British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Gateway to the Earth

Hydrogeological responses to intense groundwater pumping in the Indo-Gangetic Basin- Evidence from environmental tracers

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IAH 2016, Montpellier

Background:

- 20 million boreholes access groundwater resources across the IGB
- 1 billion people are highly dependant on this resource
- Multiple pressures and constraints: GW quality> GW quantity[1]
- Groundwater key for the *security* of drinking water supply and food production

MacDonald et al (2016), Nature Geoscience [1]

Major groundwater issues in the region

Constraints on groundwater use:

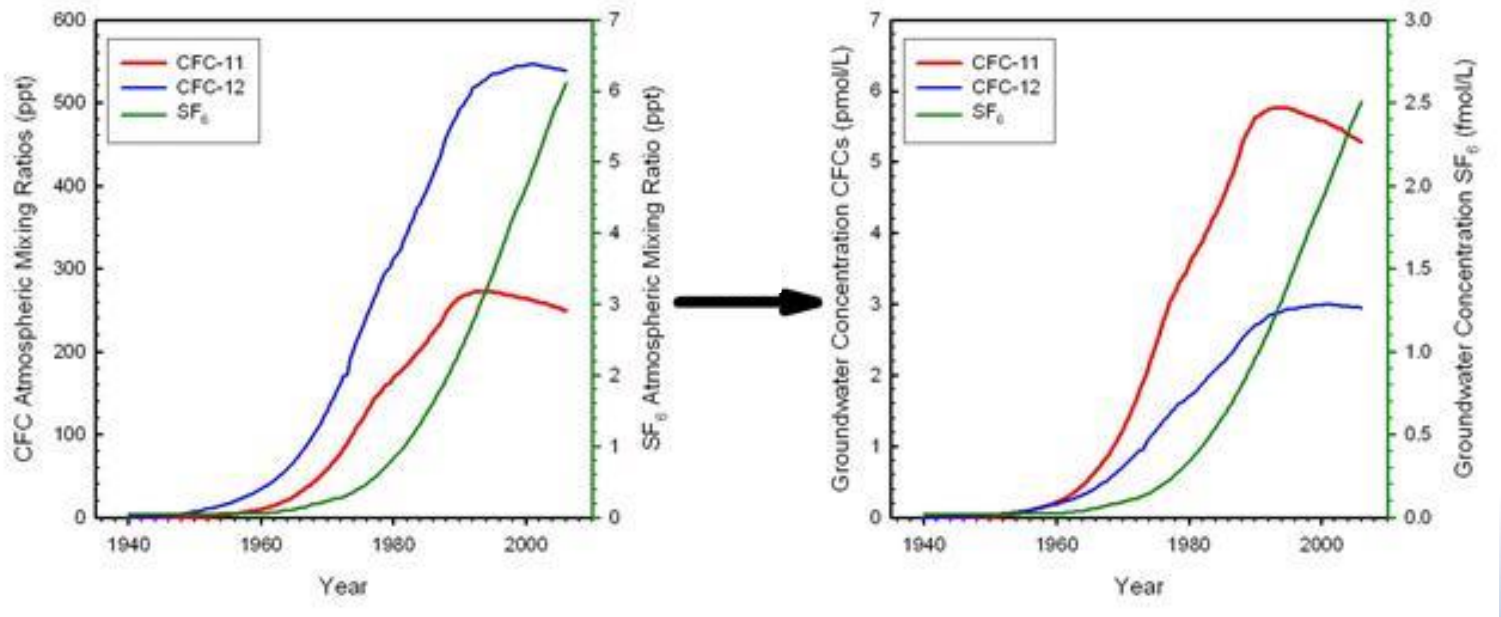
- Arsenic, fluoride, salinity
- Microbial contamination in shallow aquifers
- Contamination from agriculture and urban landuse
- Coastal flooding and sea level rise
- Falling groundwater levels locally

Deep groundwater resources are critical

- Less affected by water quality constraints
- Only feasible water source in some areas of IGB
- Knowledge gap: vertical connectivity between multi-layered aquifer system found across the IGB

Tracers used in this study

- CFCs, SF6, 14C – groundwater residence time tracers
- Inorganic chemistry
- Stable isotopes – recharge sources

