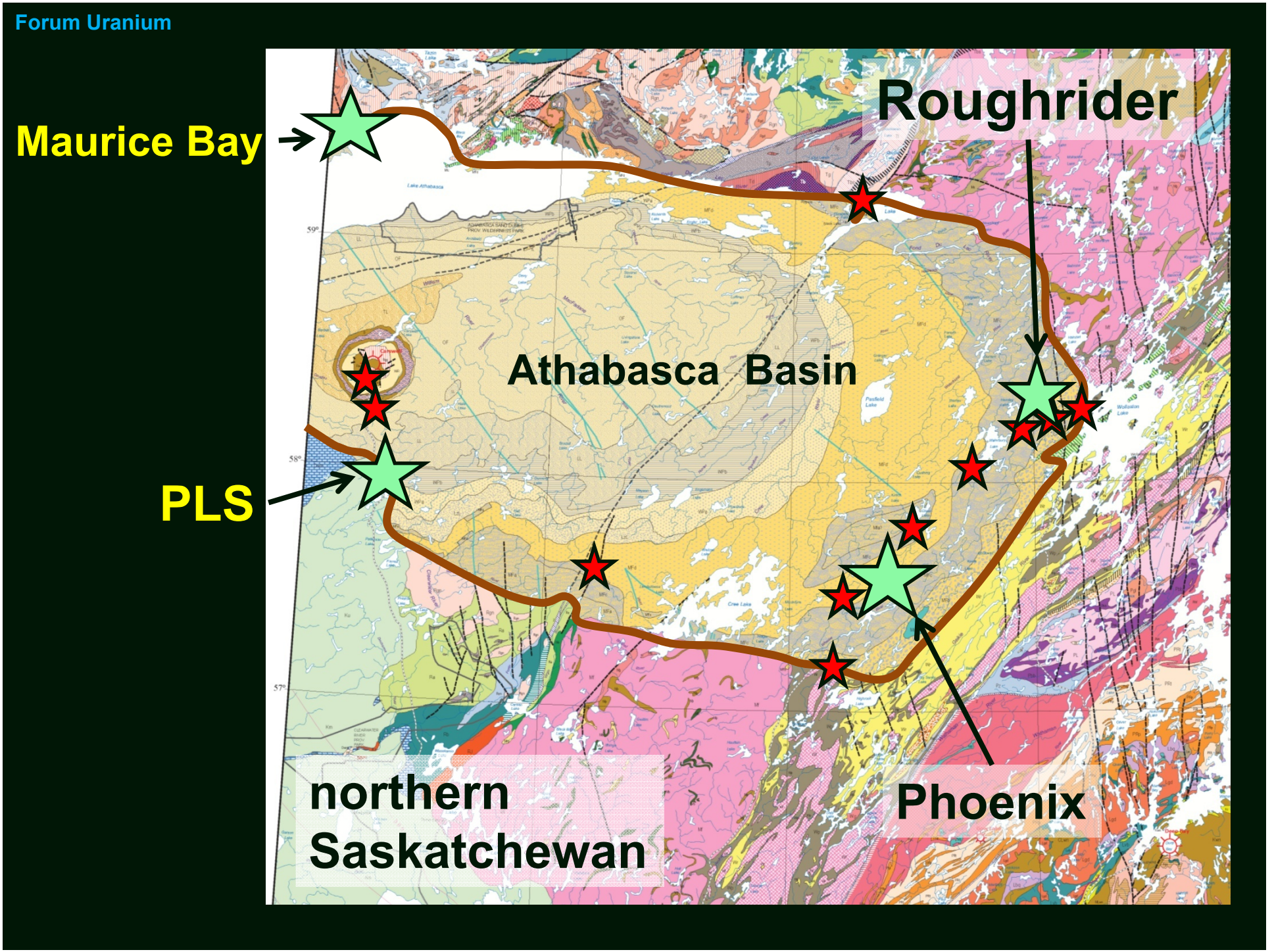

The successful application of modern exploration techniques to previously explored areas in the Athabasca Basin, Canada
Or . . . New discoveries in the four corners of the basin
Ken Wheatley
Forum Uranium


Maurice Bay
PLS
Roughrider
Athabasca Basin
northern Saskatchewan
Phoenix

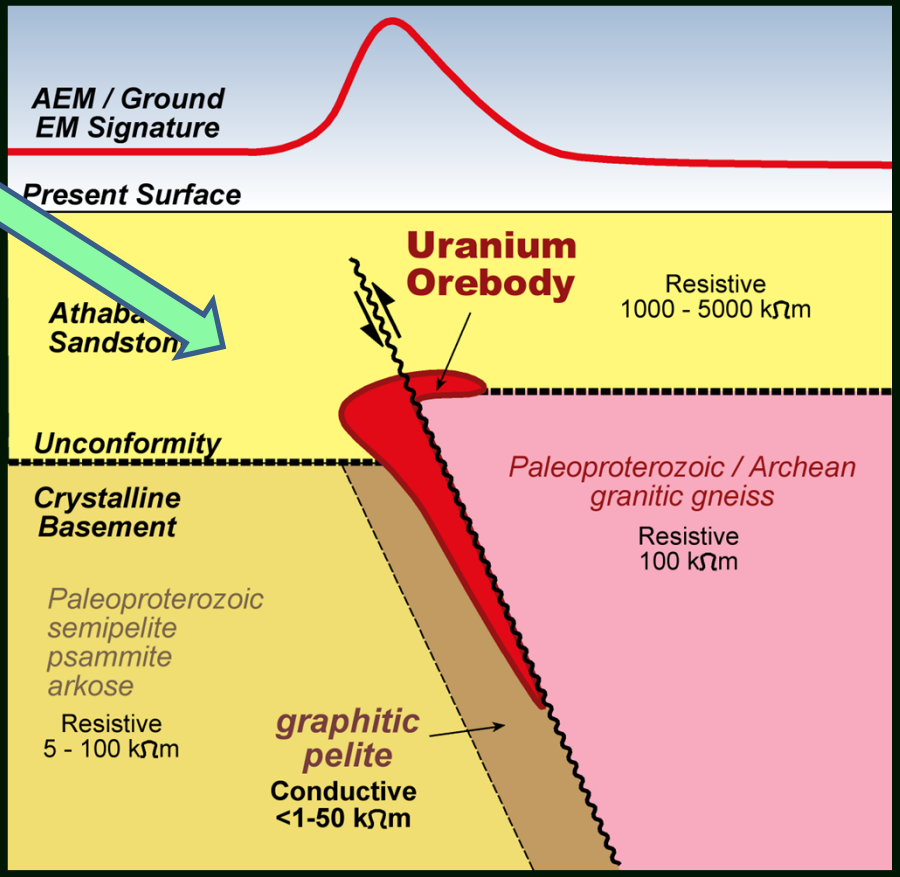
# Evolution of uranium deposit models in the Athabasca

**Roll front in sandstones and vein type in basement in early ‘70s**

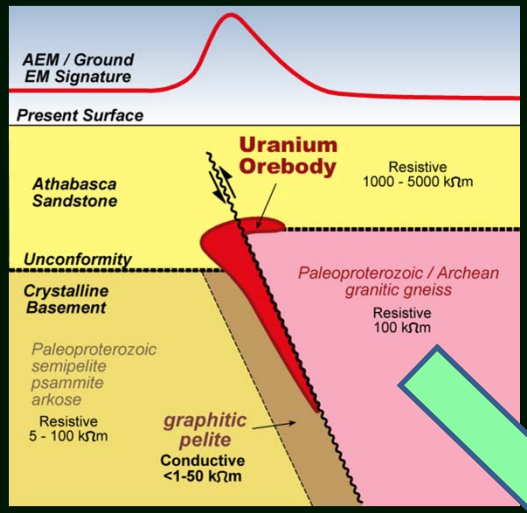
**Unconformity deposits: Key Lake (1975)**

**sandstone**

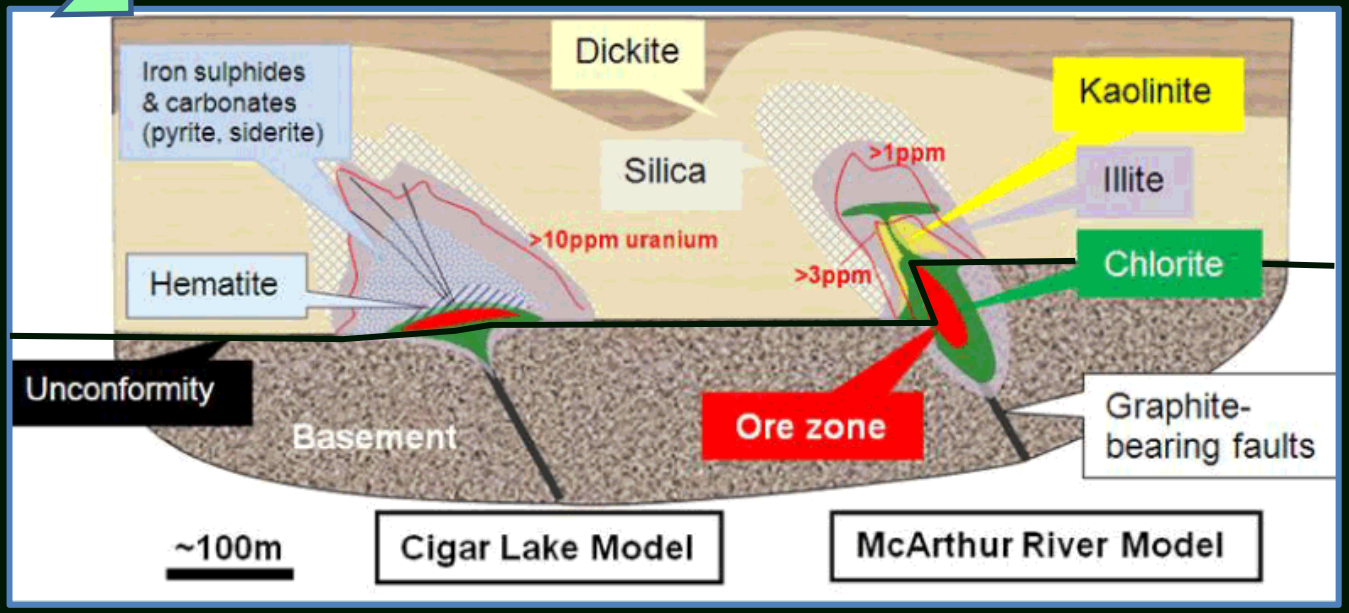
**basement**



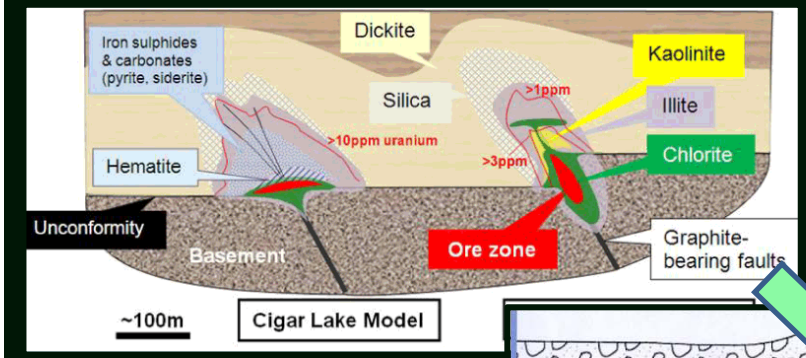
# Evolution of uranium deposit models in the Athabasca



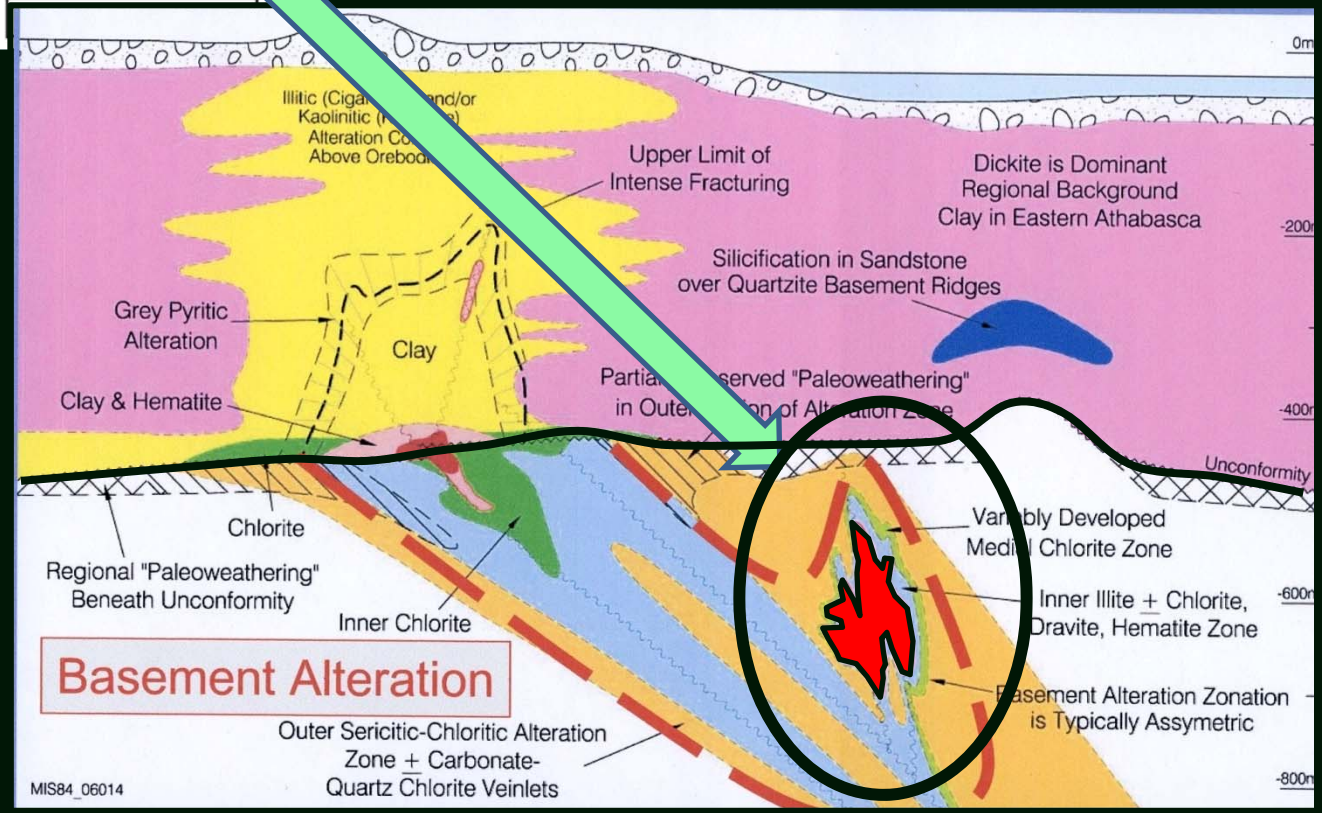

Cigar (1980) and McArthur (1988)



# Evolution of uranium deposit models in the Athabasca




**P-Patch (1997), Millennium (2000) and Roughrider (2008)**




(from Cameco)

