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State of the CCS Activities in Romania

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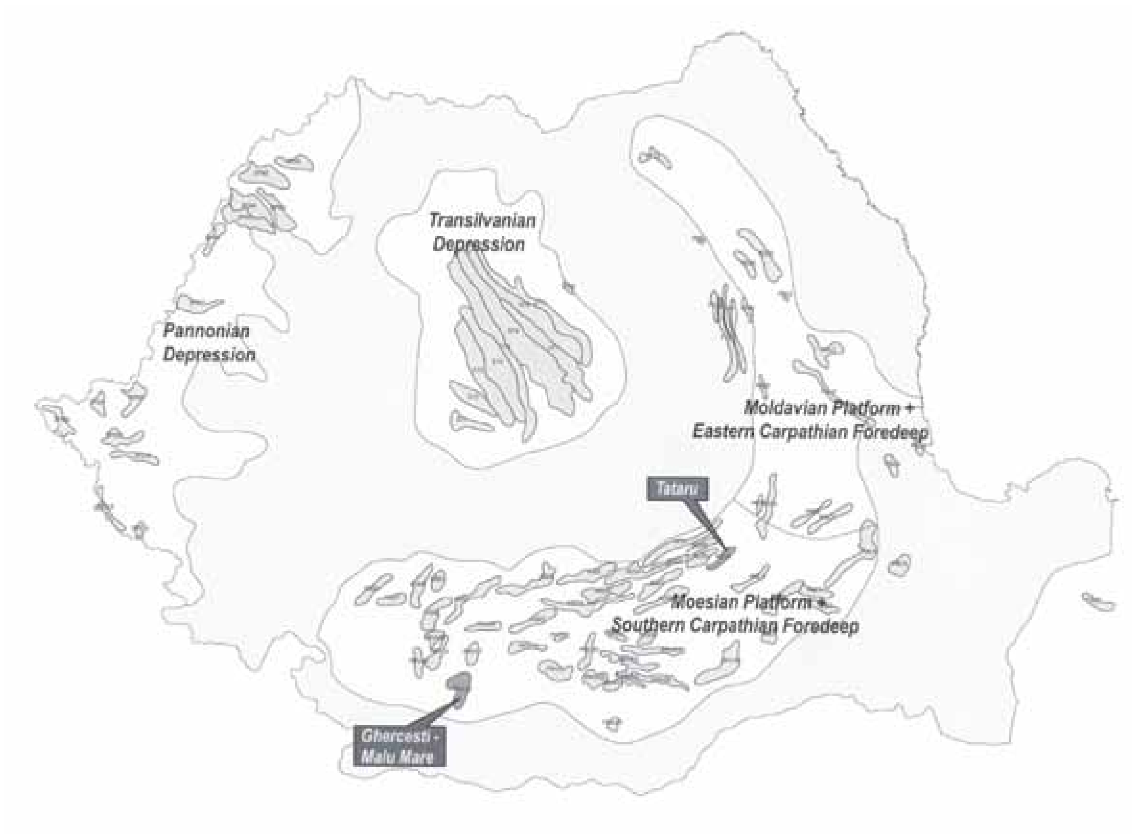
It is now almost unanimously accepted in the international scientific community that the Earth's climate changes have anthropogenic causes, first of them being the greenhouse gas (GHG) emissions among which the carbon dioxide occupies the main place. It is emitted in the atmosphere mainly from industrial installations and vehicles with engines with internal combustion engines. They reach 30.000 Mt every year, while the concentration of carbon dioxide in the atmosphere is now at 380 ppm and growing at a rate of ove 2 ppm per year. Worldwide efforts are made to reduce such emissions. If for the transport vehicles the solutions lie in more efficient engines, hybrid propulsion or even hydrogen combustion, for fixed industrial installations the efforts are toward improving the installations efficiency as well as capture of CO_2 emitted. One, probably the only feasible solution of disposing of the captured CO_2 is its safe storage for long periods of time if not forever, the best being the geological storage. After all, the fossil fuels used today (coal, oil, gas) that produces the unwanted gas are extracted from the earth, it is only logical that the carbon left after the humans have taken and used the energy to be returned back in the earth.

In the Romanian energy sector, as worldwide, it is both necessary and possible to: increase energy efficiency in energy production, distribution and end-use; reduce carbon intensity of power sector by switching coal and fuel oil with natural gas; promote policies aiming to cut down subsidies which encourage market imperfections; research, develop and increase the use of renewable energy sources. These approaches are technically and economically viable alternatives to the use of environmentally damaging conventional energy sources.

We started researches on methods for the reservoir characterization, mainly focused on saline aquifers, hydrocarbon fields and coal beds. A very preliminary screening about CO_2 storage capacity, types of aquifers, natural hazard (seismological and natural gas seepage) was performed. We started also contacts with the National Agency for Mineral Resources, for assessing the availability in Romania of data regarding wells (on-shore, offshore), depleted hydrocarbons fields, regional and more detailed seismic surveys, to be used for assessing the storage potentiality in Romania.

