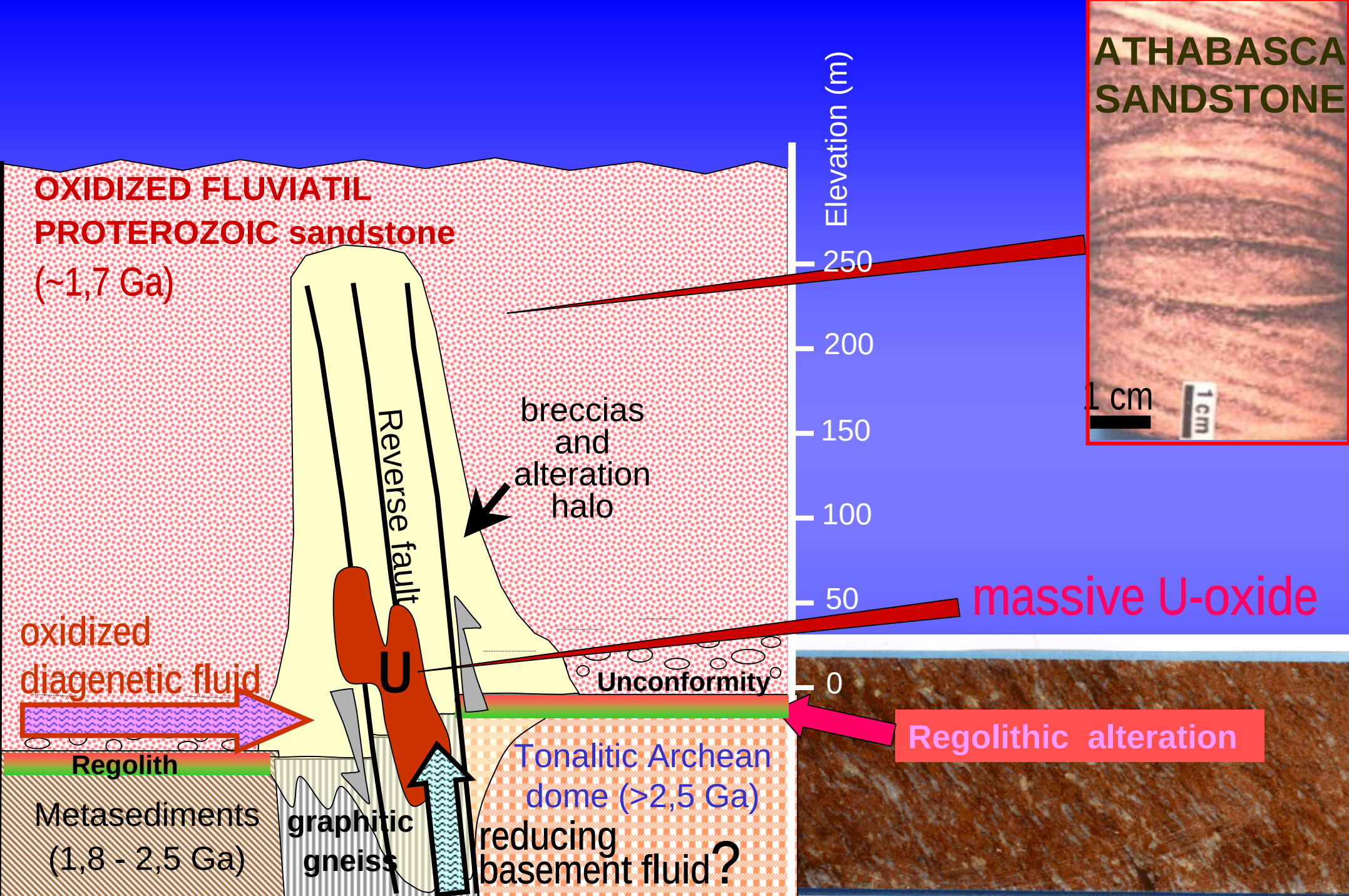
Unconformity related uranium deposits

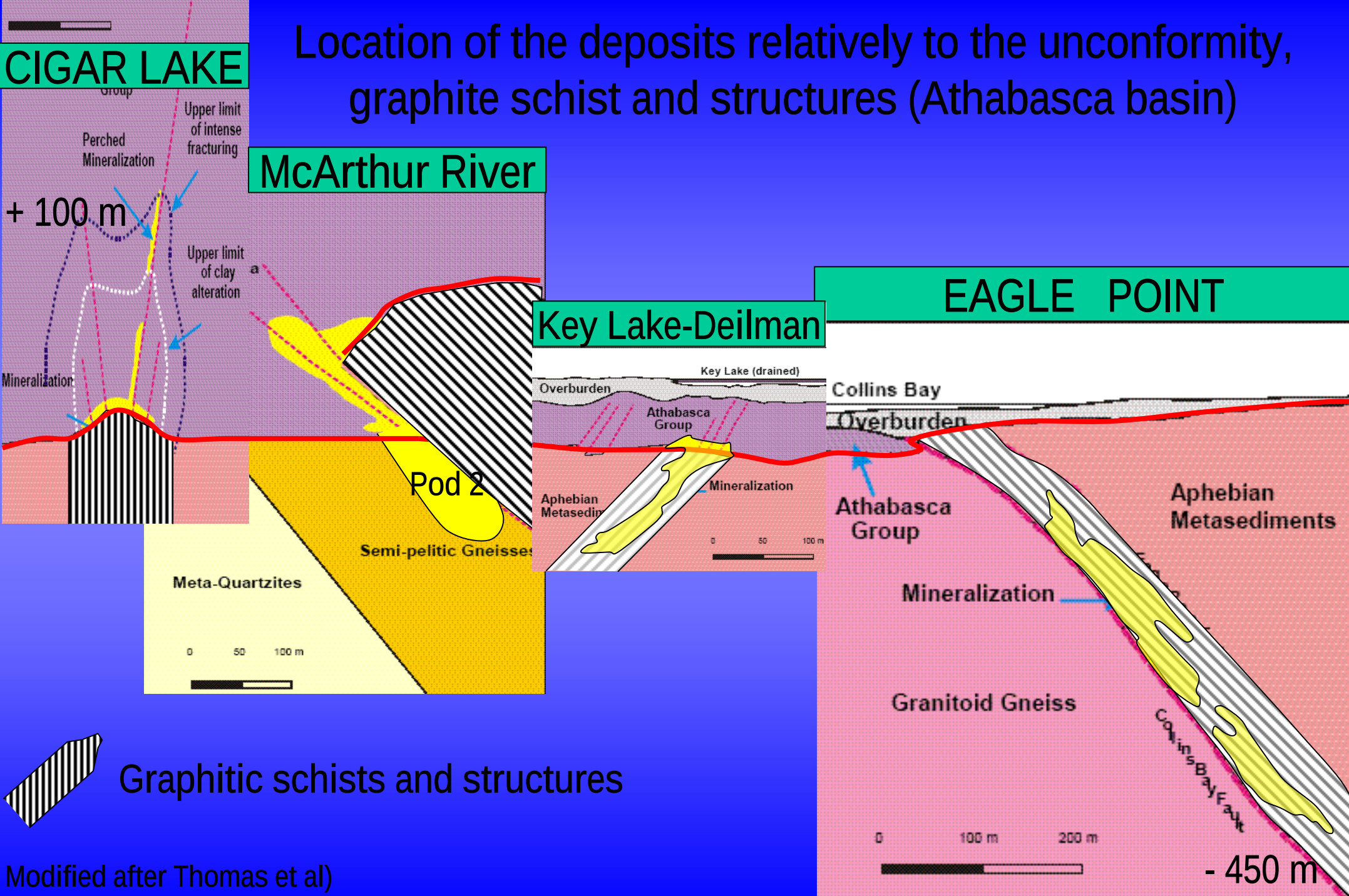
Michel CUNEY

UMR G2R – CNRS – Henri Poincaré - Nancy I University
CREGU
Centre de Recherche sur la Géologie des Matières Premières Energétiques et Minérales

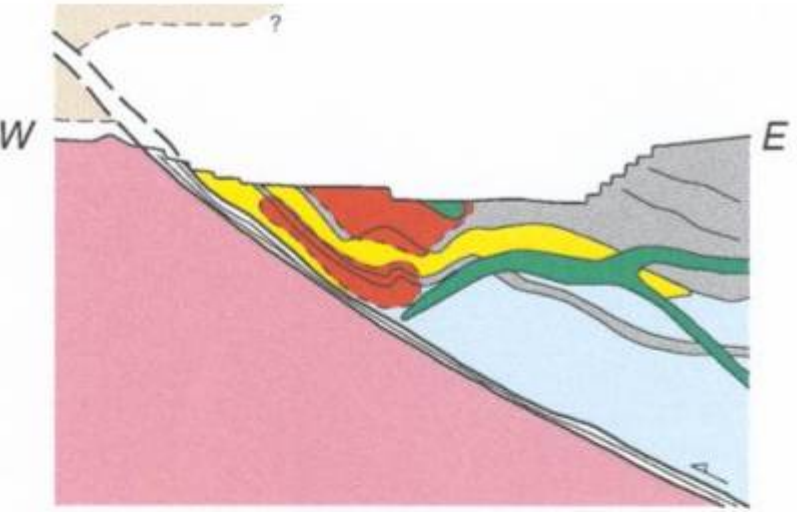

OXIDIZED FLUVIATIL
PROTEROZOIC sandstone
(~1,7 Ga)
Reverse fault
breccias
and
alteration
halo
U
oxidized
diagenetic fluid
Unconformity
Regolith
Metasediments