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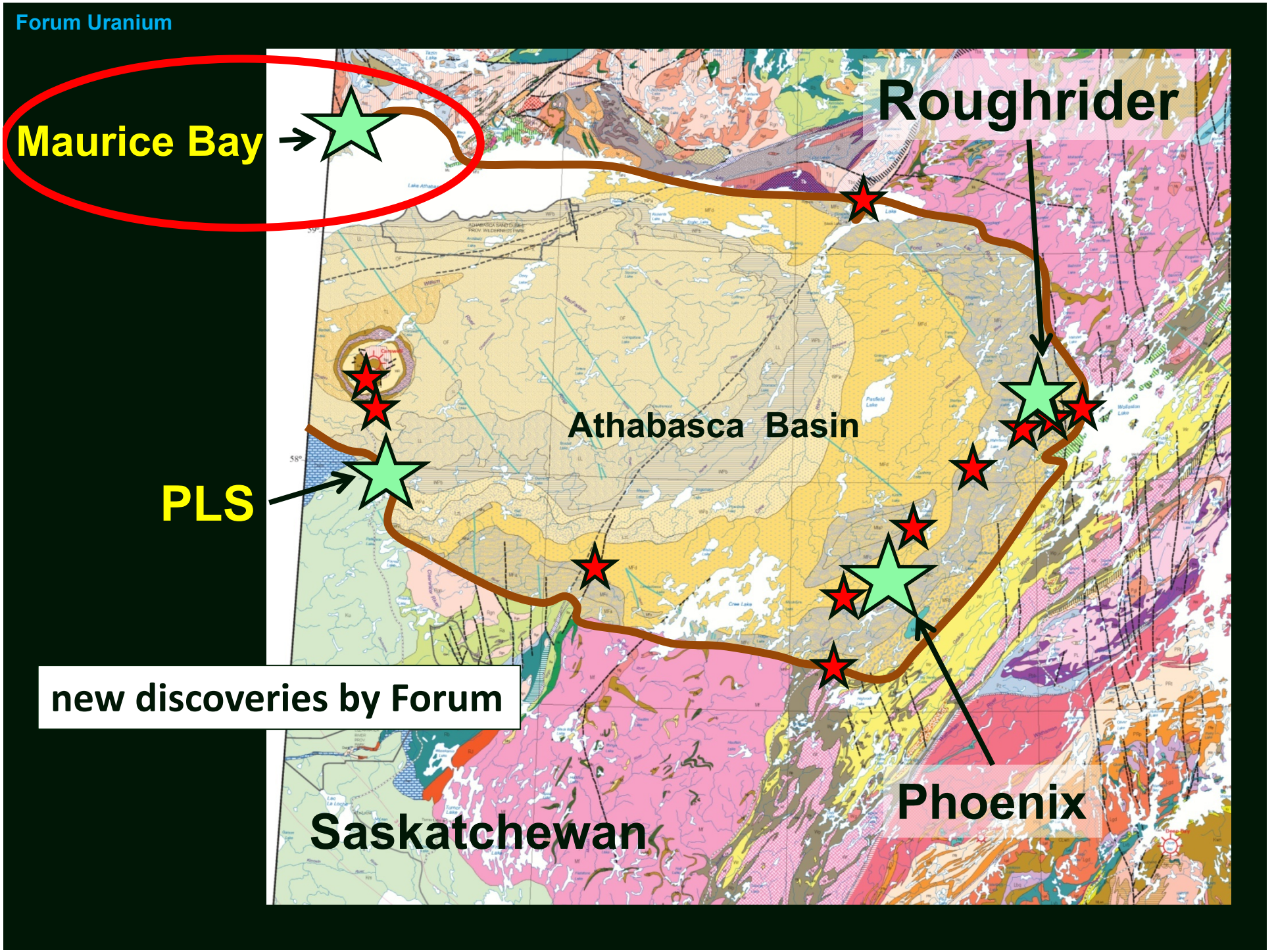
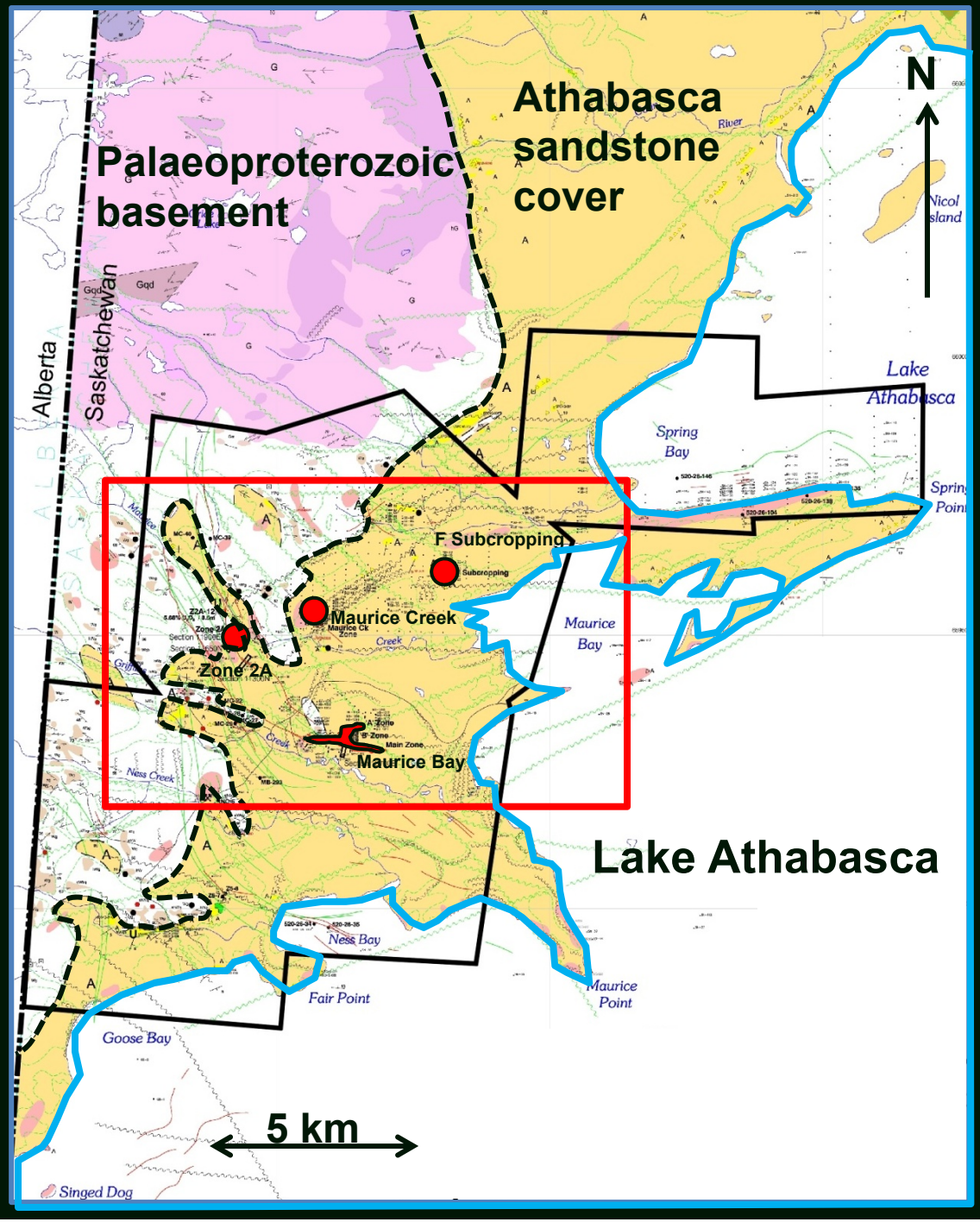


The project was successfully worked by Uranerz in the 70's and early 80's:

- Maurice Bay
- Maurice Creek
- F Subcropping
- Zone 2A

The area was explored again from 2004 to 2008: mag and EM surveys, 10 drill holes but no success

Both companies used the Key Lake deposit model

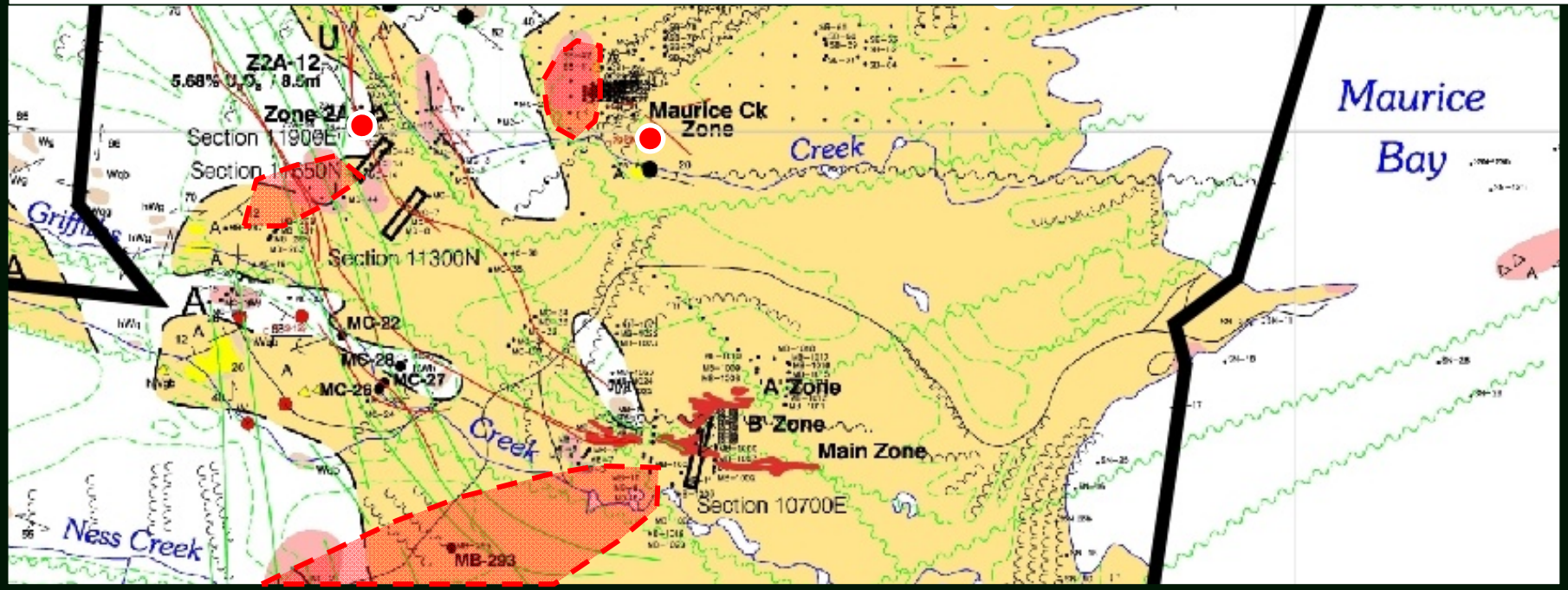


# Maurice Bay

**The historic showings were found mostly by surface prospecting: boulder fans were followed up to the apex and drilled.**

**Forum Uranium started exploring in 2012:**

**Current work is looking for basement-hosted Millennium style deposits (gravity low, boron halo, EM conductor)**



Maurice Bay

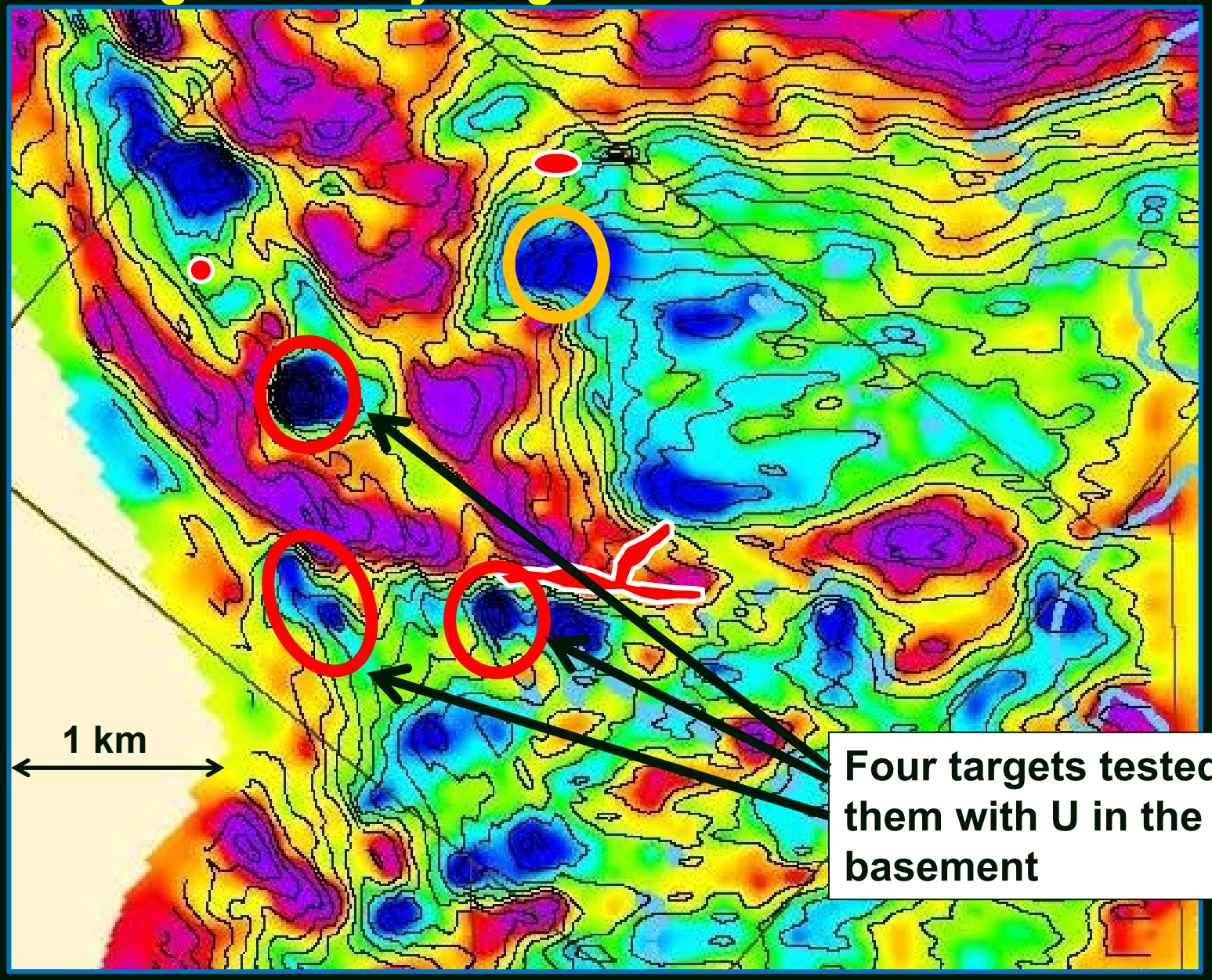
# Ground Gravity of the NWA Project - filtered

