Sampling and Characterization of 300-FF-5 Uranium Plume Sediments and Groundwaters

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Objectives

- Sample representative vertical transects from the excavated surface to groundwater in four locations
  - (2) South Process Pond
  - (2) North Process Pond
- Obtain bulk samples of groundwater for characterization and use in different experiment types
  - 618-5
  - North & South Process Ponds
- Prepare sediments and waters for use in directed laboratory studies
- Develop chemical, physical and mineralogic characterization data

Justification

- Prior to this sampling event there were no contaminated materials available from either the vadose zone or the saturated zone of the 300 A uranium plume for detailed study and further conceptual model development.

- Samples from continuous depth transects were needed to:
  - Evaluate trends in uranium concentration, mineralogic residence, and speciation
  - Determine controls on uranium adsorption, desorption, and or dissolution
  - Identify variations in physical and chemical properties and their attendant effects on uranium distribution

Approach and Scope

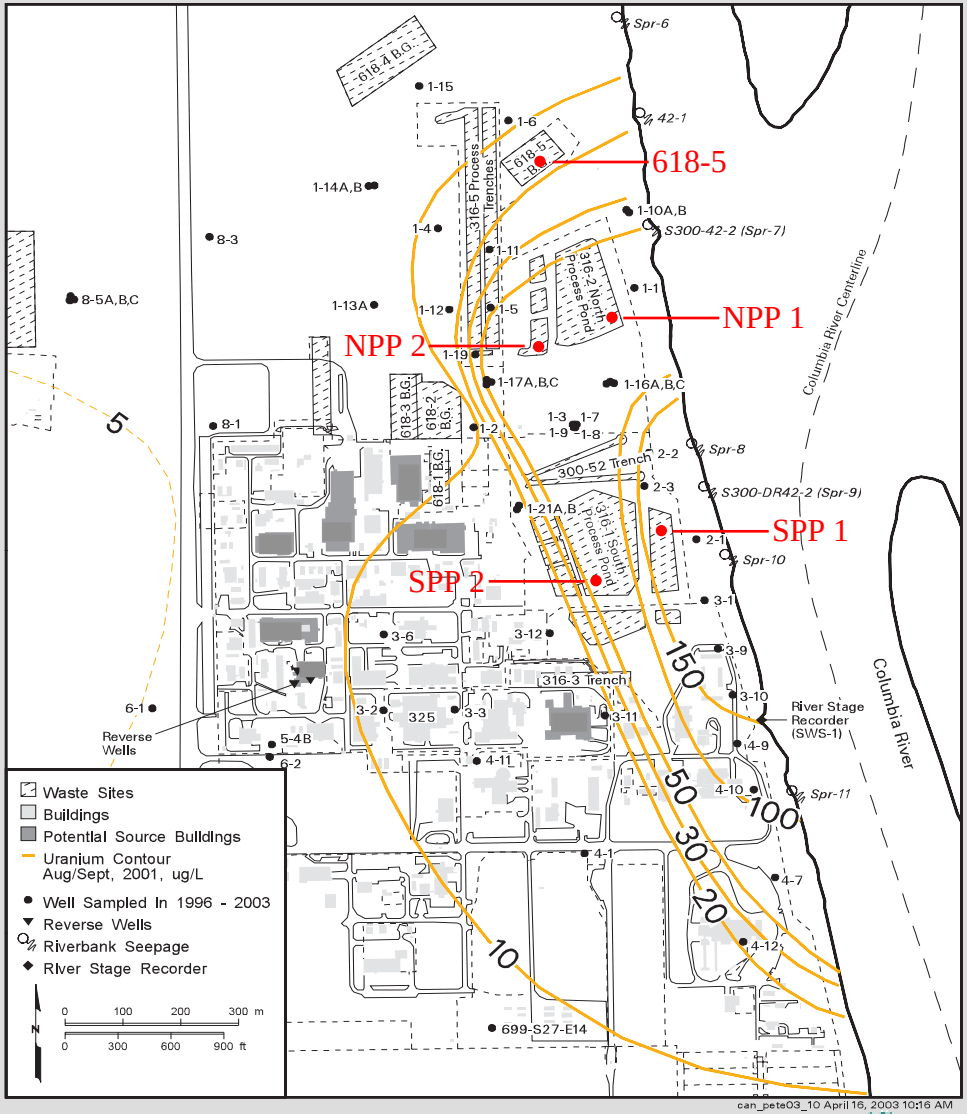
- Locations selected in the two main disposal basins (north and south process ponds) for sediment sampling
  - The north and south process ponds overlie different concentration regions of the uranium plume
  - East-west locations were sampled that are normal to uranium concentration contours and that were distal and proximate to the Columbia River
  - Sediments collected at 4 ft intervals
  - Sampling by excavator to minimize crushing of basalt clasts
  - Fines collected from influent groundwater at base of pit

Approach and Scope (cont.)

