



Journée « Sécheresse Géotechnique »

Caractérisation hydro-mécanique des sols sensibles au retrait gonflement. Approches expérimentales au laboratoire

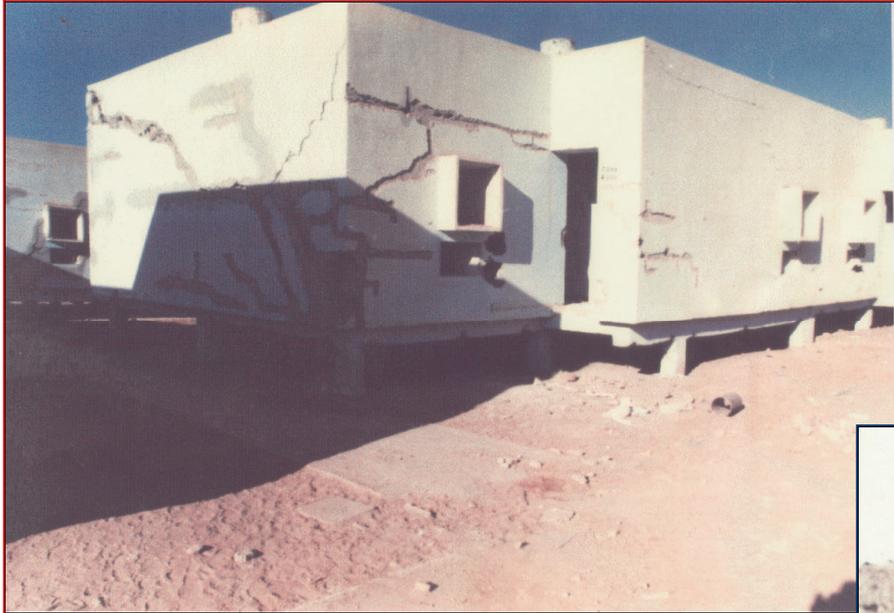
Jean-Marie Fleureau & Hanène Souli
LMSSMat / UMR 8579 CNRS / Ecole Centrale Paris



<http://www.mssmat.ecp.fr>



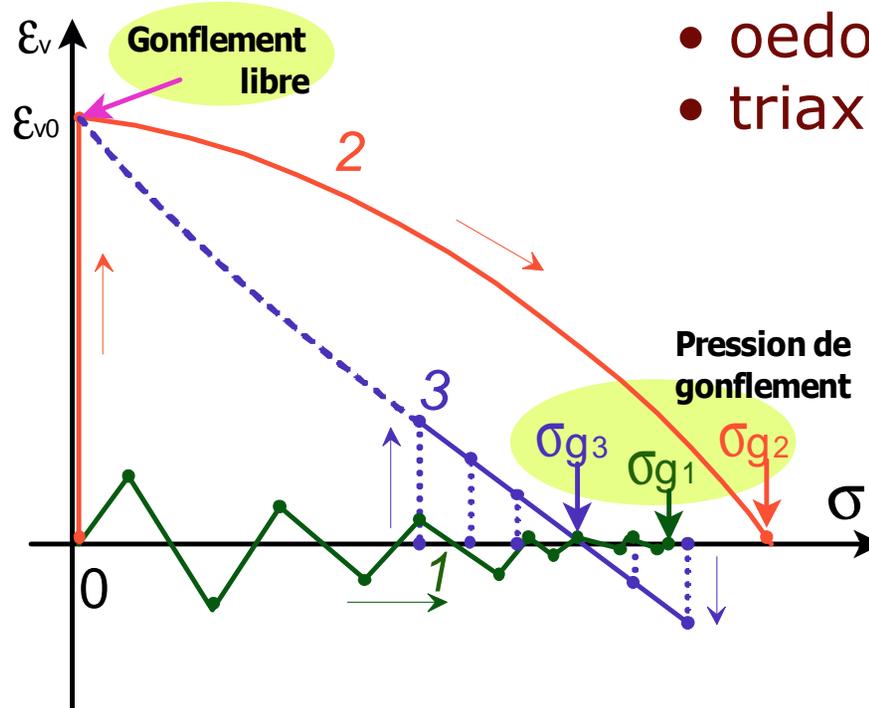
Retrait- Gonflement



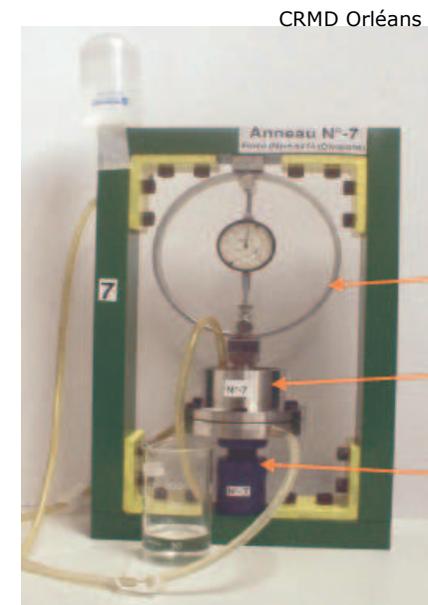
Caractérisation mécanique d'un sol vis-à-vis du retrait et du gonflement :

- Gonflement libre
- Pression de gonflement
- Chemins de séchage-humidification à pression capillaire (suction) imposée
- Limite de retrait
- Couplage entre la contrainte et la suction

Mesure du gonflement libre et de la pression de gonflement



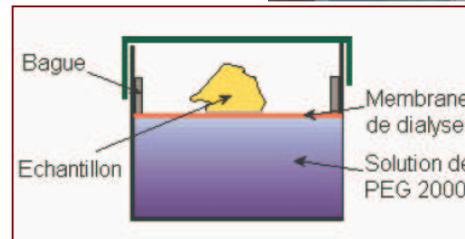
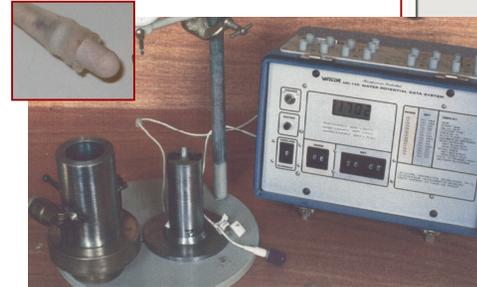
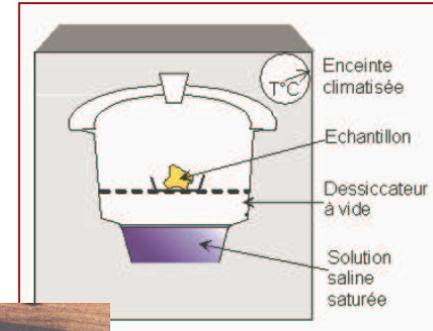
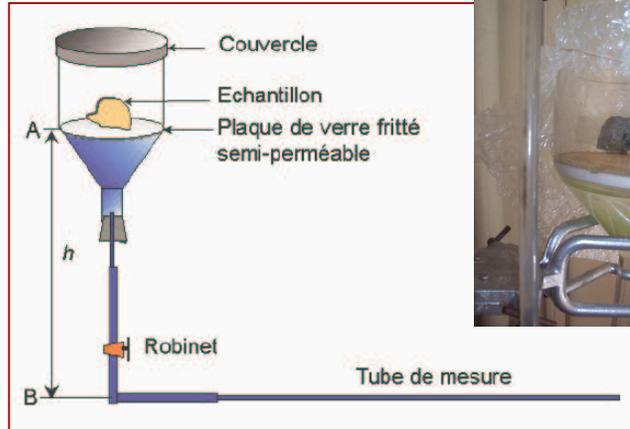
- oedométrique
- triaxial



Anisotropie du gonflement et de la pression de gonflement ?

