



VOLUME ONE

ENCYCLOPEDIA OF SOILS IN THE ENVIRONMENT

EDITOR-IN-CHIEF

DANIEL HILLEL



CONTENTS

VOLUME 1

A

ACID RAIN AND SOIL ACIDIFICATION	<i>L Blake</i>	1
ACIDITY	<i>N Bolan, D Curtin and D Adriano</i>	11
AERATION	<i>D E Rolston</i>	17
AGGREGATION		
Microbial Aspects	<i>S D Frey</i>	22
Physical Aspects	<i>J R Nimmo</i>	28
AGROFORESTRY	<i>P K R Nair</i>	35
AIR PHASE	<i>see</i> AERATION; DIFFUSION	
ALBEDO	<i>see</i> ENERGY BALANCE; RADIATION BALANCE	
ALLOPHANE AND IMOGOLITE	<i>see</i> AMORPHOUS MATERIALS	
ALLUVIUM AND ALLUVIAL SOILS	<i>J L Boettinger</i>	45
ALUMINUM SPECIATION	<i>D R Parker</i>	50
AMMONIA	<i>D E Kissel and M L Cabrera</i>	56
AMORPHOUS MATERIALS	<i>J Harsh</i>	64
ANAEROBIC SOILS	<i>P W Inglett, K R Reddy and R Corstanje</i>	72
ANION EXCHANGE	<i>see</i> CATION EXCHANGE	
APPLICATIONS OF SOILS DATA	<i>P J Lawrence</i>	78
ARCHAEA	<i>J E T McLain</i>	88
ARCHEOLOGY IN RELATION TO SOILS	<i>J A Homburg</i>	95

B

BACTERIA		
Plant Growth-Promoting	<i>Y Bashan and L E de-Bashan</i>	103
Soil	<i>L J Halverson</i>	115
BACTERIOPHAGE	<i>M Radosevich, K E Williamson and K E Wommack</i>	122
BIOCONTROL OF SOIL-BORNE PLANT DISEASES	<i>C E Pankhurst and J M Lynch</i>	129
BIODIVERSITY	<i>D H Wall</i>	136
BUFFERING CAPACITY	<i>B R James</i>	142
BULK DENSITY	<i>see</i> POROSITY AND PORE-SIZE DISTRIBUTION	

C

CALCIUM AND MAGNESIUM IN SOILS	<i>N Bolan, P Loganathan and S Sagar</i>	149
CAPILLARITY	<i>D Or and M Tuller</i>	155
CARBON CYCLE IN SOILS		
Dynamics and Management	<i>C W Rice</i>	164
Formation and Decomposition	<i>C A Cambardella</i>	170
CARBON EMISSIONS AND SEQUESTRATION	<i>K Paustian</i>	175
CATION EXCHANGE	<i>L M McDonald, V P Evangelou and M A Chappell</i>	180
CHEMICAL EQUILIBRIA	<i>A P Schwab</i>	189
CHEMICAL SPECIATION MODELS	<i>see SURFACE COMPLEXATION MODELING</i>	
CHERNOZEMS	<i>see GRASSLAND SOILS</i>	
CHILDS, ERNEST CARR	<i>E G Youngs</i>	195
CIVILIZATION, ROLE OF SOILS	<i>D Hillel</i>	199
CLASSIFICATION OF LAND USE	<i>see LAND-USE CLASSIFICATION</i>	
CLASSIFICATION OF SOILS	<i>R W Arnold</i>	204
CLASSIFICATION SYSTEMS		
Australian	<i>R W Fitzpatrick</i>	211
FAO	<i>F O Nachtergaele</i>	216
Russian, Background and Principles	<i>M Gerasimova</i>	223
Russian, Evolution and Examples	<i>D Konyushkov</i>	227
USA	<i>D J Brown</i>	235
CLAY MINERALS	<i>D G Schulze</i>	246
CLIMATE CHANGE IMPACTS	<i>P Bullock</i>	254
CLIMATE MODELS, ROLE OF SOIL	<i>P Smith</i>	262
COLD-REGION SOILS	<i>C-L Ping</i>	268
COLLOID-FACILITATED SORPTION AND TRANSPORT	<i>R Kretzschmar</i>	276
COMPACTION	<i>J J H van den Akker and B Soane</i>	285
COMPOST	<i>T L Richard</i>	294
CONDITIONERS	<i>R E Sojka, J A Entry and W J Orts</i>	301
CONSERVATION	<i>see EROSION: Water-Induced; Wind-Induced; SUSTAINABLE SOIL AND LAND MANAGEMENT; TERRACES AND TERRACING</i>	
CONSERVATION TILLAGE	<i>M R Carter</i>	306
COVER CROPS	<i>L Edwards and J Burney</i>	311
CROP ROTATIONS	<i>C A Francis</i>	318
CROP WATER REQUIREMENTS	<i>L S Pereira and I Alves</i>	322
CROP-RESIDUE MANAGEMENT	<i>D C Reicosky and A R Wilts</i>	334
CRUSTS		
Biological	<i>J Belnap</i>	339
Structural	<i>R L Baumhardt and R C Schwartz</i>	347
CULTIVATION AND TILLAGE	<i>M R Carter and E McKyes</i>	356