- **Bulk samples of groundwater were obtained from various locations to investigate compositional heterogeneity and potential co-contaminant effects.**
  - **North and South process pond excavator trenches**
  - **Recently excavated 618-5**

300 Area Uranium Plume

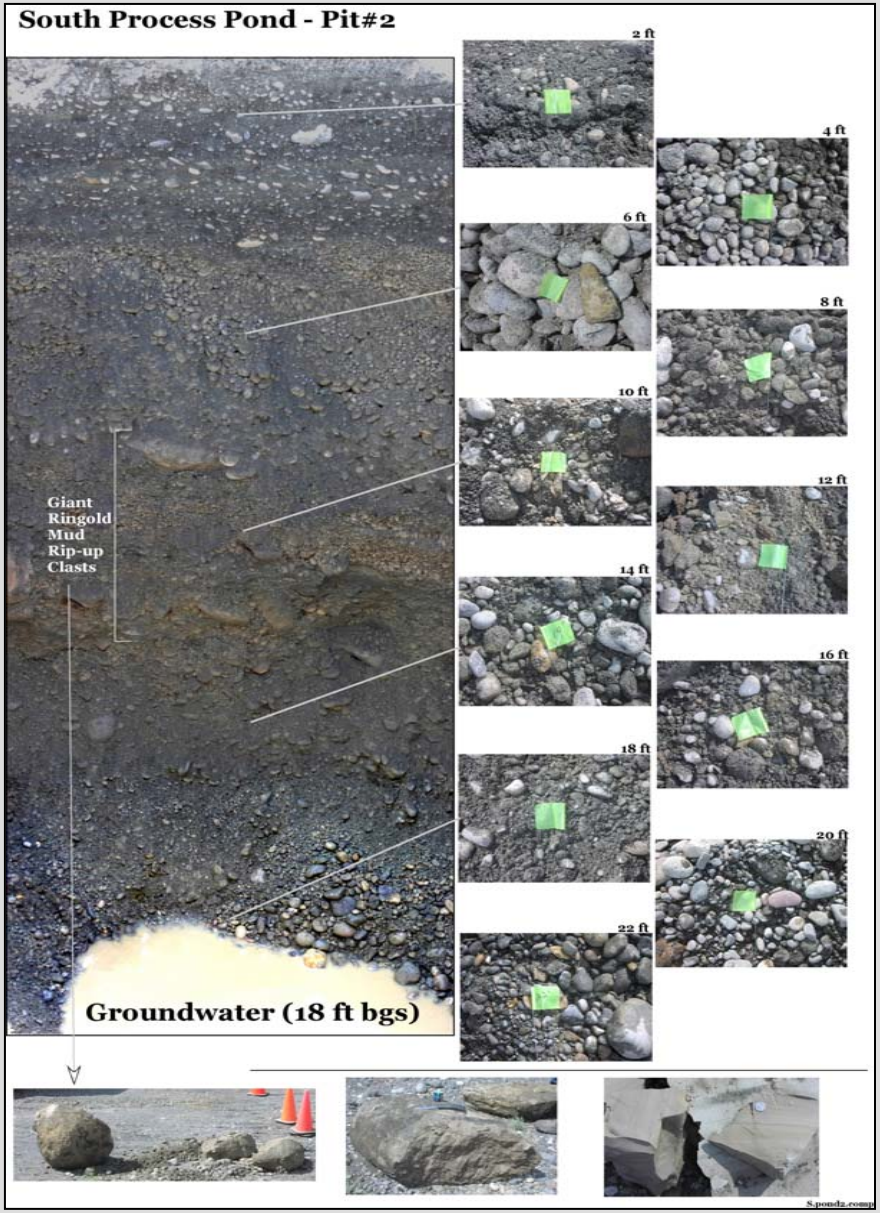
Uranium in 300 Area, Aug/Sept, 2001



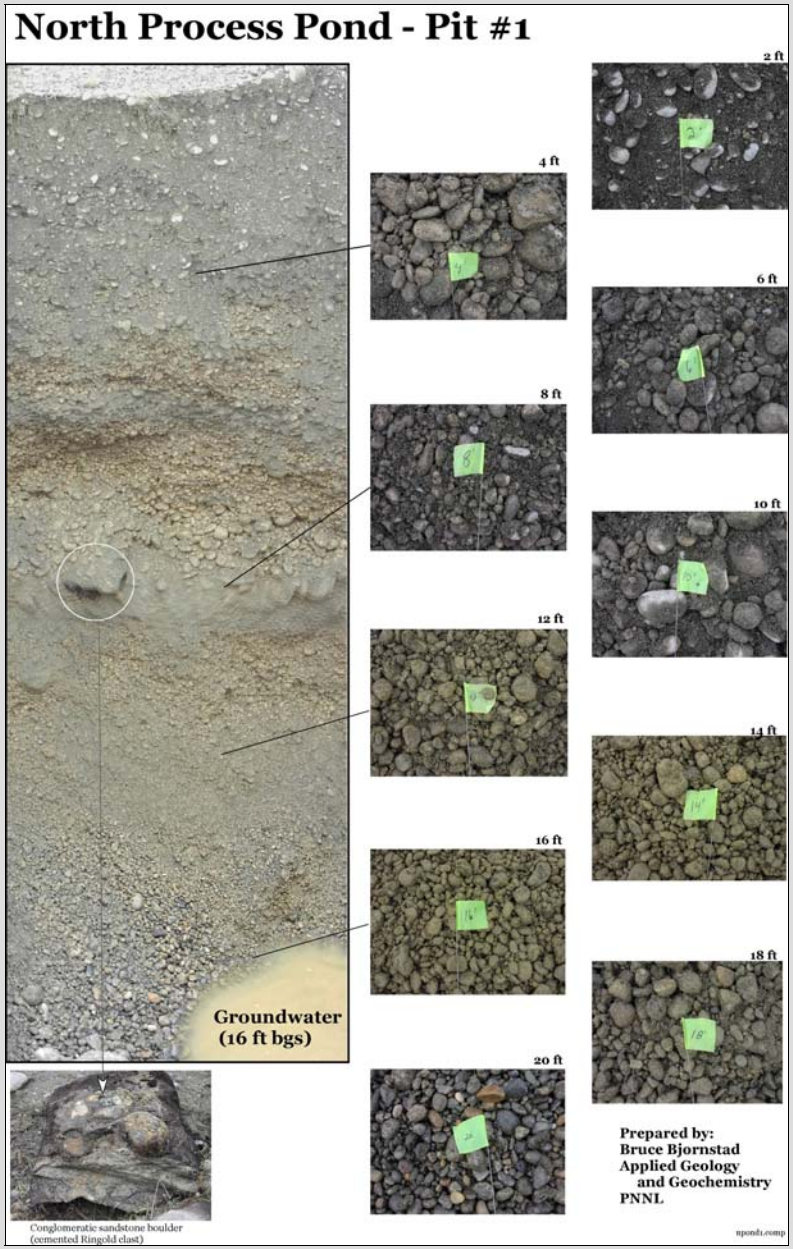
Excavated 300 Area North Process Pond

Excavation at South Pond Pit 1

South Process Pond Pit 2



North Process Pond Pit 1



Sediment and Groundwater Sample Processing

- Samples stored field moist at 4 °C until processed
- Sediments air-dried and sieved < 2 mm (sand, silt, clay fraction)
- Groundwaters filter sterilized and stored at 4 °C
  - The suspended fines collected with the groundwater samples were lyophilized

