

Selectivity and Kinetic Behavior of Heavy Metals and Radionuclides on Supported Ion-Exchange Adsorbents

Wesley T. Honeycutt, Evgueni B. Kadossov*,
Allen Apblett, Nicholas F. Materer

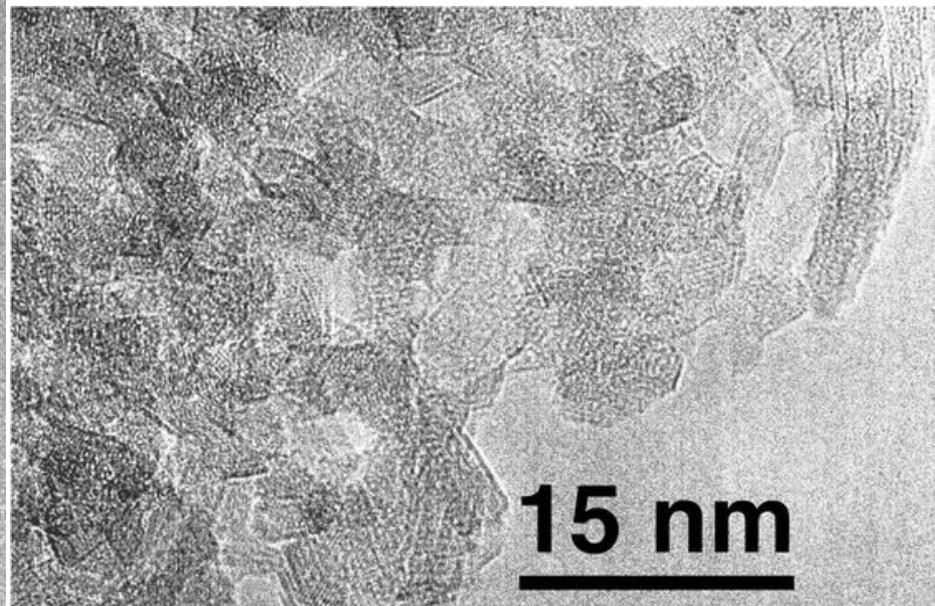
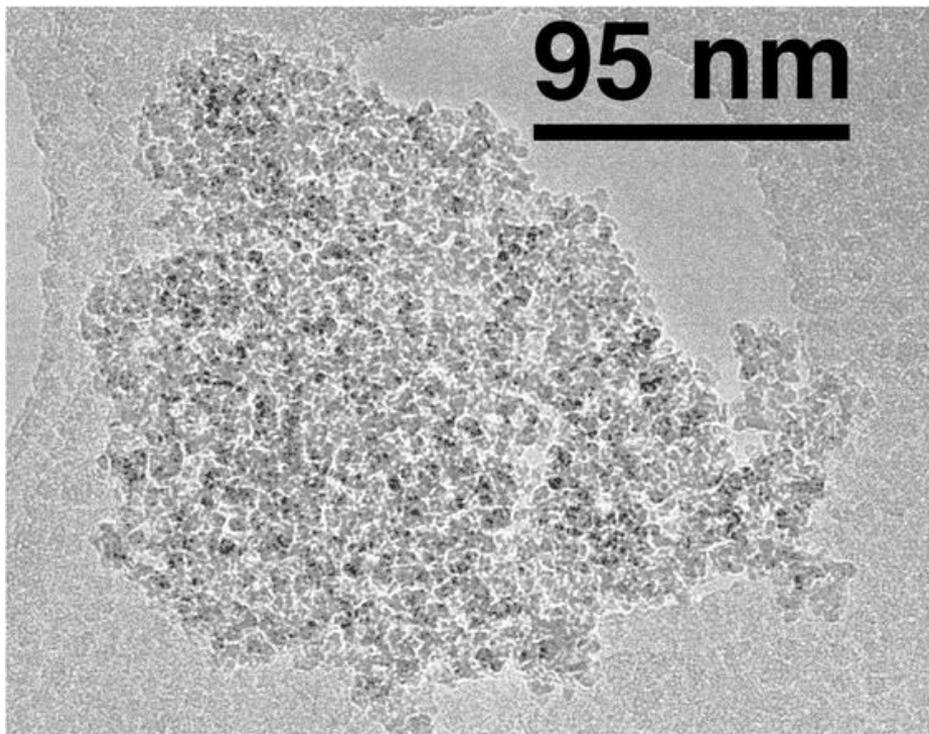
Oklahoma State University Department of Chemistry – Stillwater, OK
*XploSafe – Stillwater, OK

