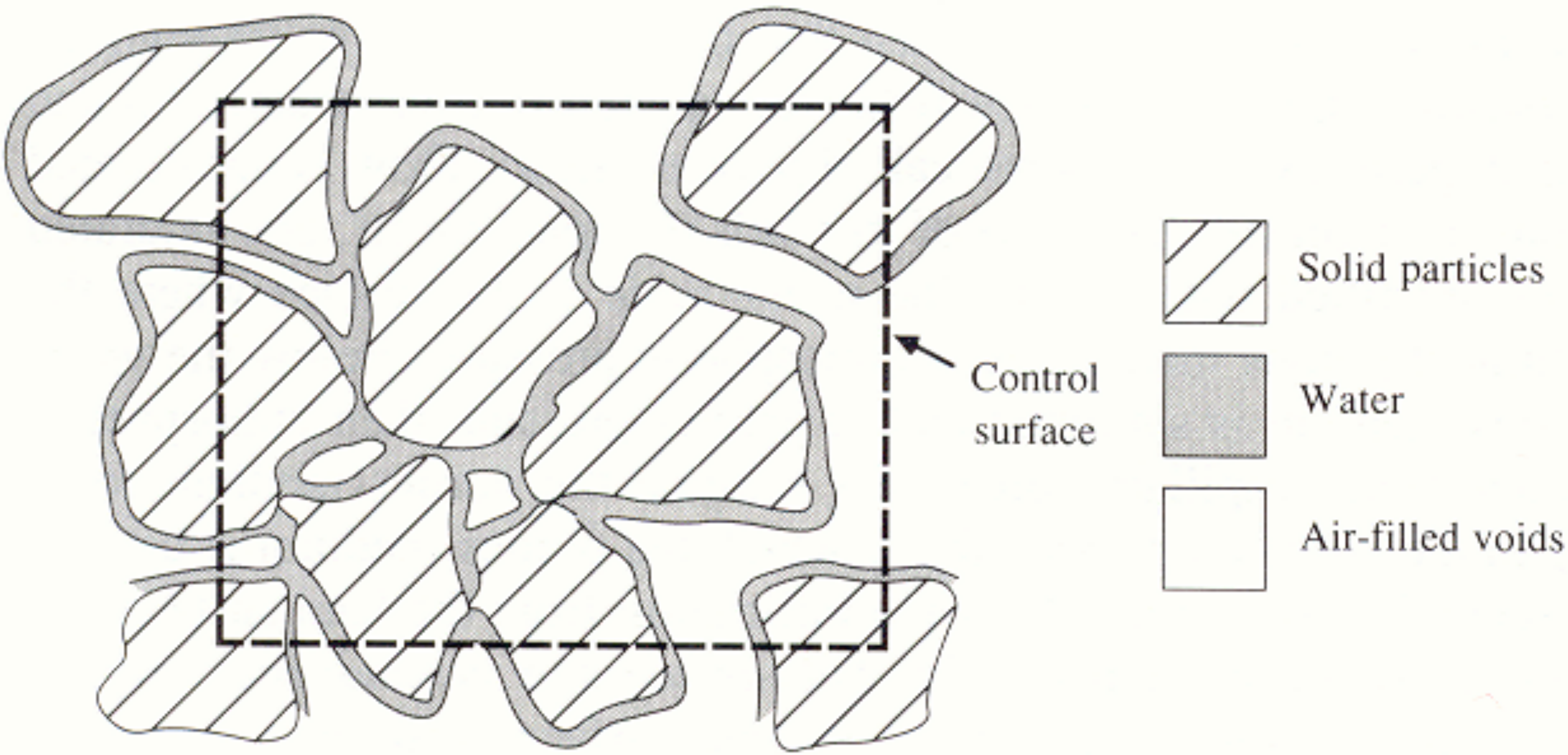
Water in Soil

Learning objectives

- Be able to quantify the properties of water held in and flowing through soil (porosity, moisture content, pressure, suction, hydraulic conductivity)

