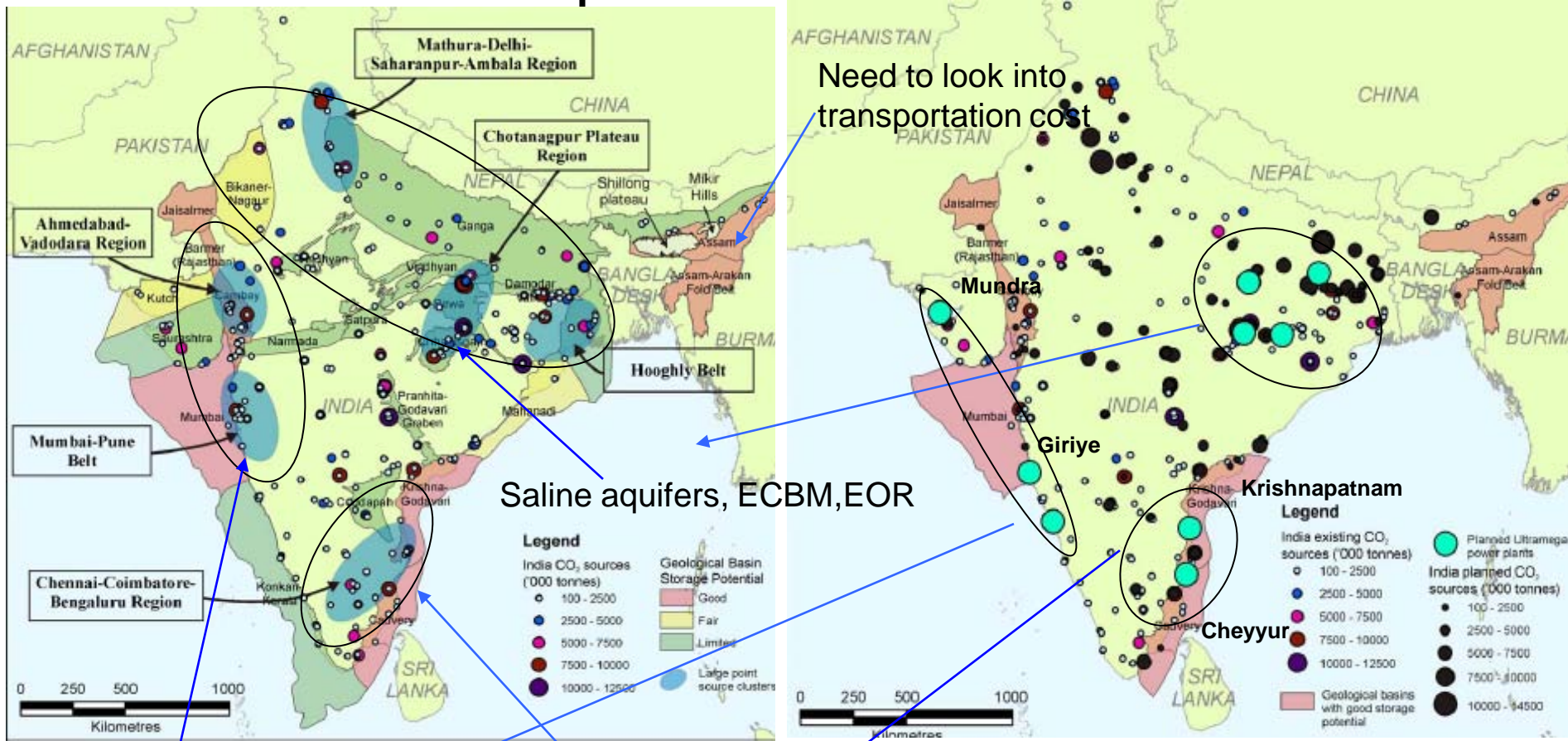


# **International Conference on Greenhouse Gas Control Technologies (GHGT-10)**

## **Research Overview**

Mr. Amit Kumar Verma  
Research Associate  
Center For Research on Energy Security  
The Energy and Resources Institute (TERI)  
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New Delhi 110 003

# India's Storage Capacity and existing or planned LSP's



Need to look into transportation cost

Saline aquifers, ECBM, EOR

Basaltic sequestration, EOR, Saline aquifers

EOR, Saline Aquifers

Source: IPCC 2007

# Research and Review of Preliminary Results for CCS Global Components, India

- **Objective:**

1. General Framework for CCS
2. CO2 sources analysis
3. Assessment of CO2 sinks
4. Source-Sink-Matching
5. Integrated assessment

