Mobility of Arsenic in Sediments of Coalbed Natural Gas (CBNG) Disposal Pond Playas in the Powder River Basin (PRB), Wyoming

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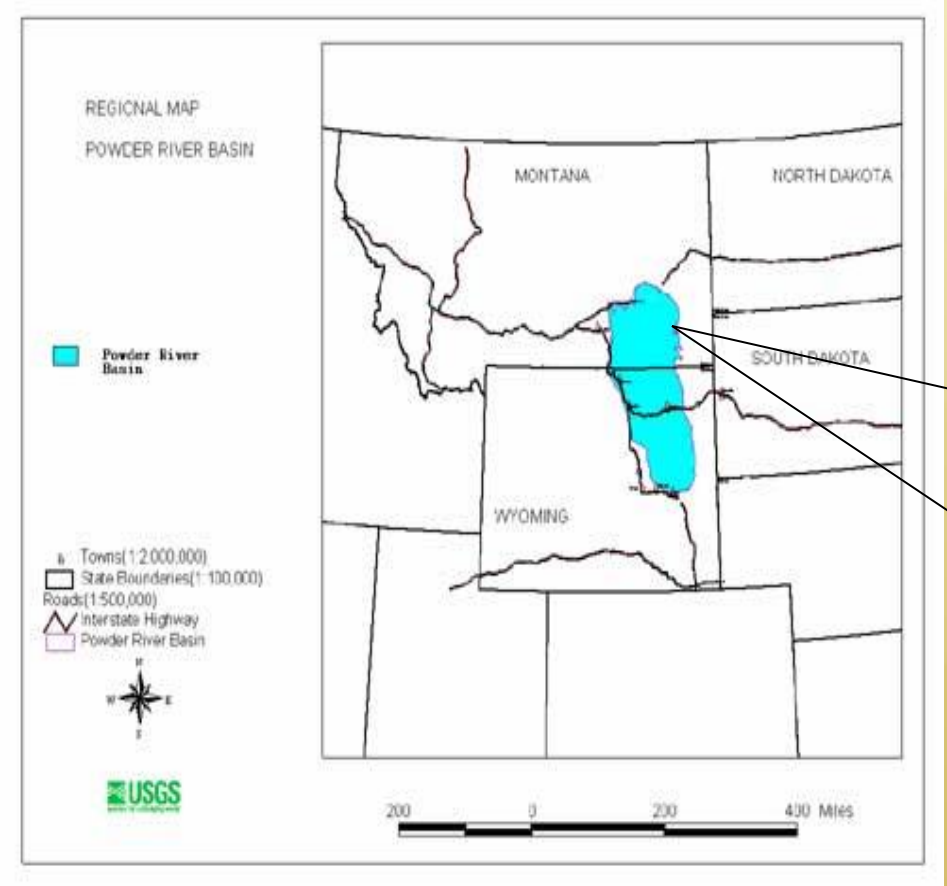
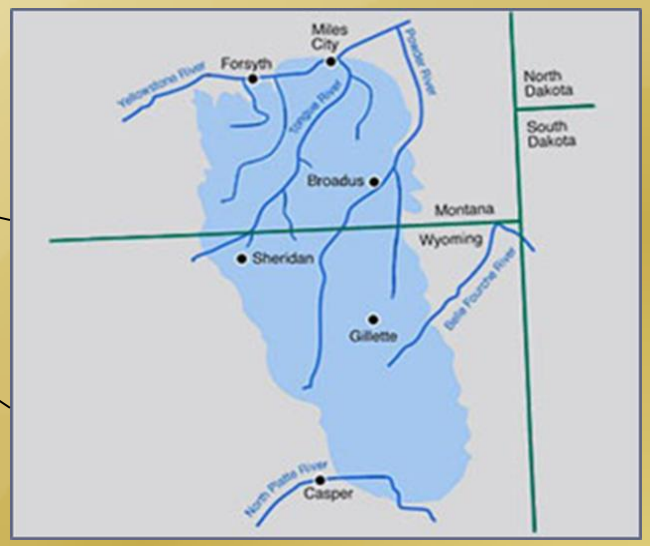
Project Background

- Continuation of previous studies of water and sediment quality in in CBNG outflow ponds in PRB
- Sampled dried ponds (playas) in five sub-basins
- Collected sediment samples from seven pond playas and prepared them for fractionation experiment
- Investigating the leaching potential of Arsenic (As) in the sediments in CBNG playas

