U Exploration Using Pb Isotopes : Opportunities In Partial Extraction Geochemistry

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Introduction

- Research Undertaken in 1990 – collaboration between CSIRO and Neil Rutherford (Surtec)
- Motive: to find a low cost broad scale geochemical exploration technique in the Pine Creek based on stream sediments
- Unreported except to the participants – dramatic downturn in U exploration interest

Contents

Pb Isotopes "101"

Q: Why use Pb isotopes as a surrogate for U?

A: Because:

- Pb isotope ratios are directly dependent on the amount of U in a system and increase with time, and more importantly
- In geocehmical explorations samples Pb isotope ratios *discriminate between U sources from "normal" rocks and those from U mineralisation.*

Pb Isotopes "101"

Why Pb isotopes vary:

- ^{238}U decays to ^{206}Pb ($T^{1/2}$ = 4.5 Ga)
- ^{232}Th decays to ^{208}Pb ($T^{1/2}$ = 14 Ga)
- ^{204}Pb has no parent (Invariate)

Therefore:

- If U levels are high, and
- Th levels are "normal",

High U/Th as in U Ore

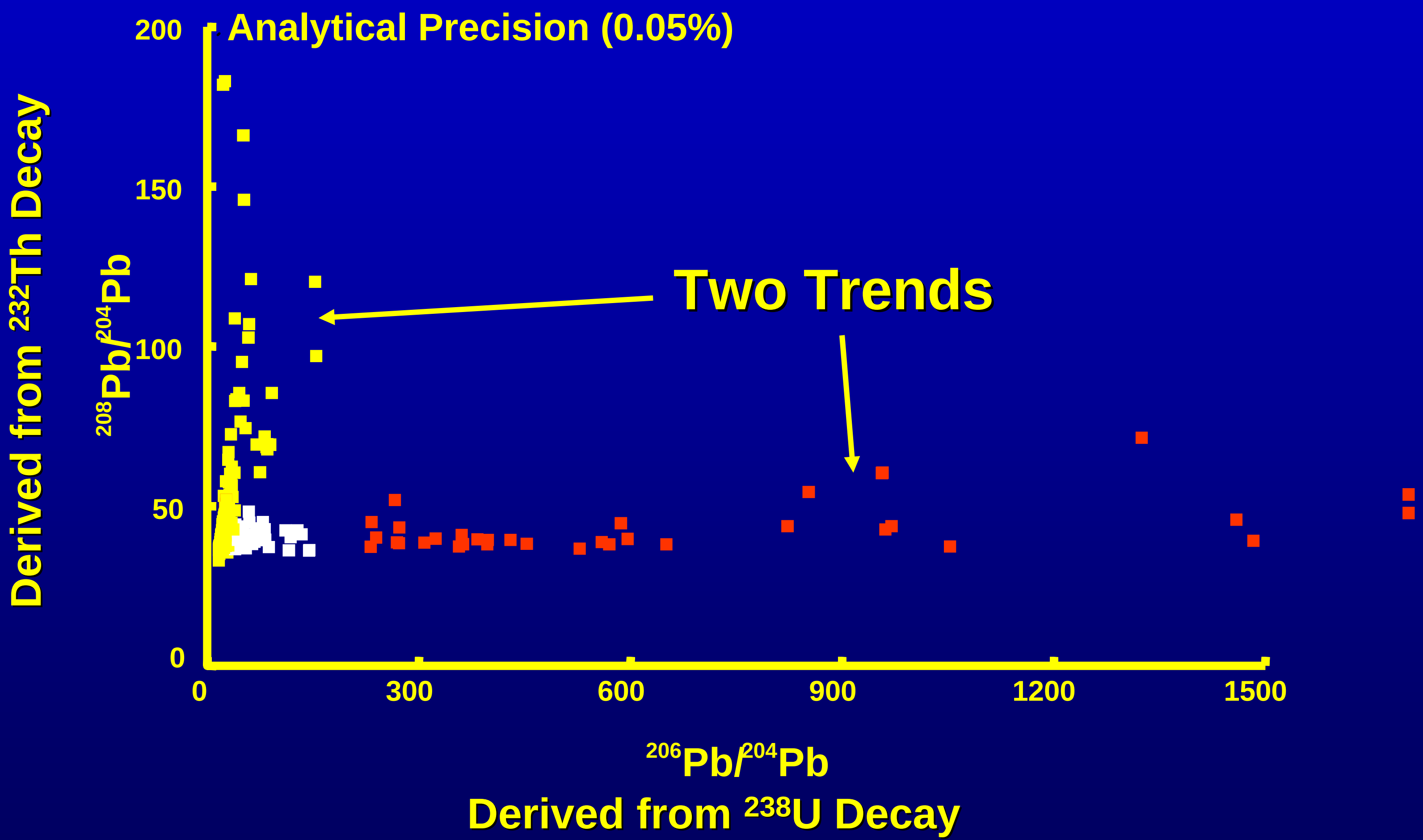
then

- $^{206}Pb/^{204}Pb$ will be high, but
- $^{208}Pb/^{204}Pb$ will be "normal"

Pb Isotopes "101"

- *Key Messages:*
  - *Pb isotope ratios are sensitive to the U/Th ratios of the source rocks*
  - *Simply looking for elevated "uranogenic" Pb ($^{206}Pb/^{204}Pb$ ratios) is not a viable exploration technique*

Conventional Pb Isotope Plot – Pine Creek Rocks (Gulson 1979)