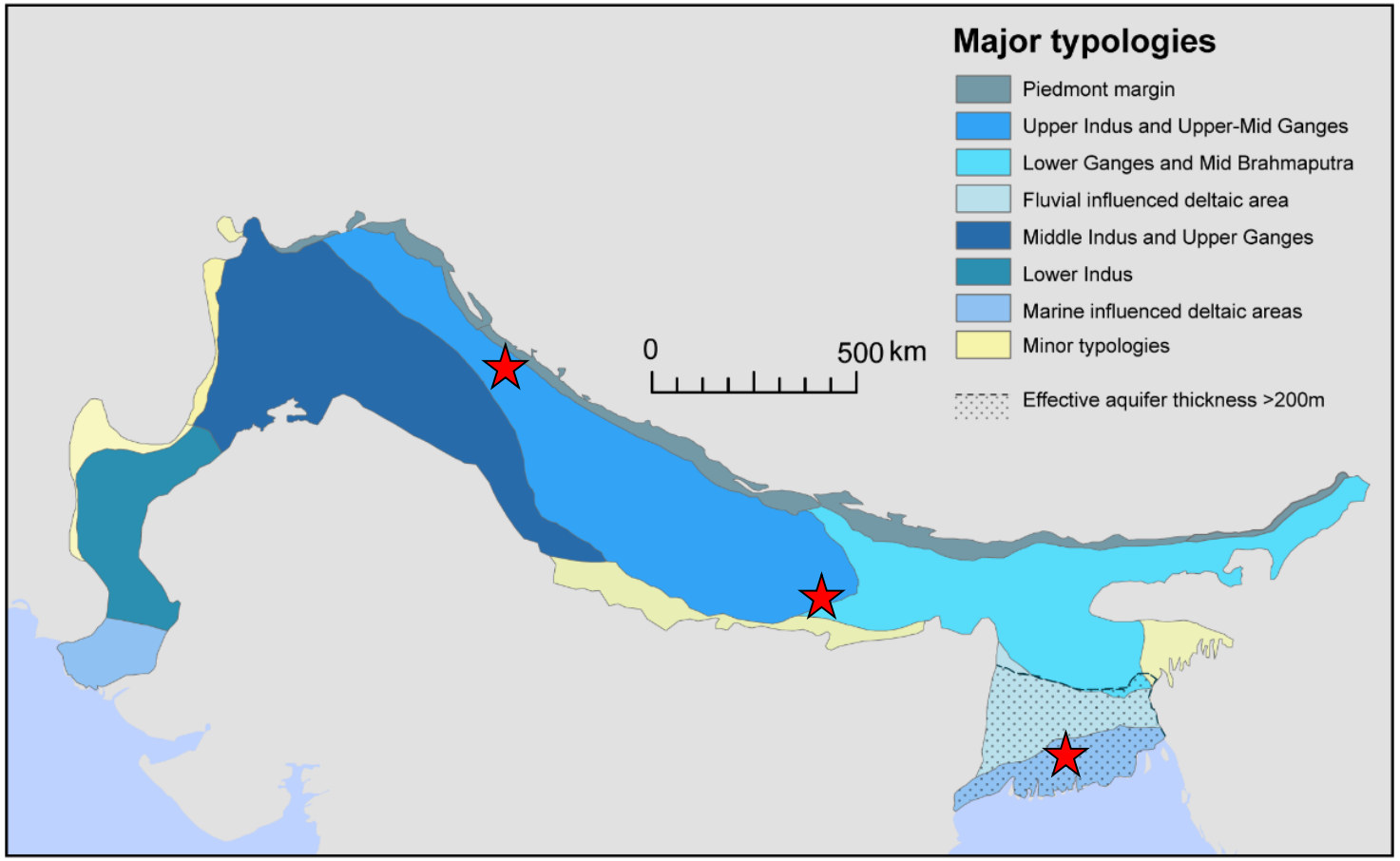


Groundwater sampling

- Multi-level piezometers where possible
- Careful selection of paired deep and shallow sites
- Locations with contrasting aquifer isotropy

