NOVEL GEOCHEMICAL TECHNIQUES INTEGRATED IN EXPLORATION FOR URANIUM DEPOSITS AT DEPTH

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URAVAN MINERALS INC.

Forward looking statement:

(1) These results reflect industry-university collaborations

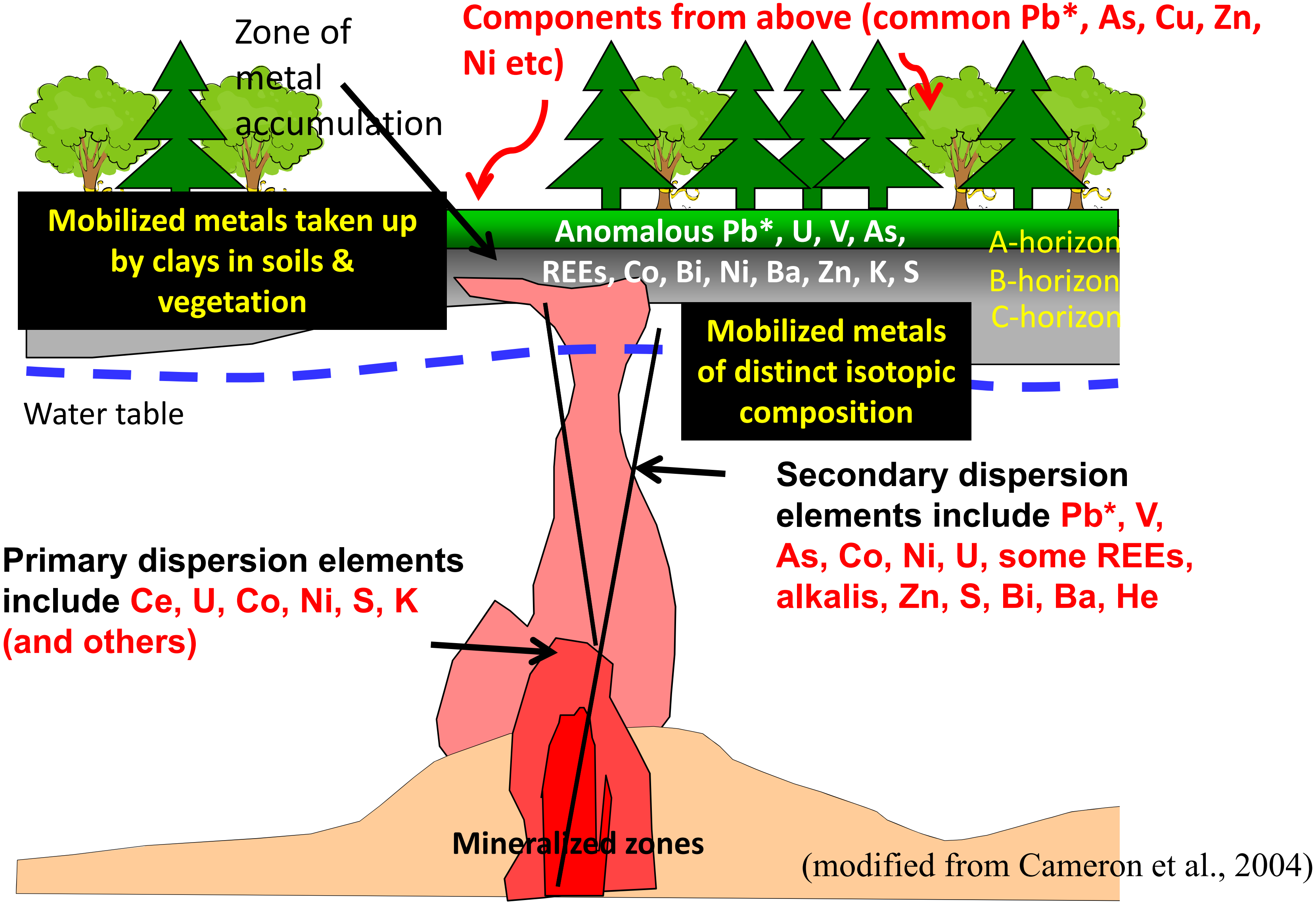
(2) The focus will be on unconformity-type U deposits, but the approach is applicable to all types of U deposits

(3) The approach is also equally applicable to most other types of metal deposits as well

Exploration geochemistry targets:

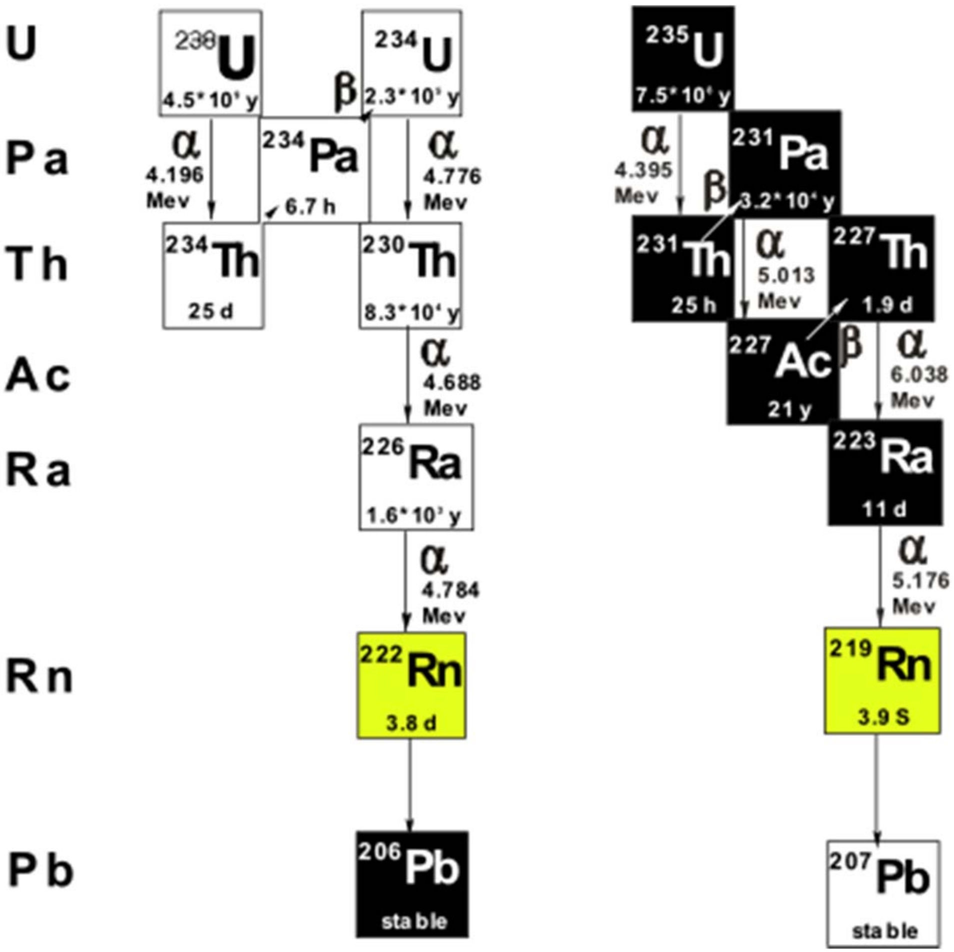
(1) Primary dispersion—alteration coeval with mineralization

(2) secondary dispersion—migration of elements post mineralization



Uranium is unique geochemically because:

(1) It produces a variety of products with distinctly different geochemical attributes that can be used to indicate a U-rich source including He, Rn, Ra, Pb, Th, U



(2) Unlike Au, U has two major isotopes (and intermediate ones) that can be used to fingerprint a U-rich source

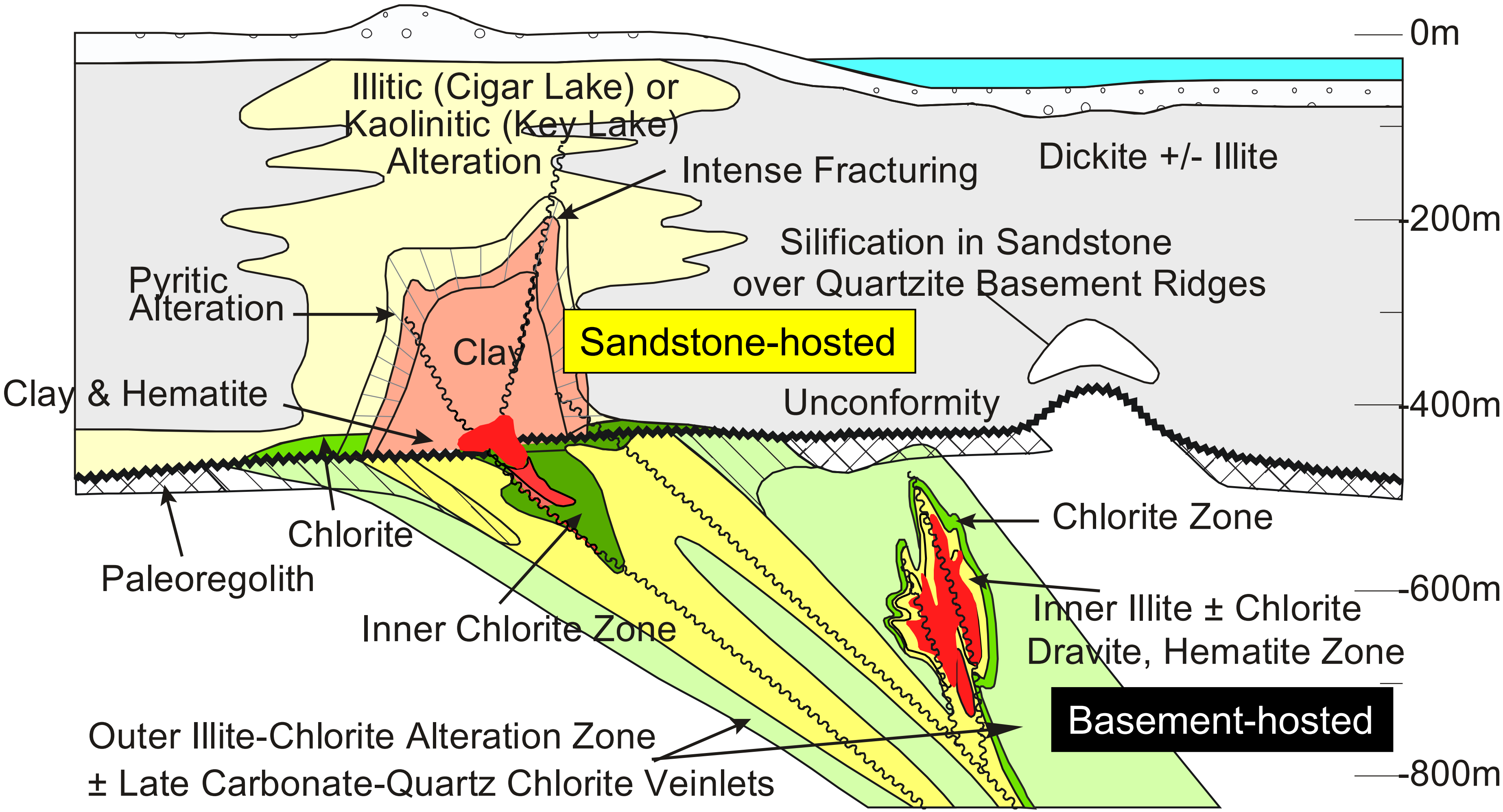
Novel techniques discussed in this talk include:

