

International Energy Agency

Collaborative Project

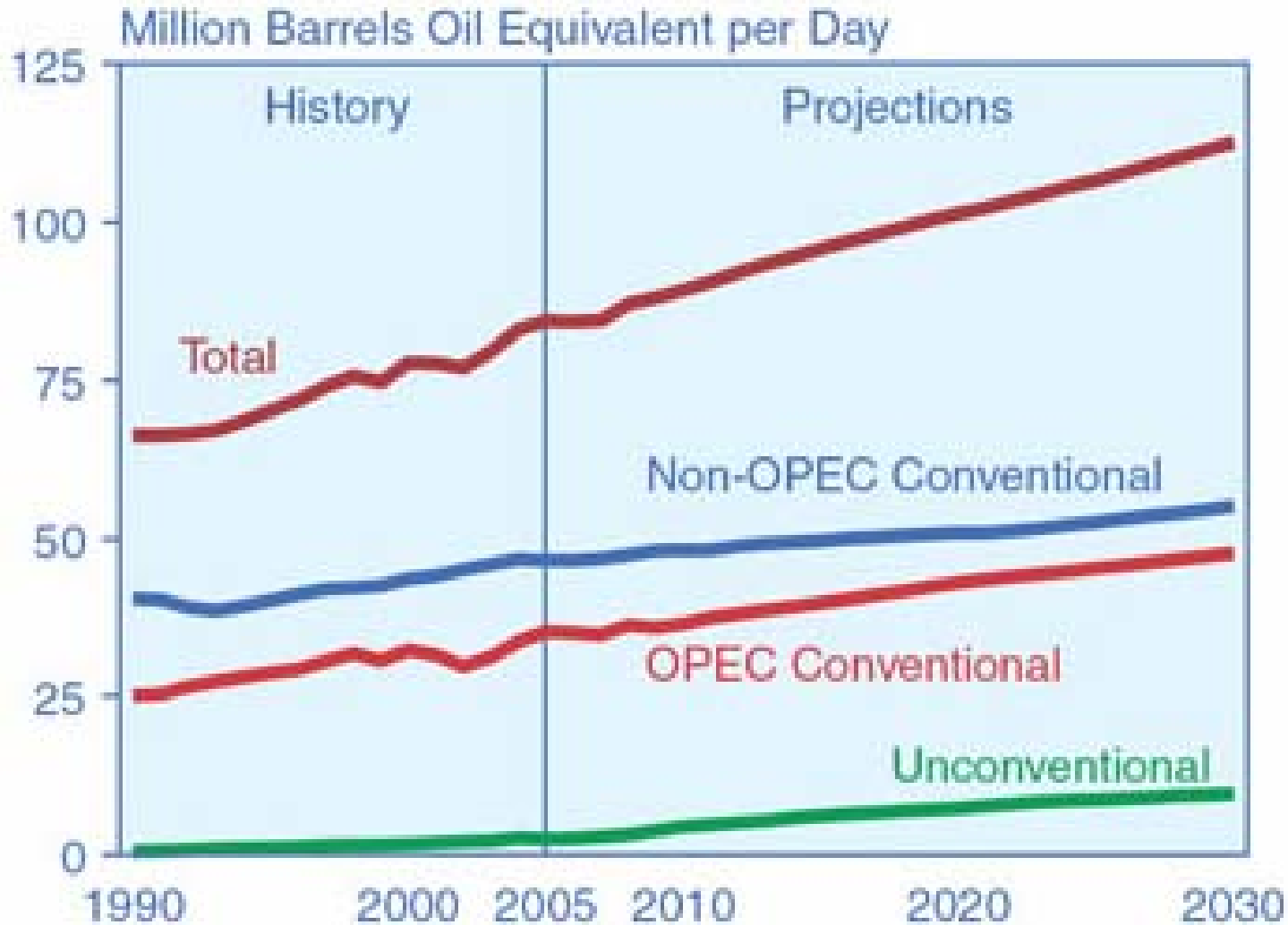
on

Enhanced Oil Recovery

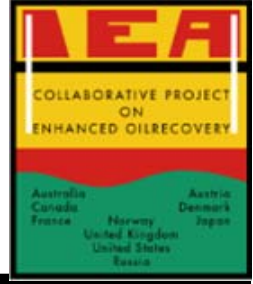
Torsten CLEMENS

Vienna, Oktober 2008

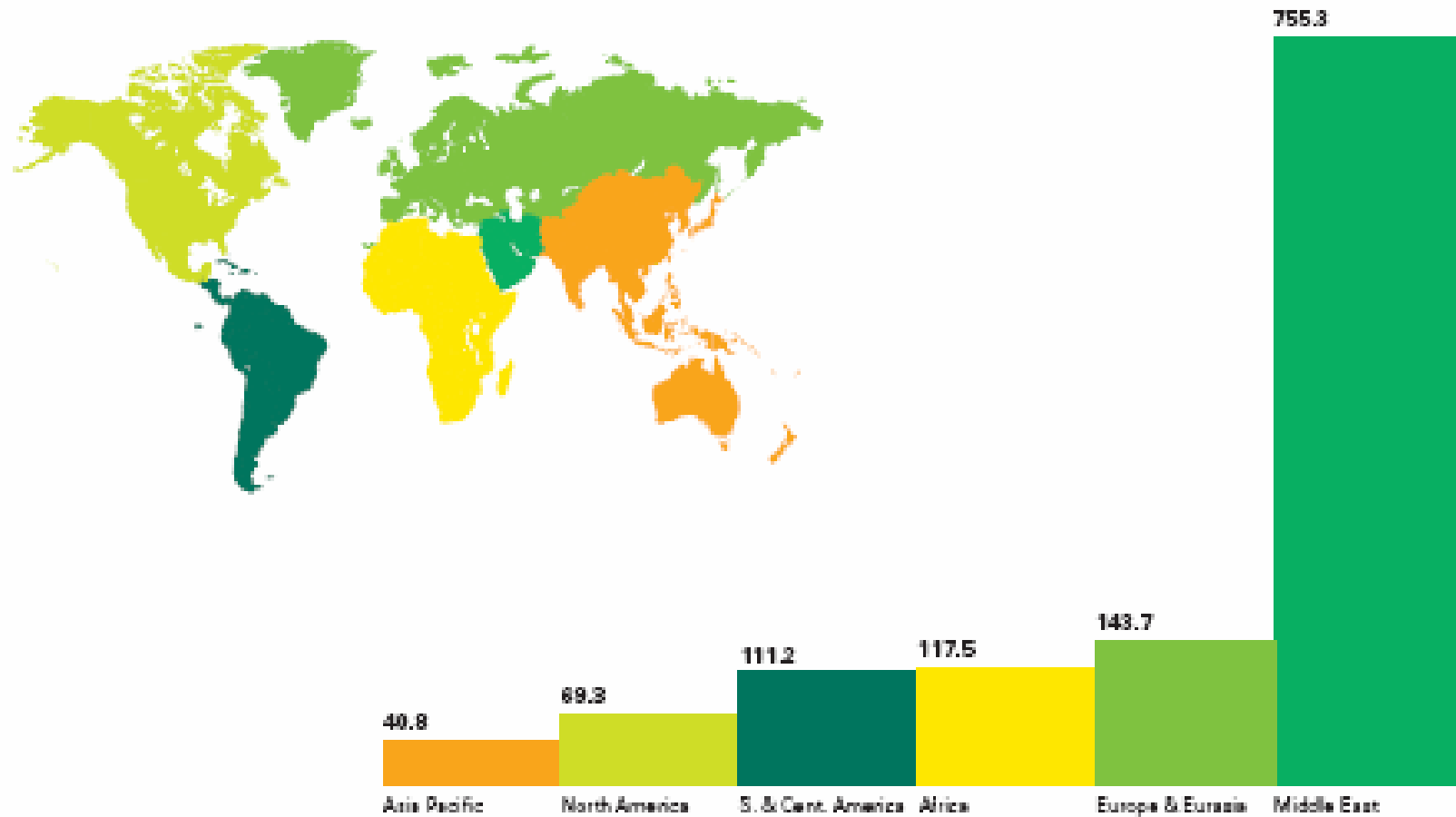
Oil Production Forecast



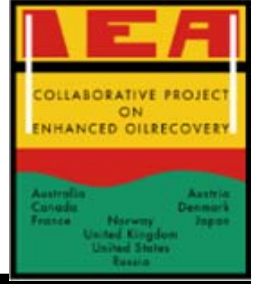
