# Radiocarbon Analysis of Microbial RNA to Determine Carbon Sources in Arsenic Contaminated Pleistocene Aquifers in Bangladesh


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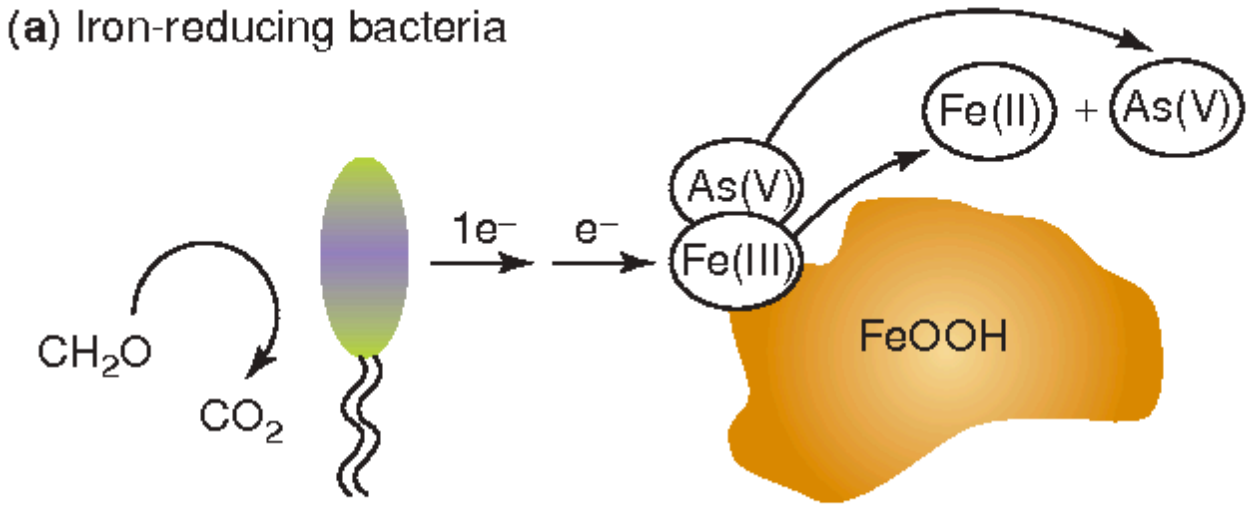
# Geogenic As and Iron Reduction

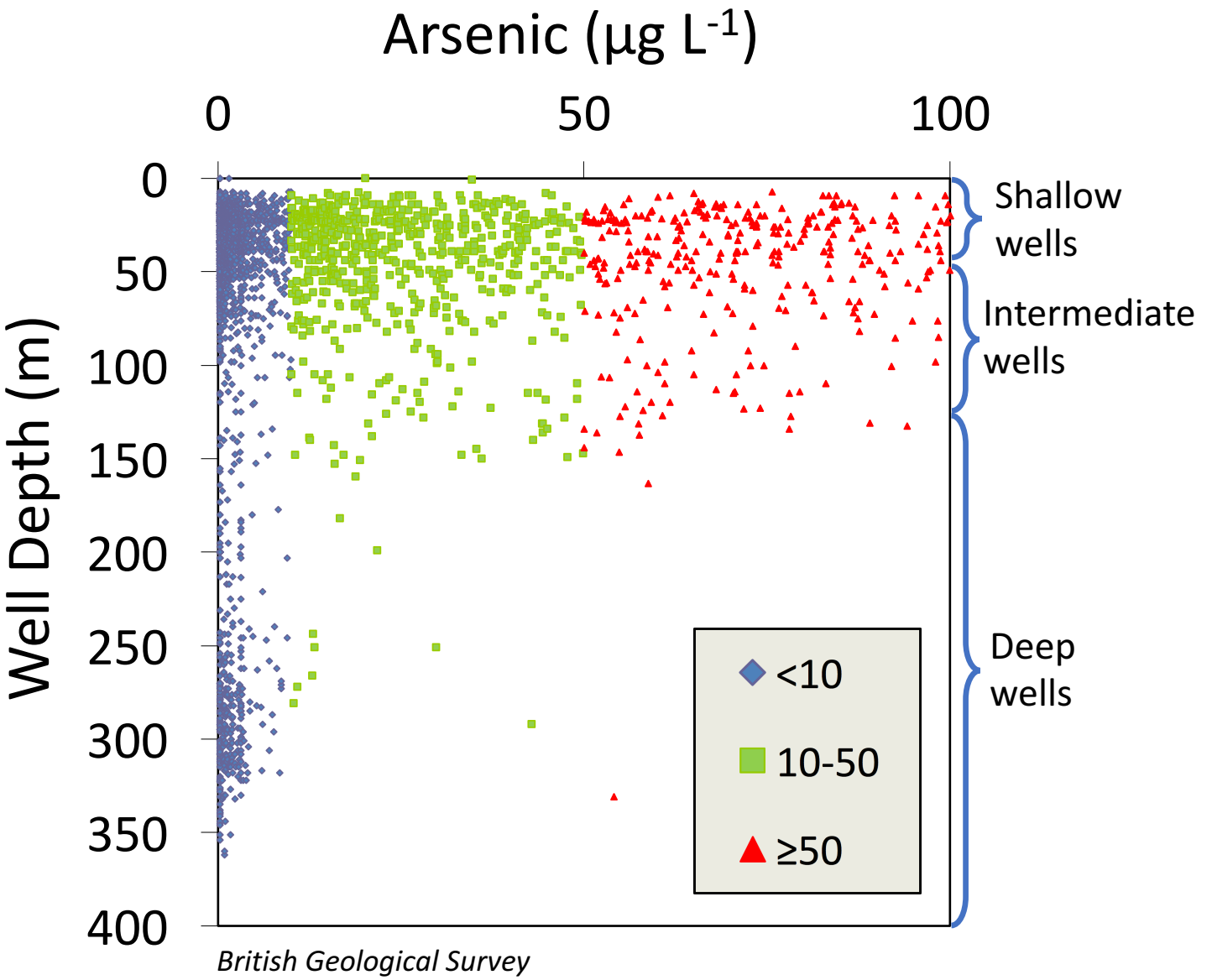
- Geogenic As
  - Naturally occurring
  - Prevalent in Southeast Asia
- Health effects:
  - Cardiovascular disease
  - Skin lesions
  - Cancers (skin, lungs, liver)
- As release through iron reduction
  - Fe III → Fe II
  - Where is the organic carbon coming from?