(1,8 - 2,5 Ga)
graphitic
gneiss
Tonalitic Archean
dome (>2,5 Ga)
reducing
basement fluid ?
Elevation (m)
250
200
150
100
50
0
massive U-oxide
Regolithic alteration
ATHABASCA
SANDSTONE
1 cm
1 cm

KOMBOLGIE SANDSTONE (North Territory, Australia)

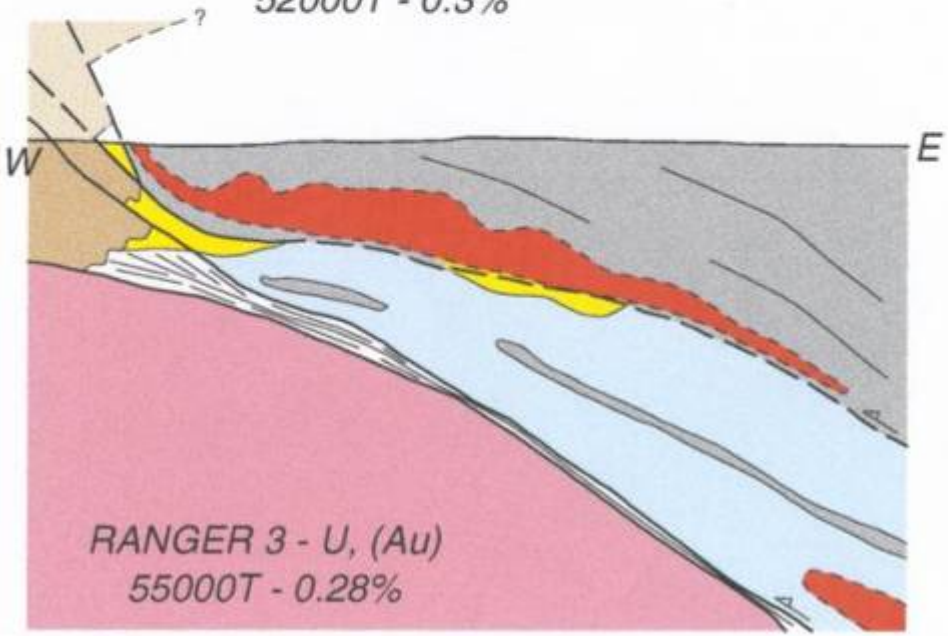
Location of the deposits relatively to the unconformity, graphite schist and structures (Athabasca basin)

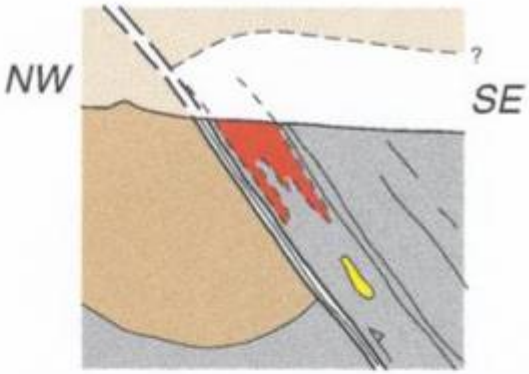


EAST ALLIGATOR RIVER DEPOSITS (Australia)