Proved Oil Reserves Distribution



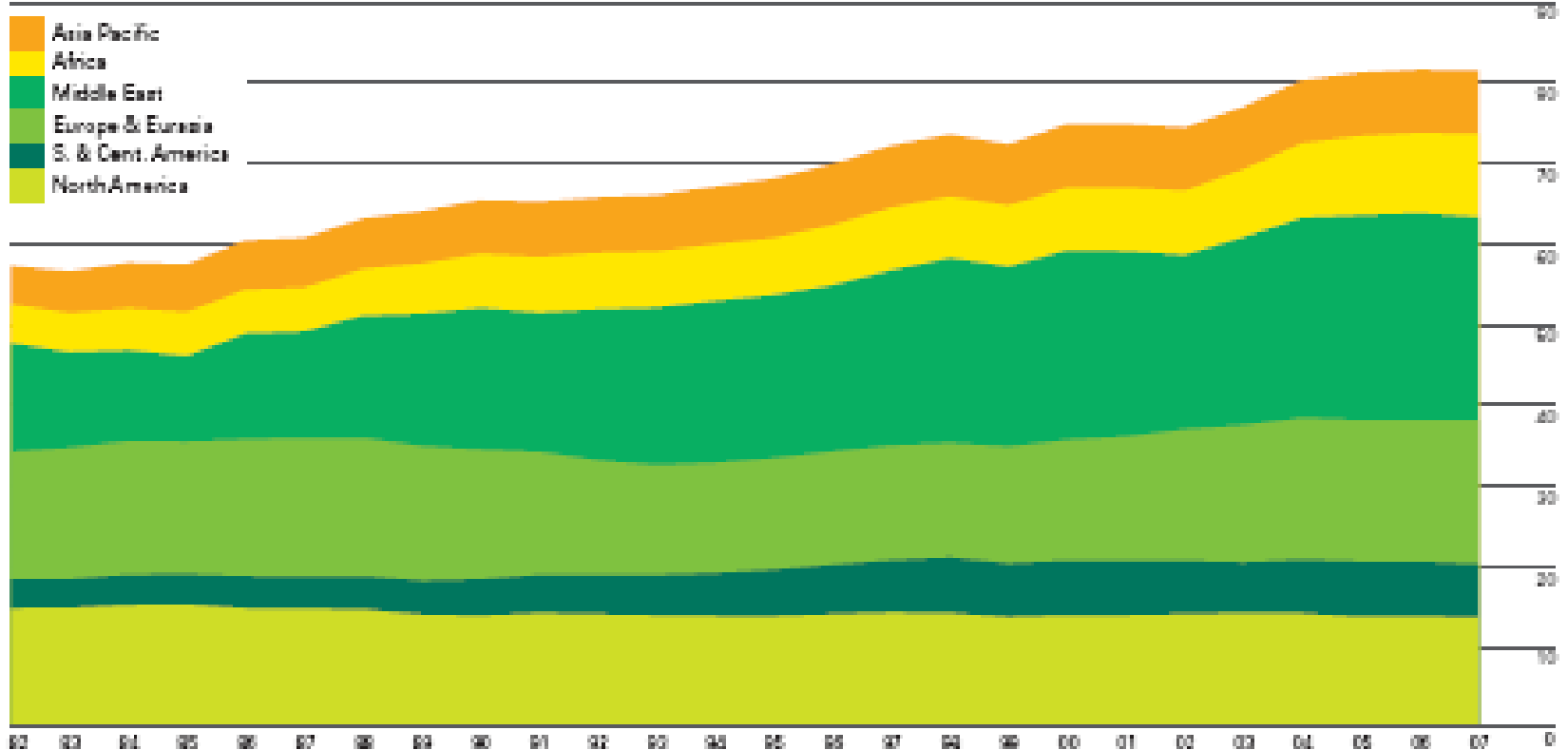
Proved reserves at end 2007
Thousand million barrels



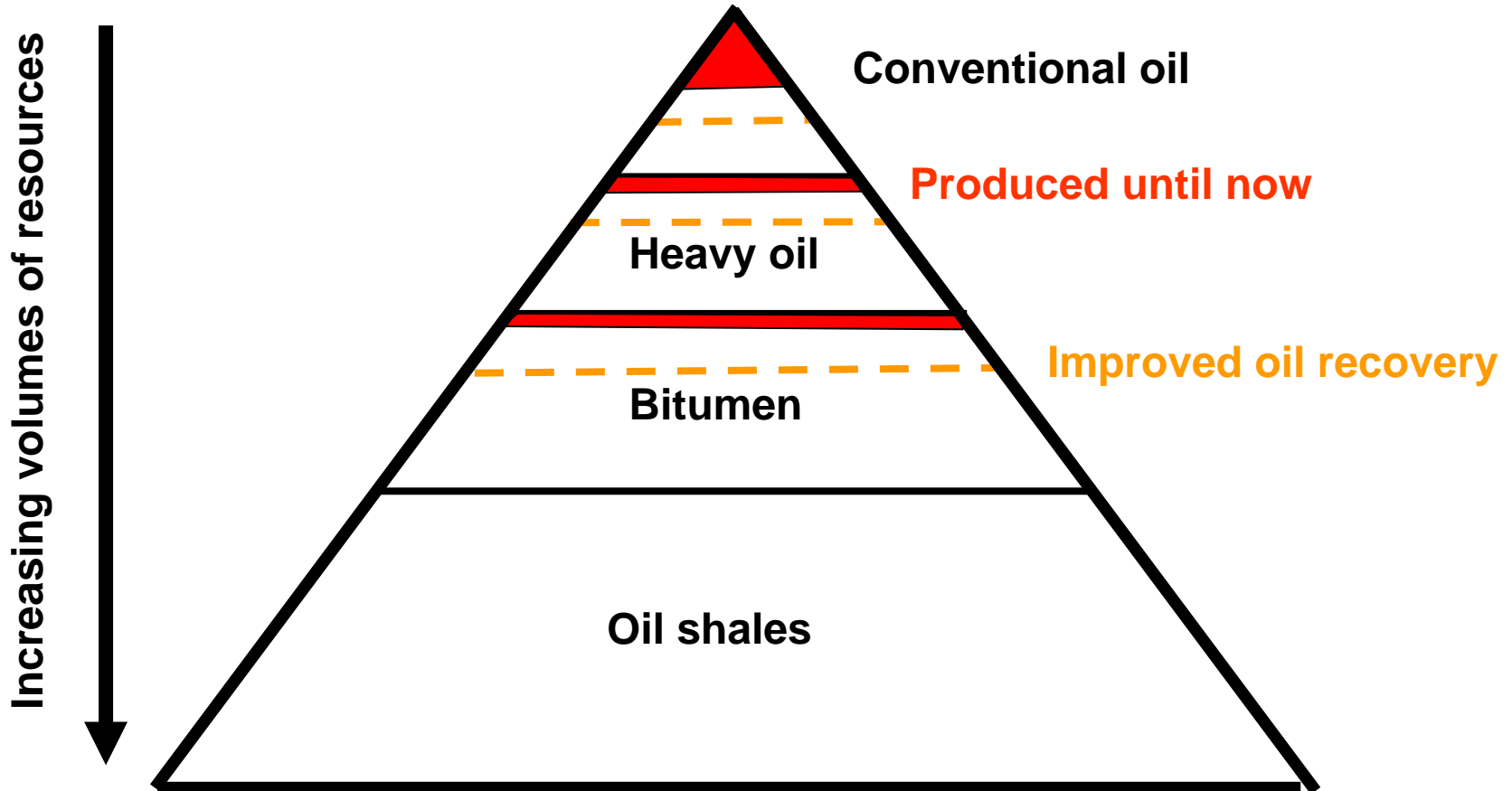
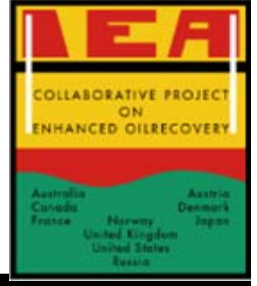
Oil Production Distribution



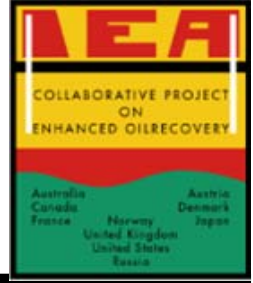
Production by region
Million barrels daily