Oremland & Stolz, 2005; Ravenscroft et al., 2001

# As Contamination of Shallow, Pleistocene Aquifer

- Shallow wells:
  - <40 m
  - Draws from Holocene aquifer
  - Cheap and easy to drill
  - As levels >10 µg/L
- Intermediate wells:
  - ~40 - 150m
  - Draws from Pleistocene aquifers
  - Cheap and easy to drill
  - Generally lower As (<10 µg/L)
  - ***Some As contamination (>10 µg/L)***
- Deep wells:
  - >120m
  - Expensive to drill
  - Low As (<10 µg/L)



## Potential Carbon Sources

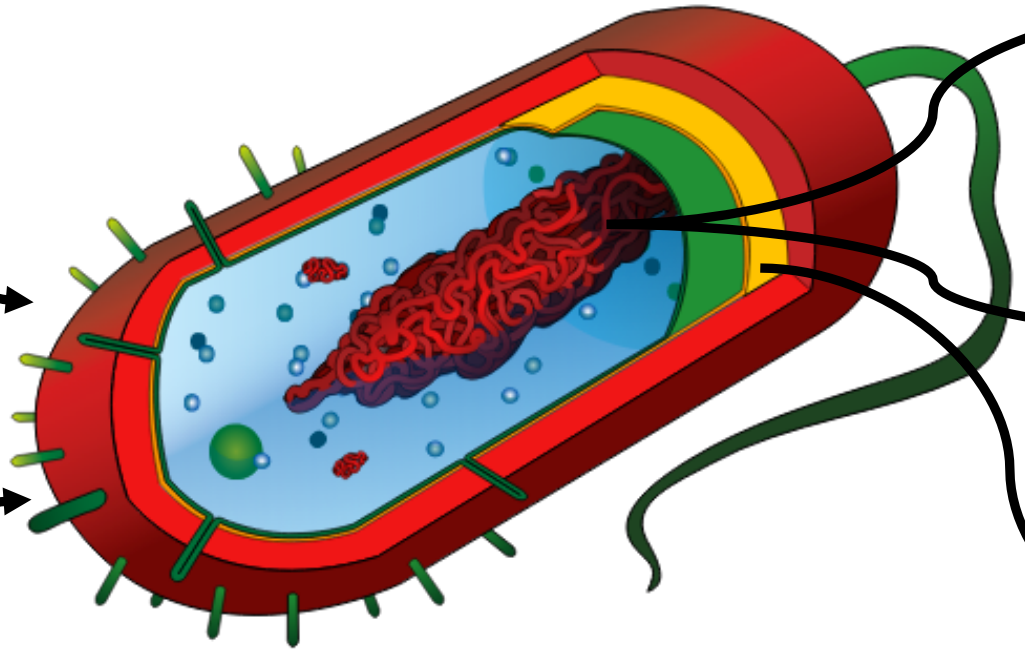
## Bacterial Reduction of Sedimentary As