Essais de séchage-humidification sur sols normalement consolidés

Méthodes expérimentales utilisées



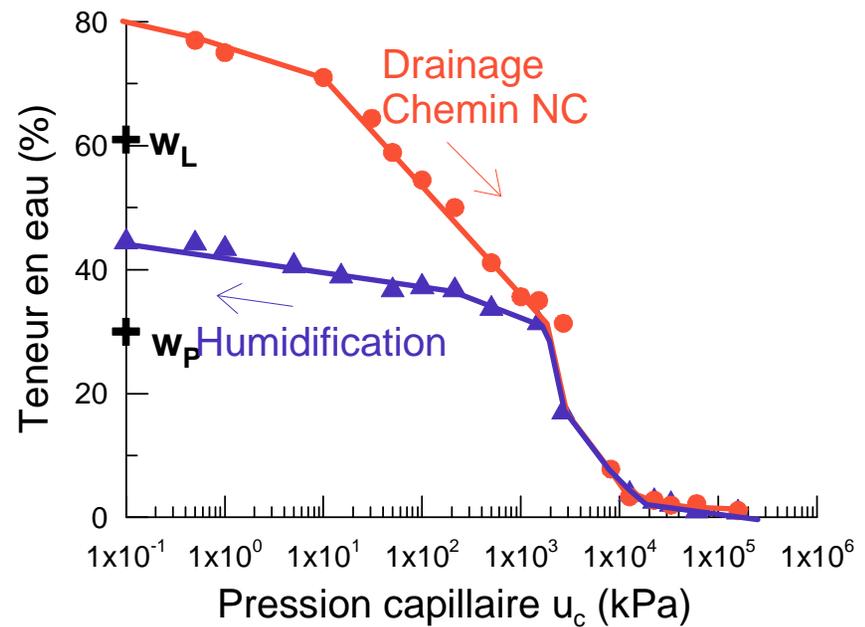
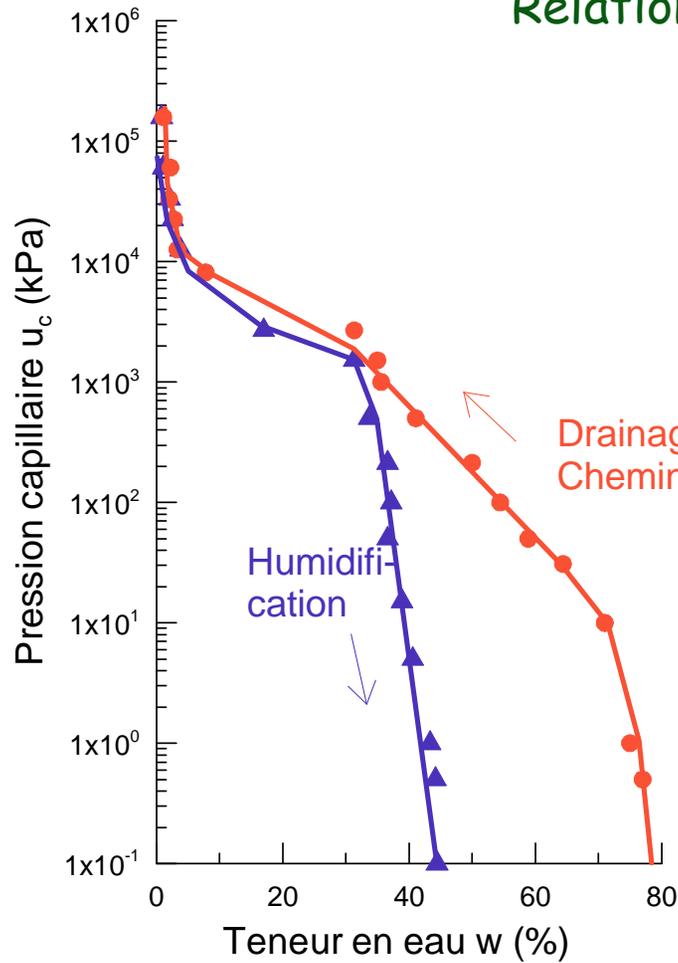
< 30 kPa