References

- Rainfall-Runoff Processes workbook chapter 4
- Dingman Chapter 6


Control
surface
Solid particles
Water
Air-filled voids

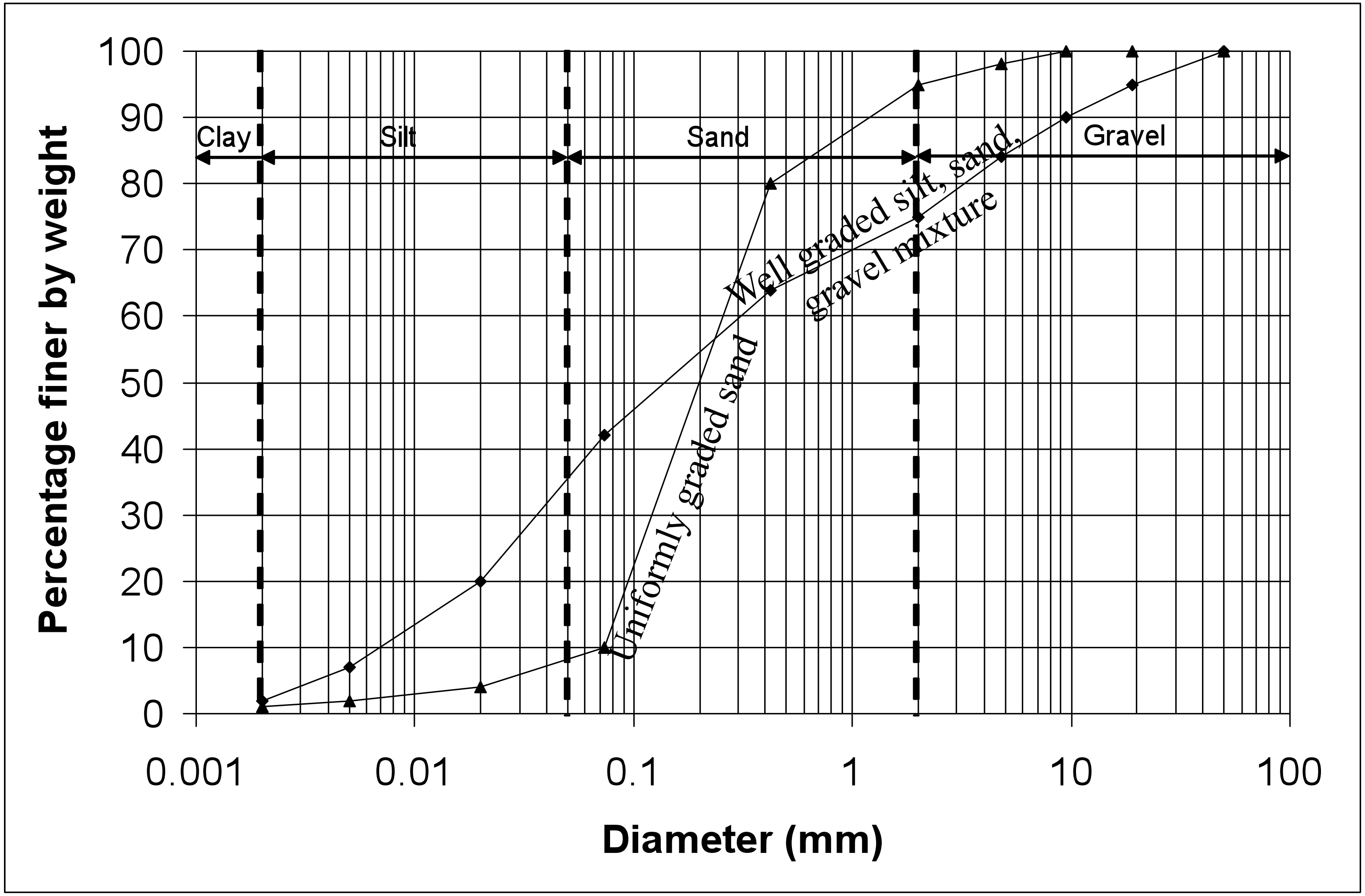
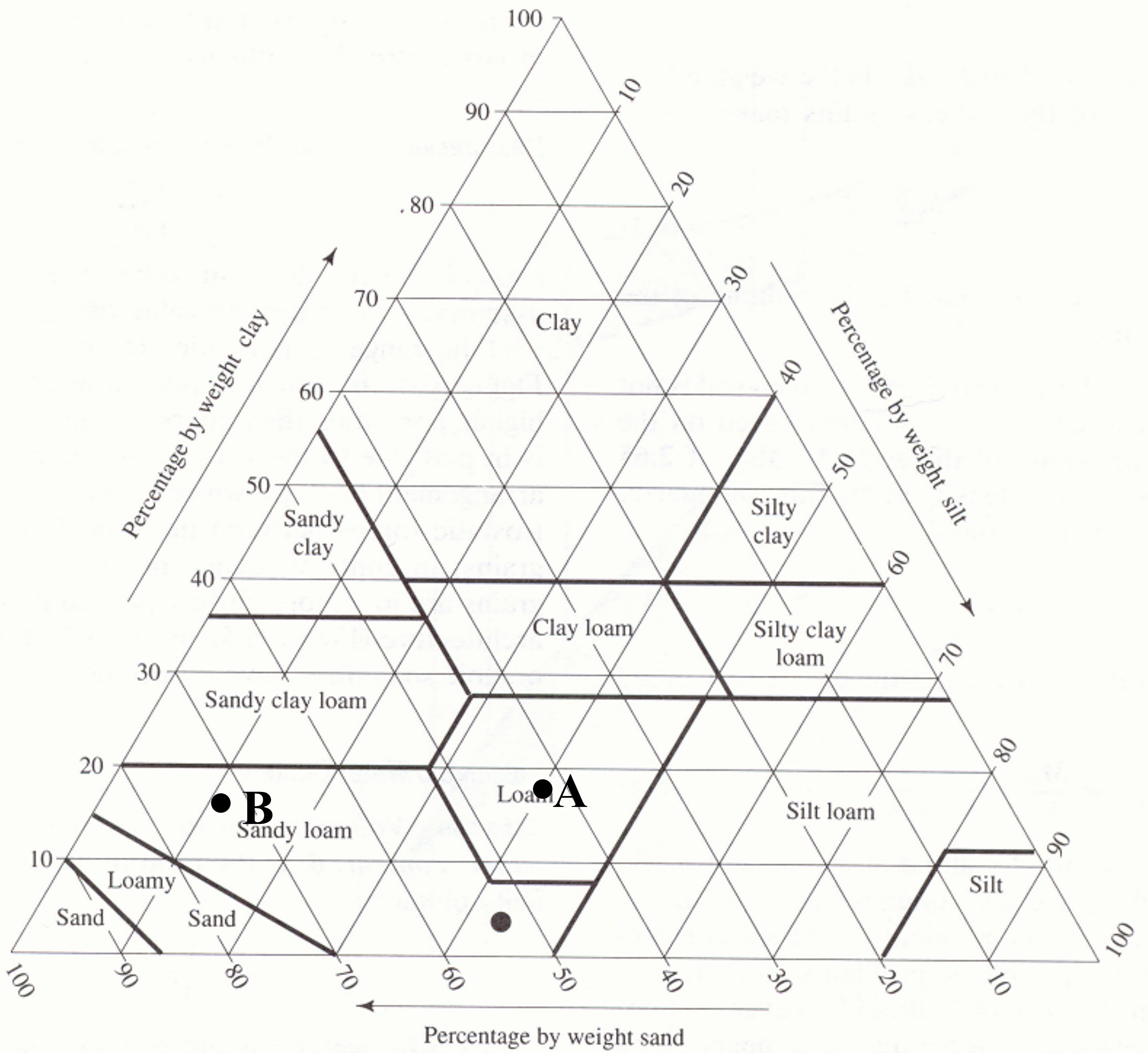
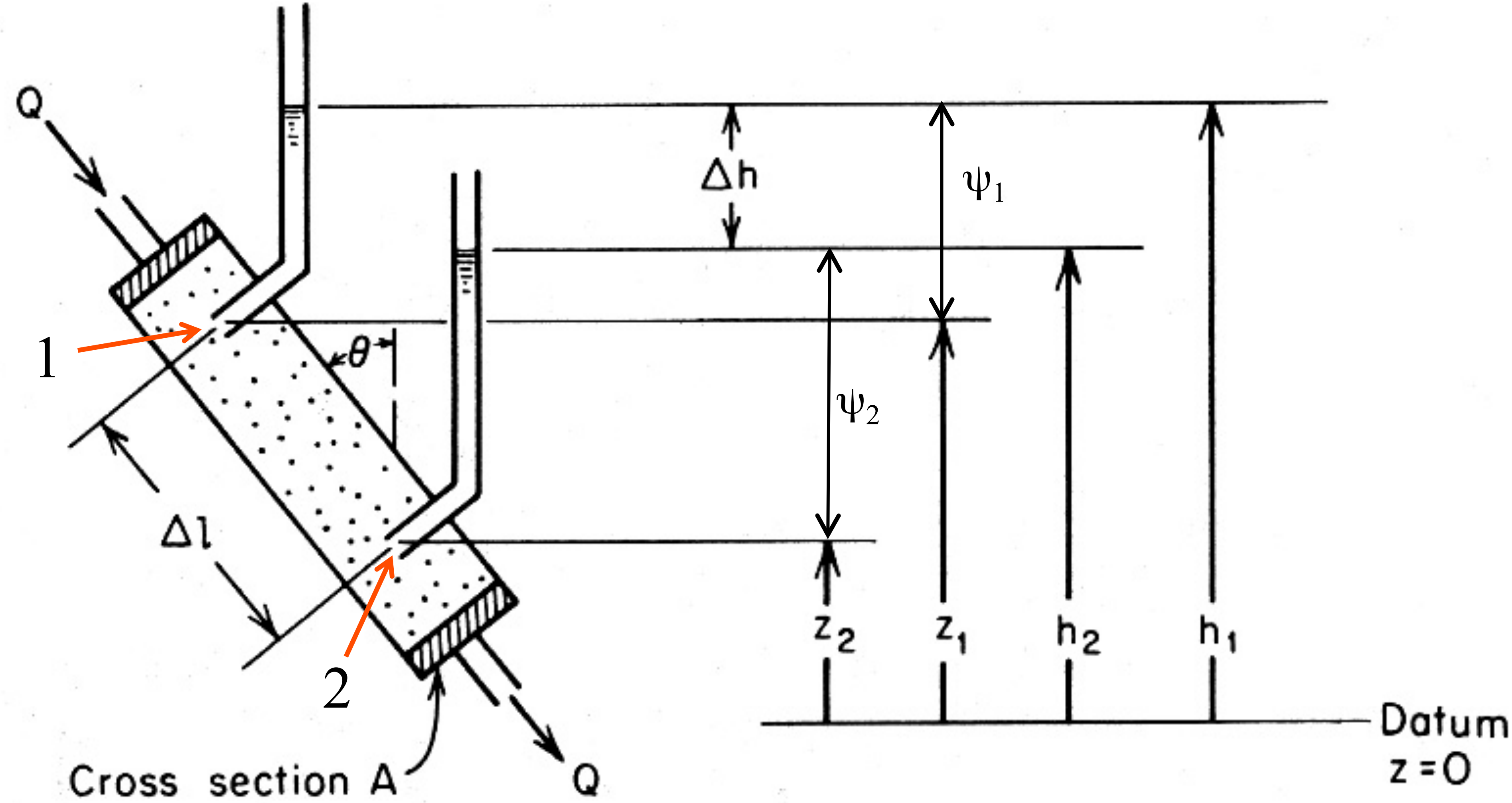


