Geological Sequestration of CO_2 in Saline Aquifers- An Indian Perspective

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Contents

Since fossil fuels particularly coal would inevitably be the mainstay for energy generation in India, carbon dioxide emissions are likely to increase exponentially. To contain and ultimately reduce the carbon dioxide emissions there are three technology driven options.

- Energy conservation and efficiency
- Substitute lower carbon or carbon free energy sources (renewable, nuclear, hydropower and low carbon fuels)
- Capture, reuse and geological storage of carbon

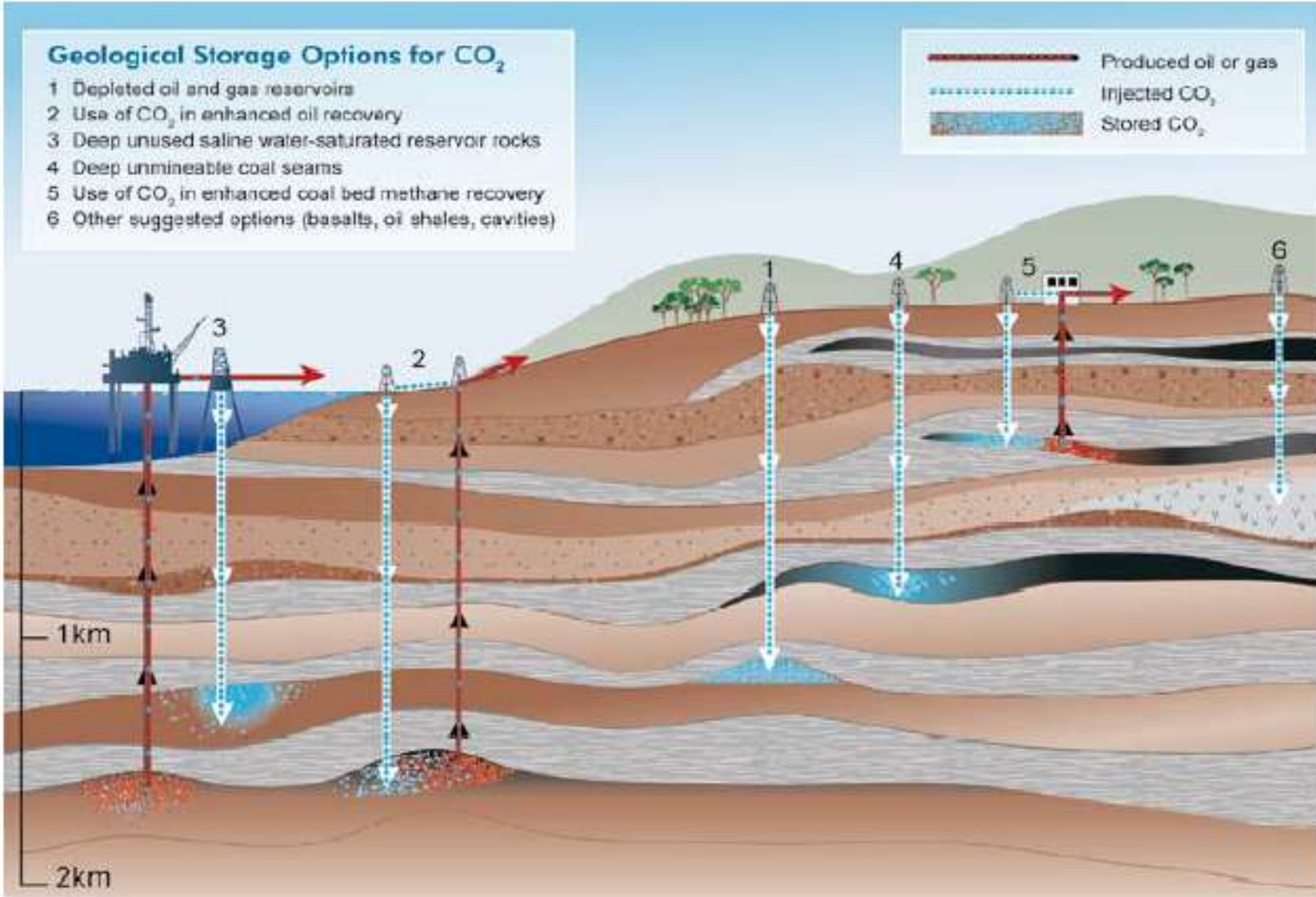


Figure 1: Options for storing CO2 in deep underground geological formations

Why Saline Aquifers?

- The estimated storage capacity of the saline formations is large enough to make them viable for any long term solution.
- Saline formations underlie many parts of the world and in the proximity of the stationary polluting sources thereby reducing the cost of infrastructure.
- It can help in achieving near zero emissions for the existing power plants and industrial units.