50 – 1500 kPa

> 3000 kPa

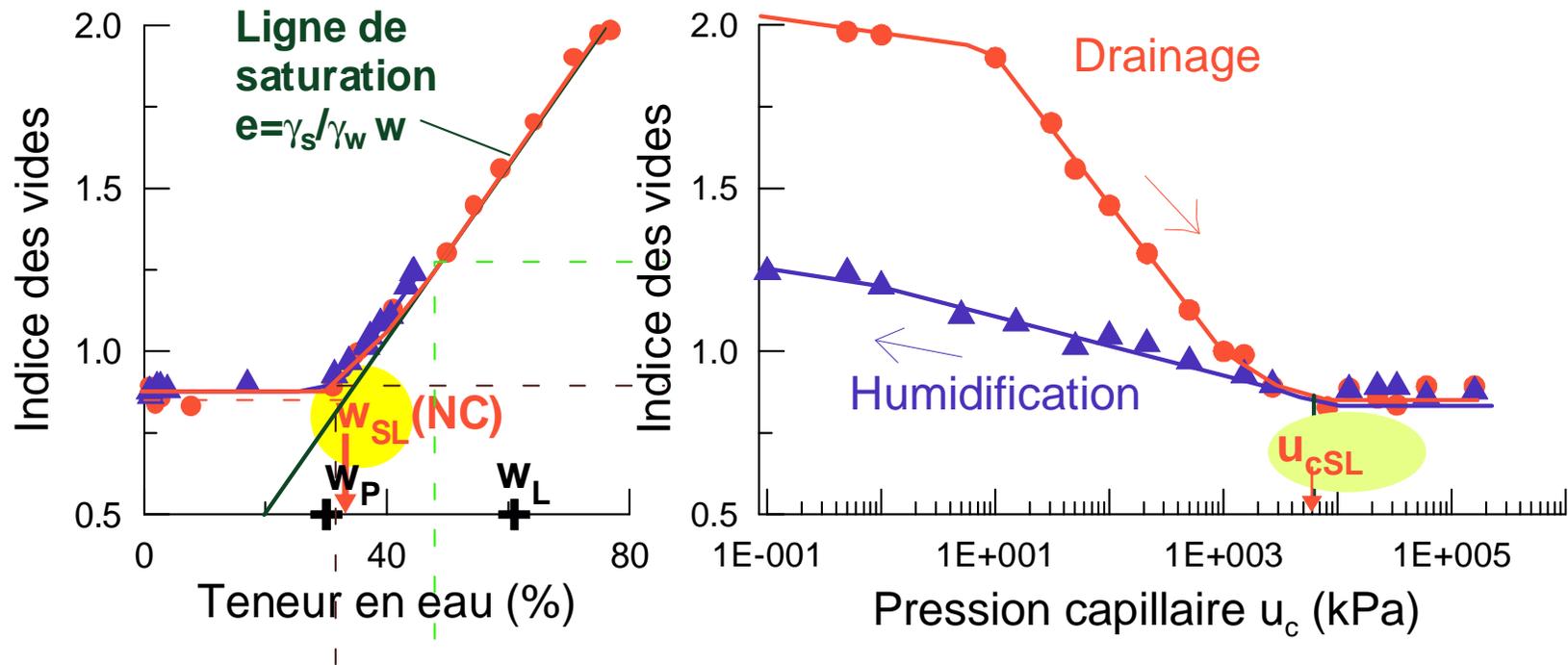
Séchage-humidification d'une pâte

Relations $w(u_c)$ et $u_c(w)$

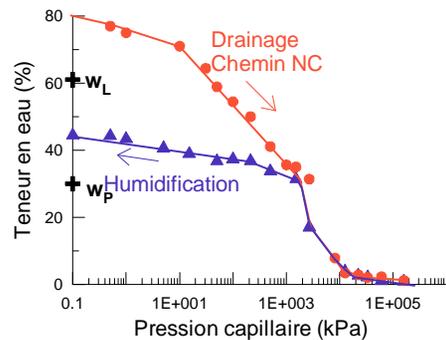
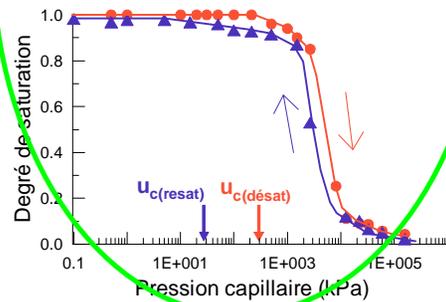
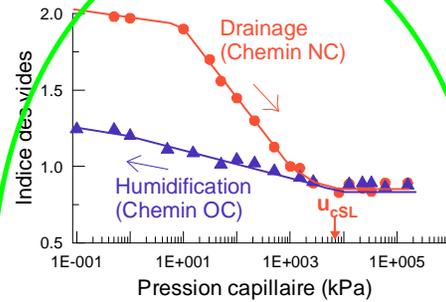
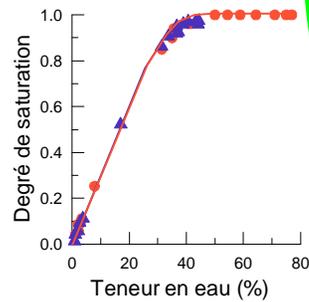
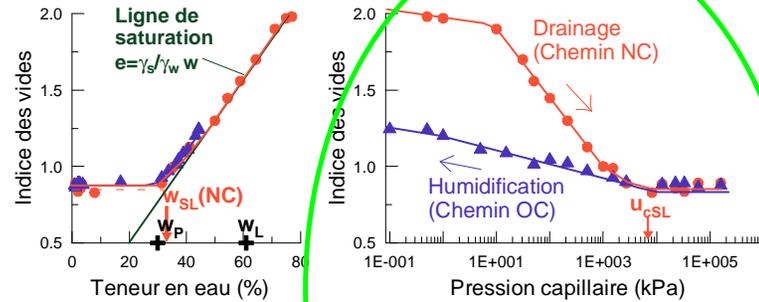


Séchage-humidification d'une pâte

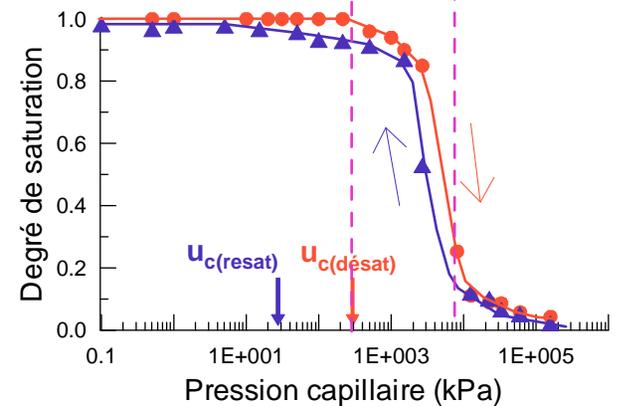
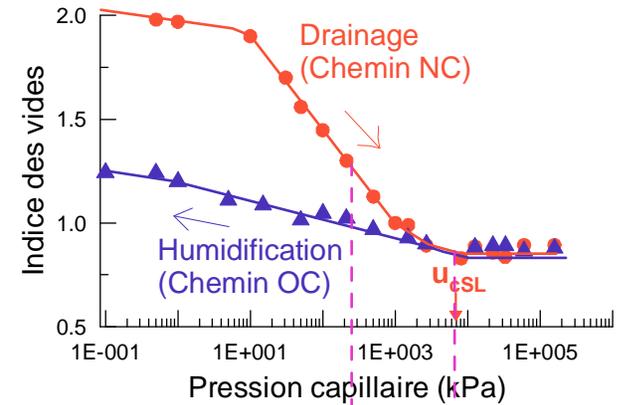
Relations $e(u_c)$ et $e(w)$



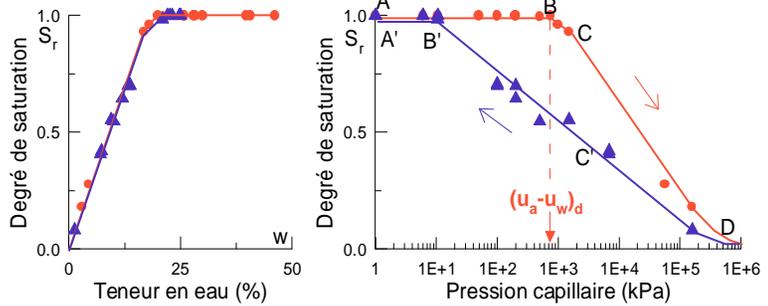
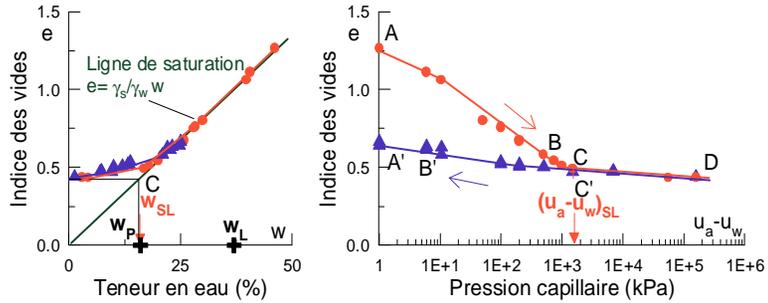
Séchage-humidification d'une pâte



Kaolinite blanche
 $w_L=61 - IP=30$
 ● Drainage NC (pâte)
 ▲ Humidification

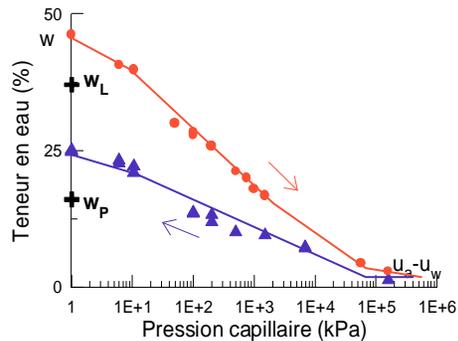


Limon moyennement plastique

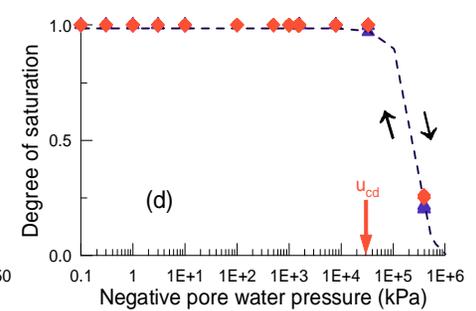
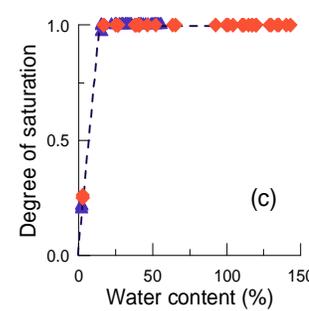
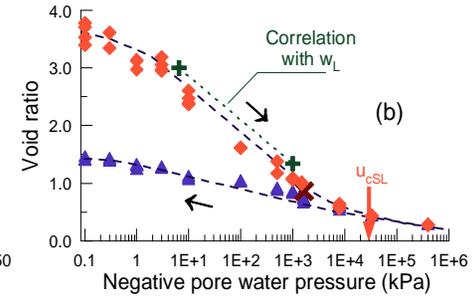
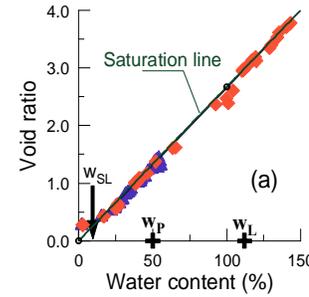