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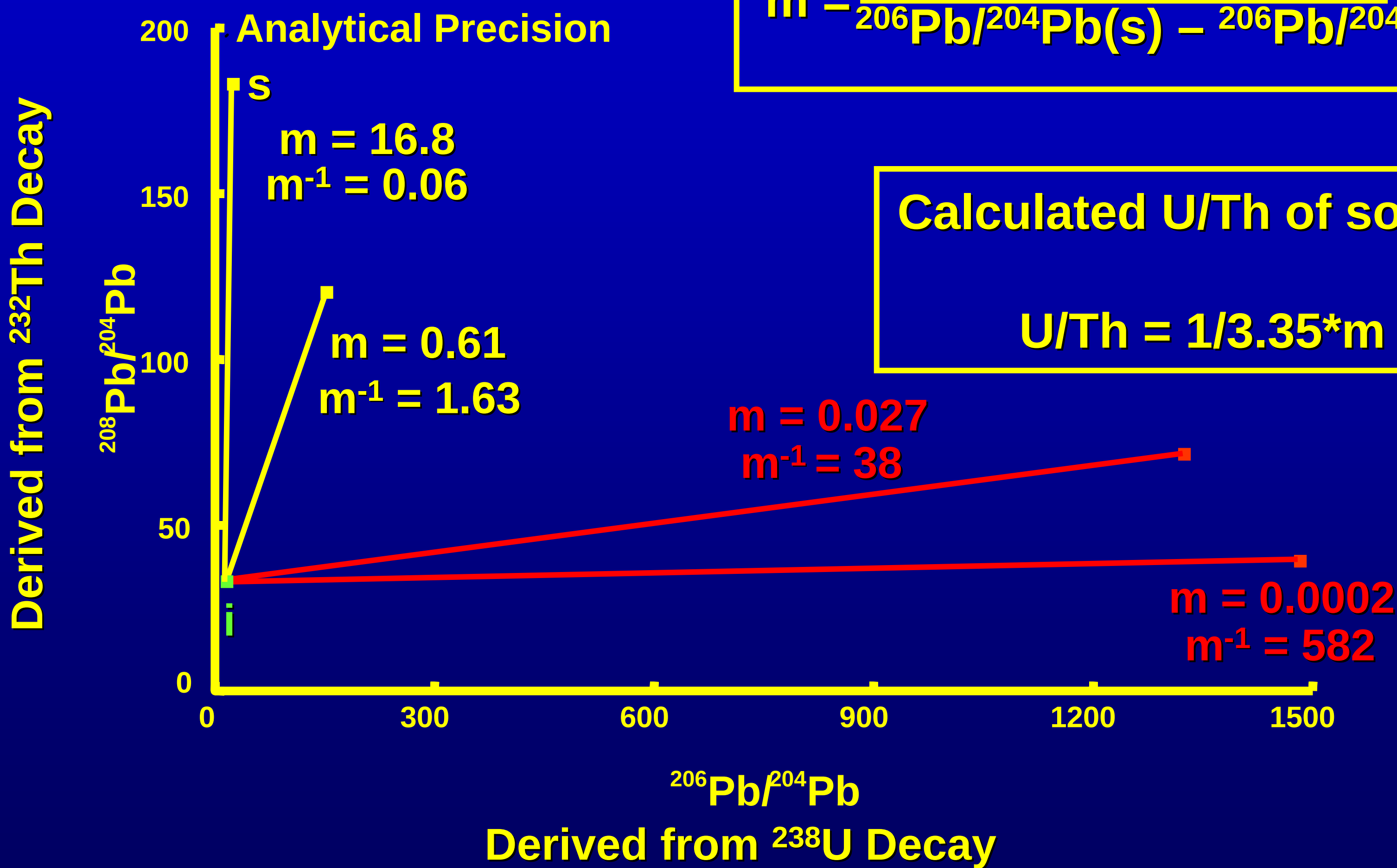
Presentation of Results

$$m = \frac{{}^{208}Pb/{}^{204}Pb(s) - {}^{208}Pb/{}^{204}Pb(i)}{{}^{206}Pb/{}^{204}Pb(s) - {}^{206}Pb/{}^{204}Pb(i)}$$



Calculated U/Th of source

$U/Th = 1/3.35*m$

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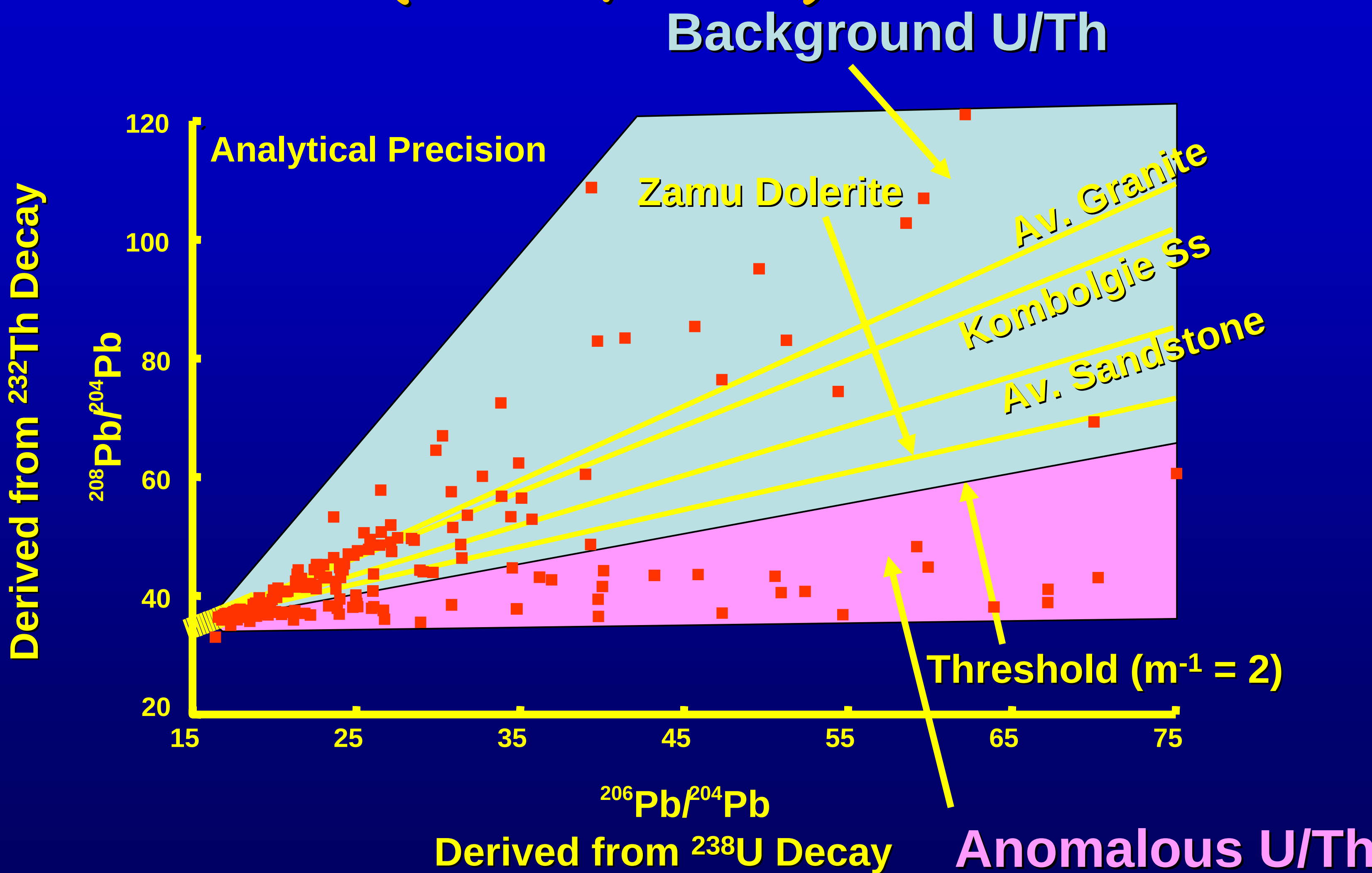
All Pine Creek Data
(Gulson, 1979)