- **Sponsor:**

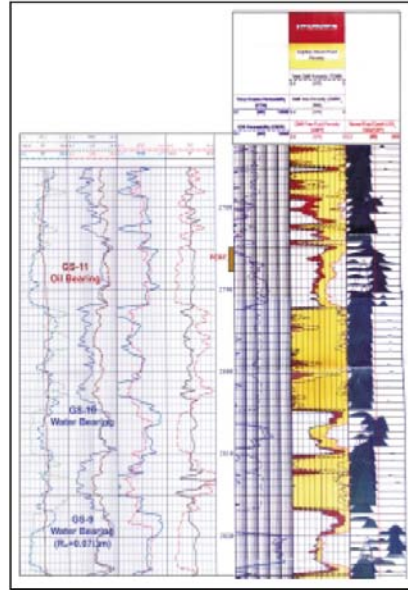
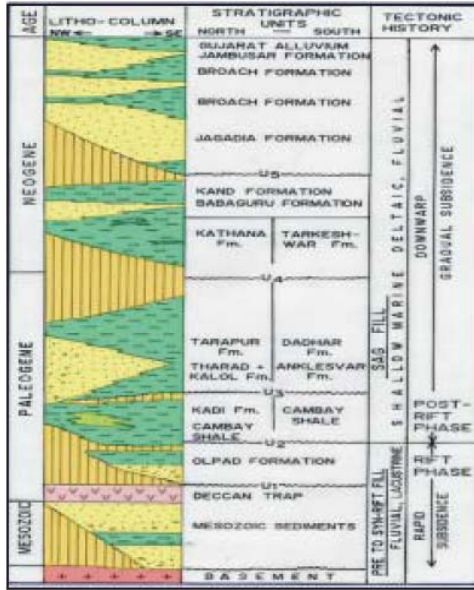
Deutsche Gesellschaft Fur Technische Zusammenarbeit (GTZ) GmbH

- **Output:**

Phase1- White paper for “Position of Carbon Capture and Sequestration (CCS) key stakeholders in India”

<b>Stakeholders</b>	
Public Authorities	Ministry of Finance Department of Science and Technology Ministry of Forest and Environment, Ministry of Power Ministry of Petroleum & Natural Gas
Industry	ONGC, NTPC, BHEL, GAIL
Societal Players	IRADe, WWF-India, Grrenpeace, TERI
Research Institutions	Institute of Reservoir Studies; Ahmedabad, NGRI, Hyderabad; Geological Survey of India
Financial Institutions	ICICI, IFCI, IDBI, ADB, World Bank

# CO2-EOR for Cambay Basin in India



Well log for GS-11 low resistivity pay which produced oil @35m³/d and associated gas @6000m³/d

Number of Model Layers	5
Dykstra Parson's Coefficient	0.8236
permeability	10-250md
Reservoir Temperature	262.4 F
Average Reservoir Pressure	4281.2263 psia
Minimum Miscibility Pressure	380.58 psia
Oil Formation Volume Factor	1.8 RB/STB
Solution Gas-Oil Ratio	760 scf/stb
Oil Gravity	42 degrees API
Gas Specific Gravity	0.79 (air = 1)
Water Viscosity	0.8 cp
Water Salinity	100,000 ppm
Area	40 acres
Net Pay Thickness	10 feet
Porosity	0.22 (fraction)
OOIP	0.2
Injection rate	8051 bbl/day of water until 2.0 pore volumes have been injected (co2 injection = 90,000m3/day)