Location of PBR

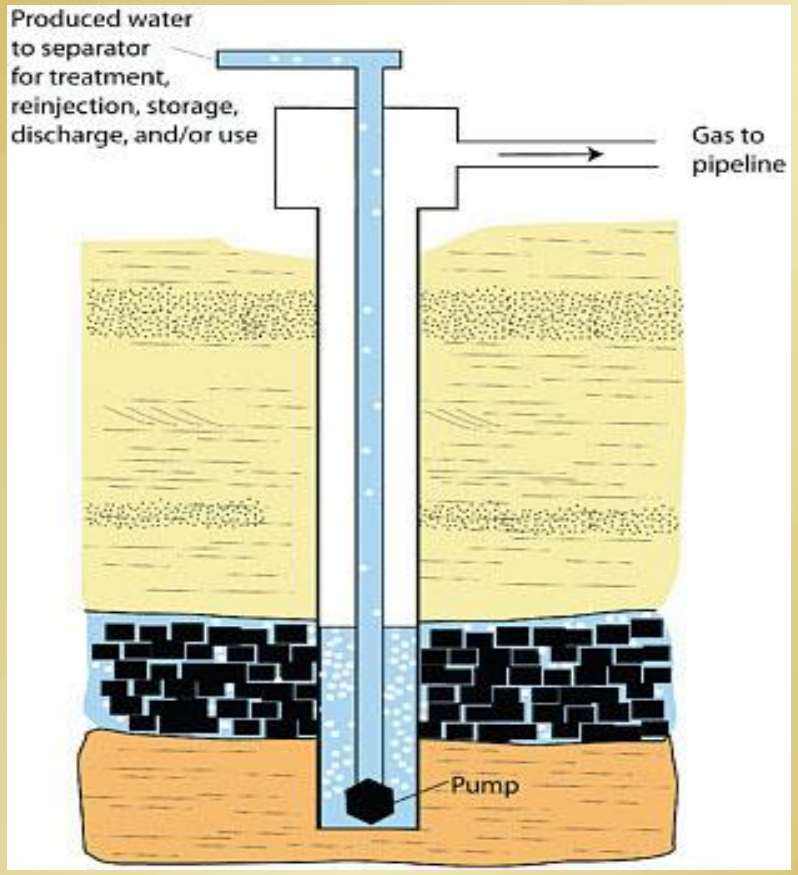




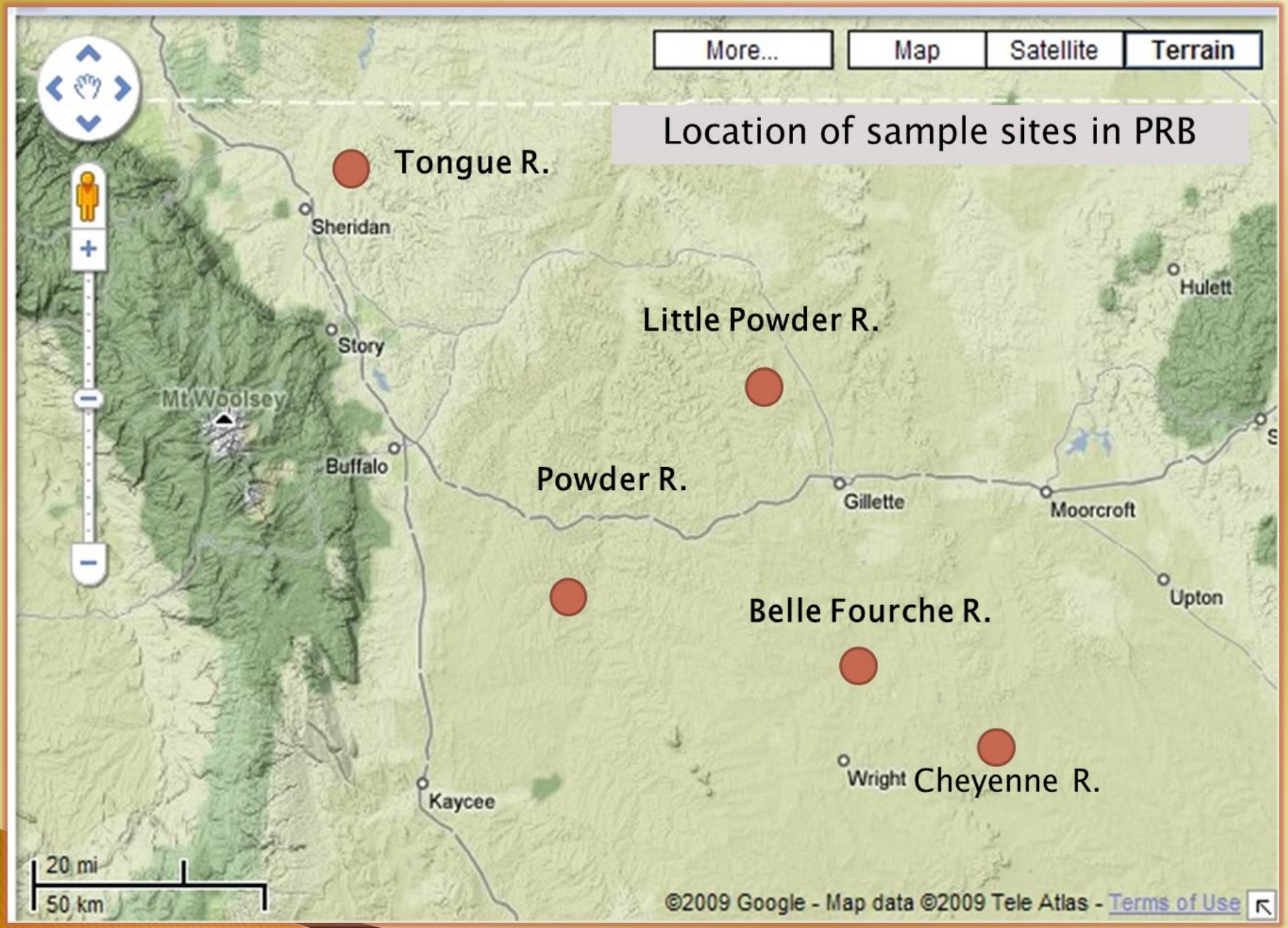
PBR Basin Environment

- Semi arid basin
  Annual Precipitation
  30-60 cm (12-24 in)
- Loamy soils
- Soil pH 7.2
- Moderately to well draining
- Northern Mixed Grass Prairie

CBNG Production



- > 4,000 impoundments in operation to manage CBNG water in Wyoming at end of 2010
- Impoundments are used to manage an estimated 65% of CBNG produced water in PRB


More...
Map
Satellite
Terrain
Location of sample sites in PRB
Tongue R.
Sheridan
Hulett
Little Powder R.
Story
Mt Woolsey
Buffalo
Powder R.
Gillette
Moorcroft
Upton
Belle Fourche R.
Wright
Cheyenne R.
Kaycee
20 mi
50 km
©2009 Google - Map data ©2009 Tele Atlas - Terms of Use

Sample site example in LPR

2004- 2009 studies

Summer 2013

Methods

- The CBNG holding pond sediments will be sampled during the summer months of 2013
- Collect sediment samples, in duplicate, from seven of the representative playas of CBNG discharge ponds in the PRB
- Will use the collection procedure given in US EPA (2005) guidelines
- Duplicate samples will be taken from the lowest elevation of each playa
- Sediment samples will be taken from the surface to approximately 20 cm depth
- These samples will be divided into 2 sections, each10 cm in length
- Then cooled to 2°C for transport back to the Water Quality Lab at the University of Wyoming in Laramie, WY
- Samples will be aired dried and sieved to < 2mm for testing