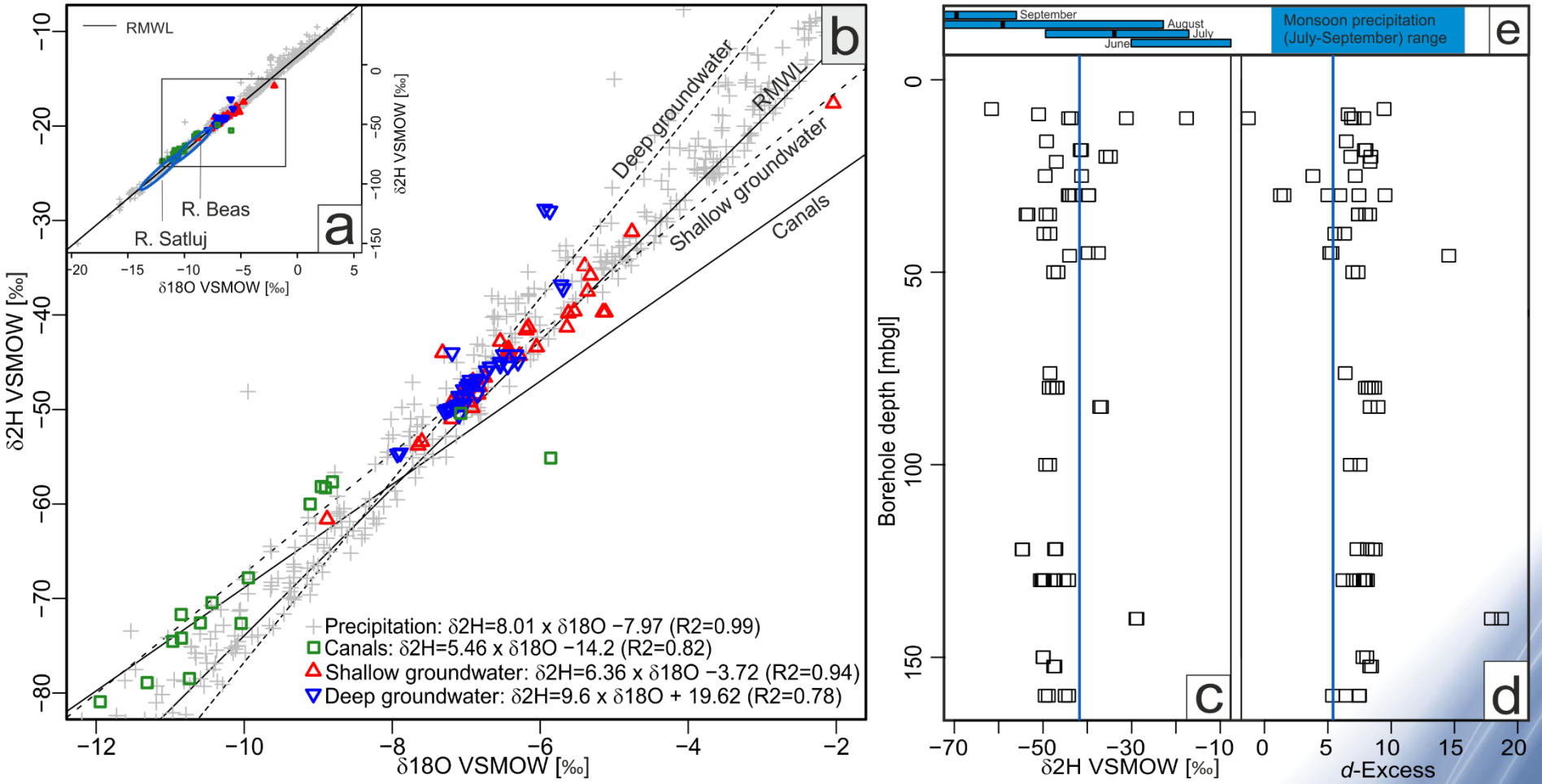
Regional setting and research sites

Highly abstracted unconsolidated layered alluvial aquifer systems