## Extraction and Radiocarbon Dating

**Young surface OC** or ages similar to the Holocene aquifer (0-1,000 years old) (Mailloux et. al)

**Old OC buried with the sediment** (>10,000 years old) (McArthur et. al)

**OC and organics diffusing out of clays** (>10,000 years old) (Erban et. al)

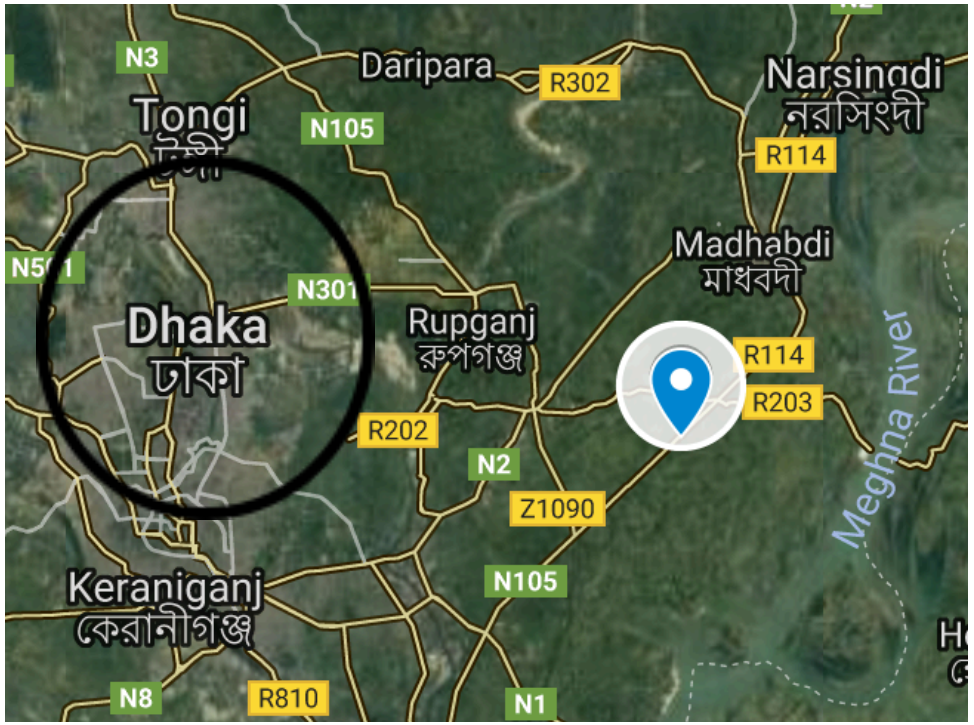