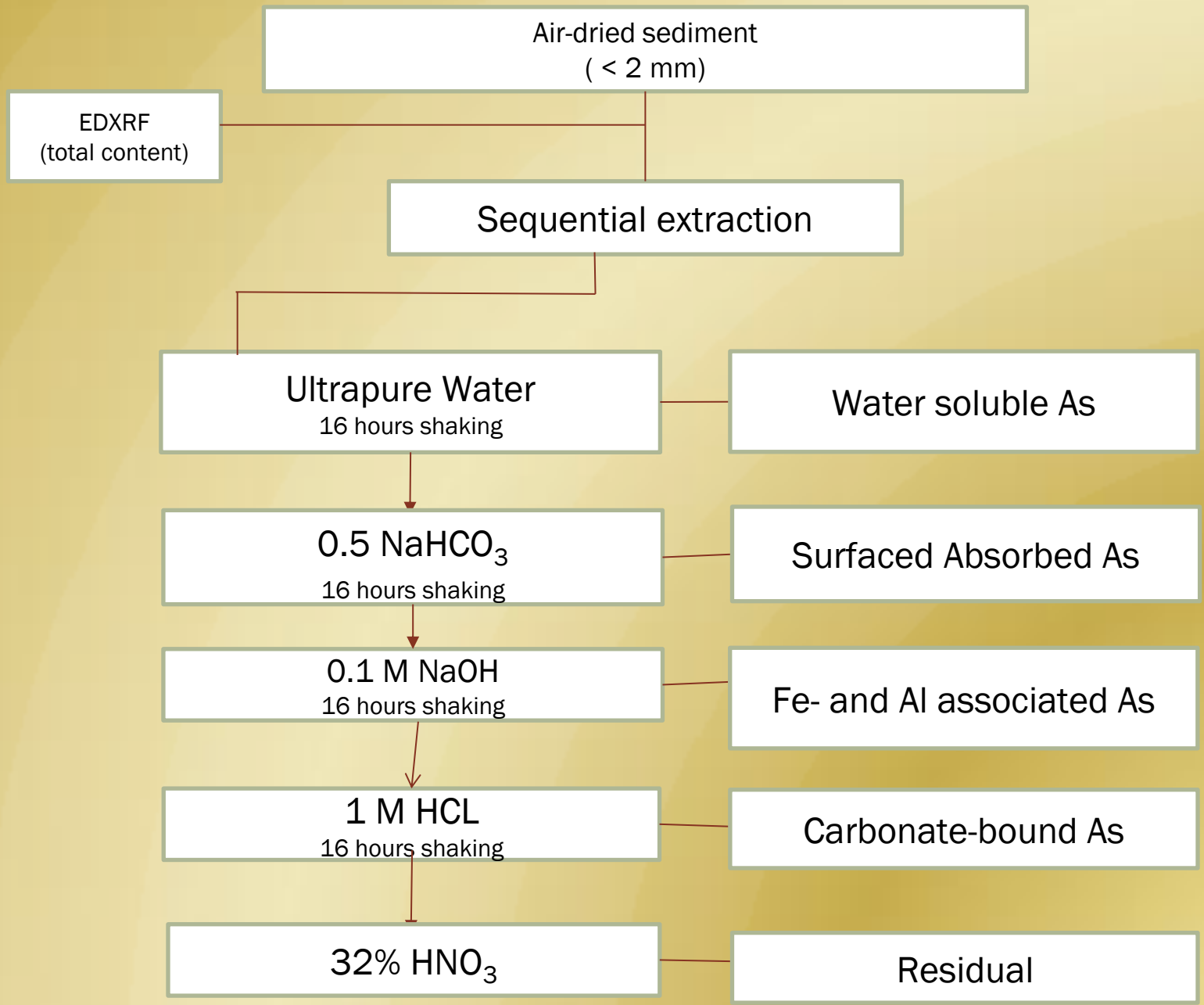
UW

Sequential Fractionation

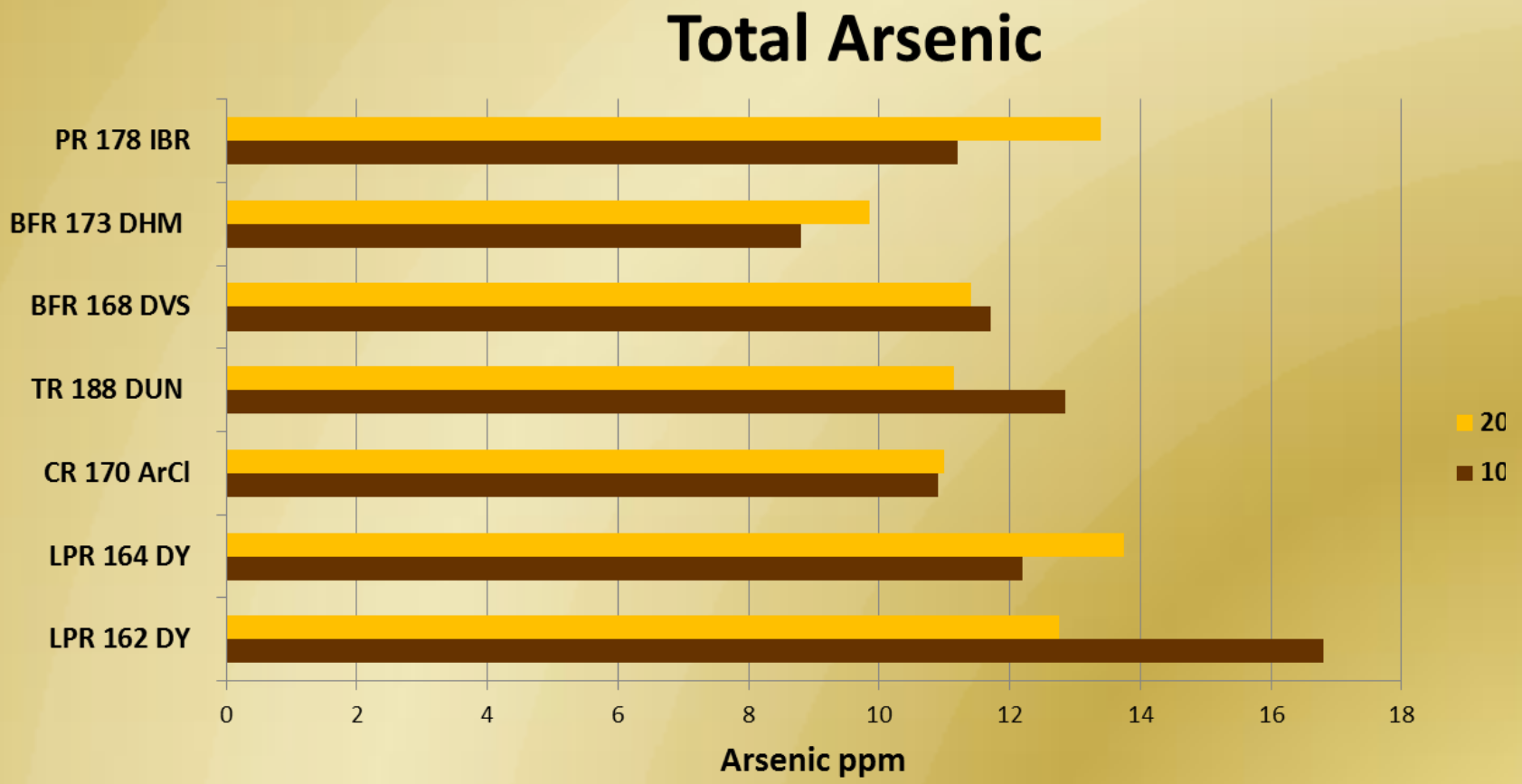
- Involves the extraction of trace elements from the sample sediments associated with different fractions:

- Water soluble As
- Surface absorbed As
- Fe- and Al-associated As
- Carbonate – bound As
- Residual As

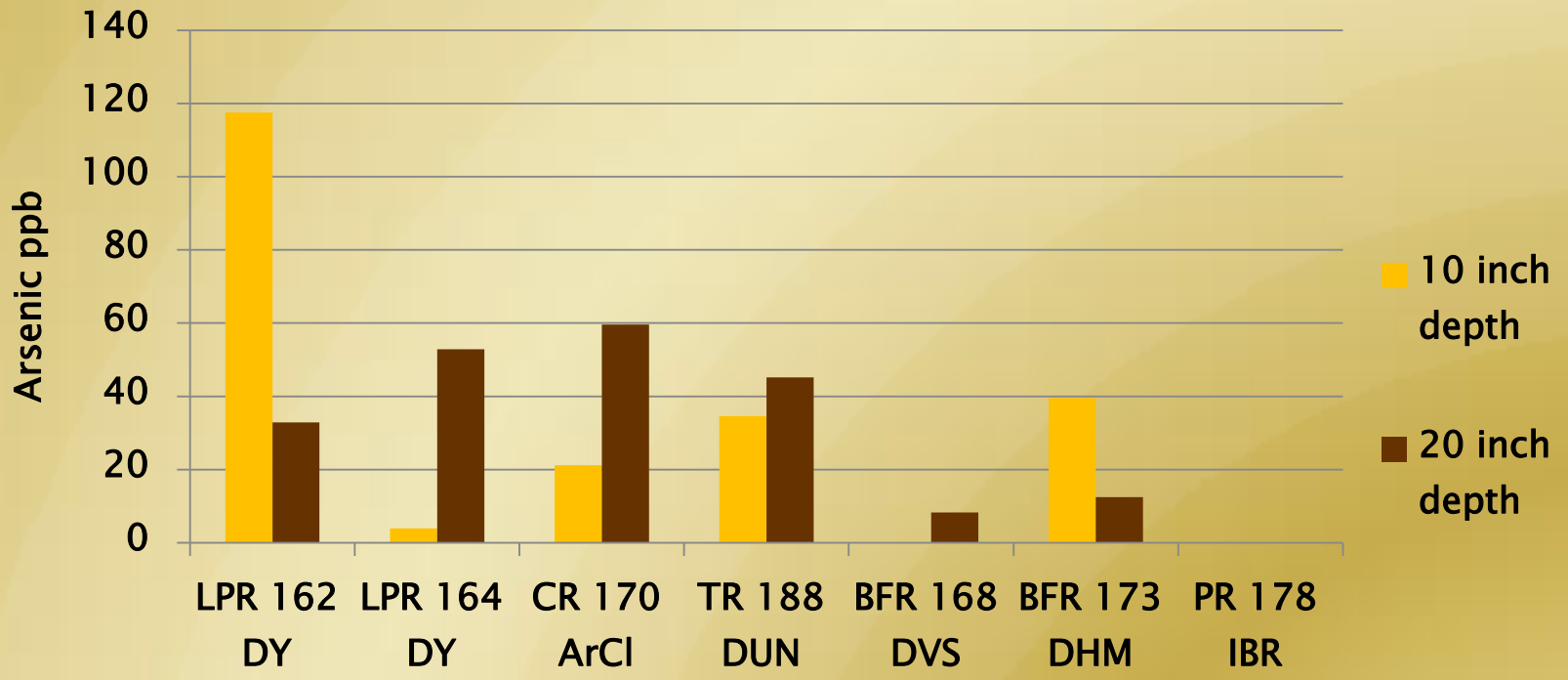
- Multistep procedure to completely extract trace element (As) and determine accurate concentration under different conditions


Air-dried sediment
(< 2 mm)
EDXRF
(total content)
Sequential extraction
Ultrapure Water
16 hours shaking
Water soluble As
0.5 NaHCO3
16 hours shaking
Surfaced Absorbed As
0.1 M NaOH
16 hours shaking
Fe- and Al associated As
1 M HCL
16 hours shaking
Carbonate-bound As
32% HNO3
Residual

