

Demonstration of capture, injection and geological Sequestration (storage) in Flood Basalt Formation of India.

National Thermal Power Corporation Ltd.

India

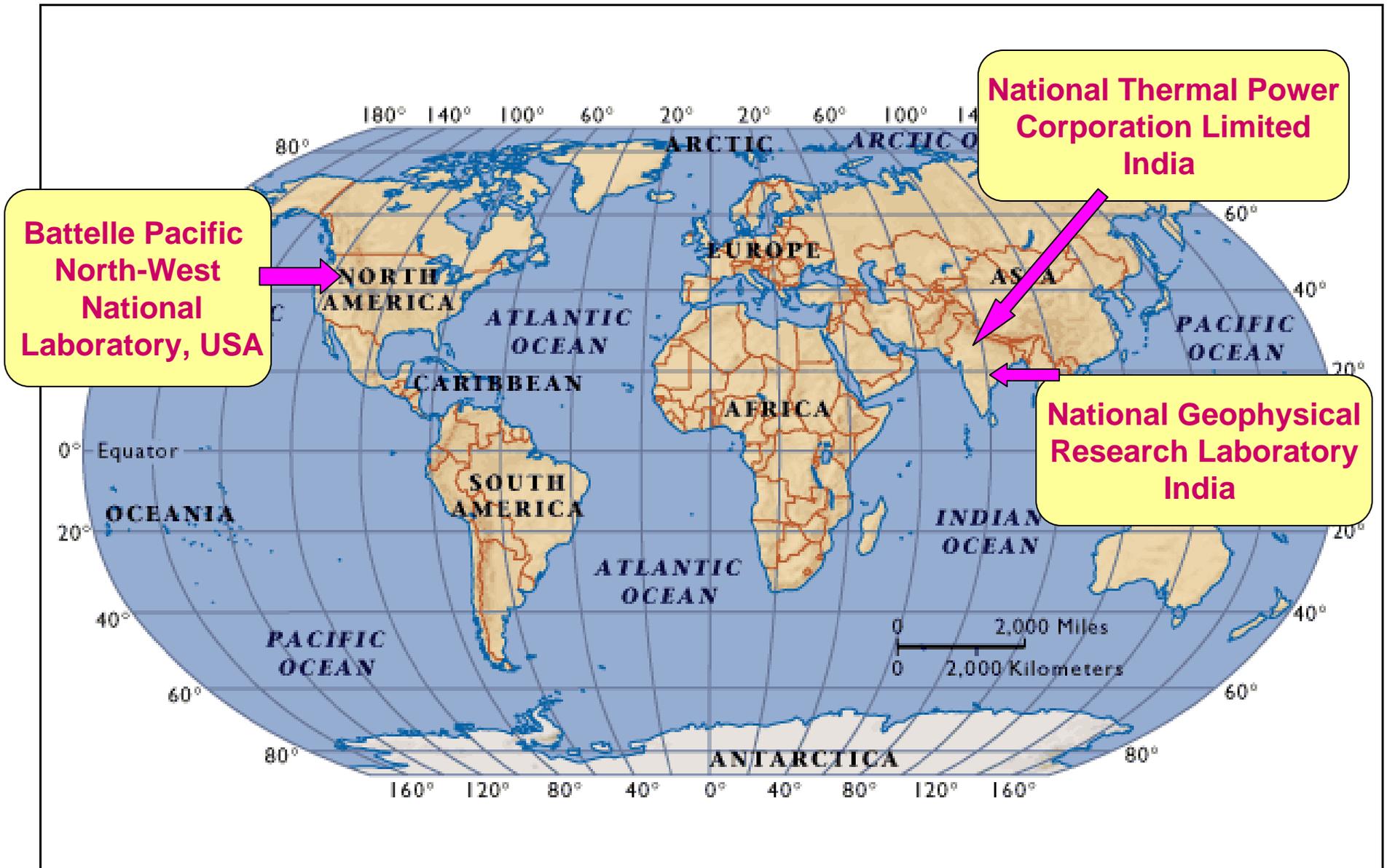
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Objectives & Significance