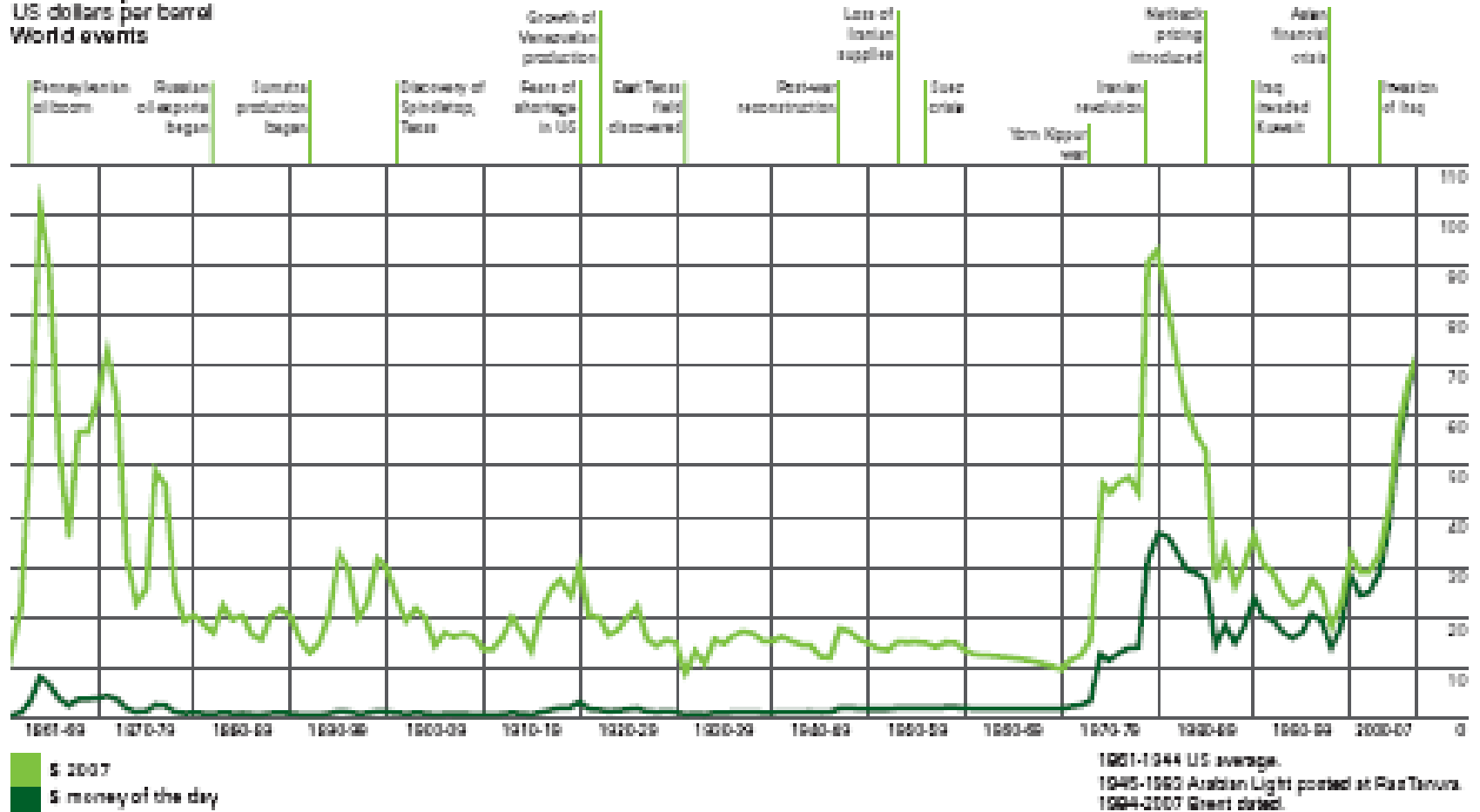
Resources Triangle



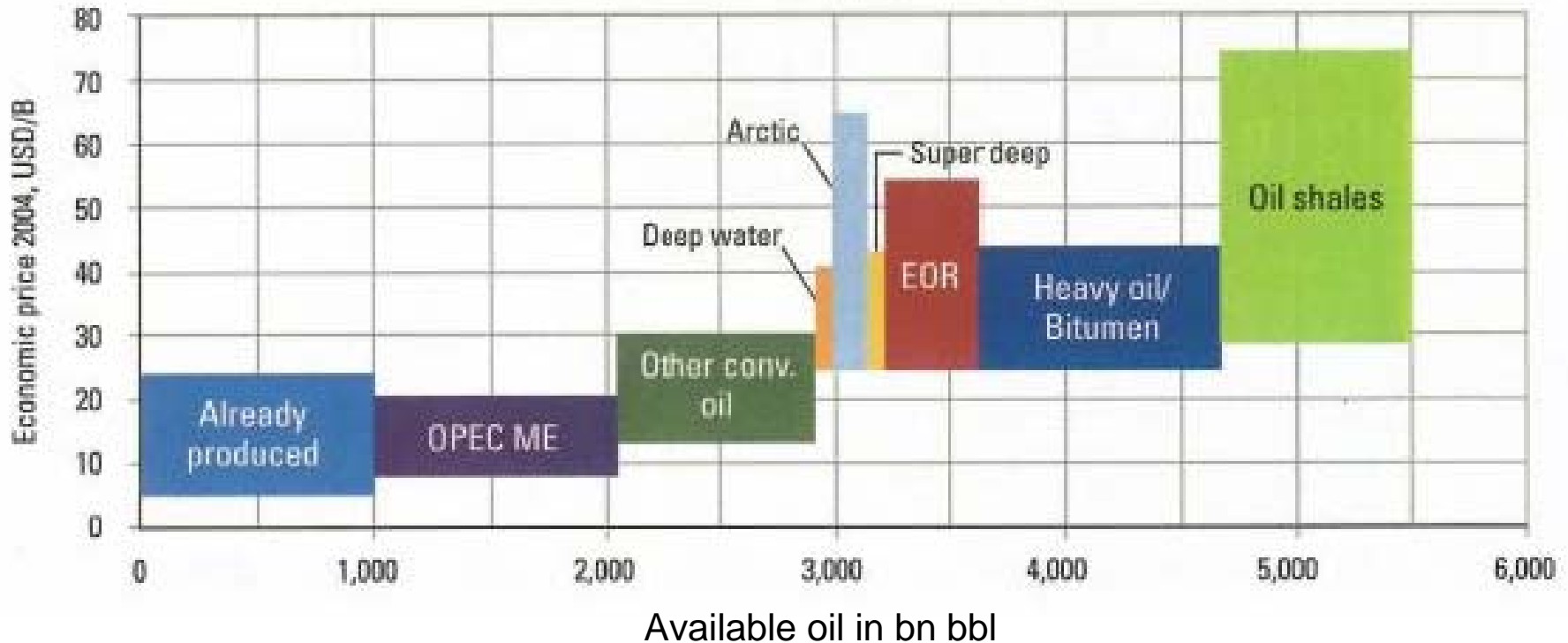
Crude Oil Prices



Crude oil prices 1861-2007
US dollars per barrel
World events



Oil production costs

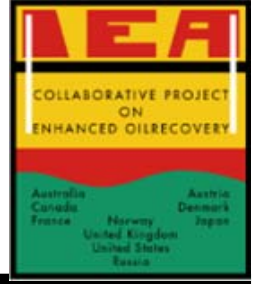


IEA Joint Implementing Agreement - commitments to study EOR technologies



TASK	A	B	C	D	E	F	Total
Australia	1		1				2
Austria			2				2
Canada		1	1				2
China		1	1			1	3
Denmark	1	1	2	1	1		6
France	1	1	1	1			4
Japan	1		1		1	1	4
Norway	1	1	1		1	1	5
Russia	1						1
Venezuela*							
United Kingdom	1		1		1	1	4
United States	(**)		(**)	(**)			(**)

Enhanced Oil Recovery Technologies



good quality oil
(1 cP)

viscous oil
(100 cP)

very viscous oil
(1000 cP)

Technologies to enhance oil production:

Water/Gas injection

Polymer injection

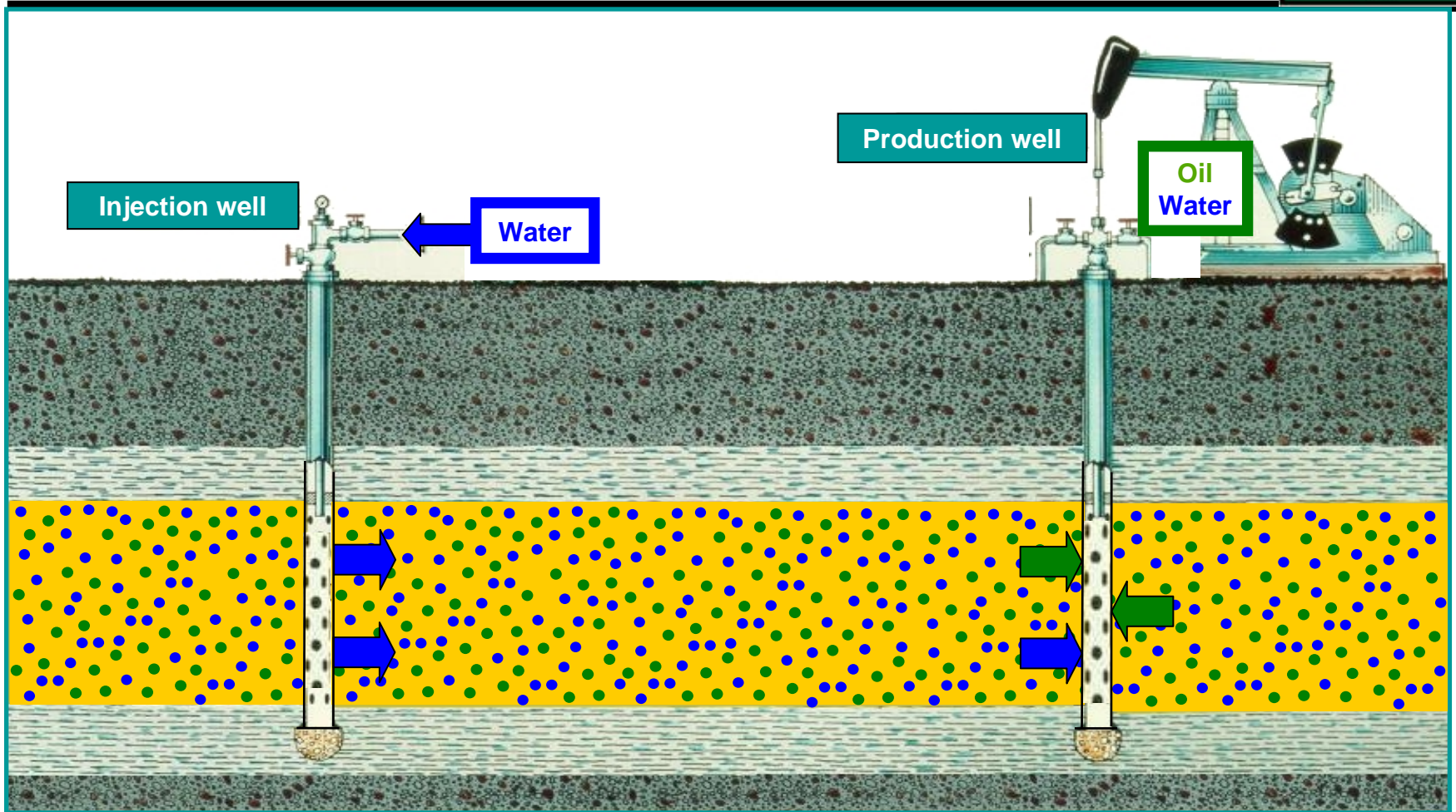
Steam injection

Surfactant injection

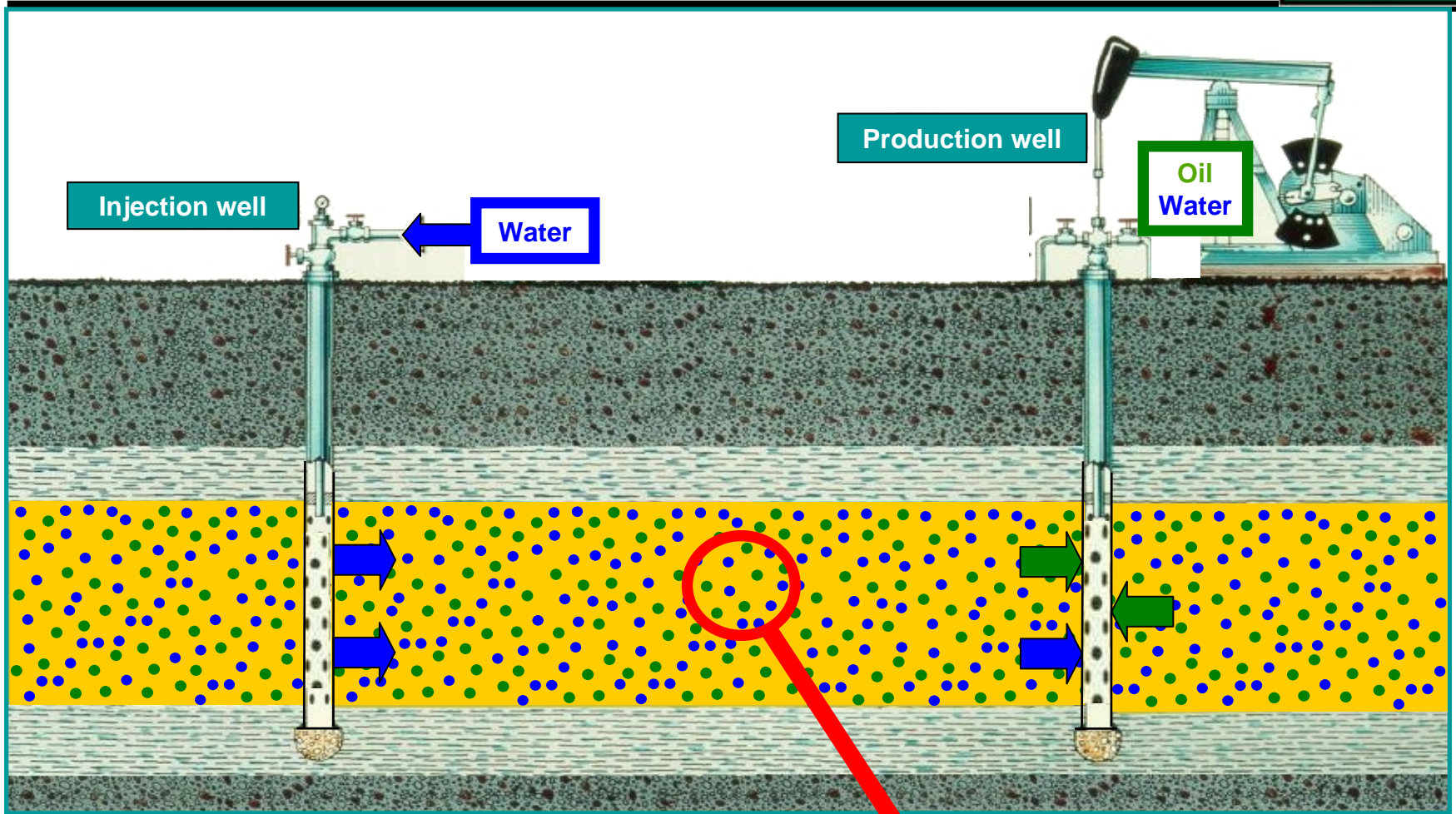
In situ combustion

High pressure Air injection

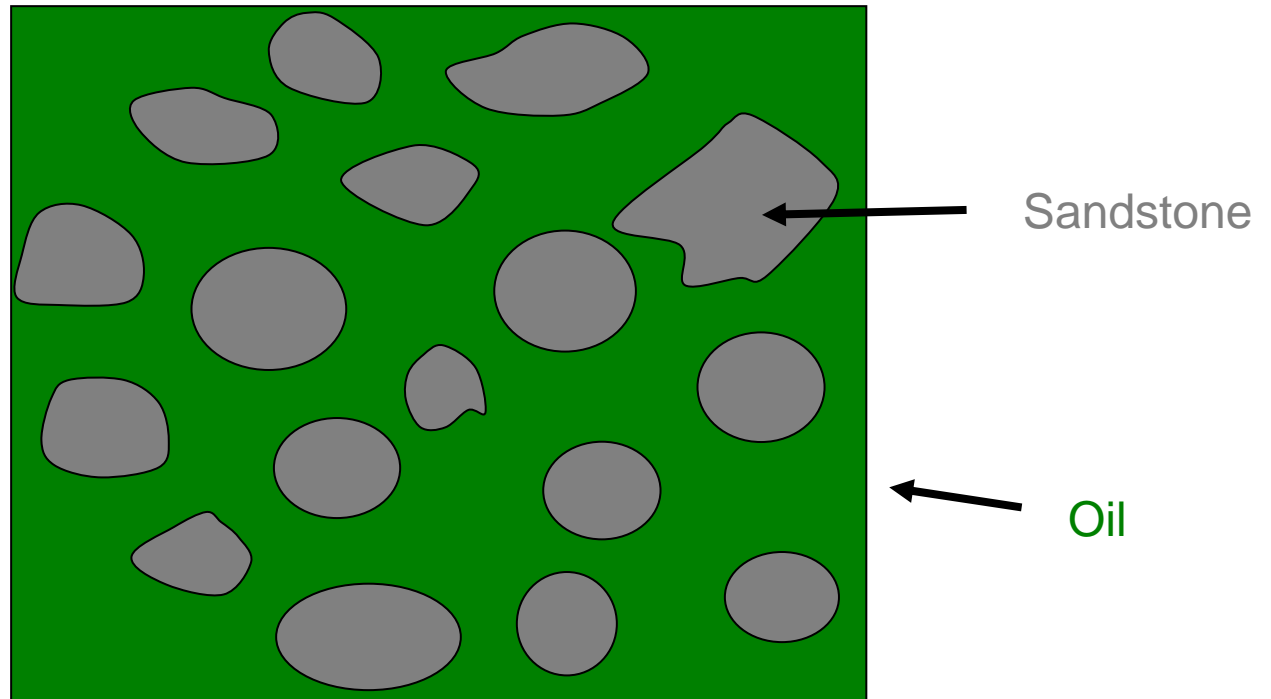
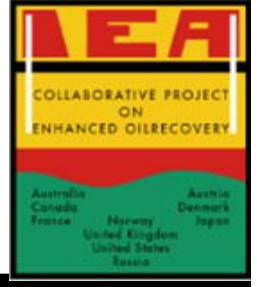
How much oil remains in the reservoir?



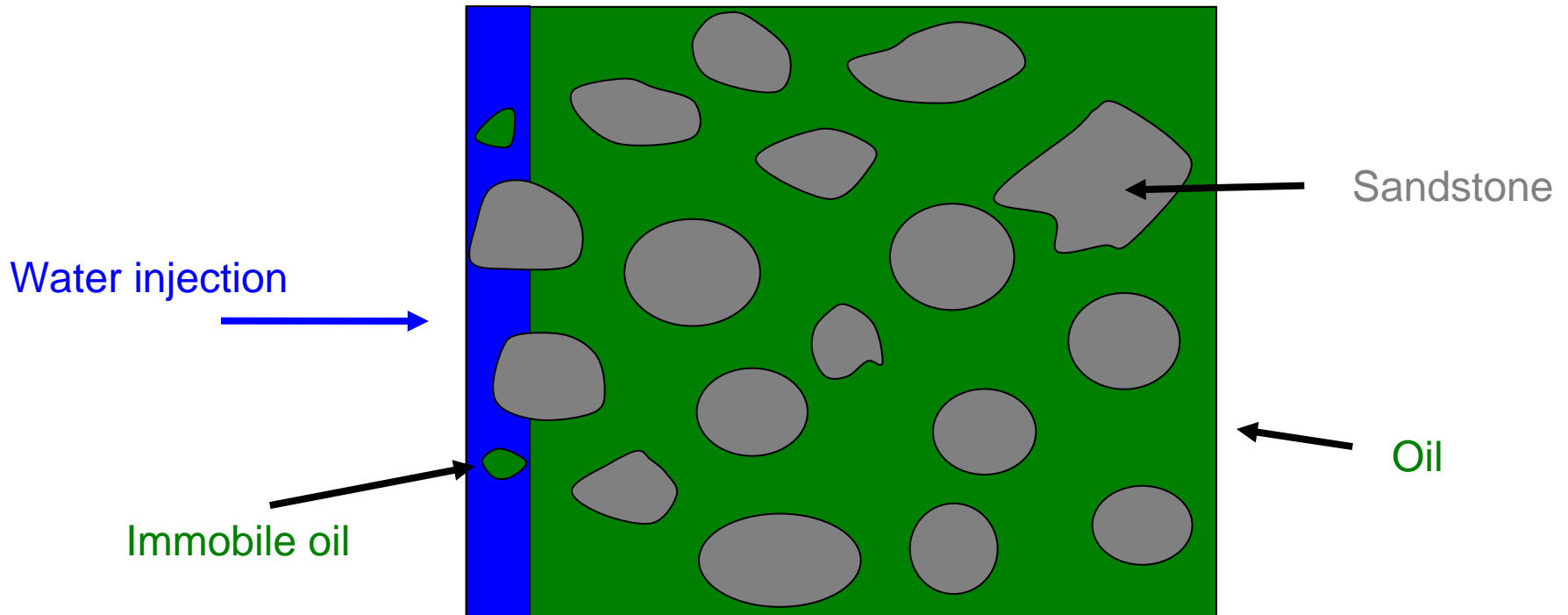
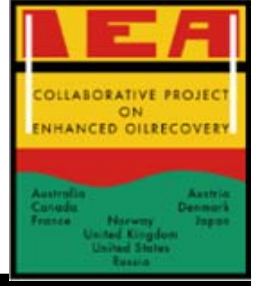
How much oil remains in the reservoir?