Mineralogy
U isotopes } primary dispersion

Pb isotopes
Organic gases } secondary dispersion

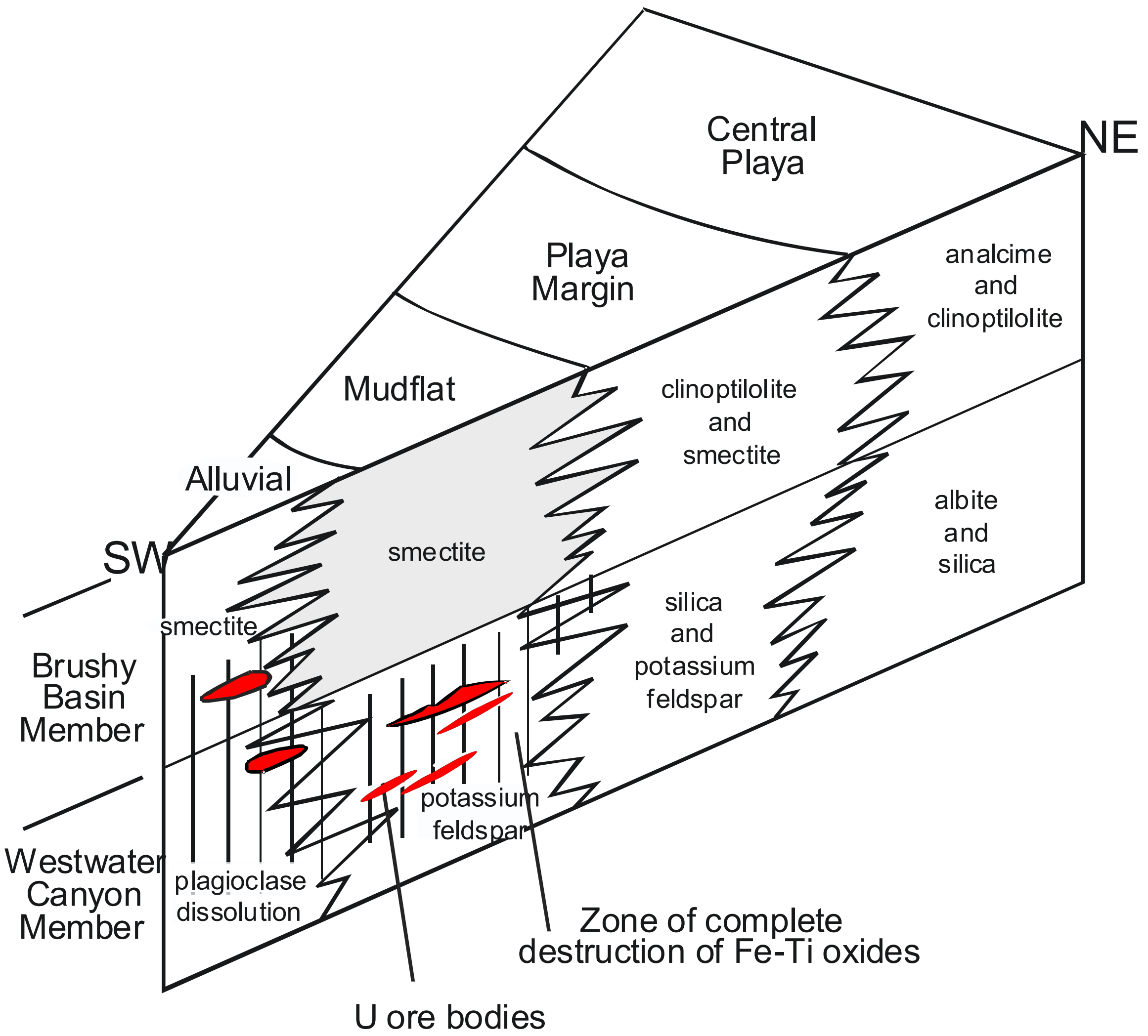
Geochemical techniques are only effective with geologic and geophysical techniques, to which they can add mutual value!

Primary dispersion in unconformity-related uranium deposits



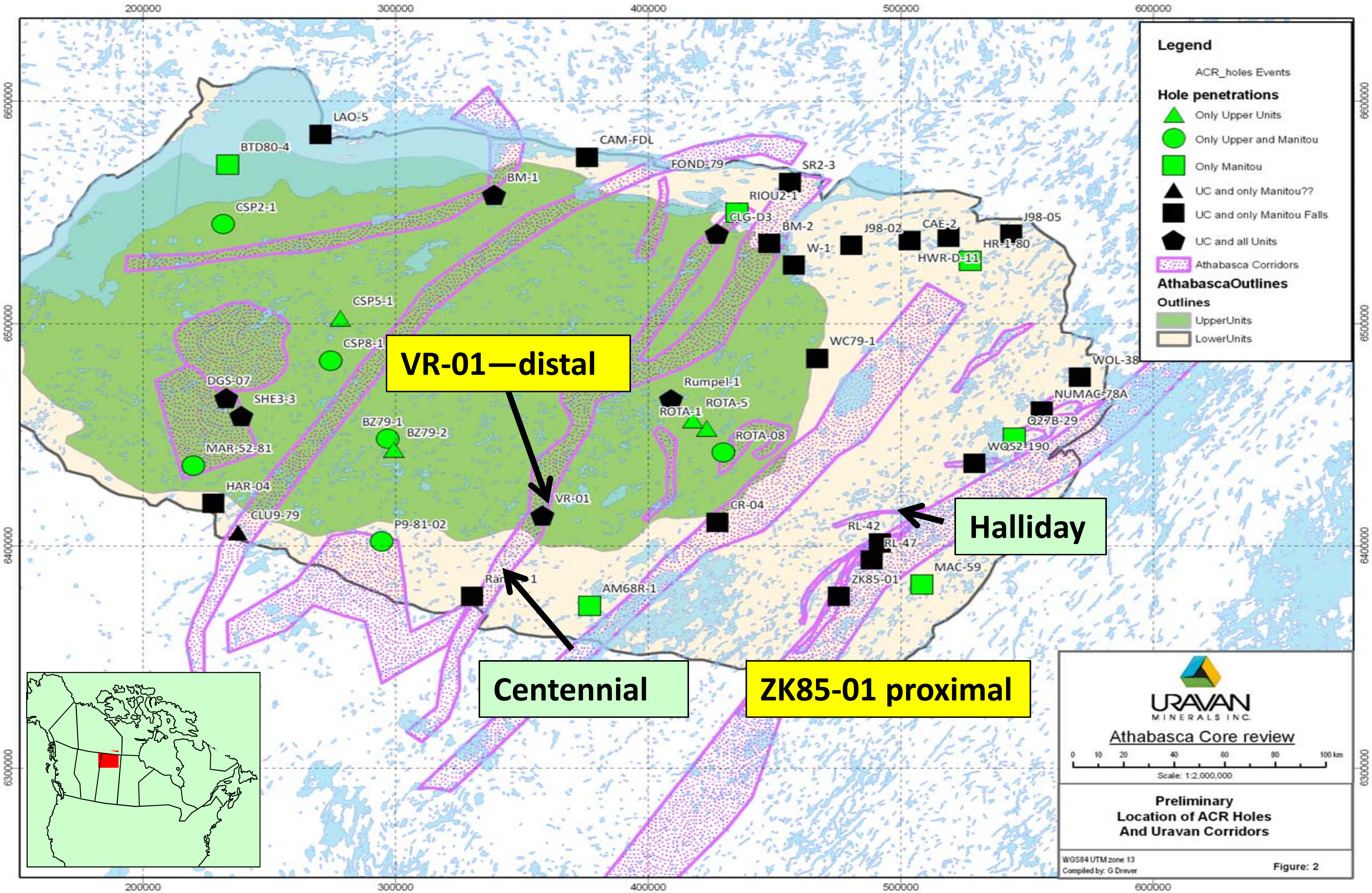
After Thomas, 2007

Primary dispersion in sandstone-hosted uranium deposits

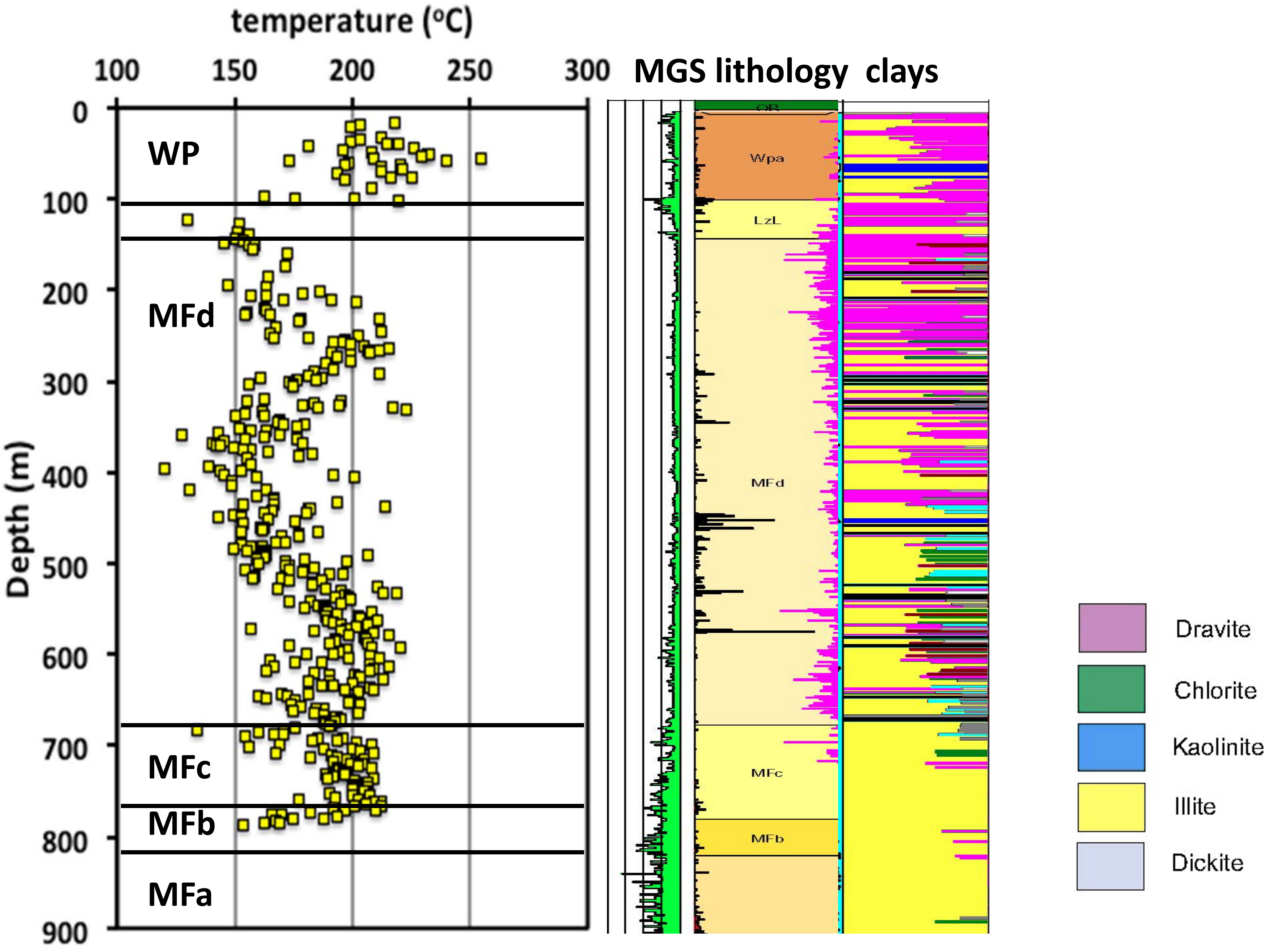


Grants Uranium Region--distribution of facies and diagenetic alteration in the Westwater Canyon Member and overlying Brushy Basin Member (Hansley, 1986; Turner-Peterson and Fishmann, 1986)