D

DARCY'S LAW	<i>D Swartzendruber</i>	363
DEGRADATION	<i>C J Ritsema, G W J van Lynden, V G Jetten and S M de Jong</i>	370
DENITRIFICATION	<i>D A Martens</i>	378
DESERTIFICATION	<i>D Hillel and C Rosenzweig</i>	382

DIFFUSION	<i>T Addiscott and P Leeds-Harrison</i>	389
DISINFESTATION	<i>A Gamliel and J Katan</i>	394
DISPERSION	<i>see FLOCCULATION AND DISPERSION</i>	
DISSOLUTION PROCESSES, KINETICS	<i>K G Scheckel and C A Impellitteri</i>	400
DRAINAGE, SURFACE AND SUBSURFACE	<i>N R Fausey</i>	409
DRYLAND FARMING	<i>G A Peterson</i>	414

E

EARTHWORMS	<i>see FAUNA</i>	
EDAPHOLOGY	<i>A L Utery</i>	419
ELECTRON PARAMAGNETIC RESONANCE	<i>see ELECTRON-SPIN RESONANCE SPECTROSCOPY</i>	
ELECTRON-SPIN RESONANCE SPECTROSCOPY	<i>N Senesi and G S Senesi</i>	426
ELECTROSTATIC DOUBLE-LAYER	<i>see CATION EXCHANGE</i>	
ENERGY BALANCE	<i>M Fuchs</i>	438
ENVIRONMENTAL MONITORING	<i>P J Loveland and P H Bellamy</i>	441
ENZYMES IN SOILS	<i>R P Dick and E Kandeler</i>	448
EROSION		
Irrigation-Induced	<i>G A Lehrsch, D L Bjorneberg and R E Sojka</i>	456
Water-Induced	<i>J E Gilley</i>	463
Wind-Induced	<i>T M Zobeck and R S Van Pelt</i>	470
ESSENTIAL ELEMENTS	<i>E A Kirkby</i>	478
EUTROPHICATION	<i>A J Gold and J T Sims</i>	486
EVAPORATION OF WATER FROM BARE SOIL	<i>C W Boast and F W Simmons</i>	494
EVAPOTRANSPIRATION	<i>G Stanhill</i>	502

F

FACTORS OF SOIL FORMATION		
Biota	<i>A H Jahren</i>	507
Climate	<i>O C Spaargaren and J A Deckers</i>	512
Human Impacts	<i>J Sandor, C L Burras and M Thompson</i>	520
Parent Material	<i>K R Olson</i>	532
Time	<i>E F Kelly and C M Yonker</i>	536
FAUNA	<i>T Winsome</i>	539

