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Introduction
- Water sorption hysteresis (H) is the difference exhibited in the relationship between the water content (w) of a soil and the corresponding water potential/relative humidity (RH) obtained by wetting or drying
- Extensive literature exist on causes and quantification of H for soil water potential range from 0 to -1.5 MPa but information on H is limited for water potentials < -10 MPa
- Consideration of H in the range from -10 to -480 MPa is crucial for modeling physical and biological soil processes

Objectives
- Assess and compare recently developed methods for quantifying water vapor sorption hysteresis in soils and pure clays for the water potential range of -10 to -480 MPa
- Investigate the role of organic matter (OM) and clay content and type on water vapor hysteresis

Methods
- Investigated Samples
  
  Five pure clays: Kaolinite, Illite, Vermiculite, Halloysite Montmorillonite

  Two groups of soils
  (i) Six soils with clay gradient (11-46%) and OM~2.6%, and clay content~11%
  (ii)20 soils, OM gradient (3-15%) and clay content gradient soils

- Sorption Isotherm Measurements
  Wetting and drying isotherms measured with Vapor Sorption Analyzer (~10 to -480 MPa; pf 5.0 to 6.6; RH 3 to 93%)

- Hysteresis Quantification Methods
  (i) Based on number of molecular layers (n) from a modified BET (MBET) isotherm equation
  
  \[ W = \frac{RH(1-RH^n)}{[k_1 + k_2 RH(1-RH^n)]} \]
  
  Model parameters: \( k_1, k_2, n \)

  n = molecular layers in multilayer

  Model fitted separately to wetting and drying curves to obtain “n” and calculate \( H_1 \)

Results
- Pure clays
  MBET-n and SPN methods were unable to capture hysteresis
  Dh method accurately described hysteresis (\( H_2 \))

Soils
- All 3 methods successfully quantified H for both groups of soils

- Clay gradient soils

<table>
<thead>
<tr>
<th>Clay%</th>
<th>12</th>
<th>20</th>
<th>23</th>
<th>35</th>
<th>46</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_1 )</td>
<td>0.22</td>
<td>0.25</td>
<td>0.24</td>
<td>0.22</td>
<td>0.22</td>
</tr>
<tr>
<td>( H_2 )</td>
<td>0.21</td>
<td>0.24</td>
<td>0.23</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>( H_3 )</td>
<td>1.22</td>
<td>1.19</td>
<td>1.16</td>
<td>1.33</td>
<td>1.37</td>
</tr>
</tbody>
</table>

- Clay characterised by interlayer hydration exhibit larger degree of hysteresis, e.g. cf. kaolinite and montmorillonite

Conclusions
- All three methods accurately captured hysteresis for soils; but for pure clays, only the Dh method was appropriate
- For pure clays, extent of interlayer hydration determines the degree of hysteresis
- For soils, OM and clay contents showed no clear effect on H

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References