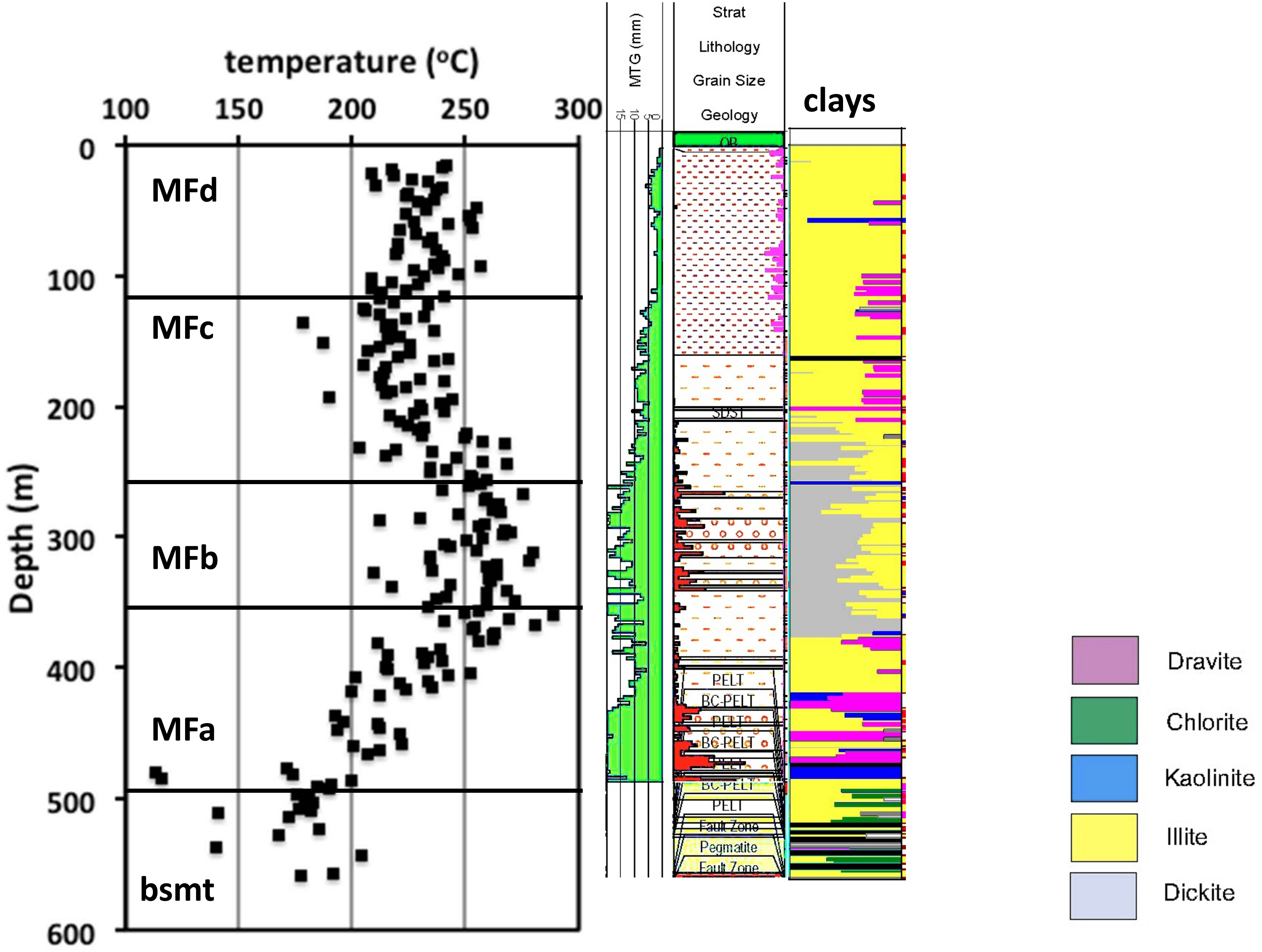
The Athabasca example—fluid temperatures and alteration from primary dispersion of mineralizing fluids



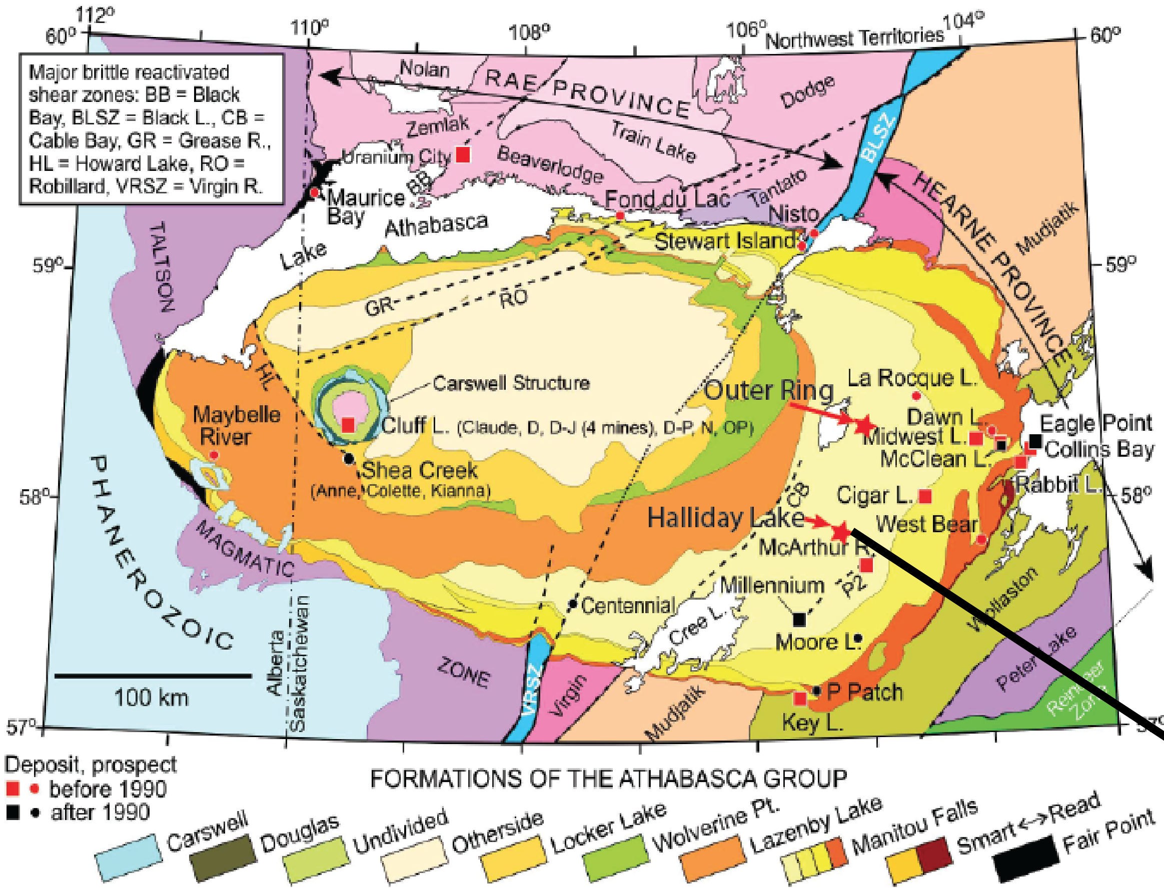
VR-01—far from mineralization—few temps above 250^{o}C and not prospective

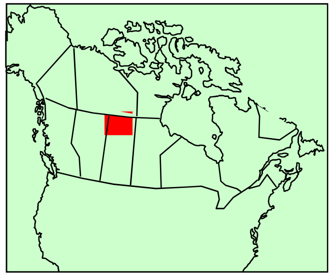


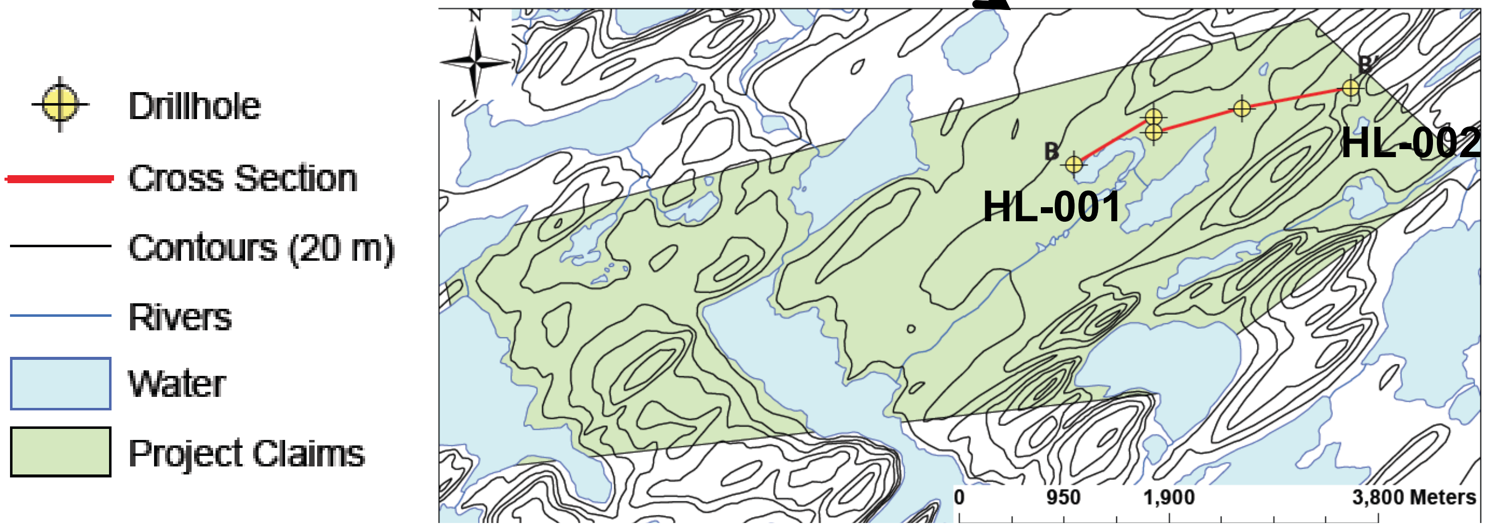
ZK85-01 near mineralization—temps >250°C in Mfa/MFb