Figure 22. Illustrative grain-size distribution curves. The boundaries between size classes designated as clay, silt, sand and gravel are shown as vertical lines.

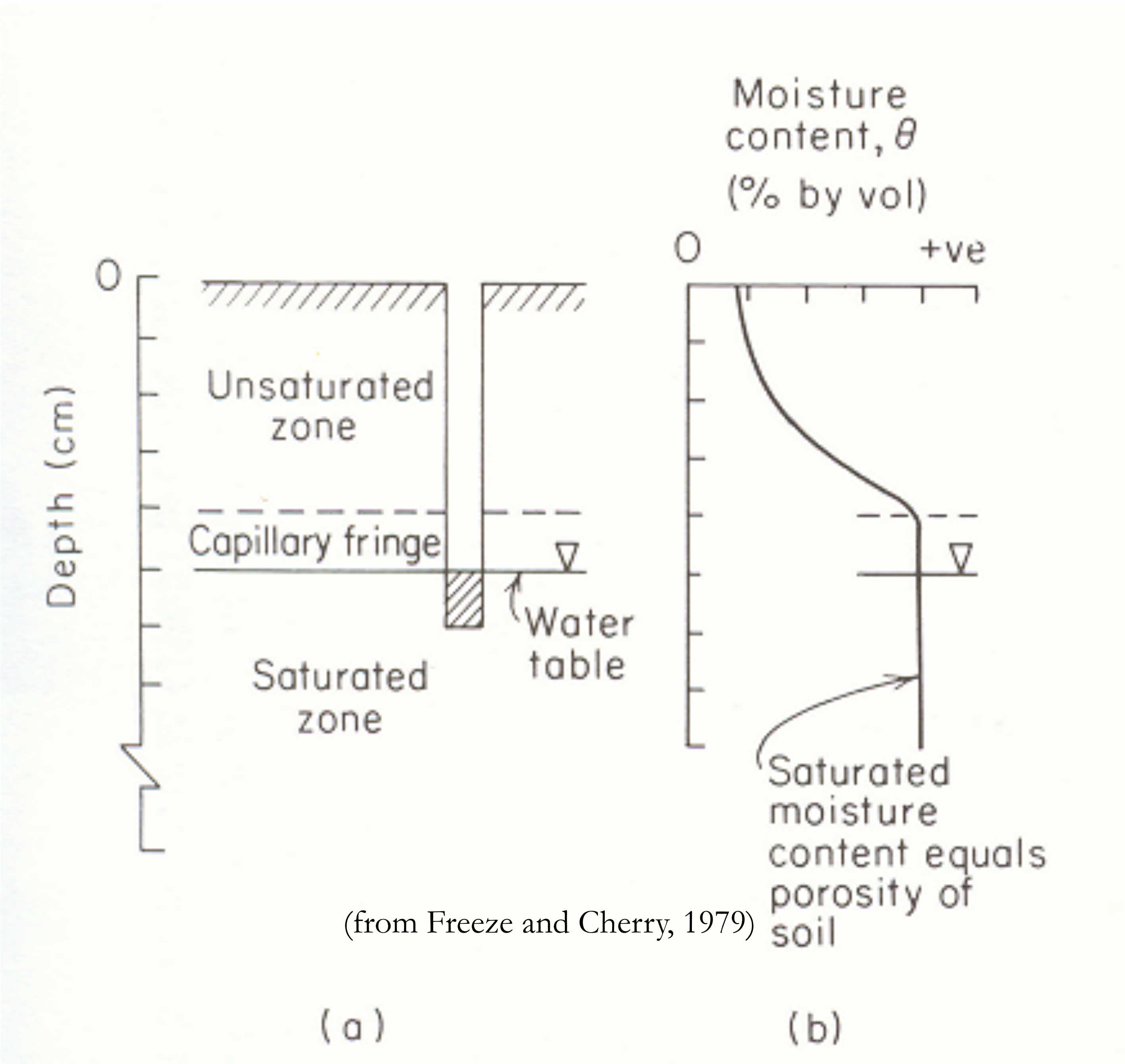


Soil texture triangle, showing the textural terms applied to soils with various fractions of sand, silt and clay. (from Dingman, 2002)



Experimental apparatus for the illustration of Darcy's equation. (From Freeze and Cherry)

Negative Pressure Head. Suction vs Moisture content



(from Freeze and Cherry, 1979)