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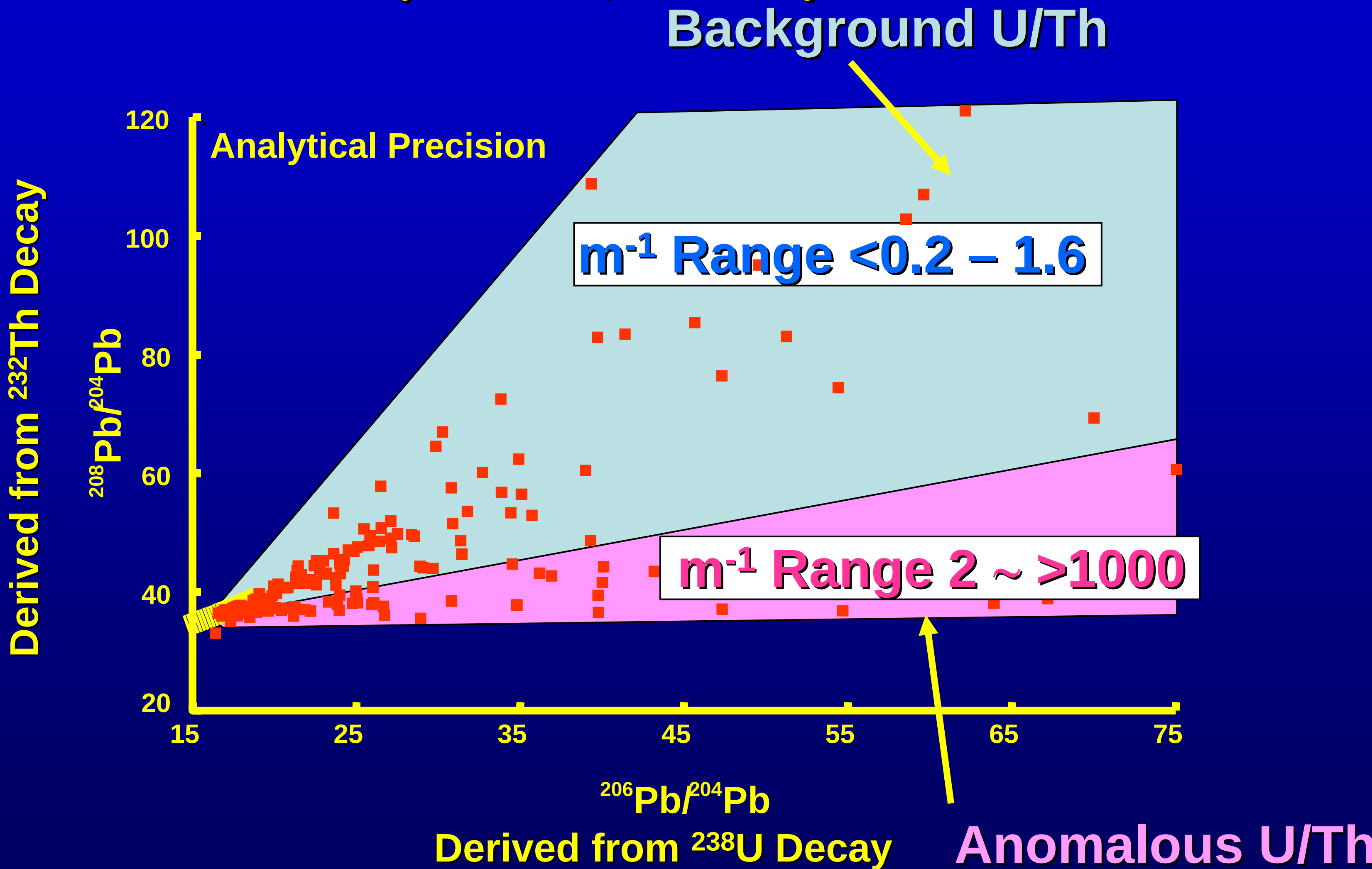

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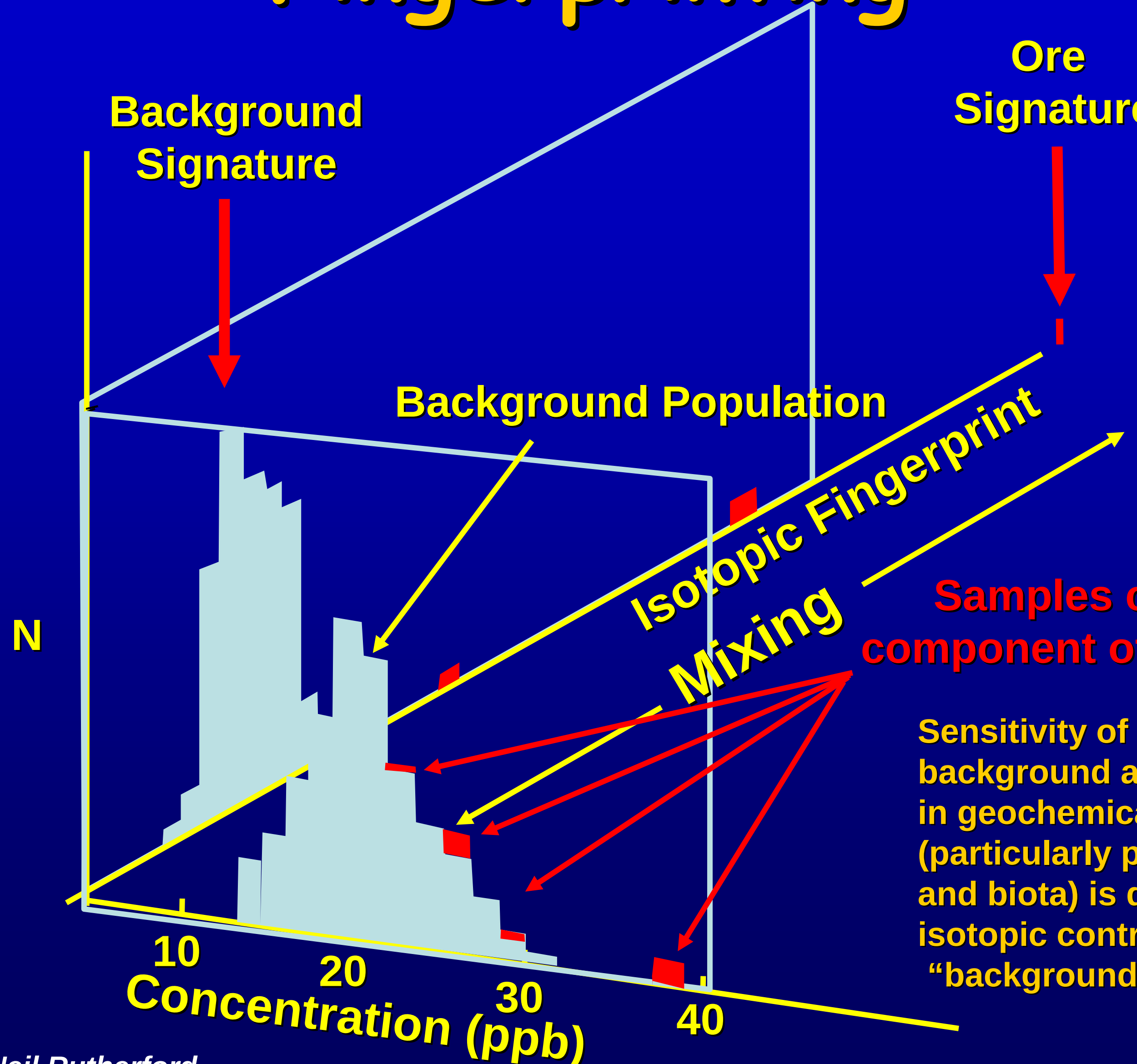
Isotopic Fingerprinting