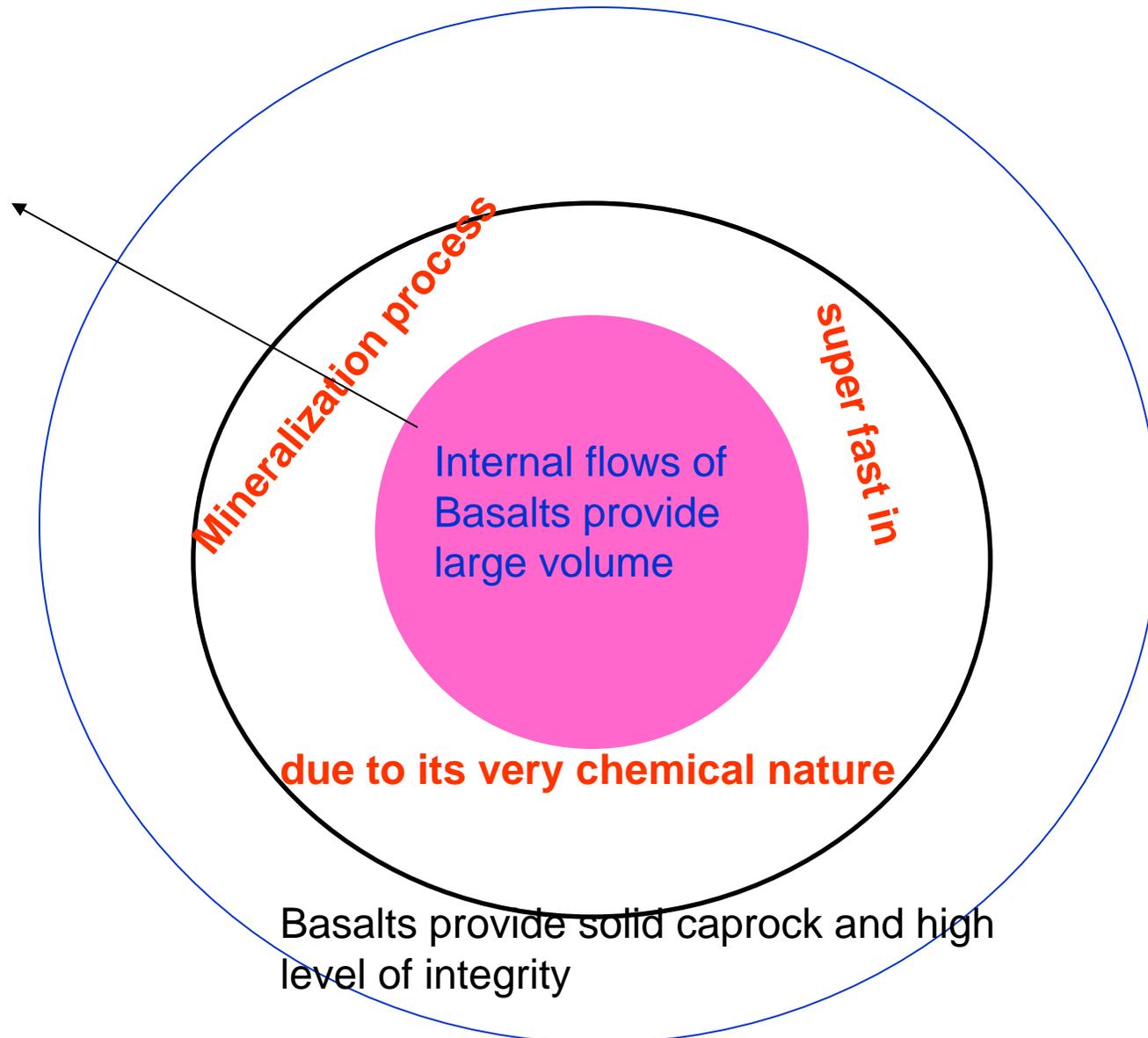
- **Evaluation of Basalt Formation in India (Deccan Trap) for environmentally safe and irreversible long time storage of CO₂**
- **The Indian study will establish globally basalt formation as potential storage for CO₂ by leveraging study carried out in Columbia River basalt group under US-DOE.**



