OCRWM Office of Science and Technology and International

# Radionuclide Dispersion Rates by Aeolian, Fluvial, and Porous Media Transport

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# Introduction

- High grade uranium ore boulders were left behind after the removal of the high grade stockpile near Nopal I uranium mine.
- A boulder was removed, followed by grid sampling of the surrounding area.
- Measured gamma radiation levels in three dimensions provide dispersion rates.

# Relevance

- Waste package release and transport
- Accident analysis
- Natural attenuation
- Model validation
- Few documented examples from complex real systems exist

# Soil Sampling Site

- **Soil sampling of PHGS site 110 was done after an analysis of 31 potential sites was performed, and site 110 was determined to be the best potential scientific target (PST) for testing of radionuclide dispersion.**

# Soil Sampling Techniques

- **After the boulder's location is marked, the boulder is removed from the site so sampling can begin.**

# Soil Sampling Techniques

- **Soil sampling is accomplished by placing grid squares around the site. Rods with orange caps are datum points.**

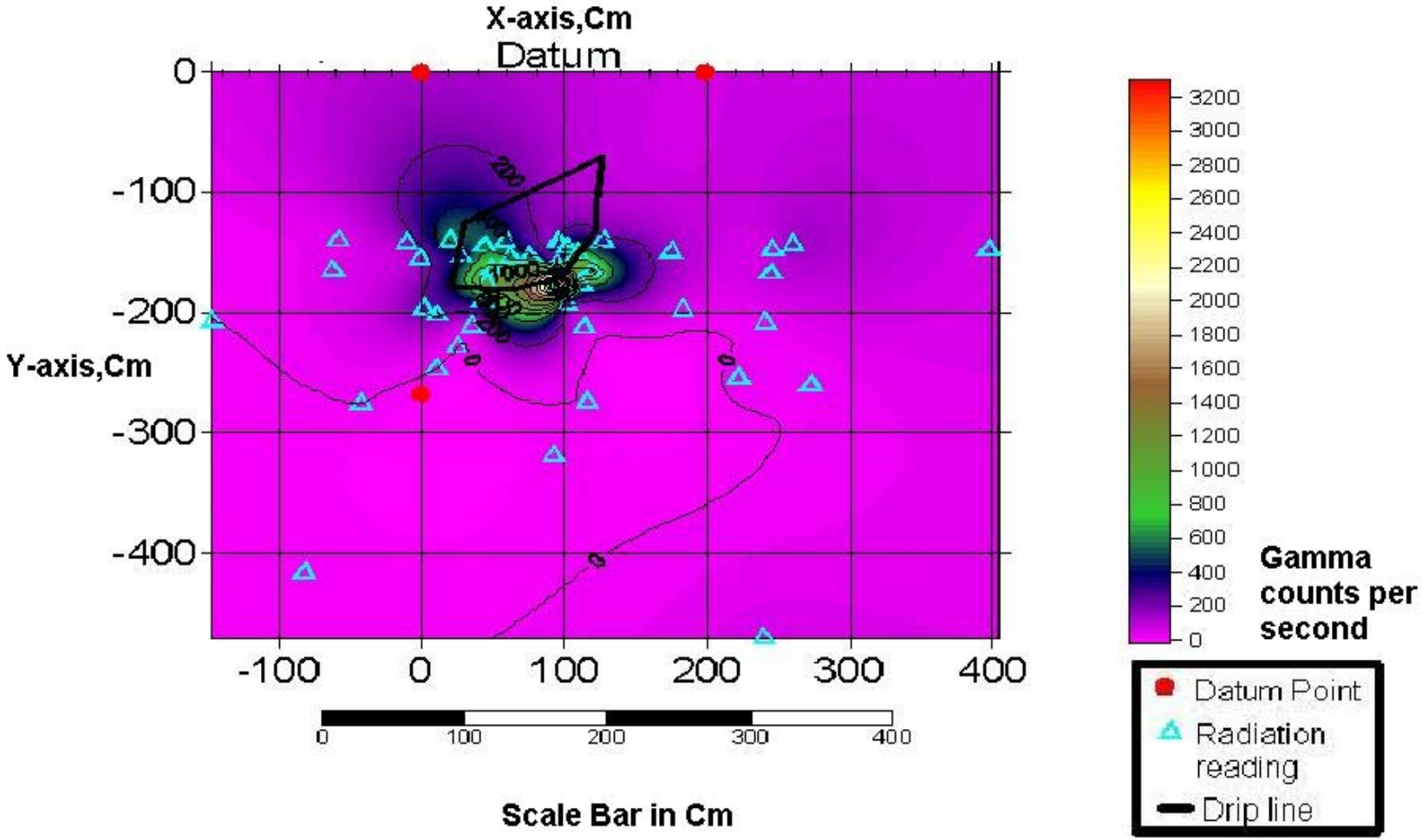
# Soil Sampling Techniques

- Soil samples are collected in 1 kg and 50 g samples
- The larger 1 kg samples were collected at the larger 30x30 cm grid squares and the smaller 50 g samples were collected at the small 5x5 cm grid squares.
- Metal channels were used to keep the soil from falling into the sample site while  samples were collected.