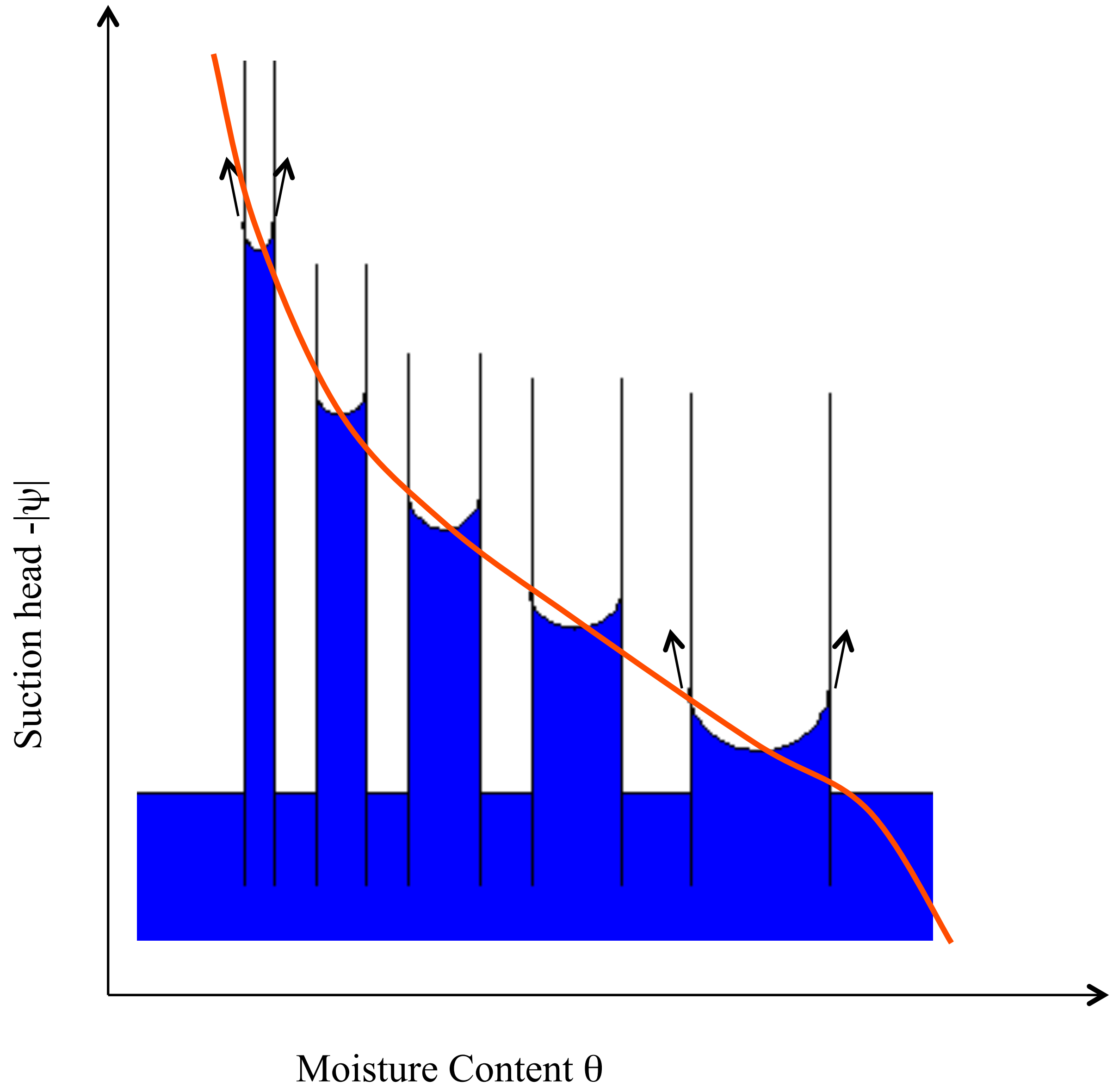


Illustration of capillary rise due to surface tension and relationship between pore size distribution and soil water retention curve.

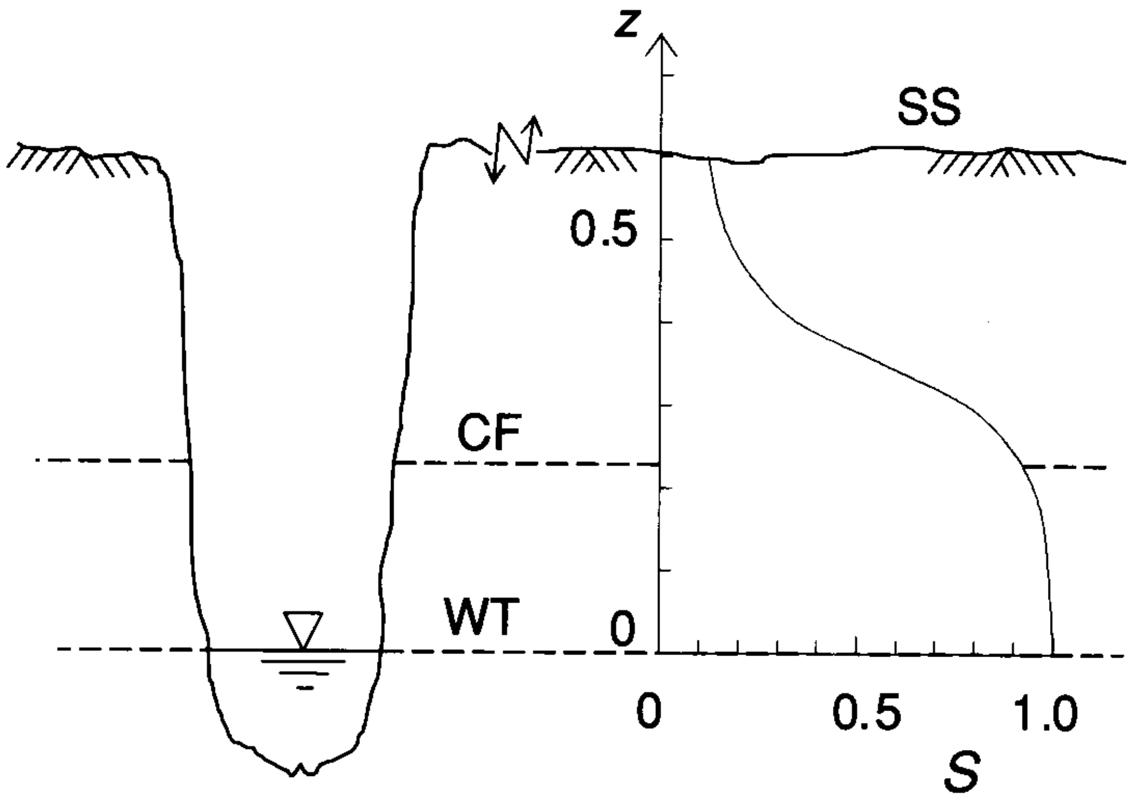
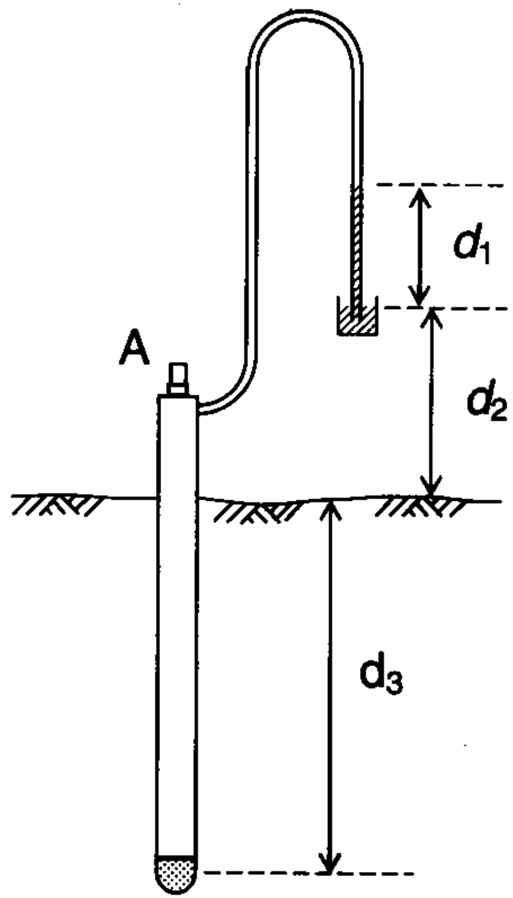