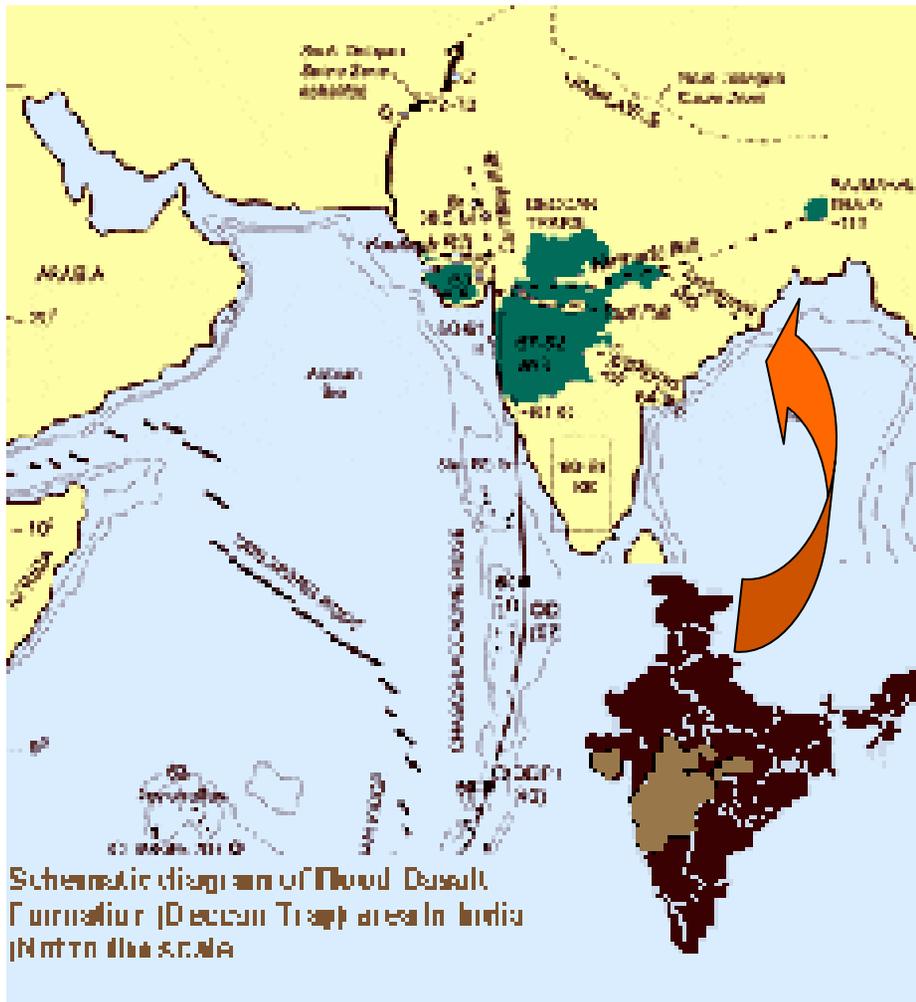
Why Basalts are attractive proposition ?

Interflow zone vesicular, brecciated, basal pillow complex & basal breccia zones

Interflow provides major permeability & porosity



1. Indian Deccan Volcanic Province (DVP) is one of the largest terrestrial flood basalt formations covering nearly 500,000 sq. KM
2. DVP is comprised of 13-20 flows consisting of massive vesicular, amygdaloidal basalt tuffs providing a volume in excess of 550,000 KM³ – three times CRBG, US
3. It can provide almost 300 GT of storage potential (Resource wise)



The Deccan Volcanic Province (DVP) located north-west of India

- Total Basalt Formation area : 500000 sq km
- Composed of typically 14 different flows
- More than 2000 m depth in western side & few meter in eastern side
- Generally seismically stable
- Approx. 300 Gt CO₂ can be stored
- Equivalent to 250 years of CO₂ at present level of power generation in India

CO₂ is injected in sedimentary rocks above its super critical temperature and pressure

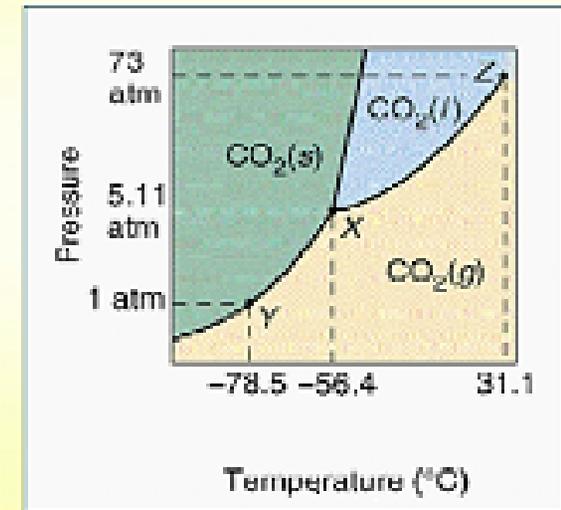
Minimum depth
800 m

Hydrodynamic Trapping

Solubility Trapping

Mineralization

Phase Diagram for CO₂



CO₂ sequestered in
Internal Flow Zone between
two basalt layers

Structure of flows depend on
Pysico-chemical phenomenon

Lava/magma
cooling

Degassing/bubble
formation

Thermal
contraction

Formation of void space

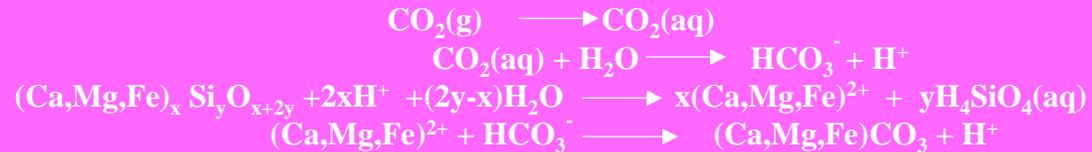
Physical Trapping

Interaction with
Water and ppt. formation

Mineralisation

Chemical Trapping

Mineralization reactions in basalt formations



Induction Time for Calcite Precipitation

Depth, m	T, °C	pH ₀	pH _f	r _d , g m ⁻² d ⁻¹	C _s , M	t _p , d
800	35	3.72	4.97	0.047	0.035	122
900	38	3.70	4.95	0.052	0.034	104
1000	42	3.68	4.92	0.060	0.032	85
1100	48	3.65	4.90	0.073	0.031	67
1200	56	3.63	4.87	0.093	0.029	50
1300	67	3.61	4.85	0.128	0.028	35