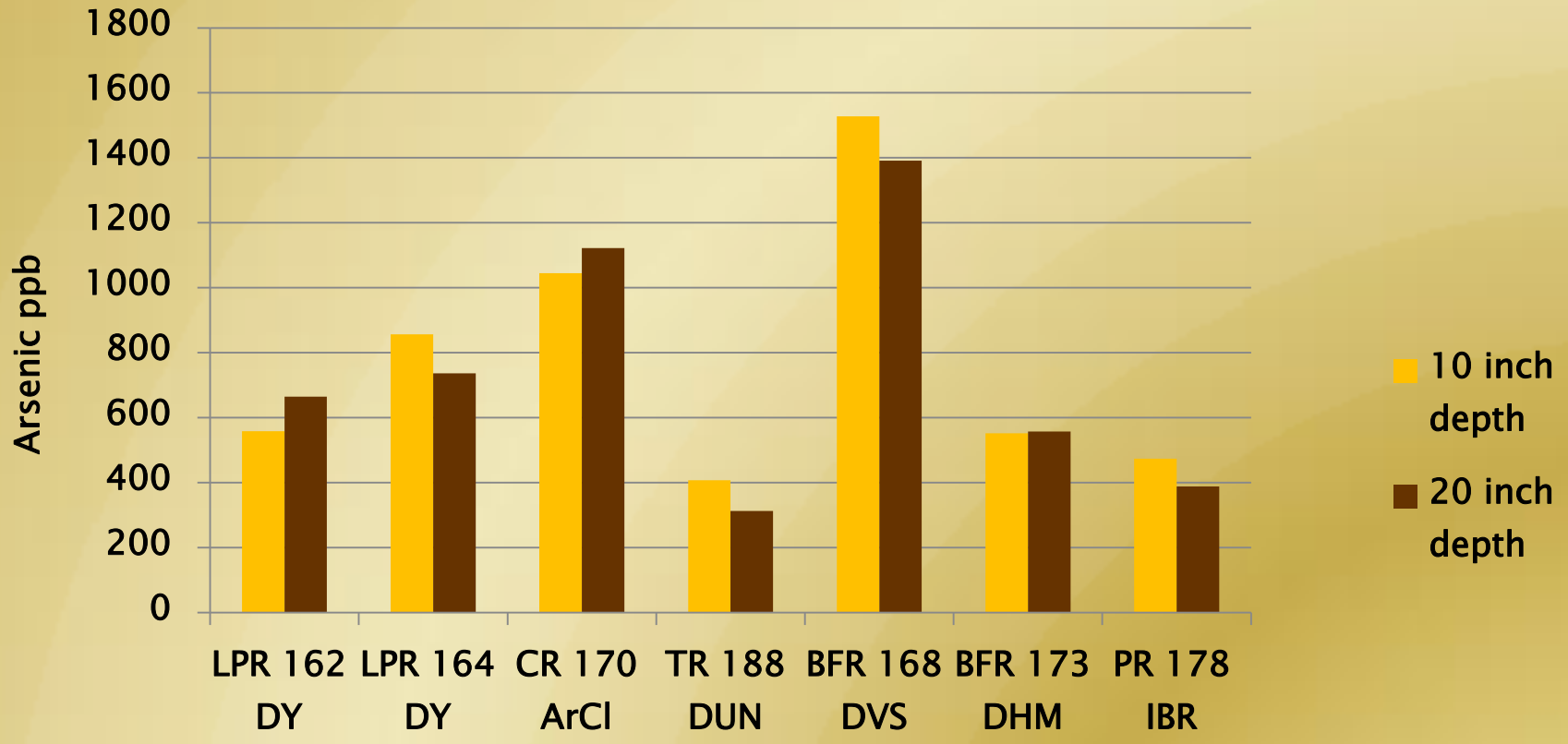
XRF Results


Total Arsenic
PR 178 IBR
BFR 173 DHM
BFR 168 DVS
TR 188 DUN
CR 170 ArCl
LPR 164 DY
LPR 162 DY
0
2
4
6
8
10
12
14
16
18
Arsenic ppm
20
10