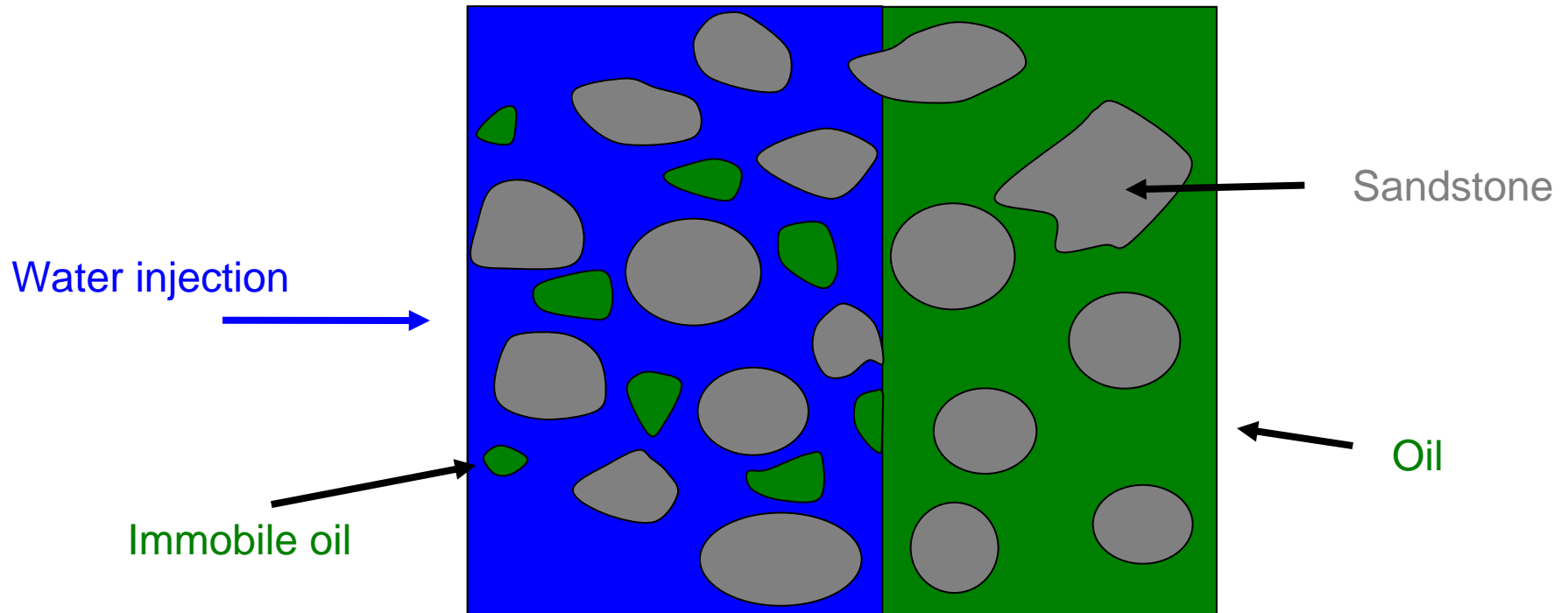
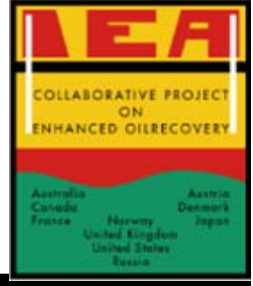
How much oil remains in the reservoir – microscopic level



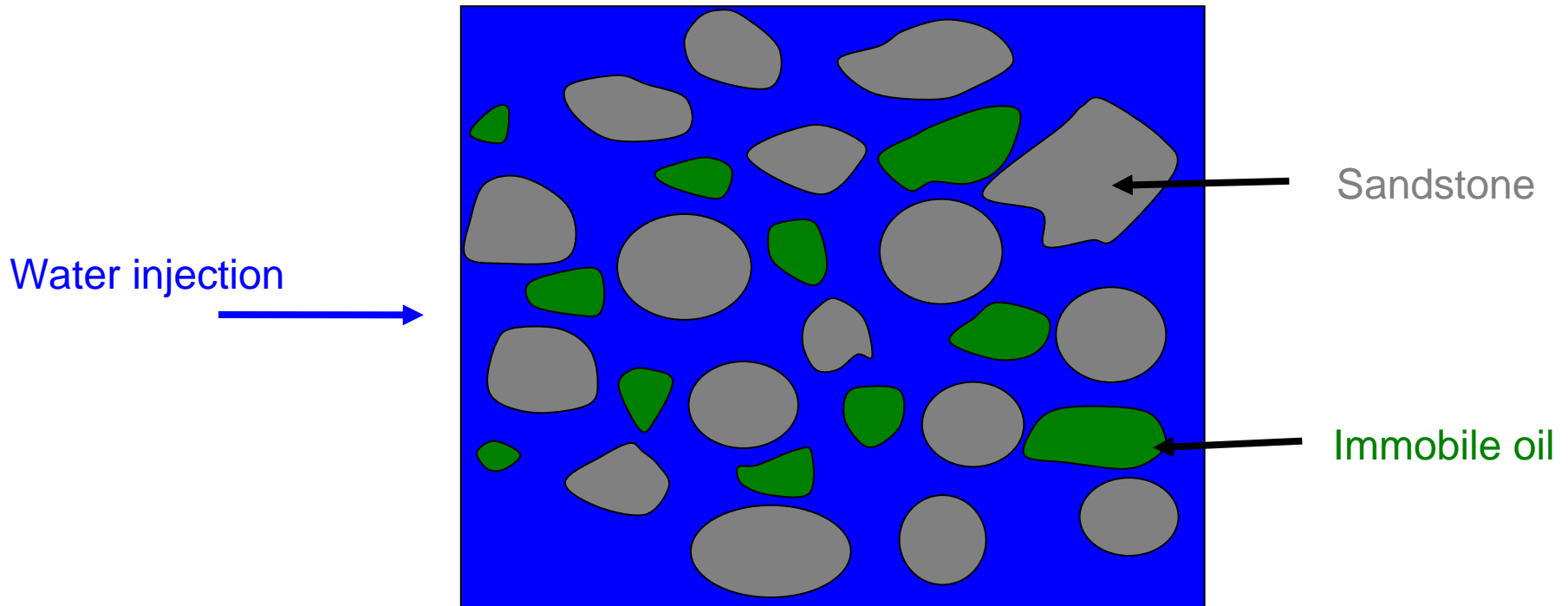
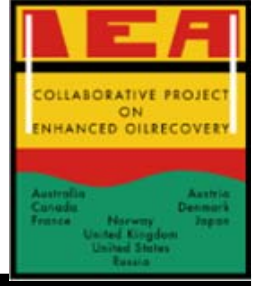
How much oil remains in the reservoir – microscopic level



How much oil remains in the reservoir – microscopic level

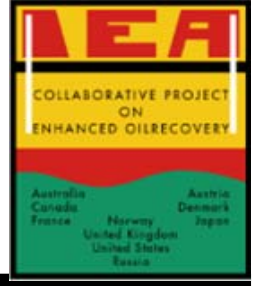


How much oil remains in the reservoir – microscopic level

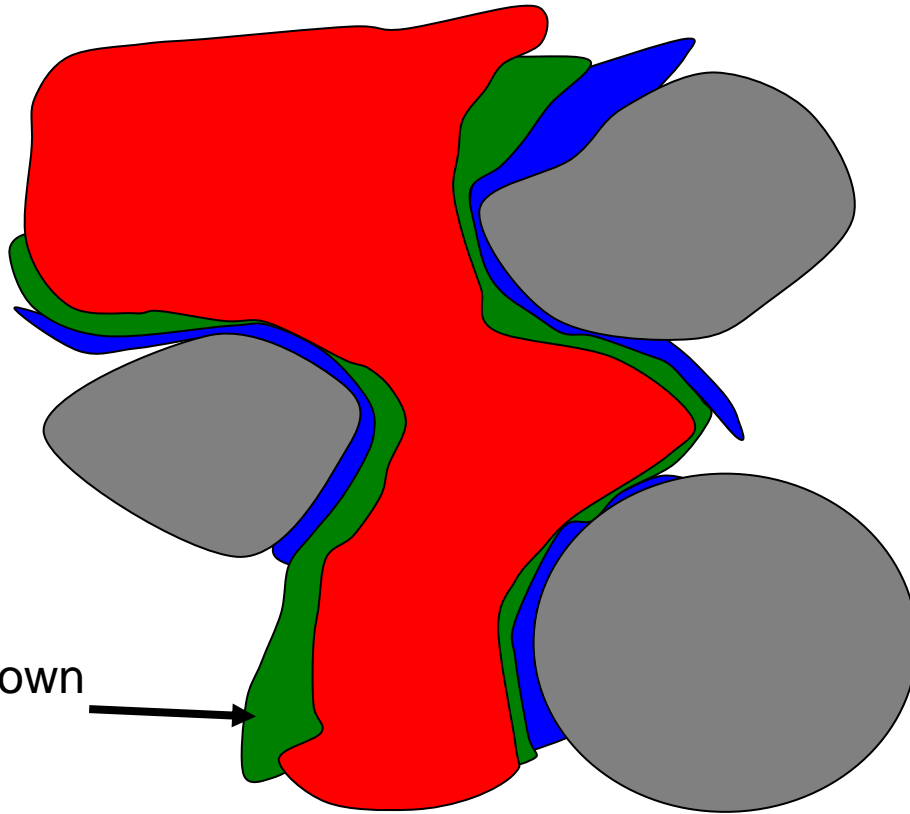


30 % or even 100 % of the oil cannot be produced!