VOLUME 2

FERTIGATION	<i>U Kafkafi and S Kant</i>	1
FERTILITY	<i>J L Havlin</i>	10
FERTILIZERS AND FERTILIZATION	<i>H W Scherer</i>	20
FIELD CAPACITY	<i>see WATER CYCLE</i>	
FLOCCULATION AND DISPERSION	<i>I Shainberg and G J Levy</i>	27
FLUORESCENCE SPECTROSCOPY	<i>N Senesi and V D'Orazio</i>	35
FOLIAR APPLICATIONS OF NUTRIENTS	<i>M Tagliavini and M Toselli</i>	53
FOOD-WEB INTERACTIONS	<i>P C de Ruiter and J C Moore</i>	59
FORENSIC APPLICATIONS	<i>W F Rowe</i>	67
FOREST SOILS	<i>J R Boyle</i>	73
FOURIER TRANSFORM INFRARED SPECTROSCOPY	<i>D Peak</i>	80

FRACTAL ANALYSIS	<i>Y Pachepsky and J W Crawford</i>	85
FREEZING AND THAWING		
Cycles	<i>B Sharratt</i>	98
Processes	<i>G N Flerchinger, G A Lehrsich and D K McCool</i>	104
FUNGI	<i>K Ritz</i>	110
G		
GEOGRAPHICAL INFORMATION SYSTEMS	<i>J Böhner, T Selige and R Köthe</i>	121
GERMINATION AND SEEDLING ESTABLISHMENT	<i>A Hadas</i>	130
GLOBAL WARMING	<i>see CARBON EMISSIONS AND SEQUESTRATION; CLIMATE CHANGE IMPACTS;</i>	
GREENHOUSE GAS EMISSIONS		
GRASSLAND SOILS	<i>J A Mason and C W Zanner</i>	138
GREEN MANURING	<i>see COVER CROPS</i>	
GREENHOUSE GAS EMISSIONS	<i>K A Smith</i>	145
GROUNDWATER AND AQUIFERS	<i>Y Bachmat</i>	153
GROUNDWATER POLLUTION	<i>see POLLUTION: Groundwater</i>	
H		
HEAT AND MOISTURE TRANSPORT	<i>R Horton and A Globus</i>	169
HEAT CAPACITY	<i>see THERMAL PROPERTIES AND PROCESSES</i>	
HEAT FLOW	<i>see THERMAL PROPERTIES AND PROCESSES</i>	
HEAVY METALS	<i>D C Adriano, N S Bolan, J Vangronsveld and W W Wenzel</i>	175
HILGARD, EUGENE WOLDEMAR	<i>R Amundson</i>	182
HOOGHOUT, SYMEN BAREND	<i>P A C Raats and R R van der Ploeg</i>	188
HUMIFICATION	<i>T C Balser</i>	195
HYDRAULIC PROPERTIES, TEMPERATURE EFFECTS	<i>S A Grant</i>	207
HYDRIC SOILS	<i>G W Hurt</i>	212
HYDROCARBONS	<i>P Kostecki, R Morrison and J Dragun</i>	217
HYDRODYNAMIC DISPERSION	<i>see SOLUTE TRANSPORT</i>	
HYDRODYNAMICS IN SOILS	<i>T P A Ferré and A W Warrick</i>	227
HYSTERESIS	<i>J H Dane and R J Lenhard</i>	231
I		
IMMISCIBLE FLUIDS	<i>R J Lenhard, J H Dane and M Oostrom</i>	239
INCEPTISOLS	<i>A Palmer</i>	248
INDUSTRIAL POLLUTION	<i>see POLLUTION: Industrial</i>	
INFILTRATION	<i>T P A Ferré and A W Warrick</i>	254
INFRARED SPECTROSCOPY	<i>see FOURIER TRANSFORM INFRARED SPECTROSCOPY</i>	
IRON NUTRITION	<i>K Mengel and H Kosogarten</i>	260
IRRIGATION		
Environmental Effects	<i>S Topcu and C Kirda</i>	267
Methods	<i>D L Bjorneberg and R E Sojka</i>	273
ISOTOPES IN SOIL AND PLANT INVESTIGATIONS	<i>K Reichardt and O O S Bacchi</i>	280
ISOTROPY AND ANISOTROPY	<i>T-C J Yeh, P Wierenga, R Khaleel and R J Glass</i>	285

J

JENNY, HANS	<i>R Amundson</i>	293
-------------	-------------------	-----

K

KELLOGG, CHARLES	<i>J D Helms</i>	301
KINETIC MODELS	<i>P M Jardine</i>	307
KIRKHAM, DON	<i>D R Nielsen and R R van der Ploeg</i>	315

