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Combined Use of Cross-Sections, Seismic and Core Data to Assess CO2 Storage Capacity and Seal Geometry in a Triangle Zone of Deformation: the MC-J1 Prospect (Cantabrian Margin, Spain)

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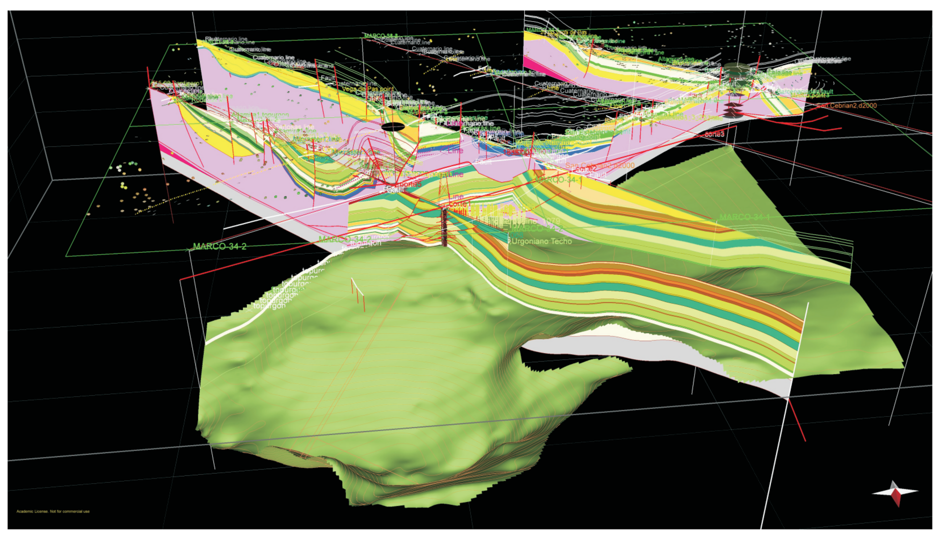
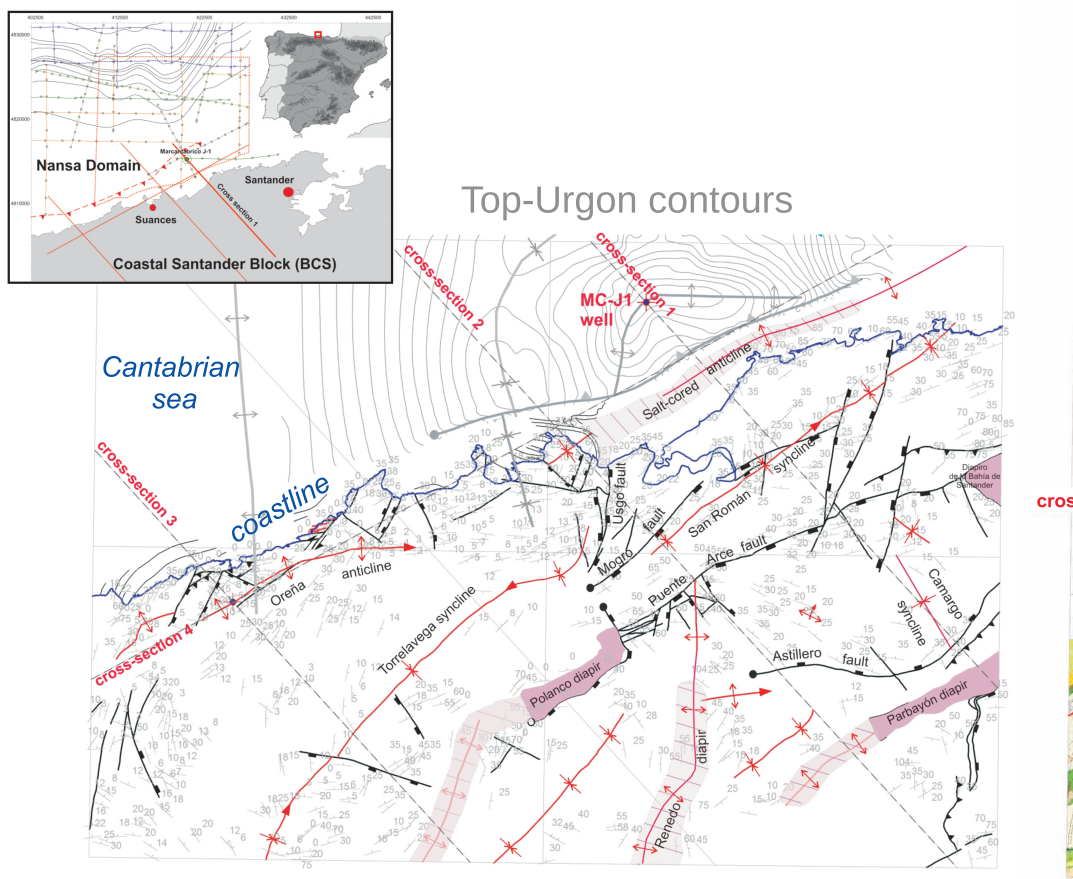
Introduction