- The fact that carbon dioxide has been naturally stored for geological time scales enhances the creditability of the storage options.
- Huge thickness of impervious (clay/ sandstone) cap rock ensures that residence times are long and accounting for volume sequestered is straight forward.
- Scenarios for negative impacts and unintended damages are limited.
- Usually due to their high saline proportions and depth, they cannot be technically and economically exploited for surface uses.

Table 1: Storage capacity for geological storage options.

Geological Storage Option	Global Capacity	
	Reservoir type Lower estimate of storage capacity (Gt CO_2)	Upper estimate of storage capacity (Gt CO_2)
Depleted oil and gas fields	675	900
Unminable coal seams	3-15	200
Deep saline reservoirs	1000	Uncertain, but possibly 10^4

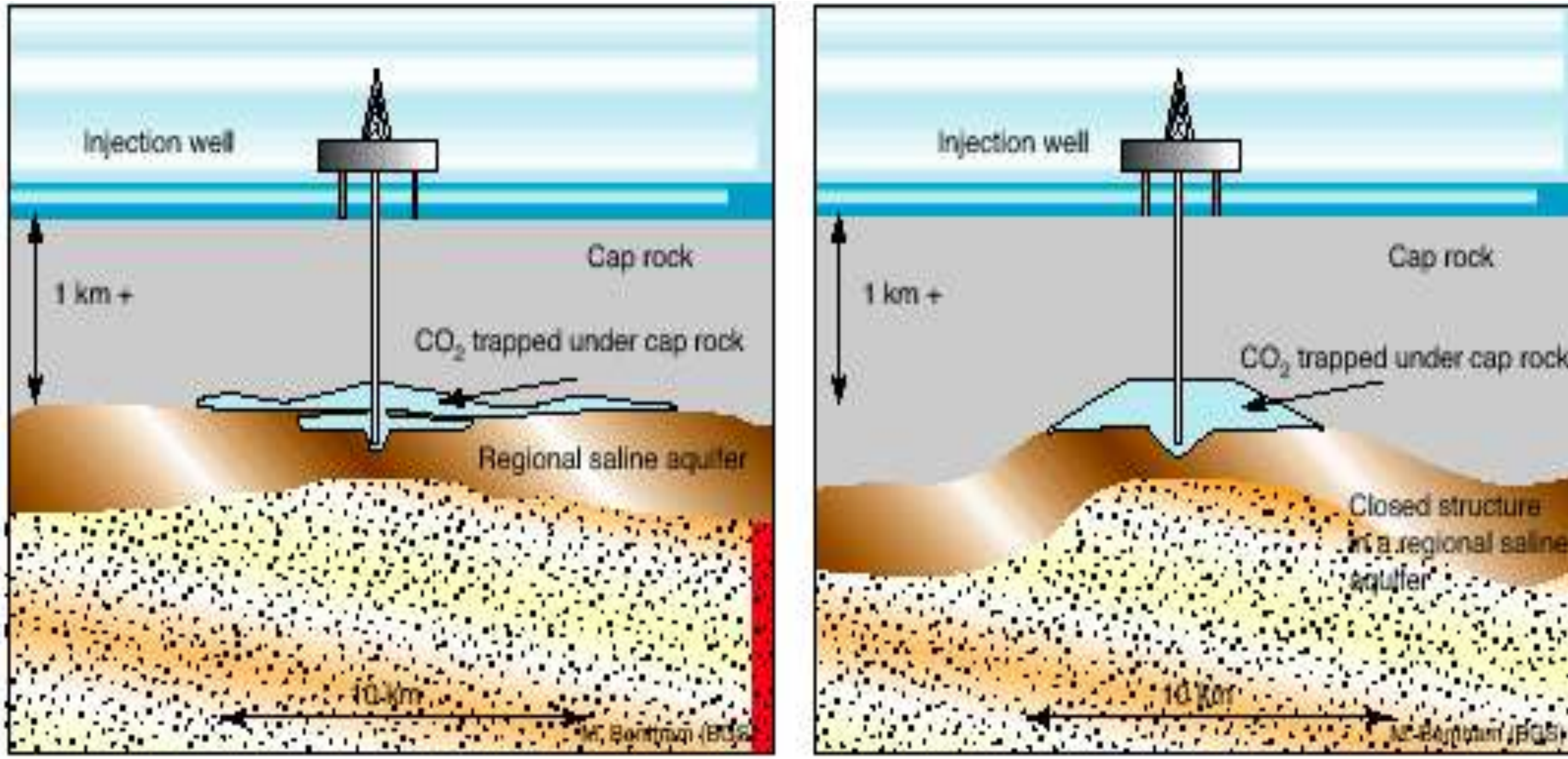


Figure 2: Conceptual diagram of storage in confined and unconfined aquifers

Specific Risk for Storage in Saline Aquifers

- Reservoir Properties and Modeling
- Cap rock Integrity
- Aquifer Flow Modeling
- Solubility in groundwater
- Reaction with host rock
- Groundwater Pollution

Screening Criteria for Storage in Saline Aquifers

In general storage sites should have;

(i) adequate capacity and injectivity;

(ii) a satisfactory sealing cap rock and confirming unit

(iii) a stable geological environment and;

(iv) Realistic and quantitative information of the characteristics of the subsurface is needed to assess the feasibility of sites.