Samples containing a component of ore derived-Pb

Sensitivity of "unmixing" background and "ore" signatures in geochemical samples (particularly partial extractions and biota) is dependent on the isotopic contrast between "background" and "ore"

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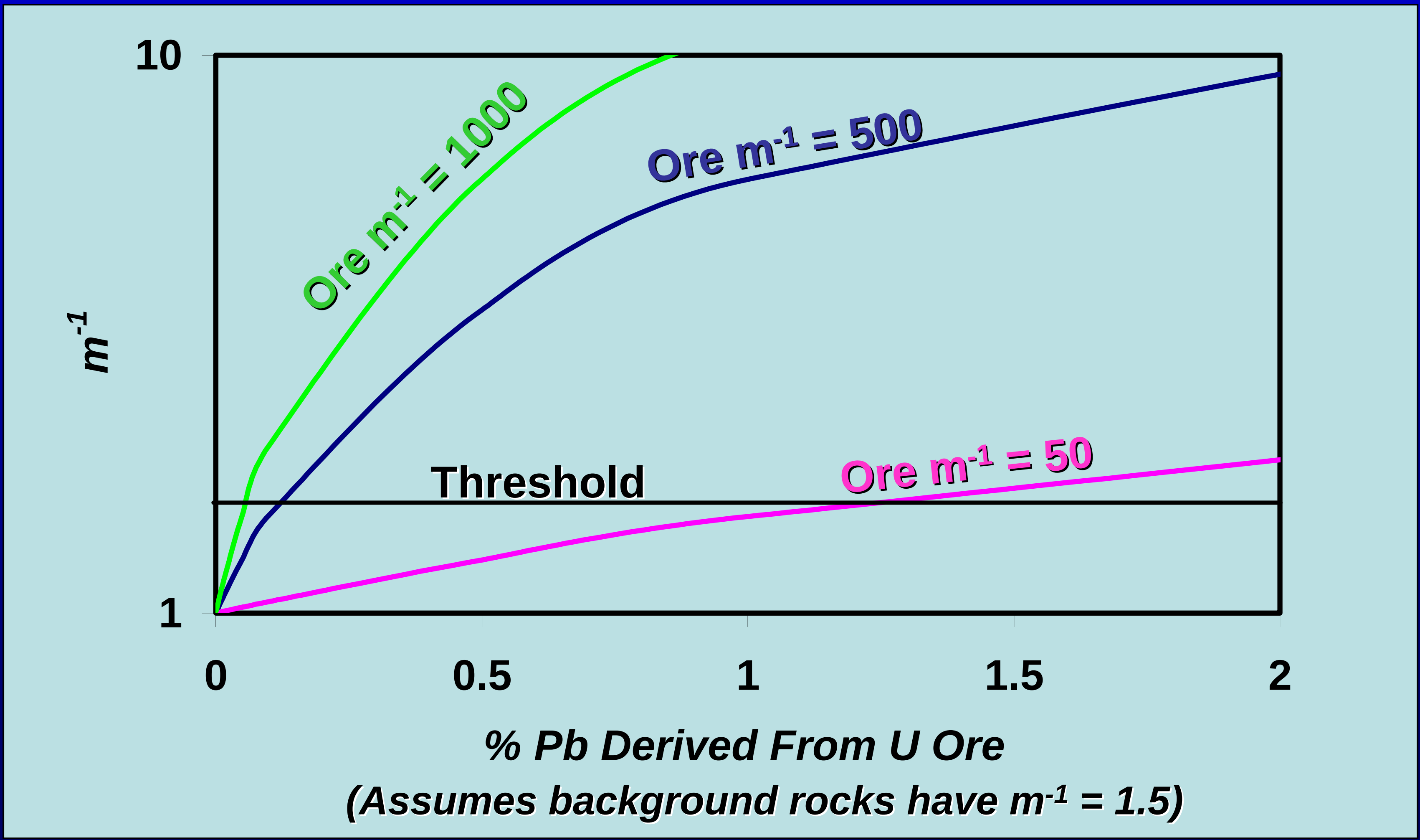
Partial Extraction- Unmixing Ore derived Pb and background Pb



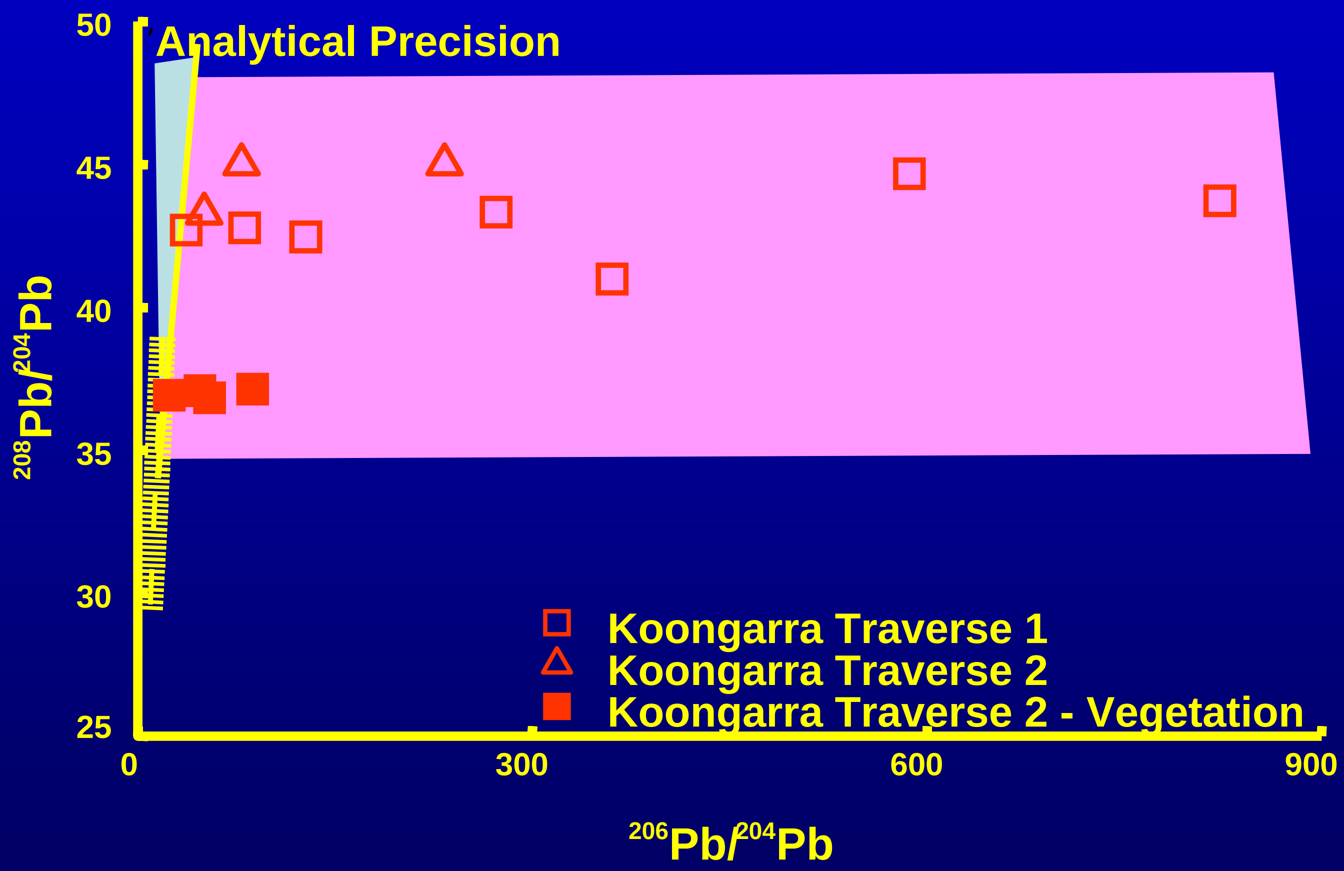
Partial Extraction- Unmixing Ore derived Pb and background Pb