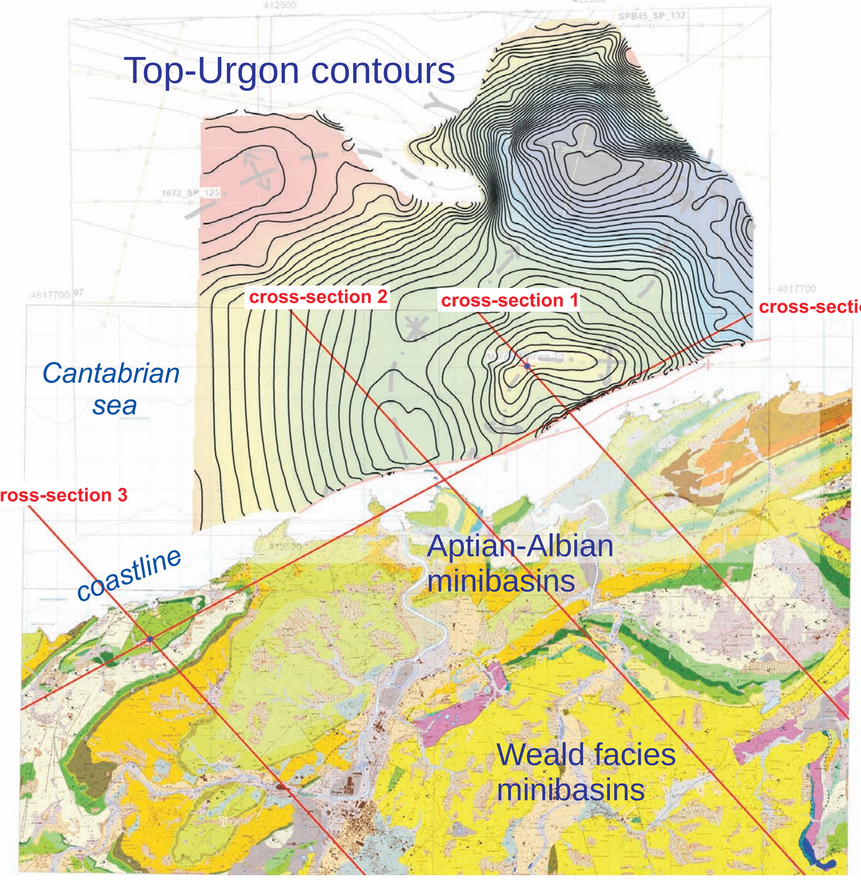


The **ALGECO2** project is a research initiative to characterize potential carbon storage reservoirs in Spain. Three targets have been selected in the Cantabrian Margin where seismic surveys have been collected around former oil wells.

