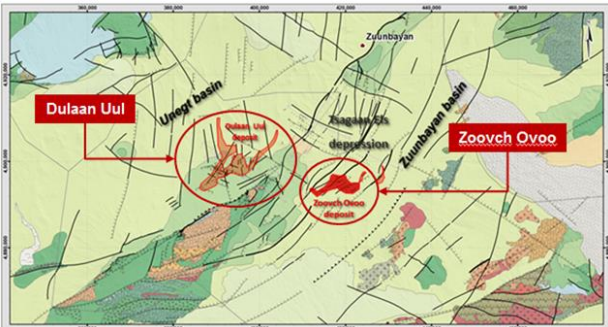
Coffinite





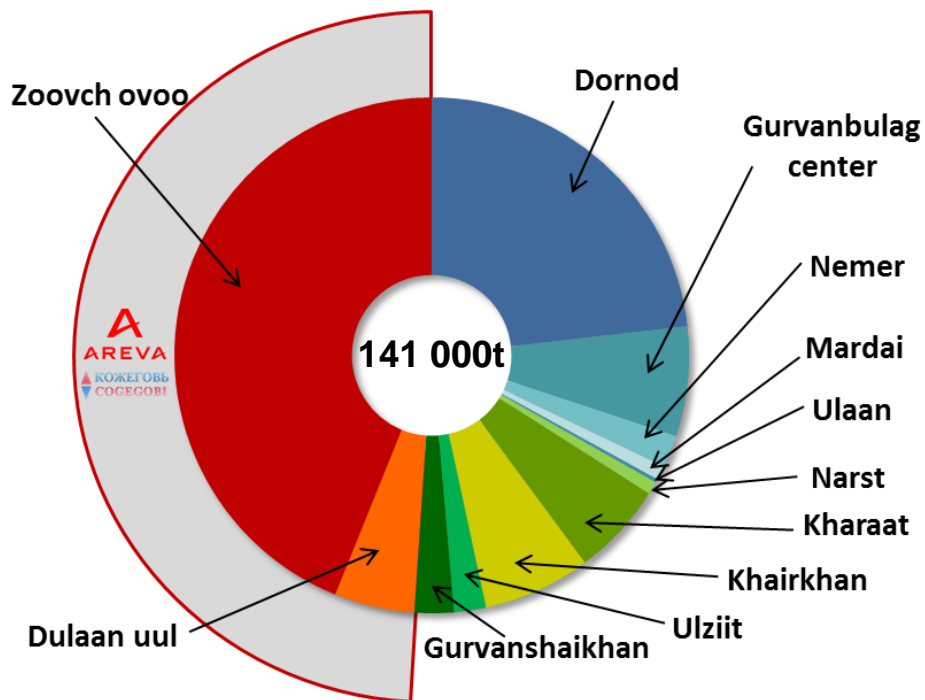


# Uranium resources – AREVA Mongol



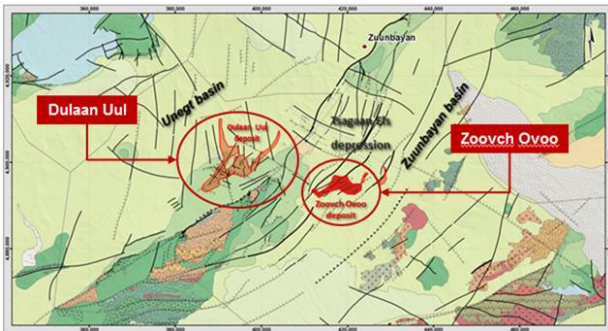
## ► Dulaan Uul and Zoovch Ovoo – global figures:

- ◆ As of today, a total of 65,650 tU is registered in the State Register of Mongolia
- ◆ Corresponding to almost half of registered resources of U