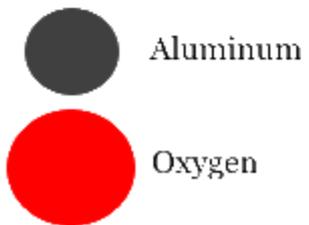
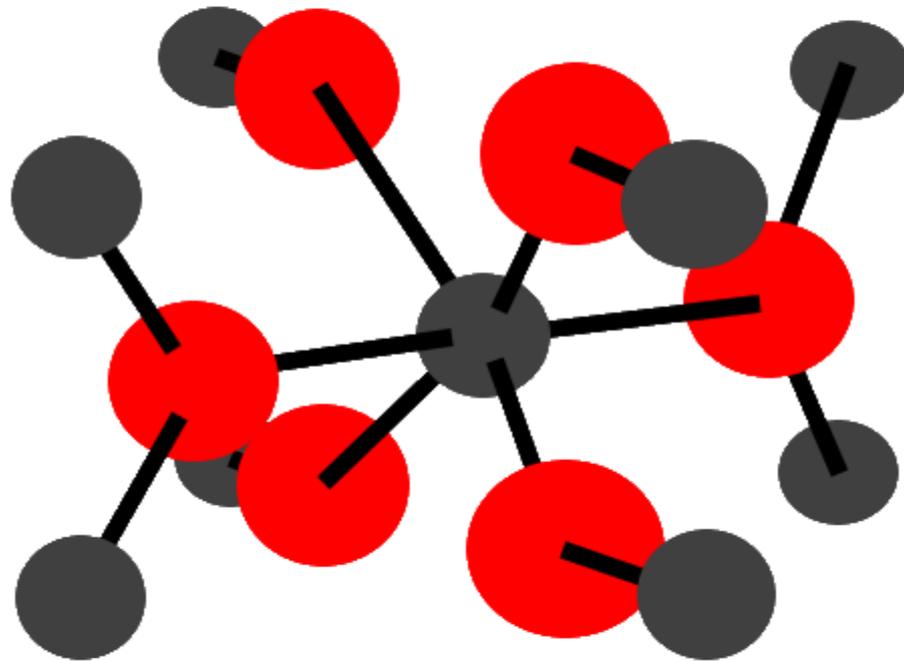