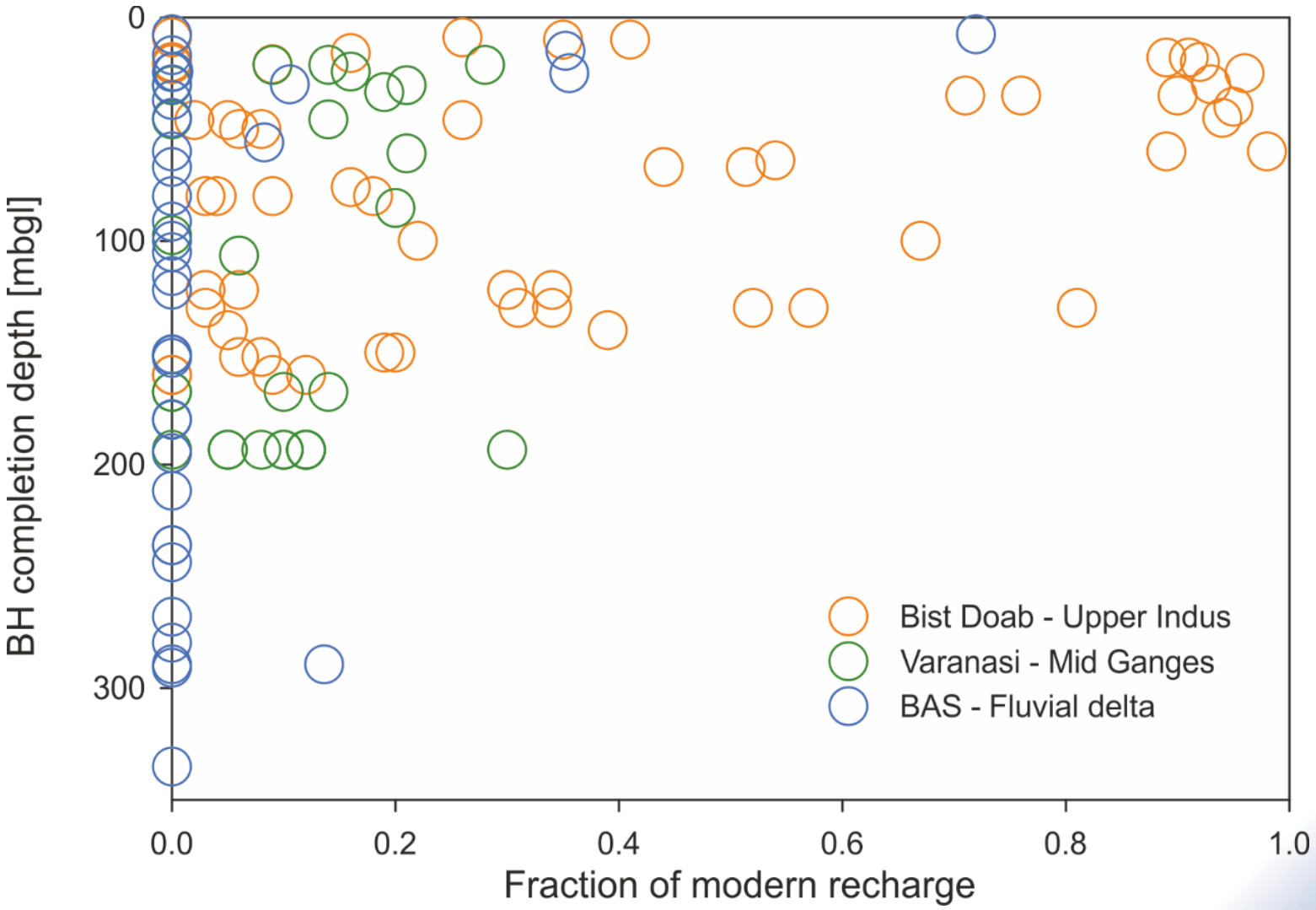
Bonsor et al (in review)

Bist-Doab (NW India) - stable isotope results show that meteoric recharge dominates