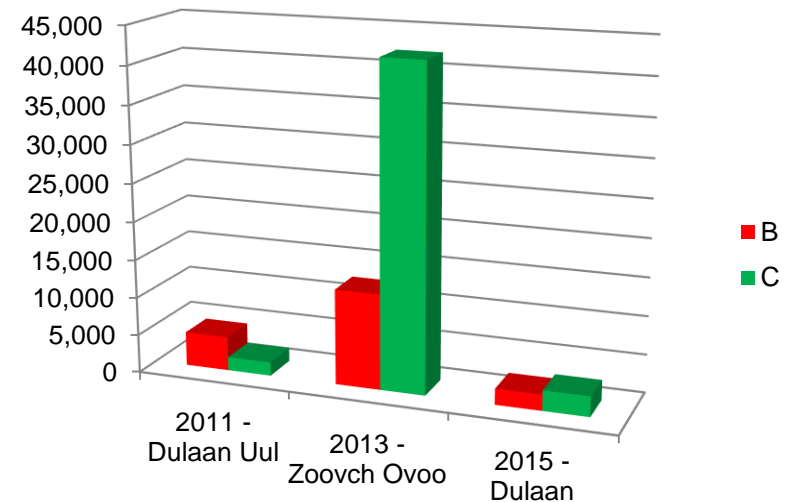
Uranium resources of Mongolia, 2014

# Uranium resources – AREVA Mongol



## ► Dulaan Uul and Zoovch Ovoo – global figures:

Deposit	year	Resource category	U metal (tU)	grade (% eU)
Dulaan Uul	2011	B	4,481	0.023
		C	1,779	0.020
Zoovch Ovoo	2013	B	12,510	0.022
		C	42,130	0.024
Dulaan	2015	B	2,089	0.018
		C	2,657	0.020
<b>Dulaan Uul (incl. Dulaan) total (B+C)</b>			<b>11,006</b>	<b>0.021</b>
<b>Zoovch Ovoo total (B+C)</b>			<b>54,640</b>	<b>0.023</b>



- ◆ Resource categories (B and C) of U in permeable rocks (U in non-permeable rocks is excluded from these figures), according to the [official register of Mongolia](#)
- ◆ >>>> NOTE: For Public Reporting of Mineral Resources and Ore Reserves, AREVA applies the CRIRSCO template