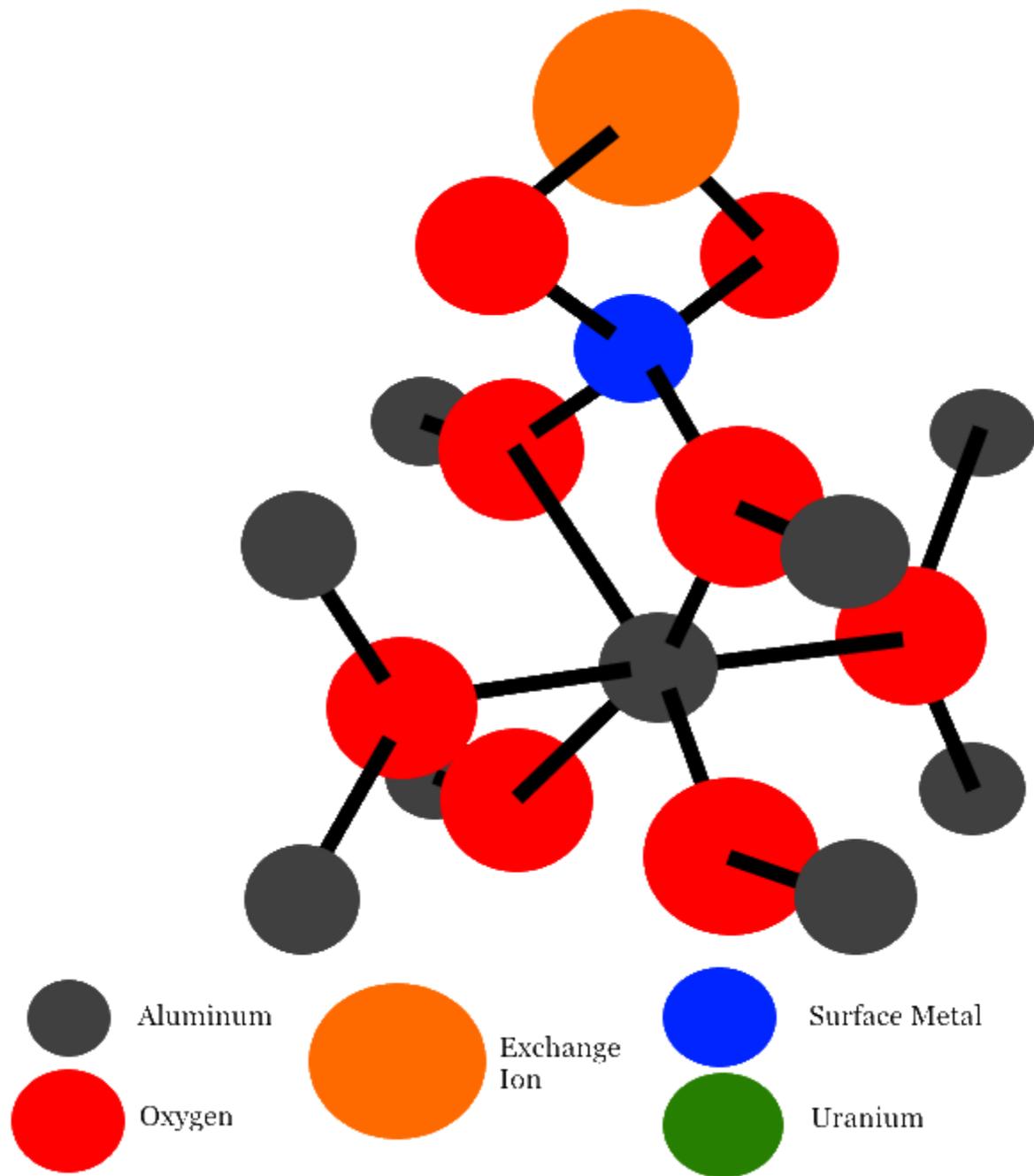
Background

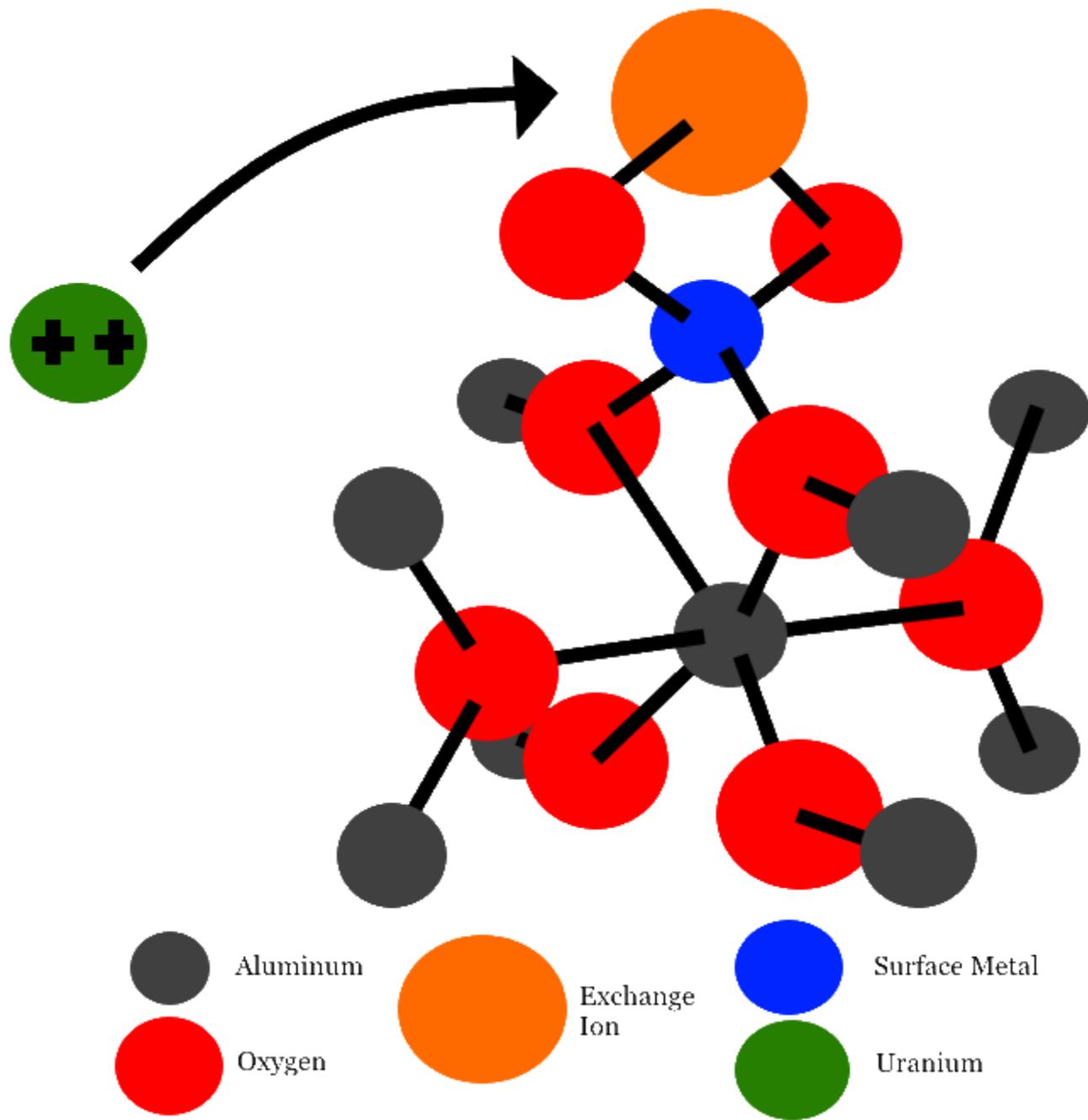
- Anthropogenic Release
 - Accidental release
 - Mining runoff
 - Depleted uranium combat use
 - Nuclear testing
- Natural Release
 - Fukushima Daiichi
- “Ocean Mining”