# Soil Sampling Techniques

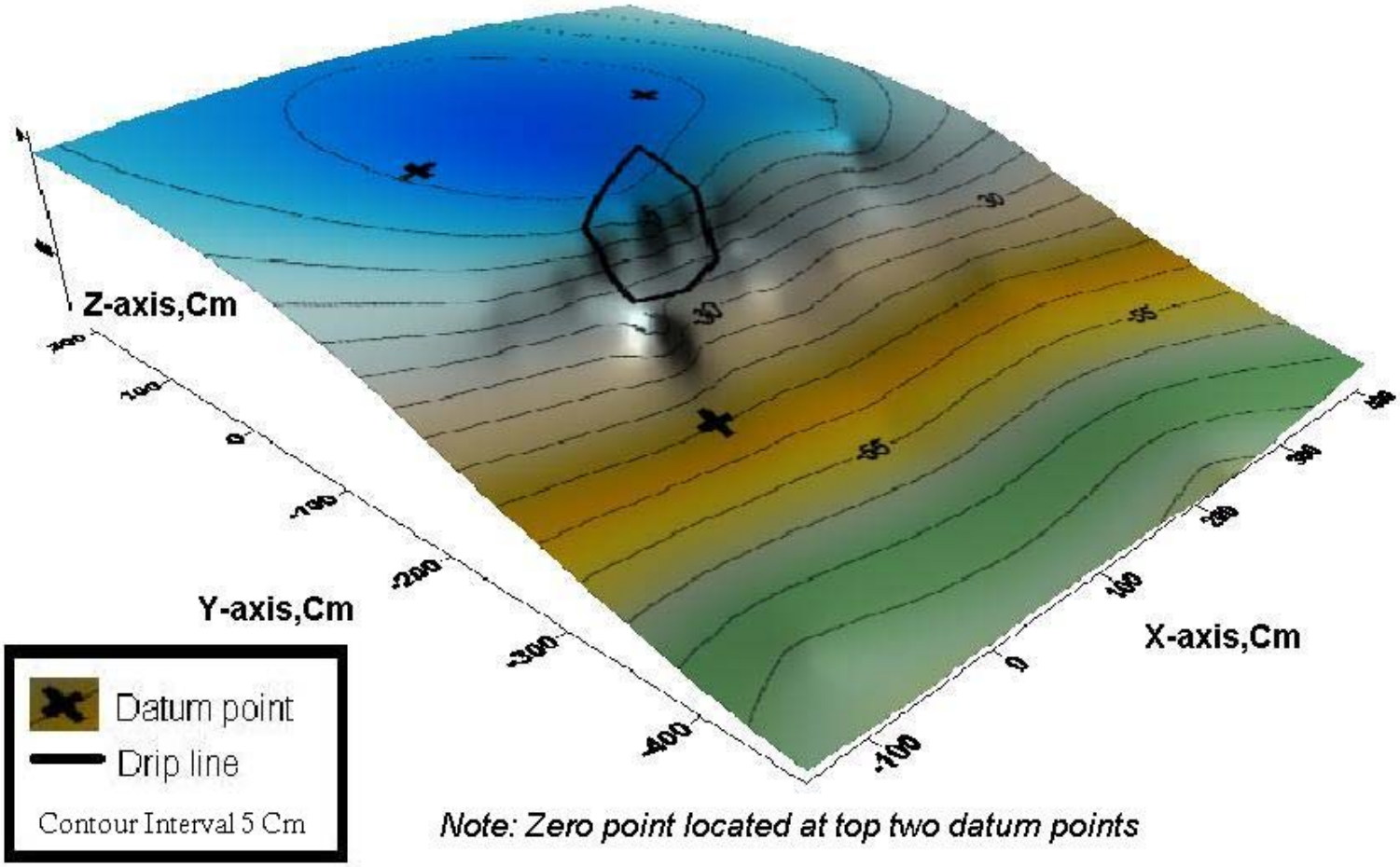
- **While sampling each grid square within the PST site, each site was recorded in X-Y-Z coordinates in relation to the datum points. A radiation reading was also taken before sampling the soil and after each sample layer was removed.**