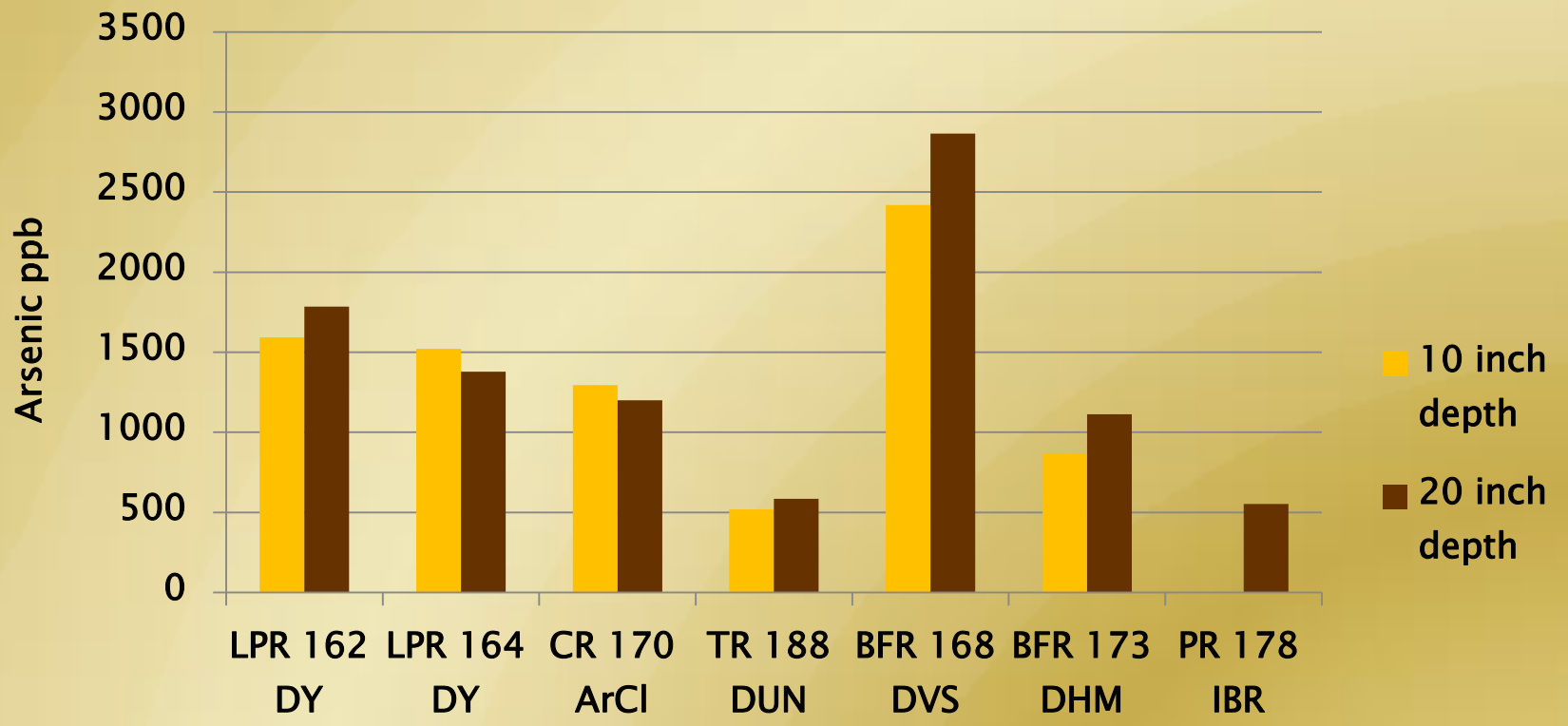
Results - Water Soluble



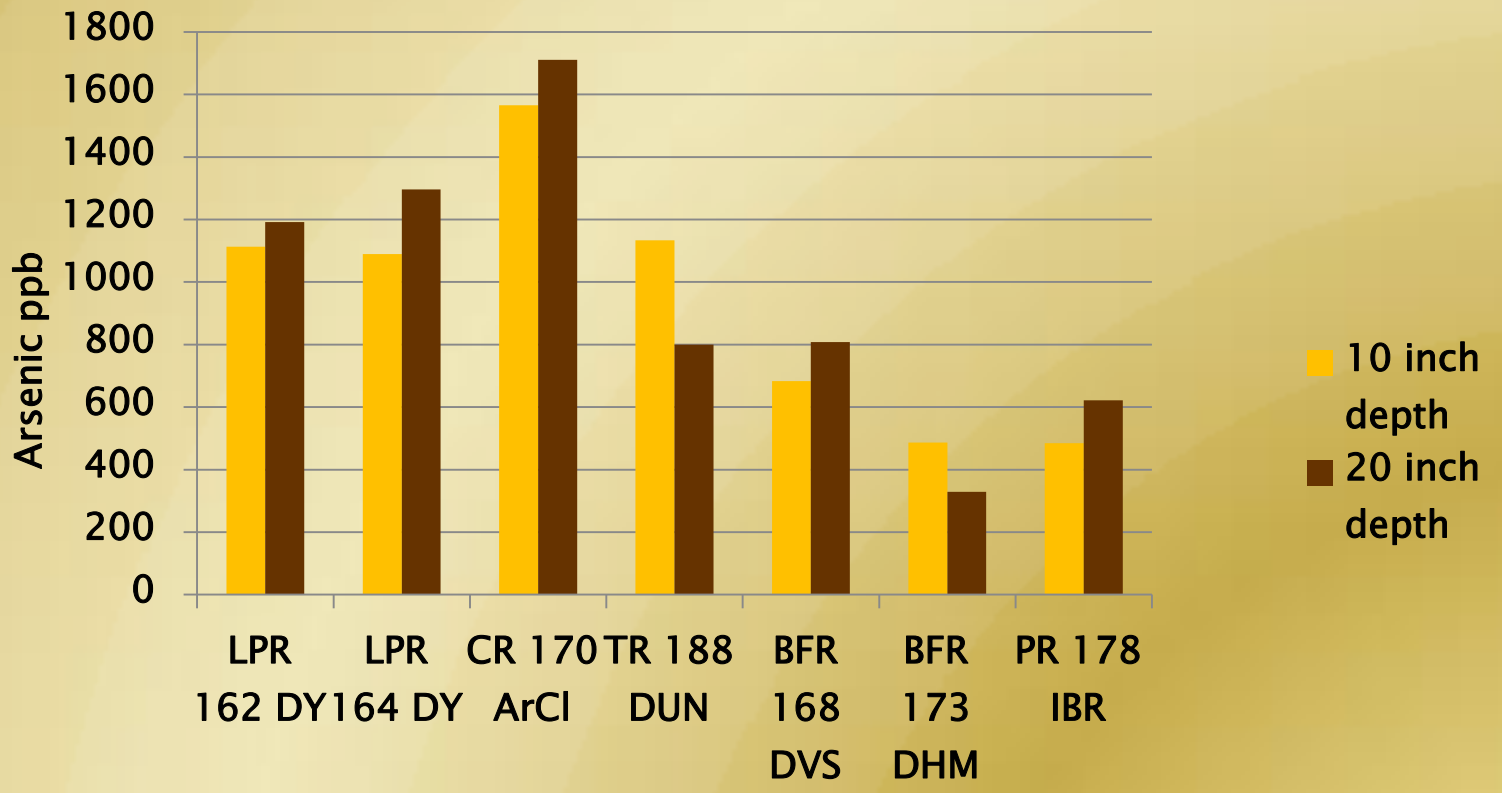
Results-Surfaced Absorbed



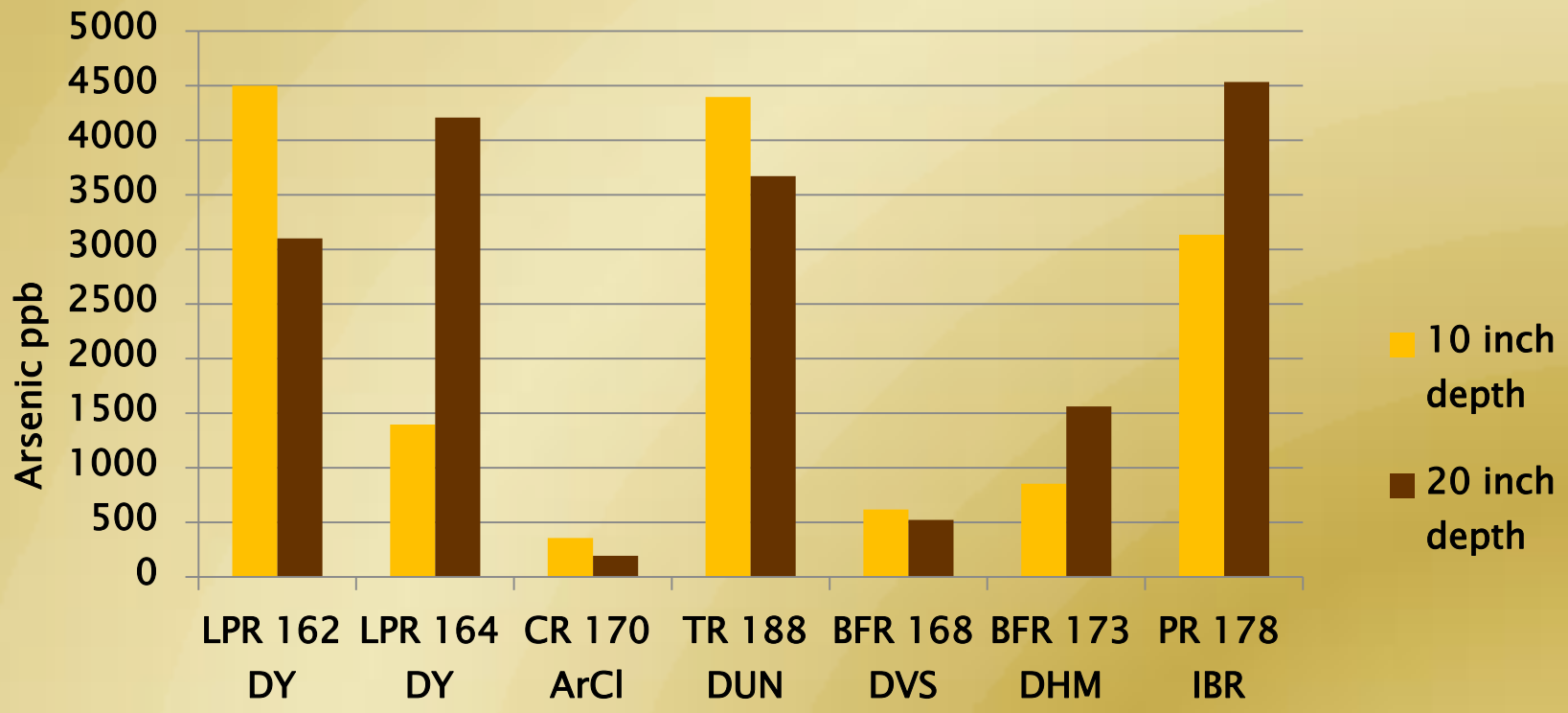
Results- Fe and Al



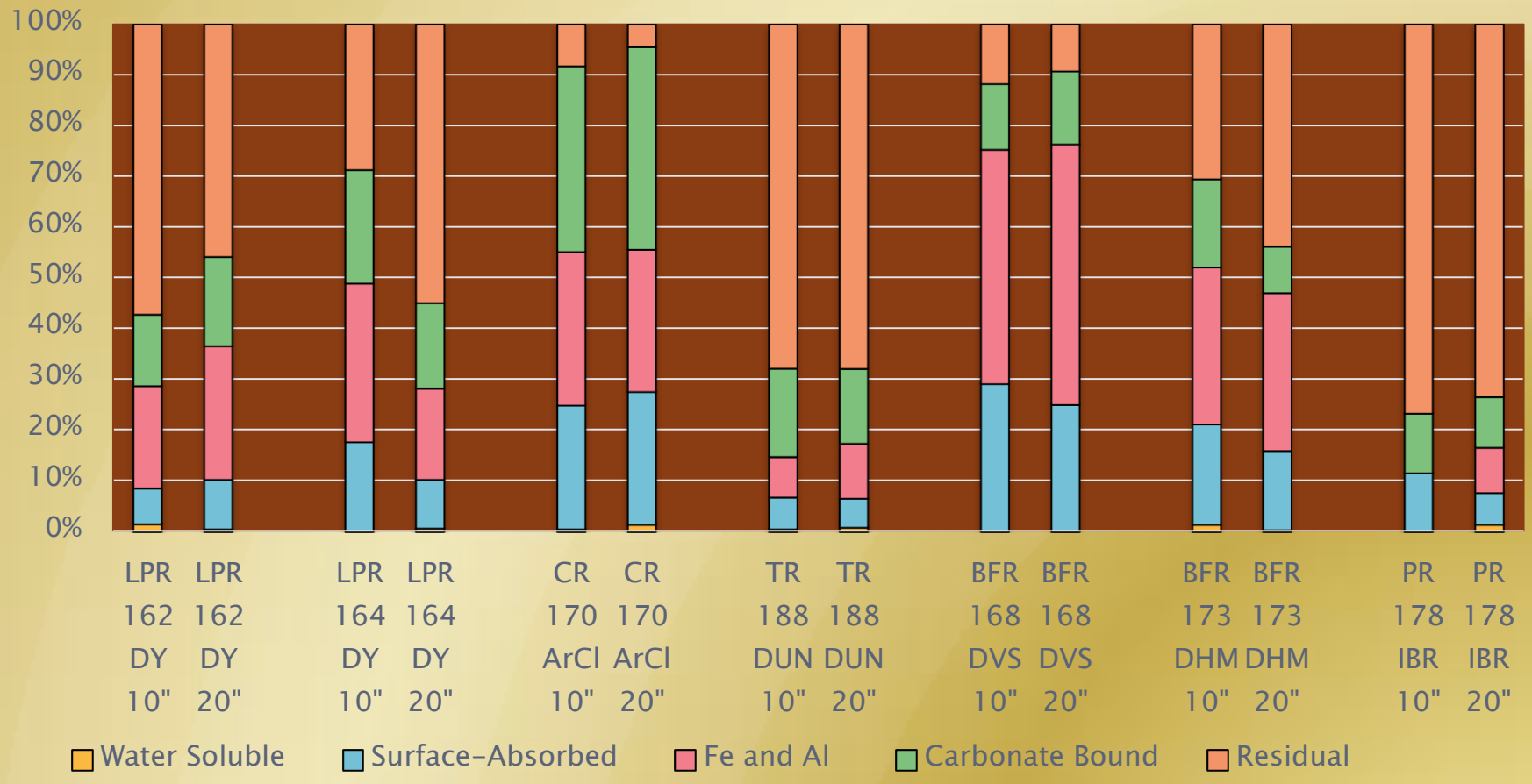
Results- Carbonates



Results- Residuals

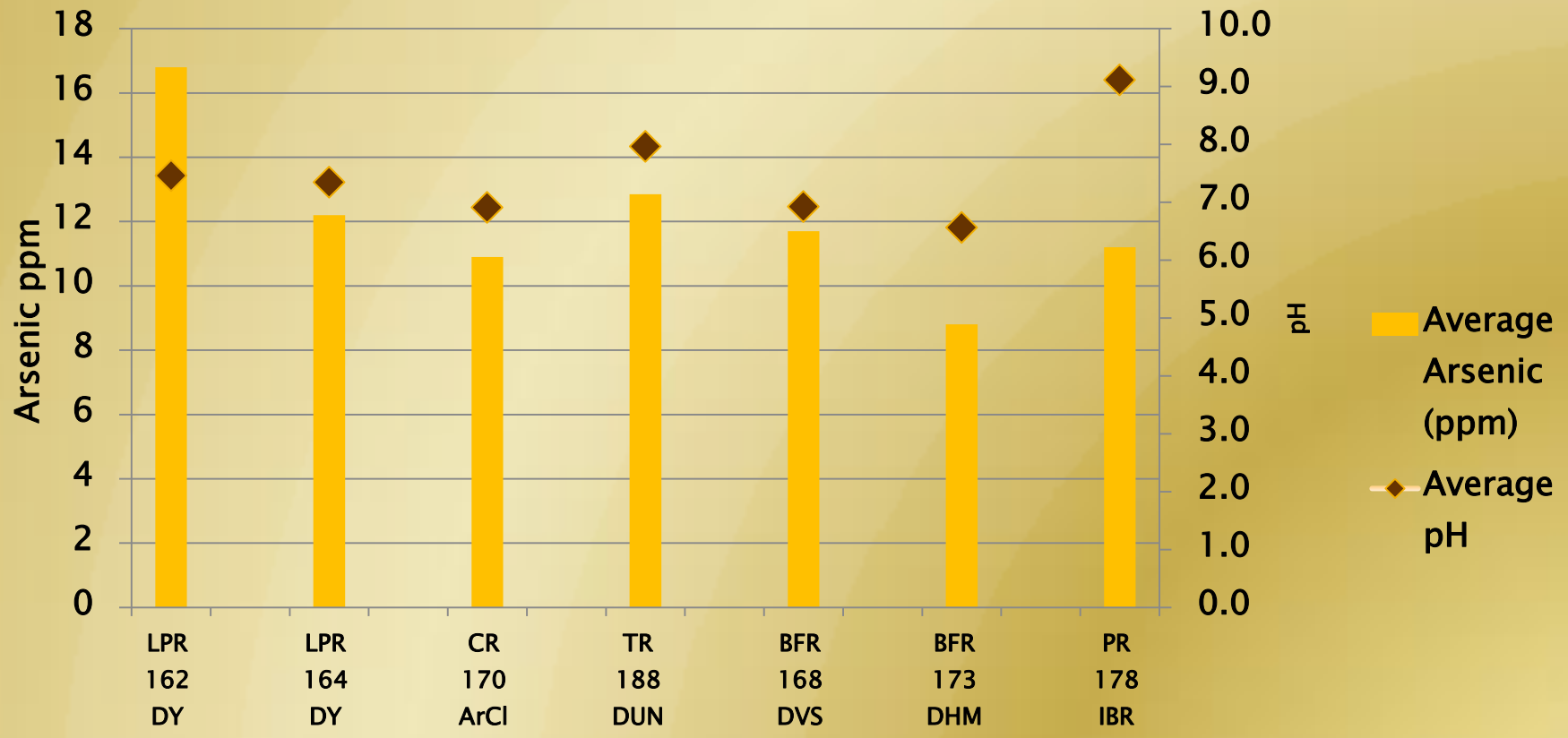


All Results


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
LPR 162 DY 10"
LPR 162 DY 20"
LPR 164 DY 10"
LPR 164 DY 20"
CR 170 ArCl 10"
CR 170 ArCl 20"
TR 188 DUN 10"
TR 188 DUN 20"
BFR 168 DVS 10"
BFR 168 DVS 20"
BFR 173 DHM 10"
BFR 173 DHM 20"
PR 178 IBR 10"
PR 178 IBR 20"
Water Soluble
Surface-Absorbed
Fe and Al
Carbonate Bound
Residual

Continuing Project Work

Results
pH and Total Arsenic



Results
Total Arsenic