Lab. scale study & geo-chemical modeling establish

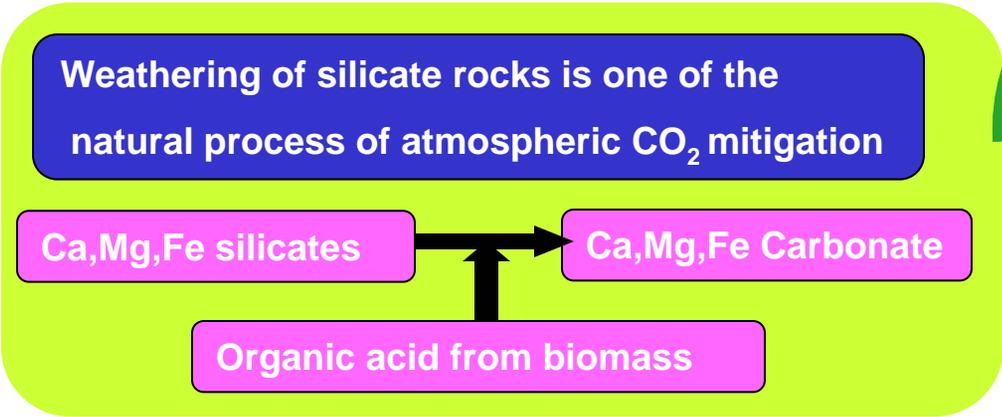
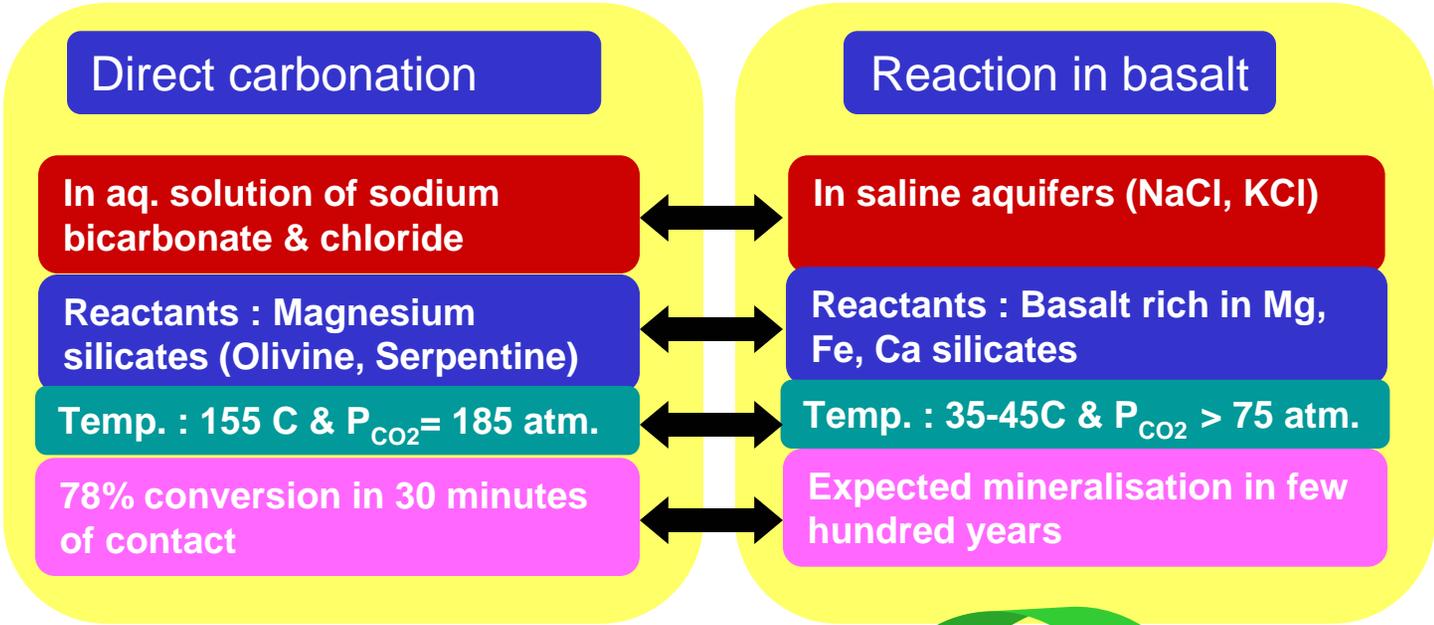
(Source : PPNL)