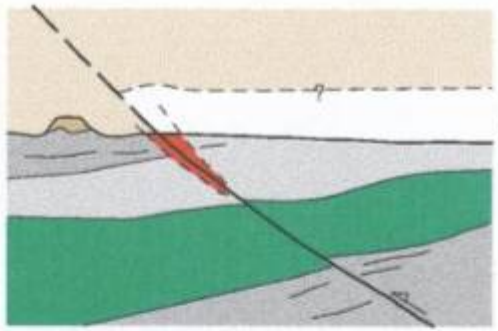


RANGER 1 - U, (Au)
52000T - 0.3%

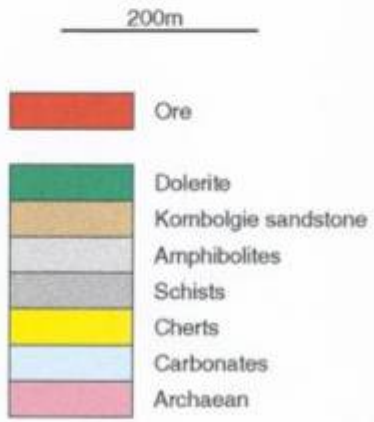


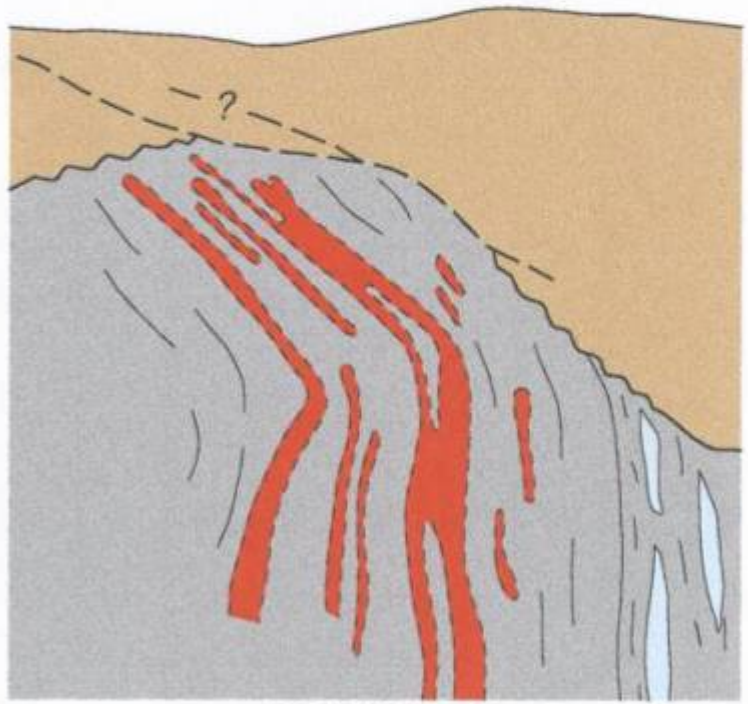


KOONGARRA - U, Au
14500t - 0.79%



NABARLEK - U, ((Au))
10800t - 1.95%





JABILUKA - U, Au
90000t - 0.46%

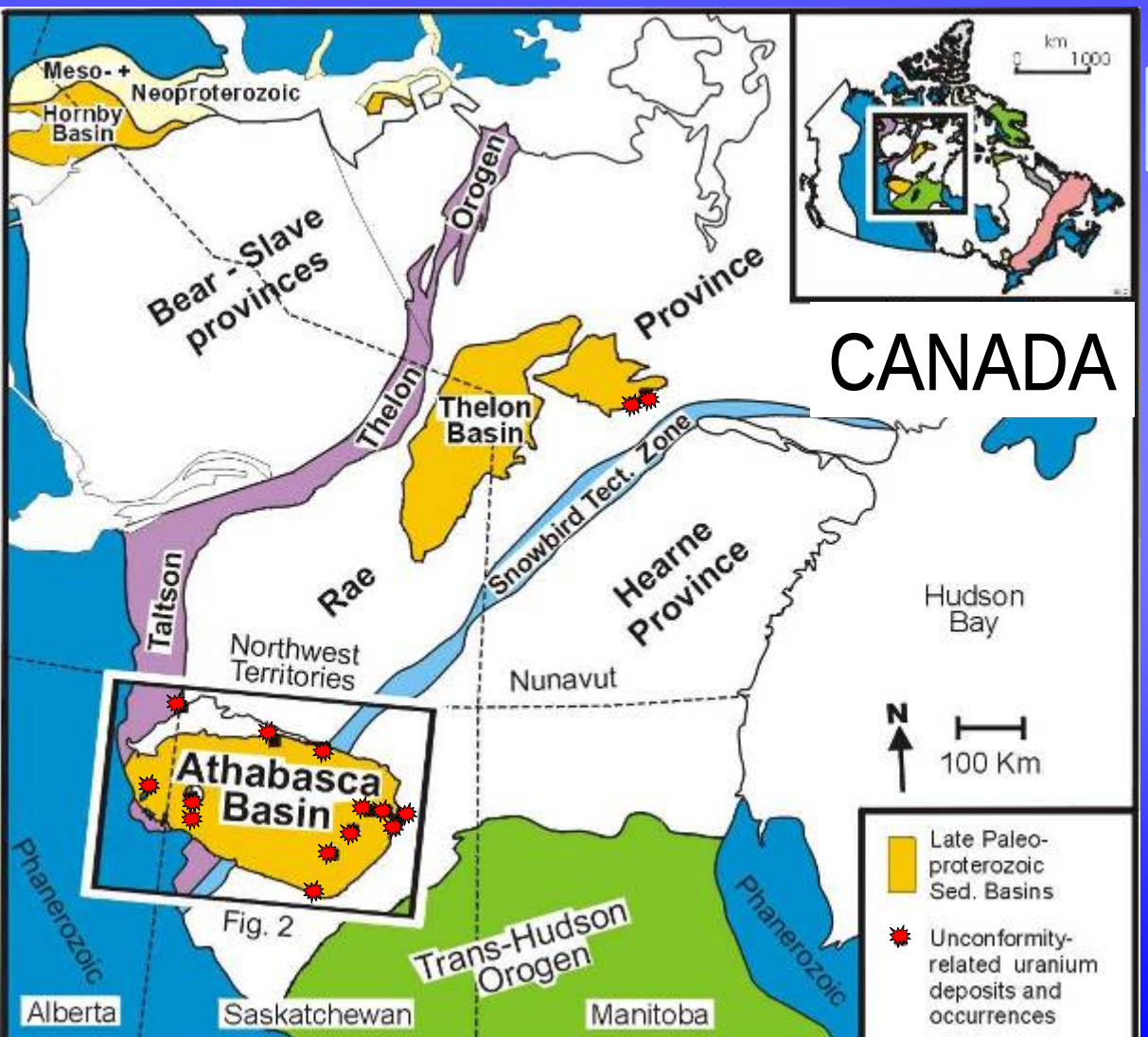
2 - Tonnage - teneurs des principaux gisements liés aux discordances