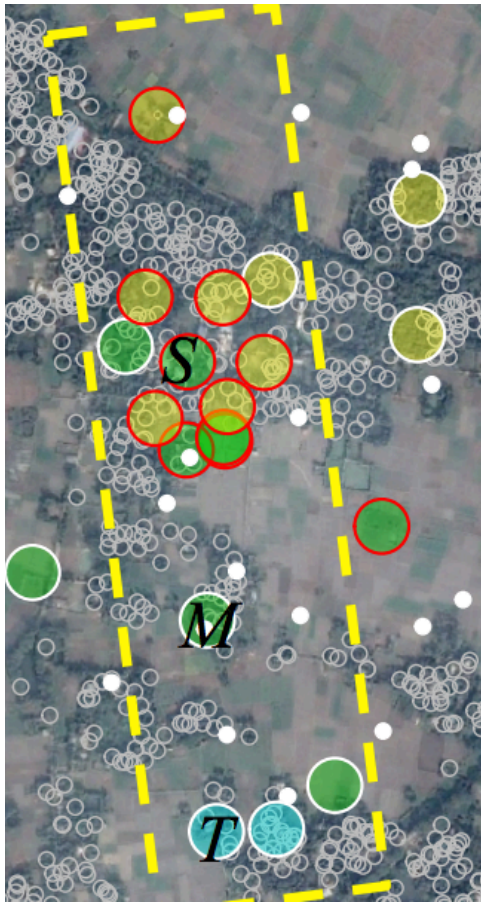
RNA

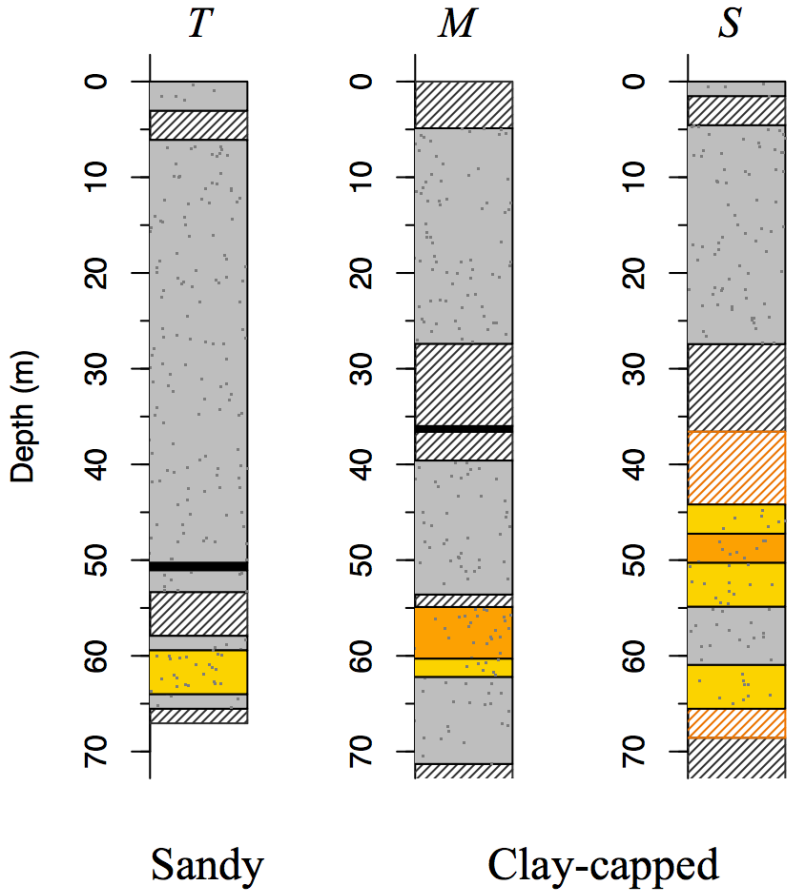
DNA

PLFA

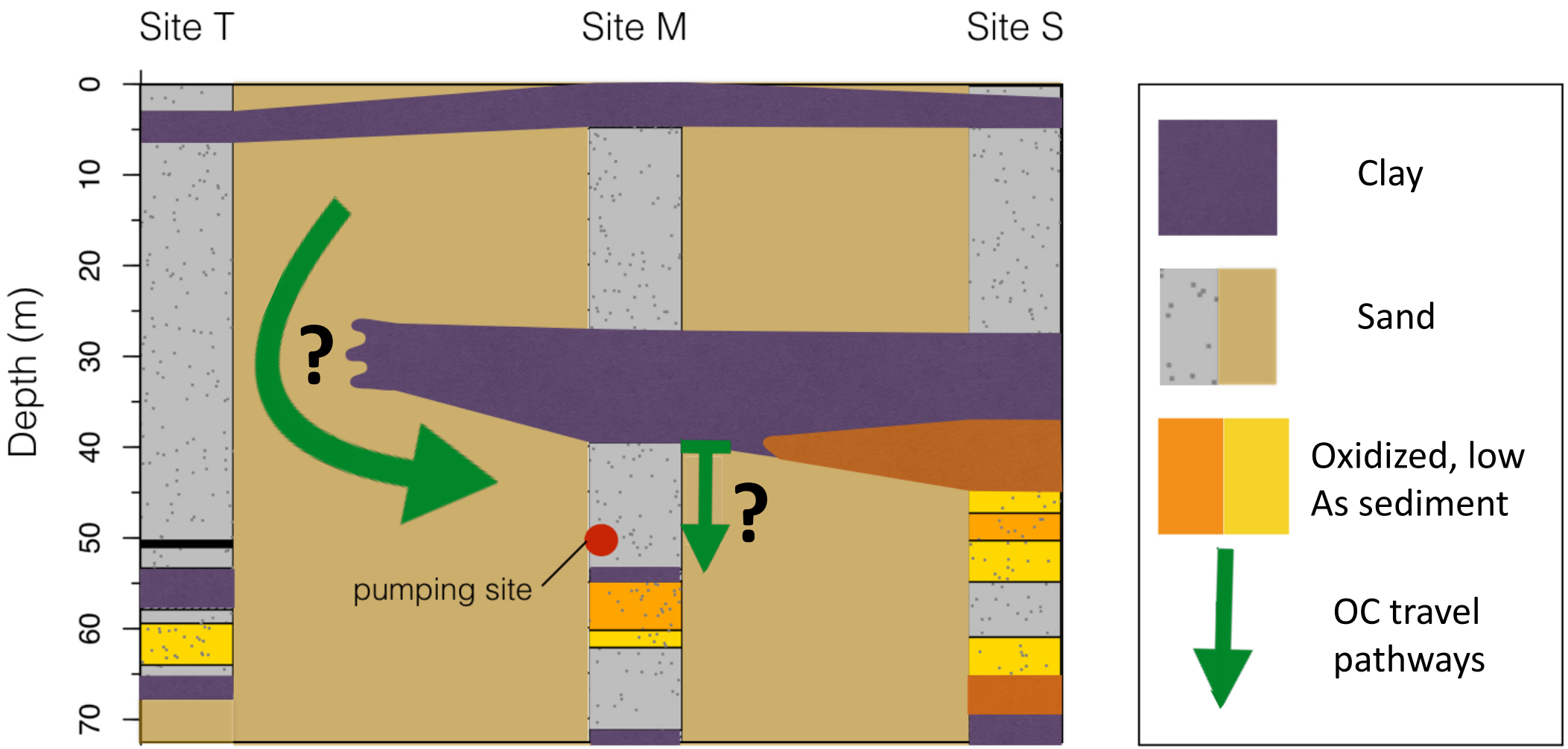
# Pleistocene wells >30 meters



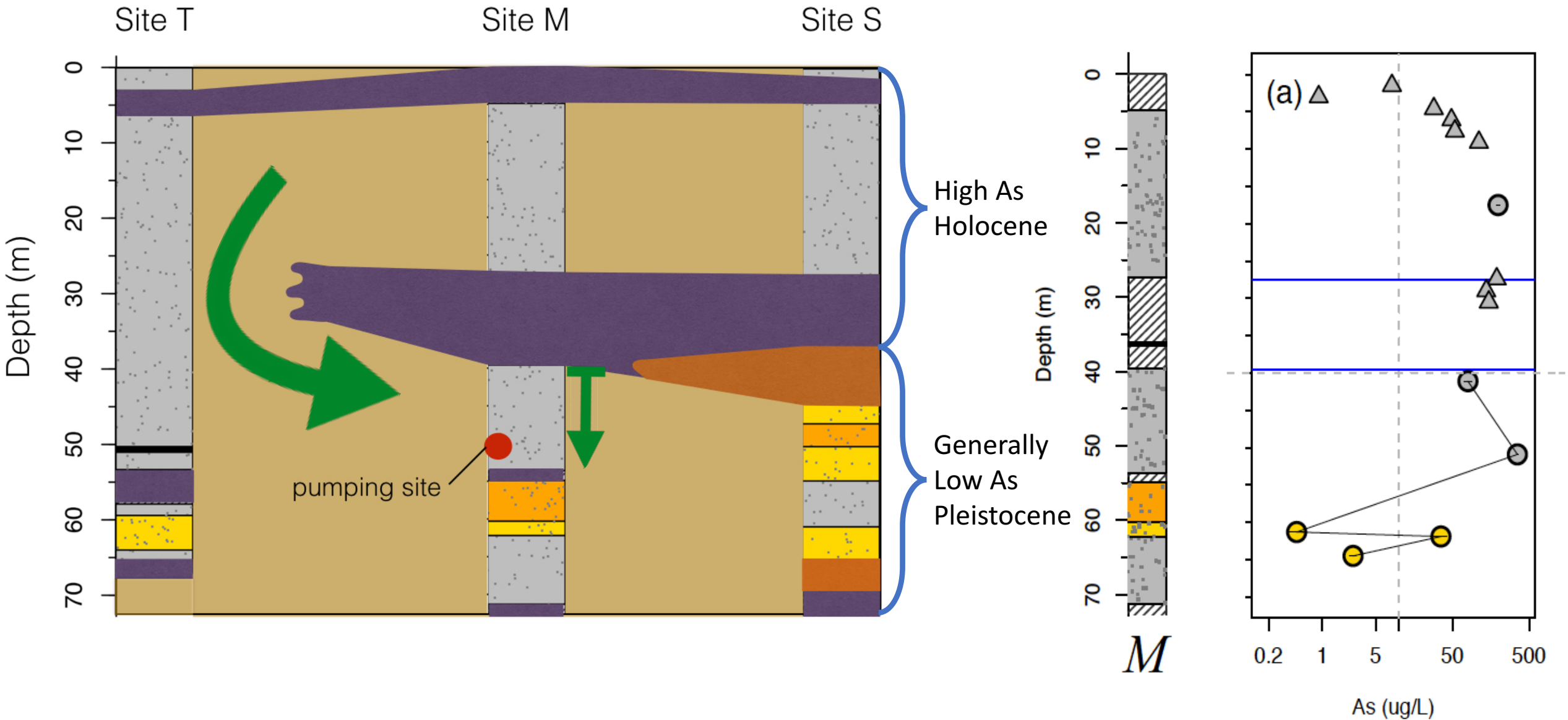



# Possibilities for Carbon Movement at Site M:

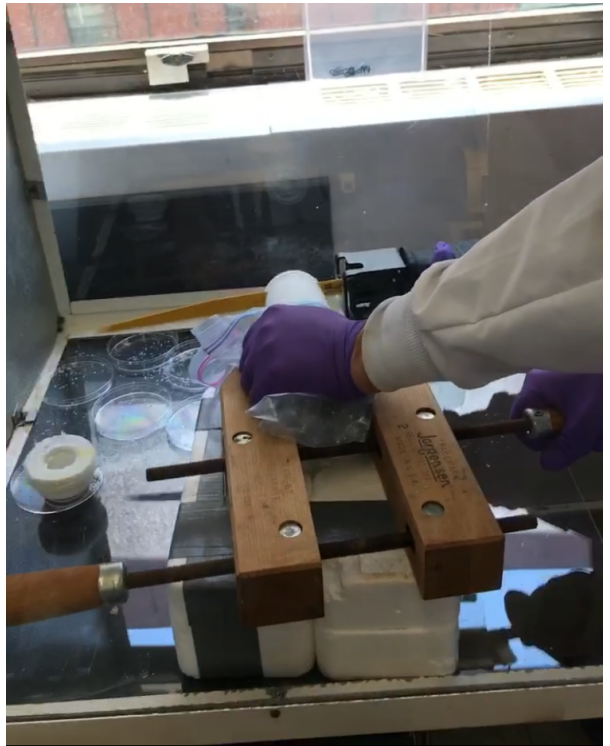