- Assuming that basement rocks would not have sufficient injectivity, thickness of sedimentary cover provides initial index for prospecting suitable formations. Younger sedimentary basins are more suitable as high porosity tends to be preserved at shallow depths. In older basins, porosity is lost due to cementation and compactness because of depth of burial.

Table 2: Ongoing Projects

Project	Country	Scale of Project	Total storage	Storage type	Age of formation	Lithology
Sleipner	Norway	Commercial	20 Mt planned	Saline Aquifer	Tertiary	Sandstone
Minami-Nagoaka	Japan	Demo	10,000 t planned	Saline Aquifer (Sth.Nagoaka Gas Field)	Pleistocene	Sandstone
Frio	USA	Pilot	1600 t	Saline formations	Tertiary	Brine bearing sandstone-shale
Snohvit	Norway	Decided Commercial		Saline formations	Lower Jurassic	Sandstone
Gorgon	Australia	Planned Commercial		Saline formations	Late Jurassic	Massive sandstone with shale seal
Ketzin	Germany	Demo.	60kt	Saline formations	Triassic	Sandstone
Otway	Australia	Pilot	0.1 Mt	Saline fm and depleted gas field	Cretaceous	Sandstone
Teapot Dome	USA	Proposed Demo	10kt	Saline fm and CO_2-EOR	Permian	Sandstone