# Mineral Resources & Ore Reserves under CRIRSCO template



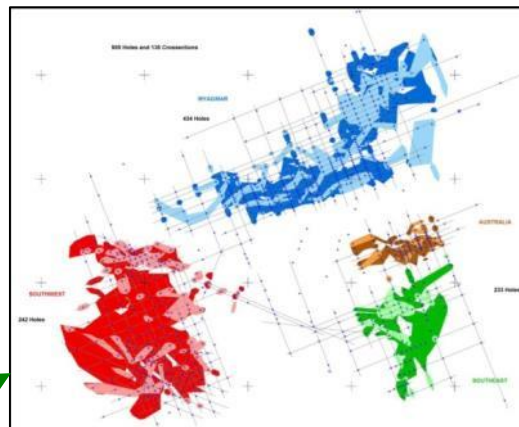
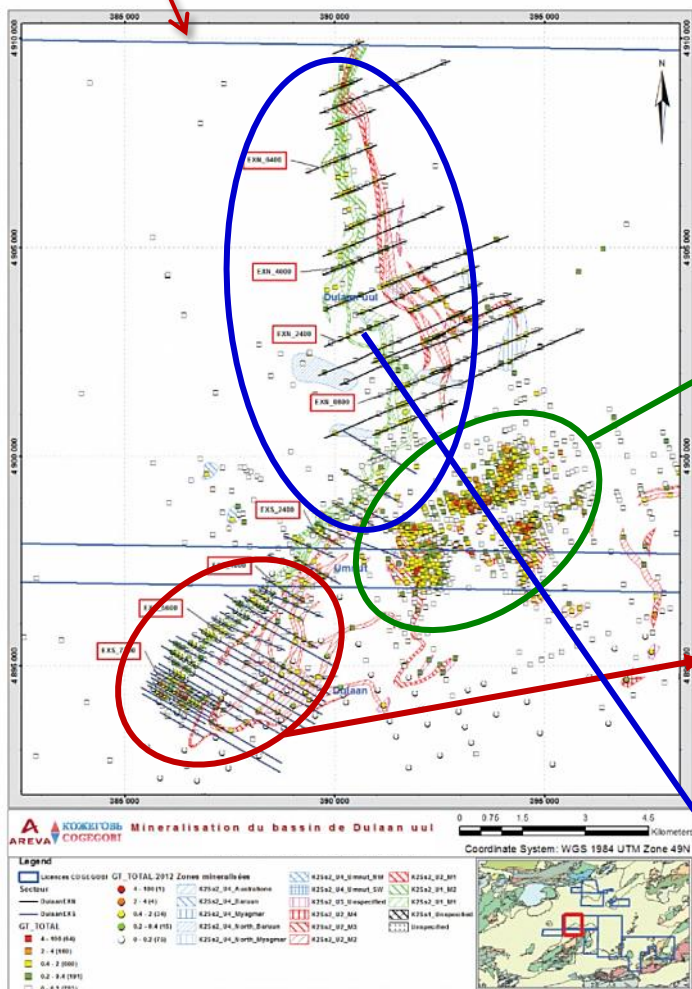
- ▶ **Conversion of classification between Mongolian Code (before MRC 2014) and the CRIRSCO template:**
  - ◆ As a general rule, **B resources can be converted to Indicated Resources and C Resources to Inferred Resources**
  - ◆ **However this is not automatic**, it depends on the results of the peer review of the estimation. At AREVA, the Resources and Reserves estimations are systematically **verified by experts (CPs and QPs in R&R)** before Public Reporting
- ▶ **R&R mineral inventory of AREVA Mines is accessible on AREVA website, in the Reference Document published on an annual basis:**

[http://www.aveva.com/mediatheque/liblocal/docs/groupe/Documentreference/2015/DDR2015\\_EN.pdf](http://www.aveva.com/mediatheque/liblocal/docs/groupe/Documentreference/2015/DDR2015_EN.pdf)

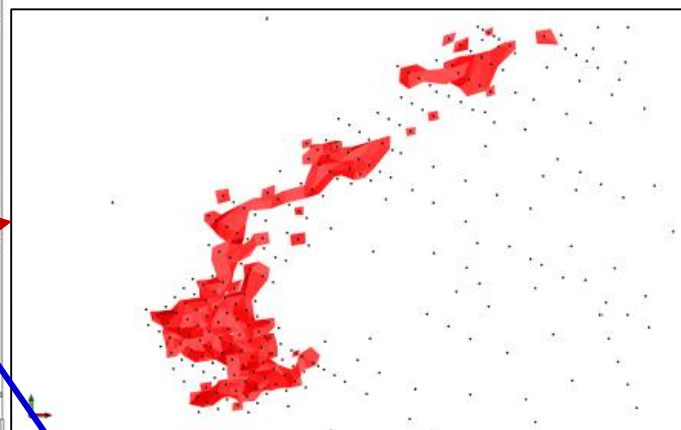
- ◆ AREVA reports R&R according to CRIRSCO template
- ◆ **The « potential »** of additional discoveries is not disclose (as per the template and Codes of Ethics of Professional Organizations)
- ◆ **AREVA also does not publicly disclose any « Exploration Results »**, as most of the major Uranium mining companies