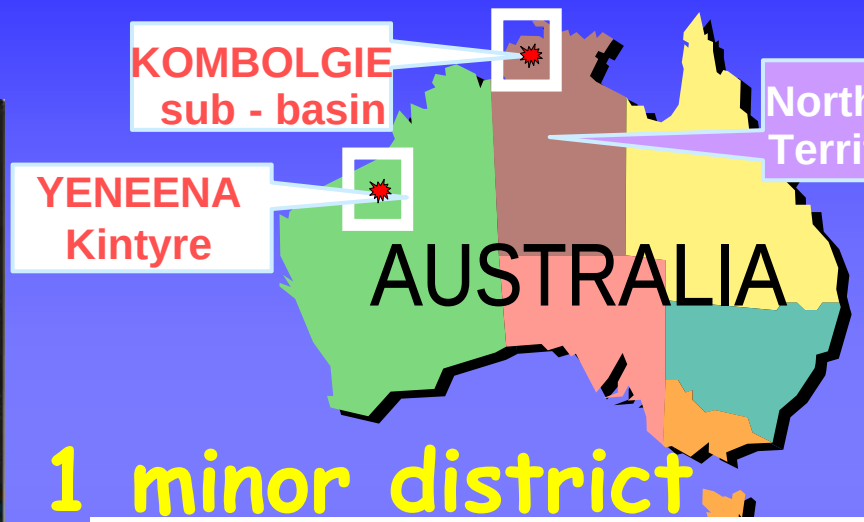
		tons U	U %	
Athabasca > 500 000 t U	McArthur River	220,000@	17.4	in operation
	Cigar Lake	142,000 @	15	in preparation
	Key Lake	68,000 @	2.3	exhausted
	Eagle Point	50,900 @	1.4	in operation
	Cluff district	24,000 @	0.92	exhausted
	Collins Bay (A,B,C)	19,890 @	1.44	exhausted
	Rabbit Lake	16,250 @	0.27	exhausted
	Sue (A,B,C,D,E)	16,050 @	1.5	in operation
East All.R. > 200 000 t U	Jabiluka 1	2,800 @	0.25	in exploration
	Jabiluka 2	90,400 @	0.46	stand-by
	Koongarra 1	14,500 @	0.79	stand-by
	Ranger 1	54,000 @	0.35	exhausted
	Ranger 3	56,500 @	0.31	in operation
	Nabarlek	11,500 @	1.86	exhausted

Dernière découverte majeure 1988

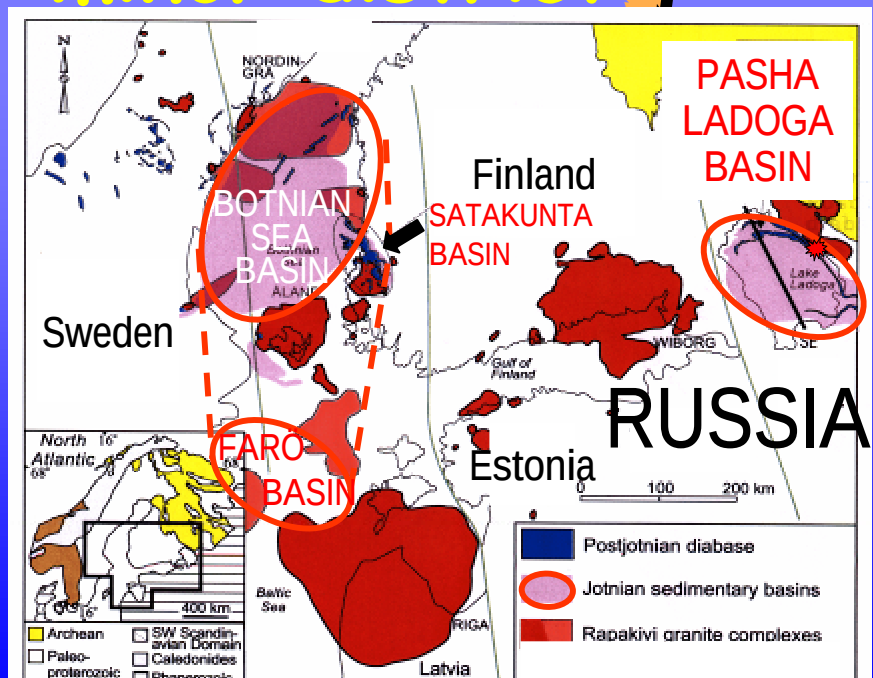
3 – IDENTIFICATION of FAVORABLE BASSINS

2 major districts:



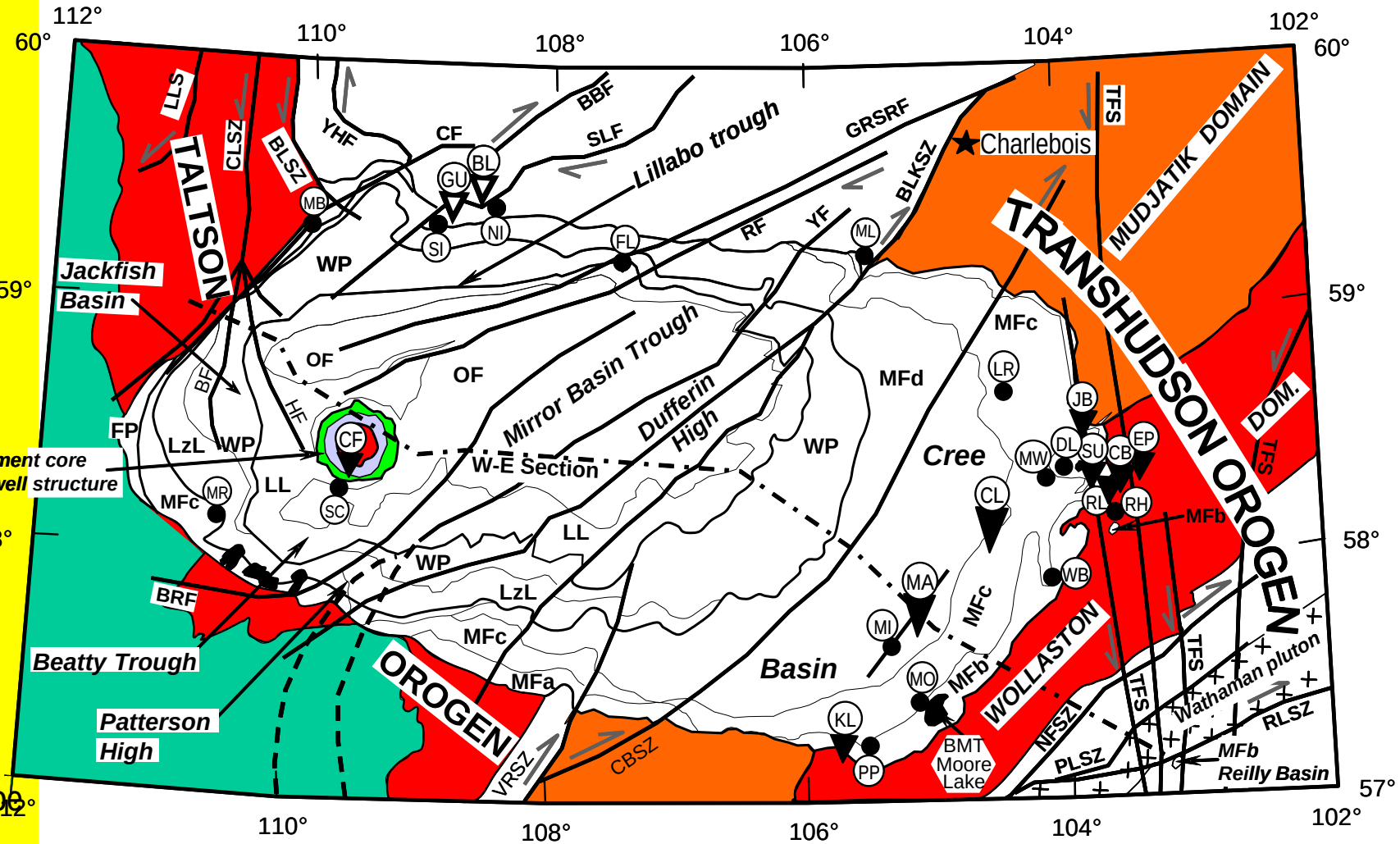


1 minor district



ATHBASCA BASIN AREA GEOLOGY & U DEPOSITS

BL = Beaverlodge
CB = Collins Bay
CF = Cluff Lake
CL = Cigar Lake
DL = Dawn Lake
EP = Eagle Point
FL = Fond du Lac
GU = Gunnar
JB = Jeb
KL = Key Lake
LR = La Roque
MA = McArthur R.
MB = Maurice Bay
MI = Millenium
ML = MacLean
MO = Moore Lake
MR = Maybelle R.
MW = Midwest
NI = Nicholson
PP = P Patch
RH = Raven Horseshoe
RL = Rabbit Lake
SC = Shea Creak
SU = Sue
SI = Stewart Island
WB = West Bear



★ Hudsonian U mineralization
▽ Late-Hudsonian U deposit
▼ Very large unconf. related U deposit
▼ Large unconf. related U deposit
● Not mined U deposit or U showings

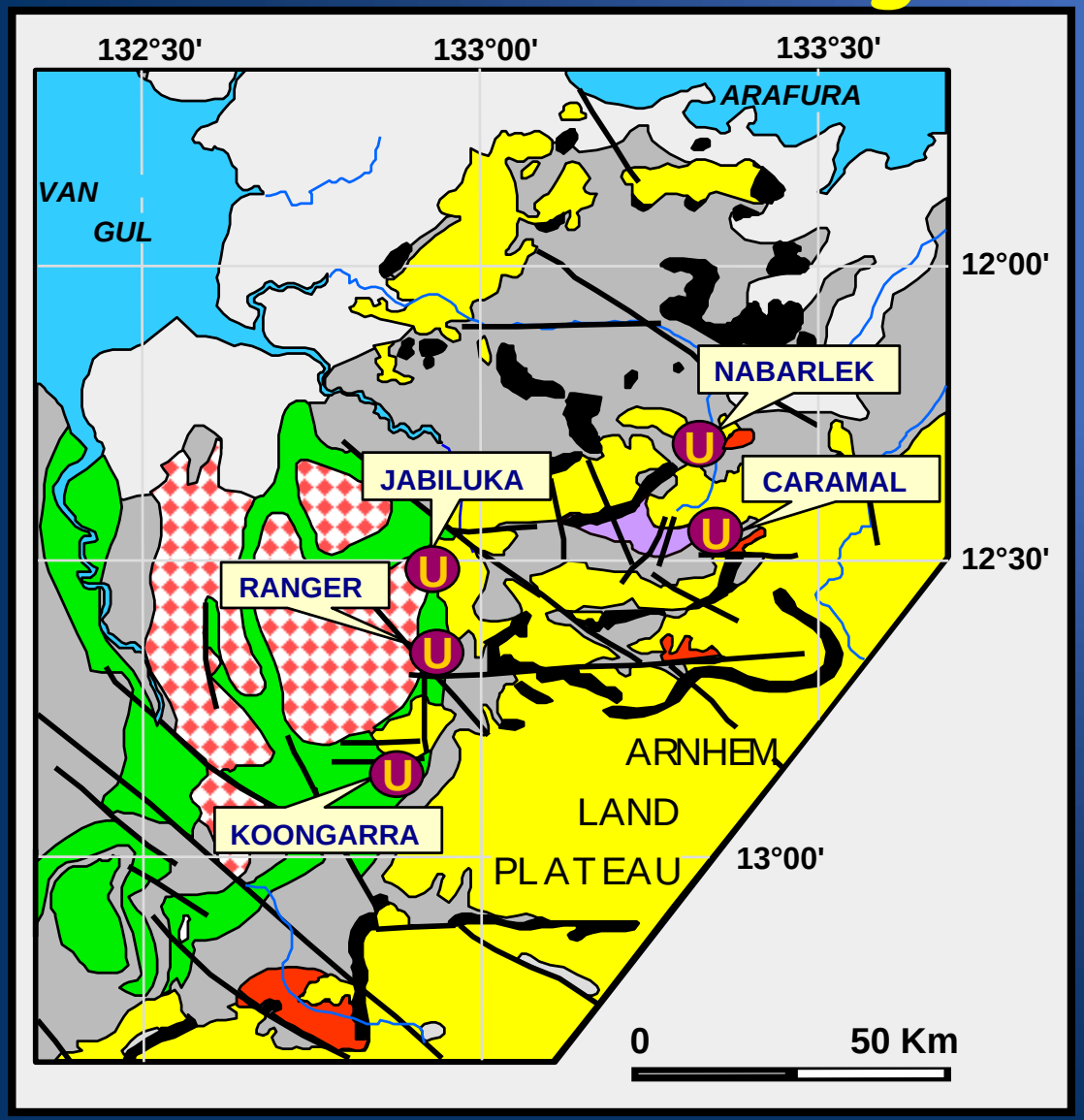
Douglas Formation
Carswell Formation
Paleozoic sediments