Calcite deposition on basalt (Source: PPNL)

- Basalt is rich in Ca, Mg & Fe Silicates
- Mineralisation reaction rate is fast on geological time scale
- Mineralisation is appeared to be controlled by mixing behaviour of CO₂ and not by kinetics of the reactions

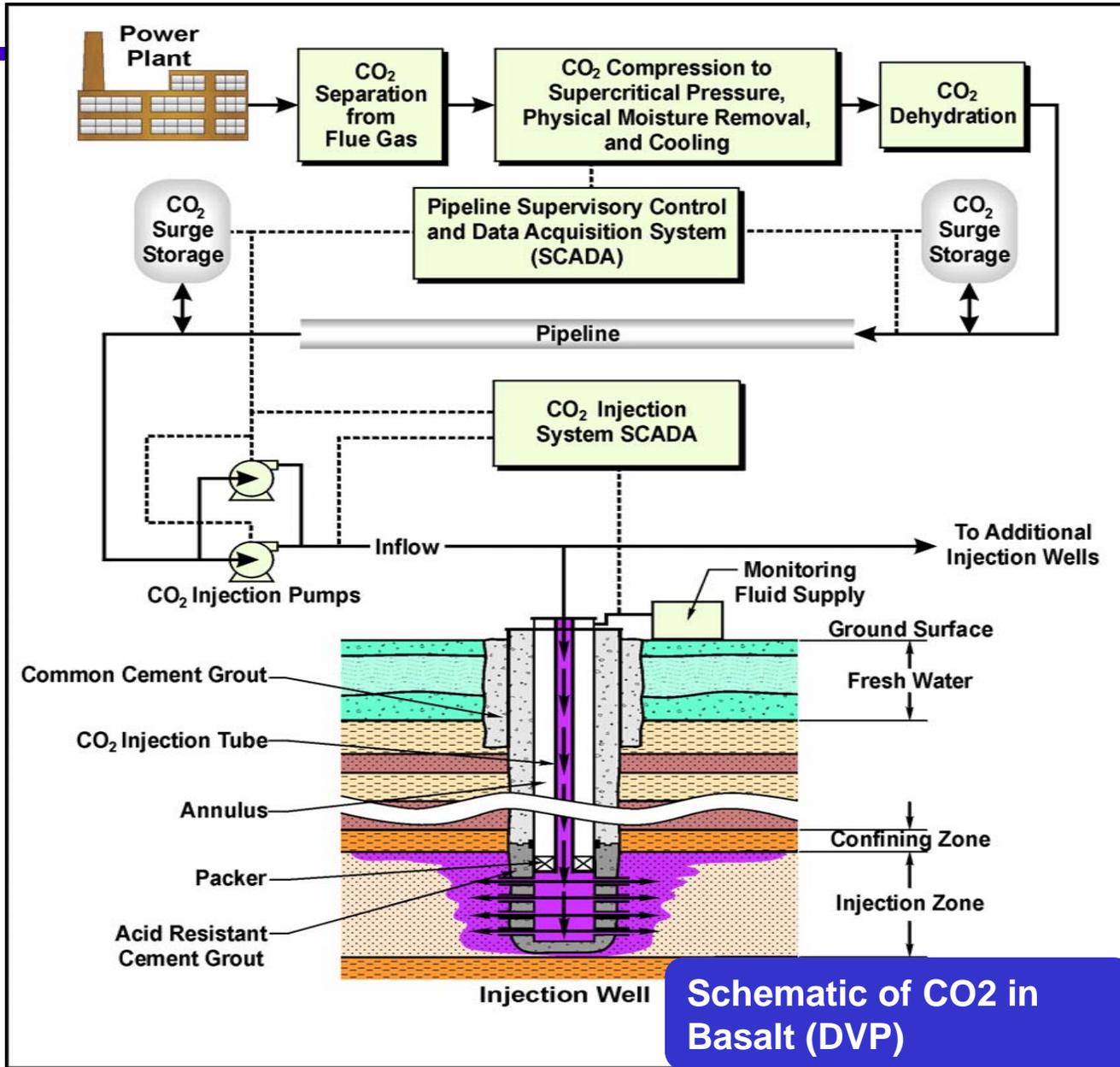