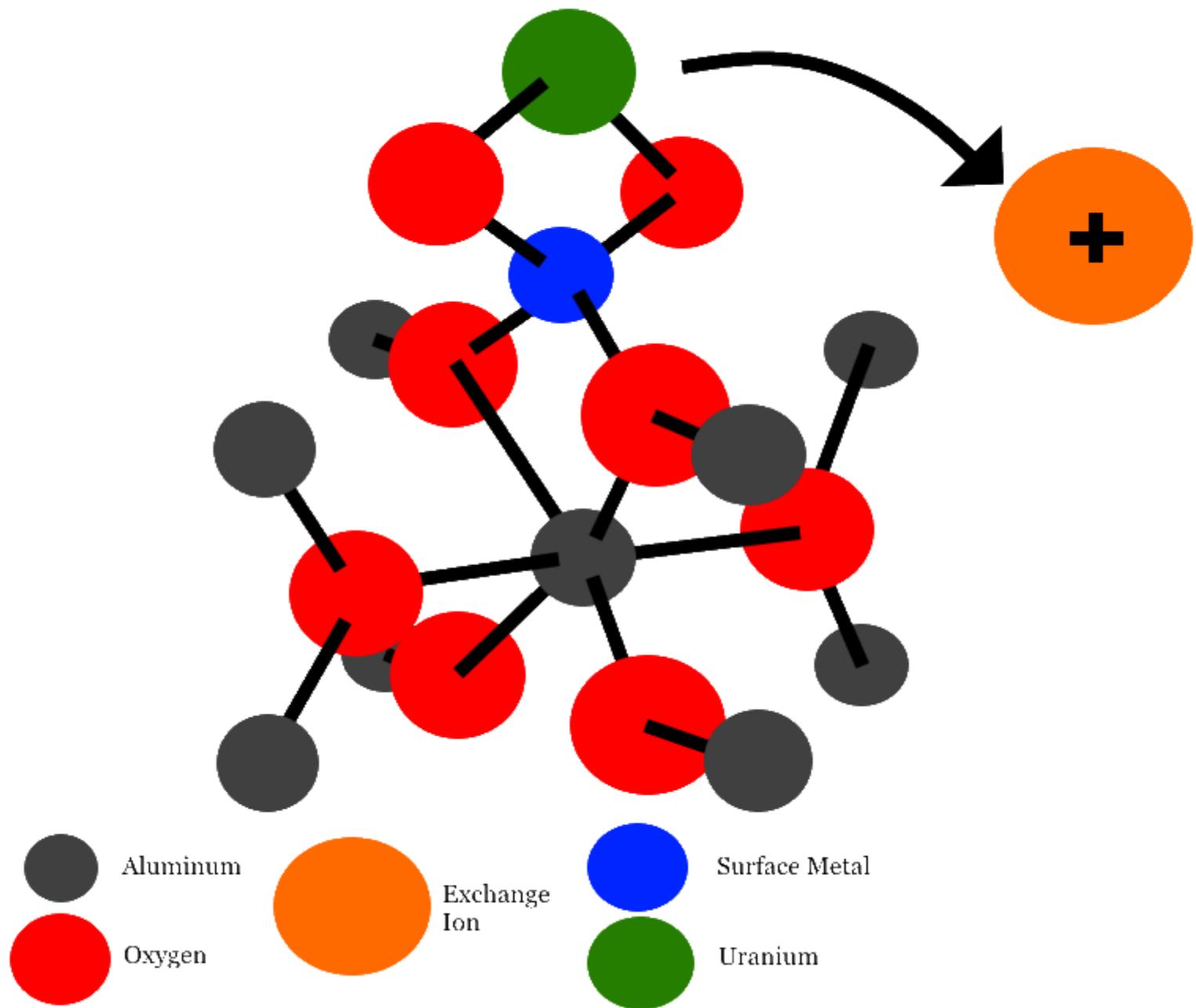
High Surface Area Substrate Mesoporous Alumina