Limon de Jossigny

- Drainage de la pâte
- ▲ Imbibition



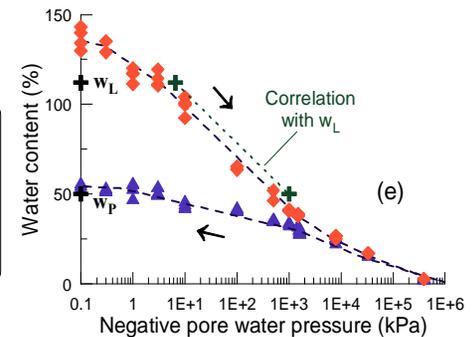
Argile très plastique



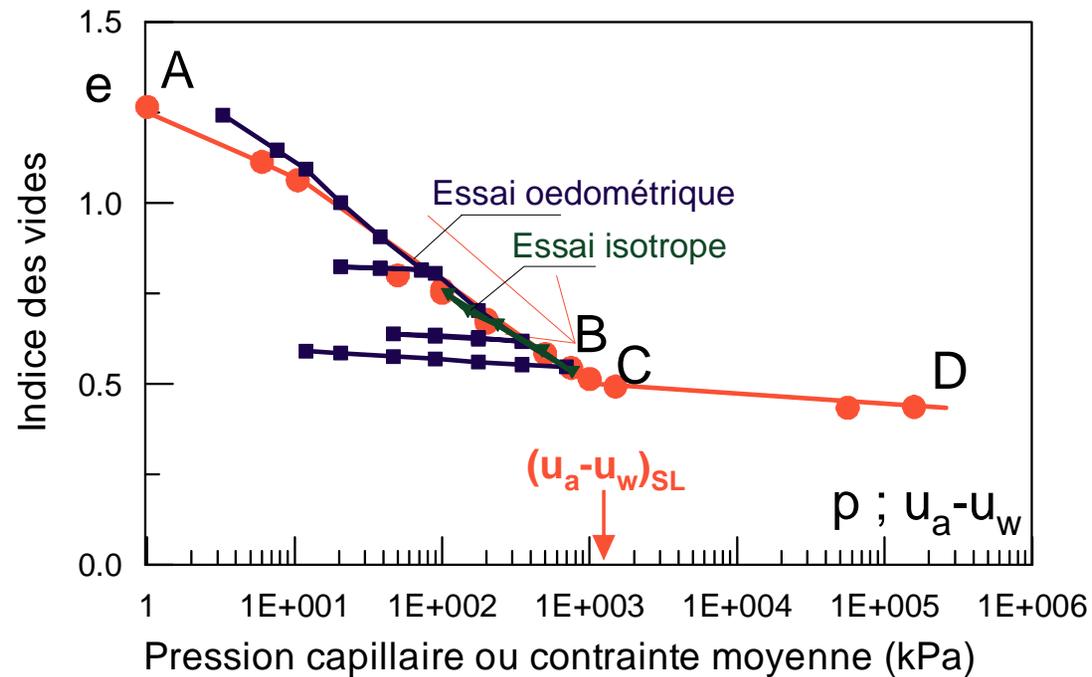
FoCa smectite

$w_L = 112\% - I_p = 62\%$

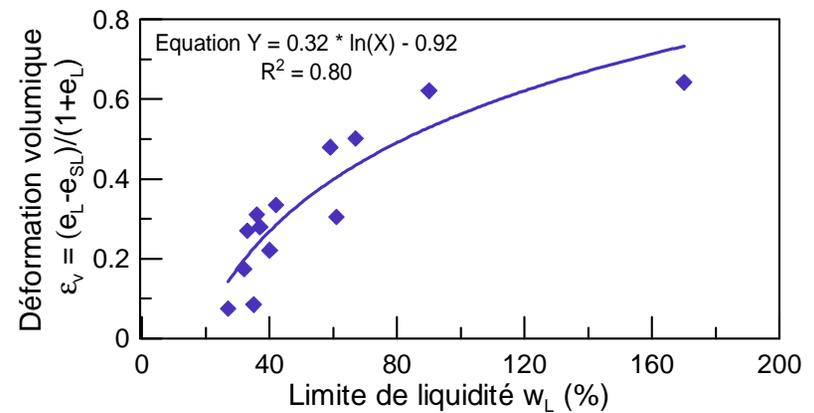
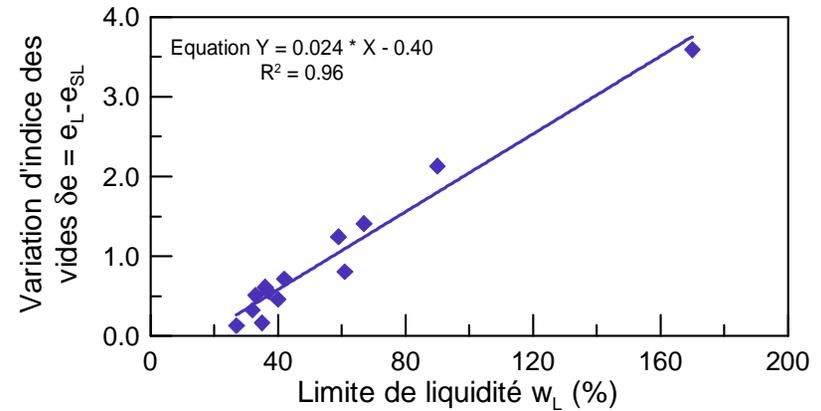
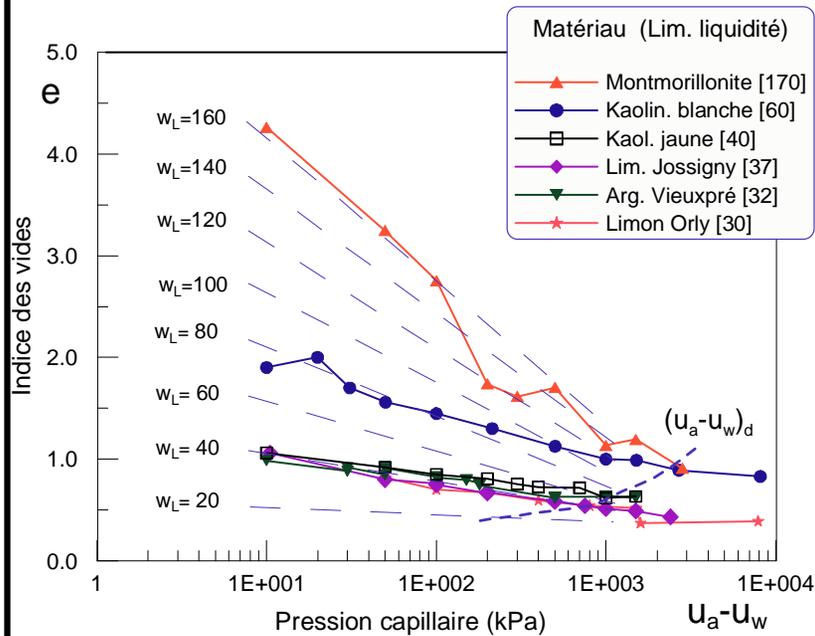
- ◆ Drying from slurry
- ▲ Wetting of dried slurry
- ⊕ Correlation with w_L



