Assessment of CO_2-EOR and its geo-storage potential in oil reservoirs of Precaspian basin, Kazakhstan

Nurlan Seisenbayev | Yerdaulet Abuov | Zhanat Tolenbekova | Woojin Lee*
E-mail: woojin.lee@nu.edu.kz
Nazarbayev University | School of Engineering and Digital Sciences

Global-EGRL
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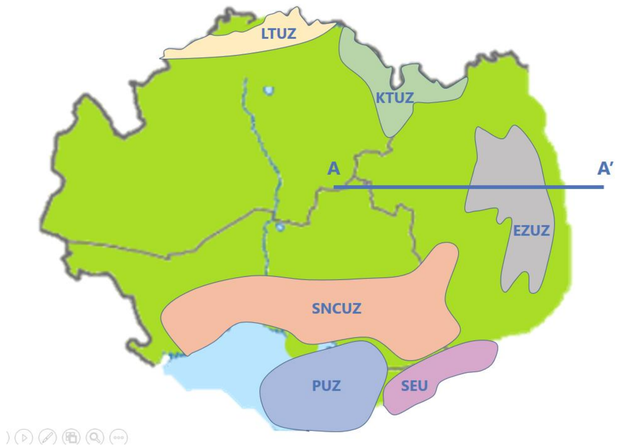
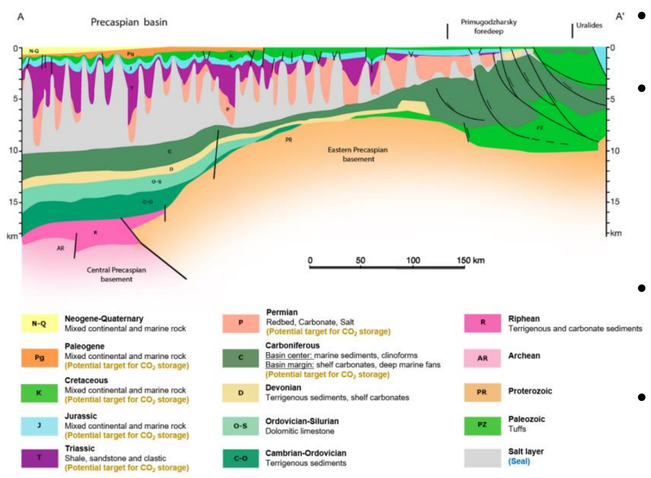
Introduction

- Kazakhstan is 12th in the world by its proven oil and gas reserves and revenues from oil sales constitute a major portion of the national budget
- Current oil recovery rate is **30-35%** and government plans to raise it to **55-60%**
- High recovery rates can be achieved with proper EOR technology
- CO_2-EOR uses CO_2 gas as an injection fluid to re-energize the reservoir
- Anthropogenic CO_2 can be utilized instead of natural CO_2 sources to reduce the GHG emissions



Map of Precaspian basin and its hydrocarbon bearing zones

Geology of the Precaspian basin



A-A' stratigraphy of the Precaspian basin (adapted from (Abuov et al. 2020))

- Most petroliferous basin in the Kazakhstan
- Basin has **178 oil reservoirs** at various stages of development
- **6 hydrocarbon bearing zones:**
  1. Karachaganak Troitsk Uplift Zone **(KTUZ)**
  2. Lobodinsk-Teplovsk Uplift Zone **(LTUZ)**
  3. Enbeksk-Zharamysskaya Uplift Zone **(EZUZ)**
  4. Shchukatsk-North Caspian Uplift Zone **(SNCUZ)**
  5. Primorsk Uplift Zone **(PUZ)**
  6. South Emba Uplift **(SEU)**
- Pre-salt and Post-salt sections are divied by prominent Kungurian salt throughout the territory of the basin
- **Pre-salt section:** terrigenous Paleozoic cover and carbonate platforms at basin margins
- **Post-salt section:** terrigenous sediments from Permian to recent that occur between salt domes

Research objectives

- To screen oil fields of the Precaspian basin for the miscible CO_2-EOR
- To estimate effective CO_2 storage capacity in screened oil fields of the Precaspian basin
- To estimate the incremental oil recovery and additional revenue opportunities

Methodology: effective CO_2 storage capacity

Estimation of effective geological CO_2 storage capacity in oil reservoirs:

$$M_{CO_2t} = C_e * \rho_{CO_2r} \left[\frac{R_f OOIP}{B_f} - V_{iw} + V_{pw} \right]$$

M_{CO2t} - effective CO_2 storage capacity
C_e - sweep factor
R_f - a recovery factor
B_f - the formation volume factor
V_{iw}, V_{pw} - volumes of injected and produced water.

Methodology: screening for miscible CO_2-EOR

N	Reservoir characteristics	Suitable for miscible CO_2-EOR
1	Depth, m	≥800
2	OOIP, kT	≥1712
3	API	22-45
4	Temperature, °C	31.1
5	Pressure, Mpa	7.4
6	Porosity, %	≥3; ≤37

- "The Oil and Gas field database of Kazakhstan" was used to obtain 178 oil reservoir characteristics
- The screening criteria was developed from the previous experience of oil reservoirs with CO_2-EOR

Screening results and their CO_2 storage potential

Hydrocarbon bearing zone	Rock type	Number of suitable oil fields for miscible CO_2-EOR	Effective CO_2 storage capacity (Mt)
Karachaganak Troitsk Uplift Zone **(KTUZ)**	Sandstone, carbonate	2	6.45
Lobodinsk-Teplovsk Uplift Zone **(LTUZ)**	Carbonate	1	0.43
Enbeksk-Zharamysskaya Uplift Zone **(EZUZ)**	Sandstone, carbonate	17	13.77
Shchukatsk-North Caspian Uplift Zone **(SNCUZ)**	Sandstone	7	1.77
Primorsk Uplift Zone **(PUZ)**	Sandstone	1	0.74
South Emba Uplift **(SEU)**	Sandstone	6	1.24
	Total	**34**	**24.41**

- **34** out of 178 oil fields are suitable for miscible CO_2-EOR
- The total effective storage capacity of screened oil fields is **24.41 Mt**
- **Enbeksk-Zharamysskaya Uplift Zone** is the most suitable candidate for CO_2-EOR with 17 oil fields having 13.77 Mt CO_2 storage capacity
- More than 100 oil fields are not suitable because of low OOIP

Conclusion & Future works

- Precaspian has a potential oil fields for CO_2-EOR to increase oil recovery
- Precaspian basin affords sufficient geological CO_2 storage capacity in oil fields of developing and mature stages of development
- Amount of incremental oil recovery will be estimated using previous industry of oil and gas industry and its economy will be estimated
- CO_2 sources will be matched with CO_2 sinks to identify most feasible CCS options

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