10 cm Watershed Control and 10 cm Sample

Conclusions

- The sequential extraction procedure has provided information on the amount of arsenic associated with different sediment fractions
- As expected most of the arsenic is being held in residual and Fe and Al oxide fraction and will not mobilize

References

- **McBeth**, I.H., K.J. Reddy, and Q.D. Skinner. 2003. Water chemistry of coalbed methane product water in three Wyoming watersheds. Journal of American Water Resources Association. 39:575-585.
- **McBeth**, I.H., K.J. Reddy, and Q.D. Skinner. 2003. Chemistry of trace elements in coalbed methane product water. Water Research. 37:884-890.
- **Jackson**, R.E., and K.J. Reddy. 2007. Geochemistry of CBNG produced water in Powder River Basin: Salinity and Sodicity. Water, Air, and Soil Pollution. 184:49-61.
- **Jackson**, R.E., and K.J. Reddy. 2007. Trace element chemistry of coalbed natural gas produced water in the Powder River Basin, Wyoming, Environmental Science and technology. 41:5953-5959.
- **Milligan**, C., K.J. Reddy, and D. Legg. 2010. ***(Invited)*** Monitoring Geochemistry of CBNG Produced Water Outfalls, Disposal Ponds, and Sediments in Powder River Basin, Wyoming, Book Chapter (8). In: K.J. Reddy (ed.) Coalbed Natural Gas: Energy and Environment, Nova Science Publishers, Inc., Hauppauge, NY 11788, pp, 145-185.
- **Whitman**, A., K.J. Reddy, A. Kniss, and S. John. Long-term water quality trends in coalbed methane natural gas (CBNG) produced water in the Powder River Basin, Wyoming (in preparation).

Questions?