L

LAMINAR AND TURBULENT FLOW	<i>see</i> HYDRODYNAMICS IN SOILS	
LANDFILLS	<i>see</i> WASTE DISPOSAL ON LAND: Municipal	
LAND-USE CLASSIFICATION	<i>J A LaGro Jr</i>	321
LAWES, JOHN BENNET AND GILBERT, JOSEPH HENRY	<i>A E Johnston</i>	328
LEACHING PROCESSES	<i>B E Clothier and S Green</i>	336
LIEBIG, JUSTUS VON	<i>R R van der Ploeg, W Böhm and M B Kirkham</i>	343
LIMING	<i>E J Kamprath and T J Smyth</i>	350
LIPMAN, JACOB G.	<i>J C F Tedrow</i>	358
LOESS	<i>A J Busacca and M R Sweeney</i>	364
LOWDERMILK, WALTER CLAY	<i>J D Helms</i>	373
LYSIMETRY	<i>T A Howell</i>	379

M

MACRONUTRIENTS	<i>C W Wood, J F Adams and B H Wood</i>	387
MACROPORES AND MACROPORE FLOW, KINEMATIC WAVE APPROACH	<i>P F Germann</i>	393
MAGNESIUM IN SOILS	<i>see</i> CALCIUM AND MAGNESIUM IN SOILS	
MANURE MANAGEMENT	<i>J T Sims and R O Maguire</i>	402
MARBUT, CURTIS FLETCHER	<i>J P Tandarich</i>	410
MATRIC POTENTIAL	<i>see</i> HYDRODYNAMICS IN SOILS; WATER POTENTIAL; WATER RETENTION AND CHARACTERISTIC CURVE	
MEDITERRANEAN SOILS	<i>J Torrent</i>	418
METAL OXIDES	<i>A C Scheinost</i>	428
METALS AND METALLOIDS, TRANSFORMATION BY MICROORGANISMS	<i>S M Glasauer, T J Beveridge, E P Burford, F A Harper and G M Gadd</i>	438
METALS, HEAVY	<i>see</i> HEAVY METALS	
MICROBIAL PROCESSES		
Environmental Factors	<i>P G Hartel</i>	448
Community Analysis	<i>C H Nakatsu</i>	455
Kinetics	<i>N S Panikov</i>	463
MICRONUTRIENTS	<i>L M Shuman</i>	479
MINERAL-ORGANIC-MICROBIAL INTERACTIONS	<i>P M Huang, M C Wang and M K Wang</i>	486
MINERALS, PRIMARY	<i>P M Huang and M K Wang</i>	500
MINERALS, SECONDARY	<i>see</i> CLAY MINERALS	
MINIMUM TILLAGE	<i>see</i> CONSERVATION TILLAGE	
MISCIBLE DISPLACEMENT	<i>see</i> SOLUTE TRANSPORT	

MORPHOLOGY	<i>P R Owens and E M Rutledge</i>	511
MULCHES	<i>C L Acharya, K M Hati and K K Bandyopadhyay</i>	521
MYCORRHIZAL FUNGI	<i>L M Egerton-Warburton, J I Querejeta, M F Allen and S L Finkelman</i>	533

VOLUME 3

N

NEMATODES	<i>D A Neher and T O Powers</i>	1
NEUTRON SCATTERING	<i>M J Fayer and G W Gee</i>	6
NITROGEN IN SOILS		
Cycle	<i>M S Coyne and W W Frye</i>	13
Nitrates	<i>D S Powlson and T M Addiscott</i>	21
Nitrification	<i>J I Prosser</i>	31
Plant Uptake	<i>A Hodge</i>	39
Symbiotic Fixation	<i>J I Sprent</i>	46
NITROGEN FERTILIZERS	<i>see FERTILIZERS AND FERTILIZATION</i>	
NUCLEAR WASTE DISPOSAL	<i>G W Gee, P D Meyer and A L Ward</i>	56
NUTRIENT AVAILABILITY	<i>N K Fageria and V C Batigar</i>	63
NUTRIENT MANAGEMENT	<i>G D Binford</i>	71