# Resources, Exploration Results, & Potential



Resources of Dulaan Uul orebodies calculated in 2011

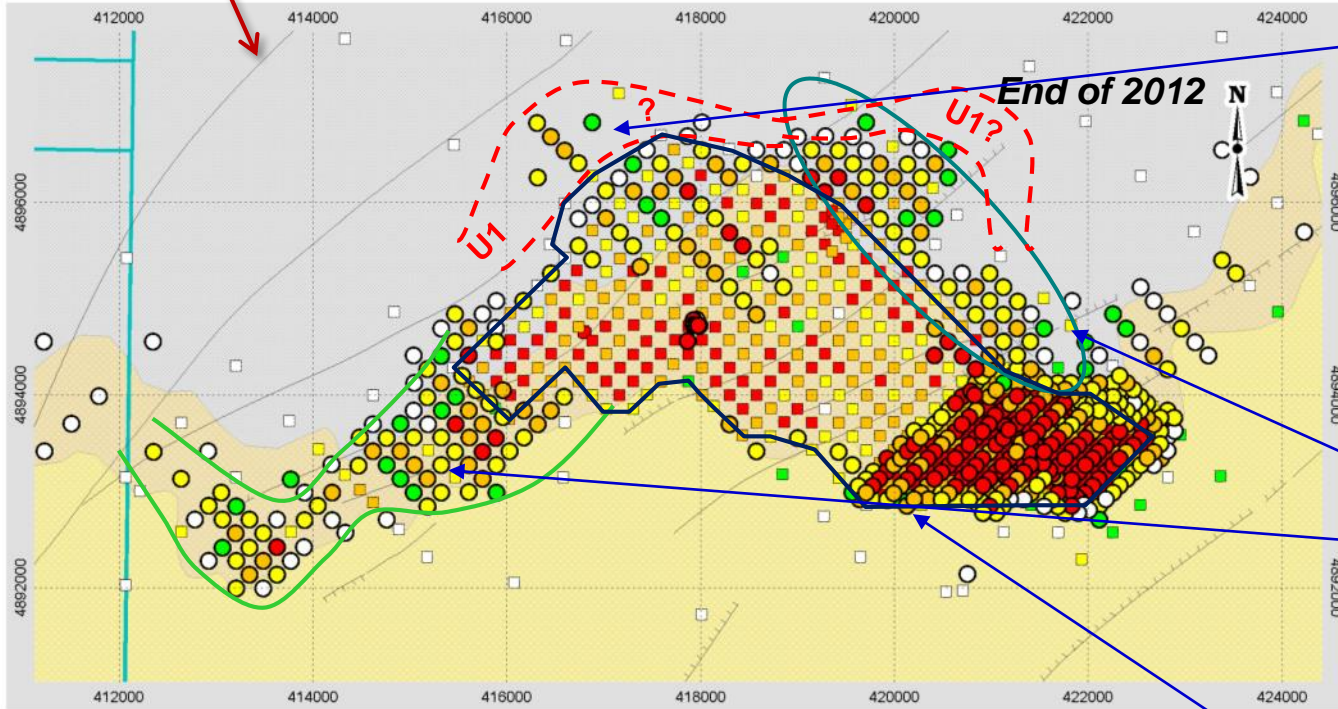


Additional resources of Dulaan Uul, calculated in 2011 (Dulaan orebodies)

Extensions of the deposit (exploration results): not reported



# Resources, Exploration Results, & Potential



Other mineralized zones  
 >> **potential** for additional discovery

Extensions of the deposit  
 >> **additional Resources to be estimated (ongoing)**

Resource contour of the 2013 estimate

ZOOVCH-OVOO - 2012 drilling campaign results  
 Redox front in K2Ss2 Unit 2 stratigraphic level