19 gravity lows

2 km

Maurice Bay

# Testing of Gravity Targets



Maurice Bay

# Density measurements: sandstone

fresh sandstone: 2.42 gm/cc

altered sandstone: 2.06 gm/cc

Maurice Bay

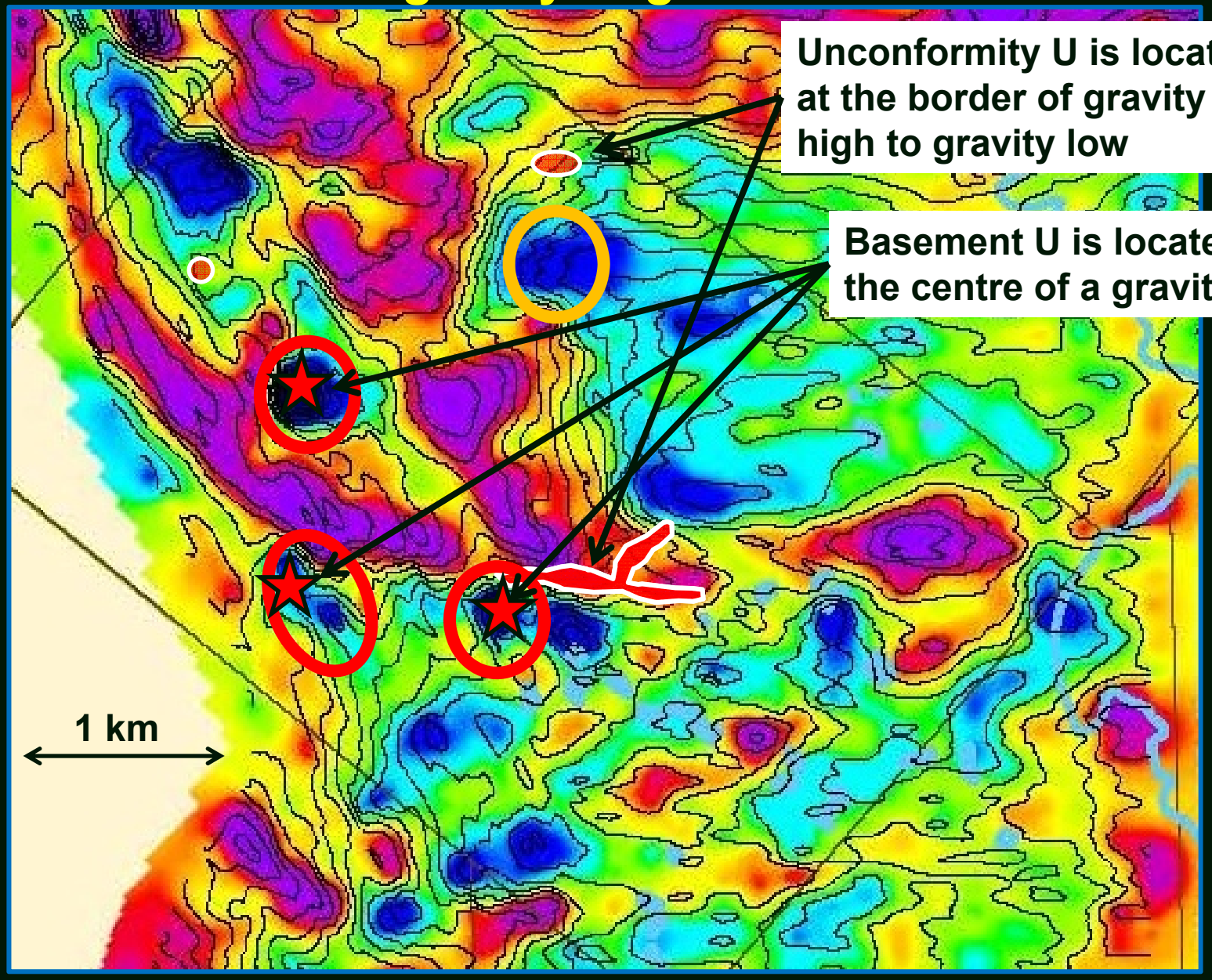
# Density measurements: basement

fresh basement: 2.71 gm/cc

altered basement: 2.29 gm/cc

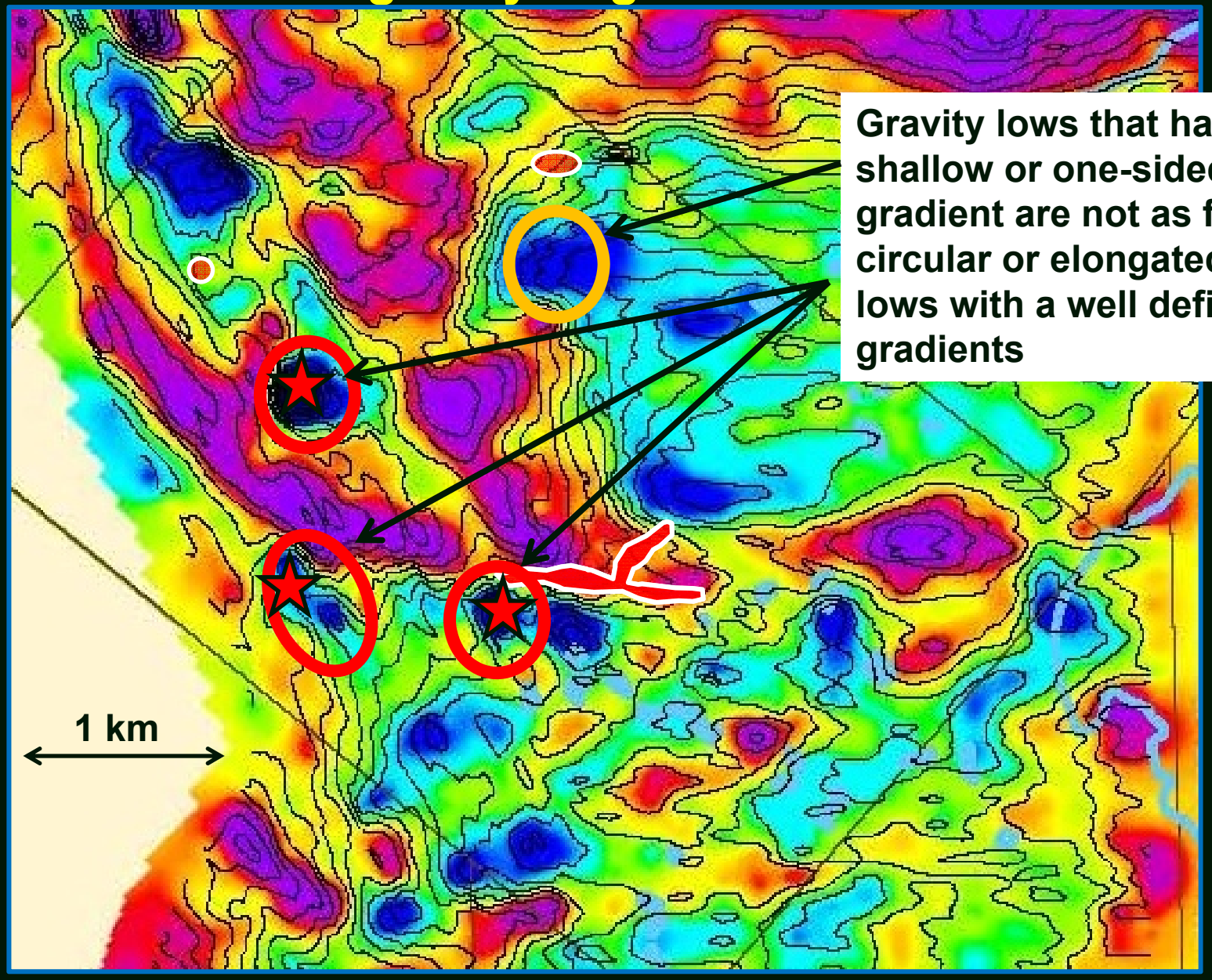
Maurice Bay

# Conclusions of gravity targets 1



Maurice Bay

# Conclusions of gravity targets 2



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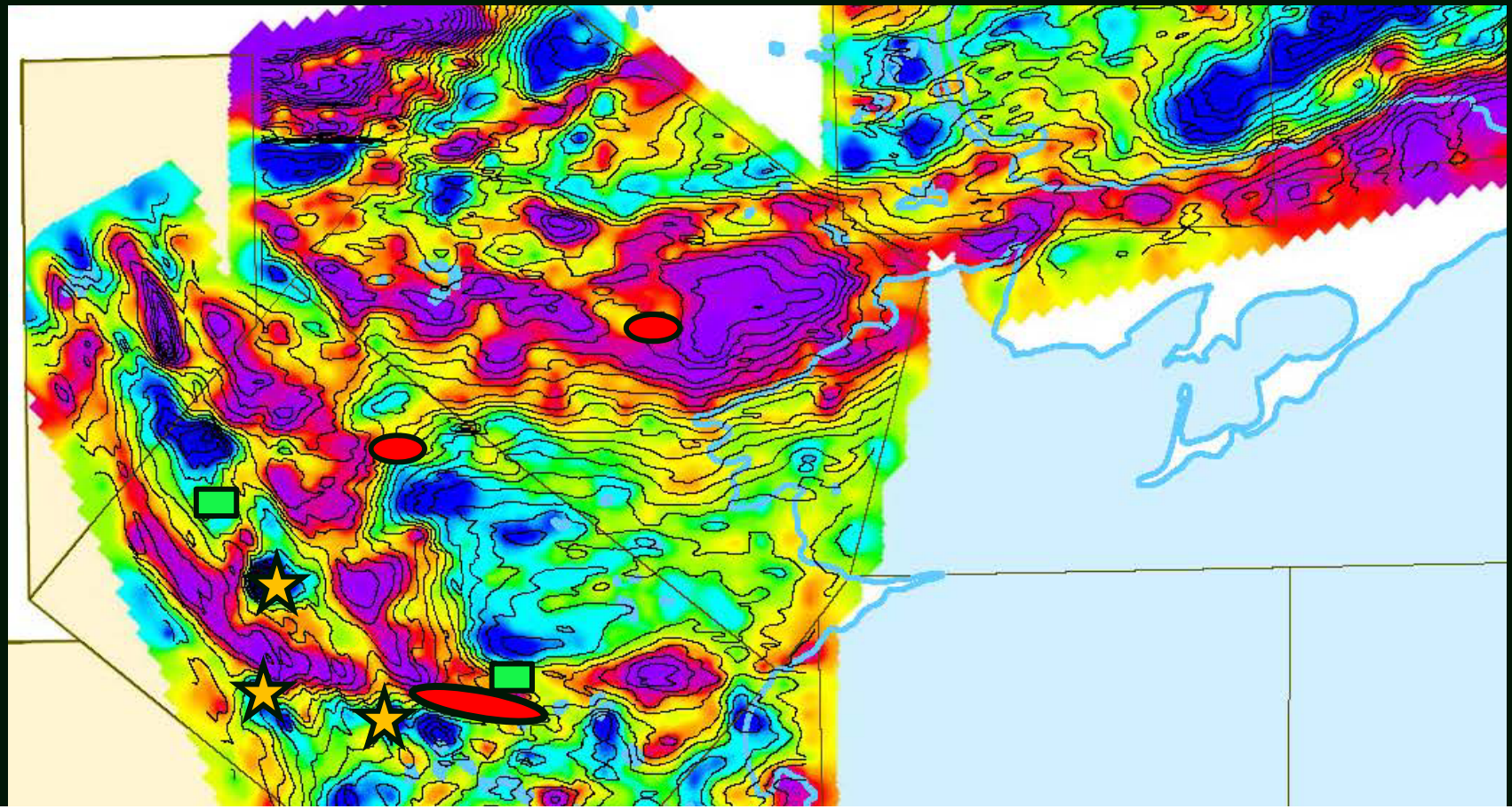
# 3 Types of U Mineralization

**Maurice Bay**

| Unconformity | Basement (Vein Type) | Basement (Millennium Type) |
|---|---|---|
| 0.1 to 0.6% U | 1 to 9% U | 0.1 to 2.8% U |
| Maurice Bay | Zone 1A | Opie |
| Maurice Creek | Zone 2A | Barney |
| F-Subcropping | | Otis West |