Fig. 8.7 Vertical distribution of the degree of saturation *S* under equilibrium conditions in a uniform soil profile. SS indicates the soil surface, WT is the position of the water table, and CF the approximate height of the capillary fringe. The height *z* above the water table is in meters; in this example the soil is a fine sand and the curve is the same as shown in Figure 8.5. "Equilibrium" indicates that there is no flow and that the soil water pressure distribution is hydrostatic.

From Brutsaert, 2005

Fig. 8.8 **Sketch of a tensiometer installed in the field; a manometer fluid has a column height d_1 above that of the reservoir surface d_2; the porous cup at the end of the tube, which is placed at depth d_3, is filled with water in contact with the soil water; at A, the main tube can be opened to fill it with water or to bleed it of air bubbles.**



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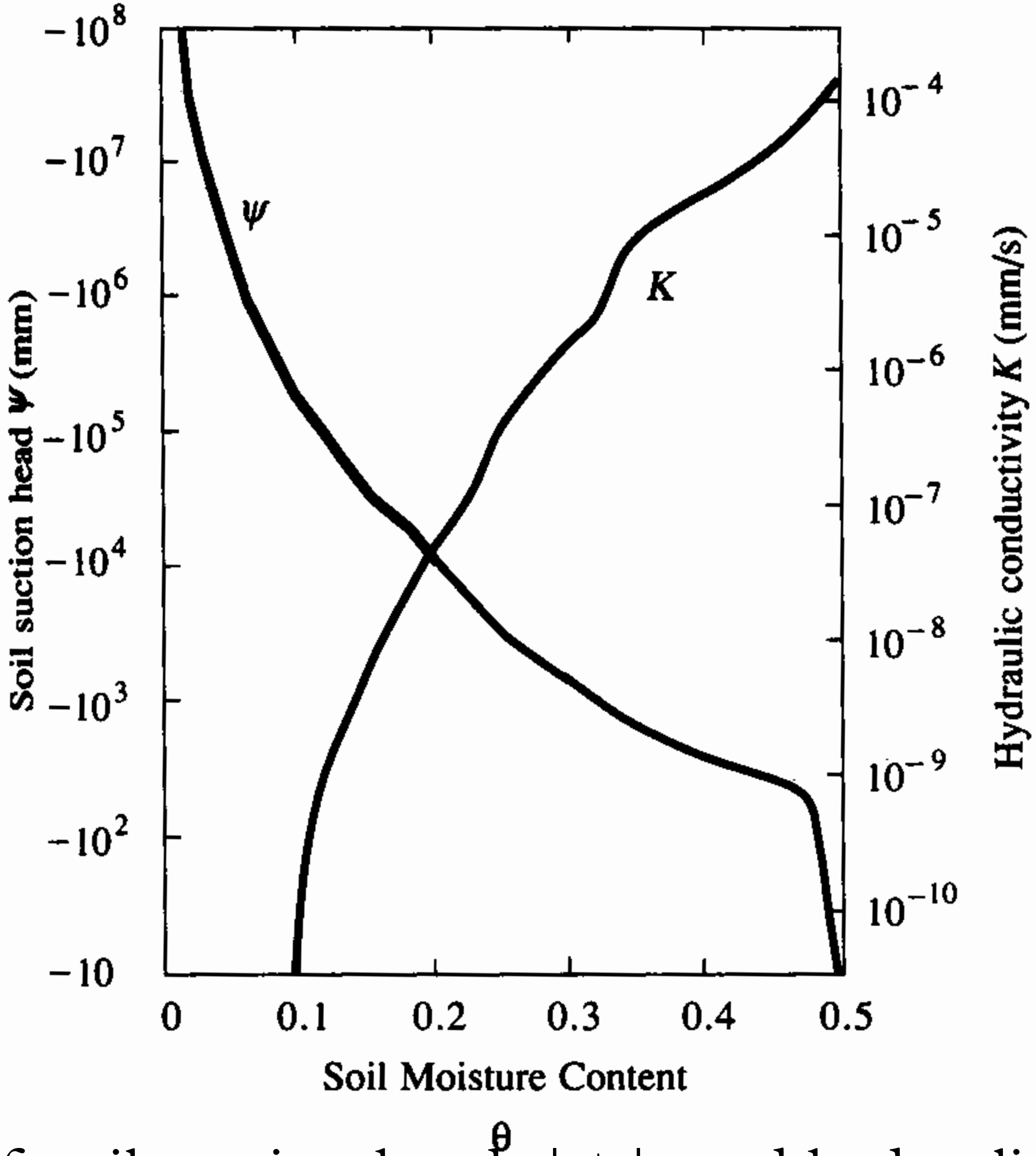
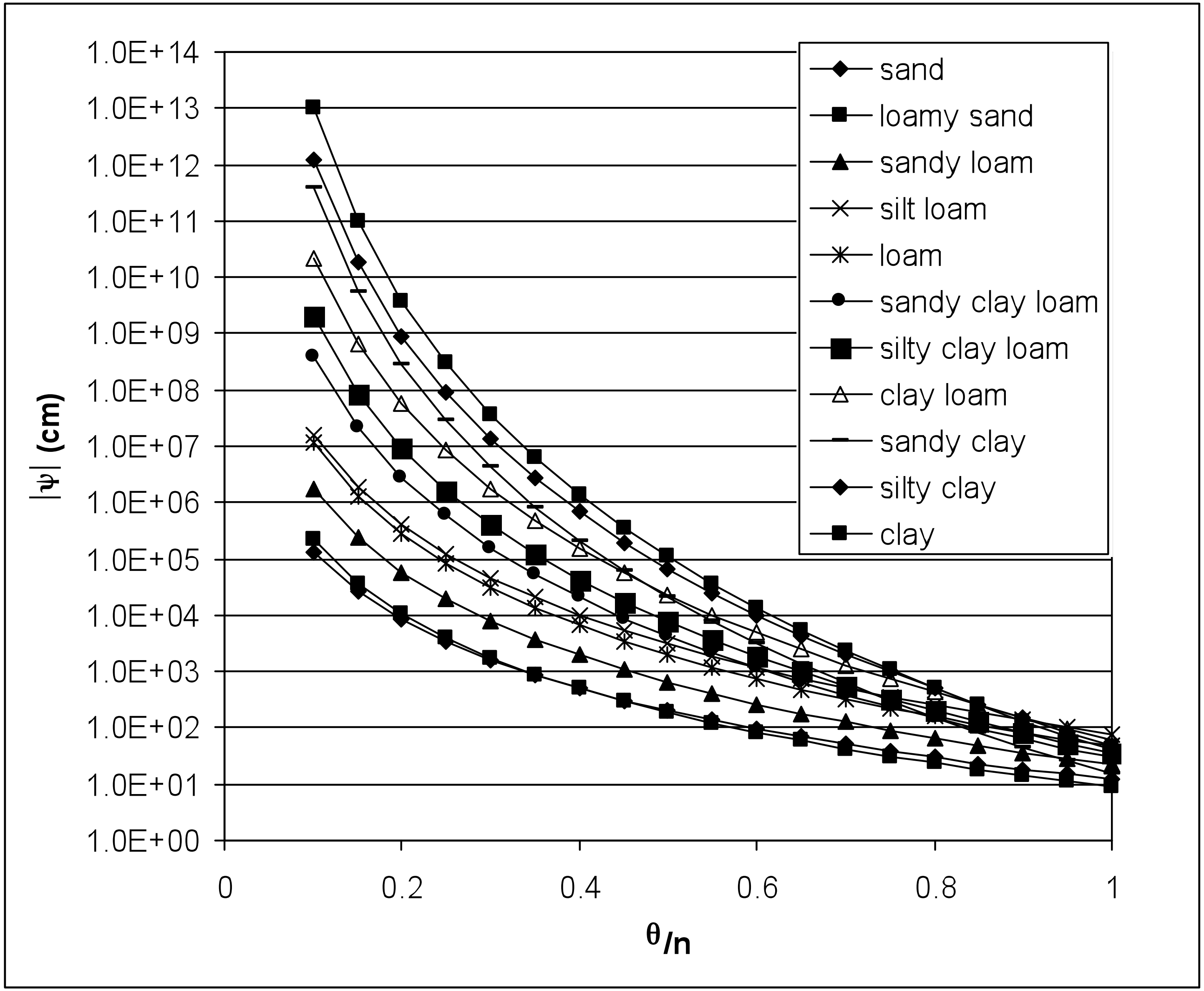