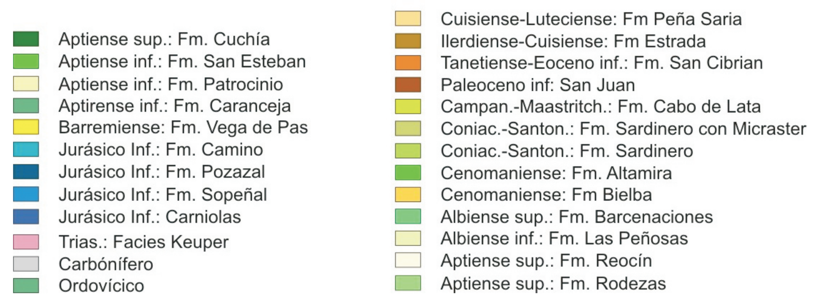
In this poster the reservoir drilled by the **MC-J1 borehole**, 1.5 km offshore of the **Cantabrian coast** of Spain is examined as a possible candidate. The MC-J1 borehole locates on an inverted Lower Cretaceous graben system, which is one of the south vergent basement-cored anticlines of the **Nansa** thrust and fold belt (Espina, 1997). As is defined here, the Nansa Belt constitutes the northern and western boundary of a **detached salt tectonics province** supporting a Lower Cretaceous "rift cover", termed the **Coastal Santander Block (BCS)**. A complex **triangle zone of deformation** connects both areas (García-Senz & Robador, 2009) whose correct interpretation is therefore critical to evaluate the seal geometry of the reservoir.