Distribution of sedimentary basins

World Scenario

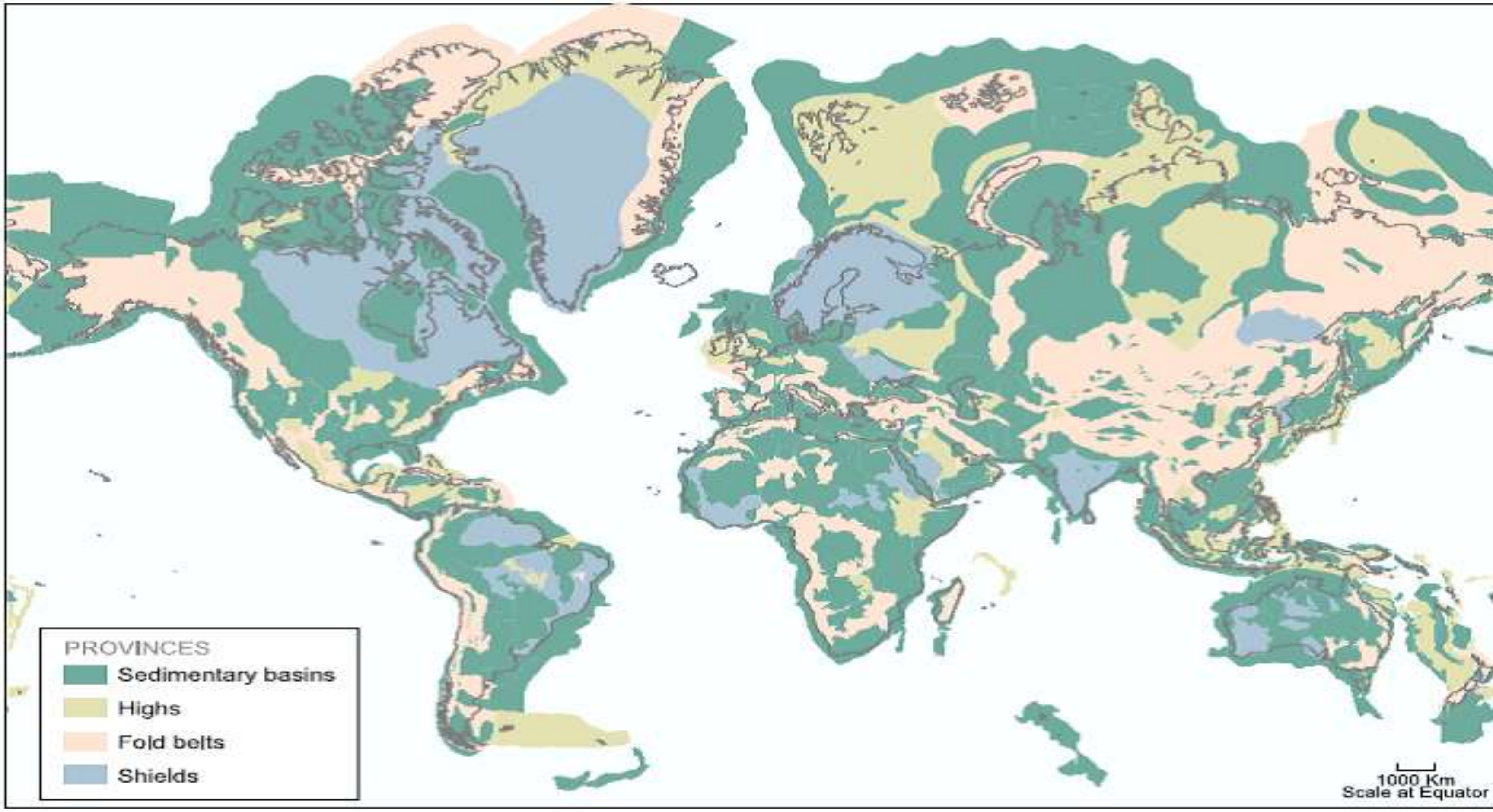


Figure 3: Distribution of sedimentary basins around the world (after Bradshaw and Dance, 2005; and USGS, 2001a)

Indian Scenario

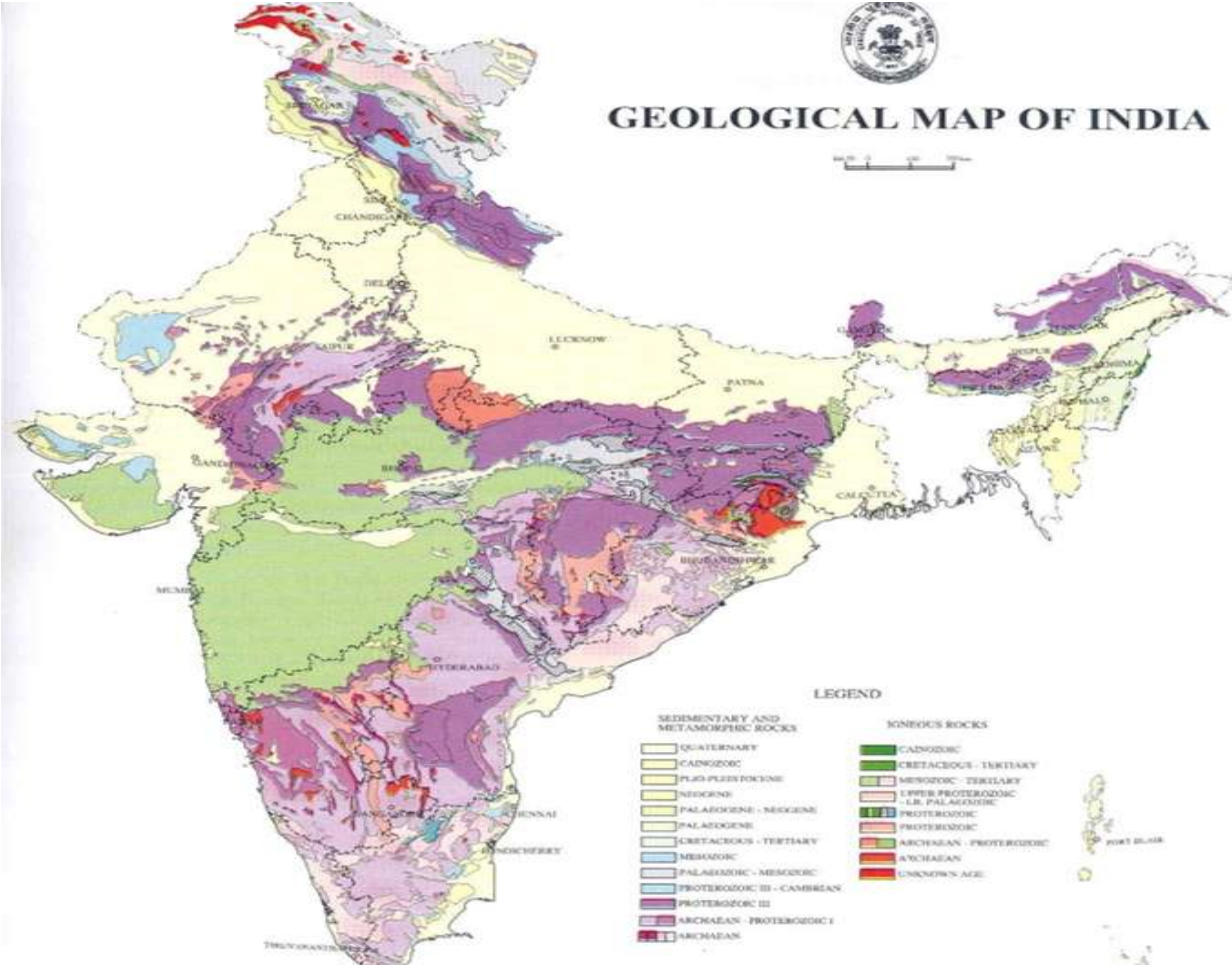
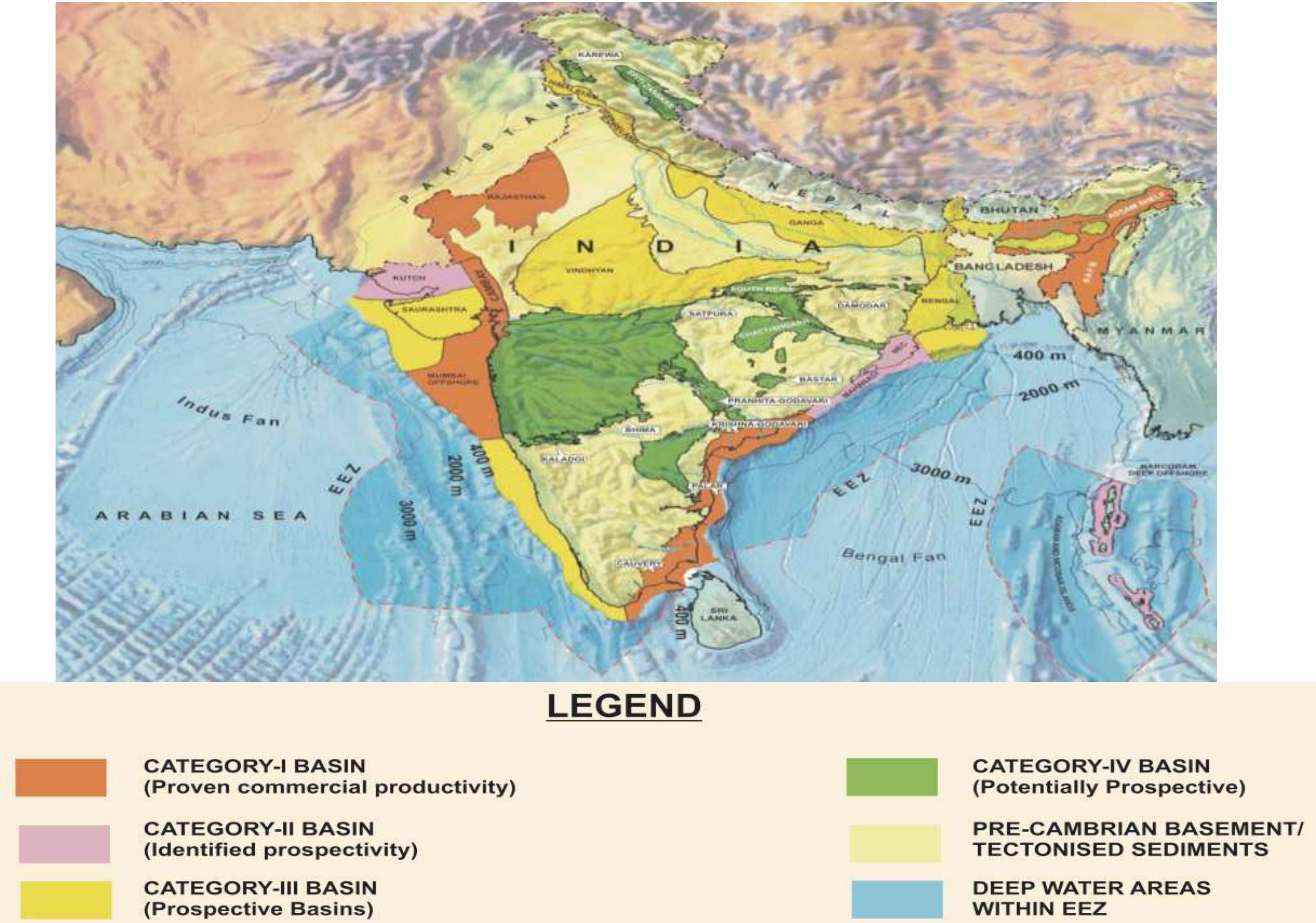