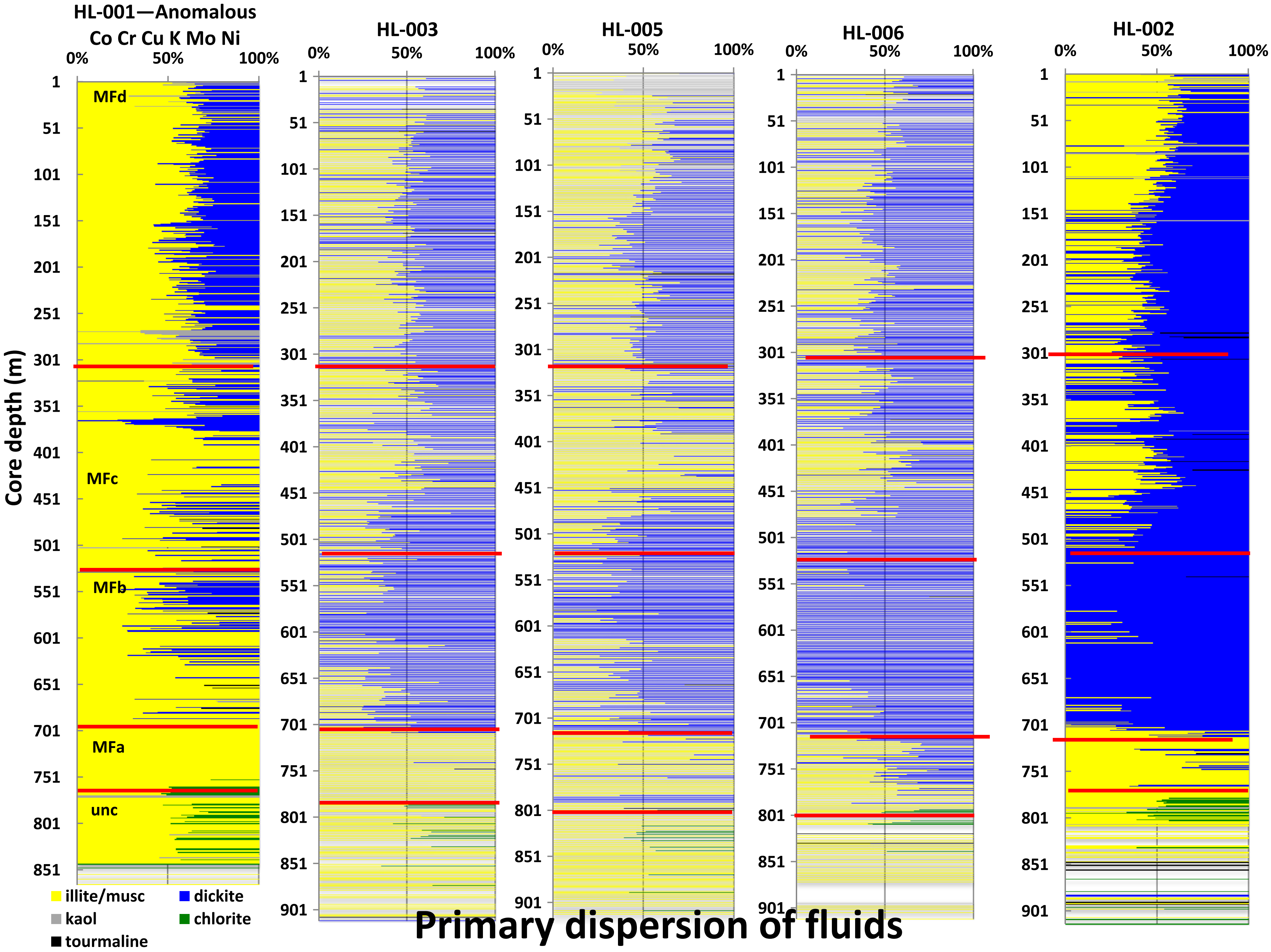


Halliday Lake Exploration Example—primary dispersion from drill core



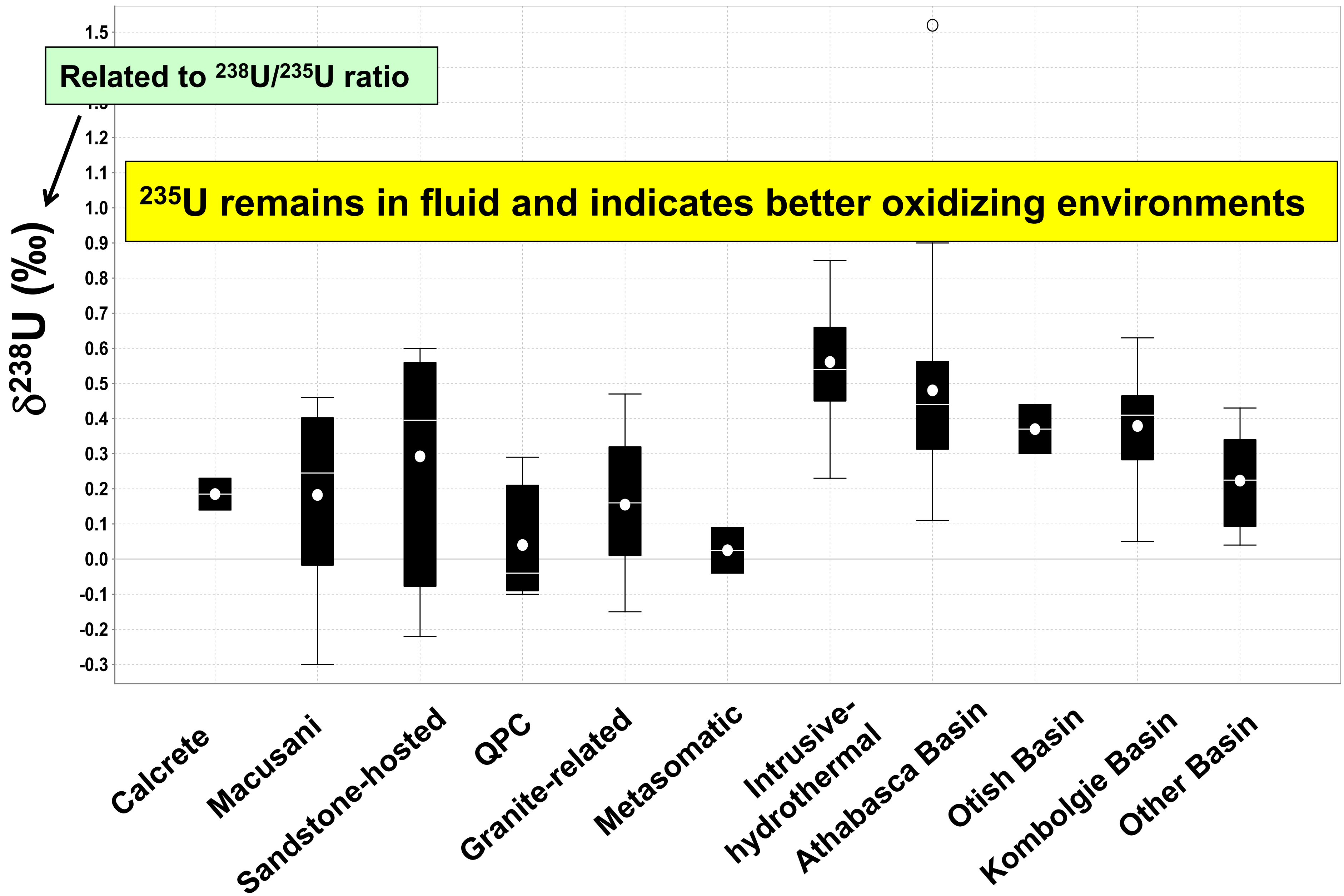






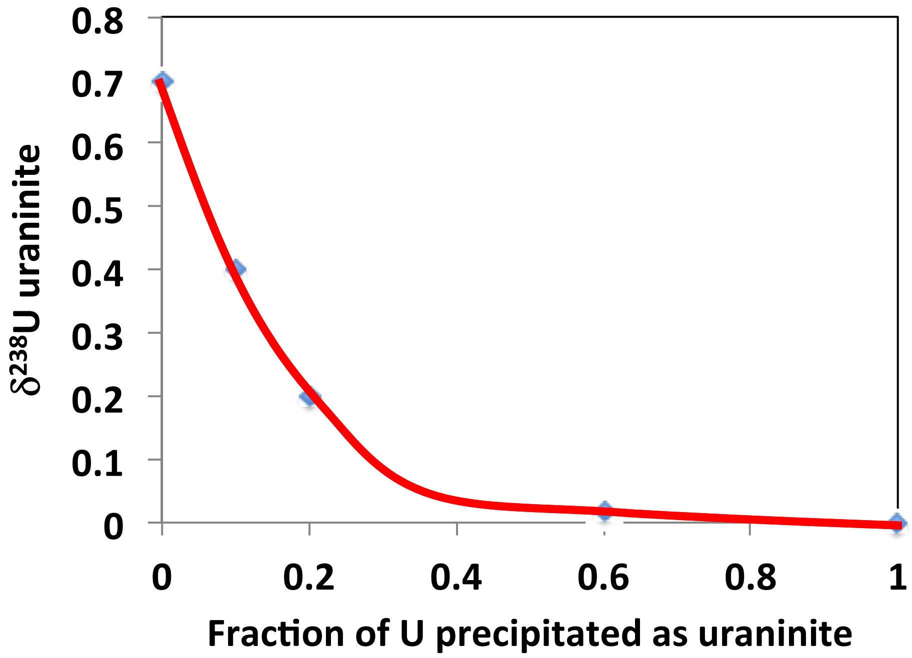
Primary dispersion of fluids

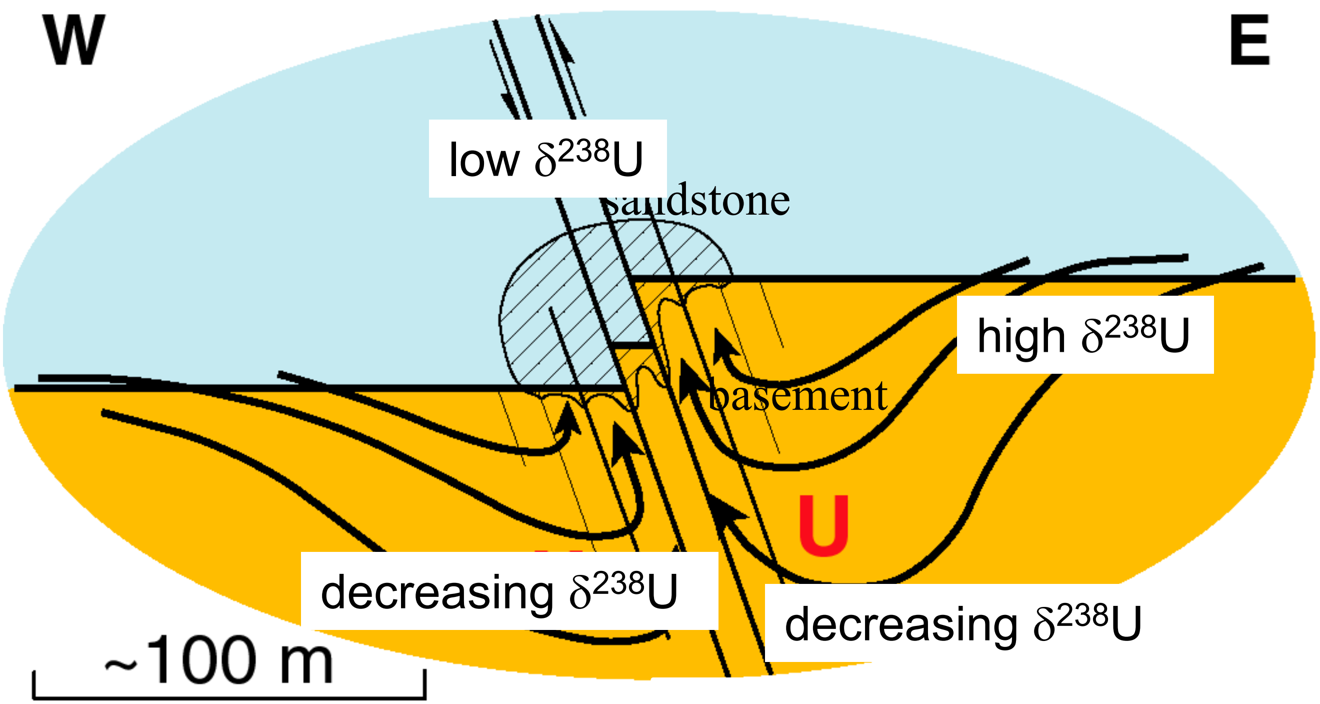
$\delta^{238}U$ for uranium ore minerals from various deposits