1. Map view

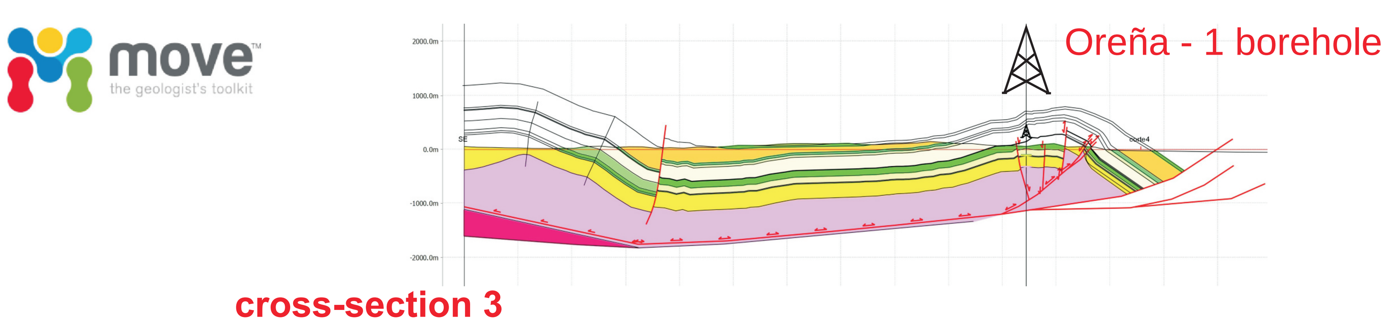


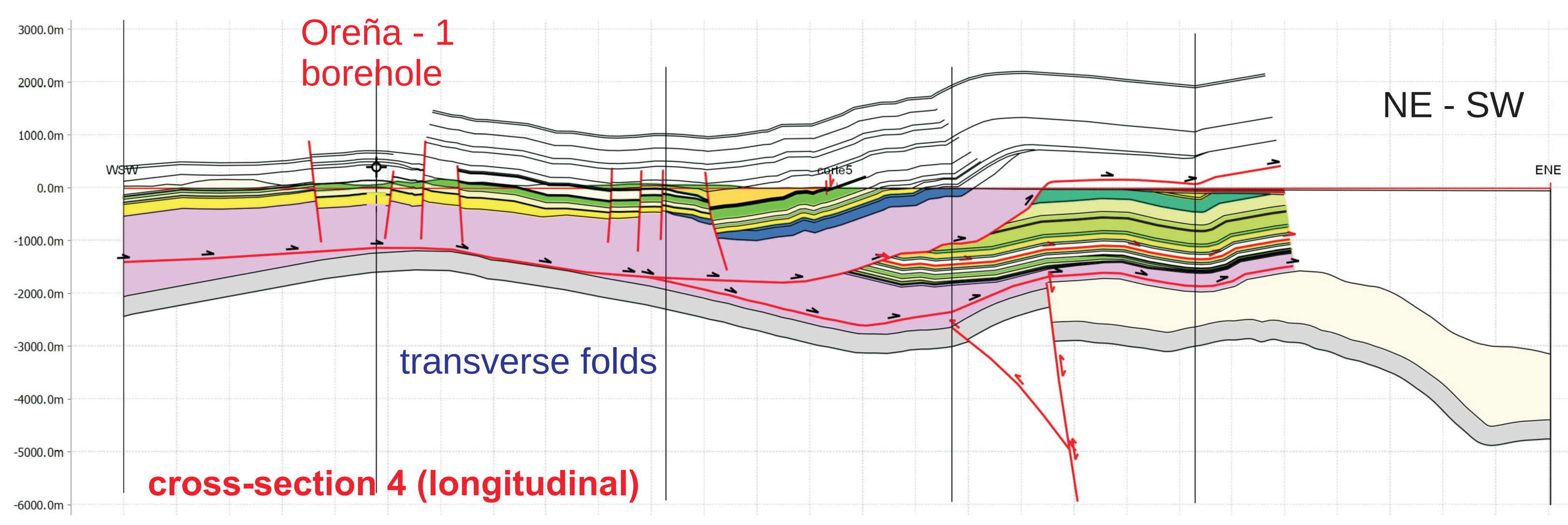


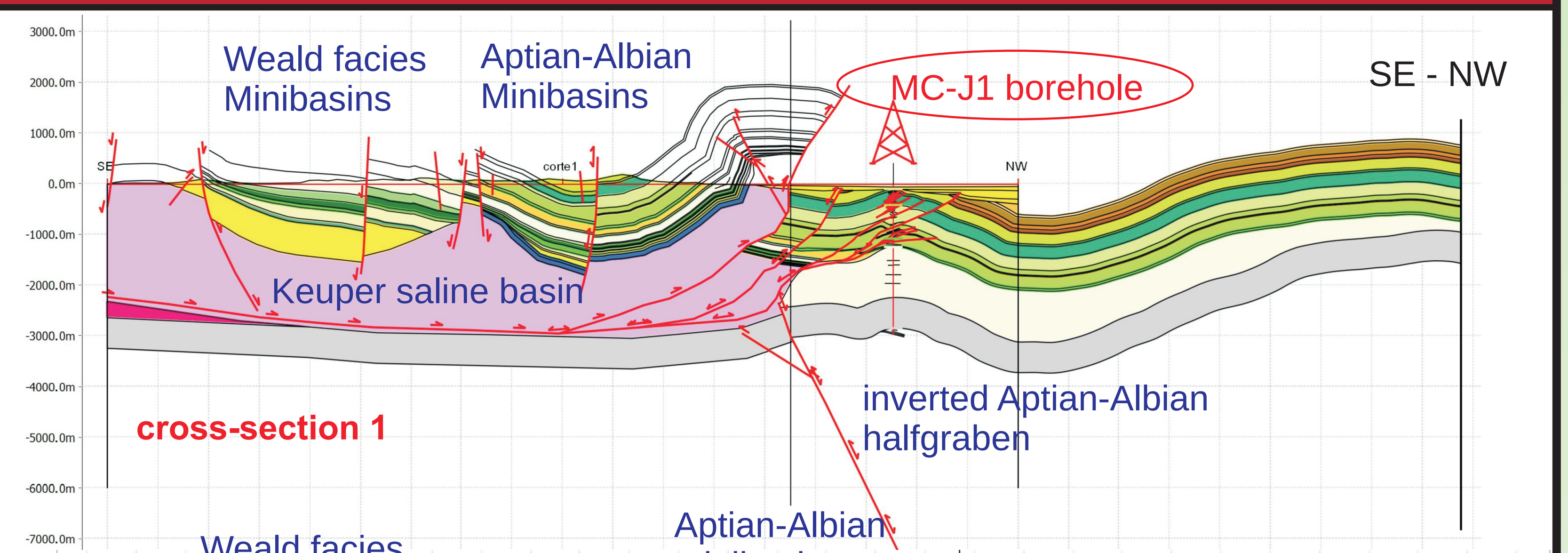
The structural map (left) shows onland the segmentation of the axial traces, faults and diapirs typical of extensional saline tectonics. A transverse relay area occurs in the centre of the map. The Top-Urgon contours offshore are constructed from the seismic lines and represent the folding directions encountered in the basement. The Mosaic of four 1:25.000 geologic maps (http://mapas.cantabria.es) on the right shows the distribution of the cretaceous formations and the locations of the geological cross-sections that greatly assist to the interpretation of the structure in $2D_{1/2}$ and 3D views.