O

ORGANIC FARMING	<i>C A Francis</i>	77
ORGANIC MATTER		
Principles and Processes	<i>M Schnitzer</i>	85
Genesis and Formation	<i>K M Haider and G Guggenberger</i>	93
Interactions with Metals	<i>N Senesi and E Loffredo</i>	101
ORGANIC RESIDUES, DECOMPOSITION	<i>A J Franzluebbers</i>	112
ORGANIC SOILS	<i>D L Mokma</i>	118
OVERLAND FLOW	<i>T S Steenhuis, L Agnew, P Gérard-Marchant and M T Walter</i>	130
OXIDATION-REDUCTION OF CONTAMINANTS	<i>C J Matocha</i>	133

P

PADDY SOILS	<i>C Witt and S M Haefele</i>	141
PARENT MATERIAL	<i>see PEDOLOGY: Basic Principles; FACTORS OF SOIL FORMATION: Parent Material</i>	
PEDOLOGY		
Basic Principles	<i>M J Singer</i>	151
Dynamic	<i>F C Ugolini</i>	156
PEDOMETRICS	<i>I O A Odeh and A B McBratney</i>	166
PENMAN, HOWARD LATIMER	<i>J L Monteith</i>	176
PENMAN-MONTEITH EQUATION	<i>R Allen</i>	180
PERCOLATION	<i>see HYDRODYNAMICS IN SOILS</i>	
PERMAFROST	<i>see POLAR SOILS</i>	
PERMEABILITY	<i>see HYDRODYNAMICS IN SOILS</i>	
PERSISTENT ORGANIC POLLUTANTS (POPS)	<i>see POLLUTANTS: Persistent Organic (POPs)</i>	
PESTICIDES	<i>R H Bromilow</i>	188

PETROLEUM <i>see</i> HYDROCARBONS	
pH <i>N Bolan and K Kandaswamy</i>	196
PHOSPHORUS IN SOILS	
Overview <i>J T Sims and P A Vadas</i>	202
Biological Interactions <i>M D Mullen</i>	210
PHYTOTOXIC SUBSTANCES IN SOILS <i>M Qadir, S Schubert and D Steffens</i>	216
PLANT-SOIL-WATER RELATIONS <i>R A Feddes and J C van Dam</i>	222
PLANT-WATER RELATIONS <i>C Gimenez, M Gallardo and R B Thompson</i>	231
POISEUILLE'S LAW <i>see</i> HYDRODYNAMICS IN SOILS	
POLAR SOILS <i>J C F Tedrow</i>	239
POLLUTANTS	
Biodegradation <i>P B Hatzinger and J W Kelsey</i>	250
Effects on Microorganisms <i>M E Fuller</i>	258
Persistent Organic (POPs) <i>D Johnson</i>	264
POLLUTION	
Groundwater <i>H Rubin</i>	271
Industrial <i>S P McGrath</i>	282
POLYMERS AND MICROORGANISMS <i>M C Rillig</i>	287
POORLY CRYSTALLINE ALLUMINOSILICATES <i>see</i> AMORPHOUS MATERIALS	
POROSITY AND PORE-SIZE DISTRIBUTION <i>J R Nimmo</i>	295
POTASSIUM IN SOILS <i>P M Huang, J M Zhou, J C Xie and M K Wang</i>	303
PRECIPITATION, WATERSHED ANALYSIS <i>J V Bonta</i>	314
PRECIPITATION-DISSOLUTION PROCESSES <i>W P Robarge</i>	322
PRECISION AGRICULTURE <i>see</i> SITE-SPECIFIC SOIL MANAGEMENT	
PREFERENTIAL FLOW <i>see</i> UNSTABLE FLOW; MACROPORES AND MACROPORE FLOW, KINEMATIC WAVE APPROACH	
PRODUCTIVITY <i>D L Karlen</i>	330
PROFILE <i>see</i> MORPHOLOGY	
PROTOZOA <i>W Foissner</i>	336
Q	
QUALITY OF SOIL <i>B J Wienhold, G E Varvel and J W Doran</i>	349
R	
RADIATION BALANCE <i>J L Hatfield, T J Sauer and J H Prueger</i>	355
RADIONUCLIDES <i>see</i> ISOTOPES IN SOIL AND PLANT INVESTIGATIONS	
RAINFED FARMING <i>see</i> DRYLAND FARMING	
RANGE MANAGEMENT <i>G L Anderson</i>	360
RECYCLING OF ORGANIC WASTES <i>see</i> POLLUTANTS: Biodegradation	
REDISTRIBUTION <i>see</i> WATER CYCLE	
REDOX POTENTIAL <i>R D DeLaune and K R Reddy</i>	366
REDOX REACTIONS, KINETICS <i>P S Nico and S Fendorf</i>	372
REMEDIATION OF POLLUTED SOILS <i>E Lombi and R E Hamon</i>	379
REMOTE SENSING	
Organic Matter <i>D K Morris, C J Johannsen, S M Brouder and G C Steinhardt</i>	385
Soil Moisture <i>T J Jackson</i>	392