Information on 244 CO_2 emission sources in Romania, totalizing 74,4 Mt was analyzed. Out of those, 64 sources with the CO_2 emissions exceeding 0,1 Mt per year was identified. Information for those sources was loaded in the database. After having analyzed the whole sedimentary succession, several prospective geological sinks have been identified within Romanian territory. Some prospective aquifer formations were defined for further analysis. Relevant data were collected to characterize those formations. The oil fields of Romania were inventoried.



Aquifers and Hydrocarbon Deposits (dark) in Romania

For the capcity calculations in *saline formations* we have used a volumetric ecuation recommended by many authors:

$$G_{CO2} = A.h.\varphi.\rho.E$$

where:

G_{CO2} (Mt) - Storage capacity;
A (Sq. km) - Area that defines the region being assessed;
h (km) - Gross thickness of the saline formation (s);
Φ (%) - Average porosity of entire saline formation(s) over thickness h;
ρ (Mt/Sq.km) - Density of CO_2 evaluated at pressure and temperature that represents anticipated storage conditions;
E (%) - CO_2 Storage Efficiency Factor that reflects, among others, the total pore volume that is filled with CO_2.

As almost everywhere in the world the saline aquifers are poorly known. So in calculating their storage capacity we had to introduce several estimations (especially on reservoir thickness and porosity). The Romanian sedimentary basins potentially containing saline formations have been combined in 4 big zones (Moesian platform and S. Carpatians foredeep, Moldavian platform and E.Carpathians foredeep, Transilvanian basin and Pannonian basin). Out of their total surface areas, the surface with sedimentary cover thinner than 800 m have been eliminated from calculations as such areas are not suitable for CO_2 storage. The efficiency factor considered is only 2 % as was recommended by CO_2 Geocapacity studies. The results are presented synthetically below.

Zone	Surface area [sq km]	Reservoir geological formations	Estimated reservoir thickness [m]	Estimated porosity [%]	CO_2 storage capacity [Gt]
Moesian Platform and South Carpatians Foredeep	38.000	Pontian Meotian Sarmatian Cretaceous Triasic	70	20	5,2
Moldavian Platform and East Carpathians Foredeep	24.000	Sarmatian Tortonian	50	20	2,5
Transilvanian Depression	22.000	Buglovian Sarmatian Tortonian	200	20	8,8
Pannonian Depression	15.000	Pannonian Tortonian Cretaceous	70	20	2,1
			TOTAL		18,6

Efficiency factor = 2%

Estimated CO_2 storage capacity in deep saline aquifers in Romania

The CO_2 storage capacity in depleted or declining *hydrocarbon (oil and gas) fields* can be calculated either by a similar volumetric equation or by a production-based equation if acceptable records of volume of hydrocarbons produced are available. It is only necessary to apply an appropriate formation volume factor (B) to convert hydrocarbon volumes reported as production to subsurface volumes.

The equation is of the form:

$$G_{CO2} = UR_P.B.\rho$$

where: UR_P is the Ultimate Recoverable Oil (or Gas) based on sum of produced volumes and expected reserves.

Romania has a history of 150 years of oil industry. It is estimated that during such a long period of time, some 720 Mt of oil and 1122 Gm^3 have been extracted from its underground. Today it may be considered a “mature” oil and gas province with 70 - 80 percent of its resources already exploited. However, the percentage of hydrocarbons produced varies in various geological units (see table below). Our calculations were based on total oil and gas reserves in each region. It was assumed that in 20 - 30 years the majority of remaining hydrocarbons will be exploited and more fields will become depleted and hence available for CO_2 storage. On the other hand, the same time span of 20 - 30 years will probably be the period until the CO_2 storage will become a mature technology for disposing of the unwanted gas an such a tehnology will be employed on a large scale. Also the possibility of using EOR and EGR should be taken into consideration.

Geological Units	Produced Oil [Mt]	Produced Gas [Gm^3]	Produced Estimated [%] Oil	Produced Estimated [%] Gas	Total Estimated Oil [Mt]	Total Estimated Gas [Gm^3]	CO_2 Deposits Capacity [Gt] Oil	CO_2 Deposits Capacity [Gt] Gas
Pannonian Depression	47	25	80	85	57	29	0,03	0,07
Transilvanian Depression	-	772	-	85	-	908	-	2,27
Barlad Depression	1	2			1	6	-	-
North Dobrogean Promontory	6	13			6	13	-	-
Eastern Carpathians	377	90	85	90	560	100	0,34	0,25
Getic Depression	120	125	70	65	156	192	0,09	0,48
Moesian Platform	169	95	75	70	211	136	0,13	0,34
TOTAL	720	1122			991	1384	0,59	3,41
					GENERAL TOTAL		4,00	

Formation volume factor: Oil - 1,5; Gas - 0,005. CO_2 density - 500 kg/m^3.

Estimated CO_2 storage capacity in oil and gas deposits in Romania

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