Figure 5: Sedimentary basins map for oil and gas recovery in India . *Source: DGH (2006)*



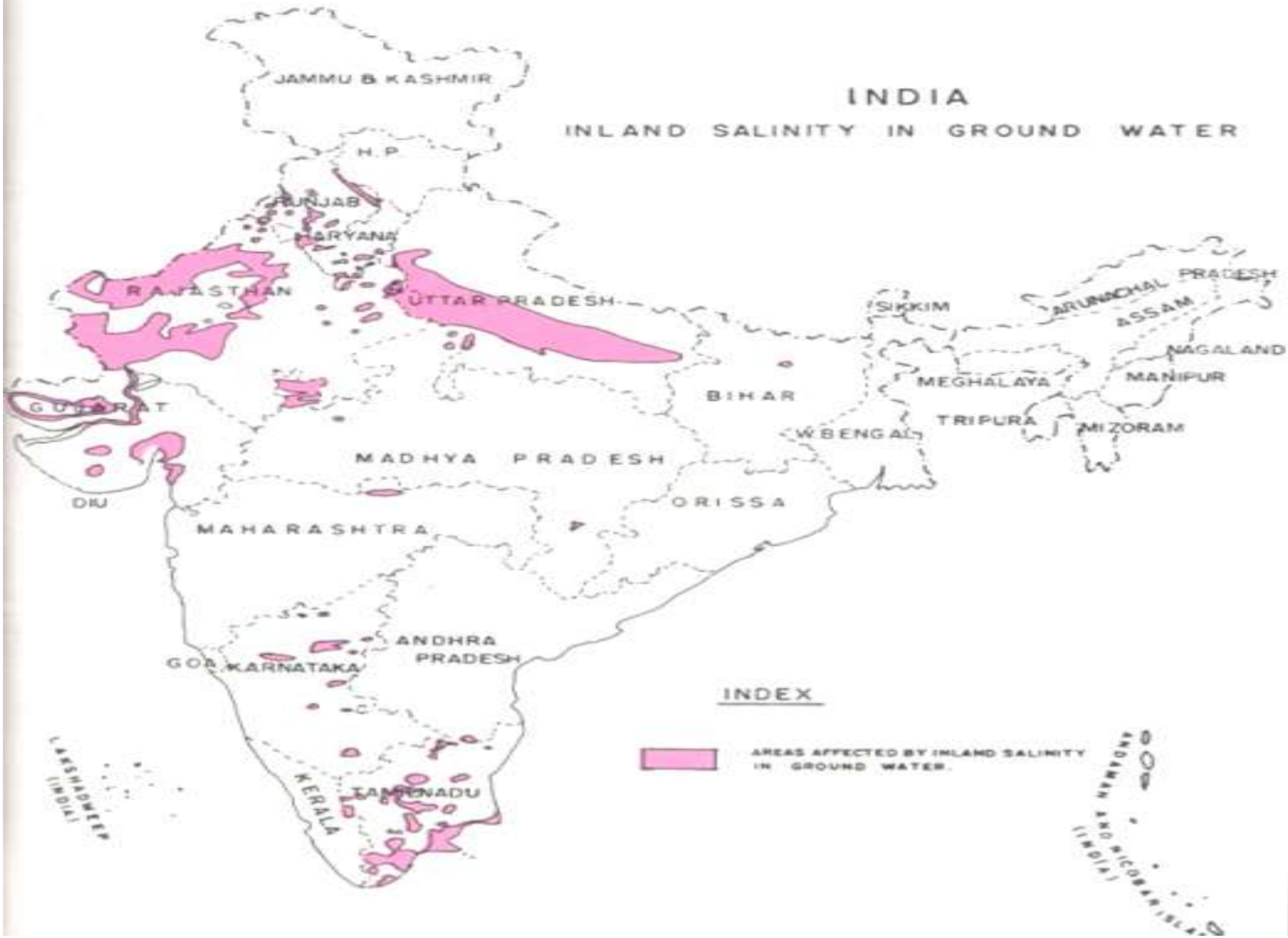
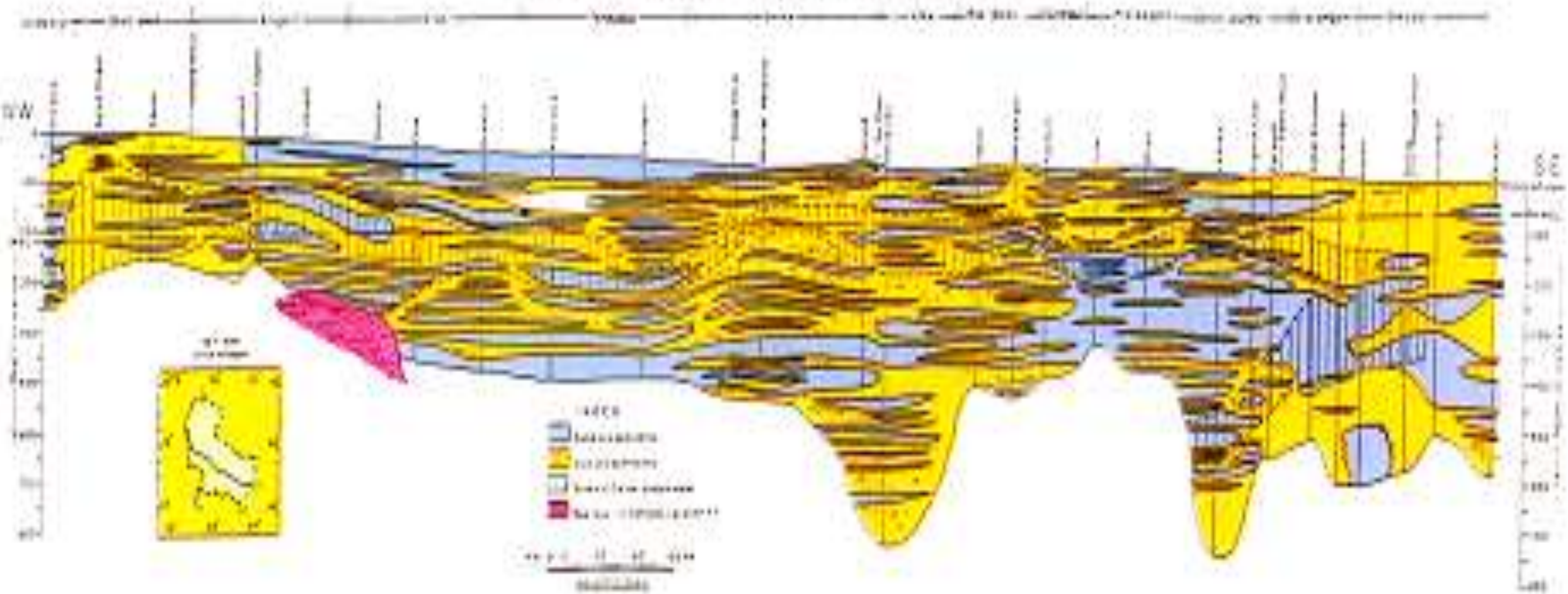