RHIZOSPHERE	<i>A C Kennedy and L Z de Luna</i>	399
RICHARDS, LORENZO A.	<i>W R Gardner</i>	407
ROOT ARCHITECTURE AND GROWTH	<i>L E Jackson</i>	411
ROOT EXUDATES AND MICROORGANISMS	<i>B-J Koo, D C Adriano, N S Bolan and C D Barton</i>	421

S

SALINATION PROCESSES	<i>I Shainberg and G J Levy</i>	429
SALINITY		
Management	<i>D Hillel</i>	435
Physical Effects	<i>D Russo</i>	442
SALT BALANCE OF SOILS	<i>see SALINATION PROCESSES</i>	
SALT-AFFECTED SOILS, RECLAMATION	<i>R Keren</i>	454
SAND DUNES	<i>H Tsoar</i>	462
SATURATED AND UNSATURATED FLOW	<i>see HYDRODYNAMICS IN SOILS;</i>	
VADOSE ZONE: Hydrologic Processes		
SCALING		
Physical Properties and Processes	<i>G Sposito</i>	472
Transport Processes	<i>R P Ewing</i>	477
SEPTIC SYSTEMS	<i>R L Lavigne</i>	485
SHIFTING CULTIVATION	<i>R Lai</i>	488
SITE-SPECIFIC SOIL MANAGEMENT	<i>C J Johannsen and P G Carter</i>	497
SLASH AND BURN AGRICULTURE	<i>see SHIFTING CULTIVATION</i>	
SLUDGE	<i>see WASTE DISPOSAL ON LAND: Liquid; Municipal</i>	
SODIC SOILS	<i>G J Levy and I Shainberg</i>	504
SOIL-PLANT-ATMOSPHERE CONTINUUM	<i>J M Norman and M C Anderson</i>	513
SOLUTE TRANSPORT	<i>M C Sukop and E Perfect</i>	521
SORPTION		
Metals	<i>D L Sparks</i>	532
Organic Chemicals	<i>B Xing and J J Pignatello</i>	537
Oxyanions	<i>C P Schultness, H Wijnja and W Yang</i>	548
SORPTION-DESORPTION, KINETICS	<i>D L Sparks</i>	556
SPATIAL PATTERNS	<i>J H Görres and J A Amador</i>	562

VOLUME 4

SPATIAL VARIATION, SOIL PROPERTIES	<i>R Webster</i>	1
SPECIFIC SURFACE AREA	<i>K D Pennell</i>	13
STATISTICS IN SOIL SCIENCE	<i>R Webster</i>	19
STERILIZATION	<i>see DISINFESTATION</i>	
STOCHASTIC ANALYSIS OF SOIL PROCESSES	<i>D Russo</i>	29
STRESS-STRAIN AND SOIL STRENGTH	<i>S K Upadhyaya</i>	38
STRUCTURE	<i>V A Snyder and M A Vázquez</i>	54
SUBSOILING	<i>R L Raper</i>	69
SULFUR IN SOILS		
Overview	<i>M A Tabatabai</i>	76
Biological Transformations	<i>S D Siciliano and J J Germida</i>	85
Nutrition	<i>M A Tabatabai</i>	91
SURFACE COMPLEXATION MODELING	<i>S Goldberg</i>	97