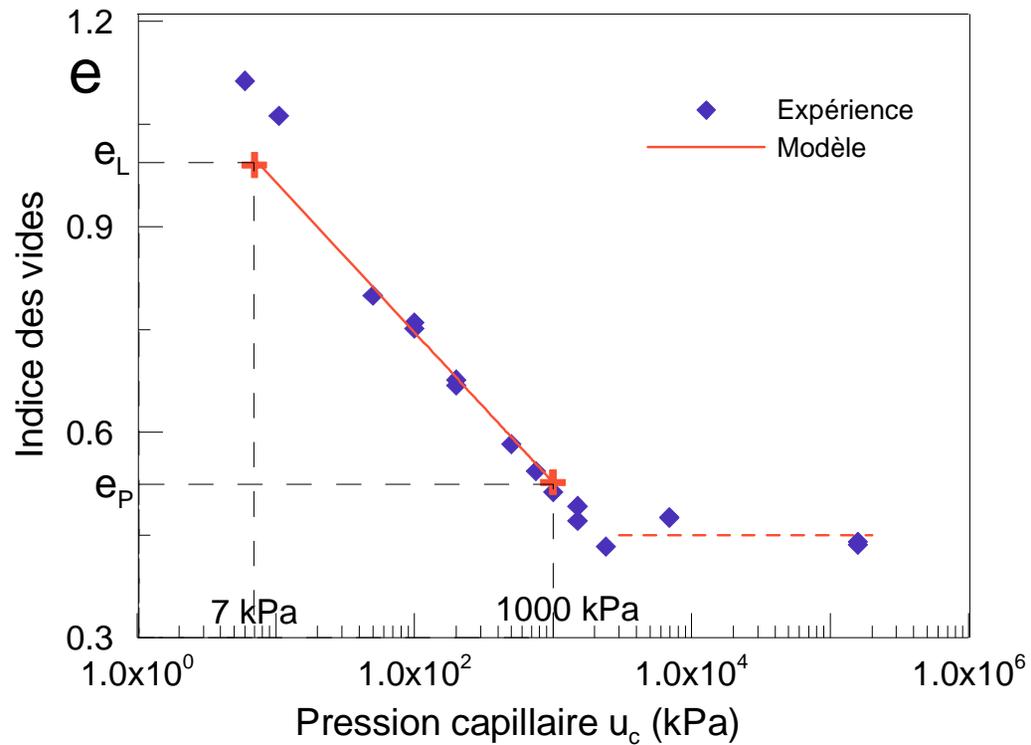
Comparaison séchage - compression isotrope ou oedométrique

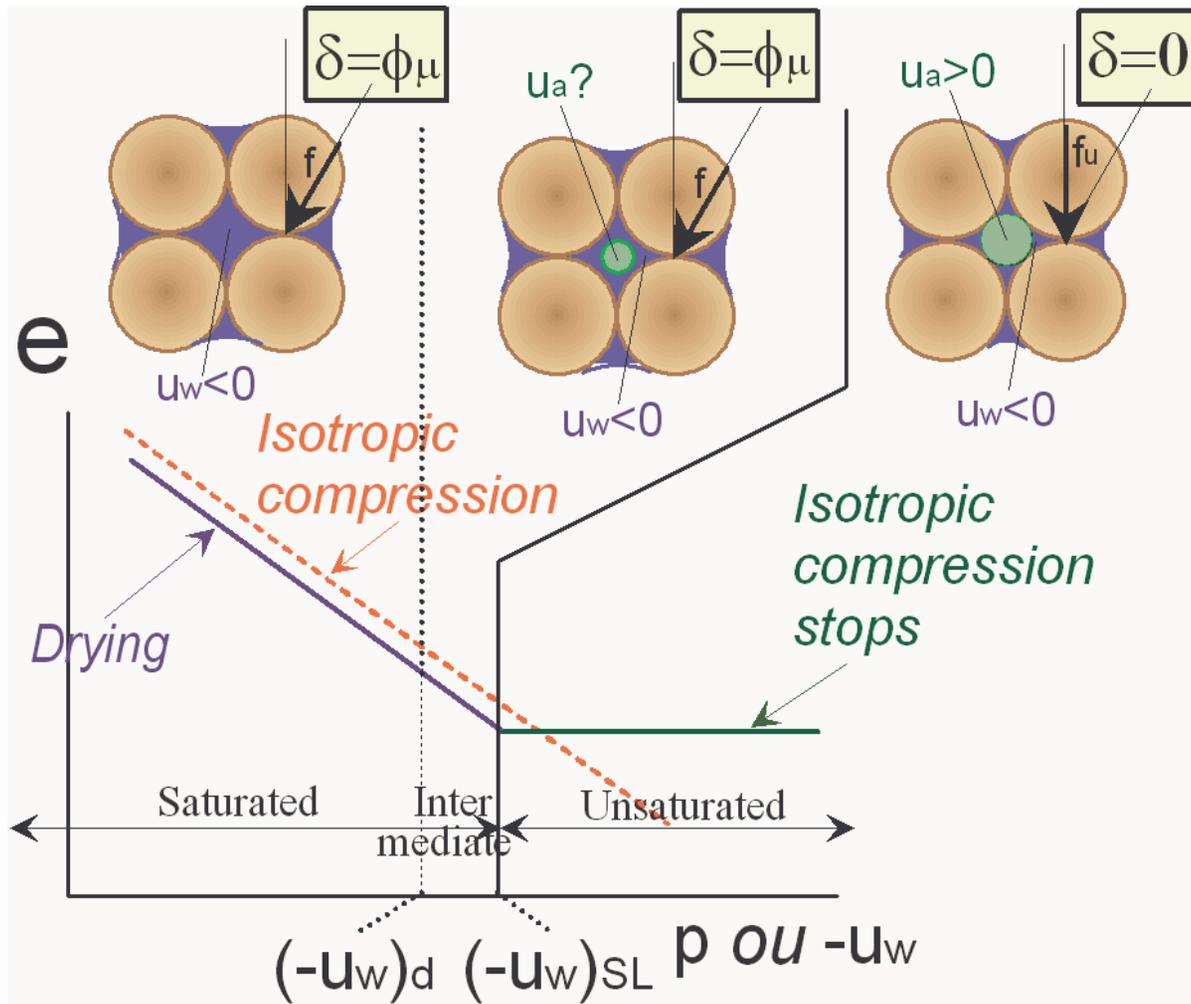


Utilisation des corrélations avec w_L



Modélisation de la courbe de séchage NC (limon de Jossigny)