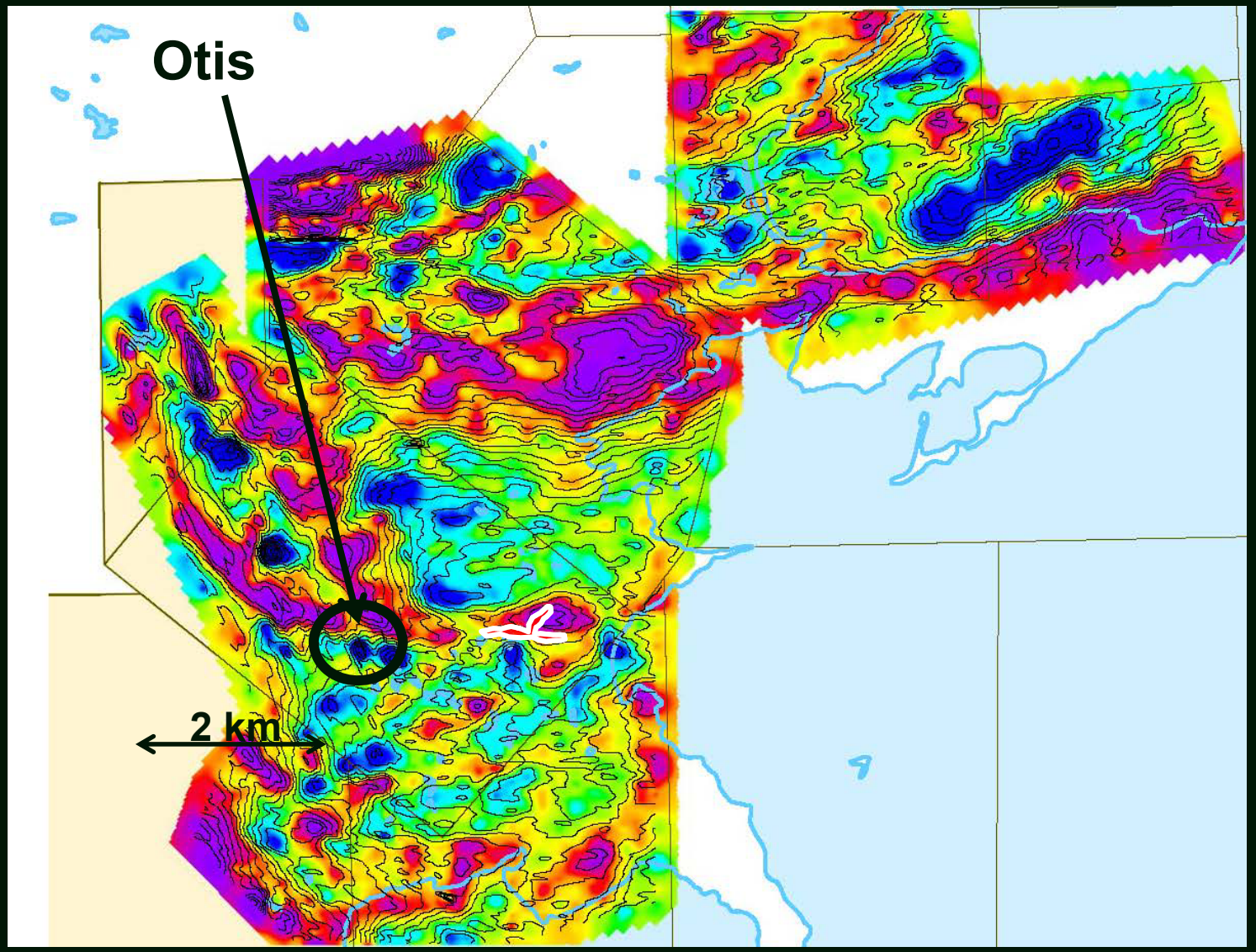
Maurice Bay

# Basement Hosted Vein Type Mineralization

## Zone A mineralization ( 1 to 9.6% U )

Maurice Bay

# Basement Hosted Millennium Type Mineralization

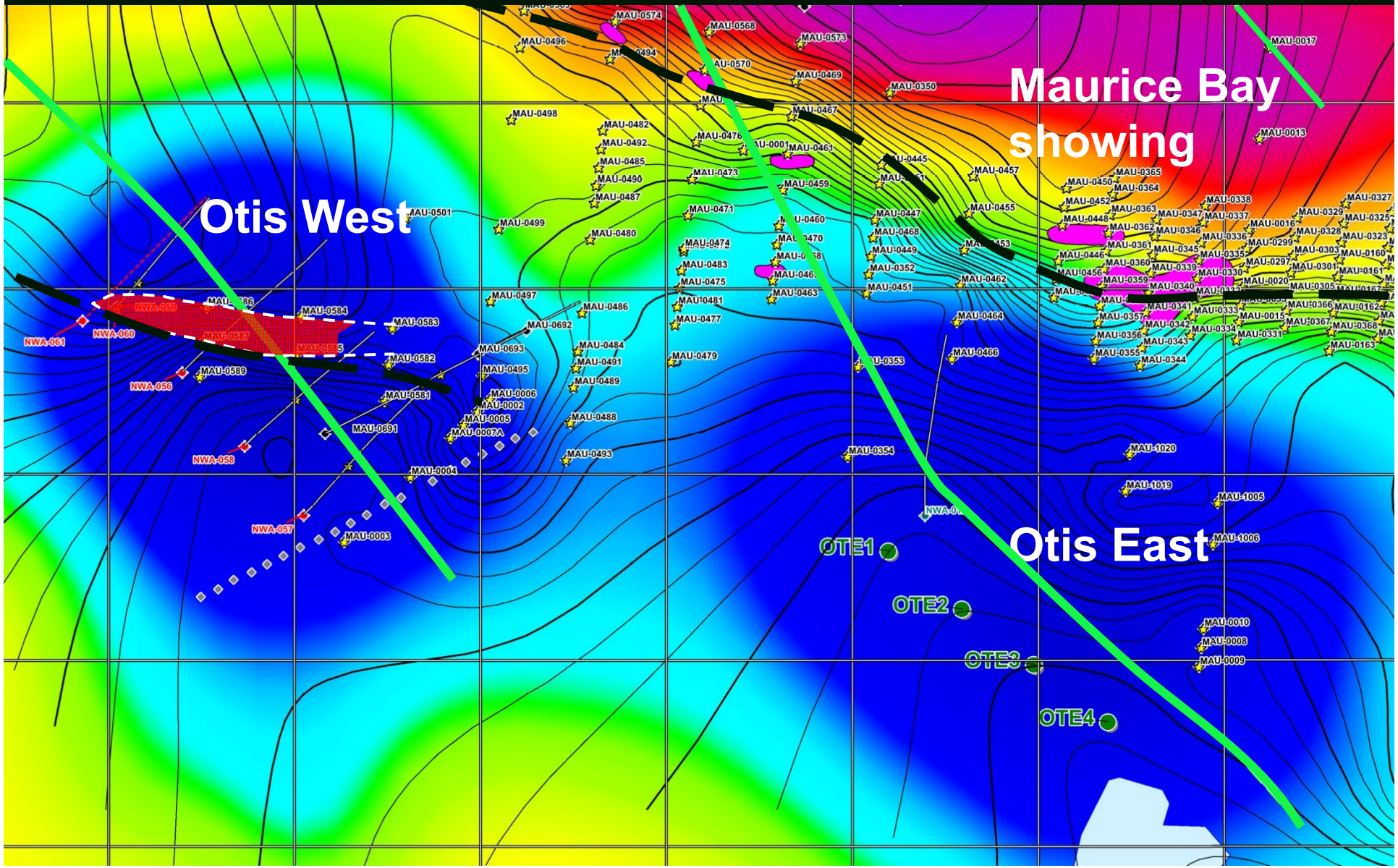


Forum Uranium

Maurice Bay

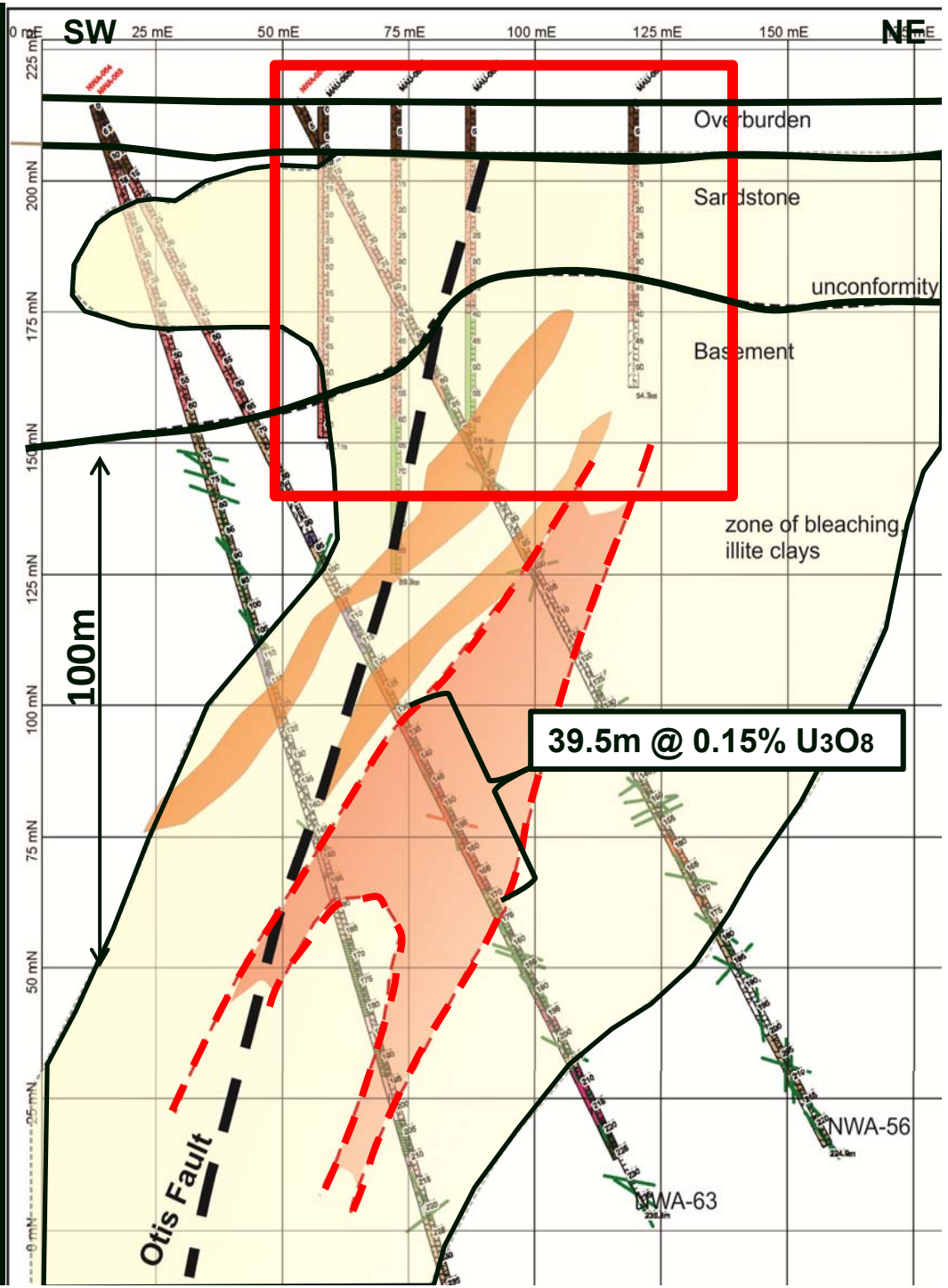
# Otis West: Plan View

U/C elevation contours



Forum Uranium

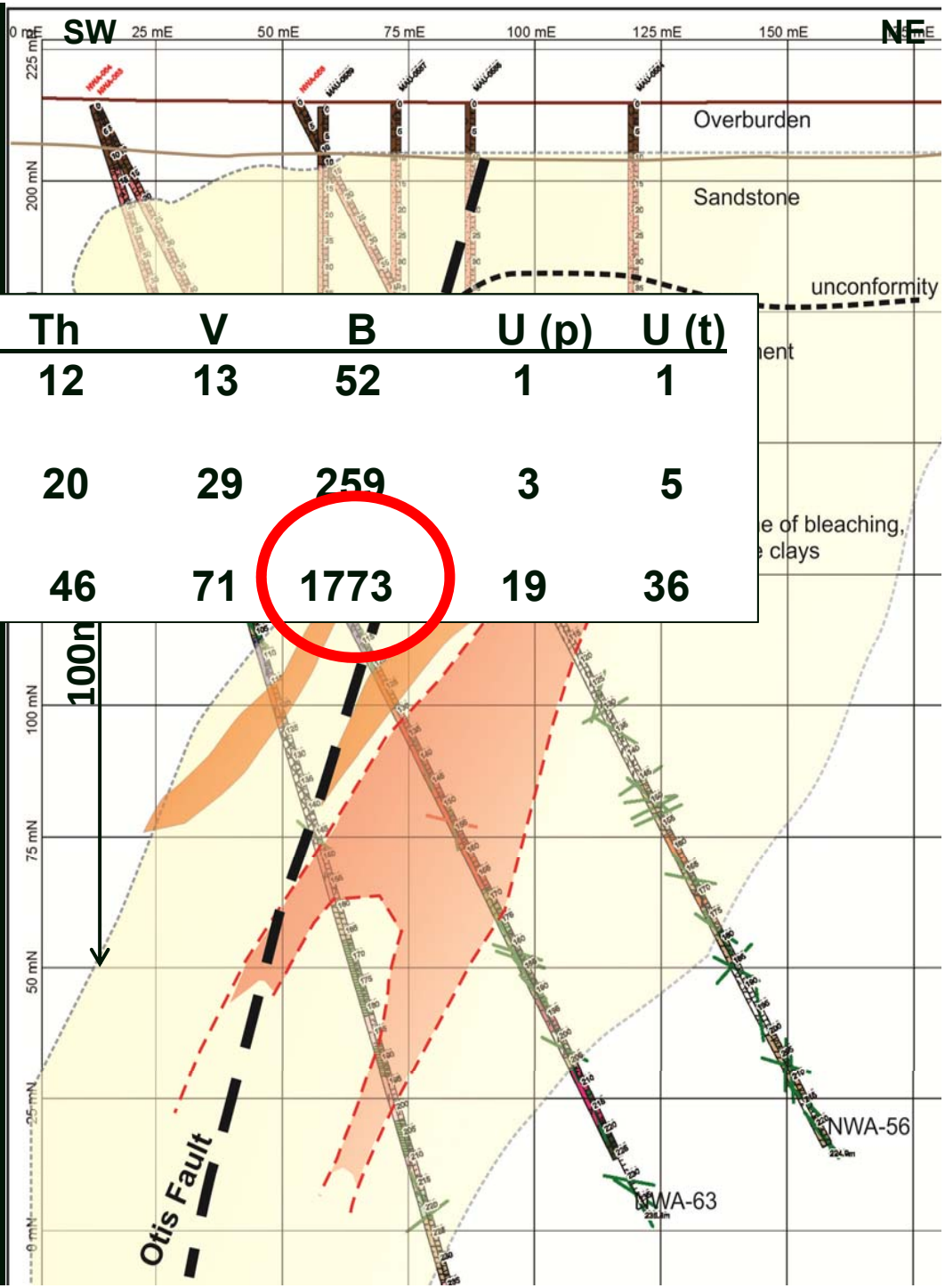
# Otis West: Cross Section




alteration halo

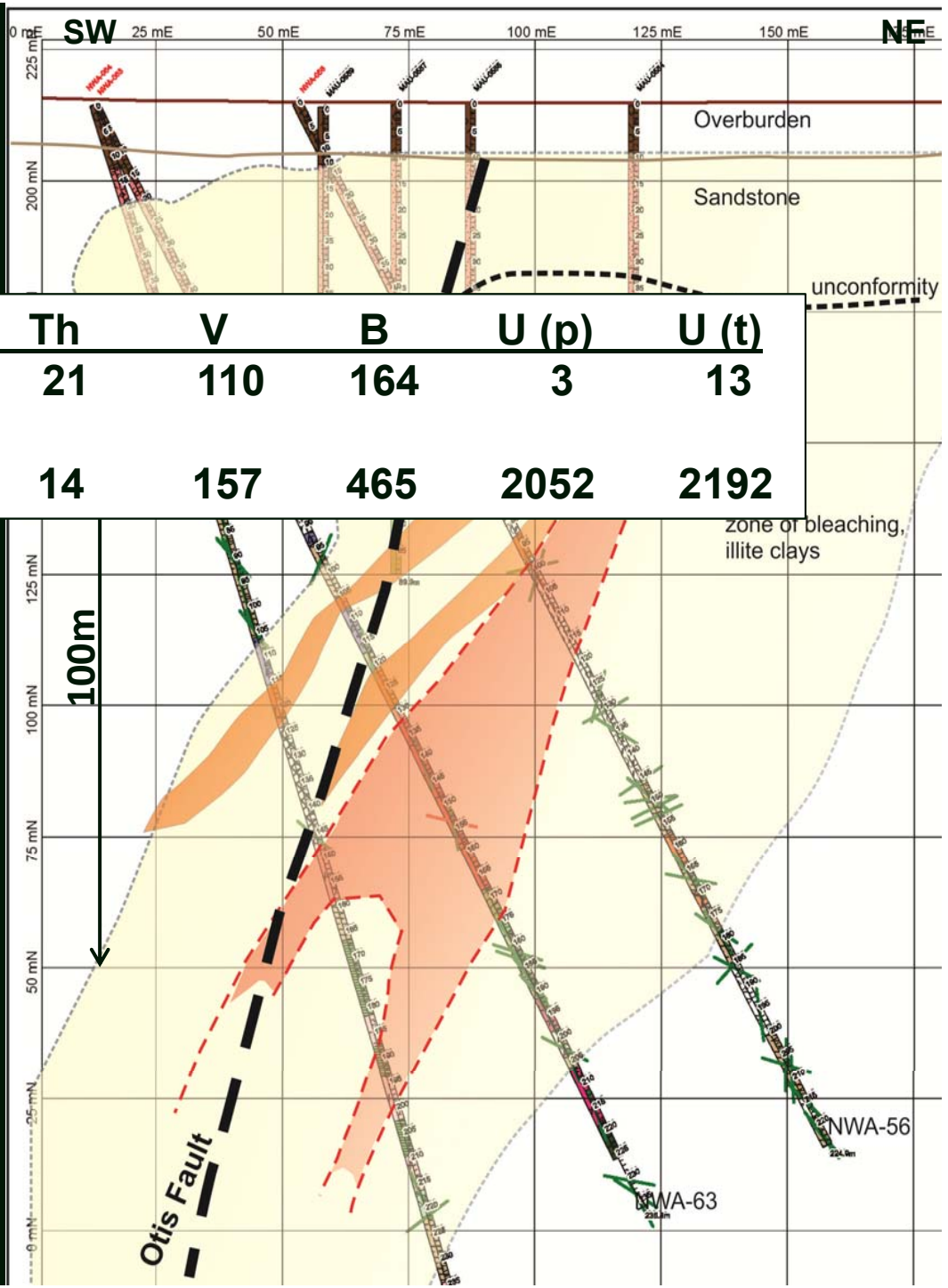
# Sandstone Geochemistry

| | As | Mo | Ni | Pb | Th | V | B | U (p) | U (t) |
|---|---|---|---|---|---|---|---|---|---|
| Barren | 1 | 1 | 3 | 6 | 12 | 13 | 52 | 1 | 1 |
| Near | 1 | 2 | 46 | 34 | 20 | 29 | 259 | 3 | 5 |
| Zone | 2 | 2 | 123 | 24 | 46 | 71 | 1773 | 19 | 36 |



# Basement Geochem

| | As | Mo | Ni | Pb | Th | V | B | U (p) | U (t) |
|---|---|---|---|---|---|---|---|---|---|
| Near | 1 | 1 | 71 | 14 | 21 | 110 | 164 | 3 | 13 |
| Zone | 40 | 58 | 164 | 86 | 14 | 157 | 465 | 2052 | 2192 |



# Otis West: Core Photos

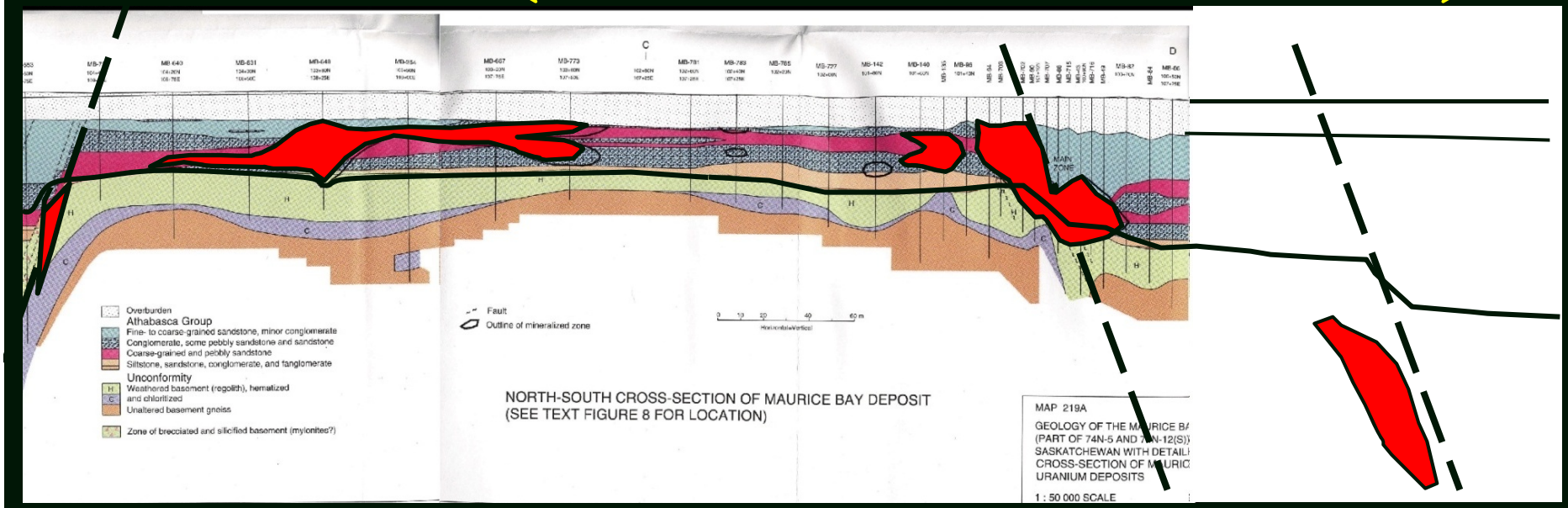
## Maurice Bay

**Dravite clay (boron host)**

# Different uranium styles in one area

## Maurice Bay

500m




**Zone A**
(vein type)

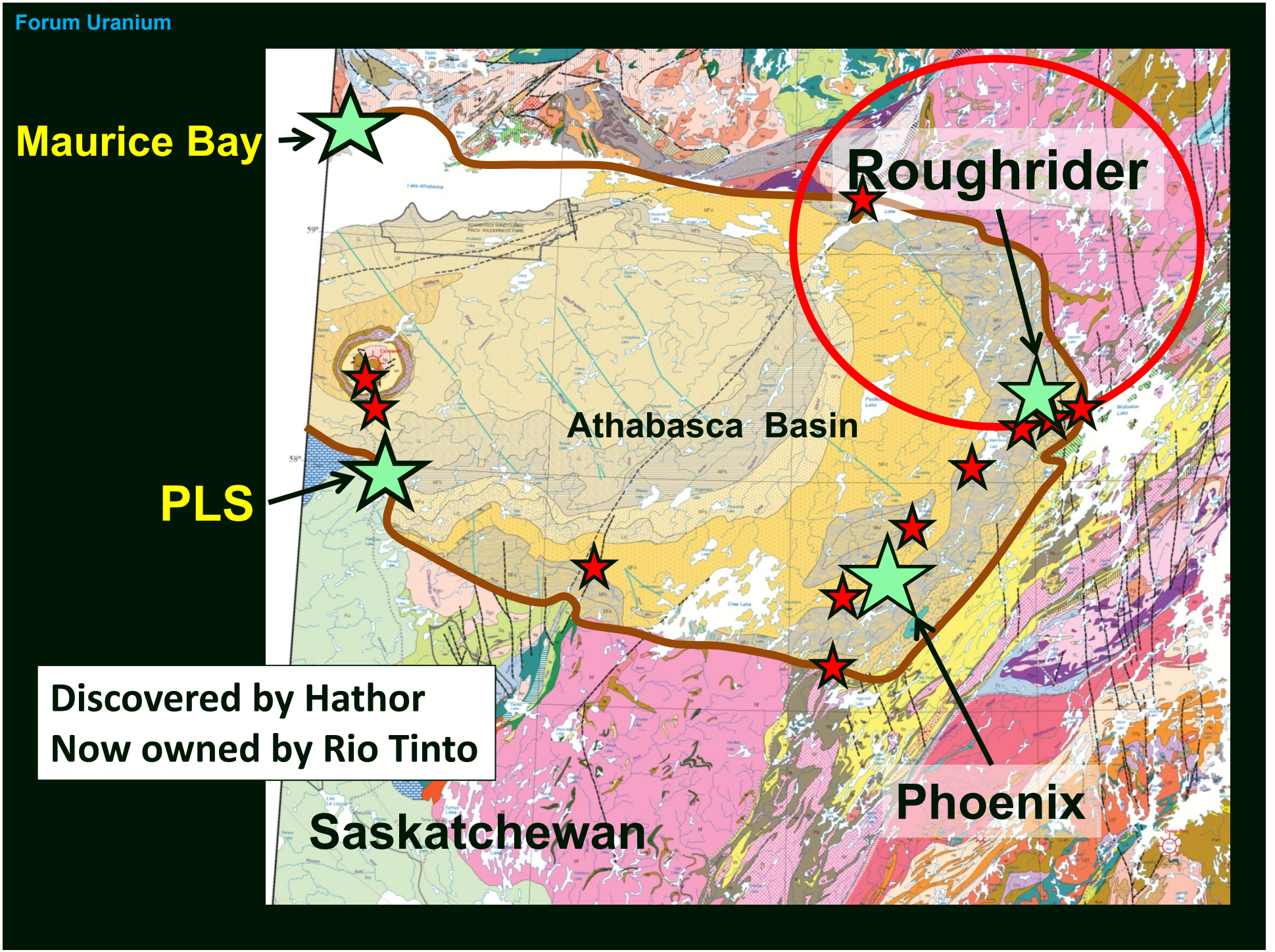
**Zone B**

**Main Zone**
**(Key Lake)**

**Otis West**
**(Millennium)**

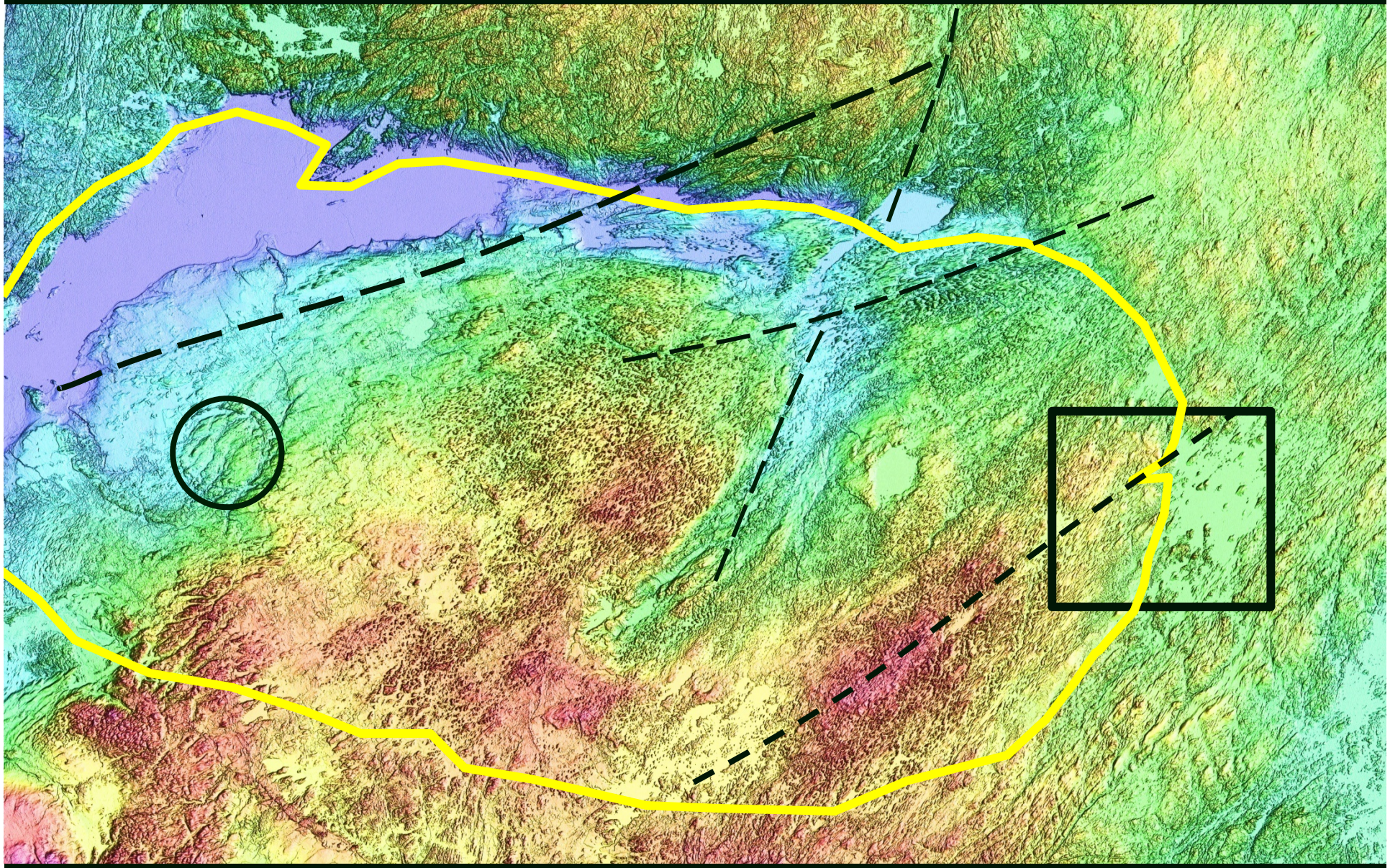
from C. Harper (1986)