Figure 6: Distribution of Saline Aquifers

BRACKISH/SALINE GROUNDWATER ZONE ALONG THE LONGITUDINAL SECTION BETWEEN KHEKHRA (MEERUT) AND BENIPUR (GHAZIPUR) U.P.

(BASED ON GEOPHYSICAL LOGS AND LIMITED CHEMICAL ANALYSIS)



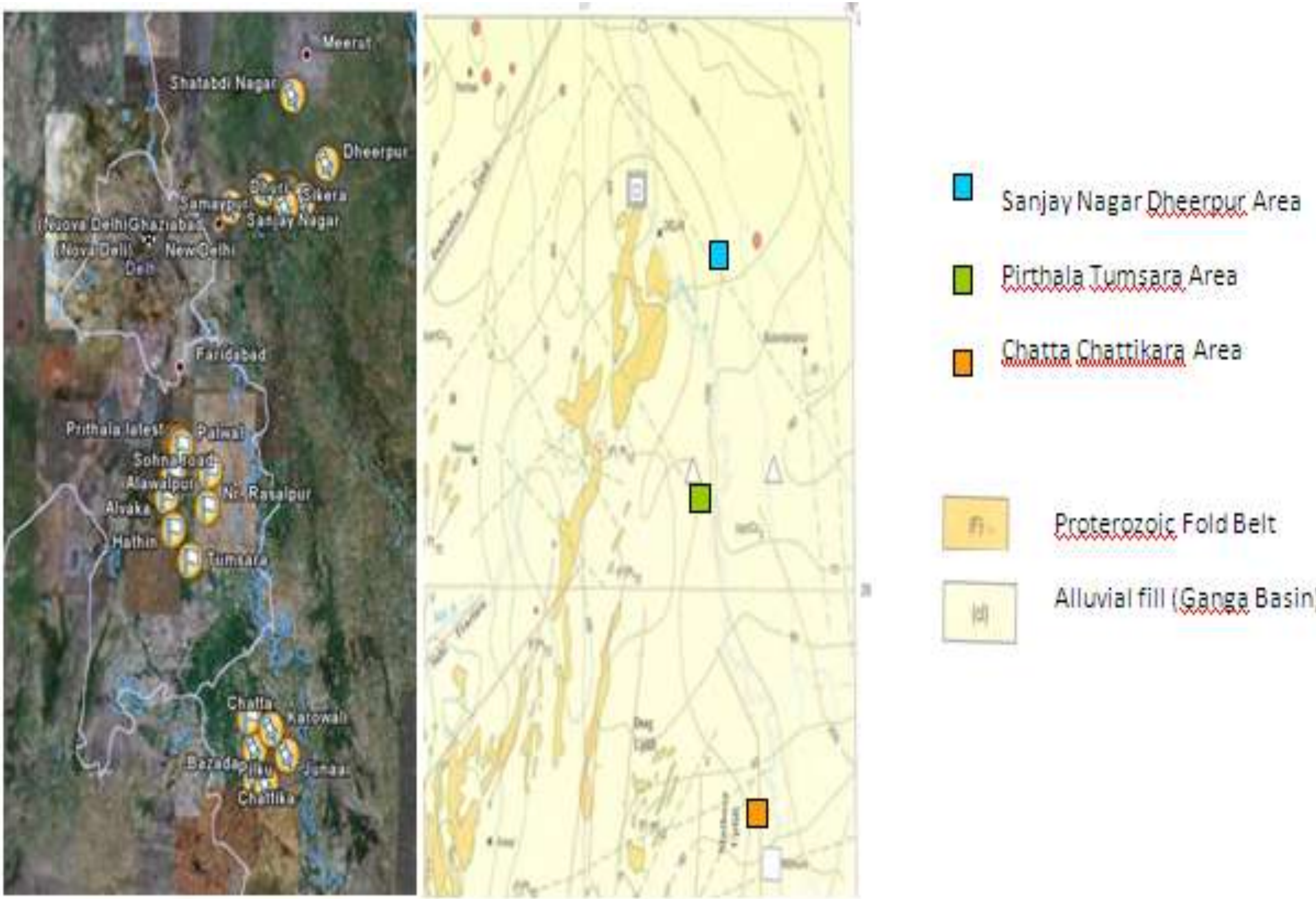
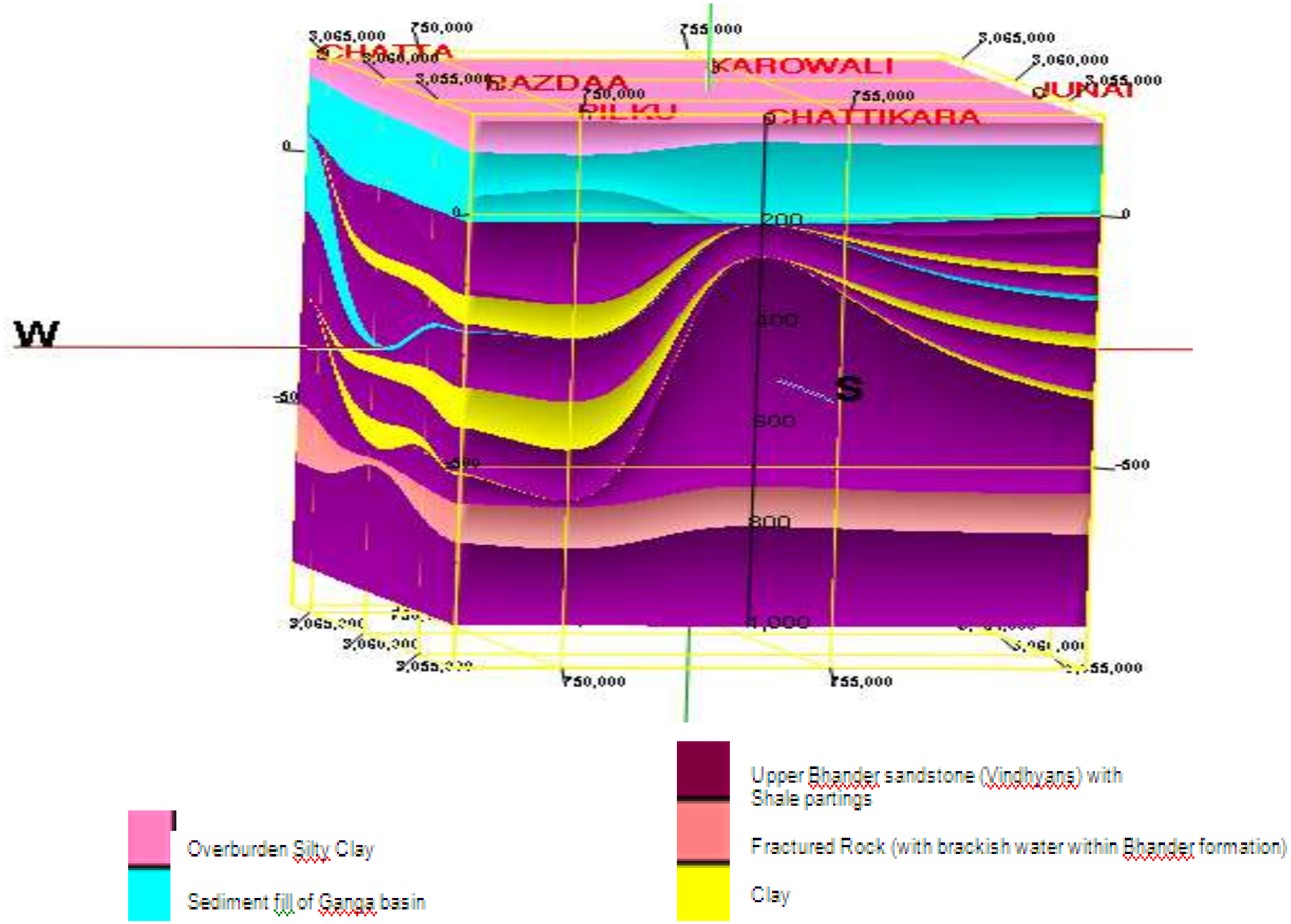


Figure 8: Location map of the study area and regional geological setup

Figure 9: Three Dimensional model of Chatta-Chattikara area showing disposition of different lithological layers.



Conclusions

- Geological storage of Carbon dioxide for reducing its emissions for mitigation of global warming is a new research area.
- There are gaps in our knowledge as to the regional storage capacity and potential of different sedimentary basins and the deep saline aquifers occurring within them.
- Extensive further research is needed both regionally and globally to study their true potential.

- Despite the fact that there are some areas where additional work is clearly needed to improve technologies and decrease uncertainties, there appear to be no insurmountable technical barriers for geological storage of CO_2 as an effective mitigation option.

THANK YOU