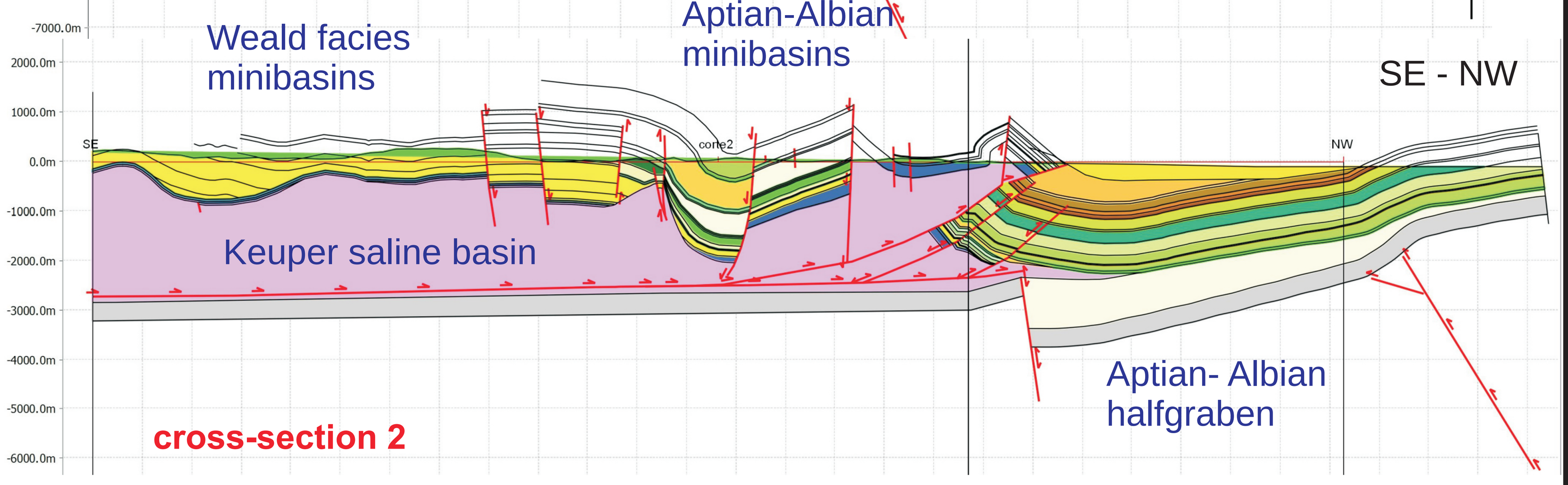


2. Geologic cross-sections



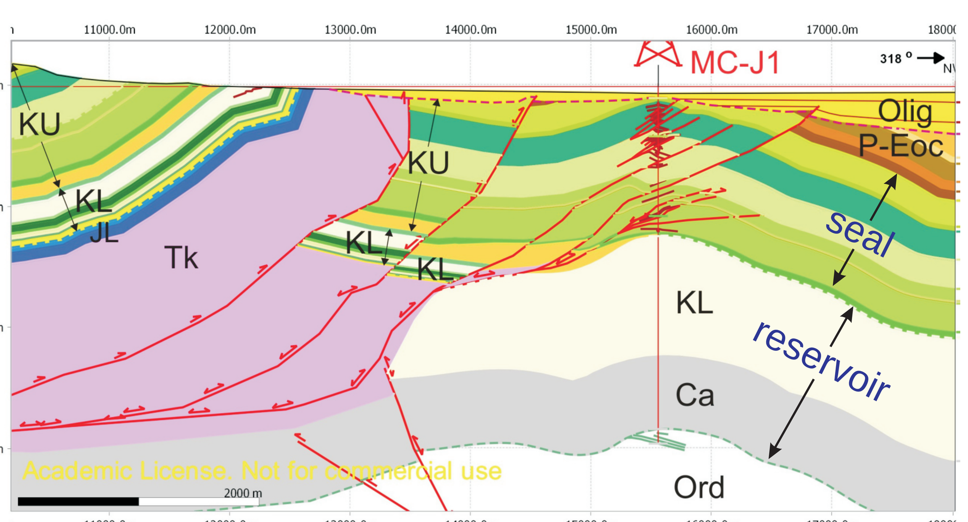


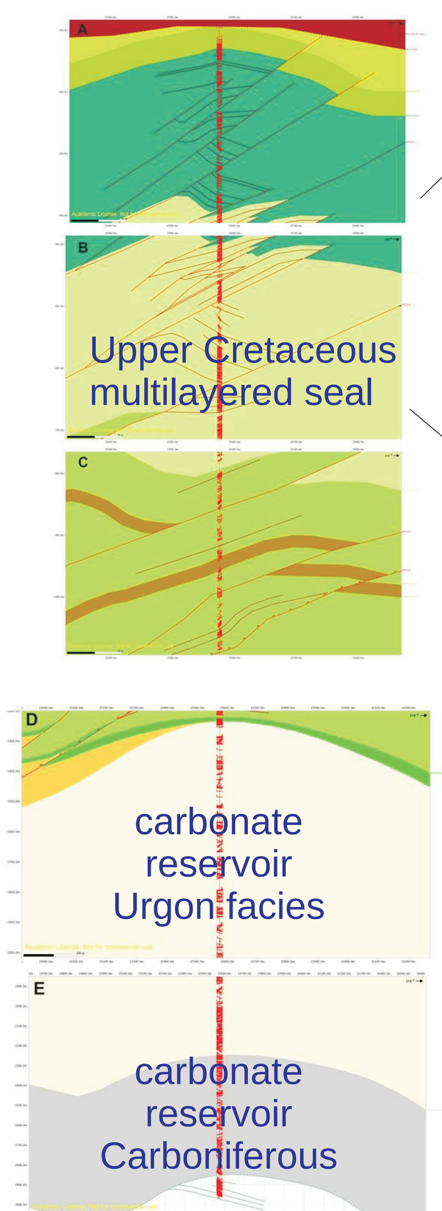


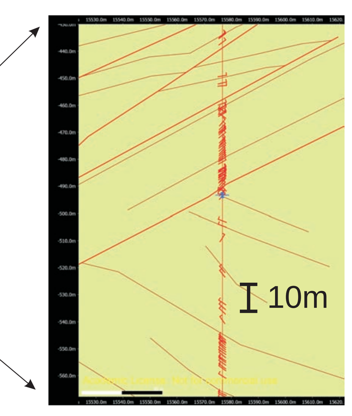


Four geological cross-sections have been constructed with the help of the *MOVE* software (Najarro and García-Senz, 2014). The MC-J1 candidate site is placed in a triangle zone of deformation. Their southern side is a cover frontal thrust that climbs up section from a detachment in Keuper salt into the pinch-out of the thin-skin Triassic-Lower Cretaceous basin, to terminate into the Upper Cretaceous-Paleogene. The imbricate thrusts nucleate in the limit with the viscous Keuper layer. Ramping in the cover in cross-section 1 is favoured by the harpoon structure formed by graben inversion on the northern side of the triangle zone, which acts as a rigid indenter. The triangle zone is anomalous in the sense that no evident structural connection and transfer of displacement exist between the thin skin and thick skin thrusts. Displacement is also superior in the cover thrust. Note the time-migration of the Lower Cretaceous minibasins from NE to SW toward the tip of the saline basin.