FP = Fair Point, MFa - MFd = Manitou Falls, LZ = Lazenby Lake, WP = Wolverine Point, LL = Locker Lake, OF = Otherside

modified from Ramaekers and Catuneanu, 2004

UNCONFORMITY TYPE U-DEPOSIT

Kombolgie sub-Basin



Middle Proterozoic

Kombolgie Formation

Early-Middle Proterozoic

Oenpelli Dolerite

Early Proterozoic

Jim Jim, Tin Camp and Nabarlek Granites

Nourlangie Schist

Cahill Formation

Kakadu Group

Archean-Early Proterozoic

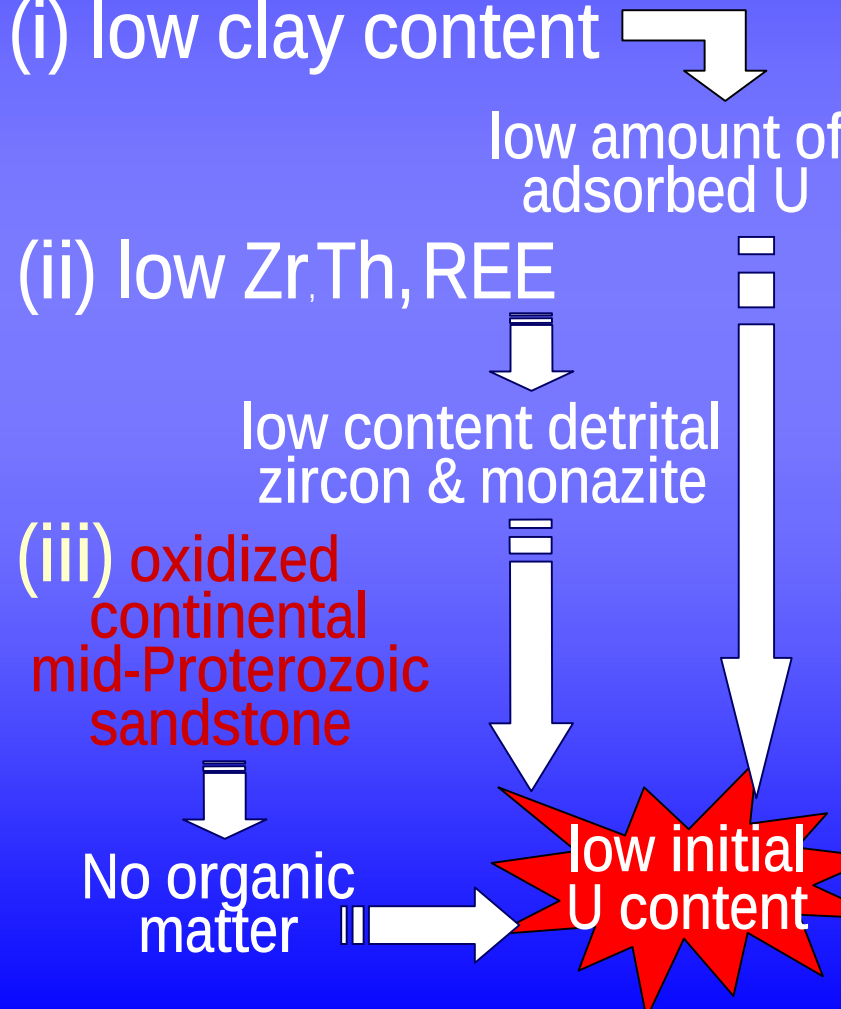
Nanambu Complex

(i) Athabasca sandstone as a major U-source ?

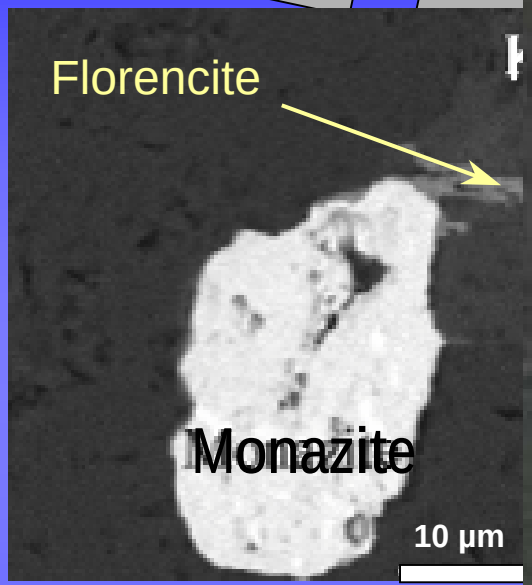
Initial U-content of the Athabasca sandstone ?