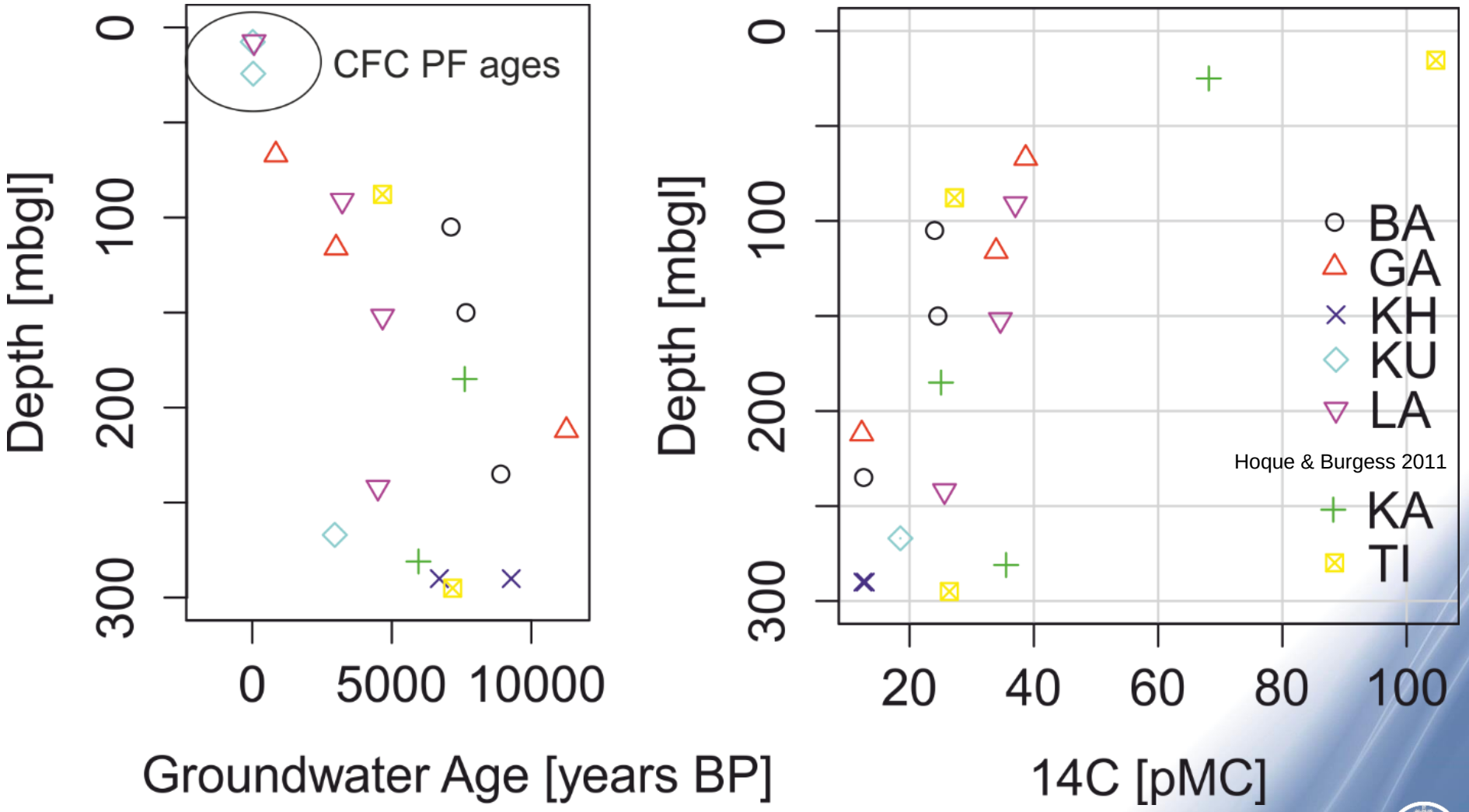


Lapworth et al (2015)