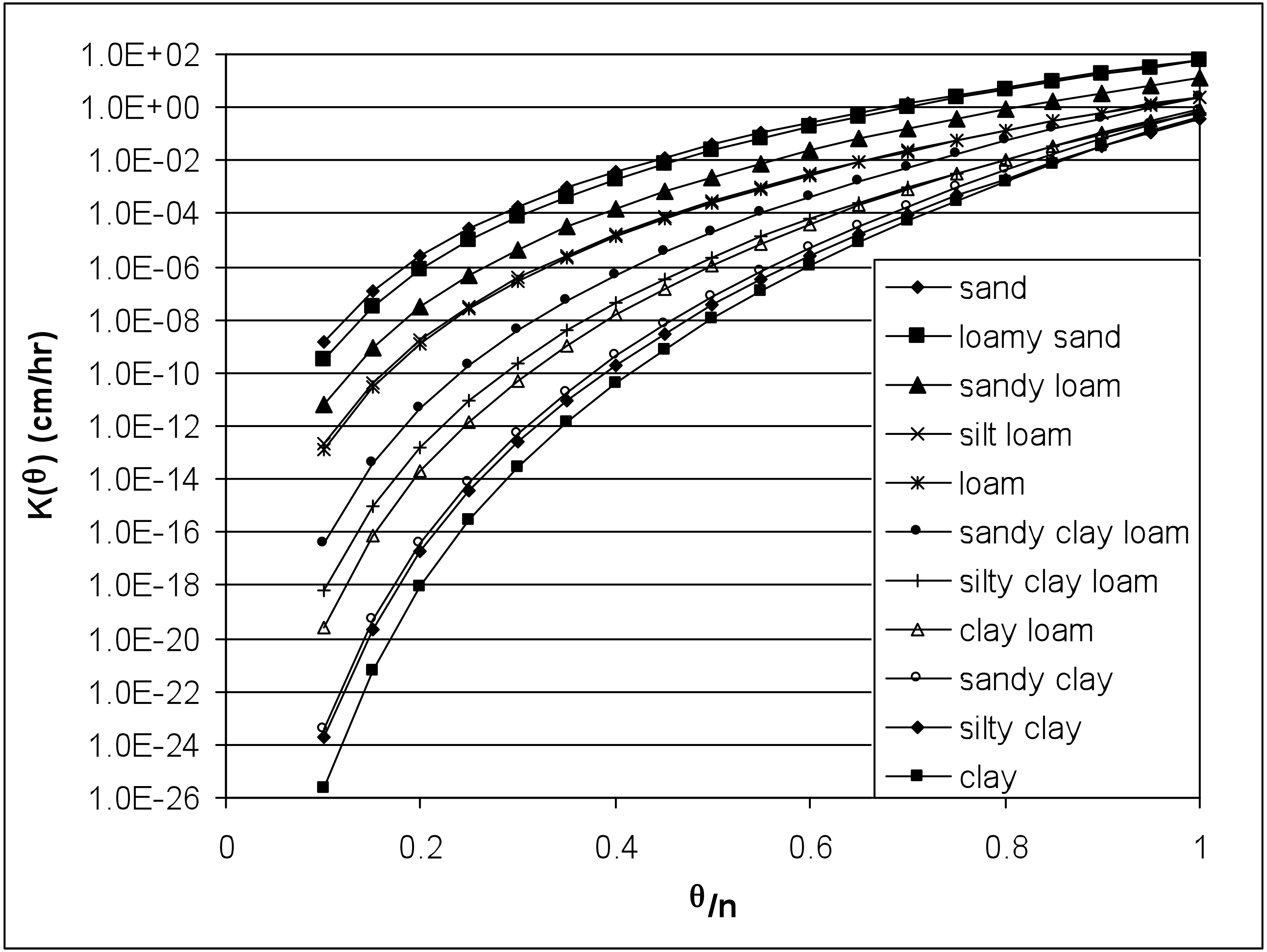
Variation of soil suction head, |ψ|, and hydraulic conductivity, K, with moisture content. (from Chow et al, 1988)

Clapp and Hornberger (1978) parameters for Soil Moisture Characteristic functions based on analysis of 1845 soils. Values in parentheses are standard deviations.