Gas injection for increased recovery

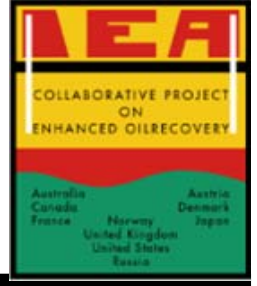


Gas injection

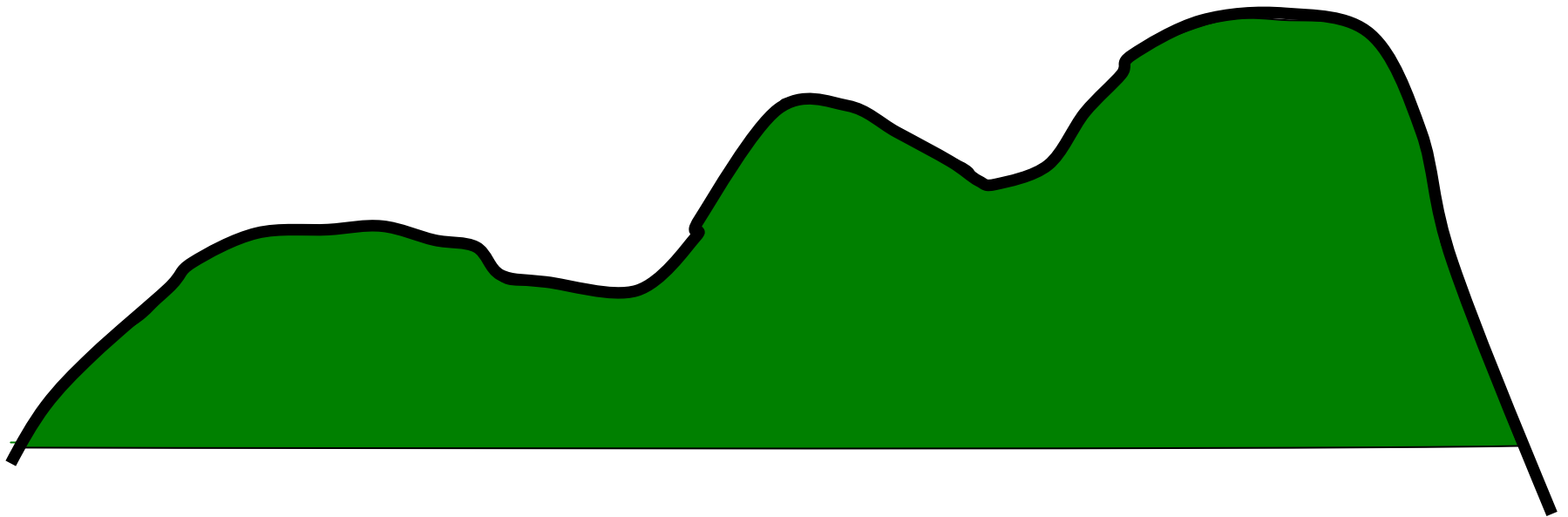


Oil drains down
(filmflow)

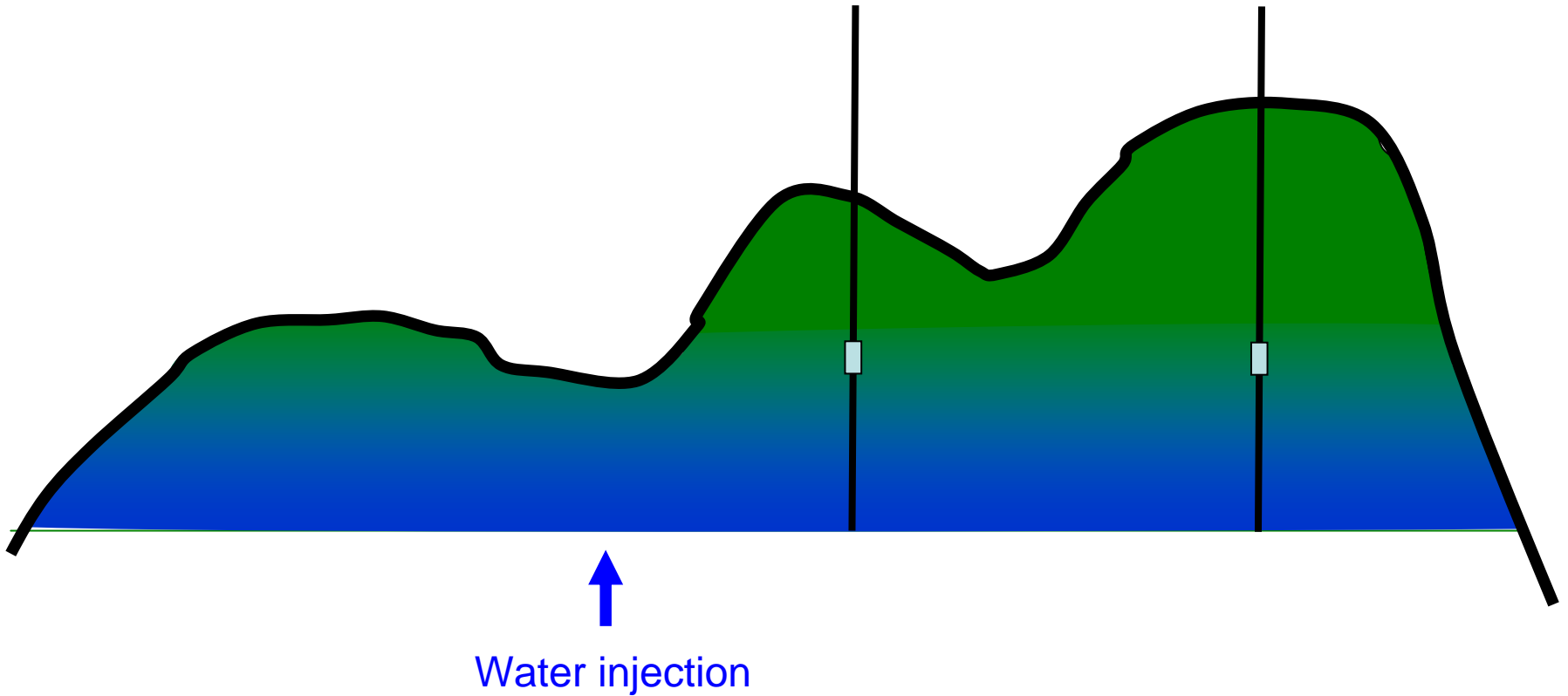
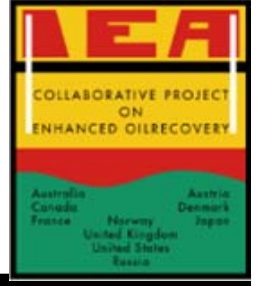
Gas injection example