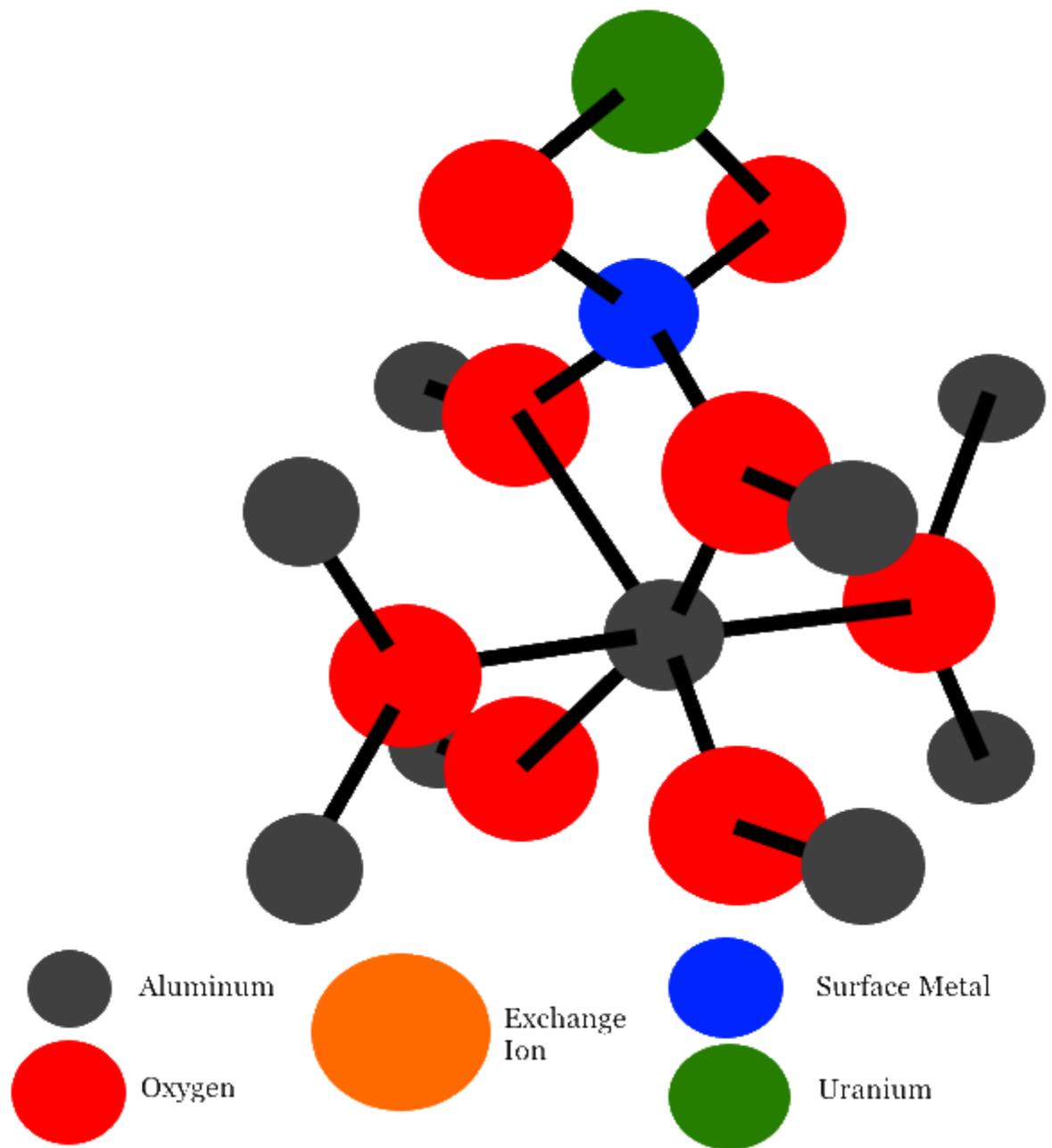












Pellets

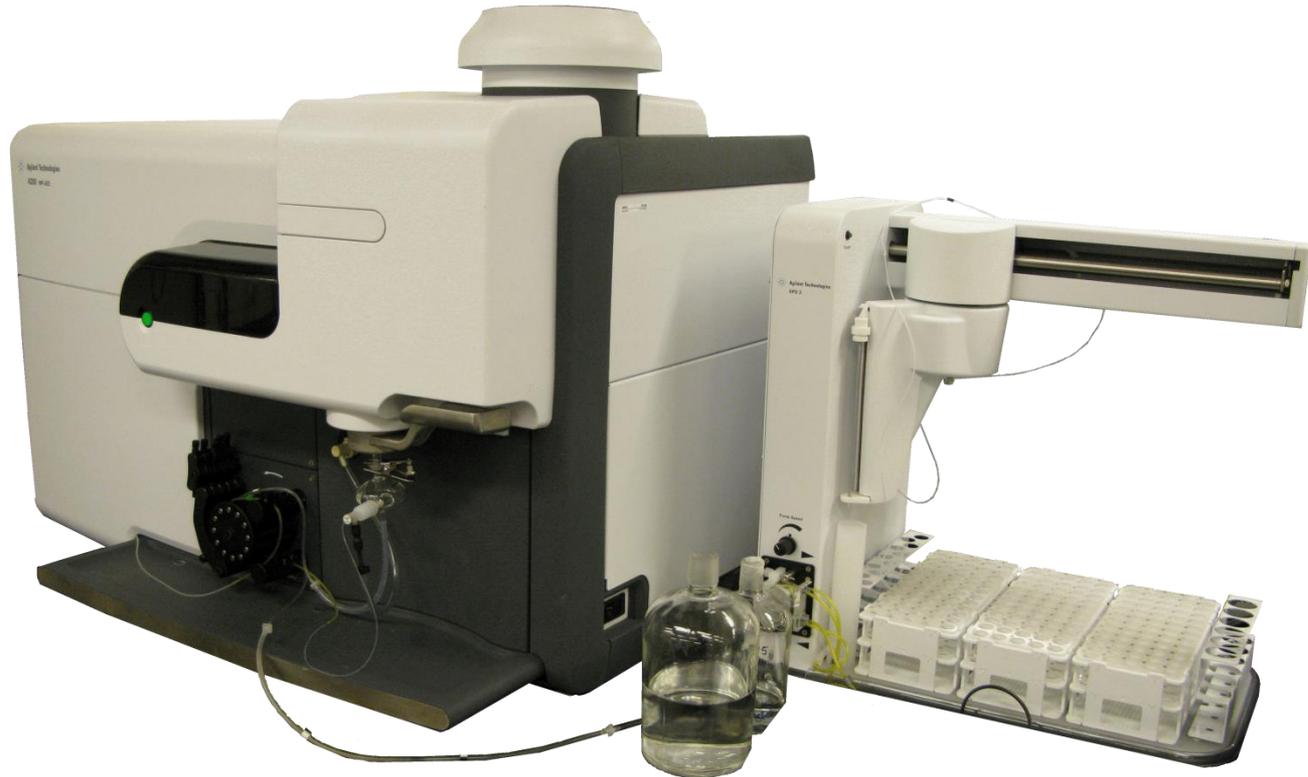


Mixing

- Break surface tension at pore
 - Prevent centrifuging of mixture
- Previous tests used standard lab mixing procedures