- For U mineralisation isotopic contrast between "background" and "ore" is very high and *we can in theory distinguish a sample leach where only 0.1% of the Pb derives from ore.*

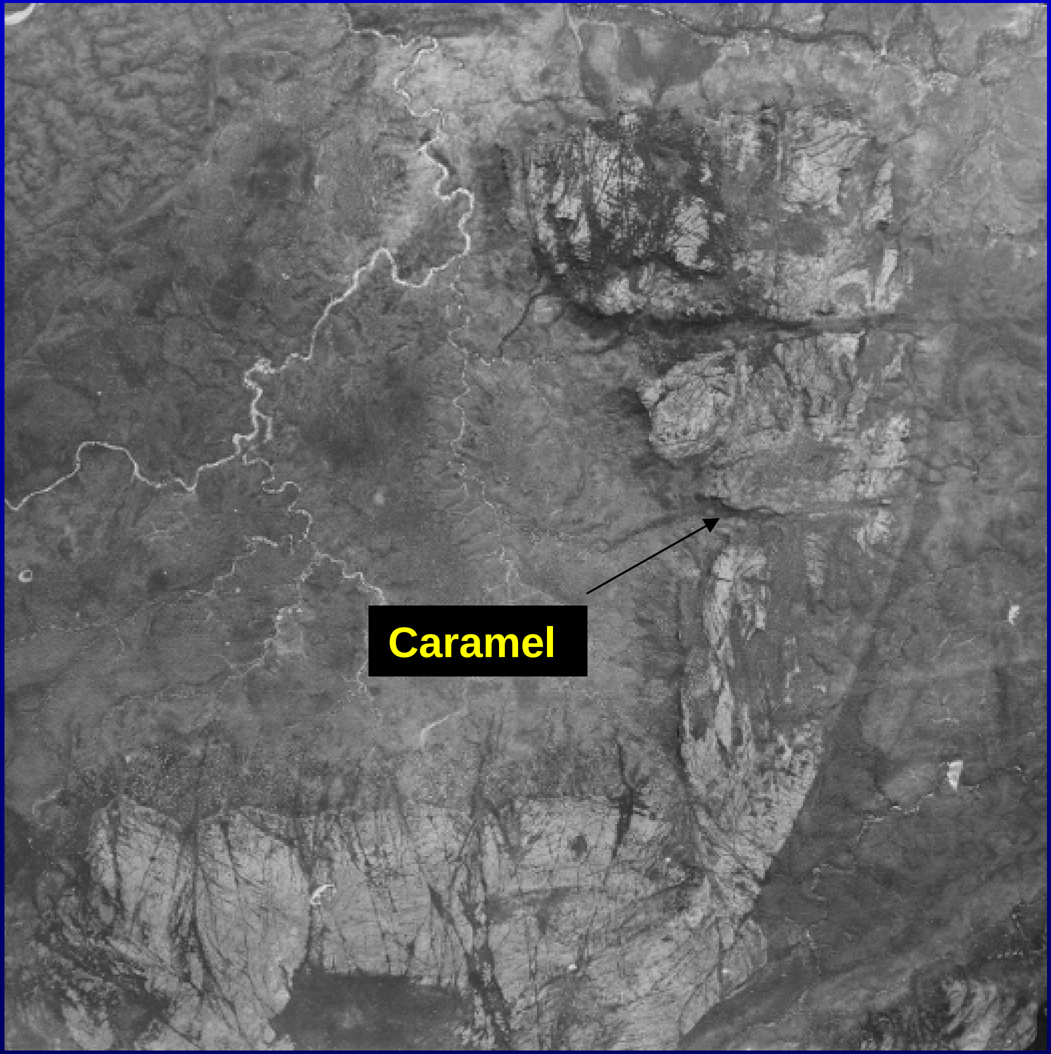
Results

1. Soil and vegetation survey over outcropping ore at Koongarra
2. Partial extractions of stream sediments at Caramel mineralisation
3. Partial extractions of streams sediments – recent (secondary) U accumulation
4. Options for analysis

Aqua Regia Leach – Soils over Outcropping Koongarra Deposit



Caramel



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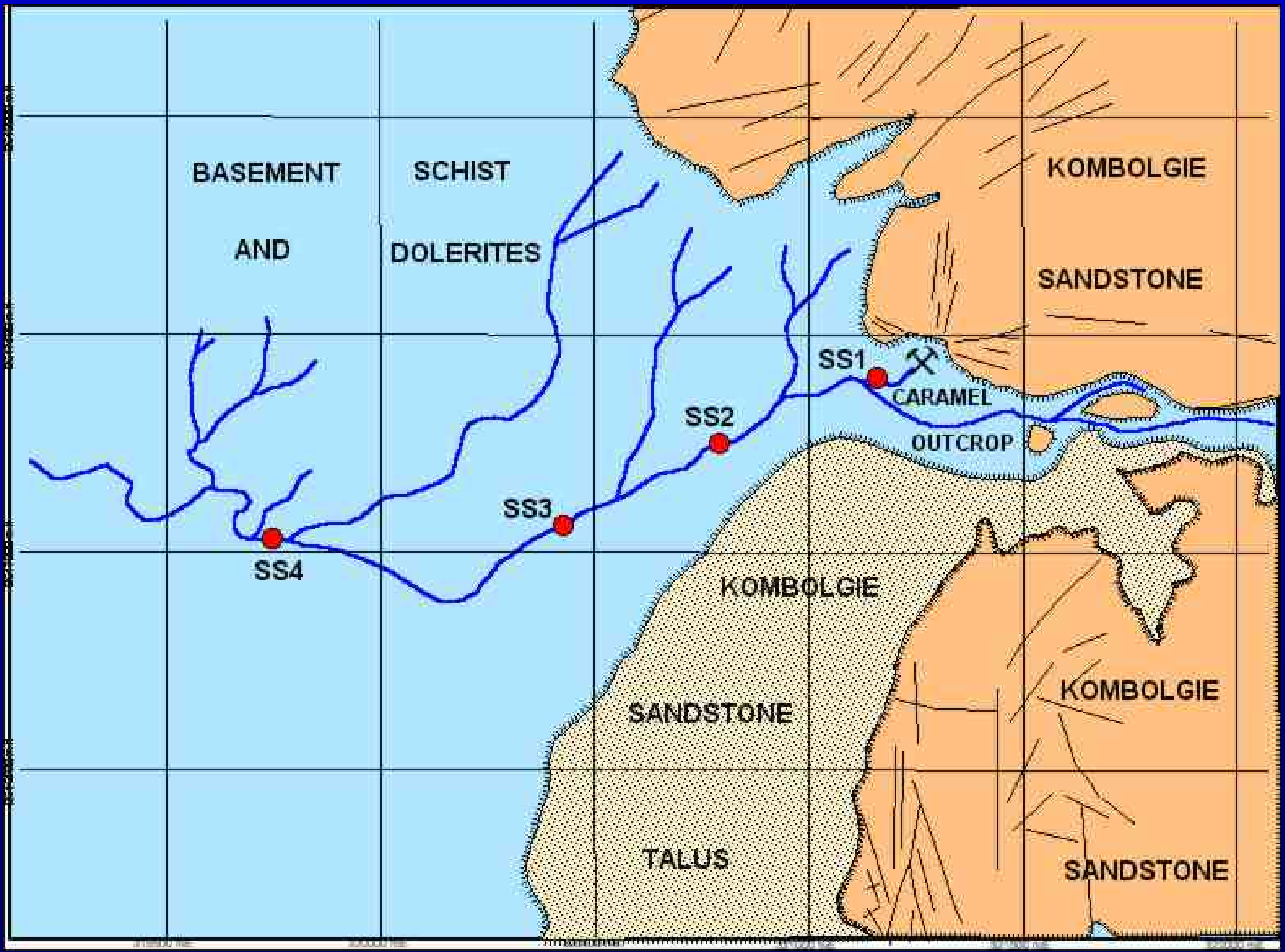
Caramel