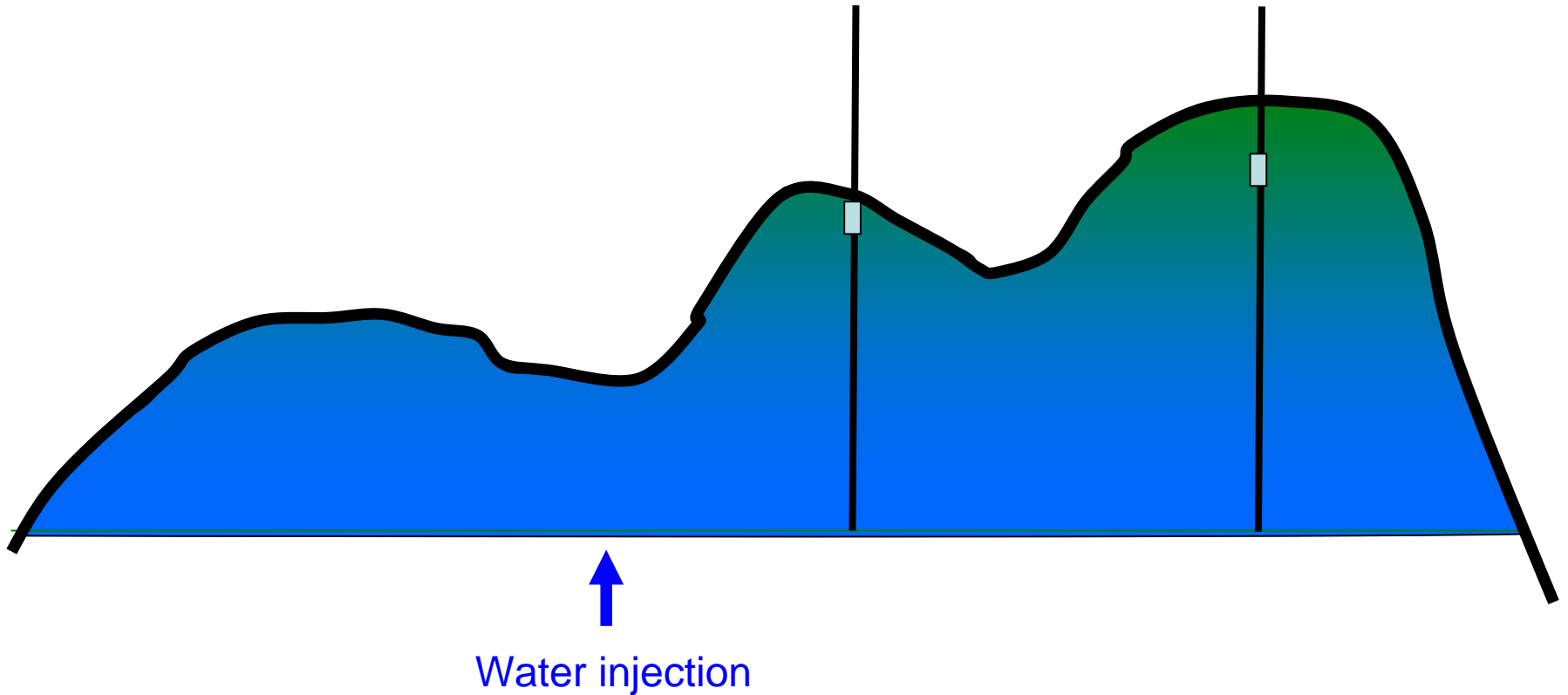
2700 m below
surface



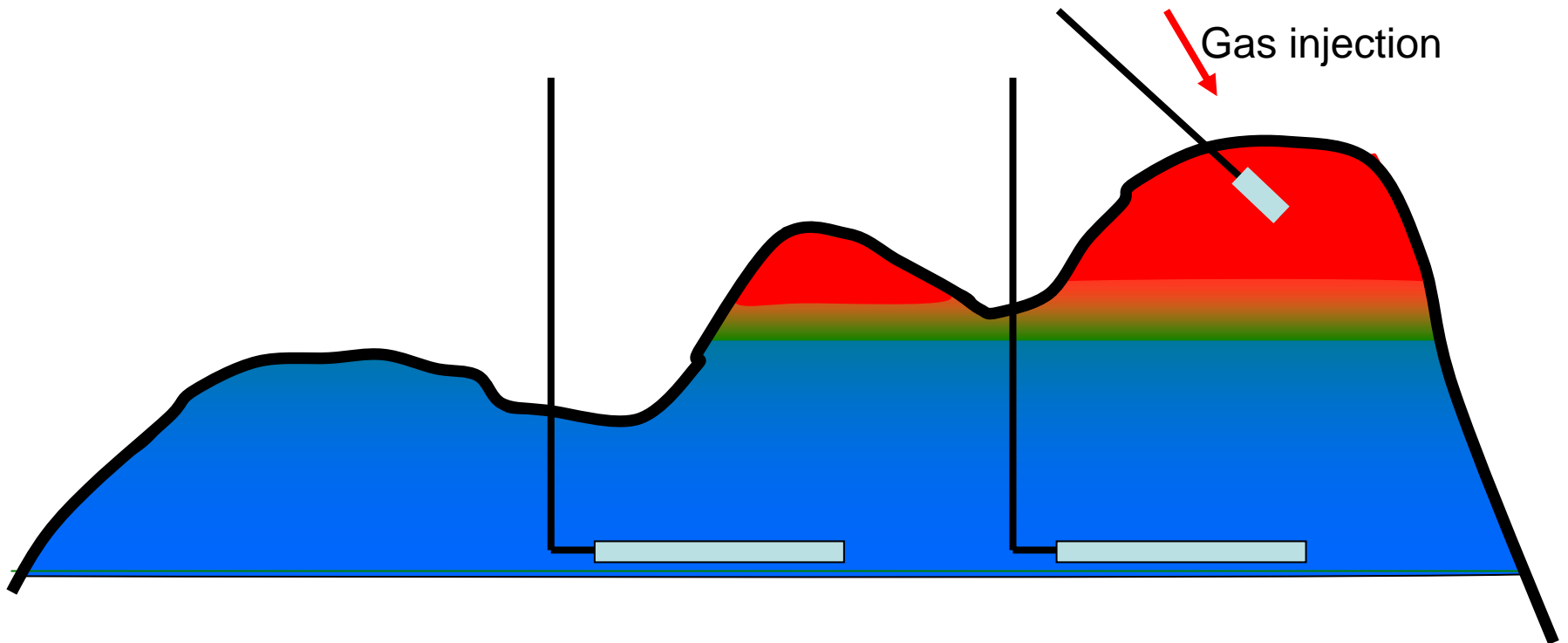
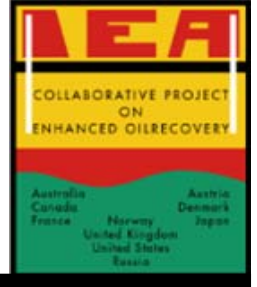
Gas injection example



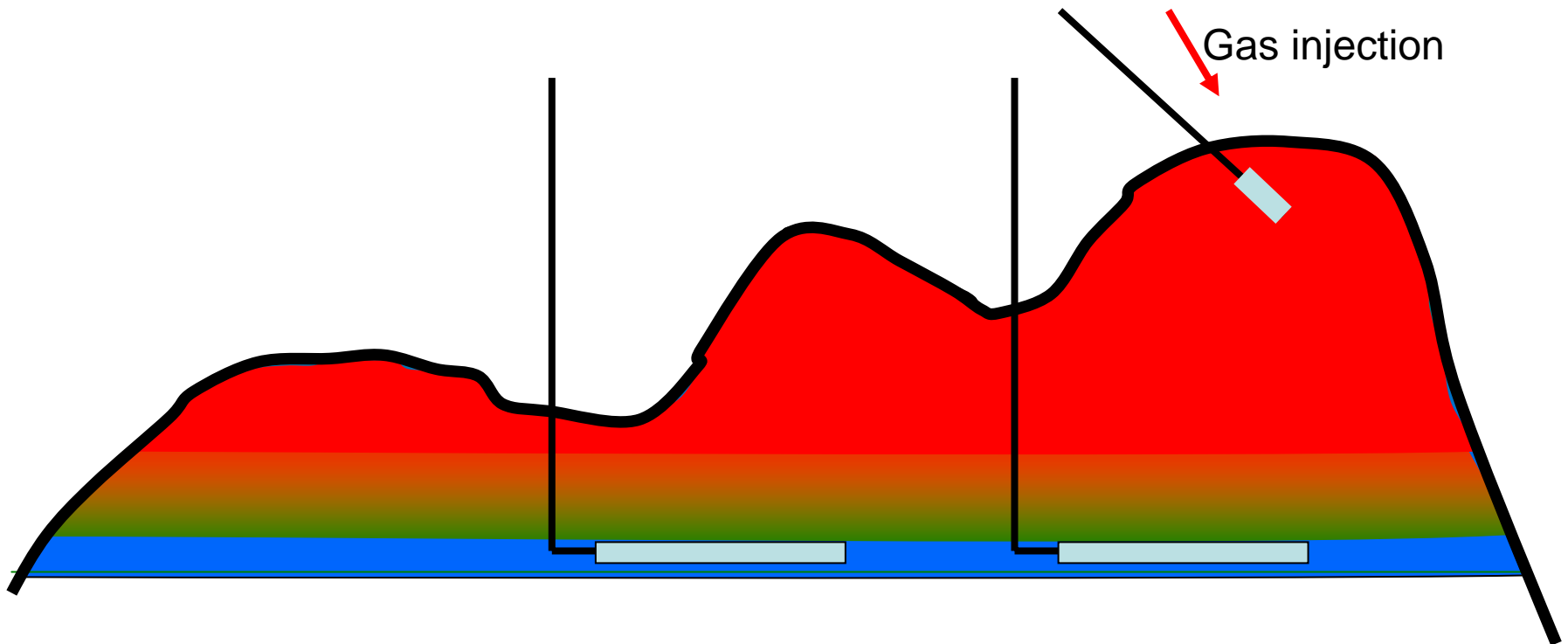
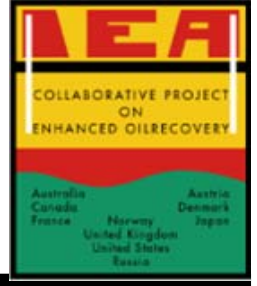
Gas injection example



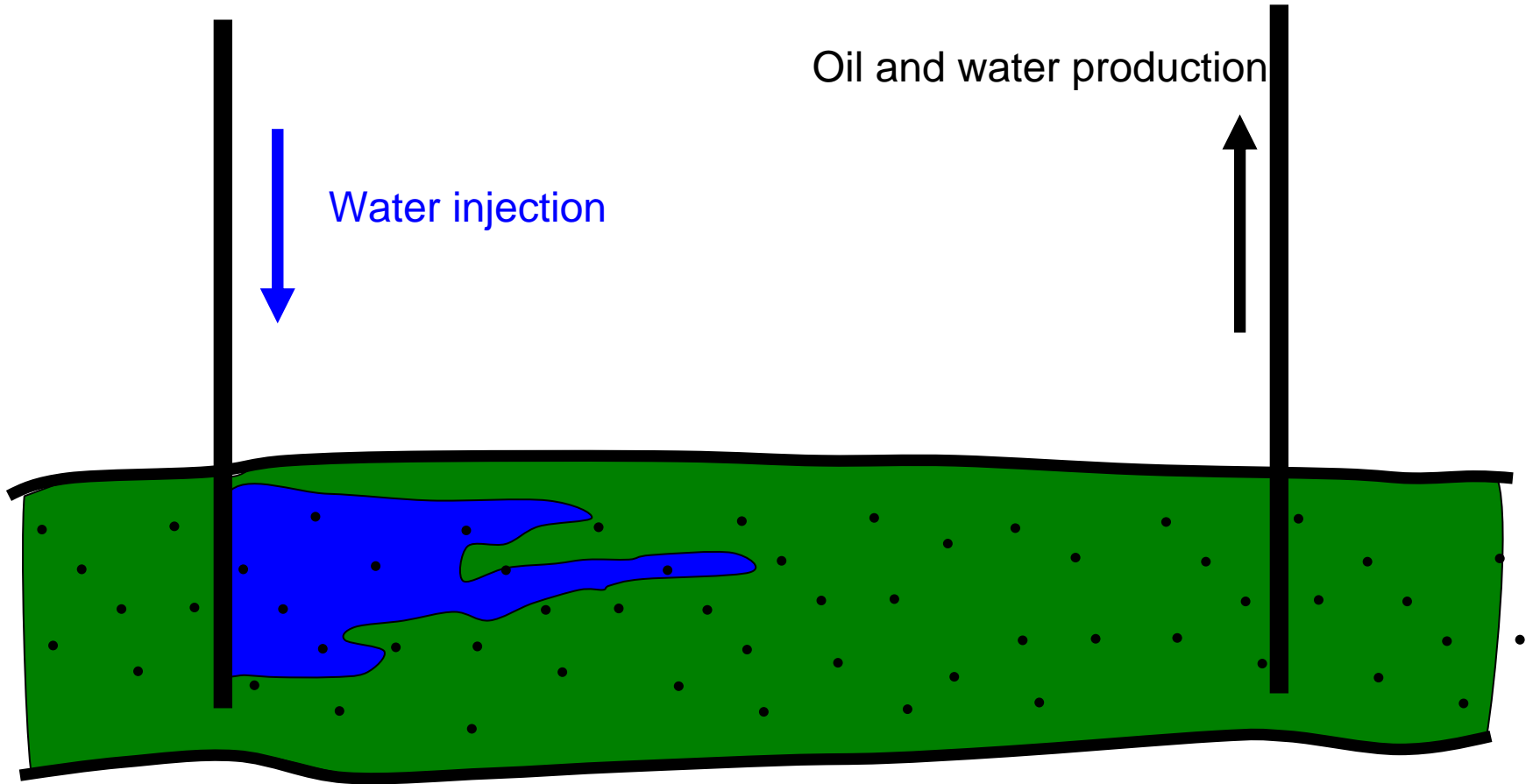
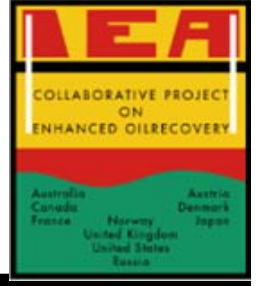
Gas injection example