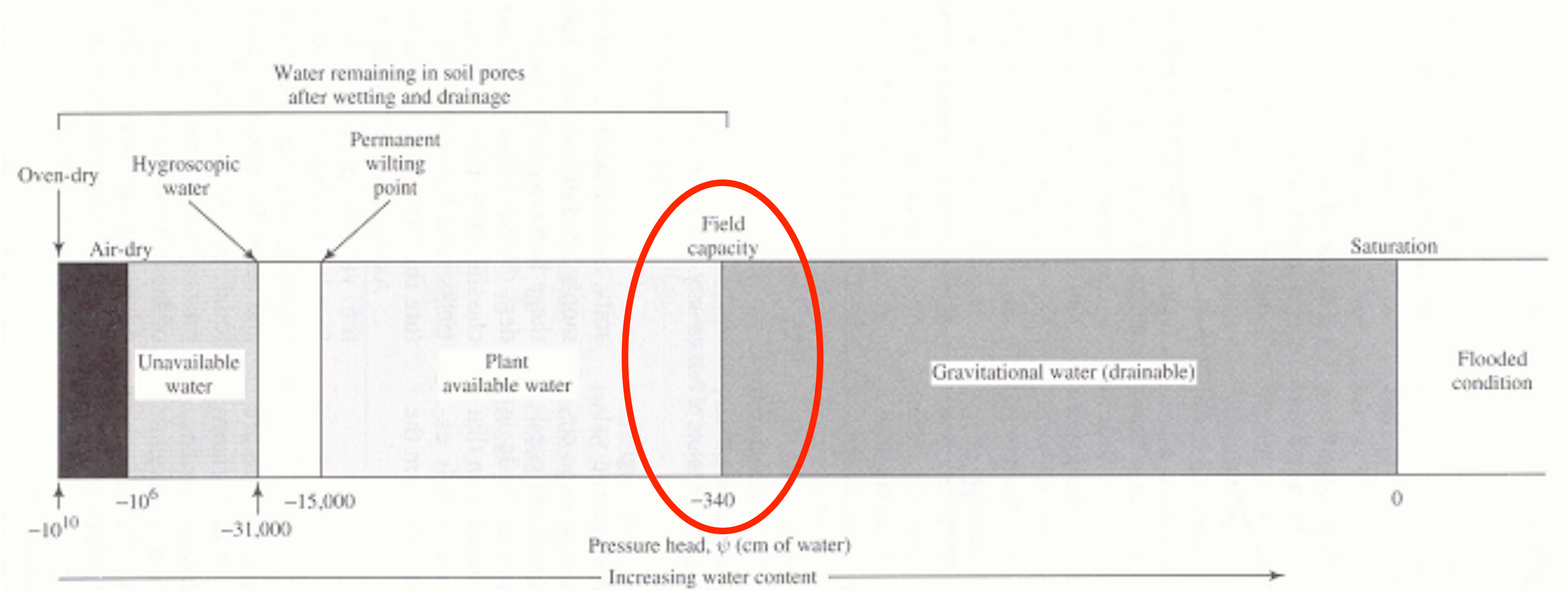
Soil Texture	Porosity n	K_{sat} (cm/hr)	$\lvert\psi_a\rvert$ (cm)	b
Sand	0.395 (0.056)	63.36	12.1 (14.3)	4.05 (1.78)
Loamy sand	0.410 (0.068)	56.16	9 (12.4)	4.38 (1.47)
Sandy loam	0.435 (0.086)	12.49	21.8 (31.0)	4.9 (1.75)
Silt loam	0.485 (0.059)	2.59	78.6 (51.2)	5.3 (1.96)
Loam	0.451 (0.078)	2.50	47.8 (51.2)	5.39 (1.87)
Sandy clay loam	0.420 (0.059)	2.27	29.9 (37.8)	7.12 (2.43)
Silty clay loam	0.477 (0.057)	0.612	35.6 (37.8)	7.75 (2.77)
Clay loam	0.476 (0.053)	0.882	63 (51.0)	8.52 (3.44)
Sandy clay	0.426 (0.057)	0.781	15.3 (17.3)	10.4 (1.64)
Silty clay	0.492 (0.064)	0.371	49 (62.0)	10.4 (4.45)
Clay	0.482 (0.050)	0.461	40.5 (39.7)	11.4 (3.7)