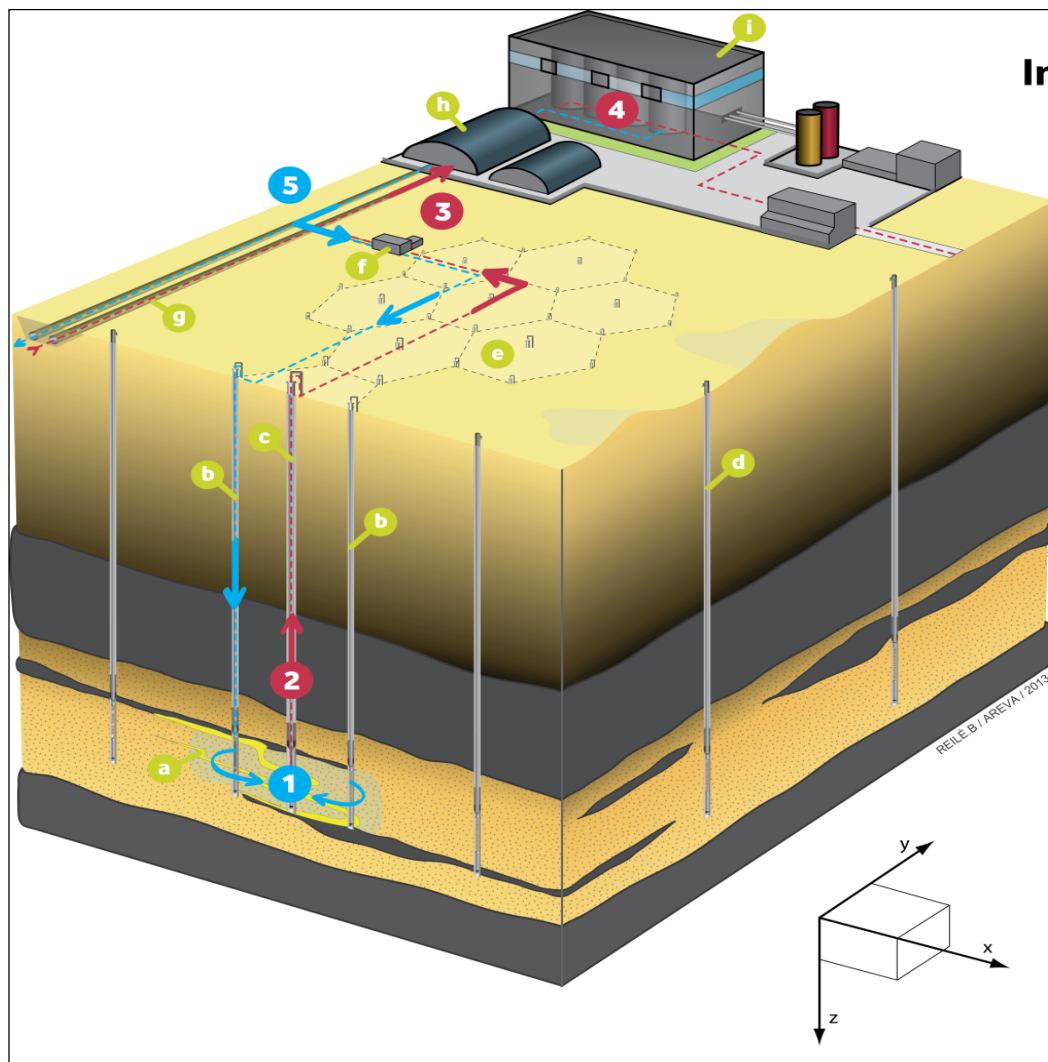
K2Ss2_U2_oxidized_zone	Drillholes_pre2012 by _75GT_TOTAL
Oxidized	4 to 100 (246)
K2Ss2_U2_reduced_zone	2 to 4 (314)
	0.4 to 2 (724)
	0.2 to 0.4 (226)
	0 to 0.1 (1177)
	all others (360)

4 to 100 (146)
2 to 4 (124)
0.4 to 2 (193)
0.2 to 0.4 (54)
0 to 0.1 (200)