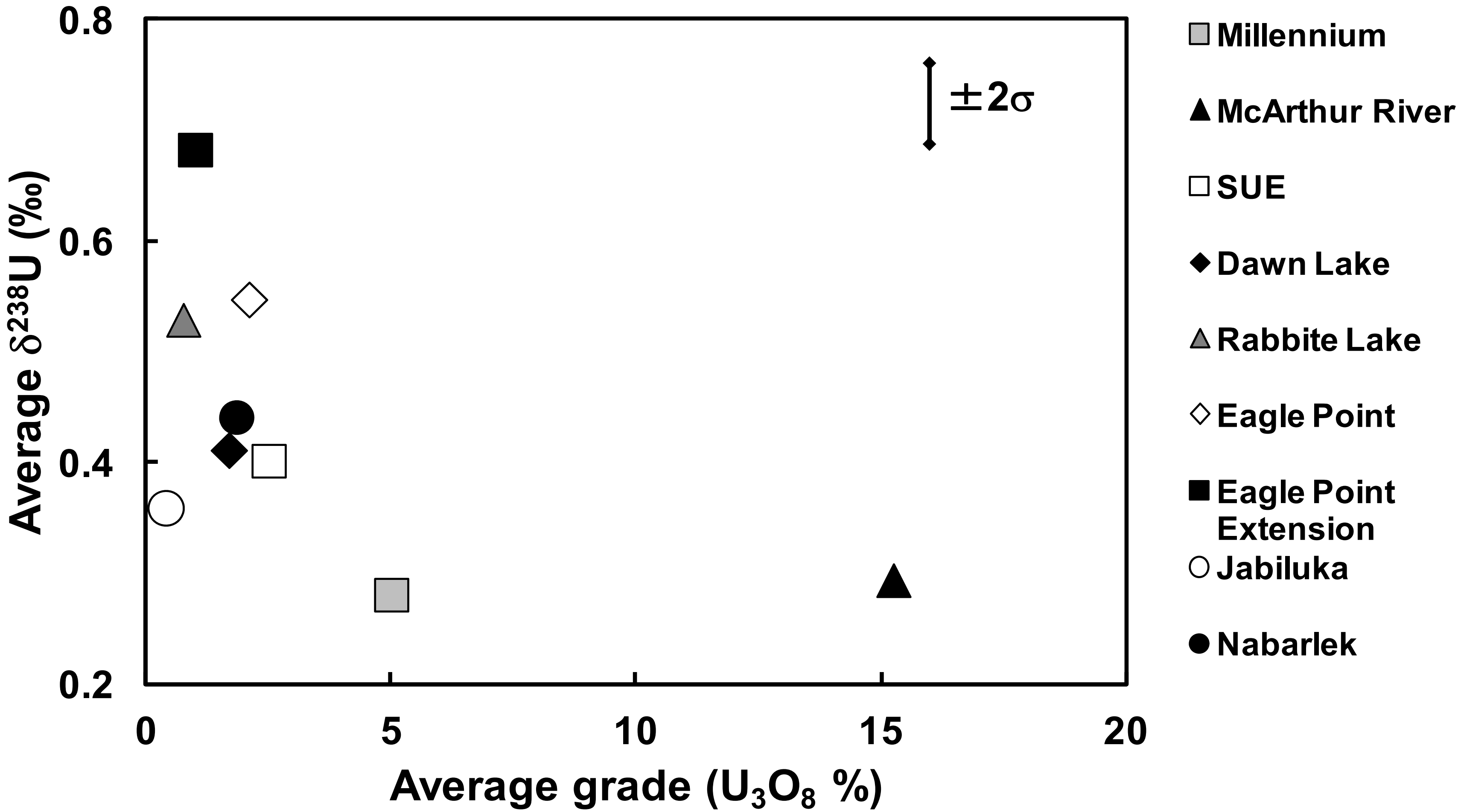
Models for U isotopes U-deposits

Fluids react with reductants (high $\delta^{238}U$) and ^{235}U stays in fluid—precipitates as reduction efficiency increases or further downstream (low $\delta^{238}U$)

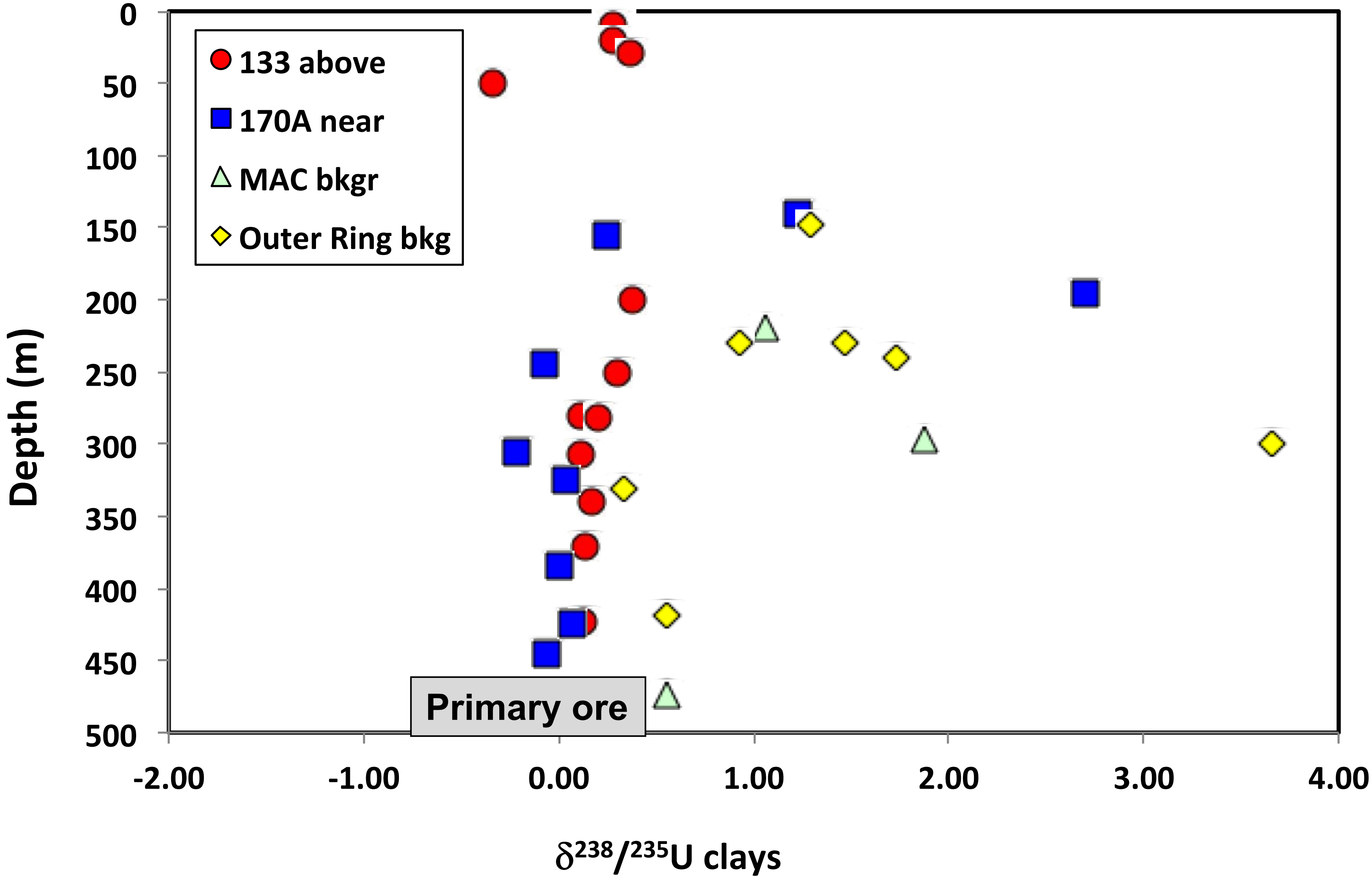


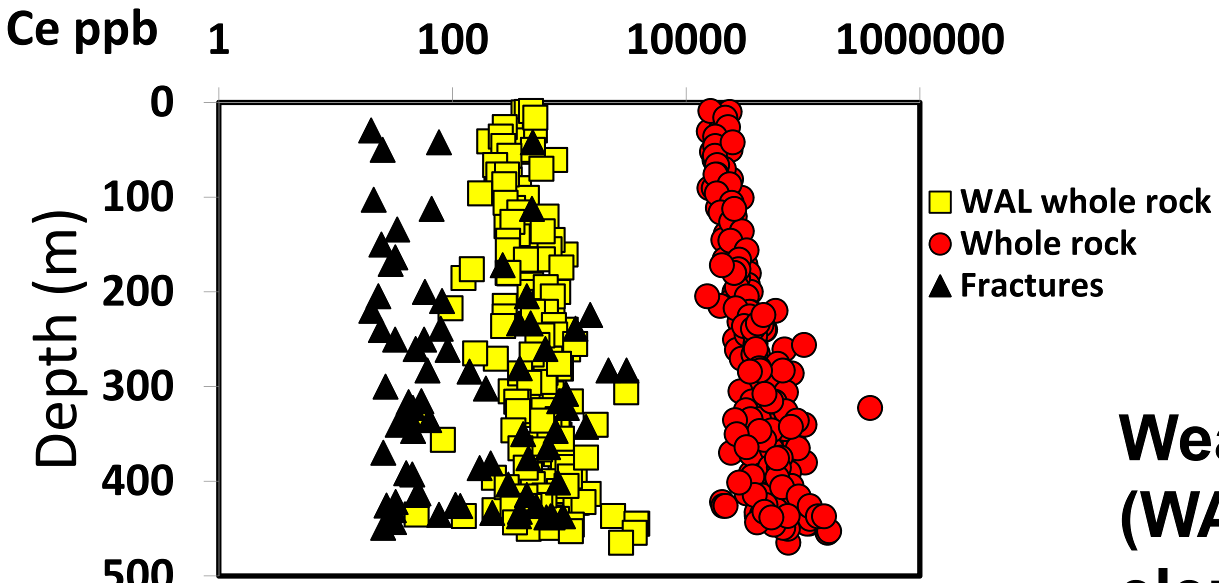


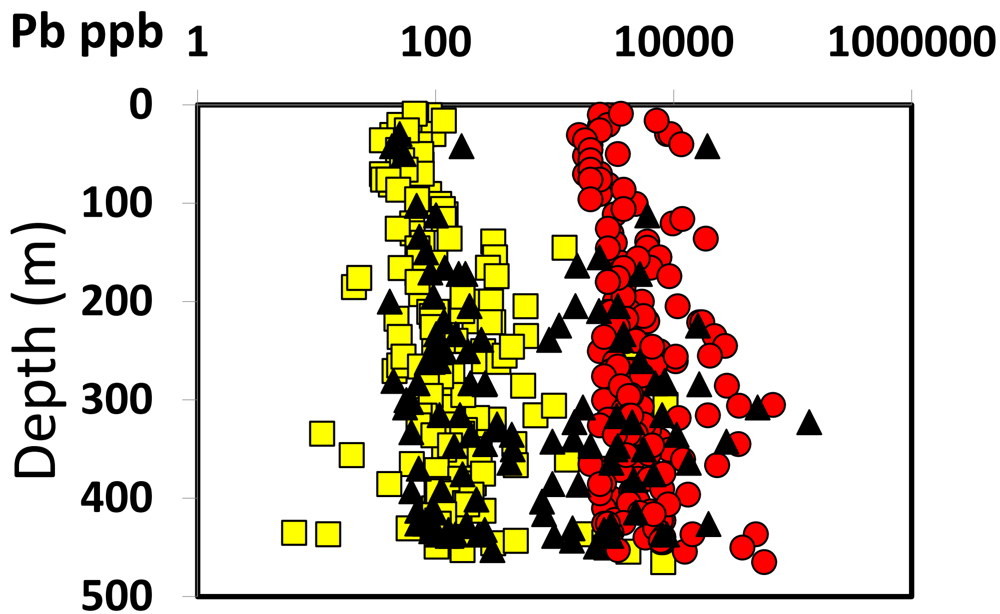
$\delta^{238}U$ values vs. average grade for uranium ores from Athabasca and Kombolgie basins unconformity-related deposits



Uranium isotopes—primary dispersion recorded in clays from Cigar (red & blue), McArthur (green) and Outer Ring