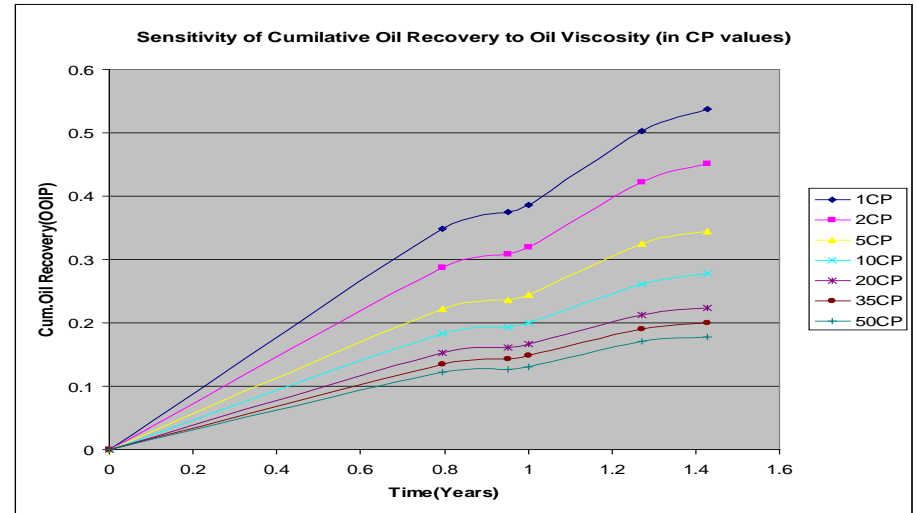
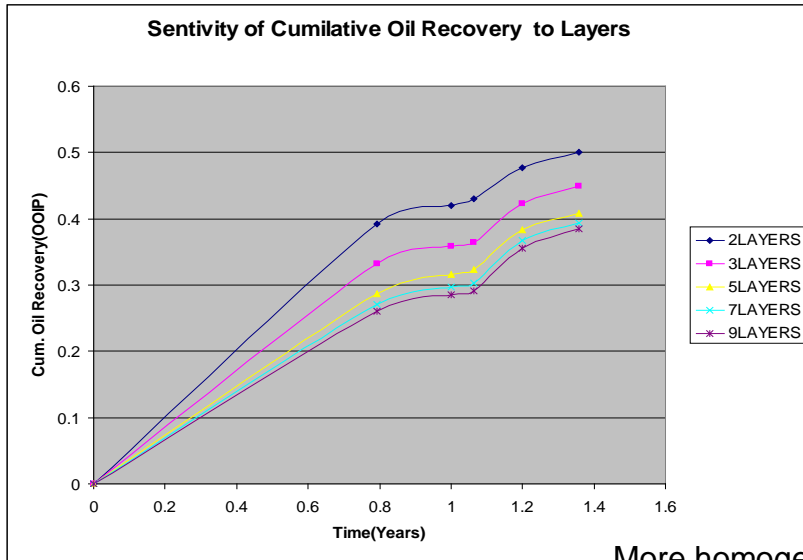
MMP is determined by [Alston et al. \(1985\)](#) correlation

$$(CO2MMP)LO=6.05 \times 10^{-6} (1.8 TR+32) 1.06 (MWC5+) 1.78 (Xvol/Xint) 0.136$$

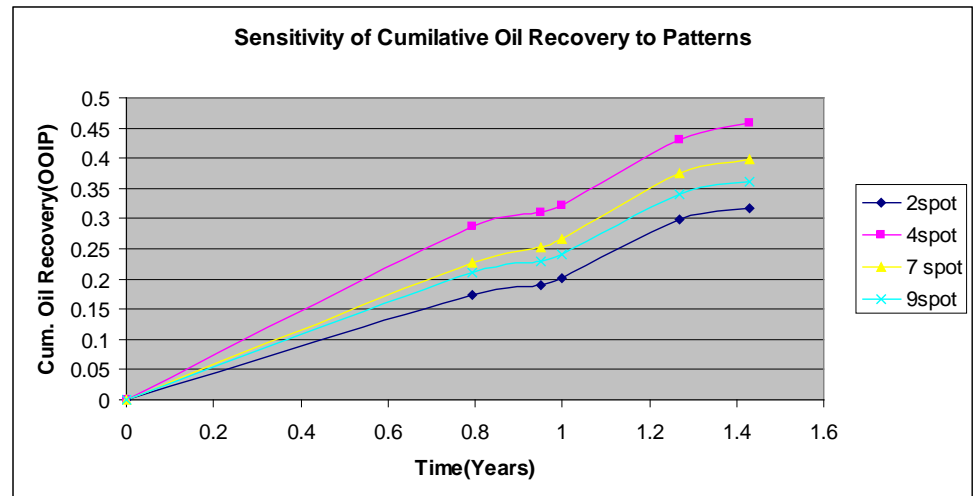
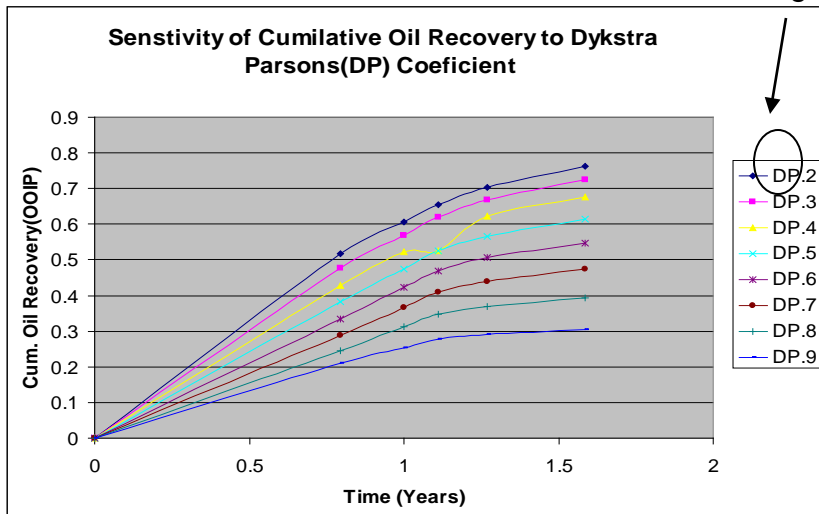
where  
 (CO2 MMP)LO=CO2 minimum miscibility pressure for live oil (MPa),  
 TR=reservoir temperature (°C),  
 MWC5+=molecular weight of the C5+ fraction (g/g mol)  
 Xvol=volatile oil fraction consisting of C1 and N2 (mol%)  
 Xint=intermediate oil fraction consisting of C2, C3, C4, CO2, and H2S (mol%).