0 750 1500 3000 Meters  
 WGS 1984, UTM zone 49N



# Mining Method: In-situ Recovery (ISR)



## In-Situ Recovery principles

### Processing

- 1 Depleted solution injection & Leaching**
  - 1.1 Reagent injection
  - 1.2 Uranium leaching & transportation
- 2 Pumping pregnant solutions**
  - 2.1 Pumping by submerged pump
  - 2.2 Transportation to well house
  - 2.3 Filtration and flow management
- 3 Pregnant solutions transportation**
  - 3.1 Transportation of pregnant solutions by pipelines
  - 3.2 Injection of pregnant solution in ponds
  - 3.3 Pumping to processing plant
- 4 Uranium treatment**
  - 4.1 Absorption
  - 4.2 Desorption
  - 4.3 Precipitation
  - 4.4 Filtration
  - 4.5 Drying/calcination
  - 4.6 Packaging & Shipping
- 5 Depleted solution transportation & Injection**
  - 5.1 Pumping of depleted solutions
  - 5.2 Transportation of depleted solution by pipelines
  - 5.3 Adding reagent in depleted solution
  - 5.4 Acid solution injection

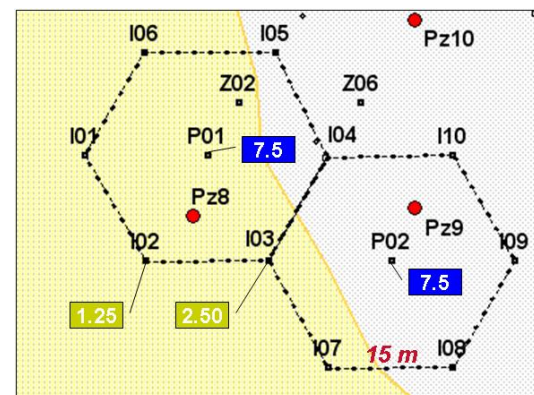
### Infrastructures

- |                             |                            |
|-----------------------------|----------------------------|
| <b>a</b> Uranium roll-front | <b>f</b> Wellhouse         |
| <b>b</b> Injection well     | <b>g</b> Primary lines     |
| <b>c</b> Production well    | <b>i</b> Decantation ponds |
| <b>d</b> Piezometric well   | <b>j</b> Treatment plant   |
| <b>e</b> Well field         |                            |



## ISR trial tests (pilot tests)

- ▶ **ISR test done in 2010-2011 on Dulaan Uul deposit (Umnut West orebody)**
  - ◆ 2 cells, operating during 6 months
- ▶ **Output: technical and economic parameters for **modifying factors** for ore reserve conversion**
  - ◆ Recovery (calculated after extrapolation of the test results): 75%
  - ◆ Results of the test used for the **first economical study** (feasibility study) for the mining projects of Dulaan Uul and Zoovch Ovoo (feb. 2015)
  - ◆ With the resources calculated at the time of this study, Mine-of-Life was estimated at 20 years, with 2,050 tU of annual extraction
- ▶ **>>> Already identified **additional resources** of Zoovch Ovoo & Dulaan Uul deposits **will significantly increase the Mine-of-Life****



# Discussion on UNFC classification for Uranium Projects



- ▶ **As of today, AREVA doesn't report under UNFC classification system, however:**
  - ◆ In our database of exploration projects we record the non-economic projects (although not publicly discloses)
  - ◆ UNFC classification could be applied to these non-economic projects
  
- ▶ **With the Bridging Document between the CRIRSCO template and the UNFC, a direct conversion is possible:**
  - ◆ UNFC could also be applied for the economical projects, with existing CRIRSCO R&R classification
  - ◆ both classifications could be recorded in the same Mineral Inventory database, for different purposes:
    - CRIRSCO R&R for Public Reporting
    - UNFC for strategical purposes and/or as per (possible) requests by State Agencies
  
- ▶ **>>> We see the UNFC as a valuable classification system for strategical purposes, especially for major mining companies (like AREVA) and for State Agencies**





*Zoovch Ovoo landscape, South-Eastern area of Zoovch Ovoo deposit, May 2014*

***Thank you for your attention - Баярлалаа***