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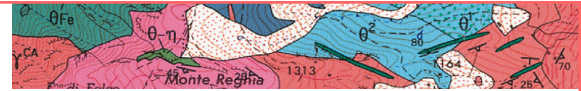
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Remediation of CO₂ Leakage from Deep Saline Aquifer Storage Based on Reservoir and Pollution Engineering Techniques

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CONTEXT

European Directive 2009/31/EC on the geological storage of CO₂ states:

Article 16, **Measures in case of leakages or significant irregularities**

« Member States shall ensure that in the event of leakages or significant irregularities, the operator immediately notifies the competent authority, and takes the necessary corrective measures ».

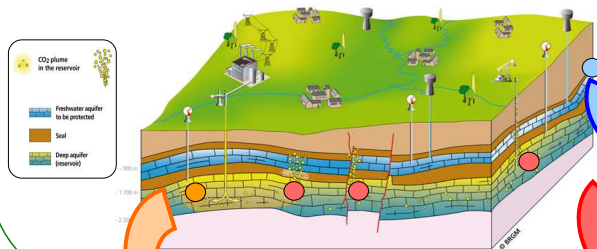
« **significant irregularity** » means any irregularity in the injection or storage operations or in the condition of the storage complex itself, which implies the risk of a leakage or risk to the environment or human health;

« **corrective measures** » means any measures taken to correct significant irregularities or to close leakages in order to prevent or stop the release of CO₂ from the storage complex.

➤ Available remediation measures mainly stem from the field of **reservoir and pollution engineering** (e.g. IEA GHG, 2007);

➤ But due to the **uniqueness of CO₂ geological storage activities** (time and spatial scale): the extent to which such measures can be used, if not **adapted**, for CO₂ storage in deep saline aquifers should be investigated;

➤ We adopt the global framework of the "**source – transfer – target**" approach in case of the **monitoring plan has detected an accidental CO₂ leakage from the reservoir** (either through faults or through abandoned wells).



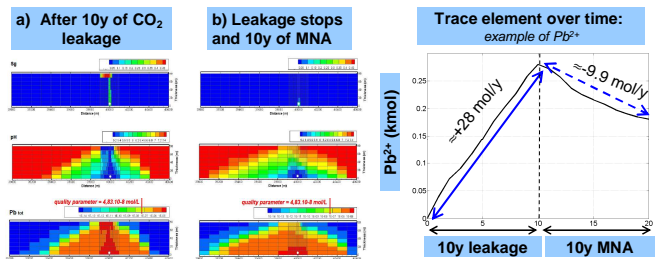
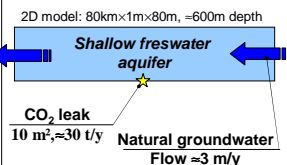
TARGET

➤ **Objective:** remediate the **geochemical impact of a CO₂ intrusion** (release of Al, Ba, Cd, Cu, Fe, Mn, P, Pb and Zn);

➤ **Remediation technique:** **monitored natural attenuation MNA**;

➤ **2D Reactive transport simulation:** TOUGHREACT (Xu et al., 2004);

➤ **Properties based on the glauconitic sandstone Albian aquifer** (France) with mineral precipitation/dissolution reactions as being the main processes, (Vong et al., 2009).



Provided that the leakage is stopped, we show:

1. **Rapid decrease** of the free mobile accumulated gas in the aquifer;
2. **Natural attenuation of trace element release may be a long process**; in this case, the re-precipitation of the released Pb²⁺ requires almost 30y;
3. **More active intervention** procedures should be envisaged (e.g. pump and treats techniques).

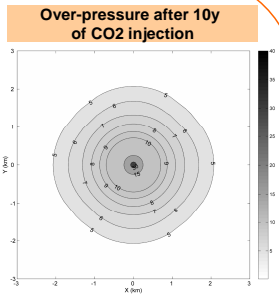
SOURCE

➤ **Objective, in case of abnormal behaviour,** control the injection-induced overpressure within the reservoir;

- **Remediation technique:**
1. **Pressure natural recovery;**
 2. **Extract the injected CO₂;**
 3. **Extract brine.**

➤ **Multiphase flow transport simulation:** TOUGH2/ECO2n (Pruess et al., 2005);

➤ **Application case:** 2D model of the Dogger aquifer in the Paris basin (Le Guenan et al., 2009).



	Benefits = Pressure decrease		Cost
	in the injection zone	at 3km from the injection zone	
1.	65%	30%	1Mt CO ₂
2.	80%	45%	1.5Mt CO ₂
3.	70%	35%	1Mt CO ₂ +1 well+0.5 Mt brine

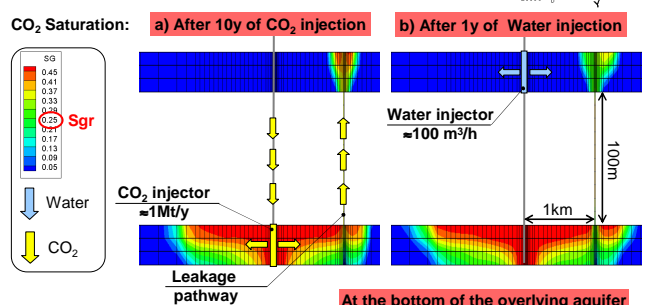
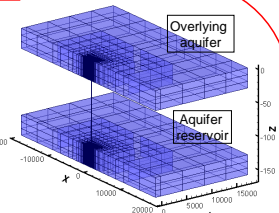
TRANSFER

➤ **Objective:** control the upwards migration of the CO₂ leak;

➤ **Remediation technique:** **hydraulic barrier** through water injection in the overlying aquifer;

➤ **Multiphase flow transport simulation:** TOUGH2/ECO2n (Pruess, 2005) and Local grid refinement (e.g. Audigane et al., 2009);

➤ **Typical properties** of sedimentary aquifers.



Hydraulic barrier has a twofold effect:

1. The **CO₂ leakage flow rate** at the bottom of the overlying aquifer is **stopped**;
2. The **trapping** (dissolution and residual) of the accumulated CO₂ is **enhanced**.

References

Audigane, P., Chiaberge, C., Lions, J., Humez, P., 2009. Modeling of CO₂ leakage through an abandoned well from a deep saline aquifer to fresh groundwater. Proceedings of the TOUGH Symposium 2009, LBNL, Berkeley, California, September 14-16, 2009.
 European Commission, 2009. Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide
 IEA-GHG, 2007. Remediation of Leakage from CO₂ Storage Reservoirs. IEA Greenhouse Gas R&D Programme, 2007/11, September 2007.
 Le Guenan T., Rohmer J., Gastine M., 2009. Managing CO₂ seepage risk for deep saline aquifer reservoirs through preventive and corrective measures based on reservoir engineering - Application to the Paris basin case., in The 5th Trondheim Conference on CO₂ Capture Transport and Storage - Norgeve - Trondheim - 16-17 June 2009
 Pruess, K., 2005. ECO2N: A TOUGH2 Fluid Property Module for Mixtures of Water, NaCl, and CO₂. Report LBNL-57952. Lawrence Berkeley National Laboratory, Berkeley, CA, USA.
 Vong C.Q., Lions J., Audigane P., Humez P., Chiaberge C., Bouc O., 2009. Potential hydrogeochemical impacts of CO₂ leakage into shallow aquifers : review and modelling., in CO₂NET 2009 Annual Seminar Agenda - Trondheim - Norway - 16-19 June 2009
 Xu T., Sonenthal E.L., Spycher N., Pruess K., 2004. TOUGHREACT user's guide. Lawrence Berkeley National Laboratory Report LBNL-55460.

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