At 128 C, MMP = 2.624 Mpa = 380.58 psia

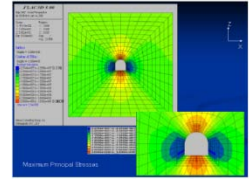
# Results



More homogeneous reservoir

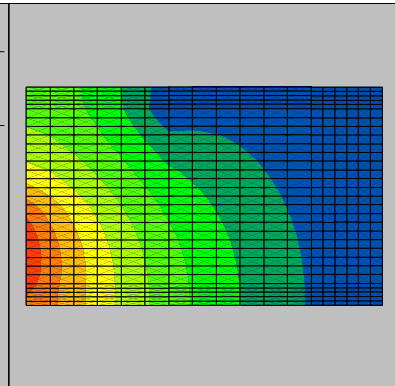
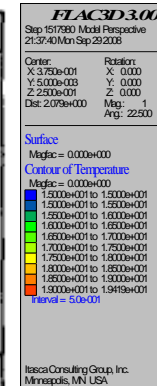
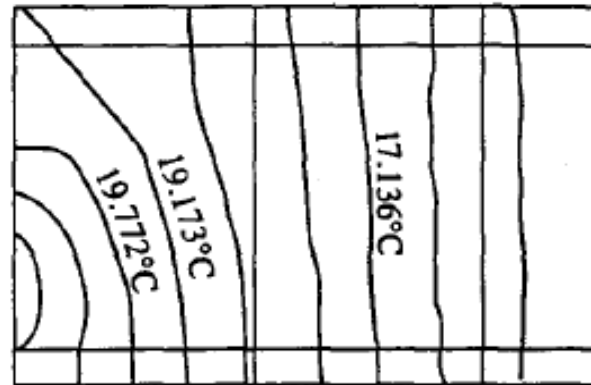
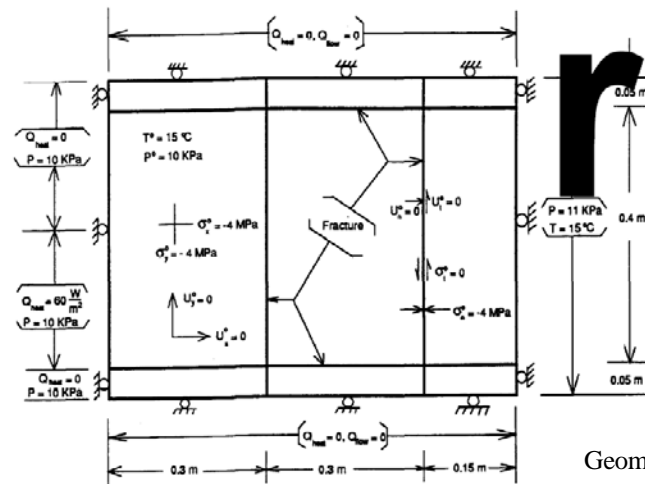
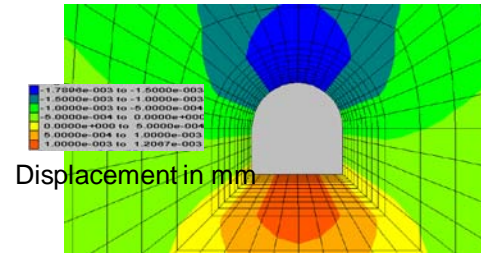