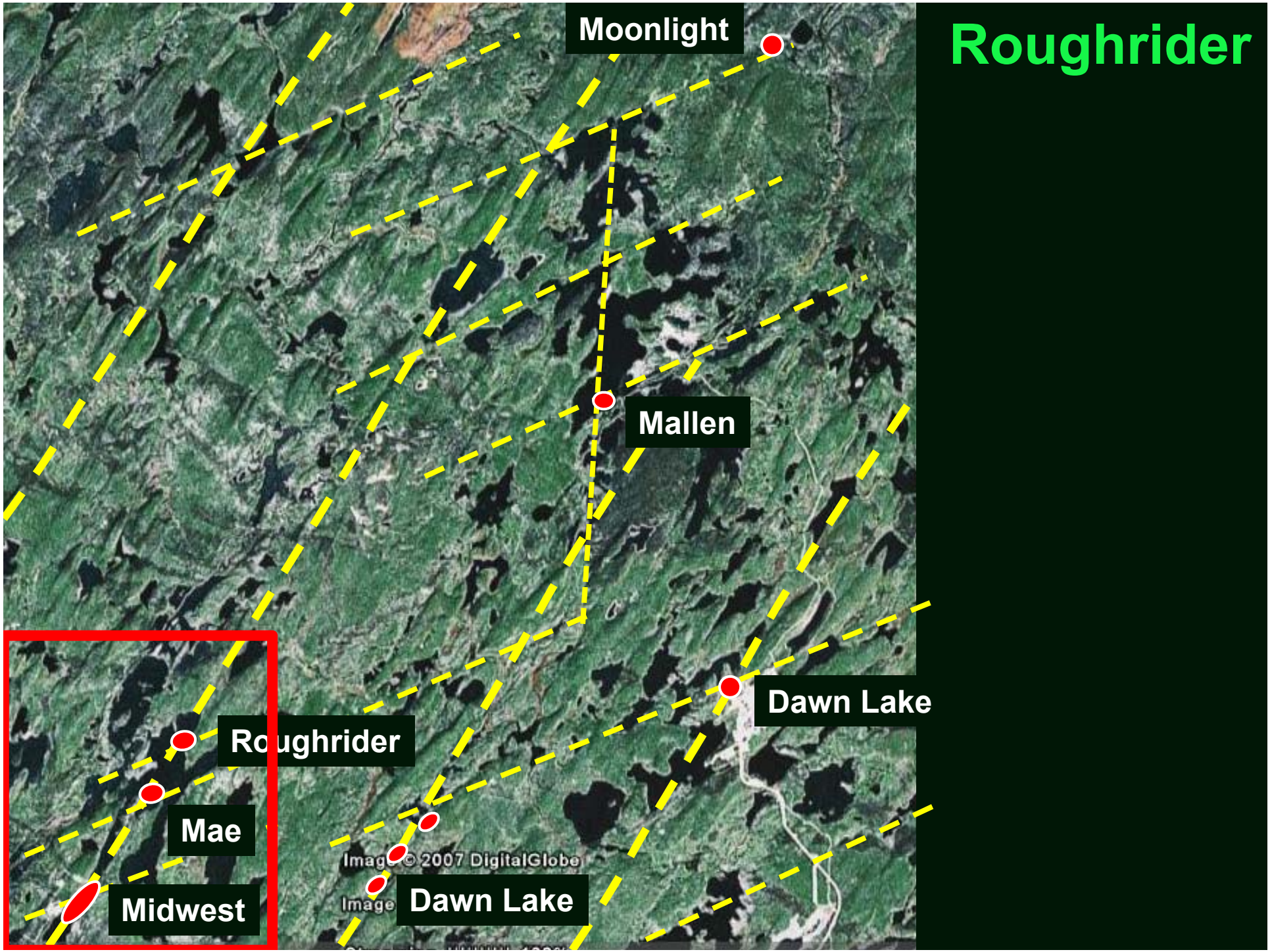
## Conclusion: - it is always important to remember the effects of gravity


Maurice Bay
Roughrider
Athabasca Basin
PLS
Discovered by Hathor
Now owned by Rio Tinto
Phoenix
Saskatchewan

Roughrider

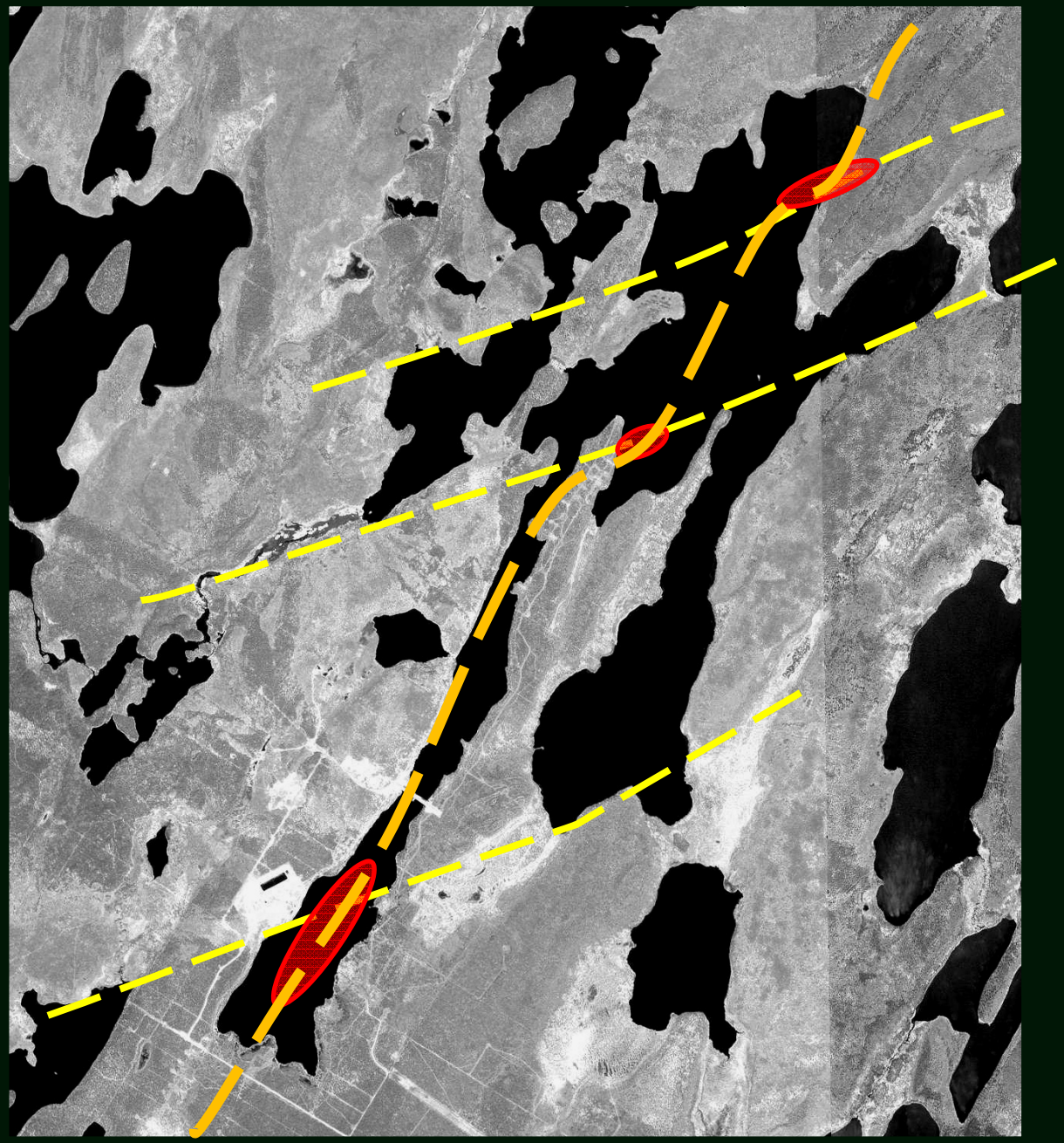
# Elevation map of the Athabasca Basin



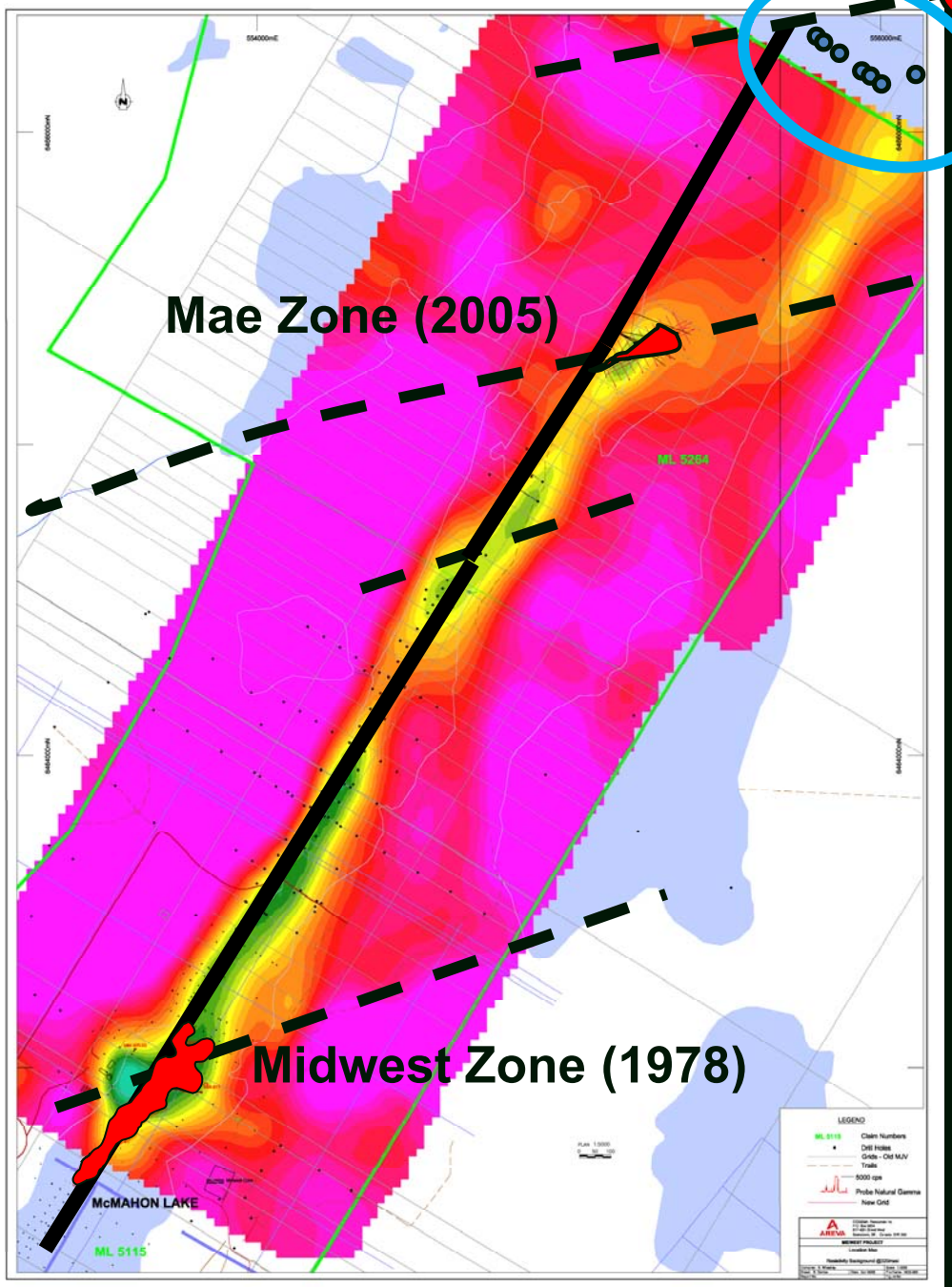

Roughrider
Moonlight
Mallen
Dawn Lake
Roughrider
Mae
Midwest
Image © 2007 DigitalGlobe
Image
Dawn Lake

Forum Uranium

# Roughrider



# Roughrider




Resampling of historic drill core for geochemistry: latest techniques in partial digestion, boron limit detections and clay determination using infrared light

Recent discovery on trend (Mae Zone) and use of the Millennium model aided in the discovery of the Roughrider deposit

# Roughrider

## Historic Core EN-14: from 170 to 200m


**Structure:** Strongly fractured to rubble

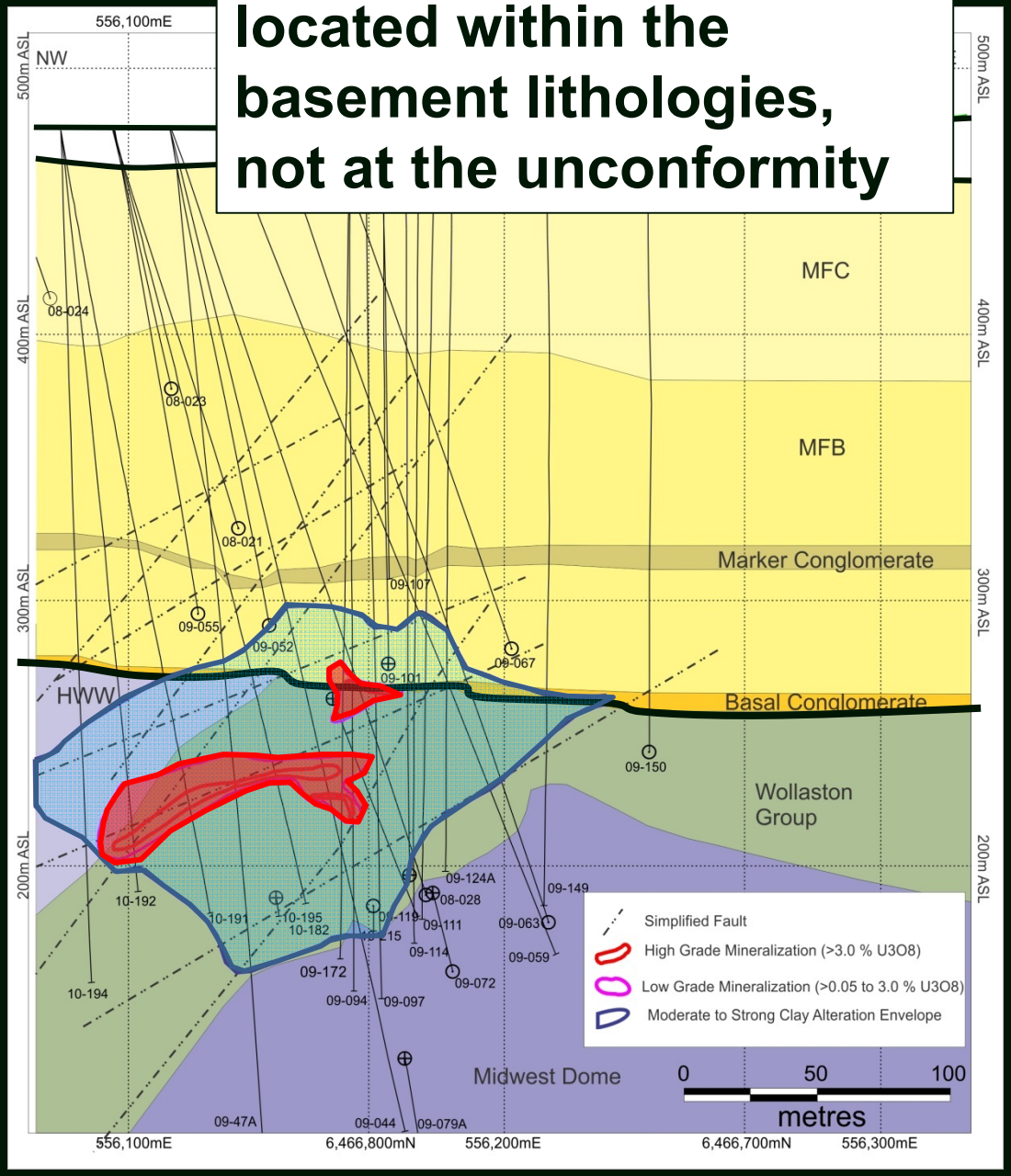
**Alteration:** Illitic clay signature, increased clay content, secondary hematite, limonite alteration