 - Kinetics tests require extremely precise timing
- Vertical Syringe Inversion Apparatus



Determining Uranium Concentration



Agilent MP-AES 4200

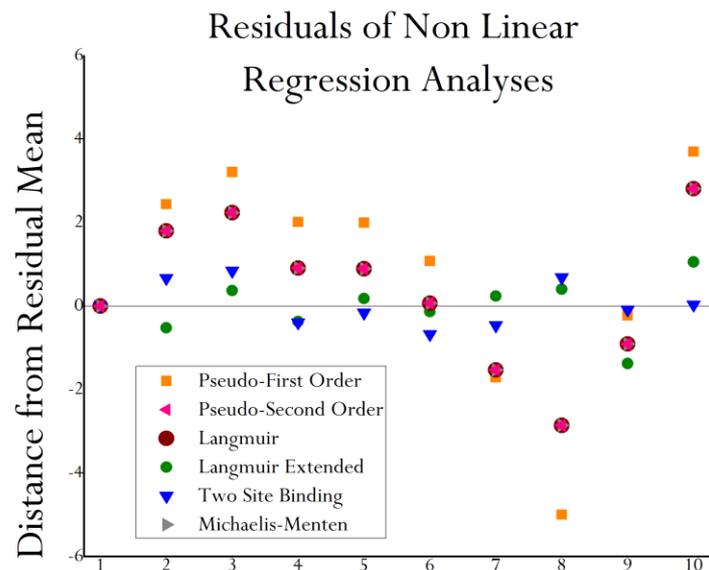
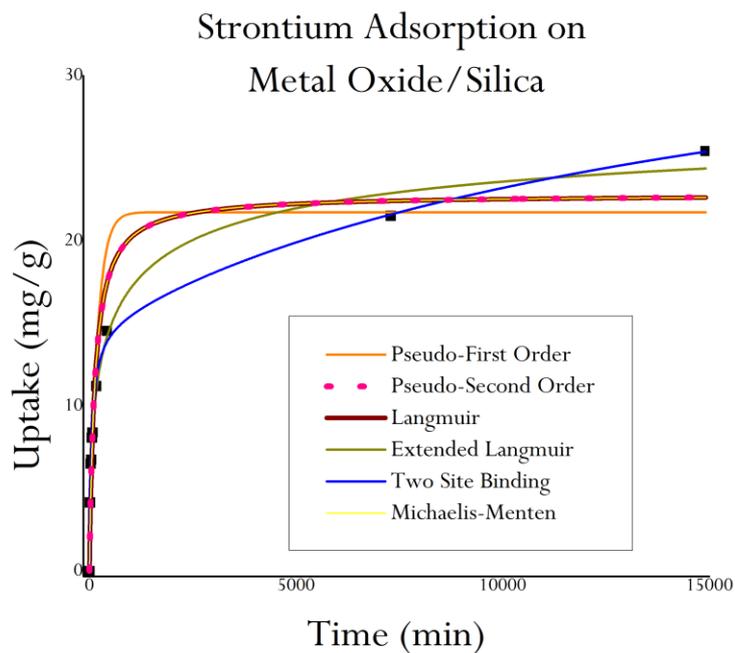
Results