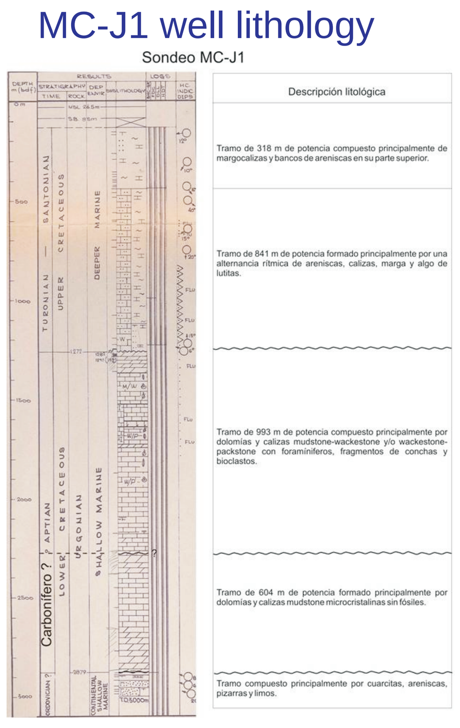
3. Core data. Reservoir and seal detail



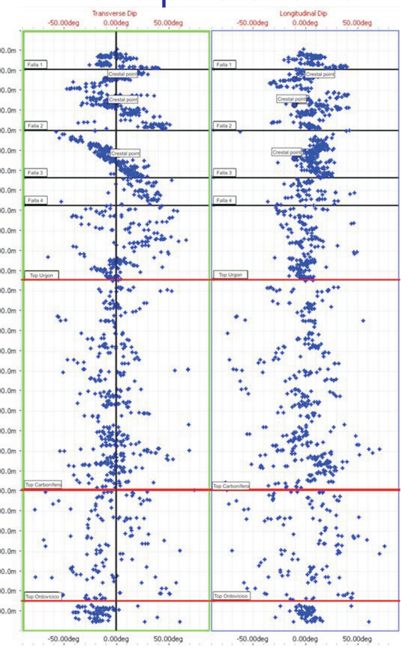




MC-J1 well lithology



Dip-Sequence analysis of dipmeter data



Potential lateral seal is provided by the thickened Keuper evaporites, whereas top seal is provided by the thick (>1000m) Upper Cretaceous to Cenozoic marly-limestones and marls that form the multilayered caprock. Seal integrity may be affected nonetheless by deformation bands and fractures linked to the thrusts.

The reservoir is formed by 1607 meters of Aptian limestones and dolomites (the lower 600m may however correspond to the Carboniferous), sandwiched between the Ordovician Q-arenites and the Upper Cretaceous marls.

4. Storage capacity calculation

Table 1

Reservoir Unit 2- Mar Cantábrico J1 borehole (1607 m)						
Lithology		Thickness		Rock volume (m^3)	Porosity Ød(%)	Pore volume (m^3)
		metres	percentage			
Carbonate	Sandy lst.	19	1,2	104,02E+06	1-9 (5)	5,20E+06
	Marly lst.	6	0,4	34,67E+06	0,1-13 (6,5)	2,25E+06
	Limestone	1448	90,1	7809,80 E+06	0,7-6 (3,4)	265,53E+06
	Dolomite	119	7,4	641,43E+06	4-7 (5,5)	35,28E+06
Marl		15	0,9	78,01E+06	N/D	N/D

Table 2

Rock volume (m3)	Pore volume (m3)	CO2 storage capacity (tons)	CO2 efficient storage capacity (tons)
17054.90E+06	**308.260E+06**	**231.195E+06**	**69.3590E+06**

Table 1 shows the data used for calculation of the pore volume in the reservoir Unit (Urgon and Carboniferous carbonates) derived from the Gamma ray and sonic registers.

Table 2 shows the total rock volume of the reservoir and the pore volume used to calculate the storage capacity at the pressure and temperature appropriate for the injection depth. The efficient storage capacity is obtained after applying a correction factor of 0,3.

Conclusions

The **MC-J1 trap** is as a **complex triangle zone** at the termination of a **detached saline basin** supporting a **thickened Lower Cretaceous cover**. The **reservoir** is a **harpoon** structure formed by the inversion of an **Aptian-Albian halfgraben**. Potential **lateral seal** is provided by a **wall of evaporites** and **vertical seal** is provided by a **multilayered caprock** affected by **deformation bands** and **fractures**. The available data indicates that the MC-J1 is a **suitable candidate site** for **geologic CO_2 storage** with an **efficient capacity** of **69.3590E+06 tons**.

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