SUSTAINABLE SOIL AND LAND MANAGEMENT	J I. Berc	108
SWELLING AND SHRINKING	D Smiles and P A C Raats	115
T		
TEMPERATE REGION SOILS	E A Nater	125
TEMPERATURE REGIME	<i>see</i> THERMAL PROPERTIES AND PROCESSES	
TENSIOMETRY	T K Tokunaga	131
TERMITES	<i>see</i> FAUNA	
TERRA ROSSA	<i>see</i> MEDITERRANEAN SOILS	
TERRACES AND TERRACING	G R Foster	135
TESTING OF SOILS	A P Mallarino	143
TEXTURE	G W Gee	149
THERMAL PROPERTIES AND PROCESSES	D Hillel	156
THERMODYNAMICS OF SOIL WATER	P H Groenevelt	163
TILLAGE	<i>see</i> CONSERVATION TILLAGE; CULTIVATION AND TILLAGE; ZONE TILLAGE	
TILTH	D L Karien	168
TIME-DOMAIN REFLECTOMETRY	G C Topp and T P A Ferré	174
TROPICAL SOILS		
Arid and Semiarid	H C Monger, J J Martinez-Rios and S A Khresat	182
Humid Tropical	S W Buol	187
U		
UNSTABLE FLOW	T S Steenhuis, J-Y Parlange, Y-J Kim, D A DiCarlo, J S Selker, P A Nektarios, D A Barry and F Stagnitti	197
URBAN SOILS	J L Morel, C Schwartz, L Florentin and C de Kimpe	202
V		
VADOSE ZONE		
Hydrologic Processes	J W Hopmans and M Th van Genuchten	209
Microbial Ecology	P A Holden and N Fierer	216
VIRUSES	<i>see</i> BACTERIOPHAGE	
VOLCANIC SOILS	G Uehara	225
W		
WAKSMAN, SELMAN A.	H B Woodruff	233
WASTE DISPOSAL ON LAND		
Liquid	C P Gerba	238
Municipal	D A C Manning	247
WATER AVAILABILITY	<i>see</i> PLANT-SOIL-WATER RELATIONS	
WATER CONTENT AND POTENTIAL, MEASUREMENT	G S Campbell and C S Campbell	253
WATER CYCLE	D K Cassel and B B Thapa	258
WATER EROSION	<i>see</i> EROSION: Water-Induced	
WATER HARVESTING	D Hillel	264
WATER MANAGEMENT	<i>see</i> CROP WATER REQUIREMENTS	
WATER POTENTIAL	D Or, M Tuller and J M Wraith	270

WATER REQUIREMENTS <i>see</i> CROP WATER REQUIREMENTS	
WATER RETENTION AND CHARACTERISTIC CURVE <i>M Tuller and D Or</i>	278
WATER TABLE <i>see</i> GROUNDWATER AND AQUIFERS	
WATER, PROPERTIES <i>D Hillel</i>	290
WATER-REPELLENT SOILS <i>J Letey</i>	301
WATERSHED MANAGEMENT <i>M D Torner</i>	306
WATER-USE EFFICIENCY <i>M B Kirkham</i>	315
WEED MANAGEMENT <i>D D Buhler</i>	323
WETLANDS, NATURALLY OCCURRING <i>E K Hartig</i>	328
WIDTSOE, JOHN A. AND GARDNER, WILLARD <i>G S Campbell and W H Gardner</i>	335
WIND EROSION <i>see</i> EROSION: Wind-Induced	
WINDBREAKS AND SHELTERBELTS <i>E S Takle</i>	340
WOMEN IN SOIL SCIENCE (USA) <i>M J Levin</i>	345
WORLD SOIL MAP <i>H Eswaran and P F Reich</i>	352

Z

ZERO-CHARGE POINTS <i>J Chorover</i>	367
ZONE TILLAGE <i>J L Hatfield and A T Jeffries</i>	373

COLOR PLATE SECTIONS

Volume 1	between pages 238 and 239
Volume 2	between pages 238 and 239
Volume 3	between pages 270 and 271
Volume 4	between pages 222 and 223

INDEX	377
-------	-----