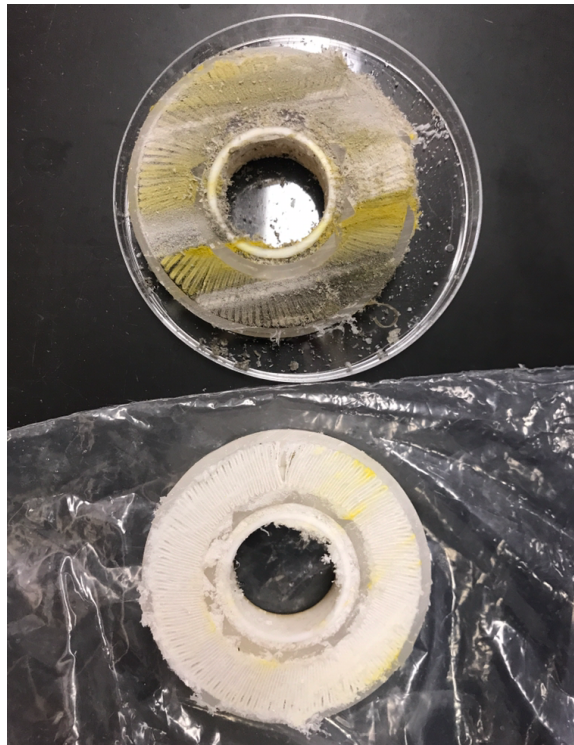
# Arsenic Measurements at Site M:



# Extraction Methodology

- 33,860 liters pumped at Site M1.4A
- Filter cut in half to create duplicates
- Cell lysis, Tris-saturated Phenol Chloroform (1:1), LiCl precipitation
- Radiocarbon dated at LLNL
- Extensive E. Coli testing reproduced end member modern dates