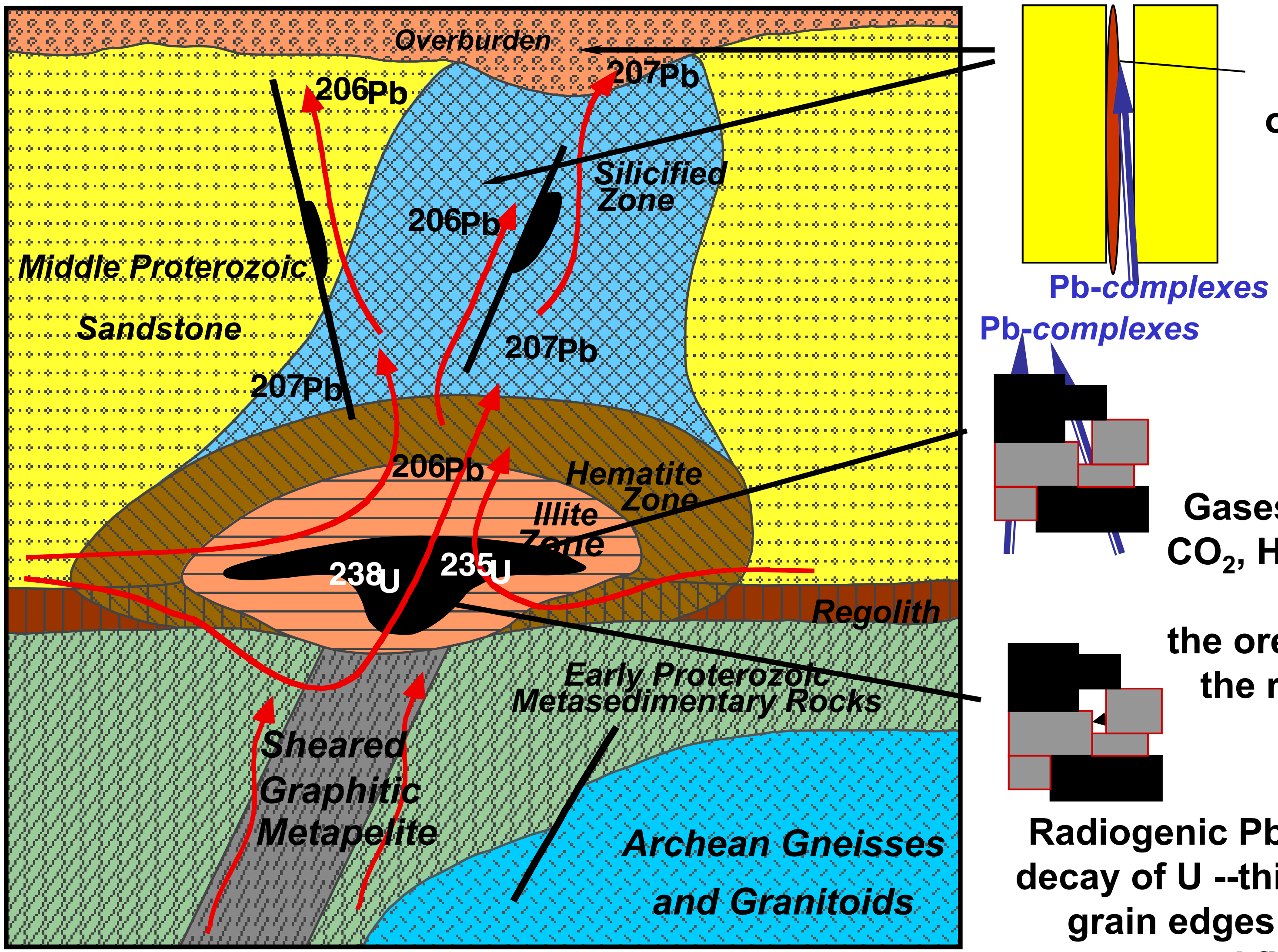






Weak Acid Leach (WAL) extraction of elements can be used to indicate which elements are mobile—example from Cigar Lake

Use of Pb isotopes and mobile elements in detecting deposits

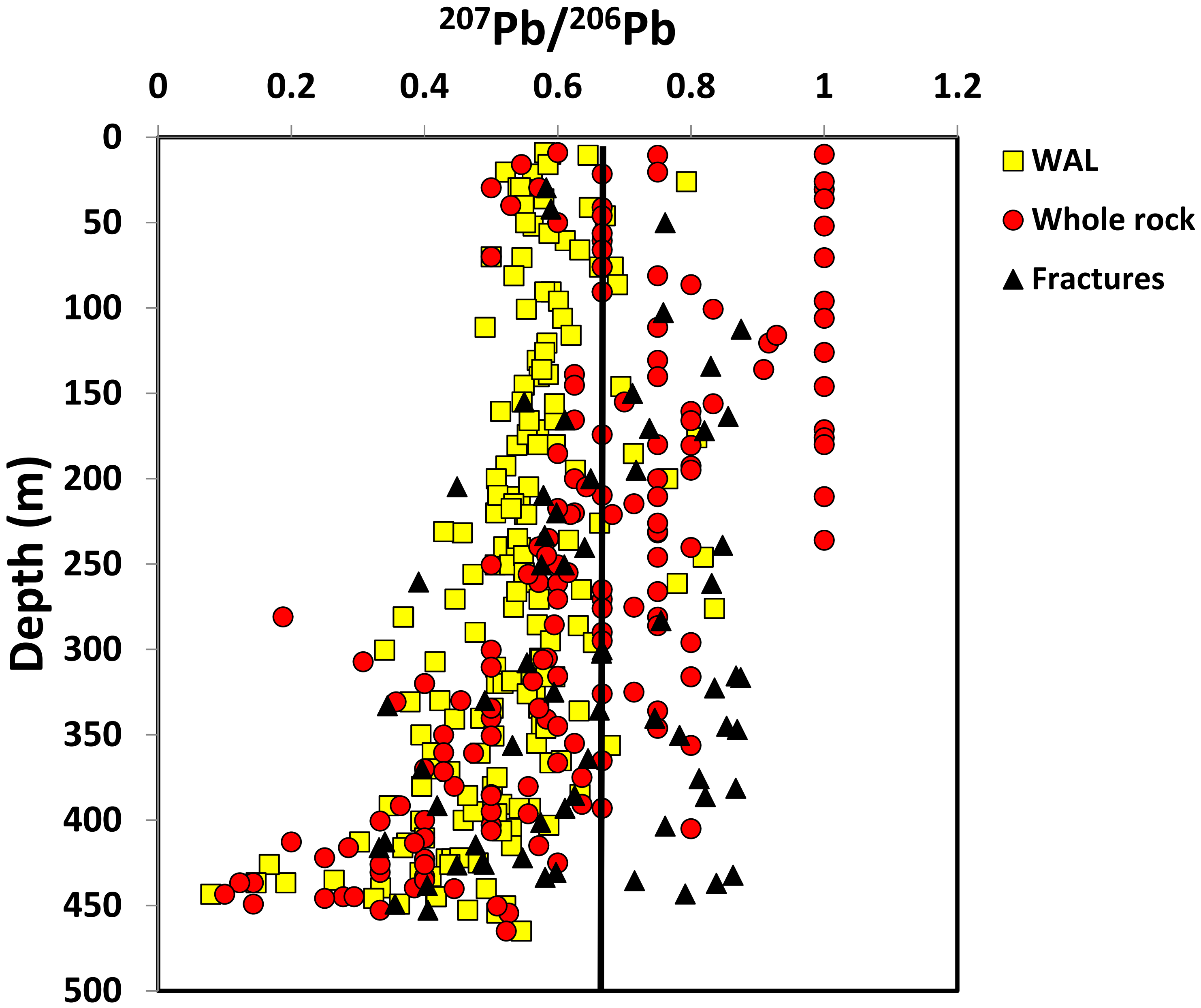


Clays & Fe-Mn-oxides effectively trap Pb complexes in permeable zones or along fractures

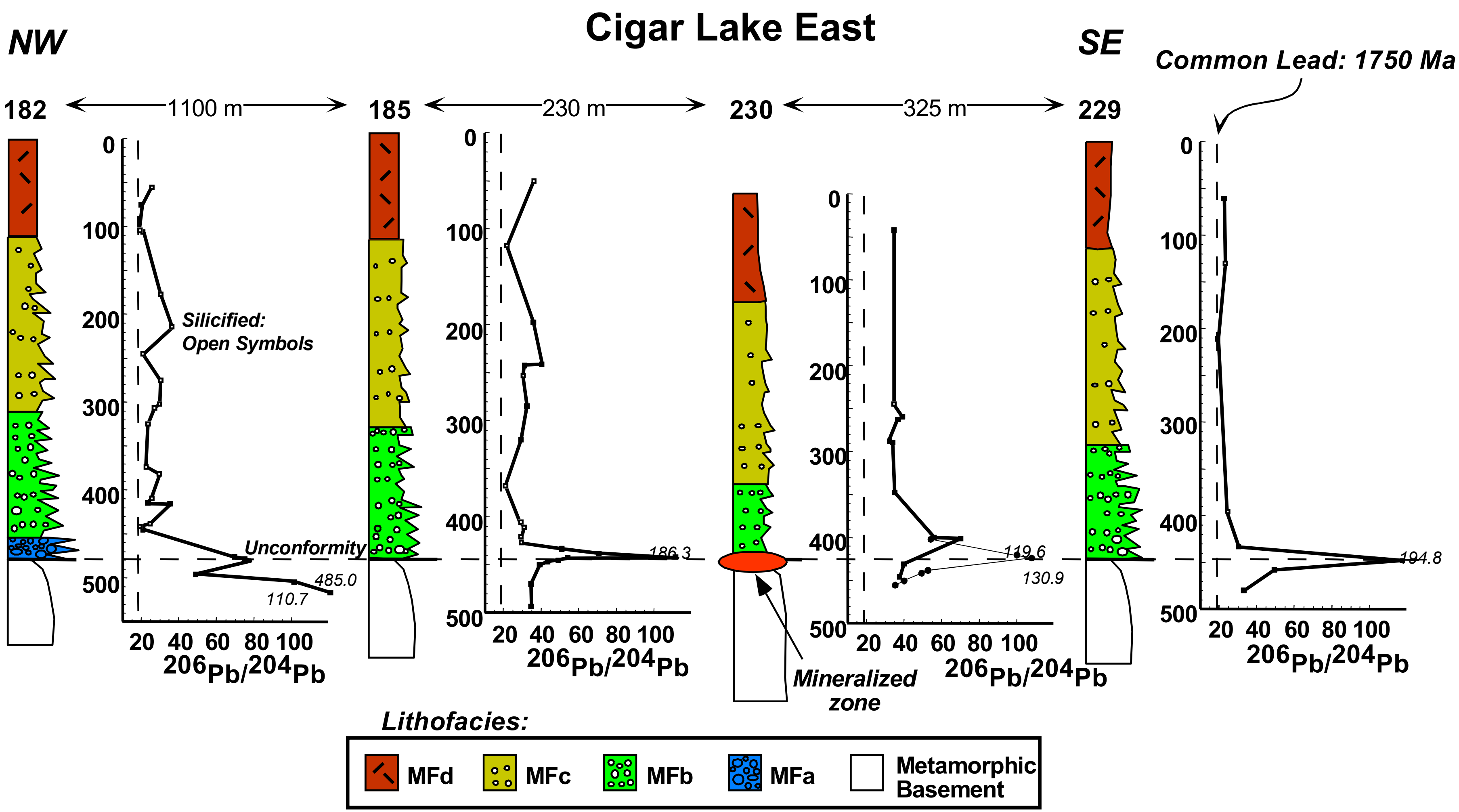
Gases such as H_2S, CO_2, HCl etc. passing through the ore zone mobilize the radiogenic Pb

Radiogenic Pb is produced by decay of U --this Pb migrates to grain edges and into pore spaces and fluids and gases

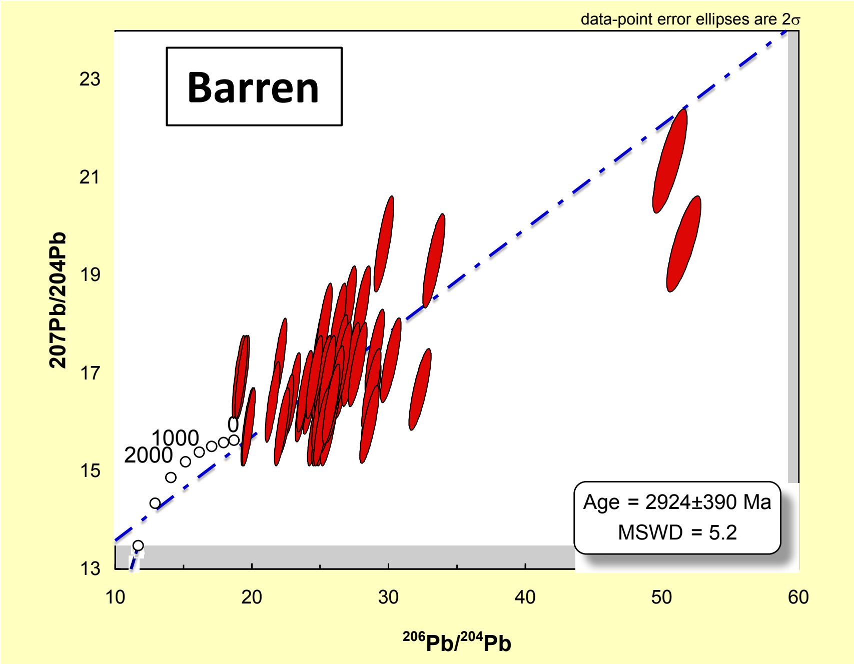
Weak Acid Leach (WAL) indicates that mobile components moved through the sandstone and fractures all the way to the surface