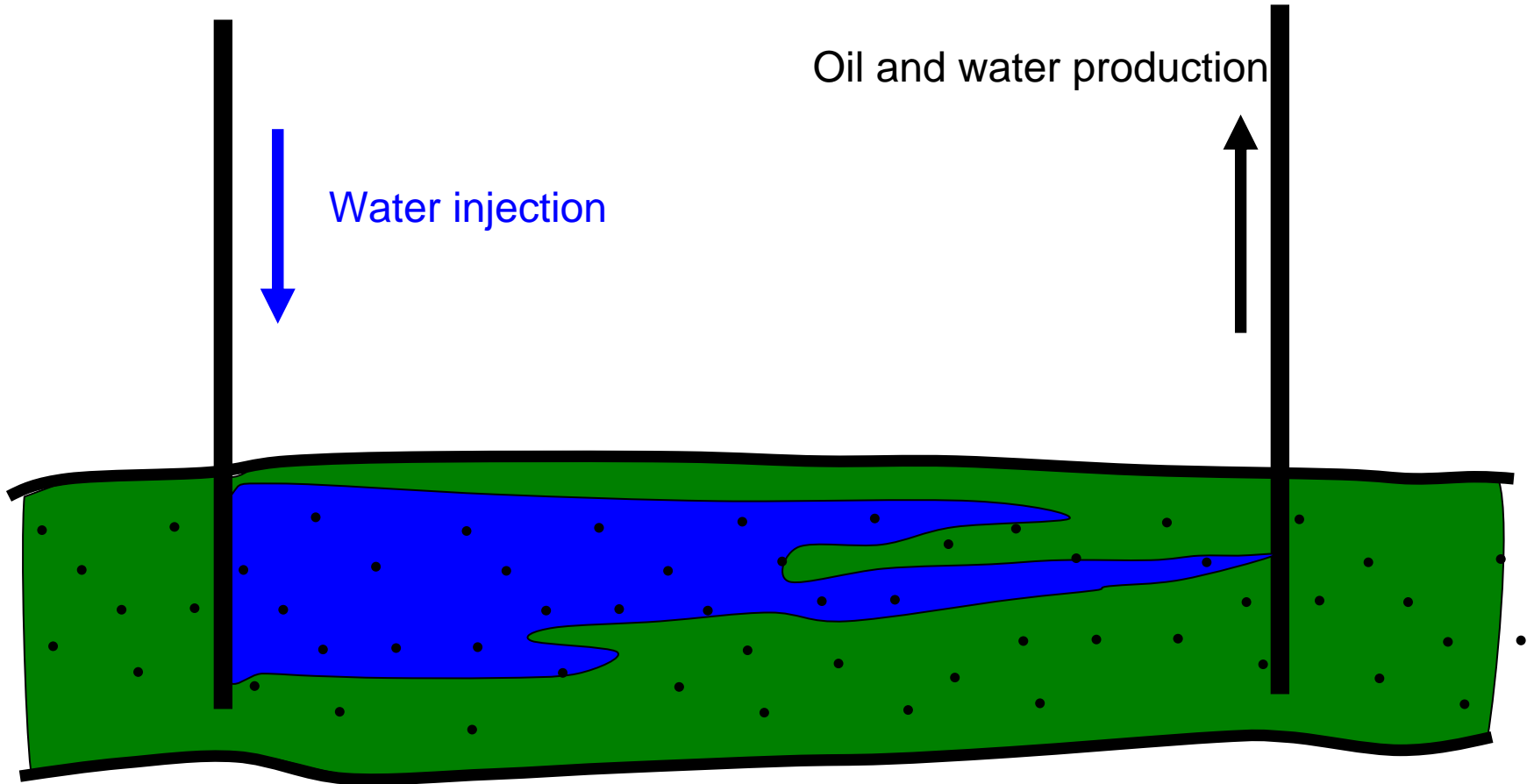
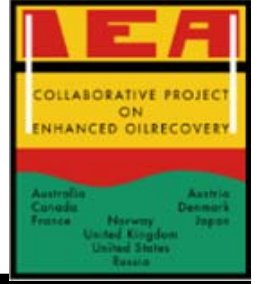
Gas injection example



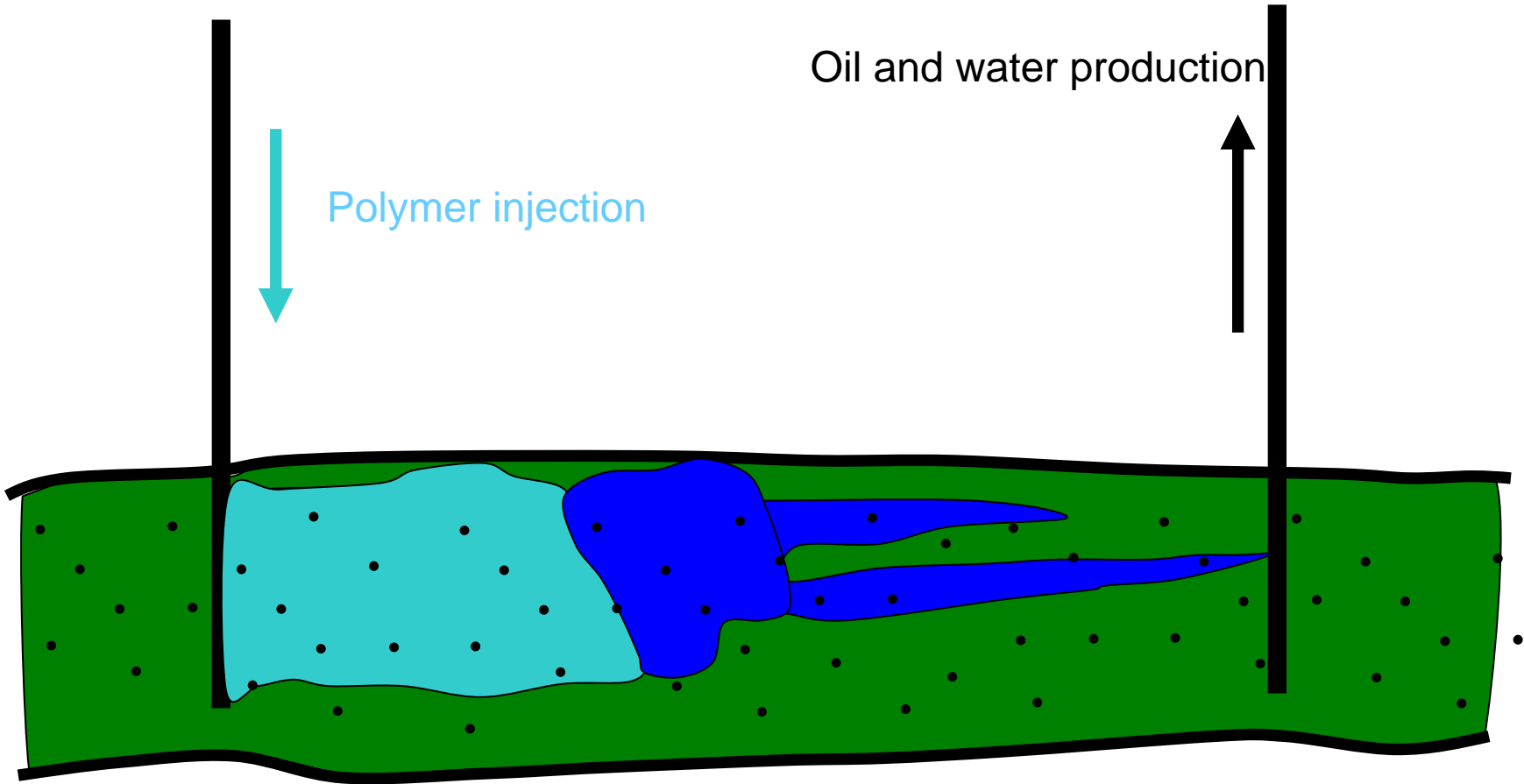
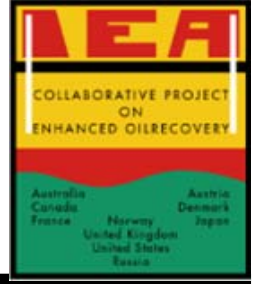
Polymer injection



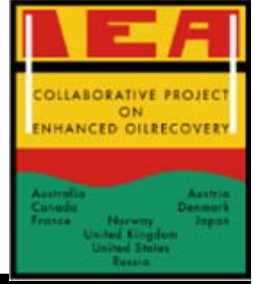
Polymer injection



Polymer injection

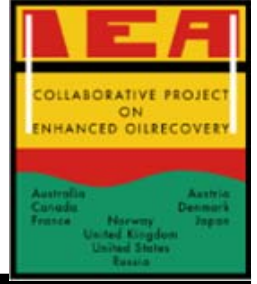


Summary of current research efforts of the IEA Joint Implementing Agreement on EOR



- Gas injection – behaviour of cost-effective gases in the subsurface (CO₂, air)
- Chemical injection – injection of polymers, surfactants, alkali
- Air injection for heavy oil recovery – in-situ combustion

Conclusions



- Higher oil prices increase interest in Enhanced Oil Recovery (EOR) methods
- Dependent on oil quality and the reservoirs, different EOR methods have to be used
- Member countries of the IEA EOR joint implementing agreement are very active
- Research for EOR of the IEA member countries focuses on gas and chemical injection