Caramel



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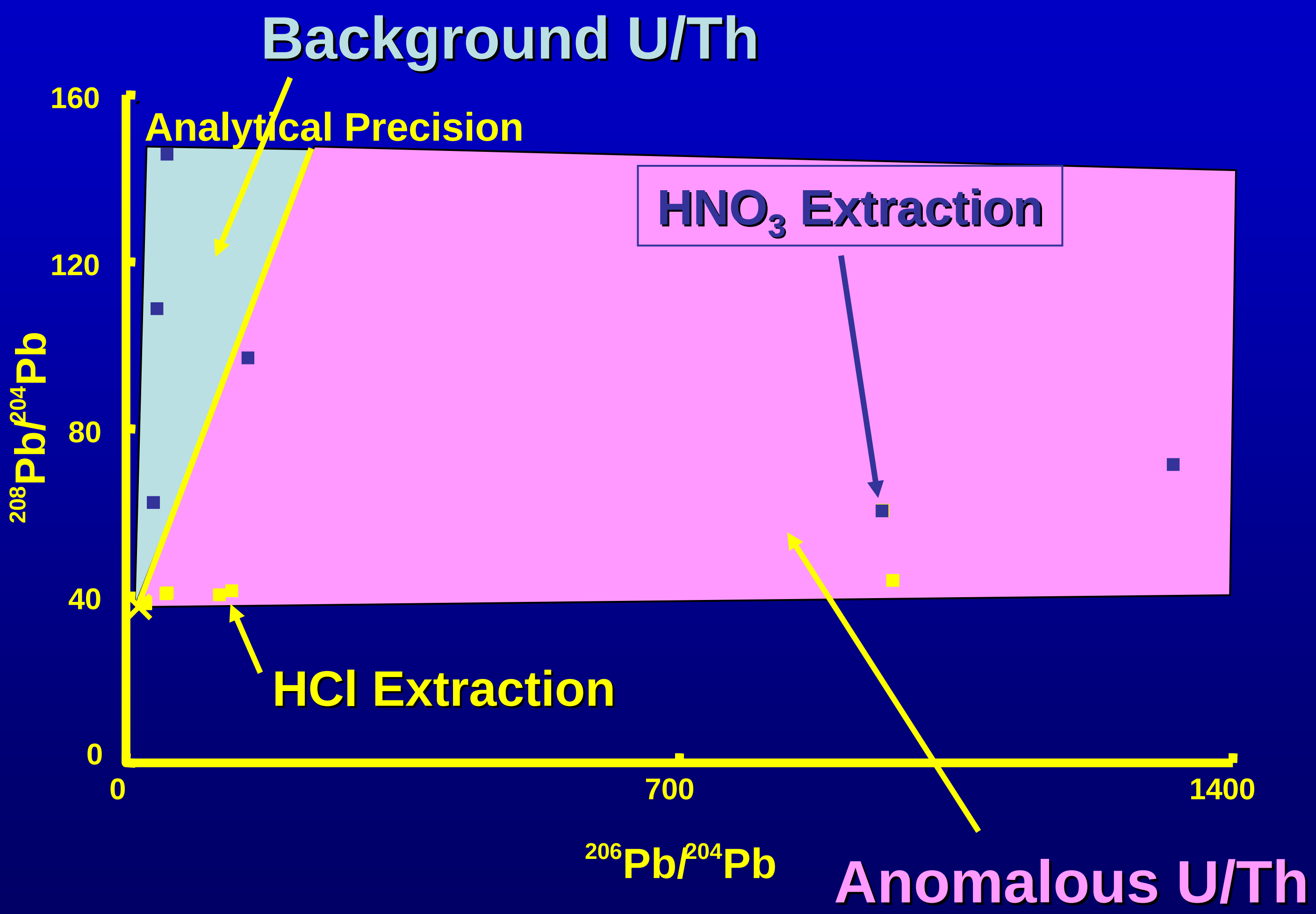
Caramel Stream Sediments