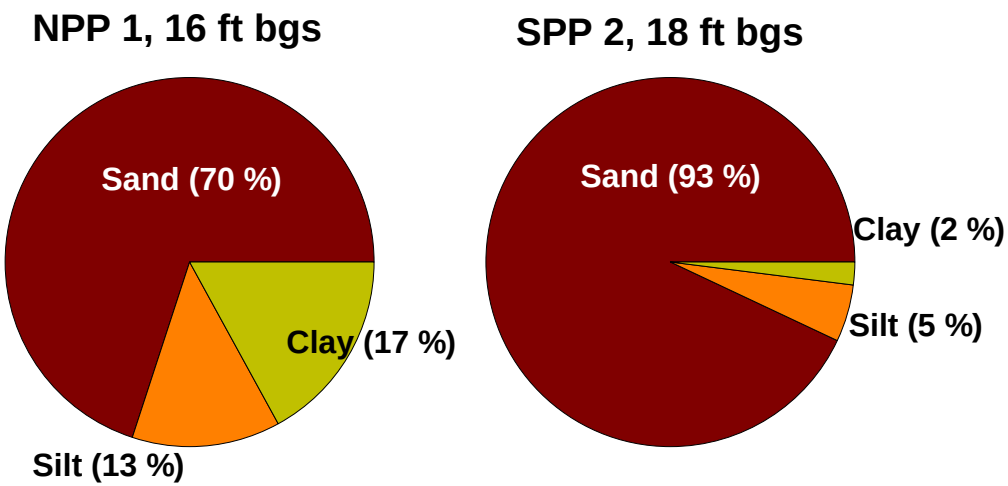
Groundwater Characterization

- **Cations**
  - **Na, K, Ca, Mg**
  - **Minor and trace elements**
- **Anions**
  - **Cl^-, NO_3^-, SO_4^{2-}, F^-, phosphate, inorganic carbon, silica species**
- **pH**

Sediment Characterization

- Particle size distribution (< 2 mm) of two large mass samples
  - SPP Pit 2 capillary fringe (18 ft bgs)
  - NPP Pit 1 capillary fringe (16 ft bgs)
- Total and labile uranium
- Surface area
- Mineralogy
- Selective chemical extractions
  - Dithionite-citrate-bicarbonate
  - Ammonium oxalate
  - Hydroxylamine hydrochloride
- pH

Basic Characteristics of the NPP Pit 1 and SPP Pit 2 Capillary Fringe Sediments (< 2 mm)



NPP 1, 16 ft bgs

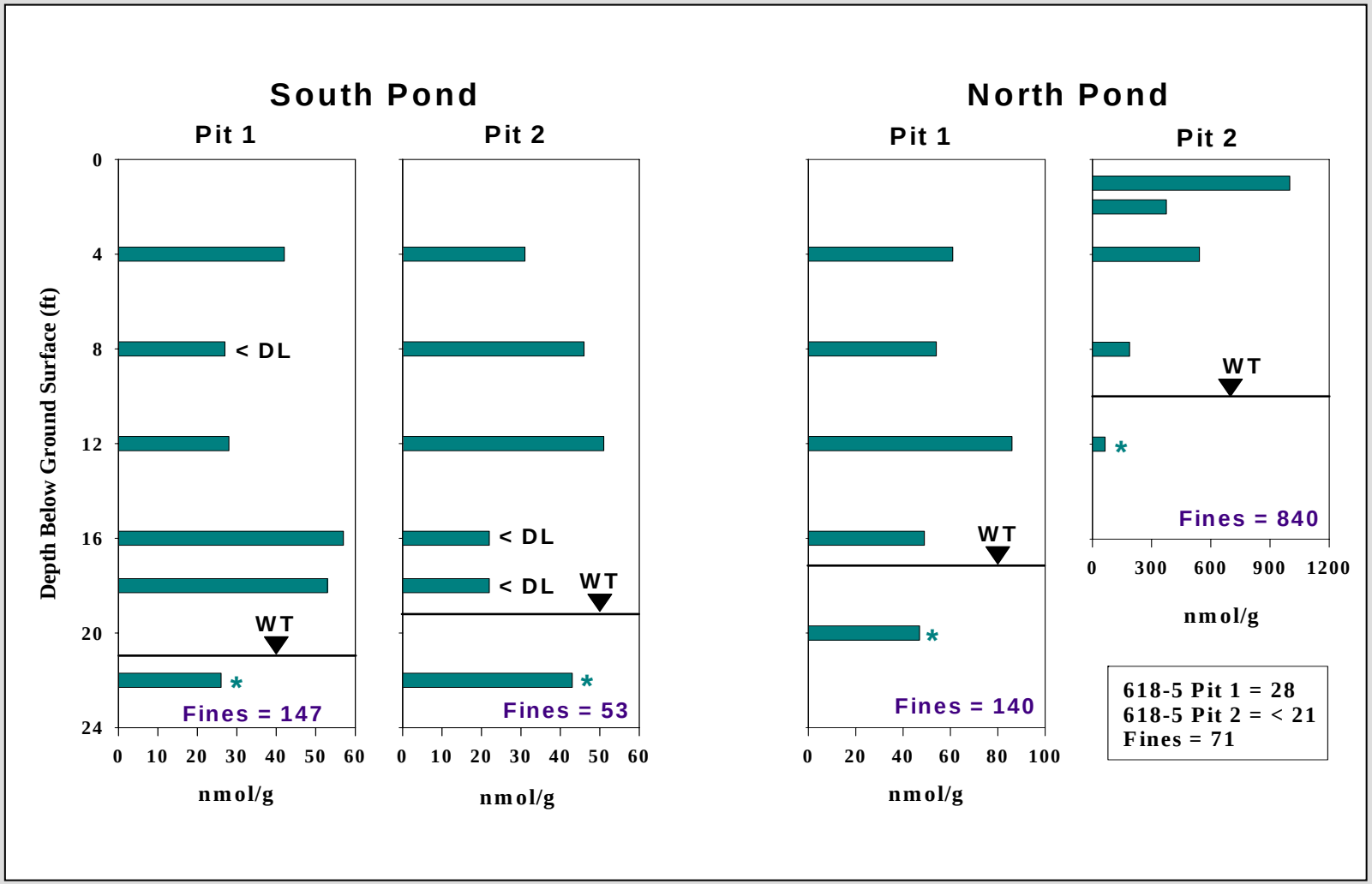
pH (1:2 water): 7.98
Surface area: 23.6 m^2/g