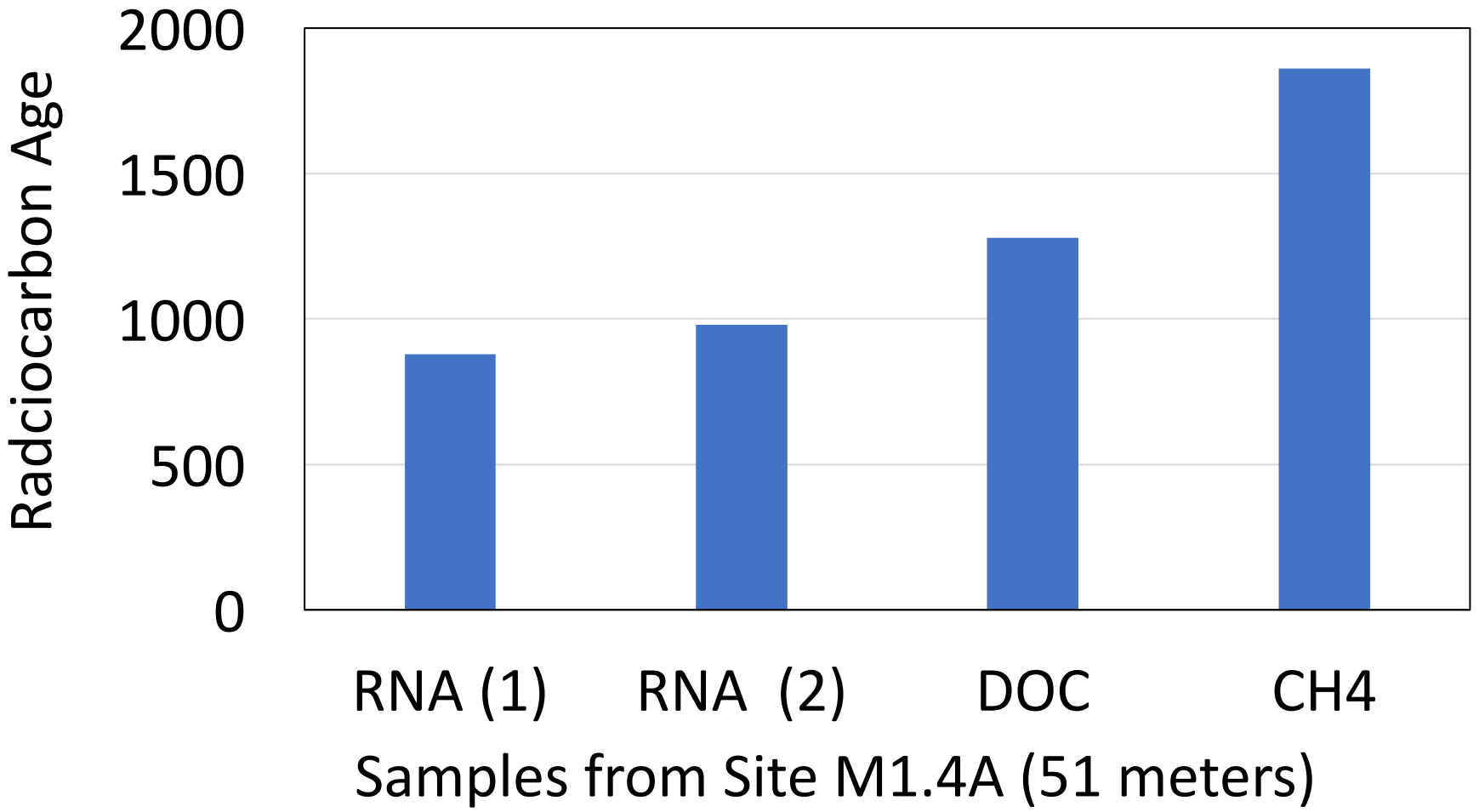




# RNA Radiocarbon Dates from Pleistocene Aquifer <1,000 years old

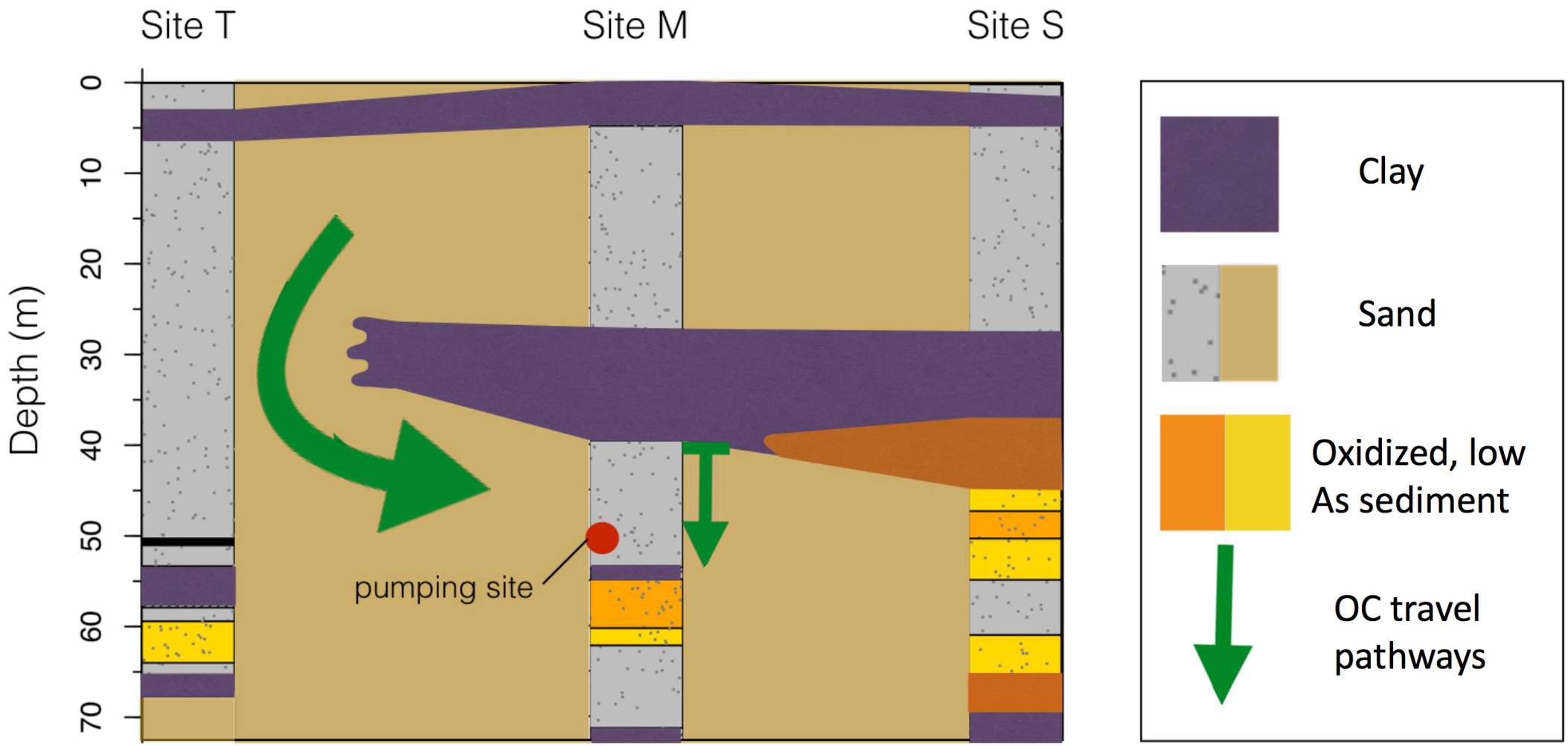
| Sample Name | $\Delta^{14}C$ | $^{14}C$ Age |
|---|---|---|
| RNA (1) | -111.4 ± 20.1 | 880 ± 190 |
| RNA (2) | -121.8 ± 6.2 | 980 ± 60 |