**Anomalous Geochemistry:** U, As, Co, Cu, Pb

Forum Uranium

# Roughrider

**Majority of the ore is located within the basement lithologies, not at the unconformity**




overburden

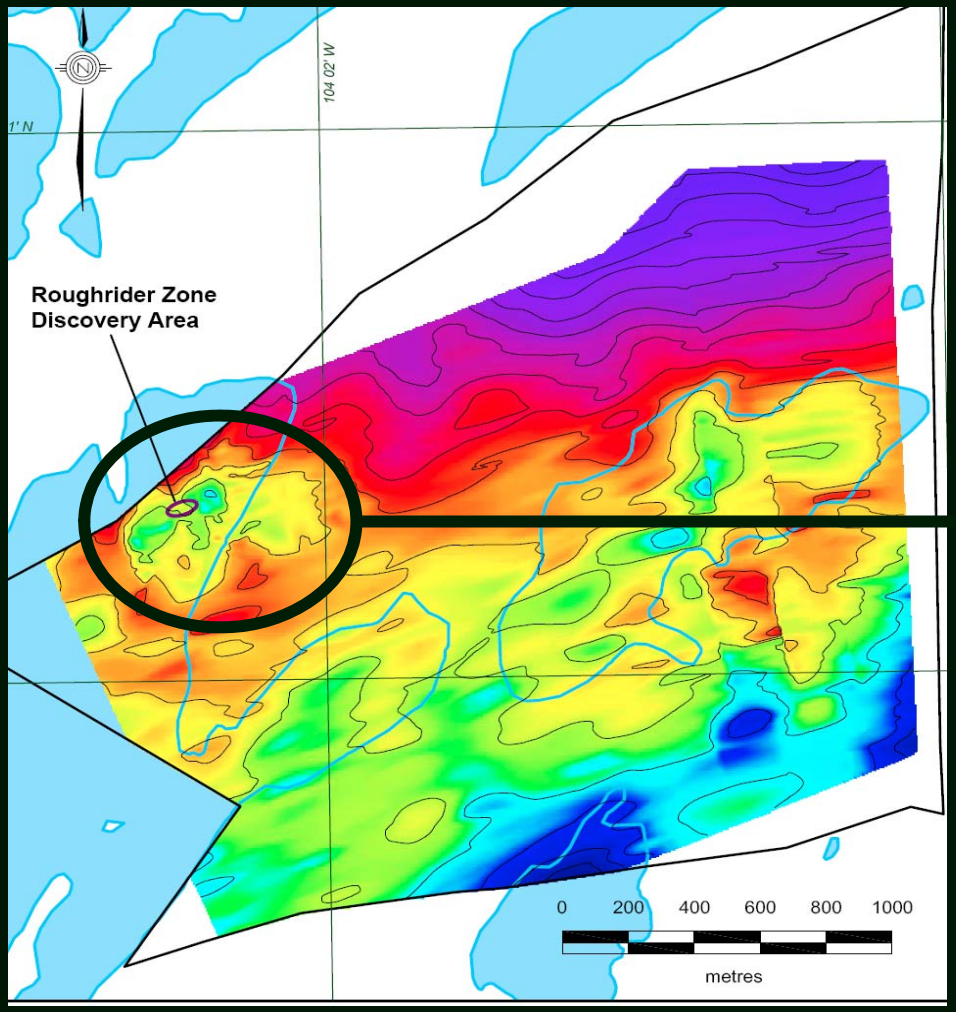
sandstone

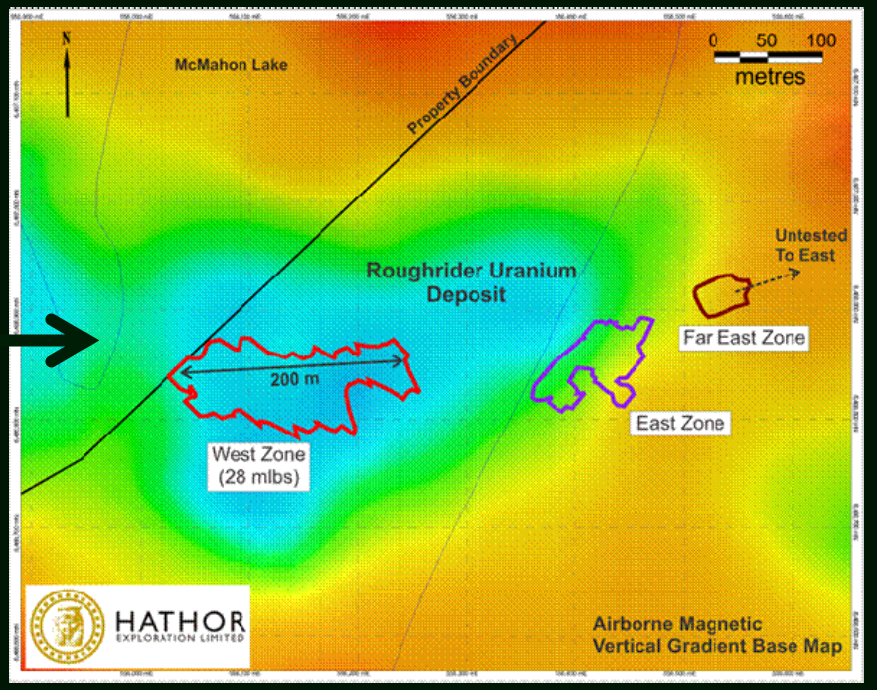
basement

200m

# Roughrider

## ground gravity



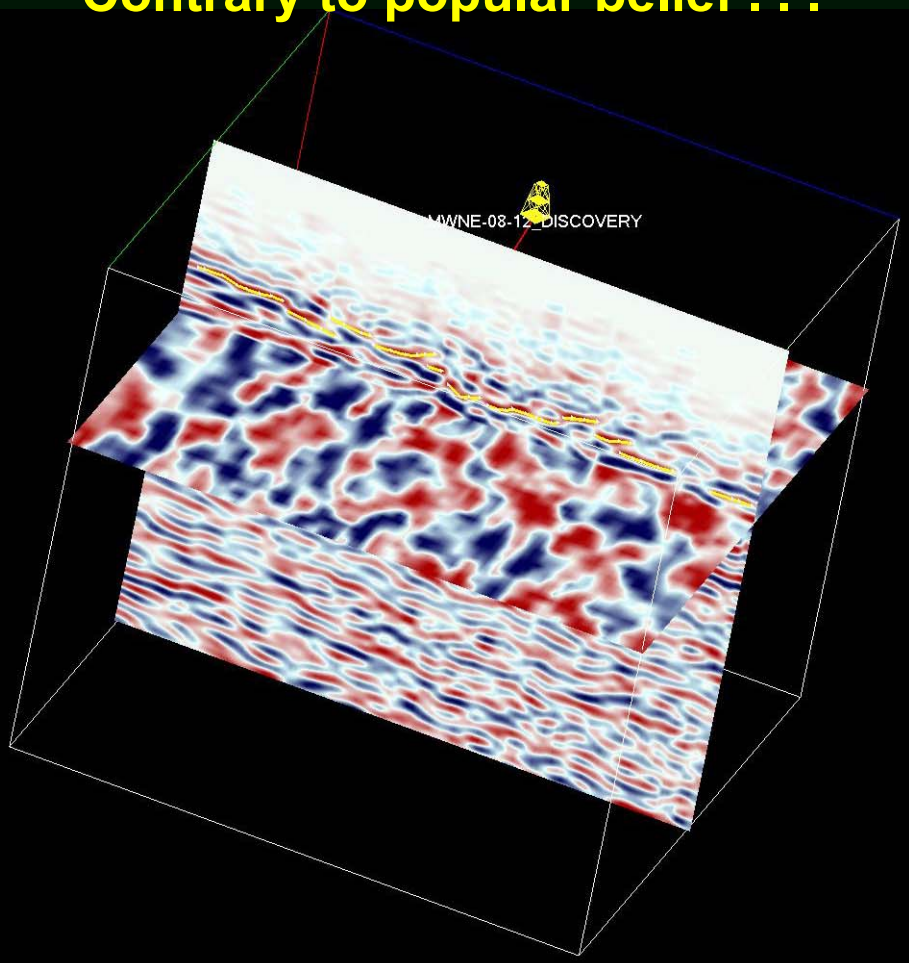



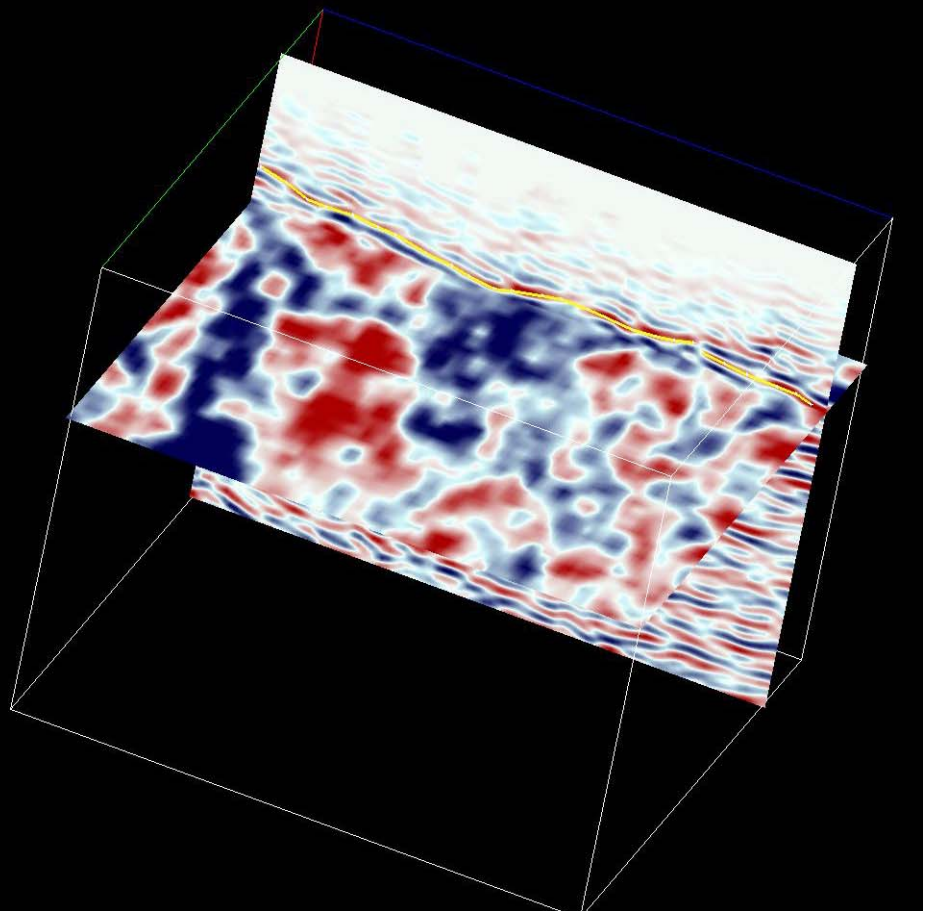
# Roughrider

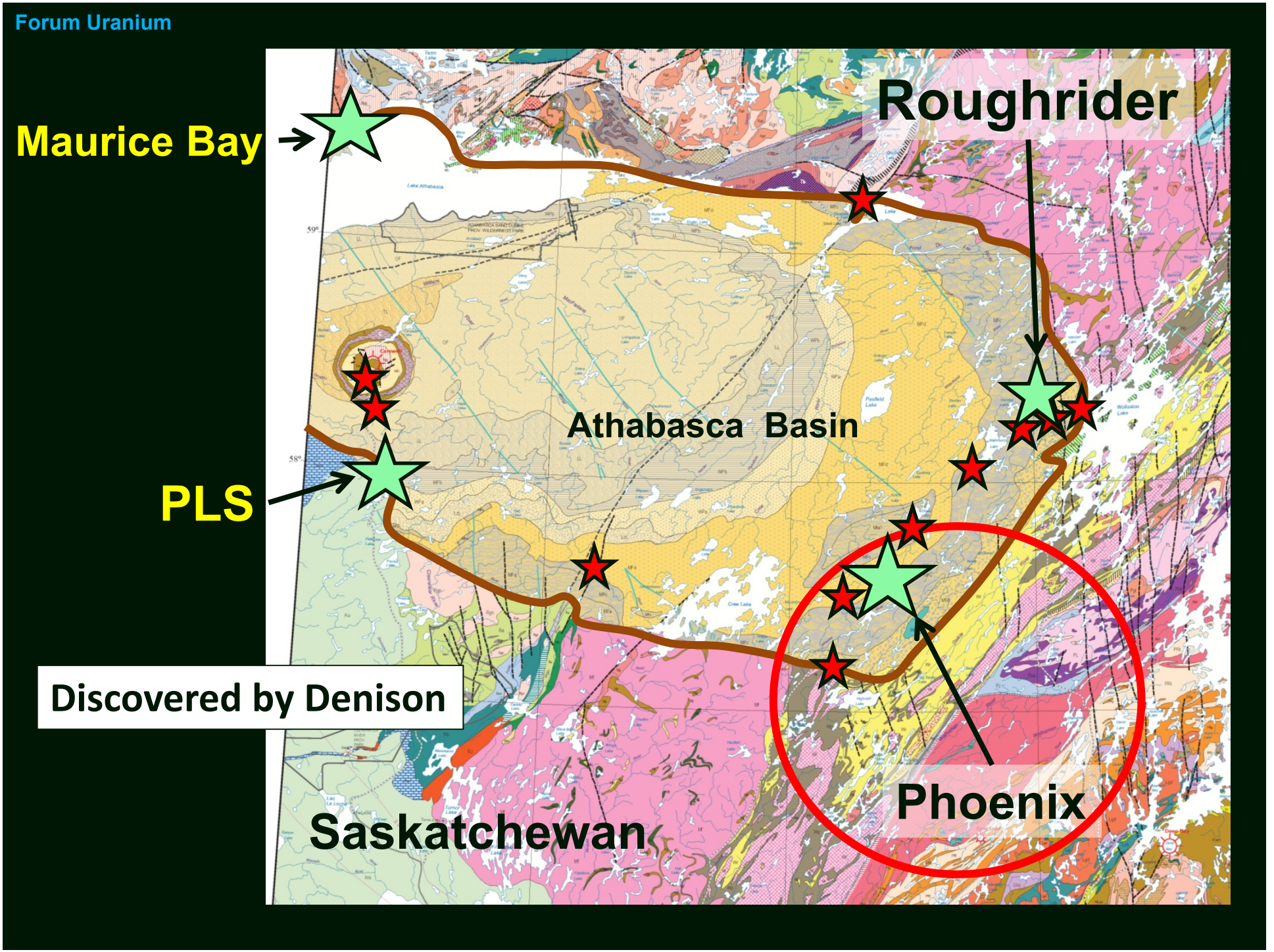
## U Mineralization - up to 84% $U_3O_8$

# Roughrider

## Contrary to popular belief . . .



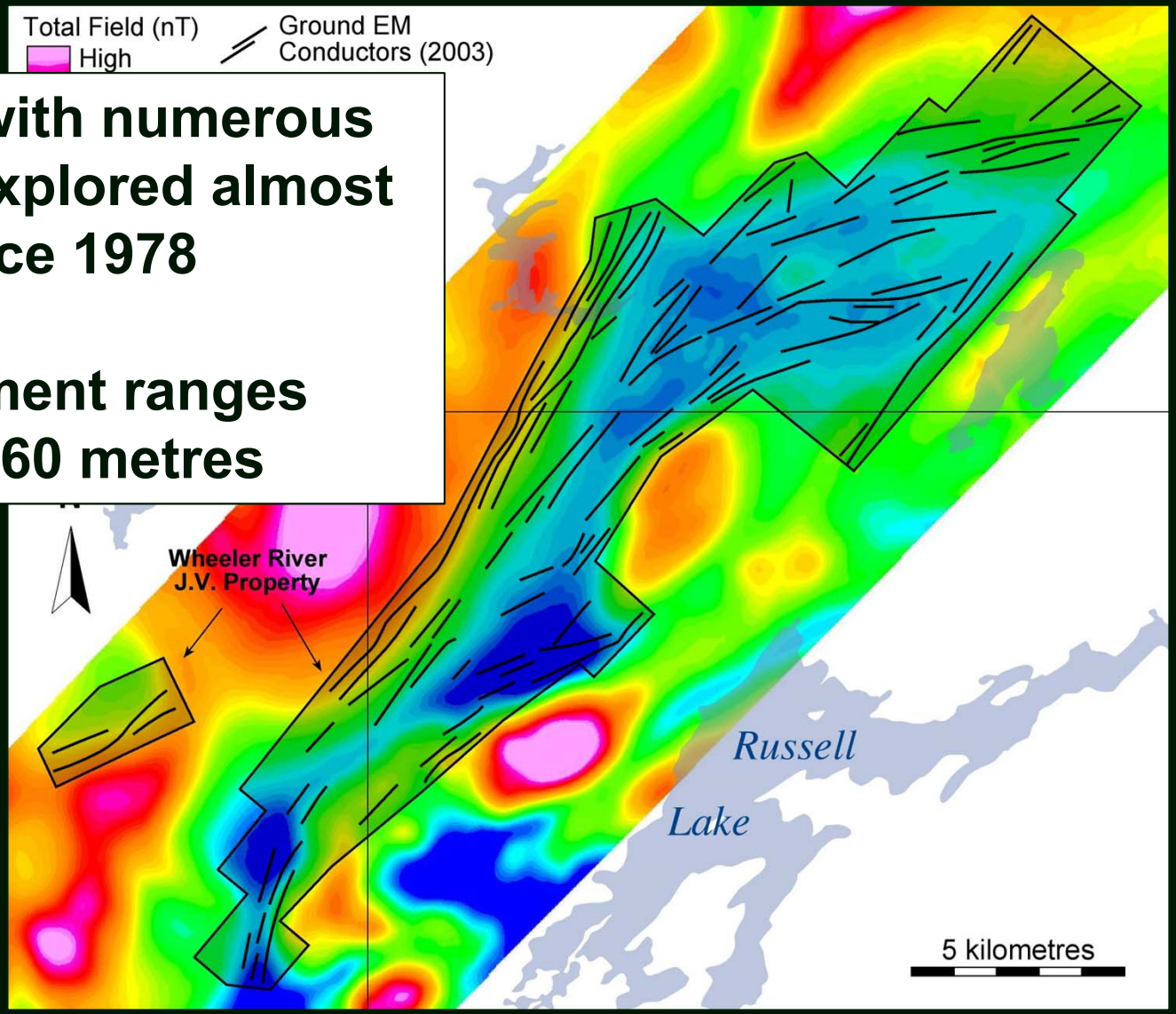

Maurice Bay
Roughrider
PLS
Athabasca Basin
Discovered by Denison
Phoenix
Saskatchewan