SPP 2, 18 ft bgs

pH (1:2 water): 8.14
Surface area: 14.3 m^2/g

Sand: 0.053 - 2.0 mm
Silt: 0.002 - 0.053 mm
Clay: < 0.002 mm

Uranium Associated with the 300-FF-5 Area Sediments (< 2 mm Size Fraction)



Uranium Concentration and Mass Distribution by Size Fraction in the NPP Pit 1, 14 ft bgs Sediment

	Size Range (mm)	Mass Distribution (%)	U_{Total} (nmol/g)
Cobbles			
	> 12.5	74.5	< 22
	2.0 - 12.5	17.2	< 19
Sand			
	1.0 - 2.0	2.64	26
	0.5 - 1.0	2.34	< 18
	0.25 - 0.5	0.78	< 21
	0.149 - 0.25	0.33	37
	0.106 - 0.149	0.19	< 23
	0.053 - 0.149	0.20	< 23
Silt + Clay			
	< 0.053	1.78	125

Groundwater Composition and Uranium Speciation

	618-5 Pit 1 (26 Feb, 03)	618-5 Pit 1 (29 May, 03)	618-5 Pit 2 (26 Feb, 03)	SPP Pit 1 (19 Apr, 03)	SPP Pit 2 (19 Apr, 03)	NPP Pit 1 (26 Apr, 03)	NPP Pit 2 (26 Apr, 03)	Range
pH	7.71	8.11	7.80	7.83	8.04	7.83	7.88	7.71 - 8.11
Ionic Strength (mmol/L)	7.5	8.2	7.5	3.5	4.9	5.2	6.3	3.5 - 8.2
Cations (mmol/L)								
Ca	1.31	1.17	1.24	0.60	0.90	1.01	1.14	0.60 - 1.31
K	0.16	0.20	0.16	0.07	0.09	0.07	0.06	0.06 - 0.20
Mg	0.58	0.49	0.56	0.21	0.28	0.34	0.40	0.21 - 0.58
Na	1.34	2.65	1.53	0.77	0.95	0.84	1.14	0.77 - 2.65
Anions (mmol/L)								
Cl^-	0.84	1.21	0.76	0.14	0.36	0.36	0.39	0.14 - 1.21
NO_3^-	0.42	0.53	0.40	0.36	0.40	0.29	0.43	0.29 - 0.53
Inorg. C	2.47	2.71	2.41	1.20	1.70	2.02	1.58	1.20 - 2.71
SO_4^{2-}	0.69	0.76	0.85	0.35	0.43	0.47	0.88	0.35 - 0.88
Si_{Total}	0.57	0.59	0.55	0.28	0.39	0.32	0.23	0.23 - 0.59
U (µmol/L)	4.96	1.39	1.82	0.30	0.36	0.30	1.07	0.30 - 4.96
Species	(%)	(%)	(%)	(%)	(%)	(%)	(%)	
$UO_2(CO_3)_2^{2-}$	5.8	2.8	5.4	22.0	6.2	7.1	7.3	
$UO_2(CO_3)_3^{4-}$	3.5	5.0	4.0	6.5	4.7	4.0	3.9	
$Ca_2UO_2(CO_3)_3^0$	90.6	92.2	90.5	70.4	88.9	88.7	88.6	
P_{CO2}	-2.559	-2.912	-2.656	-2.971	-3.035	-2.754	-2.913	

Summary

- Collected 29 sediments from various depths and 7 ground waters at the water table within the 300-FF-5 area
- Prepared sediments and waters for use in directed laboratory studies
- Developed chemical, physical and mineralogic characterization data of sediments
- Chemically characterized the ground waters
- Sediments and ground waters are available to researchers investigating the geochemical behavior of uranium in the 300-FF-5 vadose zone and aquifer