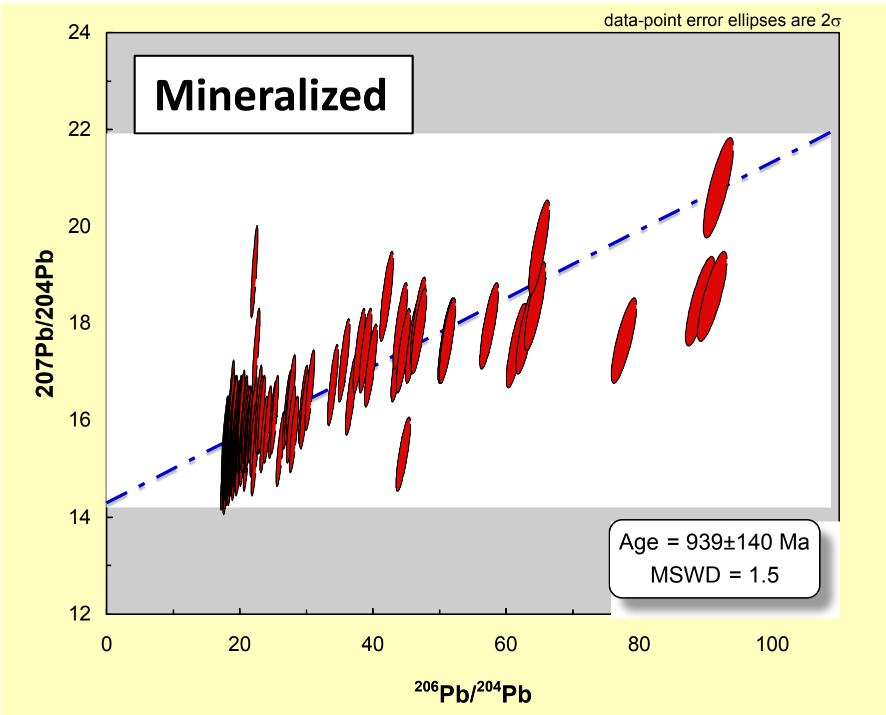


How large are these secondary dispersion haloes?



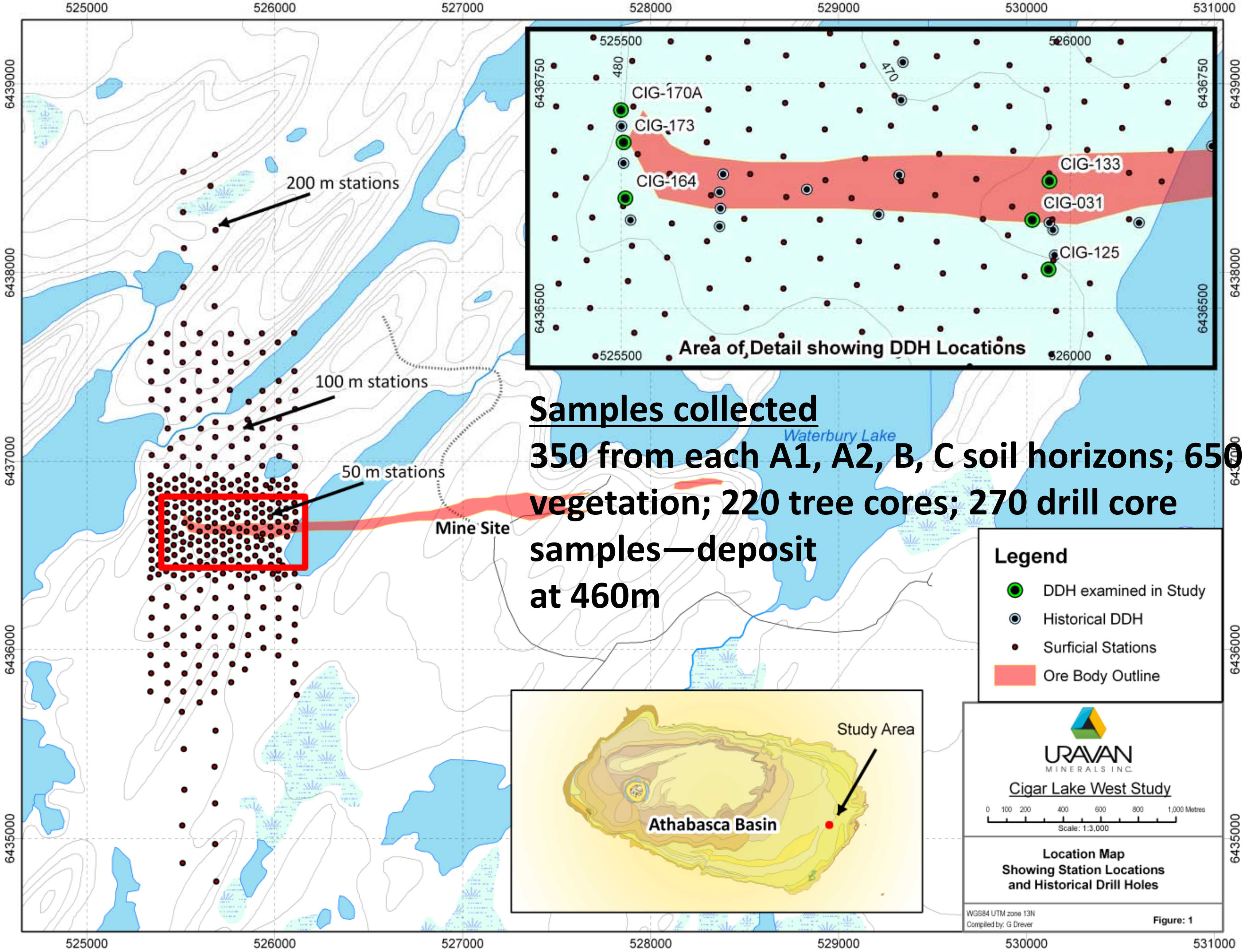
Holk et al., 2003





Model ages of the Pb extracted with WAL from the sandstone in mineralized areas are younger than the basin, whereas barren areas are older

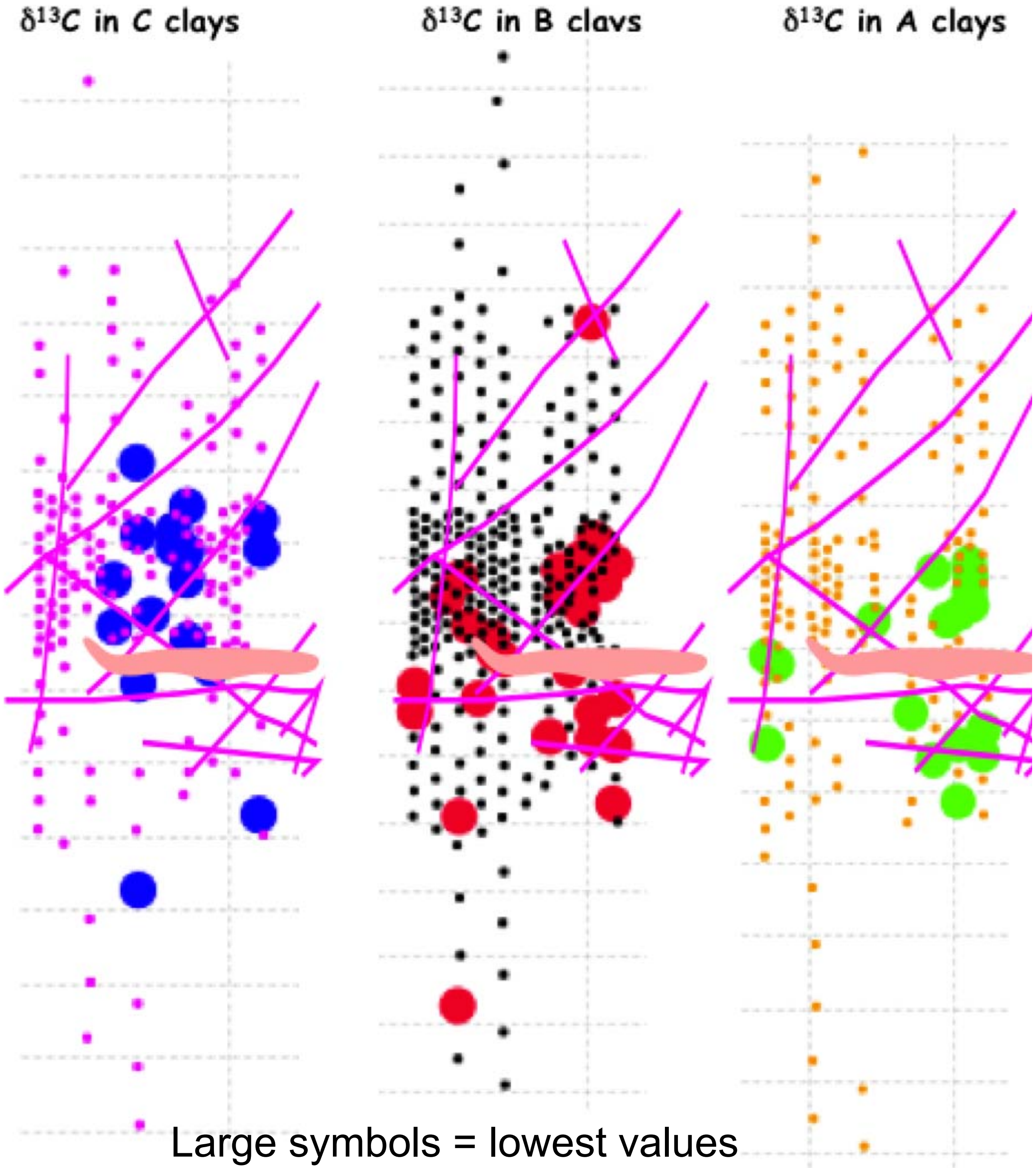
Cigar Lake West—evidence for secondary dispersion