The mineralisation process



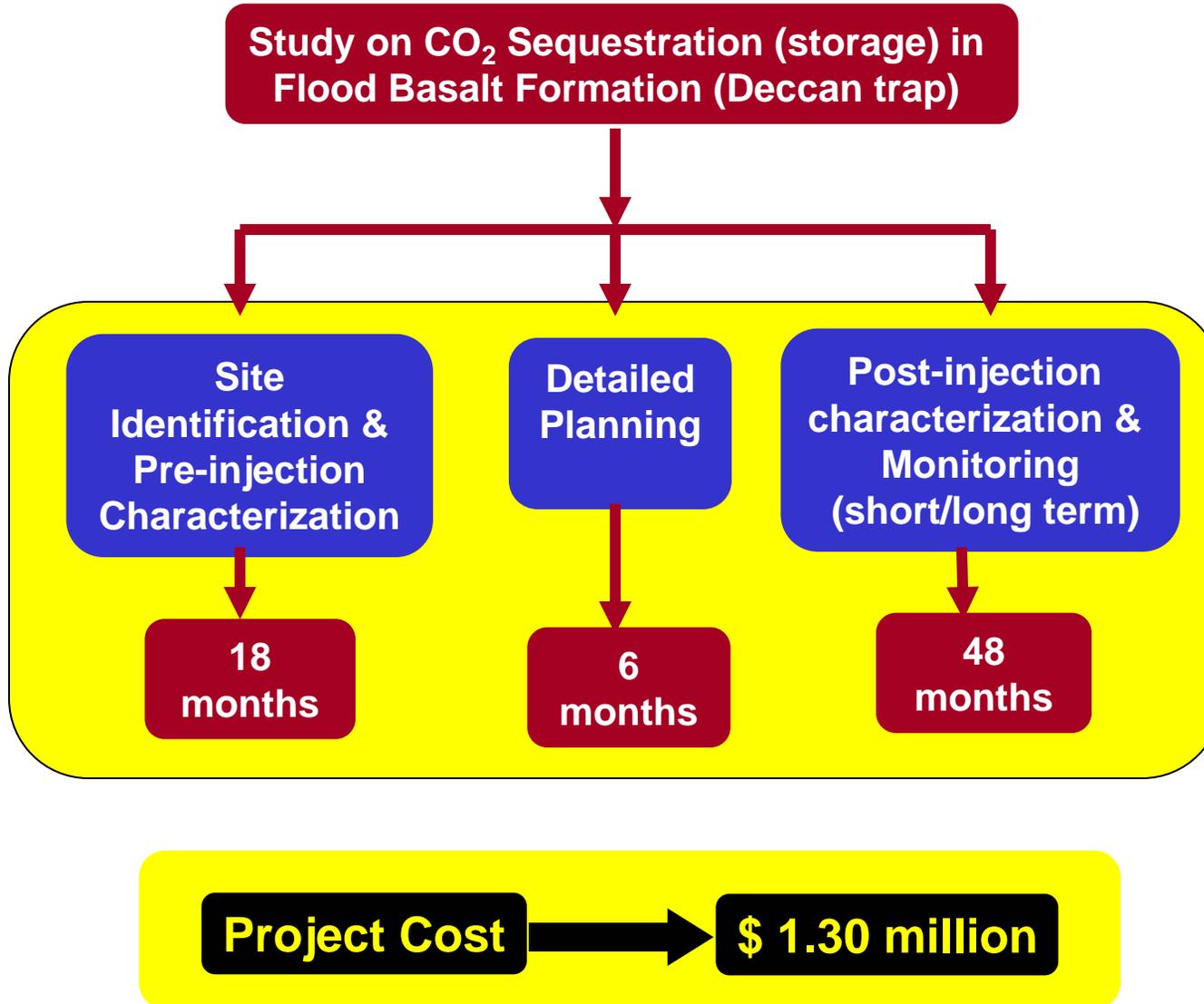
Indian Basalt		Sentinel Bluff Basal - USA (Source : PPNL)
SiO ₂	59.07	54.35
Al ₂ O ₃	15.22	14.27
FeO	6.45	12.39
CaO	6.10	7.43
MgO	3.45	3.13
Na ₂ O	3.71	2.82
K ₂ O	3.11	1.46
P ₂ O ₅	0.30	0.35
TiO ₂	1.03	2.09
MnO	0.11	0.21