# Comparison of RNA, DOC, $CH_4$ Radiocarbon Ages




- Site M sediment (50.6 m) = >10,000 years old
- Site M DIC (54.5 m) = 1,050 years old

# Young Dates Support Advection of Surface OC Around Clay to the Pleistocene Aquifer



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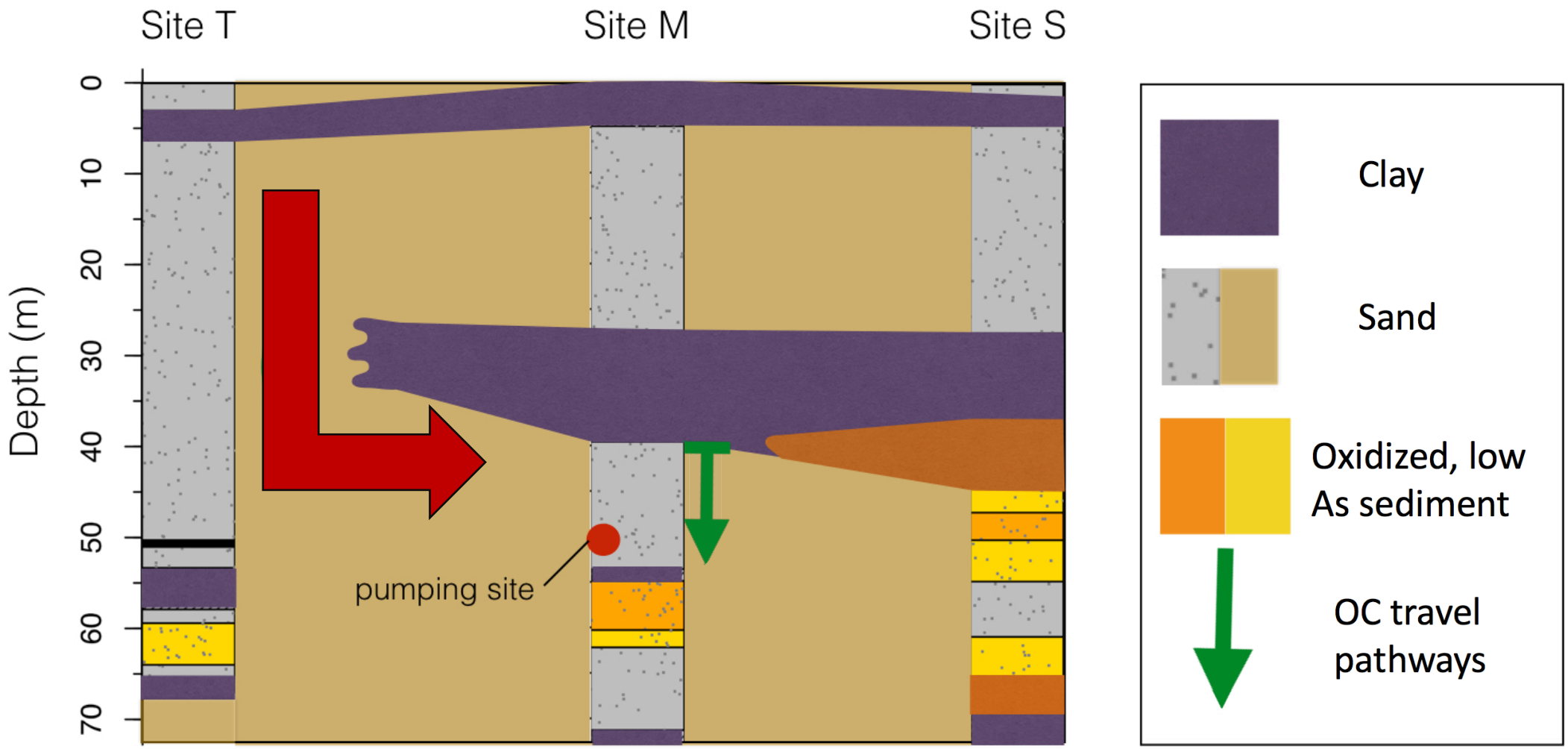

# Conclusions:

- Duplicates worked
- RNA dates <1000 years
  - Younger than sediment and in situ carbon sources
  - Young OC transported around the clay
- Long term stability of Pleistocene aquifers may be compromised by the transport of young OC down to Pleistocene depths, possibly due to groundwater pumping

# Acknowledgements


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- Van Geen Lab
- Bostick Lab
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- NIEHS

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