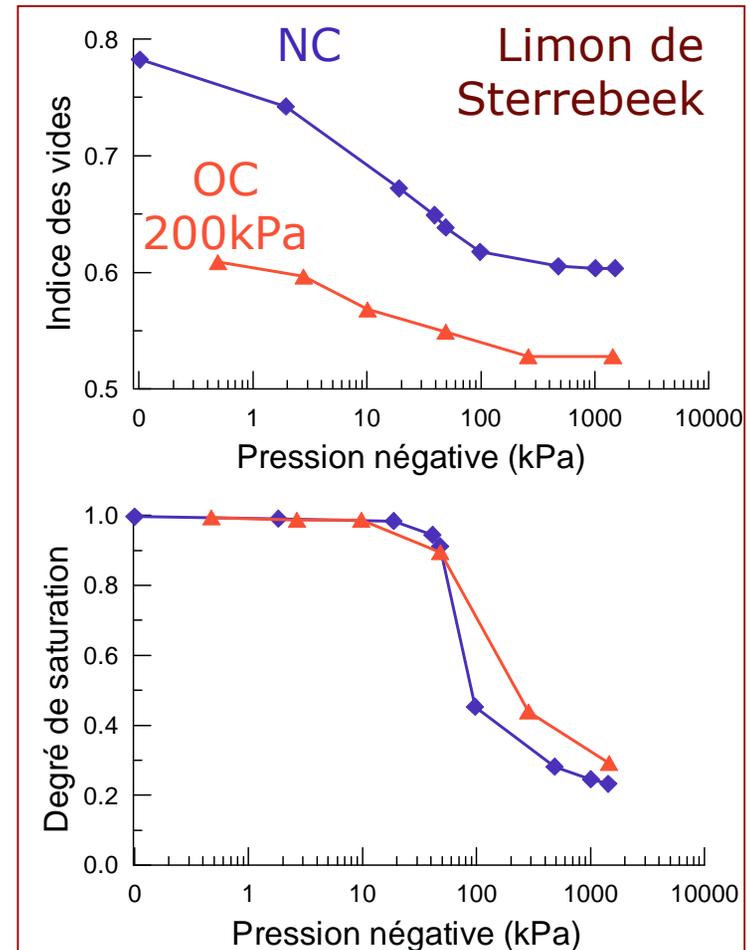
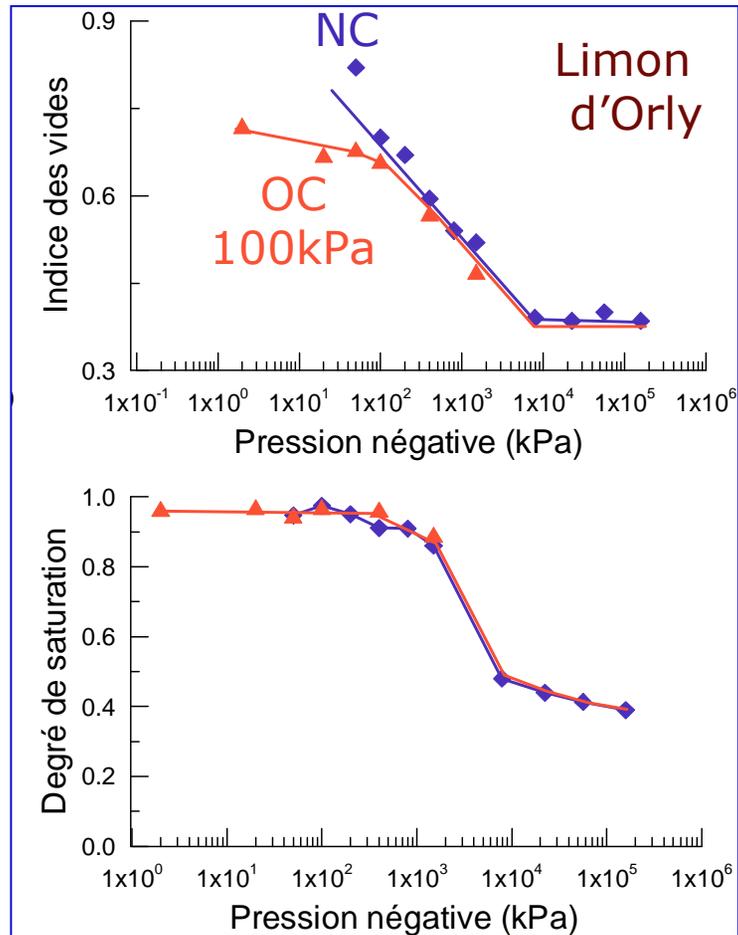




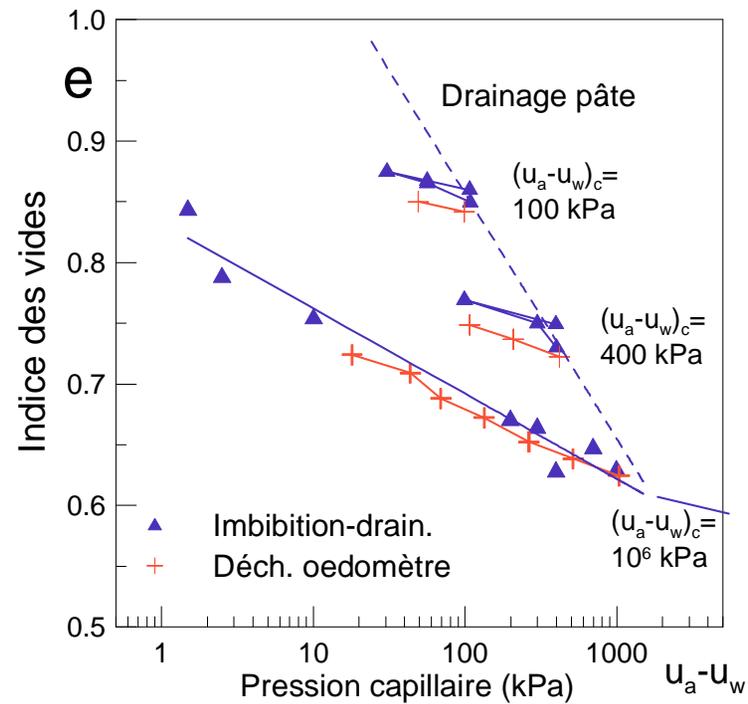
Sols naturels

- Sols surconsolidés par une contrainte mécanique
- Sols surconsolidés par une pression capillaire (séchage)
- Sols cimentés (carbonatés...)

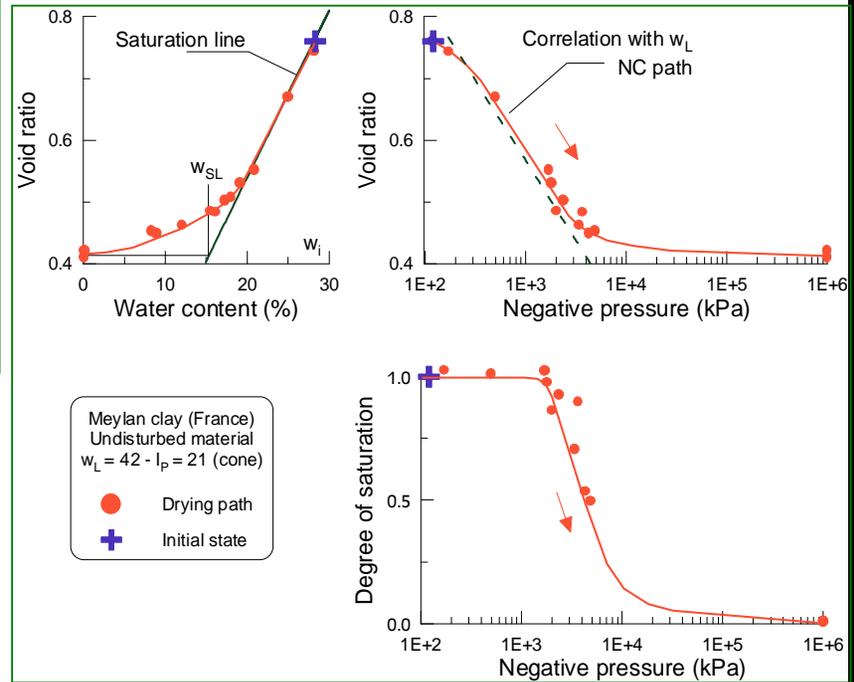
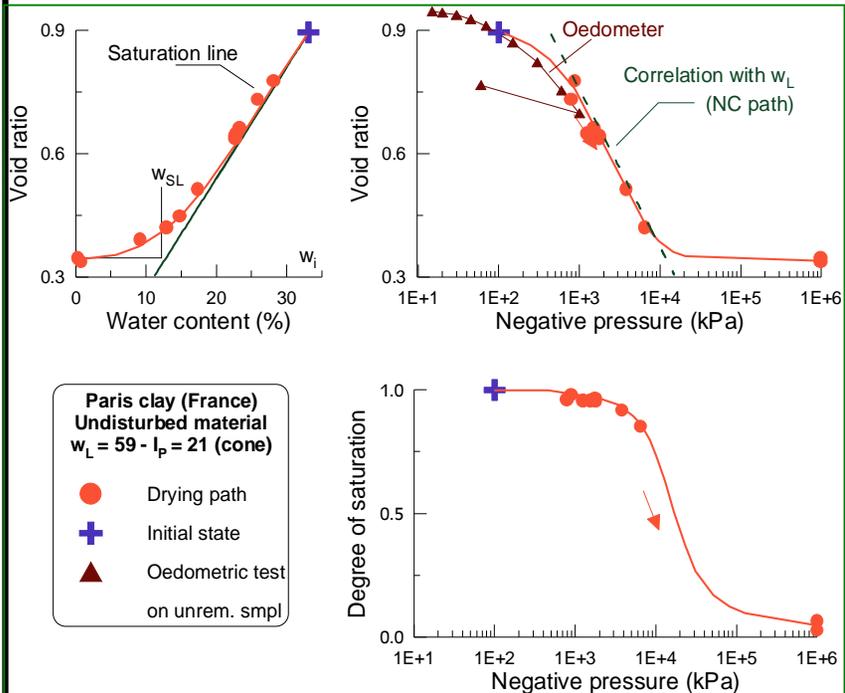
Influence de la contrainte de consolidation



