Stable Calcium Isotopic Variability in Groundwater from Coastal Aquifers from the Sundarbans Delta, India

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1. Introduction, Study Area & Sampling

- Sundarbans is a prograding delta of the Ganges-Brahmaputra riverine system that experiences marine transgression and regression.
- Aquifers in such deltaic settings are major sites of seawater-groundwater interaction; such reservoir-scale interactions have implications for marine elemental budgets
- Calcium is one of the major dissolved ions in seawater and Ca stable isotope ratios ($\delta^{44/40}Ca$) are a reliable tracer of sources of Ca as well as carbonate precipitation-dissolution processes. However, limited Ca isotope data are available for coastal aquifers.
- In this study, depth-bound groundwater samples were collected from multiple observation wells within the Bakkhali delta front covering both **near-shore (A)**, **off-shore (B)**, and **deeper tubewell (TW)** locations in 2017-18 hydrologic years.
- Water samples were collected between 14 and 333 m below ground level (mbgl).

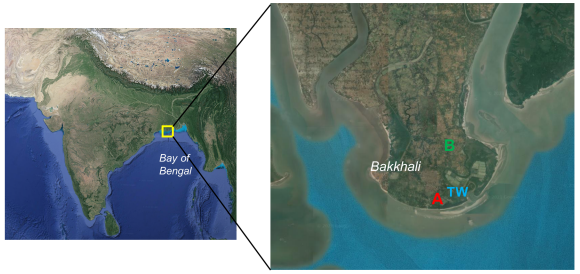

Fig. 1. Google Earth image of the study area located in Sundarbans delta, India

2. Methodology

- Water samples were filtered and stored as per standard protocols for further analysis.
- Cation concentrations were measured using an ICPMS (Thermo iCAP-Q) at IIT Kharagpur (Das et al., 2021).
- $\delta^{44/40}Ca$ values in groundwater samples were measured using a multi-collector TIMS (Thermo Triton Plus) at IISc Bangalore, using a ^{43}Ca-^{48}Ca double spike following established protocols (Mondal & Chakrabarti, 2018).
- All $\delta^{44/40}Ca$ values are reported relative to NIST SRM 915a standard.

3. Results and Discussion

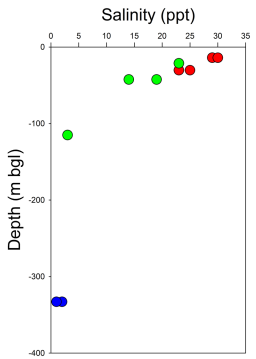

Fig. 2. Salinity (1-30 ppt) of groundwater samples decrease with depth

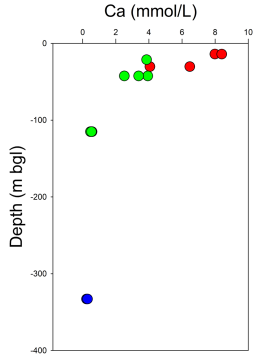

Fig. 3. Ca concentrations (0.29-8.92 mmol/L) in the groundwater samples reduce with depth

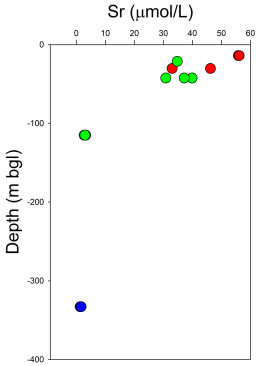

Fig. 4 Sr concentrations (1.6-62.8 µmol/L) in the groundwater samples reduce with depth

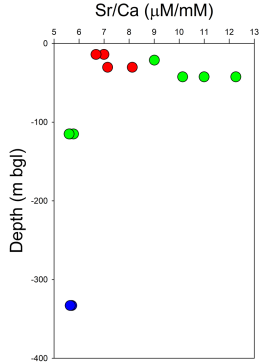

Fig.5. Variations in Sr/Ca in the groundwater samples with depth

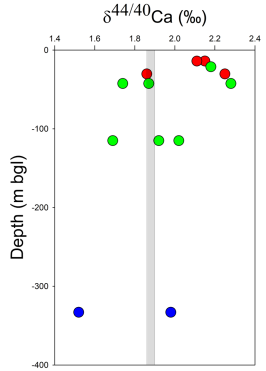

Fig. 6. $\delta^{44/40}Ca$ values of groundwater samples show significant variation (1.52-2.28‰); some samples collected from shallower depths display values higher than modern seawater (~1.88‰, vertical gray bar)

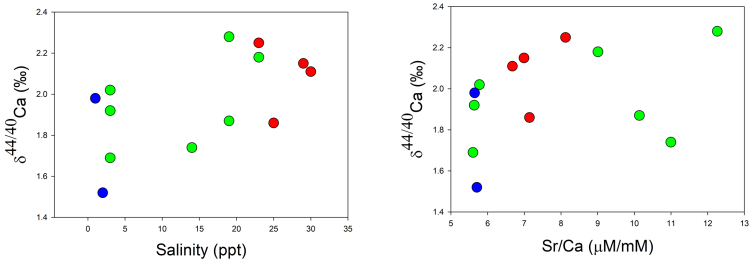

Fig. 7. Relationships between $\delta^{44/40}Ca$ values and salinity and Sr/Ca in the groundwater samples of the present study

4. Summary and Conclusions

- Lower $\delta^{44/40}Ca$ values in deeper groundwater, together with their low salinity, [Sr], and [Ca] are consistent with limited seawater incursion at depth.
- Shallower groundwater samples display higher $\delta^{44/40}Ca$ values which is consistent with greater influence of seawater.
- Some of the shallow samples show $\delta^{44/40}Ca$ values which are higher than seawater; some of these samples also display high Sr/Ca which is consistent with carbonate precipitation.
- High $\delta^{44/40}Ca$ values in groundwater samples from the Sundarbans delta could explain the high $\delta^{44/40}Ca$ values of coastal waters from the Bay of Bengal (Chakrabarti et al., Goldschmidt 2018)

References: K. Das et al., 2021, J. of Env Management,284; S. Mondal and R. Chakrabarti, 2018, JAAS, 33,141; R. Chakrabarti et al. Goldschmidt 2018,359.
Funding: Ministry of Earth Sciences, India (MoES/PAMC/H&C/103/2017-PC-II).