	West Athabasca	Central Athabasca	East Athabasca	TOTAL Athabasca	Kombolgie
SiO_2	97.27	96.18	96.04	96.74	94.37
Th	4.7	8.2	16.5	9.0	7.0
U	1.4	0.9	1.3	1.3	1.1
Zr	136	160	259	179	102
La	11.1	17.5	19.4	14.6	15.4
n	*147*	*31*	*86*	*264*	*122*

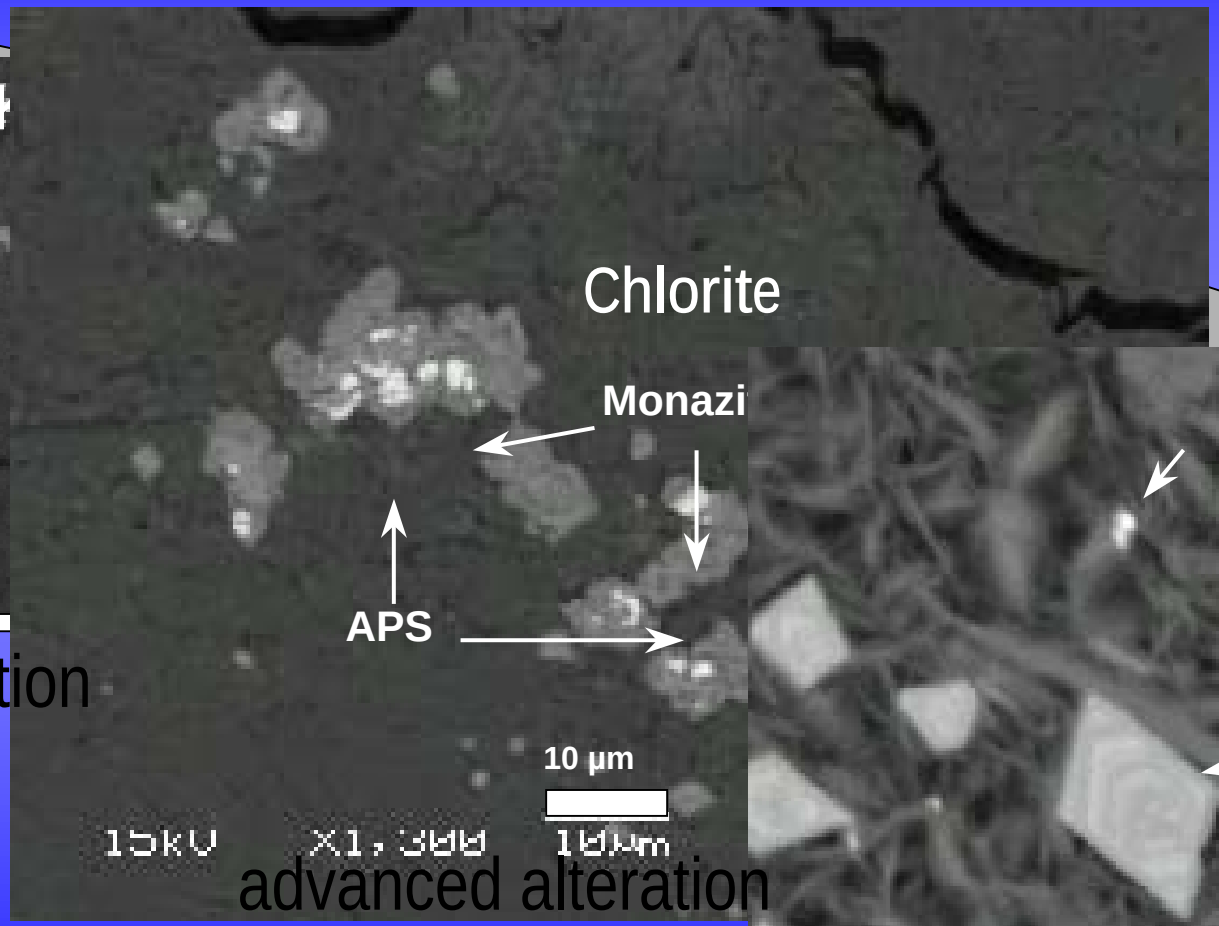
Samples outside mineralized areas



MONAZITE ALTERATION TO ALUMINOPHOSPHATES-SULFATES



Incipient alteration



advanced alteration

aluminophosphates-sulfates

U MOBILIZATION MECHANISM

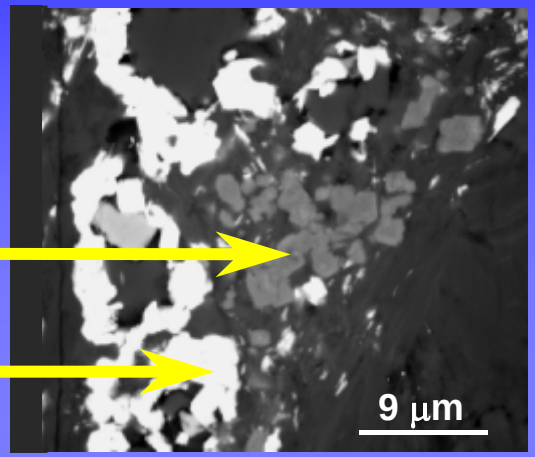
Redistribution of U liberated from MONAZITE alteration both:

- in the altered basement
- in the sandstone

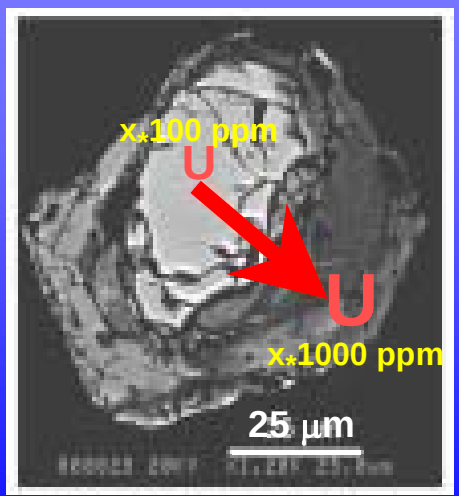
x 1000ppmU)

(i) Florencite [REE-Ca-Al phosphate]

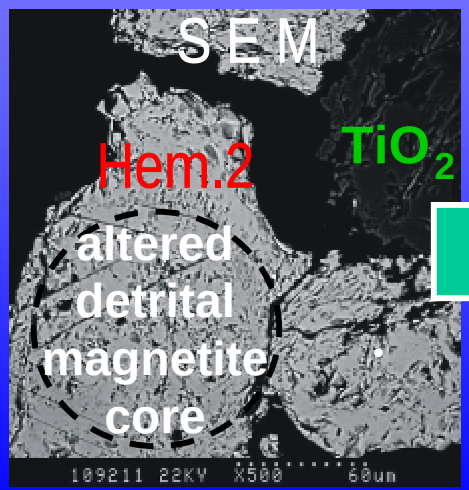
(ii) + Th-silico-phosphate

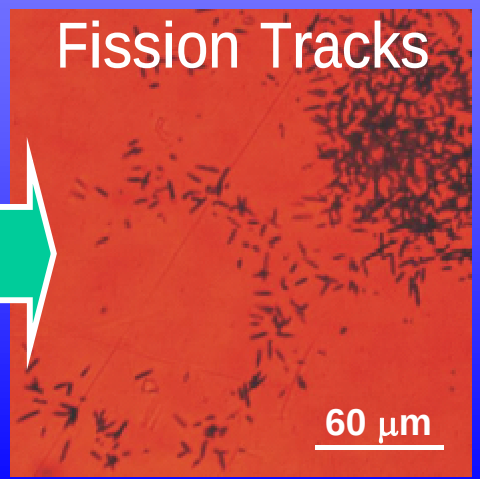


(ii) Zircon alteration



(iii) Trapping on Fe- & Ti- oxides





(iv) xenotime overgrowths on zircon (poor in uranium)

(v) Fluid transfert ?