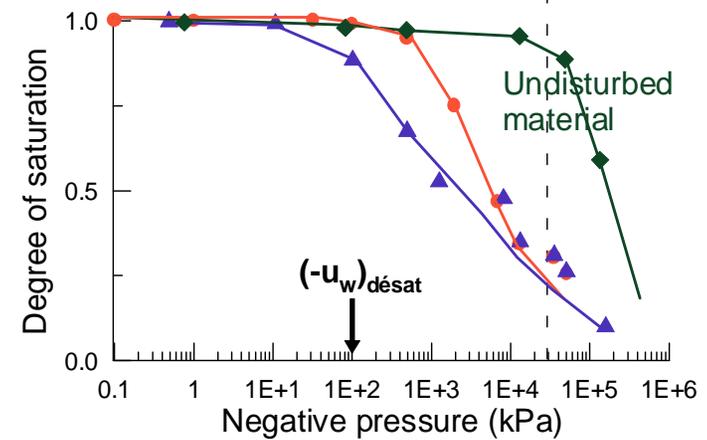
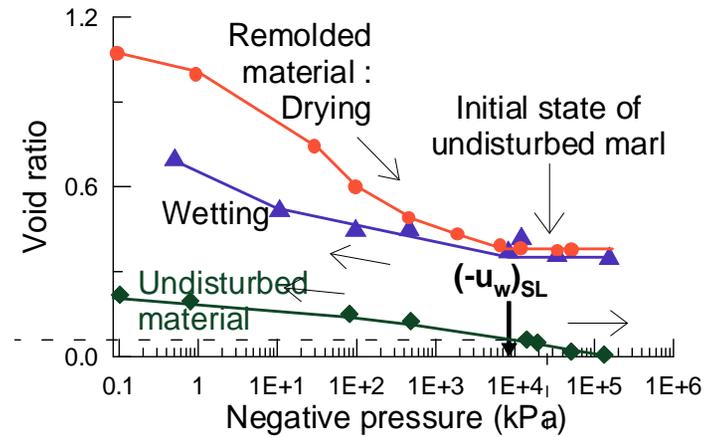
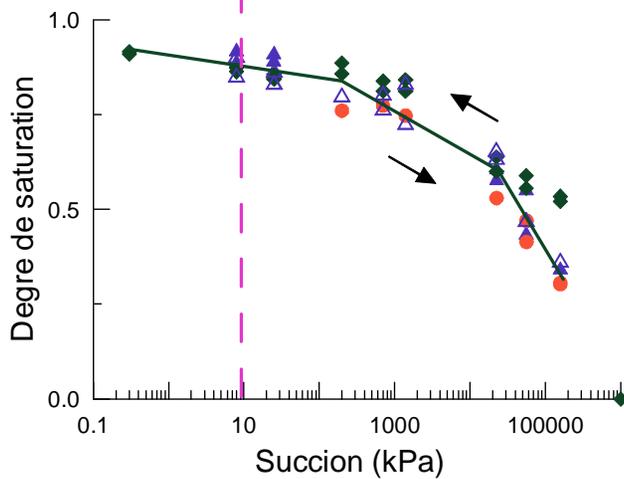
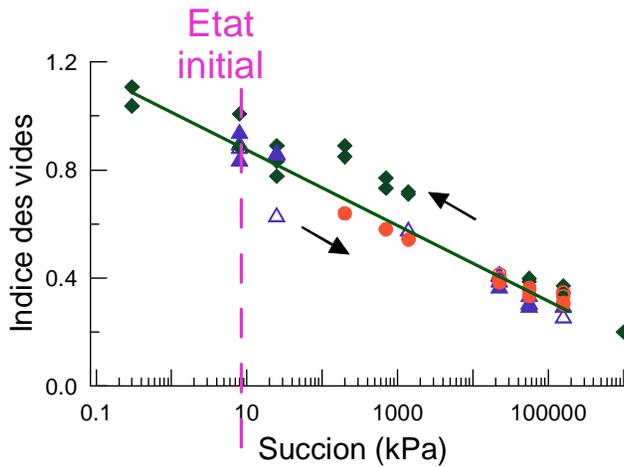
Sol surconsolidé par une pression capillaire