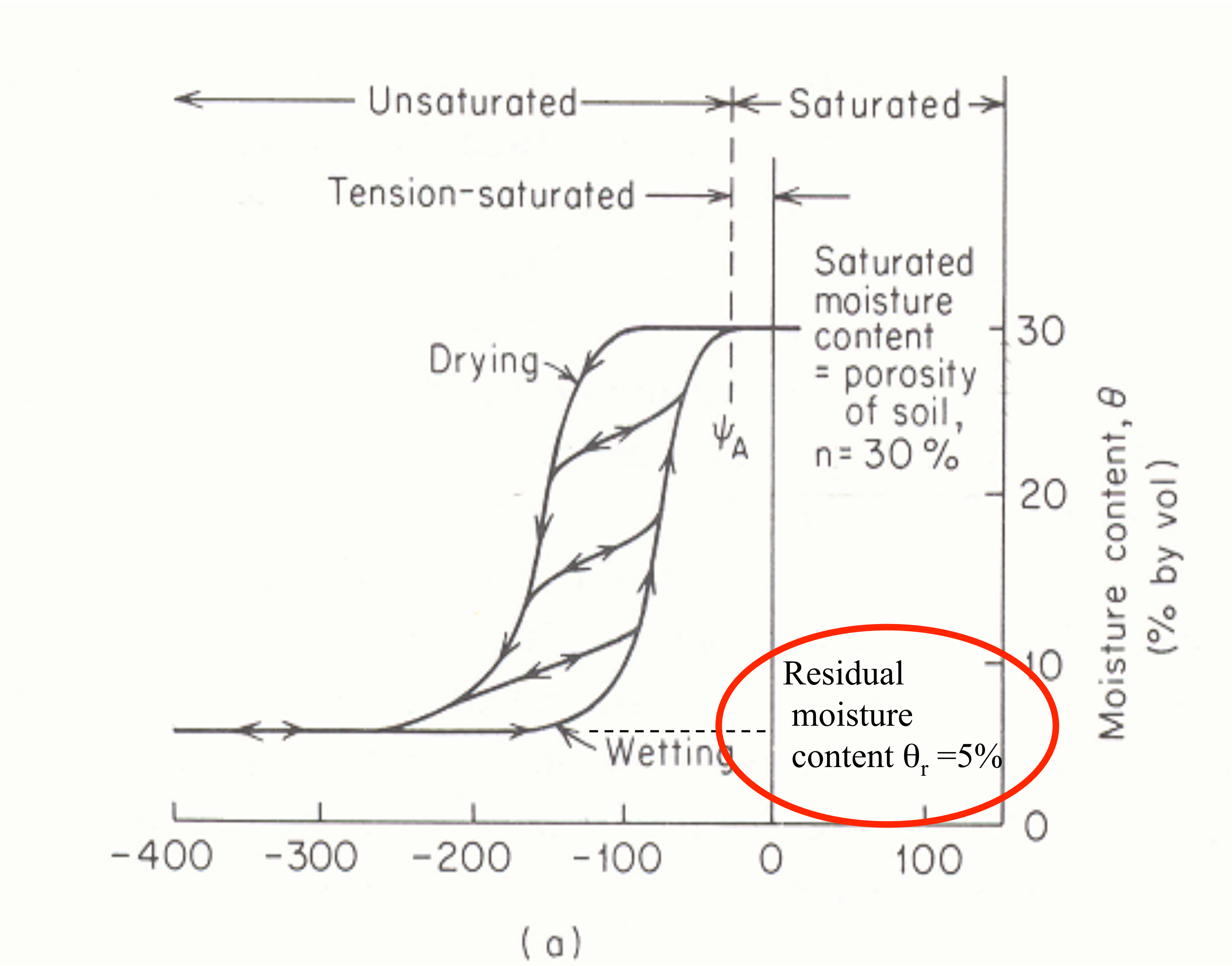
Soil suction head, |ψ|, for different soil textures using the Clapp and Hornberger (1978) parameterization.



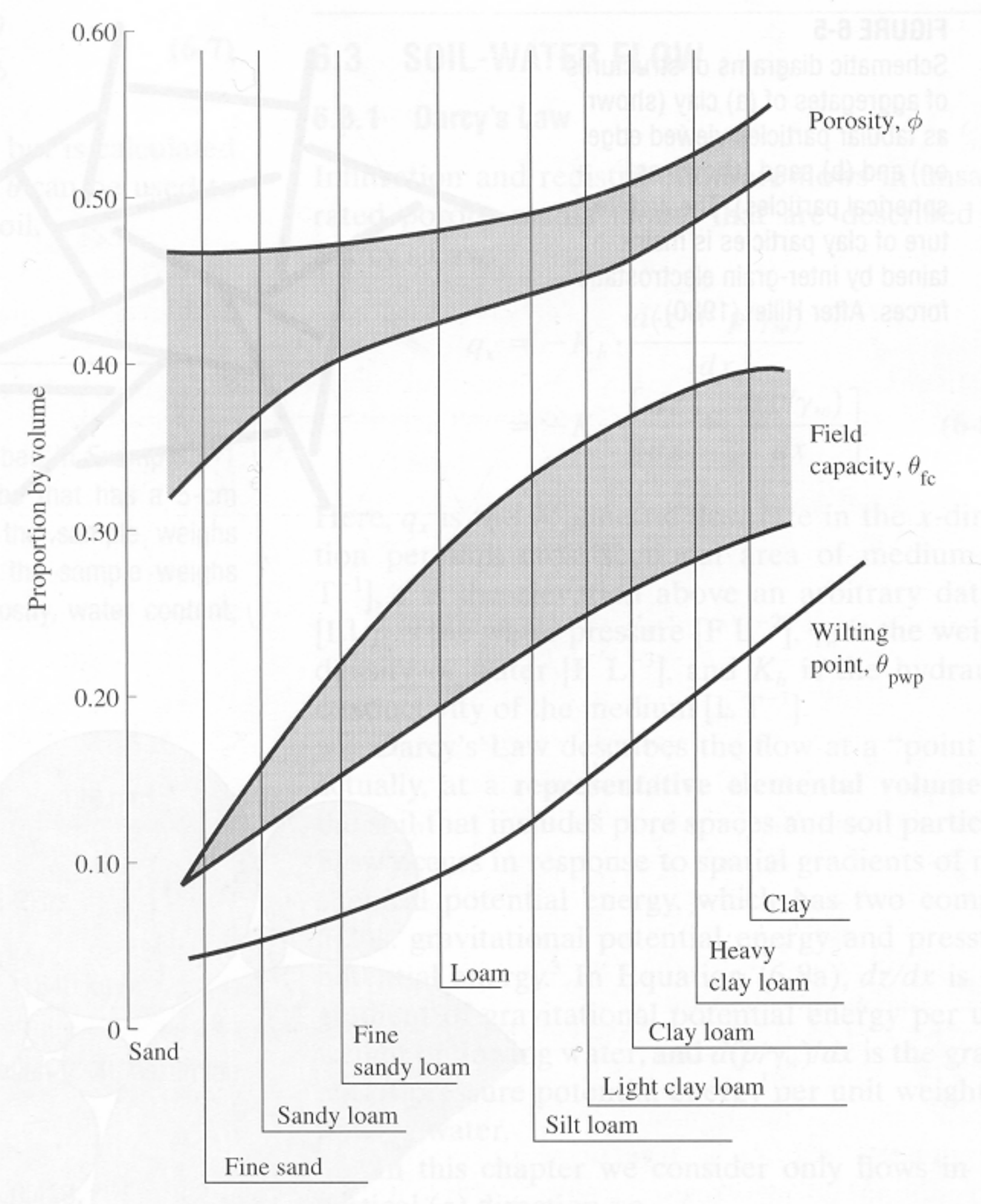
Hydraulic conductivity K(θ) for different soil textures using the Clapp and Hornberger (1978) parameterization.



Soil-water status as a function of pressure (tension). Natural soils do not have tensions exceeding about -31000 cm; in this range water is absorbed from the air. [from Dingman, 1994]



Characteristic curve relating moisture content to pressure head (from Freeze and Cherry, 1979).



Ranges of porosities, field capacities, and permanent wilting points for soils of various textures. (from Dunne and Leopold, 1978)