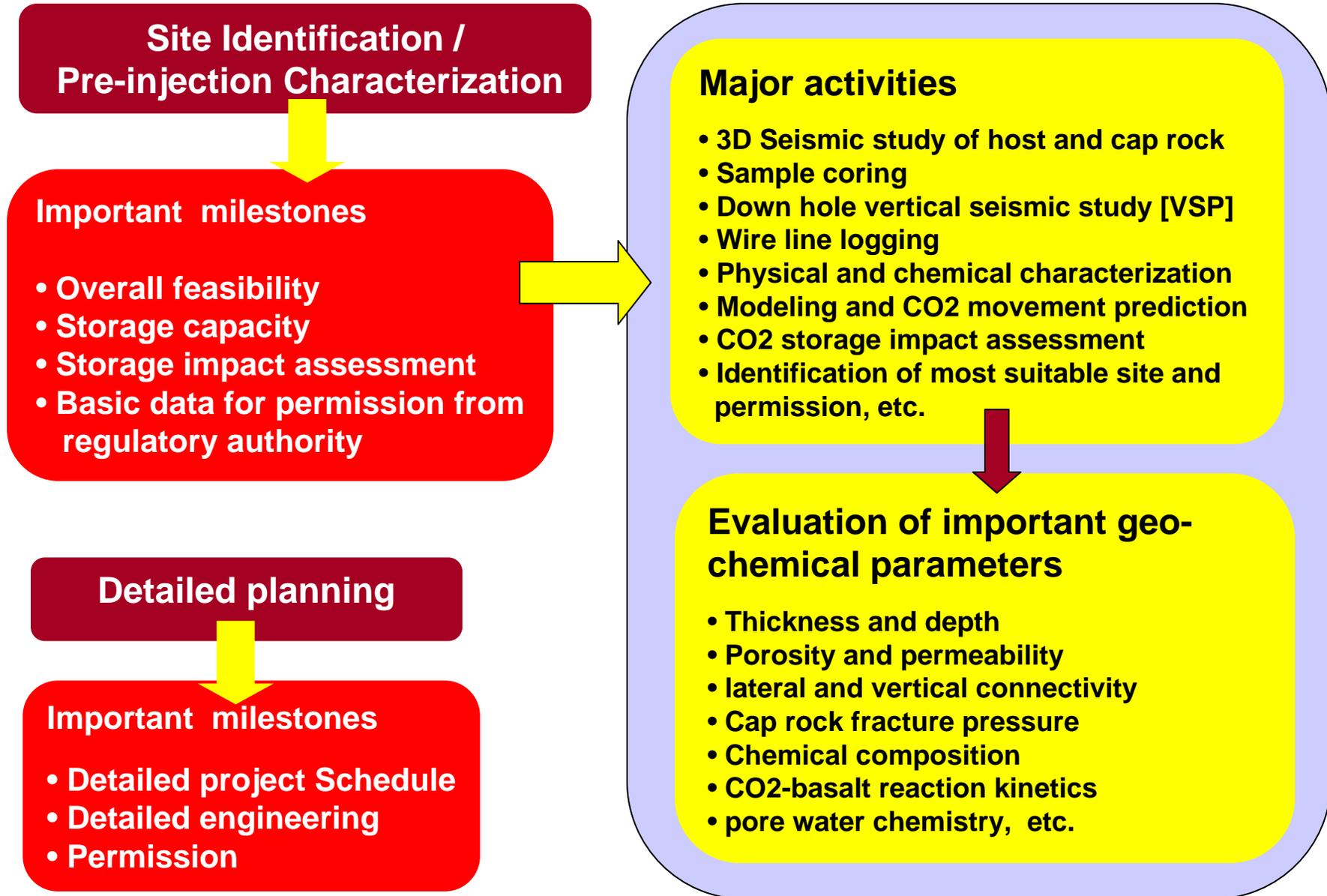
Expected a great potential for CO₂ storage In Indian Deccan trap

Shows promising potential in Laboratory



Schematic of CO₂ in Basalt (DVP)





Injection of CO₂

- Infrastructure mobilization including drilling rig
- Transport of CO₂
- Drilling of injection well, deep and shallow observation well
- Wire line logging (sensors etc.)
- Injection of tracer (suitable tracer SF₆, CH₂F₂ etc.)

Monitoring & Measurement (on line, frequent, periodical)

- CO₂ dispersion
- CO₂ transport, etc.

- Tracer break through & recovery pattern

- Migration of CO₂ in formation
- Residence & reaction time
- Horizontal anisotropy & vertical continuity, etc.