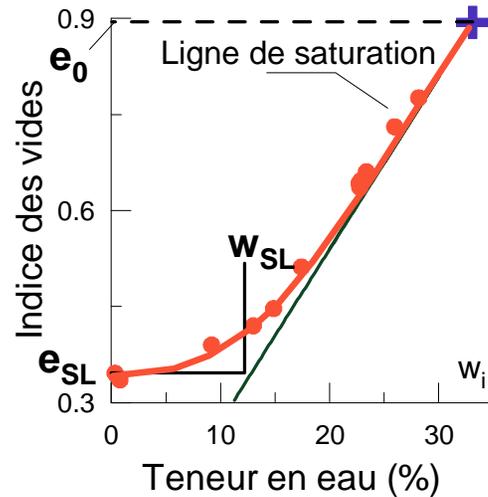
Sols naturels faiblement surconsolidés



Marnes naturelles



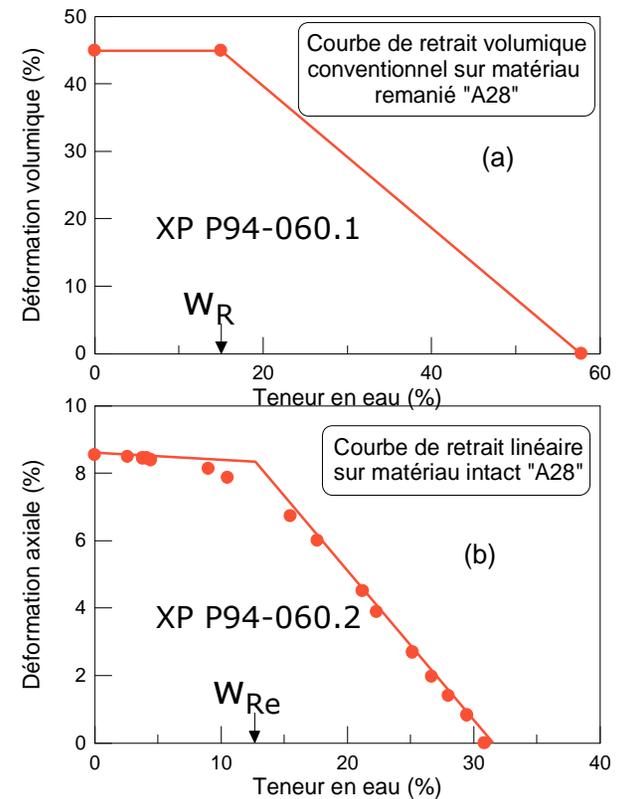
Limites de retrait



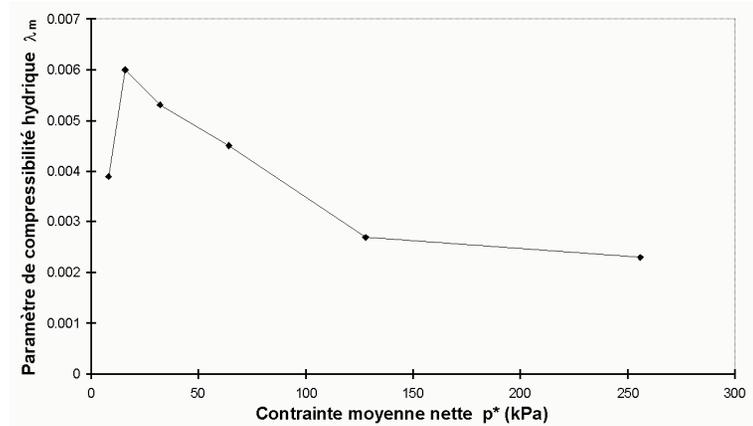
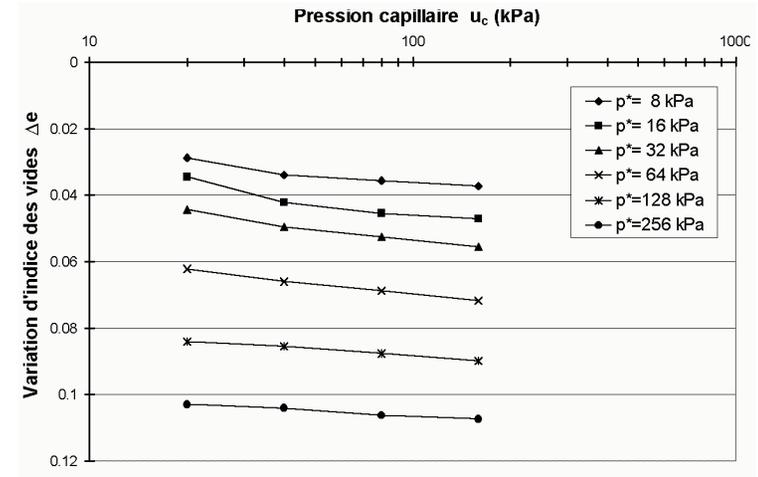
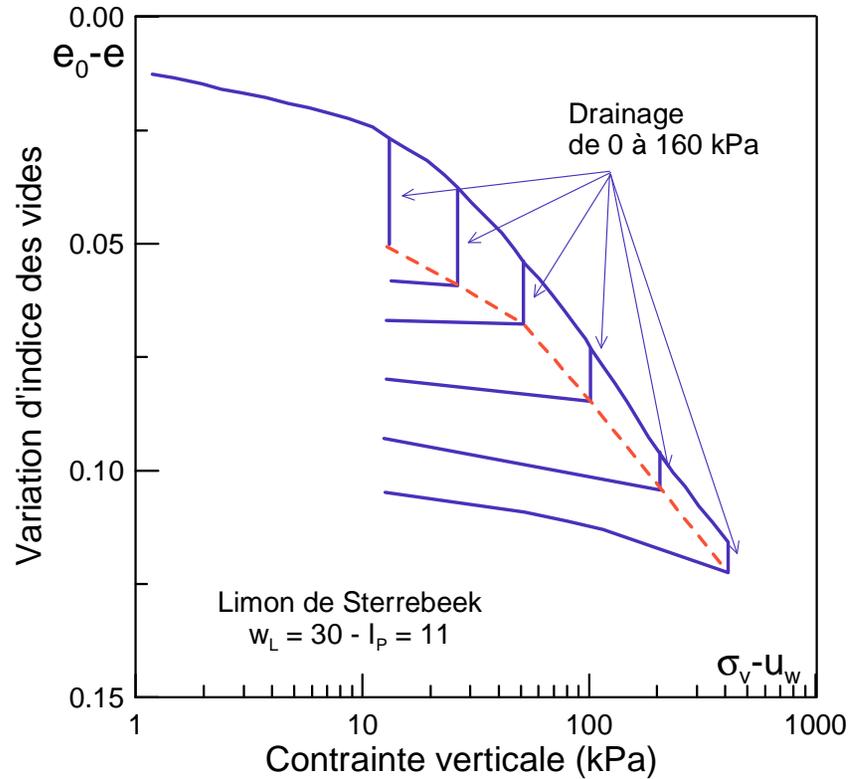
Doc. Solen

Sol rég. Parisienne

- courbe DH $w_{SL} = 12.5\%$
- effective $w_{Re} = 12.7\%$
- conventionnelle $w_R = 15\%$



Essai de séchage sous contrainte

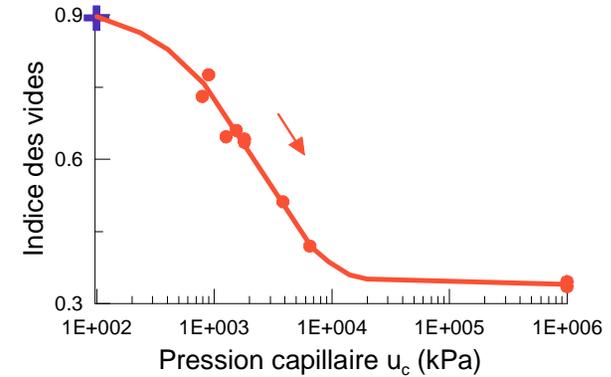
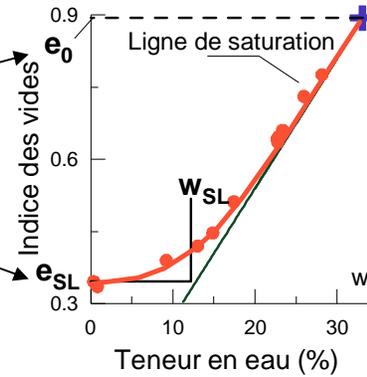


Conclusions

- Paramètres mécaniques caractérisant le potentiel de gonflement et de retrait :
 - Gonflement libre
 - Pression(s) de gonflement
 - Limite de retrait
 - Courbe de séchage-humidification
 - Paramètre de retrait...
- Facteurs importants :
 - Nature du sol : w_L , VBS, CEC... (minéralogie)
 - Etat du sol : Contrainte de consolidation (γ_d)...
 - Présence d'une phase « inactive » (non argileuse)
 - Structure, texture, « fabric » ?
 - Paramètres d'interaction sol-structure (σ)

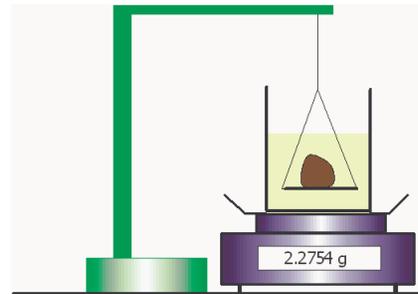
- Mesure de l'indice des vides initial

- Mesure de l'ind. des vides après 24h séchage



Poids humide, poids sec, volume

→ $e_0, e_{SL}, \varepsilon_{vmax}$



Mesure du volume par pesée hydrostatique dans du kerdane :

$$V_{\text{éch}} = (m_{\text{air}} - m_{\text{ker}}) / \rho_{\text{ker}}$$