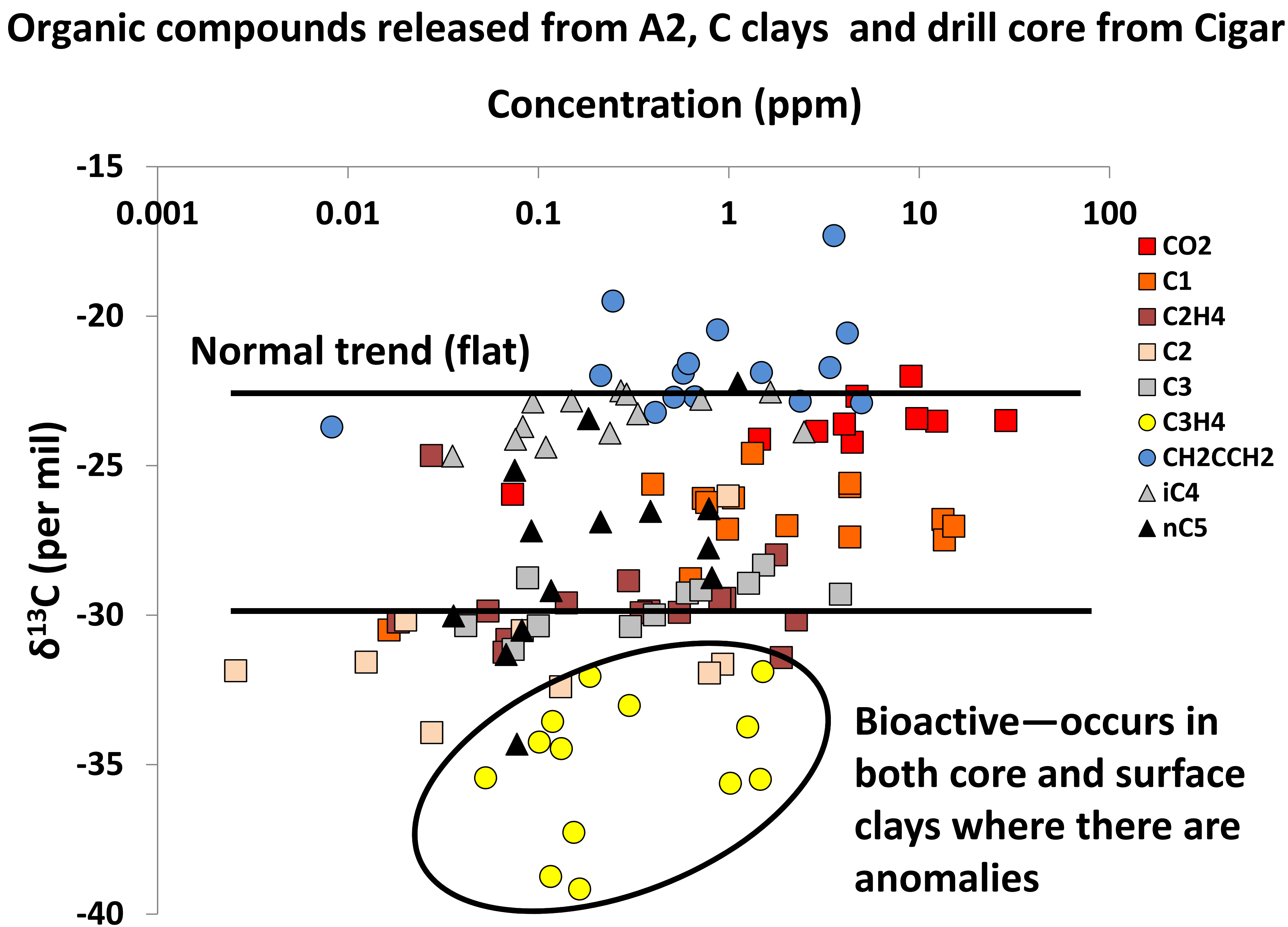
<u>Samples collected</u>

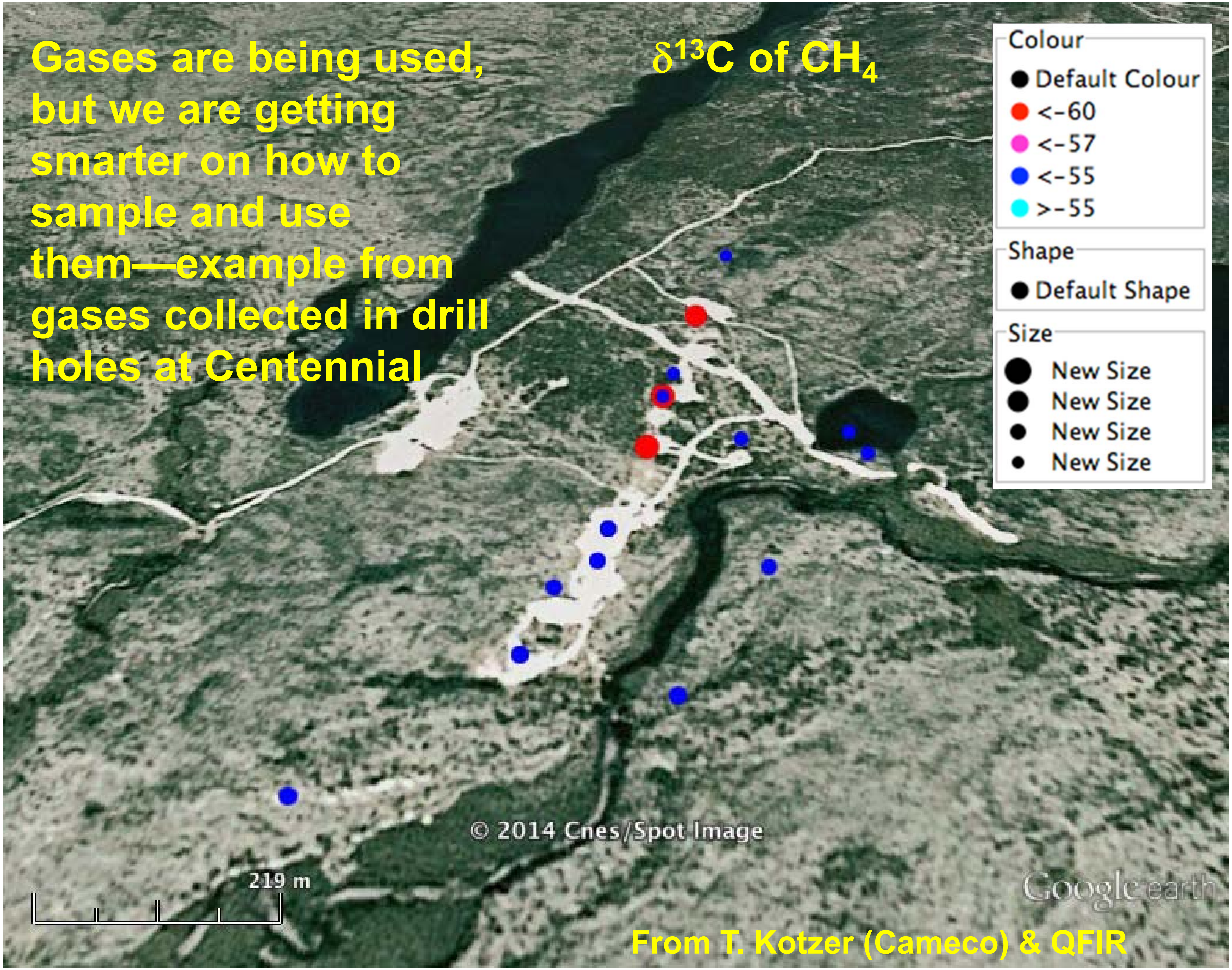
350 from each A1, A2, B, C soil horizons; 650 vegetation; 220 tree cores; 270 drill core samples—deposit at 460m

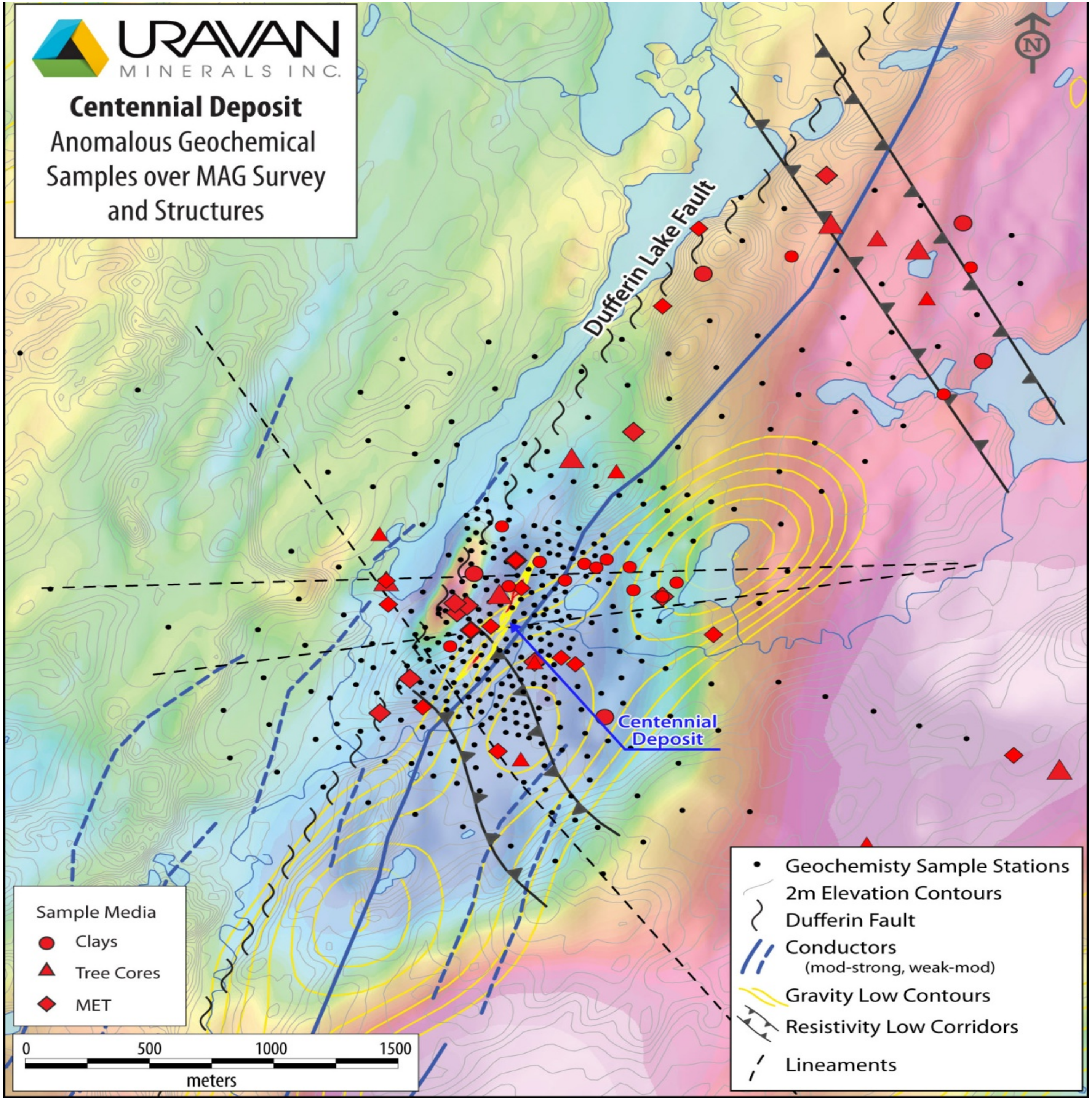
Carbon species in soil clays



Those elements in surface samples that reliably indicate mineralization or faults that transect the mineralization include Pb isotopes, U, Pb, Ni, Co, Zn, Mn, Tl and C & N isotopes—minimal relation to topography


Organic compounds released from A2, C clays and drill core from Cigar
Concentration (ppm)
0.001
0.01
0.1
1
10
100
-15
-20
-25
-30
-35
-40
δ13C (per mil)
Normal trend (flat)
CO2
C1
C2H4
C2
C3
C3H4
CH2CCH2
iC4
nC5
Bioactive—occurs in both core and surface clays where there are anomalies


Gases are being used, but we are getting smarter on how to sample and use them—example from gases collected in drill holes at Centennial
δ13C of CH4
Colour
Default Colour
<-60
<-57
<-55
>-55
Shape
Default Shape
Size
New Size
New Size
New Size
New Size
© 2014 Cnes/Spot Image
219 m
Google earth
From T. Kotzer (Cameco) & QFIR



How far down can we “see” deposits at depth?

Recent results in the use of geochemistry in detecting deep uranium deposits:

(1) Map element distributions in and around deposits to assess the total chemical environment associated with the deposit,

(2) Use element tracing with isotopic compositions in surface media to detect specific components from uranium deposits at depth,

(3) Capitalize on element mobility across the geosphere-biosphere interface to enhance exploration using select media

(4) Geochemical data from drill core or surface media can enhance target identification when integrated with geophysical data.