Adsorption efficiency: 833.3 mg/g of sorbent

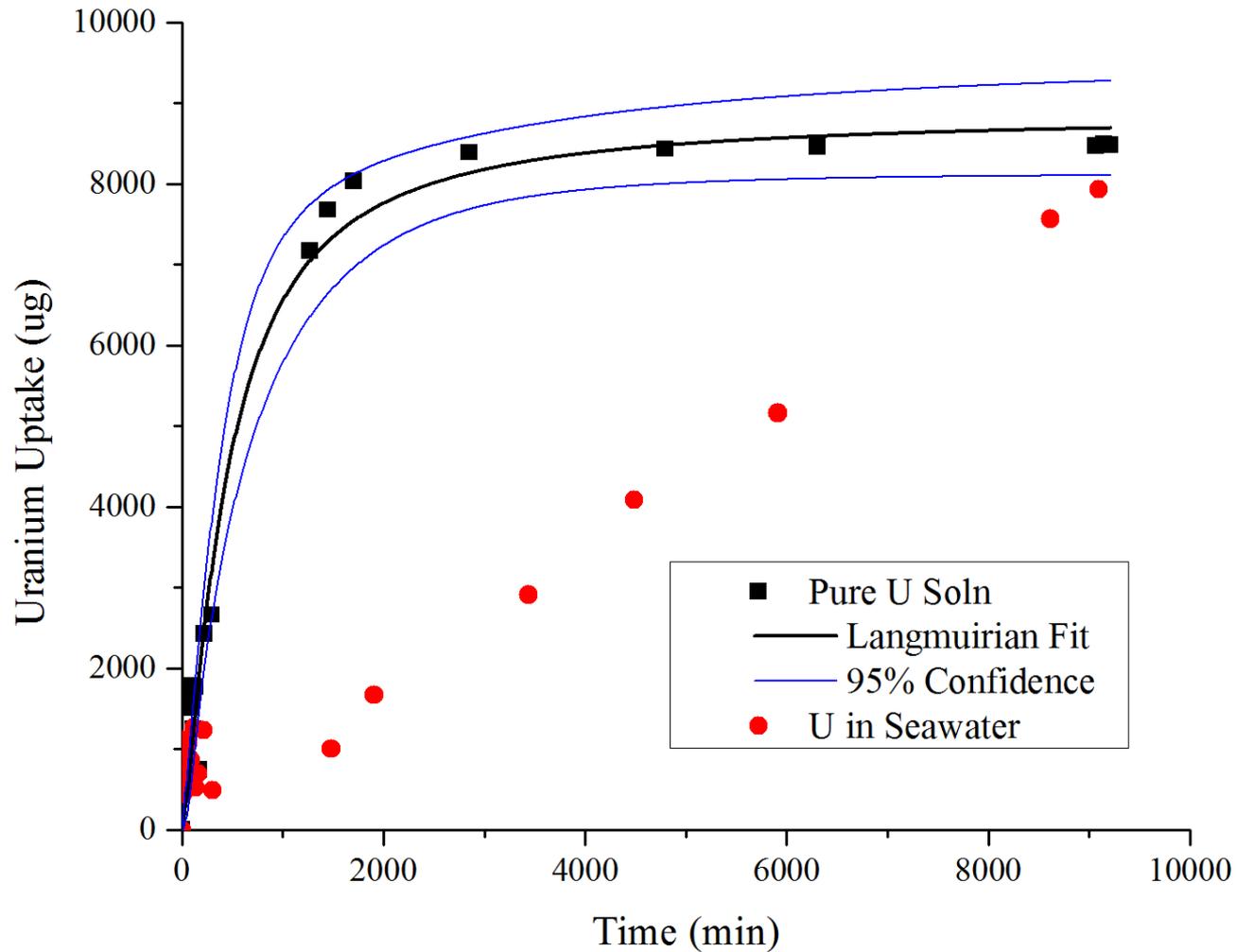
Results with a **silica** substrate

	Mw g/mol	Rel. Mass Abs. mg/g	Rel. Moles Abs. $\mu\text{mol/g}$	Rate Constant g/mgmin
Cobalt	58.93	93.9	1594	7.03E-01
Strontium	87.62	30.3	346	3.09E-04
Cesium	132.9	77.1	332.3	3.72E+00
Neodymium	144.2	183	788.4	5.65E-04
Lead	207.2	83.8	361.1	2.47E-01
Thorium	232	244	1050	6.30E-04
Uranium	238	434	1872	2.16E-04