(ii)

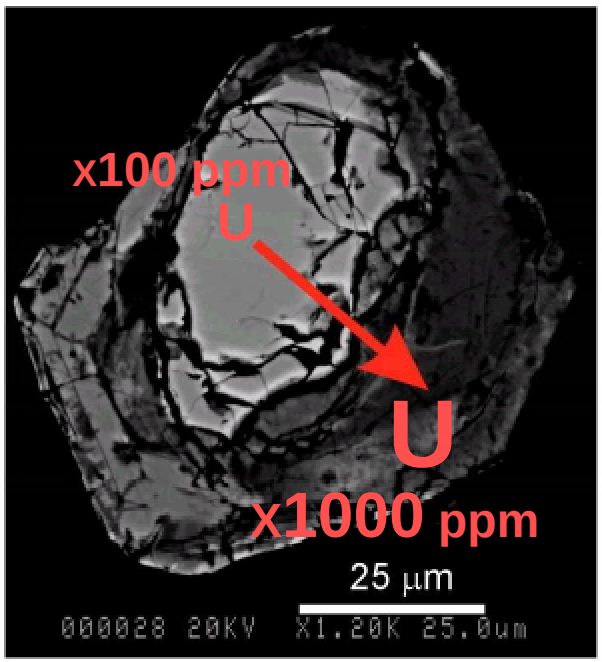
The metamorphic –igneous basement

as a major U-source ?

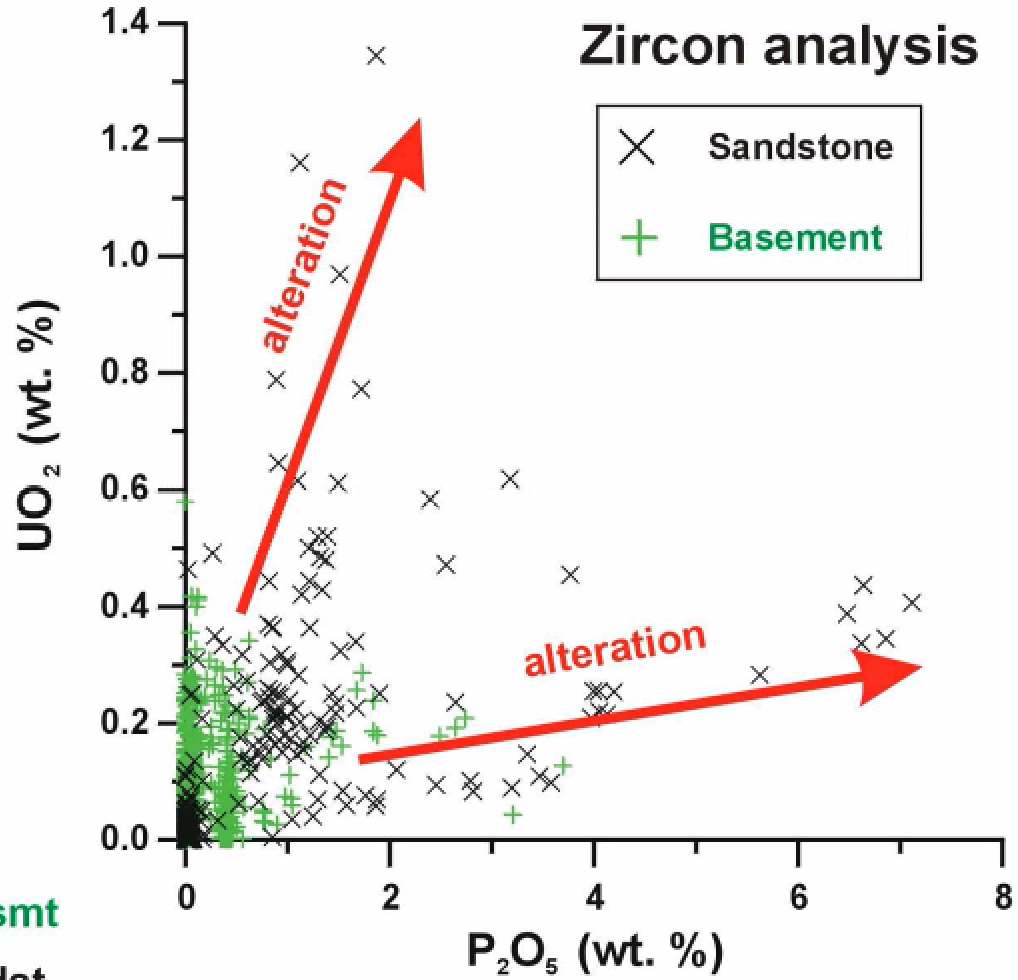
U MOBILISATION MECHANISM from the SOURCES :

L. Hecht & M. Cuney 1999

Zircon alteration



Zircon in sandstone ERC 1 - 763.66



Average U-contents of unaltered zircons

UO_2 = 0.09 wt.% (n=565) bsmt

UO_2 = 0.05 wt.% (n=128) sdst

cregu

(ii) Basement as a major U-source ?

URANIUM PRECONCENTRATIONS IN THE BASEMENT

- **pre-metamorphic**
  - **Paleoproterozoic epicontinental platform sediments :**
    - **Metamorphosed black shales**
    - **U-rich meta-arkoses, …**
- **syn-metamorphic (U fractionation during partial melting)**
  - **Leucogranites and pegmatoids**
  - **i.e : Charlebois « alaskites » in the Wollaston belt**
- **post-metamorphic pre-Athabasca**
  - **Taltson & Hudsonian high-K, Th, U calcalkaline granitoids**
  - **Vein type U-deposits (Beaverlodge (1.8 Ga)**
  - **Episyenite type U-deposit (Gunnar)**

Plenty of basement U-rich lithologies, some are weakly reduced