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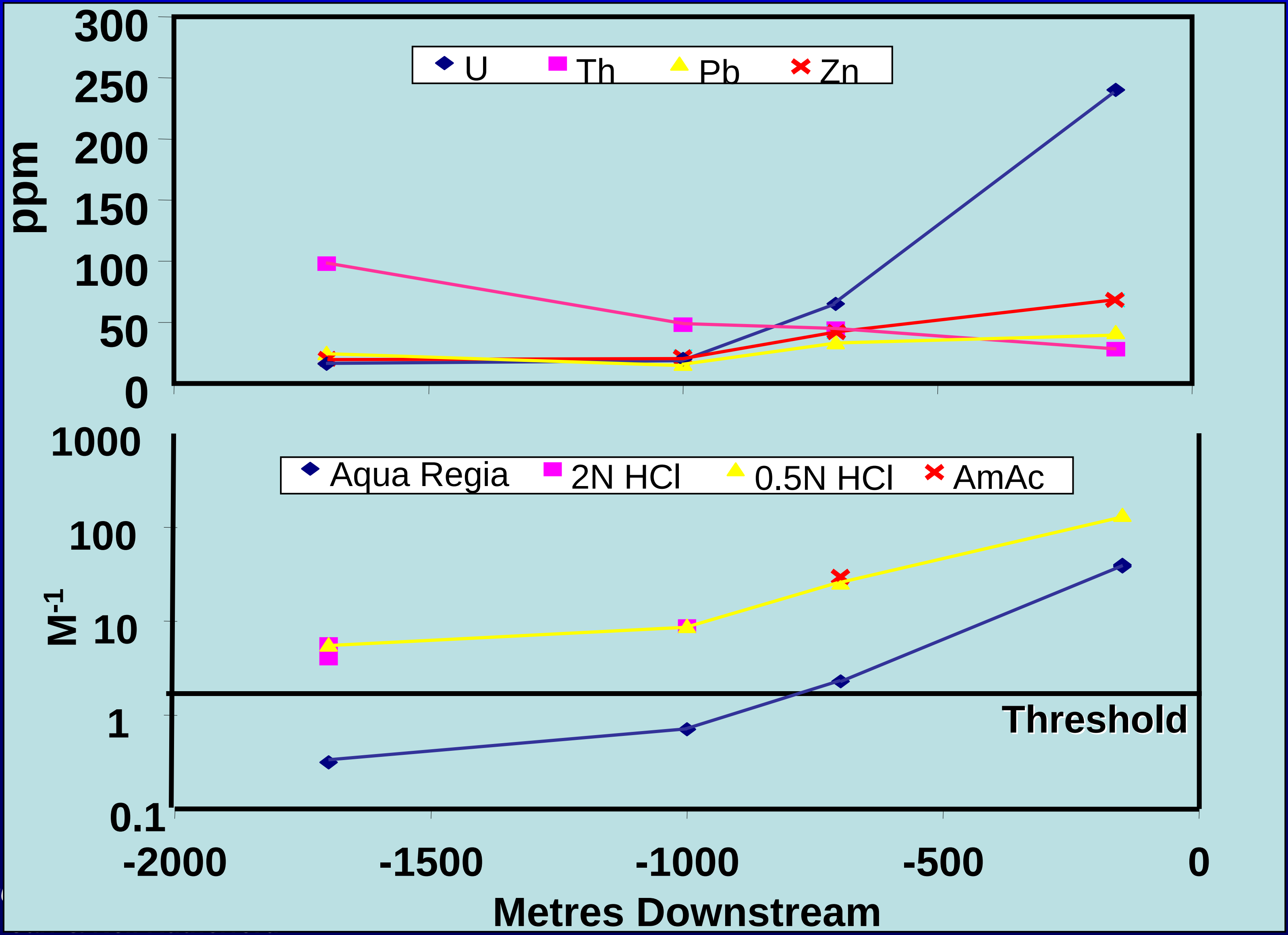
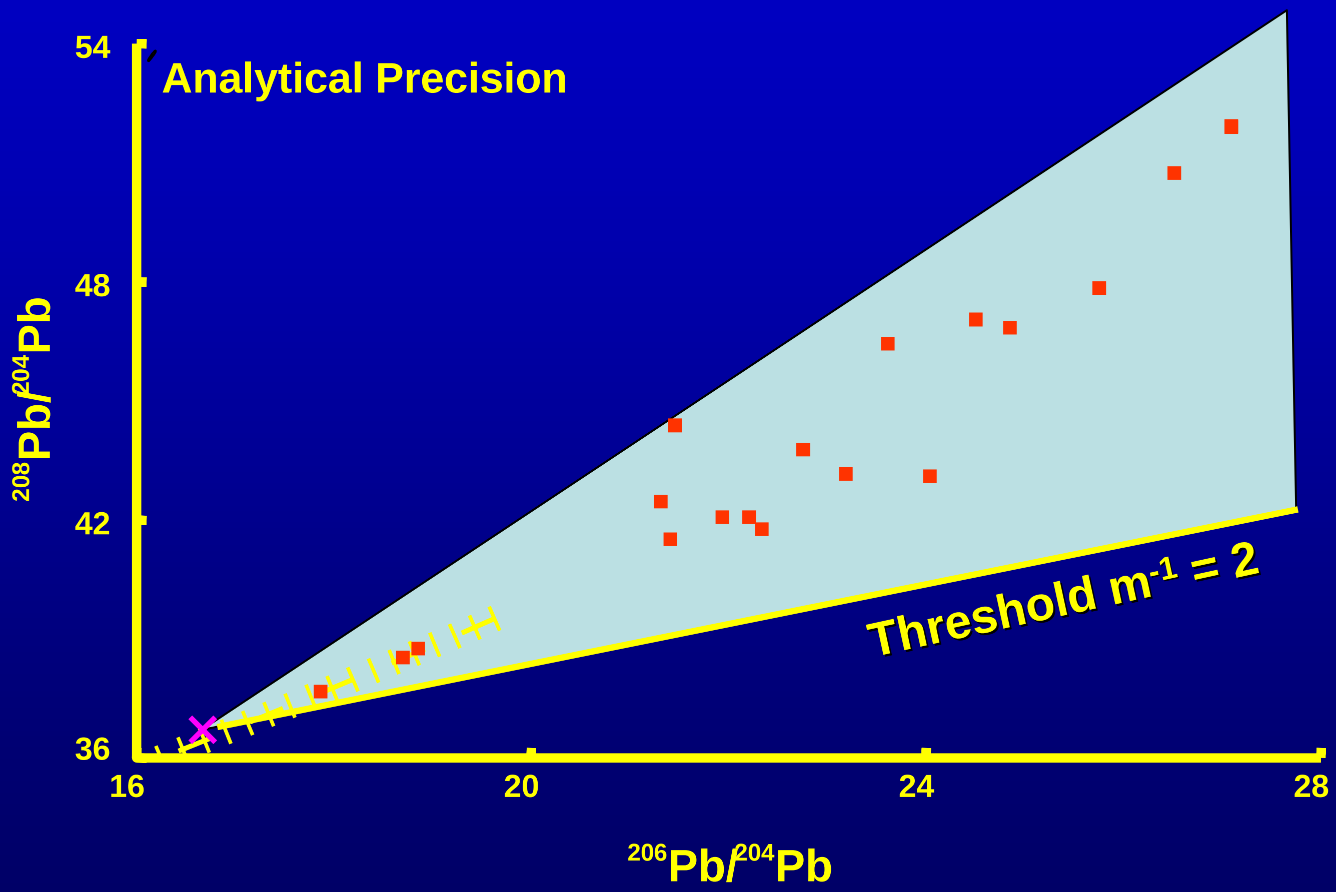
Caramel Stream Sediments