# Phoenix

## Mag background with ground EM conductors

**Large project with numerous conductors. Explored almost continually since 1978**

**Depth to basement ranges from 170m to 760 metres**

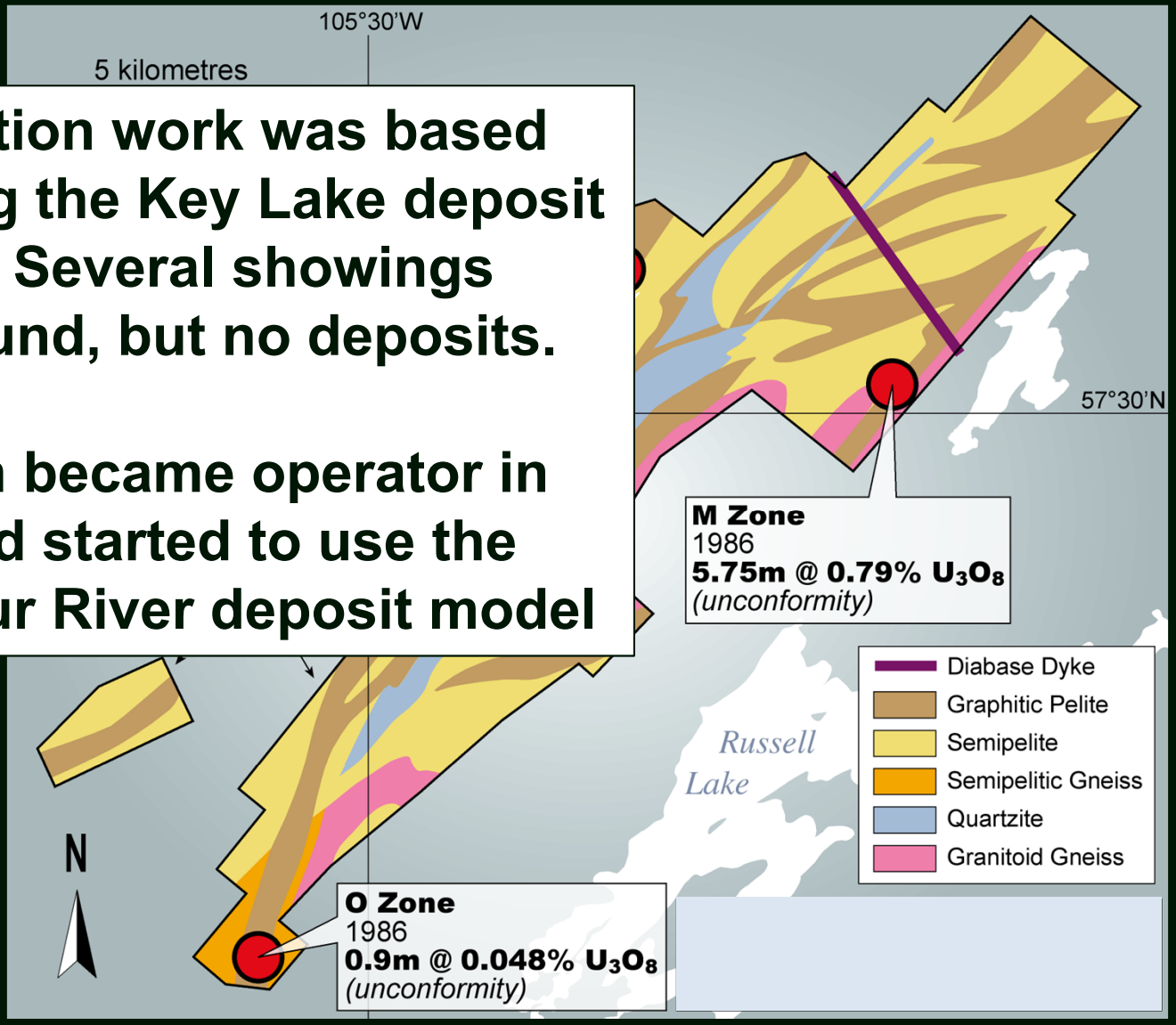


# Phoenix

## General basement geology with historic showings

**Exploration work was based on using the Key Lake deposit model. Several showings were found, but no deposits.**

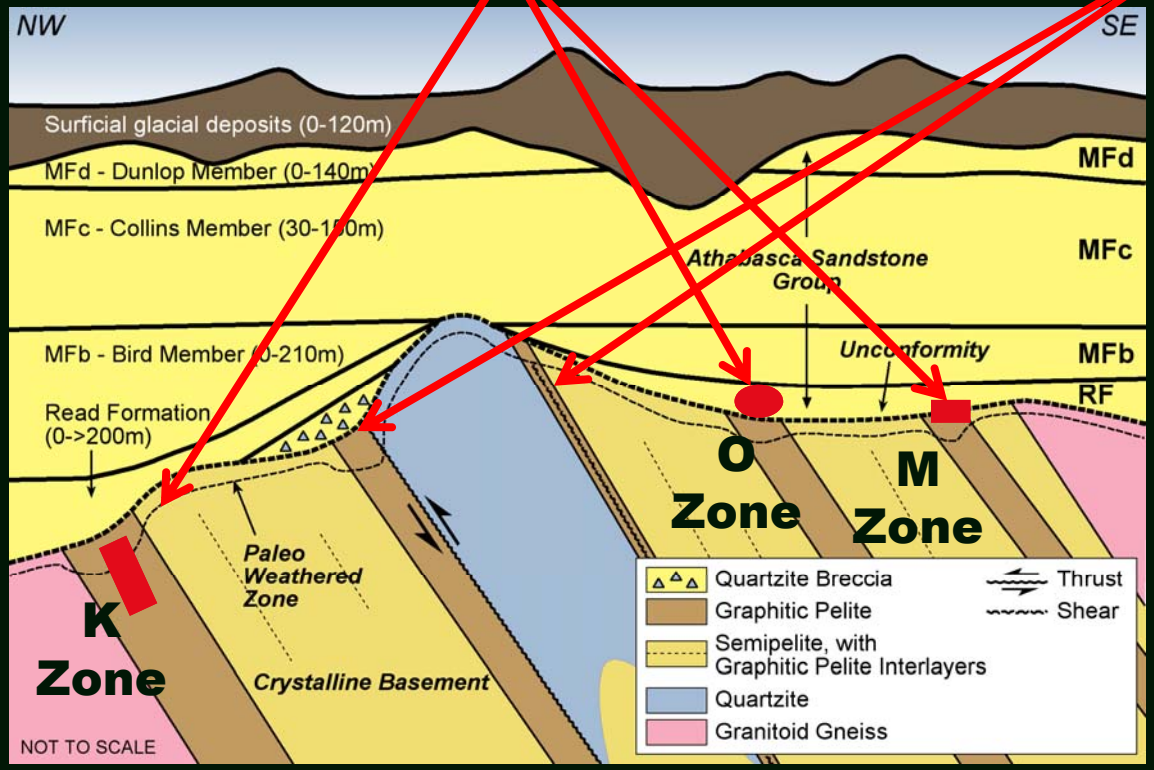
**Denison became operator in 2004 and started to use the McArthur River deposit model**

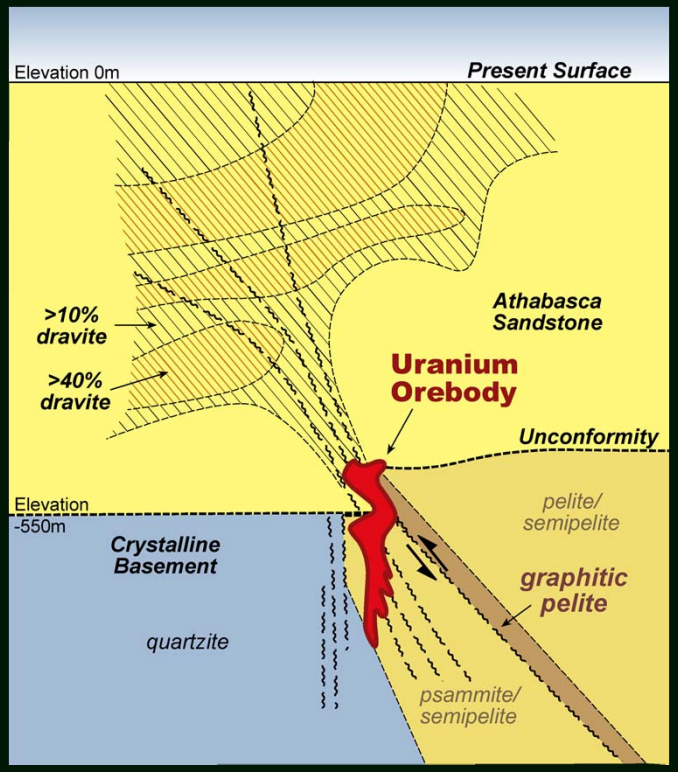


# Phoenix

**Key Lake model**
**- 3 showings found**

**McArthur model**

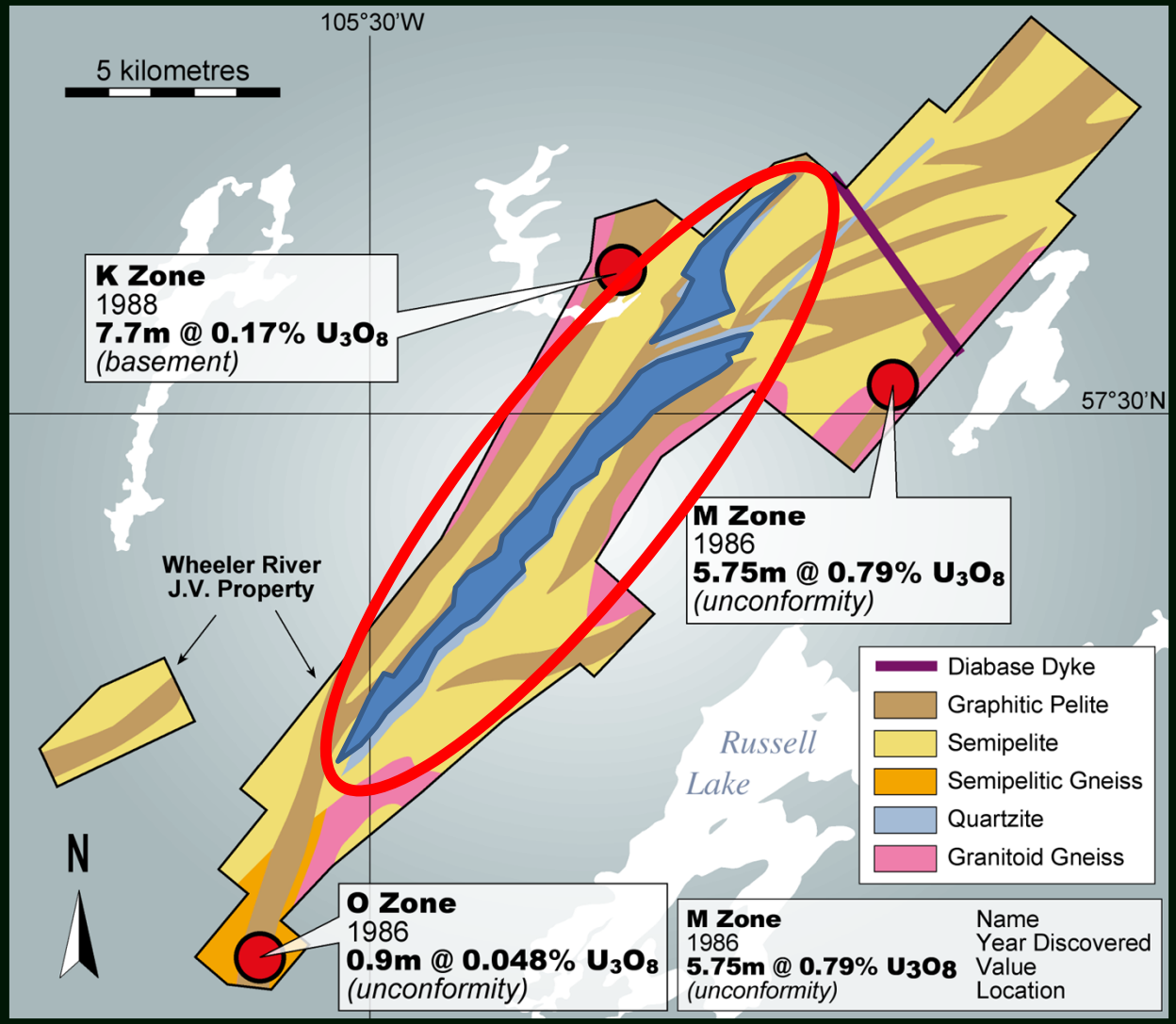



**Adjacent to quartzite ridge with associated dravite halo**

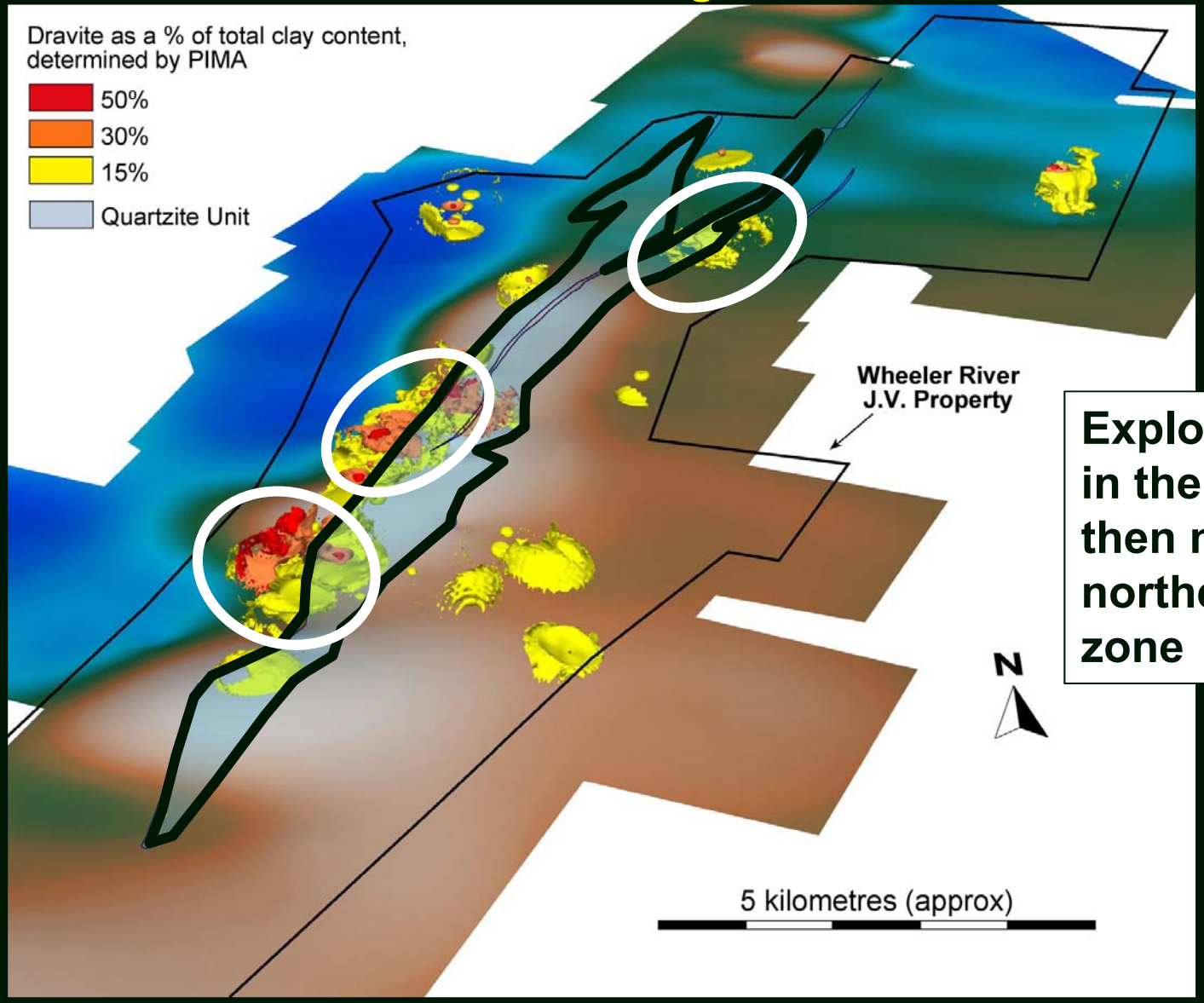
# Phoenix

## Exploration – now concentrated on geochemical haloes and resistivity lows in association with quartzite ridges



# Phoenix

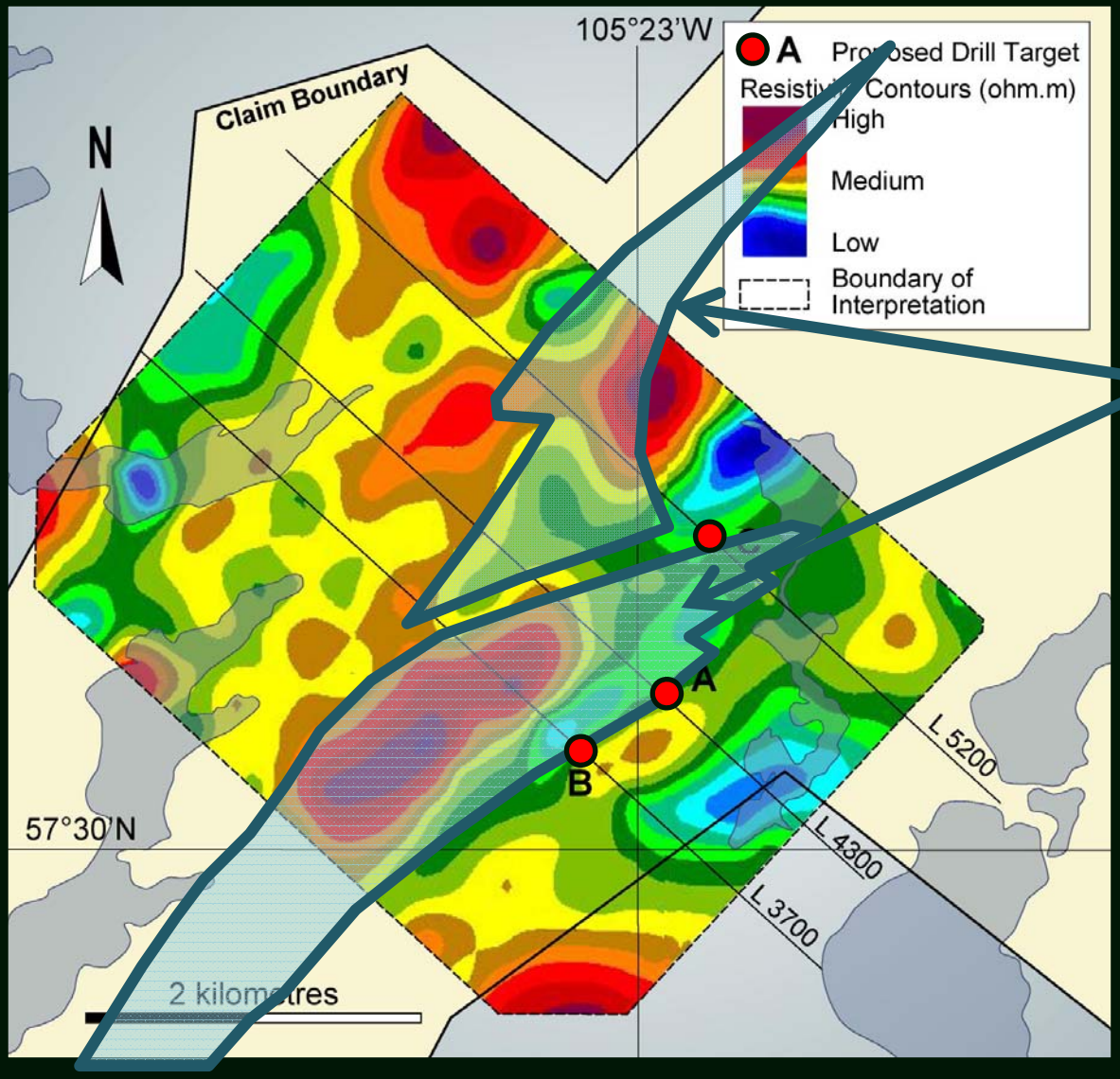
## Distribution of dravite from existing drill holes, location of quartzite