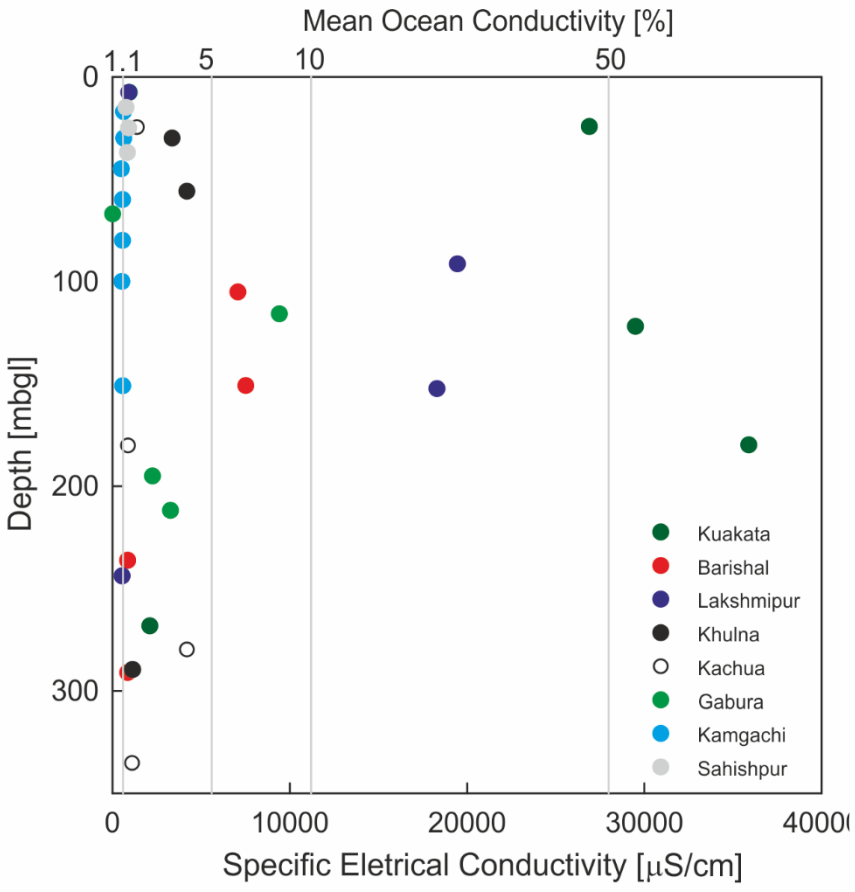
Modern groundwater residence time tracers (CFC and SF6)