# Gamma Surface Radiation Intensity Map



# Site Topography

- **Sloped with shallow bedrock above**




*Note: Zero point located at top two datum points*

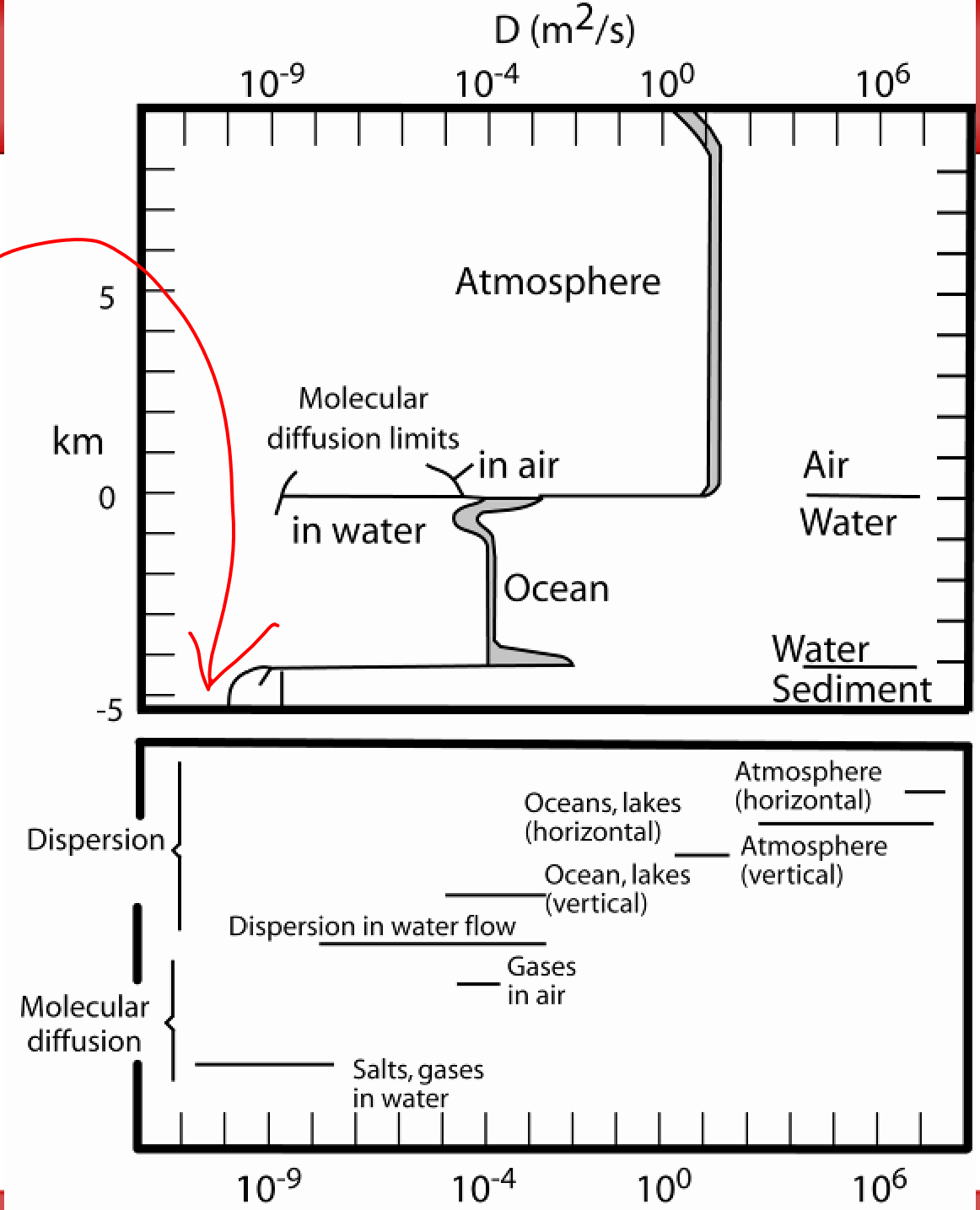
# Analysis

- First look
- Surface transport (x, y) by water ($D_y$) and wind ($D_x$)
  - Water follows gravity – $D_y > D_x$
- Porous media transport (z)
  - Infiltration (down)
  - Evaporation (up)
  - Evaluate as random walk
  - Gross gamma counts

# Analysis

- Fit data to analytical solutions
  - 22 years
  - constant release
- Surface $D_x$ = 22 $cm^2/yr$, $D_y$ = 7$cm^2/yr$
  - Aeolian transport dominates
  - Slow despite desert + wind
- Porous media $D_z$ = 1 $cm^2/yr$
  - Retardation factor > 250

Slow


D (m²/s)
10⁻⁹
10⁻⁴
10⁰
10⁶
Atmosphere
5
km
0
-5
Molecular
diffusion limits
in air
in water
Air
Water
Ocean
Water
Sediment
Dispersion
Molecular
diffusion
Oceans, lakes
(horizontal)
Atmosphere
(horizontal)
Atmosphere
(vertical)
Ocean, lakes
(vertical)
Dispersion in water flow
Gases
in air
Salts, gases
in water
10⁻⁹
10⁻⁴
10⁰
10⁶

# Conclusions

- Aeolian transport dominates sheetflow despite slope and bare rock above
- U series vadose zone transport is highly retarded
- Final results will document one case of real world migration rates

# Acknowledgement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