**Exploration started in the south and then moved to the northern dravite zone**

# Phoenix

## Resistivity – inversion slice at 400m depth



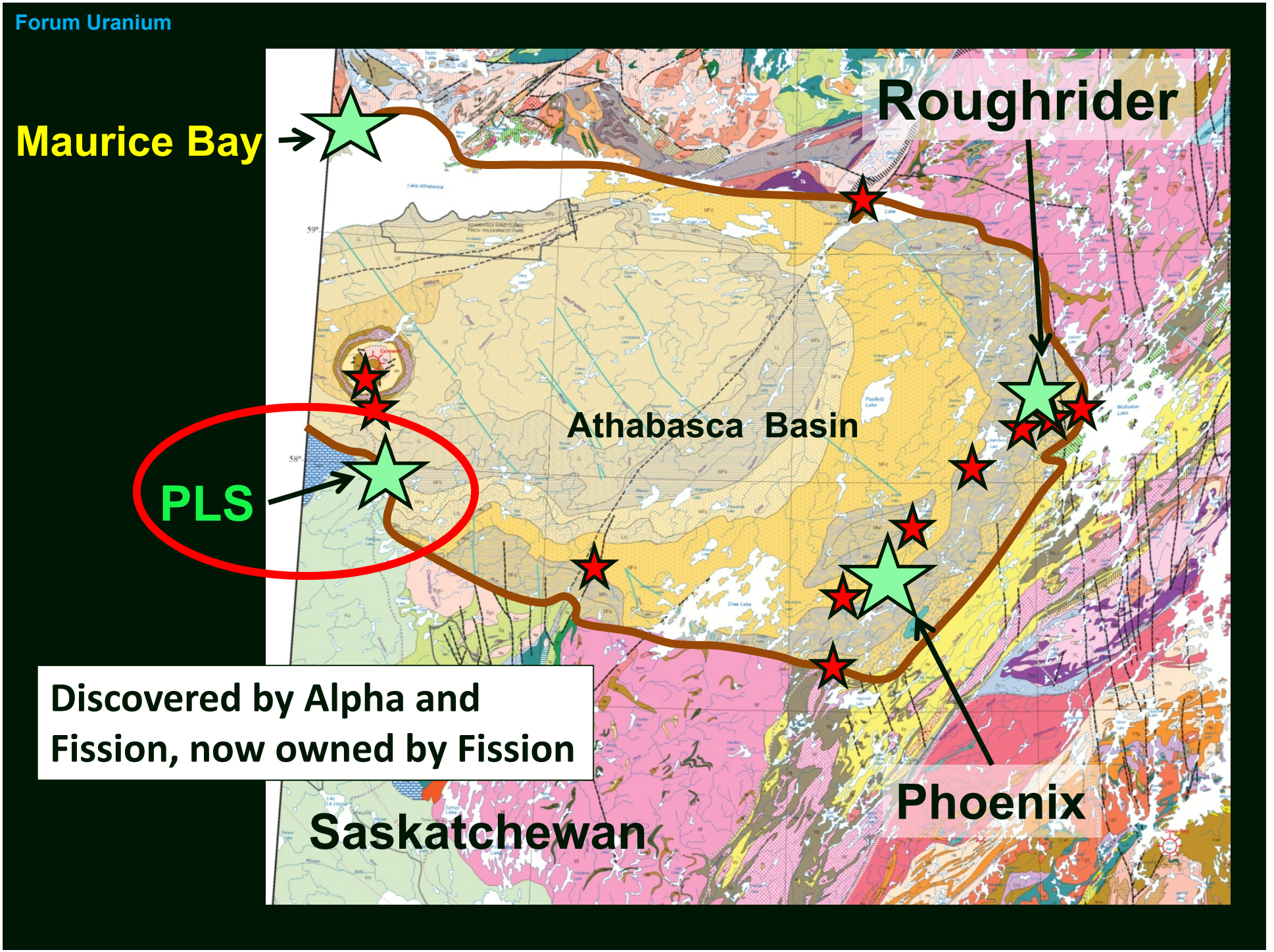

quartzite

- edge of quartzite
- dravite halo
- resistivity low

Titan 24 Resistivity survey, LOKE smoothed

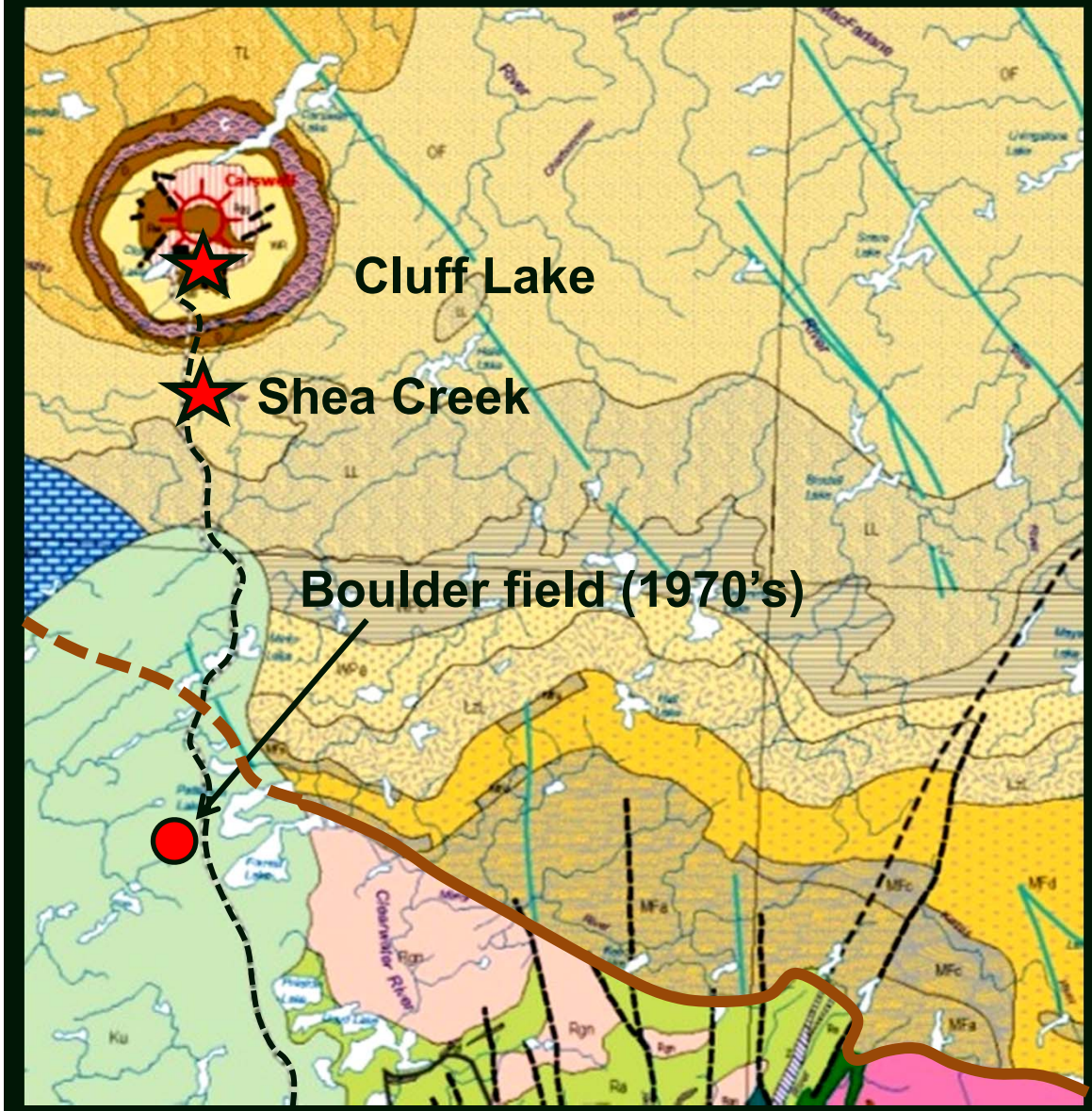
# Phoenix

## Uranium was found along the SE border of the quartzite ridge (2008)


Maurice Bay
Roughrider
Athabasca Basin
PLS
Discovered by Alpha and
Fission, now owned by Fission
Saskatchewan
Phoenix

PLS

# High sensitivity airborne radiometric survey, followed by prospecting



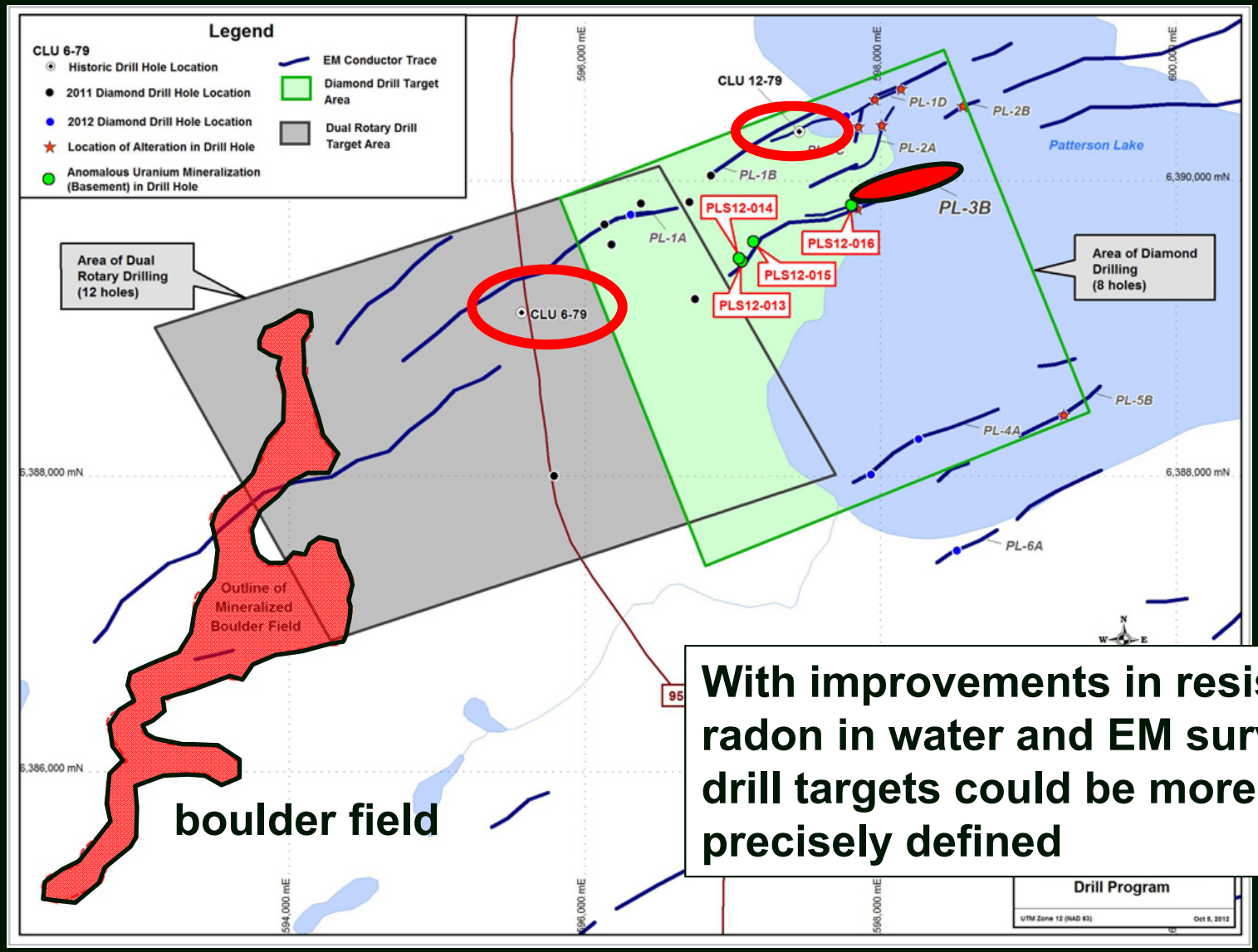

Boulder field had been known for about 35 years

Detailed low-level airborne radiometric survey relocated the field, ground follow-up work identified high-grade pitchblende boulders

Quaternary studies lead them up-ice to an area with EM conductors, and drilling starts (similar to Key Lake discovery)

P L S

# Drill along EM conductors, U hit in several holes

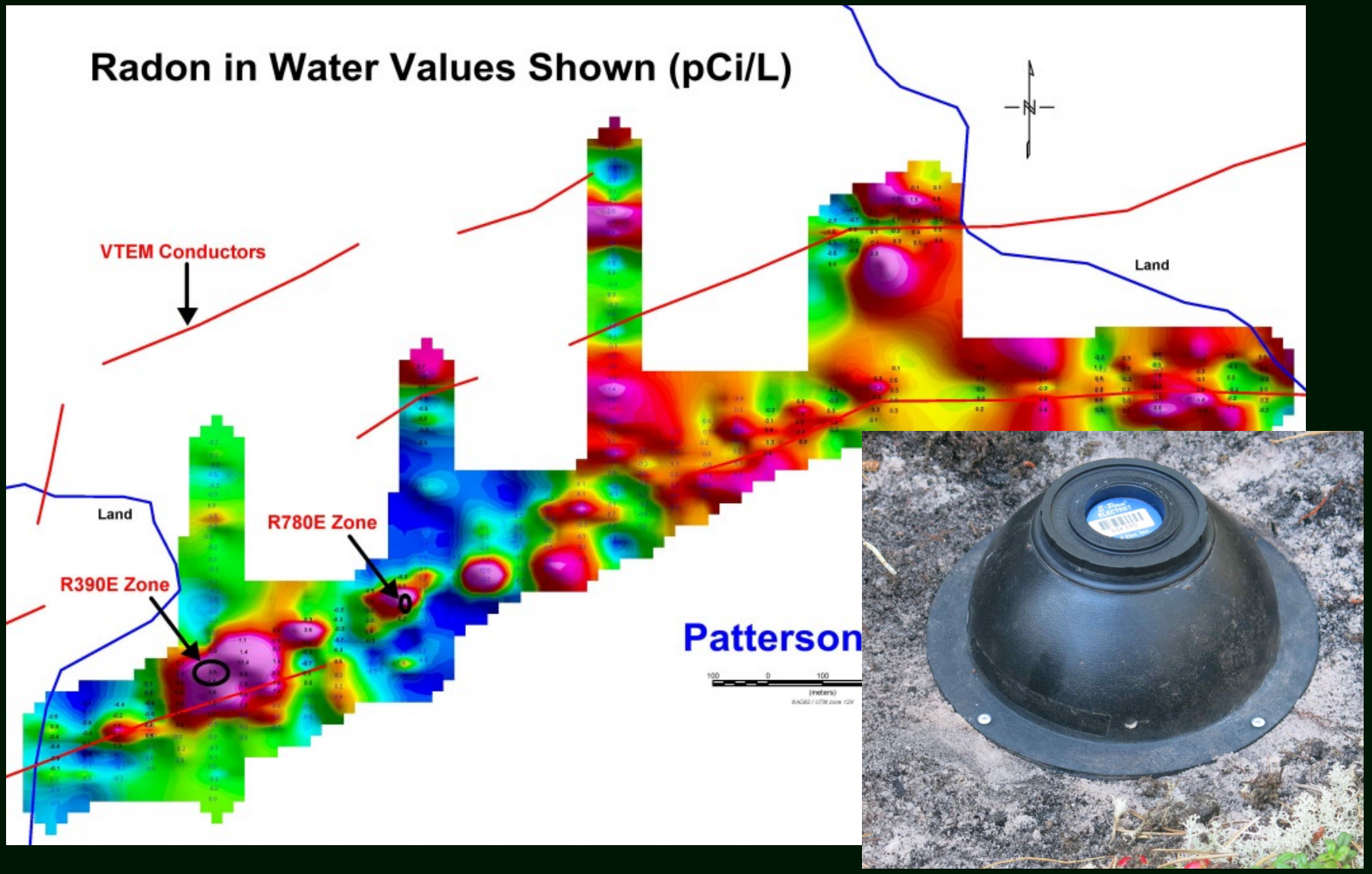



boulder field

With improvements in resistivity, radon in water and EM surveys, the drill targets could be more precisely defined

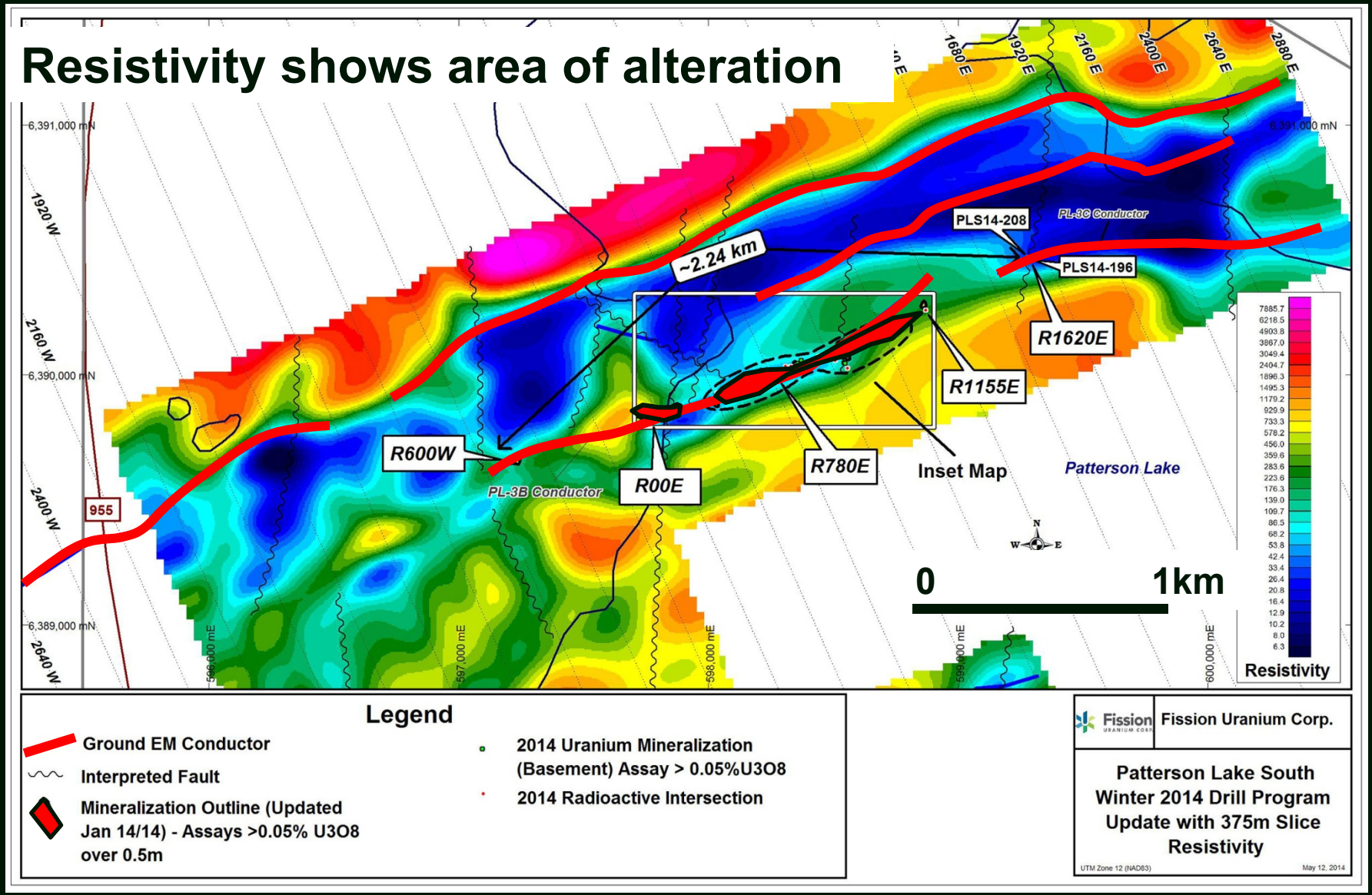
P L S

# New radon technologies applied: collect samples at lake bottom



P L S

# Mineralization now 1km long and growing.



P L S

# Drill rigs on Patterson Lake ice

P L S

# Grades of up to 57.6% $U_3O_8$, up to 102.5m at 5.98% $U_3O_8$


**Unlike most U deposits in the Athabasca, the core is light-weight and carbon rich**

# Conclusions

Geophysical (gravity, EM and resistivity), geochemical (improvements in detection limits, radon) techniques have improved considerably since the 70's and can be used in previously explored areas to develop new targets

Updated exploration models (variations of the unconformity model) in the Athabasca Basin can be successfully applied to old projects to find new deposits

Exploration geologists continually have to be kept up to date with the latest discoveries so new techniques and modesls can be applied to their projects.

What will be the next model variation ?

# Acknowledgements

**Forum Exploration Team:** Boen Tan, Anthony Williamson, Rick Mazur, Bruce Harmeson, Phil Robertshaw

**Denison Mines:** Lawson Forand

**Rio Tinto:** Alistair McCready

**Alpha / Fission:** Garrett Ainsworth, Fission website


The End