- Geophysical probes
- Distance monitoring well
- Tracer

- CO₂ leakage from reservoir

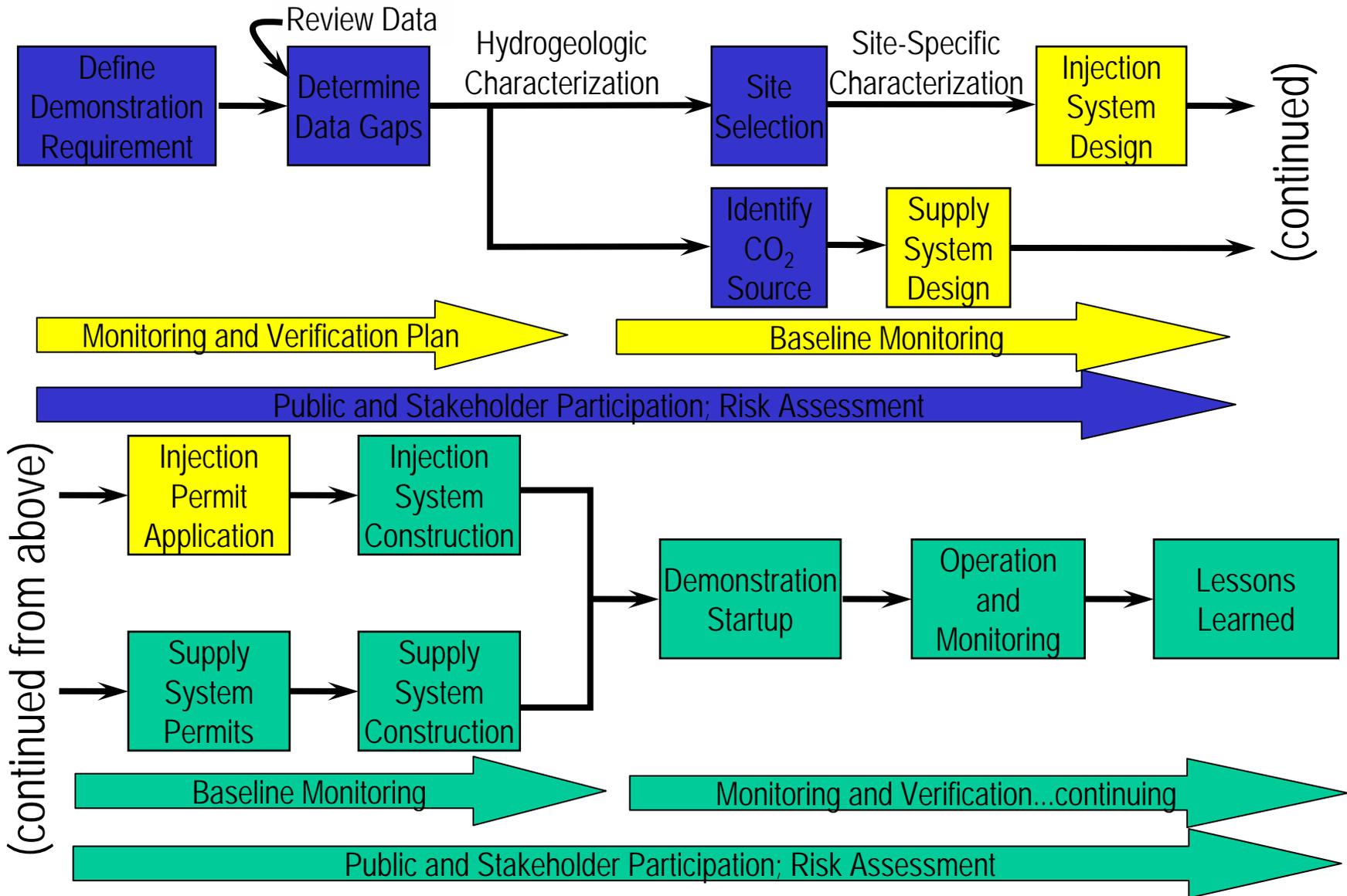
- Subsurface sites & shallow well

- Mineralisation and reservoir fluid characterization

- Sample bore hole within reservoir periphery

Progress in the Project

- Formulation of the project has been completed
- National and International research partner have been identified
- Resource mobilization is in progress



“When you really want something to happen, the whole universe conspires to help you to achieve your dreams”

..... The Alchemist

by Paulo Coelho

Thank

You

	Capture	NT	Storage
ARC-CBM Can,US,UK			√Can, US &UK
CANMET-Canada		√(Oxyfuel) Can & US	
CASTOR			
CO2capture (ph II)	√(UK,US,Nor,Italy)		
CO2 from pressurised gas stream	Japan, US		
CO2 sink			EC & Germany
CO2 Store			Norway &EC
Frio			US &Aus
ITC CO2 cap with chemical solvents	Canada &US		
Weyburn II			US, Canada &Japan



Dioxide Sequestration Project

Brent Lakeman, Program Leader, Carbon Management, Sustainable Energy Futures, Alberta Research Council, Canada

Anoxic Microbial Sequestration of Carbon Dioxide Present in Flue Gases to Methane/ Methanol/ Other Biomass

R.R. Sonde, Executive Director, Energy Technology, National Thermal Power Corporation, India

Regional Opportunities for CO₂ Capture and Storage in China

James Dooley, Co-Director, Carbon Management Solutions, Joint Global Research Institute, Pacific Northwest National Laboratories, United States