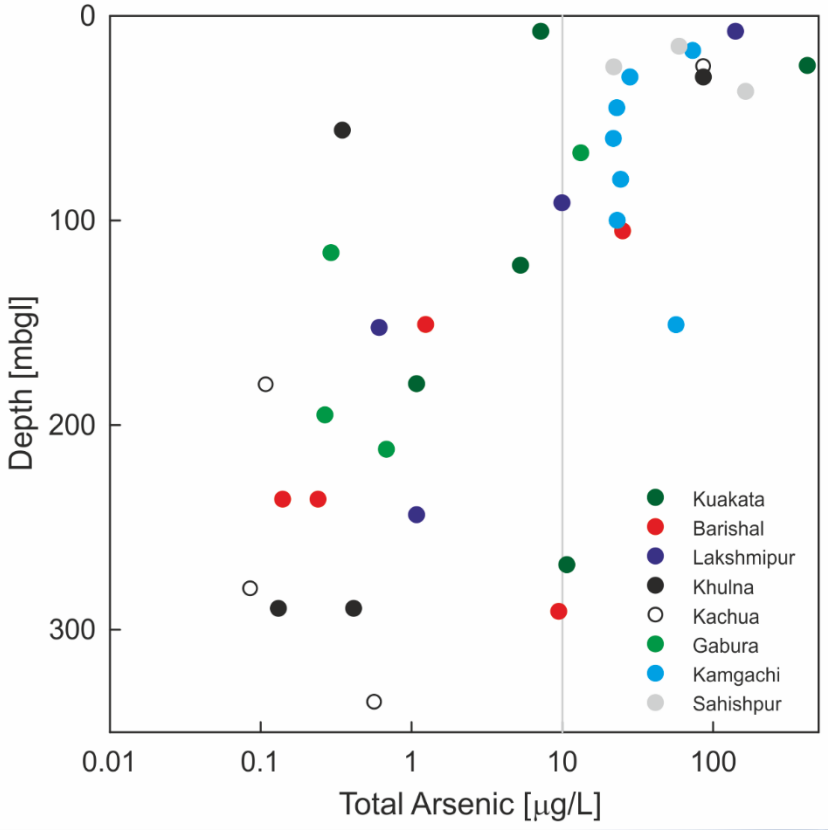


14C Results from BAS – corrected ages derived using 13C data

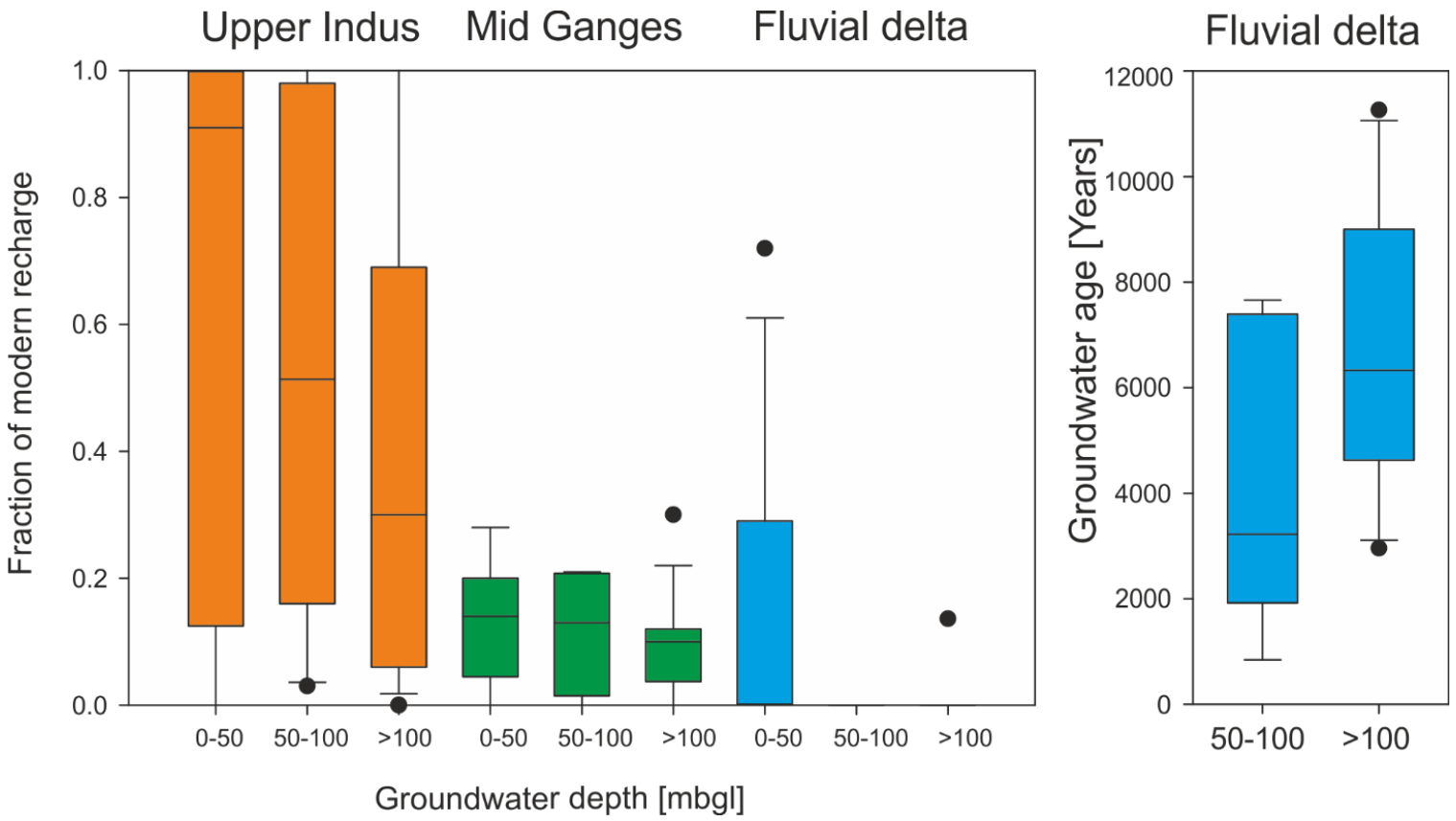


Water quality considerations in the BAS





Change in fraction of modern recharge distributions across the IGB



Initial findings

- New evidence from modern recharge tracers show active recharge across the IGB
- Even in semi-arid regions a significant proportion is from meteoric sources
- We see clear changes in the tracer depth profiles across the IGB - in these regions where that has been long term heavy pumping at depth this appears to be largely controlled by aquifer anisotropy
- Deep groundwater sources in the Upper Indus and mid Ganges are more susceptible to vertical migration of contaminants
- New evidence from the deep BAS suggests that there is limited potential for vertical migration of groundwater and associated contaminants from the shallow BAS