Discussion of Previous Findings



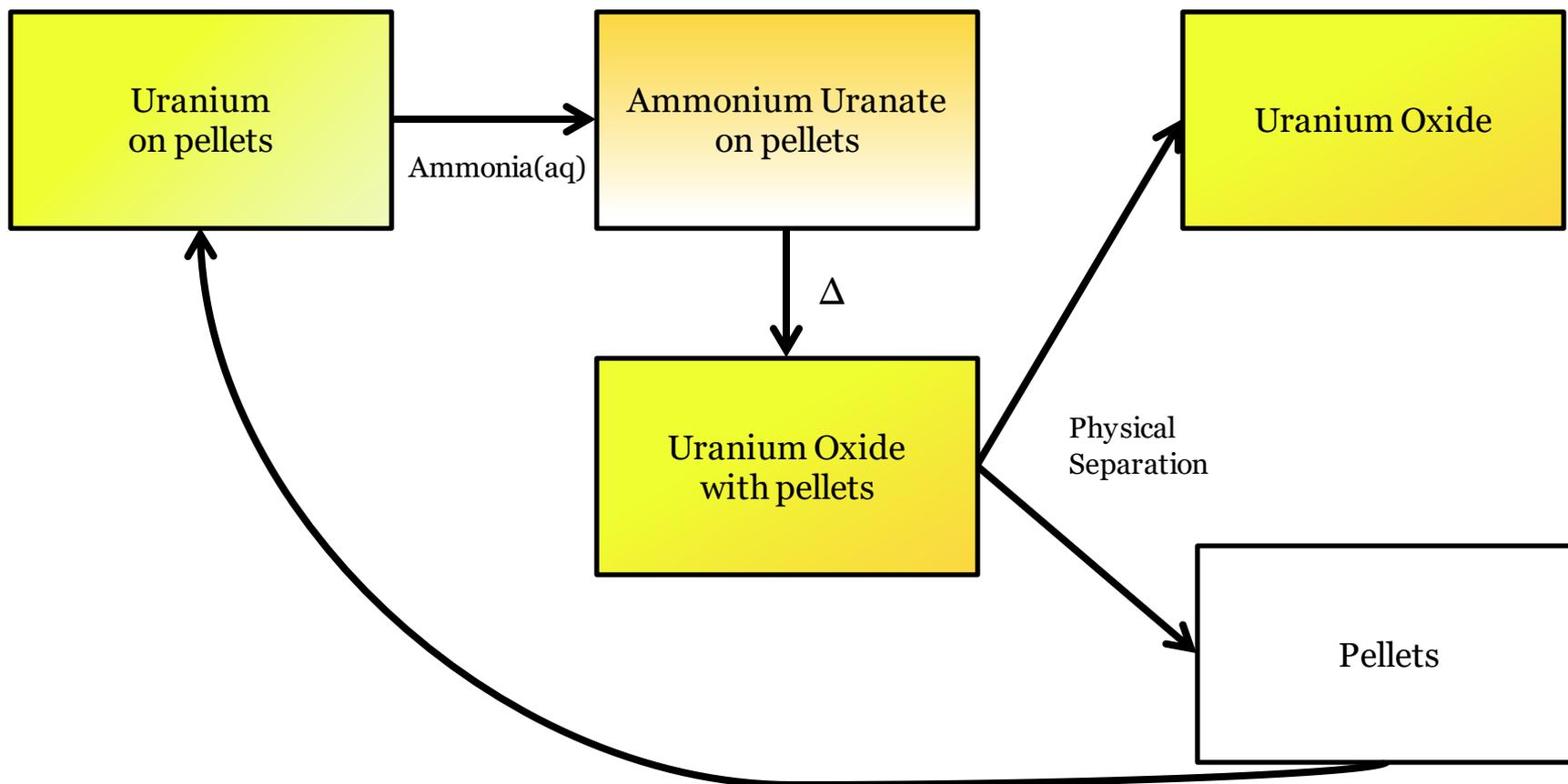
Discussion of New Findings



Methods of Deployment

- Conventional Deployment
 - Column Extraction Medium
 - Mixed Bed Reactor
- Groundwater Trough
 - Prevents contamination
 - Suitable for mining operations
- Oceanic Ion Traps
 - Deployed in areas with high concentration
 - Requires suitable mixing
 - May require security measures

Extraction and Regeneration



Cost of Production/Viability

Resin	Type	Theoretical uranyl Capacity (mmol/g)	Estimated cost per mole of Uranium
Bio-Rad Chelex 100	Weakly acidic cation-chelating resin	0.3	\$12,966
Dowex™ 21K	Styrenic strong-base anion-exchange resin	0.6	\$225
Purolite A-520E	Styrenic strong-base anion-exchange resin	1.4	\$142
Dowex™ 1-X8	Styrenic strong-base anion-exchange resin	1.6	\$356
Eichrom Diphonix	Cation-chelating resin	3.5	\$1600
Xtractite	inorganic metal oxide mineral exchanger	4.3*	\$55

**Note that performance depends on numerous variables. In particular, ion exchange resins, unlike Xtractite, are often far from the theoretical capacity when saturated. For example Xtractite sorbent has a capacity of 3.5 mmol/g while that reported for DOWEX 21K by the Dept. of Energy is only 0.00013 mmol/g*



Prof. Nicholas Materer
Prof. Allen Apblett
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