# Highlights of modeling work related to Underground Research Laboratory

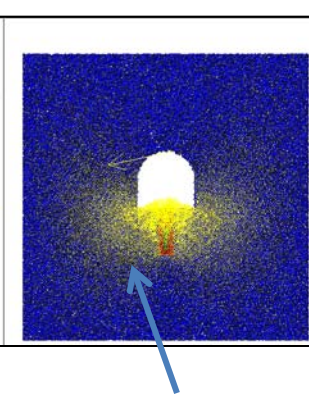
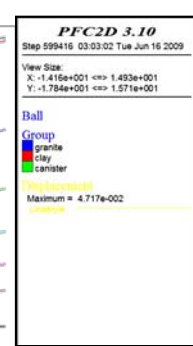
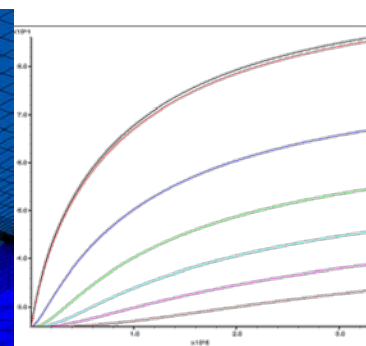
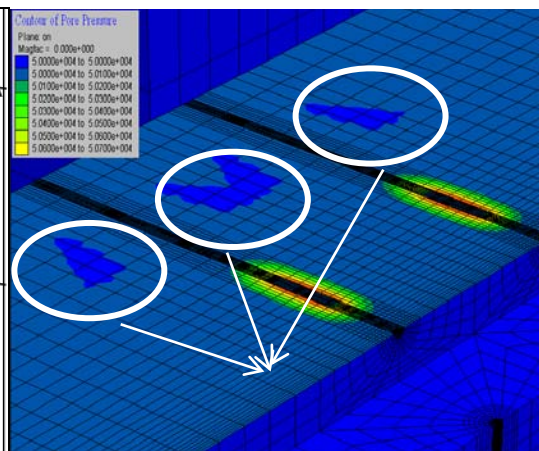
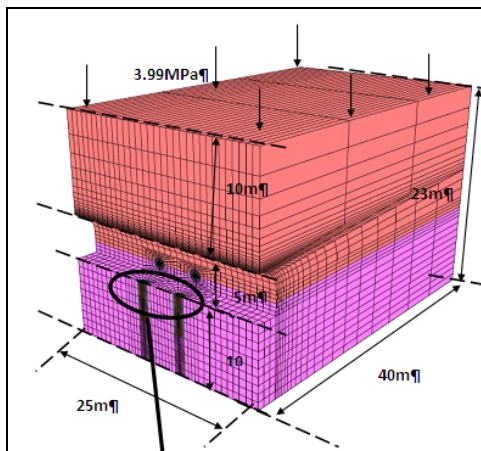


Prof. T.N. Singh - Principal Investigator  
Mr. Amit Verma - Research Fellow  
Dr. R.K. Bajpai - P.C., BARC

1. Rockmass is competent enough at 450m depth without much support
2. Damage zone is minimum in case of Horse shoe shaped tunnel
3. Displacements are well within safe limits (0.5-1.7mm)
4. Stresses do not exceed >25MPa at any point in tunnel
5. Results to be used in design and excavation of URL tunnel/chamber
6. Circular shaped tunnel has the least convergence while square shaped tunnel has the largest convergence



Geometry and boundary conditions for the multiple fracture model, bench mark test 2 (BMT2), DECOVALEX Phase I.



FLAC3D = Maximum displacement is 3.5mm after 1e6 sec  
PFC2D = Maximum displacement is 4.717cm after 0.35e6 sec