Nabarlek

Bulk Stream Sed Samples downstream from 800 ppm "recent" U anomaly



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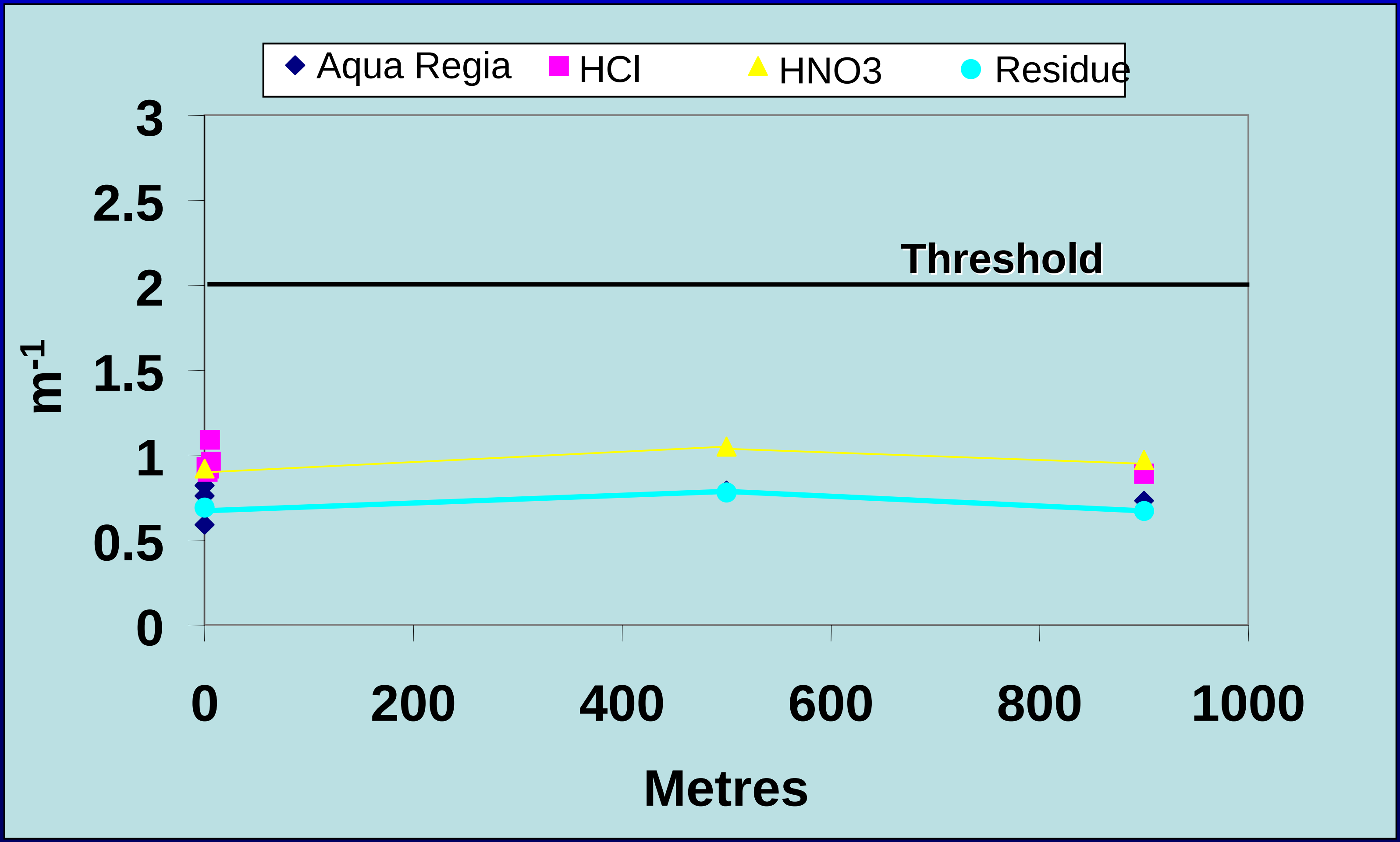
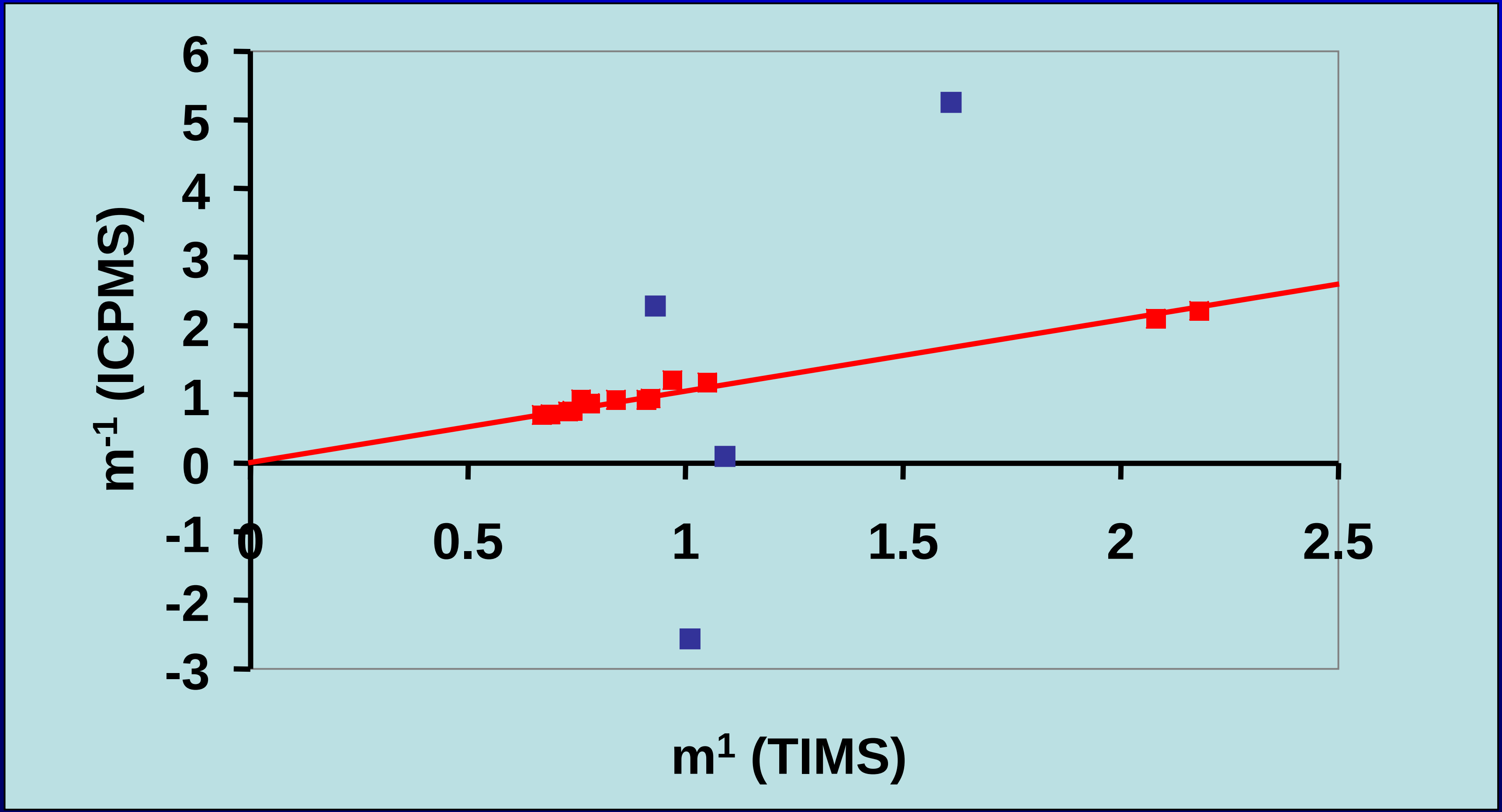


TIMS v ICPMS Comparison



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